2018 ATLAS sTGC Test Beam Results

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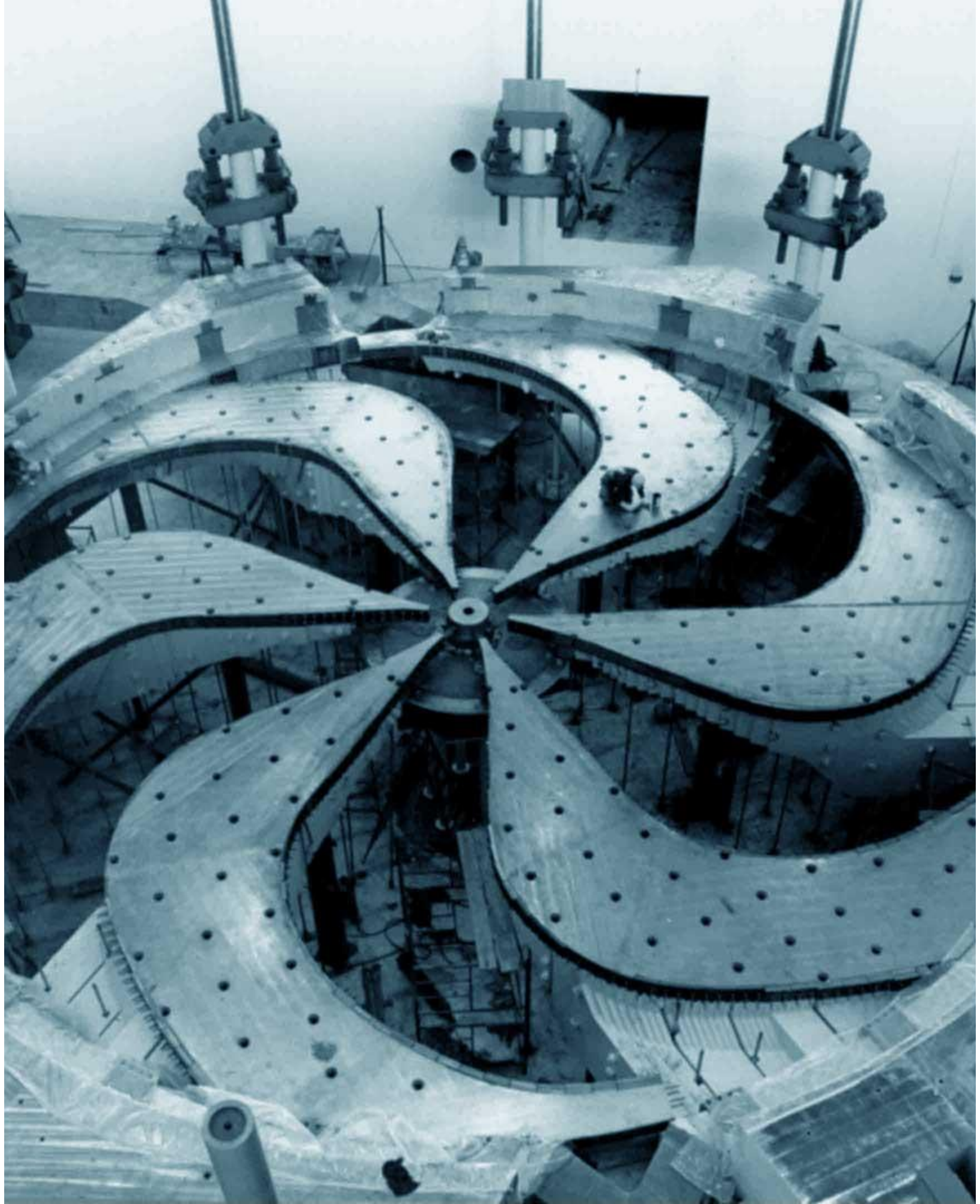


