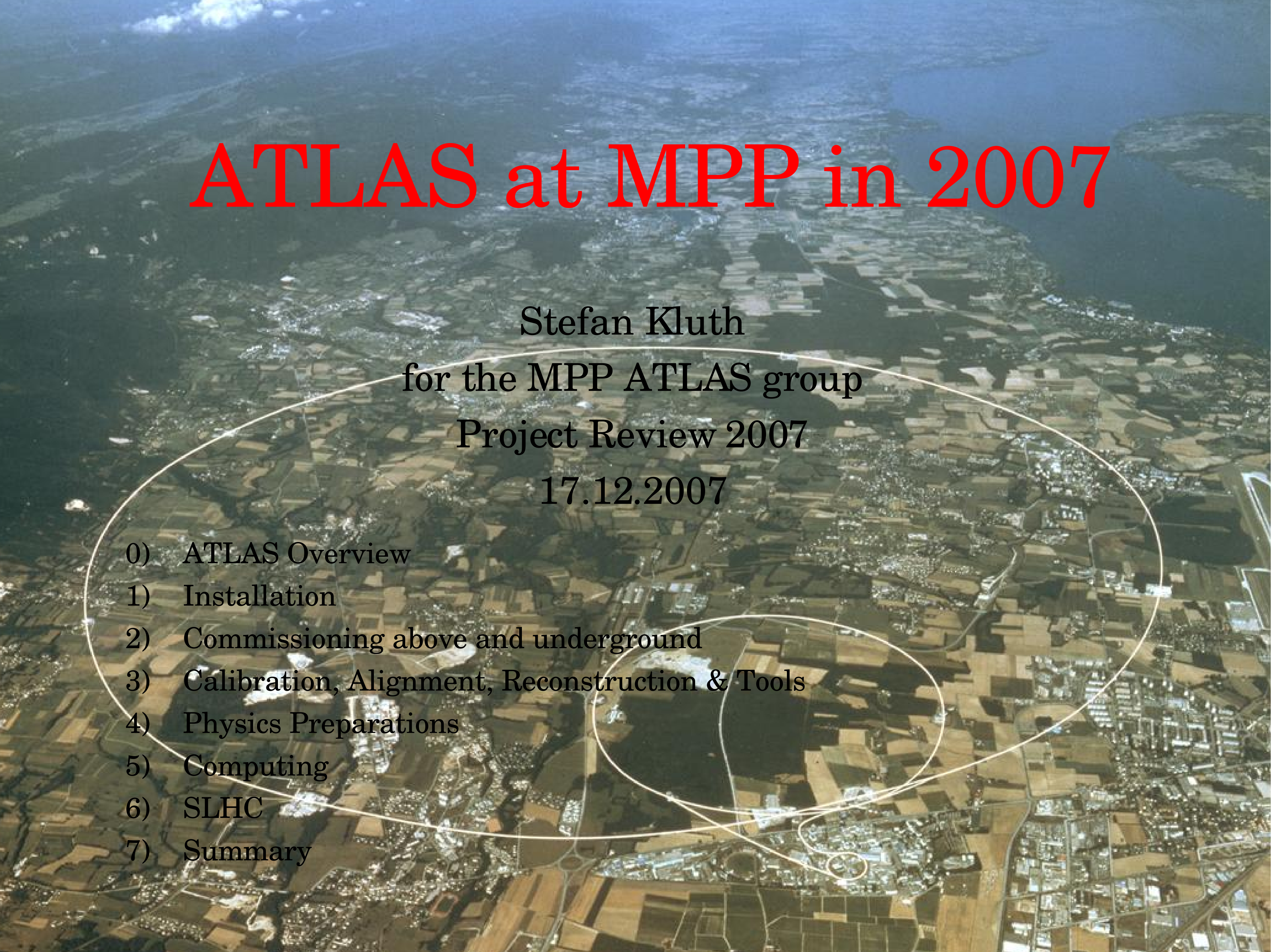


ATLAS at MPP in 2007

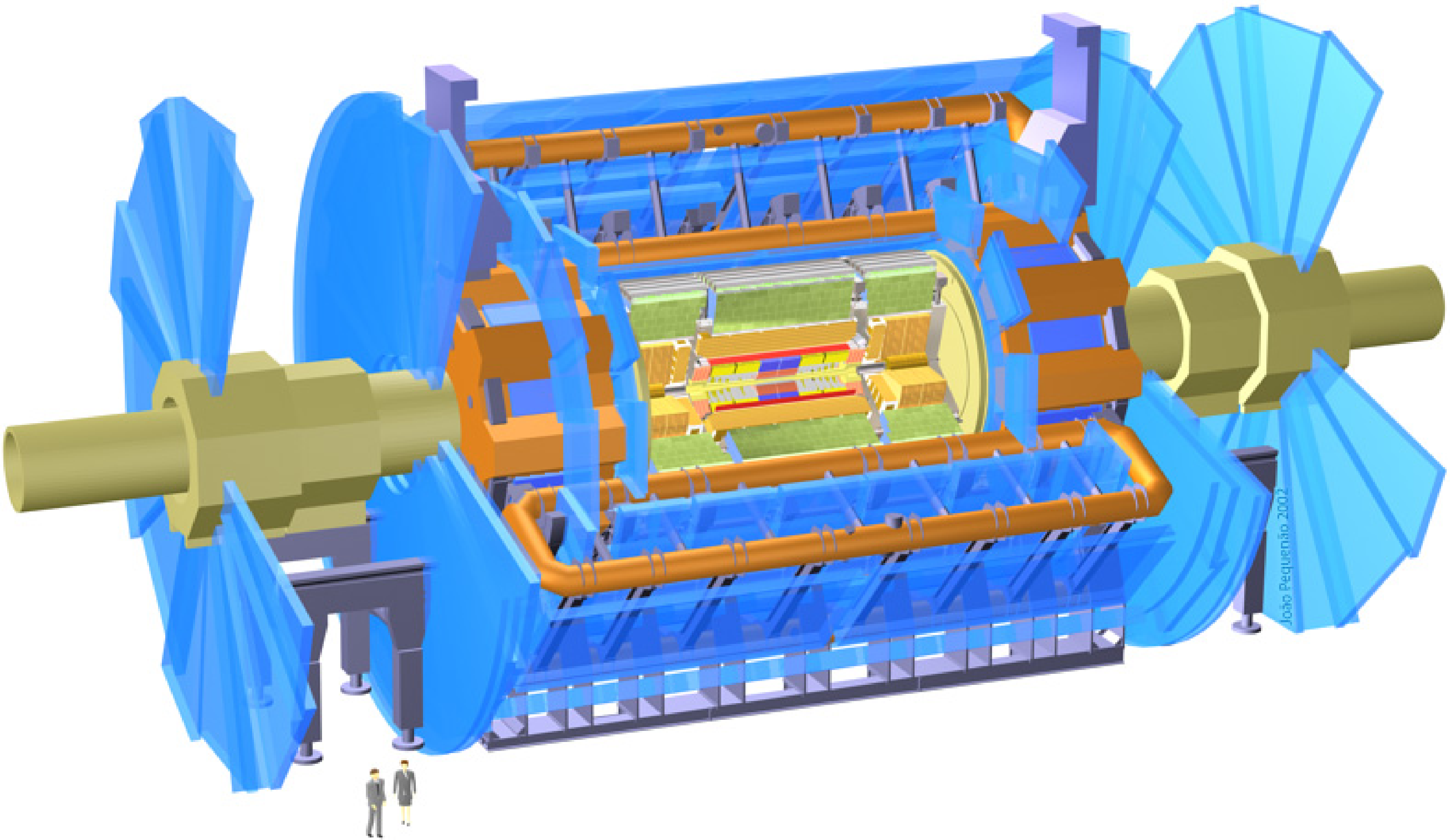
Stefan Kluth
for the MPP ATLAS group

Project Review 2007

17.12.2007

0) ATLAS Overview
1) Installation
2) Commissioning above and underground
3) Calibration, Alignment, Reconstruction & Tools
4) Physics Preparations
5) Computing
6) SLHC
7) Summary

0) ATLAS Overview



ca. 44 x 22 m, 7000 t, ca. 2000 scientists, MPP contributions to inner detector (SCT), calorimeter (HEC), muon system (MDT) and computing (Tier-2)

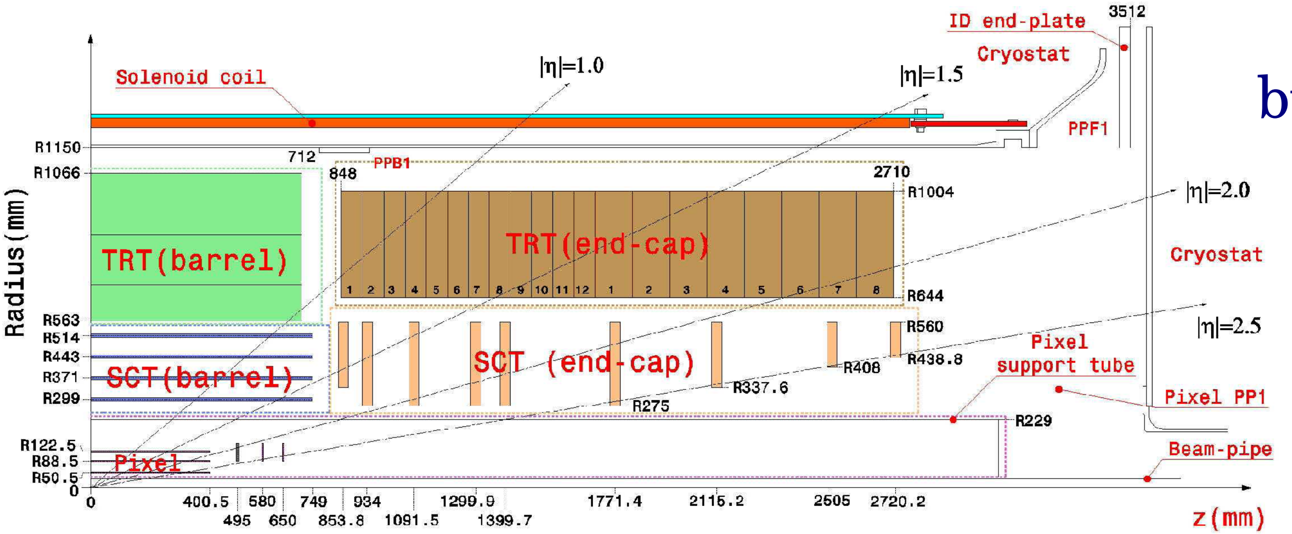
Director: Bethke

0) ATLAS People

	SCT	HEC	MDT	Computing
Staff	Kluth, Nisius, Schieck	Barillari, Huber, Kiryunin, Menke, Oberlack, Schacht	Kroha, Richter	Kluth, v.d.Schmitt
PostDoc	Ghodbane, Macchiolo	Pospelov	D´Orazio, Dubbert, Horvat, Kortner, Kotov, Legger, Mohrdieck-Möck, Rebuzzi, Yuan, Zhuang, Zhuravlov,	Stonjek Mejia
PhD/Dipl.	Beimforde, Bangert, Göttfert, Härtel, Pataraia	Erdmann, Giovannini, Jantsch, Rauter	Bittner, Dedes, Ehrich, Groh, Kaiser, v.Loeben	
Guest		Minaenko, Stavina, Strizenec	Potrap	

1) Installation: SCT ECA

Quadrant of ATLAS inner detector

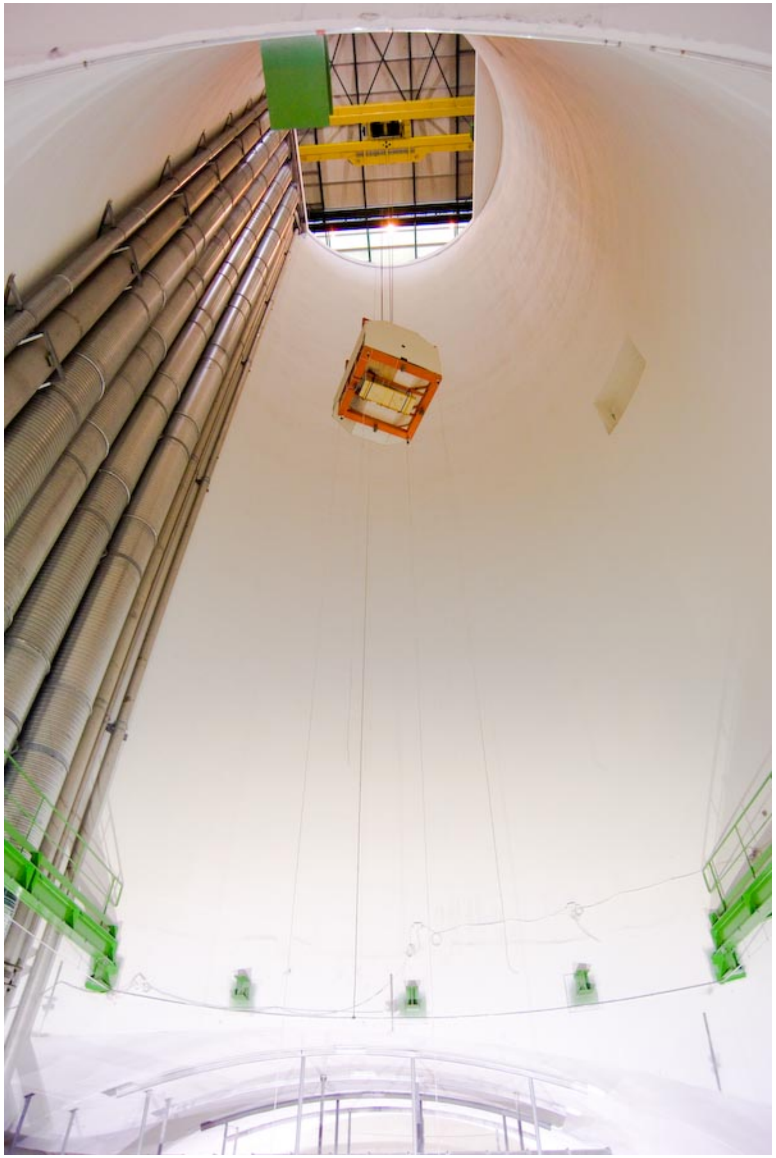


Si detector layout and design

built > 400 EC modules

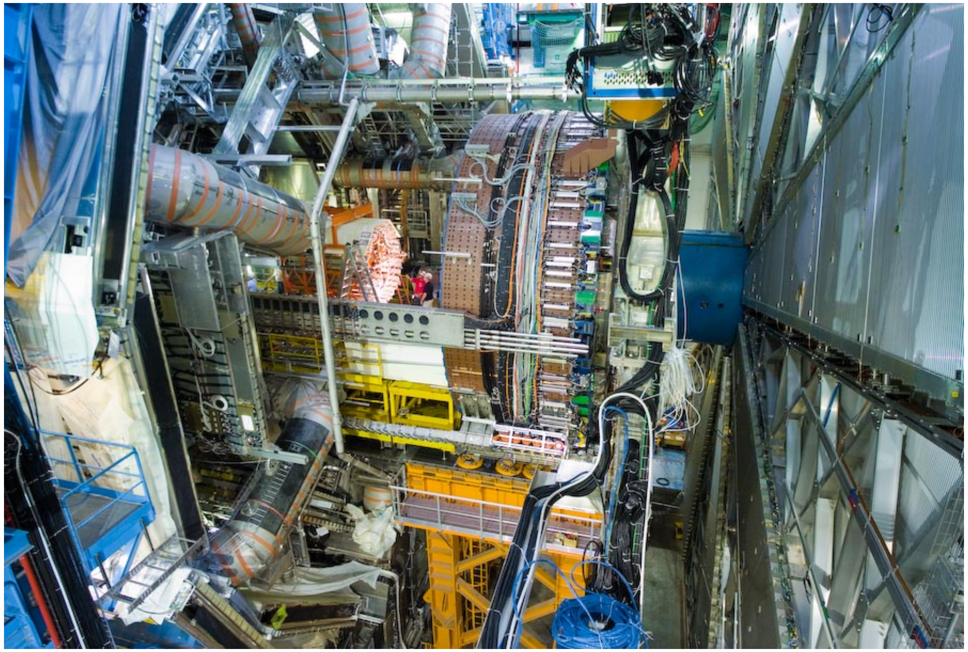
Final installation of endcap A (ECA) into ATLAS May 2007

1) Installation: SCT ECA

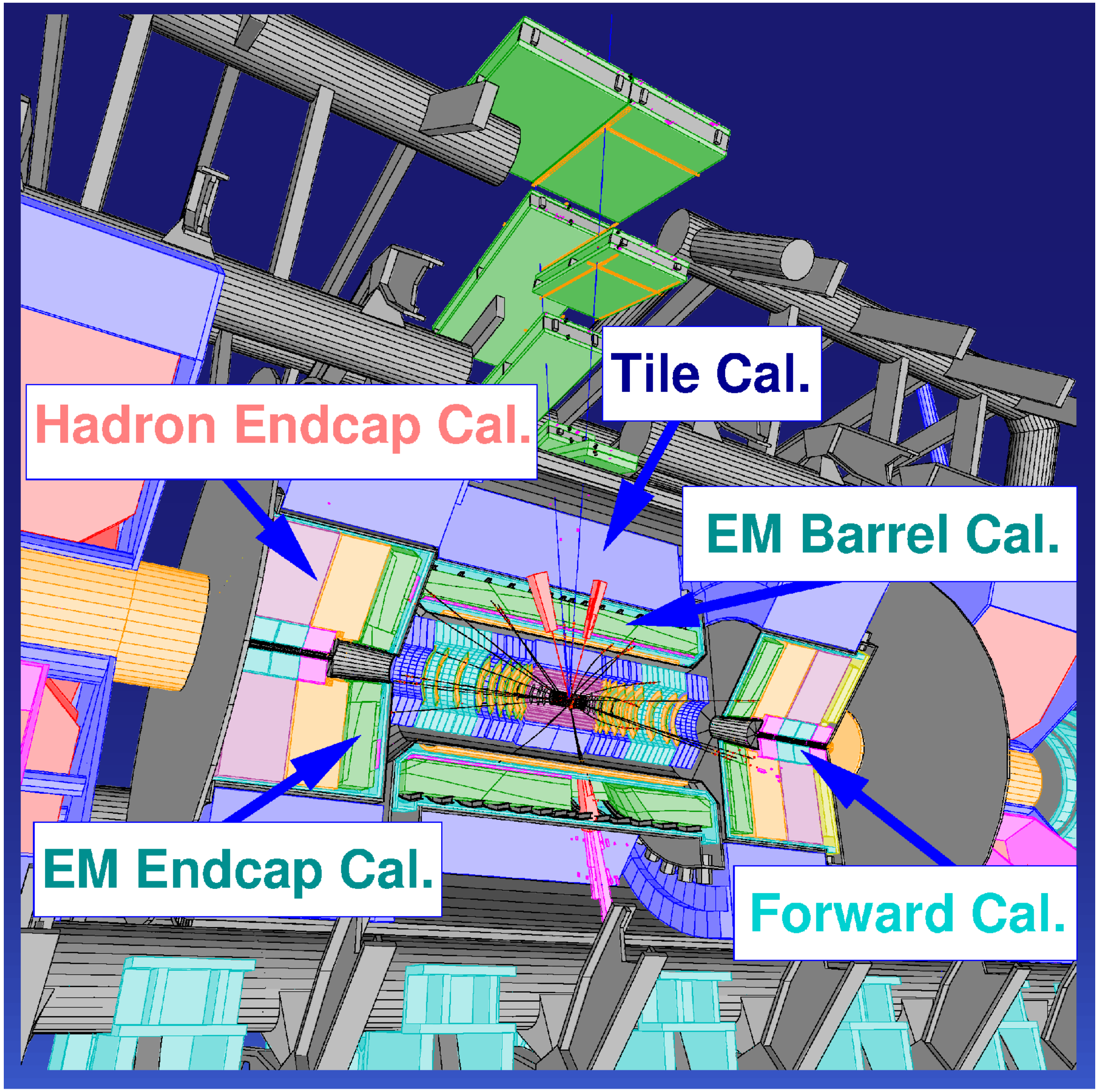


down the access shaft ...

