Test system:
Inner Tracker hardware

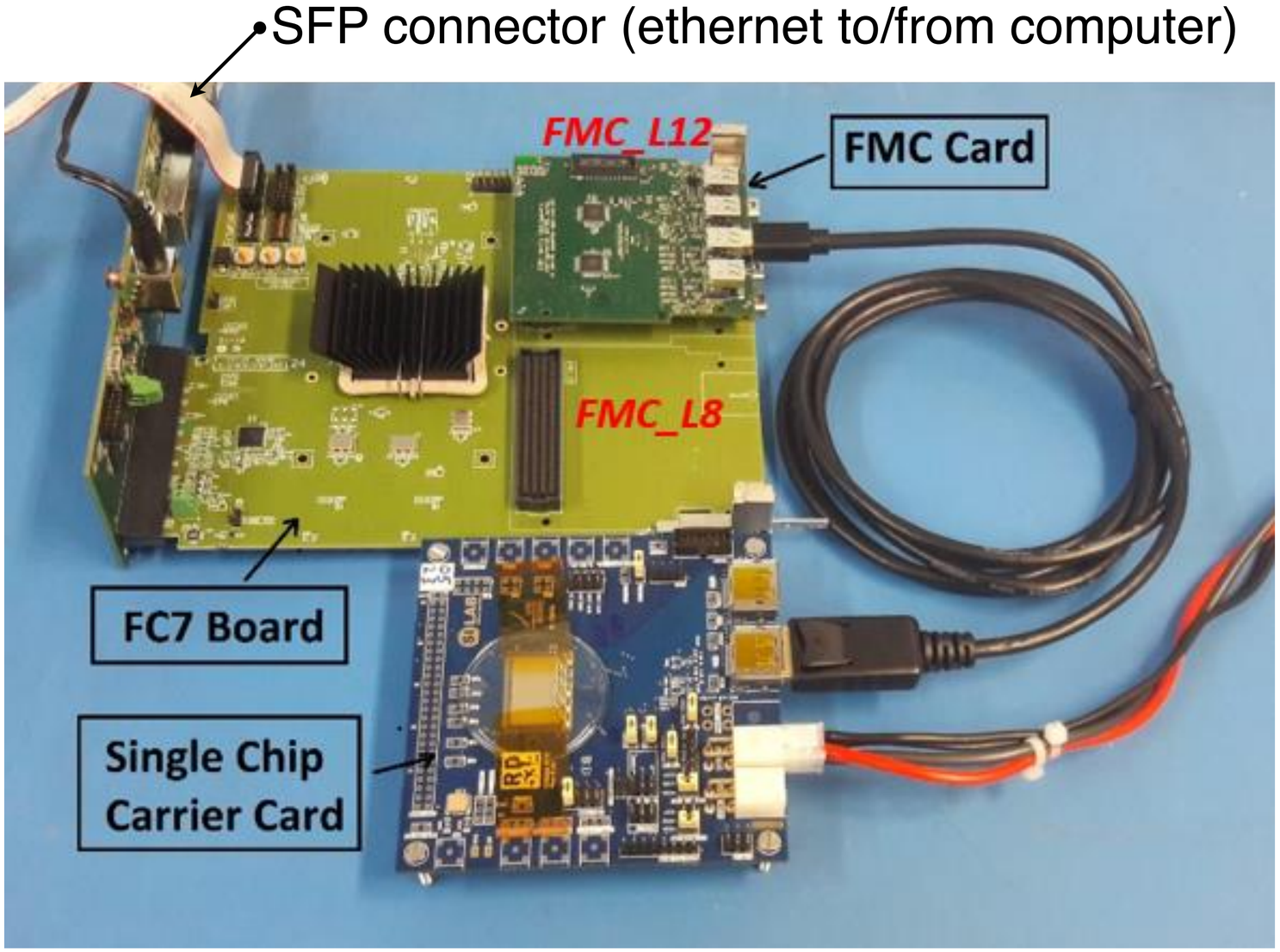
Mauro Dinardo
Università degli Studi di Milano - Bicocca and INFN

Outline

In this presentation I'll try to go through all possible types of hardware and connections which are currently available and supported within the `Ph2_ACF` software and firmware

Details on the software and firmware can be found on the official gitlab repository: https://gitlab.cern.ch/cmsinnertracker/Ph2_ACF

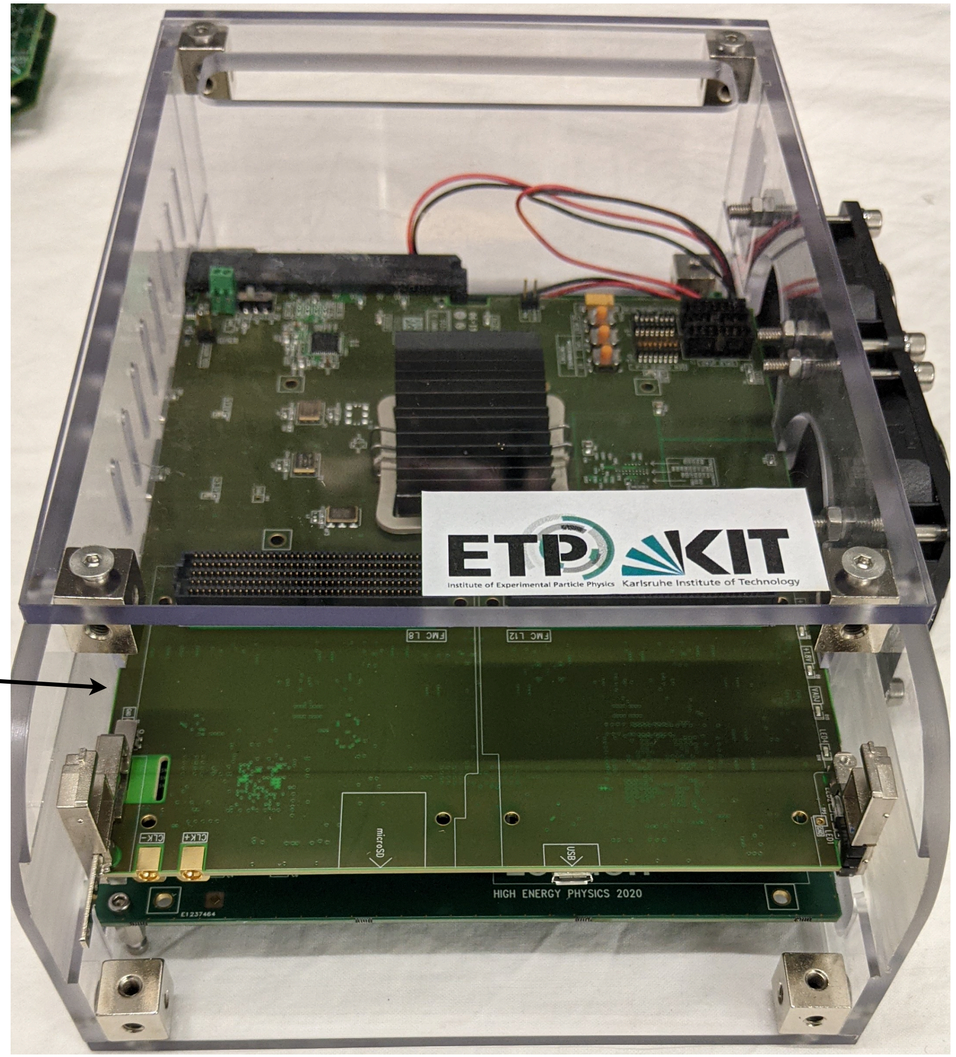
Electrical readout



Typical electrical readout for test bench:

- FC7: backend board with FPGA
- FMC board (FPGA Mezzanine Card): needed to interface multi-pins on FPGA to particular readout
- card holding the frontend chip(s)
- connection to the computer: via ethernet cable through SFP connector (Small Form-factor Pluggable transceiver)

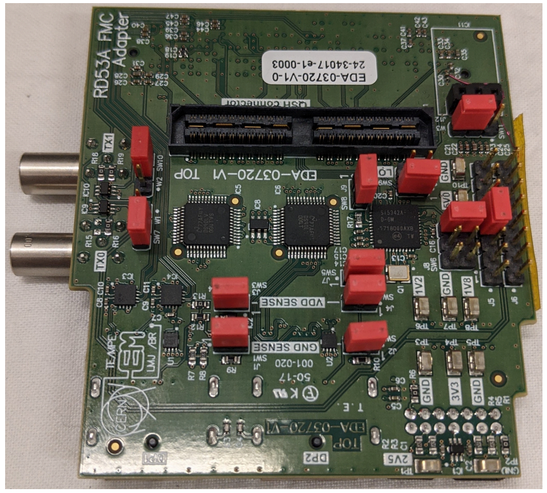
FC7 nano crate (with IC board that provides power)



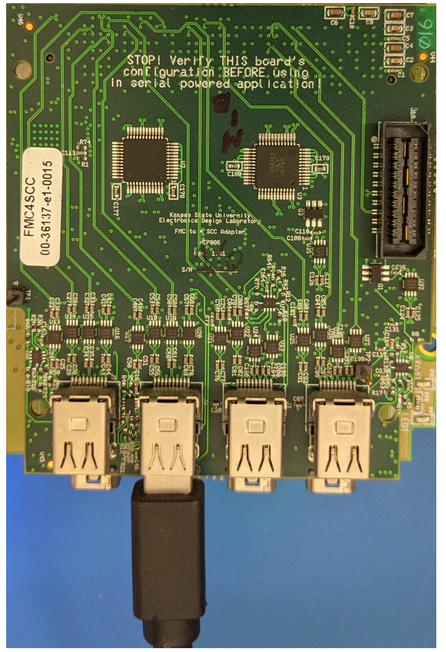
SFP connector

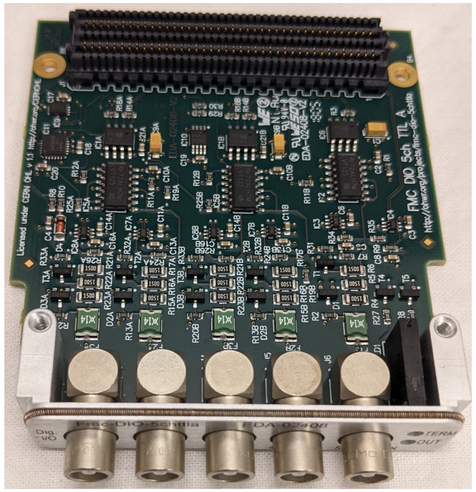
Two FMC board supported

CERN-FMC



KSU-FMC

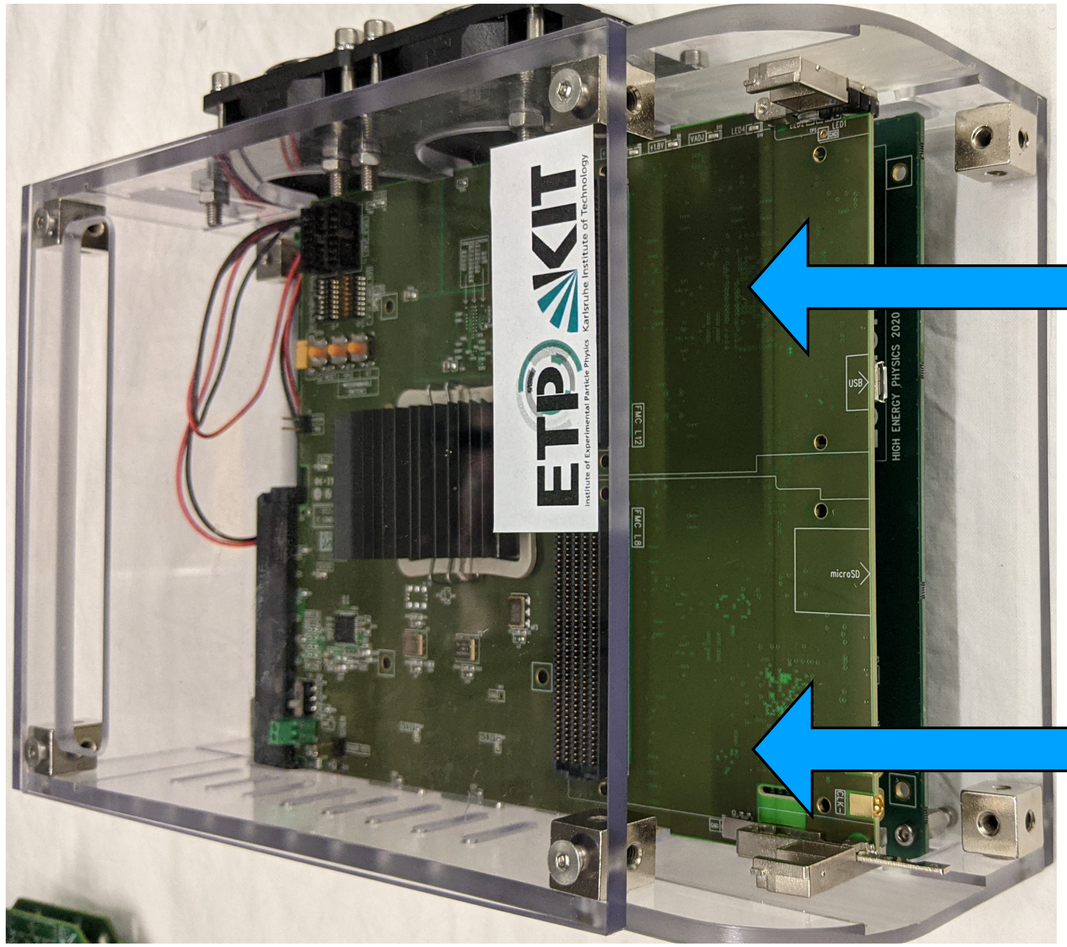




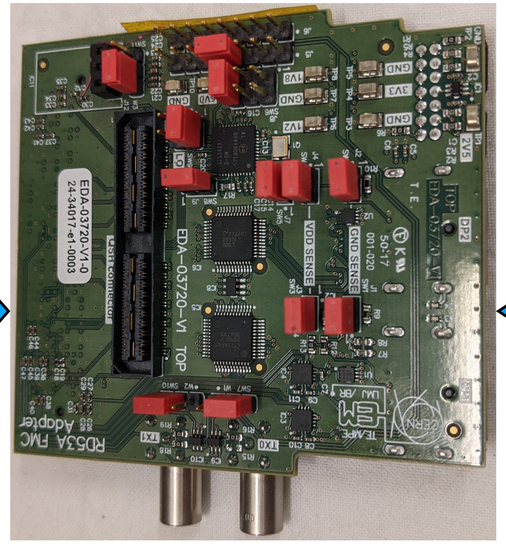
DIO5 to provide ext. clock and trigger, this is also an FMC board

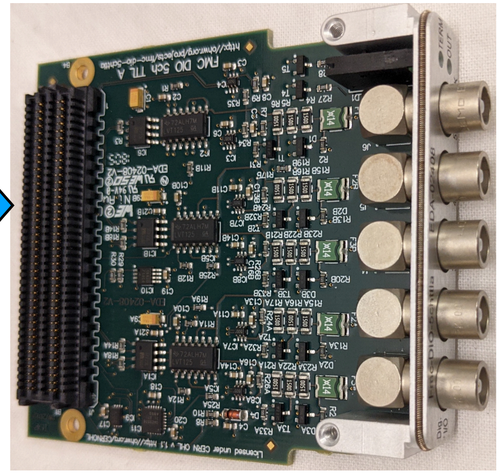
Electrical readout: possible combinations

FC7 nano crate (with IC board that provides power)

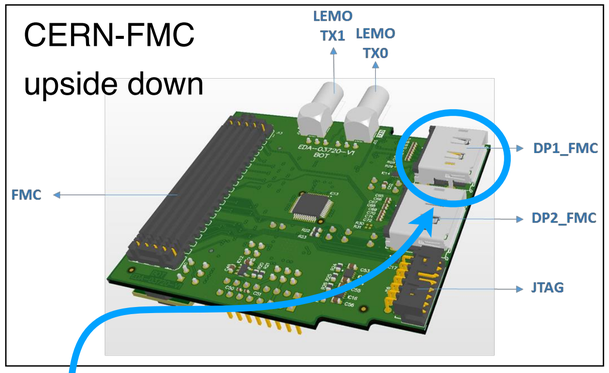


CERN-FMC

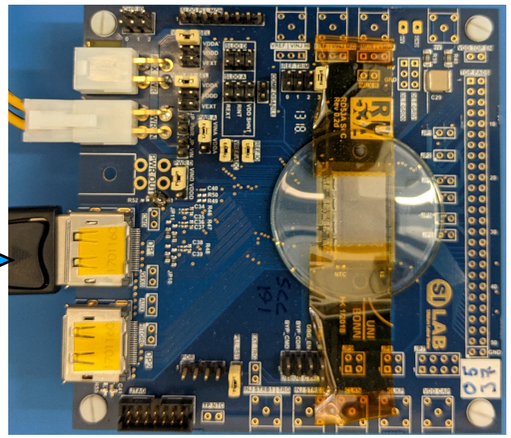




DIO5 (not strictly needed)



