

An update on

ATLAS NSW sTGC Electronics Integration and Commissioning

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ATLAS
EXPERIMENT



Outline

- Recap
- sTGC Electronics
 - FEBs
 - VMM Threshold and Baseline Calibration
 - VMM Noise Scan
 - L1DDCs
 - sTGC Trigger Chain
- Other Work
 - Large Wedge R&D
 - Software Development
 - sTGC Electronics Twiki
 - The Future
- Experiences & Thank You

Recap: The NSW and the sTGCs

- NSW → new muon tracker to be installed in ATLAS.
 - A-side and C-side.
 - Consists of Micromegas (MM) and small-strip thin gap Chambers (sTGCs).
- sTGCs a type of multiwire proportional chamber.
 - Works via the ionization of a gas in a strong E-field.
 - Wires as anodes and pads + strips as cathodes.

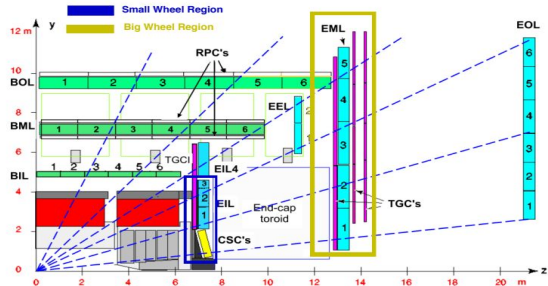


Figure 2: Small Wheel Location in ATLAS



Figure 1: The A-side New Small Wheel

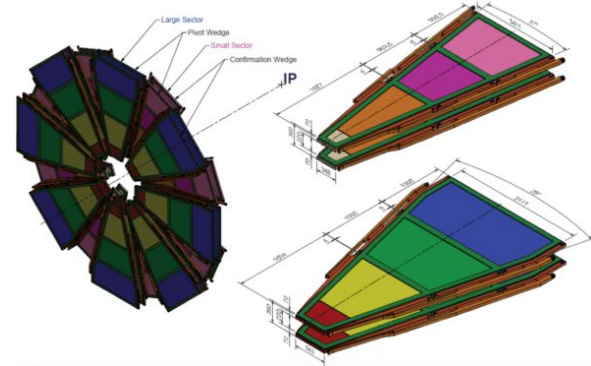


Figure 3: sTGCs wedges

Front-End Boards (FEBs)

- FEBs amplify and digitize voltage signal from chamber.
 - Two types: pad and strip (pFEB and sFEB).
- Chips
 - VMMs: ASIC used for readout and triggering.
 - SCA: Slow Control ASIC used for NSW ASIC configuration.
 - TDS: Trigger Data Serializer.
 - ROC: Readout Controller.

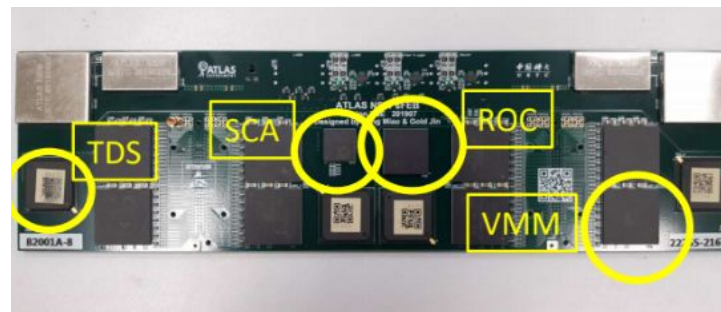


Figure 4: Example sFEB

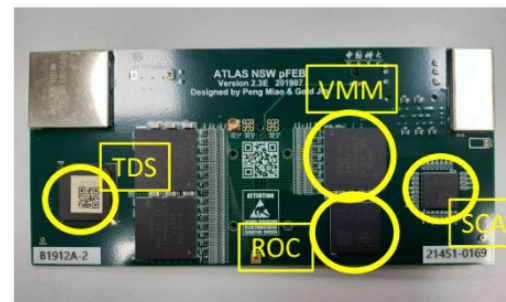


Figure 5: Example pFEB

VMM Baseline and Threshold Calibration

- Calibrated VMMs.
 - Should have consistent difference between baseline and threshold (30 mV).
 - Trims made to individual channel thresholds.

