

VMM3a/SRS-based DAQ for the new RD51 tracker

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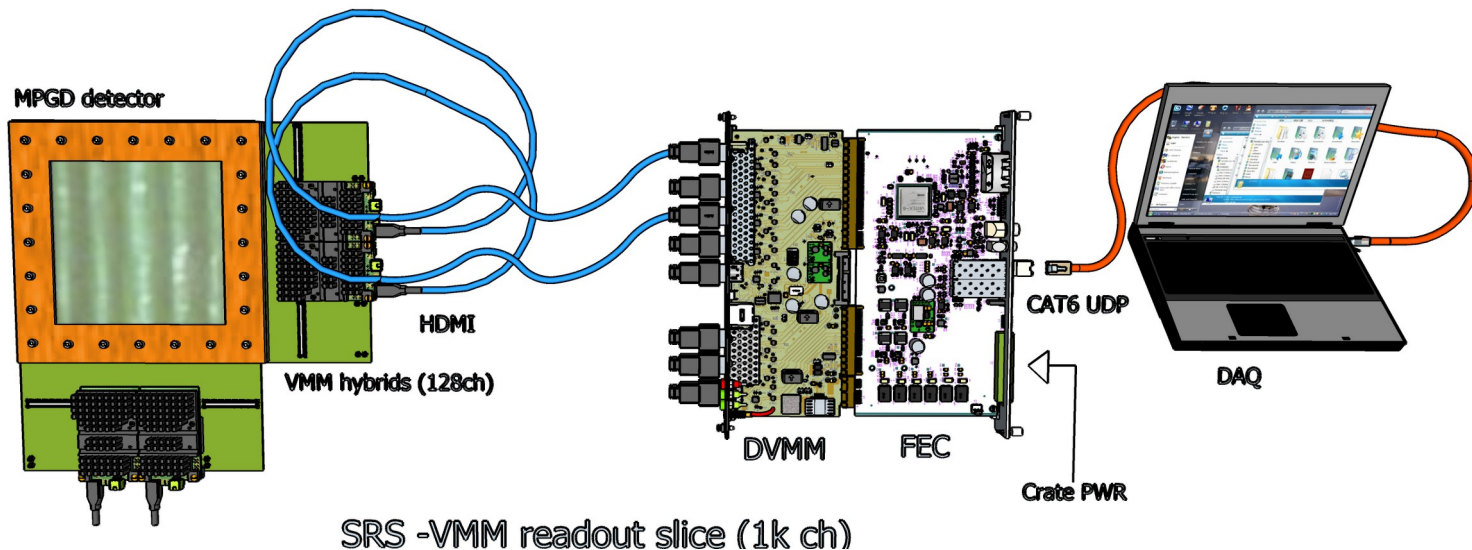
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Outline

- 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 ($>\sim 300$ 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

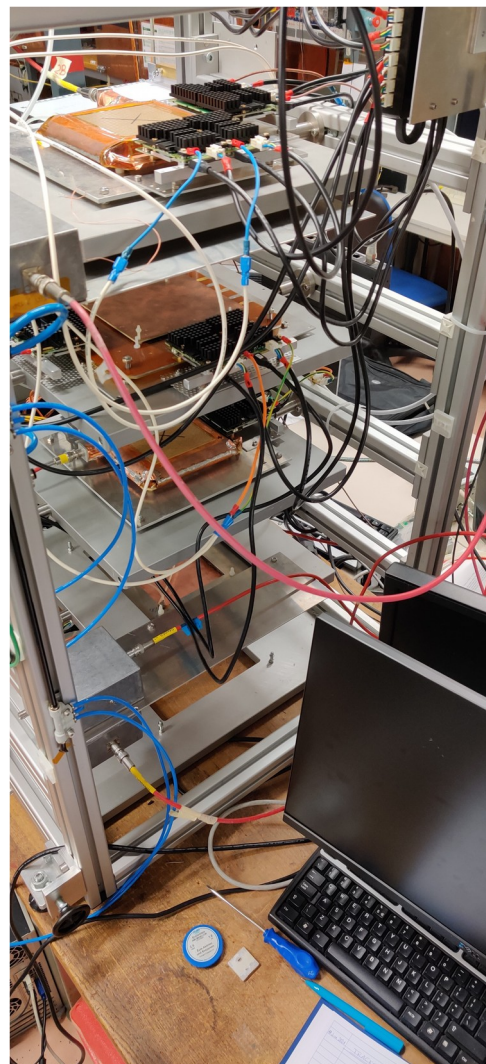
Electronics

- 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 cm² active area
- 256 + 256 strips



