STT Prototyping Activities

R. Petti

University of South Carolina, Columbia SC, USA

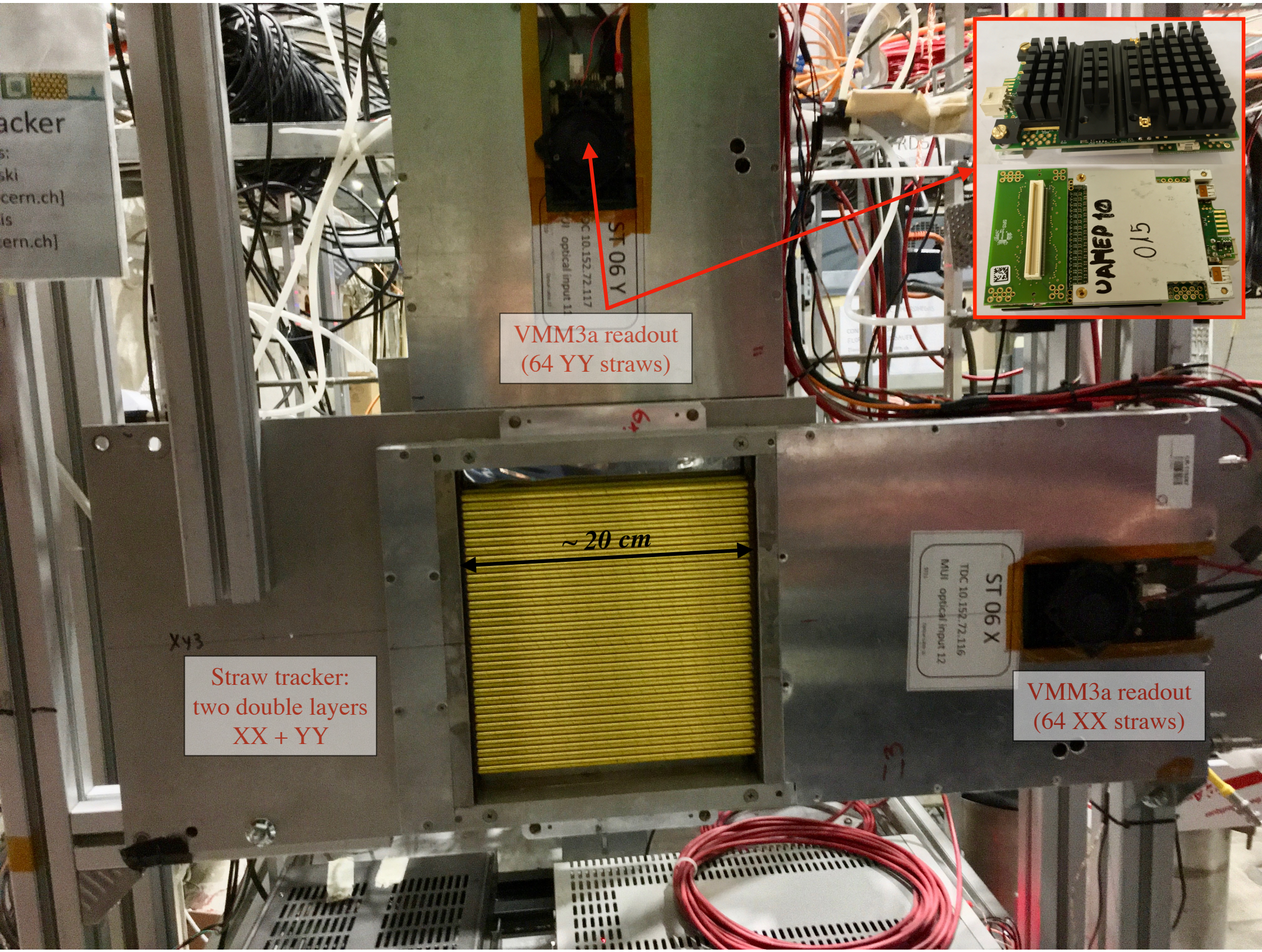
SAND meeting
October 26, 2021

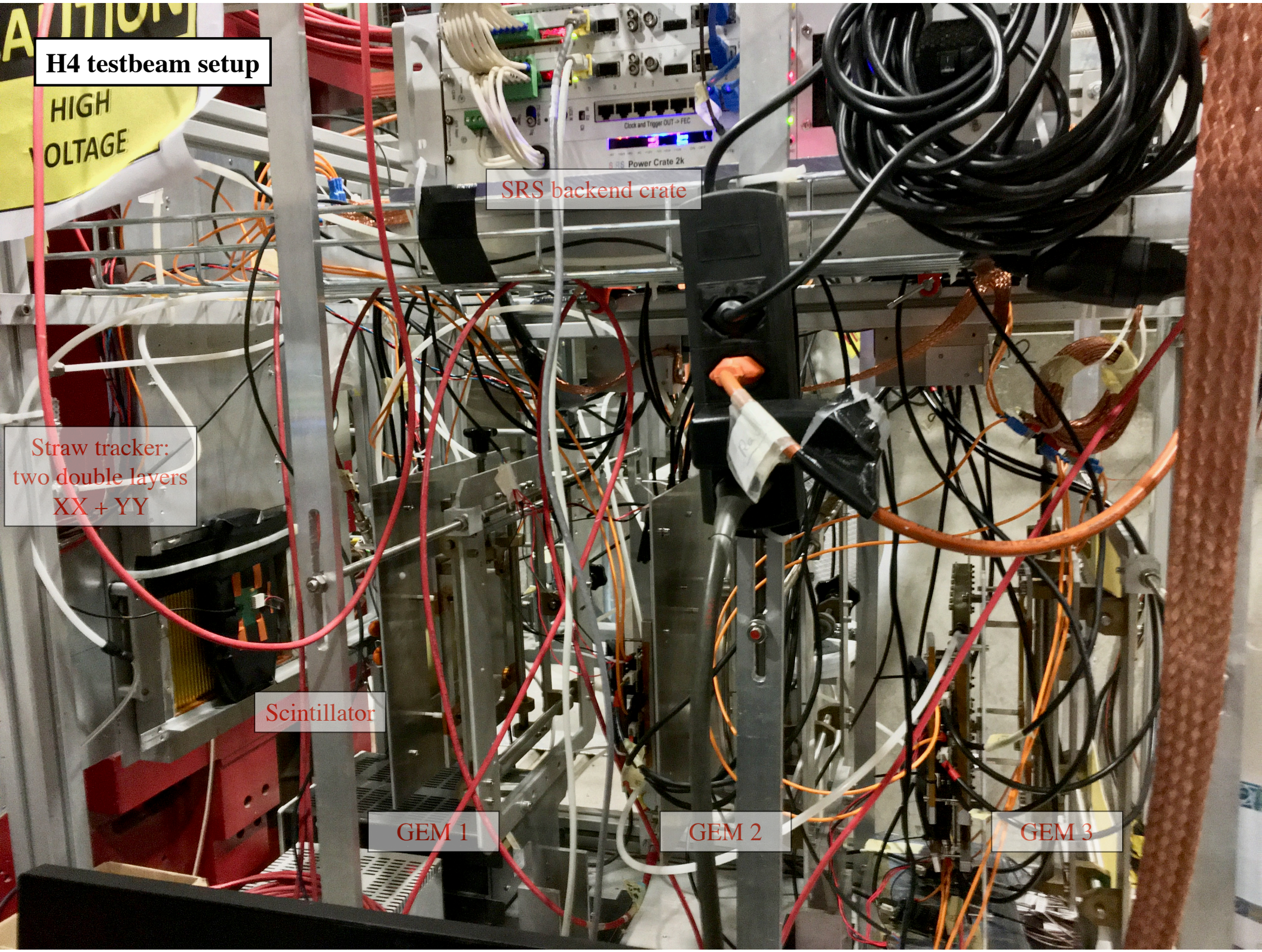
BEAM TESTS OF VMM3 READOUT

- *Setup with small (20cm $\times$ 20cm) straw tracker + VMM3a readout at RD51 testbeam:*
  - *Two double layers XX+YY with straws staggered by half diameter;*
  - *Indepedent tracking system with 3 GEM detectors ($\sigma \sim 50\mu m$) equipped with VMM3 readout;*
  - *SRS readout system with Felix based DAQ.*

- *Ongoing testbeam at H4 CERN beamline (21 October - 7 November 2021):*
  - *High energy μ, π with $E \sim 160$ GeV;*
  - *STT setup installed in H4 beamline on 20 October (JINR);*
  - *Usable data taking from 25 October with all detectors working properly.*

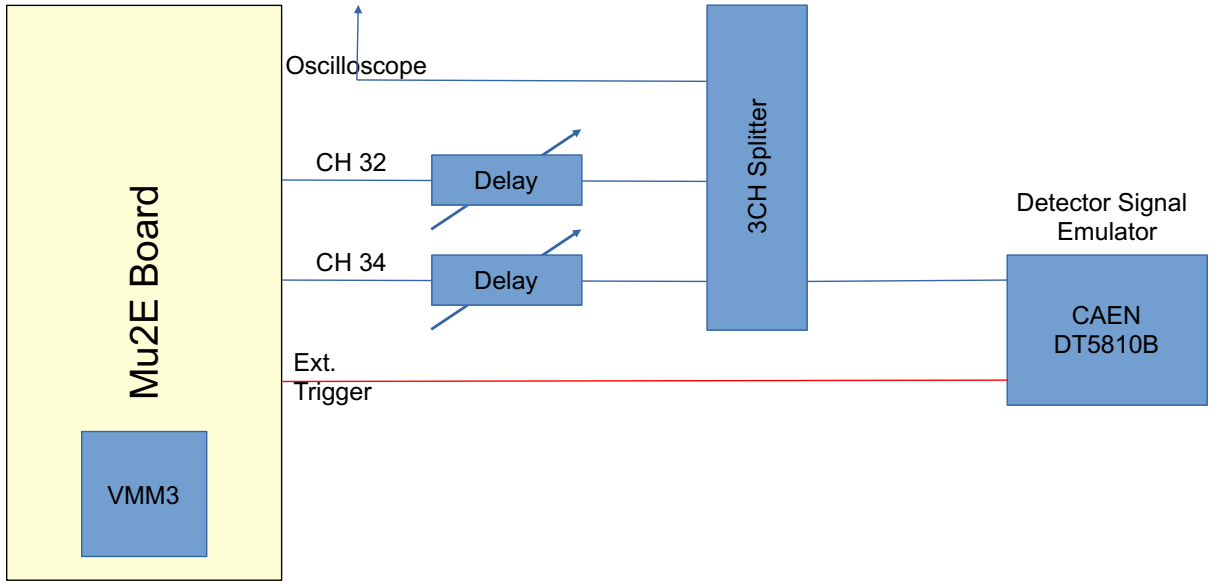
- *Comparison with data taken in August 2021 using the different NA64 readout.*

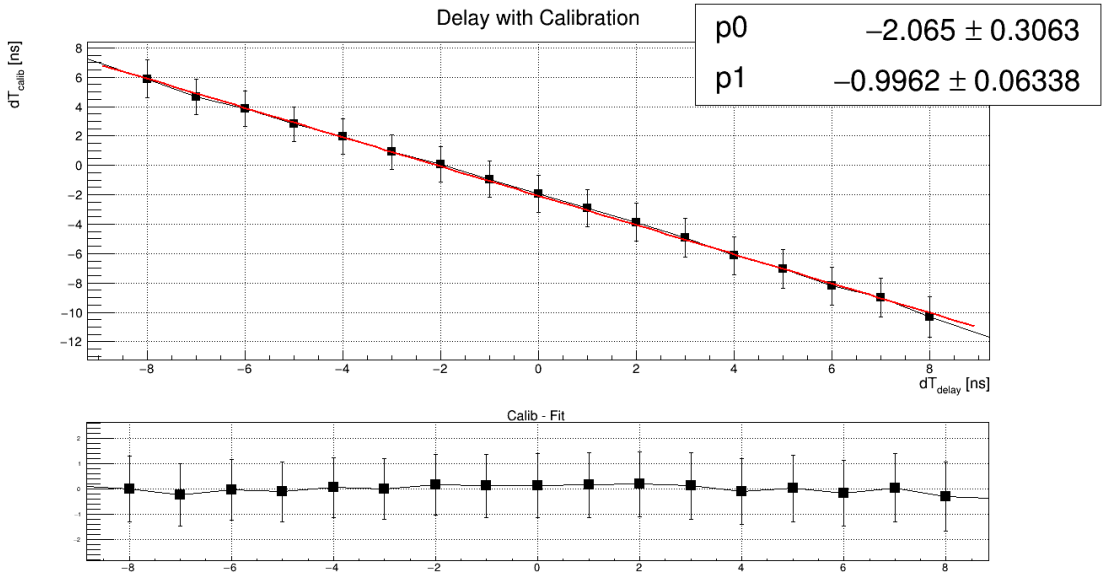

VMM3a readout
(64 YY straws)
~ 20 cm
Straw tracker:
two double layers
XX + YY
VMM3a readout
(64 XX straws)


