EMC Backward Endcap Status report
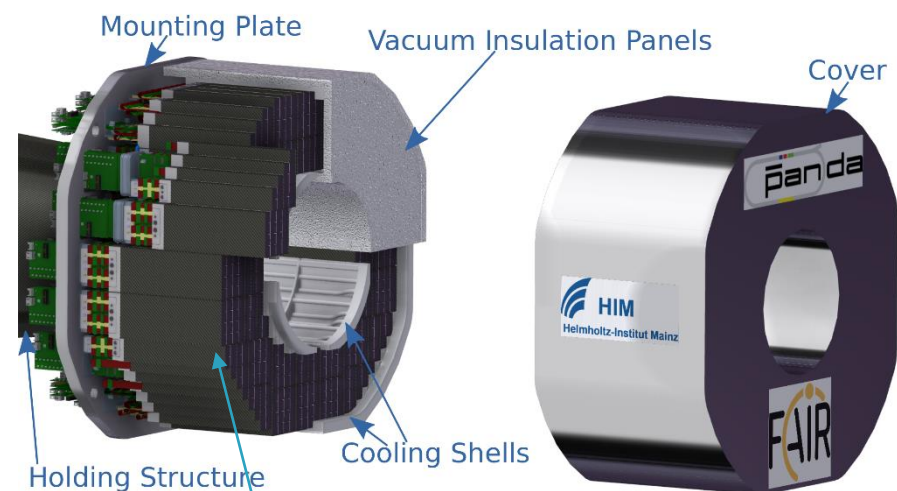
N. Baldicchi, L.Capozza , R. Gowdru , S. Katilmis , D. Liu, F. Maas,
J. Martínez, O. Noll , D. Rodríguez, C. Rosner, P. Schöner , S. Wolff

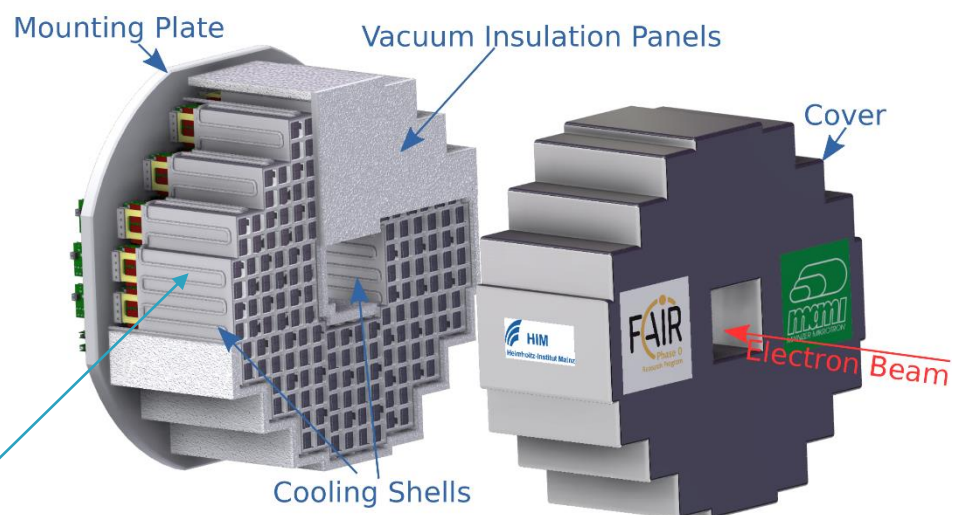Panda Collaboration Meeting, EMC session
14. 6. 2023

Outline

- Submodule Production
- Submodule calibration status
- Status of electronics
- Update on DCS and SADC firmware status
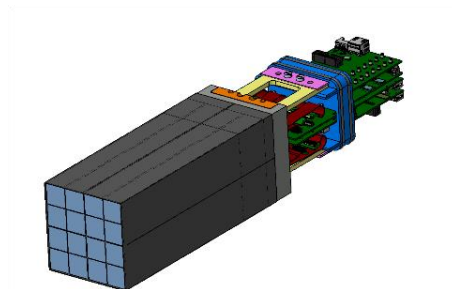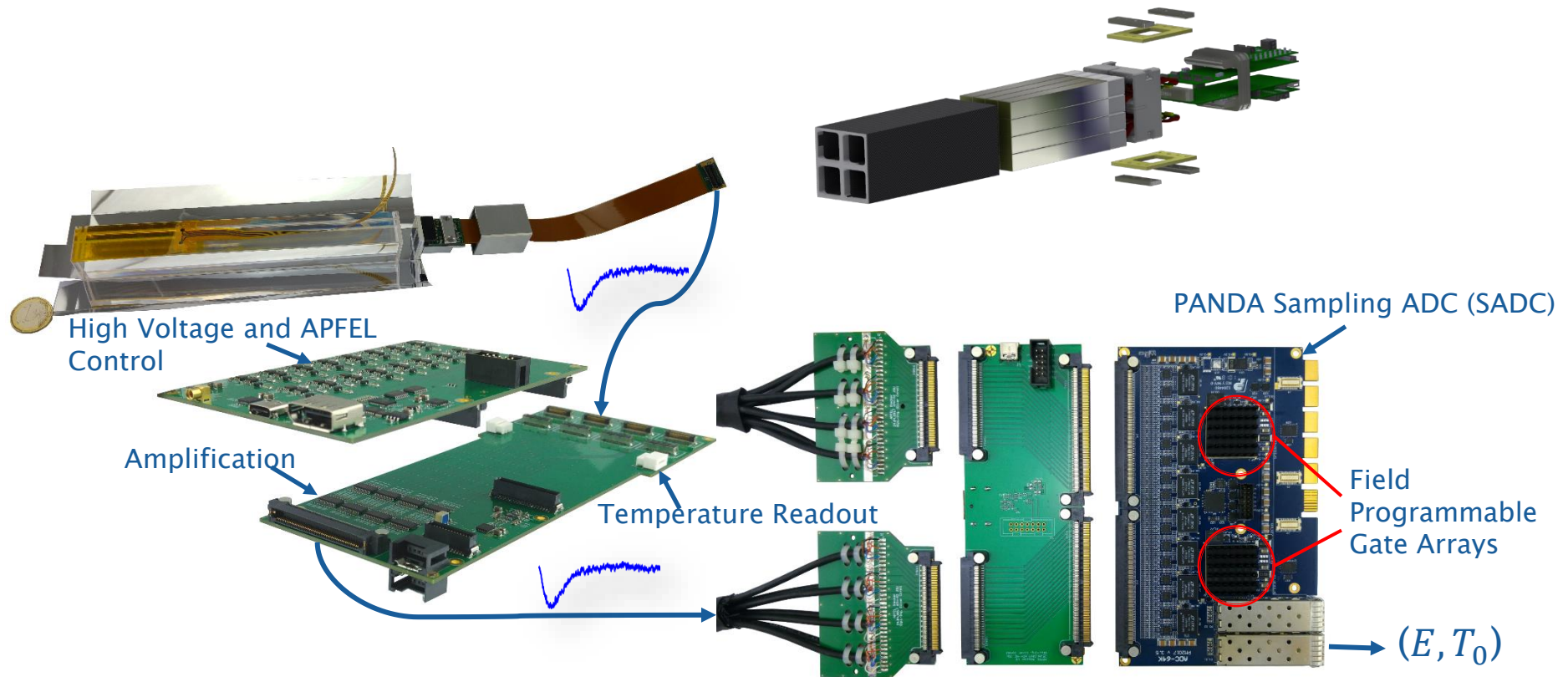- π^0 reconstruction from beamtime data
- Summary

PANDA Backward Endcap

Panda Version

Phase-0 Version

Mounting Plate

Vacuum Insulation Panels

Cover

Holding Structure

Cooling Shells

Electron Beam

PANDA Backward Endcap

High Voltage and APFEL Control

Amplification

Temperature Readout

PANDA Sampling ADC (SADC)

Field Programmable Gate Arrays
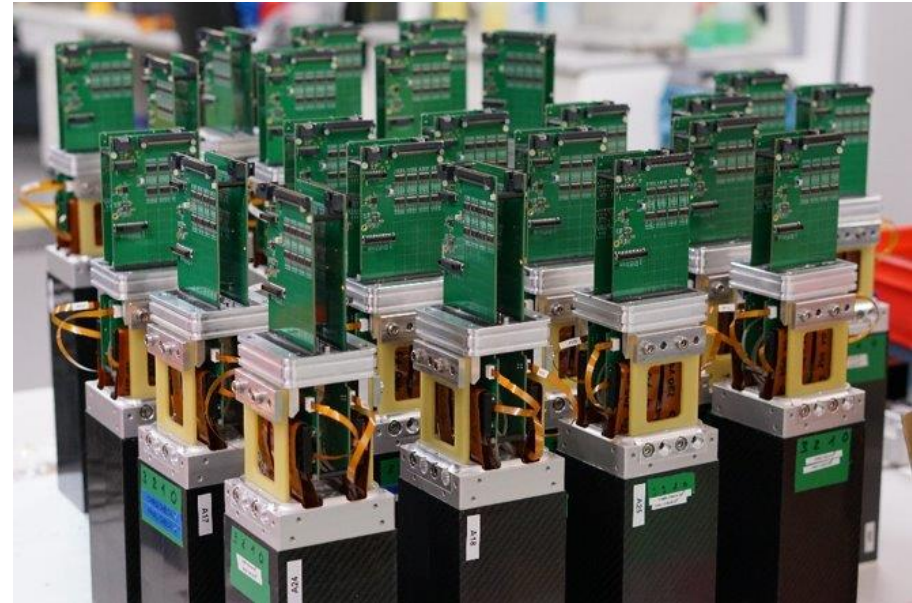
(E, T_0)

