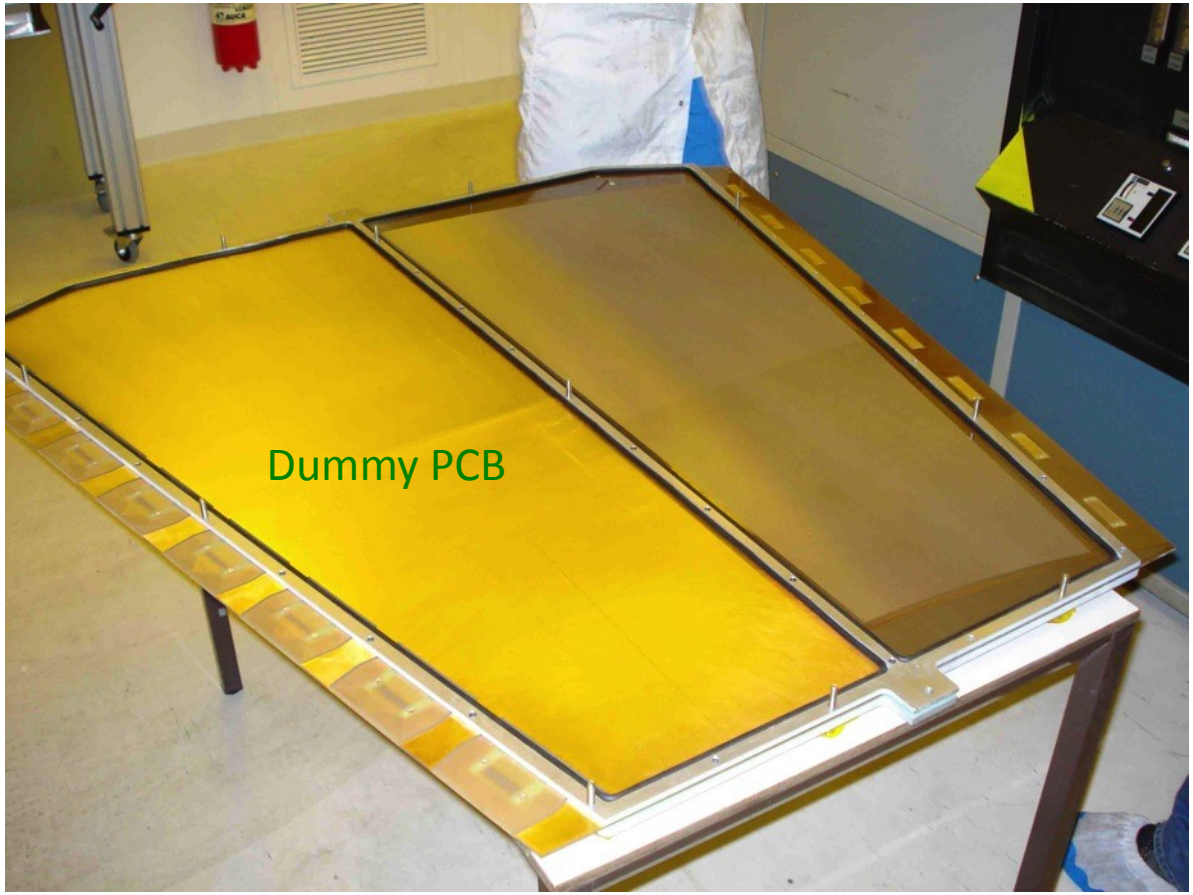
Micromegas for the ATLAS Upgrade

Status & prospects

Outline

- The large resistive chamber
- Two dimensional readout
- MMs in ATLAS cavern
- Plans

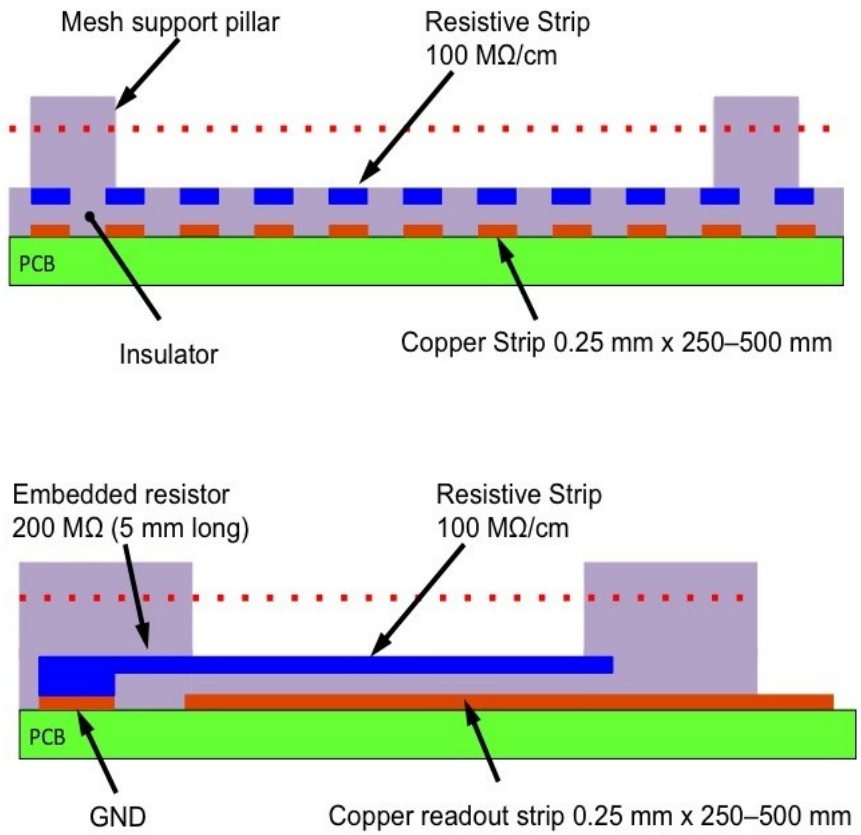
Standard MM 1.2 x 0.6 m^2 (Nov 2010)



- 2048 circular strips
- Strip pitch: 0.5 mm
- 8 connectors with 256 contacts each
- Mesh: 400 lines/inch
- 5 mm high frame defines drift space
- O-ring for gas seal
- Closed by a 10 mm foam sandwich panel serving at the same time as drift electrode