H4 testbeam setup
HIGH
OLTAGE
Clock and Trigger OUT -> FEC
Power Crate 2k
SRS backend crate
Straw tracker:
two double layers
XX + YY
Scintillator
GEM 1
GEM 2
GEM 3

TIMING CALIBRATION

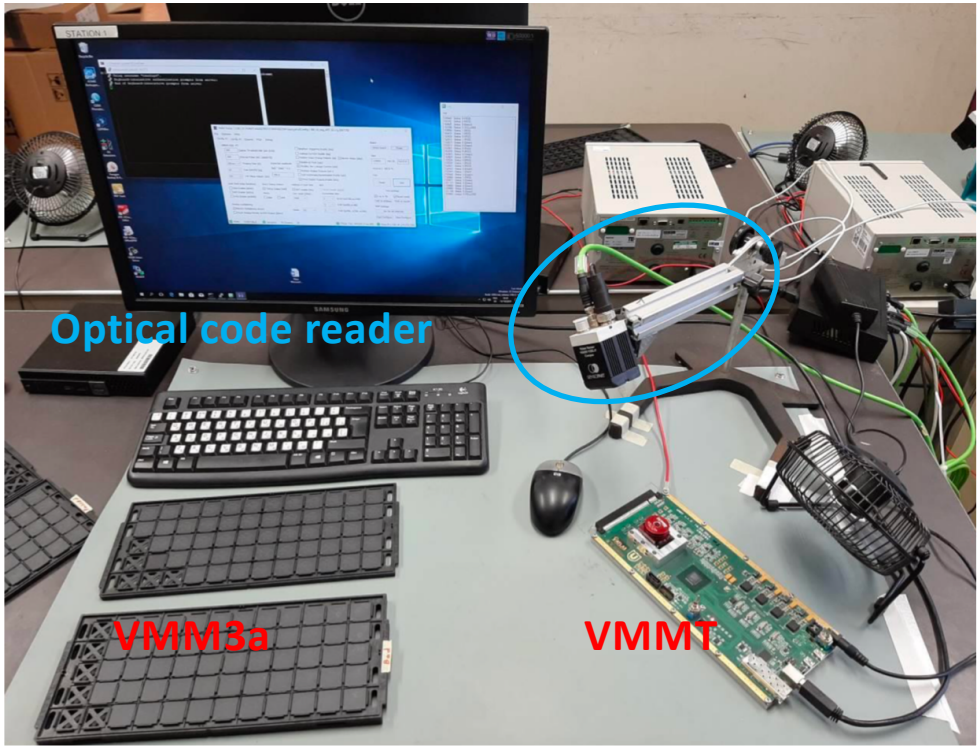
Vitalii Bautin (JINR)





VMM3A TESTING

- *Procedure to test and validate VMM3a ASICs used for 42,000 chips in ATLAS NSW*



- *Automatized VMM3a test stand*
- *Optical system to read serial numbers of the VMM3a chips being tested*
- *VMMT: multi-functional test board for testing and characterization of VMM3 ASICs developed by Tomsk State University (Russia) for ATLAS*

- *All VMM3a chips procured by UofSC tested at CERN using ATLAS NSW procedure: average yield about 70% for best selection (green) for a total of 150 chips.*

PREPARATION FOR PROTOTYPING

- *Measurements of straw elongation and tension vs. internal gas pressure (GTU):*
  - *Straws with 4.9mm diameter, 12 μm & 20 μm walls, produced by ultrasonic welding;*
  - *Studied tension drop with increase of internal pressure starting from initial pre-tension.*

- *FE analysis of deformations induced by gas pressure, wire and straw tension:*
  - *Removable lids giving access to gas manifolds and FE boards, gas tightness (O-rings, etc.);*
  - *Connection of individual straws to C-composite frame and related gas sealing;*
  - *Study interplay between internal overpressure and wire/straw tension.*

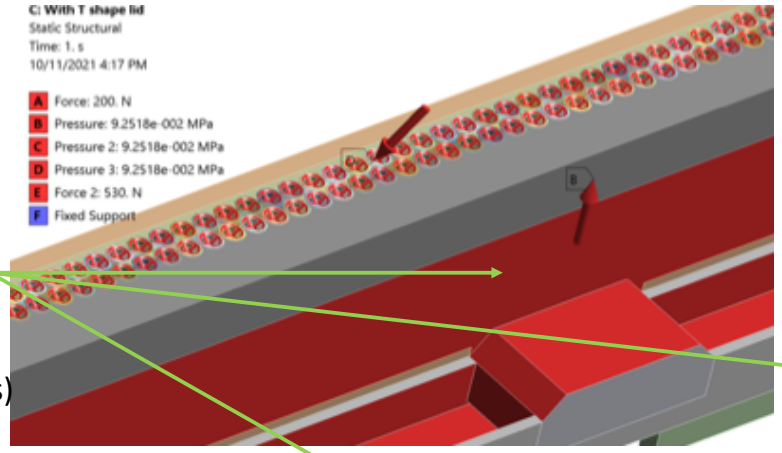
- *Design of the prototype & mockup:*
  - *Prototype 1.2m $\times$ 0.8m in C-composite, based on design & parts as in full scale STT modules;*
  - *Mockup 35cm $\times$ 35cm in plexiglass, for preliminary validation tests.*

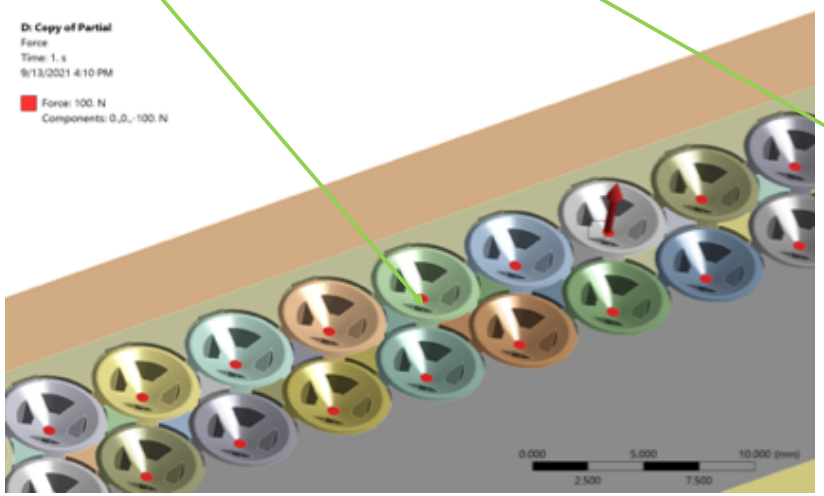
- *Procurement of components for the prototype:*
  - *Finalized straw parameters: 4.9mm external diameter, 20 μm walls, COMET film (double Al?);*
  - *Mockup frame to be machined in plexiglass (Hamburg/DESY);*
  - *C-composite frame for prototype: evaluating vendors in USA, Italy, and India;*
  - *Options for manufacturing 1,500 endplugs: machining, 3D printing, injection molding.*

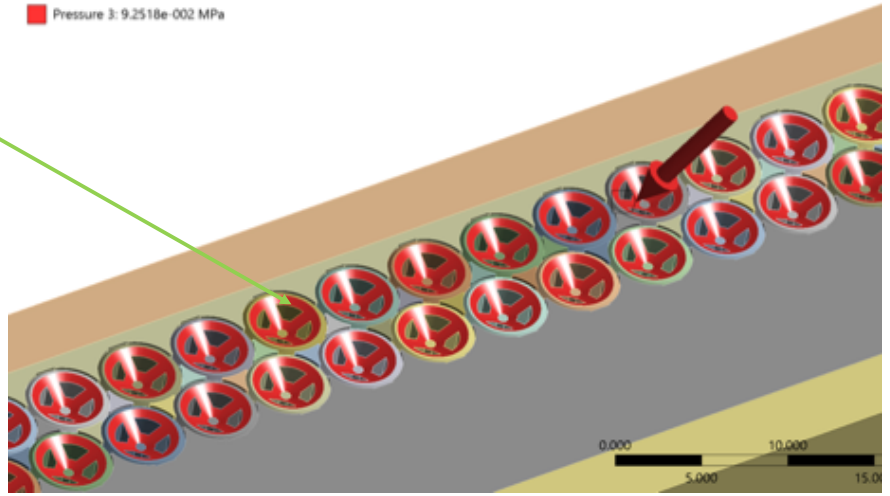
Otari Kemularia (GTU)

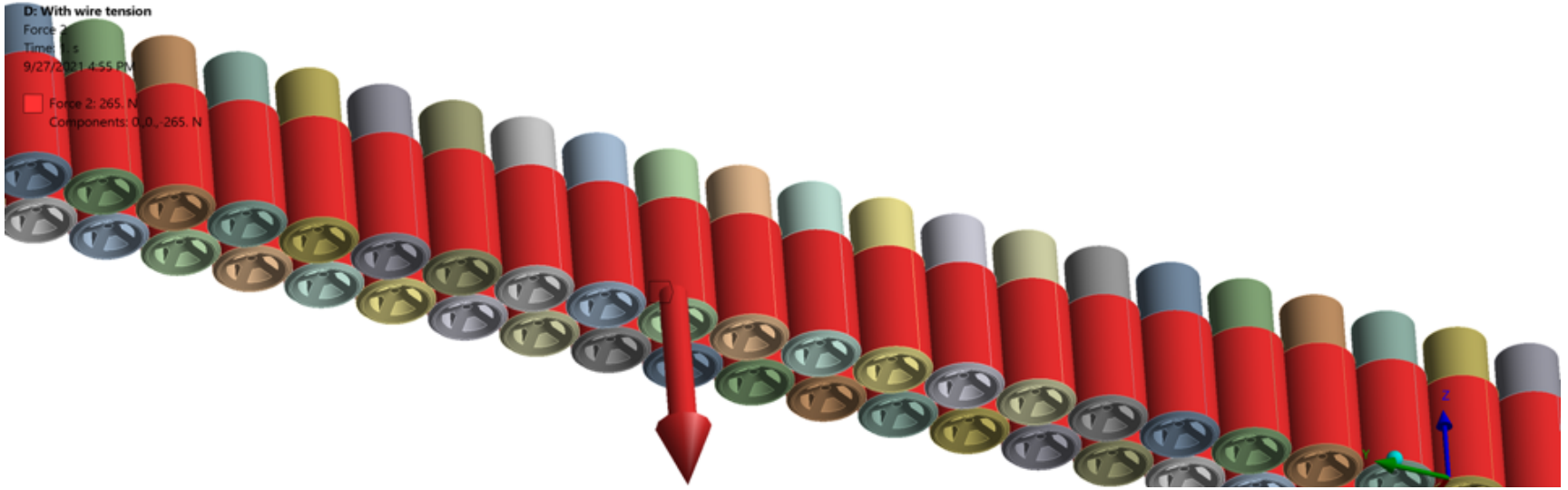
Applied pressure:
0.092 MPa

Applied Force:
100N (for 336 wires)

