Read-out overview Optoboard

SEE testing
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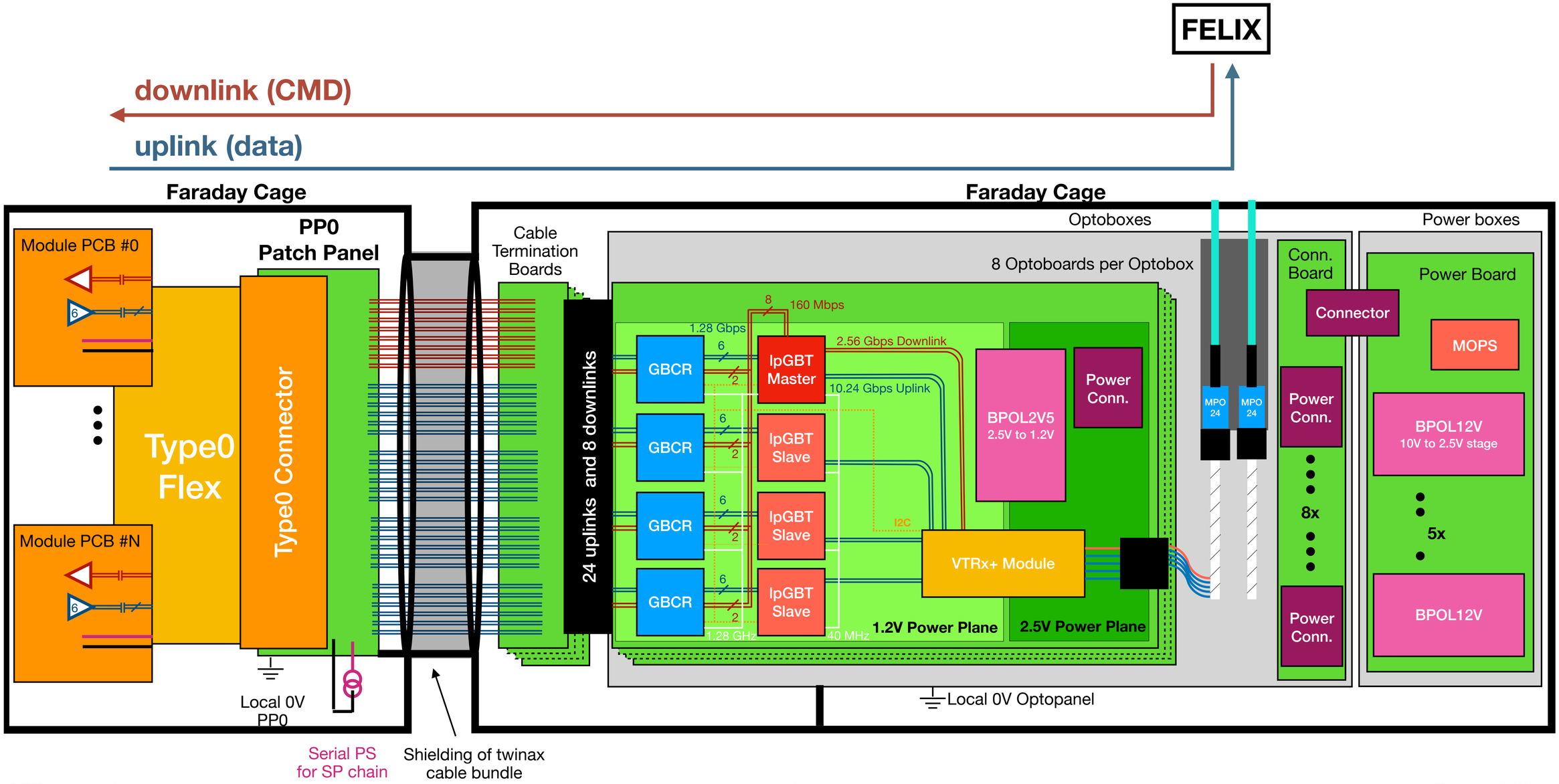
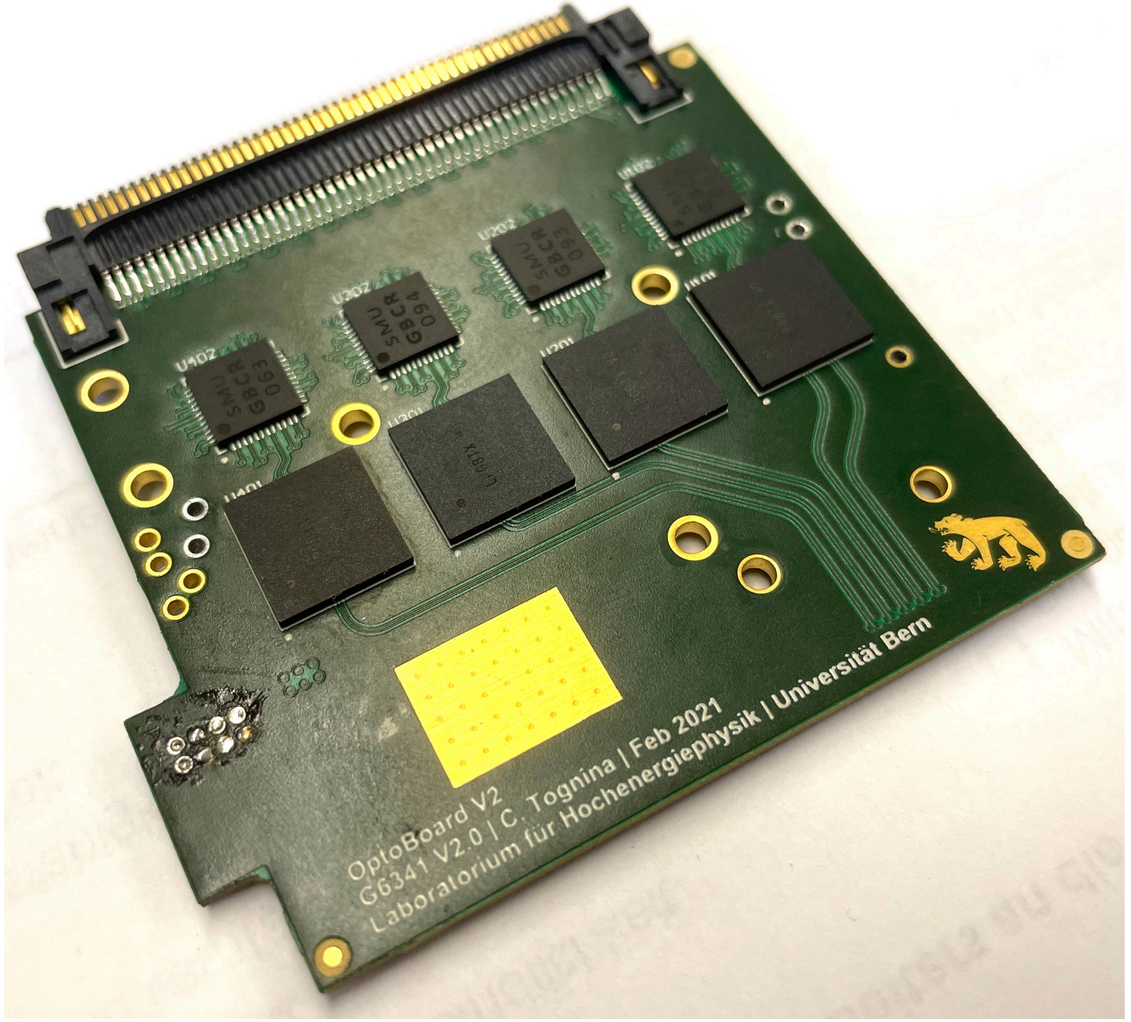
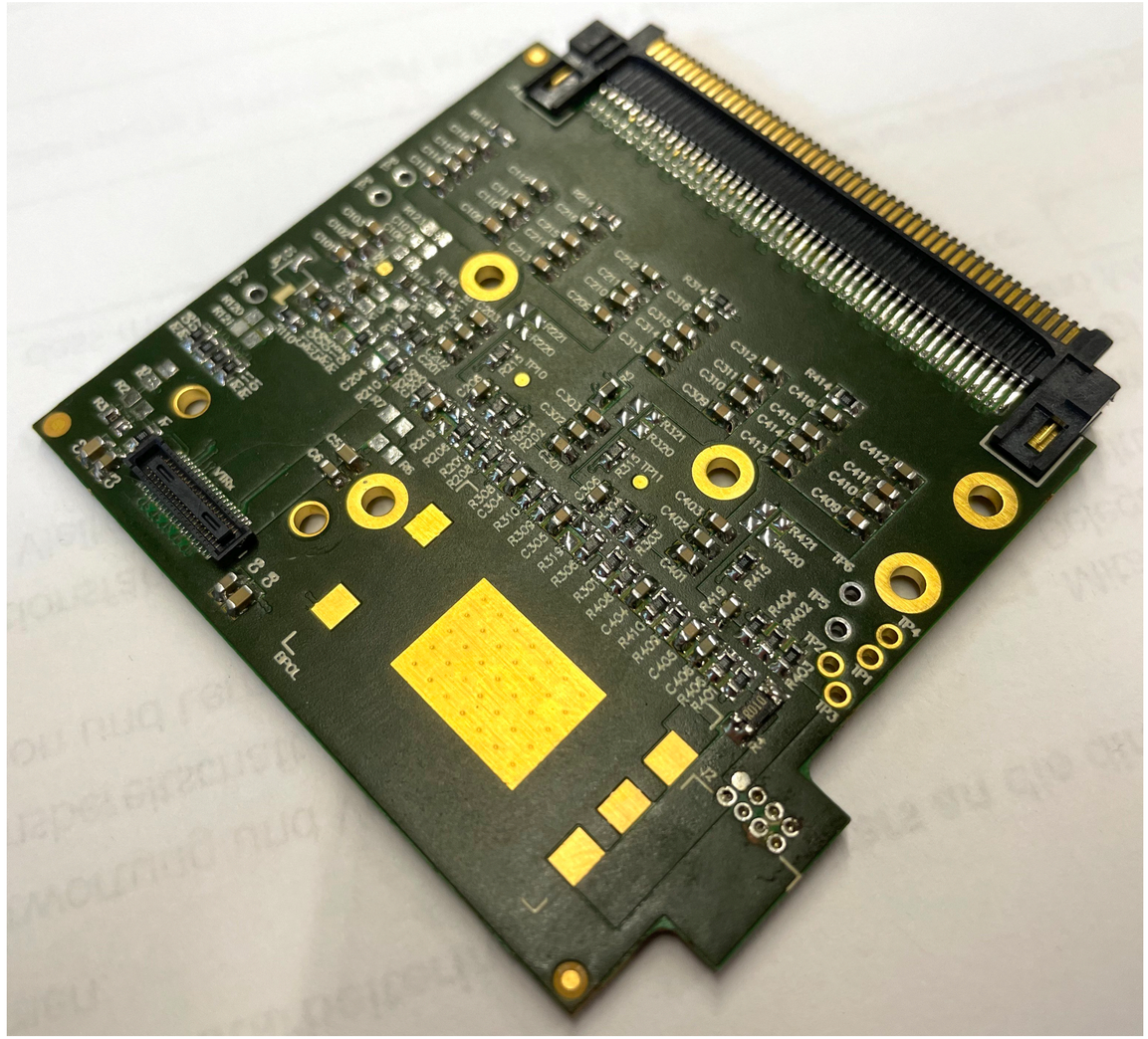
ATLAS EXPERIMENT

