Development of a full-scale readout for the active scintillator layers of the HGND detector at the BM@N experiment

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EoS and neutron flows measurements at the BM@N

- EoS describes the relation between density, pressure, energy, temperature and the **isospin asymmetry**
- The study of E_{sym} density dependence is very important for the understanding of astrophysical phenomena like supernovae and neutron stars.
- The radius of a neutron star depends on the symmetry energy behaviour at high nuclear matter density.

$$E_A(\rho,\delta) = E_A(\rho,0) + E_{sym}(\rho)\delta^2 + O(\delta^4)$$

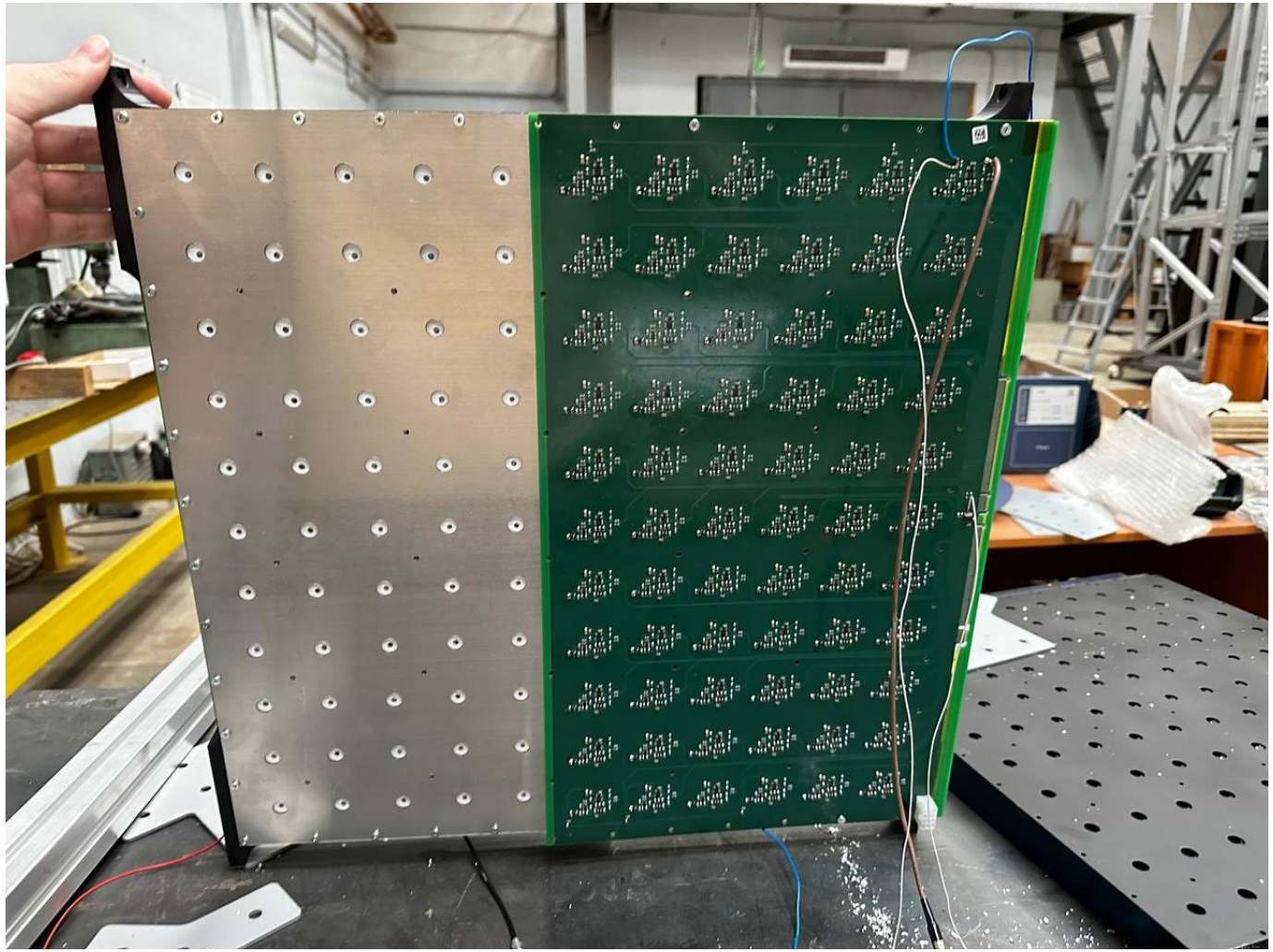
Symmetric matter — Symmetry Energy

$\delta = (\rho_n - \rho_p)/\rho$ = (N-Z)/A

- Collective flows of charged particles are **a sensitive probe** of E_{sym} at high densities at intermediate energies where reaction dynamics is largely determined by the nuclear mean field.
- Measurements of ratio of neutrons/protons flows at nuclear matter density range (2-4)ρ0 can be performed at nearest perspectives only at the BM@N.
- **Neutron detector to measure neutrons flows is needed**.

