# SMALL-STRIP THIN GAP CHAMBERS FOR THE MUON SPECTROMETER UPGRADE OF THE ATLAS EXPERIMENT

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ATLAS FUTURE MUON PERFORMANCE

- Muon trigger thresholds will have to increase at higher luminosity to maintain trigger rate

- Current Muon trigger rate dominated by fakes

- Segment loss in small wheel for high momentum (pT > 100 GeV) muons degrades momentum resolution

Big Wheel EM

EI

Small Wheel

$\Delta\theta$

C

A

B

end-cap toroid

IP

LL_SV_NSW
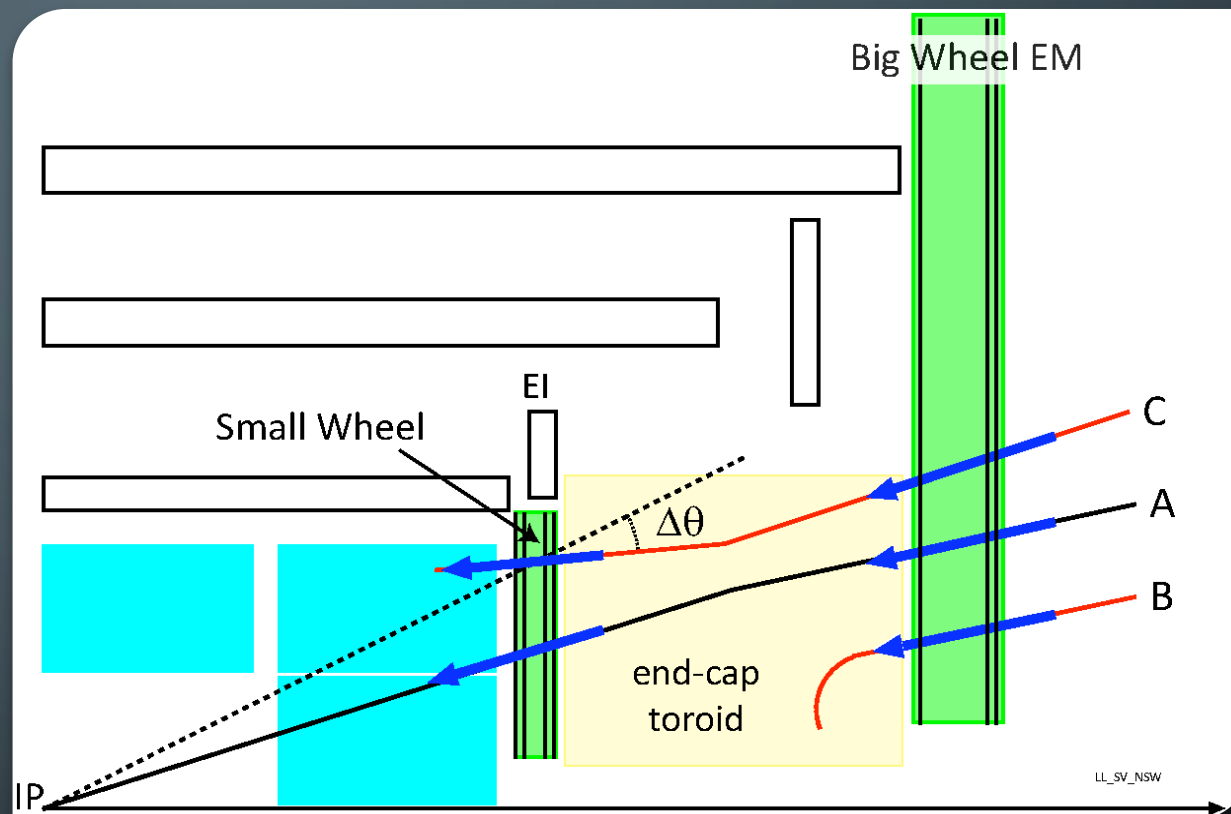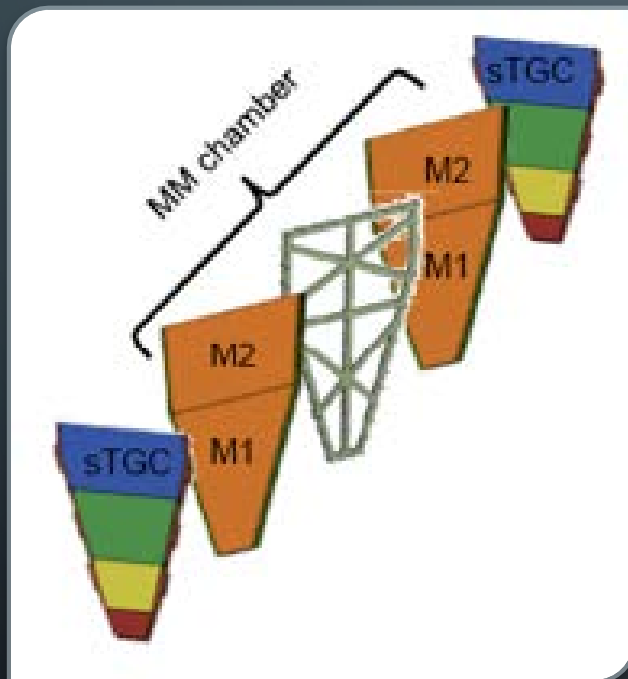
Track trajectories in the high pseudorapidity region
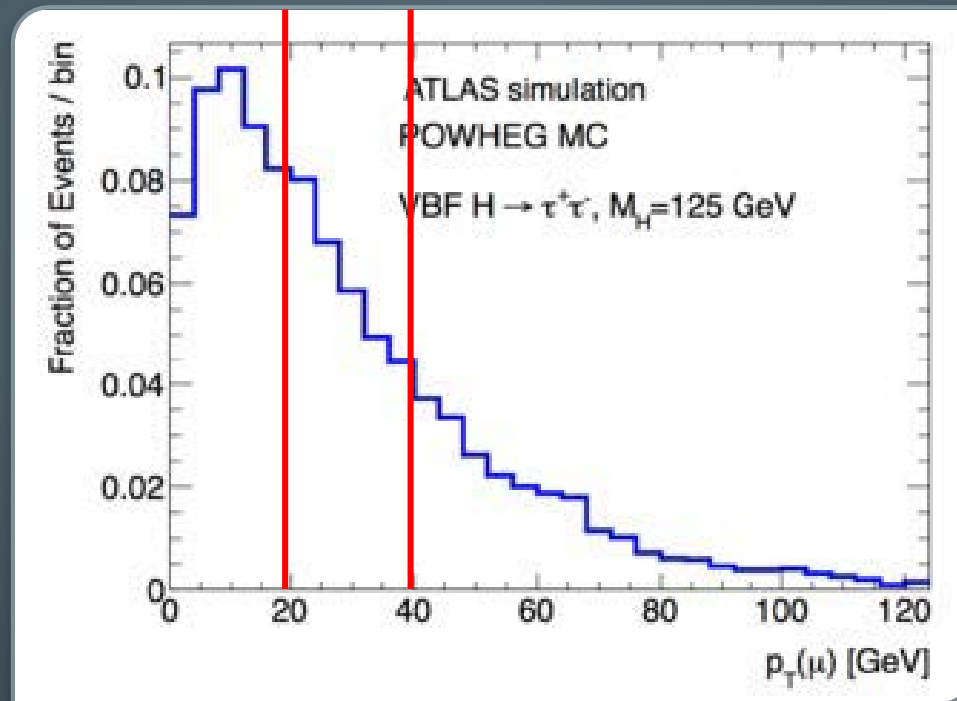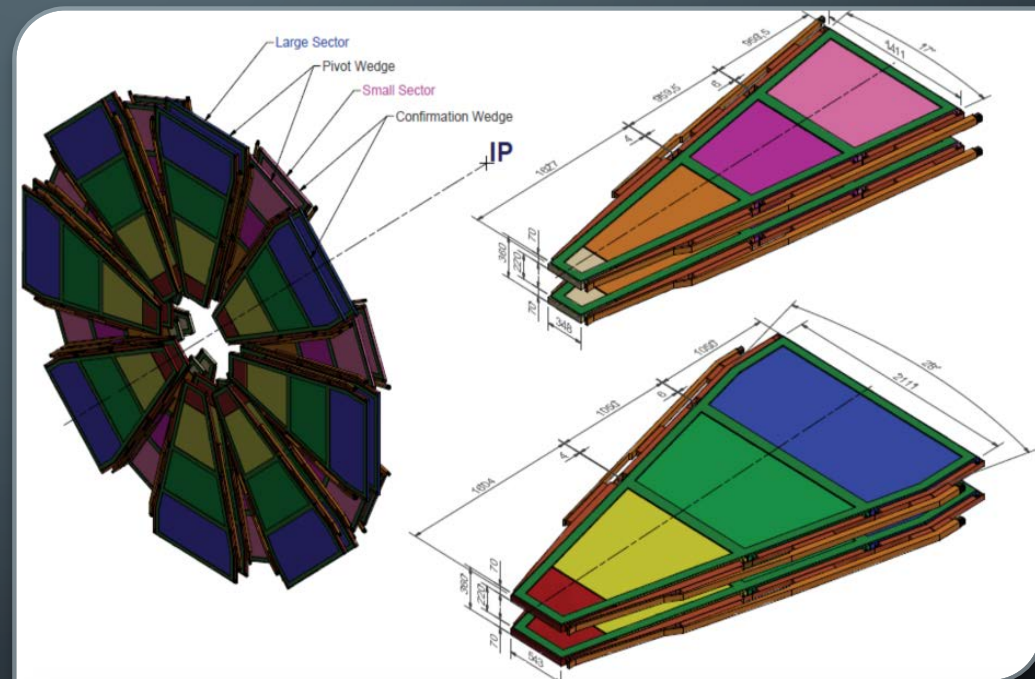
MUON TRIGGER THRESHOLDS

