ATLAS

LBNL DoE Review

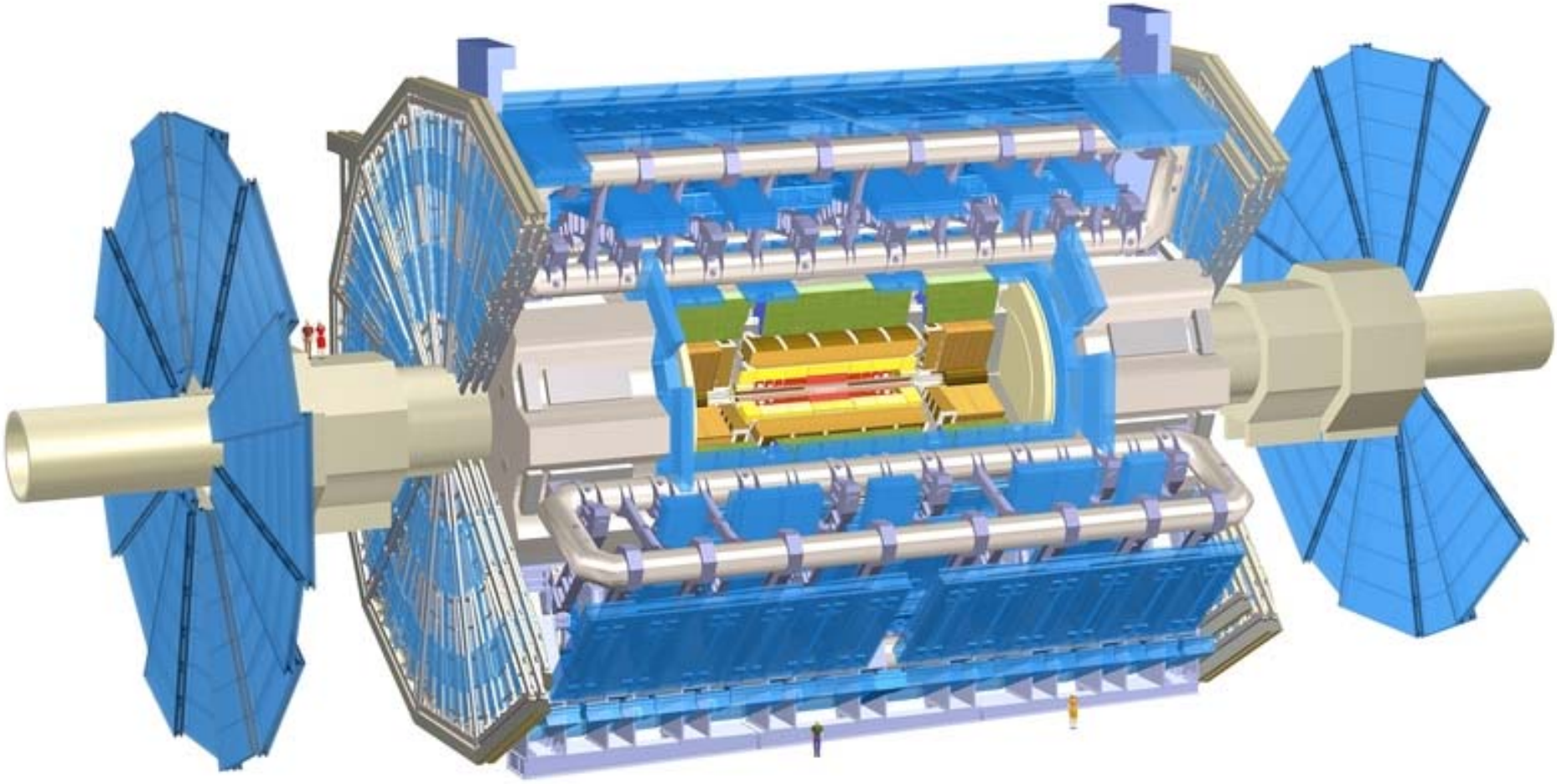
March 16, 2005

M. Gilchriese

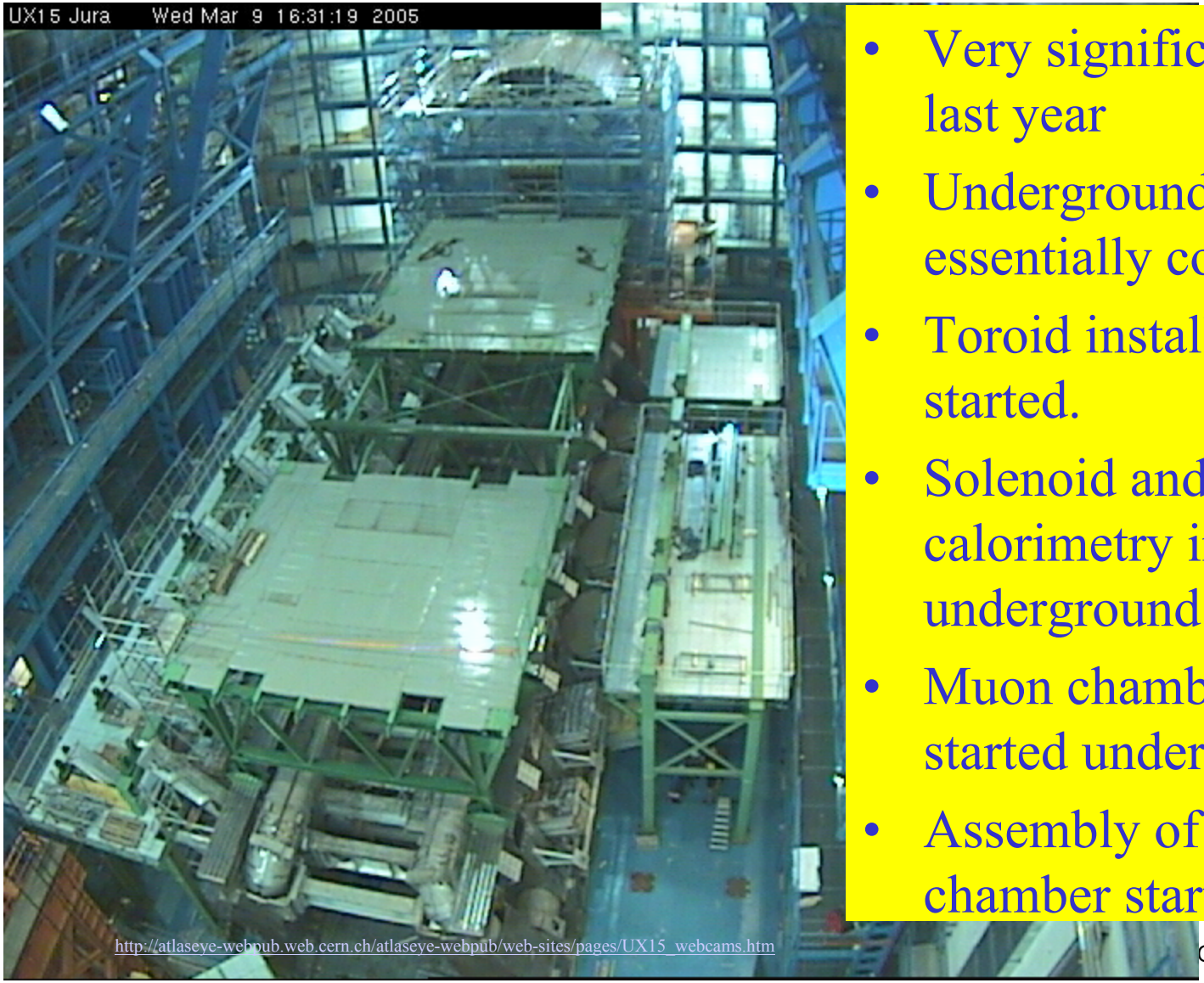
Outline

- ATLAS status overview
- Silicon tracking
  - Silicon strip tracker
  - Pixel detector
- Tracking upgrade R&D
- Software and computing
- Physics simulation
- Getting ready for the data-taking phase
- Conclusion
- Appendices

ATLAS Detector



ATLAS Detector Status(I)



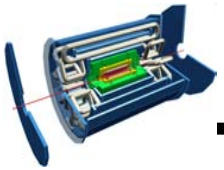
- Very significant progress in last year
- Underground infrastructure essentially complete
- Toroid installation well started.
- Solenoid and barrel calorimetry in place underground
- Muon chamber installation started underground
- Assembly of inner tracking chamber started(on surface)

ATLAS Detector Status(II)

- General ATLAS status over last year
  - Impressive and steady progress on completion of detector fabrication and installation
  - Well functioning organization for installation
  - Commissioning activities have gotten serious and are ramping up
  - Schedule to be installed and ready by early 2007 is very tight, even tighter than last year. However, good organization to respond to problems and modify schedule.
  - For short summary of current status

  http://agenda.cern.ch/askArchive.php?base=agenda&categ=a051370&id=a051370s1t0/transparencies
- How is LBNL doing on it's detector responsibilities?
  - Our deliverables for the silicon strip tracker are complete and delivered!
  - Very substantial progress on the production of the pixel detector.
  - But have about one more tough year of pixel-detector production at LBNL. Transition to CERN begins by July 2005.
  - Pixel detector schedule remains very tight but not yet on the ATLAS critical path.

ATLAS Computing



~Pb/sec

Event Builder

10 GB/sec

PC (2004) = ~1 kSpecInt2k

Event Filter
~7.5MSI2k

320 MB/sec

•Some data for calibration and monitoring to institutes

•Calibrations flow back

T0 ~5MSI2k

Tier 0

- ~5 Pb/year
- No simulation

~ 75MB/s/T1 for ATLAS

Tier 1

UK Regional Center (RAL)

Dutch Regional Center

French Regional Center

US Regional Center (BNL)

- ~2MSI2k/T1
- ~2 Pb/year/T1

≥622Mb/s links

10 Tier-1s:
rereconstruction
store simulated data
group Analysis

Tier 2

Other Tier2 ~200kSI2k

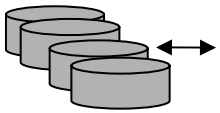
Tier2 Center ~200kSI2k

Center ~200kSI2k

Center ~200kSI2k

- ~200 Tb/year/T2

≥622Mb/s links



Tier 3 ~0.25TIPS

Tier3

Tier3

Physics data cache

100 - 1000 MB/s links

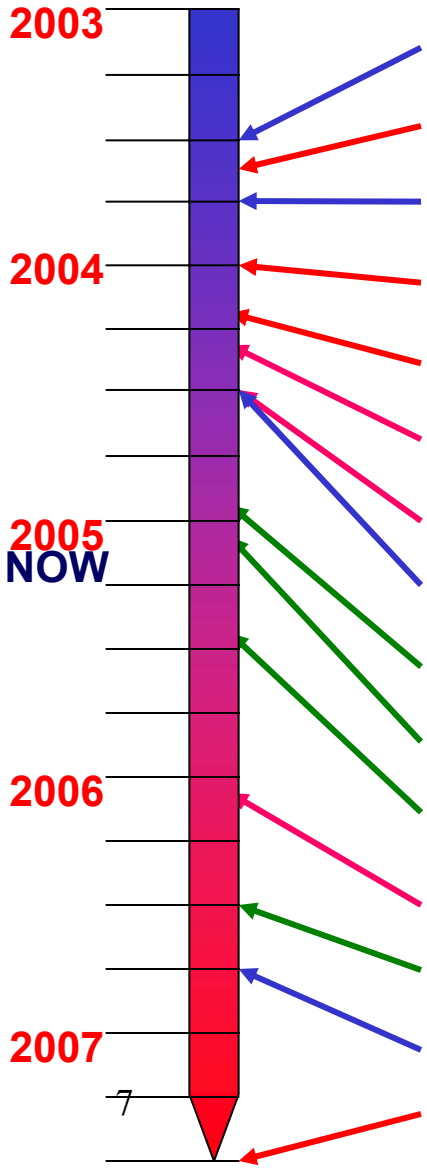
Workstations

Desktops

Each Tier 2 should have the full relevant summary data

Tier 2 do bulk of simulation

ATLAS Software Status(I)



