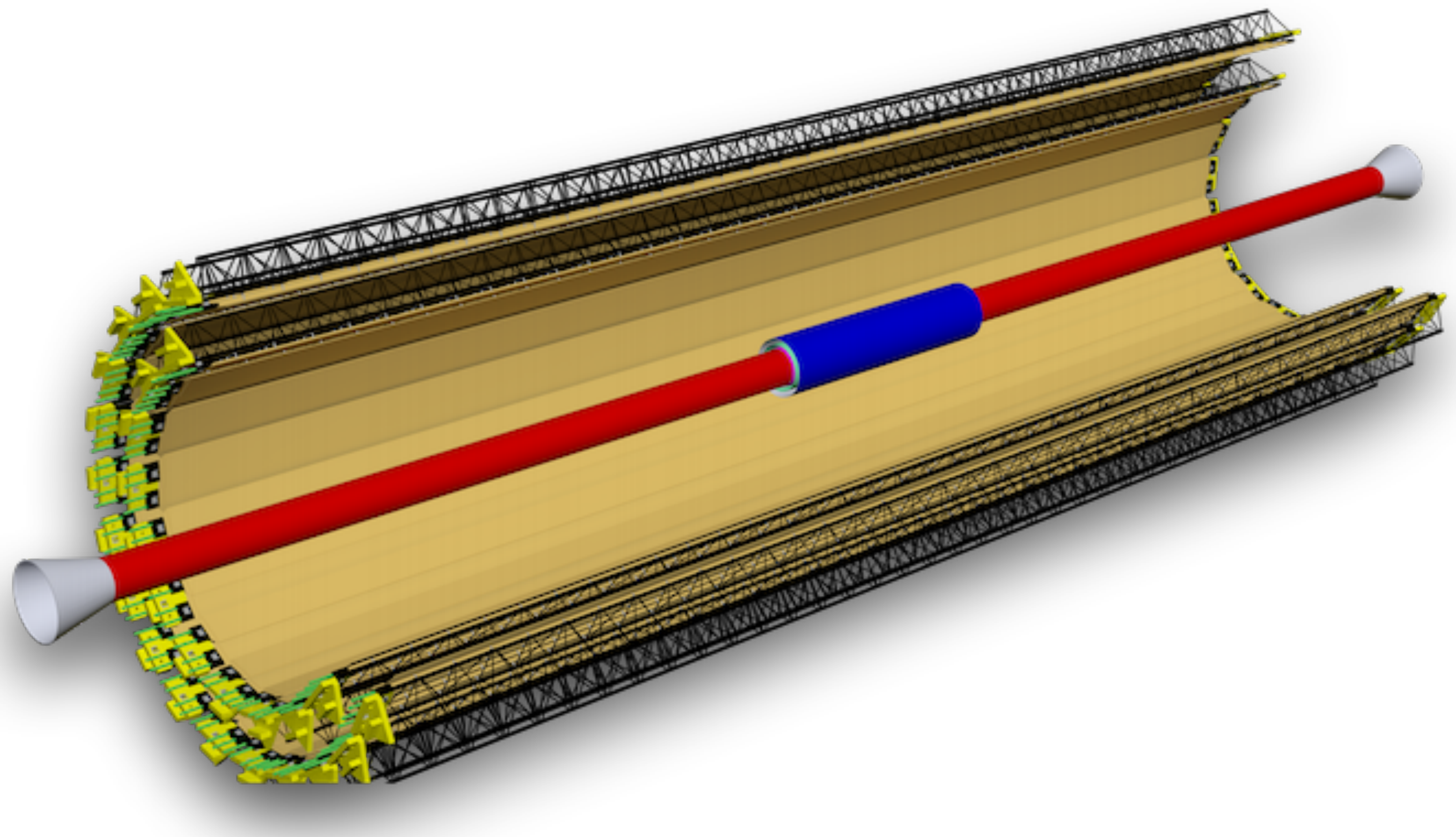
MPD - ITS

MPD-ITS Current Status.

César Ceballos Sánchez (JINR) for the MPD-ITS Collaboration.



VII-th Collaboration Meeting of the MPD Experiment at the NICA Facility - 2021.04.22

RUSSIAN FOUNDATION FOR BASIC RESEARCH
RFBR
№ 18-02-40119

CREMLIN PLUS
Connecting Russian and European Measures for Large-scale Research Infrastructures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072

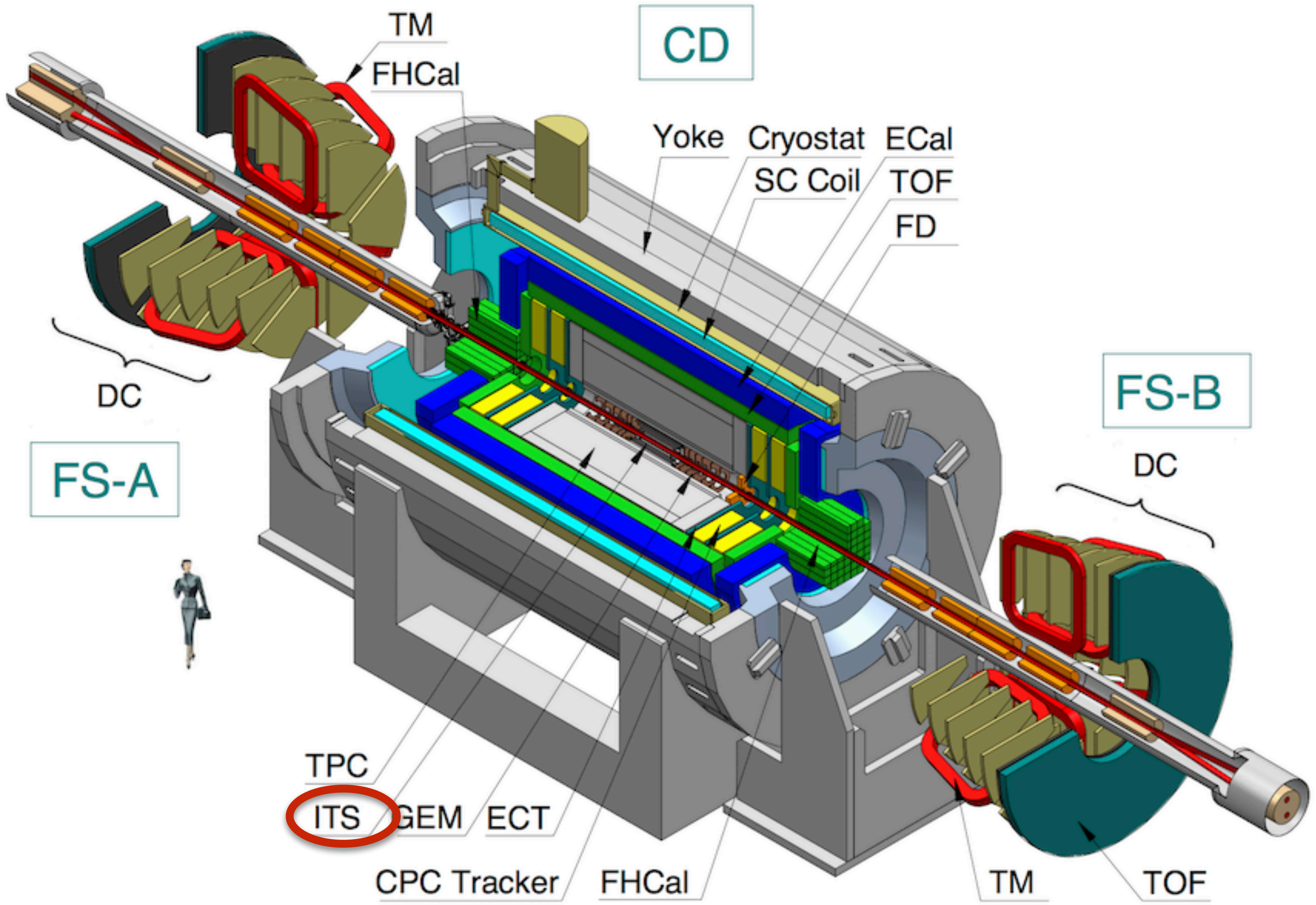
OUTLINE

- Introduction
- Overview on the work done by the Work Packages
- Goals 2021/2022

NICA's MPD-Inner Tracking System.

MPD-ITS structure: 3-layers Inner Barrel + 2-layers Outer Barrel.

It will supplement the TPC for the precise tracking, momentum determination and vertex reconstruction for **hyperons** (Λ, Ξ, Ω) and **D-mesons.**



Some of the MPD-ITS requirements:

- **Fast, high granularity CMOS pixel sensors with low noise level.**
- **Spatial resolution of track coordinate registration at the level of ~5–10 μm.**
- **Material budget as low as possible.**

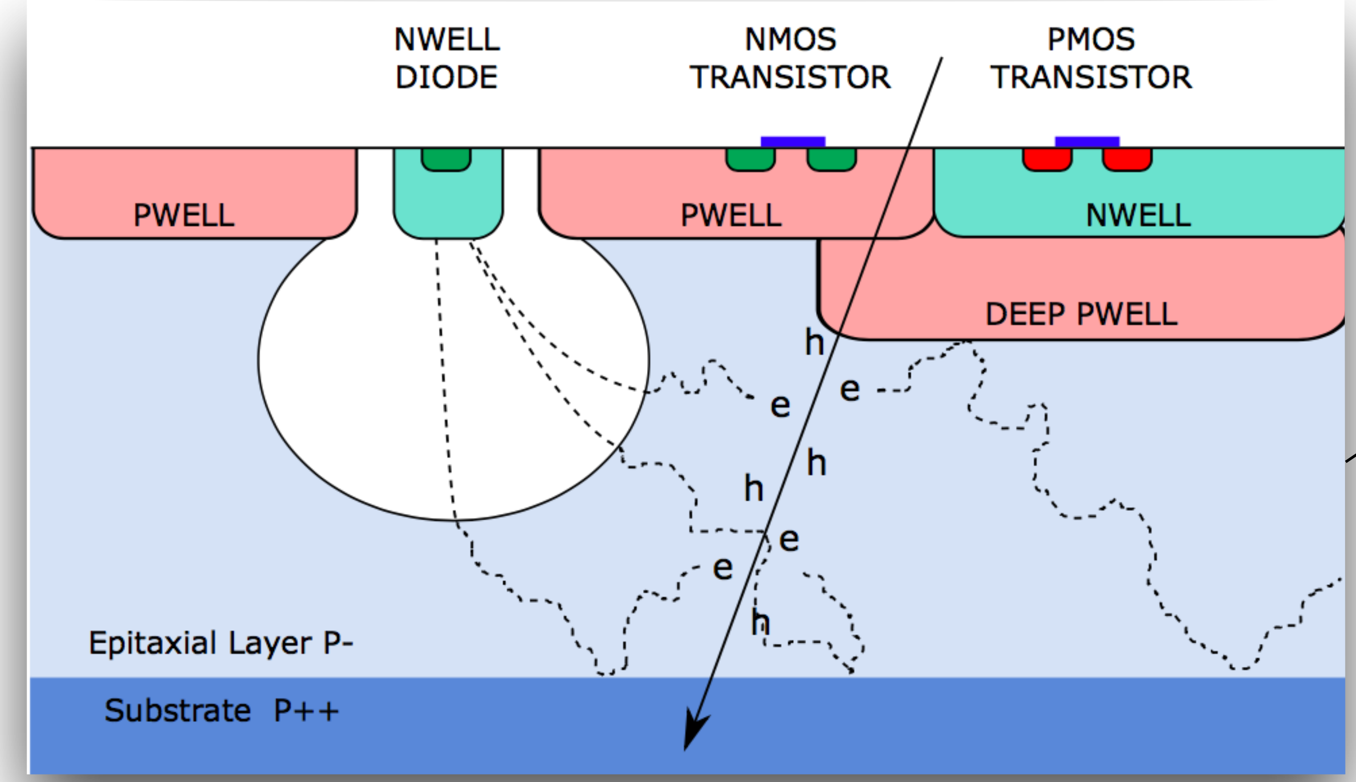
The MAPS chip

TowerJazz 0.18 µm CMOS pixel sensor

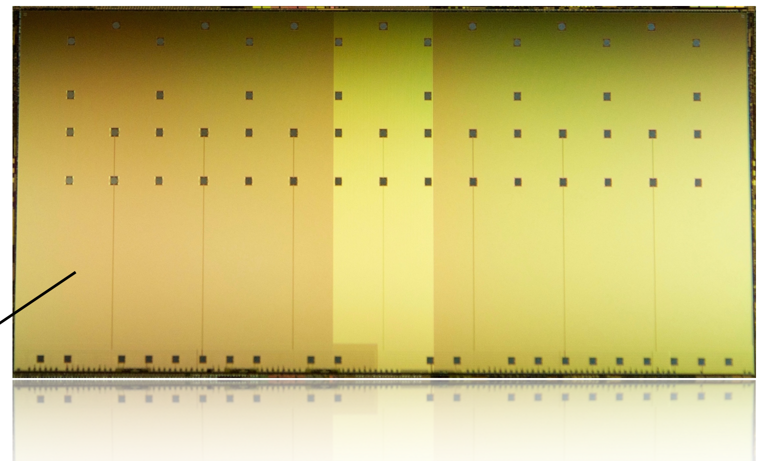
» High-resistivity (> 1kΩ cm) p-type epitaxial layer (20µm - 40µm thick) on p-type substrate.

» Small n-well diode (2-3 µm diameter), ~100 times smaller than pixel => low capacitance.

» Deep PWELL shields NWELL of PMOS transistors, allowing for full CMOS circuitry within active area.

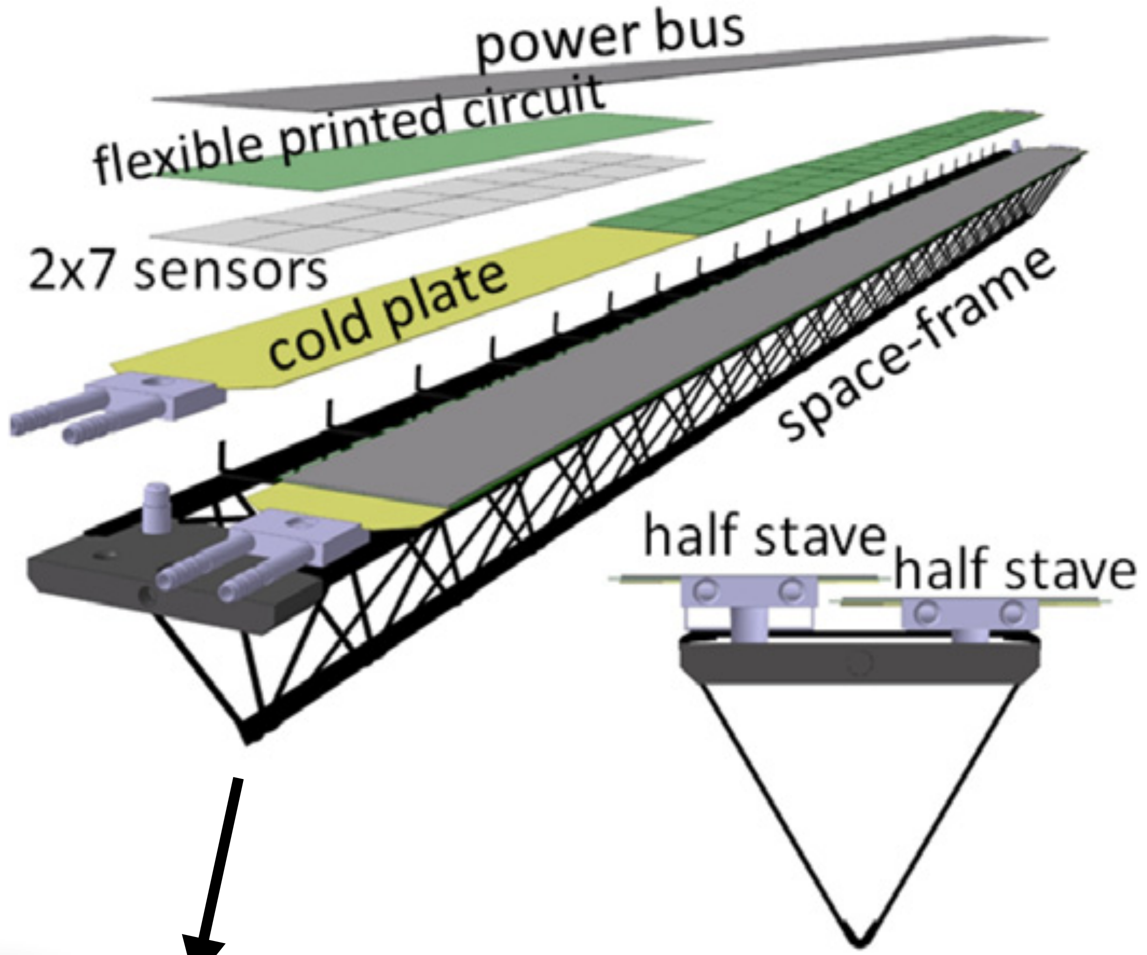


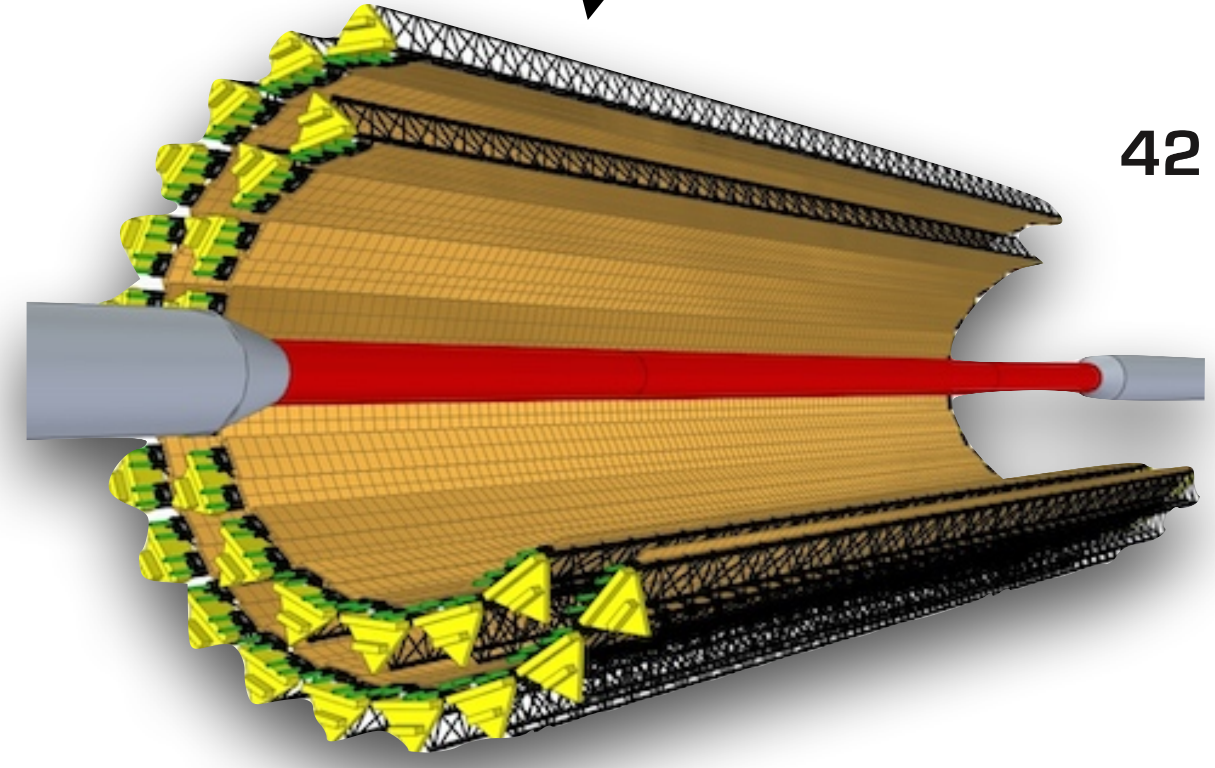
512 x 1024 pixels



Sensor architecture

Size: 15mm x 30mm
Pixel pitch: 28µm x 28µm
Event time resolution: < 2µs
Power consumption: 39mW/cm^2
Dead area 1.1mm x 30mm



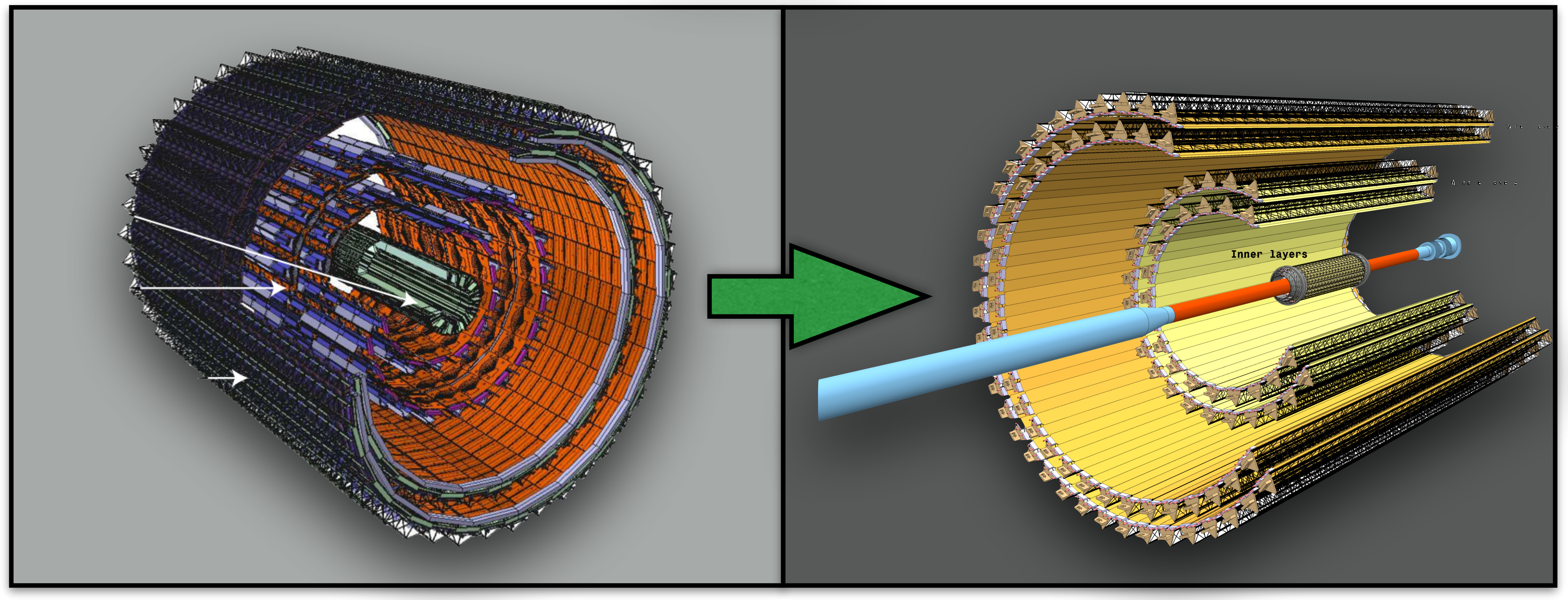


42 Staves

ALICE ITS-2. The first tracker totally based on MAPS technology

ALICE

ITS-1 ITS-2

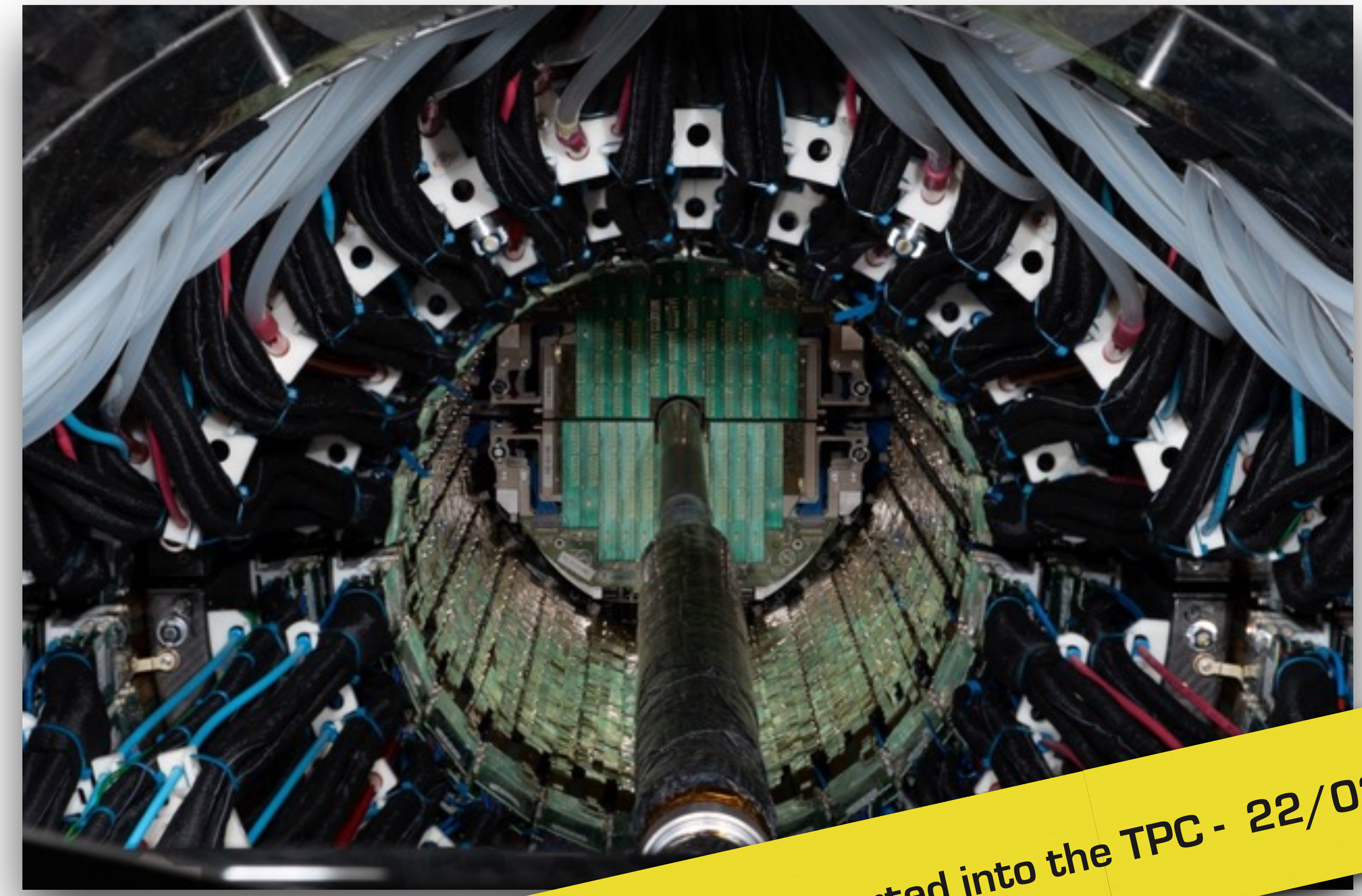


1. Improve impact parameter resolution by a factor of ~3
   - » Get closer to IP (position of first layer): 39mm → 22mm
   - » Reduce X/Xo / layer: ~1.14% → ~0.3% (for inner layers)
   - » Reduce pixel size: 50µm x 425µm → O(28µm x 28µm)
2. Improve tracking efficiency and p_T resolution at low p_T
   - » Increase granularity:
     - » 6 layers → 7 layers
     - » silicon drift + strips + pixels → pixels
3. Fast readout
   - » Currently 1 KHz → > 100 kHz (Pb-Pb) and several 10^5 Hz (p-p)
4. Fast insertion/removal for yearly maintenance
   - » Possibility to replace non functioning detector modules during yearly shutdown.

12.5 G-pixel

» Total active area ~ 10 m²

» ~ 24000 pixel chips



ALICE-ITS2 OB inserted into the TPC - 22/03/2021

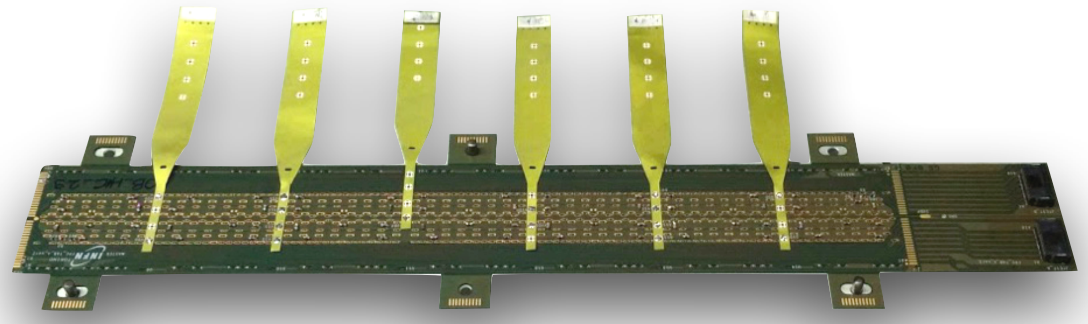
1. ALICE-ITS (LHC, CERN)
2. sPHENIX-MVTX (RHIC, BNL)
3. MPD-ITS (NICA, JINR)

Full technological transfer from ALICE to MPD

- Complete Knowhow
- Detector assembly and testing hardware/software
- Supervision and support from ALICE specialists

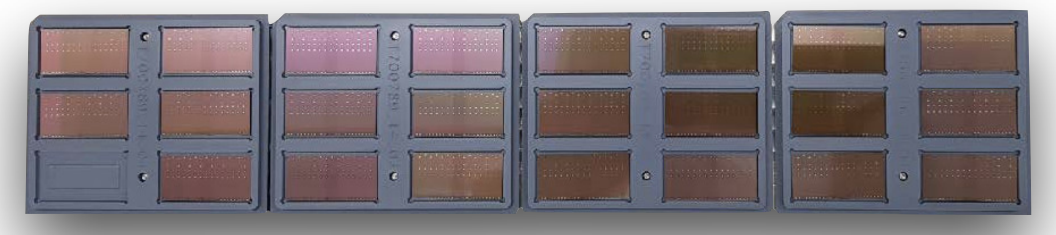
} Setup at JINR of the full detector assembly line from chips to detector layers

FPC



+

MAPS



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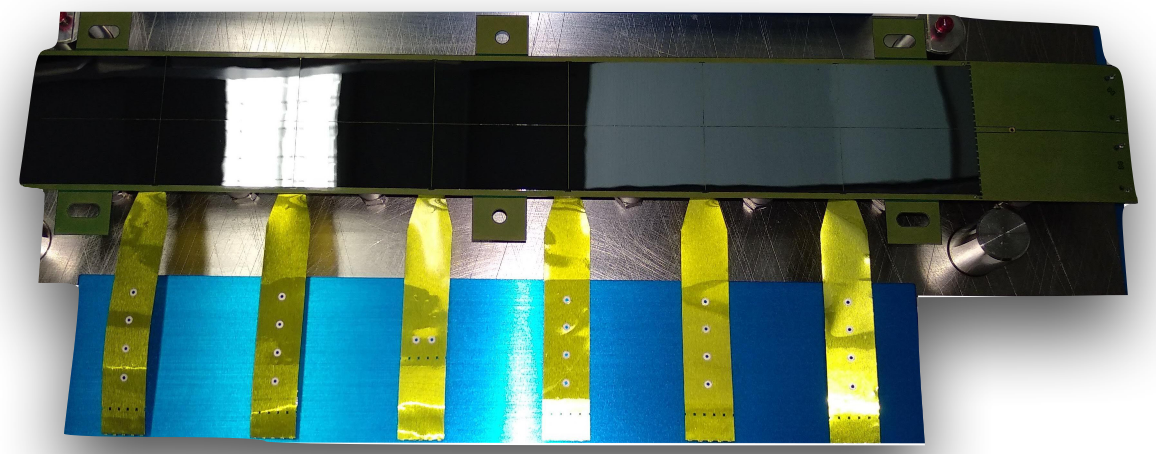
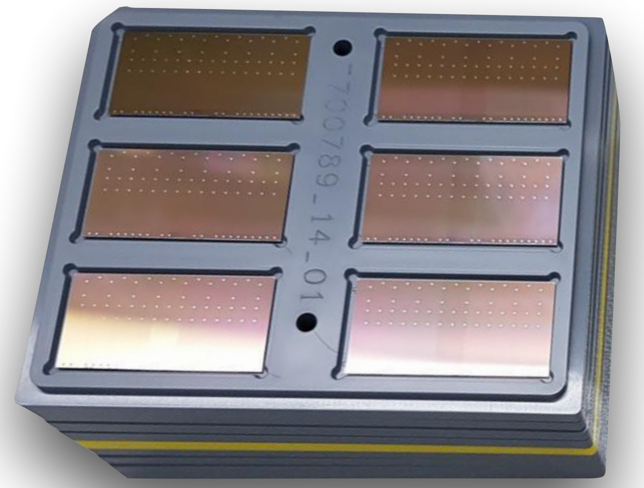
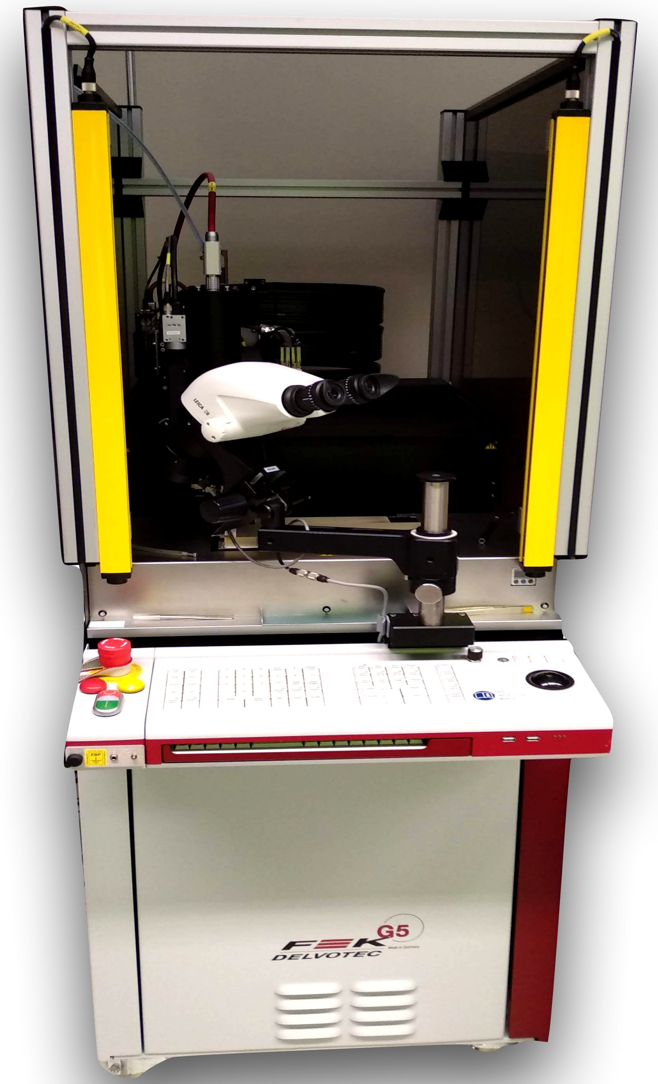
HIC