Tracker components: firmware

<https://gitlab.cern.ch/rd51-slow-control/vmm3/-/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

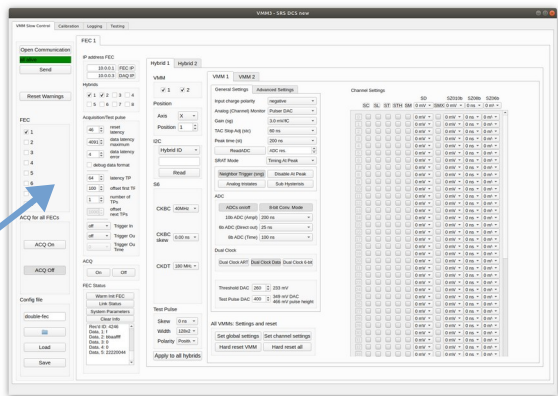
The screenshot shows the GitLab interface for the repository 'VMM3a Slow Control and Calibration Software'. The browser address bar shows the URL <https://gitlab.cern.ch/rd51-slow-control/vmm3/-/tree/ESS>. The repository page displays the 'ESS' branch selected in the dropdown menu. A commit titled 'added hybrid bitfile' by Dorothea Pfeiffer is shown. Below the commit, a table lists the files in the repository:

| Name | Last commit | Last update |
|---------------------------------|--|--------------|
| alglib | changed alglib folder | 3 months ago |
| build | Fixed config loading after removing of m_da... | 3 months ago |
| configs | changed latency settings for 180MHz DDR C... | 3 months ago |
| images | Cleaning up | 8 months ago |
| include | Added feature that one can apply stored cali... | 3 months ago |
| src | changed display of firmware version to 8 nu... | 3 months ago |
| testing | corrected testing settings | 7 months ago |
| .gitignore | Cleaning up | 8 months ago |
| .gitmodules | FINN JAEKEL: Adding test database | 7 months ago |
| README.md | added hybrid bitfile | 2 months ago |
| VMM3 Slow Control Software G... | User Guide added | 3 years ago |
| fecv6_vmm3_top_21031200.bit | added firmware | 3 months ago |
| slow_control_functions.xlsx | corrected Excel sheet with slow control funct... | 6 months ago |
| vmm3a_plugin.lua | changed latency settings for 180MHz DDR C... | 3 months ago |
| vmm3h_1_020920_20201118.bit | added hybrid bitfile | 2 months ago |

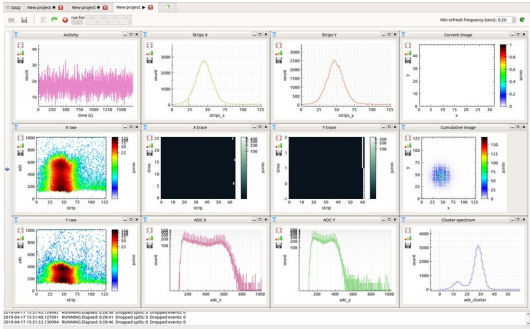
Blue arrows point from the text boxes on the left to the corresponding files in the table: from 'FEC:' to 'fecv6_vmm3_top_21031200.bit' and from 'Hybrid:' to 'vmm3h_1_020920_20201118.bit'. A red box highlights the 'ESS' branch dropdown, and another red box highlights the 'VMM3' dropdown menu.