Pixel data transmission chain overview



The Optoboard





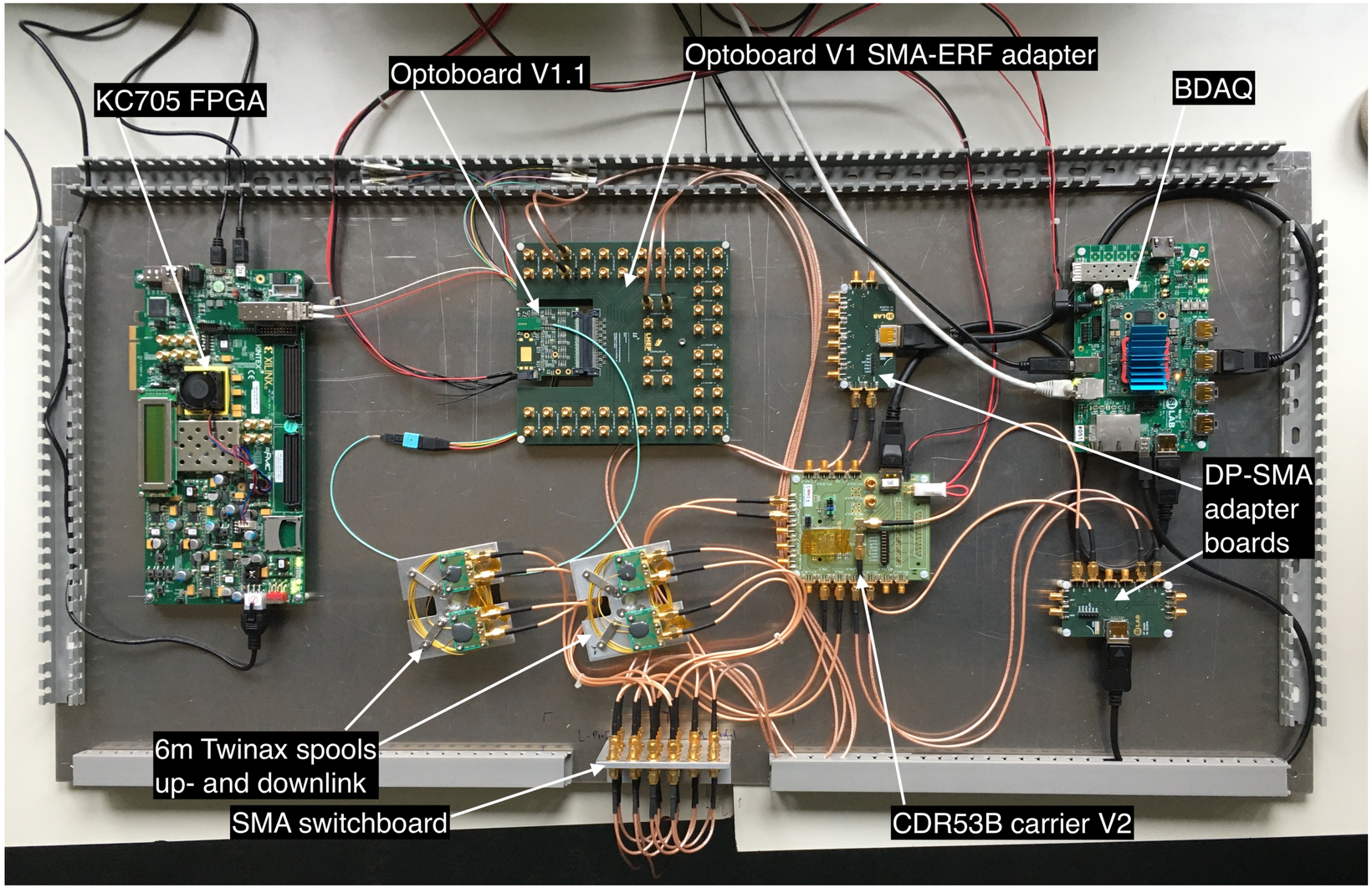
available in 3 versions: V0 (only 1 lpGBT+VTRx+), V1 and V2 (shown here), V3 in design stage

