

„TPC IN GLAD“ WG REPORT

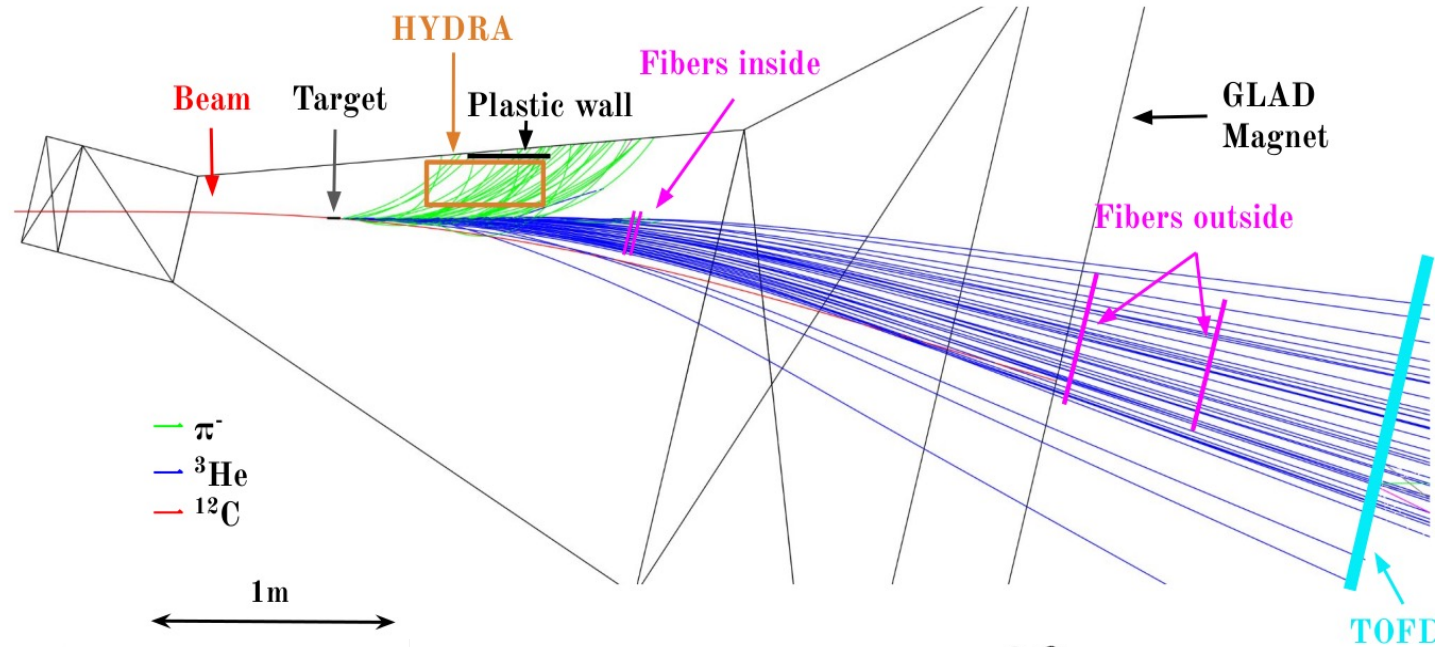
R³B Collaboration Meeting, Mainz, November 2023

Hector Alvarez Pol, Yassid Ayad, **Alexandru Enciu**, **Meytal Duer**, **Liancheng Ji**, Bastian Loehner,
Alexandre Obertelli, Simone Velardita

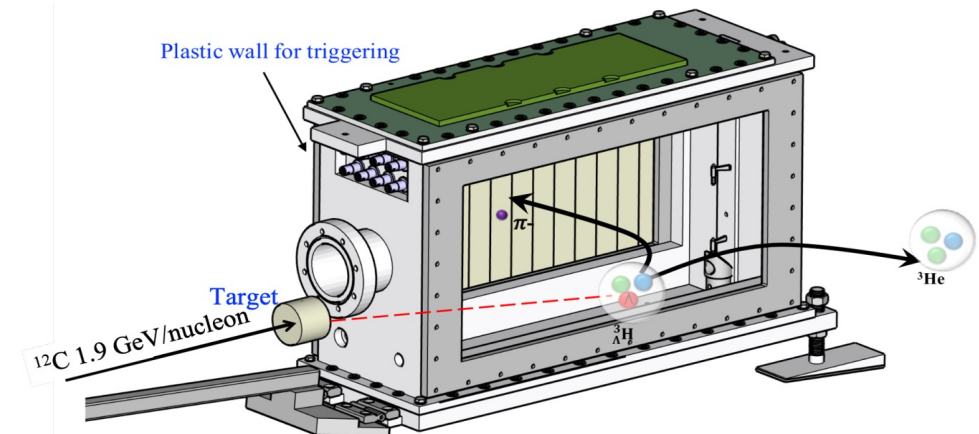
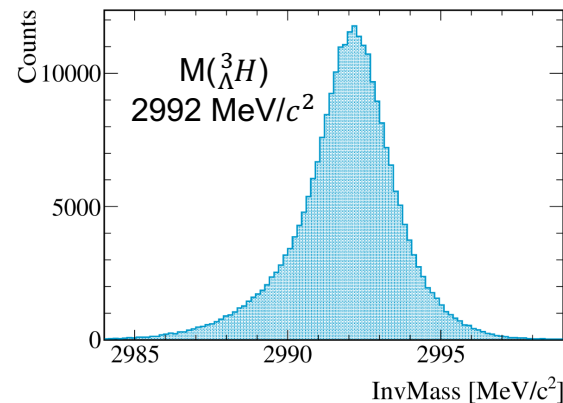
With support from Julien Taieb and **Piotr Gasik**, Joerg Hehner (GSI)

The experiment S73 (Feb. 2025)

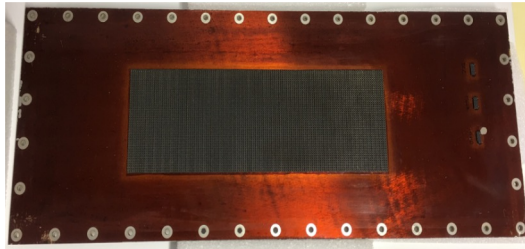
- Interaction cross section of hypertriton with ^{12}C
- Dedicated pion (π^-) tracker in GLAD
- TPC + plastic wall in GLAD
- 3 new small (x,y) fiber detectors



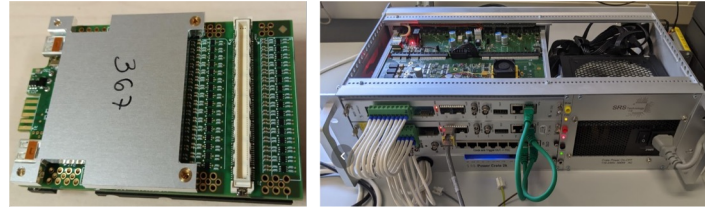
Invariant mass
(see later slide)



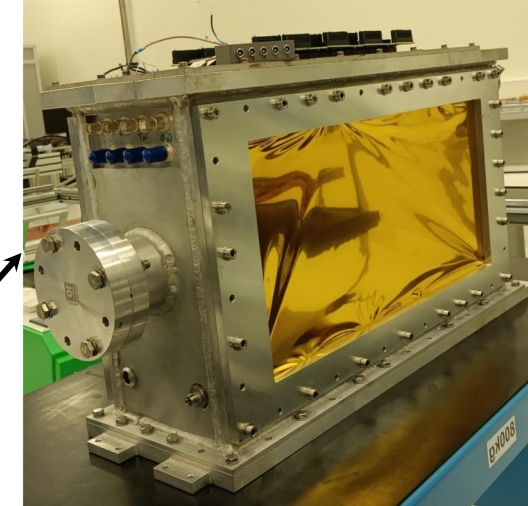
The TPC



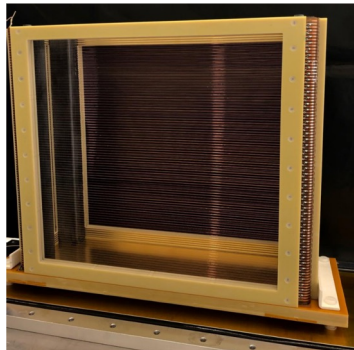
Metal core pad-plane (5632 Ch)
MicroMegas amplification + GEM to
reduce the ion back flow $< 1\%$



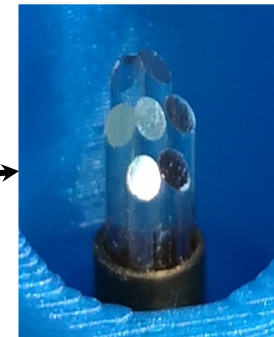
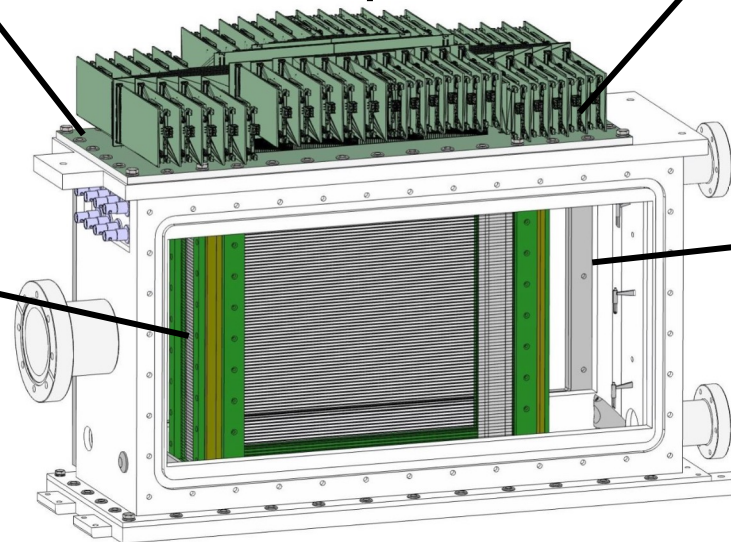
VMM3 front-end card + SRS backend
Currently (R&D): AGET / ASAD / zCOBO