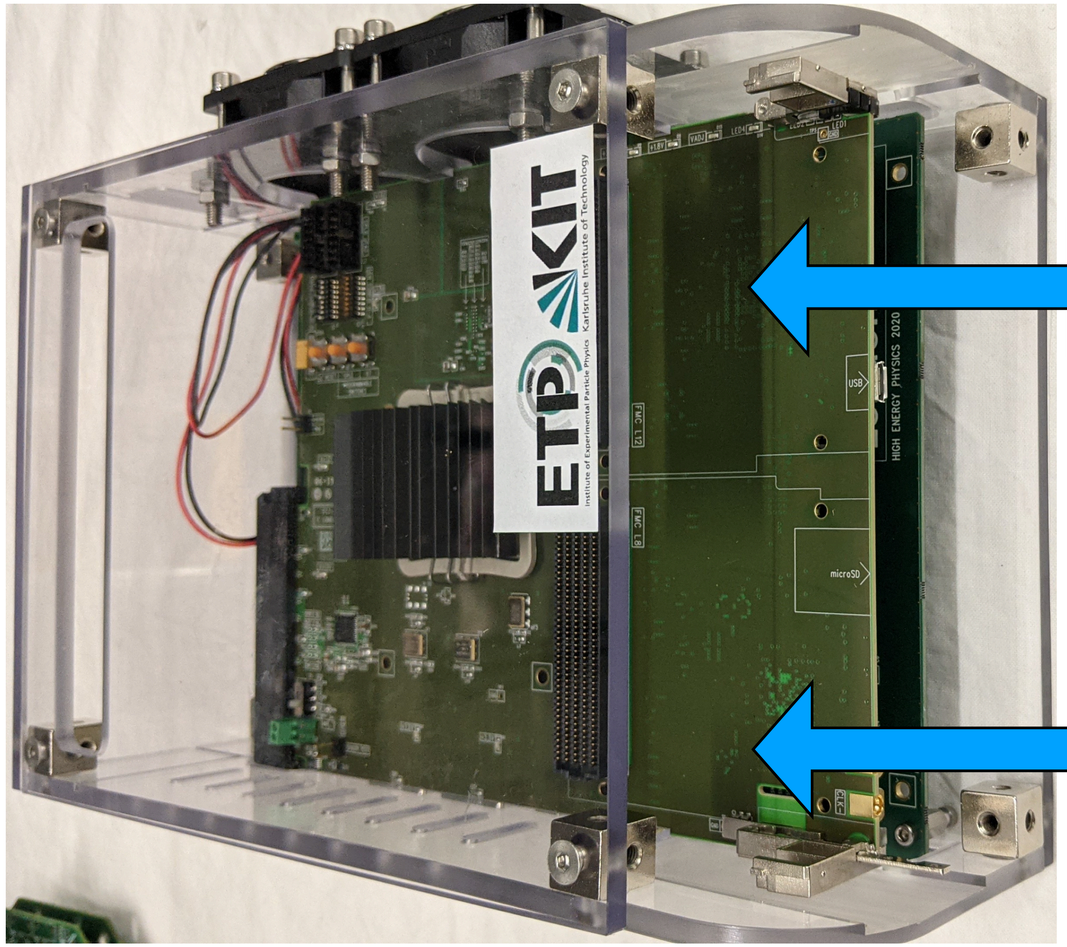
Display Port to Display Port cable



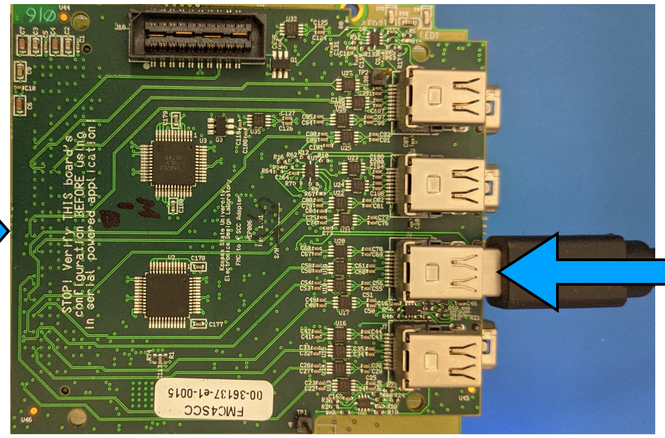
Single Chip Card

Electrical readout: possible combinations

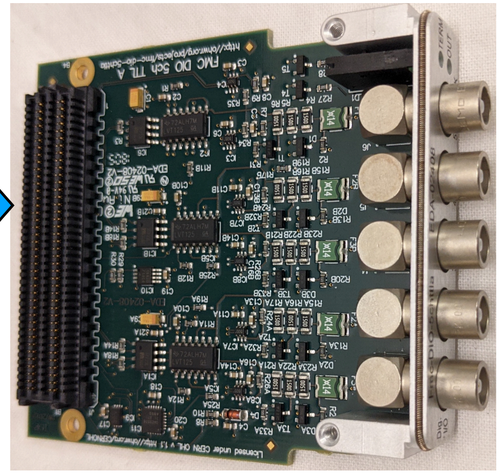
FC7 nano crate (with IC board that provides power)



KSU-FMC



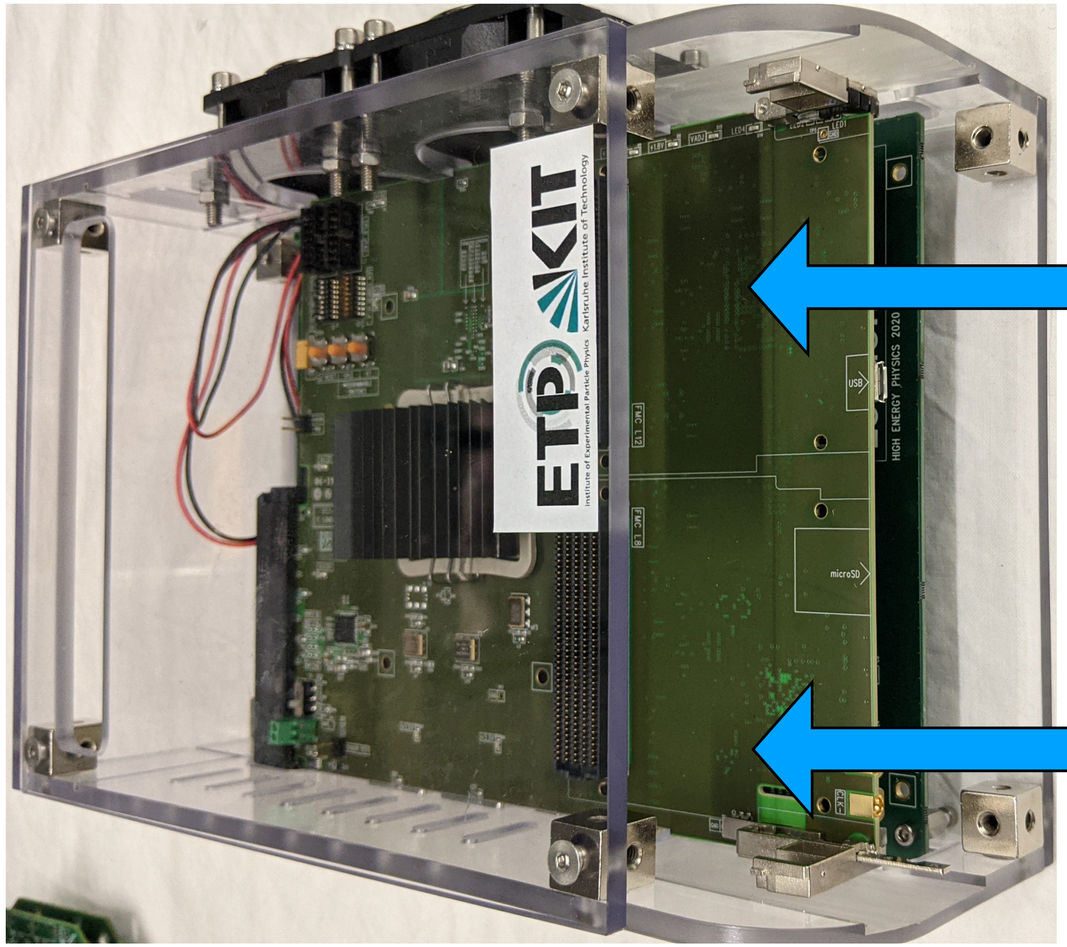
