```
    4           #.   dEtaPhiTT
   30           #.   EtaMaxTT
    0           #.   nEtThr ( =<8 ) number of thresholds

*DO C1EM        #. T1CEtMP_         no missing Et trigger
    4           #.   dEtaTT
    4           #.   dPhiTT
   32           #.   EtaMaxTT
    0           #.   nEtThr

*DO T1GL        #. T1GlobP_    LVL1 Global : multiplicity per threshold
    0           #.   nMThr   number of muon       thresholds
  999 999 999 999 999 999 999 999
    2           #.   nEThr   number of em cluster thresholds
    1   1 999 999 999 999 999 999
    0           #.   nHThr   number of tau/hadron thresholds
  999 999 999 999 999 999 999 999
    0           #.   nJThr   number of jet        thresholds
  999 999 999 999 999 999 999 999


*.-------1---------2---------3---------4---------5---------6--------7
*--                example of LVL1 calibration  (valid for    97_3,
*--                derived from 30 GeV e-
*--
*DO T1TT        #. T1CcTTP_   LVL1 calibration of trigger towers
    1                         #.   ECalib  ON
    4                         #.   nEeta   number of eta regions
    1.34    1.57   2.51   3.5   #.   Eeta(1:nEeta)     eta regions
    0.97277  -0.0426      0.    #.   coeff eta region 1
   31.064   -41.61      14.261  #.   coeff eta region 2
    0.9492   -0.01939    0.     #.   coeff eta region 3
    1.28707  -0.18538    0.     #.   coeff eta region 4
    0                          #.   HCalib  OFF  param's not yet available

*.-------1---------2---------3---------4---------5---------6--------7
```

10.5 ATRIG database for pseudo LVL1 filter

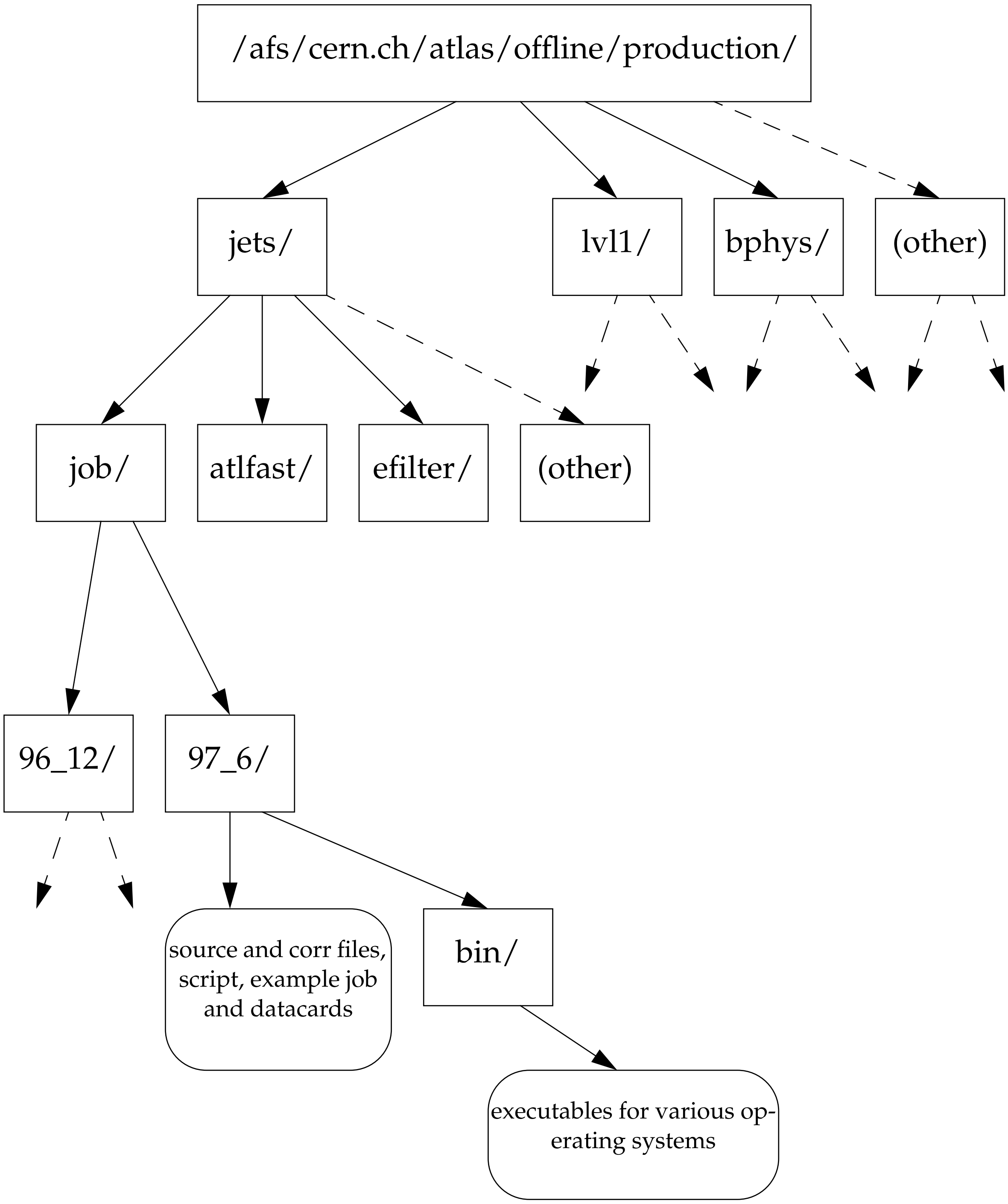
```
*--- Title version 0.01/00
*---
*---  file filter_replace.tit
*---
*PRINT
*.-------------------------------------------------------------------
*---  parameters for pseudo LVL1 filter
*---   1) program flow
*.-------1---------2---------3---------4---------5---------6--------7
*DO ATRI        #. ATriggP_ :  call only T1Main (LVL1)
    1           #.   T1Main
    0           #.   T2main
    1           #.   TOneMx
    0           #.   T1KinMx

*DO T1MA        #. T1MainP_ :  call only T1Calo
    1           #.   T1Calo
    0           #.   T1Muon
    1           #.   Slug

*.-------1---------2---------3---------4---------5---------6--------7
*---  2) parameters per module
*---     for Calo matrices and calo cluster finding
*---      o all sources of smearing are switched off
*---      o no jet finding or Etmis trigger
*.-------------------------------------------------------------------
*DO C1MX        #. T1CAMxP_
   1            #.   preSamp        ON
   0            #.   fwdCalo        OFF
   8            #.   nBits
   1.           #.   leastCount
   3.2          #.   etamax
   1.4          #.   noiseEmEta
   0.0          #.   noiseEm(1)     all noise and fluctuations 'zero'
   0.0          #.   noiseEm(2)
   1.5          #.   noiseHadEta
   0.0          #.   noiseHad(1)
   0.0          #.   noiseHad(2)
   0.0          #.   gainFluct
   20.5         #.   pedOffSet
   0.0          #.   pedOffWidth
   0.0          #.   pedWidth
   20           #.   pedSubtrac
   1            #.   thrEm
   1            #.   thrHad

*DO C1EC        #. T1CeClP_         em cluster trigger
   25           #.   EtaMaxTT
    2           #.   nEtThr ( =<8 ) number of thresholds
  50  9999 9999  #. single e/gamma (high threshold) EtThr IsoEThr IsoHThr
   16     6    3   #. single e/gamma (low  threshold)

*DO C1JT        #. T1CJetP_         no jet trigger
```

```
*     10   * R*4  *         *              * PTRIGGER * TGJT4
******************************************************************
*  Block   *  Entries  * Unpacked * Packed *   Packing Factor    *
******************************************************************
* ATLFINFO *  10000    * 32       * 32     *       1.000         *
* PMISSING *  10000    * 8        * 8      *       1.000         *
* PLEPTONS *  10000    * 124      * Var.   *    Variable         *
* PPHOTONS *  10000    * 124      * Var.   *    Variable         *
* PJETS    *  10000    * 244      * Var.   *    Variable         *
* PMUXS    *  10000    * 244      * Var.   *    Variable         *
* PHISTORY *  10000    * 604      * Var.   *    Variable         *
* PTRIGGER *  10000    * 40       * 40     *       1.000         *
* Total    *    ---    * 1420     * Var.   *    Variable         *
******************************************************************
* Blocks = 8            Variables = 49      Max. Columns = 355   *
******************************************************************
```

10.4 ATLFAST output ntuple listing

```
*******************************************************************
* Ntuple ID = 3333   Entries = 10000     ATLFAST
*******************************************************************
* Var numb * Type * Packing *    Range     *  Block   *  Name    *
*******************************************************************
*      1   * I*4  *         *              * ATLFINFO * ISUB
*      2   * I*4  *         *              * ATLFINFO * NEL
*      3   * I*4  *         *              * ATLFINFO * NMU
*      4   * I*4  *         *              * ATLFINFO * NMUX
*      5   * I*4  *         *              * ATLFINFO * NPH
*      6   * I*4  *         *              * ATLFINFO * JETB
*      7   * I*4  *         *              * ATLFINFO * JETC
*      8   * I*4  *         *              * ATLFINFO * JETL
*      1   * R*4  *         *              * PMISSING * PMISS(2)
*      1   * I*4  *         * [0,6]        * PLEPTONS * NLEP
*      2   * I*4  *         *              * PLEPTONS * KFLEP(NLEP)
*      3   * R*4  *         *              * PLEPTONS * PXLEP(NLEP)
*      4   * R*4  *         *              * PLEPTONS * PYLEP(NLEP)
*      5   * R*4  *         *              * PLEPTONS * PZLEP(NLEP)
*      6   * R*4  *         *              * PLEPTONS * EELEP(NLEP)
*      1   * I*4  *         * [0,6]        * PPHOTONS * NPHO
*      2   * I*4  *         *              * PPHOTONS * KFPHO(NPHO)
*      3   * R*4  *         *              * PPHOTONS * PXPHO(NPHO)
*      4   * R*4  *         *              * PPHOTONS * PYPHO(NPHO)
*      5   * R*4  *         *              * PPHOTONS * PZPHO(NPHO)
*      6   * R*4  *         *              * PPHOTONS * EEPHO(NPHO)
*      1   * I*4  *         * [0,12]       * PJETS    * NJETA
*      2   * I*4  *         *              * PJETS    * KFJET(NJETA)
*      3   * R*4  *         *              * PJETS    * PXJET(NJETA)
*      4   * R*4  *         *              * PJETS    * PYJET(NJETA)
*      5   * R*4  *         *              * PJETS    * PZJET(NJETA)
*      6   * R*4  *         *              * PJETS    * EEJET(NJETA)
*      1   * I*4  *         * [0,12]       * PMUXS    * NONMUX
*      2   * I*4  *         *              * PMUXS    * KFMUX(NONMUX)
*      3   * R*4  *         *              * PMUXS    * PXMUX(NONMUX)
*      4   * R*4  *         *              * PMUXS    * PYMUX(NONMUX)
*      5   * R*4  *         *              * PMUXS    * PZMUX(NONMUX)
*      6   * R*4  *         *              * PMUXS    * EEMUX(NONMUX)
*      1   * I*4  *         * [0,30]       * PHISTORY * NPART
*      2   * I*4  *         *              * PHISTORY * KFPAR(NPART)
*      3   * R*4  *         *              * PHISTORY * PXPAR(NPART)
*      4   * R*4  *         *              * PHISTORY * PYPAR(NPART)
*      5   * R*4  *         *              * PHISTORY * PZPAR(NPART)
*      6   * R*4  *         *              * PHISTORY * EEPAR(NPART)
*      1   * R*4  *         *              * PTRIGGER * TGALL
*      2   * R*4  *         *              * PTRIGGER * TGEM1
*      3   * R*4  *         *              * PTRIGGER * TGPH1
*      4   * R*4  *         *              * PTRIGGER * TGEM2
*      5   * R*4  *         *              * PTRIGGER * TGMU1
*      6   * R*4  *         *              * PTRIGGER * TGMU2
*      7   * R*4  *         *              * PTRIGGER * TGEMU
*      8   * R*4  *         *              * PTRIGGER * TGJT1
*      9   * R*4  *         *              * PTRIGGER * TGJT3
```