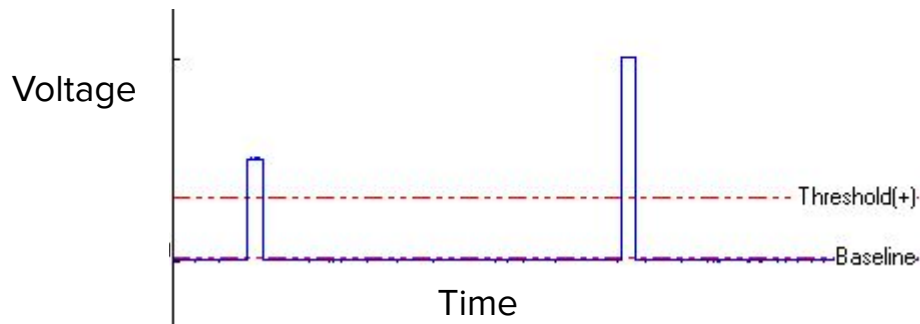


Figure 6: Example of baseline and threshold for signal detection

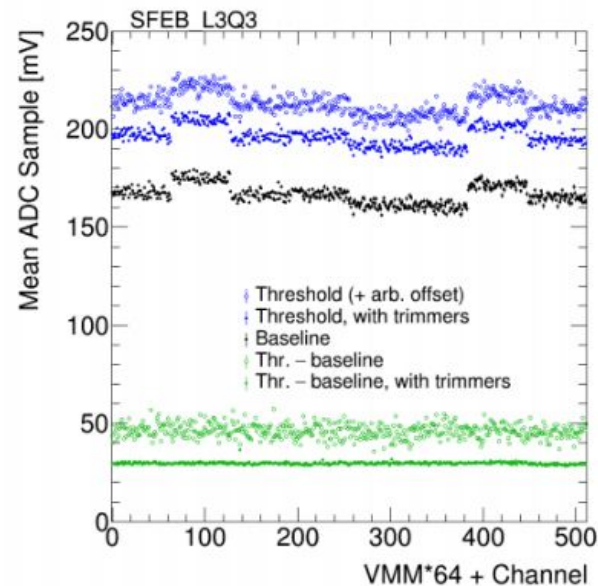


Figure 7: Example of Baseline and Threshold Calibration

VMM Noise Scan

- Measured VMM noise.
 - To identify dead/noisy VMM channels.
 - Other VMM issues.
 - Require oscilloscope to be further investigated.

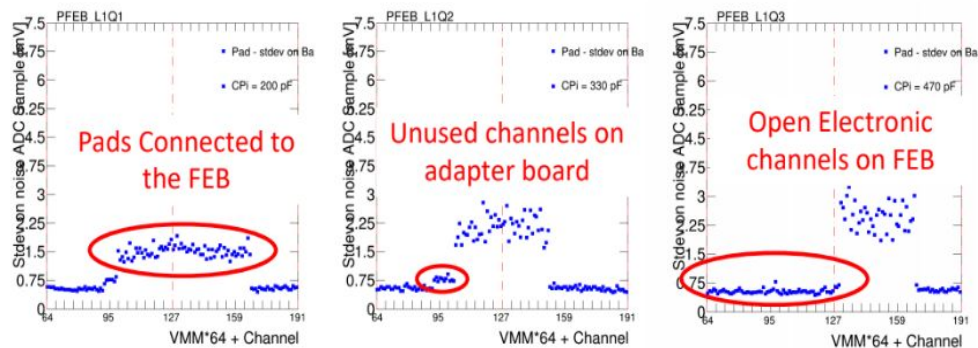


Figure 8: Noise Scan Examples



Figure 9: Small sTGC Wedge with Oscilloscope Connected

L1DDCs/FELIX

- Level 1 Data Driver Cards.
 - GBTX (Gigabit Transceiver)
 - Allows a single bidirectional link to be used simultaneously for data readout and configuration.
 - Feeds into FELIX.
- FELIX (Front-End Link Exchange)
 - Routing of detector control, configuration, calibration, monitoring and detector event data.
 - TTC (Timing, Trigger and Control) distribution.
 - Detector independent.