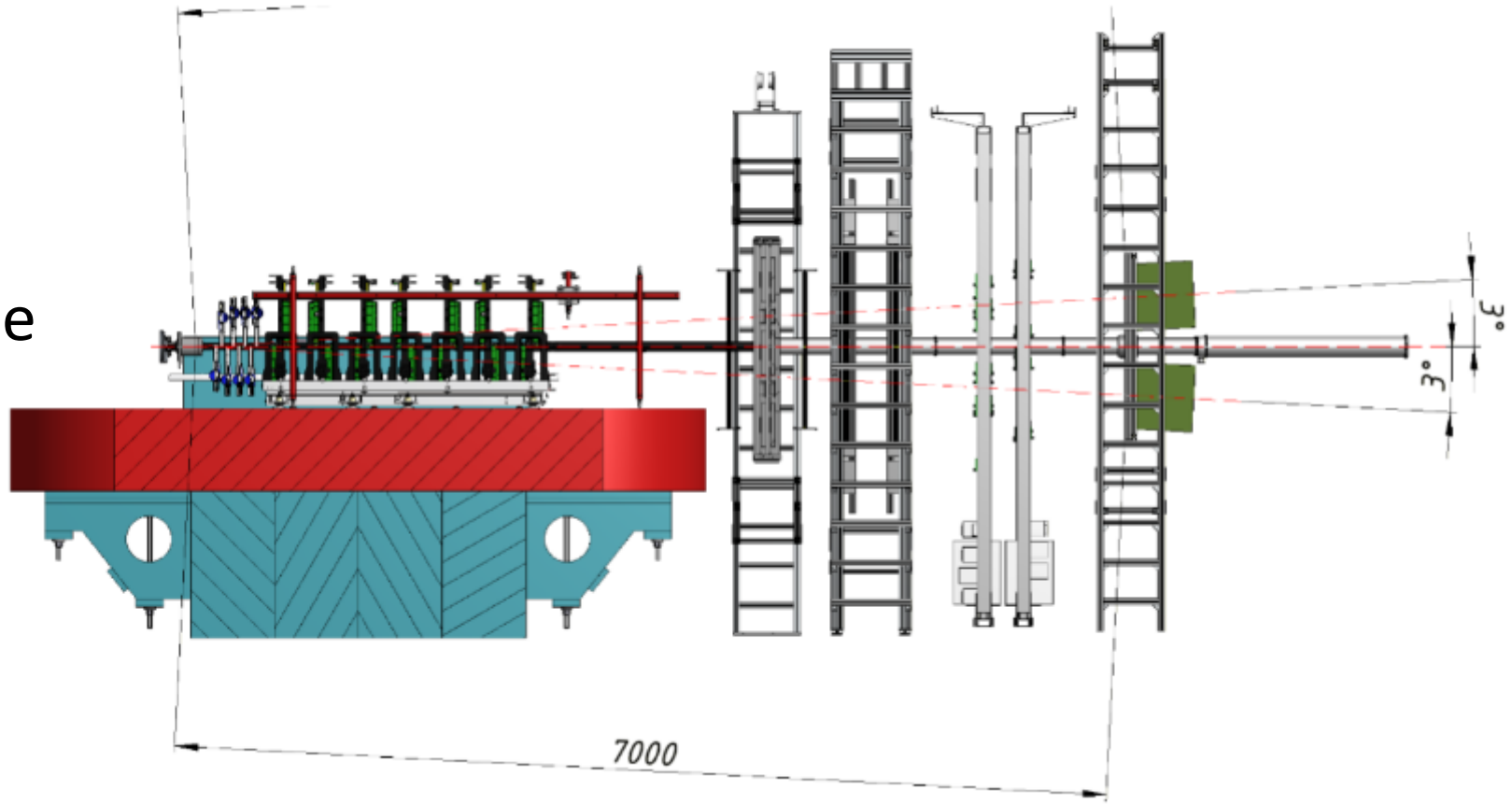
Scintillation module status

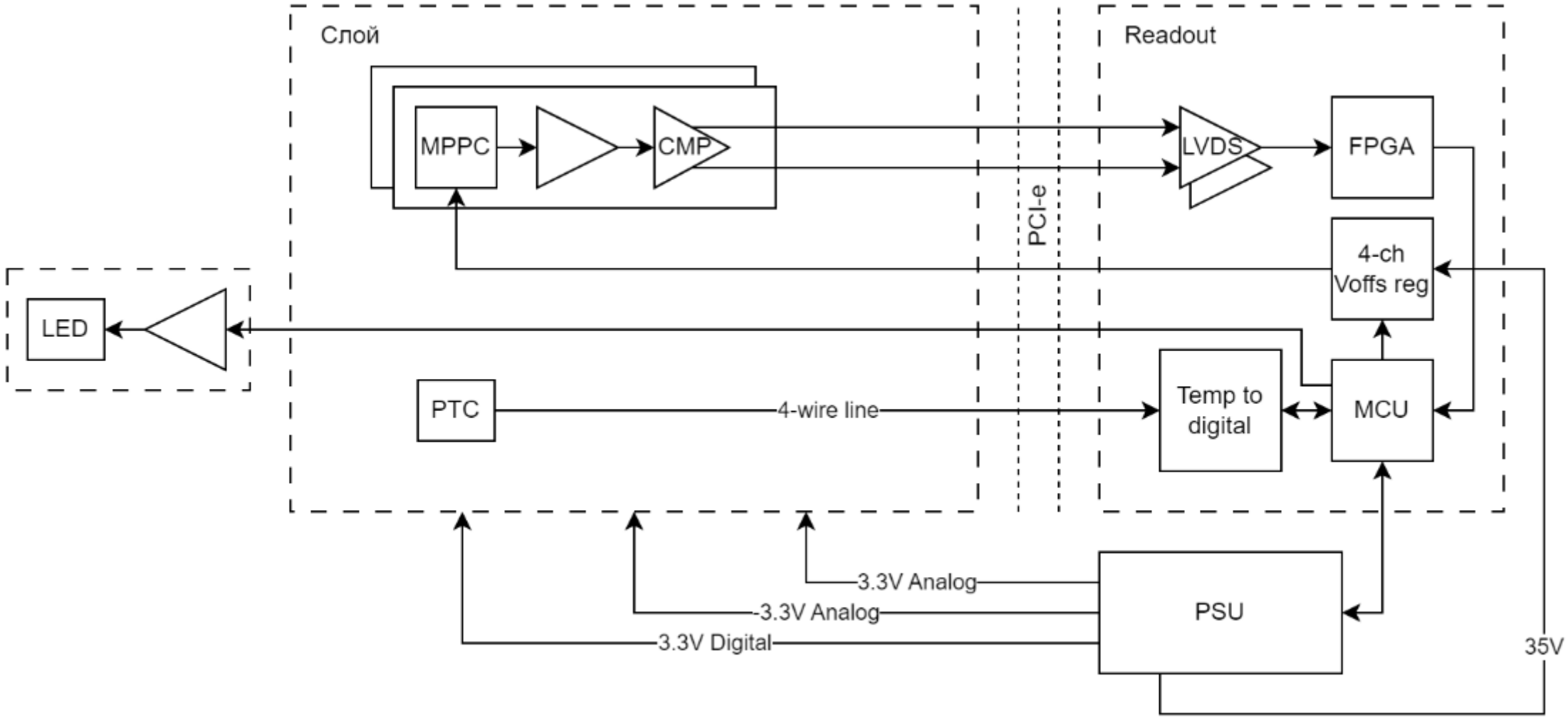
- Single-channel prototype
- Multi-channel PCB design
- Multi-channel mechanical design
- Multi-channel mechanical and PCB prototypes
- **Half-layer prototype**
- Full-scale prototype
- Full-scale completed layer

