Overview of the ATLAS CTB test beam

M.Gallas

(thanks to the ATLAS CTB community)

LCG Application area

Physics Validation

CERN 04/05/05

CERN

Outline:

- **Motivations for the CTB**
- **Setup at H8, layout/s**
- **Data taken**
- **Reconstruction**
- **Simulation**
- **Sub-detectors studies**
  - Inner detectors
  - Calorimeters
  - Muon detectors
- **Combined mode**
- **Conclusions**

The goal of this talk is to present an overview of the ATLAS Combined Test Beam. After the data taken, from May to October 2004, the CTB community is preparing the first results for the:

ATLAS Physics Roma Workshop (6-11 June 2005)

What is shown here is still very preliminary !

High level trigger studies will not be here

Motivations for the CTB

Combined test beam = ATLAS Barrel slide --> allows to test:

- o **Detector performance**
- o **Software deployment**
- o **Simulation**
- o **Reconstruction algorithms**
- o **Detectors & software integration**

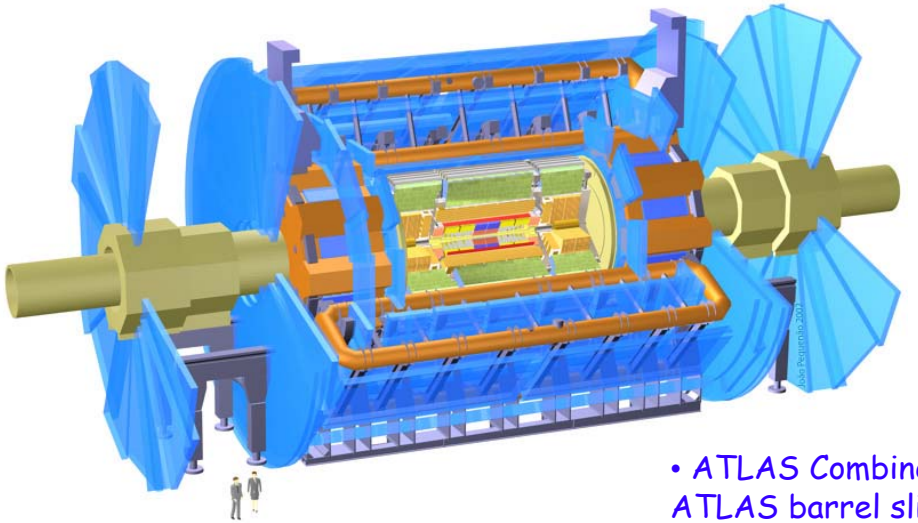
- Integration of all detectors in a common readout
- Final detectors with "final" electronics and RODs
- Full DAQ chain, DCS and configurations database
- Trigger studies during the 25 ns period
- HLT infrastructure & reconstruction algorithms
- Integration of different sub-detectors and people !!

DONE during
the data taken period
GREAT SUCCESS!

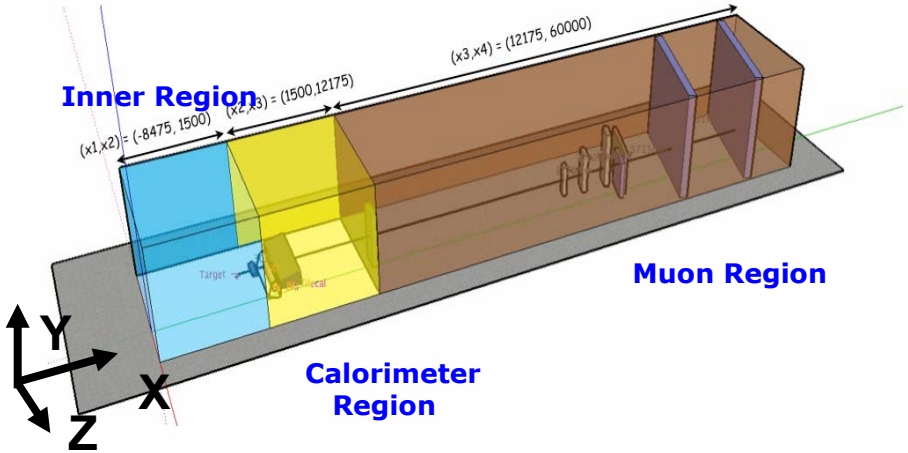
- Offline reconstruction
- Simulation
- Analysis:
  - ✓ Alignment and calibrations
  - ✓ Verify detector standalone performance
  - ✓ ATLAS combined performance
  - ✓ Physics validation for the Simulation

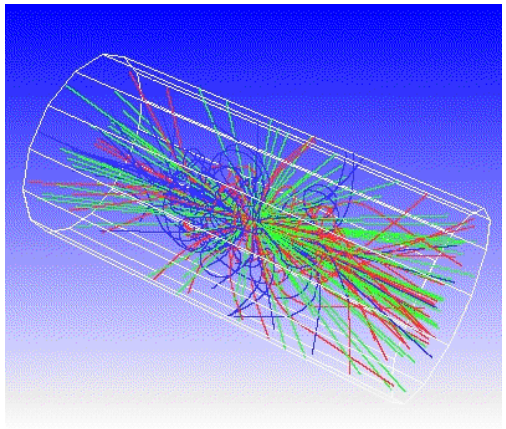
IN PROGRESS
a lot has been done &
a lot needs to be done

Setup and Layouts

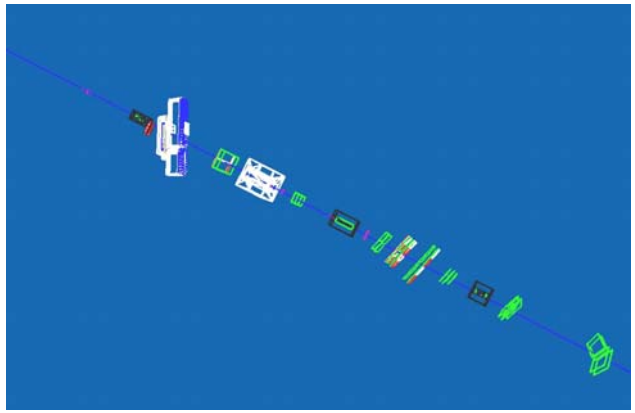


CTB layout H8 (2004)

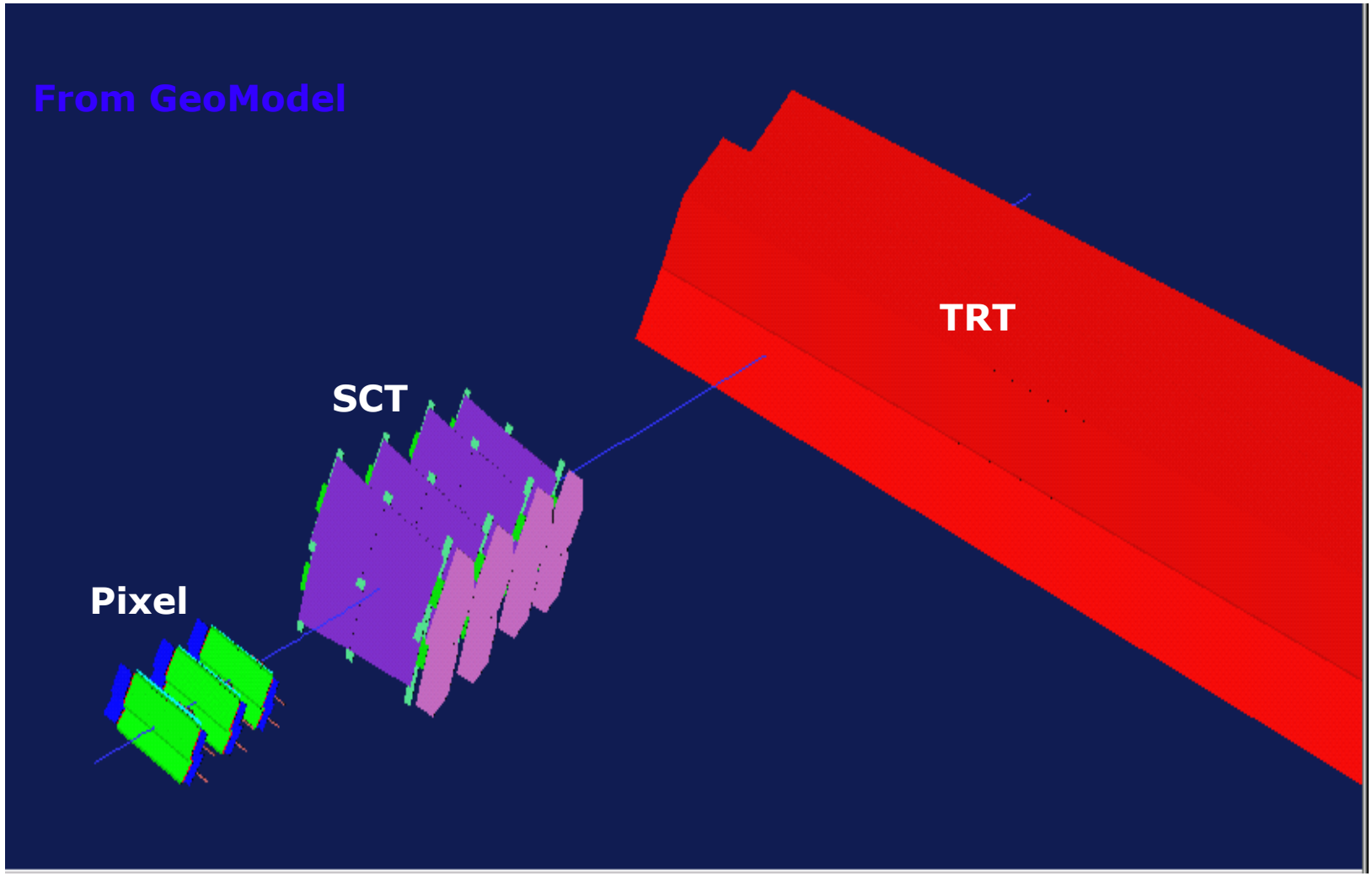




- ATLAS Combined Test Beam is a ATLAS barrel slice with the Inner, Calorimeters and Muon detectors crossed by the H8 SPS beam line.
- The beam from 1 to 350 GeV contains electrons, pions or muons
- The setup extends over 85 meters and several layouts were in use during the data taking period.
- Apart from the combined mode each sub-detector had its own standalone period.
- Eta range for calorimeters (0 to 1.2) by calorimeter rotation