Increasing single muon trigger threshold from would maintain trigger rate but would result in significant efficiency loss (~60% at 20 GeV to ~28% at 40 GeV)
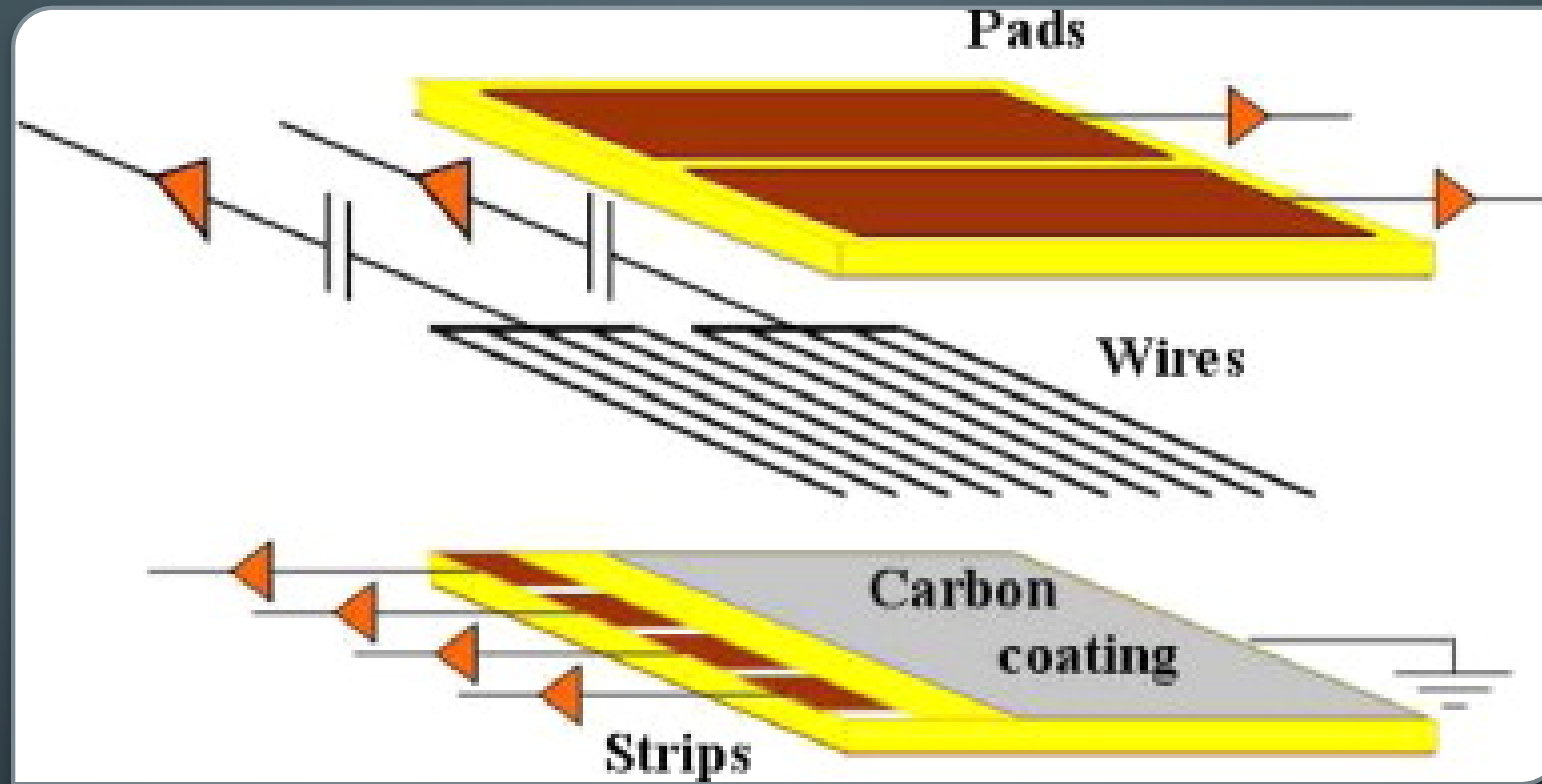
THE ATLAS NEW SMALL WHEEL

