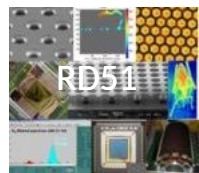


SRS VMM-based streaming readout for future GEM detectors at AMBER and in neutron science

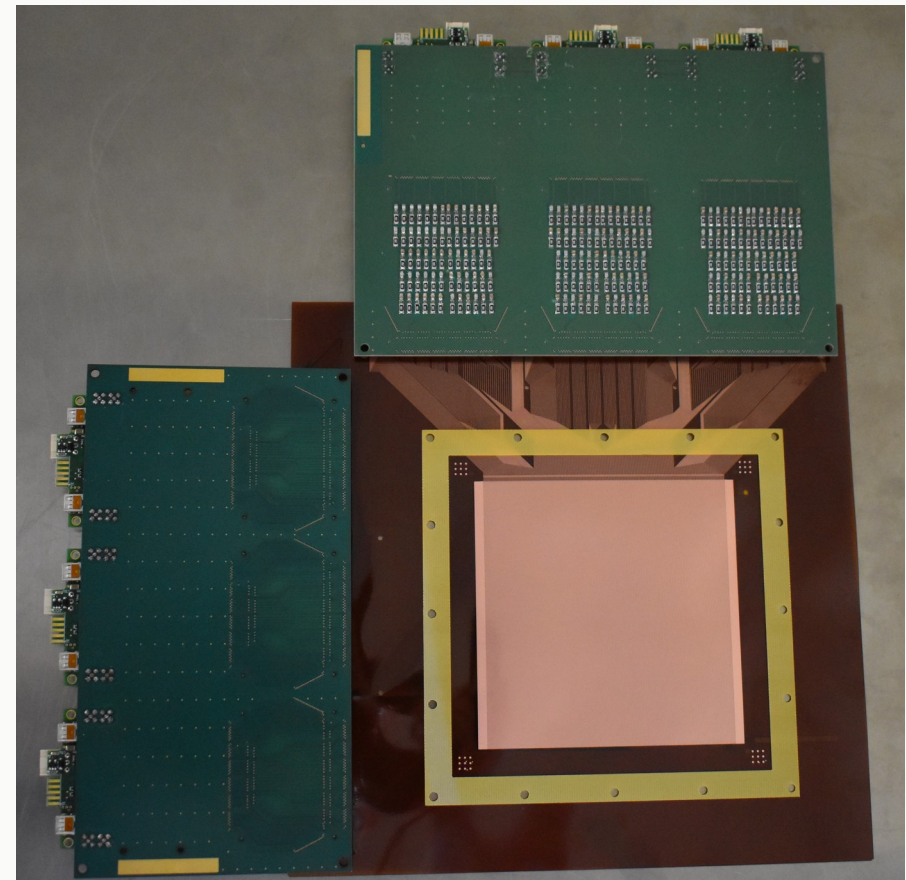
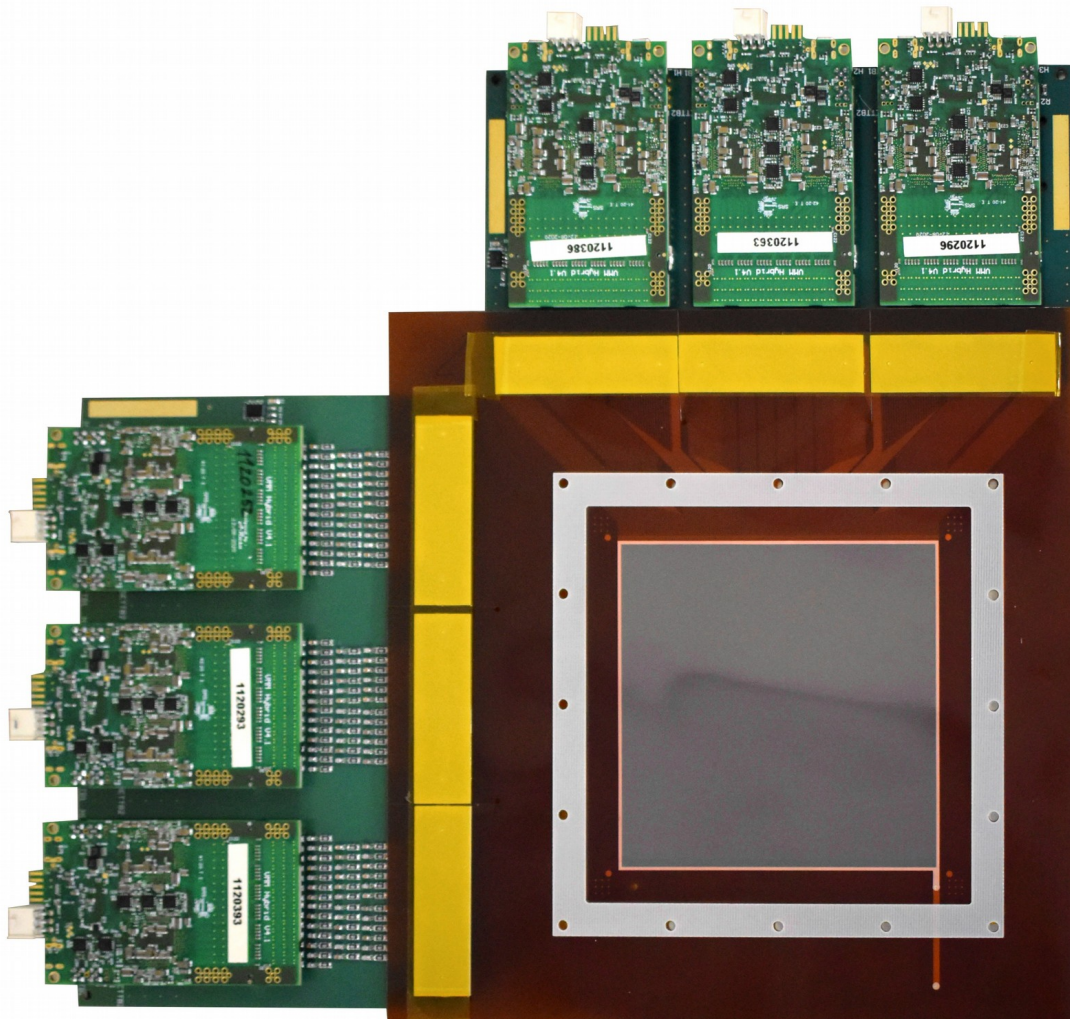
Michael Lupberger
(University of Bonn)

RD51 Collaboration Meeting
15.11.2021



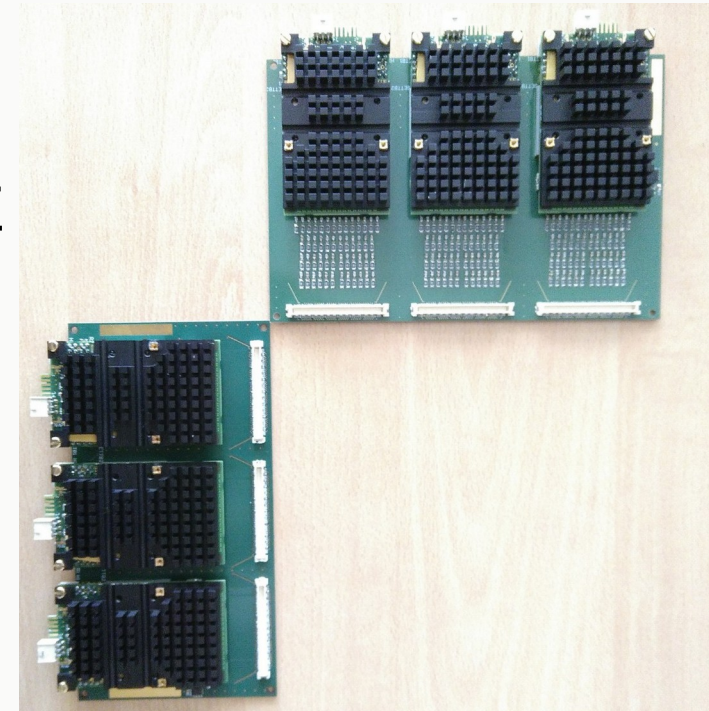
Neutron detector

Preparation of single layer highly segmented GEM



Preparation of single layer highly segmented GEM

- Simulation and measurement for optimum decoupling capacitor DONE
- Test of connections hybrids → detector DONE
- Housing DONE
- For single layer:
 - Use RD51 cooling block DONE
 - Use power via HDMI tests ONGOING
- Cooling concept: cooler between PCBs with cooling liquid pipe ONGOING

