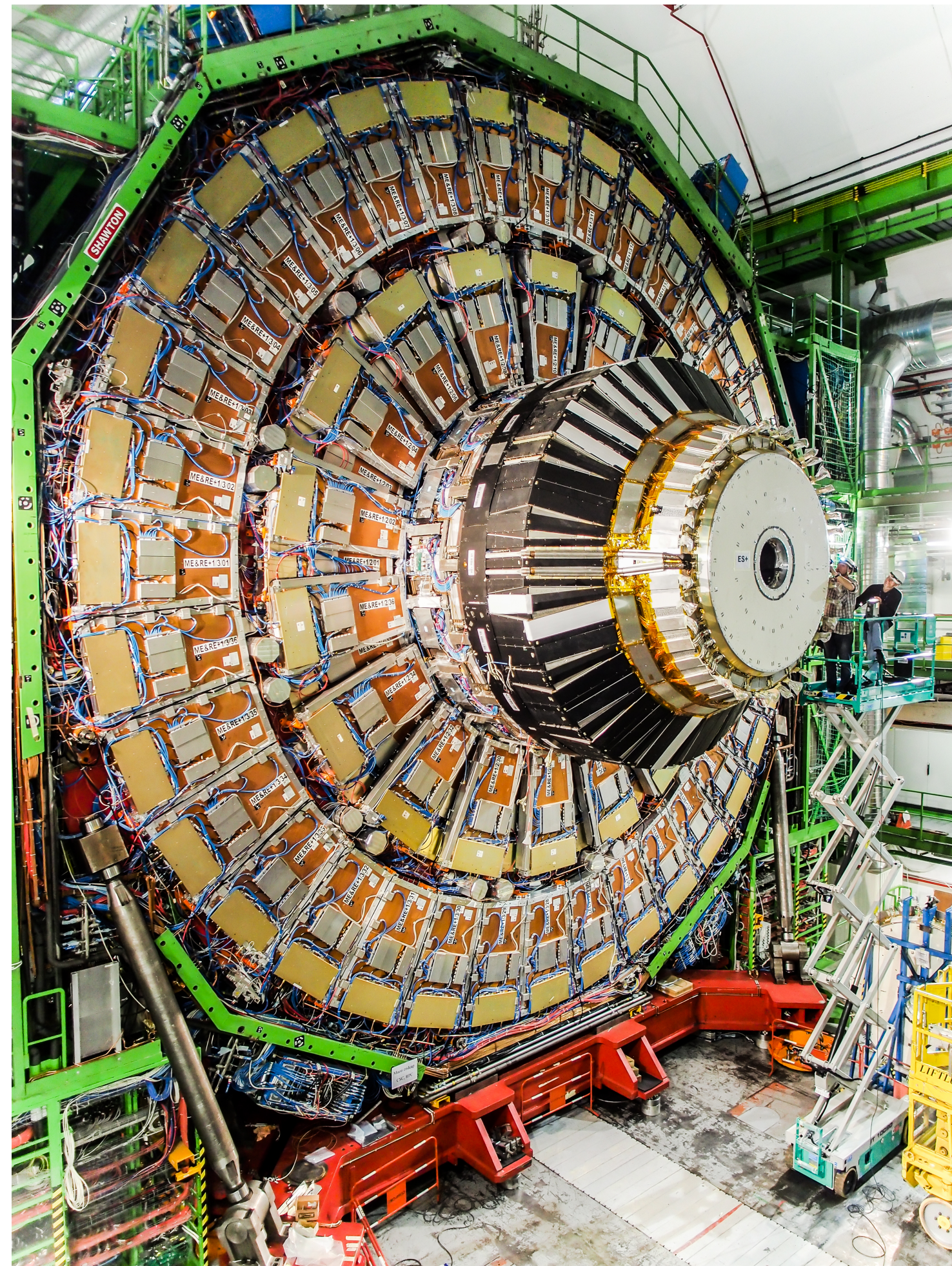


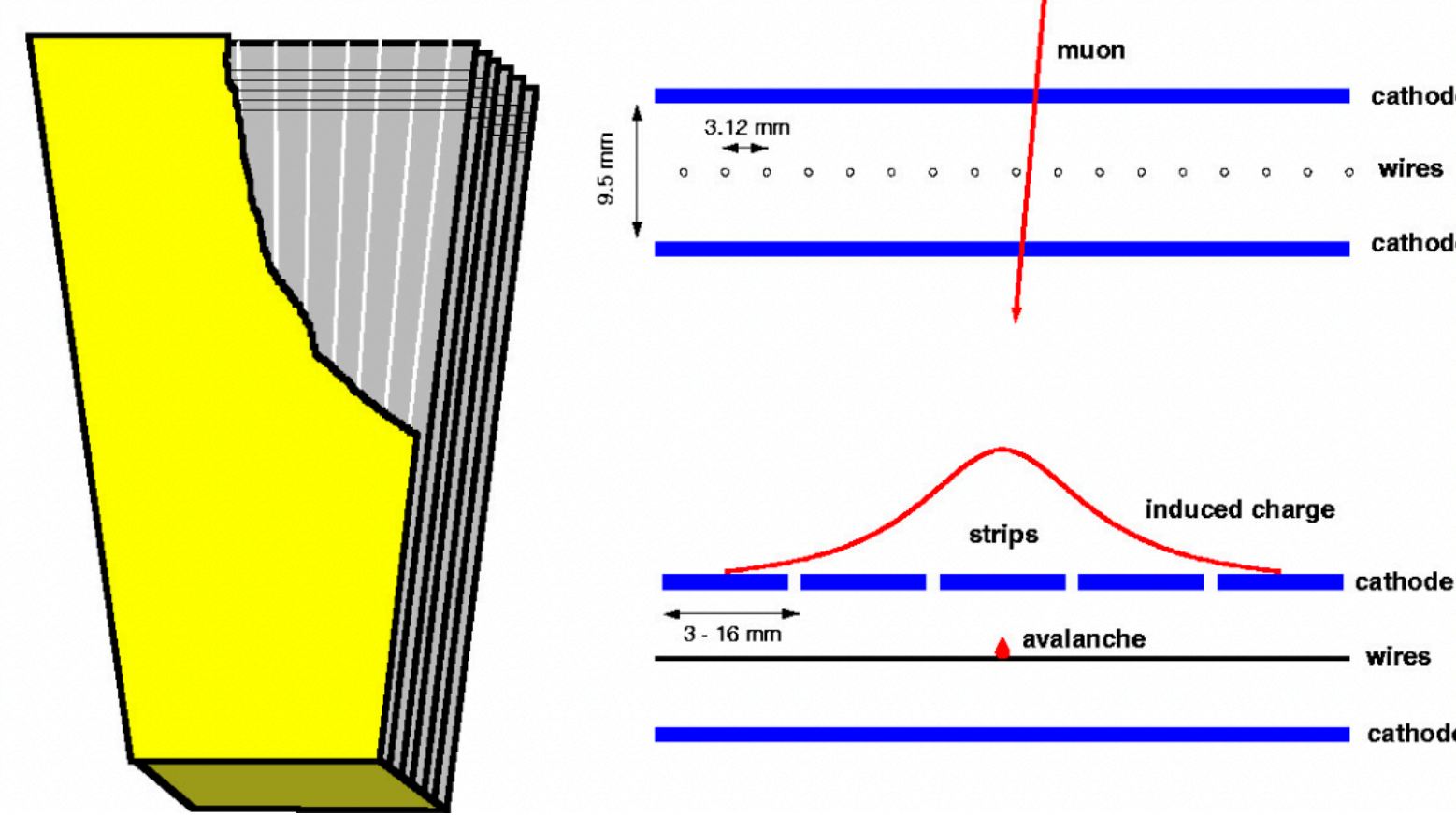
The new ODMB for the Phase II upgrade of the CMS endcap muon system

Hualin Mei on behalf of the CMS collaboration - University of California, Santa Barbara