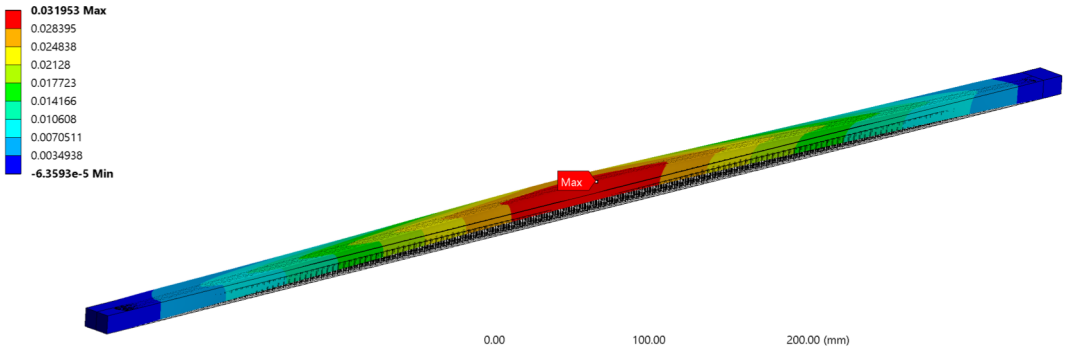




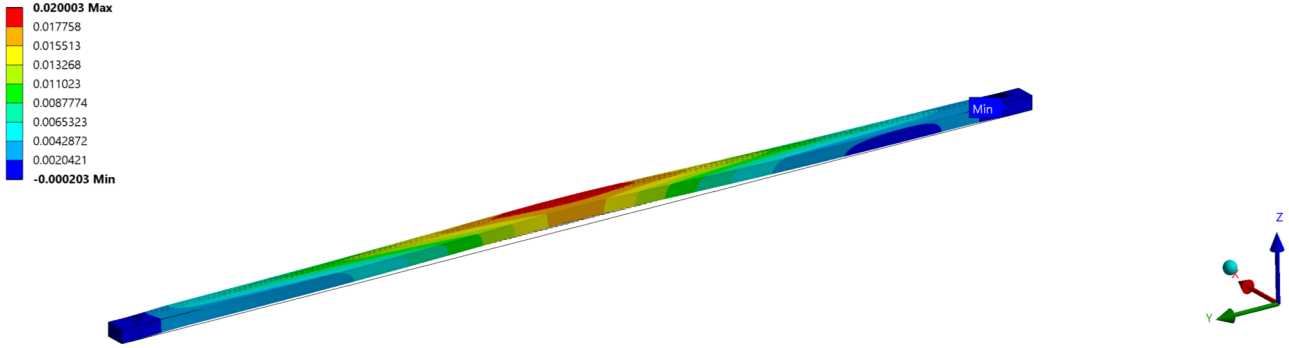




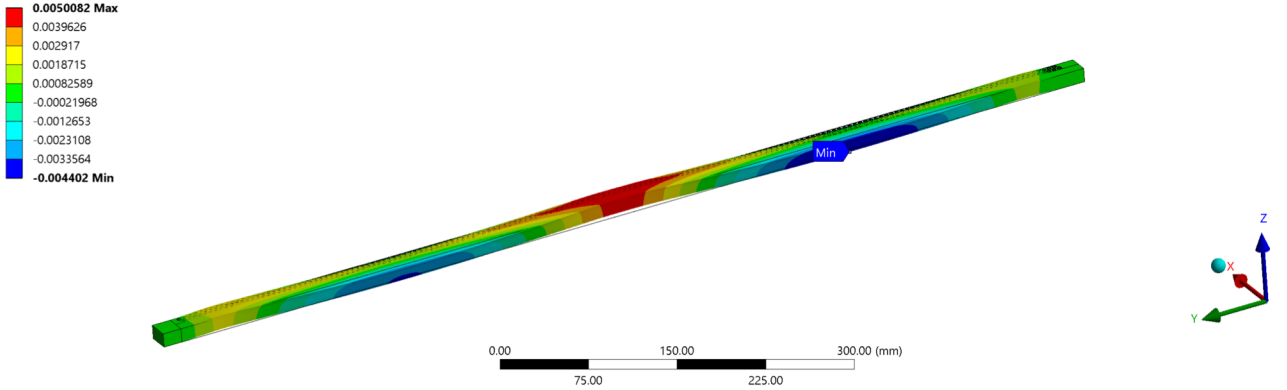
Gas pressure only:
+Z 0.032 mm
-Z 0 mm

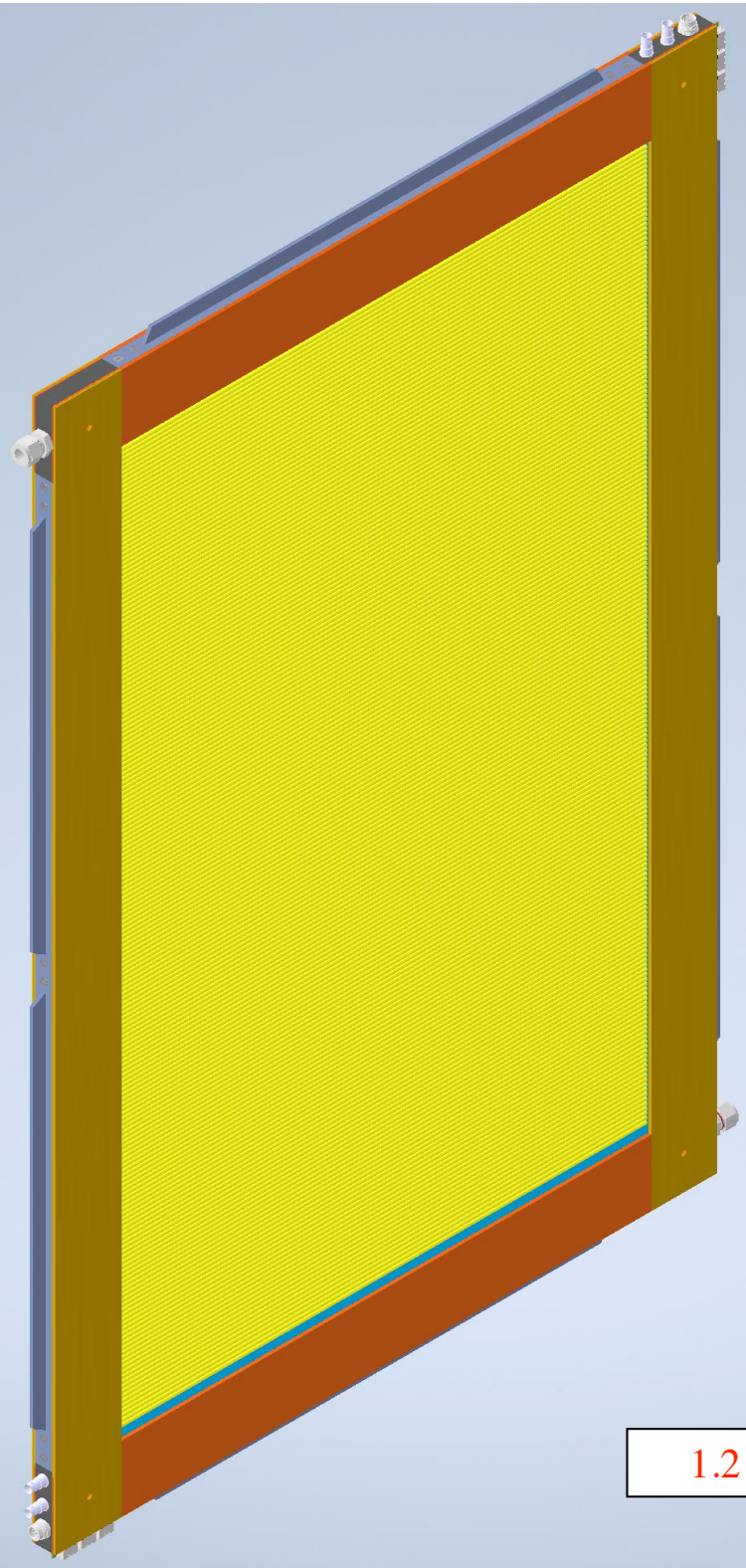


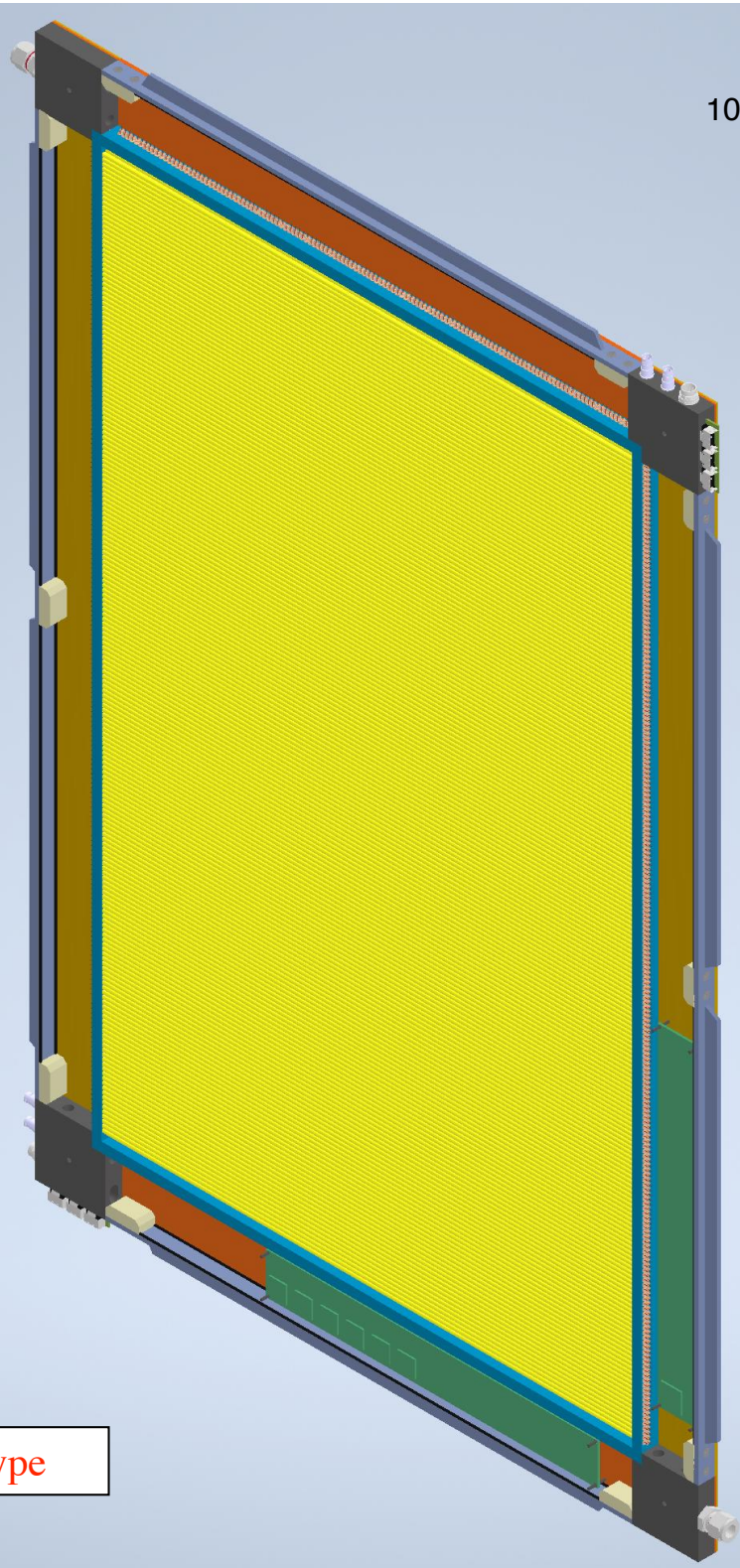
Gas pressure + wire tension:
+Z 0.02mm
-Z 0.0002mm