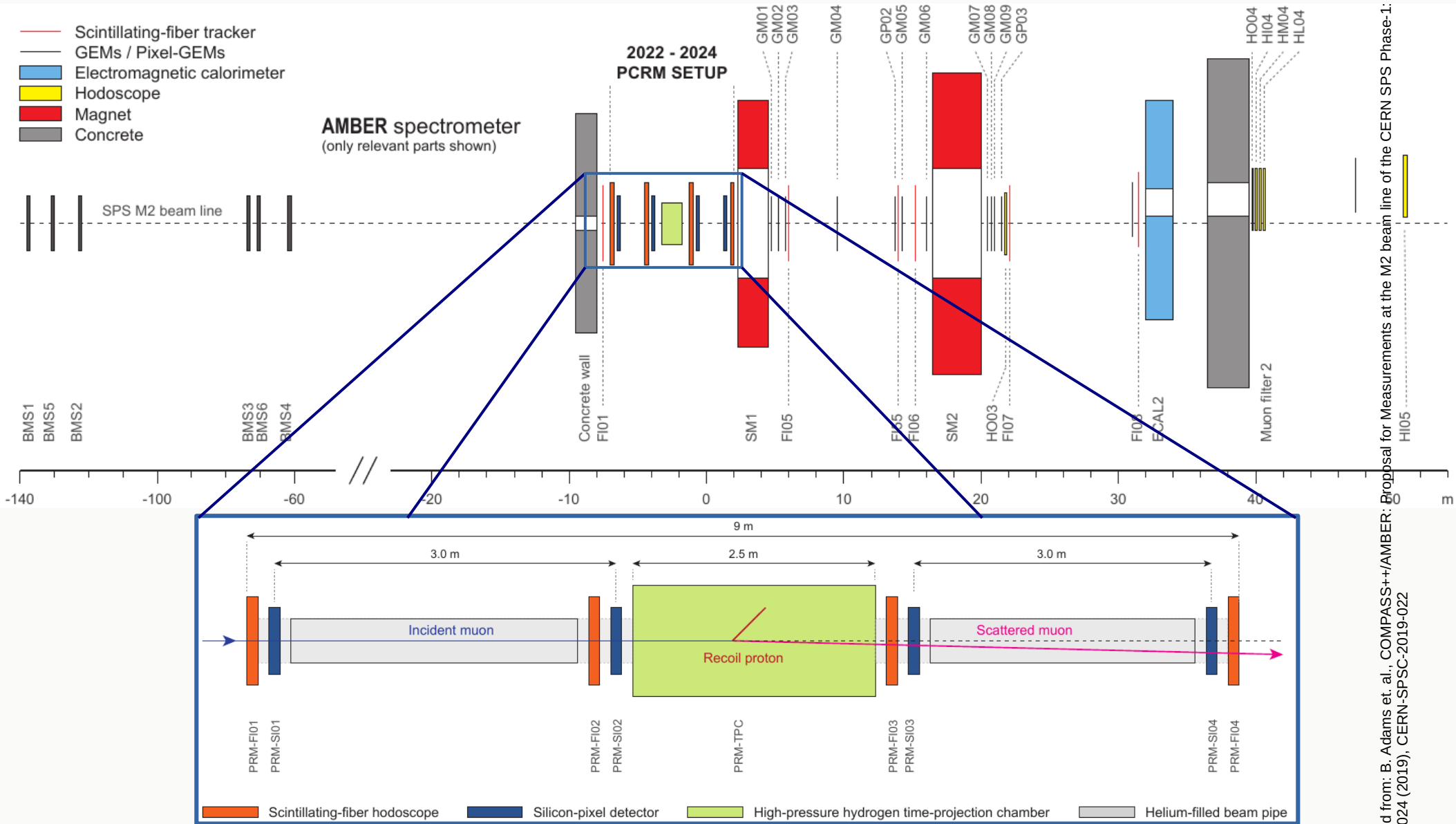


Outlook:
Operate single layer detector



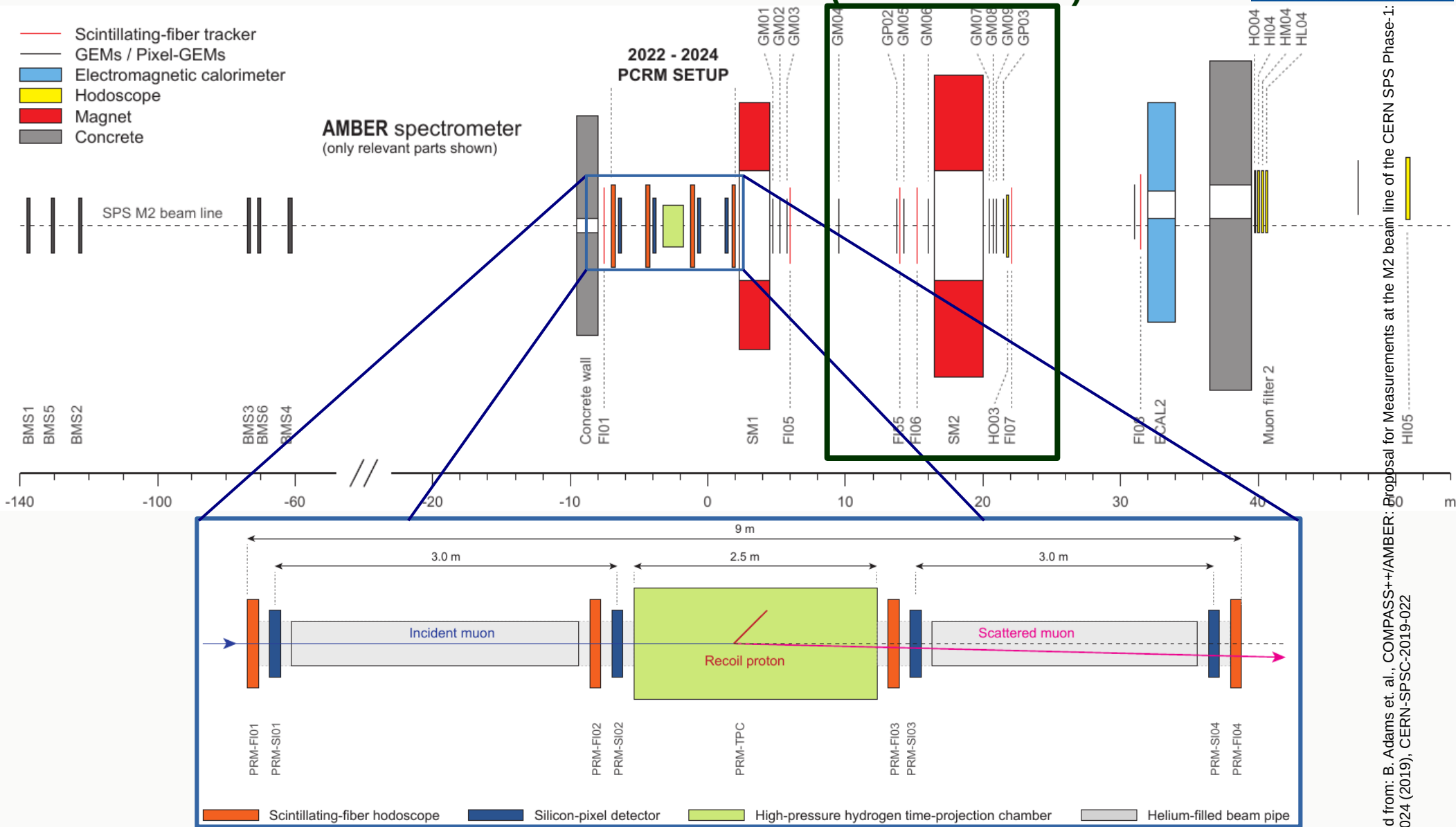
Apparatus for Meson and Baryon Experimental Research:

- In the context of CERN's *Physics Beyond Collider* initiative
 - Proposal for a *New QCD facility at the M2 beam line of the CERN SPS*
 - **LOI**: June 2018; Submitted to SPSC January 2019
 - **Proposal** for Phase 1 to SPSC: June (update Sept.) 2019
 - Physics program recommended by SPSC :October 2020
 - approval by CERN Research Board; December 2020
- ⇒ Upgrade + additions to existing COMPASS setup e.g.
- New GEM detectors (high rate)
 - + streaming readout capable frontend electronics



Modified from: B. Adams et. al., COMPASS++/AMBER: Proposal for Measurements at the M2 beam line of the CERN SPS Phase-1: 2022-2024 (2019), CERN-SPSC-2019-022

Large area GEMs with streaming readout (VMM or TIGER)



Modified from: B. Adams et. al., COMPASS++/AMBER: Proposal for Measurements at the M2 beam line of the CERN SPS Phase-1: 2022-2024 (2019), CERN-SPSC-2019-022

Goal:

- Test of new detectors types, in particular high pressure TPC
- Test of AMBER DAQ prototype on TPC
- Test of VMM in AMBER conditions
- Synchronisation of different detectors

Triggered COMPASS readout for most DUT + spectrometer:

- Begin Of Spill (BOS)
- End Of Spill (EOS)
- Physics first level trigger (FLT)
- Artificial trigger (ART)

Continuous readout of VMM with SRS:

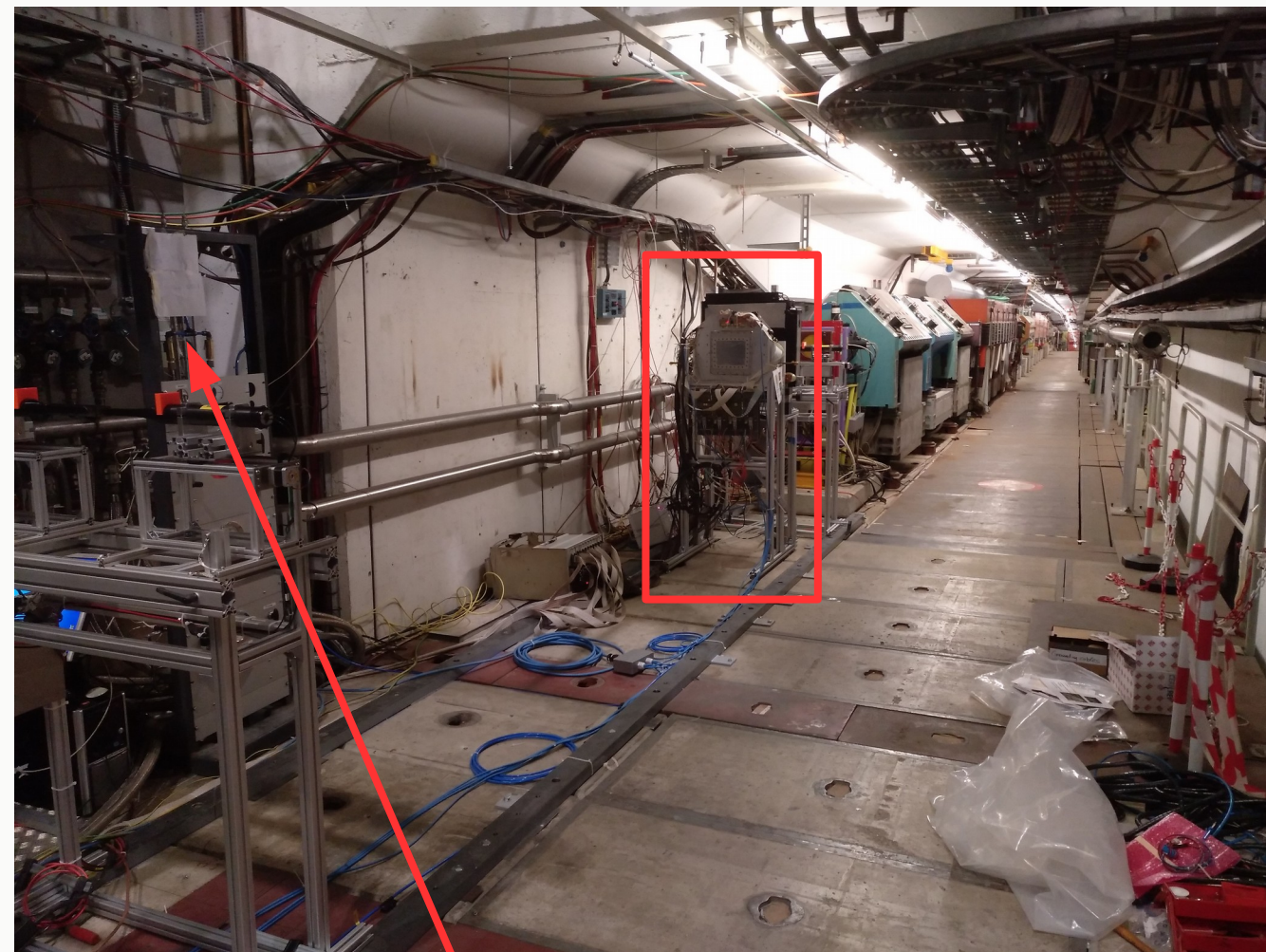
- Timestamp compass triggers with one VMM
- Standard 10x10 cm² GEM detector with 4 VMM hybrids continuously read out with SRS

Overview of setup



COMPASS
4 x silicon (DUT)
High-pressure H TPC (DUT)
Trigger scintillator
Silicon (DUT)
VMM GEM (DUT)
SciFi station
Trigger scintillator
M2 beam

