ATLAS Upgrade Plans post Chamonix

Introduction/summary ATLAS Upgrade
Ideas after Chamonix:
possibilities to adapt ATLAS Upgrade
Strategy Needs

ATLAS Upgrade Goals

- High statistics for SM measurements, e.g. Higgs and other boson couplings
- High statistics to investigate whatever is found at the LHC
  - Some rare SUSY decays, ...
- Increase mass reach in searches for new particles:
  - SUSY, MSSM Higgses, W', Z', ...
- ATLAS wants and pushes to go from LHC 500-700 fb^{-1} to sLHC ~3000 fb^{-1} by 2030

Detector Upgrade Needs

- Current detector works well up to 2 x 10^{34} cm^{-2} s^{-1}
  - Small slow deterioration with instantaneous rate above that in some regions
  - Beyond 3 x 10^{34} cm^{-2} s^{-1} problems are more marked (but gradual):
    - Forward calorimetry
    - Forward muon tracking and triggering
    - Inner tracker
    - Trigger
- Integrated dose limits (~700 fb^{-1}) and other aging effects (not dose related)
- Proposed previously:
  - New B-layer (IBL) end 2014
  - Several other improvements (more details later)
  - New Inner Tracker and possibly major end-cap calorimeter work
    - Big shutdown ~2019 (~18 months)
- How to adapt our plans following new expectations for LHC luminosity evolution?

Major ATLAS Upgrade Needs

- Inner Tracker:
  - If instantaneous L > 3 x 10^{34} cm^{-2} s^{-1}
  - If integrated luminosity > 700 fb^{-1}
  - If too many dead channels (cooling circuit leaks, HV bias, dead chips, ...) (not only radiation damage)
  - We need a new Inner Tracker
- Needs significant R&D and long lead-time to build
- Needs a clear commitment to long term future of LHC now to maintain resources
- End-cap/forward calorimetry:
  - If HEC cold electronics deteriorate with radiation damage
    - Deterioration could start ~700 fb^{-1}, and be serious at 1000 fb^{-1}
  - If instantaneous rate too high
    - (could be fixed by warm miniFCAL, to be studied)
  - We need to open up the end-cap cryostat
- Big job, avoid if possible
- ATLAS expects to need a major shutdown, ~18 months, depending on LHC 2020 or after
- This needs to coincide with CMS and LHC long shutdowns

Chamonix Outcome

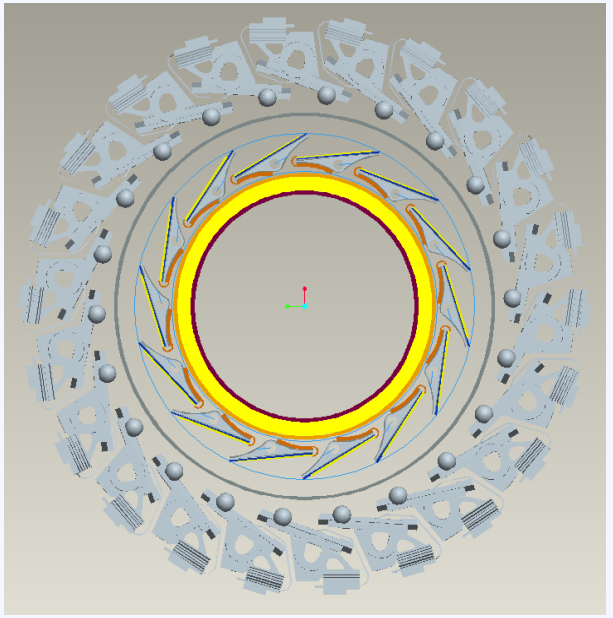
- Slower development of peak and integrated luminosity
- How many shutdowns and when?
- Task force: When can new IRQuads be ready? Report few weeks
- Task force: SPS solutions? Report few months
- Digest all Chamonix information, get experience with LHC
  - Updated long-term strategy and planning, Summer 2010
- ATLAS needs a long-term LHC strategy
  - Major development work needed for several parts of the upgrade; need to maintain momentum, attract resources, keep experience
  - Scheduling: We need something realistic and coherent, erring on optimistic side
    - It is very difficult ever to accelerate a project as complicated as a new inner tracker
  - Needs commitment now to maintain momentum

