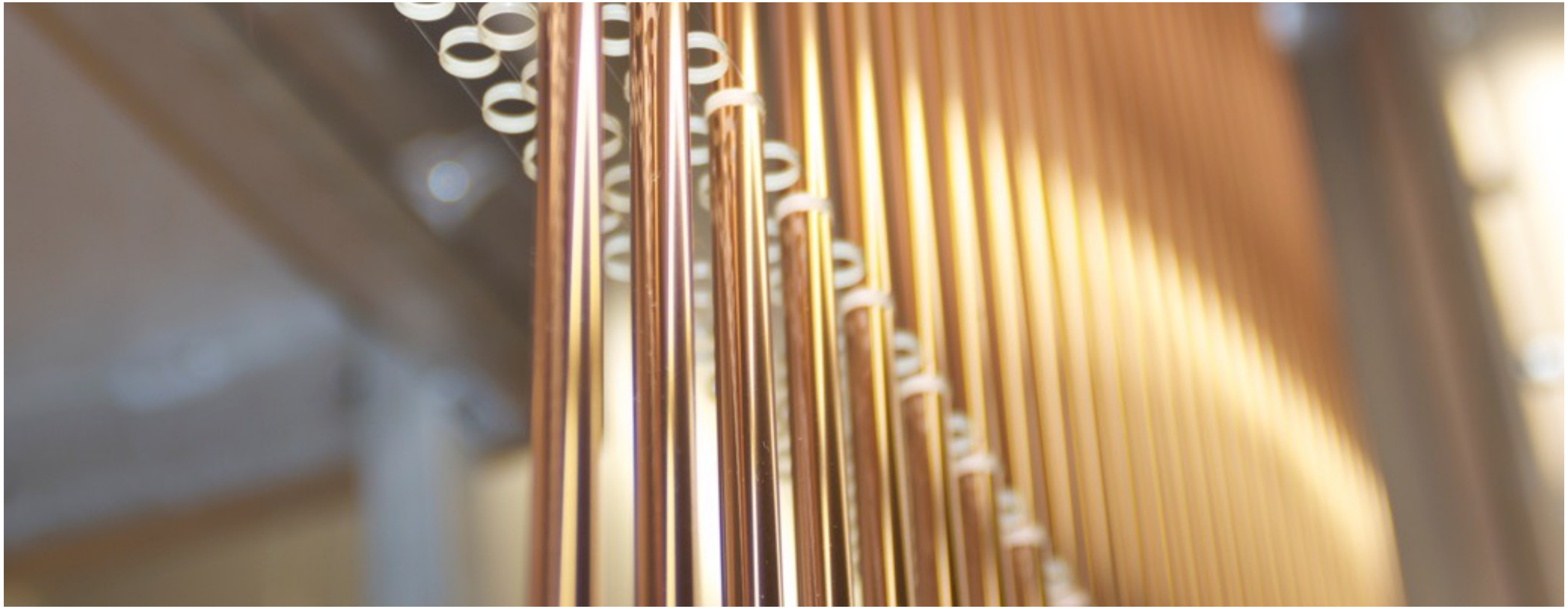
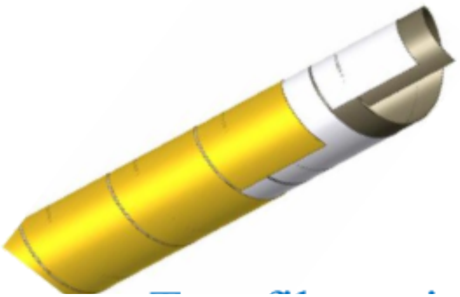
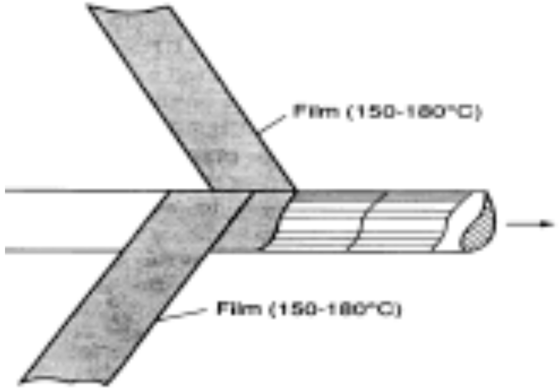
Straw tracker

T. Enik

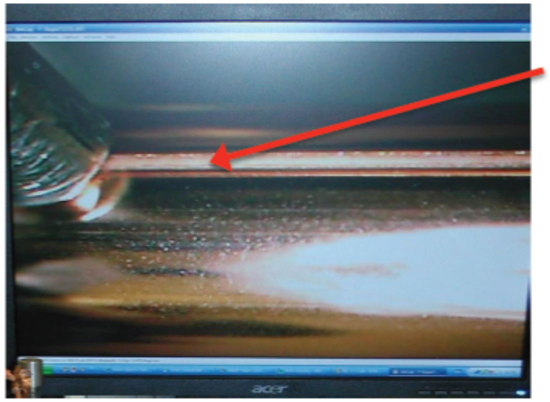


Two design of the straw-tube production

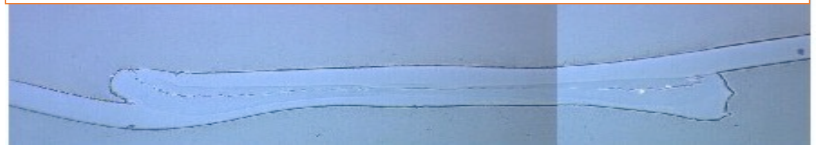




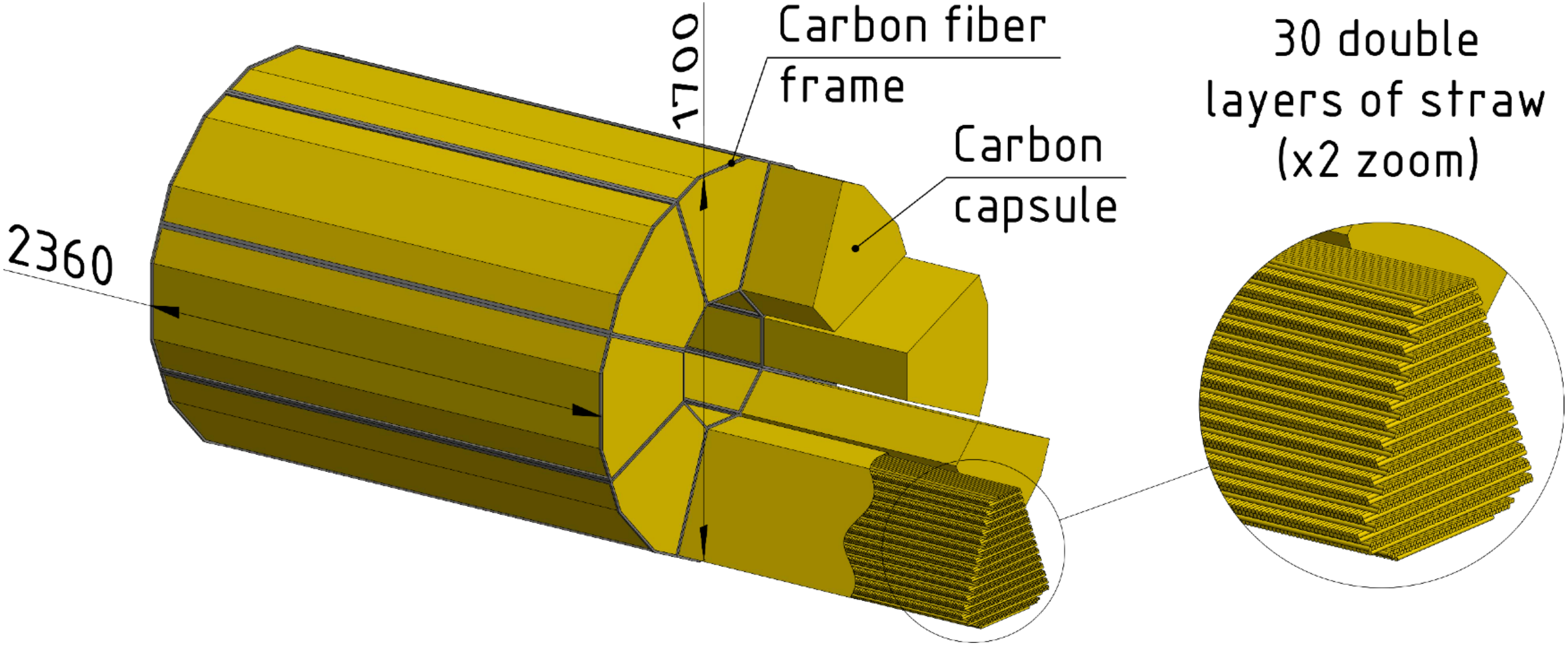
Straw winding. Two films revolve and stick together among themselves.

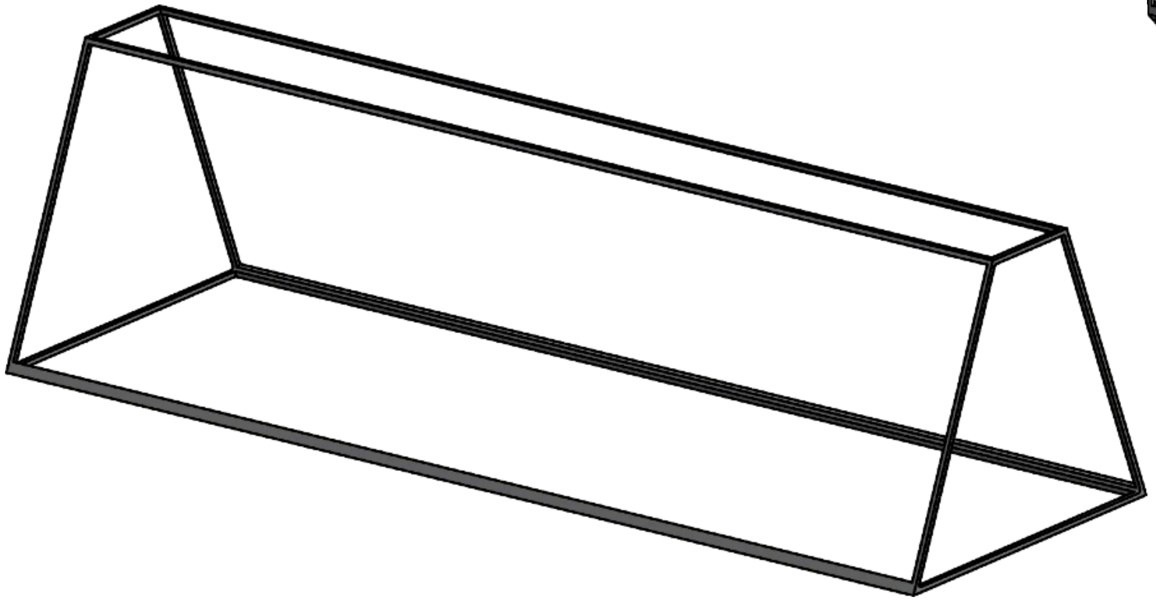


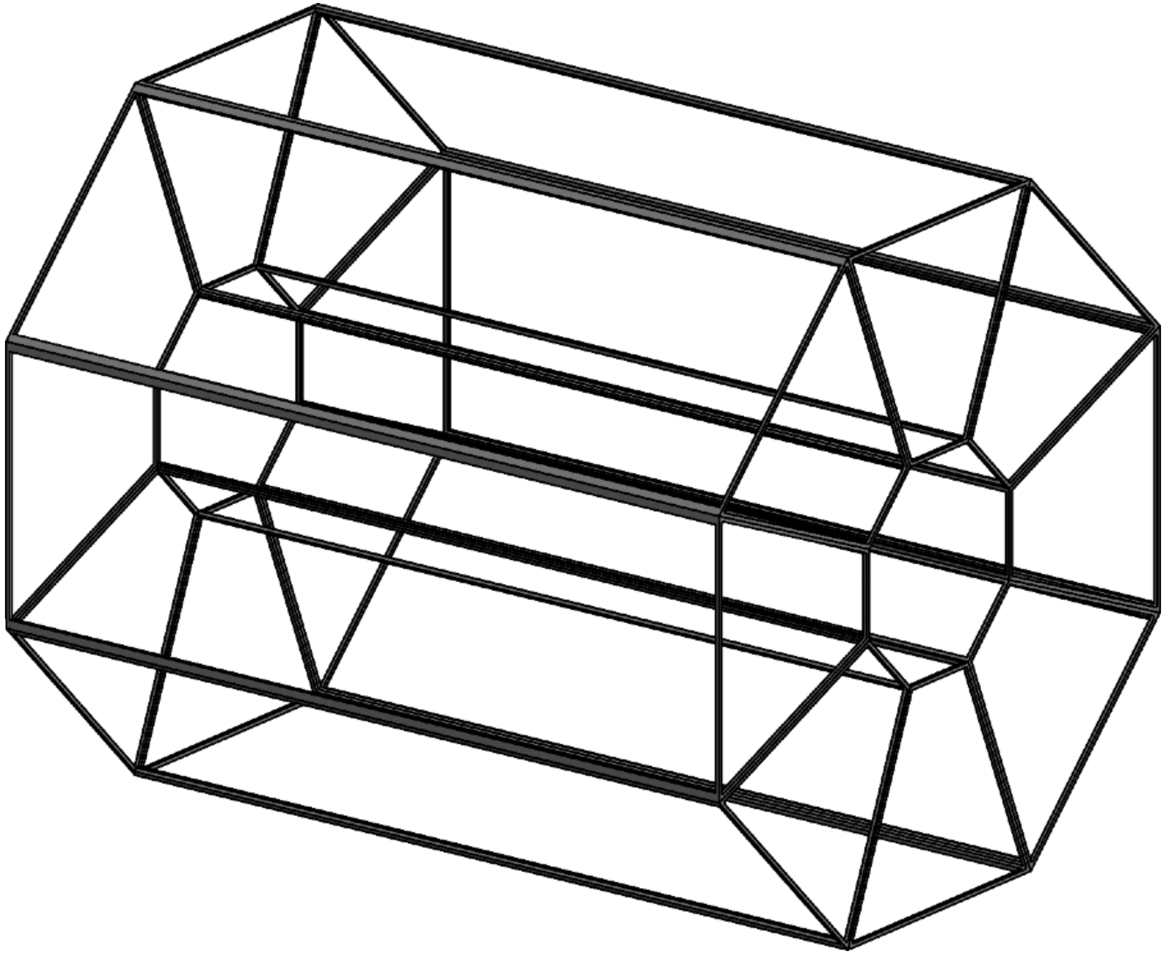
Microscope pictures of a straw cross-section for quality control of the weld