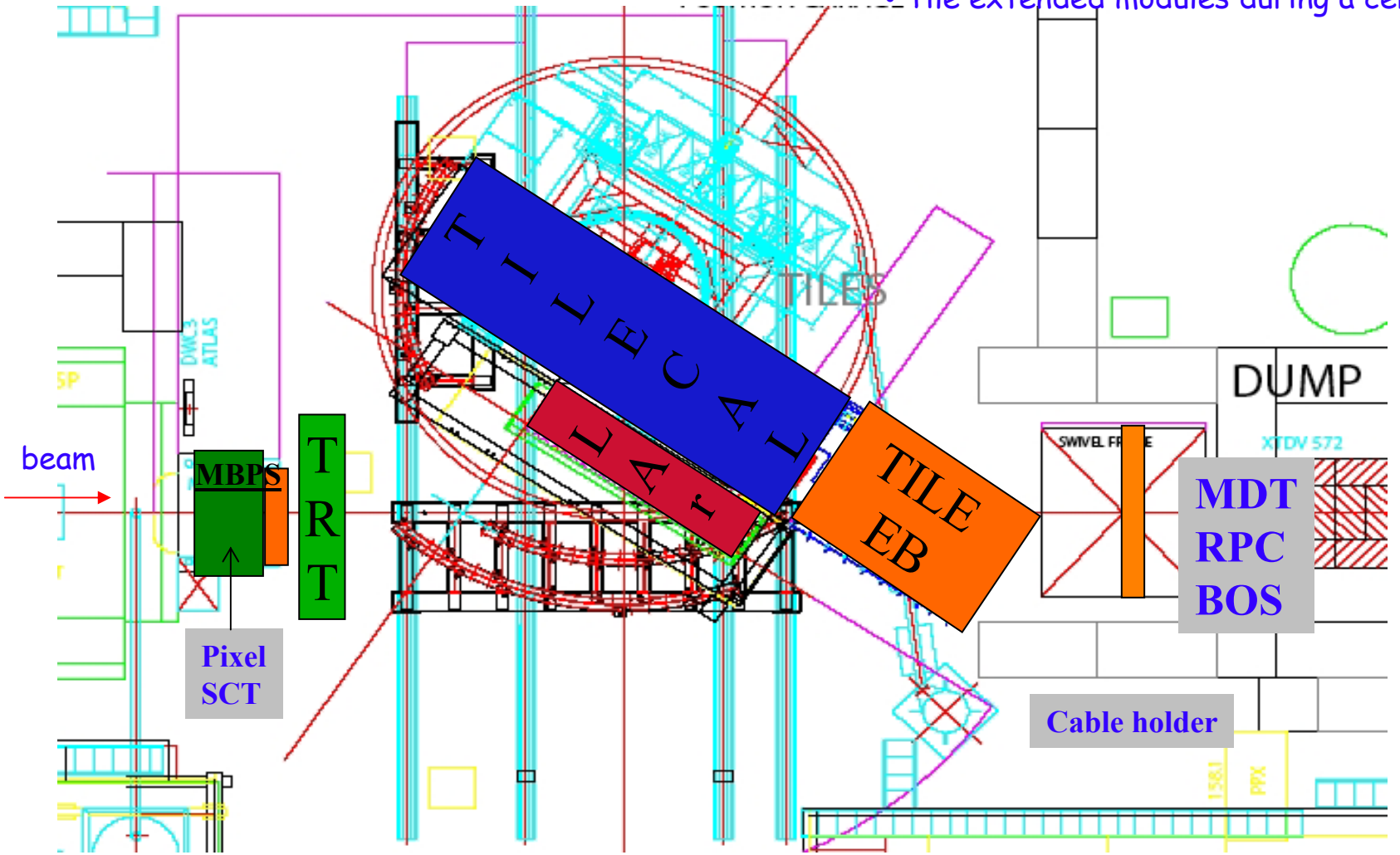


Setup: Inner Detector

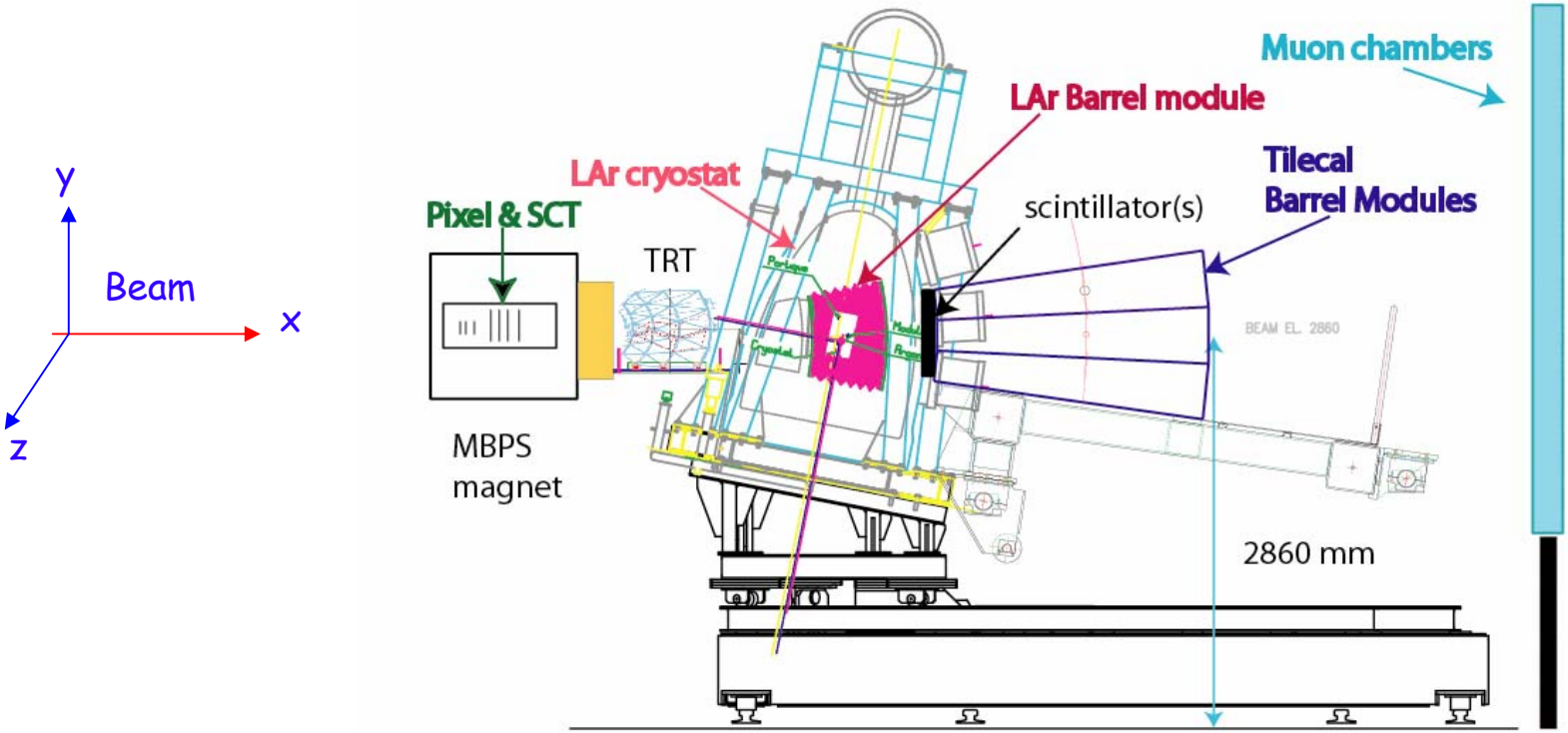


Setup: calorimeter region (top view)

- LAr module with the cryostat and Tile are in a table that can be rotated and shifted to match a given eta value (0 to 1.2).
- Tile extended modules during a certain period

