The ATLAS Electromagnetic and Hadronic End-Cap Calorimeter in a Combined Beam Test

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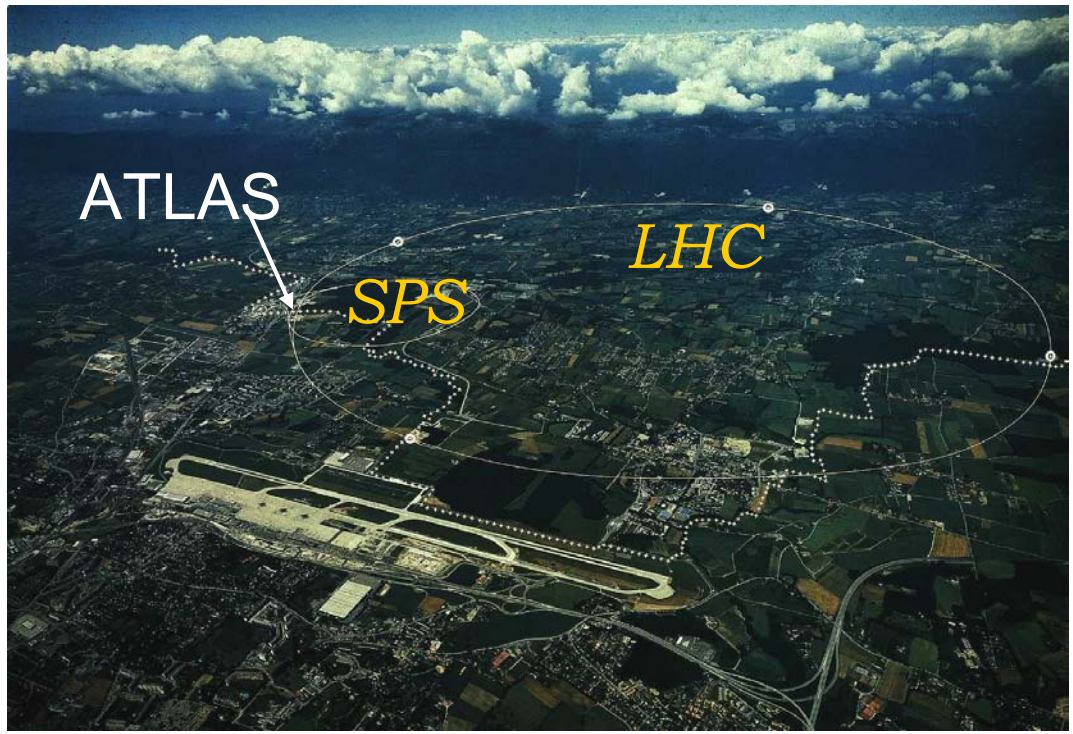
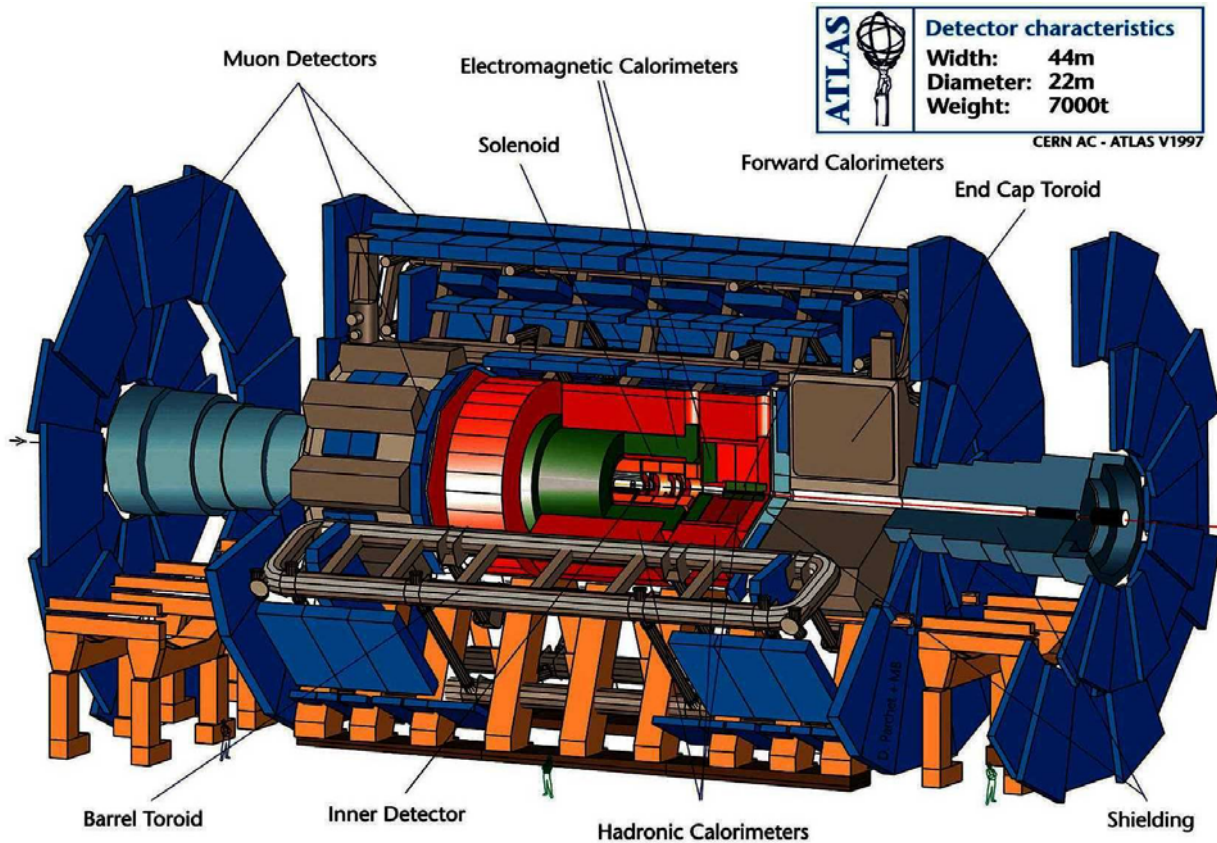
LHC Overview

