**ATLAS Internal Note**
**CAL-NO-XXX**
**10 March 1996**

# Liquid-Argon Hadronic End-Cap Calorimeter description in DICE95

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**Abstract**

The layout and module geometry of the Liquid-Argon Hadronic End-Cap Calorimeter and its digitisation are described. The description has been done in DICE-95 framework[1].

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# 1 An overall layout.

The Liquid-Argon Hadronic End-Cap calorimeter (HEND) in the ATLAS detector consists of two wheels on each of end-cap region, situated at the distance z=421.2 cm from the origin. The calorimeter wheels embedded into a cryostat. The inner wheel sits between z=427.7 cm and z=509.4 cm, the outer one - between z=513.4 cm and z=609.5 cm. Each wheel divided by 32 phi sectors. when one sector covers angle of 11.25 degrees. The layout of the HEND in the ATLAS detector shown in fig. 1. For simplicity only the end-cap region is presented.

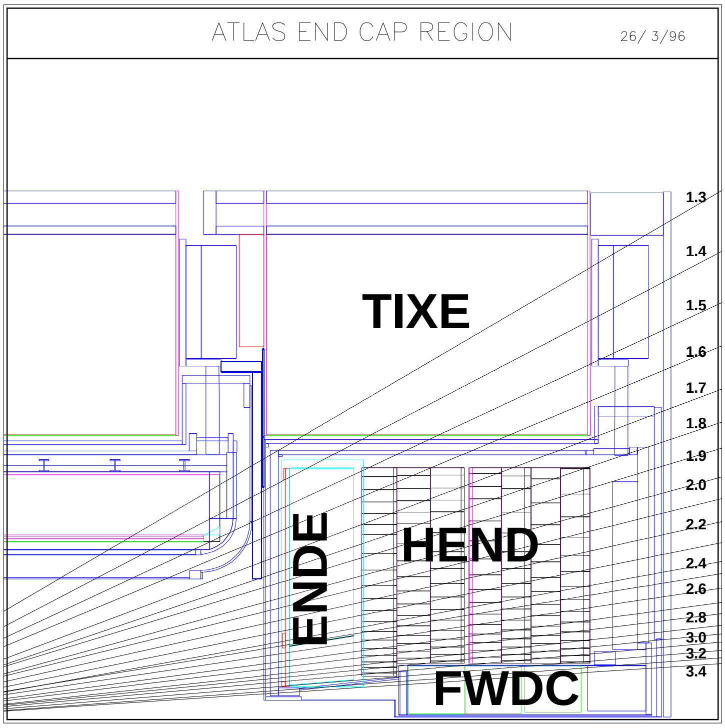



Figure 1: Cut view of the End Cap Region

# 2 The individual wheel.

The inner wheel consists of three, and outer wheel of four modules, encoded as HEMO. The last tapered copper plate in modules 1, 3, 5 and 7 (denoted as HTAP) is the readout board with electronics. The three-dimensional view of the calorimeter is presented in fig. 2.

The inner structure of the right-hand side end-cap is shown in fig. 3.

The three structure of HEND up to the modules level is shown in fig. 4.

The three-dimensional view of the 1/32 sector of the individual wheel presented in fig. 5. Each sector covers angle of 11.25 degrees.

# 3 The individual module.

Each module of the wheel, apart of the first plate in each wheel, is divided by eight inner volumes, encoded as HINE. This HINE volume consists of the the shower plates of copper

