

# SLAC Participation in ATLAS

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# LHC: Part of Energy Frontier Strategy

- The recognition of the synergy between LHC and ILC is growing in the HEP community. Direct involvement in both enterprises is a natural path to gain closer view of the whole physics picture. The reality of ILC approval is now also tied to the initial outcome of LHC.
- The operation of a new energy frontier facility and large collaborations, are relevant experience for ILC, besides breathing the same physics.
- The now expected earlier ending of BaBar data taking in 2008 and the delayed approval of ILC would mean a significant gap of >7 years in accelerator based HEP program. Joining LHC becomes an obvious and coherent choice for maintaining a healthy work force for ILC, *especially for attracting young people to SLAC.*
- The LHC is also the primary physics program in the near future for a large fraction of our SLAC users.

# The ATLAS Case

- There is a local community of US west coast institutions on ATLAS with traditional close ties with SLAC, and university groups on BaBar transitioning to ATLAS who would like to see our participation and help to provide a base for ATLAS activities at SLAC.
- The possible projects on detector and computing emerged from these investigations have remarkable match to our interests and past experience, and with a clear path for coherent integration into existing US ATLAS effort. This led our investigation to only focus on ATLAS.
- With only <2 years to go for LHC turn on, there are still many steps to go for getting the LHC detectors ready for physics. New efforts are more welcome than one naively imagined.

# Sequence of Events

- **May/05:** Initial discussions with US ATLAS senior people, with strong support and encouragements.
- **Jun/05:** CERN visit by CY and SD. Project discussions with ATLAS managers.
- **Jul-Oct/05:** Project investigations and participated in various ATLAS meetings and some detailed work started.
- **Nov/05:** SLAC faculty approval.
- **Dec/05:** Endorsement from SPC.
- **Jan/06:** SLAC EPAC approval.
- **Feb/06:** SLAC proposal submitted and announced at the Feb/06 ATLAS week. Homing in on projects and more significant presence at CERN started.
- **May/06:** Western Tier-2 center proposal submitted.
- **Jul/06:** SLAC ATLAS membership to be voted at ATLAS week in Stockholm. Tier-2 center decision expected.

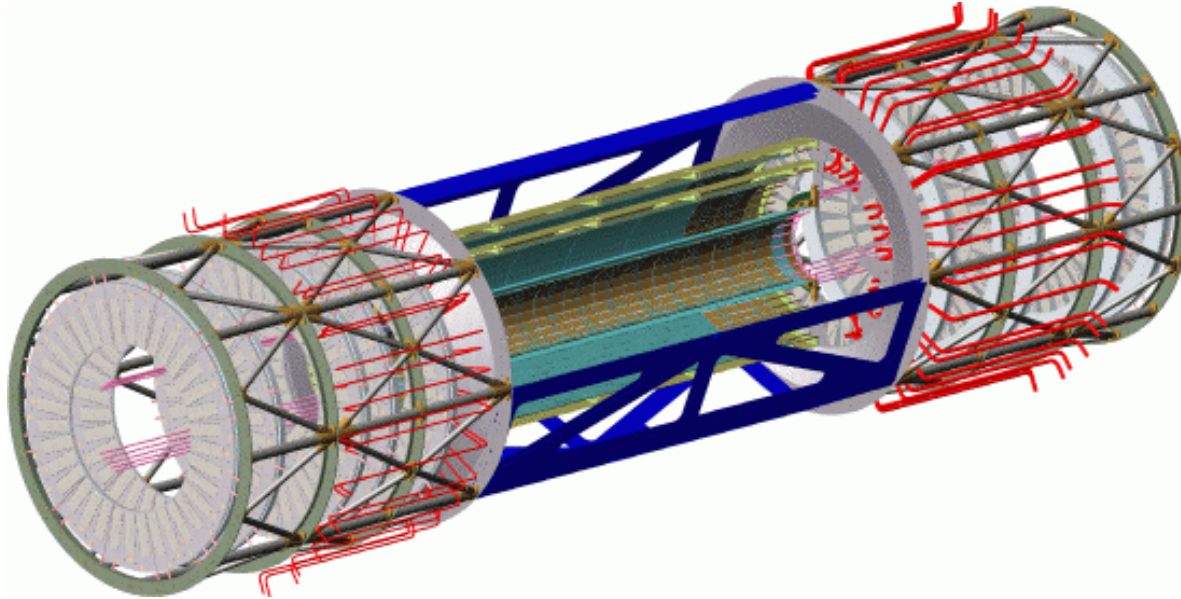
# Areas of Experimental Involvement

With inputs from ATLAS and US ATLAS managements, and many ATLAS collaborators, we identified 4 related areas:

- Pixel detector.
  - Trigger.
  - Simulation.
  - Tier 2 computing center.
- Connected to each other, to our physics interests, and to our user community.
  - Our interest in ILC is also part of the consideration.
  - The immediate needs of LHC startup has higher priority, while does not preclude participation in detector upgrade later.

We have a very talent pool of staff with experience and expertise to take on significant roles in ATLAS.

# The Pixel Detector



- Precision tracking for b-tagging and primary vertex reconstruction.
- 1744 modules each containing 46K pixels ( $50 \times 400 \mu\text{m}^2$ ).
- Endcap module production and testing (LBNL is the leading Lab) complete. Barrel production (Europe) tests still in progress.
- Very dense and complex cabling/connections. Need a lot of testing at commissioning.

# Pixel Detector

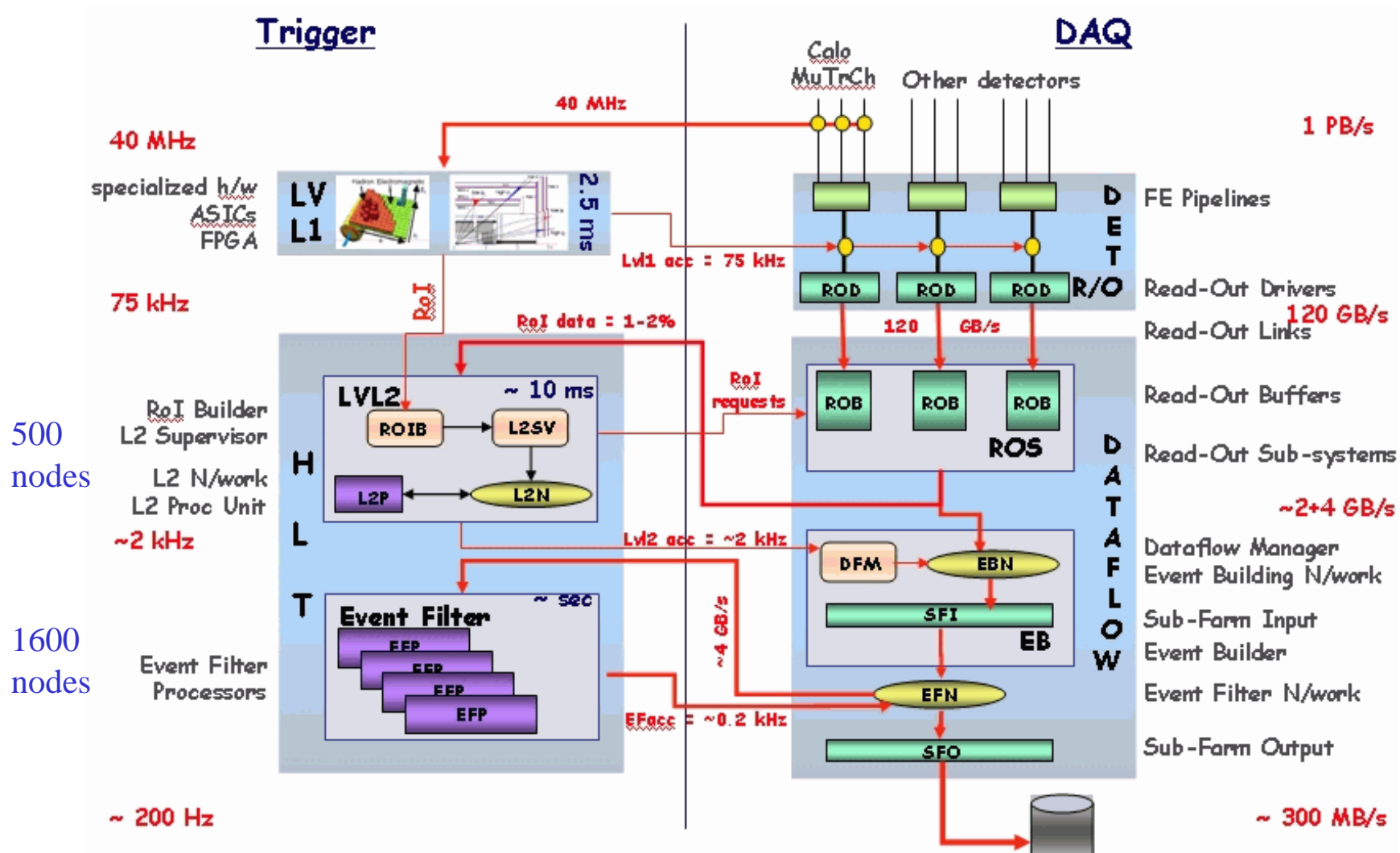
- **Resonance in interests and expertise:**
  - Experience with pixel vertex detector, alignment, and b/charm tag physics at SLD.
  - Current involvement in ILC vertex detector design.
  - Interests in ATLAS physics associated with b-tags.
  - Connection with trigger.
- **Suitable timing and need for SLAC participation:**
  - Last system to be installed (early 07), and can still 'touch' hardware through intensive assembly and installation process.
  - Pixel system has no CERN participation and European collaborators are busy with final barrel production.
  - This is on the overall critical path for ATLAS installation.
- **Collaborating community:**
  - LBNL is a leading pixel center. Some groups involved in pixel system (UCI, UCSC, Wisconsin, OSU) have base at SLAC ROB.