- The Large Hadron Collider (LHC) is under construction at CERN, outside of Geneva, Switzerland
- Operations are planned starting in 2007
- The LHC will provide proton-proton collisions at a center of mass energy of 14 TeV
- These collisions will allow us to study new physics, such as searches for the Higgs particle and evidence of supersymmetry

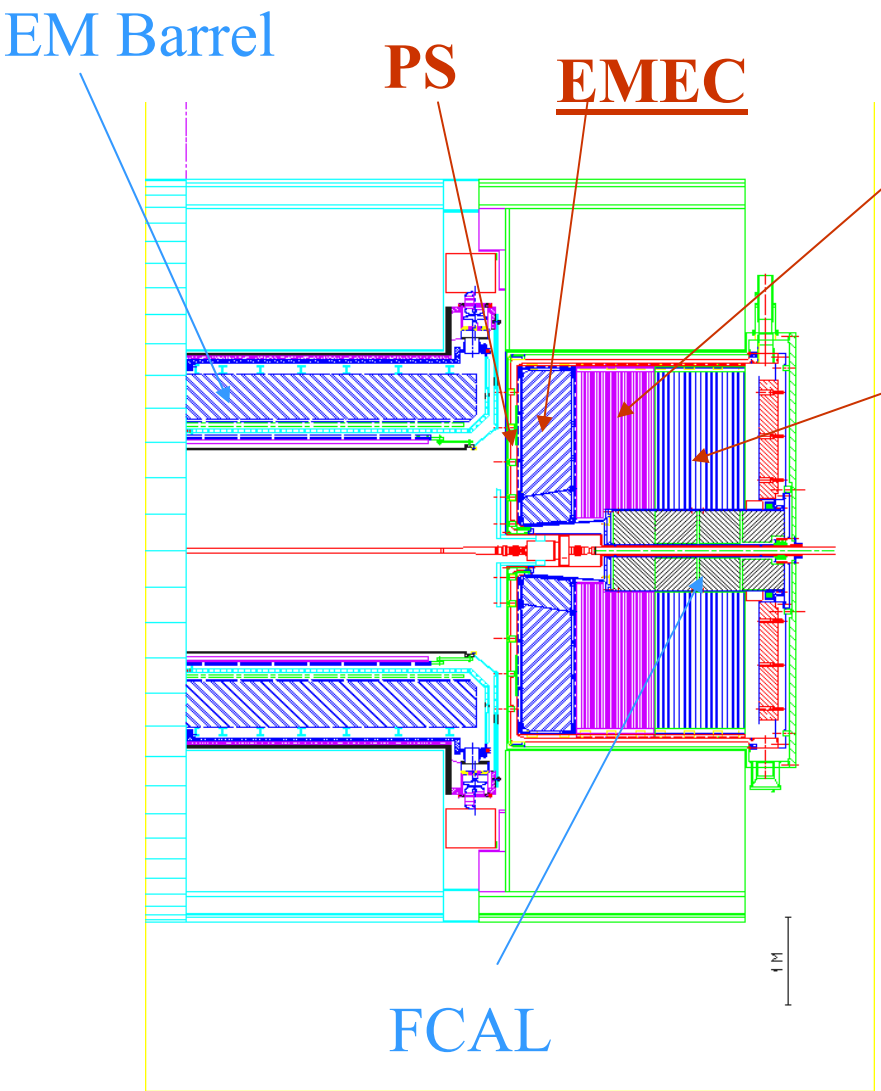


ATLAS Overview

- ATLAS: A Toroidal LHC ApparatuS
- The detector is made up of many sub-detectors, such as the inner tracker, the calorimeters and muon detectors
- The experiment is a collaborative effort between 2000 physicists in 34 countries



