Hztool
A Library for Data – Simulation Comparisons at High Energy Colliders (version 4.0)

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Abstract:

Data from high-energy physics experiments have seen the triumph of the standard model both in precision electroweak measurements and in the verification of QCD to a reasonable degree of precision. However, several aspects of high energy collisions remain poorly understood due to technical difficulties in the calculation. This can limit progress, since accurate models of the final state are often needed to design new experiments and to interpret the data from them. Simulation programs employing fits to existing data address these problems. However, consistent tuning of the parameters of these programs, and examination of the physics assumptions they contain, is non-trivial due to the wide variety of colliding beams, regions of phase space, and complex observables. HZTOOL exists to improve this situation. It provides a library of routines allowing reproduction of the experimental distributions and easy access to the published data. HZTOOL currently contains measurements from ep, γp, $\gamma\gamma$ and $p\bar{p}$ collisions. Others may easily be added.

Contents

Chapter 1

User's Guide

1.1 Introduction

Hztool consists of routines which allow comparison between published data and model predictions implemented in Monte Carlo event generators. It was initially developed within the workshop "Future Physics at Hera" [1] but has since expanded to become a more general toolkit. The Monte Carlo generators currently supported are: ARIADNE [2], CASCADE [3] HERWIG [4] (including JIMMY [5]), LEPTO [6], PYTHIA [7], PHOJET [8], QCDINS [9], RAPGAP [10], RIDI [11], and DJANGO [12]. The production versions of these programs are all currently written in Fortran, as is Hztool. Hztool is a Cedar [13] package.

1.2 Installation

Hztool is managed using CVS. The source code, along with installation instructions, is available from `http://www.cedar.ac.uk/hepforge/hztool`. Currently, a compressed tar file of the source code and access to the CVS respository are offered.

If you have any problems contact the Hztool editors at hztool@cedar.ac.uk

1.3 Directory Structure

`inc:`	include files containing FORTRAN common blocks
`doc/manual:`	each routine should have a description.
`paw:`	paw kumacs for plotting the histograms from some routines.
`src/`*$accelerator*:	histogramming routines for each accelerator
`src/interfaces:`	interfaces routines between generators (see below).
`src/evshapes:`	routines to calculate (non-jet) event shapes.
`src/jetfinders:`	routines which calculate jets.
`src/util:`	utilities which didn't fit anywhere else.
`config:`	used by autotools.

The `interfaces` directory requires some further comment. HZTOOL is supposed to be generator independent as far as possible, and in particular it must be possible to build and link against the library for one generator without requiring any code from any other generator. However, there are some useful utilities which access generator routines directly, and there is also the need to fill the `hepevtp` common block for later use. This generator dependent code is in `interfaces`. Routines in the this directory must only be called from the main program or from other routines in the same directory - they **must not** be accessed from any HZTOOL routine in any other directory, or the HZTOOL generator-independence will be broken.

Unfortunately not all generator dependent code is in here. There are cases where the generator name is used to change the behaviour of various routines. This should be avoided where possible, and may be fixed in future versions. However, at present it does not, at least, break the generator-independence completely, since no internal generator routines are accessed.

1.4 HZTOOL Usage

1.4.1 The analysis routines

In general, each paper available in HZTOOL has a corresponding subroutine which books, fills and outputs the required histograms.

The routine names relate to the publication. The preferred convention is

`HZHyymmnnn` where yymmnnn is the arXiv:hep-ex preprint number.

Alternative naming schemes which are used for older routines or when a hep-ex number is not available, are:

`HZDyynnn`	where yynnn is the DESY preprint number.
`HZCyynnn`	where yynnn is the CERN preprint number.
`HZFyynnnE`	where yynnn is the FNAL preprint number.
`HZyynnn`	where yynnn is the DESY preprint number[1].

There are some exceptions. If none of the above number schemes exist, the routine name is generally derived from the journal publication (e.g. HZPRT154247, Section 3.4). Also, occasionally a single publication contains results taken under more than one set of beam conditions, in which case there will be a routine for each beam condition, distinguished by appending a letter to the expected name (e.g. HZC88172A, HZC88172B, Sections 3.1 and 3.2).

All routines take an integer input argument (IFLAG) in which information is coded FORTRAN-style as follows:
IFLAG = 10000×IPS + 1000×IPROC + 100×IRUN + 10×JETF + I
where

- **IPS** > 0 to run on the final state of the parton shower instead of final state particles (optional).
- **IPROC** for measurements which may require more than one process to be generated (e.g. resolved & direct photoproduction, single/double resolved & direct in $\gamma\gamma$, diffractive and non-diffractive in many processes) the routine must be steerable via IPROC such that the generator may be run both (i) in a mode which runs N times for N different processes (IPROC=1... N), and (ii) once for all processes in an automatic mixture (IPROC=0). See hztemplate.fpp for an example.
- **JETF** Choice of jet finder, if relevant - see Section 1.4.3.
- **IRUN** if this is 0, any required jet finder will be rerun. If IRUN=1, the results already in the HZJETCMN common block will be reused. This is CPU time-saving in runs in which many routines use the same jet finder, but should be used with great care: in particular, the first routine in a sequence to use a given jet finder must have IRUN=0.
- **I** =1 for initialisation, 2 for filling and 3 for termination.

Not all routines implement all these options; and additional arguments may also be required. Please refer to the relevant reference manual section for details.

[1] This naming should not be used for new routines; the HZD prefix is preferred.

1.4.2 Main program

Hztool is a library, and the main program must be provided by the user. An example is given in Appendix D. Correct initialization of the generator is the users responsibility. The desired HZxxxxxx() routines must be called at the appropriate places to initialize, fill and manipulate the histograms and create generator comparisons. Some routines and generators require several runs under different conditions, e.g. direct followed by resolved interactions in most photoproduction routines. Please refer to the reference manual for details.

The `GEN` character string should be set to

ARI	-	Ariadne,
CAS	-	Cascade,
HRW	-	Herwig,
LEP	-	Lepto,
PYT	-	Pythia,
PYTHRW	-	Pythia with HERWIG,
PHO	-	Phojet,
DJA	-	Django,
INS	-	Qcdins,
RAP	-	Rapgap,
LEG	-	Lego,
RID	-	Ridi,
DSN	-	DISENT

Besides the Hztool library it is also necessary to link in the CERN library routines, the required generators and possibly PDFLIB [14]. PDFLIB and some of the generators are available from Cedar [13], as well as from the authors' main pages.

If you would like a ready-made main program, an auxilliary Cedar package, Hzsteer, provides working main programs for some generators as well as other utilities such as flexible run-time steering of Hztool and XML output of generator parameters and histograms. This package is primarily intended for use by JetWeb [15], however, and Hztool does not depend upon it in any way. Information on Hzsteer may be found at `http://www.cedar.ac.uk/hepforge/hzsteer`.

1.4.3 The Jet Finders

Overview:

The jet finders currently included in the Hztool package are:
Cluster algorithms:

- JETF=3: KTCLUS, a flexible FORTRAN package implementing many clustering options variously known as the K_T, $K_\perp$ or Durham algorithm, depending on the steering parameters. The basic references for the algorithms are here [16] and the implementation is an unaltered version of that written and maintained by M. Seymour, which may be found at `http://www.cedar.ac.uk/hepforge/ktjet/fortran`. It emerged as the standard for HERA measurements around 1997.
The code is in `src/jetfinders/ktclus`
- JETF=5: JCLUST (DIS version). The code is in `src/jetfinders/jclust`
- JETF=6: JCLUST (photoproduction version).
- JETF=8: KTCLUS (optimize for resonance decays to dijets).
- JETF=9: KTCLUS (E recombination scheme massive mode).
- JETF=10: KTCLUS (E recombination scheme in meson mode).
- JETF=11: KTCLUS ('pure' pt-mode, no p=E to achieve Et-mode as in JETF=3).
- JETF=12: KTCLUS (exclusive mode, angular kt, E scheme).
- JETF=13: KTCLUS (as JETF=12 but ycut is chosen so as to give number of jets).

Cone algorithms:

- JETF=1: EUCELL. This is a ZEUS variant on the cone algorithm which can respect the Snowmass convention [19] as far as the convention is specific. It is used in some early ZEUS publications. The code is in `src/jetfinders/eucell`
- JETF=2: PXCONE. The code is in `src/jetfinders/pxcone`
- JETF=4: GPCONE. The code is in `src/jetfinders/h1gpcone`
- JETF=7: PUCELL. This is a ZEUS variant of the cone algorithm, respecting the Snowmass convention and based upon a routine from CDF [20]. The code is in `src/jetfinders/pucell`

Some comparison between the different jet algorithms at HERA, particularly EUCELL, PUCELL and KTCLUS, can be found elsewhere [17,18]. **The histogramming routines use the jet finder used in the original data analysis.** Many (and ideally all) routines also allow the user to choose a different jetfinder by encoding the choice in the IFLAG variable (see reference manual of each routine for details). Where needed, other jet finding parameters, e.g. the cone size, are automatically chosen as in the corresponding publication. The cone size can also be set by the following command in the main program:

```
CALL HZJETRAD(1, CONER)
```

where CONER is the cone radius.

```
CALL HZJETRAD(2, CONER)
```

can be applied to read out the radius, once it has been set (see manual of HZJETRAD).

Within HZTOOL a subroutine, HZJTFIND has been written to standardize the calling of the jet finders. This should always be used, rather than calling the jet finders directly. There is an associated routine HZJTNAME to get the name of the jet finder used. (For information on HZJTFIND and HZJTNAME see the appropriate manual pages). This way, if new jet finders are added, your code will automatically be able to use them. If more flexibility is required, the jet finders have appropriate comments to easily interface them. Additional information can be found at the start of the jet finding code for each algorithm.

1.5 Submission of routines to HZTOOL

- to start writing a histogramming routine, use the template (just edit hztemplate.F in the `src/` directory
- The routine name should respect the conventions described in Section 1.4.1. The paw directory should match the routine names with the HZ characters stripped from the front.
- every routine should start with 'implicit none' to make the author think about the declaration of the variables used
- no functions residing outside HZTOOL or the CERN libraries are allowed
- no commons except HEPEVTP, the (badly named!) HERACMN and HZJETCMN can be used

- respect the IFLAG conventions given in Section 1.4.1.
- documentation must be provided for each routine (use template hztemplate.tex in `doc/manual`). The documentation should also include the main selection cuts and give an overview of the produced histograms and contain some information how to unpack the information from the histograms. In difficult cases a paw kumac or root macro may be provided.

Chapter 2

Reference Manual: The EMC Histogramming Routines

2.1 HZC87112: Jet Production And Fragmentation Properties In Deep Inelastic Muon Scattering (EMC)

Purpose:
Produces the histograms for the EMC Seagull plot [21].

Event selection:
in lab frame with $E = 280$ GeV and fixed proton target
$E_{el} > 20$ GeV, $\theta_e > 0.57$
$y < 0.9$, $16 < W < 400$, $Q^2 > 4$
Structure:
HZC87112 has the standard initialise, fill, terminate calling structure.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZC87112(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=50: Mean p_{T}^2 vs x_F

Data histograms
-id=50: Mean p_{T}^2 vs x_F

Author: T. Carli, R. Mohr

Chapter 3

Reference Manual: The SPS Histogramming Routines

3.1 HZC88172A: Charged Particle Multiplicity Distributions at 200 GeV Center-Of-Mass Energy (UA5)

Purpose:
Produces the 200 GeV CMS histograms for the UA5 paper [22] on minimum bias events.
Structure:
HZC88172A is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZC88172A(IFLAG,avrg )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
The average charged particle multiplicity in NSD events at 546 GeV is 29.4 .
Returned Histograms

MC histograms
id=10: Charged particle density - dN_{ch}/deta - MC full eta range
id=11: KNO - NSD events (non-KNO variables)
id=12: KNO - NSD events (KNO variables)'
id=13: KNO (NSD at 200 GeV): x=n/¡n1¿ (m.p.i. variable)
id=14: Charged particle density at eta=0 (NSD at 200 GeV)
id=15: Average chg particle multiplicity (NSD at 200 GeV)
id=16: harged particle density - dN_{ch}/deta - (NSD at 200 GeV)

Data histograms
id=1: KNO distribution (NSD at 200 GeV) - UA5 data: non-KNO variables
id=2: KNO distribution (NSD at 200 GeV) - UA5 data: KNO variables
id=3: KNO (NSD at 200 GeV) - UA5 data: x=n/$< n1 >$ (m.p.i. variable)
id=4: Charged particle density at eta=0 (NSD at 200 GeV) - UA5 data
id=5: Average chg particle multiplicity (NSD at 200 GeV) - UA5 data
id=6: Charged particle density - dN_{ch}/deta - UA5 data
Author: A. Moraes

3.2 HZC88172B: Charged Particle Multiplicity Distributions at 900 GeV Center-Of-Mass Energy (UA5)

Purpose:
Produces the 900 GeV CMS histograms for the UA5 paper [22] on minimum bias events (KNO distributions etc).
Structure:
HZC88172B is callable at any time.
Usage:

```
 *
         INTEGER IFLAG
         ...
         call HZC88172B(IFLAG,avrg )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
The average charged particle multiplicity in NSD events at 900 GeV is 35.6.
Returned Histograms

MC histograms
id=10: Charged particle density - dN_{ch}/deta - MC full eta range
id=11: KNO - NSD events (non-KNO variables)
id=12: KNO - NSD events (KNO variables)'
id=13: KNO (NSD at 900 GeV): x=n/¡n1¿ (m.p.i. variable)
id=14: Charged particle density at eta=0 (NSD at 900 GeV)
id=15: Average chg particle multiplicity (NSD at 900 GeV)
id=16: harged particle density - dN_{ch}/deta - (NSD at 900 GeV)

Data histograms
id=1: KNO distribution (NSD at 900 GeV) - UA5 data: non-KNO variables
id=2: KNO distribution (NSD at 900 GeV) - UA5 data: KNO variables
id=3: KNO (NSD at 900 GeV) - UA5 data: x=n/$< n1 >$ (m.p.i. variable)
id=4: Charged particle density at eta=0 (NSD at 900 GeV) - UA5 data
id=5: Average chg particle multiplicity (NSD at 900 GeV) - UA5 data
id=6: Charged particle density - dN_{ch}/deta - UA5 data
Author: A. Moraes

3.3 HZC93153: Measurement of $b\bar{b}$ correlations at the CERN $p\bar{p}$ collider (UA1)

Purpose:
Produces the histograms for the cross-section for dimuon production from semileptonic beauty decays [23].
Event selection: $\sqrt{s} = 630$ GeV
A: muons: $p_t > 3$ GeV $|\eta| < 1.5; 6 < m_{\mu\mu} < 35$ GeV for muons from different quarks. Bin cuts refer to highest-transverse-momentum-muon
B: - O. (see paper and description in code)
Structure:
HZC93153 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZC93153(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
Returned Histograms
MC histograms
id= 1: $\sigma(p\bar{p} \to b\bar{b} \to \mu\mu X)$ for cross section A.
id= 2: $\sigma(p\bar{p} \to b\bar{b} \to \mu\mu X)$ for cross section B.
id= 3: $\sigma(p\bar{p} \to bX)$ for cross section C.
id= 4: $\sigma(p\bar{p} \to bX)$ for cross section D.
id= 5: $\sigma(p\bar{p} \to bX)$ for cross section E.
id= 6: $\sigma(p\bar{p} \to BX)$ for cross section F.
id= 7: $\sigma(p\bar{p} \to BX)$ for cross section G.
id= 8: $\sigma(p\bar{p} \to BX)$ for cross section H.
id= 9: $\sigma(b\bar{b})$ for cross section I.
id= 10: $\sigma(b\bar{b})$ for cross section J.
id= 11: $\sigma(b\bar{b})$ for cross section K.
id= 12: $\sigma(b\bar{b})$ for cross section L.
id= 13: $\sigma(p\bar{p} \to bX)$ for cross section M.
id= 14: $\sigma(p\bar{p} \to bX)$ for cross section N.
id= 15: $\sigma(p\bar{p} \to bX)$ for cross section O.
Data histograms
id= -1: $\sigma(p\bar{p} \to b\bar{b} \to \mu\mu X)$ for cross section A.

id= -2: $\sigma(p\bar{p} \to b\bar{b} \to \mu\mu X)$ for cross section B.
id= -3: $\sigma(p\bar{p} \to bX)$ for cross section C.
id= -4: $\sigma(p\bar{p} \to bX)$ for cross section D.
id= -5: $\sigma(p\bar{p} \to bX)$ for cross section E.
id= -6: $\sigma(p\bar{p} \to BX)$ for cross section F.
id= -7: $\sigma(p\bar{p} \to BX)$ for cross section G.
id= -8: $\sigma(p\bar{p} \to BX)$ for cross section H.
id= -9: $\sigma(b\bar{b})$ for cross section I.
id= -10: $\sigma(b\bar{b})$ for cross section J.
id= -11: $\sigma(b\bar{b})$ for cross section K.
id= -12: $\sigma(b\bar{b})$ for cross section L.
id= -13: $\sigma(p\bar{p} \to bX)$ for cross section M.
id= -14: $\sigma(p\bar{p} \to bX)$ for cross section N.
id= -15: $\sigma(p\bar{p} \to bX)$ for cross section O.
Author: O. Gutsche

3.4 HZprt154247: KNO distributions (UA5)

Purpose:
Produces the histograms for the UA5 paper on minimum bias events.
UA5 Coll., Phys Rep 154(5,6) 247-383, 1987)
This is for 546 GeV.
Structure:
HZPRT154247 is callable at any time.
Usage:
*

```
INTEGER IFLAG
...
call HZPRT154247(IFLAG,avrg )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
The average charged particle multiplicity in NSD events at 546 GeV is 29.4 .
Returned Histograms

MC histograms
id=10: dN_{chg}/deta (full eta range) - NSD events at 546 GeV (MC)
id=11: KNO - NSD events (non-KNO variables)
id=12: KNO - NSD events (KNO variables)'
id=13: KNO (NSD at 546 GeV): x=n/¡n1¿ (m.p.i. variable)
id=14: Charged particle density at eta=0 (NSD at 546 GeV)
id=15: Average chg particle multiplicity (NSD at 546 GeV)
id=16: harged particle density - dN_{ch}/deta - (NSD at 546 GeV)

Data histograms
id=1: KNO distribution (NSD at 546 GeV) - UA5 data: non-KNO variables
id=2: KNO distribution (NSD at 546 GeV) - UA5 data: KNO variables
id=3: KNO (NSD at 546 GeV) - UA5 data: x=n/$< n1 >$ (m.p.i. variable)
id=4: Charged particle density at eta=0 (NSD at 546 GeV) - UA5 data
id=5: Average chg particle multiplicity (NSD at 546 GeV) - UA5 data
id=6: Charged particle density - dN_{ch}/deta - UA5 data

Author: A. Moraes

Chapter 4

Reference Manual: The TeVatron Histogramming Routines

4.1 HZplb4354537: KNO distributions (E735)

Purpose:
Produces the histograms for the E735 paper on minimum bias events.
E735 Coll., Phys. Lett. B 435, 453 (1998)
This is for 1.8 TeV.
Structure:
HZplb4354537 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZplb4354537(IFLAG,avrg )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
The average charged particle multiplicity in NSD events at 546 GeV is 29.4 .
Returned Histograms

MC histograms
id= 1:, KNO distribution - NSD events at 1.8 TeV (MC) non-KNO variables
id= 2:, KNO distribution - NSD events at 1.8 TeV (MC) KNO variables
id= 3:, KNO distribution - NSD events at 1.8 TeV (MC) $x = n/ < n1 >$ (m.p.i. variable)

Data histograms
id= -1:, KNO distribution - NSD events at 1.8 TeV (E735 data) non-KNO variables
id= -2:, KNO distribution - NSD events at 1.8 TeV (E735 data) KNO variables
id= -3:, KNO distribution - NSD events at 1.8 TeV (E735 data) $x = n/ < n1 >$ (m.p.i. variable)

Author: A. Moraes

4.2 HZf01211e: Underlying event (CDF)

Purpose:
Produces the histograms for the paper on underlying events at CDF.
CDF Coll., Phys.Rev.D65:092002,2002

Structure:
HZf01211e is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZf01211e(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=2: PTjet#1 toward-
id=1: NCHG vs PTjet
id=22: PTjet#1 toward soft
id=23: PTjet#1 toward hard
id=24: PTjet#1 away soft
id=25: PTjet#1 away hard
id=26: PTjet#1 transverse hard
id=3: PTjet#1 toward+'
id=4: PTjet#1 away -
id=5: PTjet#1 away +
id=6: PTjet#1 transverse tot
id=7: PTjet#1 transverse soft
id=10: $< PTSUM >$ toward-
id=11: $< PTSUM >$ toward tot
id=12: $< PTSUM >$ away-'
id=13: $< PTSUM >$ away tot
id=14: $< PTSUM >$ transverse tot
id=(15: $< PTSUM >$ transverse soft
id=16: $< PTSUM >$ toward soft

if=17: $< PTSUM >$ toward hard
id=18: $< PTSUM >$ away soft
id=19: $< PTSUM >$ away hard
id=20: $< PTSUM >$ transverse hard
id=27: total numb of partl

Data histograms
id=30:, Experimental data away $< PTsum >$
id=31:, Experimental data transverse $< PTsum >$
id=32:, 'Experimental data toward $< PTsum >$

Author: I. Borozan

4.3 HZf89201e: $dN/d\eta$ (CDF)

Purpose:
Produces the histograms for the dN/deta (minimum bias events).
CDF Coll., Phys. Rev. D 41, 2330 (1990), FNAL-PUB 89-201-E

Structure:
HZf89201e is callable at any time.
Usage:

```
 *
        INTEGER IFLAG
        ...
        call HZf89201e(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id= 4: $dN_{chg}/deta$ at eta=0 - NSD events at 1.8 TeV
id= 5: $< n_{chg} >$ - NSD events at 1.8 TeV)
id= 6: $dN_{chg}/deta$ (CDF eta range) - NSD events at 1.8 TeV

Data histograms
id= -4: $dN_{chg}/deta$ at eta=0 - NSD events at 1.8 TeV (CDF data)
id= -5: $< n_{chg} >$ - NSD events at 1.8 TeV (Tevatron data)
id= -6: $dN_{chg}/deta$ (CDF eta range) - NSD events at 1.8 TeV (CDF data)
Note: 4 and 5 contain just a single point.

Author: A. Moraes

4.4 HZh9807014: Dijet Mass Spectrum (D0)

Purpose:
Produces the histograms for the .dijet Mass Spectrum .
D0 Coll., Phys.Rev.Lett.82:2457-2462,1999 (hep-ex/9807014) Event selection:
$\sqrt{s} = 1.8$ TeV
$|\eta_{jet}| < 1.0$
Structure:
HZh9807014 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZh9807014(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=110:, dijet mass Xsec

Data histograms
Id=151:, Real data for dijet masse (D0)

Author: I. Borozan

4.5 HZh9807018: Inclusive Jet Cross Section (D0)

Purpose:
Produces the histograms for the inclusive jets X-section.
D0 Coll., Phys.Rev.Lett.82:2451-2456,1999 (hep-ex/9807018) Event selection:
$\sqrt{s} = 1.8$ TeV
$|\eta_{jet}| < 1.0$
Structure:
HZh9807018 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZh9807018(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=10:, Monte Carlo rapidity
id=24:, X-sec for Inclusive jets
id=11:, Et with Ue subtracted Inclusive jets

Data histograms
Id=50:, Measured data DO for inc jets

Author: I. Borozan

4.6 HZH9905024: Measurement of $b\bar{b}$ cross section (D0)

Purpose:
Produces the histograms for the the $b\bar{b}$ production cross section and angular correlations in ppbar collisions at $\sqrt{s}$ = 1.8 TeV D0 Coll., Phys. Lett. B487, 264 (hep-ex/9905024) Event selection:
$\sqrt{s} = 1800$ GeV
A. - D. (see paper and description in code)

Structure:
HZH9905024 is callable at any time.
Usage:
*

```
INTEGER IFLAG
...
call HZH9905024(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id= 1:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section A.
id= 2:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section B.
id= 3:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section C.
id= 4:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section D.

Data histograms
id= -1:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section A.
id= -2:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section B.
id= -3:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section C.
id= -4:, $\sigma(p\bar{p} \to b\bar{b} \to \mu^+\mu^-X)$ for cross-section D.

Author: O. Gutsche

4.7 HZh9912022: Dijet Mass Spectrum (CDF)

Purpose:
Produces the histograms for the .dijet Mass Spectrum .
CDF Coll., Phys.Rev.D61:091101,2000 (hep-ex/9912022)
Event selection:
$\sqrt{s} = 1.8$ TeV

Structure:
HZh9912022 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZh9912022(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=67:, dijet mass Xsec

Data histograms
Id=51:, Real data for dijet masse (CDF)

Author: I. Borozan

4.8 HZH0001021: The transverse momentum and total cross-section of e^+e^- pairs in the Z-boson region from $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV. (CDF)

Purpose:
Produces the histogram of the data (Table 1, Fig.1) and simulated results for the transverse momentum distribution of e^+e^- pairs in the Z region from [24].
Event selection: e^+ and an e^- in the detector and with an invariant mass in the region of the Z pole. See paper and code for details.

Structure:
Standard initialise, fill and terminate.
Usage:
*

```
INTEGER IFLAG
...
call HZH0001021(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id= 1:, $d\sigma(p\bar{p} \to e^+e^- + X)/dp_{\mathrm{T}}$

Data histograms
id= -1:, $d\sigma(p\bar{p} \to e^+e^- + X)/dp_{\mathrm{T}}$ (Fig.1 of [24]).

Authors: C. O'Dea, J. M. Butterworth, B. M. Waugh.

4.9 HZ0307080: Charm Production Cross Sections in p anti-p (CDF)

Purpose:
Produces the histograms for the Charm Production Cross Section.
CDF Coll. Phys.Rev.Lett. 91 (2003) 241804 (hep-ex/0307080)
Event selection:
D^0 , D^{*+} D^+, D_s^+
$|y| \leq 1$
Structure:
HZ0307080 is callable at any time.
Usage:

```
 *
        INTEGER IFLAG
        ...
        call HZ0307080(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=101: dsig/dpt D0
id=102: dsig/dpt D*+
id=103: dsig/dpt D+
id=104: dsig/dpt Ds+
id=111: dsig/dpt D0
id=112: dsig/dpt D*+
id=113: dsig/dpt D+
id=114: dsig/dpt Ds+

Data histograms
id=-101: dsig/dpt D0
id=-102: dsig/dpt D*+
id=-103: dsig/dpt D+
id=-104: dsig/dpt Ds+
id=-111: dsig/dpt D0

id=-112: dsig/dpt D*+
id=-113: dsig/dpt D+
id=-114: dsig/dpt Ds+

Author: H. Jung

4.10 HZh0412071: B (J/psi) cross sections (CDF)

Purpose:
Produces the histograms for the B - J/psi cross sections
CDF Coll., hep-ex/041207
Event selection:
$\sqrt{s} = 1960$ GeV
J/ψ with transverse momenta from 0 to 20 GeV and $|y| < 0.6$ %
Structure:
HZh0412071 is callable at any time.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZh0412071(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=1001:, dsigma/dpt (Jpsi)

Data histograms
id=-1001:, dsigma/dpt (Jpsi) data (stat error)
id=-1002:, dsigma/dpt (Jpsi) data (total error)
Author: H. Jung, K. Peters

4.11 HZH0010026: Differential Cross Section for W Boson Production as a Function of Transverse Momentum in $p\bar{p}$ Collisions at $\sqrt{s} = 1.8$ TeV (DØ)

Purpose:
Produces the histogram of the data (Table 1, Figure 1) and simulated results of the transverse momentum distribution of the W boson [25].
Event selection:
$e^{\pm}$ and ν_e from a W decay. See paper and code for details.
Structure:
Standard initialise, fill and terminate.
Usage:
*

```
INTEGER IFLAG
...
call HZH0010026(IFLAG)
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=1: $\frac{1}{\sigma}d\sigma/dpT(W)$ id=2: normalisation values for MC histogram

Data histograms
id=-1: $\frac{1}{\sigma}d\sigma/dpT(W)$

Author:
Emily Nurse.

4.12 HZH9907009: Measurement of the Inclusive Differential Cross Section for Z Bosons as a Function of Transverse Momentum in $p\bar{p}$ Collisions at $\sqrt{s} = 1.8$ TeV (DØ)

Purpose:
Produces the histogram of the data (Table IV, Figure 25) and simulated results of the transverse momentum distribution of the Z boson [26].
Event selection:
e^+e^- pair with $75 < M_{ee} < 105$ GeV from a Z or γ^*. See paper and code for details.
Structure:
Standard initialise, fill and terminate.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZH9907009(IFLAG)
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=1: $\frac{1}{\sigma}d\sigma/dpT(Z)$ id=2: normalisation values for MC histogram

Data histograms
id=-1: $\frac{1}{\sigma}d\sigma/dpT(Z)$

Author:
Emily Nurse.

Chapter 5

Reference Manual: The HERA Histogramming Routines

5.1 HZ94033: E_T flows and charged particle spectra and energy-energy correlations for low Q^2 DIS (H1)

Purpose:
The routine produces the following histograms:

- transverse energy flows in laboratory (lab) and hadronic center of mass (cms) frame for $x_{Bj} < 10^{-3}$ and $x_{Bj} > 10^{-3}$
- energy-energy correlation for $x_{Bj} < 10^{-3}$ and $x_{Bj} > 10^{-3}$
- charged particle spectra, i.e. $x_f = 2P_z^*/W$ spectra for 3 bins in W (77, 122, 169 GeV) and the seagull plot ($< P_t^{*2} >$ versus x_f)

To select the events the following cuts were applied to the energy and polar angle of scattered electron and the hadronic mass: $E_e > 14$ GeV, $172.5 < \theta < 157^o$, $W^2 > 3000$ GeV^2.
Furthermore a cut on the forward energy, i.e. the sum of the energy of the stable particle between 4.4^o and 15^o, is applied : $E_{\text{fwd}} > 0.5$ GeV.
Beams: 26.7 GeV electrons on 820 GeV protons (1992 HERA running).
Reference: Z. Phys C63 (1994) 377-389
*
Structure:
HZ94033 is callable after the HEP event common has been filled. HZ94033 calls the HZTOOL functions HZDISKIN, HZIDELEC, HZPHMANG, HZIBEAM, HZIPGAM, HZHCMINI, HZHCM, HZHINRM , HZCHISQ and the HBOOK functions.
Usage:
*

