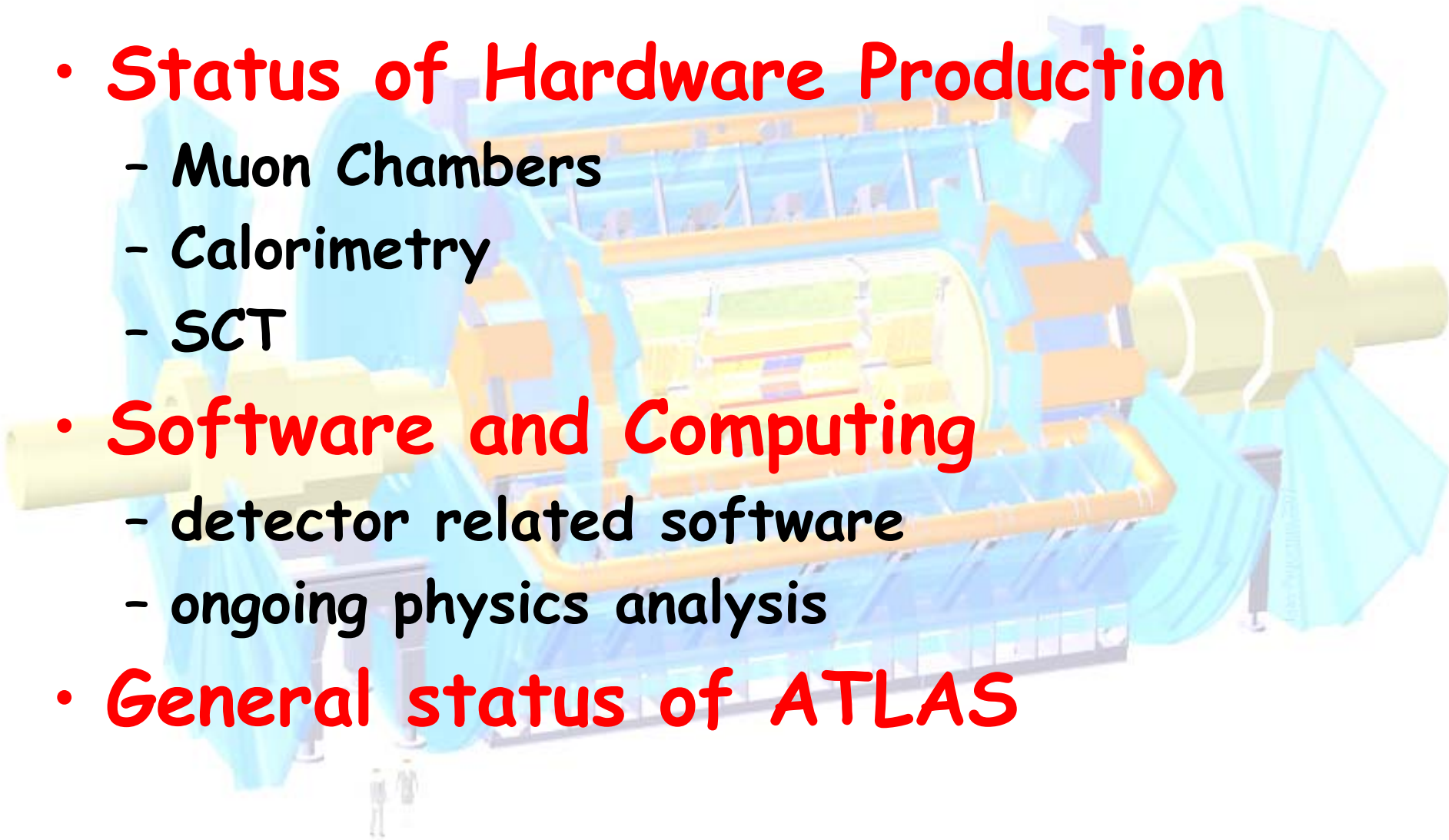
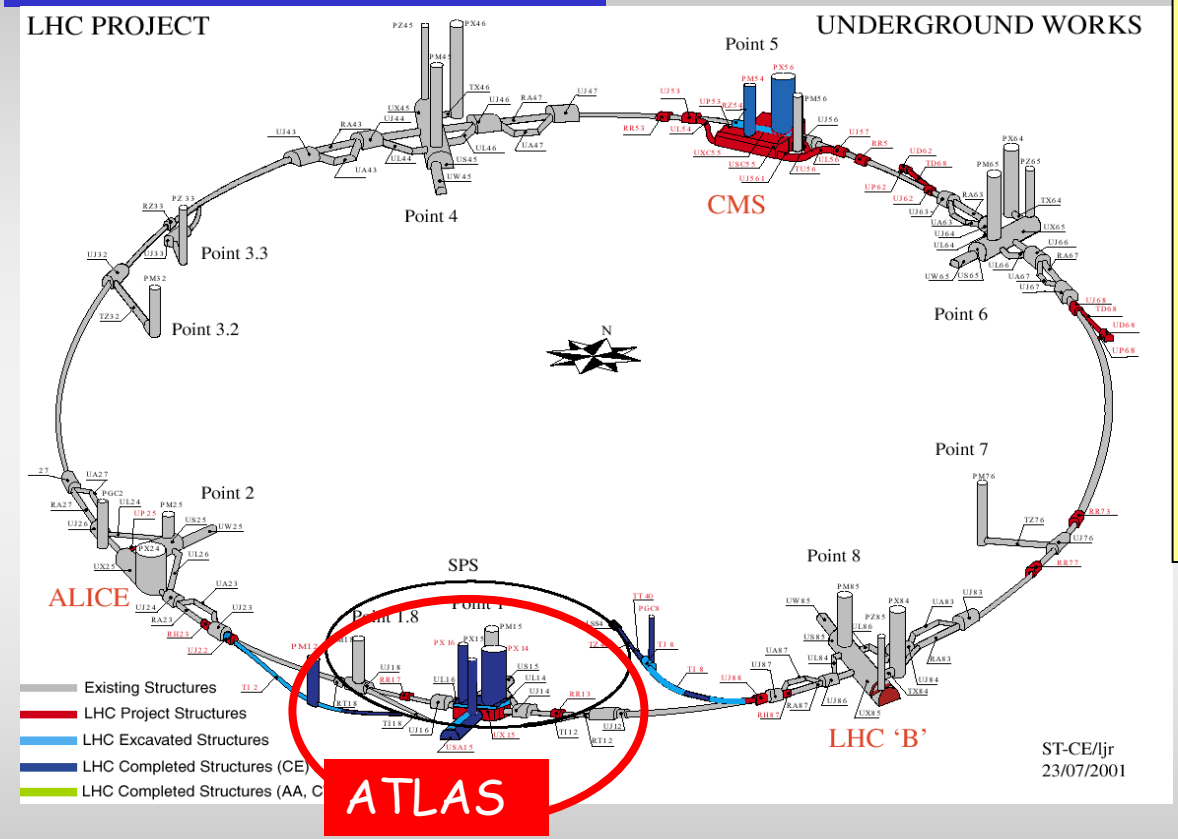
ATLAS Project Review 2004

- **Status of Hardware Production**
  - Muon Chambers
  - Calorimetry
  - SCT
- **Software and Computing**
  - detector related software
  - ongoing physics analysis
- **General status of ATLAS**



General Introduction

just as a reminder:



LHC:

Large Hadron Collider

proton-proton collider installed in the LEP tunnel at CERN

- proton accelerated to 7 TeV → $\sqrt{s}$ = 14 TeV
- collisions by 2007

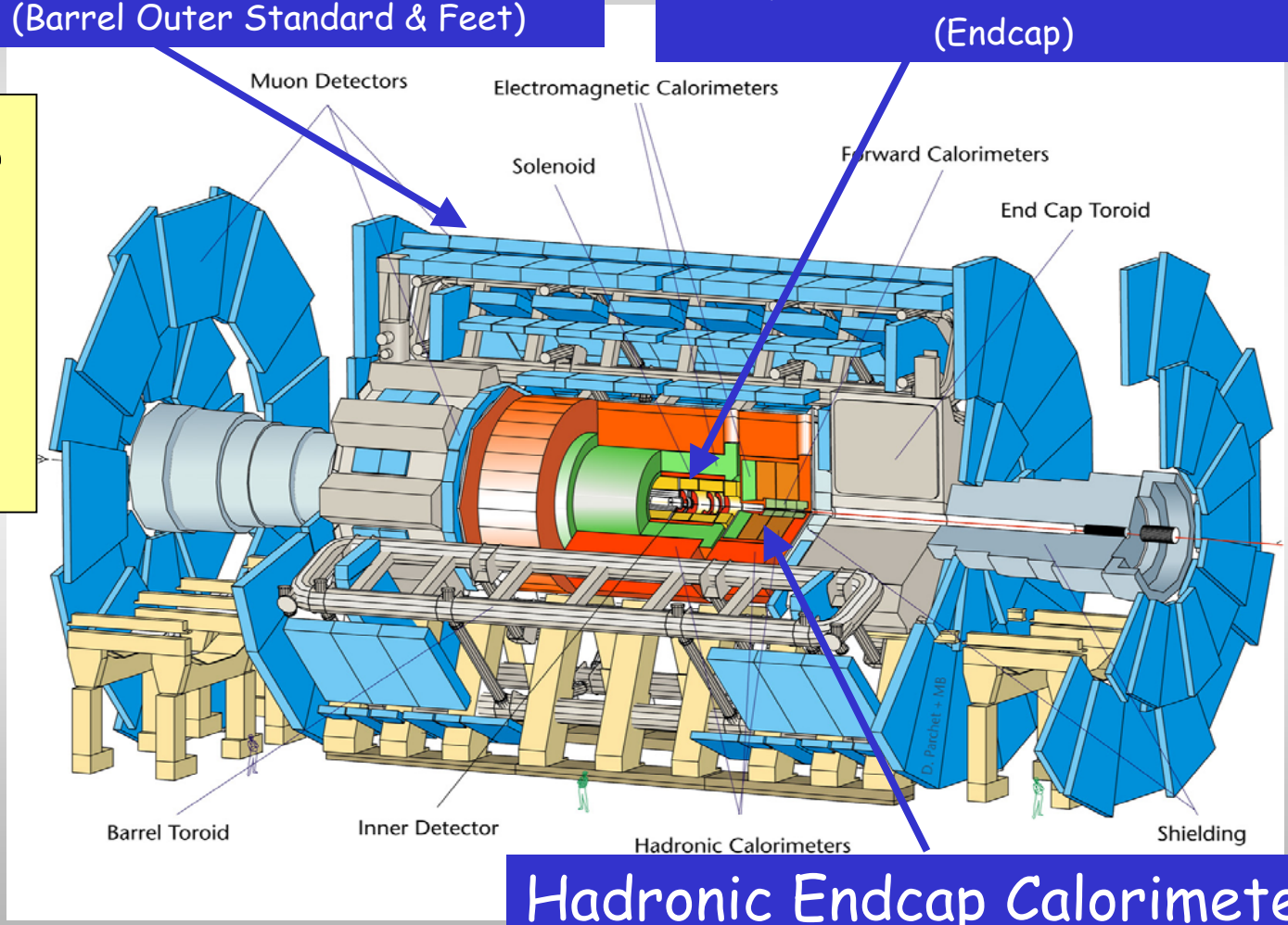
➢2 years left to get ATLAS in place!