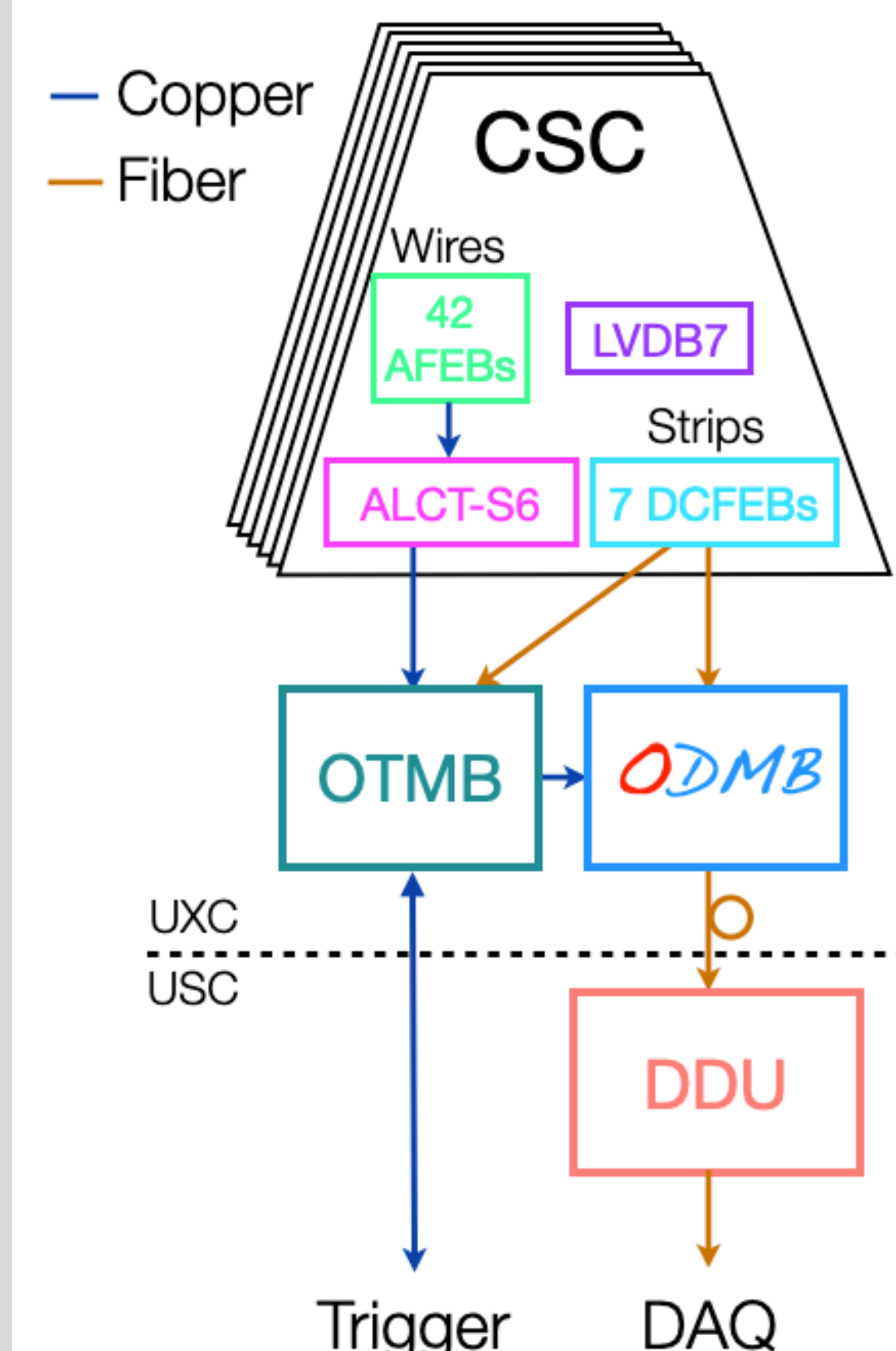
CMS endcap muon system



- Cathode strip chambers (CSC)
- Each consists of 6 gas layers
- 540 in total, covers $0.9 < |\eta| < 2.4$
- Crucial for muon triggering, identification, momentum measurements

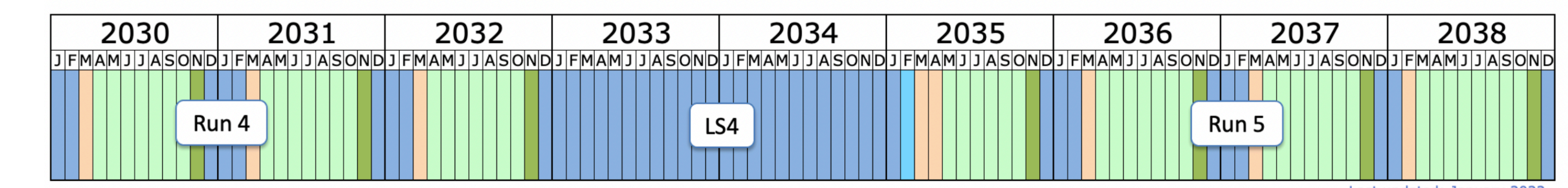
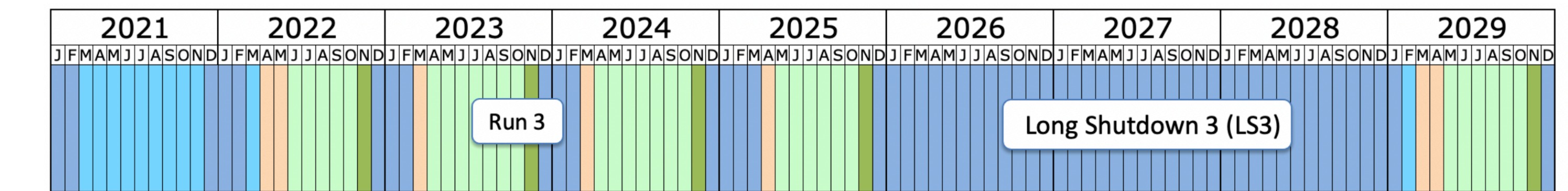