Sector layout

New Small Wheel layout

ATLAS SMALL-STRIP THIN GAP CHAMBERS

Wire Diameter – 50 um   Wire Pitch – 1.8 mm   Strip Pitch – 3.2 mm

Pad cathode signals control strip readout   Online position resolution on order of 150 microns

High efficiency for MIPs under 20 kHz/cm^2 gamma irradiation

STGC OPERATION DESIGN

- Pads staggered by half a pad width creating smaller 'logical pads'

- 3 out of 4 coincidence of pads defined region of interest and triggers strip readout

- Precision coordinate determined by fitting charge distribution on strips

  - 1 mrad <u>online</u> pointing precision to the IP
  - Offline resolution: 15% at 1TeV

- Alignment of successive layers is critical
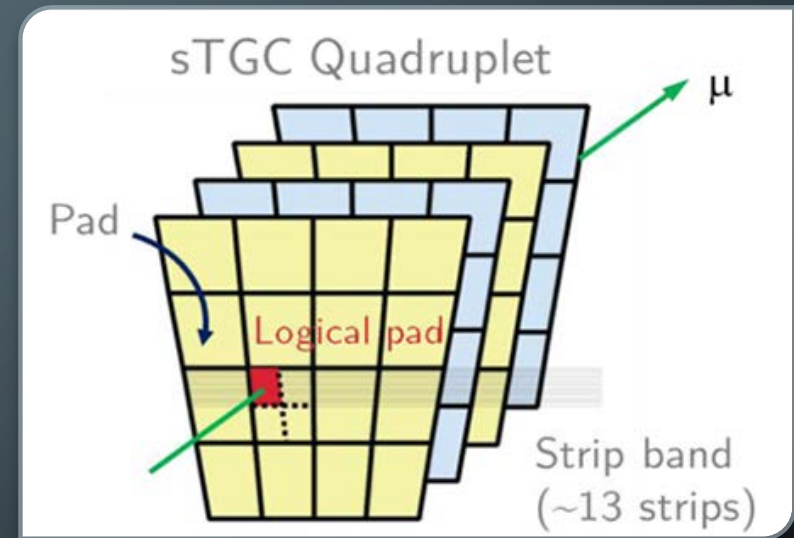
BRASS ALIGNMENT FEATURES
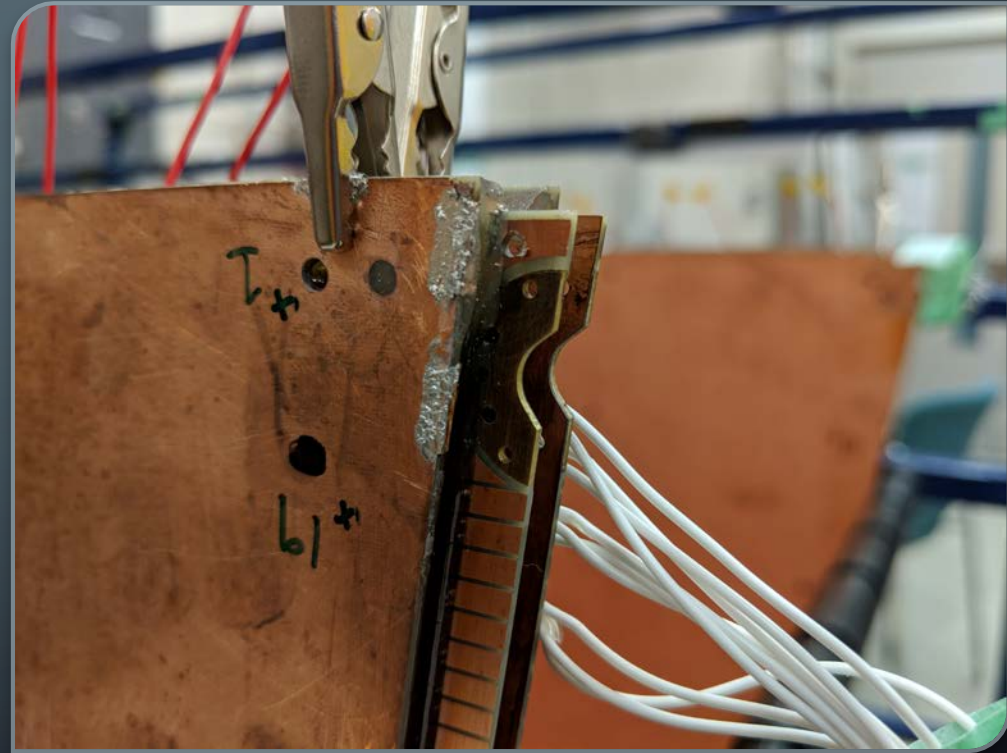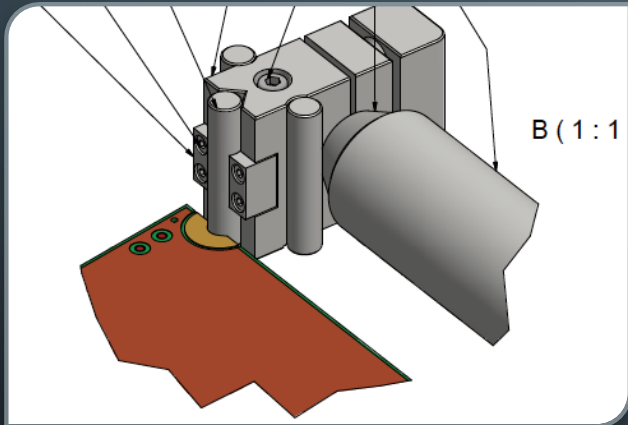
STGC ASSEMBLY

