



Report about the REALTIME WORKSHOP

Dmytro Meleshko, Jens Sören Lange (Giessen University)

JENNIFER2 Project General Meeting

KEK

02.06.2024

Realtime Workshop

- April 8–11, 2024
- Hybrid mode:
 - .48 registered participants, about 20 at Giessen campus
 - .Remote talks from Japan, Switzerland, US, UK

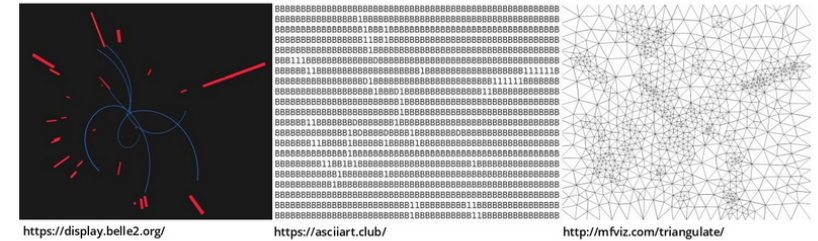


<https://indico.belle2.org/event/10782/>

Workshop // on // Fast Realtime Systems // and // Realtime Machine Learning

8–11 Apr 2024
Heinrich-Buff-Ring 58
Europe/Berlin timezone

- Overview
- Scientific Topics
- Timetable
- Contribution List
- My Conference
 - My Contributions
- Registration
- Participant List
- Confirmed speakers and/or participants
- Travel
- Accommodation and Lunch
- Map (from Giessen train station to Campus)



Jennifer2 Workshop on fast Realtime DAQ and Trigger Systems

(April 8 and 9, 2024)

This part of the workshop is supported by JENNIFER2, the evolution of the former JENNIFER project (Japan and Europe Network for Neutrino and Intensity Frontier Experimental Research), funded under the Horizon2020 program of the European Union as a Marie Skłodowska Curie Action in the RISE program under grant n.822070. For further information see <http://www.jennifer2-project.eu>.

Workshop on Realtime Machine Learning

(April 10 and 11, 2024)

This part of the workshop is supported by DIG-UM (Digital Transformation in the Research of Universe and Matter) and the ErUM-Data-Hub. For further information see <https://erumdatahub.de/en/dig-um/>.

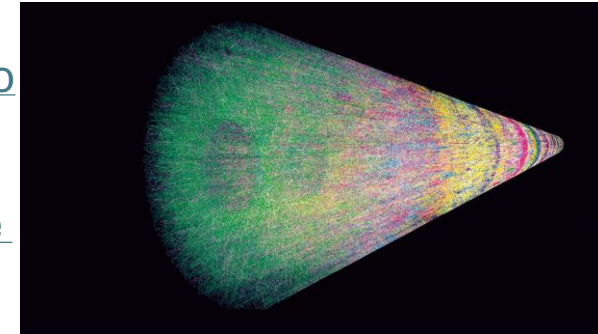
The workshop with both parts will be organized in **hybrid** format. Participation on-site and participation remote by video will be available. However, we encourage participants to consider to come to Giessen and a number of key speakers already confirmed attendance in person.

We are aiming in enlarging the network of collaboration and the interdisciplinarity of the field. We therefore especially invite people from other ErUM communities to join the workshop. While a number of key presentations will cover approaches and results from particle, hadron and nuclear physics, we explicitly welcome contributions from method scientists as well as adjacent scientific fields.