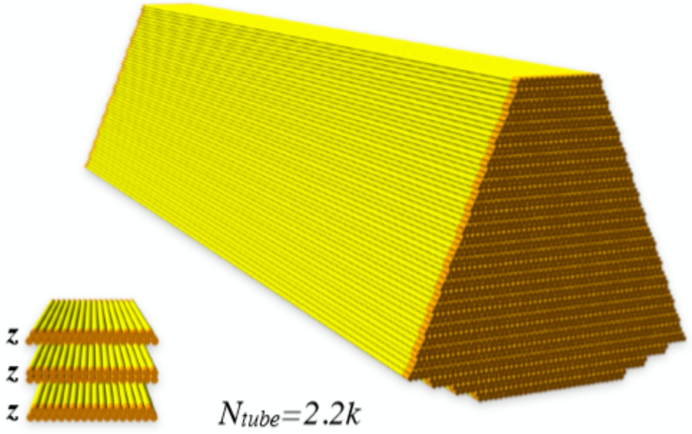
Ultrasonic welding of straws


1700
Carbon fiber frame
30 double layers of straw (x2 zoom)
Carbon capsule
2360

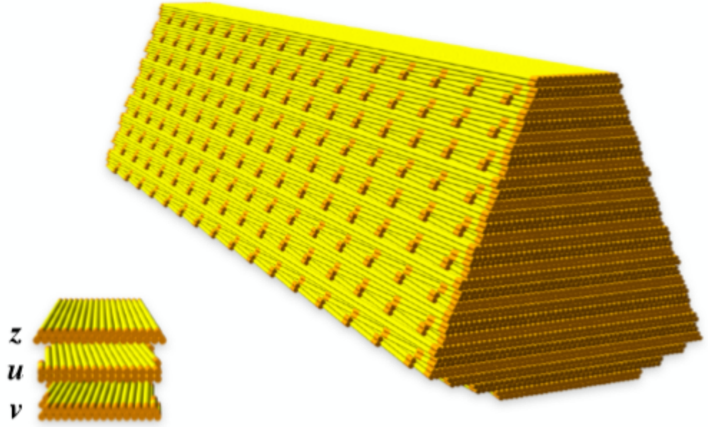




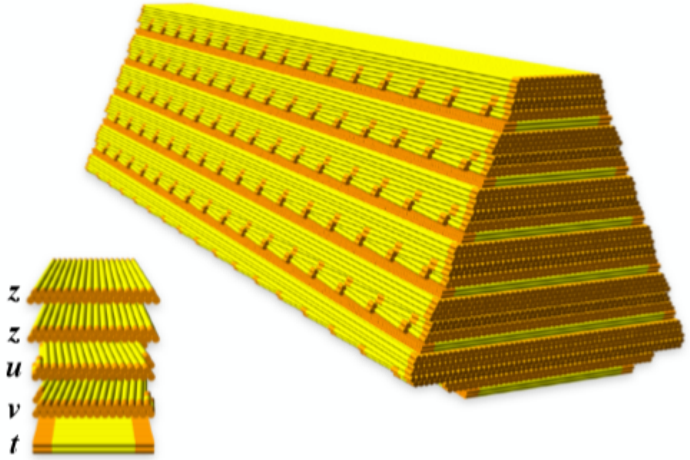
All tubes along z, 30x(Z)



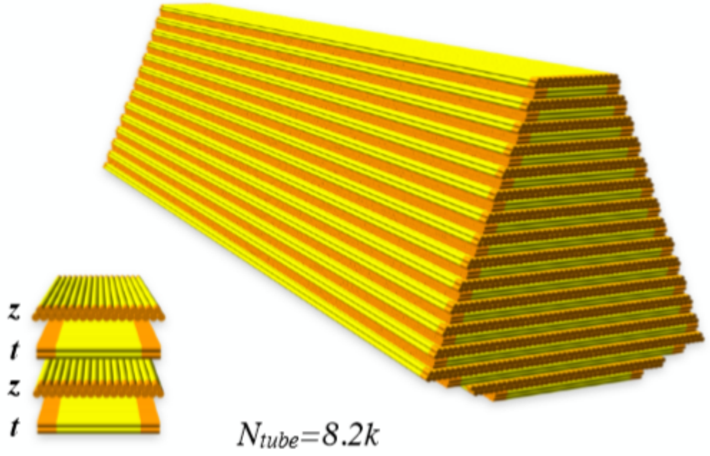
Layers 10x(ZUV)

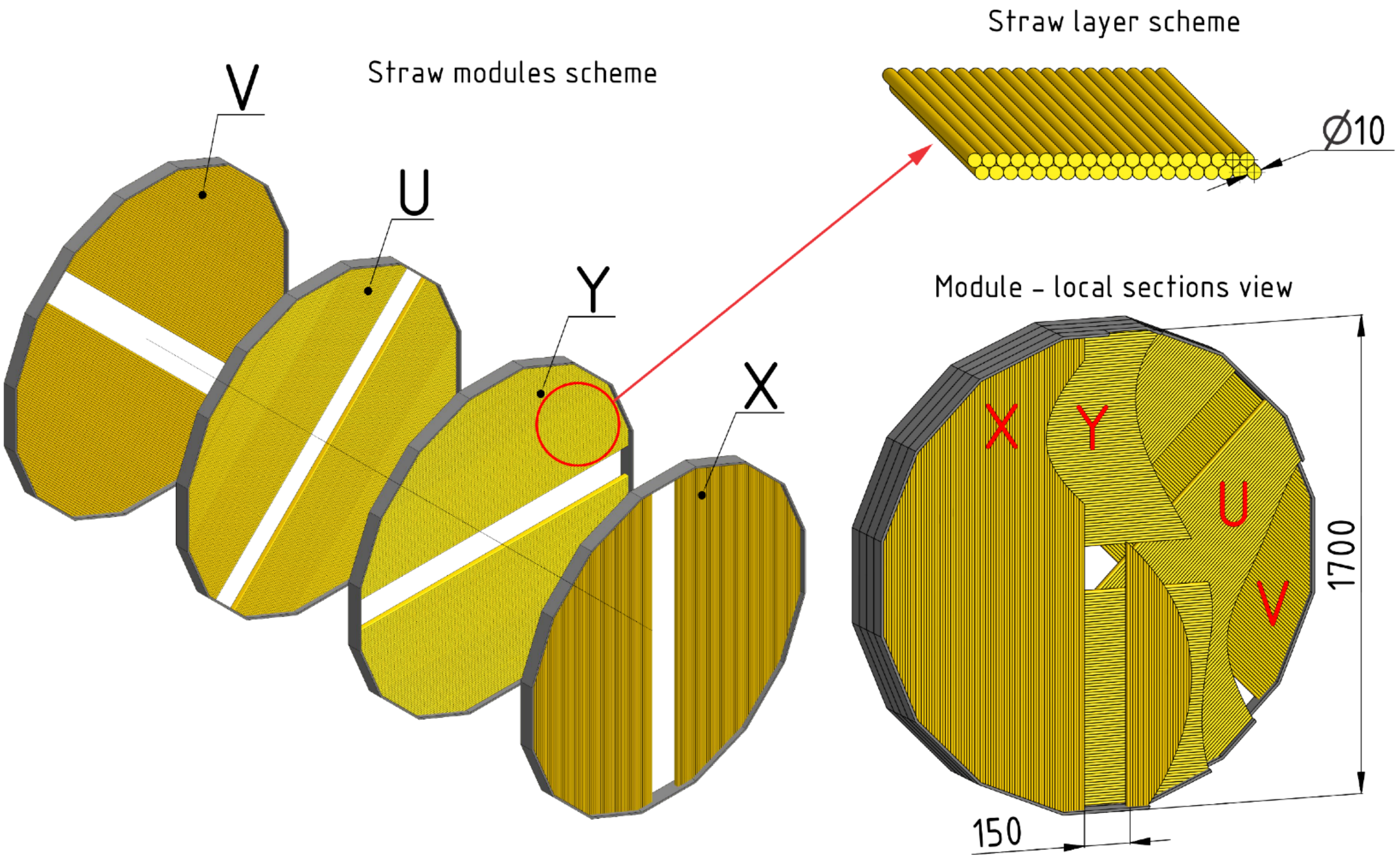


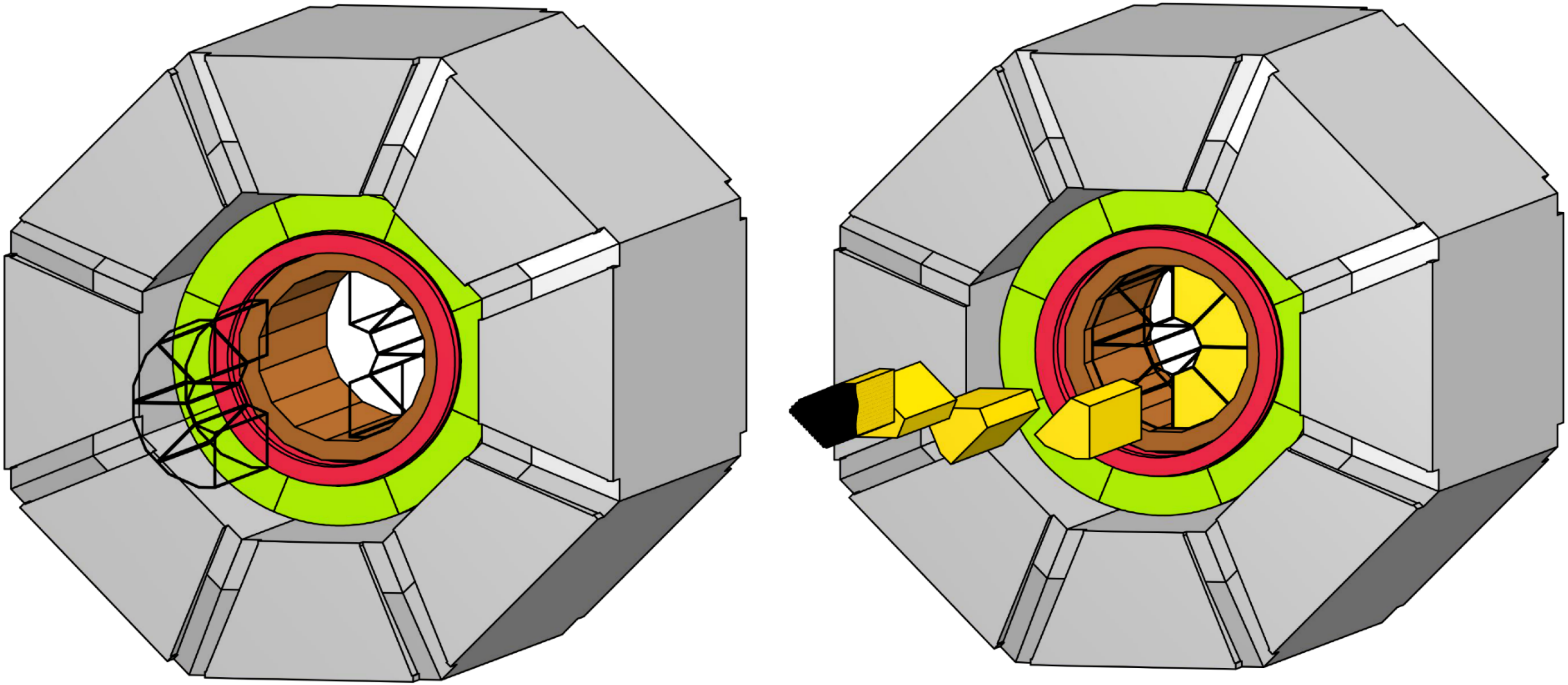
Layers 6x(ZZUVT)