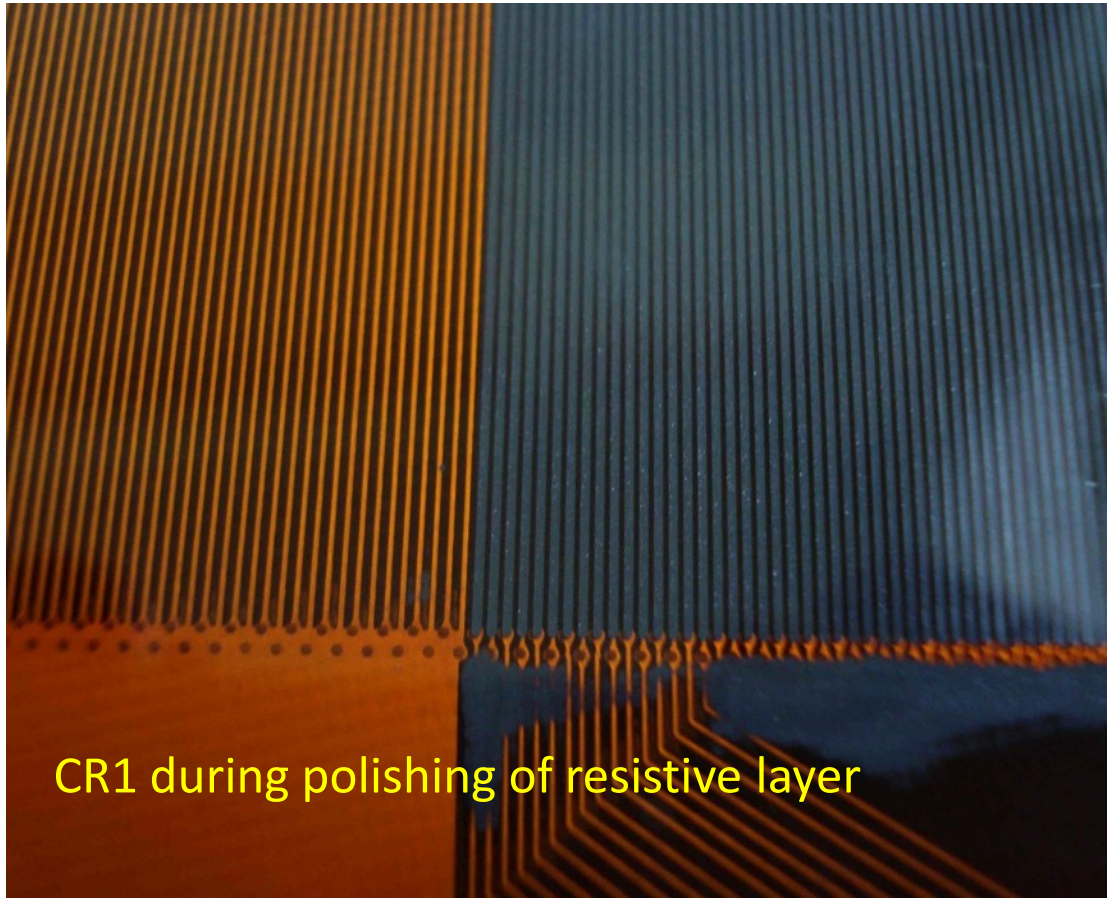
Large MM with resistive-strips (Jan 2011)

- Same spark-protection scheme as for R11–R16
- Thin insulation layer + resistive strips above readout strips
- Resistive strips are connected to ground through $R_{GND} \approx 200$ MΩ
- Resistivity along strips $R_{strip} \approx 100$ MΩ/cm



Construction of CR1

- Same PCB as for standard MM
- 500 µm strip pitch
- Same mesh as C1(400 lines/inch)
- Resistive strips only above connected strips



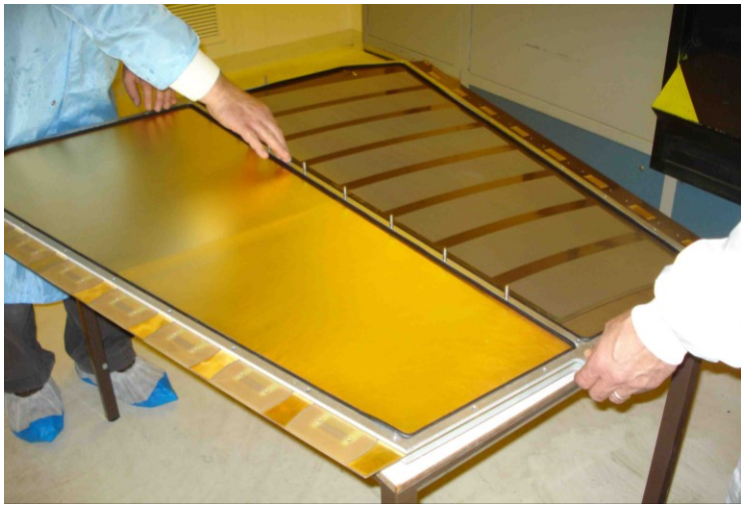
Large resistive-strip chamber (CR2)

- Production of second large chamber prototype with resistive strips started mid February at CERN/TE-MPE workshop
- Dimensions: 1.2 x 0.6 m^2, 2048 strips with 0.5 mm pitch
- Several provisions to avoid the problems encountered in 1st try
  - Adjustment of laminator
  - Mesh fixed in areas between connected strips, no pillars in this area
  - Careful development & curing

