VMM3a/SRS-based DAQ for the new RD51 tracker

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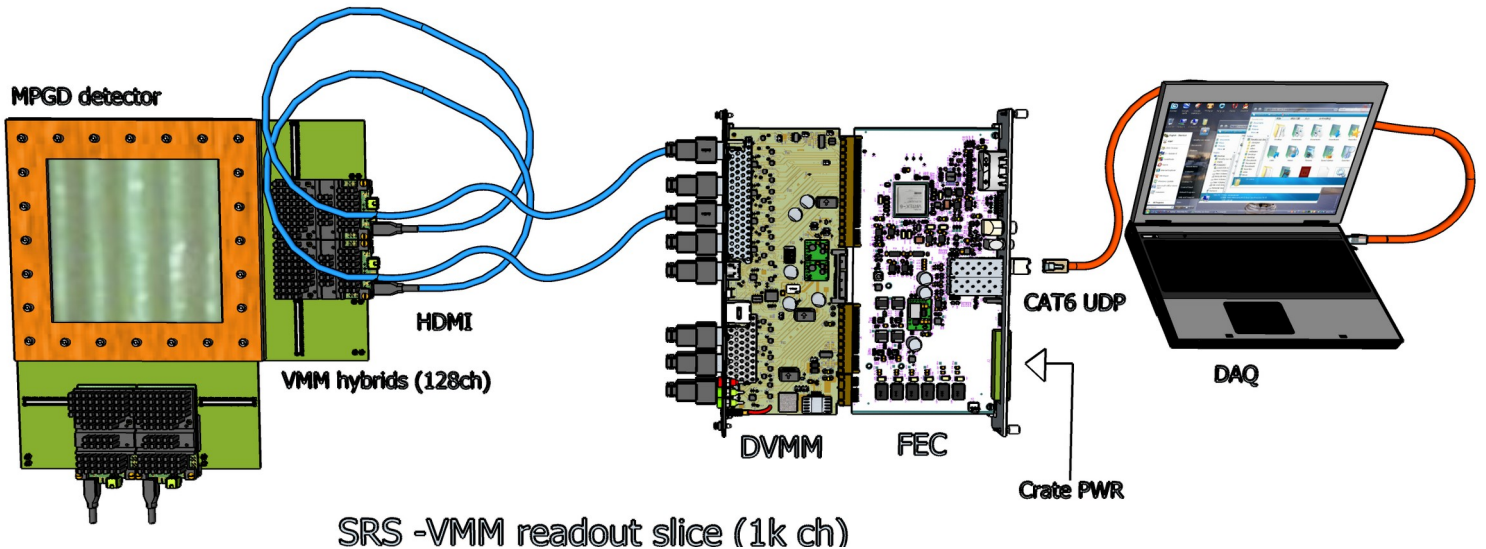
Outline

- Introduction to VMM3a and SRS
- Contributions from the community to the activity
- Tracker components
  - Hardware
  - Firmware
  - Software
- Plans for the forthcoming beam periods

Introduction to VMM3a and SRS

- VMM3a has been integrated into the SRS (many presentations in recent year during RD51 meetings, also this week)
- Principle scheme



Introduction to VMM3a and SRS

- VMM3a is a multi-channel analogue+digital ASIC → digital data stream
- Provides the following information
  - **Peak amplitude** → 10-bit ADC
  - **Peak time** → 1 ns resolution

  } No access to the waveform of the signal
- Access to charge information → position reconstruction algorithms
- Access to peak time information with this resolution → study intrinsic detector resolution
- Adjustable electronics gain → small MIP signals, compensate for detector effects (e.g. 60/40% charge sharing ratio)
- Flexible with detector capacitances (>~300 pF) → large detectors
- High-rate capability
  - Plus side: more statistics and more possible settings for detector characterisation (less data taking time required for one setting)
  - Downside: data storage

Contributions from the RD51 community to this specific activity

- Lucian Scharenberg (CERN GDD, University of Bonn)
- Hans Muller (CERN GDD, RD51)
- Dorothea Pfeiffer (ESS)
- Karl Flöthner (CERN GDD, University of Bonn)
- Daniel Sorvisto (Helsinki Institute of Physics, CERN GDD)
- Jona Bortfeldt (Ludwig Maximilian University of Munich)
- Miranda van Stenis (CERN GDD)