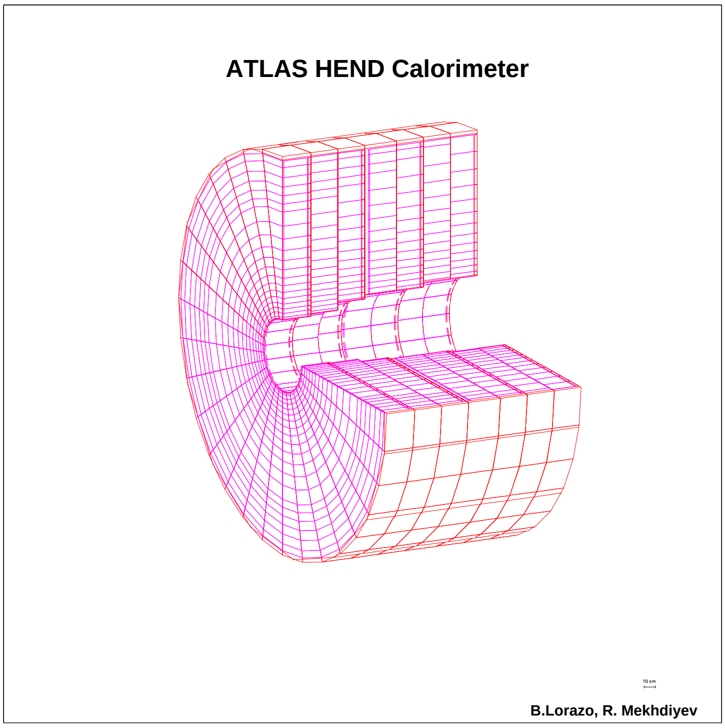



Figure 2: 3d view of the calorimeter

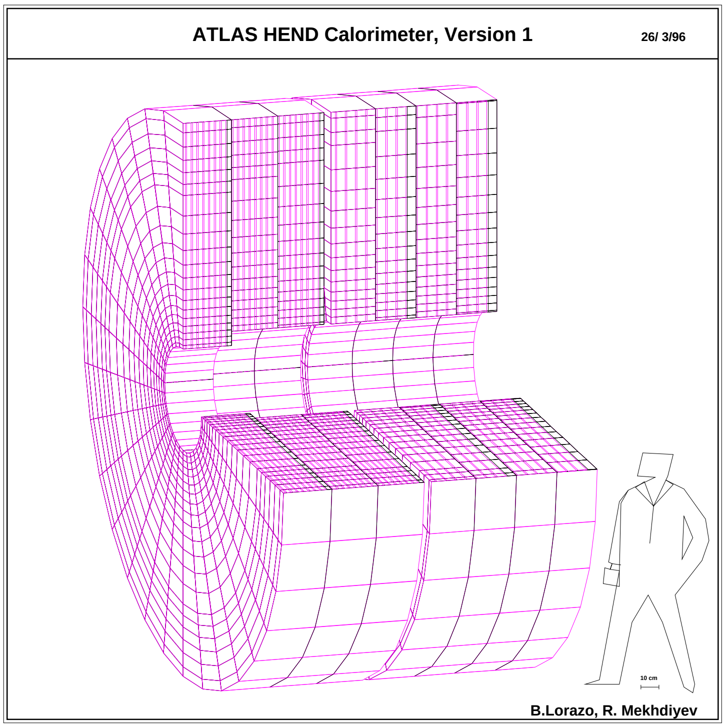



Figure 3: 3d view of the inner structure of HEND

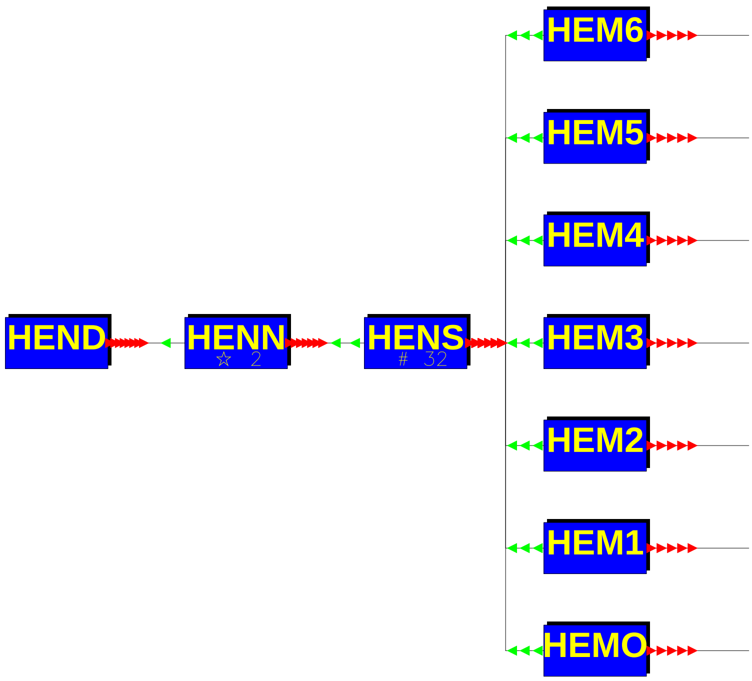



Figure 4: tree structure of HEND

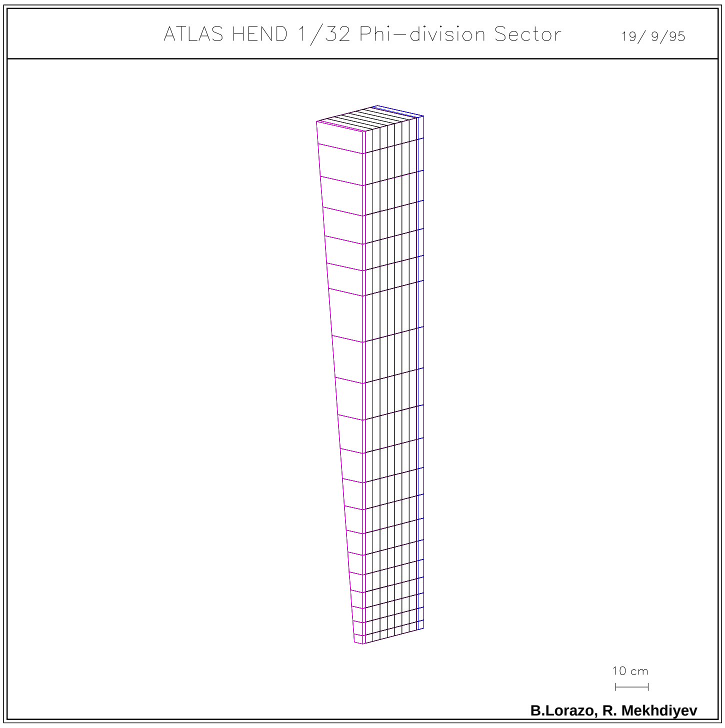



Figure 5: 3d view of the 1/32 phi sector

(HSHP), interleaved by the liquid argon gaps (HLAR). The first plate in each wheel, encoded as HFPL, also consists of copper, is 1/2 of thickness of ordinary one ( 2.5 cm and 5.0 cm for inner and outer wheels, respectively).