Station: SciFi+ GEM + Silicon

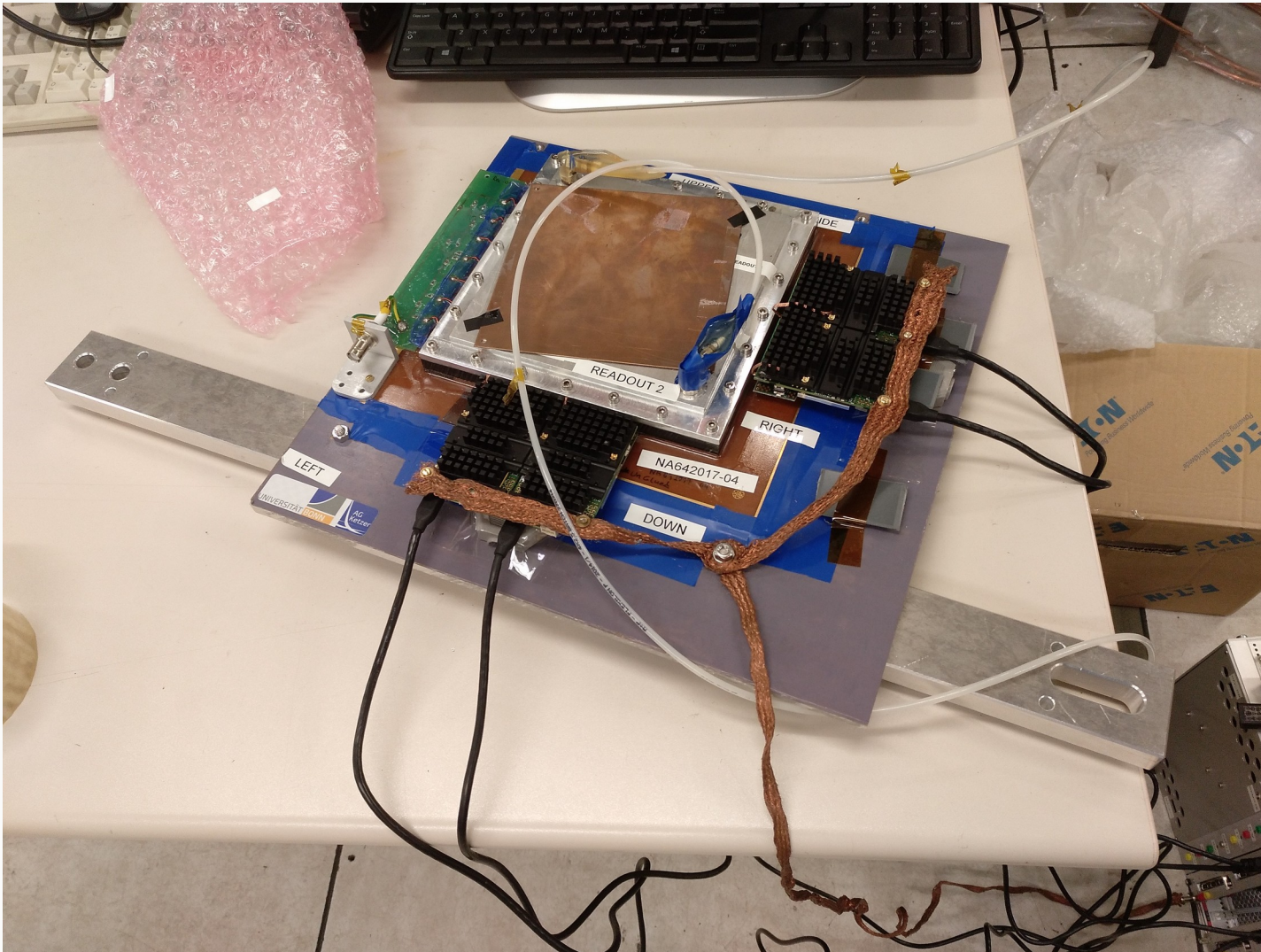


Gas mixer



GEM

GEM Detector



COMPASS style

Std. 10x10 cm² GEMs

3 mm drift

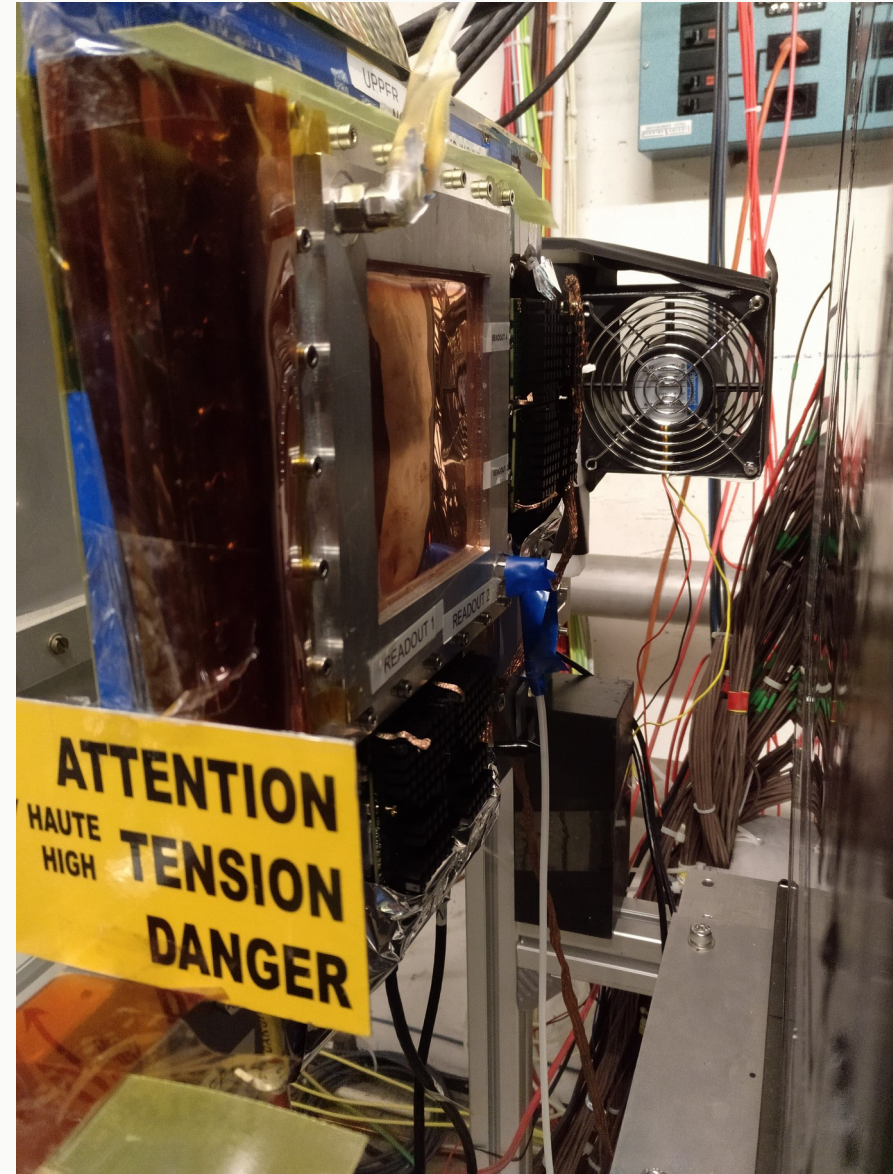
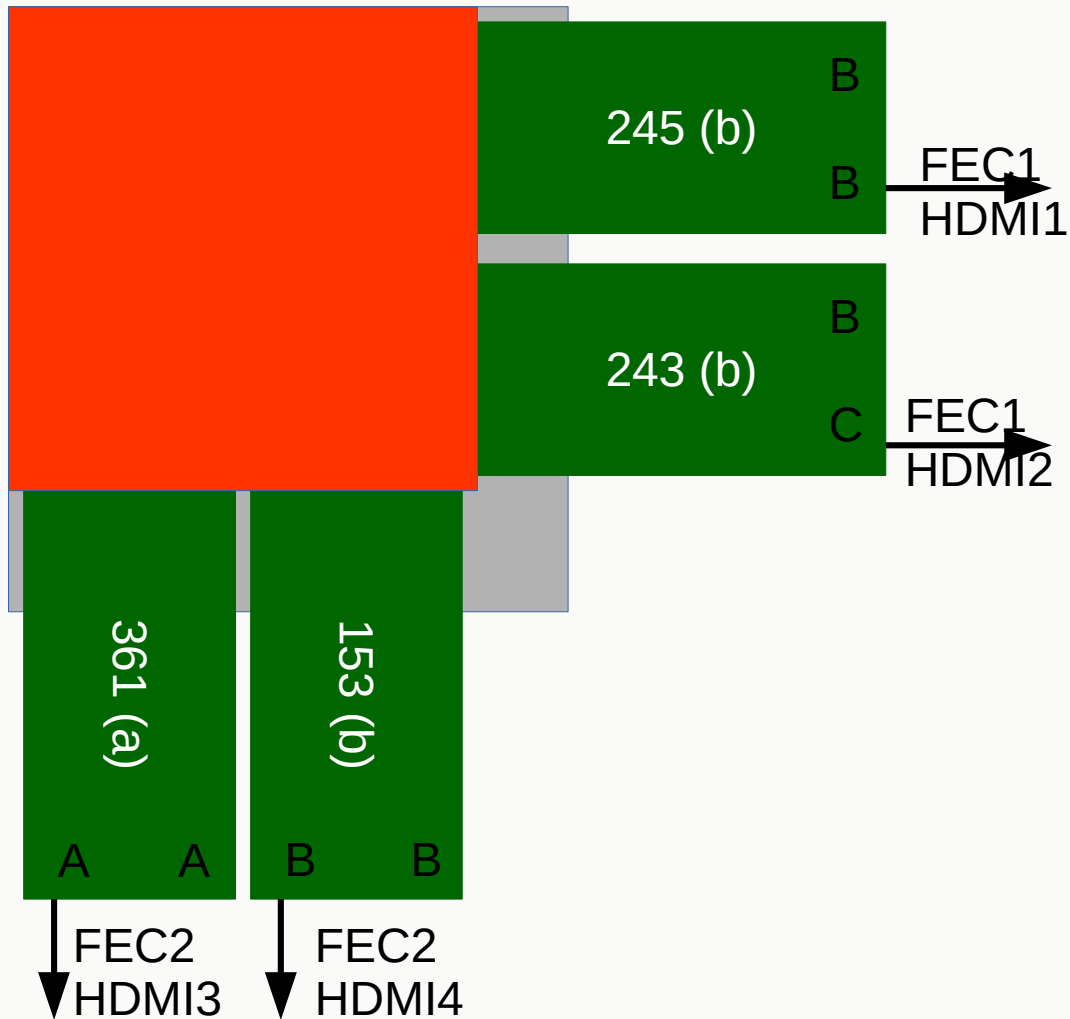
Readout 400 μ m pitch

