

Status GEM Detectors

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COMPASS/AMBER Technical Board

16.11.2021

GEM and PixelGEM system in 2021

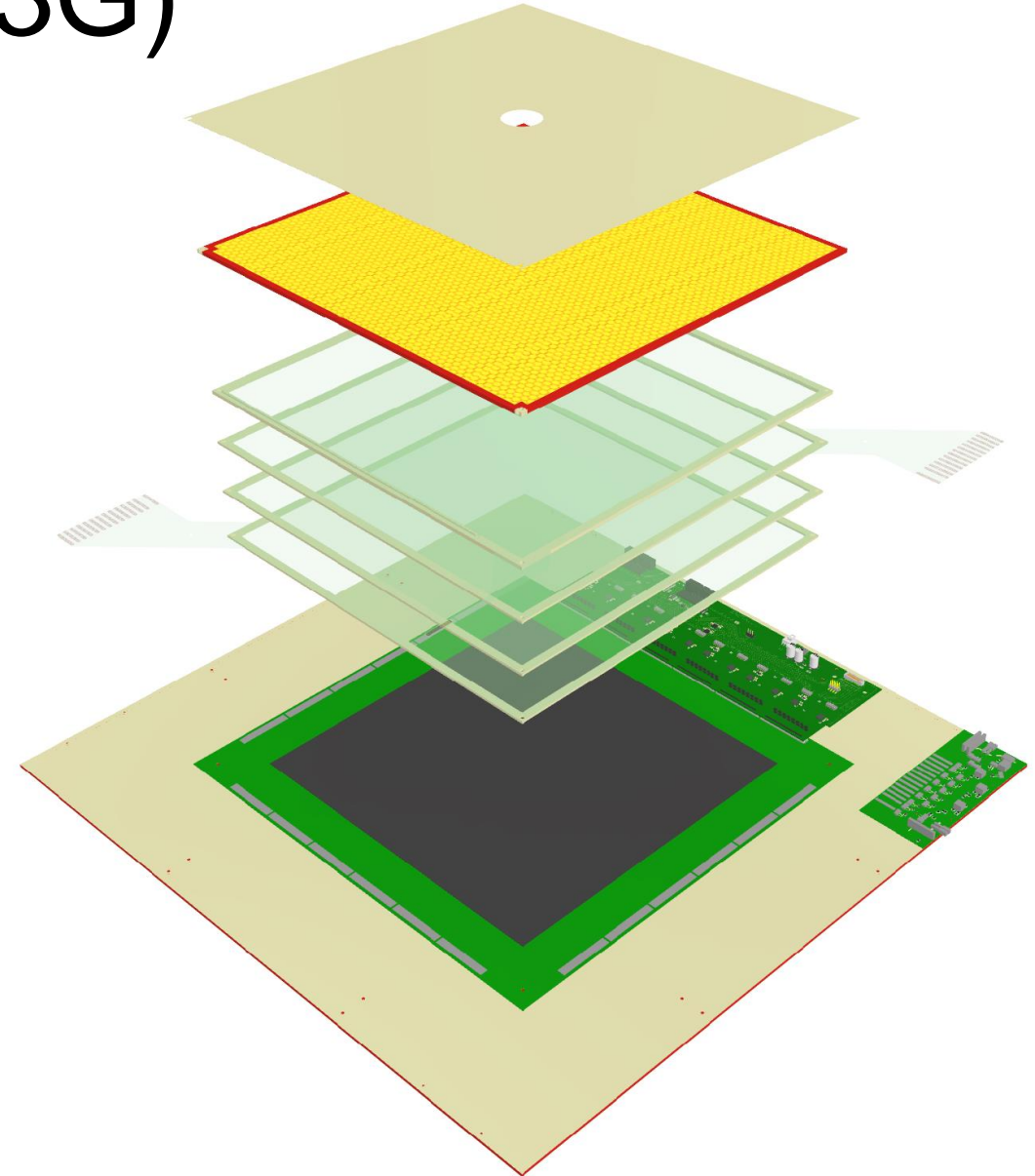
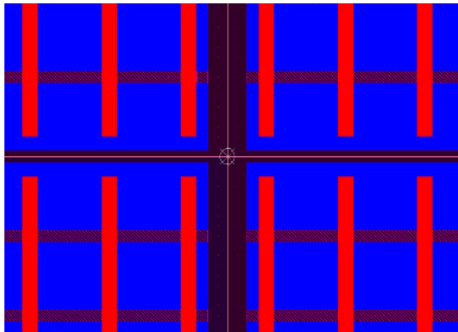
- New R&S power supplies for APV: 10 x 4ch R&S NGP804, to replace CAEN A516
 - 4 on gallery (GM01-GM04)
 - 5 under SM2 (GM05-GM09)
 - 1 on Saleve wall (GM10)
 - Adapter cables produced by CERN workshop, modified in situ
 - Slow Control implemented by Christophe Pires
- GM01 reinstalled on DC4 on 12.7.
- GM02 reinstalled on DC5 on 13.7., both very smoothly, thanks to Michael P., Vincent, Moritz, Christophe
- Central switches: CAEN A516 modules replaced by LAN I/O modules
- All detectors (GM01-10, GP02/03) operational on 15.7.
- GM11 not used
- GP02, GP03 operational

