ATLAS – Part I

DoE Review

March 2007

M. Gilchriese

Outline

- ATLAS group
- LHC and ATLAS status
- Silicon tracking detector status
- Commissioning/operations planning
- University interactions
- Upgrade R&D

- Beate will cover software and preparations for data analysis

ATLAS Group

Physics Division

Senior Physicists
- M. Barnett
- J. Beringer
- A. Ciocio(@CERN)
- K. Einsweiler(@CERN)
- M. Garcia-Sciveres(@CERN)
- M. Gilchriese
- C. Haber
- B. Heinemann(@CERN)
- I. Hinchliffe
- S. Loken
- R. Madaras
- M. Shapiro
- J. Siegrist
- G. Stravropoulos
- W. Yao

Postdoctoral Fellows
- J-F. Arguin(@CERN)
- S. Binet
- A. Gapanenko
- T. Golling(@CERN)
- A. Holloway
- A. Korn(@CERN)
- S. Vahsen
- M. Zdrazil(@CERN)

Technical Staff
- S. Dardin
- R. Witharm

Graduate Students
- M. Leyton(@CERN)
- P. Luscutoff
- S. Senz(@CERN)
- M. Scherzer(@CERN)
- L. Tompkins
- J. Virzi

Undergraduates
- K. Lung
- H. Mistry
- T. Phung

Retirees
- J. Alonso
- R. Ely
- J. Lys
- G. Trilling
- T. Weber

Visitors
- L. Skinnari

Engineering Division

Engineers
- E. Anderssen(@CERN)
- P. Denes
- N. Hartman(@CERN)
- A. Mekkaoui

Technical Staff
- M. Cepeda
- T. Johnson(@CERN)
- K. Krueger
- A. Pekedis
- R. Post
- J. Wyckoff

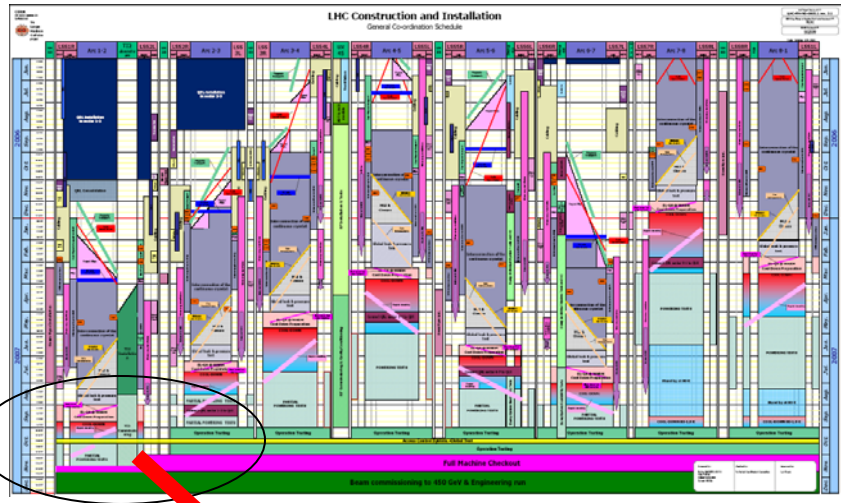
NERSC

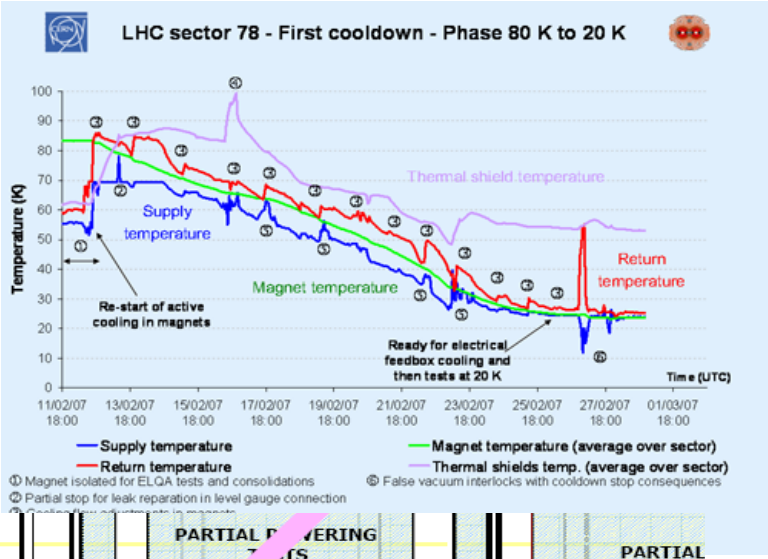
Senior Scientists
- D. Quarrie(@CERN)

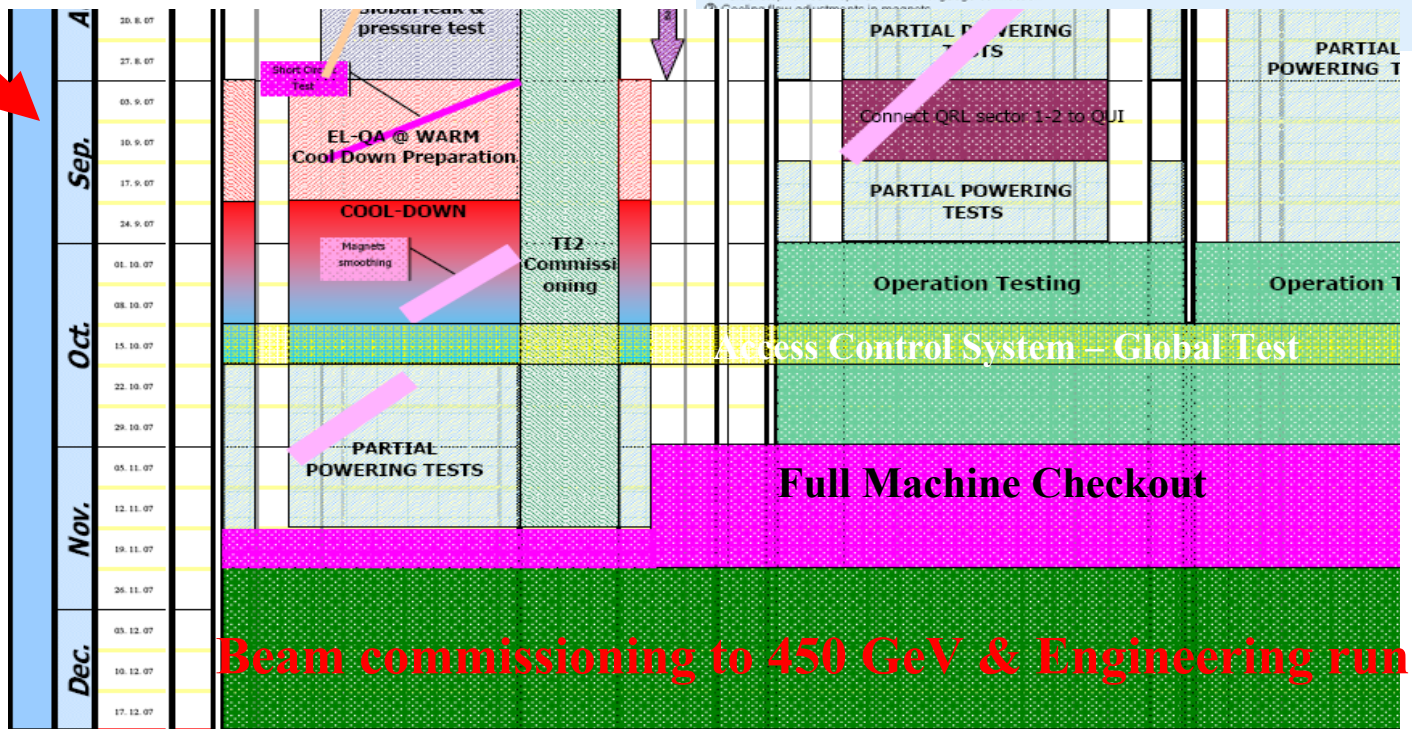
Staff Scientists
- P. Calafiura
- C. Leggett

Postdoctoral Fellows
- W. Lavrijsen
- M. Woudstra(@CERN)

LHC - 2007


LHC Construction and Installation
General Co-ordination Schedule
Full Machine Checkout
Beam commissioning to 450 GeV & Engineering run


LHC sector 78 - First cooldown - Phase 80 K to 20 K
Temperature (K)
Thermal shield temperature
Supply temperature
Magnet temperature
Return temperature
Re-start of active cooling in magnets
Ready for electrical feedbox cooling and then tests at 20 K
Time (UTC)
11/02/07 18:00
13/02/07 18:00
15/02/07 18:00
17/02/07 18:00
19/02/07 18:00
21/02/07 18:00
23/02/07 18:00
25/02/07 18:00
27/02/07 18:00
01/03/07 18:00
Supply temperature
Return temperature
Magnet temperature (average over sector)
Thermal shields temp. (average over sector)
① Magnet isolated for ELQA tests and consolidations
② Partial stop for leak reparation in level gauge connection
⑤ False vacuum interlocks with cooldown stop consequences


Sep.
Oct.
Nov.
Dec.
20. 8. 07
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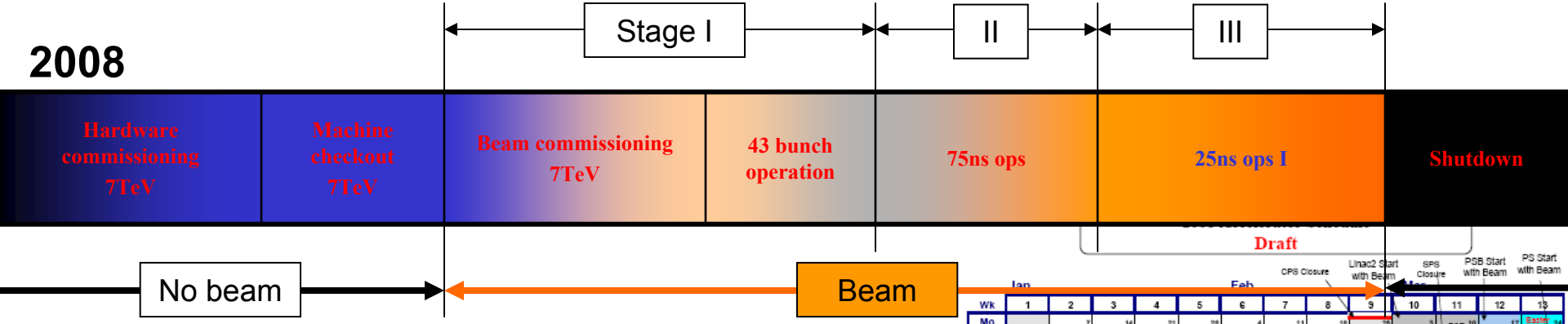
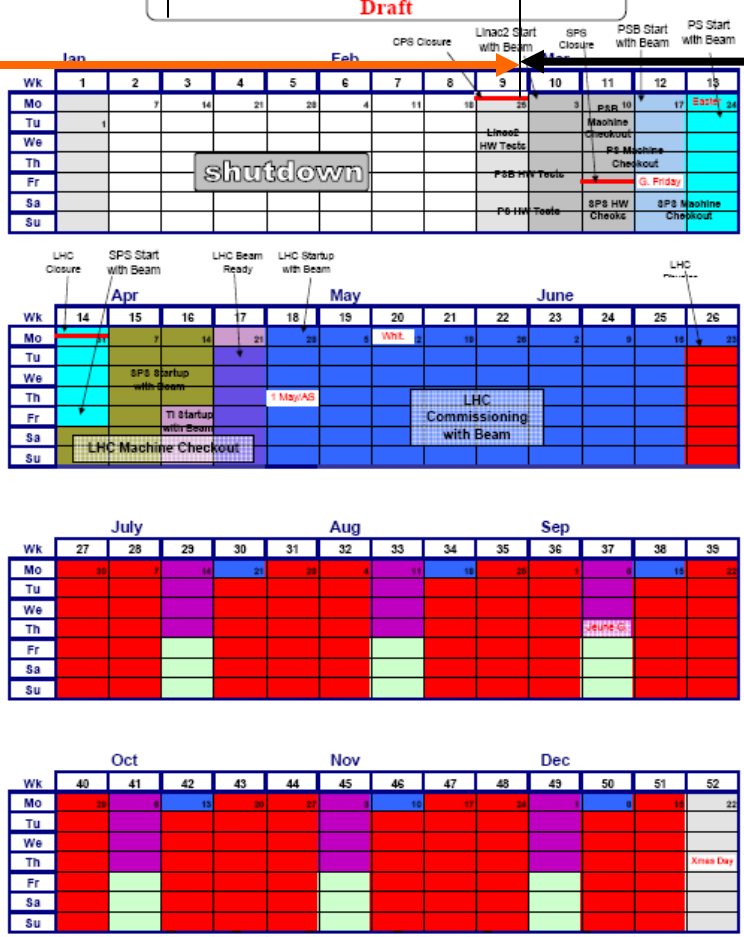
17. 9. 07
24. 9. 07
01. 10. 07
08. 10. 07
15. 10. 07
22. 10. 07
29. 10. 07
05. 11. 07
12. 11. 07
19. 11. 07
26. 11. 07
03. 12. 07
10. 12. 07
17. 12. 07
pressure test
Short Circ Test
EL-QA @ WARM
Cool Down Preparation
COOL-DOWN
Magnets smoothing
TI2 Commissi oning
PARTIAL POWERING TESTS
Connect QRL sector 1-2 to QUI
PARTIAL POWERING TESTS
PARTIAL POWERING T
Operation Testing
Operation T
Access Control System – Global Test
Full Machine Checkout
Beam commissioning to 450 GeV & Engineering run

