

# **Simulation of the CALICE Test Beams with MOKKA**



**Fabrizio Salvatore**

Royal Holloway University of London

# Simulation of 2006 test beams

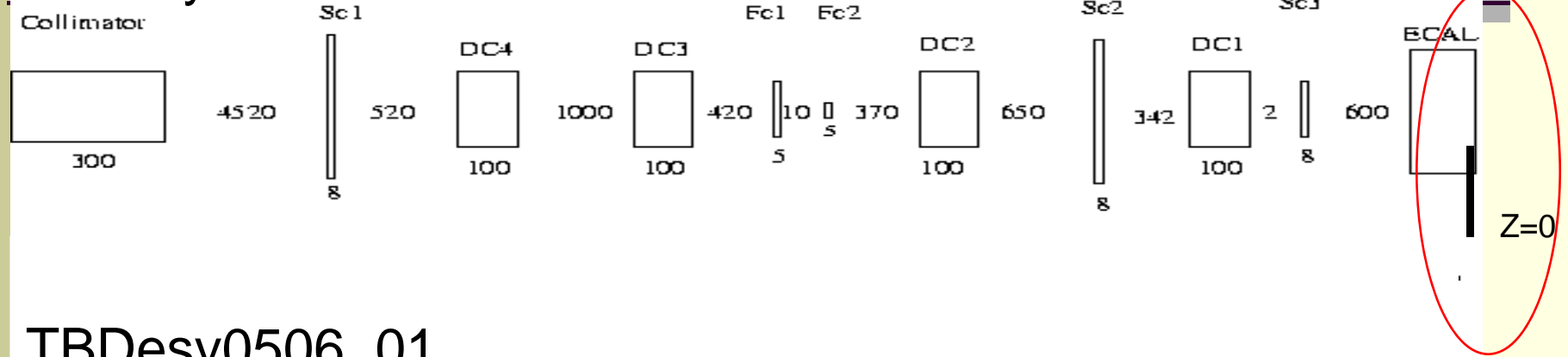
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- Latest version of Mokka (Sept 07): v06-04p03
  - Compatible with V9 of Geant4 (patch01)
  - Bug/memory leak fixes; improvement in DC simulation for Desy06
- Setup of 2006 test beams at Desy and CERN has been simulated in detail in Mokka
- Different test beam models have been implemented
  - 'Old' coordinate system: origin of coordinate system on the back plane of the ECAL
    - Desy tb: model TBDesy0506
    - CERN Aug tb: model TBCern0806
    - CERN Oct tb: model TBCern1006
  - 'New' coordinate system: origin of coordinate system on the back plane of DC closer to ECAL (DC1)
    - Desy tb: model TBDesy0506\_01
    - CERN Aug tb: model TBCern0806\_01
    - CERN Oct tb: model TBCern1006\_01

