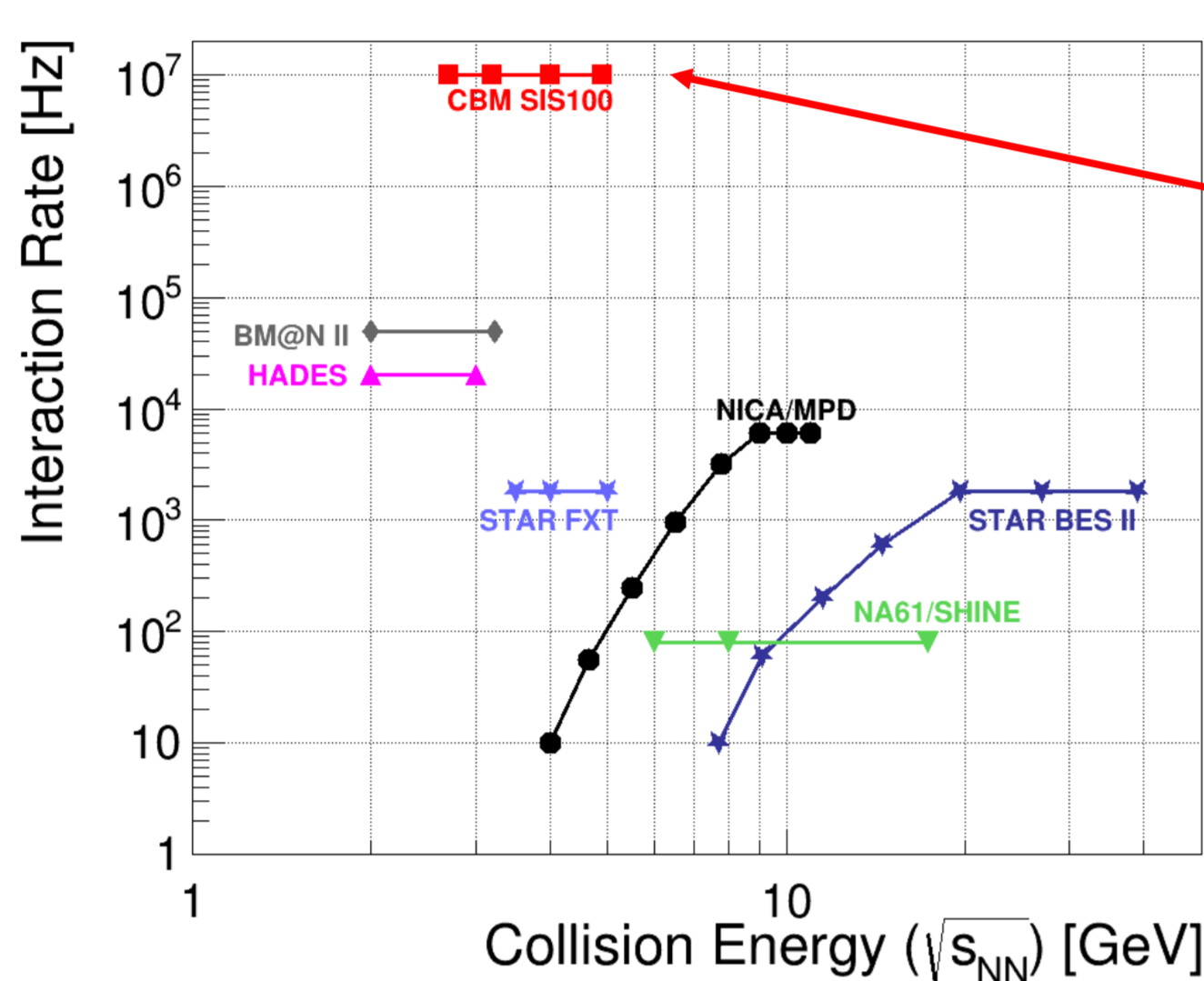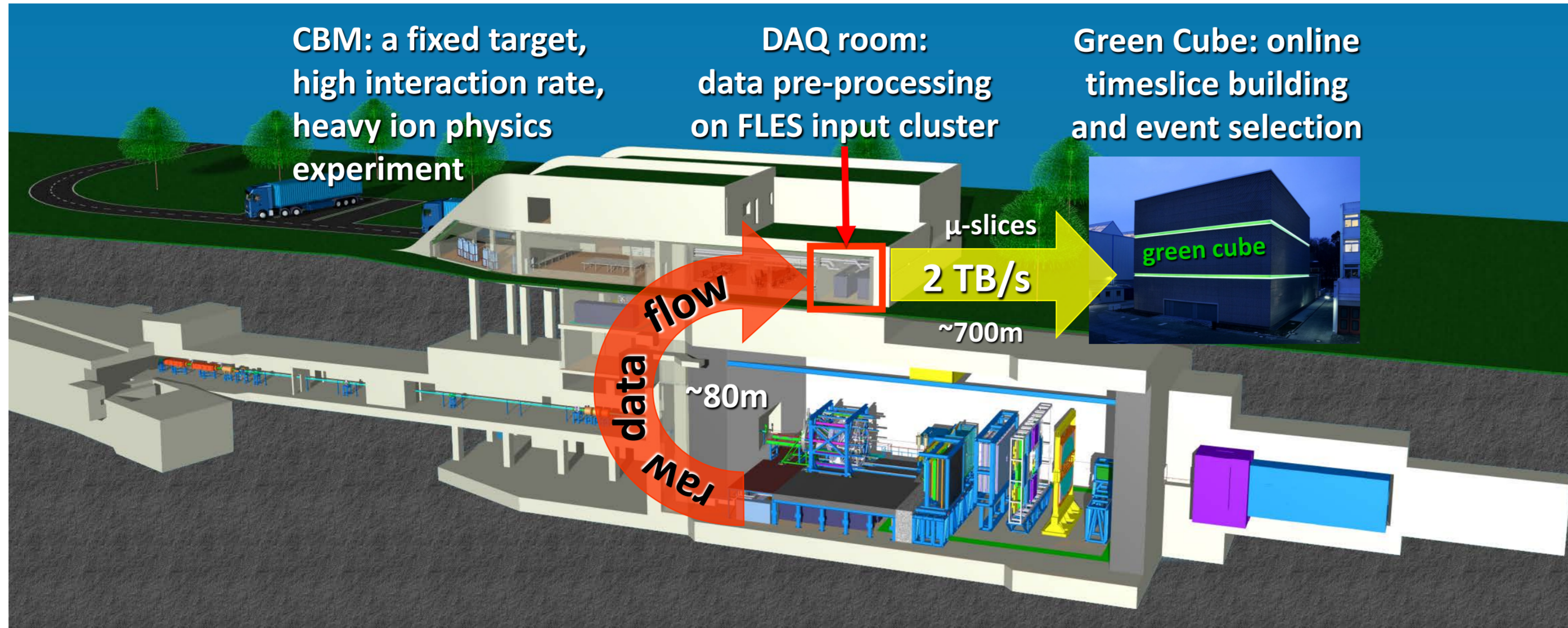# The free-streaming data acquisition system for the Compressed Baryonic Matter experiment at FAIR

