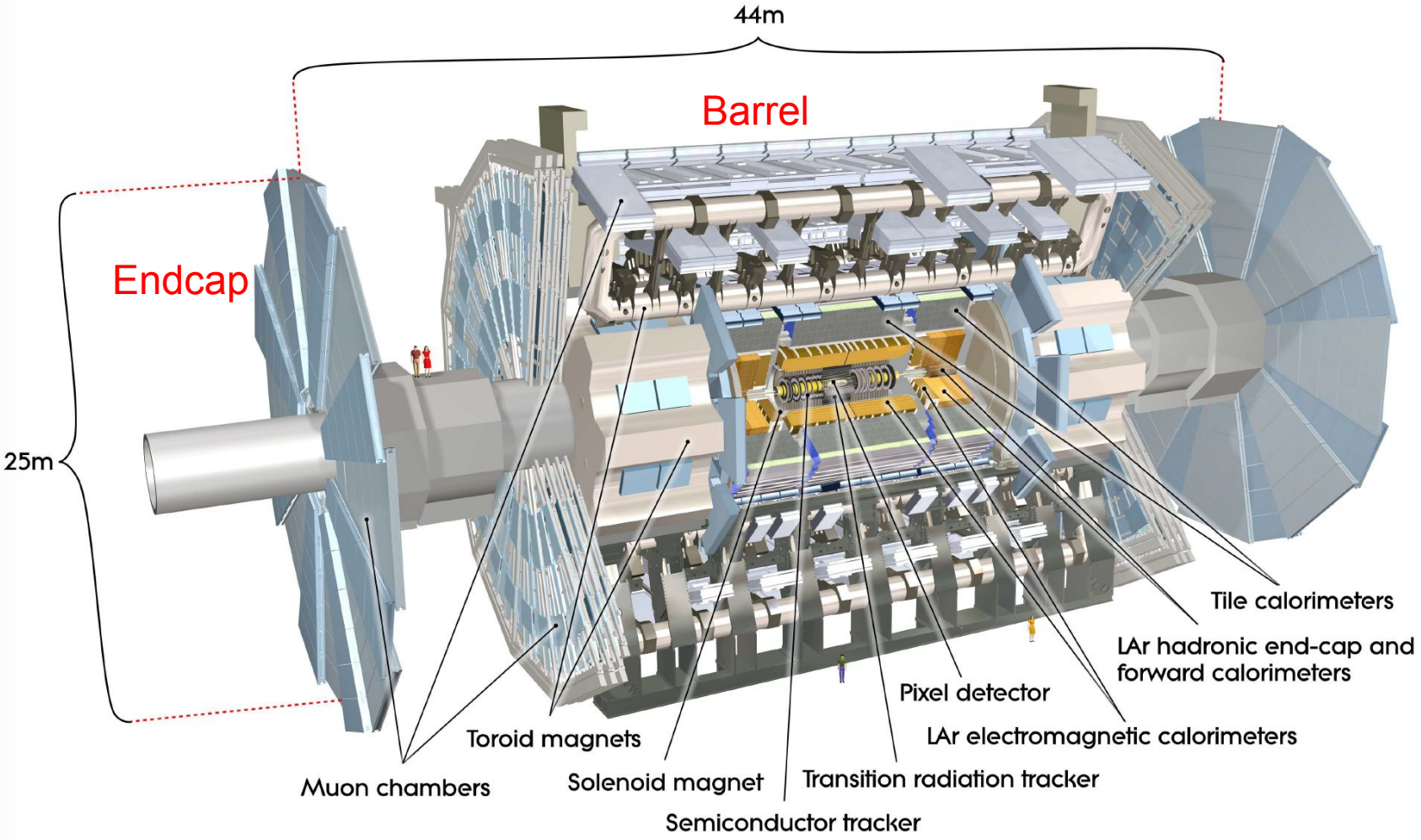
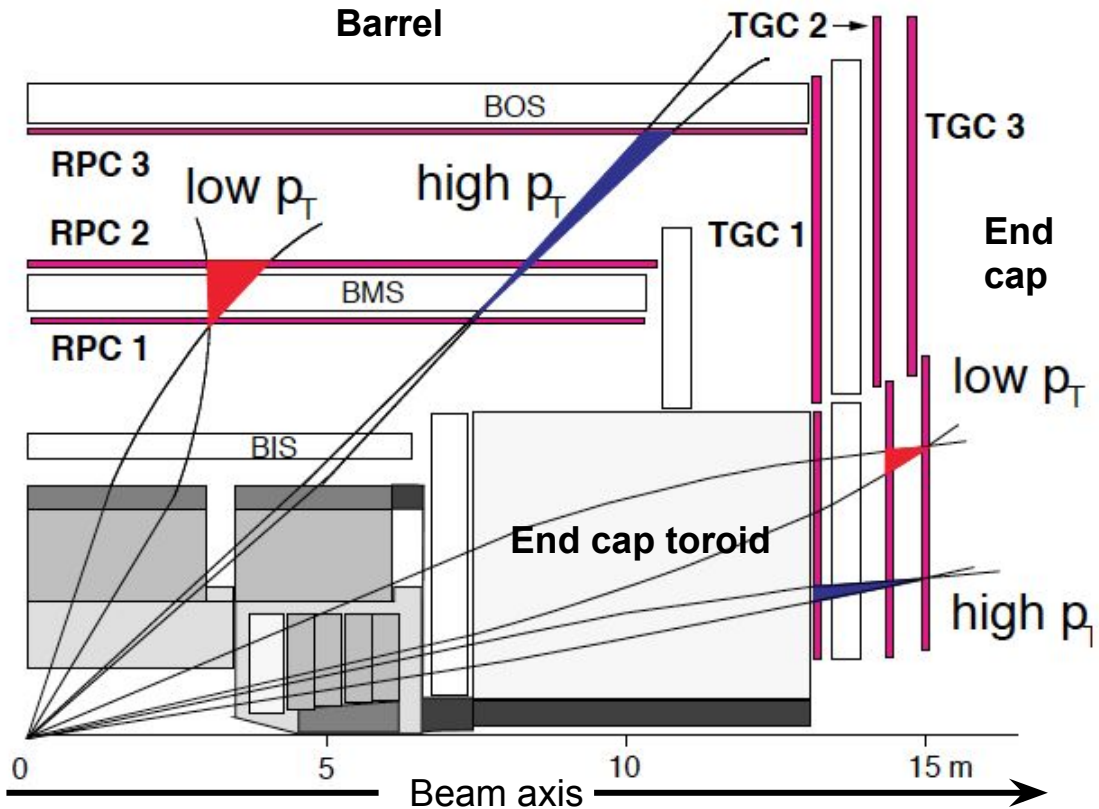
BIS78 Muon Spectrometer Vertical Slice

