

Small-Strip Thin Gap Chambers for the Muon Spectrometer Upgrade of the ATLAS Experiment

13th Pisa Meeting on Advanced Detectors, La Biodola (Italy) 24-30 May 2015 - Estel Perez Codina (TRIUMF) on behalf of the ATLAS Muon Collaboration

The small-strip Thin Gap Chambers will provide the Muon New Small Wheel with excellent triggering and tracking capabilities. The construction protocol has been validated by test beam experiments on a real-size prototype showing the performance requirements are met.

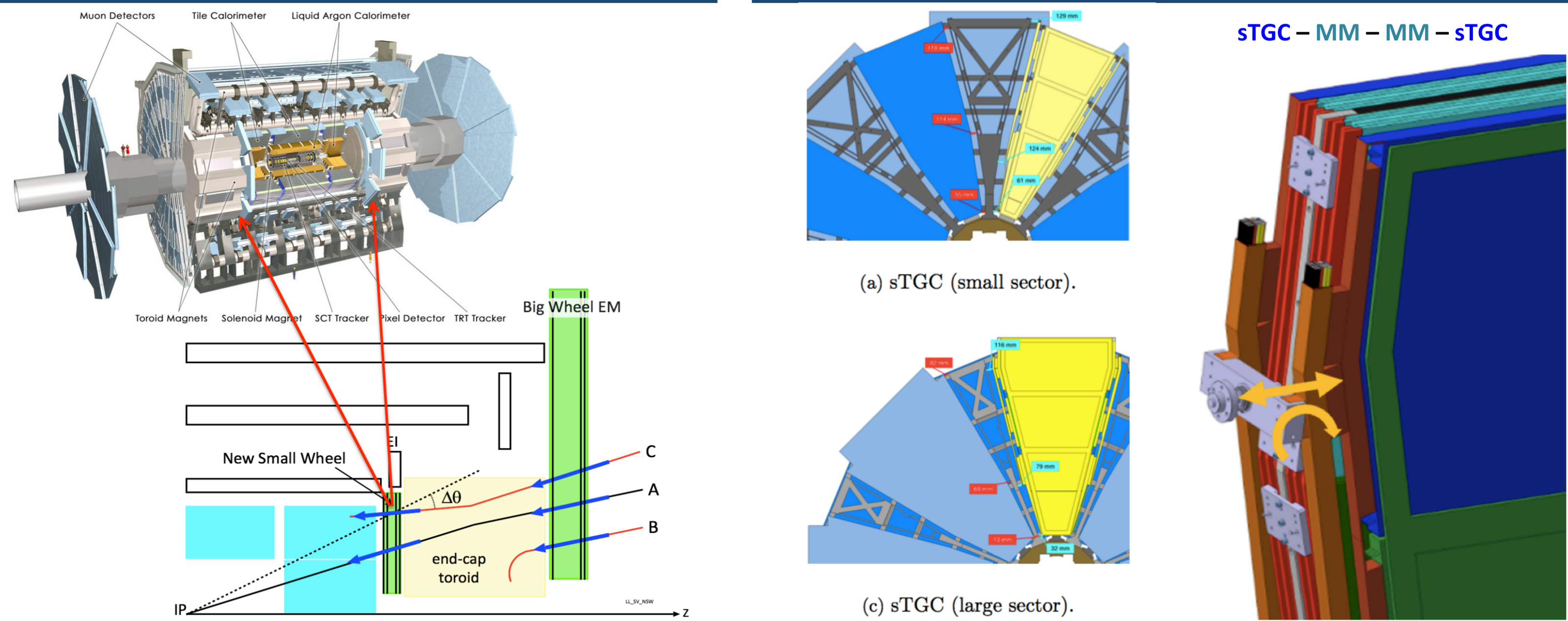
Introduction

L1 muon trigger rate is high in the forward region: fakes are currently 90% of the trigger rate in the end-cap region
Fake rate increases with luminosity: After LS2 LHC's instantaneous luminosity will be $2-3 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ (and up to $5-7 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ at HL-LHC), one bunch crossing every 25 ns.

Goal of the NSW :