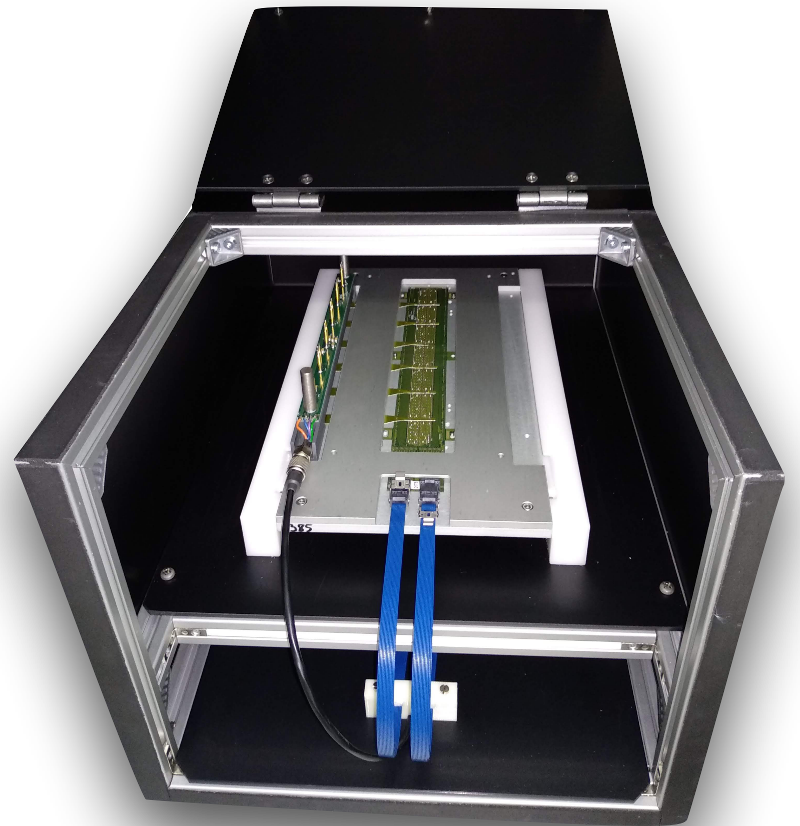


Chips selection

Chips alignment and gluing

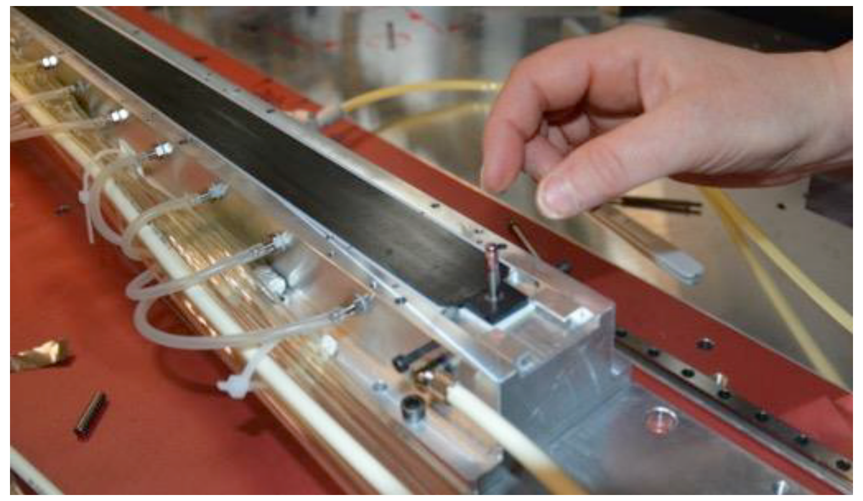


Ultrasonic bonding Chips - FPC

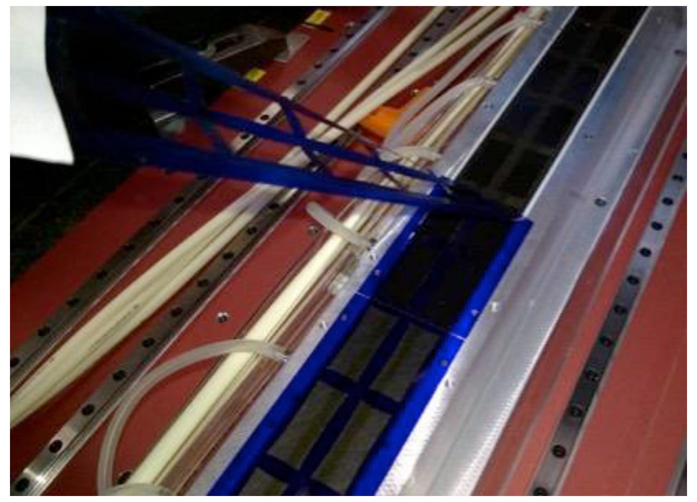


HIC testing

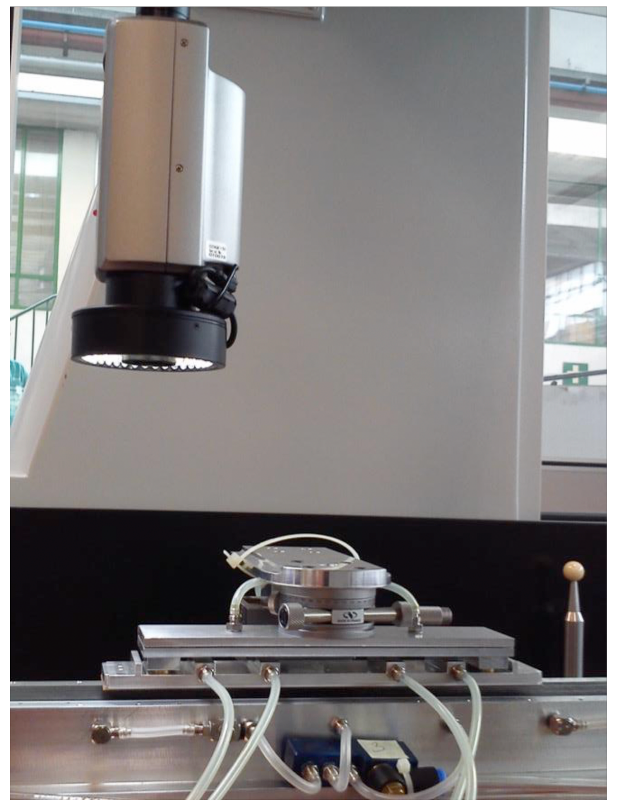
Full technological transfer from ALICE to MPD



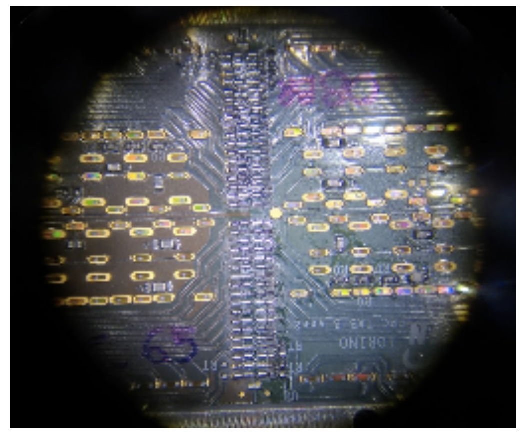
Cold Plate positioning



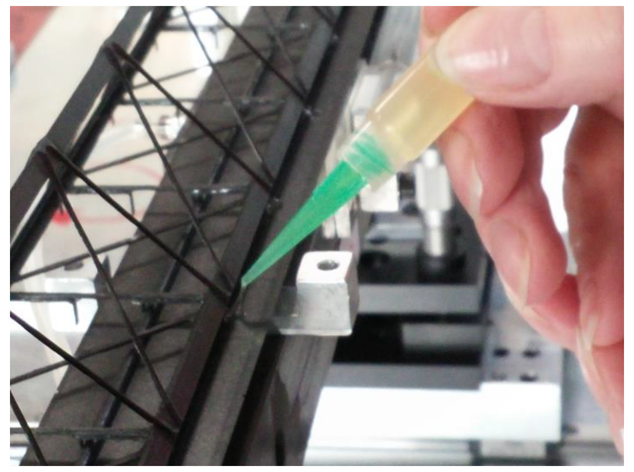
Glue deposition



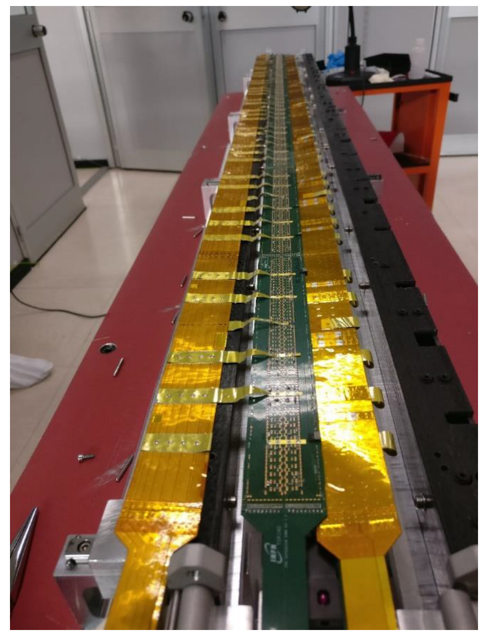
HIC positioning



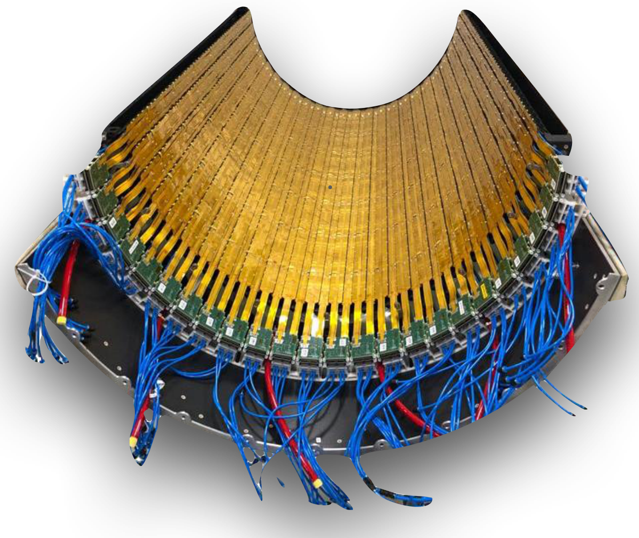
HIC to HIC interconnection



Space frame on CP



Power Bus position & folding



Additionally, a lamination workshop is being setup for the production at JINR-LHEP of almost the complete carbon fiber mechanics elements for the MPD-ITS construction and its integration with the beam pipe, the FFD and the TPC.

CMIS implementation at JINR (LIT)

CMIS

(Oracle)

File attachments

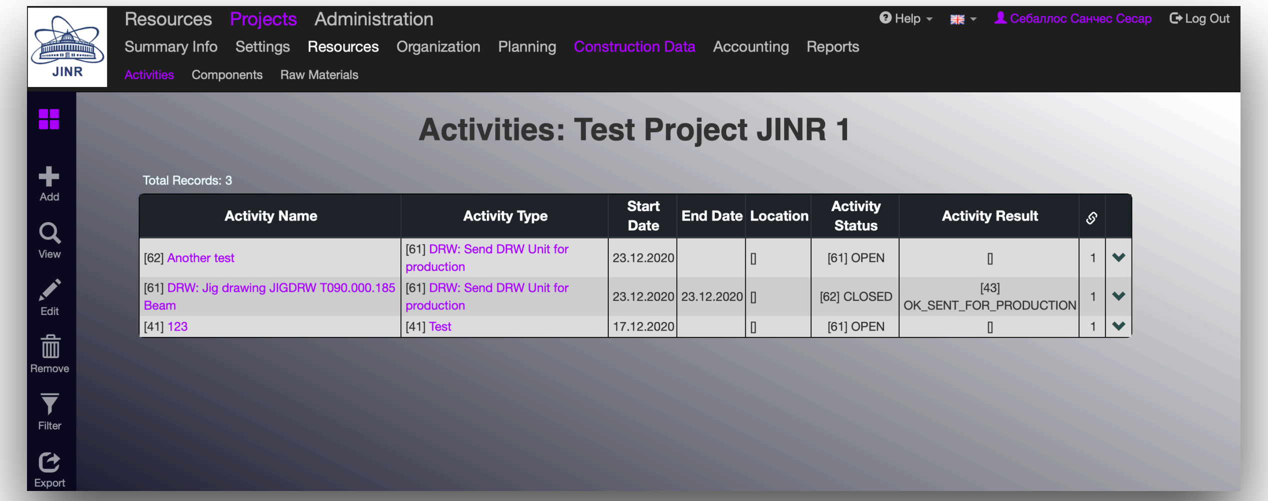
EOS

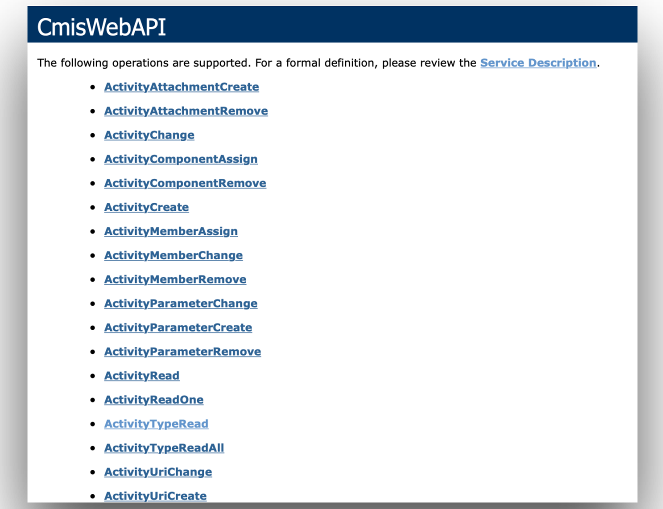
webApp
(HTTPS)

API functions
(HTTP GET/POST & SOAP)

(SSH)

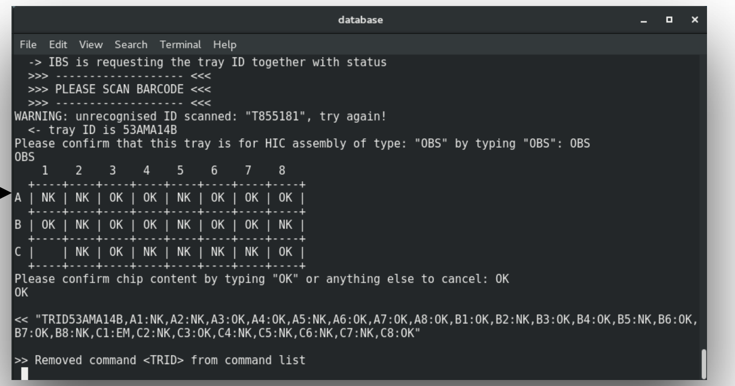
(SSO cookie)

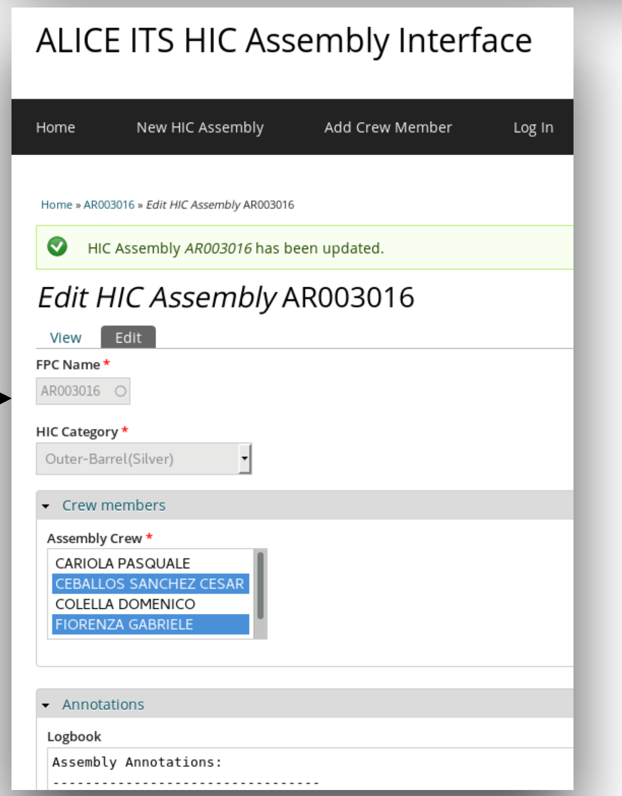


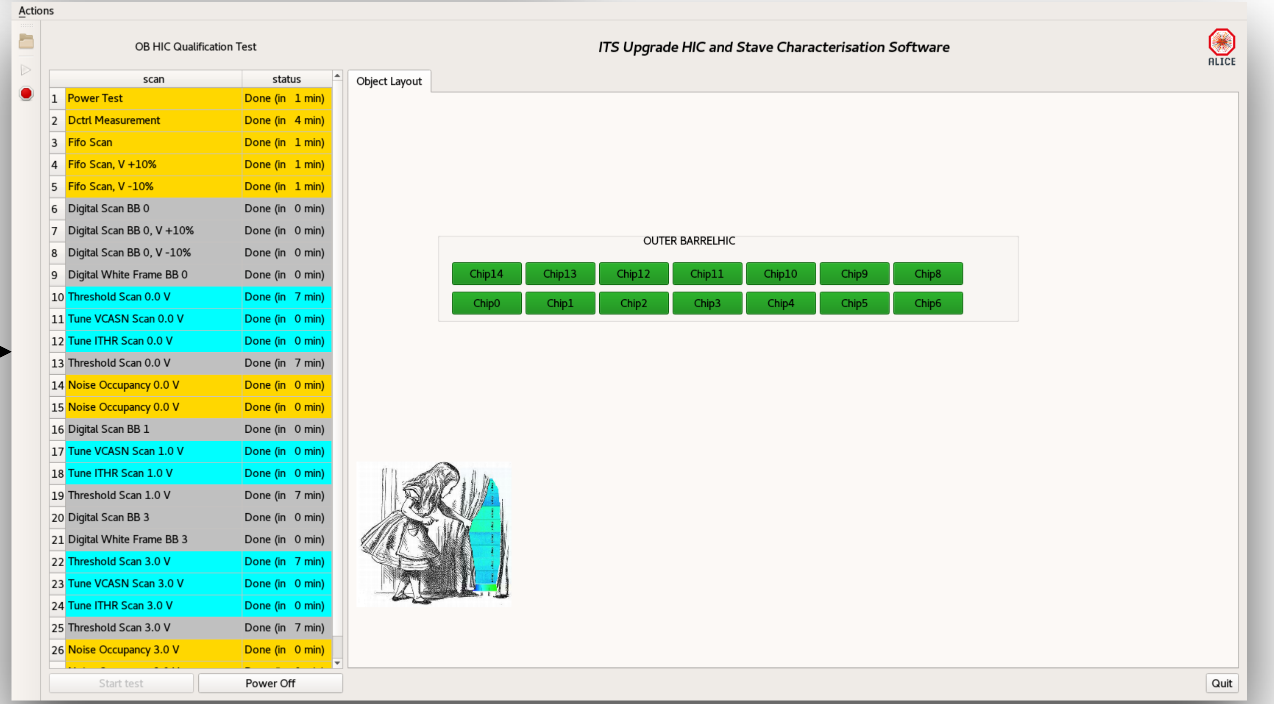


(Kerberos credentials automatically renewed)

Custom Assembly & Testing programs







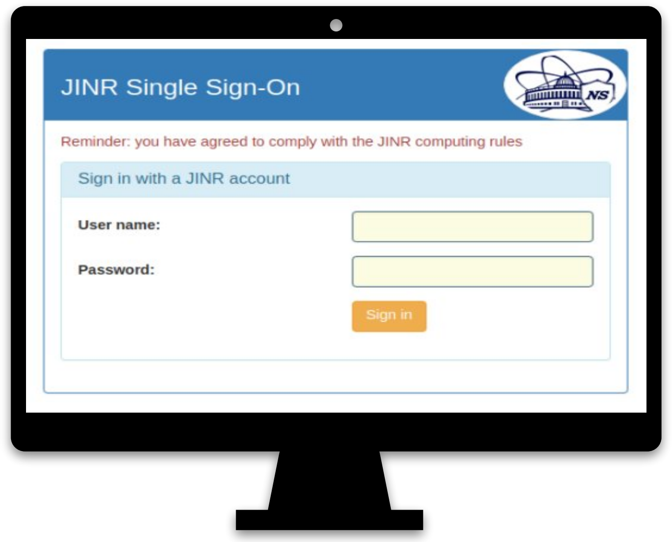
Direct HW interface to DB

JINR SSO:

» Registered service accounts.

» Kerberos credentials.

» Access cookies acquired through 'get-sso-cookie.py'.

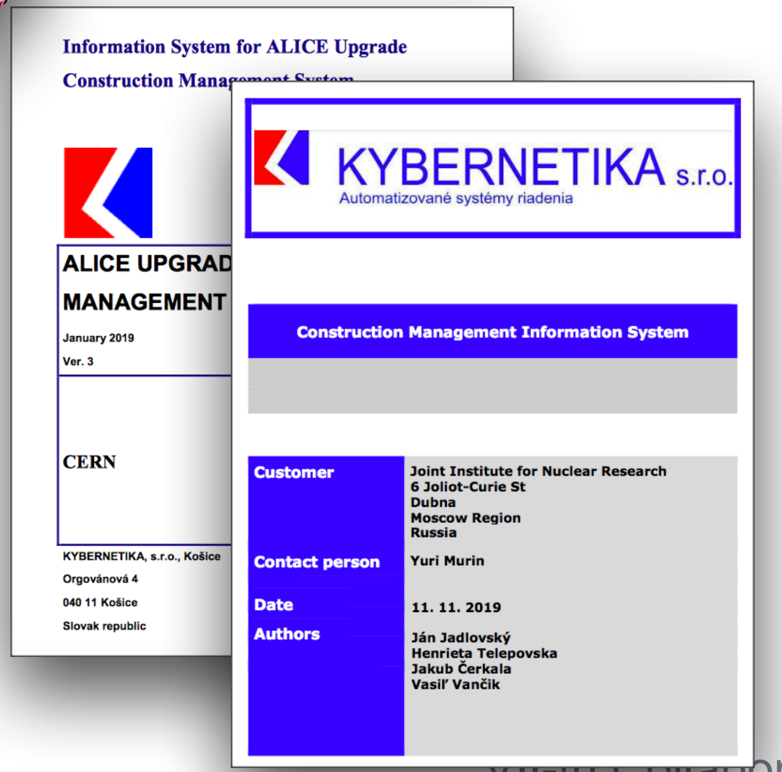


CERN SSO:

» Web access.

» Registered JINR-SSO users.

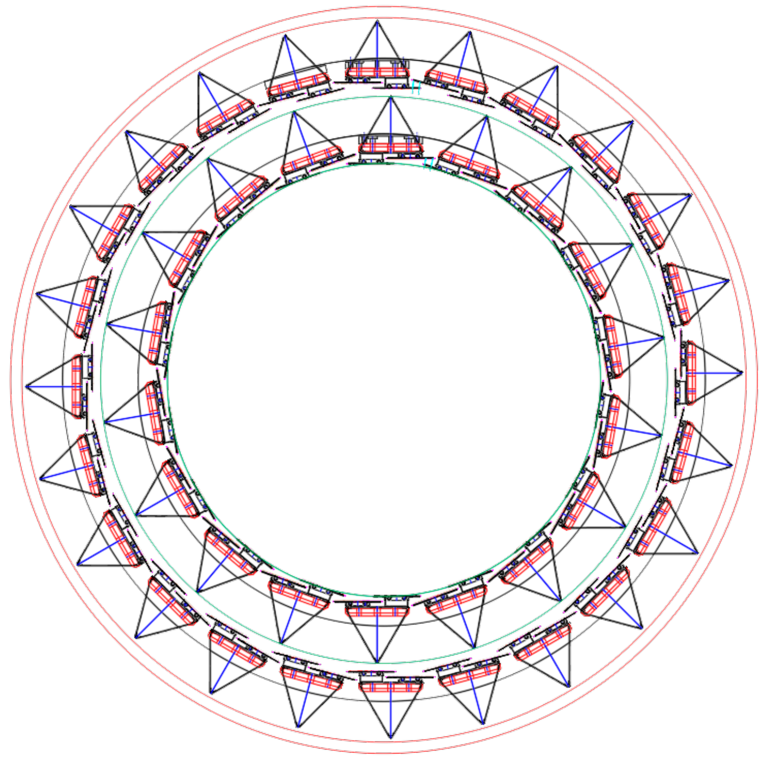
» Role-based access rights.



The two-stages construction scenario. Stage-1 (by 2022/2023)

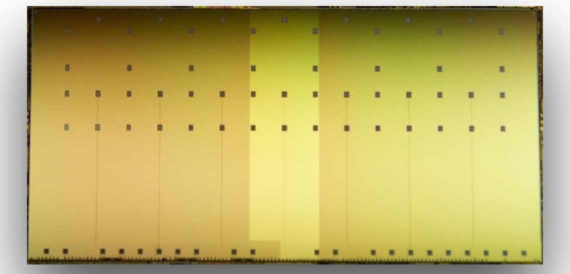
The Outer Barrel.

ALICE-ITS2 technology (42 Staves)

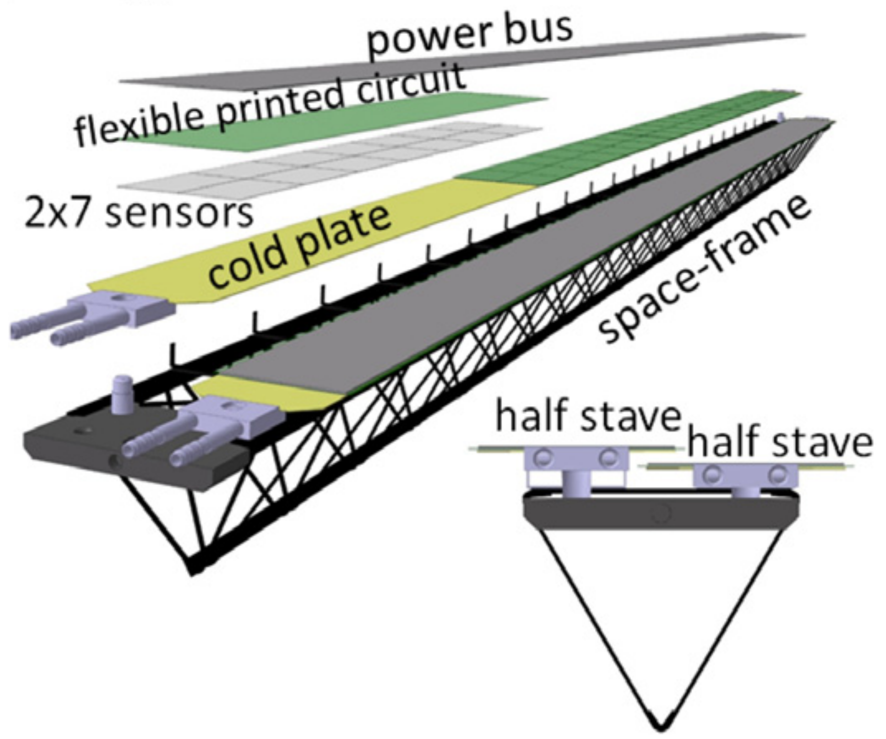


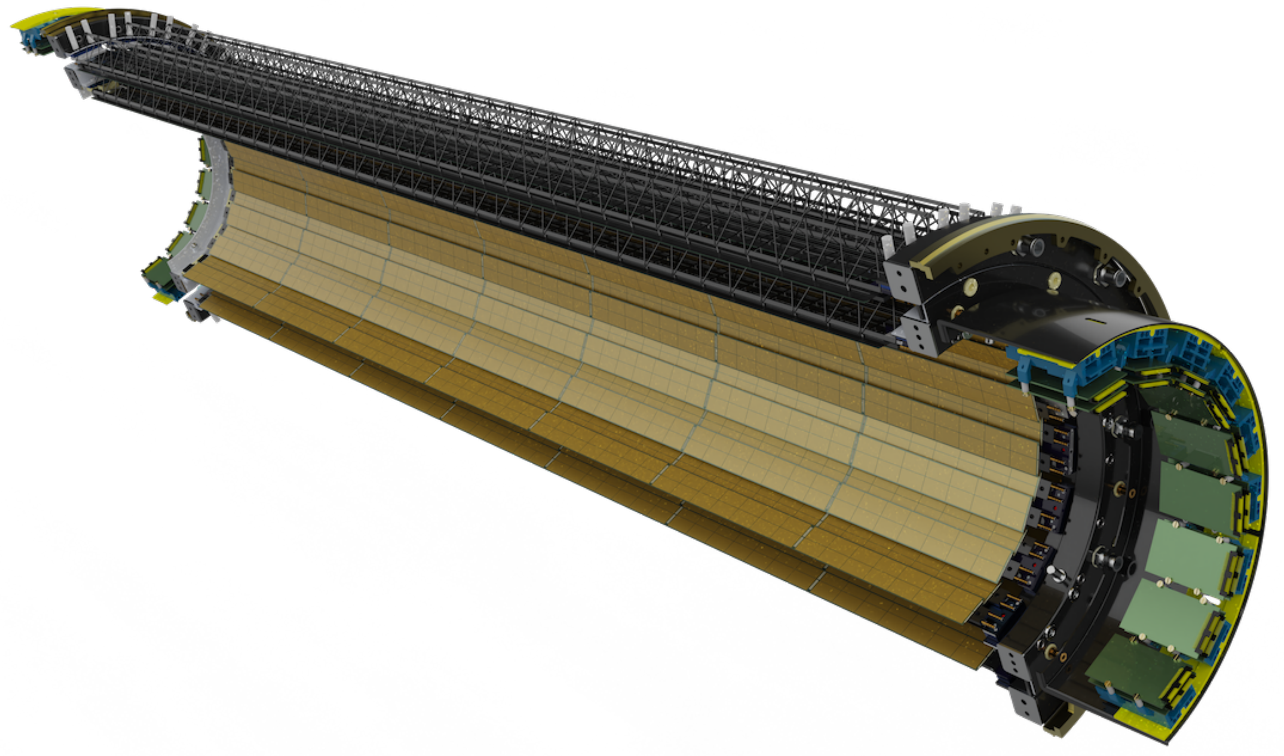
Layer 4: 18 Staves (36 Panels)
Layer 5: 24 Staves (48 Panels)

Sensor



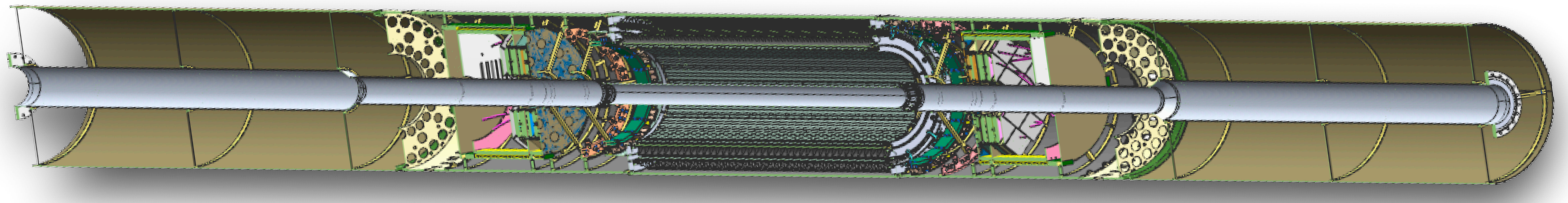
100 um-thick MAPS



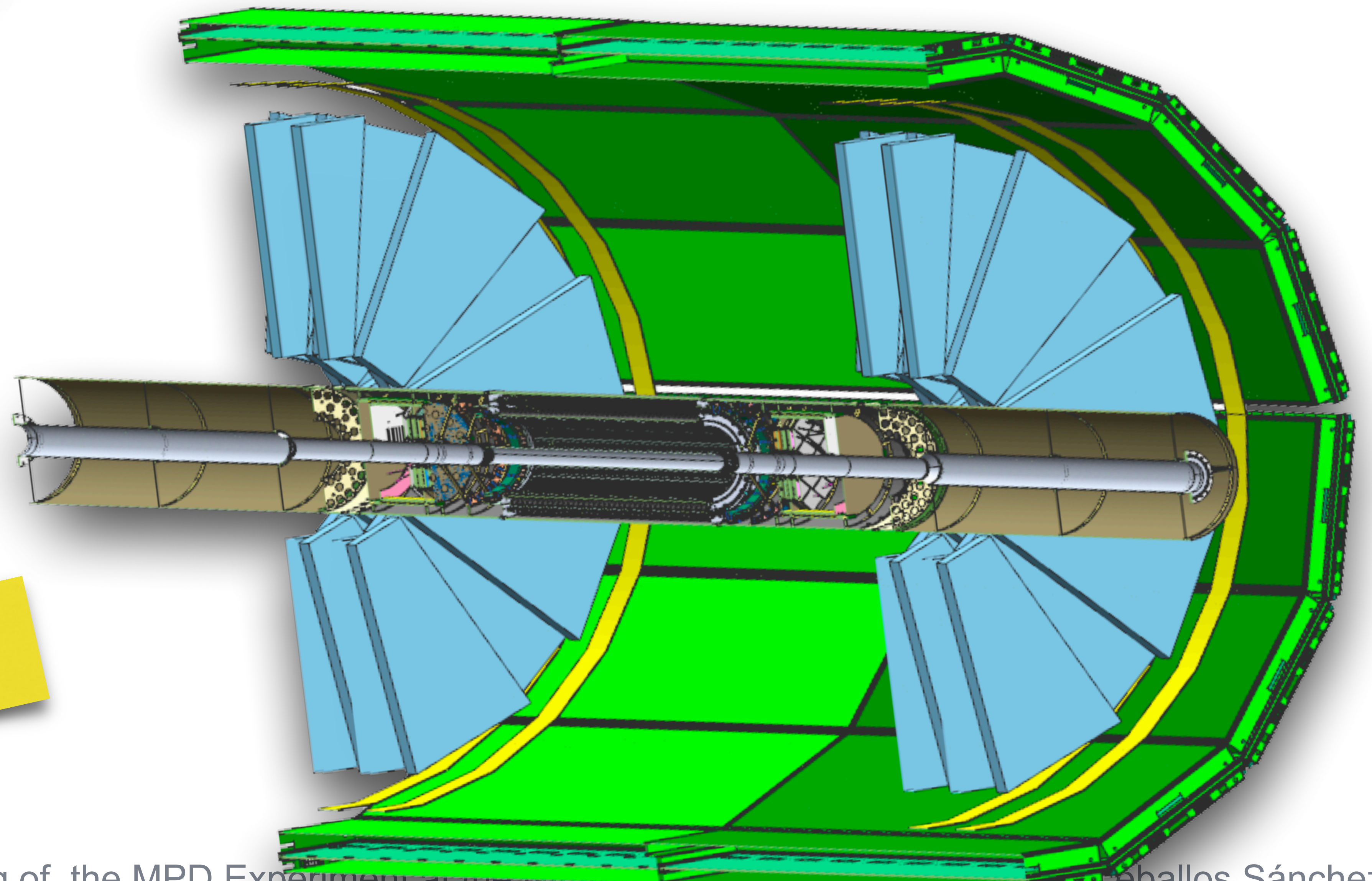


The Integration Mechanics.

