ATLAS

HEPAP

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M. Gilchriese

ATLAS LBNL Group

C. Anderson, M. Barnett, V. Chang, A. Ciocio, A. Clark, **D. Costanzo**,
S. Dardin, *A. Deisher,* **M. Dobbs**, K. Einsweiler, R. Ely, M. Garcia-Sciveres,
M. Gilchriese, F. Goozen, C. Haber, I. Hinchliffe, K. Huang, S. Loken,
J. Lys, R. Madaras, *F. McCormack,* J. Muelmenstaedt, J. Richardson,
A. Saavedra, M. Shapiro, H. Spieler, J. Snow, G. Stavropoulos, G. Trilling,
J. Virzi, T. Weber, R. Witharm

Physics Division and UC Berkeley

E. Anderssen, L. Blanquart, A. Das, *T. Doolin*, N. Hartman, *J. Hellmers*,
B. Holmes, *T. Johnson*, J. Joseph, E. Mandelli, G. Meddeler, *R. Powers,*
A. Smith, T. Stillwater, *C. Tran,* C. Vu, *J. Wirth*, *G. Zizka*

Engineering Division

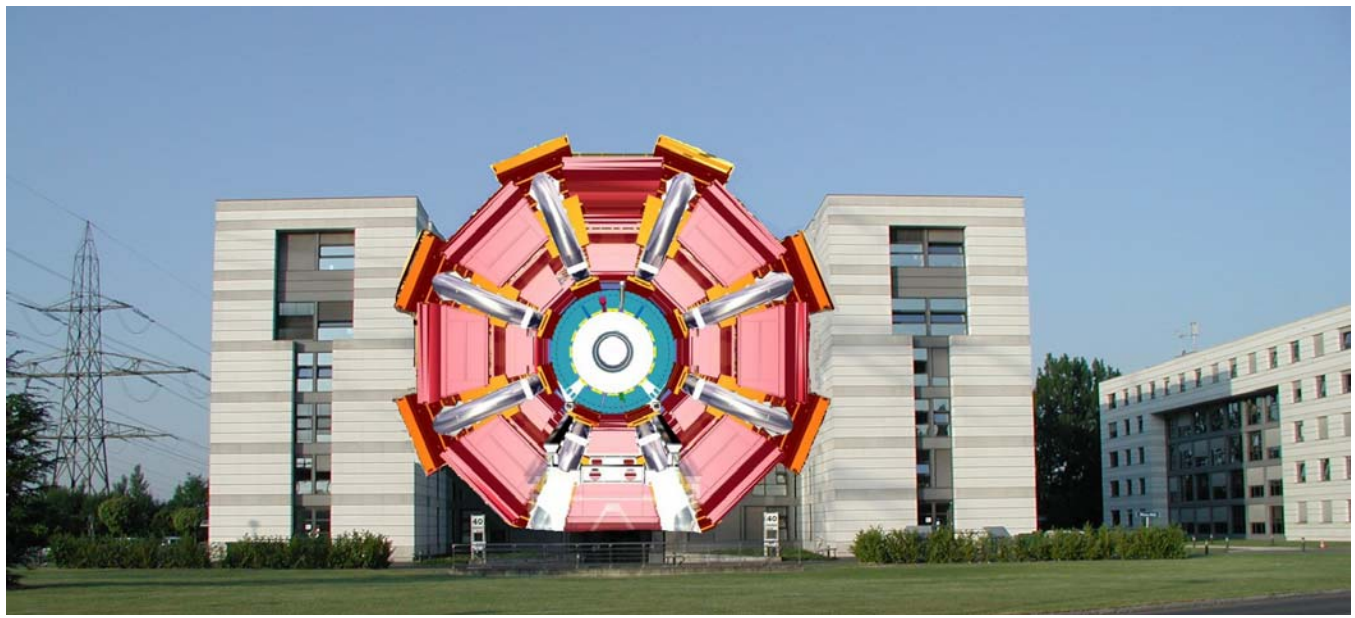
P. Calafiura, W. Lavrijsen, C. Leggett, M. Marino, D. Quarrie, C. Tull

NERSC

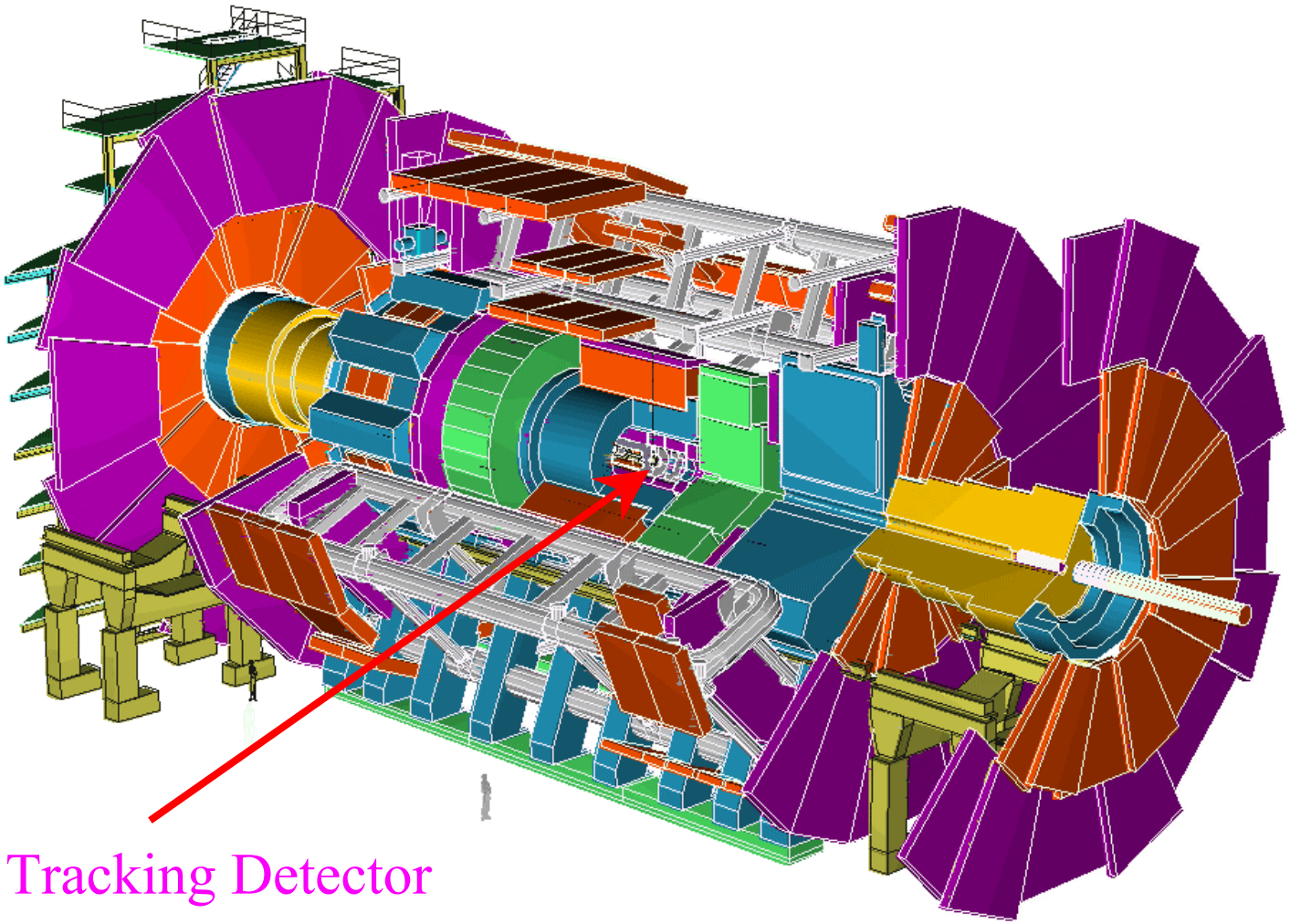
Physicist **Postdoc** *Grad Student* Undergraduate Engineer *Technician*

ATLAS Overview

- ATLAS is fully into production and many final components have been delivered to CERN. Substantial progress in last year.
- Installation underground will begin later this year and continue into global commissioning at the end of 2006.
- Although many schedules are tight, it is feasible for ATLAS to be ready for first LHC beam as planned in 2007.