Issues during 2021 data taking

- GP03XY: ADC transition card needed to be replaced (20.7.)
- GM01 removed from DC04 (21.7.), re-installed on DC04 (4.8.)
- GP02UV: ADC exchanged/changed back (26.-29.7.), problems still present, problems with one chip on V plane (0x34), disabled
- GM01UV: several HV trips, HV module ch 0 faulty, changed ch (18.8.)
- GP02 center voltage trips, ramp-up speed adjusted
- Latency scans (17.8., 26.8., 2.9.), final latencies set (4.9.), time calibration done (not yet uploaded to DB)
- Mapping of center switches corrected (2.9.)
- Detectors centered on beam, adjustments for GM03 and GM08
- GM08UV: exchanged LV power supply for ADCs (deutronics => lab p.s.), errors disappeared (5.9.)
- GM04XY: noise problem of one APV chip (18.9.), which is oscillating after it is programmed (0x2c) need to also disable 2nd chip, which needs I2C broadcast (0x3f) in order to be programmed (0x24)
- GM09/10 errors: disappeared after cleaning optical fiber and replugging LV cable (24.9.)

COMPASS GEM-3G (CG3G)

- Size of active area: $30.7 \times 30.7 \text{ cm}^2$
- Strips divided in center to reduce occupancy
- Triple GEM, foils sectorized on top (13 sectors)
- No spacer grids
- Gas in/out on drift plate, internal distribution



- Stabilized voltage divider: 3 +1 cards
- 6×4 front-end cards, 4 supply cards

Status of detector parts

- CERN Batch 1: shipped 20.10.2020
 - 6 GEM foils (2 μ m Cu) \Rightarrow 1 bad (high current), 5 good
 - 3 drift foils (2 μ m Cu) \Rightarrow 3 good
 - 2+1 R/O foils \Rightarrow 3 good
- CERN Batch 2:
 - 10 GEM foils (2 μ m Cu), shipped 30.8.2021 \Rightarrow 1 bad (high current), 7 good, 2 not yet tested
 - 2 drift foils (2 μ m Cu), shipped 30.8.2021 \Rightarrow 2 good
 - 2+1 R/O foils, shipped 27.10.2021 \Rightarrow 2 good, 1 bad (known)
- Honeycomb plates (Piepenbrink)
 - Batch 1a: 2 drift plates, 2 R/O plates (potted, bent) \Rightarrow re-treated, flattened
 - Batch 1b: 2 R/O plates (GFK frame) \Rightarrow 2 good
 - Batch 2: 2 drift plates, 2 R/O plates \Rightarrow good
- GEM frames (local workshop):
 - full frames for 3 detectors available (drift, transfer, induction)
 - 10 parts for 2,5 transfer frames available

Status of Stabilized Voltage Divider

- First detector equipped with SVD
- Several issues observed during operation:
 - oscillations with capacitive load \Rightarrow solved by adding capacitors
 - current limitation circuit broke, most likely because of a current spike that occurred before the circuit starts to work \Rightarrow solved by adding a series resistor ($\sim 30k$)
 - destruction of circuit could be recreated in test setup: transistor breaks w/o resistor
 - components ordered; repair, modification, test on detector pending
- Tests with single-channel SVD on detector, comparison to PVD \Rightarrow ongoing (Bachelor's thesis)
- Equip next detector with PVD instead

- HV PCBs:
 - SVD: 3 assembled (3+1 needed for prototype)
 - PVD: 12 PCBs available, 1 assembled (4 per det.)

Status of detector production

	Support plates	Frames	Drift foil	GEM foils	Readout PCB	HV board	Assembly	Calibration	Installation
CG3G01	✓	✓	✓	✓	✓	SVD	✓	✓	Prototype
CG3G02	✓	✓	✓	✓	✓	PVD	S3		
CG3G03	✓	✓	✓	✓	✓		QA		
CG3G04	✓		✓	✓	✓		QA		
CG3G05			✓		✓				

Assembly steps:

- QA: quality assurance
- G1, G2, G3: GEM i framed
- RO: R/O PCB glued
- D: drift foil glued
- S1, S2, S3: stack i glued
- DET: detector assembled
- GAS: gas pipes + tight
- HV: HV board assembled