(Beam pipe, TPC, FFD)



MPD Stage-I !!!

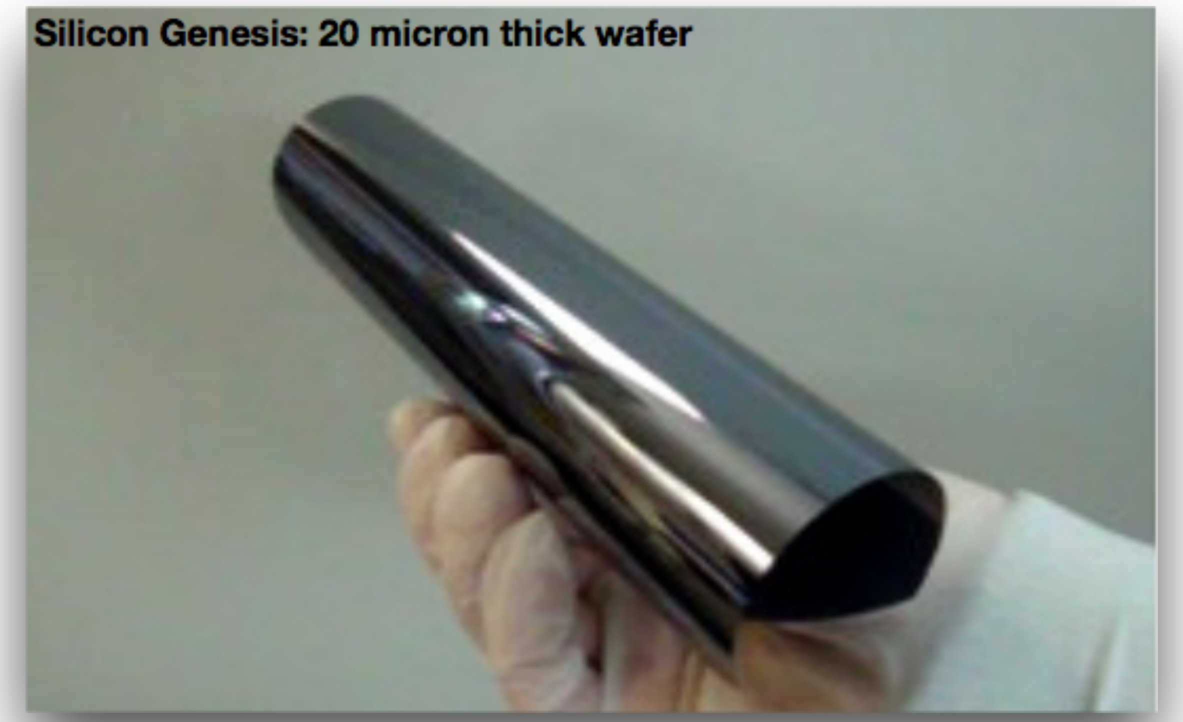


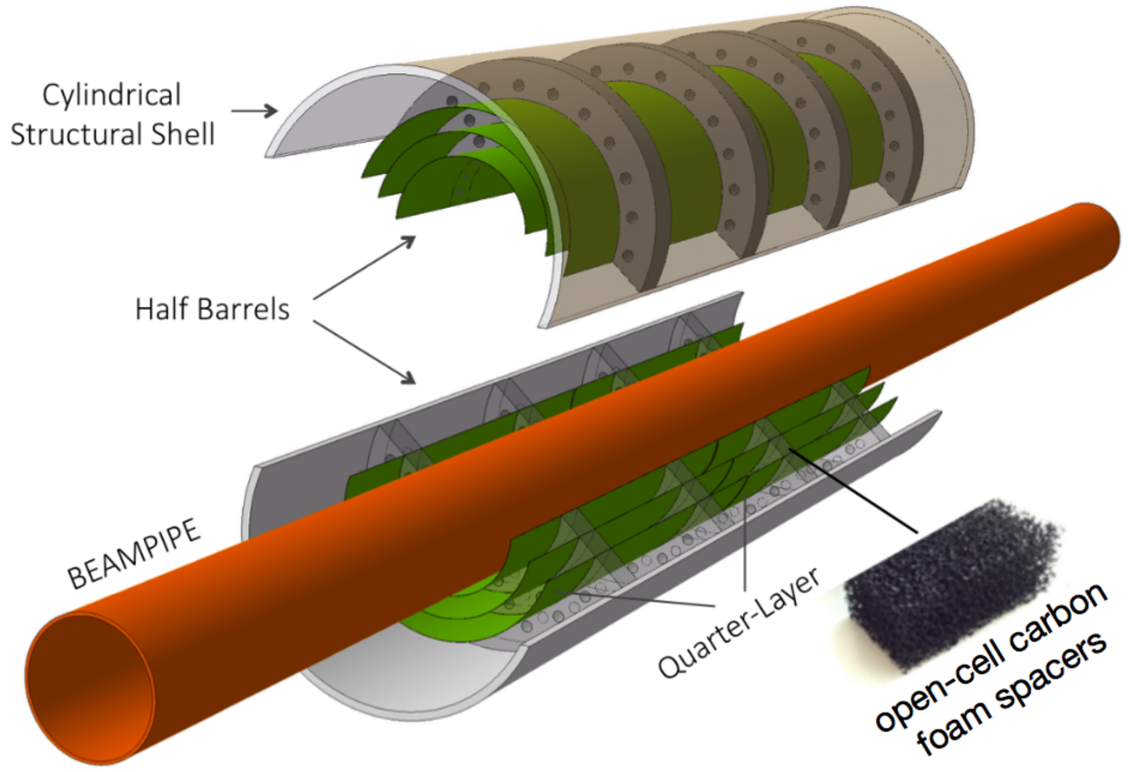
The two-stages construction scenario. Stage-2 (by 2025/2026)

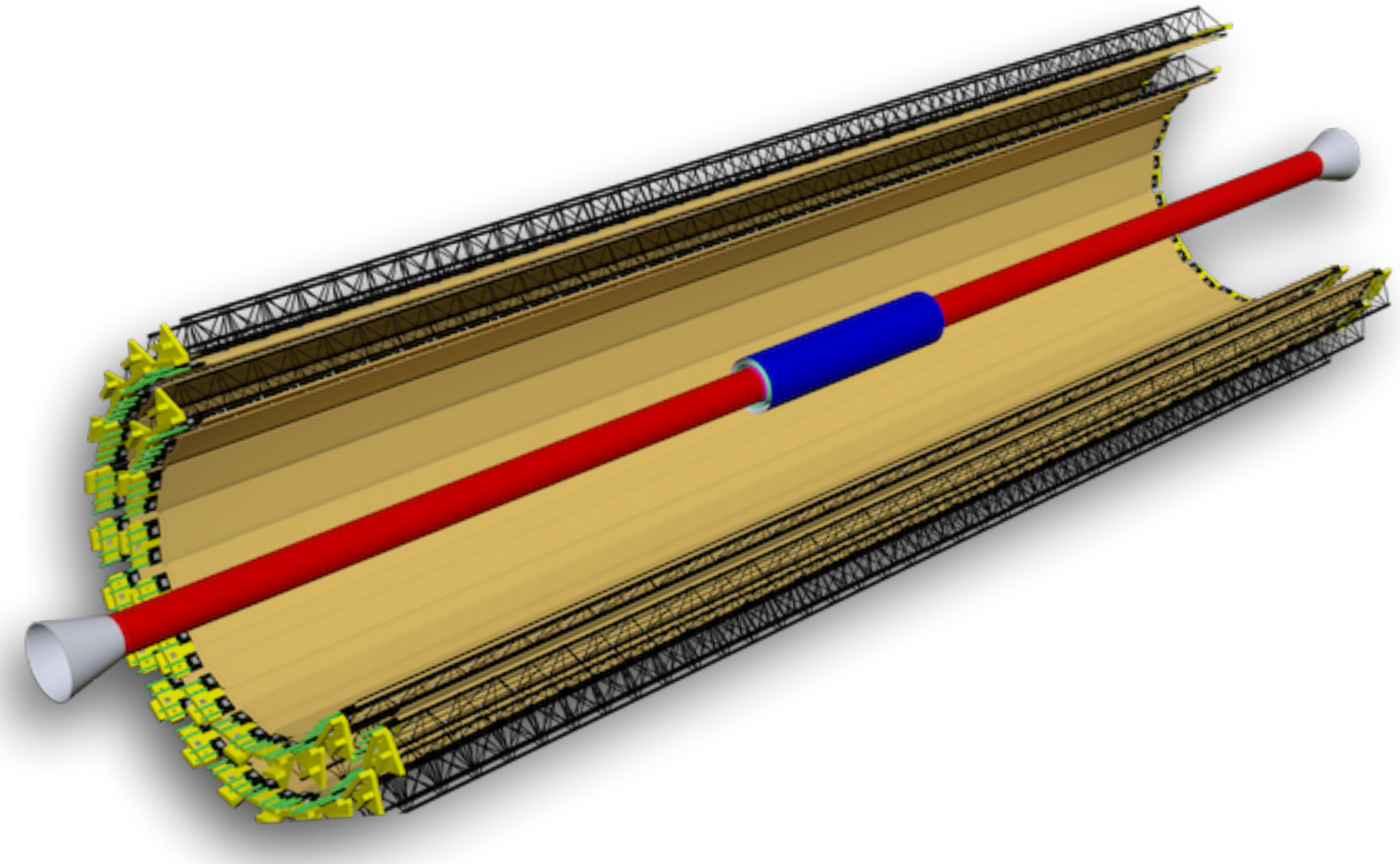
The Inner Barrel.

Goal: Use double-size ALICE-ITS3-like sensors on a beam pipe of 40 mm in diameter

ALICE-ITS3 (Under R&D): 20 um-thick (!!!) by 280 mm-long bent MAPS

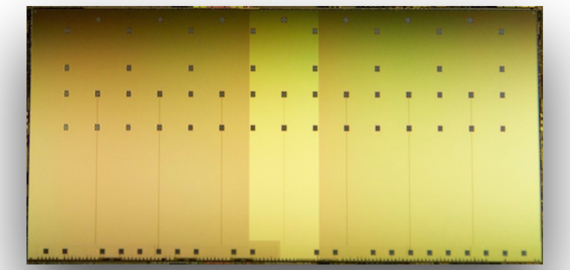






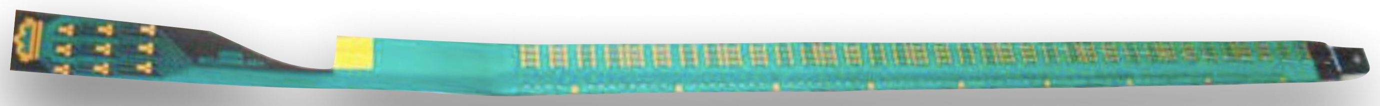
BackUp plan: Built an ALICE-ITS2-like IB

Sensor

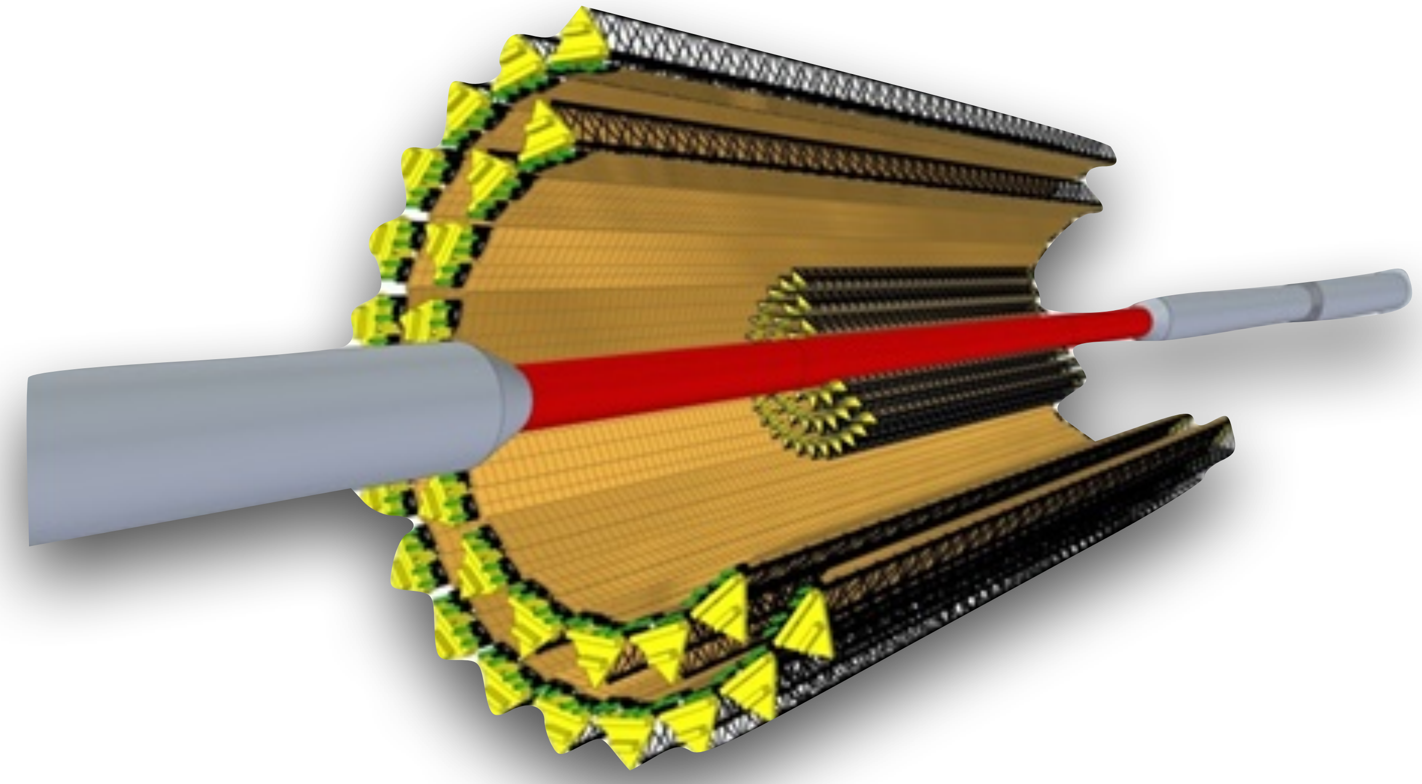


50 um-thick MAPS

IBHIC



9 Sensors



MPD-ITS Collaboration

CERN supervision

Chinese side already budgeted for 4 years

JINR

SPbSU | **MSU**

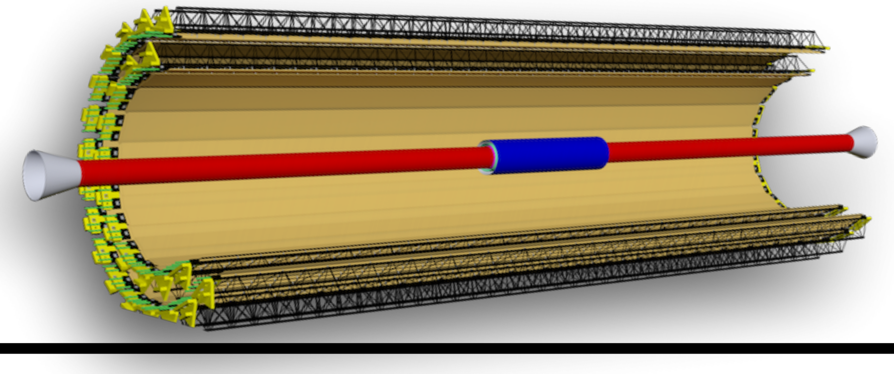
- Components distribution
- HIC assembly (33%)
- Stave assembly (33%)
- Simulations (50%)
- Integration Mech. & Cooling (100%)
- DCS (100%)

CCNU

Ins. Mod. Phys | **USTC**

- HIC Assembly (66%)
- Stave assembly (66%)
- Simulations (50%)
- Read-out electronics Devel. (100%)
- Read-out electronics Prod. (100%)

50%



50%

Layer assembly, detector commissioning and In-beam Tests at JINR

MPD-ITS Collaboration

NICA-ChINA

Chinese Working Group - Lead by Nu Xu

Xiangming Sun

- **Le Xiao, Yunpeng Lu**
  - **CCNU:** Pixel, Readout architecture, Integration, Stitching, Chip test, Thinning
  - **IHEP:** Diode, Front-end
  - **IMP:** Peripheral digital readout and control
- **Lei Zhao**
  - **USTC:** Scheme design of Readout Unit (RU), Hardware design of RU, Firmware design of RU, RU Test, Scheme design of Power Unit (PU), Hardware design of PU, PU Test, Demo circuits design based on NICA-ROC & NICA-GBT, Demo test
- **Di Guo**
  - **CCNU:** NICA_GBT ASIC, NICA_LD ASIC, NICA_TIA ASIC; Optical module development;
  - **USTC:** NICA_ROC ASIC
- **Yaping Wang, Chengxin Zhao**
  - **CCNU:** R&D on OB HIC and stave assembly and test, Production of OB HIC and stave assembly
  - **IMP:** R&D on OB HIC and stave assembly and test, Production of OB HIC and stave assembly
  - **USTC:** OB HIC and stave test
- **Jiansong Wang**
  - **HZU:** ITS simulation, Vertex resolution, Λ reconstruction, D^0 reconstruction, Physical research

MPD-ITS approach: MPD and beyond

- Bring the state of the art MAPS technology for trackers to JINR
  - ✓ High precision assembly and testing
  - ✓ Automated management system at LIT
  - ✓ Trained staff personnel
- Setting up a lamination workshop for carbon fiber structures
  - ✓ In-house production of mechanical parts with high precision
  - ✓ Possibility of implementing customized solutions
  - ✓ Trained staff personnel
- Establishing a solid collaboration
  - ✓ International (Chinese Institutions, CERN, INFN)
  - ✓ National (SPbSU, MSU)
  - ✓ Interlaboratories (LIT, FLNP)

Requires a lot of resource investment (money and time) on infrastructure, personnel training and overcoming the difficulties for keeping up with the world-level cutting edge technology.

Provides the opportunity to JINR of establishing itself in the front line of the MAPS-based tracker technology which is foreseen to become the new standard for fundamental and applied research.

Current Work Packages

Work Package	Status
1. Simulations	Active
2. Inner Barrel HIC	Low Profile
3. Outer Barrel HIC	Active
4. Outer Barrel Staves	Low Profile
5. Mechanics & Cooling Design	Active
6. Mechanics & Cooling Production	Active
7. Read-out and Electronics Devel.	Active
8. Read-out Electronics Prod.	On hold
9. DCS	Active
10. In-beam Tests	On hold
11. Services	Active

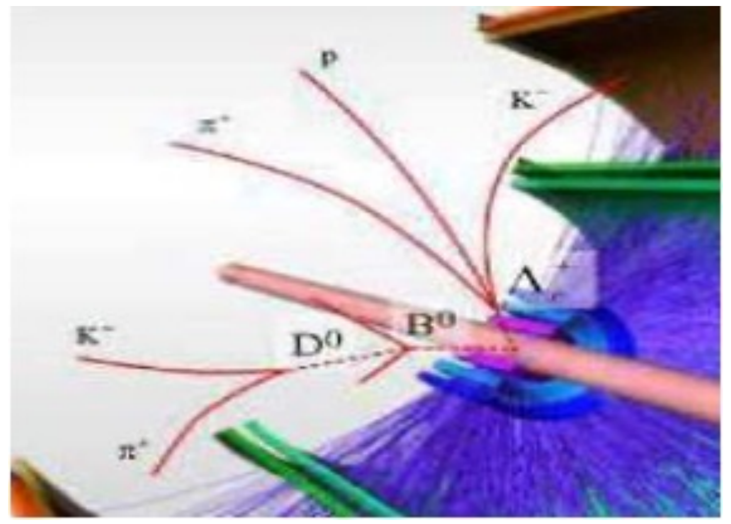
Overview on the work done by the “Active” and “Low profile” WPs

WP1 - Simulations

Goal: To asses the identification ability of the MPD tracking system (**ITS + TPC**) for the reconstruction of the decays of strange (Λ^-, Ξ^-, and Ω^--hyperons) and charmed (D^0- and D^+-mesons) particles produced in central Au + Au collisions at $\sqrt{S_{NN}}$ = 9 GeV.

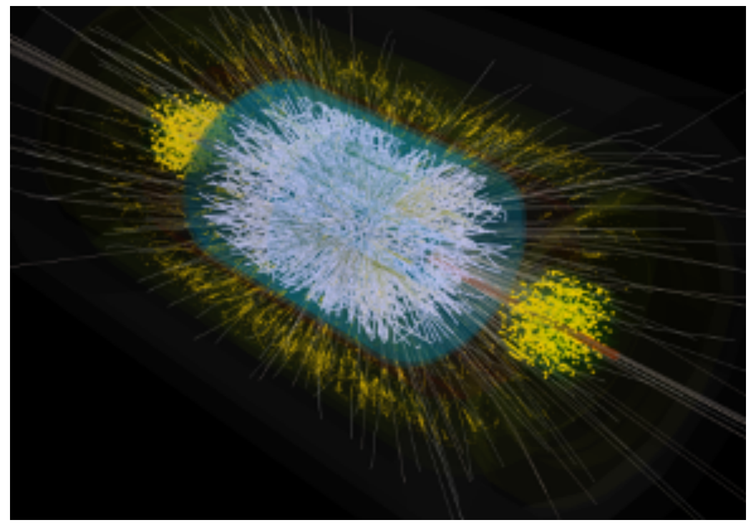
MpdRoot

Signal



Thermal Generator tuned to the energy range of NICA collider.

Background



QGSM event generator.

The decay channels of strange and charmed particles used for their reconstruction in the MPD tracking system.

Hadron	Mass (MeV/cm^2)	Average path length $c\tau$(mm)	Decay channel	BR (%)
Λ	1115.68 ± 0.01	78.9	$\pi^- + \mathrm{p}$	63.9
Ξ^-	1321.71 ± 0.07	49.1	$\pi^- + \Lambda^0$	99.9
Ω^-	1672.45 ± 0.29	24.6	$K^- + \Lambda^0$	67.8
D^+	1869.62 ± 0.20	0.312	$\pi^+ + \pi^+ + K^-$	9.13
D^0	1864.84 ± 0.17	0.123	$\pi^+ + K^-$	3.89

WP1 - Simulations

TPC + 2 layers ITS OB, beam pipe diameter 64 mm (TPC+ITS-2-64)

Reconstructed particles: Λ, **Ξ**, and **Ω**

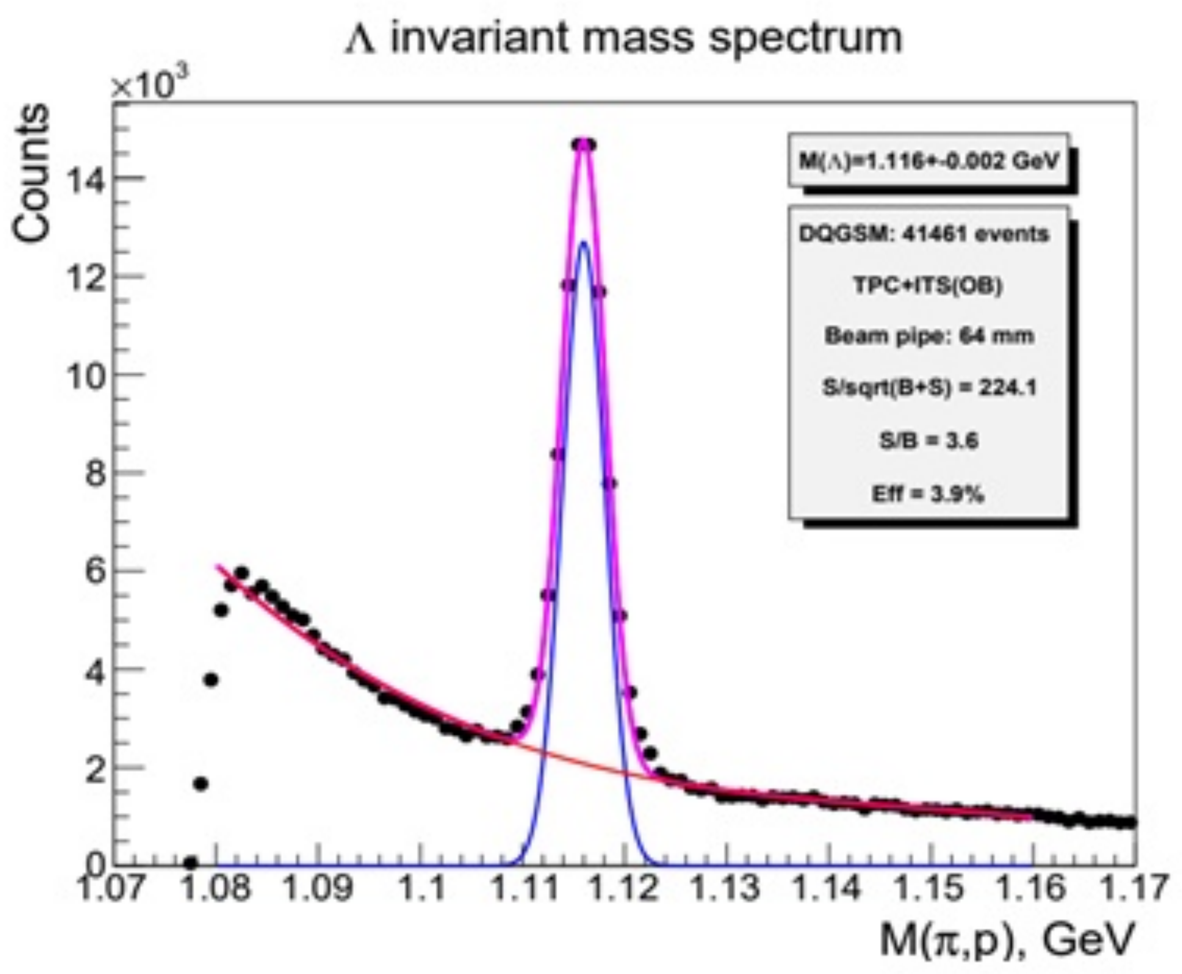
Track Reconstruction Method: Kalman filter (**KF**).

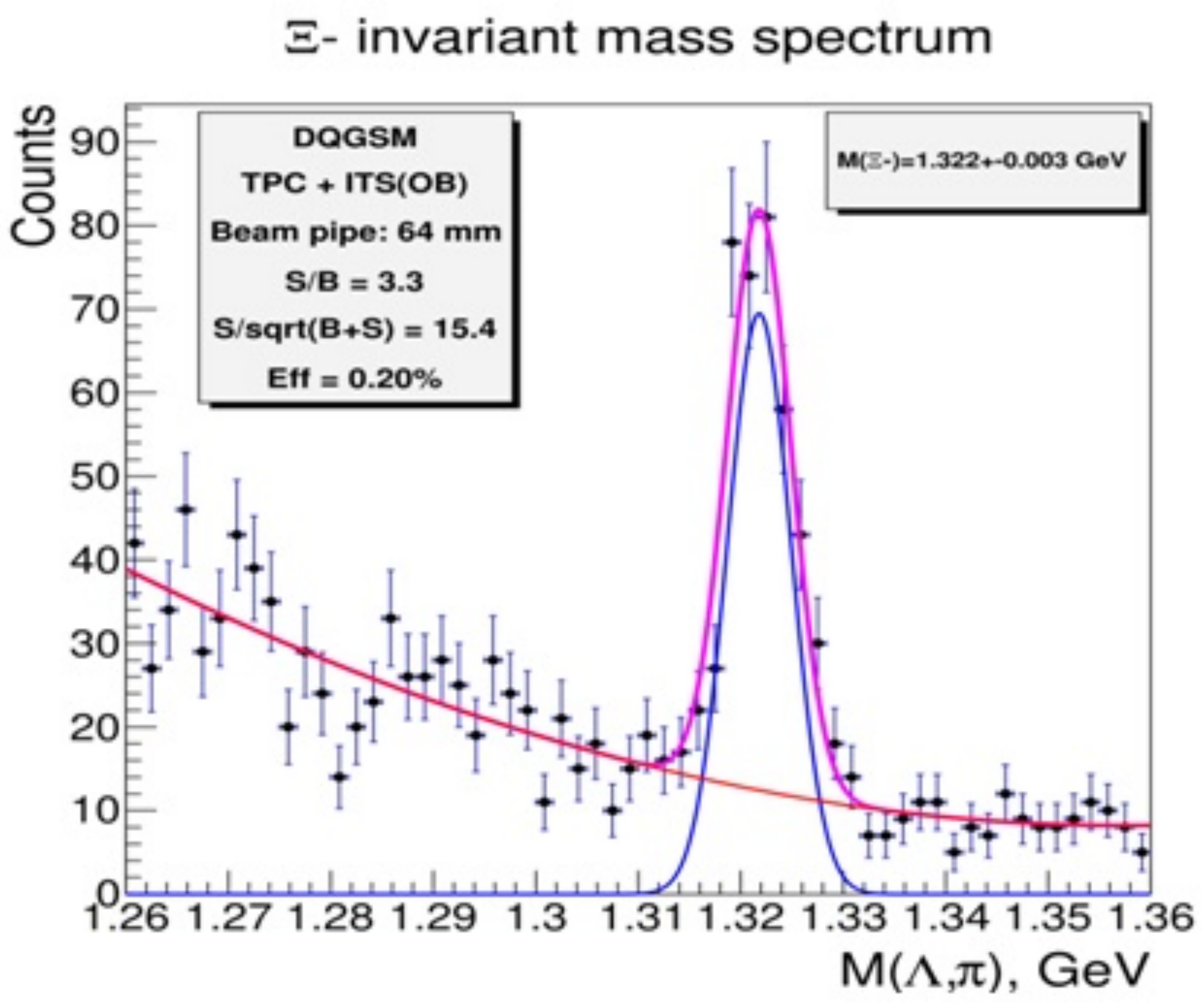
MPD Initial Stage

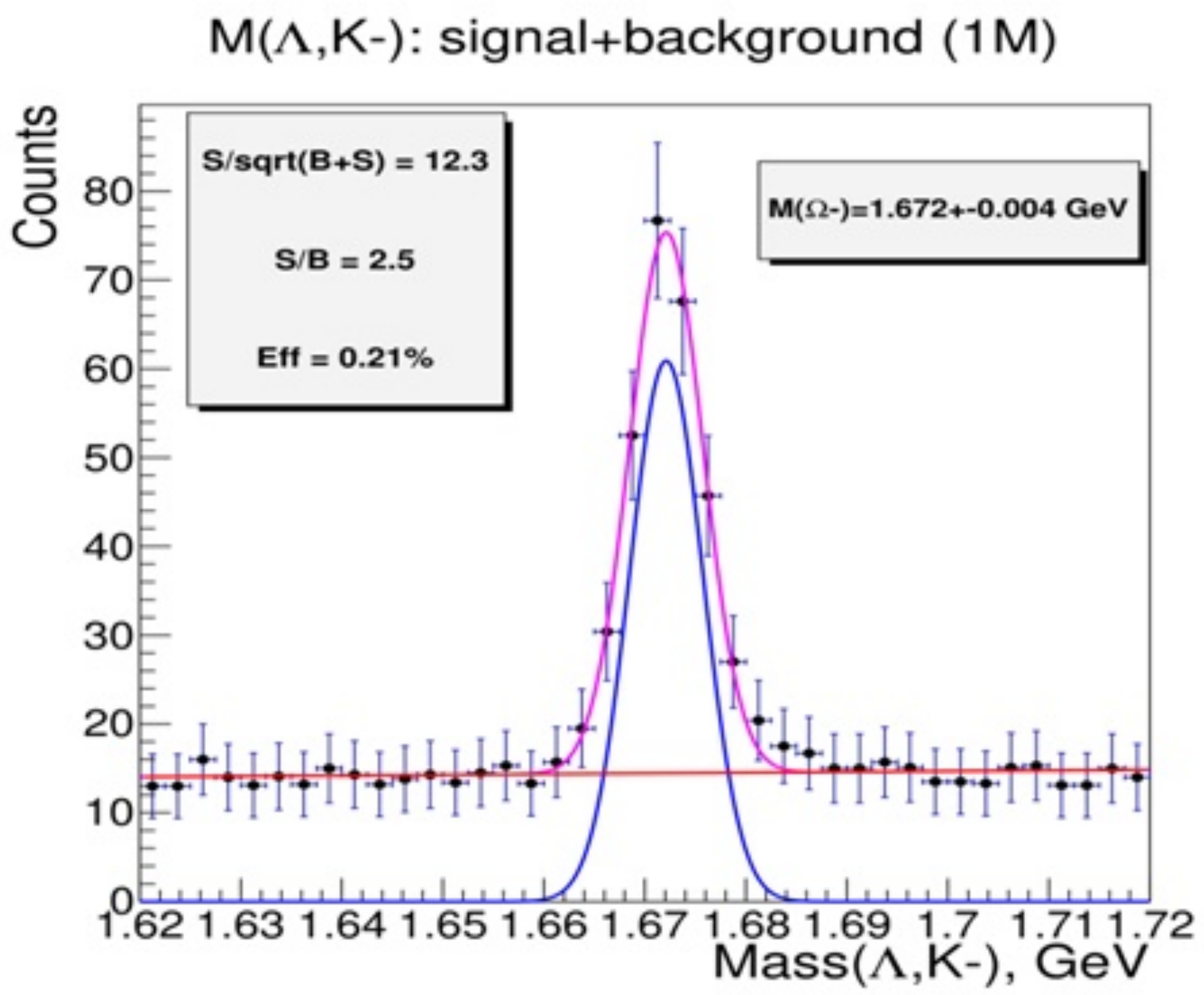
Signal selection criteria: Cuts(*) on the topology of the decay of the short-lived particles (**TC**):

- dca (tracks of decay products, primary vertex of interaction).
- distance (between tracks of daughter particles) @ vertex of the decay of the parent particle.
- path length of the parent particle (point of its formation, decay point).
- angle (vector connecting the primary and secondary vertex, vector of the reconstructed momentum of the parent particle).