- In case you are interested and want to contribute

  → contact me: lucian.scharenberg@cern.ch
- → join the WG5.1: https://e-groups.cern.ch/e-groups/Egroup.do?egroupName=rd51-wg51

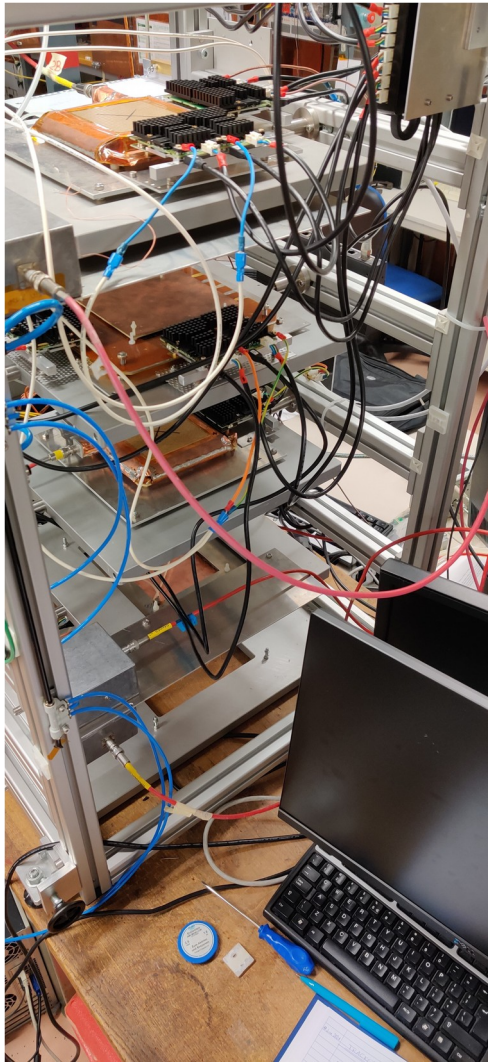
Tracker components: hardware

Electronics

- 16 RD51 VMM hybrids V5
  - 2048 readout channels
- 2 FECs
- 2 DVMMs
- 1 CTF
- 1 Powercrate 2k
- 2 PMXs (on-detector powerbox)
- 1 DAQ computer
- 1 network switch (10 Gbps)
- Cables (HDMI, power, ground, Ethernet)

Detectors

- 4 COMPASS-like triple-GEM detectors
- 10 x 10 cm^2 active area
- 256 + 256 strips