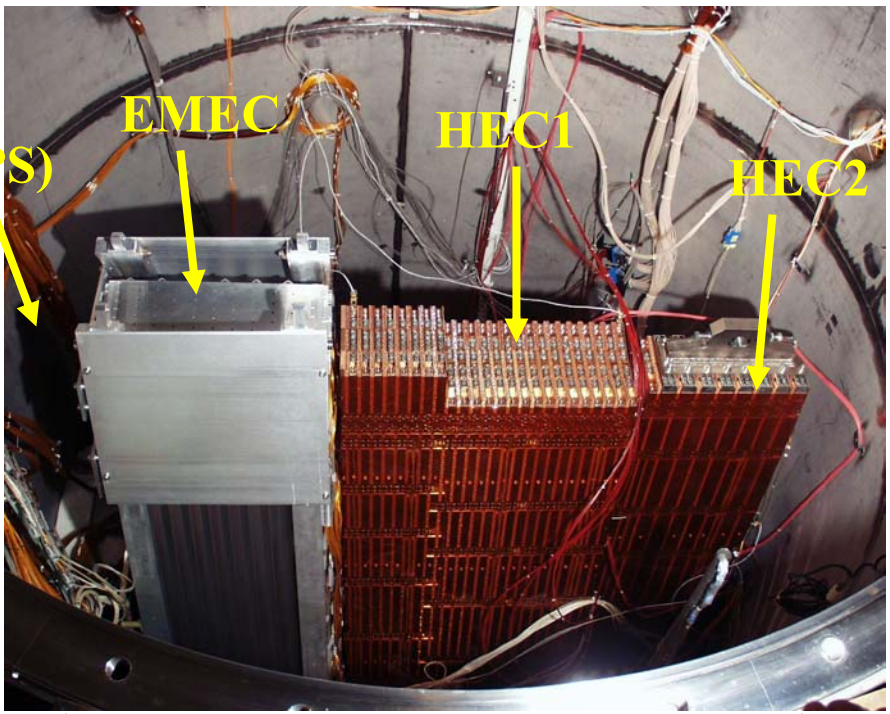
ATLAS LAr Calorimetry

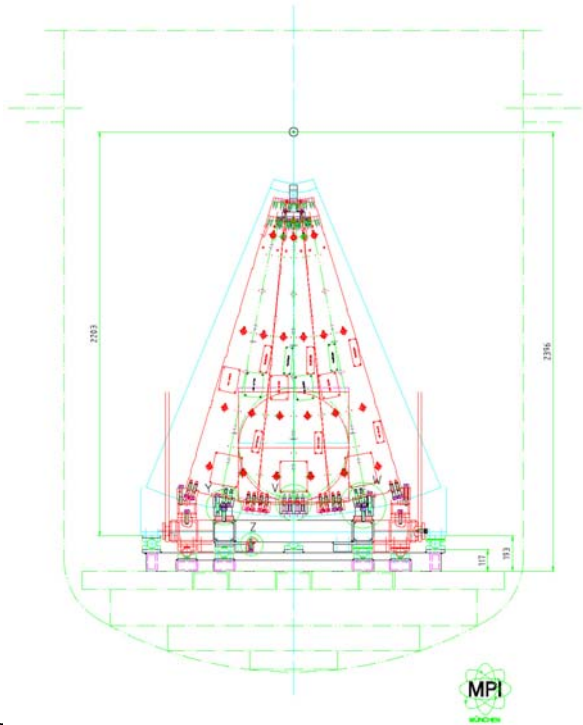


- EMEC: PB/LAr sampling calorimeter with accordion structure
- HEC: Cu/LAr calorimeter in end-cap

Beam Test Overview

- In Summer 2002, the Presampler, the Electromagnetic End-Cap Calorimeter and the Hadronic End-cap Calorimeter and were tested together
- This test (among others) allows us to further investigate how the detector will work in ATLAS, and gives us experience in identifying and solving some of the problems that may occur





Data Analysis

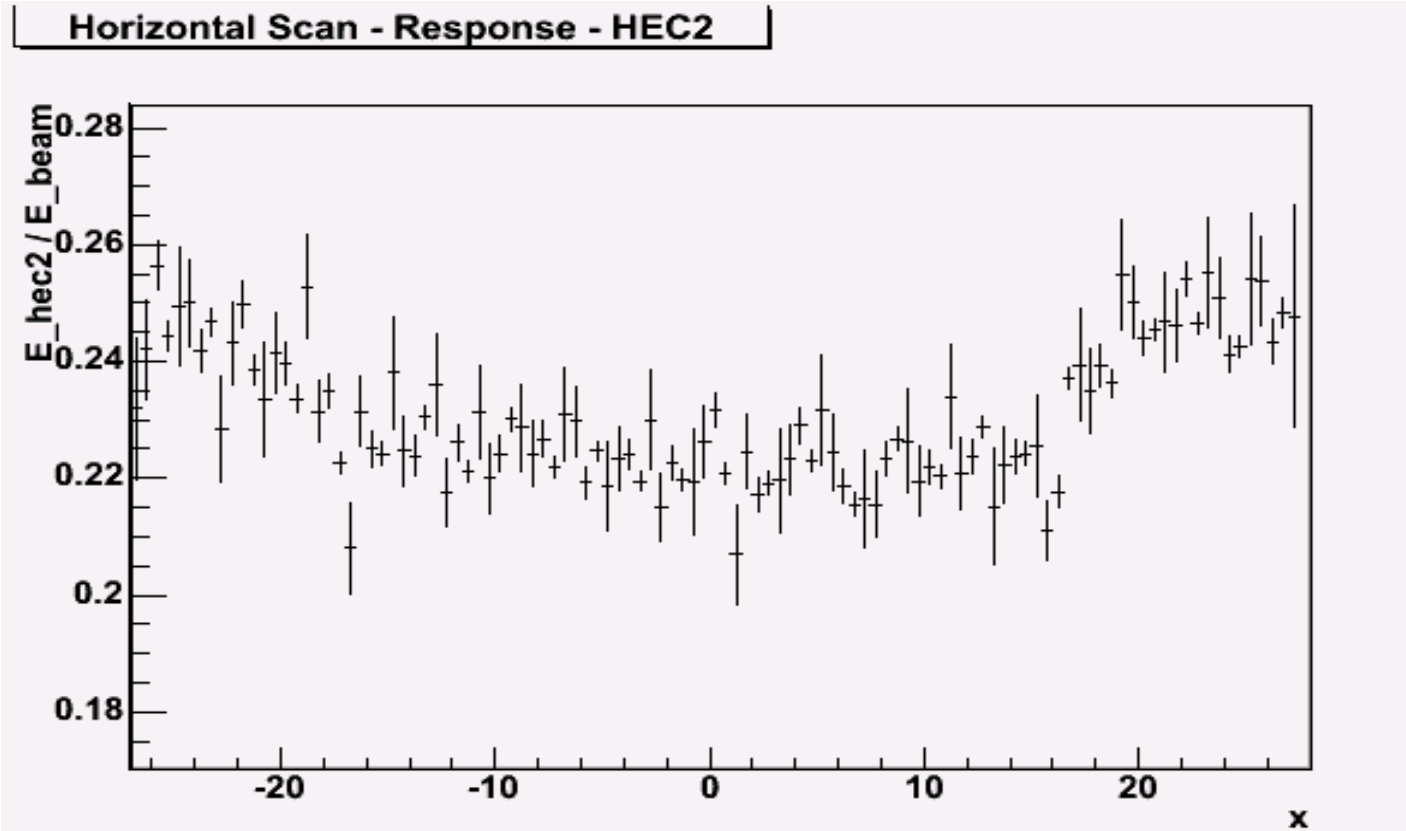
- Signal is extracted from cells in the HEC and EMEC for each event
- The signals are processed and recorded to tape
- Before beam test periods, calibration data is produced which allows us to convert from signal in ADC to nA, from which we can use physics to determine the energy of particles in GeV
  - We find from beam tests
    - $\alpha_{EN} = 0.0003855$ GeV/nA
    - $\alpha_{HAD} = 0.003266$ GeV/nA
- Using the ATLAS software framework (Athena) to produce ntuples of beam test data
- Analyzed using UVic's in-house software (TBRootAna) developed by M. Lefebvre and I. Gable
- For now, a fixed cluster of cells is used for a given impact point