... and finally into ATLAS



1) Installation: HEC

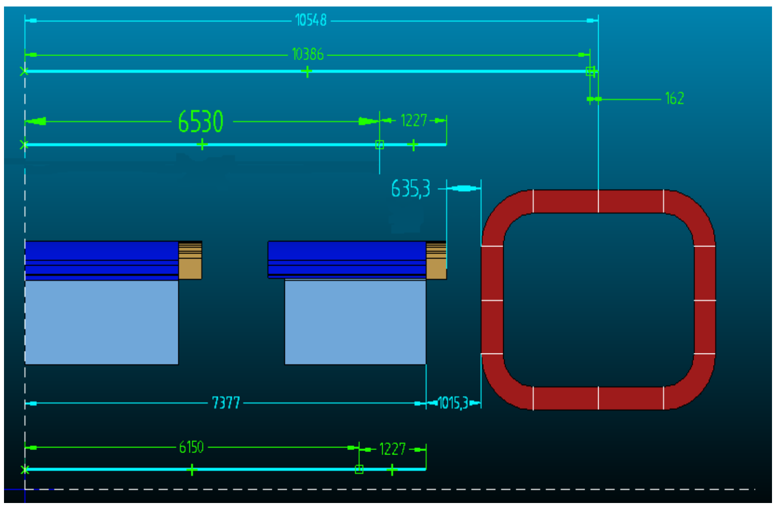


Installation of
Endcap (EC) C

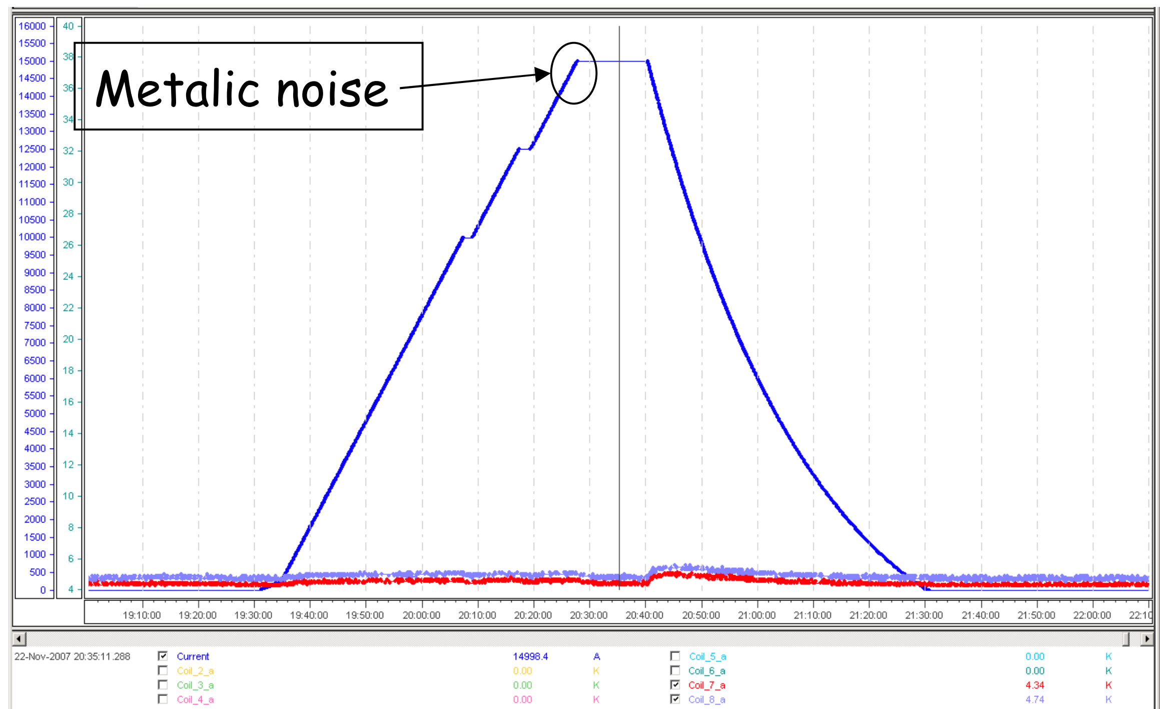
EC magnet test incident
November 22

1) HEC ECC & Magnet Test

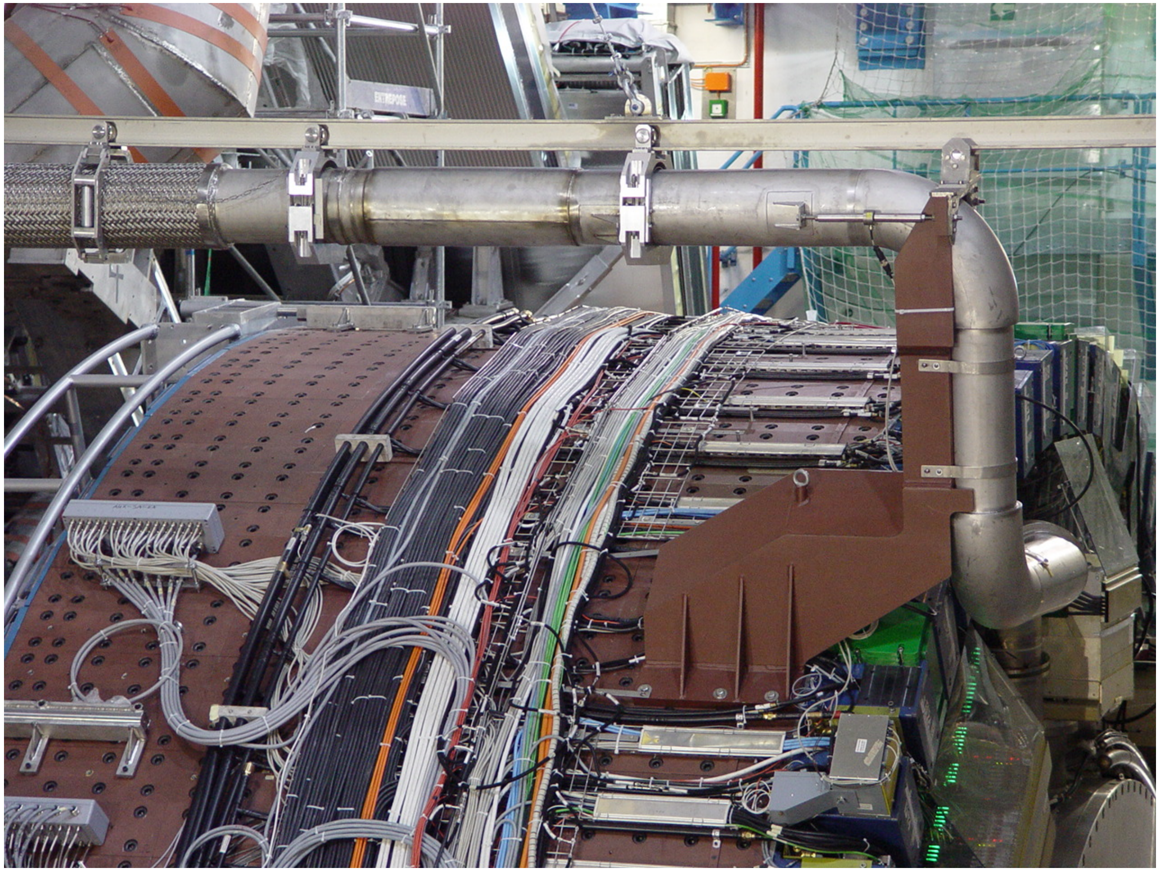
Sketch of test setup



ECC magnet current vs. time



1) HEC ECC & Magnet Test

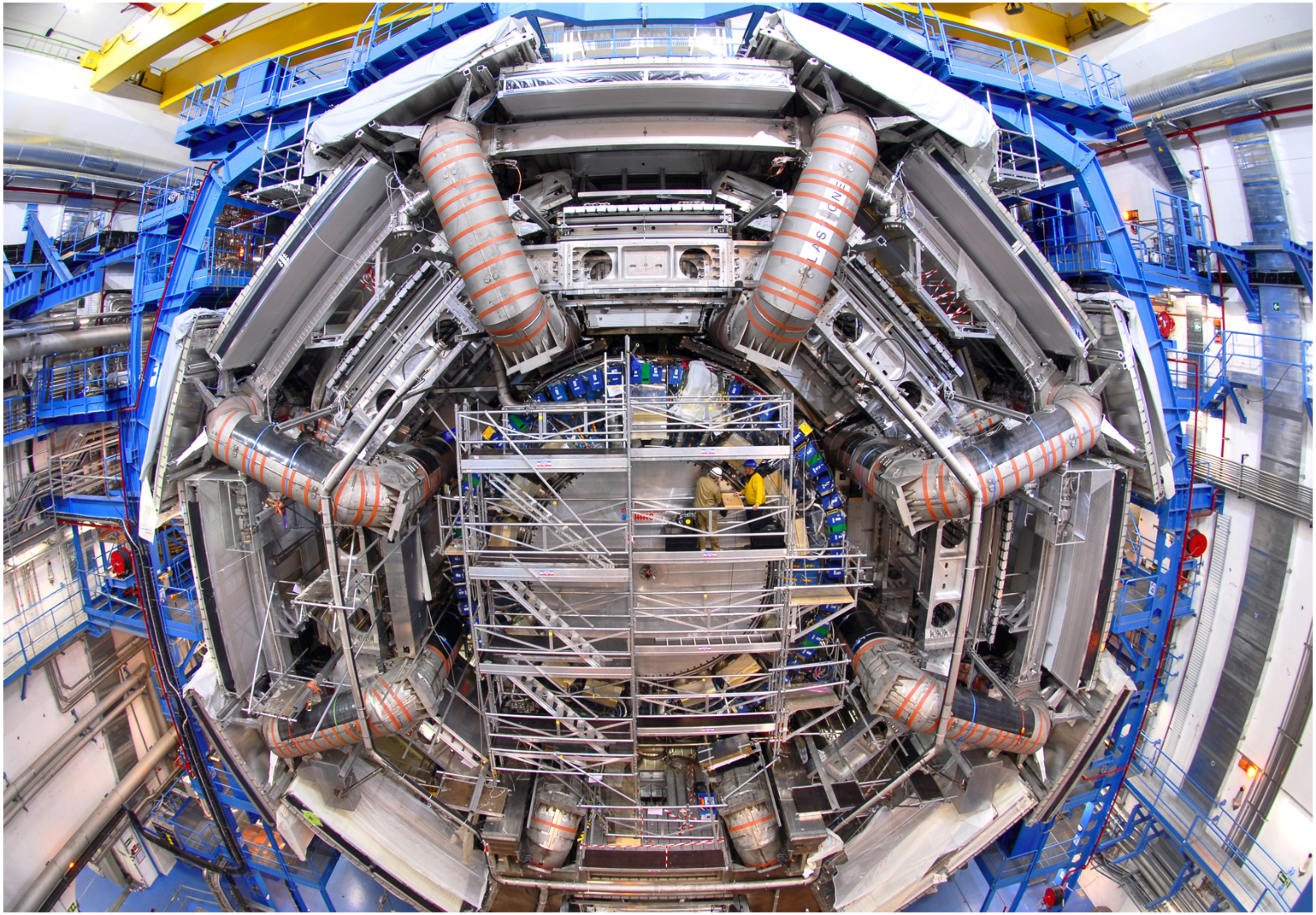


Damage to LAr transfer line
vacuum broken, cold line ok
repair until Feb. 08 ok with schedule

1) Installation: MDT

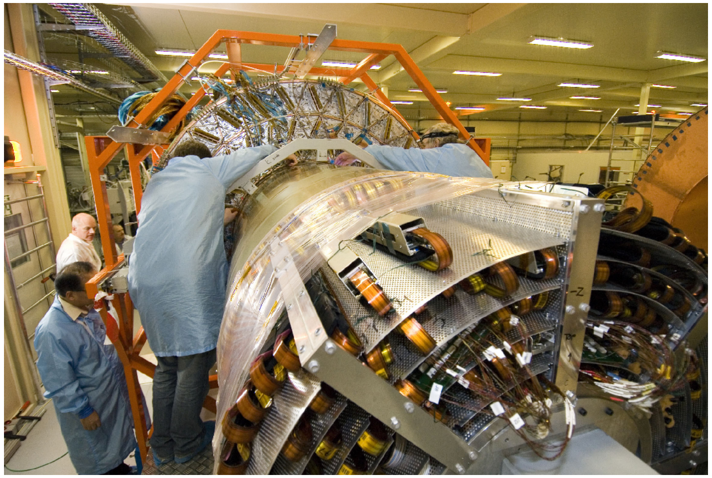
Jan.-Feb. 07 installation of barrel chambers (MDT+RPC)

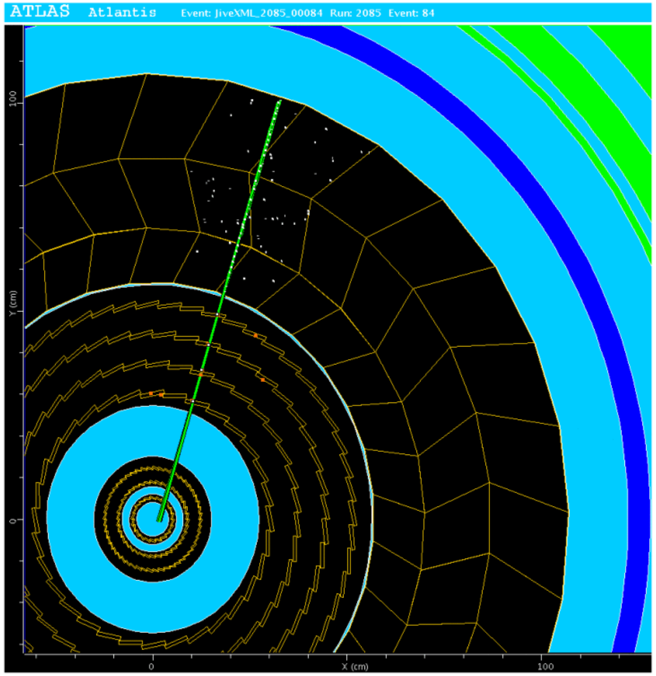
Mar.-Dec. 07 commissioning with cosmics



2) Commissioning: SCT

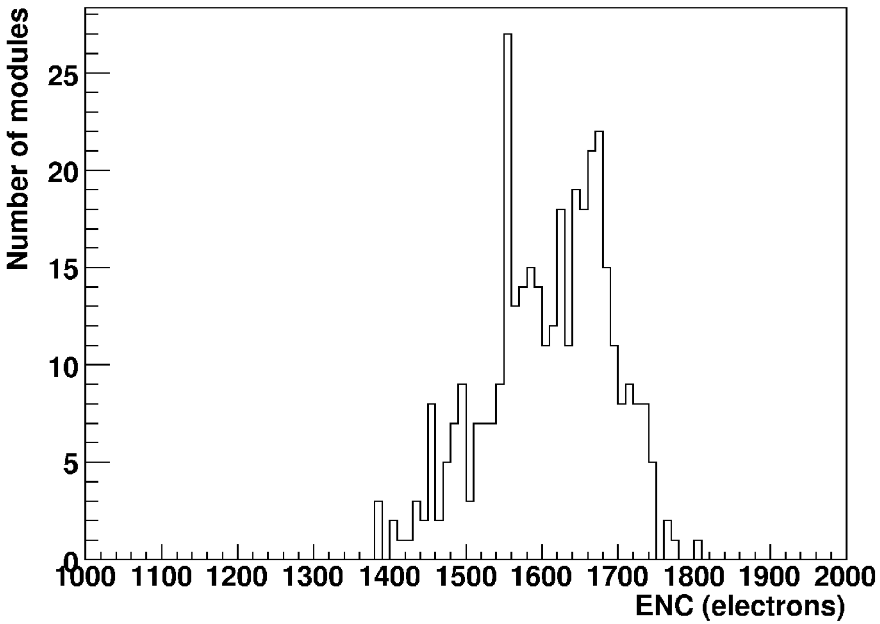
SCT/TRT data taking with cosmics in SR1 surface building

