ATLAS Detector Upgrade Opportunities

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LHC and ATLAS Upgrades

- **ATLAS Early Upgrade Installed**
- **ATLAS Major Upgrade Installed**
- **New injectors + IR upgrade phase 2**
- **Linac4 + IR upgrade phase 1**
- **Collimation phase 2**
- **Without phase 2**
- **SLHC**

L = $10^{35}$ cm$^{-2}$ sec$^{-1}$
L = $10^{34}$ cm$^{-2}$ sec$^{-1}$

Multiple upgrades to trigger, data acquisition and software/computing
ATLAS

L1Calo Stream

first beam event seen in ATLAS

SLAC

Sept. 18, 2008

SLUO 2008 Annual Meeting
Early ATLAS Upgrades

* ATLAS has just started a comprehensive review of the compatibility of the current detector configuration with the projected first phase luminosity upgrades of the LHC. Some upgrade needs have been known already for some time.

* New innermost layer of the tracker (more on next page)

* Forward calorimetry to maintain missing $E_T$ capability

* Substantial improvements of data acquisition and trigger systems to handle higher rates and improve trigger selectivity.

* Software revisions/improvements and more computing capability to handle increased data and analyses.

* Need operational experience to really understand needs!
New Innermost Tracking Layer

* Radiation damage ➔ insertion of new silicon pixel layer (and new beam pipe) inside current detector by 2012-2013 to keep tracking/b-tagging
* Requires many new technologies – integrated circuits, detectors, modules, mechanics….. to cope with Phase 1 luminosity improvements
* Maintenance of capability but also step towards SLHC

Inside existing layer
SLHC Upgrade R&D and Design Timescale

* R&D already underway, primarily for new silicon tracker components
* Significant design activity yet to start
* Letter of Intent mid-2009
* Technical Proposal mid-2010
* Technical Design Report mid-2011
  – Actual date depends on sub-detector, 2011 for new tracker
* Installation during long shutdown ~ 2017-2018
* Upgrade timescales of ATLAS, CMS, LHC (and other detectors) need to be aligned during next few years
* Completing the upgrade designs, fabrication and installation within ~ 2011-2017 will be a challenge
SLHC ATLAS Upgrades

* Personal guess is that **ALL** ATLAS subsystems (except the magnets) will require significant upgrades for SLHC.
* Largest upgrade will be new tracker
* Conceptually simple – throw old one away (at end of useful life by ~2017) and build a new one!
* Requires new electronics (more radiation hard, technology advances), detectors (more radiation hard), module concepts (more integrated, cheaper), mechanics + cooling (less material but colder), powering advances (reduce cables)… still world-wide construction
* Region within R <10-15 cm replaceable (radiation damage)
* Overall, upgrades very substantial construction effort
10^{35} and Beyond

* Functioning near the beam axis at 10^{35} will be a big challenge.
* Perhaps the R&D underway and to be done in the next few years will find solutions.
* But worth keeping in mind that 10^{35} may not be the limit.
* R&D aimed at pushing the limits of tracking, calorimetry and other technologies needs to continue even during the construction phase for the SLHC
* R&D will build on LHC, Phase 1 and SLHC experience.
* Long term opportunities
Opportunities and Conclusion

* Involvement now in ongoing R&D for both early (LHC Phase 1) and SLHC ATLAS upgrades
* Many opportunities, will focus on three here
* Tracking upgrades
  – R&D, design and construction for insertion of new pixel layer by 2012-2013. Technological step towards the SLHC.
  – New tracker for the SLHC - requires new everything
* Data acquisition and trigger upgrades
  – Driven by luminosity and physics needs
* Software and computing
  – Inevitable evolution (if not revolution)
  – Physics driven