# Sketch of Desy models

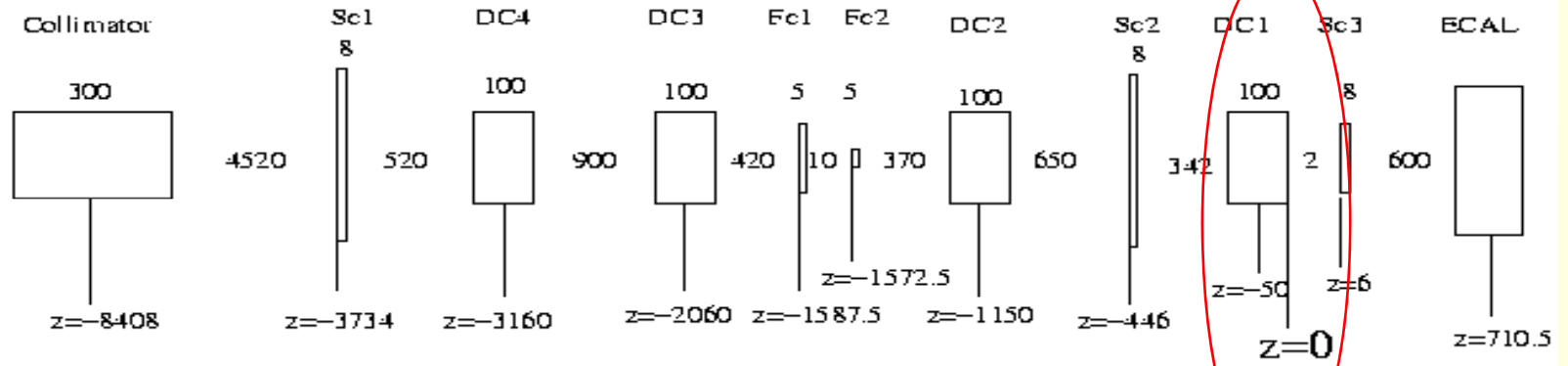
TBDesy0506

TOP

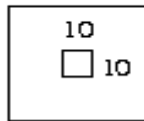


TBDesy0506\_01

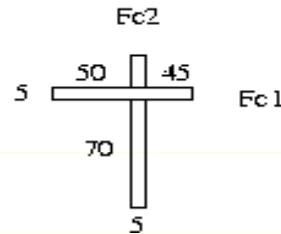
TOP – Desy May 2006



FRONT



Sc1 and Sc2 are 200x200  
Sc3 is 120x120

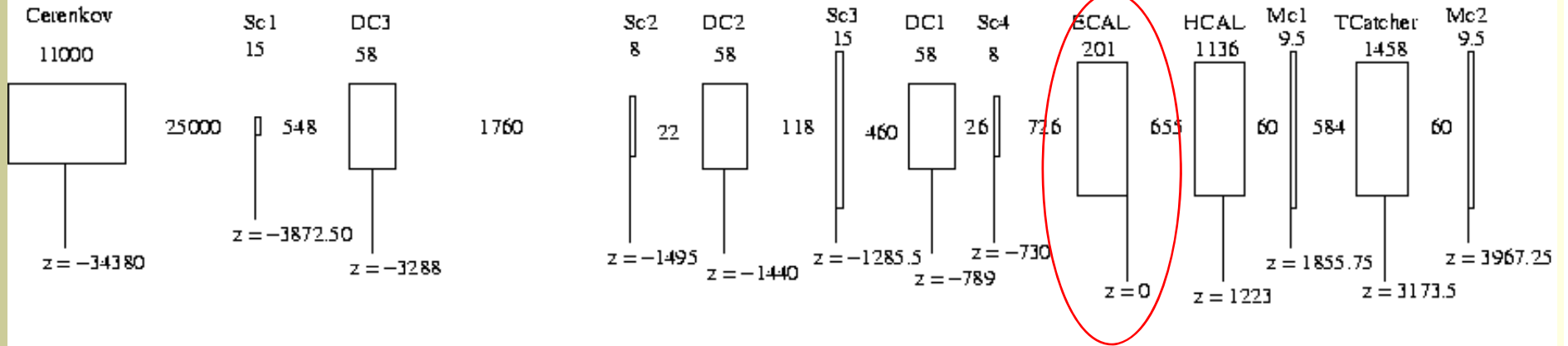


All distances are in mm