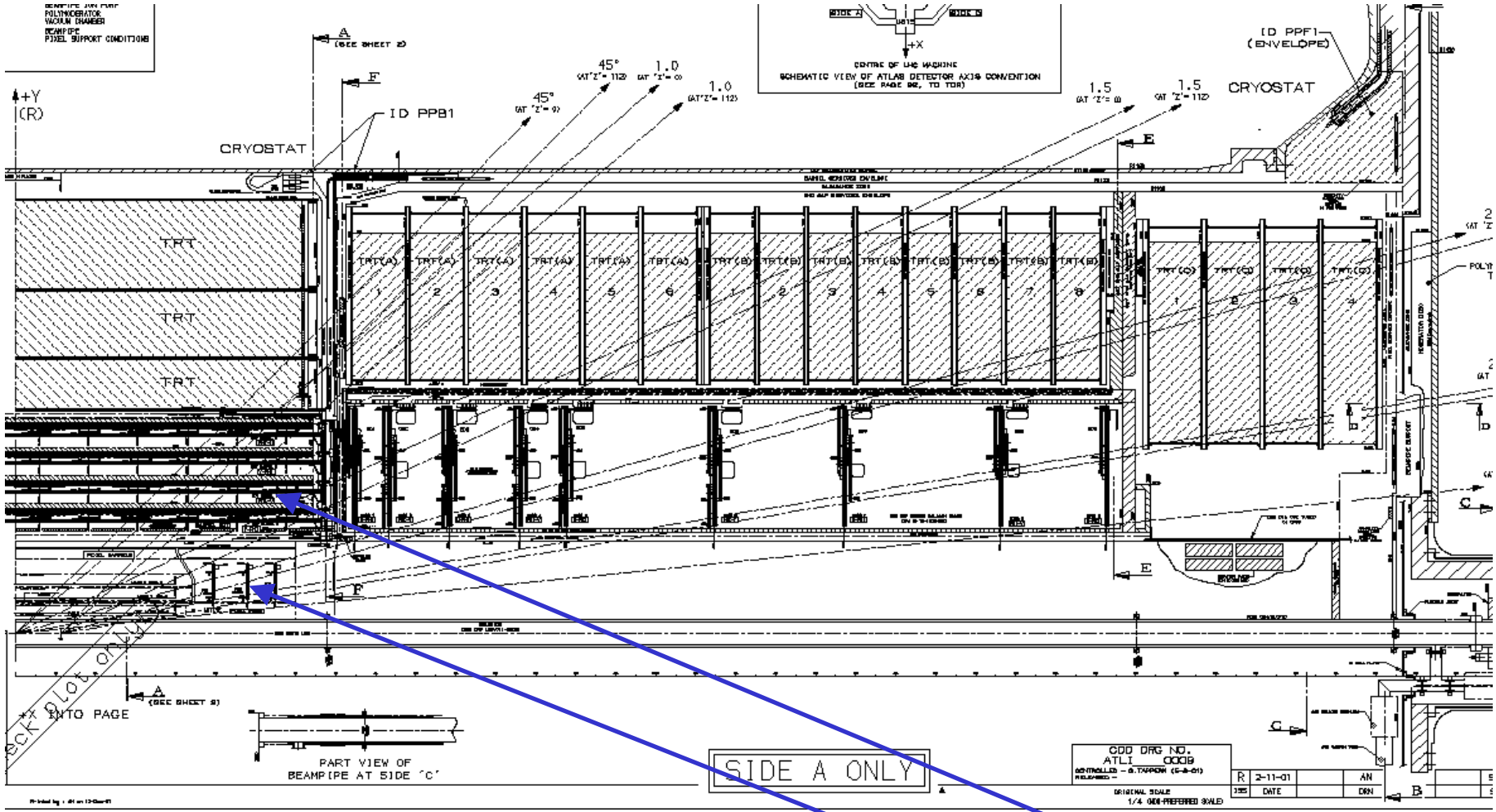


ATLAS Detector



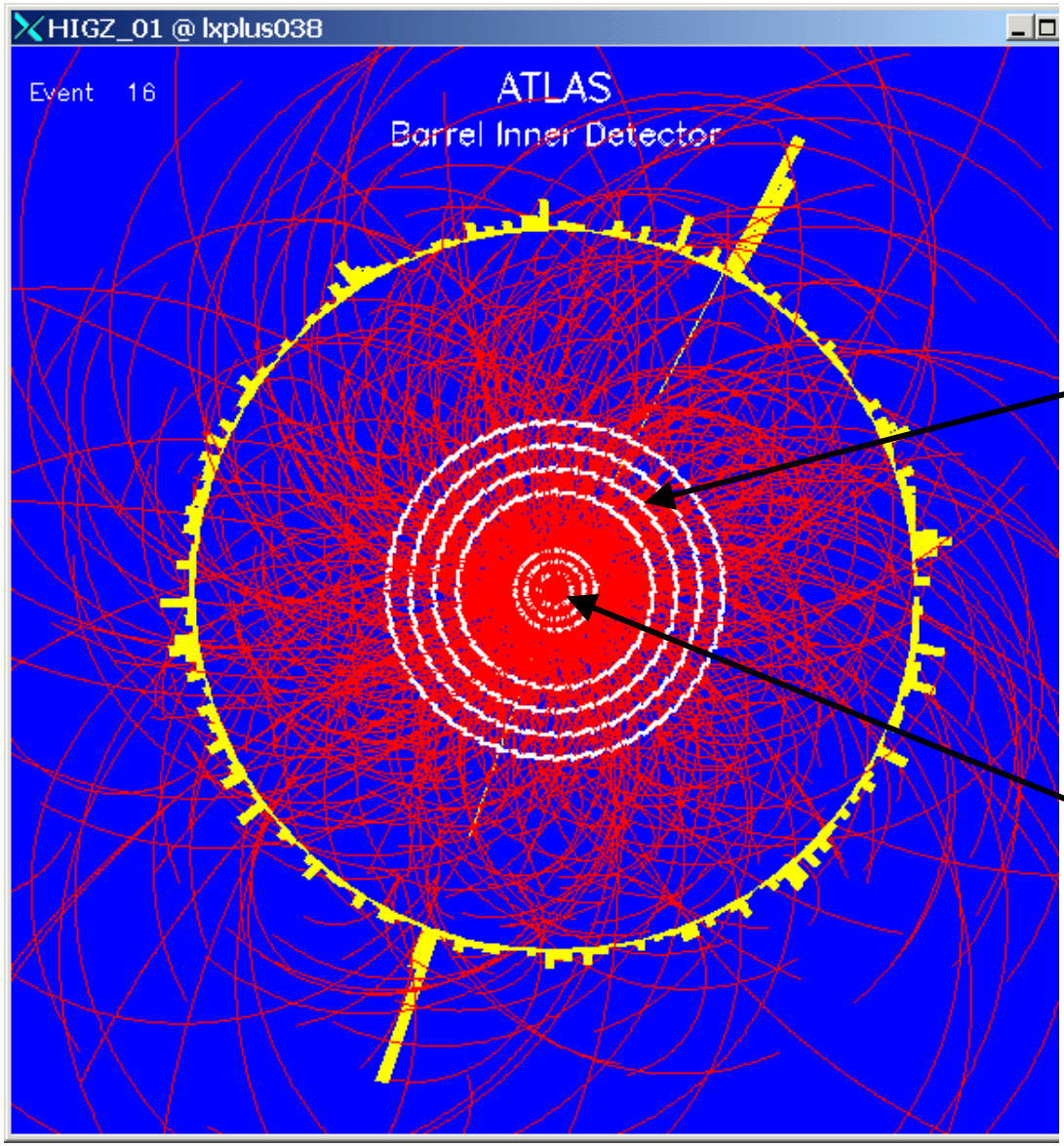
Inner Tracking Detector

ATLAS Inner Detector



LBNL Technical Roles in Pixels and SCT

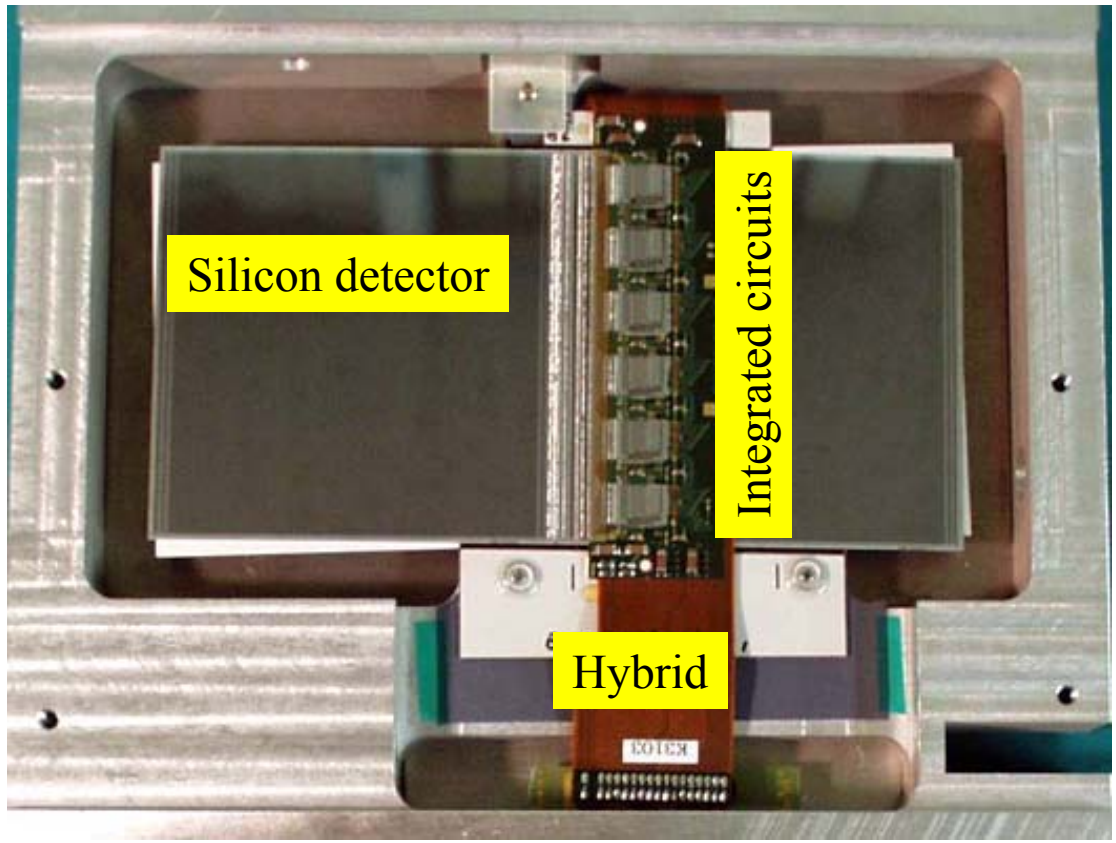
ATLAS Tracking



Silicon Strip Detector(SCT)

- About $6x10^6$ channels, $60m^2$
- Radiation hardness up to 10 MRad(roughly a decade at 10^{34} luminosity).
- About 4000 modules to be built world-wide, production is underway.
- Integration with mechanical structures, cables etc to begin later this year.

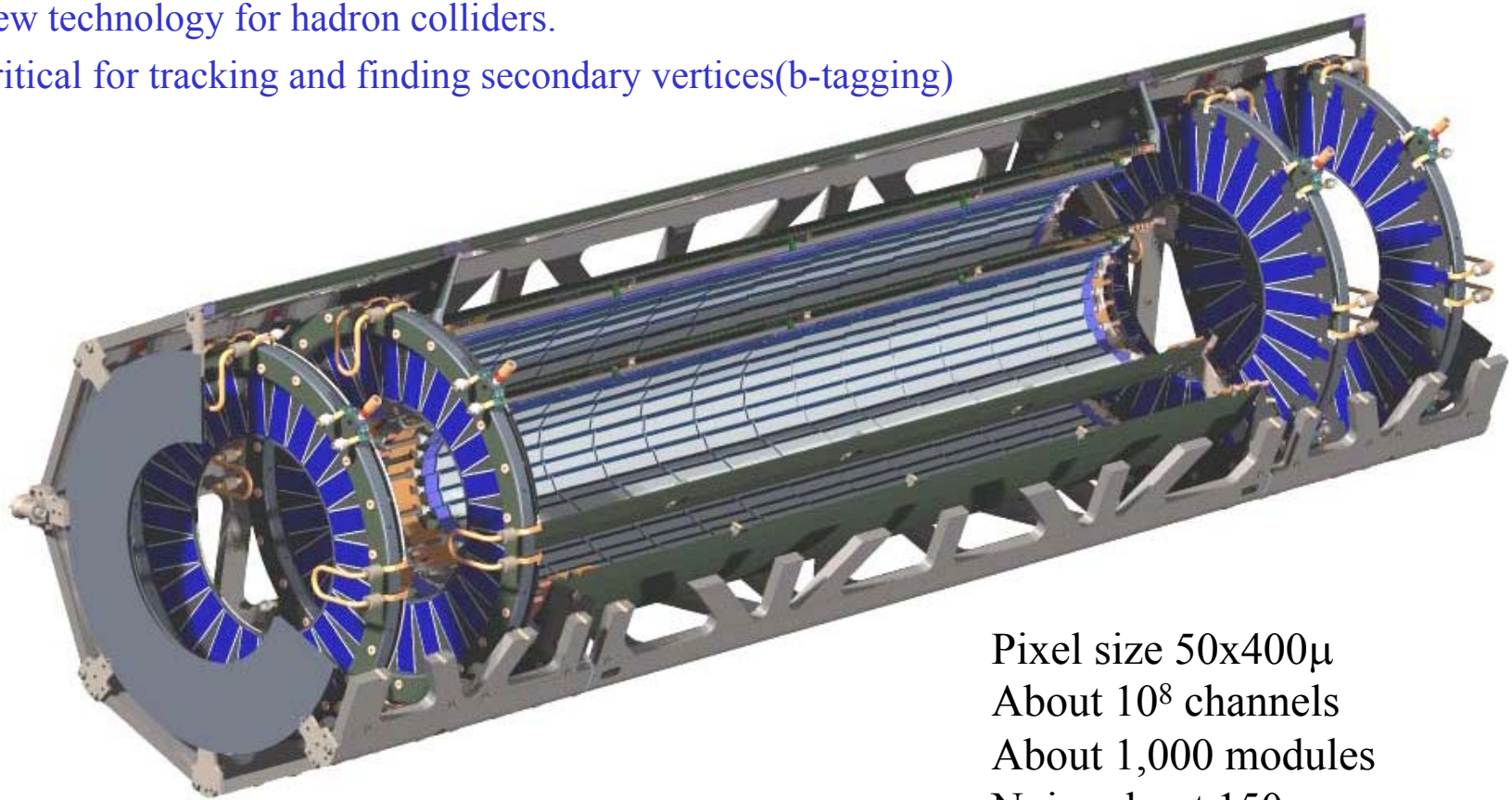
SCT Barrel Module



Strip pitch 80μ(barrel), 12cm long, noise about $1500e^-$

Pixel Detector

- LHC radiation levels at $10^{34}cm^{-2}sec^{-1}$ prevent long-term operation of silicon strip detectors for R< 25 cm.
- Pixel detectors have much smaller cell size, lower capacitance and thus noise, that results in signal-to-noise(unirradiated) about 10 times better than silicon strip detectors.
- As the pixel detectors are irradiated, the signal decreases, but still sufficient up to about 30MRad.
- New technology for hadron colliders.
- Critical for tracking and finding secondary vertices(b-tagging)