Chamber after pillar development but before curing

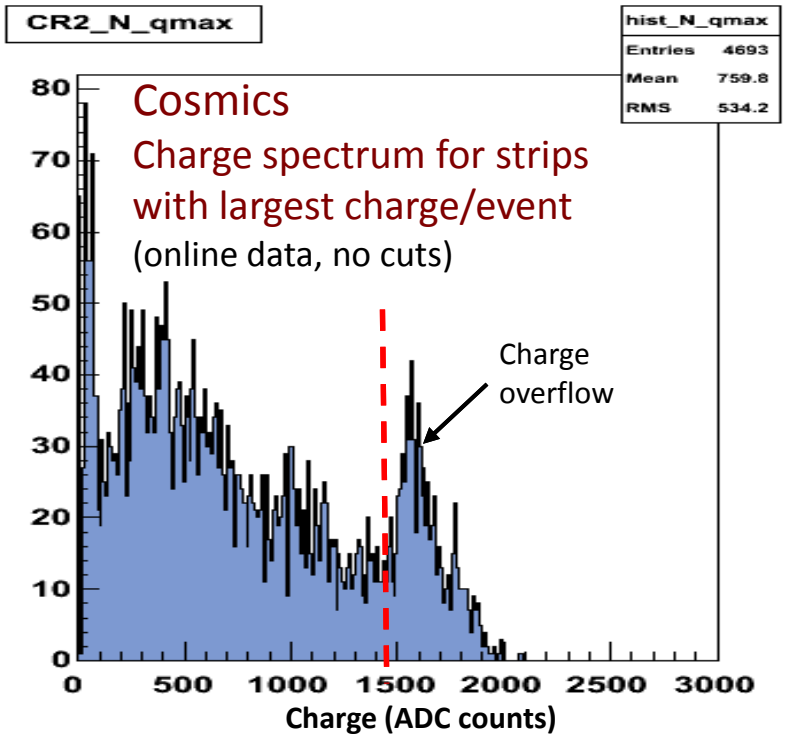
Large resistive MM (CR2) … cont'd

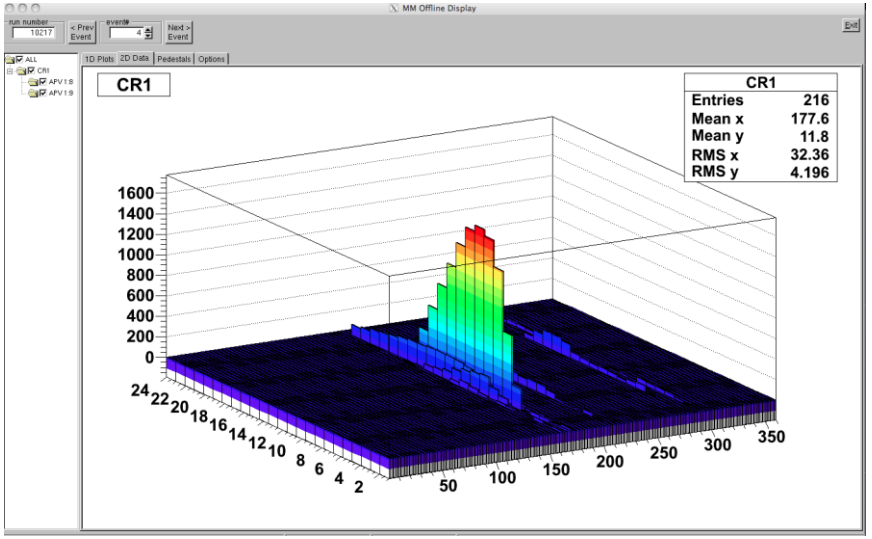
- Chamber delivered mid March
- Low current when tested in air (few 10's of nA at 850 V)
- Some (not well understood) problems with high currents (µA) during assembly, probably some dust/dirt; disappeared after cleaning
- OK after assembly and closing of chamber
- Connected to gas and applied HV a few hours later: no currents
- First cosmic tracks seen shortly after

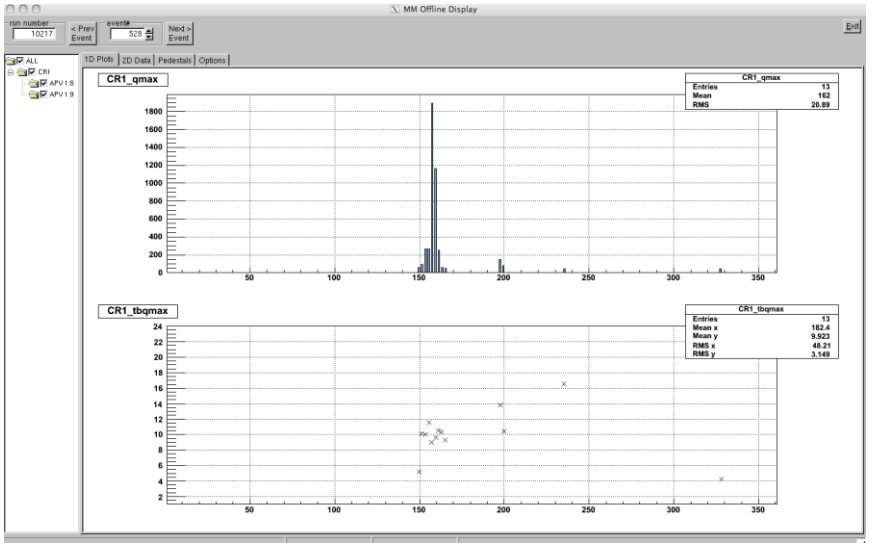


The very first events with CR2

- Connected one strip group to two APV25 hybrid cards = 2 x 128 ch
- Trigger on cosmics with scintillators
- Correct mapping b/w electronics channels and strips was not yet done for these events (done now)







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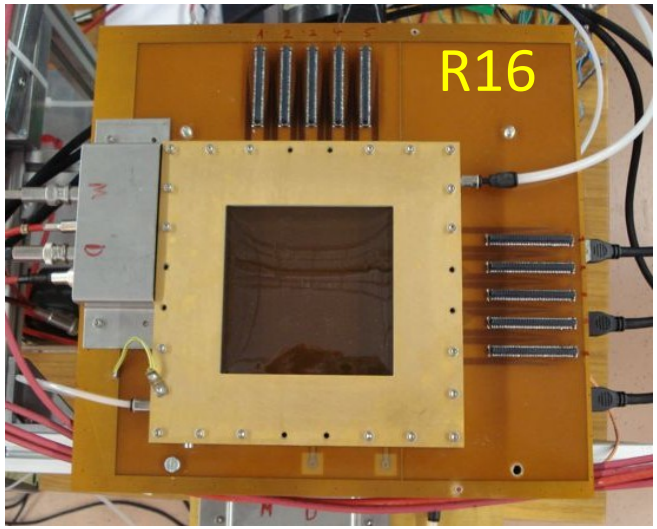
Eight resistive strip detectors tested