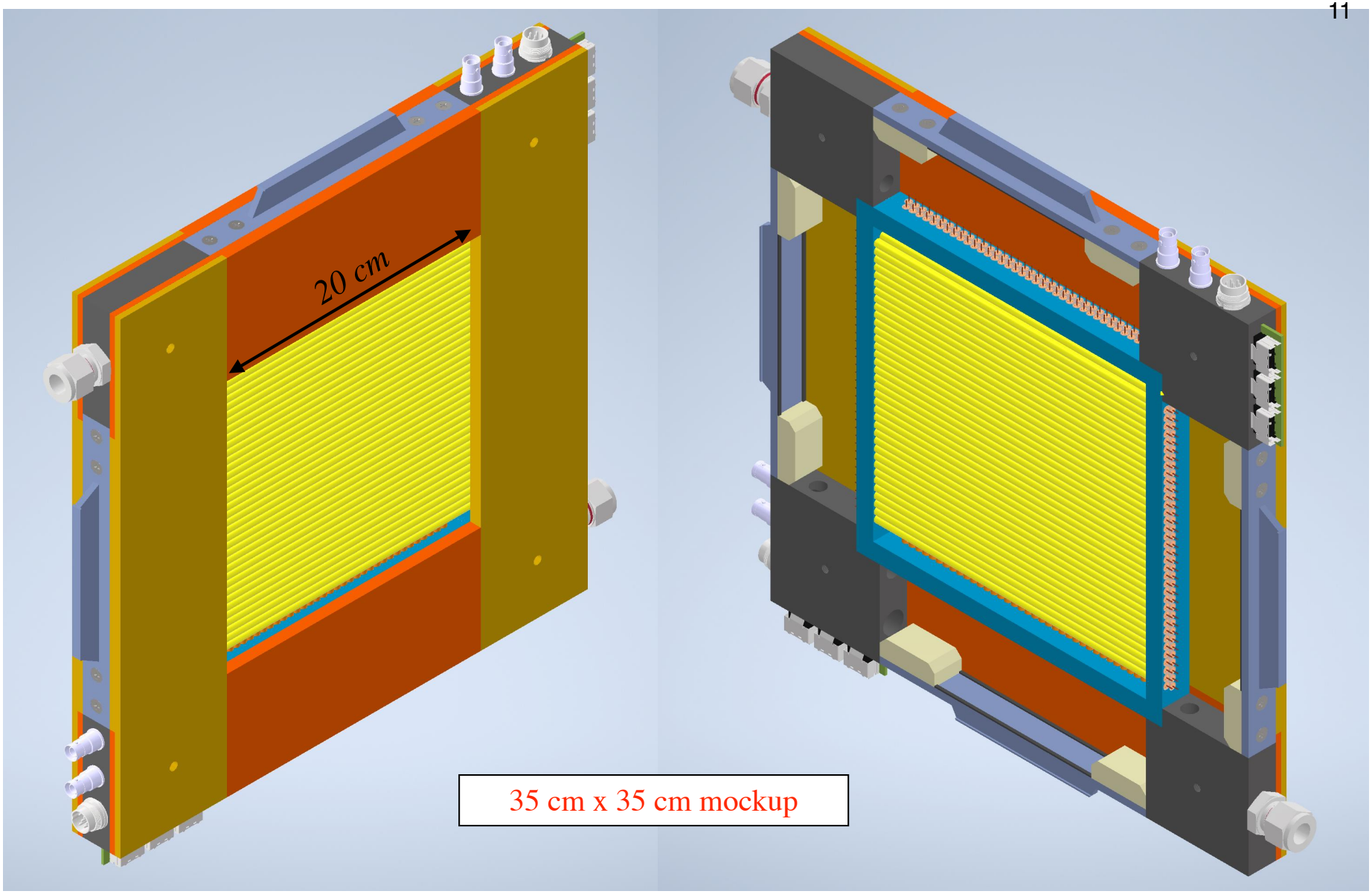
Gas pressure + wire tension
+ tension from straw walls:
+Z 0.005mm
-Z 0.004mm



