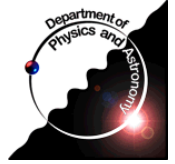




ATLAS

at the University of Victoria



- The ATLAS Experiment
- Personnel
- Physics investigations
- Endcap signal feedthrough project
- Liquid argon calorimetry
 - beam test activities
 - software development
 - detector control system
 - commissioning
- Computing
- Future plans

NSERC Site Visit
October 6th 2003
M. Lefebvre

The ATLAS Experiment

- Probe nature at the energy frontier with 14TeV pp collisions at the Large Hadron Collider
- First collisions expected in 2007
- Highlights of the experimental programme:
 - Higgs Boson: SM and MSSM Higgs searches, the origin of mass, electroweak symmetry breaking
 - Supersymmetry: squarks and gluinos, investigate SUGRA, gauge mediated SUSY breaking and R-parity breaking models
 - More searches: new gauge bosons, extra dimensions, monopoles, technicolour, excited quarks, leptoquarks, compositeness
 - Standard Model physics: QCD processes, electroweak gauge bosons, B physics, heavy quarks and leptons

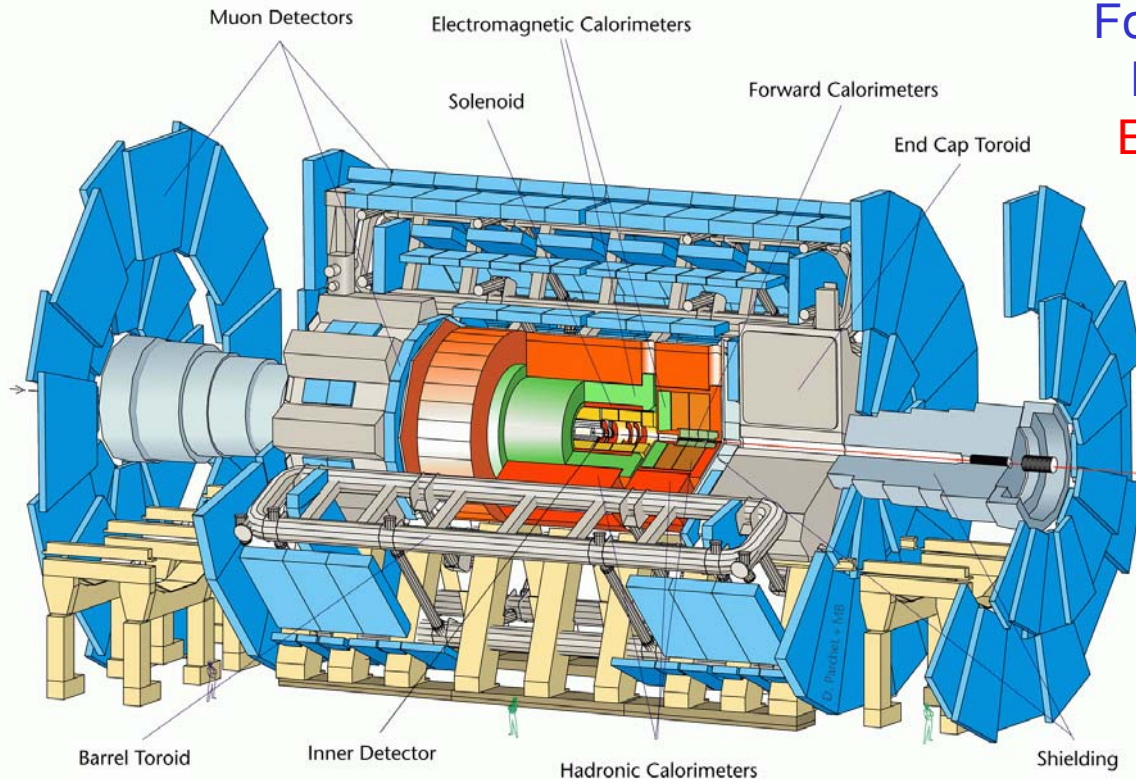


Alberta
 Carleton
 CRPP
 Montréal
 SFU
 Toronto
 TRIUMF
 UBC
 Victoria
 York

The ATLAS Experiment

Canadian activities focused on LAr calorimetry
 4 large projects funded by a Major Installation Grant:

- Endcap Hadronic Calorimeter
- Forward Hadronic Calorimeter
- Front-End-Board Electronics
- Endcap Signal Feedthroughs



LAr cryostat and
 calorimeters
 construction phase
 near completion

Efforts shifting
 toward integration,
 commissioning,
 software and
 computing

diameter	25 m
barrel toroid length	26 m
total weight	7000 tons

ATLAS Personnel

- Faculty
 - Keeler, Lefebvre (PI 92-03), McPherson (PI 03-), Sobie, Astbury (retired)
- Onsite TRIUMF Staff
 - Birney, Charron, Dowling, Langstaff, Lenckowski
- Research Associates
 - Fincke-Keeler, Kanaya (CERN), Poffenberger (MFA), TBA
- Technician
 - Holness
- Graduate Students
 - Hughes (M.Sc., Lefebvre), Ince (M.Sc., Keeler)
- Degrees Awarded
 - 4 M.Sc. (Bishop, Fortin, Robertson, White)
 - 2 Ph.D. (Dobbs, O'Neil)
- Undergraduate Students
 - typically 3 per year

ATLAS Personnel: Leadership

- Founding Spokesperson of ATLAS-Canada (Lefebvre, 1992-94)
- Hadronic Endcap Calorimeter Chief Engineer (Hodges, 1996-00)
- LAr HEC Beam Test Software Coordinator (Lefebvre, 1997-02)
- LAr Cryostat and Cryogenics Steering Committee (Hodges, 1997-00; Lefebvre, 1997-03)
- Endcap Signal Feedthrough Project Leader (Lefebvre, 1997-)
- Advisory Committee to the Collaboration Board (Lefebvre, 1998-99)
- ATLAS-Canada Co-Spokesperson (Keeler, 1998-99)
- Canadian Rep on the International Computing Board (Sobie, 1999-)
- LAr Database Coordinator (Sobie, 2000-02)
- LAr Detector Control System Coordinator (McPherson, 2002-)
- LAr Beam Test Software Coordinator (McPherson, 2002-)

