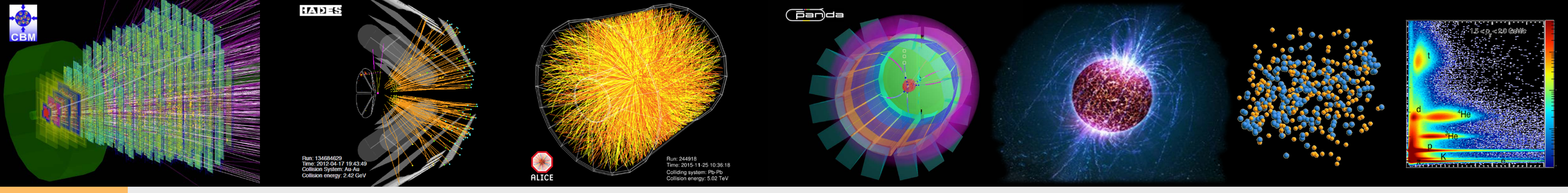
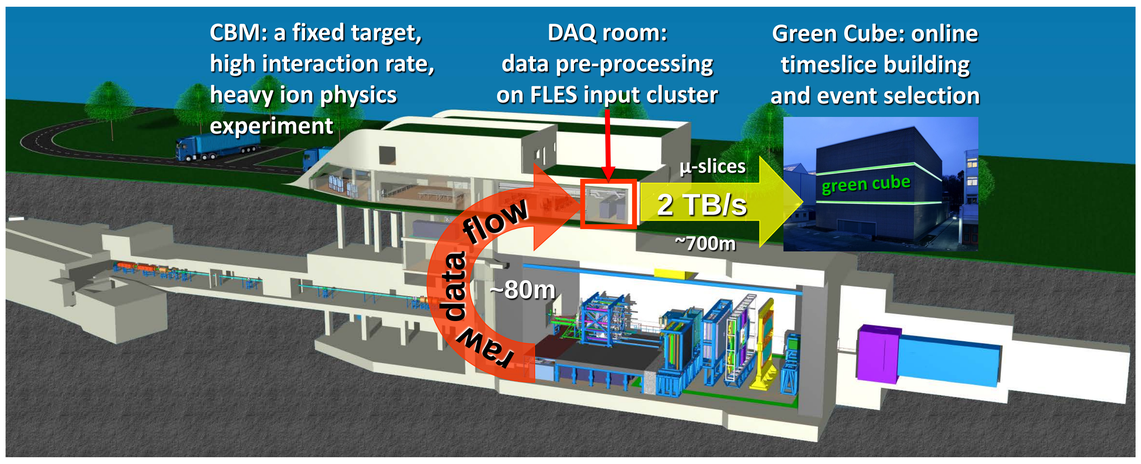
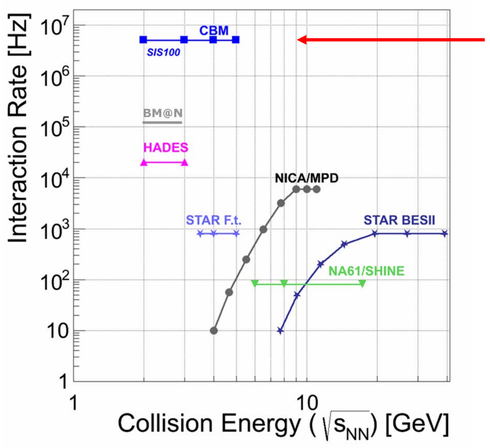