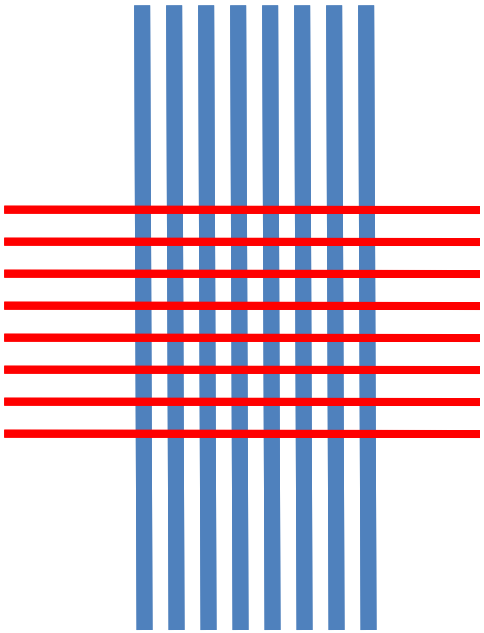
- Small 9 x 8 cm^2 chambers with 250 µm r/o strip pitch

	R_{GND} (MΩ)	R_{strip} (MΩ/cm)	N_R:N_{ro}
R11	15	2	1:1
R12	45	5	1:1
R13	20	0.5	1:1
R14	100	10	1:1/2/3/4/72
R15	250	50	1:1/2/3/4/72; d_{pillar}= 10 mm
R16	55	35	x-y (150/80)
R17	100	50	x-y (150/150); d_{pillar}= 2.5 mm
R18	150	100	x-y (150/150); d_{pillar}= 5 mm

- Variety of resistance values
- Different configurations
- Gas gains
  - 2–3 x 10^4
  - 10^4 for stable operation

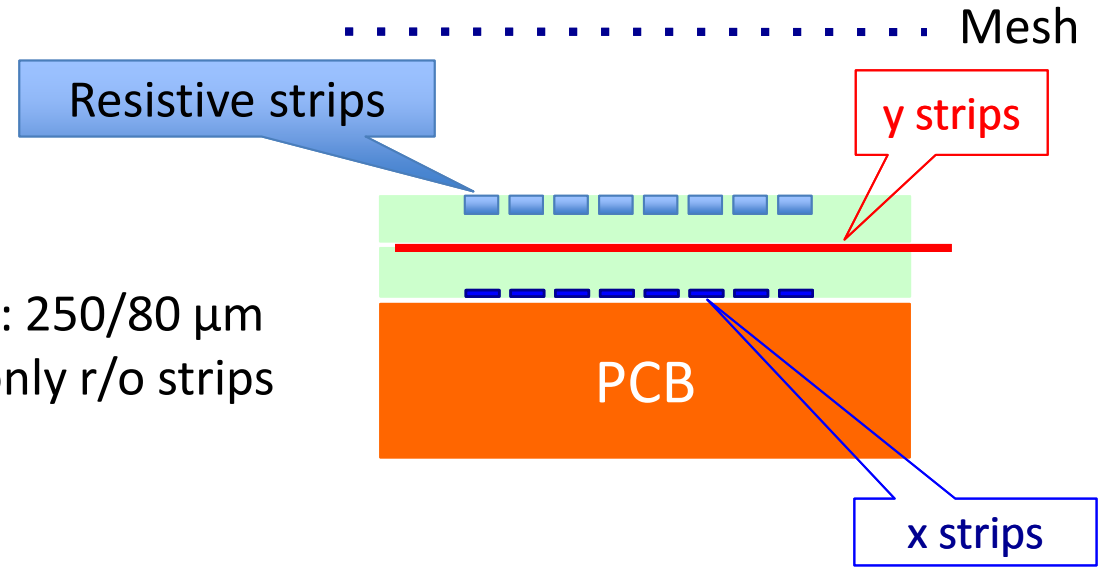


R16 with 2D readout



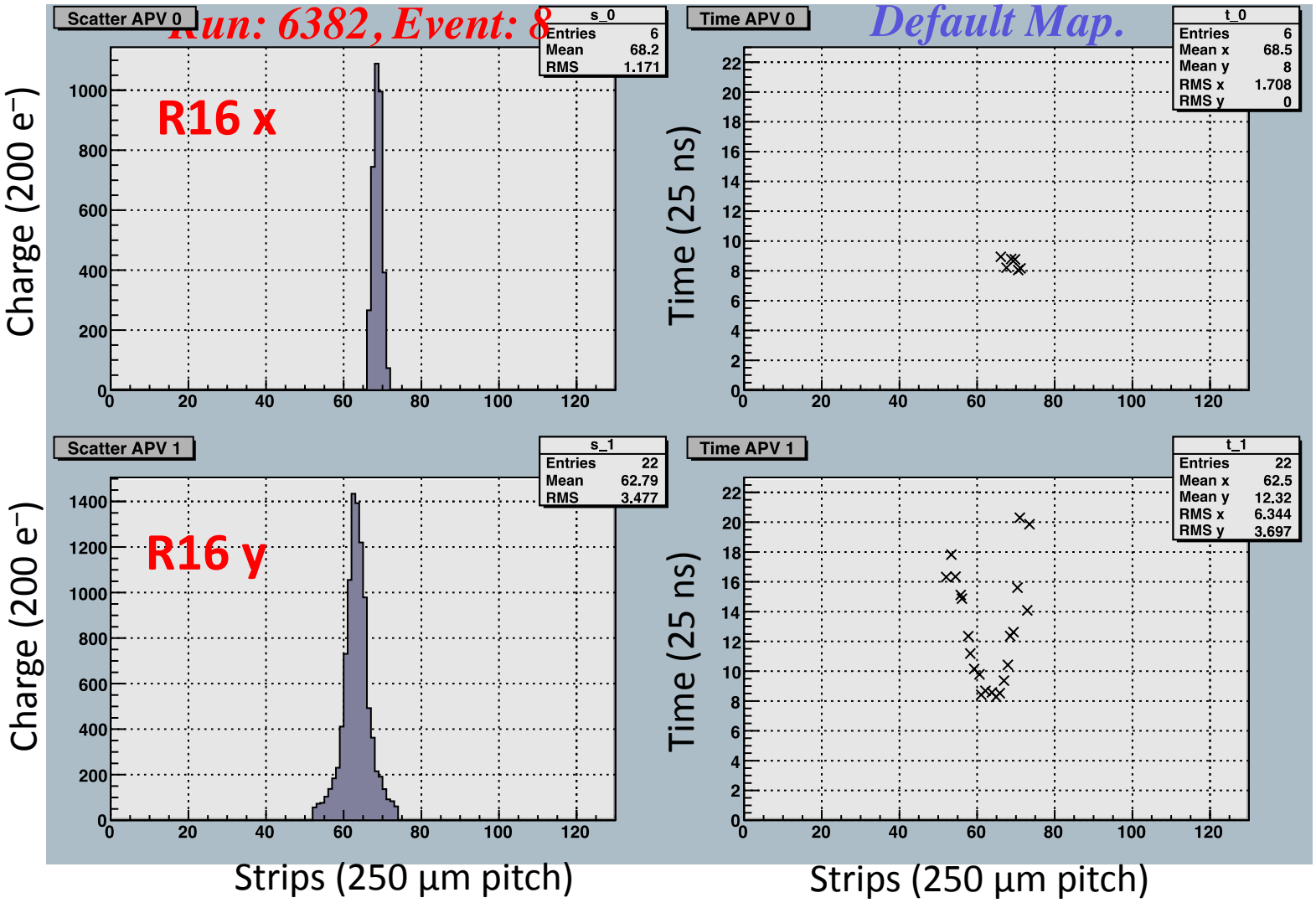
x strips: 250/150 µm
r/o and resistive strips