Tracker components: software

Control software



Online monitoring



DAQ PC

10 Gbps network card

Data stream

Quick-monitor the content of the UDP packages

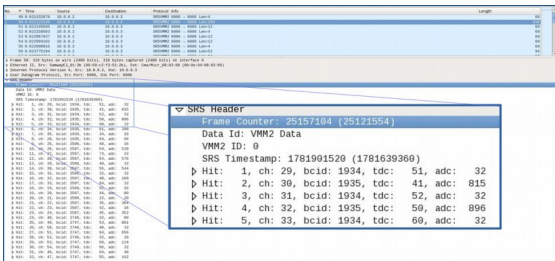
Offline analysis



Online reco



Data stream

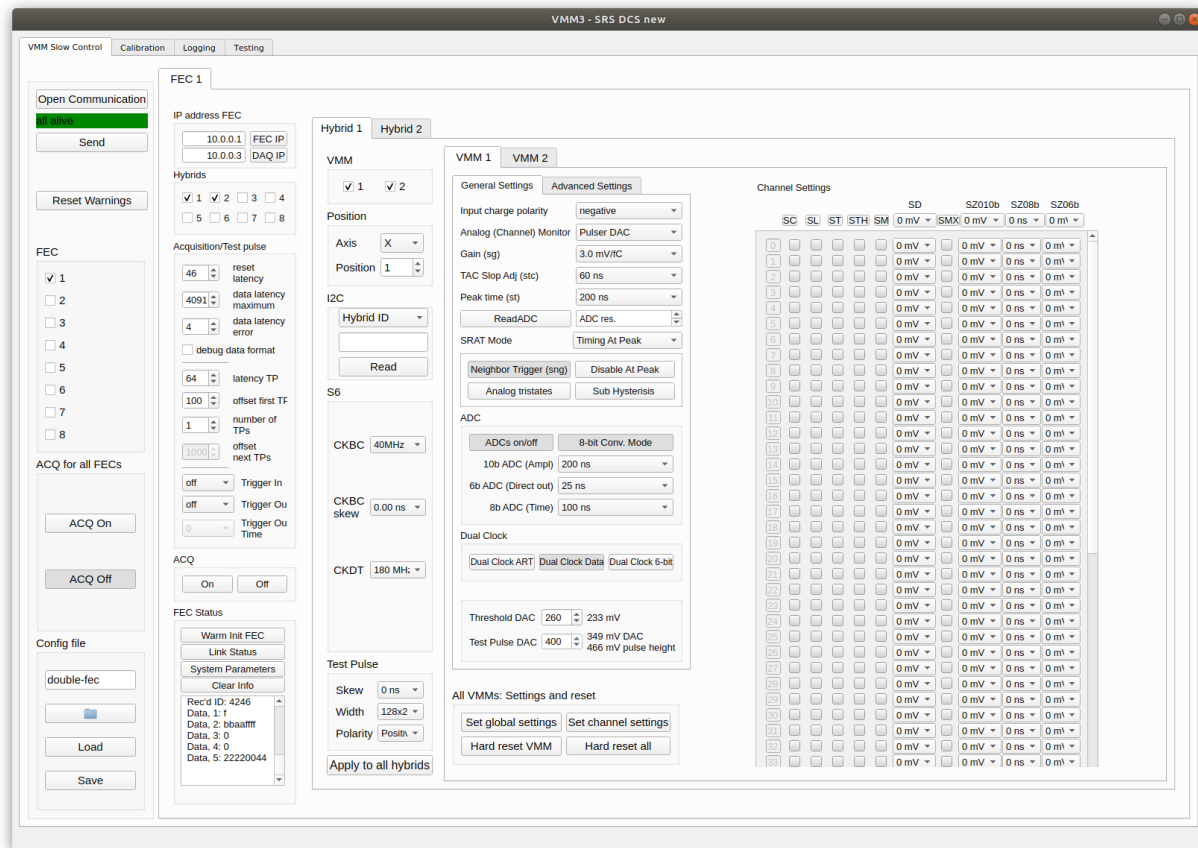


<https://indico.cern.ch/event/709670/contributions/3041841>

Tracker components: software (ACQ)