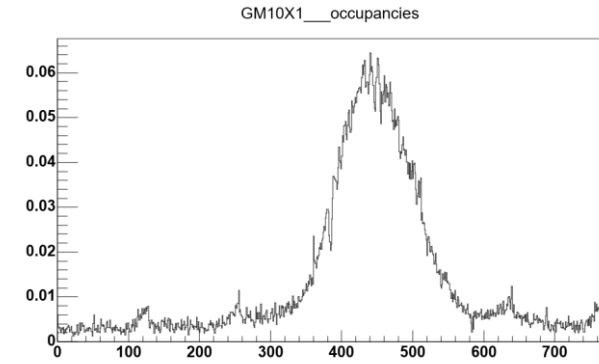
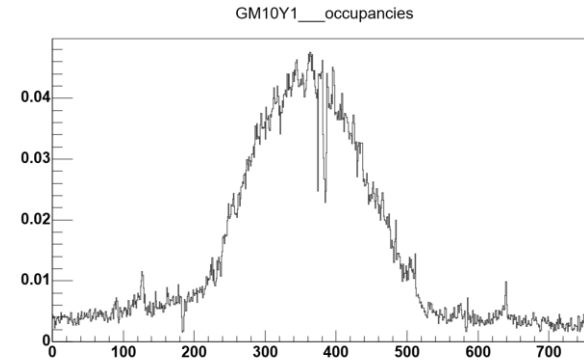
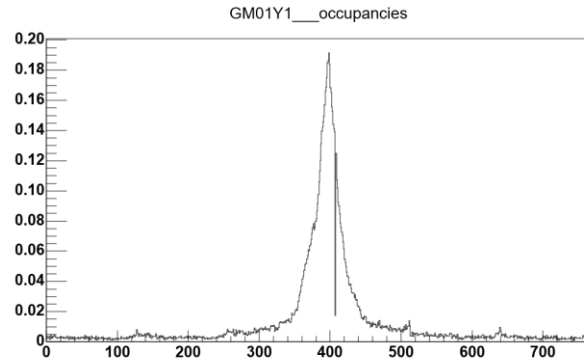
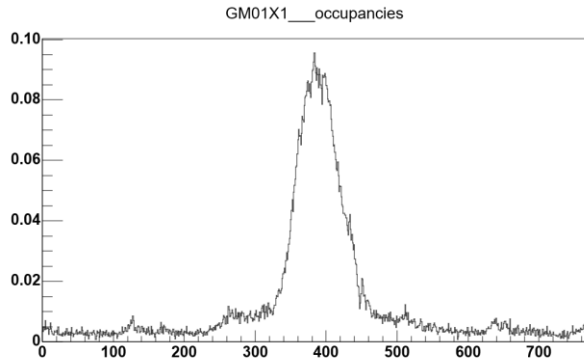
Stations to be replaced for 2022: GM05, GM08 (GM04?)

Installation: March/April 2022

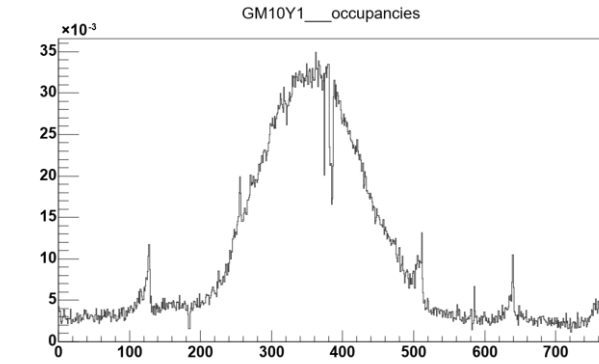
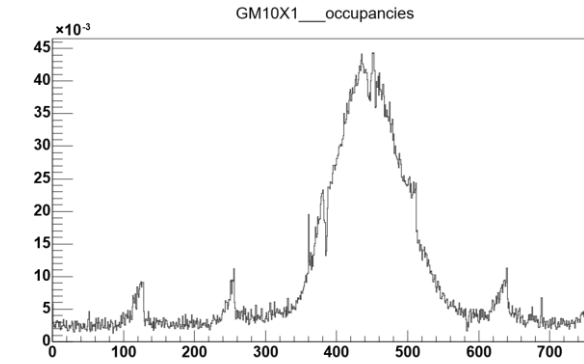
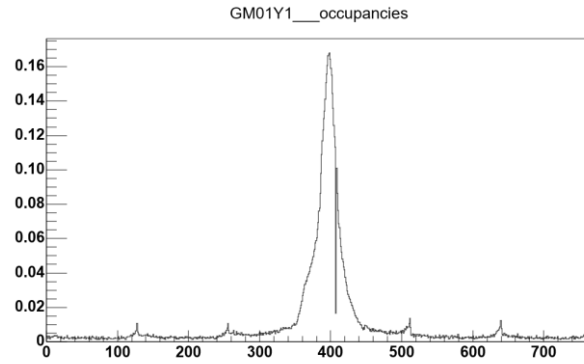
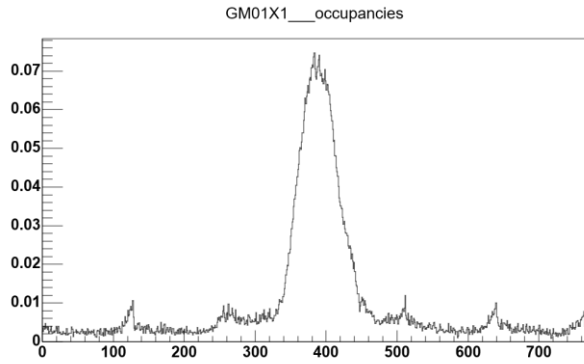
Front-end and readout electronics

