

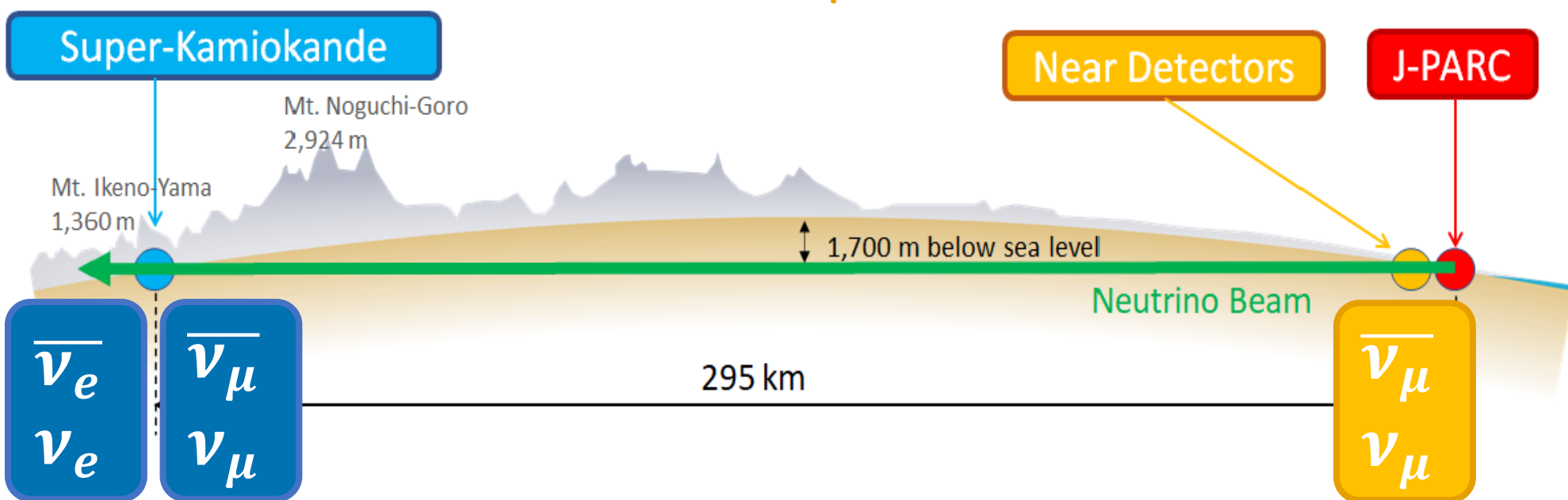
Commissioning of High Angle Time Projection Chambers for T2K ND Upgrade

Matteo Feltre, on behalf of T2K HA-TPC group
INFN Padova



The T2K Near Detector Upgrade

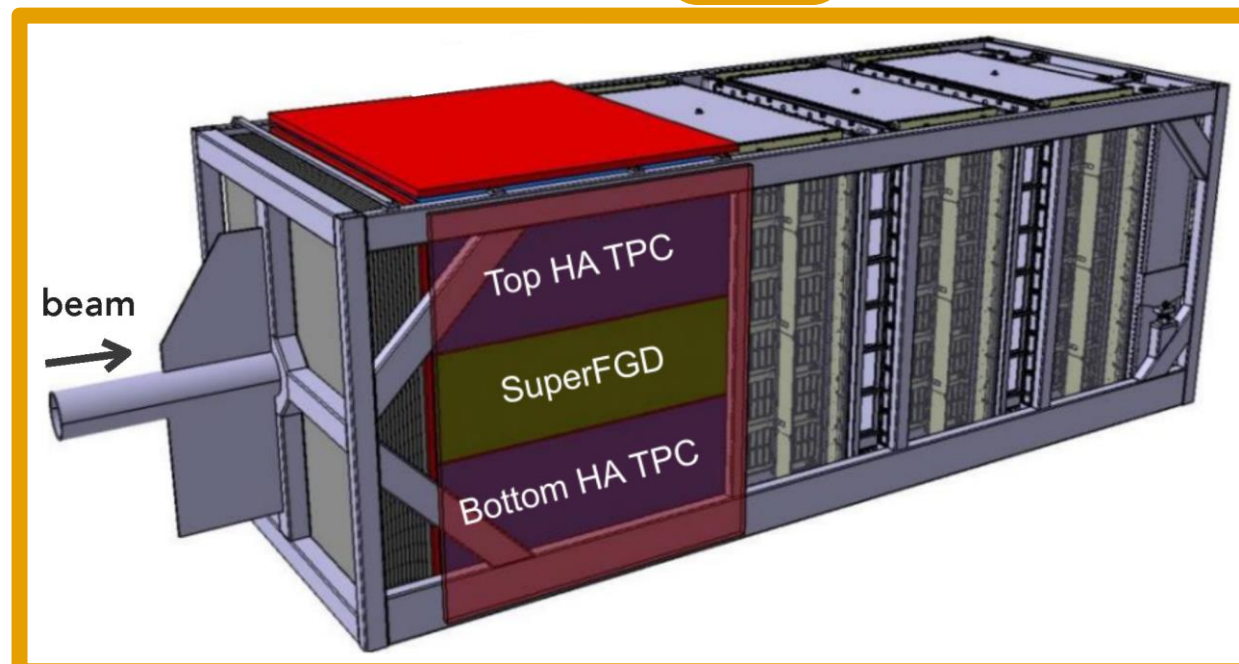
T2K is a long baseline neutrino experiment that studies neutrino oscillation parameters through ν_μ disappearance and ν_e appearance



T2K Phase II will be characterized by the upgrade of beam line and ND280 detector

The installation of the new tracking system was completed in May 2024, and it includes:

- Active target fine grained detector (SFGD)
- Two Time Projection Chambers (HA-TPC) → Tracking and PID
- Time of Flight scintillating panels (TOF)



T2K is now taking neutrino beam data with the upgraded Near Detector!