- POOL/SEAL release (done)
- ATLAS release 7 (with POOL persistency) (done)
- LCG-1 deployment (done)
- ATLAS complete Geant4 validation (done)
- ATLAS release 8 (done)
- DC2 Phase 1: simulation production (done)
- DC2 Phase 2: intensive reconstruction (the real challenge!) LATE!
- Combined test beams (barrel wedge) (done)
- Computing Model paper (done)
- Computing Memorandum of Understanding (in progress)
- ATLAS Computing TDR and LCG TDR (starting)
- Computing System Commissioning
- Physics Readiness Report
- Start cosmic ray run
- **GO!**

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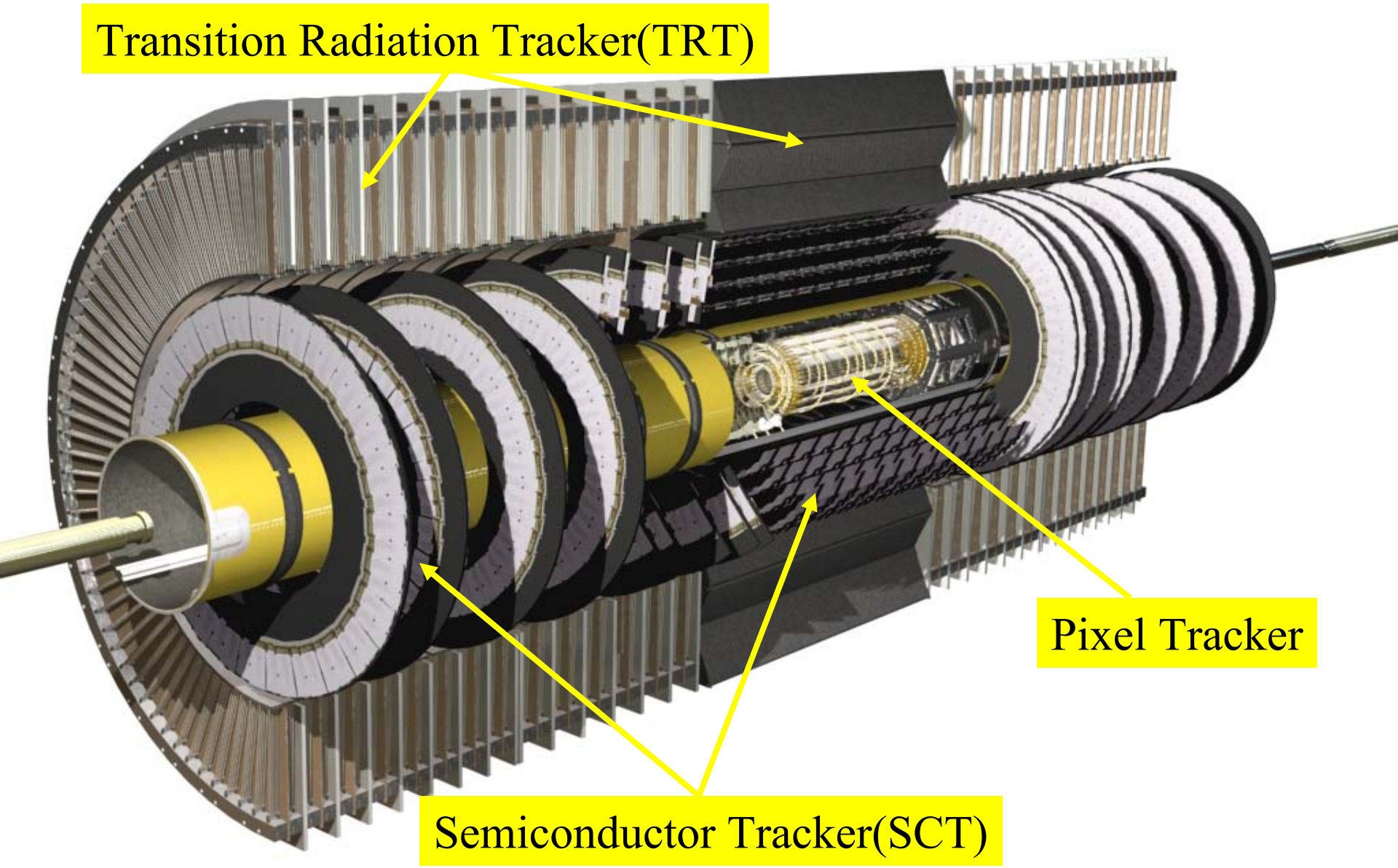
ATLAS Software/Simulation Status(II)

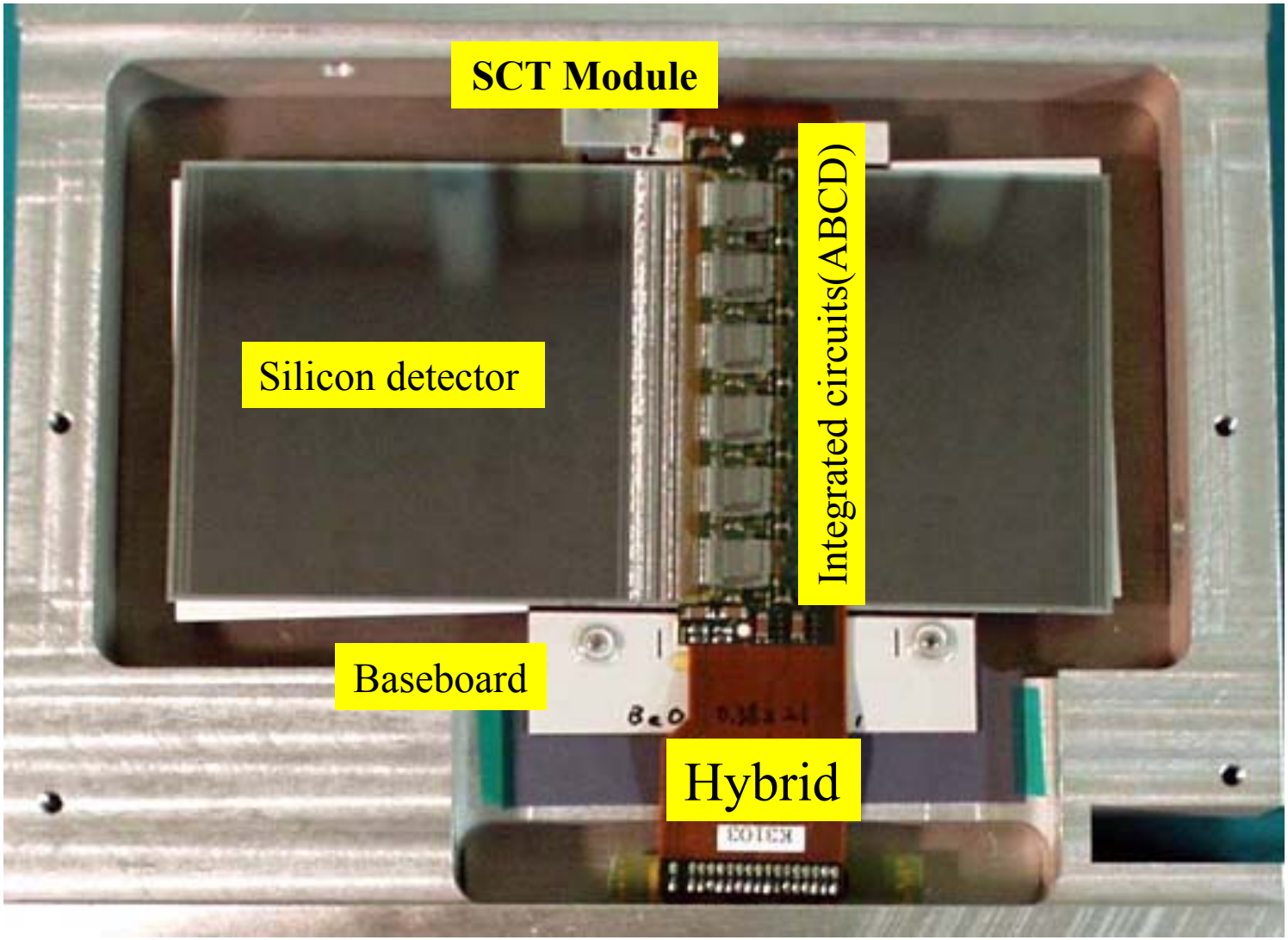
- General ATLAS status over last year
  - Combined test beam(slice of ATLAS) run has been successful but a major load(software priority)
  - Data challenge 2 has been only partially successful so far
    - Phase I (Grid-based production of Simulated data). Started in July 2004 and effectively completed in October
    - Phase II (Digitization through Tier-0 exercise). Still underway.
    - Phase III (Distributed Analysis). Still Outstanding
  - Computing/software planning proceeding reasonably
    - Computing model(what, how and when of computing resources)
    - Related Memoranda of Understanding
    - Technical Design Report by June 2005
  - Just starting to move to "commissioning" mode and organization
  - Short summary of current status

  http://agenda.cern.ch/askArchive.php?base=agenda&categ=a051370&id=a051370s1t3/transparencies
- How is LBNL doing in meeting it is software responsibilities?
  - Met significant core software responsibilities eg. "The Athena framework….extremely robust"
  - D. Quarrie re-elected to be overall ATLAS software coordinator
  - Costanzo (recently departed to BNL) has led successfully physics simulation validation effort for ATLAS
  - Hinchliffe has the leading role in coordinating physics simulation (what, when) for the upcoming ATLAS physics workshop in June in Rome.