TPC assembled and under test



Double wire field cage

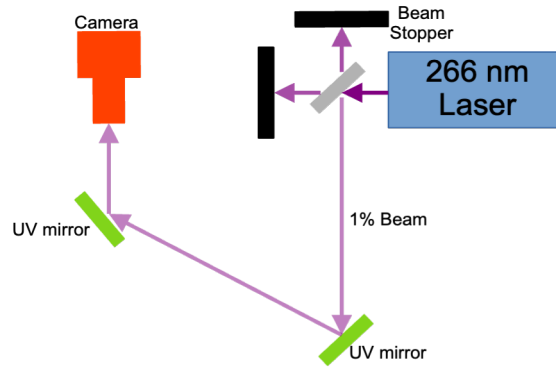


Micro-mirror bundle for UV 266 nm
laser

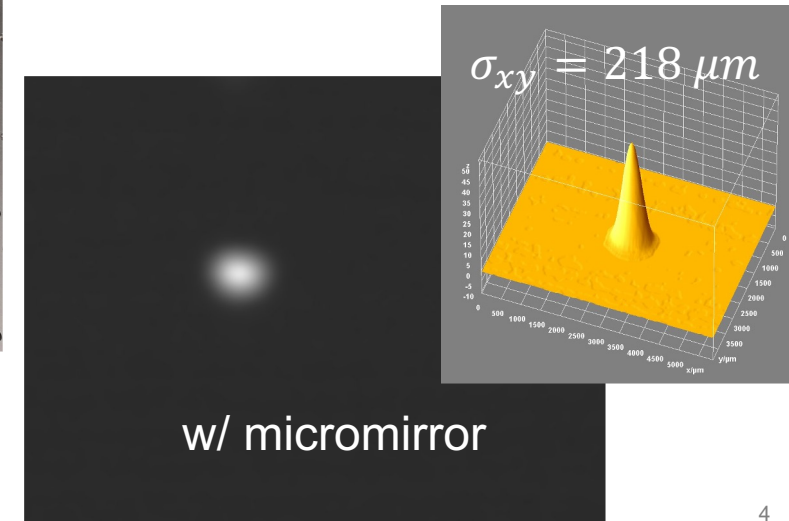
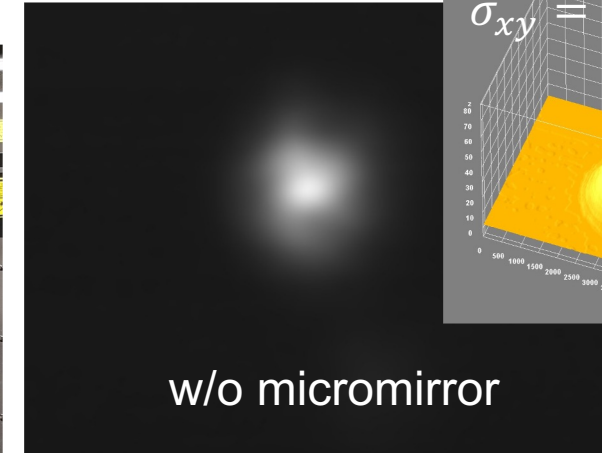
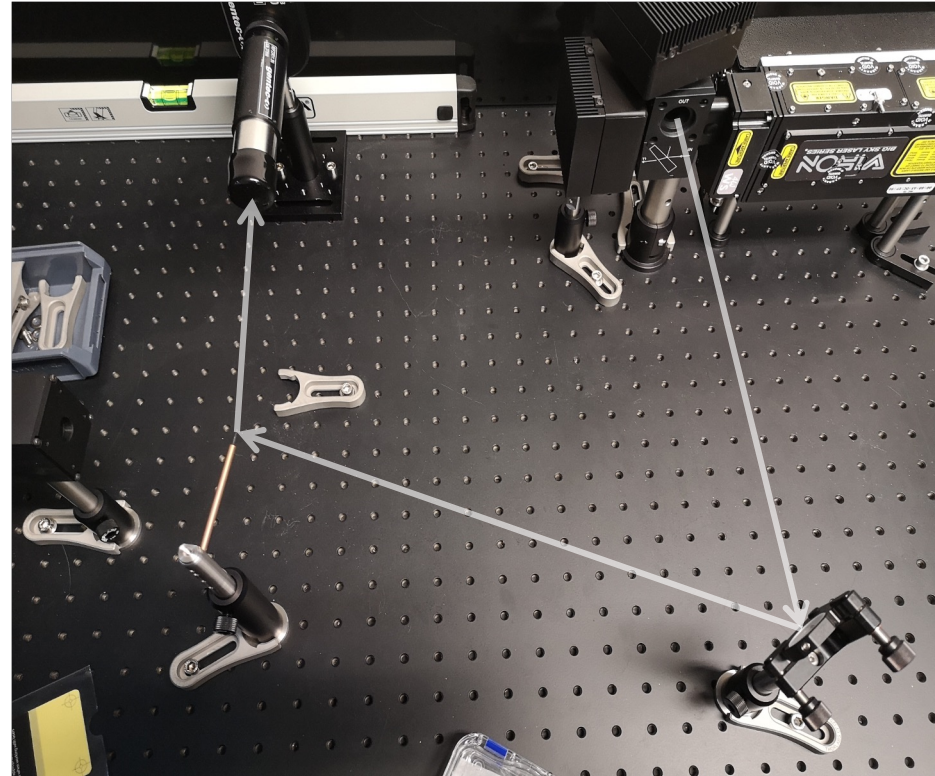
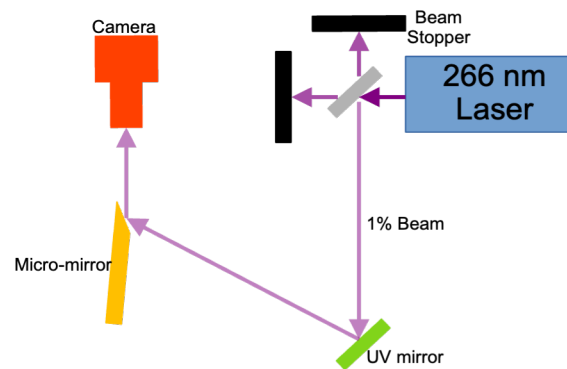
+ plastic wall: **built, validated**