# 4 Hadronic Endcap $\eta$-granularity.

The module is divided into radial blocks ( denoted as HETA ) with boundaries calculated according $\eta$ values which are corresponds to actual $\eta$ granularity of the calorimeter. The typical tree structure of the HETA branch is presented in fig. 6

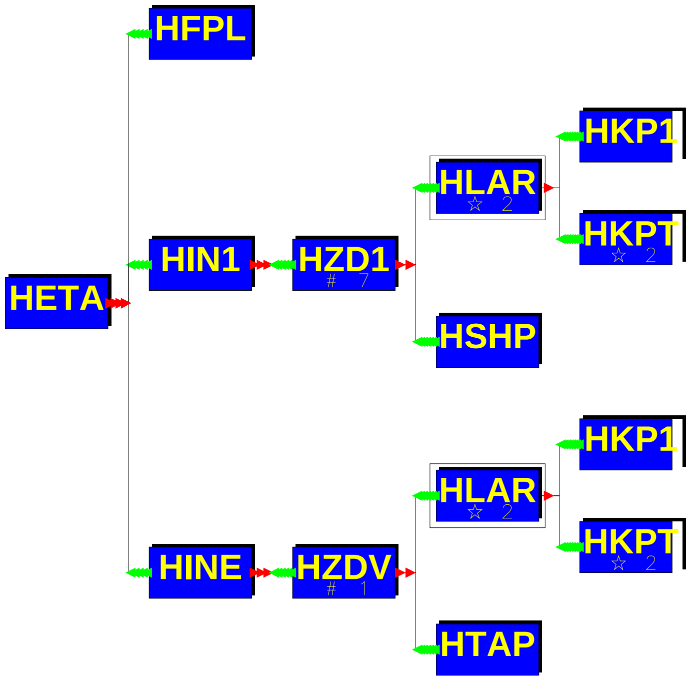



Figure 6: tree structure of HETA

# 5 The individual liquid-argon gap.

The liquid-argon gap between two subsequent shower plates is the sensitive volume with thickness 0.85 cm. Inside this sensitive volume the three kapton plates are inserted, encoded as HKAP. The thickness of these kapton foils, on which the sensitive electronics would be glued, is 300 $\mu$ for Padboard and 100 $mu$ for EST boards, as considering at present.

The z - view of the one liquid-argon gap is shown at fig. 7

# 6 Materials in HEND.

One of the important characteristics of geometry description is a correct material distribution in code. To check it, the material distribution in absorption lengths vs $\eta$ is plotted in fig. 8. This distribution was performed by geantino scan.

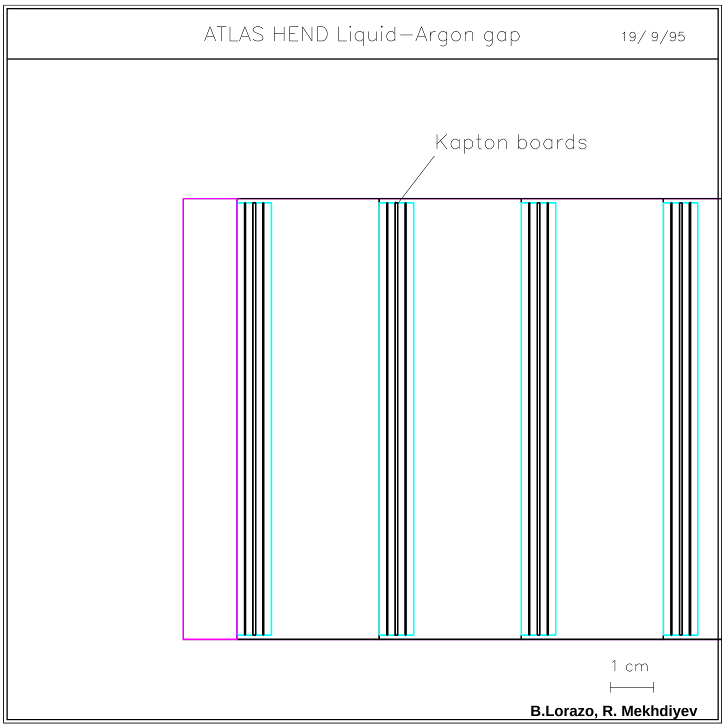



Figure 7: Z - view of Liquid-Argon gap

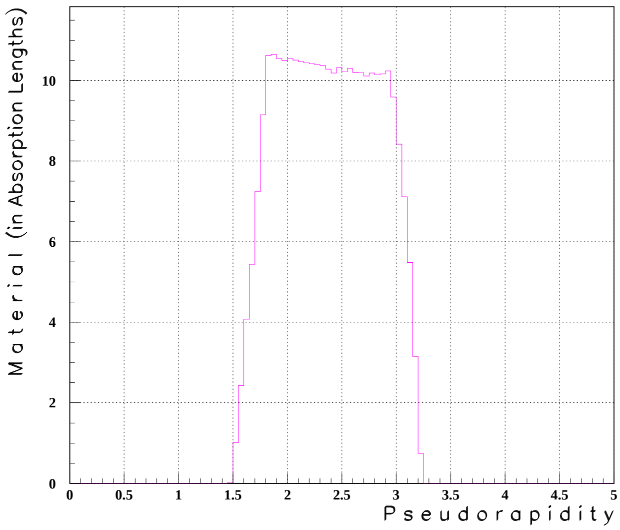



Figure 8: Material distribution in HEND

.

# 7 Access to digits.

Due to possibility in DICE95 to have different bins and the limits for digits in different places of the same logical detector[2], this feature was implemented in HENDDIG module.