10.3 The /afs/cern.ch/atlas/offline/production directory structure



```
******************************************************************
* EVHEAD   *  1000     * 24        * 24     *       1.000        *
* HEPEVT   *  1000     * 156012    * Var.   *    Variable        *
* EVSIZE   *  1000     * 300       * 290    *       1.034        *
* CALO     *  1000     * 28        * Var.   *    Variable        *
* Total    *    ---    * 156364    * Var.   *    Variable        *
******************************************************************
* Blocks = 4            Variables = 100     Max. Columns = 39091 *
******************************************************************
```

```
*      26   * I*4   *         *              * EVSIZE    * NCRYHCEPS
*      27   * I*4   *         *              * EVSIZE    * LCRYHCEPS
*      28   * I*4   *         *              * EVSIZE    * NCRYHCRAC
*      29   * I*4   *         *              * EVSIZE    * LCRYHCRAC
*      30   * I*4   *         *              * EVSIZE    * NCRYHCREC
*      31   * I*4   *         *              * EVSIZE    * LCRYHCREC
*      32   * I*4   *         *              * EVSIZE    * NACCHSTAC
*      33   * I*4   *         *              * EVSIZE    * LACCHSTAC
*      34   * I*4   *         *              * EVSIZE    * NCOPHCPCE
*      35   * I*4   *         *              * EVSIZE    * LCOPHCPCE
*      36   * I*4   *         *              * EVSIZE    * NENDHENDC
*      37   * I*4   *         *              * EVSIZE    * LENDHENDC
*      38   * I*4   *         *              * EVSIZE    * NTILHTBSA
*      39   * I*4   *         *              * EVSIZE    * LTILHTBSA
*      40   * I*4   *         *              * EVSIZE    * NHENHHLAR
*      41   * I*4   *         *              * EVSIZE    * LHENHHLAR
*      42   * I*4   *         *              * EVSIZE    * NFWDHFWAI
*      43   * I*4   *         *              * EVSIZE    * LFWDHFWAI
*      44   * I*4   *         *              * EVSIZE    * NPIXDPBCR
*      45   * I*4   *         *              * EVSIZE    * LPIXDPBCR
*      46   * I*4   *         *              * EVSIZE    * NPIXDPECR
*      47   * I*4   *         *              * EVSIZE    * LPIXDPECR
*      48   * I*4   *         *              * EVSIZE    * NSCTDSCTB
*      49   * I*4   *         *              * EVSIZE    * LSCTDSCTB
*      50   * I*4   *         *              * EVSIZE    * NZSCDZSEN
*      51   * I*4   *         *              * EVSIZE    * LZSCDZSEN
*      52   * I*4   *         *              * EVSIZE    * NXTRDXGAS
*      53   * I*4   *         *              * EVSIZE    * LXTRDXGAS
*      54   * I*4   *         *              * EVSIZE    * NCRYDCBEA
*      55   * I*4   *         *              * EVSIZE    * LCRYDCBEA
*      56   * I*4   *         *              * EVSIZE    * NCRYDCEEA
*      57   * I*4   *         *              * EVSIZE    * LCRYDCEEA
*      58   * I*4   *         *              * EVSIZE    * NCRYDCRAC
*      59   * I*4   *         *              * EVSIZE    * LCRYDCRAC
*      60   * I*4   *         *              * EVSIZE    * NCRYDCREC
*      61   * I*4   *         *              * EVSIZE    * LCRYDCREC
*      62   * I*4   *         *              * EVSIZE    * NCRYDCEPS
*      63   * I*4   *         *              * EVSIZE    * LCRYDCEPS
*      64   * I*4   *         *              * EVSIZE    * NACCDSTAC
*      65   * I*4   *         *              * EVSIZE    * LACCDSTAC
*      66   * I*4   *         *              * EVSIZE    * NCOPDCOPH
*      67   * I*4   *         *              * EVSIZE    * LCOPDCOPH
*      68   * I*4   *         *              * EVSIZE    * NENDDENDC
*      69   * I*4   *         *              * EVSIZE    * LENDDENDC
*      70   * I*4   *         *              * EVSIZE    * NTILDTBMA
*      71   * I*4   *         *              * EVSIZE    * LTILDTBMA
*      72   * I*4   *         *              * EVSIZE    * NHENDHENN
*      73   * I*4   *         *              * EVSIZE    * LHENDHENN
*      74   * I*4   *         *              * EVSIZE    * NFWDDFWSI
*      75   * I*4   *         *              * EVSIZE    * LFWDDFWSI
*       1   * I*4   *         * [0,3]        * CALO      * Nsum
*       2   * R*4   *     24  * [.0000,1000. * CALO      * E_total(Nsum)
*       3   * U*4   *     13  * [0,8000]     * CALO      * N_total(Nsum)
*******************************************************************
*  Block    *  Entries  * Unpacked * Packed *   Packing Factor    *
```

10.2 Production control ntuple listing

```
******************************************************************
* Ntuple ID = 1      Entries = 1000      Atlas_production_control
******************************************************************
* Var numb * Type * Packing *    Range     *  Block   *  Name    *
******************************************************************
*      1   * I*4  *         *              * EVHEAD   * idrun
*      2   * I*4  *         *              * EVHEAD   * idevnt
*      3   * I*4  *         *              * EVHEAD   * itrflag
*      4   * R*4  *         *              * EVHEAD   * vvx
*      5   * R*4  *         *              * EVHEAD   * vvy
*      6   * R*4  *         *              * EVHEAD   * vvz
*      1   * I*4  *         *              * HEPEVT   * ISUB
*      2   * I*4  *         *              * HEPEVT   * Nhard
*      3   * I*4  *         * [0,3000]     * HEPEVT   * Npart
*      4   * I*4  *    3    * [-1,3]       * HEPEVT   * istat(Npart)
*      5   * I*4  *    14   * [-8000,8000] * HEPEVT   * ipdg(Npart)
*      6   * U*4  *    12   * [0,3000]     * HEPEVT   * imo1(Npart)
*      7   * I*4  *    13   * [-3000,3000] * HEPEVT   * imo2(Npart)
*      8   * I*4  *    13   * [-3000,3000] * HEPEVT   * idau(Npart)
*      9   * R*4  *         *              * HEPEVT   * px(Npart)
*     10   * R*4  *         *              * HEPEVT   * py(Npart)
*     11   * R*4  *         *              * HEPEVT   * pz(Npart)
*     12   * R*4  *    12   * [-1.0000,10. * HEPEVT   * mass(Npart)
*     13   * R*4  *    10   * [.0000,.0000 * HEPEVT   * tof(Npart)
*     14   * R*4  *    16   * [-50.0000,50 * HEPEVT   * vx(Npart)
*     15   * R*4  *    16   * [-50.0000,50 * HEPEVT   * vy(Npart)
*     16   * R*4  *    16   * [-500.0000,5 * HEPEVT   * vz(Npart)
*      1   * R*4  *         *              * EVSIZE   * time
*      2   * U*4  *    16   * [0,65000]    * EVSIZE   * NpGenz
*      3   * U*4  *    16   * [0,65000]    * EVSIZE   * NgTrack
*      4   * U*4  *    16   * [0,65000]    * EVSIZE   * NgVertx
*      5   * I*4  *         *              * EVSIZE   * NgTMult
*      6   * U*4  *    16   * [0,65000]    * EVSIZE   * NgSTMAX
*      7   * I*4  *         *              * EVSIZE   * Nwords
*      8   * I*4  *         *              * EVSIZE   * Nwfree
*      9   * U*4  *    9    * [0,500]      * EVSIZE   * Nsetdet
*     10   * I*4  *         *              * EVSIZE   * NPIXHPBCR
*     11   * I*4  *         *              * EVSIZE   * LPIXHPBCR
*     12   * I*4  *         *              * EVSIZE   * NPIXHPECR
*     13   * I*4  *         *              * EVSIZE   * LPIXHPECR
*     14   * I*4  *         *              * EVSIZE   * NSCTHSCTB
*     15   * I*4  *         *              * EVSIZE   * LSCTHSCTB
*     16   * I*4  *         *              * EVSIZE   * NZSCHZSEN
*     17   * I*4  *         *              * EVSIZE   * LZSCHZSEN
*     18   * I*4  *         *              * EVSIZE   * NXTRHXGAS
*     19   * I*4  *         *              * EVSIZE   * LXTRHXGAS
*     20   * I*4  *         *              * EVSIZE   * NCOIHCOEA
*     21   * I*4  *         *              * EVSIZE   * LCOIHCOEA
*     22   * I*4  *         *              * EVSIZE   * NCRYHCBEA
*     23   * I*4  *         *              * EVSIZE   * LCRYHCBEA
*     24   * I*4  *         *              * EVSIZE   * NCRYHCEEA
*     25   * I*4  *         *              * EVSIZE   * LCRYHCEEA
```

```
*MODE 'COIL' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'PIXB' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'PIXE' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'SCTT' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'ZSCT' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'XTRT' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'INAF' 'GEOM' 1 'MFLD' 1
*MODE 'COPS' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'ENDE' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'ACCB' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'HEND' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'TILE' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'FWDC' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
*MODE 'CALO' 'GEOM' 1 'PRIN' 1 'RECO' 1
*MODE 'MUCH' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1 'PRIN' 1
STOP
STOP
```

```
MSTJ 11=3
PARJ 54=-0.07   55=-.006  56=-.000001
C number of events to print;level
PRINT 5 3
TIME 2=100. 3=1
DEBU 0 0 1
SWIT 0 2
SIMULATION    1
DIGITIZATION  1
RECONSTR      0
ANALYSIS      0
OUTP          1
*BKIO 'O' 'RUNT'
*BKIO 'O' 'EVNT'
*BKIO 'O' 'KINE'
*BKIO 'O' 'HITS'
*BKIO 'O' 'DIGI'
AUTO 0
OPTI 2
DCAY 1
MULS 2
PFIS 1
MUNU 1
LOSS 3
PHOT 1
COMP 1
PAIR 1
BREM 1
DRAY 1
ANNI 1
HADR 6
ABAN 0
CUTS 1=.0001 2=.0001 3=.0001 4=.0001 5=.0001
CUTS 6=.001  7=.001  8=.001  9=.001
CUTS 11=100.E-9
*TFLT 'ETAP' -2.7 2.7
*MODE 'TRAC' 'SIMU' 1 'HIST' 0 'PRIN' 0 'DEBU' 0
C Define:    process     Rmax    Zmax Emin(parent) Emin(daughters)
*DETP 'TRAC' 2='DCAY' 3=110. 4=340. 5=0.3 6=0.0
*DETP 'TRAC' 7='PAIR' 8=110. 9=340. 10=0.3 11=0.0
*DETP 'TRAC' 12='BREM' 13=110. 14=340. 15=0.0 16=0.01
*DETP 'TRAC' 17='HADR' 18=110. 19=340. 20=0.3 21=0.0
*MODE 'INIT'
*MODE 'GEOM'
*MODE 'DOCU'
*MODE 'CLOS'
*MODE 'DIGI'
*MODE 'RECO'
*MODE 'CONS'
*MODE 'GENE'
*MODE 'INPU'
*MODE 'MFLD' 'GEOM' 1 'MFLD' 1
*MODE 'ATLS' 'GEOM' 1 'MFLD' 1
*MODE 'PIPE' 'GEOM' 1 'MFLD' 1
*MODE 'CRYO' 'GEOM' 1 'SIMU' 1 'MFLD' 1 'DIGI' 1
```