(*)cut-off level for the specified selection parameters is based on the maximum value of the significance function $Sg(C_i)$ for each parameter C_i







Signal extraction efficiency of 0.2 % is enough for assessing identification ability at debugging stage

WP1 - Simulations

TPC+ITS-5-64 vs TPC+ITS-5-40

After MPD LS-1

Reconstructed particles: Multistrange and Charmed particles

Track Reconstruction Method: Kalman filter (**KF**).

Signal selection criteria: TC & MVA[*]

[*] $V^N \rightarrow R$ (classifier response) @ training phase, BSD (boosted decision tree classifier) @ analysis phase using the same topological parameters from TC

Particle	Ξ^-		Ω^-		D^+		D^+	
Reconstruction method	TC		TC		TC		MVA	
Number of events	10^5		10^5		10^8		10^8	
Beam pipe diameter [mm]	40	64	40	64	40	64	40	64
Efficiency [%]	1.3	1.2	0.7	0.6	0.5	0.04	1.0	0.06
Significance ($S/\sqrt{S+B}$)	43.4	42.5	3.7	3.5	7.0	0.9	10.5	0.9

TPC+ITS-5-40: Provides reliable detection with an efficiency of about 1 % for both multistrange and charmed particles.

TPC+ITS-5-64:

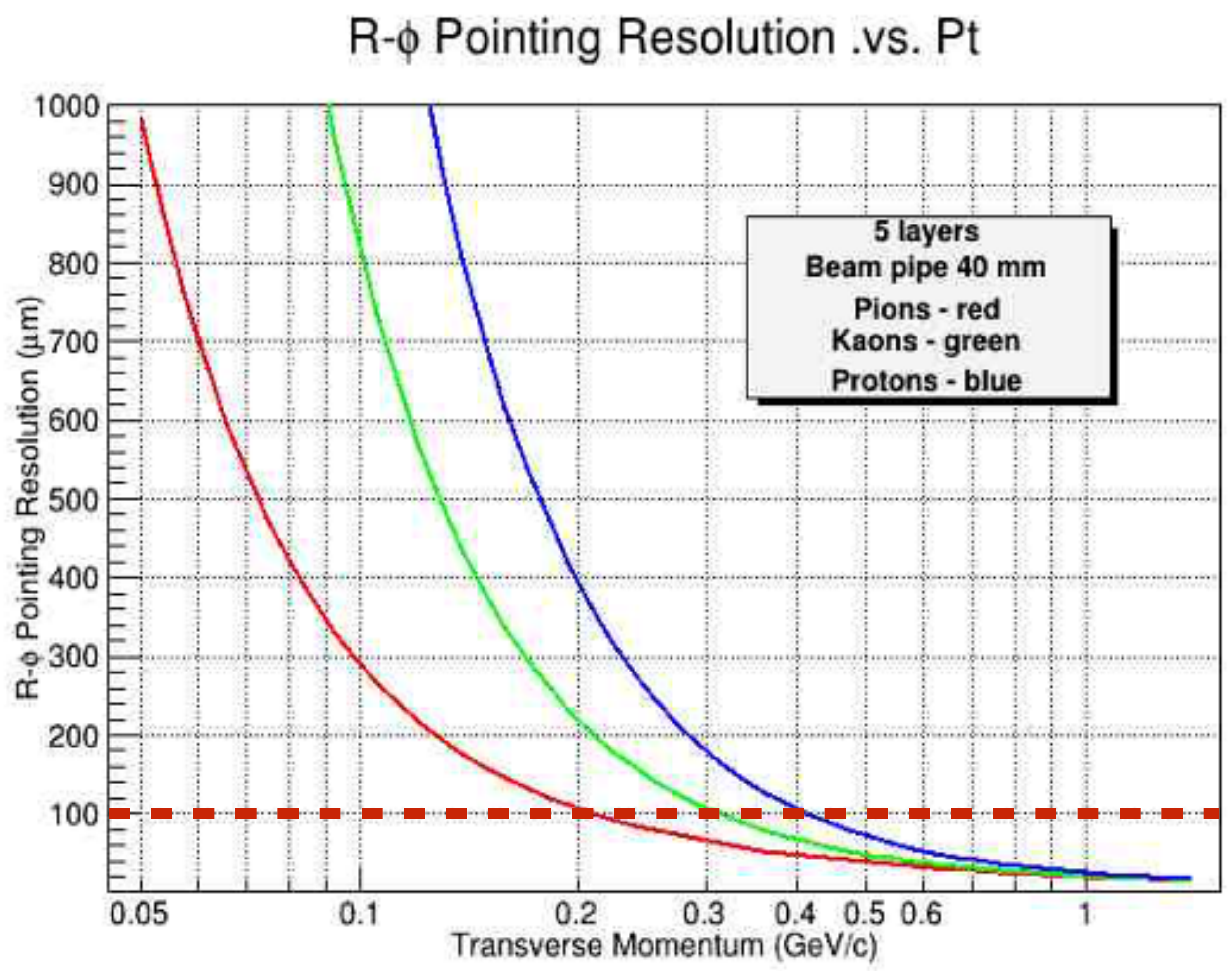
- **the efficiency of reconstruction of hyperons decreases by 10%.**
- **for D-mesons the efficiency of their reconstruction decreases by an order of magnitude.**

The study of the physics of heavy-flavour on nucleus-nucleus collisions @ NICA-MPD seems to be promising assuming the beam pipe diameter will be reduced to an optimum value of 40 mm.

WP1 - Simulations

Detection of D-mesons in central Au+Au collisions with the vertex detector TPC+ITS-5-40

Particle	Mass [MeV/c²]	Mean path cτ [mm]	Decay channel	BR	Multiplicity
D^0	1864.8	0.123	$\pi^+ + K^-$	3.89%	10^{-2}
D^+	1869.6	0.312	$\pi^+ + \pi^+ + K^-$	9.13%	10^{-2}



TPC+ITS-5-40 pointing resolution(*) of at least 100 μm allows a decay vertex reconstruction of D^0 mesons p_T down to 500 MeV/c.

Signal
Generator: TG
Statistics: 1M decays

Background
Generator: QGSM
Statistics: 100K events

Two methods were used for track reconstruction:
1)Method of Kalman filter (KF)
2)Method of vector finder (VF)

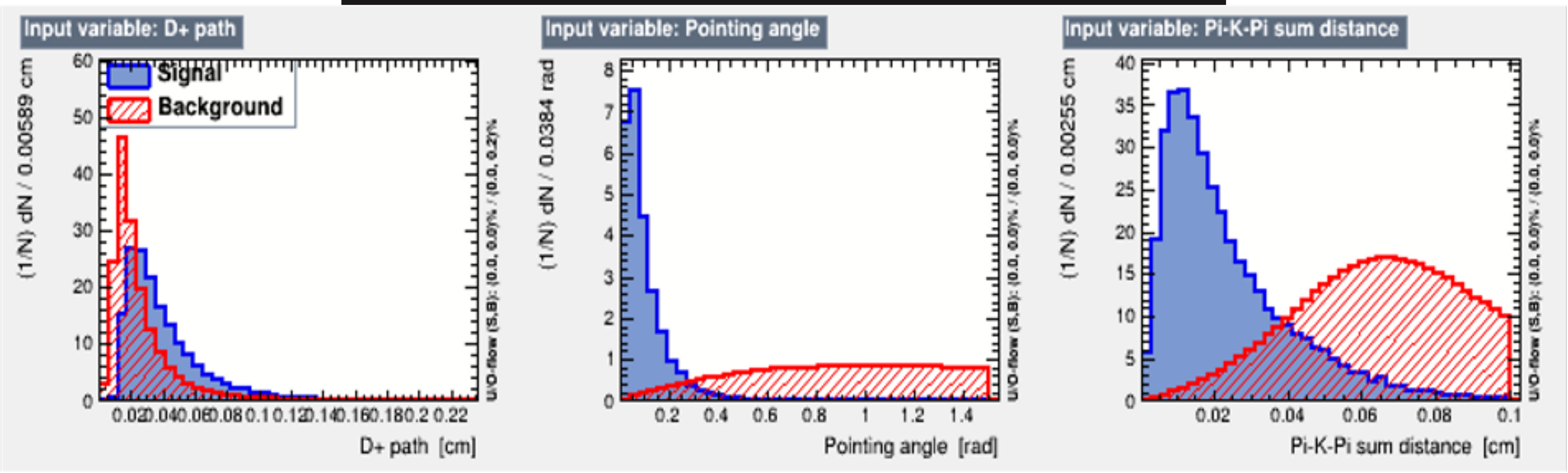
Two methods were used for D mesons selection:
1)Method of topological cuts (TC)
2)Method of multivariate data analysis (MVA)

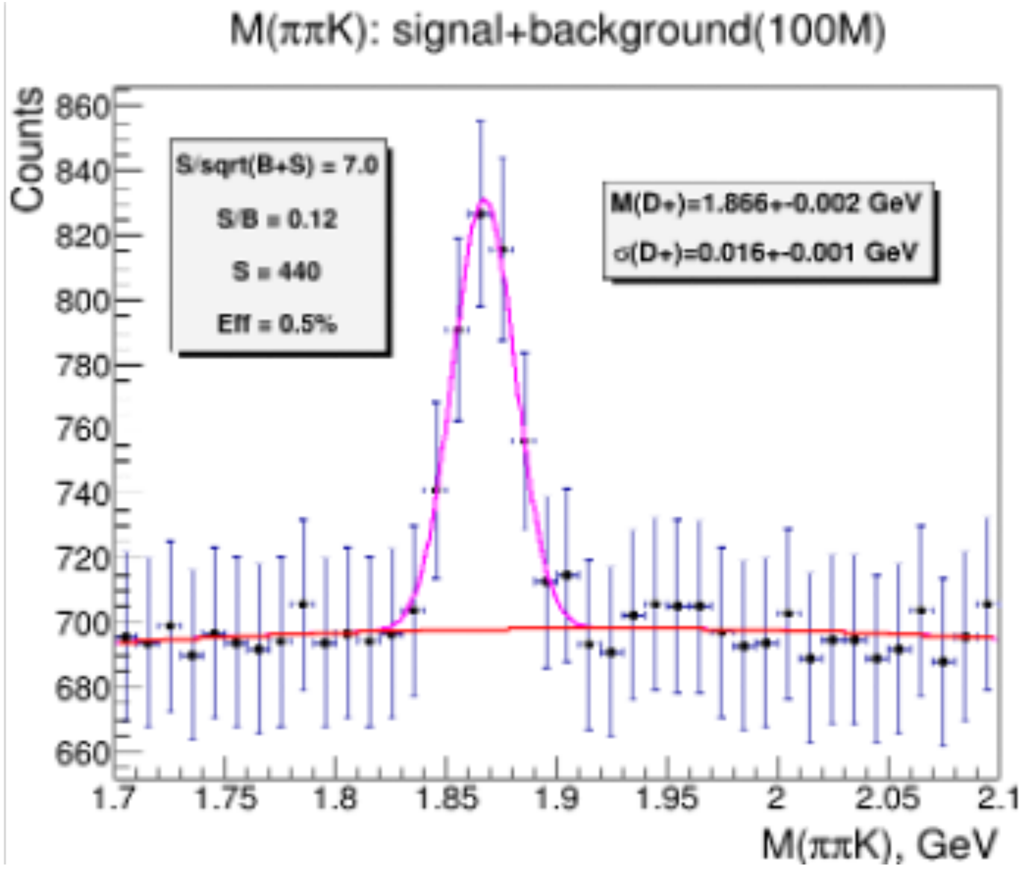
(*)The pointing resolution of the vertex detector is defined as the r.m.s value of the closest approach distance of the reconstructed particle track to the vertex.

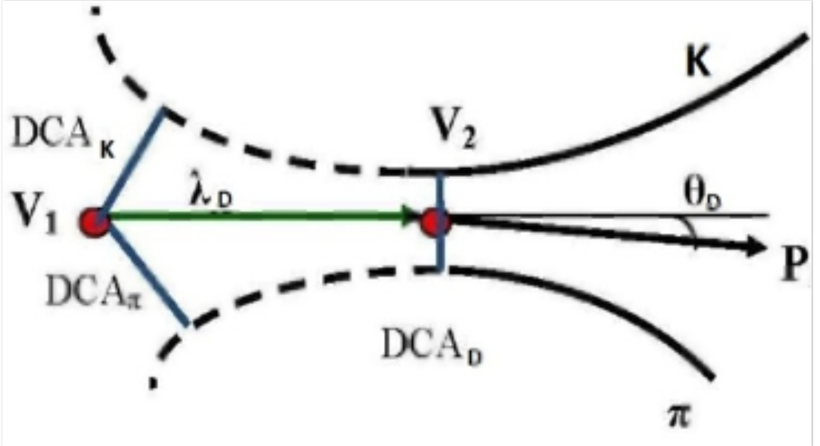
WP1 - Simulations

D⁺ and D⁰ reconstruction using KF

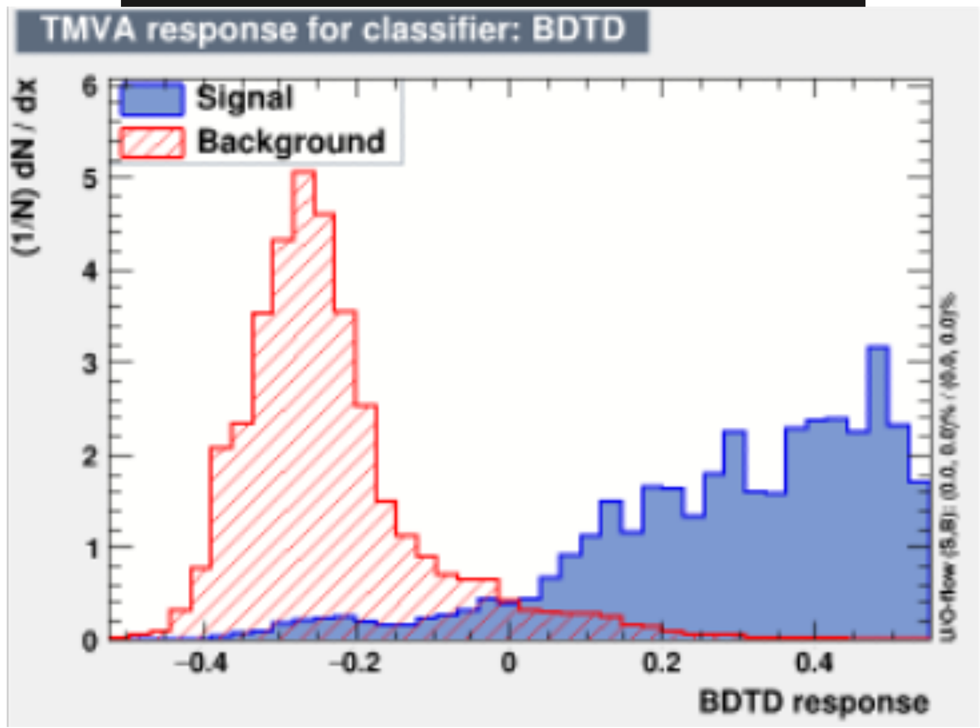
TC: dca(π), dca(K), dca(πK), λ(D), θ(D) cuts

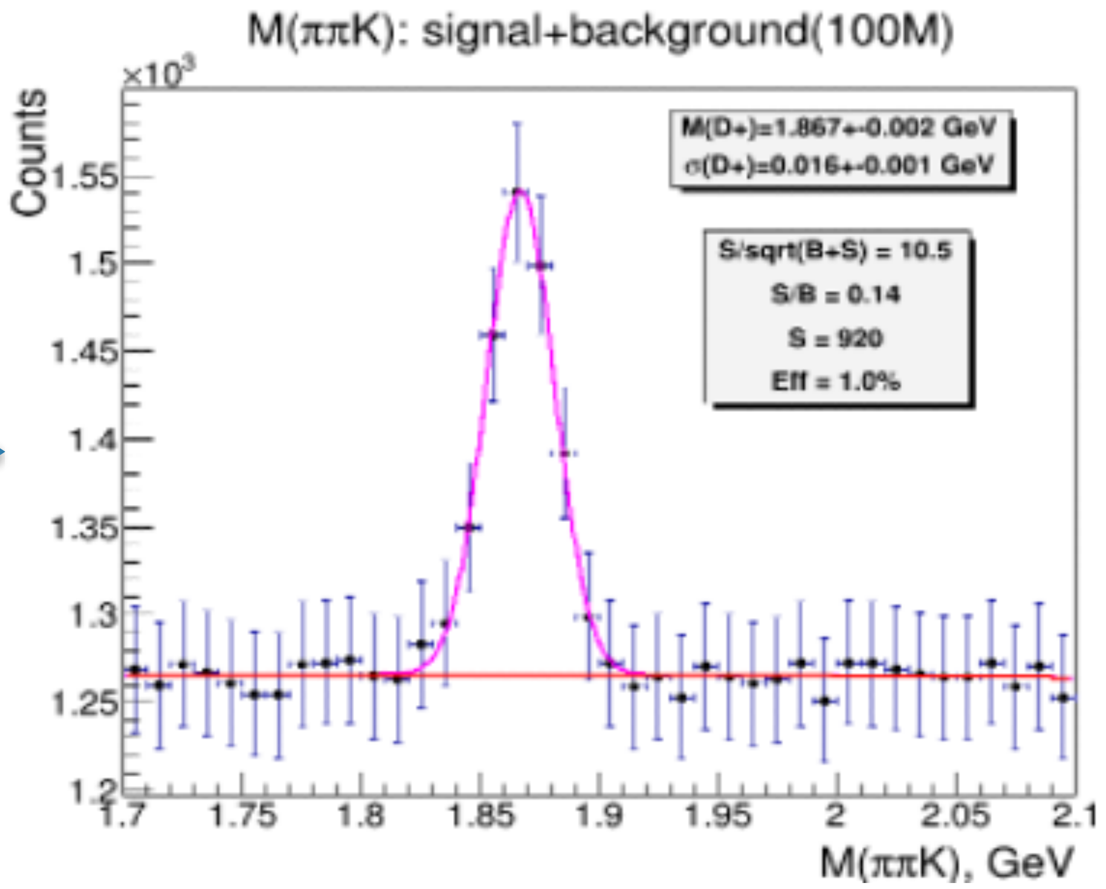






MVA: BDT classifier cuts





Particle	D⁰		D⁺	
Method	TC	MVA	TC	MVA
Efficiency, %	0.80	0.85	0.50	1.0
Significance	5.3	5.5	7.0	10.5
S/B(2σ) ratio	0.10	0.10	0.12	0.14

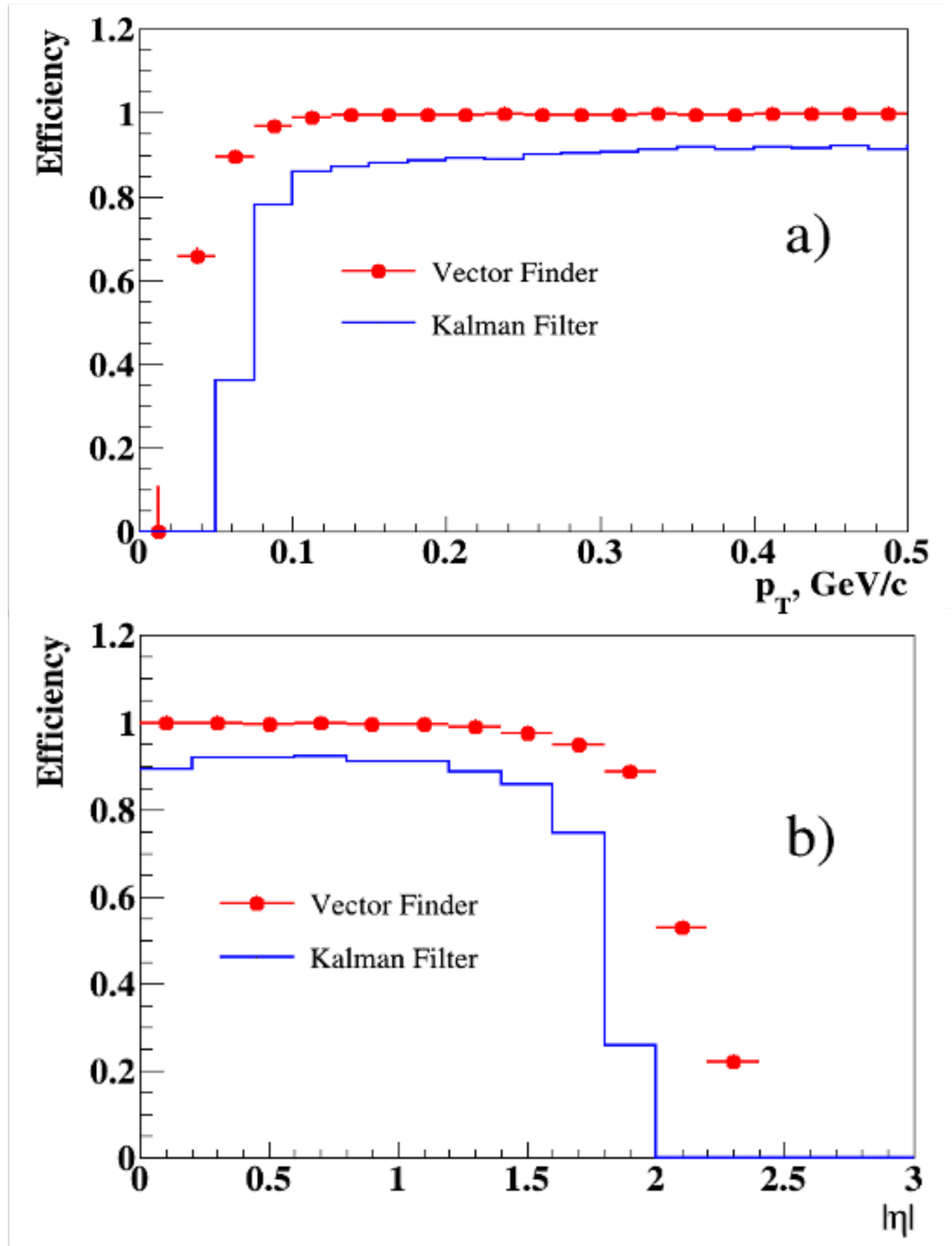
Using the topological cuts allows to reconstruct D⁰ and D⁺ decays with an efficiency of 0.8% and 0.5% respectively. Using the optimal BDT cut allows to reconstruct D⁰ and D⁺ with an efficiency of 0.85% and 1.0% respectively.

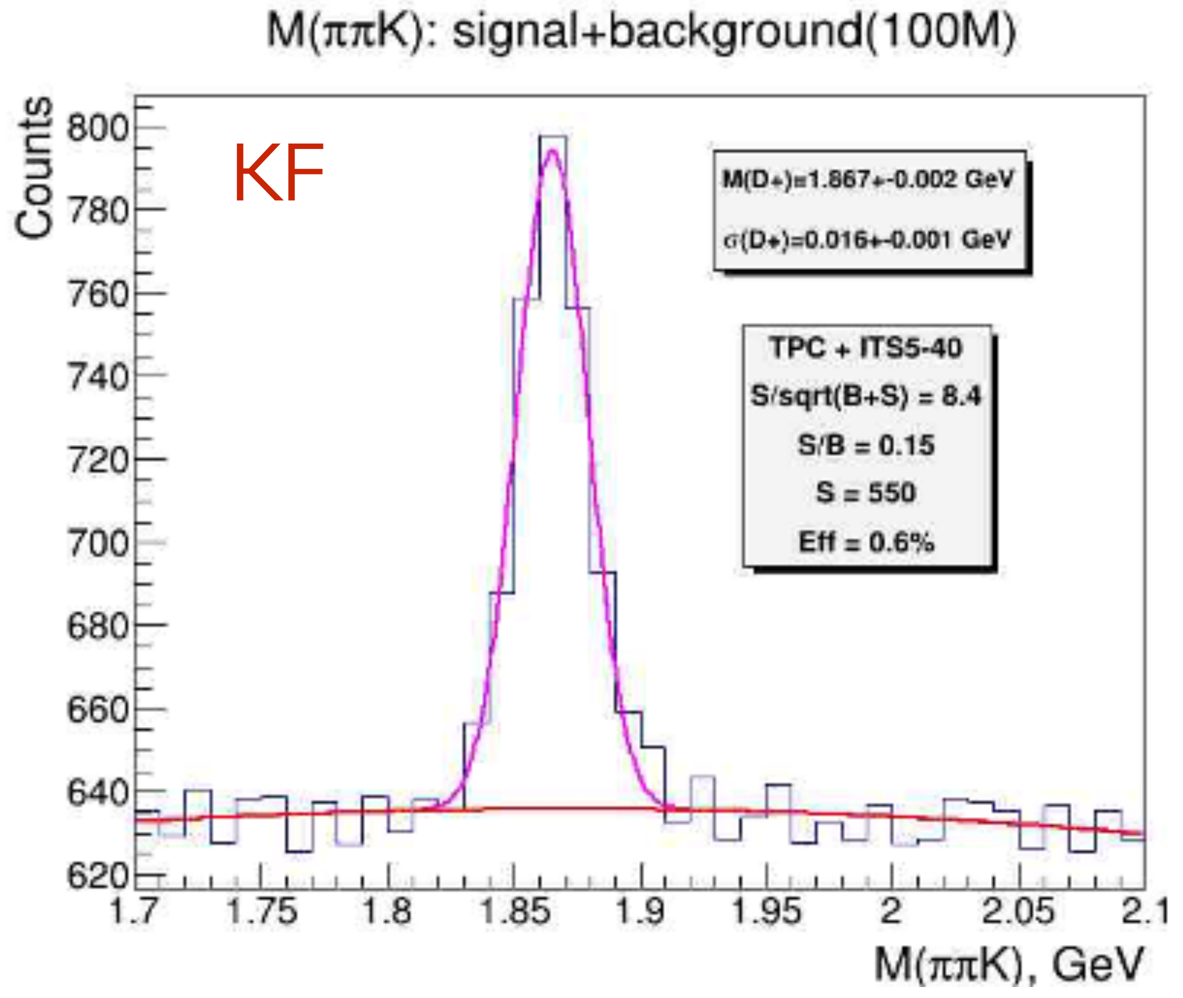
A. I. Zinchenko, S. N. Igolkin, V. P. Kondratiev & Yu. A. Murin" NICA-MPD Vertex Tracking Detector Identification Capability for Reconstructing Strange and Charmed Particle Decays". Physics of Particles and Nuclei Letters , volume 17, pages 856–870 (2020)

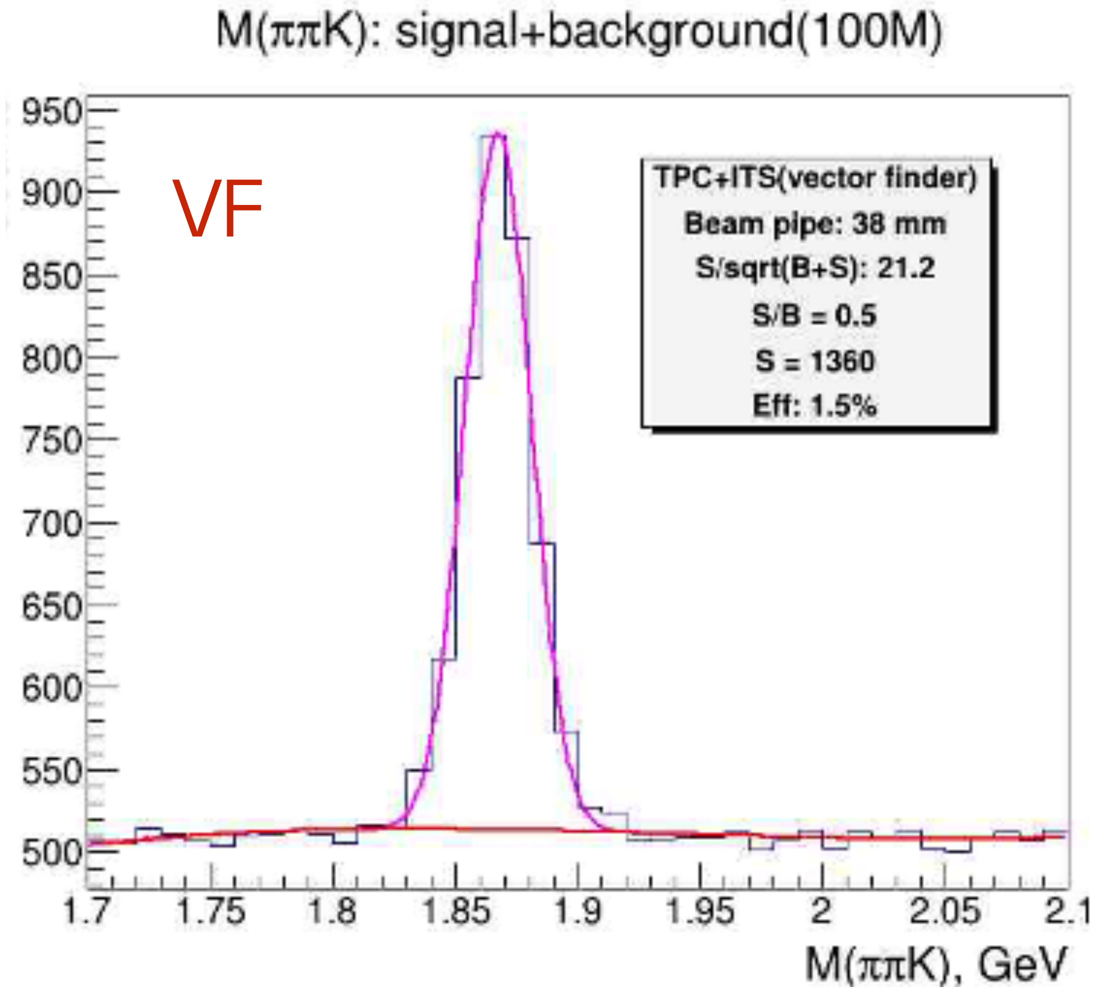
WP1 - Simulations

D+ reconstruction using KF and VF methods: comparison

Vector Finder (VF) vs Kalman Filter (KF) efficiency comparison (by A. Zinchenko)







ITS-5-40	S	S/B	$\frac{S}{\sqrt{S+B}}$	Eff (%)
VF	550	0.15	8.4	0.60
KF	1360	0.50	21.1	1.50

Using VF mechanism allows to reconstruct D+ with an efficiency 2.5 times higher and with higher level of significance compared to KF technique.

Next steps: Studying the reconstruction of D^0 and D^+s using VF.

D.A. Zinchenko, A. I. Zinchenko, E. G. Nikonov. «Vector Finder — a toolkit for track finding in the MPD experiment» Письма в ЭЧАЯ. 2021. Т. 18, No 1(233). С. 134

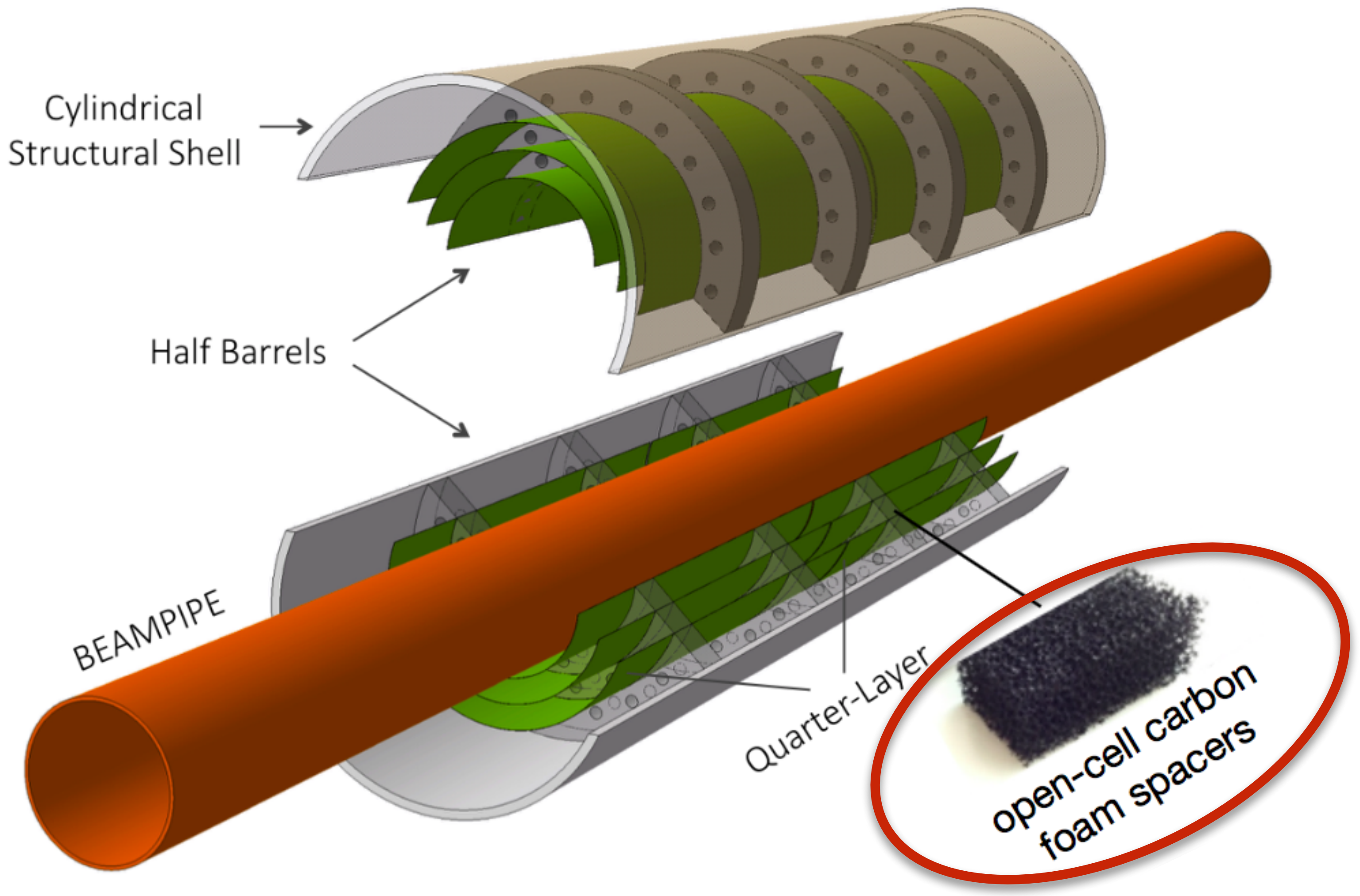
WP2 - Inner Barrel HIC

- **Contact has been established with ALICE-ITS3 for participating on:**
  - **Mechanics**
    - Study of the radiation damage induced by fast neutrons on the carbon foams spacers irradiated at JINR's IBR-2 (more on next slide)
  - **Simulations**
    - Collaborate on the physics simulations for the large-area bent MAPS for the implementation of Hit and Cluster generations
  - **In-beam tests**
- Conducting in-beam tests on large-area bent MAPS at JINR using 200 MeV electrons.

