Muographers 2026,
Budapest

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Nuclear Research

# DSTAR
# (Detector System for Tracking Angular Radiation)

## Modular 4π Muon Detector for Field Measurements and Evaluation of Ambient Conditions in Low-Background Experiments

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# Motivation

**Low-background and muography-related measurements often require:**

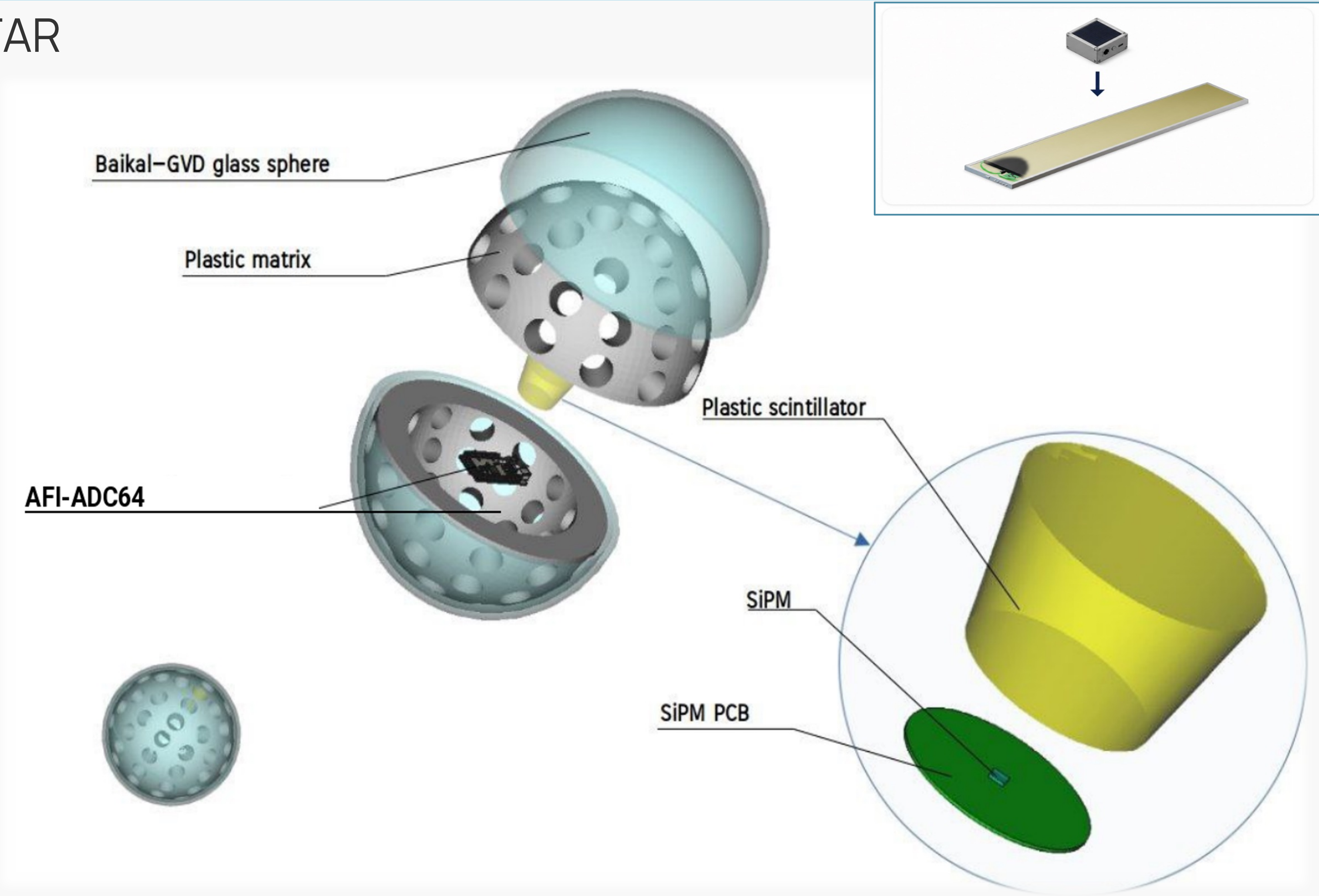
- fast site characterization;
- evaluation of effective overburden;
- environmental muon monitoring;
- measurements outside dedicated underground laboratories;
- flexible deployment geometry.