- Front-end cards (APV):
 - APVs available for all detectors
 - 56 cards ready and tested (24 per det., 2 at TUM)
 - Components and PCBs for 100 cards available, some delay in assembly
- Supply cards:
 - 2 produced and being tested (at TUM)
 - 6 PCBs in production, components ordered
 - bugfix for new PCBs: capacitor too high \Rightarrow add cut-outs
- ADC cards:
 - 2 produced, 1 working (at TUM), tested with IFTDC, production of additional ones to be clarified!
 - full system test with APV to be performed at CERN (DAQ lab)
 - components for 10-15 cards available, 2 per det. needed, delay in assembly (Covid)
 - 9 IFTDC cards produced
 - ADC firmware ported to Artix FPGA by S. Huber
 - Slow control implemented in config_server by V. Frolov

GEM Performance during PRM Pilot Run



Run 293211 (intensity scan, ion chamber $2.8E7$ per spill)



Run 293293 (physics, ion chamber $9.9E6$ per spill)

GEM with VMM readout



COMPASS style

Std. 10x10 cm² GEMs

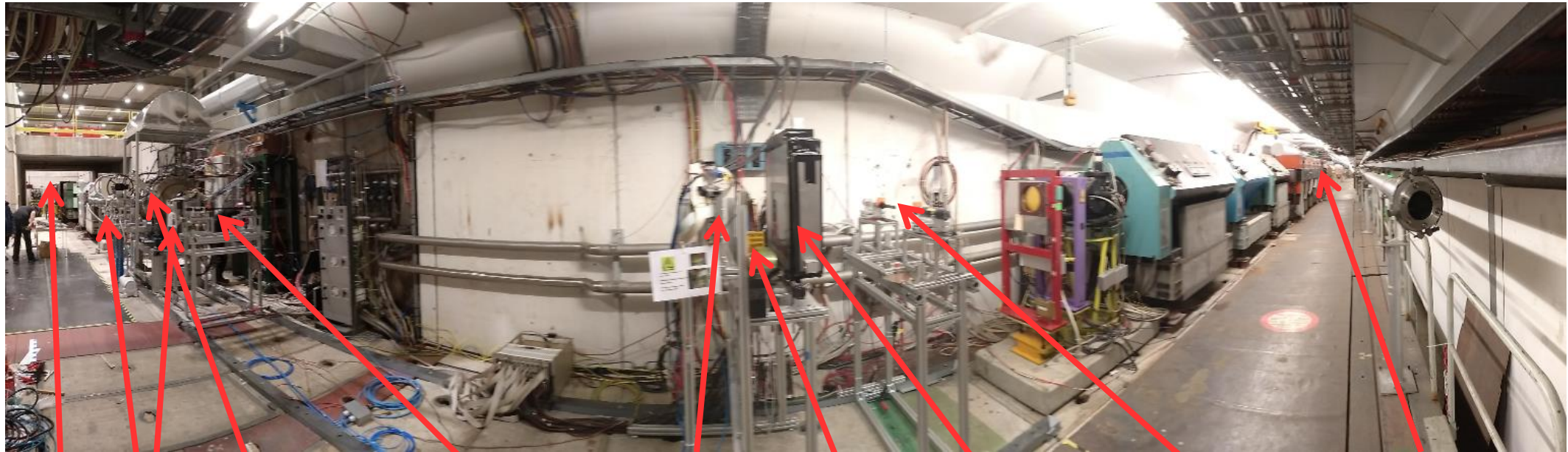
3 mm drift

Readout 400 μ m pitch

256 strips x

256 strips y

GEM with VMM readout



COMPASS

High-pressure
H TPC (DUT)

4 x silicon
(DUT)

Trigger
scintillator

Silicon (DUT)