Overview of different test setups

- KC705/FELIX ⇄ Optoboard ⇄ CDR53b ⇄ BDAQ
- FELIX ⇄ Optoboard ⇄ RD53a
- FELIX ⇄ Optoboard ⇄ ITkPixV1
- FELIX ⇄ Optoboard ← ITkPixV1 ⇄ BDAQ

KC705 ⇄ Optoboard ⇄ CDR53b ⇄ BDAQ

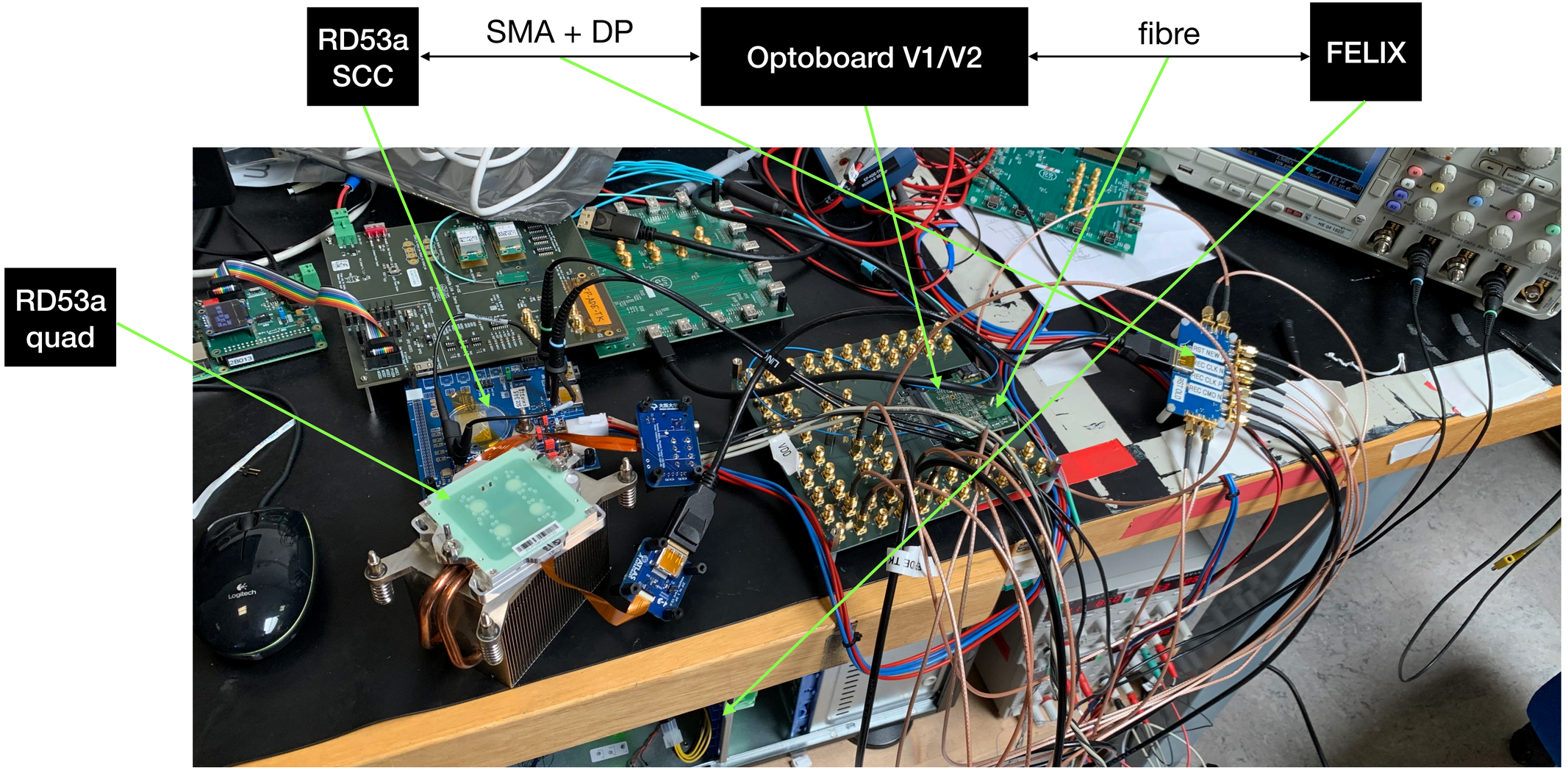
- control of Optoboard:
  - custom firmware on KC705 made by Armin Ilg (thesis on CDS)
  - FELIX
- CDR53b setup with BDAQ according to Piotr's repository
- CMD from Optoboard, PRBS7 on uplink for jitter and BER tests.