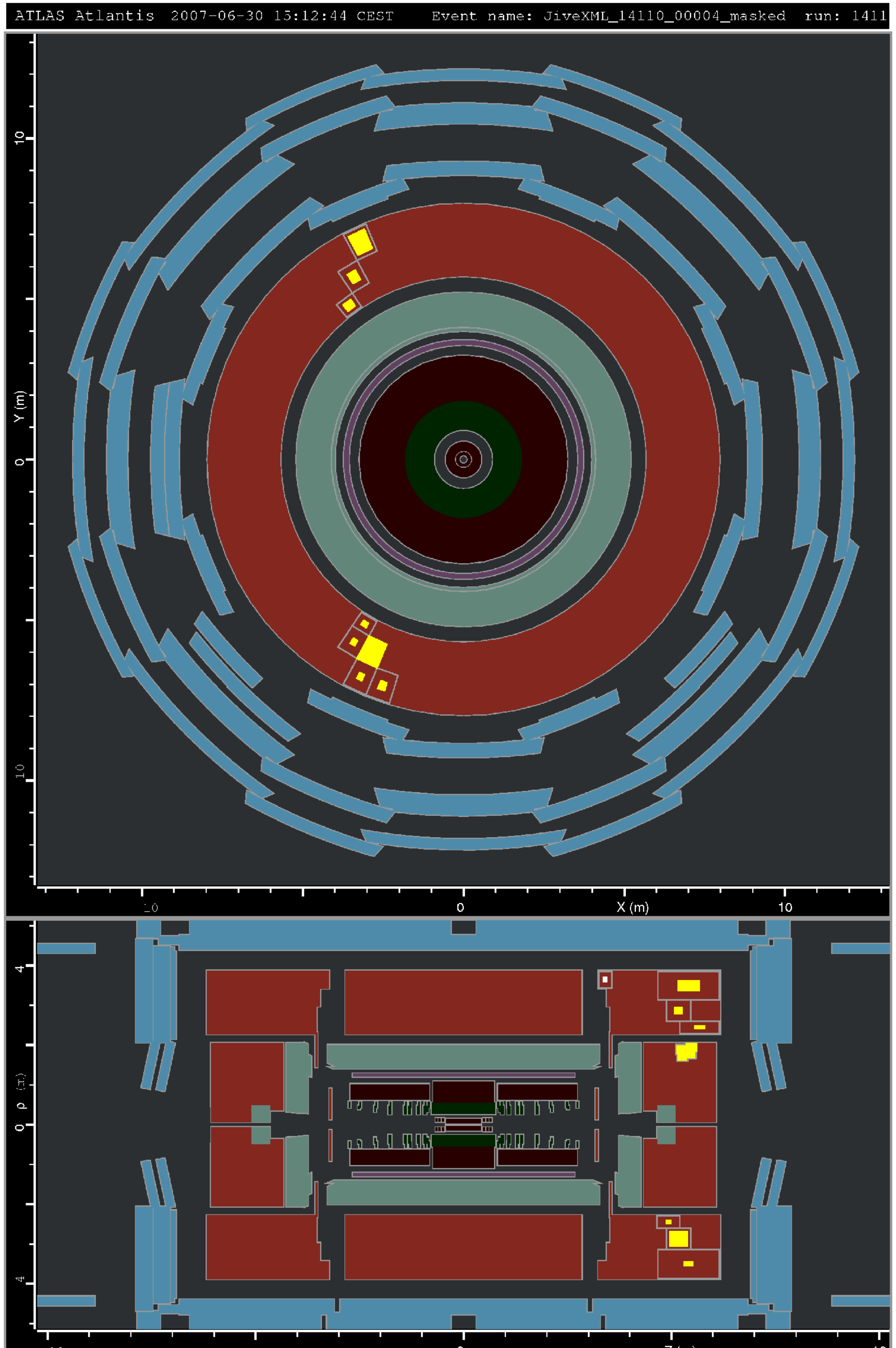




Endcap SCT

ENC from noise scans

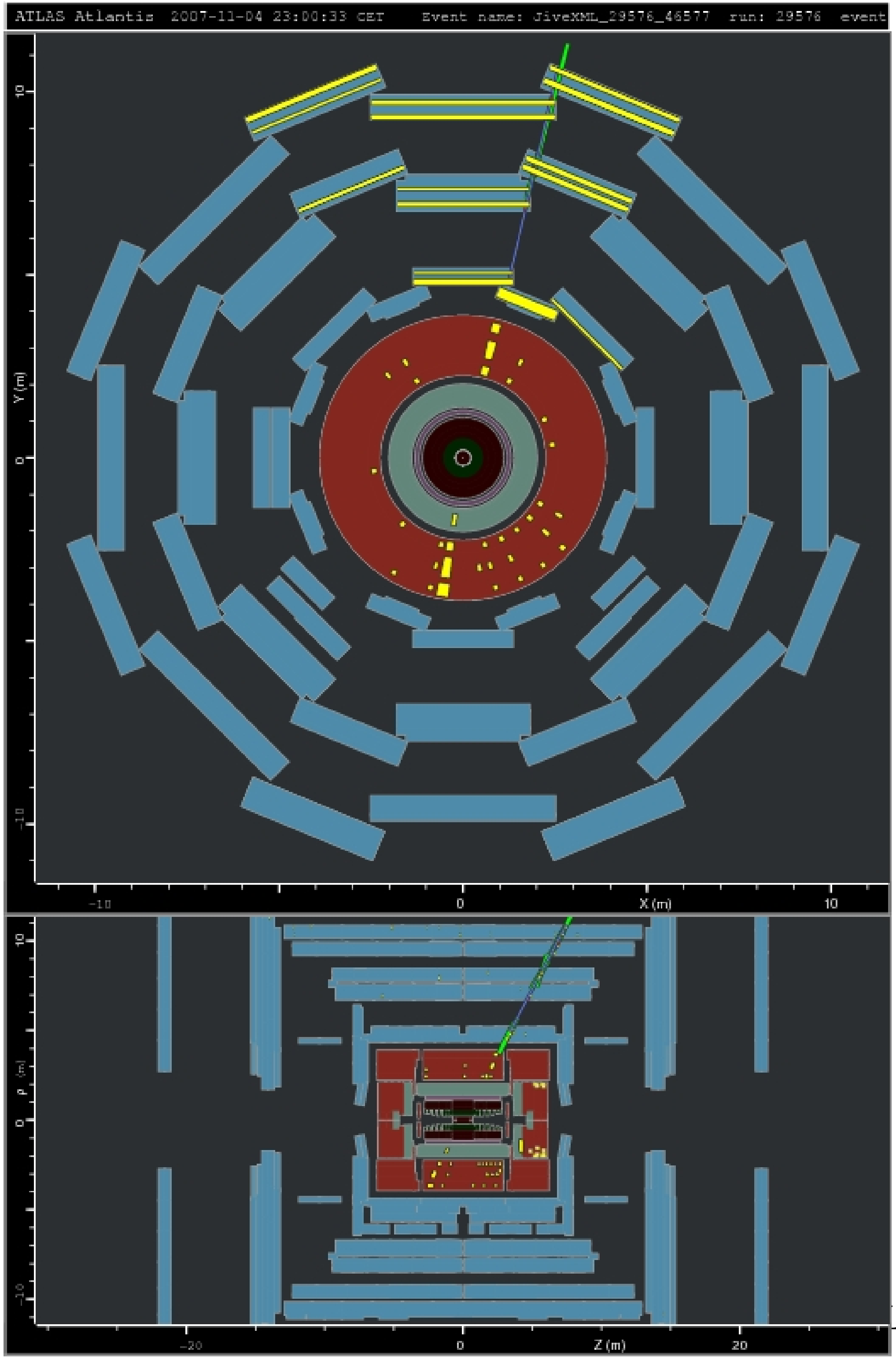




2) Commissioning: HEC

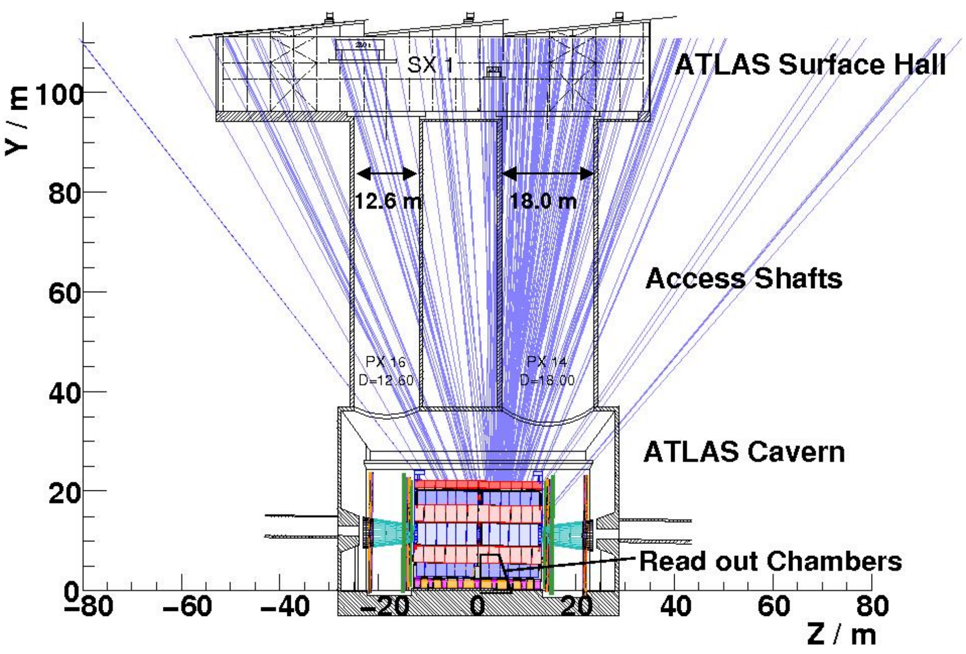
Regular data taking with cosmics barrel and ECA incl. HEC

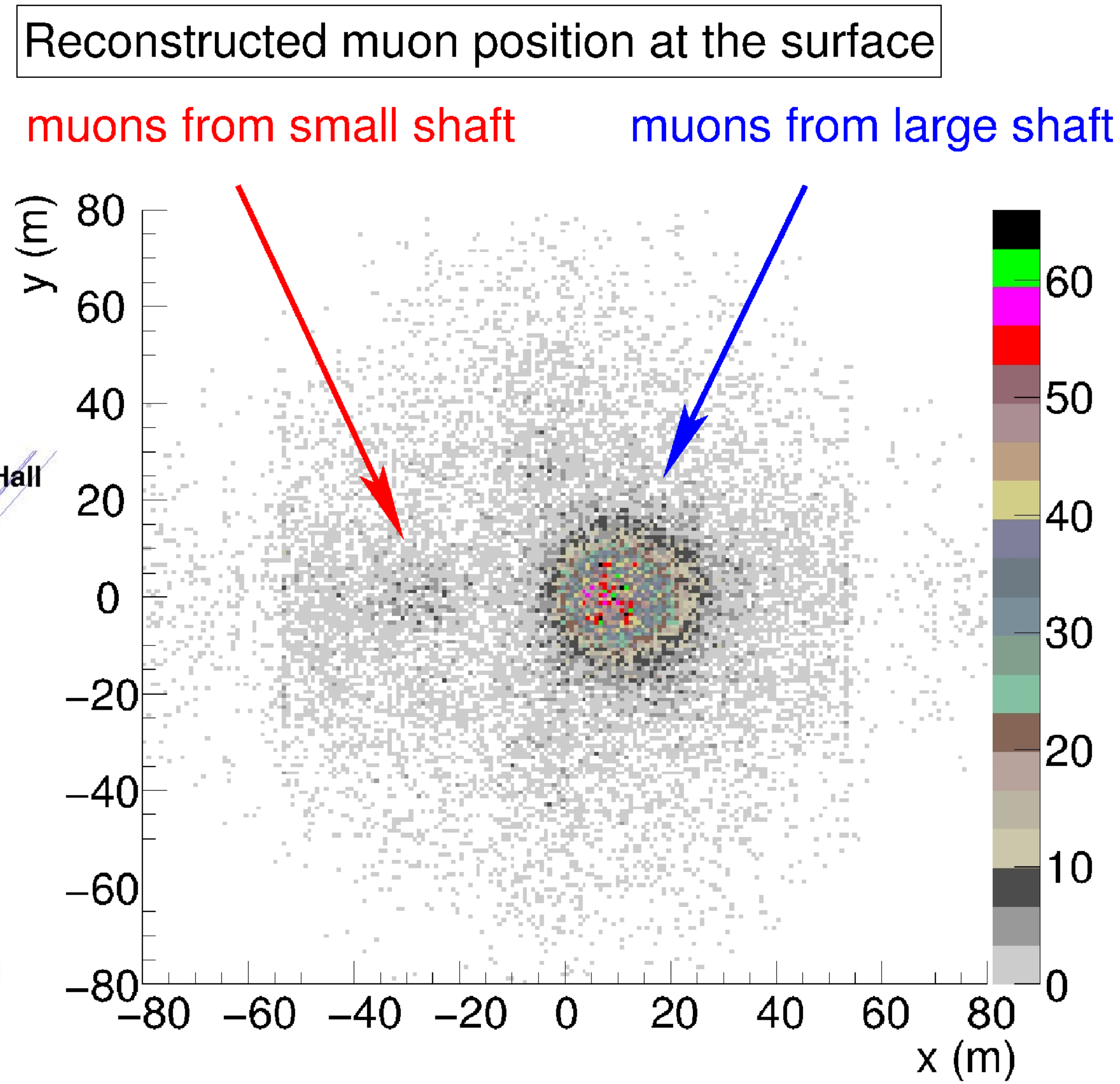
2) Commissioning: MDT



2) Commissioning: MDT

Measure cosmics using muon spectromenter



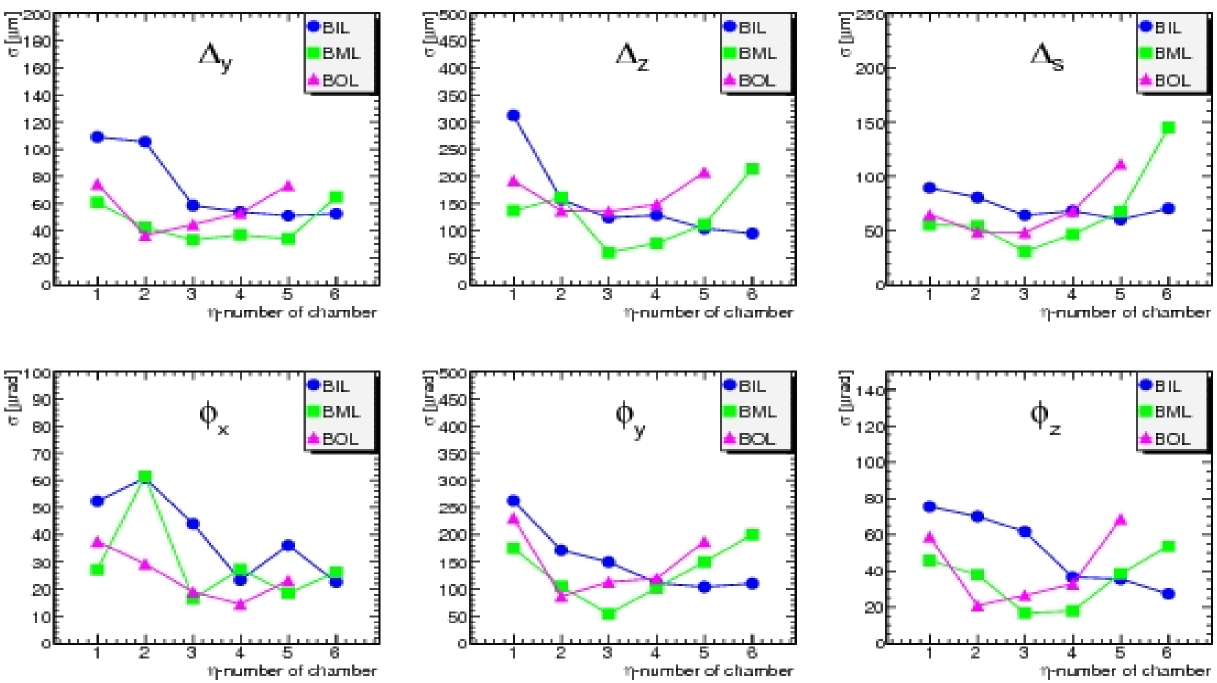


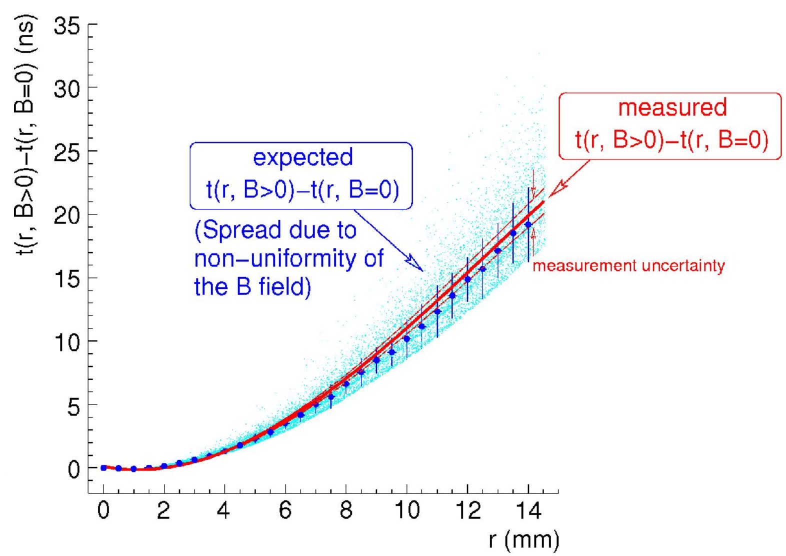
2) Commissioning: MDT

~ $2 \cdot 10^7$ cosmic muons reconstructed

ca. 25% of detectors in operation

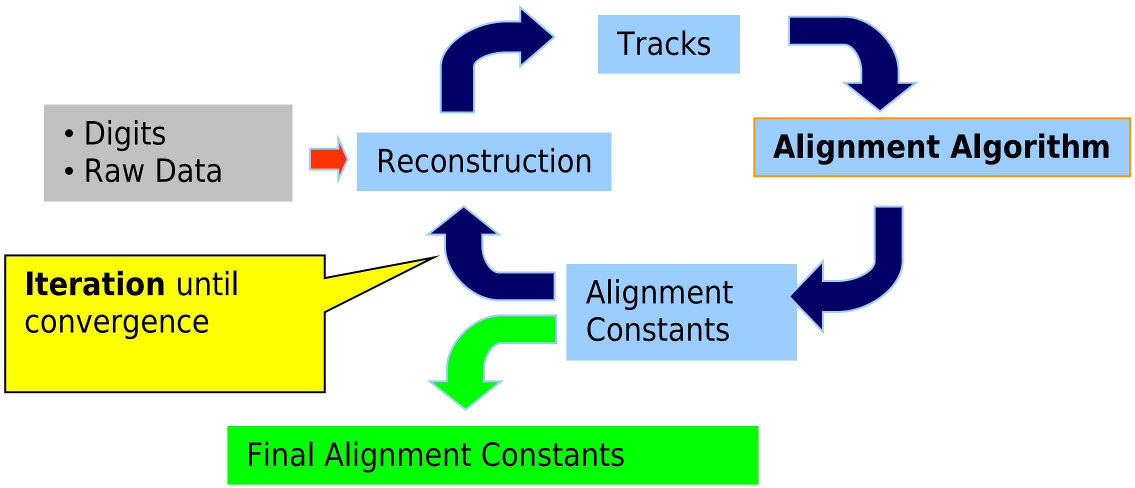
Initial alignment of installed detectors





Magnetic field corrections to drift time vs radius r

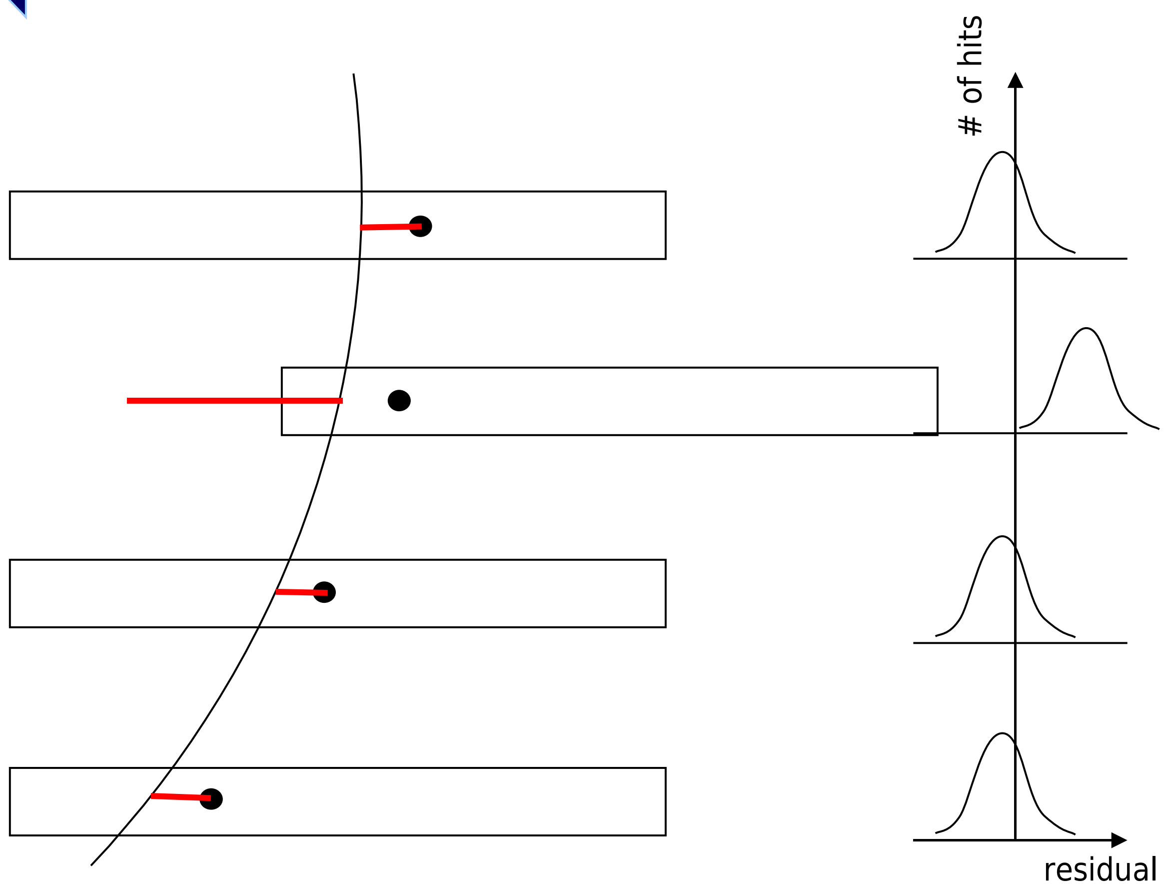
3) Local χ^2 Alignment for ID



minimise track-hit residuals
with 6 d.o.f. per module

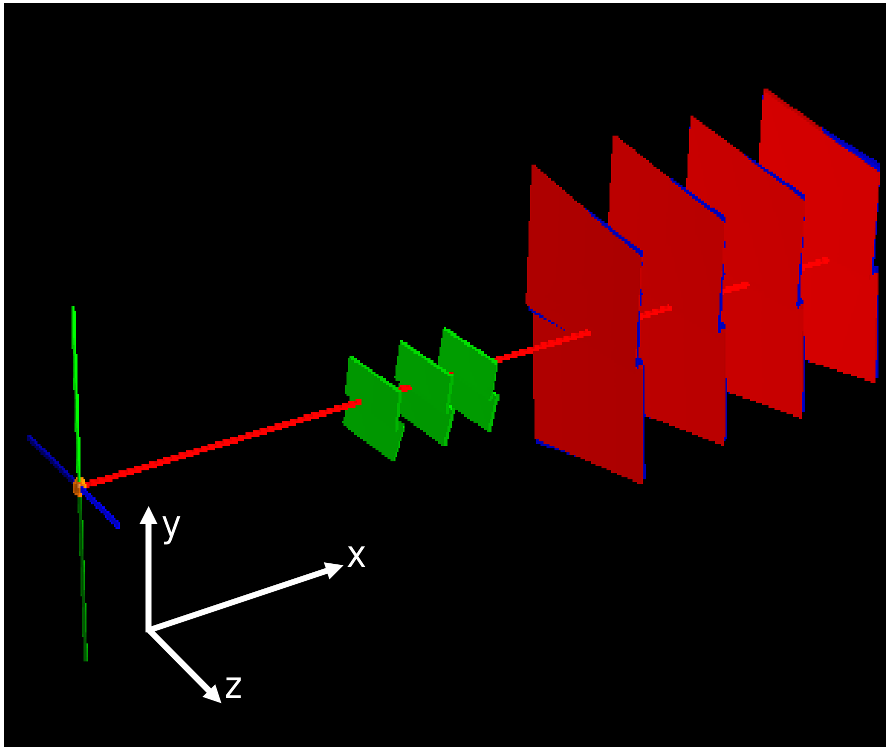
linearised $\chi^2 \Rightarrow$ solutions from
6x6 matrix inversions