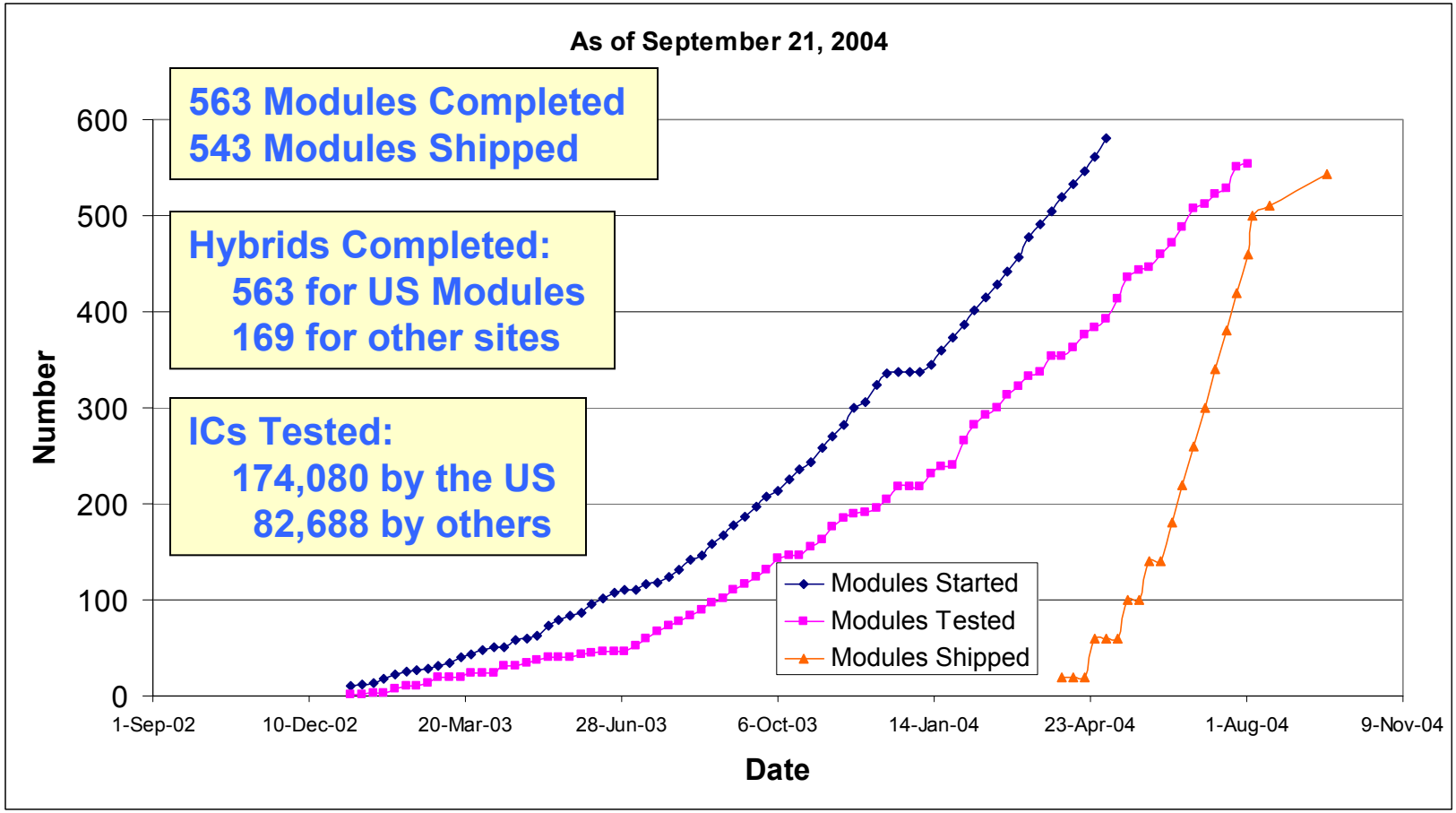
ATLAS Inner Detector



SCT Module

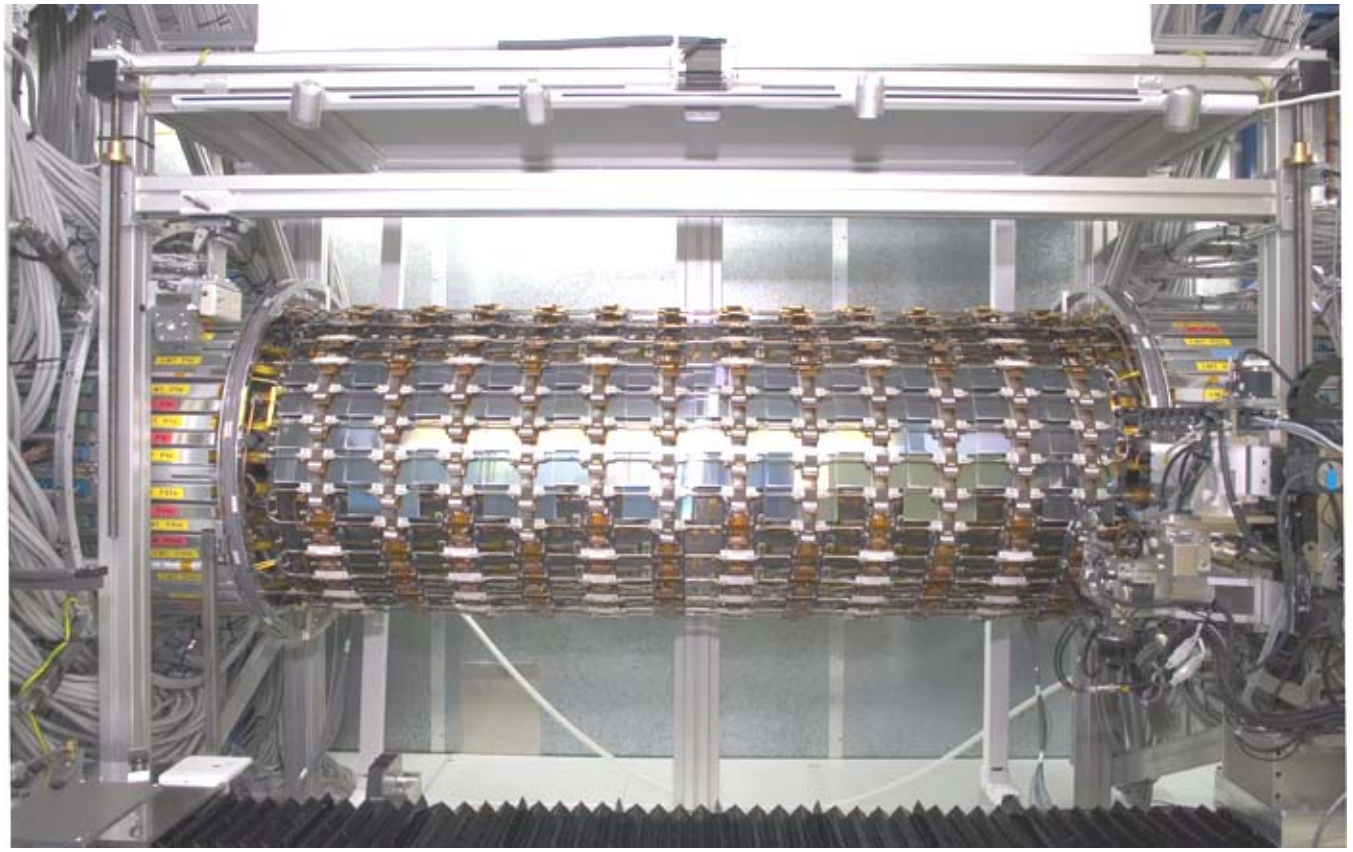

SCT Module
Silicon detector
Integrated circuits(ABCD)
Baseboard
Hybrid

US SCT Production Complete



SCT Barrel

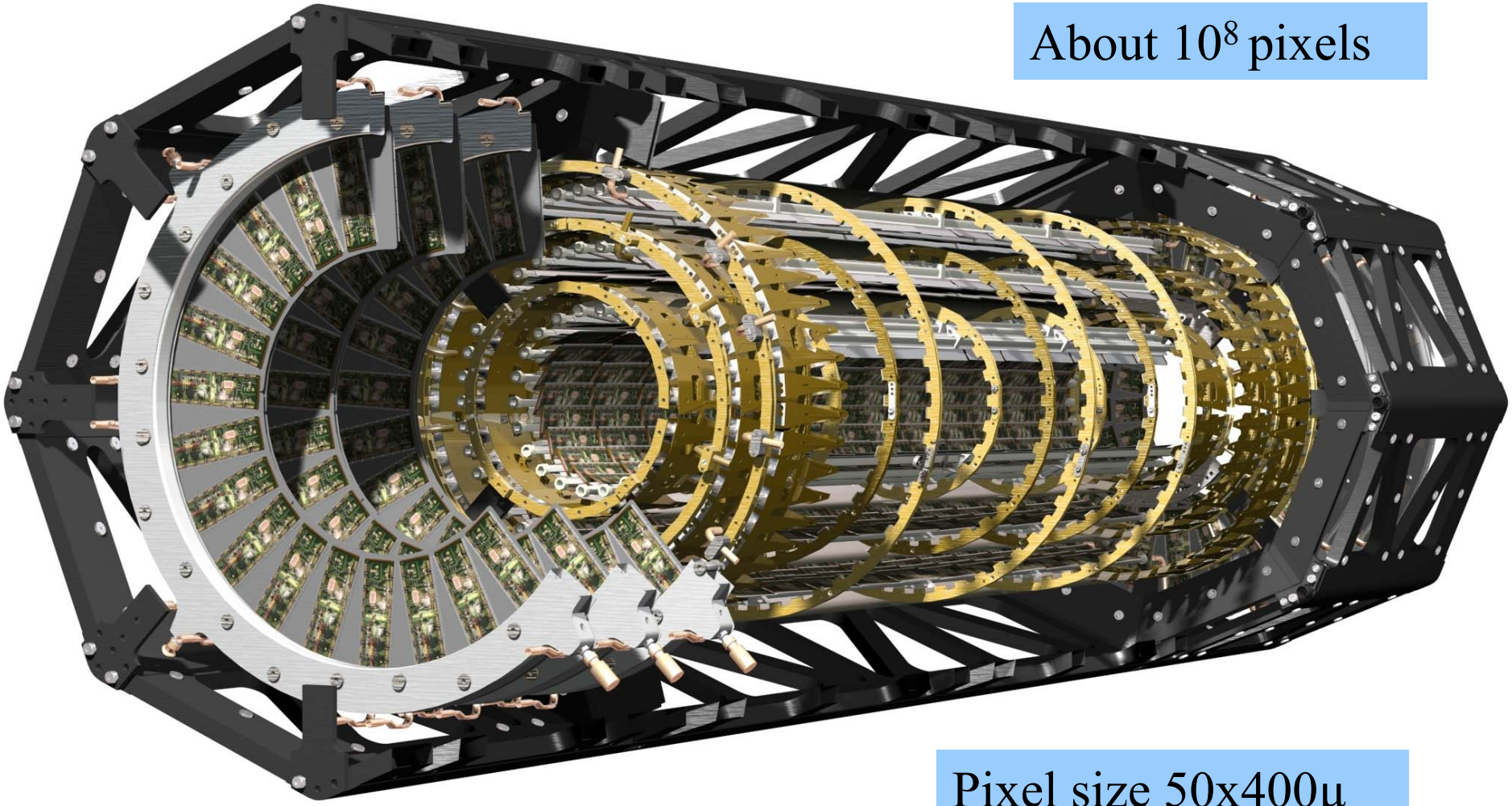
- All barrel modules fabricated.
- Innermost barrel(B3) completed and at CERN.
- Loading of B5 and B6 about to start. Schedule tight!



US and LBNL Role in SCT

- Excellent partnership between UC Santa Cruz and LBNL.
- Model for good lab-university collaboration!
- Completed
  - IC chip custom tester(LBNL)
  - Chip testing(UC Santa Cruz)
  - Hybrid loading and testing(LBNL and UC Santa Cruz)
  - Module assembly and testing(LBNL)
- Ongoing and next year
  - Electrical systems integration and management(UC Santa Cruz)
  - Barrel testing at CERN(UC Santa Cruz and LBNL)
  - Integrated cosmic ray testing with TRT at CERN(UC Santa Cruz and LBNL)
  - Personnel at CERN
    - LBNL: A. Ciocio from summer 2005 for a year
    - UC Santa Cruz: postdoc + tech
  - Critical personnel need at CERN but LBNL cannot help more and meet pixel and software/simulation commitments.