Mini Display Port to Display Port cable to Singe Chip Card or to Quad Modules



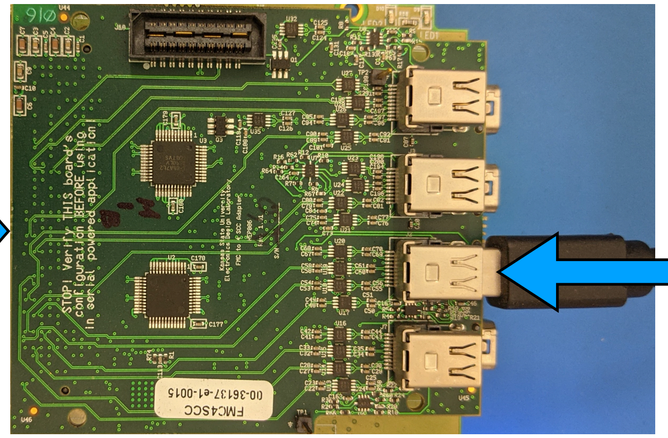
DIO5 (not strictly needed)

Electrical readout: possible combinations

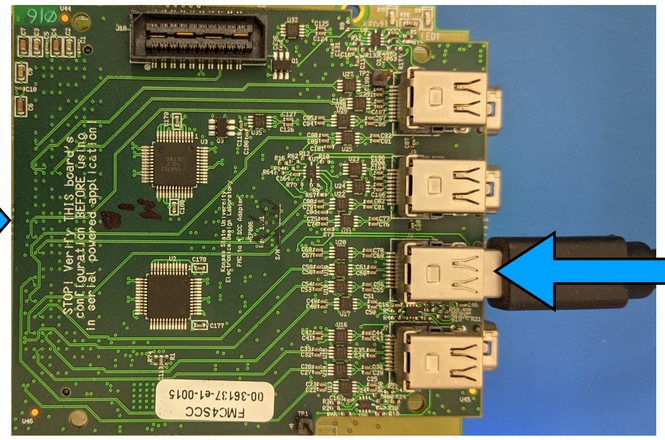
FC7 nano crate (with IC board that provides power)