y: 250/80 µm
only r/o strips

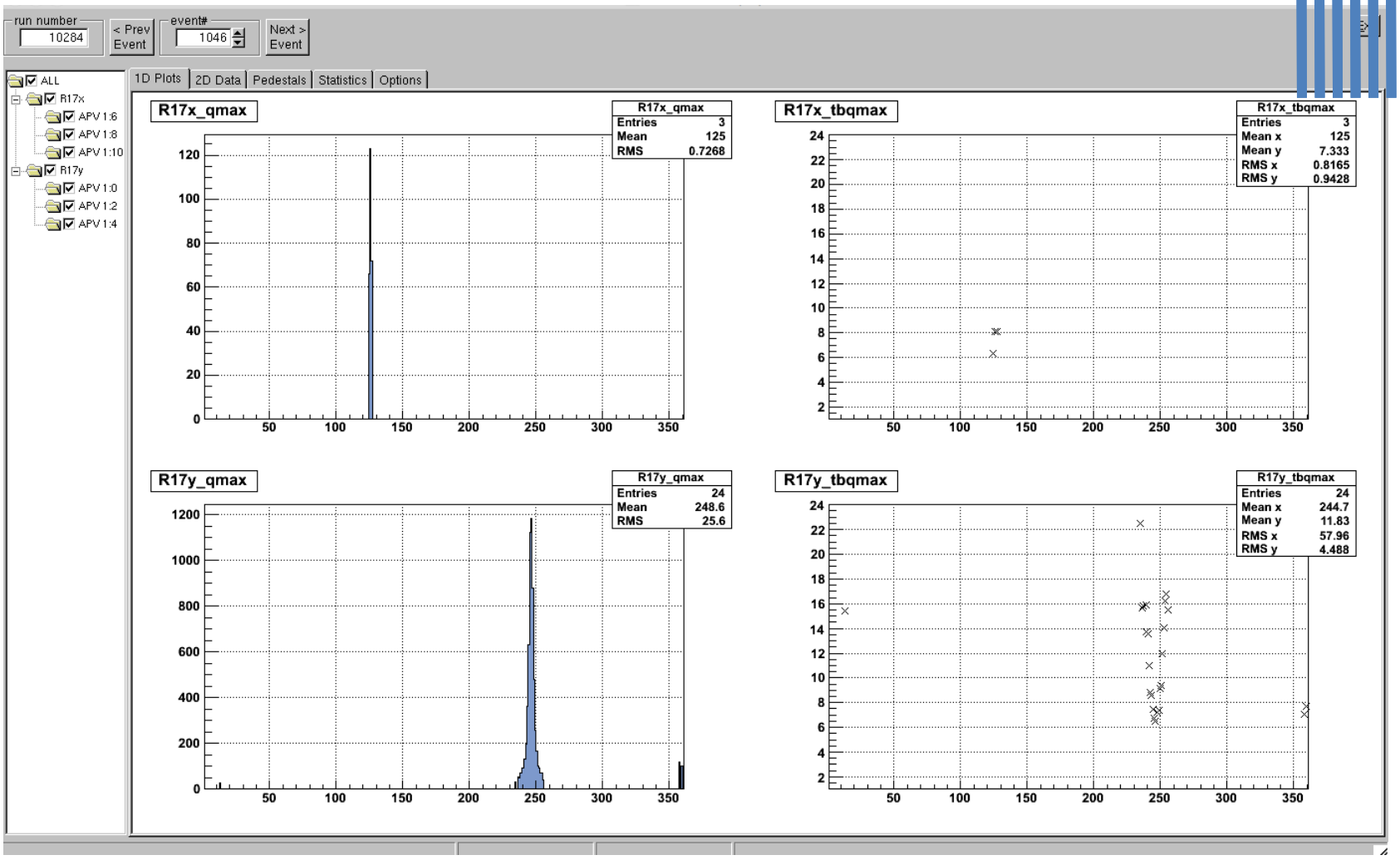


Resistivity values
$R_G \approx 55$ MΩ
$R_{strip} \approx 35$ MΩ/cm

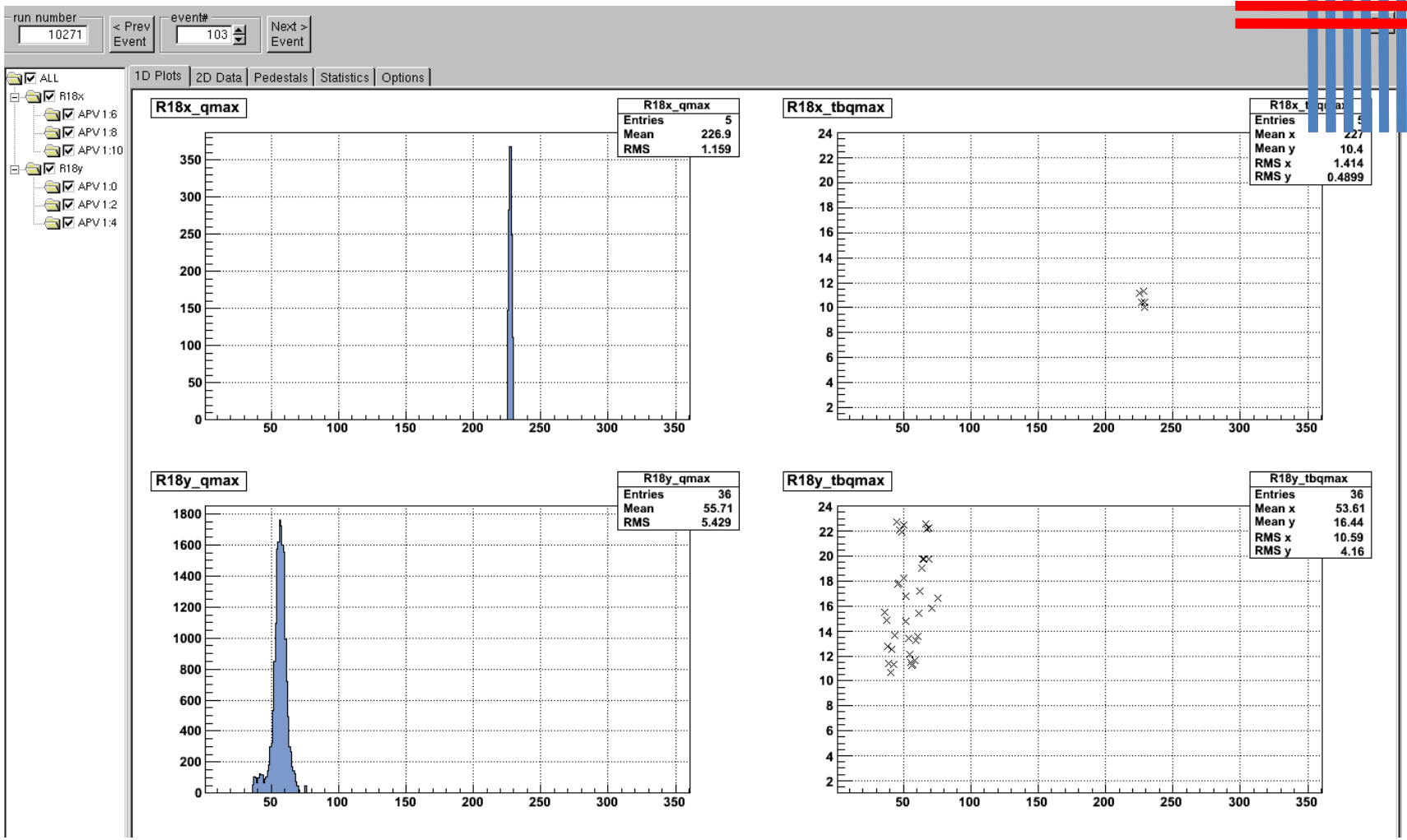
R16 x-y event display (^{55}Fe γ)



R17 event


run number
10284
< Prev Event
event#
1046
Next > Event
ALL
R17x
APV 1:6
APV 1:8
APV 1:10
R17y
APV 1:0
APV 1:2
APV 1:4
1D Plots
2D Data
Pedestals
Statistics
Options
R17x_qmax
R17x_qmax
Entries 3
Mean 125
RMS 0.7268
R17x_tbqmax
R17x_tbqmax
Entries 3
Mean x 125
Mean y 7.333
RMS x 0.8165
RMS y 0.9428
R17y_qmax
R17y_qmax
Entries 24
Mean 248.6
RMS 25.6
R17y_tbqmax