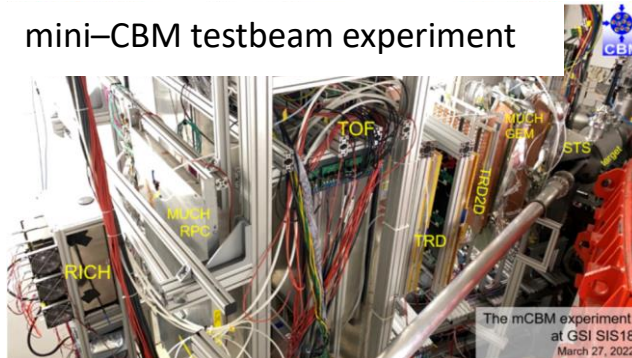
Monday: Focus on untriggered readout

- Triggerless DAQ systems is a modern trend (4 experiments reported at this workshop); for colliders easier than for fixed target experiments [ALICE: David Rohr](#) because event builder may utilize bunch crossing number [LHCb: Alberto Perro](#)
- Sending data with Terabytes/s (CBM ~ 1 TB/s, ALICE > 3 TB/s) became possible; pushing all data to CPU farm is tempting [CBM: Volker Friese](#) (“easier” than FPGA processing)
- Different concepts to reduce the large data size: data compression (keep all events) vs. data reduction (software trigger)
- High Level Trigger systems use different GPUs (nVidia or AMD)
- DAQ and trigger of neutrino experiments (Jennifer2 project): never stop the run, you may miss the supernova [Benjamin Richards](#) (taking pedestals during ongoing run!) and the supernova has orders of magnitude more data than bandwidth on a normal weekday

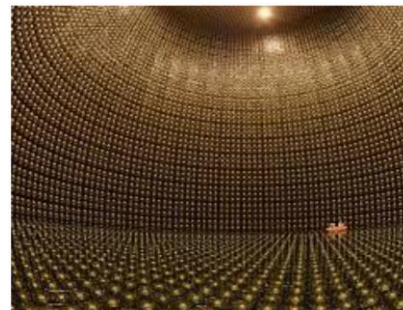


Continuous data stream of overlapping events in ALICE TPC (50 kHz Pb + Pb)

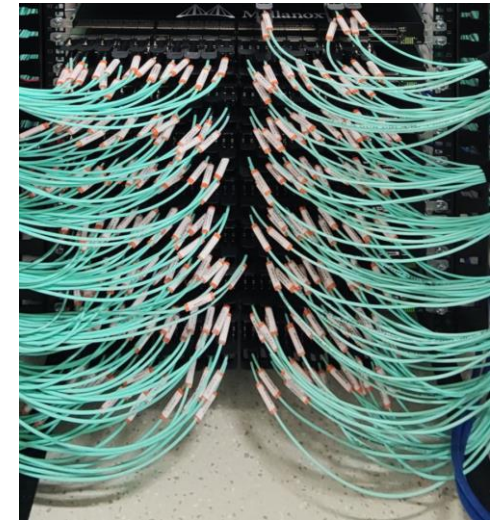
mini-CBM testbeam experiment



The mCBM experiment at GSI SIS18
March 27, 2022



Super-k ($\sim 20,000$ pmts)



LHCb event builder farm

Tuesday: Focus on FPGA systems

- Belle II PXD DAQ (Jennifer2 project), operation since 2019
300 TB zero-suppressed data, 400+ Million events recorded

[Sören Lange](#)

- TDCs on FPGAs and even ADCs on FPGAs (by time-over-threshold);
who needs ASICs? (but still required in radiation-hard environment)

[Michael Traxler](#)

- PCIe40: ALICE, LHCb and Belle II upgrade platform [Dmytro Levit](#)

PCIe40 Hardware

- Experiences with Xilinx UltraScale and UltraScale+ reported [Vladimir Savinov](#)

- Faster and faster links (AXIstream and
10G uplink tested for PXD readout)

[Matthäus Krein](#)

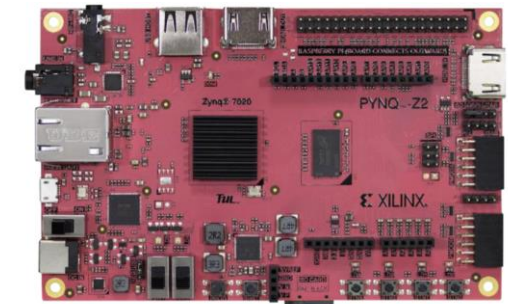
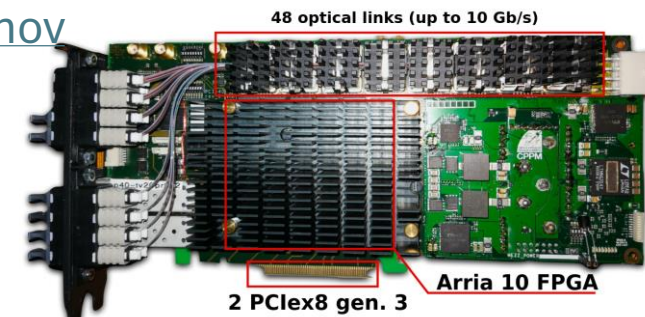
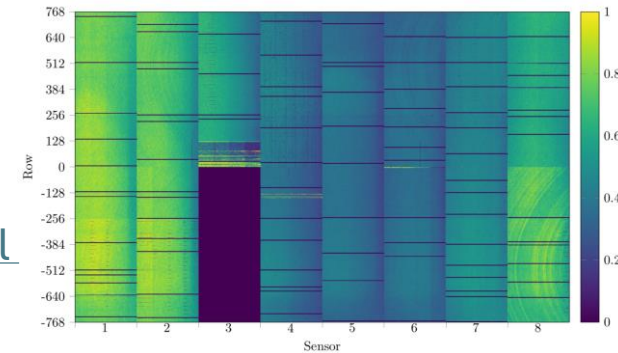
- System-on-a-chip (i.e. FPGA interfaced with ARM processors)
changed the FPGA world