Physics Investigations

- NLO(α_s) di-Boson Event Generation (Dobbs, Lefebvre)
 - Part of Dobbs Ph.D. thesis work
 - Handling of divergences in di-boson event generation currently involves the phase slicing method, leading to the generation of weighted (often negative) events. But experiments need unweighted events, which cannot be obtained from negative weighted events. An algorithm has been devised involving a two-stage integration
 - M. Dobbs and M. Lefebvre, **Unweighted Event Generation in Hadronic WZ Production of Order (α_s)**, *Physical Review D* **63**, 053011, 2001
 - M. Dobbs and J.B. Hansen, *Comp.Phys.Comm* 216 (2000)
- Prospect for probing the three gauge-boson couplings in $W+Z$ and $W+\gamma$ production at the LHC (Dobbs, Lefebvre)
 - ATLAS internal note ATLAS-PHYS-2002-022 and 023, October 2002

Physics Investigations

- Doubly charged Higgs (Kanaya, McPherson)
 - The doubly charged Higgs is an interesting particle both theoretically and experimentally. The existence of the doubly charged Higgs is strongly motivated by the evidence for neutrino mass. The signal is very specific, with same sign and same flavor leptons, and is not possible in the Standard Model. Charge determination and τ identification are critical to achieve a good sensitivity.
 - A study was performed, with backgrounds adequately understood using a fast simulation. A more detail study will be done with full detector simulation in order to understand the effect of detector performance for this analysis.

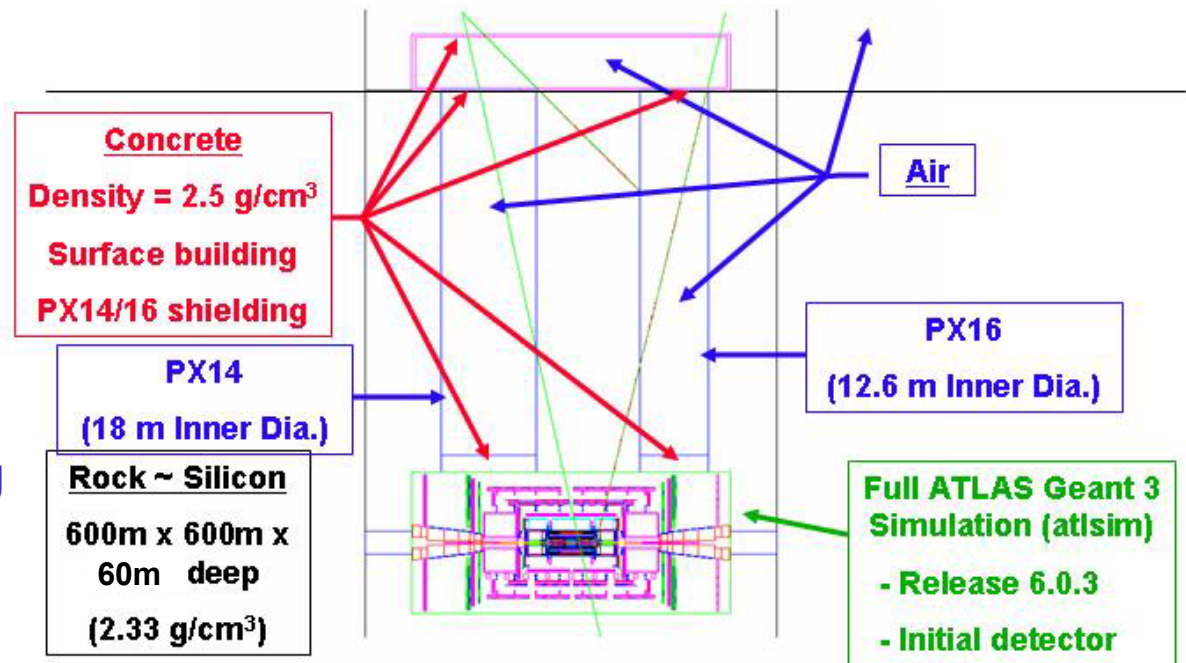
Physics Investigations

- Commissioning studies with cosmic and beam halo muons (McPherson)

- **Cosmic muons:** starting late 2004: used to test some calorimeters; October 2006: used to test ATLAS (~3 month run)
- **Beam halo muons:** from ~March to July 2007: single beam running

- **Goals:**

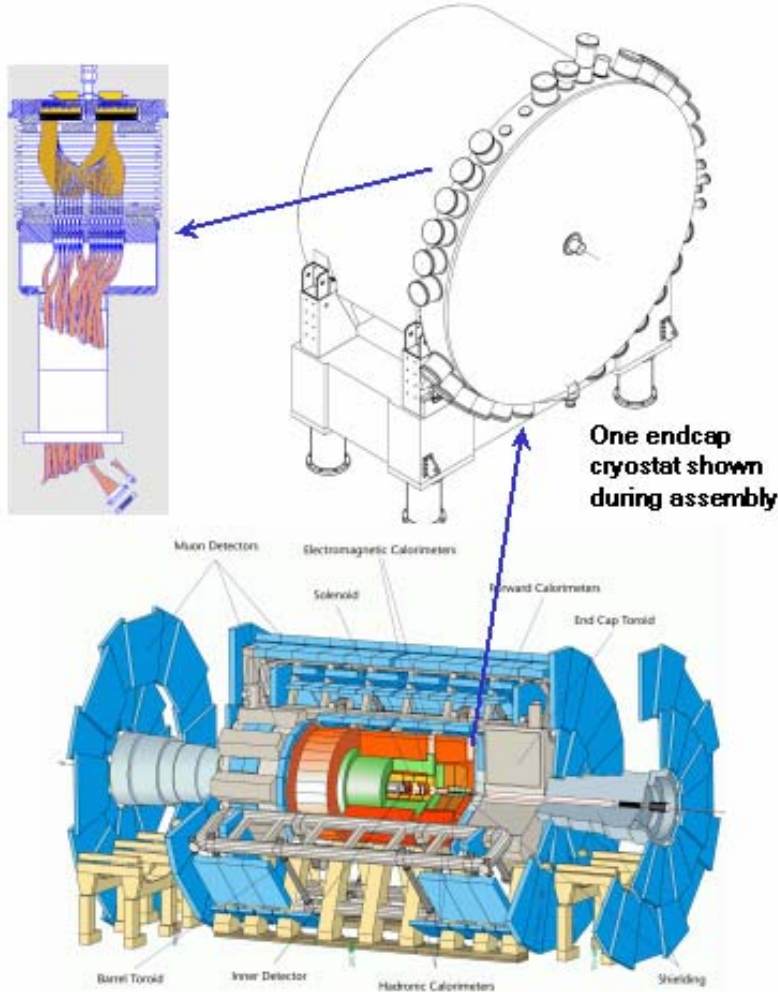
- electronics shakedown, dead/noisy channel map
- (sub)detector alignment
- electronic timing
- initial energy calibration in calo cells