The high performance, free-streaming data acquisition system of CBM

The CBM data challenge

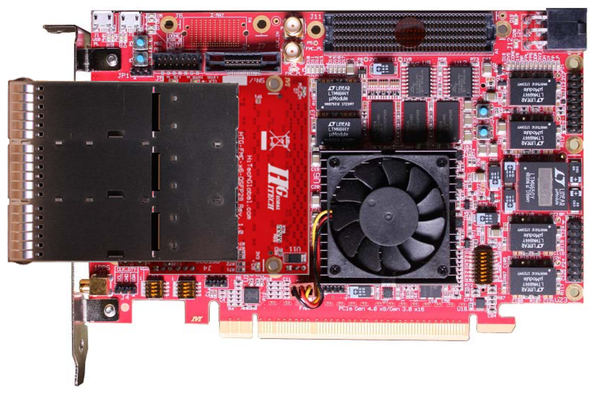




Interaction Rate for CBM at SIS100

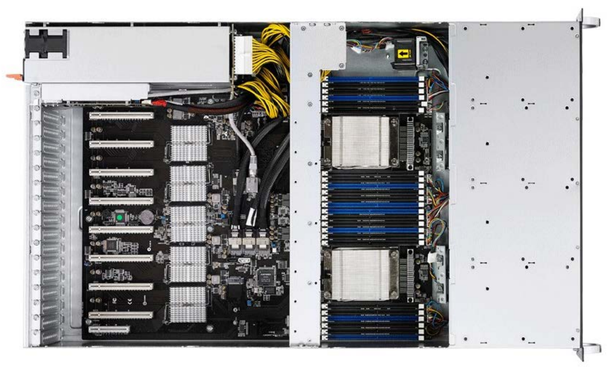
- fixed target setup to investigate the QGP phase diagram in region of high baryon-densities
- very high interaction rate environment: $10^5 – 10^7$/s (A+A), up to 10^9/s (p+A)
- fast and radiation hard detectors with free-streaming readout electronics
- high-speed Data AQuisition (DAQ) system
- FPGA based readout chains complemented by state of the art computing infrastructure allowing for online event reconstruction
- more than 5.000 GBT links operating at 4.8 Gbps as data source
- about 2 TB/s bandwidth to the Green Cube

CBM readout topology with CRI (2019)



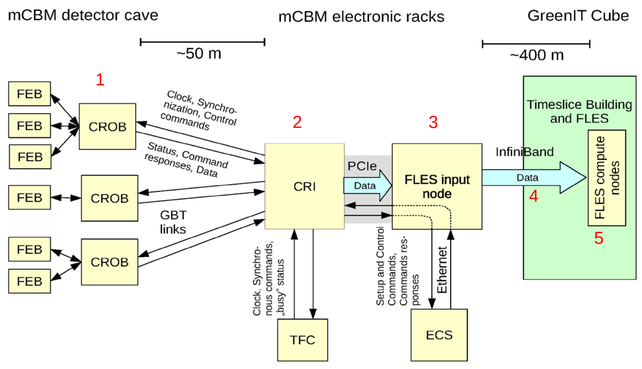
HTG-Z920 - Common Readout Interface (CRI) prototype
country of origin: California

- *Xilinx ZYNQ UltraScale+ FPGA - next generation board*
- *will be operated in the FLES input node*
- *to cover the functionality of both the AFCK and FLIB in a single FPGA board*



ASUS ESC8000 G3 Server (FLES Input Node)
country of origin: Taiwan

- *FLES input node*
- *can take up to 8x FLIB or 4x CRI*
- *used to receive data in micro-slices*
- *forwards data to the FLES compute nodes*

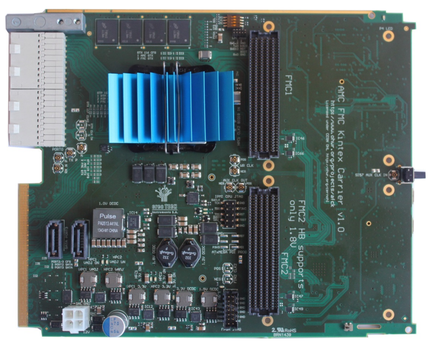


mCBM readout scheme for 2019

Mellanox SB7800 – EDR 100 Gb/s InfiniBand Smart Switch
country of origin: Israel

- *interface between FLES input and FLES compute stage*
- *will allow to transfer up to 1.2 Tb/s over 96 optical fibers*