Alexis Mulski


44m
Barrel
Endcap
25m
Tile calorimeters
LAr hadronic end-cap and
forward calorimeters
Pixel detector
LAr electromagnetic calorimeters
Toroid magnets
Muon chambers
Solenoid magnet
Transition radiation tracker
Semiconductor tracker

Resistive Plate Chamber (RPC) Stations + Trigger Algorithm

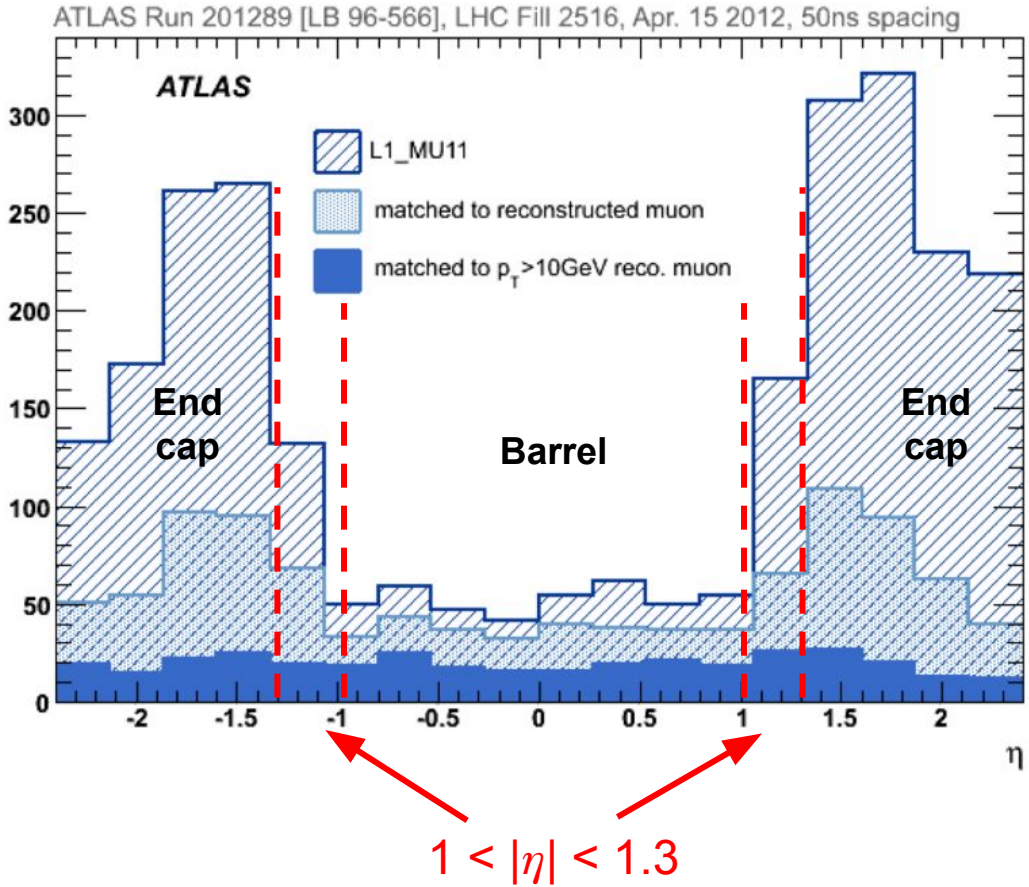


Three concentric RPC stations (2 in BM, 1 in BO): *no RPCs in barrel inner*

Low p_T tracks: coincidence in 1st two RPC layers

High p_T tracks: Requires additional outer coincidence

η distribution of the ROIs of the Level-1 single muon trigger



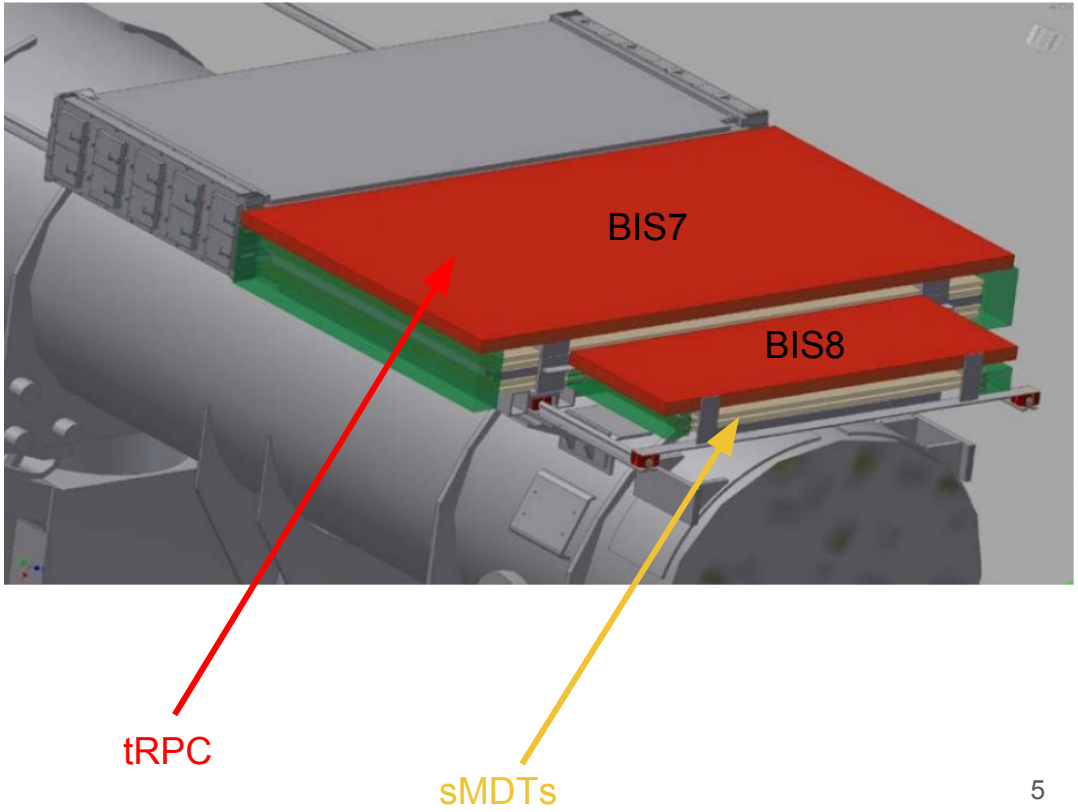
Many triggers in $|\eta| > 1$ compared to distribution of reconstructed muons

