The ATLAS Hadronic Endcap Calorimeter (HEC)

CALOR - Pasadena - March 2002

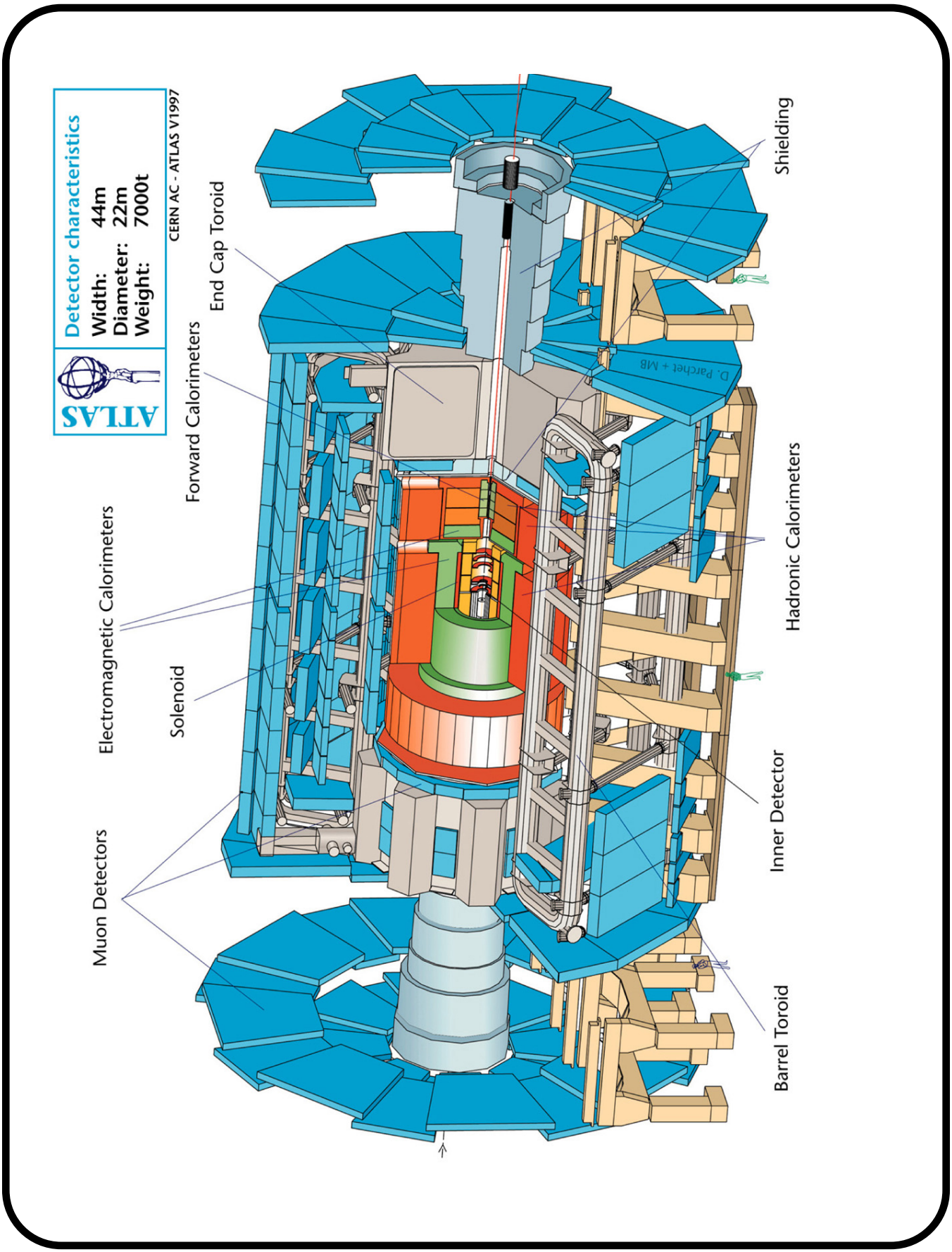
Margret Fincke-Keeler
University of Victoria, Canada
on behalf of

The ATLAS HEC Collaboration

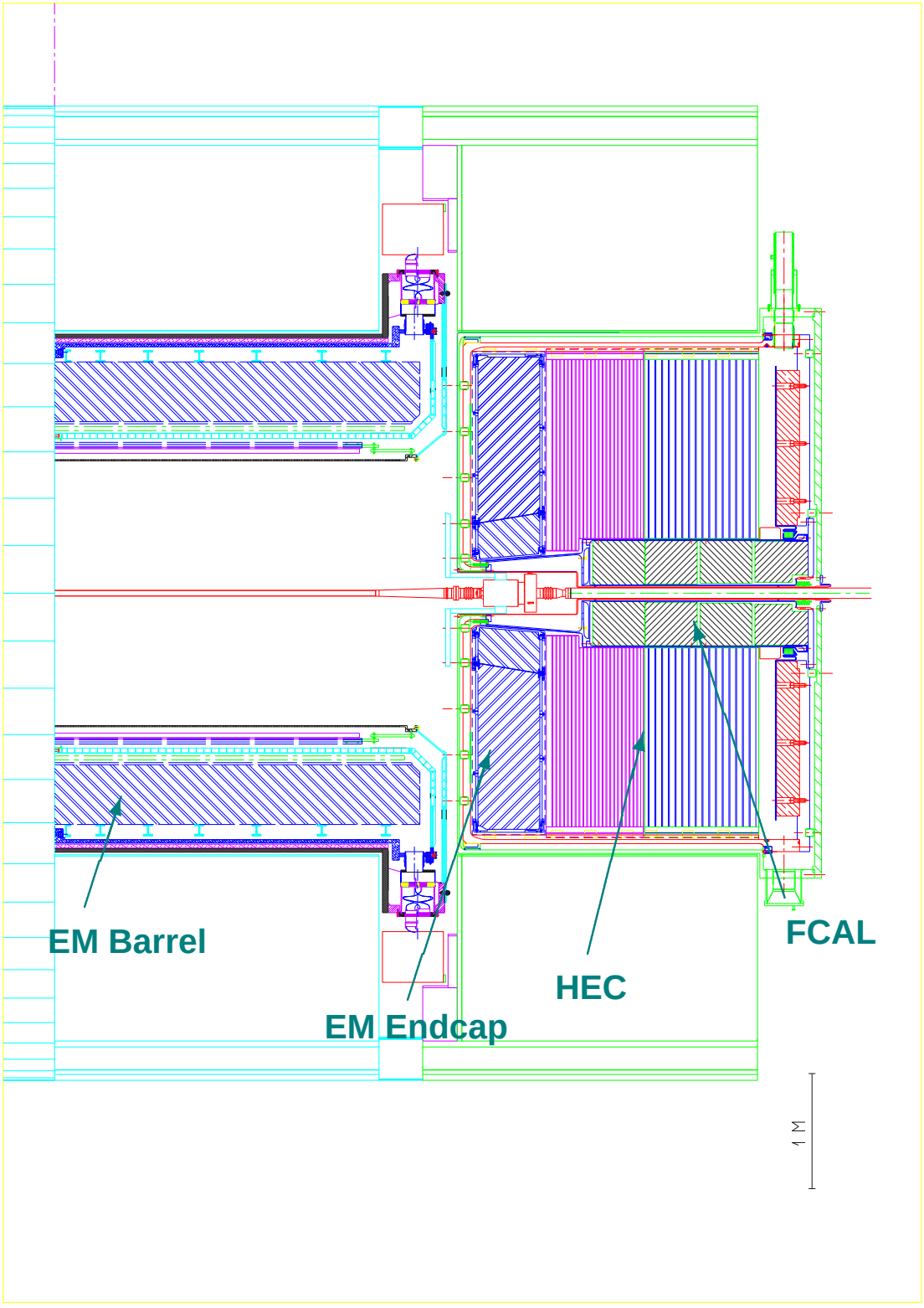
- Canada (Alberta, Montreal, TRIUMF Vancouver, Victoria)
- China (IHEP Beijing, USTC Hefei, Nanjing, Shangdong)
- Germany (Mainz, MPI Munich, Wuppertal)
- Russia (JINR Dubna, LPI Moscow, IHEP Protvino)
- Slovakia (Kosice)