Field Cages

Field cage innovative design is based on thin walls, low Z and solid dielectric composite materials. The rectangular shape is designed to minimize the dead volume and to provide Electric Field uniformity better than 10^{-3} at 1 cm from walls

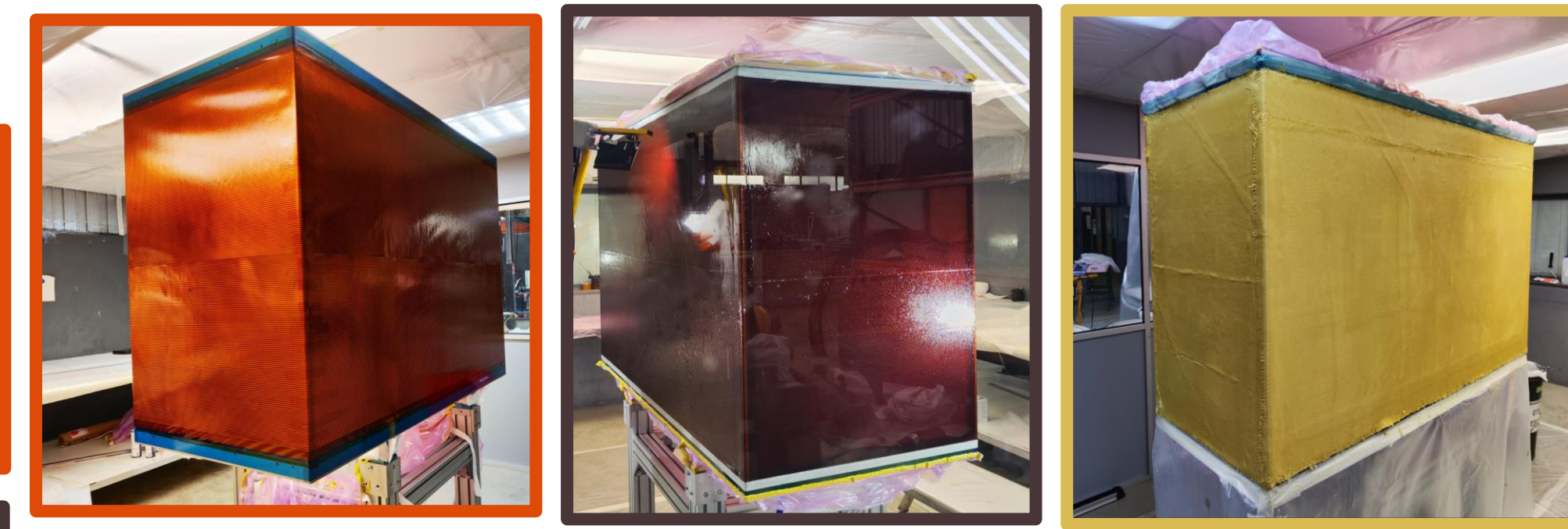


Strip foil
It provides a uniform Electric Field along the drift direction

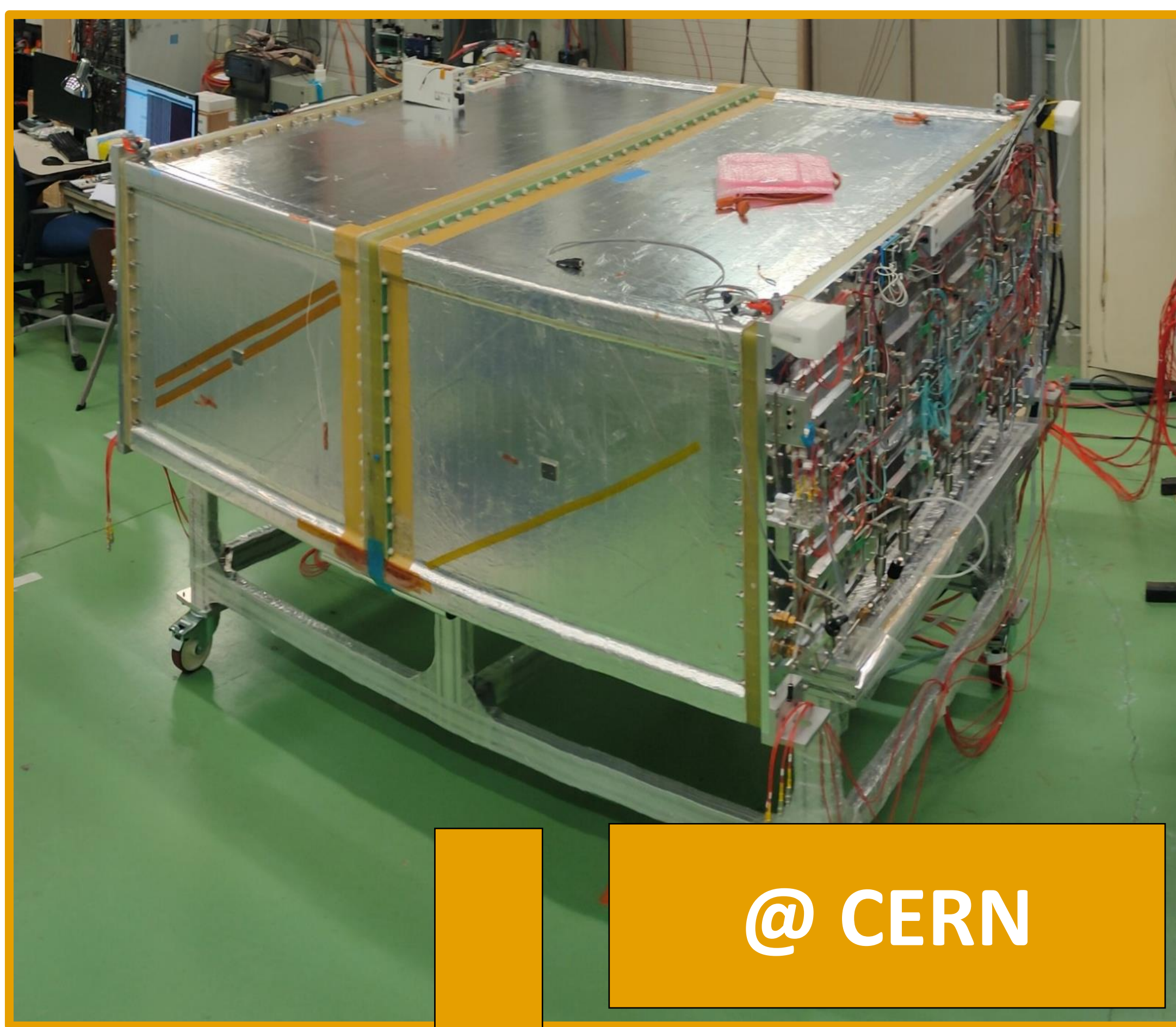
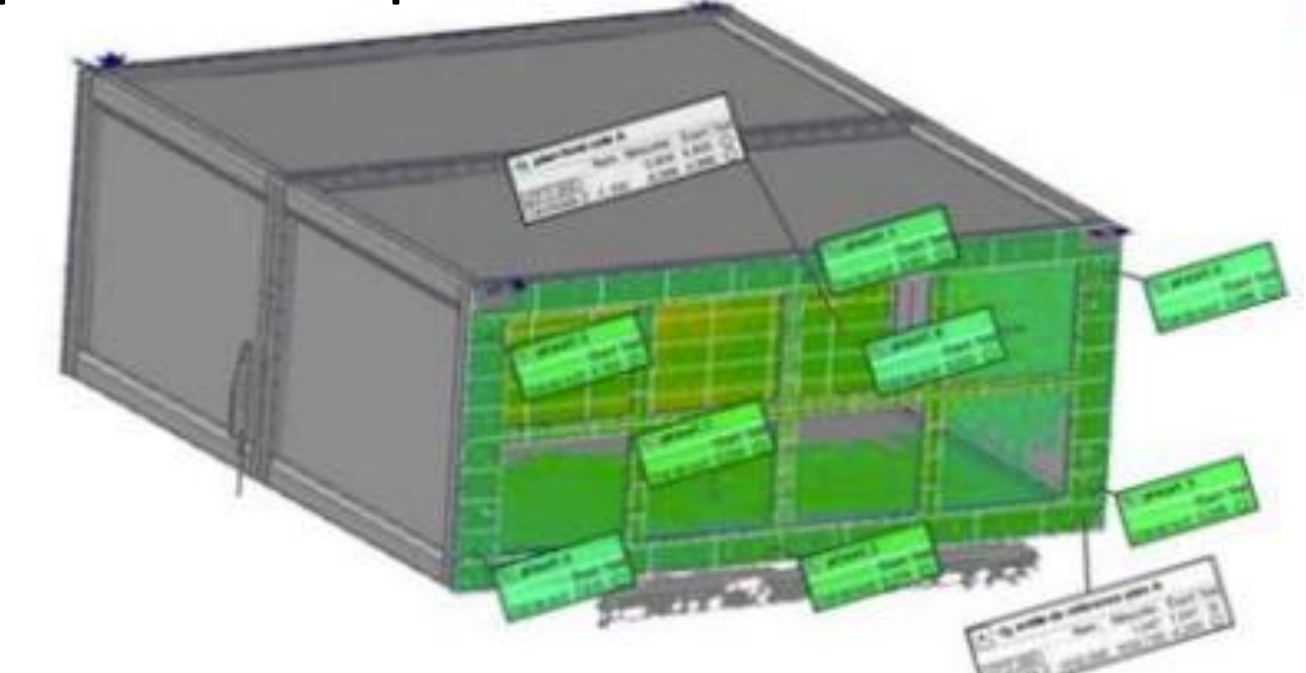
Kapton layers
Improved electrical insulation