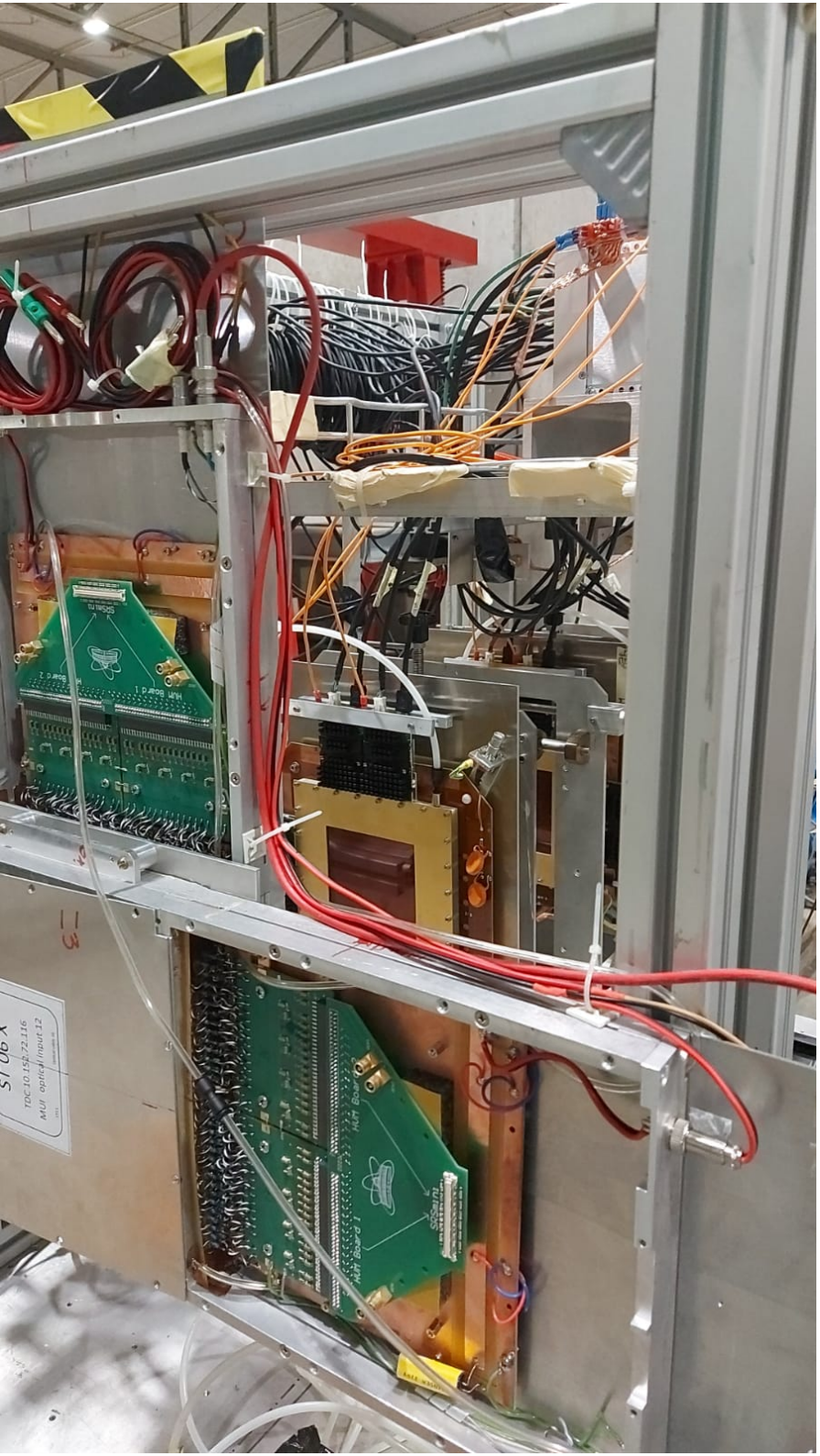


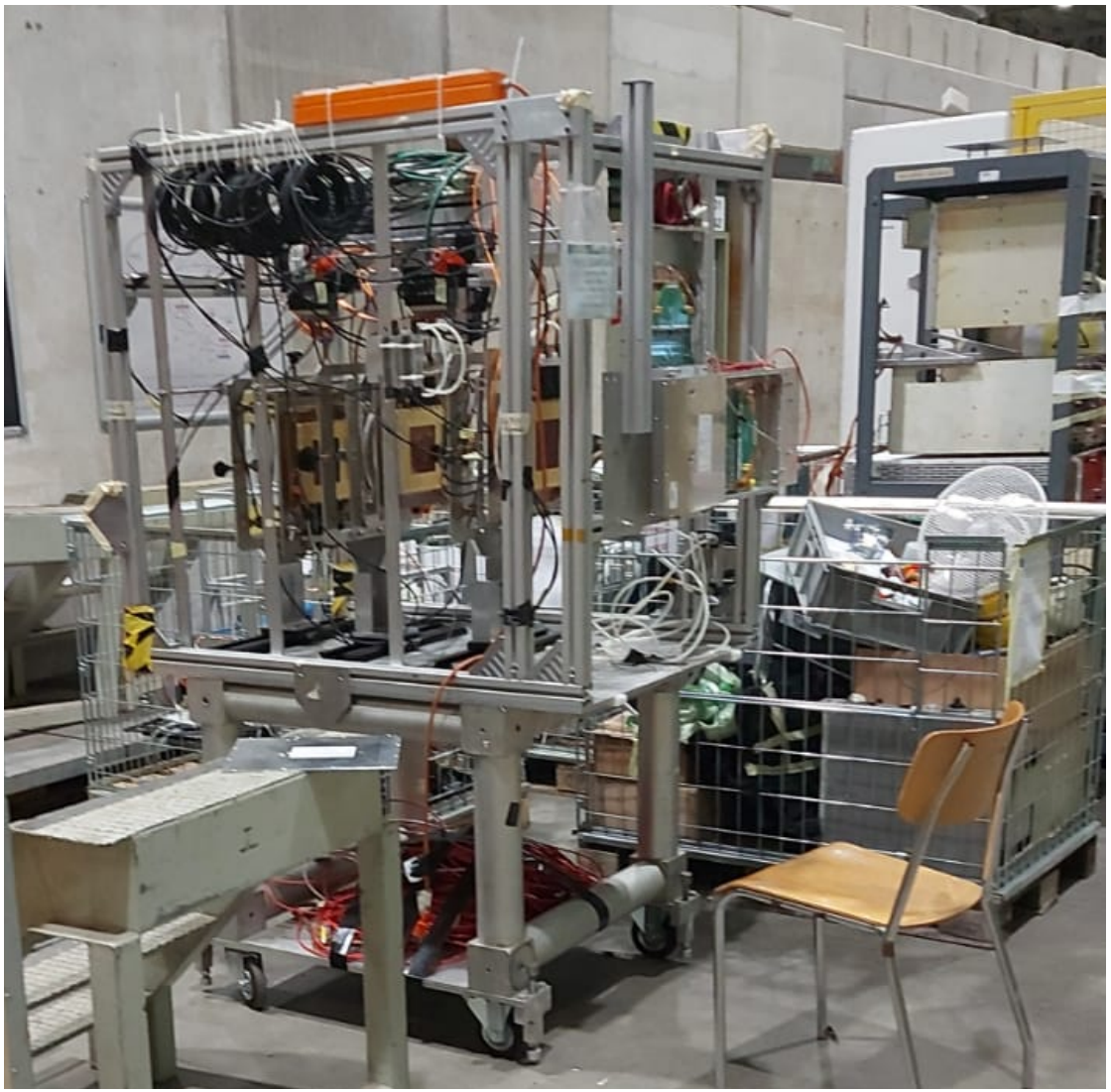


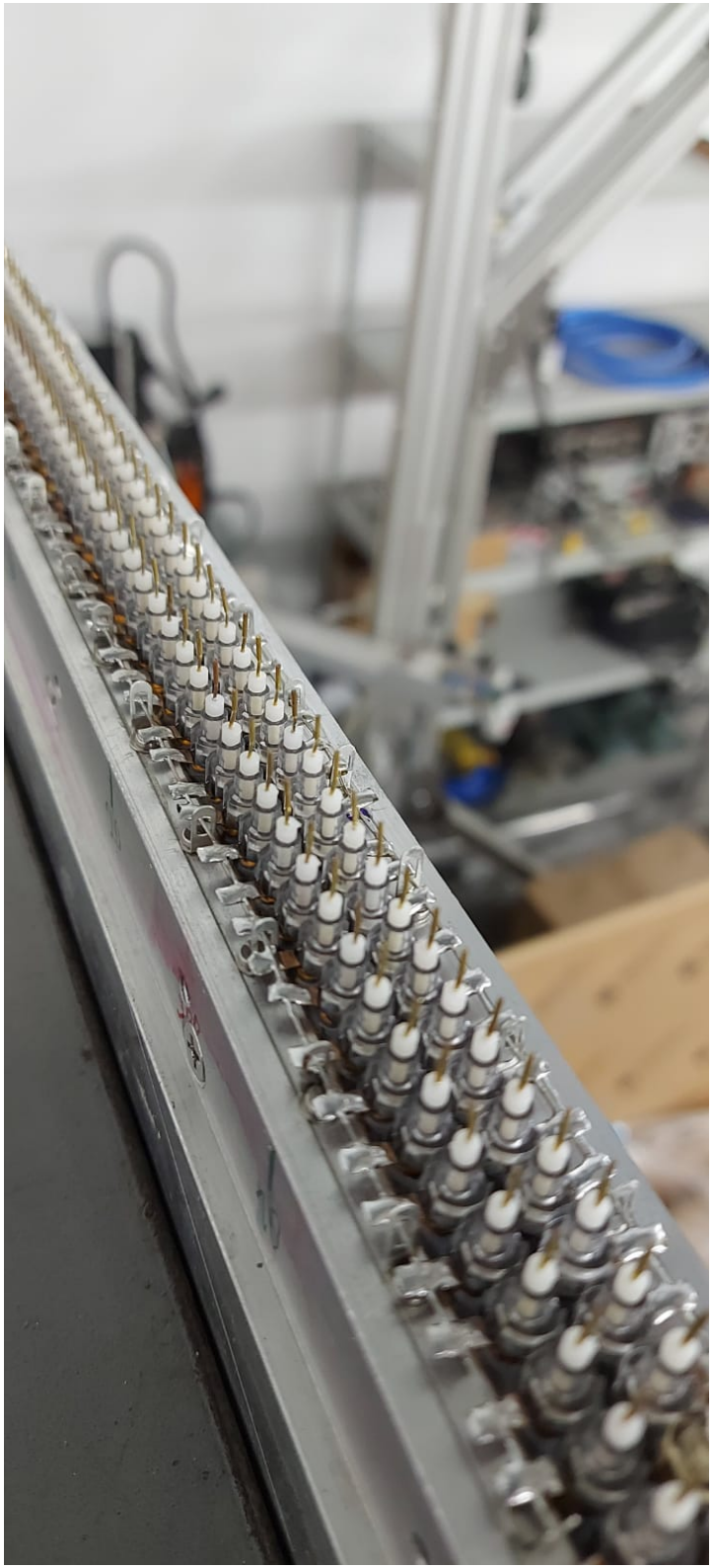
1.2 m x 0.8 m prototype

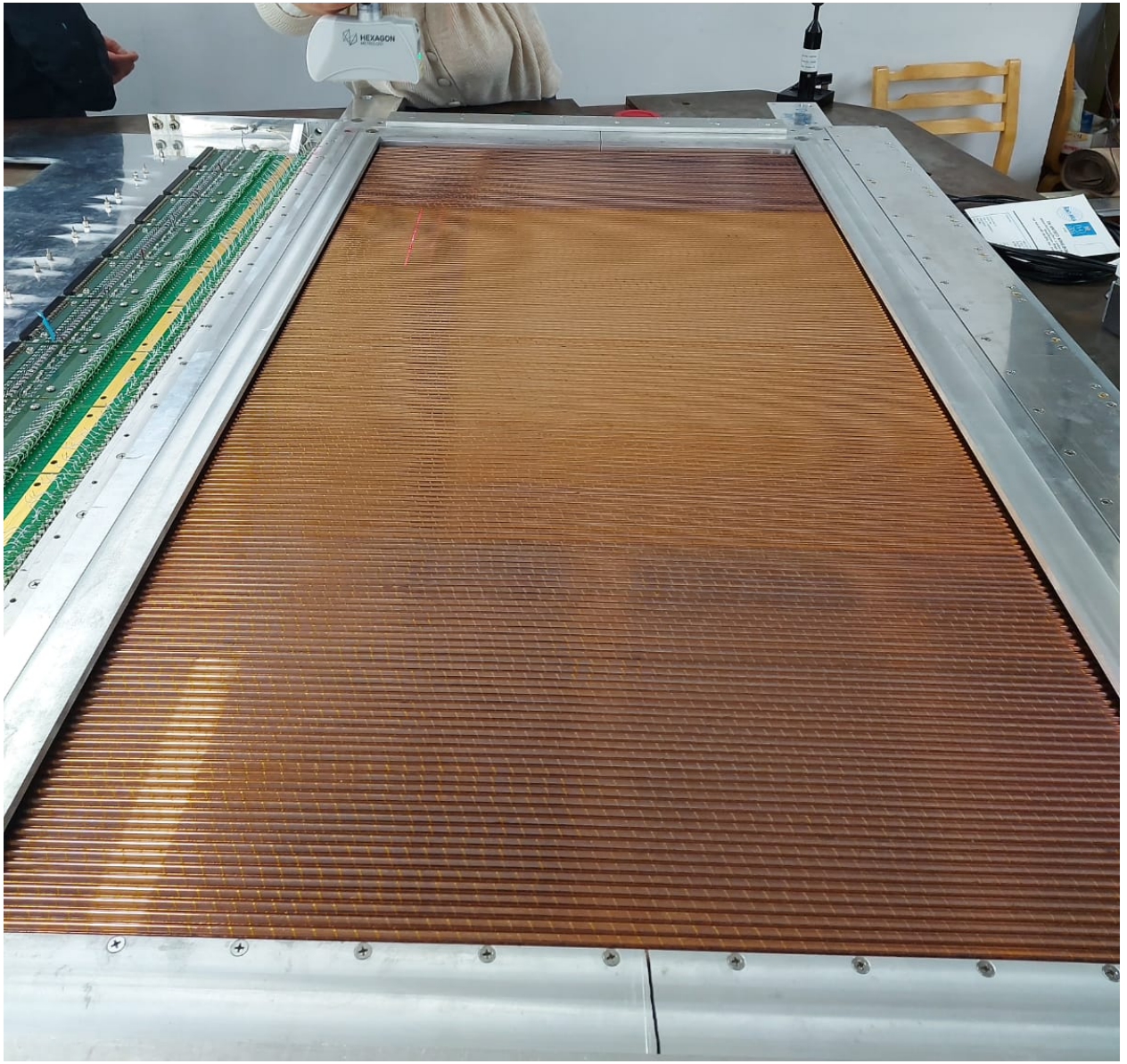

20 cm
35 cm x 35 cm mockup

Backup slides

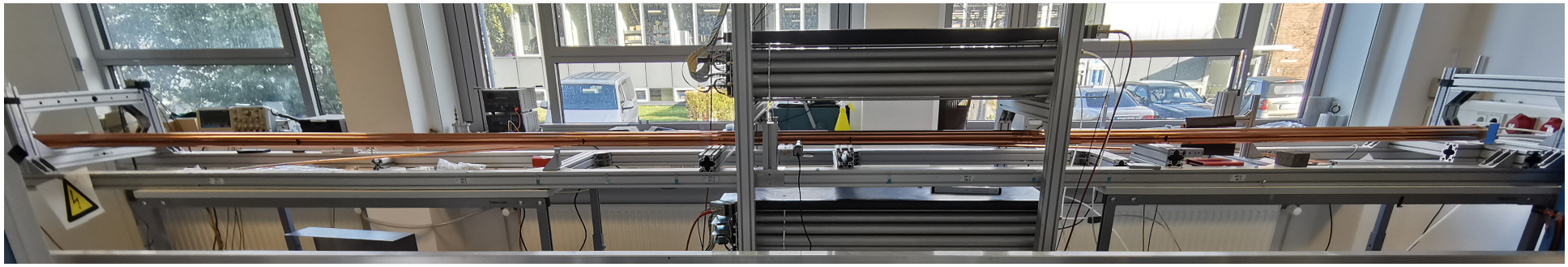








JINR built 7 detectors 1.2 m x 0.6 m for NA64
sent to CERN in August
6 detectors will be on beam from October 29

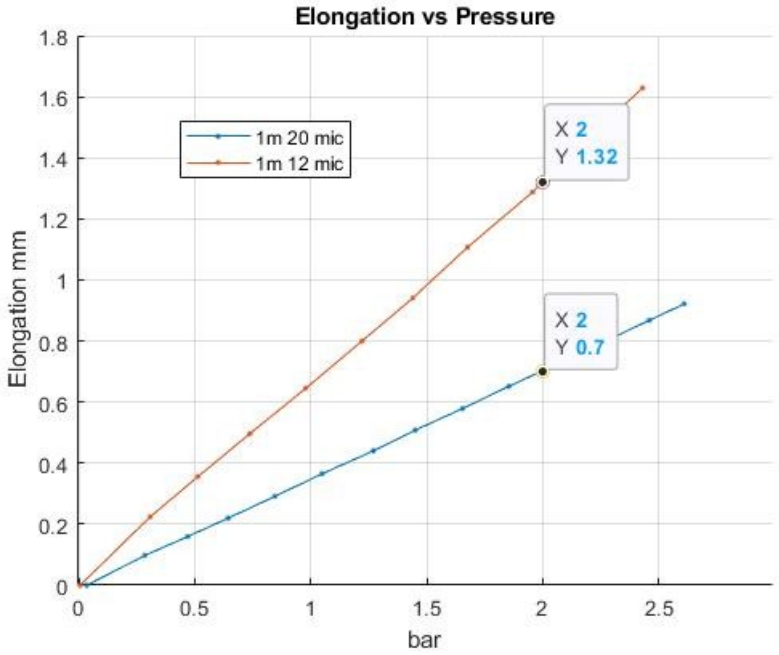


Test of 5m long straws for SHiP at the University of Hamburg

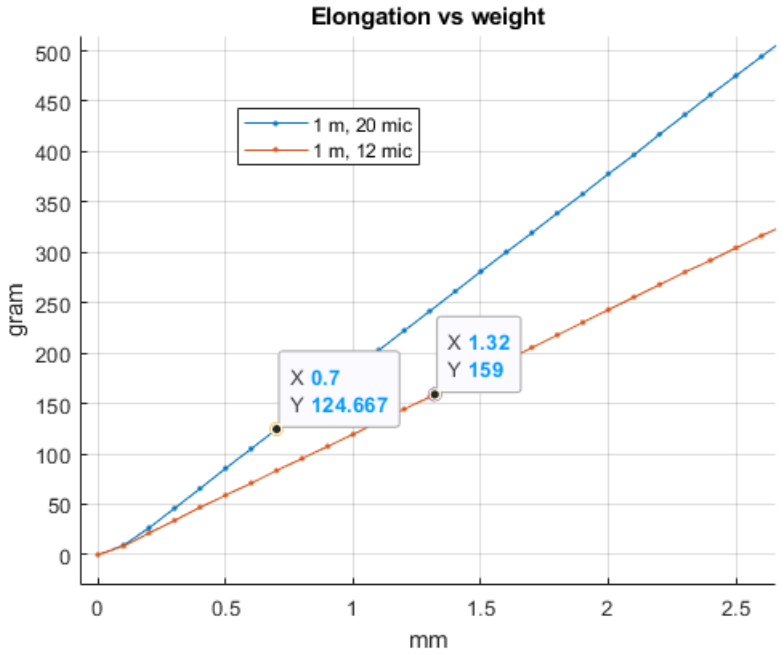
Test of 1.8m long straws for STT
at Panjab University