# Pixel Detector Involvement

- Testing pixel detector modules at LBNL.
- Optical link integration and commissioning work.
- Endcap system cosmic tests.
- Installation and commissioning early 2007.
  - will try to maintain good communication with SLAC to utilize our Tier-2 and manpower at US for analyzing commissioning data and involve users.
- Evolving into alignment, tracking and vertexing. Leading to physics.
- Starting team in 06: Charlie Young, Su Dong, Tim Barklow, Norman Graf, Ariel Schwartzman (Panofsky fellow) and a postdoc.



# Trigger & DAQ



# Trigger

- ATLAS is making a major effort in promoting trigger awareness in the transition from construction to operation, and pushing new groups into this area.
- The main area of need is the software High Level Triggers (HLT) operating on online farm CPUs.
- Very direct physics connection.
- SLAC has extensive expertise in trigger/DAQ and many problems have very familiar looks to what we addressed in BaBar.
- Some flexibility in work location and ramp up time as needs will extend well into startup.
- UC Irvine, Wisconsin and Oregon are also working on trigger system.

# High Level Trigger Involvement

- **Trigger core software development:**
  - Configuration scalability for large number of nodes.
  - Trigger release control and validation.
  - Future roles in coherent online/offline framework, trigger configuration and algorithm control.
- **Trigger selection algorithms:**
  - Investigating jet trigger strategies utilizing  $b$ -tag with pixel info, in conjunction with overall trigger menu.
  - Intend to be involved in jet/ $\tau$ / $E_{\tau}^{\text{miss}}$  algorithms which have serious needs for additional efforts and revisit of strategic issues, as our manpower grow.
- **Potential major roles in commissioning and large scale system tests.**

**Starting Team in 06: Rainer Bartoldus, Su Dong, Stephen Gowdy, Amedeo Perazzo, Steffen Luitz, and Sarah Demers-konezny (new postdoc).**

# Simulation

- **Expertise at SLAC:**
  - SLAC is the center of Geant4 expertise outside of CERN with a strong core group.
  - Geant4 user expertise from SLAC ILC detector simulation team and our BaBar and ATLAS collaborators from UCSC.
- **Activities:**
  - **Shower parameterization.**
    - Significant speed-up of simulation code. This could be crucial for ATLAS to make real MC production practical.
    - **Makoto Asai** (GEANT deputy spokesperson at SLAC) will mentor a student resident at SLAC (**Zach Marshall** from Columbia Univ.) to implement and tune GFLASH for ATLAS.
    - Tuning is CPU intensive. Tier 2 computing power will help.