Example for the HEND calorimeter:

```
    Fill HDIG          ! Digitization parameters
         Version =1                    !  Version
         Scale   =1.e6                 !  ADC scale factor
         EMax     =100                 !  Max energy
         EtaMx   =3.3                  !  Rapidity limit
         DEta    =0.05                 !  Finest eta granularity
         DPhi    =2*pi/64              !  Phi granularity
*
    do i = 1,8
        if (mod(i,2) != 0) then       "wheel outer part"
          DIGI HENN type=i:4:,
                    Eta:hdig_DEta:(1.5,1.8),
                    phi:hdig_dphi:(0,TwoPi),
                    Eloss:0:Calo(0,hdig_EMax)
        else if (mod(i,2)== 0) then    "wheel inner part"
          DIGI HENN type=i:4:,
                    Eta:hdig_DEta*2:(1.8,3.3),
                    phi:hdig_dphi:(0,TwoPi),
                    Eloss:0:Calo(0,hdig_EMax)
        end if
    end do
*
```

The /ittype parameter in DIGI statement is used as a switch between different DIGI parameters for different homogeneous parts of calorimeter.

The full text of HENDDIG routine is included in this note.

# 8 Summary.

The Liquid-Argon Hadronic Calorimeter GEANT geometry description and digitisation procedure in DICE95 standard has been created.

# References


[1] DICE95, ATLAS internal Note, SOFT/95-14.