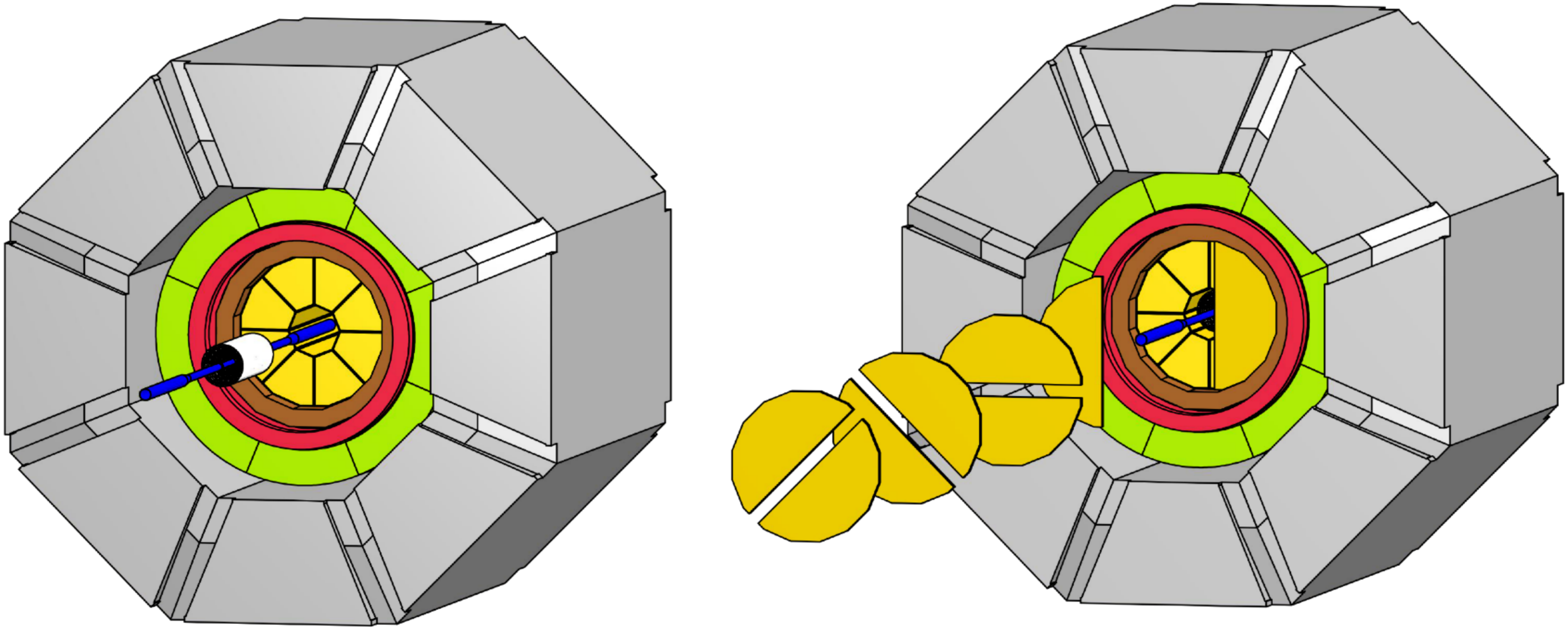


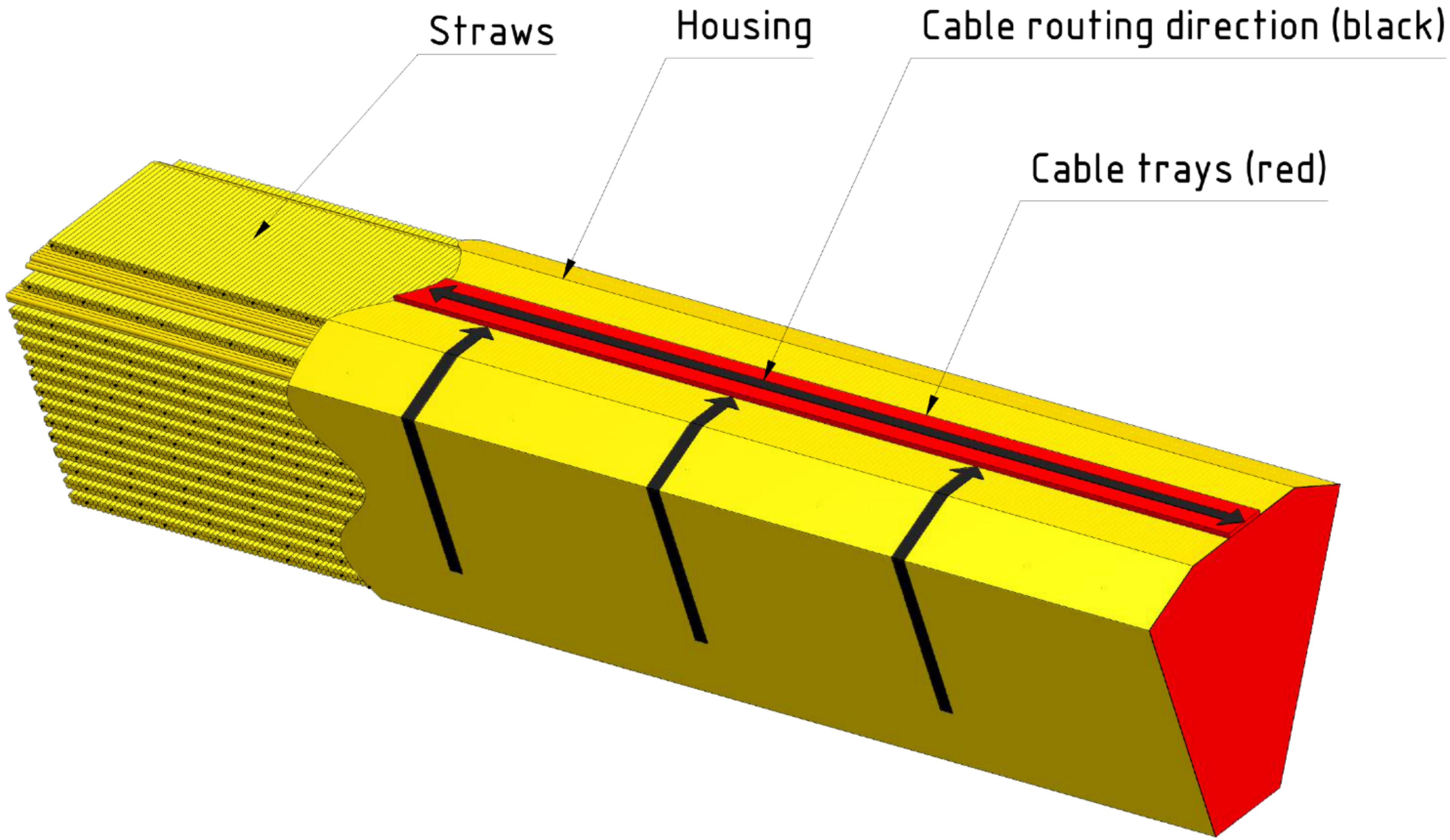
Layers 15x(ZT)