Twaron layers
Optimal mechanical properties

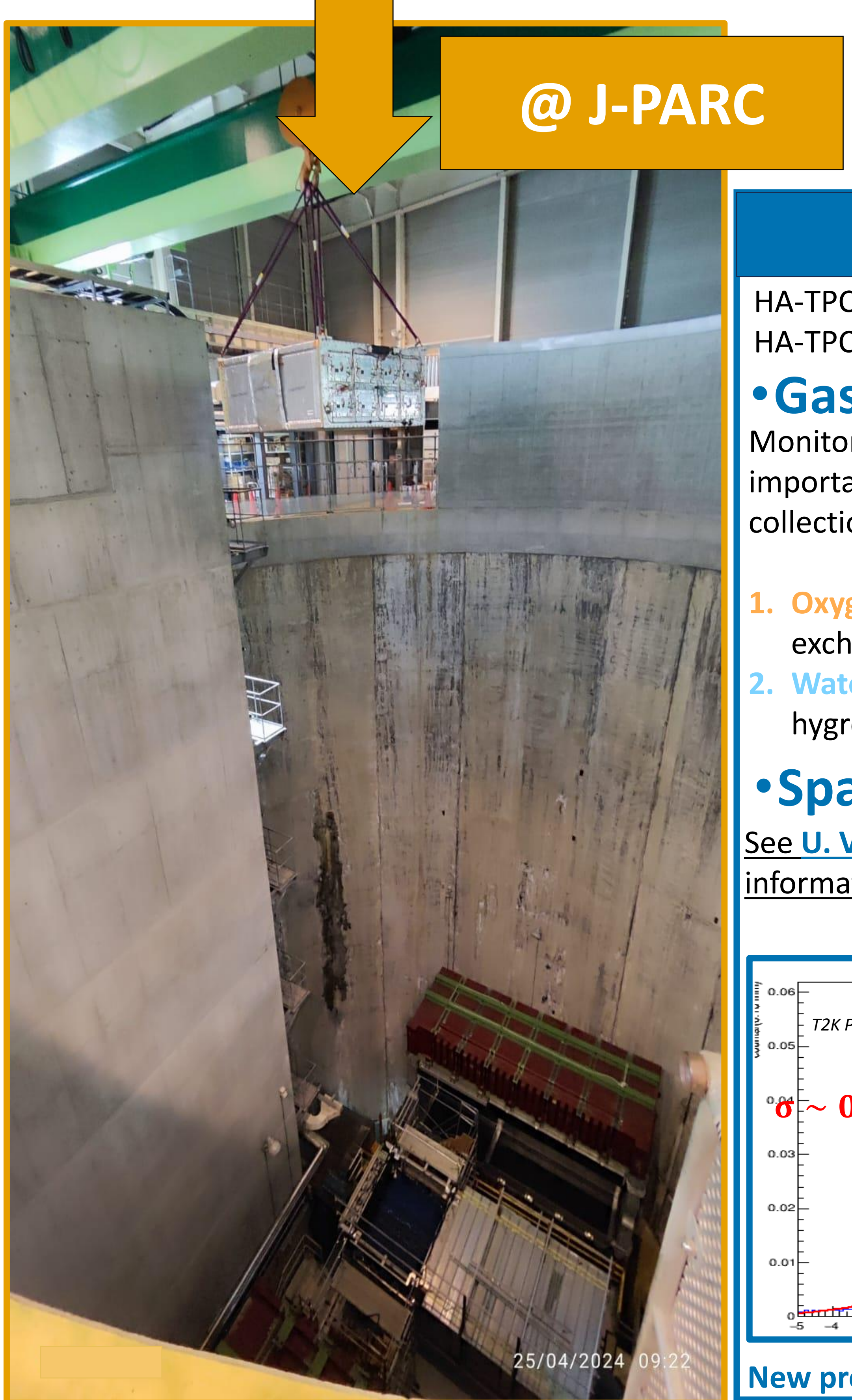
Reached limits of composite material technique:
• Large dimensions
• Hand lay-up



Metrology
Measured internal geometry after assembly agrees with nominal CAD with pull better than 300µm with few localized, acceptable exceptions



