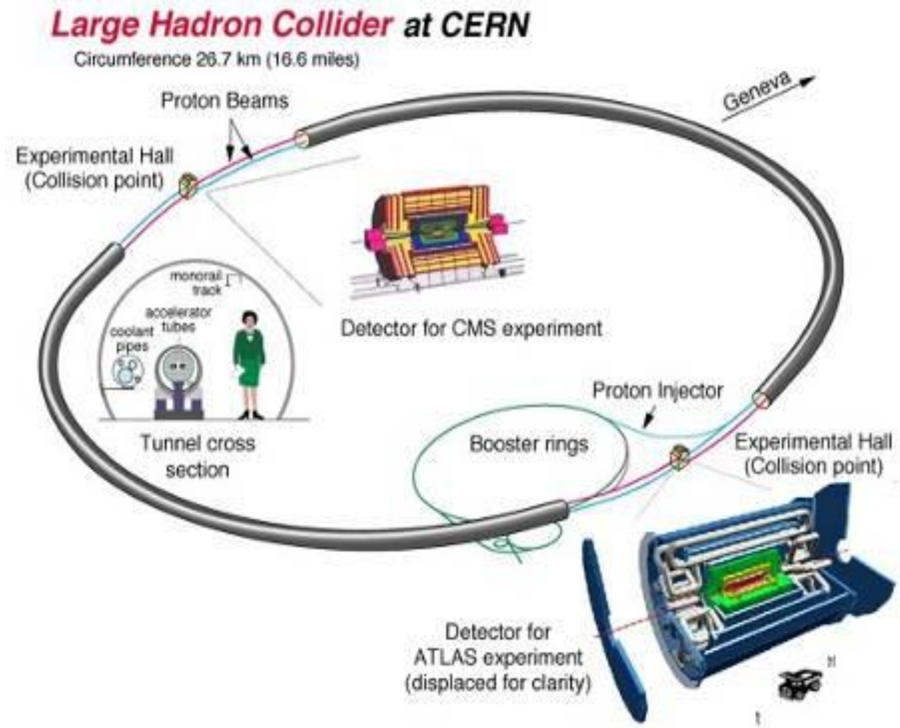
ATLAS upgrade (JINR participation).

M. Gostkin

6 june 2017

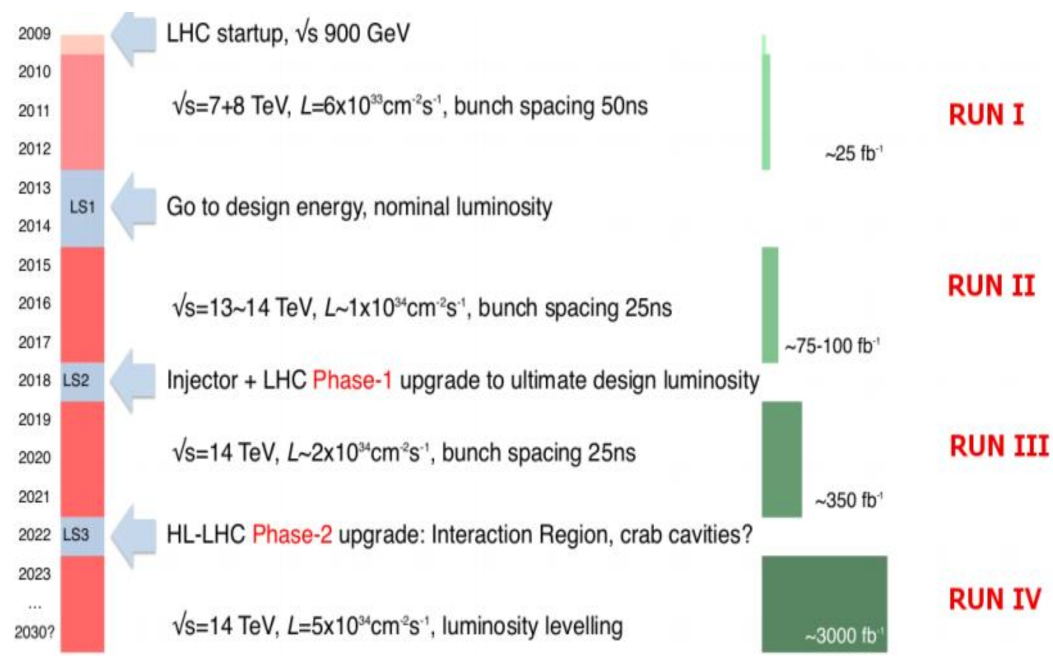


13-14 TeV proton-proton Collider,
27 km long

- In operation since September 2009

General Purpose and Discovery machine

- 2 general purpose detectors
  ATLAS and CMS
- For finding the Higgs boson (done), looking beyond the Standard Model, seeking “new physics”



A Toroidal LHC ApparatuS (ATLAS) today.

Muon spectrometer

(*μ Trigger/tracking and Toroid Magnets*)

Precision Tracking:

- **MDT** (Monitored Drift Tubes)
- **CSC** (Cathode Strip Chambers) $|\eta| > 2.4$

Trigger:

- **RPC** (Resistive Plate Chamber) barrel
- **TGC** (Thin Gas Chamber) endcap

Calorimeter:

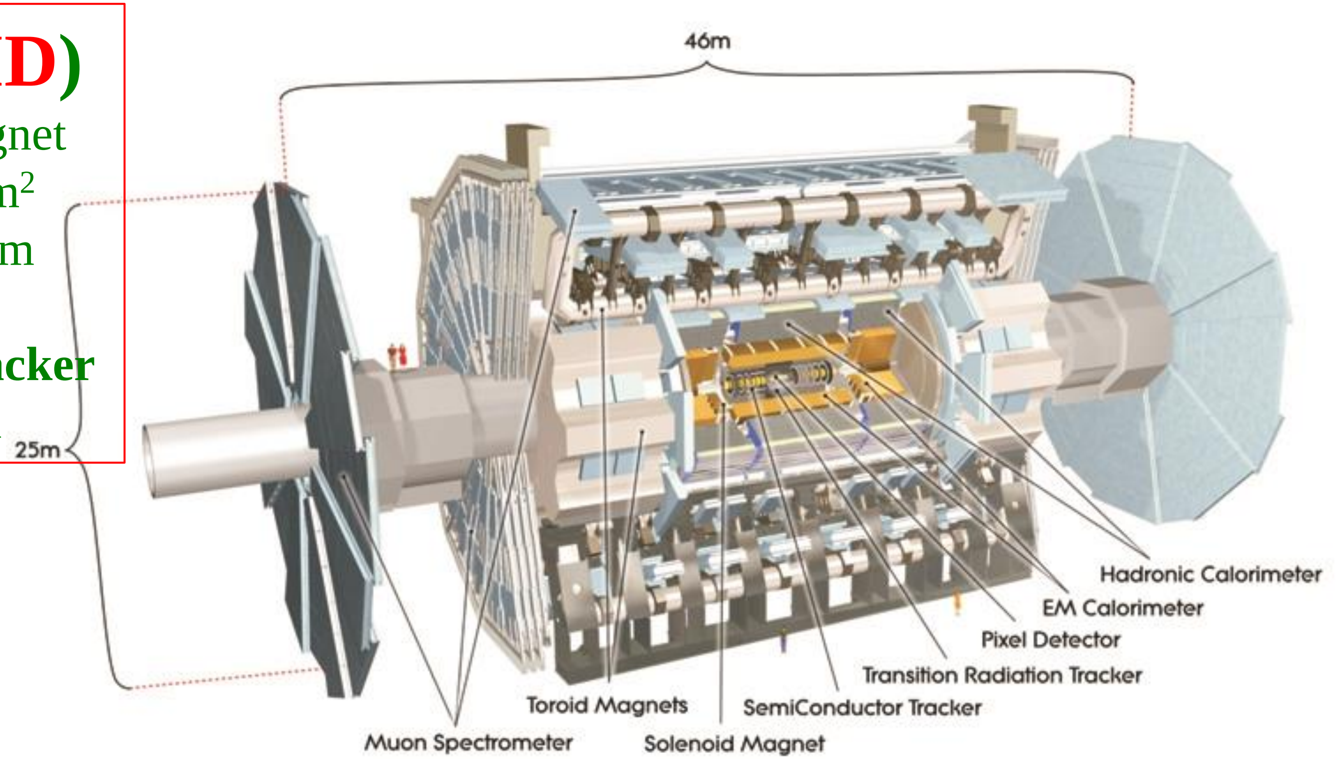
EM and Hadronic

- **Liquid Ar** (LAr) EM barrel and End-cap & Hadronic End-cap
- **Tile** calorimeter (Fe-scintillator) Hadronic barrel

Inner Detector (ID)