10 Appendices

10.1 Datacard file for jet production

(in bold-face are the cards that have been modified and the new cards added for the new batch of ~ 1 000 000 events)

```
C
C------DATACARD FILE for DICE version (jet production)------
C   Automatically Generated by the generate_jobs program
C
LIST
TRAP  0  3  10 10  1 0 10 1 4 10
MONI  2
C     [1-2146] [1-999999]  Combined to give single integer to ranlux
RNDM      2731  573442
RUNG      2731       1
TRIG 1000
*NEWV 'P' 1
C generate PYTHIA twojet events
KINE 1
C PYTHIA CARDS
BEAM 'P' 'P'
FRAME 'CMS'
ENER 14000.
C CHOOSE JET PRODUCTION
MSEL 1=0
MSUB 11=1 12=1 13=1 28=1 53=1 68=1
C Include prompt photon production
MSUB 14=1 18=1 29=1 114=1 115=1
C Include top quark, W and Z production
MSUB 81=1 82=1 1=1 2=1
C Suppress gluon to ttbar coupling for normal jet production
C This only works with mod to PYINRE routine to enable processes 81-82
C *DMOD 21 132 0
C MASS OF TOP
PMA1 6=175.
C MASS  OF Z0   AND W
PMA1 23=91.2   24=80.5
C MASS  OF HIGGS
PMA1 25=800.
C Switch on photon bremsstrahlung
MSTJ 41=2
C Force k0,lambda... to be stable
MSTJ 22=2
C Kinematic cuts
CKIN   3=17.
CKIN 13=-2.7 14=2.7 15=-2.7 16=2.7
C  Set top decay as quark 3-body decay (Sjostrand Oct. 1992)
MSTP 48=1
```

8 References

8-1 ATLAS Inner Detector Technical Design Report, CERN/LHCC/97-16, ATLAS TDR 4, 30 April 1997.

8-2 PYTHIA 5.7 and JETSET 7.4, Physics and Manual, Torbjörn Sjöstrand, CERN-TH.7112/93, W5035/W5044.

8-3 ATLFAST 1.0, a package for particle-level analysis, E. Richter-Was et al., ATLAS Internal Note, PHYS-NO-079, 1 March 1996.

8-4 R. Hawkings, private communication.

8-5 GEANT, Detector Description and Simulation Tool, Application Software Group, Computing and Networks Division, CERN Program Library Long Writeup W5013.

8-6 ATLAS production area: /afs/cern.ch/atlas/offline/production/

8-7 Management of Simulation in Atlas: Seeds and Bookkeeping, S. O'Neale and M. Stavrianakou, http://wwwcn.cern.ch/~soneale/DRAFT/SEEDY_Atlas.html.

8-8 1997 Jet Production for the ATLAS TDRs, http://atlasinfo.cern.ch/Atlas/GROUPS/SOFTWARE/HELP/jet_production.html.

8-9 ATRIG 1.00, ATLAS Internal Note, SOFT-NO-017, 2 December 1994.

8-10 ATLAS Trigger Simulation, Package ATRIG, /afs/cern.ch/user/h/hansl/public/notebook/trigger/atrig300.ps

8-11 Multi-Tape Readout in Slug, P. Nevski, ATLAS Internal Note, SOFT-NO-008, 19 June 1996.

8-12 M. Wielers, private communication.

9 Acknowledgements

This work would not have been possible without the contributions from R. Hawkings, M. Nessi and P. Nevski.

We are grateful to the IT Division and especially C. Boissat, V. Dore and A. Miotto for their technical support throughout this production and in particular over the Christmas 1996 shutdown, when the first batch of ~ 300 000 events were produced.

Finally, we wish to thank the members of the ATLAS Inner Detector community and in particular T. Pal for their analysis efforts and feedback.

The electron datasets can only be used for studies involving the inclusive single electron trigger. They are biased against level-1 and level-2 calorimeter studies by the tight particle-level filter, but can be used for any studies beyond this, i.e. for any studies of physics signals or backgrounds involving at least one electromagnetic cluster with $E_T > 20$ GeV, $|\eta| < 2.5$ and passing the level-2 calorimeter cuts. Examples of such studies are:

- evaluation of rates at level-2 involving at least one electromagnetic cluster (e.g. e–e, e–μ, γ–γ, e + jet(s),...);
- evaluation of γ/jet and e/jet separation as a function of E_T;
- evaluation of expected rates for various large cross-section signal processes (single γ, single e, ...)

The jet datasets will provide enough statistics to evaluate most of the trigger rates involving jets, in particular for multijet events with low jet E_T-thresholds. ATLFAST will have to be used however to renormalise these rates to the full acceptance of the jet triggers ($|\eta| < 3.2$).

The two main drawbacks of these datasets should never be forgotten:

- absence of GEANT simulation for $|\eta| > 2.7$, implying that no E_T^{miss} calculation can be done;
- absence of the muon system in the simulation.

7 Conclusions and plans

As stated in the beginning, the ultimate target of this production is 10^7 jets. These data sets will be used for the ATLAS performance TDR and for the trigger performance TDR. In order to achieve this, it is necessary to 'export' the production to as many production centres outside CERN as possible. We hope that the information provided in this note together with the WWW pages will facilitate the production process and assist the analysis effort.

Presently the plans for the summer are the following:

- Include the muon system, correct minor bugs and produce executable from the 97_6 software release. This will be done and checked before mid-June.
- Start production at RAL for dedicated LVL1 trigger and dataflow studies. The event generation cuts and the particle-level filter cuts will be looser for this production.
- Resume production at CERN by end of June and start production at LBL.

6 Reconstruction and analysis

All standard ATLAS reconstruction packages for calorimetry and tracking can be used for analysing the various data sets. Tables 6-1 and 6-2 summarise the available data sets.

Table 6-1 Summary of available data sets (electron stream).

	Generated events	Events processed in GEANT	Electron candidates after 'LVL1' filter	Isolated electrons from b, c after calorimeter and tracking analysis [8-1]	Isolated electrons from W,Z after calorimeter and tracking analysis [8-1]	'Isolated' photons after calorimeter analysis (excluding photons from π^0,η) [8-12]
Inner Detector TDR	501 000	72887	9998	~ 31	~ 6	...
Total at present	942 031	136 542	18 654	~ 58	~ 11	599
Goal	5×10^6	~ 725 000	~ 99 000	- 290	~ 55	~ 3200

Table 6-2 Summary of available data sets (jet stream).

	Jet candidates	Events with $\geq$ 2 jets with $p_T > 40$ GeV (1)	Events with $\geq$ 3 jets with $p_T > 40$ GeV (1)	Events with $\geq$ 4 jets with $p_T > 40$ GeV (1)
Total at present	19 036	~ 9 070	~ 1560	~ 270
Goal	~ 101 000	~ 48 140	~ 8280	~ 1420

A detailed electron/jet analysis was performed in the context of the Inner Detector TDR [8-1]. The study focused on inclusive electron reconstruction efficiency and rejection against QCD jets, using the combined information from the ATLAS calorimeter (CALOREC) and Inner Detector (XKALMAN and IPATREC). The software for this analysis, i.e. for combined calorimeter and track reconstruction will become publicly available in the ATRECON framework by September 1997.

Reduced jet datasets were also used to study the Level-2 trigger performance without and with pile-up [8-1].

1 As obtained by extrapolation after analysis with ATLFAST of a sample of 500 000 events.

5.2 Running the pseudo-LVL1 filter

An input data file contains on average ~ 145 (or ~ 75, if produced on LSF) fully processed events. The LVL1 filter reduces this typically by a factor of ~ 8. It is therefore necessary for practical reasons to provide multi-tape/file input [8-11]. Example job scripts and datacards for processing up to 20 tape-files (current upper limit in SLUG) are available from [8-6]. Each job will produce a ZEBRA output file and a histogram file with two summary ntuples. Both files are saved on tape (see below). The program is fast: the CPU time needed (on HP735) is 0.8 s per di-jet event and 0.6 s per single electron event. The run logfiles, job scripts and datacards are saved for future checks.