```
INTEGER IFLAG
...
call HZ94033(IFLAG)
```

Input arguments
IFLAG:
1 initialization step (before event generation)
2 filling step (during event generation)
3 terminating step (at the end)

Returned Histograms
ID 10 = transverse energy flow in the cms at $x_{Bj} < 10^{-3}$

ID 11 = transverse energy flow in the cms at $x_{Bj} > 10^{-3}$
ID 12 = transverse energy flow in the lab at $x_{Bj} < 10^{-3}$
ID 13 = transverse energy flow in the lab at $x_{Bj} > 10^{-3}$
ID 14 = energy-energy correlation for $x_{Bj} < 10^{-3}$
ID 15 = energy-energy correlation for $x_{Bj} > 10^{-3}$
The data histograms have the corresponding negative numbers.
ID 16 = charged particle spectrum for $< W >= 77$ GeV
ID 17 = charged particle spectrum for $< W >= 122$ GeV
ID 18 = charged particle spectrum for $< W >= 169$ GeV
ID 19 = seagull plot ($< P_t^{*2} >$ versus x_f)
ID 20 = seagull plot including the remnant region
Additional auxiliary histograms with the same binning as the data plots (Necessary for χ^2 evaluation):
ID 114 = energy-energy correlation for $x_{Bj} < 10^{-3}$
ID 115 = energy-energy correlation for $x_{Bj} > 10^{-3}$
ID 116 = charged particle spectrum for $< W >= 77$ GeV
ID 117 = charged particle spectrum for $< W >= 122$ GeV
ID 118 = charged particle spectrum for $< W >= 169$ GeV
ID 119 = seagull plot ($< P_t^{*2} >$ versus x_f)
Don't use the histograms -116 - -119 to plot the data!! The points have not the right position on the x-axis (only the bin is correct)! These histograms have to be extracted by the kumac k_94033.kumac (using the auxiliary histograms 191, 192, 193, 161, -162, -163, -172, -173, -182, -183) in order to get the x-axis right. Data histograms where only the statistical error is taken into account have an offset of -200. The ntuple ID=999 contains the χ^2 and the number of degrees of freedom of the relevant histograms.
Author: Tancredi Carli and Renate Mohr

5.2 HZ94176: E_T and η jet cross-sections in γp (ZEUS)

Purpose:
This routine produces the following graphs:

- Corrected cross-section vs. η_{jet} for $E_T > 8, 11, 17$ GeV
- Corrected cross-section vs. E_T^{jet} for $-1 < \eta_{jet} < 2$ and $-1 < \eta_{jet} < 1$
- And the unweighted events versions of these graphs.

Structure:
HZ94176 should be initialised, called after event generation and it should be terminated.
HZ94176 requires the CERNLIB and the following utility routines from the HzTool library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND.
Beams: 26.7 GeV electrons on 820 GeV protons (1993 HERA running), with the protons travelling in the +z direction. Cuts: $Q^2 < 4$ GeV^2 and $0.2 < y_{bj} < 0.85$.
The recommended value for ptmin, defining the hardness of the sub-process, in the Monte Carlo is 5 GeV.
Reference: Phys. Lett. B342 (1995) 417-432.
Usage:

```
*
      INTEGER iflag
      ...
      CALL HZ94176(iflag)
      ...
```

Input arguments Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned histograms
The histograms which are booked and filled:

- ID=10,11,12 The rapidity distributions for unweighted events for $E_T > 8, 11, 17$ GeV(respectively).
- ID=13,14 The E_T distributions for unweighted events for $-1 < \eta_{jet} < 2$ and $-1 < \eta_{jet} < 1$.

- ID=20-25 The same graphs but with cross sections (in nb) to compare to the data. Please, note these graphs will only be sensible, if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.
- ID= -20 to -24 are the equivalent data graphs.
- ID= -120 to -124 are the equivalent data graphs with full errors.

A PAW kumac is provided to facilitate plotting of these points. This can be run by, when inside PAW, typing :

```
exec k_hz94176
```

Author: Mark Hayes

5.3 HZ95007: Charged particle multiplicty and fragmentation in the current region of the Breit frame in DIS (ZEUS)

Purpose:
This routine plots the multiplicity and $\log 1/x_p$ distributions, where $x_p = P_z/W$, in the current region of the Breit frame. The distributions are corrected for particles coming from K0s and Λs.
Structure:
HZ95007 should be called before, during and after the event generation. HZ95007 calls HBOOK functions, the CERNLIB routine UCOPY and HZTOOL function HZDISKIN, HZIPGAM, HZBRTINI, HZBRT.
Beams: 26.7 GeV electrons on 820 GeV protons (1993 HERA running).
References: Z. Phys. C67(1995) 93.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ95007(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
For Monte Carlo:
ID 12: $10 < Q^2 < 20$ GeV^2 and $6.\ 10^{-4} < x < 1.2\ 10^{-3}$
ID 13: $10 < Q^2 < 20$ GeV^2 and $1.2\ 10^{-3} < x < 2.4\ 10^{-3}$
ID 23: $20 < Q^2 < 40$ GeV^2 and $1.2\ 10^{-3} < x < 2.4\ 10^{-3}$
ID 33: $40 < Q^2 < 80$ GeV^2 and $1.2\ 10^{-3} < x < 2.4\ 10^{-3}$
ID 24: $20 < Q^2 < 40$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 34: $40 < Q^2 < 80$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 44: $80 < Q^2 < 160$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 54: $160 < Q^2 < 320$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 65: $320 < Q^2 < 640$ GeV^2 and $1.\ 10^{-2} < x < 5.\ 10^{-2}$
ID 75: $640 < Q^2 < 1280$ GeV^2 and $1.\ 10^{-2} < x < 5.\ 10^{-2}$
multiplicities in the different kinematic bins. The same identifier with offset 100 give the $\log 1/x_p$ distributions. Data histograms have the corresponding negative

numbers, the data histograms only including the statistical errors are stored with an negative offset of -1000. The χ^2 and the number of degrees of freedom are given in ntuple id=999. Also returned are 2 Ntuples (ID 1000 for MC and 1001 for data) that each have 10 entries corresponding to the analysis (Q^2, x) bins. The information stored is the mean Q the lower and upper range of Q^2, the lower and upper range of x, the mean multiplicity and its statistical error and systematic error and the $\log 1/x_p$ peak position and its statistical error and systematic error. To extract the information from the NTUPLE the kumac k_95007 is provided.
Author: N. Brook

5.4 HZ95033: Jet cross-section versus η for low/high x_γ (ZEUS)

Purpose:
This routine produces the following graphs:

- Corrected cross-section vs. $\overline{\eta}$ for $x_\gamma^{\mathrm{OBS}} \geq 0.75$
- Corrected cross-section vs. $\overline{\eta}$ for $x_\gamma^{\mathrm{OBS}} < 0.75$

Structure:
HZ95033 should be initialised, called after event generation and it should be terminated. HZ95033 requires CERNLIB functions and the following from the HZTOOL library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND. Beams: 26.7 GeV electrons on 820 GeV protons (1993 HERA running), with the protons travelling in the +z direction.

Cuts: $Q^2 < 4$ GeV^2 and $0.2 < y_{bj} < 0.8$

Reference: Phys. Lett. B342 (1995) 417-432.

Usage:

```
*
        INTEGER iflag
        ...
        CALL HZ95033(iflag)
        ...
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned histograms
The histograms which are booked and filled:

- Histogram ID=10: Corrected cross-section vs. $\overline{\eta}$ for $x_\gamma \geq 0.75$
- Histogram ID=20: Corrected cross-section vs. $\overline{\eta}$ for $x_\gamma < 0.75$
- Please note these graphs will only be sensible if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.

- Histogram ID=-10: ZEUS Data for histogram 10 (statistical errors only).
- Histogram ID=-20: ZEUS Data for histogram 20 (statistical errors only).
- Histogram ID=-11: ZEUS Data for histogram 10 (statistical and systematic errors).
- Histogram ID=-21: ZEUS Data for histogram 20 (statistical and systematic errors).

A PAW kumac is provided to facilitate plotting of these plots. This can be run by, when inside PAW, typing :

```
exec k_hz95033
```

You will then be prompted for the filename of the histogram file.
Author: Mark Hayes

5.5 HZ95036: η_{max} distribution in DIS events (H1)

Purpose:
Plots the rapidity where the first energy deposition has been occured in the calorimeter (η_{max}-distribution. The data were not corrected and can therefore not directly be compared to the Monte Carlo. Pure Monte Carlo distribution are available for the distribution of the invariant mass of the event (M_x), the mass of the remanant. The remnant is defined to contain all particles which are below the largest rapidity gap in the event. Moreover, the y, $x_{pomeron}$ and β distribution are available.
Structure:
HZ95036 calls HZTOOLfunctions HZPHMANG and HZDISKIN. Moreover, the CERNLIB function FLPSOR is called.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ95036(IFLAG )
```

Input arguments
IFLAG=1 initialisation step IFLAG=2 event processing IFLAG=3 termination step
Returned values
The following histogram are produced:
ID=10 rapidity maximum distribution (ID=-10 data)
ID=110 same as 10 but with equidistant bins
ID=11 invariant mass of hadronic final state (M_x) (-11 data)
ID=12 invarinat mass of remnant
ID=13 y distribution
ID=14 logarithmn of $x_{pomeron}$
ID=15 β
Author: Tancredi Carli

5.6 HZH9505001: Study of the photon remnant in resolved photoproduction at HERA. (ZEUS)

Purpose:
Produces the histograms of the photon remnant properties in Fig.3 of [27].
Event selection:
Photoproduction (no electron seen). Dijet in the detector and a thrid jet in the photon region. See paper and code for details.
Structure:
This routine has to be run twice with iflag+1000 for the DIRECT component run. iflag+2000 for the RESOLVED component run. For each run, use the standard initialise, fill and terminate.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZH9505001(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0, 1, 2.
CHJET: not implemented.
IRUN: not implemented.

Returned Histograms

MC histograms
id= 10:, Simulation of Fig.3a of [27]
id= 11:, Simulation of Fig.3b of [27]
id= 12:, Simulation of Fig.3c of [27]
These histograms are area normalised to one, like the measurement. The corresponding simulated cross sections (i.e. normalised to luminosity) are in histograms 10,11 & 12.

Data histograms
id= -10:, Data from Fig.3a of [27]
id= -11:, Data from of Fig.3b of [27]
id= -12:, Data from of Fig.3c of [27]
Authors: C. O'Dea, J. M. Butterworth, B. M. Waugh.

5.7 HZ95072: Charged particle multiplicities and fragmentation in the current region of the BREIT frame in DIS (H1)

Purpose:
This routine produces histograms for the mean charged particle multiplicity, the mean and the width of the x_f distribution versus Q.
Beams: 26.7 GeV electron on 820 GeV protons (HERA 1993 running).
The energy flow selection is not yet applied in this routine.
Structure:
HZ95072 should be initialized, called after an event has been generated and should be terminated at the end of the job. HZ95072 calls the HZTOOL-functions HZDISKIN, HZPHMANG, HZIBEAM, HZBRTINI, HZBRT, HZCHISQ and the HBOOK functions.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ95072(IFLAG)
```

Input arguments
IFLAG=1 initialization step (before event generation)
IFLAG=2 filling step (during event generation)
IFLAG=3 terminating step (after event generation)
Returned Histograms
ID 10: Q vs peak of ln(1/Xp)
ID 20: Q vs width of ln(1/Xp)
ID 30: Q vs ln(1/Xp) mean charged particle multiplicity
ID −101: auxiliary histogram containing the x values of the data. The kumac k_95072 unpacks the data histograms. The data histograms have the corresponding negative numbers. In addition a NTUPLE ID=999 is provided containing the χ^2 and the number of degrees of freedom.
Author: Tancredi Carli and Renate Mohr

5.8 HZ95084: K0 and Λ multiplicities (ZEUS)

Purpose:
This routine plots the differential multiplicities of K0 and Λ versus both transverse momentum and pseudorapidity in a restricted pseudorapidity and P_t range.
Event selection:
$10 < Q^2 < 640$ GeV^2, $0.0003 < x < 0.01$, $y > 0.04$
K0 selection:
$-1.3 < \eta < 1.3$, $0.5 < p_t < 4.0$ GeV
Λ selection:
$-1.3 < \eta < 1.3$, $0.5 < p_t < 3.5$ GeV
Beams: 26.7 GeV electrons, 820 GeV protons (1993 HERA running).
Reference: Z. Phys. C68(1995) 29.
Structure:
HZ95084 should be called before, during and after the event generation. HZ95084 calls HBOOK functions, HZTOOL functions HZDISKIN, HZPHMANG.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ95084(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
For Monte Carlo:
ID 11 = $1/N\ dN/dP_t$ for K0,
ID 101 = $1/N\ dN/dP_t$ for Λ,
ID 10 = $1/N\ dN/d\eta$ for K0,
ID 100 = $1/N\ dN/d\eta$ for Λ.
Data histograms have the corresponding negative numbers. The data histograms only containing the statistical error are stored with an negative offset of −1000. In addition, the NTUPLE ID=999 contains the χ^2 and the number of degrees of freedom of each histogram.
Author: N. Brook

5.9 HZ95108: E_T flows in x and Q^2 bins in DIS (H1)

Purpose:
This routine produces histograms for the transverse energy flows ($dE/d\eta$) in the gamma-proton center of mass frame (cms) as a function of x and Q^2 and the mean transverse energy in the cms for a central rapidity bin $(-0.5, 0.5)$ versus x in 3 bins of Q^2.
Event selection:
$E_{el} > 12$ GeV, $173.0^o > \theta_{el} > 157.0^o$, $W^2 > 4400$ GeV^2 and a cut on the forward energy.
Running: $E_{el} = 26.7$ GeV, $E_p = 820$ GeV, HERA running 1993.
Reference: Phys. Lett. B356 (1995) 118, DESY 95-108.
Structure:
HZ95108 should be called before, during and after the event generation. HZ95108 calls HBOOK functions and the HZTOOL function HZIBEAM, HZDISKIN,HZIDELEC, HZPHMANG,HZIPGAM,HZHCM, HZHCMINI.
Usage:

```
*
          INTEGER IFLAG
          ...
          Call HZ95108(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)
Returned histograms
ID 1-9: $dE/d\eta$ versus the pseudo-rapidity (η) in the 9 kinematic bins with systematic al error of 10% added in quadrature to the statistical error.
ID 11-19: $dE/d\eta$ versus the pseudo-rapidity (η) in the 9 kinematic bins as shown in the paper (statistical error only
ID 11 : $< x >= 0.00016$ and $< Q^2 >= 6,8$ GeV^2
ID 12 : $< x >= 0.0003$ and $< Q^2 >= 8.6$ GeV^2
ID 13 : $< x >= 0.00037$ and $< Q^2 >= 13.1$ GeV^2
ID 14 : $< x >= 0.00063$ and $< Q^2 >= 14.2$ GeV^2
ID 15 : $< x >= 0.0011$ and $< Q^2 >= 14.0$ GeV^2
ID 16 : $< x >= 0.0023$ and $< Q^2 >= 14.5$ GeV^2
ID 17 : $< x >= 0.00093$ and $< Q^2 >= 28.8$ GeV^2
ID 18 : $< x >= 0.0021$ and $< Q^2 >= 30.9$ GeV^2
ID 19 : $< x >= 0.0049$ and $< Q^2 >= 32.9$ GeV^2

ID 21 : mean transverse energy in the bin at $\eta = 0$ in the 9 kinematic bins
ID 22 : mean x for the bins defined in ID 21
ID 23 : mean Q^2 for the bins defined in ID 21
The data points are packed in histograms with the corresponding negative numbers. The kumac k_95108 can be used to produce the $< E_t >$ versus x plot. The NTUPLE 999 contains the χ^2 values and the number of degrees of freedom.
Author: Michael Kuhlen and Tancredi Carli

5.10 HZ95115: Jets and rapidity gaps in γp (ZEUS)

Purpose:
This routine produces the following graphs:

- Corrected cross-section vs. η_{jet} for leading jet with a rapidity gap of up to 1.8.
- Corrected cross-section vs. η of end of gap.
- And the unweighted events versions of these graphs.

Structure:
HZ95115 should be initialised, called after event generation and it should be terminated.
HZ95115 requires CERNLIB and the following utility routines from the HZtool library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND.
Beams: 26.7GeV electrons on 820GeV protons (1993 HERA running), with the protons travelling in the +z direction. Cuts: $Q^2 < 4\text{GeV}^2$ and $0.2 < y_{bj} < 0.85$.
The recommended value for ptmin in the Monte Carlo is 2.5GeV. Reference: Phys. Lett. B356 (1995) 129-146.
Usage:

```
*
      INTEGER iflag
      ...
      CALL HZ95115(iflag)
      ...
```

Input arguments
IFLAG= 1 initialisation phase (jet finder from paper selected)
IFLAG+jetf*10 initialisation phase, to select jetfinder (see HZJTFIND for list of jets)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (to finish off histograms)
This routine requires to be run twice, once for DIRECT events generated, and once for RESOLVED. The Monte Carlos PYTHIA and HERWIG do not allow both sets to be generated at the same time. So the following offsets need to be added during the correct stage.
IFLAG+1000 for the direct stage.
IFLAG+2000 for the resolved stage.
IMPORTANT: Both stages must be run
Returned histograms
The histograms which are booked and filled:

- 10 Corrected cross-section vs. η_{jet} for leading jet with a rapidity gap of up to 1.8
- 20 Corrected cross-section vs. η of end of gap
- Please note these graphs will only be sensible if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.
- -10,-20 are the equivalent data graphs.

A PAW kumac is provided to facilitate plotting of these points. This can be run by, when inside PAW, typing :

```
exec k_hz95115
```

Author: Mark Hayes

5.11 HZ95194: Jets and rapidity gaps in γp (ZEUS)

Purpose:
This routines produces the following graphs:

- Cross section of two jet events with a rapidity range of 2 or greater between them.
- Cross section of two jet events with a rapidity range of 2 or greater between them, and no particles of $E_t > 300$ MeV between them.

Structure:
HZ95194 should be initialised, called after event generation and it should be terminated.
HZ95194 requires CERNLIB and the following from the HZTOOL library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND.
Beams: 26.7 GeV electrons on 820 GeV protons (1993 HERA running), with the protons travelling in the $+z$ direction.
Cuts: $Q^2 < 4\text{GeV}^2$ and $0.2 < y_{bj} < 0.8$.
Recommended setting for ptmin in Monte Carlo is 3 GeV.
Reference: hep-ex/9510012 (Submitted to PLB)
Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ95194(IFLAG)
      ...
```

Input arguments
IFLAG= 1 initialisation phase (jet finder from paper selected)
IFLAG+jetf*10 initialisation phase, to select jetfinder (see HZJTFIND for list of jets)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (to finish off histograms)
This routine requires to be run twice, once for DIRECT events generated, and once for RESOLVED. The Monte Carlos PYTHIA and HERWIG do not allow both sets to be generated at the same time. So the following offsets need to be added during the correct stage.
IFLAG+1000 for the direct stage.
IFLAG+2000 for the resolved stage.
IMPORTANT: Both stages must be run
Returned histograms
The histograms which are booked and filled:

- Histogram ID=10: Corrected cross-section of non gap events.
- Histogram ID=20: Corrected cross-section of gap events.
- Histogram ID=30: Fraction of gap events over non-gap events.
- Please note these graphs will only be sensible if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.
- Histogram ID=-10: ZEUS Data for histogram 10 (statistical errors only).
- Histogram ID=-20: ZEUS Data for histogram 20 (statistical errors only).
- Histogram ID=-30: ZEUS Data for histogram 30 (statistical errors only).

A PAW kumac is provided to facilitate plotting of these plots. This can be run by, when inside PAW, typing :

```
exec k_hz95194
```

You will then be prompted for the filename of the histogram file.
Author: Mark Hayes

5.12 HZ95219: Incl. jet cross-section in E_t and η in γp events (H1)

Purpose:
Produced measured inclusive jet cross sections in photoproduction events in function of the transverse energy and the pseudo-rapidity (η).
Structure:
HZ95219 calls the HZTOOL jet finding routine H1GPCONE, the CERNLIB utility VZERO and HBOOK routines.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ95219(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.
Returned histograms
ID 1: $d\sigma/dE_t$, $-1 < \eta < 2$
ID 2: $d\sigma/dE_t$, $-1 < \eta < 1$
ID 3: $d\sigma/d\eta$, $E_t > 7$ GeV
ID 4: $d\sigma/d\eta$, $E_t > 11$ GeV
ID 5: $d\sigma/d\eta$, $E_t > 15$ GeV
The negative histograms identifier contains the data distributions. Histograms with an offset of 100 contain the (unnormalized) dN/dE_t and $dN/d\eta$ distributions.
Author: Armen Buniatian

5.13 HZ95221: Charged particle spectra in DIS (ZEUS)

Purpose:
This routine plots distributions of charged hadron multiplicities in the hadronic center of mass frame as a function of the scaled longitudinal momentum x_F and the transverse momentum P_T^* in a restricted Q^2 and W^2 range. Data is given for events with and without a large rapidity gap.
Beams: 26.7 GeV electrons, 820 GeV protons (1993 HERA running).
References: DESY 95-221
Event selection:
$75 < W < 175$ GeV, $10 < Q^2 < 160$ GeV^2, for the P_T^* distributions, $x_F > 0.05$
Structure:
HZ95221 should be called before, during and after the event generation. HZ95221 calls HBOOK functions, HZTOOL function HZIBEAM, HZIPGAM, HZIDELEC, HZHCMINI, HZHCM, HZPHMANG, HZCHISQ and HZHINRM.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ95221(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)
Returned histograms
Non rapidity gap events:
ID 11: x_F, ID 12: P_t, ID 13: P_t^2 versus x_F (seagull),
Large rapidity gap events:
ID 21: x_F, ID 22: P_t, ID 23: P_t^2 versus x_F (seagull)
Both:
ID 31: x_F, ID 32: P_t, ID 33: P_t^2 versus x_F (seagull).

The data histogram have the corresponding negative numbers. Monte Carlo histograms with a finer (equidistant binning) are stored with an offset of 100. The NTUPLE 999 gives the χ^2 values and the number of degrees of freedom.
Author: Jane Bromley

5.14 HZ96039: F_2 (H1)

Purpose:
Produces the histograms for $F_2(x, Q^2)$
H1 Coll., Nucl.Phys. B470 (1996) 3-40
Event selection (data recorded in 1994):
$1.5 < Q^2 < 5000$ GeV^2
$3 \cdot 10^{-5} < x < 0.32$
Structure:
HZ96039 is callable at any time.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ96039(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=1001: f2 Q2=1.5
ID=1002: f2 Q2=2.5
ID=1003: f2 Q2=3.5
ID=1004: f2 Q2=5.0
ID=1005: f2 Q2=6.5
ID=1006: f2 Q2=8.5
ID=1007: f2 Q2=12
ID=1008: f2 Q2=15
ID=1009: f2 Q2=20.
ID= 1010: f2 Q2=25.
ID= 1011: f2 Q2=35.
ID= 1012: f2 Q2=45.
ID= 1013: f2 Q2=60.
ID= 1014: f2 Q2=90.

Data histograms
ID=-1001: f2 Q2=1.5 data stat

ID=-1002: f2 Q2=2.5 data stat
ID=-1003: f2 Q2=3.5 data stat
ID= -1004: f2 Q2=5.0 data stat
ID=-1005: f2 Q2=6.5 data stat
ID= -1006: f2 Q2=8.5 data stat
ID= -1007: f2 Q2=12. data stat
ID=-1008: f2 Q2=15. data stat
ID= -1009: f2 Q2=20. data stat
ID= -1010: f2 Q2=25. data stat
ID= -1011: f2 Q2=35. data stat
ID= -1012: f2 Q2=45. data stat
ID=-1013: f2 Q2=60. data stat
ID= -1014: f2 Q2=90. data stat

ID= -1101: f2 Q2=1.5 data tot
ID= -1102: f2 Q2=2.5 data tot
ID= -1103: f2 Q2=3.5 data tot
ID= -1104: f2 Q2=5.0 data tot
ID= -1105: f2 Q2=6.5 data tot
ID=-1106: f2 Q2=8.5 data tot
ID= -1107: f2 Q2=12. data tot
ID=-1108: f2 Q2=15. data tot
ID=-1109: f2 Q2=20. data tot
ID= -1110: f2 Q2=25. data tot
ID= -1111: 2 Q2=35. data tot
ID= -1112: f2 Q2=45. data tot
ID= -1113: f2 Q2=60. data tot
ID= -1114: f2 Q2=90. data tot

Author: H. Jung

5.15 HZ96076: F_2 (ZEUS)

Purpose:
Produces the histograms for $F_2(x, Q^2)$
ZEUS Coll., Z.Phys. C72 (1996) 399-424
Event selection (data recorded in 1994):
$3.5 < Q^2 < 5000$ GeV^2
$6.3 \cdot 10^{-5} < x < 0.08$
Structure:
HZ96076 is callable at any time.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ96076(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=1001: f2 Q2=3.5
ID=1002: f2 Q2=4.5
ID=1003: f2 Q2=6.5
ID=1004: f2 Q2=8.5
ID=1005: f2 Q2=10
ID=1006: f2 Q2=12
ID=1007: f2 Q2=15
ID=1008: f2 Q2=18
ID=1009: f2 Q2=22.
ID= 1010: f2 Q2=27.
ID= 1011: f2 Q2=35.
ID= 1012: f2 Q2=45.
ID= 1013: f2 Q2=60.
ID= 1014: f2 Q2=70.
ID= 1015: f2 Q2=90.
ID= 1016: f2 Q2=120.

Data histograms
ID=-1001: f2 Q2=3.5 data stat
ID=-1002: f2 Q2=4.5 data stat
ID=-1003: f2 Q2=6.5 data stat
ID= -1004: f2 Q2=8.5 data stat
ID=-1005: f2 Q2=10 data stat
ID= -1006: f2 Q2=12 data stat
ID= -1007: f2 Q2=15. data stat
ID=-1008: f2 Q2=18. data stat
ID= -1009: f2 Q2=22. data stat
ID= -1010: f2 Q2=27. data stat
ID= -1011: f2 Q2=35. data stat
ID= -1012: f2 Q2=45. data stat
ID=-1013: f2 Q2=60. data stat
ID= -1014: f2 Q2=70. data stat
ID= -1015: f2 Q2=90. data stat
ID= -1016: f2 Q2=120. data stat

ID= -1101: f2 Q2=3.5 data tot
ID= -1102: f2 Q2=4.5 data tot
ID= -1103: f2 Q2=6.5 data tot
ID= -1104: f2 Q2=8.5 data tot
ID= -1105: f2 Q2=10 data tot
ID=-1106: f2 Q2=12 data tot
ID= -1107: f2 Q2=15. data tot
ID=-1108: f2 Q2=18 data tot
ID=-1109: f2 Q2=22 data tot
ID= -1110: f2 Q2=27 data tot
ID= -1111: 2 Q2=35. data tot
ID= -1112: f2 Q2=45. data tot
ID= -1113: f2 Q2=60. data tot
ID= -1114: f2 Q2=70. data tot
ID= -1115: f2 Q2=90. data tot
ID= -1116: f2 Q2=120. data tot

Author: H. Jung

5.16 HZ96094: $d\sigma/d\cos(\theta^*)$ for low/high x_γ

Purpose:
This routines produces the following graphs:

- Differential cross section in bins of $\cos(\theta^*)$ for $x_\gamma^{\mathrm{OBS}} > 0.75$
- Differential cross section in bins of $\cos(\theta^*)$ for $x_\gamma^{\mathrm{OBS}} < 0.75$

Structure:
HZ96094 should be initialised, called after event generation and it should be terminated.
HZ96094 requires CERNLIB and the following from the HZTOOL library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND.
Beams: 27.5 GeV electrons on 820 GeV protons (1995 HERA running), with the protons travelling in the $+z$ direction.
Cuts: $Q^2 < 4\mathrm{GeV}^2$ and $0.25 < y_{bj} < 0.8$.
Recommended setting for ptmin in Monte Carlo is 2.5 GeV.
Reference: Phys. Lett. B384 (1996) 401-413.
Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ96094(IFLAG)
      ...
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned histograms
The histograms which are booked and filled:

- Histogram ID=10: Differential cross section in bins of $\cos(\theta^*)$ for $x_\gamma^{\mathrm{OBS}} > 0.75$
- Histogram ID=20: Differential cross section in bins of $\cos(\theta^*)$ for $x_\gamma^{\mathrm{OBS}} < 0.75$
- Please note these graphs will only be sensible if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.

- Histogram ID=-10: ZEUS Data for histogram 10 (statistical errors only).
- Histogram ID=-20: ZEUS Data for histogram 20 (statistical errors only).

A PAW kumac is provided to facilitate plotting of these plots. This can be run by, when inside PAW, typing :

```
exec k_hz96094
```

You will then be prompted for the filename of the histogram file.
Author: Mark Hayes

5.17 HZ96122: K^0 and Λ spectra in DIS (H1)

Purpose:
This routine plots angular and P_T^2 distributions of k^0 and Λ particles. Additionaly the mean number of K^0s and this number divided by the mean number of tracks is plotted with respect to x in three Q^2 bins: 10 GeV^2 $< Q^2 <$ 15 GeV^2, 15 GeV^2 $< Q^2 <$ 35 GeV^2, 35 GeV^2 $< Q^2 <$ 70 GeV^2 The seagull plot in the hadronic center of mass system is also provided. Beams: 27.5 GeV electrons, 820 GeV protons (1994 HERA running) Event selection:
10GeV^2 $< Q^2 <$ 70 GeV^2, $110^{-4} < x < 0.01$, $0.05 < y < 0.6$
Energie deposited in polar angular range $4.4 < \theta < 15$ should exceed 0.5 GeV.
Structure:
HZ96122 calls functions HZDISKIN,HZIPGAM, HZIDELEC, HZHCMINI HZPHMANG.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ96122(IFLAG )
```

Returned histograms
ID = 100 η-spectrum for K^0 particles
ID = 101 p_t^2 spectrum for K^0 particles
ID = 110 η-spectrum for Λ particles
ID = 111 p_t^2 spectrum for Λ particles
ID = 120 $< K^0 >$ in $10 < Q^2 < 15$ GeV^2
ID = 121 $< K^0 >$ in $15 < Q^2 < 35$ GeV^2
ID = 122 $< K^0 >$ in $35 < Q^2 < 70$ GeV^2
ID = 130 $< K^0 > / <$ Tracks $>$ in $10 < Q^2 < 15$ GeV^2
ID = 131 $< K^0 > / <$ Tracks $>$ in $15 < Q^2 < 35$ GeV^2
ID = 132 $< K^0 > / <$ Tracks $>$ in $35 < Q^2 < 70$ GeV^2
ID = 200 seagull
Author: Tancredi Carli and Birger Koblitz

5.18 HZ96138: Spectra of D^0 and D^* mesons in DIS (H1)

Purpose:
The transverse (p_t) and longitudinal (x_d) momentum spectrum of D^0 and D^* mesons and the charm structure function is produced.

Structure:
HZ96138 calls functions HZDISKIN,HZPHMANG,HZIDELEC,HZIPGAM, HZHCMINI,HZHCM, HZCHISQ,HZHINRM,HZHINFO.

Usage:

```
 *
        INTEGER IFLAG
        ...
        call HZ96138(IFLAG )
```

Returned histograms

ID = 1001 p_t spectrum of D^0
ID = 1002 p_t spectrum of D^*
ID = 2001 $x_d = p_z/W$ spectrum of D^0
ID = 2002 $x_d = p_z/W$ spectrum of D^*
ID = 4001 F_2 for $Q^2 = 12$ GeV^2
ID = 4002 F_2 for $Q^2 = 25$ GeV^2
ID = 4003 F_2 for $Q^2 = 45$ GeV^2
ID = 4011 F_2^{cc} for $Q^2 = 12$ GeV^2
ID = 4012 F_2^{cc} for $Q^2 = 25$ GeV^2
ID = 4013 F_2^{cc} for $Q^2 = 45$ GeV^2

Author: Frank Botterweck

5.19 HZ96160: Charged particle multiplicites in η bins in DIS (H1)

Purpose:
This routine plots distributions of charged multiplicities in the hadronic centre of mass system within 4 different η ranges $1 < \eta^* < 2$, $1 < \eta^* < 3$, $1 < 1\eta^* < 4$ and $1 < \eta^* < 5$. The distributions are ploted for 4 regions of W: $80 < W < 115$, $115 < W < 150$, $150 < W < 185$, $185 < W < 200$. The routine also plots the mean charged multiplicity in these bins.
Beams: 27.5 GeV positrons, 820 GeV protons [1994 HERA running] Event selection:

1. $80\text{GeV} < W < 220\text{GeV}$
2. $Q^2 > 10\text{GeV}$
3. Energie of scattered positron > 12 GeV
4. Energie deposited in polar angular range $4.4° < \theta < 15°$ larger than 0.5 GeV

Structure:
HZ96160 should be called before, during and after the event generation. HZ96160 calls HBOOK functions, HZTOOL function HZIBEAM, HZIPGAM, HZIDELEC HZHCMINI, HZHCM and HZPHMANG.
Usage:

```
 *
        INTEGER IFLAG
        ...
        call HZ95221(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)
Returned histograms

1. The mean charged multiplicity over W is stored in:
   ID 112: $1 < \eta^* < 2$, ID 113: $1 < \eta^* < 3$, ID 114: $1 < \eta^* < 4$, ID 115: $1 < \eta^* < 5$,
2. Multiplicity distributions $P_n/\%$ over n:
   ID 212–215: $80 < W < 115$, ID 222–225: $115 < W < 150$, ID 232–235:

$150 < W < 185$, ID 242–245: $185 < W < 200$.
The last digit corresponding to the η^*-ranges as above.