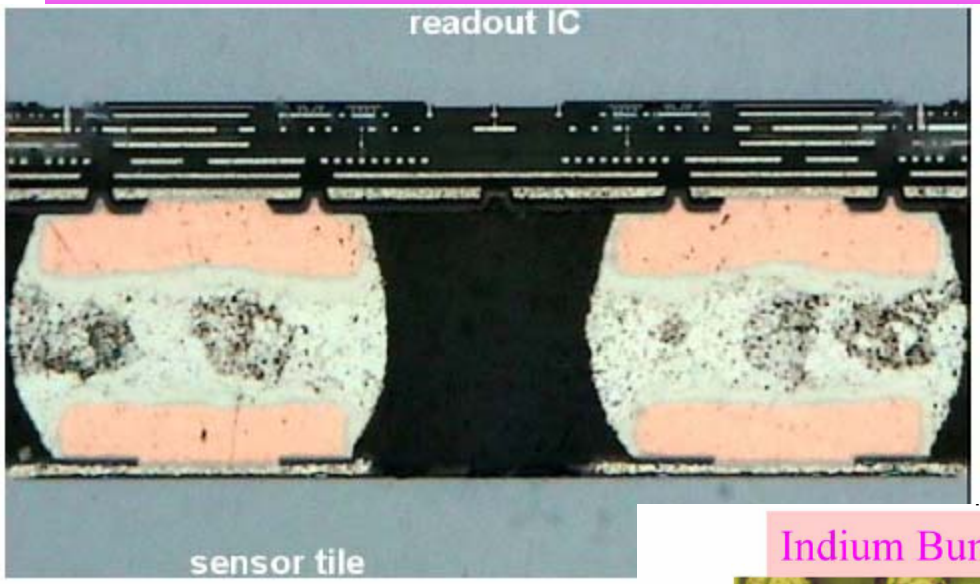
Pixel Detector



About 10^8 pixels

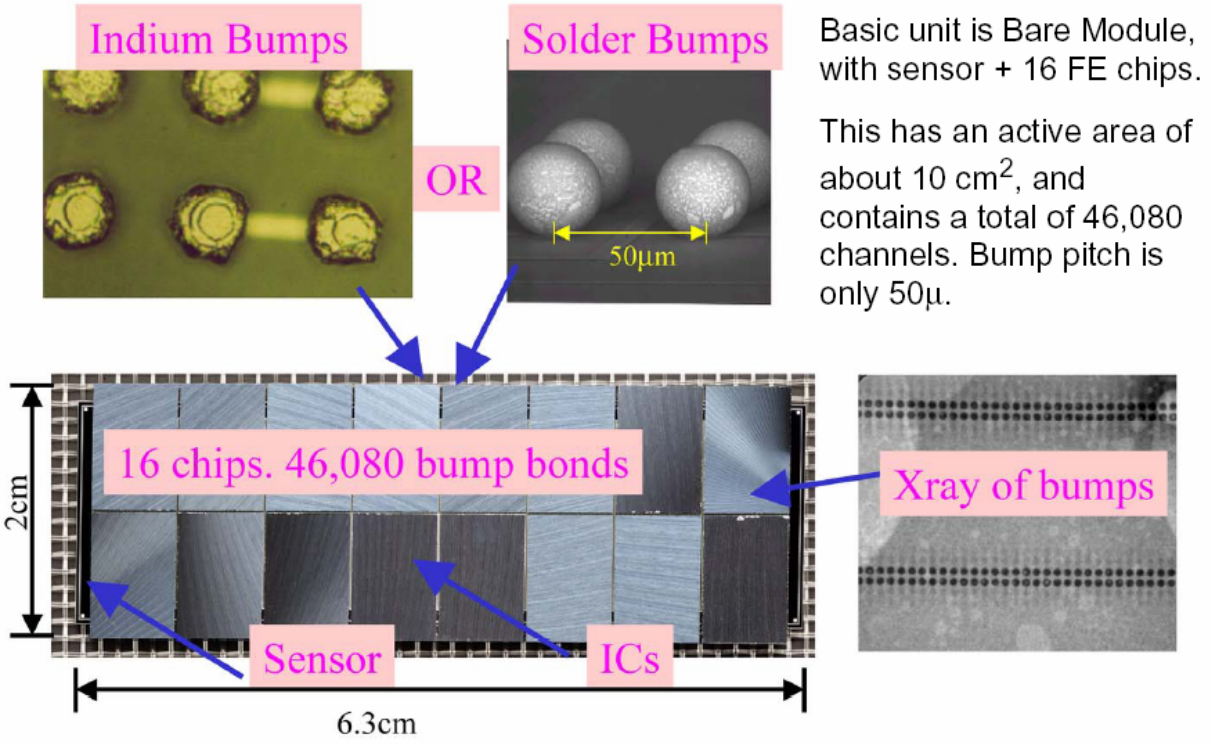
Pixel size 50x400μ

Pixel Concept



- LHC radiation levels do not allow many-year operation of strip detectors for R less than about 25cm.

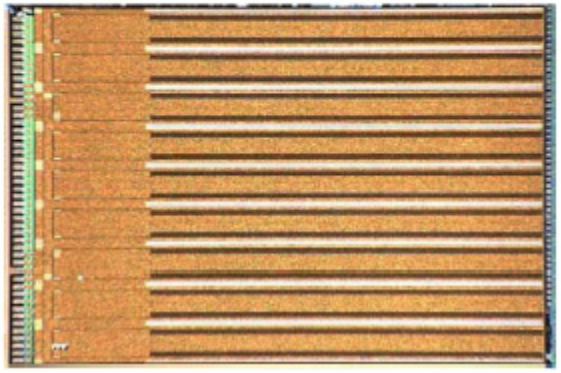
- As is by now well known, new approach was need.
- Pixel detectors with much, much finer segmentation than strip detectors are sufficiently radiation hard and provide much superior pattern recognition capability.



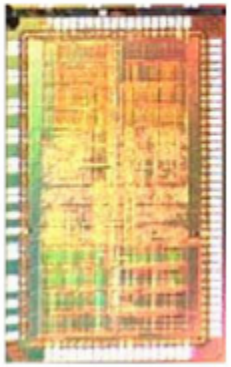
Pixel Electronics

- LBNL led the design and production of the critical front-end integrated circuit, which is a 3.5 million transistor chip fabricated in a commercial 0.25 micron process with modified design rules to provide very substantial radiation hardness.
- Fabrication of 250 wafers was completed last year and testing is almost complete(ends next month). Yield about 85%. 52K good chips identified already.
- All other integrated circuits have been completed.

Front End Chip
2880 channels



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



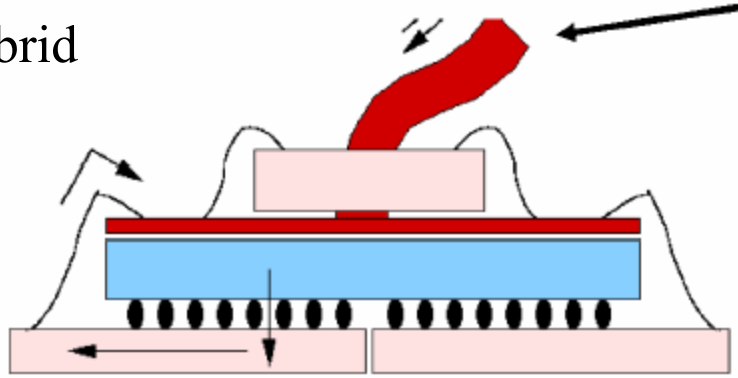
Optical interface chips

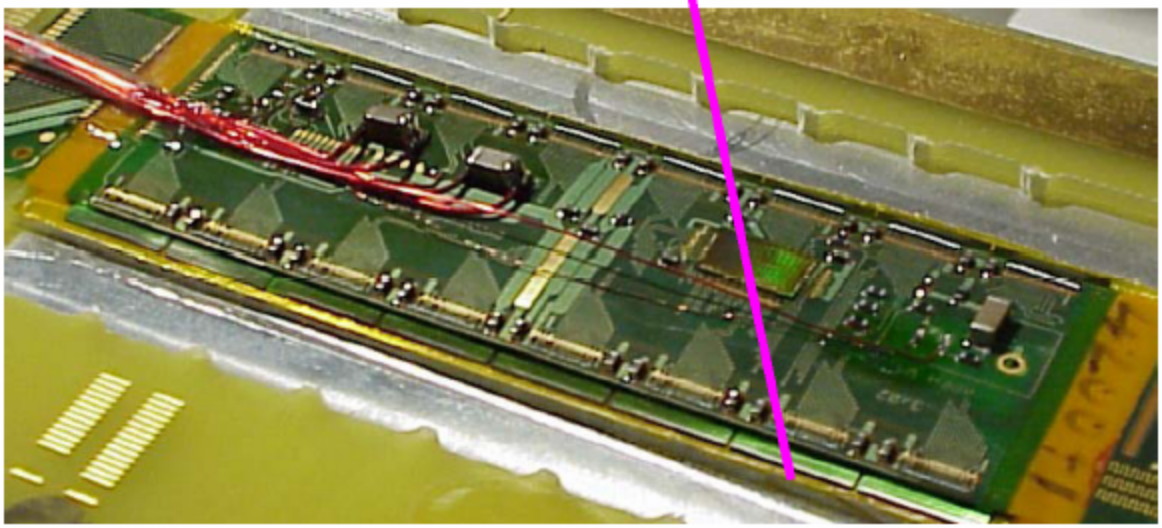
Doric
(from PIN diode to decoded LVDS)

VDC array
(from LVDS to laser diodes)

Pixel Module/Optical Hybrid

Optical Hybrid

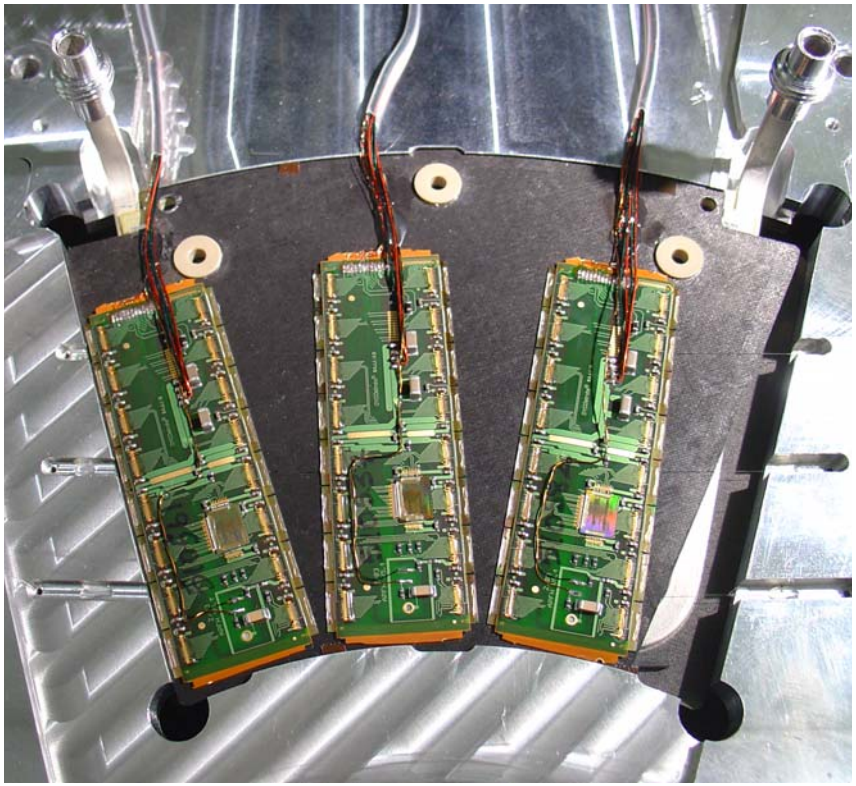




Pixel Module/Hybrid Production

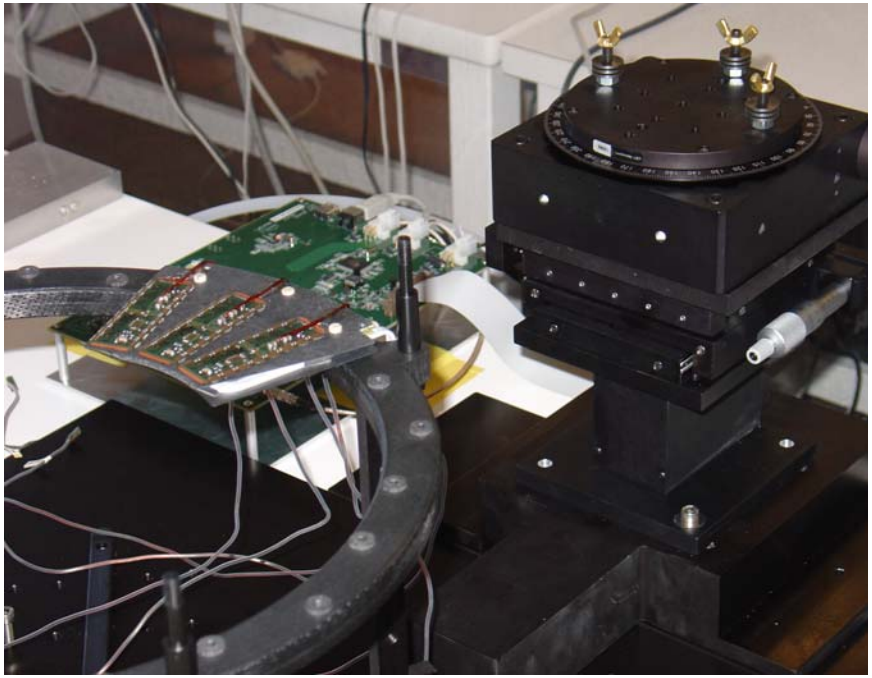
- Sensor (detector) probing in the US was done at the University of New Mexico and is now complete.
- Flex hybrid production done at the University of Oklahoma and is now complete.
- Module assembly/testing done at LBNL and is about 40% done.
- Optical hybrid pre-production complete and production just starting at Ohio State (few % done).
- Modules and optical hybrids complete before end of 2005.