# Sketch of CERN Aug models

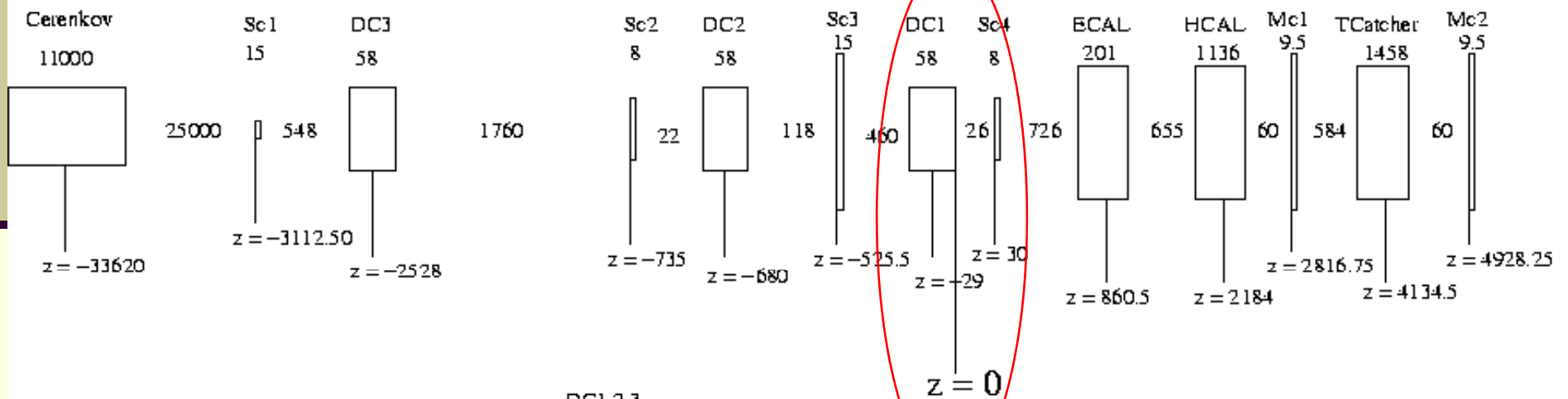
## TBCern0806

TOP



## TBCern0806\_01

TOP – CERN August 2006



FRONT

Sc1 is 30x30  
 Sc2 and Sc4 are 100x100  
 Sc3 is 200x200

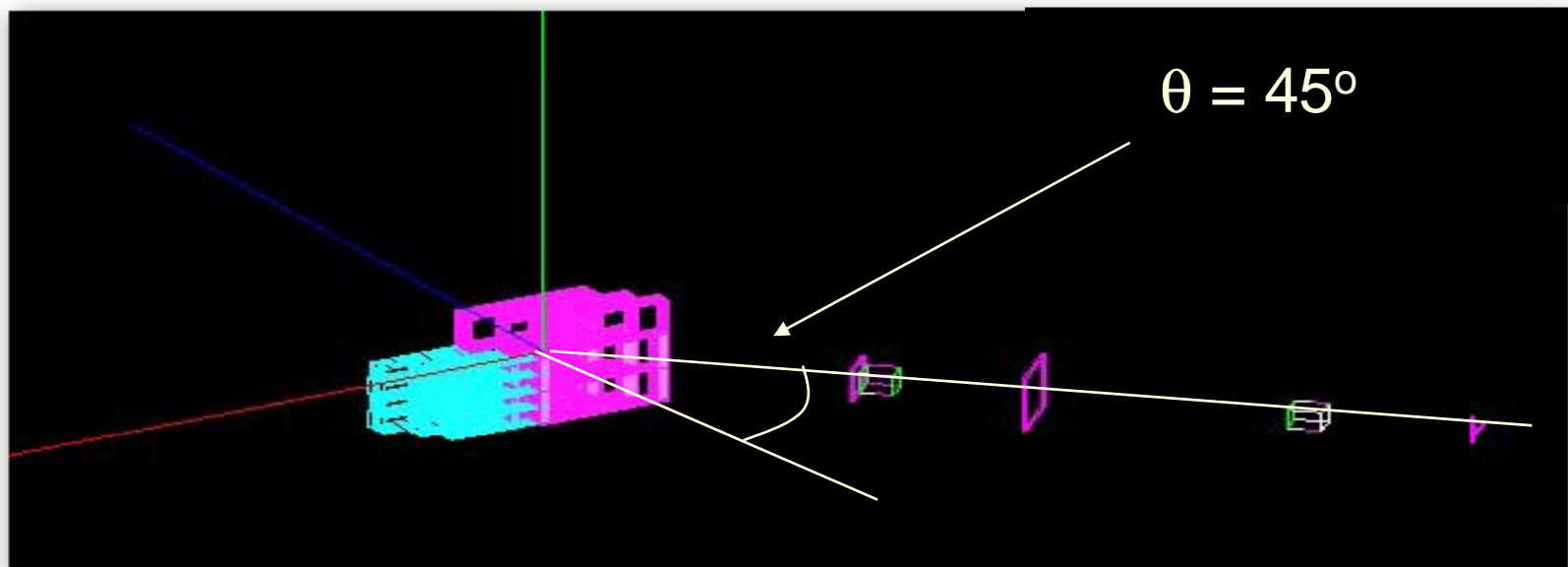


Mc1 and Mc2 are 1000x1000

All distances are in mm

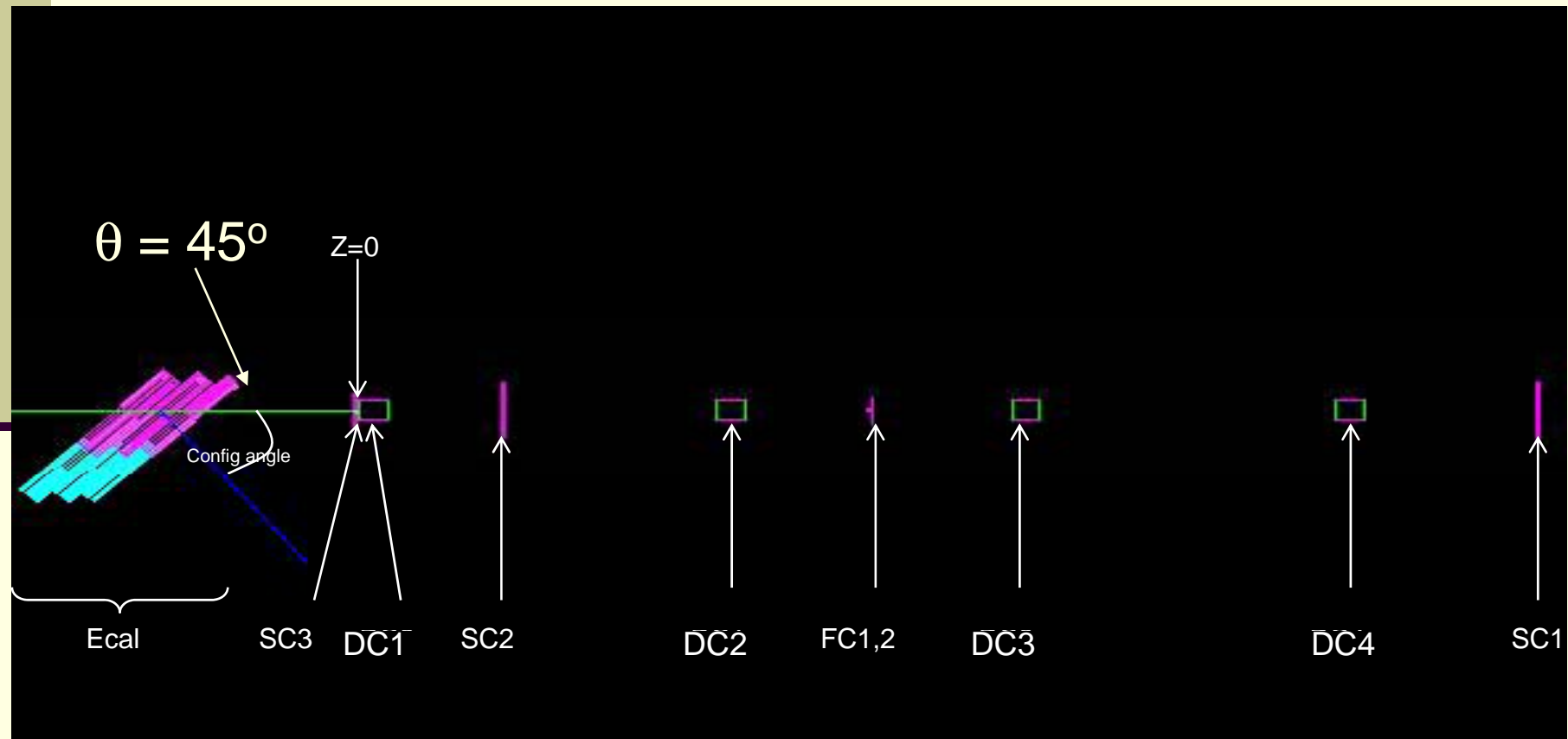
# 'Old' coord. syst. vs 'New' coord. syst. - I

- In 'old' coordinate system the axes are tied to the ECAL, therefore when the ECAL is simulated at an angle  $\theta$  wrt beam normal incidence, the ECAL is kept fixed and all beam detectors are rotated by  $-\theta$  wrt the ECAL front face
  - Not intuitive !