modules correlated
$\Rightarrow$ iterations needed

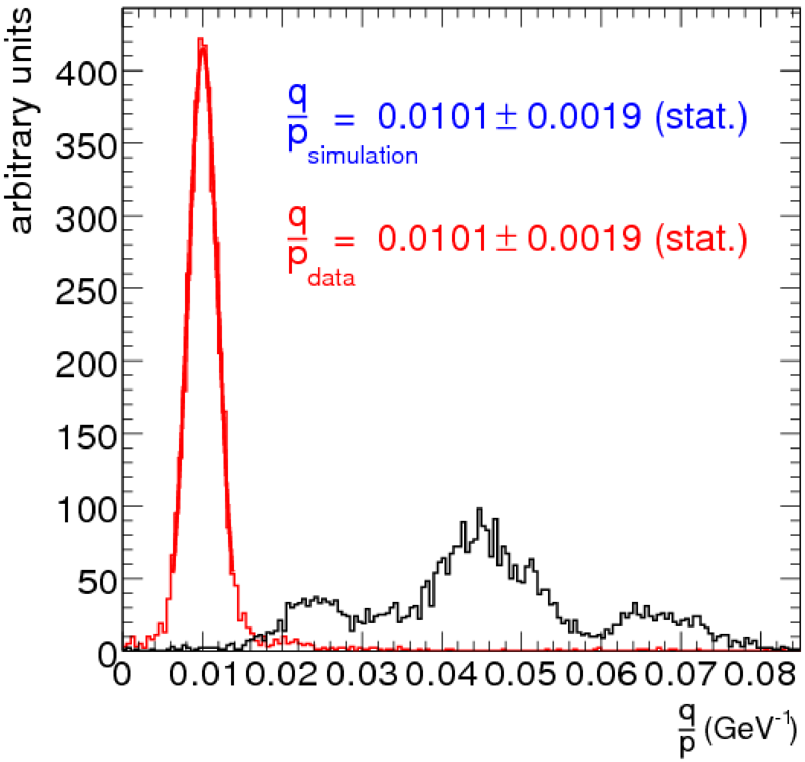


3) CTB Alignment

CTB = combined test beam (2004)



track momenta as expected after alignment



3 Pixel and 4 SCT layers

tracks (pions) 2-180 GeV/c

limited illumination

3) ID Alignment with CSC Data

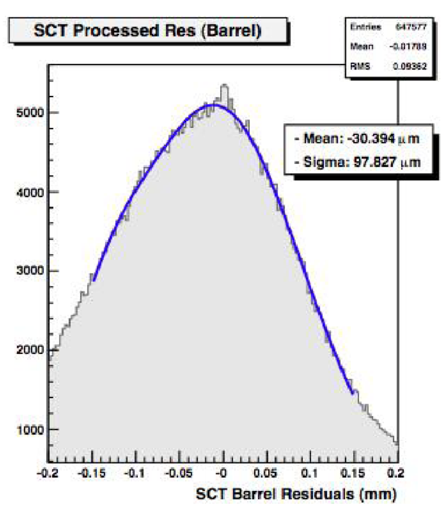
CSC = computing system challange, data contain “realistic” misalignment

Level 1: ECs, barrel etc. large structures, ca. 50 d.o.f.

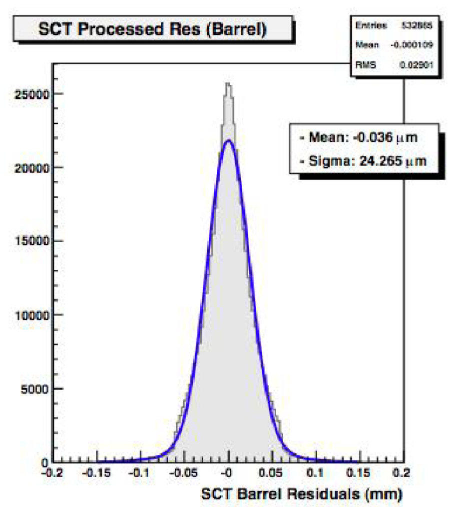
Level 2: barrel layers and EC disks, ca. 1000 d.o.f.

Level 3: modules, ca. 40k d.o.f.

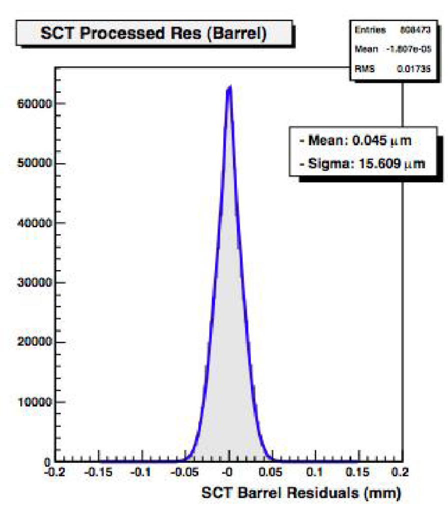
CSC data



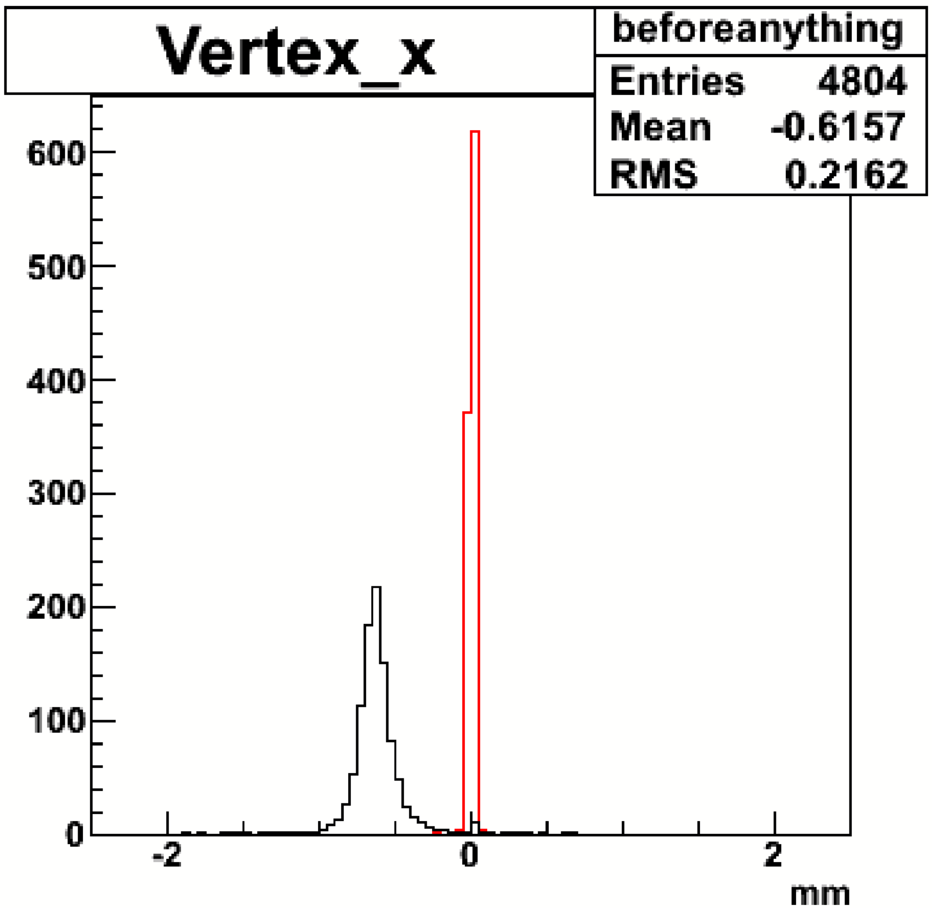
w/o L1, L2



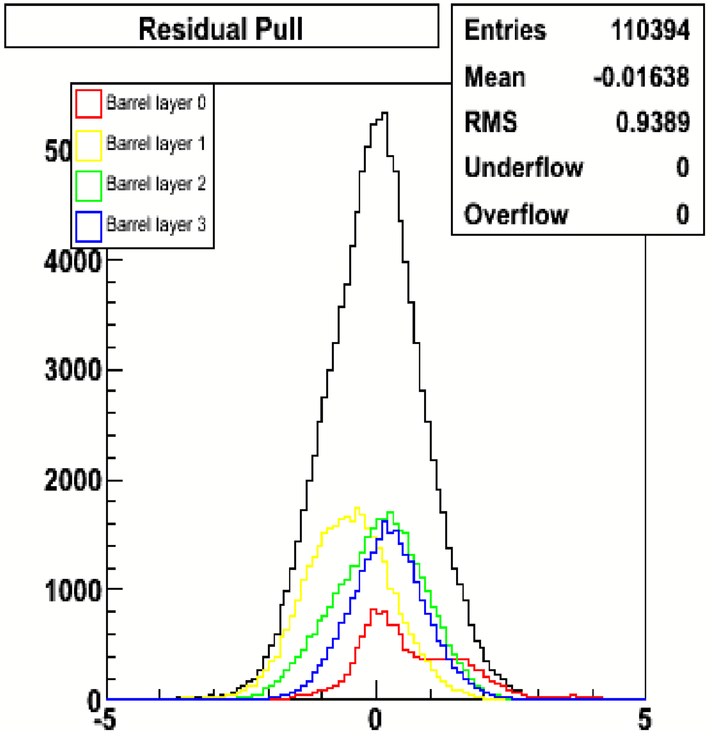
perfect



3) ID Alignment with CSC Data

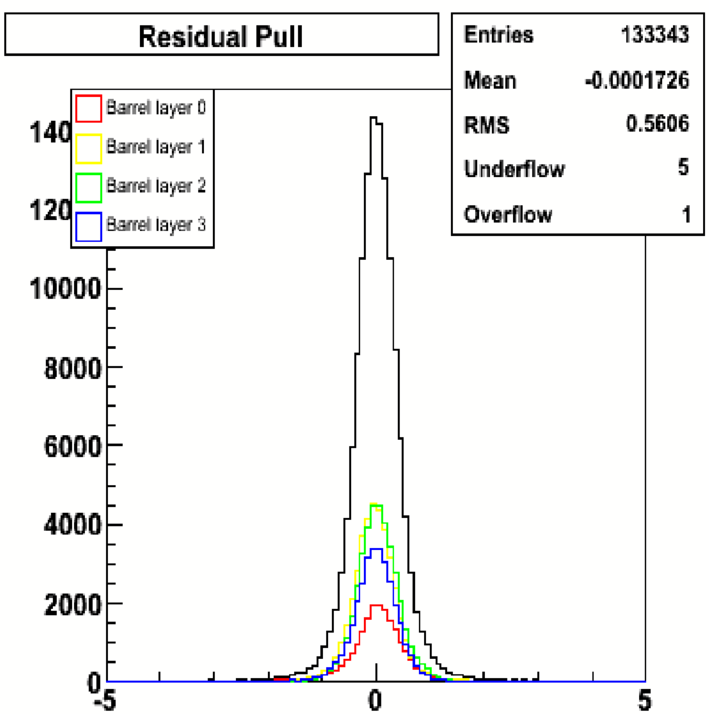


before



SCT barrel

after



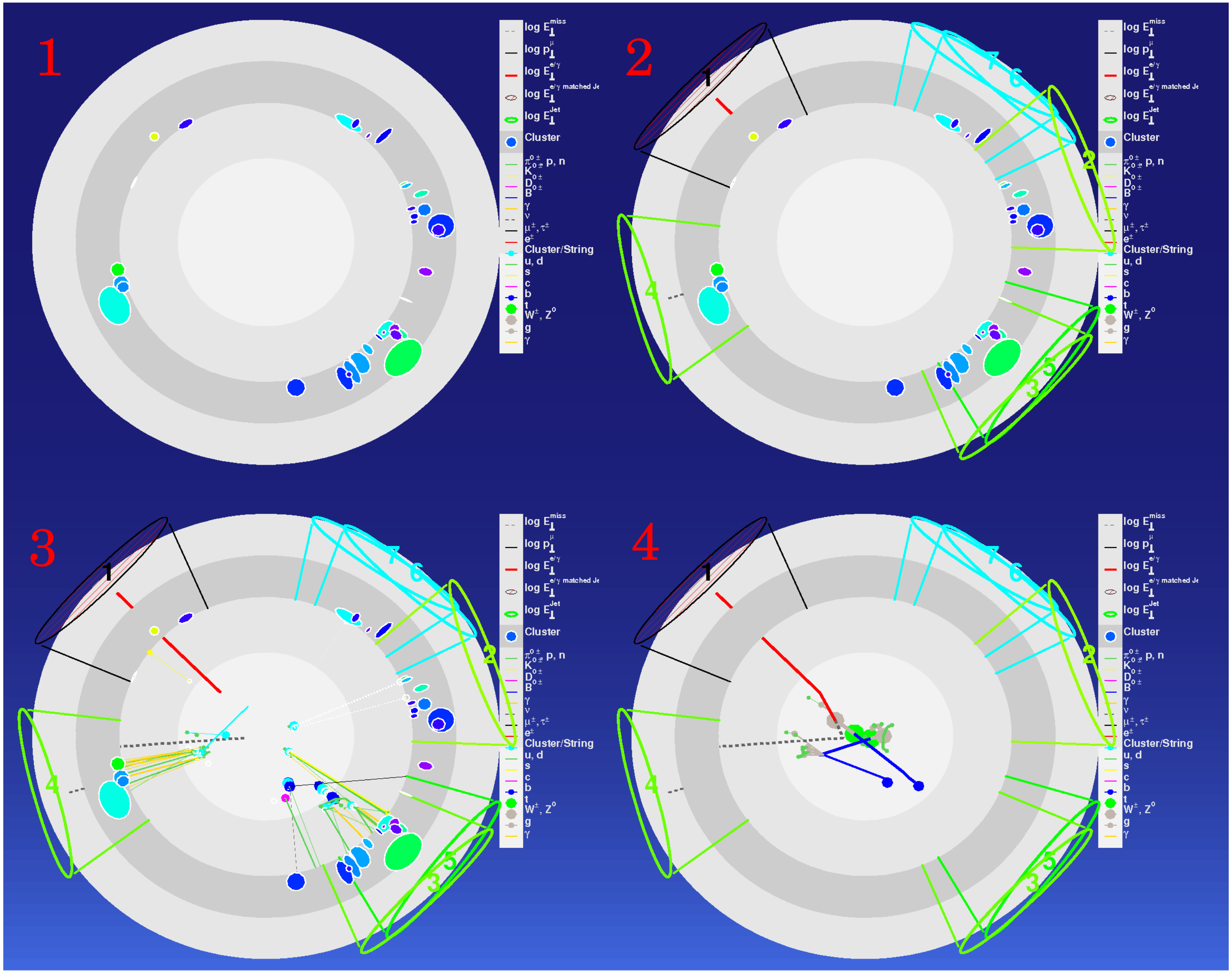
3) Calorimeter/Jet Calibration

1) cluster reconstruction (and correction)

2) jet finding

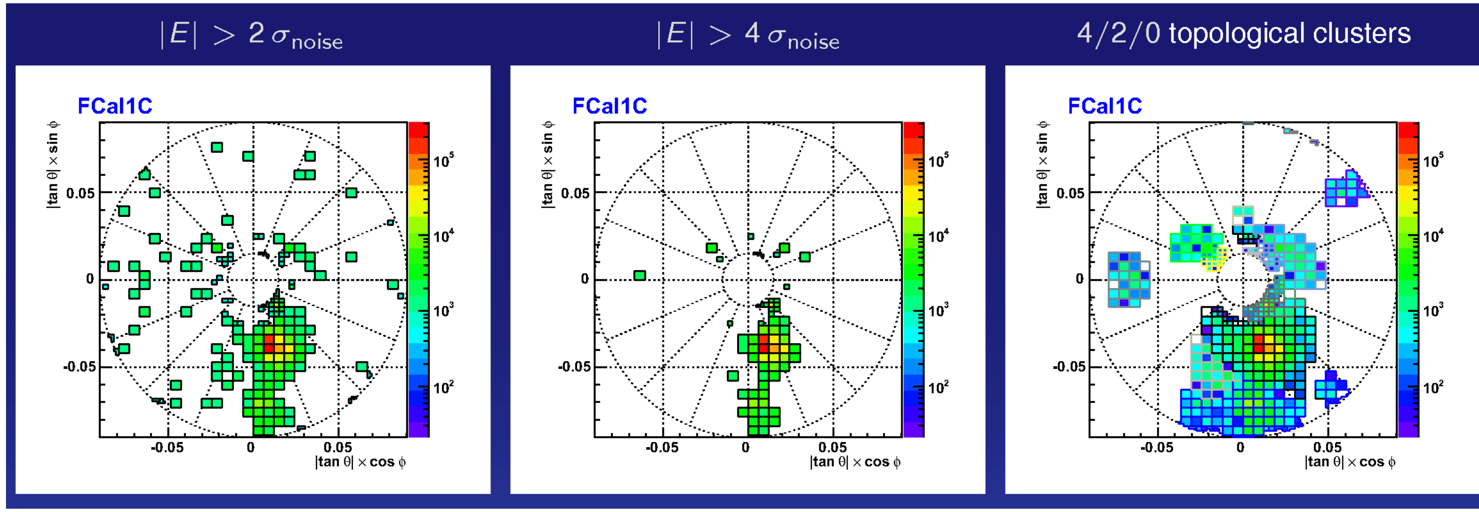
3) jet energy correction det.-had.-level