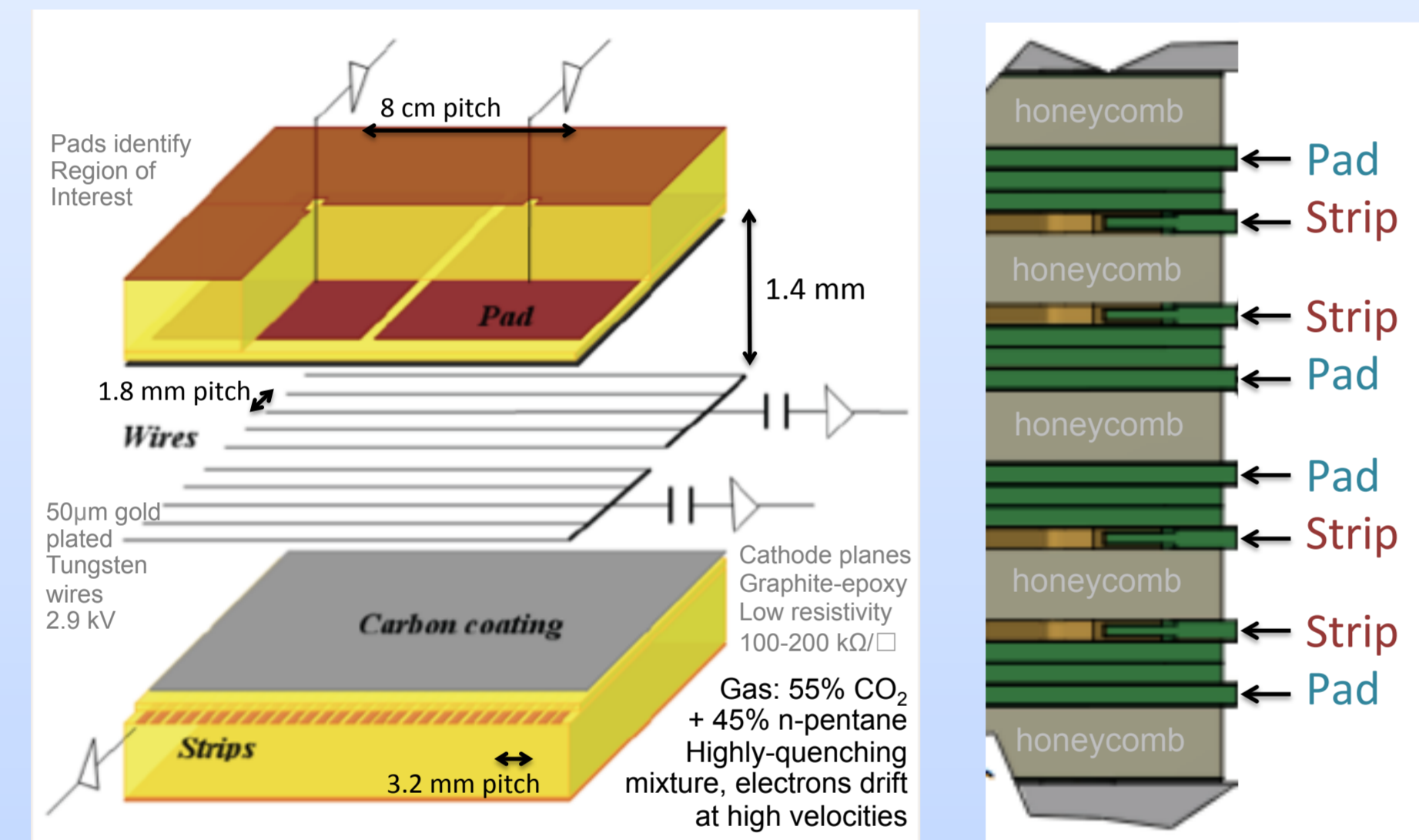
- Reconstruct muon tracks with high precision (Micromegas detectors, MM)
 - Provide information for the Level-1 trigger (small-strip Thin Gap Chambers, sTGC)
- Performance requirements:**
- 1 mrad angular resolution
 - 100 μm position resolution

The New Small Wheel



Small-Strip Thin Gap Chambers

Each module is built with 4 gaps each containing:
Strips, wires, pads
 Important to measure the angle of the muon trajectory: need high resolution on the strips



- Precise (<40 μm) alignment between layers by machining together strips with **precision brass insert**
- Cathode boards flat and parallel to better than 80 μm using **honeycomb filler**
- Avoid mechanical deformations by using the **same composite material (FR-4) everywhere**

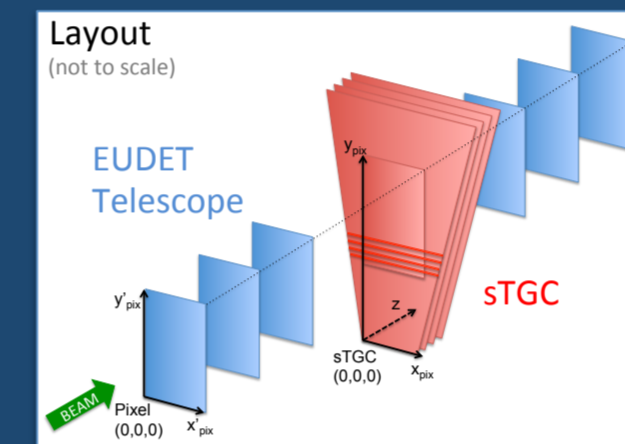
Experimental Setup at the Fermilab Test Beam