**Existing systems are often:**

- large;
- infrastructure-heavy;
- optimized for fixed installations;
- not intended for field deployment.

# Concept of DSTAR

- modular;
- scalable;
- autonomous;
- 4π coverage;
- coincidence measurements;
- portable.



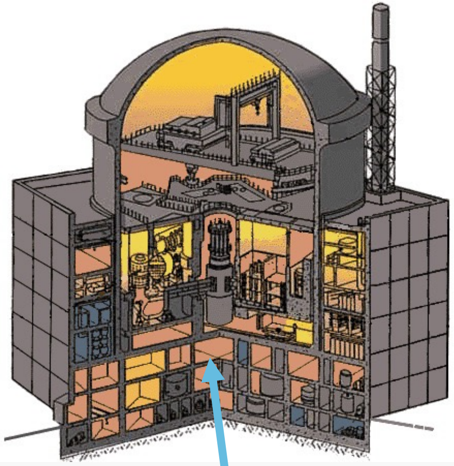
# Prototype

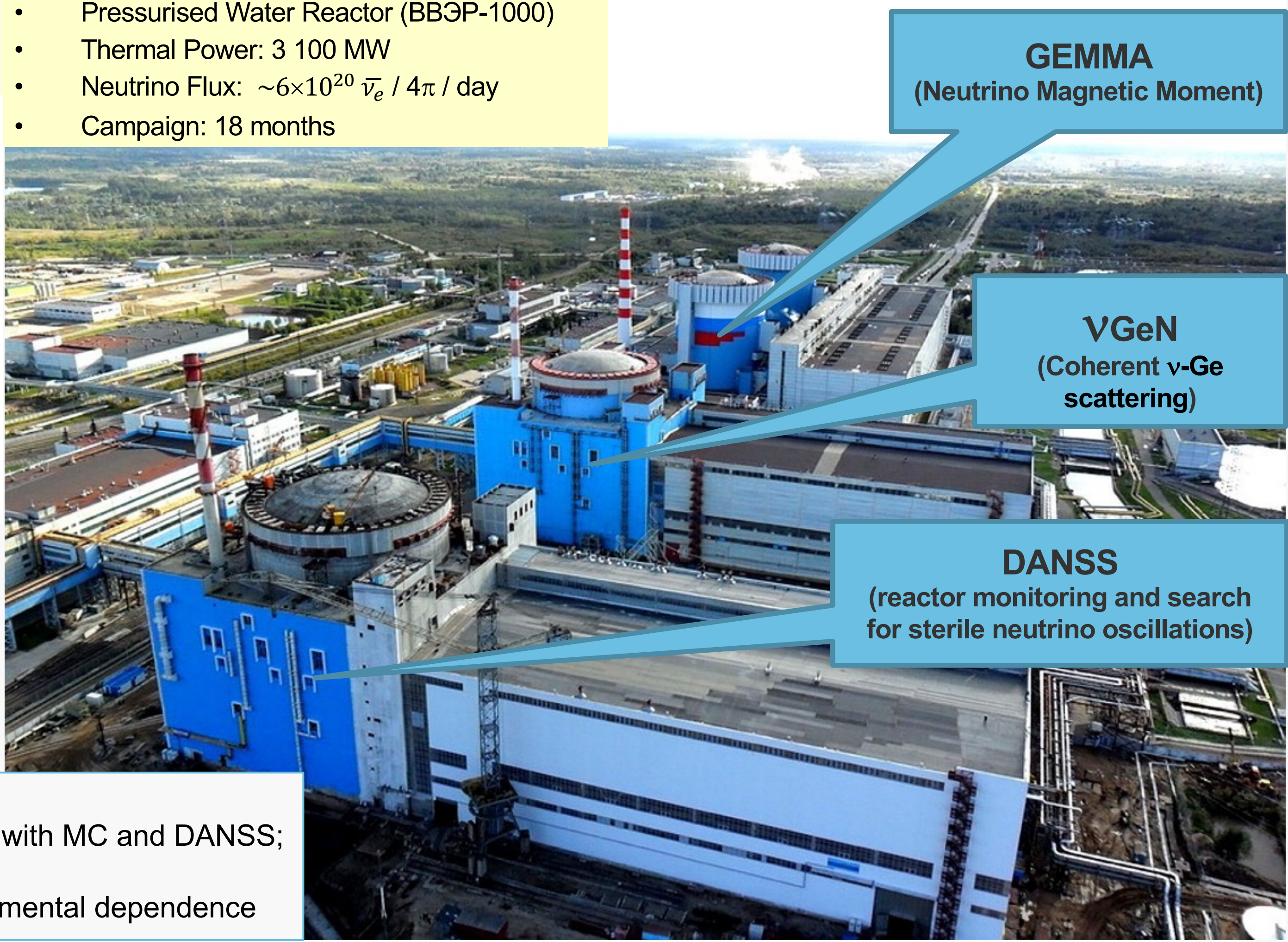

Big Challenges (Sirius school)

- 14 channels

# KNPP

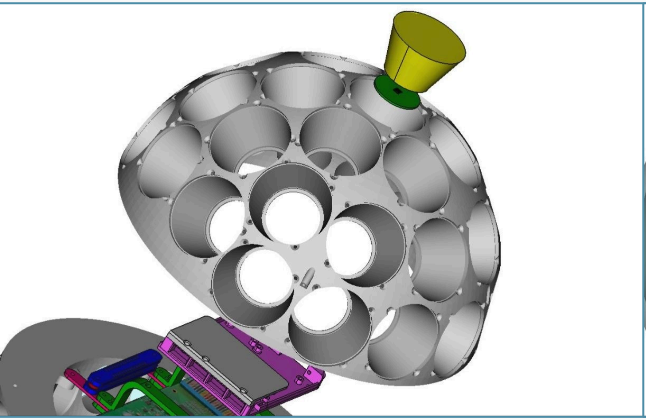
- Pressurised Water Reactor (ВВЭР-1000)
- Thermal Power: 3 100 MW
- Neutrino Flux: $\sim 6\times10^{20}\ \overline{\nu_e}$ / 4π / day
