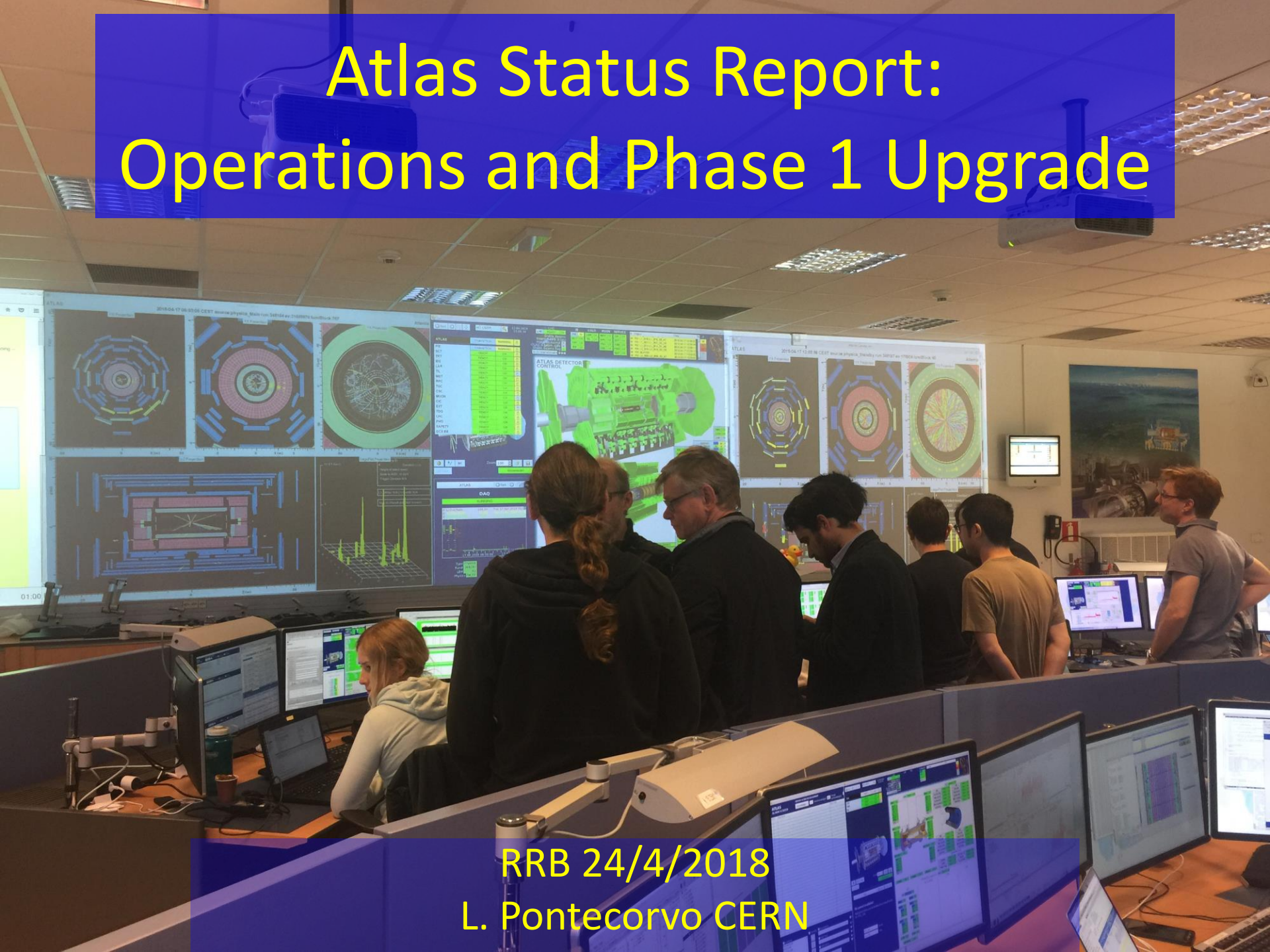
Atlas Status Report: Operations and Phase 1 Upgrade

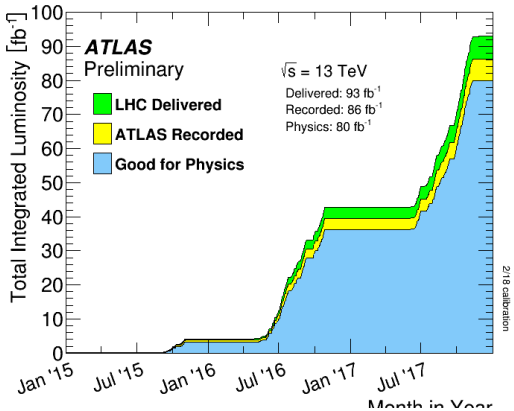


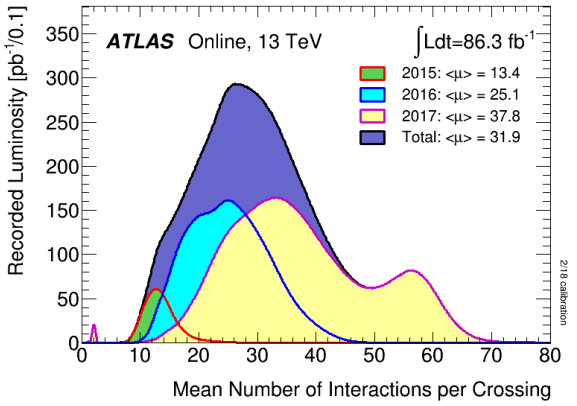
RRB 24/4/2018

L. Pontecorvo CERN

2017 Data Taking

- Excellent performance of the LHC
  - more than 50 fb^{-1} delivered to experiments
- ATLAS data recording very efficient (93.3%) despite difficult conditions due to high pile up
  - LHC filling scheme 8b4e not optimal for pile up
  - ATLAS levelled luminosity at 1.5 10^{34} cm^{-2} s^{-1} at a pile up of ~ 58
- Data quality very high throughout the year (93.6%)





