

Proposal of SLAC Participation in ATLAS

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SLAC Join LHC ?

- 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.*

Initial Discussions at SLAC

- The combination of growing excitement on the LHC startup all around us and the reality of time scales of BaBar and ILC had led to discussions among experimental faculties and grass root interests in LHC also emerged from the staff physicists, in early 2005.
- Conversations with several senior people in US ATLAS yielded very positive welcome to SLAC's participation. The needs for US western Tier-2 computing center, pixel vertex detector and trigger systems were identified.
- First presentation for possible ATLAS participation to SLAC faculty in Jun/05.

Investigations and Visits to ATLAS

CY and SD went on a fact finding trip to CERN in June/05:

- Warm reception from ATLAS management, hosting introduction talk and visit to detector cavern and detector assembly areas.
- Met with many system managers and confirmed the needs in pixel commissioning, high level trigger. Needs in computing and simulation were also strongly expressed. One frequently mentioned issue was 'integration'. The need for experienced manpower for commissioning is quite clear.
- Met with more US ATLAS senior people and they were very enthusiastic about our participation and offered to help.
- The needs for immediate LHC startup are of higher priority, while does not preclude participation in upgrades later.

We participated in Oct/05 ATLAS week and several detector subsystem weeks and physics workshops, as well as phone meetings with CERN to discuss project details. A Tier-2 computing center proposal was drafted by a group chaired by Richard Mount and Stu Loken, in collaboration with US Western institutions.

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 partition 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 <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. ATLAS is ready for us.

Further SLAC Discussions

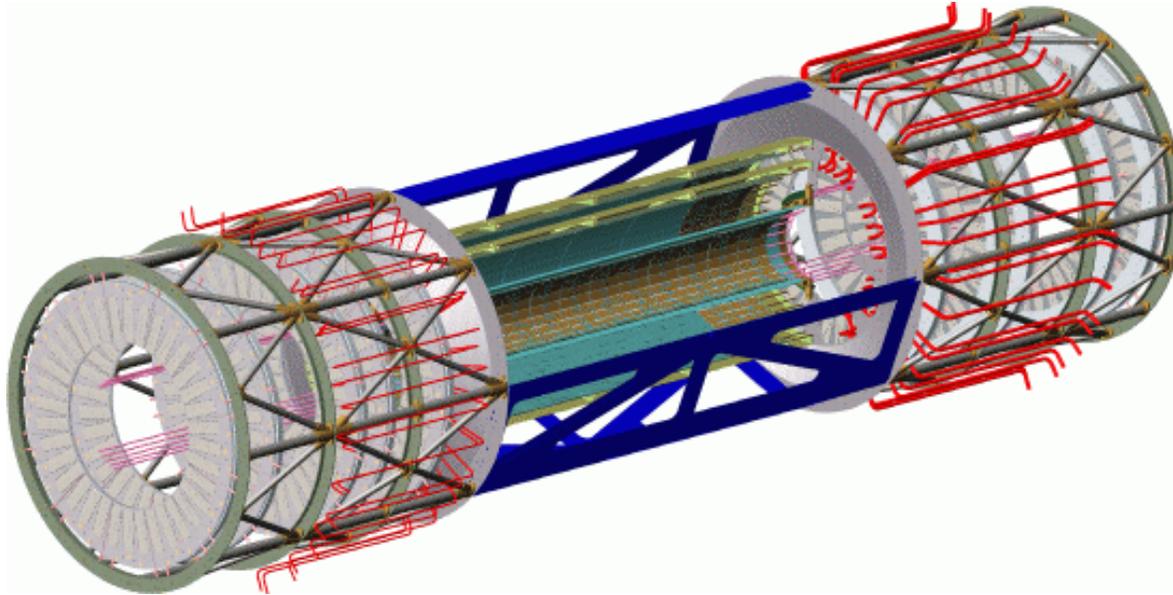
- Two more rounds of presentations and discussions at SLAC faculty meetings in Sep-Oct/05. Some of the questions discussed:
 - How can SLAC make a substantial contribution in a collaboration of this size as a late comer ?
 - How can SLAC justify its role as a National Lab. ?
 - Impact on existing program and Lab resources in general, in particular the ATLAS tier-2 on computing resources ?
- Nov/05: SLAC faculty voted unanimously in support of further pursuing a formal proposal to ATLAS.
- Dec/05: The ATLAS participation was brought up at the SLAC Policy Committee meeting and the closeout included a statement: "The SPC was really pleased to see the lab joining ATLAS. They saw excellent synergy with existing programs."

Proposed Areas of 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 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. Assembly at CERN after barrel cooling pipe refurb.
- Very dense cabling/connections. Need a lot of testing at commissioning.