LHC-2008

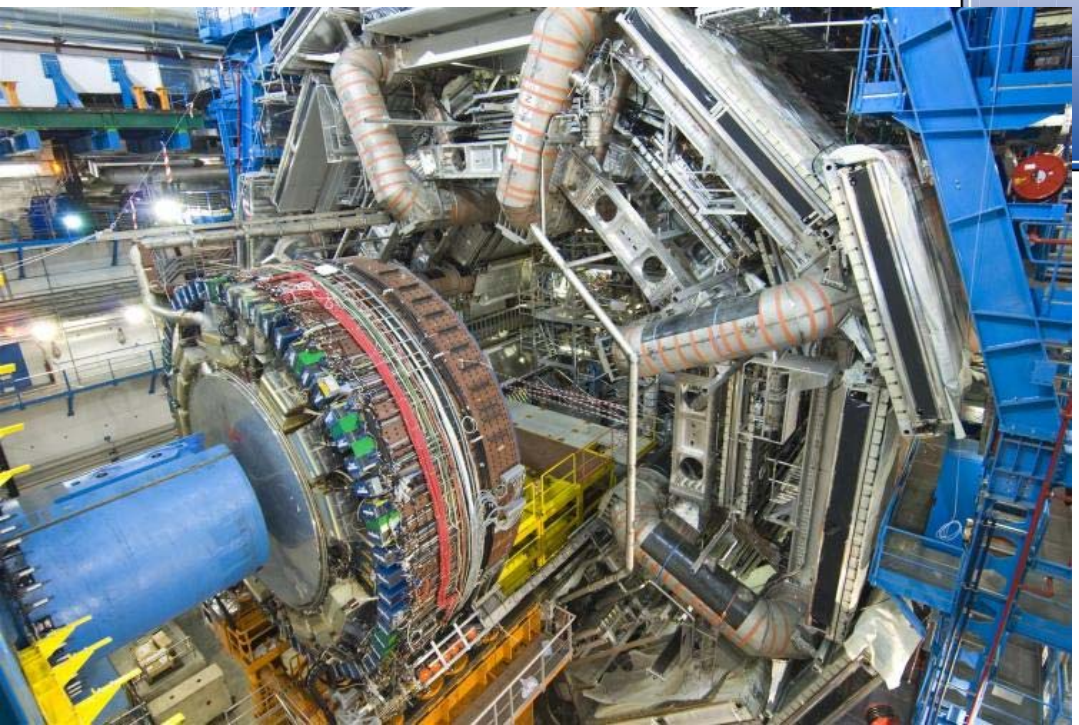


- Draft schedule shown
- 7 TeV x 7 TeV at last!
- Ramp up to 25 nsec
- Nominally 26 weeks of running (protons) albeit with mixture of
  - Physics runs(red)
  - Machine development(purple)
  - "Technical stop"(grey)



ATLAS Overview

- Installation – impressive progress since last DoE review
- Commissioning (cosmic rays) started.
- Intense activity!



Collaboration

Currently

35 Countries

164 Institutions

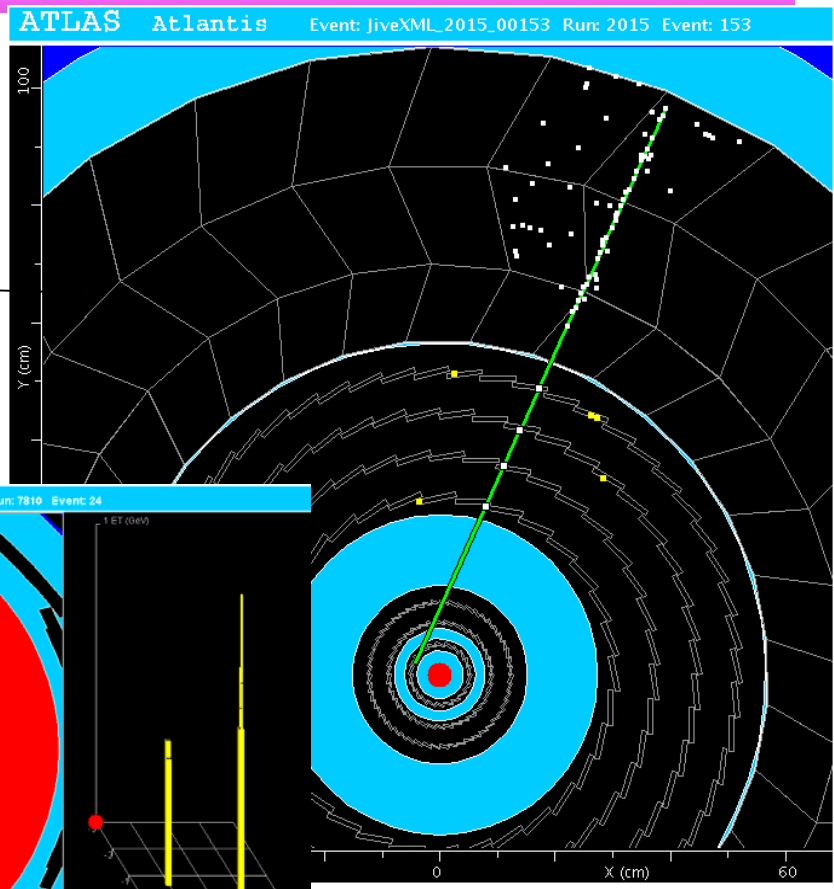
About 1800 Scientific Authors

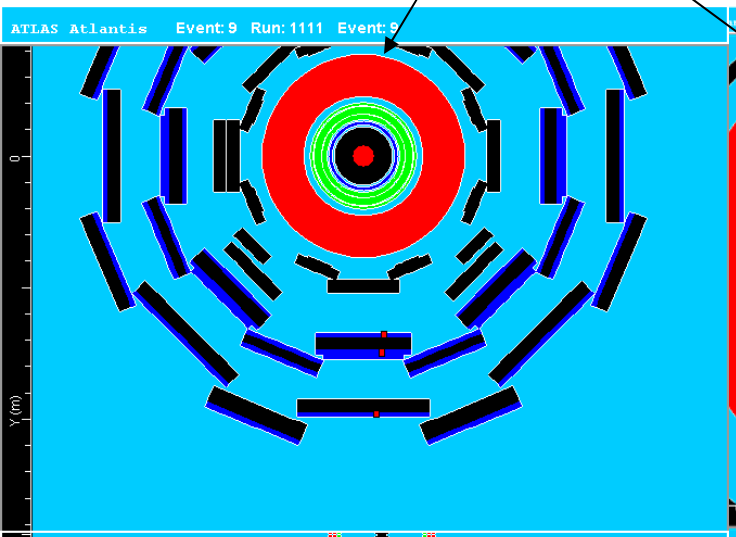
Slowly increasing

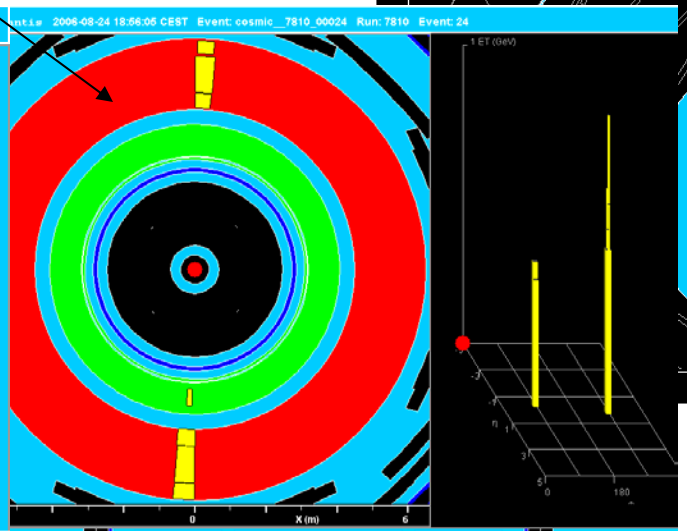
M. Gilchriese

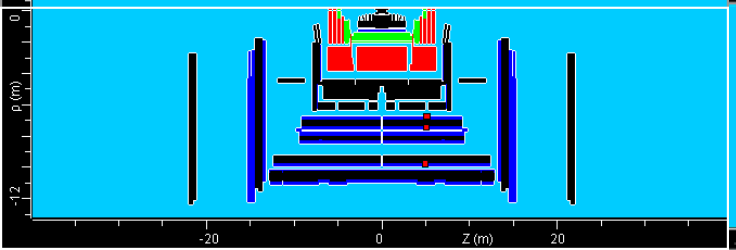
ATLAS Cosmics

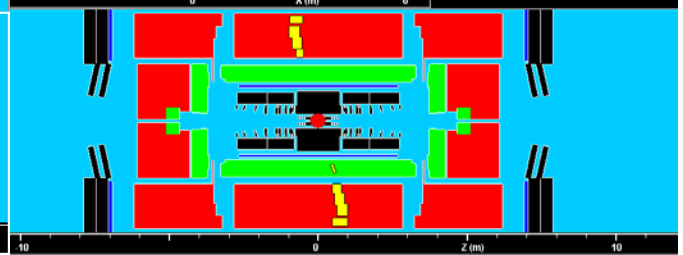
- Cosmic ray running for parts of the detector
  - Inner tracker
  - Calorimetry
  - Muon system