A regularly updated table of produced data and ntuple files, as well as general information con cerning the pseudo-LVL1 filtering, are available on WWW [8-8].

5.3 Jet filter

A jet-candidate stream was extracted from the 942 031 generated events by reapplying the particle-level filter . The jet candidates amounted, as expected, to 2.02% (19 036 events) of the generated sample.

Example job scripts and datacards for processing up to 20 tape-files (current upper limit in SLUG) are available from [8-6]. Each job produces a ZEBRA output file which is saved on tape. A regularly updated table of produced data files, as well as general information concerning the jet stream filtering, are available on WWW [8-8].

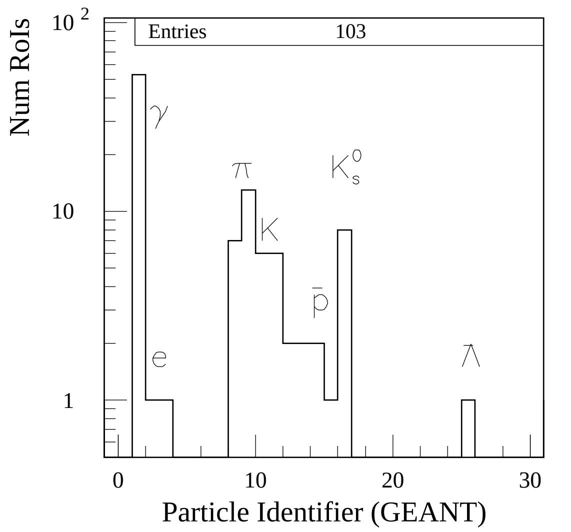


Figure 5-6 Identifier of the KINE particles associated to the selected RoI, see text.

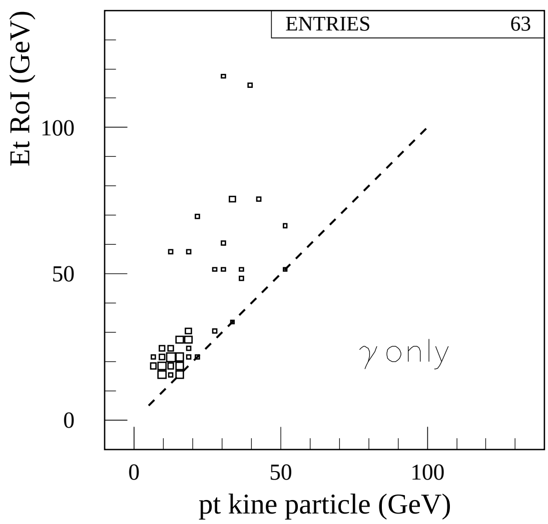


Figure 5-7 Comparison of E_T of the selected em clusters and the p_T of the associated KINE particle; only events where the associated particle is a γ are shown.

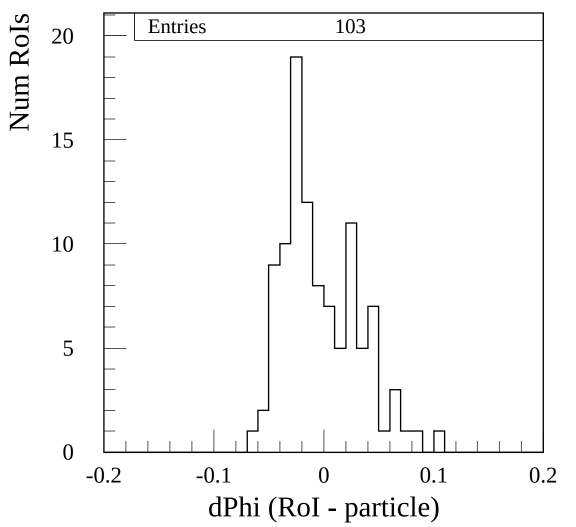


Figure 5-8 Comparison of the position in azimuth φ of the cluster and the associated KINE particle.

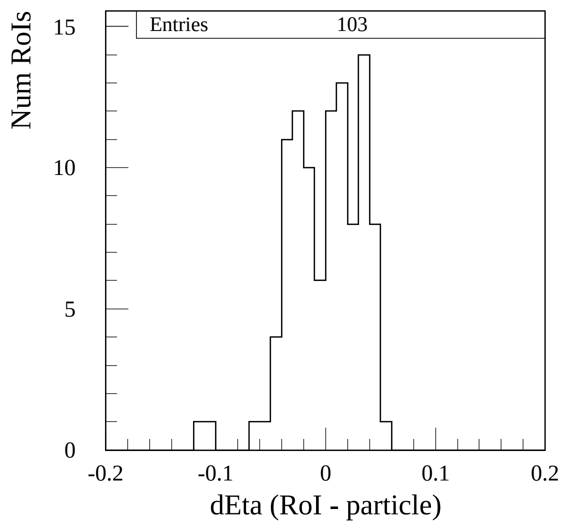


Figure 5-9 Comparison of the position in pseudo-rapidity η of the cluster and the associated KINE particle

The filter described above is not a simulation of the LVL1 trigger. Therefore rejection factors extracted from the filtered events should *not* be interpreted as rejection with respect to LVL1. In addition the window size $\Delta\phi \times \Delta\eta$ = 0.12 × 0.12, used by the particle level filter, is smaller than the LVL1 window size of 0.1 × 02 or 0.2 × 0.1.

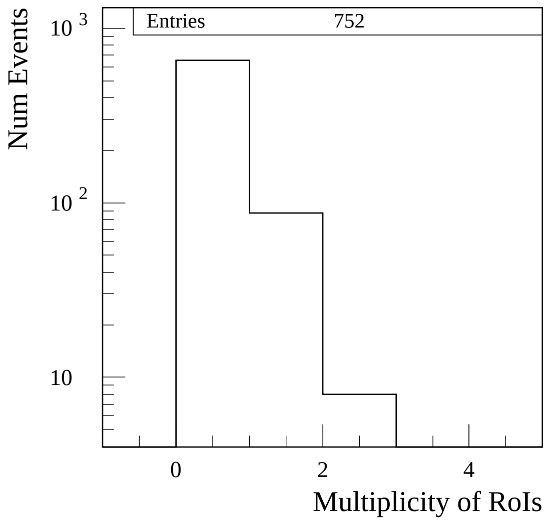


Figure 5-2 Multiplicity per event of selected em clusters (RoIs).

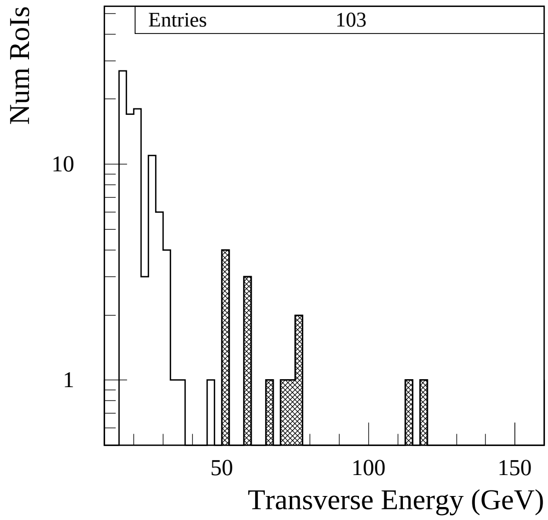


Figure 5-3 E_T distribution of the selected clusters. The hatched area corresponds to the RoIs selected by the high threshold for which no isolation is required.

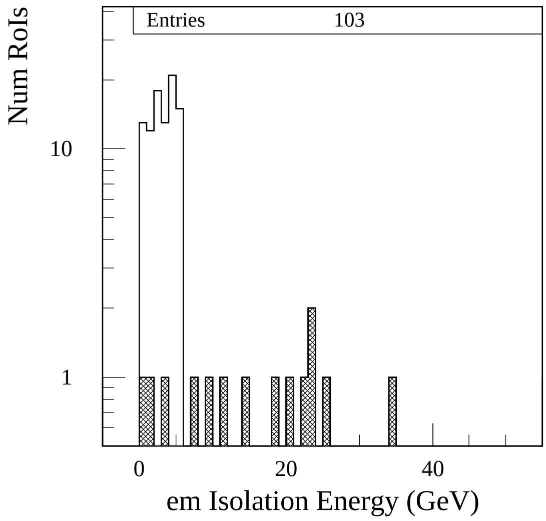


Figure 5-4 Electromagnetic isolation of accepted RoIs, hatched area as in Fig. 5-3.

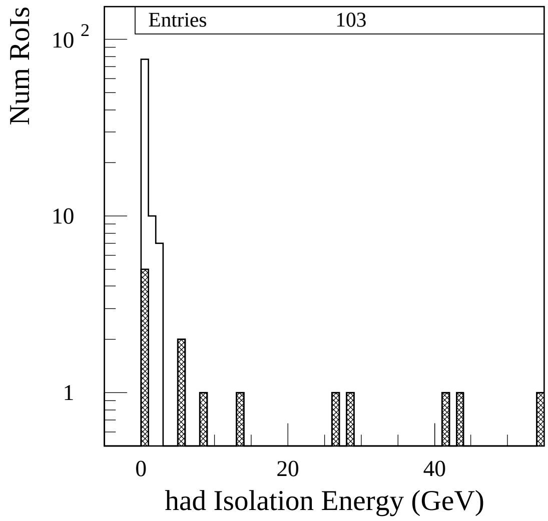


Figure 5-5 Hadronic isolation of accepted RoIs, hatched area as in Fig. 5-3.

The efficiency is close to 100% for electrons of $E_T \geq 30$ GeV and falls to about 98% for electrons of $E_T = 20$ GeV. Losses are mainly due to the E_T threshold. Figure 5-1 demonstrates for 20 GeV electrons that losses occur where there is dead material (centre and barrel/endcap transition) and close to the edge of the acceptance at $\eta \sim 2.5$. Losses at the edge of the LVL1 η - acceptance increase with decreasing E_T.

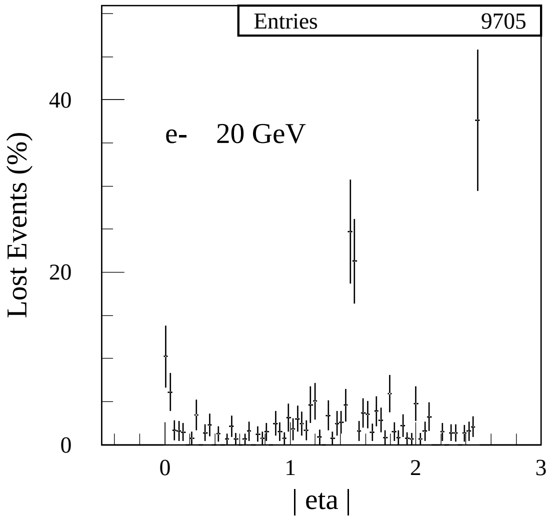


Figure 5-1 Loss of electrons of 20 GeV as function of $|\eta|$.