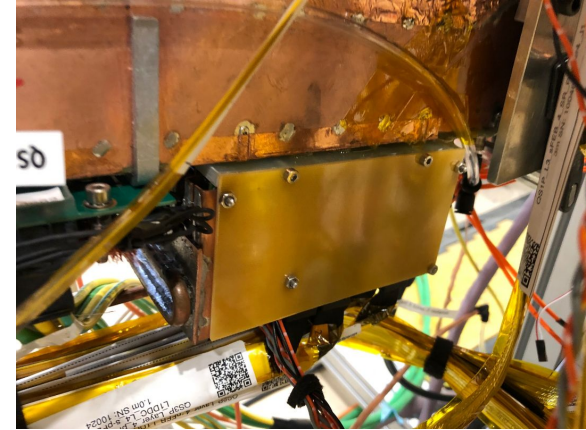


Figure 10: L1DDCs on sTGC wedge

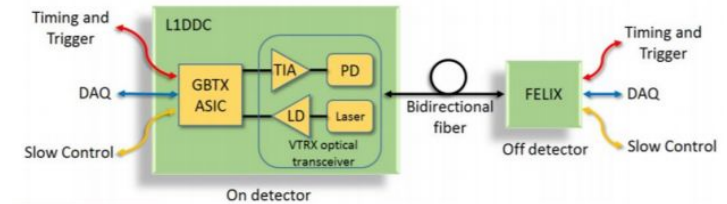
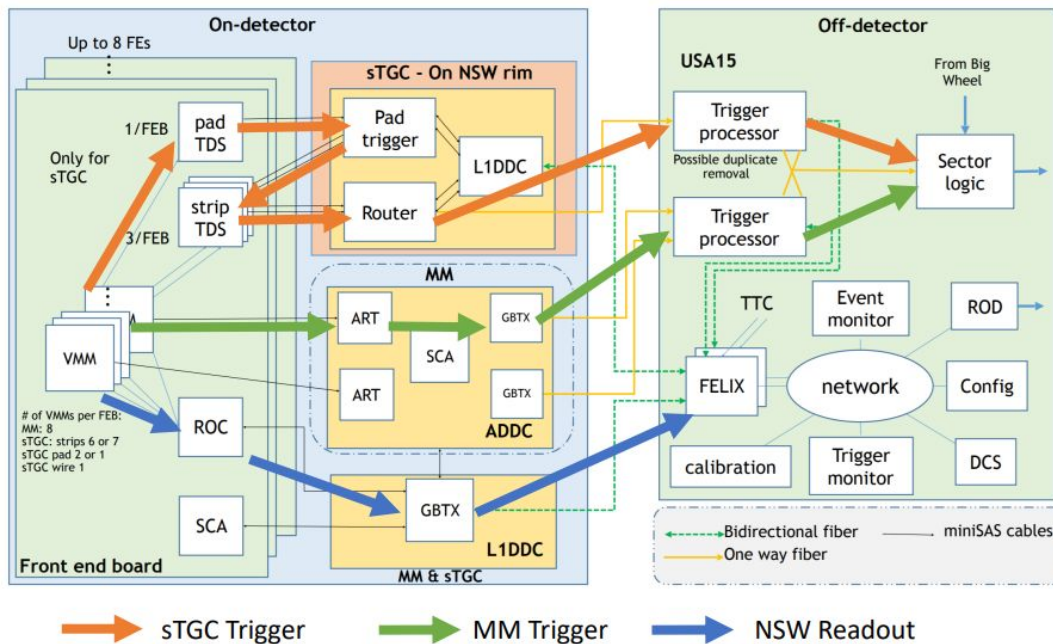


Figure 11: L1DDC/FELIX Diagram

sTGC Trigger and Readout Chain

Figure 12: NSW electronics readout and trigger map



Large Wedge Cable Routing R&D

- Large Wedge design did not account for space taken up by twinax cables.
- Developed novel cable routing scheme to overcome design flaws.
 - Presented results at general sTGC meeting.