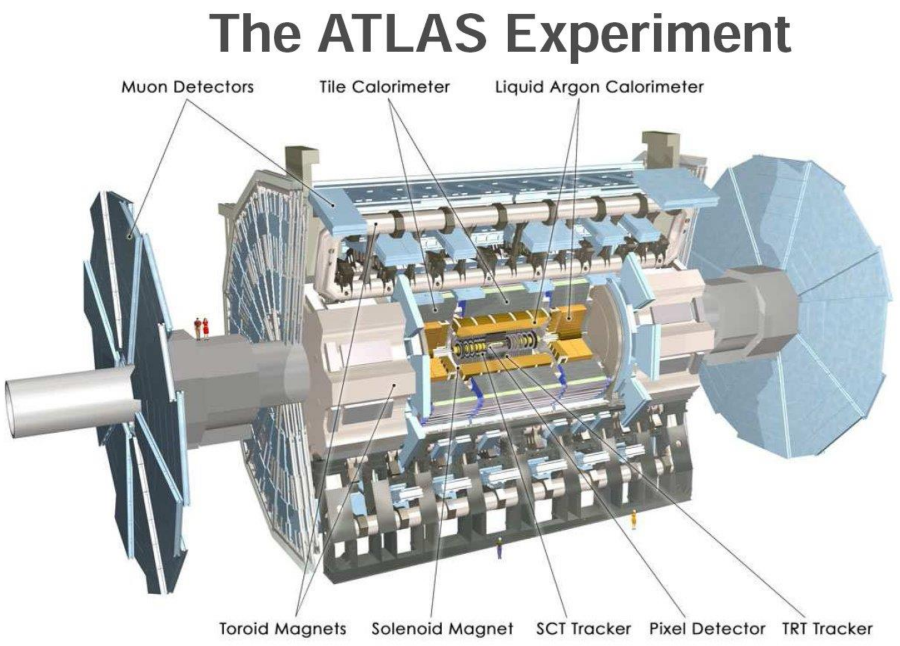
Discovery, accelerated

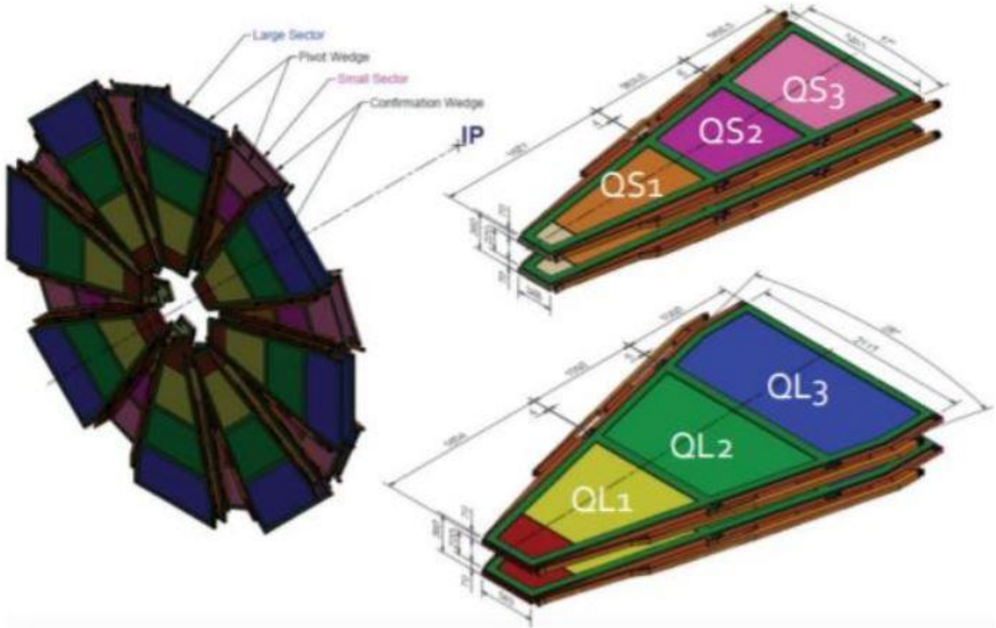
Outline

1. ATLAS and the New Small Wheel
2. Test Beam Setup and Measurements
3. Results and Conclusions

ATLAS and the New Small Wheel (NSW)