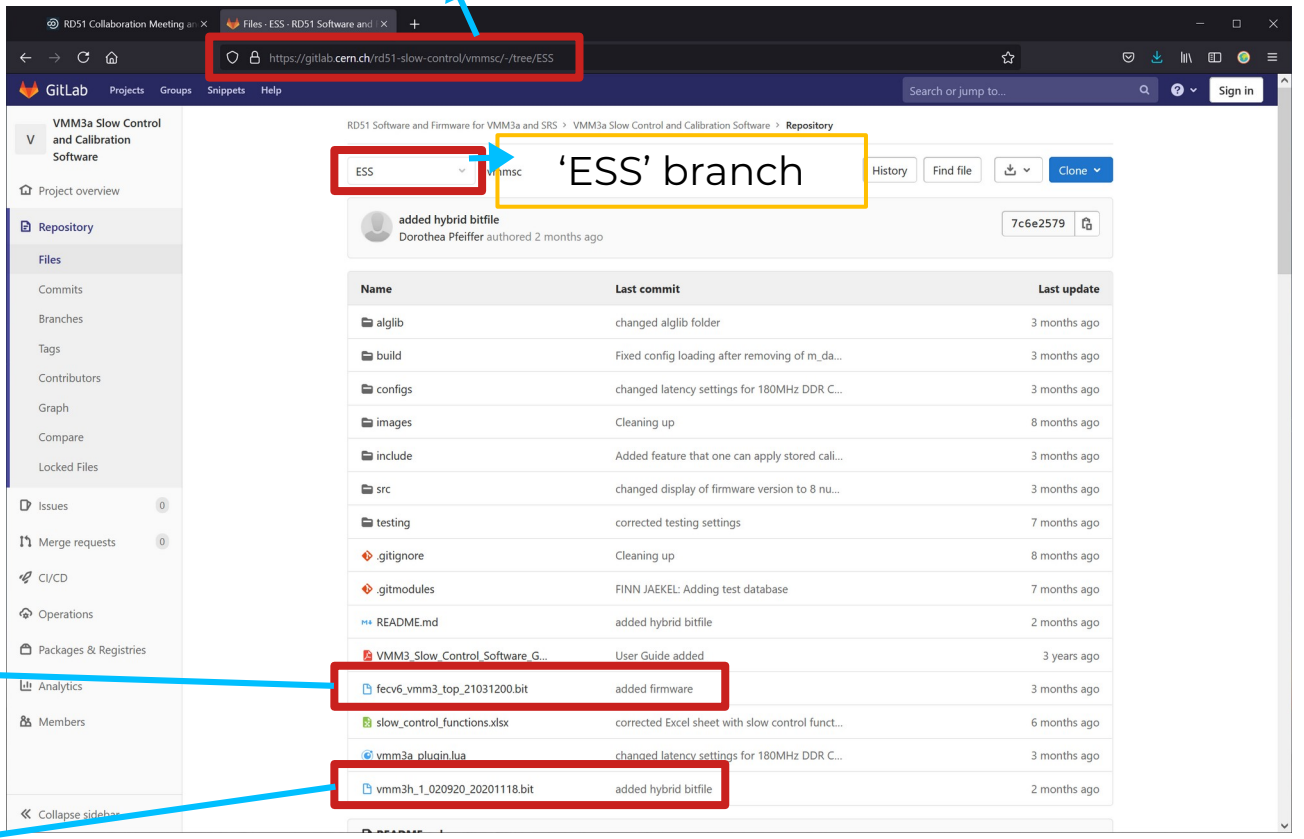
Tracker components: firmware

https://gitlab.cern.ch/rd51-slow-control/vmmsc/-/tree/ESS

‘Default’ firmware

→ shipped on the currently available hybrids

→ joint development effort within RD51, especially Bonn, ESS and GDD

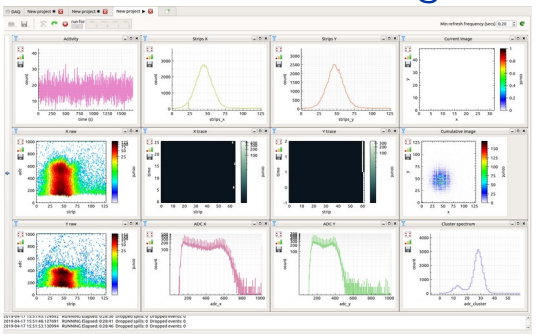


FEC:
fecv6_vmm3_top_21031200.bit

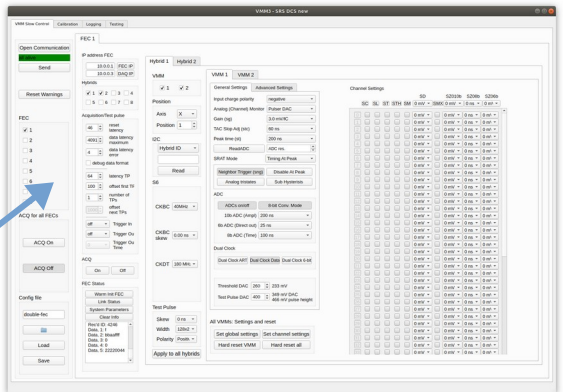
Hybrid:
vmm3h_1_020920_20201118.bit

Tracker components: software