@ CERN



@ J-PARC

Resistive MicroMegas Detectors (ERAMs)

HA-TPCs are readout by 8 ERAMs per End-Plate

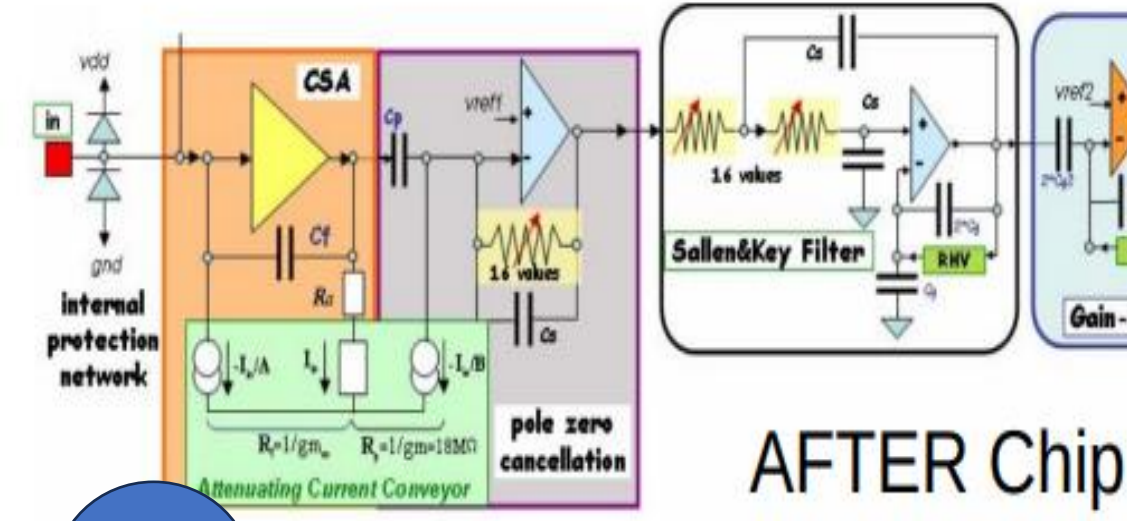
The presence of a resistive layer allows to:

- Achieve a high spatial resolution $\sim 500 \mu\text{m}$ with pad size $\sim 1 \times 1 \text{ cm}^2$
- Prevent damage from discharges and work at larger gain