ATLAS pp 25ns run: June 5-November 10 2017

Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
100	99.9	99.3	99.5	99.4	99.9	97.8	99.9	100	100	99.2

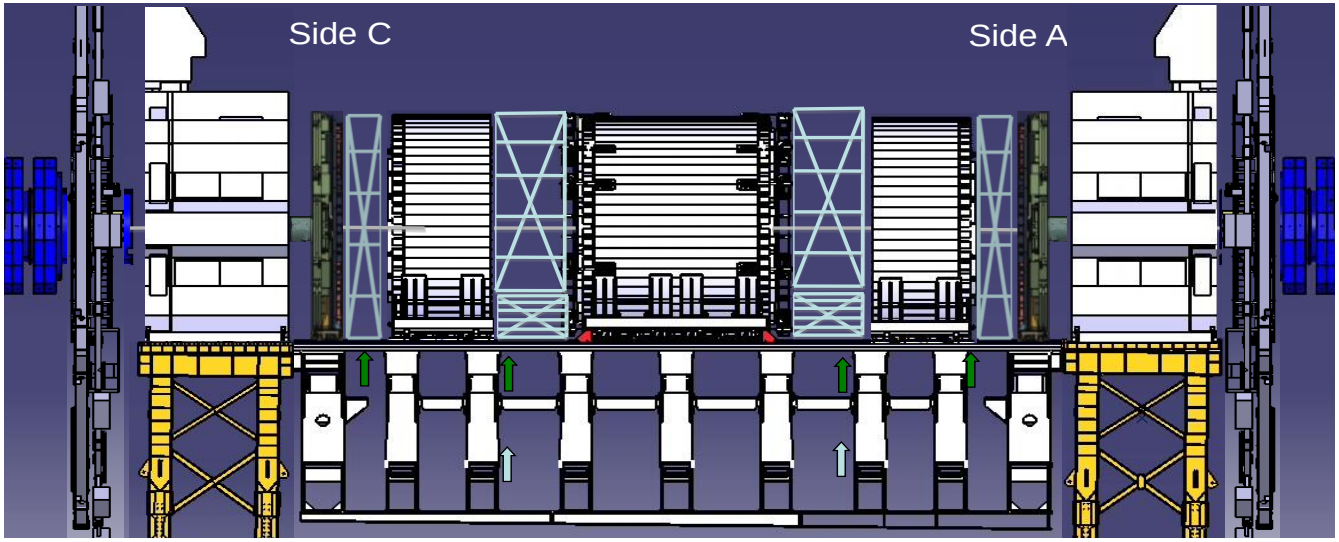
Good for physics: 93.6% (43.8 fb^{-1})

Luminosity weighted relative detector uptime and good data quality efficiencies (in %) during stable beam in pp collisions with 25ns bunch spacing at √s=13 TeV between June 5 – November 10 2017, corresponding to a delivered integrated luminosity of 50.4 fb^{-1} and a recorded integrated luminosity of 46.8 fb^{-1}. The toroid magnet was off for some runs, leading to a loss of 0.5 fb^{-1}. Analyses that don't require the toroid magnet can use these data.

Year End Technical Stop Activities

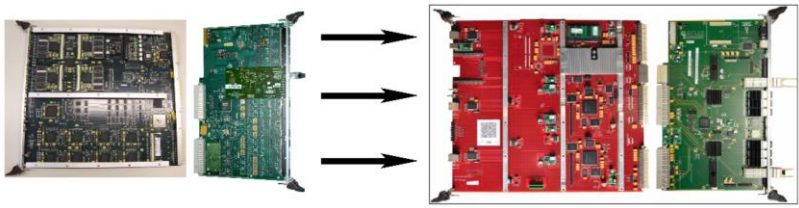
Main YETS Activities

- Access granted to all systems before Christmas (only 3 weeks to be fully open)
  - Maintenance of all infrastructures taking into account specific detector's needs
    - Cooling maintanance during Christmas closure: many thanks to CERN Cooling and Ventilation Group
  - Standard maintenance on all systems including magnets
  - Specific activities in the next slides
  - 39 VIP Visits during YETS

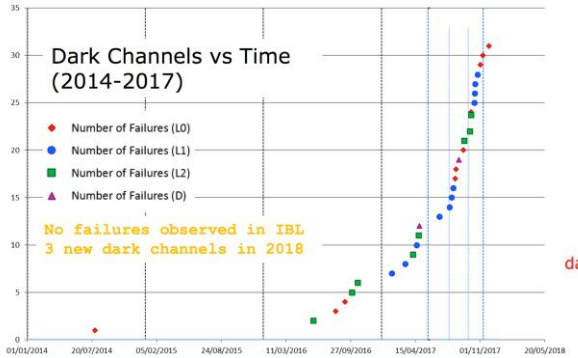


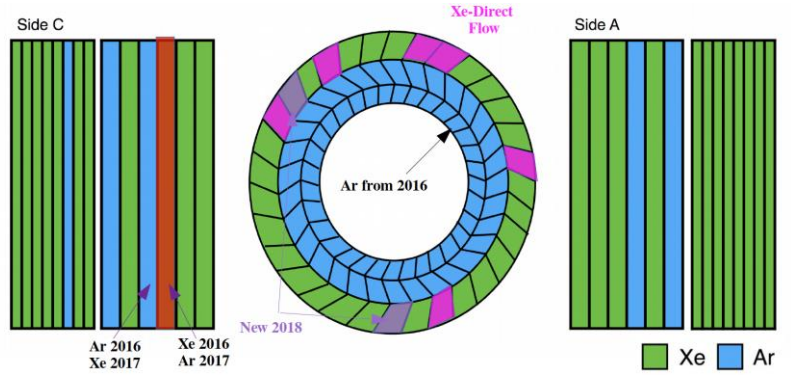
Highlights on Maintenance and consolidations