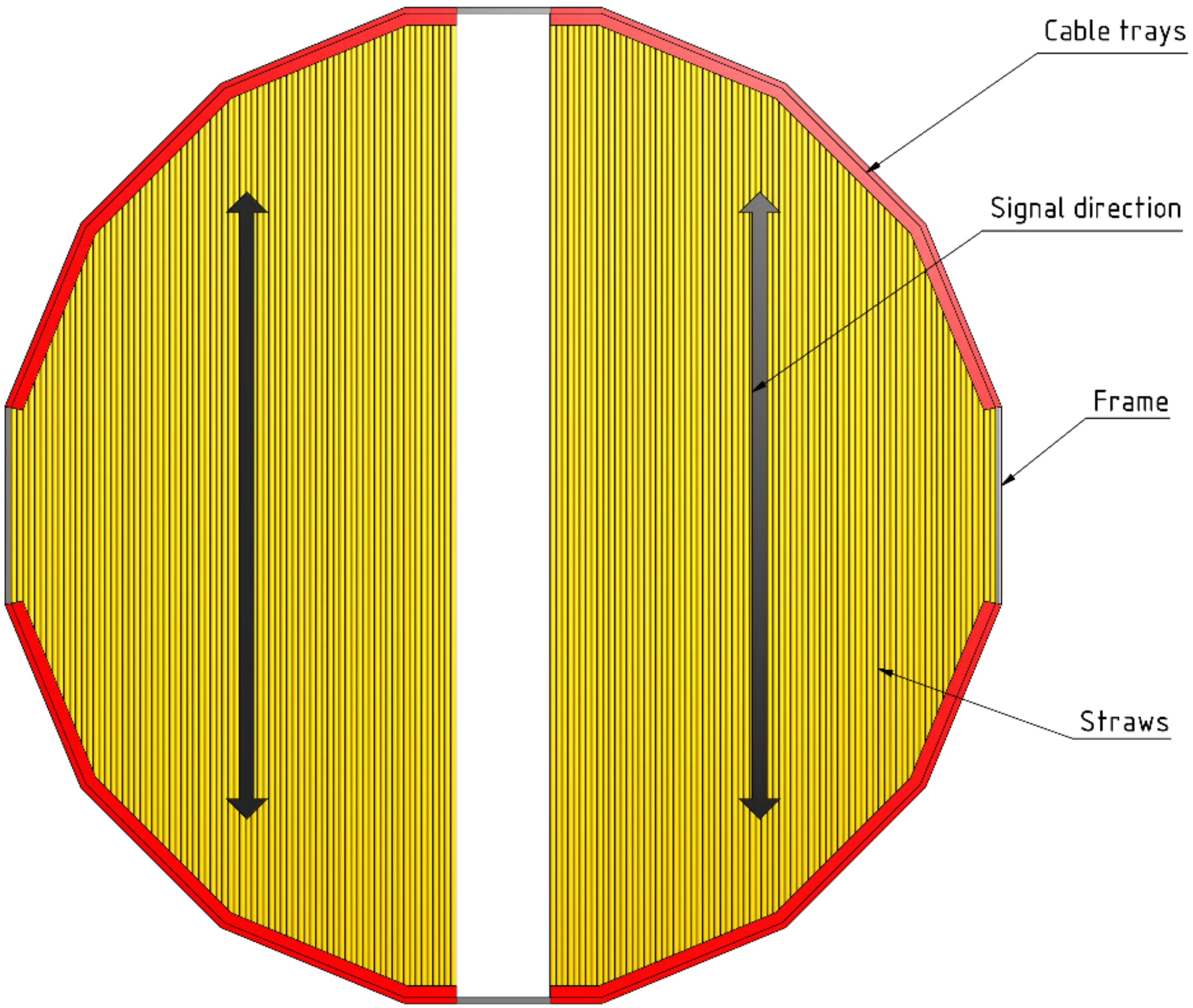


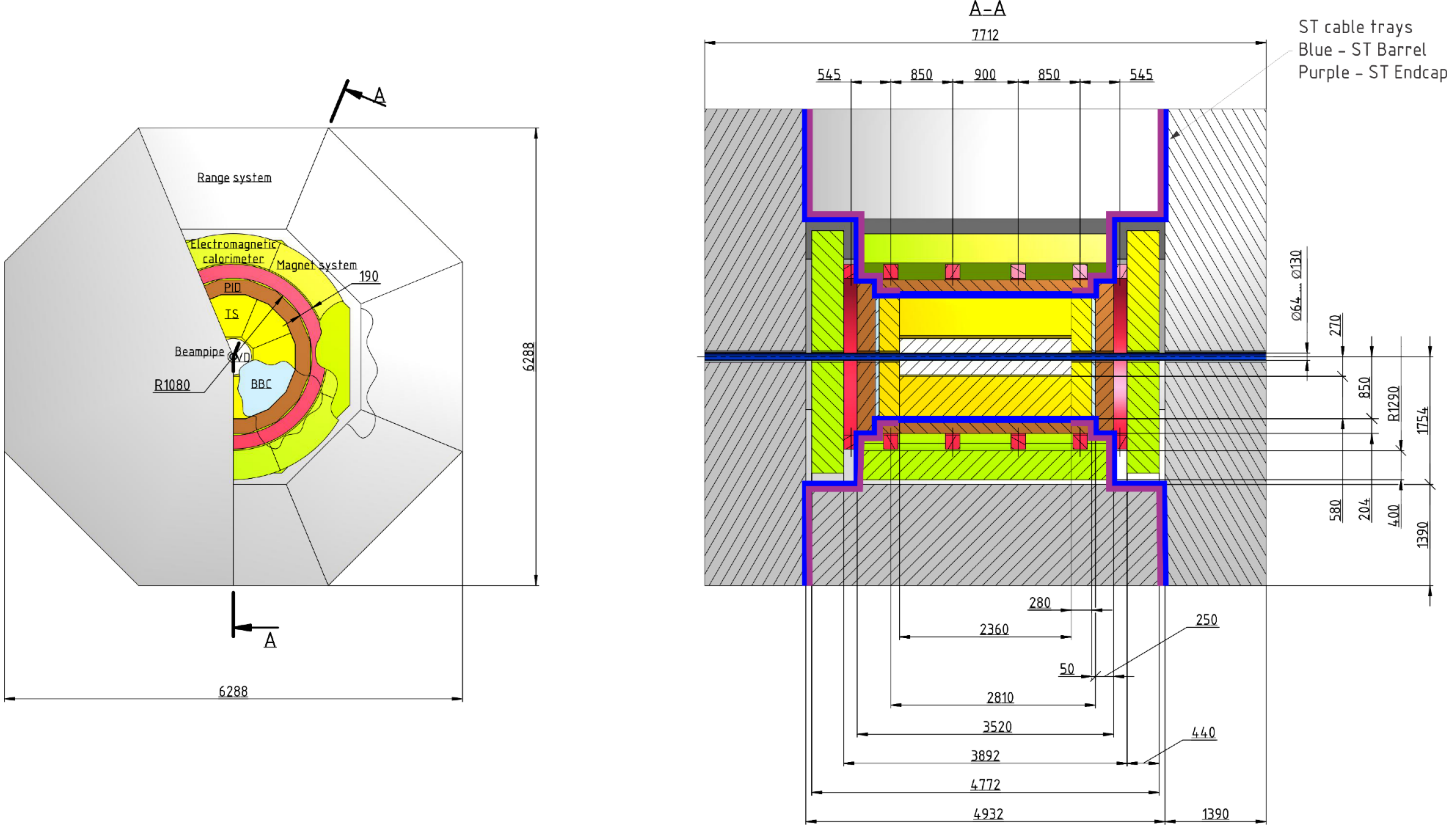

Straw modules scheme
V
U
Y
X
Straw layer scheme
∅10
Module – local sections view
X
Y
U
V
1700
150





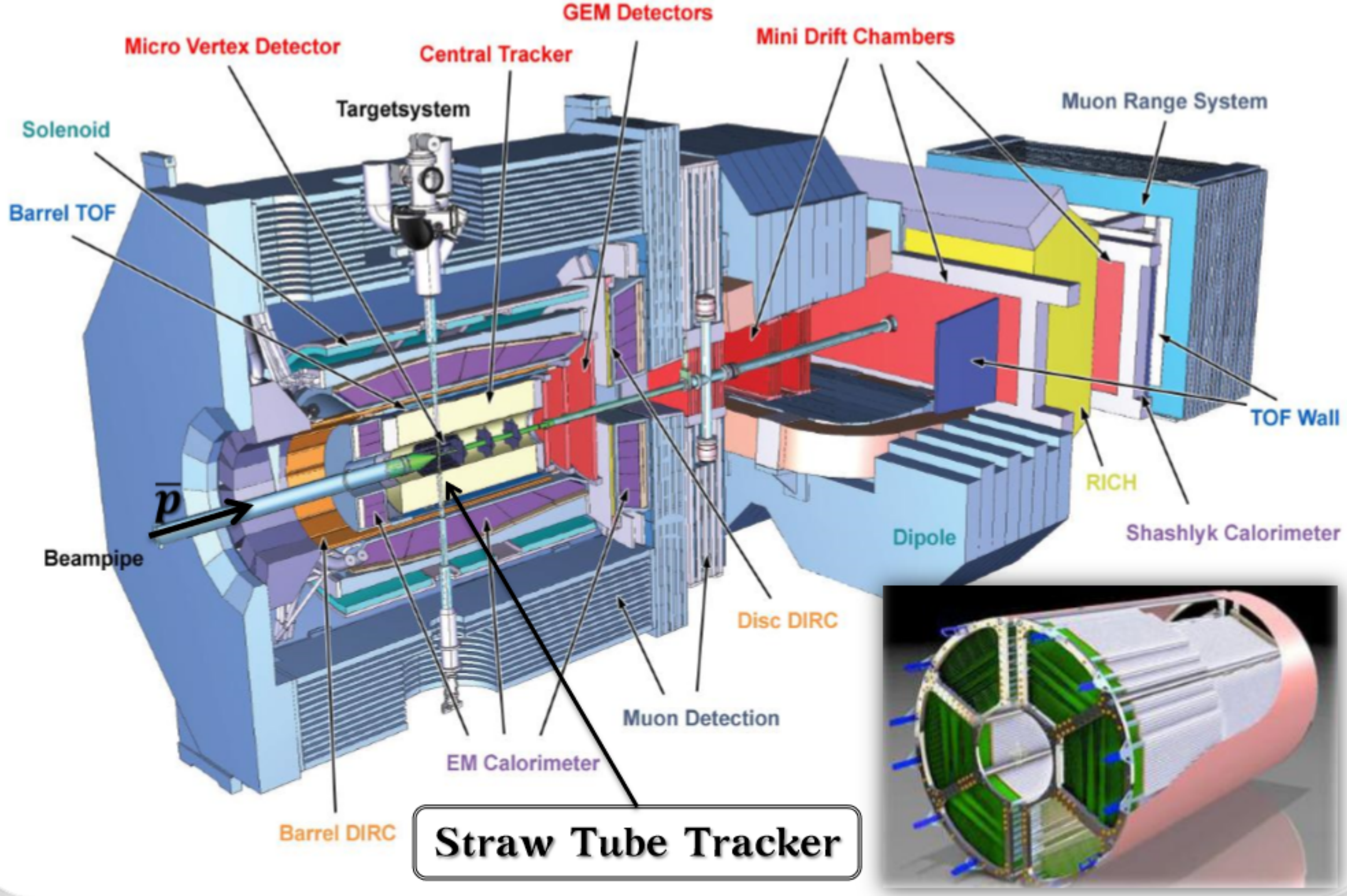

Straws
Housing
Cable routing direction (black)
Cable trays (red)

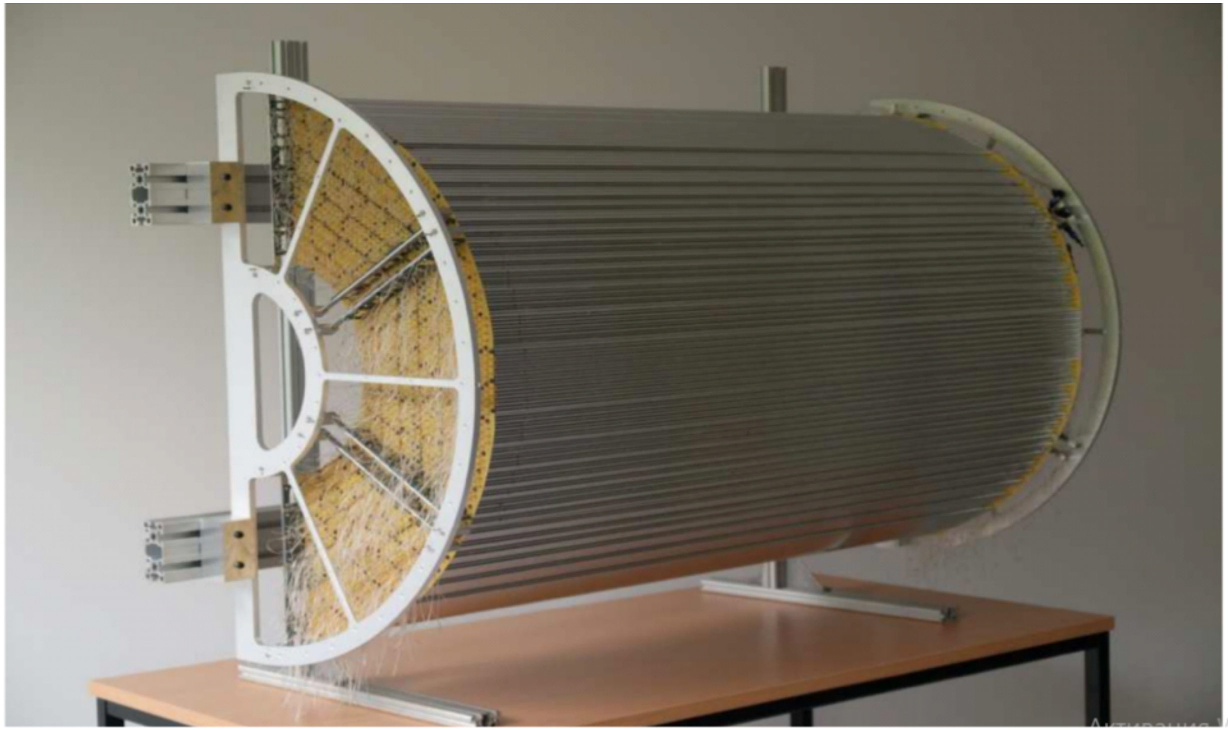

Cable trays
Signal direction
Frame
Straws

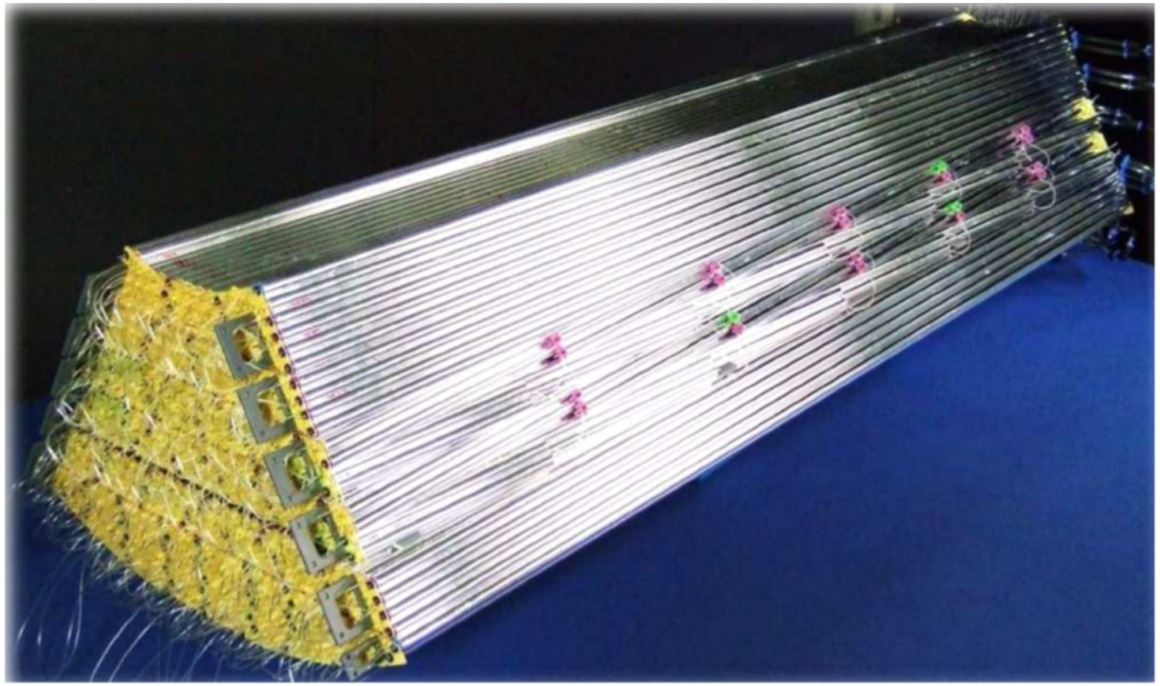


A-A
ST cable trays
Blue - ST Barrel
Purple - ST Endcap
Range system
Electromagnetic calorimeter
Magnet system
PID
TS
Beampipe
VD
BBC
R1080
190
6288
6288
7712
545
850
900
850
545
Ø64.... Ø130
270
850
R1290
1754
580
204
400
1390
280
2360
250
50
2810
3520
3892
440
4772
4932
1390