Endcap Signal Feedthrough Project

Project Leader: Lefebvre

Chief Engineer: Hodges



- ATLAS LAr calorimetry has over 180k signal channels which must come through the cryostats
- Each feedthrough unit carries 1920 electrical channels
- Feedthrough units: 64 in barrel, 50 in endcap
- The endcap signal feedthrough project is an ATLAS common fund contribution from Canada. Over \$4M from NSERC MIG.
- All endcap feedthrough units have been built in Victoria
- As of 26 Sep 2003, all units have been welded and tested on the cryostats at CERN
- The onsite TRIUMF staff have been crucial to the success of the project

Endcap Signal Feedthrough Project

- Installation and tests at CERN
 - supervision: Poffenberger
 - Holness, Poffenberger
 - with contributions from many, including
 - Birney
 - Chekulaev
 - Langstaff
 - Undergraduate students



electrical tests at CERN



last feedthrough produced at UVic, 25 Oct 2002



installation at CERN

Liquid Argon Calorimetry

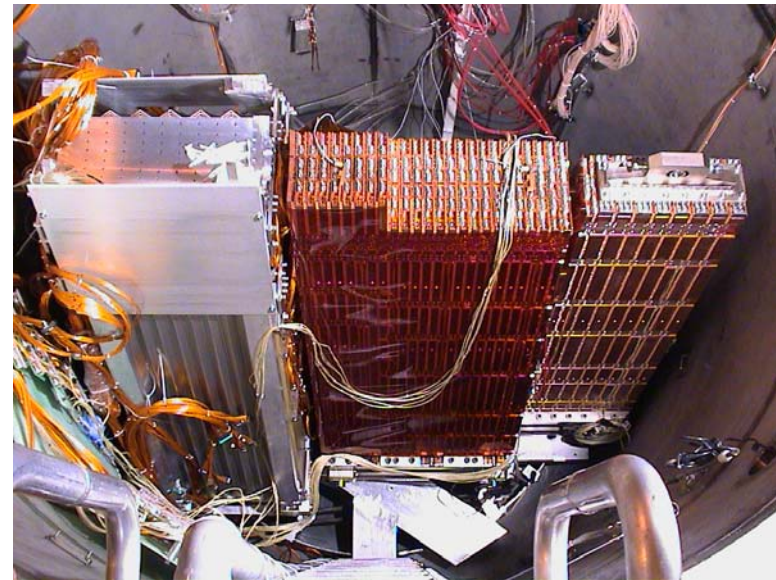
Established contributions (1991-2001)

- Accordion EM R&D (Lefebvre, White, Robertson)
- HEC mechanical design (Hodges, Chief Engineer)
- HEC assembly and installation tooling (Langstaff)
- HEC prototype design and construction (Birney, Fincke, Lefebvre)
- HEC beam tests
 - software (1996-2001, Lefebvre et al.)
 - data analysis (O'Neil, Fortin, Dobbs)

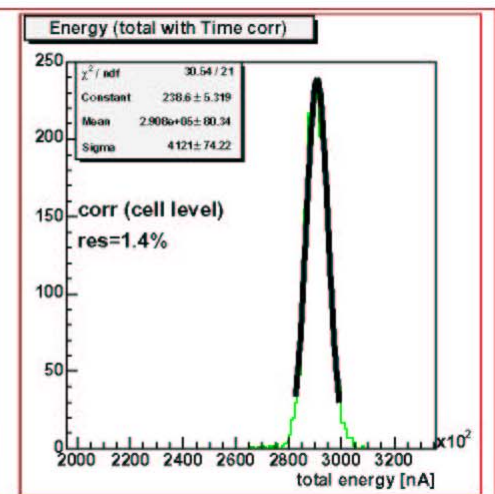
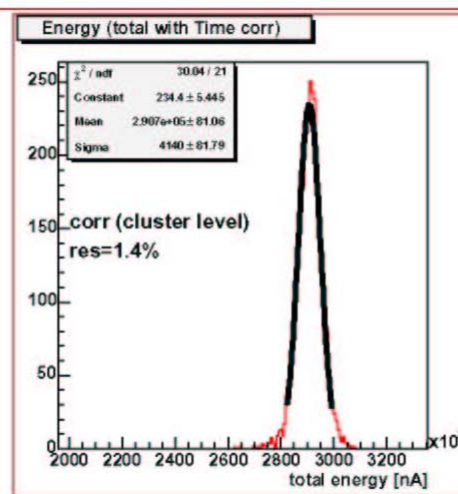
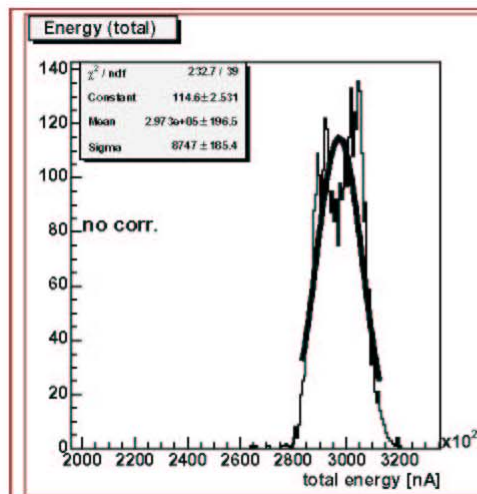
LAr Calorimetry: 2002 Combined Beam Test