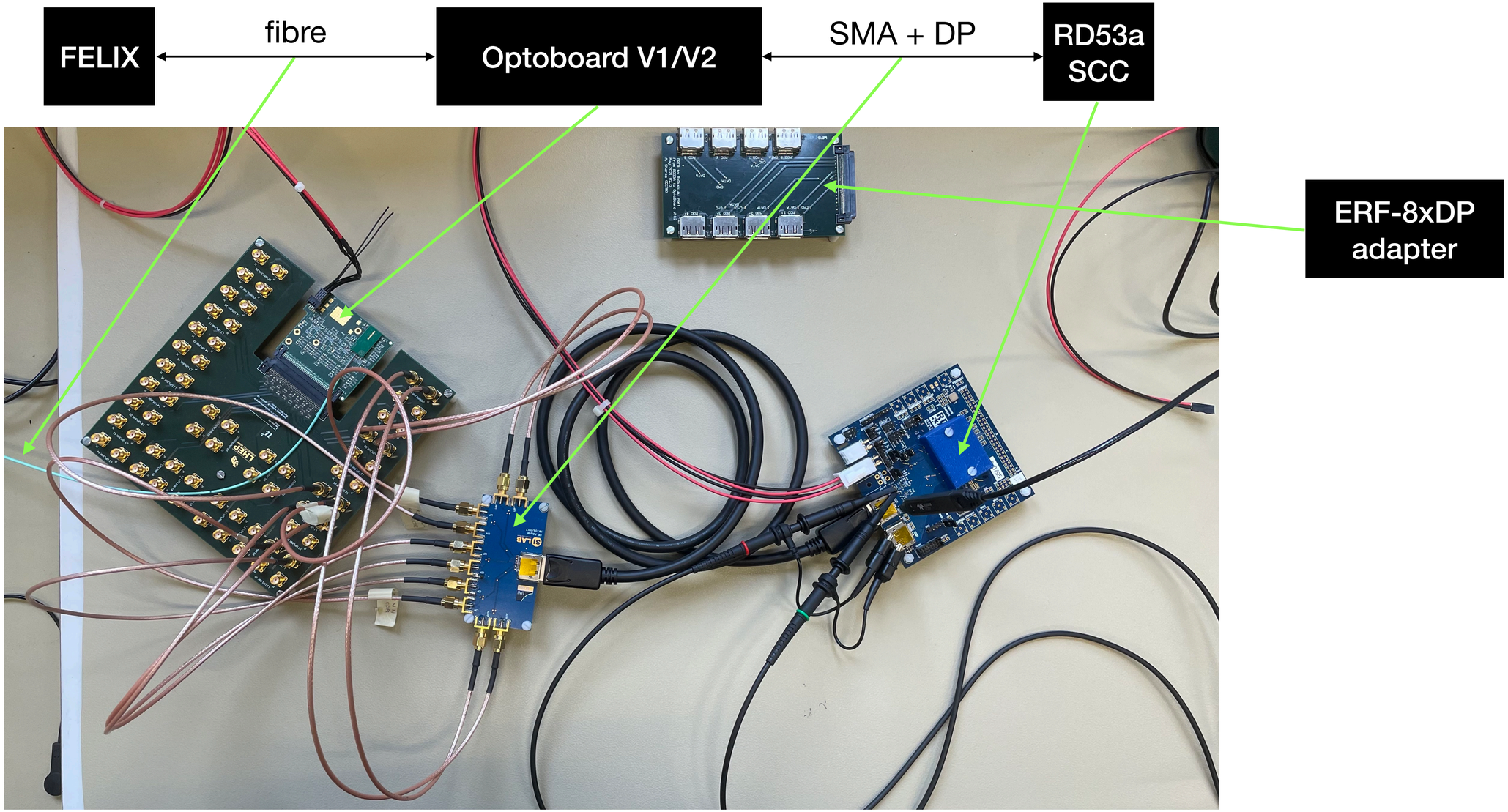
FELIX ⇄ Optoboard ⇄ RD53a

- first successful communication with RD53a (SCC and Quad Chip) through the Optoboard V1 and V2 with FELIX achieved at the end of July in collaboration with Ismet Siral at CERN!
- FELIX data acquisition with YARR being able to do digital scans and more.
- everything related to FELIX lpGBT readout efforts can be found at this link to a set of slides, this working document of ANL/Oklahoma people and this website of CERN ITk people (all work in progress!). Also see the ITk week talk by Marco Trovato

Setup for RD53a at CERN

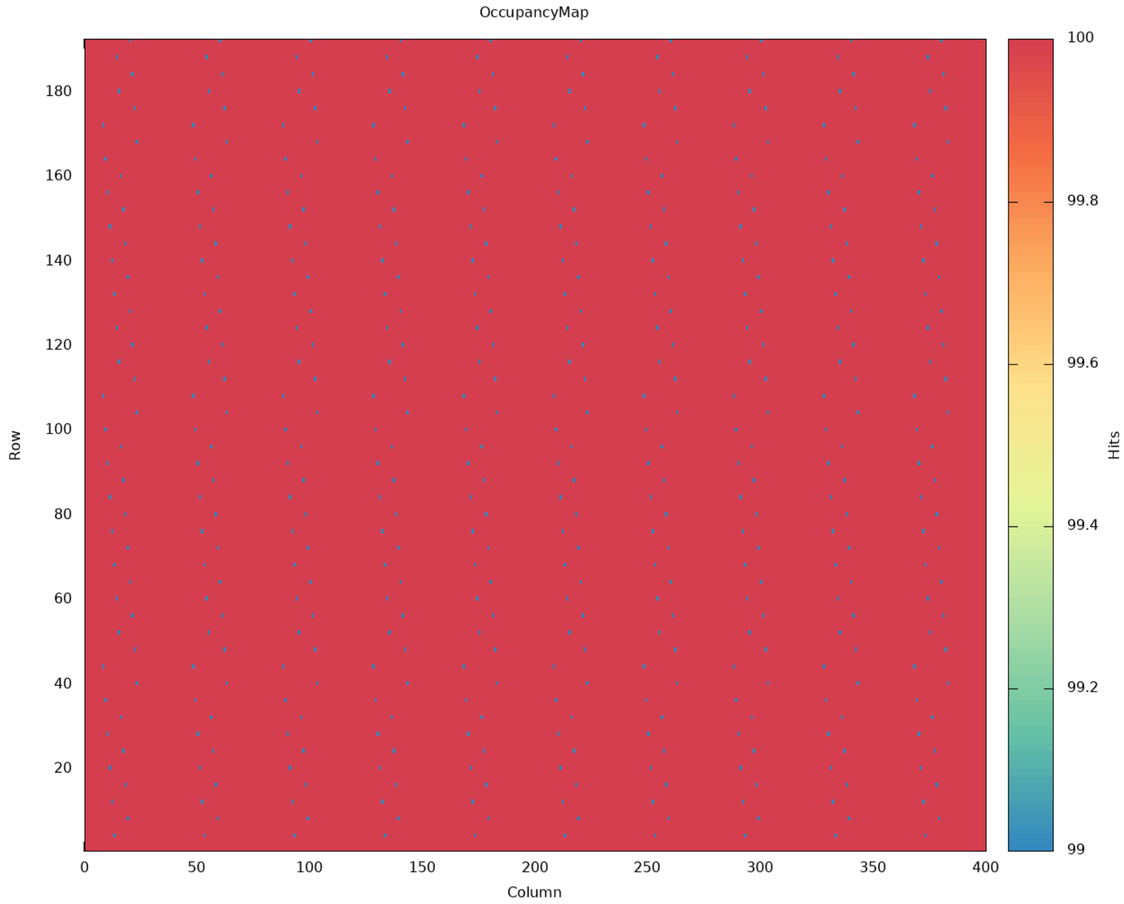


Setup for RD53a at Bern



Digital scan with RD53a, Optoboard and FELIX at Bern

- established the same setup this week at Bern
- successful RD53a clock recovery and Aurora lock
- testing now the communication with RD53a with higher attenuation e.g. including twinax etc. inside the transmission chain



digital scan done with 100 triggers per pixel

FELIX ⇄ Optoboard ⇄ ITkPixV1

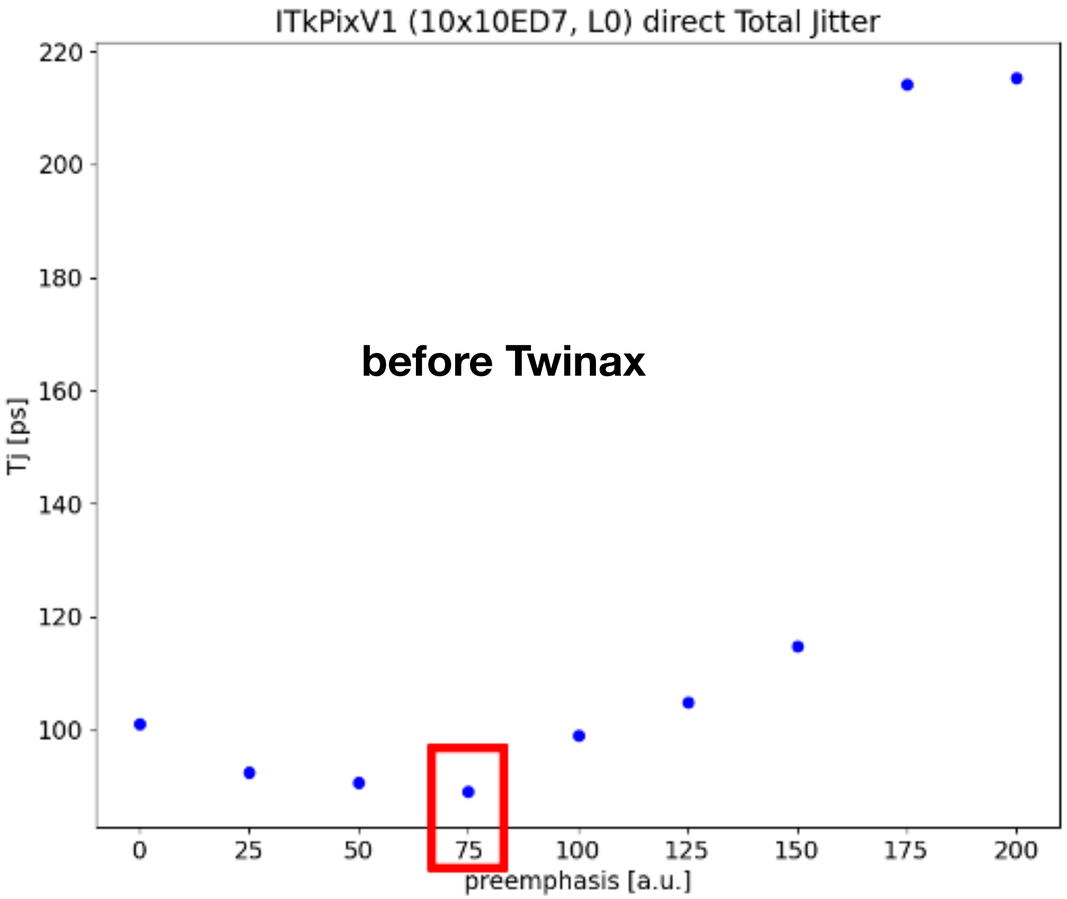
- Optoboard ready but RD53b (ITkPixV1) communication not yet possible with FELIX. YARR is also ready but «complex task» (Joern) to migrate to FELIX code.
- currently unknown how long it will take