[2] Reconstruction interface for DICE95, ATLAS internal Note,

# Appendix 1: The DICE95 code

The actual HEND geometry description is included in this note.

```
*-----------------------------------------------------------------------*
*                                                                       *
Module HENDGEO   is the Hadronic END-cap calorimeter GEOmetry
Author   Bernard LORAZO, Rashid MEKHDIYEV
                                            created  18/01/95
*                                                                       *
* Last modifications :                                                  *
*    Rashid Mekhdiyev                                Date: 21.03.96     *
*                                                                       *
*-----------------------------------------------------------------------*
*
*
Content   HEND,HENN,HENS,HEMO,HETA,HSHP,HLAR,HFPL,HINE,HZDV,HTAP,HKPT,HCOP
Structure HENG { Geometry,NSct,NSctMn,NSctMx,NBlc,NBlcMn,NBlcMx,
                 R0orig,REnd,ZOrig,ZStart,ZEnd,Cell(2),Larg,Plate(2),
                 Kapton,Copper,PadPl,EstPl,Adhes,hrcov,Hexcel,
                 RodWd,SprWd,SpRad,GapWhl,GapPlt,GapCel,KptPos(3),KptWid(3)}
Structure HETR { EtaGr,PhiGr,EtaMx,NEta,Eta(20)}
Structure HBLO { IBlc,BlRMn,BlRMx,BlDpth,Plate0,PlateE,BlMod }
Real             ANGL0,COS0,SIN0,Z(30),RMN(30),RMX(30),RBLC,ZBLC
Real             TgtDMB,TgtBot,TgtDMT,TgtTop,ZDetRf
Real             RBot,RTop,Drm,WBot,WTop,Drb,WBb,WTb,Dist,gd
Real             TrapH,TrapTL,TrapBL,TrapTH,Deta,Dphi
Integer          Iblc,Ind,IEta,MID,NBlMod,IKpt,ndv,Ity/1/
character*8      name
+CDE,AGECOM,GCONST,GCUNIT.
* -------------------------------------------------------------------------------
Fill  HENG          ! Description of the Hadronic EndCAp
      Geometry =1            ! Geometry choice (standard =1)
      NSct     =32           ! Number of sectors (Phi granularity)
      NSctMn   =1            ! Index of 1st sector (adjustable)
      NSctMx   =32           ! Index of last sector (adjustable)
      NBlc     =7            ! Number of blocs
      NBlcMn   =1            ! Index of 1st bloc (adjustable)
      NBlcMx   =7            ! Index of last bloc (adjustable)
      R0orig   =0.           ! Absolute ENDH R Origin
      REnd     =213.         ! Absolute ENDH R end
      ZOrig    =427.2        ! ABSOLUTE ENDH Z origin
      ZStart   =427.7        ! Zstart of calo itself
      ZEnd     =612.0        ! ABSOLUTE ENDH Z end
      Cell     ={3.35, 5.85} ! Cell width
      Larg     =0.85         ! Lar gap between  ground plates
      Plate    ={2.50, 5.00} ! Ground plate width
```

```
      Kapton   =0.0095       ! Kapton (Poliemid) foil width
      Copper   =0.0035       ! Copper pad width
      PadPl    =0.0260       ! Pad board width
      EstPl    =0.0100       ! Est board width
      Adhes    =0.0015       ! Kapton/Copper adhesive
      hrcov    =0.0003       ! HRC width
      Hexcel   =0.196        ! Hexcel width (Argon gap)
      RodWd    =0.1          ! Rod width
      SprWd    =0.1          ! Spring washer width value
      SpRad    =0.3          ! Spring Washer Radius
      GapWhl   =4.05         ! Inter-wheel gap
      GapPlt   =0.1/2        ! HALF inter-plate gap
      GapCel   =0.2/2        ! HALF inter-cell gap
      KptPos   ={0.206, 0.425 ,0.644} ! Kapton board position
      KptWid   ={0.010, 0.026 ,0.010} ! Kapton board width
* ------------------------------------------------------------------------------
Fill HETR           ! Eta and Phi grid values
      EtaGr  =0.05           ! Min eta granularity
      PhiGr  =.0981747       ! Phi granularity (radians)
      EtaMx  =3.4            ! Max rapidity
      NEta   =16             ! Eta granularity
      Eta ={ 3.3, 3.1, 2.9, 2.7, 2.5, 2.4, 2.3, 2.2, 2.1, 2.0,      _
             1.9, 1.8, 1.7, 1.6, 1.5, 1.0}          ! Eta granularity
* -----------------------------------------------------------------------------
Fill HBLO           ! One Longitudinal block
      IBlc   =1           ! Block #1
      BlRMn  =37.2        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =28.05       ! Depth
      Plate0 =1.25        ! First plate thickness
      PlateE =2.5         ! Last plate with electronics (needs a gap)
      BlMod  =8.          ! Number of LAR gaps (along z)
Fill HBLO           ! One Longitudinal block
      IBlc   =2           ! Block #2
      BlRMn  =47.5        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =26.8        ! Depth
      Plate0 =0.0         ! First plate thickness
      PlateE =0.0         ! last plate and gap
      BlMod  =8.          ! Number of Lar gaps (along z)
Fill HBLO           ! One Longitudinal block
      IBlc   =3           ! Block #3
      BlRMn  =47.5        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =26.8        ! Depth
      Plate0 =0.0         ! First plate thickness
      PlateE =2.5         ! Last plate with electronics (needs a gap)
```

```
      BlMod  =8.          ! Number of modules (along z)
Fill HBLO           ! One Longitudinal block
      IBlc   =4           ! Block #4
      BlRMn  =47.5        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =25.9        ! Depth
      Plate0 =2.5         ! First plate thickness
      PlateE =0.0         ! last plate thickness
      BlMod  =4           ! Number of modules (along z)
Fill HBLO           ! One Longitudinal block
      IBlc   =5           ! Block #5
      BlRMn  =47.5        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =23.4        ! Depth
      Plate0 =0.          ! First plate thickness
      PlateE =5.0         ! Last plate with electronics (needs a gap)
      BlMod  =4           ! Number of modules (along z)
Fill HBLO           ! One Longitudinal block
      IBlc   =6           ! block 6
      BlRMn  =47.5        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =23.4        ! Depth
      Plate0 =0           ! First plate thickness
      PlateE =0           ! last plate thickness
      BlMod  =4           ! Number of modules (along z)
Fill HBLO           ! One Longitudinal block
      IBlc   =7           ! Block #7
      BlRMn  =47.5        ! Rmin
      BlRMx  =203.        ! Rmax
      BlDpth =23.4        ! Depth
      Plate0 =0           ! First plate thickness
      PlateE =5.0         ! Last plate with electronics (needs a gap)
      BlMod  =4           ! Number of modules (along z)
* -------------------------------------------------------------------------------
       Use    HENG   Geometry=1

       Create and Position HEND in CENTER  konly='MANY'

* -------------------------------------------------------------------------------
Block  HEND is the Hadronic END-cap mother volume
       Material  Air
       Medium    Atlas
       Attribute HEND   seen=0
       Shape     TUBE   Rmin=HENG_R0orig  Rmax=HENG_REnd  dz=HENG_ZEnd

* ---- Rotation parameters
       ANGL0 =PI/(1.*HENG_NSct)
```

```
       COS0  =COS(ANGL0)
       SIN0  =SIN(ANGL0)
*
       IND =0
       DO IBLC =1 ,nint(HENG_NBlc)

          Use    HBLO IBLC=IBlc

          IF (IBLC=1) THEN
             Z(IND+1) =0.0                       ! First block starts from zero
          ELSE
             Z(IND+1) =Z(IND)                      ! Regular section
          ENDIF
          RMN(IND+1) =HBLO_BlRMn                   ! Low R at low Z
          RMX(IND+1) =HBLO_BlRMx/COS0              ! High R at low Z
          Z(IND+2)   =Z(IND+1) +HBLO_BlDpth        ! High Z at low/high R
          IF (IBLC=4) THEN                         ! Gap between wheels
             Z(IND+2) =Z(IND+2) +HENG_GapWhl
          ENDIF
          RMN(IND+2) =RMN(IND+1)                   ! Low R at high Z
          RMX(IND+2) =RMX(IND+1)                   ! High R at high Z
          IND=IND+2
       ENDDO

       Create    HENN
       Position  HENN   z=+HENG_ZStart
       Position  HENN   z=-HENG_ZStart,  ThetaZ=180

EndBlock
* ------------------------------------------------------------------------------
Block  HENN is one of the two Hadronic END-caps
       Material    Liquid_Argon
       Attribute   HENN    seen=0 colo=2
       Shape       PCON    Phi1=0  Dphi=360  Nz=HENG_NBlc*2   Zi={z(1:IND)},
                           Rmn={RMN(1:IND)}  Rmx={RMX(1:IND)};

       Create   HENS

EndBlock
* ------------------------------------------------------------------------------
Block  HENS is one 1/32 phi-division of the Hadronic END-cap
       Attribute   HENS      seen=0   colo=2
       Shape       division  Iaxis=2  Ndiv=nint(HENG_NSct)

      DO IBLC =nint(HENG_NBlcMn) ,nint(HENG_NBlcMx)

          Use    HBLO IBLC=Iblc
```

```
          if (IBLC >3 ) ity=2
          RBLC =(HBLO_BlRMx +HBLO_BlRMn)/2
          ZBLC =(Z(Iblc*2-1) +Z(Iblc*2))/2
          MID   =int(HBLO_BlMod)/2
          ZDetRf =HENG_Zstart +Z(Iblc*2-1) +HBLO_Plate0 _
                 +MID*HENG_Cell(ity) -HENG_Plate(ity)/2
          IF (IBLC=4) THEN                          ! Gap between wheels
             ZBLC =(Z(Iblc*2-1) +HENG_GapWhl +Z(Iblc*2))/2
             ZDetRf = ZDetRf + HENG_GapWhl
          ENDIF

          DRM  =HBLO_BlRMx -HBLO_BlRMn
          WBot =(HBLO_BlRMn*SIN0 -HENG_GapPlt)/COS0
          WTop =(HBLO_BlRMx*SIN0 -HENG_GapPlt)/COS0

          Create and Position  HEMO  x=RBLC    z=ZBLC,
                                     thetax=90 phix=90,
                                     thetay=0  phiy=0,
                                     thetaz=90 phiz=0


       ENDDO

EndBlock
* ------------------------------------------------------------------------------
Block  HEMO  is one module in the wheel
       Attribute HEMO  seen=1  colo=6  serial=Iblc
       Shape     TRD1  dx1=WBot   dx2=WTop   dy=HBLO_BlDpth/2   dz=DRM/2

* ---- Divide module (section) into radial blocks

       gd =HENG_GapCel
       DO IETA =1 ,nint(HETR_NEta)-1

          TgtDMB =EXP(-HETR_Eta(IEta))
          TgtBot =2*TGTDMB/(1. -TgtDMB*TgtDMB)
          RBot   =max(ZDetRf*TgtBot ,HBLO_BlRMn)
          TrapBL =((RBot/2+gd)*SIN0-gd)/COS0 -gd

          TgtDMT =EXP(-HETR_Eta(IEta+1))
          TgtTop =2*TGTDMT/(1. -TgtDMT*TgtDMT)
          RTop   =min(ZDetRf*TgtTop ,HBLO_BlRMx)
          TrapTL =((RTop/2-gd)*SIN0-gd)/COS0 -gd

          IF (RBot<RTop) THEN
             WBb =(RBot*SIN0 -HENG_GapPlt)/COS0
```

```
            WTb =(RTop*SINO -HENG_GapPlt)/COSO

            DRb    =RTop -RBot
            TrapH  =DRb/2 -gd
            TrapTH =RADDEG*ATAN(.5*(TrapTL-TrapBL)/TrapH)

           Create and Position  HETA   z=(RBot+RTop)/2-RBLC

         ENDIF

      ENDDO

EndBlock
* ----------------------------------------------------------------------------
Block  HETA is one radial block of the module
       Attribute HETA  seen=1 colo=1
       Shape     TRD1  dx1=WBb   dx2=WTb   dz=DRb/2

       IF (HBLO_PlateE=0) THEN
          NB1Mod =nint(HBLO_B1Mod)
       ELSE
          NB1Mod =nint(HBLO_B1Mod)-1
       Dist =HENG_Cell(ity)
          Name='Electronics'
          Ndv=1

          Create and Position HINE  y=+hblo_BLDPTH/2-heng_Cell(ity)/2
       ENDIF
       Dist =HENG_Cell(ity)*NB1Mod
       Name ='Ordinary'
       Ndv=NblMod

          Create and Position HINE y=-HBLO_B1Dpth/2+HBLO_Plate0+Dist/2
       IF (HBLO_Plate0>0) THEN

          Create and Position HFPL y=-HBLO_B1Dpth/2+HBLO_Plate0/2
       ENDIF

EndBlock
* ----------------------------------------------------------------------------
Block  HFPL is the front plate for each wheel
       Material    Copper
       Attribute   HFPL  seen=1  colo=6  fill=1
       Shape       TRD1  dy=HBLO_Plate0/2

EndBlock
* ----------------------------------------------------------------------------
```

```
Block  HINE  is built of NB1Mod sensitive sandwich
       Attribute   HINE  seen=0  colo=6  fill=1
       Shape       TRD1  dy=Dist/2

       Create      HZDV

EndBlock
* ------------------------------------------------------------------------------
Block  HZDV  is a single sensitive sandwich Z division
       Attribute   HZDV  seen=0 colo=1 fill=1
       Shape             division Iaxis=2 Ndiv=Ndv

       if(name='Ordinary') then
       Create and Position HSHP y=+HENG_Cell(ity)/2-HENG_Plate(ity)/2

       Create and Position HLAR x=-(((Rtop+Rbot)*SIN0/2-gd)/COS0+gd)/2,
                                y=-HENG_Cell(ity)/2+HENG_Larg/2,
                                thetax=90   phix=180,
                                thetay=0    phiy=0,
                                thetaz=90   phiz=90

       Create and Position HLAR x=+(((Rtop+Rbot)*SIN0/2-gd)/COS0+gd)/2,
                                y=-HENG_Cell(ity)/2+HENG_Larg/2,
                                thetax=90   phix=0,
                                thetay=0    phiy=0,
                                thetaz=90   phiz=90
       else

       Create and Position HTAP y=+Heng_Larg/2

       Create and Position HLAR x=-(((Rtop+Rbot)*SIN0/2-gd)/COS0+gd)/2,
                                y=-HBLO_PlateE/2,
                                thetax=90   phix=180,
                                thetay=0    phiy=0,
                                thetaz=90   phiz=90

       Create and Position HLAR x=+(((Rtop+Rbot)*SIN0/2-gd)/COS0+gd)/2,
                                y=-HBLO_PlateE/2,
                                thetax=90   phix=0,
                                thetay=0    phiy=0,
                                thetaz=90   phiz=90
        end if
EndBlock
* ------------------------------------------------------------------------------
Block  HTAP is tapered  plate with electronics
       Material    Copper
       Attribute   HTAP  seen=1 colo=1
```

```
       Shape       TRD1  dy=HBLO_PlateE/2

EndBlock
* -----------------------------------------------------------------------------
Block  HSHP is a shower plate in longitudinal segment
       Material    Copper
       Attribute   HSHP  seen=1 colo=6 fill=1
       Shape       TRD1  dy=HENG_Plate(ity)/2

EndBlock
* -----------------------------------------------------------------------------
Block  HLAR is a space for sensitive LAr and  boards
       Material    Liquid_Argon
       Medium      sensitive    isvol=1
       Attribute   HLAR  seen=0 colo=7
       Shape       TRAP  dz=HENG_Larg/2    thet=0    phi=0,
                         h1=TrapH   bl1=TrapBL   tl1=TrapTL   alp1=TrapTH,
                         h2=TrapH   bl2=TrapBL   tl2=TrapTL   alp2=TrapTH
*
        Deta=0.10;       Dphi=TwoPi/64;
*---

        HITS HLAR Eloss:0:(0,100)

*---

      DO IKpt =1,3

         Create and Position HKPT z=-HENG_Larg/2+HENG_KptPos(IKpt)

      ENDDO

EndBlock
* -----------------------------------------------------------------------------
Block  HKPT is a Kapton board
      Component   H   A= 1.01  Z= 1  W=0.0273
      Component   C   A=12.01  Z= 6  W=0.7213
      Component   N   A=14     Z= 7  W=0.0765
      Component   O   A=16     Z= 8  W=0.1749
      Mixture   Kapton  Dens=1.42
      Attribute   HKPT  seen=0  colo=1
      Shape       TRAP  dz=HENG_KptWid(IKpt)/2

       if ( IKpt == 2 ) then
          Create and Position HCop z=-HENG_KPtWid(IKpt)/2+HENG_PadPl/2
       else
       end if
```

