ATLAS Shutdown Needs Until 2020

ATLAS plans Phase-0 (2012)

ATLAS Needs Phase-I, ~2016

ATLAS Plans Phase-II (2020)

ATLAS Upgrades

- 2012: ATLAS Phase-0
  - We will take advantage of the 2012 shutdown to carry out repairs, de-staging some detectors, some upgrades such as new aluminium beam pipes in place of stainless steel ones, and consolidate spares and back-ups to maintain reliability
  - Also, some preparation for IBL (services installation)
- ~2016: ATLAS Phase-I
  - Install upgrades needed to run until 2020, 2e34.
- 2020: ATLAS Phase-II to cope with 5e34 and 3000 fb^{-1}:
  - New Inner Tracker
  - New calorimeter readout (if not done before)
  - Warm FCAL or open the endcap-cryostats for new FCAL and HEC cold electronics
  - Muons: New chambers in various places, trigger elements, ...
  - New trigger: Improvements to trigger beyond phase-I

Timing of Phase-I Shutdown

- ATLAS seeks a single long-shutdown for Phase-I
  - Around 2016
  - Needed to cope with 2e34 before 2020 SD
    - Especially L1 trigger which has been designed for 1e34
    - New B-layer “IBL” to restore performance loss due to inefficiencies at 2e34 and possible loss of significant fraction of channels (VCSELs, cooling leaks, ...)
  - In favour of only one shutdown between 2012 and 2020 to maximise running time
  - Timing chosen to allow a substantial physics run at 14 TeV after 2012 improvements, and for preparation of all necessary detector upgrades for Phase-1 maximum luminosity
  - In the shadow of the necessary upgrades, we may bring forward some Phase-II work to help keep the Phase-II shutdown short (~18 months), especially where these will enhance performance also at lower luminosities

ATLAS Upgrades for Phase-I

- Insertable B-layer (IBL)
  - Will be prepared for insertion in 2015 **in case of problems with current pixel detector** (VCSELs, cooling circuits, unforeseen…)
  - But it is not needed until later
    - (Lower luminosity profile of LHC -> less radiation damage)
  - Needs large opening: 3 months open-up, 3 months install, 3 months close up, about 9 months shutdown
- Simple topological trigger
  - Various schemes can be ready by 2015
  - Limited by calorimeter maximum latency of ~2.5 us
  - The ATLAS trigger was designed for nominal
    - Current full-simulation results coming in suggest there is room for improvement at nominal
    - Today no knowledge if the things we can do in 2015 would be sufficient for 2 x nominal – may well not be
- Other possibilites (next slide) not ready until early 2017
  - Hence ATLAS prefers a SD starting in second half of 2016 and lasting into 2017

Further Possibilities to improve L1 trigger to cope with 2e34

- Muon:
  - New forward trigger chambers incorporating precision measurement
    - Better trigger resolution for sharper L1
    - Creates more space for shielding
    - Best to replace entire small wheels: these will be brought to surface anyway for IBL installation
  - Some new chambers in barrel/endcap transition region (low integral B.dl region) for sharper trigger
  - MDT tracking brought into trigger (for accessible 50 % of coverage)
    - Send BC of hit arrivals (25 ns drift time resolution → ~< 1 mm resolution for sharper trigger)
    - Studies say it can be done in 3 us (but not 2.5)
- Calorimeter readout
  - Full digital readout of calorimeters; all data to counting room
    - Better granularity for trigger allowing better PID
    - Latency can go from 2.5 us to much bigger (once new IT allows it)
      - Allows MDT trigger to be brought in
    - Need to check this scheme can work inside L1 latency of 3.2 us imposed by current SCT
- All these take time to develop and cannot be ready for installation in 2015

Summary

- ATLAS preferred shutdowns:
  - Phase-0, 2012:
    - We will take advantage of the long shutdown for consolidation, repairs, and preparation for IBL
  - Phase-I:
    - One shutdown
    - Start in second half of 2016, ~9 months:
      - IBL, new L1 trigger elements, new calo readout, new muon small wheels, MDT in L1 trigger, ...
  - Phase-II, 2020:
    - We need a long shutdown, ~18 months, to install new inner tracker, muon chambers, forward calorimeter work, and whatever is not done in Phase-I
- A shutdown in 2015 will only allow a limited ATLAS Upgrade
  - IBL and a simple topological trigger
  - This will limit ATLAS L1 performance and hence data quality