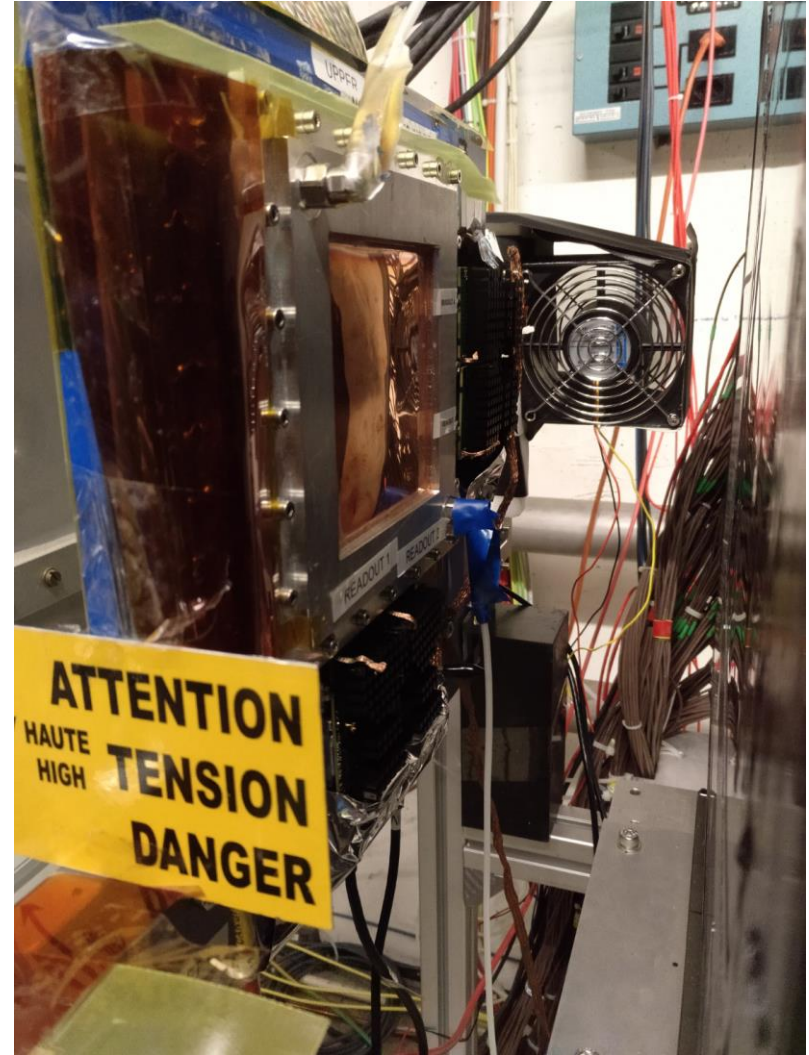