Tracking; 2T Solenoid Magnet

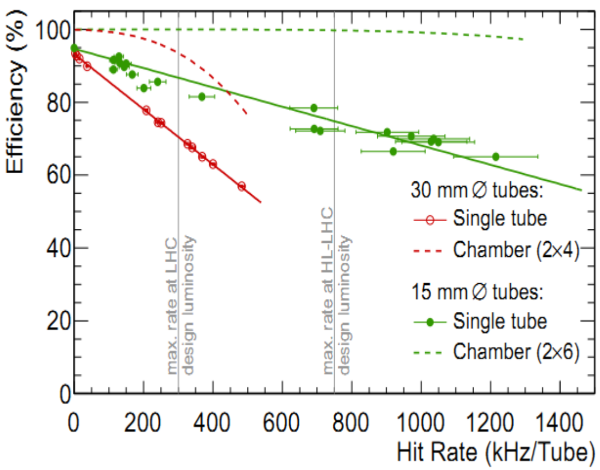
- **Silicon Pixels** 50 x 400 μm^2
- **Silicon Strips** (SCT) 40 μm rad stereo strips
- **Transition Radiation Tracker** (**TRT**) up to 36 points/track

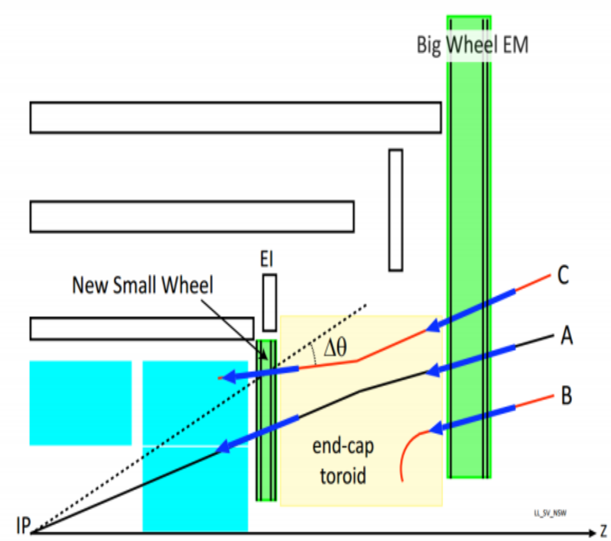


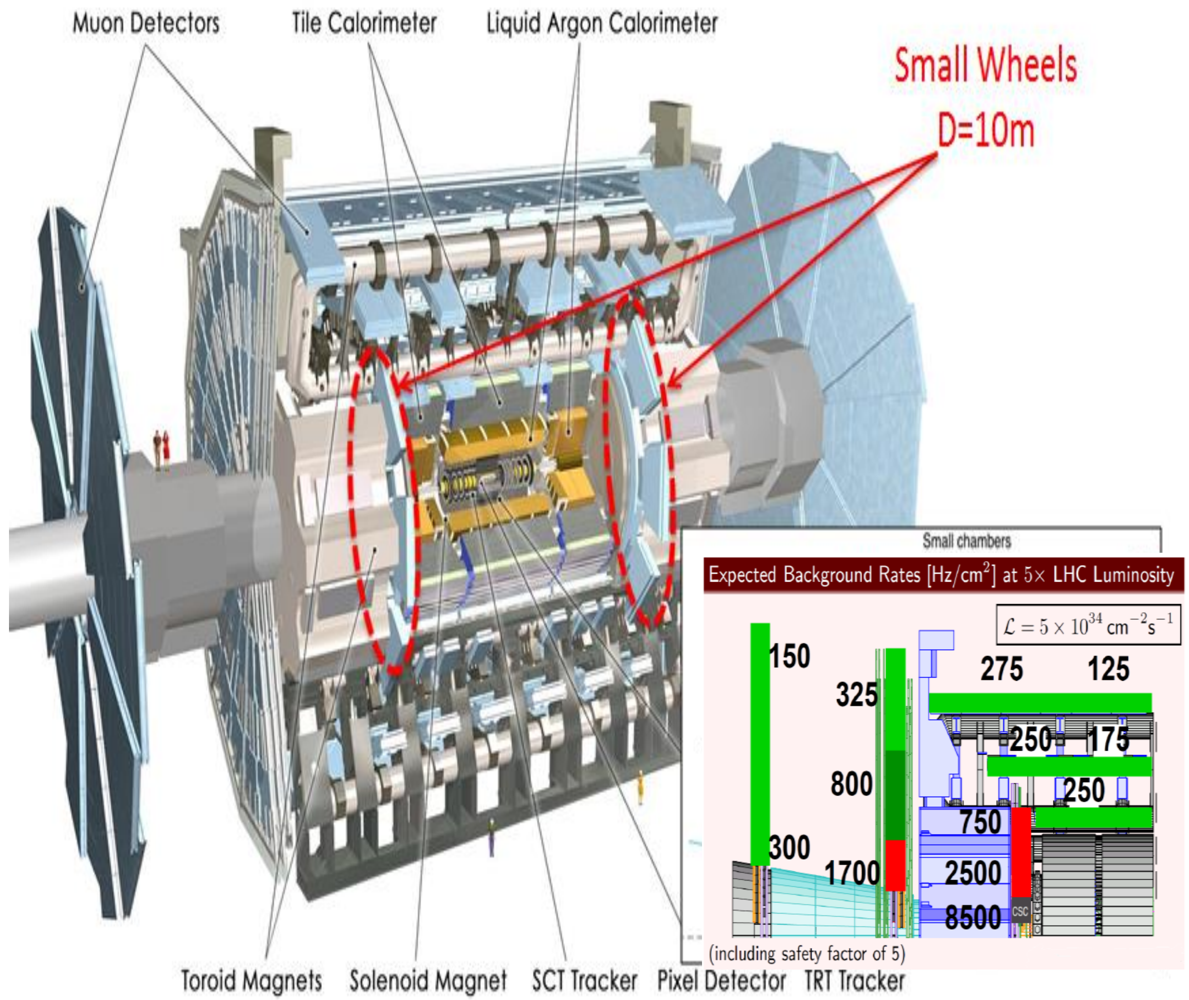
ATLAS

Small Wheel upgrade motivation:

- **MDT performance degradation**
- **Present endcap trigger high fake rate**

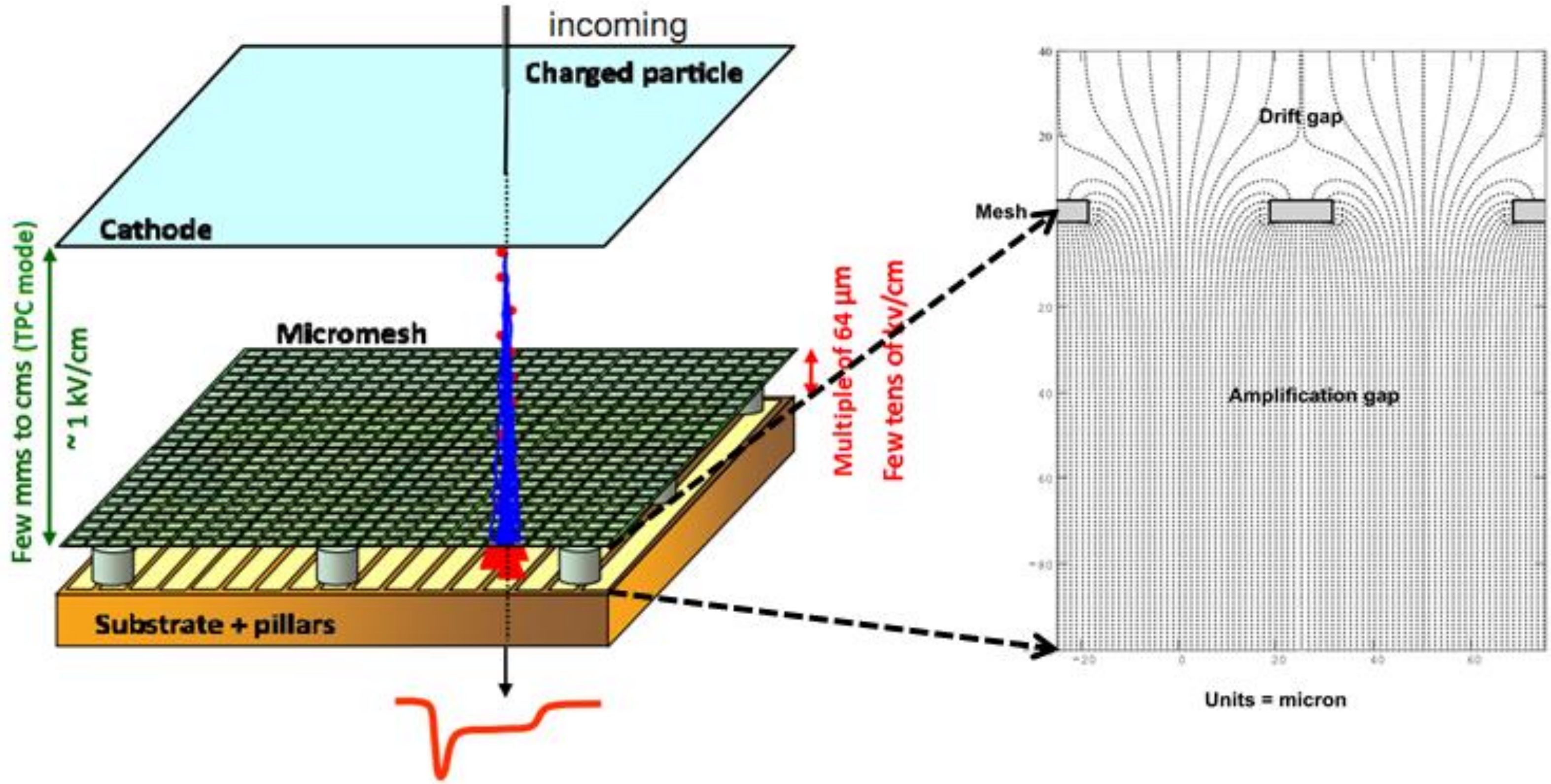






MICROMEsh GAseous Structure

G.Charpak, I.Giomataris et al., NIM-A 376(1996) 29



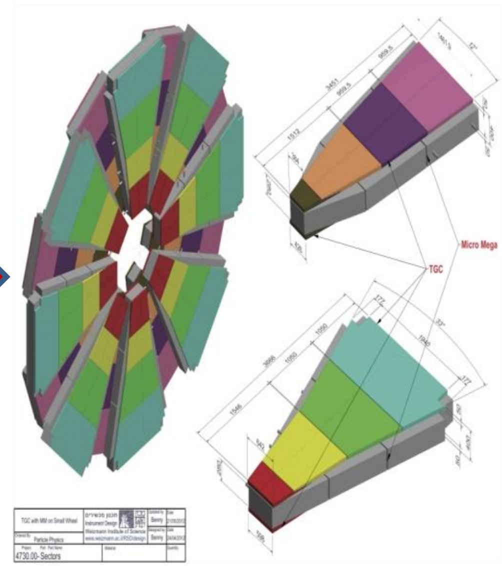
- Planar geometry
- Simple components: cathode, readout PCBs, mesh
- Large area can be achieved fairly simply and with rel. cheap cost
- Industrialization (PCB fabrication)
- Excellent high rate capability
- Small amplification gap (50 – 150 µm) → space charge effects very limited
- Segmentation of readout strips → limit “dead” time

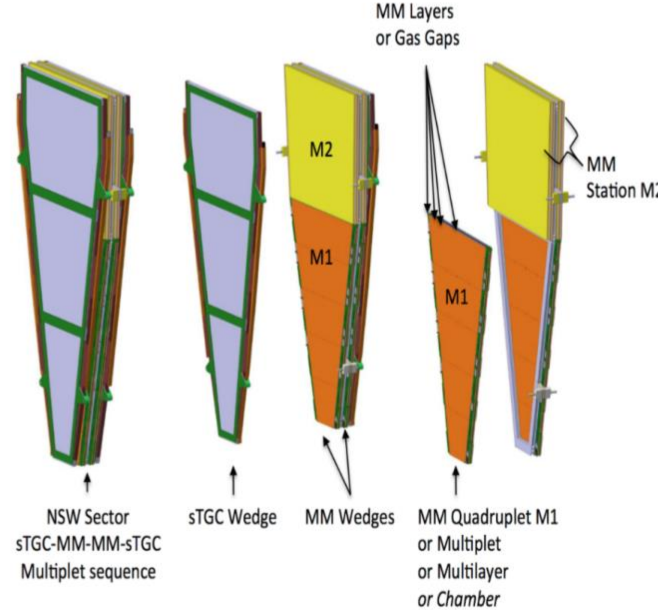
ATLAS Micromegas

Small Wheel

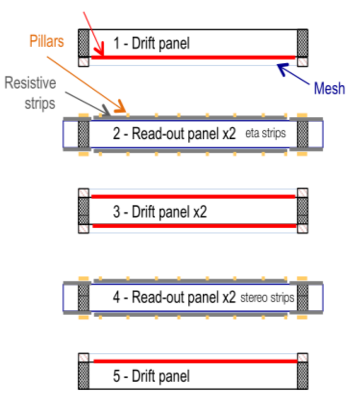
CSC+MDT+TGC

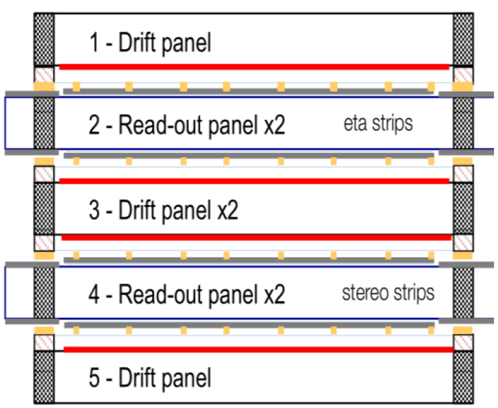
New Small Wheel

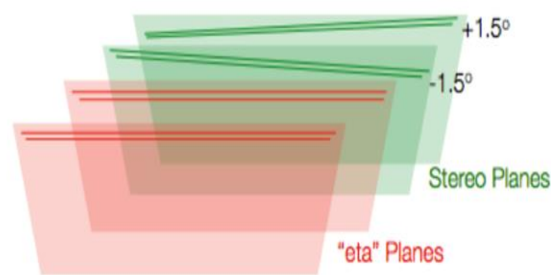




Micromegas+sTGC

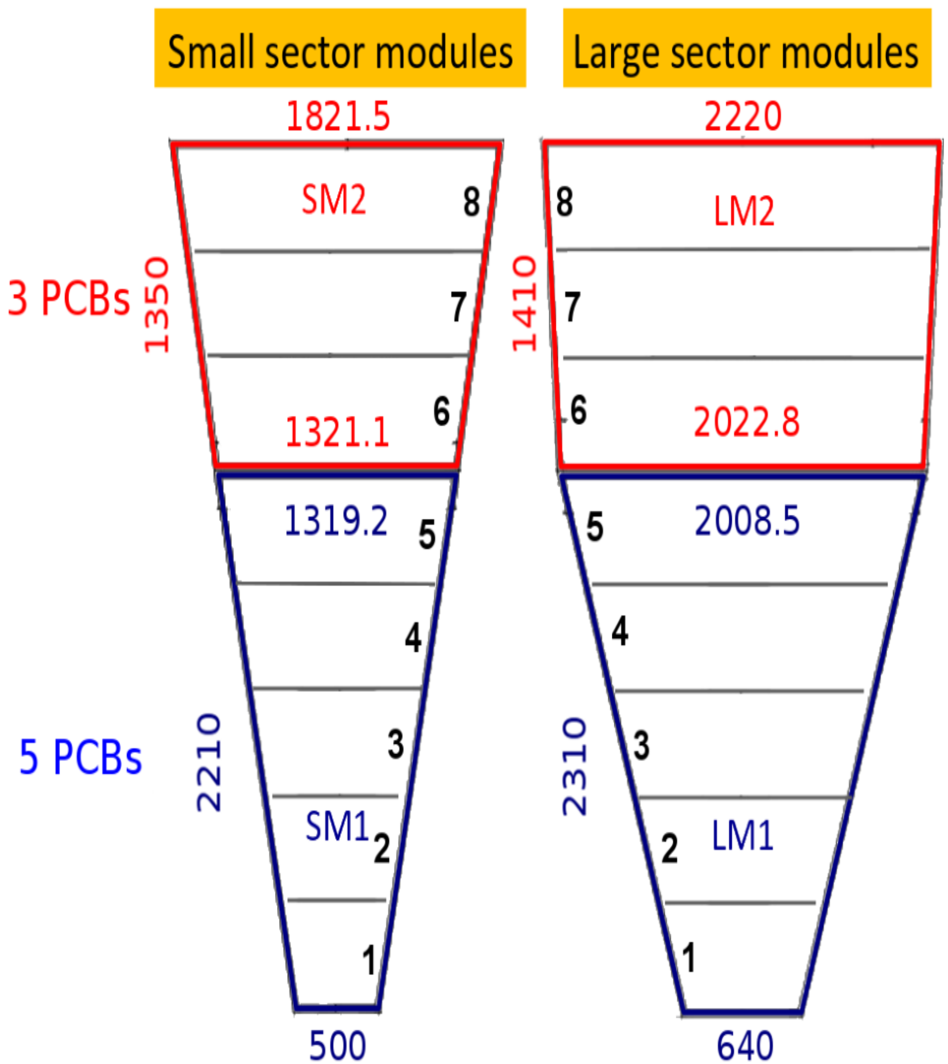






Double-sided panel with readout boards in back-to-back configuration. 'Eta' planes carry strips perpendicular to the precision coordinates, on 'Stereo' planes they are inclined by 1,5º.