Pixel size 50x400μ
About 10^8 channels
About 1,000 modules
Noise about $150e^-$

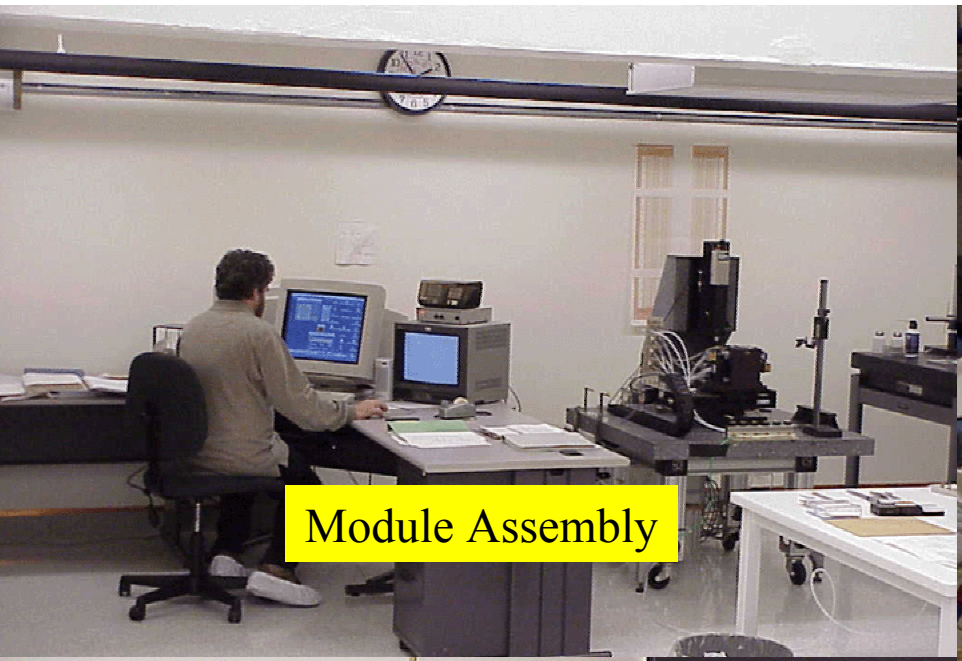
LBNL Roles in ATLAS

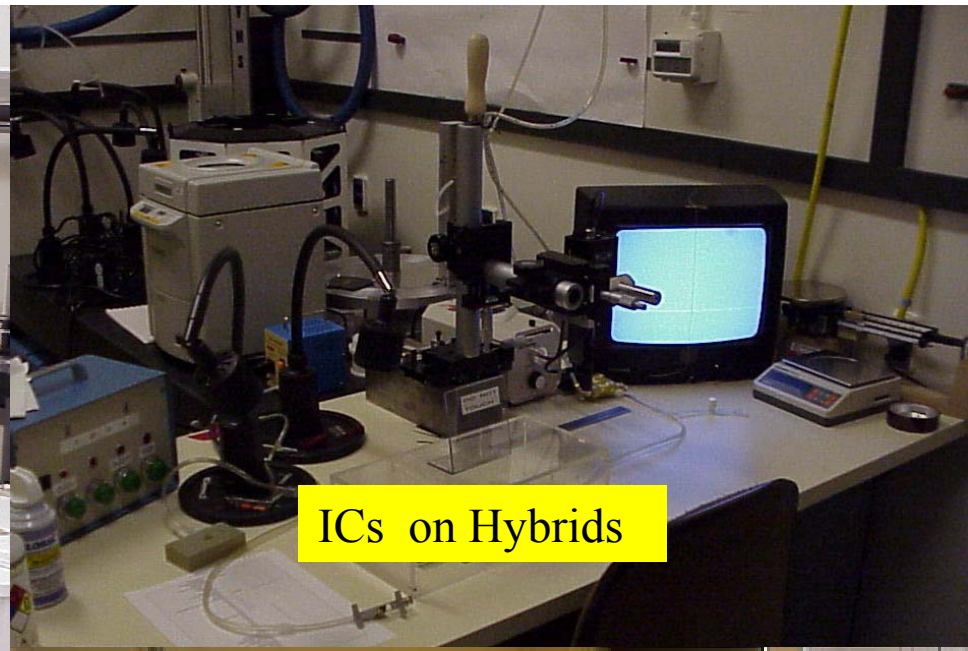
- Silicon strip detector
  - Test system for integrated circuits(ICs) completed, in operation and about 75% ICs tested.
  - Module production for barrel region started.
  - Strong collaboration with UC Santa Cruz in ICs and module production
  - Producing all readout boards for SCT(and pixels) in collaboration with Wisconsin.
- Pixel detector
  - Leadership roles in electronics, modules and mechanics
  - Production underway of mechanical supports, silicon detectors and hybrids
  - Electronics and module prototypes under test, module production to begin fall 2003.
  - Collaborate closely with Albany, Iowa State, New Mexico, Ohio State, Oklahoma
- Software, computing and physics simulation
  - Lead role in the development of the Athena framework code(the "operating system" for ATLAS software)
  - Lead role in development and maintenance of physics simulation tools
  - Overall ATLAS software coordinator

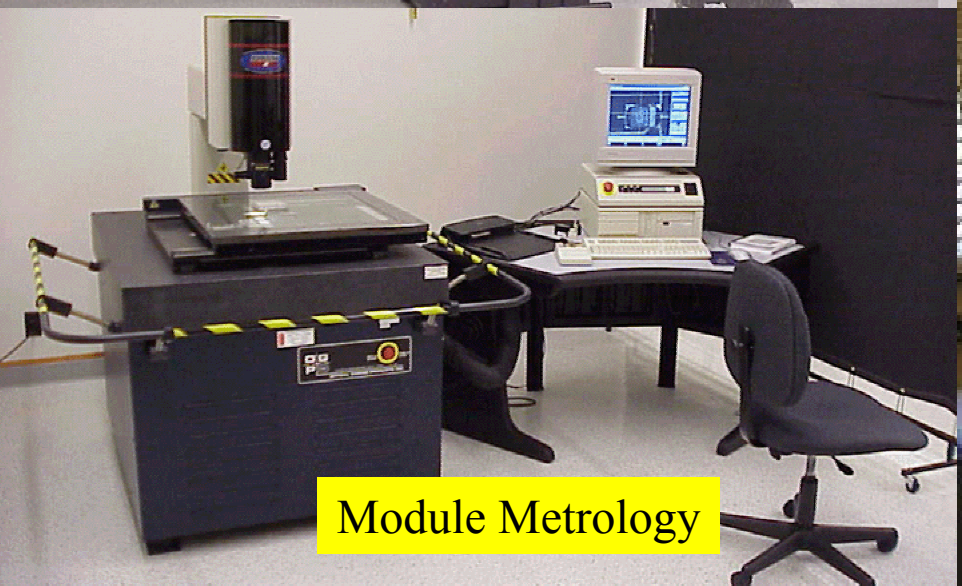
SCT at LBNL

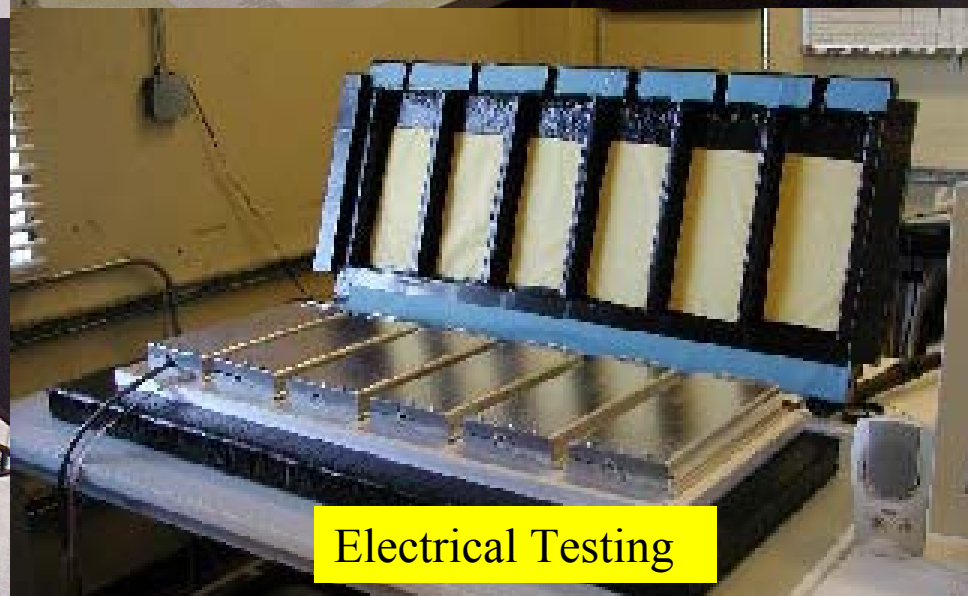
- LBNL originated, designed and built custom, high-speed test systems for the SCT integrated circuits (ABCDs). This has made it possible to keep up with delivery of wafers(more than 1000 wafers have been or will be fabricated)
- Test systems are at UCSC(2 stations), RAL(1 station) and CERN(1 station). About 75% of the total ICs needed have been tested.
- Barrel module production has started – see next page.
- The SCT(and pixel) systems are read out using VME boards located about 100m from the experiment.
- The design work is done by LBNL engineering funded through the University of Wisconsin.
- The final production of the SCT boards will begin in a few months, to be followed afterwards by the pixel boards.