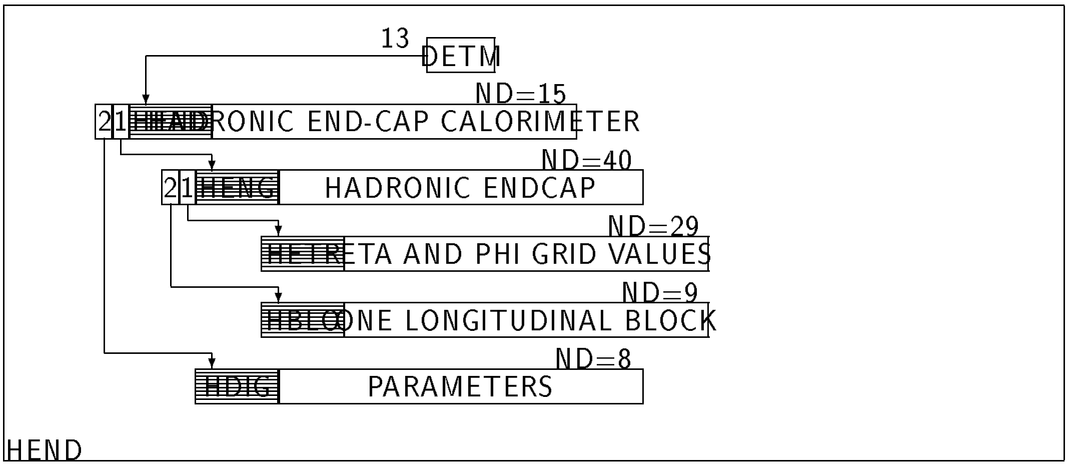
```
EndBlock
* ---------------------------------------------------------------------------
Block  HCOP is Copper in Padboard
       Material    Copper
       Attribute   HPAD  seen=0  colo=2
       Shape       TRAP  dz=HENG_Copper/2
EndBlock
* ---------------------------------------------------------------------------
       END
```

