ATLAS – Part I

Director's Review

November 8, 2006

M. Gilchriese

Outline

- LBNL ATLAS group
- LHC status
- ATLAS installation
- LBNL and ATLAS
- Semiconductor Tracker
- Pixel Tracker
- Upgrade R&D
- Conclusions – Part I

ATLAS GROUP FY07

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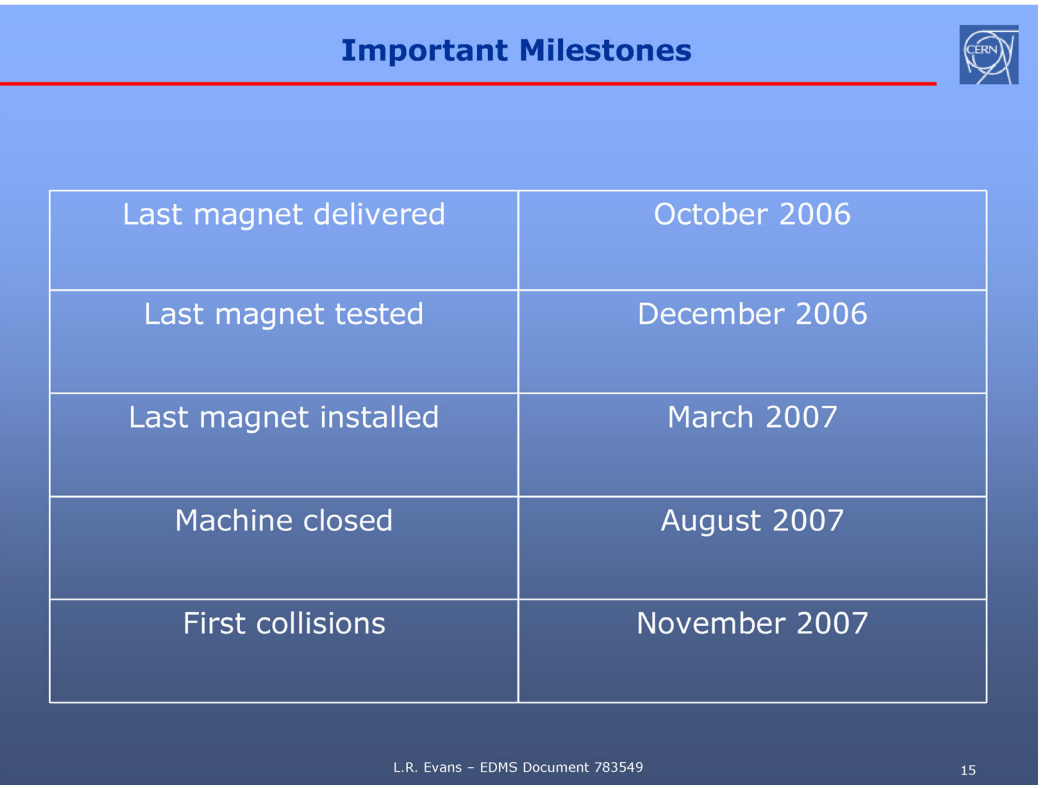
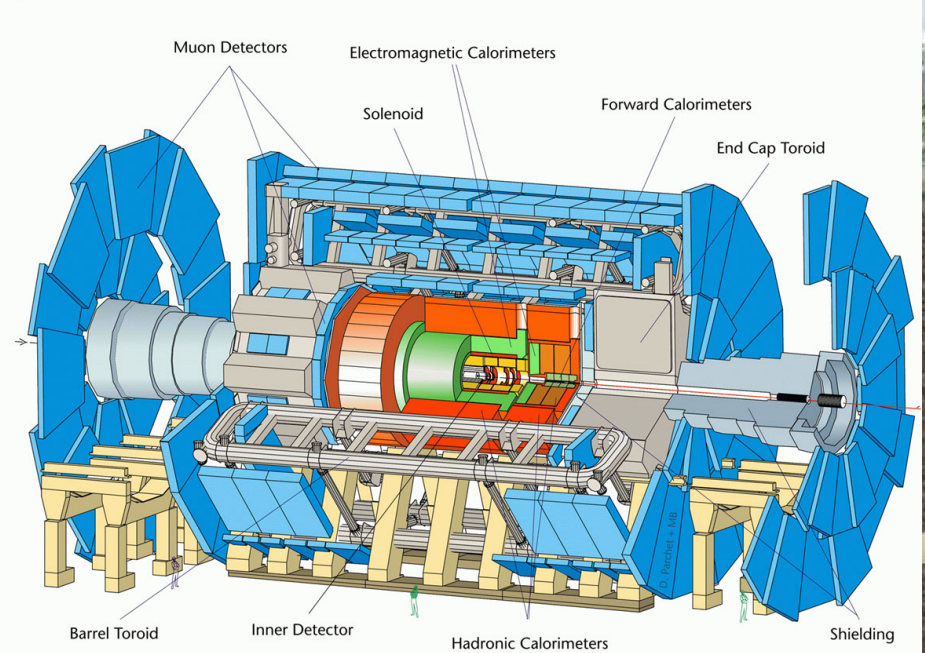
LHC Status

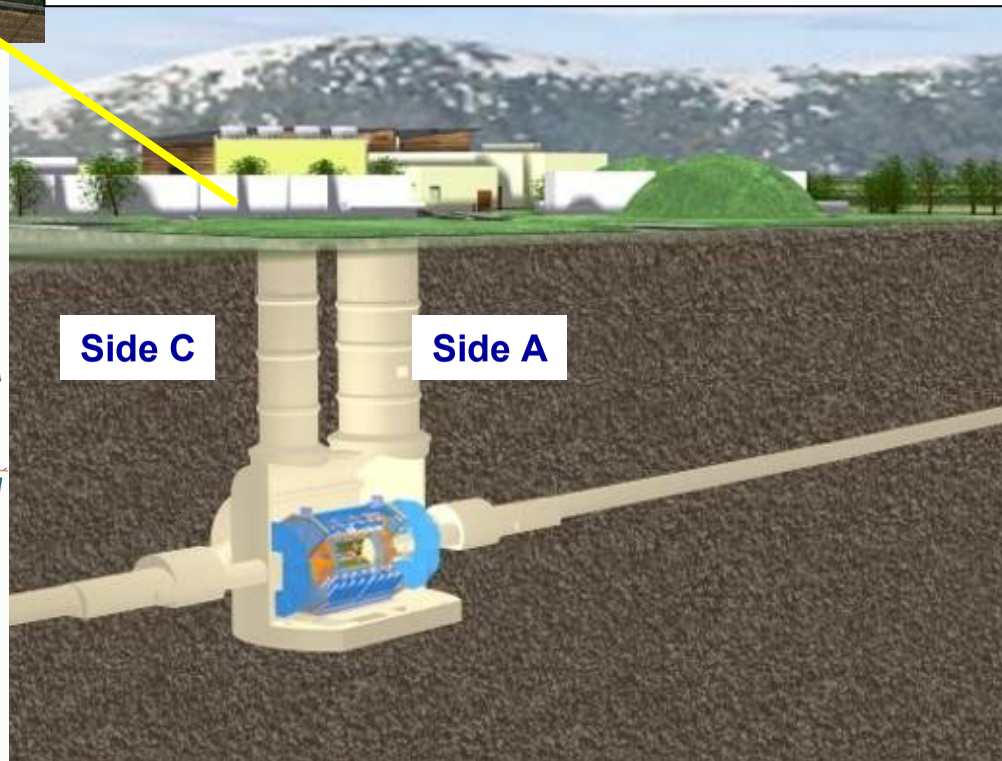


- Initial operation by late 2007 will be at 900 GeV (CM energy) with a static machine (no ramp, no squeeze) to debug machine and detectors. Low luminosity.
- Full commissioning up to 14 TeV will be done in the winter 2008 shutdown ready for a high energy run in 2008.