256 strips x

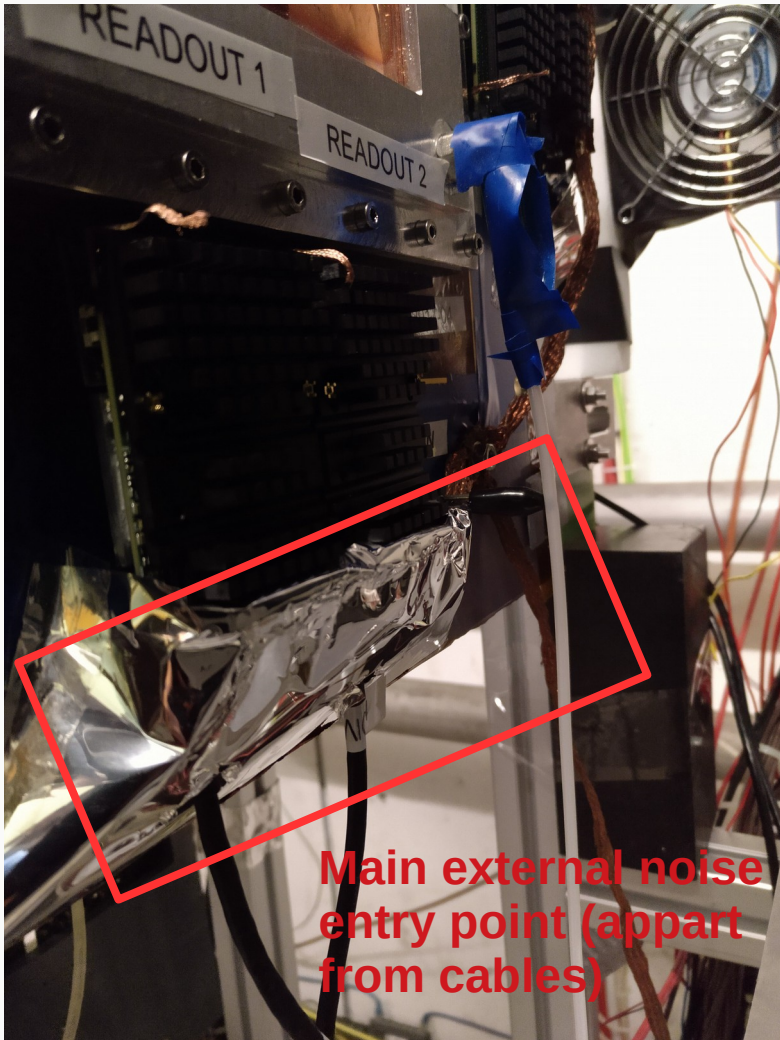
256 strips y

Note:
Grounding of hybrids

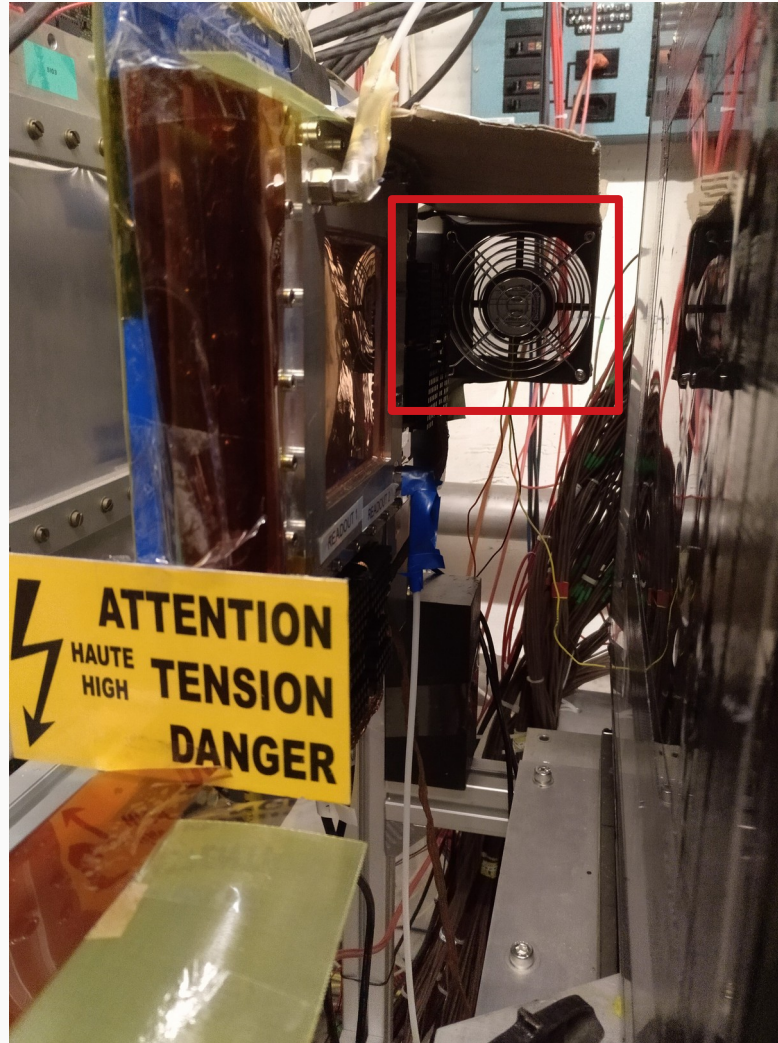
GEM Detector – readout



GEM Detector – readout – notes



Main external noise entry point (apart from cables)



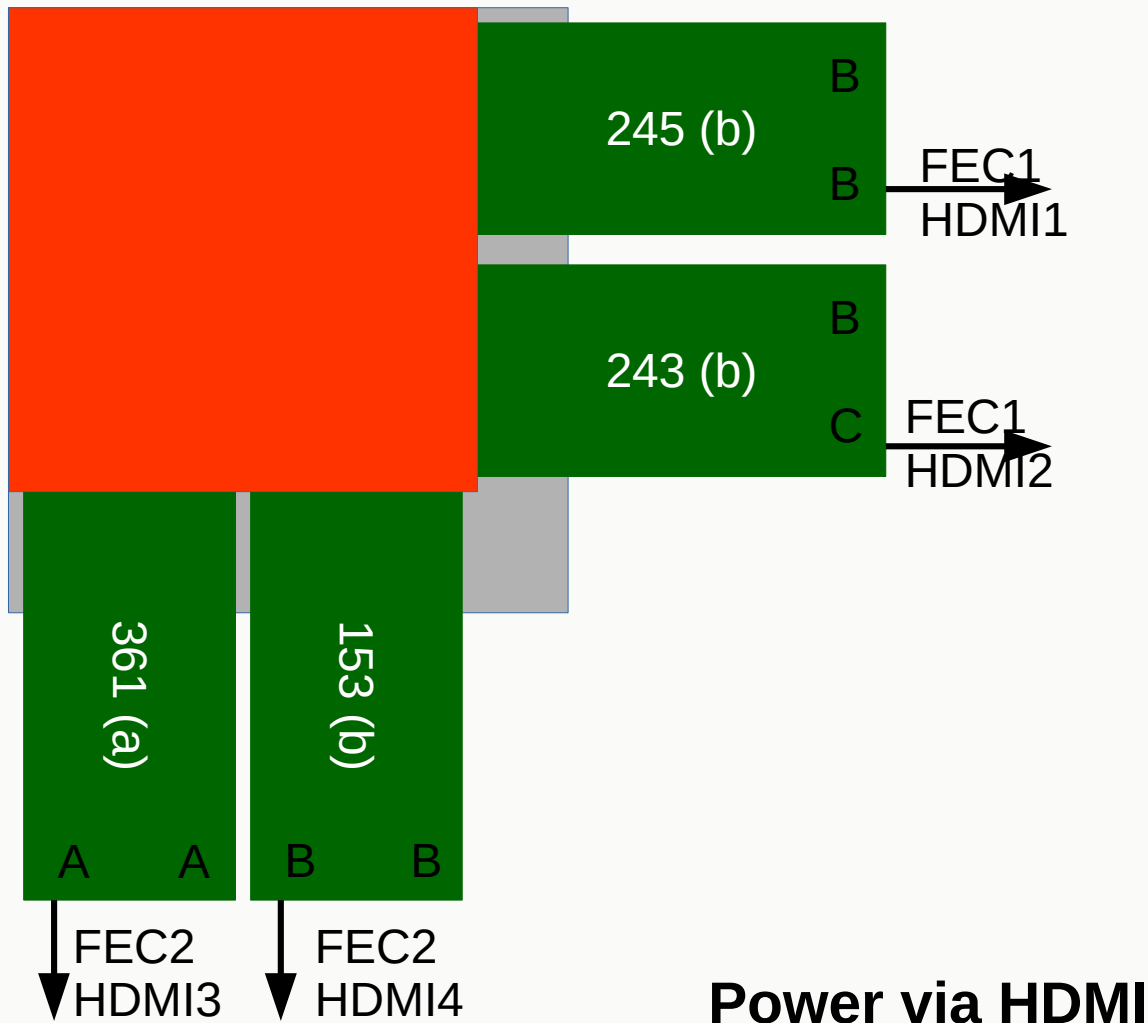
Cooling via PC fan:

VMM temperatures:
38 °C – 53 °C

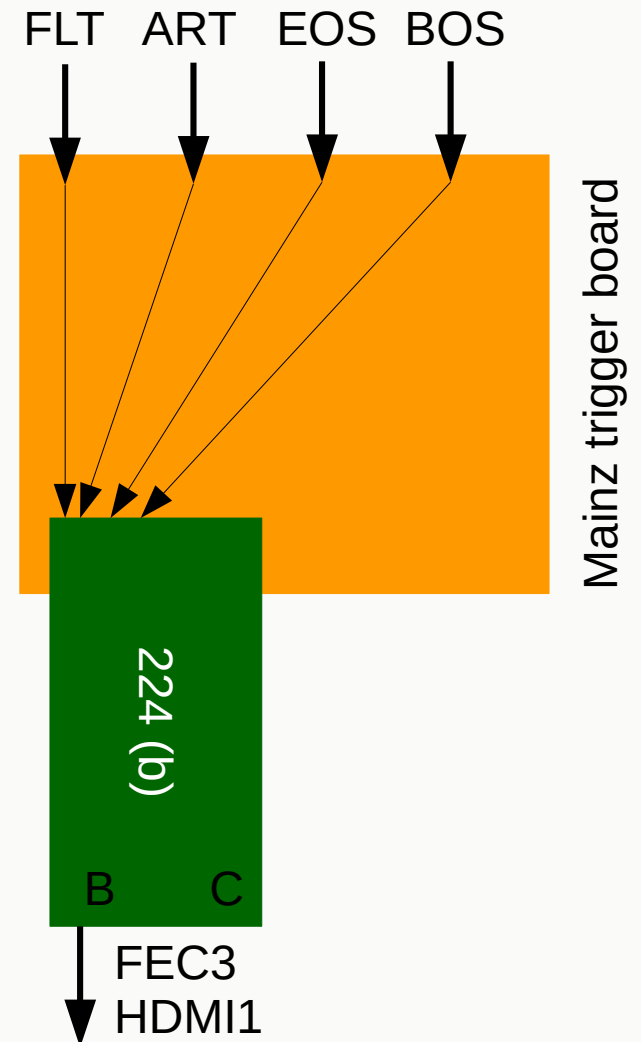
Without fan:
55 °C – 63 °C

Trigger hybrid fixed to SRS crate with cable tie → ~ 40 °C

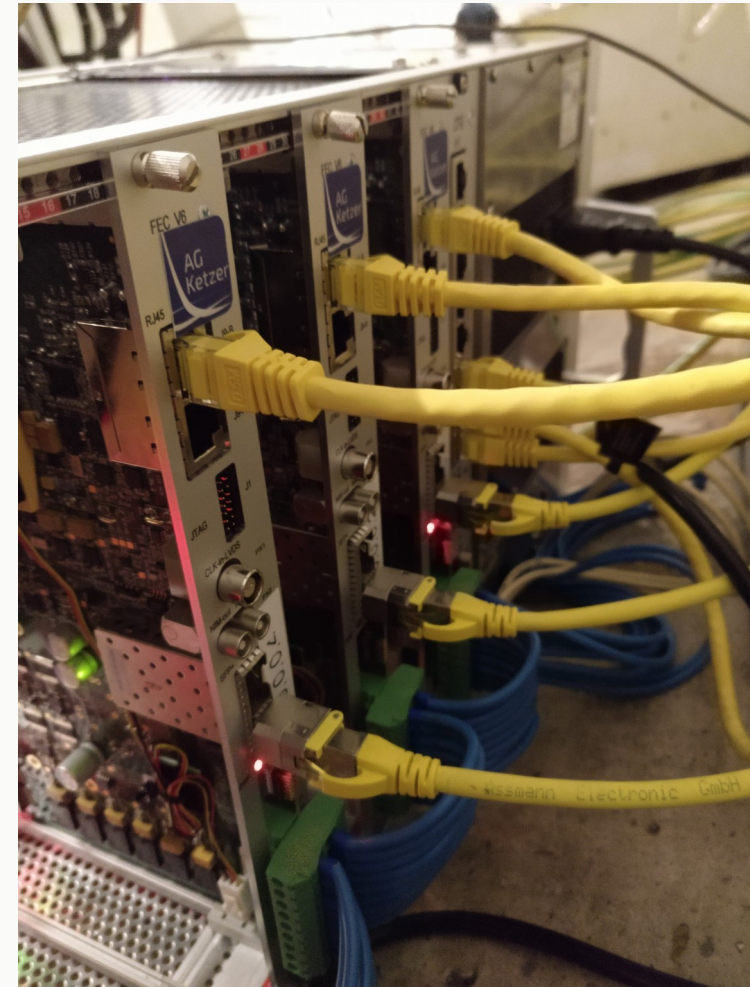
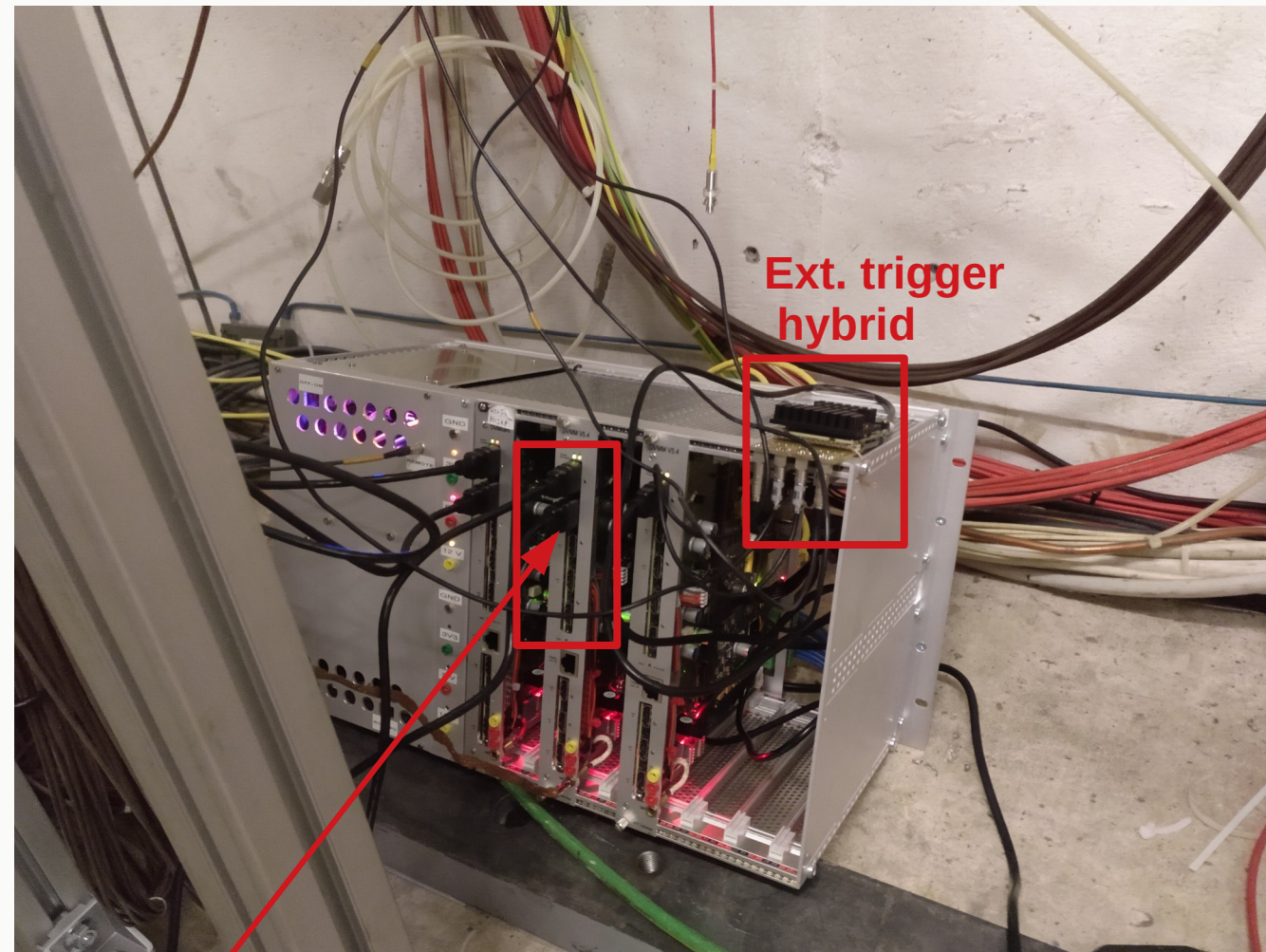
GEM Detector – readout



COMPASS trigger



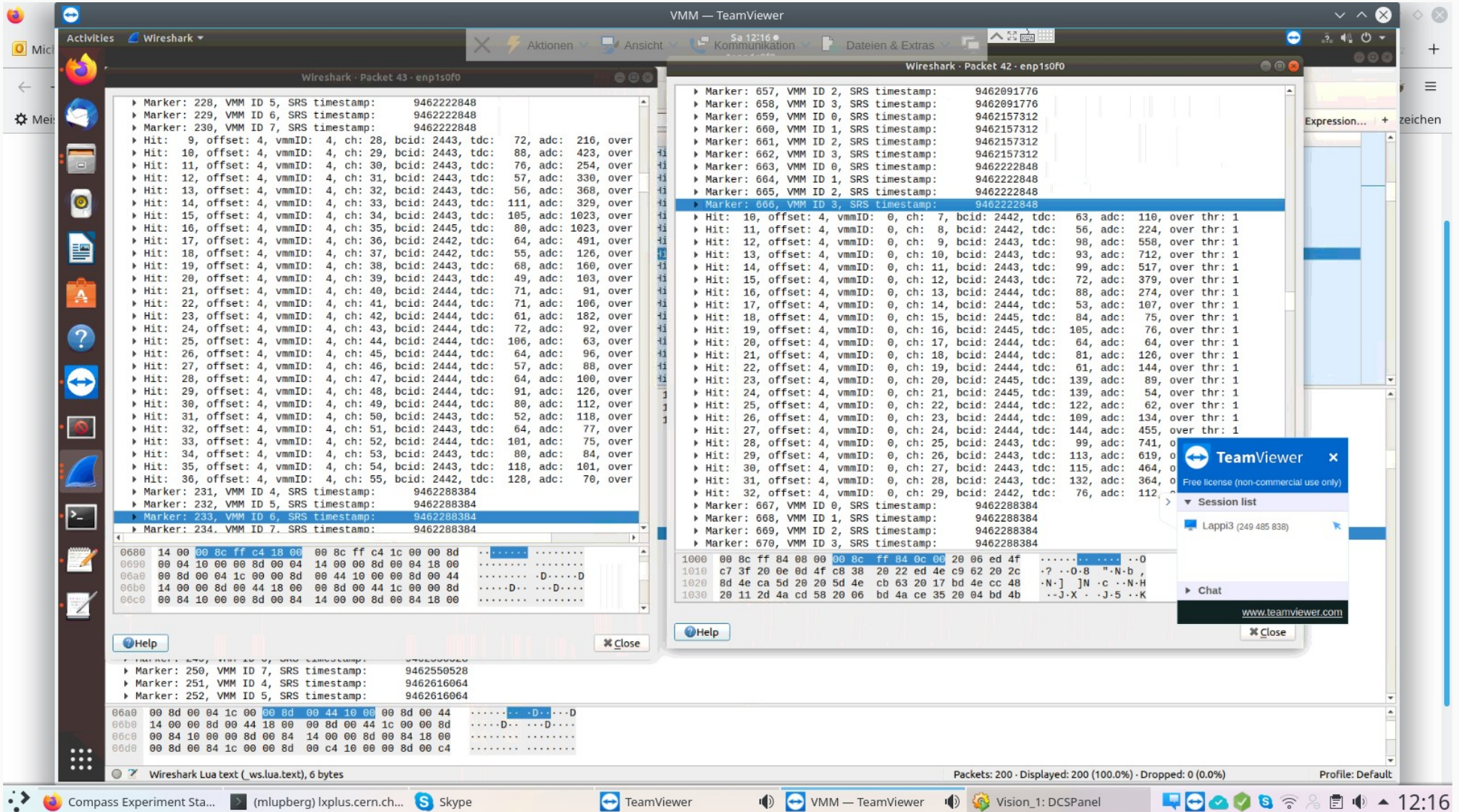
SRS crate



FEC2 HDMI1+2 → HDMI3+4 (I2C problems)

CTF synch seems to have been good (checked 160 MHz ART clock on hybrids at different FECs well phase aligned + stable)

SRS FEC synch



The screenshot shows a Wireshark network capture of SRS FEC synchronization data. The interface is split into two main windows, both showing packet lists and hex/ASCII data views.