Submodule Production

- **640/640 crystals glued** ✓
- 578/640 crystals wraped

Submodule Production

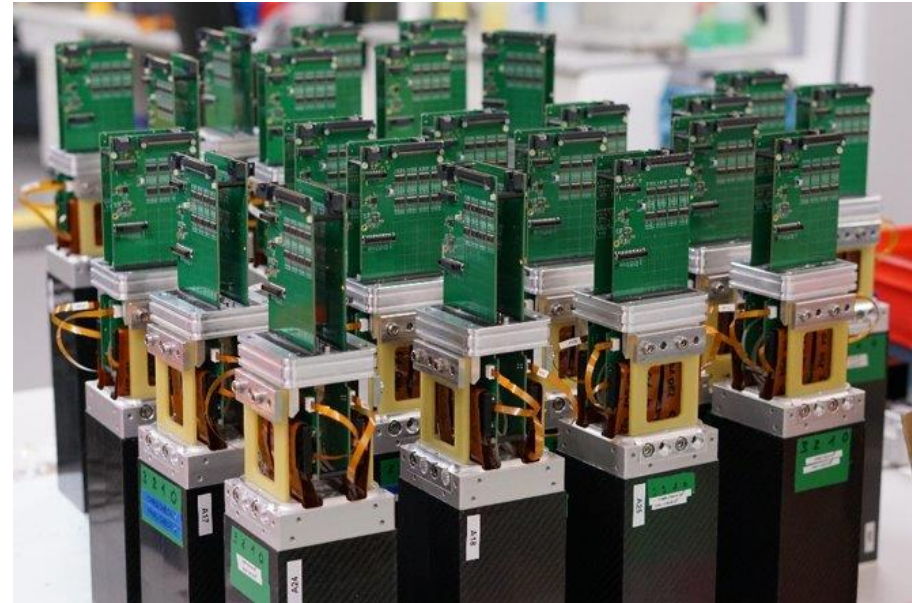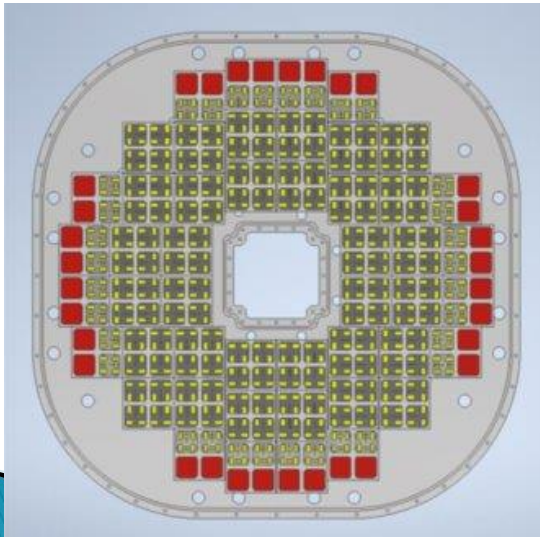- 640/640 crystals glued ✓
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Submodule Production

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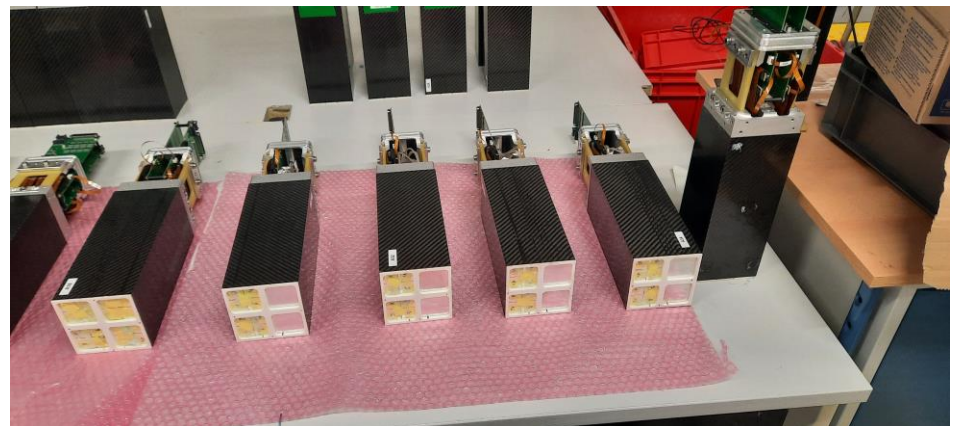- 32/32 Full subunits built and pretested ✓

Submodule Production

- 640/640 crystals glued ✓
- 640/640 crystals wraped ✓
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  and pretested ✓
- 1/16 Half subunits built

Submodule Production

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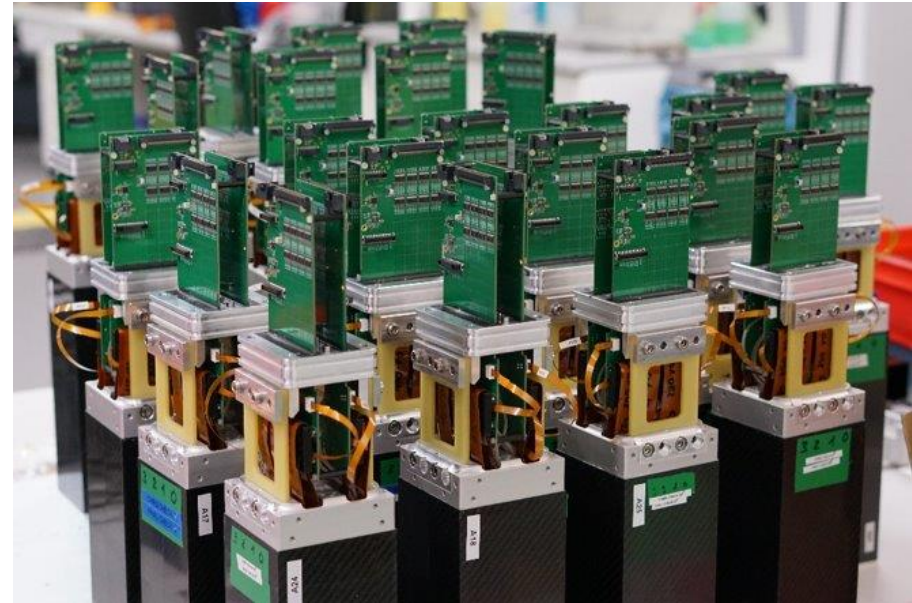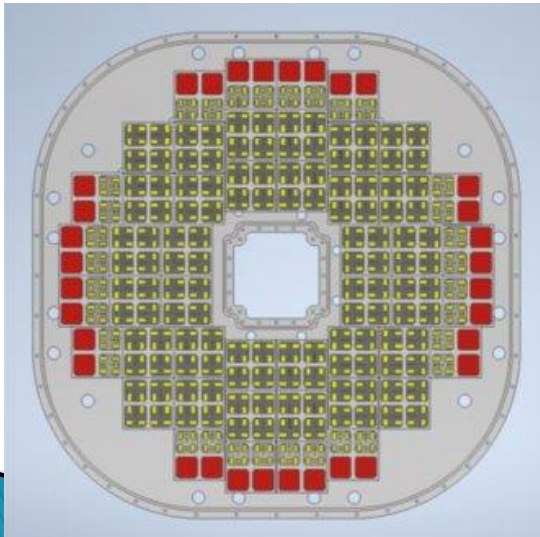- 14/16 half subunits built, pretests ongoing

