XML Description of HCAL Geometry

Version 1.0

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1 Introduction

The XML description\(^1\) of Hcal geometry is based on the engineering drawing of Hcal corresponding to the TDR [1]. Some simplification of real design is done.

2 XML File Structure

The XML description of Hcal can be found in the $LHCB/Soft/Det/XmIDDB/v*/DDDDB/Hcal directory. The whole Hcal, Hcal segmentation structure and installation of Cells into Hcal Sections are defined in “Installation” subdirectory of XML description. Inner structure of Cells is defined in “Cells” subdirectory. Structure of XML directories corresponds to Detector Transient Store.

*structure.xml* file contains the *detector elements* “Hcal”, “HcalInner”, “HcalOuter”.

The main *geometry.xml* file contains

- catalog\(^2\) of references to “Installation” and “Cells” catalogs ;

- definition of all Hcal geometry parameters.

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\(^1\)Det/Desc/v0r0 was used
\(^2\)In the following LHCb XML terminology is used
Names of parameters are mnemonic and always start with “Hcal*”. The basic parameters are Modules and Cells sizes. A full lists of parameters can be found in the Appendix.

Installation.xml file contains “/dd/Geometry/Hcal/Installation” catalog of logical volumes related to Hcal as a whole, Hcal Sections and Modules. Cells.xml file contains catalog of logical volumes “/dd/Geometry/Hcal/Cells” related to inner structure of Hcal Cells.

*.xml files related to XML description of Hcal as a whole, Hcal Sections and Modules are located in $LHCBSOFT/Det/XmlDDDDB/v*/DDDDB/Hcal/Installation. Cells and Reinforces*.xml files can be found in $LHCBSOFT/Det/XmlDDDDB/v*/DDDDB/Hcal/Cells.

Catalog “/dd/Materials/Hcal” of specific Hcal materials can be found in $LHCBSOFT/Det/XmlDDDDB/v*/DDDDB/materials/HcalMaterials.xml. The names of materials start also with “Hcal*”.

3 Definition of Hcal Sections Logical Volumes

Hcal is segmented into Inner, Outer Section and the closest to beam pipe Inner Support Frame.

Main “/dd/Geometry/Hcal/Installation/lvHcal” logical volume is defined as logical subtraction\(^3\) of <box>\(^4\) with “HcalTotXSize”, “HcalTotYSize”, “HcalTotLength” and <tubs>\(^5\) providing cylindrical hole for beam pipe.

Physical volumes of Inner Support Frame with corresponing Z offset to the geometry centre of total Hcal space (“pvHcalInnerSupportFrame”), Inner and Outer Sections (“pvHcalInnerSection”, “pvHcalOuterSection”) are installed into “lvHcal” logical volume.

“lvHcalInnerSupportFrame” logical volume is defined as logical subtraction of <box> with “HcalSupportXSize”, “HcalSupportYSize”, “HcalSupportLength”, material = “HcalSupportSteel” and <tubs> with outerRadius = “HcalInnerSupportRadius” for beam pipe hole.

“lvHcalInnerSection”, “lvHcalOuterSection” logical volume are defined as logical subtraction of two boxes.

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\(^3\)<sub>subtraction</sub> in XML

\(^4\)<sub>box</sub> corresponds to box with faces perpendicular to the axes

\(^5\)<sub>tubs</sub> here corresponds to cylindrical tube
“lvHcalInnerSection”, “lvHcalOuterSection” logical volume using two dimensional loop\textsuperscript{6} (Figure 1, 2).

![Diagram of Hcal with Half-Modules](image)

Figure 1: Hcal with Half-Modules are installed into Inner and Outer Sections. For illustration some Half-Modules are show with installed Working Part of the Half-SubModules and Reinforces. Inner Support Frame are located in the centre.

“lvHcalInnHalfModule (lvHcalInnMidleHalfModule), “lvHcalOutHalfModule” logical volume contains from 8(7) corresponding Half-SubModule’s Working Parts and Reinforces (Figure 3, 4).

Logical volume of the Half-SubModule’s Working Part (“lvHcalInnHalfSubModuleWorkPart”, “lvHcalOutHalfSubModuleWorkPart”) contains from Foward, Backward Face and one Working Stuff in case Outer Section or 4 Working Stuffs in case Inner Section (Figure 5).

4 Definition of Hcal Cells Logical Volumes

The Inner and Outer Cell’s structure permit to mark out a Common Part of Cell’s Working Stuff.