## 'Old' coord. syst. vs 'New' coord. syst. - II

- In new coordinate system the axes are not tied to the ECAL, so rotation is done keeping fixed the beam detectors and rotating the ECAL only



# Improvements in simulation wrt Mokka 06-03p01

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- **Real drift chambers** in the **Desy** setup give **separate measurement of X and Y position on hits**
  - **Fist half of the chamber gives X position, second half gives Y position**
- As chambers were simulated in **Mokka v06-03p01**, **each hit has an X and Y position**
  - **Re-write driver** to match real chambers as much as possible
- At the **digitization stage**, we would like to use **drivers that are independent of the setup** (Desy or CERN)
  - Need to write **one single collection of hits** instead of **one collection per chamber**

# New DCH driver for Desy0506 model

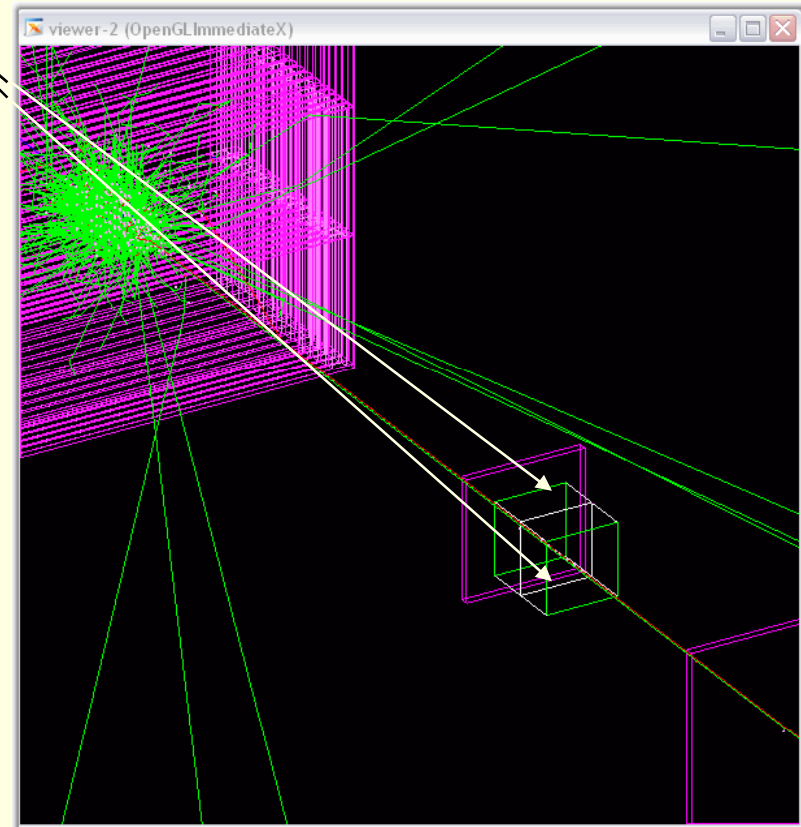
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- **New DCH driver** has been tested
  - Each chamber is built assuming **two different gas volumes** (one for X and one for Y)
  - Hits in each gas volume are **simulated as TRKHit** (==SimTrackerHit in LCIO)
    - (x,y,z) position of hit is generated
    - Digi code will have to **consider the appropriate coordinate** (x or y) depending on the layer
  - Total of **8 layers (2Xchambers)**
  - New test beam model **implemented in the DB**
    - **TBDesy0506\_dchxy\_new**



# New chamber layout

- Two separate volumes
- One single hit collection
  - TBdchXY02\_dchSDxy0
  - Use cellID to distinguish hits from each layer:
    - DC1 -> layer 0 (X), 1 (Y)
    - DC2 -> layer 2 (X), 3 (Y)
    - DC3 -> layer 4 (X), 5 (Y)
    - DC4 -> layer 6 (X), 7 (Y)



# The 2007 test beam simulation - I

- Need to implement a **new model for this year's test beam**
- **Beam line detectors are the same as last year**
  - MWPCs and scintillators are the same, need to implement the new positions wrt (0, 0)
  - Veto counters need to be added
  - Expect ~1 week to finish implementation (FS)
- **ECAL driver needs to be updated**
  - Implement 3 different setups:
    - **Complete ECAL: 30 layers – fully instrumented** One model: e.g. TBCern07
    - **Exact test beam prototype:** 2 separate models: e.g. TBCern0707
      - **Missing bottom/front 6 layers** (prototype until 24<sup>th</sup> July 2007) TBCern0807
      - **With bottom/front 3 layers + 3 alveolae with Tungsten only** (prototype from 25<sup>th</sup> July to 22<sup>nd</sup> August 2007)
    - **Add parameter in steering file**
  - Expect ~2 weeks for implementation and testing (Gabriel)