The data histograms have the corresponding negative numbers. Data histograms with only statistic and only systematic errors are stored with offsets -100 and -200.
Author: Birger Koblitz

5.20 HZ96215: Charged particle spectra in bins of x and Q^2 (H1)

Purpose:
This routines makes the plots on charged particle transverse momentum spectra and rapidity distributions in 9 different $x - Q^2$ bins at "small" x, $0.0001 < x < 0.01$ in the hadronic CMS.
Reference: H1, Nucl. Phys. B485 (1997) 3
Running: 1994 data, positrons ($E = 27.5$ GeV) on protons ($E = 820$ GeV)
Event selection:
$5 < Q^2 < 50$ GeV^2, $E_e > 12$ GeV, $157° < \theta_e < 173°$, $y > 0.05$
forward energy in $4.4° < \theta_{lab} < 15°$ larger than 0.5 GeV

Structure:
HZ96215 is to be called for each event when the HEP common has been filled, and once before and after the event loop. HZ96215 calls hbook and hztool routines.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ96215(IFLAG )
```

Input arguments
IFLAG=1 initialization (before event generation)
IFLAG=2 initialization (during event generation)
IFLAG=3 initialization (after event generation)

Returned histograms

histo ID	quantity	cuts	paper fig.
1100x	$1/N \mathrm{d}n/\mathrm{d}\eta$	all charged particles	6
1200x	$1/N \mathrm{d}n/\mathrm{d}\eta$	$p_T > 1$ GeV	5
1303x	$1/N \mathrm{d}n/\mathrm{d}p_T$	$1.5 < \eta < 2.5$	2
1300x	$1/N \mathrm{d}n/\mathrm{d}p_T$	$0.5 < \eta < 1.5$	4
1400x	$1/N \mathrm{d}n/\mathrm{d}p_{Tmax}$	$0.5 < \eta < 1.5$, $E(0 < \eta < 2) > 6$ GeV	7

x denotes the kinematic bin numbers 1 through 9, x=0 contains all bins. Histos with negative ID contain the measured H1 data.

PAW kumacs
k_hz96215.kumac makes nice plots, data overlayed with MC curves.

<u>**Author:**</u> Frank Botterweck and Michael Kuhlen

5.21 HZ97098: Events shapes in the current region of the Breit frame in DIS (H1)

Purpose:
Produces histograms for the event shape variables: thrust, jet broadening, jet mass.
Event selection:
i) energy of scattered lepton $En_{el} > 10$ GeV
ii) polar angle of scattered lepton within $157 < \theta_{el} < 173$ for low Q sample or within $30 < \theta_{el} < 150$ for hi Q sample
iii) hadronic energy in forward region (polar angle within $4 < \theta < 15$) $E_{fwd} > 0.5$ GeV
iv) total hadronic energy in Breit current hemisphere $E_{breit} > 0.1$ GeV
v) $0.05 < y < 0.80$ Running: $E_{elbeam} = 27.5$ GeV , $E_{proton} = 820$ GeV

Structure and Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ97098(IFLAG )
```

Input arguments
iflag=1 initialisation
iflag=2 filling
iflag=3 termination

Returned histograms
Q-bins: (not Q^2 !!)
low Q sample:
1) $7 < Q < 8$ GeV
2) $8 < Q < 10$ GeV
high Q sample:
3) $14 < Q < 16$ GeV
4) $16 < Q < 20$ GeV
5) $20 < Q < 30$ GeV
6) $30 < Q < 50$ GeV
7) $50 < Q < 100$ GeV
Distributions: (QbinNo = 1..7 s.a.)
ID = 10 + QbinNo: $1/Ndn/d(1 - T_c)$
ID = 20 + QbinNo: $1/Ndn/d(1 - T_z)$
ID = 30 + QbinNo: $1/Ndn/dB_c$
ID = 40 + QbinNo: $1/Ndn/d\rho_c$

Mean values:
ID = 10: $< 1 - T_c >$
ID = 20: $< 1 - T_z > /2$
ID = 30: $< B_c >$
ID = 40: $< \rho_c >$
H1 data histograms have corresponding negative numbers. Data histos with only statistic or only systematic errors are stored with offset -100 and -200. **Author:** Andreas von Manteuffel

5.22 HZ97108: Fragmentation in the current region of the Breit frame in DIS (H1)

Purpose:
This routine produces the event normalised inclusive xp and log(1/xp) distributions, the charged track multiplcity, KNO distributions and the magnitude and direction of the resultant 4-vector from summing over all stable particles particles in the current region of the Breit frame. The data are corrected for detector acceptance and inefficiencies, QED radiative affects and secondary particles coming from the decay of K0 and Λs.
Structure:
HZ97108 should be called before, during and after the event generation.
HZ97108 calls HBOOK functions, the CERNLIB routine UCOPY and HZTOOL functions HZDISKIN, HZIPGAM, HZBRTINI, HZBRT.
Beams: 26.7 GeV electrons on 820 GeV protons (1994 HERA running).
References: DESY 97-108
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ97108(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Event Selection applied to data and Monte Carlo

```
*Common cuts to all data
Ee   > 14      GeV
W2   > 4400    GeV2
0.05 < y < 0.6
Angle of quark   : 10 -> 150 degrees

*****************************************************************
                          Low Q2 selection      High Q2 selection
Q2 range (GeV2)           12 < Q2 < 100         100 < Q2 < 8000
Angle of scattered
positron (degrees)         157 -> 172.5            10 -> 150
*****************************************************************
```

Returned histograms
For Data :

```
**********************************************************************
  ID         TITLE                        Kinematic cuts
**********************************************************************
 -10  (1)  Q vs ln(1/xp)peak
 -20  (1)  Q vs ln(1/xp)width
 -30  (1)  Q vs nch
 -101 (1)  x-axis peak/width
 -200 (1)  1/N dn/dxp vs xp              Q2(12,100)
 -201 (1)  1/N dn/dxp vs xp              Q2(100,8000)
 -300 (1)  1/N dn/dln(1/xp) vs ln(1/xp)  Q2(12,100)
 -301 (1)  1/N dn/dln(1/xp) vs ln(1/xp)  Q2(100,8000)
 -400 (1)  1/N dN/dn vs n                Q2(12,30) and xbj(6E-4,2E-3)
 -401 (1)  1/N dN/dn vs n                Q2(12,30) and xbj(2E-3,1E-2)
 -402 (1)  1/N dN/dn vs n                Q2(30,80) and xbj(6E-4,2E-3)
 -403 (1)  1/N dN/dn vs n                Q2(30,80) and xbj(2E-3,1E-2)
 -404 (1)  1/N dN/dn vs n                Q2(100,500) and xbj(2E-3,1E-2)
 -405 (1)  1/N dN/dn vs n                Q2(100,500) and xbj(1E-2,2E-1)
**********************************************************************
```

For Monte Carlo, the histogram ID is positive for the list above.

Kumac k_hz97108
The purpose of this kumac is to provide the user with a complete set of predefined figures that overlay the published data and Monte Carlo distributions To run the kumac, execute paw and type :

```
h/file 1 hztool.hbook
exec k_hz97108#"macro name"
```

The user has a choice of ”macro name” from the following list :

```
********************************************************************
  macro name              description
********************************************************************
    fig1     - will reproduce figure 1 of the pre-print
```

```
    fig1mc   - will reproduce figure 1 for data and Monte Carlo events
    fig4     - plot average charged multiplcity for data and monte carlo.
               Solid line is <Nch>e+e-/2 with b-bbar, K0's and Lambdas
               removed.
     pn      - Pn distributions for data and Monte Carlo.
    eqcos    - The total energy of the the vector sum of all current
               hadrons plotted as a fraction of the event Q against
               the resultant polar angle for Monte Carlo only. Empty
               hemisphere events are excluded. QPM expectation at
               (-1.0,0.5).

     kno     - KNO distributions for data and Monte Carlo.
               The Q2 bins are the same as those defined for the pn
               distributions. The x bins have been combined.

*************************************************************************
```

Author: Dave Kant (kant@qmw.ac.uk)

5.23 HZ97158: Diffractive structure function (H1)

Purpose:

Calculate the diffractive structure function $F_2^{D(3)}$ as a function of x_{pom}, β and Q^2 according to the measurement of H1 in DESY 97-158.
. Event selection:
$0.023 < \beta < 1.0$
$8.310^{-5} < x_{pom} < 8.310^{-1}$
$3.53 < Q^2 < 89.12$
$M_Y < 1.6$ GeV
$|t| < 1$ GeV^2

Structure:

HZ97158 calls HZHADGAP, HZDISKIN, HZPHMANG, HZIDELEC, HZIPGAM, HZHCMINI,HZHCM, HZCHISQ, HZHINRM, HZHINFO.

Usage:

```
*
          INTEGER IFLAG
          ...
          call HZ97158(IFLAG )
```

Input arguments

IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

The following cuts are applied for the event selection: $0.023 < \beta < 1.0$
$8.310^{-5} < x_{pom} < 8.310^{-1}$
$3.53 < Q^2 < 89.12$
$M_Y < 1.6$ GeV
$|t| < 1$ GeV^2

Returned histograms

For Monte Carlo:
ID = 11 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 4.5$ GeV^2, $\beta = 0.04$
ID = 12 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 4.5$ GeV^2, $\beta = 0.1$
ID = 13 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 4.5$ GeV^2, $\beta = 0.2$
ID = 14 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 4.5$ GeV^2, $\beta = 0.4$
ID = 15 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 4.5$ GeV^2, $\beta = 0.65$
ID = 16 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 4.5$ GeV^2, $\beta = 0.9$

ID = 21 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 7.5$ GeV^2, $\beta = 0.04$
ID = 22 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 7.5$ GeV^2, $\beta = 0.1$
ID = 23 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 7.5$ GeV^2, $\beta = 0.2$
ID = 24 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 7.5$ GeV^2, $\beta = 0.4$
ID = 25 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 7.5$ GeV^2, $\beta = 0.65$
ID = 26 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 7.5$ GeV^2, $\beta = 0.9$

ID = 31 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 9$ GeV^2, $\beta = 0.04$
ID = 32 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 9$ GeV^2, $\beta = 0.1$
ID = 33 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 9$ GeV^2, $\beta = 0.2$
ID = 34 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 9$ GeV^2, $\beta = 0.4$
ID = 35 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 9$ GeV^2, $\beta = 0.65$
ID = 36 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 9$ GeV^2, $\beta = 0.9$

ID = 41 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 12$ GeV^2, $\beta = 0.04$
ID = 42 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 12$ GeV^2, $\beta = 0.1$
ID = 43 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 12$ GeV^2, $\beta = 0.2$
ID = 44 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 12$ GeV^2, $\beta = 0.4$
ID = 45 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 12$ GeV^2, $\beta = 0.65$
ID = 46 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 12$ GeV^2, $\beta = 0.9$

ID = 51 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 18$ GeV^2, $\beta = 0.04$
ID = 52 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 18$ GeV^2, $\beta = 0.1$
ID = 53 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 18$ GeV^2, $\beta = 0.2$
ID = 54 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 18$ GeV^2, $\beta = 0.4$
ID = 55 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 18$ GeV^2, $\beta = 0.65$
ID = 56 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 18$ GeV^2, $\beta = 0.9$

ID = 61 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 28$ GeV^2, $\beta = 0.04$
ID = 62 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 28$ GeV^2, $\beta = 0.1$
ID = 63 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 28$ GeV^2, $\beta = 0.2$
ID = 64 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 28$ GeV^2, $\beta = 0.4$
ID = 65 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 28$ GeV^2, $\beta = 0.65$
ID = 66 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 28$ GeV^2, $\beta = 0.9$

ID = 71 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 45$ GeV^2, $\beta = 0.04$
ID = 72 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 45$ GeV^2, $\beta = 0.1$

ID = 73 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 45$ GeV^2, $\beta = 0.2$
ID = 74 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 45$ GeV^2, $\beta = 0.4$
ID = 75 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 45$ GeV^2, $\beta = 0.65$
ID = 76 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 45$ GeV^2, $\beta = 0.9$

ID = 81 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 75$ GeV^2, $\beta = 0.04$
ID = 82 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 75$ GeV^2, $\beta = 0.1$
ID = 83 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 75$ GeV^2, $\beta = 0.2$
ID = 84 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 75$ GeV^2, $\beta = 0.4$
ID = 85 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 75$ GeV^2, $\beta = 0.65$
ID = 86 $F_2^{D(3)}(x_{pom})$ for $Q^2 = 75$ GeV^2, $\beta = 0.9$
Data histograms have the corresponding negative numbers.
Author: Hannes Jung

5.24 HZ97164: Dijet cross section (x_γ/E_T) in γp events (H1)

Purpose

This routine plots the double-differential cross section of di-jet events in photoproduction, in the variables $x_\gamma^{\rm jets}$ and $\log_{10}\left((E_T^{\rm jets}/1\,{\rm GeV})^2\right)$. The observed momentum fraction of the parton from the photon $x_\gamma^{\rm jets}$ is calculated from the two highest transverse energy final state jets:

$$x_\gamma^{\rm jets} = \frac{E_{T1}\exp(-\eta_1) + E_{T2}\exp(-\eta_2)}{2yE_{\rm beam}} \quad .$$

The mean transverse energy of these two jets is used as the scale $E_T^{\rm jets}$:

$$E_T^{\rm jets} = \frac{1}{2}\,(E_{T1} + E_{T2}) \quad .$$

Here, obviously, E_{T1}, E_{T2} and η_1, η_2 are the transverse energies of the two jets with respect to the beam axis and their pseudorapidities in the HERA laboratory frame, respectively, $y = E_\gamma/E_{\rm beam}$ is the scaled energy of the incoming photon and $E_{\rm beam} = 27.55\,{\rm GeV}$ is the HERA electron beam energy during the 1994 running period.

The cross section is integrated over the kinematic region defined by the following cuts:

$$Q^2 < 4\,{\rm GeV}^2$$

$$0.2 < y < 0.83$$

$$0 < \frac{1}{2}\,(\eta_1 + \eta_2) < 2$$

$$|\eta_1 - \eta_2| < 1$$

$$\frac{|E_{T1} - E_{T2}|}{E_{T1} + E_{T2}} < \frac{1}{4}$$

Reference: Eur. Phys. J. **C1** (1998) 97-107, DESY 97-164,
Figure 2 and Table 1.

Structure

HZ97164 should be called before event generation (histograms will be booked, data histograms will be filled), during event generation (MC histograms are filled) and afterwards (MC histograms will be normalised to the integrated luminosity).

HZ97164 calls the jet finder algorithm H1QGCONE, the CERNLIB routine VZERO, and several HBOOK routines.

Usage

```
 *
        INTEGER IFLAG
        ...
        call HZ97164(IFLAG )
```

Input arguments

Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0,1 and 2.
CHJET: not implemented.
IRUN: not implemented.

Filled histograms

The filled histograms contain the di-jet cross section

$$\frac{\mathrm{d}^2\sigma(ep \to 2\,\mathrm{jets} + X)}{\mathrm{d}x_\gamma^{\mathrm{jets}}\mathrm{d}\log_{10}\left((E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2\right)}$$

Histogram IDs 1–7 give the cross section as a function of $\log_{10}\left((E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2\right)$, while histograms 11–16 show the same cross section as a function of x_γ^{jets}. Histograms with the negative ID contain the data distributions from the reference. The histograms with ID+100 contain the MC event number distributions without normalisation.

The bins are:

ID=1: $0.1 \le x_\gamma^{\mathrm{jets}} < 0.2$	ID=11: $2.00 \le \log_{10}(E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2 < 2.15$
ID=2: $0.2 \le x_\gamma^{\mathrm{jets}} < 0.3$	ID=12: $2.15 \le \log_{10}(E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2 < 2.30$
ID=3: $0.3 \le x_\gamma^{\mathrm{jets}} < 0.4$	ID=13: $2.30 \le \log_{10}(E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2 < 2.50$
ID=4: $0.4 \le x_\gamma^{\mathrm{jets}} < 0.5$	ID=14: $2.50 \le \log_{10}(E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2 < 2.70$
ID=5: $0.5 \le x_\gamma^{\mathrm{jets}} < 0.6$	ID=15: $2.70 \le \log_{10}(E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2 < 3.00$
ID=6: $0.6 \le x_\gamma^{\mathrm{jets}} < 0.75$	ID=16: $3.00 \le \log_{10}(E_T^{\mathrm{jets}}/1\,\mathrm{GeV})^2 < 3.40$
ID=7: $x_\gamma^{\mathrm{jets}} \ge 0.75$	

Author: Hartmut Rick

5.25 HZ97179: Incl. jet cross-section (E_T/η) in γp events (ZEUS)

Purpose:
This routine produces histograms for the inclusive jet cross-section measurement. The kinematic range is: $0.65 < Q^2 < 49\text{GeV}^2$, $0.3 < y < 0.6$ The kt algorithmn was used in the Gamma-p frame with: $Et_{jet} > 4\text{GeV}$ and $-2.5 < \eta_{jet} < -0.5$
Structure:
HZ97179 should be called before, during and after the event generation.
HZ97179 calls HBOOK functions, the CERNLIB routine UCOPY and HZTOOL functions HZDISKIN, HZIPGAM, HZBRTINI, HZBRT.
Beams: 27.6 GeV electrons on 820 GeV protons (1994 HERA running).
References: DESY 97-179,submitted to Phys. Lett.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ97179(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)
Returned histograms

```
***************************************************************************
  ID          TITLE                        Kinematic cuts
***************************************************************************
 111        d(sigma)/d(et)        0.65.lt.Q2.lt.1.2
 112        d(sigma)/d(et)        1.2 .lt.Q2.lt.2.6
 113        d(sigma)/d(et)        2.6 .lt.Q2.lt.4.0
 114        d(sigma)/d(et)        4.0 .lt.Q2.lt.9.0
 115        d(sigma)/d(et)        9.0 .lt.Q2.lt.20
 116        d(sigma)/d(et)        20. .lt.Q2.lt.25
 117        d(sigma)/d(et)        25. .lt.Q2.lt.36
 118        d(sigma)/d(et)        36. .lt.Q2.lt.49
 121        d(sigma)/d(eta)       0.65.lt.Q2.lt.1.2
 122        d(sigma)/d(eta)       1.2 .lt.Q2.lt.2.6
 123        d(sigma)/d(eta)       2.6 .lt.Q2.lt.4.0
 124        d(sigma)/d(eta)       4.0 .lt.Q2.lt.9.0
```

```
 125         d(sigma)/d(eta)          9 .lt.Q2.lt.20
 126         d(sigma)/d(eta)         20 .lt.Q2.lt.25
 127         d(sigma)/d(eta)         25 .lt.Q2.lt.36
 128         d(sigma)/d(eta)         36 .lt.Q2.lt.49
 131         sigma(Q2)gamma*p        4.lt.et.lt.5
 132         sigma(Q2)gamma*p        5.lt.et.lt.7
 133         sigma(Q2)gamma*p        7.lt.et.lt.10
 134         sigma(Q2)gamma*p       10.lt.et.lt.20
************************************************************************
```

For Monte Carlo, the histogram ID is positive for the list above.

Kumac k_hz97179
Provides three figures $d\sigma/dE_t$, $d\sigma/d\eta$ in the 8 Q^2 bins and $\sigma(Q^2)$ in 4 $Et_{\rm jet}$ bins.
Author: Tania Ebert

5.26 HZ97183: Fragmentation in the current region of the Breit frame in DIS (ZEUS)

Purpose:
This routine plots x_p distributions, where $x_p = 2P/Q$, in the current region of the Breit frame. The distributions are corrected for particles coming from K0s and Λs.
Structure:
HZ97183 should be called before, during and after the event generation. HZ97183 calls HBOOK functions, the CERNLIB routine UCOPY and HZTOOL function HZDISKIN, HZIPGAM, HZBRTINI, HZBRT.
Beams: 27.5 GeV electrons on 820 GeV protons (1994 HERA running).
References: Phys Lett B414 (1997) 428

Usage:

```
 *
        INTEGER IFLAG
        ...
        call HZ97183(IFLAG)
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
For Monte Carlo:
ID 12: $10 < Q^2 < 20$ GeV^2 and $6.\ 10^{-4} < x < 1.2\ 10^{-3}$
ID 13: $10 < Q^2 < 20$ GeV^2 and $1.2\ 10^{-3} < x < 2.4\ 10^{-3}$
ID 23: $20 < Q^2 < 40$ GeV^2 and $1.2\ 10^{-3} < x < 2.4\ 10^{-3}$
ID 33: $40 < Q^2 < 80$ GeV^2 and $1.2\ 10^{-3} < x < 2.4\ 10^{-3}$
ID 24: $20 < Q^2 < 40$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 34: $40 < Q^2 < 80$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 44: $80 < Q^2 < 160$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 54: $160 < Q^2 < 320$ GeV^2 and $2.4\ 10^{-3} < x < 1.\ 10^{-2}$
ID 55: $160 < Q^2 < 320$ GeV^2 and $1.\ 10^{-2} < x < 5.\ 10^{-2}$
ID 65: $320 < Q^2 < 640$ GeV^2 and $1.\ 10^{-2} < x < 5.\ 10^{-2}$
ID 75: $640 < Q^2 < 1280$ GeV^2 and $1.\ 10^{-2} < x < 5.\ 10^{-2}$
x_p distributions in the different kinematic bins. Data histograms have the corresponding negative numbers offset by -1000 only include the statistical errors are stored. The χ^2 and the number of degrees of freedom are given in ntuple id=999.

Also returned are 2 Ntuples (ID 1000 for MC and 1001 for data) that each have 11 entries corresponding to the analysis (Q^2, x) bins. The information stored is the mean Q the lower and upper range of Q^2, the lower and upper range of x, the value of $1/N dn/dx_p$and its statistical error and systematic errors for several bins of x_p. To extract the information from the NTUPLE the kumac k_97183 is provided.
Author: N. Brook

5.27 HZ97191: Jet profiles in γp (ZEUS)

Purpose:
This routines produces the following integrated jet profiles:

- for inclusive jet production in these bins: $14 < E_T \leq 17$, $17 < E_T \leq 21$, $21 < E_T \leq 25$, $25 < E_T \leq 29$, $-1 < \eta < 0$, $0 < \eta < 1$, $1 < \eta < 1.5$, $1.5 < \eta < 2$
- $r = 0.5$ in bins of E_T and η
- for dijet events in these bins: $-1 < \eta < 0$, $0 < \eta < 1$, $1 < \eta < 1.5$, $1.5 < \eta < 2$, $x_\gamma^{\rm OBS} > 0.75$ and $-1 < \eta < 0$, $x_\gamma^{\rm OBS} < 0.75$ and $0 < \eta < 1$

Structure:
HZ97191 should be initialised, called after event generation and it should be terminated.
HZ97191 requires CERNLIB and the following from the HZTOOL library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND.
Beams: 27.5 GeV electrons on 820 GeV protons (1995 HERA running), with the protons travelling in the $+z$ direction.
Cuts: $Q^2 < 4\text{GeV}^2$ and $0.2 < y_{bj} < 0.8$.
Recommended setting for ptmin in Monte Carlo is 8 GeV.
Reference: accepted by ZfP. hep-ex/9710002
Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ97191(IFLAG)
      ...
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0, 1, 2.
CHJET: implemented.
IRUN: not implemented.

Returned histograms
The histograms which are booked and filled:

- for inclusive jet production: (jet profiles)

Histogram	Bin
10	$14 < E_T \leq 17$
11	$17 < E_T \leq 21$
12	$21 < E_T \leq 25$
13	$25 < E_T \leq 29$
20	$-1 < \eta < 0$
21	$0 < \eta < 1$
22	$1 < \eta < 1.5$
23	$1.5 < \eta < 2$

- Histogram 15: $r = 0.5$ in bins E_T
- Histogram 25: $r = 0.5$ in bins η
- for dijet events: (jet profiles)

Histogram	Bin
30	$-1 < \eta < 0$
31	$0 < \eta < 1$
32	$1 < \eta < 1.5$
33	$1.5 < \eta < 2$
40	$x_\gamma^{\mathrm{OBS}} > 0.75$ and $-1 < \eta < 0$
41	$x_\gamma^{\mathrm{OBS}} < 0.75$ and $0 < \eta < 1$

- Please note these graphs will only be sensible if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.
- Histogram ID=-10 to -41: ZEUS Data for histograms 10 to 41 (statistical errors only).

A PAW kumac is provided to facilitate plotting of these plots. This can be run by, when inside PAW, typing :

```
exec k_hz97191
```

You will then be prompted for the filename of the histogram file.
Author: Mark Hayes

5.28 HZ97196: Jet cross-section for (x_γ, E_T) in γp events (ZEUS)

Purpose:
This routines produces the following graphs from [18]:

- Cross sections for $x_\gamma^{\rm OBS} > 0.75$ for $E_T > 6, 8, 11, 15$ GeV respectively.
- Cross sections for $x_\gamma^{\rm OBS} < 0.75$ for $E_T > 6, 8, 11, 15$ GeV respectively.

Structure:
HZ97196 should be initialised, called after event generation and it should be terminated.
HZ97196 requires CERNLIB and the following from the HZTOOL library: HZPHOKIN, HZIPGAMN, HZIBEAM and HZJTFIND.
Beams: 27.5 GeV electrons on 820 GeV protons (1993 HERA running), with the protons travelling in the $+z$ direction.
Cuts: $Q^2 < 4{\rm GeV}^2$ and $0.2 < y_{bj} < 0.8$.
Recommended setting for ptmin in Monte Carlo is 2.5 GeV.
Reference: Eur. Phys. J. C 1 (1998) 1/2, 109-122
Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ97196(IFLAG)
      ...
```

Input arguments
IPS: implemented.
IPROC: implemented for 0, 1, 2.
CHJET: implemented.
IRUN: not implemented.

Returned histograms
The histograms which are booked and filled:

- Histograms 10,11,12,13: Cross sections for $x_\gamma^{\rm OBS} > 0.75$ for $E_T > 6, 8, 11, 15$ GeV respectively.
- Histograms 20,21,22,23: Cross sections for $x_\gamma^{\rm OBS} < 0.75$ for $E_T > 6, 8, 11, 15$ GeV respectively.

- Please note these graphs will only be sensible if Ntot and Xsec in the HERACMN common block are correct before the calling of the termination routine. It is the user's responsibility to do this.
- Histogram ID=-10 to -23: ZEUS Data for histogram -10 to -23 (statistical errors only).

A PAW kumac is provided to facilitate plotting of these plots. This can be run by, when inside PAW, typing :

```
exec k_hz97196
```

You will then be prompted for the filename of the histogram file.
Author: Mark Hayes

5.29 HZ97210: Events shapes in differative scattering

Purpose:
Study topological structure of the hadronic final state in diffractive deep inelastic scattering DESY 97-210, Eur.Phys.J. C1 (1998) 495

Event selection:
$10. < Q^2 < 100\ GeV^2$
$y < 0.5$
$x_{pom} < 0.05$
$4 < Mx < 36$ GeV
$|t| < 1 GeV^2$

Structure:
HZ97210 is callable at any time. The DECO package is called.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ97210(IFLAG )
```

Returned values
Produced are all figures like in reference paper.

MOCA histograms - mean thrust values:
510 the mean thrust in intervals of mass of the hadronic system
520 the same distribution but for events with the p_t of thrust jets>1GeV
530 the same distribution but for events with the p_t of thrust jets<1GeV
560 the mean value of mass in intervals of the mass of hadronic system
570 the same for events with the p_t of thrust jets>1GeV
580 the same for events with the p_t of thrust jets $<$ 1GeV

DATA histograms - the same absolute value but negative numbers

MOCA histograms - p_t^2 distributions of thrust jets:
i=1,6
90+i the p_t^2 distributions of thrust jets for 6 mass intervals

300+i statistical errors for 90+i

DATA histograms -
i=1,6
-90-i the p_t^2 distributions of thrust jets for 6 mass intervals
-300-i statistical errors for -90-i
-150-i systematic errors for -90-i

MOCA histograms - fractions of events with $p_t^2 > 1(3)GeV$:
calculated from 90+i

DATA histograms -
-410 the fractions of number od events with $p_t^2 > 1GeV$
-460 the systematic error
-420 the fractions of number od events with $p_t^2 > 3GeV^2$
-470 the systematic error
Author: Alice Valkarova and Gerhard Knies

5.30 HZ98018: High-E_T Inclusive Jet Cross Sections in Photoproduction

Purpose:

This routine makes data and MC plots for the inclusive jet cross sections in the reference.

Structure:

The routine needs to be called three times (initialization, event loop and termination) for each physics run. Photoproduction normally requires two physics runs, one for resolved, the other for direct.

HZ98018 requires CERNLIB and the HZTOOL library.

The beams should be e^+, p at 27.5 GeV and 820 GeV respectively (1995 running) with protons travelling in the $+z$ direction.

Cuts: $Q^2 < 4\text{GeV}^2$, $E_T > 14$ GeV, $0.2 < y < 0.85$.

Reference: The European Physical Journal C4 (1998) 591-606.

Usage:

```
INTEGER IFLAG
        ...
        CALL HZ98018(iflag)
        ...
```

Input arguments

Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned Histograms:

- ID 10 cross section differential in nb for $E_T > 14$ GeV $134 < W < 277$ GeV
- ID 20 cross section differential in nb for $E_T > 17$ GeV $134 < W < 277$ GeV
- ID 30 cross section differential in nb for $E_T > 21$ GeV $134 < W < 277$ GeV

- ID 40 cross section differential in nb for $E_T > 25$ GeV $134 < W < 277$ GeV
- ID 50 cross section differential in nb for $E_T > 14$ GeV $134 < W < 190$ GeV
- ID 60 cross section differential in nb for $E_T > 14$ GeV $190 < W < 233$ GeV
- ID 70 cross section differential in nb for $E_T > 14$ GeV $233 < W < 277$ GeV

The graphs will be meaningless unless Xsec and Ntot are set before calling the termination routine. (Xsec - total cross section returned by MC) (Ntot - number of events passed to this routine)

The errors shown are statistical and systematic added in quadrature, excluding the correlated error band.

Author: Jon Butterworth

5.31 HZ98029: Energy flow and charged particle spectra in rapidity gap events in DIS (H1)

Purpose:
This routine performs energy flow, seagull and x_f distributions in deep inelastic diffractive scattering according to the measurement of H1 in DESY 98-029.
Event selection:
$7.5 < Q^2 < 100$ GeV^2, $0.05 < y < 0.6$, $x_{pom} < 0.025$
$|t| < 1$ GeV
Beams: 27.5 GeV electrons, 820 GeV protons.
Structure:
HZ98029 should be called before, during and after the event generation. Subprogram HZHADGAP is called. HZ98029 calls HBOOK functions, HZTOOL functions HZDISKIN, HZPHMANG.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98029(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
For Monte Carlo:
ID 1001 = $1/N\ dE/d\eta*$ for $3 < M_X < 8$ GeV,
ID 1002 = $1/N\ dE/d\eta*$ for $8 < M_X < 18$ GeV,
ID 1003 = $1/N\ dE/d\eta*$ for $18 < M_X < 30$ GeV,
ID 1010 = $1/N\ dn/dp_t^2$ for $8 < M_X < 18$ GeV,
ID 1011 = $1/N\ dn/dx_f$ for $8 < M_X < 18$ GeV,
ID 1012 $=< p_t^2 >$ for $18 < M_X < 30$ GeV,
Data histograms have the corresponding negative numbers. **Author:** Hannes Jung

5.32 HZ98038: Jet shapes in DIS (ZEUS)

Purpose:
Produces the histograms of the ZEUS jet shape analysis. Events selection:
$Q^2 > 100$ GeV^2, $E_{t,jet} > 14$ GeV, $-1 < /eta_{jet} < 2$
Structure:
HZ98038 is callable at any time.
Usage:
*

```
INTEGER IFLAG
...
call HZ98038(IFLAG )
```

Input arguments IFLAG=1: initialisation 1001 (NC processes) 2001 (CC processes)
IFLAG=2: filling 1002 (NC processes) 2002 (CC processes)
IFLAG=3: termination 1003 (NC processes) 2003 (CC processes)
Returned Histograms:
For inclusive jet production in NC DIS: (differential jet shapes)
ID=311: $14 < E_{t,jet} <= 21$ GeV
ID=312: $21 < E_{t,jet} <= 29$ GeV
ID=313: $29 < E_{t,jet} <= 37$ GeV
ID=314: $37 < E_{t,jet} <= 45$ GeV
ID=411: $-1 < \eta < 0$
ID=412: $0 < \eta < 1$
ID=413: $1 < \eta < 1.5$
ID=414: $1.5 < \eta < 2$
Integrated jet shapes at $r = 0.5$ ($\Psi(r = 0.5)$) ID=511: $r = 0.5 E_{t,jet}$ ID=512: $r = 0.5\eta$ For inclusive jet production in CC DIS: (differential jet shapes): ID=321: $14 < E_{t,jet} <= 21$ GeV
ID=322: $21 < E_{t,jet} <= 29$ GeV
ID=323: $29 < E_{t,jet} <= 37$ GeV
ID=324: $37 < E_{t,jet} <= 45$ GeV
Integrated jet shapes at $r = 0.5$ ($\Psi(r = 0.5)$) ID=521: $r = 0.5 E_{t,jet}$ ID=522: $r = 0.5\eta$ * **Author:** Andreas von Manteufel

5.33 HZ98044: Multiplicity distribution in rapidity gap events in DIS (H1)

Purpose:
This routine reproduces the multiplicity analysis as detailed in the DESY report 98-044. A sample of "Large Rapidity Gap" events is defined by looking for the largest rapidity gap between final state hadrons and by making the appropriate kinematic selections. The multiplicity structure of the hadronic system "X" is then analysed in the $\gamma I\!\!P$ centre-of-mass system by looking at charged particle multiplicity distributions, their lower moments, rapidity spectra and the correlation between the number of particles in the forward and backward hemispheres.
Beams: 27.5 GeV positrons, 820 GeV protons [1994 HERA running]
Event selection:

1. $7.5\ \mathrm{GeV}^2 < Q^2 < 100\ \mathrm{GeV}^2$
2. $0.05 < y < 0.6$
3. $x_{I\!\!P} < 0.05$
4. $3\ \mathrm{GeV} < M_X < 36\ \mathrm{GeV}$
5. $|t| < 1\ \mathrm{GeV}^2$
6. $M_Y < 1.6\ \mathrm{GeV}$

Structure:
HZ98044 should be called before, during and after the event generation. HZ98044 calls HBOOK and CERNLIB functions and the HzTool functions HZIBEAM, HZIDELEC, HZHCMINI, HZHCM, HZDISKIN and HZHINRM.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98044(IFLAG )
```

Input arguments:
IFLAG=1 initialisation step (before event generation)
IFLAG=2 filling step (during event generation)
IFLAG=3 terminating step (at the end)

Returned histograms:
Bin limits are always mentioned in the histogram title.