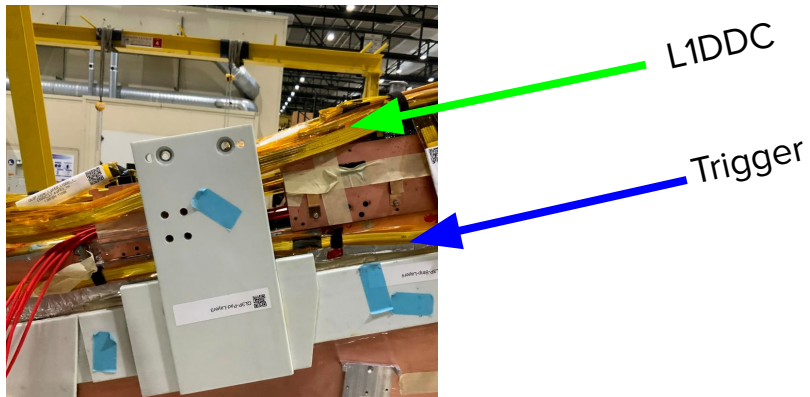
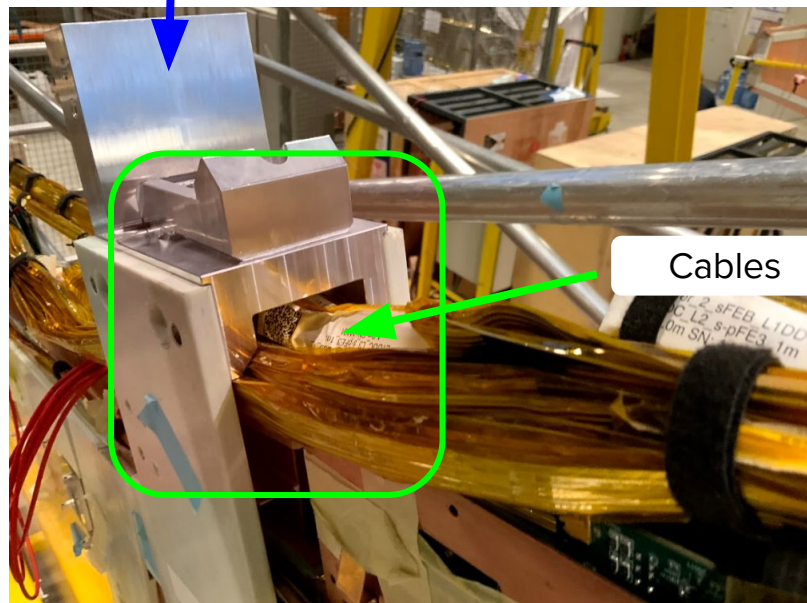


Figure 13: Large Wedge Kinematic Mount Region (side)

Kinematic Mount

Figure 14: Large Wedge Kinematic Mount Region (top)



Software Development

- Further developed GUI.
 - More control over GBTX configuration.
 - Now cross-referencing several more logs, to ensure sTGC mappings and configurations are consistent.
- Developed other code to make integration faster.
 - E.g. a script tied to a barcode reader to quickly check whether physical labels match their intended mapping.

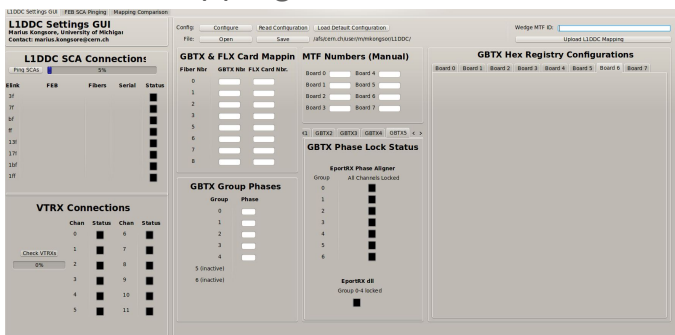


Figure 16: Screenshot of GUI

```
try:
    with open(productionlogDir+str(testMTF)+'.txt', 'r') as prodlog:
        read = prodlog.read().replace('\n', ' ').replace('\t', ' ')
        for char_idx, char in enumerate(read):
            if read[char_idx:char_idx+1] == 'SCA':
                SCAP = str(read[char_idx+:char_idx+1]).rstrip()
                # Comparing SCA IDs between logs
                if SCAP == str(SCAT[l]):
                    print('LIDDC' + str(l) + ' has matching logs!')
            else:
                same = False
                print('#####')
                print('LIDDC' + str(l) + ' has inconsistent SCA IDs log')
                print('TestSCA = ' + str(SCAT[l]))
                print('ProductionLogSCA = ' + SCAP)
                print('#####')
```