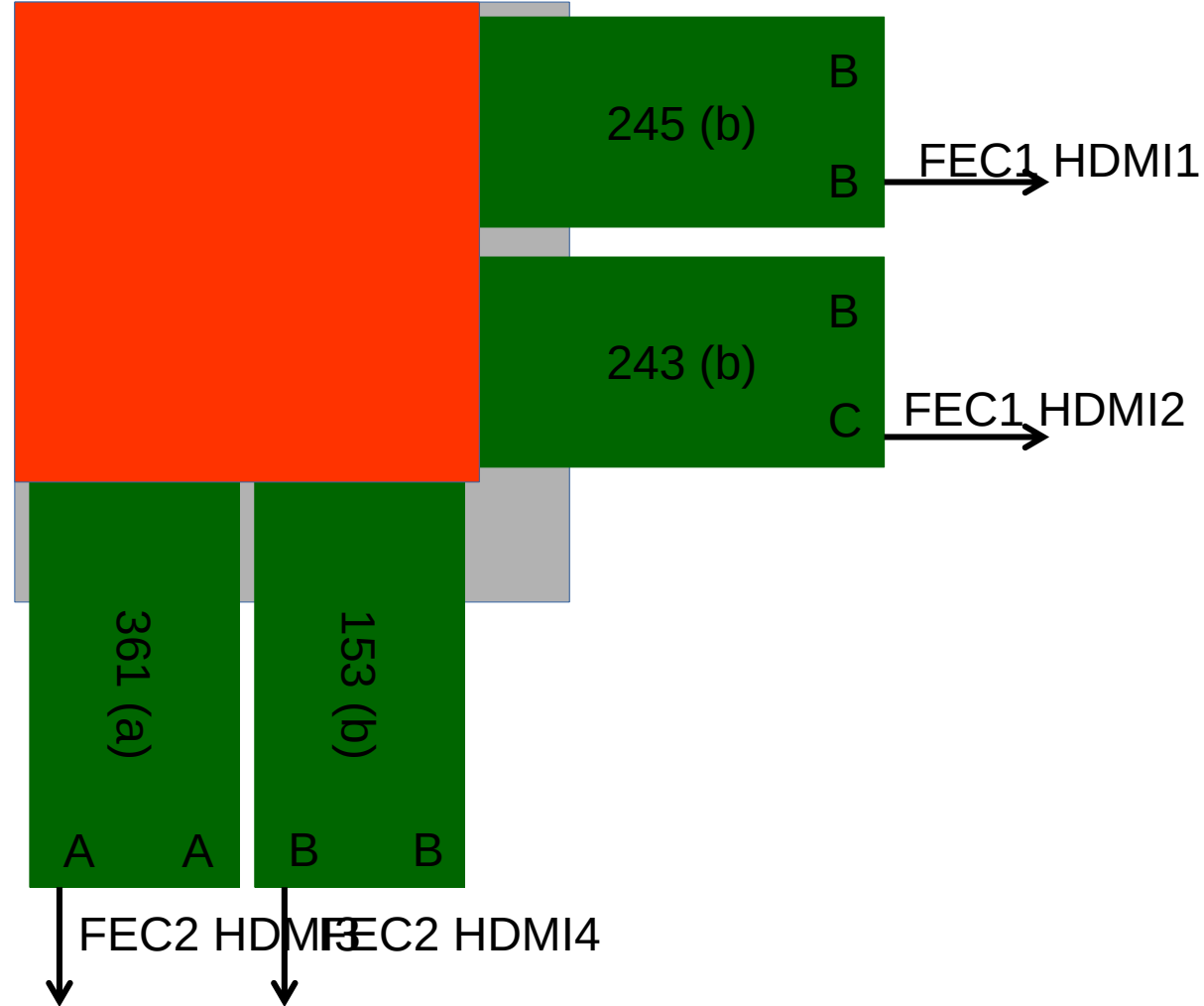
VMM GEM
(DUT)