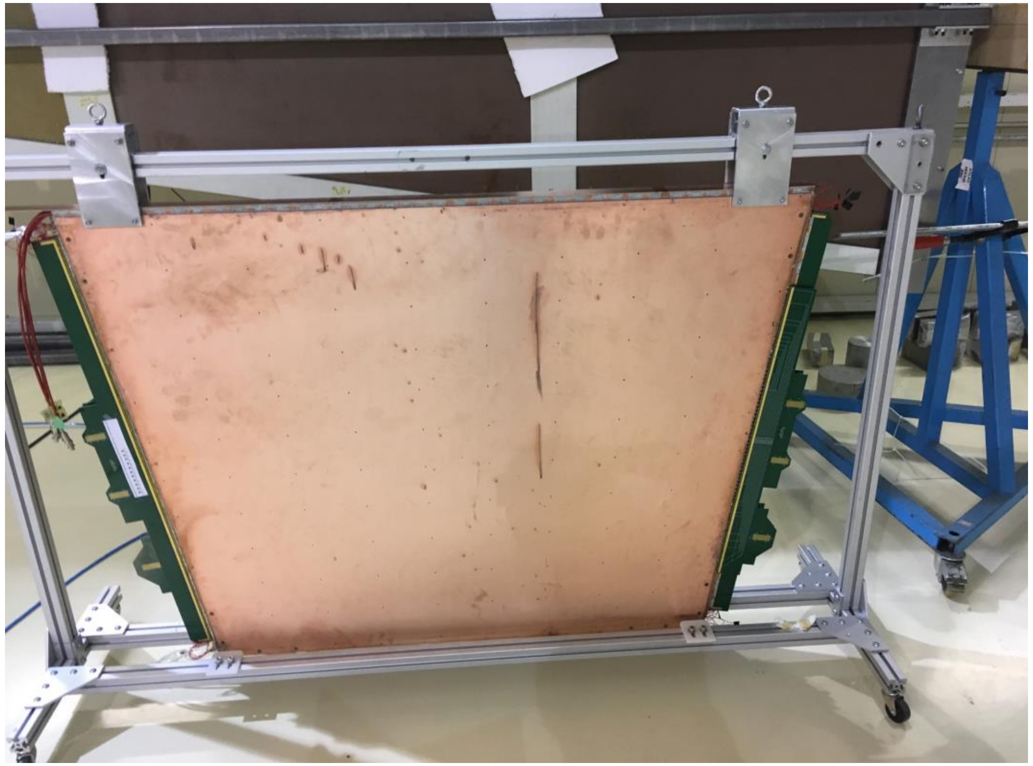
- ATLAS – A general purpose detector at the LHC at CERN
  - Detected Higgs boson in 2012
  - Will continue searches for dark matter and physics beyond the Standard Model into 2038
- Long Shutdown 2 of the LHC is now in progress after a successful run
  - Luminosity increase for next run
- Muon NSW will replace the old small wheel during the Phase 1 Upgrade in 2019-2020
  - Goal is to install first wheel in March 2020
- Designed to fix some problems associated with the increase in luminosity