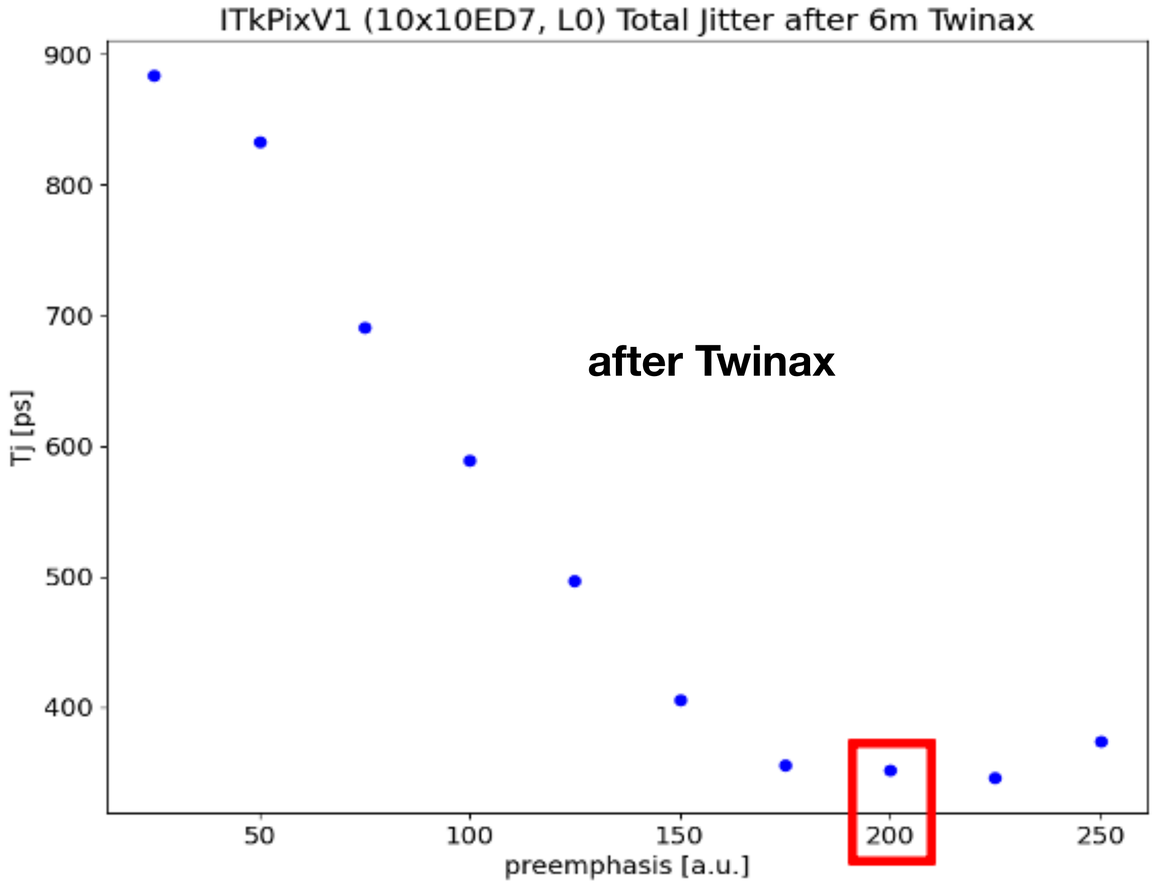
FELIX ⇄ Optoboard ← ITkPixV1 ⇄ BDAQ

- current solution for gathering experience with ITkPixV1:
  using the BDAQ to control ITkPixV1 and use its serialiser to generate a PRBS7 pattern for jitter measurements and BERT with parts of the data transmission chain including Optoboard.

- drawback:
  - no CMD sent to ITkPixV1 from Optoboard, CDR recovers clock from BDAQ
  - could use CMD from Optoboard with ITkPix in bypass mode according to Piotr. Method under investigation.

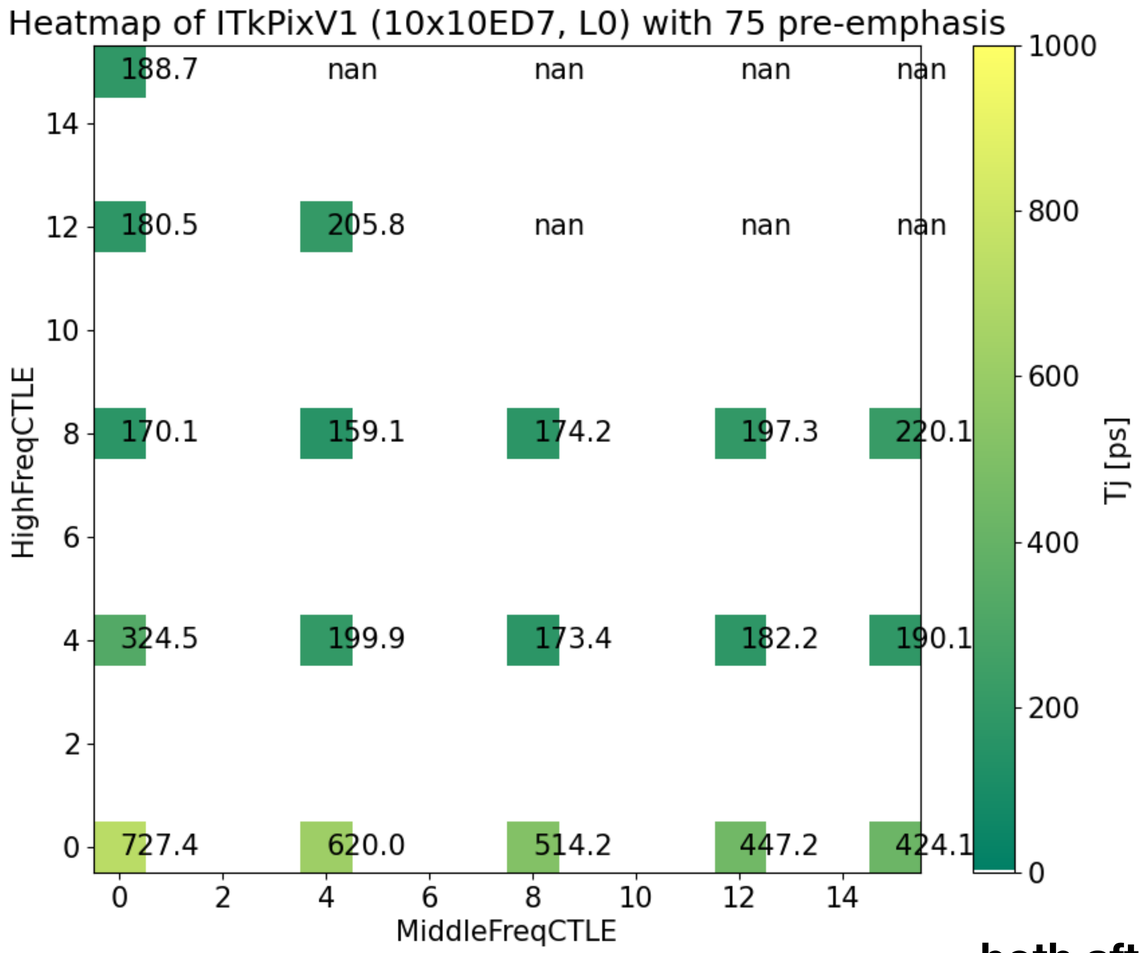
ITkPixV1 TJ with different pre-emphasis settings before and after twinax