1. The multiplicity distributions are stored in the histograms with ID 10-14, 20-24, 30-34, 110-112, 120-122, 130-132, 140-142, 150-152, 160-162 and 170-172.
2. The rapidity spectra are stored in the histograms with ID 15, 25 and 35.
3. The M_X evolution of the average multiplicity, dispersion and normalised second factorial moment is stored in the histograms with ID 40-42, 50-52 and 60-62, respectively.
4. The M_X evolution of the central rapidity density is stored in the histogram with ID 43.
5. The M_X evolution of the forward-backward correlation is stored in the histogram with ID 70.

The data histograms with statistical errors only have the corresponding negative numbers. Data with statistical and systematic errors added in quadrature are stored in the corresponding histograms with offsets -100.

PAW kumac:
k_hz98044 produces nice, clear (for transparencies) plots like in the DESY report 98-044. The user is asked to provide a name tag for the Monte Carlo generator and to specify whether the Monte Carlo multiplicity distribution should be smoothed. (On a logarithmic scale, the tail of the multiplicity distribution has large statistical errors. Therefore a fit to a Levy function can be performed to produce nice looking plots. In case of *very* low statistics, the fit will also not work.) This option is turned off by default.

Author: Pierre Van Mechelen (pvanmech@mail.desy.de)

5.34 HZ98050: Forward jet cross-sections (ZEUS)

Purpose:
Forward Jet Production in Deep Inelastic Scattering at HERA
ZEUS Coll. DESY 98-050 (May 1998) The European Physical Journal C6 (1999) 239-252
together with: Measurement of the $E_T^2, jet/Q^2$ dependence of forward jet production at HERA
ZEUS Coll., DESY 99-162 (October 1999) Physics Letters B 474 (2000) 1-2, 223 - 233
The cuts applied to obtain the forward jet sample are:

$E_t > 5$ GeV, $0.5 < E_{t2}/Q^2 < 2$, $0 < \eta < 2.6$, $x_{jet} > 0.036$, $E_e > 10$ GeV, $y > 0.1$
Structure:
HZ98050 is callable in the event loop.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98050(IFLAG )
```

Input arguments

Returned values
Histogram:
id=-1: The data (hadron level) cross sections as a function of x divided by the bin size

id=1: The MC cross sections as a function of x /

The following routines are not divided by the bin size. id=700: The η distribution of the forward jet (highest xjet)
id=701: The η distribution of the forward jet (2nd highest xjet)
id=710: The E_t distribution of the forward jet (highest xjet)
id=711: The E_t distribution of the forward jet (2nd highest xjet)
id=720: The E_{t2}/Q^2 distribution of the forward jet (highest xjet)
id=721: No E_{t2}/Q^2 cut applied (2nd highest xjet)
* Parton level (divided by the bin size):
id=300: MEPJET (scale 0.25*kt**2)
id=301: MEPJET (scale 2*kt**2)
id=400: BFKL LO
id=401: BFKL first term
The systematics are written out at the end of the program.

Author: Tancredi Carli

5.35 HZ98076: Dijet rates (cone) for Q^2 and x in DIS (H1)

Purpose:
Dijet fraction for $5 < Q^2 < 100$ GeV^2 as a function of Q2 and x using the cone algorithm (PXCONE)

Event selection:
$156 < \theta_{el} < 173$ deg
$E_{el} > 11$ GeV
$y > 0.05$

Jet reconstruction and selection in photon-proton cms: $R = 1$, $p_{t,min} = 5$ GeV, $f = 0.75$ exactly two jets per event fulfilling the above criteria are demanded, in addition $|\eta_{jet1} - \eta_{jet2}| < 2$.

In data 112806 DIS events are selected of which 4957 are di-jet events. The dijet fractions have been corrected to the hadron level in the phase space region given by the cuts under event selection above. They are given in bins of Q^2 ($5 < Q^2 < 100$ GeV^2), integrated over x, and in bins of x ($0.0001 < x < 0.01$), integrated over Q^2.

Statistical and systematic errors are included. Not included is an overall systematic error of $+10\%$ and -8% for the symmetric and $+11\%$ and -8% for the asymmetric and the sum scenario, arising from the uncertainty of the hadronic energy scale of the calorimeter and the uncertainty of the rad. QED corrections. * Running: In generating events, besides applying the cuts under event selection above, the ranges in Q2 and x should not have stricter limits than: $5 < Q^2 < 120$ GeV^2 and $0.00009 < x < 0.023$ *

Structure:
HZ98076 is callable at any time.

Usage:

```
INTEGER IFLAG
...
call HZ98076(IFLAG )
```

Input arguments IFLAG=1: initialisation
IFLAG=2: filling
IFLAG=3: termination

Histograms
ID= 120: R_2 vs x symetric cuts

ID= 130 R_2 vs Q^2 symetric cuts
ID= 220: R_2 vs x cut on difference
ID= 230: R_2 vs Q^2 cut on difference
ID= 320: R_2 vs x cut on sum
ID= 330: R_2 vs Q^2 cut on sum
The histogram IDs with +1,+2,+3 correspond to +1 the total error (up), +2 the total error (down), +3 the statatical error.

Author: Tancredi Carli, Günter Grindhammer

5.36 HZ98085: D^* + jets measurement

Purpose:

Produces the histograms for the D^* + jets measurement
ZEUS Coll., Eur.Phys.J. C6 (1999) 67-83
Event selection:
$Q^2 < 1$ GeV^2
$0.19 < y < 0.87$
Jets: $E_{T1} > 7$ GeV, $E_{T2} > 6$ GeV, $|\eta| < 2.4$
D^*: $p_t > 3$ GeV , $|\eta| < 1.5$

Structure:

HZ98085 is callable at any time.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98085(IFLAG )
```

Input arguments

Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned Histograms

MC histograms
id = 10, xgamma cross-section
id = 20, pT(D*) cross-section
id = 32, eta(D*) cross-section for $pT(D*) > 2GeV$
id = 33, eta(D*) cross-section for $pT(D*) > 3GeV$
id = 34, eta(D*) cross-section for $pT(D*) > 4GeV$
id = 35, eta(D*) cross-section for $pT(D*) > 6GeV$

Data histograms
id = -10, xgamma cross-section
id = -20, pT(D*) cross-section
id = -32, eta(D*) cross-section for $pT(D*) > 2GeV$
id = -33, eta(D*) cross-section for $pT(D*) > 3GeV$

id = -34, eta(D*) cross-section for $pT(D*) > 4GeV$
id = -35, eta(D*) cross-section for $pT(D*) > 6GeV$

Author: Matthew Wing

5.37 HZ98085p: D^* + jets measurement

Purpose:
Produces the histograms for the D^* + jets measurement
ZEUS Coll. Eur.Phys.J. C6 (1999) 67-83
Event selection:
$Q^2 < 1$ GeV^2
$0.19 < y < 0.87$
Jets: $E_{T1} > 7$ GeV, $E_{T2} > 6$ GeV, $|\eta| < 2.4$
D^*: $p_t > 3$ GeV , $|\eta| < 1.5$

Structure:
HZ98085 is callable at any time.
New coding
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98085p(IFLAG )
```

Input arguments
To be run onely once
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id = 11, xgamma cross-section
id = 1, pT(D*) cross-section
id = 3, eta(D*) cross-section for $pT(D*) > 2GeV$
id = 5, eta(D*) cross-section for $pT(D*) > 3GeV$
id = 7, eta(D*) cross-section for $pT(D*) > 4GeV$
id = 9, eta(D*) cross-section for $pT(D*) > 6GeV$

Data histograms
id = -11, xgamma cross-section
id = -1, pT(D*) cross-section
id = -3, eta(D*) cross-section for $pT(D*) > 2GeV$
id = -5, eta(D*) cross-section for $pT(D*) > 3GeV$
id = -7, eta(D*) cross-section for $pT(D*) > 4GeV$
id = -9, eta(D*) cross-section for $pT(D*) > 6GeV$

Author: L. Gladilin

5.38 HZ98087: Dijets rates (JADE) in function of Q^2 (H1)

Purpose:
Produces Dijet rates in function of Q^2 using the JADE algorithm. Cuts: $W^2 >$ 5000 GeV^2, $z_p > 0.1$ where $z_p = \frac{E_{jet,i}*(1-\cos\theta_{jet,i})}{\sum_{jet} E_{jet}*(1-\cos\theta_{jet})}$

Low Q^2:
$40 < Q^2 < 100$ GeV^2,
Energy of scattered $En_{el} > 14$ GeV,
Theta of scattered electron: $160 < \theta_{el} < 173$
High Q^2:
$Q^2 > 100$ GeV^2, $y < 0.7$,
energy of scattered electron $En_{el} > 11$ GeV,
Theta of scattered electron: $10 < \theta_{el} < 150$
$E - P_z$: $38 < \delta < 70$ GeV

Structure:
HZ98087 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98087(IFLAG )
```

Input arguments
IFLAG=1: initialisation
IFLAG=2: filling
IFLAG=3: termination

Returned Histograms
ID=1: N_{1+1} vs Q^2 1+1 jet events are counted
ID=2: N_{2+1} vs Q^2 2+1 events
ID=3: N_{tot} vs Q^2 total sample
ID=4: R_2 vs Q^2
ID=-4: R_2 vs Q^2 data
ID=-104: systematical error to ID=-4 (largest, if asssymetric)
ID=-204: data corrected to parton level assumming LEPTO 6.5
Author: Tancredi Carli

5.39 HZ98092: jet analysis in diffractive scattering

Purpose:
This routine performs a jet analysis in diffractive scattering for DIS and photoproduction according to the measurement of H1 in DESY 98-092.
Event selection (deep inelastic diffractive scattering):
$7.5 < Q^2 < 80$ GeV^2, $0.1 < y < 0.7$, $0.005 < x_{pom} < 0.05$
$|t| < 1$ GeV
Event selection (photoproduction diffractive scattering):
$Q^2 < 0.01$ GeV^2, $0.25 < y < 0.7$, $x_{pom} < 0.05$
$|t| < 1$ GeV
Beams: 27.5 GeV electrons, 820 GeV protons.
Structure:
HZ98092 should be called before, during and after the event generation. Subprogram HZHADGAP is called. HZ98092 calls HBOOK functions, HZTOOL functions HZDISKIN, HZPHMANG, HZIPGAM, HZPHOKIN.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98092(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
For Monte Carlo:
ID 100 = $d\sigma/dz$ for DIS,
ID 120 = $d\sigma/dp_t$ for DIS,
ID 1000 = $d\sigma/dz$ for photoprod.,
ID 1020 = $d\sigma/dp_t$ for photoprod.,
ID 1030 = $d\sigma/dx_\gamma$ for photoprod.,
ID 1040 = $d\sigma/d\eta$ for photoprod.,
Data histograms have the corresponding negative numbers.
Author: Hannes Jung

5.40 HZ98121: $dF_2/d\ln Q^2$

Purpose:
Produces the histograms for the $dF_2/d\ln Q^2$.
ZEUS Coll., Eur.Phys.J. C7 (1999) 609-630
ZEUS 1995 shifted vertex data
Event selection:
$0.6 < Q^2 < 17GeV^2$
$1.2 \times 10^{-5} < x < 1.9 \times 10^{-3}$

Structure:
HZ98121 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98121(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=100: df2/dlnq2

Data histograms
ID=-100: df2/dlnq2

Author: Hannes Jung

5.41 HZ98143: Forward jet and Forward π cross-section in DIS (H1)

Purpose:
Produces the histograms for the forward jet analysis according to the measurement of H1 in DESY 98-143.
Event selection:
$y > 0.1$, $0.0001 < x < 0.004$, $E_{el} > 11$ GeV, $160 < \theta_e < 173^o$
Jet selection: (PXCONE): $E_{jet} > 28.7$ GeV, $P_{T,jet} > 3.5$ GeV, $7 < \theta_{jet} < 20^o$, $0.5 < P^2_{T,jet}/Q^2 < 2$
Structure:
HZ98143 is callable at any time.
Usage:

```
*
          INTEGER IFLAG
          ...
          call HZ98143(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms for forward jets:
ID=301: Cross-section vs x ($p_t > 3.5$)
ID=302: Cross-section vs x ($p_t > 5.0$)
ID=303: Cross-section vs $\Delta(\Phi)$
ID=304: Cross-section vs $\Delta(\Phi)$

H1 data histograms for forward jets:
ID=-301: Cross-section vs x ($p_t > 3.5$) (stat err)
ID=-1301: Cross-section vs x ($p_t > 3.5$) (tot err)
ID=-302: Cross-section vs x ($p_t > 5.0$) (stat err)
ID=-1302: Cross-section vs x ($p_t > 5.0$) (tot err)
ID=-303: Cross-section vs $\Delta(\Phi)$ (high x, stat err)
ID=-1303: Cross-section vs $\Delta(\Phi)$ (high x, tot err)
ID=-304: Cross-section vs $\Delta(\Phi)$ (low x, stat err)
ID=-1304: Cross-section vs $\Delta(\Phi)$ (low x, tot err)

MC histograms for forward π:

ID=201: $1/N dn_\pi/dx$, (π^0), $0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=202: $1/N dn_\pi/dx$, (π^0), $0.015 < x_\pi < 0.15$, $p_{t\,\pi^0} > 1$ GeV
ID=203: $1/N dn_\pi/dx$, (π^0), $0.01 < x_\pi < 0.15$, $p_{t\,\pi^0} > 2$ GeV
ID=204: $1/N dn_\pi/dx$, $(\pi^- + \pi^+)/2$,$0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=205: $1/N dn_\pi/dx$, Char. Part.,$0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV

H1 data histograms for forward π:
ID=-201: $1/N dn_\pi/dx$ (stat err), (π^0), $0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=-1201: $1/N dn_\pi/dx$ (tot err), (π^0), $0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=-202: $1/N dn_\pi/dx$ (stat err), (π^0), $0.015 < x_\pi < 0.15$, $p_{t\,\pi^0} > 1$ GeV
ID=-1202: $1/N dn_\pi/dx$ (tot err), (π^0), $0.015 < x_\pi < 0.15$, $p_{t\,\pi^0} > 1$ GeV
ID=-203: $1/N dn_\pi/dx$ (stat err), (π^0), $0.01 < x_\pi < 0.15$, $p_{t\,\pi^0} > 2$ GeV
ID=-1203: $1/N dn_\pi/dx$ (tot err), (π^0), $0.01 < x_\pi < 0.15$, $p_{t\,\pi^0} > 2$ GeV
ID=-204: $1/N dn_\pi/dx$ (stat err), $(\pi^- + \pi^+)/2$,$0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=-1204: $1/N dn_\pi/dx$ (tot err), $(\pi^- + \pi^+)/2$,$0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=-205: $1/N dn_\pi/dx$ (stat err), Char. Part.,$0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV
ID=-1205: $1/N dn_\pi/dx$ (tot err), Char. Part.,$0.01 < x_\pi < 0.015$, $p_{t\,\pi^0} > 1$ GeV

Author: Tancredi Carli, Guillermo Contreras, Th. Wengler, H. Jung

5.42 HZ98162: Three-jet photoproduction cross sections.

Purpose:
This routine produces the following graphs:

- Measured three-jet cross-section with respect to invariant mass, $d\sigma/dM_{3j}$ (pb/GeV)
- Normalised cross-sections w.r.t angles $cos\theta_3$, ψ_3, and energy sharing quantities X_3 and X_4.
- And the unweighted events versions of these graphs.

Structure:
HZ98162 should be initialised, called after event generation and it should be terminated.
HZ98162 requires the CERNLIB and the following utility routines from the HzTool library: HZJETRAD, HZJTNAME, HZPHOKIN, HZJTFIND, HZBOOST
Beams: 27.5 GeV positrons on 820 GeV protons (1996 HERA running), with the protons travelling in the $+z$ direction.
Cuts: $Q^2 < 1$ GeV^2 , $0.2 < y < 0.8$, $\eta^{jet} < |2.4|$. At least two jets with $E_T^{jet} > 6$ GeV and a third with $E_T^{jet} > 5$ GeV. In addition $M_{3J} > 50$ GeV , $X_3 < 0.95$ and $|cos(\theta_3)| < 0.8$.
The recommended value for ptmin, defining the minimum hard scale of the subprocess, in the Monte Carlo should be set to 6.5 GeV or lower.
Reference: Physics Letters B 443 (1998) 394-408
Usage:

```
*
      INTEGER iflag
      ...
      CALL HZ98162(iflag)
      ...
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned histograms
The histograms which are booked and filled:

- ID=40,41,42,43,44 The generated direct events for the M_{3J}, $cos\theta_3$, ψ_3, X_3, and X_4 distributions.
- ID=50,51,52,53,54 The generated resolved events for the M_{3J}, $cos\theta_3$, ψ_3, X_3, and X_4 distributions.
- ID=-60 Data for the measured M_{3J} cross section in pb/GeV.
- ID=-61,-62,-63,-64 Data for the area renormalised distributions of $cos\theta_3$,ψ_3, X_3, and X_4 respectively.
- ID=60,61,62,63,64 Measured MC three jet cross section with respect to M_{3J}, $cos\theta_3$,ψ_3, X_3, and X_4 respectively. (pb)
- ID=161,162,163,164 Area renormalised distributions for the above.

The errors shown are the systematic and statistical uncertainties added in quadrature.

Author: Eileen Heaphy

5.43 HZ98169: Leading Proton and Neutron Cross Sections (H1)

Purpose:
This routine produces histograms which can compared to the H1 measurements of leading proton and neutron production with $p_T \leq 0.2$ GeV. Event selection: $2 \leq Q^2 \leq 50$ GeV^2, $6 \cdot 10^{-5} \leq x \leq 6 \cdot 10^{-3}$ and baryon $p_T \leq 200$ MeV, for events with a final state proton with energy $580 \leq E' \leq 740$ GeV, or a neutron with energy $E' \geq 160$ GeV. The cross sections are parametrized by a structure function $\mathrm{F}_2^{\mathrm{LB}(3)}$ which is denoted by $\mathrm{F}_2^{\mathrm{LP}(3)}$ and $\mathrm{F}_2^{\mathrm{LN}(3)}$ for the semi–inclusive processes which have final state protons and neutrons respectively. The H1 measurements of $\mathrm{F}_2^{\mathrm{LP}(3)}$ are in the range $0.73 \leq z \leq 0.88$ and of $\mathrm{F}_2^{\mathrm{LN}(3)}$ for $0.3 \leq z \leq 0.9$.

Structure:
HZ98169 is callable at any time.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98169(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms
101 - 112: $\mathrm{F}_2^{\mathrm{LP}(3)}$ data for leading protons.
201 - 212: Monte Carlo predictions for protons.
301 - 312: $\mathrm{F}_2^{\mathrm{LN}(3)}$ data for leading neutrons.
401 - 412: Monte Carlo predictions for neutrons.
The PAW kumac in hztool/paw/k_hz98169 produces two plots which show the Monte Carlo predictions compared to the cross section measurements.

Author: Douglas M. Jansen

5.44 HZ98204: D^* photoproduction

Purpose:
Produces the histograms for the D^* photoproduction
H1 Coll., Nucl.Phys. B545 (1999) 21-44
Event selection:
$Q^2 < 0.01$
$0.29 < y < 0.62$
$2.5 < p_t(D^*) < 10.5$GeV
$|\eta(D^*)| < 1.5$

Structure:
HZ98204 is callable at any time.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ98204(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=9955: $\eta(D^*)$ for $2.5 < pt < 3.5$
ID=9956: $\eta(D^*)$ for $3.5 < pt < 5$
ID=9957: $\eta(D^*)$ for $5 < pt < 10.5$

Data histograms
ID=-9955: $\eta(D^*)$ for $2.5 < pt < 3.5$
ID=-9956: $\eta(D^*)$ for $3.5 < pt < 5$
ID=-9957: $\eta(D^*)$ for $5 < pt < 10.5$

Author: H. Jung

5.45 HZ98205: Measurement of Dijet Cross-Sections at Low Q^2

Purpose:
Produces the histograms for the triple-differential dijet cross-section, $d^3\sigma_{ep}/dQ^2 dE_{t2} dx_\gamma$.
H1 Coll., Eur.Phys.J. C13 (2000) 397-414
Event selection:
$0.1 < y < 0.7$, $1.6 < Q^2 < 80$
$-3\bar{\eta} < -0.5$, $\bar{E}_t^2 > 30$ GeV^2

Structure:
HZ98205 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ98205(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=100+10*I+J : $d\sigma/dx_\gamma$ in bins of Q^2 and η
id=200+10*I+J : $d\sigma/dEt$ in bins of Q^2 and x_γ
id=300+10*I+J : $d\sigma/dQ^2$ in bins of E_t and x_γ

Data histograms
id=-(100+10*I+J) : $d\sigma/dx_\gamma$ in bins of Q^2 and η
id=-(200+10*I+J) : $d\sigma/dEt$ in bins of Q^2 and x_γ
id=-(300+10*I+J) : $d\sigma/dQ^2$ in bins of E_t and x_γ

Author: H. Jung

5.46 HZ98210: Jet shapes at low Q^2 in Breit frame

Purpose:
Produce histograms for:
integrated jet shape (psi) in Breit frame (using different jetfinders, in bins of Et(jet) and eta(jet))

subjet multiplicities in Breit frame (using KTCLUS, in bins of Et(jet) and eta(jet))

event selection:
i) energy of scattered lepton > 11 GeV
ii) 156 ¡ polar scattering angle of lepton < 173
iii) $y > 0.15$
iv) $Q^2 > 10$ GeV^2

jet selection:
Ji) number of jets >= 2 only the two jets with highest E_t are considered
Jii) for both jets: $E_{t,jet}$ in Breit frame > 5 GeV
Jiii) for both jets: $-1 < \eta_{jet}$ in lab. frame < 2

used Jetalgorithms:
Jetfinder 1: KTCLUS
Jetfinder 2: PXCONE with cone radius = 1.0
Jetfinder 3: PXCONE with cone radius = 0.7

Hera running: E_{el} = 27.5 GeV (positrons), E_p=820 GeV

Structure:
HZ98210 is callable at any time. HZ98210 calls functions HZIBEAM, HZIPGAM, HZBRT, HZJTFIND, HZLIJET, HZBRTOLA, HZJETSHP, HZSUBJM HzMeanHi

Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ98210(IFLAG )
```

Input arguments

Returned values
ITEM = Search item
E_t-binning:

Et bin 1: 5 GeV $< E_{t,jet}$ in Breit frame < 8 GeV
Et bin 2: $E_{t,jet}$ in Breit frame > 8 GeV

η-binning:
eta bin 1: ηjet in Breit frame < 1.5
eta bin 2: $1.5 < \eta jet$ in Breit frame < 2.2
eta bin 3: ηjet in Breit frame > 2.2

MC histos for subjet multiplicities:
id = 120+(Etbin-1)*10+etabin
MC histos for integrated jet shapes:
id = 100*jetfinder+Etbin*10+etabin

Histos with H1 data have corresponding negative numbers plus:
offset = 0: for combined errors
offset = -1000: for statistical errors only
offset = -2000: for systematical errors only

Author: Andreas von Manteufel

5.47 HZ99057: High-E_T Dijet Cross Sections in Photoproduction

Purpose:

This routine makes data and MC plots for the dijet cross sections in the reference.

Structure:

The routine needs to be called three times (initialization, event loop and termination) for each physics run. Photoproduction normally requires two physics runs, one for resolved, the other for direct.

HZ99057 requires CERNLIB and the HZTOOL library.

The beams should be e^+, p at 27.5 GeV and 820 GeV respectively (1995 running) with protons travelling in the $+z$ direction.

Cuts: $Q^2 < 1\text{GeV}^2$, $E_T^{1,2} > 14, 11$ GeV, $0.2 < y < 0.85$.

Reference: DESY 99-057.

Usage:

```
INTEGER IFLAG

        ...

        CALL HZ98018(iflag)