- Gaps are assembled on granite tables that are flat to within 20 um

- Vacuum system keeps wound pad half-gaps flat on the table

- Assembly and testing done in climate controlled clean environment

- Individual gaps are tested and assembled into quadruplets

- Electronics integration and cosmic tests completed before shipment to CERN for wedge assembly

Gap closing in Canada

SMALL WEDGE QUADRUPLET ASSEMBLY

CHILE

QS1 construction is split between Pontificia Universidad Católica de Chile and Universidad Técnica Federico Santa María
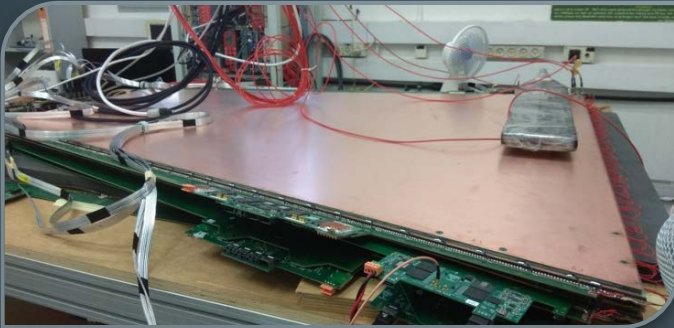
CHINA

QS2 construction is conducted at Shandong University

CANADA/ISRAEL

QS3 construction is split between Canada and Israel

LARGE WEDGE QUADRUPLET ASSEMBLY

ISRAEL

QL1 construction is carried out at the Weizmann Institute

CANADA

QL2 construction is split between TRIUMF, Carleton University, and McGill University