5.1.4 Rejection of di-jet events

The selection cuts tuned for electrons were then applied to di-jet events and yielded a rejection factor close to 8. Some typical distributions (extracted from the standard ntuples) are shown below for a small sample of di-jet events (Tape LL0028, files 2-9). Out of a total of 752 events, 87 events (8 events) with one (two) em clusters are selected, as shown in Figure 5-2. There are 87 + $2 \times 8 = 103$ 'Regions of Interest' (RoIs), which enter the distributions of Figures 5-3 to 5-9. In these figures, the clusters with E_T above the high threshold, are shown hatched.

Figure 5-3 depicts the steeply falling E_T distribution of the accepted clusters. Raising the threshold from 16 GeV to 20 GeV (26 GeV) reduces the number of events by a factor of 1.8 (3.8). The next two figures (5-4 and 5-5) show the em and hadronic isolation of the RoIs. The tails are due to the high threshold, for which no isolation is required. Whereas the distribution of the hadronic isolation E_T is steeply falling, the distribution of the em isolation is showing a sharp cut due to the filter selection. The E_T cut and the em isolation cut are most effective in rejecting di-jet events.

To get an indication of the origin of the RoIs, each RoI can be associated to a particle at the production vertex by selecting the highest energy KINE track in a window of $\Delta\eta = \Delta\phi = 0.4$, centered at the position of the RoI. Figure 5-6 shows the GEANT particle identifiers of the associated particles: ~ 50% of the clusters are associated to γ's; pions and kaons contribute about ~ 20% each. Even anti-protons or anti-lambdas are as frequent as true electrons (~ 2%). The E_T of the cluster is in general higher than the E_T of the associated particle. This is especially true for γ's, as shown in Figure 5-7. Figures 5-8 and 5-9 demonstrate that the position (ϕ, η) of the associated particle matches well the position of the cluster.

Table 5-3 lists the number of accepted and rejected events per bin and the corresponding efficiencies.

Table 5-3 Efficiency for electron trainings samples of 20, 30 and 40 GeV.

E_T	bin	number of events: accepted	number of events: rejected	efficiency
20 GeV e^-	1	2645	35	0.9869 ± .0022
	2	2372	37	0.9846 ± .0025
	3	508	41	0.9253 ± .0112
	4	1782	31	0.9829 ± .0030
	5	1842	23	0.9877 ± .0026
	6	53	28	0.6543 ± .0528
	Total - 3	8694	154	0.9826 ± .0014
	Total	9202	195	0.9792 ± .0015
30 GeV e^-	1	424	0	1.0000 ± .0000
	2	443	0	1.0000 ± .0000
	3	81	0	1.0000 ± .0000
	4	282	0	1.0000 ± .0000
	5	301	0	1.0000 ± .0000
	6	8	1	0 .8889 ± .1048
	Total - 3	1458	1	0.9993 ± .0007
	Total	1539	1	0.9994 ± .0006
40 GeV e^-	1	1167	3	0.9974 ± .0015
	2	1099	0	1.0000 ± .0000
	3	242	0	1.0000 ± .0000
	4	788	1	0.9987 ± .0013
	5	751	0	1.0000 ± .0000
	6	25	3	0.8929 ± .0585
	Total - 3	3830	7	0.9982 ± .0007
	Total	4072	7	0.9983 ± .0006

Appendix 10.5 lists the corresponding values that control the ATRIG program flow[1] and the parameters for the em cluster algorithm. The SLUG datacards, which are needed in addition to run the filter job can be found in [8-6].

The calorimeter data are calibrated in two steps: first the cells are calibrated using the calibration of the standard reconstruction package ATRECON, then the energies summed in towers are calibrated, correcting for the energy that escapes the window used by the LVL1 algorithm. The calibration coefficients are listed in Appendix 10.5; they are optimal for the lowest threshold.

5.1.3 Efficiency for electrons

Table 5-1 lists the data samples used. The cuts were tuned using electrons as training samples. The electron efficiency is evaluated for the η bins listed in Table 5-2, where $\eta_{min} \leq |\eta| < \eta_{max}$.

Table 5-1 Data samples

E_T	tape	file	event type
20 GeV	LT0052	25	e-
30 GeV	LT0023	7 + 8	e-
40 GeV	LT0052	23	e-
	LL0028	2-9	di-jet

Table 5-2 Definition of pseudorapidity bins used in Table 3

Bin	η_{min}	η_{max}	Comment
1	0.0	0.70	
2	0.70	1.37	
3	1.37	1.52	Barrel/end-cap transition
4	1.52	2.0	
5	2.0	2.48	
6	2.48	2.50	Edge effects close to η=2.5
Total	0.0	2.50	
Total - 3			All bins except bin 3

1. The version used for filtering the first batch of ~10^6 di-jet events was based on ATRIG version 3.02, see [8-6].

5 Pseudo-LVL1 filter

After the events have passed the simulation in DICE, further reduction is possible by applying a filter similar to the LVL1 electromagnetic (em) cluster trigger (pseudo-LVL1 filter). The efficiency of this filter for electrons and the rejection factors achieved are described in this section. Only events flagged as electron events by the particle level filter are considered. Throughout the selection process, each event maintains its unique event and run number as assigned at generation time.

5.1 The Pseudo-LVL1 algorithm

5.1.1 Requirements

The filter is expected to provide significant rejection of di-jet events (of order 10) while preserving high efficiency for electrons (> 97%) . The event selection should be looser than the true LVL1 selection. The events are filtered before pile-up is added. The fraction of electron events that are rejected by the filter, but would pass the true LVL1 selection after addition of pile-up, should be small (< 1%). The values of the electron efficiency should be provided for the E_T values and η bins used for the study of electron identification in [8-1].

5.1.2 Algorithm and selections

The LVL1 code is part of the trigger simulation package ATRIG [8-10]. To save CPU time, only the LVL1 em trigger and global LVL1 trigger code are executed. The filter differs from the true LVL1 selection because all sources of smearing are switched off and fewer thresholds with looser selection cuts are used:

- no noise due to front-end electronics,
- no noise due to trigger layer and tower summation electronics,
- no uncertainty in amplification and pedestal values.

Two trigger thresholds are applied, one at low threshold with loose isolation cuts and one at high threshold without isolation cuts:

- low threshold: $E_T \geq 16$ GeV
  em isolation ≤ 6 GeV
  had. isolation ≤ 3 GeV;
- high threshold: $E_T > 50$ GeV
  no isolation requirement.

Table 4-1 ATLFAST expected species - comparison with generated jet sample for $|\eta| < 2.7$

Species	ATLFAST predictions for 500 000 events		ATLFAST analysis of 500 000 generated events	
ALL JETS	338 800	67.8% of total	349 611	69.9% of total
c - jets	18 170	5.4% of jets	18 911	5.4% of jets
b - jets (all)	7 643	2.3% of jets	8 049	2.3% of jets
b - quarks	17 960	5.3% of jets	18 133	5.2% of jets
ALL e	112	2×10^{-4} of total	96	2×10^{-4} of total
from $t\bar{t}$	0.10	9×10^{-4} of e	0	-
from W,Z	7.9	7.1% of e	6	6.2% of e
from b,c	104	92.9% of e	90	93.8% of e
ISOLATED e	49.49	1×10^{-4} of total	40	8×10^{-5} of total
from $t\bar{t}$	0.09	0.2% of isolated e	0	-
from W,Z	7.4	15.0% of isolated e	6	15.0% of isolated e
from b,c	42	84.9% of isolated e	34	85.0% of isolated e
ALL γ	2458.2	0.5% of total	2512	0.5% of total
hard process	87	3.5% of γ	94	3.7% of γ
quark brem.	141	5.7% of γ	102	4.1% of γ
lepton brem.	1.2	5×10^{-4} of γ	0	-
from π^0,η	2230	90.7% of γ	2316	92.2% of γ
ISOLATED γ	625	0.1% of total	565	0.1% of total

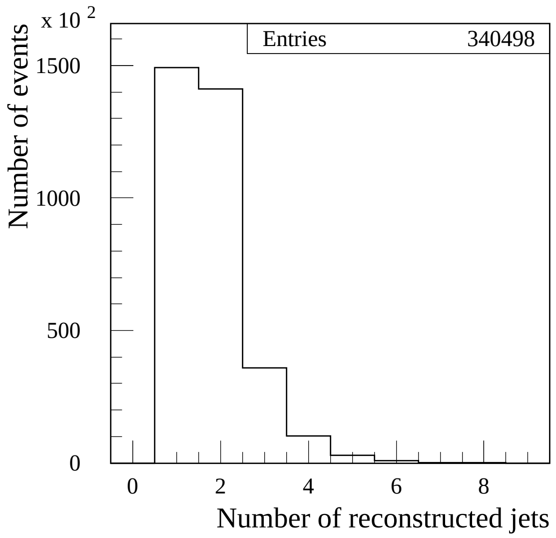


Figure 4-1 Number of reconstructed jets with |η| < 2.5 and p_T > 17 GeV (sample of 500 000 generated events analysed with ATLFAST)

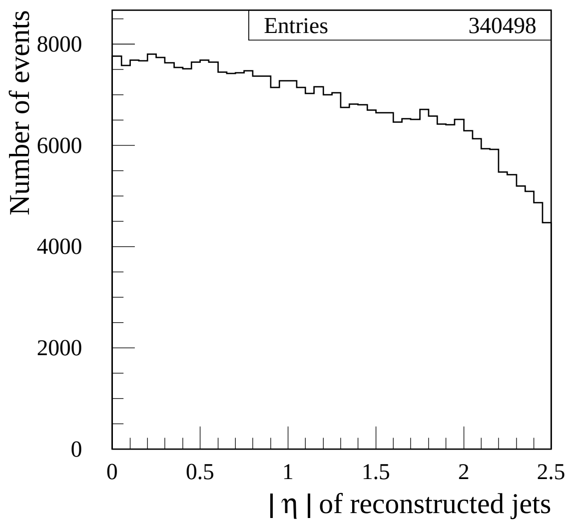


Figure 4-2 |η| distribution of reconstructed jets with p_T > 17 GeV (sample of 500 000 generated events analysed with ATLFAST)

4 Analysis with ATLFAST

4.1 The ATLFAST package

ATLFAST is an independent simulation package for particle-level analysis [8-3]. It is meant to be used as an intermediate step between simple parton-level analysis and full simulation. The stable, final-state particles of the generated events are processed and the reconstructed isolated leptons and photons, hadronic jets and jets labelled as b- or c- jets are selected and stored. The package includes a more or less accurate parametrisation of the most critical detector performance parameters and has been cross-checked with full simulation results for a number of the most sensitive physics processes.