4) jet energy correction had.-part.-level



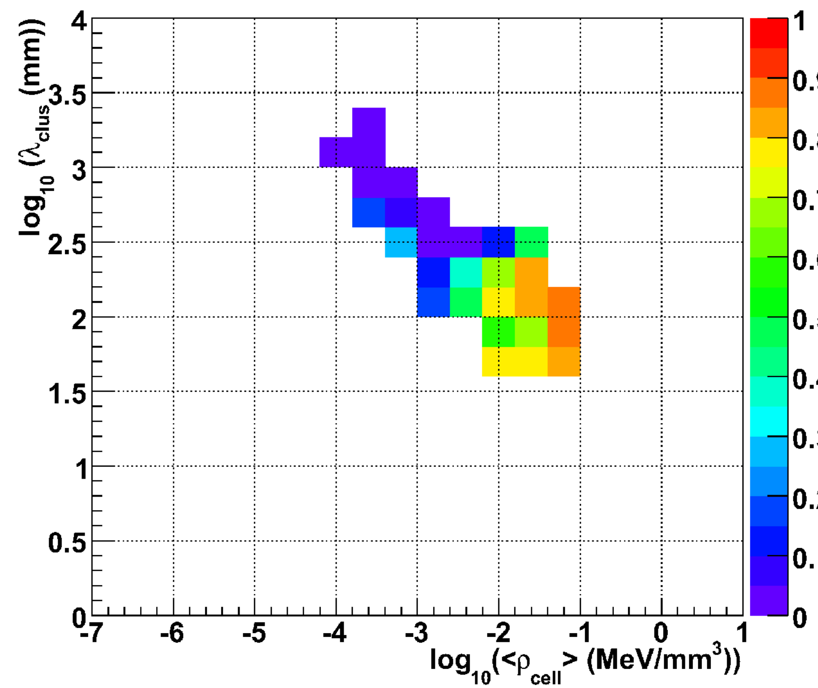
3) Calorimeter/Jet Calibration

Topological 4/2/0 clustering algo-rithm



Classify clusters as "π^0" or "$\pi^\pm$" depending on depth and energy density

Apply MC based correction for $\pi^\pm$ like clusters



3) Calorimeter/Jet Calibration

MC Performance study with di-jets

$0.2 < |\eta| < 0.4$,

$E_{jet} \approx 150 \pm 40$ GeV

k_t (R=0.4)

red: uncorrected

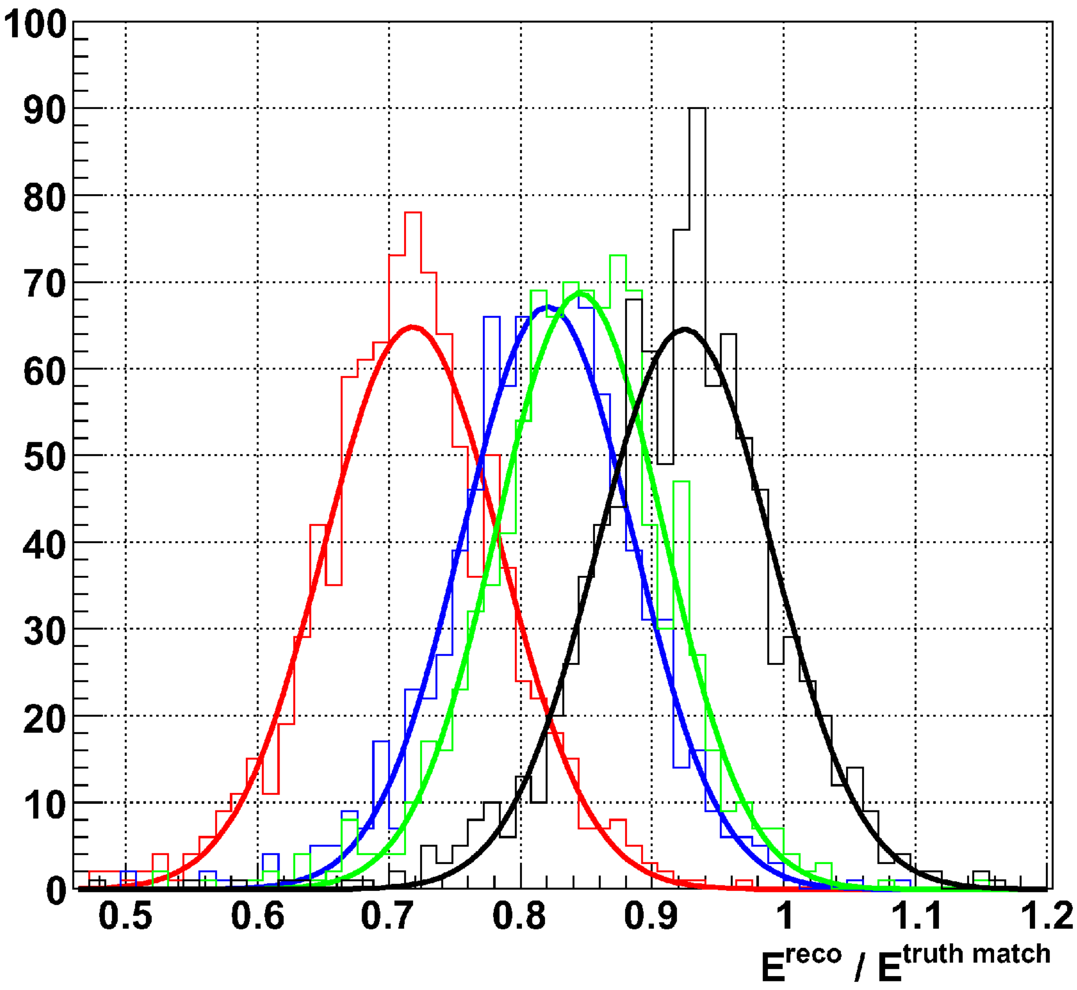
blue: cluster correction

green: + out-of-cluster corr.

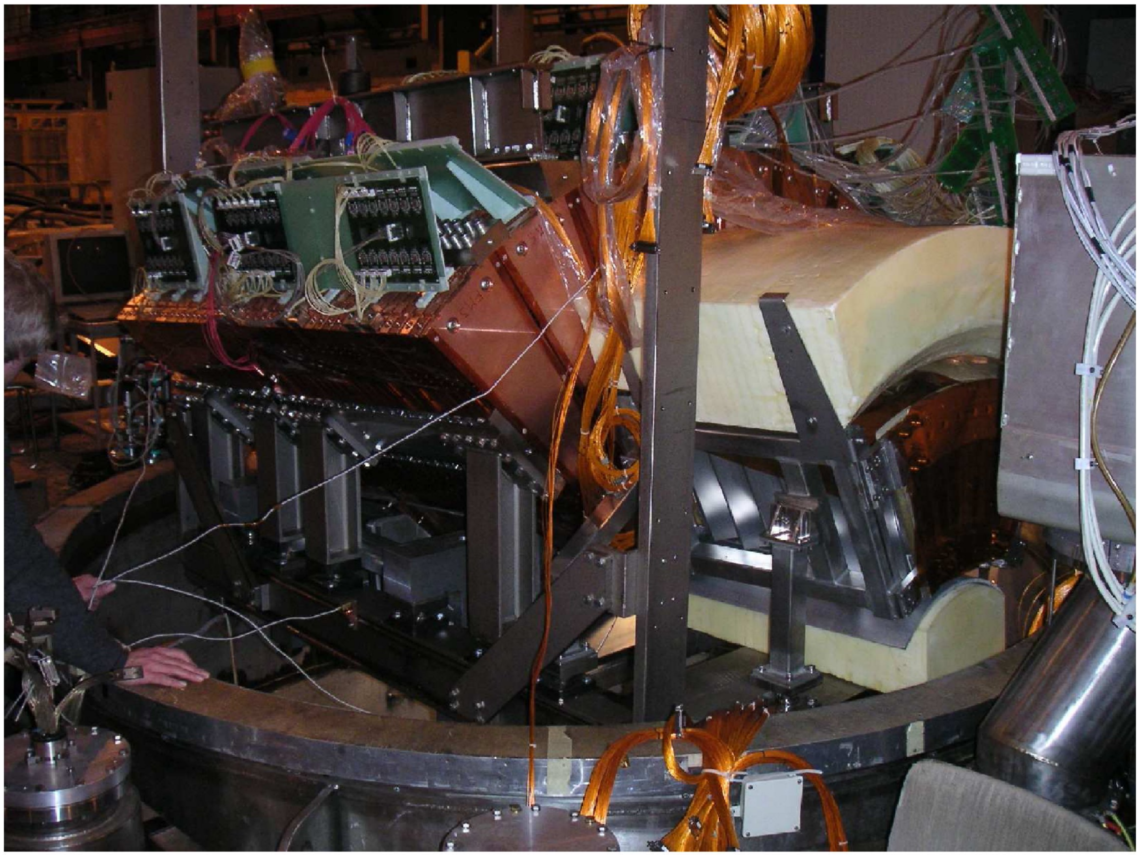
black: + dead material corr.

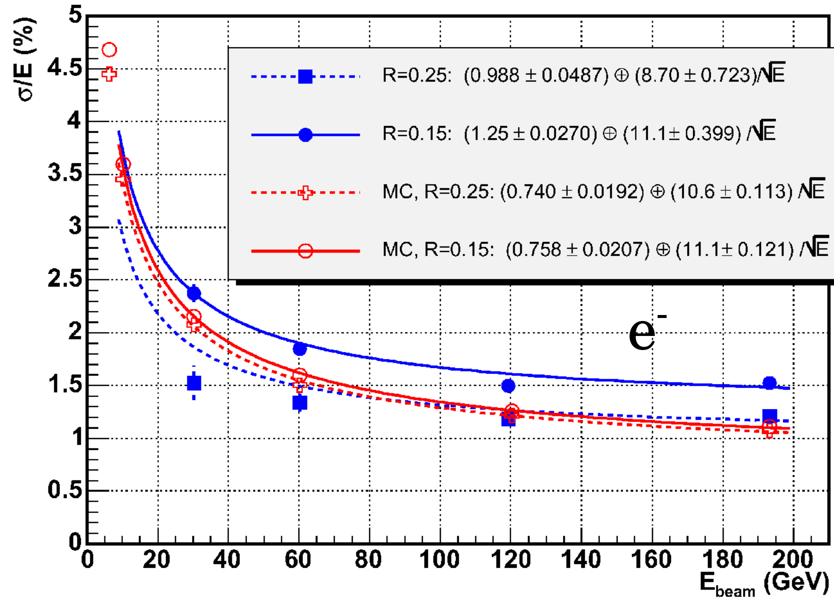
remaining discrepancy due

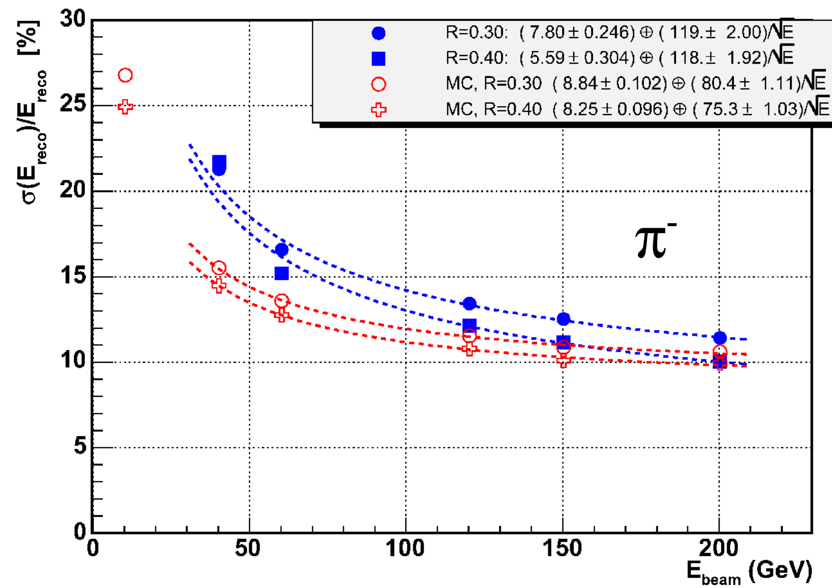
to out-of-jet and misclassification



3) CTB Calorimeter Analysis





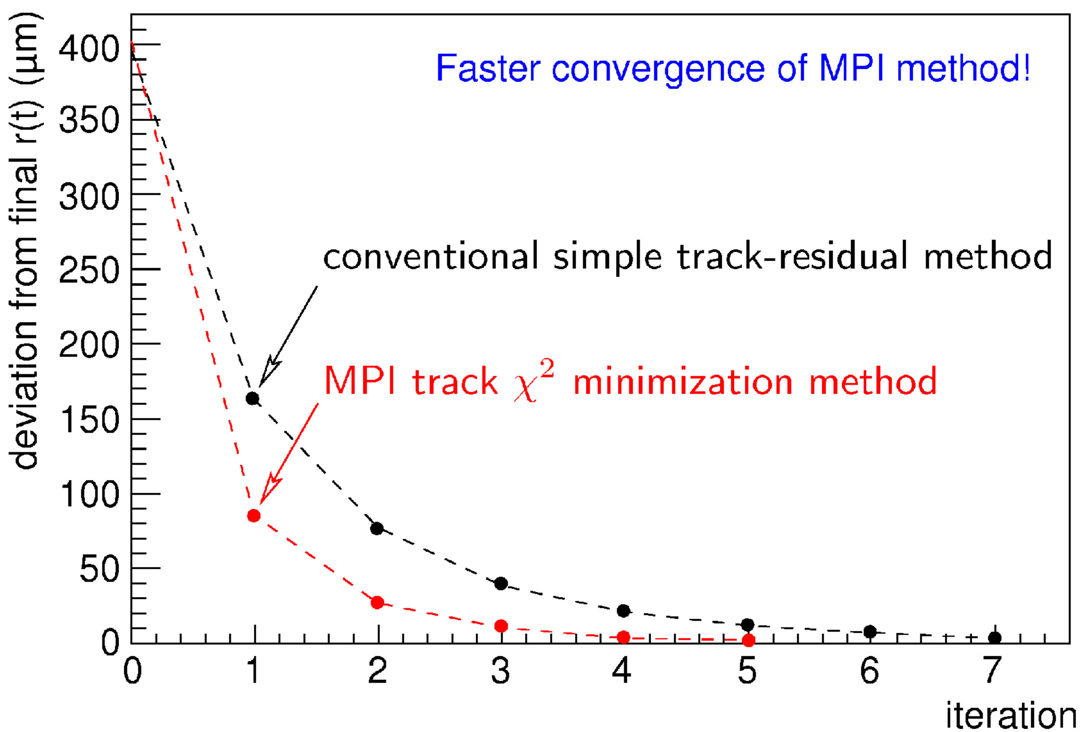


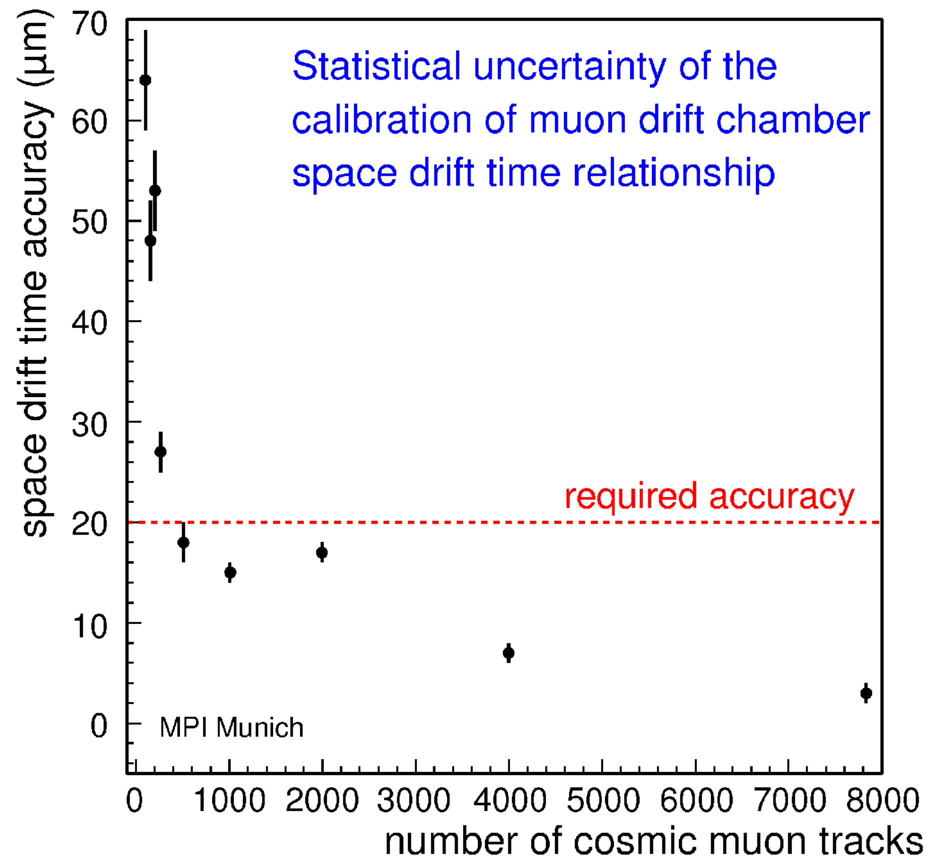
CTB and MC (Geant4) agree ok

Basis for using MC for cluster/jet calibrations

3) Muon Chamber Calibration

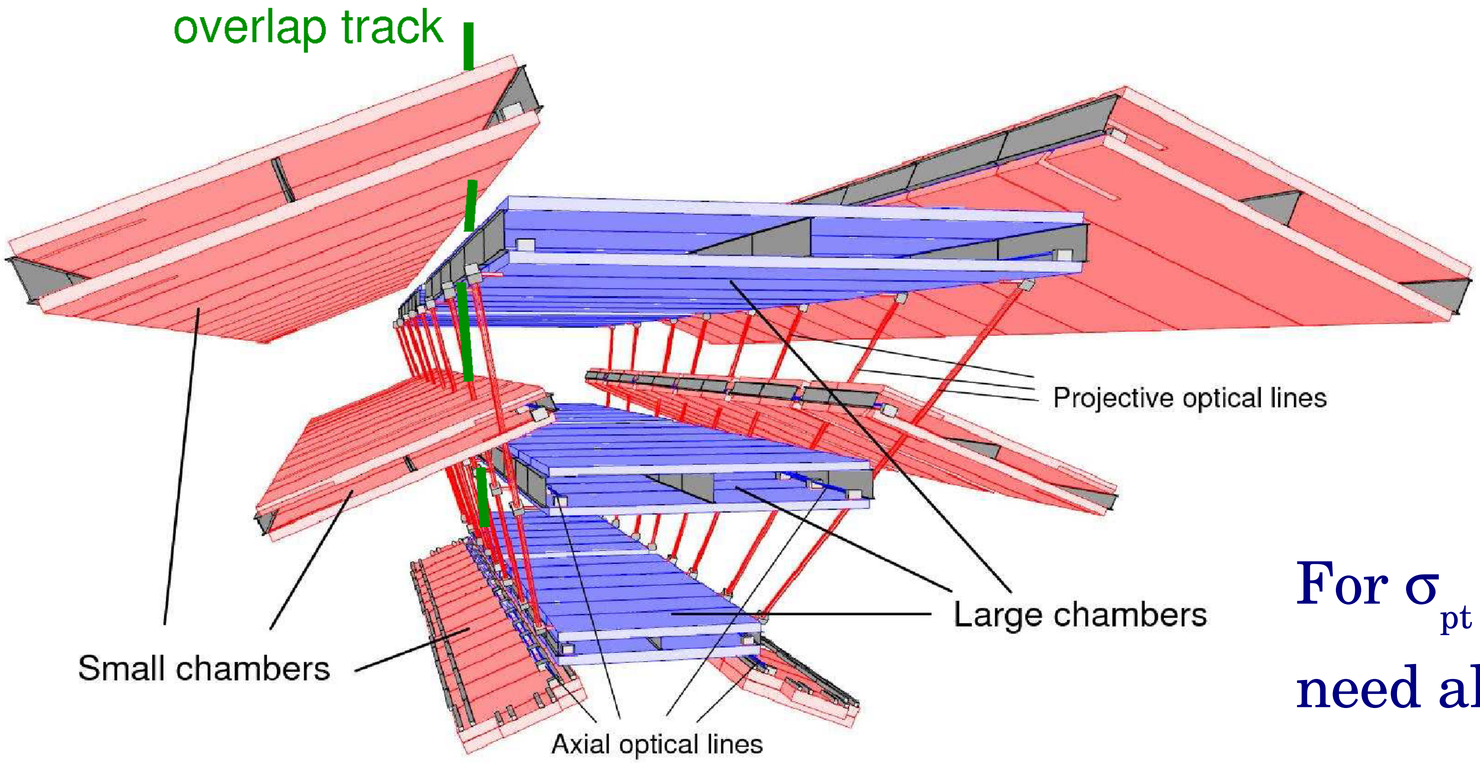
Determination of time-to-distance (r-t) relation, sychronisation, resolution, including mag. field and high-rate corrections





Need O(1000) tracks per calibration

3) Muon Alignment with Tracks



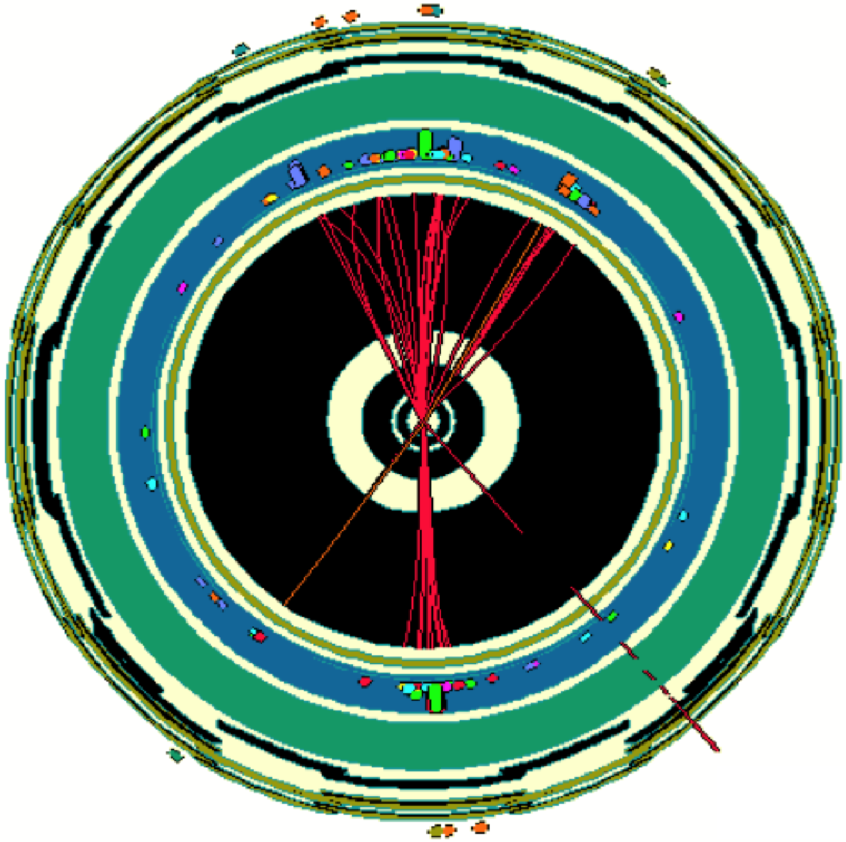
For σ_{pt}/p_t (1 TeV) = 10%
need alignment to 30 μm