Overview

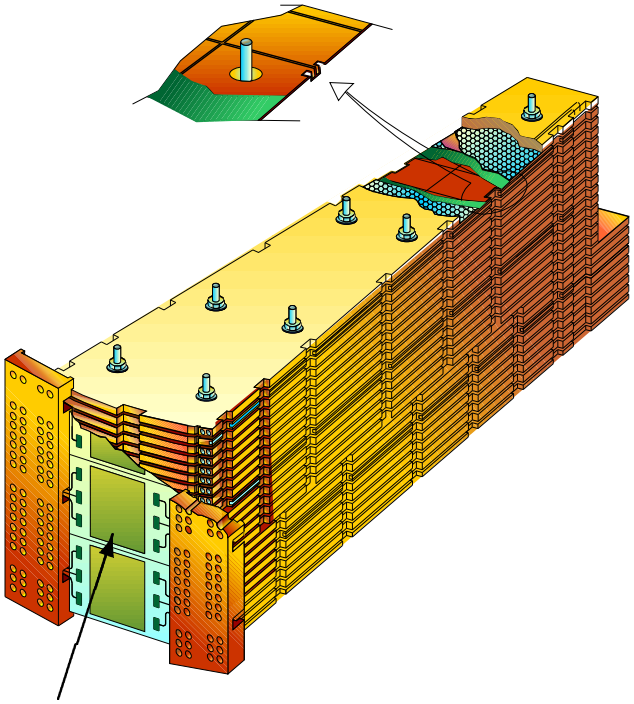
- The Atlas Hadronic Endcap Calorimeter
- Production Status Report
- Beam Tests:
  - Resolution for e and π
  - Uniformity and Linearity
  - Response to μ
  - v_{dr} and I_{init} as a Function of HV
  - t_{dr} and I_{init} as a Function of Temperature
- Conclusions


ATLAS
Detector characteristics
Width: 44m
Diameter: 22m
Weight: 7000t
CERN AC - ATLAS V1997
D. Parchet + MB
Shielding
End Cap Toroid
Forward Calorimeters
Electromagnetic Calorimeters
Solenoid
Muon Detectors
Hadronic Calorimeters
Inner Detector
Barrel Toroid

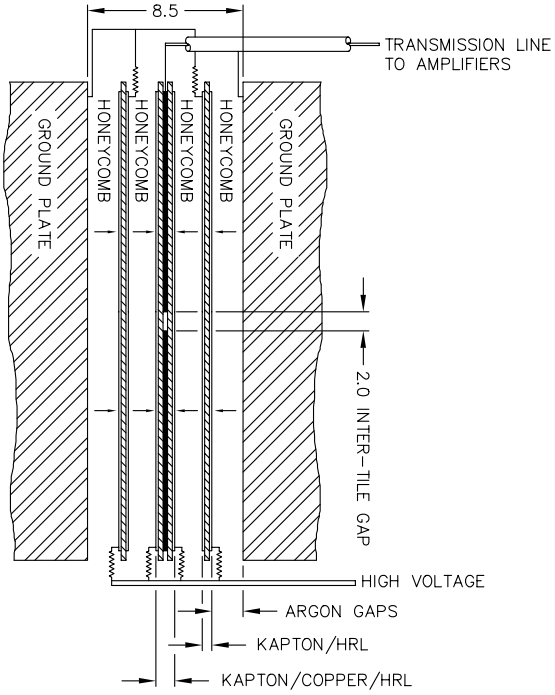
Atlas Liquid Argon Calorimeters



HEC Module



cold preamplifiers



operating HV: 1800V

Hadronic Endcap Calorimeter:

Cu/LAr sampling calorimeter

2 wheels ($\approx 10\lambda$) - 32 modules each

Front wheel: 25mm Cu plates (24 gaps)

Rear wheel: 50mm Cu plates (16 gaps)

Each gap: 4 subgaps of 1.85mm

Granularity:

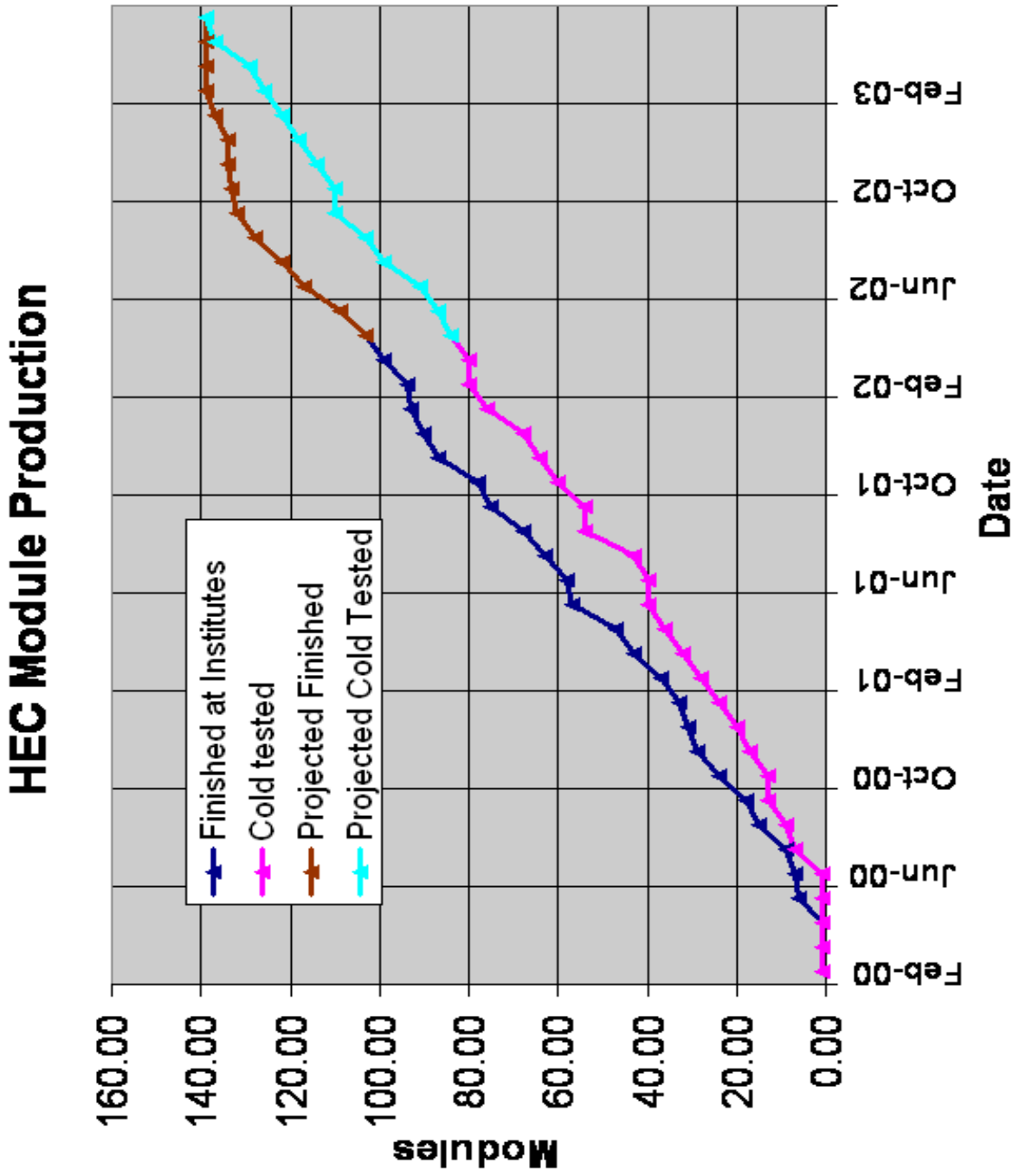
$1.5 < |\eta| < 2.5$: $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$