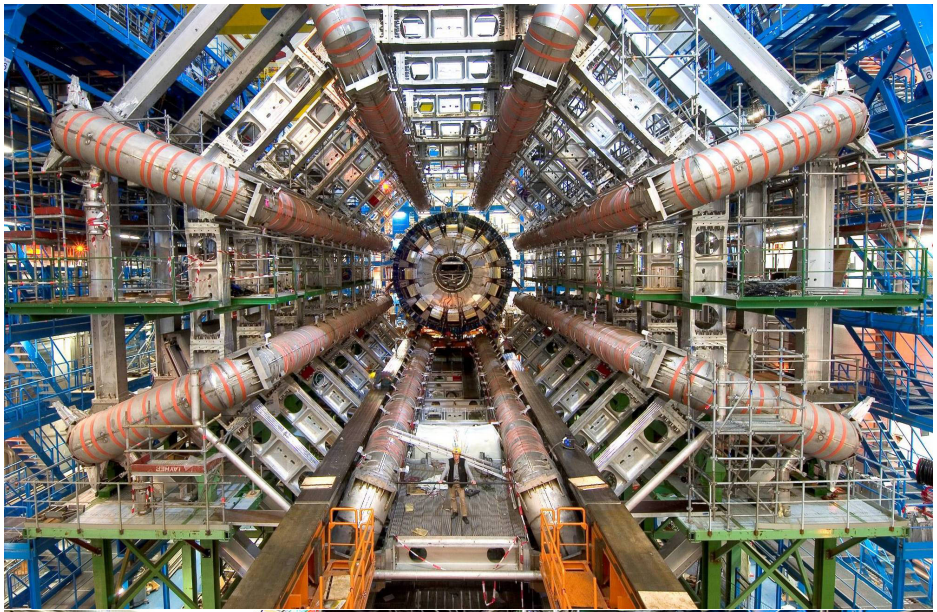
ATLAS at the LHC

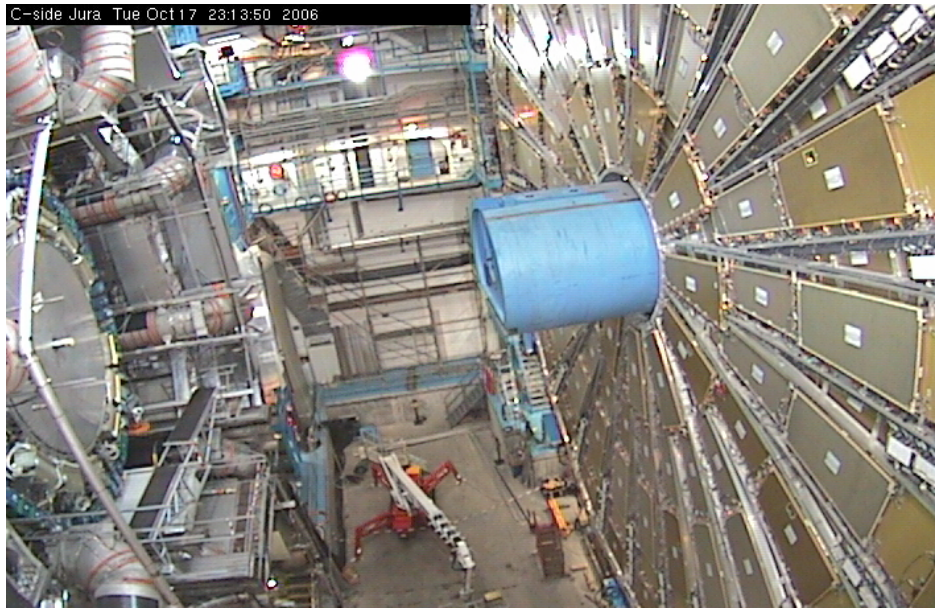
- **Tracking ($|\eta|<2.5$, B=2T) :**
  - -- Silicon pixels and strips
  - -- Transition Radiation Detector (e/π separation)
- **Calorimetry ($|\eta|<5$) :**
  - -- EM : Pb-LAr
  - -- HAD: Fe/scintillator (central), Cu/W-LAr (forward)
- **Muon Spectrometer ($|\eta|<2.7$) :**
  air-core toroids with muon chambers