G. Adamov, N. Tsverava (GTU)

Elongation of fixed tube based on pressure change



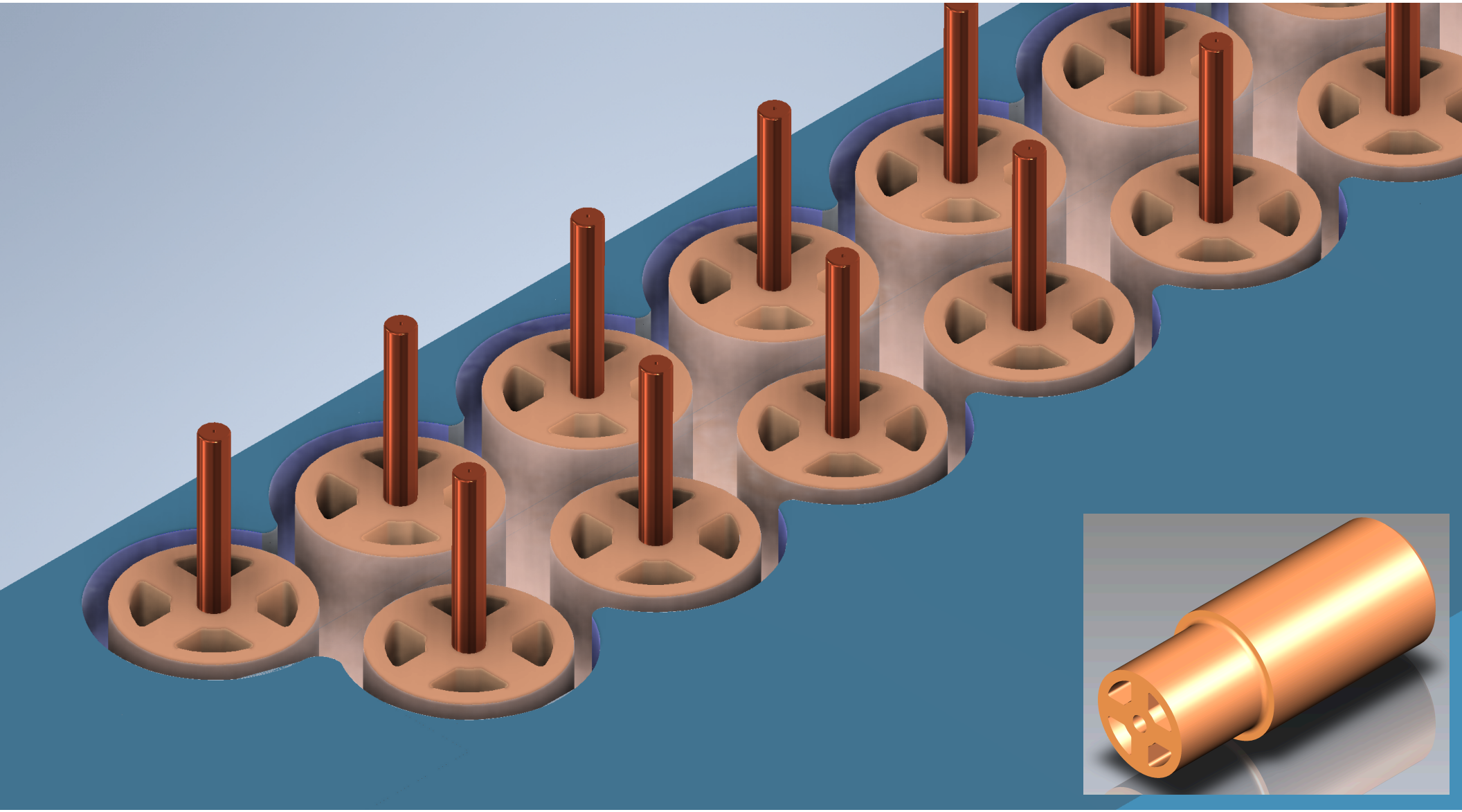
Tube elongation with weights with no pressure

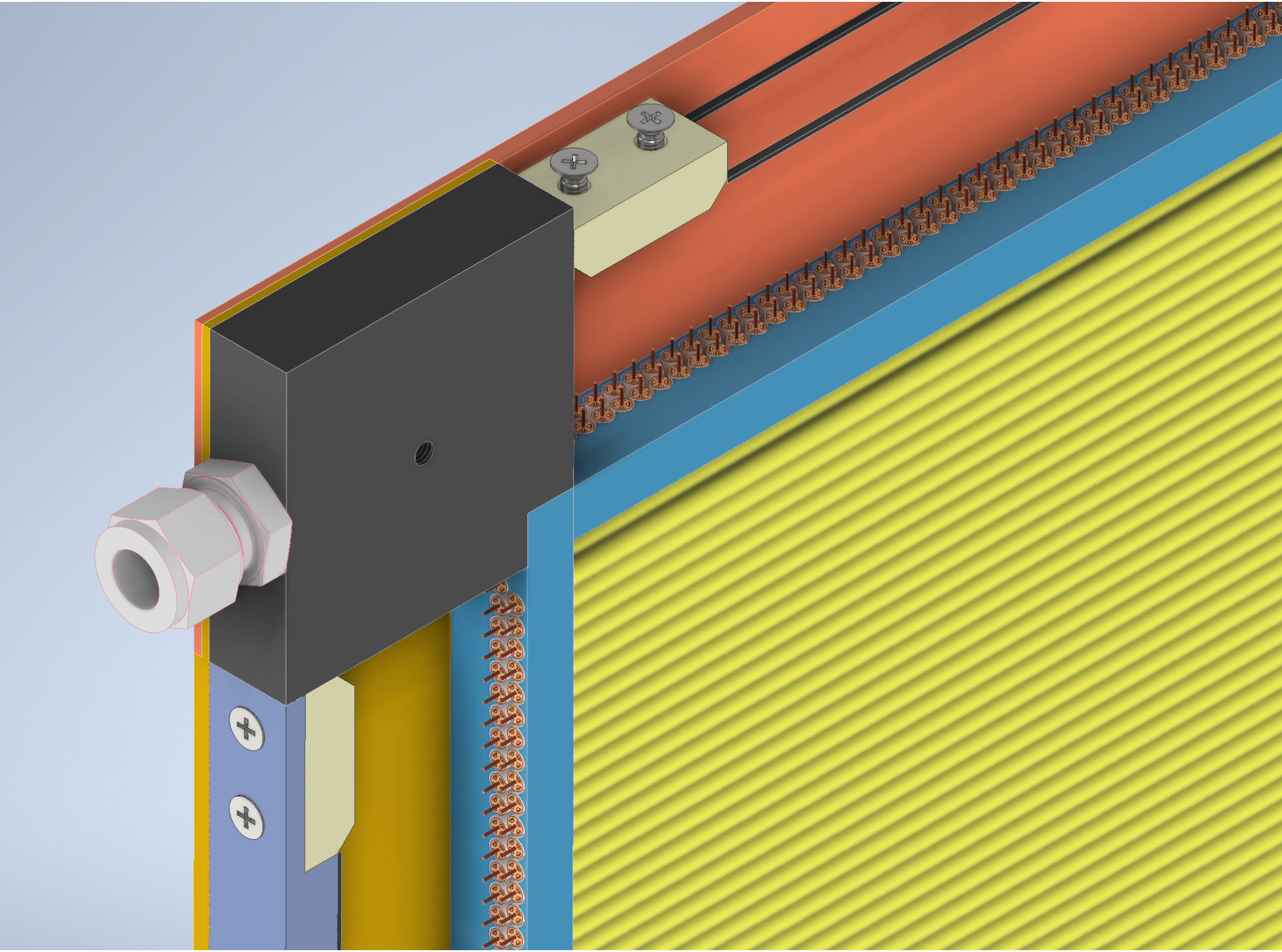


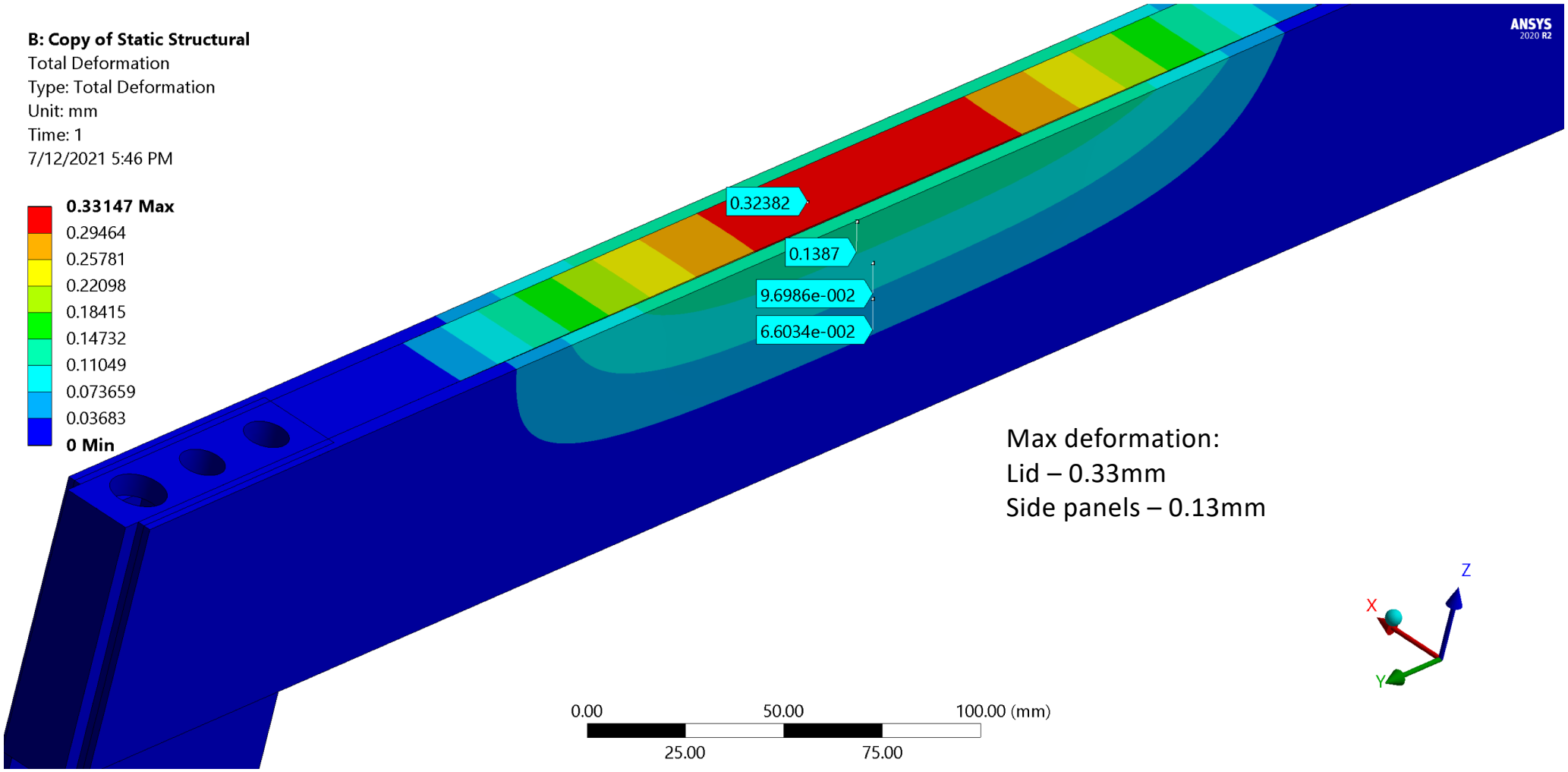
Measurement of elongation and tension with straws 1.0 m long, 5 mm diameter

Straw numbers	Length	Diameter	Thickness	Elongation at 1 bar (relative)	Weight
1	1 m	5 mm	12 µm	0.66 mm	78.5 g
1	1 m	5 mm	20 µm	0.35 mm	56 g
1	0.5 m	5 mm	12 µm	0.276 mm	35 g
1	0.5 m	5 mm	20 µm	0.17 mm	44 g
400	1 m	5 mm	12 µm		31.4 kg
400	1 m	5 mm	20 µm		22.4 kg

Expected maximal elongation for 4m long straws ~2.6 mm
similar maximal frame deformation expected with assembly based on pressurized straws