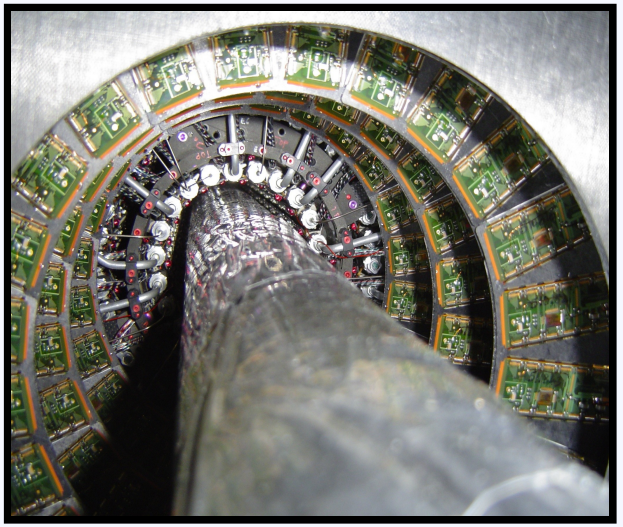
Shutdowns

- Need to optimise the number of shutdowns
  - Realistic estimates of time needed for LHC and injector work
  - Time needed to ramp up new machine back to previous L
  - As few SD as possible, as short as possible, as much in parallel as possible
- Balance getting good data sets early versus shutdowns and re-tuning machine to get high luminosity
- Experiments and LHC synchronised

Some ATLAS (possible) Projects unchanged:

- Extra pixel layer (IBL) Project
  - Improves ATLAS vertexing, even at low L (smaller r, less X0)
  - Acts as back-up to current B-layer if it develops many dead channels (not only radiation damage)
  - Continue to make ready-for-installation end 2014
    - Install first long SD (~8 months)
  - Project is advancing well with a good organisation
    - TDR draft being reviewed by small number of experts; iMoU in preparation
- Proposals:
  - New hardware track finder, FTK, to supply L2 with good seeds
    - TP being internally reviewed to study benefit to ATLAS
  - Proposal for ATLAS Forward Physics, AFP, being considered:
    - Continue to study technical solutions
    - Can benefit from longer run at lower luminosity



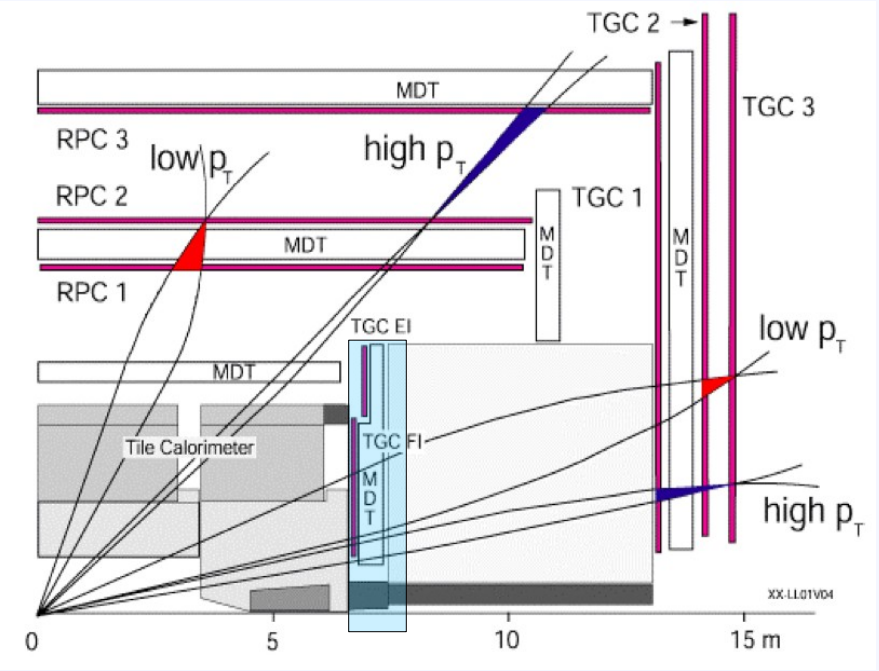


Adapting ATLAS Upgrade Plans to new LHC Schedule

- To compensate for slower than anticipated rise in L, we investigate bringing several projects into Phase-I Upgrade to improve ATLAS performance, even at low luminosity
  - Extract as much as possible from the data
- Doing as much as possible outside a major sLHC shutdown reduces time pressure and helps us keep to the goal of 18 months
- We envisage organising these like the IBL project: self-contained projects with
  - Approval stage
  - TDR and MoU
  - Management structure