MPI ATLAS Hardware Commitments

three major hardware projects at the MPI

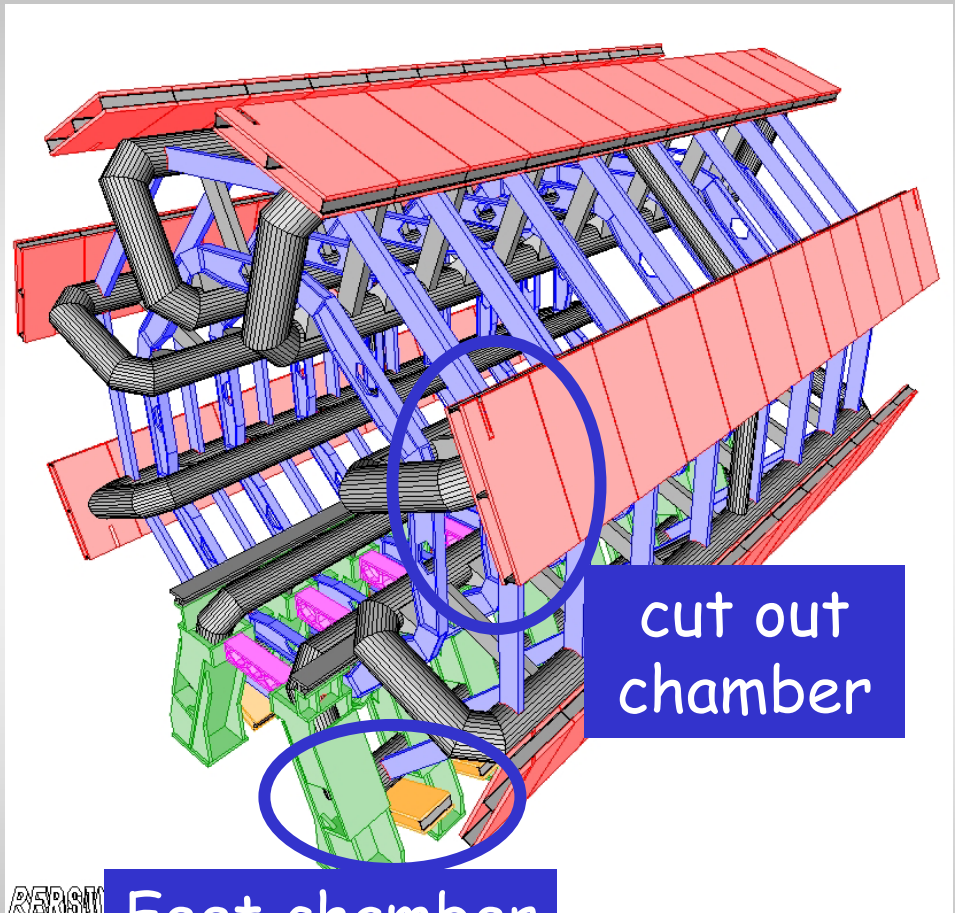
Monitored Drift Tubes
(Barrel Outer Standard & Feet)

SemiConductor Tracker
(Endcap)



Hadronic Endcap Calorimeter

Monitored Drift Tubes (MDT)



Production of chambers
- ✓ 62 standard chambers
- ✓ 4 spare standard
- ✓ 16 feet chambers
- ▪ 2 out of 12 cut-out-chambers

•82 out of 94 chambers done

MDT chambers:

46 with gas system

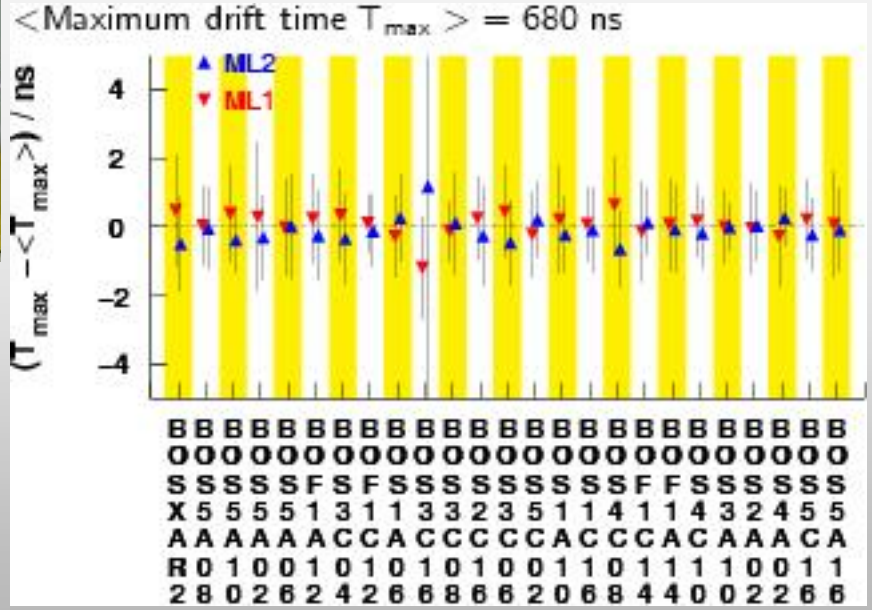
44 tested at LMU

15 with electronics

Monitored Drift Tubes (MDT)

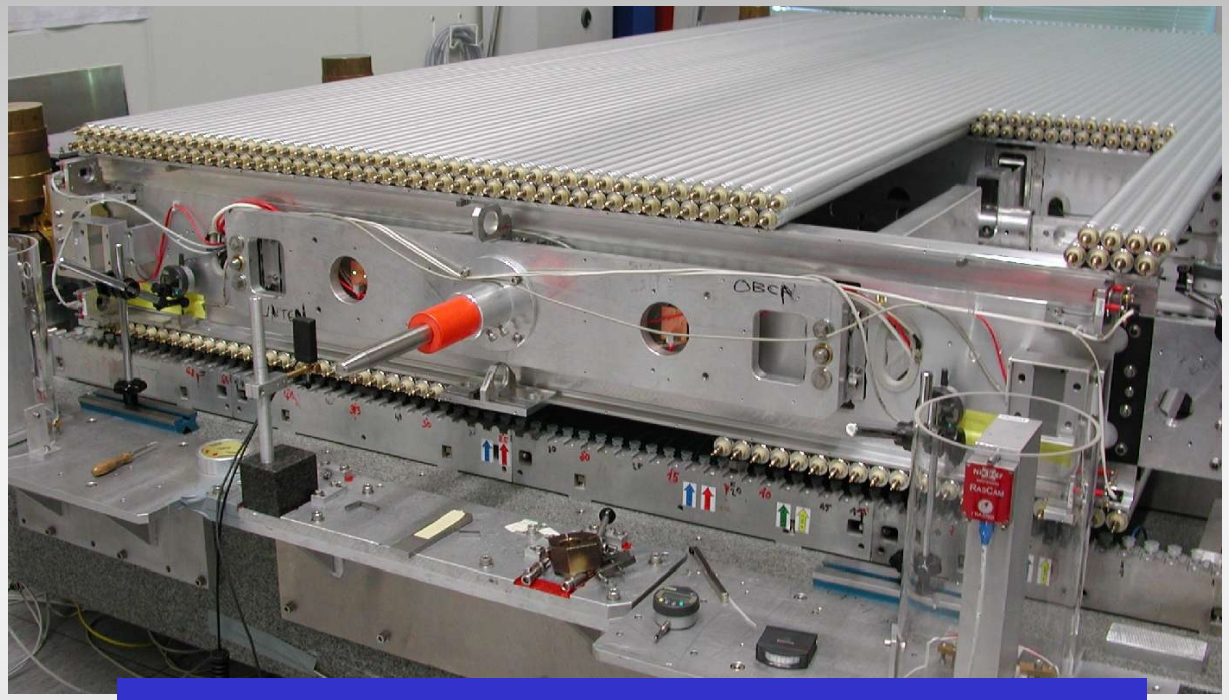
cosmic ray test stand at LMU

confirm geometrical accuracy and correct performance



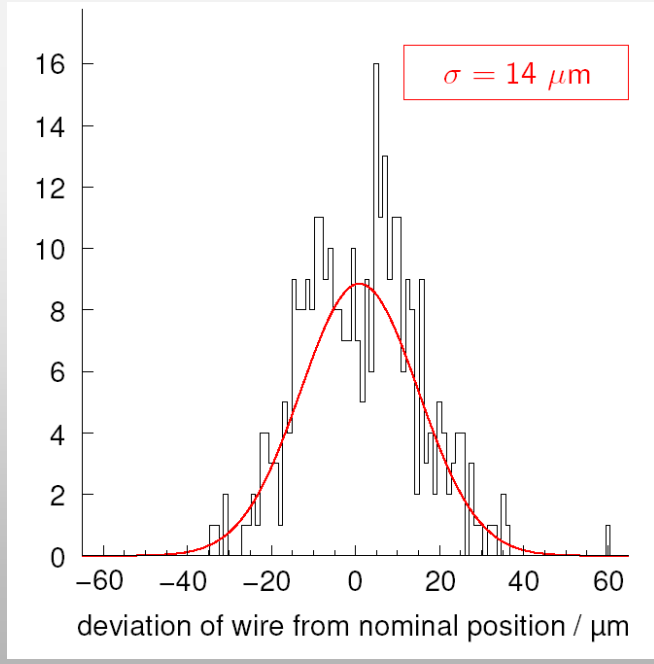
- good agreement between multi-layers
- high homogeneity

Monitored Drift Tubes (MDT)