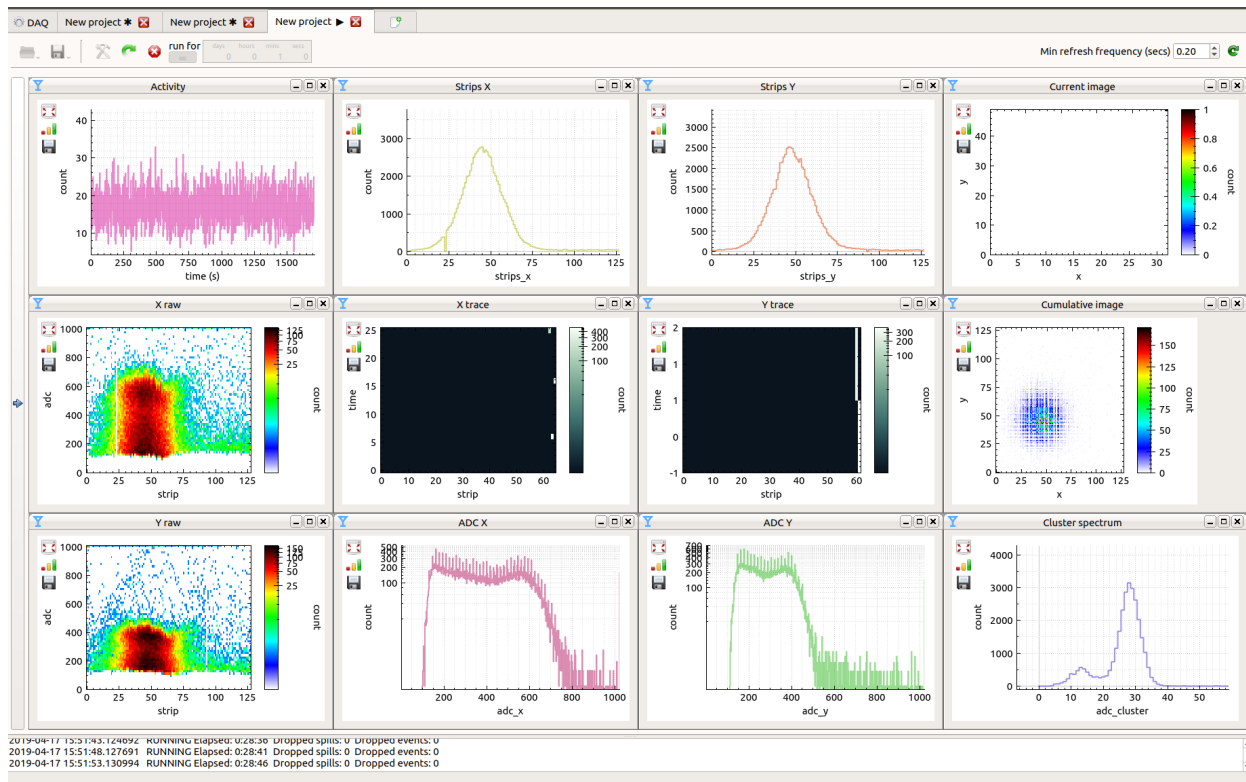
- RD51 VMM slow control software (**open source**)
<https://gitlab.cern.ch/rd51-slow-control/vmm-sc>
- Data acquisition by writing network packages directly to disk (**open source**)