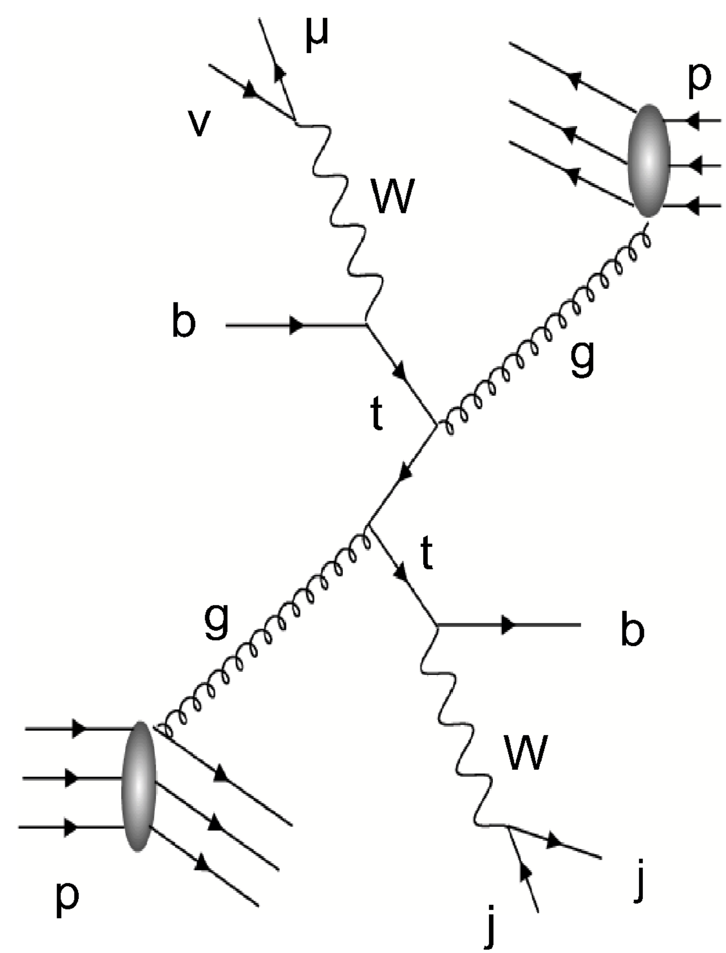
Optical monitoring of large chambers, monitoring with tracks of small chambers, initial alignment with straight (B=0) tracks

4) Physics: top Quark Properties

- Top quark mass (CSC note T2)
  - semileptonic: golden channel
  - hadronic: challenging, connected with jet calib.
- pp → $t\underline{t}$ production cross section
  - semileptonic w/o b-tag (safe), w b-tag (better errors)
- commissioning with $t\underline{t}$
  - understand/calibrate calorimeter/jets

4) Physics: top Quark





$\sigma_{t\bar{t}} \simeq 800$ pb $\Rightarrow$ 1 $t\bar{t}$/s at $\mathscr{L} = 10^{33}/(\text{cm}^2\text{s})$

Selection cuts: 1 lepton $p_t > 20$ GeV, ≥ 4 jets ($k_t(0.4)$)

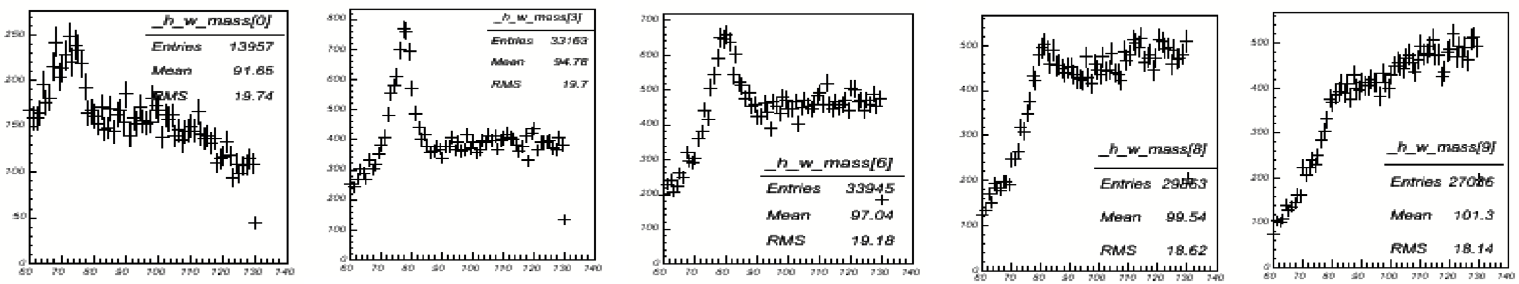
(p_t = 40,40,40,20 GeV), $|\eta|<2.5$, $E_{t,miss} > 20$ GeV,

highest-p_t 3-jet comb. $\Rightarrow$ t, highest-p_t 2-jet comb $\Rightarrow$ W

4) Physics: top Quark

Invariant Mass Distribution of the W Boson

- Jet reconstruction algorithm was run on Monte Carlo truth after hadronization.
- No detector simulation was performed.



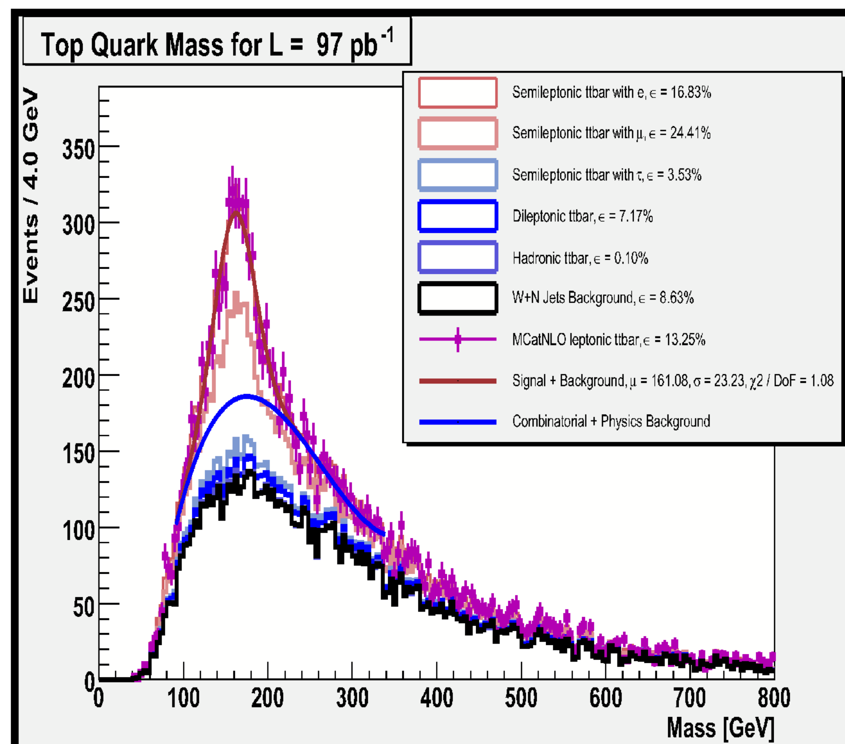
D = 0.1 D = 0.4 D = 0.7 D = 0.9 D = 1.0

tune k_t jet algorithm for $t\underline{t}$ analysis

from highest-p_t 3-jet mass distribution

extract cross section or mass

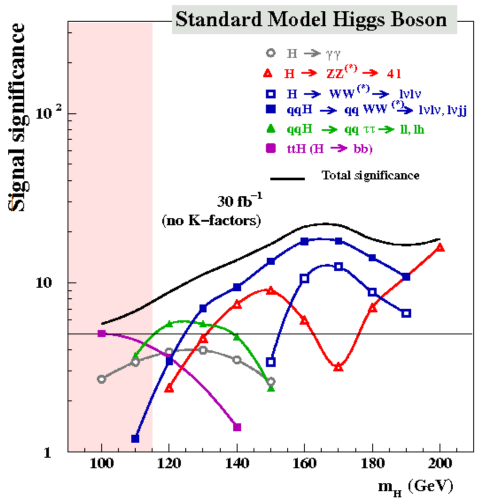
backgrounds: W+jets, QCD



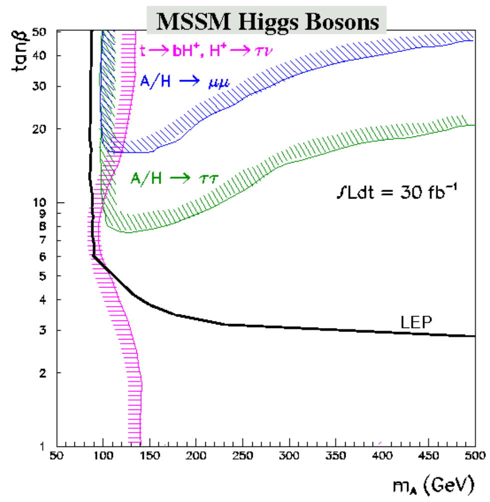
4) Physics: Higgs & SUSY

Contributions to important searches for SM/MSSM Higgs and SUSY

CSC-2: $H \rightarrow ZZ^{(*)} \rightarrow 4\ell$
CSC-3: $qqH, H \rightarrow \tau\tau$
CSC-4: $(gg, qq)H, H \rightarrow WW$
CSC-5: $t\bar{t}H, H \rightarrow b\bar{b}$



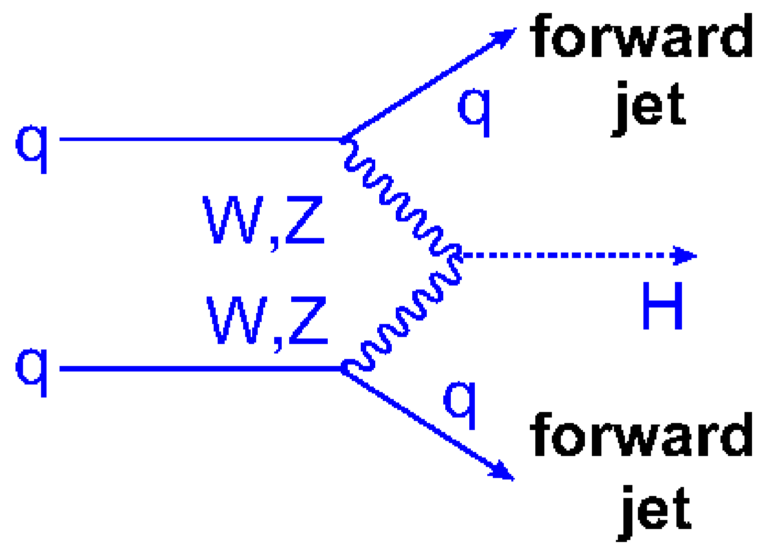
CSC-7: $A/H \rightarrow \tau^+\tau^-$
CSC-8: $A/H \rightarrow \mu^+\mu^-$ (co-editor: S.Horvat)
CSC-10: $t \rightarrow bH^+, H^+ \rightarrow (\tau^+\nu, tb)$

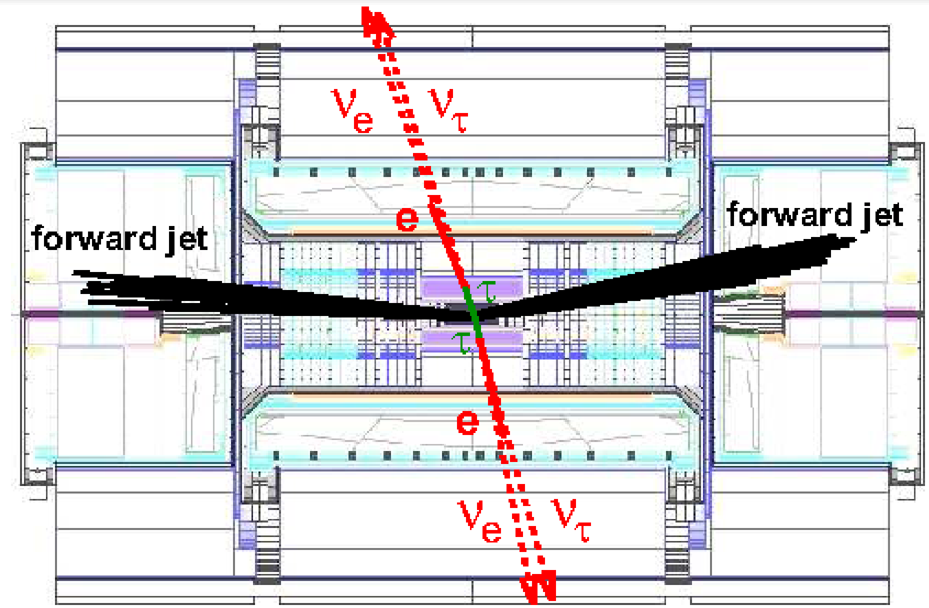


SUSY:

contributions to 3 CSC notes

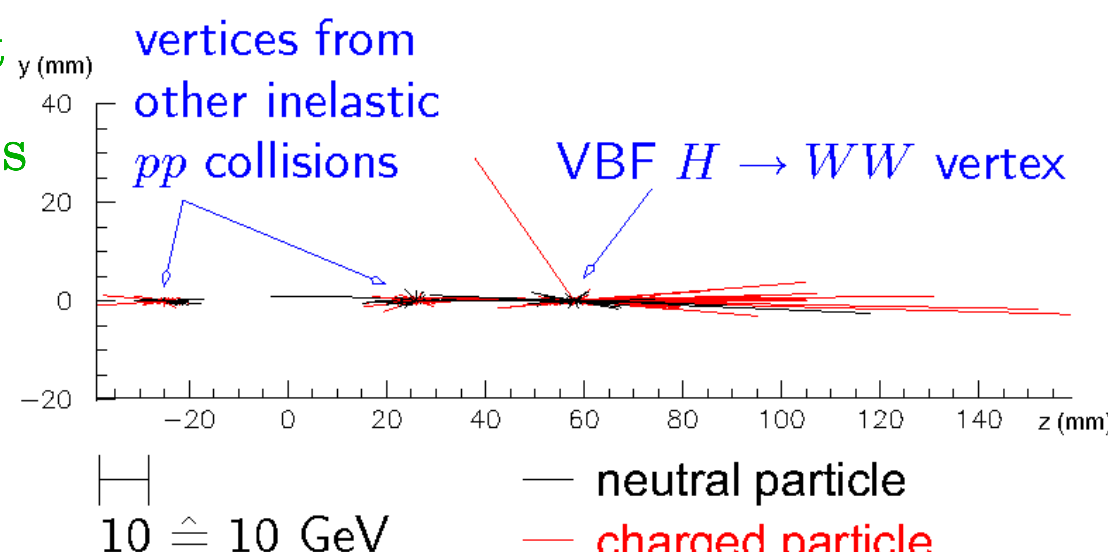
4) Physics: SM Higgs in VBF





Many variables ($E_{t,miss}$, lepton/jet topology) ⇒ multivariate analysis

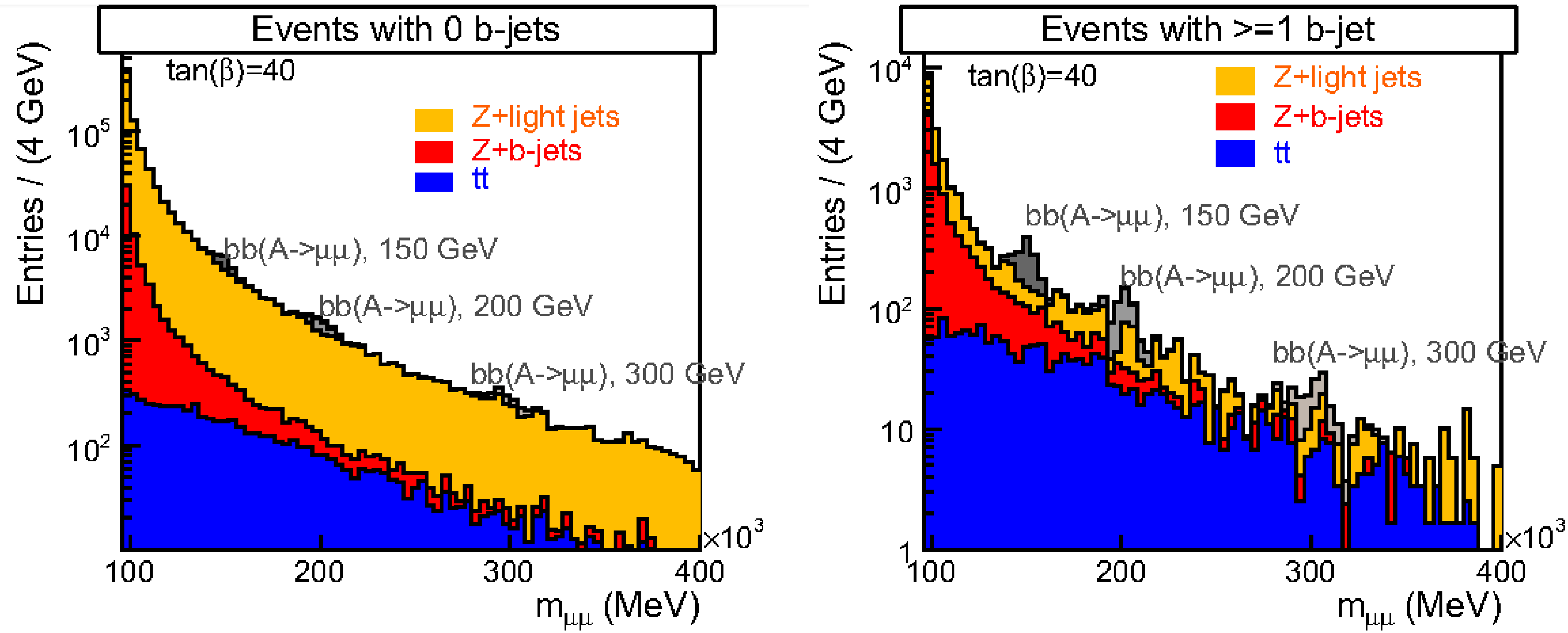
Use track-based jets to improve central jet veto



4) Physics: MSSM Higgs

Heavy (large tanβ) neutral MSSM Higgses: $pp \rightarrow (H/A \rightarrow \mu^+\mu^-)$ + b-jets +X

good mass resolution, but background from Z decays ⇒ use b-tagging

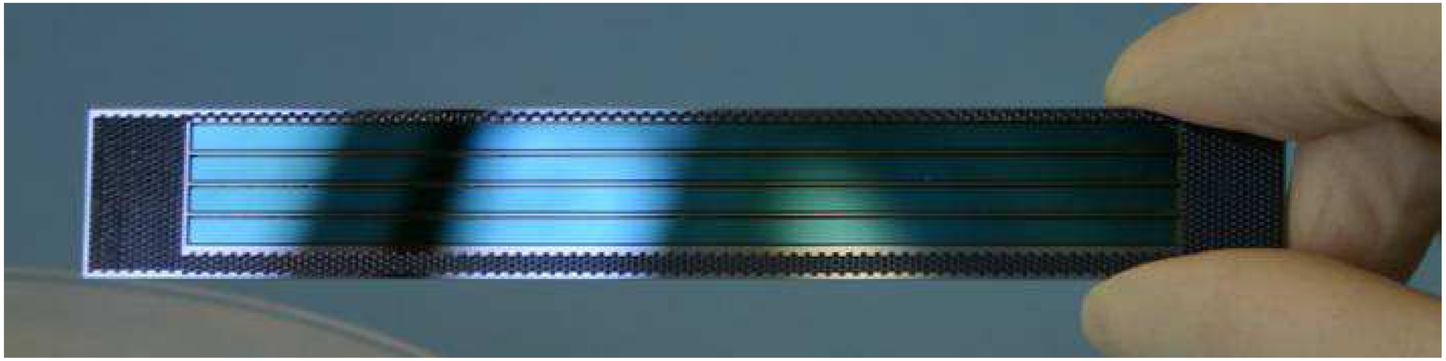


5) S-LHC/ATLAS upgrades

- S-HLC = Super-LHC
  - major luminosity upgrade (x 10) of LHC planned for ~ 2015
  - some new ATLAS detector components needed
- MPP contributions to ATLAS upgrades
  - more rad.-hard Si ID (new Pixel inner layer for 2011/2012?)
  - more rad.-hard HEC readout electronics
  - faster muon chambers, more rad.-hard readout