David Emschermann[1] for the CBM-collaboration

[1] GSI, Darmstadt, Germany

CBM

Compressed Baryonic Matter experiment at FAIR

The CBM data challenge

CBM: a fixed target, high interaction rate, heavy ion physics experiment

DAQ room: data pre-processing on FLES input cluster

Green Cube: online timeslice building and event selection

μ-slices
2 TB/s
~700m

raw data flow
~80m
green cube
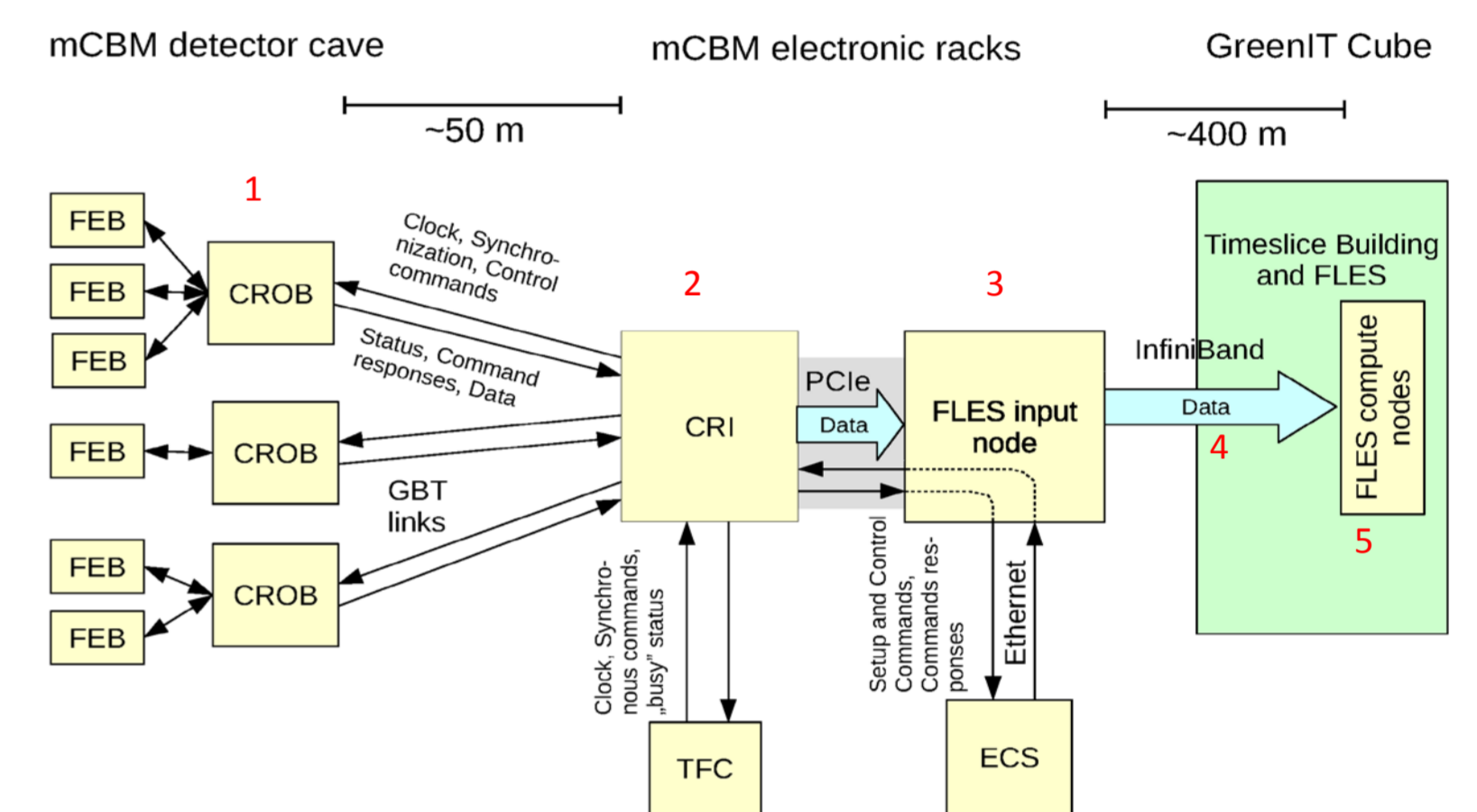

Interaction Rate for CBM at SIS100

- 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 TByte/s bandwidth to the Green Cube
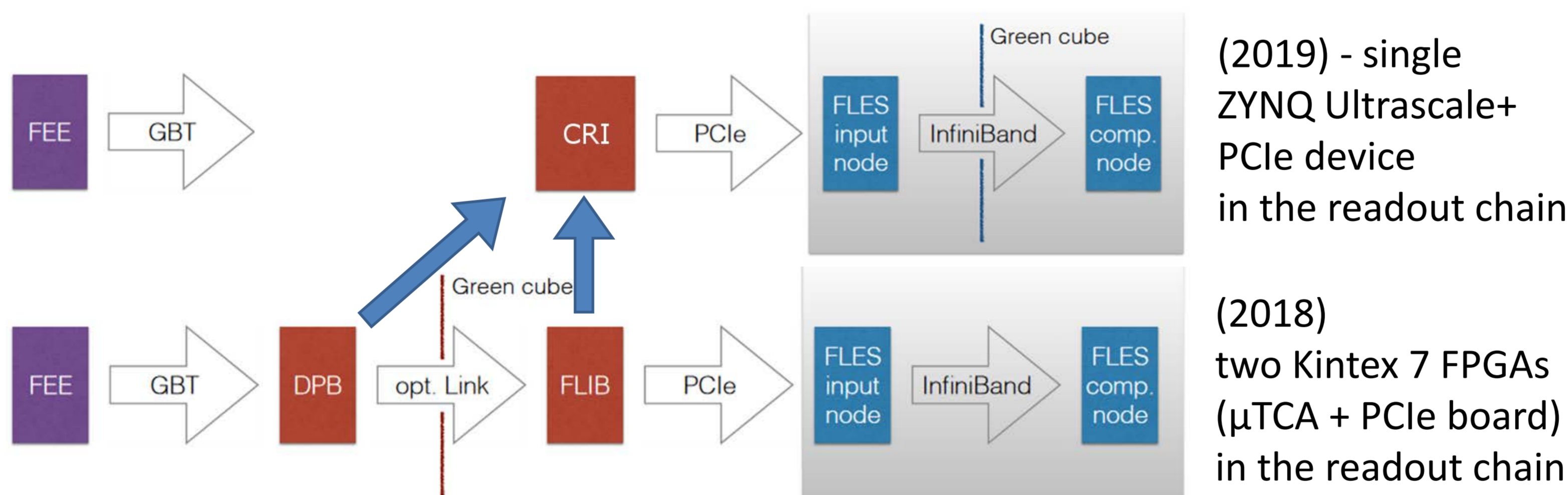
CBM readout topology with CRI (2019+)
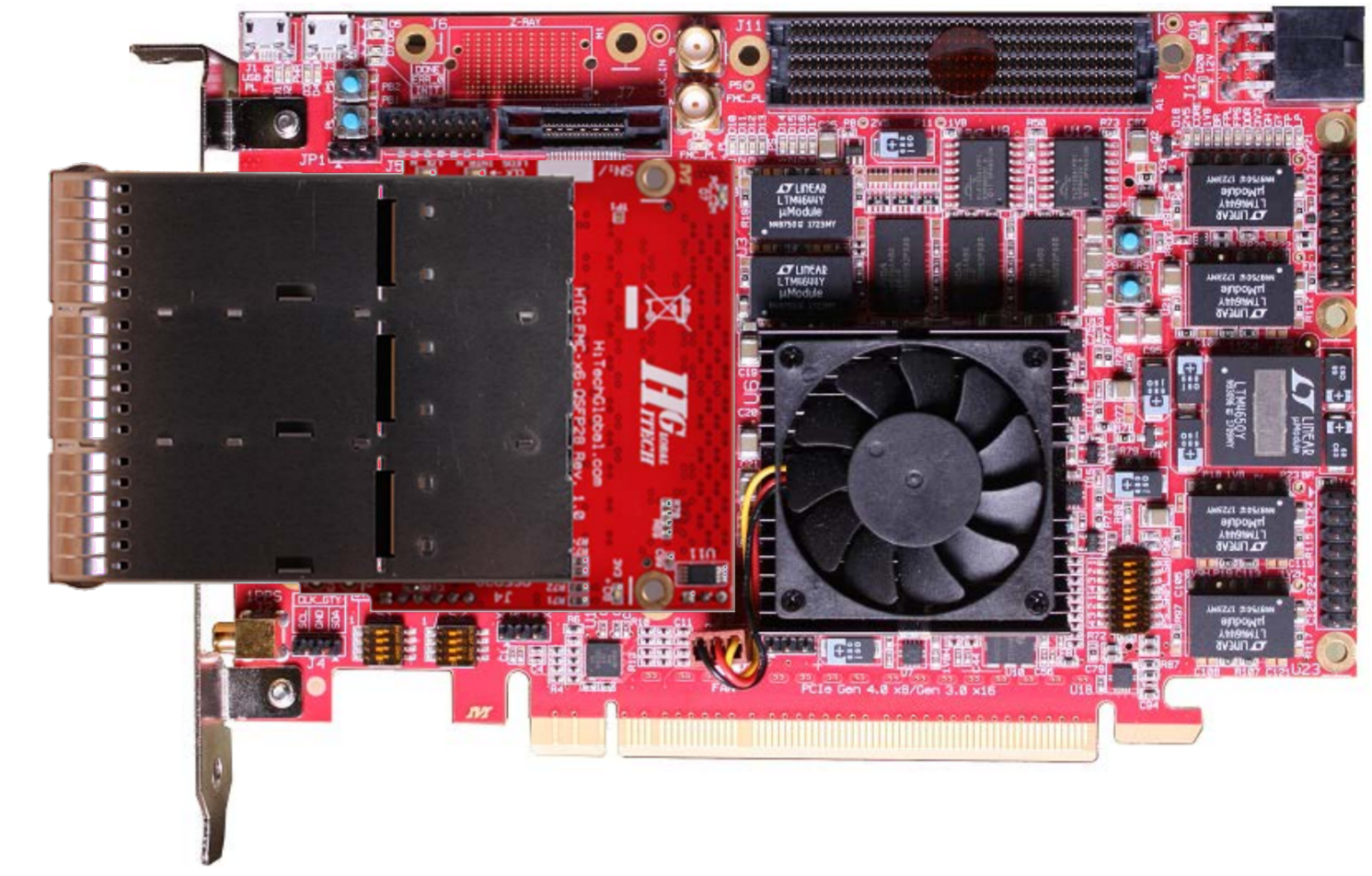
HTG-Z920 - Common Readout Interface (CRI) prototype country of origin: California