Most are <u>protons from end cap shielding</u>

In Run 3: LVL1 rate could reach *57.6 kHz* (p_T > 20 GeV), ~2x the allotted bandwidth

Upgrade Motivation

- Provide trigger coverage in 1 < $|\eta|$ < 1.3- currently only tracking
- Require confirming track segment to reduce LVL1 muon trigger rate to within trigger budget
- Serves as pilot project for Phase 2 upgrade
    - Replace MDTs in BIS78 regions with integrated sMDT and tRPC modules

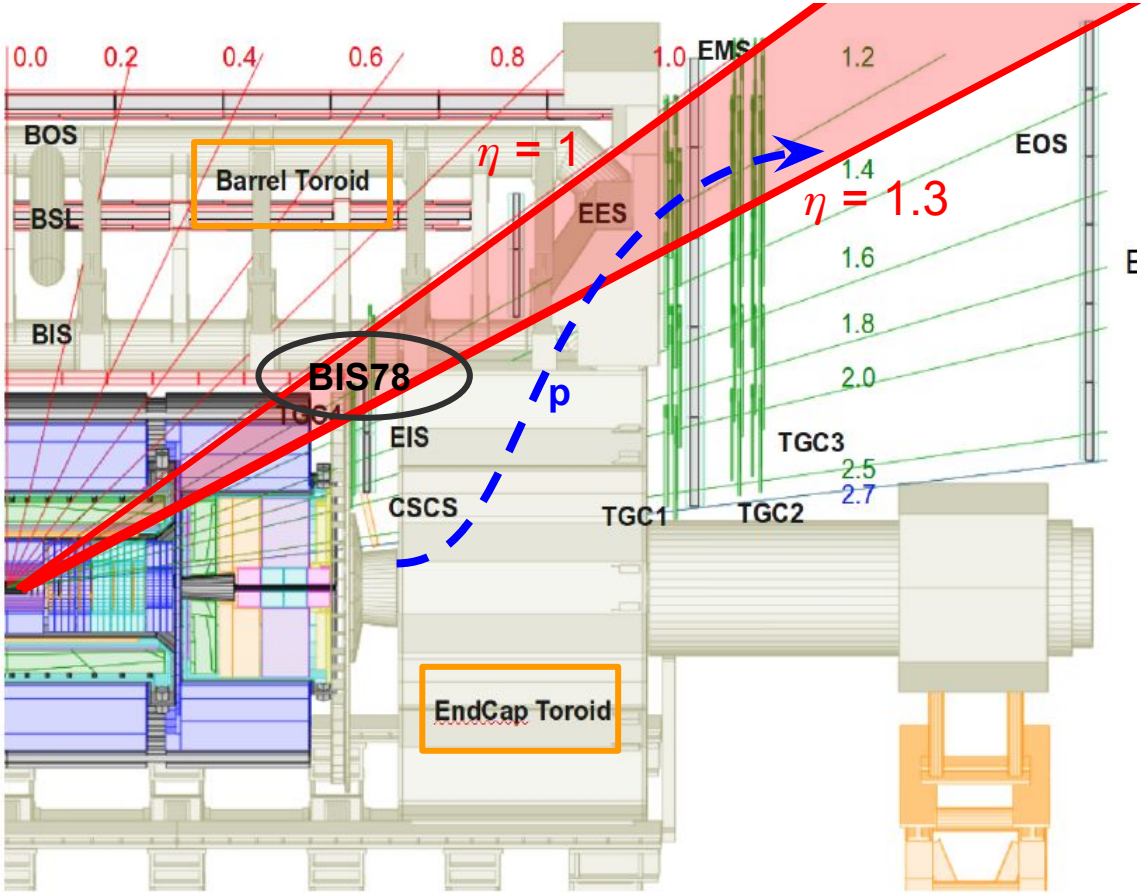


Placement

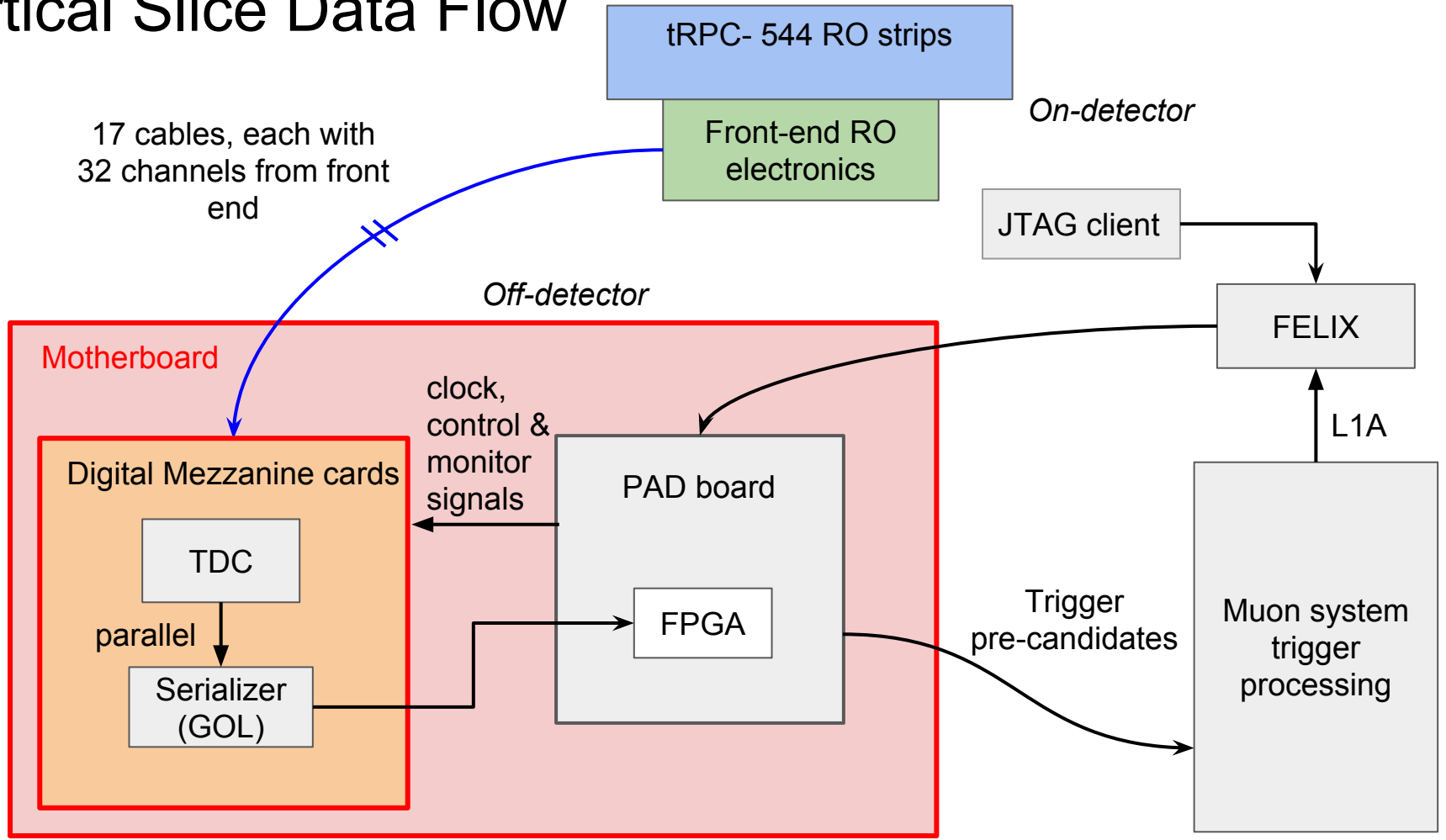
Located in barrel-endcap transition region: change in detector geometry, trigger technology, magnetic field

Upstream of endcap toroid (where protons are generated in low-energy interactions w/ shielding)

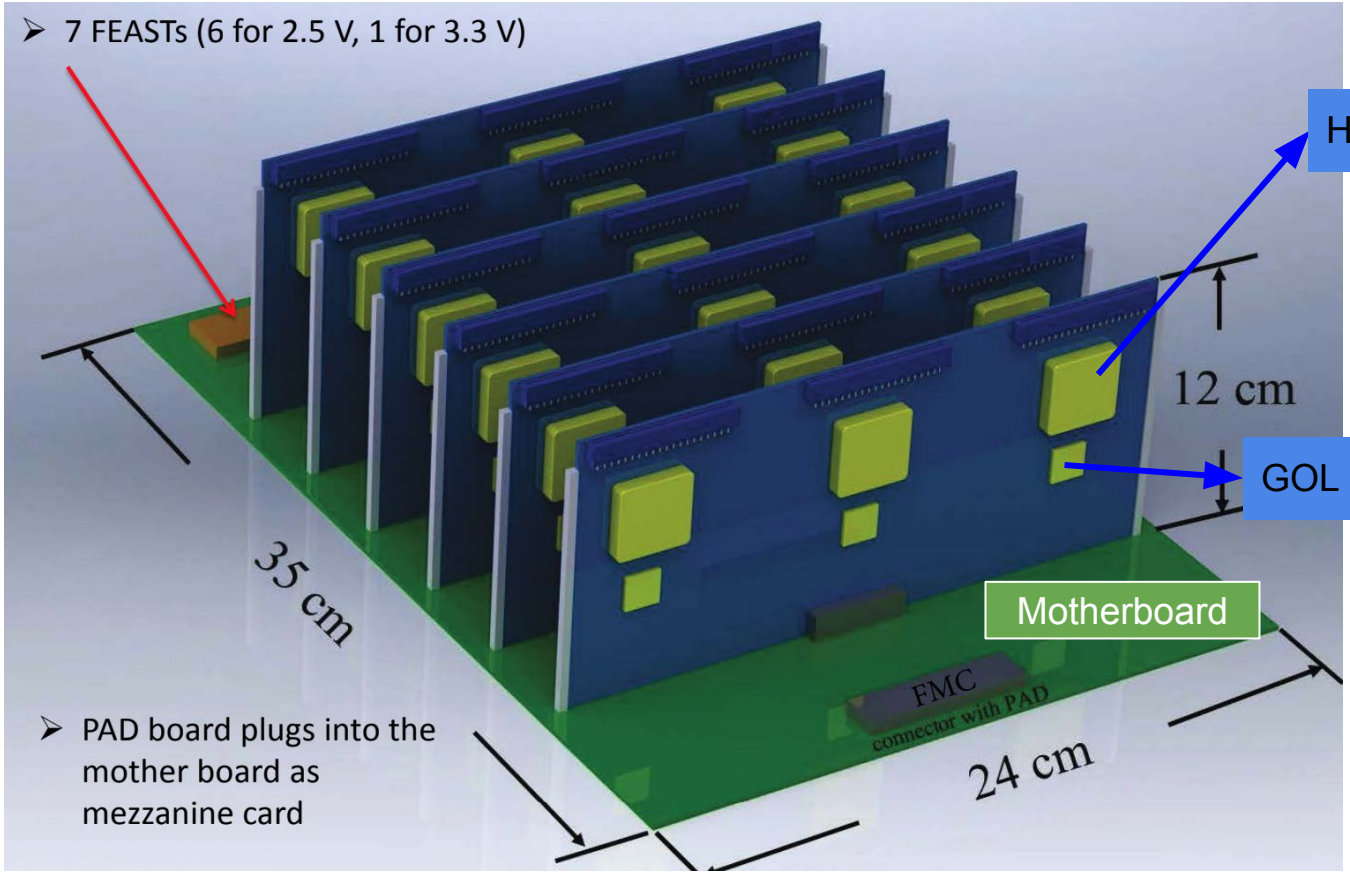
Provide confirming track with small wheel TGCs