Left Window (Packet 43 - enp1s0f0):

- Markers: 228, 229, 230 (VMM ID 5, 6, 7) with SRS timestamps: 9462222848.
- Hits: 9 through 36, each with offset 4, vmmID 4, and various channel (ch), base CID (bcid), time delay (tdc), and ADC values.
- Markers: 231, 232, 233, 234 (VMM ID 4, 5, 6, 7) with SRS timestamps: 9462288384.
- Hex/ASCII view: Shows data bytes such as 00 8c ff c4 1c 00 00 8d and their corresponding ASCII characters.

Right Window (Packet 42 - enp1s0f0):

- Markers: 657, 658, 659, 660, 661, 662, 663, 664, 665, 666 (VMM ID 2, 3, 0, 1, 2, 3, 0, 1, 2, 3) with SRS timestamps: 9462091776 and 9462222848.
- Hits: 10 through 32, each with offset 4, vmmID 0, and various channel (ch), base CID (bcid), time delay (tdc), and ADC values.
- Hex/ASCII view: Shows data bytes such as 00 8c ff 84 0c 00 20 06 ed 4f and their corresponding ASCII characters.

Bottom Right: A TeamViewer session list window is open, showing a session for 'Lappi3 (249 485 838)'.

Bottom Status Bar: Displays 'Packets: 200 - Displayed: 200 (100.0%) - Dropped: 0 (0.0%)' and 'Profile: Default'.

Operation – other experiences

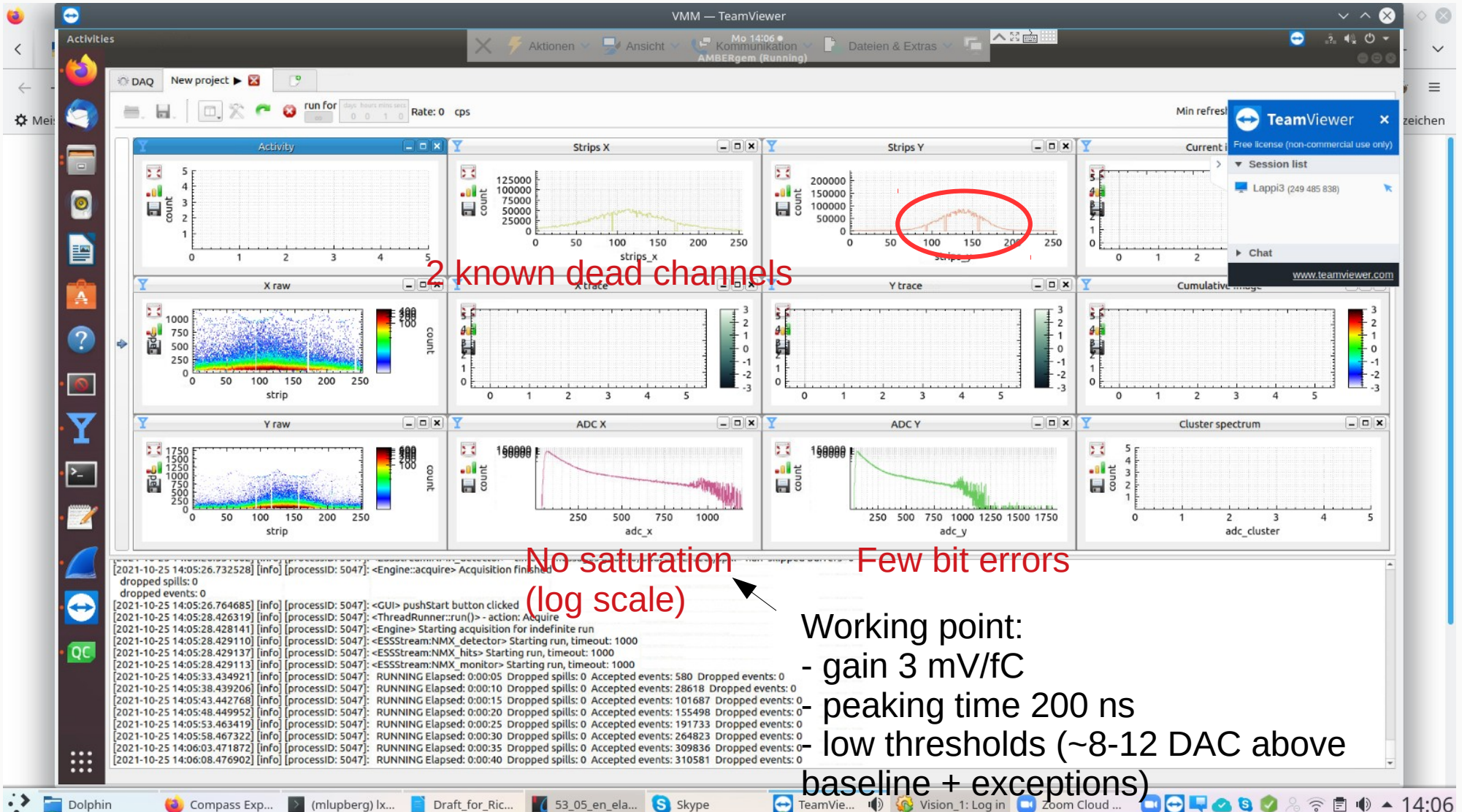
- In general very happy with SRS VMM operation
- Few power cycles needed: FEC IP loss or hybrid loos
 - Found out: most of the cases can be recovered in software
 - Use Warm Init FEC + few tricks (e.g. disable ping test)
- Often lost certain VMM channels (token stocked)
 - Used test pulse + neighbouring logic to recover
 - When neighbouring enables during DAQ → no channel loss
- Main problem of VMM: bad data due to Dual Clock readout
 - Change to 180 MHz Single Clock → reduces readout rate
 - Needs investigation: bit shift, possibly auto realign?

Software – experiences

- Some modifications in Slow Control GUI
 - Link status output
 - VMM channel settings scroll bar
- Better automatic threshold setting needed
- Daquiri crashes at least after 1 spill
 - Sometimes survives few spills if started during acq
- Graphana needed new profile (renaming in ESS DAQ)
- In general installation of ESS DAQ challenging