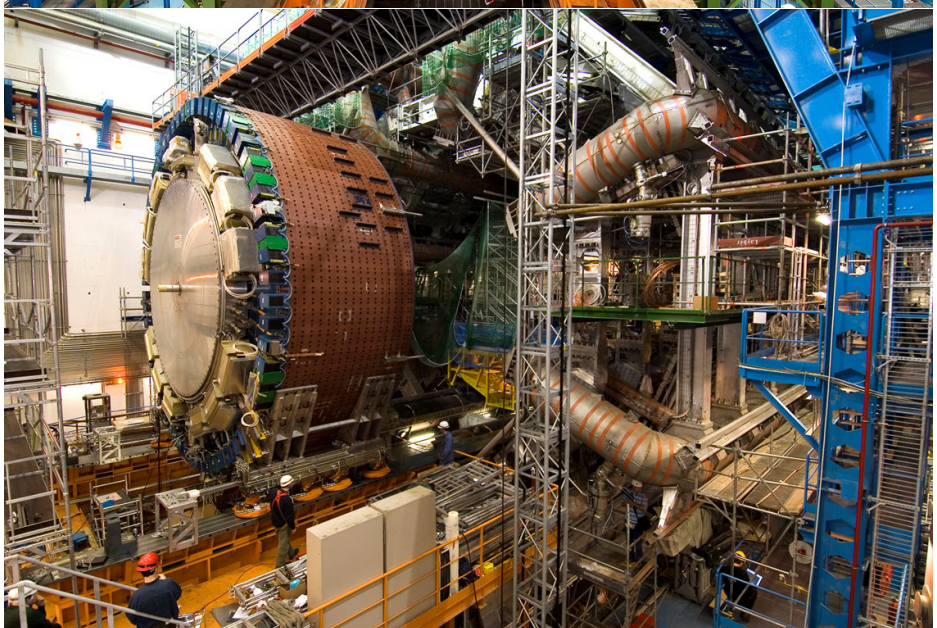




ATLAS Installation

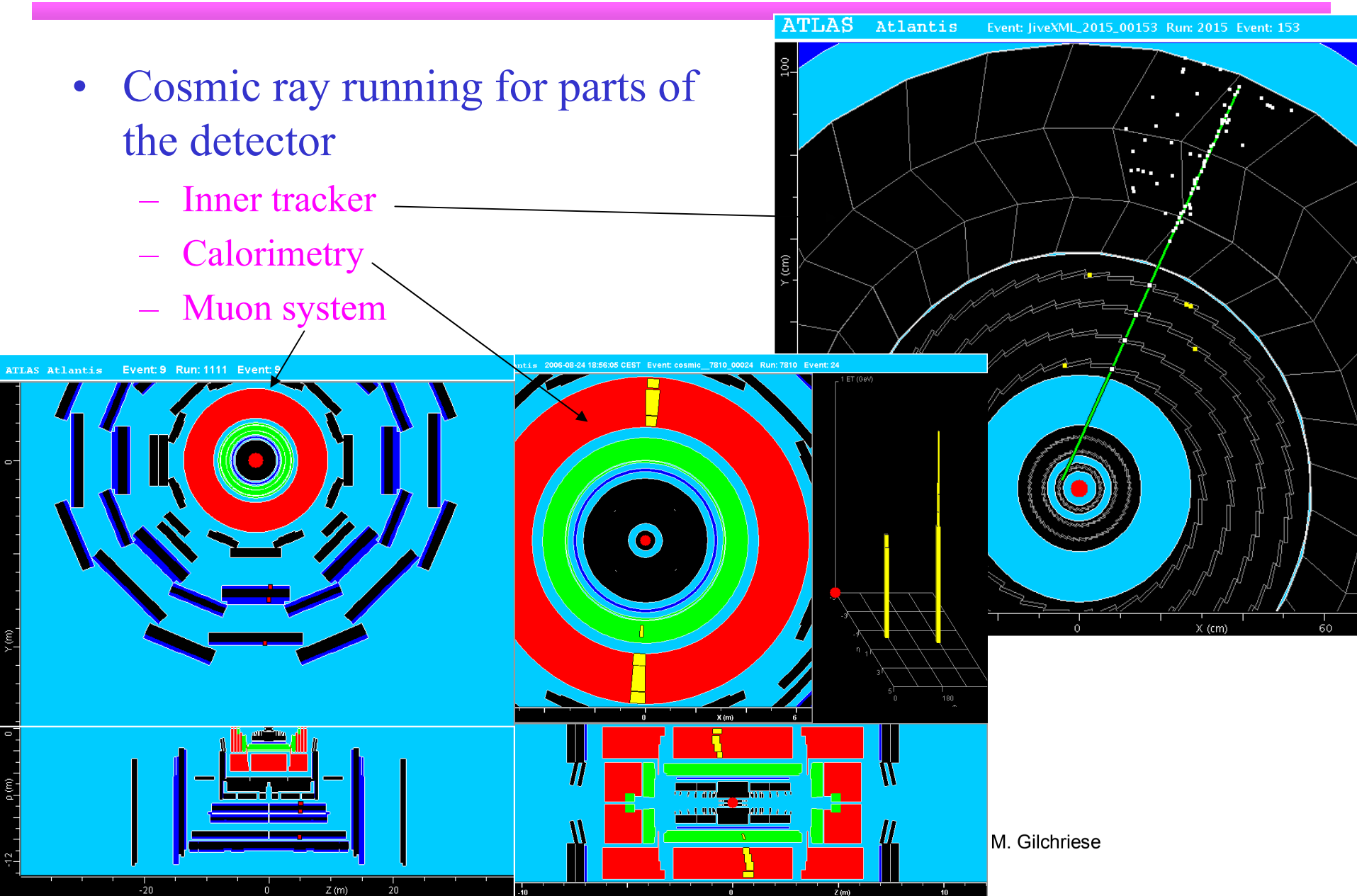






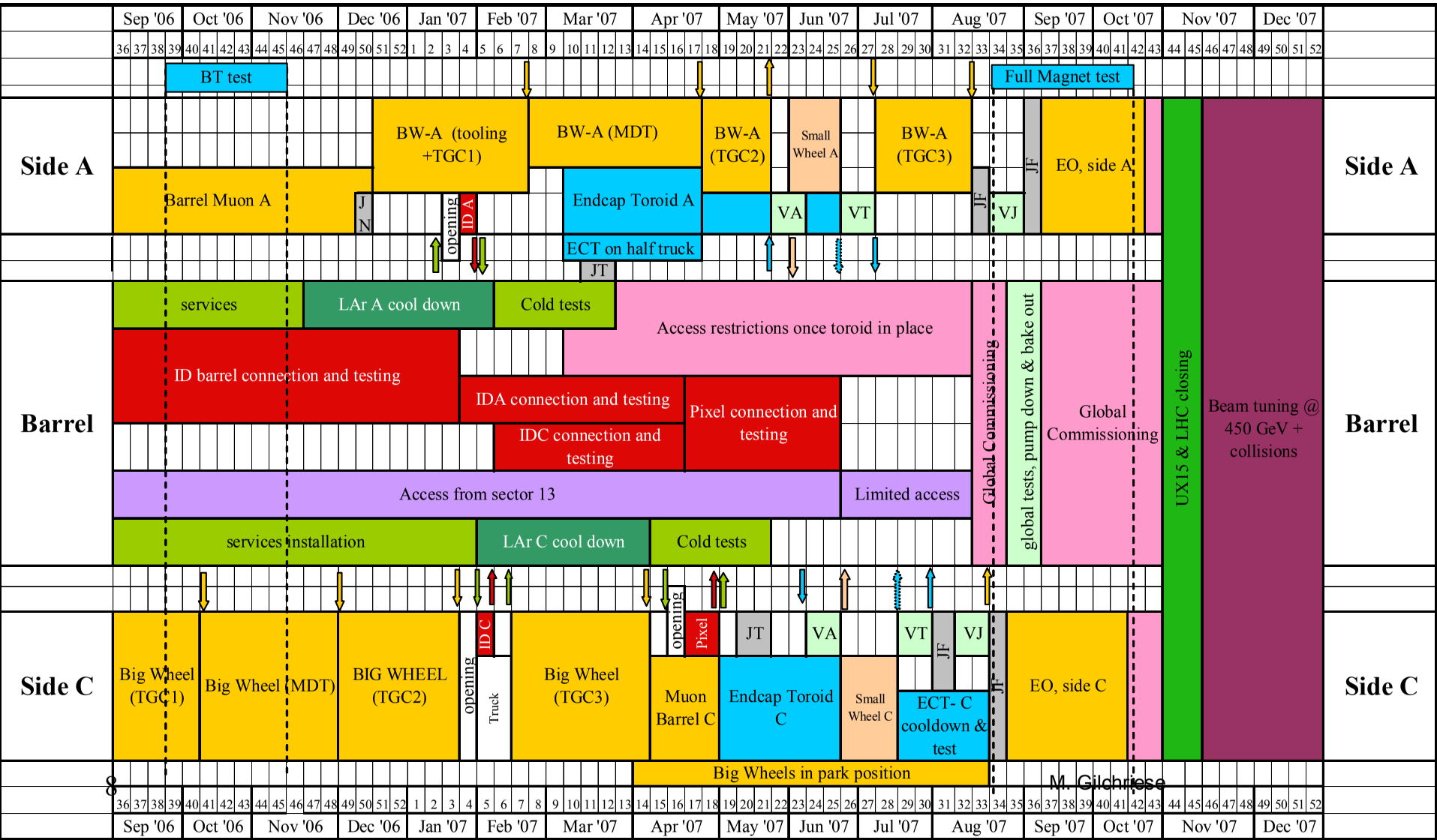
ATLAS Cosmics

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



ATLAS Schedule

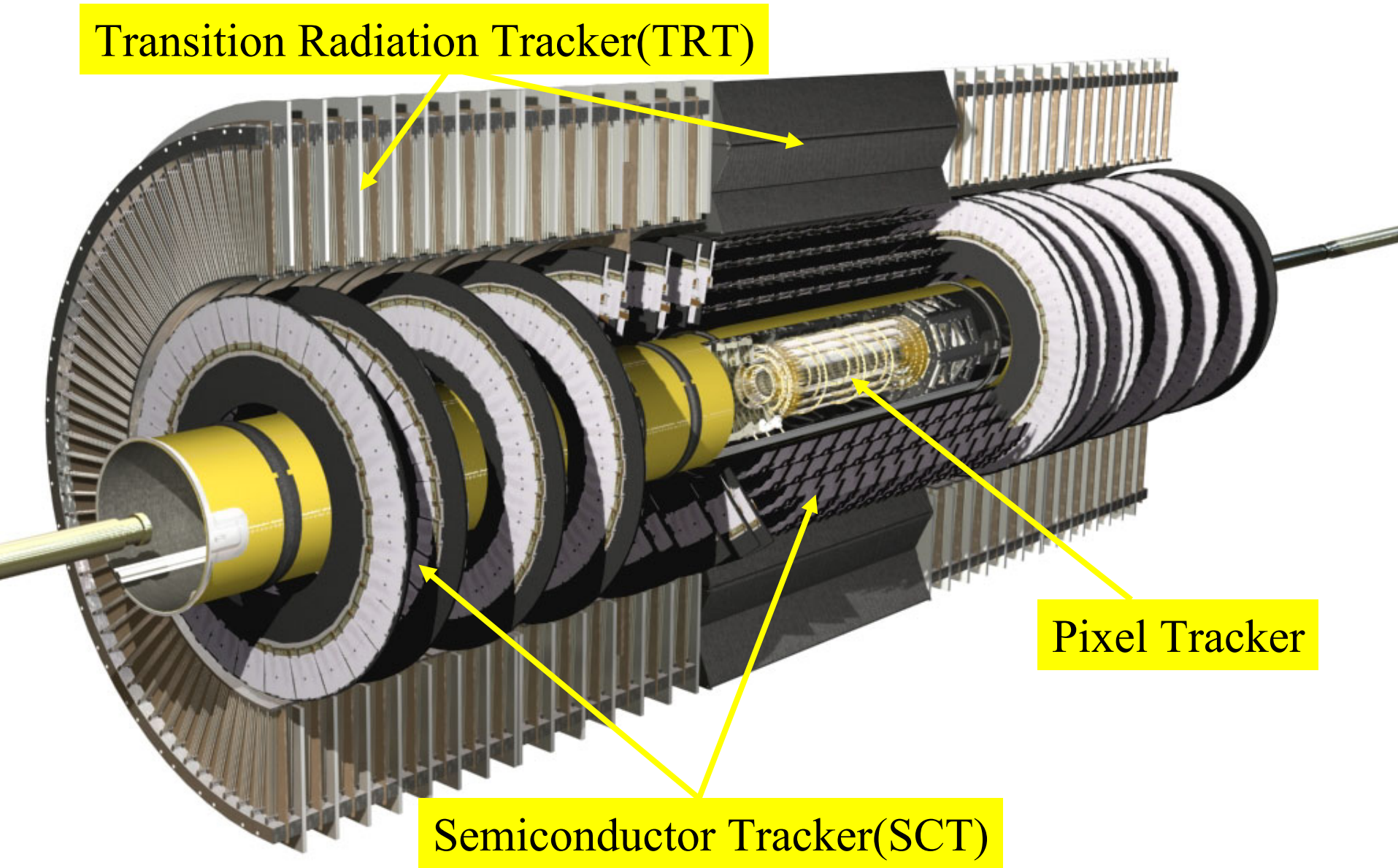
Ready for collisions by about one year from now!



LBNL and ATLAS

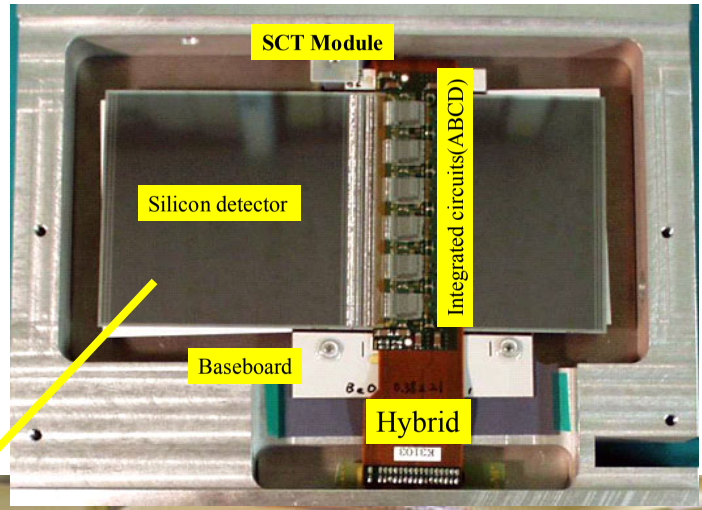
- Detector construction, installation and commissioning
  - Semiconductor Tracker
  - Pixel Tracker
- Software, physics simulation and preparations for data analysis
  - Core software
  - Pixel and tracking software and performance monitoring
  - Event generators
  - Luminosity and data streaming task forces
  - Physics simulation and coordination
- Upgrade R&D
  - Silicon tracker R&D for Super LHC or earlier replacement of pixel tracker elements.