Vertical Slice Data Flow



Signal Digitization Hardware



HPTDC & GOL = commercial chips that meet performance requirements

To service 544 RO strips: 17 total HPTDC GOL pairs on 6 total mezzanine cards

Vertical Slice Program at CERN

Objectives:

- Process & check data word integrity
- Verify functioning of all 6 motherboard slots for mezzanine cards
- Measure timing offsets
- Measure power consumption and heat dissipation
- Confirm placement of RO electronics in ATLAS
- Interface with FELIX for data readout and JTAG configuration
- Test with tRPC chamber

Test area in BB5-pre UMICH occupation

FELIX system

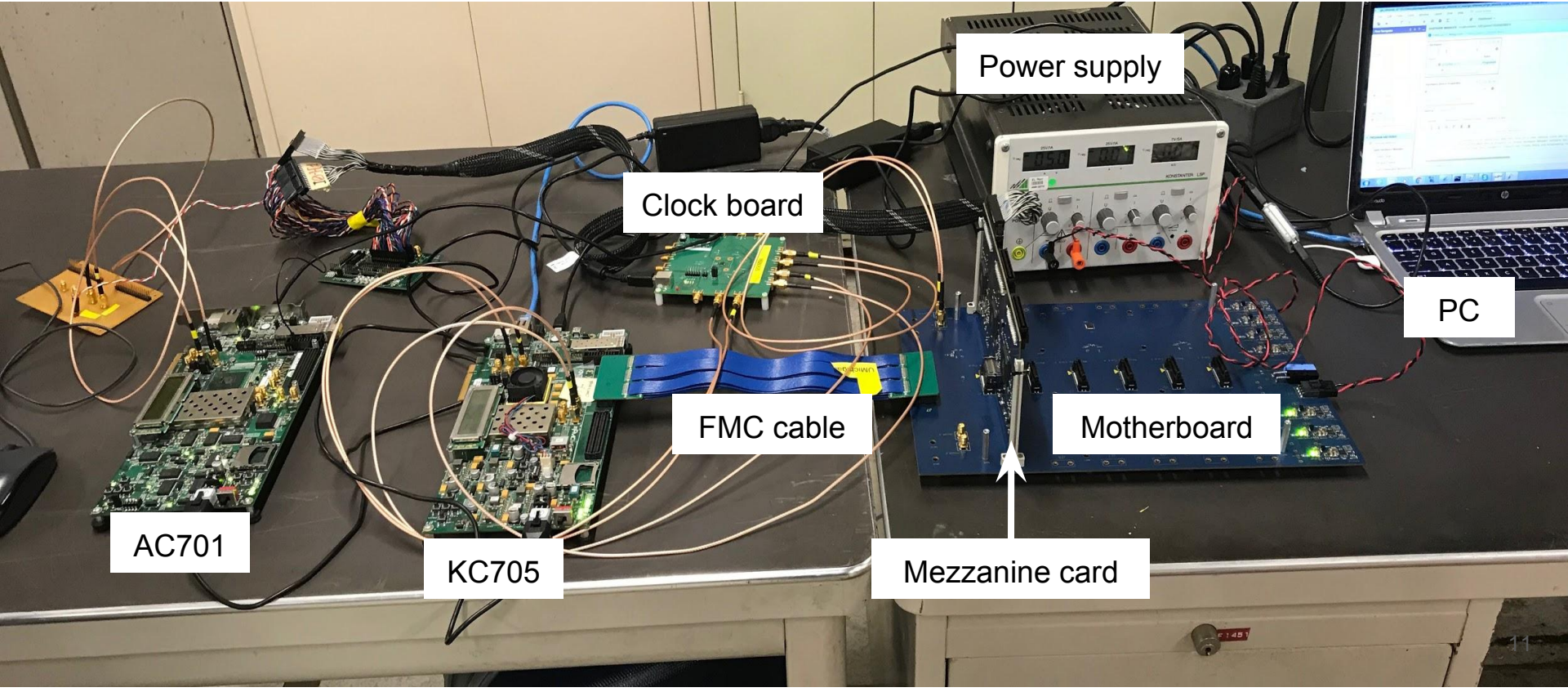
Power supply

Gas system

Digitization electronics and test chamber

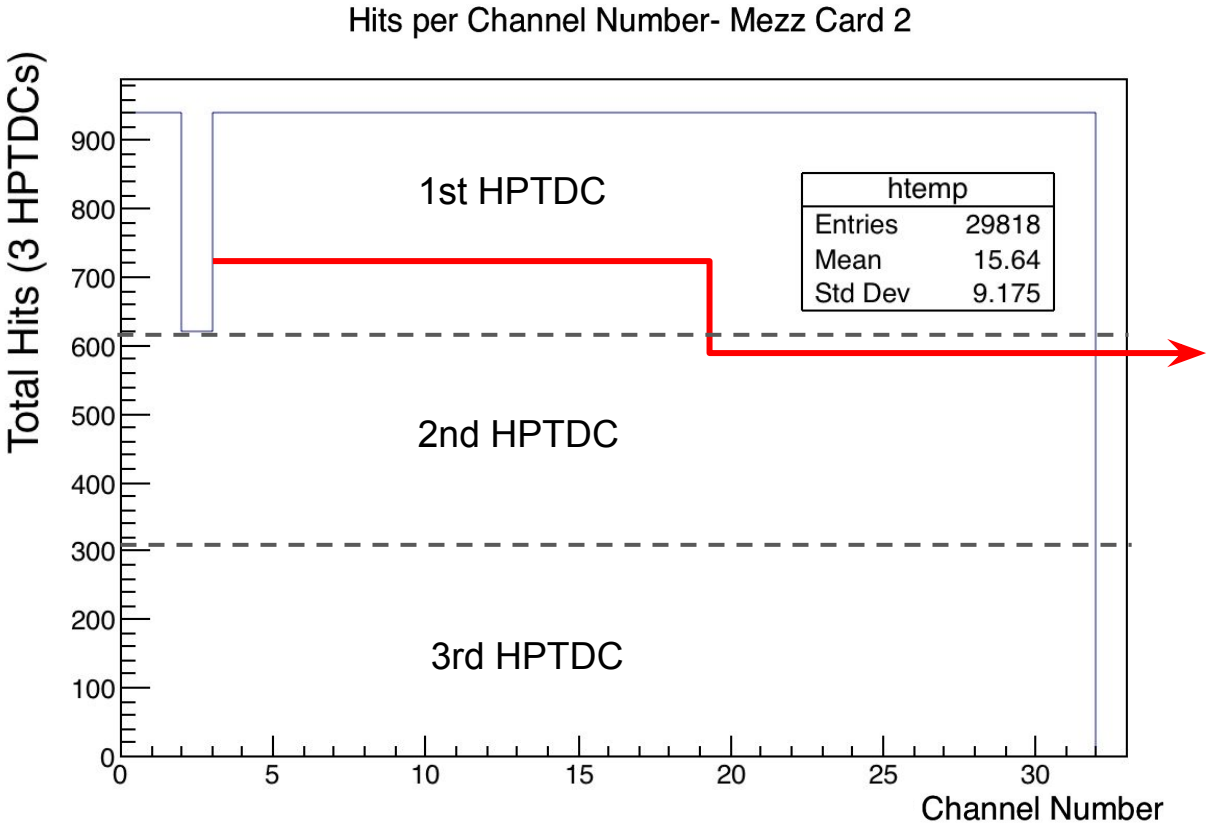
BB5 cows

Initial Setup- Testing Mezz Cards



Channel Functionality

Out of all 576 channels on 18 HPTDCs: one failed channel



Sent 10,000 LVDS signals to all 32 channels of an HPTDC simultaneously -> Each channel should have 312 hits

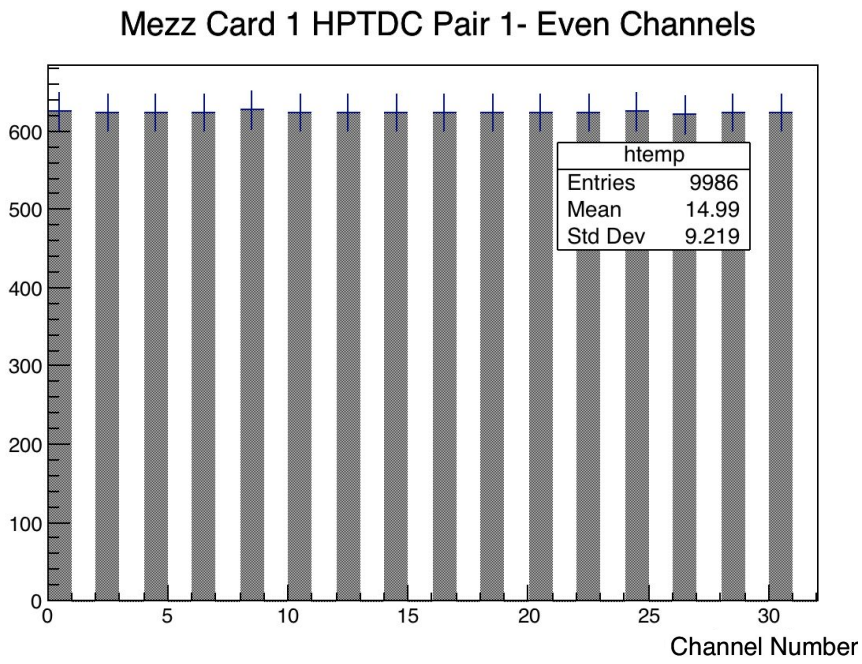
Add together hit count from all HPTDCs on mezz card: missing 312 hits from 1st HPTDC

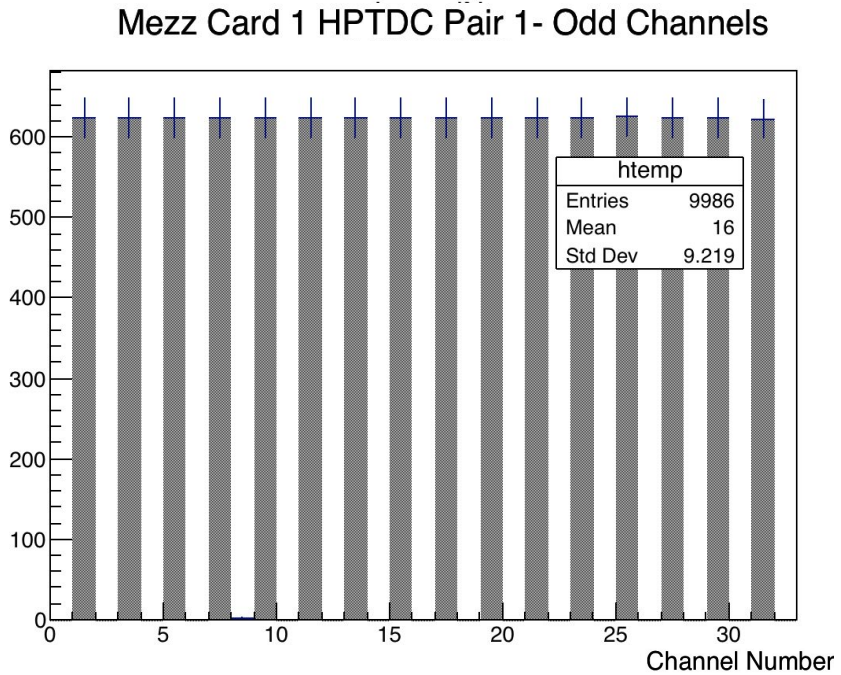
Tested all 32 P/N input pairs of HPTDC, no issue with inputs of HPTDC