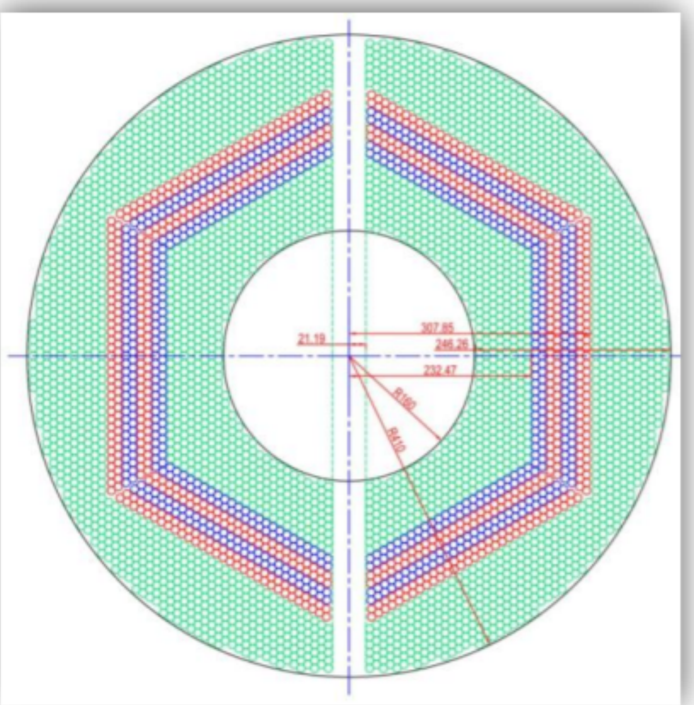
PANDA Detector Overview







The PANDA Straw Tube Trackers



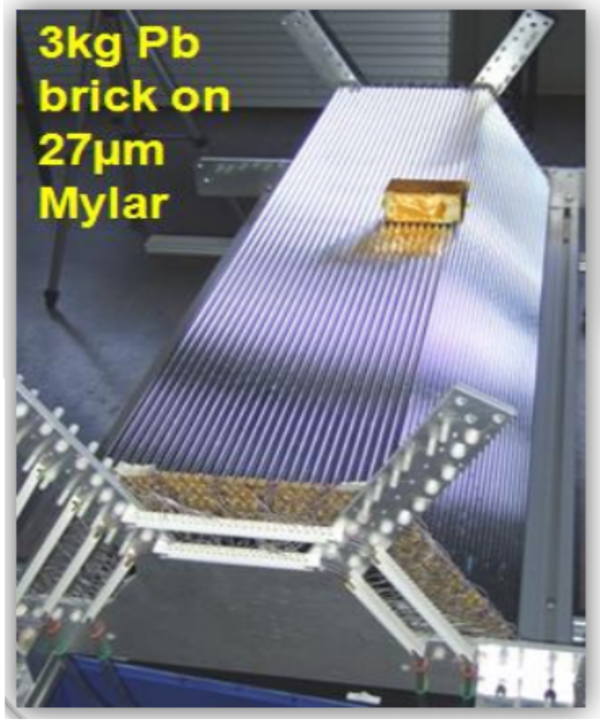
STT LAYOUT

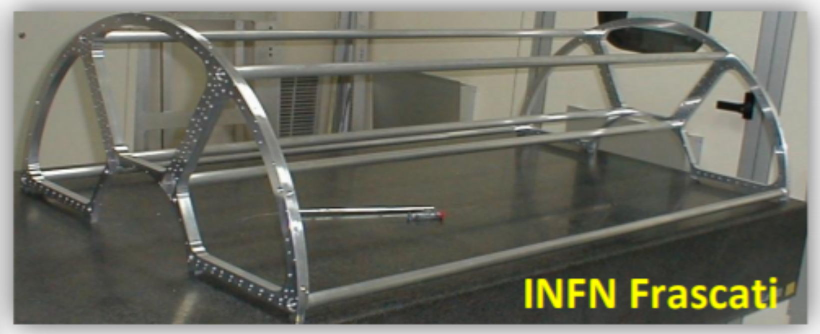
- 4636 straw tubes in 2 semi-barrels around beam/target pipe
- 23-27 planar layers in 6 hexagonal sectors
  - 15–19 axial layers (green) parallel to the detector axis
  - 8 stereo layers ($\pm$ 2.89°) for 3D reconstruction (blue/red)
- Length: 1500mm + 150mm (RO upstream)
- R_{in}/R_{out}: 150 / 418 mm
- Angular acceptance: near 4π
- High momentum resolution: δ_p/p ~ 1-2% at B = 2 Tesla
- High spatial resolution: $\sigma_{r\varphi}$ ~ 150 (100) μm, σ_z ~ 3.0 (2.0) mm (single hit)

ADVANTAGES of self-supporting straws:

lowest weight, precise geometry, maximal straw density

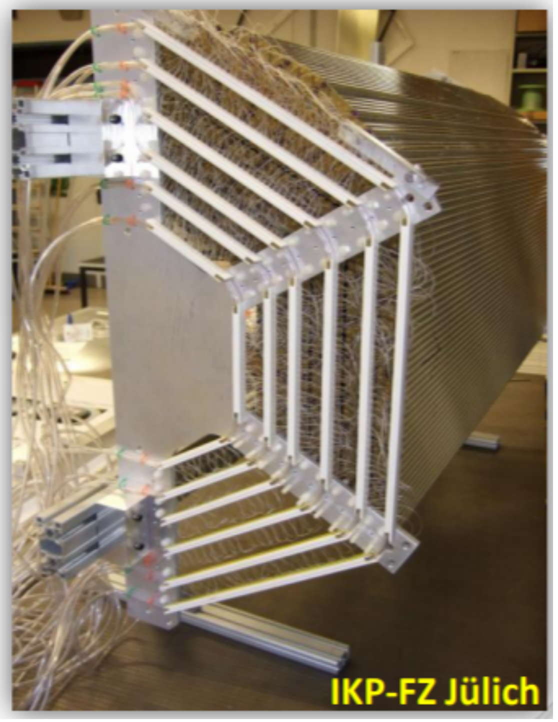
- **Strong rigidity**: pressurised, close-packed multi-layer straw modules are self-supporting
- **Perfect and cylindrical tube shape** thanks to inner gas overpressure
- **Strong wire/tube stretching** corresponding to 230 kg/3.6 t equiv.
    - No stretching of straw ends from mechanical frame are needed
    - No reinforcements structure are needed along the tube length
- "Light" mechanical **support frame** needed (STT: 2x 8.2 kg)

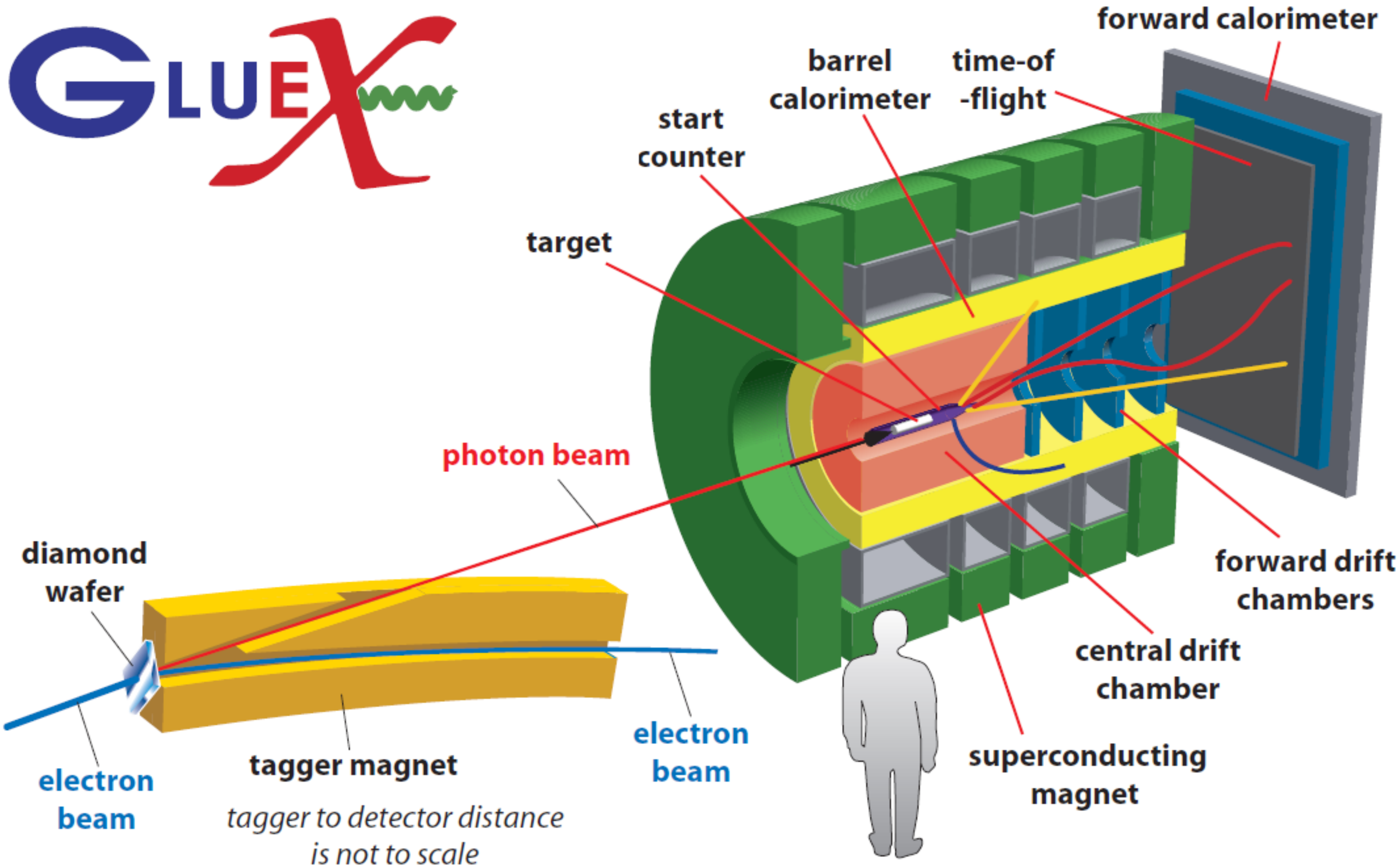




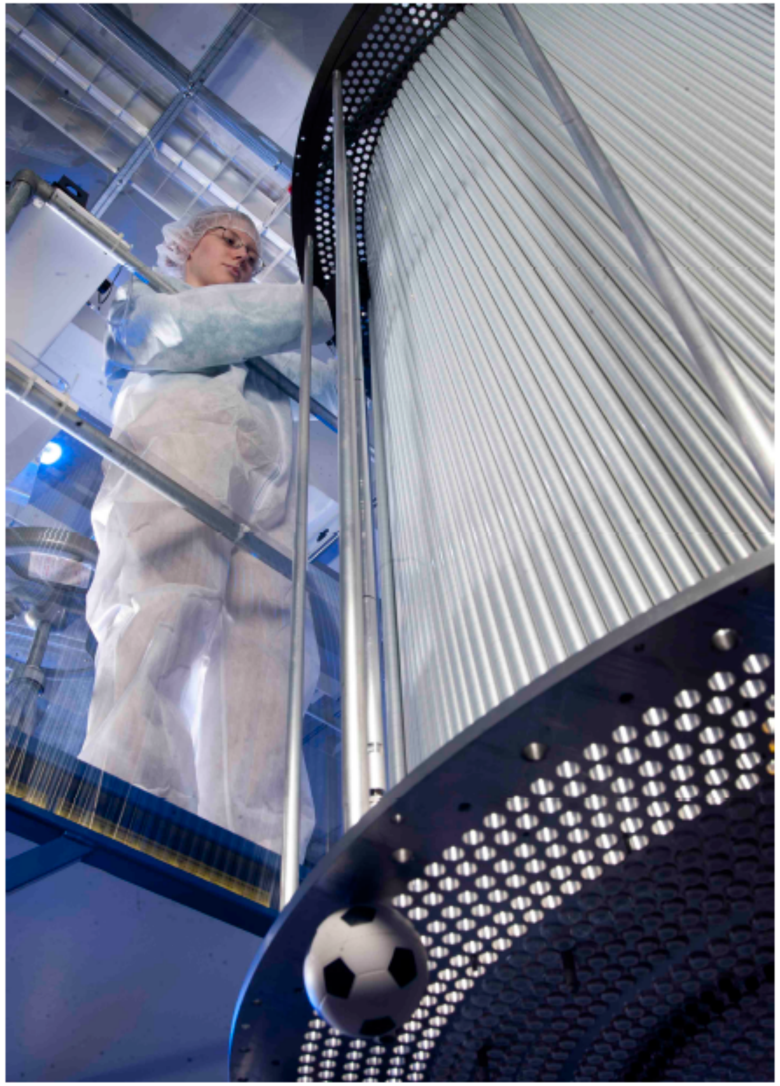
Material	Aluminum
Density	2.7 g/cm^3
Youngs modulus	70 GPa
Radiation length (X_0)	9 cm
Thermal expansion	24 ppm/°C