HEC+EMEC combined test

- Large data analysis effort
 - detail timing corrections
 - pulse shape analysis and digital filtering weight calculation
 - EM and hadronic shower studies
 - Fincke, Hughes, Ince, Kanaya, Keeler, Lefebvre, McPherson



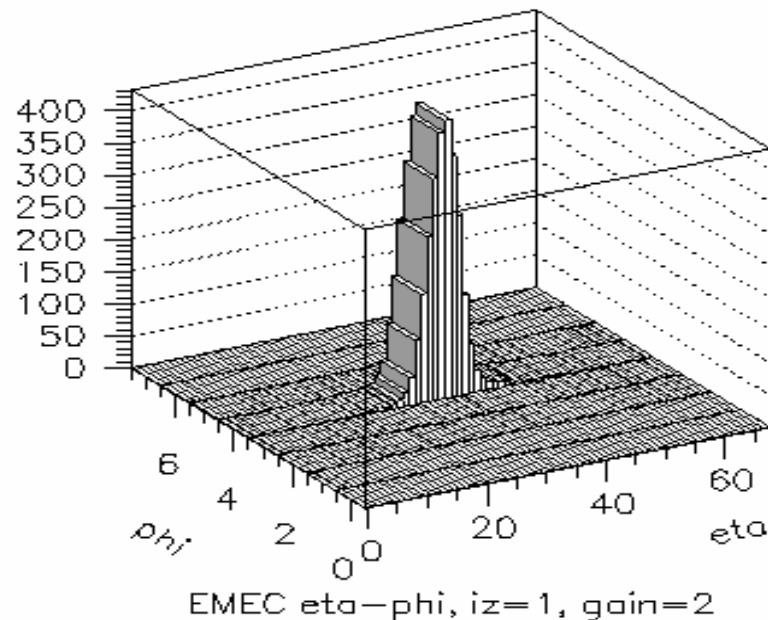
timing corrections on 119GeV e+ shower energy reconstruction (Kanaya)



LAr Calorimetry: 2002 Combined Beam Test

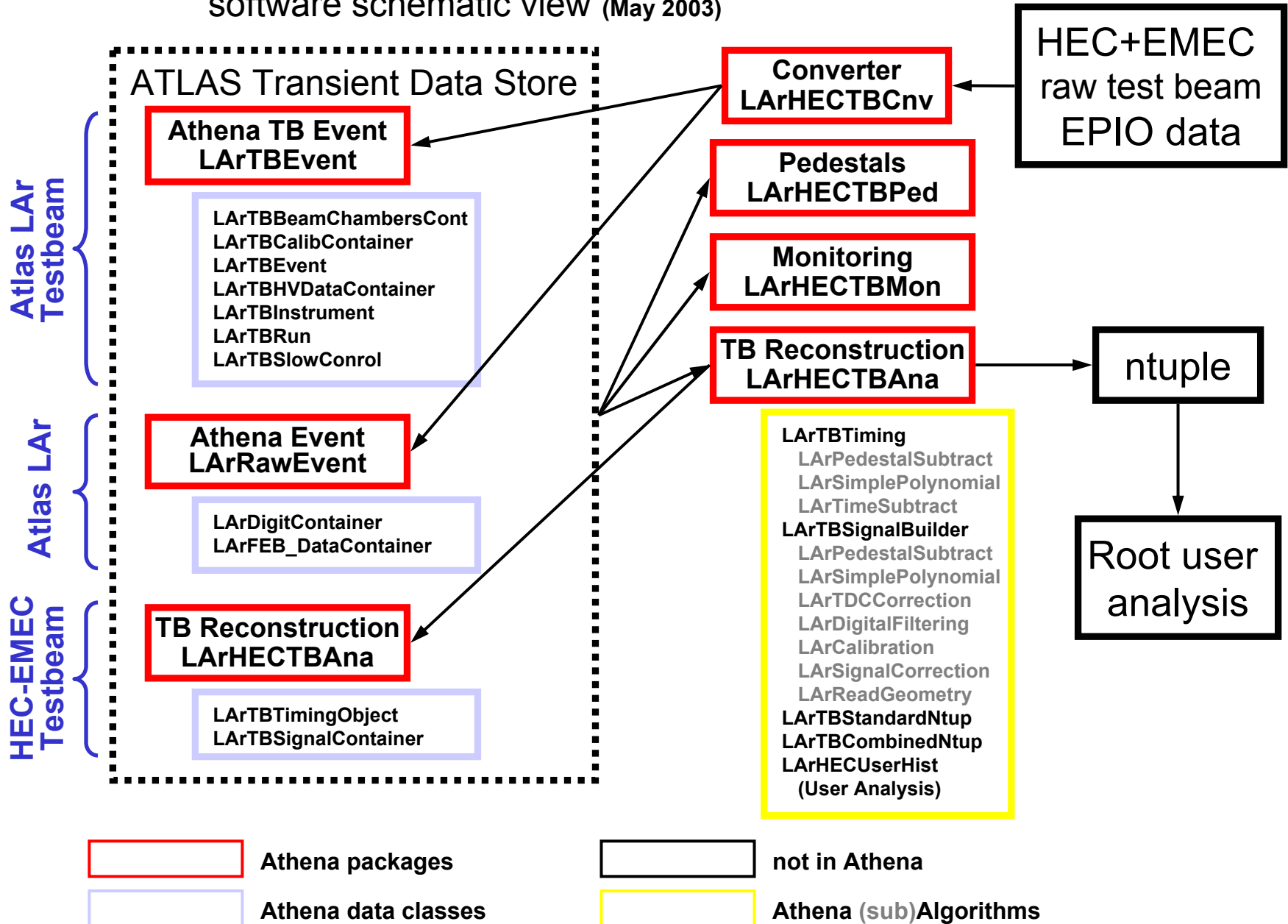
- First use of ATLAS Athena software framework in LAr calorimeter beam test
 - Kanaya, Lefebvre, McPherson
 - provided tutorials and help to the community to switch from Fortran to C++ OO and the ATLAS Athena software framework
 - bold use of Athena framework for pseudo-online monitoring