KSU-FMC

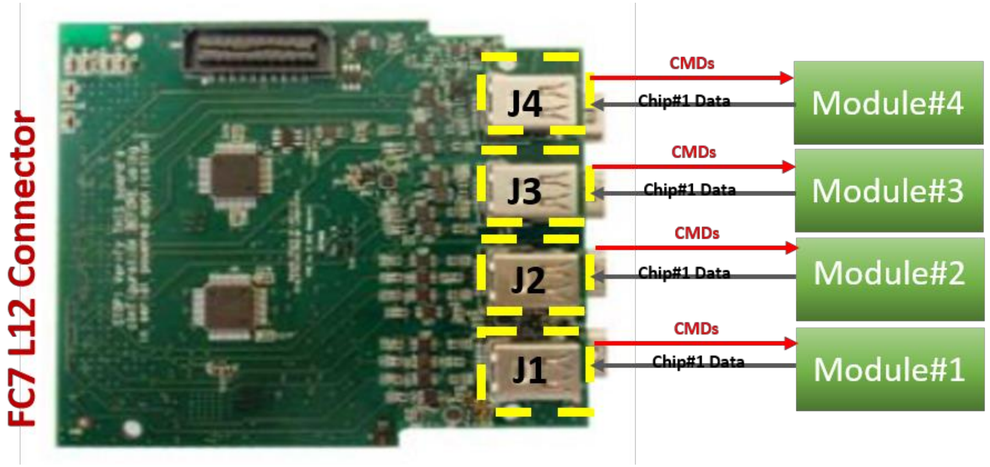


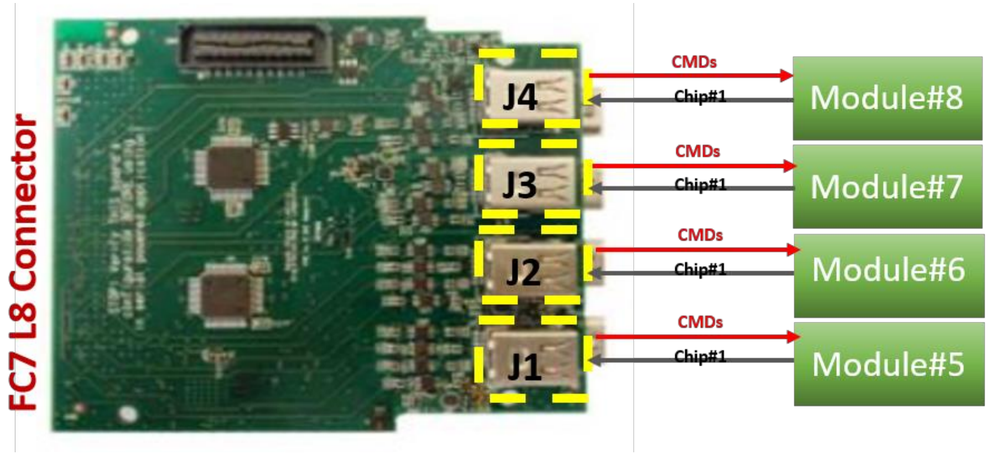
Mini Display Port to Display Port cable to Singe Chip Card or to Quad Modules



KSU-FMC

Electrical readout: possible combinations





Possible connections to Single Chip Cards

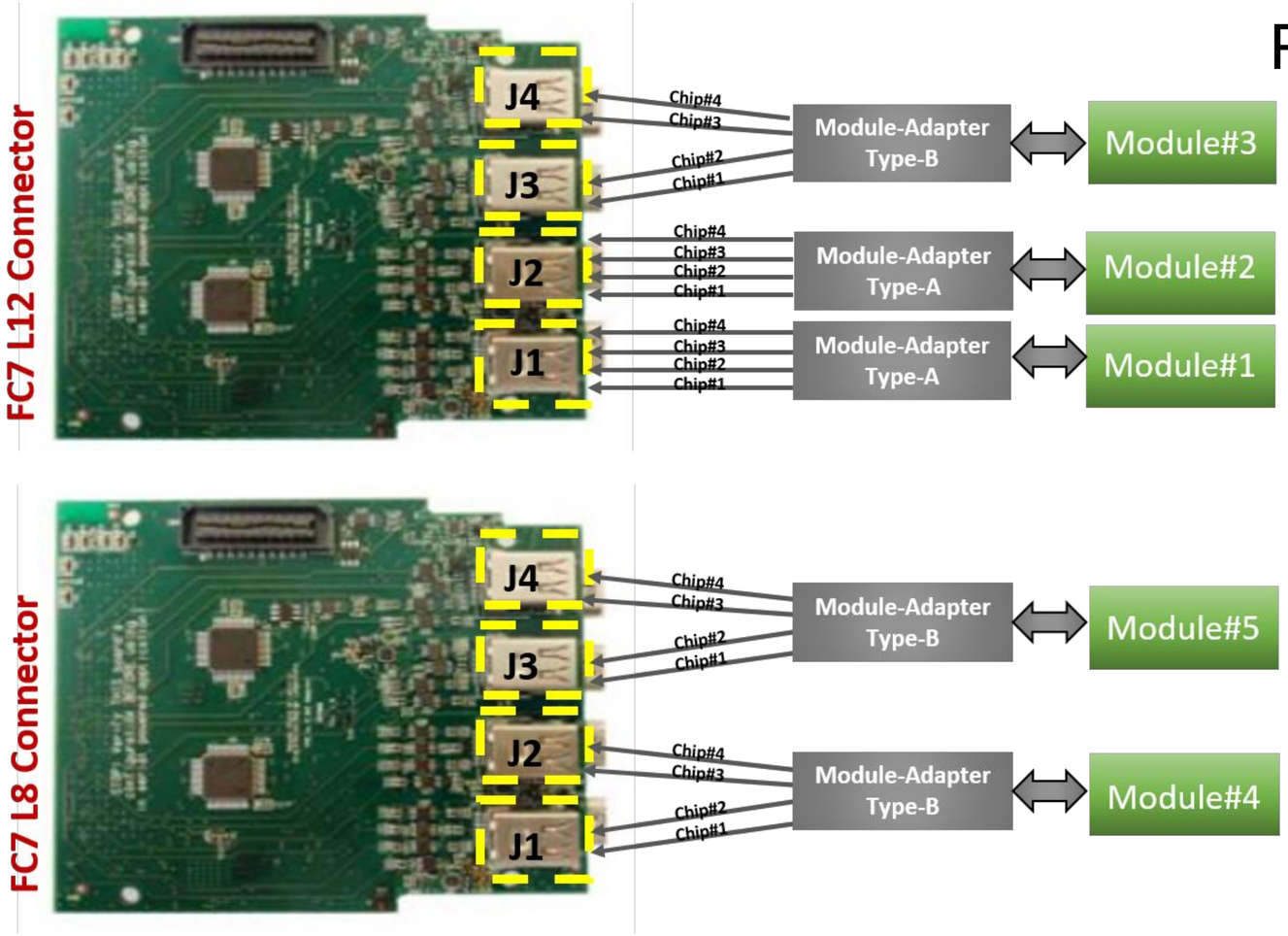
In xml configuration file:

```
<Hybrid Id="0" Status="1">
  <RD53_Files path="./" />
```