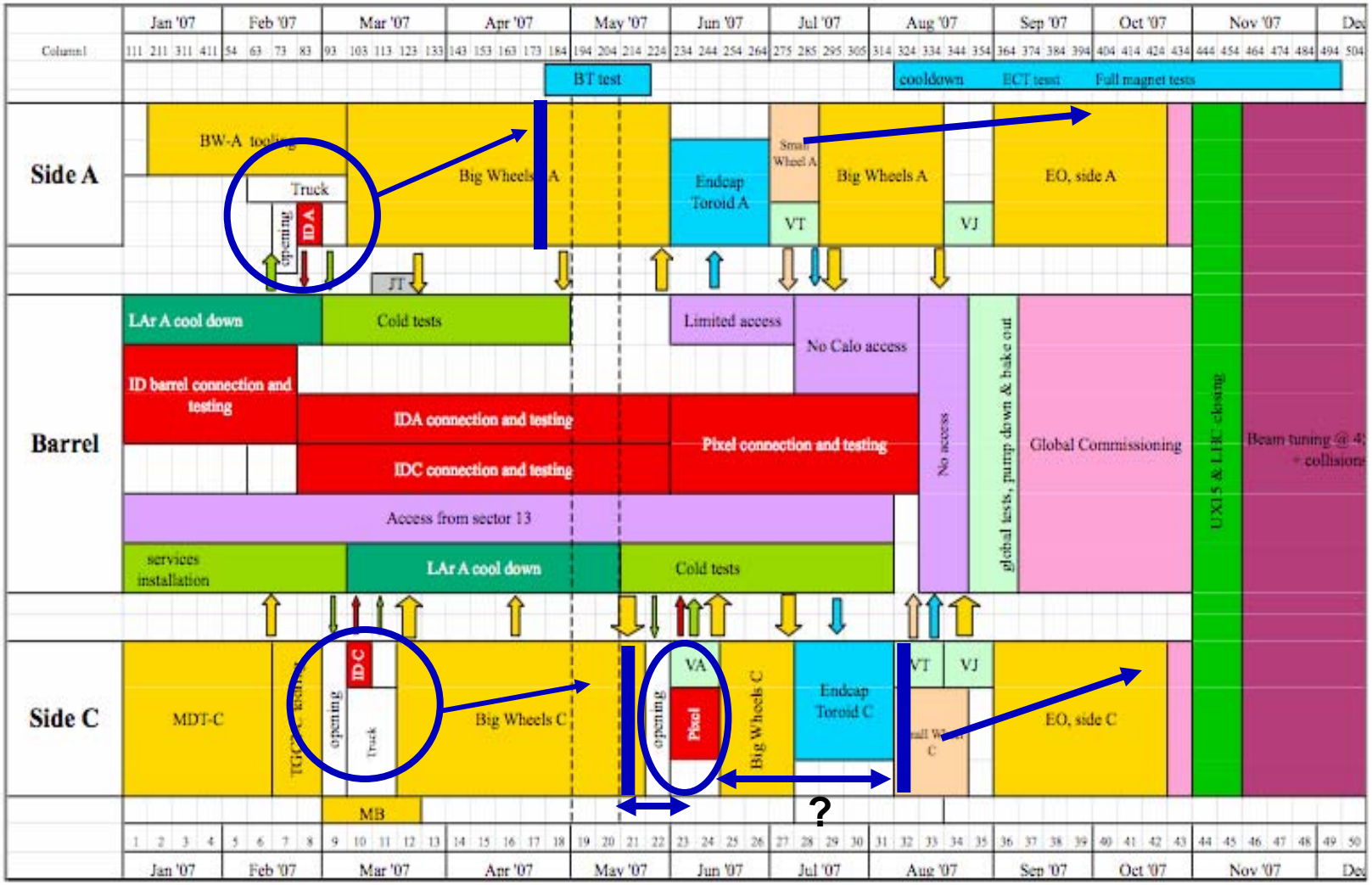




More on pixels later!

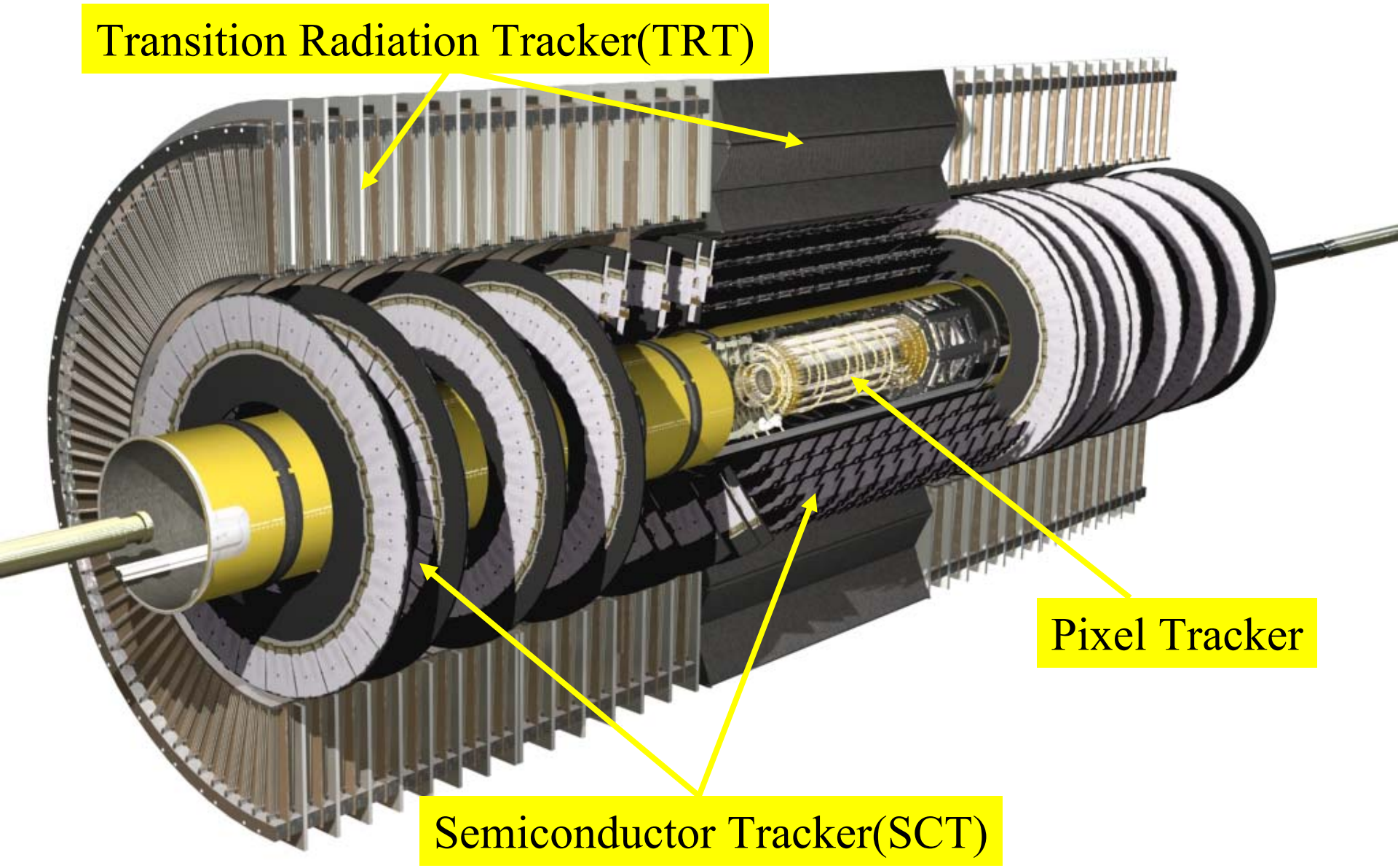
ATLAS Installation schedule version ~~9.0~~

M. Kotamäki, M.Nessi



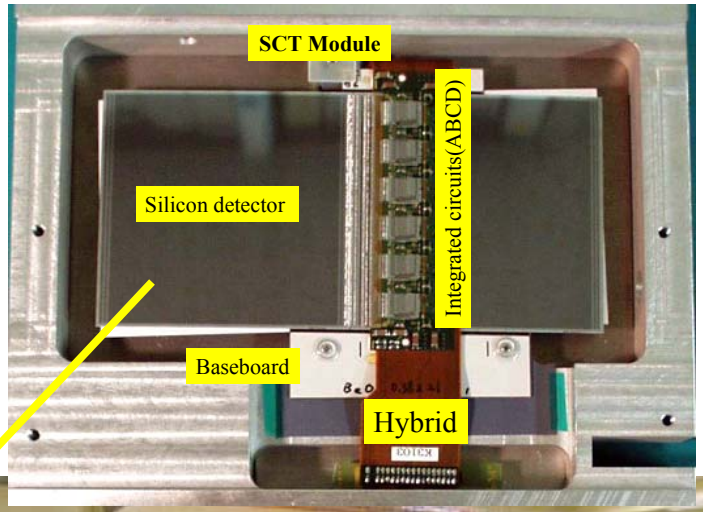
- Significant very recent problems with heating elements for Inner Detector cooling system have caused delay and reordering of schedule – more details later.

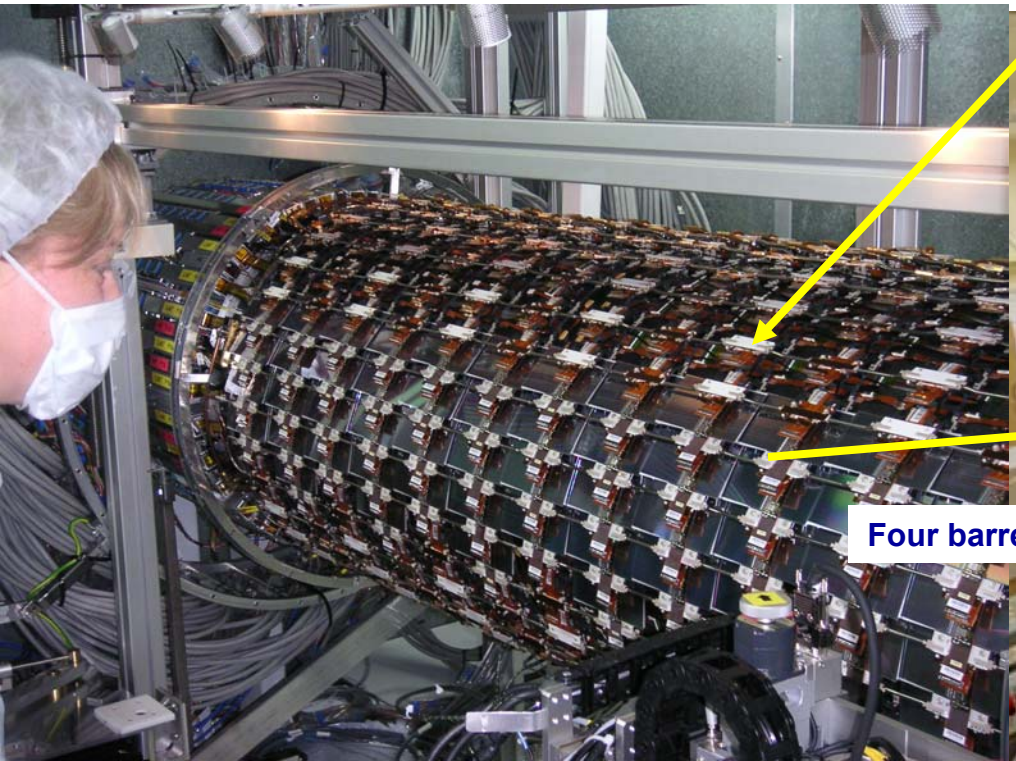
ATLAS Tracking



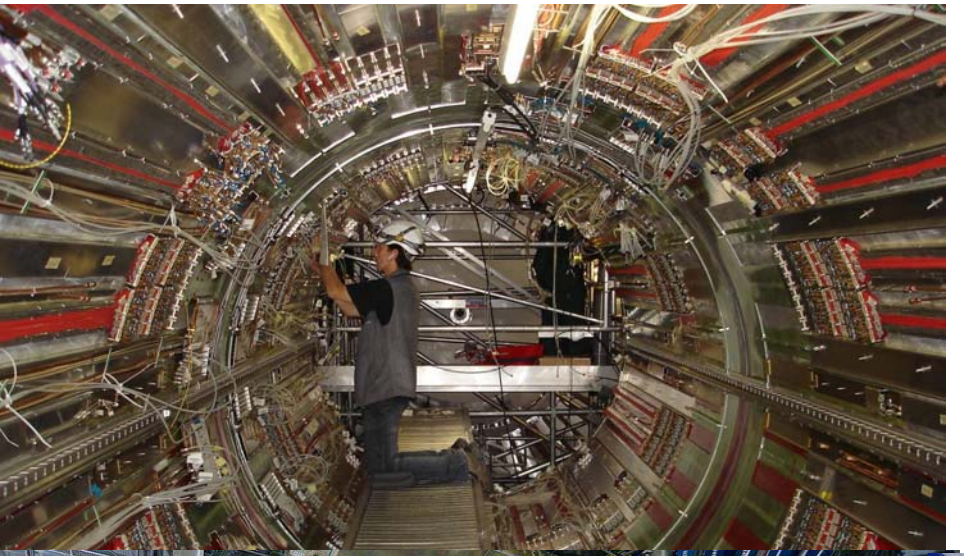
Semiconductor Tracker(SCT) - I

- Silicon strip module production for barrel SCT completed at LBNL over two years ago(~ 550 modules)
- Installation in ATLAS about six months ago – next page.