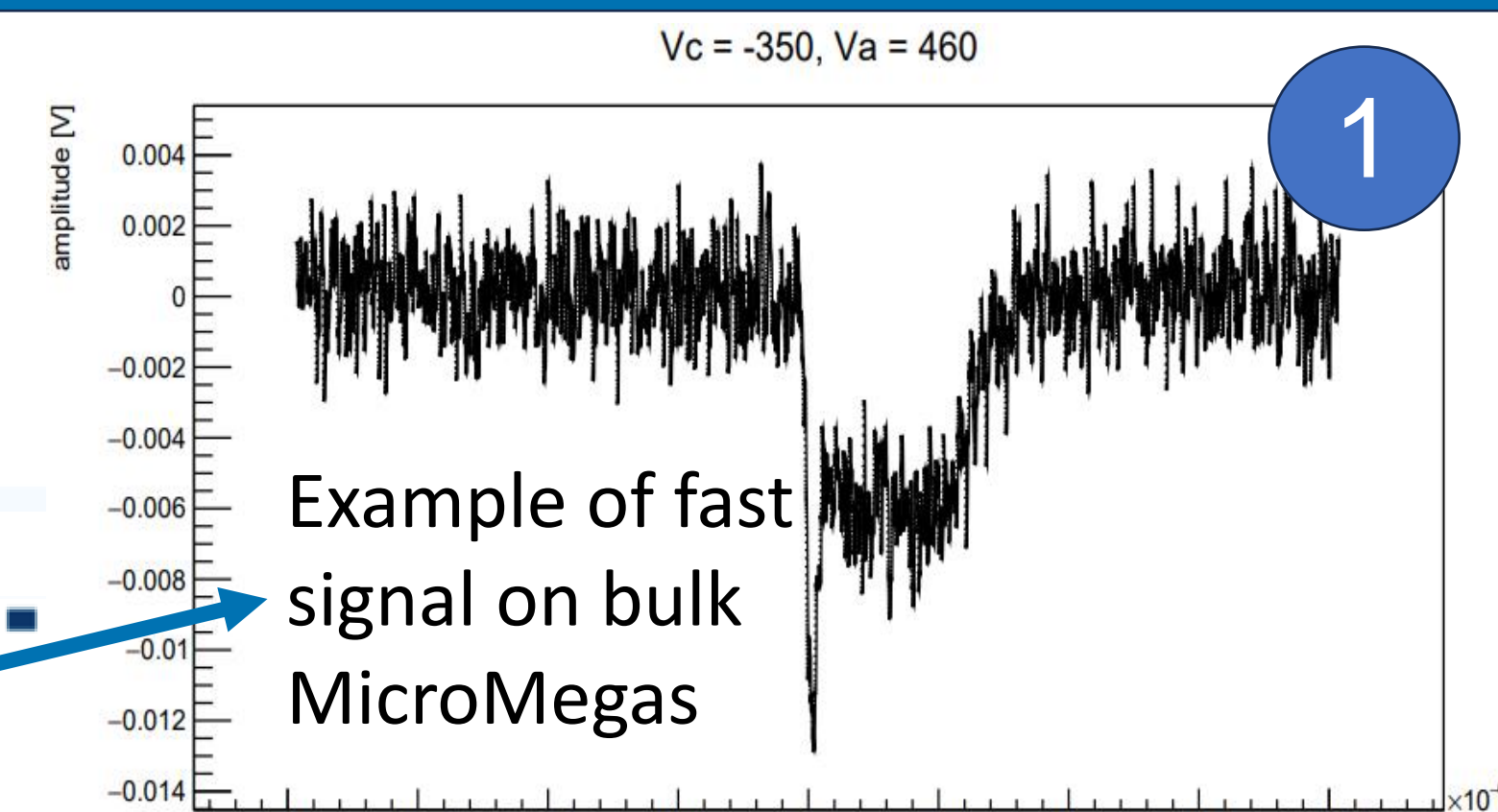
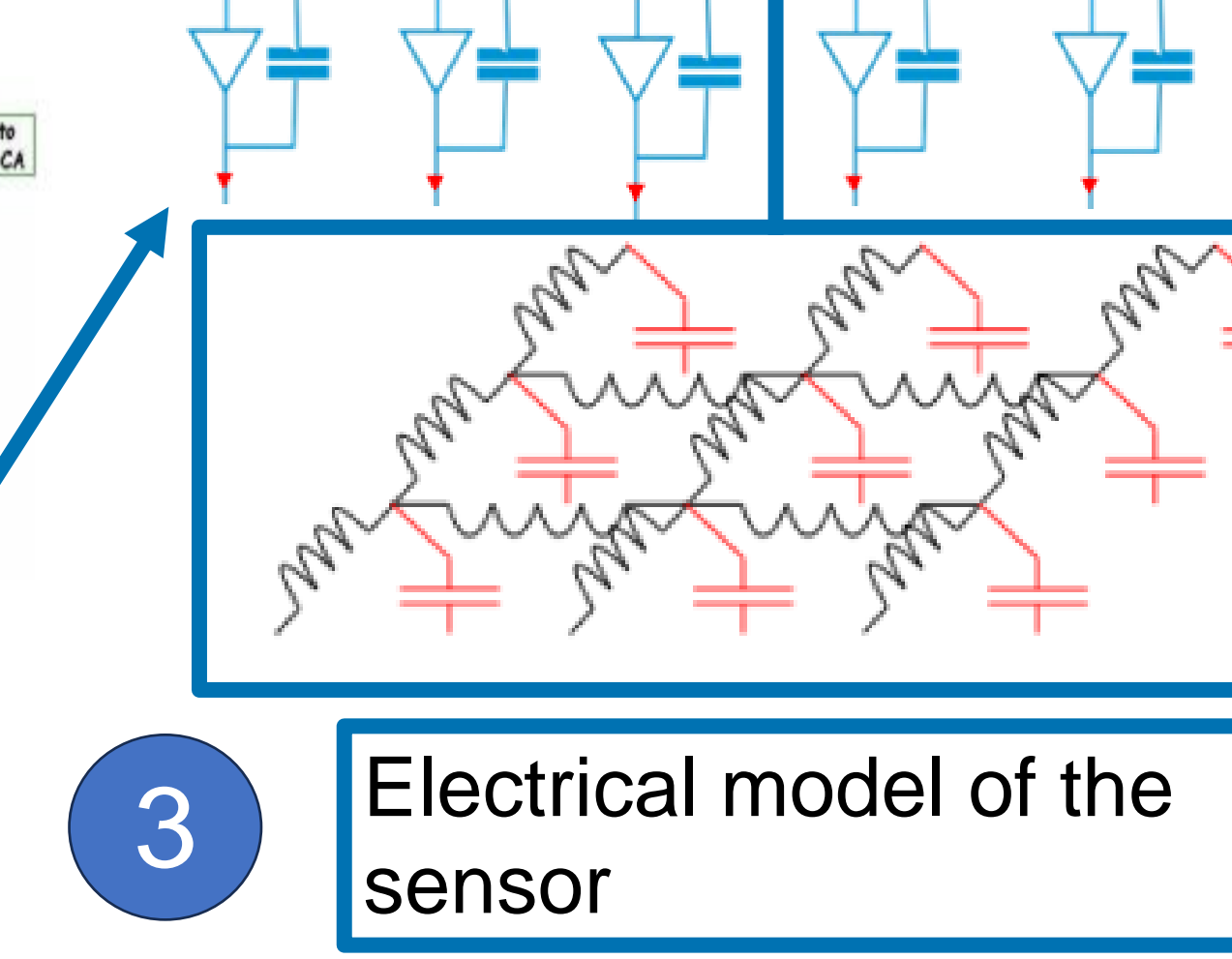
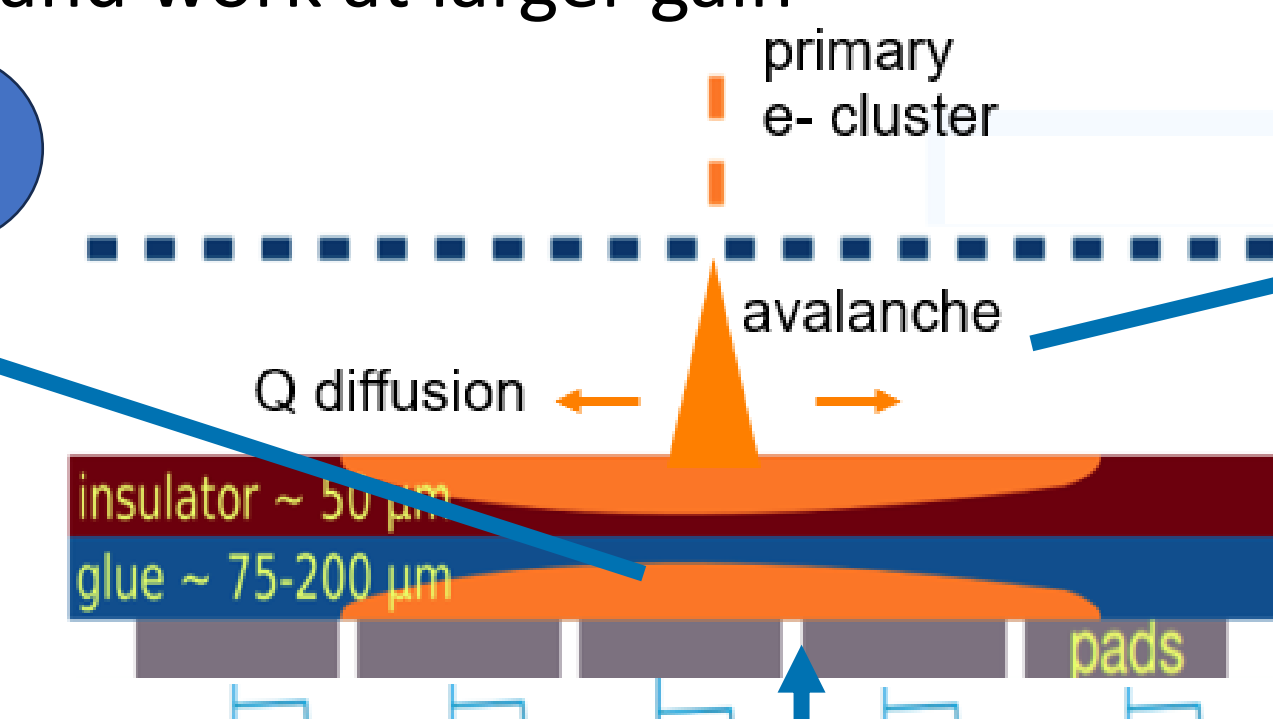
Signal has same time scale as shaping time $O(100 \text{ ns})$