Readout chain hardware components (2018)

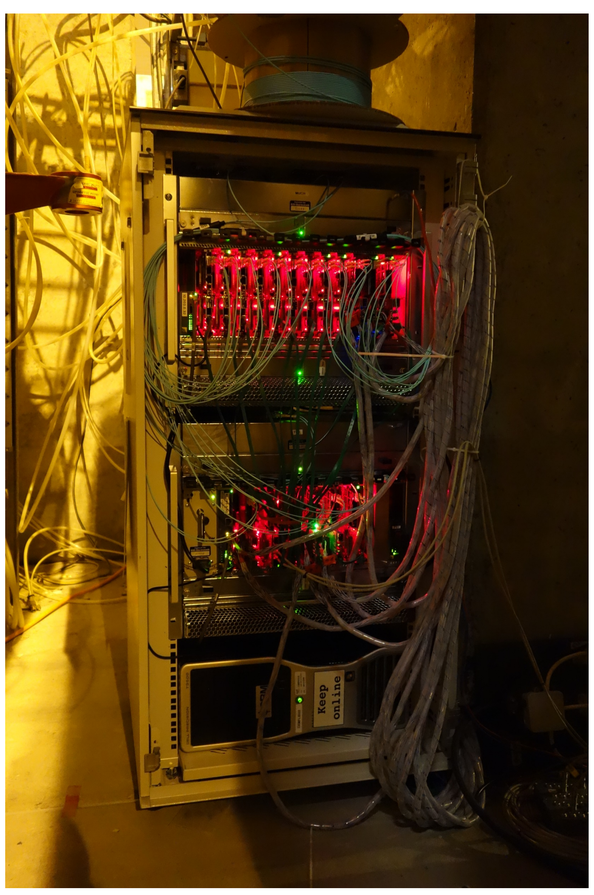


AMC FMC Carrier Kintex (AFCK)
country of origin: Poland

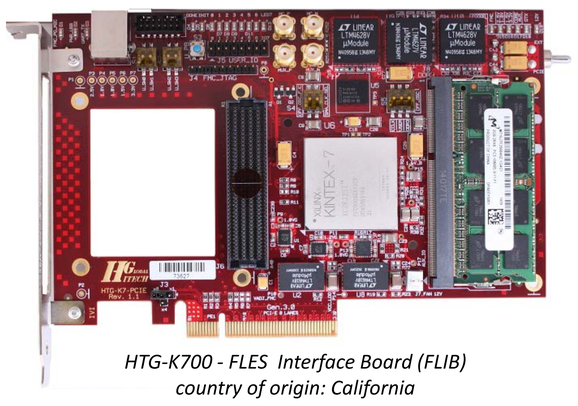
- *Xilinx Kintex 7 FPGA*
- *operated in a microTCA crate*
- *1st stage data processing board (DPB)*
- *transmits micro-slices to the FLIB*

Pentair microTCA crate
country of origin: Germany

- *equipped with up to 12 AFCK boards*
- *GBT links are converted to micro-slice streams*



CBM DAQ rack in operation (SPS 2016)



HTG-K700 - FLES Interface Board (FLIB)
country of origin: California

- *Xilinx Kintex 7 FPGA*
- *operated in the FLES input node*
- *2nd stage data processing board*
- *receives micro-slices from DPB*

CBM readout in a nutshell

- Collect raw data from subsystems
- Pre-process data in FPGAs
- Send micro-slices to Green Cube
- Pack data into time-slices
- Deliver time-slices to online analysis
- Digest a total bandwidth of 2 TByte/s