SCT Production in Cleanrooms

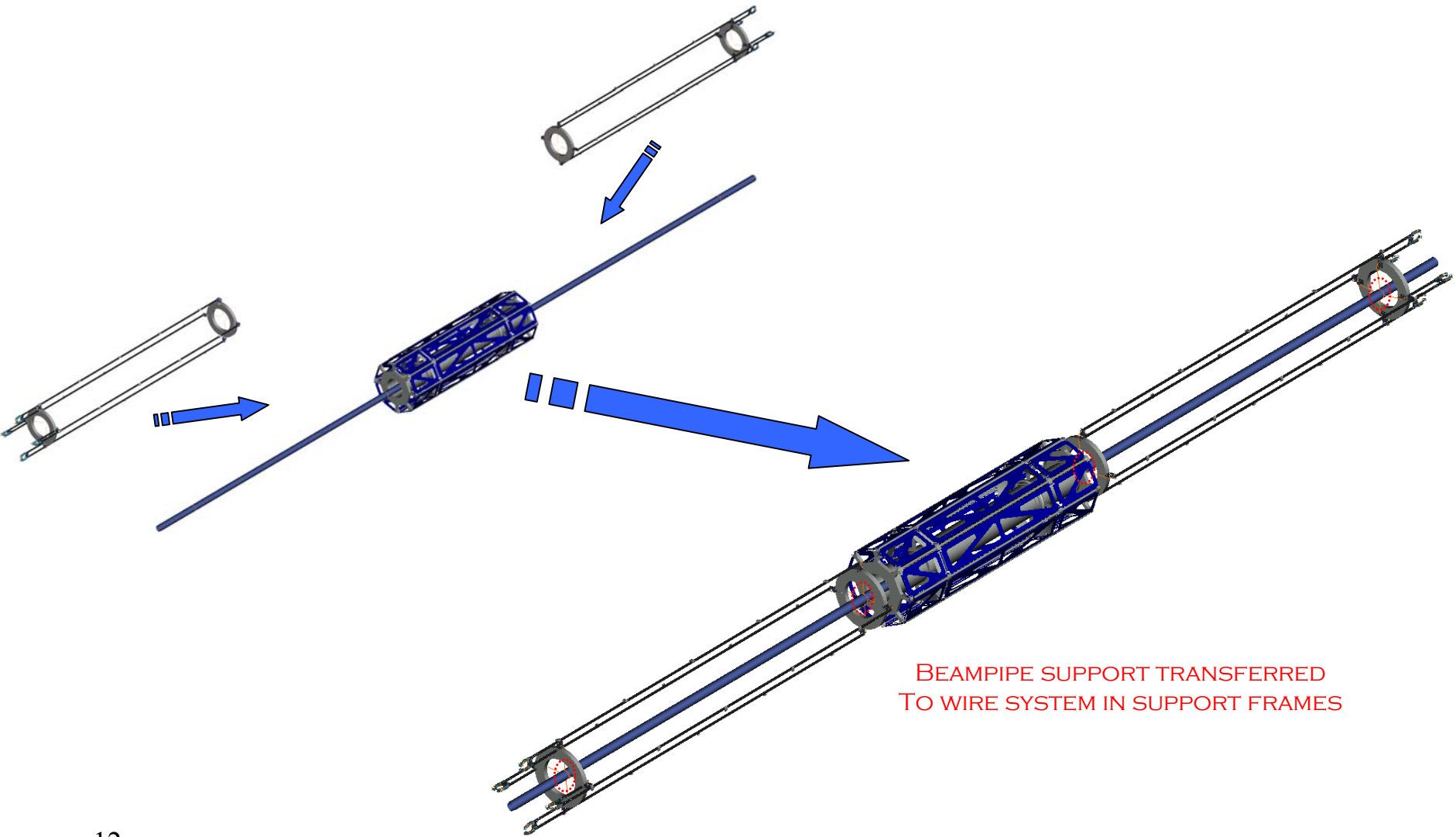








Pixel and Beam Pipe Assembly

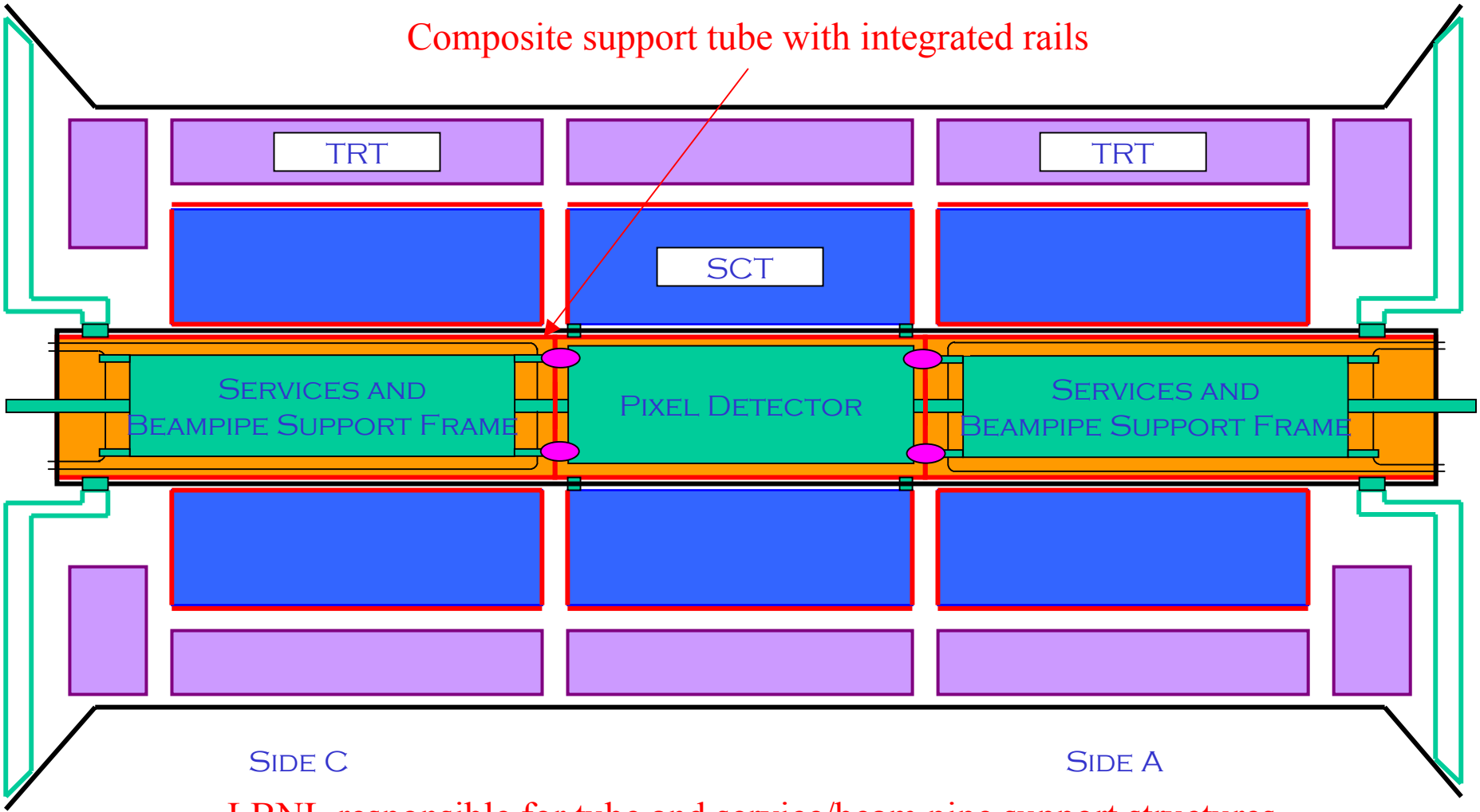


Beampipe support transferred
To wire system in support frames

Pixel and Beam Pipe Assembly

About 7m long package
assembled on surface and lowered
into collision hall for insertion
into detector in early 2006