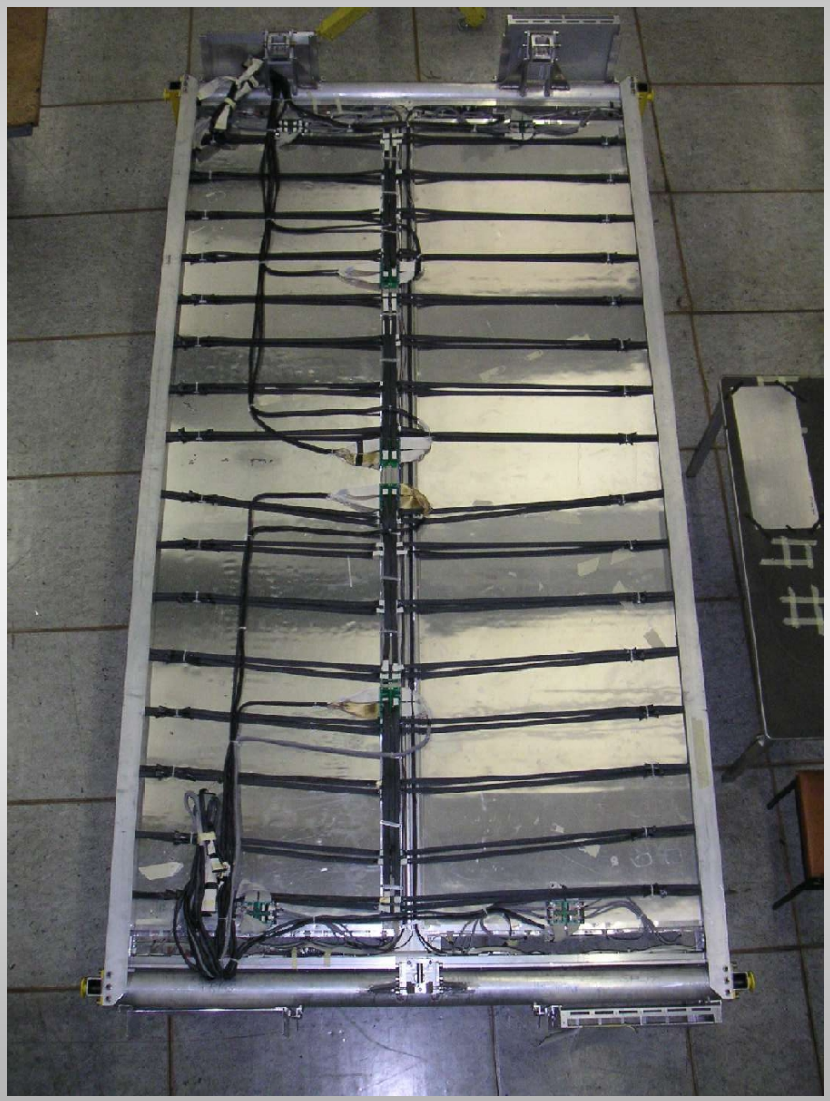
cut-out chamber production

Problem:
precision of wire position for wires with different length



requirement for
mechanical precision: < 20µm

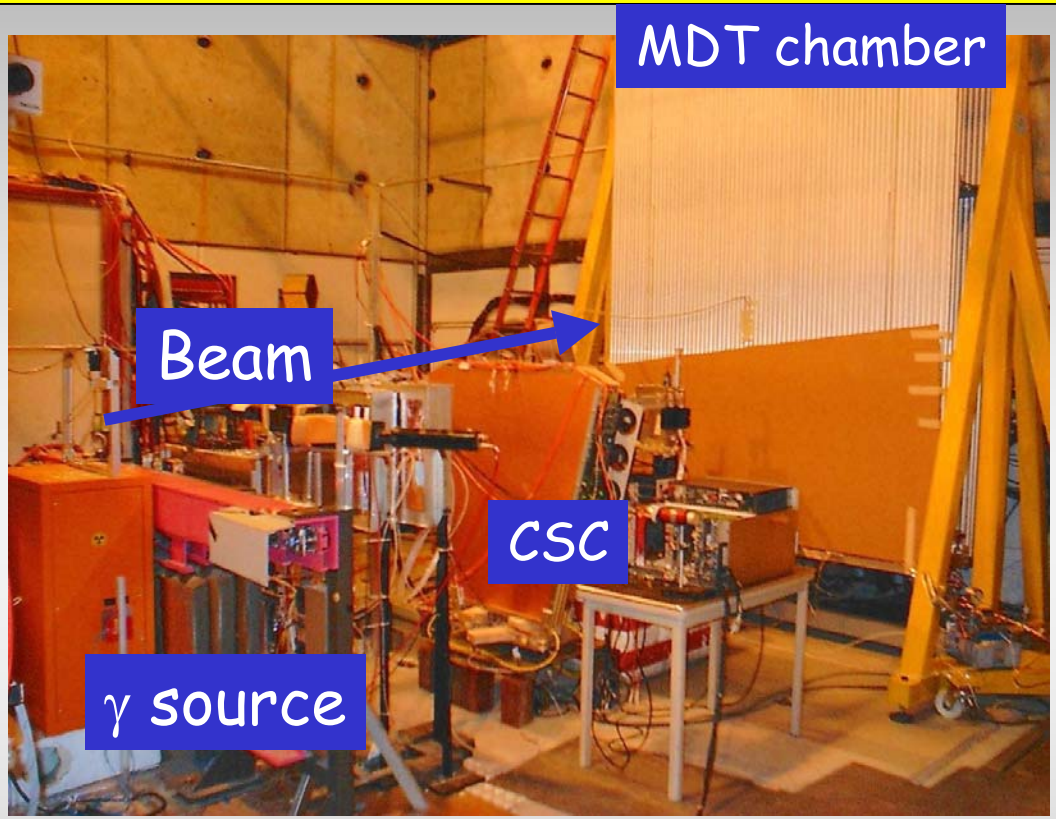
MDT and RPC Assembly at CERN



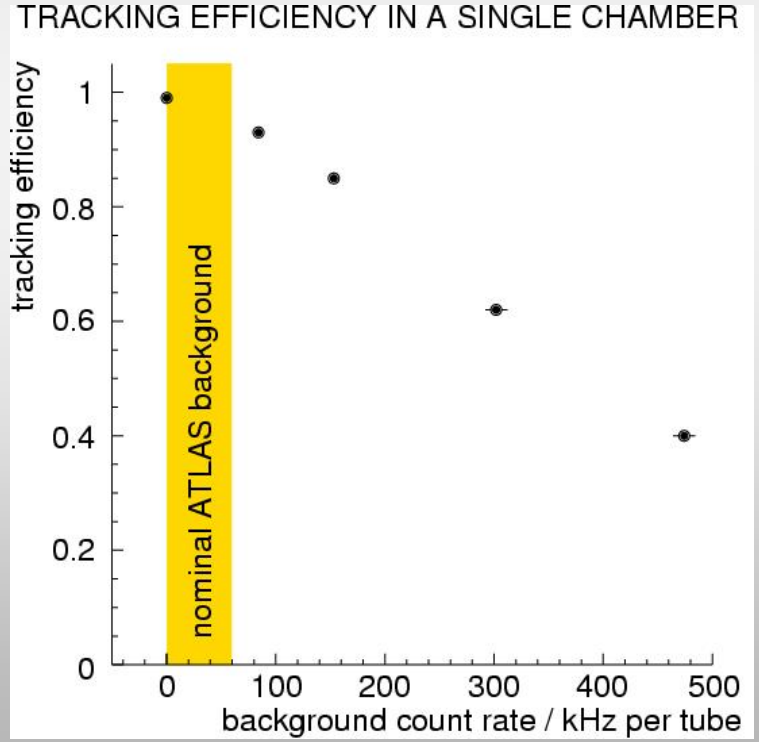
MDT/RPC assembly between Nov '04 and Sep '05

- MDT noise pickup from RPC shielding necessary

MDT Background Studies



neutron and γ background deteriorate MDT performance

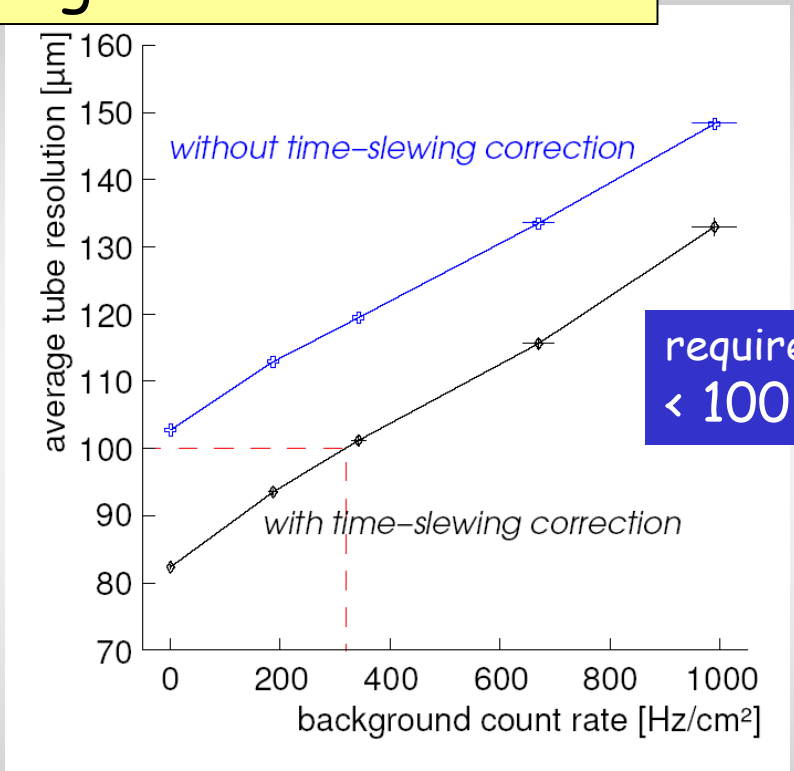


✓ efficiency > 95 % for nominal BG

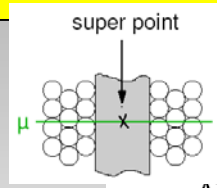
➢ significantly improved by better algorithm

MDT Spatial Resolution

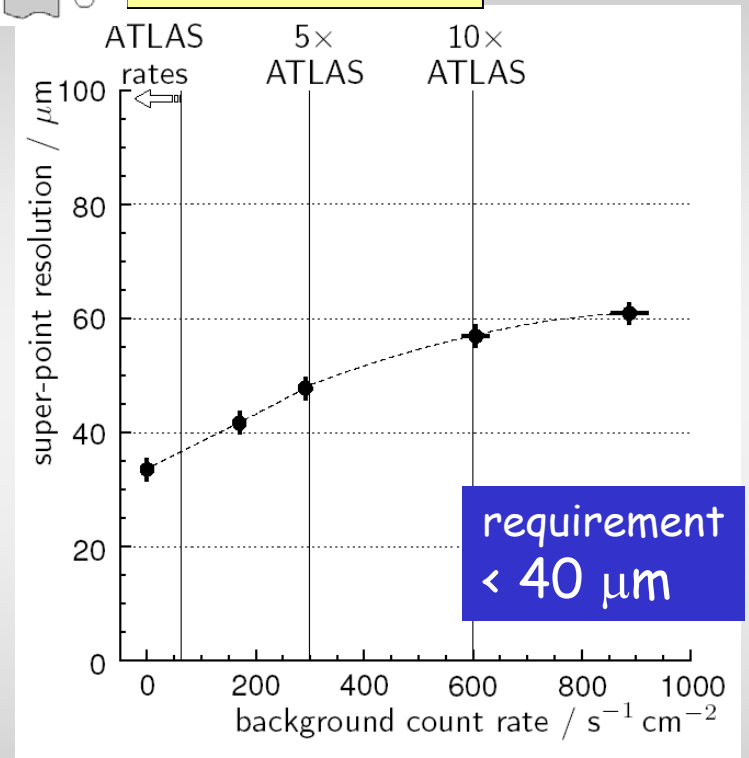
single tube resolution:



requirement:
< 100 μm



resolution:



requirement
< 40 μm

time-slewing correction:

- take shape of pulse into account

✓ safe up to 3 x maximum ATLAS rate

Further Studies & Schedule

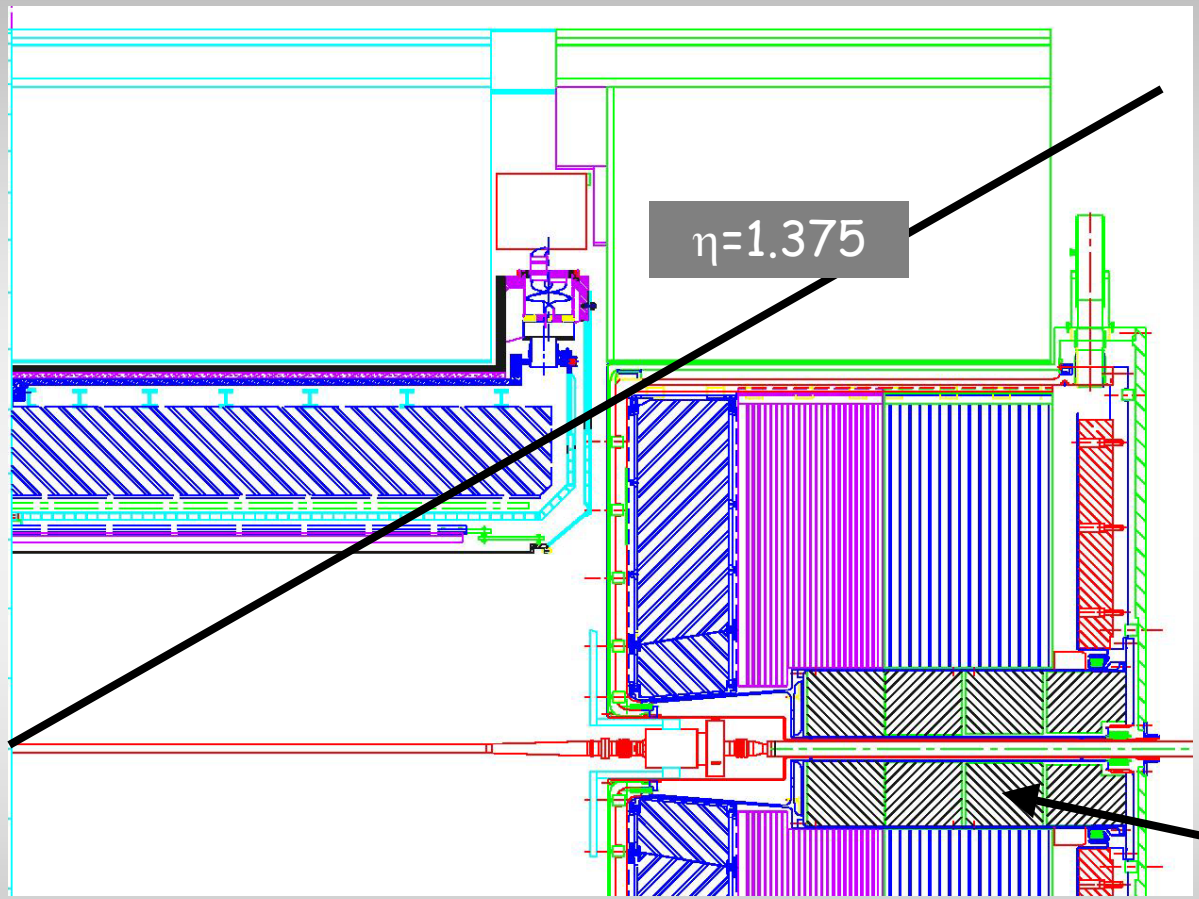
MDT software contribution:

- ✓ Muon chamber calibration (< 20 μm)
- ✓ Muon chamber alignment (< 20 μm)

schedule:

•cut out chamber series production	-05/2005
•installation of the on-chamber gas system	-07/2005
•mounting of the final read-out electronics	-07/2005
•assembly of 106 MDT-RPC supports	-02/2005
•MDT-RPC assembly at CERN	-09/2005
•installation in the ATLAS cavern	-10/2005

Calorimetry (Endcap)



EM accordion:
- Lar-Pb

hadron:
- scintillator/steel (Barrel)
- LAr/Cu (endcap)

Forward:
LAr/Cu ; LAr/W

Forward Calorimeter

EM Accordion Calorimeter

HEC wheel 1

HEC wheel 2

Endcap Cryostat C

✓ cold electronics signal/calibration cabling :
one error in Endcap C out of 3072 Signal and 512 calib. channels

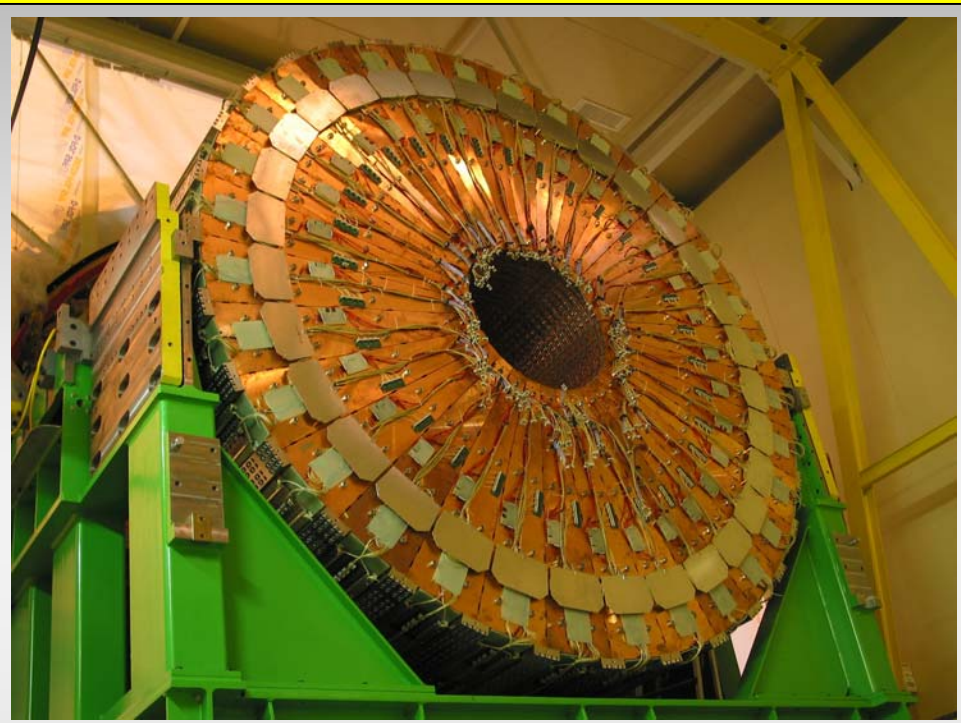
✓ **HV:** 6 problems out of 5120 LAr-gaps

closing of Endcap cryostat C on 6th August

- cooldown end Nov
- cold QC in January 05

HEC Endcap A

survey of HEC1 A wheel inside cryostat



HEC2 A wheel in front of cryostat

positioning precision better than 1mm

inside cryostat:

- ✓ cold electronics signal/calibration cabling: no error
- ✓ **HV**: two problems

HEC Electronic and Schedule

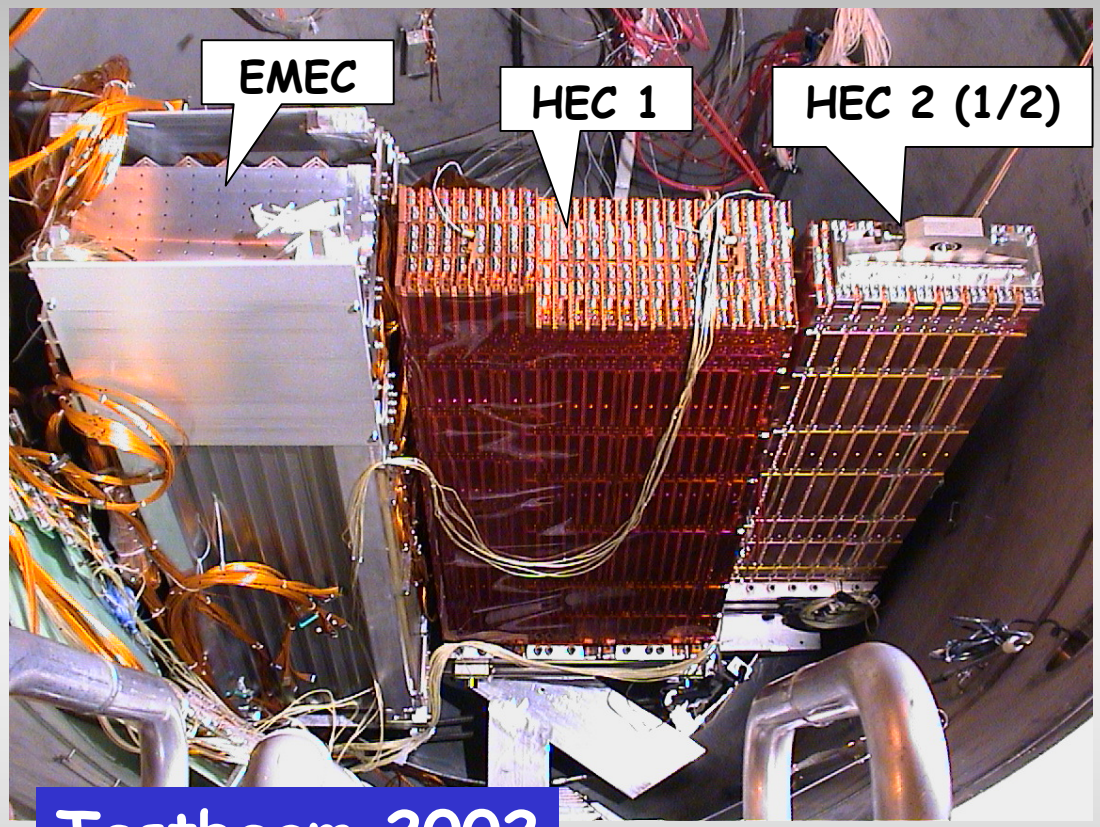
- ✓ LV power supplies construction done
  - prototype tested in beam
  - radiation hardness tests ongoing
  - start of mass production
  - control software under development
- ✓ trigger board production ongoing

Schedule

Endcap C:
- cooldown now and full cold QC beginning of 2005
- lowering in pit August 2005
- LV and TDR installation end 2005

Endcap A:
- cooldown and cold test May-September 2005
- lowering in pit November 2005
- LV and TDR installation early 2006

Calorimeter Testbeam Activities



Testbeam 2002

LAr Calorimeter is not compensating

- different response from EM and HADR part of shower
- determine hadr contribution

calibration: weighting approach similar to H1

- topological 3D clustering
- identify EM clusters
  - treat as EM cluster
- determined weights by
  1. testbeam
  2. Monte Carlo

See: NIM A 531 (2004), 481

Calorimeter Testbeam Activities

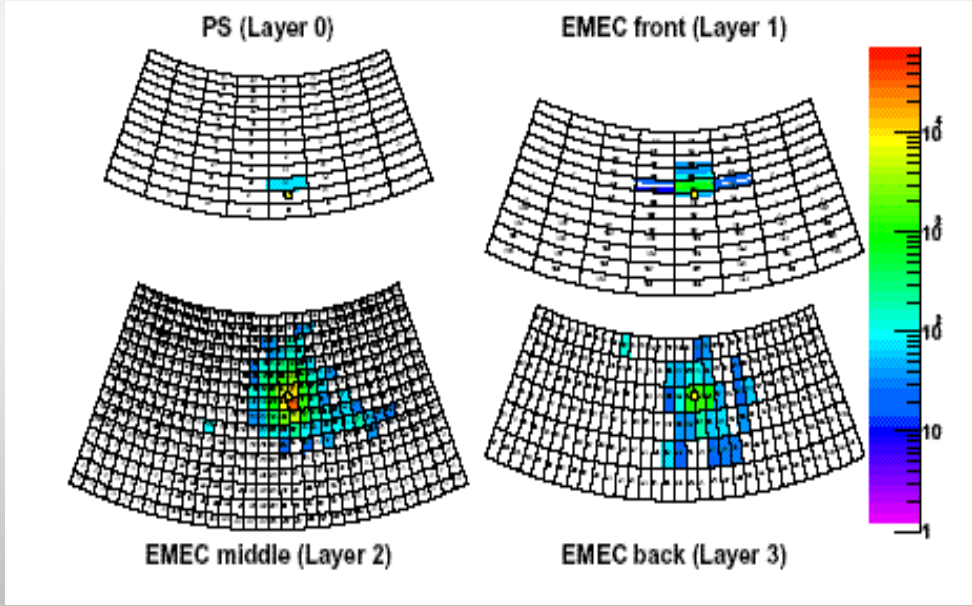
1. determine cluster
2. calculate weight