Full-scale prototype assembly
@ IKP-FZ Jülich




GlueX
forward calorimeter
barrel calorimeter
time-of-flight
start counter
target
photon beam
diamond wafer
electron beam
tagger magnet
tagger to detector distance is not to scale
electron beam
superconducting magnet
central drift chamber
forward drift chambers

CDC: Central Drift Chamber (CMU)

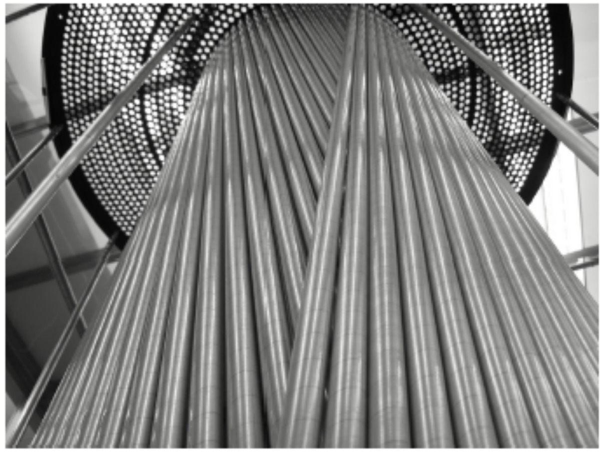


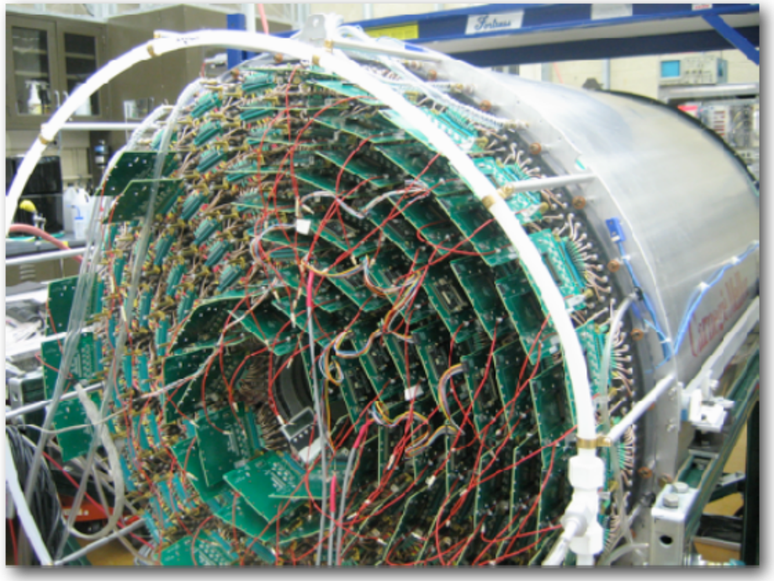
Straw tube chamber

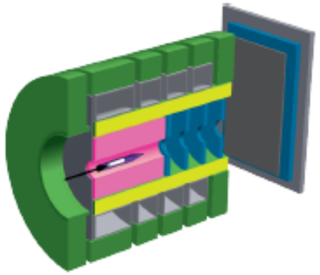
1.5m long x 1.2m diameter

3522 straws, 1.6cm diameter

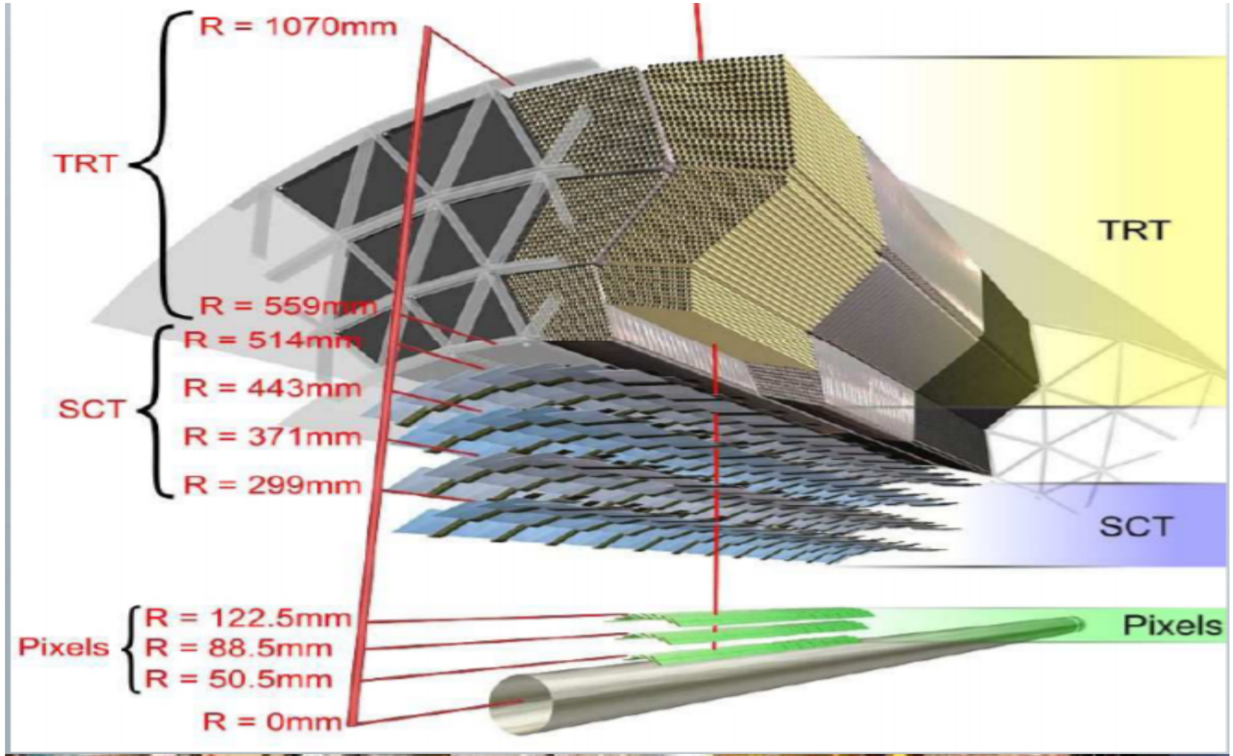
28 layers, 12 straight, 16 stereo

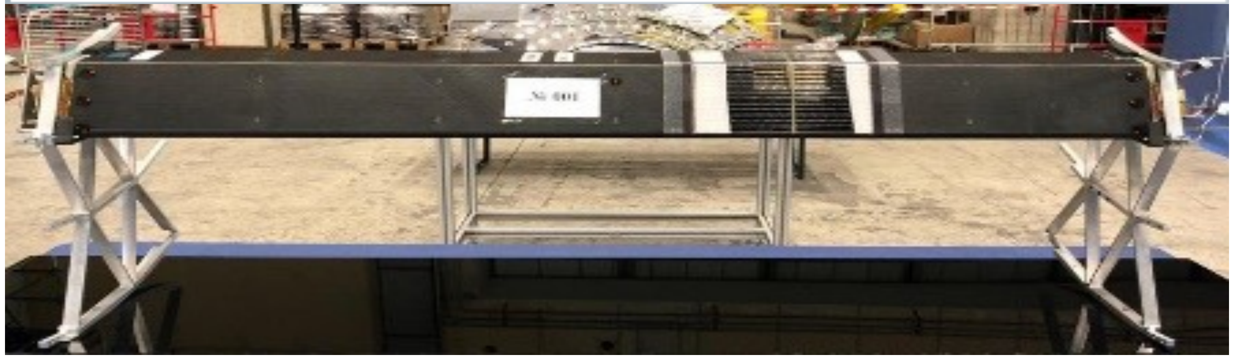


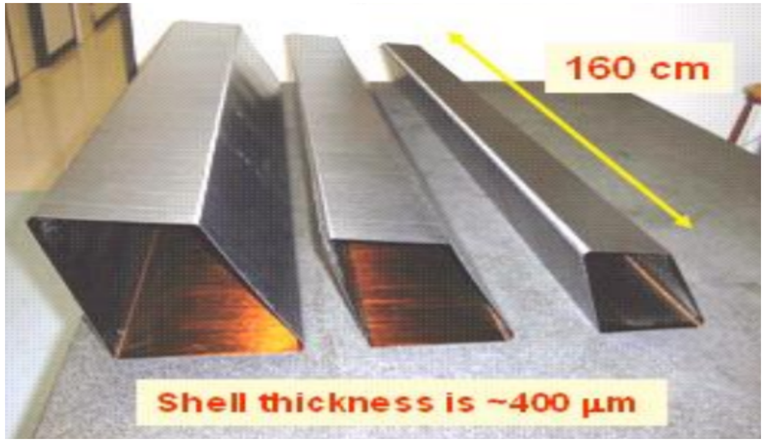




A schematic view of the ATLAS TRT inner detector.







TRACKER MECHNICS

Boundary conditions:

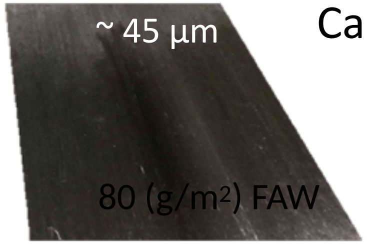
- high radiation levels
- Inelastic deformation
- temperature and humidity variations

Requirements:

- support the tracker in position, with minimum mass, low X/X0
- provide cooling and thermal stability
- provide high dimensional and dynamic stability

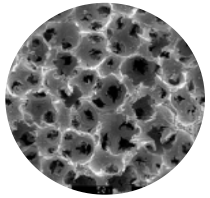
Carbon Unidirectional Prepreg: Ready to mold or cure material in sheet form which contains fiber all aligned in one direction. Filament diameter=11 μm

	Filaments [K=1000]	E1 [GPa]	X_t / X_c [MPa]	E2 [GPa]	Y_t [MPa]	K [W/mK]	CTE [$10^{-6}K^{-1}$]
K13D2U [0] fibre	2K	935	3688			800	-1,1
K13D2U [0] prepreg	2K	563	1800/340	6	25	~450	-1,2 / 61



Carbon Fibre Reinforced Plastics

Carbon foam: *high thermal performance, properties are porosity dependent*



POCOGRAPHITE An Entegris Company

	Density [g/cm3]	K In plane [W/mK]	K Out of plane [W/mK]
POCO HTC	0.9	70-245	245

Thermal Pyrolytic Graphite: *Thermal management material with very high thermal conductivity and flexibility*