ATLAS MM

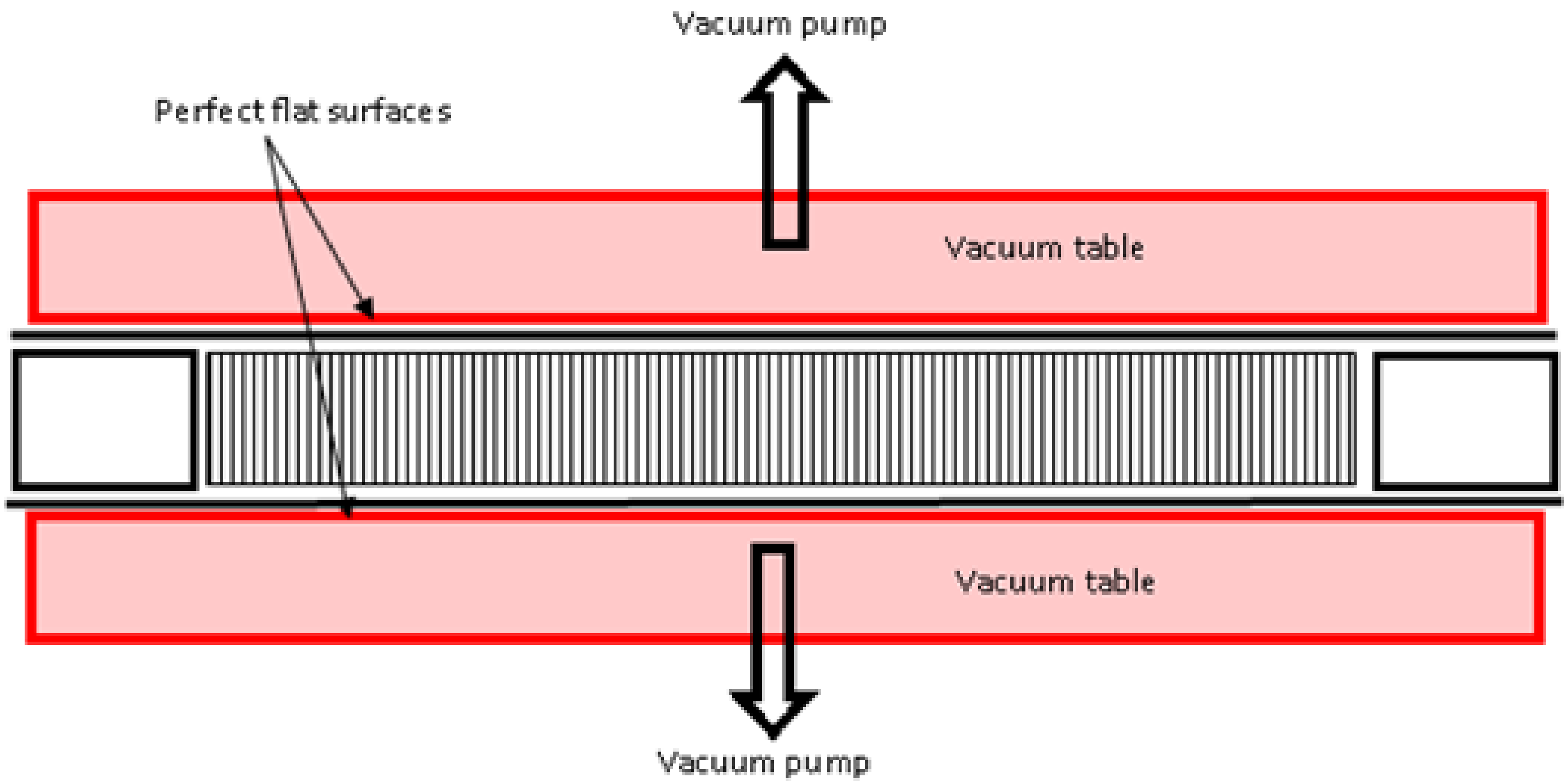


<u>Commitment:</u>

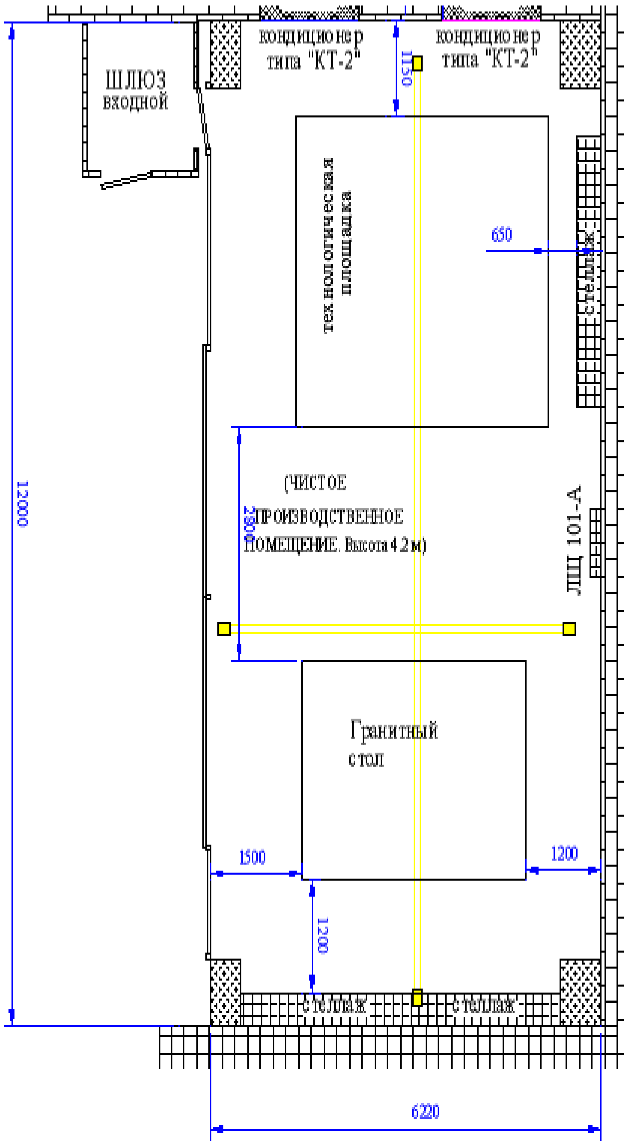
LM2 modules - JINR + AUT:

Dubna: all 64 RO panel production&testing + all 32 quadruplet assembly&testing

Panel assembly/gluing method -
two vacuum tables sandwich + stiffback



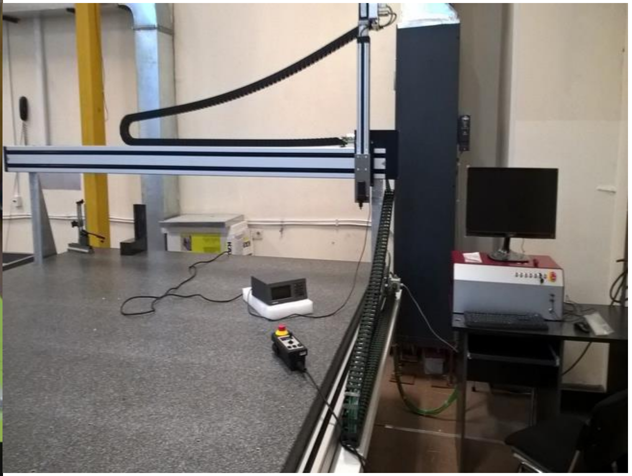
Assembly room:



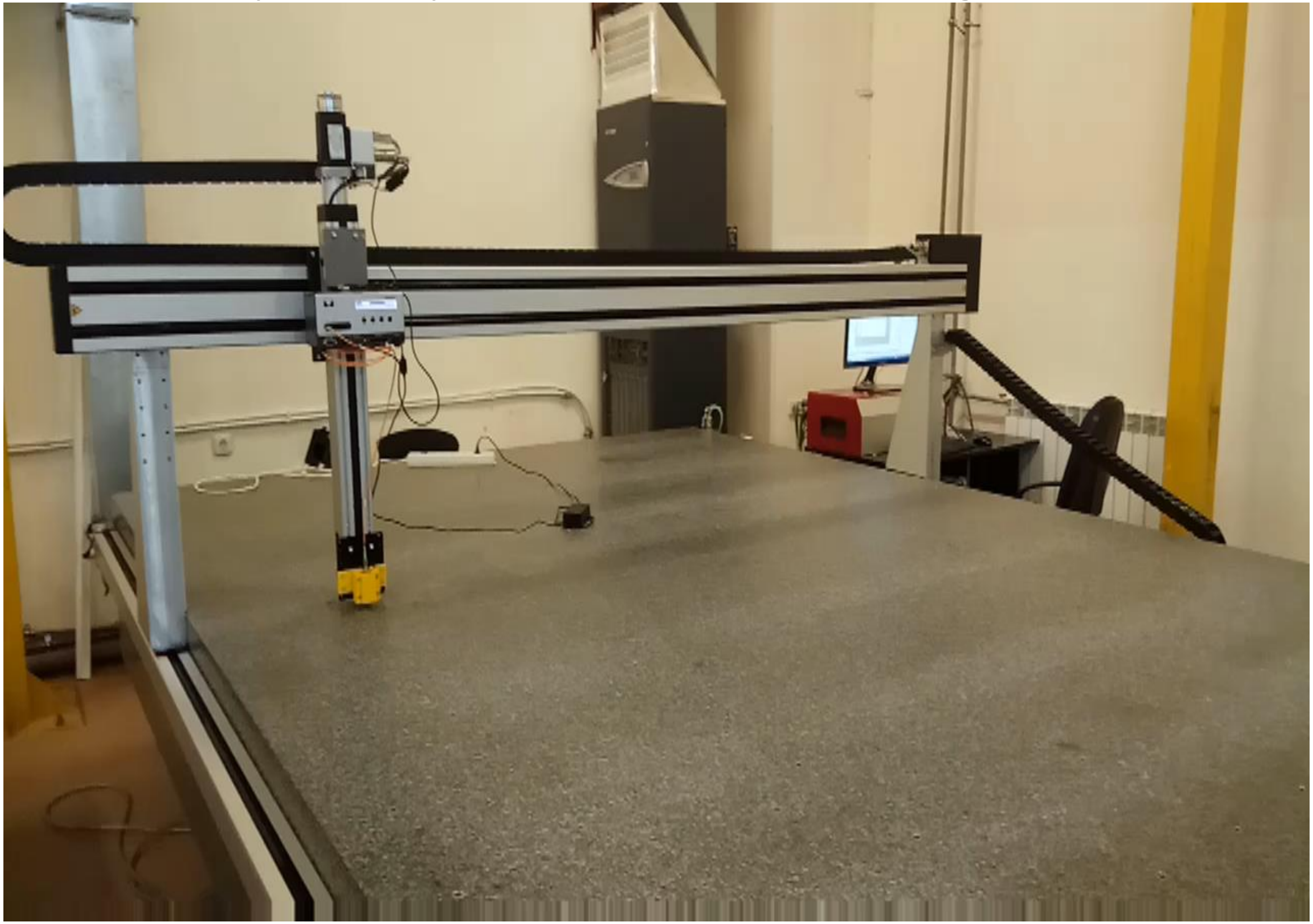
- Renovated

- New combined extract and input ventilation +2 new precision air conditioner + additional air ducts → ISO 7 classes clean room (6x12 m^2) with temperature (±0,5°C) and humidity (±10%) control

- Computer Numerical Controller (CNC) machine on granite table **(Precision 20 µm)**

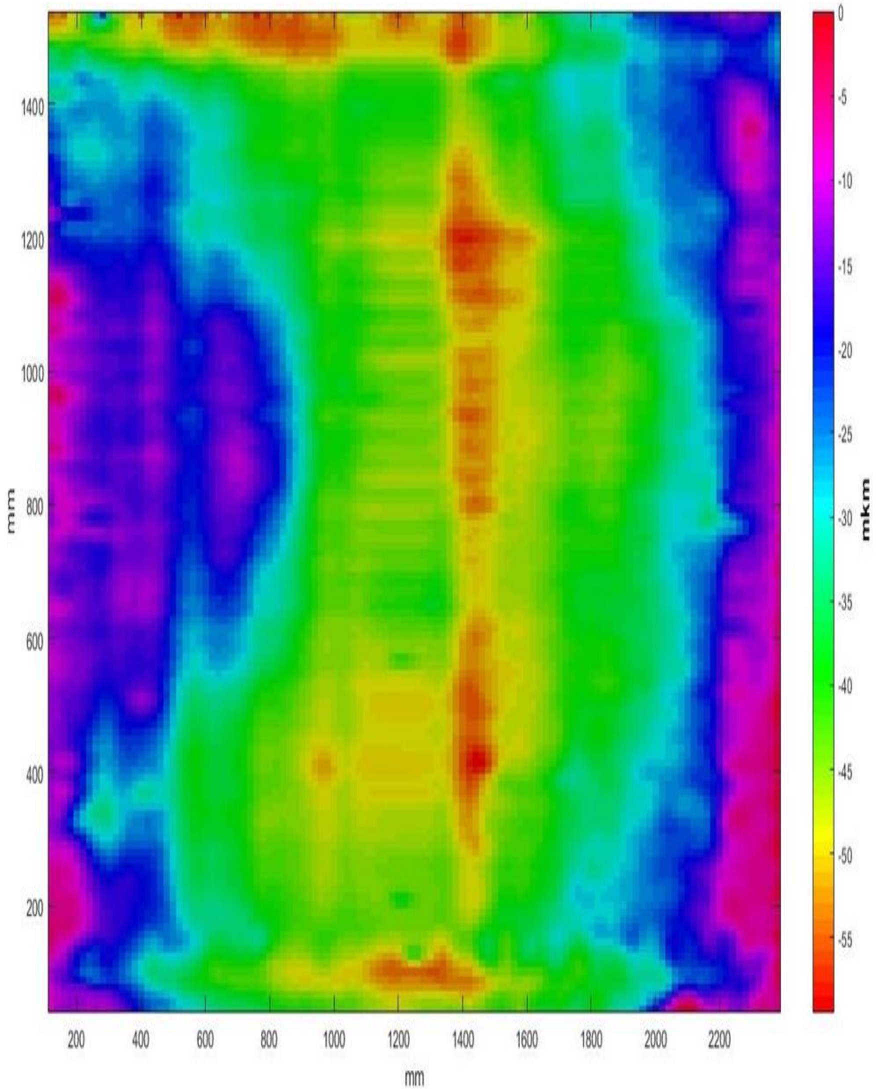


CNC machine (2990x2500x500 mm working area) on the granite table for measuring of geometrical characteristic of panels and alu.bars jointly with optical probe (precision 70 nm), micrometer, profiler (possible to connect milling cutter)