Online monitoring



Control software



DAQ PC

10 Gbps network card

Data stream

Data stream

Online reco

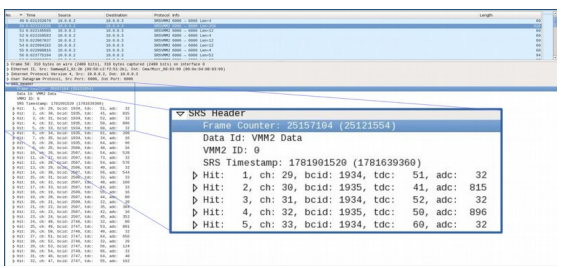
Data stream

kafka

Aggregator

Data stream

Quick-monitor the content of the UDP packages



https://indico.cern.ch/event/709670/contributions/3041841

Write UDP packages directly to disk

Offline analysis

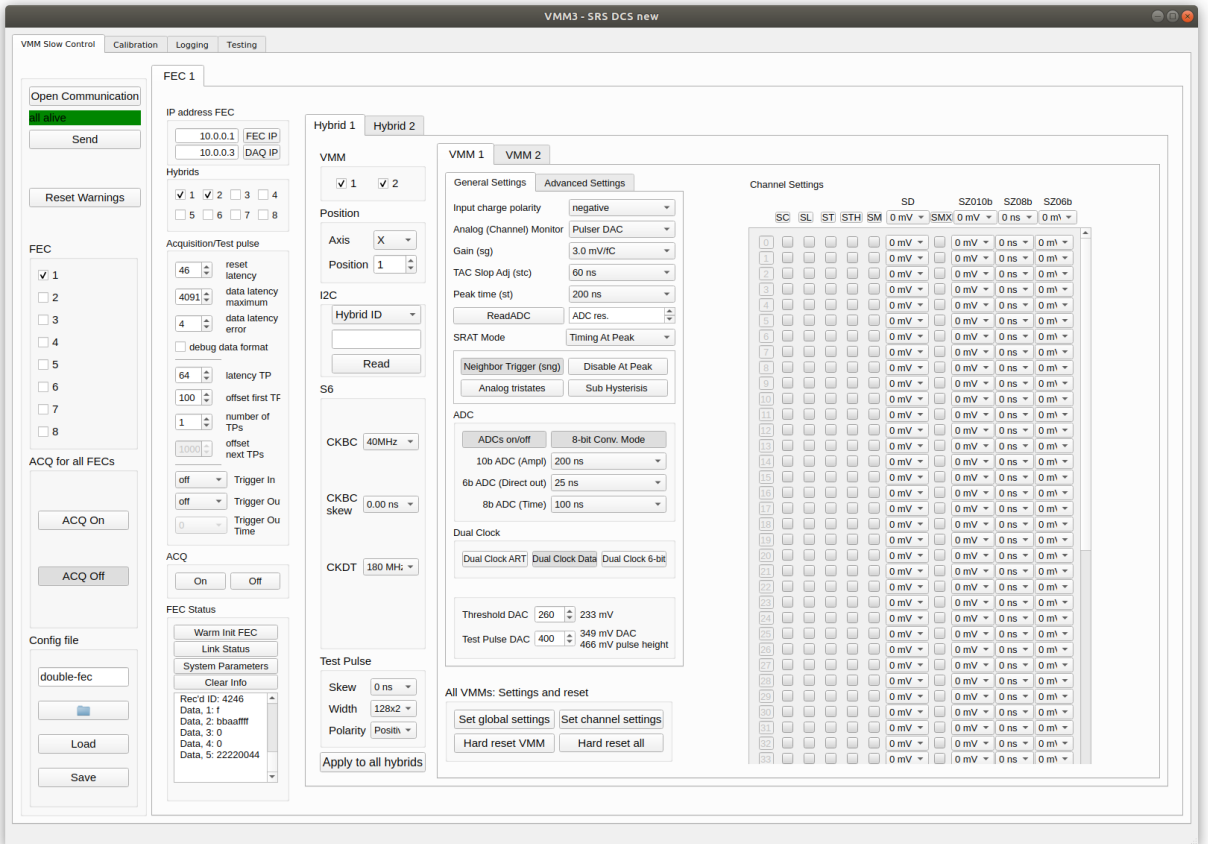
Tracker components: software (ACQ)