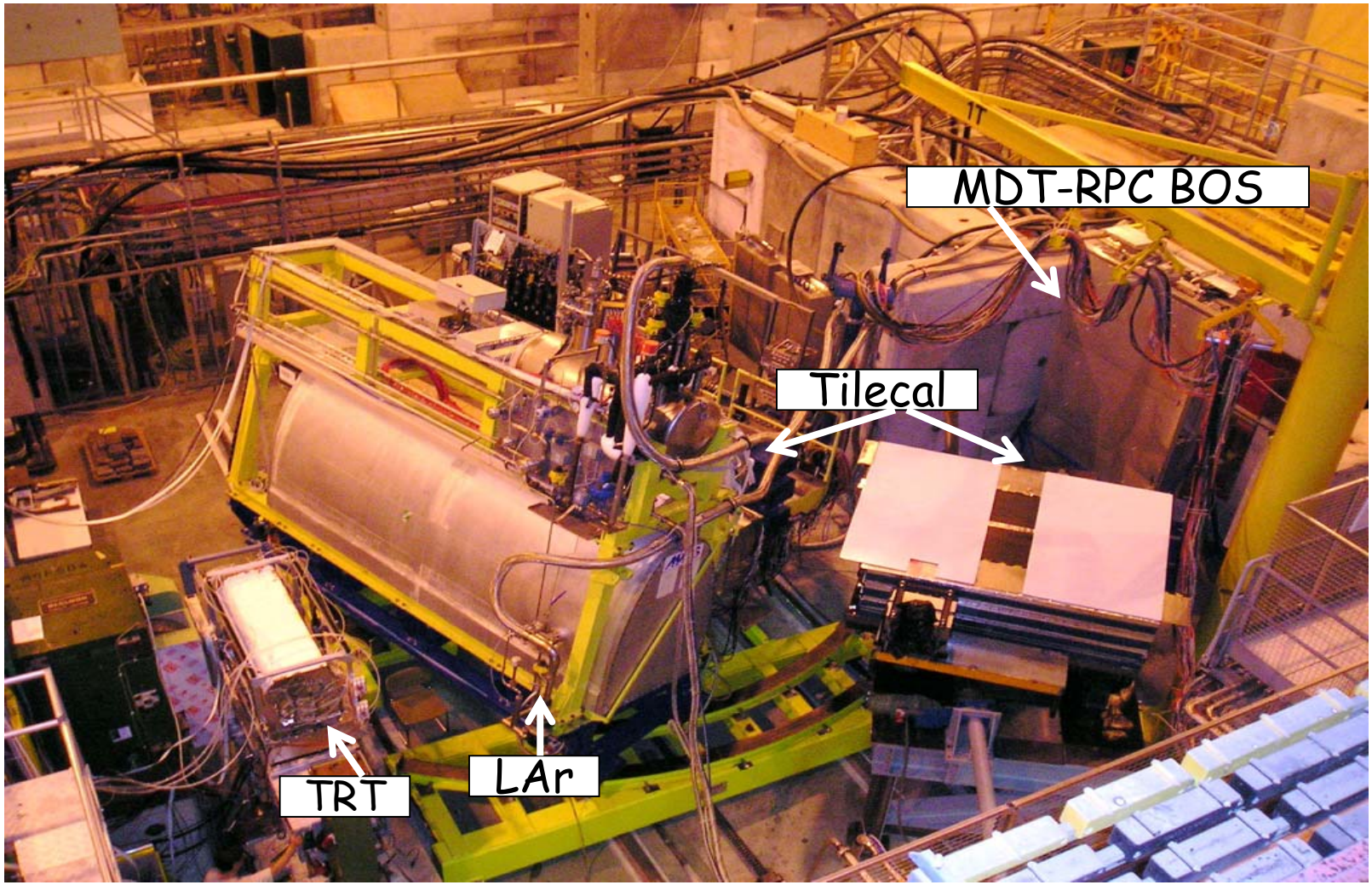


Setup: calorimeter region (lateral view)



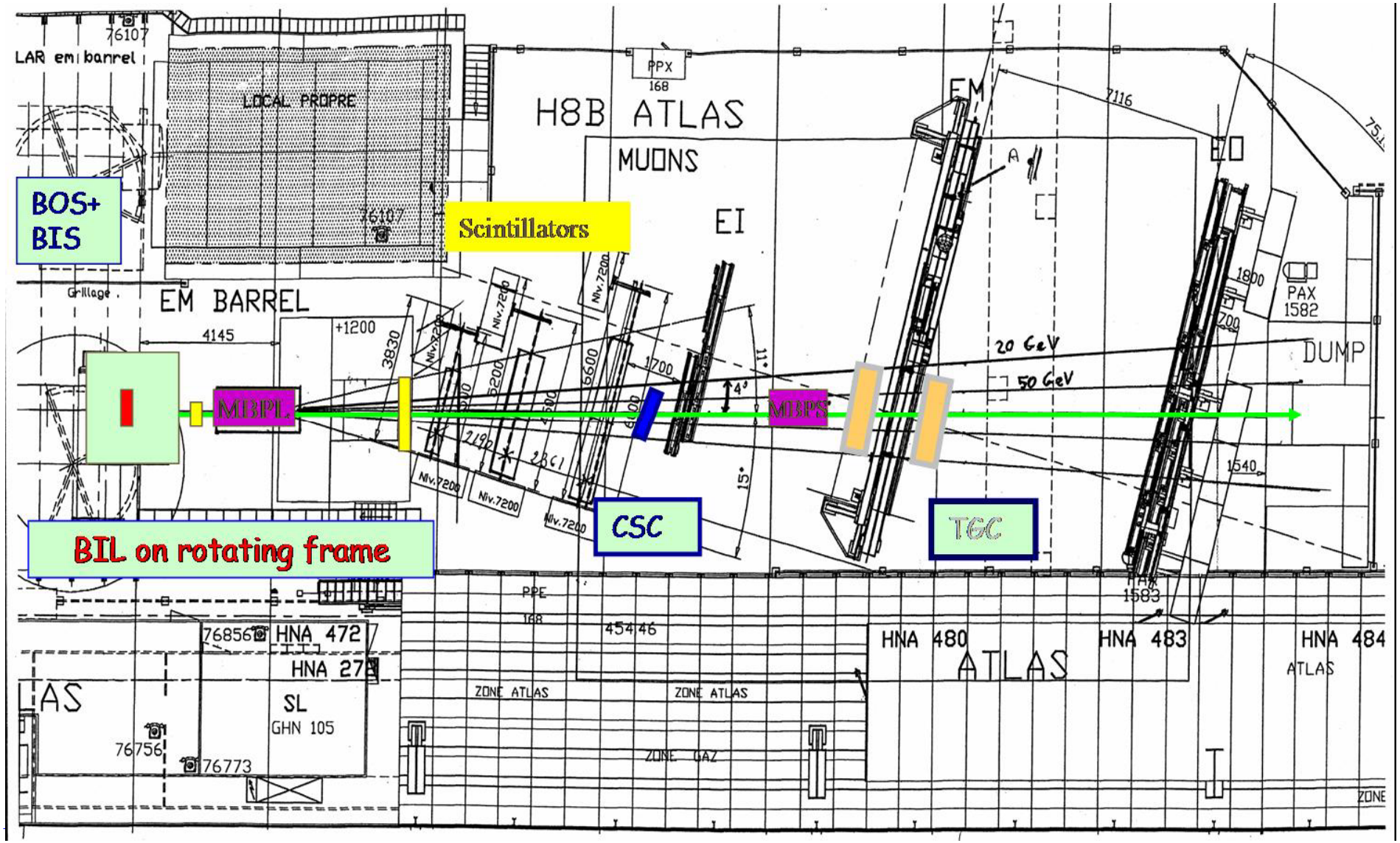
- Tile and LAr moving together for the Eta scan and the inner detector magnet (MBPSID) bends particles in Y coordinate (phi scan).

