ATLAS Experiment Upgrade

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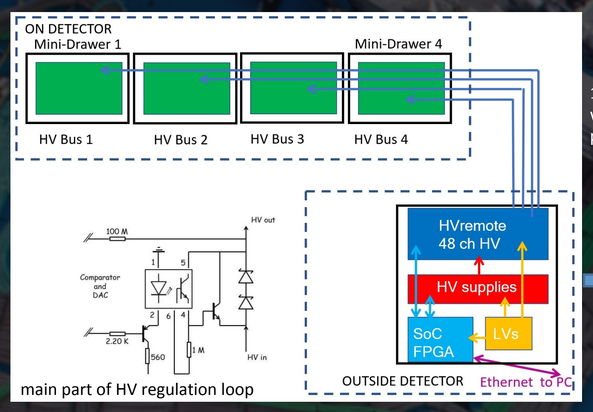
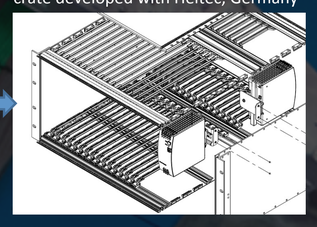
Tilecal High Voltage System Upgrade

- Radiation ageing and obsolescence of components requires a new Tilecal HV distribution system for operation at the HL-LHC
- Profit from change to move HV regulation to USA15, far from detector: improve reliability and ease accessibility and maintenance
- Provide 10 000 voltages of [-470,-830] or [-590,-950] V



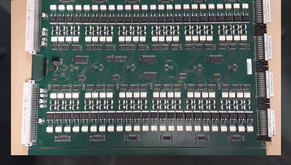
100m long cables with 12, 32 or 48 pairs of wires

crate developed with Heitec, Germany



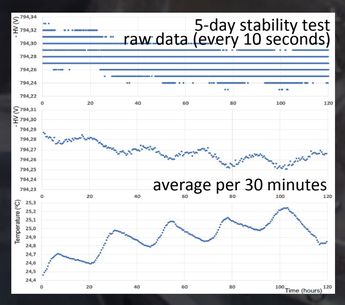
Reviews:

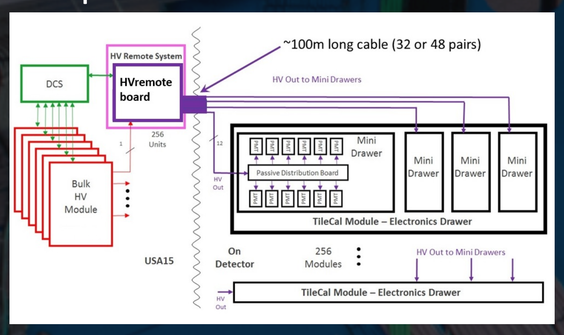
- HVbus,HVremote and cables PDRs passed in June with recommendations
- HVsupplies PDR expected January 2020



Challenges and status

- Certification of long cables from Portuguese industry: fire, noise and connectors breakdown
- Achieve needed control&monitoring performance
- Development of the FPGA adaptation board
- Testing new 48-channel HVremote prototype
- Next: vertical slice test with all HV components in April-June 2020



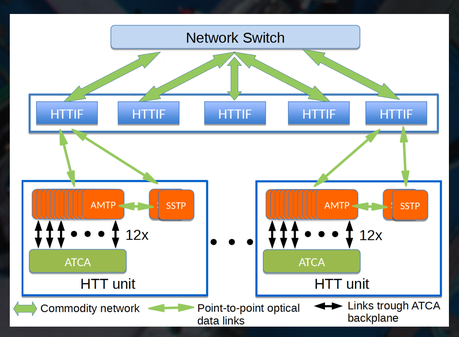


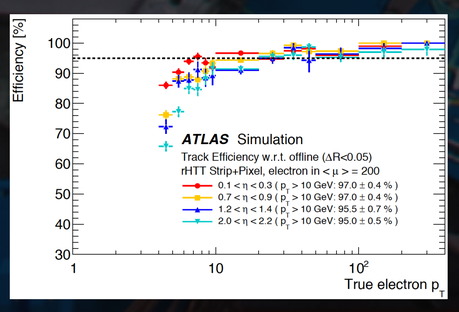
Specs and parameters:

- High Voltage < 950 V
- Average applied HV so far ≈750 V
- Individual channel current < 400 μA
- HV stability < 0.5 V rms
- Setting/reading precision 0.25 V

Hardware Tracking for the Trigger (HTT)

- Hardware tracking co-processor for the trigger based on custom Associative Memory ASIC: matches hit groups to predefined patterns
- Crucial to: reject low-p_T leptons, identify vertex, jet and MET resolution
- Portugal responsible for production of RTM communications module
- Will contribute to:
  - Prototyping and testing of boards – ATCA testing station will be purchased and installed at LIP and person power allocated
  - Development of HTT DCS – profiting from Tilecal and AFP experience
  - Development of HTT fast simulation and performance estimates





Status and schedule

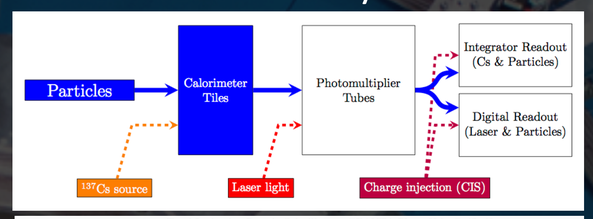
- PDRs for initial prototypes in June 2019
- System Specification Review passed July
- Demonstrators & slice testing 2020/21
- Prototypes & pre-production 2022/23

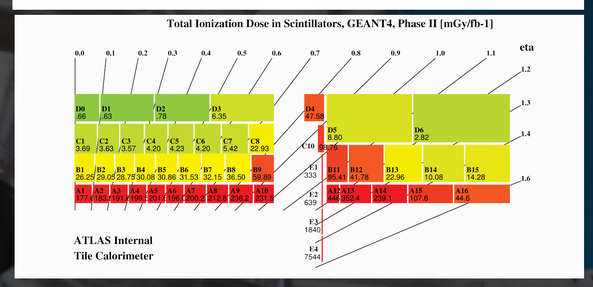
HTT Specs and Numbers

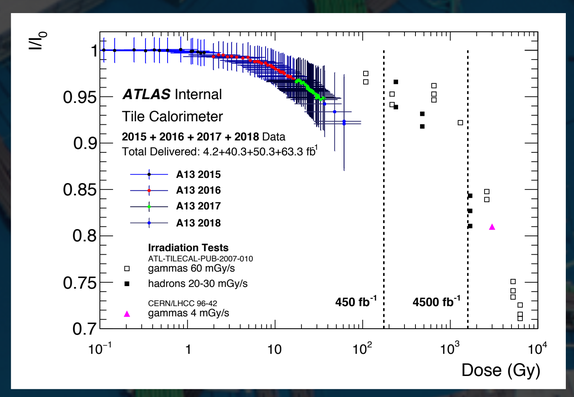
- Regional tracking:
  - 1 MHz, 10% of ITk, $p_T > 4$ GeV, $|\eta| < 4$
- Global tracking:
  - 100 kHz, 100% of ITk, $p_T > 1$ GeV, $|\eta| < 4$
- 58 ATCA shelves
- 727 Tracking Processor boards
- 1245 Pattern Recognition Mezzanines

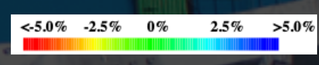
Ageing of Tilecal optics

- Future LHC running will lead to increased radiation damage to TileCal scintillators and fibres – crucial to study light yield vs dose
- We're developing a combined analysis with inputs from all Tilecal calibration systems to isolate light loss from optics degradation
- Separate effects from scintillators, WLS fibres, PMTs, electronics
- Will model performance vs ionising dose to extrapolate to HL-LHC
- Complement and cross check analysis with measurements at the LOMaC laboratory in LIP



