# First projects at Diamond Light Source involving MTCA

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Diamond Light Source
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- Why did we decide on MicroTCA?

- Bunch-by-Bunch Feedback System

- Digital Low Level RF Feedback

- Future Digital Low Level RF Feedback

- Source Feedback from X-Rays

- Future Orbit Feedback Controller

- Future Beam Position Monitor

- Conclusions

- VME has been the workhorse at DLS
  - coming to age
- We listened to many MTCA talks
  - always wanted to 'give it a try'
- Diamond-II emerges at the horizon
  - we have a goal to work to
- The modularity is hugely attractive
  - offers a multitude of upgrade paths
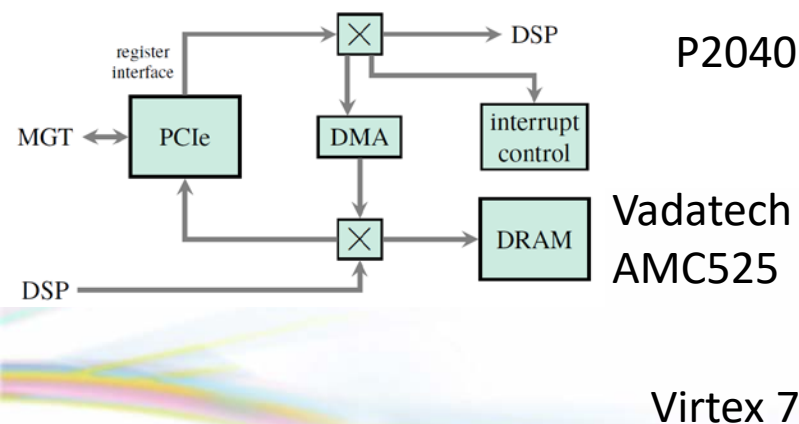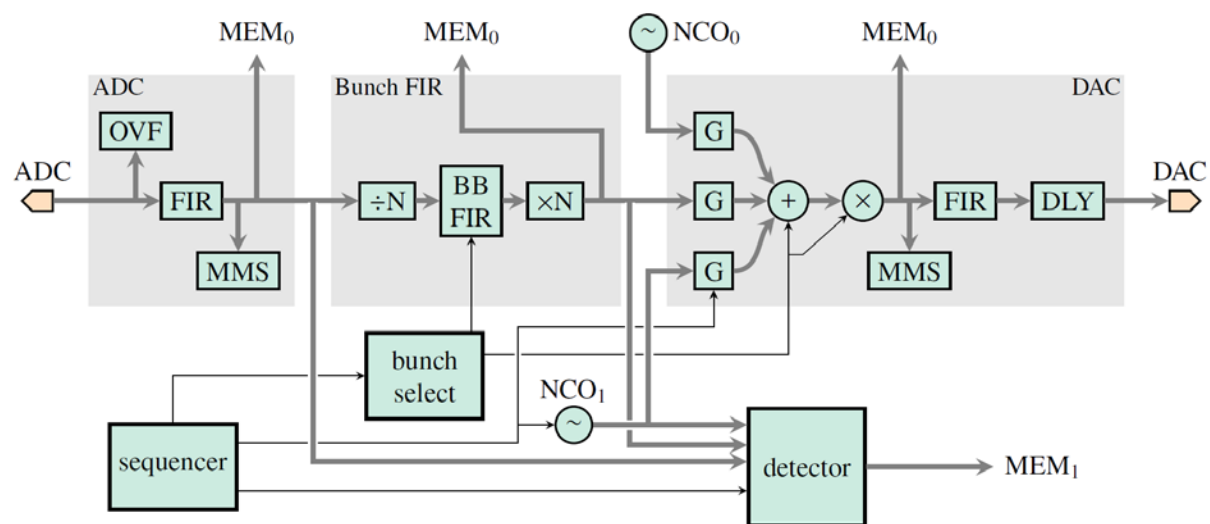 - particularly for systems in the unpredictable future