Pixel Mechanical/Cooling Subassemblies

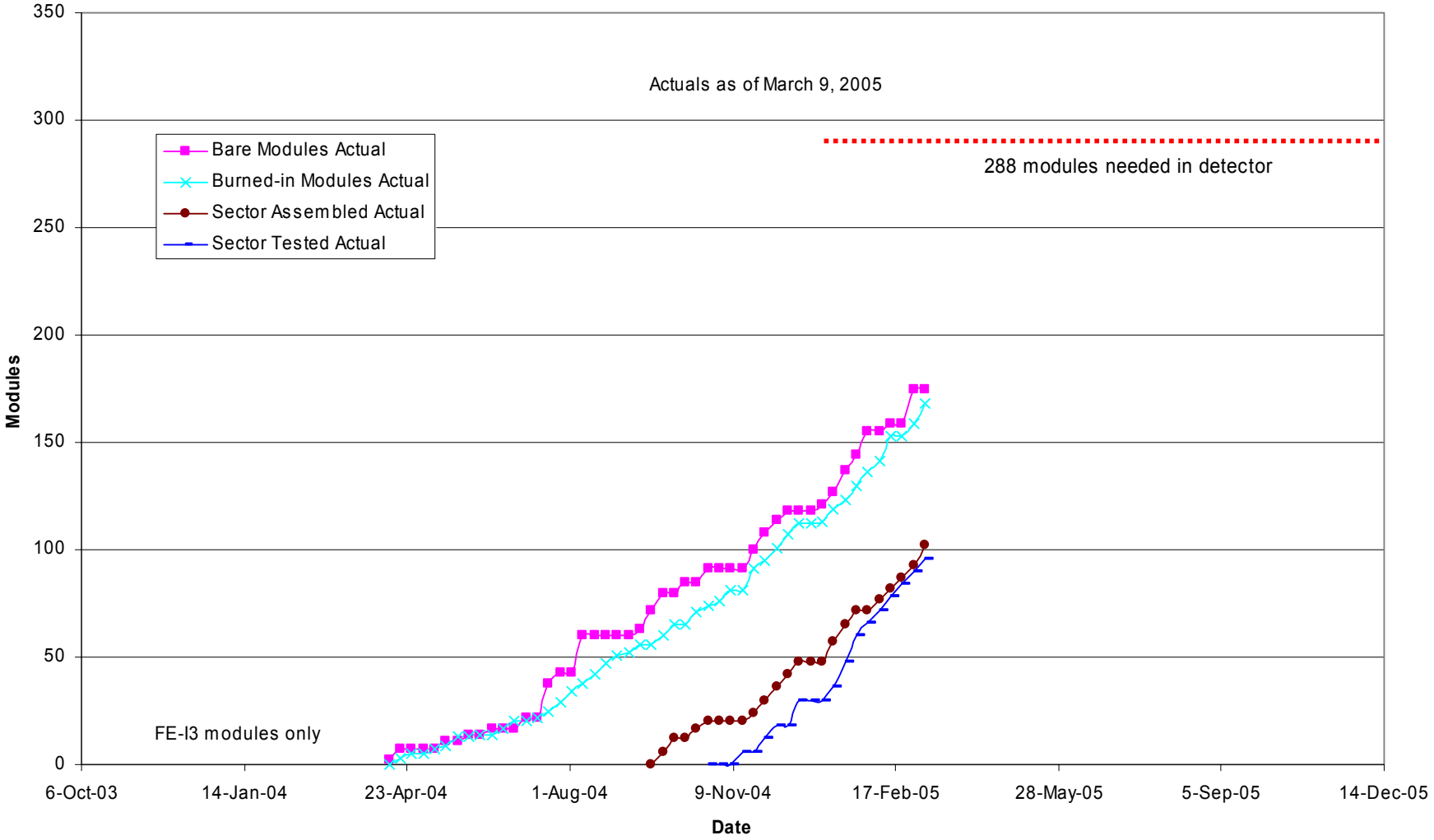


- Module placement on support/cooling elements (sectors) about 35% complete.
- Yield is 100% so far!

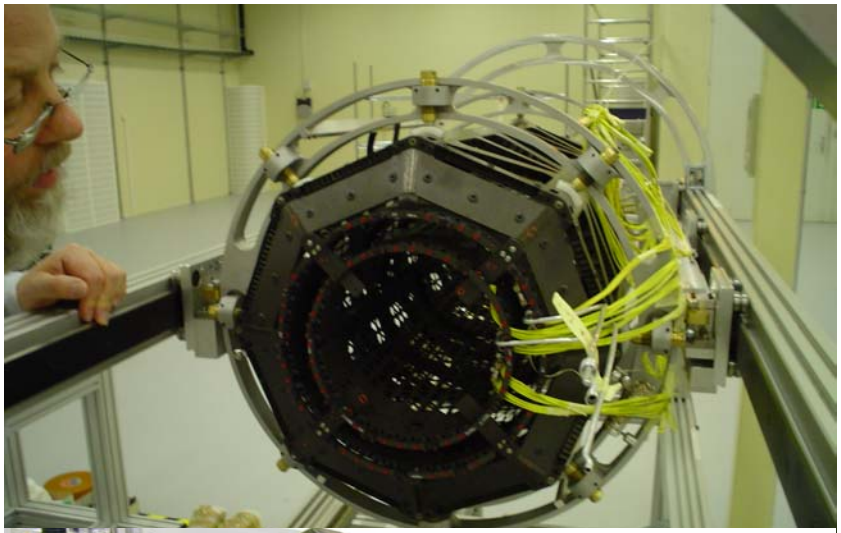
- Final assembly of disks has very recently started.



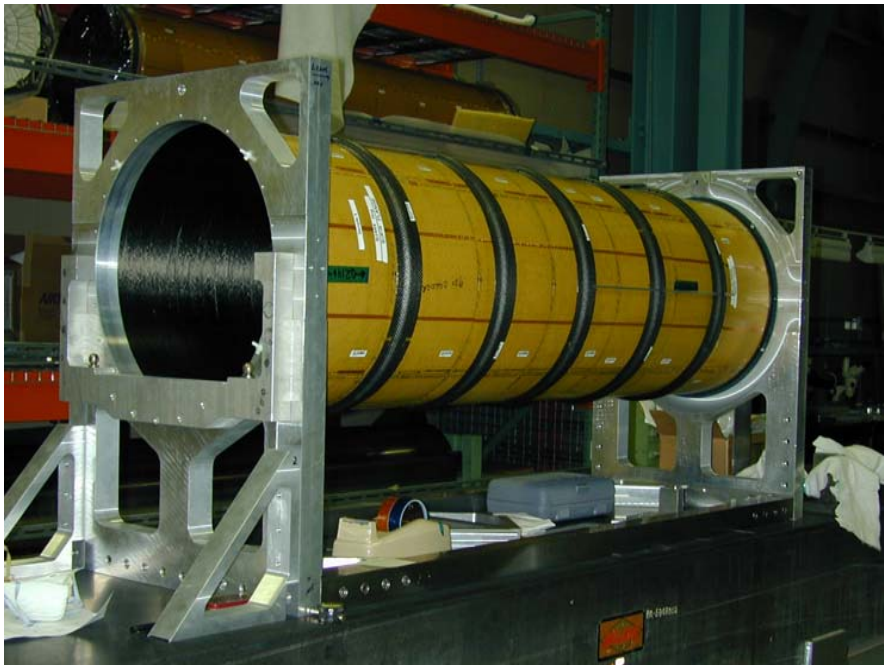
Pixel Disks Status



Pixel Mechanical Structures



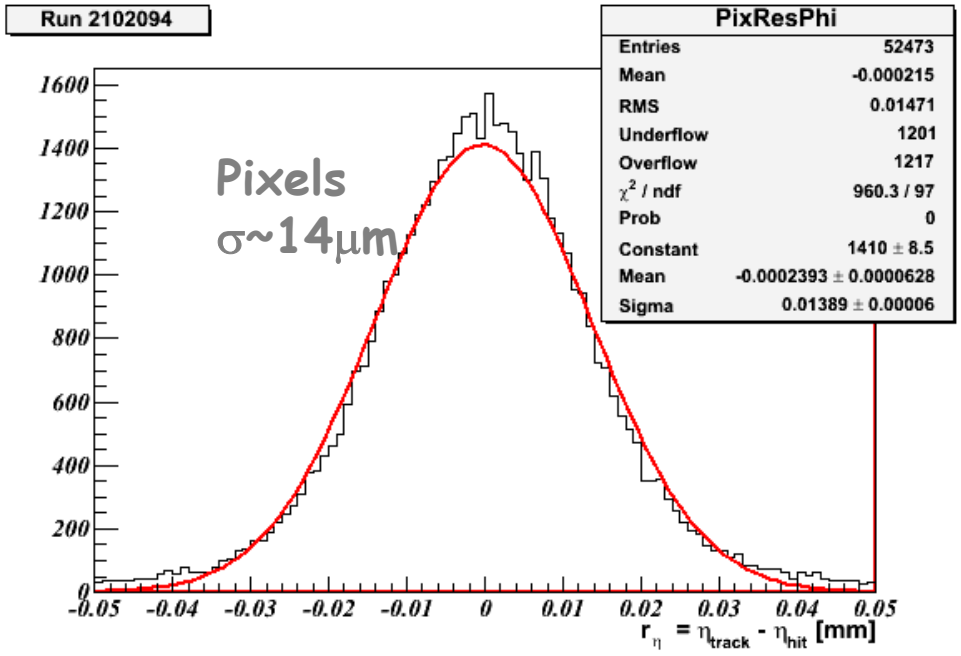
- Support frame ready
- Trial mechanical test with EU parts completed at CERN
- Support tube nearing completion
- Services and related in production



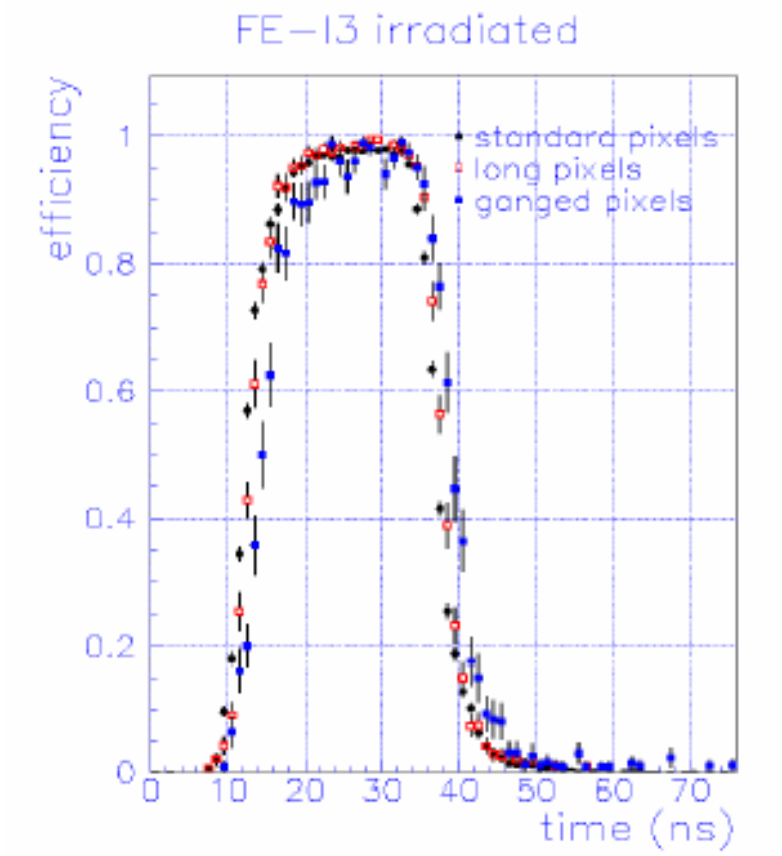
Test Beam Studies

- Irradiated module efficiencies 98% (vs 99.9% pre-rad)
- Pixel modules performed well in ATLAS combined test beam run (extensive test beam operation of slice of ATLAS)

http://agenda.cern.ch/askArchive.php?base=agenda&categ=a05748&id=a05748s1t3%2Ftransparencies%2FCTBOverview_18_02.05.ppt



Track residuals from pixel-SCT-TRT tracks



Pixel Plans at CERN Over Next Year

- Einsweiler elected to be ATLAS Pixel Project Leader starting March 1, 2005 for a two year term. He will relocate to CERN this summer.
- We plan to begin to ship our deliverables to CERN in about July and finish about one year from now.
- LBNL technical staff (engineers and tech) will relocate to CERN starting this summer. This is supported by U.S. ATLAS project funding.
- Postdocs will relocate to CERN as their pixel work at LBNL is completed and work on surface assembly/testing
- By about this time next year there will be 7-8 people from LBNL resident at CERN working on pixels. We believe this is sufficient but will only know by spring 2006.
- Pixel in-pit installation begins October 2006 in the current schedule.