- Campaign: 18 months

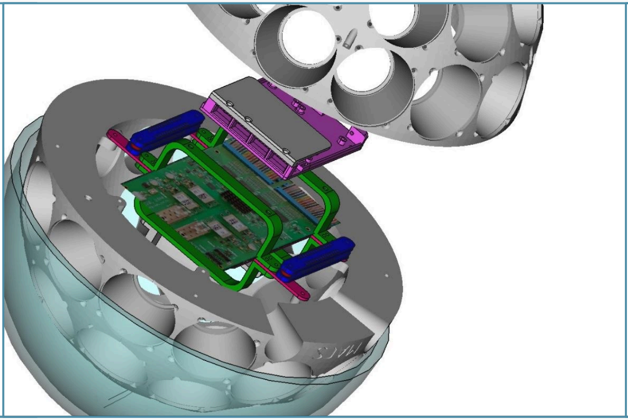


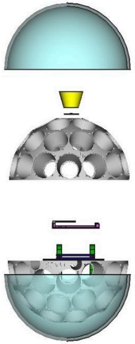



- stability over months;
- count rate consistent with MC and DANSS;
- > 95% uptime;
- no significant environmental dependence

# Detector architecture







## Scintillator + SiPM

- ➢ 64-channel (32 pairs);
- ➢ diffuse reflective coating;

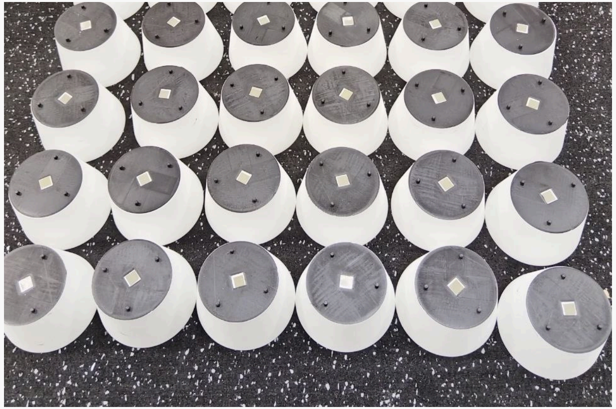
## DAQ

- ➢ 64-channel FADC;
- ➢ CAEN → AFI-ADC64;
  - 12 bit, 62.5 MS/s
  - sampling interval: 16 ns
  - up to 2048 events/s