- 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

mCBM readout scheme for 2019

Evolution of readout chains to a single FPGA

(2019) - single ZYNQ Ultrascale+ PCIe device in the readout chain

(2018) two Kintex 7 FPGAs (μTCA + PCIe board) in the readout chain

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

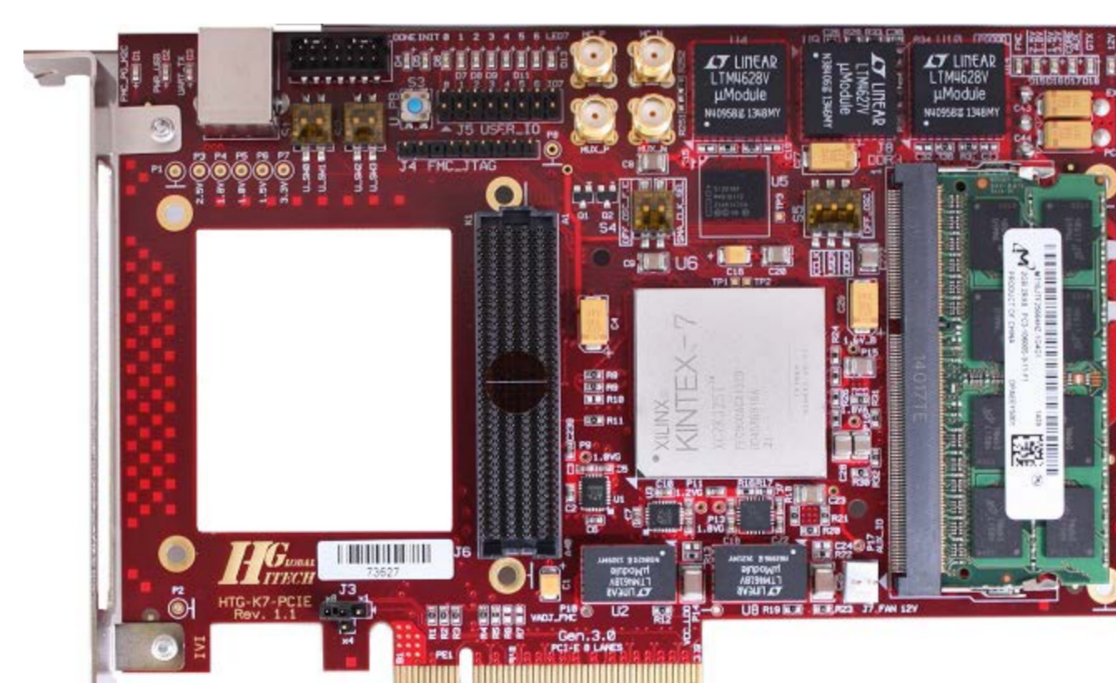## CBM readout chain hardware components (2018)