- Pixel:
  - Upgrade of the readout system on B-layer and disks
    - Improve bandwidth and maintainability
  - Opto-board replacement →~30 Pixel modules recovered
  - Optoboard lifetime is a point of concern:
    - Studying how to solve the problem during LS2



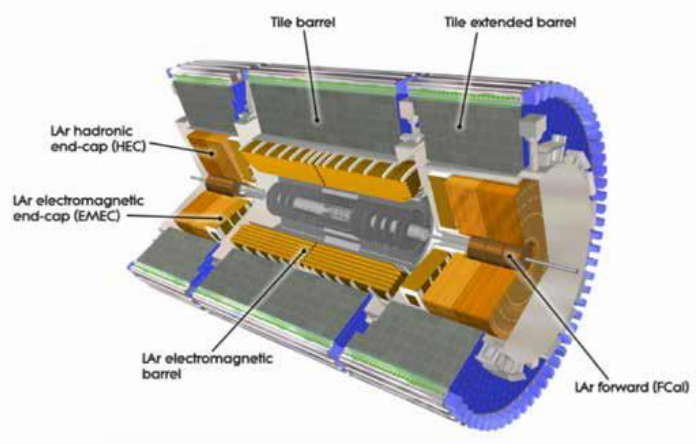
- Transition Radiation Tracker:
  - Gas leaks increasing as expected
    - Maintain the same configuration through the whole Run 2.
    - Xe needed for the 2018 operations already procured
    - Reduced O_2 in the gas mixture to reduce the formation of Ozone at high luminosity
  - Found a leak in the front-end electronics cooling system
    - Detailed search located leak (8 l/Day) inside ID volume
    - Optimization of the cooling distribution minimised leak to 0,7 l/Day
    - Further studies/repairs will be done in LS2

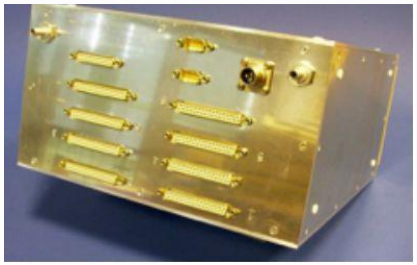


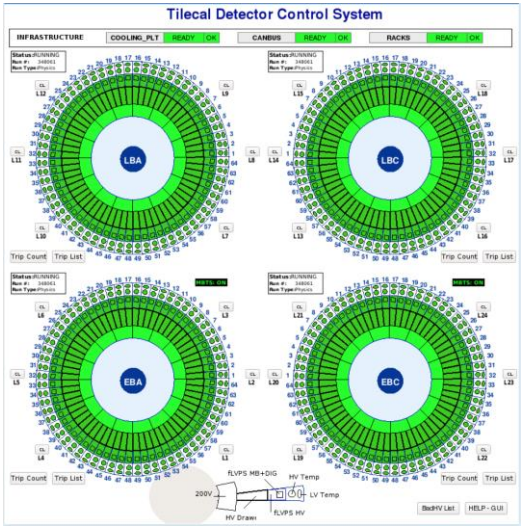


Highlights on Maintenance and consolidations

- Liquid Argon Calorimeter:
  - Replacement of a front end cooling manifold on the Barrel Liquid Argon
  - Refurbishment of all 8 Low Voltage power supply units for the Liquid Argon Hadronic End Cap
- Tile:
  - Repair two modules that failed at the beginning of the 2017 data taking
  - repairs of all minor issues on other ~15 modules
  - Now 100% operational
  - Installation of additional readout fibers for the Minimum Bias Trigger Scintillator system

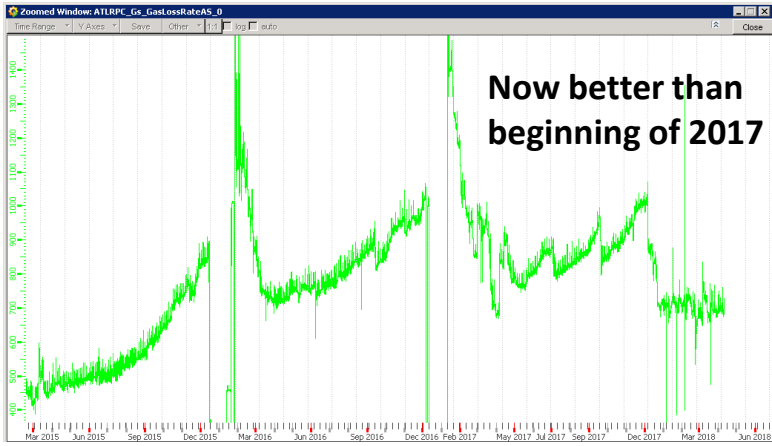




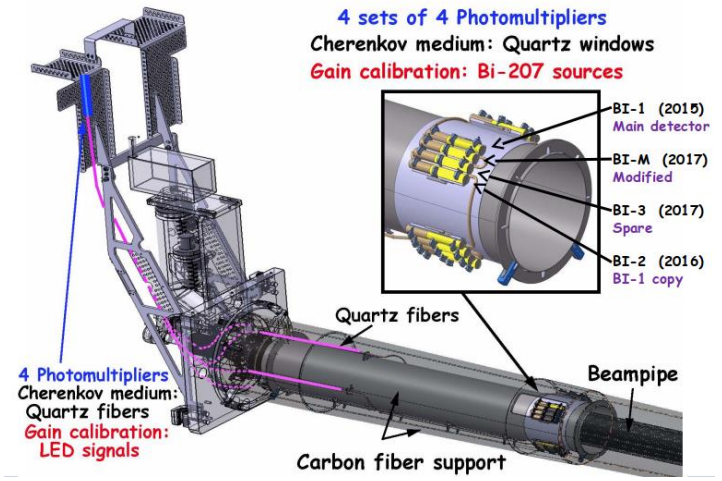


Highlights on Maintenance and consolidations

- Muons:
  - Repair of two CSC chambers showing HV trips + mods in gas system to allow humidification of the gas mixture
  - Standard maintenance for MDT and TGC
  - Large campaign of leak search and repair on the RPC system
    - Optimization of the operation of the Gas System, no sudden increase of leaks observed during the shut down
    - Focus on optimization of the trigger coverage