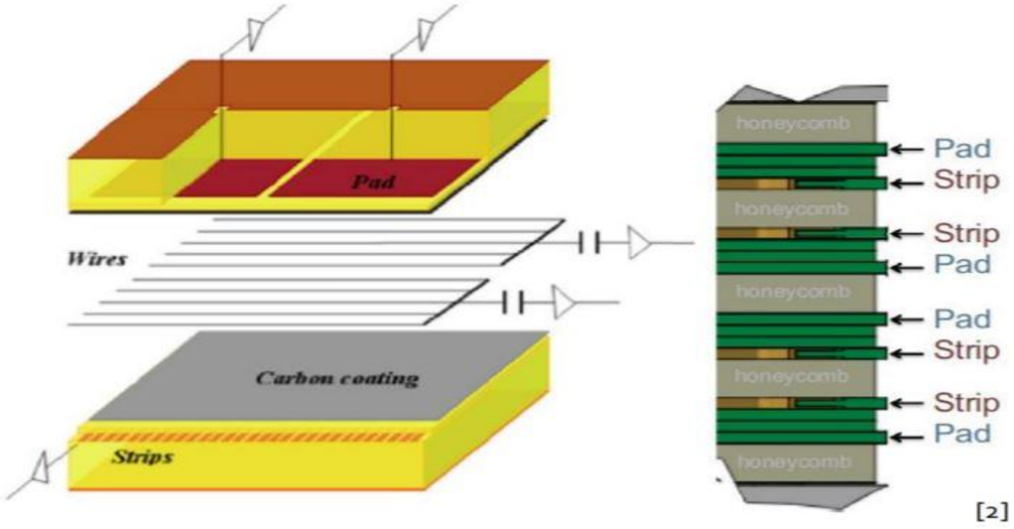




sTGC Quadruplets

- The New Small Wheel consists of two detector technologies
  - Micromegas – Primarily tracking
  - Small-strip Thin Gap Chambers (sTGC)
- sTGCs are a type of gas detector
  - Consists of high voltage wires between cathode layers of strips and pads
- Assembled into quadruplets consisting of four layers
- Serves in the Level 1 Muon Trigger
  - Uses 3-out-of-4 layer coincidences



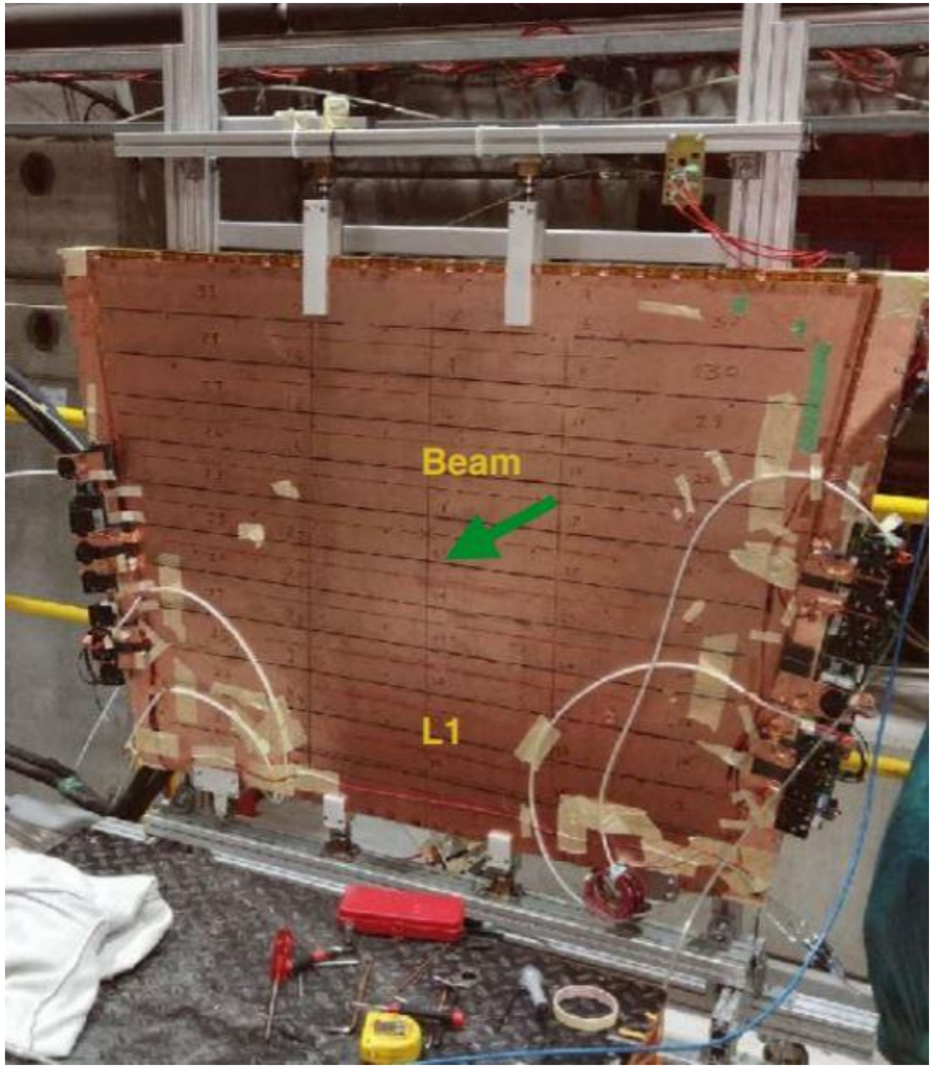


Front End Boards (FEBs)