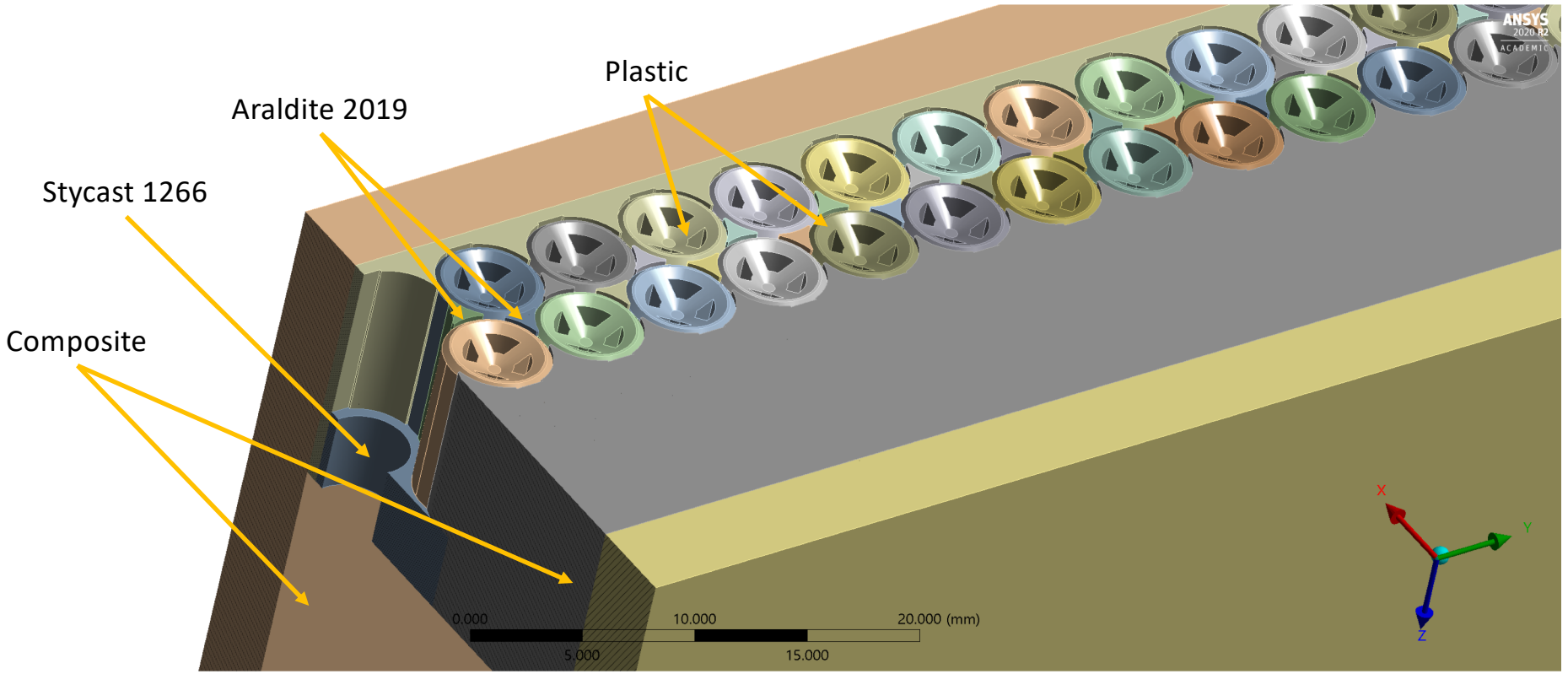


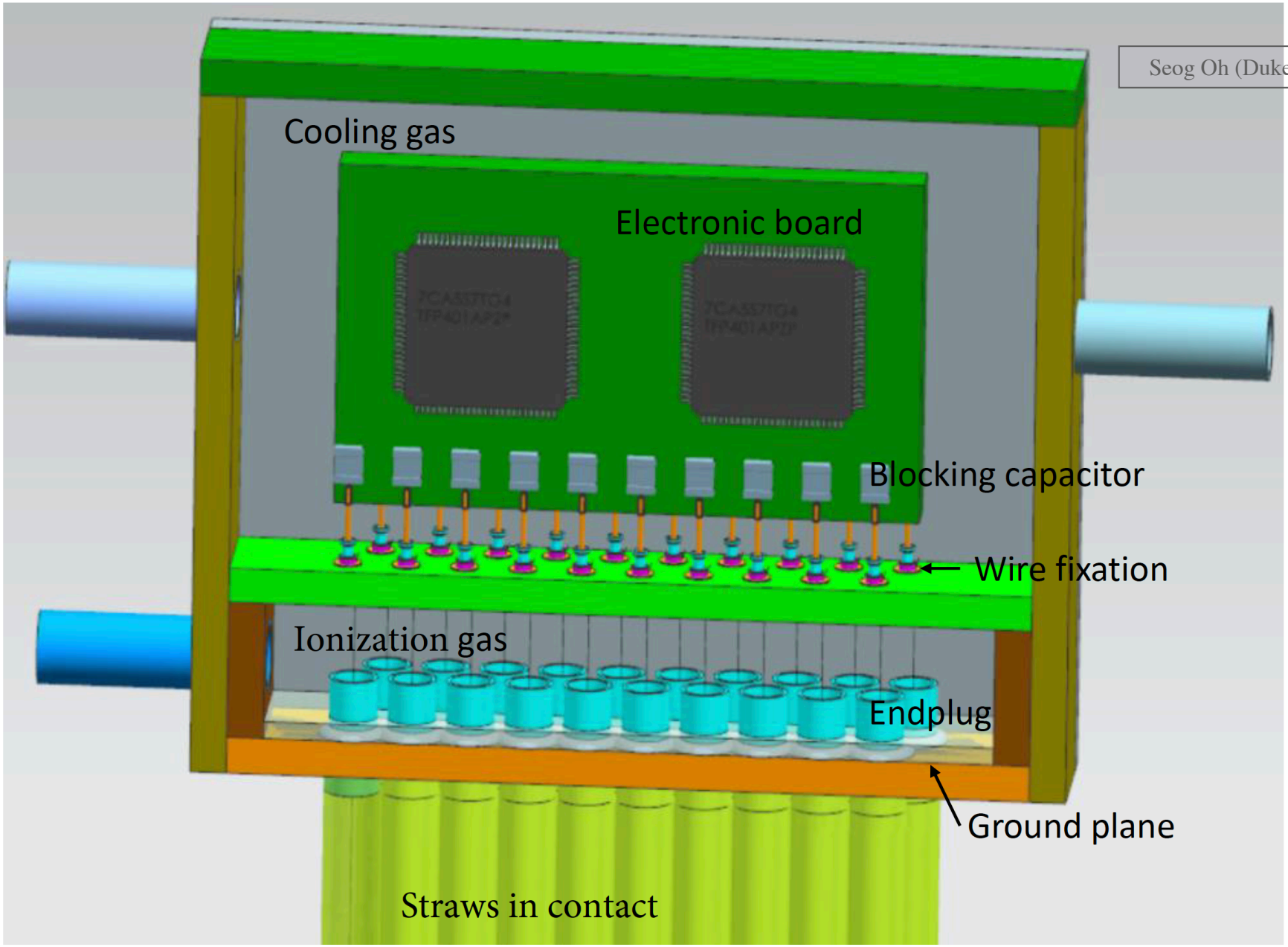


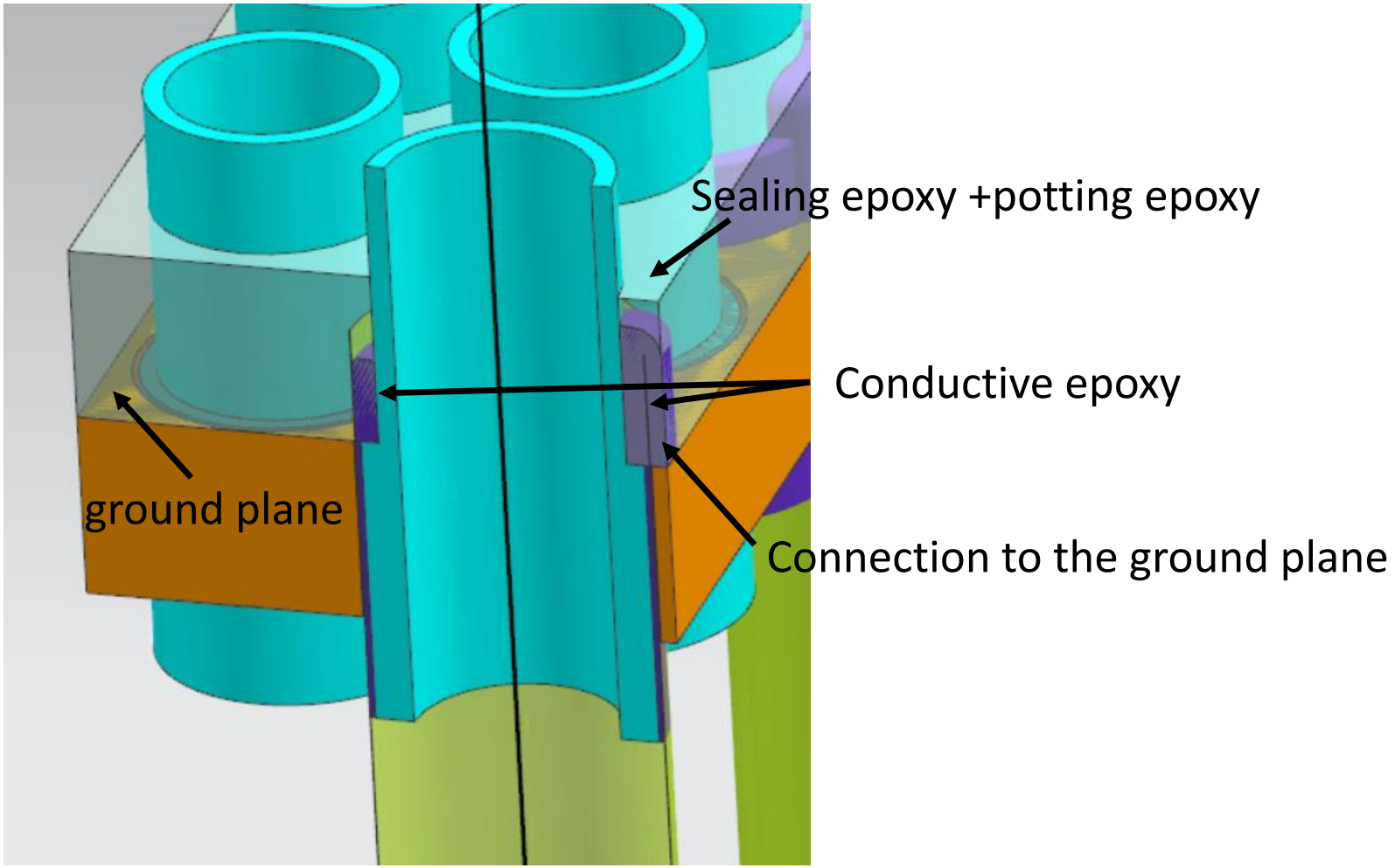


Max deformation:
Lid – 0.33mm
Side panels – 0.13mm

Geometry
9/13/2021 3:45 PM



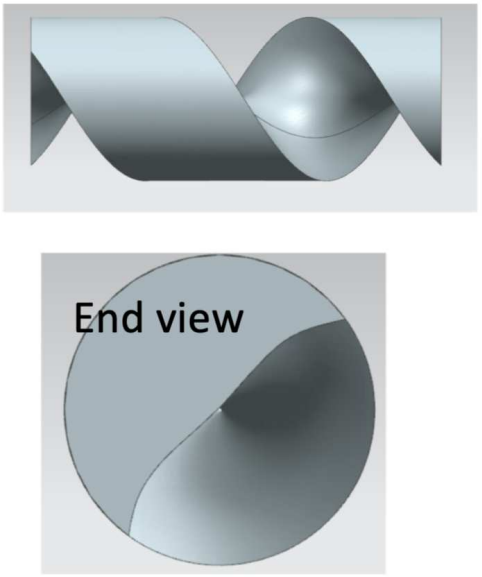

Seog Oh (Duke)
Cooling gas
Electronic board
Blocking capacitor
Wire fixation
Ionization gas
Endplug
Ground plane
Straws in contact


Sealing epoxy +potting epoxy
Conductive epoxy
ground plane
Connection to the ground plane

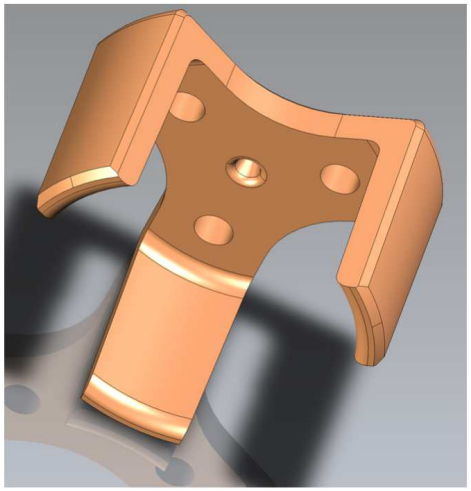
WIRING OF STRAWS

- *Consider a new wire support:*
  - *"Twister" design used in ATLAS TRT can simplify wiring procedure;*
  - *Wires can be replaced even after completion of module assembly;*
  - *Increased mass & inefficiency (∼ 7mm long).*

- *Old design of wire support:*
  - *Minimized mass & inefficiency (3.5mm long);*
  - *Wires cannot be replaced after module assembly is completed & end-plugs are sealed by epoxy.*