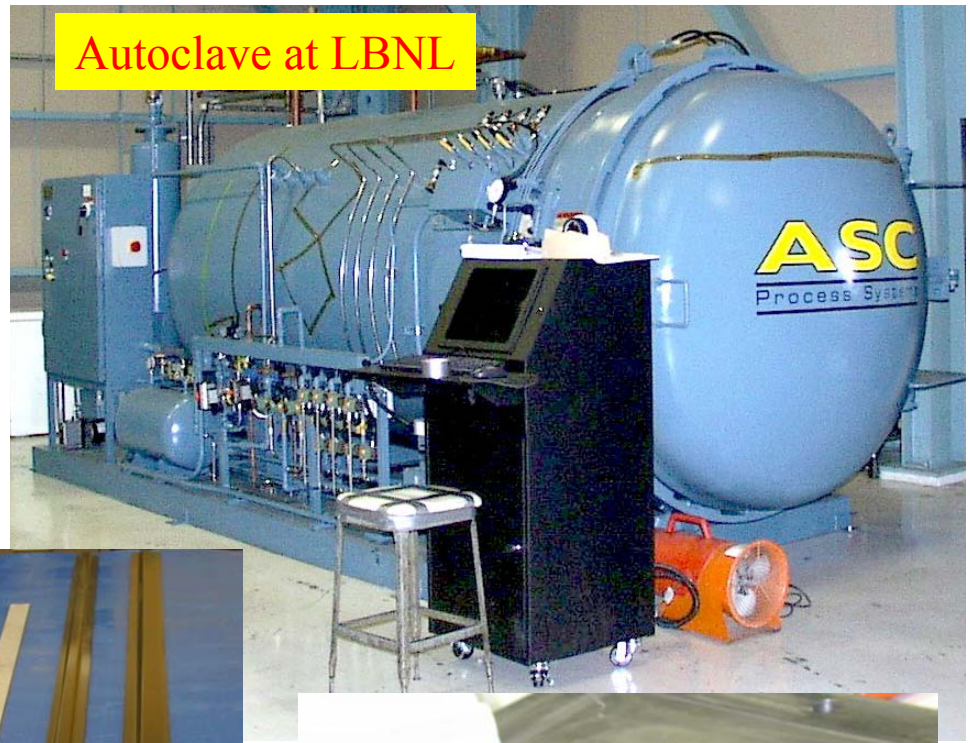
Pixels Installed

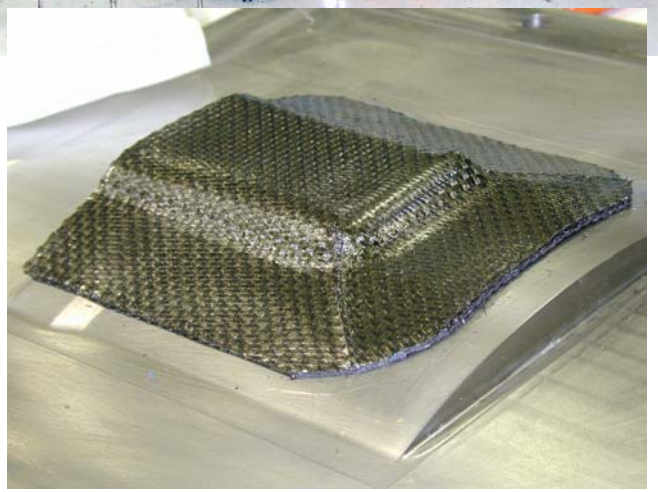


LBNL responsible for tube and service/beam pipe support structures

Composite Structures

- We have developed the capability to make custom composite structures.
- Combined thermal, structural and electrical properties to meet the pixel needs.





Support/Cooling Structures

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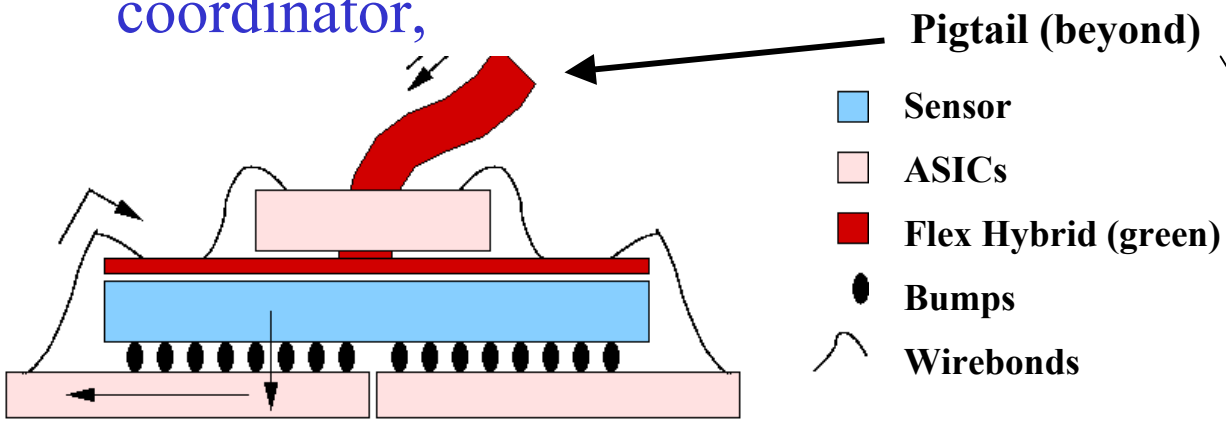
Pixel Hybrids and Modules

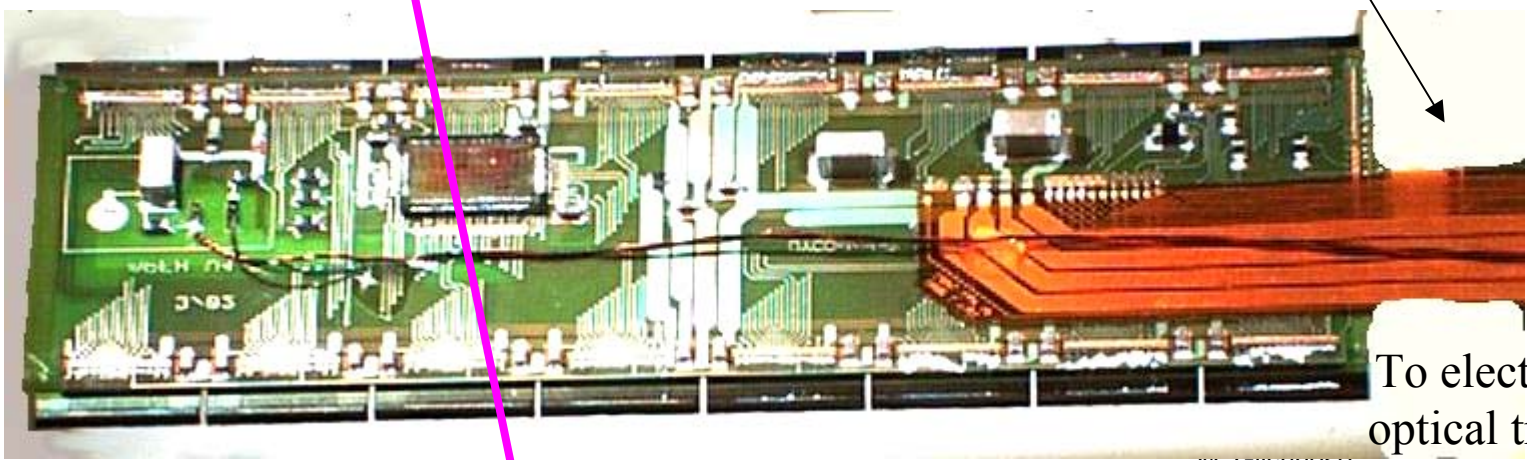
- M. Garcia-Sciveres from LBNL is the overall ATLAS module coordinator,



Schematic Cross Section
(through here)

About 1/3 of sensors(detectors) have been produced.

Flex hybrid production underway



To electrical-to-optical transition

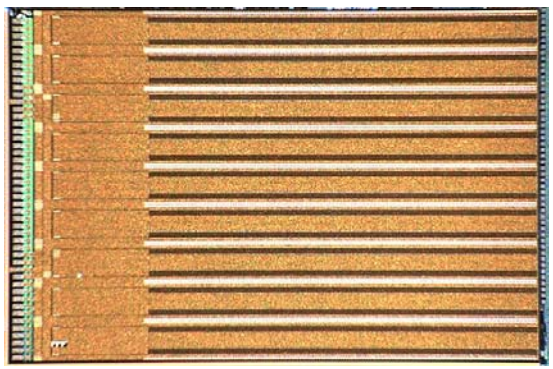
Pixel Electronics

- K. Einsweiler from LBNL is the overall ATLAS pixel electronics coordinator.
- The strong LBNL IC group allows us to lead the pixel electronics effort.
- In addition, we are responsible for providing most of the IC and module tests systems for the collaboration, and these have also been designed and implemented by LBNL.
- First full integrated circuit prototypes were delivered about a year ago and exhaustively tested.
- Chips work rather well. Lab and beam tests complete.