Setup: calorimeter region

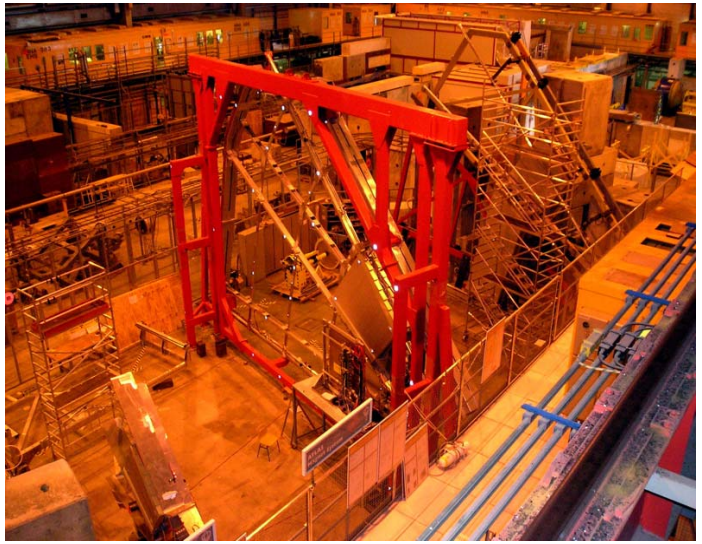


Setup: Muon region

- MDT, RPC, TGC and CSG technologies involved



Setup: Muon region



Data taken

Total ~ 90 millions events
~ 4.6 TB

Combined mode ~ 22 millions events

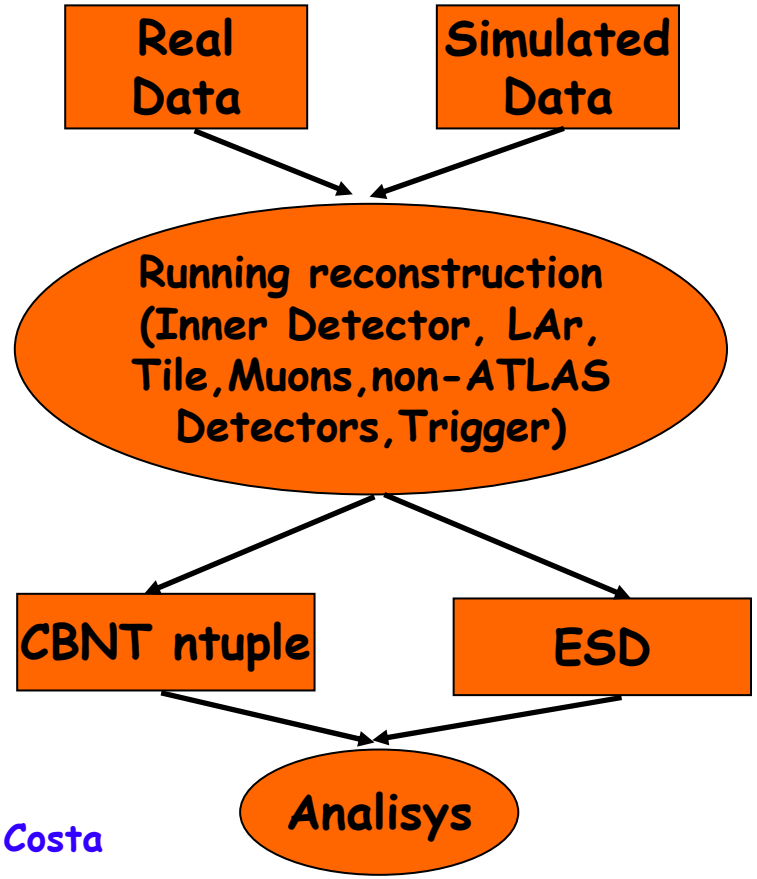
Done with an evolving CTB setup

- **Electrons/pions**
  - Energy scans: 1-250 GeV
  - Eta scans: 0-1.2
  - Phi scans
  - Material studies:
    - Al plates in front of LAr at eta = 0.4
    - Al plates between Inner Detector parts (1-180 GeV)
  - Magnetic field scans
- **Pions/Muons**
  - Energy (320 GeV, 350 GeV) and Eta scans
- **25 ns runs**
  - Pions/protons at 350 GeV and Muons/Pions at 180 GeV
  -
- **Muon runs**
  - Magnetic field scans at different energies (100-350GeV)
  -
- **Photon runs**
  - 180 GeV electron beam (~60 GeV photons)

From May to October 2004

Reconstruction

- Full reconstruction runs in Athena using the ATLAS software:
  - Small adaptation to reconstruction algorithms themselves but big effort to deal with CTB geometry.



M. Costa

- A package called RecExTB has been setup to run the CTB reconstruction.

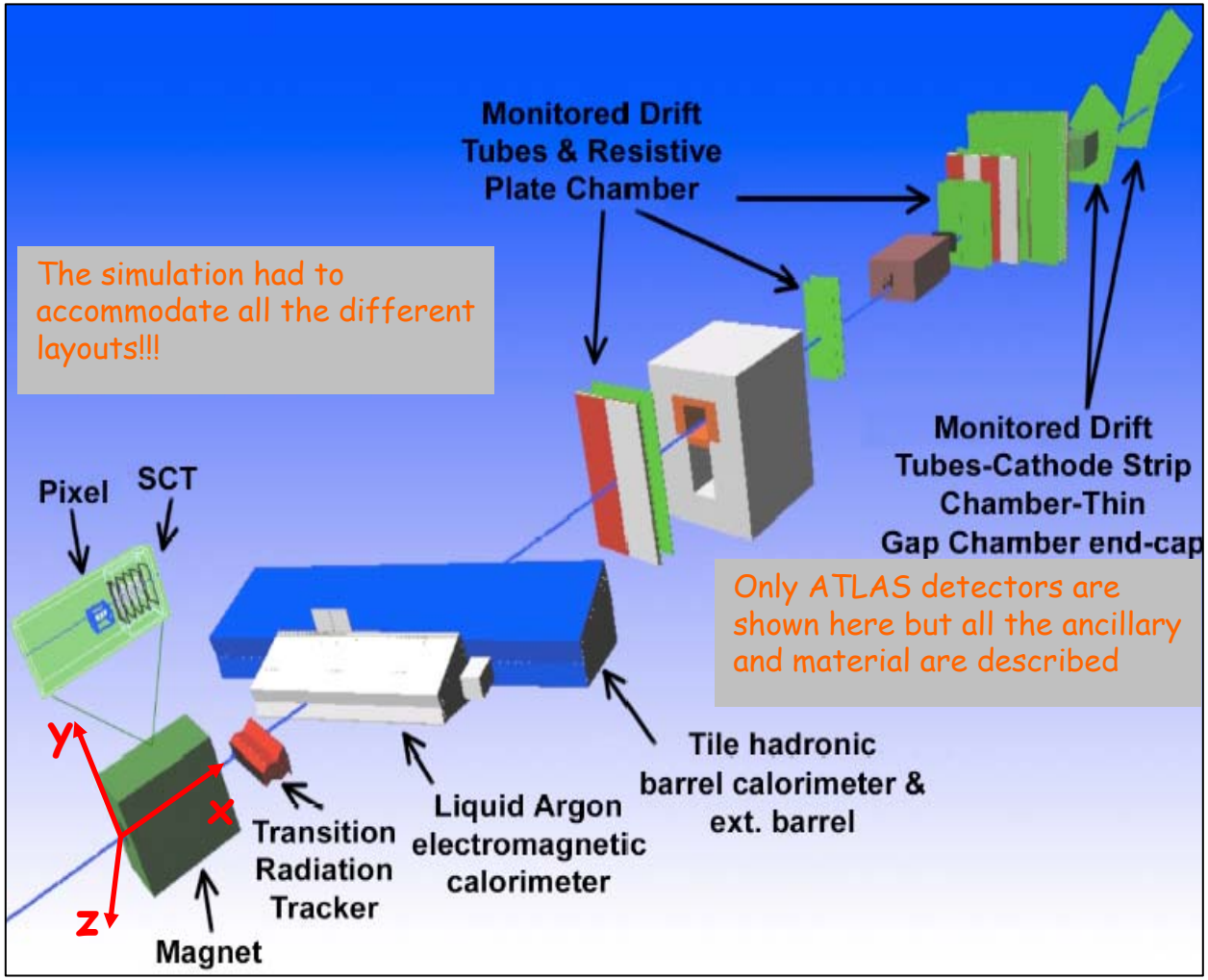
- The reconstruction chain works for the different detectors for both real and simulated data.

- For real data needs to:
  - Deal with alignment and calibrations
  - Real detectors (imperfections)
  - Use Conditions database

All this infrastructure was tested for the first time thanks to the CTB!

- The LVL2 ID algorithms do also run in RecExTB

Simulation



- Simulation infrastructure has to deal with all the different configurations:
  - combined mode
  - photon beams
  - material studies
  - eta scans
  - calibration
  - different ancillary detectors

  and follow their evolutions over the 24 weeks running period --> simulation uses run conditions mode

- Single particle generator, is used in most of the cases although Hijing can be used as well for speed up material studies

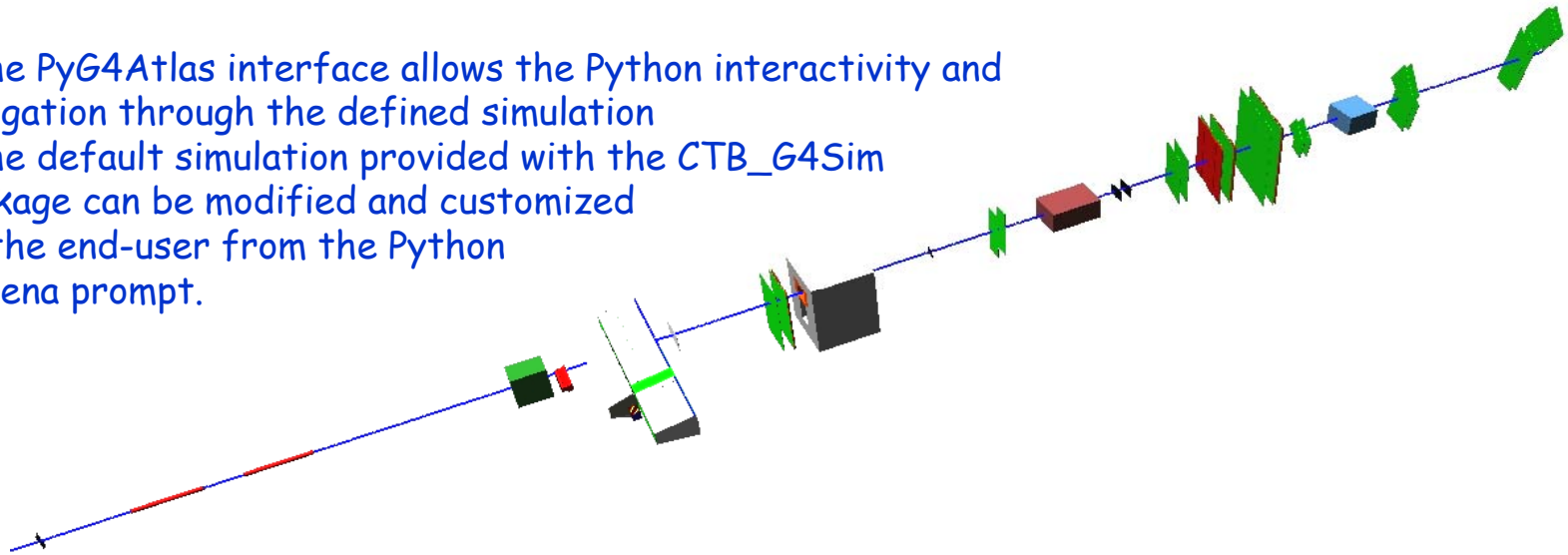
- Simulation in GRID production for 200 good validated runs using Geant4-07-patch-01 through a complete Python Interface integrated in Athena

Simulation

• CTB Geant4 simulation uses a complete Python interface (PyG4Atlas) to interact from the Athena python prompt with the FADS (Framework for the ATLAS Detector Simulation) and G4

• Eta values, magnetic fields, geometries from GeoModel, physics lists, regions, etc can be established from the Python jobOptions in an interactive session or in batch.