- RD51 VMM slow control software (**open source**)

  https://gitlab.cern.ch/rd51-slow-control/vmmsc

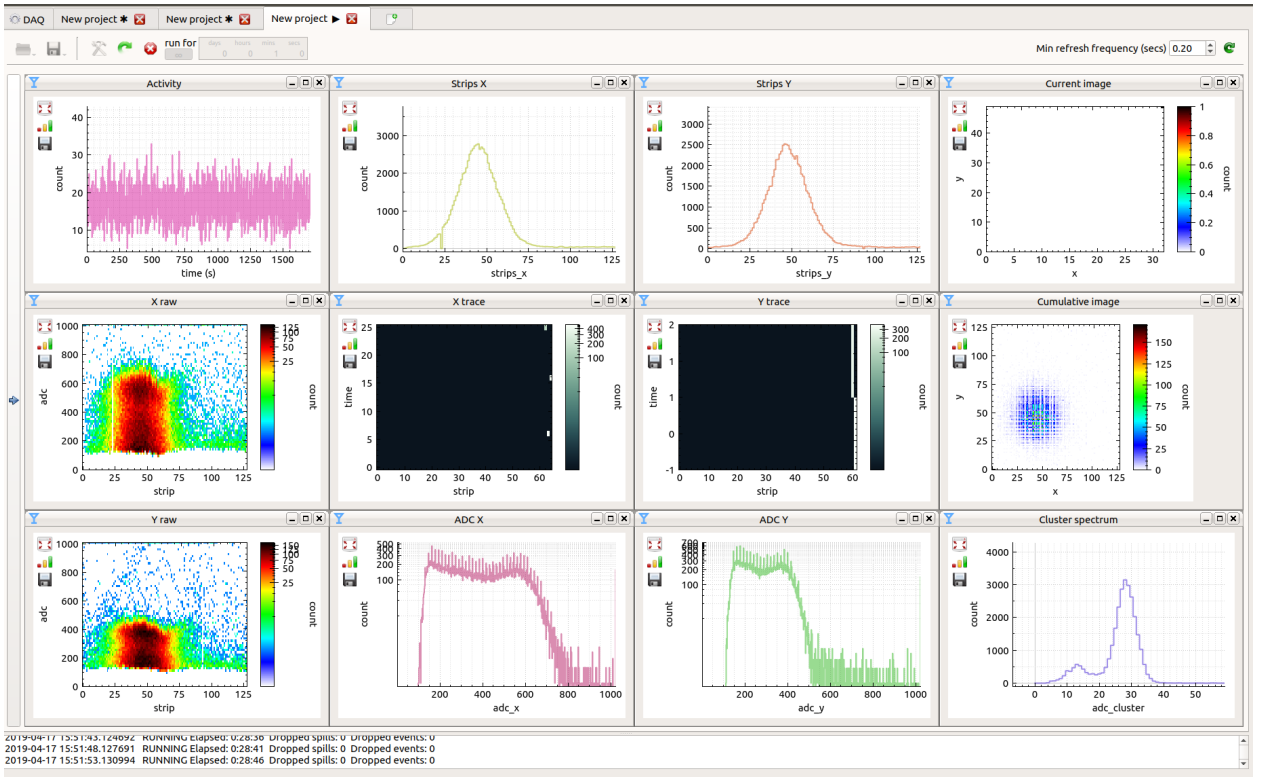
- Data acquisition by writing network packages directly to disk (**open source**)

  https://github.com/the-tcpdump-group/tcpdump



Tracker components: software (monitoring)

- Wireshark with Lua-plugin (**open source**)
  - https://gitlab.com/wireshark/wireshark
  - https://gitlab.cern.ch/rd51-slow-control/vmmsc/-/blob/ESS/vmm3a_plugin.lua
- DAQ and online monitoring software developed by ESS (**open source**)
  - https://github.com/ess-dmsc/essdaq
- Main tools: Event Formation Unit (EFU) and Daquiri (**open source**)
  - https://github.com/ess-dmsc/event-formation-unit
  - https://github.com/ess-dmsc/daquiri