Figure 17: Example Code Snippet from Log Comparison Script

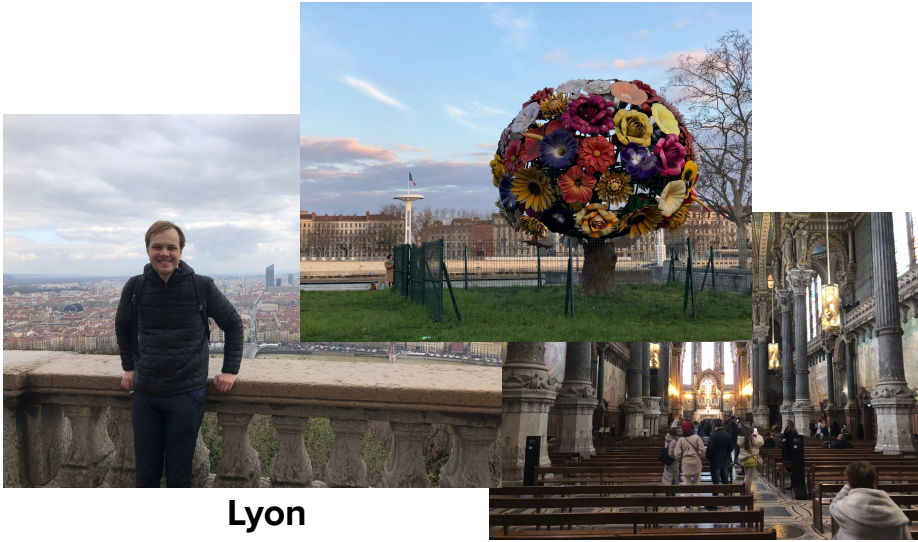
The Future

- Sector A16 sTGCs prepared before full shutdown and ready for installation onto NSW once CERN reopens.
- ATLAS Upgrade Week.
 - sTGC Plenary: Integration and Commissioning status update + update on ability to go faster than scheduled
- Finalize Twiki and other documentation remotely.
- NSW-A likely to be delayed until sometime in 2021.



Figure 20: NSW with Sector A16 highlighted

Final Experiences



Lyon



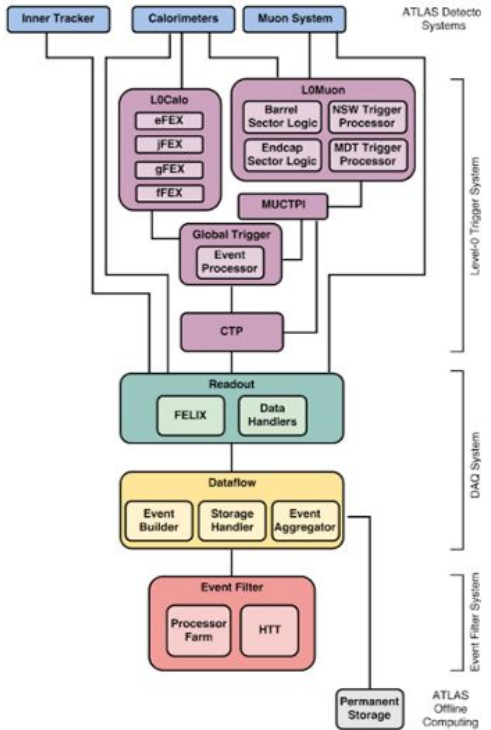
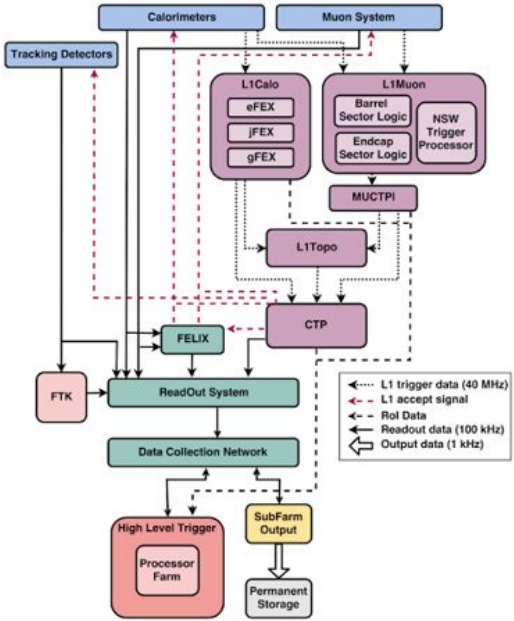
The Juras