Problem tracked either to bad connection from HPTDC to PCB or HPTDC itself is faulty- will return to manufacturer

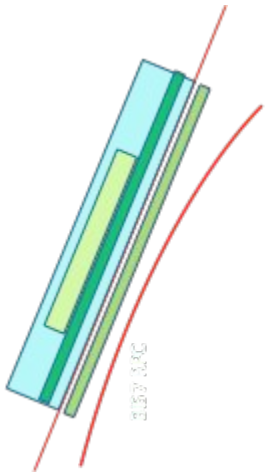
Cross-Talk Checks

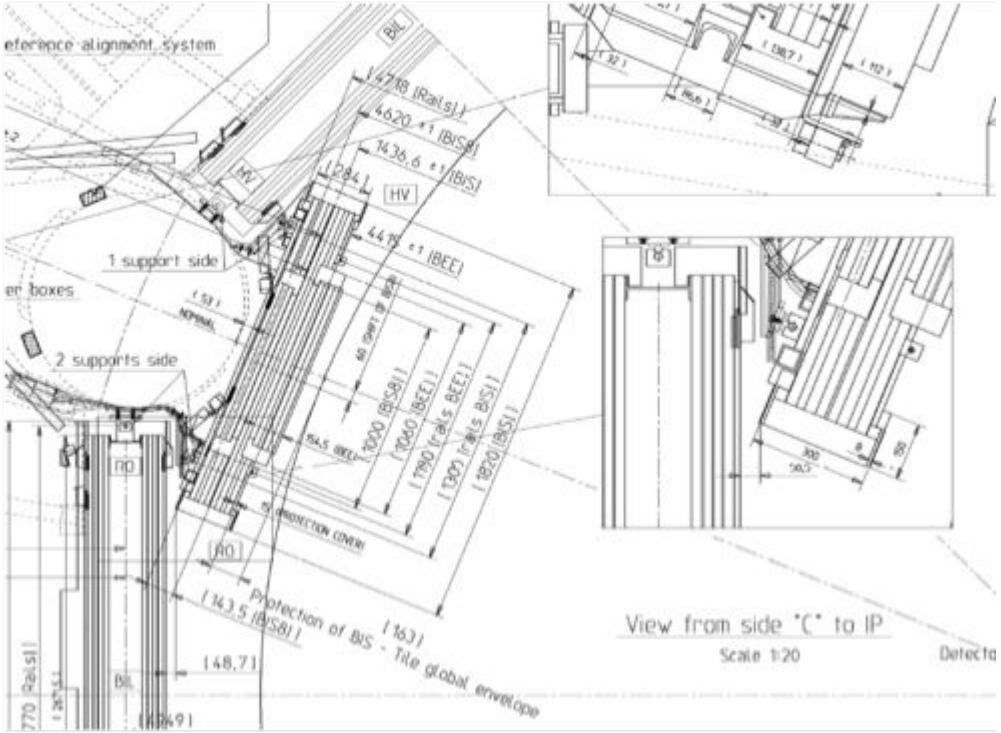
Sent LVDS signals generated at 3 kHz to 16 channels at a time on one HPTDC (odd channels, then even channels)- no hits on odd channels when even channels hit and vice versa