CSC readout system and ODMB



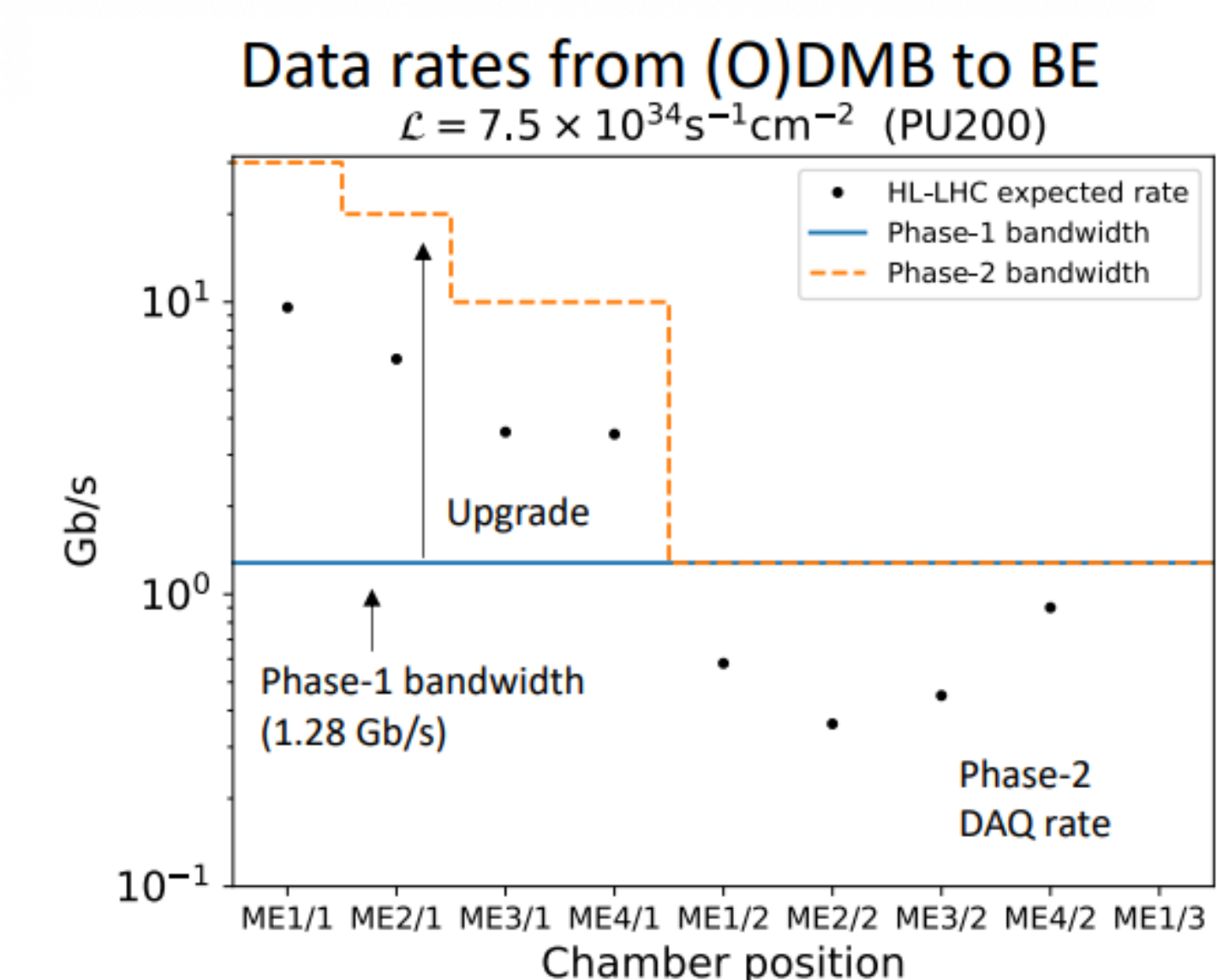
- **ODMB: optical data acquisition motherboard**
- Takes data from ALCT/DCFEB/OTMB, builds packet and sends to DDU at a rate up to 1.6 Gb/s
- Responsible for slow control, distributing trigger signals, LV control/monitoring
- Located at the VME peripheral crates
- AFEB/ALCT and DCFEBs amplify and digitise anode/cathode signals
- OTMB (optical trigger motherboard) builds trigger primitives for CMS Level 1 trigger decision
- Each DDU collects data from 15 (O)DMBs and sends information to CMS global DAQ