diamond
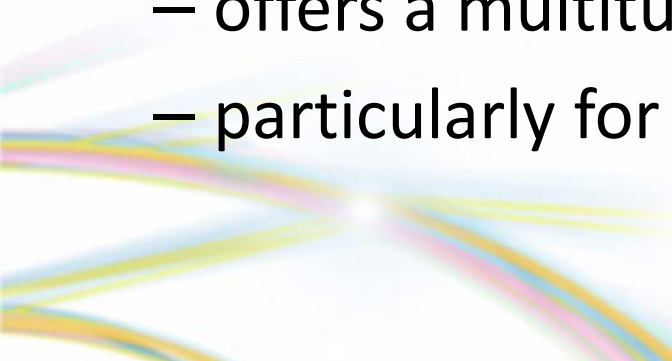
- Controls/manipulates individual bunches (2ns separation)
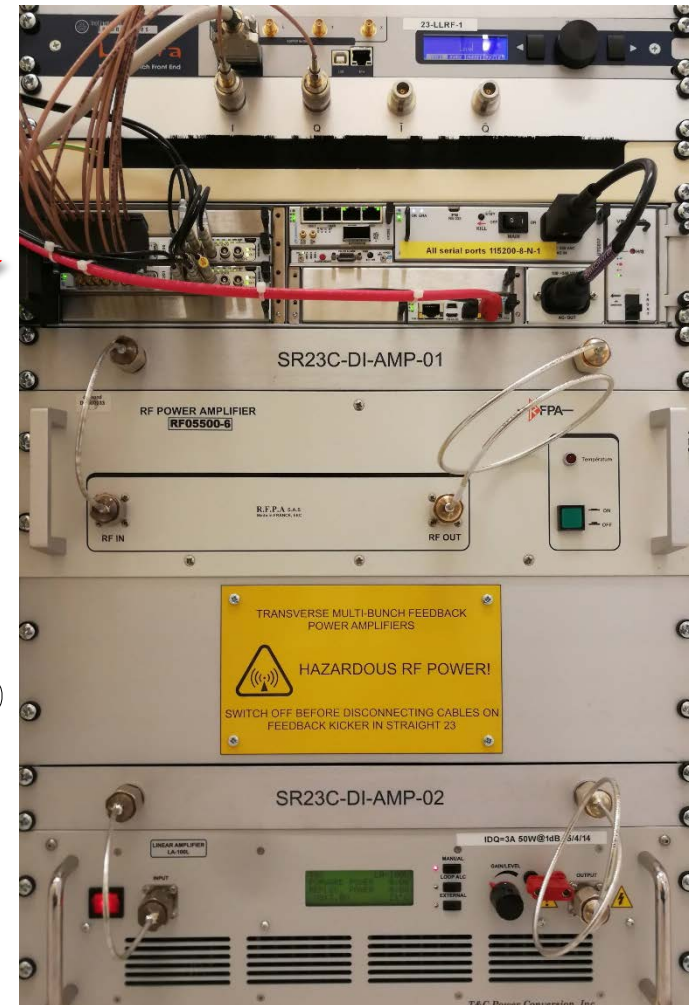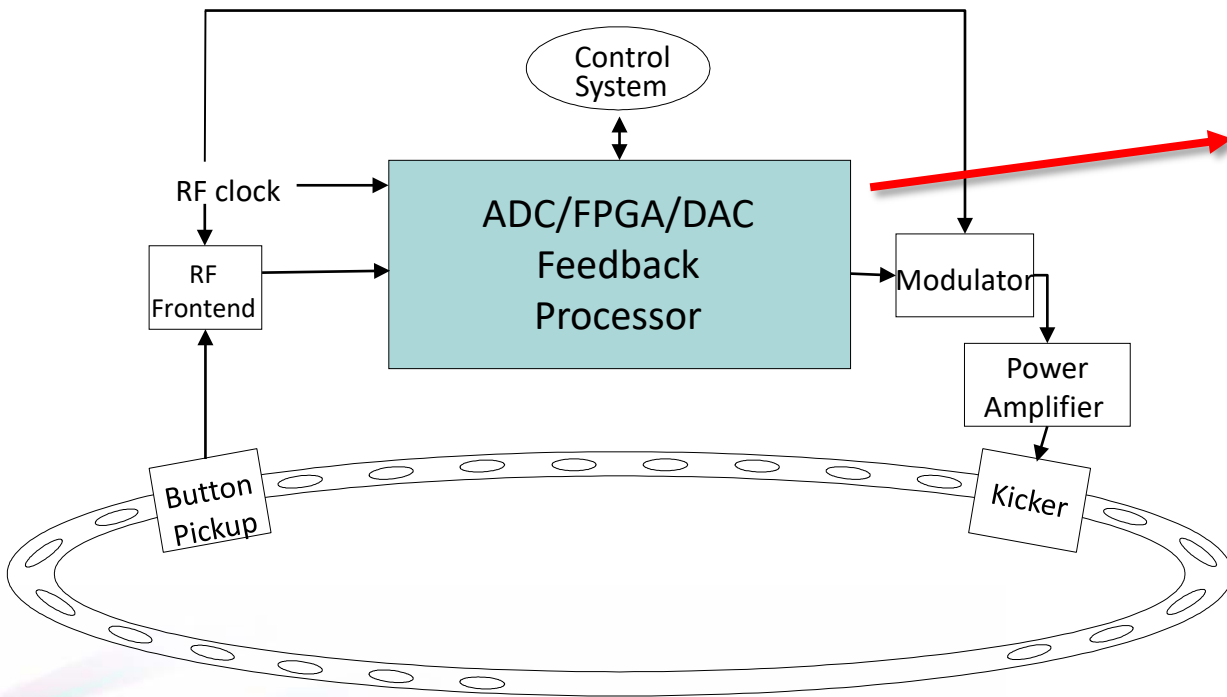
- 500MS/s ADC/DAC
- DSP implemented in FPGA
- Single chain running at sample rate
- Two chains for two ADC/DAC