- online plot from August 2002 HEC-EMEC data showing an $\eta - \phi$ lego plot of the energy deposited in the EMEC first layer for 40 GeV electrons



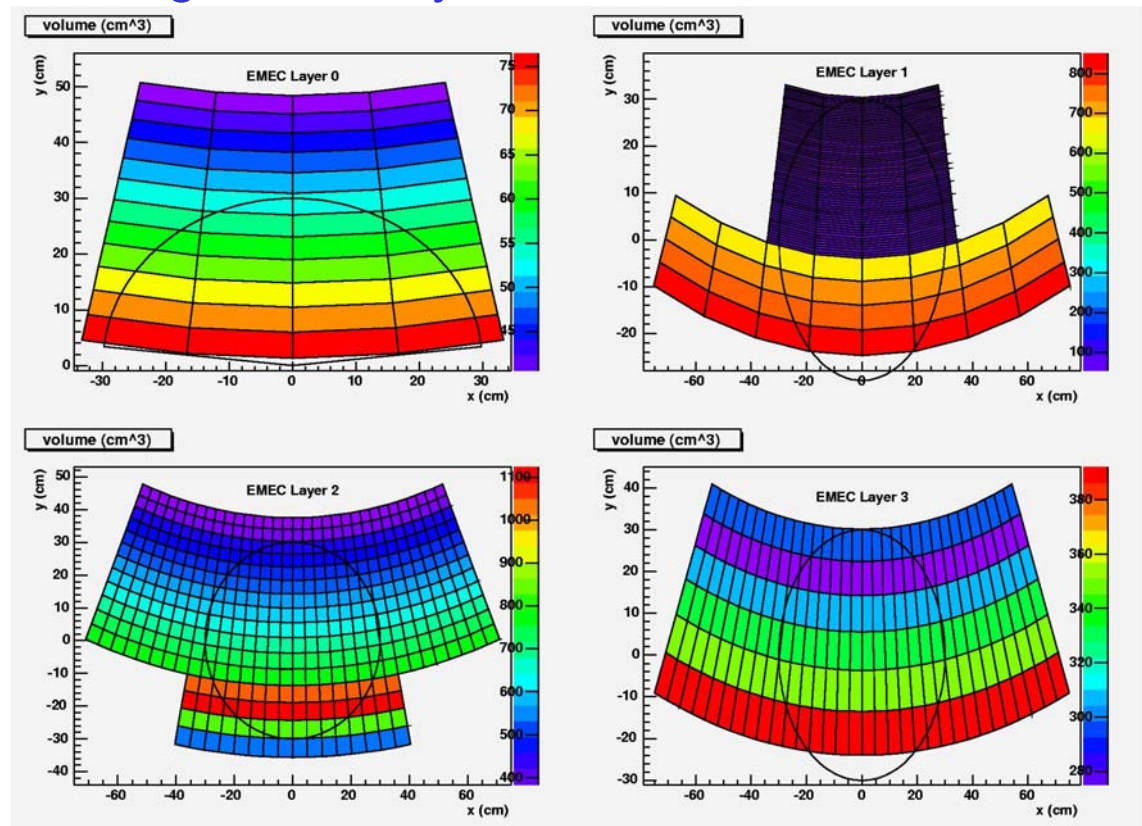
LAr Calorimetry: 2002 Combined Beam Test

software schematic view (May 2003)



LAr Calorimetry: 2002 Combined Beam Tests

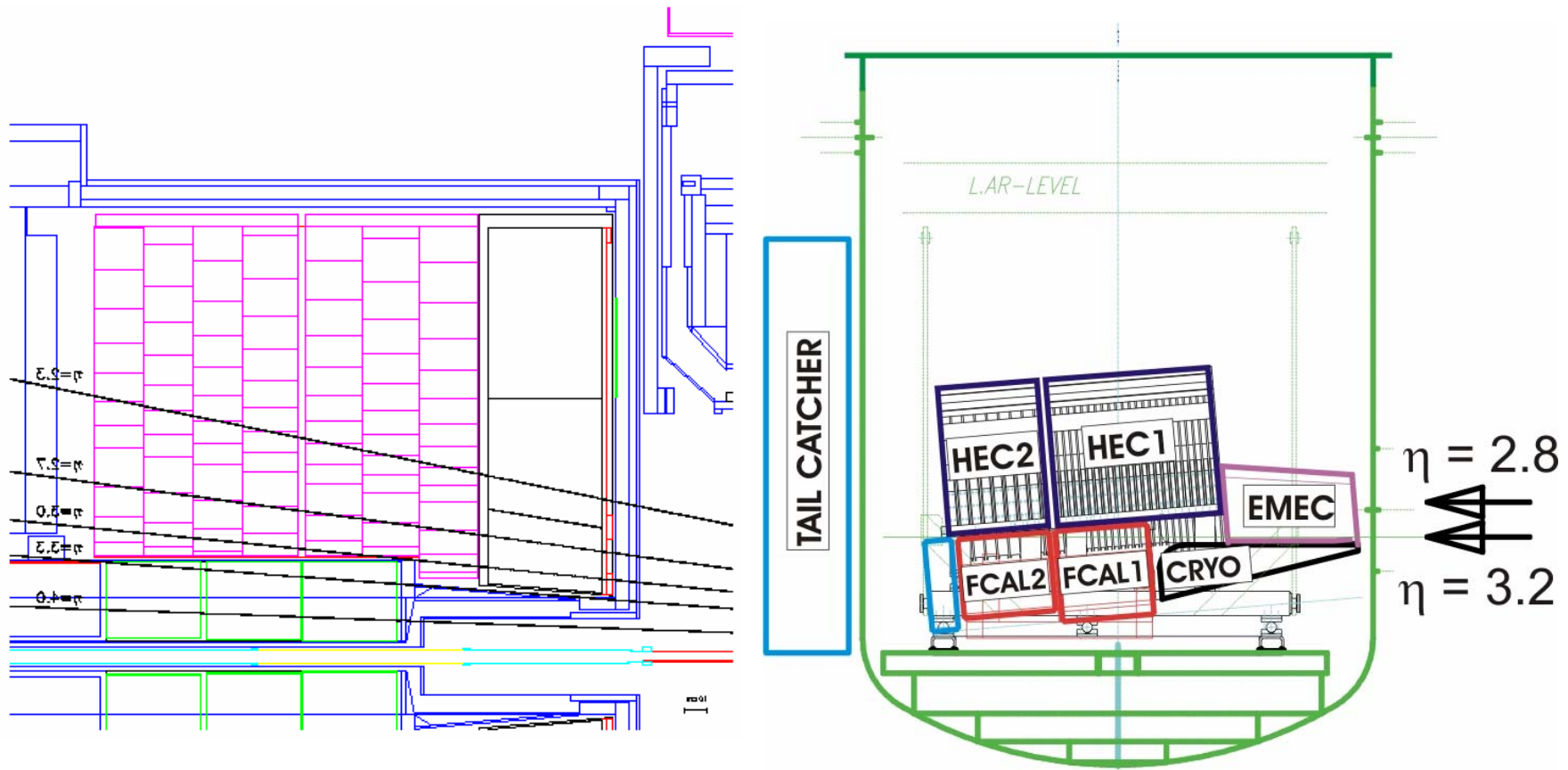
- Development of in-house OO framework software analysis tool (TBRootAna)
 - needed because Athena not yet ready to play this role
 - extremely useful for sharing data analysis effort