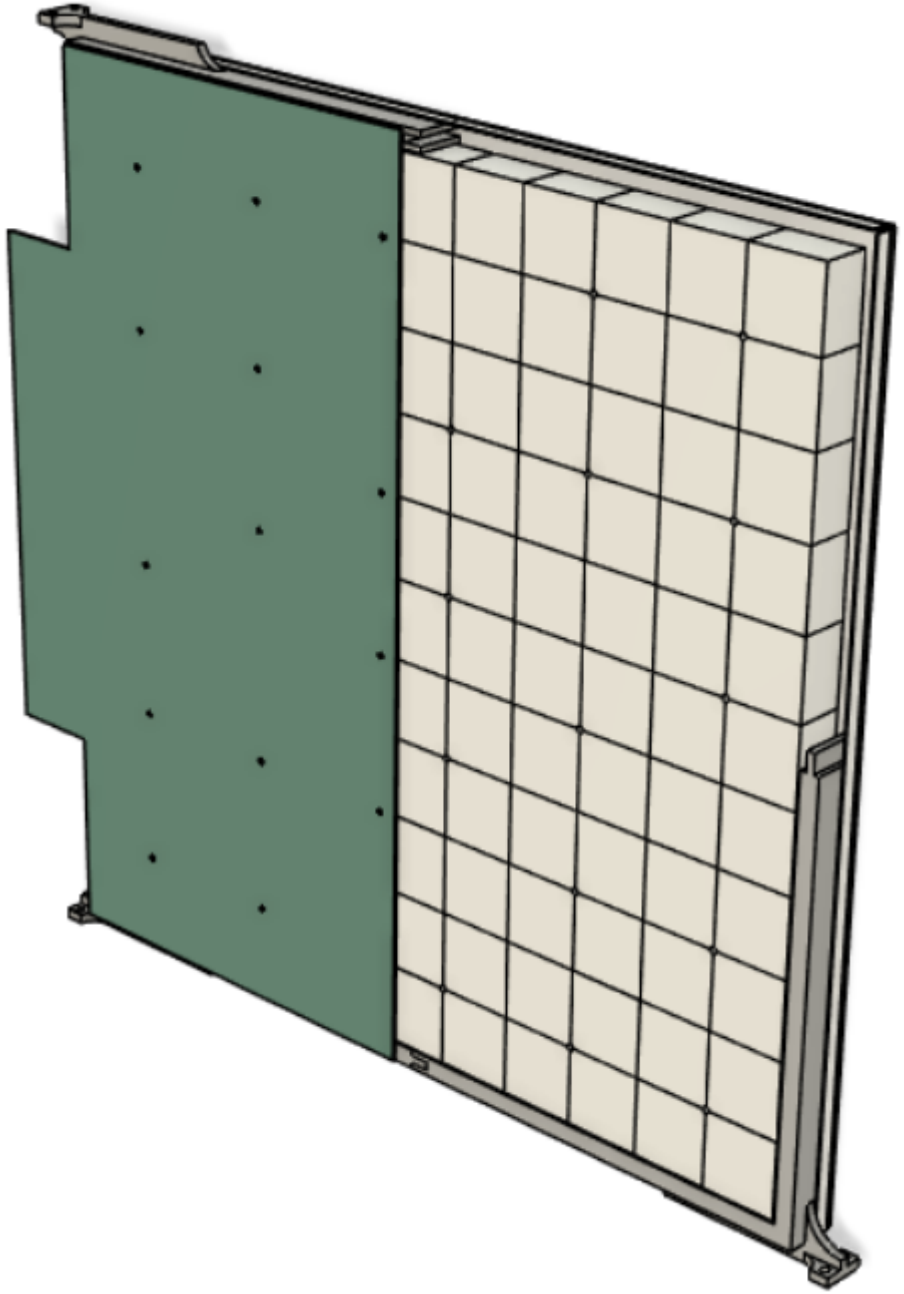


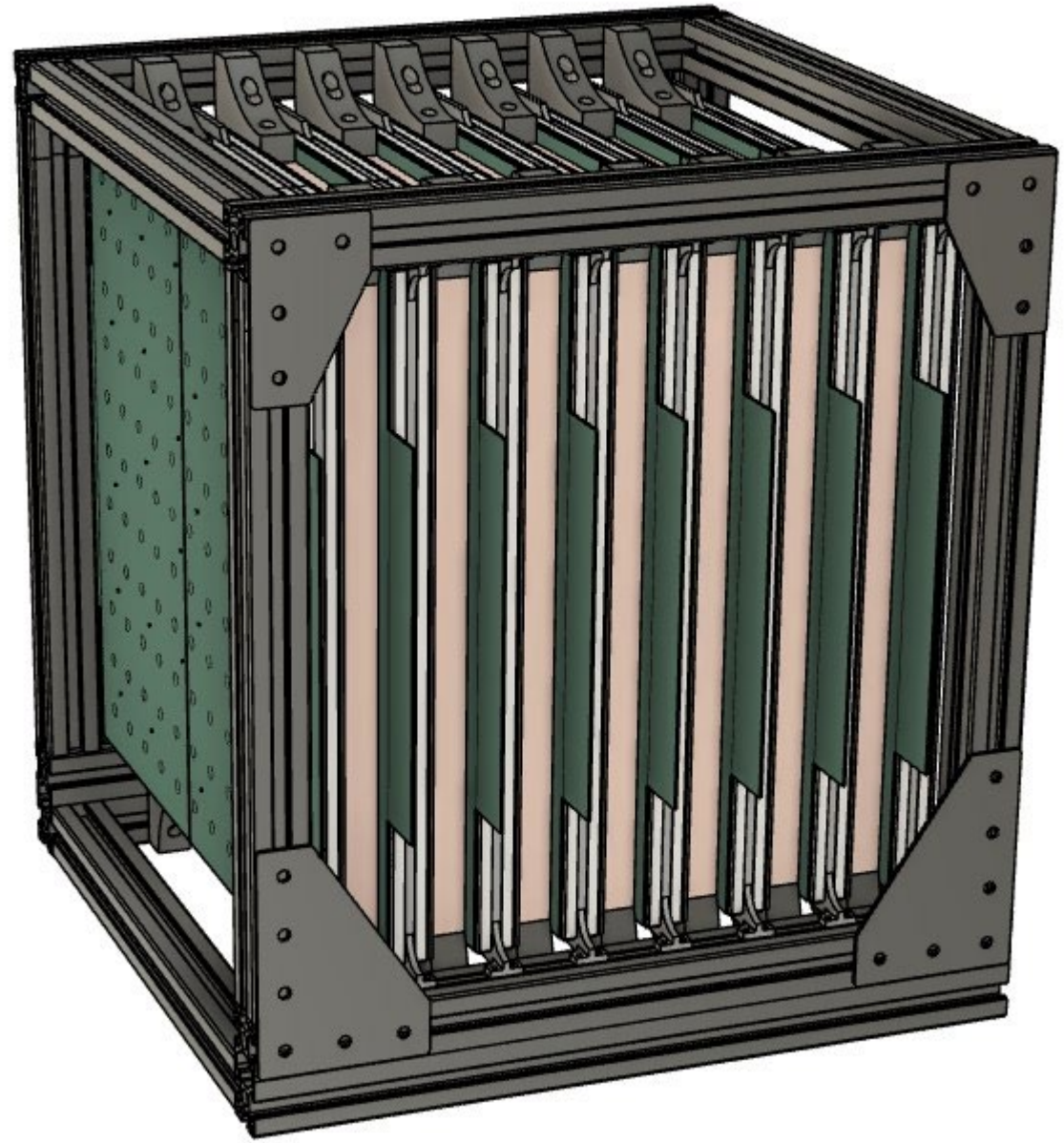
Detector arrangement

- Detector for high-energy neutron flow measurement
- ToF method with T0 as the “start” signal source
- 7m measurement distance
- Detector is split into 2 “blocks” for improved acceptance