## Appendix 2: The HEND geometry ZEBRA banks

# ZEBRA bank documentation
# from
# detm.rz
# banks below:
# HEND

printed by DZEDIT - DZDOC at

April 19, 1996




## HEND HADRONIC END-CAP CALORIM

```
---------------------------------------------- entered file at 20-Mar-96 12:12
Bank IDH  HEND     HADRONIC END-CAP CALORIMETER
Author             BERNARD LORAZO, RASHID MEKHDIYEV
Version            18/01/95
NL               2
NS               2
ND              15
Up        DETM
IO-Charac          -I
             ---------- Description of the links  ----------
1         HENG     - DESCRIPTION OF THE HADRONIC ENDCAP
2         HDIG     - DIGITIZATION PARAMETERS
             ---------- Description of the data words   ----------
1         PNOW     - current print level
2         DEBU     - GEANT debug level
```

```
3         PRIN     - system print level
4         GEOM     - geometry version
5         HIST     - system histogram flag
6         GRAP     - system graphics level
7         SIMU     - store GEANT hits flag
8         DIGI     - digitisation flag
9         RECO     - reconstruction flag
10        MFLD     - magnetic field flag
11        ANAL     - user analysis level
12        BACK     - pile-up bunch select.
13        resa     - reserve
14        resb     - reserve
15        resc     - reserve
```