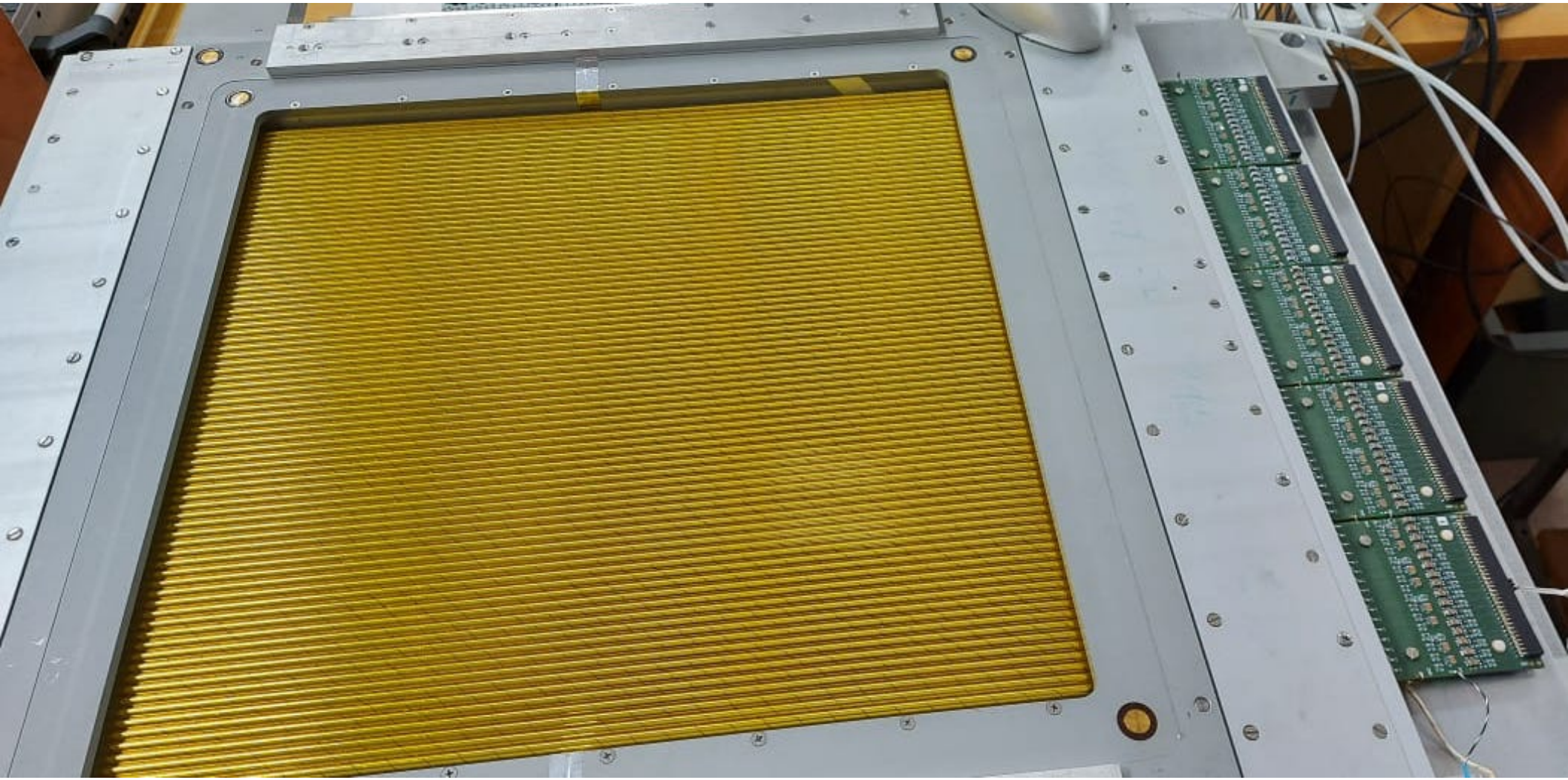


ATLAS "twister"

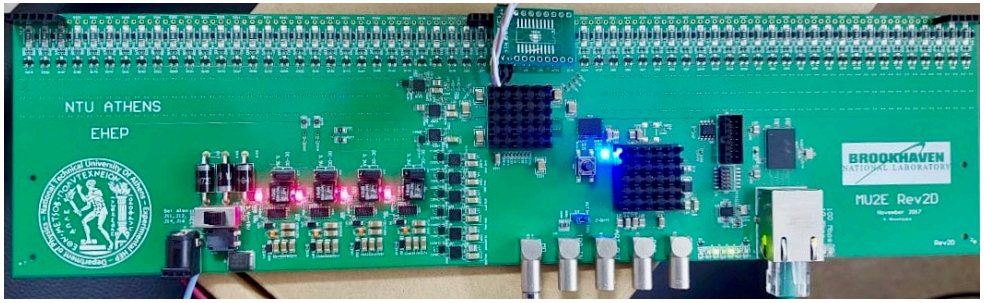


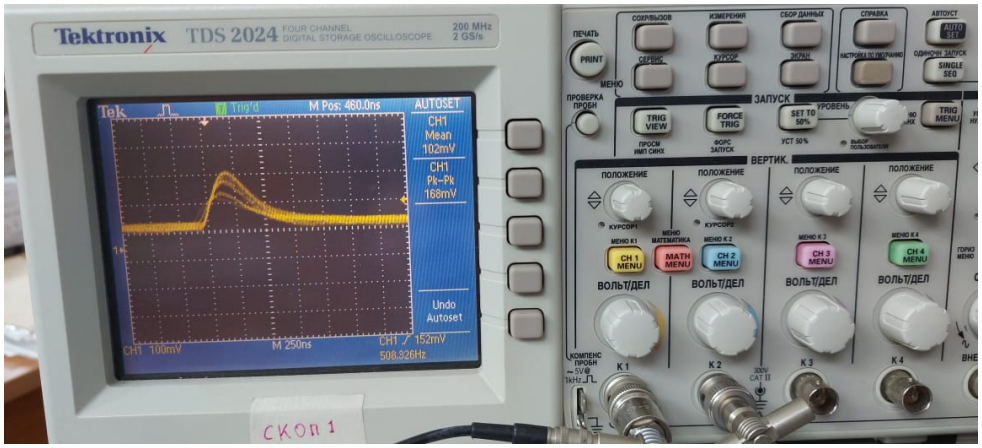
Old wire spacer

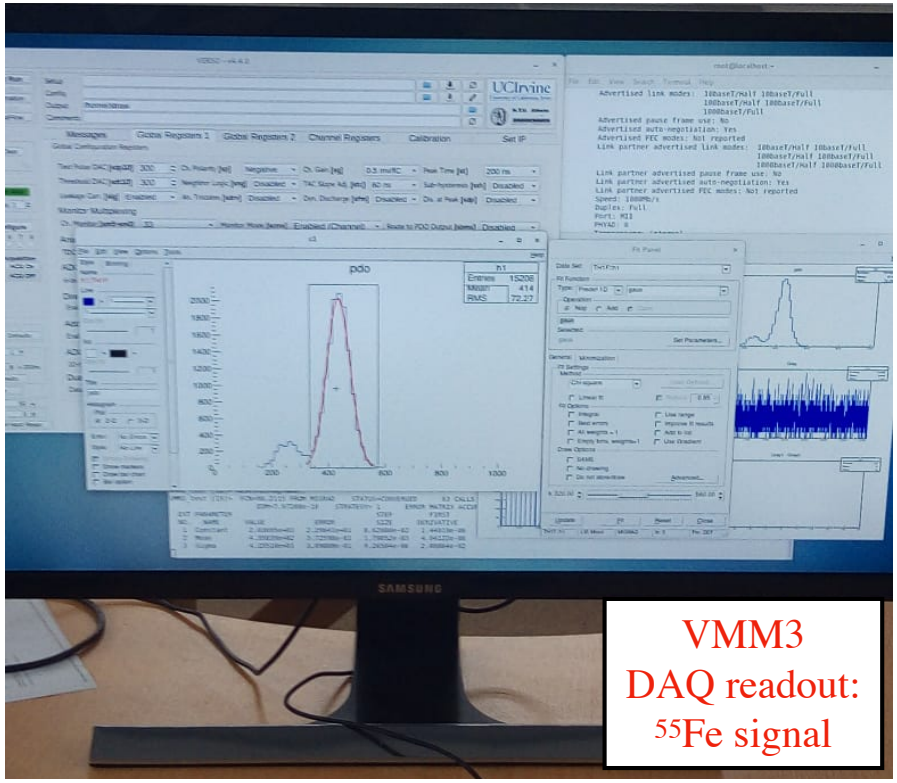
EXISTING PROTOTYPE



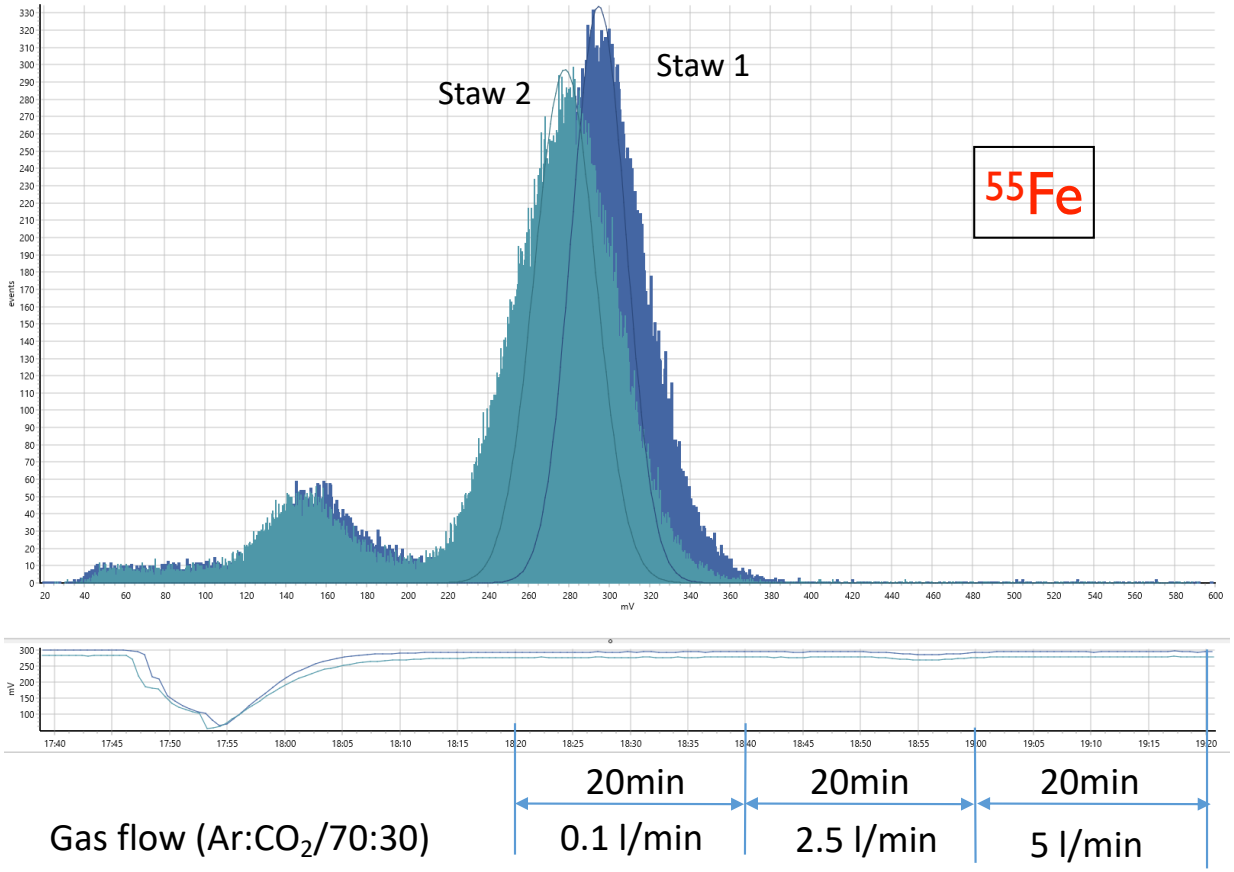
Prototype 50cm x 50cm tested at JINR with
VMM3a readout FE boards from Mu2e Cathode Strip Chamber test stand (BNL)







Validation of VMM3a readout with the prototype at JINR:
signals from cosmic rays and ^{55}Fe source with Ar/CO_2 80/20
using FPGA-based DAQ readout with existing VMM3 firmware+software



Monitoring of gas gain with increased gas flow up to 2,000 times nominal (JINR)