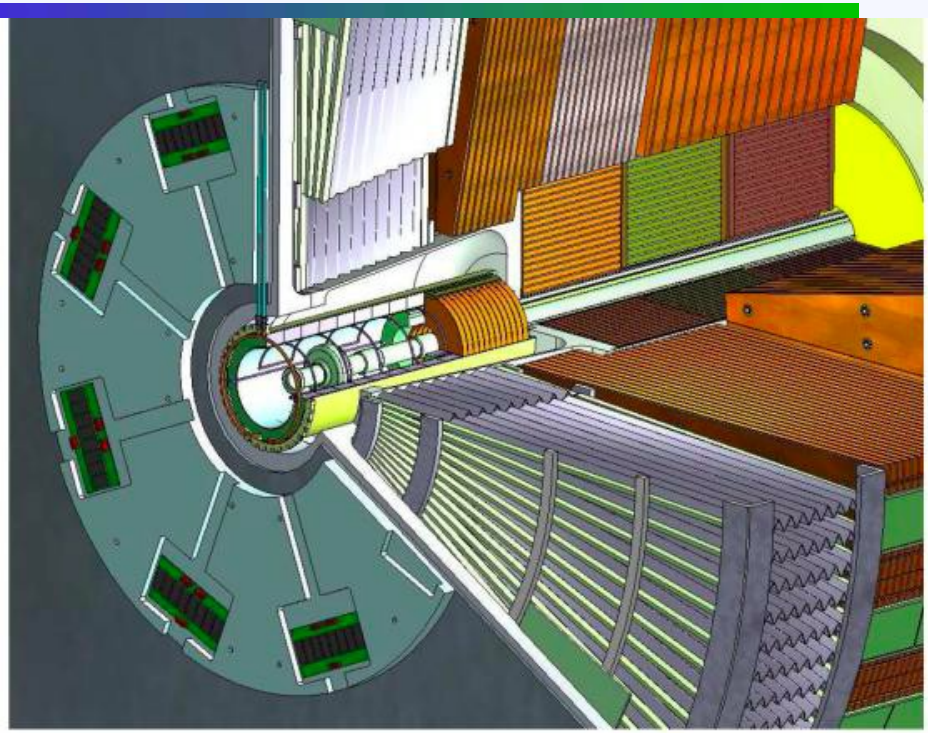
Projects to consider before Phase-II Upgrade

- Beampipes
  - Al or Be everywhere (in 2012 SD)
- Trigger:
  - Combined trigger objects (L1Muon and L1Calo)
  - Full granularity readout of calorimeters
    - Can it be done inside 3.2 μs? Main benefit comes with new inner tracker, 6.4 or 9.6 μs latency
  - Upgraded HLT farms
- Muon:
  - New small wheels, recover staged CSCs with new detector technologies
  - Some new electronics (mezzanine boards)
  - Consider bringing MDT into trigger
  - Improved shielding



Before Phase-II (cont)