        ...
```

Input Arguments:
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.

Returned Histograms:

- id 10 is d(sigma)/d(eta) in pb for all x_γ^{OBS}, all y, 2nd jet backward
- id 11 is d(sigma)/d(eta) in pb for all x_γ^{OBS}, all y, 2nd jet central

- id 12 is d(sigma)/d(eta) in pb for all x_γ^{OBS}, all y, 2nd jet forward
- id 13 is d(sigma)/d(eta) in pb for high x_γ^{OBS}, all y, 2nd jet backward
- id 14 is d(sigma)/d(eta) in pb for high x_γ^{OBS}, all y, 2nd jet central
- id 15 is d(sigma)/d(eta) in pb for high x_γ^{OBS}, all y, 2nd jet forward
- id 16 is d(sigma)/d(eta) in pb for all x_γ^{OBS}, high y, 2nd jet backward
- id 17 is d(sigma)/d(eta) in pb for all x_γ^{OBS}, high y, 2nd jet central
- id 18 is d(sigma)/d(eta) in pb for all x_γ^{OBS}, high y, 2nd jet forward
- id 19 is d(sigma)/d(eta) in pb for high x_γ^{OBS}, high y, 2nd jet backward
- id 20 is d(sigma)/d(eta) in pb for high x_γ^{OBS}, high y, 2nd jet central
- id 21 is d(sigma)/d(eta) in pb for high x_γ^{OBS}, high y, 2nd jet forward
- id 22 is d(sigma)/d(et) in pb for all $x_\gamma^{OBS}, 1 < \eta_2 < 2, 1 < \eta_1 < 2$
- id 23 is d(sigma)/d(et) in pb for all $x_\gamma^{OBS}, 0 < \eta_2 < 1, 1 < \eta_1 < 2$
- id 24 is d(sigma)/d(et) in pb for all $x_\gamma^{OBS}, -1 < \eta_2 < 0, 1 < \eta_1 < 2$
- id 25 is d(sigma)/d(et) in pb for all $x_\gamma^{OBS}, 0 < \eta_2 < 1, 0 < \eta_1 < 1$
- id 26 is d(sigma)/d(et) in pb for all $x_\gamma^{OBS}, -1 < \eta_2 < 0, 0 < \eta_1 < 1$
- id 27 is d(sigma)/d(et) in pb for all $x_\gamma^{OBS}, -1 < \eta_2 < 0, -1 < \eta_1 < 0$
- id 28 is d(sigma)/d(et) in pb for high $x_\gamma^{OBS}, 1 < \eta_2 < 2, 1 < \eta_1 < 2$
- id 29 is d(sigma)/d(et) in pb for high $x_\gamma^{OBS}, 0 < \eta_2 < 1, 1 < \eta_1 < 2$
- id 30 is d(sigma)/d(et) in pb for high $x_\gamma^{OBS}, -1 < \eta_2 < 0, 1 < \eta_1 < 2$
- id 31 is d(sigma)/d(et) in pb for high $x_\gamma^{OBS}, 0 < \eta_2 < 1, 0 < \eta_1 < 1$
- id 32 is d(sigma)/d(et) in pb for high $x_\gamma^{OBS}, -1 < \eta_2 < 0, 0 < \eta_1 < 1$
- id 33 is d(sigma)/d(et) in pb for high $x_\gamma^{OBS}, -1 < \eta_2 < 0, -1 < \eta_1 < 0$

The graphs will be meaningless unless Xsec and Ntot are set before calling the termination routine. (Xsec - total cross section returned by MC) (Ntot - number of events passed to this routine)

The errors shown are statistical and systematic added in quadrature, excluding the correlated error band.

Note: Since the systematic errors on the data are very asymmetric, they are not included properly on these plots. The lowest (up or down) error is included. The rest should be dealt with seperately in a fitting procedure.

Author: Jon Butterworth

5.48 HZ99091: Measurement of the Transverse Energy Flow in Deep-Inelastic Scattering at HERA (H1)

Purpose:
This routine creates histograms for the transverse energy flows ($dE/d\eta$) in the gamma-proton center of mass frame (CMS).

Structure:
HZ99091 is to be called for each event when the HEP common has been filled, and once before and after the event loop. HZ99091 calls HBOOK and the the HZTOOL functions HZDISKIN, HZIDELEC, HZPHMANG, HZIBEAM, HZIPGAM, HZHCMINI, HZHCM, HZMEANHI.

Usage:
INTEGER IFLAG
...
call HZ99091(IFLAG)

Input arguments
IFLAG=1 initialization (before event generation)
IFLAG=2 initialization (during event generation)
IFLAG=3 initialization (after event generation)

Returned histograms
Histograms for four different event selections are created. Table 1 shows the cuts used for the different event selections. For each event selection the energy flow was measured in several x-Q^2-bins (selection A) or Q^2-bins (selection B). Table 2 s

PAW kumacs
rapmix99091.kumac correctly adds the histograms created by HZ99091 for the direct and resolved component given according to the MC generator RAPGAP. They must be given as two different HZTOOL output files. This corresponds to the approach in RAPGAP, where
Author: Carmen Tesch, Reimer Selle, Dirk Kruecker and Guido Nellen

Selection	Cuts
low Q^2, Sel. A	$2.5\ \mathrm{GeV}^2 < Q^2 \leq 100\ \mathrm{GeV}^2$, $W^2 > 4400\ \mathrm{GeV}^2$, $E_e > 12$ GeV, $157° < \theta_e < 176°$, $E_{forward} > 0.5$ GeV
low Q^2, Sel. B	$2.5\ \mathrm{GeV}^2 < Q^2 \leq 100\ \mathrm{GeV}^2$, $0.3 < y < 0.5$, $E_e > 12$ GeV
high Q^2, Sel. A	$Q^2 > 100\ \mathrm{GeV}^2$, $W^2 > 4400\ \mathrm{GeV}^2$, $0.05 < y < 0.6$, $E_{forward} > 0.5$ GeV, $12° < \theta_e < 150°$
high Q^2, Sel. B	$Q^2 > 100\ \mathrm{GeV}^2$, $12° < \theta_e < 150°$, $27110\ \mathrm{GeV}^2 < W^2 < 45182\ \mathrm{GeV}^2$ ($\Leftrightarrow 0.3 < y < 0.5$ for low Q^2)

Table 5.1: The Selection cuts used for the different event selections.

5.49 HZ99094: Forward π^0-Meson Production at HERA (H1)

Purpose:
Produces the histograms for the forward π^0 analysis according to the measurement of H1 in DESY 99-094.
Event selection:
$0.1 < y < 0.6$, $2 < Q^2 < 70$ GeV^2,
π^0 selection: $P_{T,\pi} > 2.5$ GeV (hcms),
$5 < \theta_\pi < 25^o$ (lab),
$x_\pi = E_\pi / E_{proton} > 0.01$ (lab)
Structure:
HZ99094 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ99094(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms for forward π:
ID=114: $d\sigma/dQ^2$, [pb/GeV^2]

bin	low Q^2, selection A	bin	low Q^2, selection B
1	$10^{-5} < x \leq 10^{-4}$, $2.5\ \mathrm{GeV}^2 < Q^2 \leq 5\ \mathrm{GeV}^2$	1	$2.5\ \mathrm{GeV}^2 < Q^2 \leq 5\ \mathrm{GeV}^2$
2	$10^{-4} < x < 2 \cdot 10^{-4}$, $2.5\ \mathrm{GeV}^2 < Q^2 \leq 5\ \mathrm{GeV}^2$	2	$5\ \mathrm{GeV}^2 < Q^2 \leq 10\ \mathrm{GeV}^2$
3	$2 \cdot 10^{-4} < x \leq 3.5 \cdot 10^{-4}$, $2.5\ \mathrm{GeV}^2 < Q^2 \leq 5\ \mathrm{GeV}^2$	3	$10\ \mathrm{GeV}^2 < Q^2 \leq 20\ \mathrm{GeV}^2$
4	$3.5 \cdot 10^{-4} < x \leq 10^{-3}$, $2.5\ \mathrm{GeV}^2 < Q^2 \leq 5\ \mathrm{GeV}^2$	4	$20\ \mathrm{GeV}^2 < Q^2 \leq 50\ \mathrm{GeV}^2$
5	$10^{-4} < x \leq 2 \cdot 10^{-4}$, $5\ \mathrm{GeV}^2 < Q^2 \leq 10\ \mathrm{GeV}^2$	5	$50\ \mathrm{GeV}^2 < Q^2 \leq 100\ \mathrm{GeV}^2$
6	$2 \cdot 10^{-4} < x \leq 3.5 \cdot 10^{-4}$, $5\ \mathrm{GeV}^2 < Q^2 \leq 10\ \mathrm{GeV}^2$		
7	$3.5 \cdot 10^{-4} < x \leq 7 \cdot 10^{-4}$, $5\ \mathrm{GeV}^2 < Q^2 \leq 10\ \mathrm{GeV}^2$		
8	$7 \cdot 10^{-4} < x \leq 2 \cdot 10^{-3}$, $5\ \mathrm{GeV}^2 < Q^2 \leq 10\ \mathrm{GeV}^2$		
9	$2 \cdot 10^{-4} < x \leq 5 \cdot 10^{-4}$, $10\ \mathrm{GeV}^2 < Q^2 \leq 20\ \mathrm{GeV}^2$		
10	$5 \cdot 10^{-4} < x \leq 8 \cdot 10^{-4}$, $10\ \mathrm{GeV}^2 < Q^2 \leq 20\ \mathrm{GeV}^2$		
11	$8 \cdot 10^{-4} < x \leq 1.5 \cdot 10^{-3}$, $10\ \mathrm{GeV}^2 < Q^2 \leq 20\ \mathrm{GeV}^2$		
12	$1.5 \cdot 10^{-3} < x \leq 4 \cdot 10^{-3}$, $10\ \mathrm{GeV}^2 < Q^2 \leq 20\ \mathrm{GeV}^2$		
13	$5 \cdot 10^{-4} < x \leq 1.4 \cdot 10^{-3}$, $20\ \mathrm{GeV}^2 < Q^2 \leq 50\ \mathrm{GeV}^2$		
14	$1.4 \cdot 10^{-3} < x \leq 3 \cdot 10^{-3}$, $20\ \mathrm{GeV}^2 < Q^2 \leq 50\ \mathrm{GeV}^2$		
15	$3 \cdot 10^{-3} < x \leq 10^{-2}$, $20\ \mathrm{GeV}^2 < Q^2 \leq 50\ \mathrm{GeV}^2$		
16	$8 \cdot 10^{-4} < x \leq 3 \cdot 10^{-3}$, $50\ \mathrm{GeV}^2 < Q^2 \leq 100\ \mathrm{GeV}^2$		
17	$3 \cdot 10^{-3} < x \leq 2 \cdot 10^{-2}$, $50\ \mathrm{GeV}^2 < Q^2 \leq 100\ \mathrm{GeV}^2$		
bin	high Q^2, selection A	bin	high Q^2, selection B
1	$2.51 \cdot 10^{-3} < x \leq 6.31 \cdot 10^{-3}$, $100\ \mathrm{GeV}^2 < Q^2 \leq 400\ \mathrm{GeV}^2$	1	$100\ \mathrm{GeV}^2 < Q^2 \leq 220\ \mathrm{GeV}^2$
2	$6.31 \cdot 10^{-3} < x \leq 1.58 \cdot 10^{-2}$, $100\ \mathrm{GeV}^2 < Q^2 \leq 400\ \mathrm{GeV}^2$	2	$220\ \mathrm{GeV}^2 < Q^2 \leq 400\ \mathrm{GeV}^2$
3	$1.58 \cdot 10^{-2} < x \leq 3.98 \cdot 10^{-2}$, $100\ \mathrm{GeV}^2 < Q^2 \leq 400\ \mathrm{GeV}^2$	3	$400\ \mathrm{GeV}^2 < Q^2$
4	$6.31 \cdot 10^{-3} < x \leq 1.58 \cdot 10^{-2}$, $2.5\ \mathrm{GeV}^2 < Q^2 \leq 1100\ \mathrm{GeV}^2$		
5	$1.58 \cdot 10^{-2} < x \leq 3.98 \cdot 10^{-2}$, $5\ \mathrm{GeV}^2 < Q^2 \leq 1100\ \mathrm{GeV}^2$		
6	$3.98 \cdot 10^{-2} < x$, $400\ \mathrm{GeV}^2 < Q^2 \leq 1100\ \mathrm{GeV}^2$		
7	$1100\ \mathrm{GeV}^2 \leq Q^2$		

Table 5.2: Definition of the used x-Q^2- and Q^2-bins for the different event selections.

histo ID	quantity	paper fig.
1 - 17	$1/N\, dE_T/d\eta$ for low Q^2, sel. A, x-Q^2-bins 1-17	2
21 - 25	$1/N\, dE_T/d\eta$ for low Q^2, sel. B, Q^2-bins 1-5	7
26	$\overline{1/N\, dE_T/d\eta}$ vs. Q^2 for $-0.5 < \eta < 0.5$, low Q^2, sel. B	8
27	$\overline{1/N\, dE_T/d\eta}$ vs. Q^2 for $2 < \eta < 3$, low Q^2, sel. B	8
31	$\overline{x}$ vs. x-Q^2-bin (low Q^2, sel. A)	2
32	$\overline{Q^2}$ vs. x-Q^2-bin (low Q^2, sel. A)	2
33	$\overline{\text{origin(breitframe)}}$ vs. x-Q^2-bin (low Q^2, sel. A)	2
34	$\overline{Q^2}$ vs. Q^2-bin (low Q^2, sel. B)	7
35	number of gen. events vs. x-Q^2-bin (low Q^2, sel. A)	
36	number of gen. events vs. Q^2-bin (low Q^2, sel. B)	
41 - 47	$1/N\, dE_T/d\eta$ for high Q^2, sel. A, x-Q^2-bins 1-7	3
51 - 53	$1/N\, dE_T/d\eta$ for high Q^2, sel. B, Q^2-bins 1-3	7
54	$\overline{1/N\, dE_T/d\eta}$ vs. Q^2 for $-0.5 < \eta < 0.5$, high Q^2, sel. B	8
55	$\overline{1/N\, dE_T/d\eta}$ vs. Q^2 for $2 < \eta < 3$, high Q^2, sel. B	8
61	$\overline{x}$ vs. x-Q^2-bin (high Q^2, sel. A)	3
62	$\overline{Q^2}$ vs. x-Q^2-bin (high Q^2, sel. A)	3
63	$\overline{\text{origin(breitframe)}}$ vs. x-Q^2-bin (high Q^2, sel. A)	3
64	$\overline{Q^2}$ vs. Q^2-bin (high Q^2, sel. B)	7
65	number of gen. events vs. x-Q^2-bin (high Q^2, sel. A)	
66	number of gen. events vs. Q^2-bin (high Q^2, sel. B)	
71	gen. crossection	
72	total number of gen. events	

Table 5.3: Listing of the different histograms created by HZ99091.

ID=115: $d\sigma/dQ^2$, [pb/GeV^2] for $p_t > 3.5$ GeV (in hcms)
ID=116: $d\sigma/dx$, [nb] for $p_t > 3.5$ GeV (in hcms)
ID=101: $d\sigma/dx$, [nb] $2.0 < Q^2 < 4.5$ GeV^2
ID=102: $d\sigma/dx$, [nb] $4.5 < Q^2 < 15.0$ GeV^2
ID=103: $d\sigma/dx$, [nb] $15.0 < Q^2 < 70.0$ GeV^2
ID=131: $d\sigma/d\eta$, [pb] $2.0 < Q^2 < 4.5$ GeV^2
ID=132: $d\sigma/d\eta$, [pb] $4.5 < Q^2 < 15.0$ GeV^2
ID=133: $d\sigma/d\eta$, [pb] $15.0 < Q^2 < 70.0$ GeV^2
ID=171: $d\sigma/dp_t$, [pb/GeV] $2.0 < Q^2 < 4.5$ GeV^2
ID=172: $d\sigma/dp_t$, [pb/GeV] $4.5 < Q^2 < 15.0$ GeV^2
ID=173: $d\sigma/dp_t$, [pb/GeV] $15.0 < Q^2 < 70.0$ GeV^2
rate histos: divided by DIS histo
ID=100101: dR/dx, [nb] $2.0 < Q^2 < 4.5$ GeV^2
ID=100102: dR/dx, [nb] $4.5 < Q^2 < 15.0$ GeV^2
ID=100103: dR/dx, [nb] $15.0 < Q^2 < 70.0$ GeV^2

H1 data histograms for forward π:
ID=-114: $d\sigma/dQ^2$, [pb/GeV^2] (stat error)
ID=-10114: $d\sigma/dQ^2$, [pb/GeV^2] (tot. error)
ID=-115: $d\sigma/dQ^2$, [pb/GeV^2] for $p_t > 3.5$ GeV (in hcms) (stat error)
ID=-10115: $d\sigma/dQ^2$, [pb/GeV^2] for $p_t > 3.5$ GeV (in hcms) (tot. error)
ID=-116: $d\sigma/dx$, [nb] for $p_t > 3.5$ GeV (in hcms) (stat error)
ID=-10116: $d\sigma/dx$, [nb] for $p_t > 3.5$ GeV (in hcms) (tot. error)
ID=-101: $d\sigma/dx$, [nb] $2.0 < Q^2 < 4.5$ GeV^2 (stat error)
ID=-10101: $d\sigma/dx$, [nb] $2.0 < Q^2 < 4.5$ GeV^2 (tot. error)
ID=-102: $d\sigma/dx$, [nb] $4.5 < Q^2 < 15.0$ GeV^2 (stat error)
ID=-10102: $d\sigma/dx$, [nb] $4.5 < Q^2 < 15.0$ GeV^2 (tot. error)
ID=-103: $d\sigma/dx$, [nb] $15.0 < Q^2 < 70.0$ GeV^2 (stat error)
ID=-10103: $d\sigma/dx$, [nb] $15.0 < Q^2 < 70.0$ GeV^2 (tot. error)
ID=-131: $d\sigma/d\eta$, [pb] $2.0 < Q^2 < 4.5$ GeV^2 (stat error)
ID=-10131: $d\sigma/d\eta$, [pb] $2.0 < Q^2 < 4.5$ GeV^2 (tot. error)
ID=-132: $d\sigma/d\eta$, [pb] $4.5 < Q^2 < 15.0$ GeV^2 (stat error)
ID=-10132: $d\sigma/d\eta$, [pb] $4.5 < Q^2 < 15.0$ GeV^2 (tot. error)
ID=-133: $d\sigma/d\eta$, [pb] $15.0 < Q^2 < 70.0$ GeV^2 (stat error)
ID=-10133: $d\sigma/d\eta$, [pb] $15.0 < Q^2 < 70.0$ GeV^2 (tot. error)
ID=-171: $d\sigma/dp_t$, [pb/GeV] $2.0 < Q^2 < 4.5$ GeV^2 (stat error)
ID=-10171: $d\sigma/dp_t$, [pb/GeV] $2.0 < Q^2 < 4.5$ GeV^2 (tot. error)
ID=-172: $d\sigma/dp_t$, [pb/GeV] $4.5 < Q^2 < 15.0$ GeV^2 (stat error)
ID=-10172: $d\sigma/dp_t$, [pb/GeV] $4.5 < Q^2 < 15.0$ GeV^2 (tot. error)
ID=-173: $d\sigma/dp_t$, [pb/GeV] $15.0 < Q^2 < 70.0$ GeV^2 (stat error)
ID=-10173: $d\sigma/dp_t$, [pb/GeV] $15.0 < Q^2 < 70.0$ GeV^2 (tot. error)

Please note that the rate histograms for the data points are obtained from the cross section data points divided by the total deep inelastic cross section obtained from the Monte Carlo.

Author: Th. Wengler

5.50 HZ99101: Measurement of D^{*+-} production in DIS

Purpose:
Produces the histograms for the Measurement of D^{*+-} production in DIS
ZEUS Coll., Eur.Phys.J. C12 (2000) 35-52
Event selection:
$1 < Q^2 < 600$ GeV^2, $0.02 < y < 0.7$
$1.5 < p_T(D^{*+-}) < 15$ GeV, $|\eta(D^{*+-})| < 1.5$
Structure:
HZ99101 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ99101(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=1001: f2c Q2=1.8
ID=1002: f2c Q2=4
ID=1003: f2c Q2=7
ID=1004: f2c Q2=11
ID=1005: f2c Q2=18
ID=1006: f2c Q2=30
ID=1007: f2c Q2=60
ID=1008: f2c Q2=130
ID=11001 etc with finer binning
ID=2001: dsigma/dlogq2
ID=2002: dsigma/dlogx
ID=2003: dsigma/dW
ID=2004: dsigma/dxD
ID=2005: dsigma/dpt
ID=2006: dsigma/deta

ID=2101 etc with finer binning

Data histograms
same as above with :
ID=-1001: f2c Q2=1.8 stat
ID=-1101: f2c Q2=1.8 tot
Author: H. Jung, K. Peters

5.51 HZ99126: Measurement of Open Beauty Production

Purpose:
Produces the histograms for Open Beauty Production.
H1 Coll., Phys.Lett. B467 (1999) 156-164; Erratum-ibid. B518 (2001) 331-332
Event selection:
$Q^2 < 1$ GeV^2, $0.1 < y < 0.8$
$35^o < \theta^\mu < 130^o$, $p_T^\mu > 2.0$ GeV

Structure:
HZ99126 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ99126(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
1301: $\log(xg)$ (muon + jets)
1302: kt (muon + jets)
1401: $\log(xg)$ (muon)
1402: kt (muon)
1001: Et of muon jet
1002: η of muon jet
401: pri. p_μ in Lab
402: pri. p_μ in CMS of B-hadron
501: sec. p_μ in Lab
502: sec. p_μ in CMS of B-hadron

Data histograms
None

Author: H. Jung

5.52 HZ99193: Means and Distributions of Event Shape Variables in ep DIS (H1)

Purpose:

Produce histograms for the distributions and the $Q = \sqrt{Q^2}$ dependence of the means of seven event shape variables: Two versions of thrust $\tau_C = 1 - T_C$ and $\tau = 1 - T$, jet broadening B, jet mass ρ, C parameter and two versions of differential two-jet rate y_{k_t} and y_{fJ}.

Q binning:

Low Q sample:

1) $7\,\text{GeV} < Q < 8\,\text{GeV}$
2) $8\,\text{GeV} < Q < 10\,\text{GeV}$

High Q sample:

3) $14\,\text{GeV} < Q < 16\,\text{GeV}$
4) $16\,\text{GeV} < Q < 20\,\text{GeV}$
5) $20\,\text{GeV} < Q < 30\,\text{GeV}$
6) $30\,\text{GeV} < Q < 50\,\text{GeV}$
7) $50\,\text{GeV} < Q < 70\,\text{GeV}$
8) $70\,\text{GeV} < Q < 100\,\text{GeV}$

Reference: *Eur. Phys. J.* **C** 14 (2000) 255, DESY 99-193.
Running: 1994–1997 data, $E_e = 27.5\,\text{GeV}$, $E_p = 820\,\text{GeV}$.
Event selection (Phase space):

1. Energy of scattered lepton:
   $E'_e > 14\,\text{GeV}$ (low Q)
   $E'_e > 11\,\text{GeV}$ (high Q)

2. Polar angle of scattered lepton:
   $157^\circ < \theta'_e < 173^\circ$ (low Q)
   $30^\circ < \theta'_e < 150^\circ$ (high Q)

3. Inelasticity y_e (from lepton) and y_h (from hadronic final state):
   $0.05 < y_e < 0.80$
   $0.05 < y_h$ $\quad$ ($= y_e = y$ on generator level)

4. Angle of 'quark' direction as deduced from the scattered lepton in QPM:
   $\theta_q > 20^\circ$

5. Hadronic energy in forward region (polar angle within (4°, 15°)):
   $E_{\text{forw}} > 0.5\,\text{GeV}$

6. Total hadronic energy in Breit current hemisphere:
   $E_{CH} > 0.1 \cdot Q$ (part of the event shape definition, NOT for y_{k_t}, y_{fJ})

7. No. of hadronic objects in Breit current hemisphere:
   $N_{CH} \geq 2$ (NOT for y_{k_t}, y_{fJ})

8. Note:
   There is a usually ineffective cut-off (s. statistics in log file) of $O(10^{-5})$ to stay away from the exact left and right borders of the distributions. For y_{k_t} overflow events may occur. In case of the mean values this cut is NOT active.

Structure:
If subroutine HZ99193(IFLAG) is called for initialization (IFLAG=1) the program expects to find the two data files hz99193mean.dat and hz99193dist.dat in the current directory. Otherwise all data histograms are filled with zeros.
The data files can be found in the //HZTOOL/DATA directory. You can extract them by: set *.dat -F TEXT, ctot hz99193mean.dat
Called subroutines and functions:
From HBOOK lib: HCDIR, HMDIR, HBOOK1, HBOOKB, HFILL, HPAK, HPAKE, HBARX
From HzTool lib: DEVSHP, HzDiskin, HzIdelec, HzIpgam, HzIbeam, HzBrtini, HzBrt, HzHinrm, HzHinfo, HzChisq

Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ99193(IFLAG)
```

Input arguments:
IFLAG = 1: Initialization
IFLAG = 2: Filling
IFLAG = 3: Termination

Returned histograms

Mean values:	ID = 10:	$\langle\tau\rangle$
	ID = 20:	$\langle B\rangle$
	ID = 30:	$\langle\tau_C\rangle$
	ID = 40:	$\langle\rho\rangle$
	ID = 50:	$\langle C\rangle$
	ID = 60:	$\langle y_{fJ}\rangle$
	ID = 70:	$\langle y_{k_t}\rangle$

Distributions:	(QbinNo = $1\ldots8$)	
	ID = 10 + QbinNo:	$1/Ndn/d\tau$
	ID = 20 + QbinNo:	$1/Ndn/dB$
	ID = 30 + QbinNo:	$1/Ndn/d\tau_C$
	ID = 40 + QbinNo:	$1/Ndn/d\rho$
	ID = 50 + QbinNo:	$1/Ndn/dC$
	ID = 60 + QbinNo:	$1/Ndn/dy_{fJ}$
	ID = 70 + QbinNo:	$1/Ndn/dy_{k_t}$

H1 data histograms have corresponding negative numbers. Data histograms with symmetrized systematic uncertainties only and total uncertainties are stored with offsets of -100 and -200. Note that HBOOK does not allow to save asymmetric uncertainties within one histogram together with the measured points. In order to produce histograms showing statistical (inner error bars) and asymmetric total uncertainties one has to take the measured points and statistical uncertainties from histograms $-10\ldots-78$ and overlay the total uncertainty from histograms $-210\ldots-278$.
Example: `set mtyp 0, set errx 0.00001, h/pl -13 e1, h/pl -213 e0s, set mtyp 20, set errx 0.5, set dmod 1, h/pl -13 e0s`

Author: Klaus Rabbertz

5.53 HZ00017: The Q^2 Dependence of Dijet Cross Sections in gamma p Interactions at HERA

Purpose:
Produces the histograms for the Q^2 Dependence of Dijet Cross Sections.
ZEUS Coll., Phys.Lett. B479 (2000) 37-52
Event selection:
$134 < W < 223$ GeV, $0.2 < y < 0.55$, $0 < Q^2 < 4.5$ GeV^2,
$-1.125 < \eta < 2.2$, $E_T^{jet} > 5.5$ GeV
and
$-1.125 < \eta < 1.875$, $E_T^{jet} > 7.5$ GeV, $E_T^{jet} > 6.5$ GeV

Structure:
HZ00017 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ00017(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
For Monte Carlo with both direct and resolved interactions call hz00017 with iflag +1000 for the DIRECT component run and iflag +2000 for the RESOLVED component run for all three phases (iflag=1,2,3). For a direct only / DIS Monte Carlo just use iflag=1,2,3.
Returned Histograms

MC histograms
For symmetric jets:
ID = 10 Low to high xGamma cross section ratio vs Q2
ID = 11 xGamma cross section of Q2 ¡ 1
ID = 12 xGamma cross section of 0.1 ¡ Q2 ¡ 0.55
ID = 13 xGamma cross section of 1.5 ¡ Q2 ¡ 4.5

For asymmetric jets
ID = 20 Low to high xGamma cross section ratio vs Q2
ID = 21 xGamma cross section of Q2 ¡ 1

ID = 22 xGamma cross section of 0.1 ¡ Q2 ¡ 0.55
ID = 23 xGamma cross section of 1.5 ¡ Q2 ¡ 4.5

Data histograms

For symmetric jets:
ID = -10 Low to high xGamma cross section ratio vs Q2
ID = -11 xGamma cross section of Q2 ¡ 1
ID = -12 xGamma cross section of 0.1 ¡ Q2 ¡ 0.55
ID = -13 xGamma cross section of 1.5 ¡ Q2 ¡ 4.5

For asymmetric jets
ID = -20 Low to high xGamma cross section ratio vs Q2
ID = -21 xGamma cross section of Q2 ¡ 1
ID = -22 xGamma cross section of 0.1 ¡ Q2 ¡ 0.55
ID = -23 xGamma cross section of 1.5 ¡ Q2 ¡ 4.5

Author: B. West, M. Wing

5.54 HZ00035: Dijet Cross section in photoproduction σ/dx_γ

Purpose:
* Produces histograms for the differential di-jet cross section in photoproduction, as a function of the momentum fraction of the parton in the photon as reconstructed from the two highest transverse energy final state jets. $d\sigma_{ep\rightarrow jets+X}/dx_\gamma$

Event selection cuts : $Q^2 < 0.01\text{GeV}^2$
Cut scenario 1: $0.5 < y < 0.7$, $-0.5 < \eta_1, \eta_2 < 2.5$ $|\eta_1 - \eta_2| < 1$, $E_{T1}, E_{T2} > 4$ GeV, $M_{2Jet} > 12$ GeV

Cut scenario 2: $0.5 < y < 0.7$, $-0.5 < \eta_1, \eta_2 < 2.5$, $|\eta_1 - \eta_2| < 1$, $E_{T1}, E_{T2} > 6$ GeV after Pedestal subtraction, $\eta_1, \eta_2 > -0.9 - \ln x_\gamma$

Definition Pedestal: $E_{T,Ped} = 1/A \sum ET$, with $\sum = -1 < \eta - \eta_1 < 1$, $-\pi < \phi - \phi_1 < \pi$,
A=Area for which the sum of Et is taken, outside of jets

Q^2 = photon virtuality
$y = E_{photon}/E_{beam}$ = normalized photon energy
η_1, η_2 = pseudorapidities of the two highest transverse energy jets in HERA laboratory frame
$E_{T,1}$, $E_{T,2}$ = transverse energies of these two jets
M_{2Jet} = invariant mass of these two jets
$x_\gamma = (E_{T,1}exp(-\eta_1) + E_{T,2}exp(-\eta_2))/(2E_{photon})$

Structure:
HZ00035 is callable at any time. No other subprogram is called. HZ00035 calls functions

Usage:
*

```
INTEGER IFLAG
...
call HZ00035(IFLAG )
```

Input Arguments:
Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0,1 and 2.
CHJET: not implemented.
IRUN: not implemented.

Returned histograms

1+100*iproc: $d\sigma/dx_\gamma$ for scenario 1
2+100*iproc: $d\sigma/dx_\gamma$ for scenario 2

The data histograms are on the corresponding negative numbers. **Author:** Tancredi Carli

5.55 HZ00040: Azimuthal Distribution of Charged Particle in the Hadronic Centre of Mass Frame in DIS (ZEUS)

Purpose:
This routines produces the differential phi distribution as a function of minimum transverse momentum, p_c, of leading charged particles. Also produces the $\cos\phi$ and $\cos 2\phi$ moments of p_c. The kinematic range under study is $0.01 < x < 0.1$ and $0.2 < y < 0.8$.
Structure:
HZ00040 should be called before, during and after event generation. HZ00040 calls HBOOK functions as well as assorted HZTOOL utility routines.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ00040(IFLAG )
```

Input arguments
IFLAG=1 intialisation step (before event generation)
IFLAG=2 filling step (during event generation)
IFLAG=3 terminating step (after event generation)
Returned histograms
For Monte Carlo:
ID 10: Differential ϕ distribution, $p_c > 0.5$ GeV.
ID 20: Differential ϕ distribution, $p_c > 1.0$ GeV.
ID 30: Differential ϕ distribution, $p_c > 1.5$ GeV.
ID 40: Differential ϕ distribution, $p_c > 2.0$ GeV.
ID 100: $\cos\phi$ moment as a function of p_c.
ID 200: $\cos 2\phi$ moment as a function of p_c.
Data histograms are given with the corresponding negative ID with only stat errors. Systematic errors are given for the distributon of the moments: -1000-ID for the upper systematic & -1000-ID-1 for the lower systematic. The χ^2 and NdF are stored in the NTUPLE ID=999.
Author: N. Brook

5.56 HZ00166: Measurement of open beauty production in photoproduction

Purpose:
Produces the histograms for the measurement of open beauty production in photoproduction.
ZEUS Coll., Eur.Phys.J. C18 (2001) 625-637
Event selection:
$Q^2 < 1$, $134 < W_{\gamma p} < 269$ GeV,

Structure:
HZ00166 is callable at any time.
Usage:

```
*
          INTEGER IFLAG
          ...
          call HZ00166(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0, 1, 2.
CHJET: implemented.
IRUN: not implemented.

Returned Histograms

MC histograms
ID=10: Monte Carlo cross section (nb) xgamma
ID=20: Monte Carlo cross section (nb) ptrel

Data histograms
ID=-10: Monte Carlo cross section (nb) xgamma
ID=-20: Monte Carlo cross section (nb) ptrel

Author: M. Hayes

5.57 HZ00174 - Diffractive Jet Production in Deep-Inelastic e^+p Collisions at HERA (H1)

Purpose:
This routine calculates dijet and 3-jet cross sections in diffractive deep inelastic scattering as they have been measured by the H1 collaboration. The cross sections are defined at hadron level for the kinematic range given in the following table:

Kinematic Range of Hadron Level Cross Sections
$4 < Q^2 < 80$ GeV^2 $0.1 < y < 0.7$
$x_{I\!P} < 0.05$ $M_Y < 1.6$ GeV $\|t\| < 1.0$ GeV^2
$N_{\rm jets} \geq 2$ or $N_{\rm jets} = 3$ $p^*_{T,jet} > 4$ GeV $-3 < \eta^*_{jet} < 0$

The beams should be set to 820 GeV protons on 27.5 GeV positrons (HERA 1996/7 running conditions).

References:
1. DESY 00-174, hep-ex/0012051, to appear in Eur. Phys. J. C
2. F.-P. Schilling, Ph.D. Thesis, University of Heidelberg (Germany), 2000, DESY-THESIS-2001-010, `http://www.ub.uni-heidelberg.de/archiv/1440`

Structure:
HZ00174 is callable at any time.
HZ00174 calls the following functions: HZIBEAM, HZIPGAM, HZIDELEC, HZDISKIN, HZHADGAP,HZHCMTOL and a few other HZTOOl standard routines.

Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ00174(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)

IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms

In the following table, the histograms filled with the Monte Carlo predictions for the various differential cross sections are listed. The histograms which contain the measured data points including the statistical errors (statistical plus systematic errors added in quadrature) have the id's given by adding 1 (2) to the MC histogram.

ID	Description
1010	Q^2
1020	$p^*_{T,jets}$
1030	$\langle\eta\rangle^{lab}_{jets}$
1040	M_X
1050	W
1060	$\log_{10} x_{I\!P}$
1070	$\log_{10} \beta$
1080	$z_{I\!P}^{(jets)}$
1090	$x_\gamma^{(jets)}$
1100	$E_{rem}^{(\gamma)}$
1110	$z_{I\!P}^{(jets)}$ ($\log_{10} x_{I\!P} = -1.5 \ldots -1.3$)
1120	$z_{I\!P}^{(jets)}$ ($\log_{10} x_{I\!P} = -1.75 \ldots -1.5$)
1130	$z_{I\!P}^{(jets)}$ ($\log_{10} x_{I\!P} = -2.0 \ldots -1.75$)
1140	$z_{I\!P}^{(jets)}$ ($\log_{10} x_{I\!P} < -2.0$)
1150	$z_{I\!P}^{(jets)}$ ($Q^2 + p_T^2 = 20 \ldots 35$ GeV^2)
1160	$z_{I\!P}^{(jets)}$ ($Q^2 + p_T^2 = 35 \ldots 45$ GeV^2)
1170	$z_{I\!P}^{(jets)}$ ($Q^2 + p_T^2 = 45 \ldots 60$ GeV^2)
1180	$z_{I\!P}^{(jets)}$ ($Q^2 + p_T^2 > 60$ GeV^2)
1190	Q^2 ($x_{I\!P} < 0.01$)
1200	$p^*_{T,jets}$ ($x_{I\!P} < 0.01$)
1210	$z_{I\!P}^{(jets)}$ ($x_{I\!P} < 0.01$)
1220	$p_{T,rem}^{(I\!P)}$ ($x_{I\!P} < 0.01$)
1230	M_{123} (3 Jets)
1240	$z_{I\!P}^{(3\ jets)}$ (3 Jets)

PAW Kumac:

A PAW kumac labelled `k_HZ00174` is provided to produce plots from the histograms. Information on the usage is provided within the code.

Author:

Frank-Peter Schilling (`fpschill@mail.desy.de`), April 2001.