## HENG HADRONIC ENDCAP

```
---------------------------------------------- entered file at 26-Mar-96  9:33
Bank IDH  HENG     HADRONIC ENDCAP
Author             BERNARD LORAZO, RASHID MEKHDIYEV
Version            18/01/95
NL              2
NS              2
ND             40
Up        HEND
IO-Charac          -F
             ---------- Description of the links  ----------
1         HETR     - ETA AND PHI GRID VALUES
2         HBLO     - ONE LONGITUDINAL BLOCK
             ---------- Description of the data words   ----------
1         -        - usage counter
2         -        - system reserve
3         GEOMETRY - GEOMETRY CHOICE (STANDARD =1)
4         NSCT     - NUMBER OF SECTORS (PHI GRANULARITY)
5         NSCTMN   - INDEX OF 1ST SECTOR (ADJUSTABLE)
6         NSCTMX   - INDEX OF LAST SECTOR (ADJUSTABLE)
7         NBLC     - NUMBER OF BLOCS
8         NBLCMN   - INDEX OF 1ST BLOC (ADJUSTABLE)
9         NBLCMX   - INDEX OF LAST BLOC (ADJUSTABLE)
10        ROORIG   - ABSOLUTE ENDH R ORIGIN
11        REND     - ABSOLUTE ENDH R END
12        ZORIG    - ABSOLUTE ENDH Z ORIGIN
13        ZSTART   - ZSTART OF CALO ITSELF
14        ZEND     - ABSOLUTE ENDH Z END
15        WHEEL    - WHEEL WIDTH
16        WHEEL    - 2
17        CELL     - CELL WIDTH
18        CELL     - 2
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19        LARG     - LAR GAP BETWEEN GROUND PLATES
20        PLATE    - GROUND PLATE WIDTH
21        PLATE    - 2
22        KAPTON   - KAPTON (POLIEMID) FOIL WIDTH
23        COPPER   - COPPER PAD WIDTH
24        PADPL    - PAD BOARD WIDTH
25        ESTPL    - EST BOARD WIDTH
26        ADHES    - KAPTON/COPPER ADHESIVE
27        HRCOV    - HRC WIDTH
28        HEXCEL   - HEXCEL WIDTH (ARGON GAP)
29        RODWD    - ROD WIDTH
30        SPRWD    - SPRING WASHER WIDTH VALUE
31        SPRAD    - SPRING WASHER RADIUS
32        GAPWHL   - INTER-WHEEL GAP
33        GAPPLT   - HALF INTER-PLATE GAP
34        GAPCEL   - HALF INTER-CELL GAP
35        KPTPOS   - KAPTON BOARD POSITION
36        KPTPOS   - 2
37        KPTPOS   - 3
38        KPTWID   - KAPTON BOARD WIDTH
39        KPTWID   - 2
40        KPTWID   - 3
```

## HETR ETA AND PHI GRID VALUES

```
---------------------------------------------- entered file at 26-Mar-96  9:33
Bank IDH  HETR     ETA AND PHI GRID VALUES
Author             BERNARD LORAZO, RASHID MEKHDIYEV
Version            18/01/95
ND              29
Up        HENG
IO-Charac          -F
             ---------- Description of the data words   ----------
1         -        - usage counter
2         -        - system reserve
3         ETAGR    - MIN ETA GRANULARITY
4         PHIGR    - PHI GRANULARITY (RADIANS)
5         ETAMX    - MAX RAPIDITY
6         NETA     - ETA GRANULARITY
7         ETA      - ETA GRANULARITY
```

## HBLO ONE LONGITUDINAL BLOCK

```
---------------------------------------------- entered file at 26-Mar-96  9:33
Bank IDH  HBLO     ONE LONGITUDINAL BLOCK
Author             BERNARD LORAZO, RASHID MEKHDIYEV
Version            18/01/95
```

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ND                9
Up         HENG
IO-Charac           -F
             ---------- Description of the data words   ----------
1          -        - usage counter
2          -        - system reserve
3          IBLC     - BLOCK #1
4          BLRMN    - RMIN
5          BLRMX    - RMAX
6          BLDPTH   - DEPTH
7          PLATE0   - FIRST PLATE THICKNESS
8          PLATEE   - LAST PLATE WITH ELECTRONICS (NEEDS A GAP
9          BLMOD    - NUMBER OF LAR GAPS (ALONG Z)
```

## HDIG PARAMETERS

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---------------------------------------------- entered file at 20-Mar-96 14:38
Bank IDH  HDIG      PARAMETERS
Author              BERNARD LORAZO, RASHID MEKHDIYEV
Version             19/01/1995 *
ND                8
Up         HEND
IO-Charac           -F
             ---------- Description of the data words   ----------
1          -        - usage counter
2          -        - system reserve
3          VERSION  - VERSION
4          SCALE    - ADC SCALE FACTOR
5          EMAX     - MAX ENERGY
6          ETAMX    - RAPIDITY LIMIT
7          DETA     - FINEST ETA GRANULARITY
8          DPHI     - PHI GRANULARITY
```

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