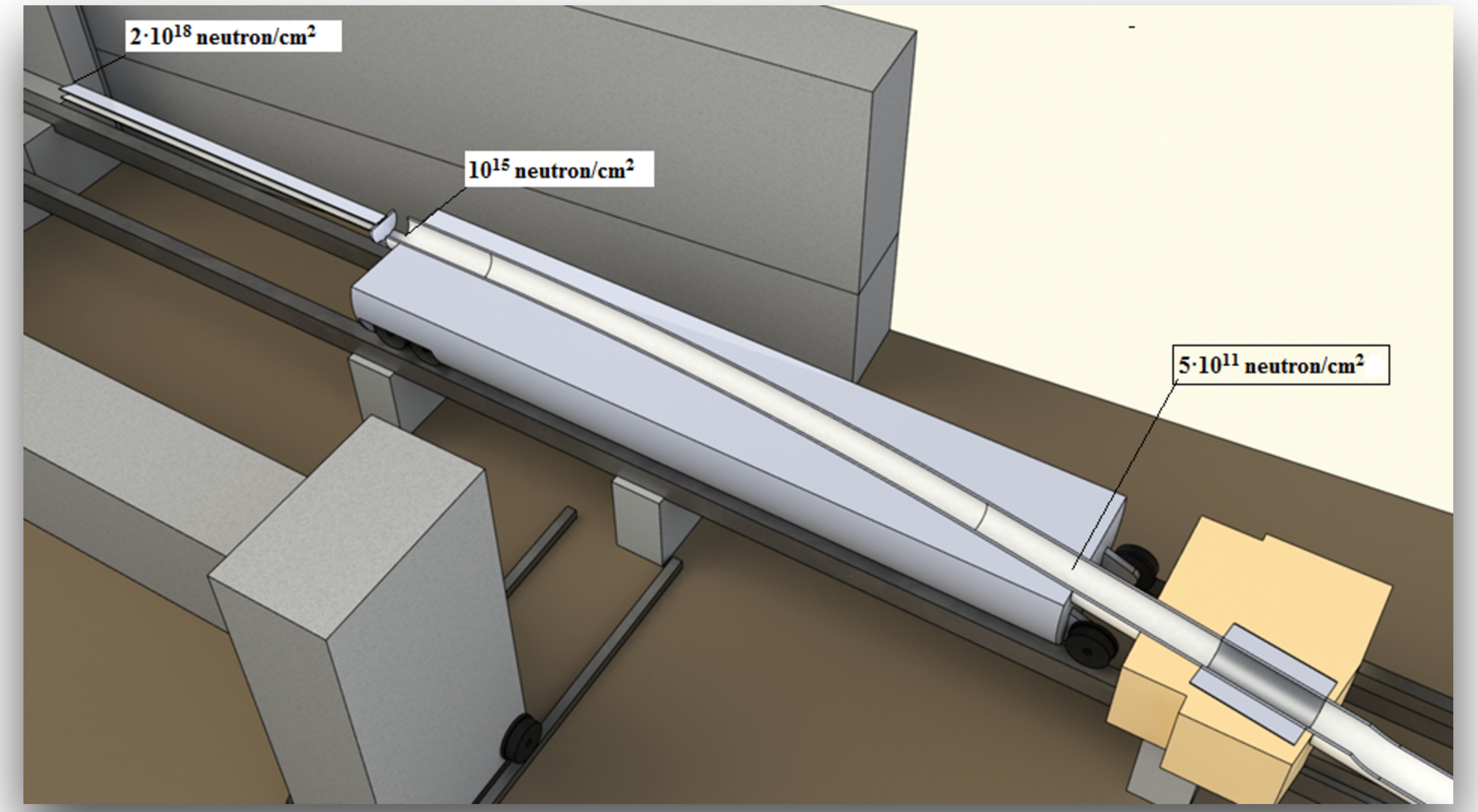
WP2 - Inner Barrel HIC: Study of Radiation Damage on Carbon Foams

MPD - ITS

Mechanics



FLNP's IBR-2 irradiation positions



Taking advantage of JINR's diversity

The type of samples to be tested for radiation damage divided into three categories:

- Carbon Foams
- Glues
- Subassembly structures

Three types of carbon foams are proposed:

- ERG (novel material for whom little information is available)
- AllComp LD
- AllComp HD

For the AllComp there has been previous studies about radiation damage that may be used as reference for the current studies to be performed.

WP2 - Inner Barrel HIC: Study of Radiation Damage on Carbon Foams

MPD - ITS

Sample: Carbon Foam, Carbon Foam with carbon fleece impregnated on it and glued

Sample Provision (& related Info): CERN

Input parameters

Experiment

Sample Irradiation at JINR's IBR-2

Input parameters

Sample measurement pre/post irradiation

- Thermal conductivity tests
- Peeling tests
- Raman spectroscopy
- X-ray diffraction
- Neutron diffraction

Damage correlation

Simulations

Neutrons

MCNP
+
in-between code for PKA spectrum generation
+
SRIM
=
DPA Spectrum

NICA

FLUKA
=
DPA Spectrum

Damage correlation

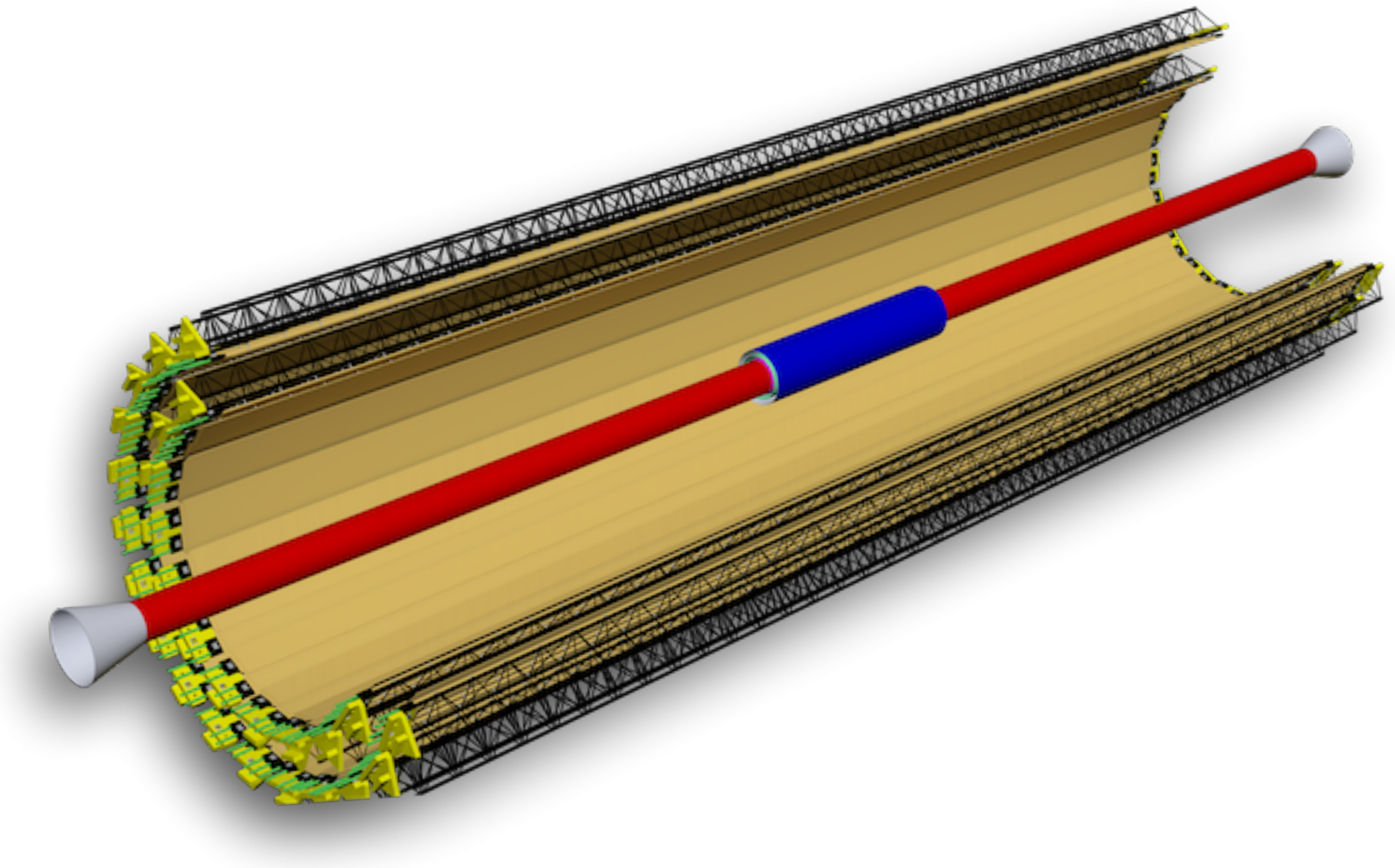
WP2 - Inner Barrel HIC

MPD - ITS

Simulations

Contact has been established with ALICE-ITS3 (M.Mager) for participating on the IB simulations:

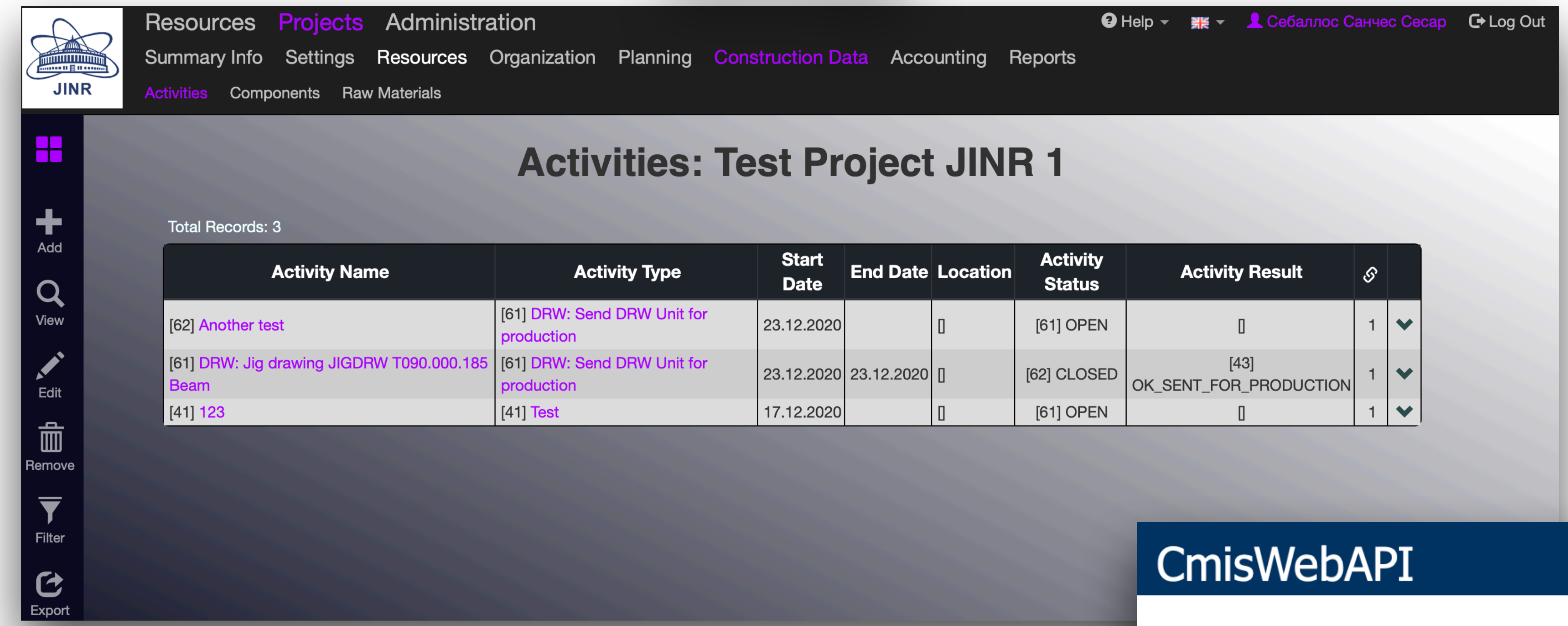
- First technical task has been established: "Implement an ITS3-like IB geometry for the MPD-ITS setup using the "realistic" pixel size from ALICE"
  - Pixel size = pixel Pitch = 15 µm.
  - Sensor thickness: 30 µm.



- Run the simulations for the entire setup IB+OB+TPC for three consecutive goals:
  - Hit generation.
  - Cluster generation.
  - Track reconstruction (Hyperons and D-mesons).

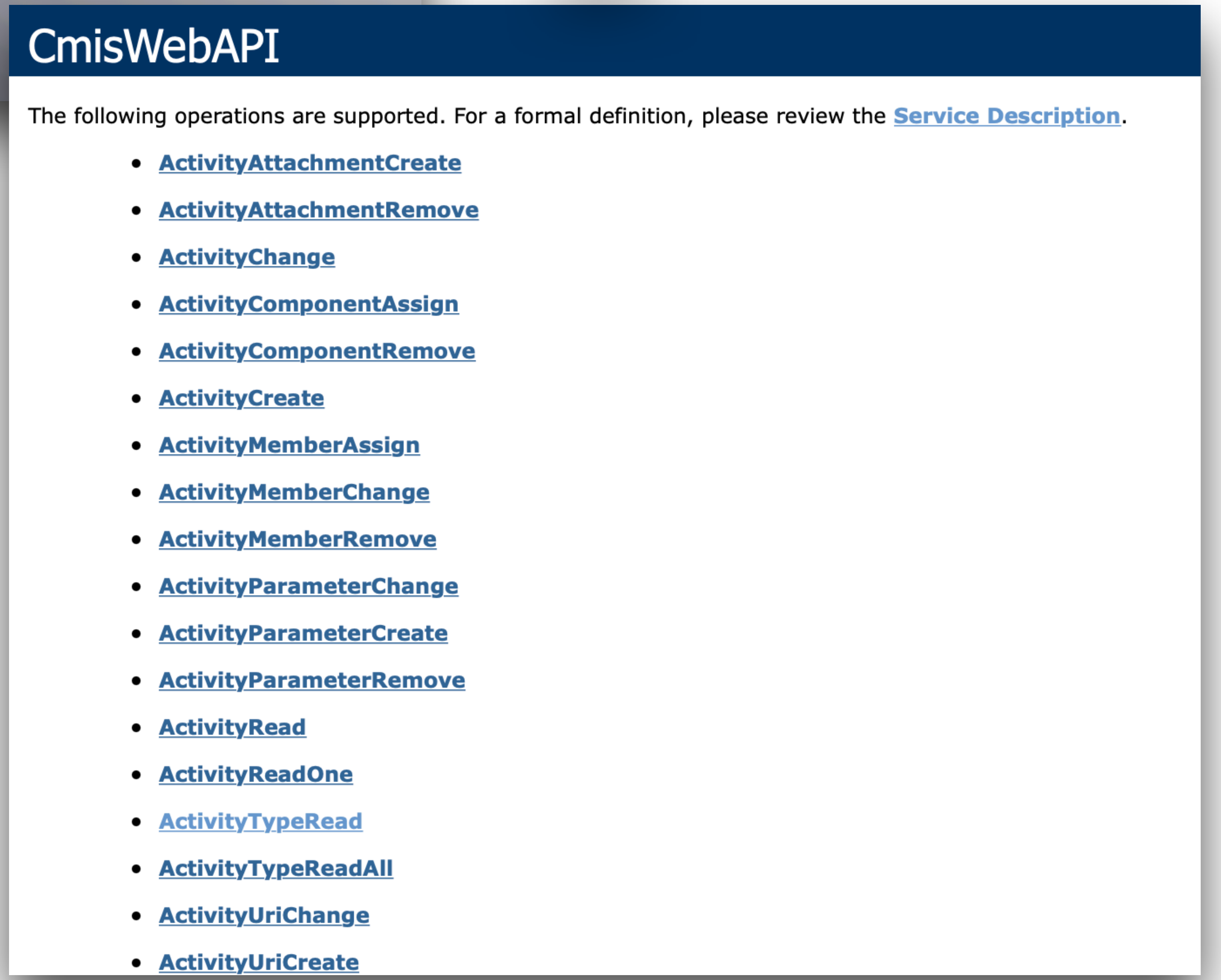
WP3 - Outer Barrel HIC (squeezed summary)

WebApp



- **Construction Management information System:**
  - Oracle DB installed and configured at LIT
  - Test and Production sites already deployed
  - System tuning in progress

API



Additionally

- A functional **BM@N** project started to implemented for:
  - Detector production/test data
  - Mechanical drawings
  - Technical documentation

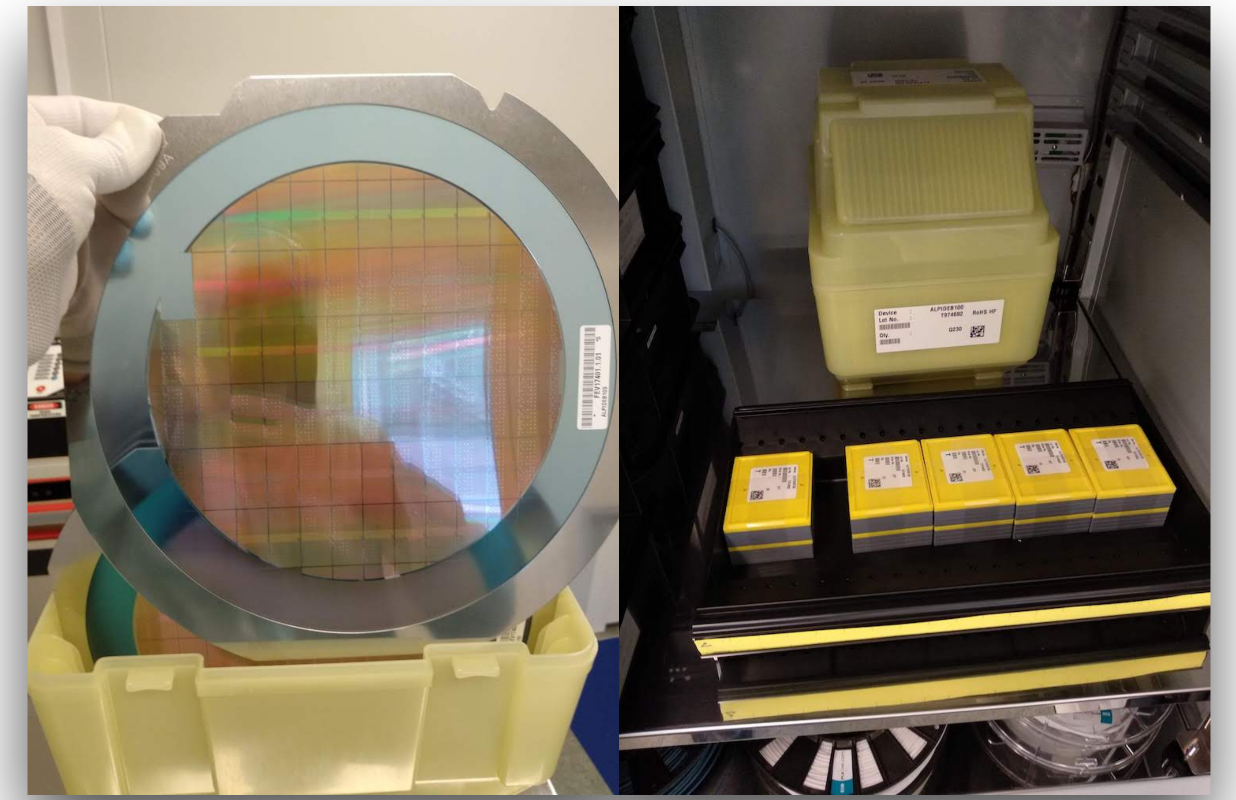
It may host multiple projects independently (!)

WP3 - Outer Barrel HIC (squeezed summary)

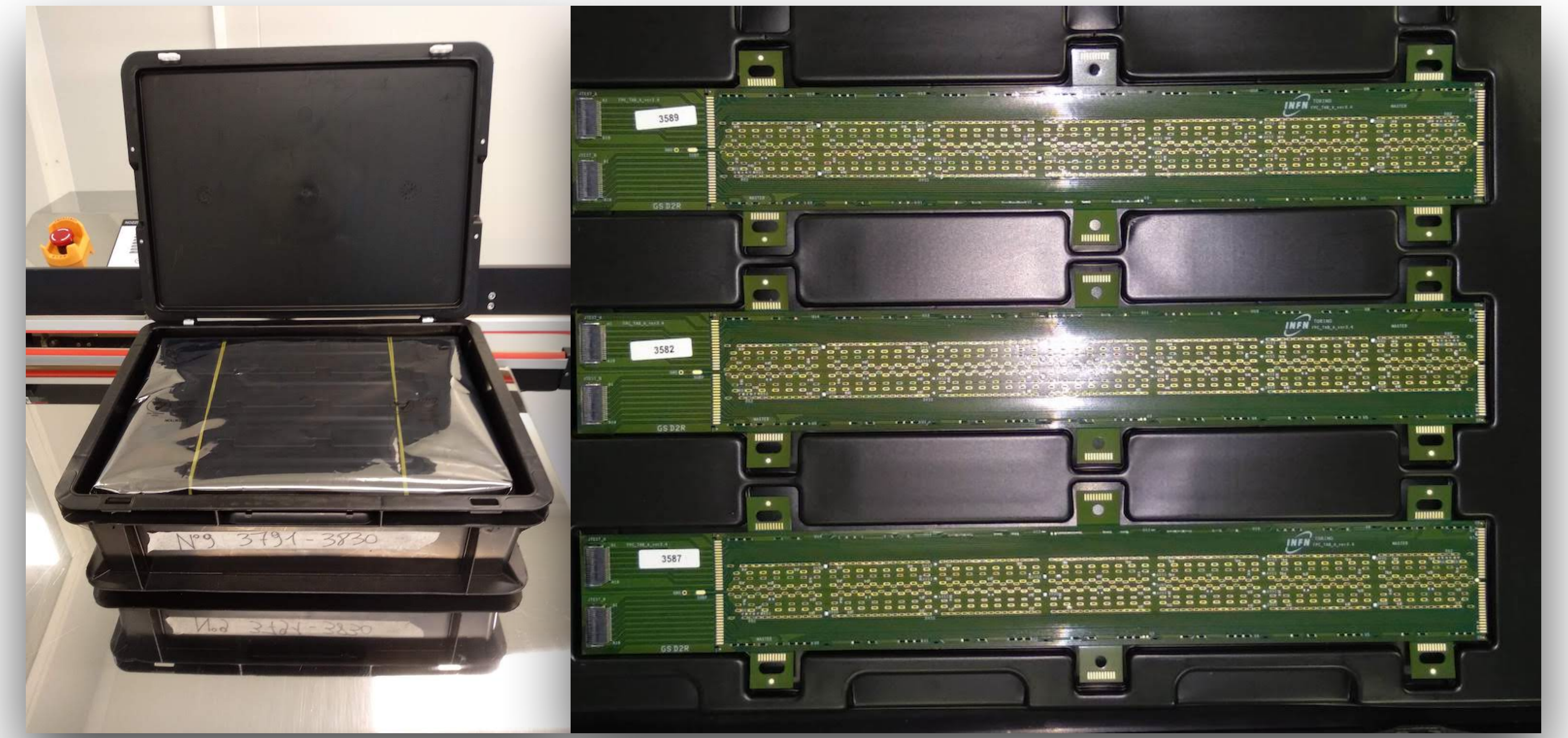
- **ALPIDE PAD-Chips:**
  - 20 wafers (46 chips each) and trays already received from CERN.
  - 5 of them sent to CCNU for training.

- **FPC production:**
  - First batch (399 pcs) Blank FPC produced by SwissPCB arrived at JINR.
  - Metrology test performed by “Modus97” in Bologna, Italy (90% detector-grade yield).
  - Cross-Cable Soldering and FPCs Test Stations ready.
  - Second batch of 440 FPCs in the process of contract.

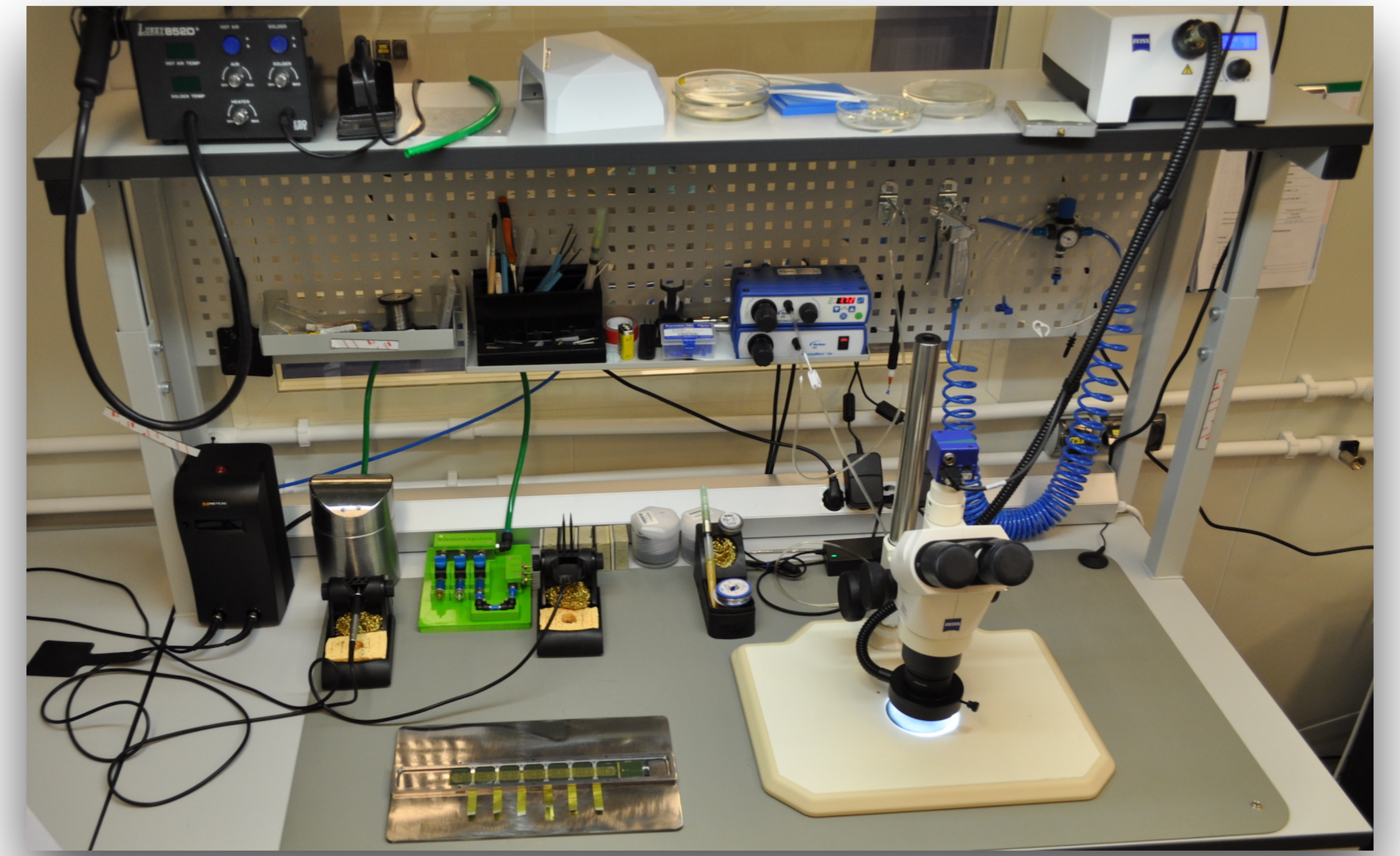
PAD Chips



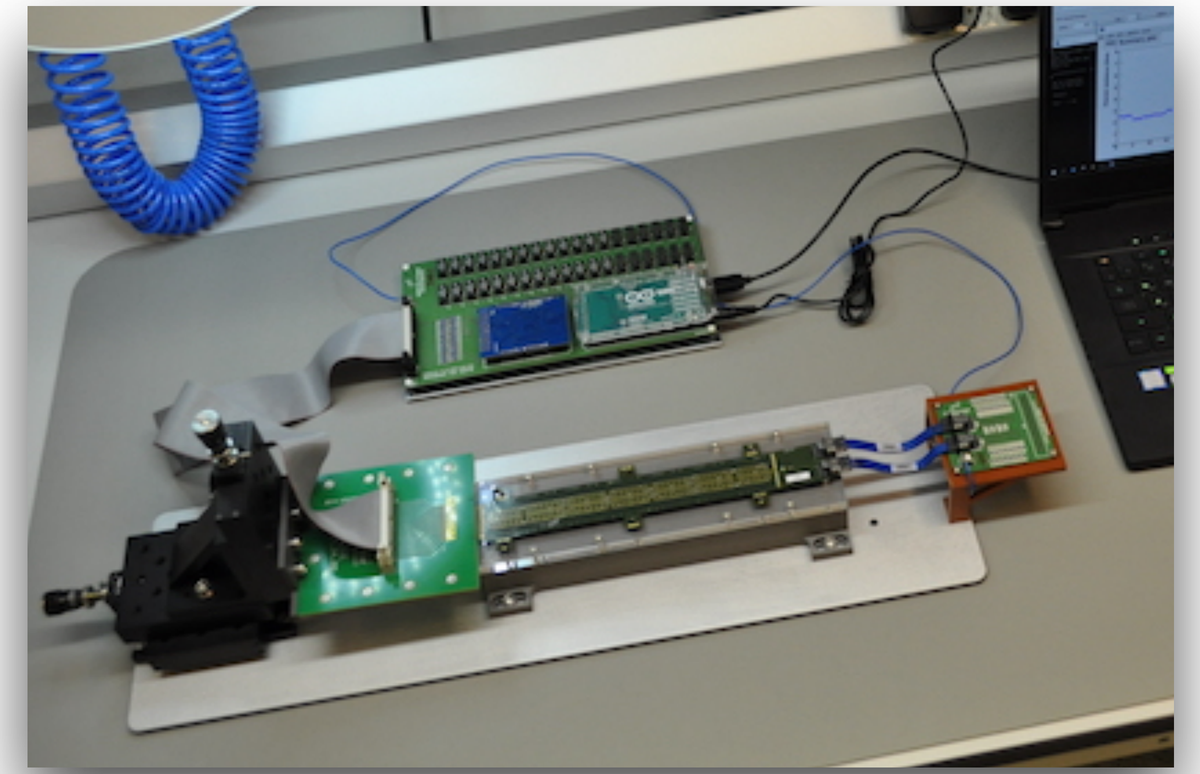
Blank FPCs



Cross-Cable Soldering station



FPC Electrical Test Sation

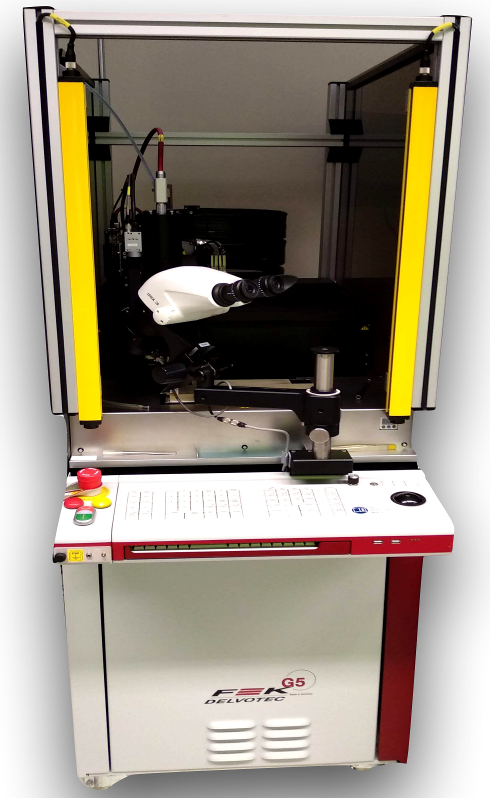


WP3 - Outer Barrel HIC (cont.)

MPD - ITS

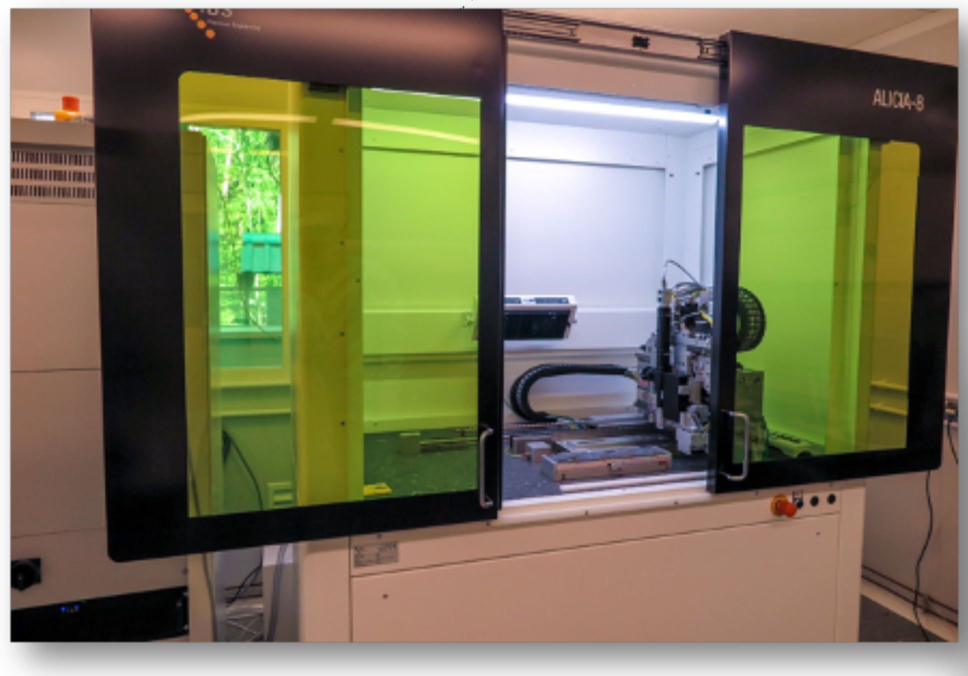
- OBHIC production area being set up in the clean room ISO6.