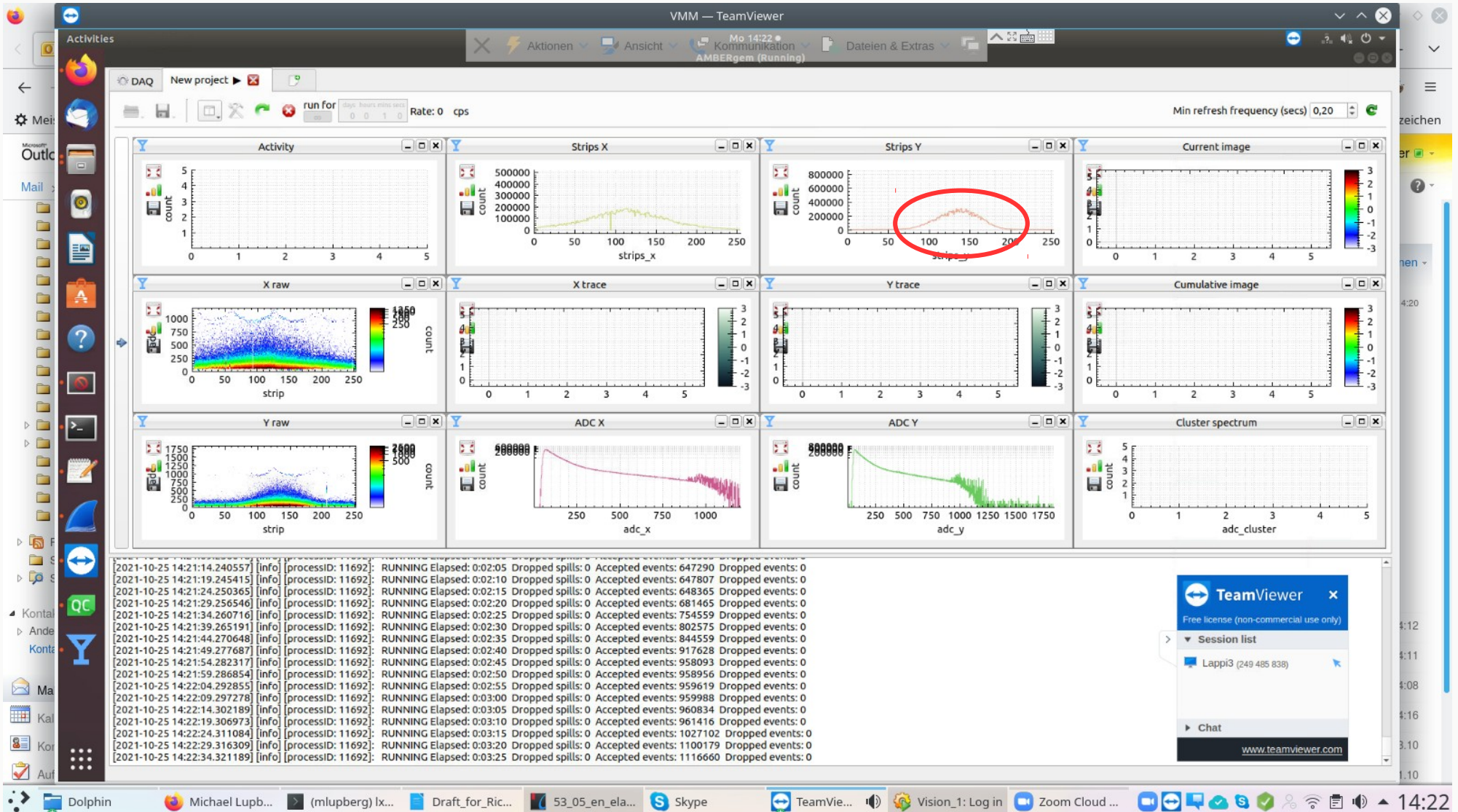
Some impressions from Daquiri

Neighbouring off



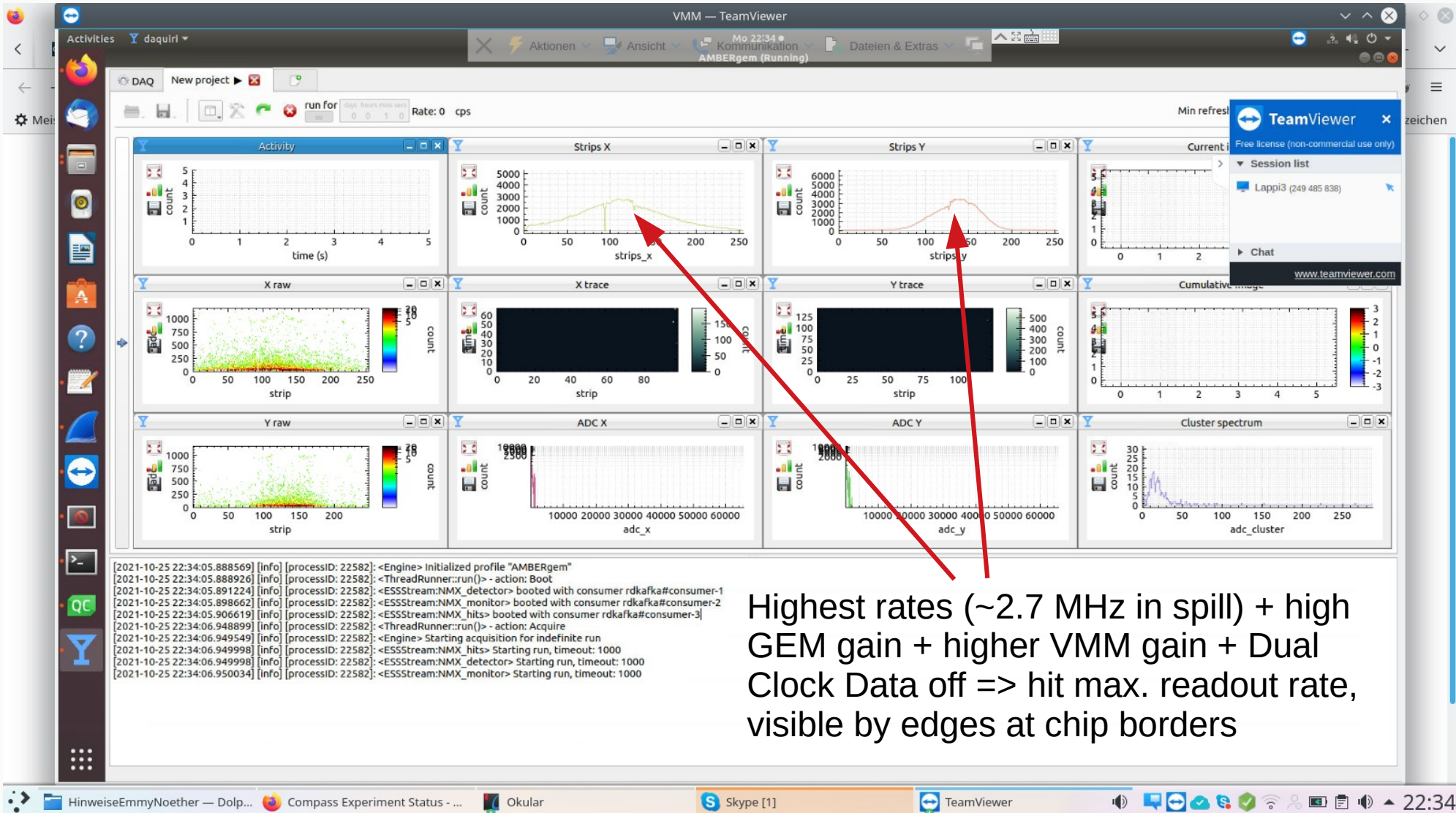
Some impressions from Daquiri

Neighbouring on



Some impressions from Daquiri

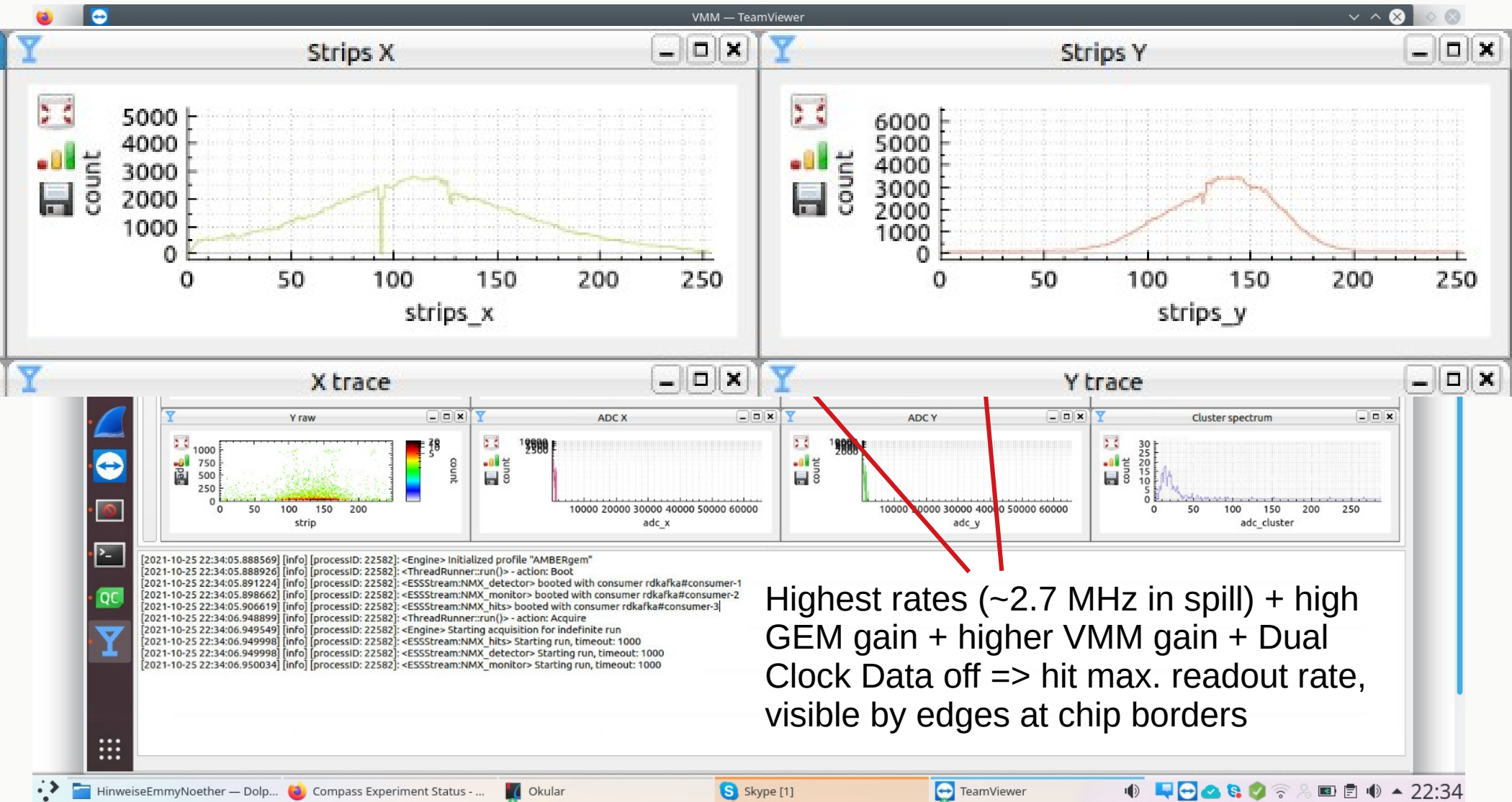
Neighbouring on



Highest rates (~2.7 MHz in spill) + high GEM gain + higher VMM gain + Dual Clock Data off => hit max. readout rate, visible by edges at chip borders

Some impressions from Daquiri

Neighbouring on



Highest rates (~2.7 MHz in spill) + high GEM gain + higher VMM gain + Dual Clock Data off => hit max. readout rate, visible by edges at chip borders

Outlook

- Need someone to analyse 1.2 TB of data
 - Analyse VMM S/N ratio from cosmics measurement in lab
- => prepare GEM frontend review + decision (VMM or TIGER)

In parallel:

- AMBER GEM detector R&D ongoing
- Stabilised voltage divider currently under test