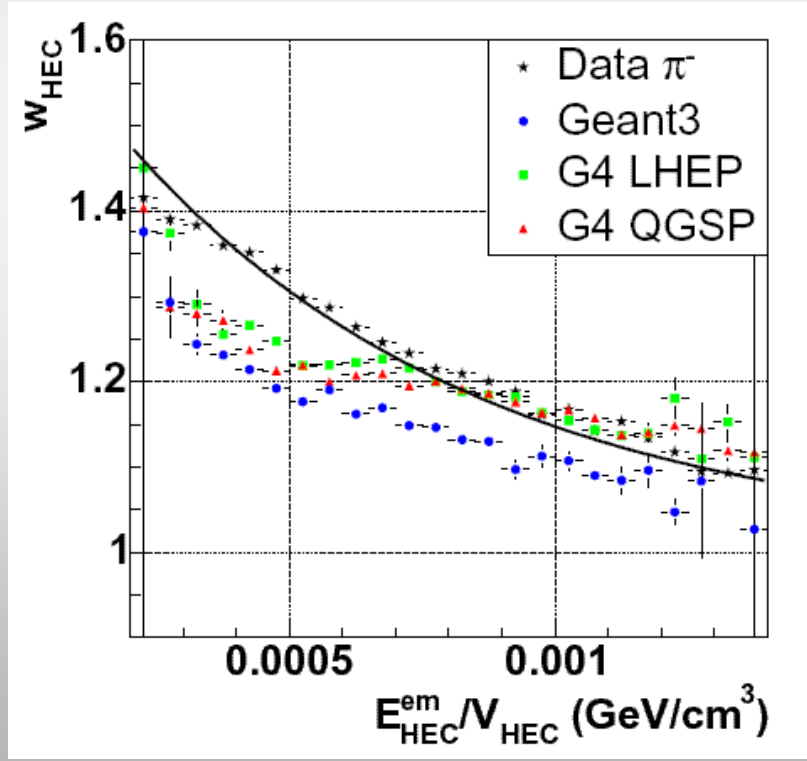
$$E'_{\text{Cell}} = w \cdot E_{\text{Cell}}$$

cluster reconstruction

- weights obtained from minimizing χ^2 energy resolution

$$\chi^2 = \sum \frac{(E_{\text{beam}} - E_{\text{leak}} - E_{\text{reco}}(w))^2}{\sigma^2_{\text{noise}} + \sigma^2_{\text{leak}}}$$





pions 180 GeV, topological clustering

Calorimeter Testbeam Activities

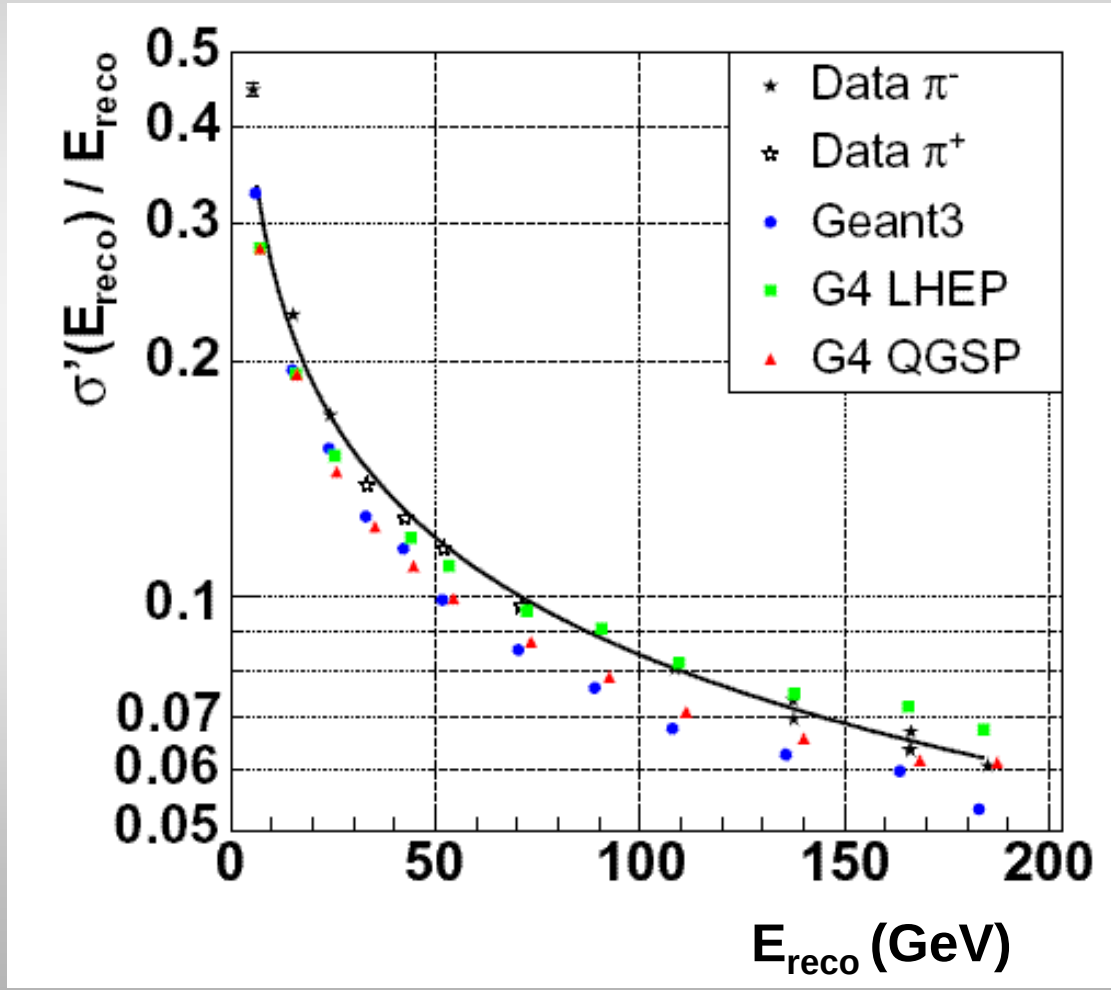
… energy resolution with 'poor man's weighting':

•energy resolution for single pions:

$$\frac{\sigma_E}{E} \approx \frac{80\,\%}{\sqrt{E\,/\,\mathrm{GeV}}} \oplus 0.0$$

value for Jets in TDR

$$\frac{\sigma_E}{E} \approx \frac{50\,\%}{\sqrt{E\,/\,\mathrm{GeV}}} \oplus 3.0\%$$

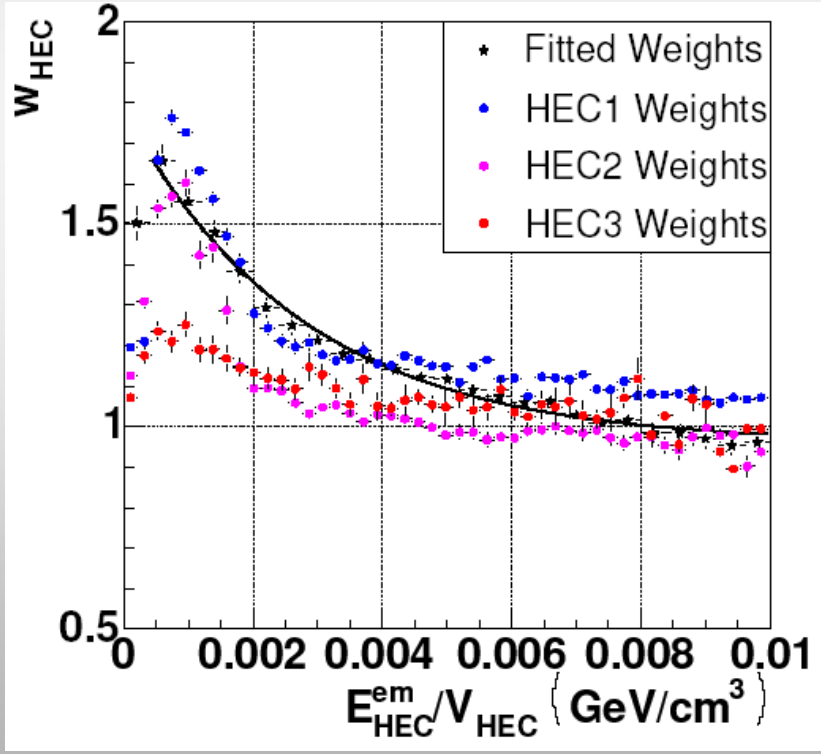


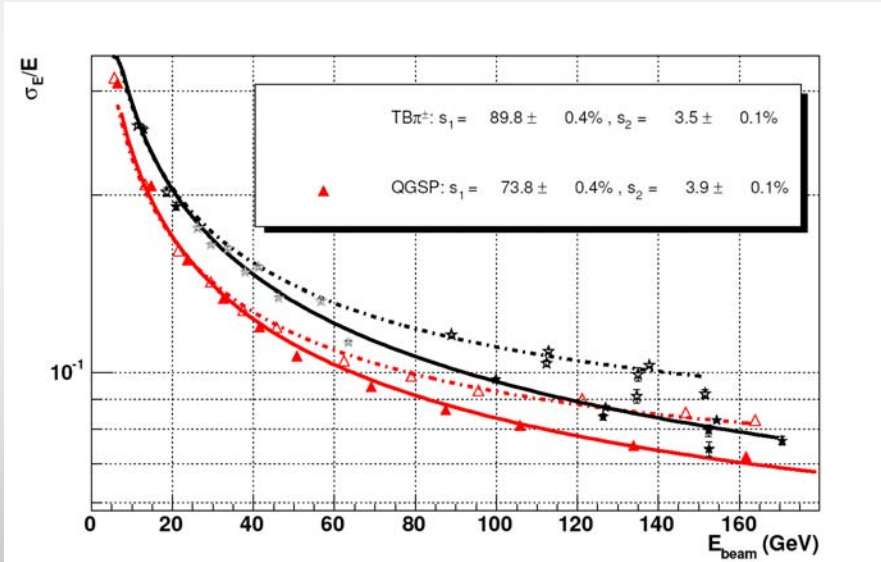
Calorimeter Testbeam Activities

determine weights using Monte Carlo:

$$E'_{\text{Cell}} = w \cdot E_{\text{Cell}}$$

$$w = (E^{\text{EM}}_{\text{LAr+Abs}} + E^{\text{non-EMvis}}_{\text{LAr+Abs}} + E^{\text{non-EMinvis}}_{\text{LAr+Abs}} + E^{\text{escaped}}_{\text{LAr+Abs}}) / (E^{\text{EM}}_{\text{LAr}} + E^{\text{non-EMvis}}_{\text{LAr}})$$