Motivation for upgrade

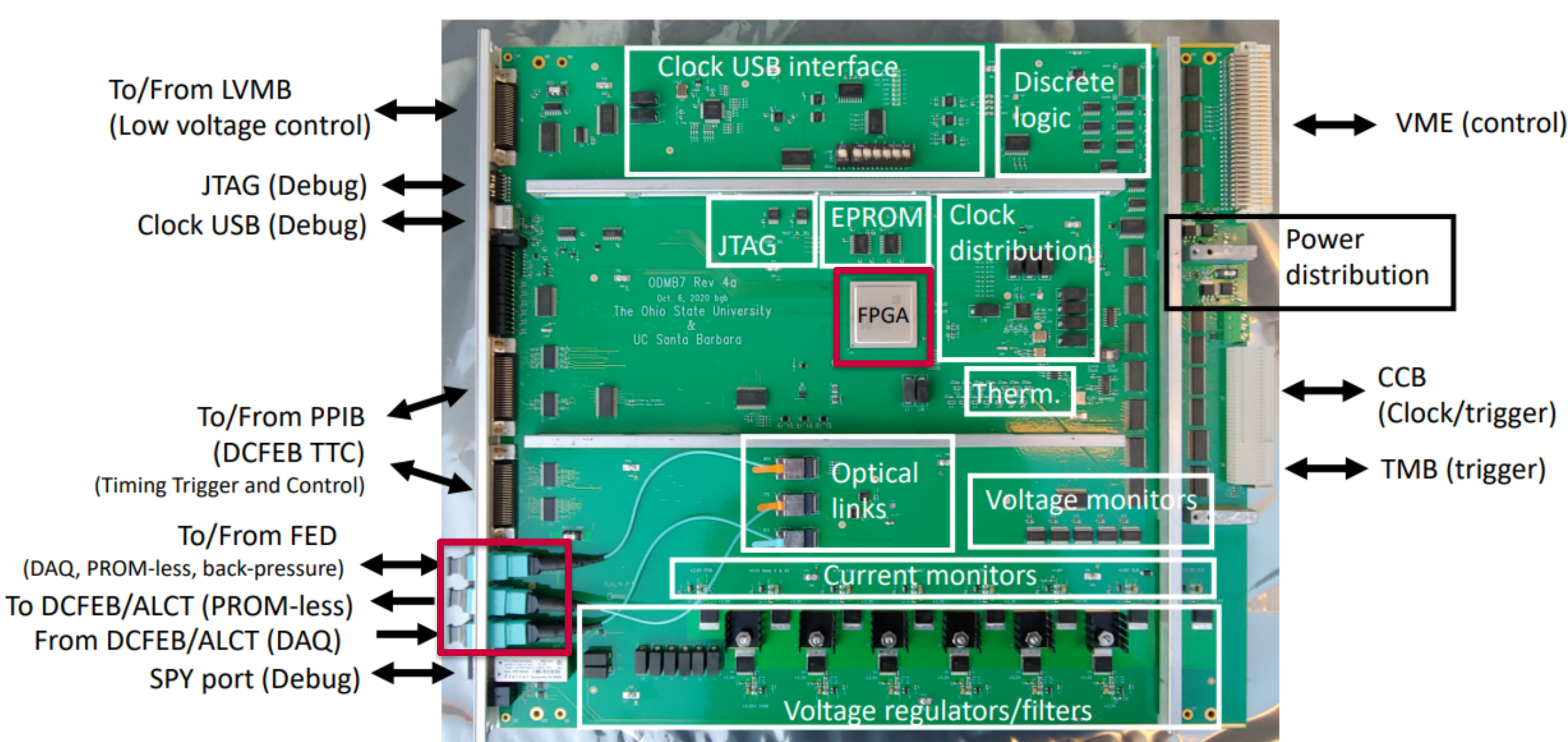


Shutdown/Technical stop
Protons physics
Ions
Commissioning with beam
Hardware commissioning/magnet training

- HL-LHC (since 2029) is expected to operate with ~ 7 times higher luminosity than the current LHC
- Current (O)DMBs for CSCs closest to the beam pipe are **incapable of handle increased data rate**