`Hybrid Id` goes from `0` to `7`, depending on where you plugged the Mini Display Port

For the CERN-FMC, since it has just one Display Port connector, you just need to use `0` as ***`Hybrid Id`***

Electrical readout: possible combinations



Possible connections to Quad Modules

In xml configuration file:

```
<Hybrid Id="0" Status="1">
  <RD53_Files path="./" />
```

`Hybrid Id` goes from 0 to 4, depending on where you plugged the Mini Display Port

Pixel modules TEPX

- chip ID 0 <-> lane 0
- chip ID 1 <-> lane 1
- chip ID 2 <-> lane 2
- chip ID 3 <-> lane 3

Pixel modules TBPX

- chip ID 4 <-> lane 0
- chip ID 5 <-> lane 1
- chip ID 6 <-> lane 2
- chip ID 7 <-> lane 3

Pixel modules TFPX

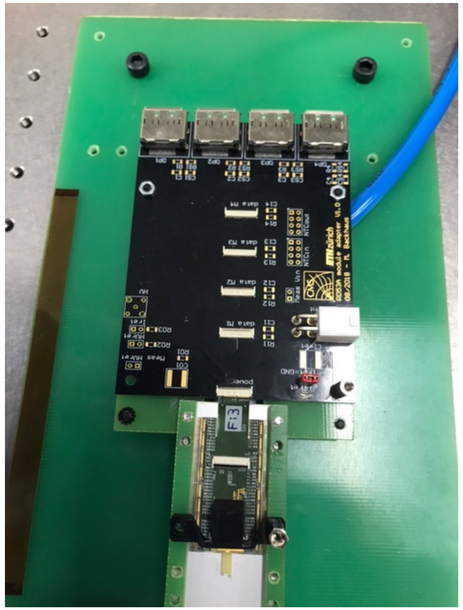
- chip ID 4 <-> lane 0
- chip ID 2 <-> lane 1
- chip ID 7 <-> lane 2
- chip ID 5 <-> lane 3

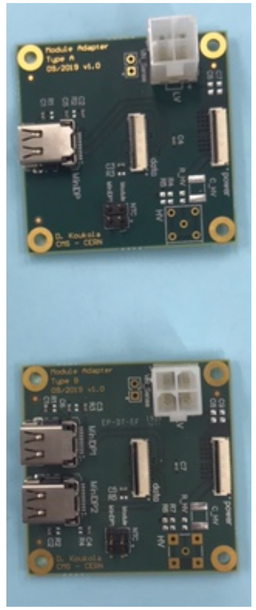
The **`RD53 Id`** and **`Lane`** need to be configured accordingly to these tables within a module

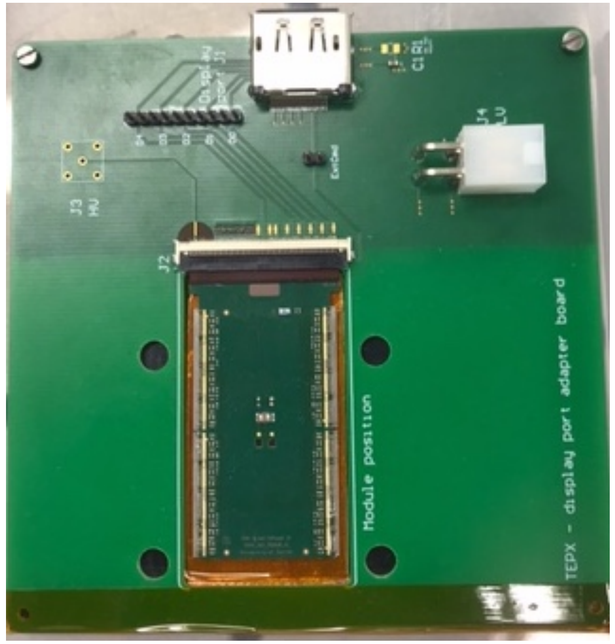
```
<RD53 Id="0" Lane="0" configfile="CMSIT_RD53.txt">
  <!-- Overwrite .txt configuration file settings -->
  <Settings
```

Electrical readout: possible combinations

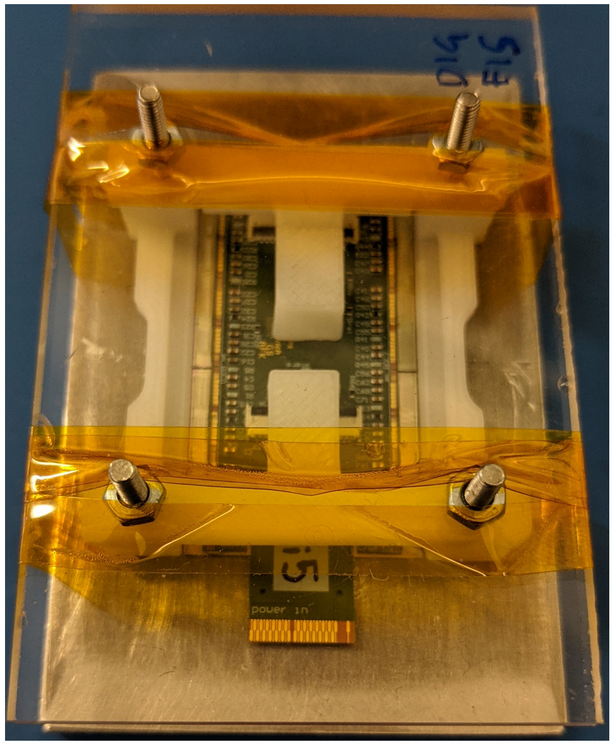
Module adapter types







TEPX Quad Module



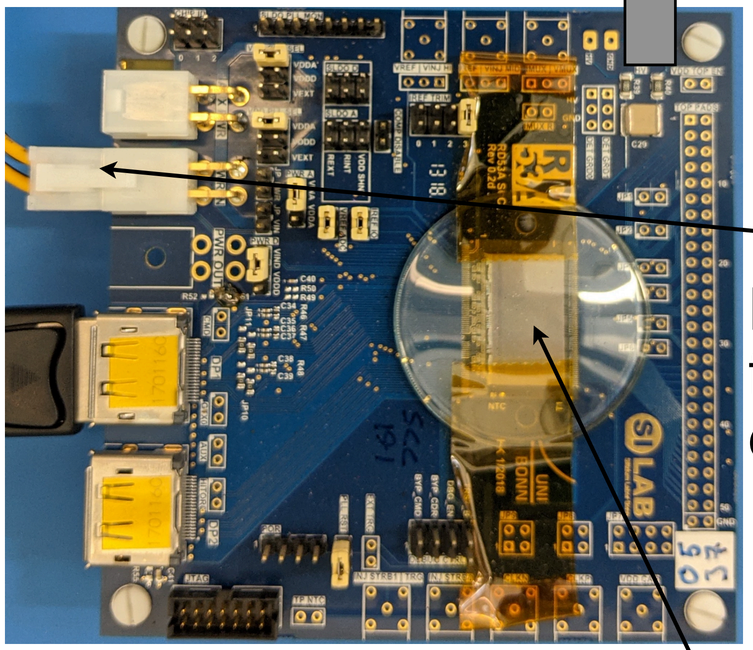
TBPX Quad Module

Power supply for modules: recommended a professional one that can provide ~8A, like `Keysight Technologies E3633A`