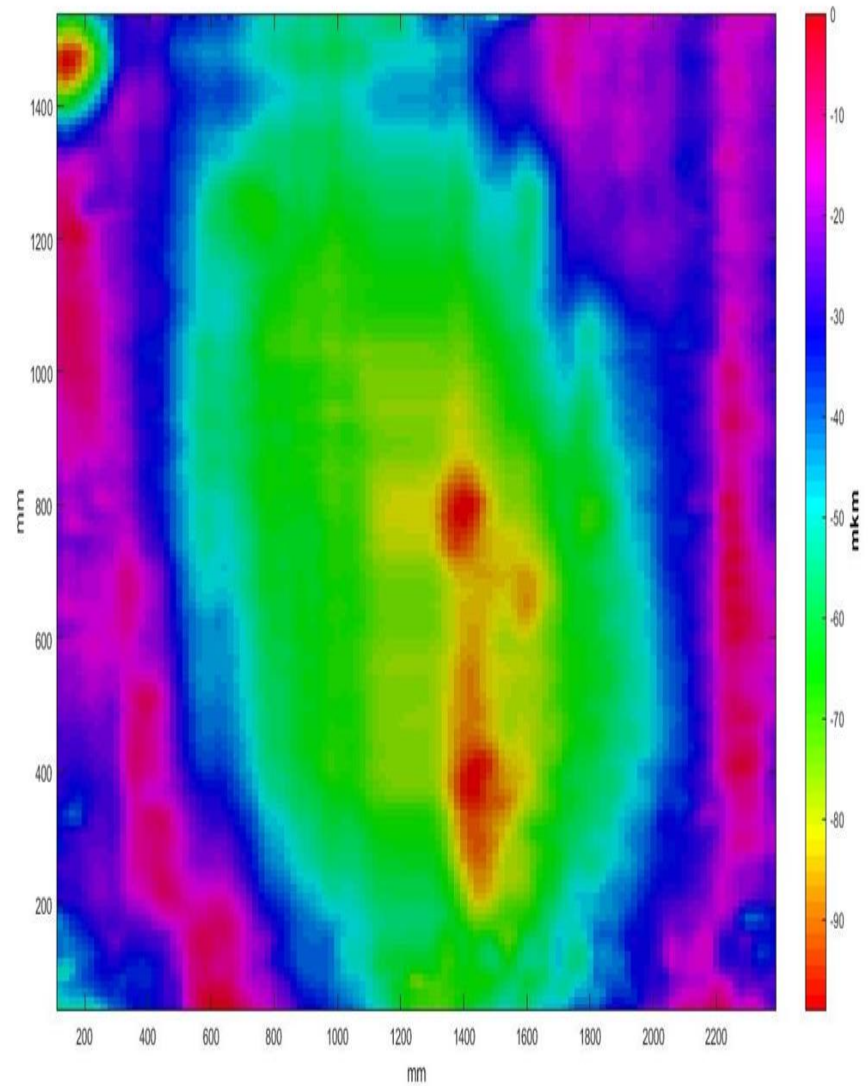


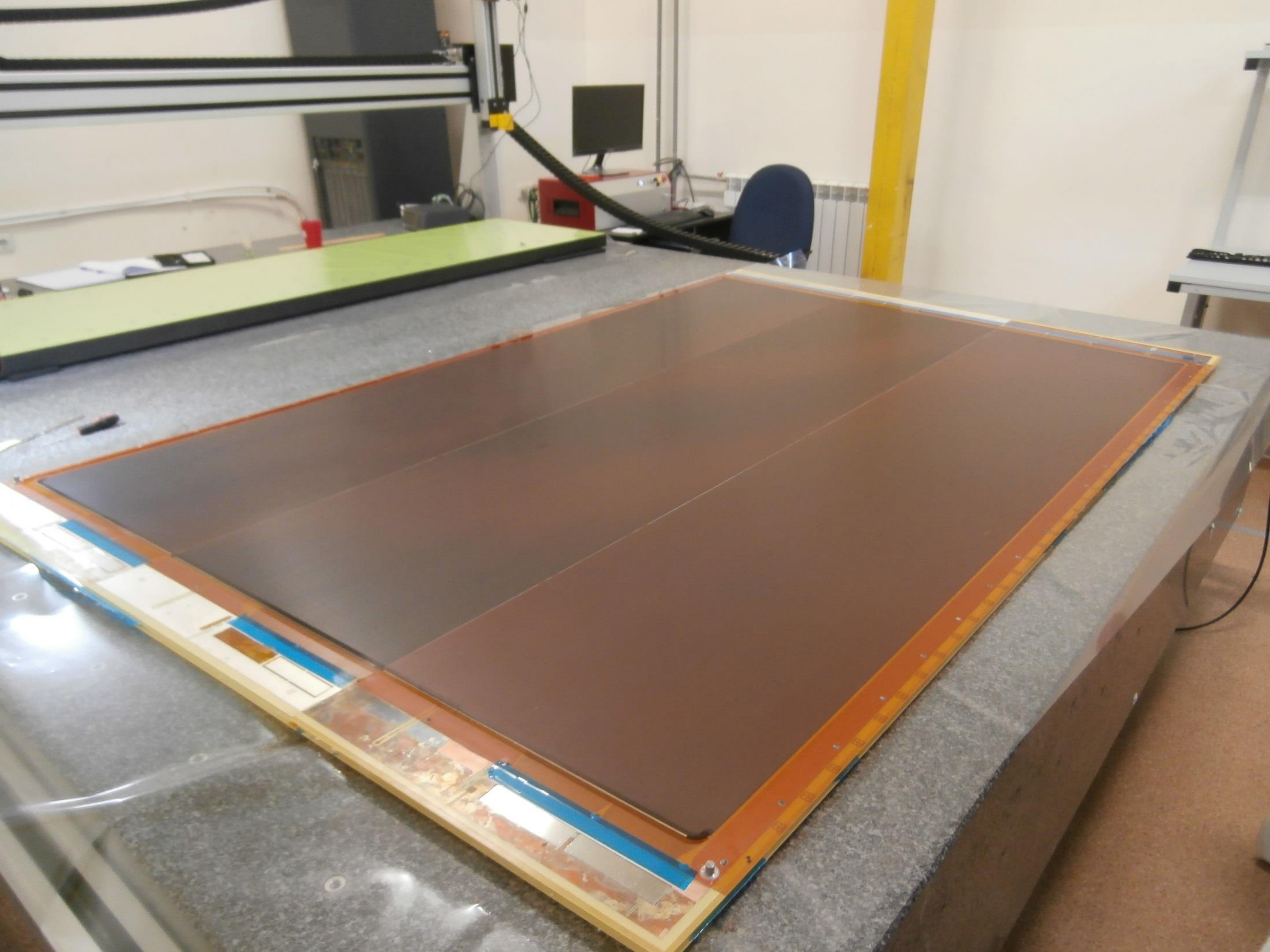
Vacuum table flatness measurements

Bottom VT
min/max = 59 мкм



Top VT
min/max = 99 мкм





PLANS

Series production - beginning of July

- **Site review– July 6th 2017!!!**
- **June 2018 - 16 quadruplets**
- ***May 2019 – 16 quadruplets***

Participants:

Gongadze A., Gongadze I., Gostkin M., Dedovich D., Demichev M., Kharchenko D., Kruchonok V., Kuznetsov N., Minashvili I. Jr., Potrap I., Rudenko T., Shelkov G., Sotenskii R., Tskhadadze E.

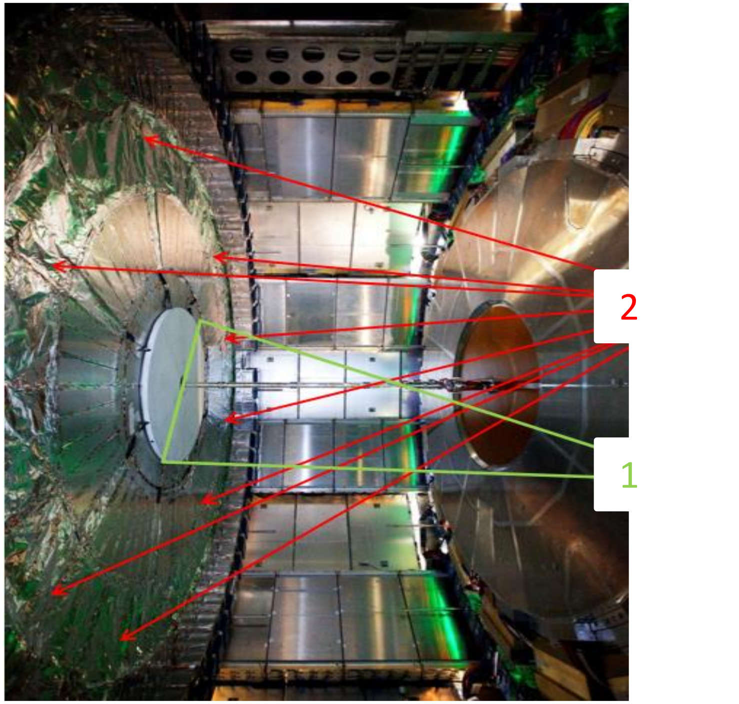
Line II: bring the new technology, set up a site at DLNP for any future experiments and applications!

- Oven
- DuPont photoresist PC1025 (64 мкм)
- Mesh
- Test PCBs and photomasks from our Gerber files

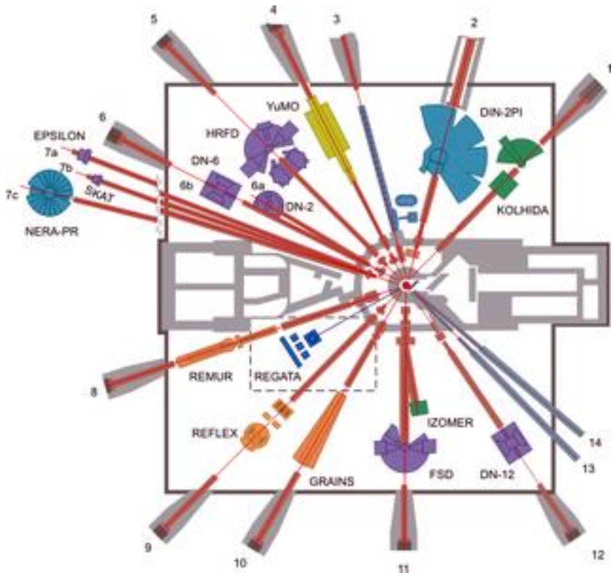
Tile Calorimeter

The gap region:

- Gap regions contain additional scintillator plates distributed radially. [1: MBTS scintillators, 2:crack scintillators]
- Scintillators in the gap will sustain a significant amount of radiation damage during HL-LHC run time and may require replacement during the long shutdown.
- Thus, conducting a comparative study into the radiation damage of several scintillators marketed for their radiation hardness.