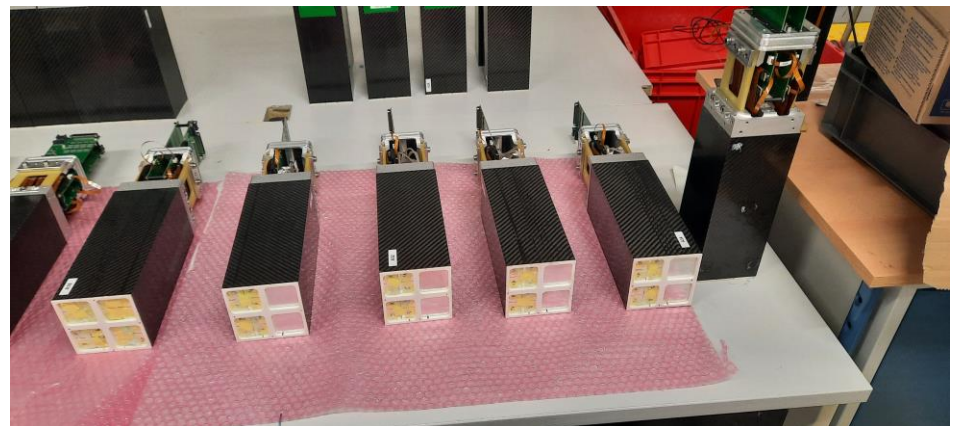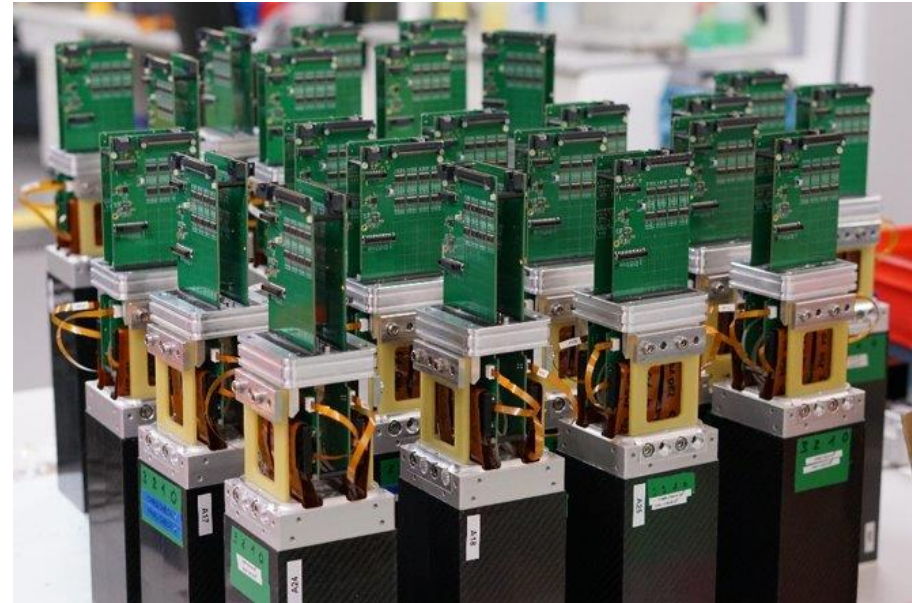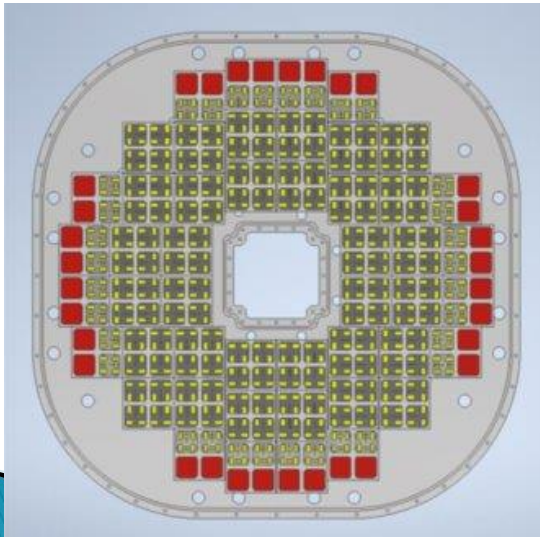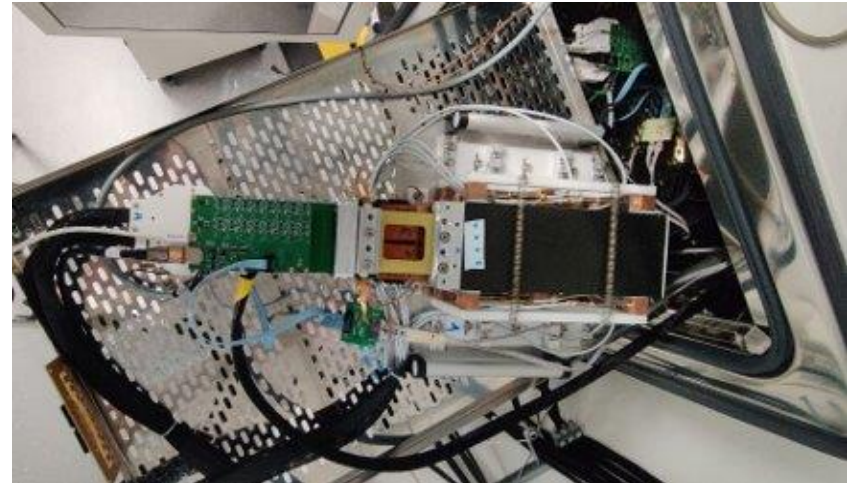# Submodule Production

- 640/640 crystals glued ✓
- 640/640 crystals wraped ✓
- 32/32 Full subunits built and pretested ✓
- 14/16 half subunits built, pretests ongoing
- Remaining 2 half subunits from prototype number 2

Submodule Calibration

- Fully automated calibration in climate chamber of:
    - Temperature sensors
    - Apd gain curve
    - Energy calibration with cosmics
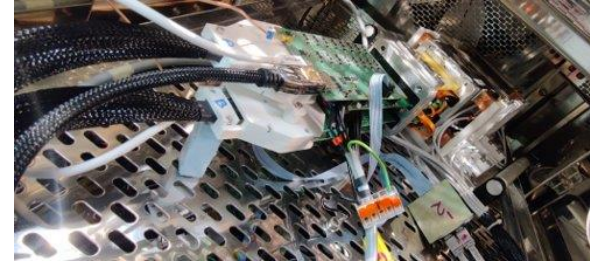
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- Last meeting estimate:
  72 hours for 3 submodules ⟹ ~2 month for 48 submodules

Submodule Calibration

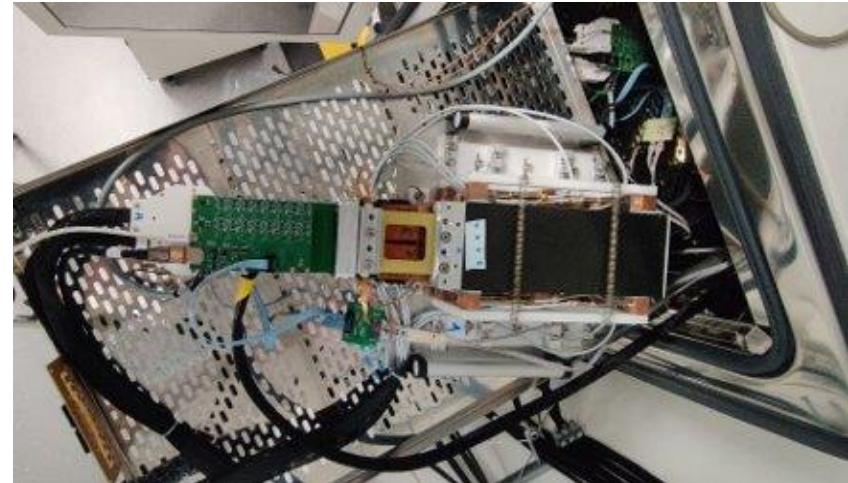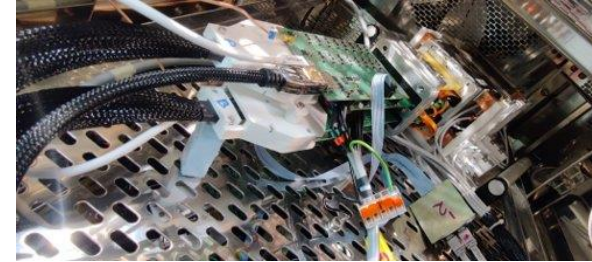- Fully automated calibration in climate chamber of:
  - Temperature sensors
  - APD gain curve
  - Energy calibration with cosmics

- Last meeting estimate:
  72 hours for 3 submodules ➡ ~2 month for 48 submodules