- sample graphics showing the EMEC channels volumes

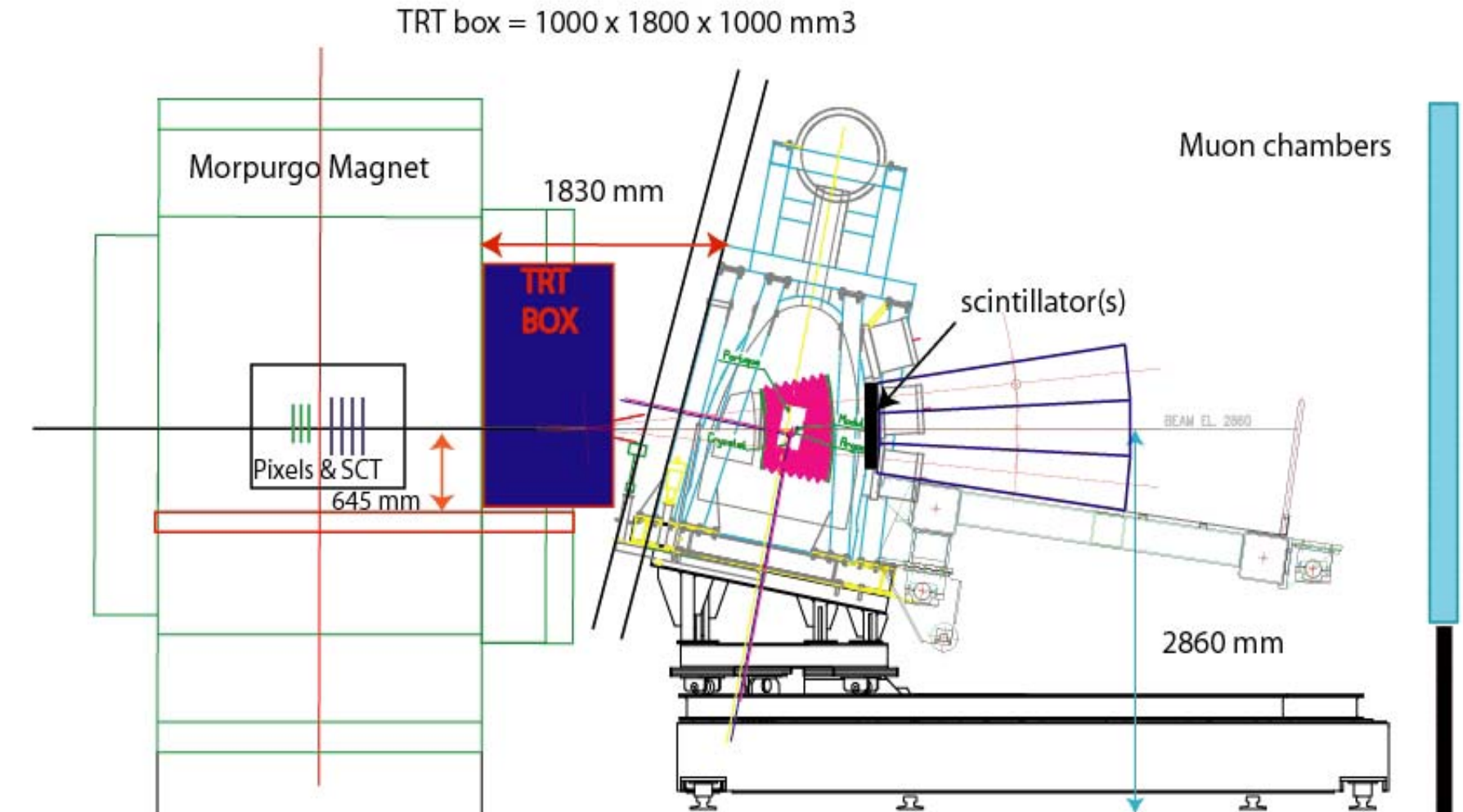
LAr Calorimetry: 2004 Combined Beam Tests

- H6 beam line: EMEC+HEC+FCAL beam test setup
 - complete system integration tests in preparation for ATLAS commissioning
 - calorimeter combined performance test for initial calibration



LAr Calorimetry: 2004 Combined Beam Tests

- H8 beam line: ID+Calo+Muon beam test setup



LAr Calorimetry: Software Development

- Use of full ATLAS offline software for beam test analysis
- Pioneered by Victoria (Kanaya, Lefebvre, McPherson)
- Being used as test bench for ALL offline calorimeter code development
 - signal reconstruction in the presence of noise
 - EM+Hadronic calibration
 - databases
 - geometry issues
 -
- This effort now drives the LAr software development
- Overall LAr beam test software coordinated by Victoria (McPherson)