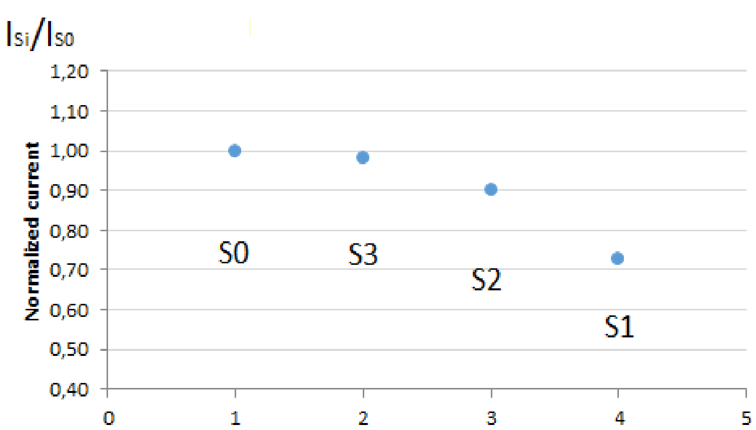


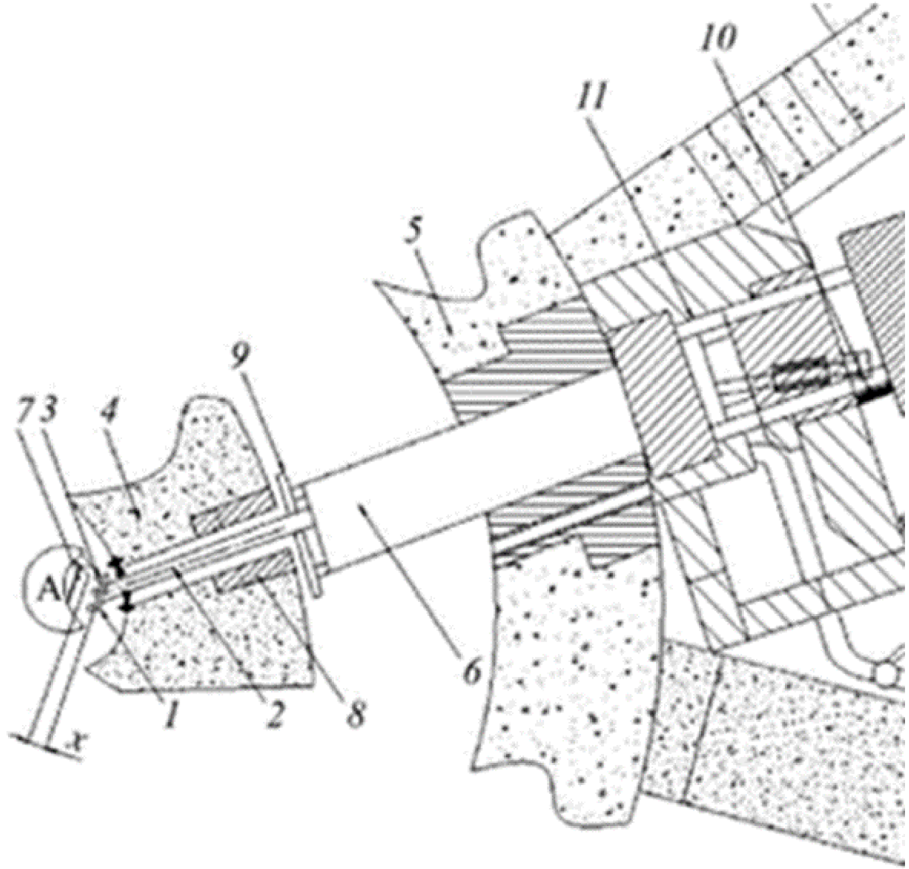
Scintillators for Tile calorimeter



The irradiation was carried out on the channel №3 of the IBR-2 reactor at FLNP, JINR

M.Bulavin et al. NIM B343(2015) 26-29



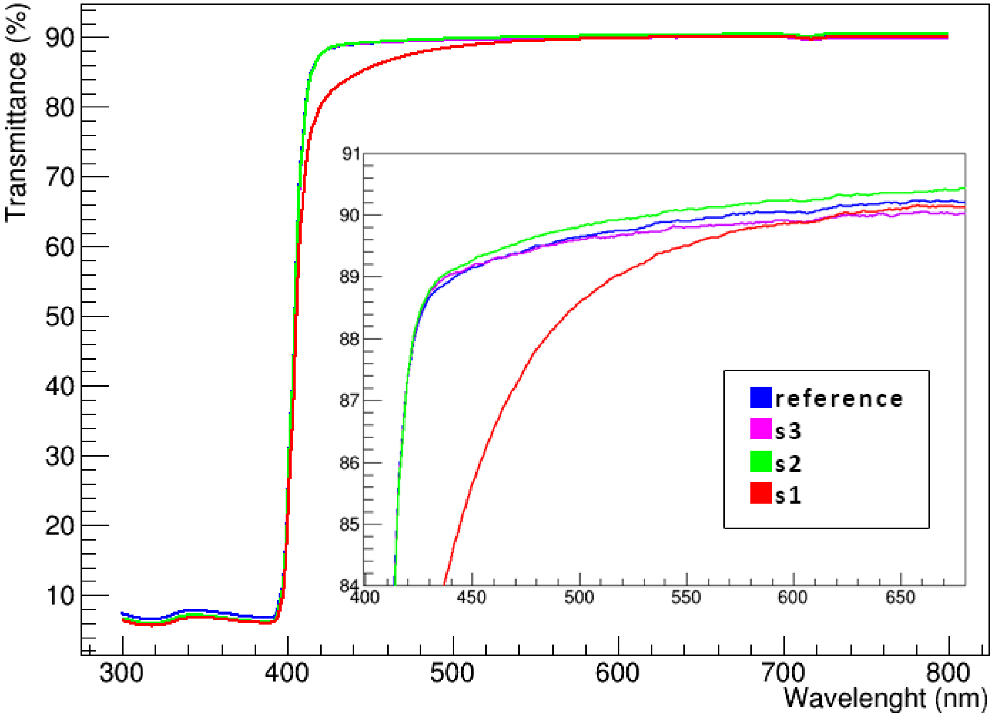


The light yield decreased by ~28% after the neutron irradiation of $1.8 \cdot 10^{14}$ n/cm^2

Scintillators for Tile calorimeter

Light transmission of the irradiated samples

Light transmission of the irradiated samples over the wavelength range 300-800 nm was measured at WITS University employing a Varian Carry 500 spectrophotometer and at JINR using SolidSpec-3700 DUV spectrophotometer



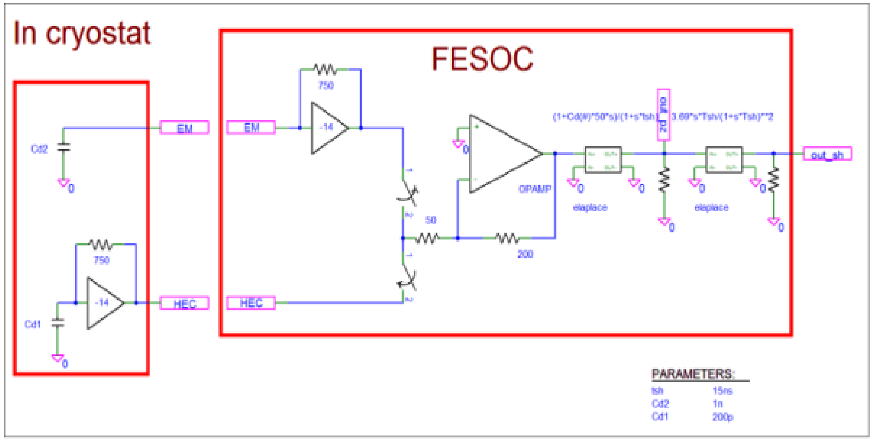
No visible changes on the samples light transmission up to neutron fluence of 10^{13} n/cm^2

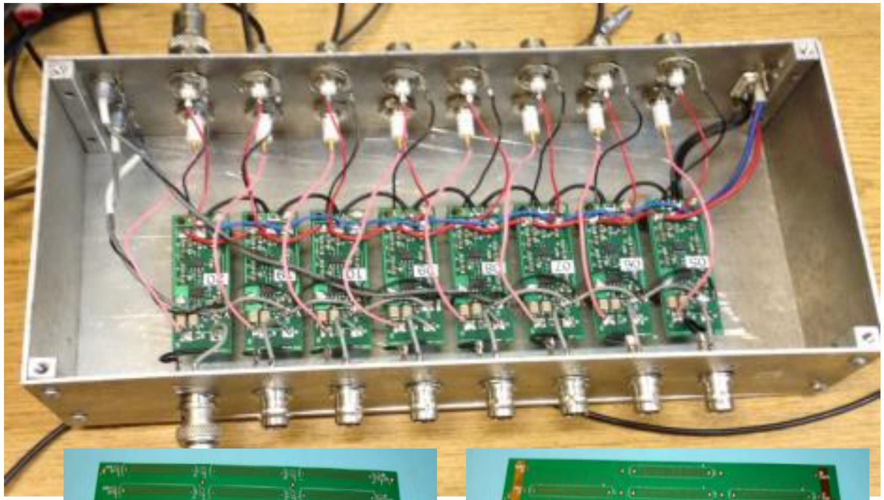
Neutron irradiation on the level ~ 10^{14} n/cm^2 resulted in a few percents light transmission loss in the range of 400-550 nm

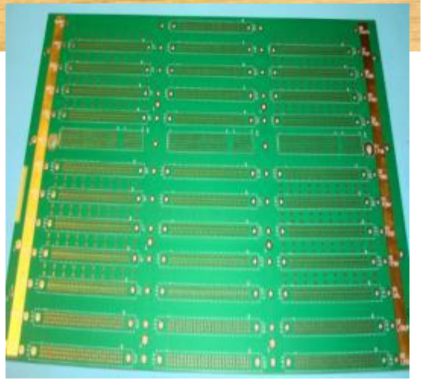
LAr readout electronics (Phase-II).