- Delay due to:
  - Noisy signals in climate chamber,
    Preventing energy calibration
    (solved)
  - SADCs were needed to develop
    Apfel and HV control with arduino
    (more later)
  - More details later by Samet
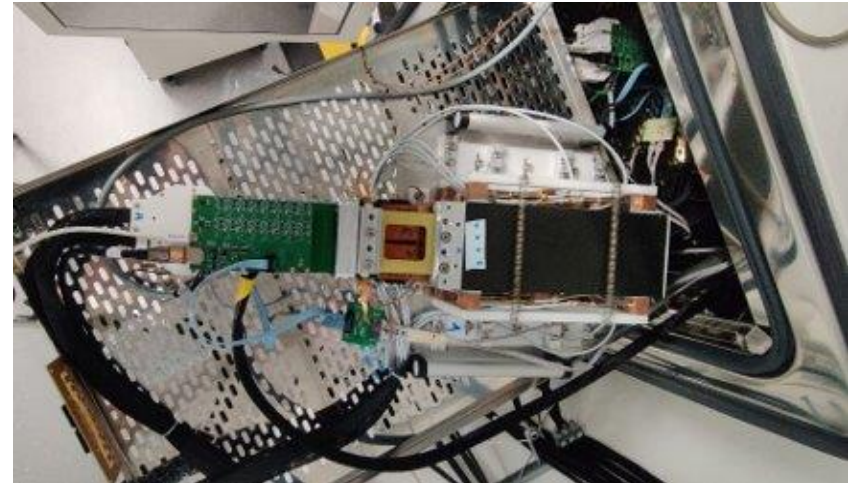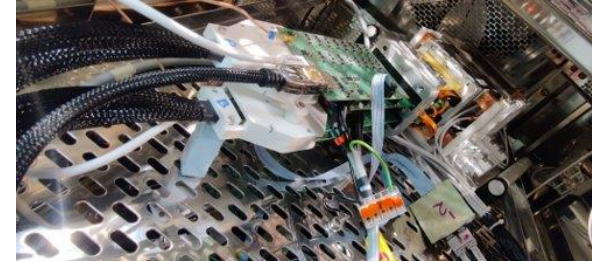
Lightpulser system

- Lightpulser system: individually adjustable lightpulser for each crystal

- Design: one master PCB, 5 slave PCBS, 720 channels

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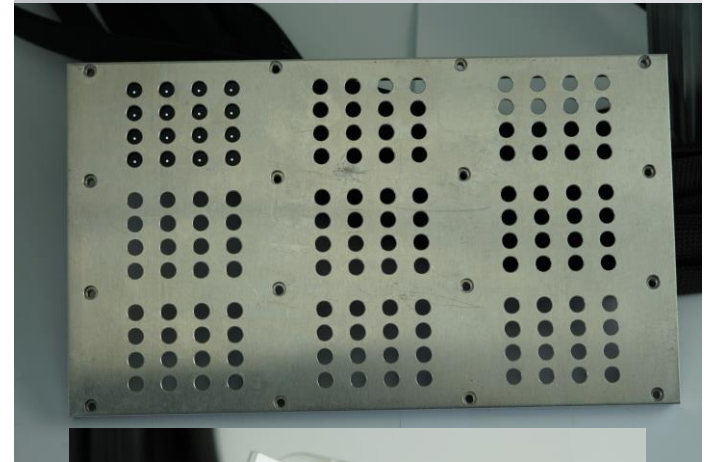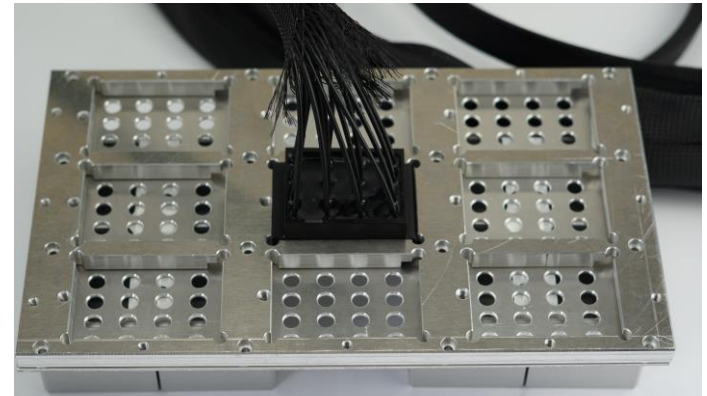   - 55/55 light fiber bundles are assembled and polished ✓

Lightpulser system

- Lightpulser system: individually adjustable lightpulser for each crystal

- Design: one master PCB, 5 slave PCBS, 720 channels

- Current status:
  - Mechanical parts all produced ✓
  - 55/55 light fiber bundles are assembled and polished ✓
  - Electronic components are there, PCBs ordered
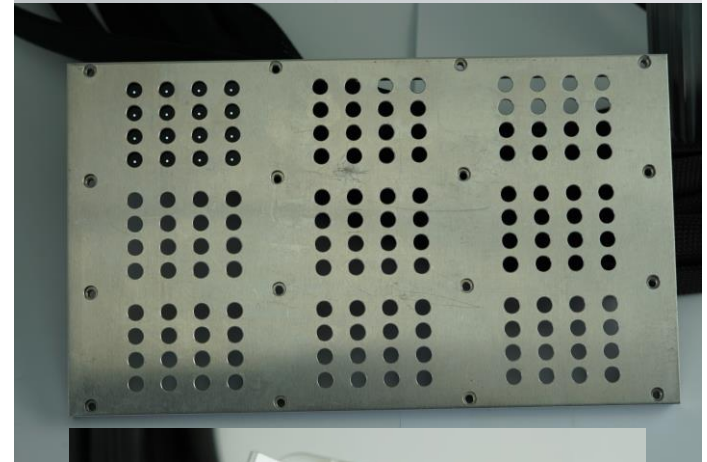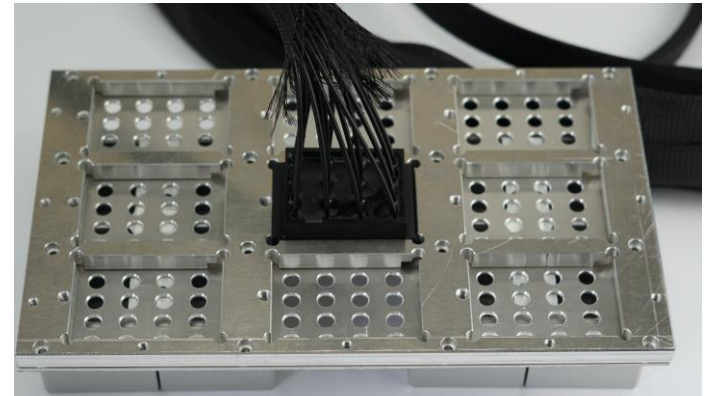
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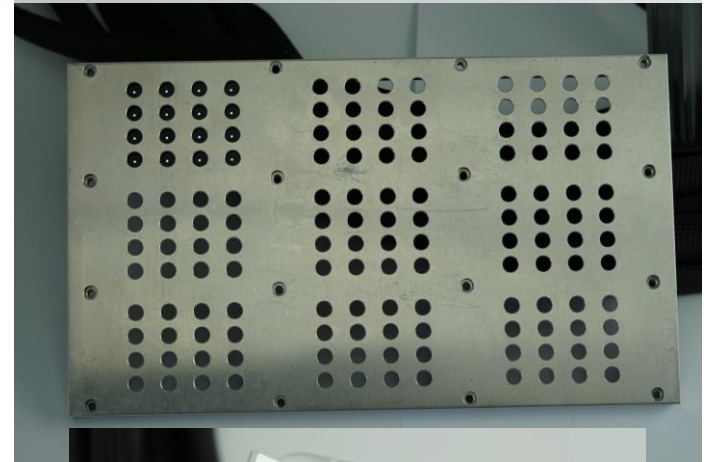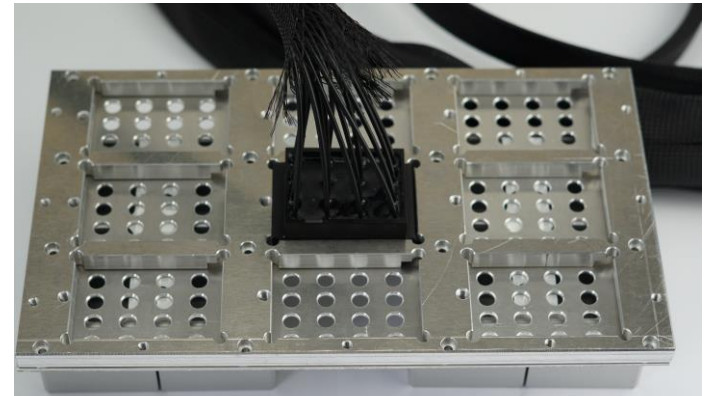 - Mechanical parts all produced ✓
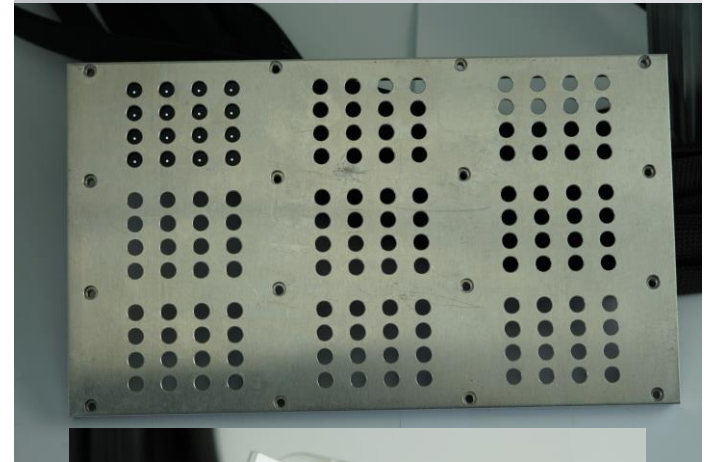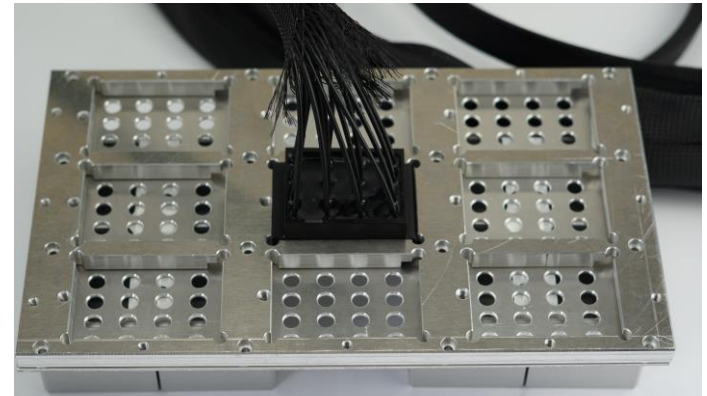 - 55/55 light fiber bundles are assembled and polished ✓
  - PCBs are beeing assembled in house