US and LBNL Roles in Pixels

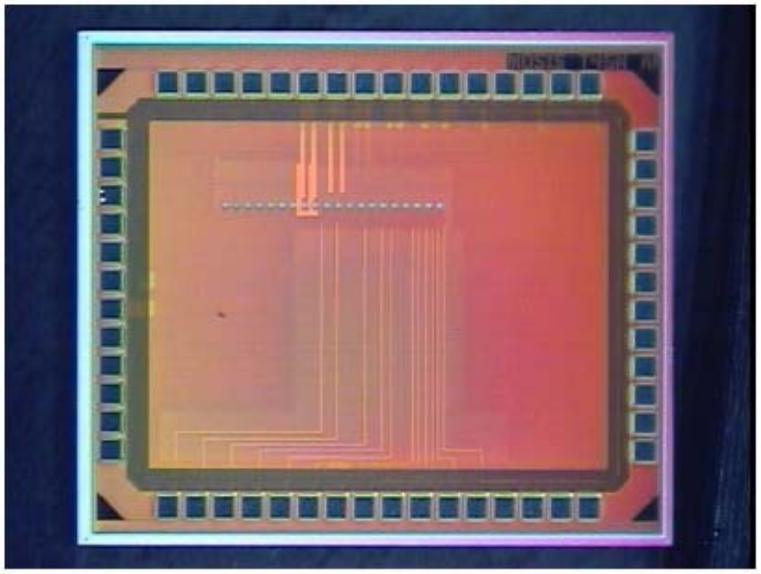
- LBNL has had the largest role of any institution in ATLAS in the pixel detector.
- Einsweiler was responsible for the front-end integrated circuit, the heart of the pixel detector. Was Electronics Coordinator and now Pixel Project Leader.
- Garcia-Sciveres was appointed Module Coordinator for collaboration a few months after joining ATLAS and will continue in this role until the end of production.
- LBNL has built much of the mechanical system for the pixels.
- New Mexico(sensors), Oklahoma(flex hybrids), Ohio State (optical hybrids), Wisconsin/Iowa State(off detector readout boards) have made critical contributions in very close collaboration with LBNL.
- Universities enabled in the development of this frontier technology through this partnership with LBNL.

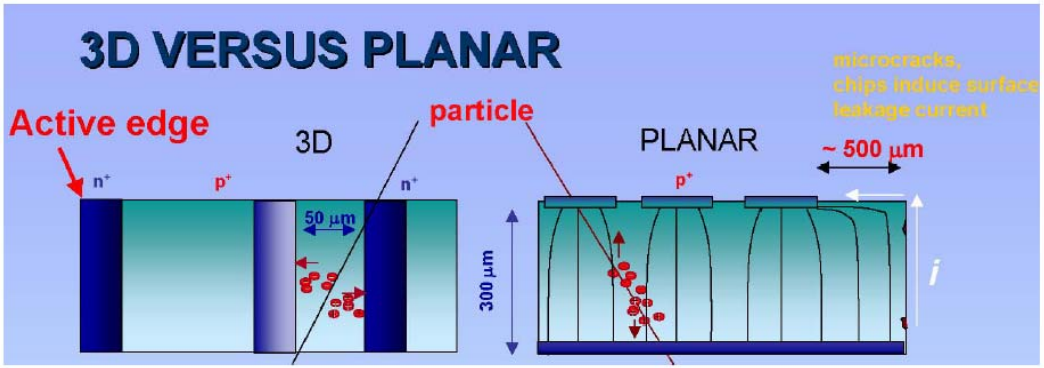
Tracking Upgrade R&D

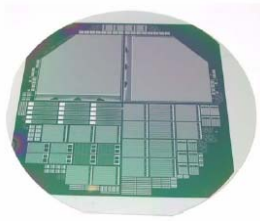
- ATLAS, US ATLAS and LBNL recognize that by far the most important goal in the next few years is to complete ATLAS and obtain physics results.
- Nevertheless, a complete replacement of the ATLAS tracking will be needed for luminosities around 10^{35}, the upgrade goal for the LHC.
- The R&D and production time for an upgrade is very long. It was 15+ years for ATLAS, so have to start now.
- US ATLAS planning is relatively advanced
  http://scipp.ucsc.edu/UpgradeR&D/index.htm
- ATLAS has established a committee to guide upgrade R&D
  http://cdsweb.cern.ch/search.py?recid=816180
- And recently held a well-attended, multi-day workshop at CERN.
  http://agenda.cern.ch/fullAgenda.php?ida=a045387

LBNL Upgrade R&D(I)

- Innermost(B-layer) pixel replacement
  - Innermost layer expected to die after about 3 years as design luminosity
  - Einsweiler has led the planning for replacement in about 2012. Soon!
    http://agenda.cern.ch/askArchive.php?base=agenda&categ=a045387&id=a045387s1t3/transparencies
  - New integrated circuits in 0.13 micron technology(more rad hard, smaller pixel size). Small test chip made and tested. Looks good.
  - Possibly new sensors(eg. 3D or other). 3D prototypes made(Kenney and Parker) being bump-bonded to existing pixel front-end ICs. Then tested here(and in EU).







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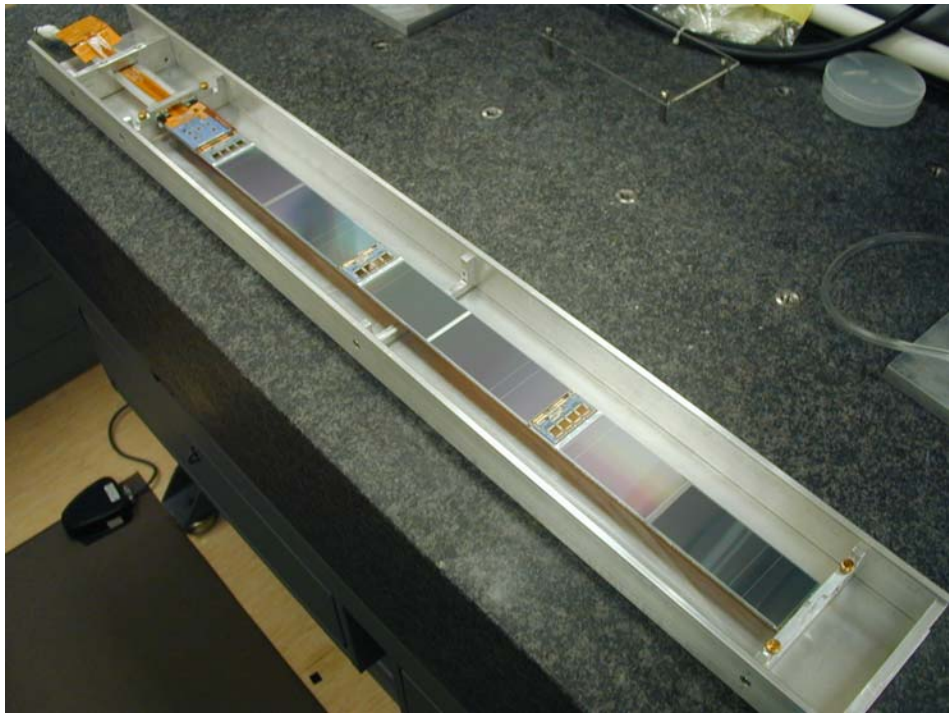
LBNL Upgrade R&D(II)

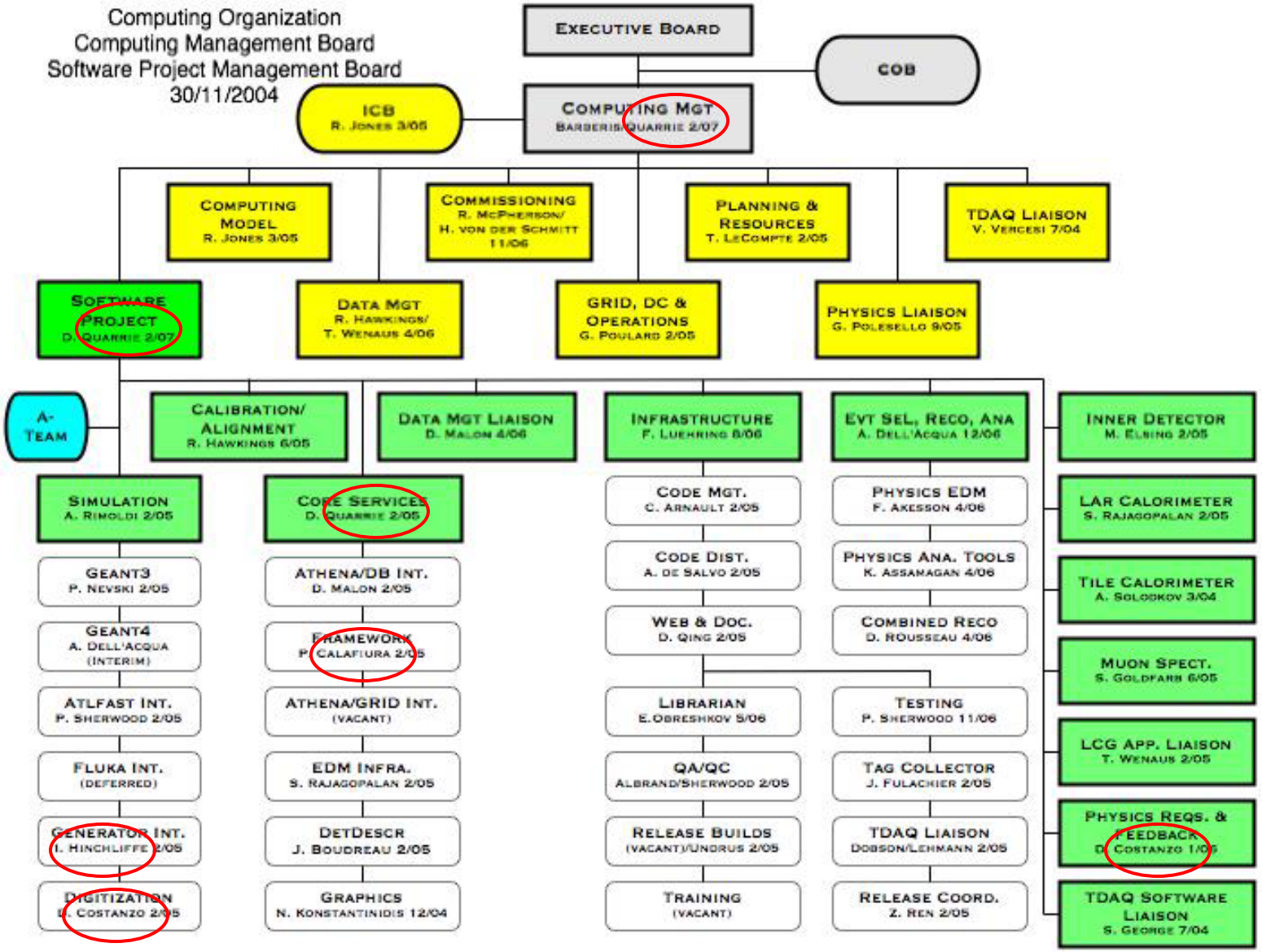
- Pixels for SLHC
  - B-layer replacement is stepping stone to complete replacement
  - Continue development of 0.13 micron (or smaller) technology
  - Development of ideas (serial power, DC-DC converters,..) to reduce power cabling and thus material. Later mechanics
  - Note that our pioneering work in 0.25µ technology is paying off in developments outside HEP for instrumentation in electron microscopy, synchrotron radiation detectors and X-ray astronomy. Expect same for 0.13µ.