5.58 HZ00181: F_2 (H1)

Purpose:
Produces the histograms for $F_2(x, Q^2)$
H1 Coll., Eur.Phys.J. C21 (2001) 33-61
Event selection (data recorded in 1996 and 1997):
$1.5 < Q^2 < 150$ GeV^2
$3 \cdot 10^{-5} < x < 0.2$
Structure:
HZ00181 is callable at any time.
Usage:

```
*
          INTEGER IFLAG
          ...
          call HZ00181(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=1001: f2 Q2=1.5
ID=1002: f2 Q2=2.0
ID=1003: f2 Q2=2.5
ID=1004: f2 Q2=3.5
ID=1005: f2 Q2=5.0
ID=1006: f2 Q2=6.5
ID=1007: f2 Q2=8.5
ID=1008: f2 Q2=12
ID=1009: f2 Q2=15
ID= 1010: f2 Q2=20
ID= 1011: f2 Q2=25
ID= 1012: f2 Q2=35
ID= 1013: f2 Q2=45
ID= 1014: f2 Q2=60
ID= 1015: f2 Q2=90
ID= 1016: f2 Q2=120
ID= 1017: f2 Q2=150

Data histograms
ID=-1001: f2 Q2=1.5 data stat
...
ID= -1017: f2 Q2=150 data stat

ID=-1101: f2 Q2=1.5 data tot
...
ID= -1017: f2 Q2=150 data tot

Author: H. Jung

5.59 HZ01064: F_2 (ZEUS)

Purpose:
Produces the histograms for $F_2(x, Q^2)$
ZEUS Coll., Eur.Phys.J. C21 (2001) 443-471
Event selection (data recorded in 1996 and 1997):
$2.7 < Q^2 < 30000$ GeV^2
$6 \cdot 10^-5 < x < 0.65$
Structure:
HZ01064 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ01064(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=1001: f2 Q2=2.7
ID=1002: f2 Q2=3.5
ID=1003: f2 Q2=4.5
ID=1004: f2 Q2=6.5
ID=1005: f2 Q2=8.5
ID=1006: f2 Q2=10
ID=1007: f2 Q2=12
ID=1008: f2 Q2=15
ID=1009: f2 Q2=18
ID= 1010: f2 Q2=22
ID= 1011: f2 Q2=27
ID= 1012: f2 Q2=35
ID= 1013: f2 Q2=45
ID= 1014: f2 Q2=60
ID= 1015: f2 Q2=70
ID= 1016: f2 Q2=90
ID= 1017: f2 Q2=120

Data histograms
ID=-1001: f2 Q2=2.7 data stat
. . .
ID= -1017: f2 Q2=120 data stat

ID=-1101: f2 Q2=2.7 data tot
. . .
ID= -1017: f2 Q2=120 data tot

Author: H. Jung

5.60 HZ01100: Measurement of D^{*+-} Meson Production and F_2^c (H1)

Purpose:
Produces the histograms for the D^{*+-} Meson Production and F_2^c
H1 Coll., Phys.Lett. B528 (2002) 199-214
Event selection:
$1 < Q^2 < 100$ GeV^2,$0.05 < y < 0.7$
$p_{tD^*} > 1.5$ GeV, and $|\eta_{D^*}| < 1.5$
Structure:
HZ01100 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ01100(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID=1001: f2c Q2=1.5
ID=1002: f2c Q2=3.5
ID=1003: f2c Q2=6.5
ID=1004: f2c Q2=12
ID=1005: f2c Q2=25
ID=1006: f2c Q2=60
ID=2001: dsigma/dq2
ID=2002: dsigma/dlogx
ID=2003: dsigma/dW
ID=2004: dsigma/dxD
ID=2005: dsigma/dpt
ID=2006: dsigma/deta
ID=3101: dsigma/dq2 $1.5 < pt < 4$
ID=3102: dsigma/dq2 $4 < pt < 10$
ID=3201: dsigma/dq2 $-1.5 < \eta < -0.5$

ID=3202: dsigma/dq2 $-0.5 < \eta < 0.5$
ID=3203: dsigma/dq2 $0.5 < \eta < 1.5$
ID=3301: dsigma/deta $1.5 < pt < 2.5$
ID=3302: dsigma/deta $2.5 < pt < 4.0$
ID=3303: dsigma/deta $4 < pt < 10.0$
ID=3401: dsigma/dzd $1.5 < pt < 2.5$
ID=3402: dsigma/dzd $2.5 < pt < 4.0$
ID=3403: dsigma/dzd $4 < pt < 10.0$
ID=3501: dsigma/deta $0 < zd < 0.25$
ID=3502: dsigma/deta $0.25 < zd < 0.5$
ID=3503: dsigma/deta $0.5 < zd < 1$

Data histograms
ID=-1001 data
...
ID-3503 data

Author: H. Jung, K. Peters

5.61 HZ01220: Dijet photoproduction (ZEUS)

Purpose:
Produces the histograms for the dijet photoproduction.
ZEUS Coll., Eur.Phys.J. C23 (2002) 615-631
Event selection:
$134 < W_{\gamma p} < 277$ GeV, $Q^2 < 1$ GeV^2 $E_T^{\rm jet1} > 14$ GeV and $E_T^{\rm jet2} > 11$ GeV
$-1 < \eta^{\rm jet1,2} < 2.4$
Structure:
HZ01220 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ01220(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0,1 and 2.
CHJET: implemented.
IRUN: not implemented.
+100000 is used by NLO intergration options.

Returned Histograms

MC histograms
11: costheta*, low xgamma
12: costheta*, high xgamma
13: high xgamma, 2nd jet backward
· · ·
30: Both jet backward, high xgamma
31 -34: xgamma a-d

Data histograms
-11 · · · -30
-30 · · · -34

Author: J. Butterworth

5.62 HZ01225: Dijet Cross Sections in Photoproduction (H1)

Purpose:
Produces the histograms for the Dijet Cross Sections in Photoproduction.
H1 Coll., Eur.Phys.J. C25 (2002) 13-23
Event selection:
$Q2 < 1\mathrm{GeV}^2$, $0.1 < y < 0.9$
$Et > 15, 25\mathrm{GeV}$, $-0.5 < \ eta < 2.5$
Structure:
HZ01225 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ01225(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0, 1, 3.
CHJET: implemented.
IRUN: not implemented.

Returned Histograms

MC histograms
id 11, $d\sigma/dM_jj$
id 12, $d\sigma/dET(mean)$
id 13, $d\sigma/dET(max)$
id 14, $d\sigma/detabar, 0.1 < y < 0.5, 25 < ET(max) < 35GeV$
id 15, $d\sigma/detabar, 0.1 < y < 0.5, 35 < ET(max) < 80GeV$
id 16, $d\sigma/detabar, 0.5 < y < 0.9, 25 < ET(max) < 35GeV$
id 17, $d\sigma/detabar, 0.5 < y < 0.9, 35 < ET(max) < 80GeV$
id 18, $d\sigma/dxgamma, xp < 0.1$
id 19, $d\sigma/dxgamma, xp > 0.1$
id 20, $d\sigma/dxp, xgamma < 0.8$
id 21, $d\sigma/dxp, xgamma > 0.8$
id 22, $d\sigma/dxgamma, 25 < ET(max) < 35GeV$
id 23, $d\sigma/dxgamma, 35 < ET(max) < 80GeV$
id 24, $d\sigma/d\cos(theta*), xgamma < 0.8$

id 25, $d\sigma/d\cos(theta*), xgamma > 0.8$
id 26, $d\sigma/d\cos(theta*), xgamma < 0.8, M_jj > 65GeV$
id 27, $d\sigma/d\cos(theta*), xgamma > 0.8, M_jj > 65GeV$

Data histograms
id= -11 $\cdots$ -27

Author: M. Wing

5.63 HZ02023: Energy Flow and Rapidity Gaps Between Jets (H1)

Purpose:
Produces the histograms for the Energy Flow and Rapidity Gaps Between Jets.
H1 Coll., Eur.Phys.J. C24 (2002) 517-527
Cuts : $0.3 < y < 0.65$, $Q^2 < 0.01\text{GeV}^2$,
$Et > 6.0, 5.0$ GeV, $\eta < 2.6$ $\Delta\eta > 2.5$
Structure:
HZ02023 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ02023(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
+1000 for direct, +2000 for resolved
Returned Histograms

MC histograms
ID=1001: ETGAP
ID=1002: DETA
ID=1003: XGAM
ID=1004: XPRO
ID=1021: DETA ETCUT 0.5
ID=1022: DETA ETCUT 1.0
ID=1023: DETA ETCUT 1.5
ID=1024: DETA ETCUT 2.0
ID=1031: XGAM ETCUT 0.5
ID=1032: XGAM ETCUT 1.0
ID=1033: XGAM ETCUT 1.5
ID=1034: XGAM ETCUT 2.0
ID=1042: XPRO ETCUT 1.0
ID=1043: XPRO ETCUT 1.5
ID=1044: XPRO ETCUT 2.0
res. histo: 2000 + ...

Data histograms
ID=-4001: ETGAP
ID=-4002: DETA
ID=-4003: XGAM
ID=-4004: XPRO
ID=-4025: DETA ETCUT 0.5
ID=-4026: DETA ETCUT 1.0
ID=-4027: DETA ETCUT 1.5
ID=-4028: DETA ETCUT 2.0
ID=-4035: XGAM ETCUT 0.5
ID=-4036: XGAM ETCUT 1.0
ID=-4037: XGAM ETCUT 1.5
ID=-4038: XGAM ETCUT 2.0
ID=-4046: XPRO ETCUT 1.0
ID=-4047: XPRO ETCUT 1.5
ID=-4048: XPRO ETCUT 2.0

Author: B. Cox

5.64 HZ02079: Measurement of Inclusive Jet Cross-Sections in DIS (H1)

Purpose:
Produces the histograms for the Inclusive Jet Cross-Sections.
H1 Coll., Phys.Lett. B542 (2002) 193-206
Event selection:
$5 < Q^2 < 100$ GeV^2, $0.2 < y < 0.6$, $\theta_e > 156^o$
$Etbreit > 5$ GeV, $-1 < \eta_{lab} < 2.8$
Structure:
HZ02079 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ02079(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
ID: 101 - 103 Et distributions in eta bins
ID: 201 - 205 Et distributions forward in q2 bins
ID: 301 - 303 Et2/Q2 distributions in eta bins

Data histograms
ID: -101 - -103 Et distributions in eta bins DATA stat. err. only
ID: -201 - -205 Et distributions forward in q2 bins DATA stat. err. only
ID: -301 - -303 Et2/Q2 distributions in eta bins DATA stat. err. only
ID: -1101 - -1103 Et distributions in eta bins, total error
ID: -1201 - -1205 Et distributions forward in q2 bins, total error
ID: -1301 - -1303 Et2/Q2 distributions in eta bins, total error
Author: T. Schoerner, H. Jung

5.65 HZ02228: Scaling violations and determination of α_s from jet production in gamma-p

Purpose:
Produces the histograms for the Scaling violations.
ZEUS Coll., Phys.Lett. B560 (2003) 7-23
Event selection:
$E_T^{jet} > 17$ GeV, $1 < \eta^{jet} < 2.5$
Structure:
HZ02228 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ02228(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: implemented.
IPROC: implemented for 0, 1, 2.
CHJET: implemented.
IRUN: not implemented.

Returned Histograms

MC histograms
id 11 $d\sigma/dETjet$ (pb/GeV) versus ETjet (GeV) (fig 1)
id 12 $(ETjet^4) < (Ejet)(d^3)(\sigma)/dpxdpydpz >_{et}$vs $< xT >$ W=180GeV (fig 2a)
id 13 $(ETjet^4) < (Ejet)(d^3)(\sigma)/dpxdpydpz >_{et}$ vs $< xT >$ W=255GeV (fig 2b)
id 14 Ratio of id 12 and id 13 plots vs xT (fig 3)

Data histograms
id -11 $\cdots$ -14

Author: C Targett-Adams

5.66 HZ03015: Dijet angular distributions in photoproduction of charm (ZEUS)

Purpose:
Produces the histograms for the Dijet angular distributions.
ZESU Coll., Phys.Lett. B565 (2003) 87-101
Event selection:
$D^{*\pm}$ in photoproduction
Structure:
HZ03015 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ03015(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=101: $|costh|$ xgamma.gt.0.75
id=102: $|costh|$ xgamma.lt.0.75
id=201: costh xgamma.gt.0.75
id=202: costh xgamma.lt.0.75

Data histograms
id=-101: $|costh|$ xgamma.gt.0.75 (stat)
id=-1101: $|costh|$ xgamma.gt.0.75 (tot)
id=-102: $|costh|$ xgamma.lt.0.75 (stat)
id=-1102: $|costh|$ xgamma.lt.0.75 (tot)
id=-201: costh xgamma.gt.0.75 (stat)
id=-1201: costh xgamma.gt.0.75 (tot)
id=-202: costh xgamma.lt.0.75(stat)
id=-1202: costh xgamma.lt.0.75(tot)

Author: H. Jung

5.67 HZ03094: Measurement of diffractive open-charm (ZEUS)

Purpose:
Produces the histograms for the diffractive charm
ZEUS Coll., Nucl.Phys. B672 (2003) 3-35
Event selection:
$1.5 < Q^2 < 200$ GeV^2, $0.02 < y < 0.7$,
$x_{IP} < 0.035$, $\beta < 0.8$,
$p_T(D^{*+/-}) > 1.5$ GeV and $|\eta(D^{*+/-})| < 1.5$
Structure:
HZ03094 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ03094(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=900: ZEUS log10(q2) MC
id=901: ZEUS beta MC
id=902: ZEUS xpom MC
id=903: ZEUS eta MC
id=904: ZEUS pt MC

Data histograms
with negative ids

Author: H. Jung

5.68 HZ03160: Inclusive Dijet Production at Low x (H1)

Purpose:
Produces the histograms for the Inclusive Dijet
H1 Coll., Eur.Phys.J. C33 (2004) 477-493
Event selection:
$10^-4 < x < 10^-2$ and $5 < Q^2 < 100$
Structure:
HZ03160 is callable at any time.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZ03160(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
id=101-103: dsig/deta, q2bin 1, xbin 1-3
id=201-204: dsig/deta, q2bin 2, xbin 1-3
id=301-302: dsig/deta, q2bin 3, xbin 1-3
id=401-404: dsig/det, q2bin 1, xbin 1-4
id=501-504: dsig/det, q2bin 2, xbin 1-4
id=601-602: dsig/det, q2bin 3, xbin 1-4

id=801: S vrs x 5.l.q2.lt.10
id=802: S vrs x 10.l.q2.lt.15
id=803: S vrs x 15.l.q2.lt.20
id=804: S vrs x 20.l.q2.lt.30
id=805: S vrs x 30.l.q2.lt.50
id=806: S vrs x 50.l.q2.lt.100

Data histograms
with negative ids

Author: R. Poeschl

5.69 HZ03206: Dijet Production at Low Q^2 (H1)

Purpose:
Produces the histograms for dijet Production at Low Q^2
H1 Coll., Eur.Phys.J. C37 (2004) 141-159
Event selection:
$2 < Q^2 < 80\,GeV^2$, $0.1 < y < 0.85$
$E_{T1} > 7$ GeV, $E_{T2} > 5$ GeV, $-2.5 < \eta_1^*, \eta_2^* < 0$
Structure:
HZ03206 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZ03206(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination

Returned Histograms

MC histograms
$d(\sigma)/dQ^2dE3dx_g$
$d(\sigma)/dQ^2dx4gdy$
$d(\sigma)/dQ^2dy1dR5$
$d(\sigma)/dQ^2dRdE1$

Data histograms
see code for deatils

Author: K. Sedlak

5.70 HZH9505001: Study of the photon remnant in resolved photoproduction at HERA. (ZEUS)

Purpose:
Produces the histograms of the photon remnant properties in Fig.3 of [27].
Event selection:
Photoproduction (no electron seen). Dijet in the detector and a thrid jet in the photon region. See paper and code for details.
Structure:
This routine has to be run twice with iflag+1000 for the DIRECT component run. iflag+2000 for the RESOLVED component run. For each run, use the standard initialise, fill and terminate.
Usage:

```
*
        INTEGER IFLAG
        ...
        call HZH9505001(IFLAG )
```

Input arguments
Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0, 1, 2.
CHJET: not implemented.
IRUN: not implemented.

Returned Histograms

MC histograms
id= 10:, Simulation of Fig.3a of [27]
id= 11:, Simulation of Fig.3b of [27]
id= 12:, Simulation of Fig.3c of [27]
These histograms are area normalised to one, like the measurement. The corresponding simulated cross sections (i.e. normalised to luminosity) are in histograms 10,11 & 12.

Data histograms
id= -10:, Data from Fig.3a of [27]
id= -11:, Data from of Fig.3b of [27]
id= -12:, Data from of Fig.3c of [27]
Authors: C. O'Dea, J. M. Butterworth, B. M. Waugh.

5.71 HZH9810020: Charged Particle Cross Sections in Photoproduction and Extraction of the Gluon Density in the Photon (H1)

Purpose:
Produces histograms for charged particle cross sections in photoproduction as functions of the charged particle pseudorapidity and transverse momentum.

Event selection cuts:

Photon Virtuality:	$Q^2 < 0.01\,\mathrm{GeV}^2$,
Inelasticity:	$0.3 < y < 0.7 \quad (165 < W < 251\,\mathrm{GeV})$,
Pseudorapidity:	$-1 < \eta < 1$,
Transverse momentum:	$p_\mathrm{T} > 2\,\mathrm{GeV/c}$ or $p_\mathrm{T} > 3\,\mathrm{GeV/c}$.

The beam energies should be set to 820 GeV for protons and 27.5 GeV for positrons (HERA 1994 running conditions).

Reference [28]:
C. Adloff *et al.* [H1], Eur. Phys. J. C **10** (1999) 363 [DESY–98–148, hep–ex/9810020]

Structure:
HZ98148 is callable at any time.
HZ98148 calls HZDISKIN, HZETA, HZLCHGE, HZHINRM.

Usage:

```
...
INTEGER IFLAG
...
CALL HZH9810020(IFLAG)
```

Input arguments:
Integer argument IFLAG as documented in Section 1.4.1.
IPS: not implemented.
IPROC: implemented for 0, 1, 2.
CHJET: not implemented.
IRUN: not implemented.

Returned histograms:

H1 Data	MC	Description
-101	101	Transverse momentum squared (Fig. 2a)
-103	103	Pseudorapidity η in lab. frame for $pt > 2\,\mathrm{GeV/c}$ (Fig. 3a)
-104	104	Pseudorapidity η in lab. frame for $pt > 3\,\mathrm{GeV/c}$ (Fig. 3b)

Authors:
Stefan Lausberg (lausberg@mail.desy.de),
Victor Lendermann (victor@mail.desy.de).

5.72 HZH0302034: Measurement of Inclusive Jet Cross Sections in Photoproduction at HERA (H1)

Purpose:
Produces histograms for inclusive jet cross sections in photoproduction as measured by the H1 collaboration. The cross sections are calculated as functions of the jet transverse energy E_T^{jet}, pseudorapidity η^{jet} and the kinematic variable $x_T = 2E_T^{\text{jet}}/W_{\gamma p}$. Furthermore, correction factors are provided, which shall correct parton level calculations for multiple interactions and hadronization effects.

Event selection cuts:

γp cms energy:	$95 \leq W_{\gamma p} \leq 285\,\text{GeV}$,
Jet energy:	$5 \leq E_T^{\text{jet}} \leq 75\,\text{GeV}$,
Jet pseudorapidity:	$-1 \leq \eta^{jet} \leq 2.5$,
Photon virtuality:	$Q^2 \leq 1\,\text{GeV}^2$.

Detailed information on the applied cuts and ranges for each histogram is provided within the code. The beams should be set to 820 GeV for protons and 27.5 GeV for positrons (HERA 1996/1997 running conditions).

References:

1. C. Adloff *et al.* [H1 Collaboration], Eur. Phys. J. C **29** (2003) 497 [DESY–02–225, hep–ex/0302034]
2. S. Ferron, Doctoral Thesis, Ecole Polytechnique (France), http://www-h1.desy.de/psfiles/theses/h1th-295.ps

Structure:
HZH0302034 is callable at any time.
HZH0302034 calls: HZBRTOLA, HZDISKIN, HZHINRM, HZIBEAM, HZIDELEC, HZIPGAM, HZJTFIND, HZPHMANG.

Usage:

```
...
INTEGER IFLAG
...
CALL HZH0302034(IFLAG )
```

Input arguments:
Integer argument IFLAG as documented in Section 1.4.1.

IPS: not implemented.
IPROC: implemented for 0, 1, 2.
CHJET: not implemented.
IRUN: not implemented.

Returned histograms:

ID	Description
101 to 603	Histograms filled by the MC generator
-101 to -601	Measured cross sections with statistical errors only
-1101 to -1601	Measured cross sections with total (statistical and systematic) errors
1011 to 5011	Correction factors for hadronization: $(1+\delta_{\text{hadr.}})$
1012 to 5012	Correction factors for underlying events: $(1+\delta_{\text{u.e.}})$
1013 to 5013	Correction factors for fragmentation: $(1+\delta_{\text{frag.}})$
9001 to 9017	(Unpublished) correction factors for Fig. 9, $S(x_T)$: $\mathcal{A}$, $\langle E_T^{\text{jet}}\rangle$, $\mathcal{H}$

Definitions of correction factors:

- Ratio between the full event simulation and the event simulation after parton showers but before fragmentation and underlying events:

$$(1+\delta_{\text{hadr.}}) = \frac{+\text{ps} + \text{frag} + \text{ue}}{+\text{ps} - \text{frag} - \text{ue}}$$

- Ratio between the full event simulation and the event simulation with parton showers and fragmentation but without underlying events:

$$(1+\delta_{\text{u.e.}}) = \frac{+\text{ps} + \text{frag} + \text{ue}}{+\text{ps} + \text{frag} - \text{ue}}$$

- Ratio between the event simulation with parton showers and fragmentation but without underlying events and the event simulation with parton showers but before fragmentation and underlying events:

$$(1+\delta_{\text{frag.}}) = \frac{+\text{ps} + \text{frag} - \text{ue}}{+\text{ps} - \text{frag} - \text{ue}}$$

Definitions of bin-wise correction factors for Fig. 9 (Histo 602):

- $\langle E_T^{\text{jet}}\rangle$ – average E_T of jets in a x_T bin;
- $\mathcal{A}$ - correction factor from the measured differential γp cross section in E_T bins, σ_{m}, to the required one at a fixed $W_{\gamma p} = 200\,\text{GeV}$ in x_T bins, σ_{t}:

$$\mathcal{A} = \frac{{E_T^{\text{jet}}}^3\ \sigma_{\text{t}}\big|_{|\eta^*|<0.5,\ W_{\gamma p}=200\,\text{GeV},\ Q^2<1\,\text{GeV}^2}}{\langle E_T^{\text{jet}}\rangle^3\ \sigma_{\text{m}}\big|_{1.5<\eta<2.5,\ 164<W_{\gamma p}<242\,\text{GeV},\ Q^2<0.01\,\text{GeV}^2\text{in bins }1-3,\ Q^2<1\,\text{GeV}^2\text{in bins }4-6}}\ .$$

Note also the different pseudorapidity and Q^2 ranges;

- $\mathcal{H}$ – total correction factor:

$$\mathcal{H} = \frac{1}{\mathcal{A}\langle E_T^{\rm jet}\rangle^3}$$

All factors were determined using PYTHIA for all bins, and separately, using PHOJET for the three lower bins and HERWIG for the three upper bins. The final $\mathcal{H}$ factors are average values for each x_T bin between PYTHIA and PHOJET/HERWIG:

$$\mathcal{H} = \frac{(\mathcal{H}_{\rm PYTHIA} + \mathcal{H}_{\rm HERWIG/PHOJET})}{2} \ .$$

In histogram 601, the desired function for Fig. 9

$$S = \frac{E_T^{\rm jet^3}}{\pi W_{\gamma p}} \frac{d\sigma_{\gamma p}}{dx_T}$$

is filled directly. To compare to the published H1 data, MC programs have to be run at a fixed $W_{\gamma p} = 200\,{\rm GeV}$. However, the HZTool functions for kinematic calculations may not work correctly in this mode. As a solution, one can run MC in the *ep* mode and fill histo 601 in a narrow $W_{\gamma p}$. The narrower the region, the more precise the result but the more statistics is required. The region can be set in the code by parameters **Wlow, Whigh**. The photon flux is recalculated for the given region (see Ref. 2, sect. 1.2.3, eq. (1.45)). By default, the region is: $164 < W < 242\,{\rm GeV}$.

Instead, in histogram 602 the measured γp cross section

$$\sigma_{\rm m} = \frac{1}{2\pi} \frac{d^2\sigma_{\gamma p}}{dE_T d\eta} = \frac{1}{2\pi F} \frac{d^2\sigma_{ep}}{dE_T d\eta} \ ,$$

where F is the photon flux factor, is filled in bins of E_T (in one bin of η: $1.5 < \eta < 2.5$ in lab. frame) for normal MC simulations with HERA running conditions. To transform it to S, one has to multiply it by $\langle E_T^{\rm jet}\rangle^3$ and by $\mathcal{A}$ factors, or, instead, in one step, divide by $\mathcal{H}$. The result has to be put in corresponding x_T bins. Am example PAW macro **k_hzh0302034** for Fig. 9 is provided. Thus, using histo 602 and dividing by the averaged $\mathcal{H}$ factors, one follows at closest the H1 analysis procedure. But here one uses the pre-defined correction factors obtained from some previous MC simulations.

Note: S is given in natural units, in which it is dimensionsless.

PAW macro in hztool/paw/k_hzh0302034:

The user is assumed to have two hbook files filled using this routine by a MC generator with direct and resolved photon, respectively. The file names are written in initialisation step. The histograms from both files are summed, and the sums are plotted.

Macro input arguments:

iflag = 1 – opening hbook files,
iflag = 2 – plotting to the screen and eps file,
iflag = 3 – closing hbook files,
iflag = 0 – (default) all above steps at once;
corr = 'pythia' – apply correction factors determined using PYTHIA,
corr = 'herwig' – apply correction factors determined using PHOJET/HERWIG,
corr = anything else - apply average correction factors as in the publication (default);
factor – common scale factor for MC (default = 1.2 as in the paper).

Macro output eps file:

desy02-225_fig9.eps .
H1 data (closed circles), MC histo 601 (open triangles) and MC histo 602 multiplied by correction factors (open circles) are plotted. Data of other experiments are not plotted.

Authors:

Kristin Lohwasser (`lohwass@mail.desy.de`), Victor Lendermann (`victor@mail.desy.de`).

Chapter 6

Reference Manual: The LEP Histogramming Routines

6.1 HZC96132: Inclusive Jet Production in Photon-Photon Collisions at $\sqrt{s}_{\text{ee}} = 130$ and 136 GeV (OPAL)

Purpose:
This routine produces the graphs for the inclusive one- and two-jet production cross-sections in collisions of quasi-real photons radiated from the LEP beams at e^+e^- centre-of-mass energies $\sqrt{s}_{\text{ee}} = 130$ and 136 GeV using the OPAL detector at LEP.
Reference: CERN-PPE/96-132, Zeit. fur Physik C73 (1997) 433
Structure:
HZC96132 should be initialised, called after event generation and it should be terminated.
HZC96132 requires CERNLIB, and from HZTOOL: HZEEKIN, HZJETRAD, HZJTNAME, HZJTFIND, HZHINRM, HZCHISQ
Beams: The data were taken at e^+e^- centre-of-mass energies of 130 and 136 GeV, so $\sqrt{s}_{\text{ee}}$ should be set to 133 GeV with e^+e^- travelling in z-direction.
Cuts: anti-tag on scattered beam particles (< 25 mrad),$E_t > 3$ GeV, $|\eta_{jet} < 1.0$.
Recommended value for minimum p_{T} is 2.2 GeV (to be set in MC setup)
Usage:

```
*
        INTEGER IFLAG
        ...
        CALL HZ96132(IFLAG)
        ...
```

Input arguments:
IFLAG=1 initialisation phase
IFLAG=2 filling the MC-histograms
IFLAG=3 termination phase
This routine has to be run three times to generate direct, single-resolved and double-resolved events.
IFLAG+1000 for direct component run
IFLAG+2000 for single-resolved component run
IFLAG+3000 for double-resolved component run
ATTENTION: all three stages must be run. Graphs are only sensible if NTOT and XSEC in the HERACMN common block are correct before calling the termination phase.
Returned histograms:

- ID=10 (Figure 7): The inclusive one-jet cross-section as a function of $E_{\text{T}}^{\text{jet}}$

for jets with $|\eta^{\text{jet}}| < 1$

- ID=11 (Figure 8): The inclusive two-jet cross-section as a function of $E_{\text{T}}^{\text{jet}}$ for jets with $|\eta^{\text{jet}}| < 1$
- ID=20 (Figure 9): The inclusive one-jet cross-section as a function of $|\eta^{\text{jet}}|$ for jets with $E_{\text{T}}^{\text{jet}} > 3$ GeV
- ID=21 (Figure 10): The inclusive two-jet cross-section as a function of $|\eta^{\text{jet}}|$ for jets with $E_{\text{T}}^{\text{jet}} > 3$ GeV

The data histograms have corresponding negative numbers. Data histograms with only statistical errors are stored in -10 to -21 and histograms with statistical and systematic errors are stored in -110 to -121
Author: Russell Taylor, Johannes Elmsheuser

6.2 HZC98091: Inclusive Production of Charged Hadrons and K^0_S Mesons in Photon-Photon Collisions (OPAL)

Purpose:
This routine produces the graphs for the production of charged hadrons and K^0_S mesons in the collisions of quasi-real photons measured using the OPAL detector at LEP.
Reference: CERN-EP/98-091 or hep-ex/9808009, Published in Eur.Phys.J.C6:253-264,1999
Structure:
HZC98091 should be initialised, called after event generation and it should be terminated.
HZC98091 requires: LUEXEC from JETSET, and from HZTOOL: HZEEKIN, HZETA, HZLCHGE, HZFILHEP, HZHINRM, HZCHISQ
Beams: The data were taken at e^+e^- centre-of-mass energies of 161 and 172 GeV, so $\sqrt{s_{ee}}$ should be set to 166.5 GeV with e^+e^- travelling in z-direction.
Cuts: Anti-tag on scattered beam particles (< 33 mrad), charged hadrons: $t >$ 0.3 ns, $|\eta| < 1.5$
Choose gamma-gamma invariant mass range: ECMIN=4 for jets, ECMIN=10 for K^0_S
Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ98091(IFLAG)
      ...
```

Input arguments:
IFLAG=1 initialisation phase
IFLAG=2 filling the MC-histograms
IFLAG=3 termination phase
This routine has to be run three times to generate direct, single-resolved and double-resolved events.
IFLAG+1000 for direct component run
IFLAG+2000 for single-resolved component run
IFLAG+3000 for double-resolved component run
ATTENTION: all three stages must be run. Graphs are only sensible if NTOT and XSEC in the HERACMN common block are correct before calling the termination phase.

Returned histograms:

- ID=10-13 (Figure 3): Differential inclusive charged hadron production cross-sections $d\sigma/dp_T$ for $|\eta| < 1.5$ and in the W ranges (10) $10 < W < 30$ GeV; (11) $30 < W < 55$ GeV; (12) $55 < W < 125$ GeV and (13) for all W ($10 < W < 125$ GeV) measured at $\sqrt{s}_{ee} = 161$ and 172 GeV.
- ID=20-23 (Figure 5): Differential inclusive charged hadron production cross-sections $d\sigma/d|\eta|$ for $p_T > 120$ MeV/c and in the W ranges (20) $10 < W < 30$ GeV; (21) $30 < W < 55$ GeV; (22) $55 < W < 125$ GeV and (23) for all W ($10 < W < 125$ GeV) measured at $\sqrt{s}_{ee} = 161$ and 172 GeV.
- ID=30-33 (Figure 6): Differential inclusive charged hadron production cross-sections $d\sigma/d|\eta|$ for $p_T > 1.5$ GeV/c and in the W ranges (30) $10 < W < 30$ GeV; (31) $30 < W < 55$ GeV; (32) $55 < W < 125$ GeV and (33) for all W ($10 < W < 125$ GeV) measured at $\sqrt{s}_{ee} = 161$ and 172 GeV.
- ID=40,41 (Figure 7): Differential inclusive K^0_S production cross-sections (40) $d\sigma/dp_T$ and (41) $d\sigma/d|\eta|$ for $p_T(K^0_S) > 1$ GeV/c and $|\eta(K^0_S)| < 1.5$ in the W range $10 < W < 125$ GeV.
- ID=50,51 (Figure 8): Differential inclusive K^0_S production cross-sections $d\sigma/dp_T$ for $p_T(K^0_S) > 1$ GeV/c and $|\eta(K^0_S)| < 1.5$ in the W ranges (50) $10 < W < 35$ GeV and (51) $35 < W < 125$ GeV.