- FEBs serve as the readout electronics for sTGC quadruplets
- Two types of FEBs – one for pads/wires and one for strips
- Used a prototype version of the FEBs for these tests
- Some FEBs outfitted with an attenuation circuit (“pi-network”) for pad signals
    - Values of components determine attenuation factor

Test Beam at CERN

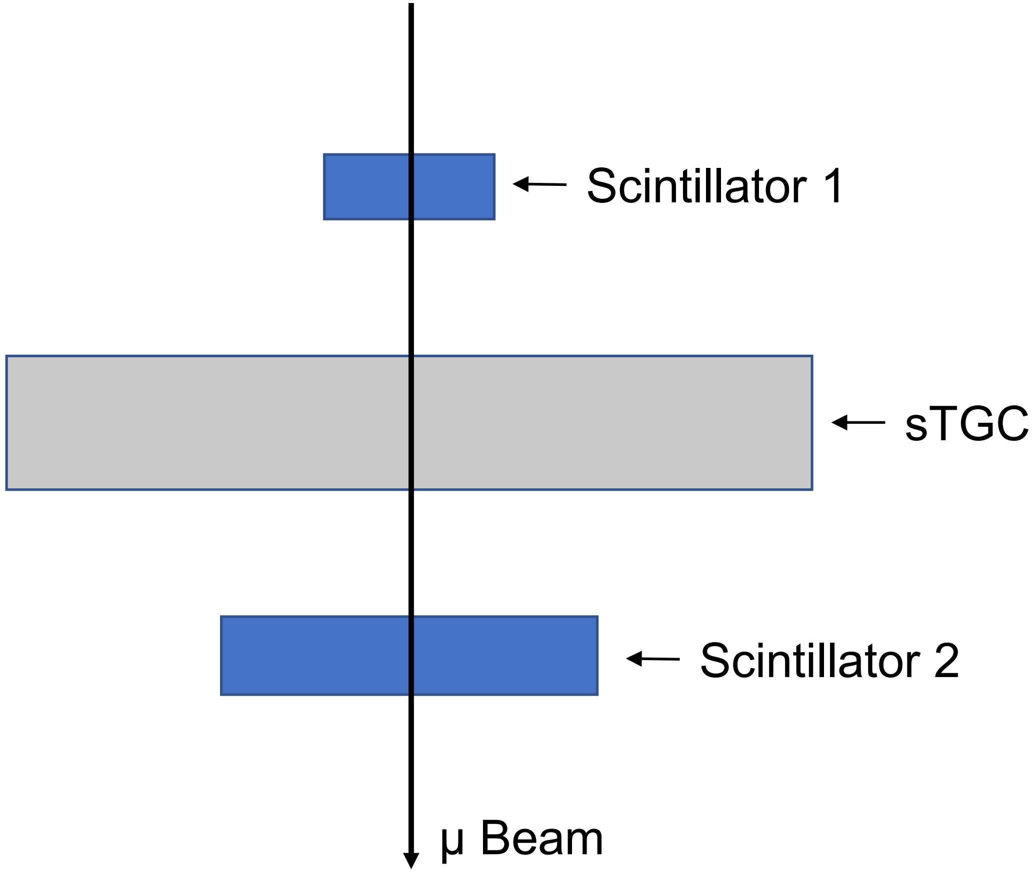
- Tested a Canadian quadruplet in Super Proton Synchrotron beams at CERN
    - Used fully functional production module
- Test Beam Goals
    - Test readout and data acquisition electronics
        - Determine thresholds, etc.
        - Evaluate Pi-Network on FEBs
    - Determine efficiency of the detector in presence of high gamma background
        - **Pad efficiency goal of ~96.5%**
    - Measure noise of detector and electronics



Detector Setup

- Tested the detector in two locations
  - One contained a strong gamma source
- Gamma Irradiation Facility
  - Contains a 14 TBq ^{137}Cs source
  - Test under high gamma background
  - Variable filters allow for tuning of background rate
- Trigger – Two 4cm x 12cm scintillators
  - One horizontal and one vertical to give a 16 cm^2 coincidence area
- Electronics – Full set of 8 FEBs