Thank you all for a short, but great semester!

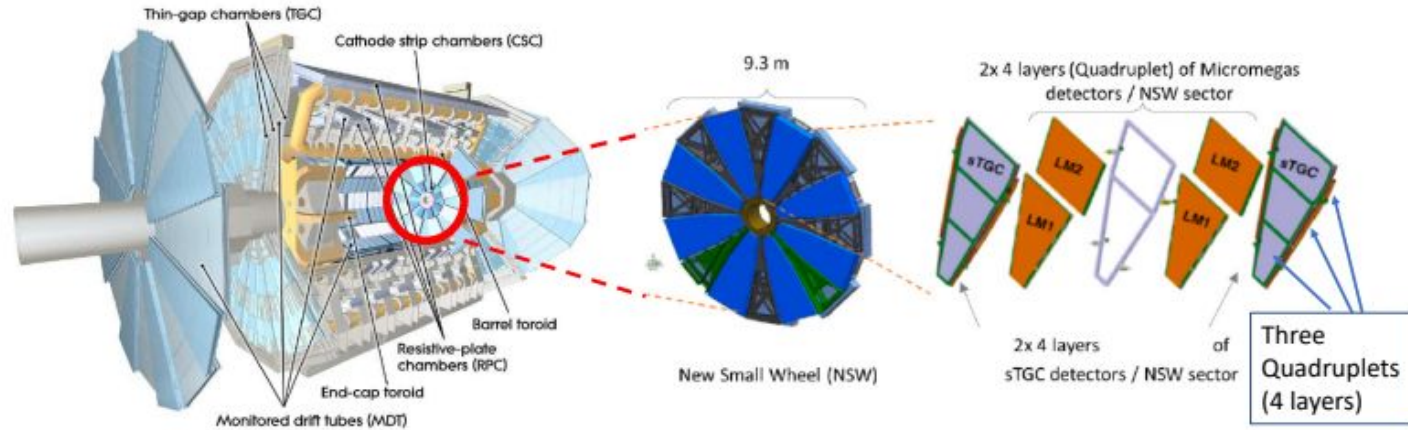
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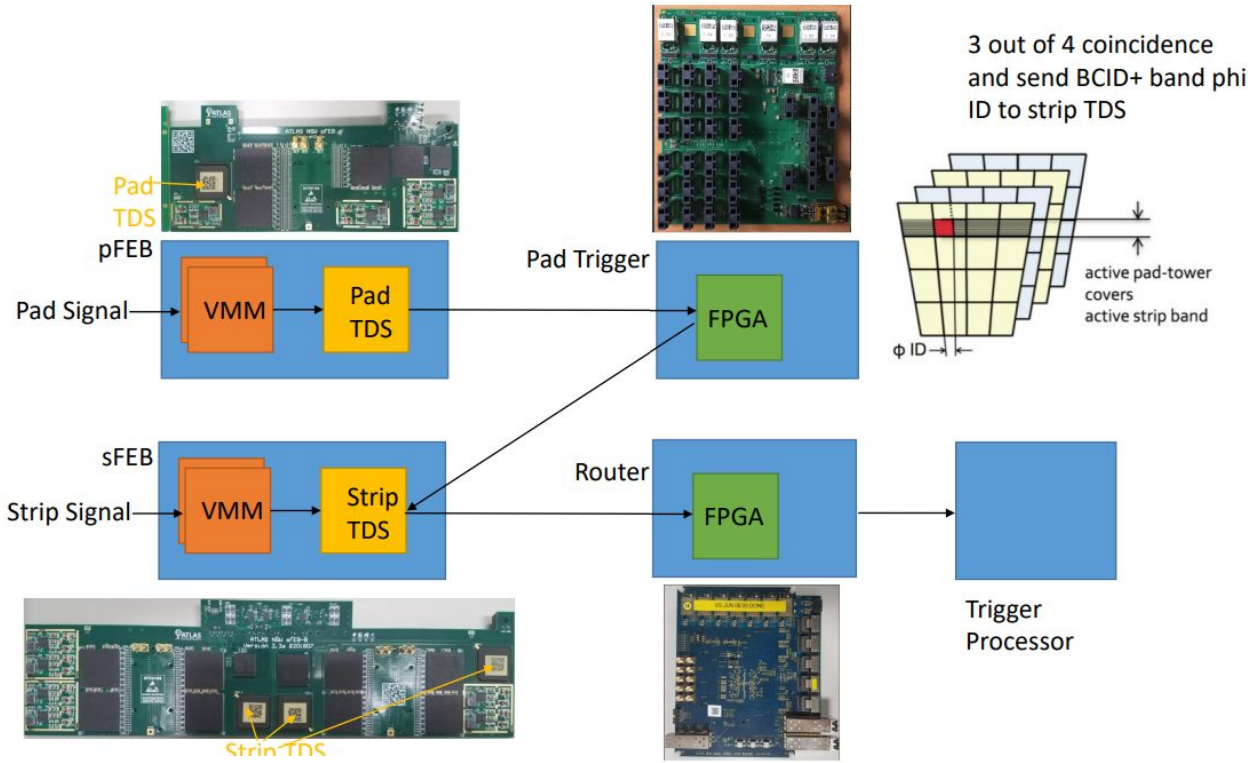
Backup I - ATLAS Muon Trigger System