Data Analysis Challenges

Several challenges were encountered in data taking and subsequent analysis (not unlike what could happen in ATLAS!):

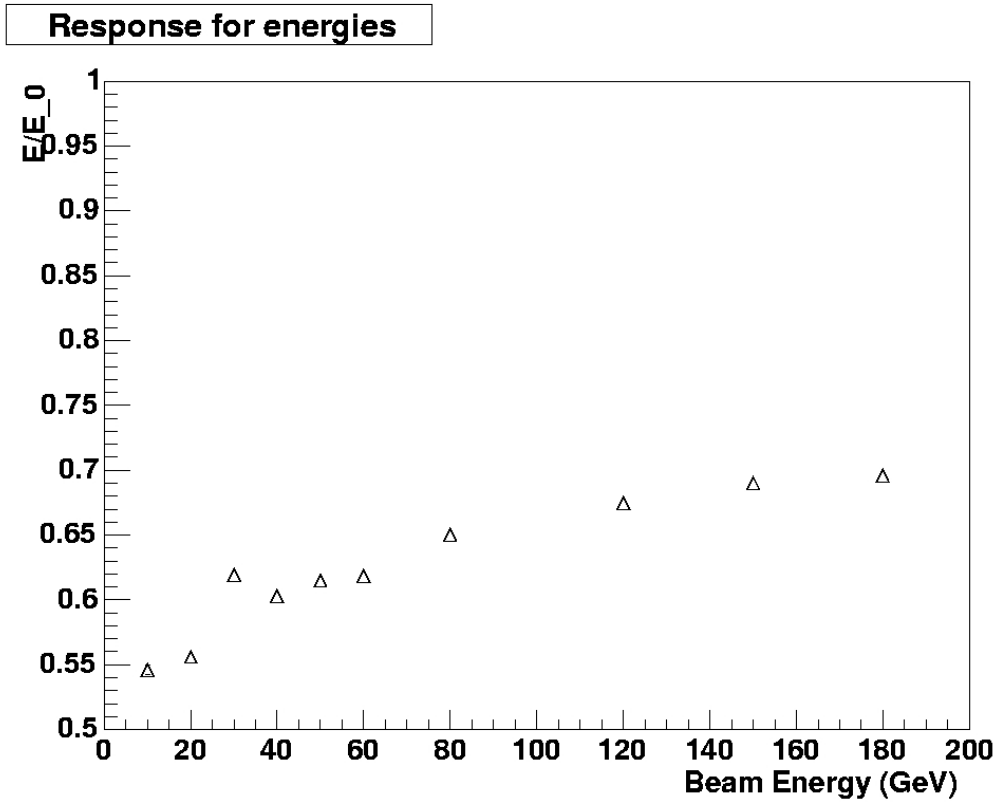
- Timing issues which affect signal reconstruction, and in particular energy response
- A high voltage gap in the HEC malfunctioned, causing the signal in the affected cells to be lower on average than other cells
- Sampling fractions (the amount of energy measured as a fraction of the total energy deposited) differs between the first and second wheel of the HEC
- Geometrical corrections were necessary in the EMEC