# U.S. ATLAS Tier 2 Status and Plans

- **Tier-2 functions:**
  - Simulation production, calibrations, and **primary location for physics analysis.**
- **US computing facilities:**
  - Three sites selected in 2005: BU/Harvard, Midwest and Southwest.
  - Two more in 2006. Submissions collected May/06. Decision July/06.
  - One Tier-1 site at BNL for re-reconstruction, data archive and analysis dataset production.
- **Funding:**
  - \$600K / year per site.
  - Actual scale of hardware depends on local leveraging.

# Western Tier 2 Center at SLAC

- The Western Tier-2 is jointly proposed by **SLAC, LBNL, UCSC, UCI, Washington, Arizona, Oregon, Wisconsin**, to be located at SLAC, with Richard Mount as PI and an advisory board consists of members from the institutions.
- **Aspire to be a premier Tier 2 center.**
  - Good data access is crucial for analysis. The chaotic data access is the main challenge, while SLAC has experience with BaBar.
- **A strong case for supporting activities besides physics analysis for all west coast institutions and user groups at SLAC:**
  - Pixel and Inner Detector tracking/alignment.
  - Trigger development and analysis.
  - Event simulation.
- **Very effective leverage of existing investments.**
  - Proven management tools and scalable infrastructure.
  - "Lights out" no operator 24x7 operation for last 10 years.
  - Common pool with BaBar can benefit both sides by exploiting staggered peak usage.
- **ATLAS software already running at SLAC since Dec/05.**

# Tier 2 Resource Needs

- Proposed Tier-2 scale: ~2500 KspecInt2000 CPU and 1400TB disk by 2010, while SCCS has ~4000 kspecInt2000 CPU and ~500 TB today. Can easily accommodate the Tier-2 hardware compared to a green site.
- Building 50 power and cooling for currently planned expansion will leave sufficient capacity to operate ATLAS Tier-2.
- Charge incremental costs to Tier 2 funds:
  - Expect ~1 FTE. Some direct infrastructure needs, e.g. racks for Tier-2 hardware and Tier 2 specific CPU and disks.

# Computing at SLAC

- Significant investments by DOE and BaBar in establishing the computing infrastructure and expertise at SLAC, in particular the capacity for data intensive analyses.
- The data intensive analysis frontier will be further pushed by LHC. The SCCS development projects such as PetaCache, can have a major influence on the trend in the future. The ATLAS Tier-2 could be a demonstration ground which can benefit ATLAS, LHC and HEP in general.
- Computing resources need to grow for other projects: Particle Astrophysics and LCLS. The continuing expansion of expertise will lead to common benefits, with most effective return of investments.



# Physics Opportunities

- It's not only energy frontier, but also with a large range of physics topics.
- There is no 'ownership' to any given analysis topic in ATLAS.
- There is a heavy concentration on  $H \rightarrow \gamma\gamma$  in existing analysis effort, while other opportunities (even other Higgs analyses) appear to be not as crowded.
- Detailed understanding of Standard Model processes through innovative and sophisticated analyses are needed to form the foundations for major discoveries which may otherwise be nonviable.
- Analyses on similar final states, e.g. events with multiple b-tags can cover wide range of topics involving SUSY, Higgs and exotic searches. The detector expertise on pixel/tracking and trigger are advantageous in effectively pursuing these analyses.
- The close interaction with the SLAC theory group will be a significant advantage to do physics analysis at SLAC.

# An Example of Possible Physics Interest



- The remaining allowed phase space for MSSM is largely in the large  $\tan\beta$  regime, where  $bbH/A$  production greatly enhanced. The decay of  $H/A$  to  $tt, ww, zz$  strongly suppressed so that the only significant decay modes are  $bb, \tau\tau$ .
- Currently envisaged jet trigger thresholds (especially HLT) are too high to preserve  $bbH(bb)$ .
- Alternative HLT strategy on 4 jets with b-tagging at level-2 trigger? Need combined knowledge on pixel for b-tagging and fast trigger software. A natural extension of our detector work.
- Succeeding in this path is not only useful for this example.