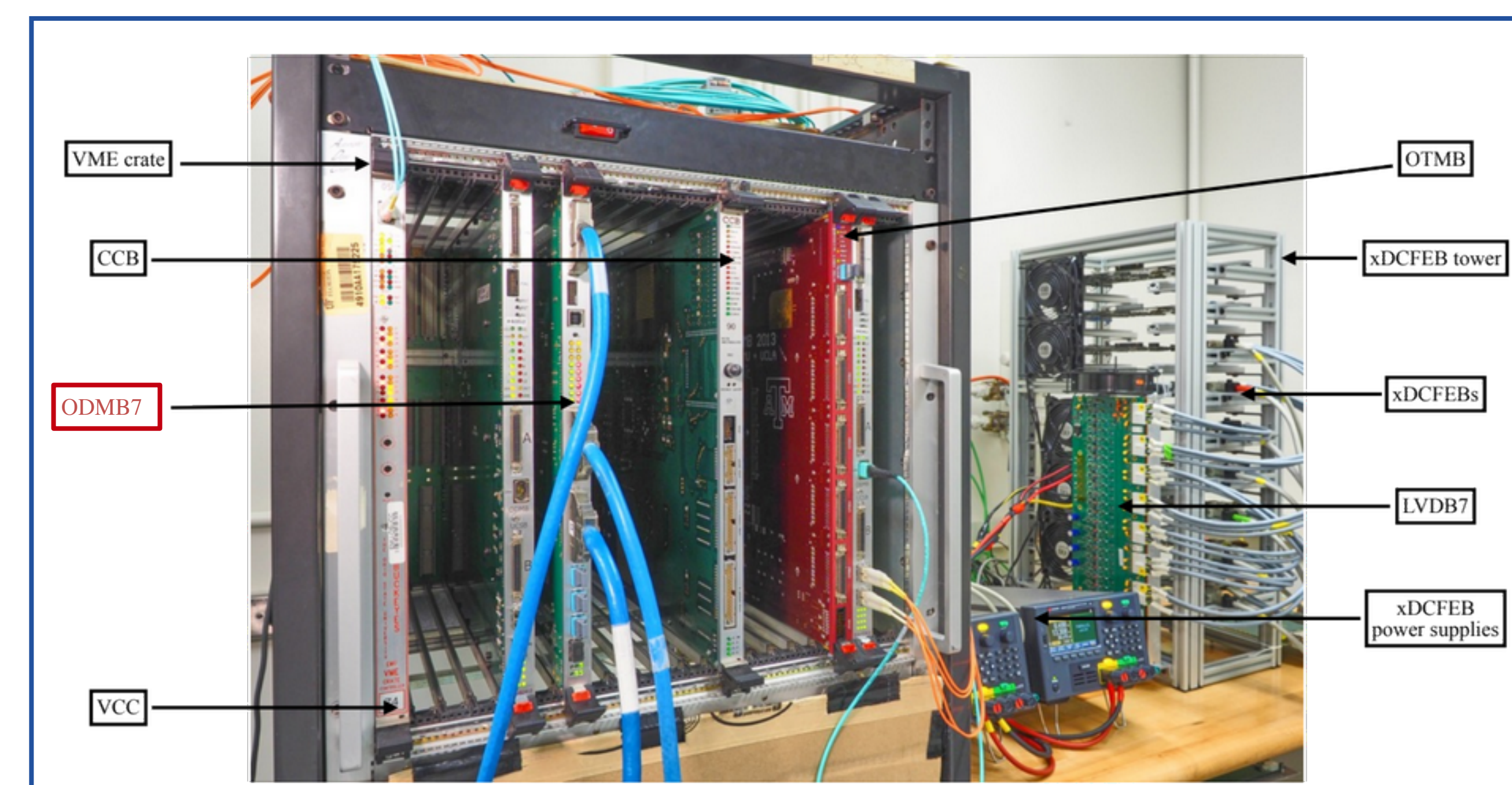


Highlights of new ODMB7



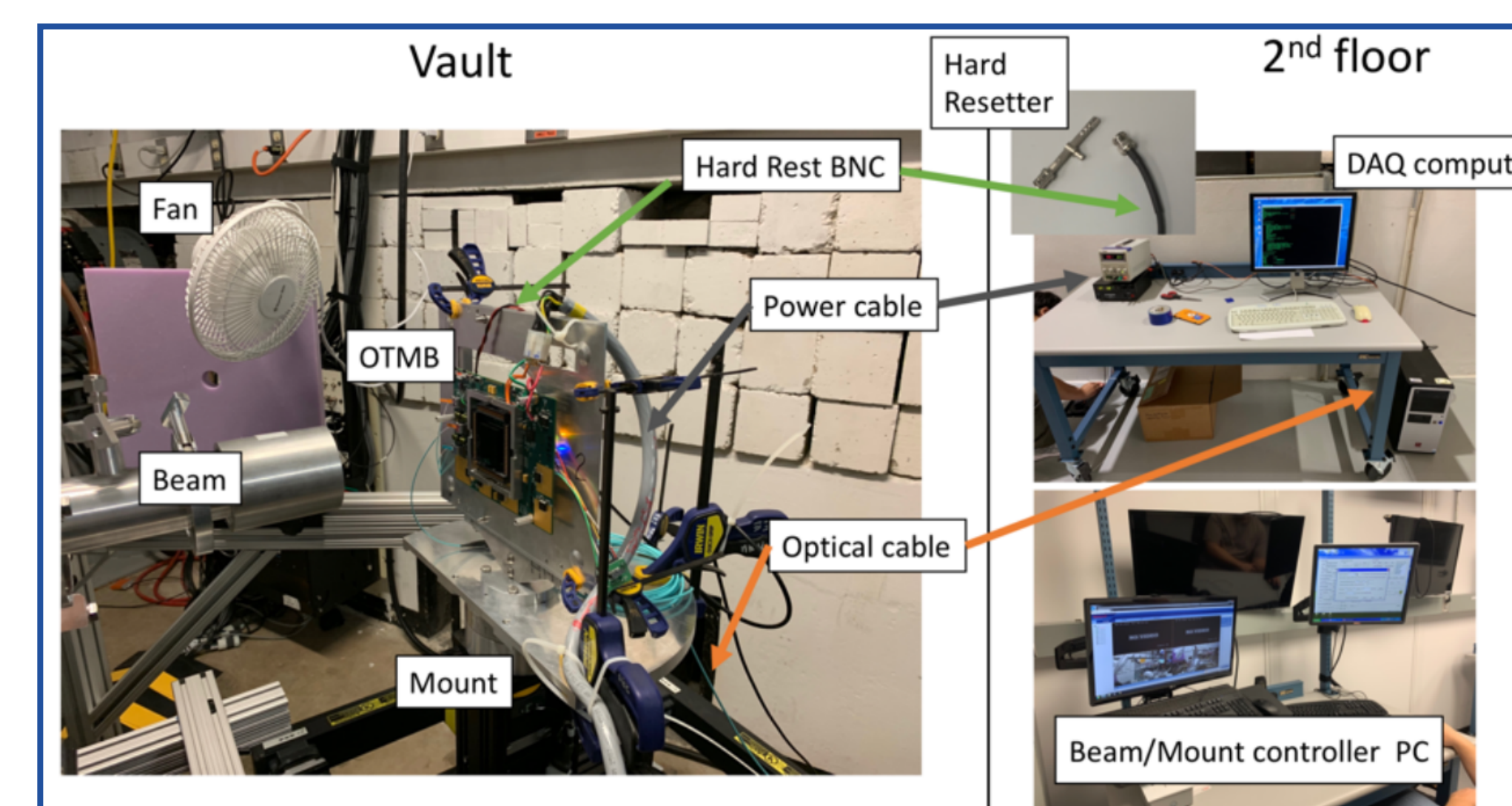
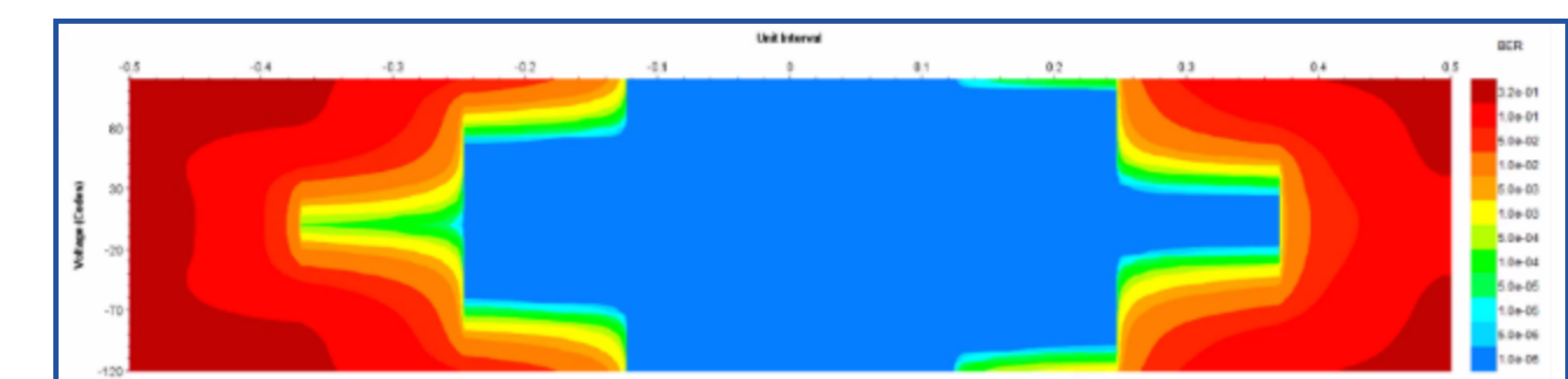
- Kintex Ultrascale FPGA, up to 12.5 Gb/s data rate per transceiver
- Firefly optical transceivers, up to 14 Gb/s data rate per lane, use multiple lanes for transmitting data for DAQ, was the bottleneck
- Total bandwidth 3 times more than expected data rate
- Allow prom-less programming of front-end boards, in case their EEPROM stops working after high radiation