Beam:
 32 GeV pion beam
 Rate 1kHz
 Beam spread: 1 cm²

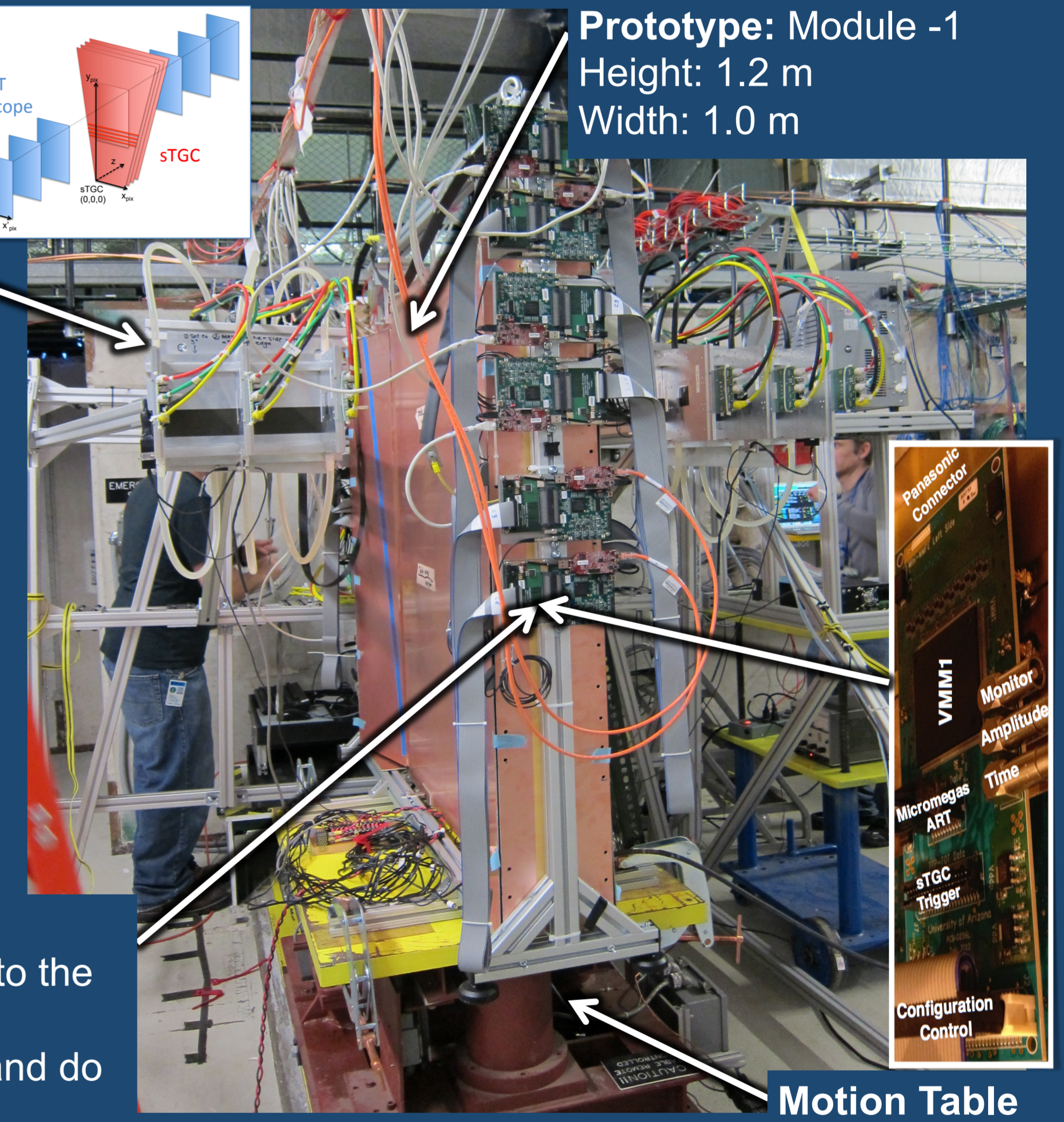
EUDET Telescope:
 3+3 pixel sensors:
 2cm (high) x 1cm (width)
 Pixel size: 18 x 18 μm

Trigger:
 2+2 scintillators + PMTs around the first and last pixel sensors

Read-out:
VMM: chip interface connected to the chamber (shaper discriminator)
Jack's Cards: configure VMM and do the Analog \rightarrow Digital conversion



Prototype: Module -1
 Height: 1.2 m
 Width: 1.0 m



Construction Steps

- 1) Components quality control:** Check precisely thickness and dimensions
 - 2) Part cleaning:** Use acetone and isopropyl-alcohol on strip boards and assembling parts to remove oily pollutants. Remove dust with dry air.
 - 3) Cathode board preparation:** Laminate 0.1 (0.2) mm pre-preg on readout copper layers
 - 4) Spacer gluing and wire winding:** Glue wire frame and internal support spacers using epoxy lacquer.
 - 5) Single layer assembling:** Place clean cathode boards with wire planes on a granite table (flatness deviations of less than 20 μm).
 - 6) Doublet, quadruplet assembling:** Glue two single planes on granite table (with honeycomb supports) Check for flatness
- Additional steps shown in the images:
 - Wiring anode wires using winding machine.
 - Cover support and frame areas with jigs
 - Spraying graphite mixture.
 - Close chambers with strip boards using precision pins for alignment
 - Apply vacuum on two sides

Test Beam Data Analysis and Results