LAr Calorimetry: Detector Control System

- LAr DCS

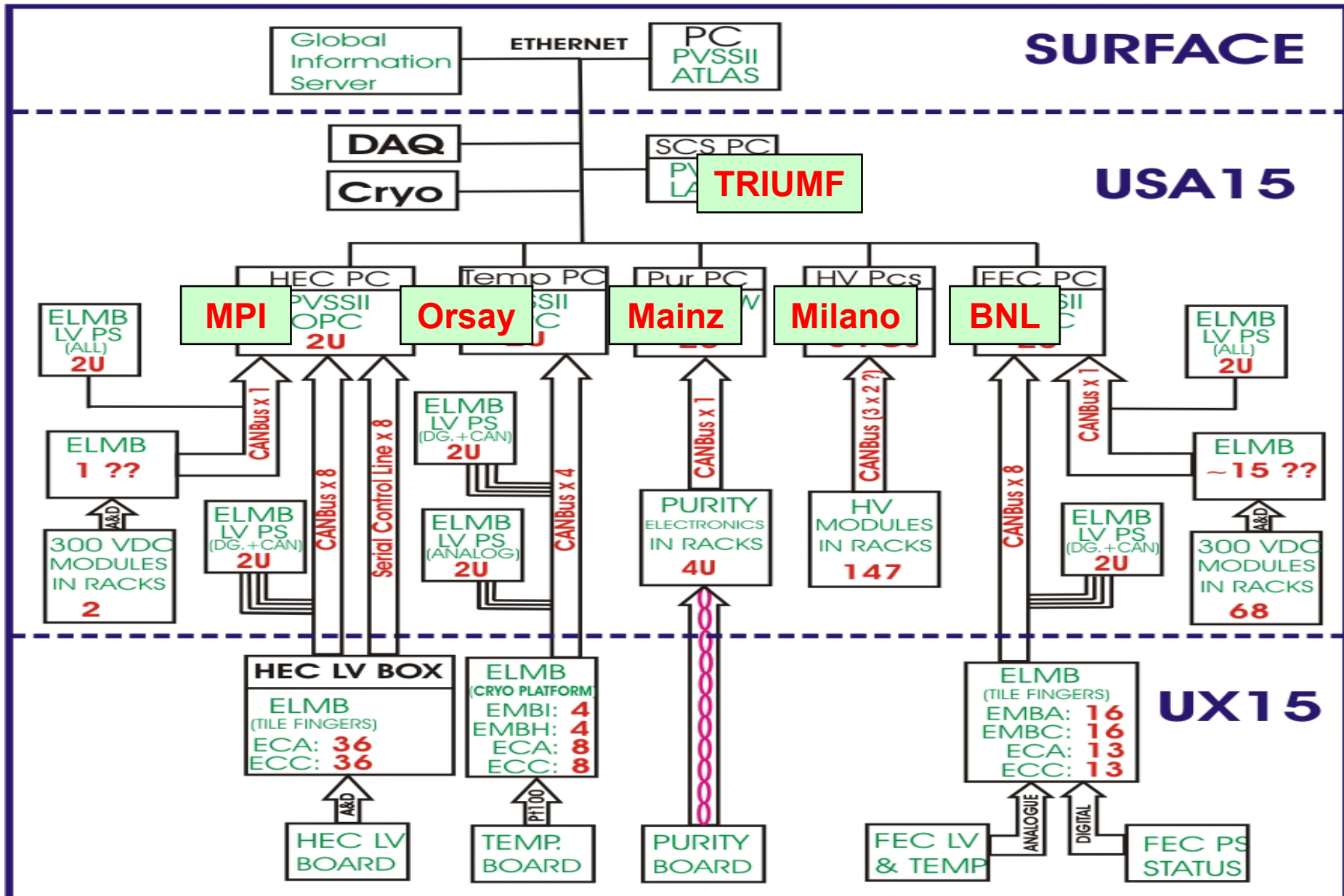
- HEC LV system MPI
- LAr module temperature monitoring Orsay
- LAr purity monitoring Mainz
- Module HV control system Milano
- Front end crate LV monitoring and control BNL
- System integration TRIUMF

- Overall Coordination: McPherson Victoria

- Timescales

- Integration tests: 2004-05
- Combined testbeams: 2004
- ATLAS installation in the pit:
 - need complete DCS available before installation start in autumn 2004
 - needed continuously during installation and testing until 2006