# The 2007 test beam simulation - II

- Existing AHCAL driver can be used to simulate this year's setup (Oliver)
  - Needs the updated information in the db for the geometry
  - Update driver to **account for re-staggering** after rotation
- TCMT driver not capable of simulating the staggering feature introduced in the latest run at CERN
  - Cassettes have been staggered

- alternate cassettes have been moved up (horizontal) or sideways (vertical)

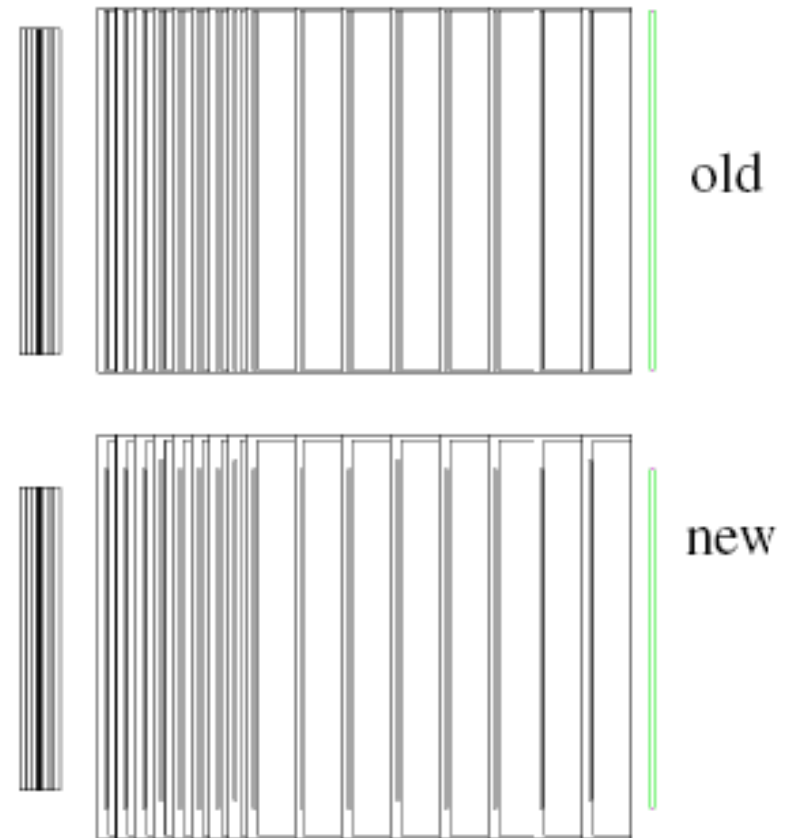
Layer 1 (vertical) ----> nominal position  
Layer 2 (horizontal) ----> nominal  
Layer 3 (vert) ---> moved -1.0 inch in x  
Layer 4 (hori) ----> moved +1.0 inch in y  
Layer 5 and 6 ---> nominal  
Layer 7 (vert) ---> -1.0 inch in x  
Layer 8 (hori) --> +1.0 in y  
.....

- Time estimate: ~2 weeks to solve some technical problems with G4 and implement changes (Guilherme)

# TCMT model already in progress...

## Mokka: TCMT model for TBCern0707

- New Mokka driver TBcatcher06 is ready for simulations of July'07 running period at CERN
  - Staggering of TCMT modules (hardcoded!):
    - For horizontal strips:
      - layers 2,6,10,14: nominal ( $y_{nom}$ )
      - layers 4,8,12,16:  $y' = y_{nom} + 2.54\text{cm}$
    - for vertical strips:
      - layers 1,5,9,13: nominal ( $x_{nom}$ )
      - layers 3,7,11,15:  $x' = x_{nom} + 2.54\text{cm}$
  - Absorbers have been enlarged




TCMT side views

# Conclusions

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- **Models for detailed simulations** of the 2006 test beam setup are available
- **Several models** are implemented in **latest version of Mokka (06-04p02)**
- **'Old' coordinate system**
  - TBDesy0506, TBcern0806, TBCern1006
- **'New' coordinate system**
  - TBDesy0506\_01, TBcern0806\_01, TBCern1006\_01
- **New DCH layout, with one collection of hits**
  - TBDesy0506\_dchxy\_new
- Preparation for TB models for the 07 data already under way
  - **ECAL and TCMT needs updating**
  - **Beam detectors and AHCAL ready**
    - **Time-scale: ~2 weeks (after this meeting)**