• The PyG4Atlas interface allows the Python interactivity and navigation through the defined simulation
• The default simulation provided with the CTB_G4Sim package can be modified and customized by the end-user from the Python Athena prompt.

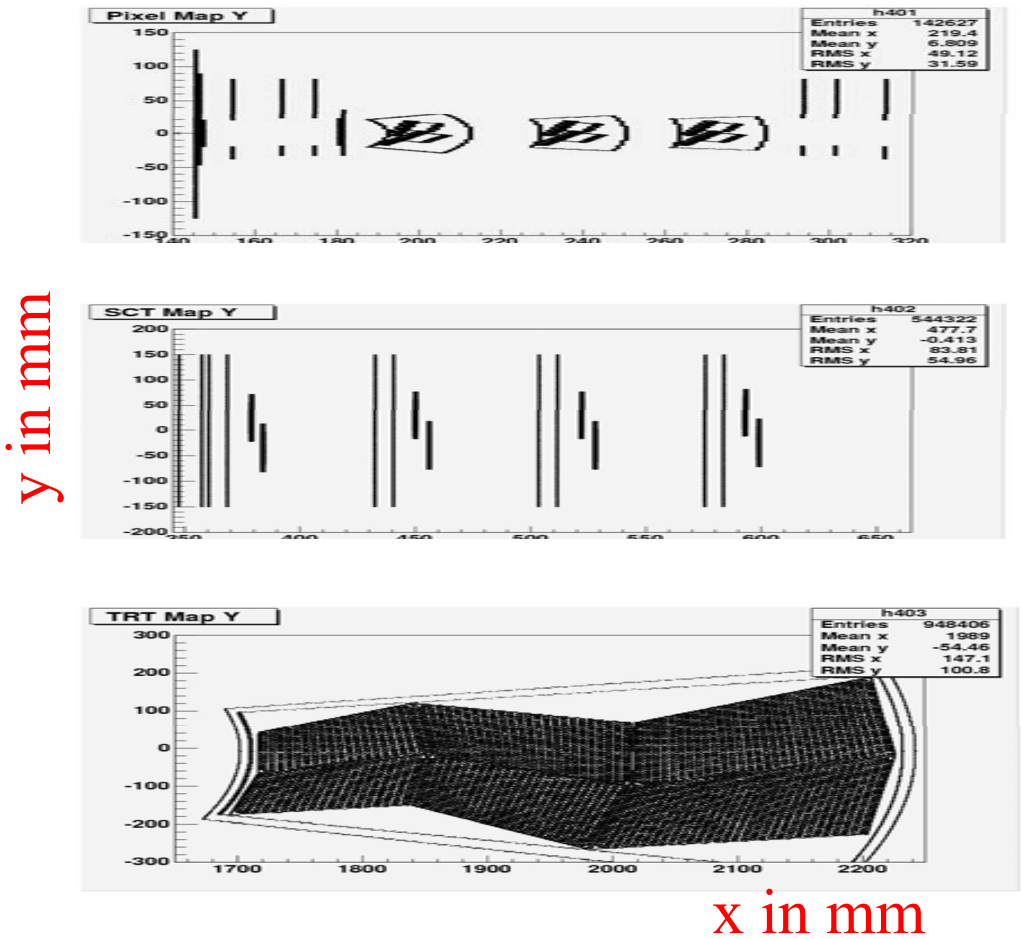


• The different layouts, geometries for the sub-detectors, eta rotation, magnetic fields configurations, and other simulation parameters can be set base on the run number (user only needs to set the run number) . The GRID simulation production for the CTB uses run conditions for the simulation of the "good" validated data.

Sub-detector studies: Inner detector (*Pixel, SCT, TRT*)

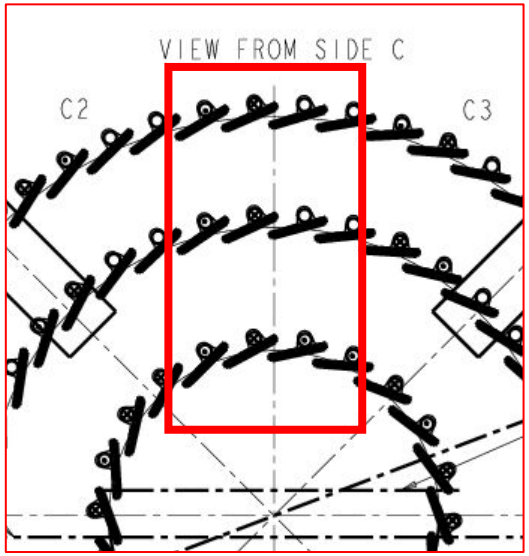
R. Petti and T. Koffas

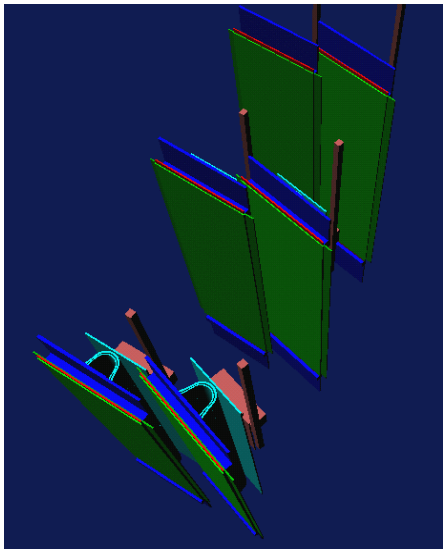
Propagating a 100GeV pencil shaped geantino beam, through the Inner Detector

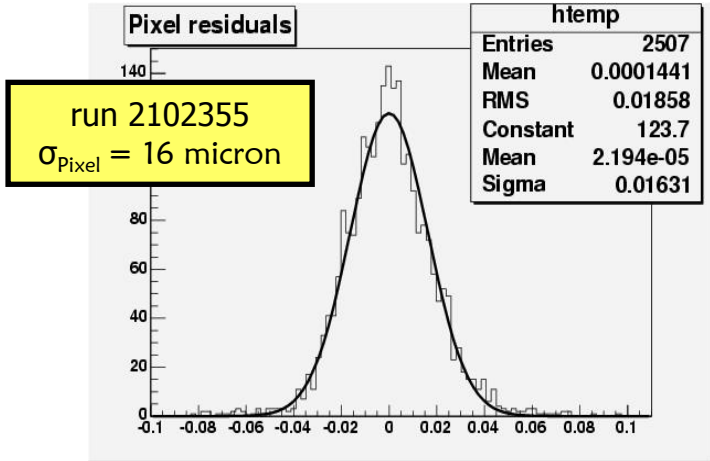


- Checks of the material description (Xo maps and comparisions with the ATLAS setup), first item on the validation process
- Primary numbers for GeoModel in Oracle DB
- 5 main DB geometry tags for the combined period, 1 tag for photon runs and 1 tag for earlier runs in September
- Simulation has to deal with different geometry tags, top shifts and different magnetic field configurations (this information must be shared with the digitization and reconstruction process)
- Map of dead channels is read from CondDB and used in the digitization, noisy channels still randomly distributed.
- Data validation -> 22 millions of good events with full ID already identified for the Rome production

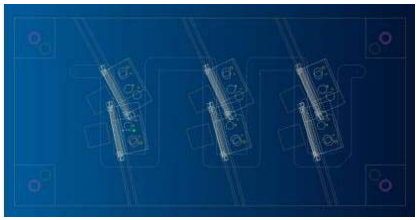
Sub-detector studies: Inner detector (*Pixel*, SCT, TRT)

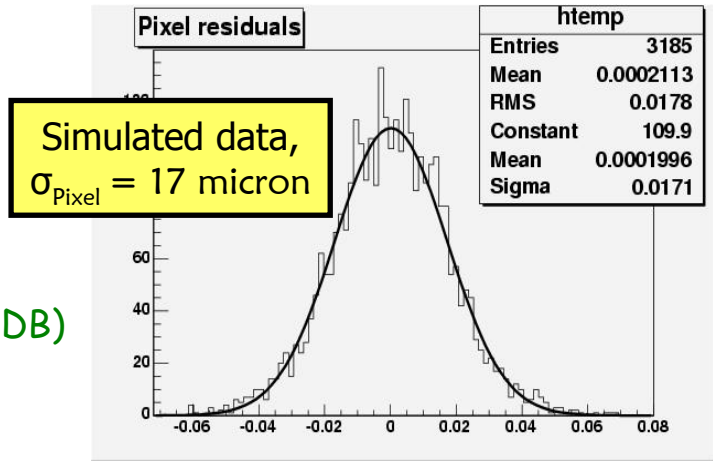






beam

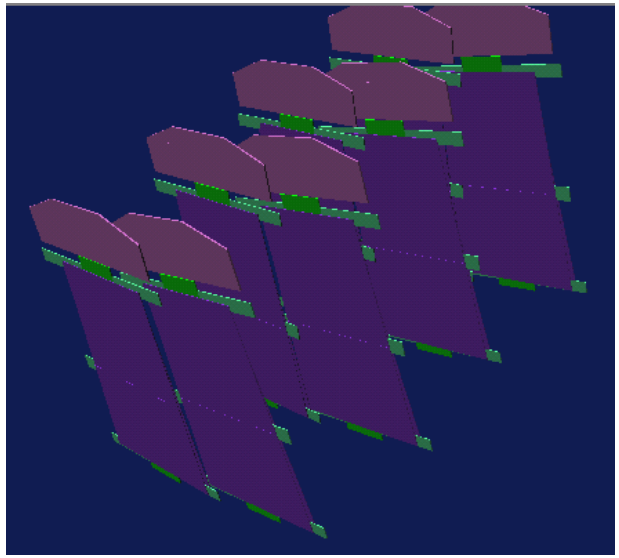




T. Cornelissen

- Reconstruction with straight line fitter (100 GeV pions)
  - Alignment corrections taken into account for data (CondDB)
- The resolution in MC seems consistent with data