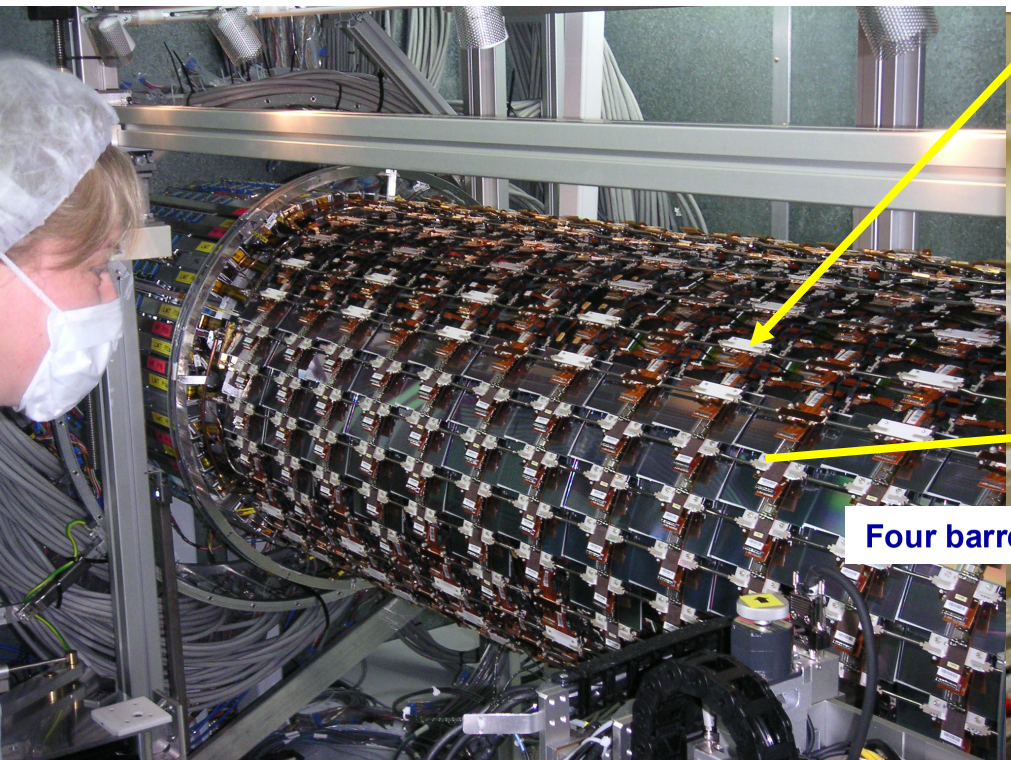
ATLAS Tracking



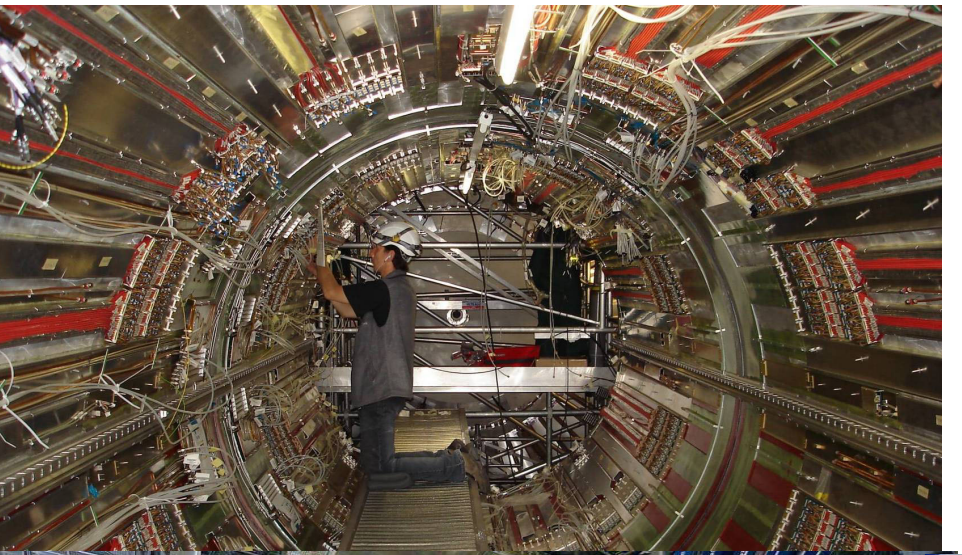
Semiconductor Tracker(SCT) - I

- Silicon strip module production for barrel SCT completed at LBNL about two years ago.
- Installation in ATLAS about 2.5 months ago – next page.

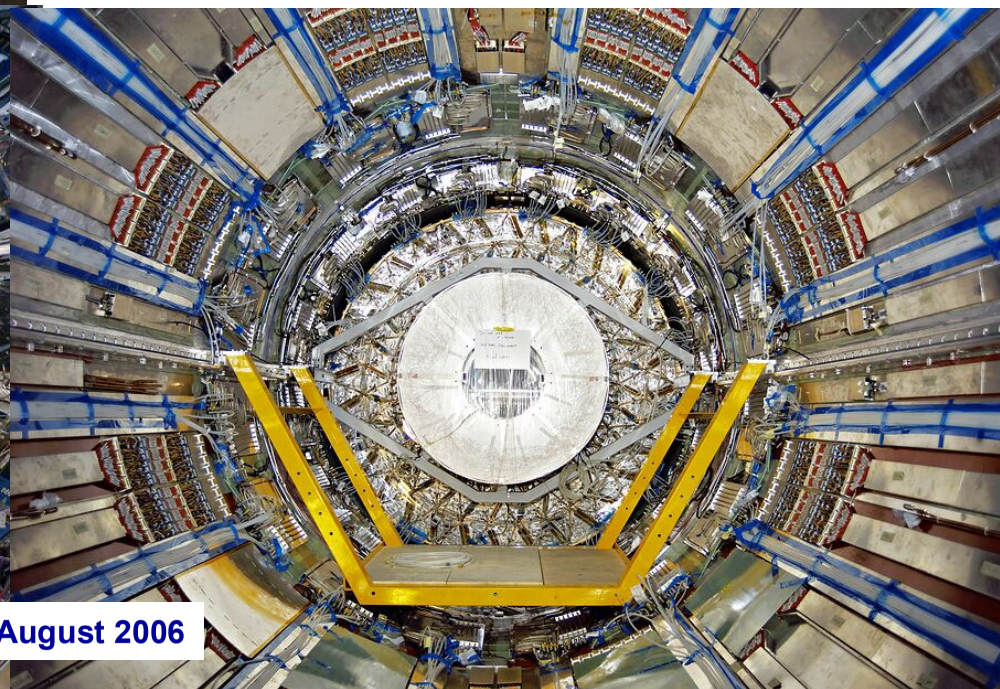




Semiconductor Tracker(SCT) - II



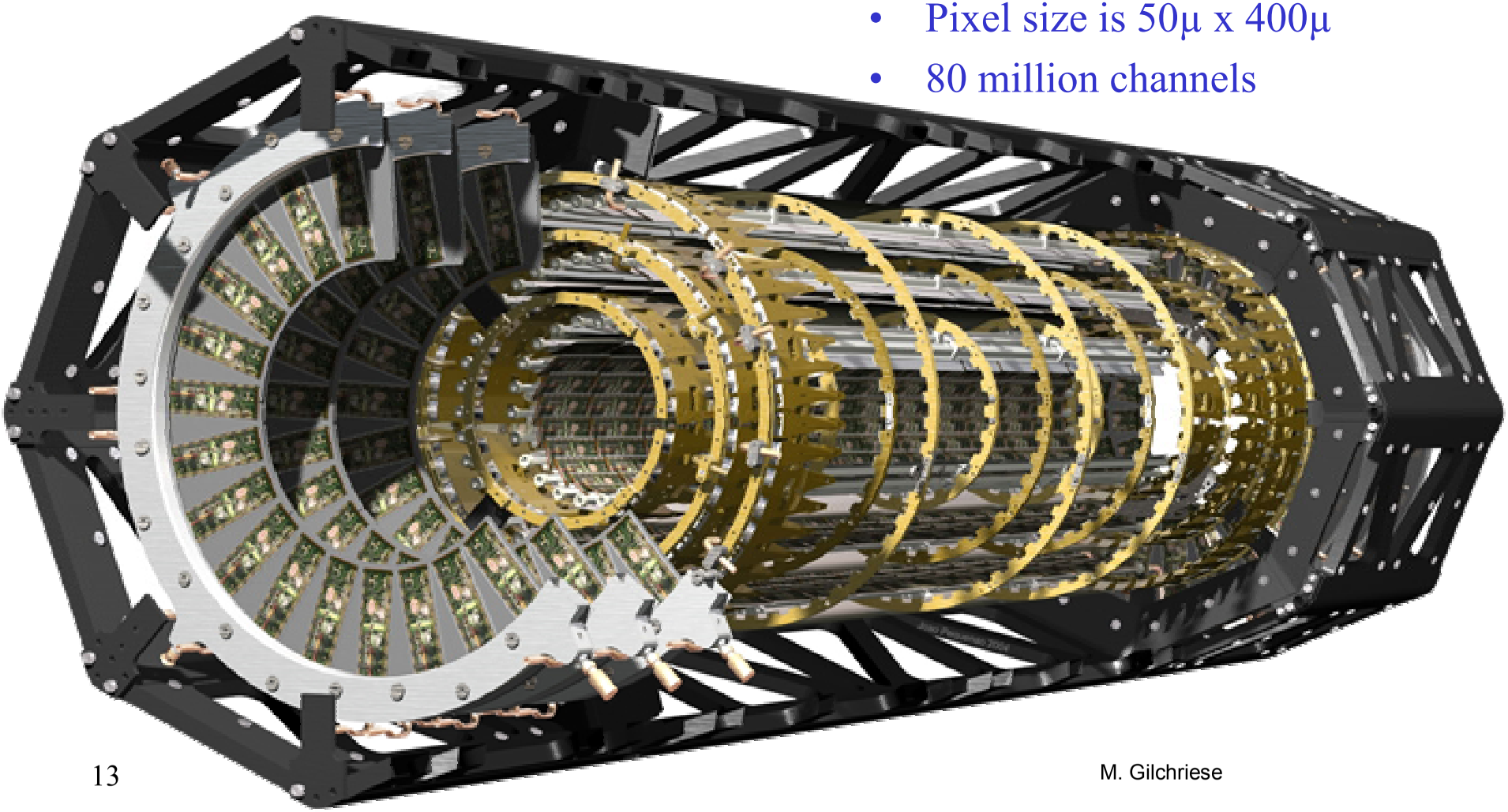
- A Ciocio from LBNL has been coordinating all cable installation and QC for the SCT and this is nearing completion.
- Barrel TRT/SCT installed



End of August 2006

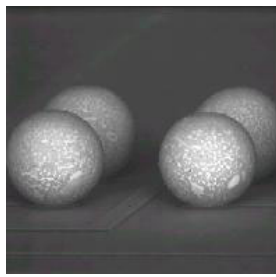
ATLAS Pixel Detector - Overview

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

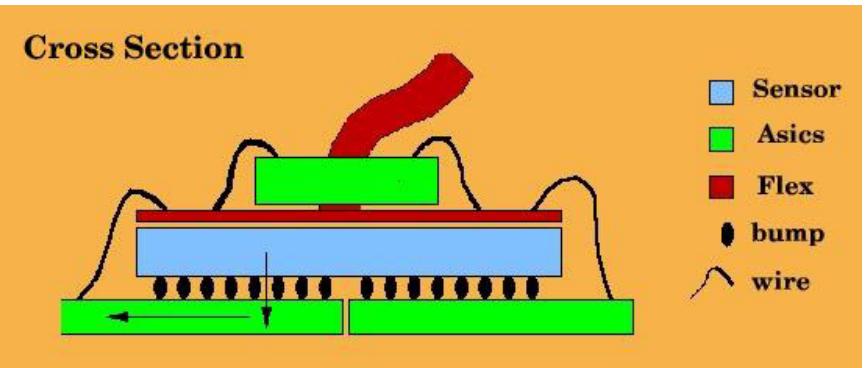


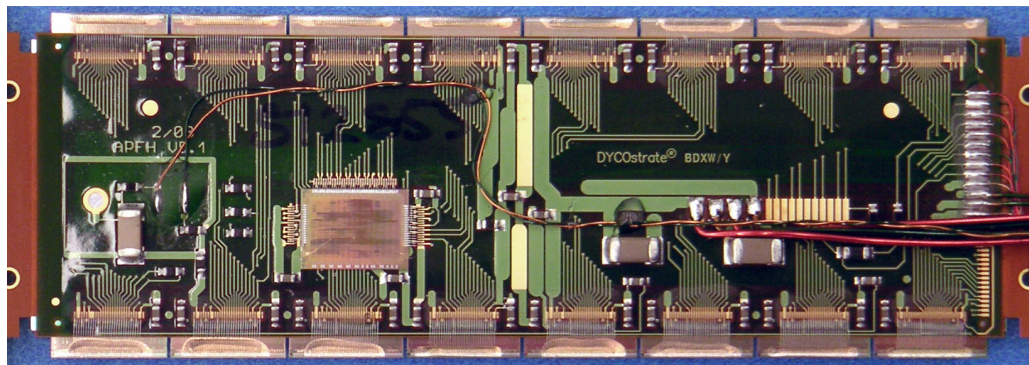
Pixel Electronics and Modules

- Integrated circuit electronics
  - Completed more than a year 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 months ago
  - 1744 good in detector, many more produced
  - Coordinator was M. Garcia-Sciveres from LBNL
  - LBNL did final assembly/testing of disk modules