Logical volume “Working Stuff” (“lvHcalOutCellWorkStuff”) is defined as $\langle \text{box} \rangle$ with “HcalOutCellXSize”, “HcalMsP1Height”, “6\times HcalMsP1StepLength” sizes and installed by $\langle \text{paramphysvol2D} \rangle$ “Com- 

\textsuperscript{6}$\langle \text{paramphysvol2D} \rangle$
Figure 2: View of one half of the hadron calorimeter: there are 26 horizontal modules stacked on top of each other. Two central modules are shorted to allow the accelerator beam-pipe to traverse.

mon Part of Working Stuff” (“pvHcalOutCellComPartWorkStuff”) physical volumes (Figure 6).

Logical volume “Common Part of Working Stuff” (“1vHcalOutCellComPartWorkStuff”) is defined as <box> with “HcalCellPeriodWidth”, “HcalMsPLHeight”, “2 × HcalMsPLStepLength” sizes, material = “Air” and are filled 4 layers of physical volumes:

- 1st layer: (at X = HcalOutCellXPos1stLayer × HcalCellPeriodWidth)
  “Master Plate”

- 2nd layer: (at X = HcalOutCellXPos2ndLayer × HcalCellPeriodWidth)
  “Small Forward Spacer”, “Scintillating Tile” and “Big Backward Spacer”
Figure 3: Hcal Half-Module with installed Working Parts and Reinforces. 1 – Working Part, 2 – Reinforce.

Figure 4: The module structure: eight submodule are assembled to one module, and an I-shape holder is mounted at the back. The whole module is covered with light protecting black paper show as hatched surface.

- **3d layer**: \((X = \text{HcalOutCellXPos3dLayer} \times \text{HcalCellPeriodWidth})\)
  - “Master Plate”

- **4th layer**: \((X = \text{HcalOutCellXPos4thLayer} \times \text{HcalCellPeriodWidth})\)
  - “Big Foward Spacer”, “Scintillating Tile” and “Small Backward Spacer”

*Logical volume* “Working Stuff” for Inner Cells are filled two types “Common Part of Working Stuff” because it don’t have unbroken numbers of period: \(7 \times 3\) first type and \(6 \times 3\) second type in one case or \(6 \times 3\) first type and \(7 \times 3\) second type in another case. First type — 1st and 2nd laeys as in Outer Cell; second type — 3d and 4th layers as in Outer Cell.

*Logical volume* “Master Plate” (“lvHcalOutCellMsPl”), “Scintillating Tile” (“lvHcalOutCellScTile”), “Big Spacer”
Figure 5: Half-SubModule’s Working Part with installed Forward, Backward Face and Working Stuff. a) – Inner Section, b) – Outer Section. 1 – Backward Face, 2 – Working Stuff, 3 – Forward Face.

Figure 6: Cell’s Common Part of Working Stuff (3×13) are installed into Cell’s Work Stuff.

(“lvHcalOutCellfwBigSpacer”, “lvHcalOutCellBwBigSpacer”) for Outer Cell are defined as <box> with corresponding material (“HcalMsPSteel” and “HcalSc”) and including physical volume “Calibration Hole”.

Logical volume “Master Plate”, “Scintillating Tile”, “Big Spacer” for Inner Cell are defined as <box> with material = “Air” and including corresponding physical volume are defined as <subtraction> <box> and <tubs> with material “HcalMsPSteel” or “HcalSc”.

Logical volumes “Small Spacers” are defined as <box> with material = “HcalMsPSteel”.

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Logical volumes “Calibration Holes” are defined as <tubs> with material = “Air”.

5 Definition of Hcal Foward, Backward Face of Half-SubModule and reinforce Logical Volumes

Logical volumes “Foward Face”, “Backward Face” are defined as <box> with material = “Air” and including physical volumes “Strips” (material = “Hcal-StripSteel”) for join Hcal SubModule and “Foward (Backward) Parts of Working Stuff” (material = “HcalMsPlSteel”).

Logical volumes “Reinforce” are defined as <box>. In this version its volume is empty.

References

# Appendix

## Hcal Geometry Parameters Definition

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<th>Hcal Basic Parameters</th>
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## Hcal Installation Parameters

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## Inner Structure Section: 2×26 Modules, 4 Modules — 16 Outer Cells or 4×16 Inner Cells

<p>| HcalInnCellXSize                                         |
| &quot;0.5<em>HcalOutCellXSize&quot;                                  |
| HcalInnCellYSize                                         |
| &quot;0.5</em>HcalOutCellYSize&quot;                                  |
| HcalSubModXSize                                          |
| &quot;2.0<em>HcalOutCellXSize&quot;                                  |
| HcalSubModYSize                                          |
| &quot;HcalOutCellYSize&quot;                                      |
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| &quot;8.0</em>HcalSubModXSize&quot;                                   |
| HcalModYSize                                             |
| &quot;HcalSubModYSize&quot;                                       |
| HcalTotXSize                                             |
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