$2.5 < |\eta| < 3.2$: $\Delta\eta \times \Delta\phi = 0.2 \times 0.2$

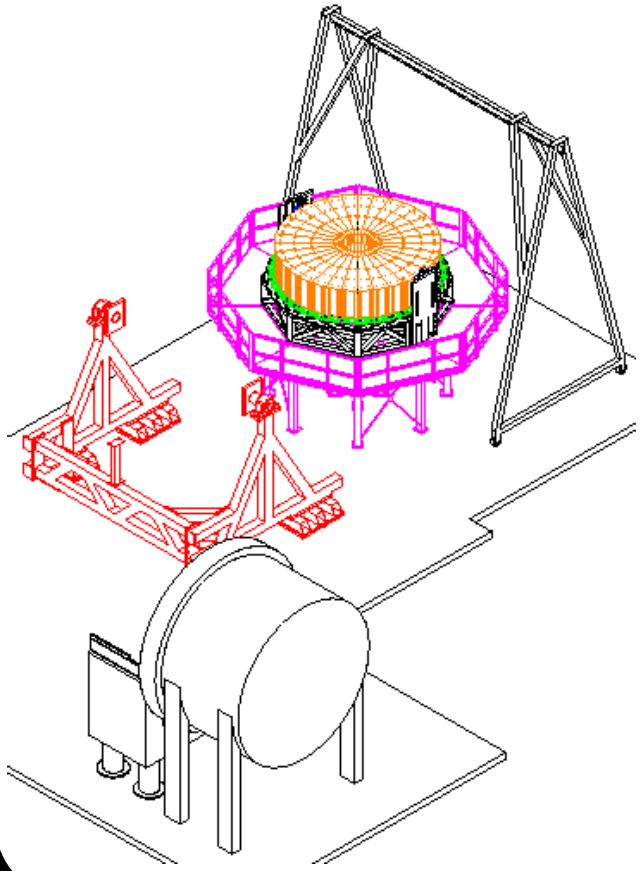
Present Status

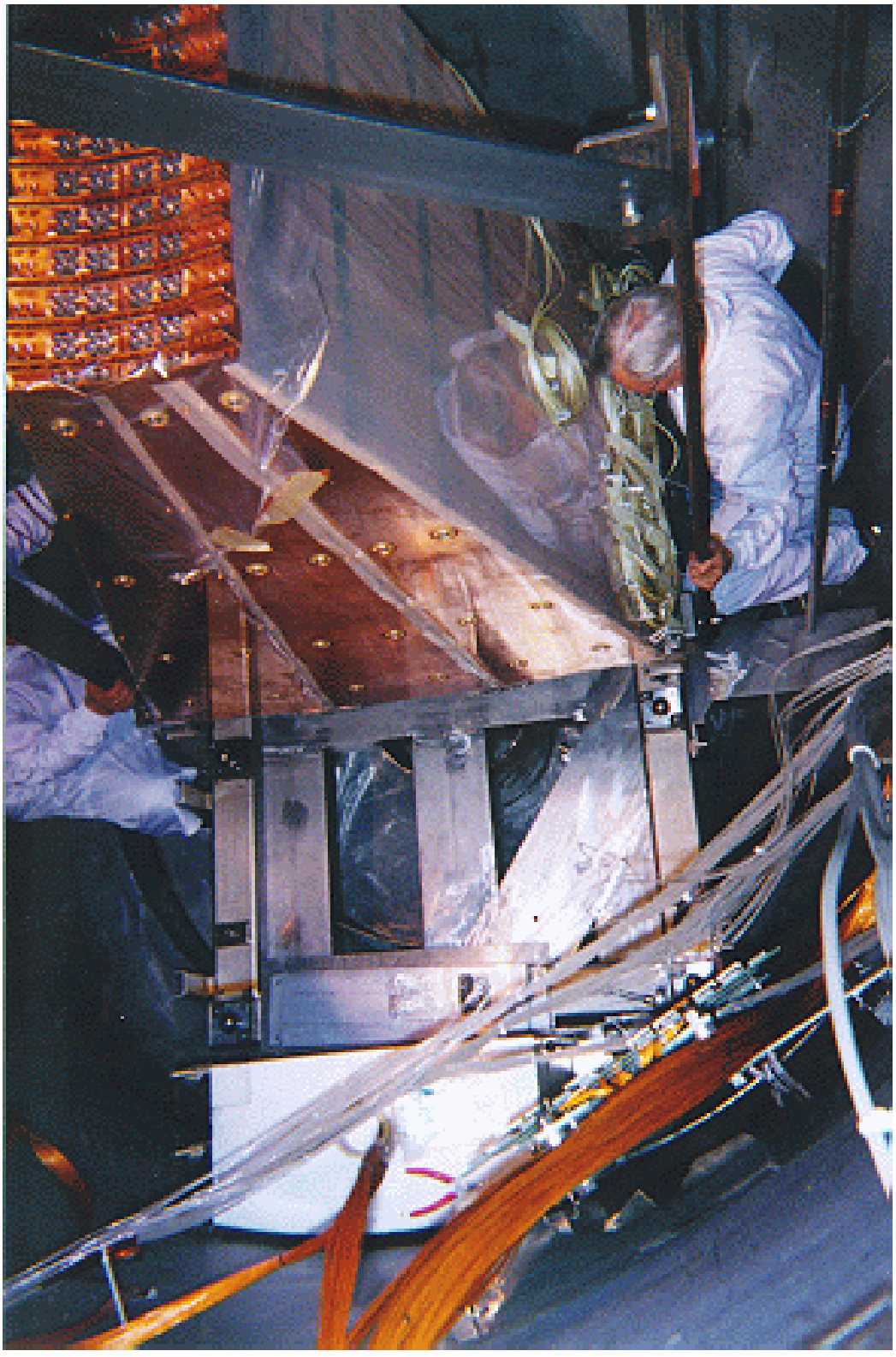
HEC Modules are assembled in Canada, Germany and Russia. All modules are cold tested at CERN and more than 1/8 have been exposed to beam tests.

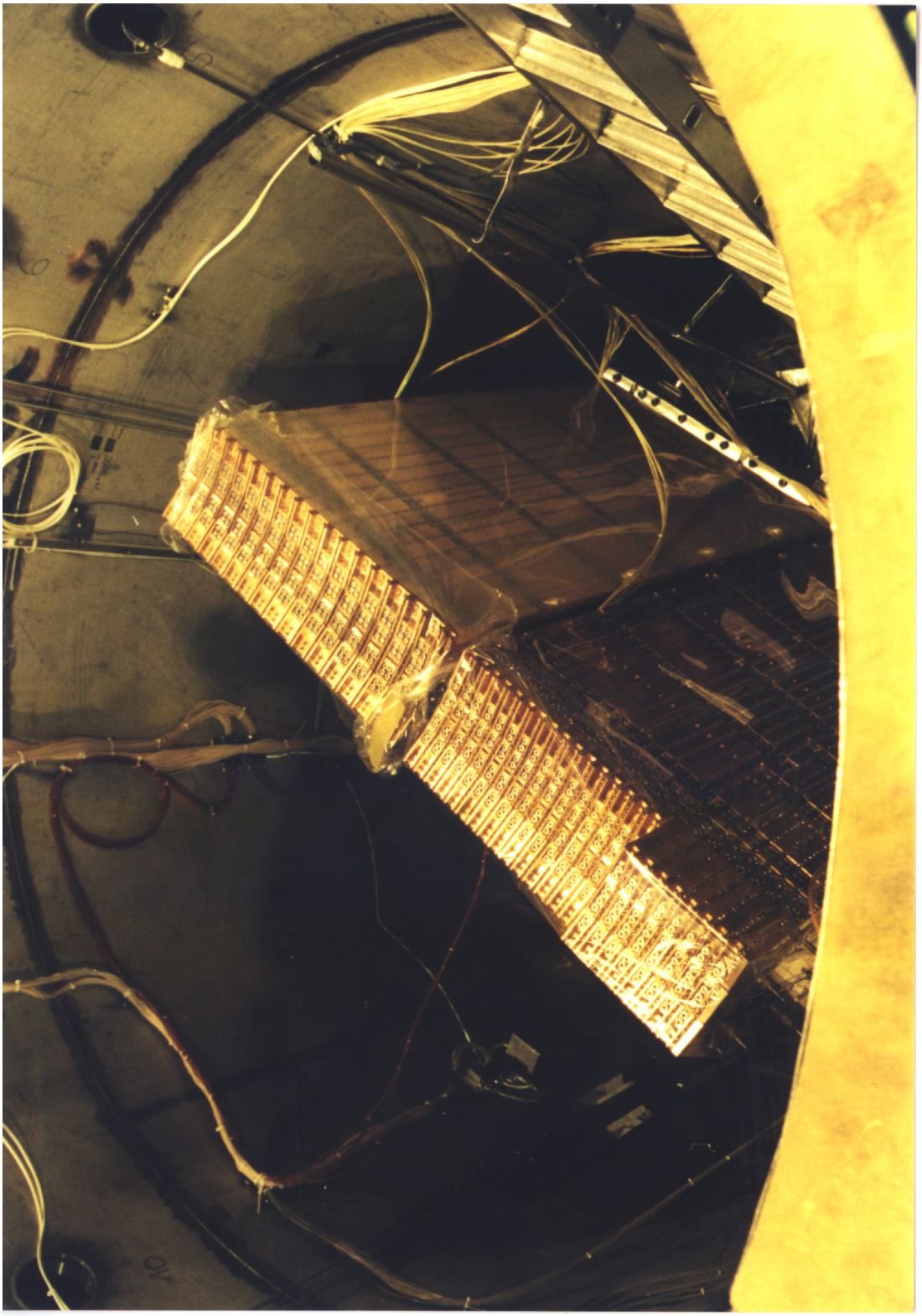
- 77% of all 134 modules have been built world-wide
- 24 modules have been beam tested (beam tests complete now)
- 63% of all modules have been cold tested
- All 32 front wheel modules for the first endcap have been completed and cold tested
- All 32 rear wheel modules for the first endcap have been completed and cold tested