Sub-detector studies: Inner detector (Pixel, *SCT*, TRT)



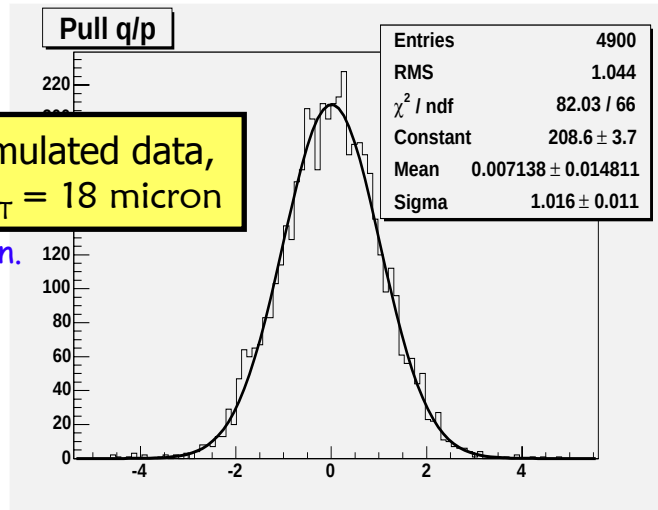
SCT

- **4 layers**
- **2 modules per layer**
- **forward modules**
- **pitch: 70-90 μm**

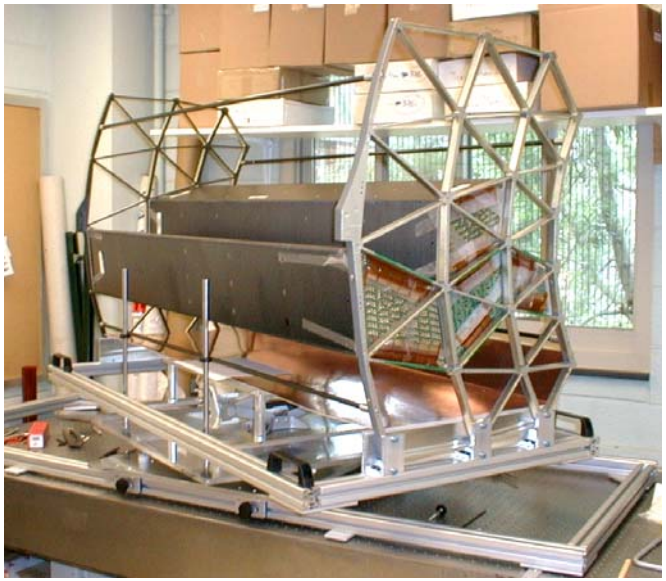
T. Cornelissen

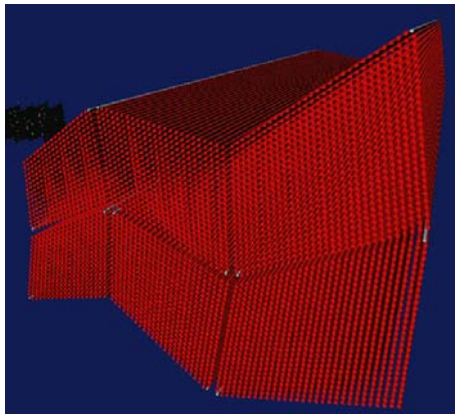
•According to SCT test beam, the SCT hit error should be about 21-22 micron. But according to xKalman the errors are about 18 micron in the simulation.

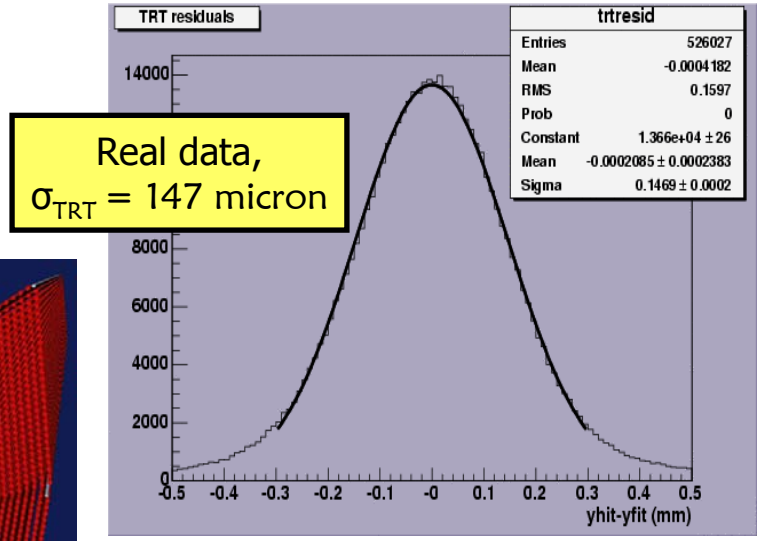
•The resolution according to the digitization is too optimistic…



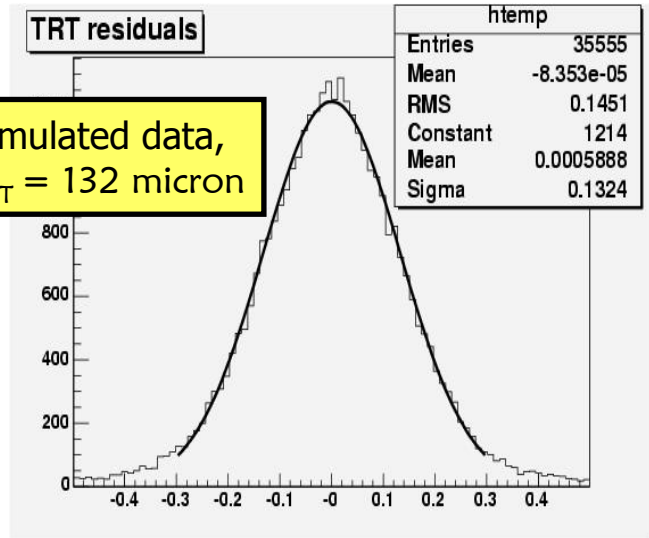
Sub-detector studies: Inner detector (Pixel, SCT, *TRT*)







Real data,
σ_{TRT} = 147 micron



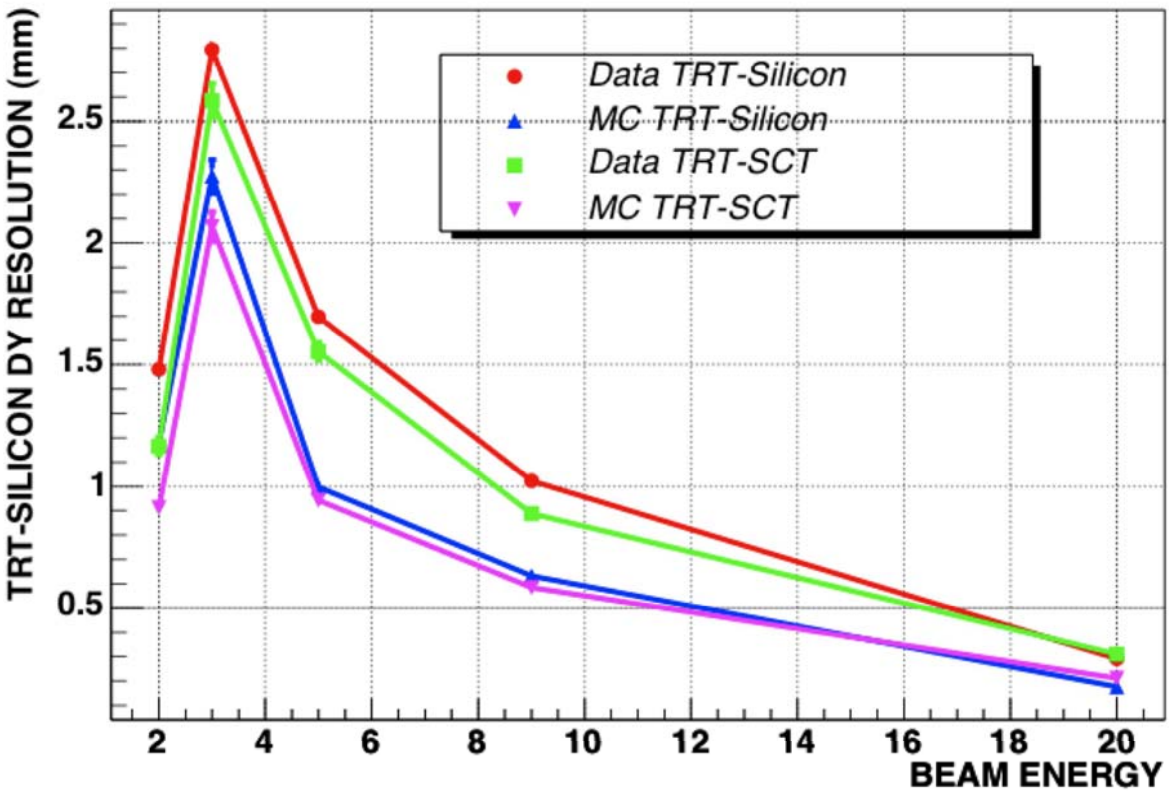
Simulated data,
σ_{TRT} = 132 micron

- TRT Detector: 1/16th of the TRT barrel
- Final grounding/shielding scheme
- 3284 straws
- straw diameter: 4 mm
- 1 barrel side is readout