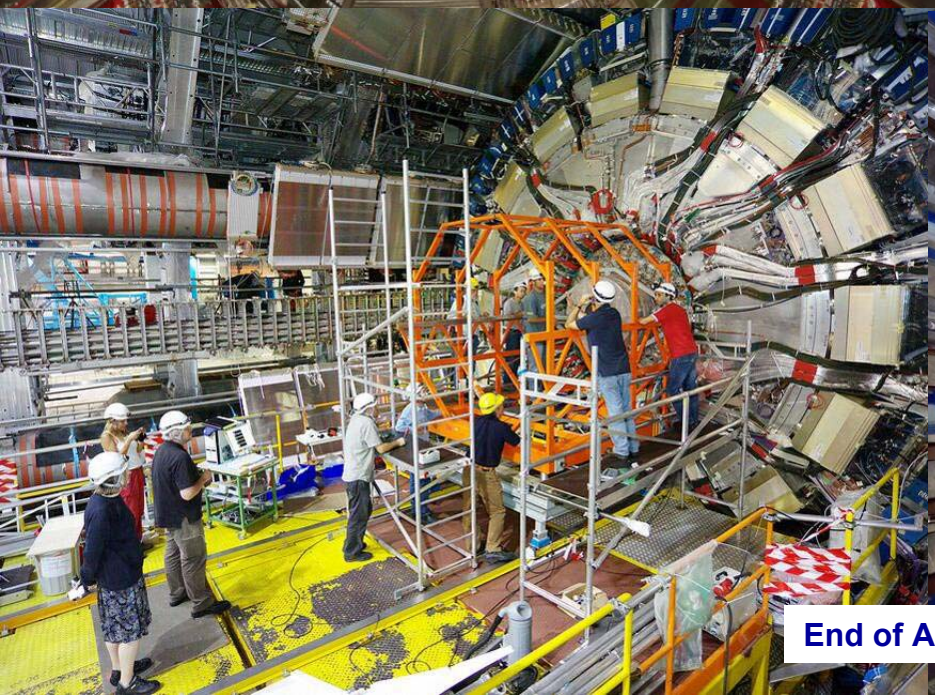


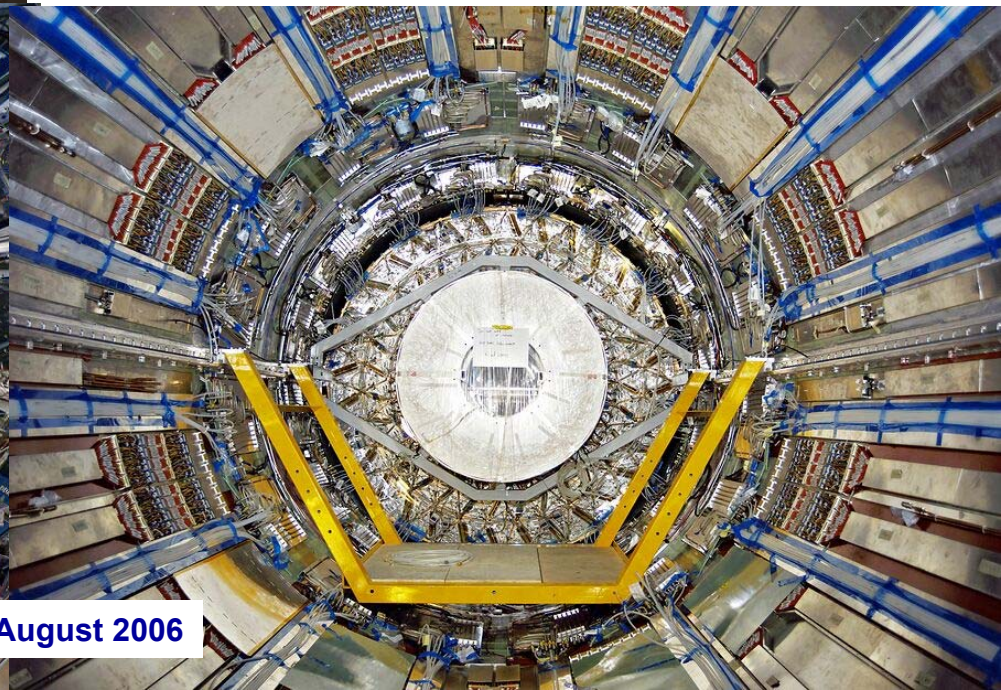


Semiconductor Tracker(SCT) - II



- A Ciocio from LBNL has been coordinating all cable installation and QC for the SCT and this is almost complete.
- Barrel TRT/SCT installed

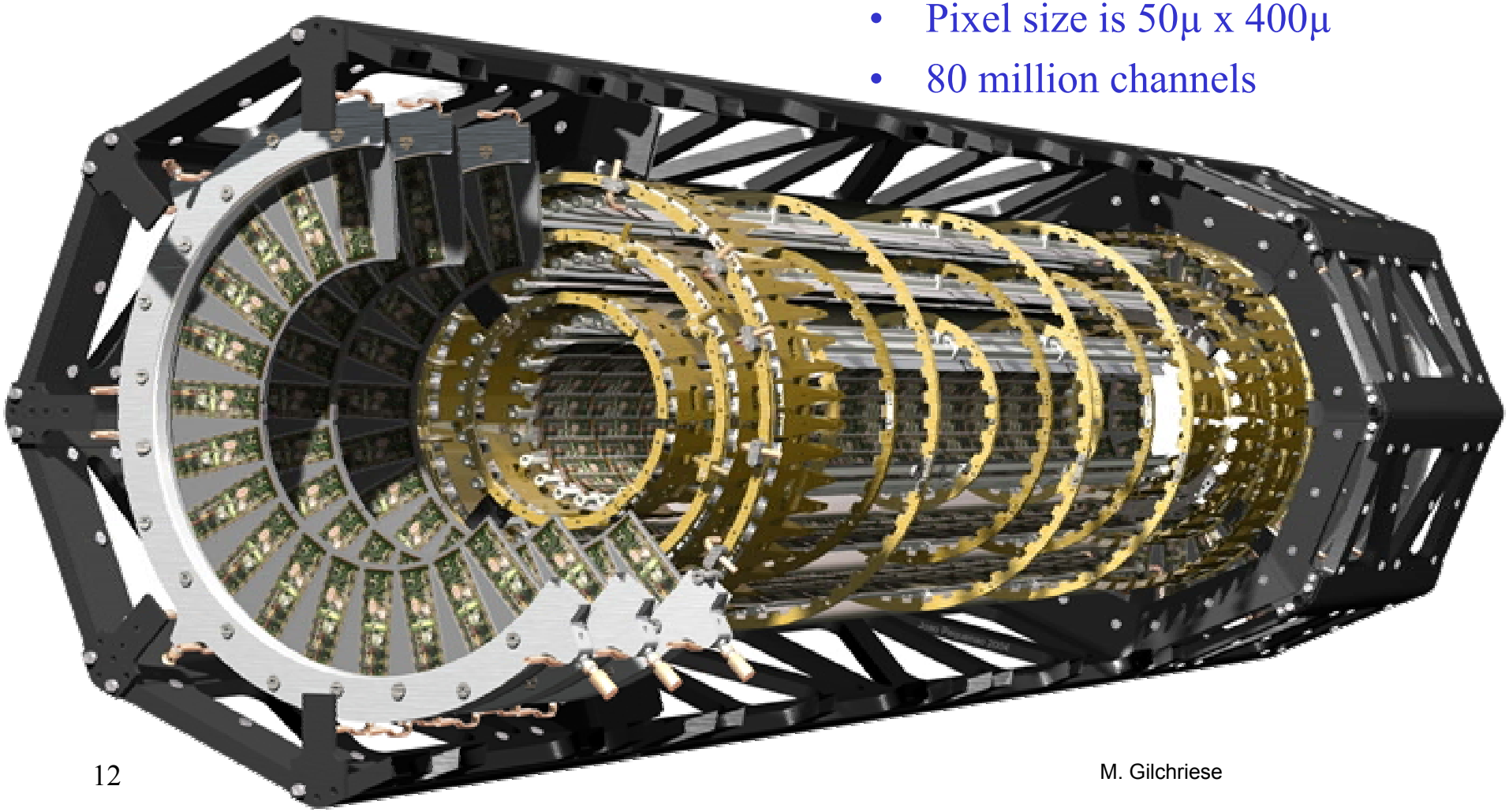




End of August 2006

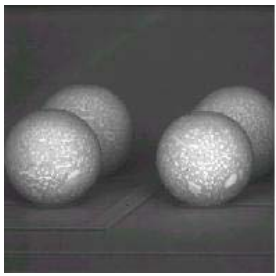
ATLAS Pixel Detector - Overview

- New technology for pp collider!!
- Three space points for $|\eta|<2.5$
- Pixel size is 50μ x 400μ
- 80 million channels

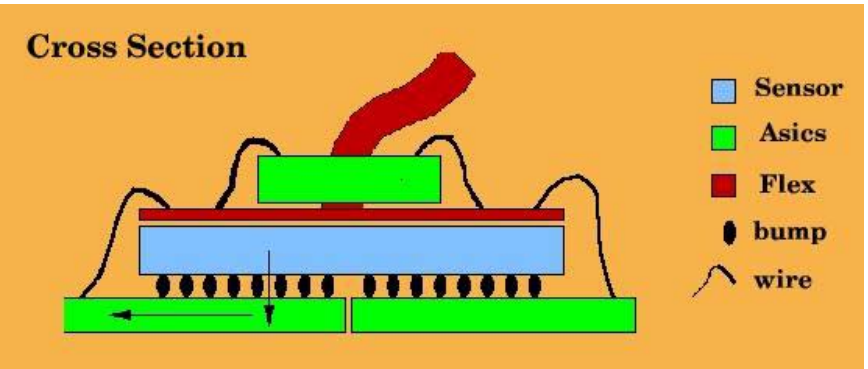


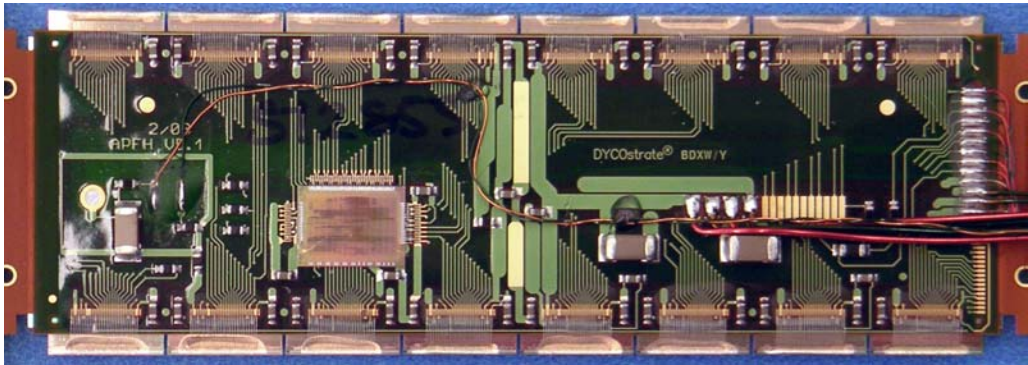
Pixel Electronics and Modules

- Integrated circuit electronics
  - Completed more than 1.5 years ago
  - Overall leader was K. Einsweiler from LBNL
  - LBNL led development of front-end IC, 0.25µ technology, rad-hard to >30 MRad, roughly 3 million transistors
- Modules
  - Completed nearly a year ago
  - 1744 good in detector, many more produced
  - Coordinator was M. Garcia-Sciveres from LBNL
  - LBNL did final assembly/testing of disk modules