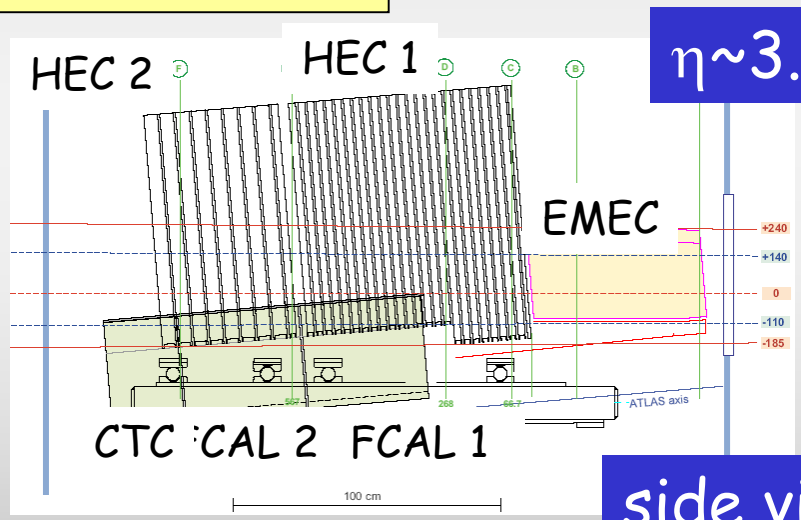
$$\frac{\sigma_E}{E} = \frac{89.8\%}{\sqrt{E / \text{GeV}}} \oplus 3.5\%$$

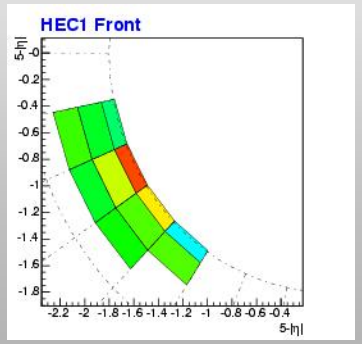
CTB 2004 & Reconstruction SW

- testbeam 2002 was in the η-region 1.6-1.8
- EMEC and HEC testbeam only
  - ➢ testbeam at larger η-region
  - ➢ include FCAL in testbeam

data taken and wait to be analyzed!

- ➢ Project Review 2005

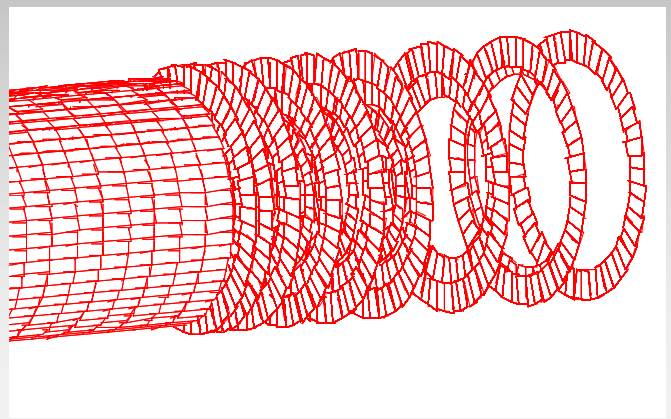




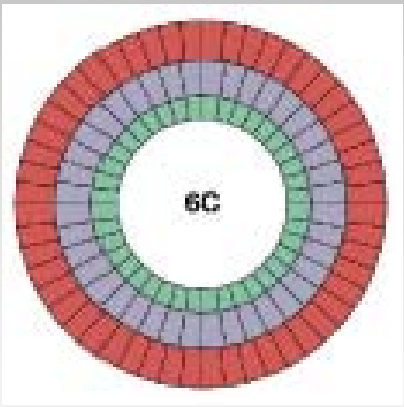
calorimeter reconstruction software:

- development of clustering algorithms

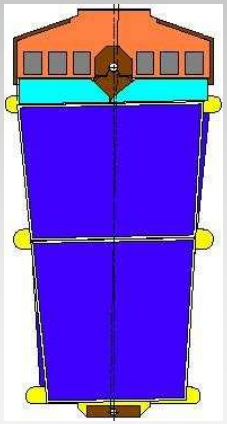
SemiConductor Tracker



9 discs/side with
988 modules



3 rings with
52+40+40 Modules



Middle
Module

MPI produces 400 (+20%) middle modules

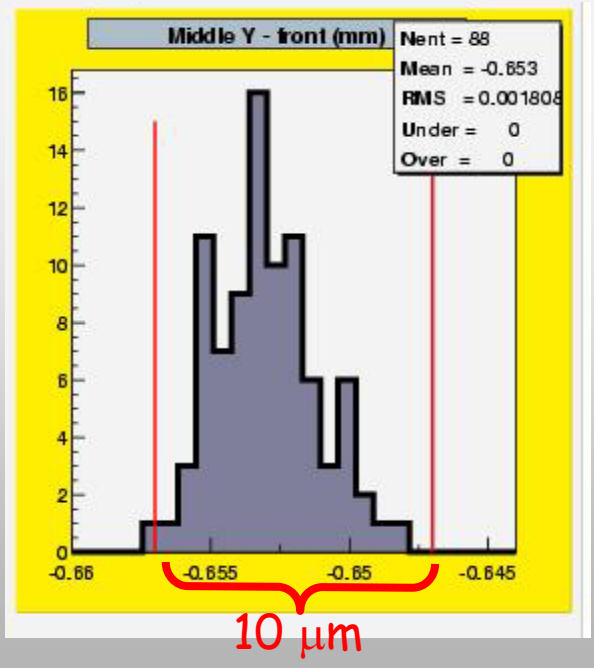
- ✓ 80 short middles (1 wafer/side, disc 8 only)
- ~100 out of 320 long middles assembled (2 wafers/side)

SCT - Short Middle Modules

Short middle Module
- 2 wafers replaced by glass plate at $\eta > 2.5$ region

- production of short middle modules finished
- yield: 87.5% = 84 modules
- steep learning curve

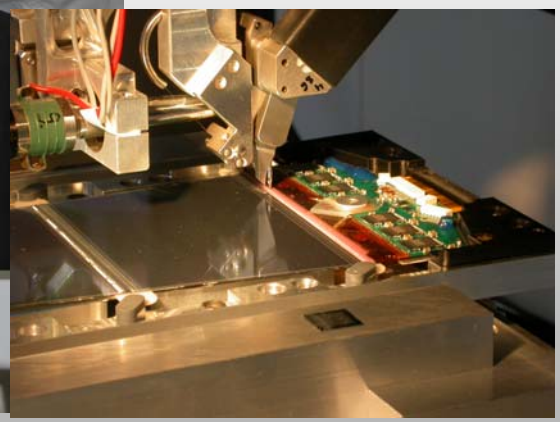
position of module center perpendicular to the strips



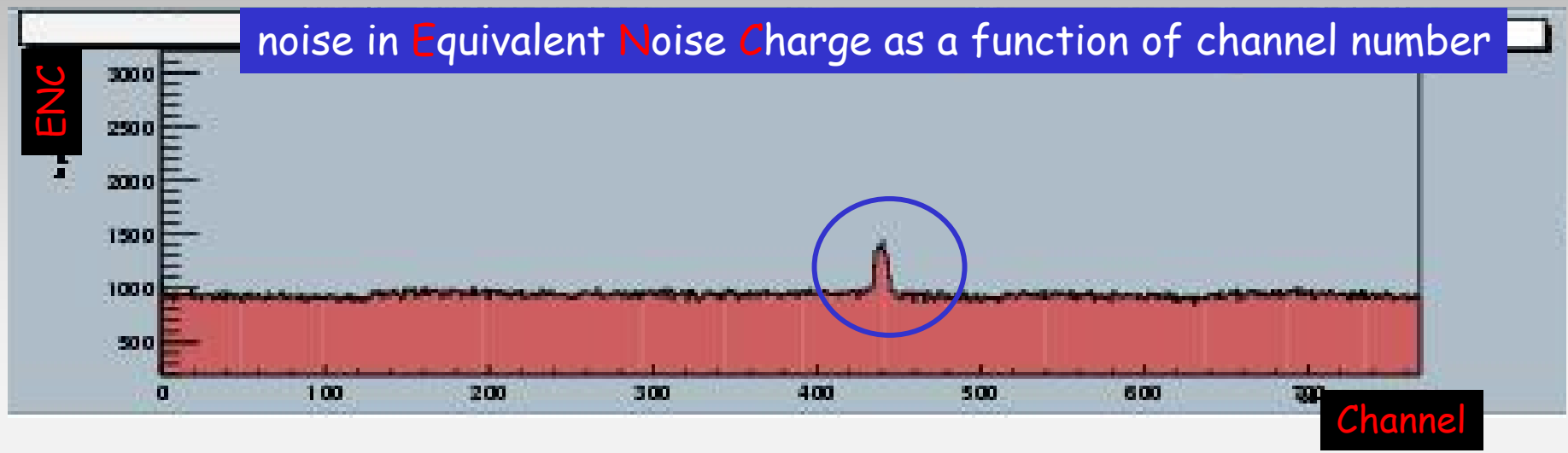
SCT Assembly

production rate increased from
- 3 modules/week to
- 12 modules/week

production steps at MPI:
1. assembly of sensors to spine and hybrid attachment
2. bonding
3. electrical characterization