T. Cornelissen

- TRT residuals after track reconstruction with straight line fitter
- Compare data and MC for same run/configuration (100 GeV pions)
- The MC resolution seems better than real data

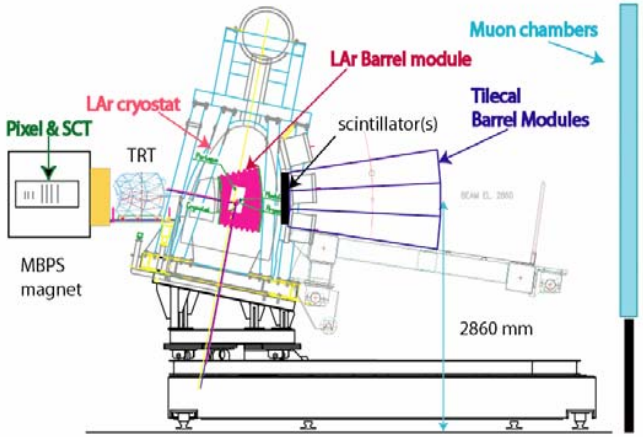
Sub-detector studies: Inner detector (Pixel, SCT, *TRT*)



2 GeV -> Run 2102115
3 GeV -> Run 2102162
5 GeV -> Run 2102163
9 GeV -> Run 2102139
20 GeV -> Run 2102397

The simulation uses the Python interface and the RunConditions. The run number is enough to set properly all the parameters for the simulation including the different inner detector geometries

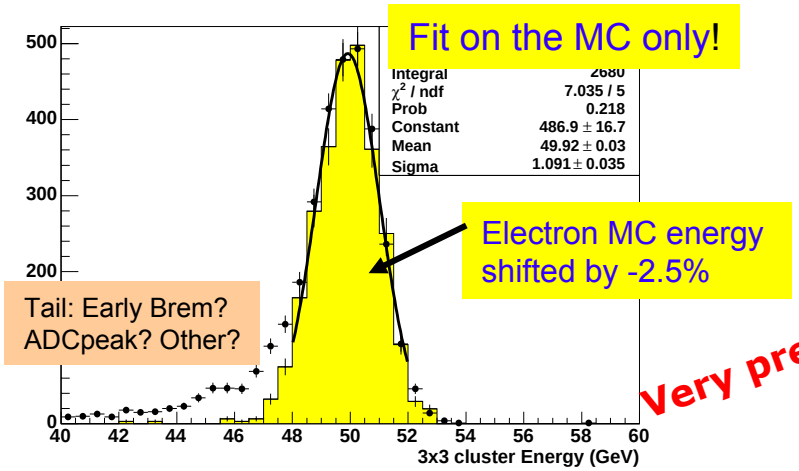
Sub-detector studies: LAr



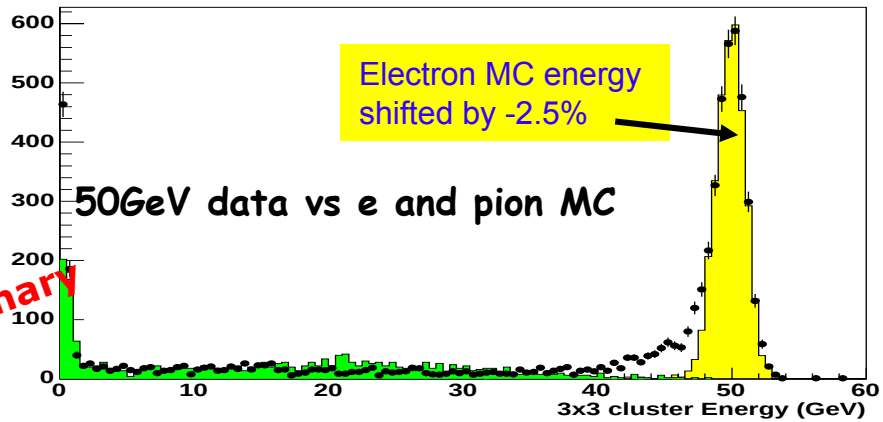
✓ Energy resolution already achieved
(M. Aleska, I. Wingerter et alt.)

✓ Detailed LAr studies are being done to:
- improve calibrations
- understand the HV dependence
- study the material effects
- compare the performance of the different clustering algorithms

✓ Started the MC vs Data analysis

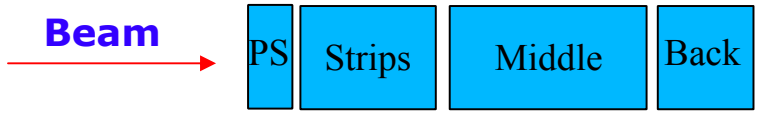


Very preliminary



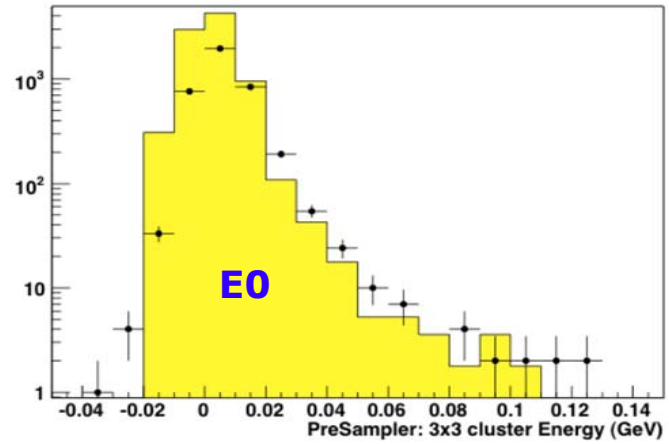
More in LARH8 analysis meeting by Stathes Paganis et alt.

Sub-detector studies: LAr

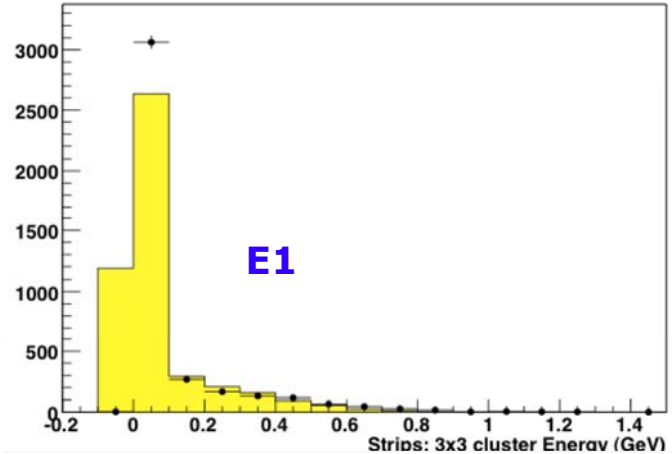


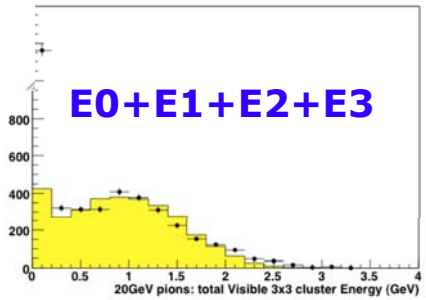
- **Pions** seen by the LAr. Visible energies per LAr sampling (E0,E1,E2,E3)

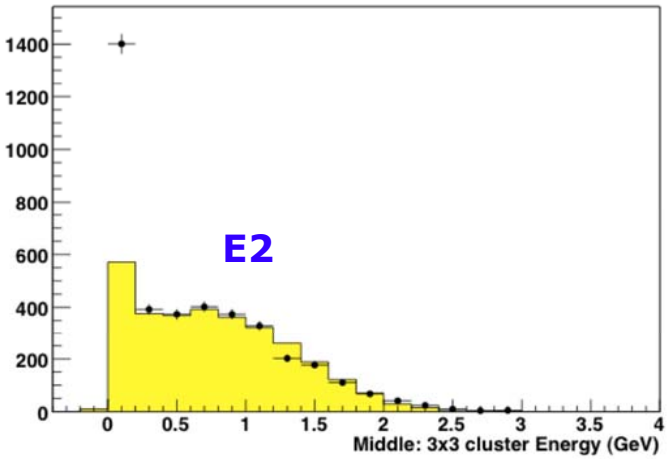
(visible means after removing the sampling fractions in data (points) and MC)
More in LARH8 analysis meeting by Stathes Paganis et alt.



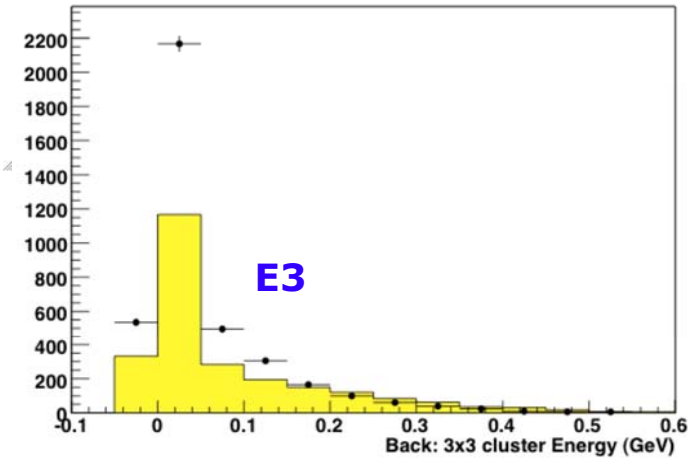
Very preliminary



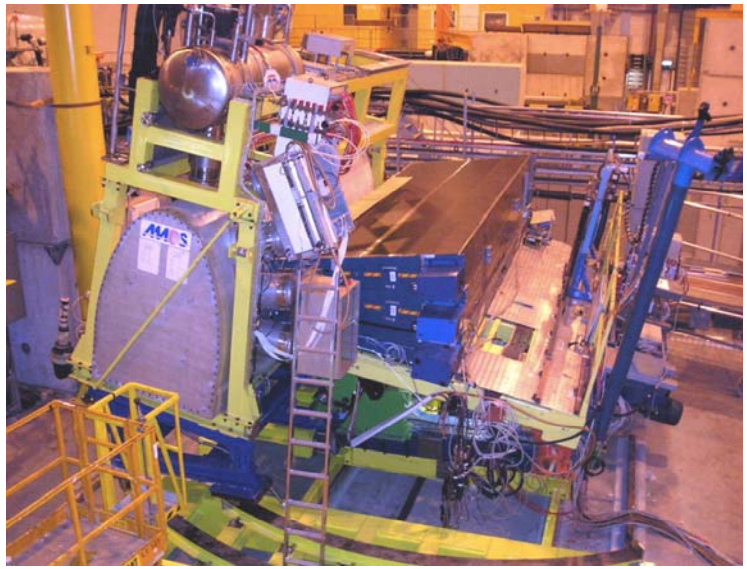




Very preliminary



Sub-detector studies: Tile



• Three barrel modules (each of them is 1/64 of the 2pi ATLAS barrel) and three extended barrel used only during a certain running period.