About 46,000 pixels per module

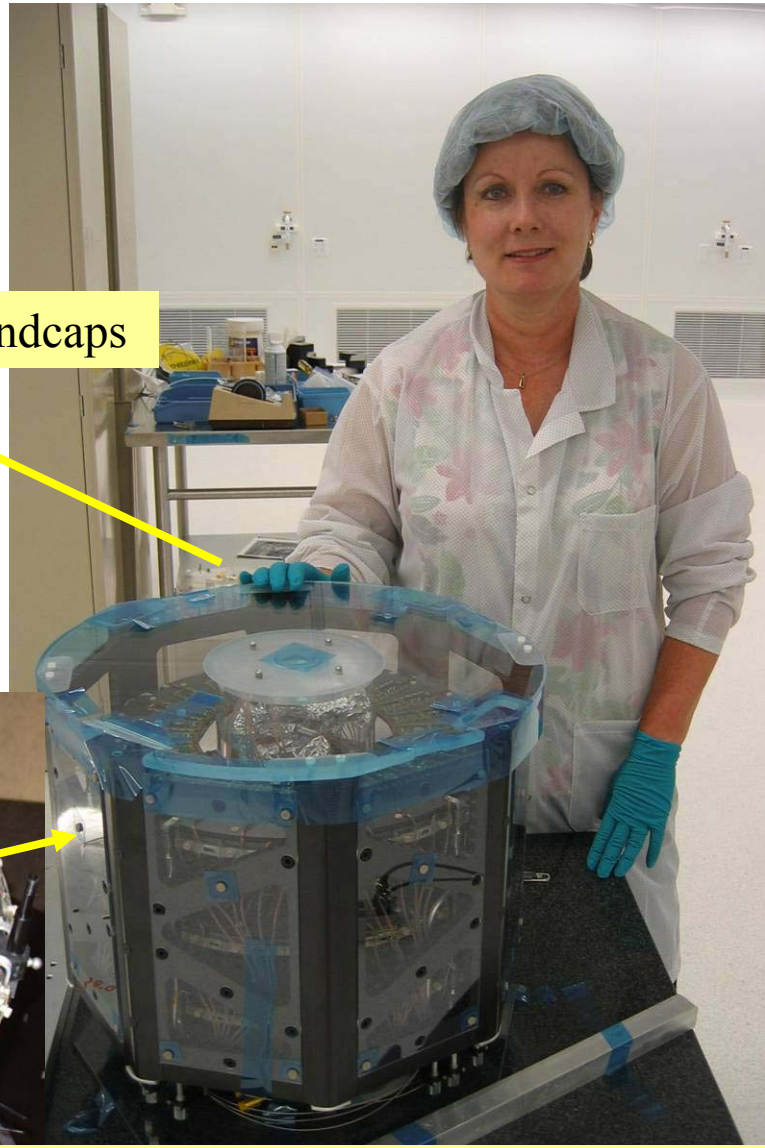


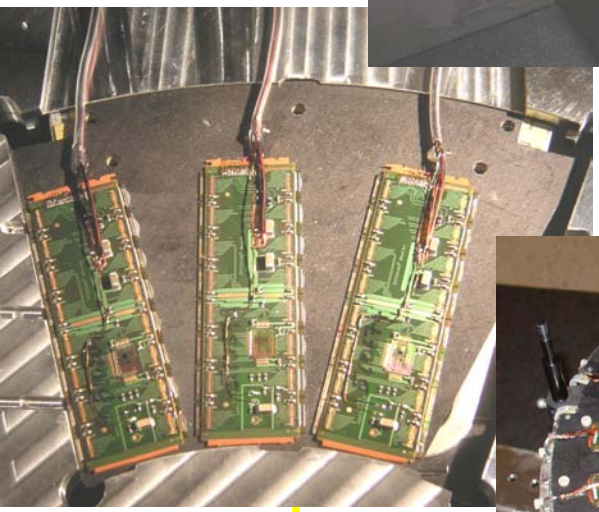


Pixel Endcaps to CERN

2 flights to CERN

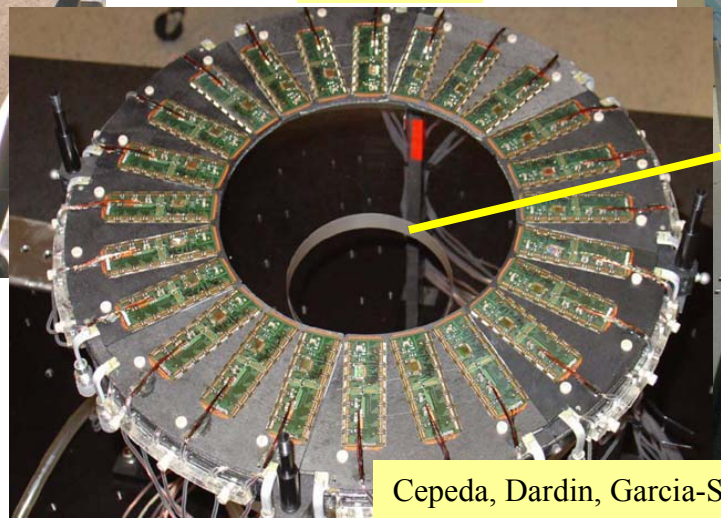
2 endcaps





8 sectors

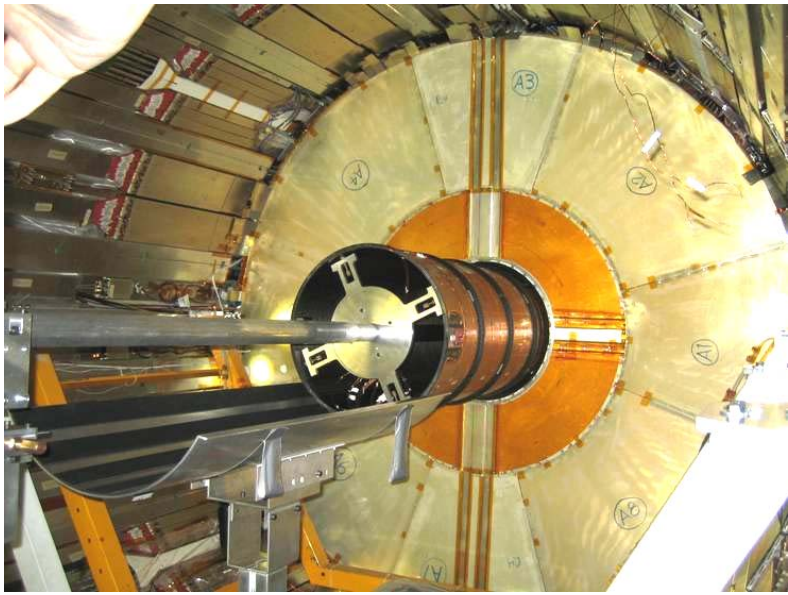
3 disks



Cepeda, Dardin, Garcia-Sciveres, Gilchriese, Lys, Madaras, Witharm, Wyckoff

Pixel Support Tube

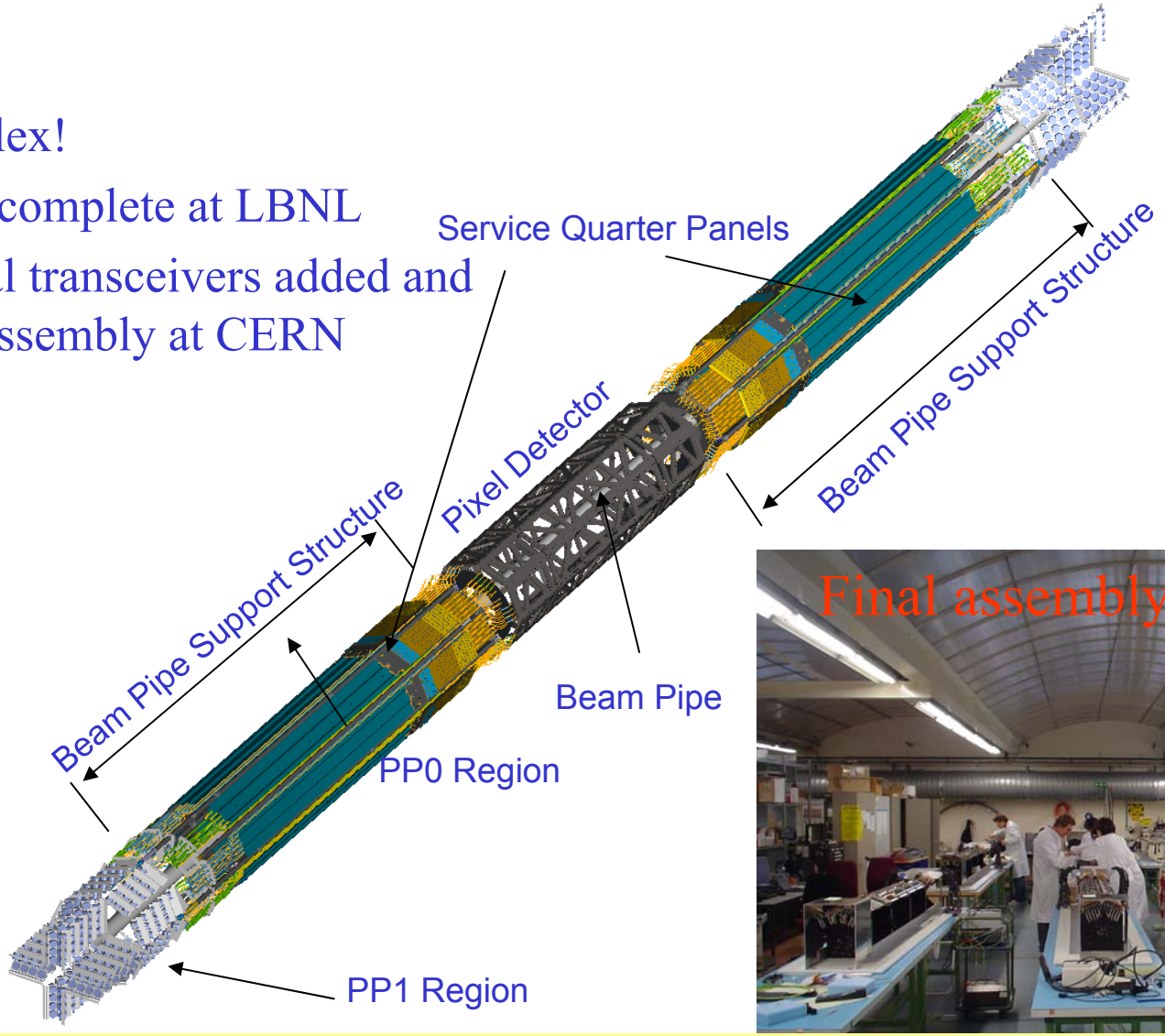
- Made at LBNL. Installed at CERN



Anderssen, Cepeda, Hartman, Johnson, Post

Pixel Services - I

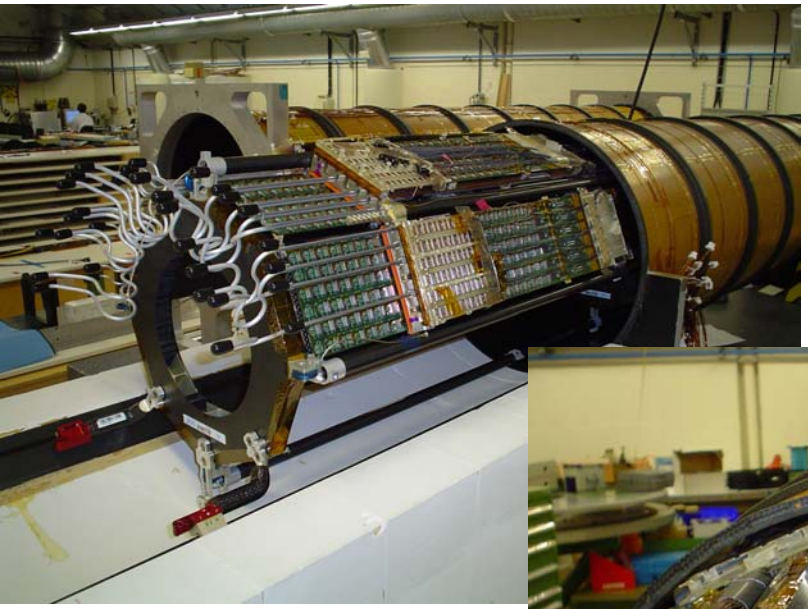
- Complex!
- Work complete at LBNL
- Optical transceivers added and final assembly at CERN