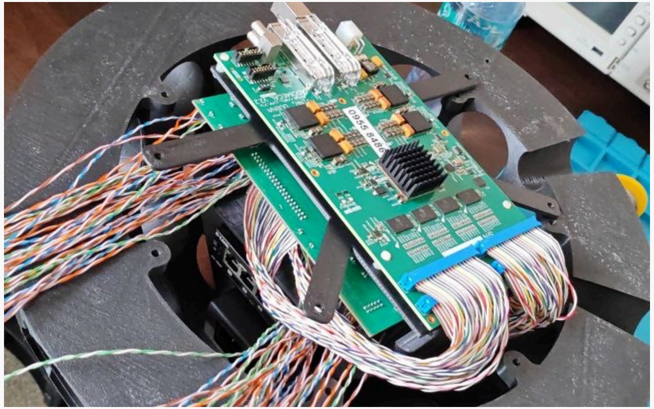
## Geometry

- ➢ Printed plastic matrix
- ➢ Baikal telescope sphere

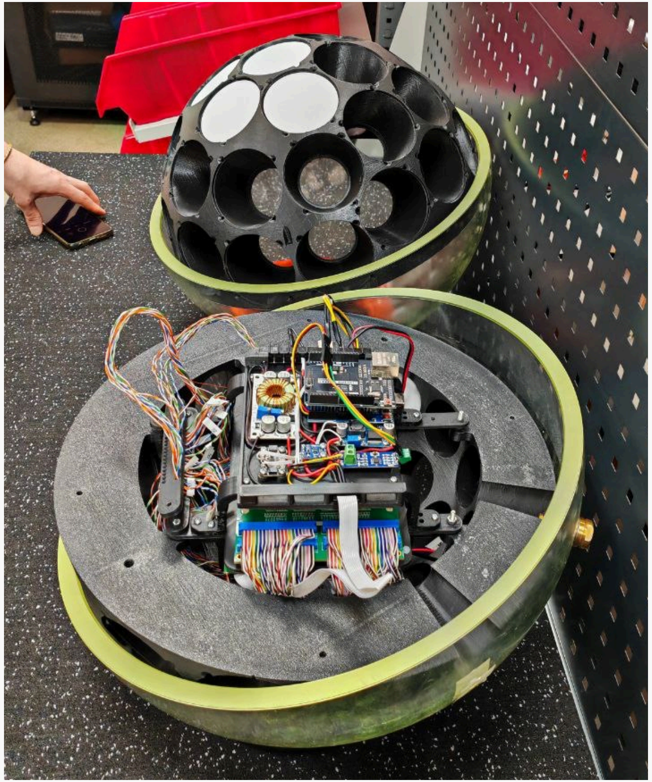
# Detector architecture



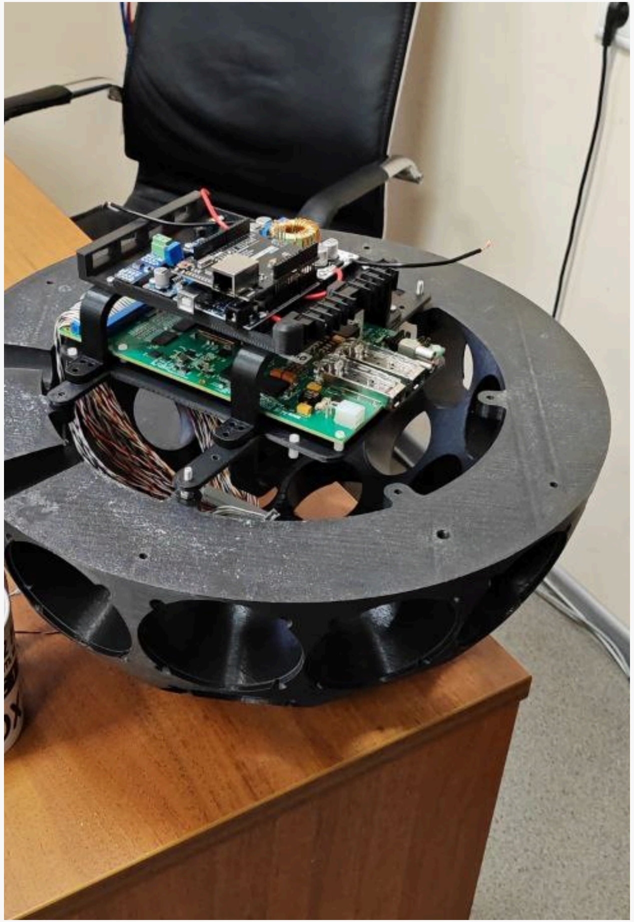
Scintillator + SiPM

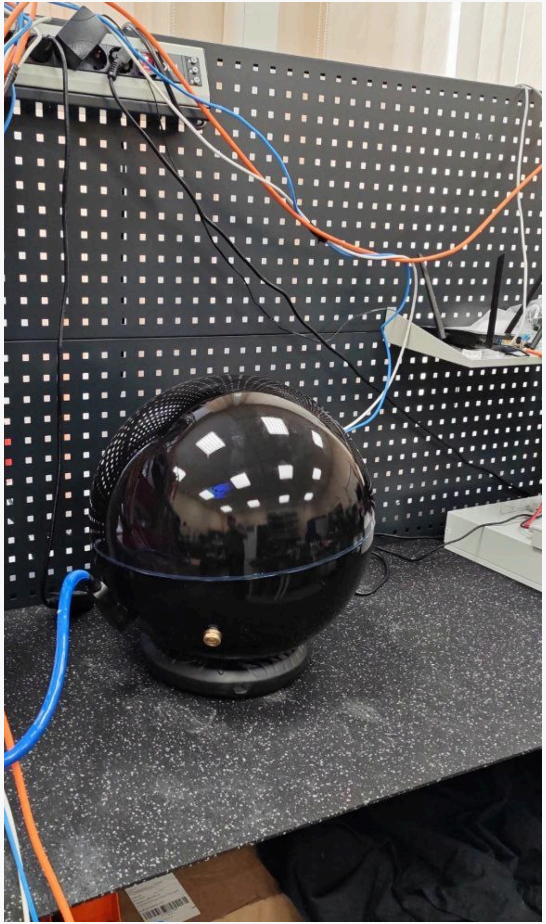


DAQ



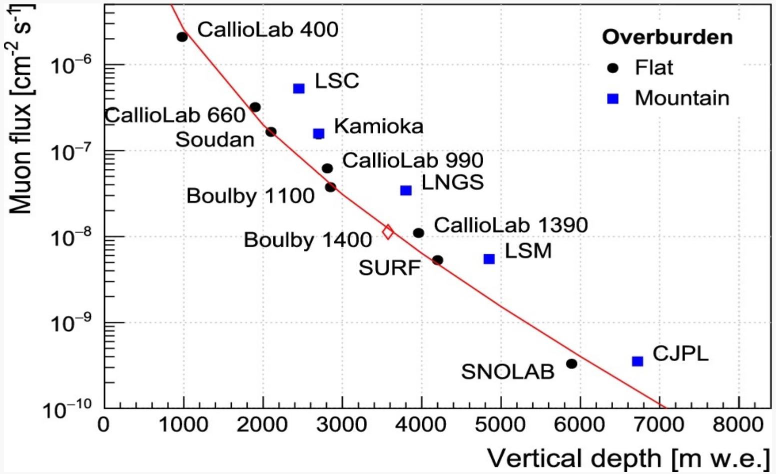
Prepacking





# Field application (Onega lake)

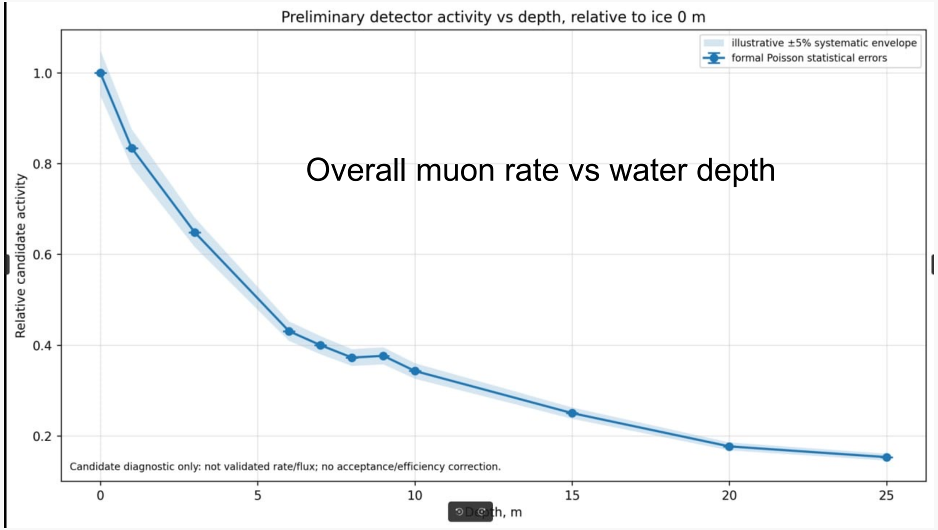
- Lack of data down to 1 km
- Direct water-equivalent depth measurements