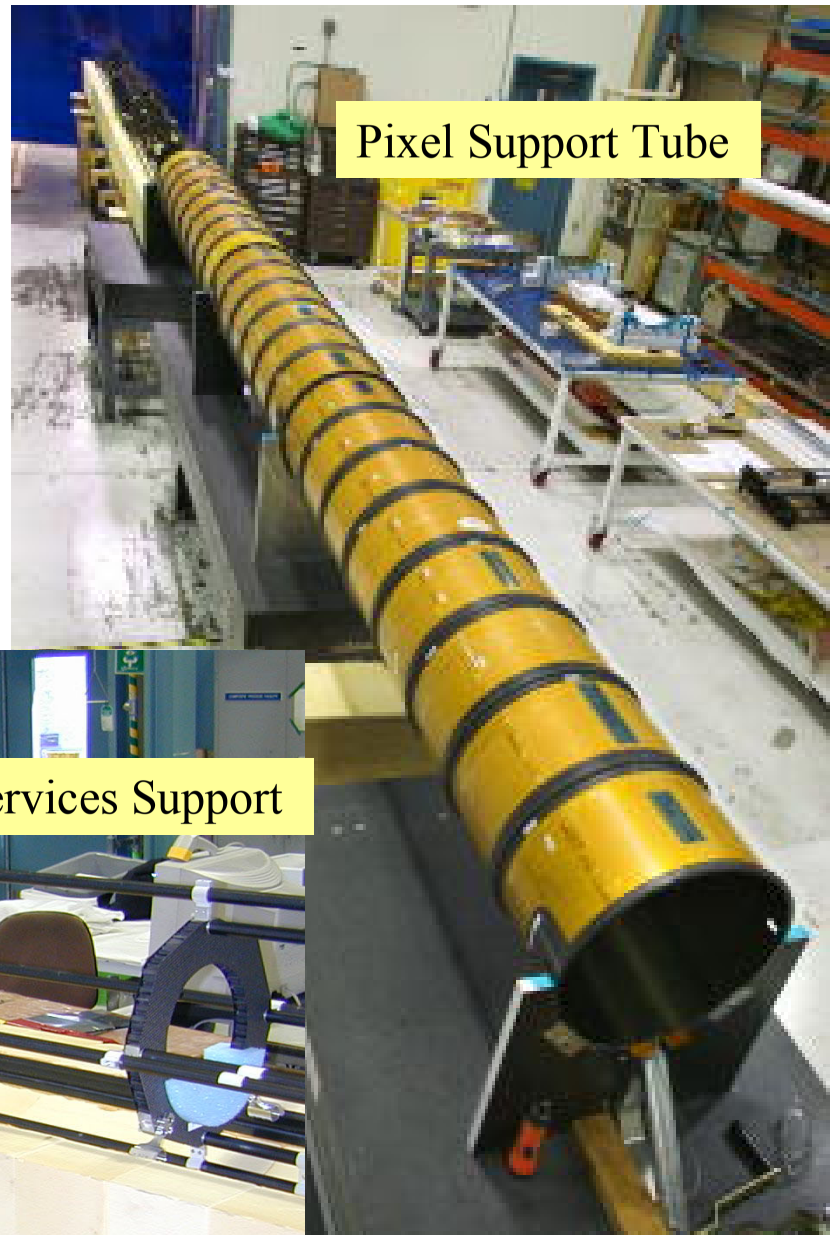
About 46,000 pixels per module

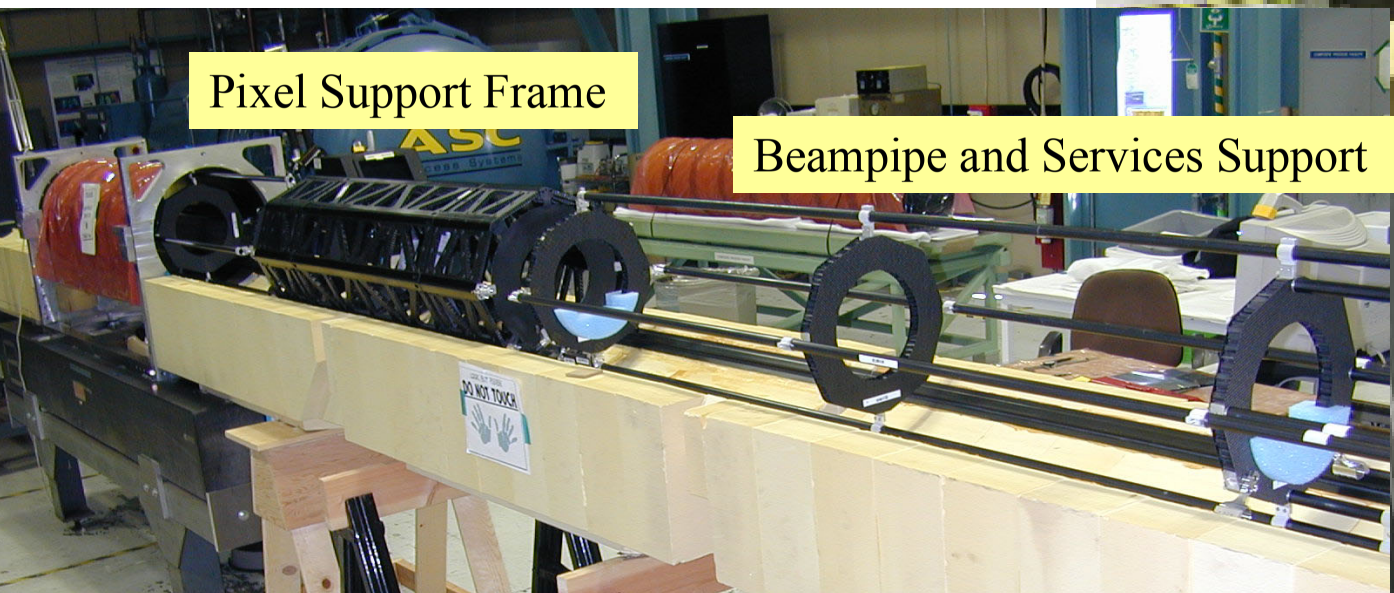




Pixel Support Structures

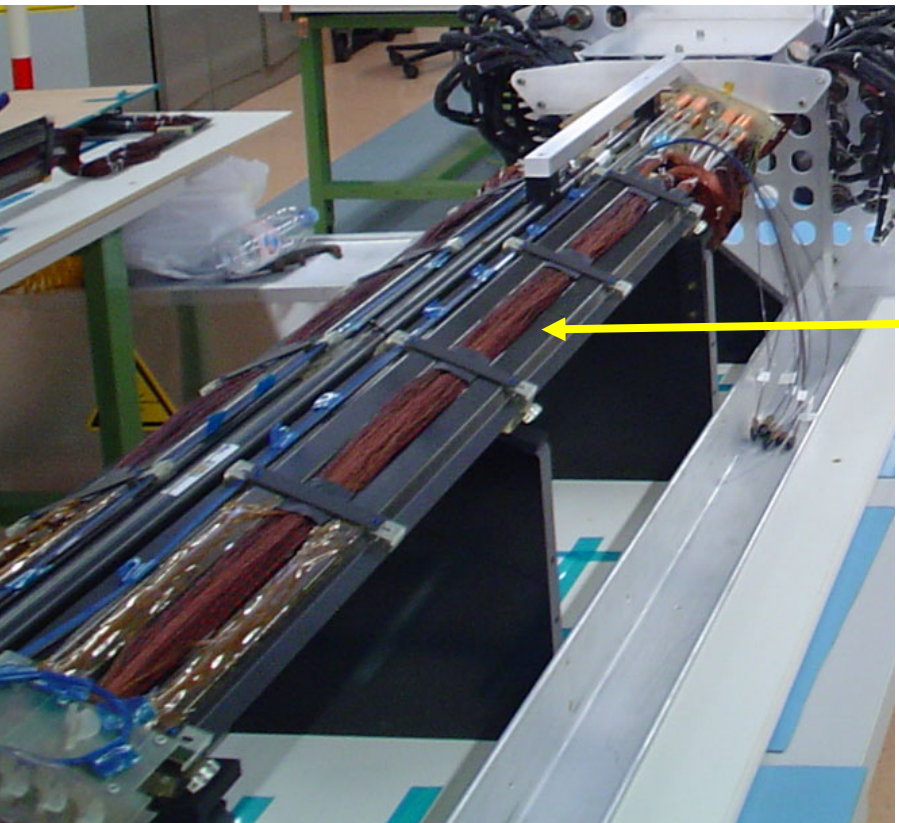
- Precision, low mass carbon-composite support structures made at LBNL or under contract to LBNL.
- All are now at CERN