R17y_tbqmax
Entries 24
Mean x 244.7
Mean y 11.83
RMS x 57.96
RMS y 4.488

R18 event


run number
10271
< Prev Event
event#
103
Next > Event
ALL
R18x
APV 1:6
APV 1:8
APV 1:10
R18y
APV 1:0
APV 1:2
APV 1:4
1D Plots
2D Data
Pedestals
Statistics
Options
R18x_qmax
Entries 5
Mean 226.9
RMS 1.159
R18x_tbqmax
Mean x 227
Mean y 10.4
RMS x 1.414
RMS y 0.4899
R18y_qmax
Entries 36
Mean 55.71
RMS 5.429
R18y_tbqmax
Entries 36
Mean x 53.61
Mean y 16.44
RMS x 10.59
RMS y 4.16

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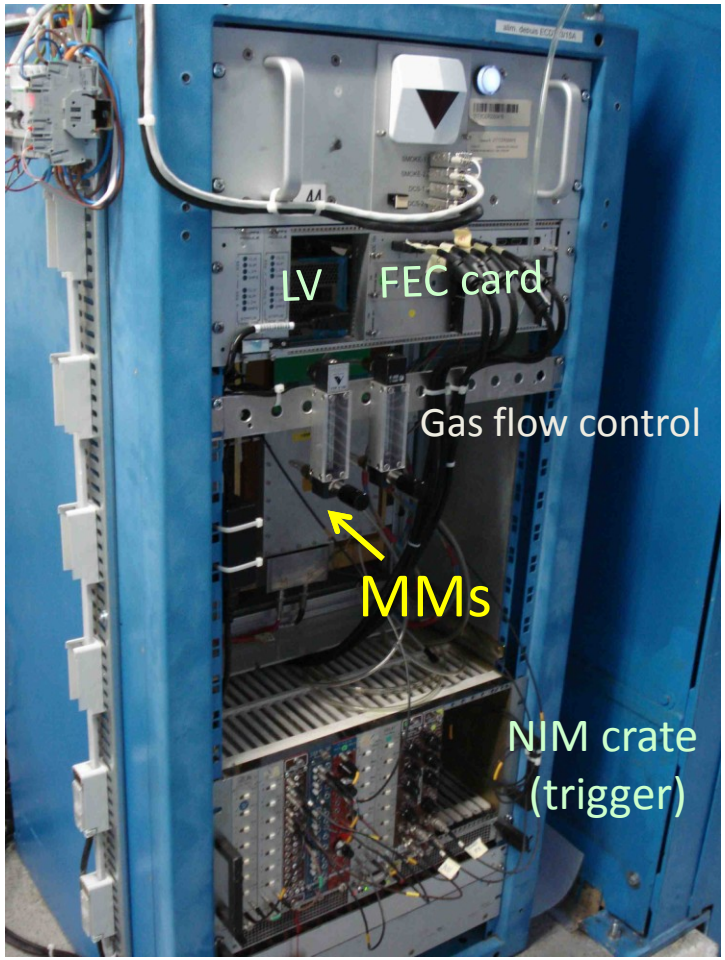
MM test in ATLAS cavern