Example – HV Gap Failure



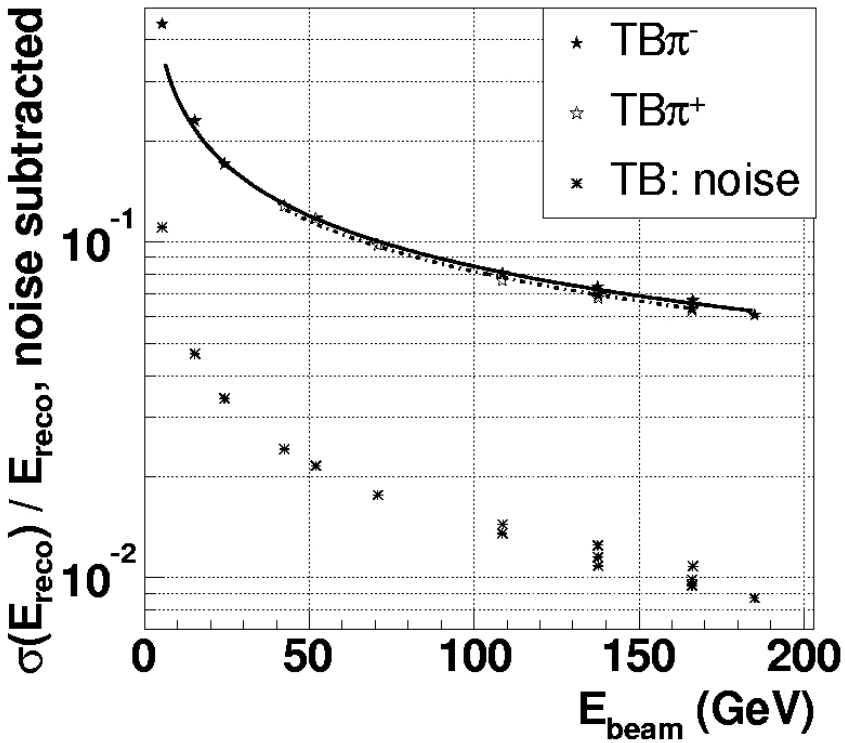
- We can see that the response dips in the middle segment of layer 2 of the HEC
- This can be largely using information from neighbouring samplings

Pion Energy Response



- The energy response shows a non-linear dependence on the pion beam energy, as expected for a non-compensating calorimeter

Pion Energy Resolution



- Preliminary results from HEC/EMEC group (to be published soon in NIM paper)
- These results produced using sophisticated clustering and correction algorithms
- Intrinsic resolution in agreement with ATLAS design

Future Work

- Finish applying all corrections to the data
- Perform noise subtraction to determine the intrinsic resolution of the calorimeter to pions
- Move to a clustering algorithm
  - This will help improve the resolution of the calorimeter by removing unneccessary cells from the cluster, thereby reducing the the total noise of the cluster in further work
- Investigate hadronic weighting schemes
  - Hadronic weighting schemes will improve the hadronic energy reconstruction of the two calorimeters together

Conclusions

- The HEC/EMEC combined beam test is an important and necessary step in the commissioning of the ATLAS experiment
- Techniques are being developed to properly reconstruct hadronic shower energies in ATLAS

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- HEC, EMEC, and FCAL combined beam test occurs in summer 2004