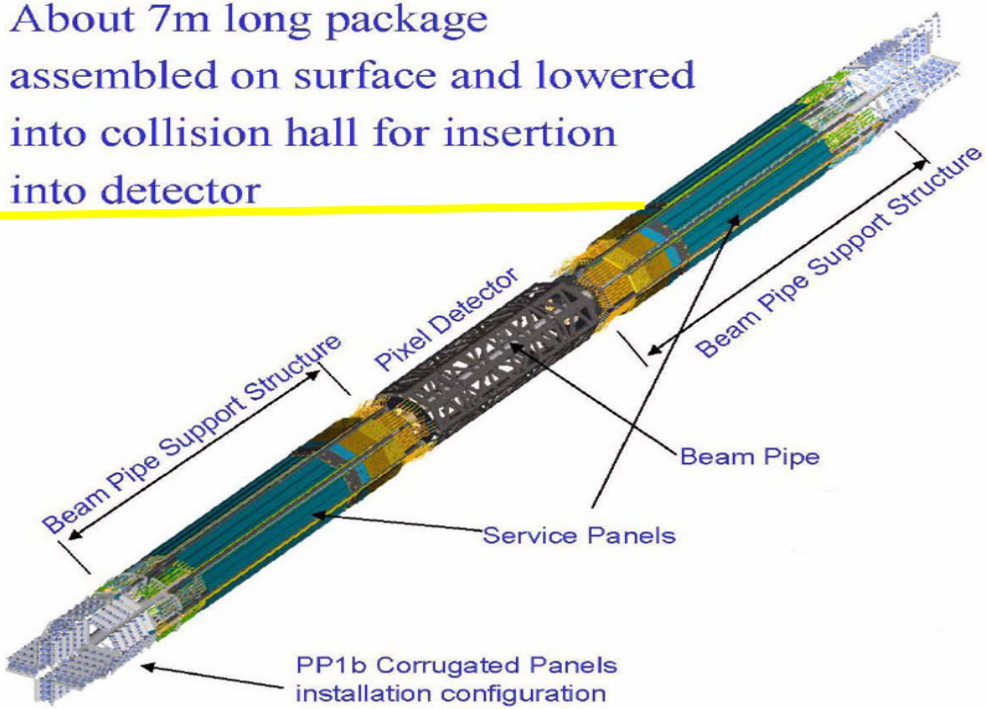




Pixel Services

- External connections to the pixels are at the end of the Inner Detector volume, meters from the active pixel region.
- Complex structures hold power and monitoring wires and cooling tubes (made as heat exchangers). All done at LBNL.



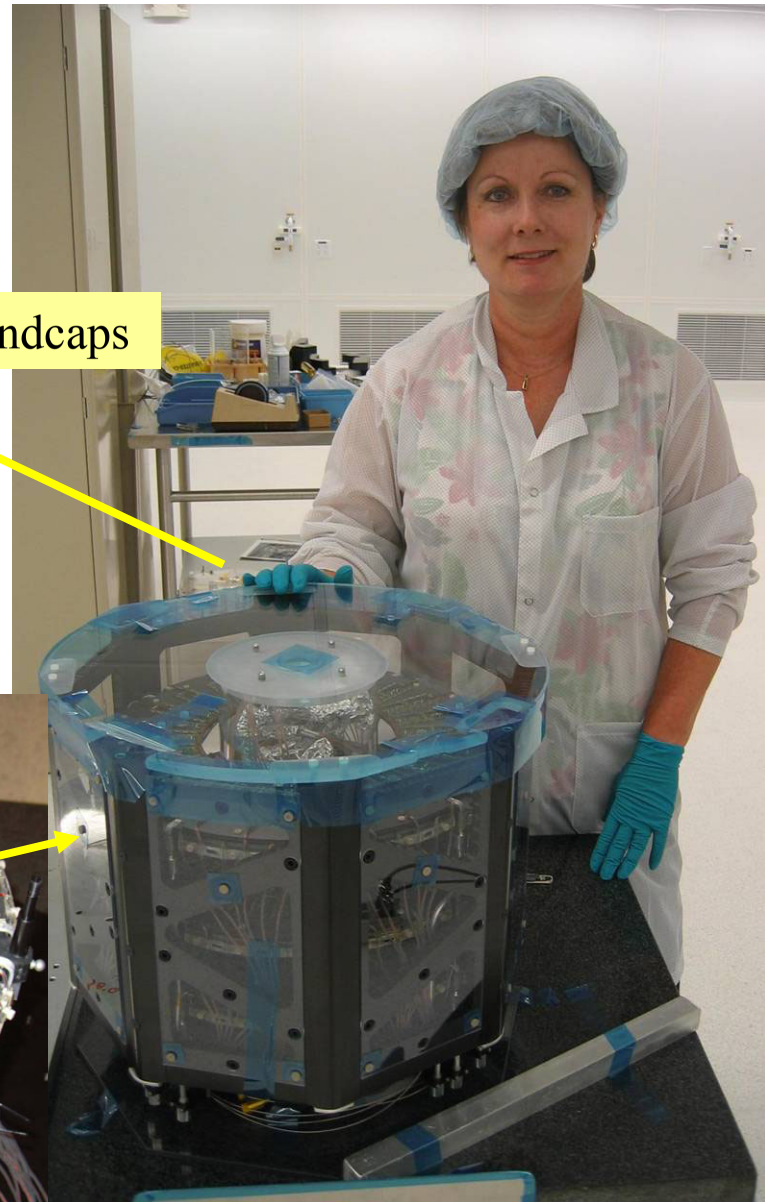


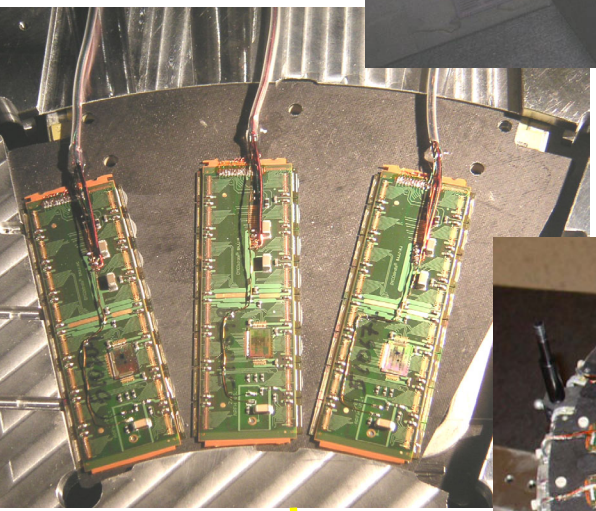
Pixel Status at LBNL

- All major deliverables from LBNL have been completed and shipped to CERN
  - Two endcaps, fully assembled at LBNL
  - Support frame
  - Support tube
  - Complex, integrated service structures and services(power and cooling tubes) – many elements
- A few smaller parts will be completed by the end of the year.
- Work at LBNL will then be completed after more than 10 years of design, development and fabrication!
- Note K. Einsweiler has been overall Pixel Project leader since March 2005.