Backup II - NSW in ATLAS



Backup III - sTGC Trigger Chain



Backup IV - Bethe-Bloch Formula

$$-\frac{dE}{dx} = 2\pi N_a r_e^2 m_e c^2 \rho \frac{Z}{A} \frac{z^2}{\beta^2} \left[\ln \left(\frac{2m_e \gamma^2 v^2 W_{\max}}{I^2} \right) - 2\beta^2 - \delta - 2 \frac{C}{Z} \right],$$

with

$$2\pi N_a r_e^2 m_e c^2 = 0.1535 \text{ MeVcm}^2/\text{g}$$

Backup V - Leak Testing

- Tested for gas leakage
 - Design flaw → dozens to hundreds of leaks in outer faraday cages.
 - Overcome by pre-applying epoxy to large sections of each wedge.
- Tested cooling capabilities and cooling pipe leakage.
 - Bad cooling contact common problem.
 - Discovered a few leaks.

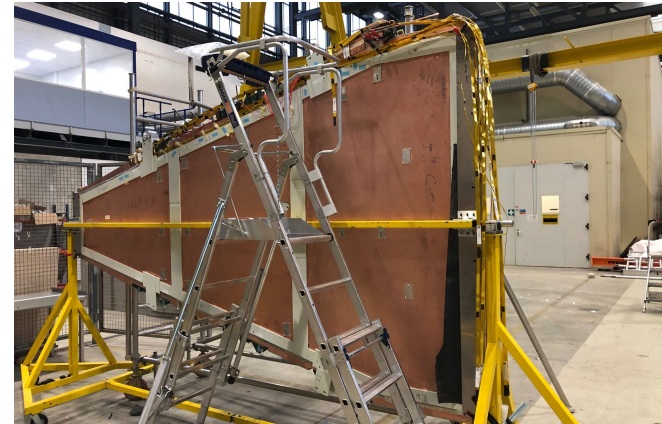


Figure 15: Large Wedge