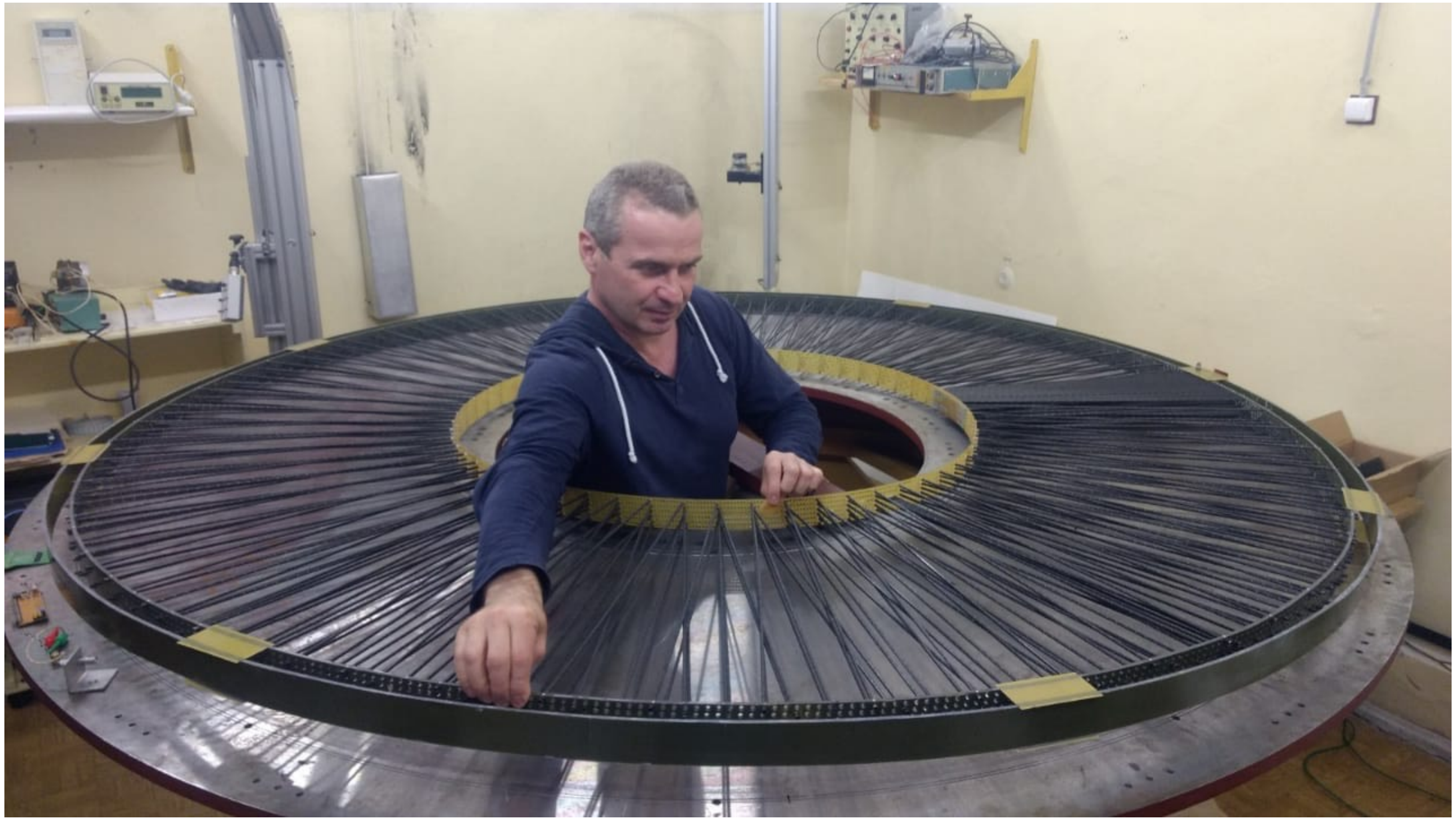
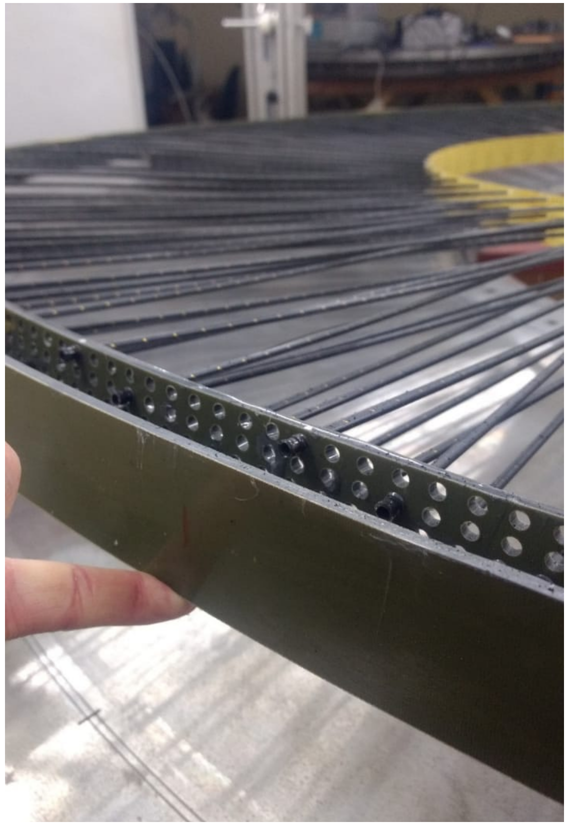
amecthermasol
MOMENTIVE

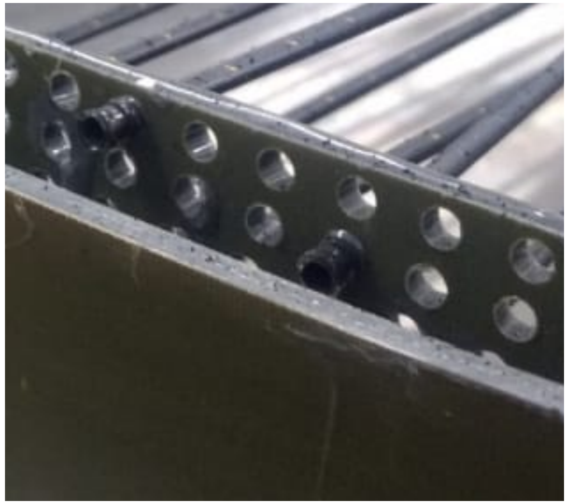
	Thick. [μm]	Density [g/cm3]	K **In plane** [W/mK]	K **Out of plane** [W/mK]
Amec FGS_003	30	1.6	1500	15
TPG @ Tile	250	2.25	1500-1700	6-10

Aluminium Graphite Composites, Thermal phase change material

schunk	Density [g/cm3]	K In plane [W/mK]	K Out of plane [W/mK]
ALG2208	2.2	220	140

Laird TECHNOLOGIES	Thick. [μm]	Trans. T [°C]	K [W/mK]
Tpcm 580	76-400	50	3.8



1.Размеры и вес-не более100кг

2. Сегментирование- 3 основные секции(баррель-8 частей, 2ендкапа-по 4 части

3. Способ размещения относительно других систем –?

4. Точность размещения подсистемы относительно других элементов установки-?

5. Выделяемая мощность (+/-30%)- 0,1W на канал (примерно 1,0-1,5 кW на 10000-15000 каналов)

6. Особенности материалов-использование углепластика

7. Необходимость возможности доступа-желательно

8. Необходимость диагностики-обязательно

9. Другие особенности подсистемы, которые, по-вашему мнению, могут оказаться важными- автоматический климат- контроль (~2 град)

TRACKER ELECTRONICS DUNA

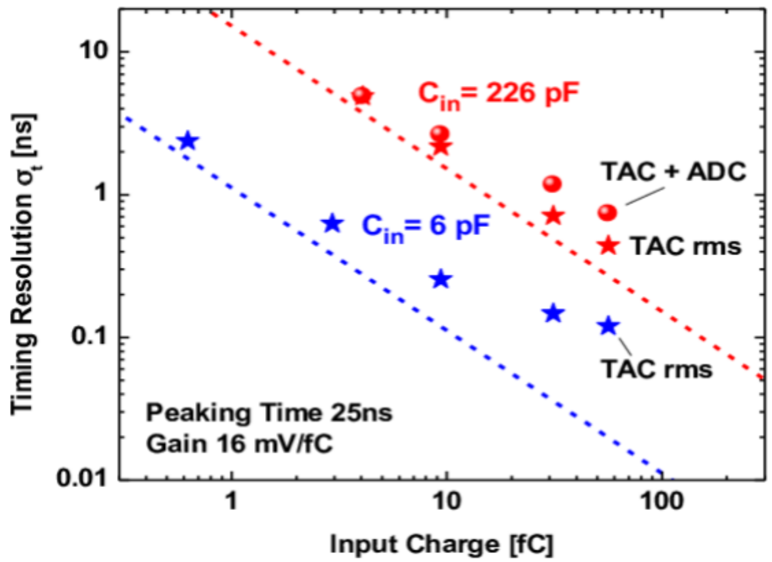


Figure 4: VMM3a time resolution as a function of input charge. Better than ns time resolution is obtained for suitably large deposited charge signals. [4]

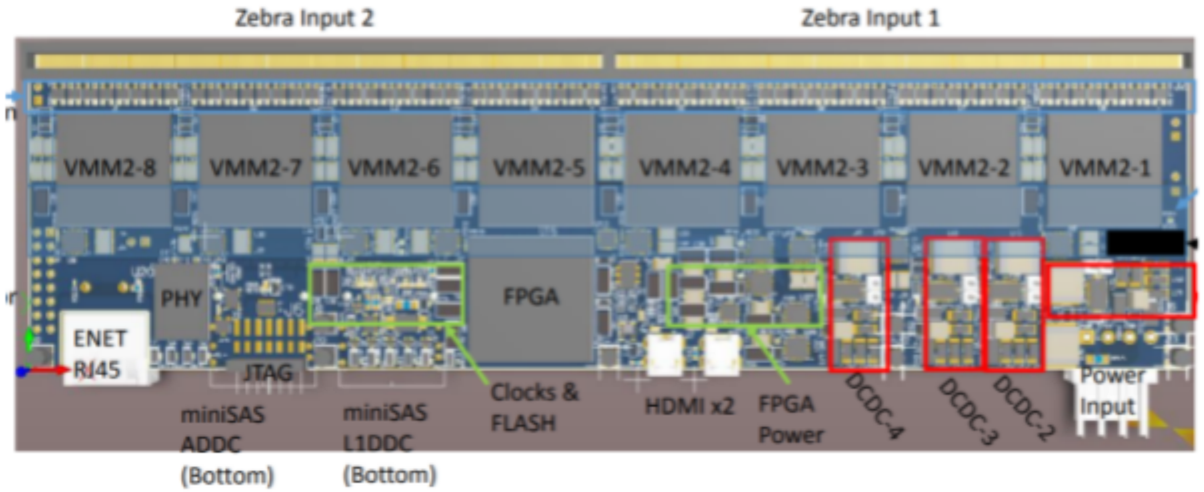
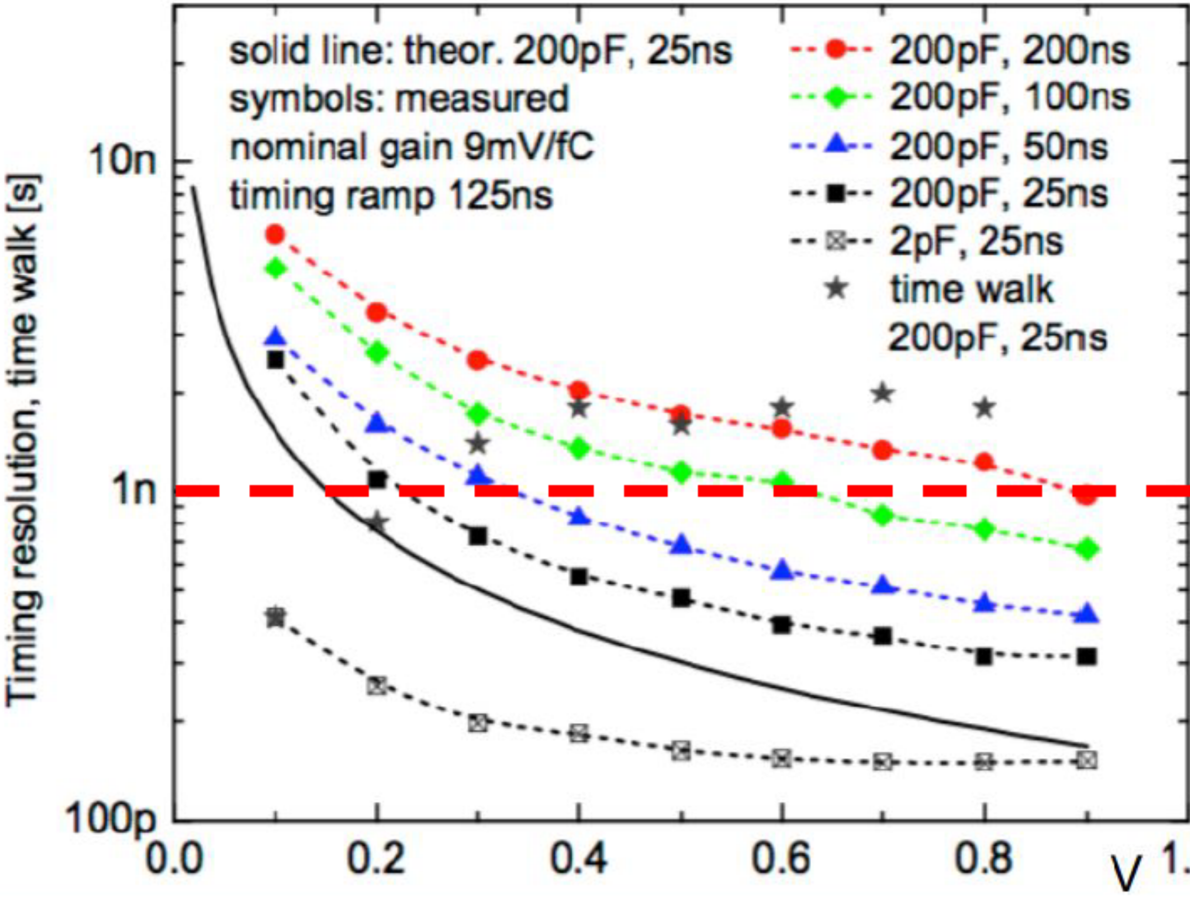


Figure 5: MMFE-8 readout board implements 8 VMM ASICs, equivalent to 512 channels, in a board with dimensions 215mm x 60mm x 2.54mm.