- Work has also started on concepts for the outer silicon tracker
  - Based on the CDF Run 2b stave concept + ATLAS experience
  - Prototype under fabrication
  - Workshop on this held at LBNL in January 2005

http://www-cdf.lbl.gov/~slhc/



ATLAS Computing Organization



Software and Computing – LBNL(I)

- D. Quarrie was recently re-elected to be the software project leader for ATLAS and is resident at CERN.
- The NERSC team of Calafiura, Generowicz (recent hire), Lavrijsen, Leggett and Marino are primarily responsible for the "Framework" for ATLAS
  - Framework is the core system under which all of the simulation, reconstruction and physics analysis code operates
  - Generowicz and Marino are currently resident at CERN
  - These activities (and Quarrie) are supported by U.S. ATLAS computing funds.
  - We expect this level of support to persist through the first data-taking period in order that the Framework and related work can be brought to a stable state.
  - A review of the Framework was held last week
    https://uimon.cern.ch/twiki/bin/view/Atlas/FrameworkReview

Software and Computing – LBNL(II)

- D. Costanzo (postdoc who departed February to BNL) has been leading the physics validation effort for ATLAS
  - Does the output of the detector/physics simulation make sense
  - Critical role in validating the simulation tools. Not only essential but has worked well for ATLAS
  - Closely connected with other ongoing simulation responsibilities – see later
  - Costanzo will continue in this role at BNL. For more details http://agenda.cern.ch/displayLevel.php?fid=250
- G. Stavropolous (along with a fraction of Ian) is responsible for the continued integration of event generators and related that are at the "front-end" of the simulation chain.
- Stavropolous is also supported by U.S. ATLAS computing funds.

Software and Computing – LBNL(III)

- Costanzo has also been responsible for the current description (geometry, material, etc) of the pixel system and "digitization" – how the hits appear in the pixel system.
- This activity in entering a more detailed phase as the actual detector starts to near completion.
- We (Zdrazil, Gilchriese, Madaras, Shapiro) have just started more detailed work
  - How to put as-built material into the pixel detector description
  - Input of survey data into the geometry definition
- Attempting to involve pixel U. S. university collaborators in pixel software….will take time to build this part of collaboration.
- It's too early to understand the complete scope of this work in the U.S. but practically expect to limit involvement to critical items in the next year or so – personnel limited

Simulation – LBNL(I)

- Context and background
  - Data challenge I(DC1) completed some time ago.
    - Test bed for development of software
    - Some full-simulation physics studies
  - Data challenge 2(DC2) underway
    - Continued role as test bed
    - Testing of computing model(Tier 0 -> Tier 1, etc)
    - Physics simulation in preparation for ATLAS physics workshop in Rome in early June
- Hinchliffe has many critical roles in leading physics simulation for ATLAS
  - Deputy Physics Coordinator
  - U.S. ATLAS Physics Coordinator
  - Helps organize physics tutorials during ATLAS meetings
  - Day-to-day leadership of what is simulated by whom
  - Leading studies of physics capabilities (SUSY, Little Higgs, extra dimensions…..)

Simulation – LBNL(II)

- As part of the SUSY work for DC1: 100K events simulated and reconstructed with the latest version software at that time (LBNL lead role). Corresponds to about $5fb^{-1}$
- Needed 50k CPU hrs for simulation: approximately half of this was done at LBNL on the PDSF (see later). Needed 50k CPU hrs for reconstruction: all of this was done on PDSF.
- Results published – see list of notes and publications in Appendix and plenary talk by Shapiro
- Complete simulation and analysis of SUSY events will be done for DC2 and the Rome physics workshop and is in progress now.
- Ciocio and Vahsen recently started to contribute to these simulation activities.

Simulation – LBNL(IV)

- Hinchliffe is coordinating extensive simulation activity for the Rome physics workshop
- Hope to simulate and utilize about five million events

https://uimon.cern.ch/twiki/bin/view/Atlas/RomeListOfSamples

Edit Attach Printable Atlas.RomeListOfSamples r1.11 - 24 Feb 2005 - 16:55 - IanHinchliffe topic end

List of Rome Samples

An overview of the rome production can be found in the (RomeOverviewWiki)

The status and news rome production can be found in the (RomeStatusWiki)

Rome files will have the following form:

rome.AAAAAA.TYPE.DECS._NUM.END

AAAAAA is a 6 digit number assigned according to the following scheme

- 0040xx and 0049xx is a single particle sample (RomeCalibrationWiki)
- 0041xx is a "background sample" (RomeBackgroundWiki)
- 0042xx is a sample owned by the standard model group (RomeStandardWiki)
- 0043xx is a sample owned by the Higgs group (RomeHiggsWiki)
- 0044xx is a sample owned by the SUSY group (RomeSUSYWiki)
- 0045xx is a sample owned by the Top (RomeTopWiki)
- 0046xx is a sample owned by the Exotics group (RomeExoticWiki)
- 0047xx is a sample owned by the B-group (RomeBWiki)
- 0048xx (xx =01 to 49) is a sample owned by the jet/missing Et group group (JetMissingET)
- 0048xx (xx =50 to 99) is a sample owned by b-tagging group (RomeBtagging)

2005

March 2005
- 03 Rome event generation New!
- 02 Rome production New!

February 2005
- 24 rome event generation
- 23 rome production
- 16 Rome production
- 14 Atlas Monte Carlo Group.
- 10 Rome event generation
- 09 Rome production
- 03 Rome event Generation
- 02 Rpme production

January 2005
- 27 Rome background production
- 26 Rome Grid production
- 19 Rome Production
- 19 Rome Background event generation
- 12 Rome production management
- 05 Rome production planning

M. Gilchriese

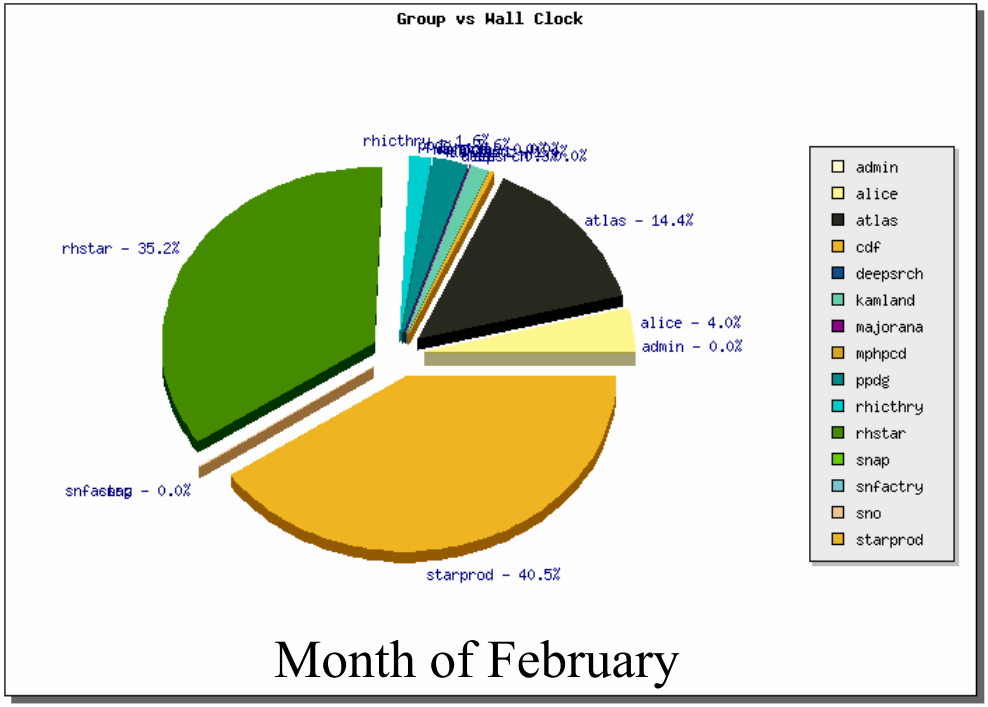
Computing Resources - LBNL

- Utilizing the Parallel Distributed Systems Facility (PDSF) operated by NERSC.

  http://cerncourier.com/main/article/44/9/16/1

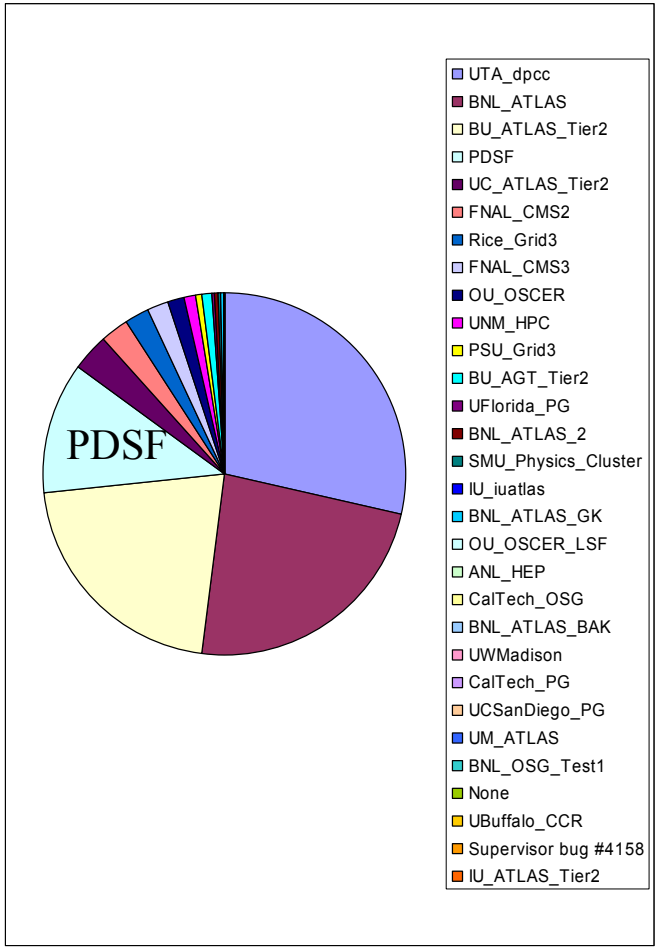
  http://www.nersc.gov/nusers/resources/PDSF/

- Multiple users, of which ATLAS is currently one.