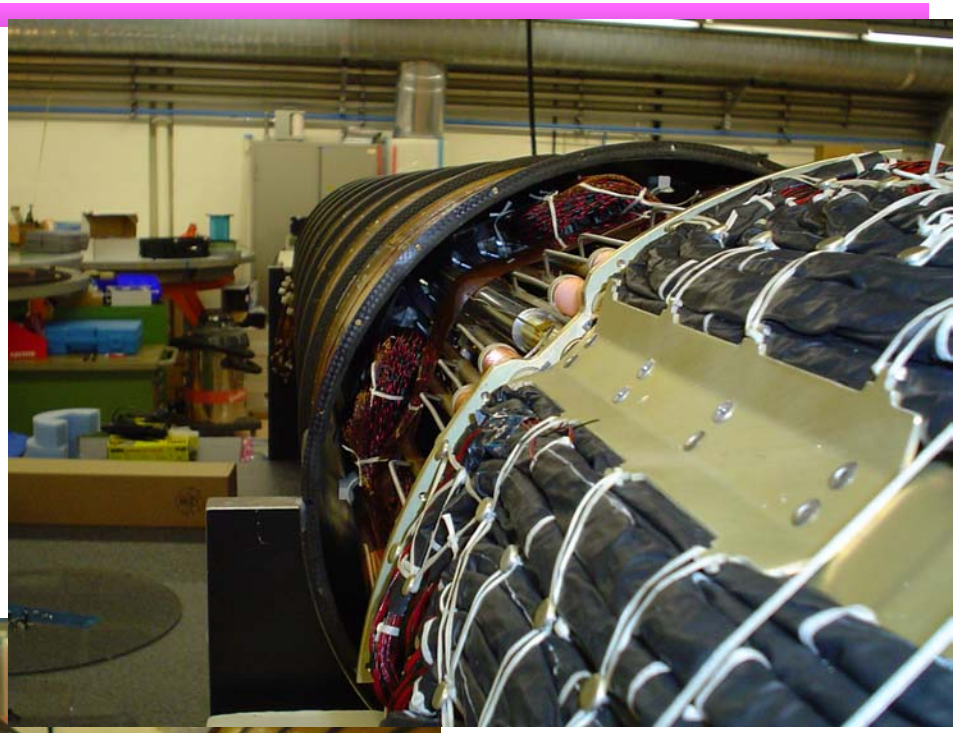


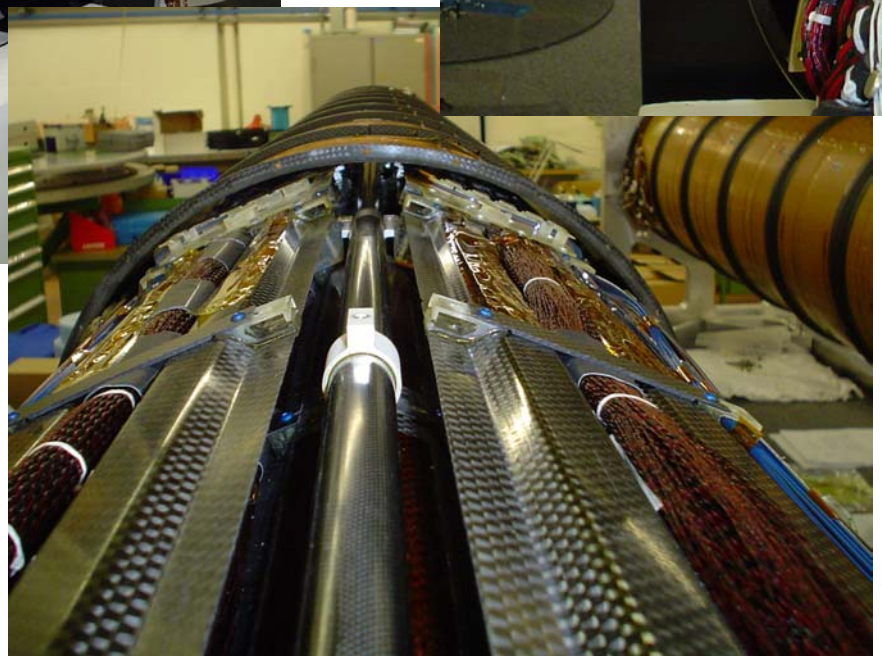
Alonso, Anderssen, Cepeda, Dardin, Garcia-Sciveres, Gilchriese, Hartman, Johnson, Madaras, Pekedis, Post, Wyckoff

Services - II

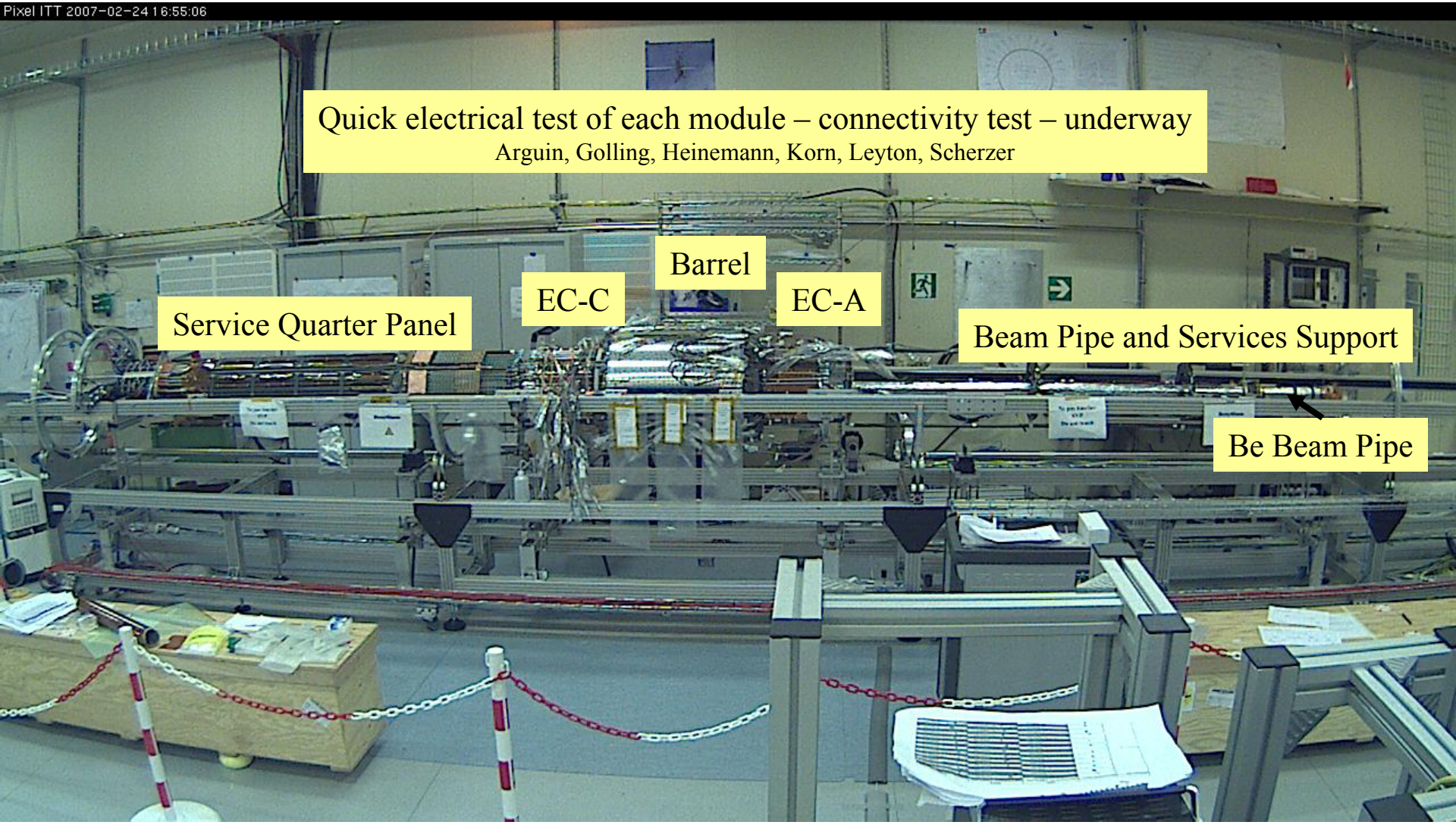
- Very tight fit in support tube
- Practiced in November