Testing the micromirrors

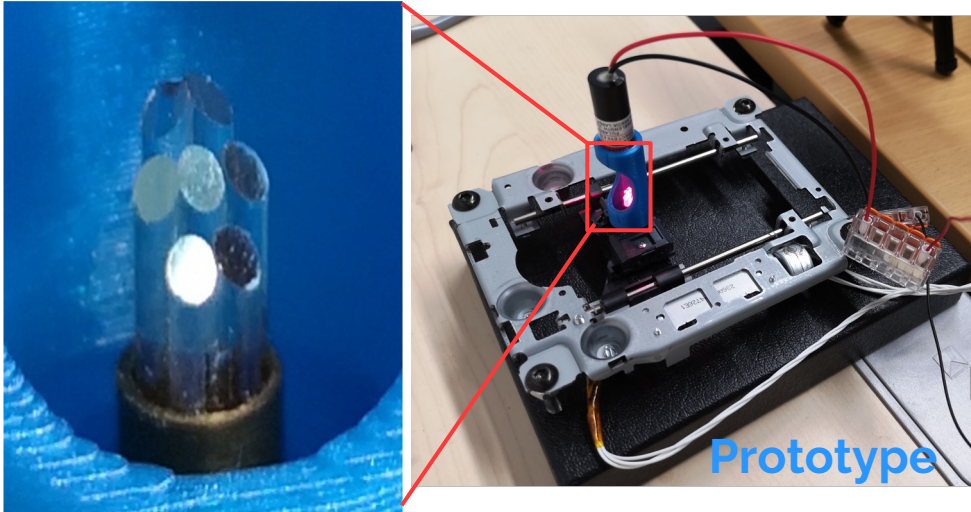
Profile of primary laser beam



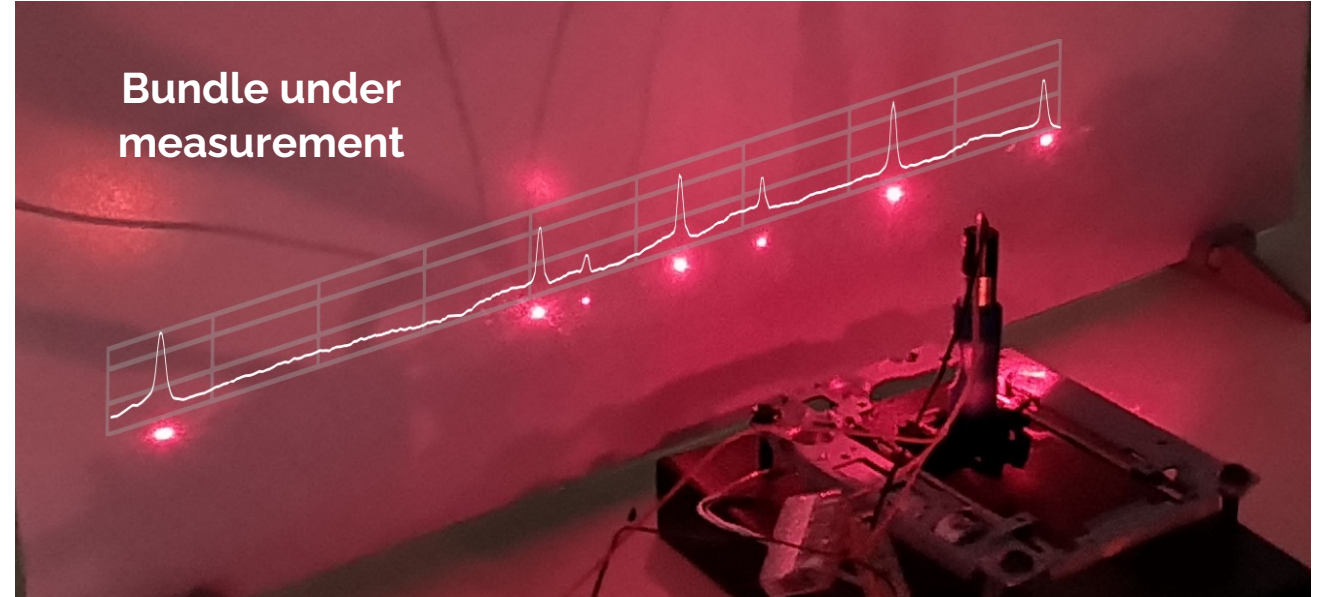
Profile reflected by micro-mirror



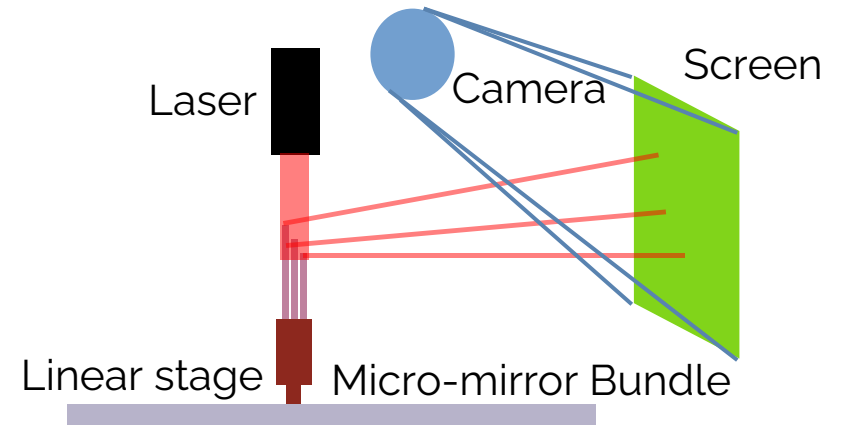
Micromirror bundles



STAR TPC Micro-mirror bundle

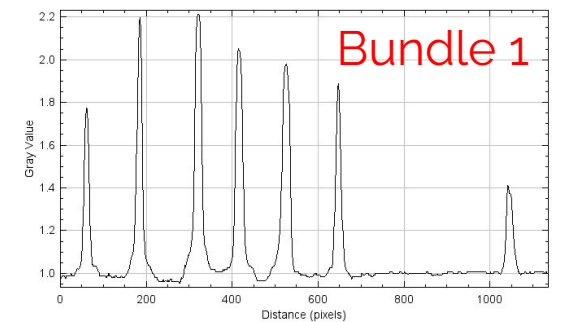
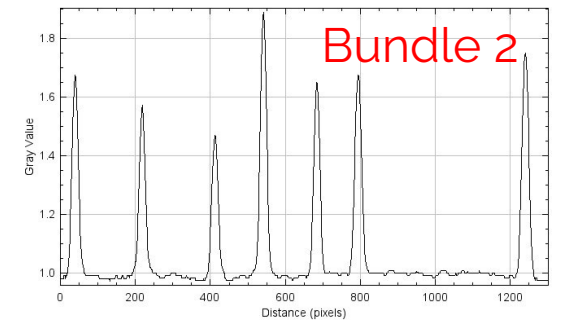
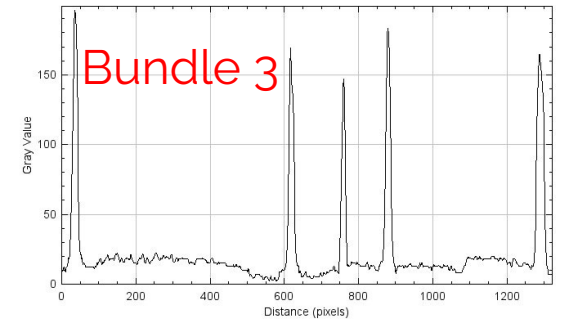
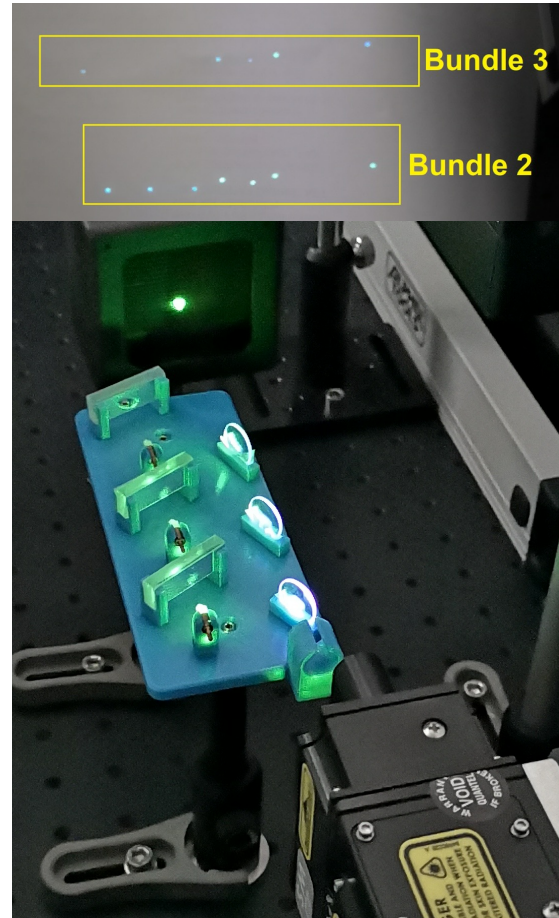
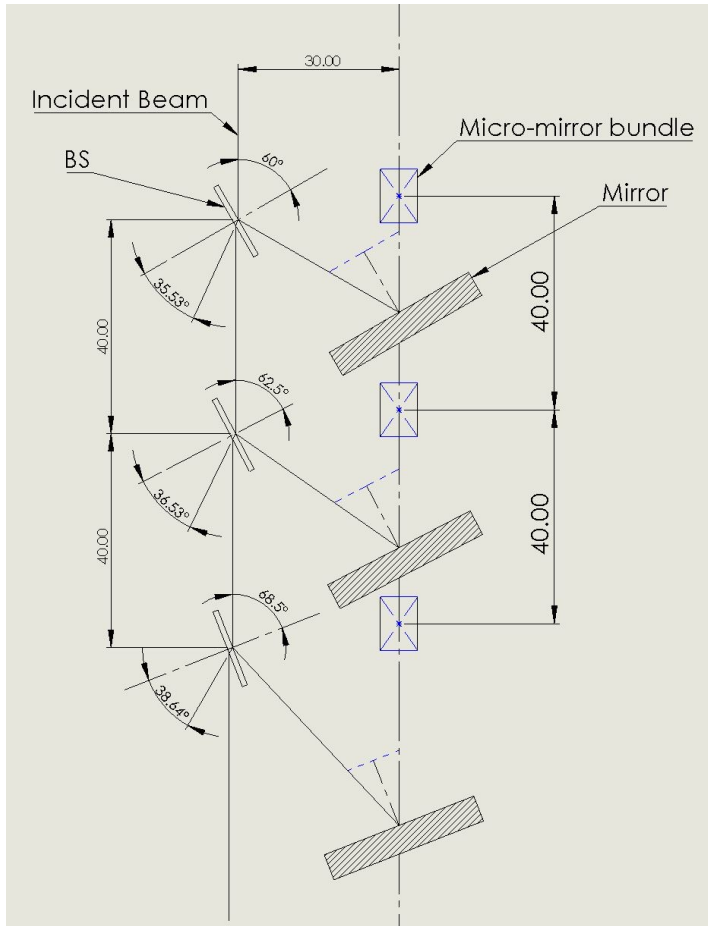


- Bundles provided by STAR for 203/2024 tests
- HYDRA bundles to be built in 2024
- All materials purchased and received