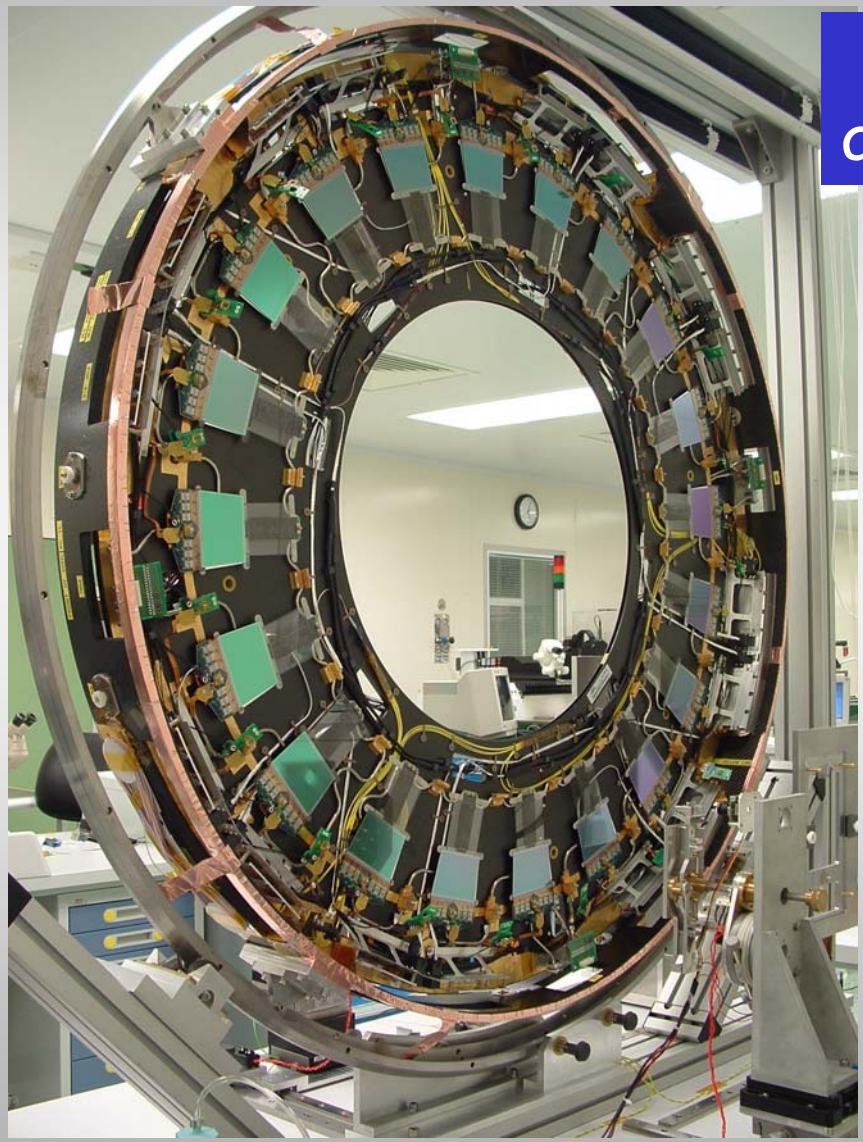


SCT-Problems during Production



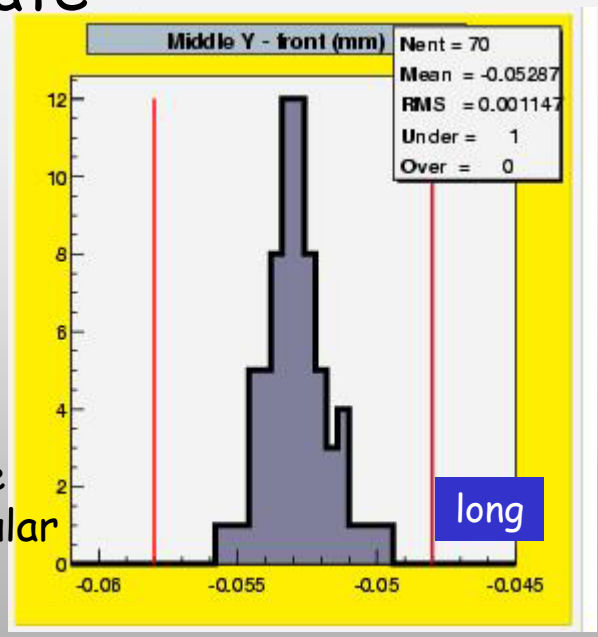
- about 20% of short modules showed increased noise for a couple of channels
- increased noise originates from surface charges
  - treatment with ionized air removes surfaces charges
- module production held for about 4 weeks ~ 1 disc

SCT Module to Disc Assembly



first short middle modules assembled on disc 8C at Liverpool

- production of 'long' modules is in full swing
- may need to further increase production rate



position of module center perpendicular to the strips

SCT Schedule & Software

disc mounting schedule requires to be finished by June '05

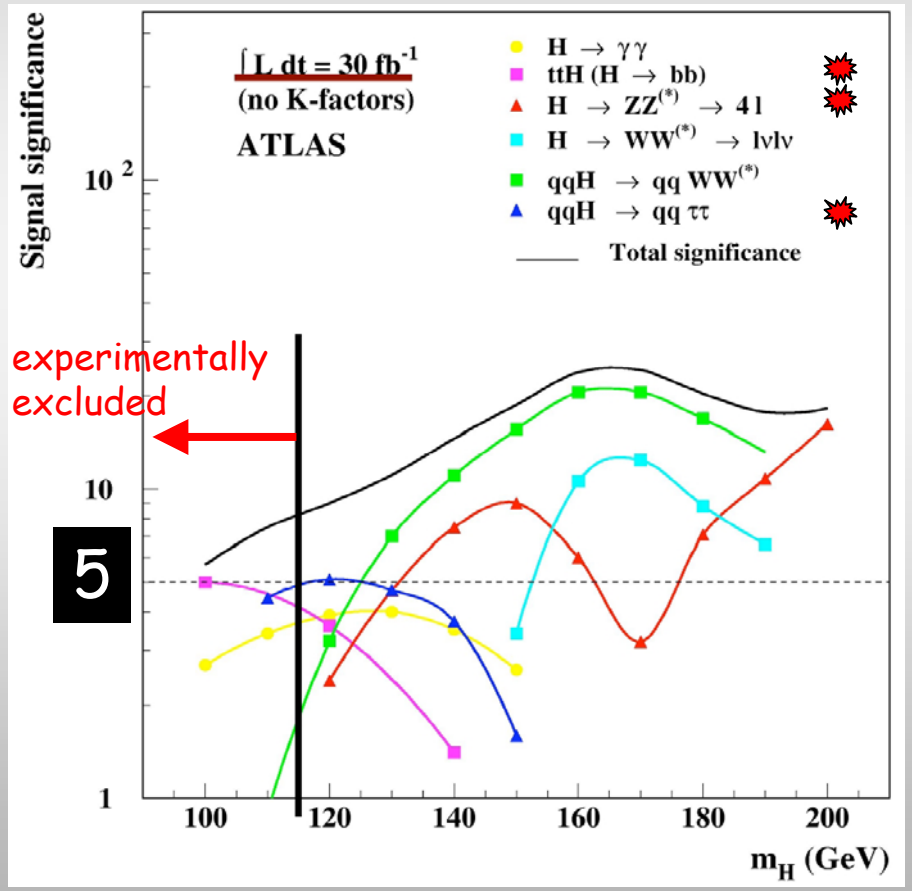
- shortage: bonding of modules
  - C. Gryska now on maternity leave
  - reduced availability of M. Wachler up to February
  - not all modules can be bonded direct after assembly
- quality assurance chain also at the edge
- barrel module production almost finished
- about half of the endcap modules finished

SCT software:

- involvement in the alignment effort of the inner detector

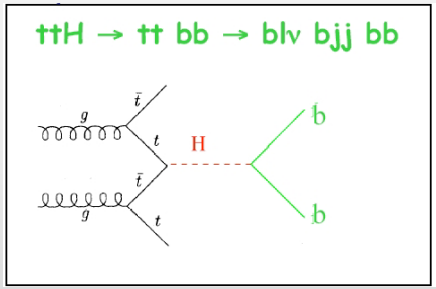
Higgs Analysis

focus on low mass Higgs discovery channels at low luminosity

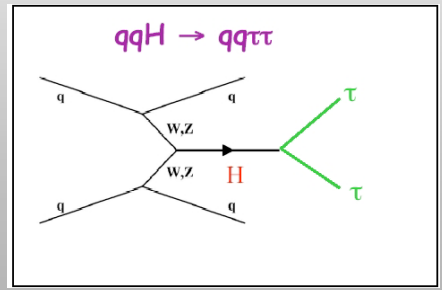


30 fb^{-1} = 3 years of ATLAS at low luminosity

Higgs Studies at the MPI



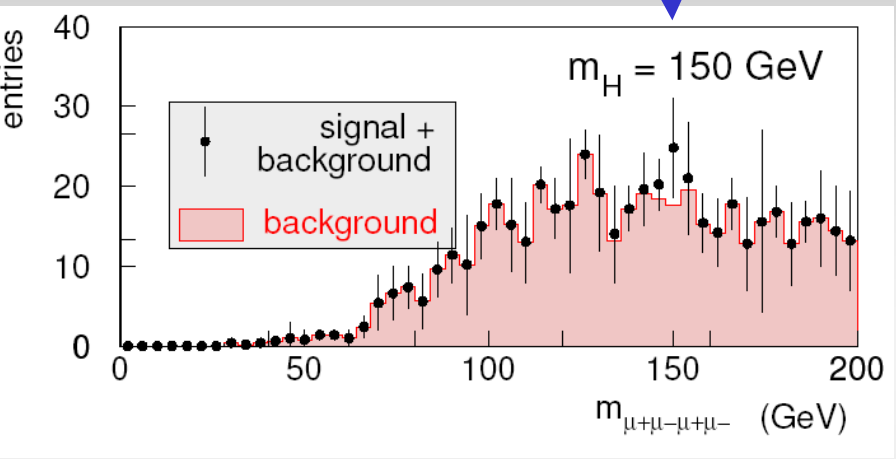
b-tagging



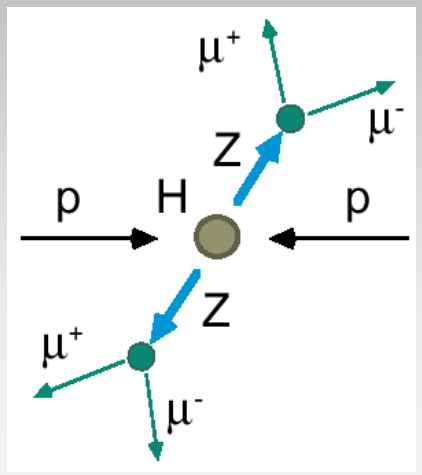
forward jets

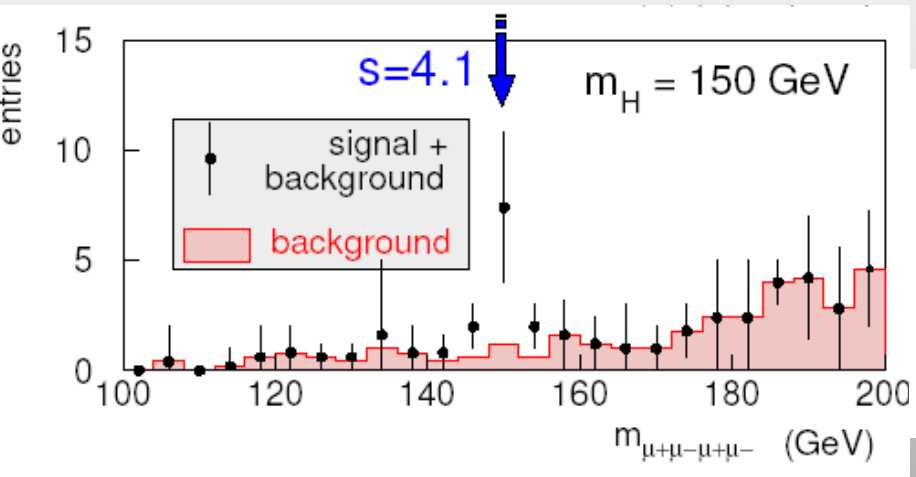
Higgs Analysis

'golden channel': $H \rightarrow ZZ^* \rightarrow \mu^+\mu^-\mu^+\mu^-$



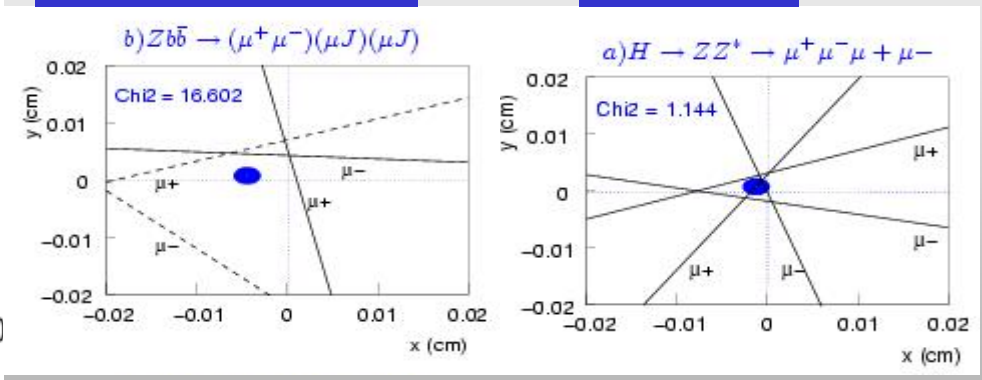
Tracking helps!