Month of February

Snapshot of US ATLAS production over last month

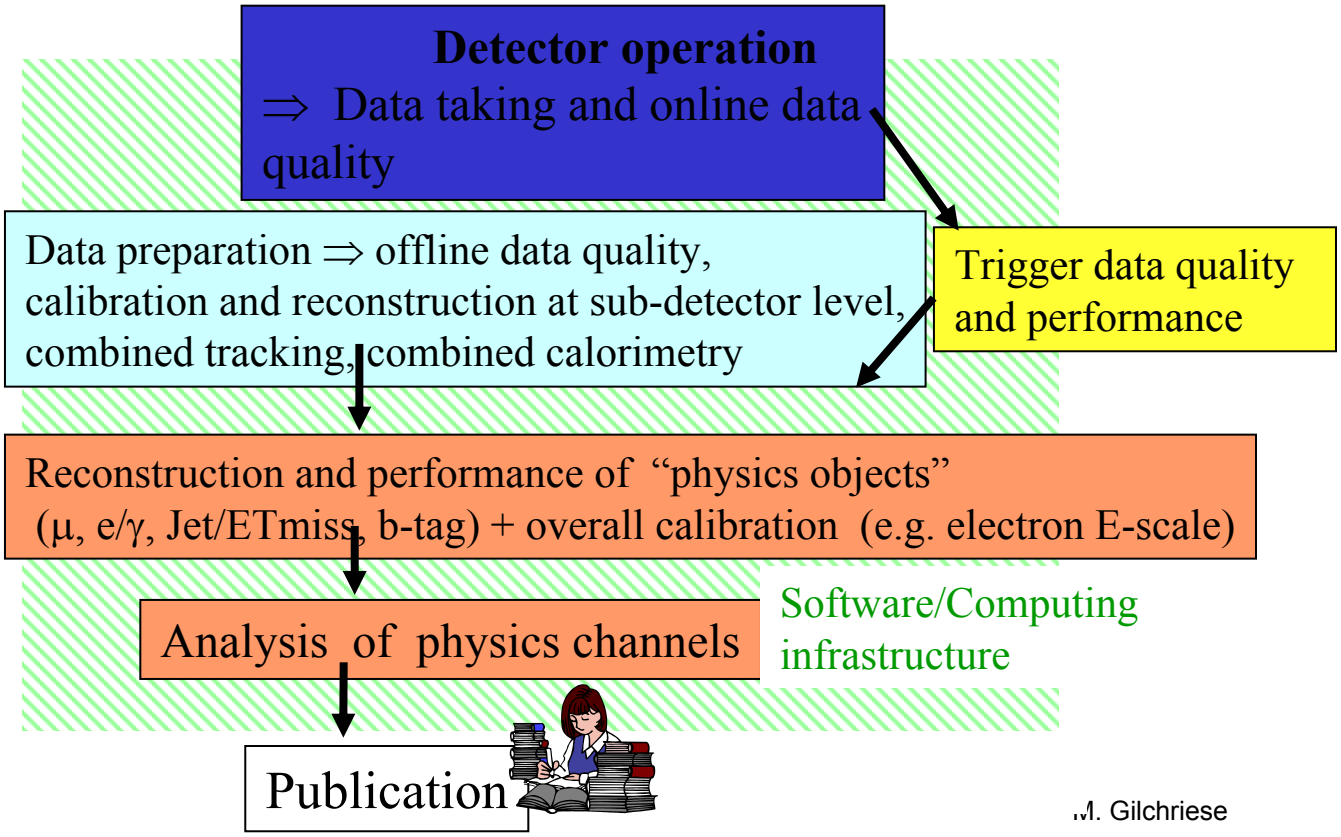


M. Gilchriese

Preparations for Data-Taking Phase(I)

- ATLAS has recently started to develop a model for operations during the data-taking phase of the experiment. See

http://agenda.cern.ch/askArchive.php?base=agenda&categ=a05748&id=a05748s1t7/document



Preparations for Data-Taking Phase(II)

- Some aspects of LBNL's role within the context of this structure are clear and some remain to be developed more fully.
- Complete the pixel system and commission it
- Limited involvement in pixel-specific and possibly inner-detector-specific software(material, geometry, alignment…)
- Continue critical support of core software until sufficient stability is reached (likely to be some years after first data)
- Continue critical role in development of physics simulation tools and coordination of their use for extraction of early physics results
- Coherent and integrated approach to obtaining first physics results
- Balanced but leading role in upgrades for silicon tracking
- To achieve this, the group will be roughly split 60:40 (in terms of physicist FTEs) based at LBNL:CERN by spring-summer 2006.

Risks and Issues

- Completion of the pixel detector
  - Something goes wrong….all-hands on deck to fix
- Upgrade R&D
  - Pixel IC designers lost to start-up company. Revival plan in motion.
  - Achieving balance between continued leadership in this and completing pixel detector, software and physics analysis
- Core software
  - Risk low currently….departure of critical software talent
- Reconstruction software and simulation
  - Large need but will have to continue to limit role to essentials
- Computing resources
  - PDSF works well for the HEP/NS community and locally…..maintain for ATLAS
- Preparations for data-taking and first physics
  - Recognized need to strengthen already some time ago
  - Failed last year to hire Divisional Fellow, candidate pool too shallow
  - Pool much stronger this year and have identified multiple candidates, offer in process
  - Transition of people from hardware accelerating but next year will be critical

Conclusions

- Substantial progress in completing ATLAS detector, aiming for readiness to meet LHC schedule in 2007
- LBNL silicon strip tracker deliverables completed
- World leader in development of pixel technology. Now in production, about one more year at LBNL to go.
- Continued leadership in core software, framework for ATLAS code.
- Leadership on many fronts of physics simulation
- Completion of detailed studies of physics capabilities using simulated data.
- Good start on upgrade R&D
- Started planning for transition to CERN operations and data-taking phase of ATLAS

Appendices

ATLAS GROUP

Physics Division

Senior Physicists
- M. Barnett(0.25, outreach)
- A. Ciocio(1.0, SCT, simulation)
- K. Einsweiler(1.0, pixels,R&D)
- M. Garcia-Sciveres(1.0, pixels, R&D)
- M. Gilchriese(1.0, pixels)
- C. Haber(0.8, SCT, R&D)
- I. Hinchliffe(1.0, software/simulation)
- S. Loken(0.1, software)
- R. Madaras(0.5, pixels)
- M. Shapiro(0.15, software/simulation)
- J. Siegrist(0.05, simulation)
- G. Stravropoulos(1.0, software)

Postdoctoral Fellows
- J-F. Arguin(0.2, software/simulation)
- T. Golling(0.6, pixels)
- A. Korn(1.0, pixels)
- S. Vahsen(1.0, pixels, simulation)
- M. Zdrazil(1.0, pixels)

Technical Staff
- S. Dardin(0.9, pixels)
- T. Weber(0.9, pixels)
- R. Witharm(1.0, pixels)

Graduate Students
- M. Leyton(pixels)
- S. Senz(pixels)
- J. Virzi(pixels,simulation)

Undergraduates
- J. Allen(pixels)
- E. Feng(pixels)
- D. Wu(pixels)

Retirees
- J. Alonso(0.4, pixels)
- R. Ely(0.2, pixels)
- F. Goozen(0.2, pixels)
- J. Lys(0.4, pixels)
- G. Trilling(0.05, general)

Visitors
- D. Hallberg(pixel upgrade R&D)
- J. Pequenao(outreach)
- P. Sicho(pixels)
- P. Zarzhitsky(SMU grad student, simulation)
- F. Zetti(pixels)

Engineering Division

Engineers
- E. Anderssen(1.0, pixels)
- N. Hartman(0.9, pixels)
- A. Smith(0.25, pixels)

Technical Staff
- J. Hellmers(1.0, pixels)
- T. Johnson(1.0, pixels)
- R. Post(0.5, pixels)
- C. Tran(0.75, pixels)
- C. Weldon(0.25, pixels)
- J. Wirth(1.0, pixels)

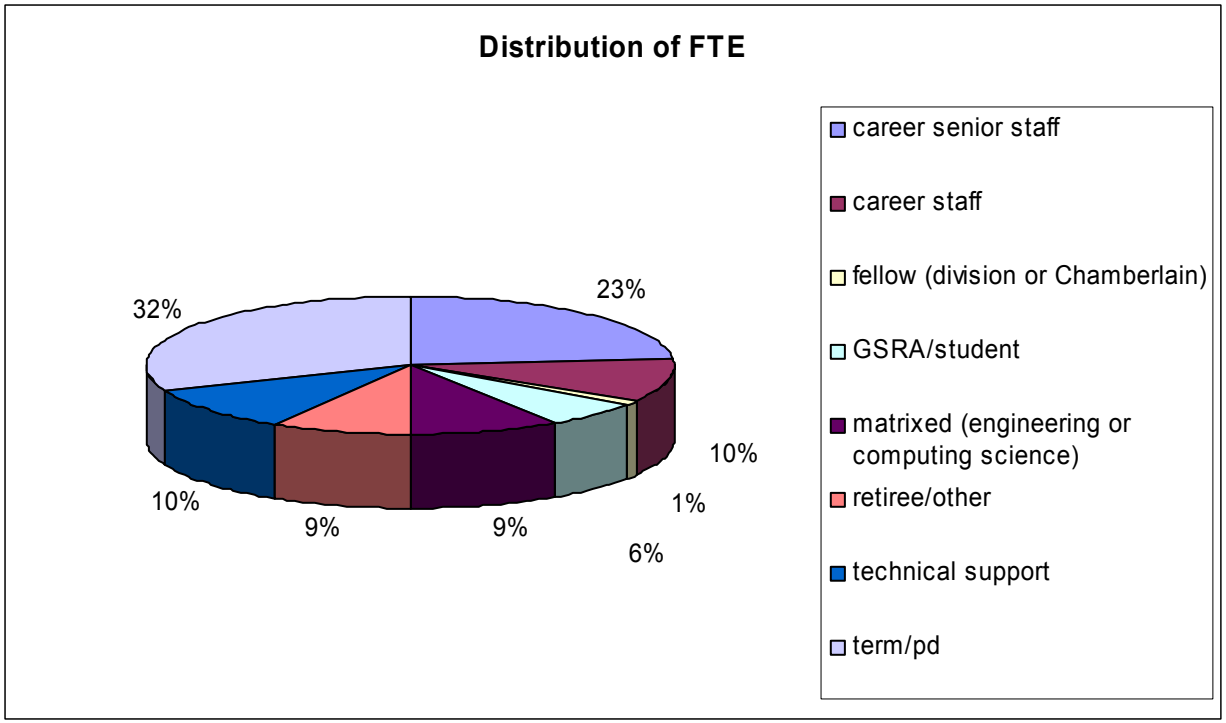
NERSC

Senior Scientists
- D. Quarrie(1.0, software)

Staff Scientists
- P. Calafiura(1.0, core software)
- C. Leggett(1.0, core software)
- M. Marino(1.0, core software)

Postdoctoral Fellows
- J. Generowicz(1.0, core software)
- W. Lavrijsen(1.0, core software)

Distribution of FTE



Notes and Publications

Beam tests of ATLAS SCT silicon strip detector modules, F. Campabadal et al. Nucl. Instr. and Methods, A 538 (2005)384–407

Diagnostic analysis of silicon strips detector readout in the ATLAS semi-conductor tracker module production, A. Ciocio (on behalf of the ATLAS SCT Collaboration), LBNL-56632(December 2004). To be published in Nucl. Instr. and Methods

FULL SUPERSYMMETRY SIMULATION FOR ATLAS IN DC1. M. Biglietti *et al.*. LBNL-55641, (Received Aug 2004). 38pp.

A STEP TOWARDS A COMPUTING GRID FOR THE LHC EXPERIMENTS: ATLAS DATA CHALLENGE 1. By ATLAS DC1 Task force

Collaboration (R. Sturrock *et al.*). CERN-PH-EP-2004-028, Apr 2004. 24pp. Submitted to Nucl.Instrum.Methods

COLD DARK MATTER AND THE LHC.
By Marco Battaglia (UC, Berkeley & LBL, Berkeley), Ian Hinchliffe (LBL, Berkeley), Daniel Tovey (Sheffield U.),. Jun 2004. 33pp.
Published in **J.Phys.G30:R217-R244,2004** e-Print Archive: **hep-ph/0406147**

EXPLORING LITTLE HIGGS MODELS WITH ATLAS AT THE LHC. G. Azuelos *et al.*. LBNL-54488, SN-ATLAS-2004-038, Feb 2004. 28pp.

e-Print Archive: **hep-ph/0402037**

Summary Comments from Nov. 2004 Director's Review

The Physics Division has made major contributions to the design and construction of the silicon-strip and pixel charged-particle trackers for the ATLAS detector. LBNL is well positioned to play a major role in ATLAS physics. The Deputy Physics Coordinator is an LBNL physicist and NERSC has a significant amount of computing power and expertise.To be ready to exploit the physics potential of the ATLAS experiment, the analysis effort at LBNL should be strengthened significantly. The Division is currently conducting a search for an ATLAS Division Fellow. New graduate students and post docs are gradually joining the ATLAS effort. Senior people now active on CDF plan to transition to ATLAS as the CDF program comes to an end. This buildup of personnel dedicated to physics analysis in ATLAS should be supported.