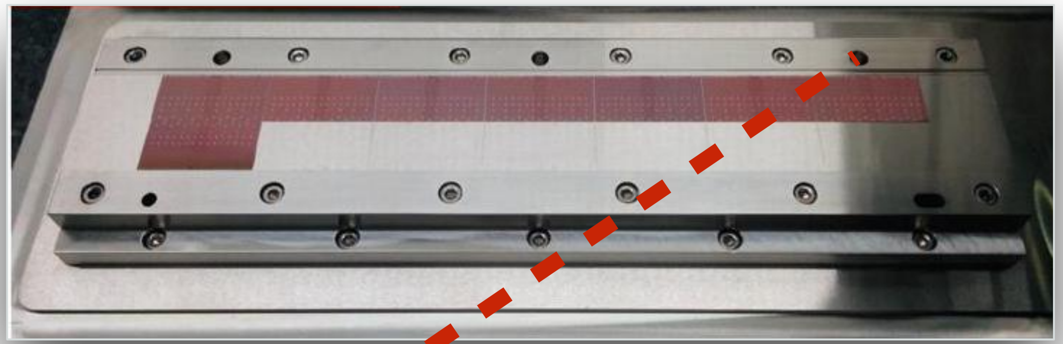
ALICIA-8@CleanRoom
- To be reconfigured to OB

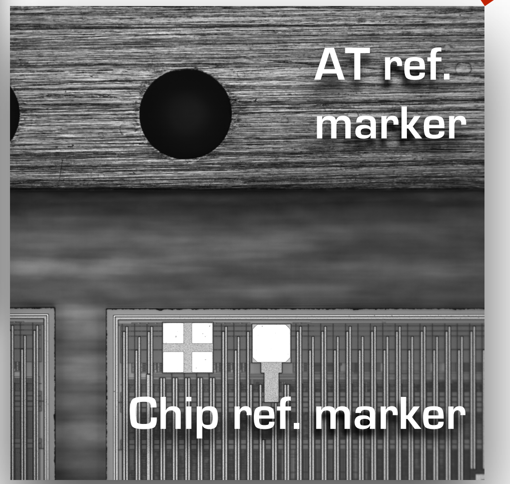


Ultrasonic bonding Chips - FPC

Delvotec@CleanRoom
- A dedicated one to be bought







Chips alignment precision < 5µm.

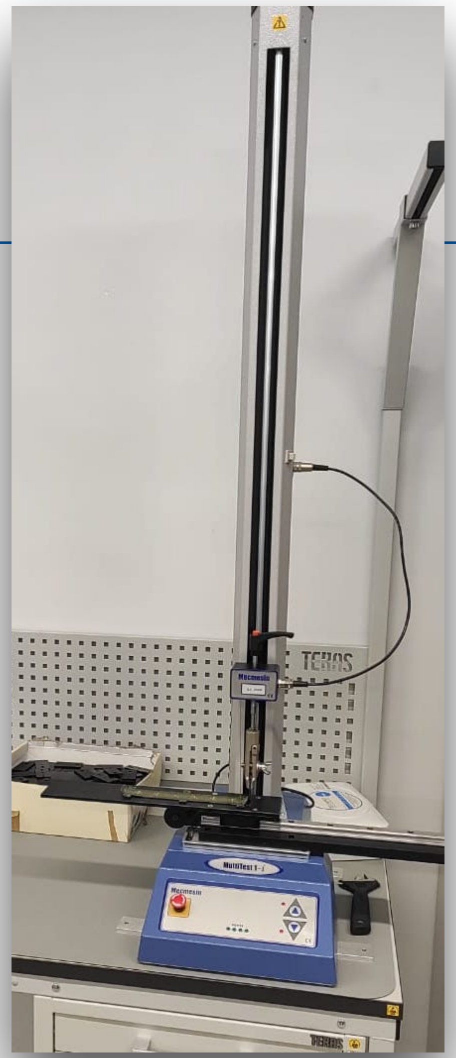
WP3 - Outer Barrel HIC (cont.)

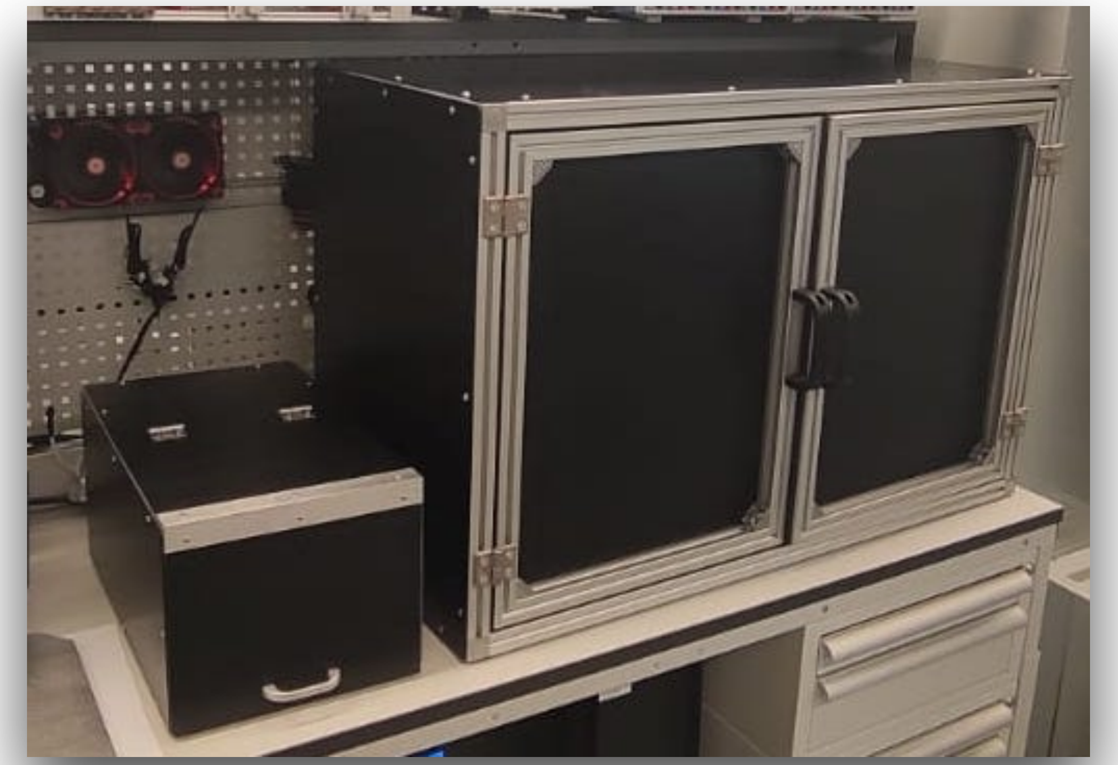
MPD - ITS

Same technology as ALICE-ITS

HIC testing

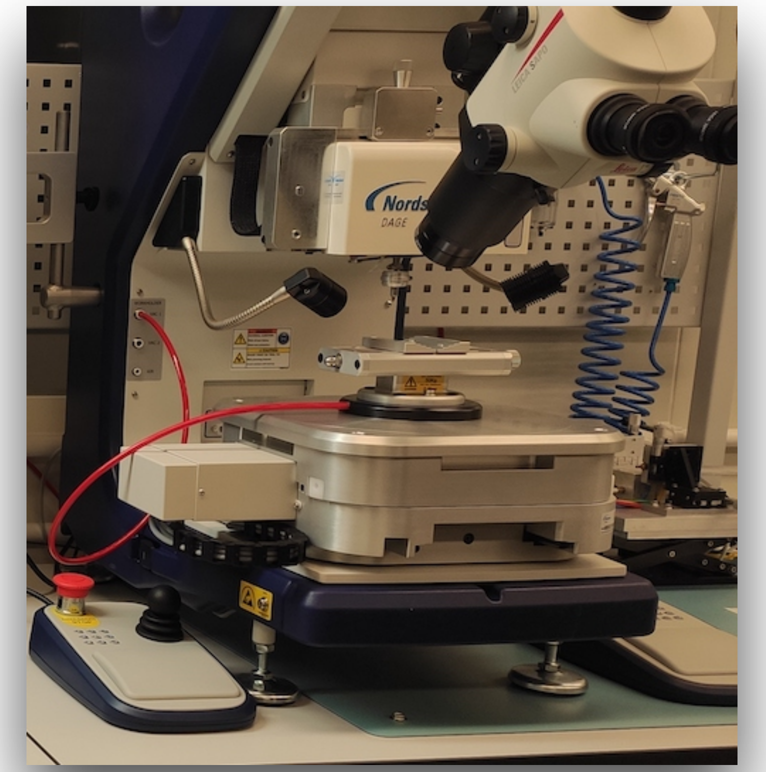

Carrier Plates (First batch)

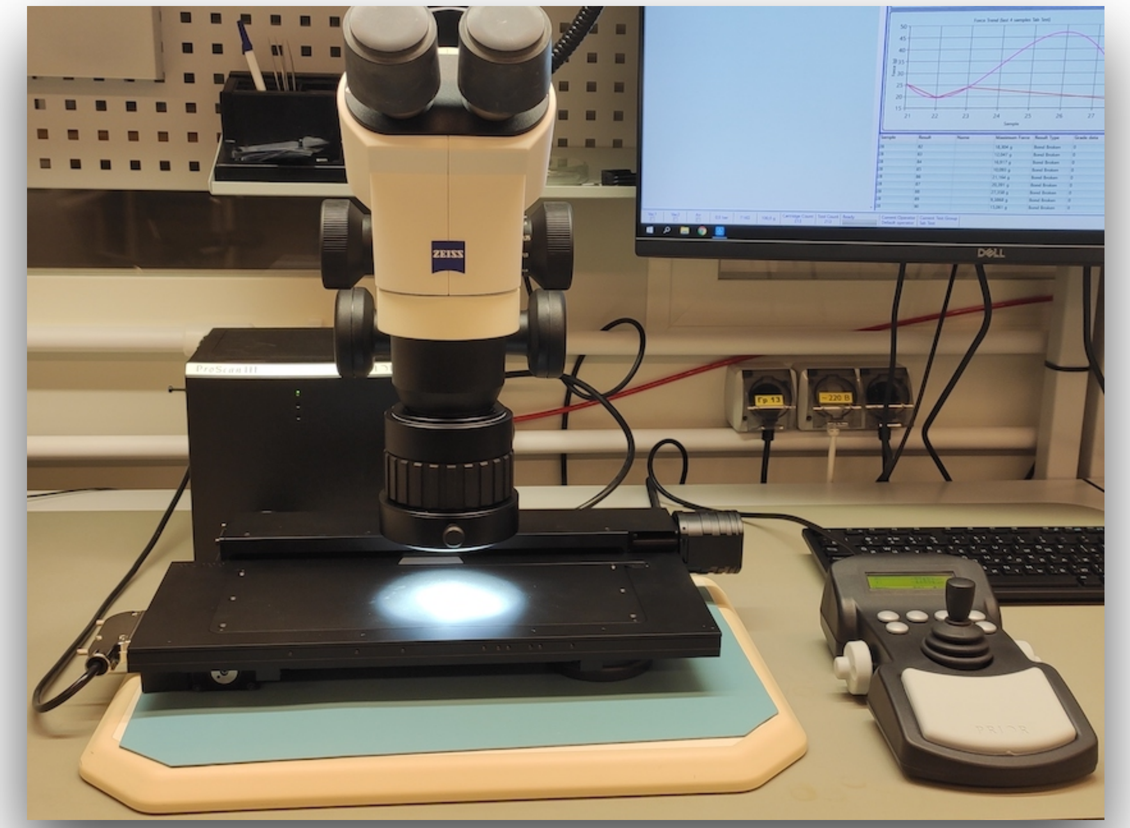

Peel test station


Qualification and Endurance test boxes


MOSAIC boards


Power boards (*)


Pull test station


Visual inspection Station

(*) Power Boards BoB to be produced

WP4 - Outer Barrel Staves

Same technology as ALICE-ITS

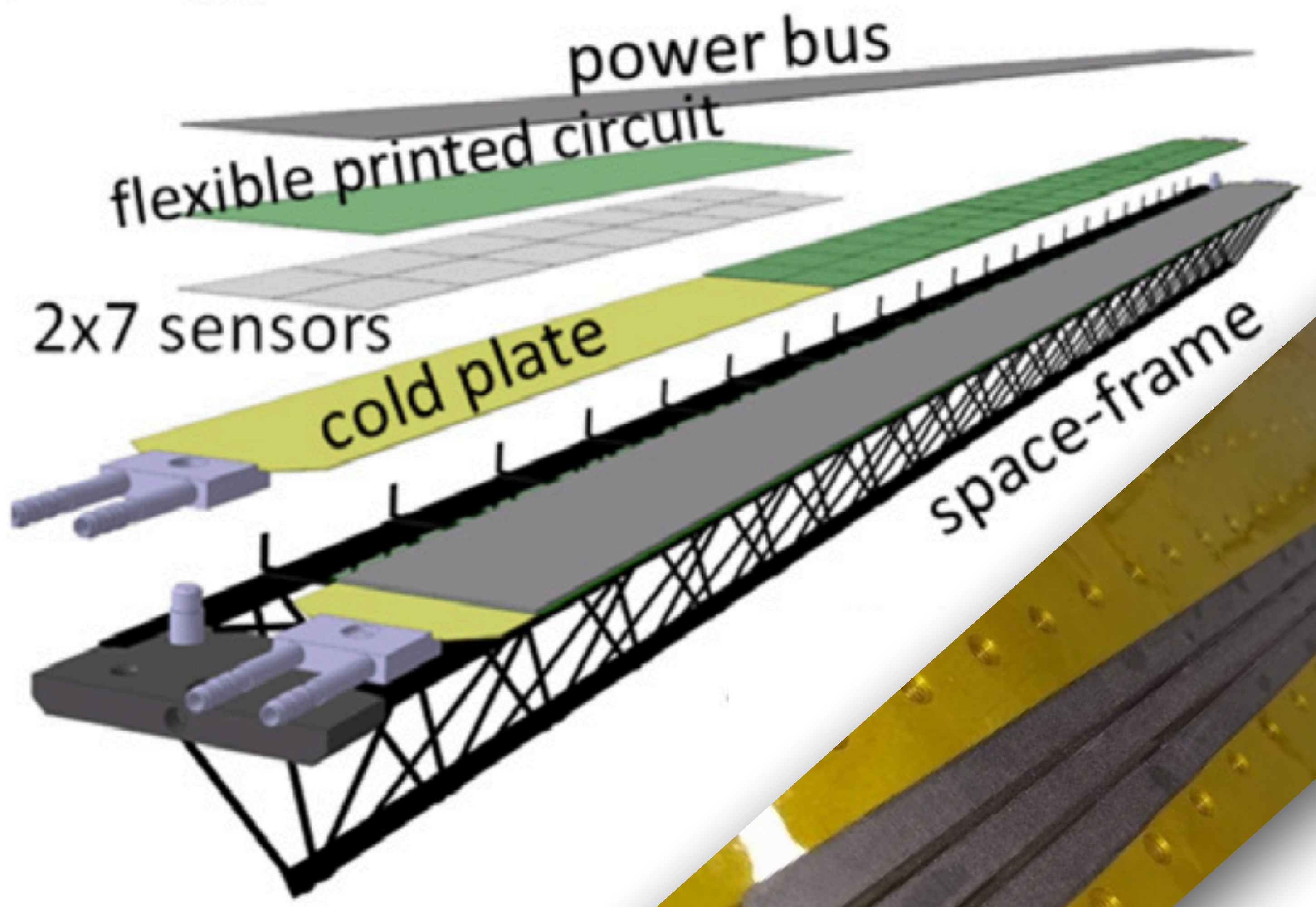
Mitutoyo CMM waiting to be unboxed

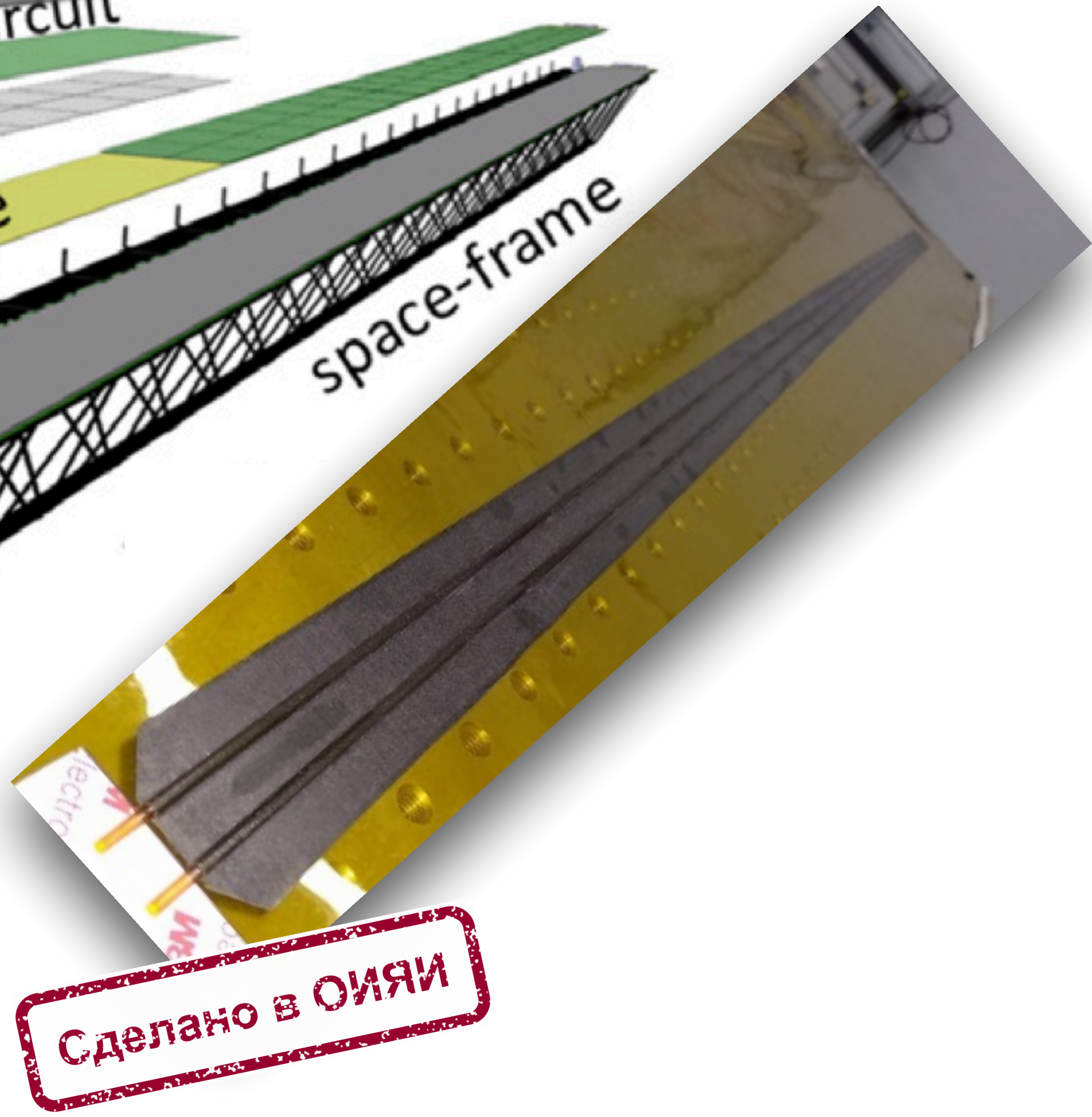
Stave Assembly and testing

All Parts received from CERN

WP5/6 - Mechanics & Cooling Design/Production

- **Design, Produce(*) and Assembly all parts for:**
  - **MPD-ITS Mechanics and Cooling**
  - **MPD-ITS integrations with the beam pipe, the TPC and the FFD**

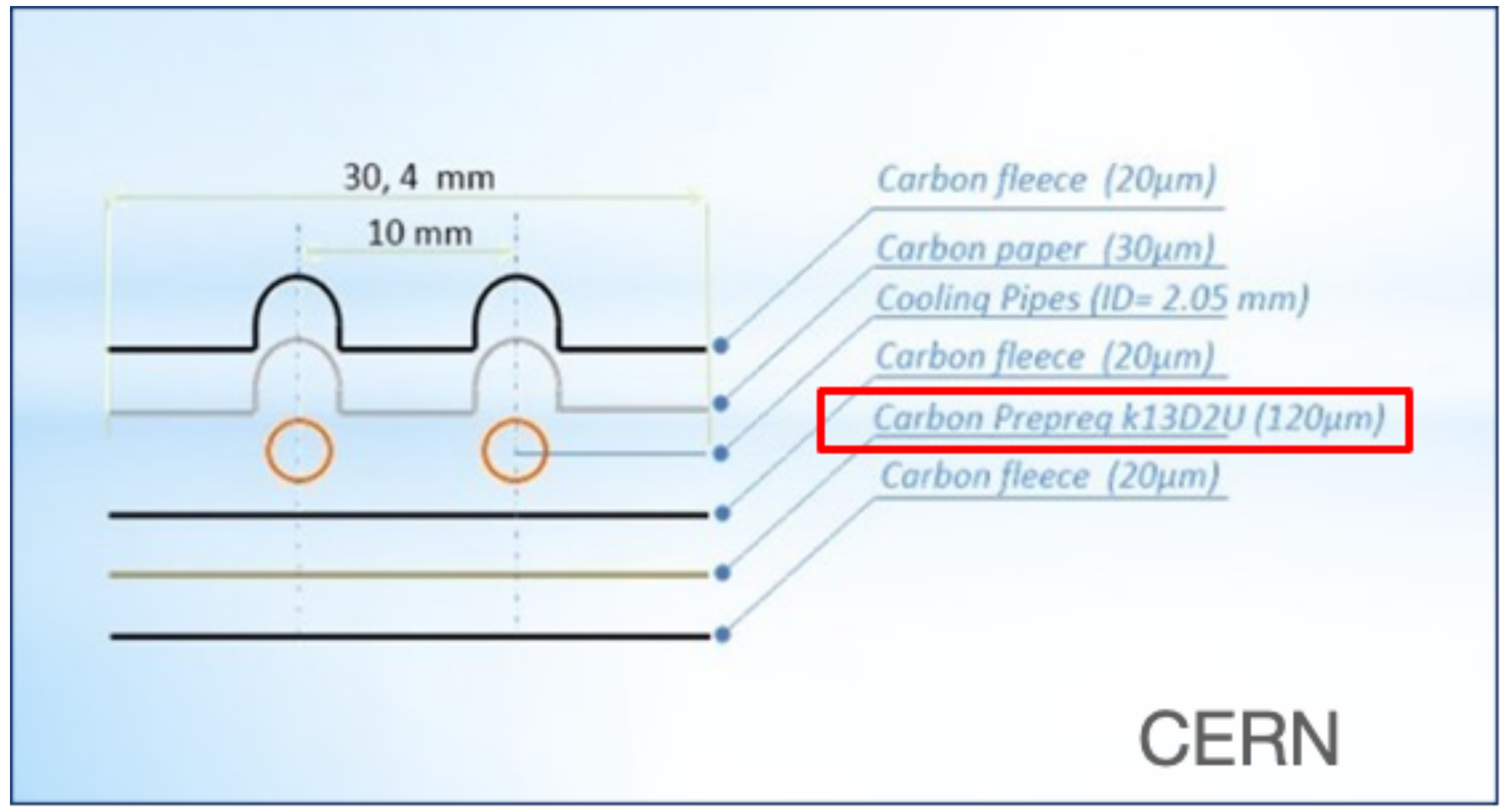


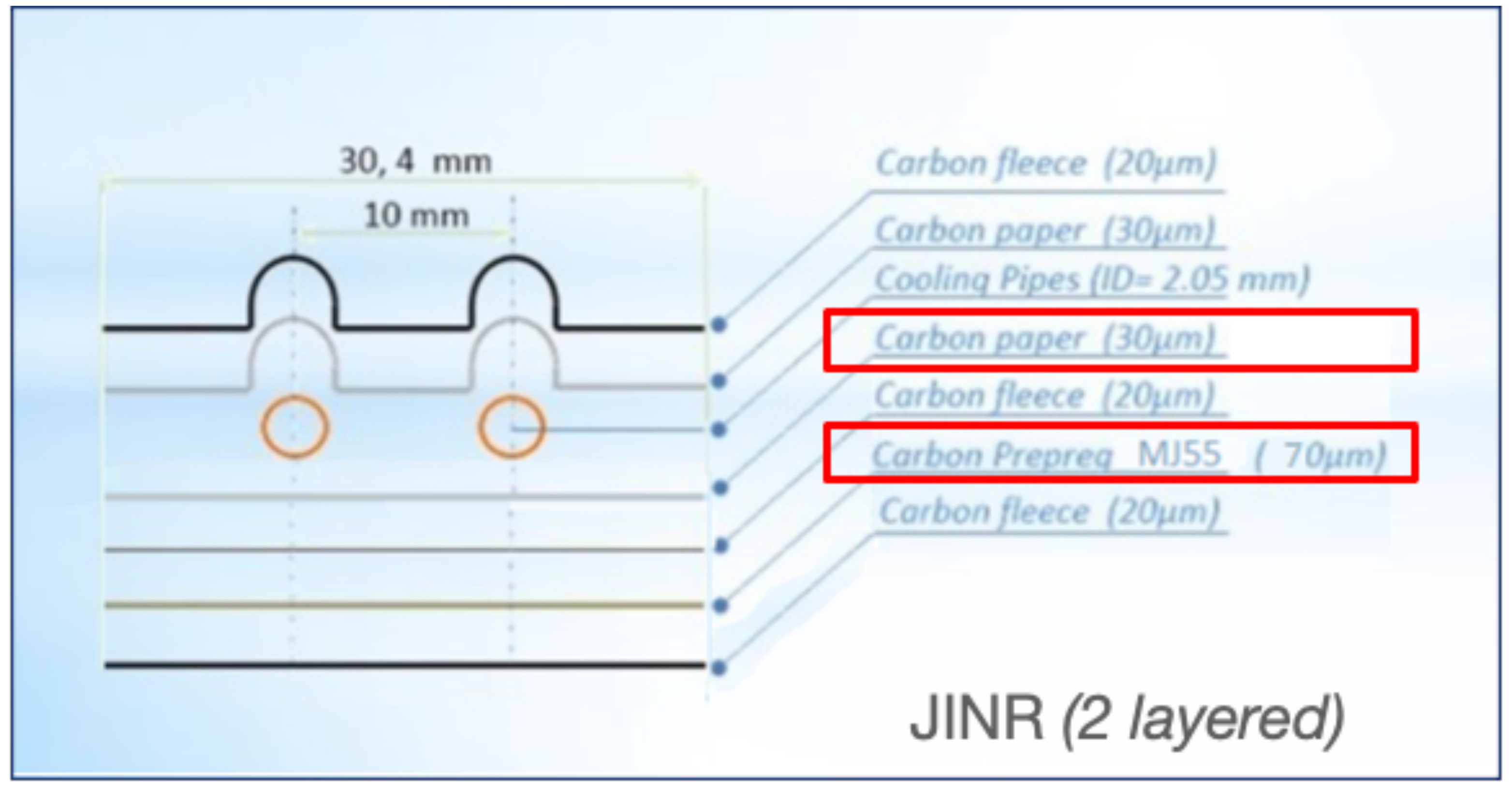


Cold Plates: Water-cooled large-area (30 mm x 1502 mm) for dissipating a total of 20W each with a power density of 40mW/cm² (CERN technology).

Task: To produce Cold Plates with a similar performance as the ones form CERN but using only "civilian-grade " materials instead of the double-use **prepreg k13d2u** included on the original design.

A new version of the CP was produced substitution the prepreg k13d2u to **MJ55** and adding an **additional layer of carbon paper**, with a planar high-thermal conductivity rated to 1500 W/(m*K) .

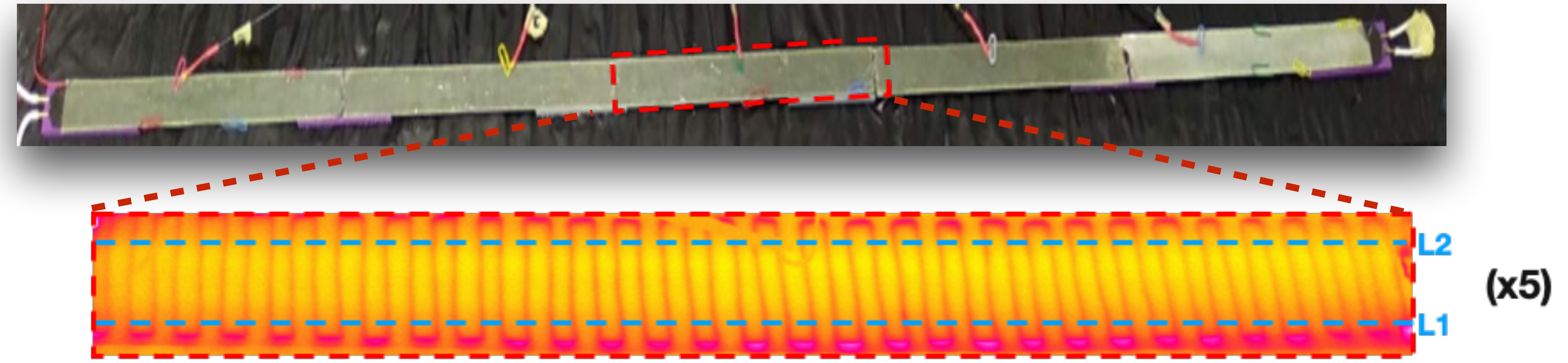




(*) Almost all carbon fiber structures for the mechanics are produced at LHEP

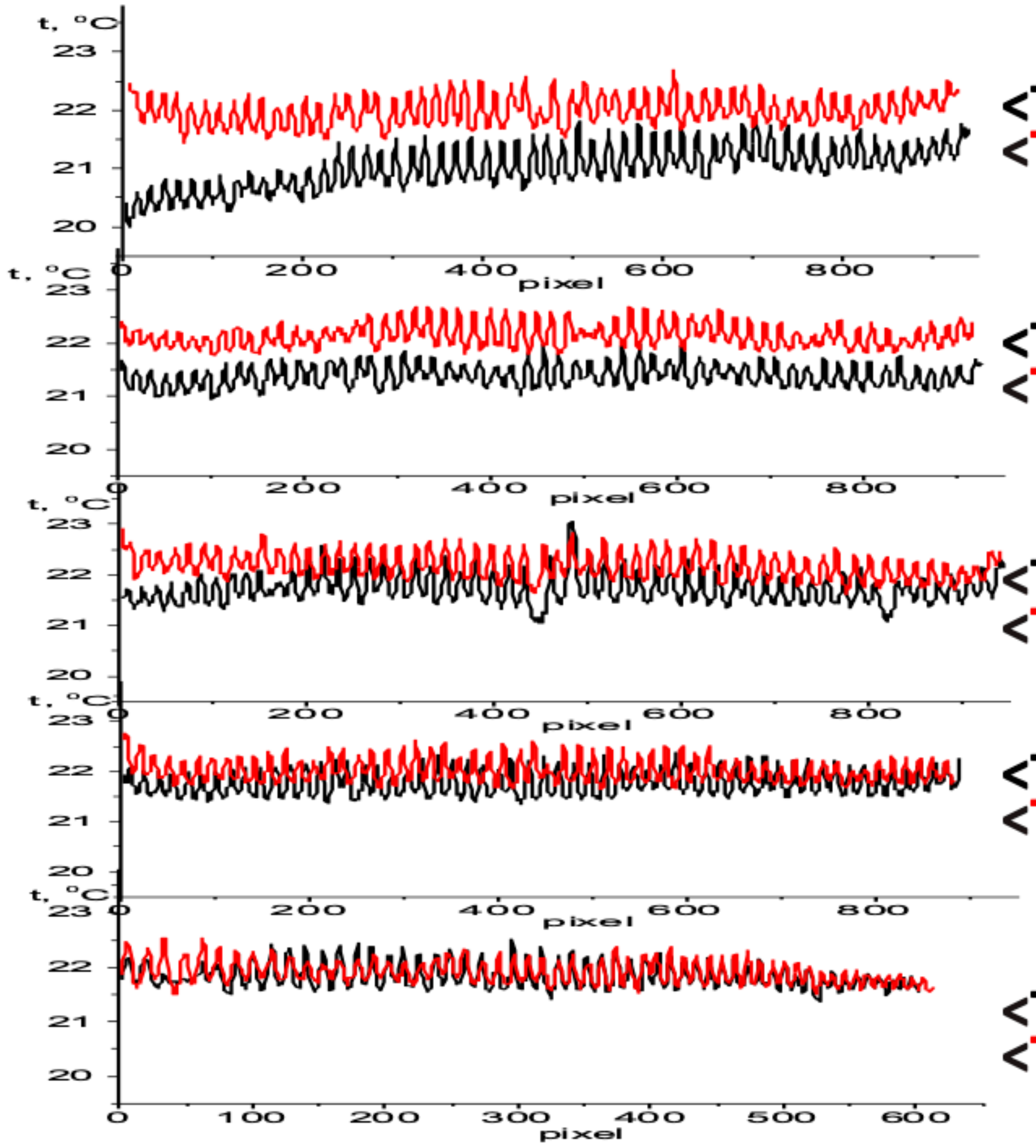
WP5/6 - Mechanics & Cooling Design/Production

