Karlsruhe Institute of Technology

MATTER AND TECHNOLOGIES
Detector Technologies and Systems

Serenity-S1:
A Versatile Data Processing Card for CMS Phase-2

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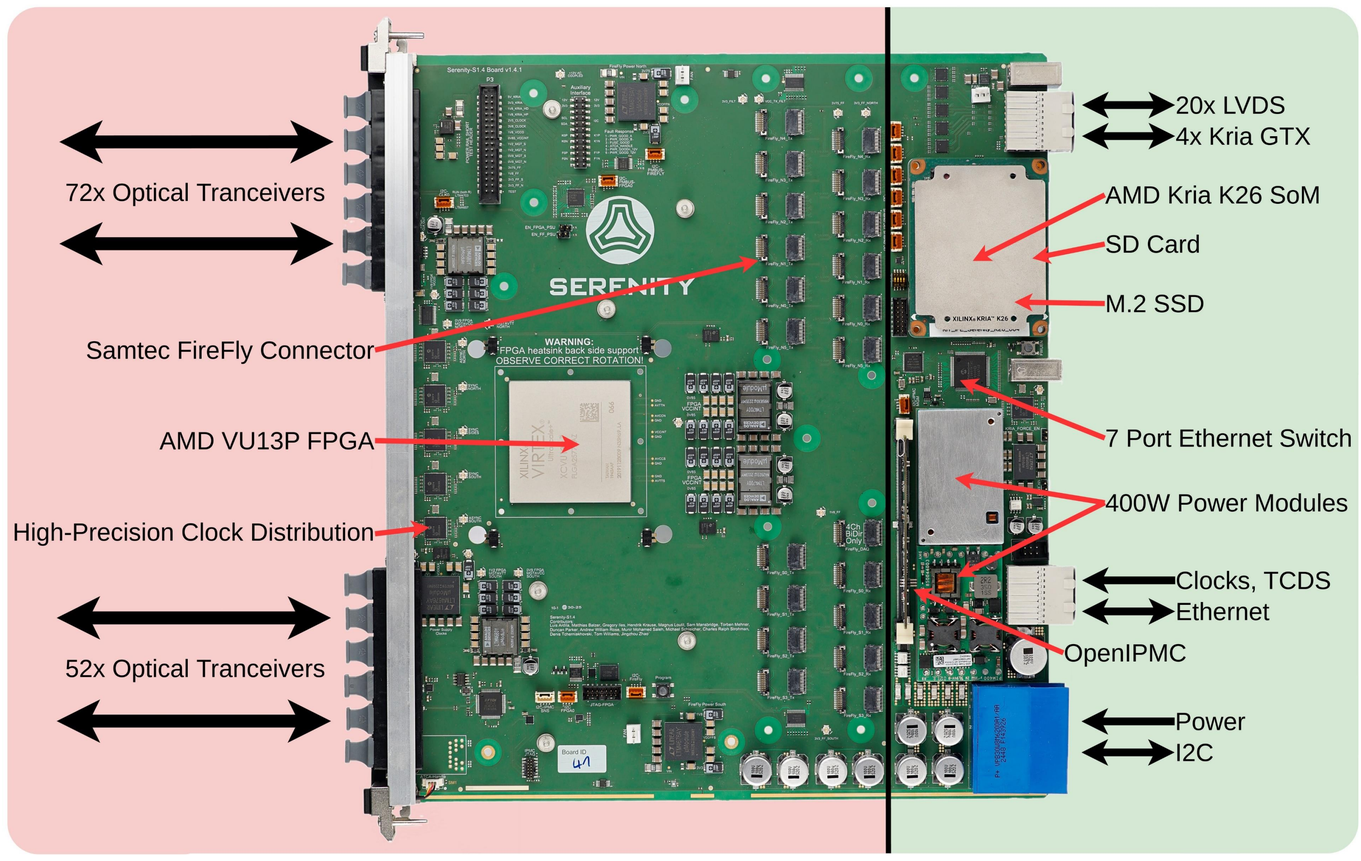


Payload Area

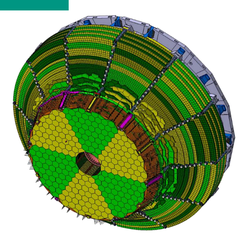
- Performance optimized
- Two FPGA options
  - AMD **VU13P** or VU9P
- Multiple FireFly options
  - 10x T12 / R12, 1x B04
  - Copper / optical
  - Up to **25 Gb/s** each
- Sync or async clock paths
- Central power control

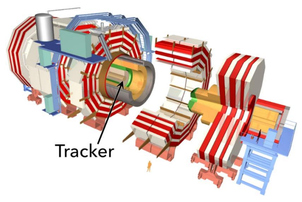
Service Area

- Space optimized
- Board management
  - AMD **Kria K26 SoM**
- Monitoring and control per ATCA standard
  - **OpenIPMC**
- Cascade power modules
- Ethernet access via backplane