HV distribution boards

- HV distribution boards:
  - Serial production of boards going on
  - 50 boards produced, 50 more to go

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  - Calibration of HV ADC values

High Voltage Board Calibration of Channel 15 at +20 °C and -25 °C

HV distribution boards correction

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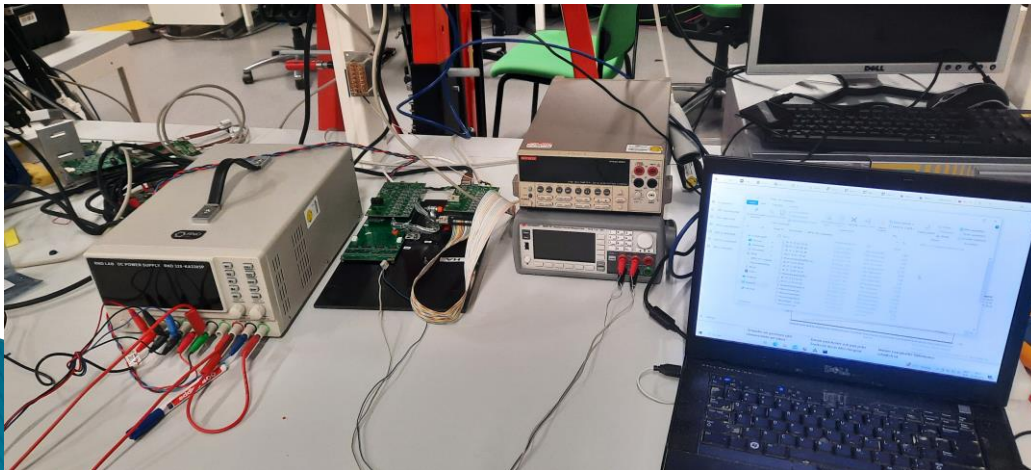

HV distribution boards correction
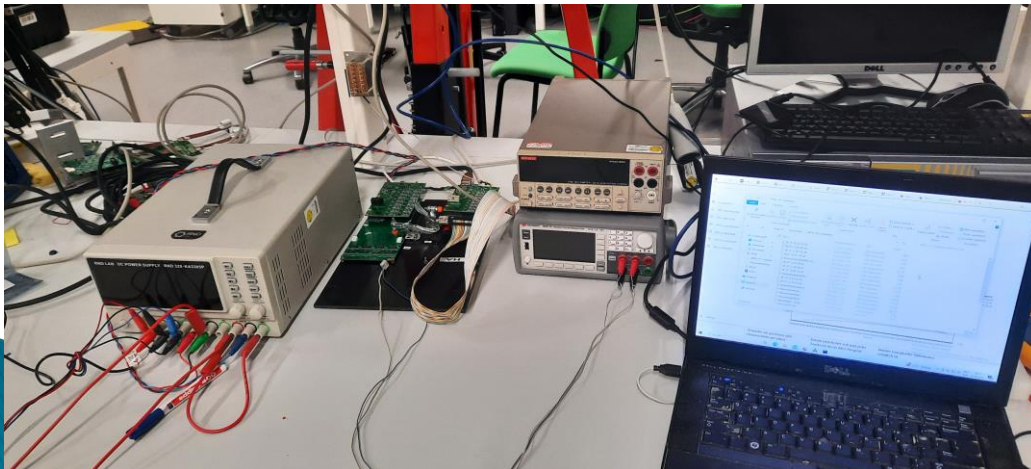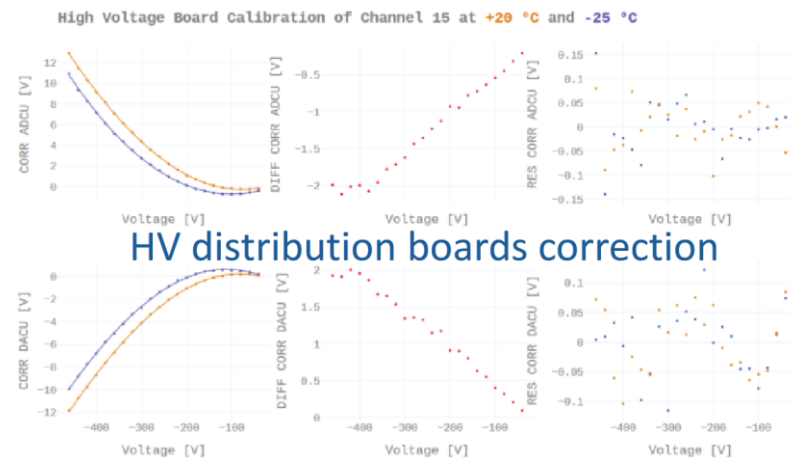
HV distribution boards
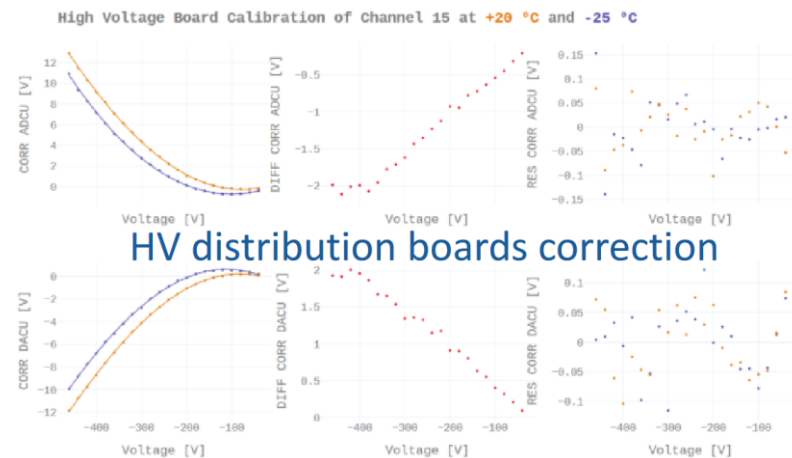
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- Calibration setup:
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  - Calibration of current ADC values
  - Mass calibration has started at room temperature
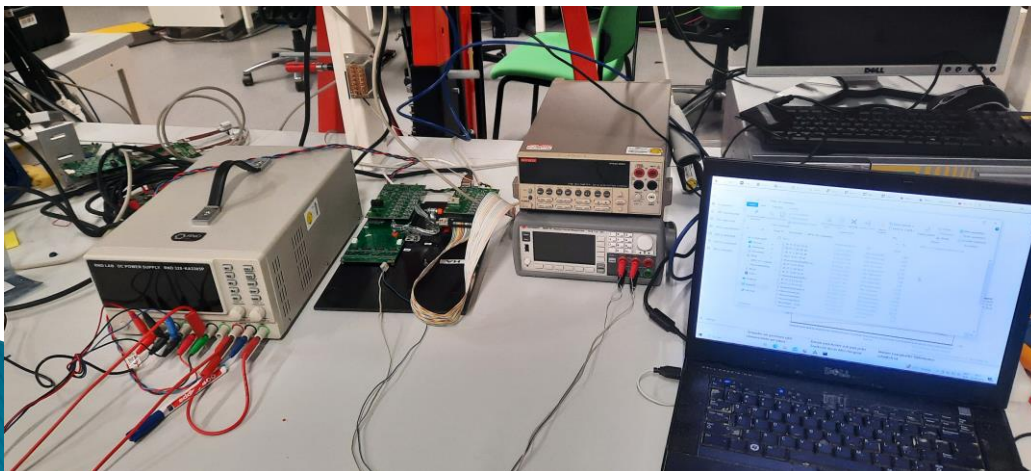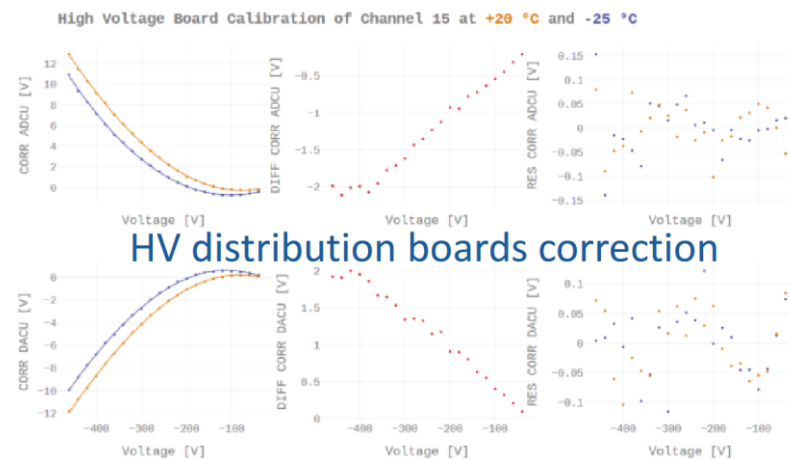
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HV distribution boards correction