RUSSIA

QL3 construction is carried out at PNPI

ELECTRONICS INTEGRATION AND COSMIC TESTING

- Before shipment to CERN, all quads pass through a cosmic test stand

- Commissioning of test stands on first quads happening now

- Test stands have external scintillator triggers

- Measure efficiency of ¾ coincidence for trigger path

- Measure gain uniformity of gaps
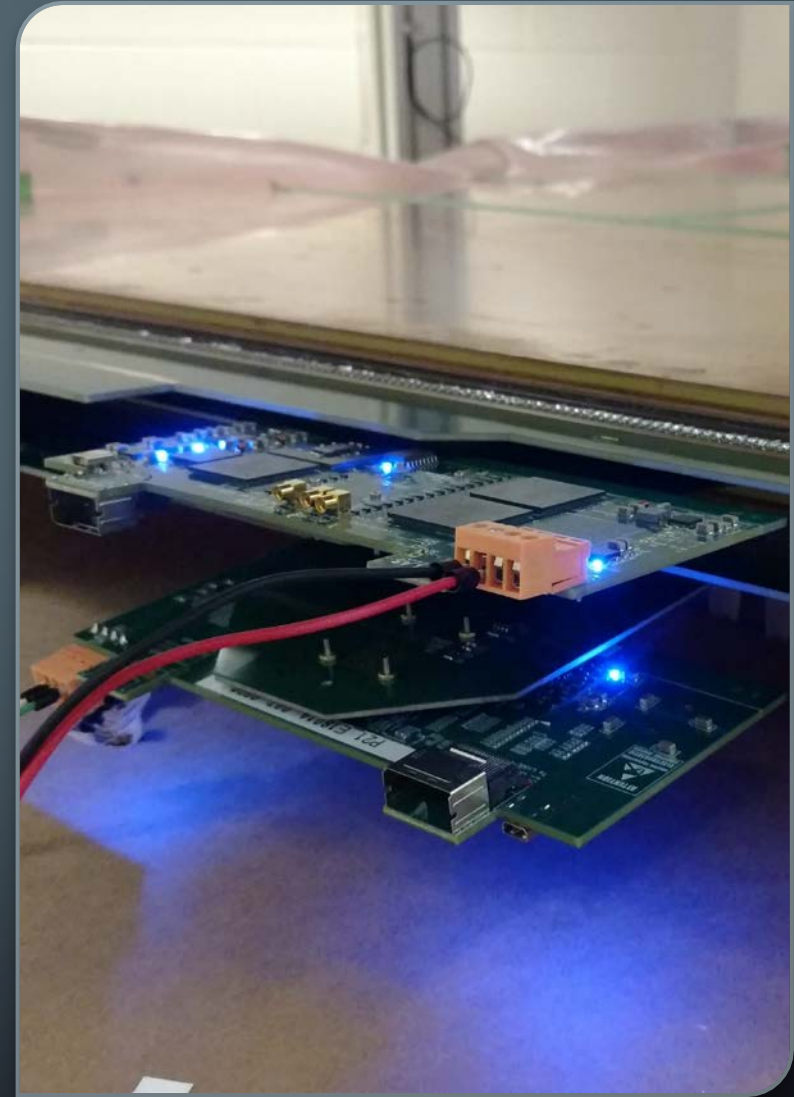
Pad Front End Boards (pFEBs)

FIRST COSMIC TESTS IN CANADA

- Commissioning of test stand at McGill is nearly complete

- Achieved configuration and readout of 4 out of 4 pad Front End Boards simultaneously