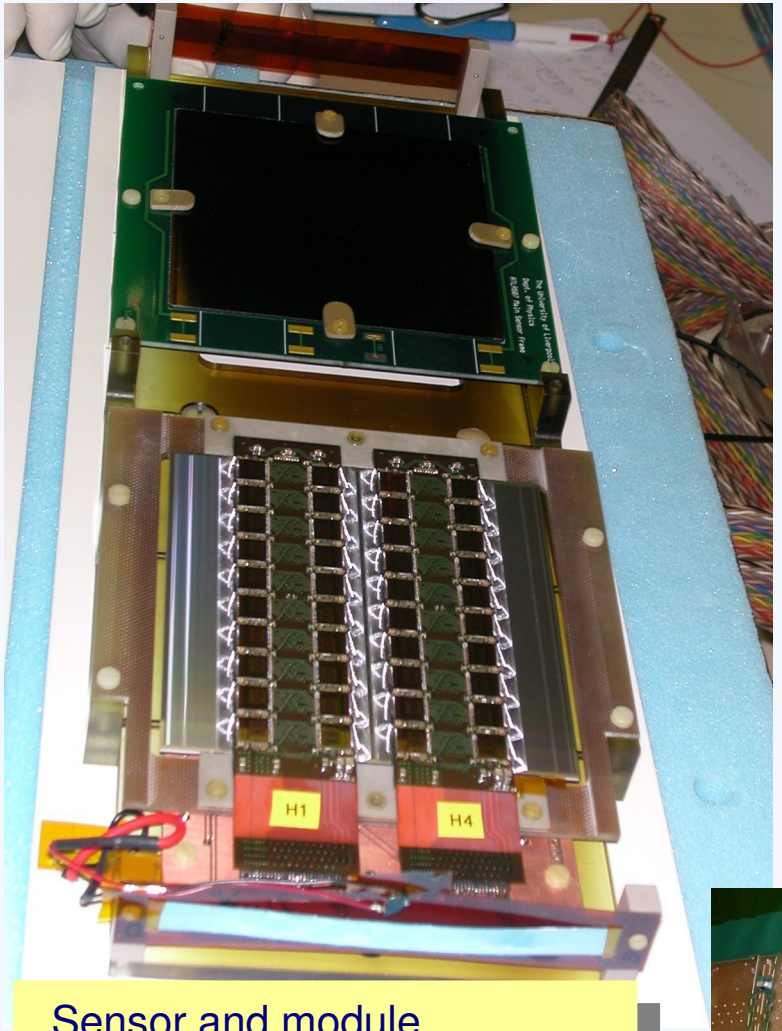
- Calorimeters:
  - New warm miniFCAL
    - Does it improve low-L performance? Early insertion reduces pressure on long SD
    - Help understand necessity of opening up end-cap cryostats for sLHC
- New shielding e.g. cavern walls
- New TAS and forward shielding to suit new IRQuads
- Inner Tracker
  - Investigate benefits and feasibility of extra Si discs in place of staged TRT C-wheels
  - Investigate replacing current pixel before sLHC shutdown
  - Can we do modular ID sections and avoid a long shut-down for sLHC?
  - Fast gasses for TRT



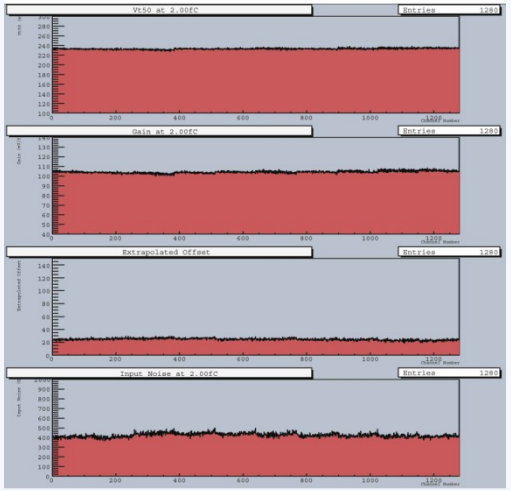
Progress: Cu/diamond miniFCAL studied in Athena/Geant