5) S-LHC: thin pixel sensors

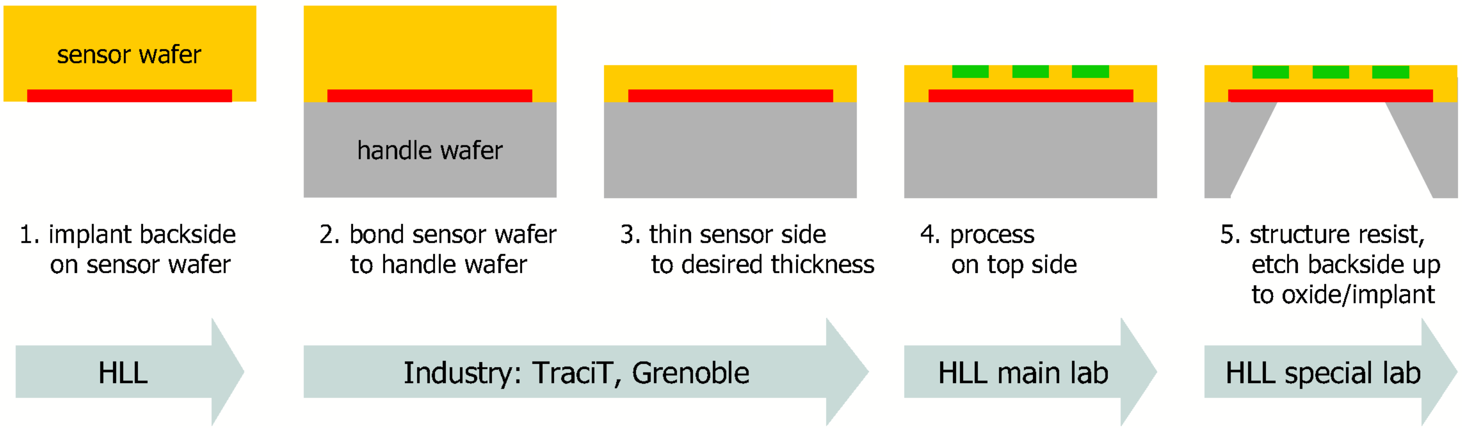
Problem: depletion E-field rises with rad. damage ⇒ O(1000 V) for normal Si detector (250 μm) ⇒ thin detectors (50 – 100 μm)



Detailed simulations: depletion O(100 V), fast signal, low noise, sufficient signal (~4000 e^-)

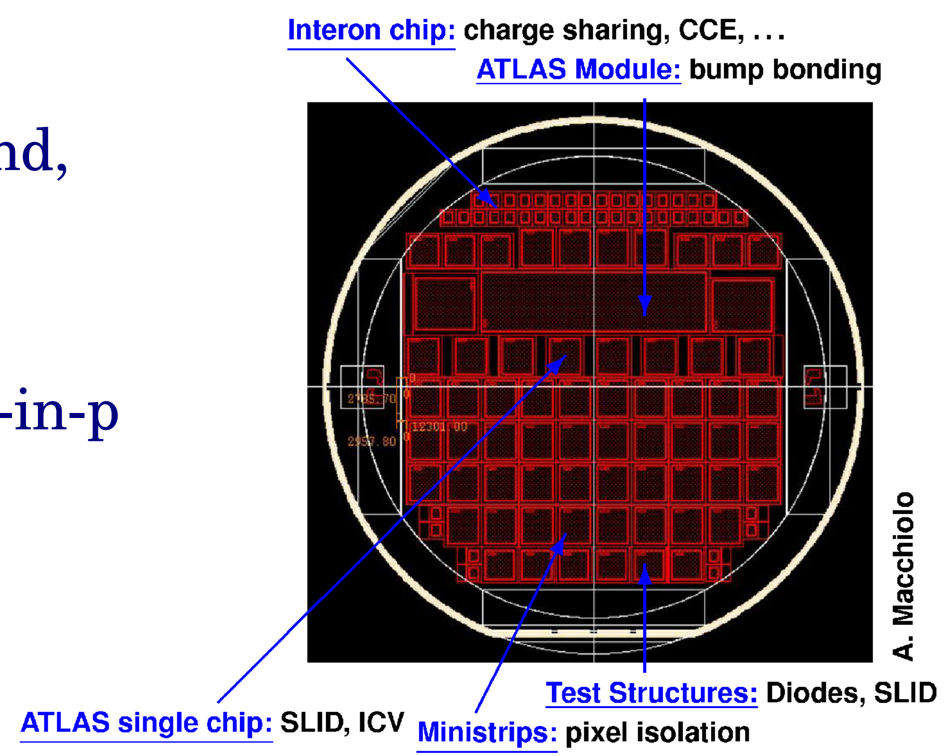
Verification with real test devices needed

5) Thin Sensor Test Devices

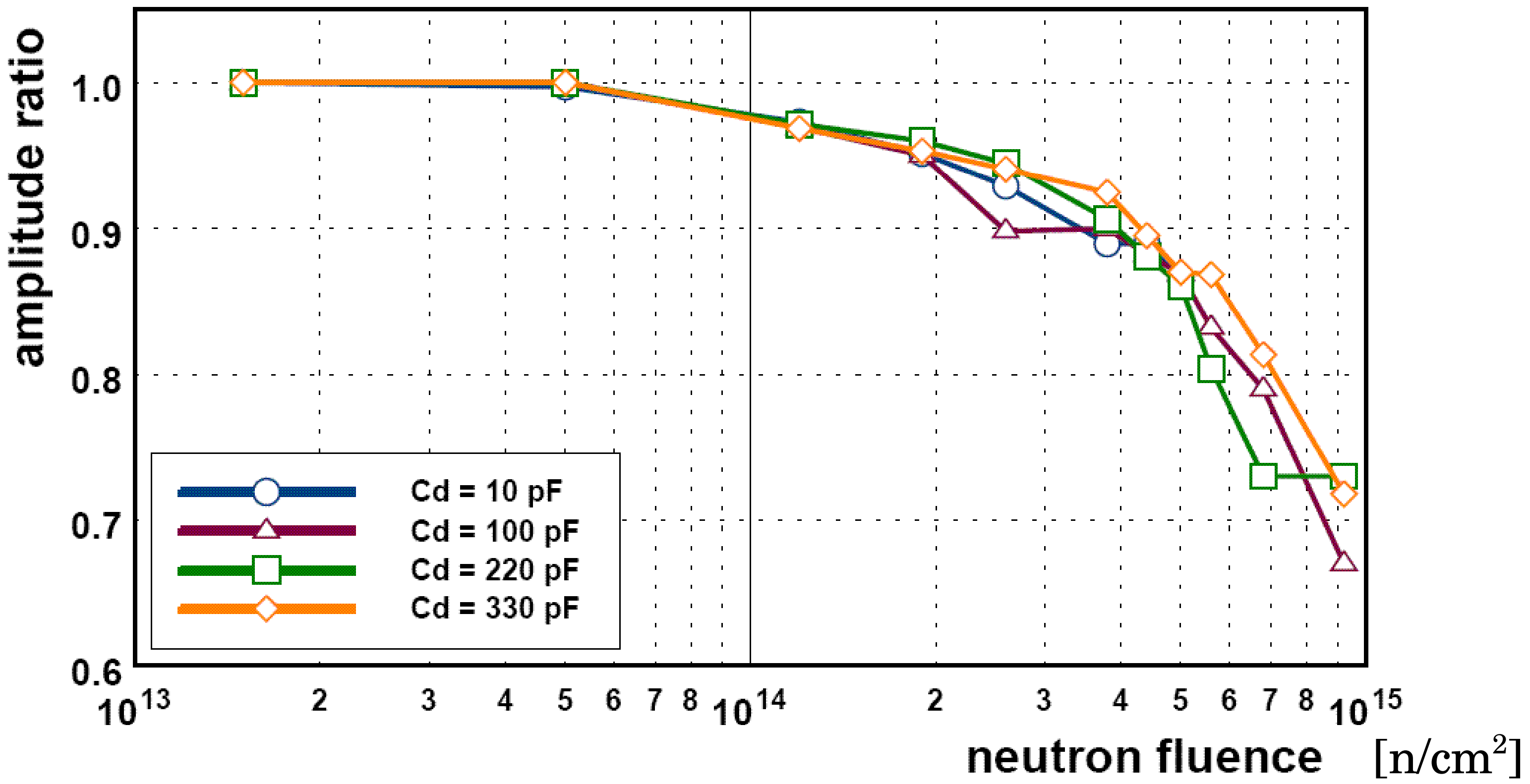


Collaboration with Bonn, Dortmund, Oslo, IZM Interon; RD50

Make 75 and 150 µm n-in-n and n-in-p wafers at HLL and industry



5) New HEC Readout

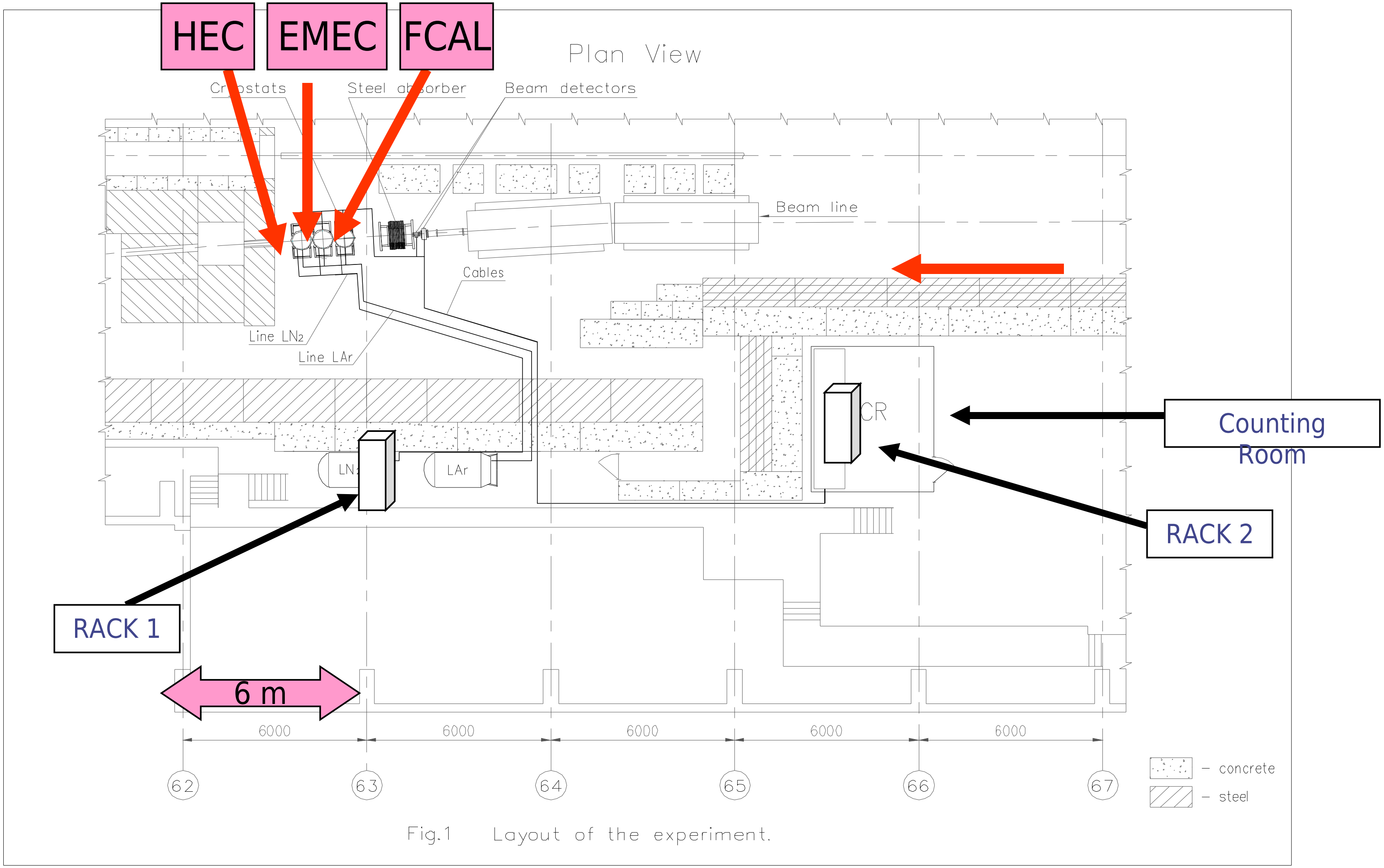


Expect in 10a ATLAS@LHC $2 \cdot 10^{13}$ n/cm^2

Plan for ATLAS@S-LHC few $\cdot\ 10^{15}$ n/cm^2

Develop pin-compatible more rad.-hard cold electronics

5) HiLum Tests



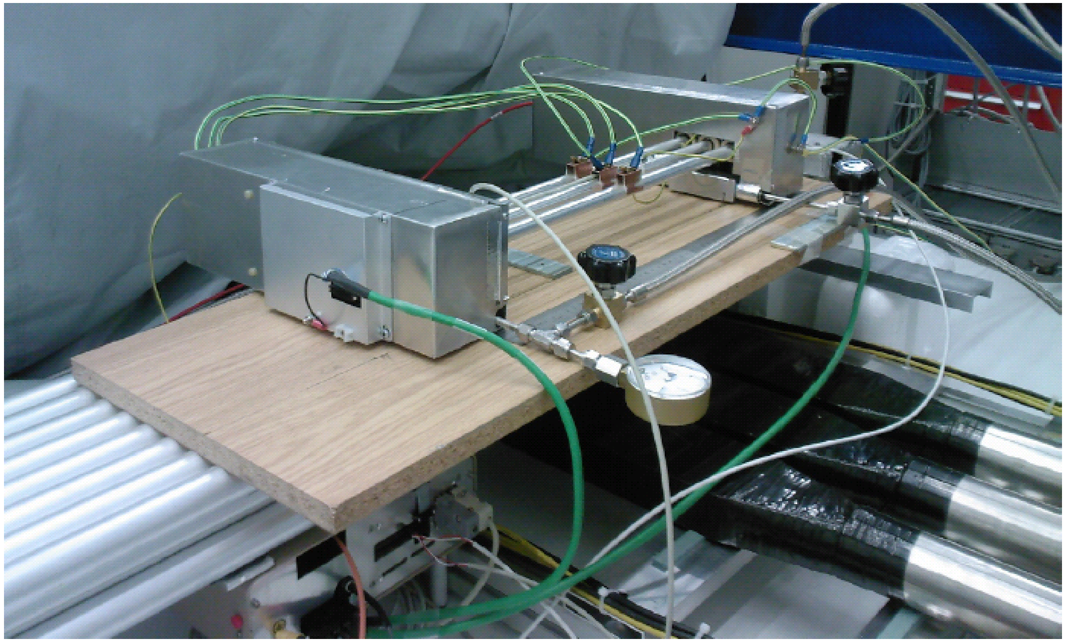
First testrun at IHEP Protvino 50 GeV/c p beam 10-17 November

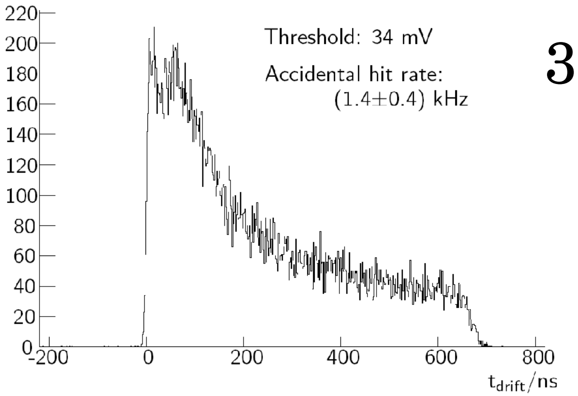
5) New MDTs

S-LHC: high n/γ cavern background ⇒ high occupancy

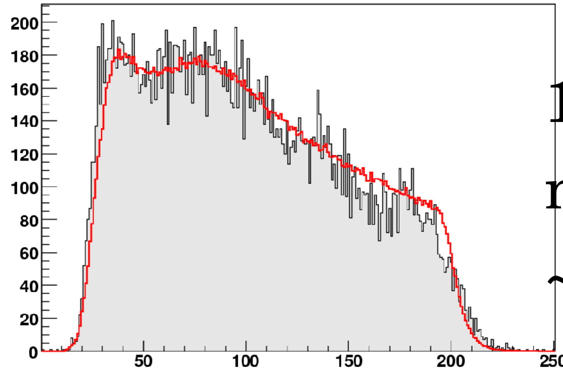
develop fast 15 mm drifttube, more rad.-hard electronics, selective readout

Test thin drifttubes with cosmics





30 mm



15 mm

max. drifttime

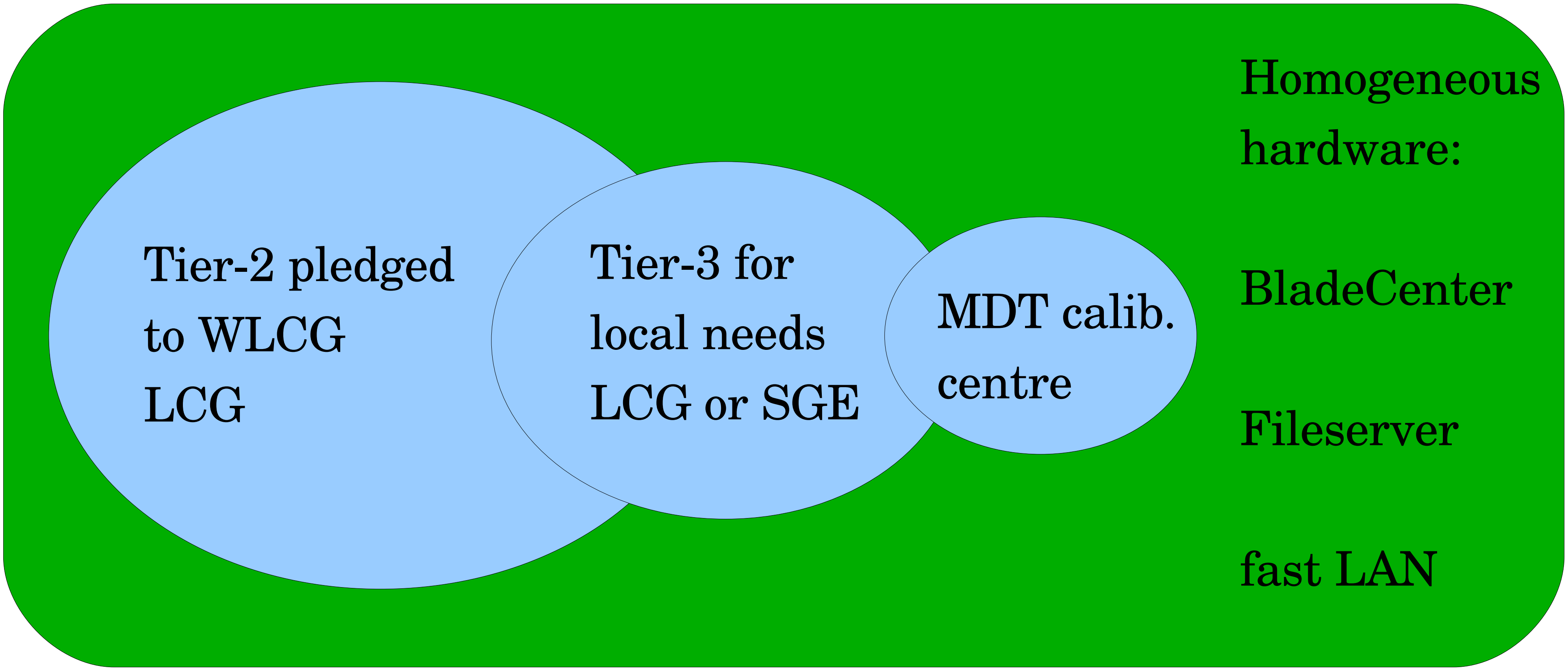
~3 x shorter

6) Computing

- Worldwide LHC Computing Grid (WLCG)
  - provide resources for LHC experiments on grid
  - ATLAS MPP group is member of WLCG collab.
- Munich Tier-2 centre (LMU/LRZ/MPP/RZG)
  - our ½ located/operated at RZG
  - plege ressources to WLCG for ATLAS
  - ATLAS uses via grid
  - other VOs possible