Pixel Endcaps to CERN

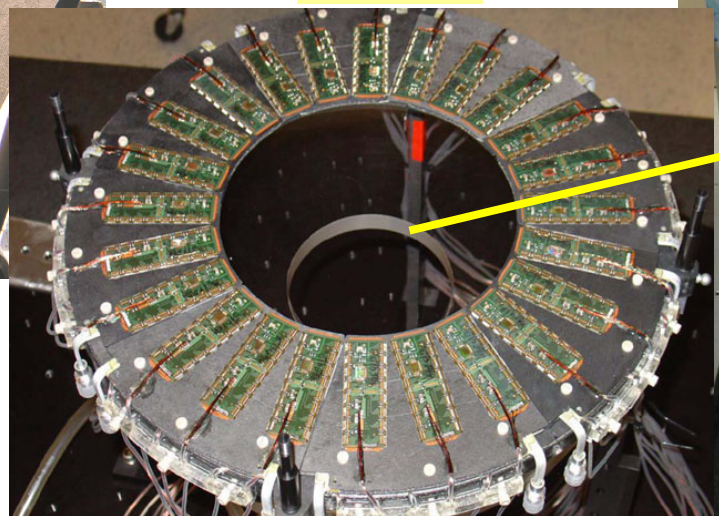
2 endcaps





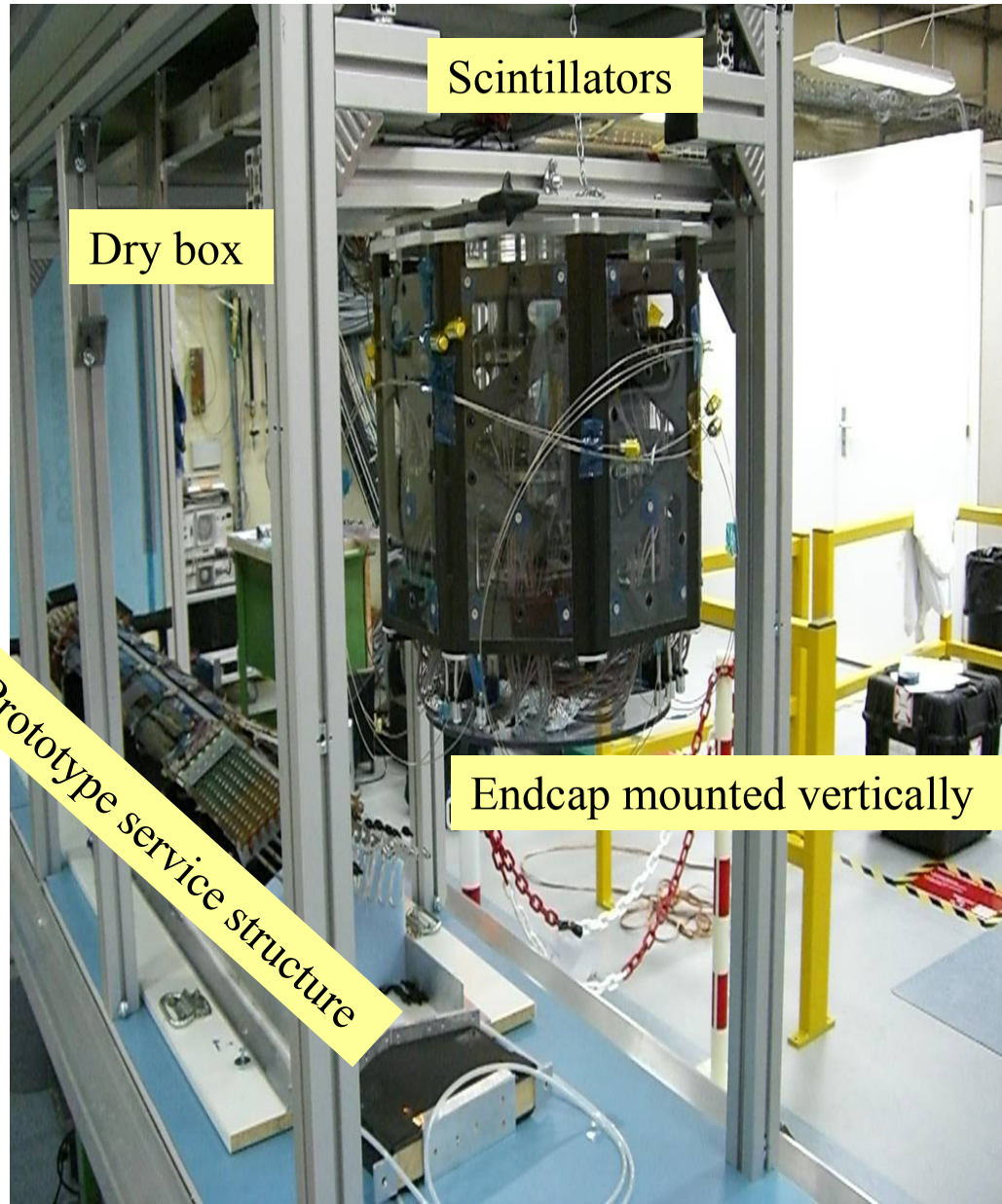
8 sectors

3 disks



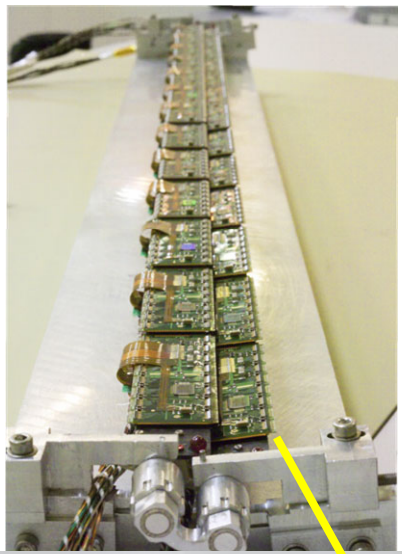
Pixel Endcap System Test at CERN

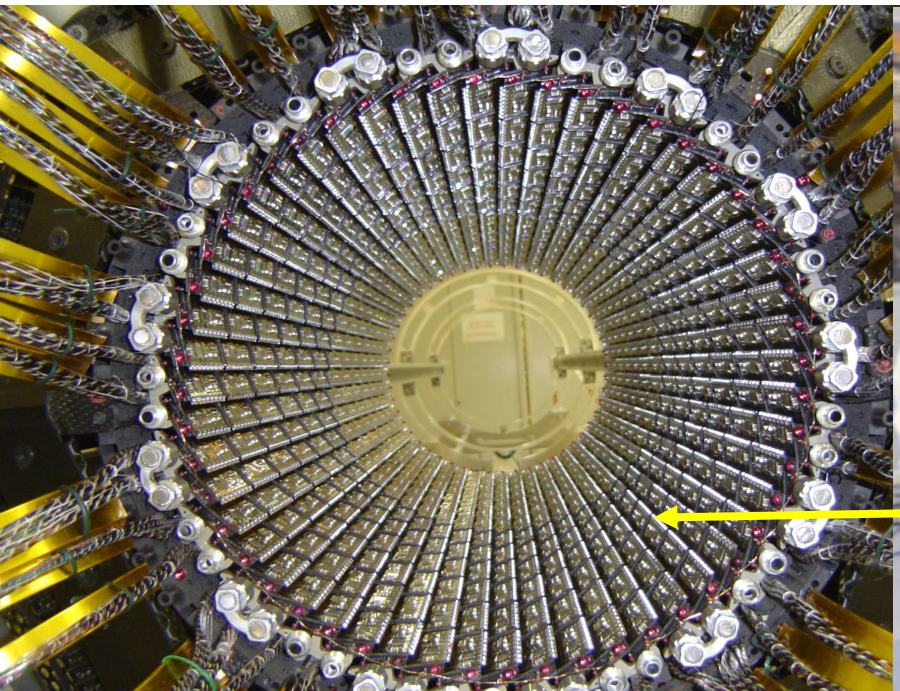
- One endcap(A) mounted vertically to maximize (small) cosmic ray rate.
- Prototype power, cooling and monitoring structure
- Data control and data acquisition systems
- Roughly 10% of final system
- Lots of learning ie. problems, mostly plumbing and wiring
- Just underway. Too soon to evaluate. Schedule tight

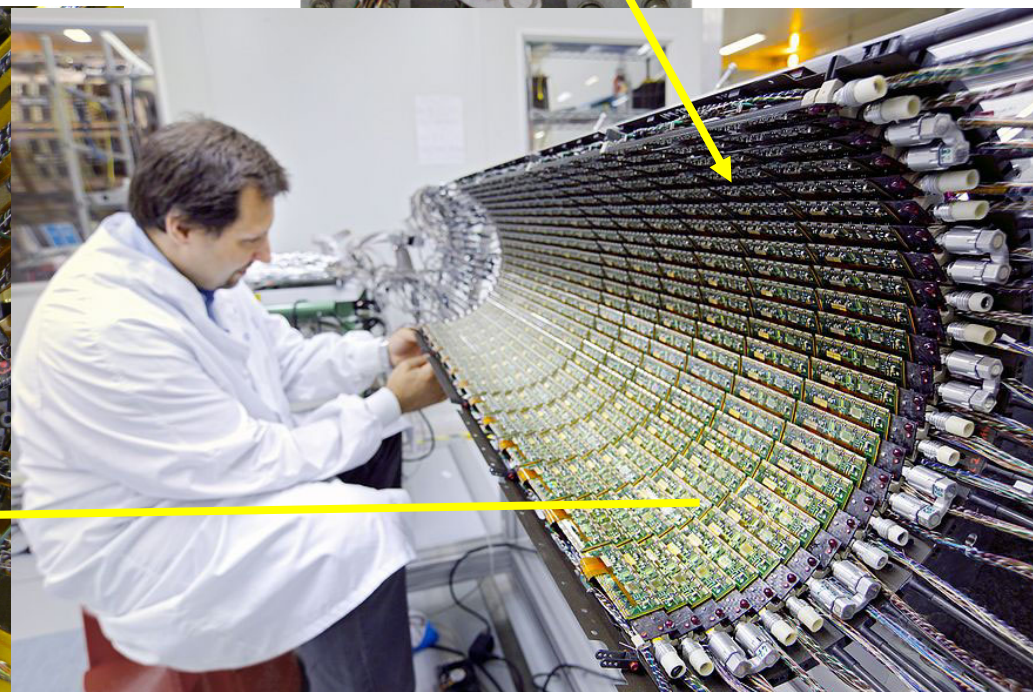


Pixels - Barrel

- Barrel modules and structures – EU responsibility(France, Germany, Italy)
- Barrel assembly nearly done