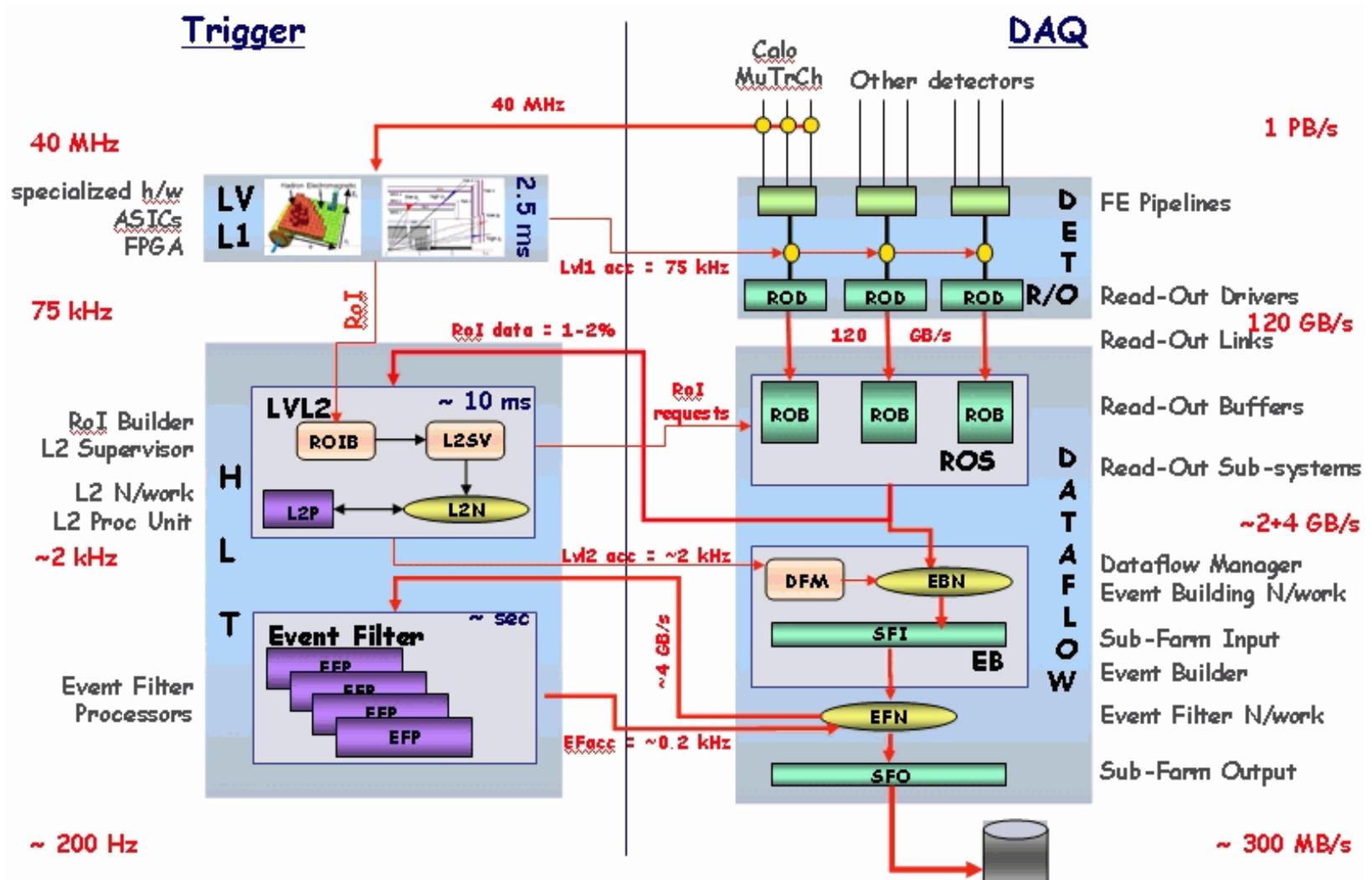
Pixel Detector

- **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 to become familiar with detector now.
- Teststand at SLAC for preparing fiber connectivity tests.
- Pixel detector simulation to get familiarized with detector and ATLAS software:
 - irregular pixel configurations: ganged pixels, edge pixels.
 - ionization and diffusion simulation (needed for ILC VXD also).
- Final assembly, testing at CERN starting Feb 2006 with 10% system on surface.
- 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.
- Alignment, tracking and vertexing. Leading to physics.
- Starting team in 06: Charlie Young, Su Dong, Tim Barklow, Norman Graf, 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 (for the algorithmic part at least).
- UC Irvine, Wisconsin and Oregon are also working on trigger system.

Trigger Involvement

Phone meetings with HLT manager Chris Bee and other experts to identify projects for SLAC participation. Topics in focus:

- **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:**
 - e.g. $\text{jet}/\tau/E_{\text{T}}^{\text{miss}}$ algorithms have serious needs for additional efforts and revisit of strategic issues.
 - We are thinking about alternative jet trigger strategies utilizing b -tag with pixel info, in conjunction with overall trigger menu.
- **Commissioning:**
 - opportunity for major responsibility.

Starting Team in 06: Su Dong, Amedeo Perazzo, Steffen Luitz, Rainer Bartoldus, and a postdoc.

Geant4 Expertise at SLAC

- SLAC is the center of Geant4 expertise outside of CERN with a strong core group including, e.g.
 - Makoto Asai: Deputy Spokesperson & chief architect.
 - Joseph Perl: Visualization coordinator.
 - Dennis Wright: Documentation coordinator & hadronics package coordinator.Demonstrated help to BaBar and ATLAS and expect to continue for LHC in general and ILC.
- Geant4 user expertise.
 - Norman Graf for ILC.
 - BaBar and ATLAS collaborators from UCSC.