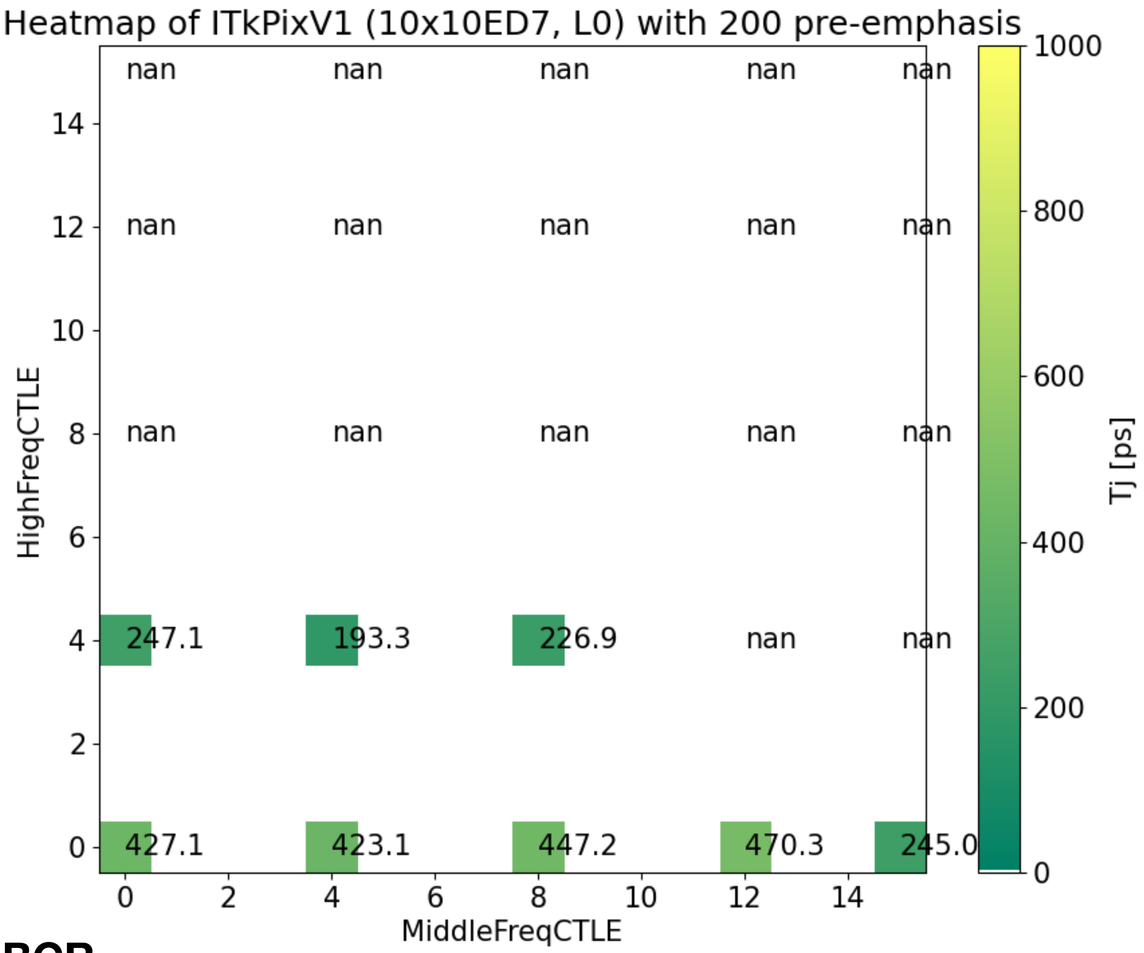




each measurement ~14min at 1.28 Gb/s (oscilloscope sample rate 40GS/s)

TJ after GBCR with different CTLE





both after GBCR

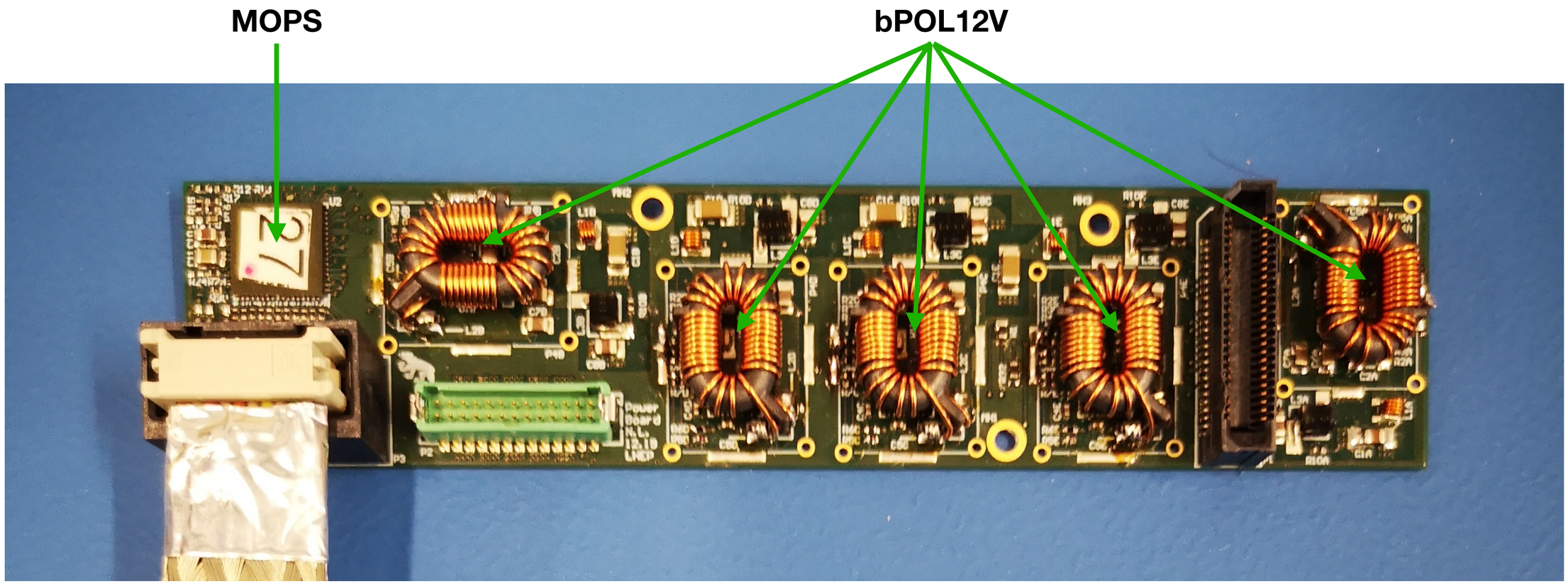
(nan: no pattern recognition by oscilloscope)