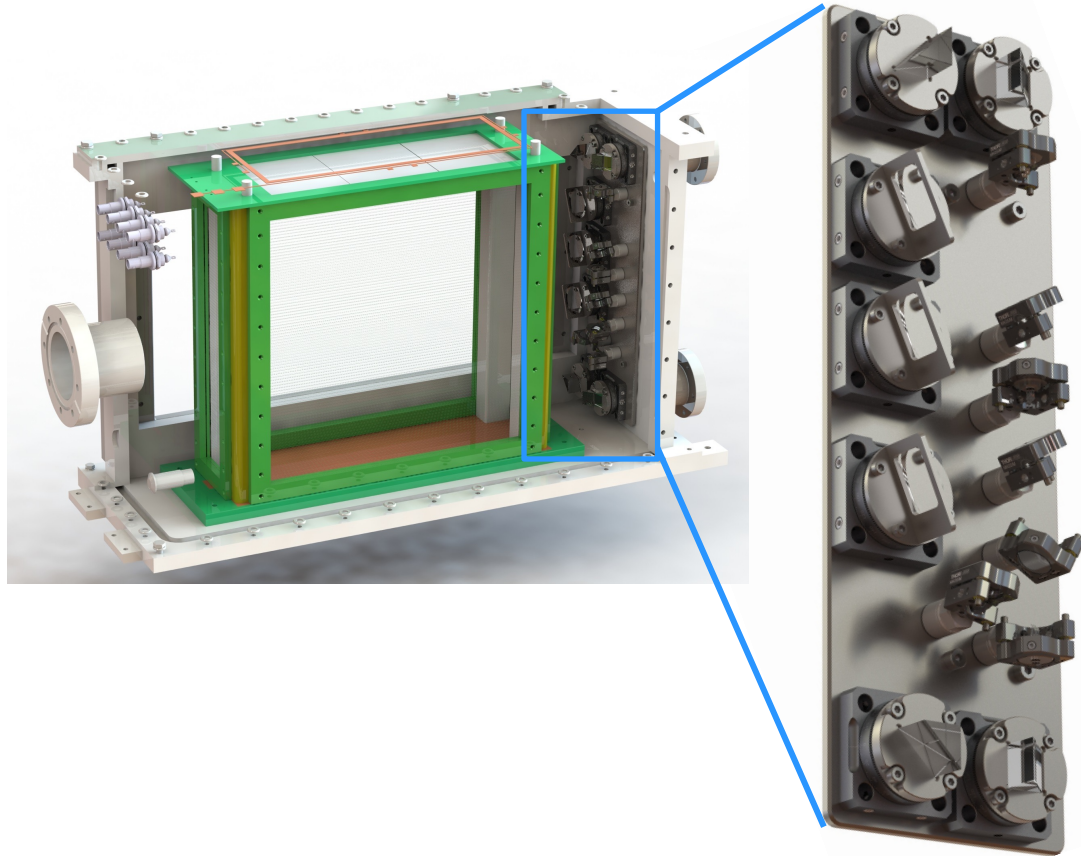


Micromirror assembly

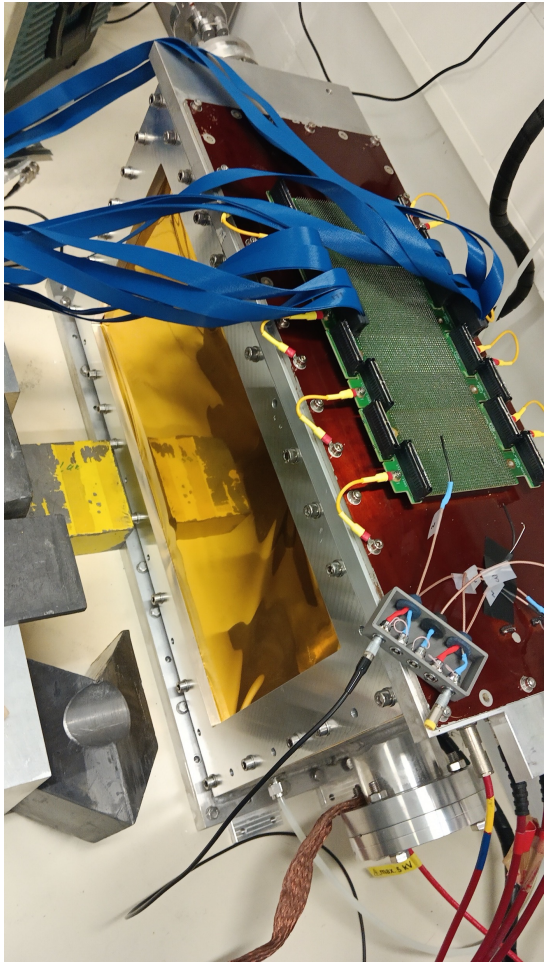
- System of 3 beam splitters, 15% of primary beam



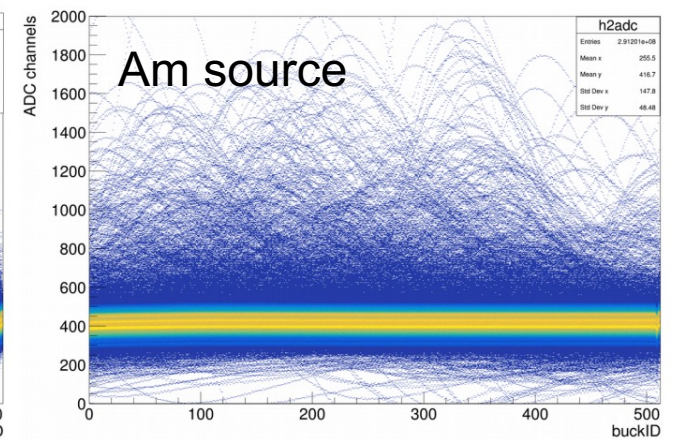
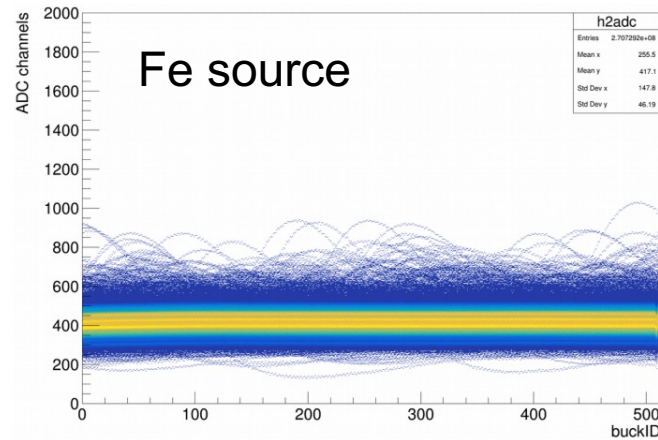
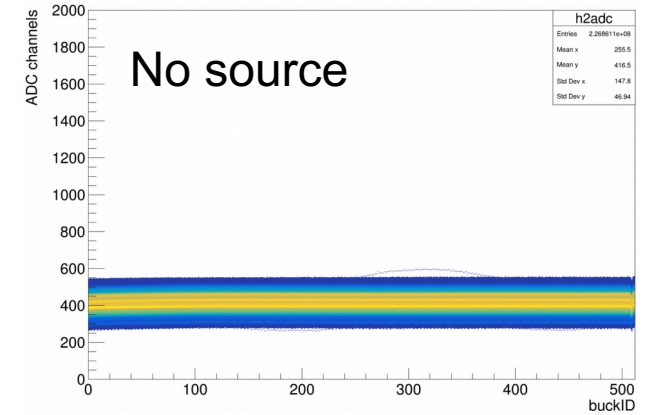
Assembly in TPC



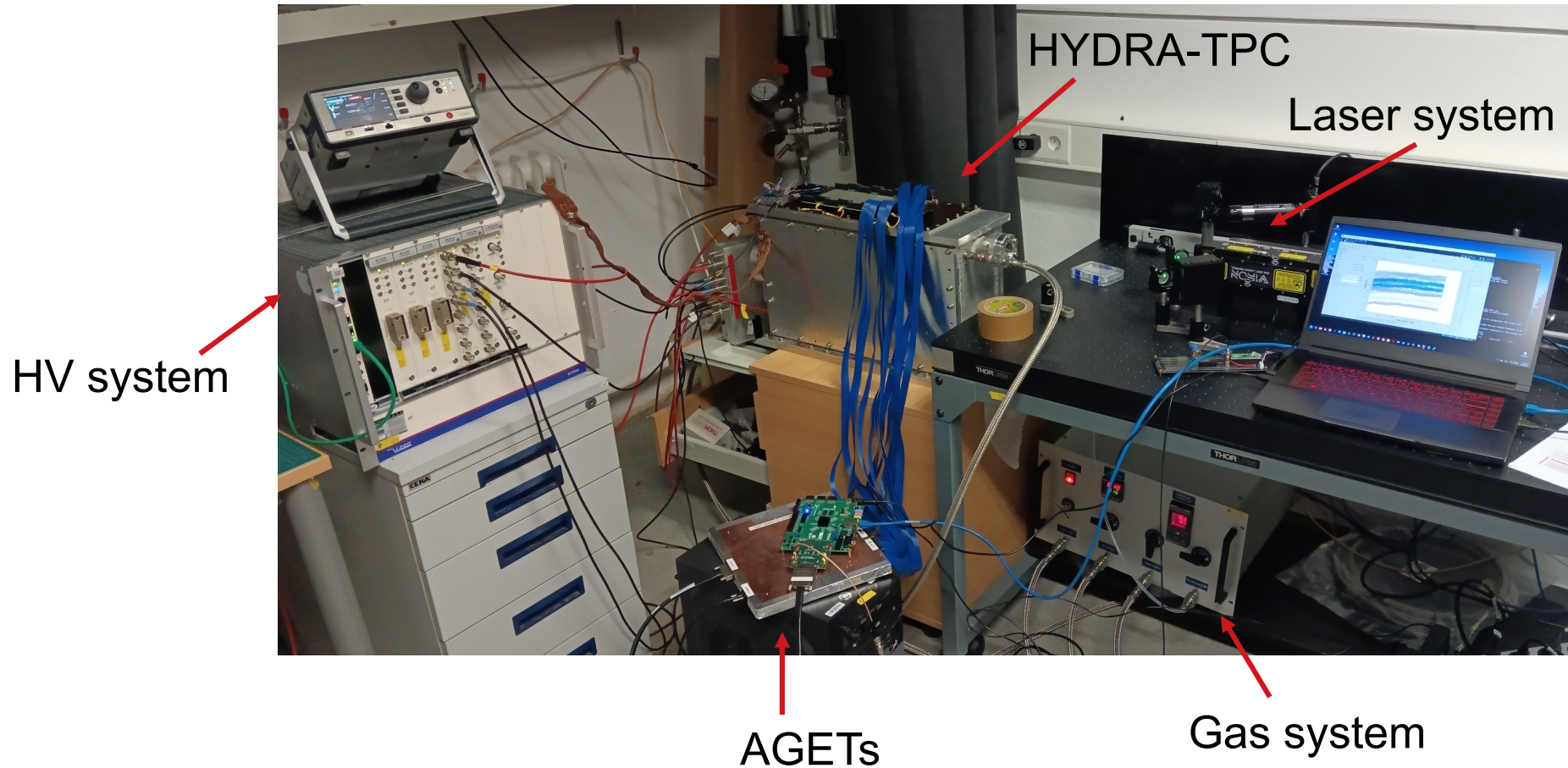
Source validation at GSI (Oct.)