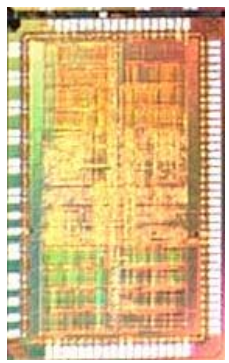
Pixel Integrated Circuits

- The lab and test beam studies in the last year were led by LBNL, and we achieved the first demonstration that pixel technology will work at the LHC.
- Fabrication of dozens of prototype modules complete, more in progress
- Production versions of chips about to be submitted to IBM

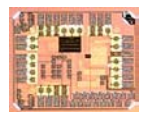
Front End Chip
2880 channels



Module Control Chip
Manages data & control between module's 16 chips



Optical interface chips



Doric
(from PIN diode to decoded LVDS)

VDC array
(from LVDS to laser diodes)

Test Beam Efficiencies

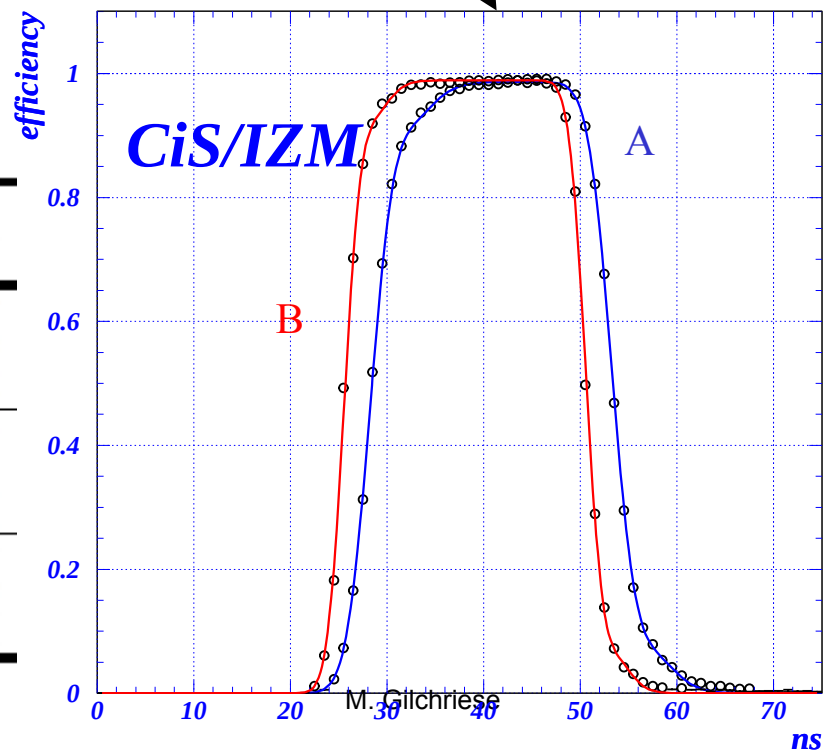
Chip	ε [%]
0	99.15
1	99.22
2	99.64
3	99.61
4	99.70
5	99.68
6	99.64
7	99.65
8	99.72
9	99.72
10	99.71
11	99.65
12	99.67
13	99.62
14	99.60
15	98.95

Unirradiated module
Noise occupancy is
$< 6 \times 10^{-9}$ per pixel

Single-chip assemblies irradiated to about 30MRad dose with different sensors and bump bonds. Different chip configurations.

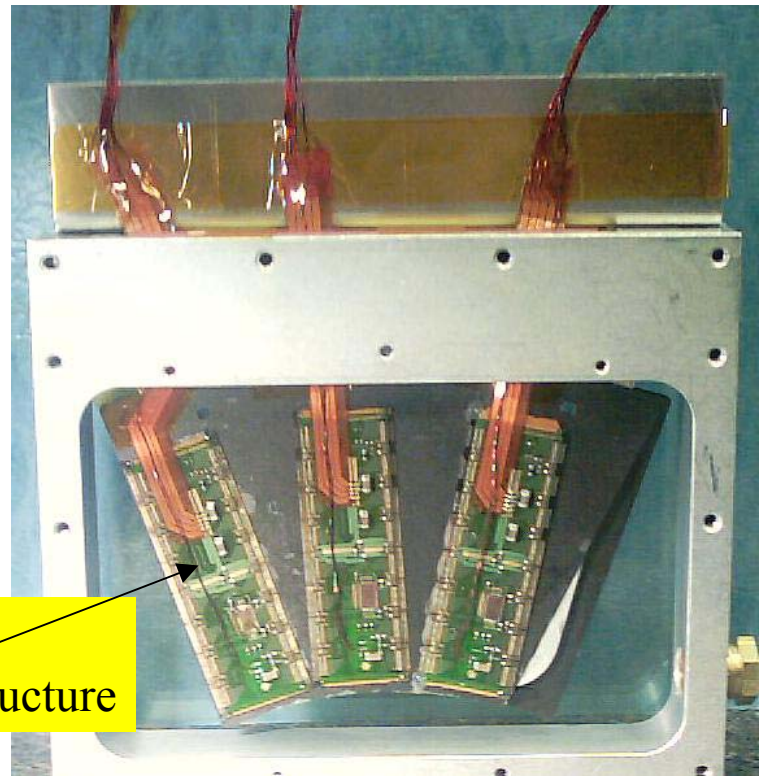
Sensor	Bumps	Conf.	ε [%]
Tesla	IZM	A	98.07
		B	98.41
Tesla	AMS	A	97.91
		B	98.36
CiS	IZM	A	98.62
		B	98.82

A and B are design options

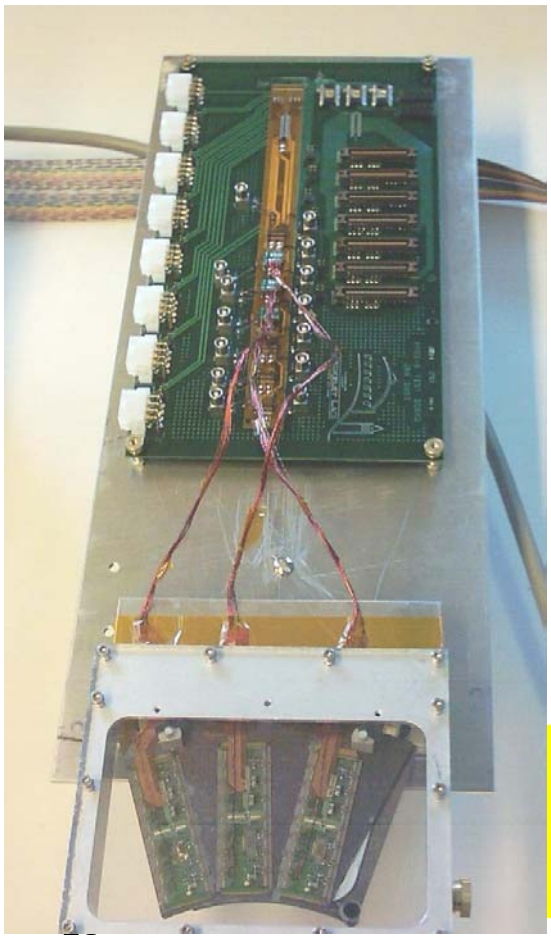


Pixel System Tests

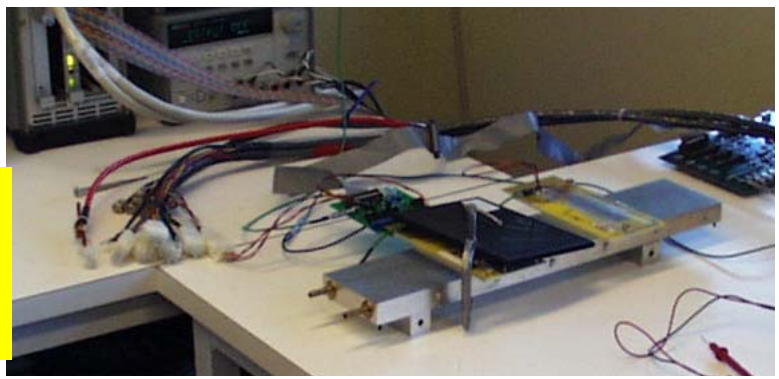
- System tests underway at LBNL.
- Will grow to long-term test of section of detector soon.