VMM3 Meets STT Readout Requirements

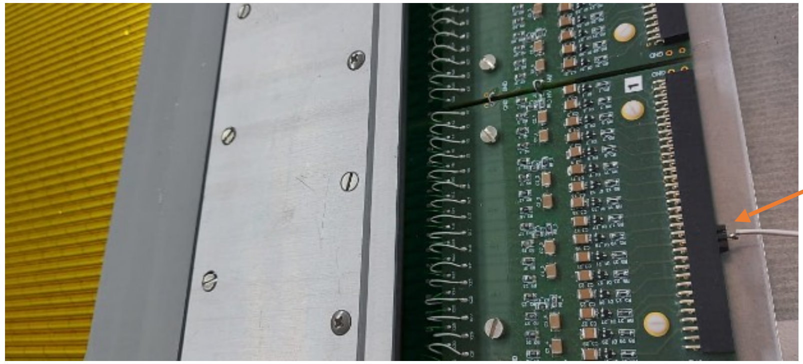
- Readout requirements:
  - Measure deposited charge & time t;
  - Timing resolution << 1ns;
  - Low threshold: charge from single ion pair;
  - Dynamic range > 1000 on charge;
  - Max width of readout board: 5cm;
  - Max length of readout board: 16 cm every 64 channels for double readout

VMM3 Time Resolution



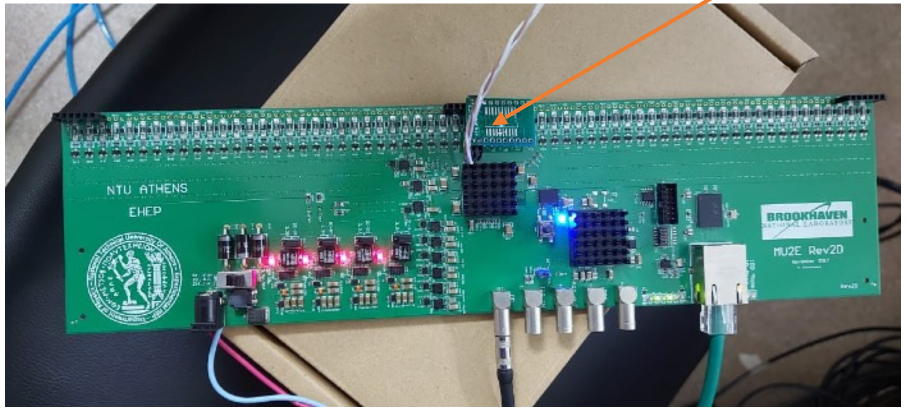
- VMM3 satisfies required <1ns timing
- Measures Q + T for each input
- Built-in pulser for accurate electronic response calibration
- Compact 64-ch ASIC well suited to tight spatial constraints

Signals from STRAW chambers with ^{55}Fe

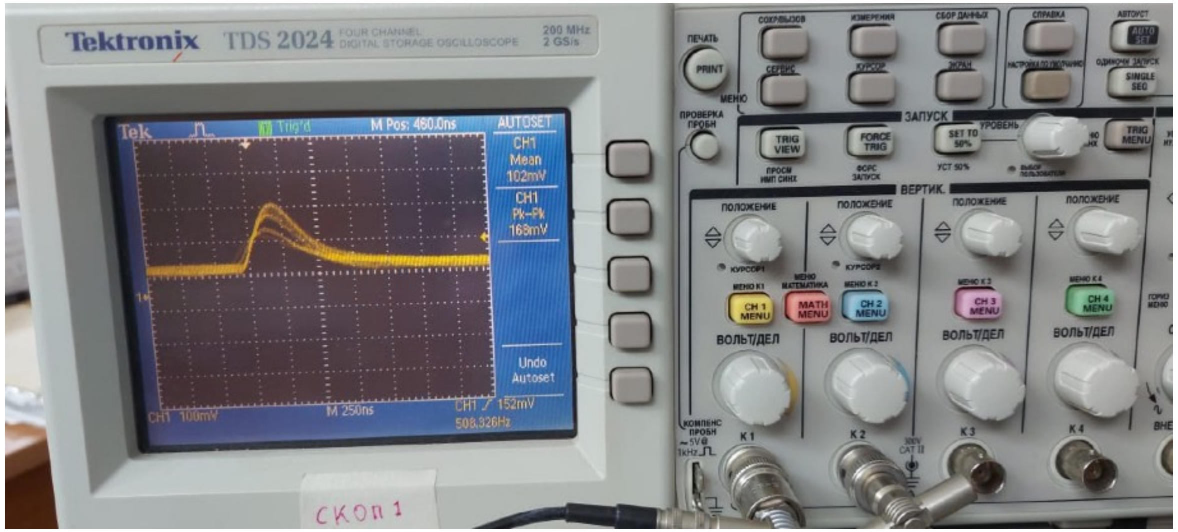


Adapter to get the signal from STRAW chamber

Adapter to delivery signal from STRAW chamber into the VMM3 board

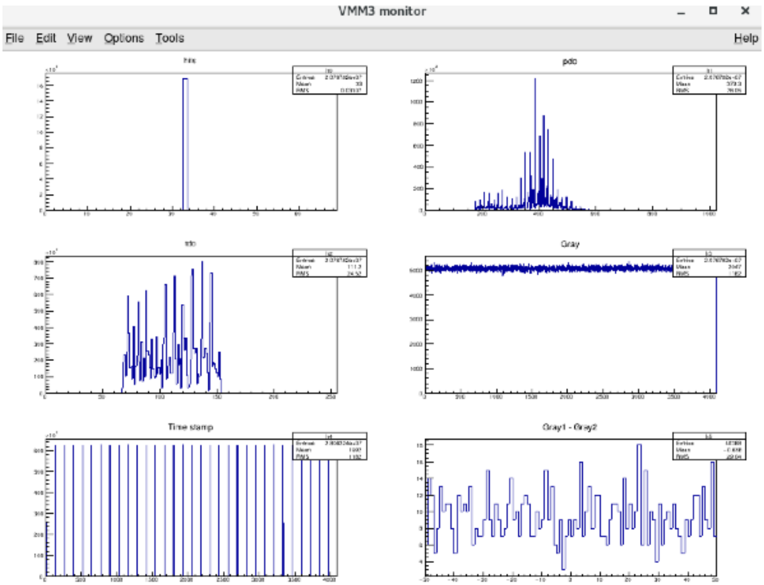


Monitor output

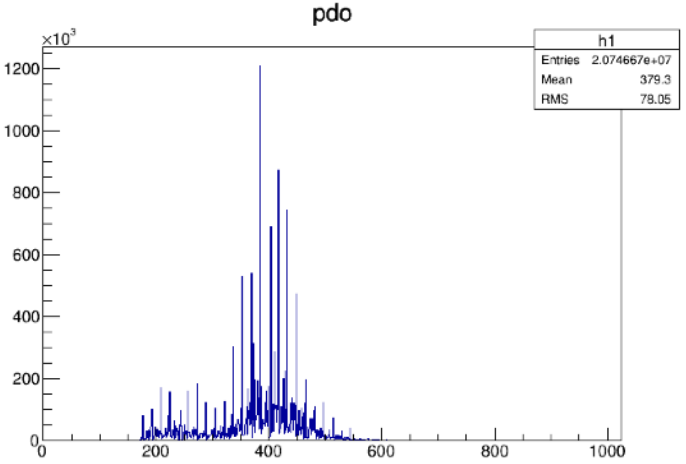


Signal from monitor output.
^{55}Fe is attached to the STRAW chamber

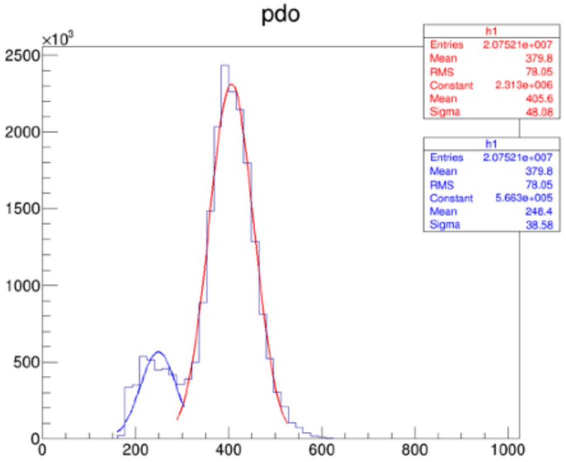
Test of the STRAW chamber with ^{55}Fe



Online monitor software for VMM3



Binning case: 1 bin is 1 ADC channel



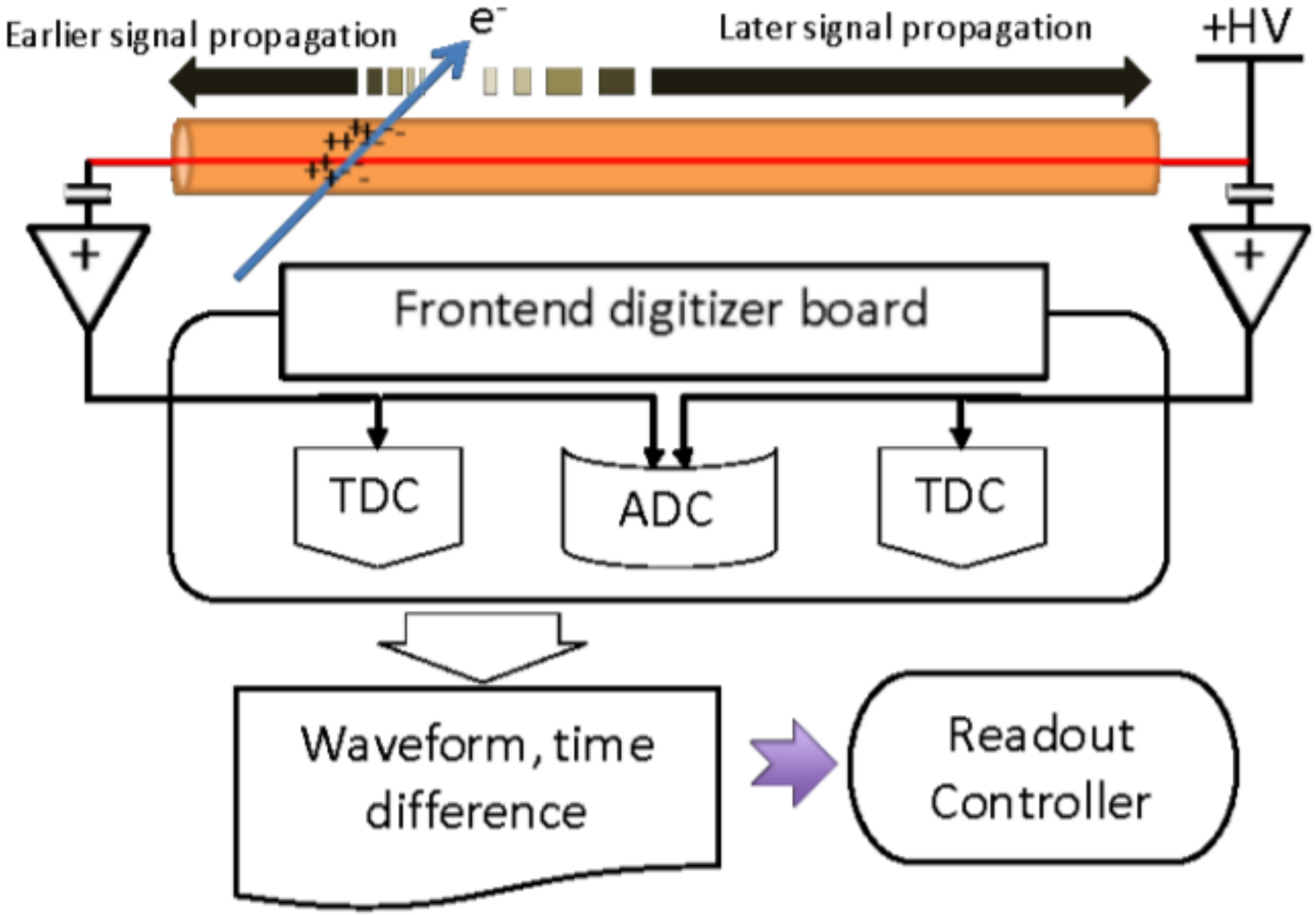
Binning case: 1 bin is 16 ADC channels

"red" fit by Gaussian – peak of ^{55}Fe (5.9 kEv)

"blue" fit by Gaussian – argon escape peak (2.7 kEv)

- The software to monitor the online data from VMM3 is created
- The known problem with built in 10-bit ADC non-linearity is appeared
- Nice distribution in case jointing/merging 16 ADC channels
- The resolution by peak of ^{55}Fe is about 15%

Mu2e Conceptual Design Report



TRACKER ELECTRONICS TIGER

In Turin the electronics based on the **TIGER** chip (Turin Integrated Gem Electronics for Readout) is developed for trigger-less readout ***of the GEM detectors***.

Charge and time measurements provided.

TIGER parameters

5 x 5 mm^2 110nm CMOS technology
64 channels: preAmp, shapers, TDC/ADC, local controller
Digital backend inherited from TOFPET2 ASIC (SEU protected)
On-chip bias and power management
On-chip calibration circuitry
Fully digital output
4 TX SDR/DDR LVDS links, 8B/10B encoding
Nominal 160 MHz system clock
10 MHz SPI configuration link
Sustained event rate > 100 kHz/ch