2D diffusion equation

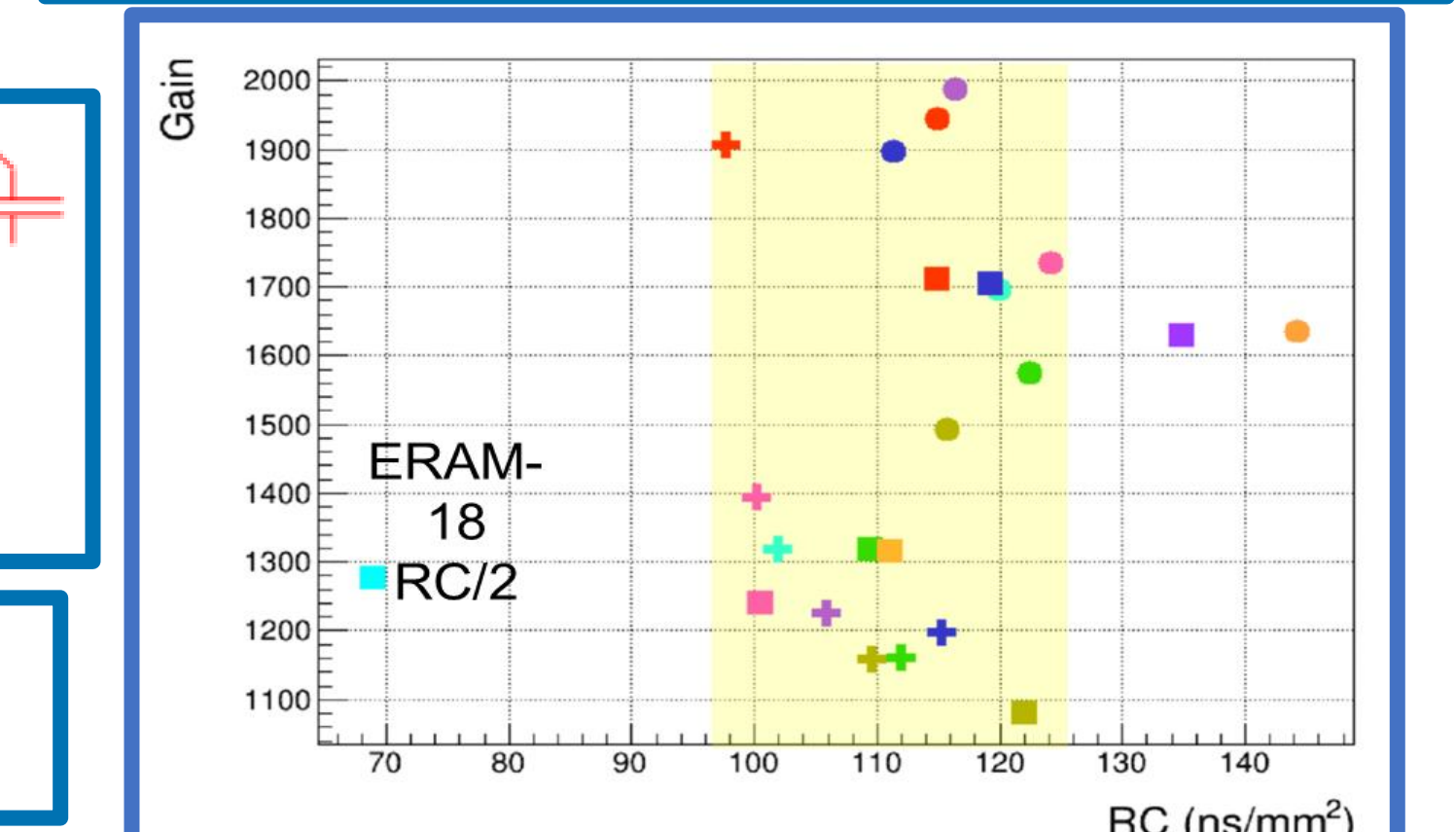
$$\rho(r, t) = \frac{RC}{4\pi t} \exp\left(-\frac{r^2 RC}{4t}\right)$$



AFTER Chip
FEE response function



ERAM response characterization was performed at CERN on a test bench with a 55-Fe source