Conclusion

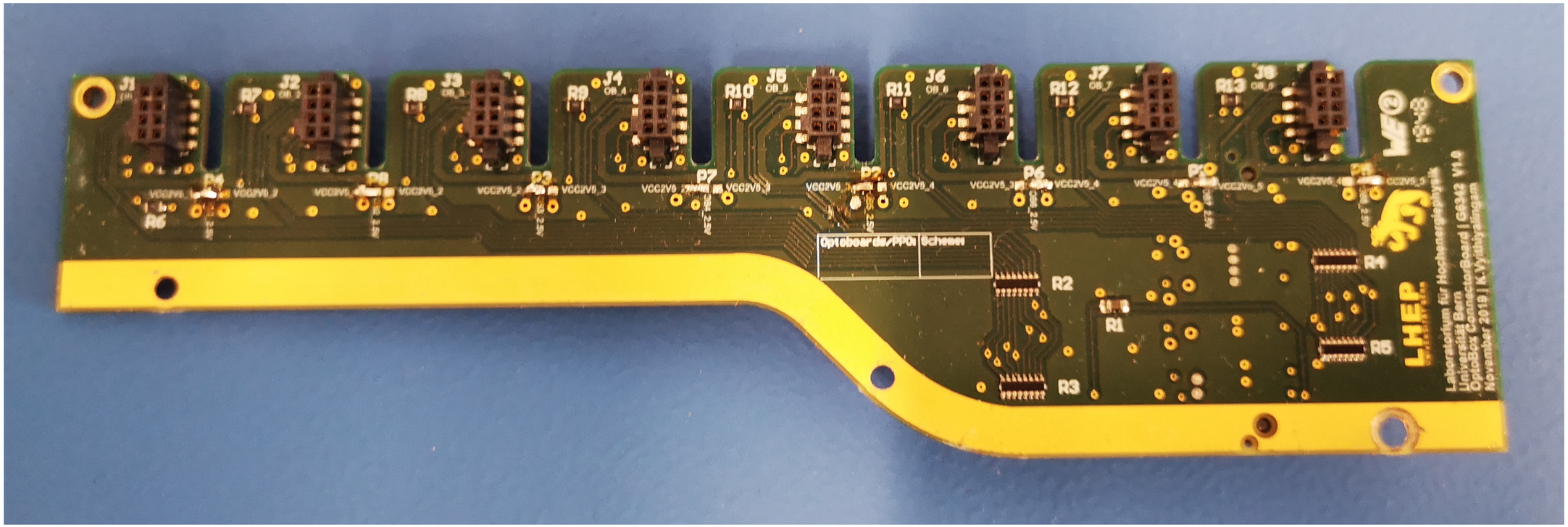
- communication with RD53a through Optoboard V1/V2 with FELIX established, support for ITkPixV1 in preparation but unknown when ready. SEE/SEU tests therefore, as of now, not possible with RD53b.
- first preliminary ITkPixV1 pre-emphasis and GBCR CTLE tests with 6 m twinax at Bern. Tests with CMD through and from Optoboard lpGBT/ GBCR awaits progression in FELIX software or using the CDR bypass mode.
- measurement strategy for different twinax cable lengths and optimal parameter selection in preparation.