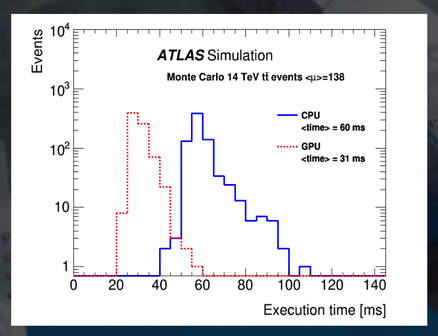


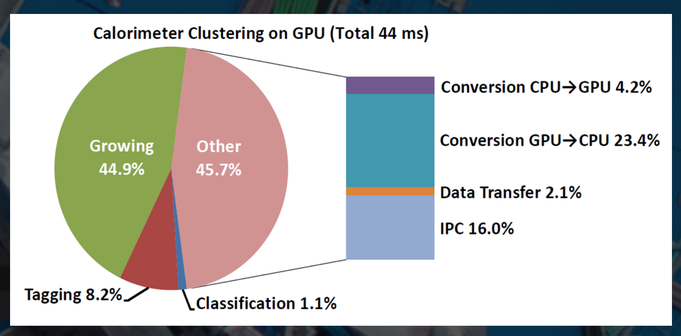




Use of GPUs in trigger processing

- Contributing to new trigger and offline GPU efforts
- Port the old TAC (Topo-Automaton Clustering) to the new Athena offline framework
- TAC performance studies in the new framework
- Identify current bottlenecks and develop new solutions
- Study alternative machine learning clustering algorithms





Prospective Physics Studies

- The purpose of this task is to reserve time and resources for the reason we're building the HL-LHC: the physics – we want to prepare the future by developing new analysis ideas and techniques
- Higgs: EFT studies of anomalous $H \to b\bar{b}\gamma$ coupling and $HH \to b\bar{b}b\bar{b}$
- Top: contributing to development within LHCTopWG of global combination of top-quark related observables; preparing HL-LHC search for new physics in top quark sector in trilepton final states
- Developing use of machine learning techniques to maximize sensitivity and generality of future HL-LHC analyses

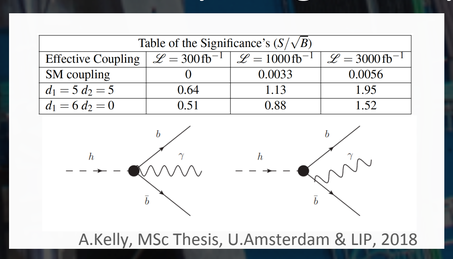
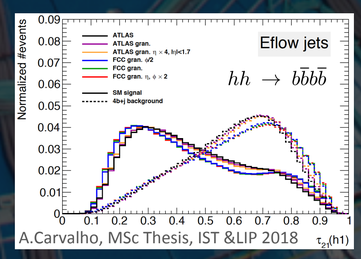
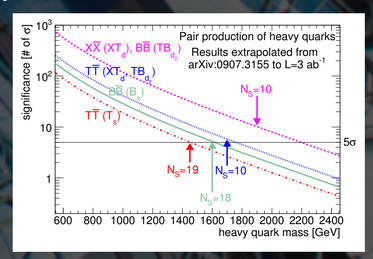


Table of the Significance's ($S/\sqrt{B}$)			
Effective Coupling	$\mathscr{L} = 300\,\text{fb}^{-1}$	$\mathscr{L} = 1000\,\text{fb}^{-1}$	$\mathscr{L} = 3000\,\text{fb}^{-1}$
SM coupling	0	0.0033	0.0056
$d_1 = 5\ d_2 = 5$	0.64	1.13	1.95
$d_1 = 6\ d_2 = 0$	0.51	0.88	1.52

A.Kelly, MSc Thesis, U.Amsterdam & LIP, 2018



A.Carvalho, MSc Thesis, IST &LIP 2018



Outreach: senior team members keep a regular outreach activity including CERN masterclasses, lectures, summer students, etc. Involvement of PhD students in outreach will be strongly encouraged.

Acknowledgements:

FCT Fundação para a Ciência e a Tecnologia