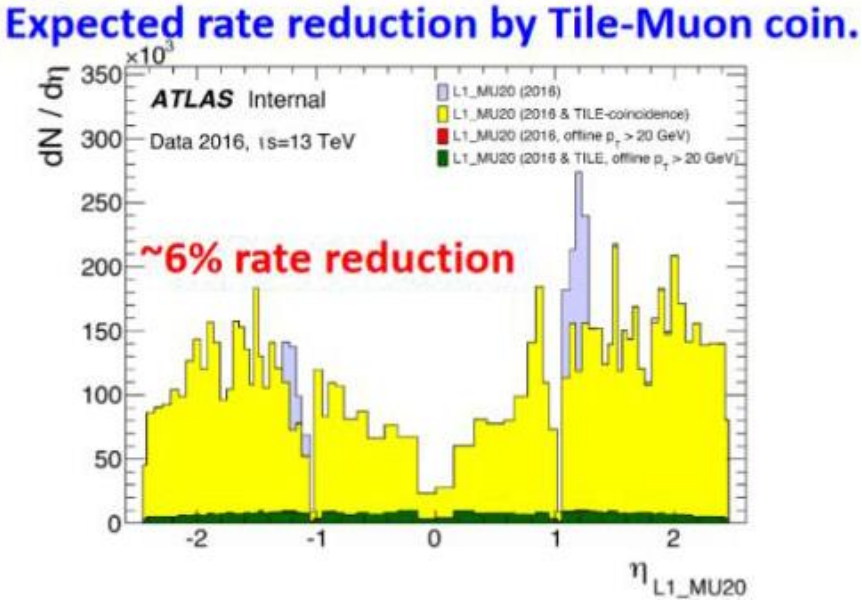


- Forward Detectors:
  - Lucid: replacement of 7 Photomultipliers failing due to ageing
  - ALFA: Ready for beam, large irradiation studies showed that ALFA electronics is more radiation hard than expected
  - ZDC: refurbishment of the quarz radiator rods before the 2018 Run
  - AFP: Preparation of 12 new silicon planes to serve in the remaining of Run 2 and Run 3, studies on the low efficiency of the TOF system ongoing



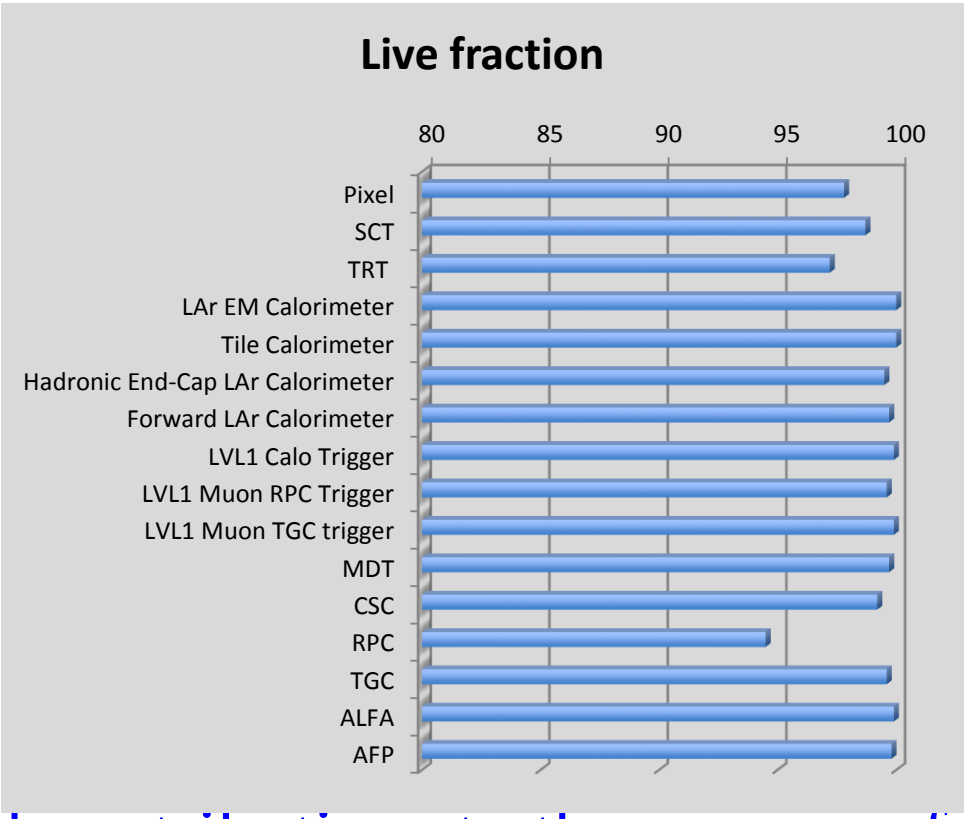
TDAQ

- Rolling replacement of the HLT farm: 20 racks have been installed
- Additional ROS and 8 readout links installed for Pixel
- Numerous firmware updates on all systems
- New feature in 2018 running : Tile-TGC Coincidence
  - **Aiming to reduce the fake rate in L1 endcap muon trigger** at $1.0<|\eta|<1.3$
  - Fully validated at the end of 2017 pp Run : no efficiency reduction, relevant fake rate reduction