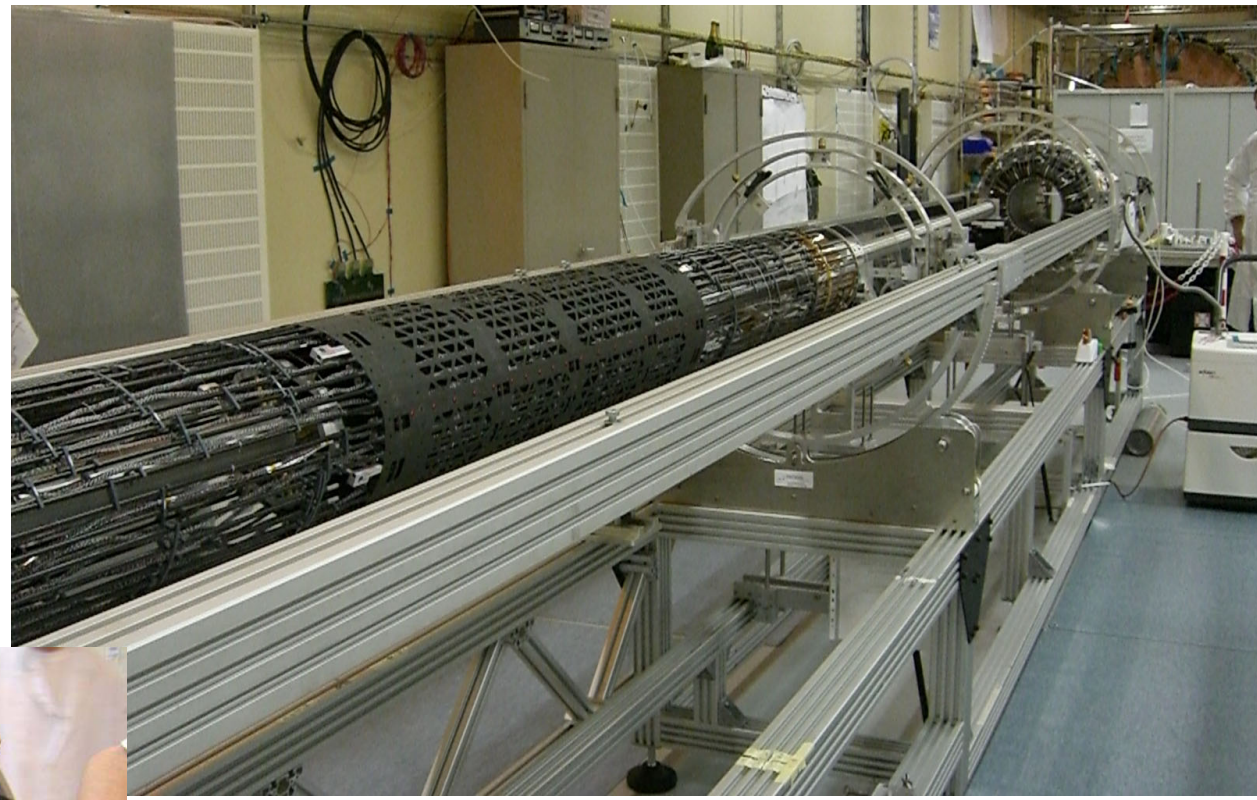


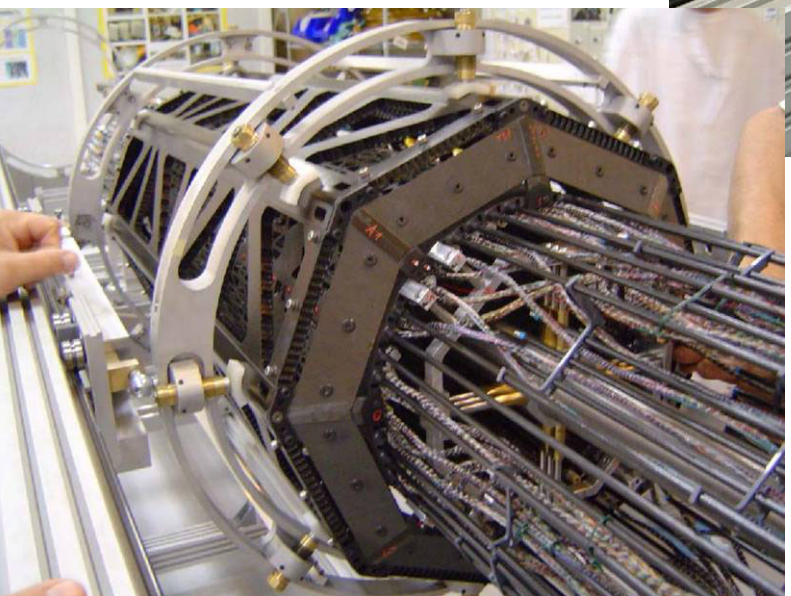




Pixels – Surface Integration

- In large clean room near ATLAS pit
- Tooling in place





- One layer integrated with frame
- Second in progress

Pixel Services at CERN

- Integration of optical components underway at CERN.
- Final integration of service structures also at CERN.

Pixel Schedule

- Tight!!!
- Technical problems have resulted in delays over the last year+
  - Corroded barrel cooling pipes – solved
  - Poor quality cables connected to barrel modules – solved
  - Failures in optical drivers/receivers – throw out bad, keep going
  - Cooling plumbing – in progress, getting better
- Installation of the pixel package as a single unit after integration on surface – barrel+endcaps+services+beampipe.
- April 2007 target date.
- Requires “all-hands-on-deck” effort.
- LBNL, as largest institution in the pixel collaboration and based on fabrication responsibilities, must supply the most “hands”.

Upgrade R&D

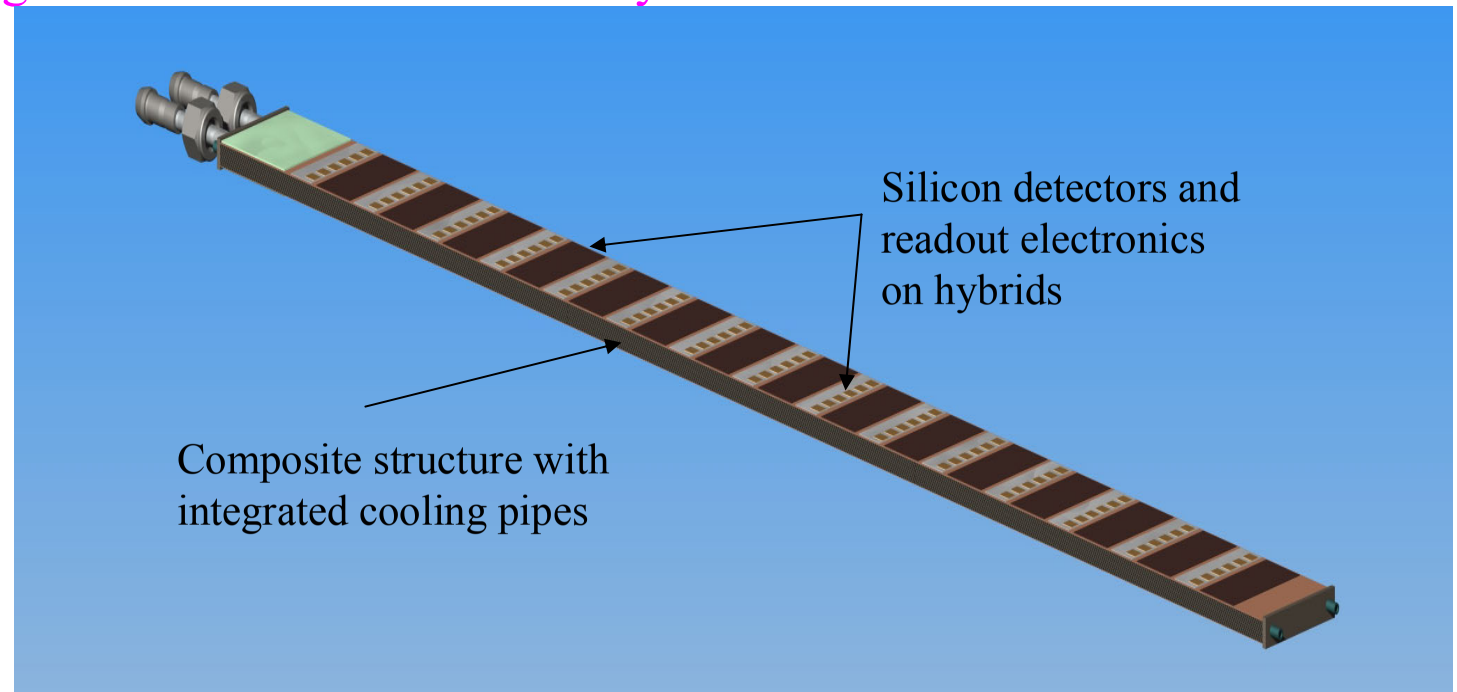
- An upgrade of the LHC to eventually reach a luminosity of 10^{35} is foreseen.
- This luminosity, 10 times the nominal design luminosity of the LHC, has many implications for ATLAS(and CMS or other LHC experiments).
- The largest challenge in ATLAS – completely replace all of the current Inner Detector.
- R&D in this direction along with an initial engineering organization has already started in ATLAS.
- 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.
- 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 timescale

ATLAS Upgrade R&D at LBNL - I

- Pixel integrated circuits
  - Increase radiation resistance(~ x10) and single-event upset immunity
  - Smaller pixel size eg. 50x200 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, more sophisticated test chip for submission in early 2007.
- Powering schemes
  - Universal agreement that current solution for powering silicon modules does not scale to much larger tracker – too many wires and cables.
  - Ely, Garcia-Sciveres and Denes (engineer) designing IC for local (in the detector) DC-DC conversion. Test chip submission by early next year.
  - Haber, RAL testing serial powering at module and system level.

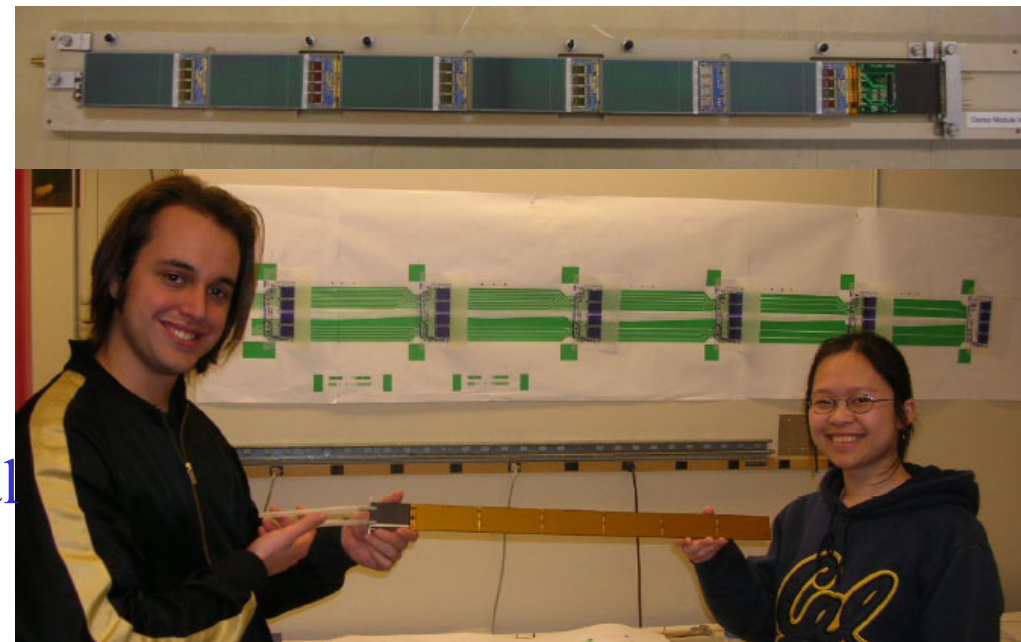
ATLAS Upgrade R&D at LBNL - II

- 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 - III

- 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 – (in progress) full scale electrical stave fabrication and test
- Stave mechanical prototyping
  - Conceptual design complete.
  - Extensive FEA for sag and thermal properties. Looks good.
  - Tooling design almost complete
  - Materials on order
  - Start fabrication by January using LBNL composite capability
- Combined mechanical/electrical test in Spring 2007



Conclusions – Part I

- First LHC collisions expected about one year from today.
- ATLAS installation proceeding at furious pace and schedule tight.
- Silicon strip installation partly completed and commissioning underway
- Enormous progress in pixel detector but schedule for last months before installation very tight. All-out effort needed.
- Significant upgrade R&D effort launched aimed at new, all-silicon tracker. Takes advantage of LBNL experience and capabilities built up over last decades.