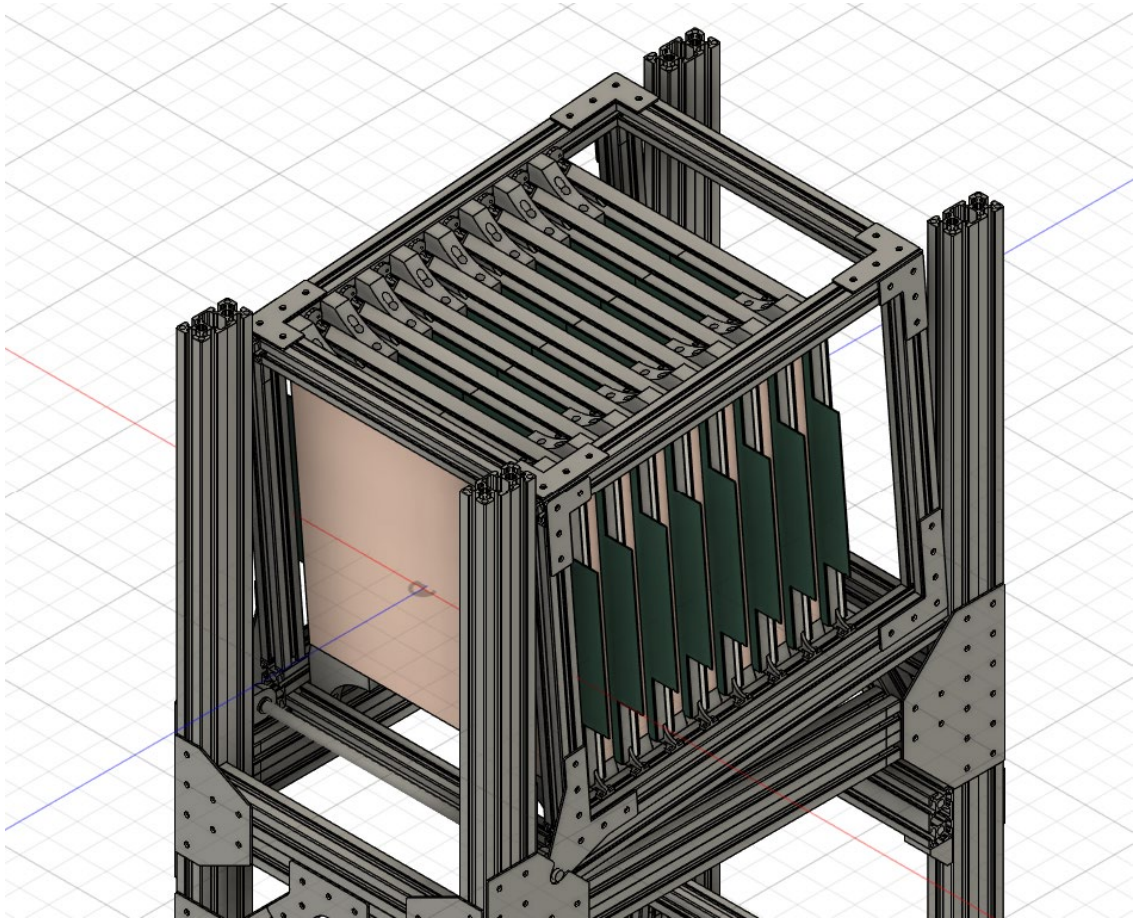


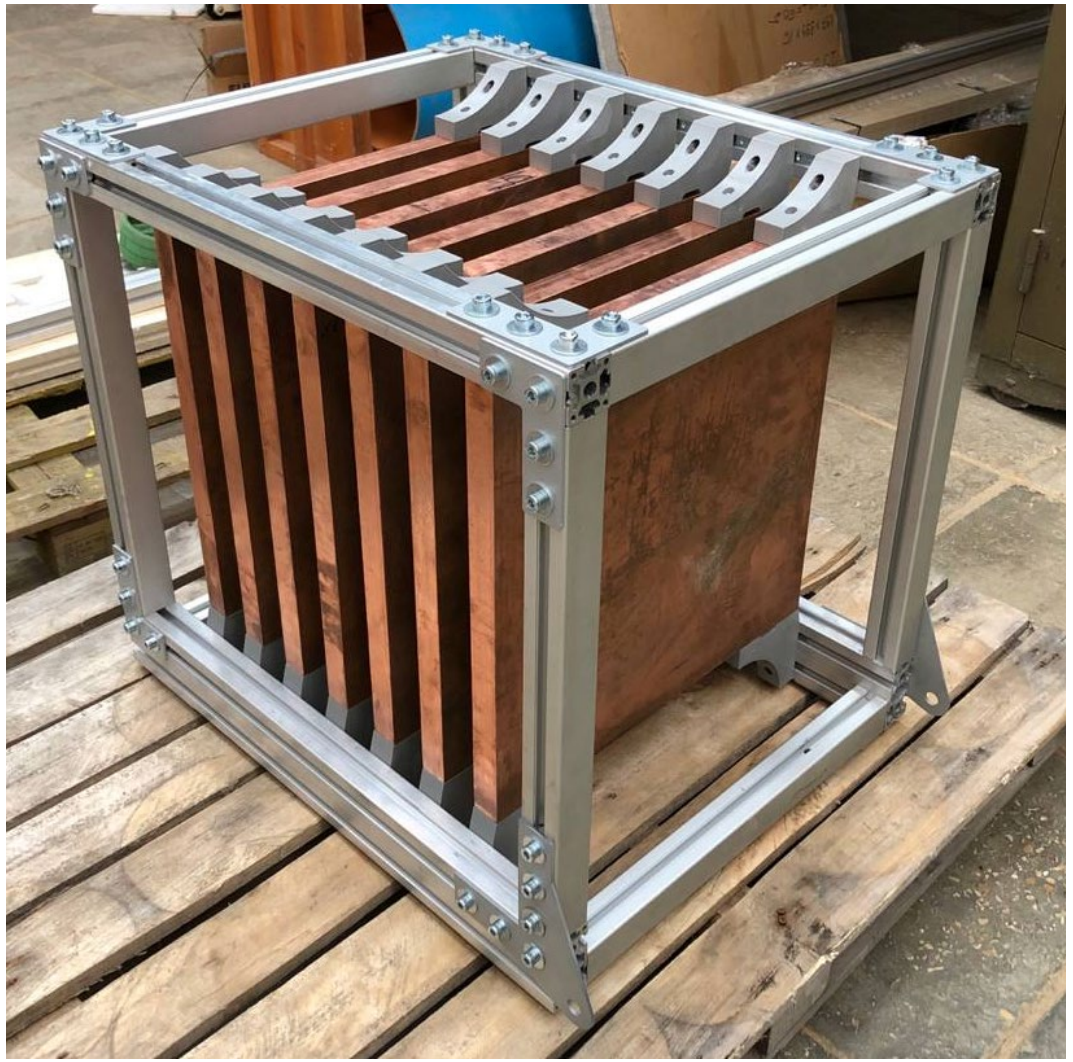

Слой
MPPC
CMP
LVDS
FPGA
PCI-e
Readout
4-ch
Voffs reg
LED
PTC
4-wire line
Temp to
digital
MCU
3.3V Analog
3.3V Analog
3.3V Digital
PSU
35V