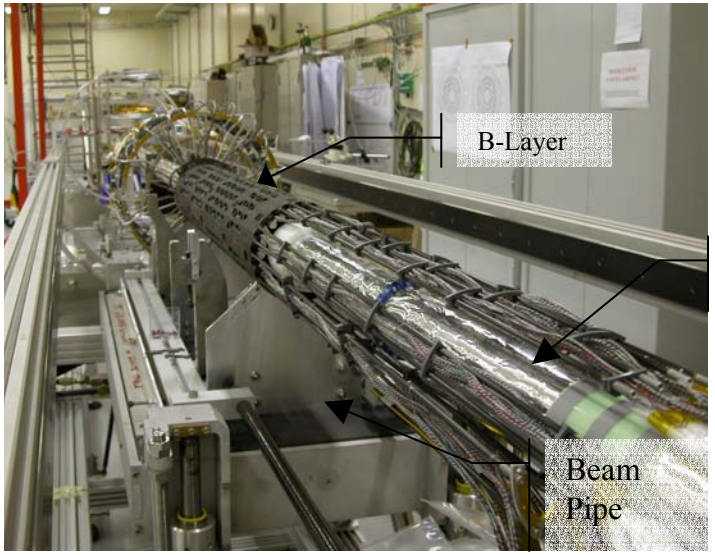


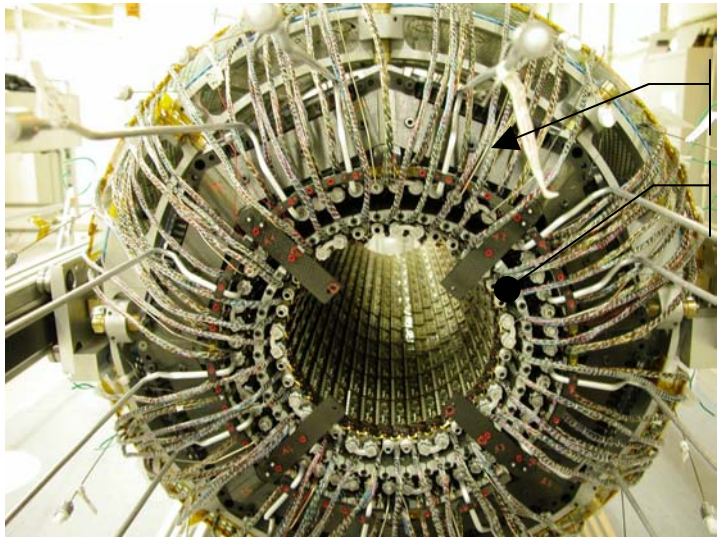
Surface Integration - Overview

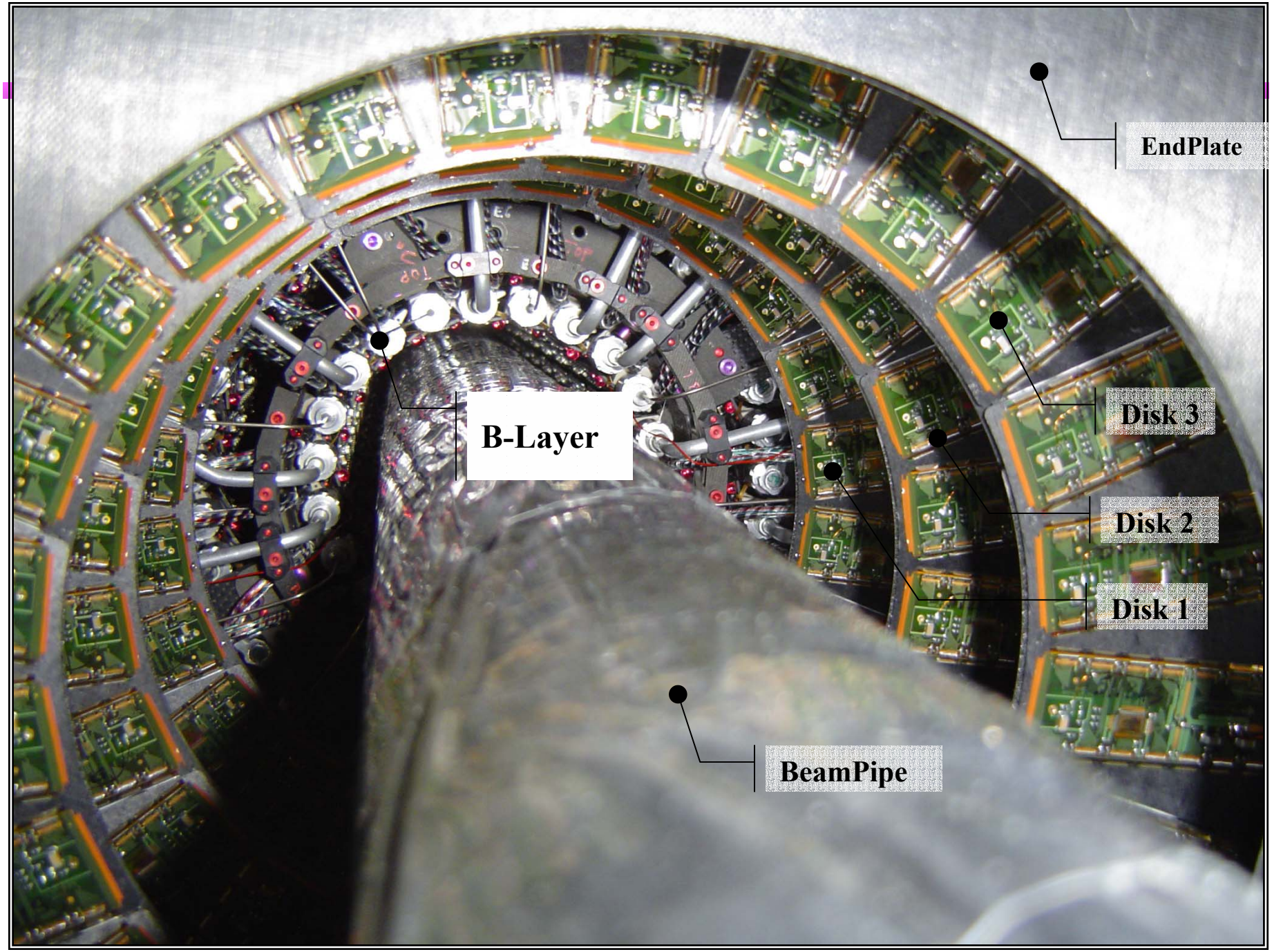


Integration - II

- Outer barrel layers
- Beam pipe
- Innermost barrel layer(B-layer)
- Endcaps





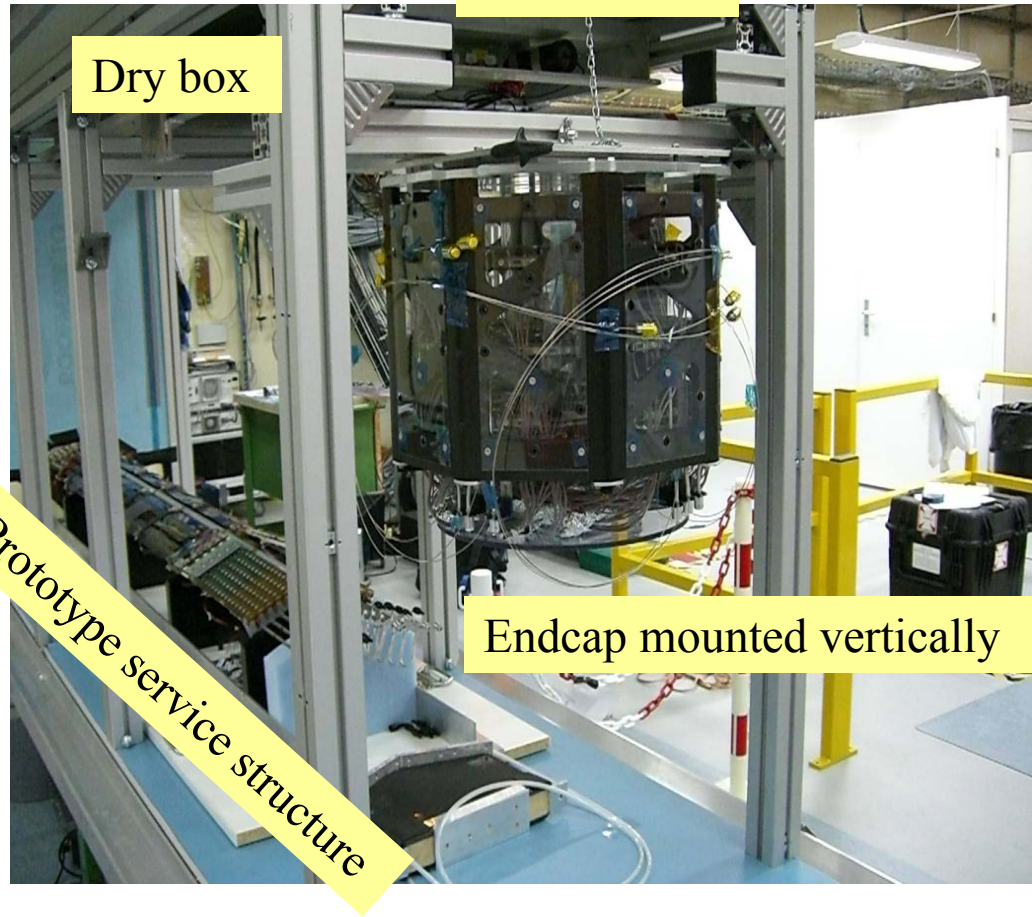

EndPlate
B-Layer
Disk 3
Disk 2
Disk 1
BeamPipe

Inner Detector Schedule

- Pixel detector schedule continues to be very tight
  - Many problems with optical transceivers =>increased production and retrofit of services to add controlled heating elements => delay
- Problems with heating elements in all evaporative cooling circuits for SCT and pixels, in last 1-2 months.
  - Commercial product used to heat unevaporated liquid to avoid condensation and guarantee gas for condensers
  - Corrosion and ground faults
  - Remove, repair, replace and/or change location. In current design, many not accessible. Must be reliable
- Heater problems prevent endcap SCT/TRT units from being installed => prevents pixels from being installed
- Current plan is to proceed with mechanical installation of endcaps(starting next month) and pixels(June) and revise connection plan to work in parallel rather than sequentially. Will require very intense and difficult work.
- Note beam pipe integrated into pixel detector, which is installed as single “package”.

Pixel Endcap System Test at CERN

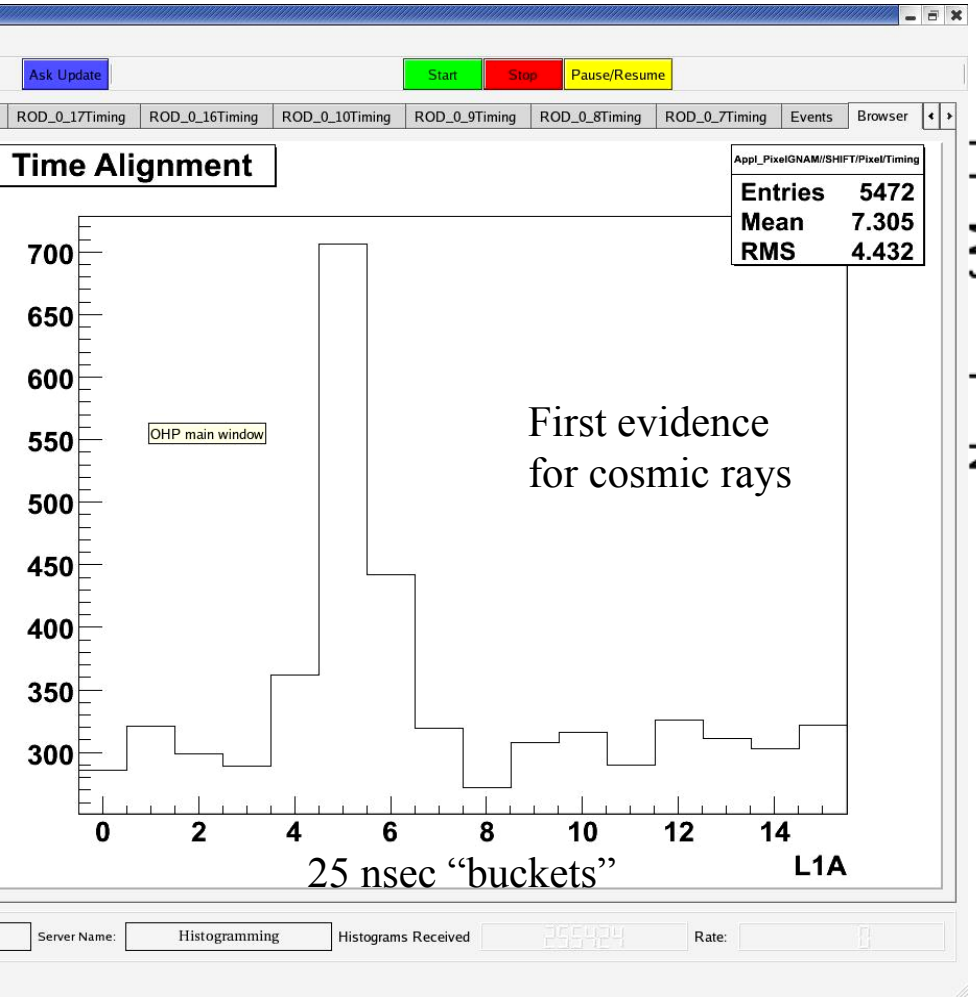
- One endcap(A) mounted vertically to maximize (small) cosmic ray rate.
- Prototype power, cooling and monitoring structure
- Data control and data acquisition systems
- Roughly 10% of final system
- Lots of learning ie. problems
- Cosmic ray data taken
- LBNL leadership essential!
- Alignment - Beate