Apfel & HV control with Arduino

- Control of HV distribution boards and Apfel ASICs with arduino microcontroler instead of raspberry Pi
- Better scalability compared to Pi configuration

Apfel & HV control with Arduino

- Control of HV distribution boards and Apfel ASICs with arduino microcontroler instead of raspberry Pi
- Better scalability compared to Pi configuration
- Test setup established in laboratory, tests performed with submodule array in climate chamber
- System is running without major problems, should be ready to be deployed for the full detector

Epics integration

- Goal: Full integration of DCS into epics containers
- Status:
  - ➢ Fully integrated:
    - Control of high voltage crate
    - Control of low voltage crate
    - Light pulser

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  - To be integrated:
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    - Cooling with chiller

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  - ➢ To be integrated:
    - Temperature sensors
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- Additional DCS projects:
  - Temperature readout: app to show temperature gradient in submodules
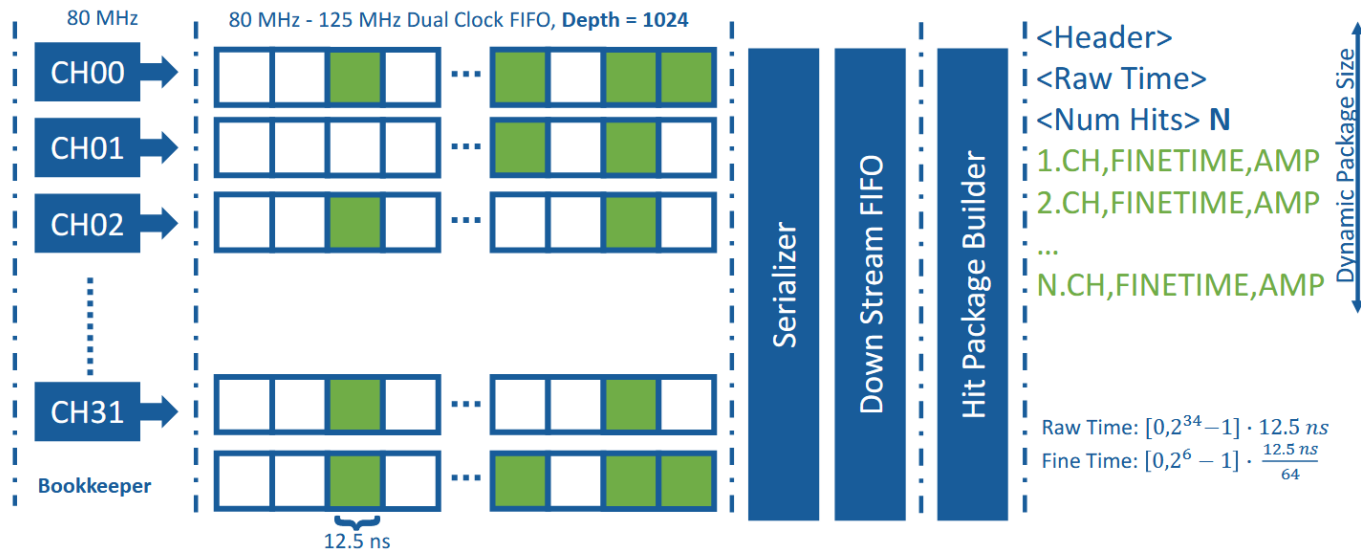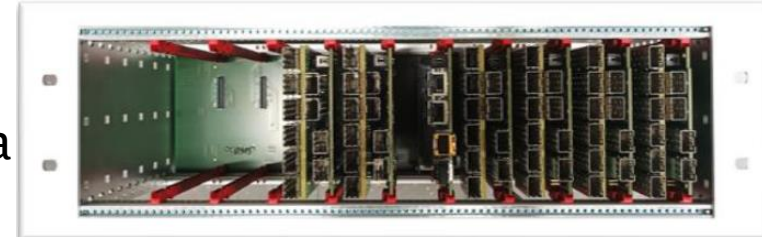 - Alert system for full detector

SADC firmware status
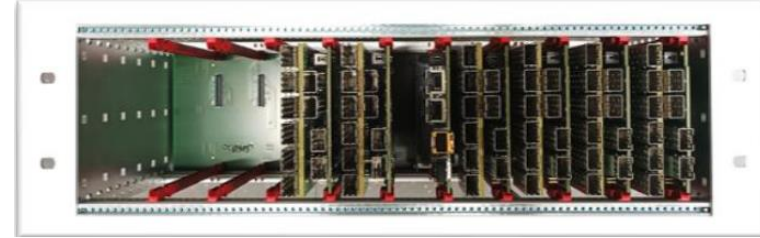
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SADC firmware status

- Clock distribution via TRB3 SC is working
- Time Sorted Hit Packaging (Hits with the same raw time are collected in one package)
- Implementation on FPGA is done
- Receiver software is updated for the new data frame
- The first test with the prototype was successful

80 MHz

80 MHz - 125 MHz Dual Clock FIFO, **Depth = 1024**

CH00
CH01
CH02
⋮
CH31

Bookkeeper

12.5 ns

Serializer

Down Stream FIFO

Hit Package Builder

<Header>
<Raw Time>
<Num Hits> **N**
1.CH,FINETIME,AMP
2.CH,FINETIME,AMP
...
N.CH,FINETIME,AMP

Dynamic Package Size

Raw Time: $[0,2^{34}-1] \cdot 12.5\ ns$
Fine Time: $[0,2^{6}-1] \cdot \frac{12.5\ ns}{64}$

SADC firmware status

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- First preparations for the chip2chip-bridge (Aurora) were done (aim: stream data from one FPGA to the other and use only one SFP to transfer data to the concentrator)
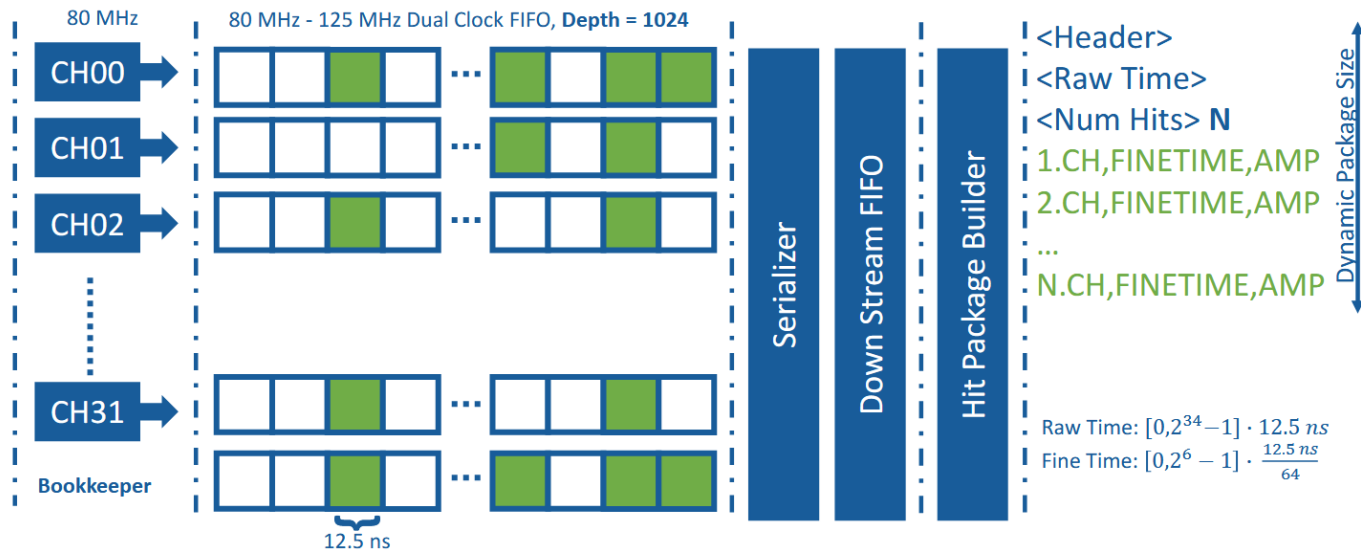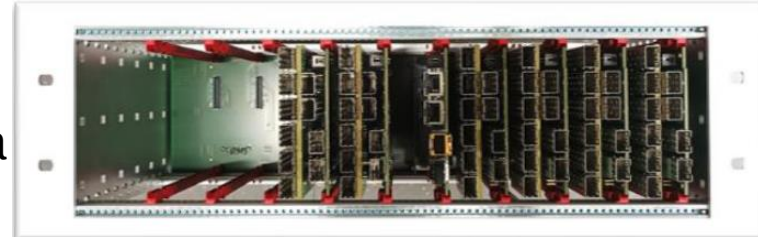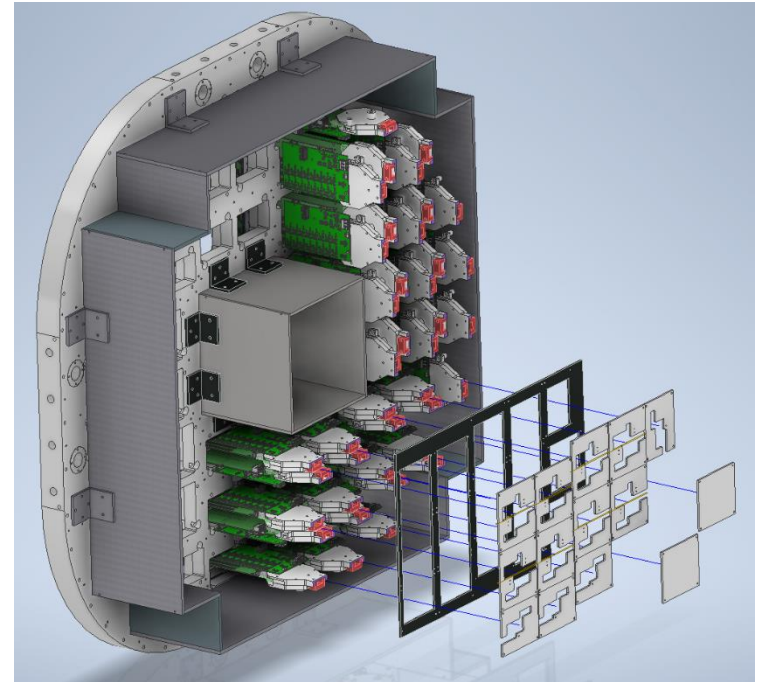
Electromagnetic shielding for FEE