P2040

Vadatech AMC525

Virtex 7

Innovative Integration FMC-500

CERN-OHWR DIO-5ch TTL

Digital Low Level RF
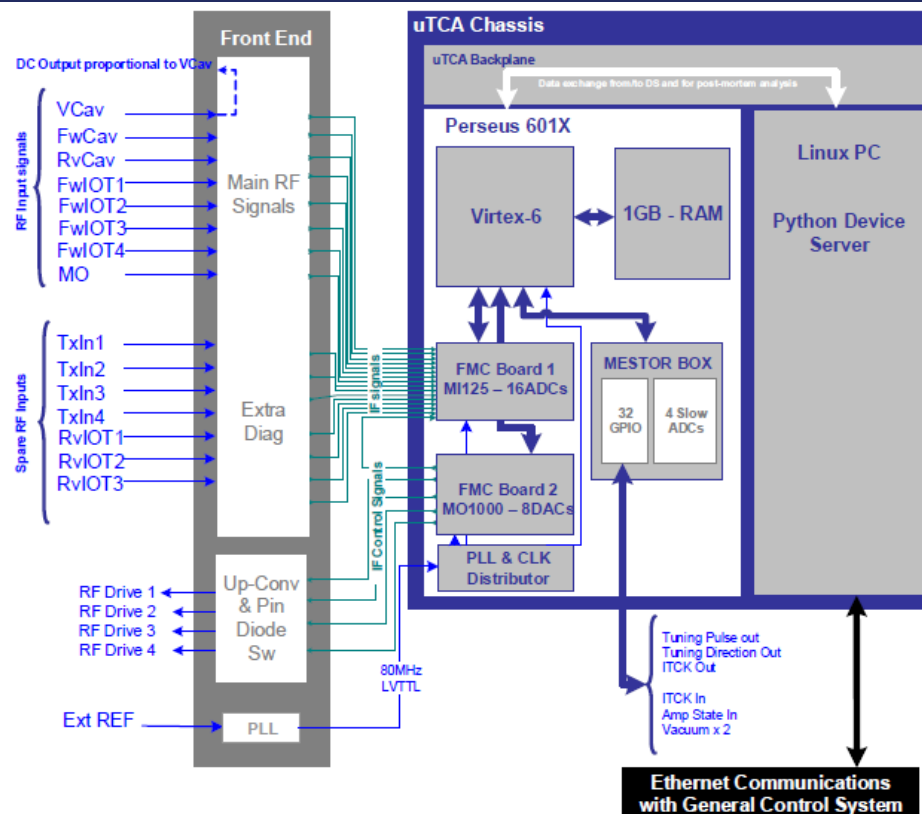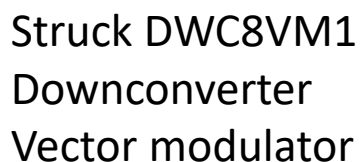
Collaboration with ALBA to adapt the MAX IV DLLRF to Diamond

- IQ or polar PI loops of the cavity field to control amplitude and phase.
- Monitoring of RF signals
- Post-mortem for analysis
- Digital LLRF offers more flexibility