SciFi station

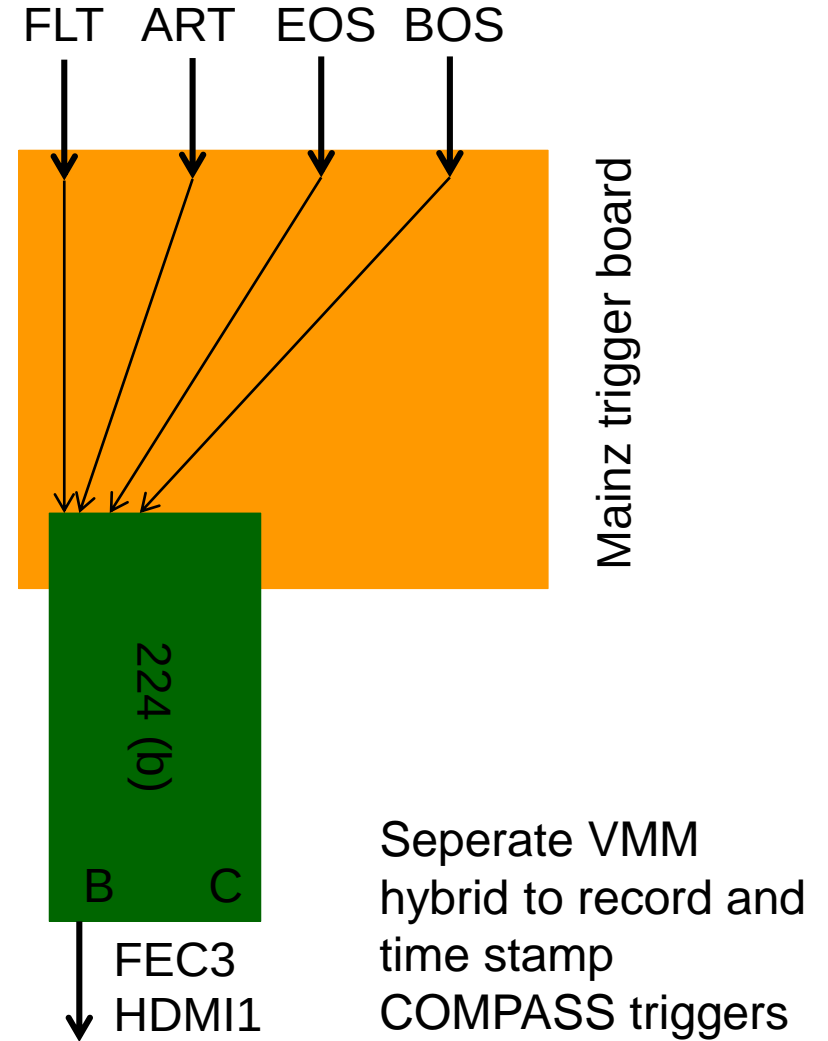
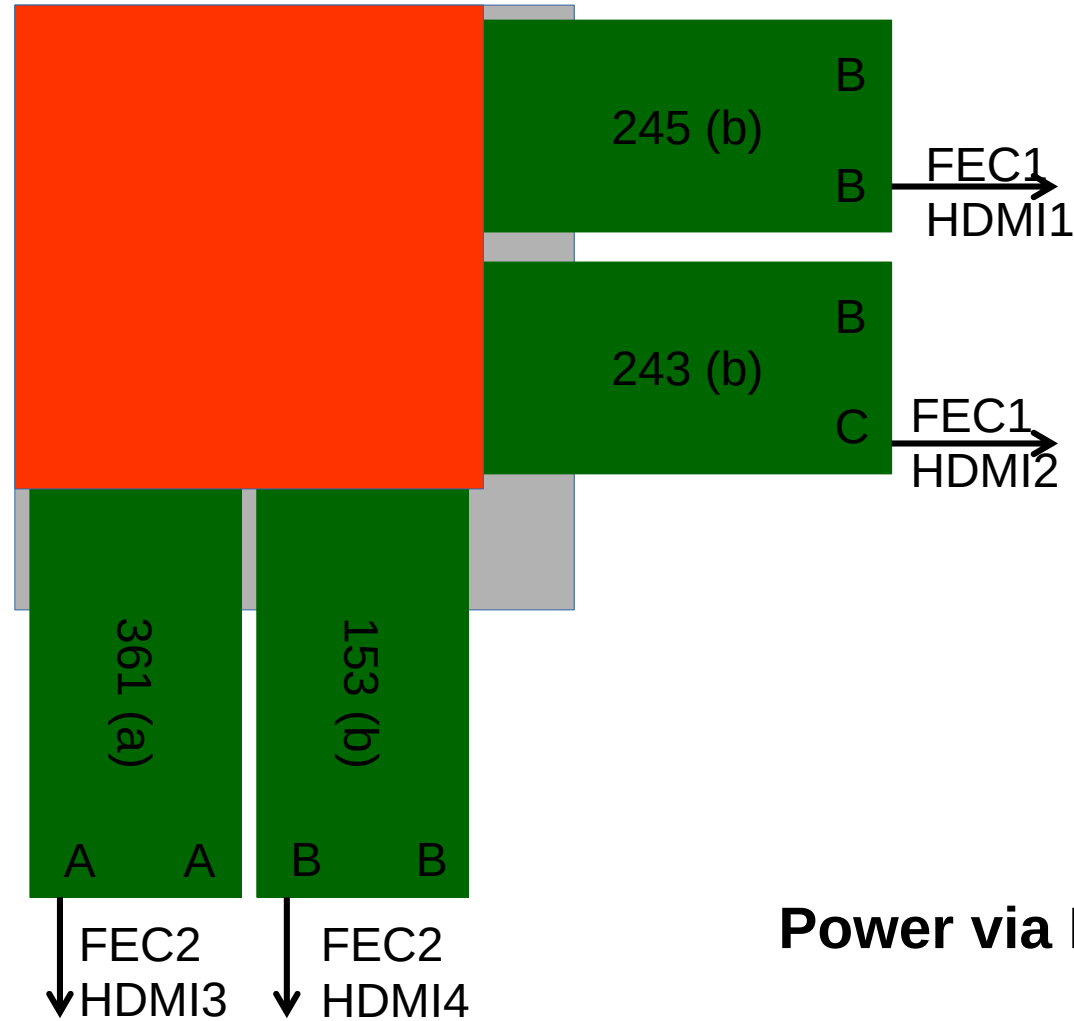
Trigger
scintillator