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

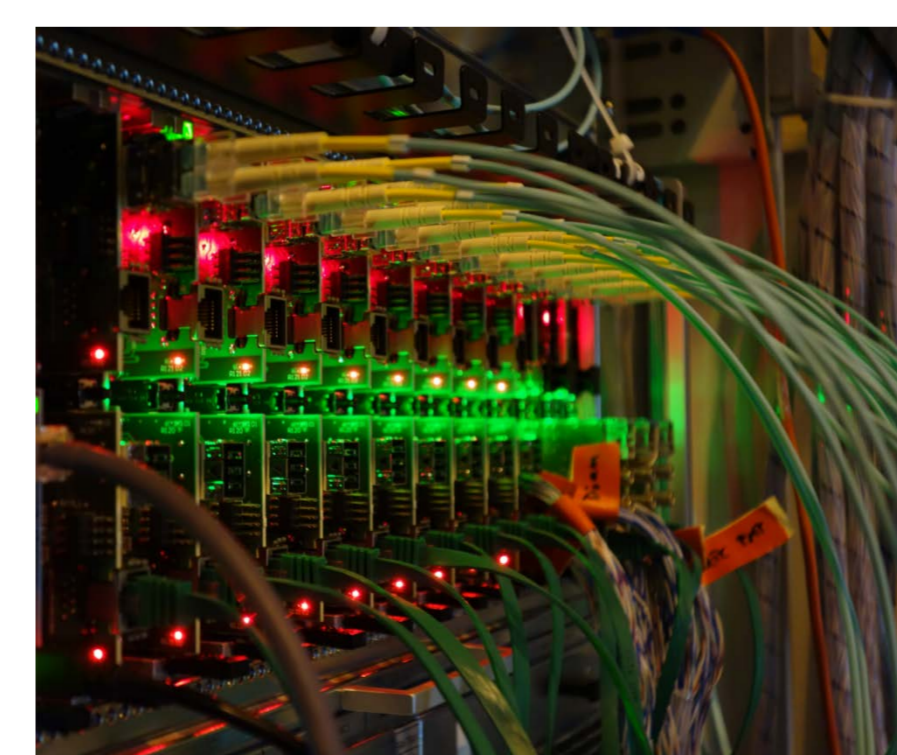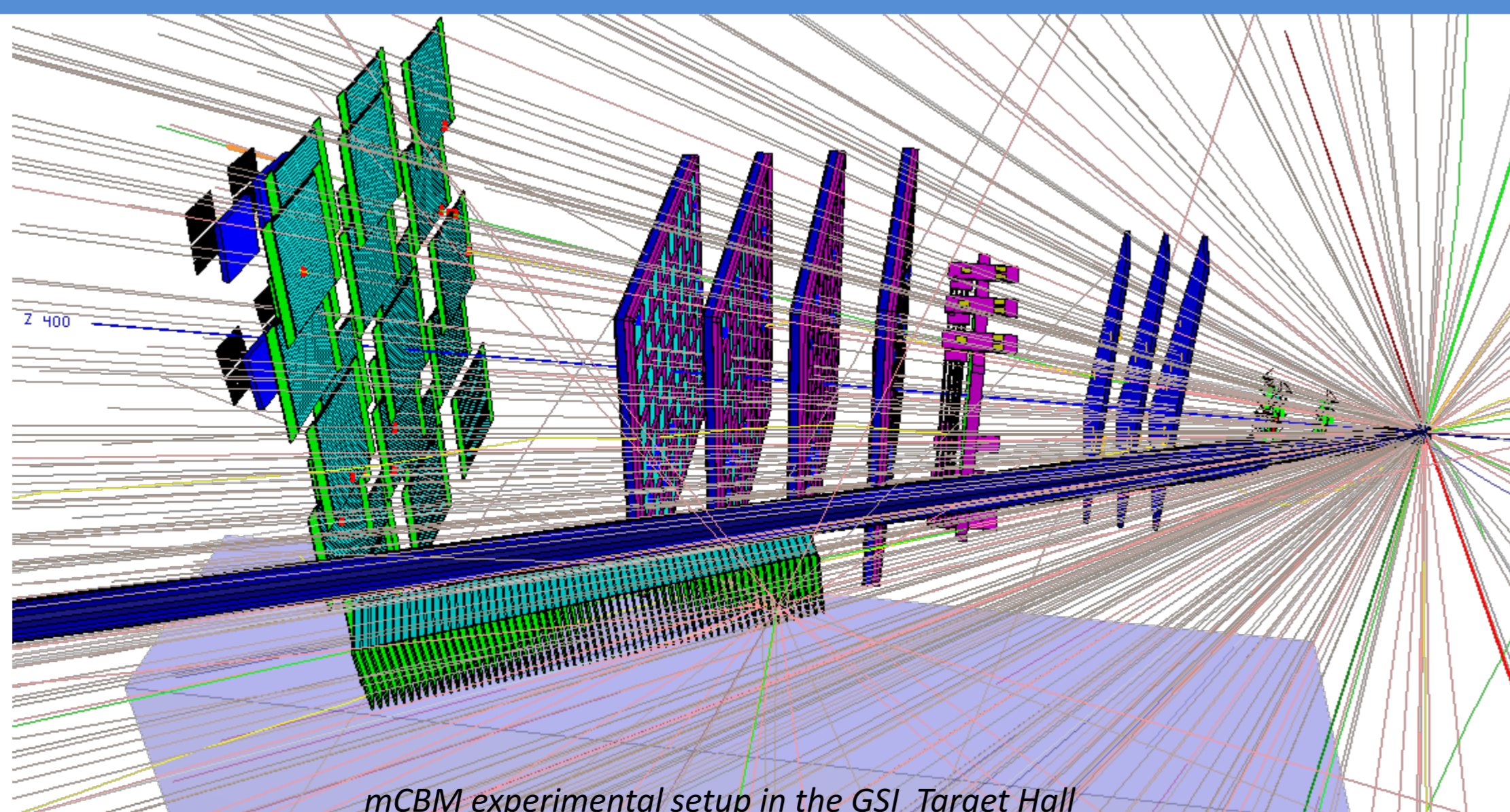*HTG-K700 - FLES Interface Board (FLIB) country of origin: California*