- Perseus 601X AMC with Virtex 6 from Nutaq is used as the core processor of the control algorithm

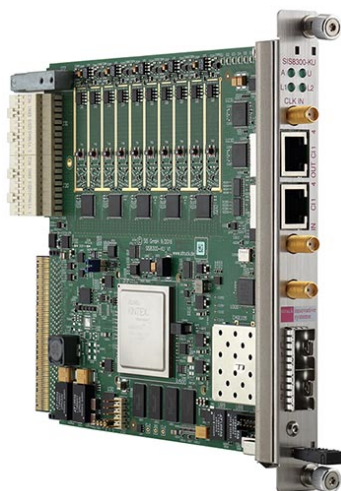- 16 Channel 14-bit ADCs and 8 channel 16-bit DACs FPGA mezzanine cards used as interface

- Perseus 601X comes with a strange stack of 2 FMCs and one special purpose PCB

- Double full size single module was not a natural fit for MTCA.4, but it works!

- Current firmware communicates only via GBEthernet with CPU, this might be grown to PCIx

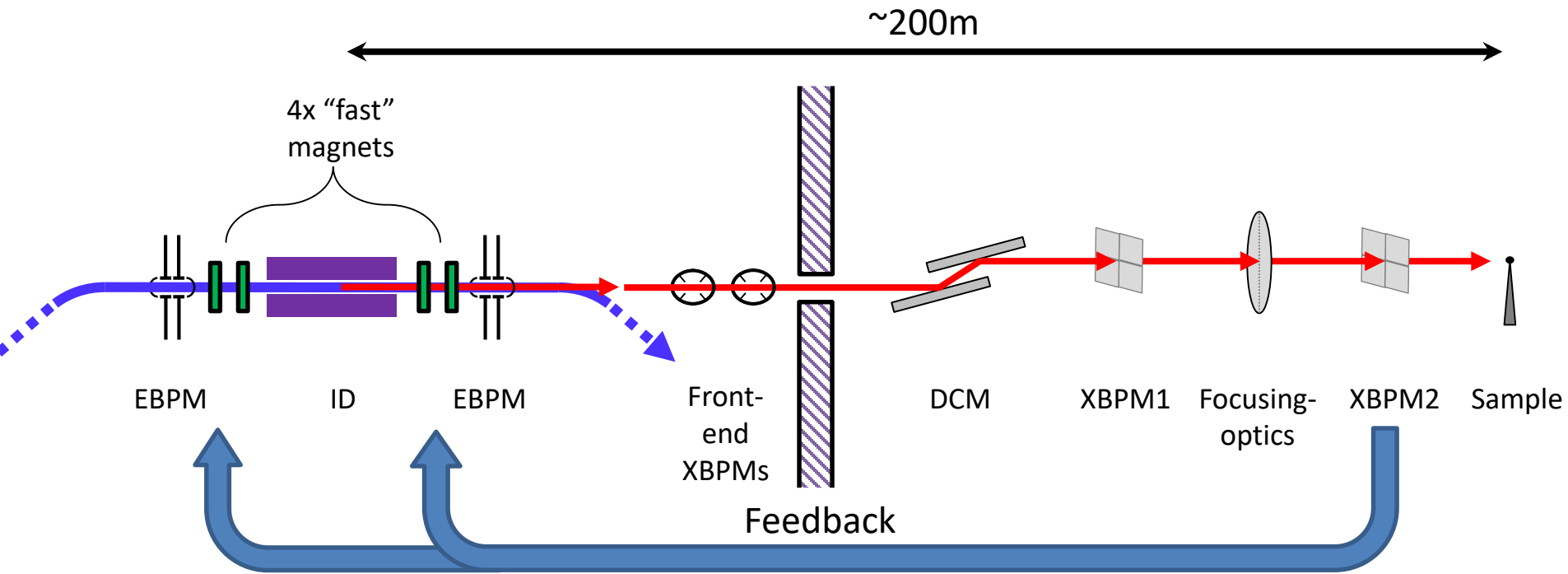Struck DWC8VM1
Downconverter
Vector modulator

Struck SIS8300KU
10ch 125MS/s
16 bit ADC/DAC

Source Feedback from X-Rays

~200m

4x "fast" magnets

EBPM   ID   EBPM   Front-end XBPMs   DCM   XBPM1   Focusing-optics   XBPM2   Sample