Readout chain development

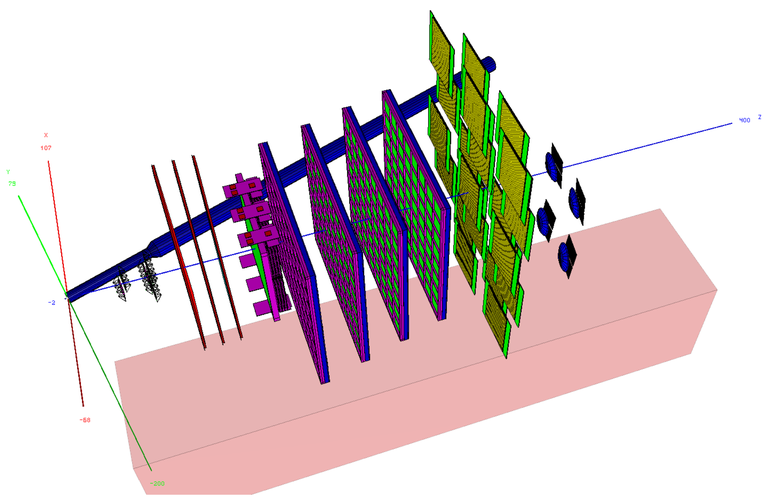
Activities at GSI:

- Coordination of collaboration-wide DAQ activities
- Identification and procurement of DAQ hardware
- Firmware development for FPGA components
- Pooling of DAQ hardware for CBM subsystems
- Setup and test of readout chains under development
- Support of readout chain operation for beam-tests
- Development of DAQ controls and online monitoring
- Preparation of "Online Technical Design Report - Part I"

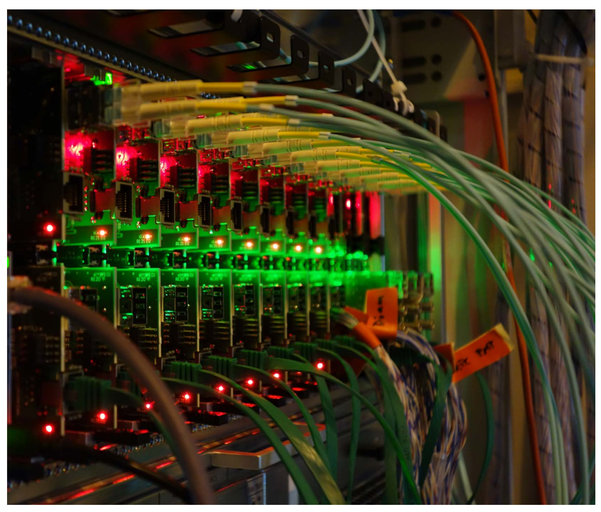
Key Project Institutes:

GSI, Darmstadt, Germany;
CQU, Chongqing, China;
FIAS, Frankfurt, Germany;
IRI, Frankfurt, Germany;
KIT, Karlsruhe, Germany;
USTC, Hefei, China;
VECC, Kolkatta, India;
WUT, Warsaw, Poland;

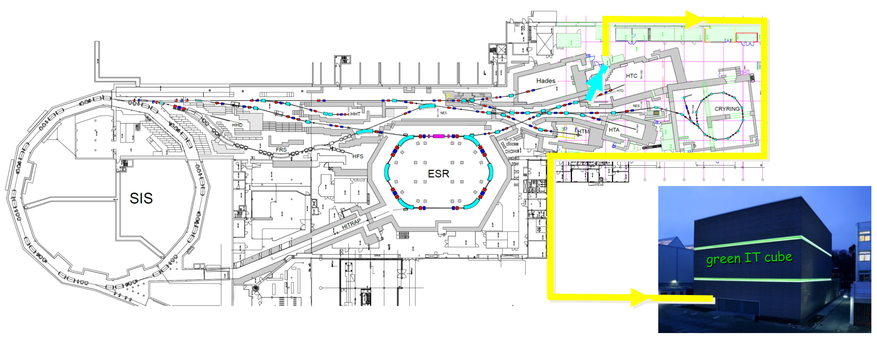
mCBM – the DAQ experimental test bench (2018)



mCBM experimental setup in the GSI Target Hall



data processing on AFCK boards in the mCBM DAQ container



optical fiber connection between the mCBM cave, DAQ container and the Green IT Cube