- .makes it much easier to get e.g. NN training data to the FPGA
(compared to “pure” FPGAs)

- .non-expensive boards available (ZYNQ)

- .HLS (high level synthesis, C/C++ like code),
maybe code is still VHDL but generated
by “transpilers” and not written by students anymore,
frameworks for NN on FPGAs existing e.g. hls4ml, FINN

Supported by Jennifer2

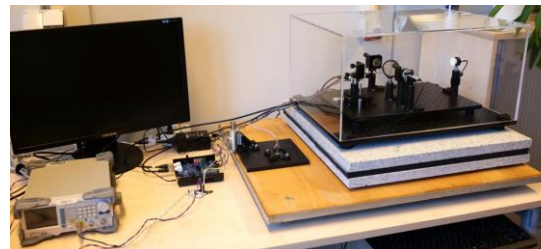


<https://www.realdigital.org/img/16ebb6e013abdd79d4a33733c8ff0fc9.png>

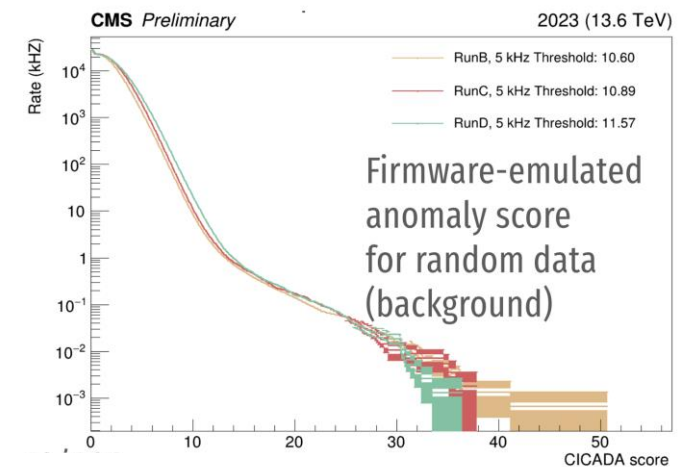
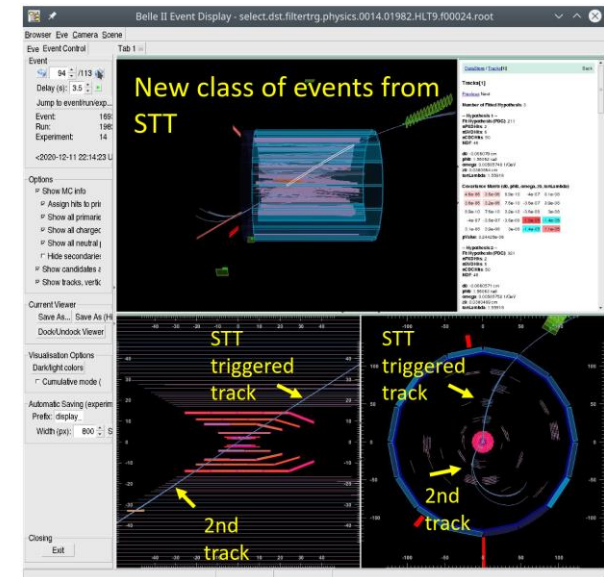
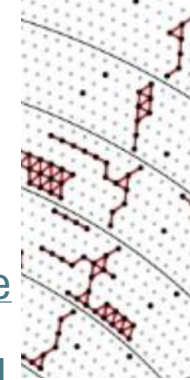
Wednesday: Focus on neurotriggers