Feedback

- Developed by CAENels for DLS
- Delivered and to be tested early 2019
- Aiming at closed loop BW limited by magnets/vessel not by latency

DAMC FMC25

Virtex 5

FMC-Pico   FMC-4SFP
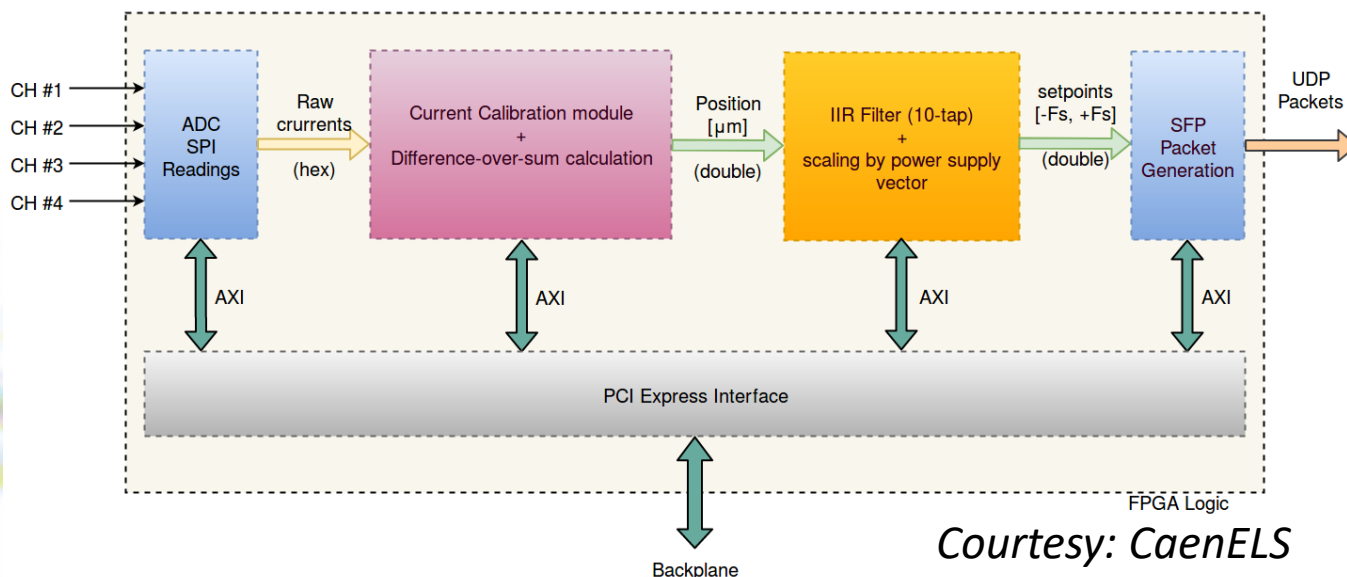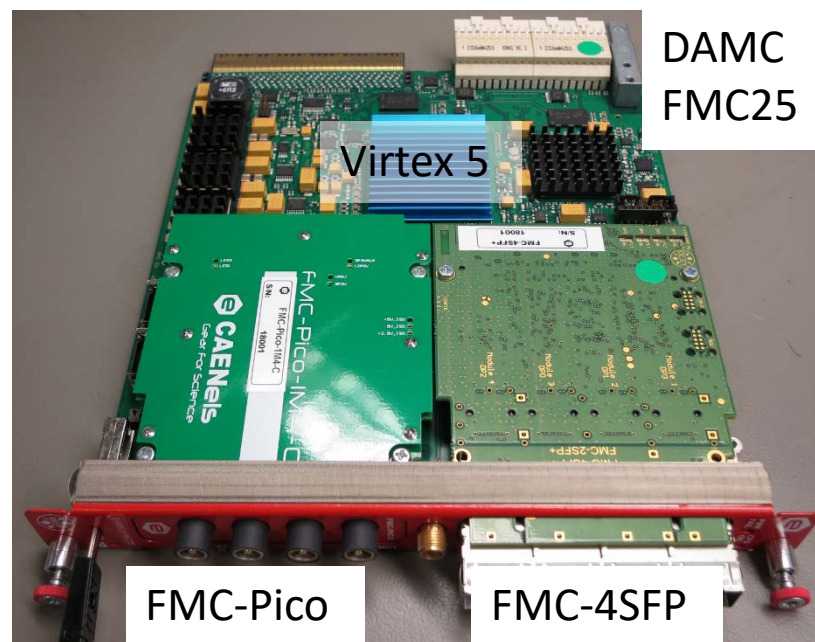
Courtesy: CaenELS

- Vadatech AMC540

- Virtex 7

- 2 x TMX320C6678
  1 GHz DSP

- 24 TX/RX on up to 12.5Gb fibres

- Will implement connection to BPMs on
  FPGA (we have 24 cells!)