-Simulation work on the universal FESOC chip
-Development of the preshaper prototypes
-Baseplane for the HEC Fe crate
-Analog part of the digital trigger board

Responsible - Evgeni Ladygin





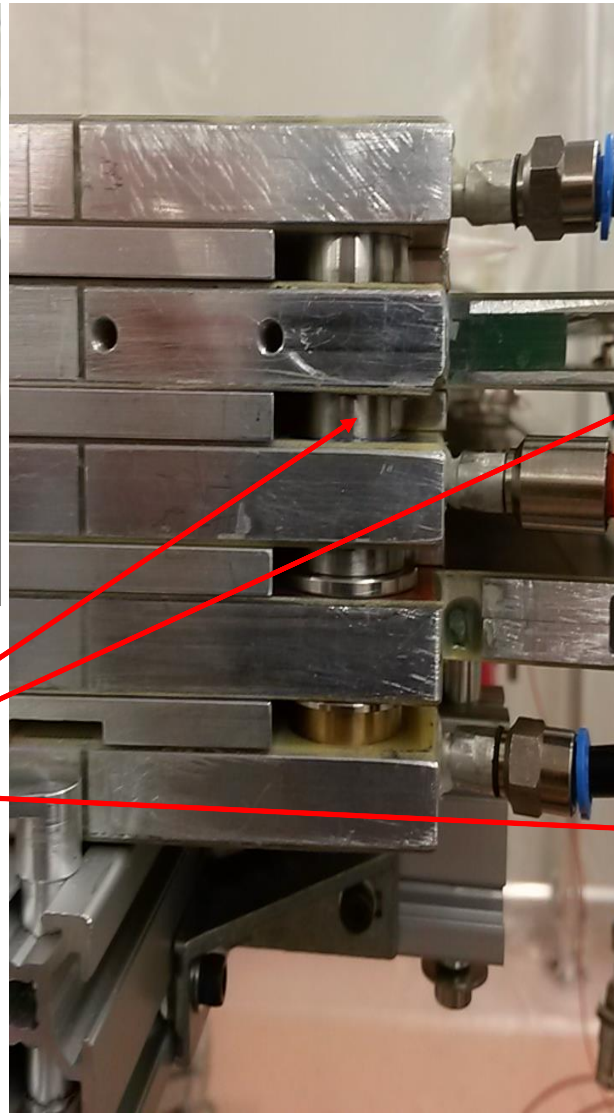


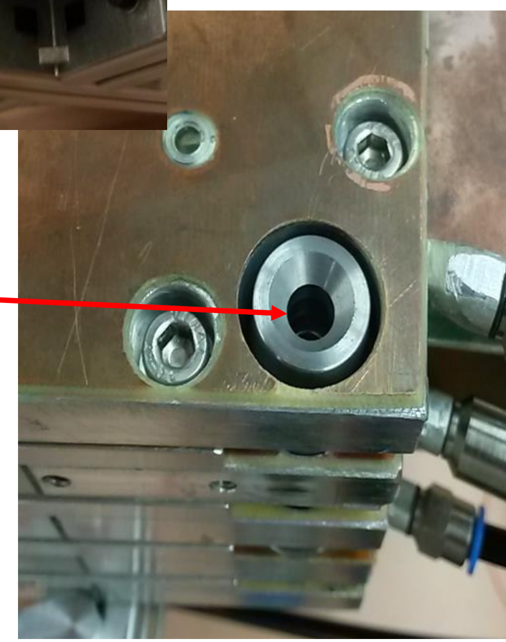
Conclusion

- JINR play essential role in the ATLAS upgrade
- Muon
- Tile calorimeter
- Lar calorimeter

Backup

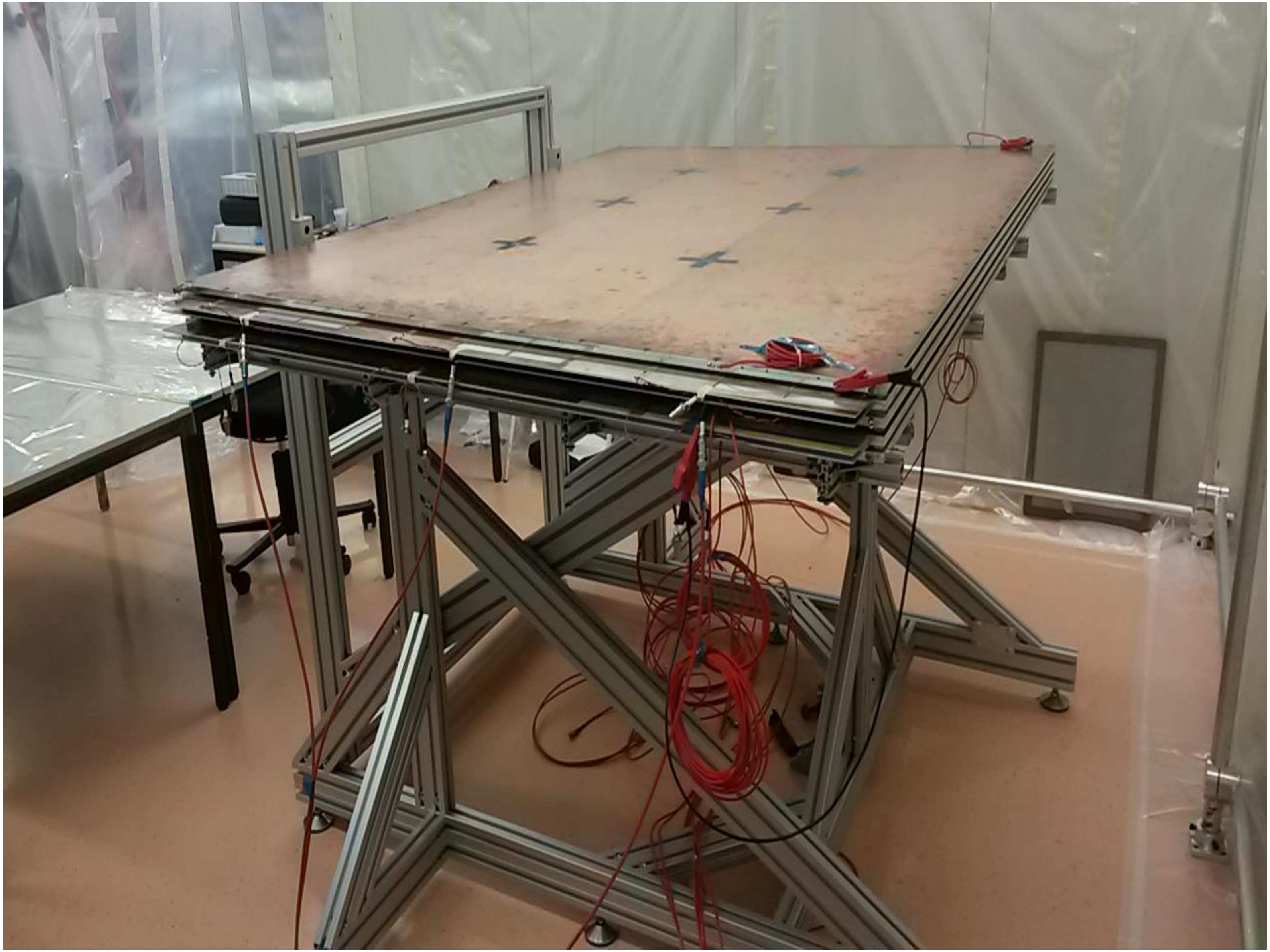
ASSEMBLY PROCEDURE





Alignment pin

ASSEMBLY PROCEDURE



АТЛАС ММ

- Ionization of $\approx 100\ \frac{e^-}{cm}$ in Ar:CO_2 93:7
- Electron drift velocity $v_{drift} = 47\ \frac{\mu m}{ns}$
- Collection of avalanche charges on resistive strips (anode)
- Capacitive coupling between resistive and copper readout strips
- Pulseheight and timing information, $25\ ns$ sampling
- Strip width $300\ \mu m$, Strip pitch $425 - 450\ \mu m$
- Resistivity of strips $\approx 10 \frac{M\Omega}{cm}$