Expected running conditions in 2018

- All systems consolidated their operational channel fractions
- Pile up and rate limitations have been improved:
  - For a standard LHC filling scheme ATLAS can take data at 2 10^{34} cm^{-2} s^{-1} at a Level 1 trigger rate of 95 KHz and pile up of 60



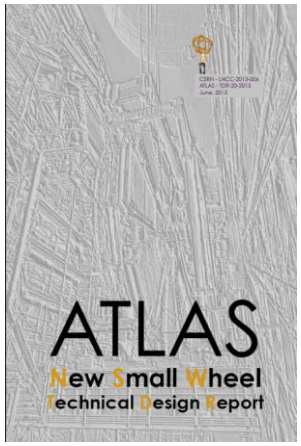
Detector experts made crucial contributions to the success of the YETS activities and to enhance the ATLAS capability for the end of RUN 2

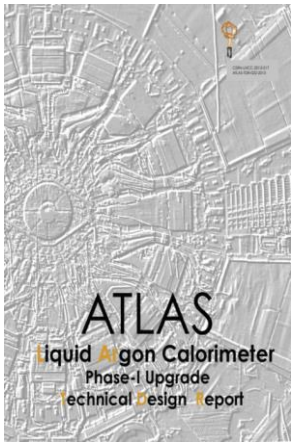
The success of the experiment in the next years is dependent on our ability to keep and enlarge this expertise

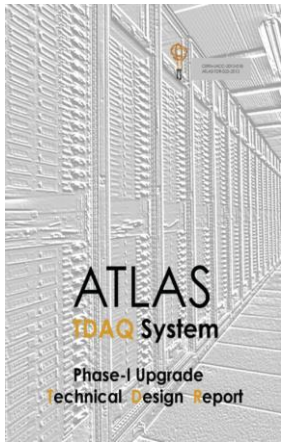
ATLAS is Closed and is taking Data

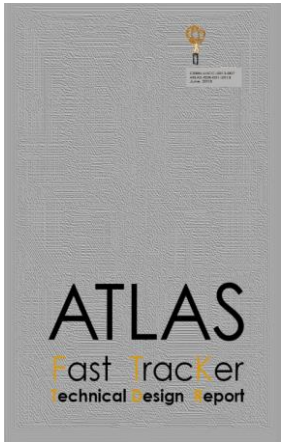
Phase I upgrade

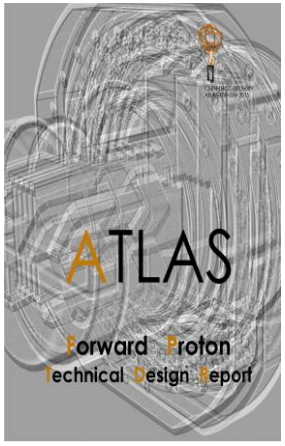
- The ATLAS Phase I upgrade consists of five main projects:
  - The New Small Wheel (NSW)
    - Improve end cap muon trigger sharpness and detector rate capability
  - The LAr Upgrade
    - Control electron and photon trigger rates through use of shower shapes at trigger level
  - TDAQ phase I upgrade
    - Improve L1 trigger hardware for calorimeters and muons, and upgrade DAQ hardware.
  - FastTracKer (FTK)
    - Provide Fast Tracking information at the input of HLT
  - AFP (ATLAS Forward Proton)
    - Produce a new physics object for ATLAS physics: 2 forward protons











MOUs done in 2014

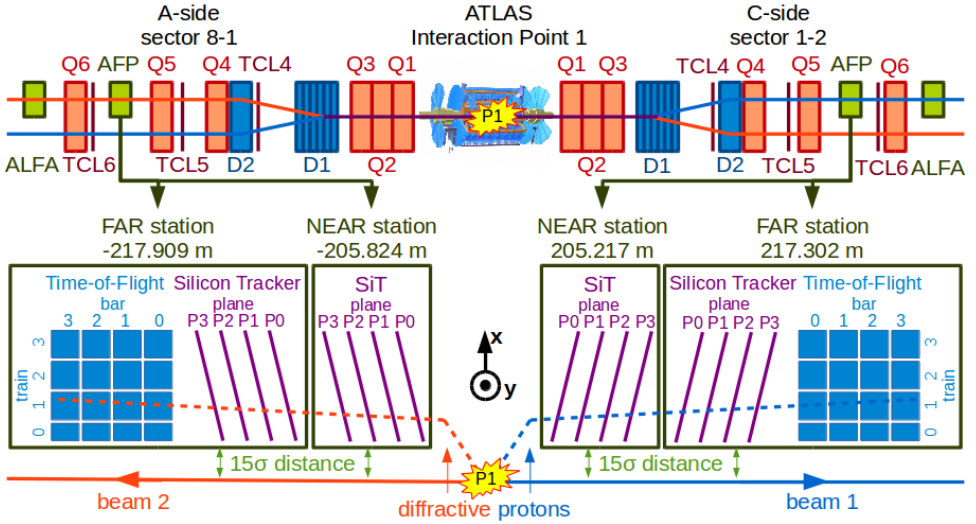
AFP status in 2017

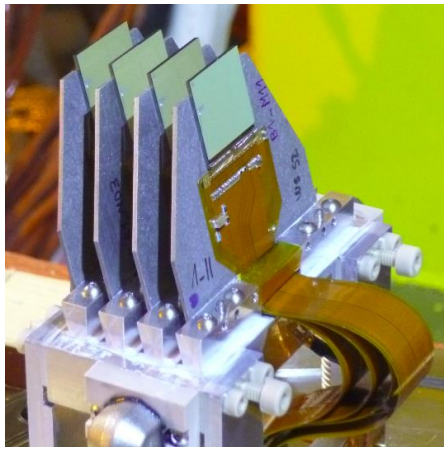
AFP fully integrated in ATLAS data taking