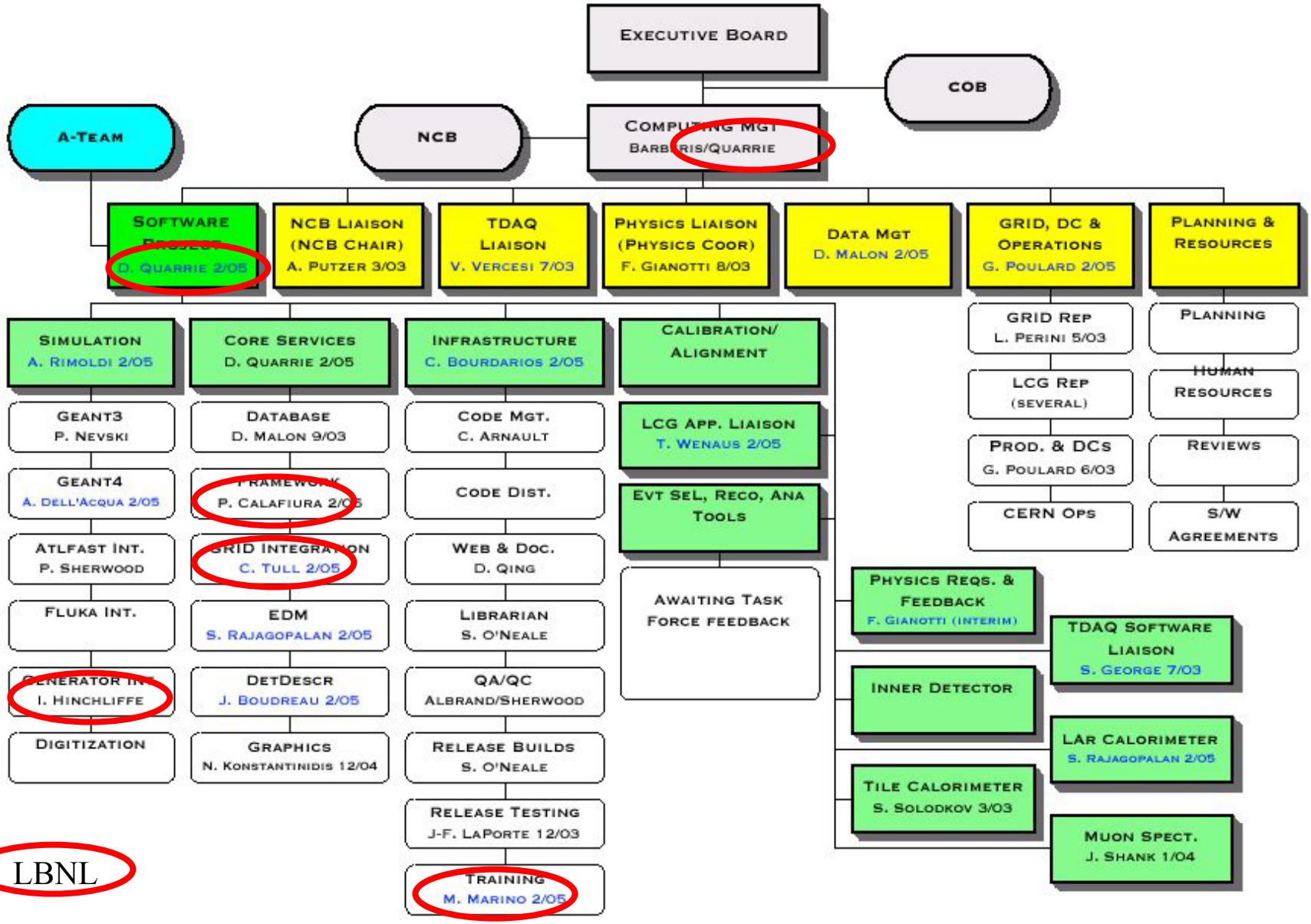
Pixel Modules on Support/Cooling Structure



About 30lbs of cable needed to bring power to each module!



New ATLAS Computing Organization



LBNL

Data Challenges

- Data challenges completed or underway
  - DC0 – a "continuity" test of system. Completed
  - DC1(Phase I) – simulated events to study high-level triggers(for preparation of Technical Design Report) and to advance system. Completed.
    - Events simulated ~10^7 ,18 countries, 39 institutions involved, completed in August 2002
    - LBNL provided about 30% of US computing power.
  - DC1(Phase II) – underway. 70 Tb goal. More countries, more Grid
- Future data challenges
  - DC2: 2004, like DC1 in scale
  - DC3: 2005. 5 x DC2
  - DC4: 2006. 2 x DC3

LBNL Software Expertise

- Software Project Leader (David Quarrie)
  - Leads all software development activities and is the Chief Architect
- Physics Generators Coordinator (Ian Hinchliffe)
  - Provides support for all particle generators (Isajet, Pythia, etc.) and integrates them into the overall control framework
- Framework Coordinator (Paolo Calafiura)
  - In charge of the Athena framework and the collaboration with the LHCb developers
  - Responsible for coordinating software development for the core services associated with the framework
- ATLAS software training coordinator (Massimo Marino)
  - Arranges tutorials and other training courses and is also responsible for detailed design of parts of an LCG common project which will be shared by ATLAS, CMS & LHCb
- Scripting support (Wim Lavrijsen)
  - Responsible for making Athena an interactive framework based and for GUI & command line shell designed as a beginners aid
- Calibration/Alignment Infastructure (Charles Leggett)
  - Responsible for providing a transparent mechanism whereby time varying data may be automatically tracked by an application code (I.e. the correct geometry for each event is automatically present with no explicit manipulations of the databases by the application code. Also responsible for ROOT histogram & n-tupe support and Geant4 integration into Athena
- GRID Integration (Craig Tull)
  - Responsible for the integration of GRID services into Athena (e.g. monitoring, file access, etc.)
  - Responsible for definition of Data Dictionary that allows for run-time interrogation of arbitrary objects

Computing Summary

- Collectively LBNL provides a nucleus of experienced Object Oriented designers around which much of the ATLAS software development is based.
- They provide consultancy services to a large, relatively untrained, developer community
- They coordinate many critical development activities
- They leverage NERSC strengths and provide a core competency within LBNL that can be (and is) applied to other programs (BaBar, SNAP, IceCube, SN-Factory)
- Close collaboration with physics simulation(and later analysis).
- This experience and expertise will be needed well beyond LHC turn-on in 2007, as the avalanche of LHC data arrives.

On to First Beam

- Complete the fabrication of SCT modules and deliver them to the UK by end 2004.
- Complete fabrication and testing of pixel components and deliver them to CERN by early 2005.
- Then assemble, install and commission pixel detector, which will require continuous presence at CERN with support from the US ATLAS Research Program.
- Make ATLAS software work for data challenges and then ready for first data.
- Increase LBNL participation in physics analysis, as part of data challenge activity, and be ready for first data.
- New physics possible with very little integrated luminosity!

Beyond The Initial Detector

- ATLAS has been staged to meet funding realities.
- Pixel system(one layer) staged, current plan is to insert in long shutdown after 1st "physics run". Would use current technology.
- Innermost layer of pixels will die after few years at 10^{34}. Must be replaced, critical for b-tagging.
- Replacement would use new technology (improved ICs, better detectors, lower mass structures, etc) for improved pixel performance => R&D needed soon.
- Continued software development will be essential as the luminosity increases towards the design value and to respond to the actual data environment.

Major Upgrades

- A luminosity upgrade to 10^{35}(SLHC) will require the complete replacement of the tracking detectors.
- Tracking R&D for 10^{34} has been hard over 10-15 years.
- Tracking R&D for 10^{35} will be very hard, will take at least as long => should have started already!
- LBNL plans to remain leader in silicon(pixel) detectors for SLHC

Concluding Remarks

- ATLAS is on its way to be ready for first LHC beam.
- LBNL is a world-wide leader in silicon detector technology and leads the development of the ATLAS pixel detector.
- We are providing critical leadership in software and physics simulation, the keys to successful data analysis.
- We look forward to first physics with ATLAS!