4.2 Interface to the raw-data ntuple

The ATLFAST package has been interfaced to the raw-data ntuple so that it can access and analyse the GENZ information for all generated events. The interface consists of reading the information stored in the ntuple and transferring the GENZ information from it into the PYTHIA [8-2] common block /LUJETS/ needed for the ATLFAST simulation. FASTJET (an example of this interface) is available from [8-6]. Several ntuple files can be analysed in one FASTJET job, as specified by the user in the fastjet.input file. A new ntuple (see Appendix 10.4) is returned on output. The ntuple contains the PYTHIA subprocess for each event, the numbers of reconstructed electrons, muons, photons and jets, the missing p_T, the 4-vector information for all jets, muons and isolated leptons and photons, the event 'history' and some trigger information. Information on FSR b-quarks and all leptons and photons from various processes (which are not output in the ntuple) is retrieved and printed by user routines. A dummy user routine which is called by the steering routine is also provided. This example was developed for some specific studies and is by no means exhaustive; it can, however, provide a starting point for more elaborate applications.

This interface, as implemented in the FASTJET example, was used to reproduce Table 2-2 for part of the jet production sample. The results, which, as expected, are in very good agreement with the predictions (wherever there is enough statistics), are summarised in Table 4-1. The same interface was used for the normalisation of the jet sample as a function of $|\eta|$ in the case of the electron identification studies for the Inner Detector TDR (Figures 4-1 and 4-2).

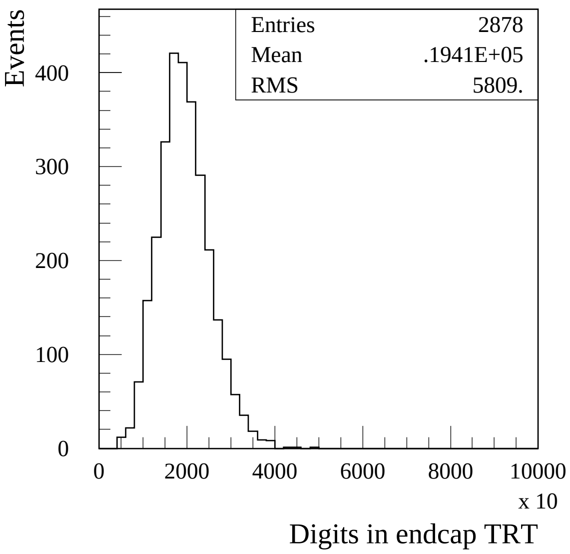


Figure 3-6 Total number of digits in endcap TRT detector (per fully simulated event).

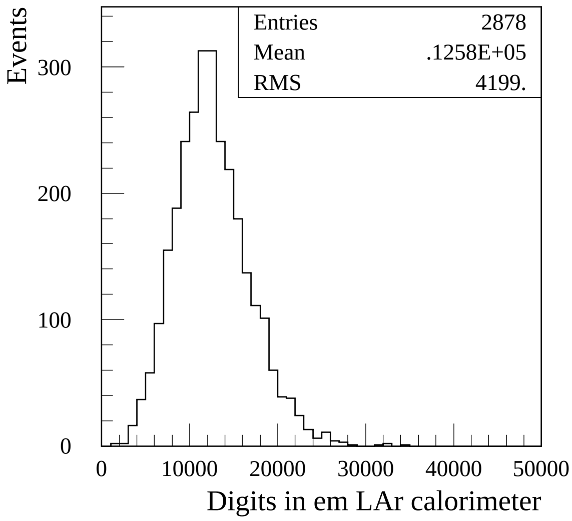


Figure 3-7 Total number of digits in electromagnetic LAr calorimeter (per fully simulated event).

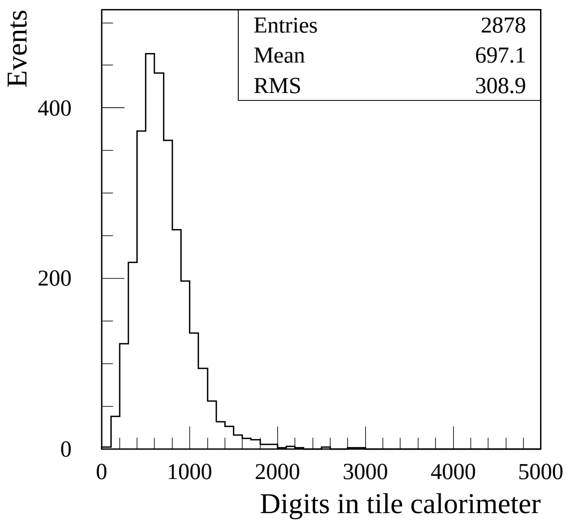


Figure 3-8 Total number of digits in tile calorimeter (per fully simulated event).

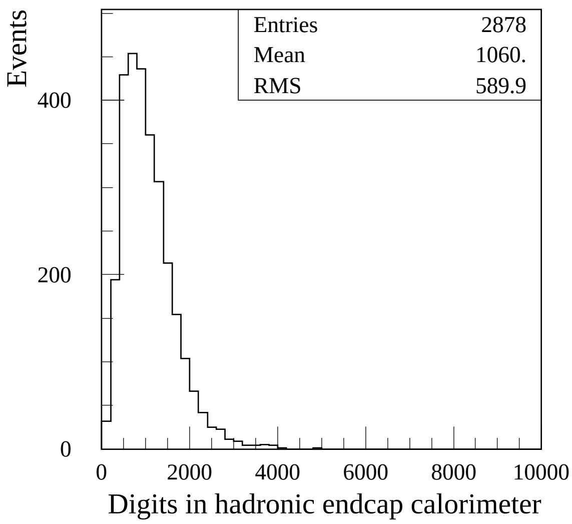


Figure 3-9 Total number of digits in hadronic endcap calorimeter (per fully simulated event).

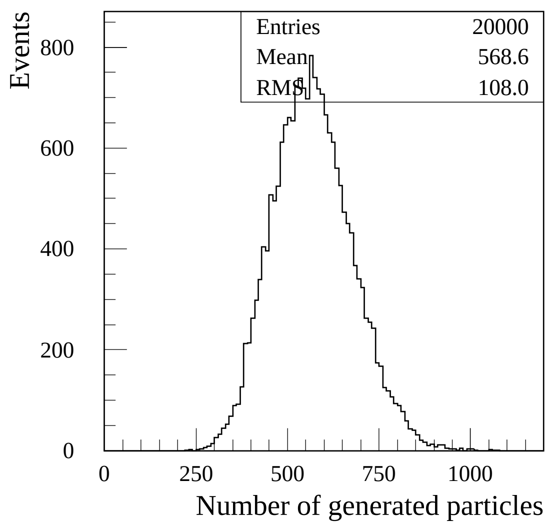


Figure 3-2 Number of generated particles per event.

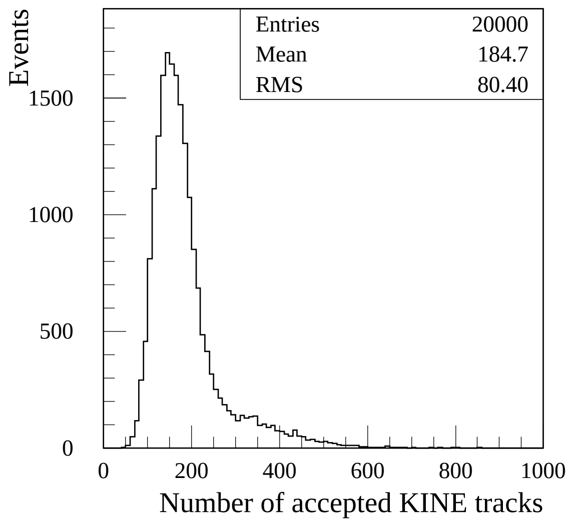


Figure 3-3 Number of accepted KINE tracks per event.

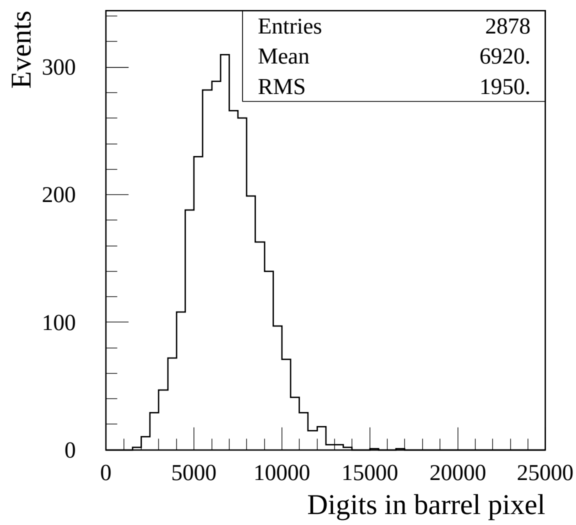


Figure 3-4 Total number of digits in barrel pixel detectors (per fully simulated event).

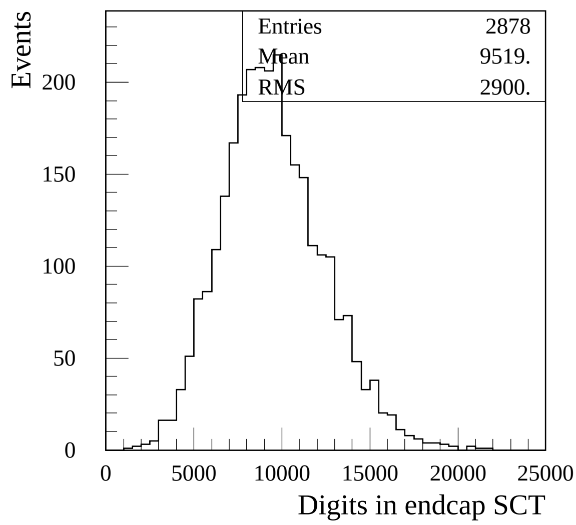


Figure 3-5 Total number of digits in endcap SCT detectors (per fully simulated event).

3.5 Book-keeping

Finished jobs typically return a full-length logfile, a short file summarising information on the numbers of events processed (if the job is successful), a 'monitor' file of the random numbers used (which, at present, cannot be re-used) and two 'output' files (data and ntuple) on the staging area chosen (see below). The analyse_jobs utility can then be run on a list of jobs; this returns the numbers of events generated and processed for each run (or a message that the job has either failed or not run yet) and the total numbers of events generated and analysed for that set of runs. It also returns an error file if staging problems occurred during the job execution and a script for writing the staged output files on tape. The analyse_jobs utility is available from [8-6].