- Initially Diamond Communication Controller @ 10KS/s

- Might be migrated to UDP over GBEthernet @ 100KS/s

- Feedback algorithm will run on DSP
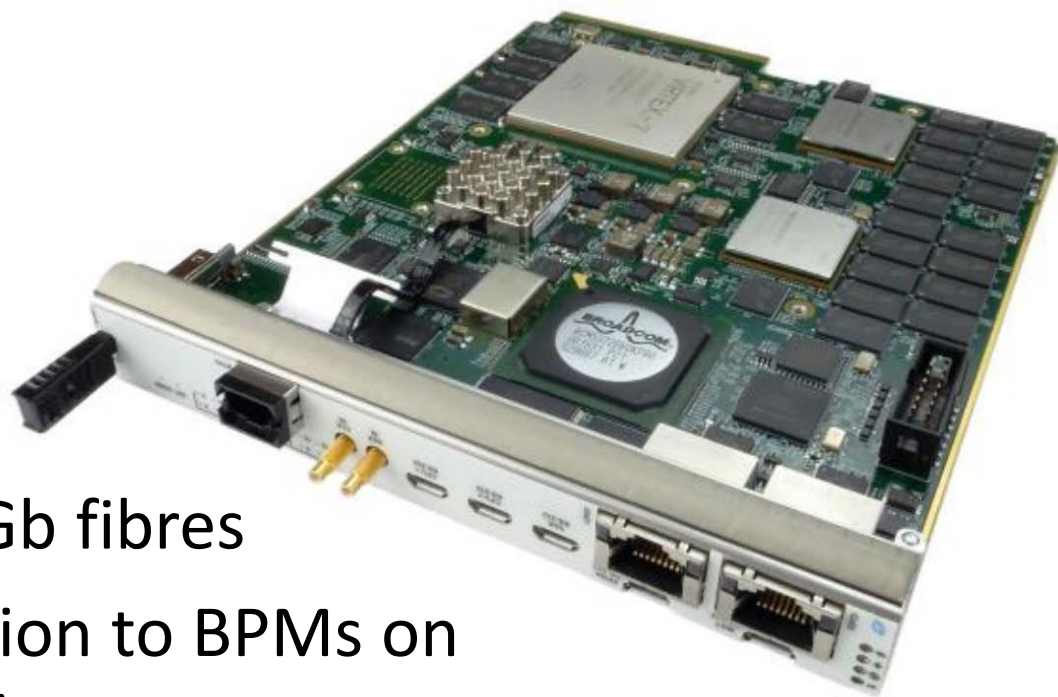
- Working towards a CDR for Diamond-II by March 2019, upgrade from 07/2024 to 07/2025
- New BPMs planned to be installed before
- Close collaboration with Elettra on pilot tone compensated approach with analogue FE in the tunnel
- Digital backend might be built with COTS MTCA components:
  - 4 (8) channel 200-250MS/s high linearity 16bit ADCs on FMC
  - 2 FMCs per FPGA AMC, on-board RAM for ADC and TbT data
  - 6 (3) AMC per crate to equip whole cell with up to 12 BPMs
  - Fast data (100kS/s) to be gathered via backplane and sent to orbit feedback controller
  - Event distribution and machine protection coordination also via backplane
- Currently evaluating various AMCs (Vadatech, IOxOS, OHWR) and FMCs (IOxOS, Elettra, OHWR)

Conclusions

- The entry to MTCA was easier than we thought.
- MTCA offers on the same backplane:
  - high-speed connections
  - GBEthernet
  - Management IPMI
- MTCA crates/MCH are (still?) costly
  - Not best fit for low throughput applications
  - Great for reliability and manageability of high throughput
- DLS is weak on PCB development
  - We're OK with firmware/software development
  - We like to combine COTS components.
- We gathered practical experience on a few projects, but we are still in the learning phase…