Top Down Schematic



Successful Measurements

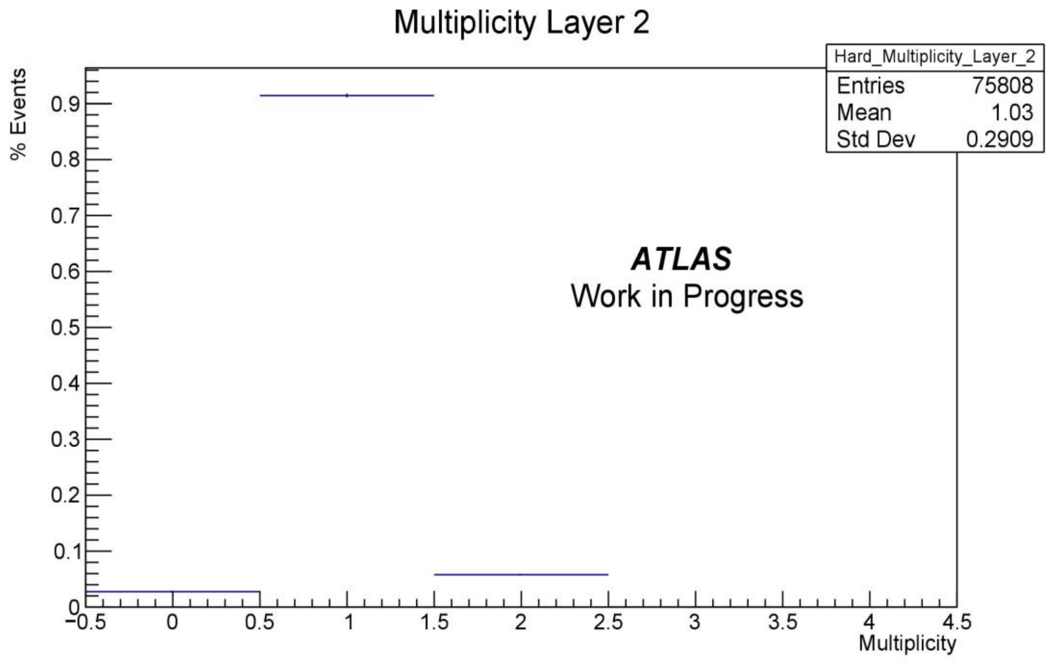
Analysis I Was Involved In

- Pad Efficiency and Multiplicity
  - Pad Hit Maps
- Pad Peak Detector Output (PDO) Analysis
  - Peak Detector Output - peak amplitude of a signal
- Wire Efficiency
- Wire PDO Analysis

Analysis Done By Colleagues

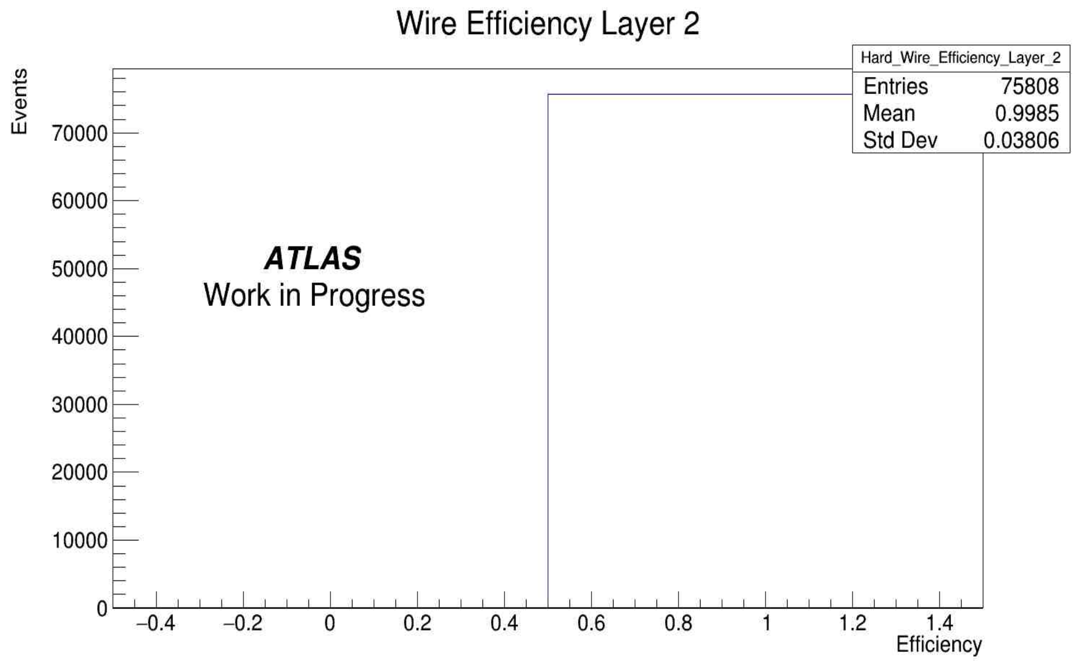
- Strip Efficiency and Multiplicity
  - Observed beam profile
- Strip Resolution
- Noise Measurement and Reduction