HEC Module Production
Finished at Institutes
Cold tested
Projected Finished
Projected Cold Tested
Modules
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Feb-00
Jun-00
Oct-00
Feb-01
Jun-01
Oct-01
Feb-02
Jun-02
Oct-02
Feb-03
Date

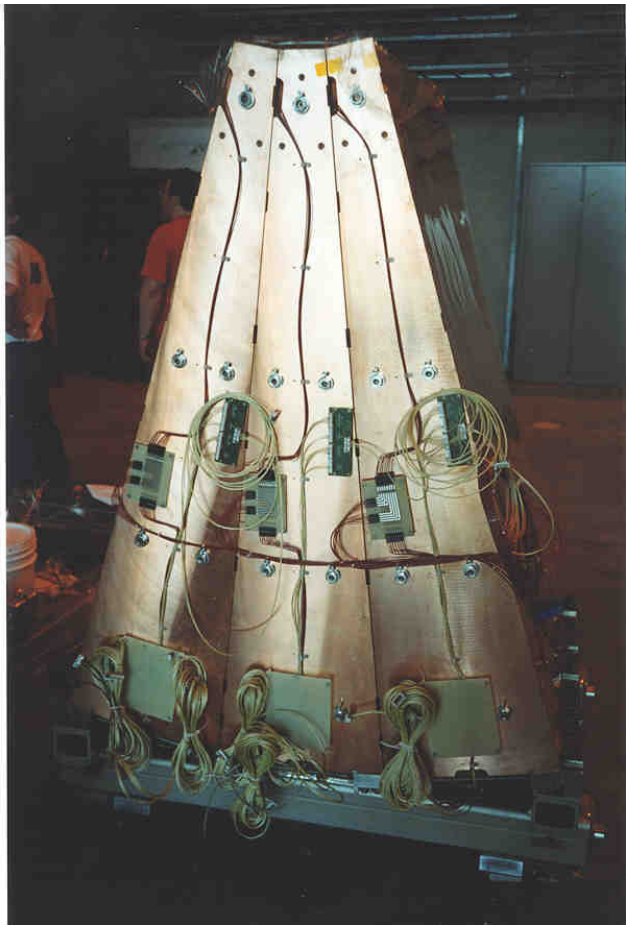
Wheel Rotator

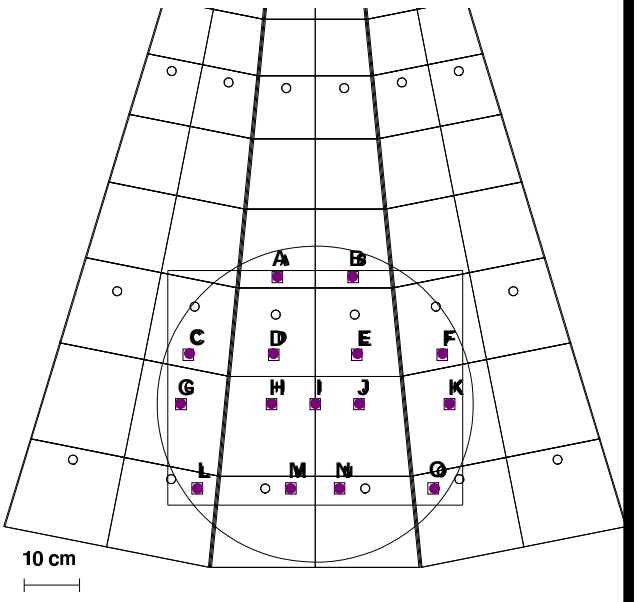






Beam Tests





Testbeam Setup:

3 front modules + 3 rear modules

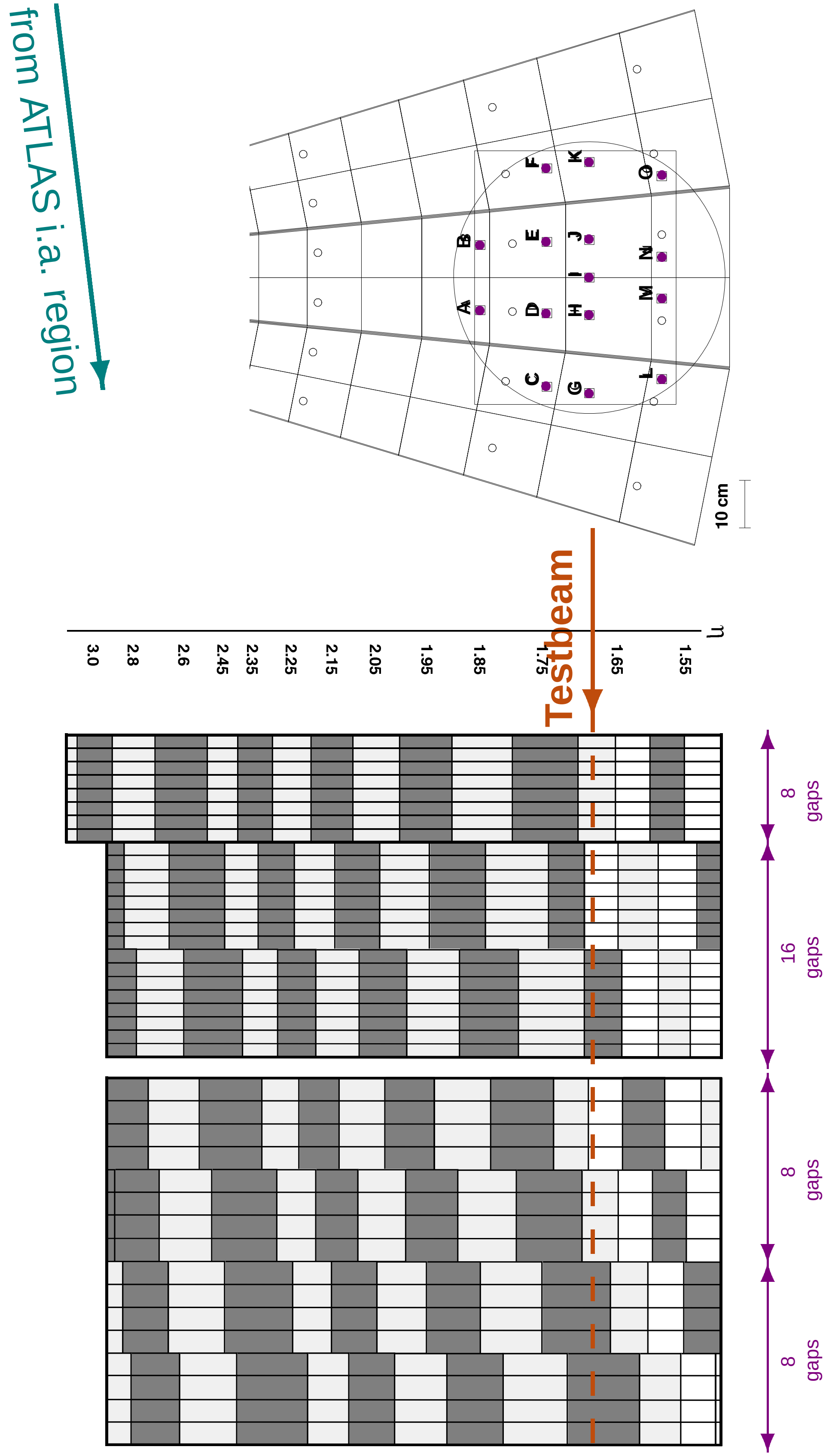
available beam:

e: 6-193 GeV π: 10-200 GeV μ: 120, 150, 180 GeV

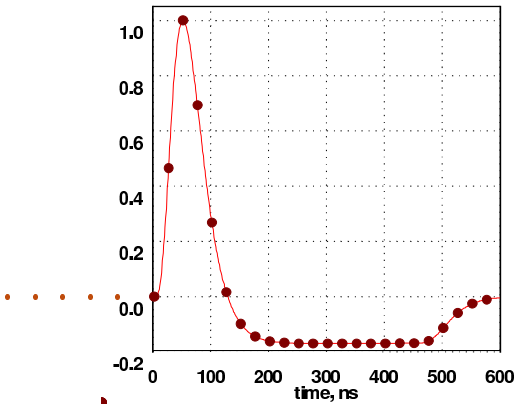
total data taken (1999-2001): 100×10^6 triggers

during 6 beam periods of 2-3 weeks each

position scans as well as 15 well-defined impact points


from ATLAS i.a. region
Testbeam
10 cm
η
3.0
2.8
2.6
2.45
2.35
2.25
2.15
2.05
1.95
1.85
1.65
1.55
8 gaps
16 gaps
8 gaps
8 gaps

For each read-out cell:



Shaped pulses for each event are accumulated in 16(32) time samples separated by 25ns.

Their amplitude is determined with Optimal Filtering over 5 time samples in the region of the signal peak.

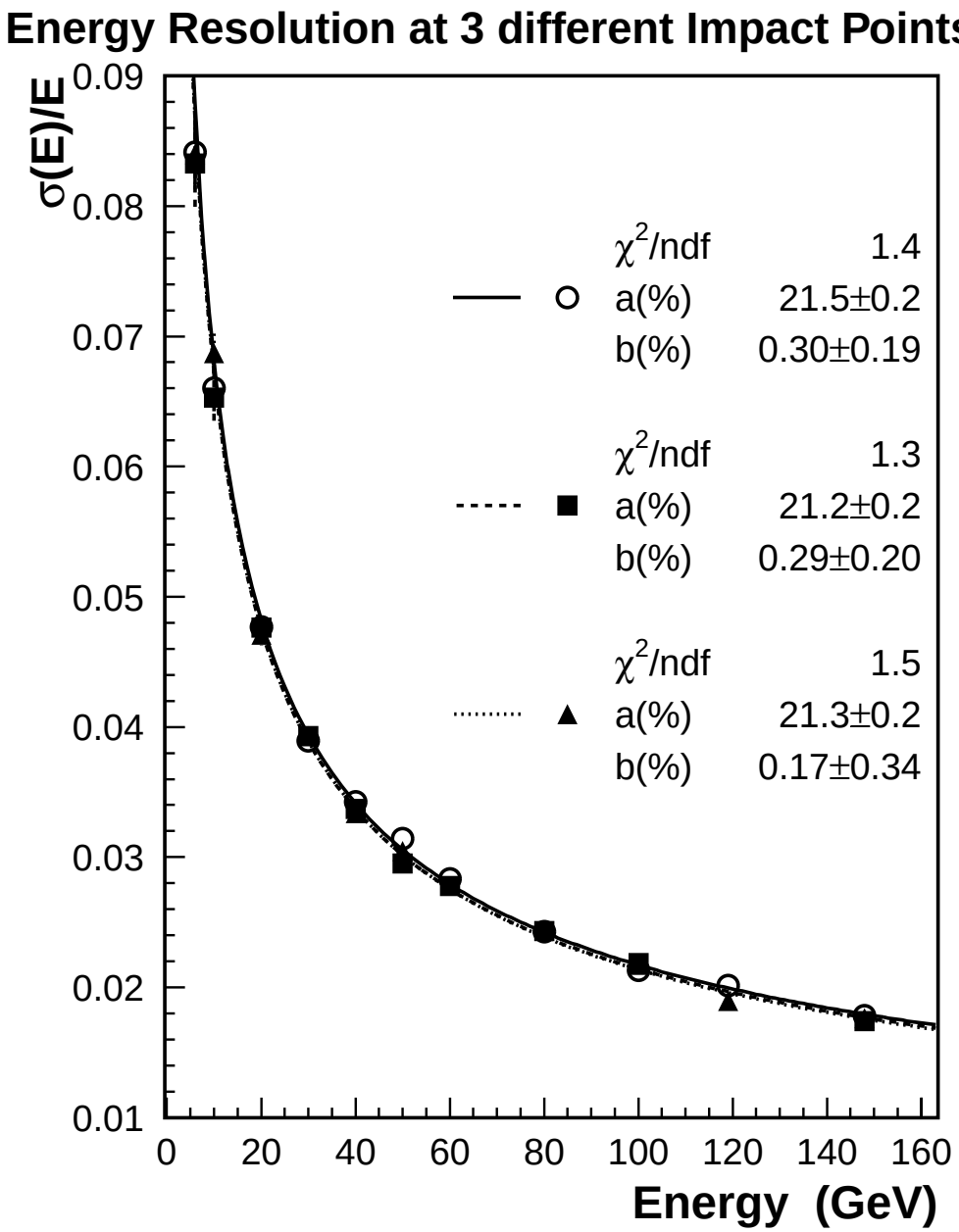
(W.E.Cleland E.G.Stern, NIM A338 (1994) 467)

After subtraction of electronic noise in quadrature, the energy resolution can be parametrized as:

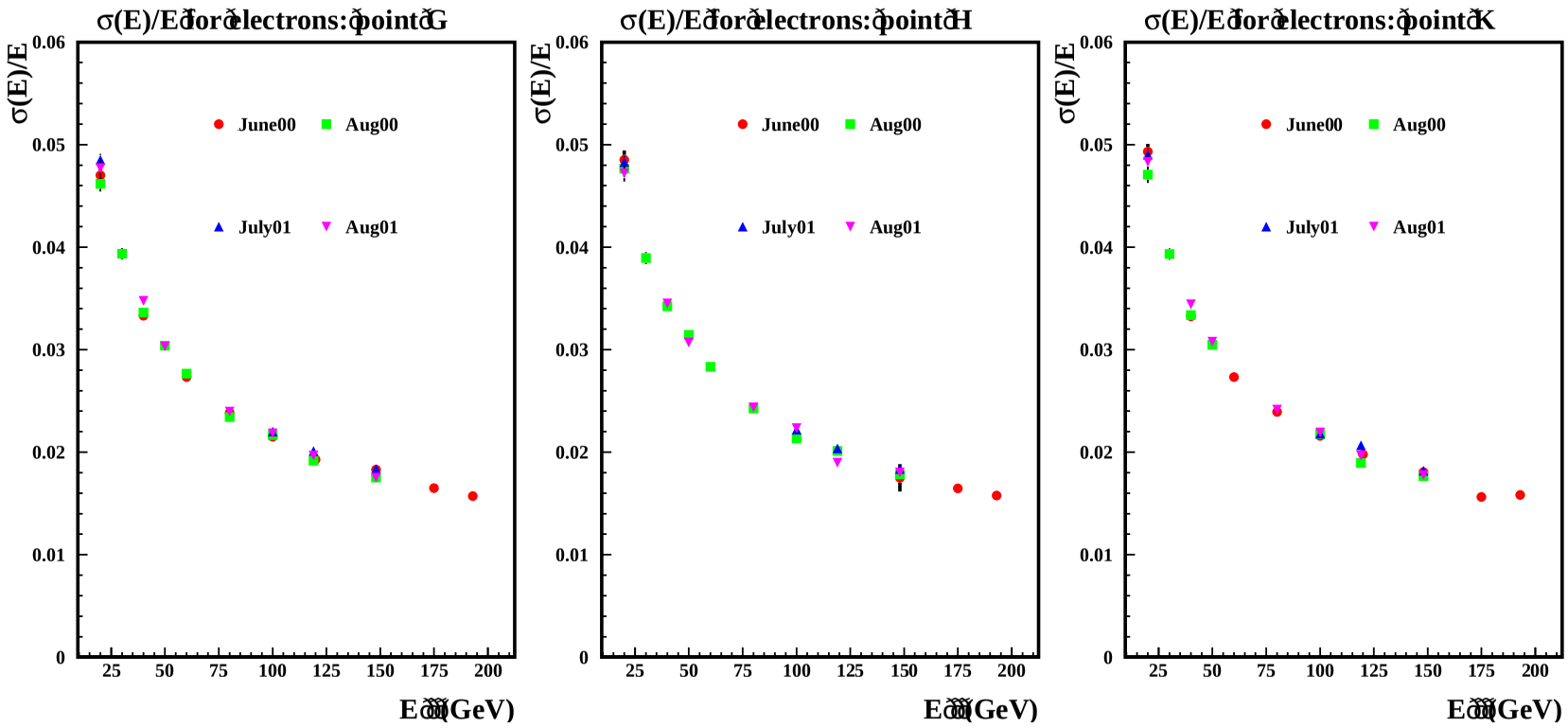
$$\frac{\sigma(E)}{E} = \frac{a}{\sqrt{E}} \oplus b$$