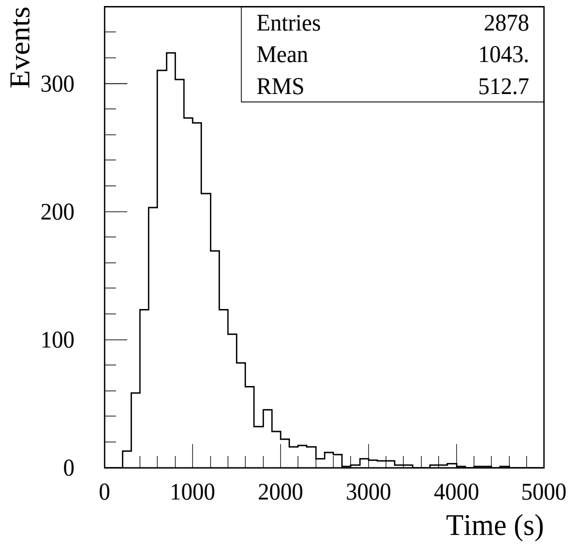


Figure 3-1 Time to process a fully simulated event.

Each data set consists of 1000 generated physics events of which ~ 14.5% pass the particle level filter [8-4] and are fully simulated in the ATLAS detector. One fully processed event occupies ~1 Mbyte on average and needs ~1000 seconds (on HP735) to be processed (Figure 3-1). The fully processed events (including both HITS and DIGI) are output into a ZEBRA file which is subsequently written to tape. The size of the ZEBRA output file (i.e. the number of events) depends on the production execution host (due to different time limits on different hosts). CSF-produced runs contain 1000 events (14.5% fully processed) so the ZEBRA output file sizes range from ~ 120 Mbytes to ~ 180 Mbytes. LSF-produced runs contain 500 events (unless otherwise stated in the database - see below) and are therefore approximately half the size of CSF runs.

All events, including those rejected by the particle-level filter, are output to a control ntuple (see listing in Appendix 10.2), which contains general information about each event (run number, event number, particle-level filter flag), the full physics-generation information (GENZ) including the PYTHIA process number, as well as a summary of the GEANT information (numbers of digits in the various subdetectors) for the fully processed events. Some generation information and GEANT digits for a few systems are shown in Figures 3-2 to 3-9. These figures can be used as references for future productions outside CERN. The ntuple files for CSF runs are compressed (~ 11 Mbytes). LSF produced ntuples are not compressed. If the job was successful, the two output files are written to tape. The tapes used are robot-mountable 10 Gbyte NTPs (backups also available). The run logfiles, job scripts and datacards are saved for future checks for all jobs, including those that failed.

A regularly updated table of produced data and ntuple files, as well as general information concerning the jet production, are available on WWW [8-8].

- the GEANT cards for physics process control and the tracking cuts, with the latter set to 100 keV for γ, e, neutral and charged hadrons and μ, and 1 MeV for muon and hadron bremsstrahlung and δ–rays from electrons and muons;
- the detector geometry and digitisation cards.

Major changes and improvements for the production of the second batch of ~ 1 000 000 are summarised below:

- a correction in order to store in the KINE banks the information on tracks with energy above 0.3 GeV and the bremsstrahlung information when the emitted photons are above 10 MeV. This new standard is better for detailed studies of the Inner Detector performance;
- the NEWV datacard to include the vertex spread.

3.3 Run and random numbers

As mentioned above, for the production of the first 942 031 events, the run numbers used were 1-300 and 2001-2800. A random number seed management scheme has been proposed in the context of an overall production management process for ATLAS [8-7]. In the absence of central production management, participating institutes are allocated 3-digit institute codes that will be used to implement the starting seeds. The run number ranges to be used will have to be 'booked' centrally (scheme in preparation). The future production will at least partly adopt this proposal.

The random numbers cannot at present be saved usefully for later re-processing of chosen events, due to problems remaining with the FLUKA package.

3.4 Job generation and submission

The production jobs were generated semi-automatically with the generate_jobs utility. Job scripts and datacards were generated for each run in the requested range of run numbers. A submission script for all generated jobs was also created. The generate_jobs utility is provided in [8-6] (see also Section 10.3). A WWW remote job submission application is foreseen in the near future.

3 Jet production software

3.1 Simulation code

The simulation code used for the first batch of 942 031 events (run numbers 1-300 and 2001-2800) was mainly derived from the 96_12 software release with some modifications for the particle-level filter (see Section 1.3.1) and the output control ntuple. The code included a full GEANT [8-5] simulation of the ATLAS Inner Detector and calorimetry but no muon system. The GEANT simulation was 'standard' in terms of the GEANT cuts, of the KINE stack increase in size to include secondary particles and of the output bank structures (see Section 3.2 and Appendix 10.1). The events were generated using PYTHIA [8-2]. All signal processes of interest (t, W, Z, γ) were enabled (see Section 3.2 and Appendix 10.1), but the vertex spread was inadvertently not included in this first part of the production.

The simulation code to be used for the second batch of ~ 1 000 000 events is derived from the 97_6 software release. It includes the modified version of the particle-level filter described in Section 1.3.1 and the same output control ntuple. The major changes and improvements are summarised below:

- an improved version of SLUG including saving the particle-level filter flags in the event header;
- an improved version of the TRT digitisation including updated values for the expected performance of the TRT in terms of transition radiation yield;
- the latest DICE release that includes the muon system description

The scripts to create the jet production executable as well as the various correction files needed are available on AFS from [8-6] (see also Section 10.3). Also available are example job scripts and datacard files (see also the following Sections).

3.2 Datacards

A detailed discussion on the choice of the datacard parameters is given in Section 3.2. An example datacard file is given in Appendix 10.1. Such datacard files with their unique sets of random number seeds are generated automatically for each job/run .

In summary, each datacard file consists of five parts:

- a general part where the number of events to be processed, the run number and the random number seeds are defined;
- a set of physics cards for generating PYTHIA di-jet events: the main parameters [8-2] are MSUB to select processes of interest, PMA1 to define masses for t, W, Z^0, H (m_t = 175 GeV, m_H = 800 GeV) and CKIN for the kinematic cuts at generation (see also Section 1.2 and Section 3.2);
- a set of control cards for debugging, printing and output;

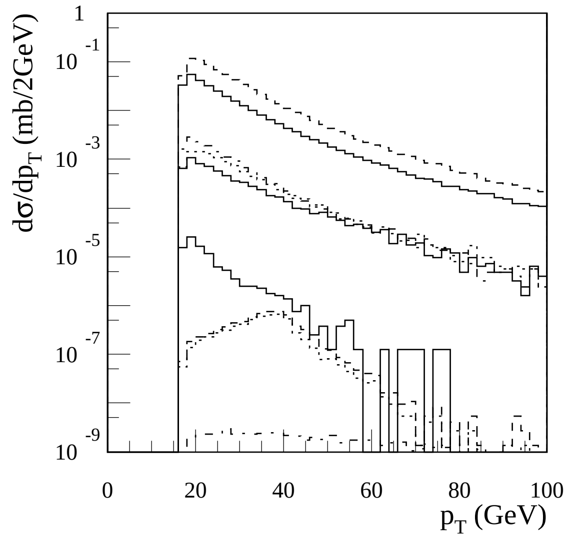


Figure 2-1 Expected $d\sigma/dp_T$ distribution for a generated sample of QCD jets with p_T > 17 GeV. Shown from top to bottom: 1) all partons (dashed) and all reconstructed jets (solid) 2) all b-quarks (dot-dashed), only b-quarks from the hard process (dotted) and all reconstructed b-jets (solid) 3) all electrons from heavy-flavour semi-leptonic decays (solid), electrons from W decay (dashed), from Z^0 decay (dotted) and from $t\bar{t}$ (dot-dashed).

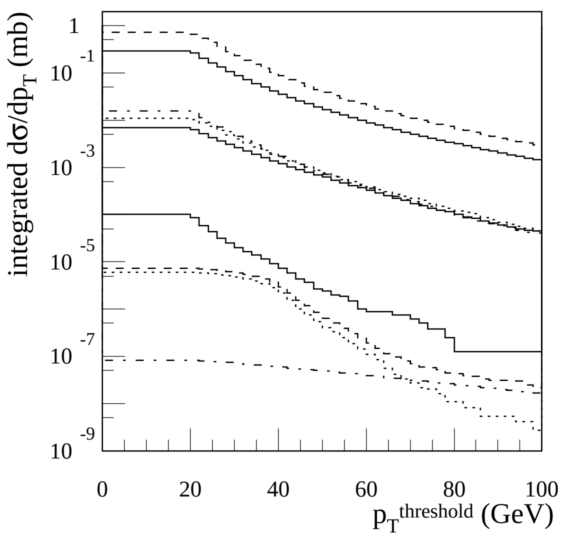


Figure 2-2 Expected integrated $d\sigma/dp_T$ distribution for a generated sample of QCD jets p_T > 17 GeV. Shown from top to bottom: 1) all partons (dashed) and all reconstructed jets (solid) 2) all b-quarks (dot-dashed), only b-quarks from the hard process (dotted) and all reconstructed b-jets (solid) 3) all electrons from heavy-flavour semi-leptonic decays (solid), electrons from W decay (dashed), from Z^0 decay (dotted) and from $t\bar{t}$ (dot-dashed).

To avoid complications arising from the jet calibration, results are given for uncalibrated jets (energy deposited inside the jet cone, appropriately smeared). The calibration factor, defined as $K_{jet} = p_T^{parton} / p_T^{jet}$ [8-3] can be as big as ~2 for low-p_T jets (around p_T = 15 GeV).

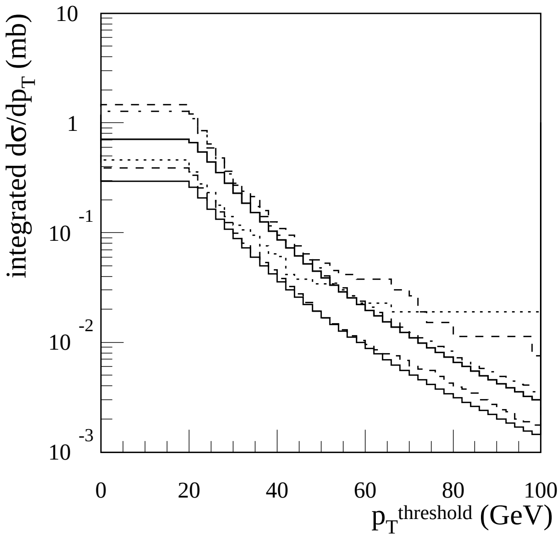


Figure 2-3 Expected integrated $d\sigma/dp_T$ distribution as a function of the p_T-threshold for partons (solid, dot-dashed, dashed) and for reconstructed jets (solid), dashed, dotted) with p_T > 17 GeV generated with p_T^{gen} = 17, 10, 1 GeV respectively.