Placement in ATLAS

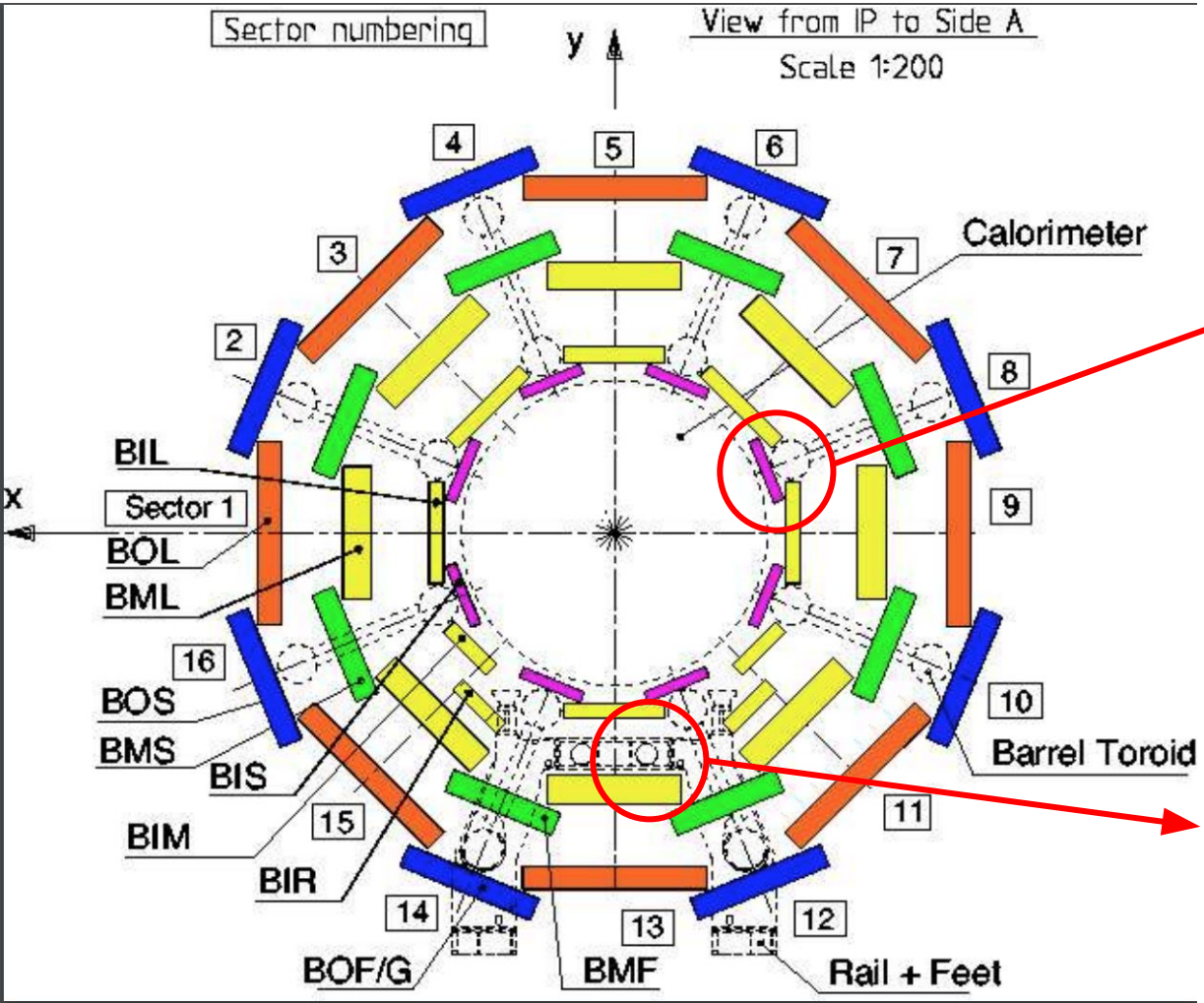


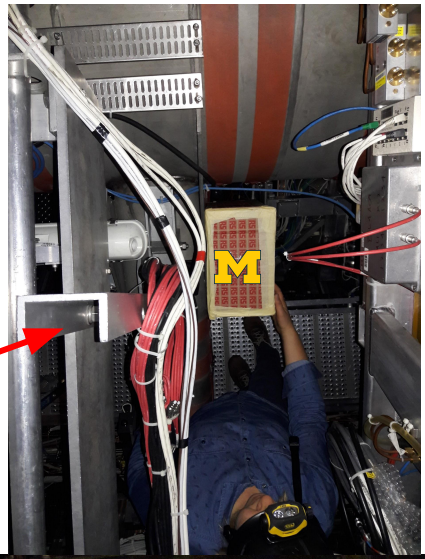


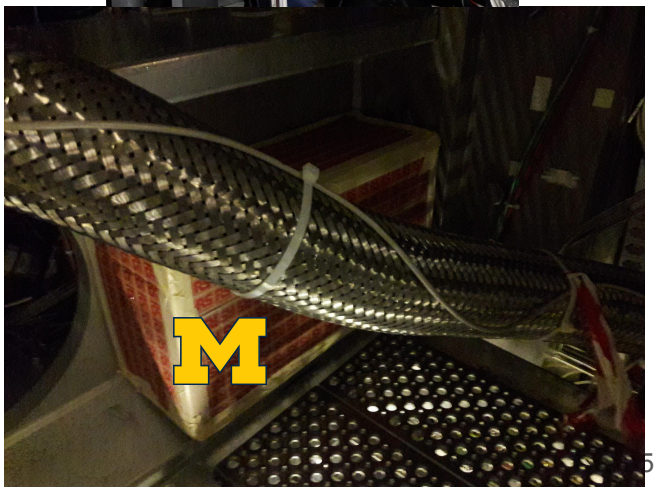
Must fit into tight envelope close to support rails, accommodate PAD + digitization electronics

To test spatial constraint: constructed a cardboard box* of appropriate dimensions + extra room- 59 cm x 33 cm x 20 cm

**Offical University of Michigan BIS78 muon spectrometer upgrade RO electronics test box*


Sector numbering
y
View from IP to Side A
Scale 1:200
4
5
6
3
7
Calorimeter
2
8
BIL
x
Sector 1
9
BOL
BML
16
10
BOS
BMS
BIS
Barrel Toroid
15
11
BIM
BIR
14
13
12
BOF/G
BMF
Rail + Feet



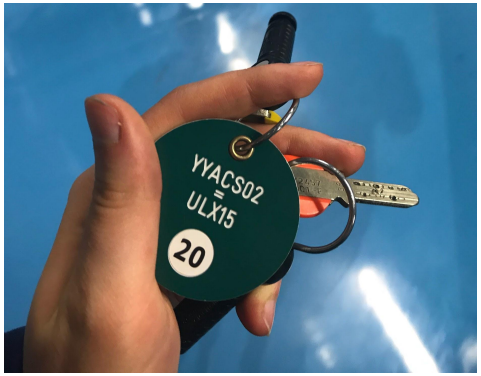


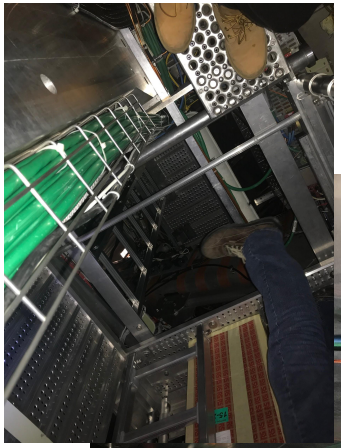

Atelier
PETZL

Coming Up

Project extended until August with support from UM ATLAS and UM Summer REU Program

- Connect to RPC test chamber in BB5
- Test in gif++ in H8 at high rates, 1st week of May
- Sending data out to FELIX
- Interface with PAD, trigger candidate identification
- Heat load tests


YYACS02
=
ULX15
20




POCHETTE
ISOTHERME
SEVERED BODY PARTS KIT
BLEEDING
KIT HEMO