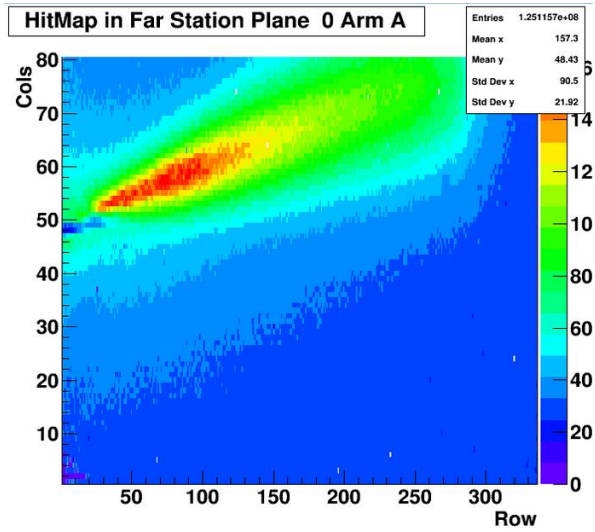
- Silicon detectors successfully operated (trigger, 29.6 fb-1 data taken)
- Now focus on the calibration of the silicon tracker to provide the momentum of tagged protons
- Time-of-Flight system showed low efficiency
- Currently under investigation: radiation damage?, rate saturation?

Plans for 2018

- Operate the silicon Tracker in all ATLAS runs
- Continue the commissioning of the TOF system:
- Aim to re-install TOF system as soon as possible





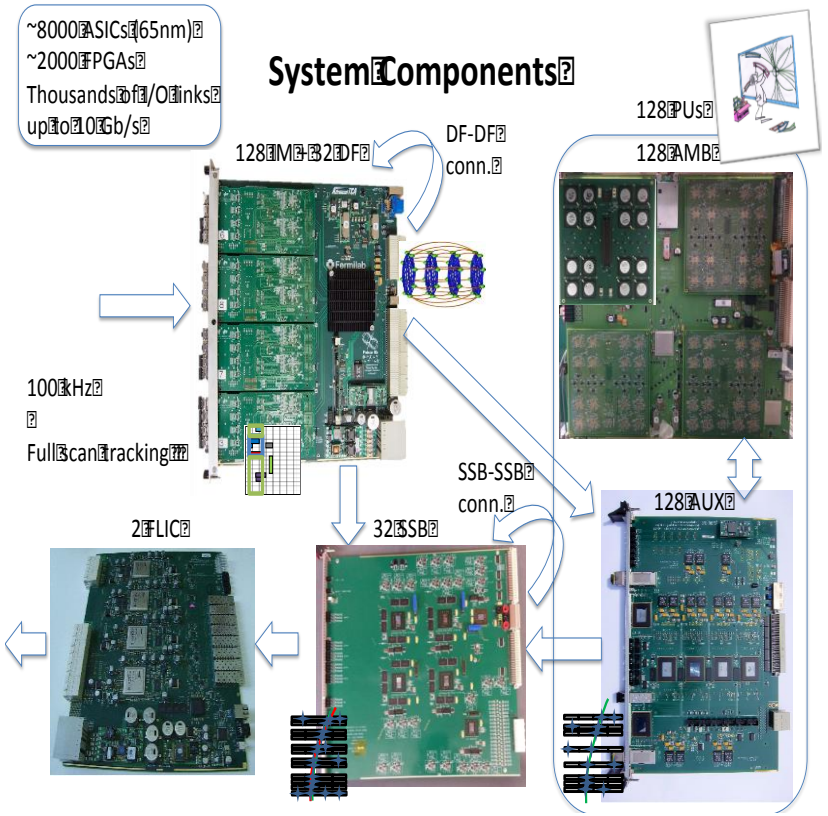


FTK: Hardware Track Finder

- Fast track information based on Pixel and SCT data
  → input to Higher Level Triggers (HLT)

- Based on Associative Memory system (custom ASIC AM06)
  → Track candidates based on predefined patterns
  → Re-fit in FPGA-based system → HLT

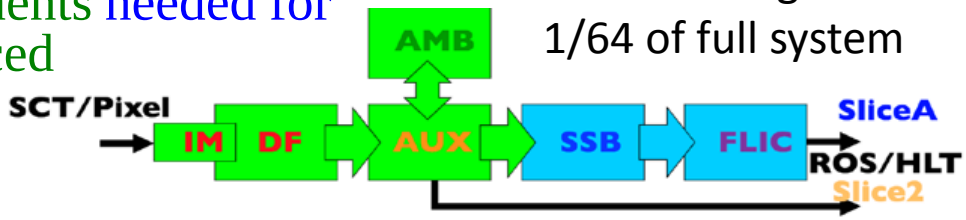
Module	Name
IM	Input Mezzanine
DF	Data Formatter
AM	Associative Memory
AMB	AM Board
LAMB	Little AMB (Mezzanine)
SSB	Second Stage Board
FLIC	FTK L2 Interface Card

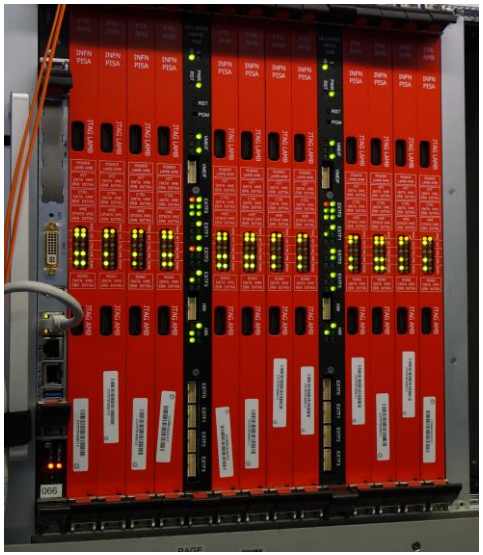


FTK Status

- Currently still in installation and commissioning phase:
  - By end of 2017 all hardware components needed for FTK operation in Run 2 were produced
  - Commissioning with two Slices
    - Slice A: Full chain
    - Slice 2: Branch off before SSB board (8 layer tracks)
      - Slice 2 exercised with beam at the end of 2017,
      - Both exercised with cosmics at the end of the YETS
    - The FTK community presented full commissioning program aimed at having 50% of the full system ready by October
      - Main points: extending the system and understanding the Second Stage Board (SSB) used for track extrapolation ambiguity resolution and final fit
  - Some problems have been uncovered with the SSB board, likely requiring a fix or a re-design (more tests needed)
  - The FTK project has the full attention of the ATLAS management