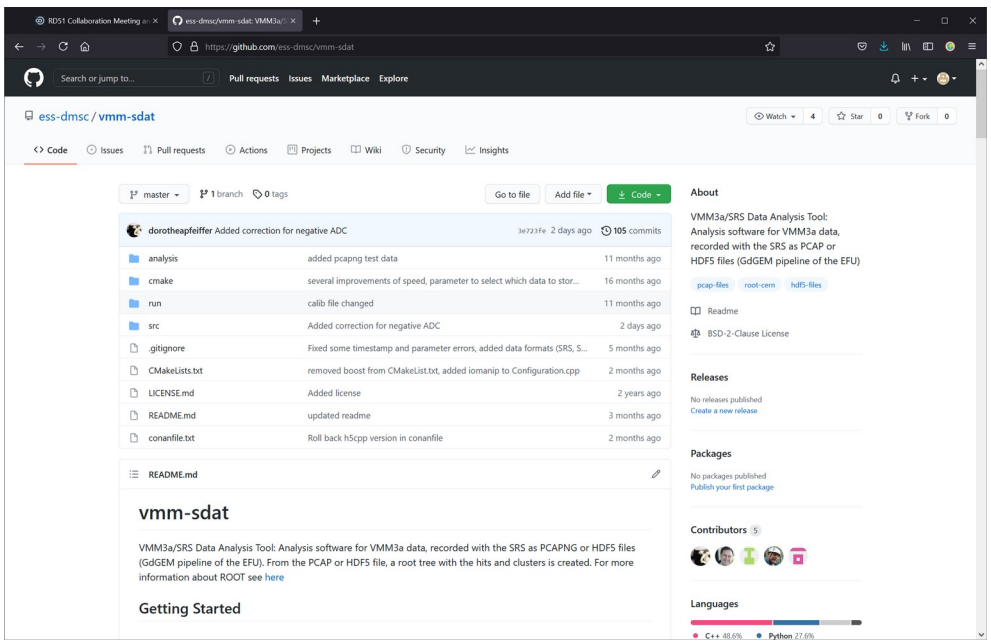


Tracker components: software (analysis)

- Cluster reconstruction: vmm-sdat from *Dorothea Pfeiffer* (**open source**)

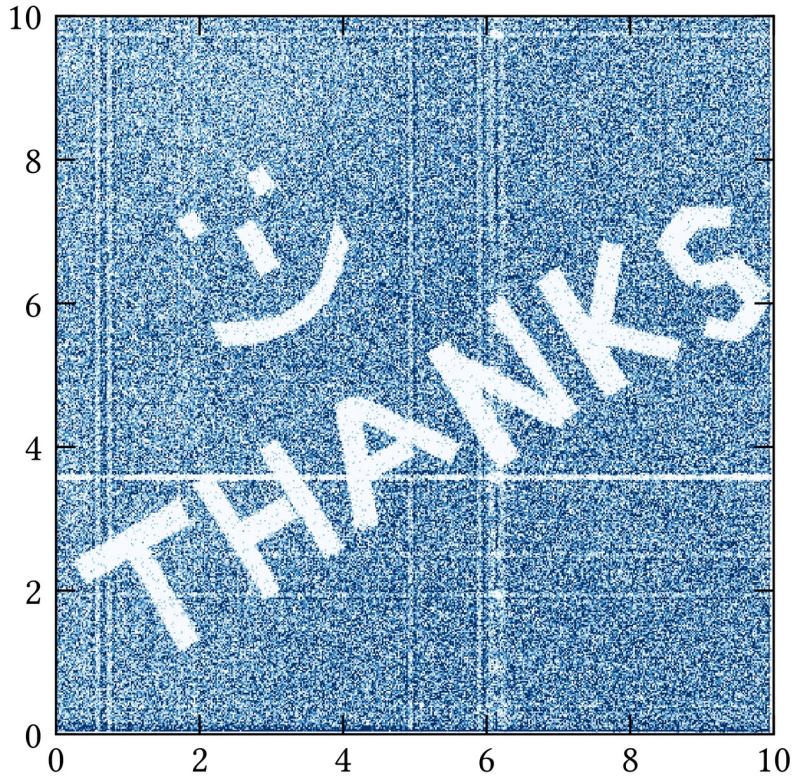
  → https://github.com/ess-dmsc/vmm-sdat

- Track reconstruction: modified APV25/SRS tracking software from *Jona Bortfeldt*



Plans for the forthcoming beam periods

- **July 2021:** Development and commissioning of a tracking system read out with the new VMM3a/SRS DAQ
  - *Operate* RD51 GEM telescope with VMM3a/SRS
  - Reconstruction and tracking software for VMM3a/SRS
  - Understanding electronics features on *spatial resolution* (effect of the NL) and *time resolution*
- **October 2021:** Detector performance studies, using the previously commissioned DAQ system
  - µRWELL (prototype for the 2022 RD51 tracker)
  - GEM detectors for COMPASS++/AMBER → Bonn University/GDD



for your Attention