- NN on L1 tested, commissioned and running in Belle II and CMS; latency <100 ns (!) achieved
- Single track triggers became available [Christian Kiessling](#)
- Graph Neural Networks (GNN) [Greta Heine](#) [Isabel Haide](#) for hit clean-up or finding tracks of any curvature [Marc Neu](#) (wide p_T range, advantage compared to cellular automata)
- Anomaly detection: find rare, new phenomena in a huge data set
- New ideas: “half autoencoder” (CMS) or anomaly detection using decision trees instead of autoencoder; does not need multiplications but only “if statements”
- tempting to find new physics, but contradicts “blind analysis”
→ requires a protocol what to do with the data
- ErUM-Wave project: earthquake realtime detection and wave propagation prediction

[Jochen Steinmann](#)
[Conny Hammer](#)



[Tae Min](#)



Thursday: Focus on Versal

- New hardware platform generation by Xilinx (the new “Porsche”)
- Factor 30–40 more FPGA resources compared to e.g. Belle II PXD hardware
- Dedicated “AI accelerators”
- Board price ~17.000 €
- 3 groups reported preliminary test results
- Part of project proposal for Jennifer3

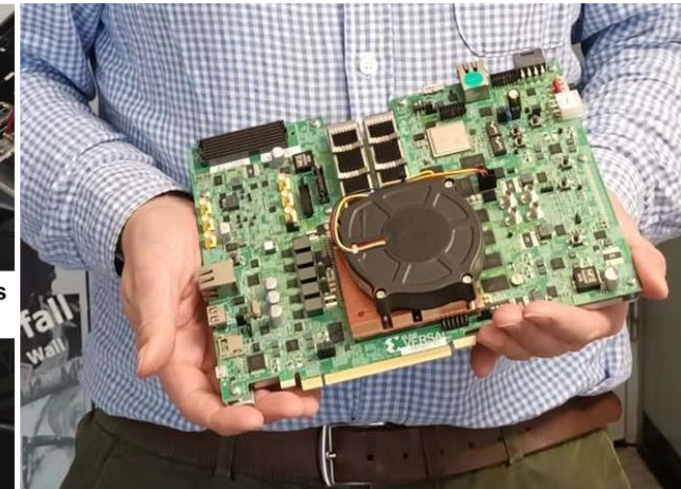
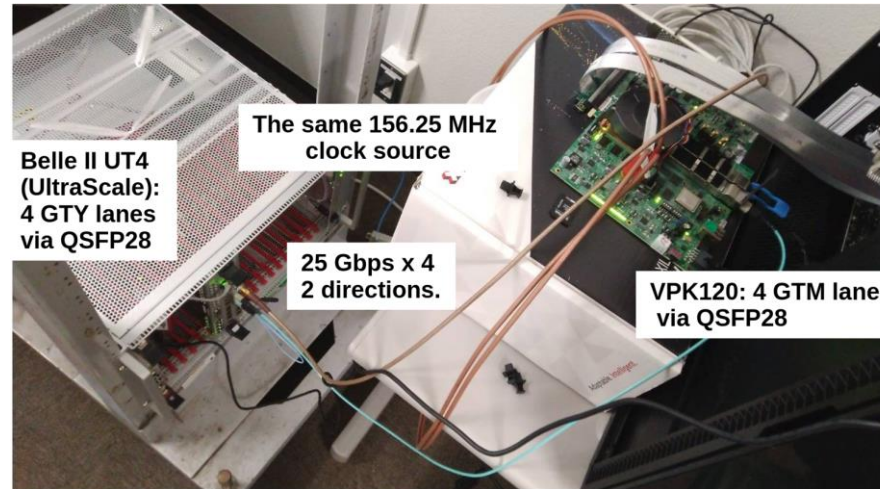
[Yun-Tsung Lai](#)

[Sören Lange](#)

Versal @ Bonn

Versal @ KEK

Versal @ Giessen



**THANK YOU
FOR YOUR ATTENTION**