Slice Coverage:
1/64 of full system





New Small Wheel

LHCC (February 2018):

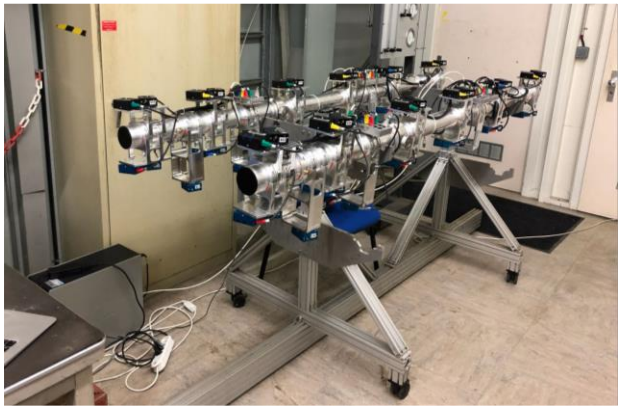
"For the NSW project, significant progress has been reported in many areas, however, the project remains a cause of serious concern."

"The LHCC encourages contingency planning for cases in which full assembly of one or both NSWs might not be possible for their installation in LS2"

Mechanics and integration:

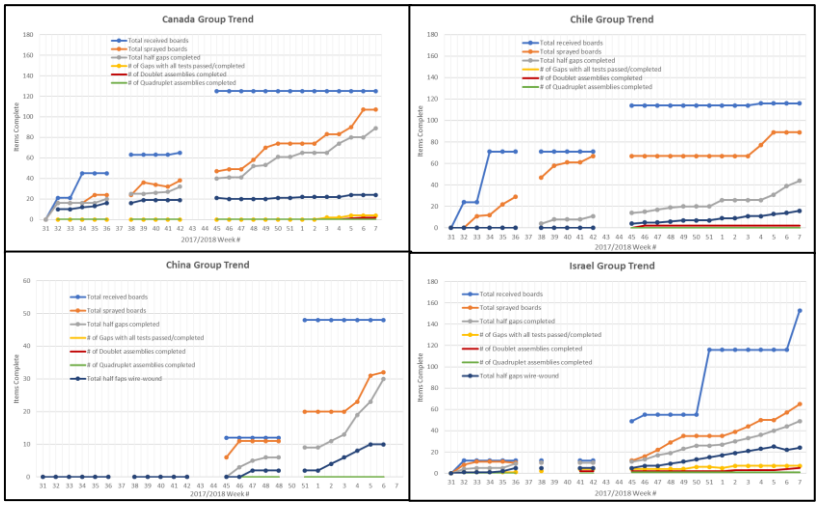
Excellent progress has been made on all fronts:

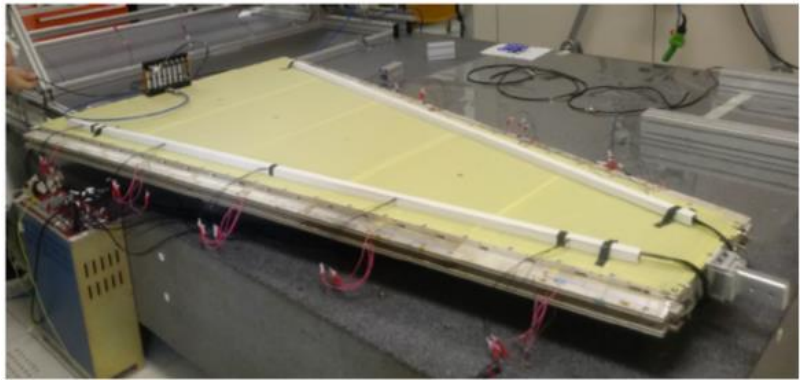
- New JDs (shieldings disks) have been assembled, now services are being mounted
- The Hubs are under construction in the integration area
- All transport tooling have been designed (FDR end of April)
- Alignment bars received for the Small sectors of side A and part of side C, rest coming soon
- First spacer frames for Micromegas received, test of integration procedures done
- sTGC wedge assembly week succesful, close to ready for reception of first quadruplets and first wedge assembly in June



NSW

- Chamber construction:
  - sTGC:
    - Cathode board needs covered combining the two production lines
    - Four out of five chamber production sites are operational
    - First Batch of boards shipped to fifth production site, now also last production site is set for production
  - MicroMegas:
    - PCB production rate OK from one vendor but still low from the other one
    - All Sites produced Module 1 before the end of 2017
    - However HV problems were observed, mostly due to insufficient cleaning
    - Quadruplet production put on hold
    - Task force including CERN EP-DT experts defined the right cleaning sequence now implemented in all sites with good results
    - Still on one of the first production modules the observed HV operational margin is very limited