- 1 ASAD FE board (256 channels)
- Fe, Am, Sr sources through Mylar window
- Uncorrelated trigger (no drift information)

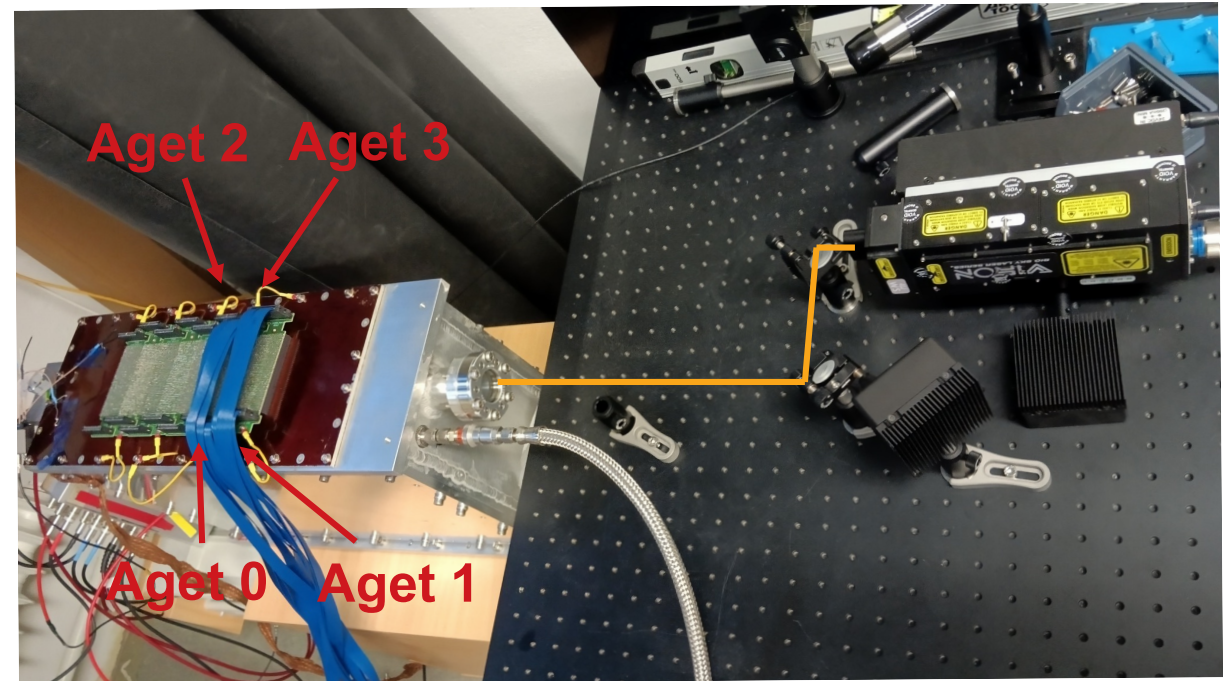
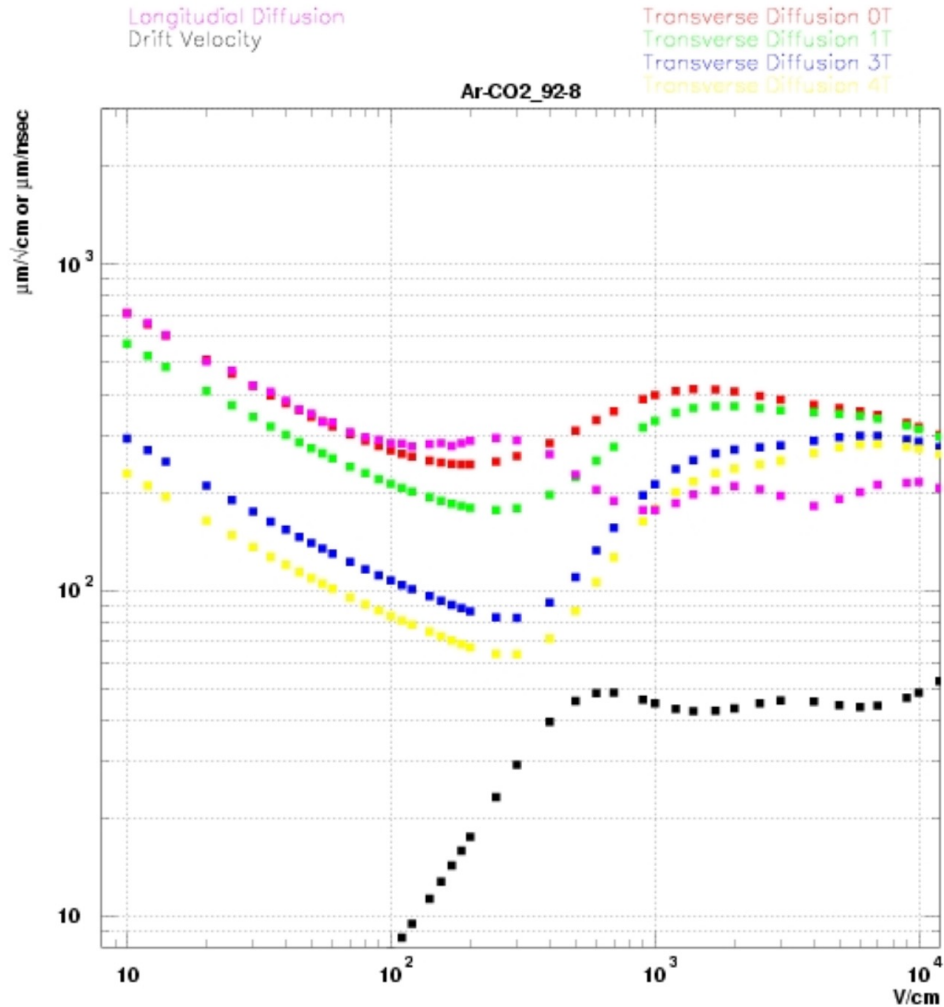


Installation at TUDa (Oct., Nov.)

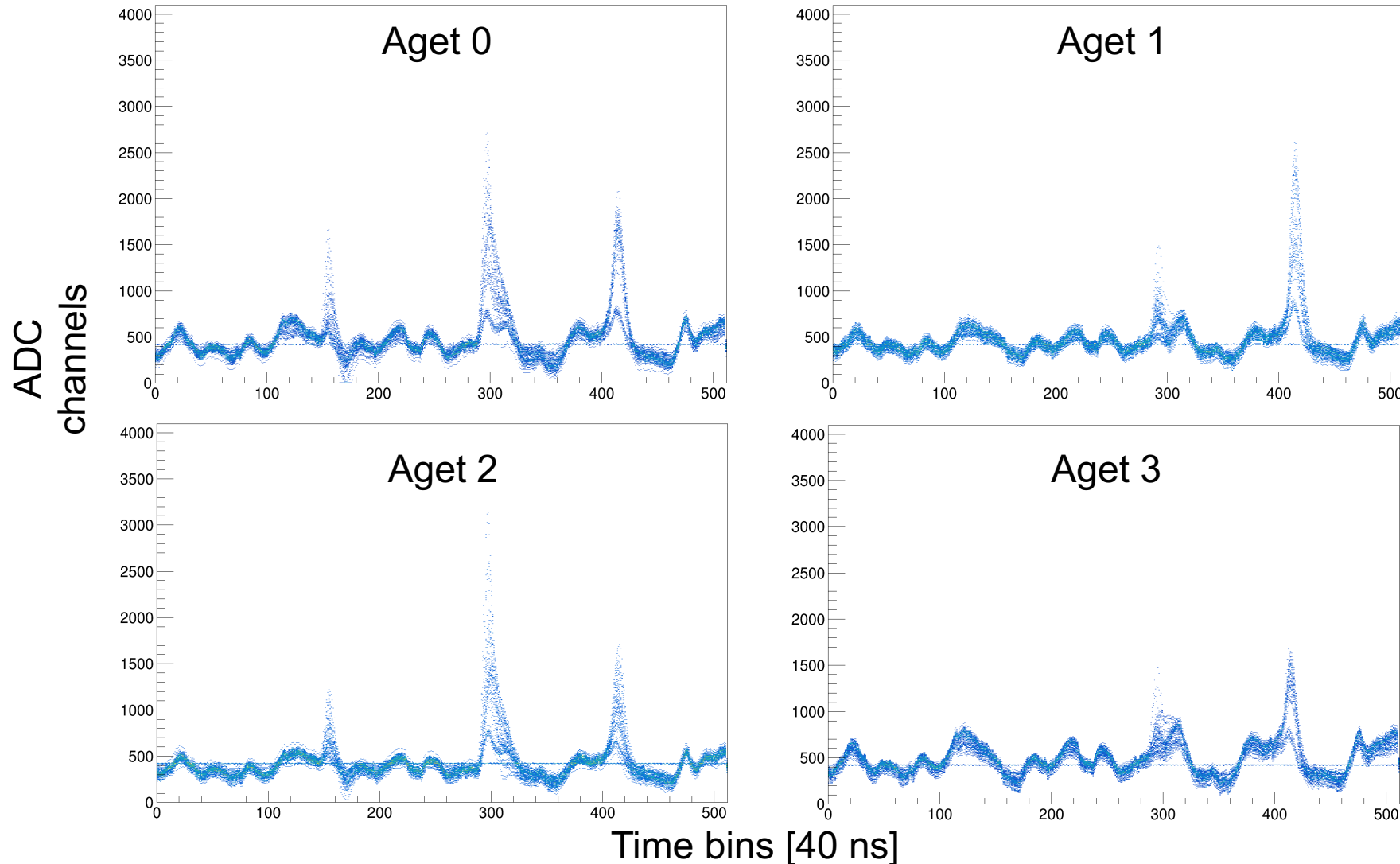


Settings

- Full laser power (4 W), 9 mJ/pulse, 20 Hz
- 7 ns pulse width
- Drift electric field: 170 V/cm
- Amplification(gain): 10k
- Test gas mixture: 92% Ar + 8% CO₂