Power reduction in FCAL ~50%

ID Progress

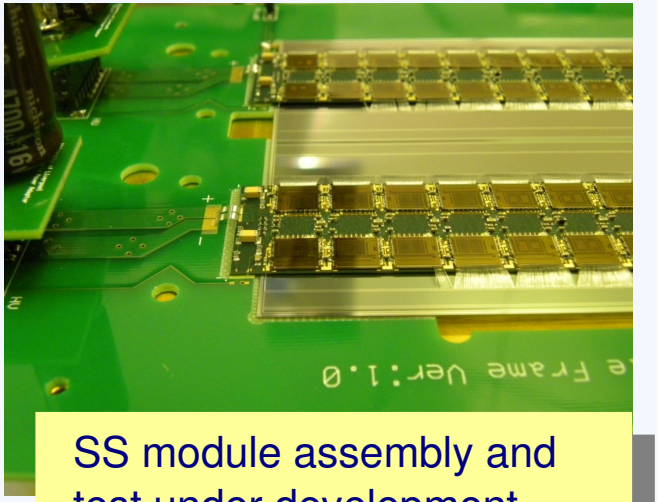


Sensor and module irradiation programme



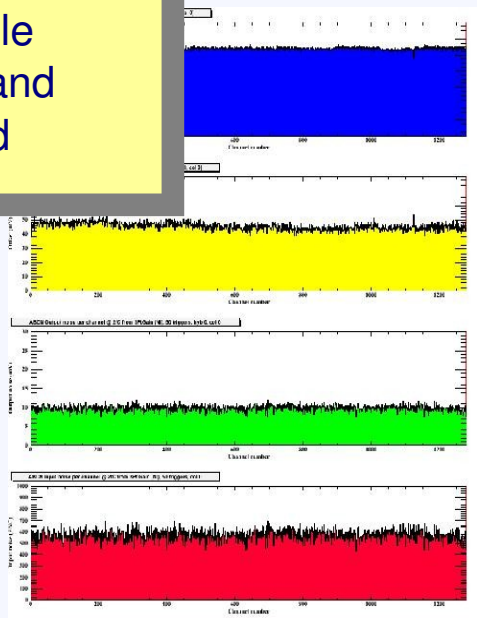
Hybrid development well advanced

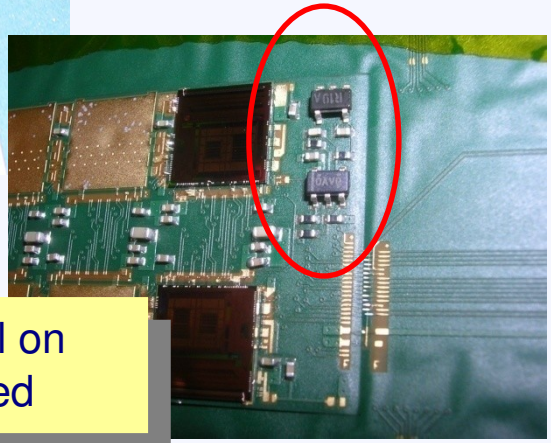
ABCNext 250 nm chips excellent yield and performance



SS module assembly and test under development

Double-sided module built and tested





Serial power control on hybrid; DC-DC tested

Extend R&D

- Benefit from more time for an Inner Tracker
  - Extend R&D phase to improve basic building blocks
  - Material reduction and cost reduction
  - Multiplexing:
    - Serial and/or DC-DC powering
    - Optical readout
    - DCS, HV, cooling...
  - Pixel bump-bonding, thinning, ...
  - New detectors – can they reliably bring cost and material savings?
  - Track trigger at L1 ideas
  - ...

LoI Plans

- ATLAS has been preparing an LoI for the LHCC proposing the Phase-II/sLHC Upgrade
- We will discuss how to modify the goals, content and schedule next week
- e.g. move several projects out of the LoI and into separate TDRs, concentrating LoI more on ID and LAr end-caps; submission at appropriate time.
- We can adjust our overall planning once the LHC schedule is better known

Conclusions

- ATLAS Upgrade plans and R&D continue to make good progress
- ATLAS aims for high integrated L ramping p at an optimised rate and leading to ~3000 fb^{-1} by ~2030
  - Achieved by a plan that optimises early integrated luminosity and long range goals
  - Following Chamonix, we look forward to an updated planning from CERN in summer 2010
- To maximise the use of the slower than previously expected LHC intensity, we will upgrade some elements in Phase-I
- For a timely Upgrade project to achieve our physics goals, we need
  - CERN statement goal ~3000 fb^{-1} around ~2030
  - A realistic (if slightly optimistic) and coherent LHC schedule with
    - Peak L, integrated L, shutdowns (when, how long)
    - Taking into account the needs of the experiments
  - These 2 elements are needed for sound technical planning and maintaining R&D Momentum
- We look forward to working with the machine and other experiments to arrive at an optimised plan