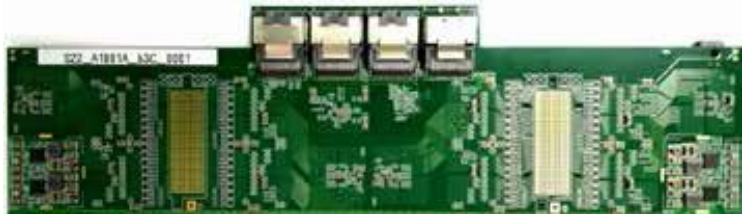




Start of series production kept on hold to allow further investigations

NSW

- Electronics:
  - All four of the NSW ASICs (VMM, ART, TDS and ROC) underwent their FDR in Sep 17 (with significant delays)
  - Pre-production versions have been fabricated & packaged Validation of VMM3a and ROC1/a ongoing
  - PRR for VMM3a scheduled for beginning of May
  - Prototype versions of the sTGC and MM front-end PCBs demonstrated to work on full-size pre-series chambers
  - New version of MM front-end PCB shows acceptable noise performance;
  - In addition, a production order of 25% of the ASIC was placed in Oct 17 to speed up the integration

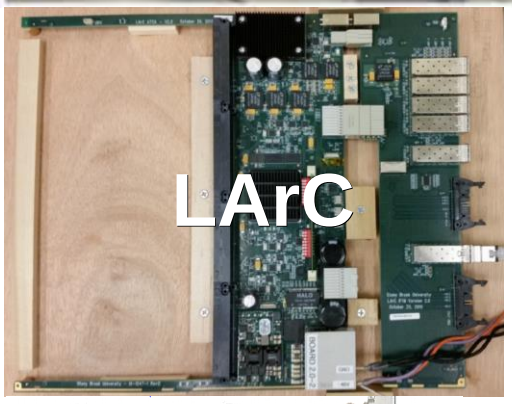


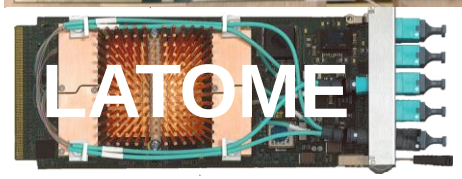
If new ASICs and updated FEBs work as expected, and series production gets under way according to schedule, electronics will rapidly be able to move off the critical path

LAr

Project On Track, most of the components passed the PRRs, risks are reducing:

- Layer-summing boards and baseplanes (on-detector) PRR passed in Oct 16 / June 17
  - Baseplane assembly expected to be completed in Sep 18
- ASICs
  - 12 bit ADC: production engineering run subm. in Oct 17, back, currently being packaged
  - Serializer ASIC produced, packaging in progress:
  - New trigger digitizer board (LTDB) (on-detector)
  - FDR passed in Sep 17 pre-production run
  - Two pre-production boards fully tested, installed in ATLAS for use by demonstrator project; PRR scheduled for May
  - LATOME mezzanine cards and carrier board (off-detector)
  - Successful system test at CERN (pre-production), firmware operational, PRR passed in March 18

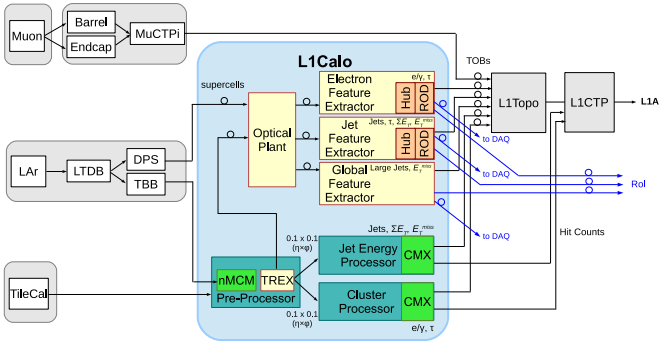


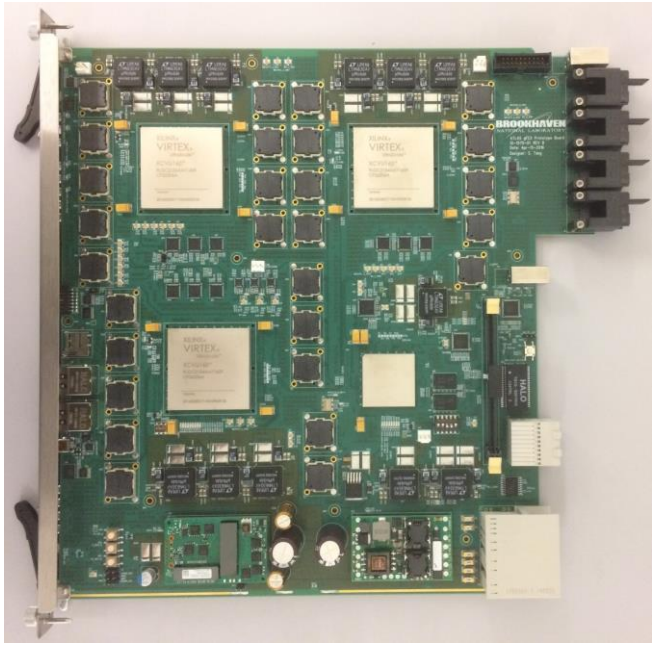


TDAQ

Biggest challenge are the Feature Extractor (FEXes)

- eFEX: prototypes successfully tested, incl. system test, FDR successfully completed in Dec 17
- jFEX: extensive testing of final prototype started in Nov 17; excellent progress incl. firmware, FDR scheduled for May
- gFEX: several full-scale prototypes, upgrading FPGAs, PRR completed in Dec 17,
  - In production, first board in hand





Other parts of the system progressing well (FELIX, FOX, ROD, HUB, muon SL, MuCTPI...)

Overall: despite some delays, all PRRs expected to be completed in 2018, consistent with LS2 installation schedule

Conclusions

- ATLAS is taking data from the start of 2018 Run
- ATLAS in excellent conditions thanks to the large maintenance activity on all detectors during YETS
- Phase I Upgrade projects generally in good shape but NSW Project remains on the critical path to succeed the installation in LS2:
  - Special attention is given from the ATLAS and NSW management to the NSW project to succeed in the installation of the New Small Wheels in LS2

THANKS FOR YOUR SUPPORT