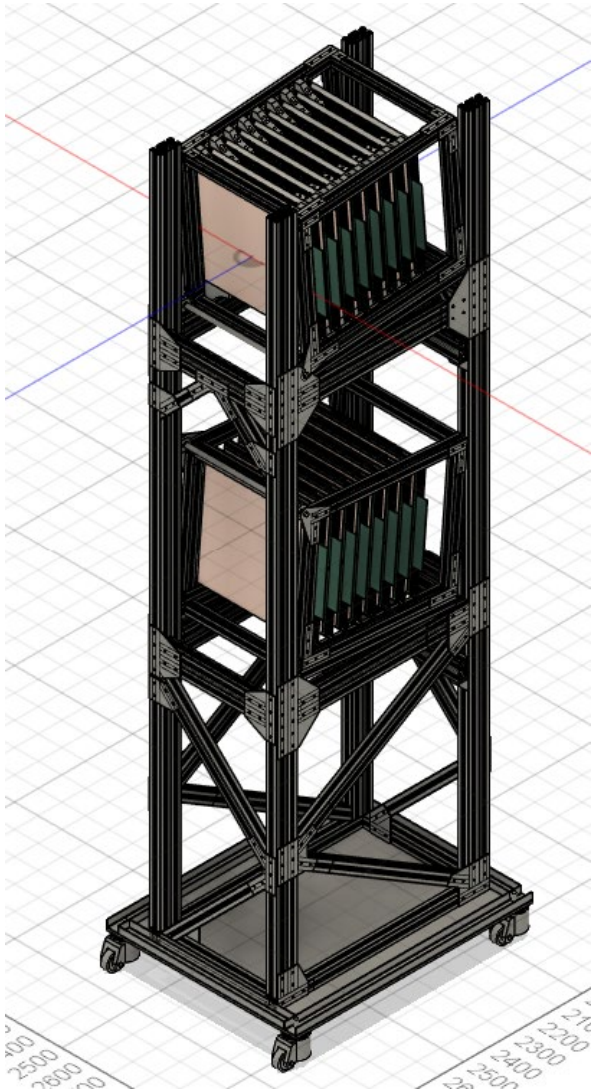


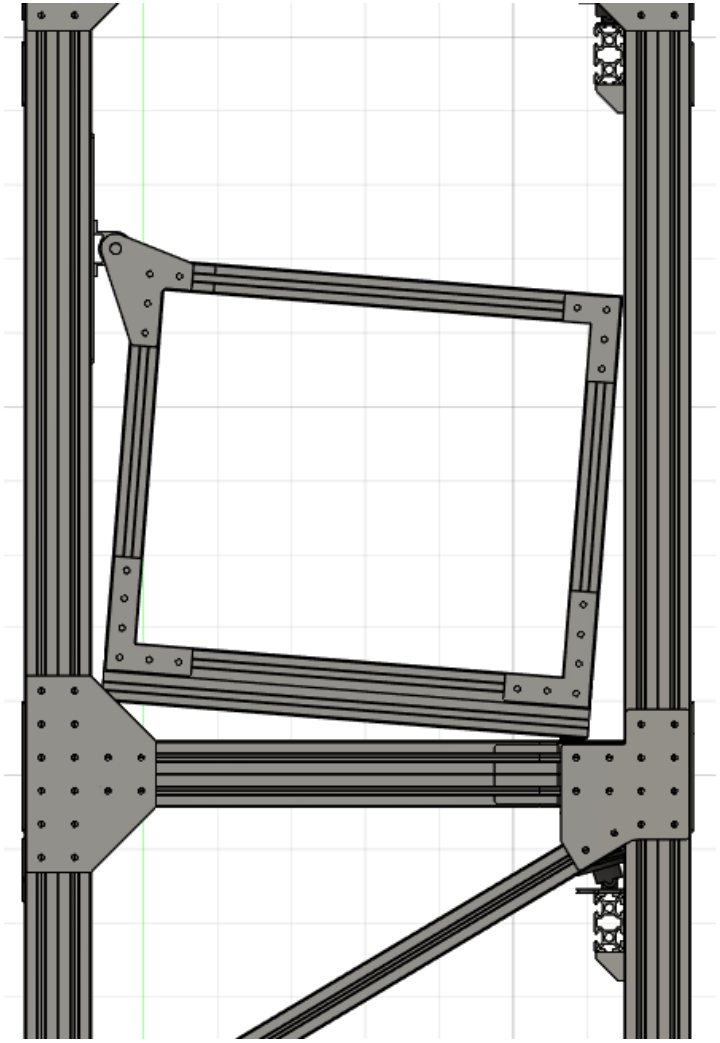
Mechanical construction - module





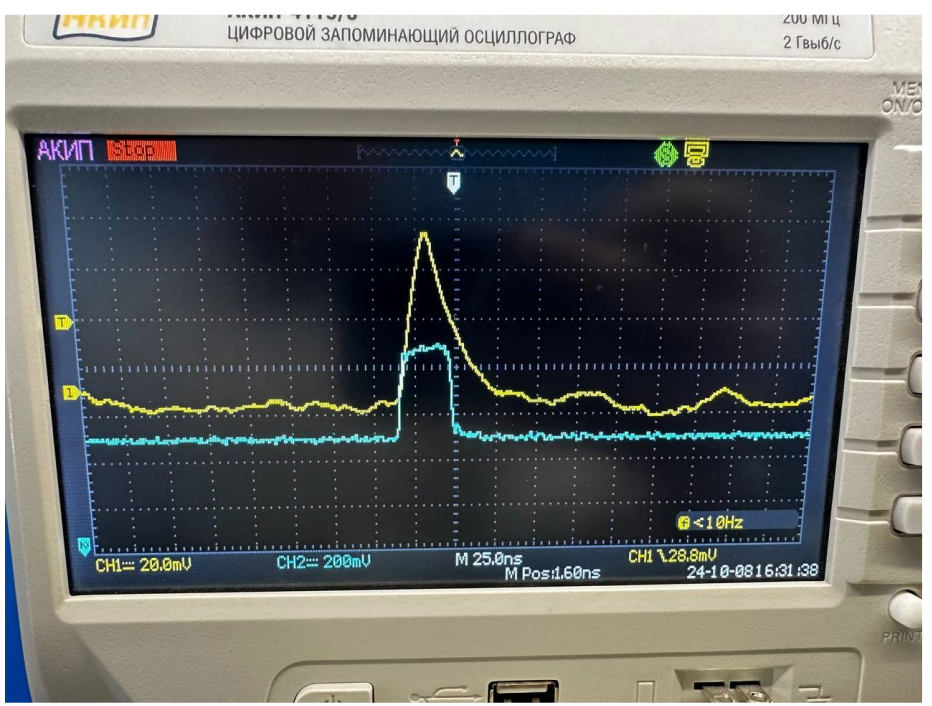
Mechanical construction - support





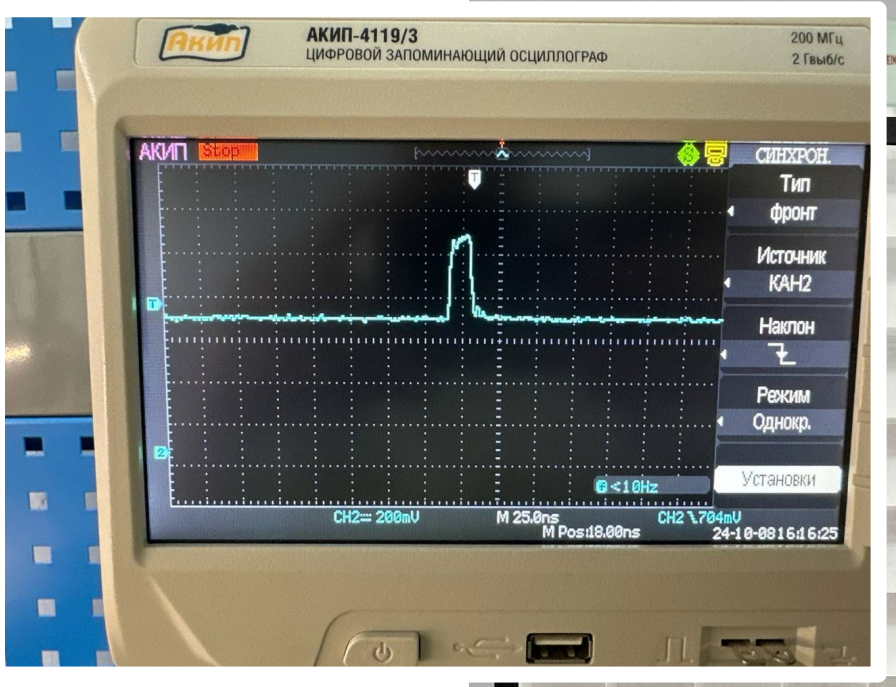
MPPC board

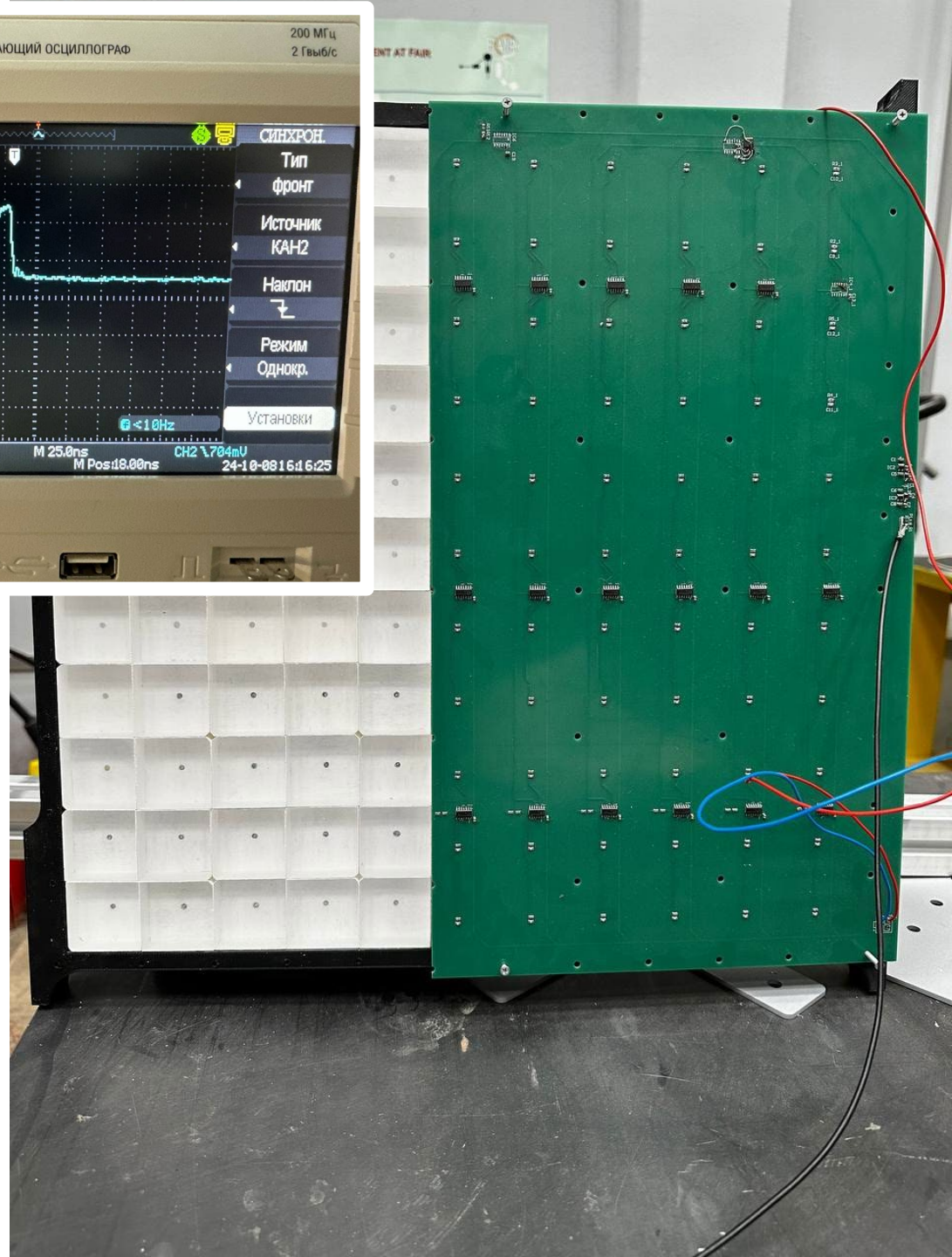
- Single-channel prototype
- Multi-channel PCB design
- **Full-scale prototype**
  - **Single-channel test**
  - **Crosstalk test**
  - **Readout integration**
- Full-scale completed PCB



LED board

- Single-channel prototype
- Multi-channel PCB design
- **Full-scale prototype**
  - **Single-channel test**
  - **Crosstalk test**
  - **Current loop test**
  - **Slow control integration**
- Full-scale completed PCB





TODO items

- Mechanical construction completion
- Full-scale tests of the readout board
- Full-scale tests of the LED board
- Readout integration
- Slow control integration
- Full-scale readout tests
- LED+Readout PCBs and modules mass production – by the end of 2024