Table 2-2 Expected species for a sample of 500 000 events generated with PYTHIA.

Species	$\|\eta\| < 2.7$	$\|\eta\| < 0.7$	$0.7 < \|\eta\| < 1.4$	$1.4 < \|\eta\| < 1.6$	$1.6 < \|\eta\| < 2.7$
JETS					
jets (all)	338 800	101 600	95 210	24 970	116 200
c - jets	18 170	5 837	5 283	1 319	5 735
b - jets (all)	7 643	2 587	2 256	576	2 223
b - quarks (all)	17 960	5 713	5 251	1 374	5 567
ALL e					
from $t\bar{t}$	0.10	0.05	0.03	0.006	0.014
from W,Z	7.9	2.5	2.4	0.6	2.4
from b,c	104	32	34	8	30
ISOLATED e					
from $t\bar{t}$	0.09	0.04	0.03	0.006	0.014
from W,Z	7.4	2.5	2.3	0.5	2.1
from b,c	42	12	15	3	12
ALL γ					
hard process	87	26	25	7	30
quark brem.	141	41	39	17	43
lepton brem.	1.2	0.5	0.5	< 0.2	0.2
from π^0,η	2230	710	610	137	780
ISOLATED γ					
hard process	76	24	23	6	24
quark brem.	116	38	33	15	30
lepton brem.	0.1	0.1	< 0.1	< 0.1	< 0.1
from π^0,η	433	144	134	17	138

The systematics from generation p_T^{gen} cuts were also studied. The predictions for the total di-jet cross-section suffer from large theoretical uncertainties (factor of 2 or more). The tree-level hard scattering process $d\sigma/dp_T$ is divergent in the limit of small p_T , and, in PYTHIA, this is not regularised by higher order or non-perturbative corrections. Consequently, the cut on p_T^{gen} introduces a bias on the estimate of the inclusive rates for jets above the chosen threshold of 17 GeV. This effect is demonstrated in Figure 2-3, which shows the integrated (above threshold) $d\sigma/dp_T$ distribution for all partons (upper set) and for reconstructed jets (lower set) for events generated with p_T^{gen} = 17 GeV (solid), 10 GeV (dashed) and 1 GeV (dotted). The effect (factor of ~ 1.6 for jets) is less severe (at most ~10%) for electrons from semi-leptonic decays of heavy flavours.

2 Physics overview

A sample of 3×10^7 events was generated with the jet-production datacards and simulated with the ATLFAST package [8-3]. Separate smaller samples were generated for W, Z, $t\bar{t}$, $\gamma\gamma$ and $q\gamma$ production. No unstable particle decays were forced, thus allowing to collect from the unbiased generated sample of b and c quarks an inclusive and unbiased sample of electrons from semi-leptonic decays of heavy flavours. The cross-sections for all generated processes are given in Table 2-1.

Table 2-1 PYTHIA cross-sections for generated sample with $p_T^{hard} > 17$ GeV and $|\eta^{hard}| < 2.7$.

Hard-scattering process	PYTHIA subprocess	σ (mb)
qq, qg, gg	11,12,13,28,53,68	0.5
qγ, gγ	14,29,115	1.0×10^{-4}
γγ	18,114	1.2×10^{-7}
Z^0/γ	1	2.0×10^{-5}
W	2	6.0×10^{-5}
$t\bar{t}$	81,82	5.0×10^{-7}

Jets were reconstructed with ATLFAST, using the standard procedure of summing the energy deposited in a cone of $\Delta R = \sqrt{\Delta^2\eta + \Delta^2\phi} = 0.4$. Table 2-2 shows for a sample of 5×10^5 events the expected numbers of reconstructed jets and of high p_T electrons and photons, for various η-bins and for $p_T > 17$ GeV. Also shown are the numbers of electrons and photons surviving crude isolation criteria. The differential and integrated $d\sigma/dp_T$ distributions are shown in Figure 2-1 and Figure 2-2 respectively.

For jets with $|\eta| < 2.5$, b- and c-jets were identified as such if the corresponding heavy-flavour quark with $p_T^q > 5$ GeV was found within $\Delta R < 0.2$. The b-jet reconstruction efficiency increases with increasing b-jet p_T . For example, for quarks coming from the hard process, with required $p_T^{b\text{-quark,hard}} > 17, 27, 37, 45$ GeV, the efficiencies for b-jet reconstruction with $p_T^{b\text{-jet}} > 17, 27, 37, 45$ GeV are 55, 56, 65 and 77%. The expected numbers of b-quarks with $p_T > 17$ GeV produced in the hard process or in subsequent parton showering are also given. The hard process (single or double b-quark production) accounts for about 60% and the gluon splitting for about 40% of the observed b-quarks.

Semi-leptonic cascade decays produce electrons in the di-jet sample. The numbers of electrons coming from W, Z and $t\bar{t}$ decays as well as the numbers of electrons coming from semi-leptonic decays of b and c quarks are given in Table 2-2. The latter contribute about 90% of the total number of electrons. If isolation criteria (separation from jets and small energy deposition around the electron) are applied to the electron sample with $|\eta| < 2.5$, only 40% of the electrons from semi-leptonic decays survive, compared to more than 93% of those from W, Z and $t\bar{t}$ decays.

The dominant (91%) contribution to photons with $p_T^\gamma > 17$ GeV comes from π^0 decays. The direct γ or γγ production contributes 3.5% and bremsstrahlung from quarks 5.5% of the total number of photons. If isolation criteria (as for electrons) are applied, only 28% of the photons from π^0 decays survive, compared to 84% of the direct and bremsstrahlung samples.

option. As one might expect, the number of useful generated events, as reflected by the number of jets reconstructed with ATLFAST [8-3], is higher in this case and the number of di-electron events is 17% higher.

- All interesting signal processes are switched on (t, W, Z, γ) so that the signal efficiency can also be monitored directly from these data (although the statistics will be marginal in many cases).

1.3 General features

1.3.1 The particle level filter

The original particle-level filter [8-4] has been modified slightly and its present functionality is the following:

- Two classes of generated physics events are allowed to be processed through GEANT [8-5]. A dominant electron-candidate class and a dijet class which almost totally overlaps with the electron-candidate class.
- An event is accepted in the electron-candidate class if the summed E_T of all particles in a square grid of size $\Delta\eta \times \Delta\phi$ is above a certain threshold (muons and neutrinos are excluded from this sum). The threshold was set to 17 GeV and the grid size was set to 0.12×0.12, which corresponds to the smallest size useable without bias for level-2 trigger studies and offline electron-identification studies. This size is however too small for unbiased level-1 trigger studies and an independent production will be run for these level-1 studies (see Section 5).
- An event is accepted in the jet-candidate class if the summed E_T of all particles in a much larger grid of 1.0×1.0 is above a threshold of 40 GeV in two such regions. This is a crude emulation of a dijet trigger with a very low threshold set to 40 GeV, so that multi-jet event triggers and single-hadron triggers can be studied using this production. The original code was modified to request two such objects because otherwise the overlap of this trigger with the electron one was not sufficient at this low E_T-threshold. More can be learned by maintaining this low threshold and requiring two jets as proposed, than by raising the threshold to 50 GeV and requiring only one jet.
- With these cuts, 14.4% of the generated events are selected as electron-candidates, 2% as dijet candidates and a total of 14.5% of the generated events are thus selected for full GEANT simulation.

1 Introduction

1.1 Purpose and scope of the 1997 jet production

A large-scale production aiming at a total sample equivalent to 10^7 jets with full GEANT simulation of the ATLAS Inner Detector and calorimetry is in progress. This production is essential for physics studies related to the various ATLAS Technical Design Reports (TDRs). Those include the ATLAS Inner Detector TDR, the overall ATLAS performance TDR and the trigger performance TDRs. A first sample of 500 000 events (~ 10^6 jets) was produced and used for the ATLAS Inner Detector TDR [8-1]. A total of 942 000 events have been produced to-date.

1.2 Choice of generation parameters

For many reasons (explained below) the production is run with the same PYTHIA [8-2] generation cuts as for the old production, that is:

- CKIN(3) = 17, i.e. $p_{T\,(\text{hard-scattering})}$ > 17 GeV. This is chosen to maximise without too much bias the statistics needed for the 20 GeV electron identification studies. It will eventually also provide enough data for the 35 GeV threshold for single electrons at high luminosity.
- CKIN(13 to 16) = ± 2.7, i.e. $|\eta|_{(\text{hard-scattering parton})} < 2.7$. This was chosen originally for optimal use of our CPU. A comparison between this and the $|\eta| < 7$ option proposed by the trigger group is summarised in Table 1-1 for the case of tight particle level filter cuts (see Section 1.3.1). This comparison is based on the same amount of CPU time spent run-

Table 1-1 Comparison between two sets of |η| cuts for event generation

	|η| < 2.7	**|η| < 7.0**
Cross-section (mb)	0.5	1.0
Number of events processed through GEANT	41 660	41 660
Number of generated events	300 000	375 000
Number of jets with E_T > 17 GeV (reconstructed with ATLFAST) for all events generated	210 000	187 000
Number of events passing particle-level electron filter	41 070	41 340
Number of accepted electron clusters	46 440	45 780
Number of events with at least 2 EM clusters	4 920 ± 270	4 220 ± 440
Number of events passing particle-level jet filter	6 100	5 440
Number of events with at least 3 jets	390 ± 80	425 ± 200

ning production, which has shown that within statistical errors the CPU time per event is the same for both options (1130 s/event for $|\eta| < 2.7$ and 1160 s/event for $|\eta| < 7.0$ with an error of ± 90 s). Most numbers in the above table are slightly in favour of the $|\eta| < 2.7$

ATLAS Internal Note
PHYS-NO-102
30 July 1997

1997 ATLAS JET PRODUCTION

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Abstract

A large scale jet production with full GEANT simulation of the ATLAS inner detector and calorimetry is in progress. The physics goals of this production, the software framework, the filtering process, the particle level analysis facilities and some reconstruction tests are presented.

[1] Supported in part by Polish Government funds 2P03B00212 and 2P03B17210 and Polish-French Collaboration within IN2P3