The data histograms have corresponding negative numbers. Data histograms with only statistical errors are stored in -10 to -51 and histograms with statistical and systematic errors are stored in -110 to -151
Author: Johannes Elmsheuser

6.3 HZC98113: Di-Jet Production in Photon-Photon Collisions at $\sqrt{s}_{\rm ee} = 161$ and 172 GeV (OPAL)

Purpose:
This routine produces the graphs for the di-jet production in collisions of quasi-real photons radiated by the LEP beams at e^+e^- centre-of-mass energies $\sqrt{s}_{\rm ee} = 161$ and 172 GeV measured with the OPAL-detector.
Reference: CERN-EP/98-113 or hep-ex/9808027
Structure:
HZC98113 should be initialised, called after event generation and it should be terminated.
HZC98113 requires CERNLIB and from HZTOOL: HZEEKIN, HZJETRAD, HZJTNAME, HZJTFIND, HZJETSHP, HZEEBEAM, HZHINRM, HZCHISQ
Beams: The data were taken at e^+e^- centre-of-mass energies of 161 and 172 GeV, so $\sqrt{s}_{\rm ee}$ should be set to 166.5 GeV with e^+e^- travelling in z-direction.
Cuts : Anti-tag on scattered beam particles (< 33 mrad), $E_t > 3$ GeV, $|\eta_{jet}| < 2.0$, in events with more than two jets, only the two jets with the highest E_t values are taken. Recommended value for minimum $p_{\rm T}$ is 2.2 GeV (to be set in MC set up)
Usage:

```
*
      INTEGER IFLAG
      ...
      CALL HZ98113(IFLAG)
      ...
```

Input arguments:
IFLAG=1 initialisation phase (default jet finder PXCONE is selected)
IFLAG+jetf*10 in initialisation phase to change jet finder
IFLAG=2 filling the MC-histograms
IFLAG=3 termination phase
This routine has to be run three times to generate direct, single-resolved and double-resolved events.
IFLAG+1000 for direct component run
IFLAG+2000 for single-resolved component run
IFLAG+3000 for double-resolved component run
ATTENTION: all three stages must be run. Graphs are only sensible if NTOT and XSEC in the HERACMN common block are correct before calling the termination phase.
Returned histograms:

- ID=1,2 (Figure 3): Differential di-jet cross-section as a function of $|\cos\theta^*|$. The cross section is shown for events with $x_\gamma^\pm < 0.8$ and for event with $x_\gamma^\pm > 0.8$.

- ID=10 (Figure 6): The inclusive di-jet cross-section as a function of $E_{\rm T}^{\rm jet}$ for events with $|\eta^{\rm jet}| < 2$

- ID=20-22 (Figure 8): The inclusive di-jet cross-section as a function of $|\eta^{\rm jet}|$ for events with $E_{\rm T}^{\rm jet1} > 4$ GeV and $E_{\rm T}^{\rm jet2} > 3$ GeV is shown for (20) all events and (21) for events with a large contribution of double-resolved events by requiring $x_\gamma^\pm < 0.8$ and (22) for events with a large contribution of direct events by requiring $x_\gamma^\pm > 0.8$.

- ID=23-25 (Figure 9): The inclusive di-jet cross-section as a function of $|\eta^{\rm jet}|$ for events with $E_{\rm T}^{\rm jet1} > 5$ GeV and $E_{\rm T}^{\rm jet2} > 3$ GeV are shown (23) for all events and (24) for events with a large contribution of double-resolved events by requiring $x_\gamma^\pm < 0.8$ and (25) for events with a large contribution of direct events by requiring $x_\gamma^\pm > 0.8$.

- ID=26-28 (Figure 10): The inclusive di-jet cross-section as a function of $|\eta^{\rm jet}|$ for events with $E_{\rm T}^{\rm jet} > 5$ GeV are shown (26) for all events and (27) for events with a large contribution of double-resolved events by requiring $x_\gamma^\pm < 0.8$ and (28) for events with a large contribution of direct events by requiring $x_\gamma^\pm > 0.8$.

- ID=30-33 (Figure 4): The measured jet shapes, $\psi(r)$, corrected to the hadron level for each of the two highest $E_{\rm T}^{\rm jet}$ jets. The jet shapes are shown in bins of $\bar{E}_{\rm T}^{\rm jet}$; (30) $3 < \bar{E}_{\rm T}^{\rm jet} < 6$ GeV, (31) $6 < \bar{E}_{\rm T}^{\rm jet} < 9$ GeV, (32) $9 < \bar{E}_{\rm T}^{\rm jet} < 12$ GeV and (33) $12 < \bar{E}_{\rm T}^{\rm jet} < 20$ GeV.

- ID=34-37 (Figure 5): The fraction of the transverse energy of the jets inside a cone of radius $r = 0.5$ around the jet axis is shown (34) as a function of $\bar{E}_{\rm T}^{\rm jet}$ and (35) as a function of $\eta^{\rm jet}$. The measured jet shapes corrected to the hadron level, $\psi(r)$, are shown in (36) for $x_\gamma^\pm < 0.8$ and in (37) for $x_\gamma^\pm > 0.8$.

- ID 39 (Figure 7): Transverse energy flow outside the jets in the central rapidity region $|\eta^*| < 1$ as a function of x_γ.

The data histograms have corresponding negative numbers. Data histograms with only statistical errors are stored in -1 to -39 and histograms with statistical and systematic errors are stored in -101 to -139
Author: Johannes Elmsheuser, Russell Taylor

Chapter 7

Reference Manual: The TEST Histogramming Routines

7.1 HZTH002

Purpose:
This routines measures the fraction of events with forward jets in different bins of x and x_{jet}.
Event selection:
$E_{el} = 26.7$ GeV, $E_p = 820$ GeV, $E'_{el} > 12$ GeV, $173.0^o > \theta'_{el} > 157.0^o$, $y > 0.1$ and a cut on the forward energy as in Reference Phys. Lett. B356 (1995) 118, DESY 95-108.
Jet finding is done with the PXCONE algorithm using a cone radius of 0.7, a minimum jet p_t of 5 GeV and a jet overlap parameter of 0.75. The forward jet was required to have $0.25 < p_t^2/Q^2 < 4$.

Structure:
HZTH002 is callable after having filled the HEP common. HZTH002 calls functions HzPhmang, HzDiskin, HzIdelec and PXCONE.

Usage:

```
*
        INTEGER IFLAG
        ...
        call HZTH002(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)

IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
ID = 11: Fraction of events with forward jets for different kinematic al bins: first $0.0002 < x < 0.001$ requiring $x_{\rm jet} < 0.025$, then $0.001 < x < 0.002$, $x_{\rm jet} < 0.025$ and finally $0.0002 < x < 0.002$ requiring $x_{\rm jet} < 0.05$. In all cases $6^o < \theta_{\rm jet} < 20^o$.
ID = 21: Fraction of events with forward jets vs x and $x_{\rm jet}$ assuming a perfect calorimeter covering $\eta_{\rm LAB} < 4$ with $6^o < \theta_{\rm jet} < 20^o$.
ID = 31: As 21 but assuming maximum $\eta_{\rm LAB} < 7$ and $\eta_{\rm jet} < 6$.
ID = 41: As 21 but assuming maximum $\eta_{\rm LAB} < 5$ and $\eta_{\rm jet} < 4$.

Author: Leif Lönnblad

7.2 HZTH001

Purpose:
This routines measures the E_t distribution in a couple of rapidity bins in the hadronic center of mass system for 9 different bins in x and Q^2.
Event selection:
$E_{el} = 26.7$ GeV, $E_p = 820$ GeV, $E'_{el} > 12$ GeV, $173.0^o > \theta_{el} > 157.0^o$, $W^2 > 4400$ GeV^2 and a cut on the forward energy as in reference: Phys. Lett. B356 (1995) 118, DESY 95-108. The 9 bins in x and Q^2 are the same as in this reference.

Structure:
HZTH001 is callable at any time. HZTH001 calls functions HzPhmang, HzDiskin, HzIdelec, HzIpgam, HzIbeam, HZHCMINI, HZHCM and HZCHISQ

Usage:

```
*
        INTEGER IFLAG
        ...
        call HZTH001(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned values
ID = -31: pseudo data for $E_\perp$ distribution for $|\eta_{\text{CMS}}| < 0.5$ in the bin $0.0002 < x < 0.0005$, $10 < Q^2 < 20$ GeV^2, generated with Ariadne version 4.03 which was found to be in good agreement with data in the reference above.
ID = $11 - 19$: $E_\perp$ distribution for $|\eta_{\text{CMS}}| < 0.5$ assuming a perfect calorimeter covering $\eta_{\text{LAB}} < 4$
ID = $31 - 39$: as $11 - 19$ but $-1.5 < \eta_{\text{CMS}} < -0.5$
ID = $41 - 49$: as $11 - 19$ but $-2.5 < \eta_{\text{CMS}} < -1.5$
ID = $51 - 59$: as $31 - 39$ but assuming detector covering $\eta_{\text{LAB}} < 5$
ID = $61 - 69$: as $41 - 49$ but assuming detector covering $\eta_{\text{LAB}} < 5$
ID = $71 - 79$: as $31 - 39$ but assuming detector covering $\eta_{\text{LAB}} < 7$
ID = $81 - 89$: as $41 - 49$ but assuming detector covering $\eta_{\text{LAB}} < 7$

Author: Leif Lönnblad

7.3 HZTH002

Purpose:
This routines measures the fraction of events with forward jets in different bins of x and x_{jet}.
Event selection:
$E_{el} = 26.7$ GeV, $E_p = 820$ GeV, $E'_{el} > 12$ GeV, $173.0^o > \theta'_{el} > 157.0^o$, $y > 0.1$ and a cut on the forward energy as in Reference Phys. Lett. B356 (1995) 118, DESY 95-108.
Jet finding is done with the PXCONE algorithm using a cone radius of 0.7, a minimum jet p_t of 5 GeV and a jet overlap parameter of 0.75. The forward jet was required to have $0.25 < p_t^2/Q^2 < 4$.

Structure:
HZTH002 is callable after having filled the HEP common. HZTH002 calls functions HzPhmang, HzDiskin, HzIdelec and PXCONE.

Usage:

```
*
      INTEGER IFLAG
      ...
      call HZTH002(IFLAG )
```

Input arguments
IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histograms
ID = 11: Fraction of events with forward jets for different kinematic al bins: first $0.0002 < x < 0.001$ requiring $x_{\rm jet} < 0.025$, then $0.001 < x < 0.002$, $x_{\rm jet} < 0.025$ and finally $0.0002 < x < 0.002$ requiring $x_{\rm jet} < 0.05$. In all cases $6^o < \theta_{\rm jet} < 20^o$.
ID = 21: Fraction of events with forward jets vs x and $x_{\rm jet}$ assuming a perfect calorimeter covering $\eta_{\rm LAB} < 4$ with $6^o < \theta_{\rm jet} < 20^o$.
ID = 31: As 21 but assuming maximum $\eta_{\rm LAB} < 7$ and $\eta_{\rm jet} < 6$.
ID = 41: As 21 but assuming maximum $\eta_{\rm LAB} < 5$ and $\eta_{\rm jet} < 4$.

Author: Leif Lönnblad

Chapter 8

Reference Manual: The LC Histogramming Routines

8.1 HZNLC1: Jet Cross Section in $\gamma\gamma$

Purpose:
Produces the histograms for Jet Cross Section in $\gamma\gamma$
Event selection:
$Q^2 < 4\text{GeV}^2$
Structure:
HZNLC1 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZNLC1(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
This photoproduction routine has to be run 3 times with the following code additions:
+1000 for the DIRECT component run (iproc=1).
+2000 for the SINGLY-RESOLVED component run (iproc=2)
+3000 for the DOUBLY-RESOLVED component run (iproc=3)

Returned Histograms

MC histograms
id=1: X-Sec (nb), Barrel ECAL
id=2: X-Sec (nb), Forward/Backward ECAL
id=3: Barrel ECAL
id=4: Forward/Backward ECAL
id=10: X-Sec (nb), Et>2 GeV
id=11: X-Sec (nb), Et>4 GeV
id=12: X-Sec (nb), Et>6 GeV
id=13: X-Sec (nb), Et>10 GeV
id=14: X-Sec (nb), Et>15 GeV
id=15: X-Sec (nb), Et>20 GeV

Author: R. Taylor

8.2 HZNLC2: Particle Spectra in $\gamma\gamma$

Purpose:
Produces the histograms for Particle Spectra in $\gamma\gamma$
Event selection:
$Q^2 < 4\text{GeV}^2$
Structure:
HZNLC2 is callable at any time.
Usage:

```
*
      INTEGER IFLAG
      ...
      call HZNLC2(IFLAG )
```

Input arguments
IFLAG=1 initialisation
IFLAG=2 filling
IFLAG=3 termination
This photoproduction routine has to be run 3 times with the following code additions:
+1000 for the DIRECT component run (iproc=1).
+2000 for the SINGLY-RESOLVED component run (iproc=2)
+3000 for the DOUBLY-RESOLVED component run (iproc=3)

Returned Histograms

MC histograms
id=1:, Momentum spectrum for particles inside mask
id=2:, Momentum spectrum for particles into mask
id=3:, Momentum spectrum for particles outside mask
id=4:, Momentum spectrum for particles into VDet
id=11:, Charged particles - inside mask
id=12:, Charged particles - into mask
id=13:, Charged particles - outside mask
id=14:, Charged particles - into VDet
id=21:, E/event inside mask
id=22:, E/event into mask
id=23:, E/event outside mask
id=31:, Charged E/event inside mask
id=32:, Charged E/event into mask
id=33:, Charged E/event outside mask

id=1+iproc*100:, Particles - inside mask
id=2+iproc*100:, Particles - into mask
id=3+iproc*100:, Particles - outside mask
id=4+iproc*100:, Particles into VDet
id=11+iproc*100:, Charged particles - inside mask
id=12+iproc*100:, Charged particles - into mask
id=13+iproc*100:, Charged particles - outside mask
id=14+iproc*100:, Charged particles - into VDet
id=21+iproc*100:, E/event inside mask
id=22+iproc*100:, E/event into mask
id=23+iproc*100:, E/event outside mask
id=31+iproc*100:, Charged E/event inside mask
id=32+iproc*100:, Charged E/event into mask
id=33+iproc*100:, Charged E/event outside mask

Author: R. Taylor

Chapter 9

Reference Manual: The Utility Routines in Alphabetic Order

9.1 HZBOOST: Lorentz boost of 4-vector

Purpose:
Performs Lorentz boosts of given 4-vector.
Structure:
HZBOOST is callable at any time. No other subprogram is called.
Usage:

```
*
      Double Precision DBEX, DBEY, DBEZ, P, PNEW(4)
      ...
      call HZBOOST(DBEX, DBEY, DBEZ, P, PNEW)
```

Input arguments
BEX, BEY, BEZ =
gives the direction and size, β, of a Lorentz boost, such that a particle initially at rest will have p/E = β afterwards.
P= is the vector to be acted upon
Returned values
PNEW = is the boosted vector
Author: LUROBO in JETSET (modified by N. Brook)

9.2 HZBRTINI and HZBRT: Boost to Breit Frame

Purpose:
HZBRTINI and HZBRT (entry point) perform Lorentz boost to the Breit frame.
HZBRTINI has to be called once an event to set up boost and rotation variables.
HZBRT performs the actual boost of the particles.
Structure:
HZBRTINI or HZBRT are callable at any time. HZBRTINI calls HZBOOST,HZPHMANG.
HZBRT calls HZBOOST,HZPHMANG,HZPHMROT.
Usage:

```
*
      INTEGER IERR
      DOUBLE PRECISION PBEAM(4), PGAM(4), P(4), PNEW(4)
      ...
      call HZBRTINI(PBEAM,PGAM,IERR)
      call HZBRT(P,PNEW,IERR)
```

Input arguments
PBEAM = the 4-vector of the proton beam
PGAM = the 4-vector of the virtual exchanged boson
P = the 4-vector to be acted upon

Returned values
PNEW = the boosted vector
IERR = an error flag (1 = failed)
Author: N. Brook

9.3 HZCHISQ: Calculation of χ^2

Purpose:
Calculates $\chi^2 = \sum_i^n (\mathrm{MC} - \mathrm{DATA})^2/(\mathrm{ErrMC}^2 + \mathrm{ErrData}^2)$ between histograms containing the data and the Monte Carlo prediction and stores it in an ntuple (ID=999) for further analysis. In addition the number of degrees of freedom is stored. The ntuple is only created, if it does not exist in the corresponding PAW directory. Only points in the histograms are taken into account, for which the error on the data is not equal zero. The routine returns an error message, if the compared histograms do not have the same binning.
Structure:
HZCHISQ is callable at any time (even from PAW !). HZCHISQ calls the HBOOK functions HEXIST, HBOOKN, HGIVE, HREBIN,HUNPAK AND HFN.

Usage:

*

```
INTEGER IDDAT,IDMC
...
call HZCHISQ(IDDAT, IDMC)
call HZCHISQA(iddatu,iddatl,IDMC)
```

Input arguments

Iddat = histogram ID of data
Idmc = histogram ID of Monte Carlo
or
Iddatu - histogram ID of data (with upper syst error)
Iddatl - Histogram ID of data (with lower syst error)
Idmc - Histogram ID of Monte Carlo

Returned NTUPLE

Ntuple with identifier 999 containing the histogram identifier, the χ^2 and the number of degrees of freedom.

Author: Nick Brook

9.4 HZDISKIN: returns kinematic variables

Purpose:

Returns DIS kinematic variables (Q^2, x_{Bj}, y_{Bj} and W^2).

Structure:

HZDISKIN is callable at any time after the HEP common has been filled. HZDISKIN calls the functions HZIPGAM, HZIBEAM

Usage:

*

```
INTEGER ITYPE
DOUBLE PRECISION HZDISKIN,VAR
...
VAR=HZDISKIN(ITYPE)
```

Input arguments

ITYPE= 1: Q^2
ITYPE= 2: x_{bj}
ITYPE= 3: y_{bj}
ITYPE= 4: W^2

Returned values

VAR = kinematic variable (see above) (-1 mean error)
Author: N. Brook

9.5 HZET: returns E_T of particle

Purpose:
Calculates transverse energy of particle in PHEP common
Structure:
HZET is callable at any time.
Usage:
*

```
INTEGER IPART
DOUBLE PRECISION ET
...
ET=HZET(IPART )
```

Input arguments
ipart: index of particle in HEP common
Returned values
transverse energy of particle **Author:** Andreas von Manteuffel

9.6 HZETA: returns η of particle

Purpose:
Gives pseudo-rapidity for a particle in the HEP common.
Structure:
HZETA is callable at any time.
Usage:
*

```
INTEGER IPART
DOUBLE PRECISION ETA
...
ETA=HZETA(IPART )
```

Input arguments
ipart: index of particle in HEP common
Returned values
pseudo-rapidity of particle, or +/-20.D0 if calculation not possible **Author:** Andreas von Manteuffel

9.7 HZEEBEAM: returns the position of beam particles

Purpose:
Returns the position of the beam particles in the HEP common for e^+e^- collisions at LEP.
Structure:
HZEEBEAM is callable at any time after the HEP common has been filled. No other function is called.
Usage:

```
*
      INTEGER IFLAG, HZEEBEAM, I1, I1
      ...
      IFLAG = HZEEBEAM(I1,I2)
      ...
```

Input arguments:
none
Returned values:
IFLAG=1: both beams are found
IFLAG=-2: no beam was found
IFLAG=-1: only electron beam was found
IFLAG=0: only positron beam was found
I1 = pointer to electron
I2 = pointer to positron
Author: Johannes Elmsheuser, M.Hayes

9.8 HZEEGAMN: flags whether two virtual photons are found or not

Purpose:
Flags whether two virtual photons are found or not in e^+e^- collisions. If found, the five components (p_x,p_y,p_z,E,m) for both photons are passed back.
Structure:
HZEEGAMN is callable at any time after the HEP common has been filled. No other function is called.
Usage:

```
*
          INTEGER IFLAG, HZEEGAMN
          DOUBLE PRECISION PGAMN1(5), PGAMN2(5)
          ...
          IFLAG = HZEEGAMN(PGAMN1,PGAMN2)
          ...
```

Input arguments:
none
Returned values:
IFLAG=1: both virtual photons are found
IFLAG=-1: no scattered electron/positron was found
PGAMN1 = (p_x,p_y,p_z,E,m) of the virtual photon from the electron
PGAMN2 = (p_x,p_y,p_z,E,m) of the virtual photon from the positron
Author: Johannes Elmsheuser, J.Butterworth, M.Hayes

9.9 HZEEKIN: returns kinematic variables

Purpose:
Returns kinematic variables for e^+e^- collisions at LEP.
Structure:
HZEEKIN is callable at any time after the HEP common has been filled. HZEEKIN calls HZEEGAMN, HZEEBEAM and HZPHMANG
Usage:

```
*
          INTEGER ITYPE
          DOUBLE PRECISION HZEEKIN, VAR
          ...
          VAR = HZEEKIN(ITYPE)
          ...
```

Input arguments:
ITYPE=1: Q^2 of highest Q^2-photon
ITYPE=11: Q^2 of lowest Q^2-photon
ITYPE=2: Largest electron (positron) scattering angle
ITYPE=3: y_{bj} of highest Q^2 photon
ITYPE=13: y_{bj} of lowest Q^2 photon
ITYPE=4: W^2
Returned values:
VAR = kinematic variable (see above) (-1: error)
Author: Johannes Elmsheuser, Russell Taylor, M.Hayes, J.Butterworth

9.10 HZFILHEP: Data transfer from HEP commom to Hztool common

Purpose:
Transfer data from HEP common to HERACMN and HEPEVTP common.
Structure:
HZFILHEP should be called just after an event has been generated. The HZTOOL functions HZLUHEPC, HZLUNCOP (for LEPTO and ARIADNE) and HZHRWCOP (for HERWIG) are called.
Usage:
*

```
...
call HZFILHEP
```

Input arguments
none
Returned values
none
Author: N. Brook

9.11 HZHADGAP: reconstructs hadronic final state for rap. gap events

Purpose:
Reconstruct the hadronic final state at the (generated) hadron level following the H1 definition of diffraction presented at Eilat 1995. In this scheme the hadronaic final state is separated into two systems ep—¿eXY where X (the diffractive system) and Y (the proton dissociation system) are separated by the largest gap in rapidity in the event. This definition works for all processes and diffractive and non-diffractive. *
Structure:
HZHADGAP is callable at any time. No other subprogram is called. HZHADGAP calls functions
Usage:
*

```
REAL XMAS,YMAS,T,XPOM
...
call HZHADGAP(XMAS,YMAS,XPOM,T)
```

Input arguments
none
Returned values
XMAS= mass of diffractive system YMAS= mass of remnant XPOM= X Pomeron T = momentum transfer from proton side **Author:** Hannes Jung

9.12 HZHEPTOP: replaces HEP common with partons

Purpose:
Replaces the HEP-Common with the partons in the event (keeping beam particles, documentation-Z_o and the scattered lepton).
Structure:
HZHEPTOP is callable at any time after the HEP-Common has been filled. HZHEPTOP calls HZPARTON to get the partonlist.
Usage:

```
 *
        ...
        call HZHEPTOP
```

Input arguments
none.
Returned values
Returns new HEP-Common based on partons (with status ISTHEP set to 1 (=stable))
Author: Reimer Selle

9.13 HZHCMINI and HZHCM: boost to HCM system

Purpose:
HZHCMINI and HZHCM (entry point) perform a Lorentz boost to the hadronic center of mass system.
HZHCMINI is called once an event to set up boost and rotation variables. HZHCM performs the actual boost of the particles

Structure:
HZHCMINI or HZHCM are callable at any time and call HZBOOST, HZPHMANG

and HZPHMROT.
Usage:
*

```
INTEGER IERR
DOUBLE PRECISION PBEAM(4),PGAM(4), P(4), PNEW(4)
...
call HZHCMINI(PBEAM, PGAM, IERR)
call HZHCM(P, PNEW, IERR)
```

Input arguments
PBEAM = the 4-vector of the proton beam
PGAM = the 4-vector of the virtual exchanged boson
P = the vector to be acted upon

Returned values
PNEW = the boosted vector
IERR = an error flag (1 = failed)
Author: N. Brook

9.14 HZHCMTOL boost to HCM system

Purpose:
BOOST PARTICLES BETWEEN HADRONIC CMS AND LAB (BOTH DIRECTIONS) (wrapping KTFRAM)
Structure:
HZHCMTOL is callable at any time and call
Usage:
*

```
INTEGER IOPT,IRET
DOUBLE PRECISION PLEP2(4),PHAD(4),POUT(4),P2(4),Q2(4)
...
HZHCMTOL(IOPT,PLEP2,PHAD2,POUT,P2,Q2,IRET)
```

Input arguments IPOT: 0 (boost lab-¿CMS) 1 (boost CMS-¿lab)
PLEP2(4): 4-vector of of lepton
PHAD2(4): 4-vector of of protonPOUT2(4): 4-vector of of scattered lepton
P2(4): 4-vector of particle before boost
Returned values
Q2(4): 4-vector of particle after boost
IRET: Error flag (=0: OK)

Author: F.P. Schilling

9.15 HZHINFO

Purpose:
Fills number of entries of a given histogram in the Ntuple 998
Structure:
HZHINFO is callable at any time. No other subprogram is called. HZHINFO calls functions
Usage:
*

```
INTEGER IDMC, NBIN
...
call HZHINFO(IDMC, NBIN)
```

Input arguments
IDMC: Histogram identifier
NBIN: number of entries of histogram
Author: Tancredi Carli

9.16 HZHINRM: Normalise histogram

Purpose:
Normalize a given 1-dim histogram with factors 1/nevt and 1/binwidth. This routine also works for non-equidistant bins.
Structure:
HZHINRM is callable at any time. HZHINRM calls the HBOOK functions.
Usage:
*

```
INTEGER IID, IIDNEW, IIFL
REAL NEVT
...
call HZHINRM(IID, IIDNEW, NEVT, IIFL)
```

Input arguments
iid= histogram id to be normalized (200 bins maximally !)
iidnew= new histo id (if 0, old histo is modified)
nevt= normalization factor (usually number of events)
iifl= 1: normalize errors too, otherwise they are zeroed

Author: Michael Kuhlen

9.17 HZHRWCOP: copy HERWIG HEPEVT to HEPEVTP common

Purpose:
Deals with copying HERWIG HEPEVT to HEPEVTP common.
Structure:
HZHRWCOP is callable at any time. No other subprogram is called. HZHRWCOP calls the functions HZPHMROT and HZLCHGE.
Usage:

```
*
      ...
      call HZHRWCOP
```

Input arguments
none
Returned values
none
Author: N. Brook

9.18 HZIBEAM: returns the position of the beam particles

Purpose:
Returns the position of the proton and lepton beam in the HEP common.
Structure:
HZIBEAM is callable at any time after the HEP common has been filled. No other function is called.
Usage:

```
*
      INTEGER IFLAG, HZIBEAM, IP, IL
      ...
      IFLAG=HZIBEAM(IP, IL)
```

Input arguments
none
Returned values

IFLAG=1: both beams are found
IFLAG=0: only lepton beam found
IFLAG=−1: only proton beam found
IP = pointer to beam proton in HEP common
IL = pointer to beam lepton in HEP common
Author: N. Brook

9.19 HZIDELEC: returns the position of the scattered lepton

Purpose:
This routines returns the position of the scattered lepton in the HEP common. For LEPTO, ARIADNE, HERWIG, DJANGO amd QCDINS the first stable particle is assumed to be the scattered lepton.
Structure:
HZIDELEC is callable at any time after the HEP common has been filed. No other function is called.
Usage:

```
*
      INTEGER IND,HZIDELEC, IDUM
      ...
      IND=HZIDELEC(IDUM)
```

Input arguments
IDUM= only a dummy.
Returned values
IND=position of the scattered electron (= −1, if error)
Author: N. Brook

9.20 HZIDNTRO: returns index of first neutrino

Purpose:
HzIdntro returns index of first neutrino in HEP common (for CC events). Please, note: current version will only work with LEPTO !
Structure:
HZIDNTRO is callable at any time. No other subprogram is called. HZIDNTRO calls functions
Usage:

```
*
          INTEGER IDUM,IDNE
          ...
          IDNE=HZIDNTRO(Idum )
```

Input arguments
Idum: dummy argument
Returned values
IDNE: index of first neutrino in HEP common **Author:** Andreas von Manteuffel

9.21 HZIPGAM: returns the virtual boson

Purpose:
Flags whether a virtual boson is found or not and returns its vector giving five components (px,py,pz,e,m).
Structure:
HZIPGAM is callable only after the HEP common block has been filled.
No other subprogram is called.
Usage:

```
*
          INTEGER IFLAG, HZIPGAM
          DOUBLE PRECISION PGAM(5)
          ...
          IFLAG = HZIPGAM( PGAM )
```

Input arguments None
Returned values
PGAM = the vector of the virtual boson (px,py,pz,e,m)
IFLAG = 1 if boson found (−1 otherwise)
Author: Mark Hayes

9.22 HZIPGAMN: Flags virtual boson

Purpose:
Flags whether a virtual boson is found or not and returns its vector giving five components (px,py,pz,e,m).
Structure:
HZIPGAMN is callable only after the HEP common block has been filled.
No other subprogram is called.