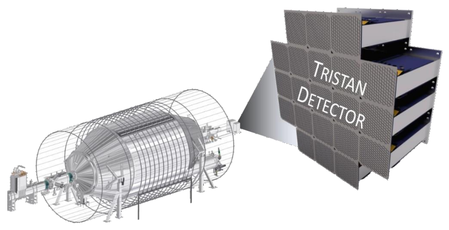
Versatile Applications

- The High-Granularity-Calorimeter (**HGCAL**) will replace the endcap calorimeters in CMS
- Due to high data rates, **302 Serenity-S1 cards** will be used for DAQ and trigger





- CMS **Tracker** will be upgraded for HL-LHC
- **214 Serenity-S1 cards** will be used as DAQ and timing cards (DTC)
- **104** additional **Serenity-S1 cards** will be used by various other CMS subsystems for phase-2 (**BRIL**, **MTD**, **L1T**, …)
- **TRISTAN** is the next experiment generation at KATRIN
- New detector requires new readout system with online cluster-evaluation
- **3 Serenity-S1 cards** will be used

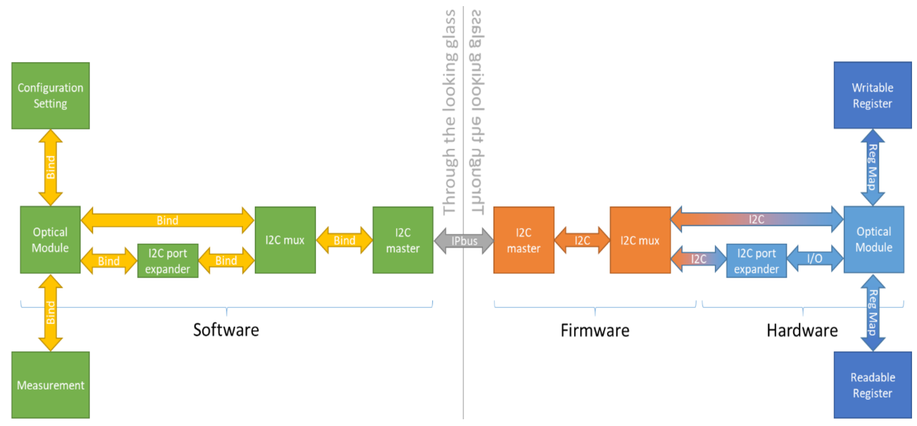


➡ **Suitable for large-, medium- and small-scale setups!**

Advanced Board Management

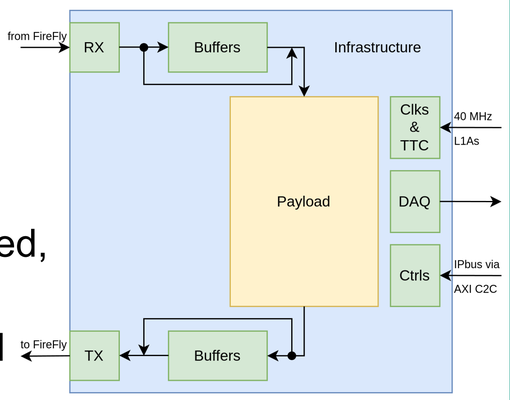
Serenity Management Shell (SMASH)

- Framework that runs on the Kria K26 SoM
- Controls the board communication infrastructure
  - **I2C** and **PMBus** based
- Works by mirroring the physical bus topology into software
- **Flexible** against **hardware changes** through independent modules connected by bind commands



Extensible Modular (data) Processor (EMP)-Framework

- Framework that runs on the FPGA
- Centered around a **payload area**
- Infrastructure **easily configurable** via single config file
  - Link Type/Protocol, Clock Speed, Buffer, …
- Register access from the Kria SoM
  - **IPBus** via AXI chip2chip



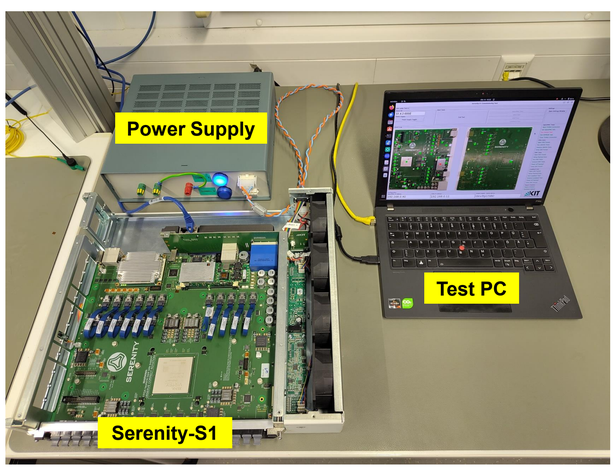
➡ **You can focus on your awesome physics algorithm!**

Road to Production and Testing

- **Pre-series Production** started in **August 2025**
- **Main-series Production** started in **October 2025**

➡ **Hardware development done and production started!**

- **Factory Acceptance Test**
  - Test / Configure every board in **10 Minutes**
  - Highly automated
  - Used directly at the production site
- **User Acceptance Test**
  - Sub-detector specific tests at CERN



➡ **My work ensures every board is properly tested!**

Interested and want to know more?!
Visit our webpage and read our paper ➡