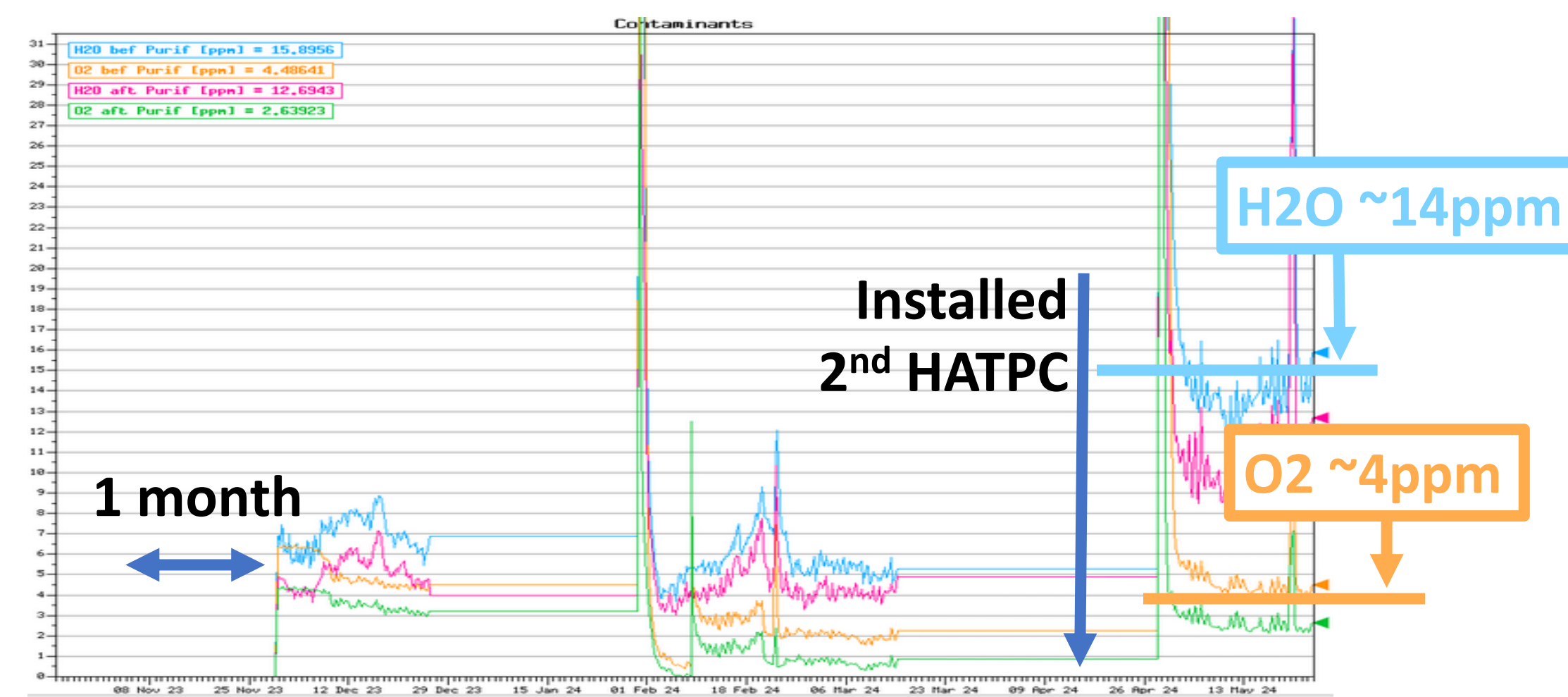
Commissioning at J-PARC

HA-TPCs performances were evaluated at CERN before shipping and at J-PARC after installation with cosmic rays campaigns. HA-TPCs are designed to provide estimation on particle momentum and dE/dx

Gas Quality Check

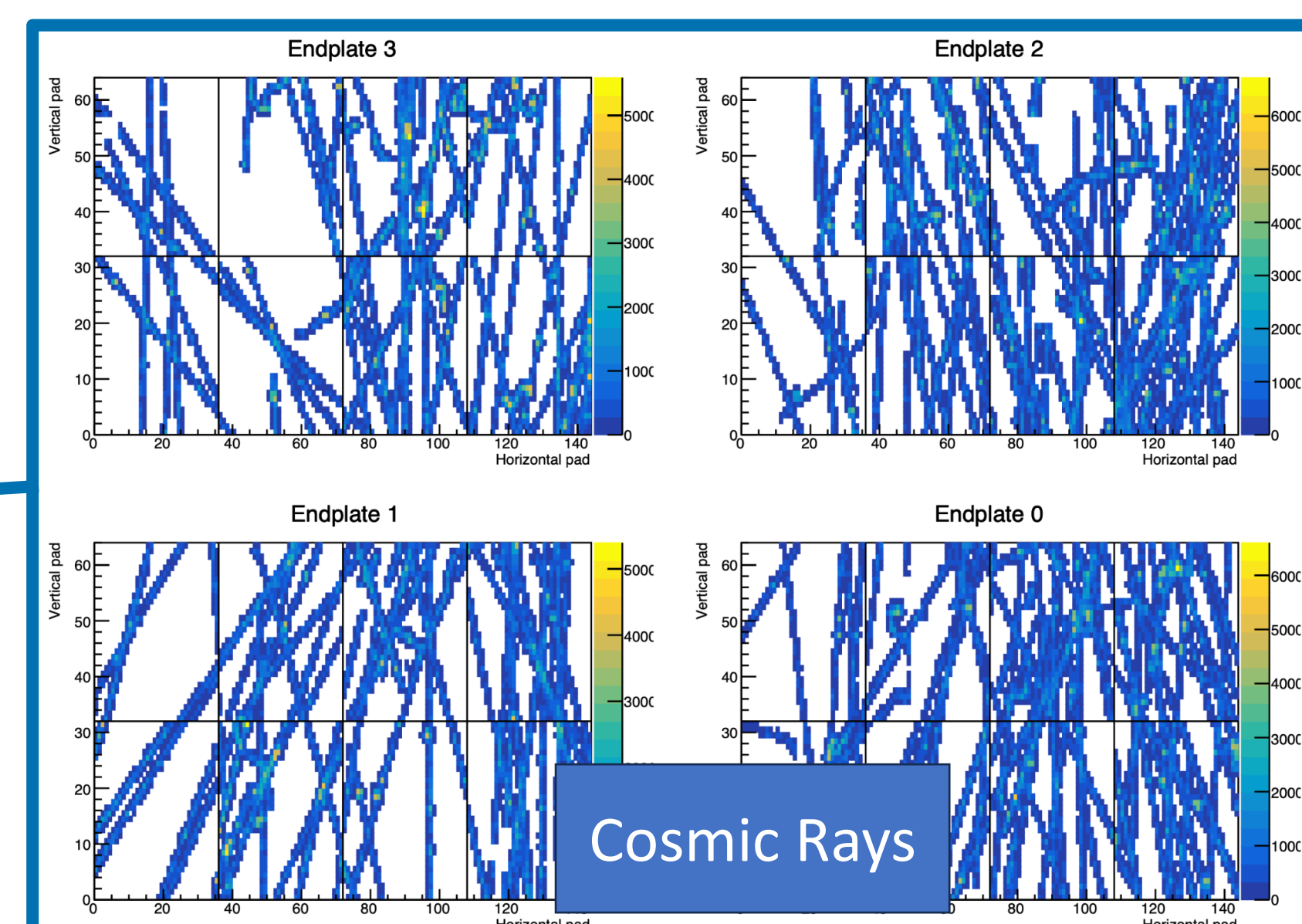
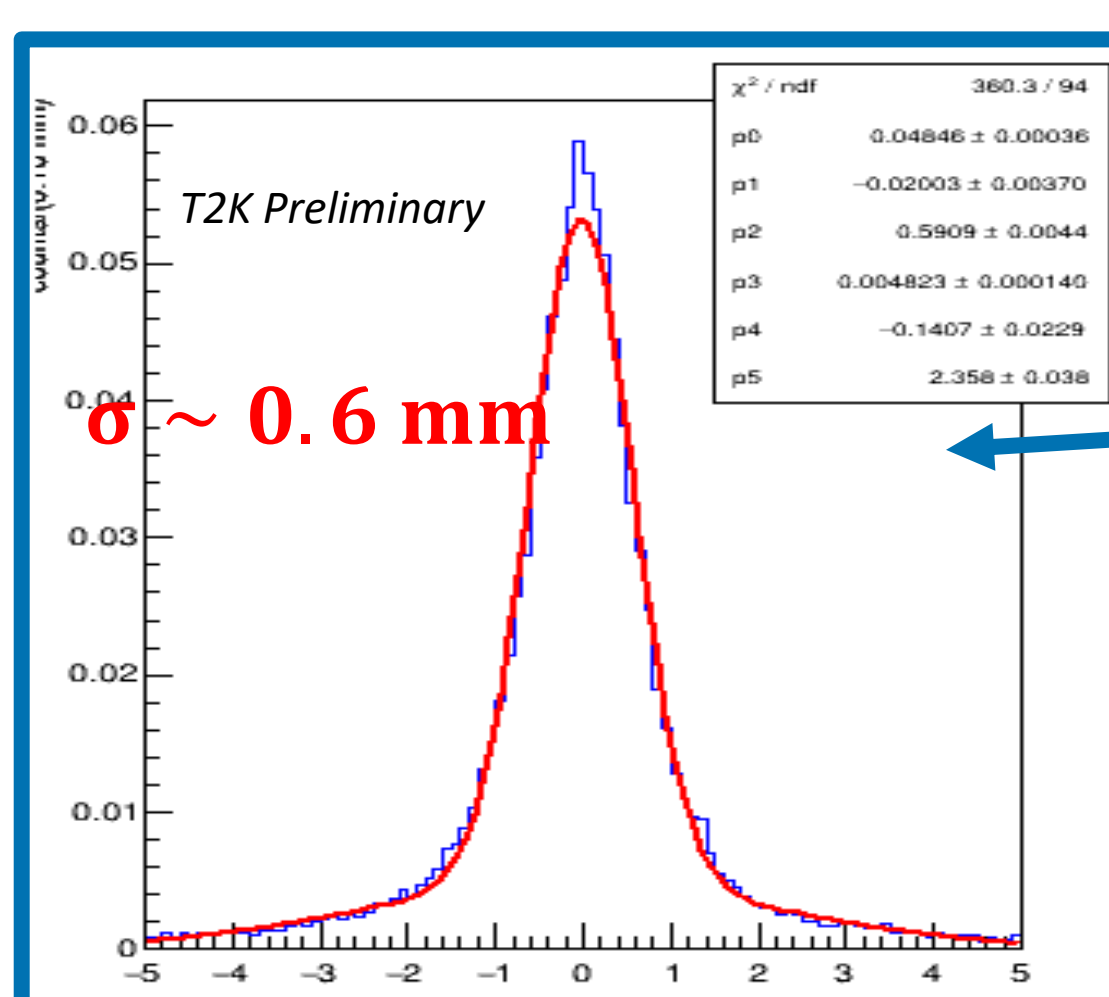
Monitoring of water and oxygen contaminations in T2K gas is important for maintaining constant drift velocity and charge collection by ERAMs