- Sea level
- Flat surface
- 0 – 130 meters

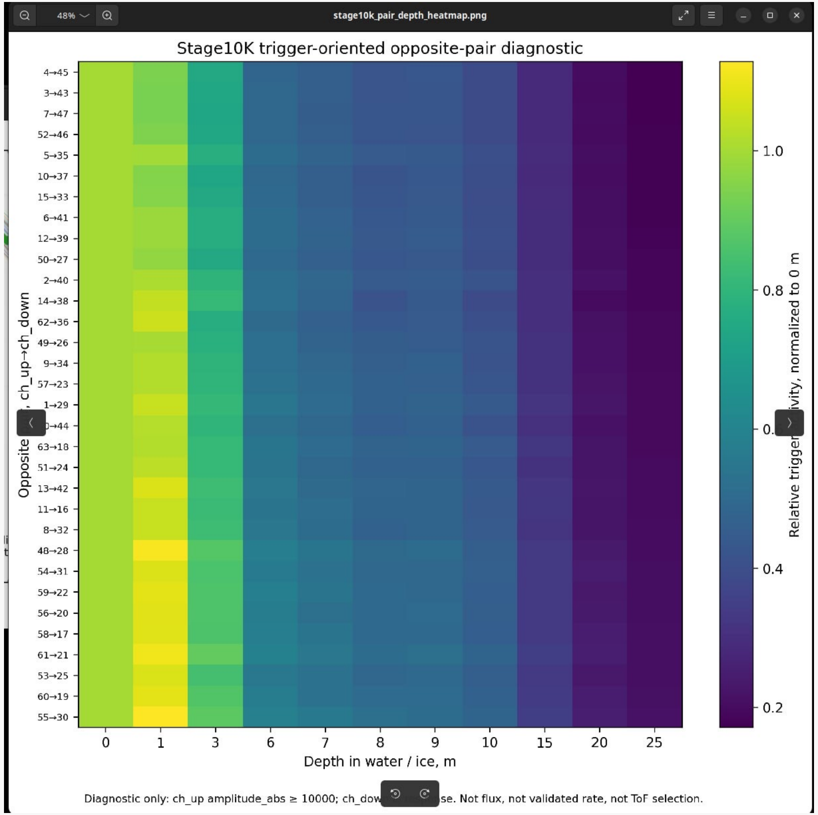



# Great help from ”Northern Water Problems Institute”, KarRC RAS

- 1 month on the ice
- 0 – 25 meters measurements

# Preliminary results




Channel-by-channel attenuation vs water depth

- •Muon rate decreases monotonically with depth.
- •Consistent behaviour is observed across all coincidence channels.
- •Detector response can be used to estimate effective water-equivalent overburden.

# Conclusions

- DSTAR demonstrates stable autonomous long-term operation;
- the modular architecture enables flexible field deployment;
- first measurements of direct water-equivalent depth have been successfully performed;
- future scaling opens the path toward underwater measurements and muography applications.

## Possible applications

- Overburden estimation
- Environmental monitoring
- Underground surveys
- Muography R&D
- Education and outreach