Single Chip Card comes in two flavours: “Bonn card” and “Rice card”

Bonn card

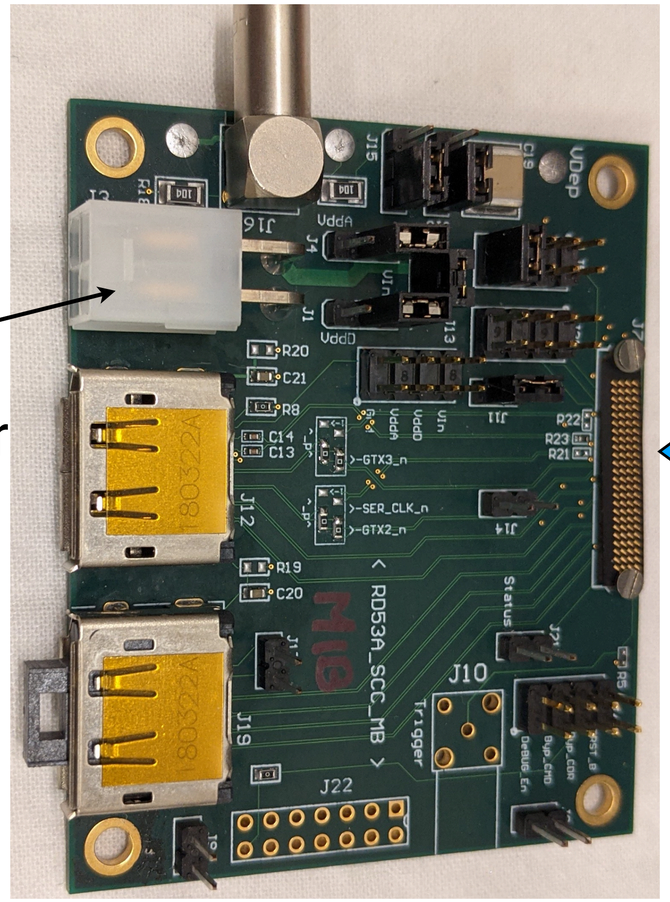
Lemo connector for High Voltage



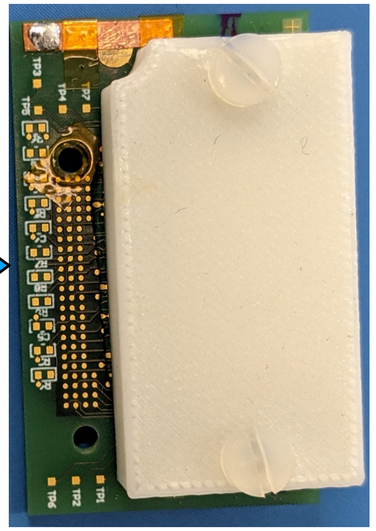
Molex connector for analog and digital voltages