Possible Simulation Activities

- As-built geometry.
 - Essential to physics exploitation, but not yet implemented.
 - Possible role for coordinating the effort and involved in the pixel implementation.
- Shower parameterization.
 - Significant speed-up of simulation code. This could be crucial for ATLAS to make real MC production practical.
 - GFLASH developed by Makoto Asai.
 - Will mentor a student to implement in ATLAS.
 - Detailed tuning is CPU intensive.
 - Tier 2 computing power very helpful.

ATLAS Computing Model

- Tier 0 at CERN.
 - First pass reconstruction and data archival.
 - Access limited to central production group.
- ~10 Tier 1's around the world.
 - Reprocessing and redundant data archive.
 - Production of analysis datasets.
 - Access for production managers only.
 - One in U.S. at BNL.
 - Significant ramp-up from present facilities.
- Tier 2 regional centers.
- Tier 3 - (off-grid) computing resources for a university group.

Role of Tier 2

- Three major activities. Balance depends on the center.
- Simulation production.
 - Organized activity fairly easy to manage.
 - Within capability of many university groups.
- Calibration.
 - Intermediate between physics analysis and simulation production.
- Primary location for physics analysis.
 - Chaotic access to large amounts of data.
 - Scaling problems not easy to deal with.
 - SLAC has experience from BaBar.
- A really functional Tier 2 requires much more than keeping a bunch of boxes running.

U.S. ATLAS Tier 2 Status and Plans

- Three sites selected in 2005.
 - BU/Harvard, Midwest and Southwest.
- One to two more in 2006.
 - Call for proposals expected in May/06.
 - Submissions due in another 1-2 months.
- Funding = \$600K / year per site.
 - Either NSF or DOE.
 - Actual scale of hardware depends on local leveraging.

It has been clarified that DOE funds can be used to establish a Tier-2.

Tier 2 Center at SLAC

- Aspire to be a premier Tier 2 center.
 - Good data access is crucial for analysis.
 - Simulation production is not the driver.
- A strong case for supporting all West Coast institutions and user groups at SLAC: SLAC, LBNL, UCSC, UCI, Washington, Arizona, Wisconsin, OSU, Iowa State, Oregon, etc.
 - Pixel and Inner Detector tracking/alignment.
 - Trigger and event simulation.
 - Physics analysis.
- 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.

Scale Comparison

Consortium		2005	2006	2007	2008	2009
BU/Harvard						
	CPU	210	350	730	1090	1600
	Disk	40	170	370	480	630
Southwest						
	CPU	500	900	1500	1700	2100
	Disk	60	200	380	540	700
Midwest						
	CPU	360	510	900	1100	1300
	Disk	50	130	260	465	790

SCCS has ~4000 CPU and ~500 TB today. Can easily accommodate the Tier-2 hardware compared to a green site.

Tier 2 Resource Needs

Charge incremental costs to Tier 2 funds:

- Expect ~1 FTE.
- Some direct infrastructure needs, e.g. racks for Tier-2 hardware.
- 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.

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.

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 $bbH(bb)$, and missing E_{T} trigger at HLT also looks technically difficult which is necessary to help preserving $bbH(\tau\tau)$.
- 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 recently released a recommendation:

- 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. Two postdocs by mid 2006. On going discussions on additional staff physicists not listed as current proposal authors to start already in 2006 .
 - ~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.
 - 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.

Manpower Profile

		Pixel	Simulation	Trigger	Total
2006					
	<i>CERN</i>	1.5	0.0	1.0	2.5
	<i>SLAC</i>	0.5	0.5	1.0	2.0
	<i>Sum</i>	2.0	0.5	2.0	4.5
2007					
	<i>CERN</i>	4.5	0.0	1.5	6.0
	<i>SLAC</i>	1.0	1.0	1.5	3.5
	<i>Sum</i>	5.5	1.0	3.0	9.5

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

Time Line and Next Steps

- With first beam expected in summer 07, a fast ramp up on detector projects is crucial. The subsystems are still accommodating to allow people to ramp up at different rates, but it's to the interests of SLAC, ATLAS and individuals involved to make an early start to give ourselves a chance to make more significant impact.
- We have the endorsement from SLAC faculty and SPC, and is looking for approval from the EPAC to enable us submitting the formal proposal to ATLAS in Feb/06 and expected ATLAS decision in July/06, synched to the ATLAS weeks. It is essential to keep to this schedule to enable the Tier-2 bid as a member institution.

Summary

- We have a proposal for SLAC's participation in ATLAS, which we believe is an important enhancement of the accelerator based program, bridging between BaBar and ILC.
- This should be particularly effective in attracting young people to our program.
- The detector and computing projects we can potentially be involved in are important to ATLAS and to the US ATLAS community, which exploits our expertise.
- ATLAS is extending warm welcome to our proposal.
- We have the endorsement of SLAC faculty and SPC.
- We are seeking approval from EPAC.