water supply temperature 18ºC
water flow rate 4-6 l/h



[T] = º C

CERN Version



CERN Version	JINR Version
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<T(L2)> = 21.4 <T(L1)> = 22,15	<T(L2)> = 21,35 <T(L1)> = 21,69
<T(L2)> = 21,76 <T(L1)> = 22,23	<T(L2)> = 21,47 <T(L1)> = 21,87
<T(L2)> = 21,83 <T(L1)> = 22,01	<T(L2)> = 21,67 <T(L1)> = 21,77
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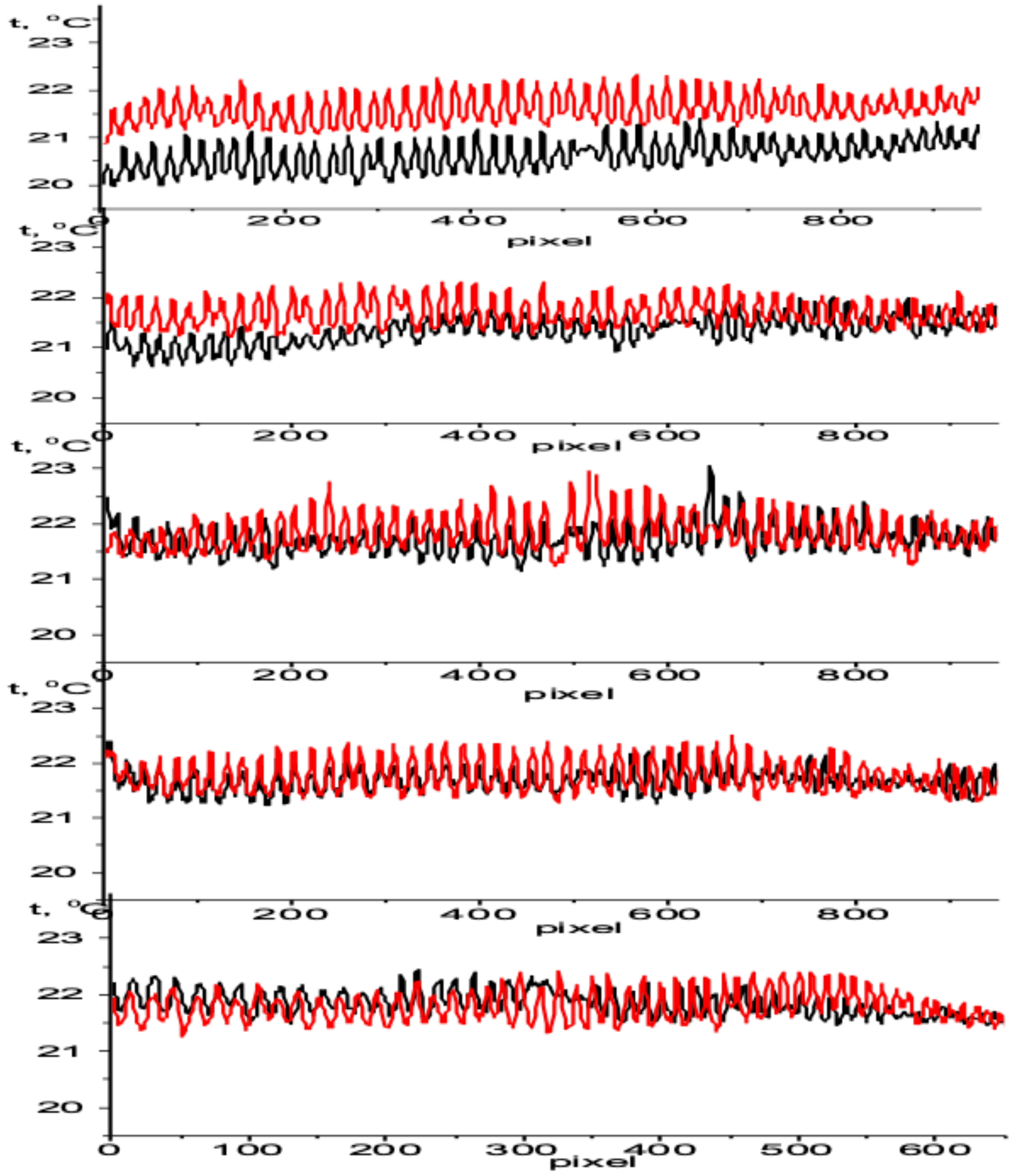
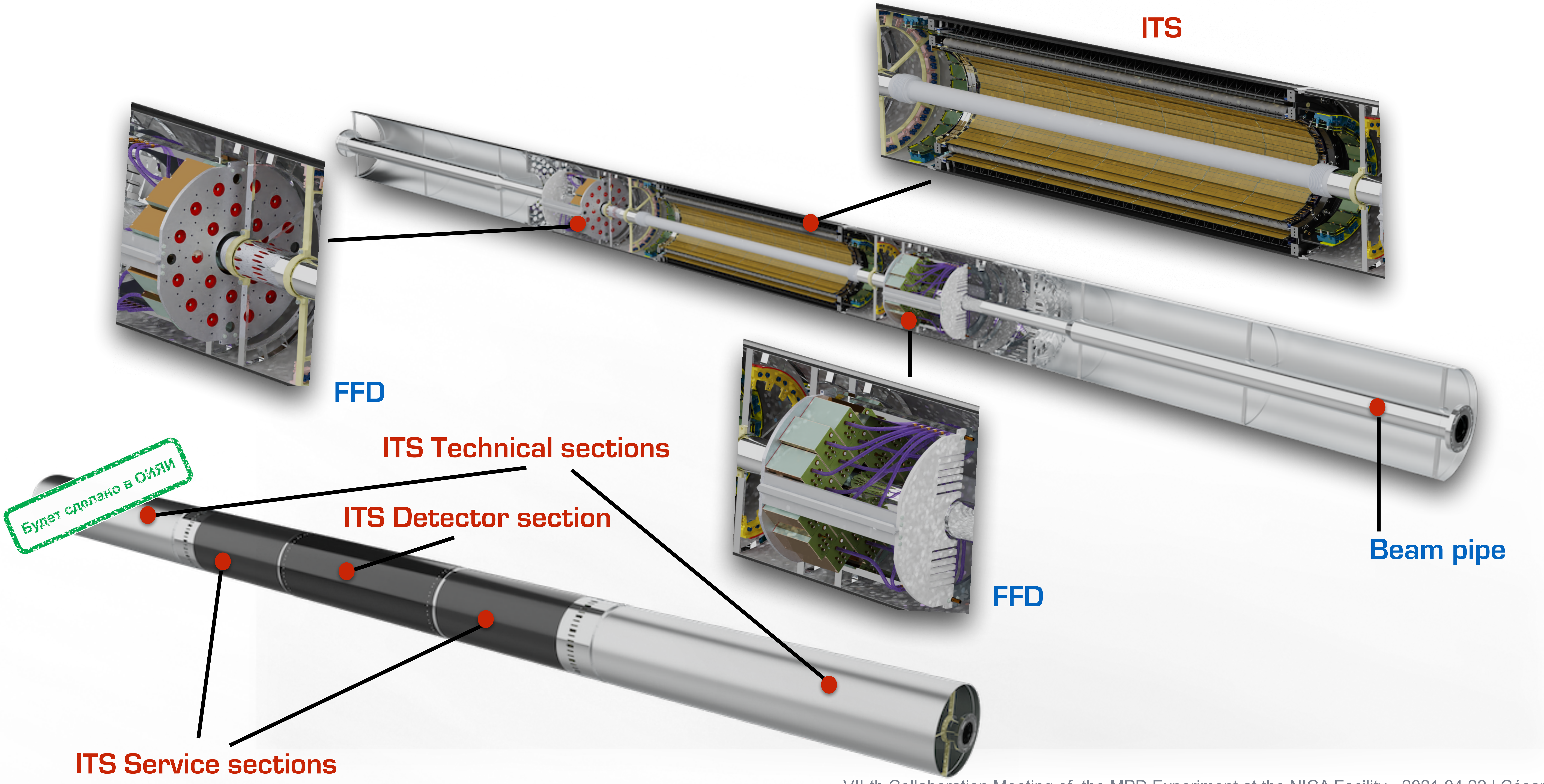
JINR Version



WP5/6 - Mechanics & Cooling Design/Production

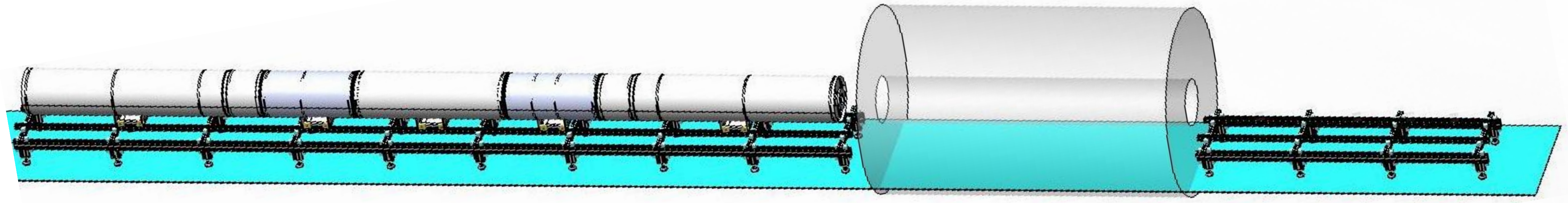
Highest Priority (!)

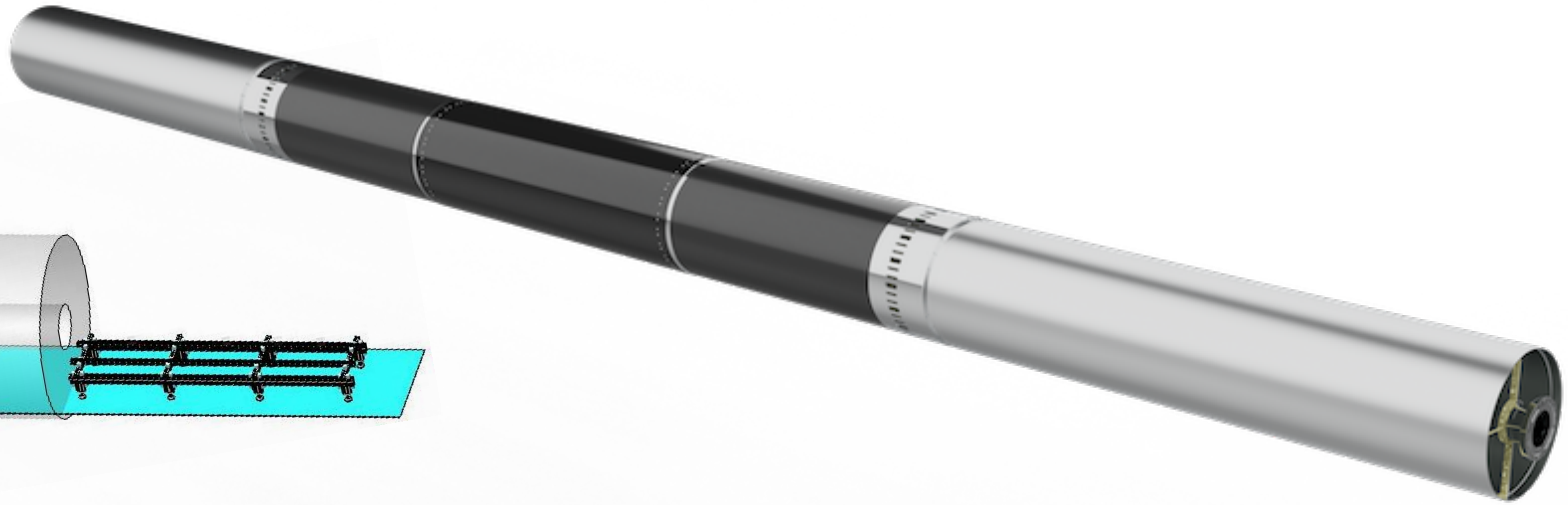
Integration

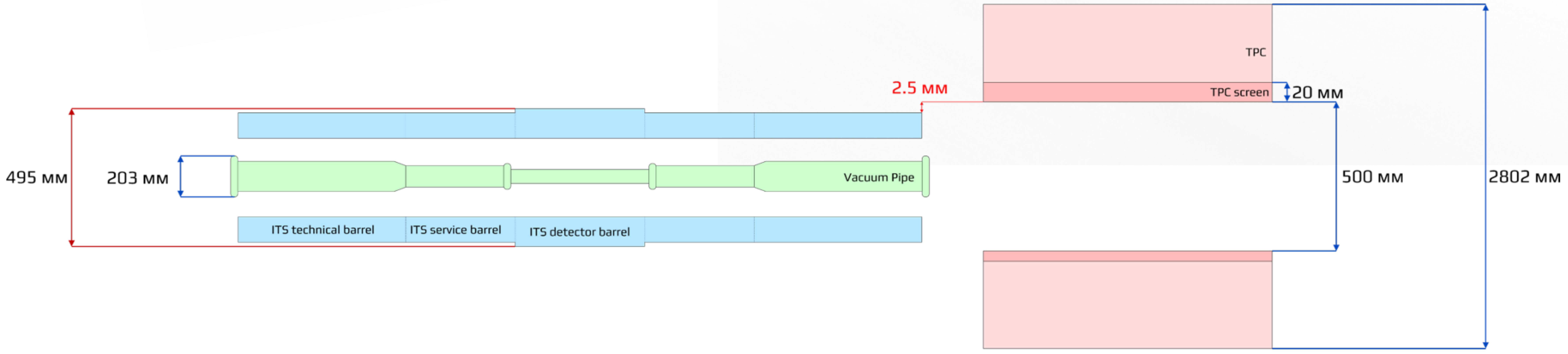


WP5/6 - Mechanics & Cooling Design/Production

Integration







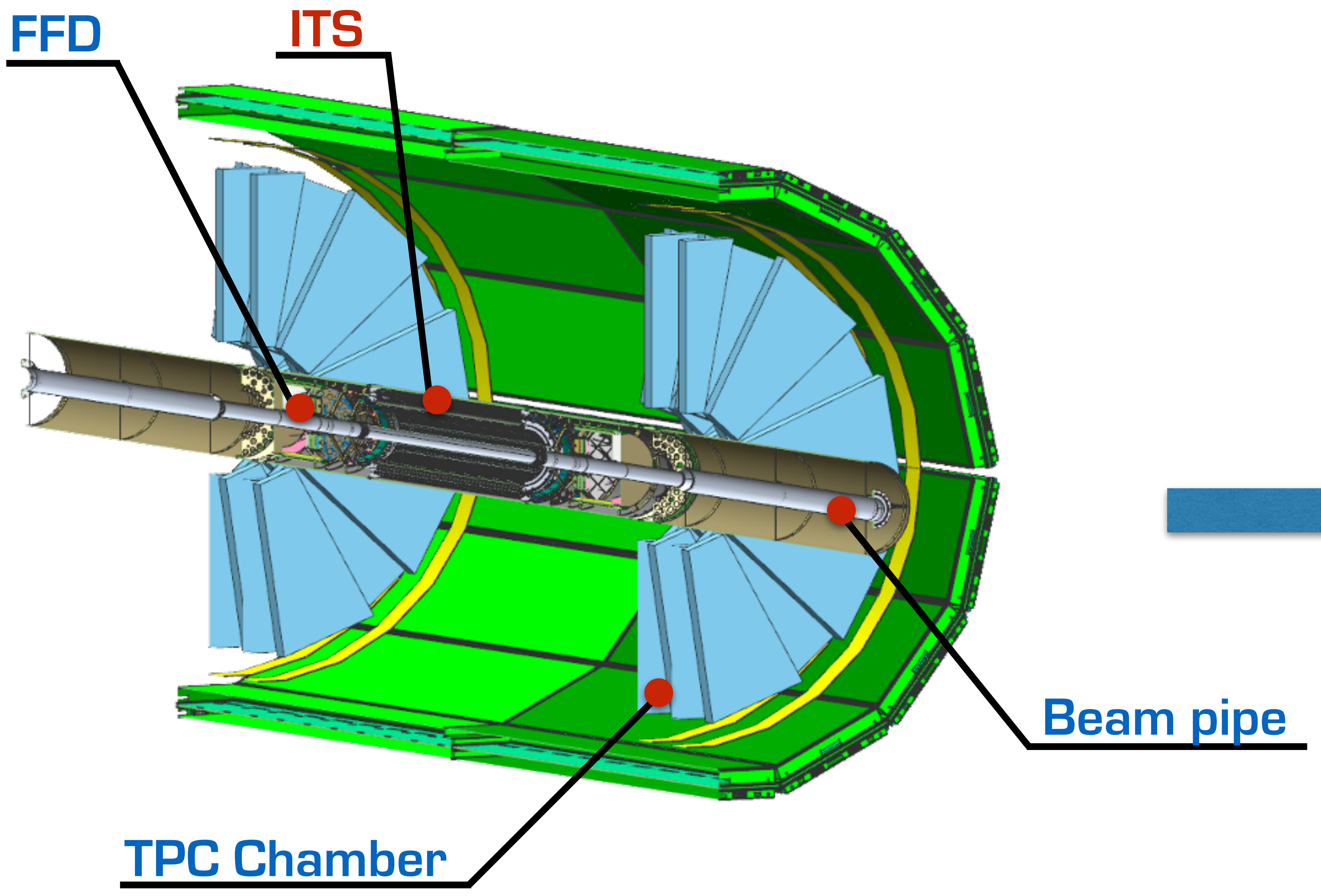
WP5/6 - Mechanics & Cooling Design/Production

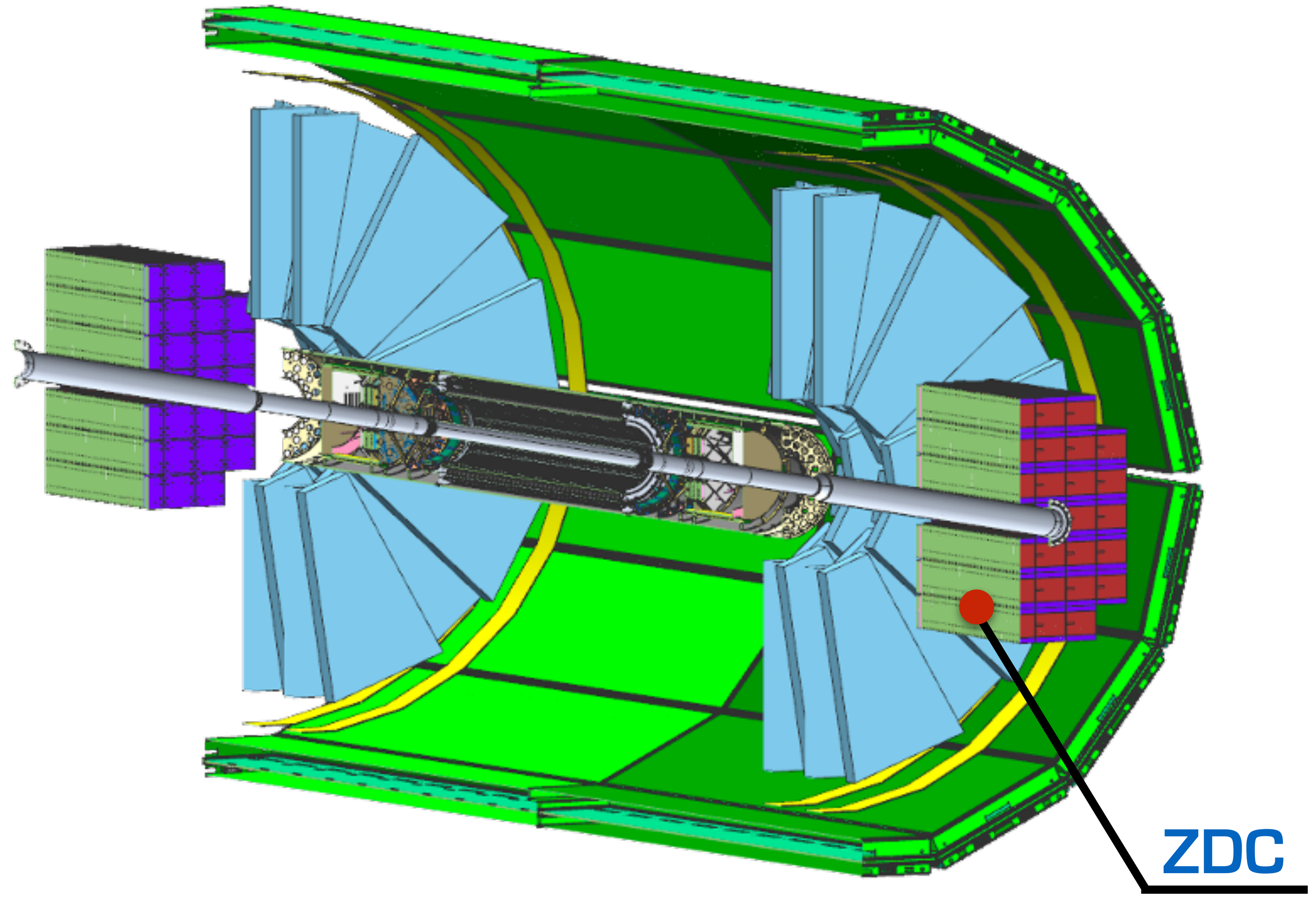
Integration

Current proposal

Main installation steps:

- ☑ Installation of the container (ITS+FFD+Pipe) to TPC;
- ☑ Fix of central section clamp;
- ☑ Remove technical section case.





WP5/6 - Mechanics & Cooling Design/Production

MPD - ITS

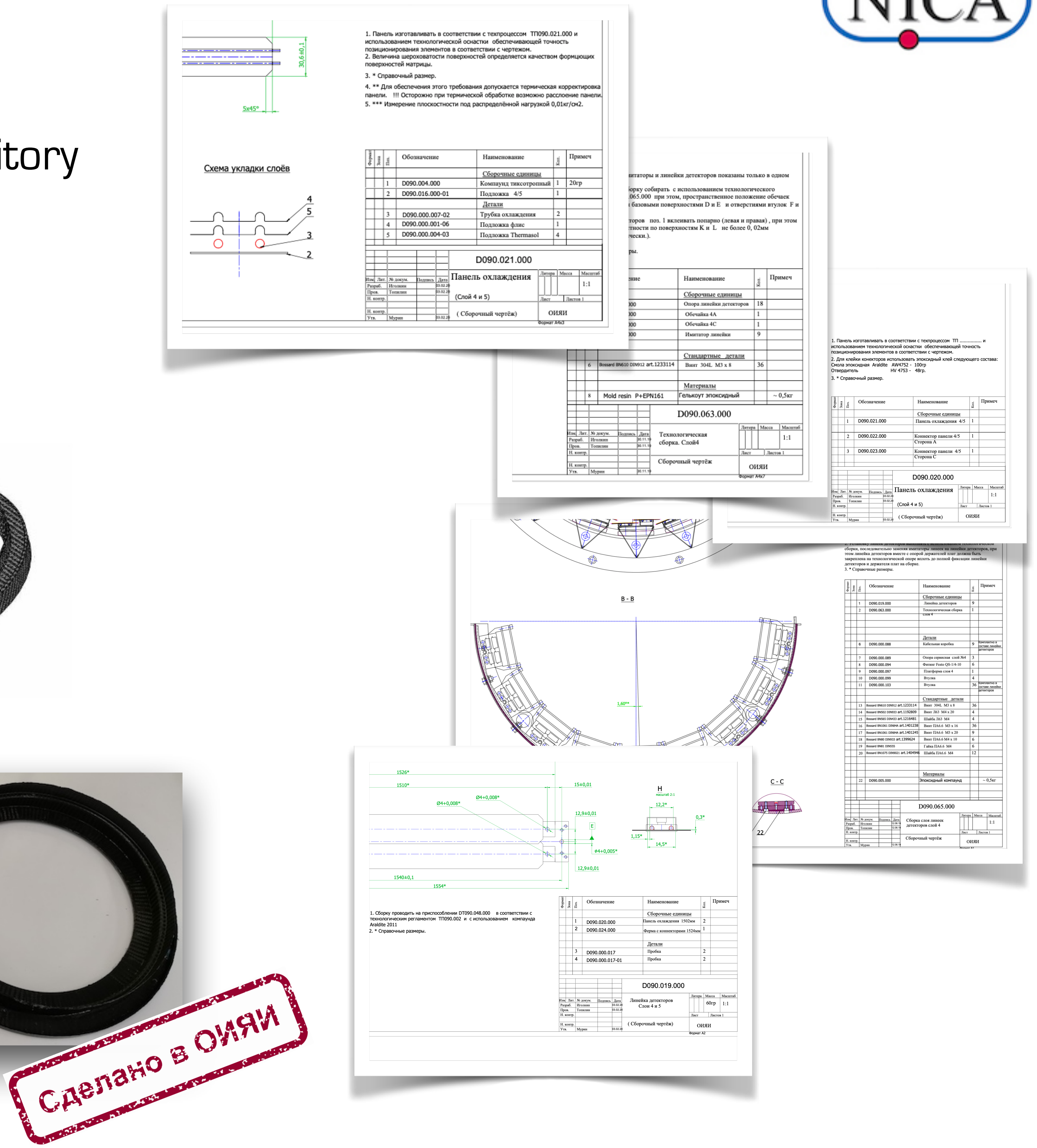
- **Design:**
  - All Parts and Jigs drawings already created (> 300) and storage in a central repository @ JINR-disk

- **Production already started:**
  - Production of the end-wheels already started at JINR.



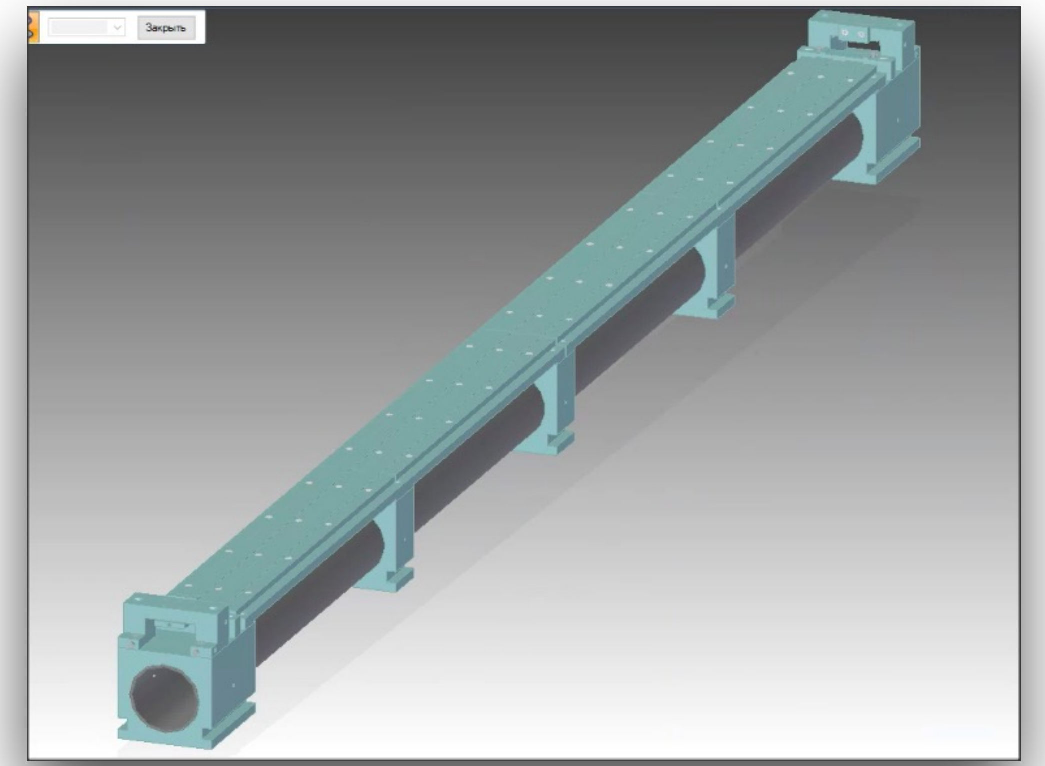
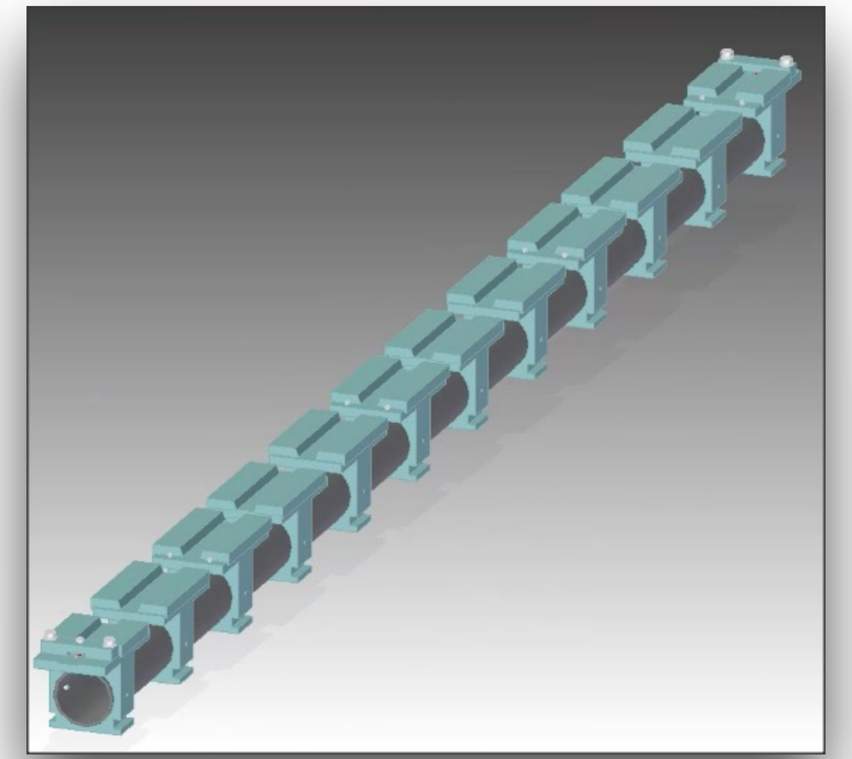
Matrix produced by "Мезон"

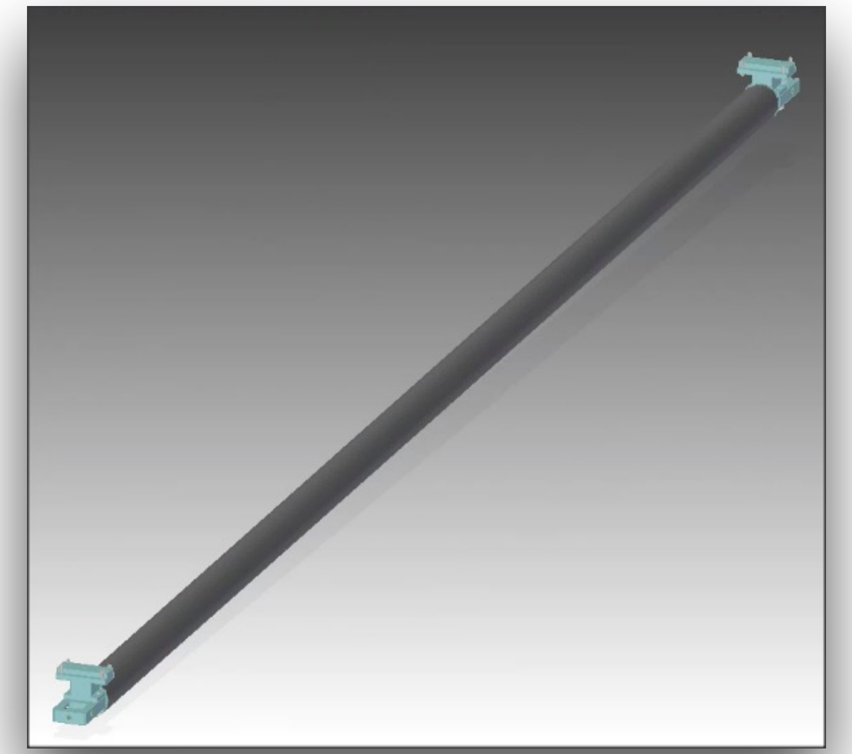
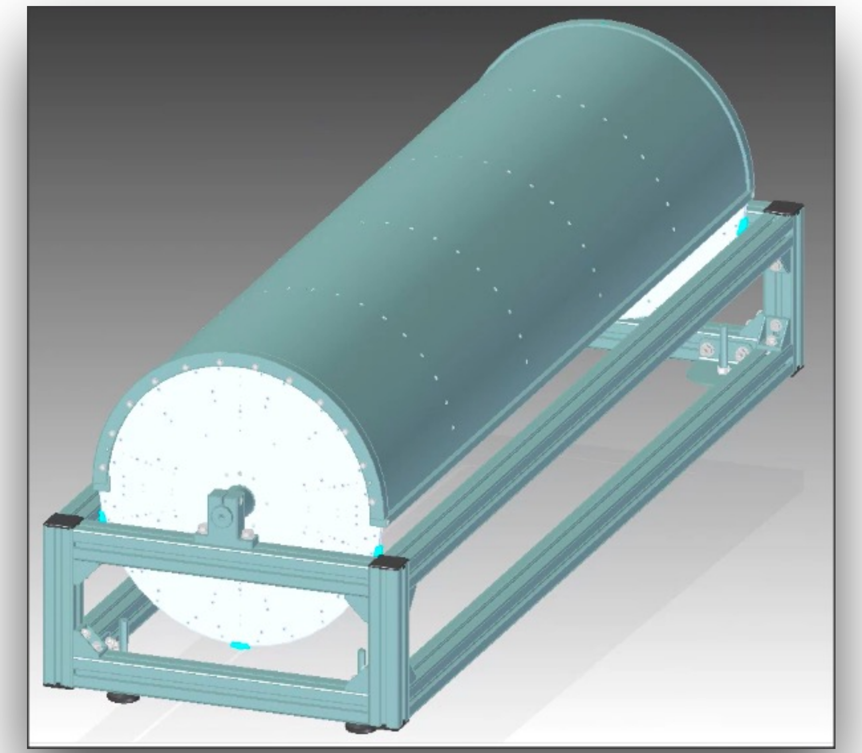


WP5/6 - Mechanics & Cooling Design/Production

- **Production already started:**
  - Complex metallic jigs for producing central detector cases contracted to **"Euromec s.r.l."** (Modena, Italy)

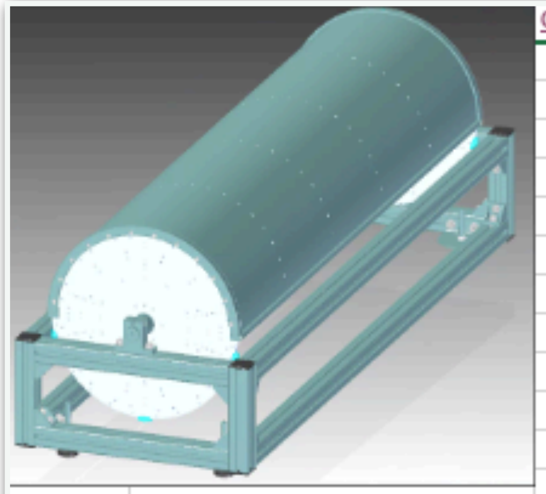



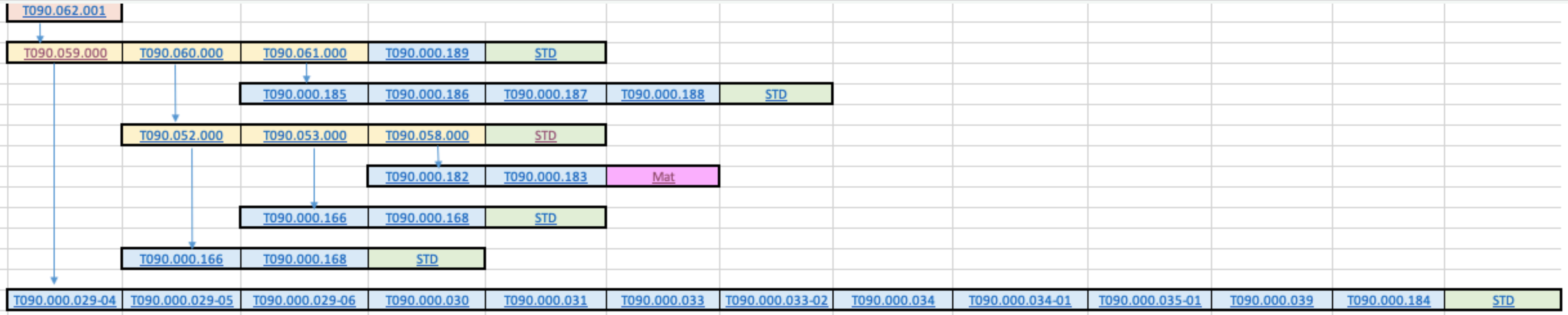
- Complex structures
- Composed by many substructures
- To be produced with high accuracy

WP5/6 - Mechanics & Cooling Design/Production

A dedicated document was created as a subset of the main document with the parts grouped into 5 main assembly structures and shared with EUROMEC with all designs linked to JINR-disk.