- Oxygen level drop below 10 ppm after ~ 10 volumes exchanged
- Water level has a much lower decrease rate due to hygroscopicity of Kapton surfaces



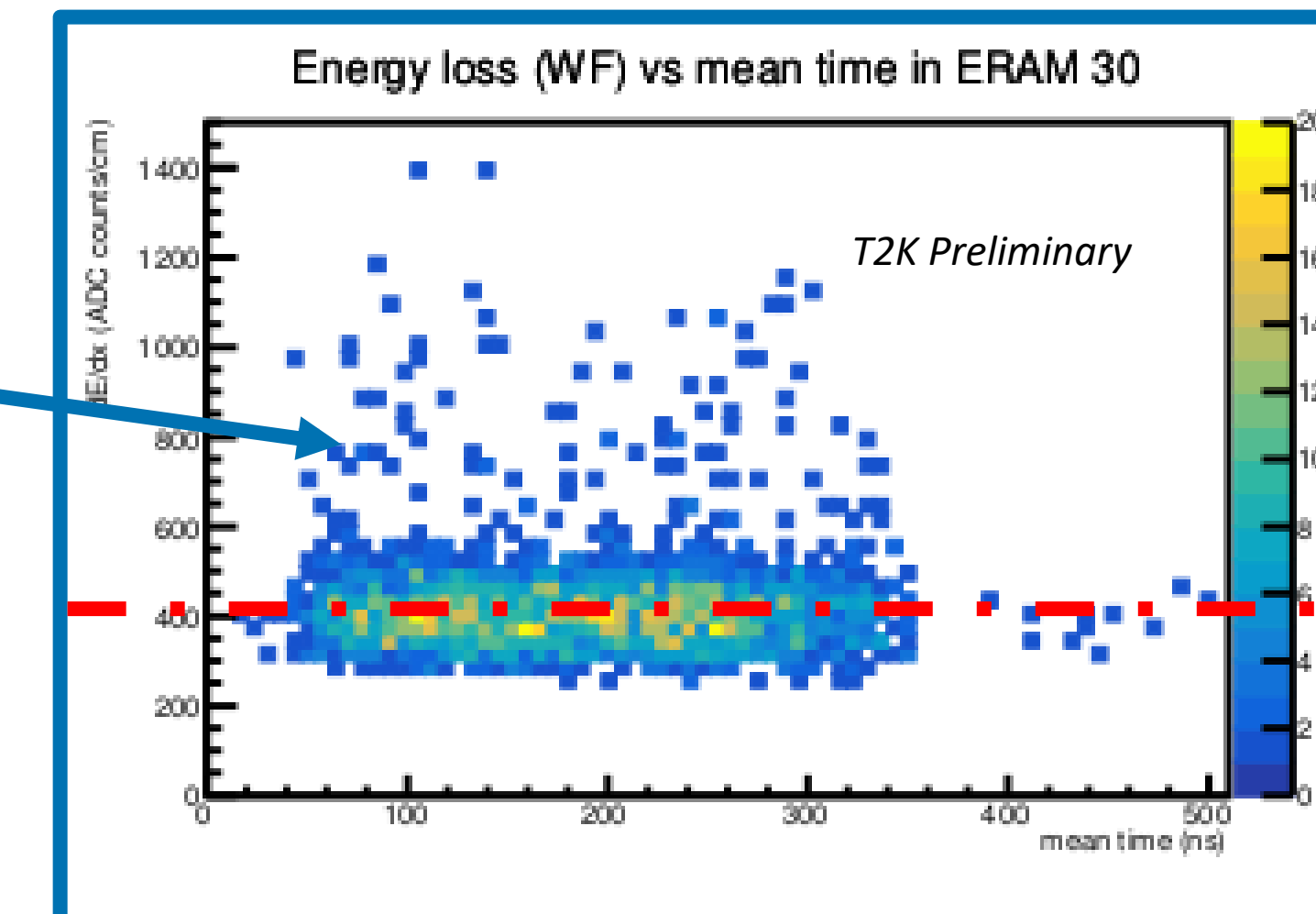
Spatial Resolution

See U. Virginet's poster (#247) for more information about reconstruction



dE/dx Estimation

Energy loss is uniform across drift length: Check on gas quality and stability!



New promising techniques to further improve the results on both spatial resolution and energy Loss are being studied!