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

## 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"

mCBM – the DAQ experimental test bench (2018)

288x OM4 multi-mode fiber: mCBM cave – DAQ container, 50m long
144x OS2 single-mode fiber: DAQ container - GreenITCube, 300m long

mCBM experimental setup in the GSI Target Hall

data processing on AFCK boards in the mCBM DAQ container
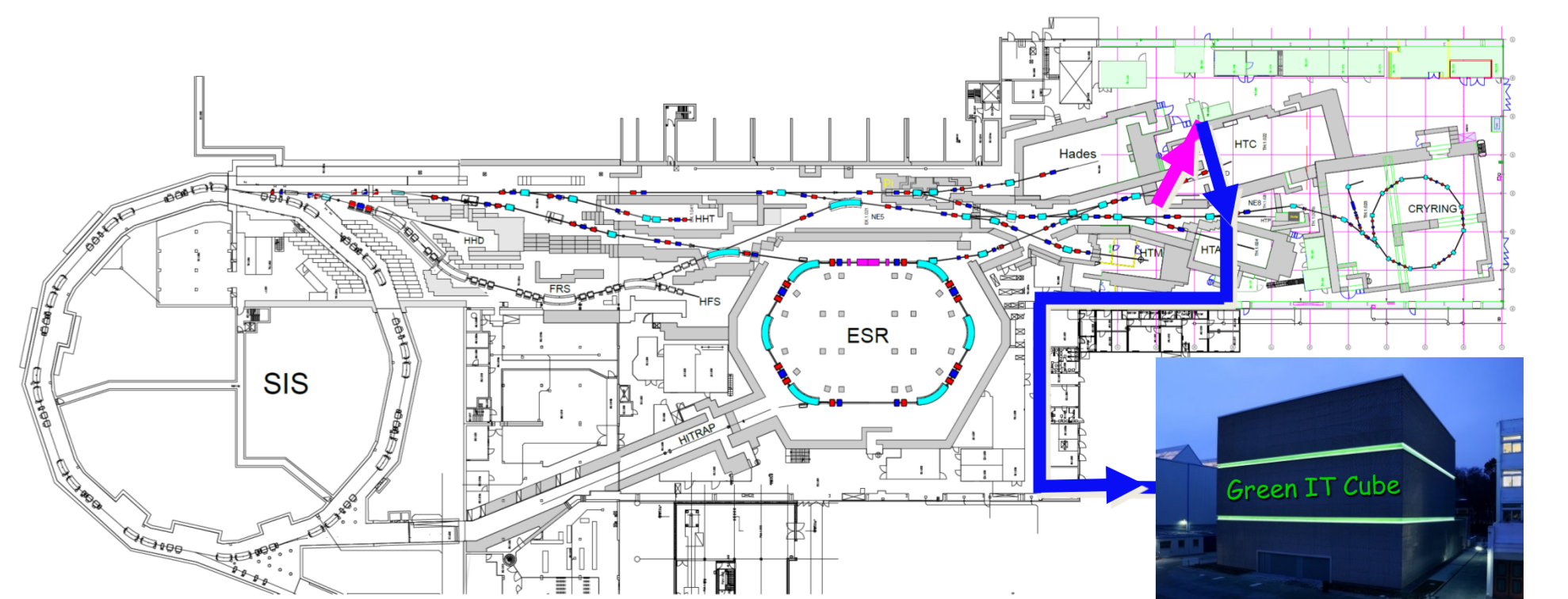
optical fiber connection between the mCBM cave, DAQ container and the Green IT Cube