Usage:
*

```
INTEGER IFLAG, HZIPGAMN
DOUBLE PRECISION PGAM(5)
...
IFLAG = HZIPGAMN( PGAM )
```

Input arguments None
Returned values
PGAM = the vector of the virtual boson (px,py,pz,e,m)
IFLAG = 1 if boson found (−1 otherwise)
Author: Mark Hayes

9.23 HZGAMAD: Adds virtual gamma to event record

Purpose:
Adds virtual gamma to event record for PYTHIA and POMPYT
Structure:
HZGAMAD is callable at any time.
Usage:
*

```
INTEGER IFLAG
...
call HZGAMAD(IFLAG )
```

Input arguments IFLAG is not used

Returned values
None **Author:** Hannes Jung

9.24 HZJETRAD: Set and read the jet cone radius

Purpose:
To set and read the jet cone radius, used by jet finders using a cone.
Structure:
HZJETRAD must be called before the initialization of the relevant histogram rou-

tine.
HZJETRAD needs no other functions.
Usage:
*

```
INTEGER ITYPE
DOUBLE PRECISION CONER
...
CALL HZJETRAD( ITYPE , CONER )
```

Input arguments
ITYPE = 1 set the cone radius to CONER (in radians)
ITYPE = 2 return the cone radius in CONER
Returned values
(when ITYPE =1) CONER= -1 for radius set with no problems.
(when ITYPE =2) CONER= radius of cone or -1 for radius not set/error occured
Author: Mark Hayes

9.25 HZJETSHP: calculates jetshape variables

Purpose:
this subroutine calculates jetshape variables: differential jetshape rho, integrated jetshape psi in standard bins of r/R: 0.0,0.1,0.2,...,1.0 Note: sum over pt (and not Et) of particles is used !
Structure:
HZJETSHP is callable at any time.
This subroutine will only work correctly, if the common block HZJETCMN has been filled before (by HzJtfind) !!! This subroutine calls the following subroutine/functions: From HzTool lib: HzEta, HzPhi, HzPt from PXCONE lib: PXMDPI
Usage:
*

```
INTEGER iNormMod
Double Precision dconeRad
Double Precision djshpRho(10,MAXHZJETS)
Double Precision djshpPsi(10,MAXHZJETS)
Integer IERR
...
call HZJETSHP(iNormMod, dconeRad, djshpRho, djshpPsi, ierr)
```

Input arguments
iNormMod : normalization mode

= 0: jetshapes will be normalized with jet pt
= 1: jetshapes will be normlized with
summed pt of all particles belonging to jet AND lying inside a cone of radius dconeR (with cone axis=jet axis)
dconeRad : cone radius R
(if dconeR ¡= 0.D0, cone radius returned by HzJtfind is used)
Returned values
djshpRho(i,j): differential jetshape rho of jet no.j in r/R bin no.i
djshpPsi(i,j): integrated jetshape rho of jet no.j in r/R bin no.i
ierr : error flag
= 0: everything o.k.
=-1: an error occured
Author: Andreas von Manteufel

9.26 HZJTFIND: find jets

Purpose:
To find jet structures in the HEPEVTP block. A general interface to the jet finders.
Structure:
HZJTFIND can be called at any time after the HEPEVTP block has been filled. It will invoke the appropriate jet finder and fill the HZJETCMN common block.
Usage:

```
*
      INTEGER JETF,NUMJETS
      DOUBLE PRECISION RADIUS
      DOUBLE PRECISION JETS(50,8)
      ...
      CALL hzjtfind(JETF,RADIUS,NUMJETS,JETS)
```

Input arguments
jetf = the number of the jet finder to be called.
1 EUCELL,
2 PXCONE,
3 KTCLUS,
4 GPCONE,
5 JCLUST (DIS version),
6 JCLUST (photoproduction version))
7=PUCELL,
8=KT algorithm optimize for resonance decays to dijets
9=KTCLUS in E recombination scheme (massive mode)

10=KTCLUS in E recombination scheme in meson mode
11=KTCLUS in 'pure' pt-mode, no p=E to achieve Et-mode as in 3
12 = KTCLUS in exclusive mode, angular kt, E scheme
13 = as 12 but ycut is chosen so as to give number of jets
radius = radius of jet to find.
(−1 to get from HZJETRAD, but this slows down the program since HZJETRAD will be called every event)

Returned values

numjets = Number of jets found (max. 50)
Jets(50,x) = information about jets found

```
*
x =   1,2 eta,phi of jet axis
      3 Et of jet
      4-8 (e,px,py,pz,m) of jet axis
```

Author:

Mark Hayes, G. Flucke

9.27 HZJTNAME: return a six letter mnemonic of a jet finder

Purpose:

To return a six letter mnemonic of a jet finder.

Structure:

HZJTNAME can be called at any time.
HZJTNAME needs no other functions.

Usage:

```
*
      INTEGER CHJET
      CHARACTER*6 JETF
      ...
      CALL HZJTNAME(CHJET,JETF)
```

Input arguments

chjet = number of jet finder (as used in call to HZJTFIND)

Returned values

jetf = mnemonic for specified jet finder

Author: Mark Hayes

9.28 HZLCHGE: returns particle charge

Purpose:
This routines gives three times the charge for a particle/parton.
Structure:
HZLCHGE is callable at any time. HZLCHGE calls the CERNLIB routine UCOPY and the HZTOOL function HZLCOMP.
Usage:

```
*
      INTEGER IC, HZLCHGE,KF
      ...
      IC=HZLCHGE(KF)
```

Input arguments
KF = particle code as defined in JETSET
Returned values
IC= three times the charge for a particle/parton.
Author: N. Brook

9.29 HZLIHEP: prints HEPEVTP event record

Purpose:
Prints the HEPEVTP event record in a human readable form.
Structure:
HZLIHEP is callable at any time.
Usage:

```
*
      ...
      call HZLIHEP(IPRINT)
```

Input arguments
IPRINT=1 for the whole common
IPRINT=0 exluding the arrays referring to the vertices
Returned values
none
Author: R. Selle

9.30 HZLUHEPC: Fills the HEP common form the LUND common

Purpose:
Fills the HEP common form the LUND common. This routine is simply taken form JETSET74 and has to be here, since HERWIG runs independent of the JETSET library.
Structure:
HZLUHEPC is callable at any time. No other subprogram is called.
Usage:

```
*
        ...
        call HZLUHEPC
```

Input arguments
none
Returned values
none
Author: JETSET (modified by N. Brook)

9.31 HZLULIST: prints Lund event record (JETSET 74)

Purpose:
Prints the Lund event record in a human readable form.
Structure:
HZLULIST is callable at any time. HZLULIST calls the subroutine LULIST.
Usage:

```
*
        ...
        call HZLULIST(MLIST)
```

Input arguments
MLIST as for LULIST call
Returned values
none
Author: H. Jung

9.32 HZLUNCOP: copy Lund HEPEVT to HEPEVTP common

Purpose:
Deal with copying Lund HEPEVT to HEPEVTP common for LEPTO and ARIADNE.
Structure:
HZLUNCOP is callable at any time. HZLUNCOP calls the function HZLCHGE.
Usage:
*

```
...
call HZLUNCOP
```

Input arguments
none
Returned values
none
Author: N. Brook

9.33 HZLCOMP

Purpose:
This routine compresses the standard KF codes (see JETSET) for use in mass and decay arrays and checks whether a given code actually is defined.
Structure:
HZLCOMP is callable at any time. No other subprogram is called.
Usage:
*

```
INTEGER IC, HZLCOMP, KF
...
IC=HZLCOMP(KF)
```

Input arguments
KF = particle code (see JETSET)
Returned values
IC = compressed particle code.
Author: LUCOMP in JETSET (modified by N. Brook)

9.34 HZMEANHI: profile histogram with non-equidistant bins

Purpose:
This subroutine calculates weighted mean values of a variable in different bins, their errors and stores them in a hbook histogram the produced histograms are similiar to hbprof-histos, but this routine allows you to use non-aequidistant bins The formula for the error is taken from: Michael Kuhlen (H1-01/95-418) **Structure:** this subroutine calls the following subroutine/functions (only the ones not included in this file are listed): HEXIST,HGIVE,HI,HIE,HIX,HPAK,HPAKE (all from hbook-lib)
usage: 1. initialization step:
book histogram with HBOOK1 or HBOOKB
2. filling step:
call this routine
3. termination step:
nothing to do
Usage:

```
*
      INTEGER IID
      DOUBLE PRECISION dX, dY
      REAL wtx
      ...
      call HZMEANHI(iid,dX,dY,wtx)
```

Input arguments
IID = histo id in hbook context (that one used for booking the histo in step 1) DX = current value of binned variable (Abszissa) DY = current value of variable, whose mean value is of interest (Ordinate) WTX = event weight (note: dX, dY declared double precision !)
Returned values
Histogram with identifier IID **Author:** Andreas von Manteuffel

9.35 HZPARTON: returns the partons in the HEP-Common

Purpose:
Returns the partons in the HEP-Common and their number for LEPTO,ARIADNE and HERWIG. For the used search-strategies read the header of the routine.

Structure:
HZPARTON is callable at any time after the HEP-Common has been filled. HZPARTON calls HZIDELEC and HZIBEAM.
Usage:

```
*
      INTEGER NPART,PLIST(NMXHEP)
      ...
      call HZPARTON(NPART,PLIST)
```

Input arguments
none.
Returned values
NPART: total number of partons in the event.
PLIST: list of the positions of the partons in the HEP-Common.

Author: Reimer Selle

9.36 HZPCOMP: compress the standard KF codes

Purpose:
Compress the standard KF codes for use in mass and decay arrays; also checks whether a given code actually is defined. (for Pyhtia)
Structure:
HZPCOMP is callable at any time.
Usage:

```
*
      INTEGER HZPCOMP,KF,KC
      ...
      KC=HZPCOMP(KF )
```

Input arguments

Returned values
ITEM = Search item
Author: Hannes Jung

9.37 HZPHI: returns azimuth angle of a particle

Purpose:
Gives azimuth angle for a particle in the HEP common.
Structure:
HZPHI is callable at any time.
Usage:

```
*
      INTEGER IPART
      DOUBLE PRECISION PHI
      ...
      PHI=HZPHI(IPART )
```

Input arguments
ipart: index of particle in HEP common
Returned values
azimutal angle (phi) of particle, or 0.D0 if calculation not possible **Author:** Andreas von Manteuffel

9.38 HZPHMANG: returns polar angle of a particle

Purpose:
Returns an angle between -π and +π from the components of a 4-vector,i.e.
θ=HZPHMANG(z,$\sqrt{x^2+y^2}$) ($0 < \theta < \pi$)
ϕ =HZPHMANG(x,y) ($-\pi < \phi < \pi$)

Structure:
HZPHMANG is callable at any time. No other subprogram is called.
Usage:

```
*
      DOUBLE PRECISION HZPHMANG, X,Y,ANG
      ...
      ANG=HZPHMANG(X , Y )
```

Input arguments
X = x- or z-component of the 4-vector of a particle
Y = y-component or $\sqrt{x^2+y^2}$ of the 4-vector of a particle
Returned values
ANG = polar θ or azimuth ϕ angle of the 4-vector

Author: ULANGL in JETSET (modified by N. Brook)

9.39 HZPHMROT: rotations of a 3-vector

Purpose:
Performs rotations in space of a given vector with 3 components.
Structure:
HZPHMROT is callable at any time. No other subprogram is called.
Usage:

```
 *
        DOUBLE PRECISION PHI, THE, P(3) ,PNEW(3)
        ...
        call HZPHMROT( PHI , THE , P , PNEW)
```

Input arguments
PHI, THE =
are standard polar coordinates giving the direction of a momentum vector initially along the z-axis.
P = is the vector to be acted upon
Returned values
PNEW= is the rotated vector

Author: LUROBO in JETSET (modified by N Brook)

9.40 HZPHOKIN: photoproduction kinematic variables

Purpose:
To return the photoproduction kinematic variables (Q^2,y_{Bj}).
Structure:
HZPHOKIN is callable at any time after the HEP common has been filled.
HZPHOKIN calls functions HZIPGAMN and HZIBEAM.
Usage:

```
 *
        INTEGER ITYPE
        DOUBLE PRECISION HZPHOKIN, VAR
        ...
        VAR=HZPHOKIN( ITYPE )
```

Input arguments
ITYPE = 1 returns Q^2
ITYPE = 2 reserved for future expansion
ITYPE = 3 returns y_{Bj}
ITYPE = 4 reserved for future expansion
Returned values
VAR = kinematic variable (as above) (-1 means an error has occured)
Author: Mark Hayes

9.41 HZPYHEPC: copies PYTHIA event record to PHEP

Purpose:
Converts PYTHIA event record contents to or from the standard event record commonblock.
Structure:
HZPYHEPC is callable at any time. No other subprogram is called. HZPYHEPC calls functions
Usage:
*

```
INTEGER IFLAG
...
call HZPYHEPC(IFLAG )
```

Input arguments
IFLAG=1: Conversion from PYTHIA to standard
IFLAG NE 1: Conversion from standard to PYTHIA **Author:** Hannes Jung

9.42 HZPYLIST: prints Lund event record (PYTHIA6)

Purpose:
Prints the Lund event record in a human readable form.
Structure:
HZPYLIST is callable at any time. HZPYLIST calls the subroutine PYLIST.
Usage:
*

```
...
call HZPYLIST(MLIST)
```

Input arguments
MLIST as for PYLIST call
Returned values
none
Author: H. Jung

9.43 HZPSCON: conservation of P_t

Purpose:
This routine checks the conservation of transverse momentum and s in generated events on the parton level. $s = \sum_n p^2 = W^2$ (the total invariant mass of all partons should equal W^2).
Structure:
HZPSCON should be called before, during and after the event generation. HZPSCON calls HBOOK functions and HzTool-functions HZIDELEC,HZIBEAM and HZPARTON.
Usage:

```
 *
        INTEGER IFLAG
        ...
        call HZPSCON(IFLAG)
```

Input arguments

IFLAG= 1 initialization step (before event generation)
IFLAG= 2 filling step (during event generation)
IFLAG= 3 terminating step (at the end)

Returned histgramms
(For Monte Carlo only)
ID 10: relative error in s
ID 11: relative error in p_x
ID 12: relative error in p_y

Author: Reimer Selle

9.44 HZPT: get transverse momentum of particle

Purpose:
Calculates transverse momentum of particle in PHEP common.
Structure:
HZPT is callable at any time.
Usage:

```
*
      INTEGER IPART
      DOUBLE PRECISION PT
      ...
      PT=HZPT(IPART )
```

Input arguments
ipart: index of particle in HEP common
Returned values
transverse momentum of particle **Author:** Andreas von Manteuffel

9.45 HZTERM: prints information about histograms

Purpose:
Scans through sub-directories and prints out the χ^2 and the number of degrees of freedom for each histogram in a nice little table.
Structure:
HZTERM is callable at any time (even in PAW ?). HZTERM calls the HBOOK functions HCDIR, HRDIR, HGNPAR, HNOENT and HGNF.
Usage:

```
*
      ...
      call HZTERM
```

Input arguments
none
Returned values
none
Author: Nick Brook

9.46 HZTHETA: returns polar angle of particle

Purpose:
Calculates polar angle of particle in PHEP common
Structure:
HZTHETA is callable at any time.
Usage:
*

```
INTEGER IPART
DOUBLE PRECISION THETA
...
THETA=HZTHETA(IPART )
```

Input arguments
ipart: index of particle in HEP common
Returned values
Polar angle of particle **Author:** Andreas von Manteuffel

9.47 HZVERS: prints the HZTOOL version

Purpose:
This routines prints the HZTOOL version and the time and date of the last change.

Structure:
HZVERS is callable at any time. No other subprogram is called.

Usage:
*

```
...
call HZVERS
```

Input arguments
none
Returned values
none
Author: Tancredi Carli

Appendix A

The HEP common

```
NMXHEP: maximum numbers of entries (partons/particles) that can be
    stored in the commonblock. The default value of 2000 can be changed
    via the parameter construction. In the translation, it is
    checked that this value is not exceeded.
NEVHEP: is normally the event number, but may have special meaning,
    according to description below.
    > 0 : event number, sequentially increased by 1 for each call to
        the main event generation routine, starting with 1 for the
        first event generated.
    = 0 : for a program which does not keep track of event numbers,
        like JETSET.
    = -1 : special initialization record; not used by JETSET.
    = -2 : special final record; not used by JETSET.

NHEP: the actual number of entries stored in current event. These are
    found in the first NHEP positions of the respective arrays below.
    Index IHEP, 1 <= IHEP <= NHEP, is below used to denote a given
    entry.
ISTHEP(IHEP): status code for entry IHEP, with following meanings:
    = 0 : null entry.
    = 1 : an existing entry, which has not decayed or fragmented.
        This is the main class of entries which represents the
        "final state" given by the generator.
    = 2 : an entry which has decayed or fragmented and therefore
        is not appearing in the final state, but is retained for
        event history information.
    = 3 : a documentation line, defined separately from the event
        history. This could include the two incoming reacting
```

```
        particles, etc.
    = 4 - 10 : undefined, but reserved for future standards.
    = 11 - 200 : at the disposal of each model builder for constructs
        specific to his program, but equivalent to a null line in the
        context of any other program.
    = 201 - : at the disposal of users, in particular for event tracking
        in the detector.
IDHEP(IHEP) : particle identity, according to the Particle Data Group
    standard. The four additional codes 91 - 94 have been introduced
    to make the event history more legible, see section 2.1 and the
    MSTU(16) description.
JMOHEP(1,IHEP) : pointer to the position where the mother is stored.
    The value is 0 for initial entries.
JMOHEP(2,IHEP) : pointer to position of second mother. Normally only
    one mother exist, in which case the value 0 is to be used.
    In JETSET, entries with codes 91 - 94 are the only ones to have
    two mothers. The flavour contents of these object, as well as
    details of momentum sharing, have to be found by looking at the
    mother partons, i.e. the two partons in positions JMOHEP(1,IHEP)
    and JMOHEP(2,IHEP) for a cluster or a shower system, and the range
    JMOHEP(1,IHEP) - JMOHEP(2,IHEP) for a string or an independent
    fragmentation parton system.
JDAHEP(1,IHEP) : pointer to the position of the first daughter. If an
    entry has not decayed, this is 0.
JDAHEP(2,IHEP) : pointer to the position of the last daughter. If an
    entry has not decayed, this is 0. It is assumed that daughters are
    stored sequentially, so that the whole range JDAHEP(1,IHEP) -
    JDAHEP(2,IHEP) contains daughters. This should be done also when
    only one daughter is present, like in K0 -> K_S0 decays.
    Normally daughters are stored after mothers, but in backwards
    evolution of initial state radiation the opposite may appear,
    i.e. that mothers are found below the daughters they branch into.
    Also, the two daughters need then not appear one after the other,
    but may be separated in the event record.
PHEP(1,IHEP) : momentum in the x direction, in GeV/c.
PHEP(2,IHEP) : momentum in the y direction, in GeV/c.
PHEP(3,IHEP) : momentum in the z direction, in GeV/c.
PHEP(4,IHEP) : energy, in GeV.
PHEP(5,IHEP) : mass, in GeV/c**2. For spacelike partons, it is allowed
    to use a negative mass, according to PHEP(5,IHEP) = -sqrt(-m**2).
VHEP(1,IHEP) : production vertex x position, in mm.
VHEP(2,IHEP) : production vertex y position, in mm.
```

```
VHEP(3,IHEP) : production vertex z position, in mm.
VHEP(4,IHEP) : production time, in mm/c (= 3.33*10**(-12) s).
```

Appendix B

The HERACMN common

```
*
*     GEN: Name of generator
*     XSEC: total cross section
*     IHCHRG: charge of particle/parton times 3
*     NTOT : Number of total events
*
      Character*8 Gen
      Double Precision Xsec
      Integer ihchrg
      Real Ntot, wtx
      Common /HERACMN/ Xsec, Gen, ihchrg(nmxhep), Ntot, wtx
*
```

Appendix C

The JET common

```
*
* Warning ! Not all algorithm have everything filled
* Not all variables are filled
* Only NUMJETS and JETS is always there !
*
 *
*     MAXHZJETS: maxmial number of jet allowed
*     NUMJET: number of jets from jet algo
*     NSEL  : number of selected jets
*     IPJET : pointer to selected jets
*     JETS  : Jet variables (eta,phi,et,e,px,py,pz,m) in choosen frame
*     IJETNO: pointer which objects in PHEP common belong to jets
*
      INTEGER MAXHZJETS
      PARAMETER (MAXHZJETS=50)
      INTEGER NSEL,NUMJETS,IPJET(MAXHZJETS),IJETNO(NMXHEP)
      DOUBLE PRECISION JETS(MAXHZJETS,8)
*
      COMMON /HZJETCMN/JETS,NUMJETS,NSEL,IPJET,IJETNO
*
```

Appendix D

Example Main Program

```
C...Demonstration job for LEPTO 6.1
      COMMON /LEPTOU/ CUT(14),LST(40),PARL(30),X,Y,W2,Q2,U
*
*#include "hepevtp.inc"
* HEP event prime common
* (for explanation see manual)
      Integer NMXHEP
      PARAMETER (NMXHEP=4000)
      Integer NEVHEP,NHEP,ISTHEP,IDHEP
      Integer JMOHEP,JDAHEP
      Double Precision PHEP,VHEP
      COMMON/HEPEVTP/NEVHEP,NHEP,ISTHEP(NMXHEP),IDHEP(NMXHEP),
     & JMOHEP(2,NMXHEP),JDAHEP(2,NMXHEP),PHEP(5,NMXHEP),VHEP(4,NMXHEP)
*
*#include "heracmn.inc"
*
* HERA common
*
*     GEN: Name of generator
*     XSEC: total cross section
*     IHCHRG: charge of particle/parton times 3
*     NTOT : Number of total events
*
      Character*8 Gen
      Double Precision Xsec
      Integer ihchrg
      Real Ntot, wtx
      Common /HERACMN/ Xsec, Gen, ihchrg(nmxhep), Ntot, wtx
*
      PArameter(NWPAWC=20000)
      common/pawc/h(NWPAWC)
      call hlimit(NWPAWC)
*
* Inform job what generator you are using and open o/p
```

```
* histogram file
*
      GEN='LEP'
*
* DO NOT CHANGE 'HISTO'
*-----------------------+
*                       |
      call hropen(45,'HISTO','hzsteer.lepto64.parl7a.rz','N',1024,istat)
*
* Initialise plots
* I've chosen to call subroutine HZnnnnn - where nnnnn is DESY preprint #
*
      call hz95221(1)
      call hz95084(1)
      call hz95007(1)
      call hz94033(1)
*
* Initialisation of generator eg LEPTO
*
      parl(7) = 0.
      cut(5) = 10.
      cut(6) = 1280.
      CALL LINIT(0,11, -26.7,820.,4)
*
* event loop over generator
*
      DO 500 NE=1,100000
         CALL LEPTO
*
* Fill the HEPEVT' common
*
         call Hzfilhep
* Fill plots
         call hz95221(2)
         call hz95084(2)
         call hz95007(2)
         call hz94033(2)
  500 CONTINUE
*
* manipulate plots and produce the date plots
      call hz95221(3)
      call hz95084(3)
      call hz95007(3)
      call hz94033(3)
*
* write out ALL histograms in their PAW subdirectory structure
*
      Call hcdir('//PAWC',' ')
      Call hcdir('//HISTO',' ')
      call hrout(0,icycle,'T')
```

```
call hrend('HISTO')
END
```

Appendix E

hztemplate.F

```
      SUBROUTINE HZTEMPLATE(IFLAG)
***************************************************************************
*     [For subroutine naming conventions, see the hztool manual.]
*
*     Purpose: This routine reproduces the data from Fig.Xa, Yb, Yc and
*     Table Za from [reference], and produces histograms of simulated data
*     which can be compared to them.
*
*     Initial state: XX GeV things vs YY GeV other things.
*
*     Reference: [reference]
*     Arguments: iflag=10000*[A]+1000*[B]+100*[C]+10*[D]+1 initialisation
*                iflag=10000*[A]+1000*[B]+100*[C]+10*[D]+2 filling
*                iflag=10000*[A]+1000*[B]+100*[C]+10*[D]+3 termination
*
*     [A]= IPS   >0 to run on the final state of the parton shower, 0 to run on
*                final state particles.
*     [B]= IPROC decides which process is being run when more than one is
*                generated (e.g. single/double resolved and direct or
*                diffractive and non-diffractive). Leave this to 0 if there is
*                only one process type.
*     [C]= IRUN  =0 rerun jetfinder, =1 use results already stored.
*     [D]= JETF  decides jet finder type. Ignored if IRUN=1. If set to 0 the
*                finder set by chjet below is used. This should be the finder
*                used in the paper (only necessary if using jets!).
*     See manual section "The analysis routines" for more details.
*     NB If you do not implement all these options, change the comments to say
*     so!
*
*     It is assumed you run either (a) with iproc = 0
*                               or (b) with iproc = 1, 2... in order.
*     This example has only 2 processes (iproc=1,2) but others may be added.
*
*     Histograms: -N data for Fig.Xa
```

```
*                  N simulation for Fig.Xa
*                  ... etc.
*
*     written by: [me] on [today]
****************************************************************************
      IMPLICIT NONE

****** These included files contain function declarations and various
****** parameter declarations which are required by the hztool routines.
****** In particular Xsec and Ntot (global variables) are defined in
****** 'heracmn.inc'

#include "hzfunc.inc"
****** for histograms
#include "hzhbook.inc"
#include "hepevtp.inc"
#include "heracmn.inc"
****** (only necessary if using jets!)
#include "hzjetcmn.inc"

****** declare variables
      INTEGER ihep,iflag,chjet,iproc,njet,iloop
      REAL ptdata(10),ptdataerr(10),pt,rapdata(10),rapdataerr(10),rap,
     +     rapcut(2),q2,q2cut
      DOUBLE PRECISION coner
      SAVE coner
      CHARACTER*8 xxxx

****** initialize variables
      DATA q2cut/100./
      DATA rapcut/-2.,2./
****** save variables that retain their values between different subroutines
      SAVE chjet

****** (only necessary if using jets!)
****** Set the default jet finder as that in the paper.
****** (see the hztool manual section "The Jet Finders" for the different jet
******  finders available).
      DATA chjet/3/

****** Initialize data points and errors from plots/tables
      DATA ptdata    /10.,9.,8.,7.,6.,5.,4.,3.,2.,1./
      DATA ptdataerr /1., 1.,1.,1.,1.,1.,1.,1.,1.,1./
      DATA rapdata   /1.,2.,3.,4.,4.,5.,5.,6.,6.,6./
      DATA rapdataerr/1.,1.,1.,1.,1.,1.,1.,1.,1.,1./
****** Set xxxx equal to the arXiv:hep-ex number.
******  [For alternative subroutine naming conventions, see the manual.]
      DATA xxxx /'hyymmnnn'/

****** set the jet cone radius. (only necessary if using jets!)
```

```
****** CALL hzjetrad(1,coner) sets the radius to coner
****** CALL hzjetrad(2,coner) sets coner to the radius, or -1.
******  check if the radius has been set eleswhere
      CALL hzjetrad(2,coner)
******  if not set it to the value used in the paper.
      IF (coner.LT.0.0) THEN
      coner=1.0
      ENDIF

****** Determine the process type (single/double resolved etc)
****** (only necessary if > 1 process types!)
      iproc=(mod(iflag,10000)/1000)
      IF ((iproc.LT.0).OR.(iproc.GT.2)) THEN
         WRITE(HZUNIT,*) xxxx,': illegal IPROC:',iproc
         RETURN
      ENDIF

****** choose jet finder (only necessary if using jets!)
      IF ((MOD(iflag,100)/10.GT.0).AND.MOD(iflag,10).eq.1) THEN
         chjet=INT(MOD(iflag,100)/10)
      ENDIF

****** Decide if we are running on parton showers or final state particles.
      IF (MOD(iflag,100000)/10000.GT.0) THEN
****** use a different paw directory for parton showers.
         xxxx = 'PS'//xxxx
****** tell jet finder that we running on parton showers
****** (only necessary if using jets!)
         chjet=-1*ABS(chjet)
      ENDIF
*******************************************************************************
********************************  Initialise *********************************
      IF (MOD(iflag,10).EQ.1) THEN
****** Initialisation: The following MUST always be done
******     (i) make subdirectory in PAWC
******     - use the name as the xxxxxx in HZHxxxxxx subroutine
******     (i) make subdirectory in o/p file

         CALL hcdir('//PAWC',' ')
         IF (iproc.LE.1) THEN
             CALL hmdir(xxxx,'S')
         ELSE
             CALL hcdir(xxxx,' ')
         ENDIF

         CALL hcdir('//HISTO',' ')
         IF (iproc.LE.1) THEN
             CALL hmdir(xxxx,'S')
         ELSE
             CALL hcdir(xxxx,' ')
```

```
        ENDIF

******  book your histograms using:
******   1D histo
******     CALL hbook1(long key, char* title, long bins,  float xmin,
******                 float xmax, float VMX)
******   2D histo
******     CALL hbook2(long key, char* title, long bins1, float xmin1,
******                 float xmax1, long bins2, float xmin2, float xmax2,
******                 float VMX)
******  1D histo with variable bin width
******     CALL hbookb(long key, char* title, long bins,  float* xvalues,
******                 float VMX)
******
******  VMX upper limit of single channel content, set to 0.0 which  means 1
******  word per channel (no packing).

******  Give key a different value depending on which process you are running
******  (only necessary if > 1 process types!)
        CALL hbook1(1000*iproc+11,'1/N dn/d-pt(MC)',10,0.0,20.,0.)
        CALL hbook1(1000*iproc+12,'1/N dn/d-rap(MC)',10,-2.0,2.0,0.)

*******************************************************************************
*********************  Loop over events (fill) *****************************
      ELSE IF(MOD(iflag,10).EQ.2) THEN
******  Filling: The following MUST always be done
******    (i) move to the correct sub-directory in PAWC
         CALL hcdir('//PAWC/'//xxxx,' ')
******  example cut...
******  hzdiskin(x) returns the DIS kinematic variables
******  (see hztool manual for details)
         q2  = hzdiskin(1)
         IF(q2.GT.q2cut) THEN
******  Loop through all particles in the events
            DO 30 ihep = 1, nhep
****** The HEPEVT standard is used for the Monte Carlo output, see the
****** hztool manual for details.
****** If the particle is a final state particle
              IF (ISTHEP(ihep).EQ.1) THEN
******  calculate pT of the particle
                  pt = sqrt(phep(1,ihep)**2+phep(2,ihep)**2)
******  Fill your histograms
                  CALL hfill(1000*iproc+11,pt,0.,wtx)
              ENDIF
 30         CONTINUE

****** run the hzjtfind jet finder (only necessary if using jets!)
******  chjet     : gives the type of jet finder to be used
******  coner     : gives the cone radius
******  njet      : gets set to the number of jets (maximum is 50)
```

```
****** jets(50,x): gets set to info about jets with
******            x=1,2 -> eta,phi of jets axis; x=3 -> eT of jet
******            x=4-8 -> e,px,py,pz,m of jet axis
****** NB/ jets is declared in heracmn.inc
           CALL hzjtfind(chjet,coner,njet,jets)
****** loop through all jets in the event
           DO 20 iloop = 1, njet
****** get rapidity of jet
 rap=Jets(iloop,1)
****** if the jet passes rapidity cuts
 IF (rap.GE.rapcut(1).AND.rap.LE.rapcut(2)) THEN
****** Fill your histograms
       CALL hfill(1000*iproc+12,rap,0.,wtx)
                ENDIF
 20        CONTINUE
        ENDIF

*******************************************************************************
****************************** Terminate **********************************

      ELSE IF(MOD(iflag,10).EQ.3) THEN

****** Termination: The following MUST always be done
******    (i) Move to the correct PAW subdirectory
        CALL hcdir('//PAWC/'//xxxx,' ')

****** write the number of events and xsec for the process just finished.
        WRITE(6,*) xxxx,' X-section is',xsec, ' and number of events '
     +    ,ntot, ' for process ',iproc

****** normalise the histograms using hzhinrm(iid,iidnew,nevt,iifl)
****** with arguments: iid = histogram id,
******                 iidnew = new histo id (if 0, old histo is modified)
******                 nevt = normalization factor
******                 iifl =1: normalize errors too, otherwise they are zeroed

        CALL hzhinrm(1000*iproc+11,0,real(ntot/xsec),1)
        CALL hzhinrm(1000*iproc+12,0,real(ntot/xsec),1)

****** Add the histos from different iproc values in the last call
****** (only necessary if > 1 process types!)
        IF (iproc.EQ.2) THEN
****** add your histograms using:
******    CALL HOPERA (ID1,CHOPER,ID2,ID3,C1,C2)
******     Action: Fills an histogram I3 with values such that
******             ID3 = C1 * ID1 (OPERATION) C2 * ID2
******     Parameters: IDn = histogram identifiers,
******                 CHOPER =  Character variable specifying the kind of
******                 operation to be performed (+,-,*,/) and 'E' for errors.
******                  C1,C2 = Multiplicative constants.
```

```
          CALL hopera(1011,'+e',2011,11,1.,1.)
          CALL hopera(1012,'+e',2012,12,1.,1.)
        ENDIF

******  Deal with data plots once only
        IF (iproc.EQ.0.OR.iproc.EQ.2) THEN
****** book histograms
           CALL hbook1(-11,'1/N dn/d-pt(data)',10,0.0,20.,0.)
           CALL hbook1(-12,'1/N dn/d-rap(data)',10,-2.0,2.0,0.)
****** fill data points
           CALL hpak(-11,ptdata)
           CALL hpak(-12,rapdata)
****** fill data errors
           CALL hpake(-11,ptdataerr)
           CALL hpake(-12,rapdataerr)
        ENDIF

      ENDIF

      RETURN

      END
```

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