RD53 chip

Lemo connector for High Voltage



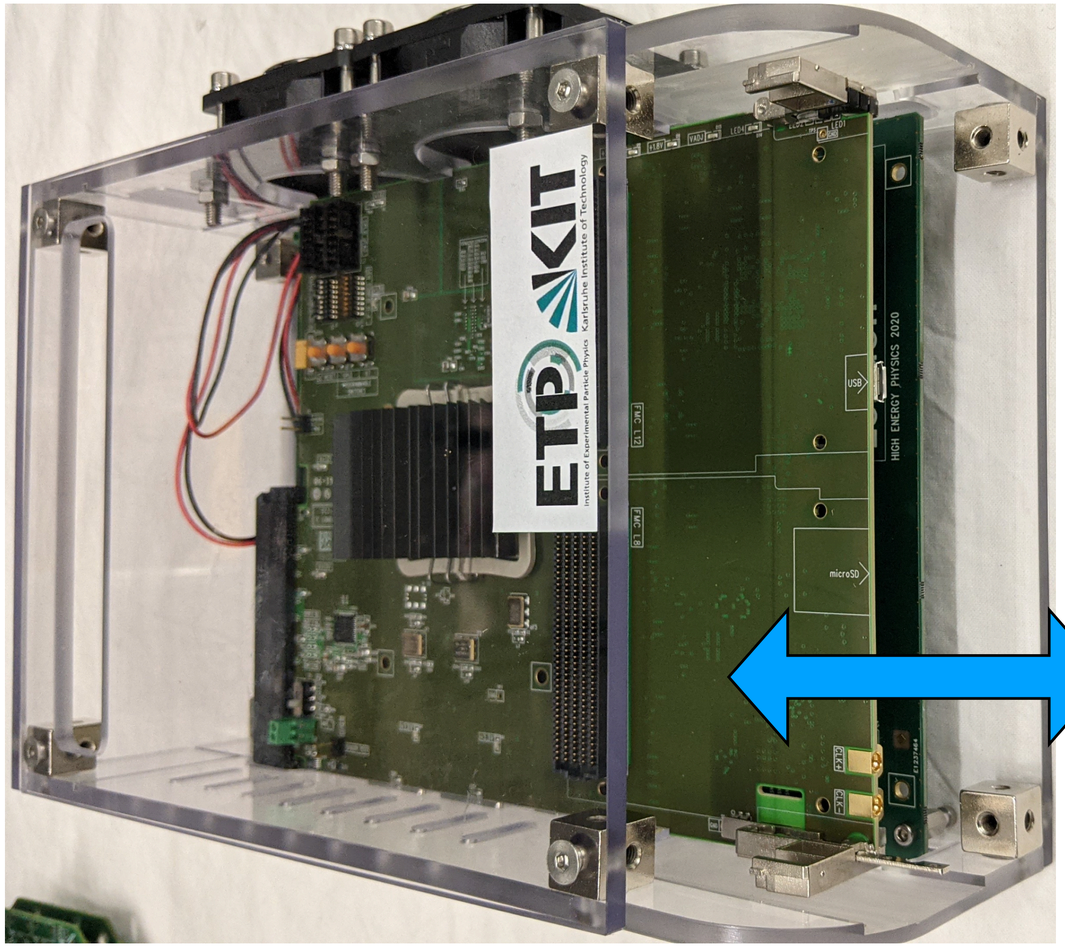
Rice card



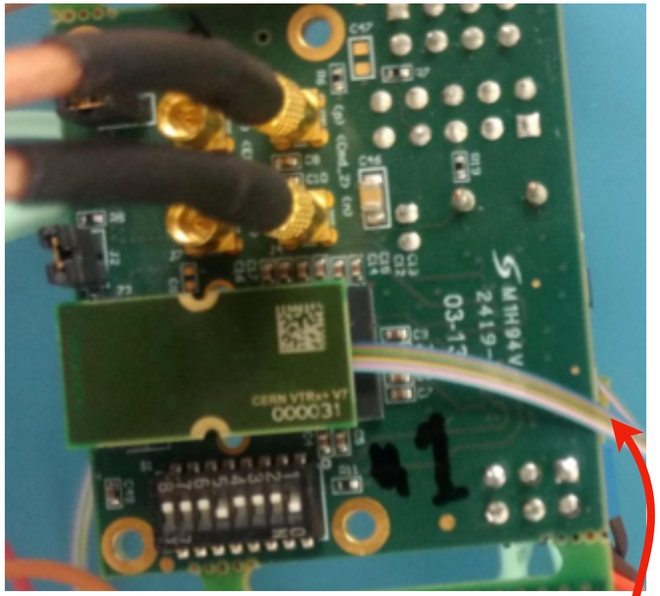
RD53 chip

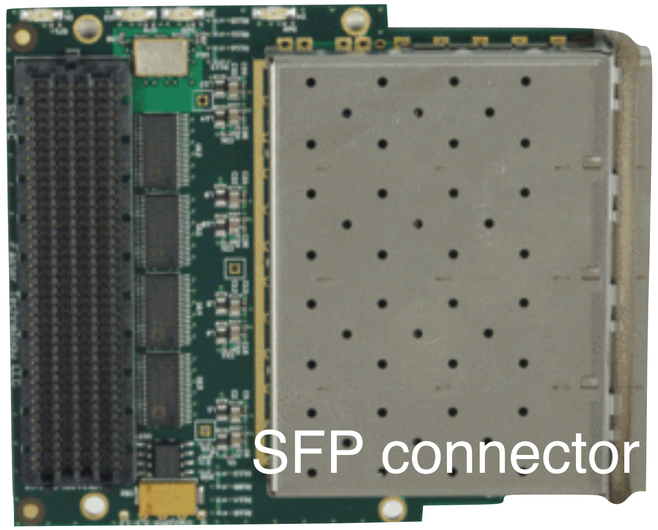
Optical readout

FC7 nano crate (with IC board that provides power)



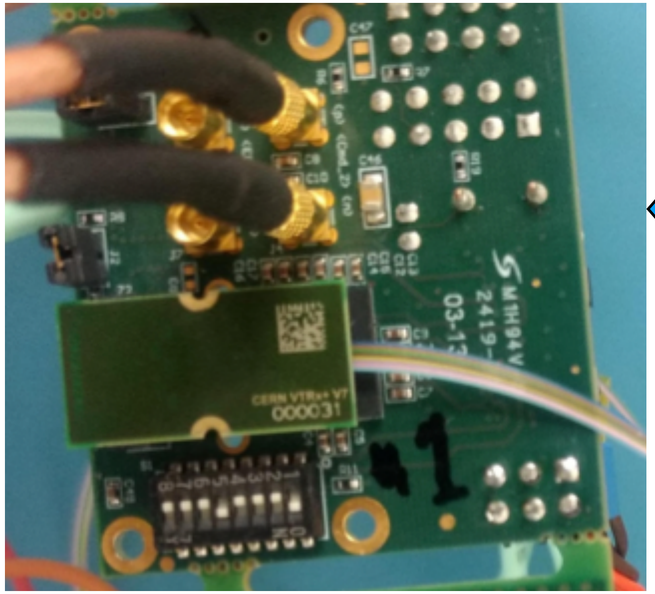
Portcard mounting LpGBT chip (Low power GigaBit Transceiver)





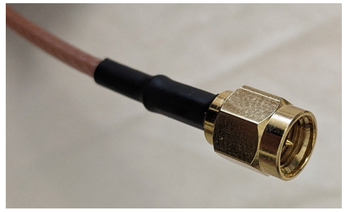
Optical fiber

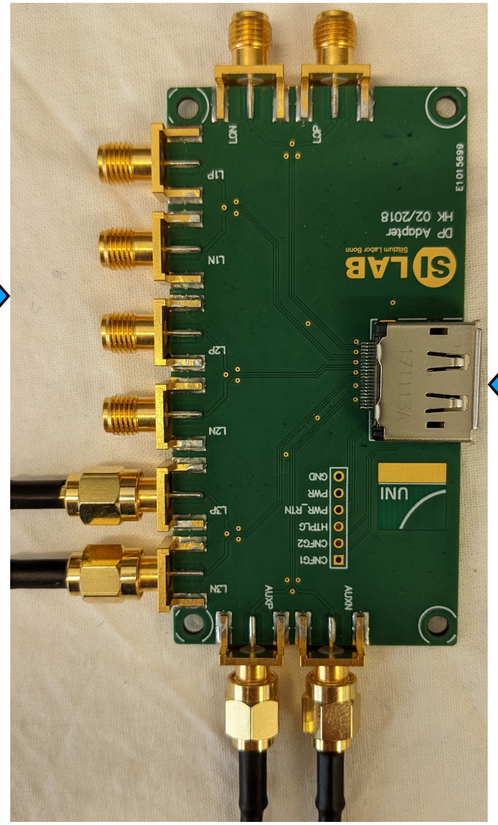
Optical readout



Portcard mounting LpGBT chip (Low power GigaBit Transceiver)

MMCX to SMA cable

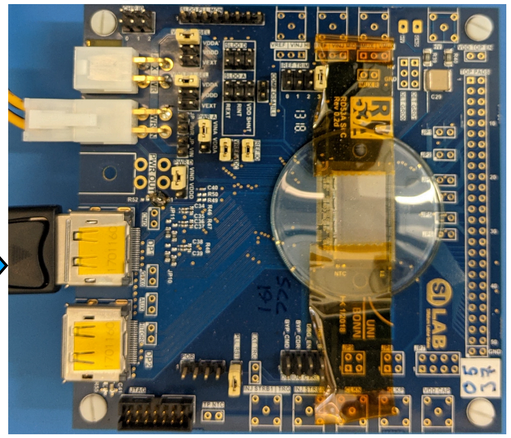




Adapter board

Display Port to Display Port cable

Single Chip Card



Commercial parts

- DIO5 FMC board (https://www.ohwr.org/project/fmc-dio-5chttla/wikis/home)
- Power supply for FC7 (12 V - 6 A)
- Electrical SFP connector (suggested: ABCU-5740ARZ)
- Optical SPF connector (suggested: FS-10GSR-85)