Pad Efficiency at 2.9 kV



Layer	2.8 kV	2.9 kV	3.0 kV	3.1 kV
1	81.91%	94.3%	96.85%	96.75%
2	83.01%	97.23%	98.4%	97.59%
3	-	-	-	-
4	5.89%	10.16%	18.02%	33.66%

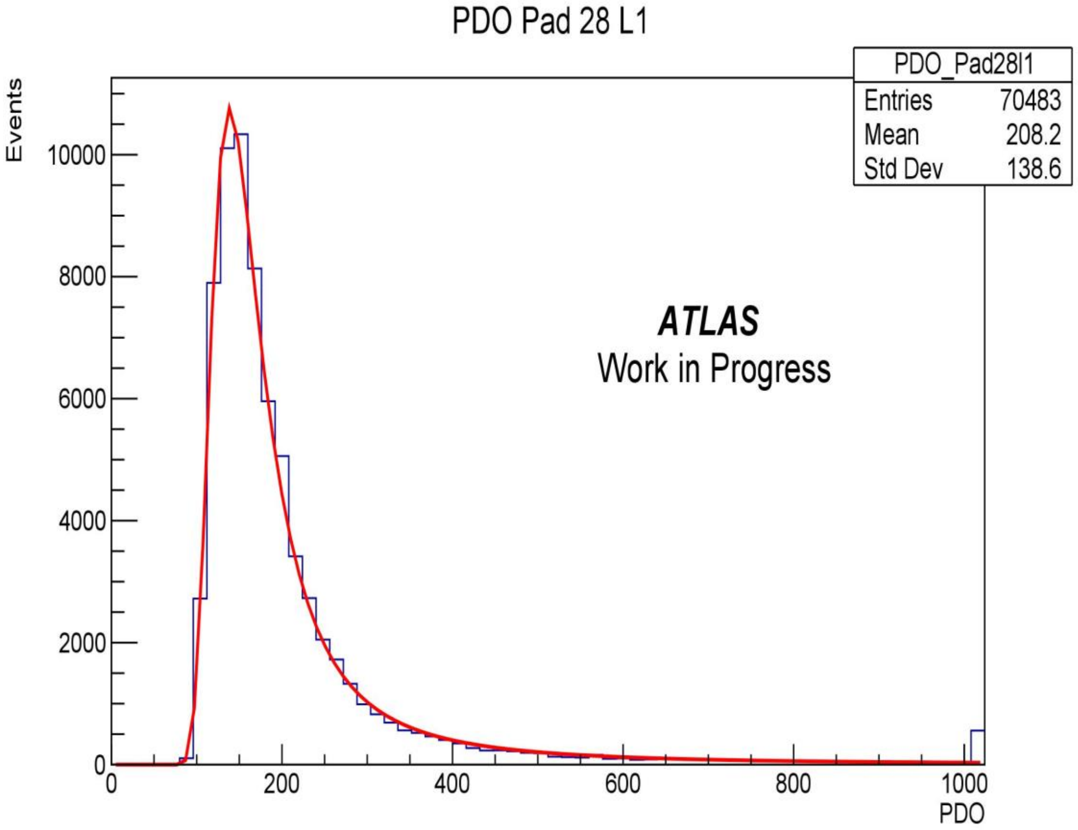
Wire Efficiency at 2.9 kV



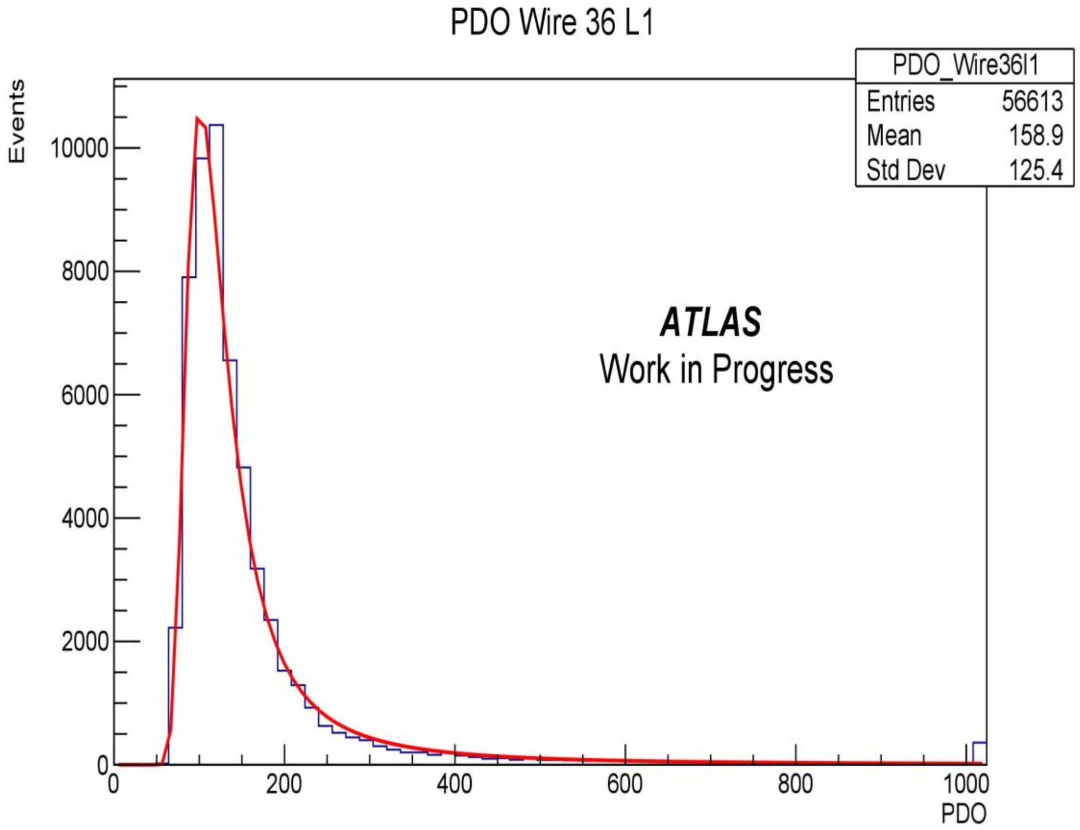
Layer	2.8 kV	2.9 kV	3.0 kV	3.1 kV
1	96.57%	98.34%	98.74%	98.73%
2	98.07%	99.85%	99.87%	99.76%

Pad and Wire Peak Detector Output (PDO)

Layer 1 Pad PDO at 2.9 kV



Layer 1 Wire PDO at 2.9 kV



Summary

- The NSW will be installed in 2020 to replace the old small wheel of the ATLAS muon spectrometer
- sTGC detectors will serve as the primary trigger mechanism of the NSW
- Fall 2018 beam tests at CERN showed promising results for pads and wires efficiency and multiplicity
  - Strips exhibited excellent efficiency as well
- Further work to study ideal pi-network capacitance values as well as significant noise reduction has taken place

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ATLAS EXPERIMENT

Thank you
Merci

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Acknowledgements

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