Prototype testing

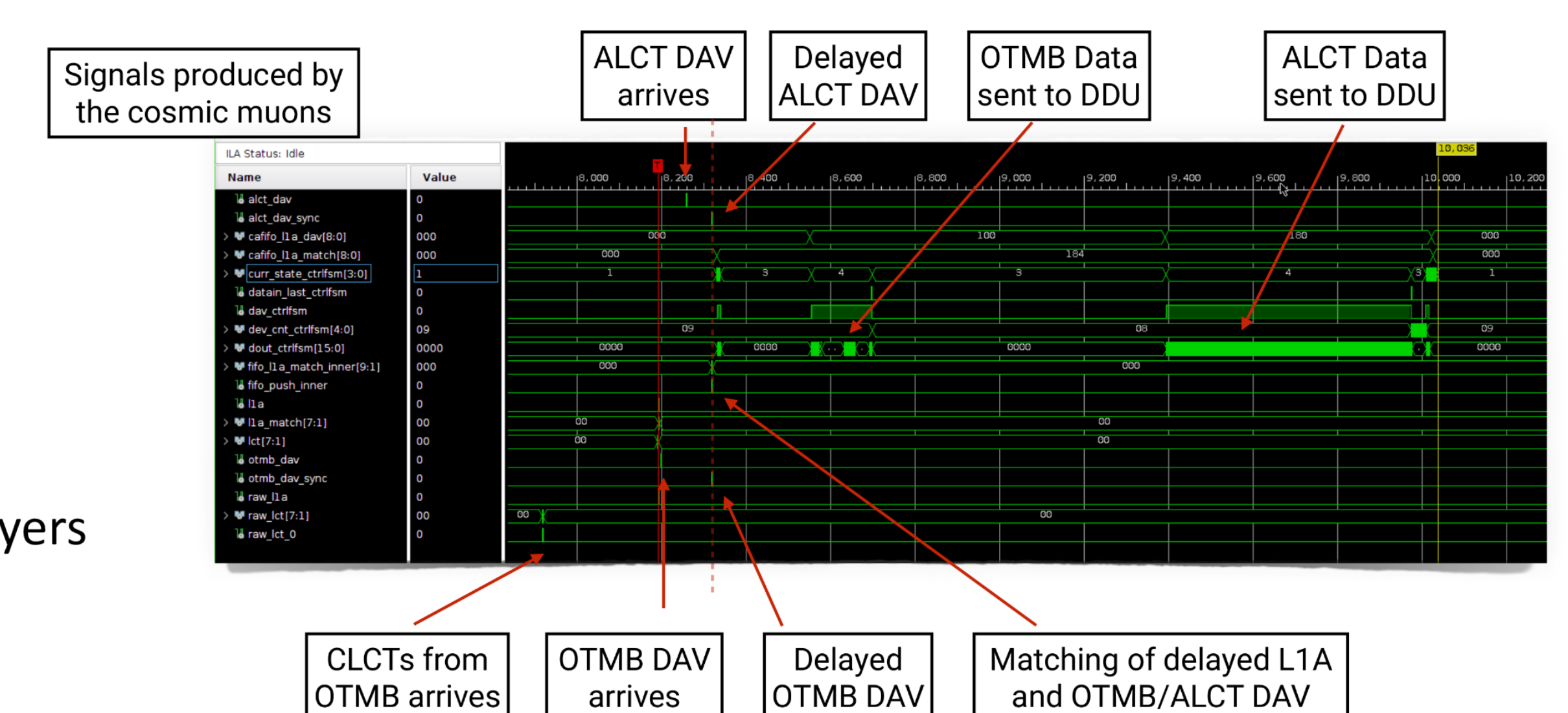
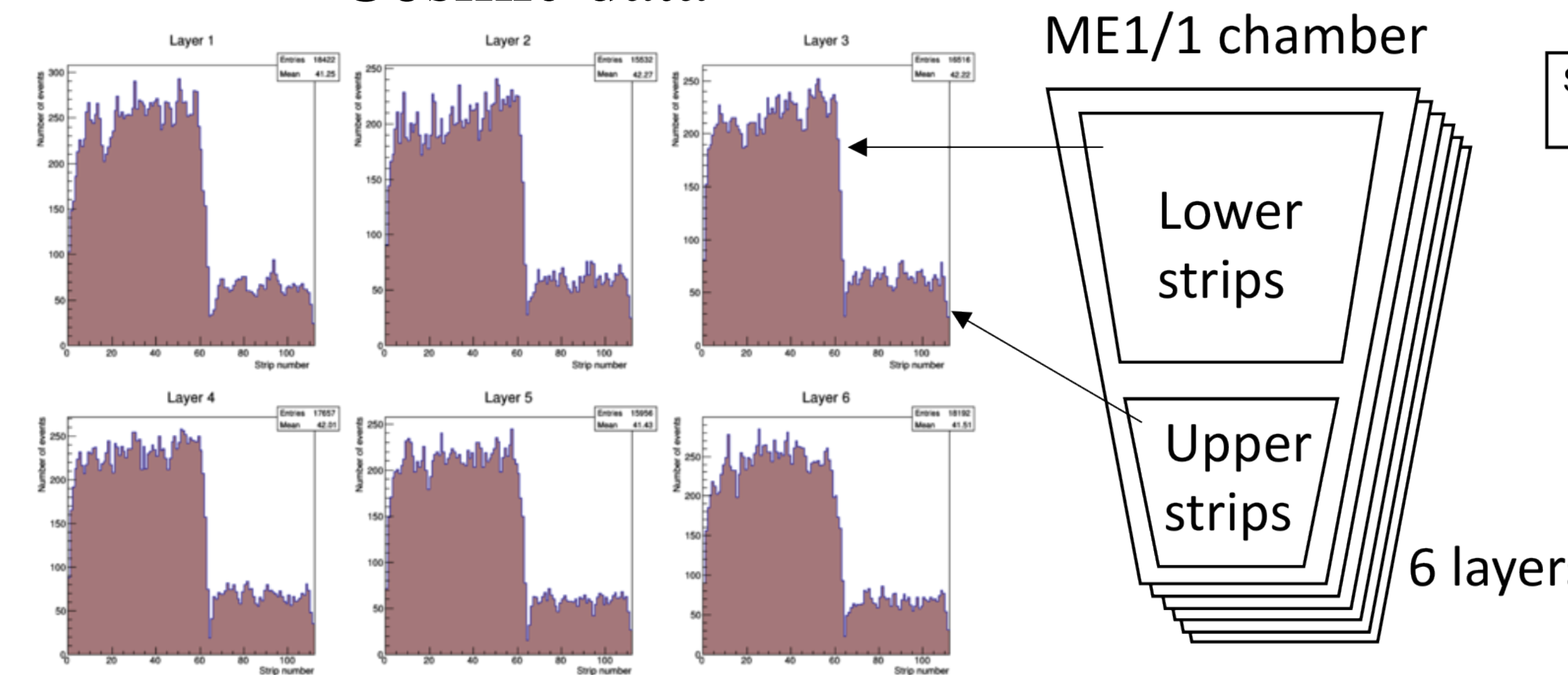


- All interfaces (VME crate, other CSC electronics, SPI EPROM) for 4 ODMB7 prototypes have been verified to be working in both UCSB and CERN
- **Successfully took cosmic data with a real CSC chamber and a new ODMB7 prototype at CERN test stand**
- Data is also probed with an Integrated Logic Analyzer (ILA) — digital Oscilloscope

ODMB lab setup at UCSB, a similar exists at CERN



Cosmic data



Key components validated to sustained radiation environment with dedicated radiation tests