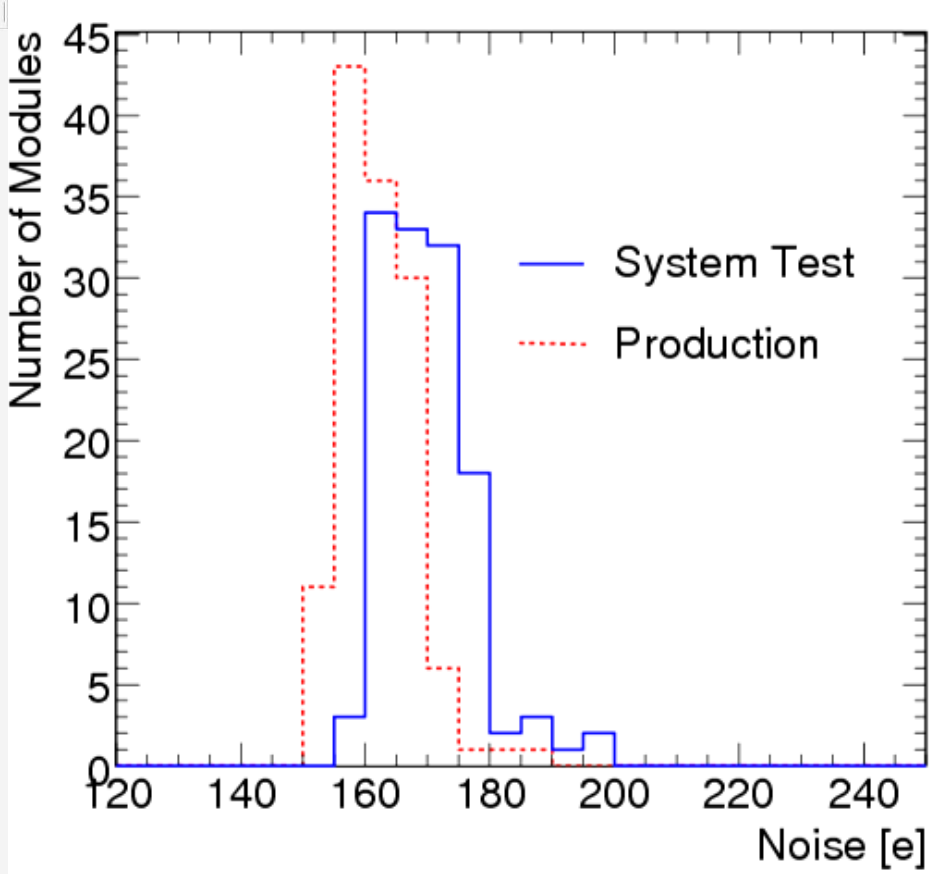


Garcia-Sciveres, Hartman, Johnson, Korn, Leyton, Zdrazil

System Test - II

- Electrical performance in system test ~ as for single modules





Commissioning/Operations - I

- ATLAS has started detailed planning for the commissioning -> operations phase of the detector.
- 500-600 FTEs in total are estimated to be needed by about the end of this year
- Most of the FTEs are expected to be located at CERN, although some aspects of data quality monitoring could be done remotely
- Personnel accounting will be done based on the number of scientific authors + those in process of qualifying as authors from each institution
- Accounting is expected to be done primarily at the national level as a practical matter.

Commissioning/Operations - II

- K. Einsweiler re-elected as Pixel Project leader for 2-year term until Feb. 2009
- M. Garcia-Sciveres chairs task force to define pixel commissioning/operations organization and personnel, and will be first pixel operations coordinator
- A. Ciocio is deputy commissioning coordinator for the SCT
- Ongoing and substantial commitments to commissioning core software(Quarrie, Calafiura, Leggett, Lavrijsen, Binet, Woudstra)
- Other responsibilities to be concentrated in pixel commissioning and tracking data quality monitoring(senior people, postdocs, grad students)
- Anticipated need from LBNL: roughly dozen FTEs

University Interactions

- US SCT design and fabrication done by LBNL in collaboration with UC Santa Cruz
- US pixel detector design and fabrication done by LBNL in collaboration with New Mexico, Ohio State and Oklahoma
- Collaboration with LBNL helped enable university groups to have significant roles in challenging detectors.
- Pixel collaboration has continued at CERN and additional US groups have joined(Columbia, Iowa, Iowa State, UT Dallas, SLAC).
- M. Garcia-Sciveres from LBNL, as US ATLAS pixel M&O manager, has taken lead in helping to integrate old and new US groups at CERN

Analysis Support Center - I

- US ATLAS formed regional Analysis Support Centers(ASCs) at BNL, ANL and LBNL.
- Workshops/meetings at LBNL prior to formal start of ASCs in March 2006
  - October 2005 on software organization and plans. 50 attendees, mostly from western universities
  - Second Workshop January 2006 on Beyond the Standard Model and software tutorials. ~14 tutorial attendees and ~40 Workshop Attendees
- Advisory Committee formed in July 2006
  - Abe Seiden, UCSC, chair
  - Peter Loch, Arizona
  - Henry Lubatti, Washington
  - David MacFarlane, SLAC
  - David Strom, Oregon

Analysis Support Center - II

- Workshop October 2006
  - 27 attendees, mostly new students and postdocs from western universities
  - 5 days of software tutorials with analysis exercises to use the software
  - Excellent computing support from the Western Tier 2 Center at SLAC
- Tracking workshop scheduled for 11-13 April
  - We are planning to introduce participants to tracking detectors, tracking software and alignment
  - Advisory committee would like to see introductory talks for people new to ATLAS. Will try with tracking detectors.
  - Will include talks on physics analysis that will use tracking information
- Follow up in the summer, topics to be decided
- So far no interest shown in visits more than a week, although would be welcome.

Upgrade R&D - I

- An upgrade of the LHC to eventually reach a luminosity of 10^{35} is foreseen – Super LHC
- This luminosity, 10 times the nominal design luminosity of the LHC, has many implications for ATLAS(and CMS or other LHC experiments).
- The largest challenge in ATLAS – completely replace all of the current Inner Detector.
- The approximate desired timescale for new tracker is about 2015. This is very soon given the technical goals as well as the engineering and organizational challenges.
- In addition, the innermost pixel layer (B-layer) is anticipated to deteriorate such that replacement by about 2012 is needed.
- Note that by far first priority of ATLAS and LBNL is to complete the current detector….but have started R&D already to try to meet desired timescales.

ATLAS Upgrade R&D at LBNL - I

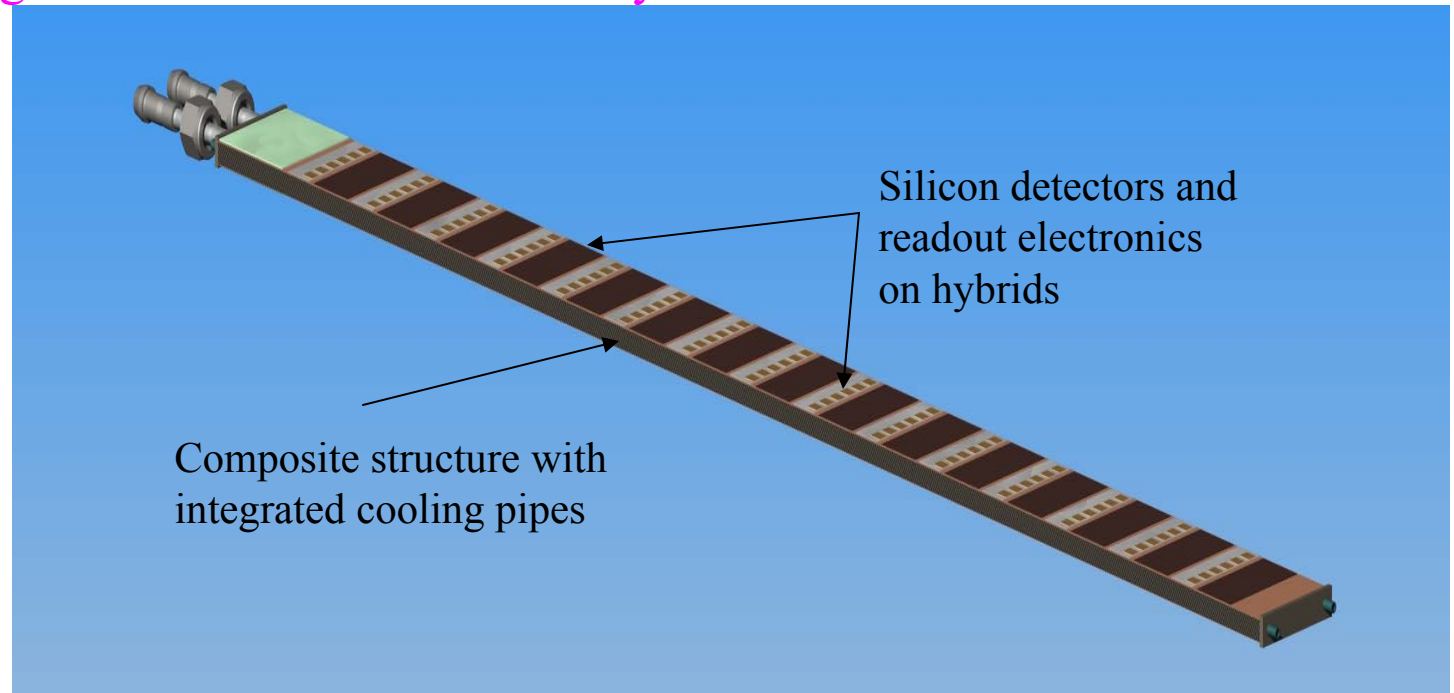
- Existing pixel integrated circuit coupled to 3D silicon sensor development
  - Critical to understand this new sensor concept
  - 3D sensors may be candidate for B-layer replacement as well as SLHC
- Next generation pixel integrated circuits
  - Increase radiation resistance(~ x10) and single-event upset immunity
  - Smaller pixel size eg. 50x250 microns to reduce track confusion
  - Small test chip fabricated more than a year ago in 0.13μ technology. Test results promising but needed much more design effort
  - Work now underway by Einsweiler, Garcia-Sciveres with experienced IC engineer(Mekkaoui) in 0.13μ technology to develop next generation
  - Test chip submitted last month to return by about end of May.
  - Collaboration with EU groups initiated to build up team
  - Initial phase of this development could lead to new IC for B-layer replacement, stepping stone to SLHC replacement

ATLAS Upgrade R&D at LBNL - II

- Powering schemes
  - Universal agreement that current solution for powering silicon modules – individual powering of each module - does not scale to much larger tracker.
  - Ely, Garcia-Sciveres and Denes (engineer) designing IC for local (in the detector) DC-DC conversion.
  - Test chip submitted last month, back about end of April
  - Part of larger ATLAS R&D proposal
  - Haber, RAL testing serial powering at module and system level.
  - Silicon strip development – see next pages – compatible with trying serial power or DC-DC conversion

ATLAS Upgrade R&D at LBNL - III

- Stave concept for silicon strips
  - Currrent ATLAS concept has single modules mounted on large structures (barrels or disks)
  - C. Haber with other groups is investigating stave concept in which silicon is directly mounted on flexible printed circuit to distribute power, controls and readout in turn glued to composite structure with integrated cooling.
  - Similar in concept (but larger in scale) to extensive work done for Run 2b CDF upgrade and with some similarity to CMS outer tracker



ATLAS Upgrade R&D at LBNL - IV

- Stave electrical prototyping
  - Phase I – (early 2006) ATLAS electronics on a stave structure with individual power/clocks to each module: performance on/off stave consistent
  - Phase II – (summer 2006) test of stave with serial power and parallel clock distribution: performance consistent with Phase I.
  - Phase III – (shortly) full scale electrical stave fabrication and test
- Stave mechanical prototyping
  - Conceptual design complete.
  - Extensive FEA for sag and thermal properties. Looks good.
  - Tooling completed and materials in hand
  - Fabrication done at LBNL using composites capability developed for pixels
  - Test samples being fabricated leading to full-scale(1 meter) prototype fabrication and testing over next months
- Combined mechanical/electrical test in summer 2007

Conclusions

- Construction of ATLAS silicon strip and pixel detector components completed at LBNL. A major milestone!
- "10%" system test of pixel detector made at LBNL completed, excellent results
- ATLAS assembly and installation at CERN – great progress
- But ATLAS schedule, inner detector in particular, very tight
- Personnel planning for commissioning/operations developing rapidly to meet need to have large team in place in the next months.
- US regional Analysis Support Center established and operating at LBNL
- Substantial progress on upgrade R&D for future pixel and silicon strip detectors.