# A detailed description of the TB06 models

# Detector description: TBDesy0506

I

- **Drift Chambers (FS):**
  - installed by Kobe collaborators for the 05 test beam
  - **gas mixture is non-flammable** (96% Ar, 4% Ethane)
    - **4 drift** chambers (72x72x88 mm<sup>3</sup>)
    - **hits written out in LCIO format**
      - To reduce number of hits, only hits with  $E_{\text{rel}} > 0.001$  are written in output
- **Trigger scintillators (FS):**
  - **3 scintillators** (one 120x120x8 mm<sup>3</sup>, two 200x200x8 mm<sup>3</sup>) used in the trigger
  - **hits written out in LCIO format**
    - Hits simulated as **Calorimeter hits** (one hit per chamber)

# Detector description: TBDesy0506 II

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- **Finger counters (FS):**
  - 2 scintillators (5x100x5 mm<sup>3</sup>) placed in T shape to monitor beam position
  - hits written out in LCIO format
    - Hits simulated as Calorimeter hits (one hit per chamber)
- **ECAL (G.Musat):**
  - 3 modules (5 slabs)
    - tungsten thicknesses = 1.4, 2.8, and 4.2 mm.
    - silicon planes divided into wafers
      - 6x6 cells (10x10 mm<sup>2</sup>), guard-rings (1 mm width)
      - Two separate hits collections, one for hits in cells and the other for hits in guard-rings



# Detector description: TBCern0806

I

- **Cerenkov detector (FS):**
  - It is **upstream of the first trigger scintillator** (~25 m)
    - 100x100x11000 mm<sup>3</sup>, 180μ mylar windows, helium gas
    - **Only the material is simulated**
- **Drift Chambers (FS):**
  - provided by CERN (50% Ar, 50% CO<sub>2</sub>)
    - **3 drift chambers** (108x108x44 mm<sup>3</sup>)
    - **hits written out in LCIO format**
      - To reduce number of hits, only hits with  $E_{rel} > 0.001$  are written in output
- **Trigger scintillators (FS):**
  - **3 scintillators** used in the **trigger** (one 30x30x15 mm<sup>3</sup>, two 100x100x15 mm<sup>3</sup>)
  - **One veto** scintillator (200x200x15 mm<sup>3</sup>)
  - **hits written out in LCIO format**
    - Hits **simulated as Calorimeter hits**

# Detector description: TBCern0806

II

- **ECAL (G.Musat):**
  - same as for TBDesy0506
- **HCAL (R.Poeschl, O.Wendt):**
  - 39 layers (900x900x30 mm<sup>3</sup>). Each layer is composed by an iron absorber and scintillating material and is sub-divided into 90x90 mm<sup>2</sup> cells of 10x10mm<sup>2</sup> (virtual cell scheme)
    - Cell numbering scheme (from lower left corner of each layer)
      - i = row, j = column, k = layer.
- **TailCatcher (J.McCormick, G.Lima):**
  - 16 layers (absorber+air+readout module)
    - 2 different absorber thicknesses (19 mm - layers 1 to 8, 101 mm – layers 9 to 16).  
Readout modules: 9.5 mm. X,Y dimensions: 1168x1168 mm<sup>2</sup>
    - All absorbers in place, but only 8 readout modules (1, 4, 7, 10 – vertical strips, 2, 5, 8, 11 – horizontal strips)
- **Muon Counters (FS):**
  - 2 scintillators (1000x1000x50mm<sup>3</sup>)
  - hits written out in LCIO format
    - Hits simulated as Calorimeter hits

# Detector description: TBCern1006

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- **Cerenkov detector (FS):**
  - same as TBCern0806
- **Drift Chambers (FS):**
  - same as TBCern0806
- **Trigger scintillators (FS):**
  - same as TBCern0806
- **ECAL (G.Musat):**
  - same as TBCern0806
- **HCAL (R.Poeschl, O.Wendt):**
  - **Only 30 layers**, with same characteristic as TBCern0806
- **TailCatcher (J.McCormick, G.Lima):**
  - Same as TBCern0806, but with **all layers fully instrumented**
- **Muon Counters (FS):**
  - same as TBCern0806