LAr Calorimetry: Detector Control System

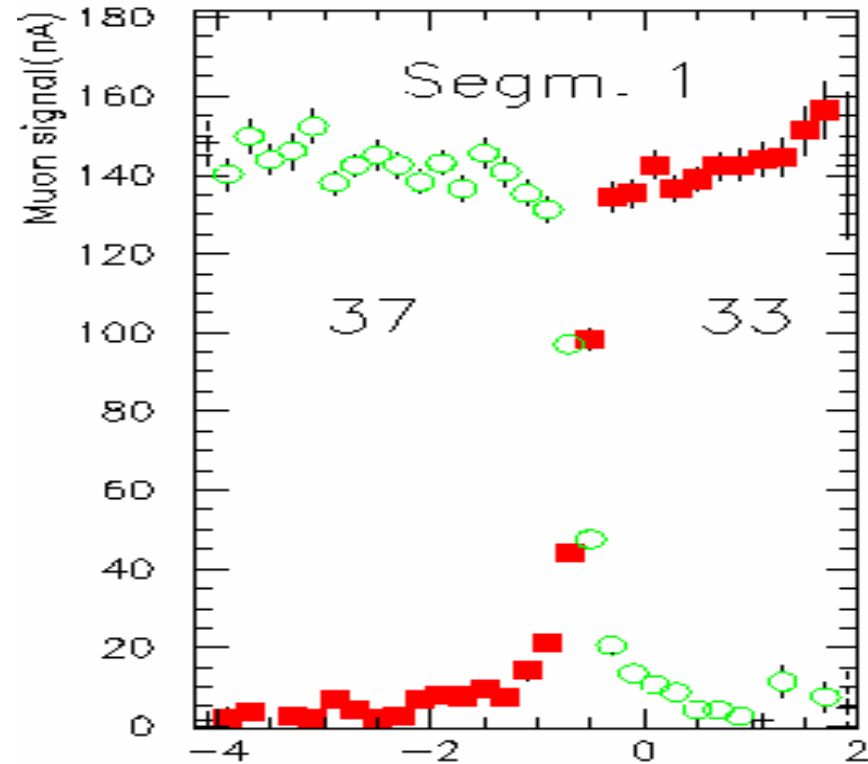
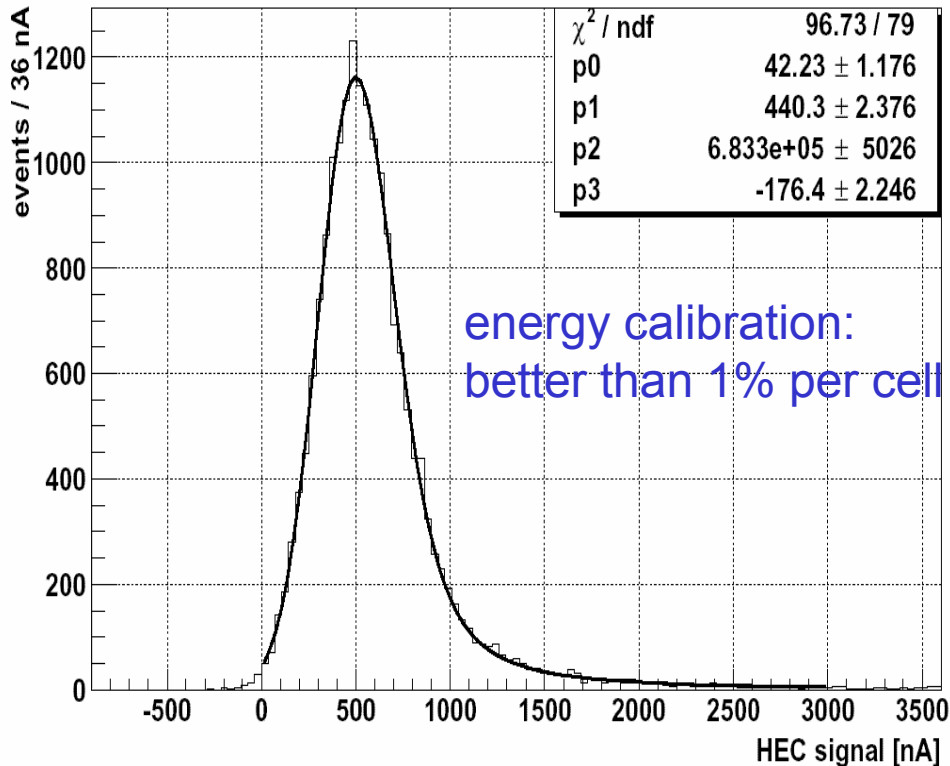


LAr Calorimetry: Commissioning Studies

HEC commissioning with beam halo muons (McPherson)

- Use halo rates from MC and ~1 month of single beam running (3 to 4 months are scheduled in mid 2007)
- Compare with beam test muon response

alignment from measurement of pad boundaries: better than 1mm



Computing: ATLAS Data Challenges

Goals:

- Simulation, reconstruction and data analysis on a large scale
 - assess I/O performances and identify bottlenecks ...
- Data management
 - Evaluate persistency technology and learn about distributed analysis
- Exploit CERN and outside resources
- Utilize GRID middleware
- Provide MC samples for trigger and physics studies

Schedule:

- | | | | |
|----------------|---------------|---|---------------|
| ▪ DC 1 Phase 1 | April 2002 | – | August 2002 |
| ▪ DC 1 Phase 2 | December 2002 | – | February 2003 |
| ▪ DC 2 | Summer 2004 | – | Spring 2004 |

Computing: ATLAS Data Challenges

- Canadian participation in DC 1 Phase 1
 - B.Caron (Alberta), M.Wielers (TRIUMF) and R.McPherson (Victoria)
 - Utilize computational resources in Alberta and CERN (from Alberta)
 - Contribution to the overall CPU time:
 - CERN 29%, US 14%, Canada 11%, Italy 11%, France 10%
- DC 2: June 2004 ?
 - Full use of Geant4; POOL; LCG applications
 - Pile-up and digitization in Athena
 - Deployment of the complete Event Data Model and the Detector Description
 - Simulation of full ATLAS and 2004 combined testbeam
 - Test the calibration and alignment procedures
 - Use widely the GRID middleware and tools
 - Large scale physics analysis
 - Computing model studies (document end 2004)
 - Run as much as possible of the production on LCG-1

Computing: ATLAS Data Challenges

- **September 03: Release7**
- **Mid-November 03: pre-production release**
- **February 27th 04: Release 8 (production)**
- **April 1st 04:**
- **June 1st 04: “DC2”**
- **July 15th**



- **Put in place, understand & validate:**
 - Geant4; POOL; LCG applications
 - Event Data Model
 - Digitization; pile-up; byte-stream
 - **Conversion of DC1 data to POOL;** large scale persistency tests and reconstruction
- **Testing and validation**
 - Run test-production
- **Start final validation**
- **Start simulation; Pile-up & digitization**
- **Event mixing**
- **Transfer data to CERN**
- **Intensive Reconstruction on “Tier0”**
- **Distribution of ESD & AOD**
- **Calibration; alignment**
- **Start Physics analysis**
- **Reprocessing**

Future Plans

Short term

- Close the books on the endcap signal feedthrough project
 - storage of components, keep some readiness for repairs until 2007
- Continue data analysis of 2002 combined beam test
 - M.Sc. of Hughes and Ince
- Prepare for 2004 combined beam tests
 - software coordination
- Overall LAr software development
 - effort driven by the beam test effort
- LAr calorimeters commissioning and integration
 - LAr DCS, calibration, ...
- Data challenges and GRID
 - connect GRID tools with ATLAS software
- Recruit graduate students

Medium term

- Increase participation in physics working groups