6) Computing

MPP Linux Cluster at RZG ATLAS usage



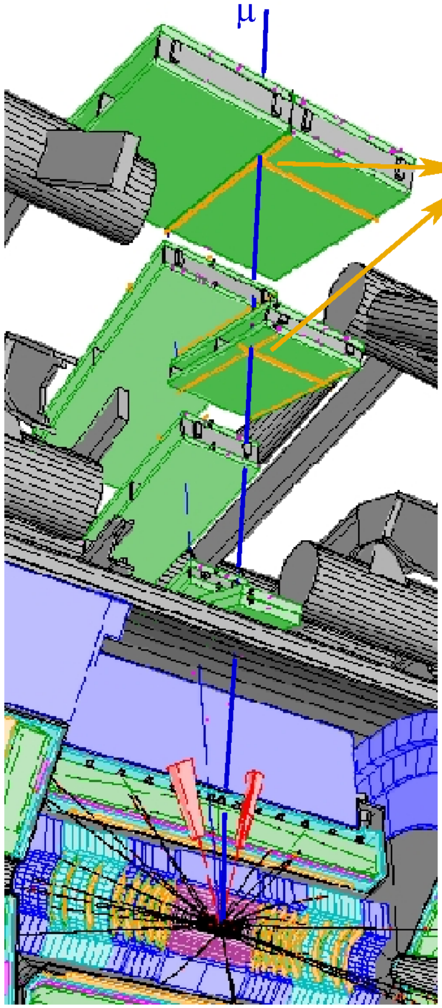
Status: ATLAS LCG functions complete (except SRM)

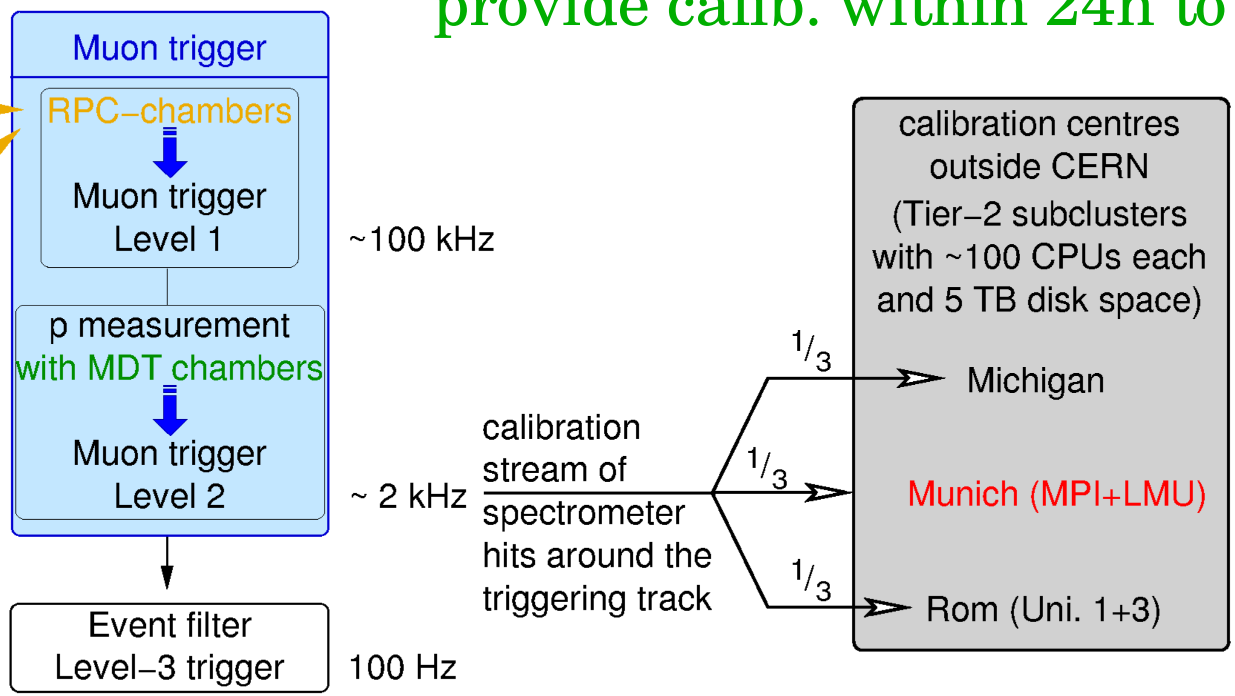
6) Muon Calibration Centre

MDT calibration centres

each receive 1/3 of calibration stream

provide calib. within 24h to ATLAS

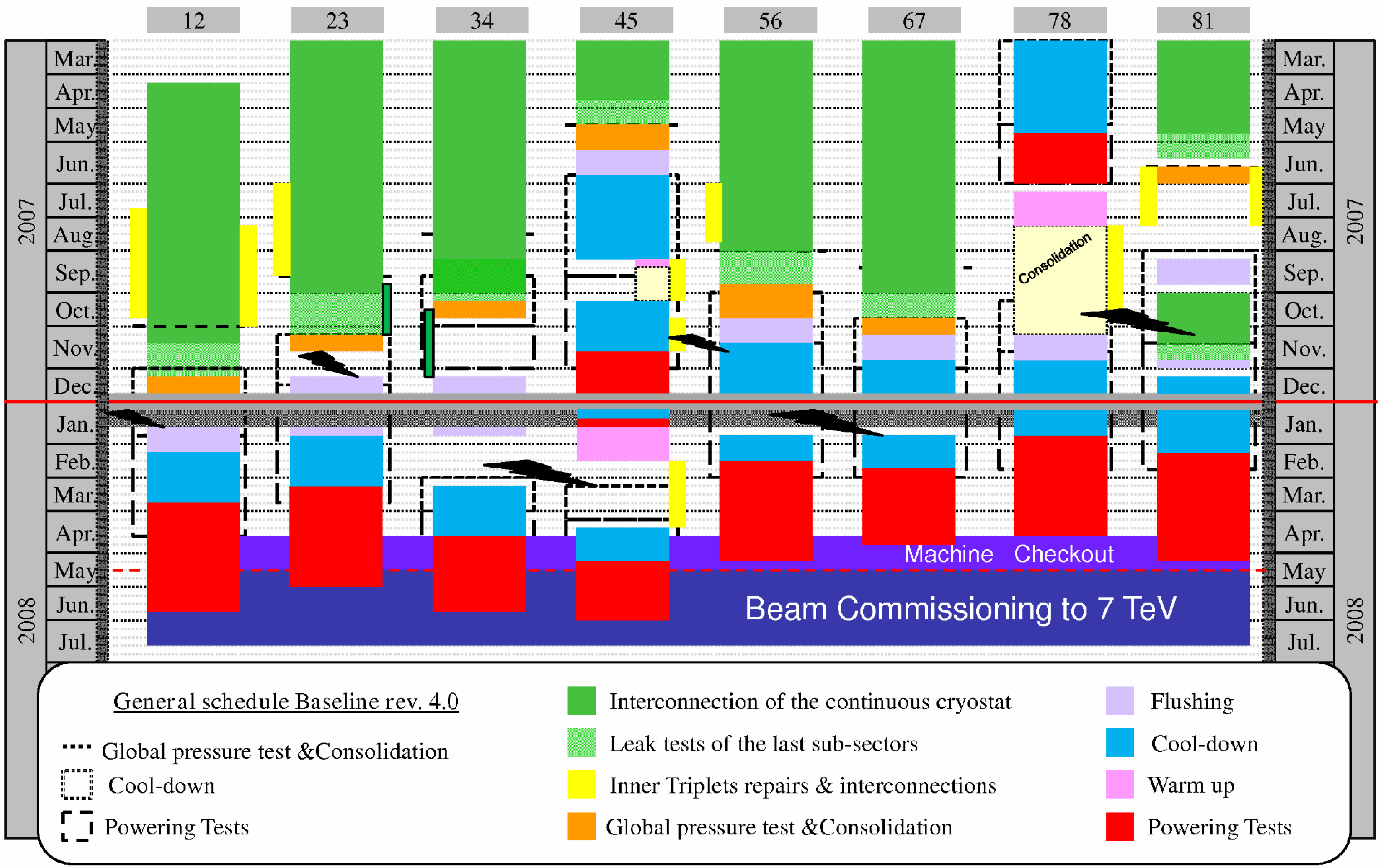




Munich MDT calib. centre is part of MPP Munich Tier-2 at RZG

7) LHC Schedule

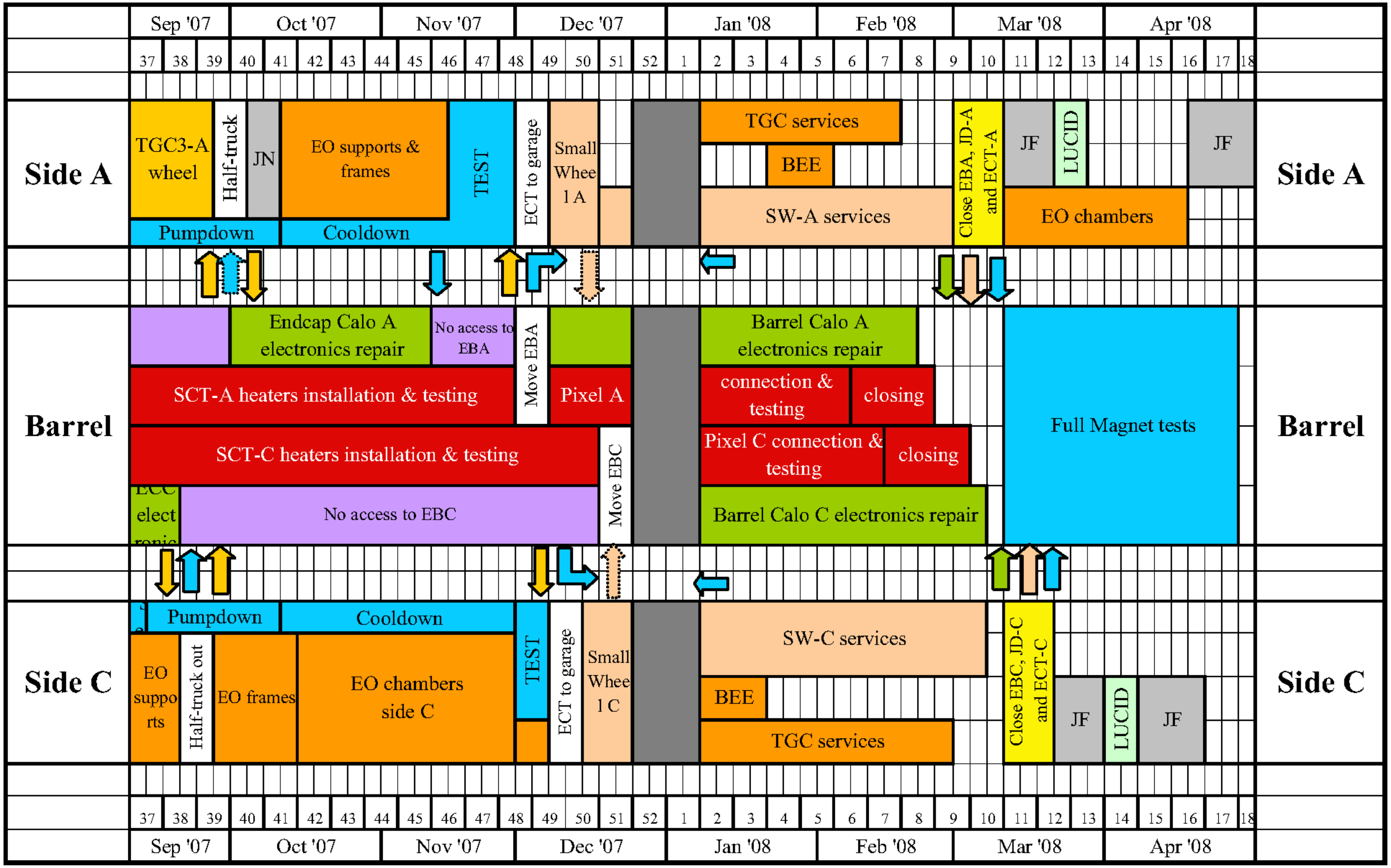
Upated General schedule – wk 41



7) ATLAS Schedule

ATLAS Installation schedule v. 9.2b

M. Kotamäki, M.Nessi
10-Oct-2007

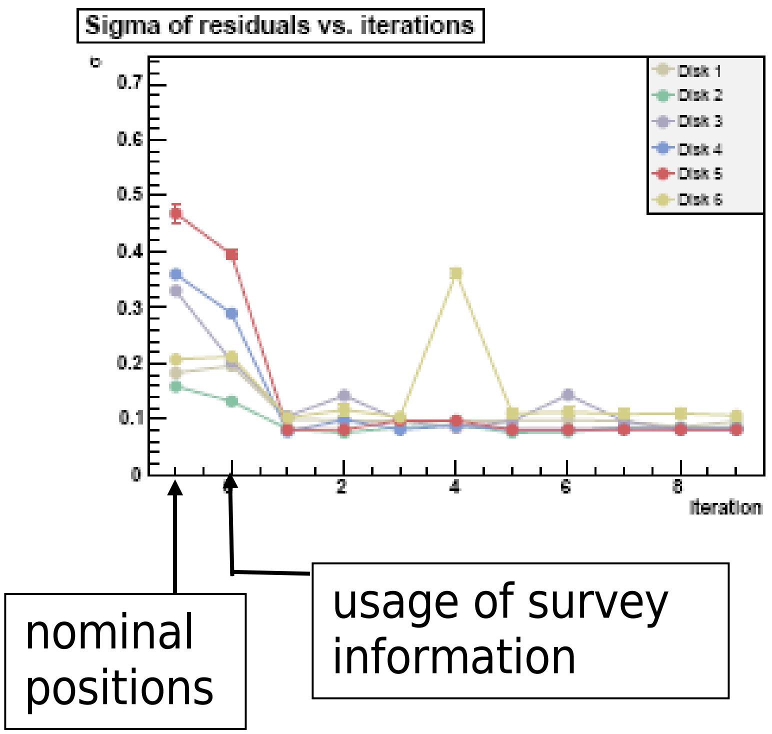


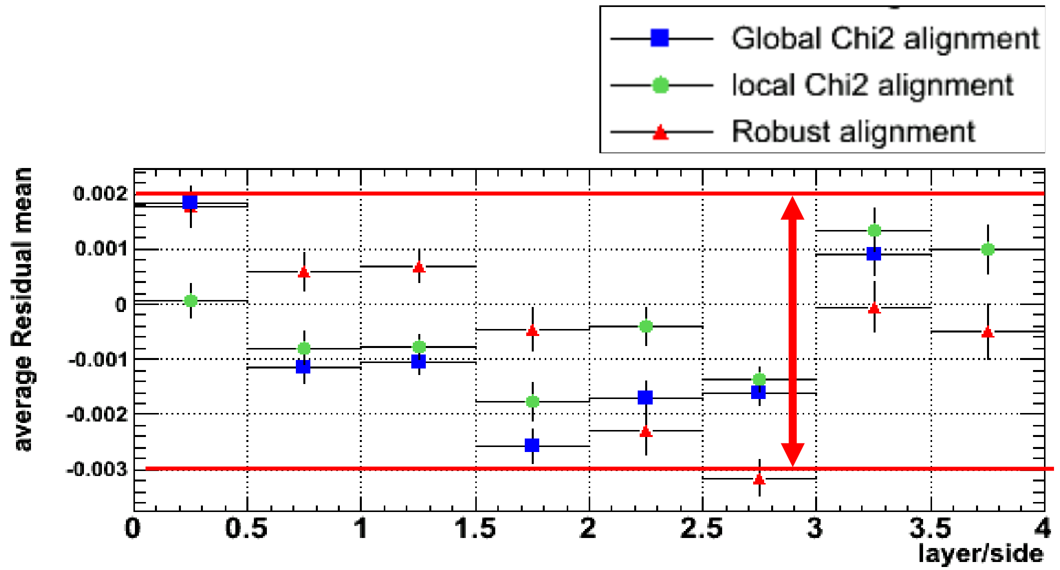
7) Summary

- ATLAS installation essentially complete
- commissioning of hard- and software is top priority now
- Subdetectors take cosmics data successfully
- Schedules converge for mid-2008!

3) SR1 Alignment

Alignment of SCT endcap disks in SR1





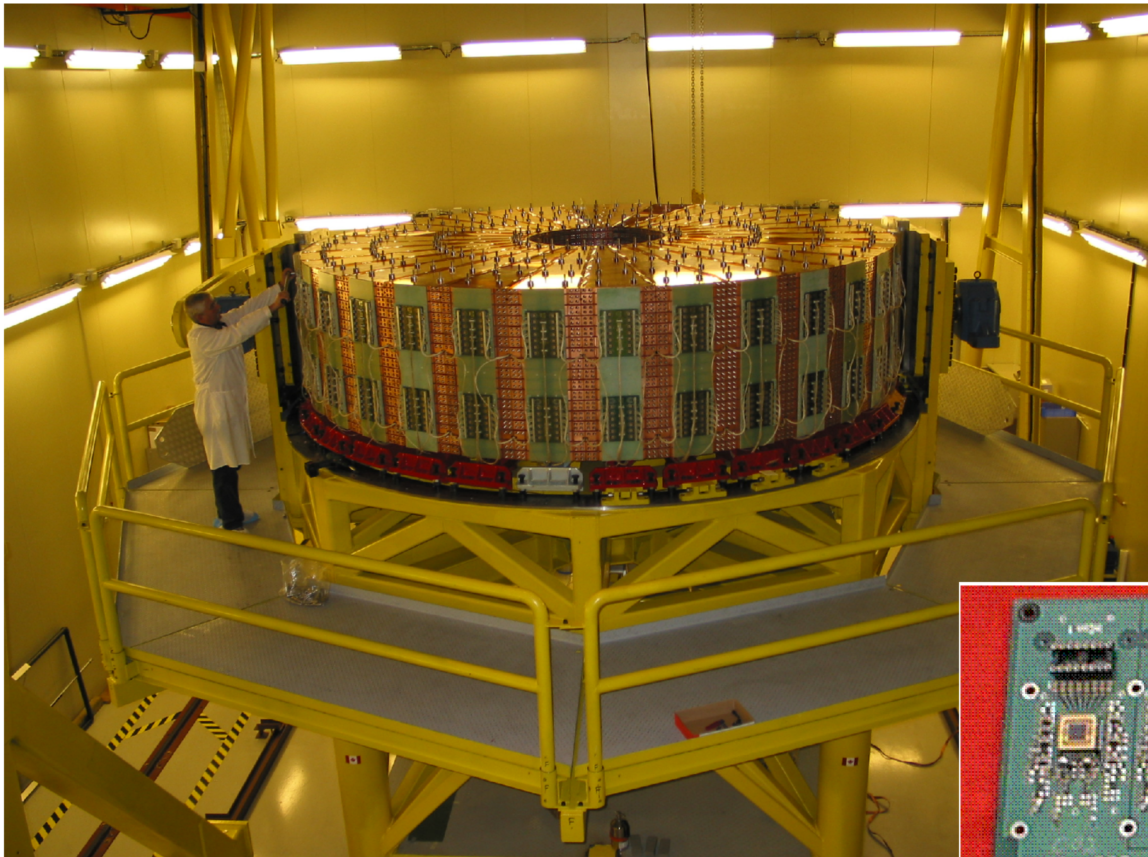
3) ID Alignment with CSC data

Itr N	1	2	3	4	5	6	7	8	9	...	20	21	...	30	31	...	40	41
Alignment Level	1	1	1	1	1	1	1	1	2	2	2	3	3	3	3	3	3	3
Fixed Pixel Detector	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
Glb. shift	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N
Event Number	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k	5k
Error Scaling	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Vertex Constraint	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Beam Constraint	N	N	N	N	N	N	N	N	N	N	N	N	N	N	IBC	I	I	BC
CHI2 cut for Tracks	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
TRT hits forTrack	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Endcap Hts	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

First deal with large displacements, then improve smaller local displacements

Use vertex and beam spot constraints

5) New HEC Readout



Develop more rad.-hard pin-compatible PSB boards

Upgrade possible without wheel disassembly