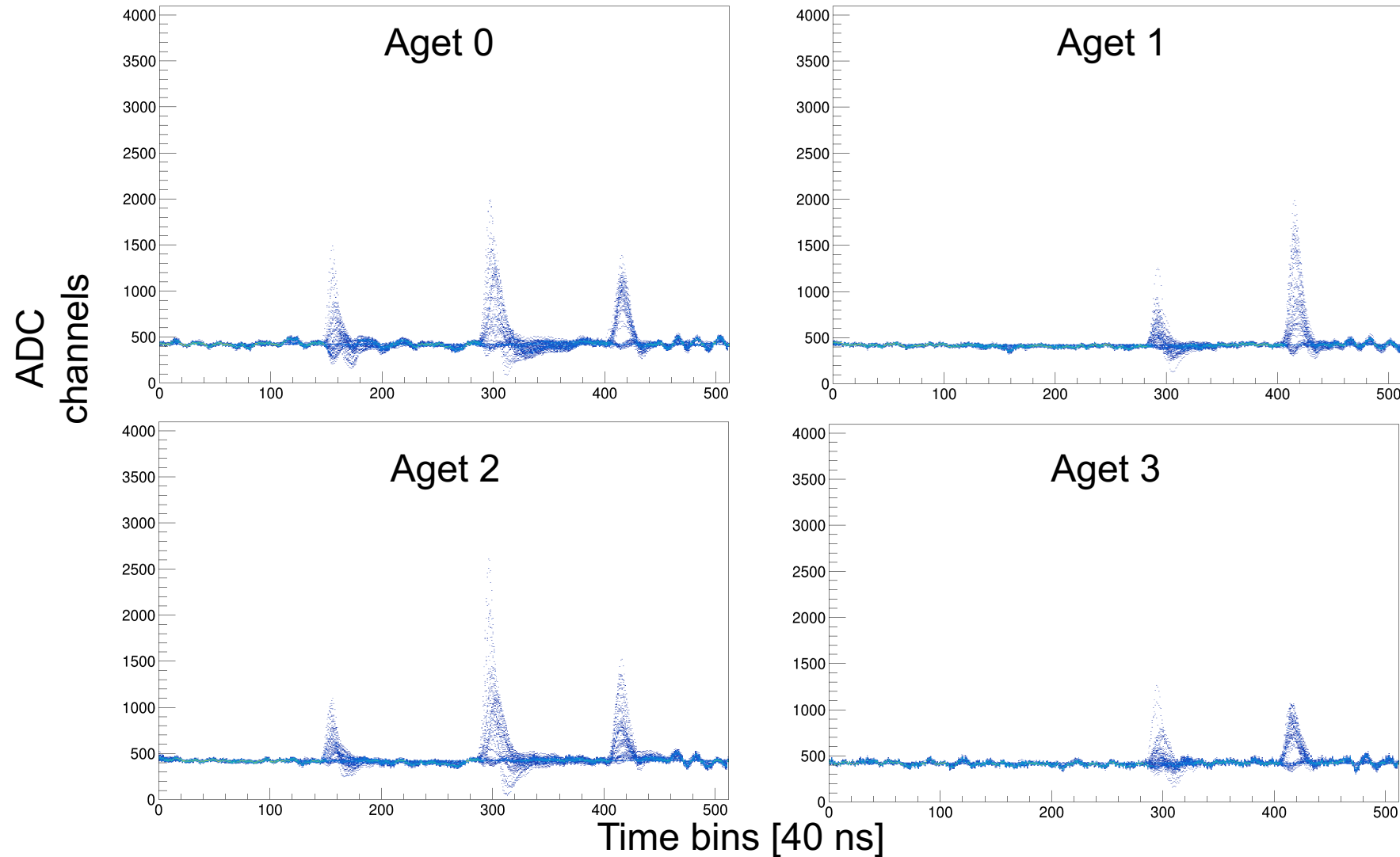


Raw waveforms



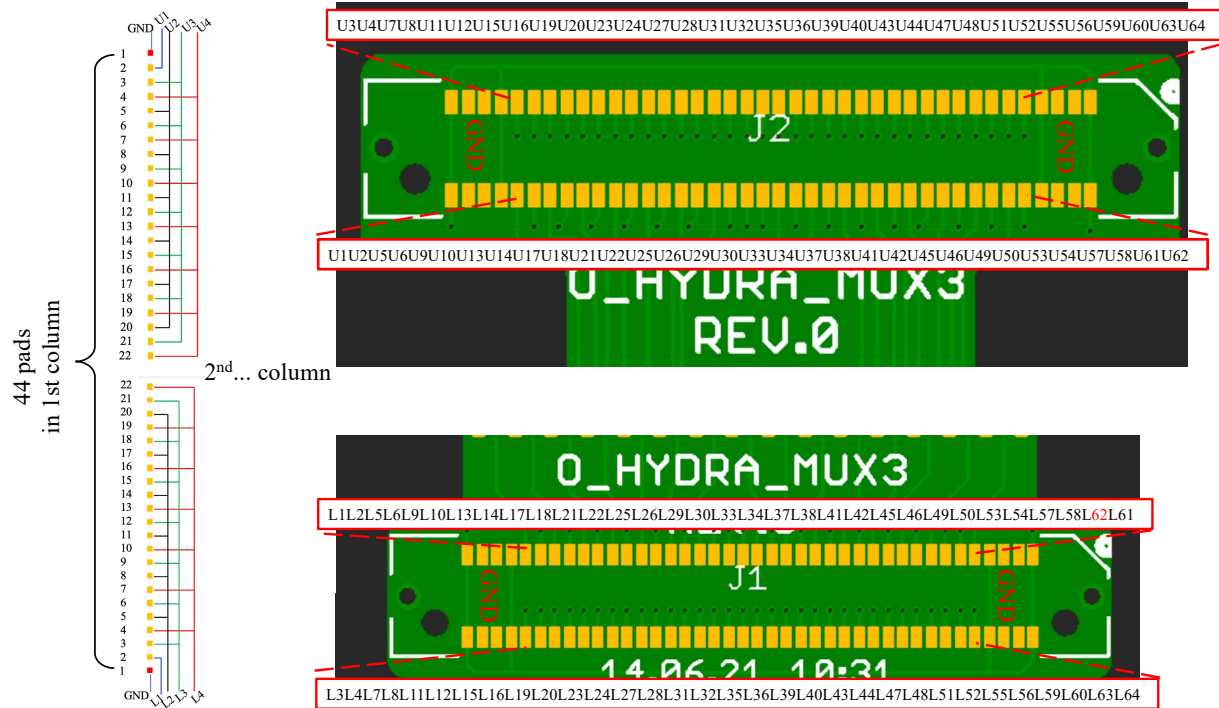
Integration time: 232 ns
Time bins: 40 ns
ADC range: 120 fC (12 bits)