M2 beam

GEM with VMM readout

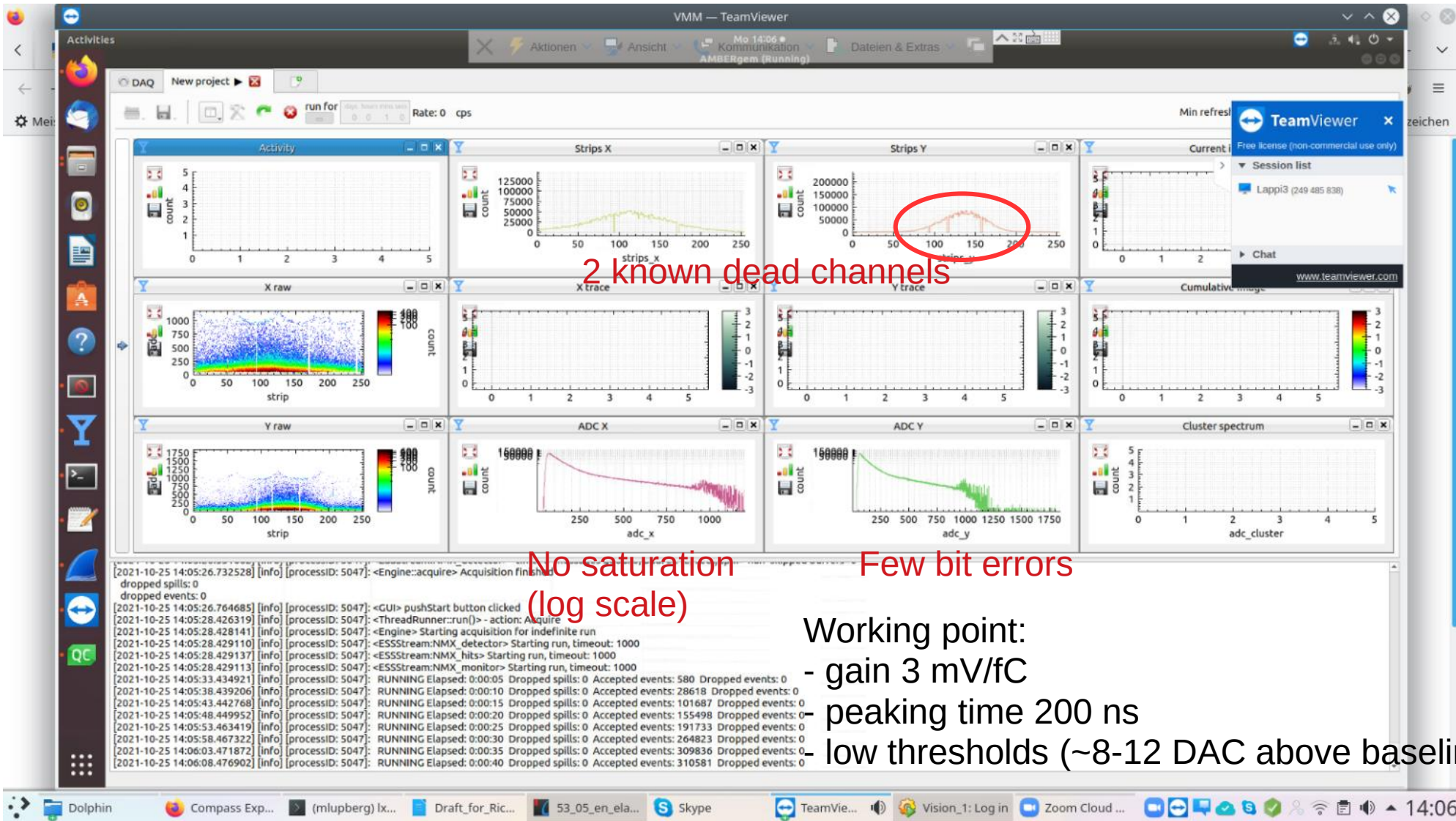


GEM with VMM readout



GEM with VMM readout

Neighbouring off



No saturation
(log scale)

Few bit errors

Working point:

- gain 3 mV/fC
- peaking time 200 ns
- low thresholds (~8-12 DAC above baseline + exceptions)

Spare Slides

LV Configurations

green: existing
 dark orange: plan for 2021
 light orange: possible future

Generation	p.s. type	GMnnU1	GMnnV1	GMnnX1	GMnnY1
CG1G	APV: CAEN A516	2ch, $\pm 3.5V$, - 0.9A, +0.7A	2ch, $\pm 3.5V$, - 0.9A, +0.7A	2ch, $\pm 3.5V$, - 0.9A, +0.7A	2ch, $\pm 3.5V$, - 0.9A, +0.7A
	APV: NGP804	2ch, $\pm 3.5V$, -1.8A, +1.4A		2ch, $\pm 3.5V$, -1.8A, +1.4A	
	ADC: DN35-5	2ch, $\pm 5V$, +3.2A, -0.6A			
CG2G (PGEM)	APV: DN35-5	2ch, $\pm 3.5V$, -1.8A, +1.4A		2ch, $\pm 3.5V$, -1.8A, +1.4A	
	ADC: DN35-5	3ch, $\pm 5V$, +6A, -3A			
CG3G	APV: NGP804	1ch, +3.3V, 8-12A		1ch, +3.3V, 8-12A	
	ADC: NGP804	1ch, +5V, <6A		1ch, +5V, <6A	
CG4G	VMM (SRS): NGP804	1ch, 1.9-3.5V, 19.2A		1ch, 1.9-3.5V, 19.2A	
	Auxiliary	1ch, 2.9-3.5V, 2.4A		1ch, 2.9-3.5V, 2.4A	

For Center HV switch: 1 ch 12V, no current \Rightarrow find simpler solution