Energy resolution for electrons, averaged over impact points:

$a = (21.4 \pm 0.2)\%\sqrt{GeV}$ $\quad$ $b = (0.3 \pm 0.2)\%$

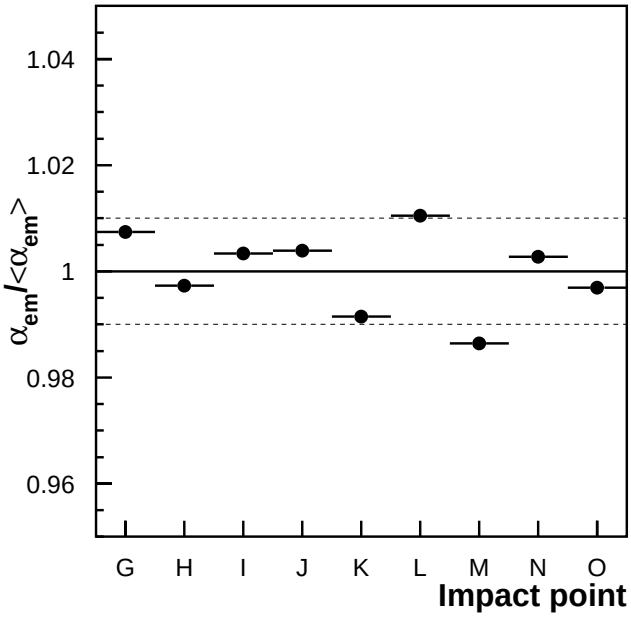


Energy resolution of electrons for different impact points and different beam tests:

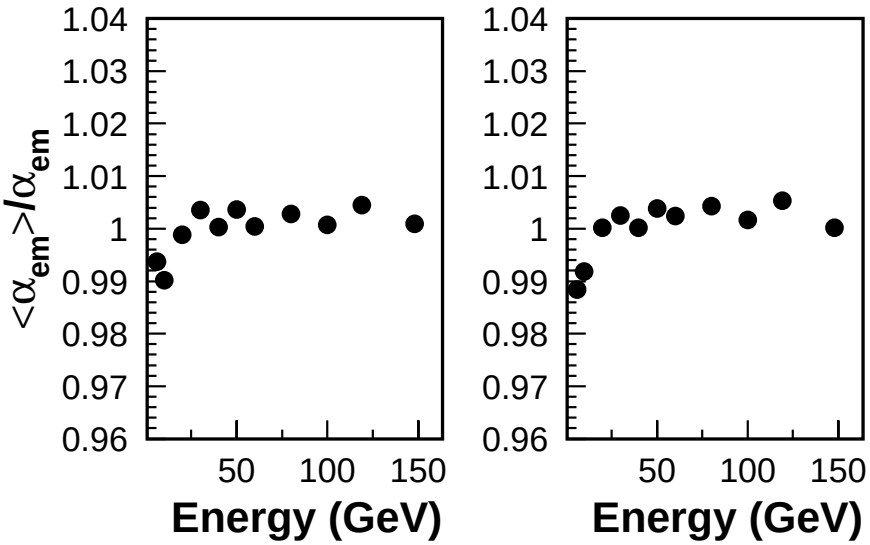


Electron Response

Spatial Uniformity



Linearity



Pions

Average Resolution:

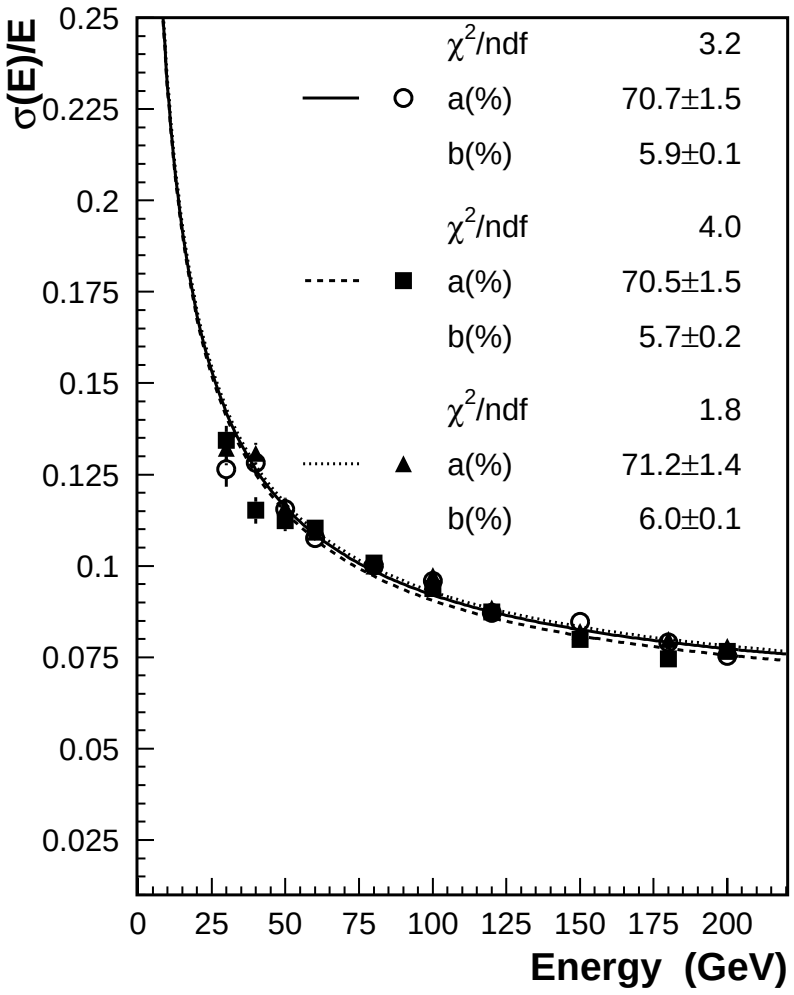
$a = (70.6 \pm 1.5)\%\sqrt{GeV}$

$b = (5.8 \pm 0.2)\%$

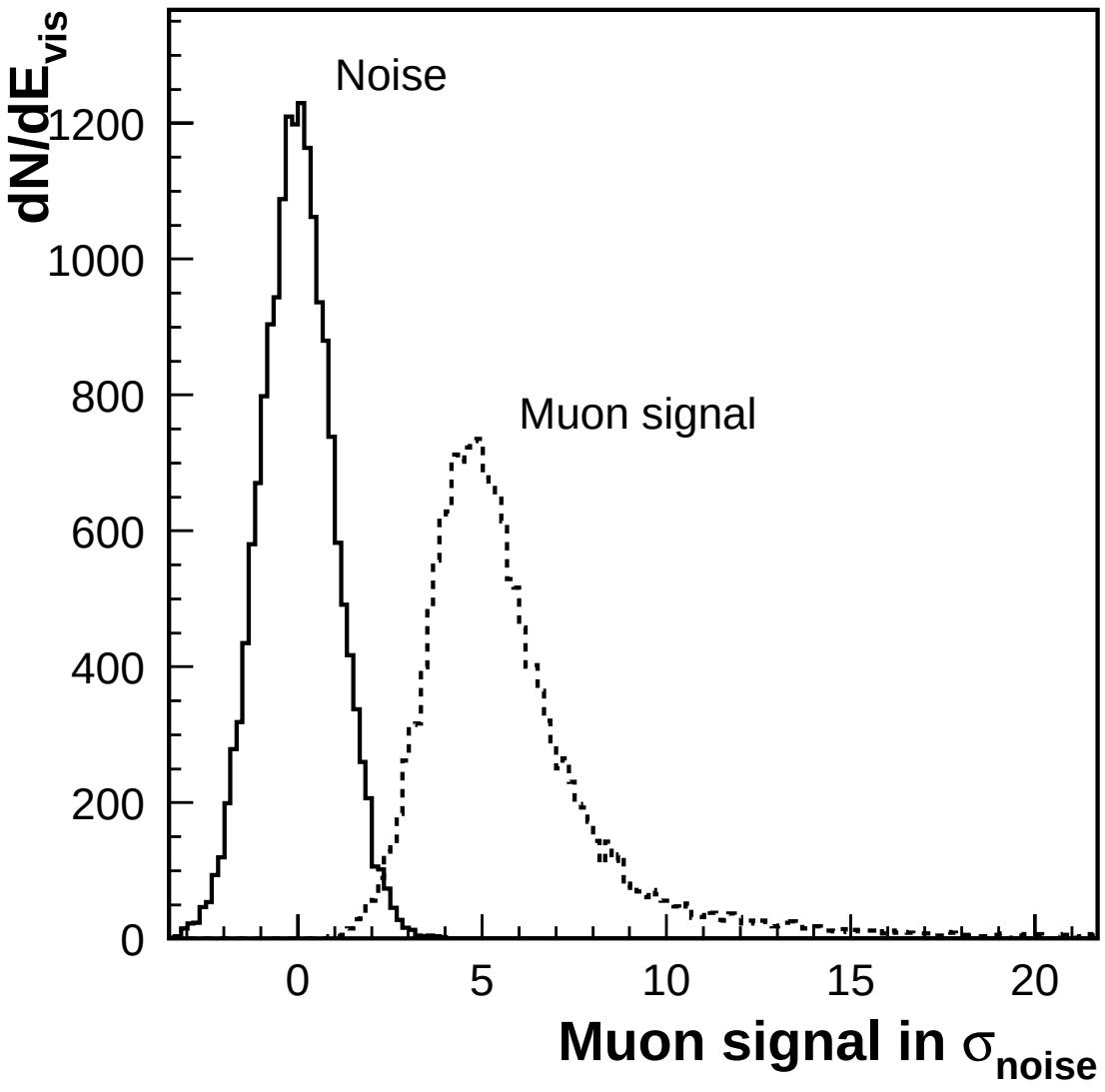
e/h Ratio: $e/h = 1.49 \pm 0.01 \pm 0.10$

(Parametrization by D.Groom, CALOR'97)

Energy Resolution at 3 different Impact Points

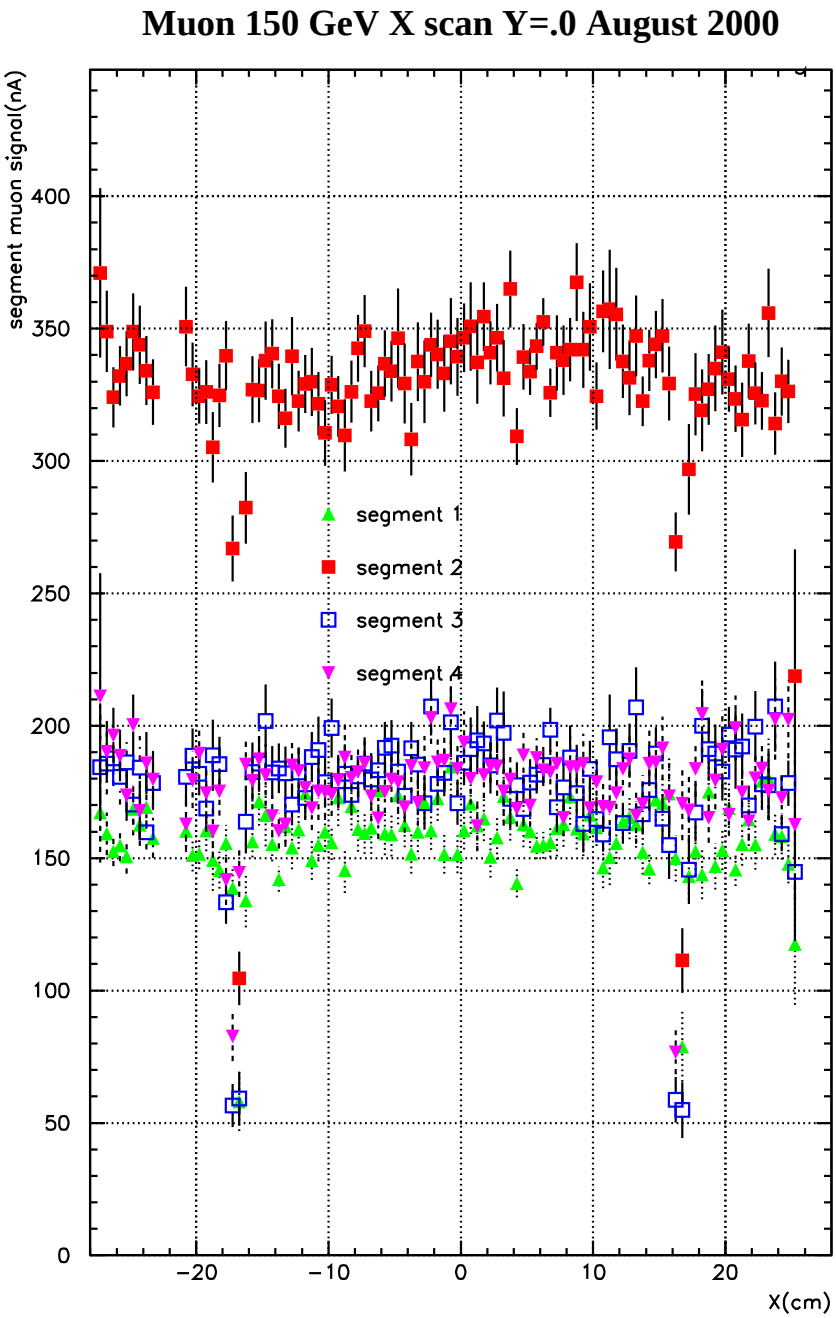


Muon Response



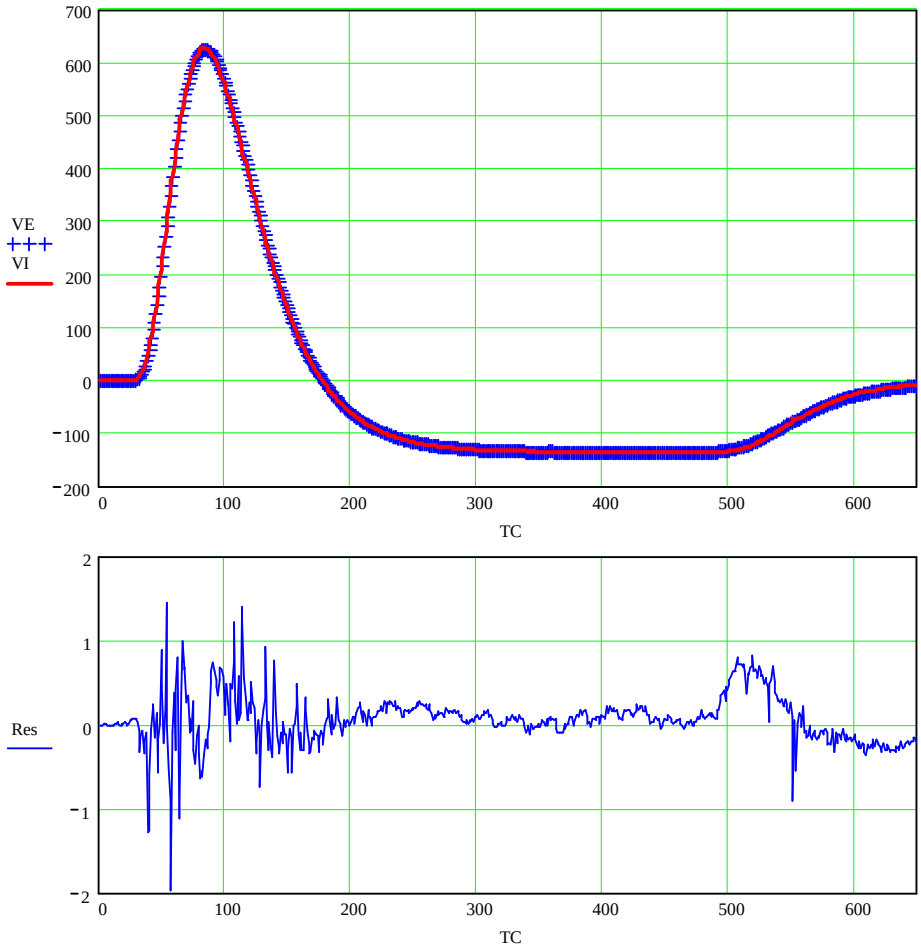
Muons

Response in the 4 Longitudinal Segments:

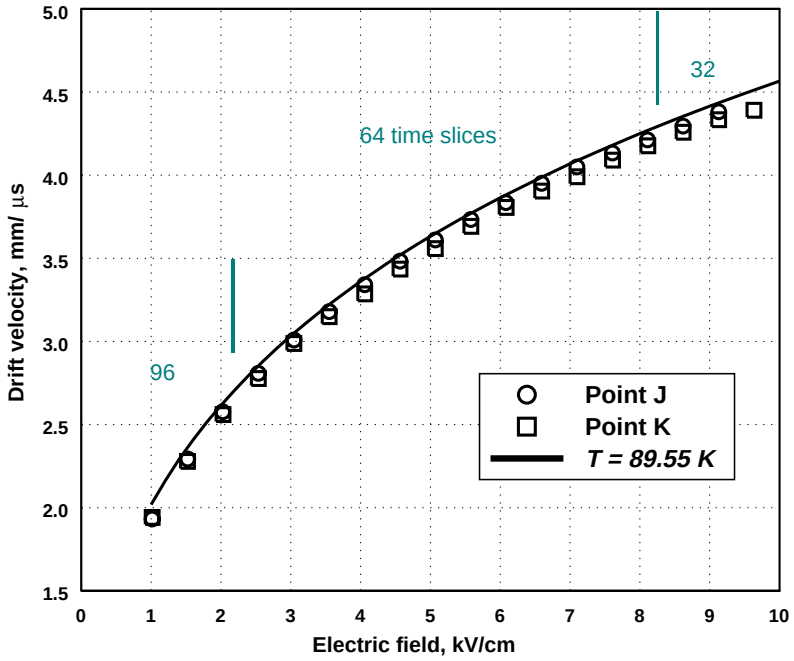


For individual ADC channels:

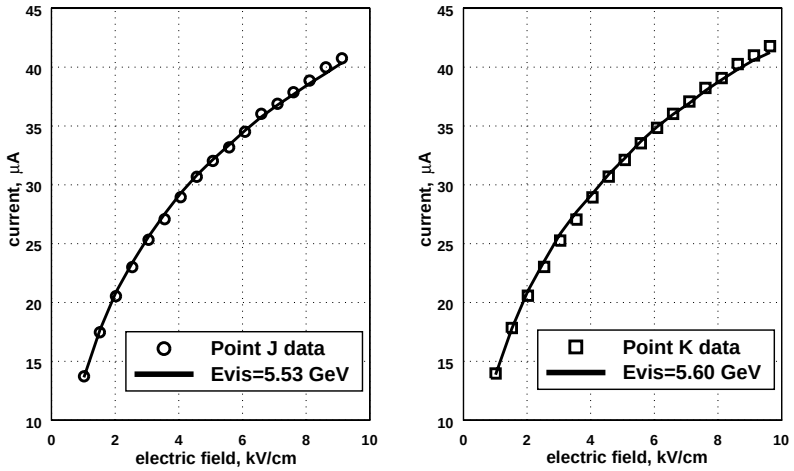
Least squares fit of electronic model prediction to data gives initial ionization current and drift time.



HV Dependence of Drift Velocity and Ionization Current

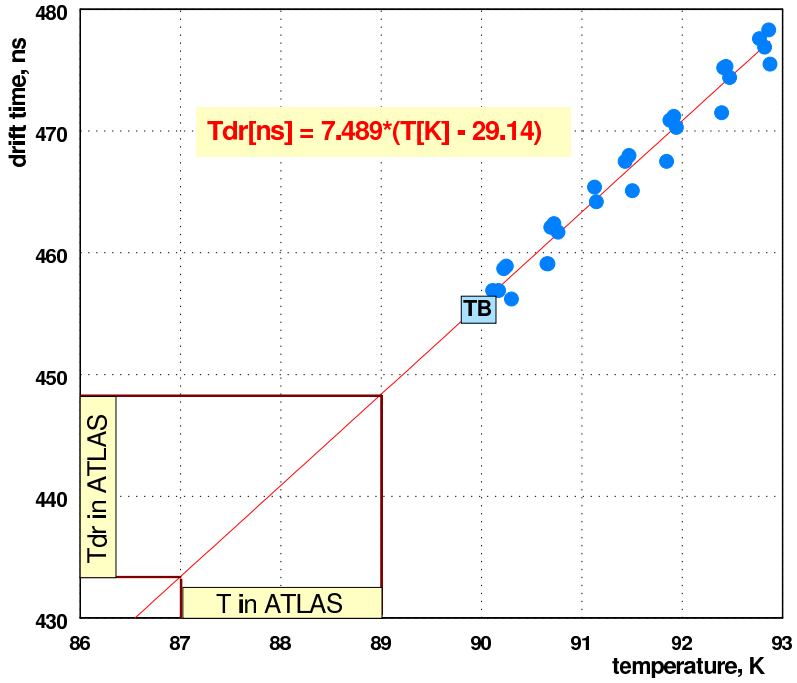


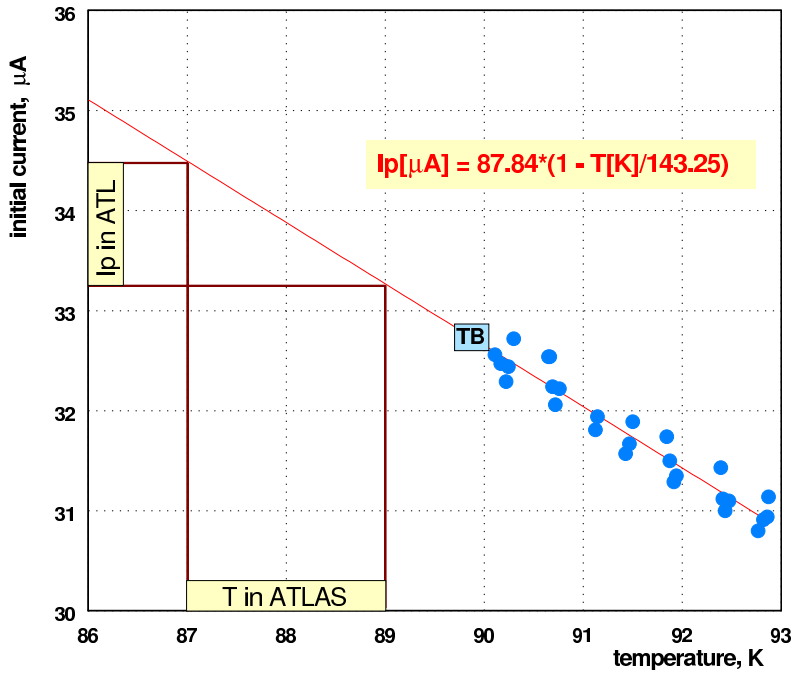
(Solid line: Prediction - W. Walkowiak, NIM A449 (2000) 288)



(Solid line: Fit to Thomas-Imel Model)

Temperature Dependence of t_{dr} and I_{init}





Conclusions:

- The construction of the Atlas Hadronic Endcap Calorimeter is nearing completion.
- Tooling for the final assembly and installation of the calorimeter is in place.
- Beam tests on production modules have been completed and verified the performance of the calorimeter.