Backup

Powerboard

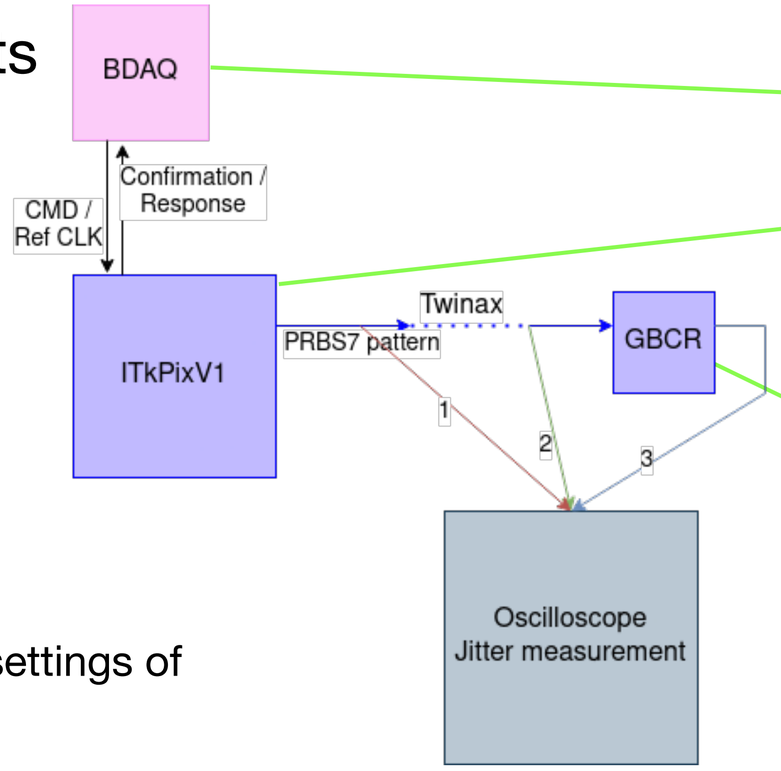


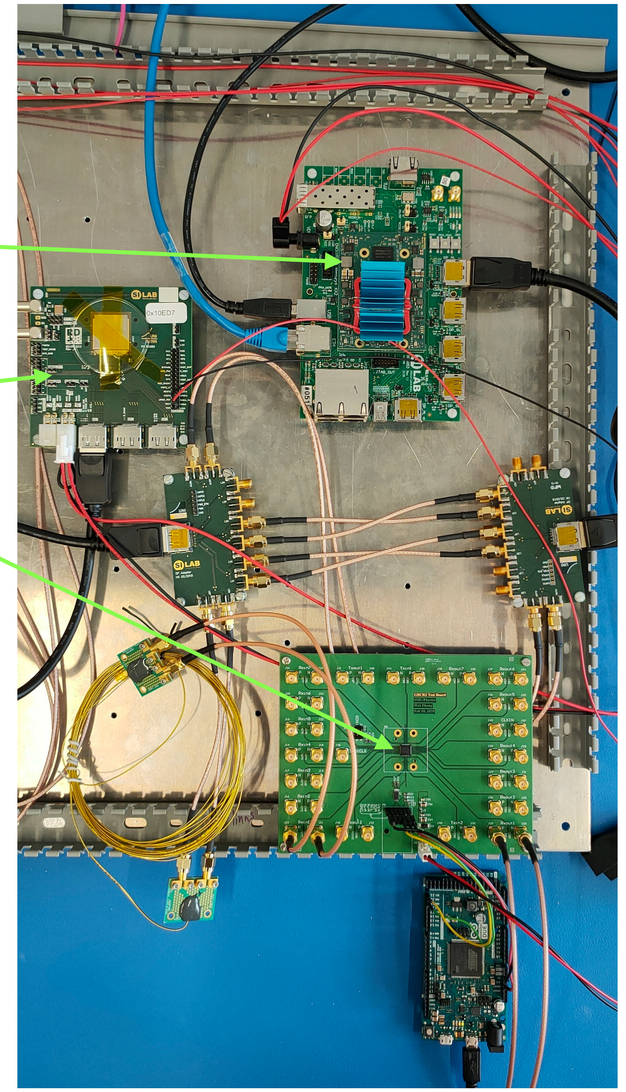
Connectorboard



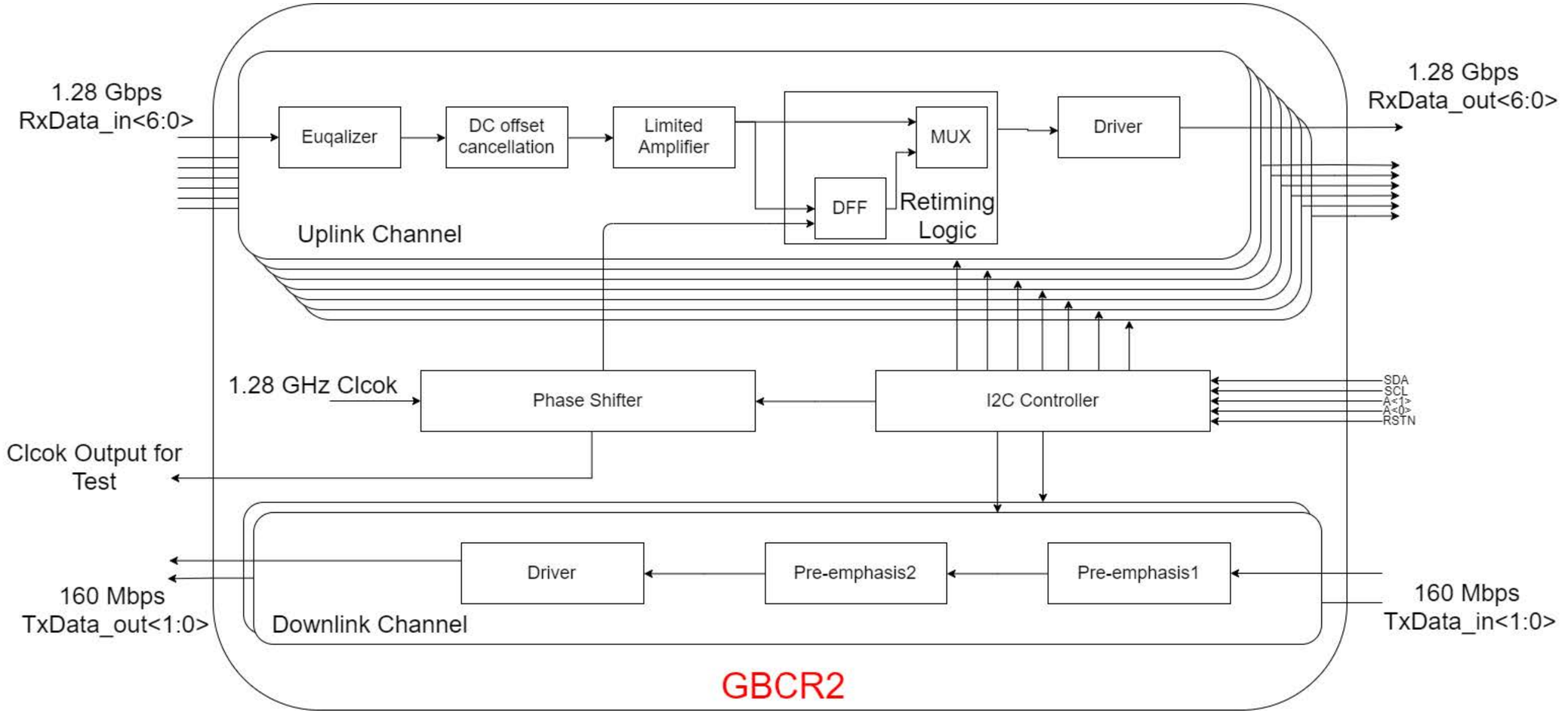
ITkPixV1 with BDAQ

- measure jitter at 3 different points
  - ITkPixV1 output (TP 1)
  - after 6 m Twinax cable (TP 2)
  - after 6 m Twinax cable and GBCR in equaliser mode only (TP 3)
- test parameters:
  - pre-emphasis on output signal of ITkPixV1
  - CTLE (continuous time linear equalisation) settings of GBCR:
    - middle frequency CTLE [0:15] (effect range ~250-400 MHz)
    - high frequency CTLE [0:15] (effect range ~400-1300 MHz)



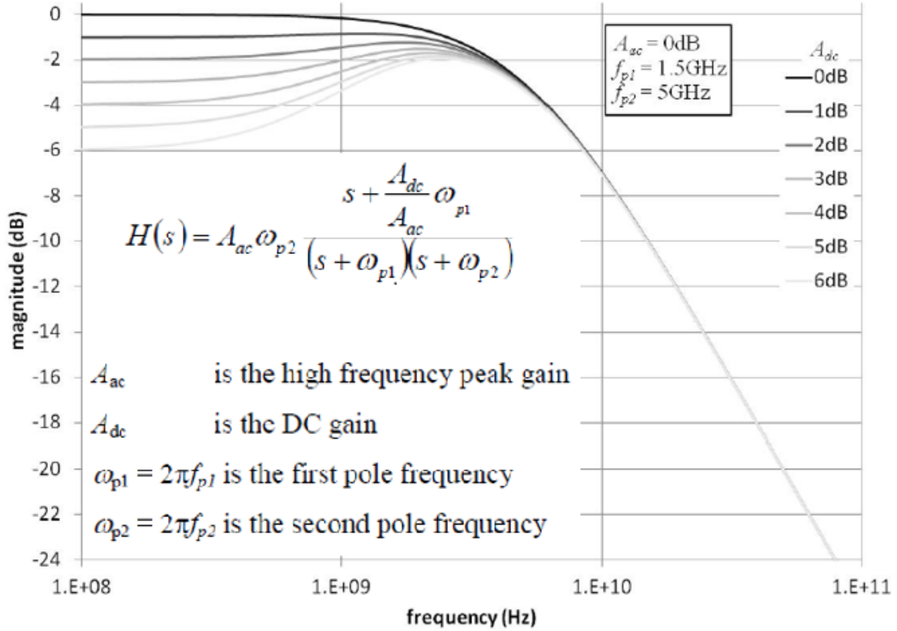


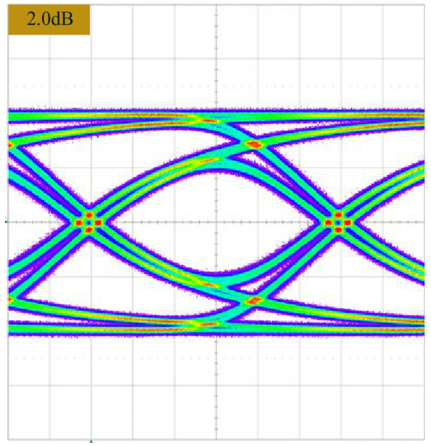
GBCR2 block diagram

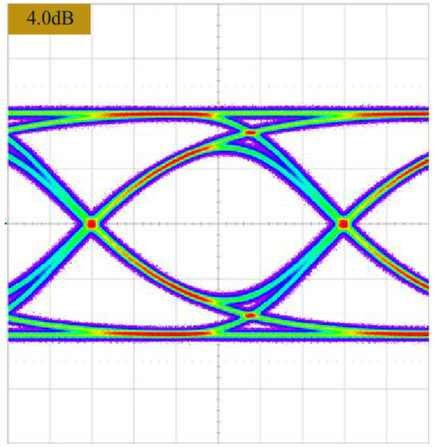


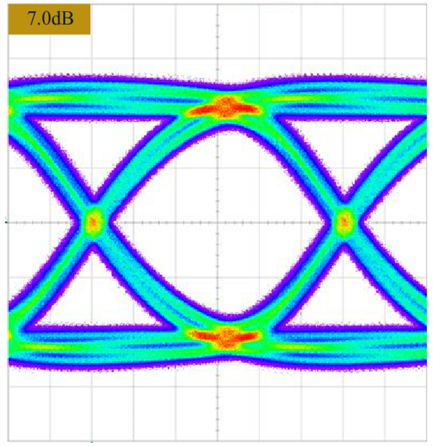
CTLE

- serial data channel attenuates signal stronger in the high frequency range
- no or low CTLE: ISI jitter
- too high CTLE: noise









further reading here

Twinax cable attenuation

- measurements done with VNA
- twinax on spool for irradiation tests