- During February the infrastructure was installed in the ATLAS cavern
  - Location on HO (side A) 6th floor, R=6 m
  - HV and ethernet cables to USA15; HV mainframe and DAQ PC in USA15
  - Gas pipe from GSX1 to location close to rack
  - Small rack connected to safety system
- End of March installation of MMs & DAQ
  - 2 MMs for triggering only (standalone)
  - 2 MMs (R16 with xy readout and R13)
  - DAQ using the SRS system and DCS (Talks by M. Byszewski and G. Iakovidis in WG5 session)
- So far only x strips read out; lack of APV25 hybrids cards

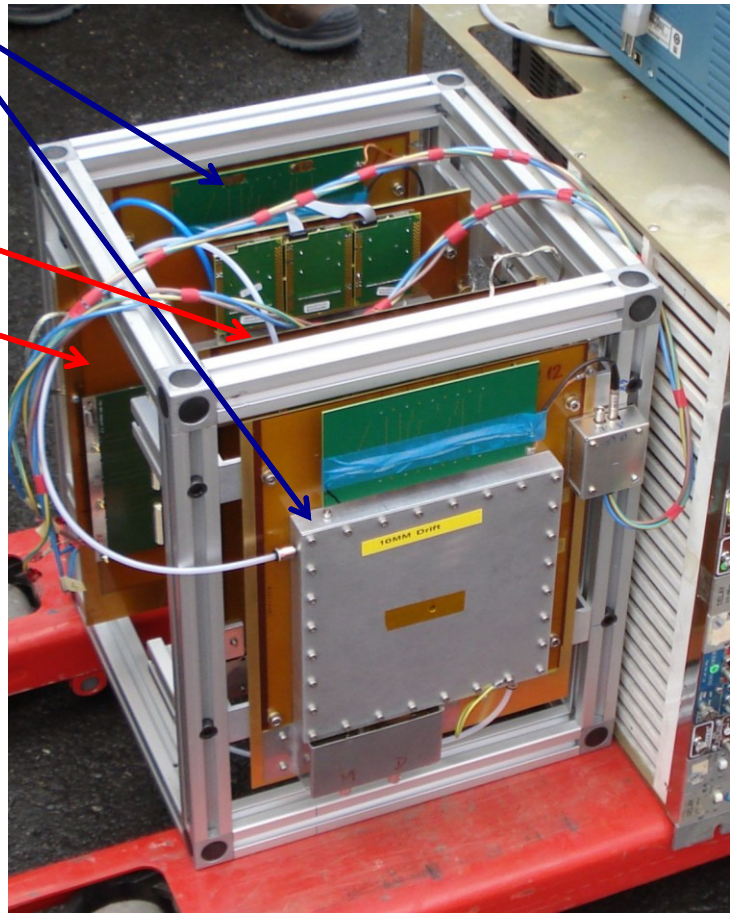


MMs in ATLAS cavern

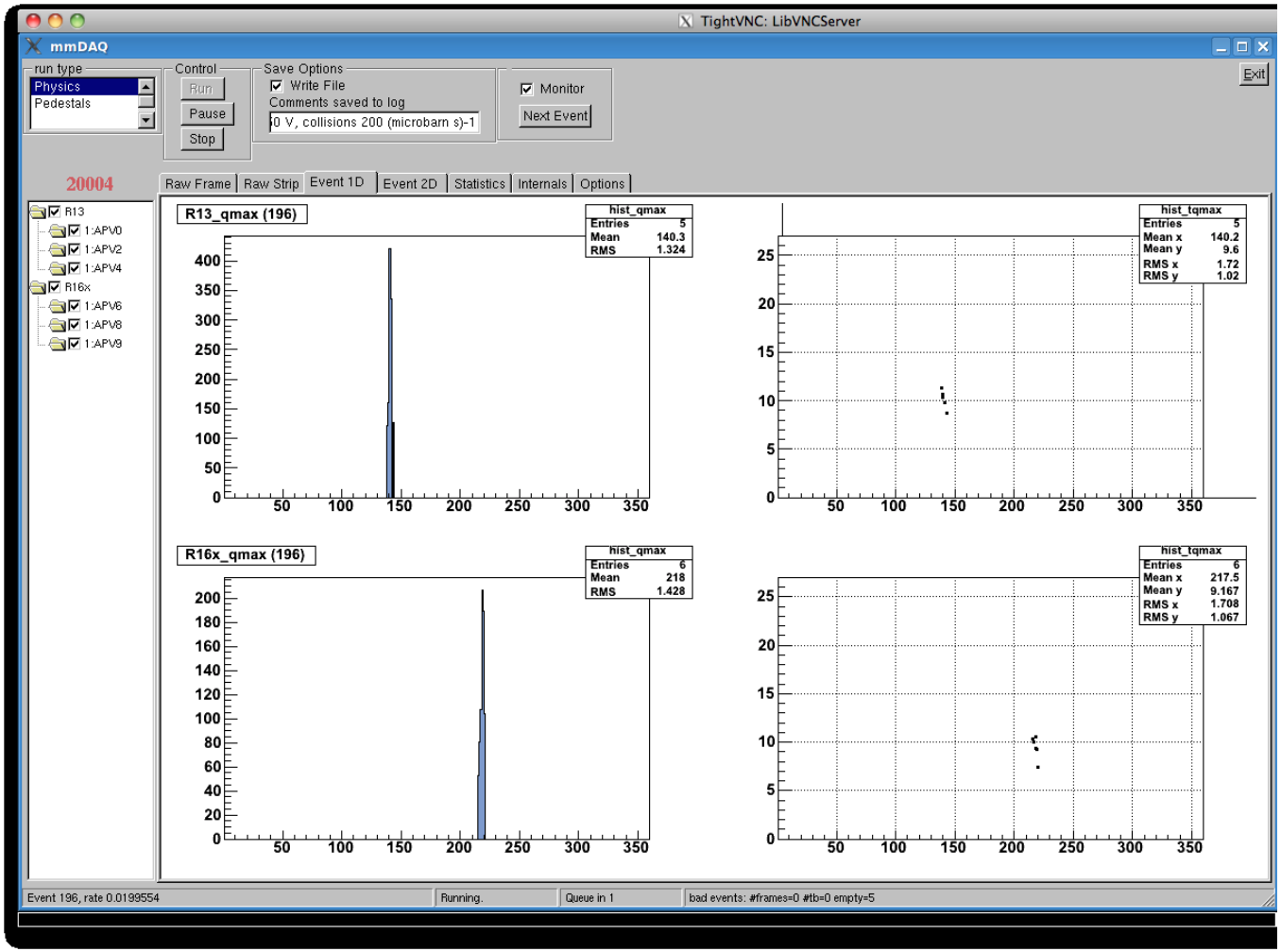
Trigger MMs

R13

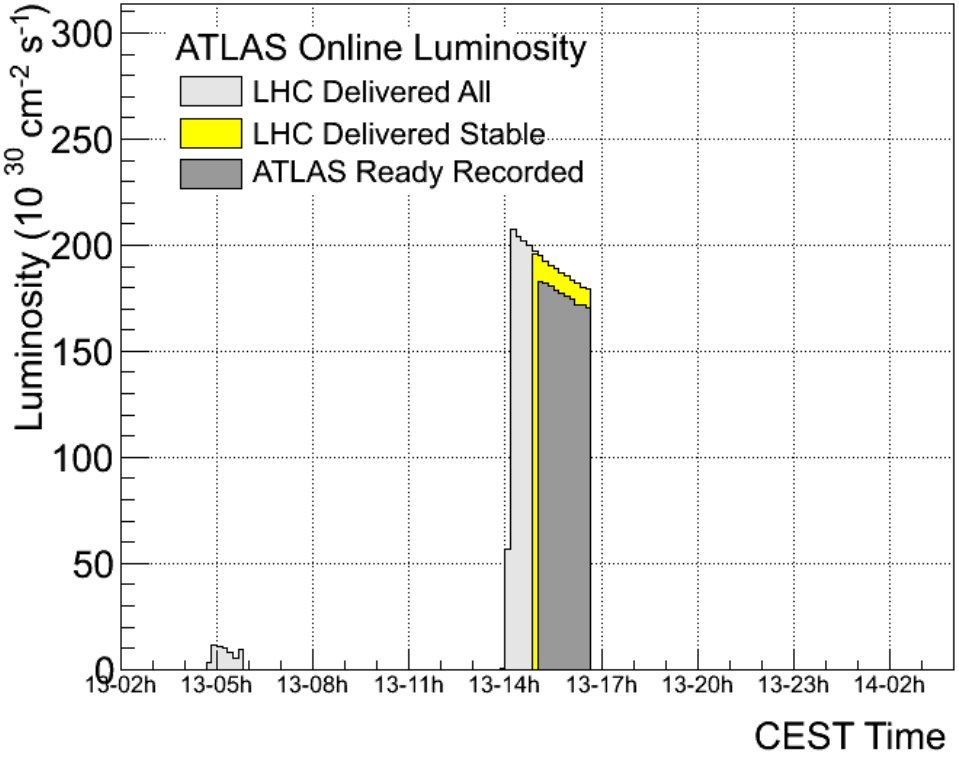
R16



First collision events (yesterday)

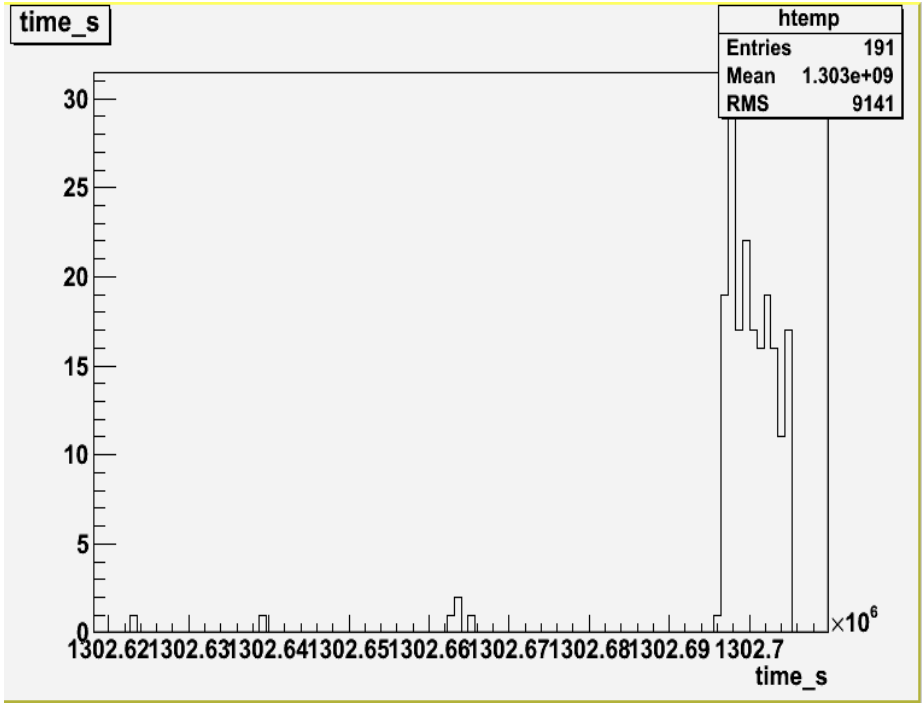


LHC luminosity ‘measurement’ with MMs



Events as function of time taken yesterday afternoon

Rate at L ≈ 2 x 10^{32} cm^{-2} s^{-1} is about 1/minute



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MM project time line

- 2011: Summer/Fall: Proposal for Small Wheel Upgrade
  - Construction of CSC-size chamber with several layers and xy readout (to be installed in ATLAS); fully equipped with first version of new VMM1 chip (BNL)
  - Detector long-term tests and ageing studies (material choice)
- 2012: Technology choice in ATLAS (? maybe already end 2011)
  - Construction of full-size module-0 chamber with two multilayers and xy readout, compatible with new Small Wheel design; fully equipped with VMM1 chip; commissioning of readout and trigger system
- 2012/13: Design optimization & industrialization of production; setup of production, assembly, and test sites; MoU
- 2014-16: Construction of 128 MM chambers, each with eight active layers (≈2000 m^2)
- 2016/17: Installation of MMs on Small Wheel & commissioning
- 2018: Installation of Small Wheels in ATLAS detector

Summary & outlook

- The large resistive chamber: production successful in second try, a second plane is under work in CERN/TE-MPE workshop, expected to be delivered in a week (or two)
  - Use the two large MM planes to make a two-layer (back-to-back) chamber to be tested in July test beam and (possibly) in neutron beam
- The two-dimensional readout works nicely, but needs optimization of strip arrangement
  - Build another small 2D MM with resistive strips and optimized the strip dimensions
- Four small resistive-strip MM chambers were installed in the ATLAS cavern and are read out through the SRS; recorded the first clean LHC collision tracks