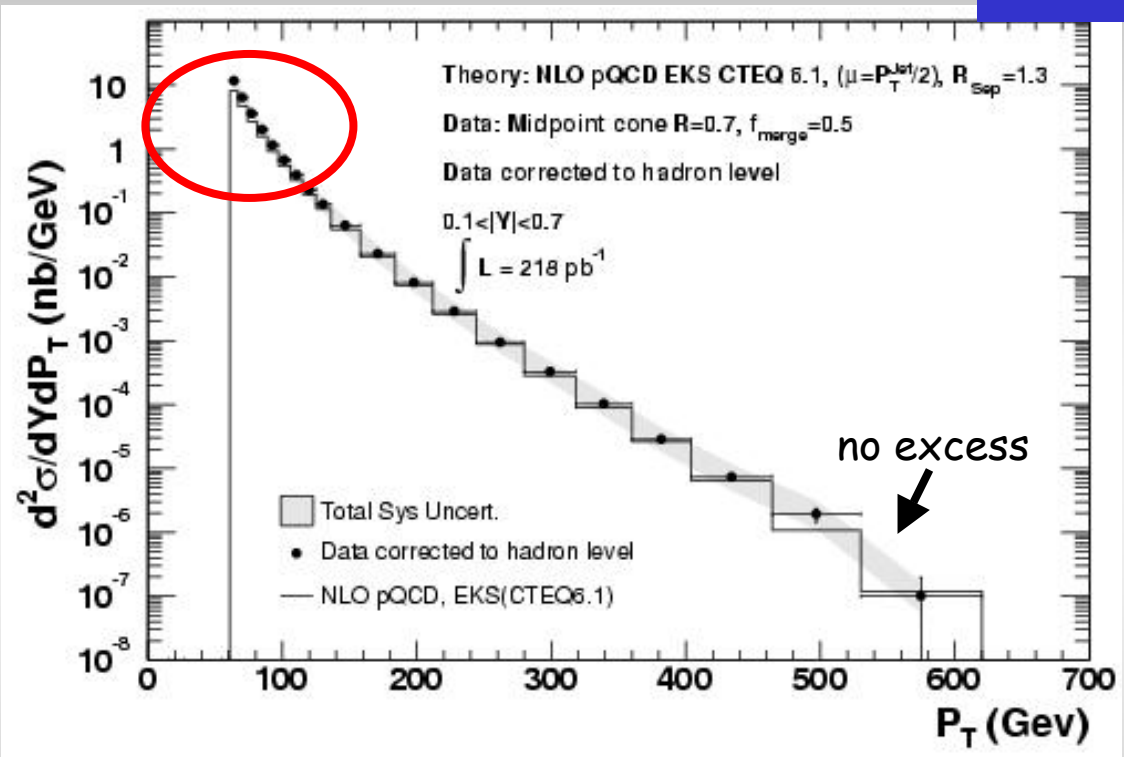
Background

Signal



Jet Finder Algorithm

CDF data run II



cone algorithm:

(Snowmass cone)

- not collinear safe
- not infrared safe

Midpoint algorithm:

improved Snowmass algorithm

- ✓ collinear safe
- ✓ infrared safe

- good agreement between data and Monte Carlo
- analysis for K_T algorithm under production

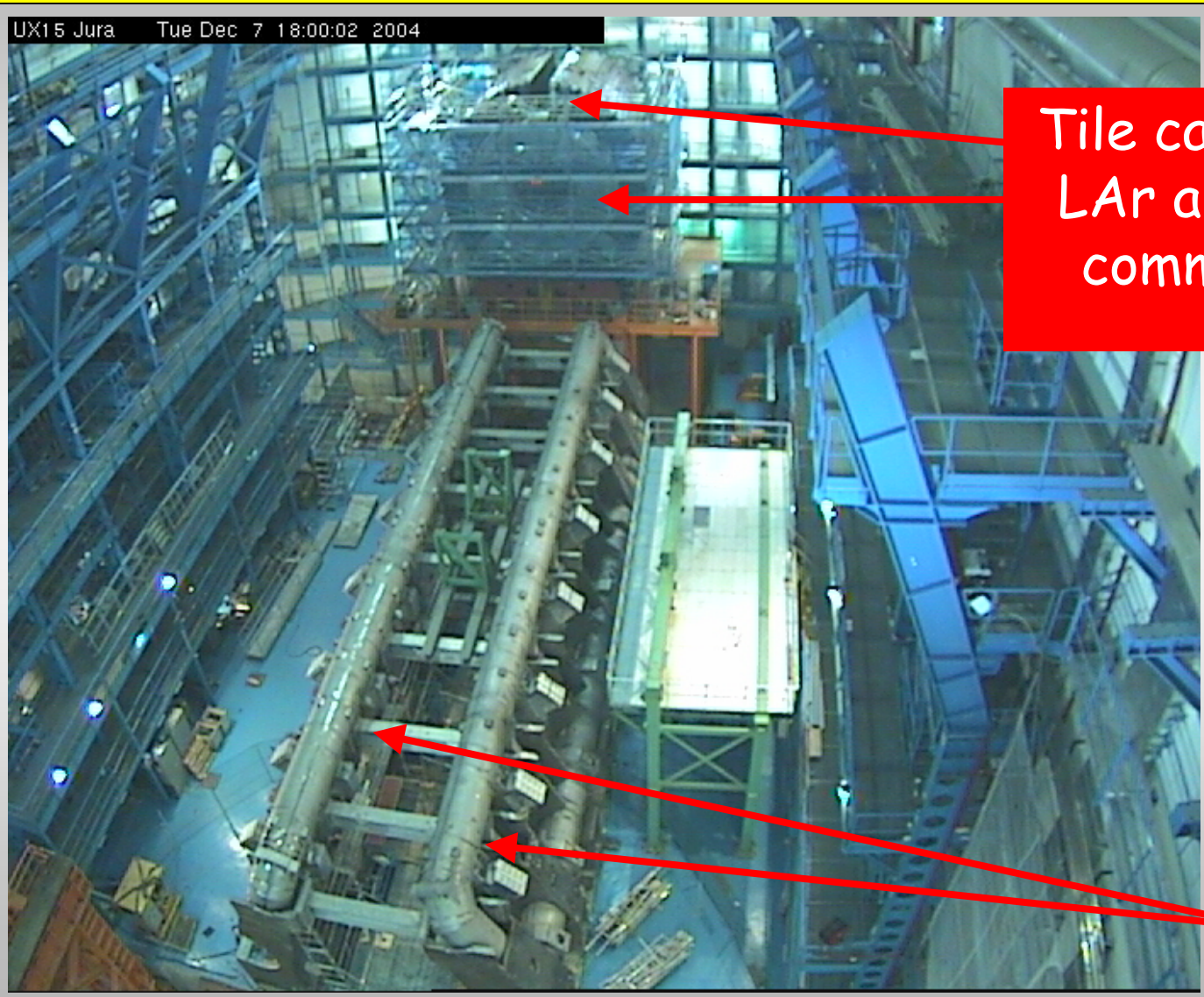
(looks slightly better than Midpoint)

Activities at CERN

software engagement at CERN

- offline commissioning coordinator
  - detector needs for installation, cosmic runs, combined detector data flow, …
  - database, Trigger
- ATLAS core software development
  - involvement in the ATLAS GRID developments at CERN
  - production of large Monte Carlo samples using the GRID

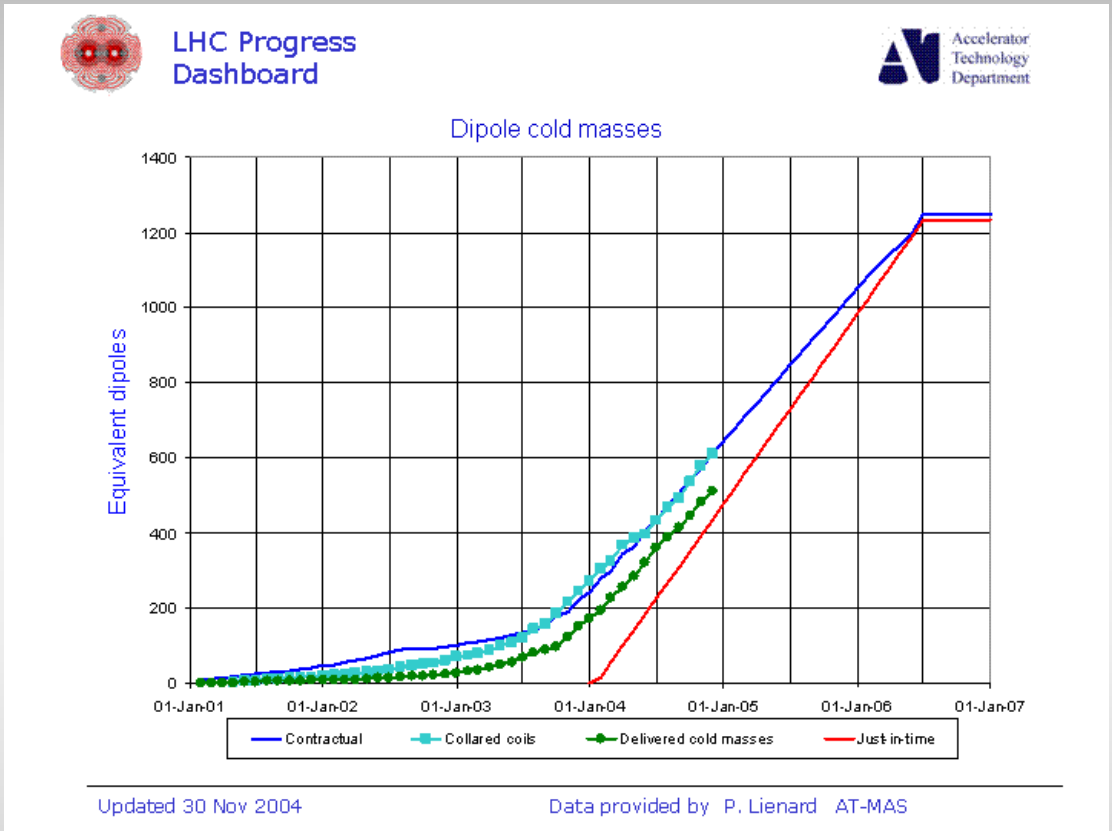
General Atlas Status



Tile calorimeter, EM LAr and solenoid in common Cryostat
(Barrel)

two out of 8 toroids

Status of the Accelerator



production of accelerator components is on time

- problems with QRL cryolines inside tunnel
  - broken lines will be replaced → big effort
- no delay expected → beams in LHC in summer 2007

Conclusion

- hardware production at the MPI close to the end
  - expected to be finalized in 2005
- major detector software contribution for
  - calorimeter
  - muon chamber
  - inner detector
- ongoing physic analysis studies (Higgs, QCD,…)
- core software development and commissioning
- the production of the LHC Accelerator and the ATLAS detector is on time