After noise subtraction

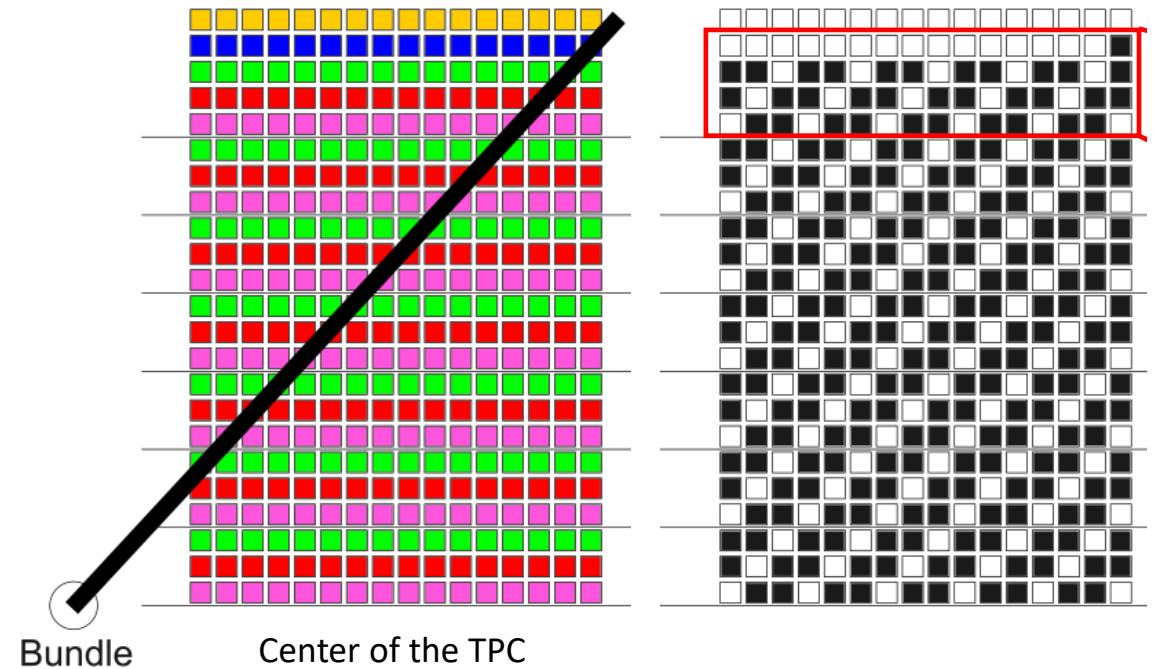


FEE and mapping

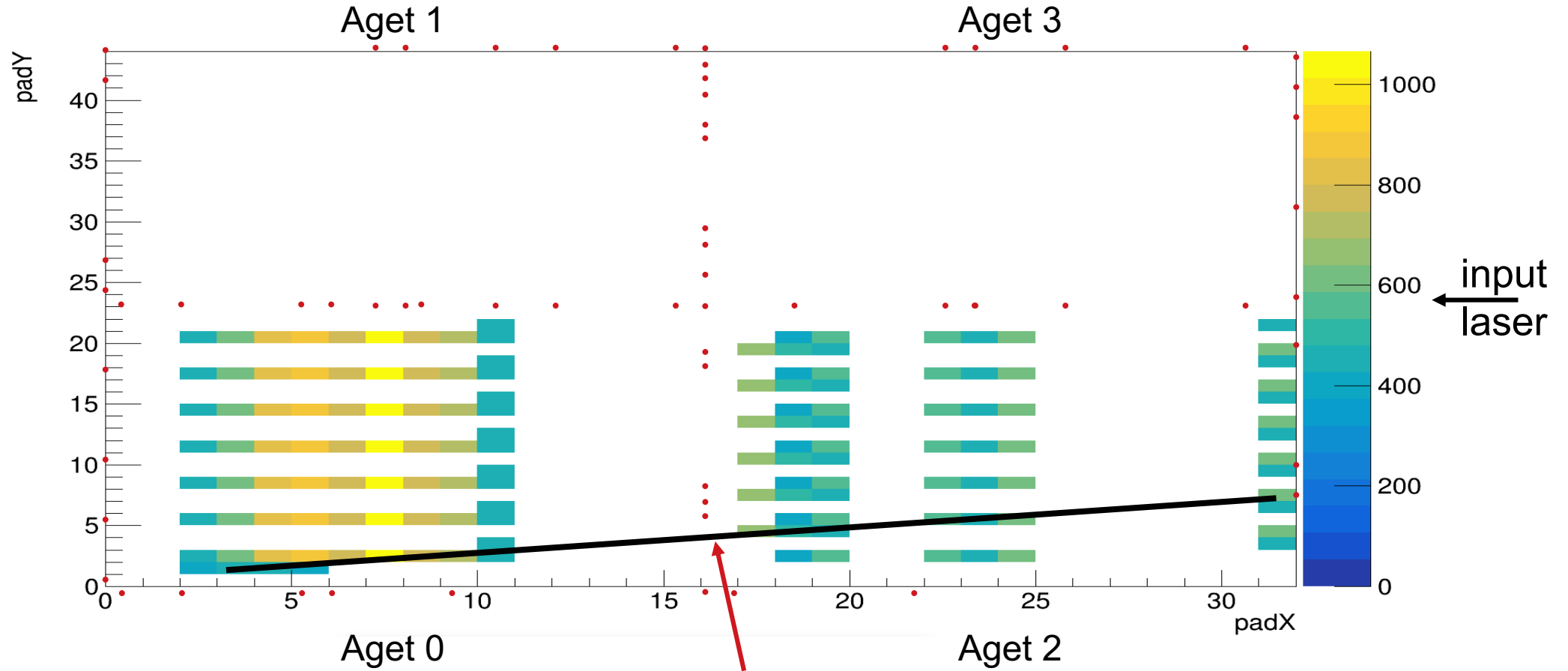
- 1024 electronics channels for 5000 pads
- Most channels connected to 5 or 6 pads (multiplexing)
- Multiplexing boards between TPC and FEE



V2

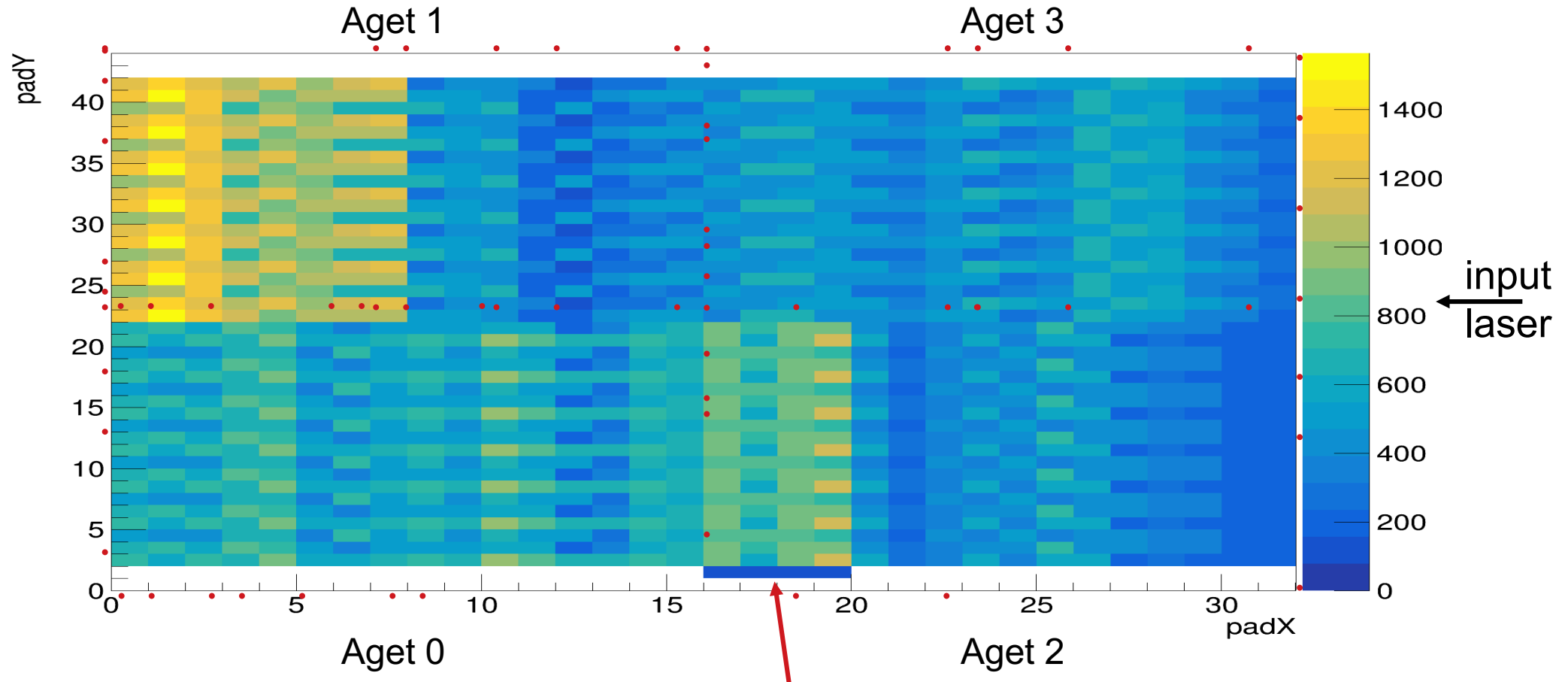


First laser track event (1 ASAD)

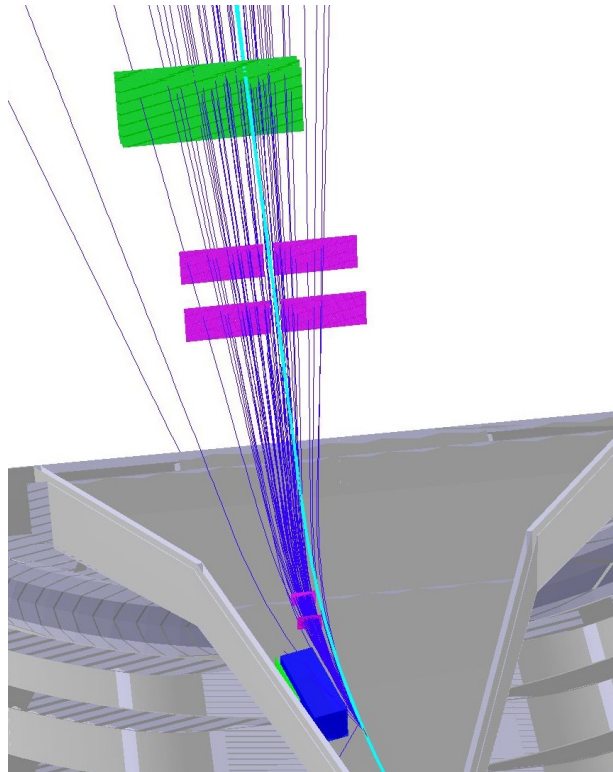


Reconstructed track from the laser

Case of several tracks



Configuration



^3He from hypertriton decay

Fibers outside GLAD (FB30-33): new configuration

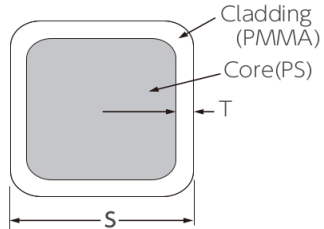
- Only x direction, side-by-side with a gap for the beam (proposed by Michael Heil)
- **^3He acceptance + efficiency: 60.9%** (GEANT4 simulations)

Fibers inside GLAD: to be built

Full simulations performed to validate specifications (see next slides)

- 2 (x,y) 13x13 cm² for ^3He tracking
- 1 (x,y) in front of target for beam position