# US ATLAS Physics Organization

The US ATLAS physics support task force has released a recommendation in summer 05:

- Analysis Support Group: with experts spread around Labs and universities (~10 FTE) to provide analysis information and technical help.
- Analysis Support Centers: at BNL, ANL and LBNL, with office space for users to facilitate training, meetings, seminars and direct communications on analysis issues. Collaborating with Tier 1/Tier 2 computing centers to facilitate analysis.

The practical arrangements to realize this model is still being experimented.

SLAC has the facilities and easy access to effectively operate as an analysis support center. ATLAS users also working on BaBar/ILC at SLAC will further broaden analysis expertise available at SLAC. This should naturally attract users for increasing ATLAS physics activities at SLAC.

# Manpower (Non-Tier2) and Other Resources

- Manpower and related costs dominate.
  - ~5 FTE in 2006. ~8 staff members transitioning from existing programs with various time fractions. Two new postdocs (Jul/Aug 06). A new Panofsky fellow (Aug/06) .
  - ~5 additional FTE each year until we reach ~20, including hiring of postdocs at ~2 per year to reach a steady state of ~8 postdocs. We of course expect many students to join this program in addition.
  - No significant M&S. Main cost is travel support.
- Needs careful management.
  - Must not threaten existing commitments.
  - Delayed participation of interested people with key responsibilities in existing programs.
  - Strive for "win-win", e.g.
    - Retain staff from BaBar today to ILC in the future.
    - Sharing of post-docs with ILC.

# Summary

- SLAC's participation in ATLAS is well underway. With first beam expected in just ~1 year from now, a fast ramp up on detector projects is crucial. The detector and computing projects we are involved in are important to ATLAS and to the US ATLAS community, which exploits our expertise.
- It is an important enhancement of the accelerator based program, bridging between BaBar and ILC. It should be particularly effective in attracting young people to our program.
- We are preparing for the exciting physics ahead at LHC together with our user community and the strong theoretical community at SLAC/Stanford.

# Backup Slides

# Tier 2 Scale Comparison (as proposed)

Consortium		2005	2006	2007	2008	2009	2010
<b>BU/Harvard</b>							
	<b>CPU</b>	<b>210</b>	<b>350</b>	<b>730</b>	<b>1090</b>	<b>1600</b>	
	<b>Disk</b>	<b>40</b>	<b>170</b>	<b>370</b>	<b>480</b>	<b>630</b>	
<b>Southwest</b>							
	<b>CPU</b>	<b>500</b>	<b>900</b>	<b>1500</b>	<b>1700</b>	<b>2100</b>	
	<b>Disk</b>	<b>60</b>	<b>200</b>	<b>380</b>	<b>540</b>	<b>700</b>	
<b>Midwest</b>							
	<b>CPU</b>	<b>360</b>	<b>510</b>	<b>900</b>	<b>1100</b>	<b>1300</b>	
	<b>Disk</b>	<b>50</b>	<b>130</b>	<b>260</b>	<b>465</b>	<b>790</b>	
<b>Western</b>							
	<b>CPU</b>		<b>111</b>	<b>427</b>	<b>872</b>	<b>1503</b>	<b>2505</b>
	<b>Disk</b>		<b>64</b>	<b>244</b>	<b>498</b>	<b>858</b>	<b>1430</b>

# Manpower Profile

		Pixel	Simulation	Trigger	Total
2006					
	<i>CERN</i>	1.2	0.0	1.0	2.2
	<i>SLAC</i>	1.2	0.0	1.6	2.8
	<i>Sum</i>	2.4	0.0	2.6	5.0
2007					
	<i>CERN</i>	3.8	0.0	3.0	6.8
	<i>SLAC</i>	1.5	0.7	1.7	3.9
	<i>Sum</i>	5.3	0.7	4.7	10.7

(not including students)

- **Activities will evolve, especially beyond 2007.**
  - Other detector systems.
  - Physics analysis.
  - Global responsibilities.