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



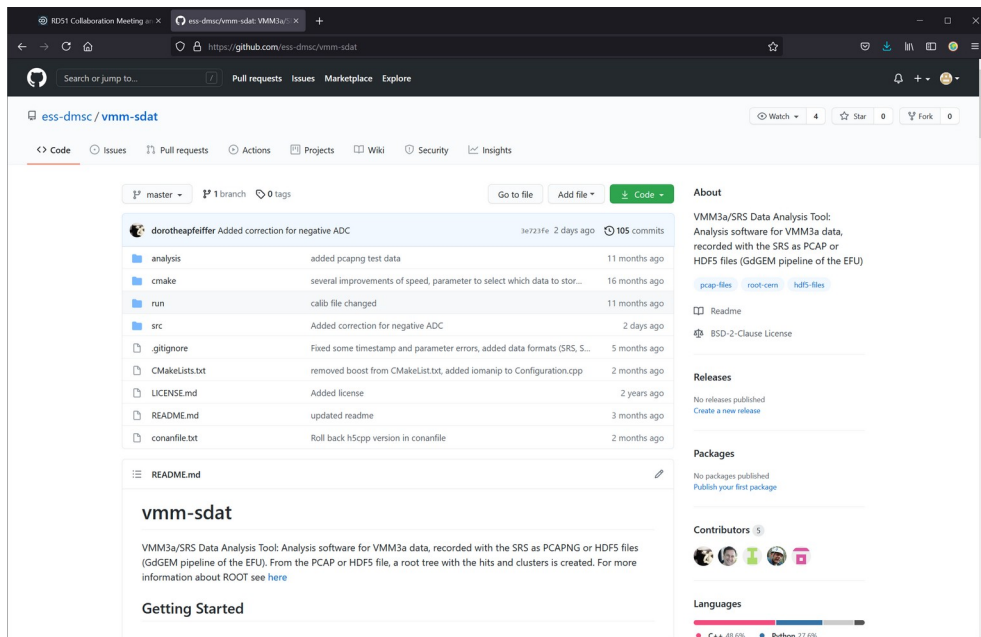
Tracker components: software (monitoring)

- Wireshark with Lua-plugin (**open source**)
 - <https://gitlab.com/wireshark/wireshark>
 - https://gitlab.cern.ch/rd51-slow-control/vmmisc/-/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>



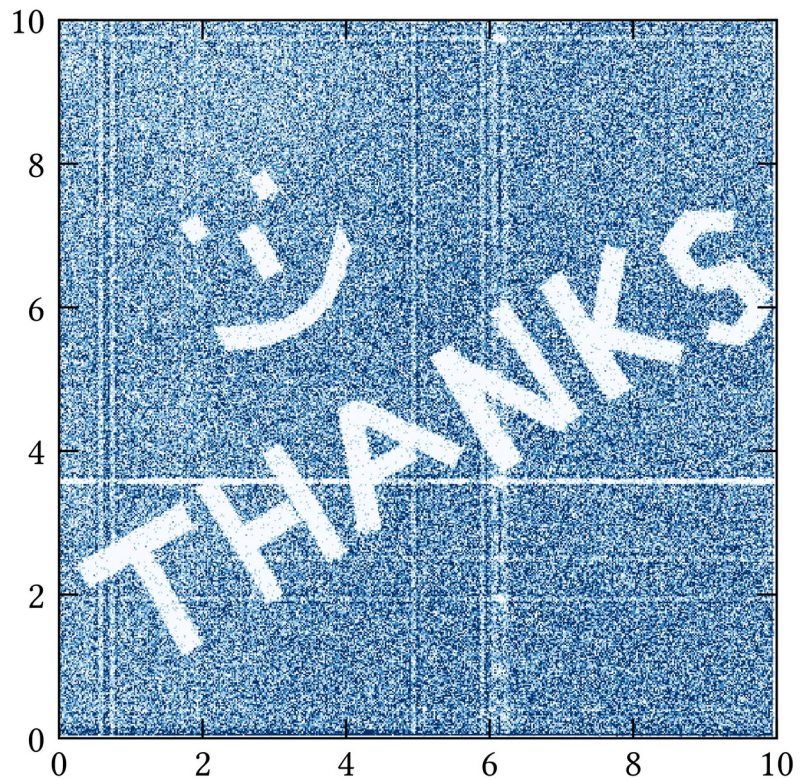
Tracker components: software (analysis)

- Cluster reconstruction: vmm-sdat from *Dorothea Pfeiffer* (**open source**)
→ <https://github.com/ess-dmnc/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
 - μ RWELL (prototype for the 2022 RD51 tracker)
 - GEM detectors for COMPASS++/AMBER \rightarrow Bonn University/GDD



for your Attention