- Design for electromagnetic shielding of frontend boards ongoing
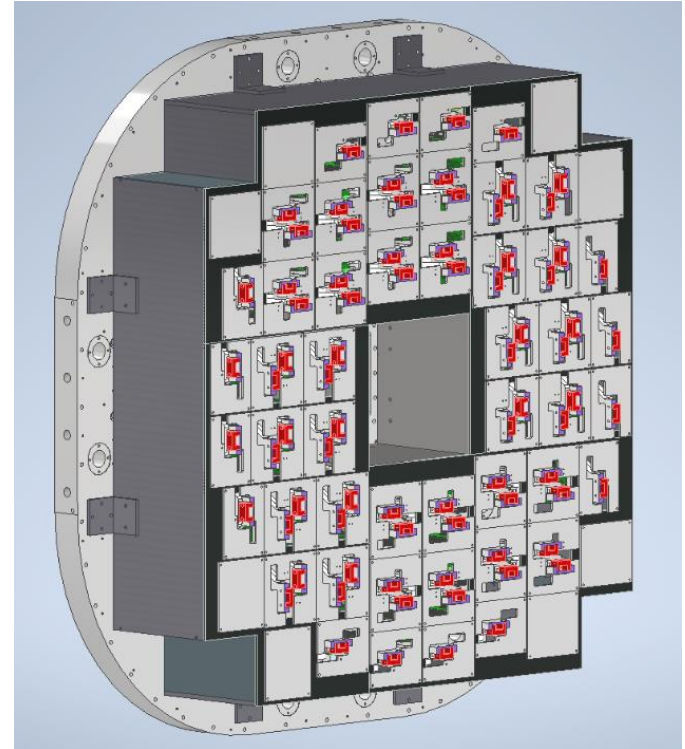
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- Every modules need feedthroughs for:
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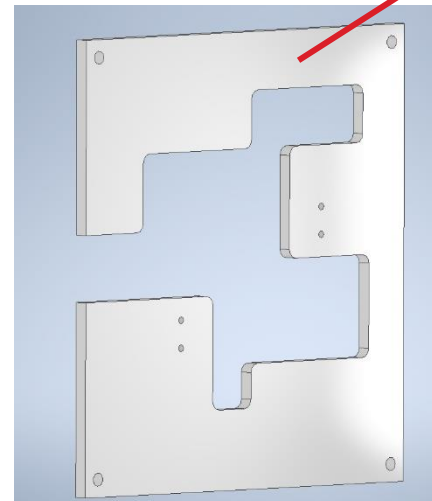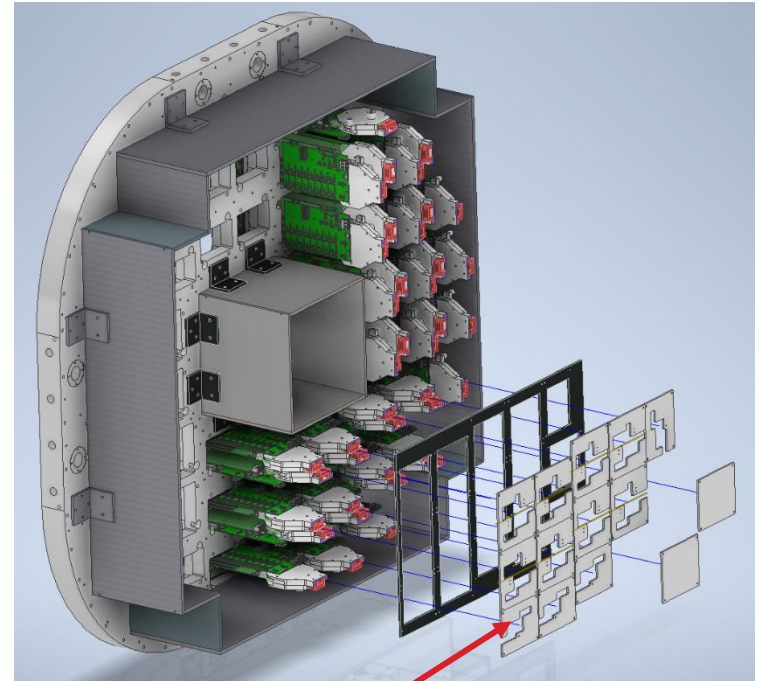
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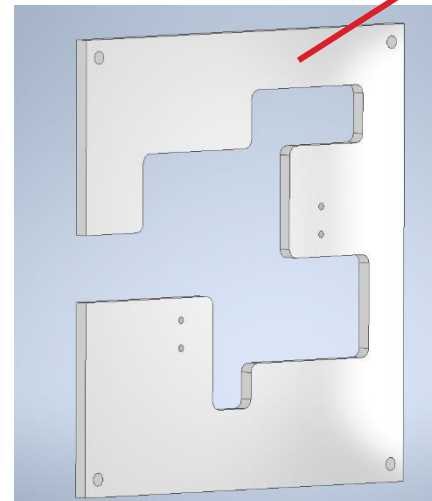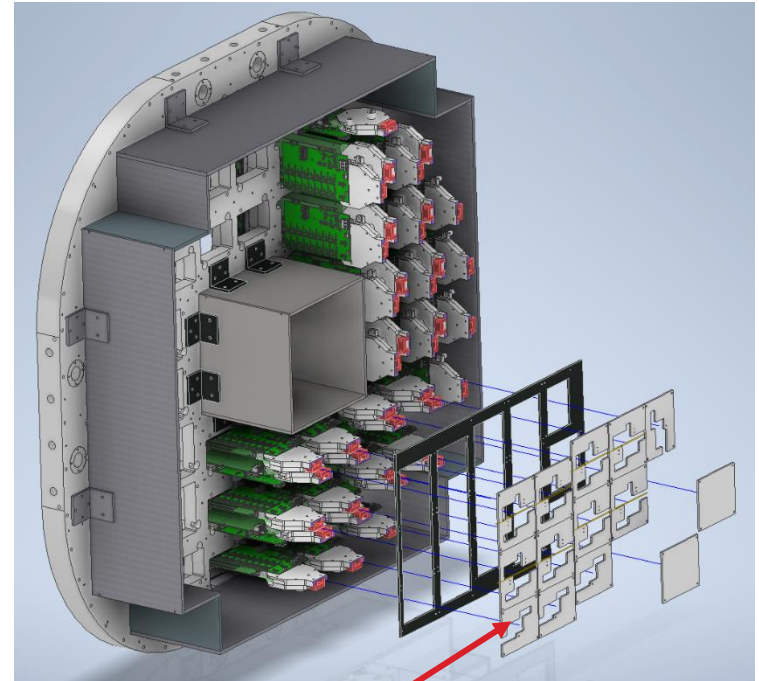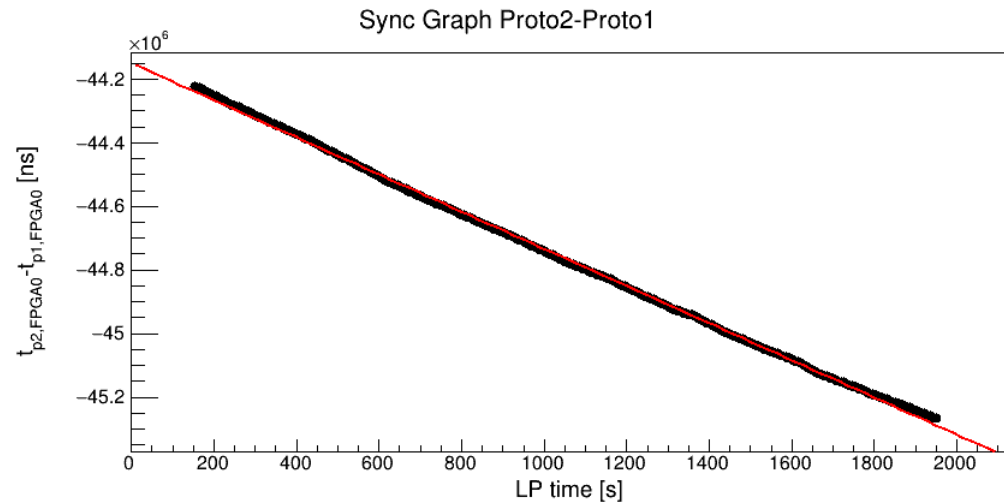 - Displayport cable (apfel&hv board control)
    ⟹ modular design to have each submodules boards accessible