- External trigger electronics nearly complete

- Strip Front End Board require extra cooling and temperature monitoring (nearing completion)
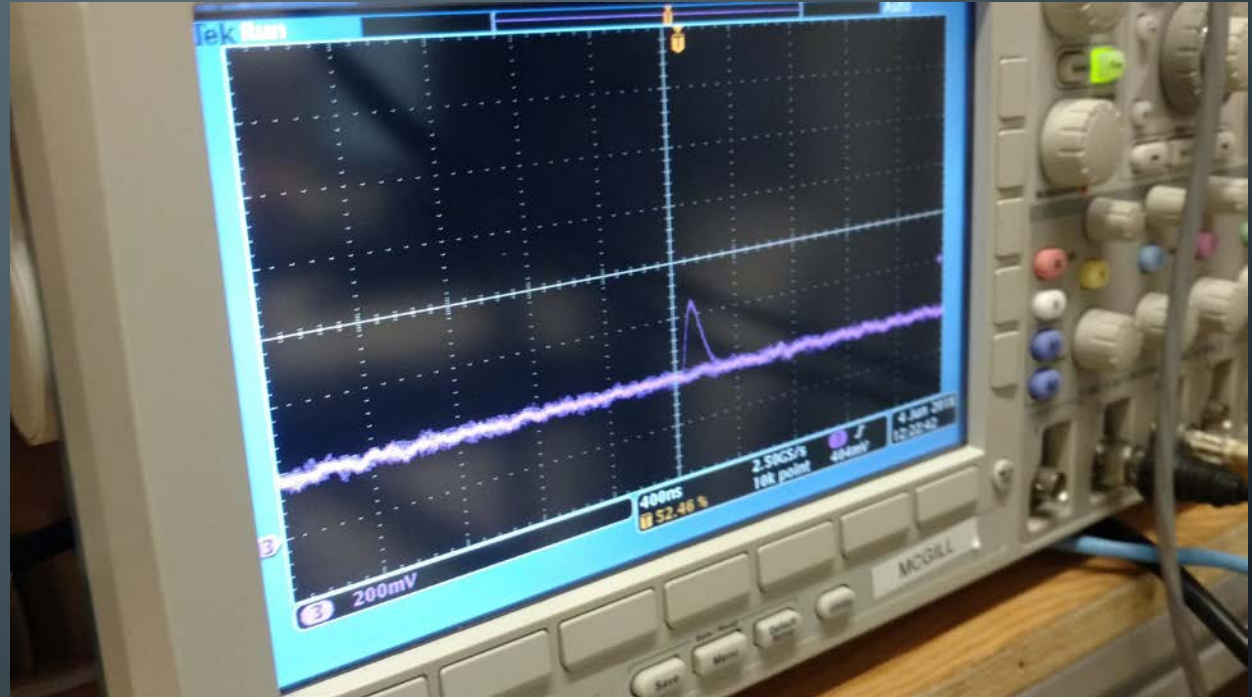
Cosmic pulse on a single pad

FIRST COSMIC TESTS IN CHINA

- First commissioning tests performed with prototype module with 3 working gaps

- External trigger operating

- Local spatial resolution measured at ~150um
  - Cosmic rays are multiple scattering dominated
  - Test beams show ~50 micron resolution of sTGC technology
    - NIM A 817 (2016) 85–92

- Efficiency scan performed
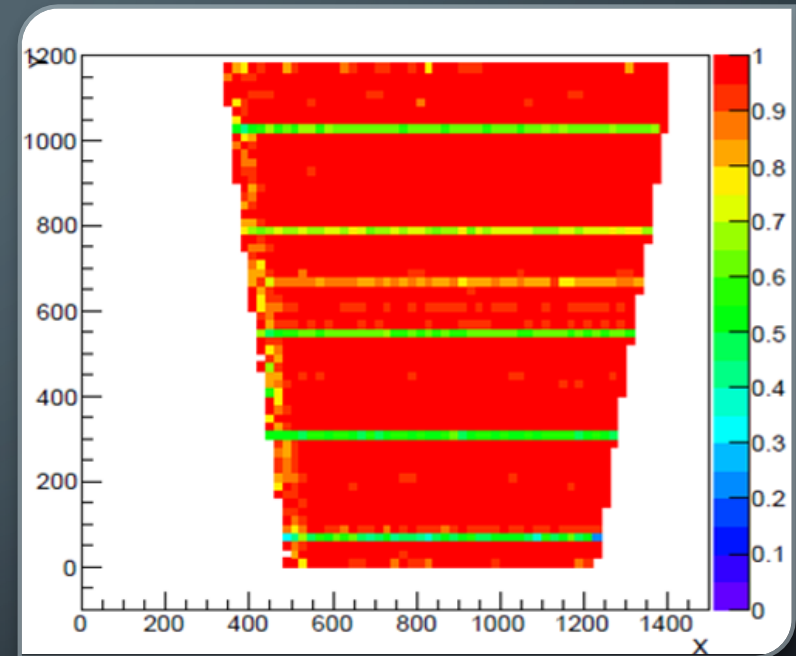
Layer 3 efficiency

WEDGE ASSEMBLY PLANS

- First modules for the small wedge will be shipped to CERN early/mid-July

- First small wedge assembly will take place beginning of August

- After assembly wedges will be integrated with electronics

- Eventual assembly with MicroMegas into NSW Sectors

SUMMARY

- sTGC production underway at all assembly sites

- Cathode board procurement nearing completion

- First few modules have been completed

- Small wedge assembly will begin in the next few weeks