Fibers, vertex reconstruction



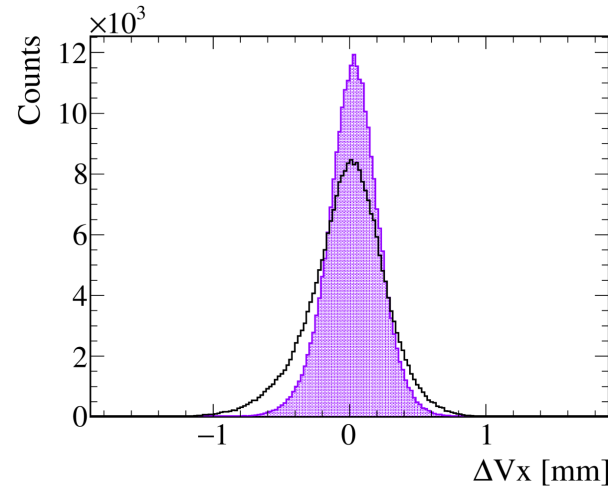
Cladding Thickness : $T=2\%$ of S
 Numerical Aperture : $NA=0.55$
 Trapping Efficiency : 4.2%

Black = one layer 0.1 cm Color = 3 layers 0.05 cm

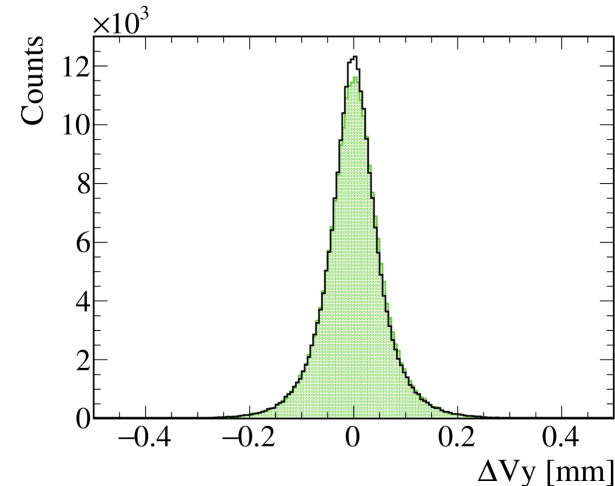
Simulating two possibilities:

- (i) one layer: $S = 0.1$ cm thick
- (ii) 3 layers: $S = 0.05$ cm thick

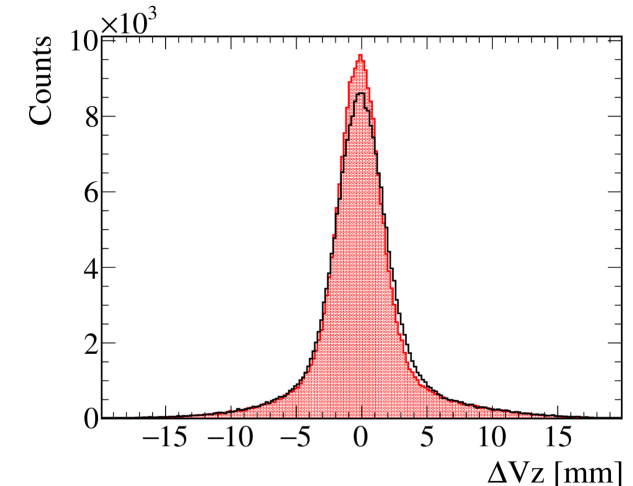
Vertex x
 $\sigma=0.28$ mm; **0.20** mm



Vertex y
 $\sigma=0.1$ mm; **0.1** mm



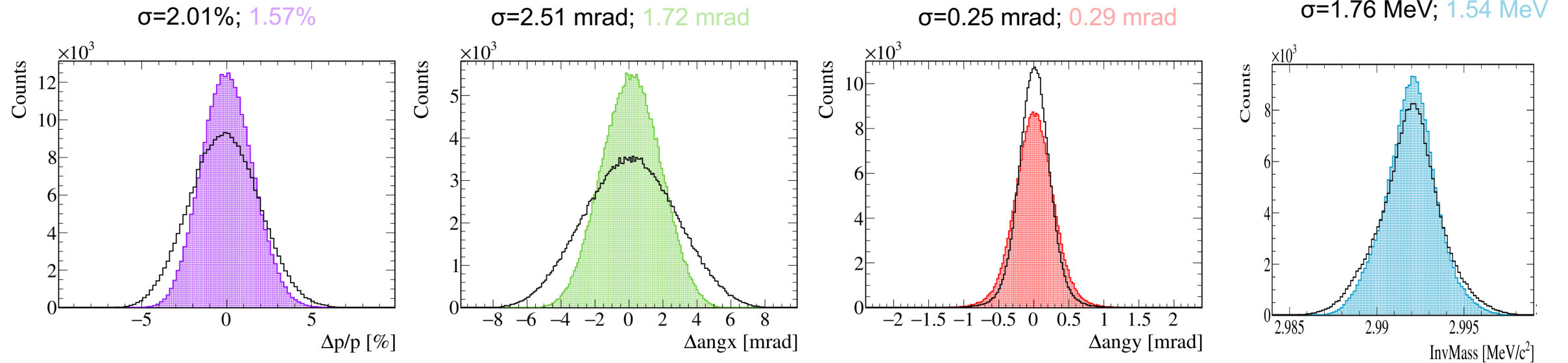
Vertex z
 $\sigma=3.7$ mm; **3.5** mm



- ^3He from hypertriton decay
- Pion momentum smeared with 1% at the entrance to the TPC
- Merging with pion simulations ongoing: still need to include GLAD field map in Genfit

Fibers: invariant mass resolution

Black = one layer 0.1 cm Color = 3 layers 0.05 cm



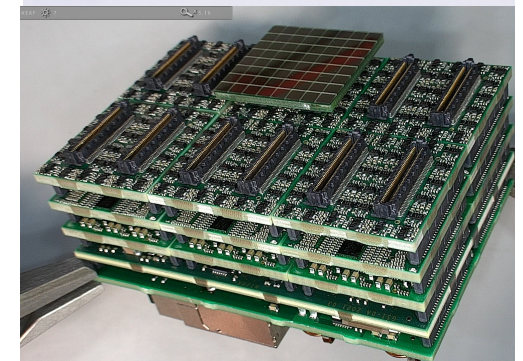
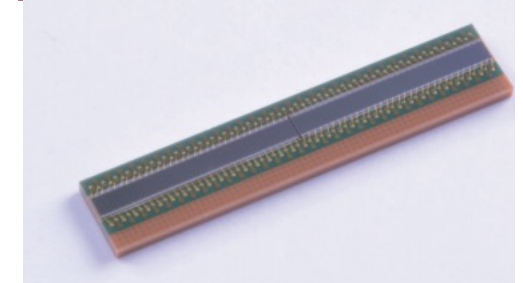
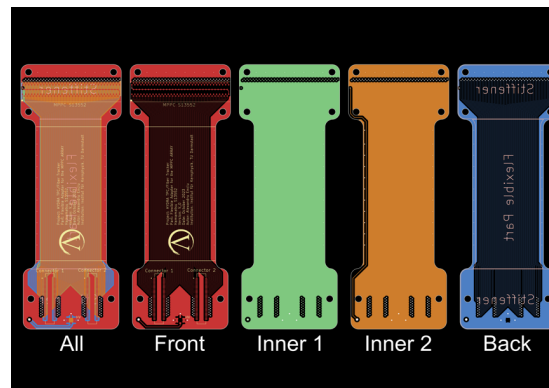
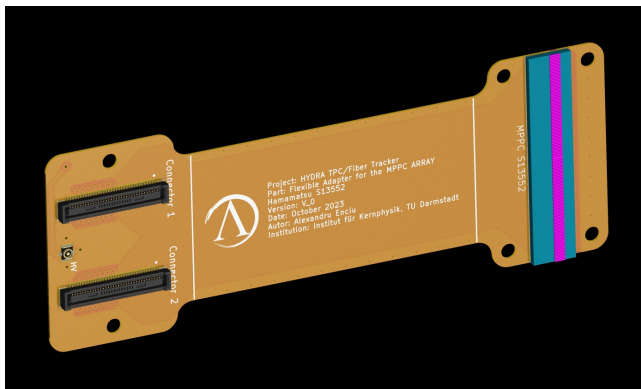
$M(^3\text{H})=2992.14$ MeV

Decision: 3 layers: S = 0.05 cm thick

Development in-GLAD fibers

- 13x13 cm²: 3x0.05 cm layers (C. Caesar, D. Savran)
- 128-element MPPC arrays
 - 14 arrays **ordered** (expected in Dec. 2023)
- Readout electronics: FaRICH (384 channels per system) + trb3sc
- Rigid-flexible PCB adapter (**ordered**)

- Prototype 1/2 fiber-plane detector:
 - 2 MPPC arrays from C. Caesar
 - 1 FaRICH system **ordered** (available at the GSI electronics lab.)
 - PCB **ordered**
 - Continuation the GLAD-laser measurement



Summary

- HYDRA detector (TPC and plastic) built and first validation in laboratory
- Laser system works

This week

- All channels (4 ASAD) connected and laser data
- Tracking algorithm

Next week

- Packing and move to GSI
- Installation from November 16, Week of Nov. 17-24: measurement in GLAD (see wiki)

Parasitic beam time in February 2024

- Reduced scope if no VMM3 FE

Experiment in February 2025

- Fiber detectors (inside GLAD)
- VMM3 FE implementation, validation (laser at TUDa + in-beam in a location still to be defined)
- R3B DAQ (VMM3 / TRB3)
- Ion-back flow measurements and potential optimization of TPC settings