- Additional feedthroughs which serve multiple subunits:
  - Hv supply cables
  - Lv supply cables
  - Temperature sensors
  - Humidity sensors
  - Cooling pipes

Reconstruction of π^0

- Data from beamtime 2022
- Looking for coincident signal in both prototypes
- 2 SADC boards, different clocks
  ⇒ timestamps drift apart, synchronisation needed
- Lightpulser events (every 5 sec.) for synchronisation
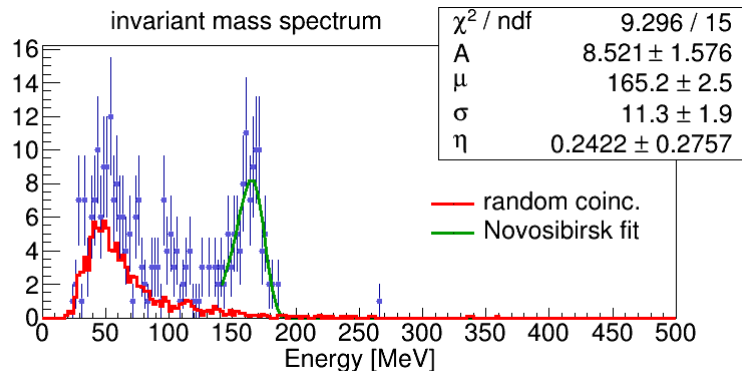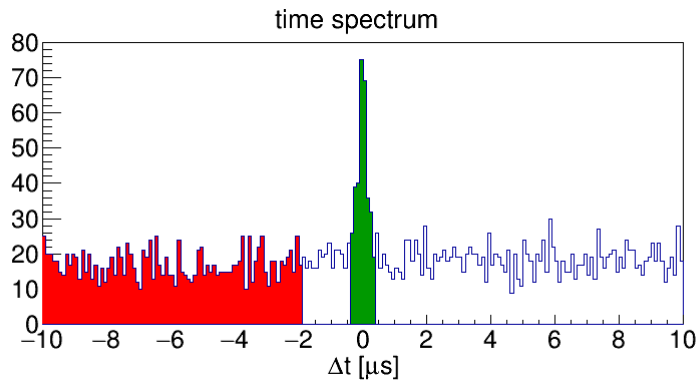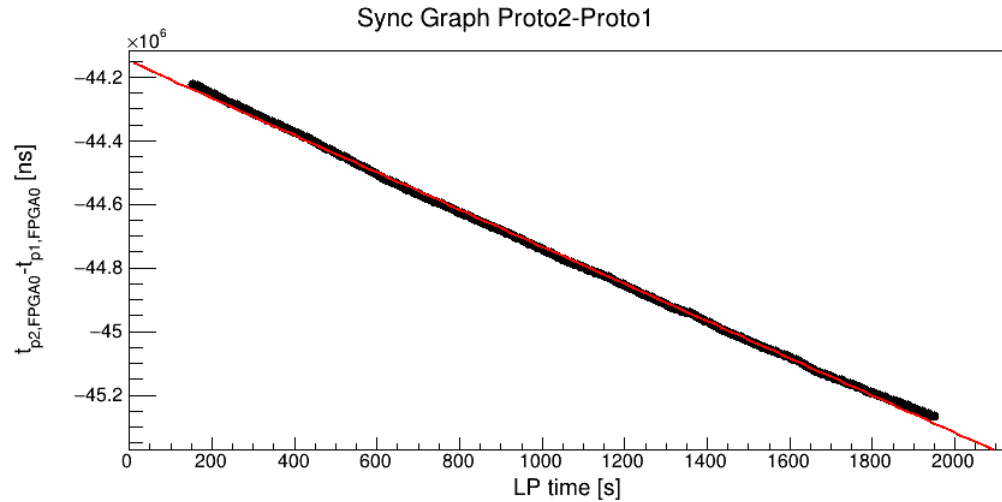

Sync Graph Proto2-Proto1
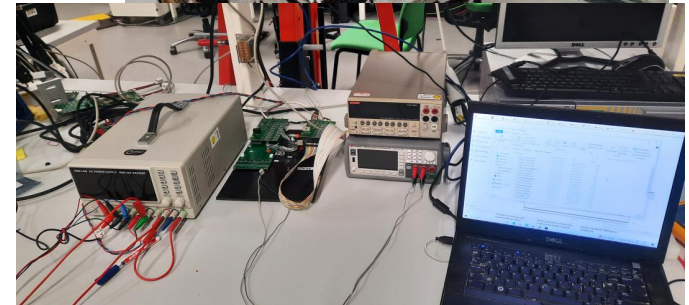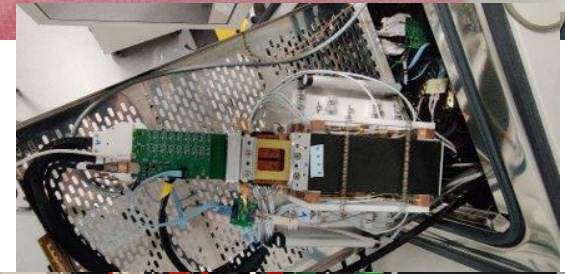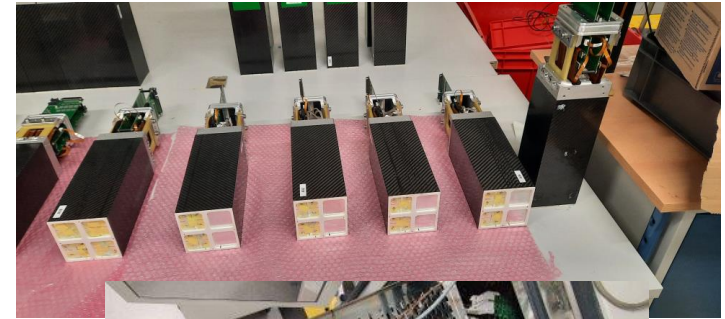
37

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Sync Graph Proto2-Proto1

time spectrum

invariant mass spectrum

χ^2 / ndf	9.296 / 15
A	8.521 ± 1.576
μ	165.2 ± 2.5
σ	11.3 ± 1.9
η	0.2422 ± 0.2757

— random coinc.
— Novosibirsk fit

- ~1h of data with Ta target
- Angles of prototypes: 14° and 18°, merged
- Coincidence time window: ± 300 ns, sideband region
- ~100 π^0 events with $\mu = 165.2 \pm 2.5$ MeV
  ⇒ energy calibration needs to be improved
- Good energy resolution

Summary

- **Submodule production:**
  - Almost all submodules (full and half) are built and tested
  - Remaining 2 require disassembly of prototype
- **Calibration of submodules:**
  - Delay due to infrastructure needed for other projects
  - Projects finished -> calibration can start
- **Electronics:**
  - HV boards: about half of series boards produced, calibration in progress
  - Lightpulser system: fibrebundles all produced, PCB boards in production
  - Arduino Apfel&HV control: tested and working with climate chamber setup
- **DCS:**
  - Epics integration of Apfel-Asic control and HV board control finished
  - ◦

Thank You!