Energy resolution for pions (data)

σ(E)/E

- Standalone 1998 η = 0.35
- CTB 2004 ™ and a

TTFF (LZW) decom
are needed to see this

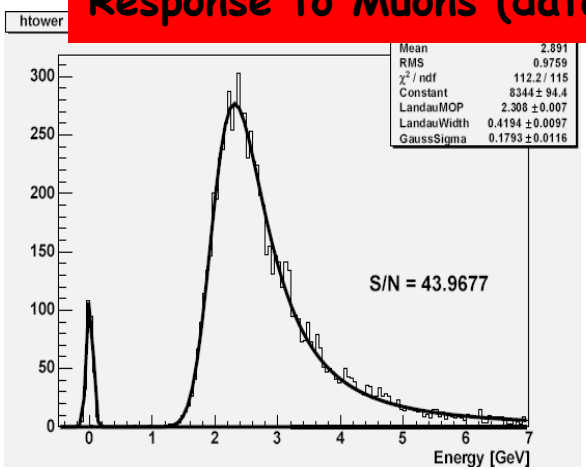
$\sigma(E)/E = aE^{-1/2}+b$

$a = 55 \pm 2\ \%\ GeV^{1/2}$

$b = 6.2 \pm 0.1\ \%$

(T.Davidek, C.Santoni et al)

Response to Muons (data)



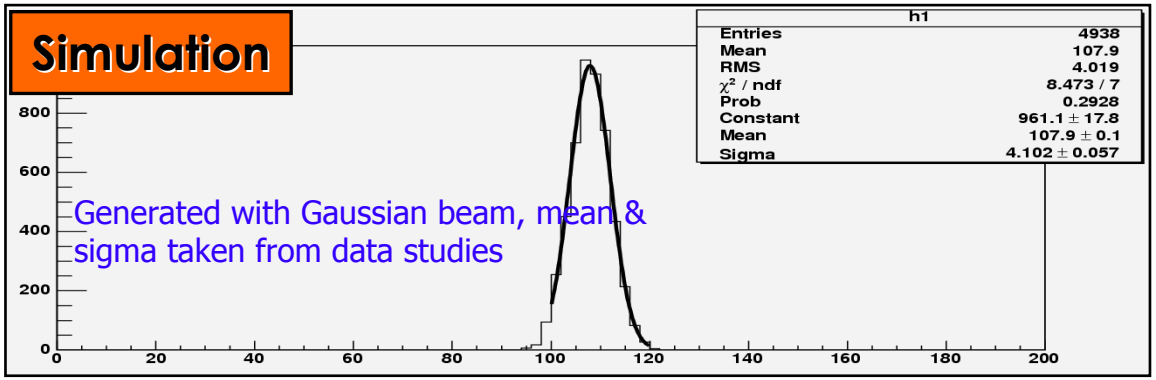
Talk about **Geant4 and CTB-Tile data** by
by Andrea Dotti & Per Johansson at the
Physics Validation for LHC meeting (23th February)
http://agenda.cern.ch/fullAgenda.php?ida=a051142

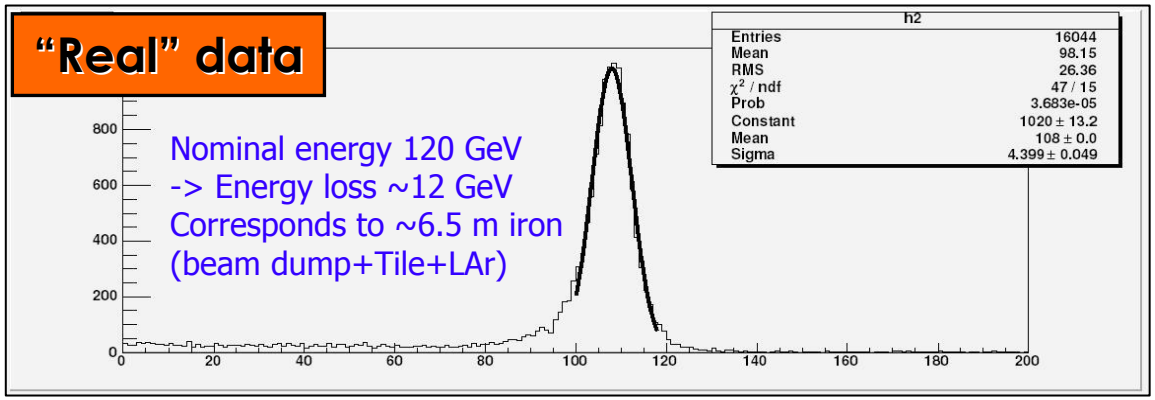
See also next talk the agenda.

Sub-detector studies: Muons

- A lot of work has been done to improve the alignment and calibrations (validation efforts should focus in these two items and geometry).
- Intrinsic & m.s. contributions to sagitta resolution agree with the expectations --> CTB simulation of materials seems reliable.

- *BEAM ENERGY*:





G4/CTB comparison note in preparation by Avolio, Cerruti, Meoni, Policicchio, Rebuzzi, Rosati and Ventura on the Intrinsic resolution and material effect

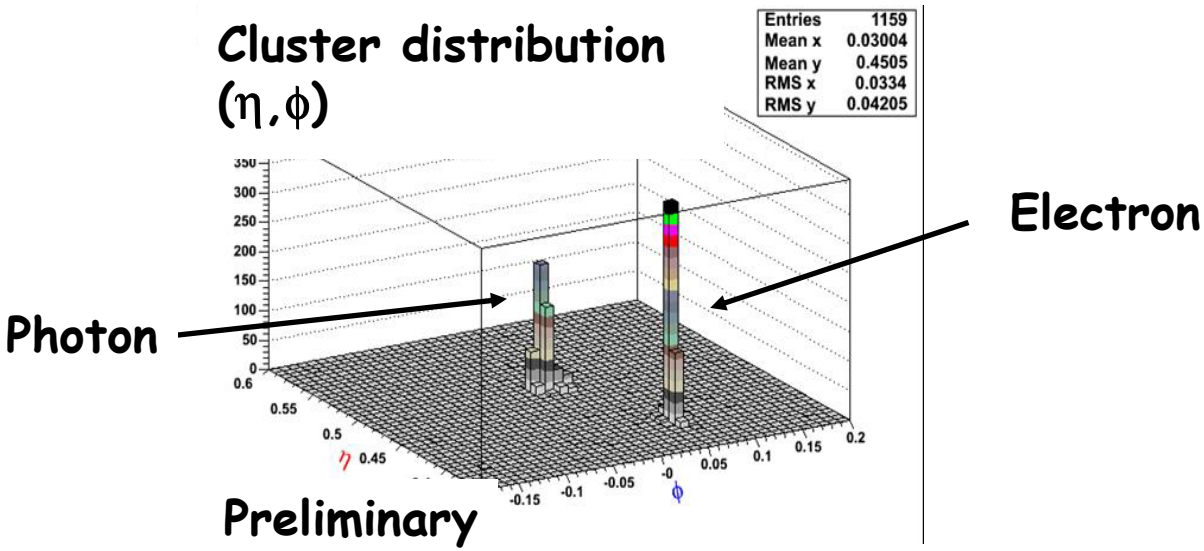
Combined analysis

•The CTB simulation can be used for each detector in standalone or to reproduce the combined periods in which all detectors were active (the GRID simulation for the Rome Atlas Physics WorkShop is focused in the combined period)

• Results are expected in the Calo-ID matching, electron/pion separation, use of the TRT for particle identification, ID-Muon matching etc.

• As an example, one of the most actives areas are the photon runs:

First results with the photon run



Conclusions:

✓ **From the Atlas week on February 2005:**

- ATLAS has shown that the CTB has been a very successful exercise for all communities:
  - Detector, TDAQ, DCS goals were accomplished
  - The ATLAS reconstruction and simulation software has also been successfully tested
  - The standalone reconstruction of the individual detectors is in a good shape to start real combined analysis.

- Data has been validated and all detectors made already clear requirements for the MC production

- A new production for simulation and reconstruction is expected for March and a second one for April to be ready for Rome (although more refined analysis are expected to go on)

- The CTB life will continue in the combined performance group

✓ **First results expected at the** Atlas Physics Workshop Roma, 6 - 11 June 2005

✓ **CTB is a big potential source for the Physics Validation at LHC**

Thanks to the ATLAS community and in special to the CTB people