Go to README



1	Для формовки оболочки ITS	T090.062.001	Кол.	3D	PDF	DWG
	Composite Parts					
1CP_1	Шасси	T090.059.000	1	3D	PDF	DWG
1CP_2	Ось с дисками	T090.060.000	1	3D	PDF	DWG
1CP_3	/Формообразующая оболочка	T090.061.000	1	3D	PDF	DWG
	Simple Parts					
SP_1.1	Имитатор фланца	T090.000.189	2	3D	PDF	DWG
	Standard Parts					
1StdP_1	Bossard BN 20244 art.3371055	Винт M3 x 8 DIN963A	32	3D		
1StdP_2	Bossard BN 3 art.1 004166	Болт M5 x 30 DIN 912	4	3D		
1StdP_3	Bossard BN3 art.1 004123	Болт M5 x 20 DIN 912	24	3D		
1StdP_4	Bossard BN 857 art.1304399	Штифт 5x 30 DIN 6325	4	3D		

2	Шасси	T090.059.000		3D	PDF	DWG
	Simple Parts					
SP_2.1	Профиль 50x50 260	T090.000.029-04	4	3D	PDF	DWG
SP_2.2	Профиль 100x50 500	T090.000.029-05	4	3D	PDF	DWG
SP_2.3	Профиль 50 x 50 1720 мм	T090.000.029-06	4	3D	PDF	DWG
SP_2.4	Угловой соединитель 45 x 45	T090.000.030	16	3D	PDF	DWG
SP_2.5	Адаптер опоры	T090.000.031	4	3D	PDF	DWG
SP_2.6	Т болт M8 x 20	T090.000.033	32	3D	PDF	DWG
SP_2.7	Т болт M10 x 30	T090.000.033-02	4	3D	PDF	DWG
SP_2.8	Гайка M8	T090.000.034	32	3D	PDF	DWG
SP_2.9	Гайка M10	T090.000.034-01	16	3D	PDF	DWG
SP_2.10	Регулируемая опора M12	T090.000.035-01	4	3D	PDF	DWG
SP_2.11	Заглушка 50 x 50	T090.000.039	8	3D	PDF	DWG
SP_2.12	Опора вала SK-35	T090.000.184	2	3D	PDF	DWG
	Standard Parts					

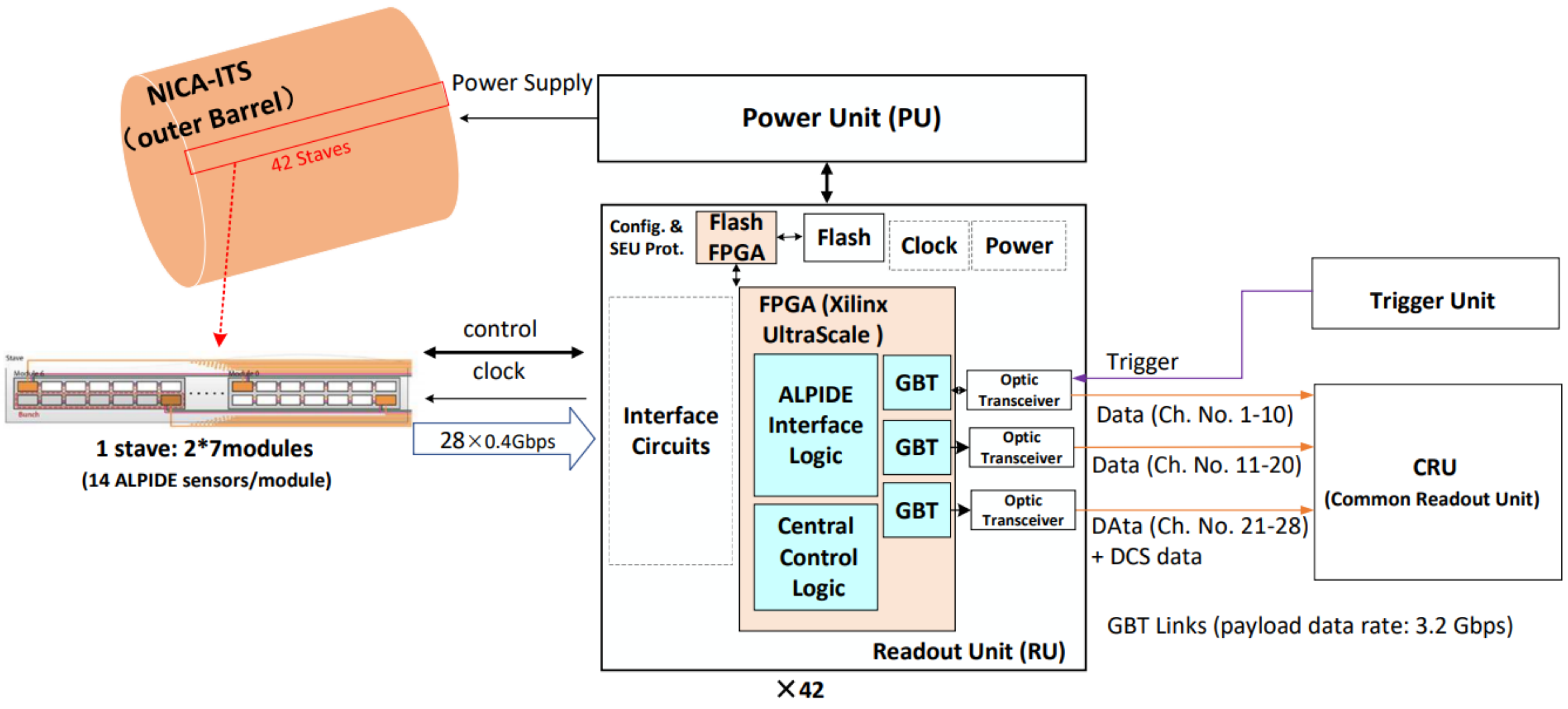
- **Easier for the producer to understand an evaluate the task**
- **Easier for the producer and ourselves to check the drawings for eventual inconsistencies**
- **Easier to maintain**

WP7/8 - Readout electronics Design/Production

Details at:

https://indico.jinr.ru/event/1909/contributions/11787/attachments/9278/14813/Readout%20Electronics%20Design%20for%20ITS%20of%20MPD%20in%20NICA%202021-02-08.pdf

General structure of the MPD-ITS readout system



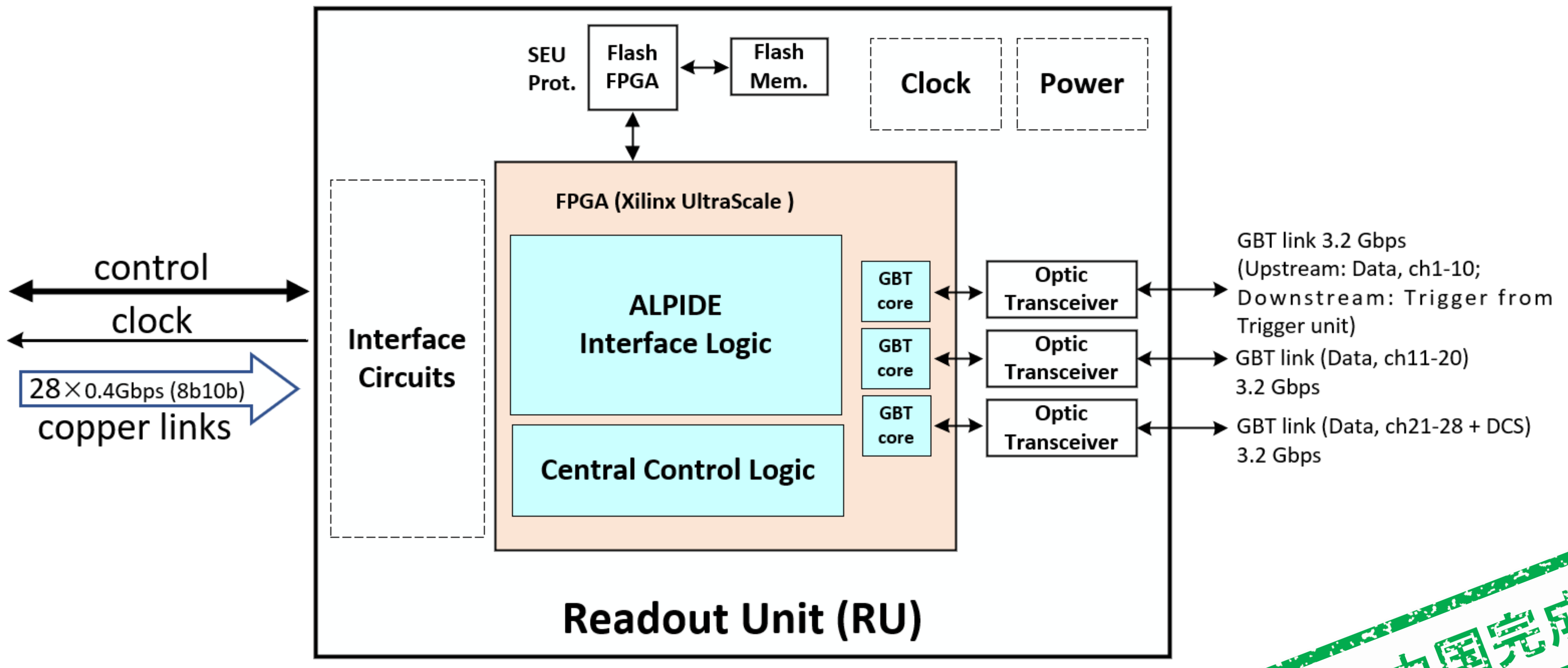
- A cluster of Readout Units (RUs) will control, trigger and read each single sensor in the detector.
- The RUs receives control commands and delivers data directly from/to the CRU, via the MPD implementation of the CERN Versatile Link.
- To maximize modularity, a single RU design will serve the whole detector.

GBTx ASICS can not be imported neither to Russia nor to China (!)

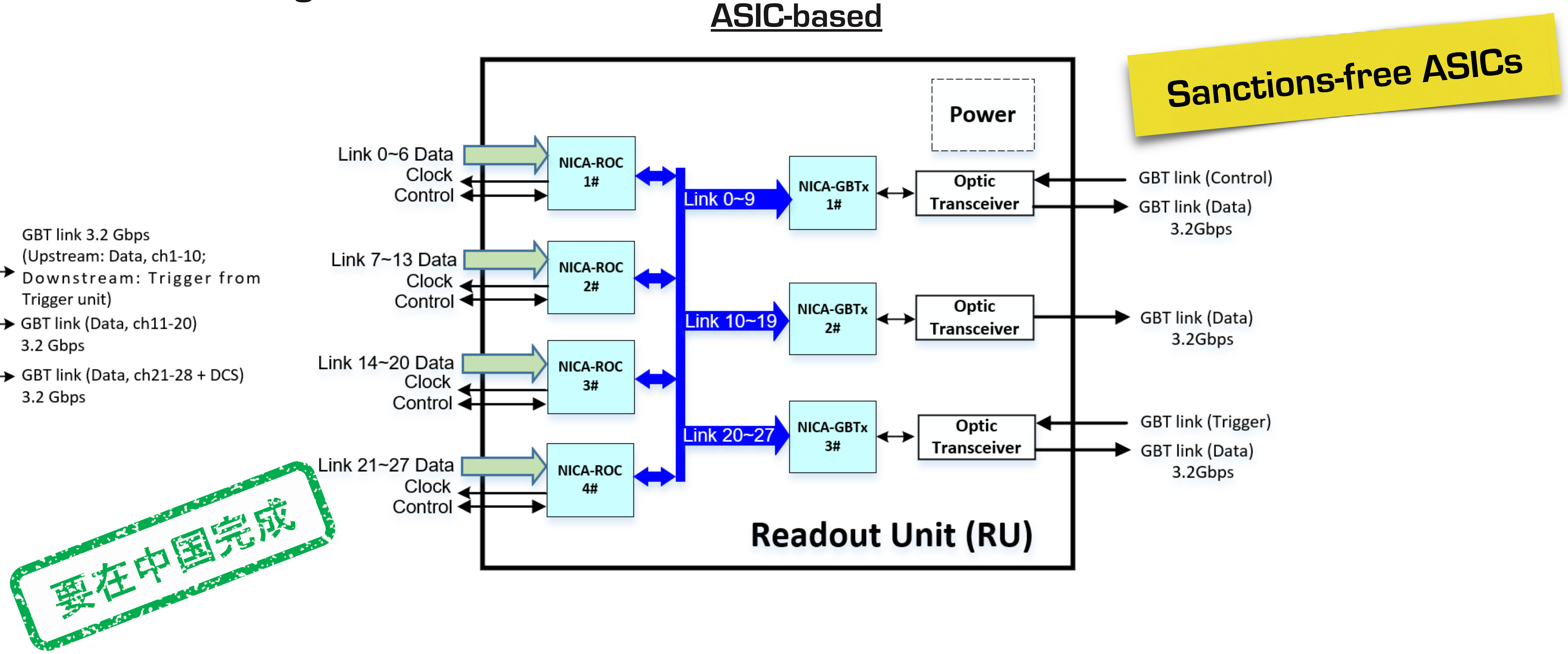
WP7/8 - Readout electronics Design/Production

MPD-ITS RU design solutions.

FPGA-based



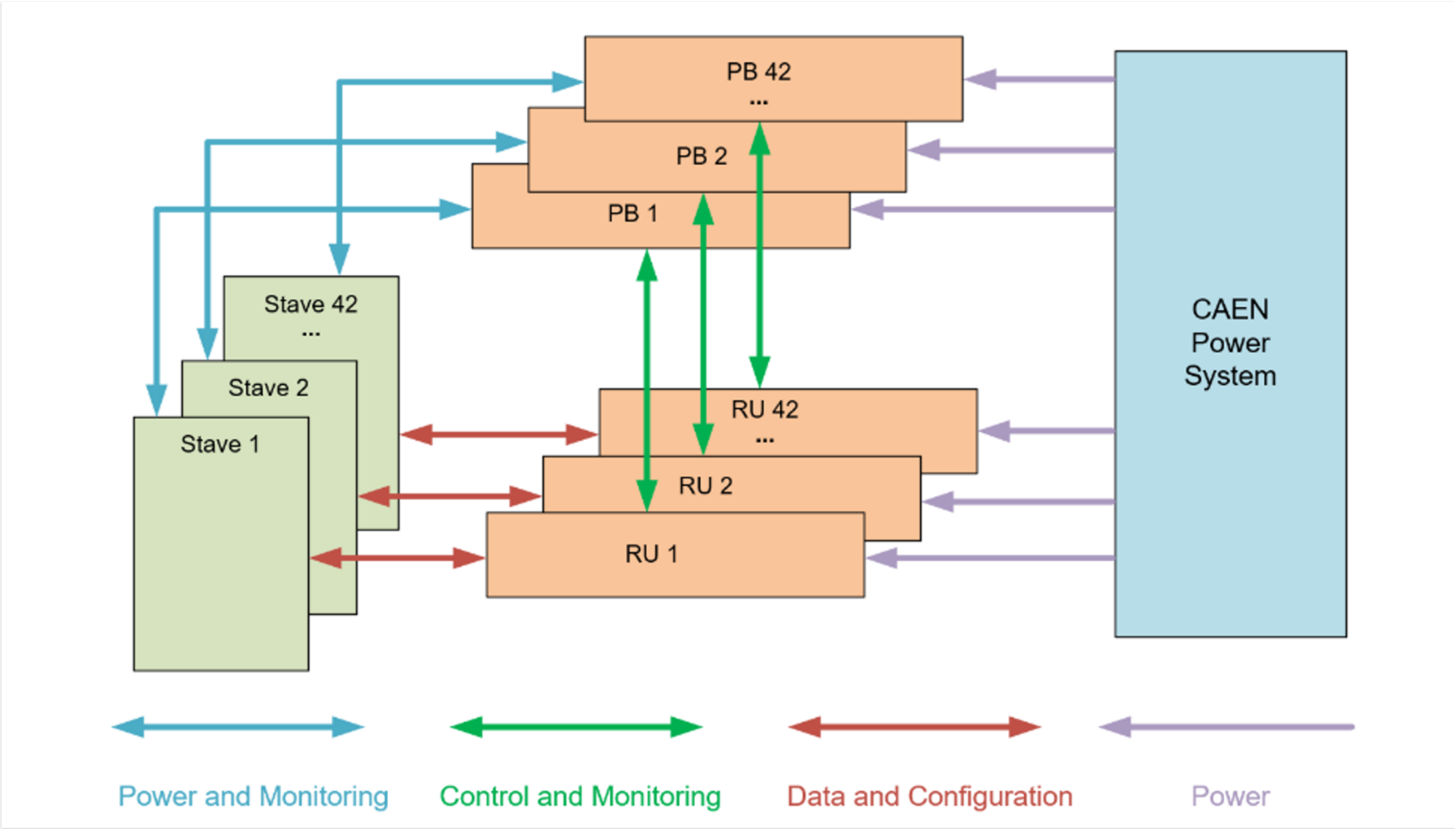
ASIC-based



- **NICA_ROC:** Concentrates the output data of front-end ALPIDE chips and transfer the packaged data to the following NICA_GBTx ASIC. It also receives control commands, clocks, and trigger signals from the backend and distributes them to ALPIDE chips.
- **NICA_GBTx:** A high-speed bidirectional data interface ASIC for optical links.
  - It receives multichannel data from the front-end (NICA_ROC), performs scrambling, encoding, frame building and serializing as the main function for the up-link direction.
  - It receives high-speed serial data from the back-end, performs CDR (Clock and Data Recovery), deserializing, decoding and distributing to the front-end as the main function for the down-link direction.
- **NICA_LD (Laser Driver) and NICA_TIA (Transimpedance Amplifier):** Are two analog ASICs that would be integrated together with the laser and PD (Pin Diode) in the customized optical transceiver module.
  - NICA_LD receives the high-speed up-link serial data from NICA_GBTx and amplifies the signal to driver the laser.
  - NICA_TIA receives the down-link serial signal from the pin diode, and amplifies the signal to NICA_GBTx, so that the data can be furthered processed in NICA_GBTx. These four ASICs will be introduced in the following sections.

WP7/8 - Readout electronics Design/Production

Structure of the power system of MPD-ITS



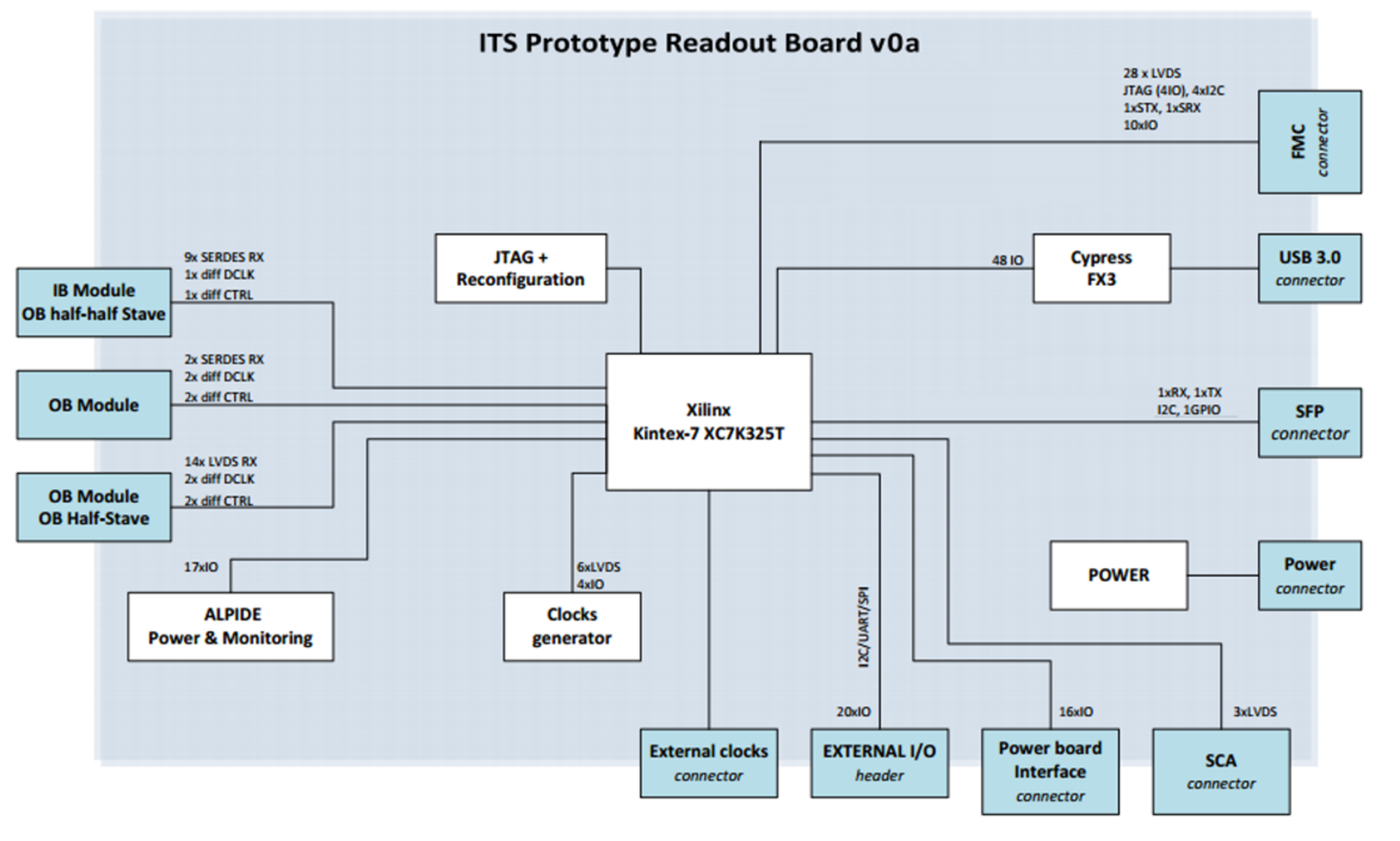
要在中国完成

- The **PU** supplies 1.8 V positive power, as well as negative power used as bias for the staves.

- **In addition to supplying power to the staves**, the PU is also controlled by RU through the serial interface to implement the following functions:
  - Separate enabling of power channels and bias channels.
  - Adjusting the power supply voltage separately.
  - Adjusting the bias voltage in one PU.
  - Over current protection with adjustable threshold on each power channel.
  - Overheat protection on each PU.
  - Monitoring of voltage, current and temperature.

WP7/8 - Readout electronics Design/Production

MPD-ITS Test bench base on RUv0a



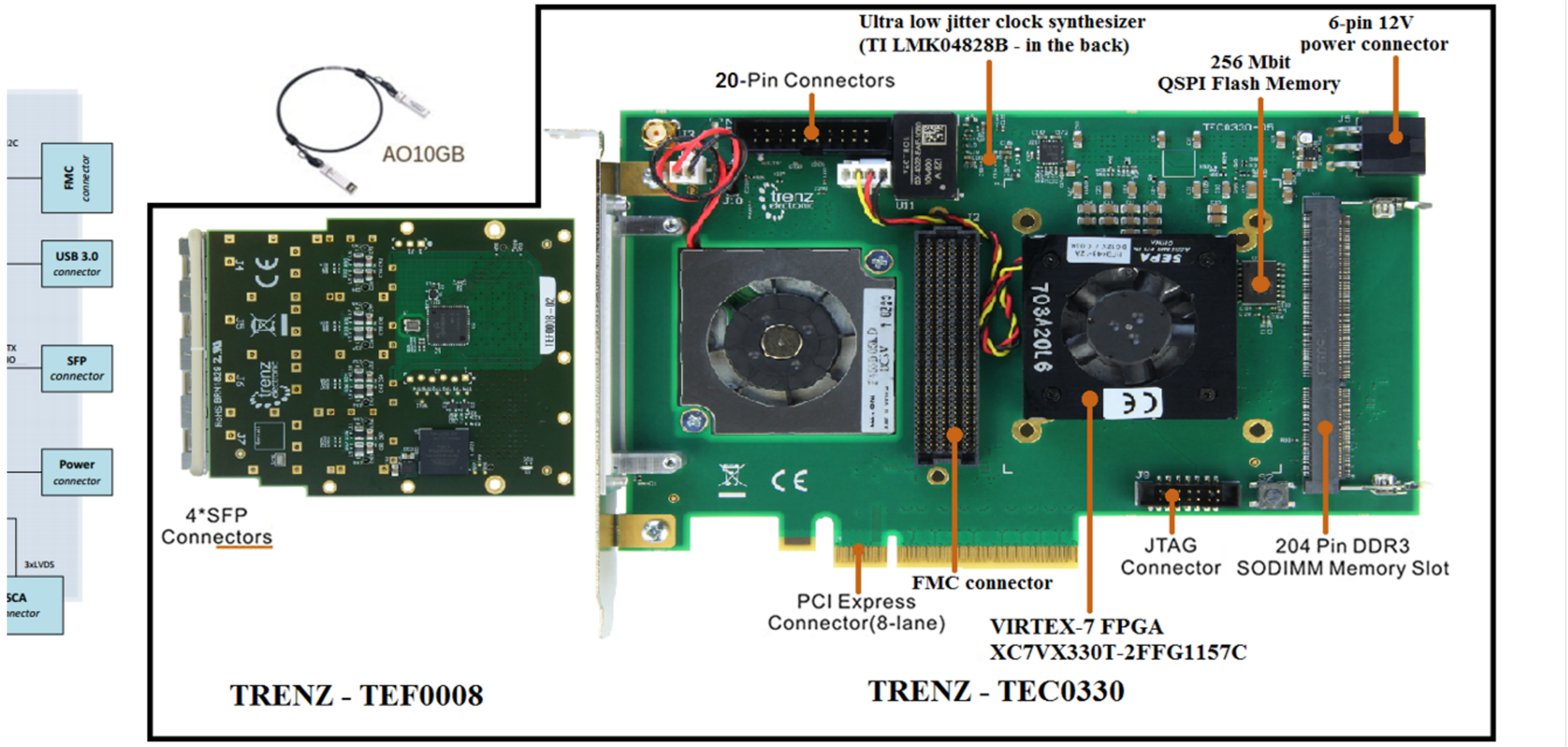
Будет сделано в ОИЯИ

The MPD-ITS test bench will be based on a ALICE-ITS prototype Readout Board, in order to test several aspects of readout development:

- Test the FPGA implementation of the GBT protocol.
- Test the FPGA-GBTx interface.
- Try different connection schemes to ITS sensors / modules.
- Try different clock schemes.
- Try different interfaces for CRUs.
- Provide readings for modules and sensors during production and testing.
- Provides easy reading and control to and from a PC.

WP7/8 - Readout electronics Design/Production

MPD-ITS Test bench using GERI Board



GERI BOARD

Будет сделано в ОИЯИ

In combination with the GERI BOARD or equivalent board we are going to evaluated other aspects of readout development:

- the firmware/software implementation PCIe DMA Engine.
- Interface between the RU and CRU using the GBT protocol.
- Readout Control and data transfer implementation.

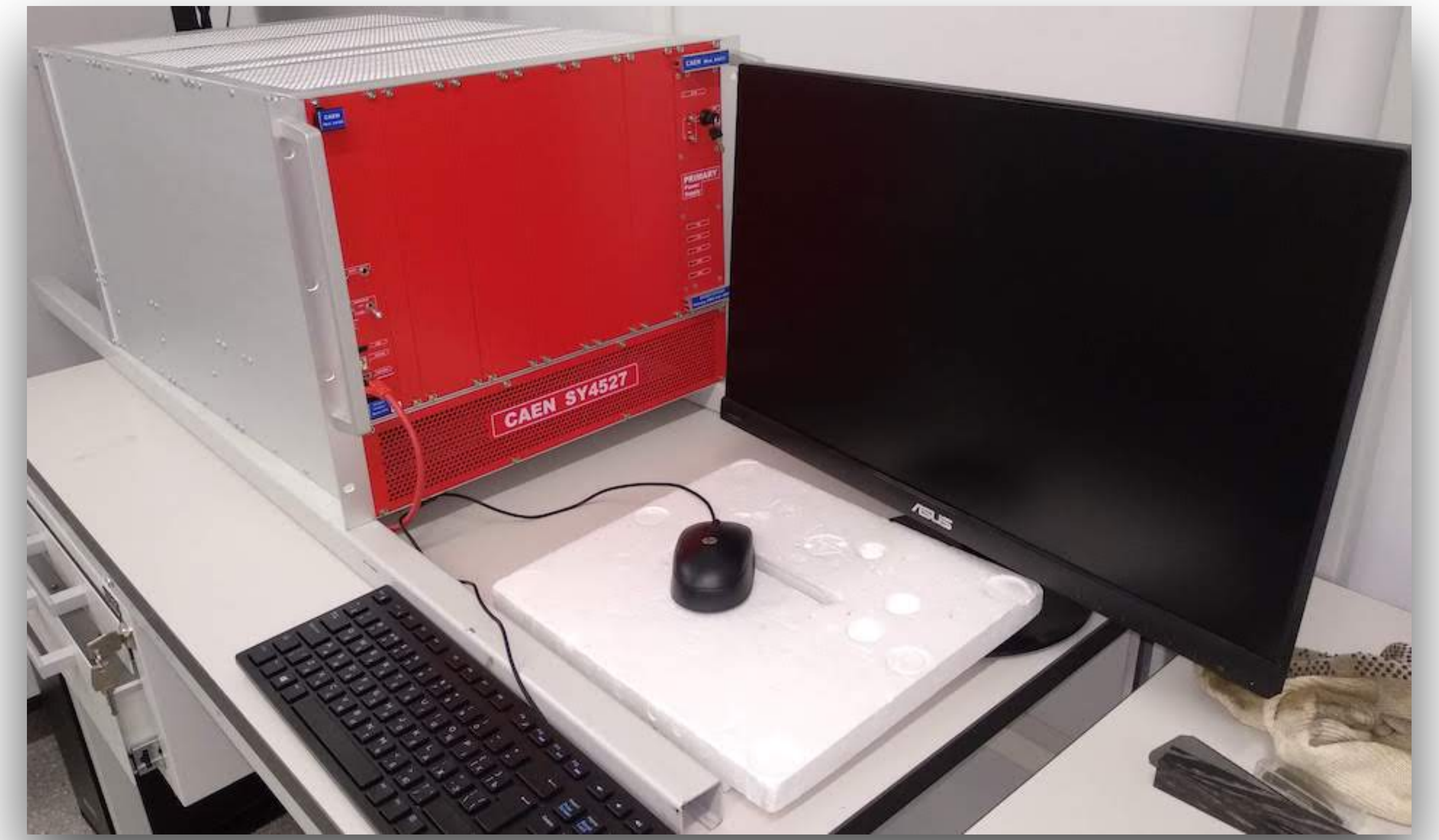
WP9 - DCS

- **Low voltage power system:**
  - All CAEN modules already arrived.

- **SCADA:**
  - JACOB framework for WinCC OA obtained from CERN.
  - Introductory seminar already performed by CERN specialist for JINR.
  - Free-trial licenses obtained for WinCC OA from Siemes.
  - 5 WinCC OA user licenses to be bought by MPD-ITS for NICA(*).

(*) Including TPC, Accelerator and Cryogenics

- Test area currently being set up.



- **Contact has been established with CERN DCS development group and they offered:**
  - The participation of JINR-designated personnel on their official training sessions.
  - The inclusion on their work group at CERN of a JINR-designated person for a training period of about 6 months.

WP11 - Services

- **The first studies are being performed by the Services group at JINR including:**
  - Cabling.
  - Air cooling simulations.
  - Integration with the TPC and the rest of the MPD.

- **MPD-ITS is also supporting for the MPD to address :**
  - The leak-less water cooling plant setup.
  - The dry gas cooling system.
  - The beam pipe production and setup.

Similarly needed by TPC and Ecal

MPD-ITS TDR

MPD - ITS

Current version - Draft v.0.7 - April. 2021 at: **https://disk.jinr.ru/index.php/s/SgscL93JwxKpoDp**

Contents

Chapter 1: Introduction.

Chapter 2: The Pixel Chips.

Chapter 3: Detector Layout.

Chapter 4: Support Structures and System Integration.

Chapter 5: The DAQ System.

Chapter 6: The DCS.

Chapter 7: Detector Performance.

Chapter 8: Physics Performance.

Chapter 9: Project Organizations and Time Lines

Major project weak point

- There is a lack of expertise in some key aspects of the projects like:
  - Readout and microelectronics (A specialist already under contracting process)
  - DCS (Three positions offered)

https://lhep.jinr.ru/information/positions-and-vacancies/

Veksler and Baldin
LABORATORY OF HIGH ENERGY PHYSICS

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LHEP > Information > Positions and Vacancies

Positions and Vacancies

SCADA Engineer – WinCC OA for NICA Facility

SCADA Engineer – WinCC OA for NICA Facility (3 positions)

Position: Physicist/Engineer specialist in Automated Control Systems.

Qualification: Higher Technical Education, University of Applied Sciences or Technical University.

Nature of work: SCADA systems development for projects of the NICA accelerator complex (for details see: nica.jinr.ru/projects/mpd.php). Fixed term employment contract for 3+ years.

Реклама

Working day duration: 8 hours.

Professional qualification: Higher education. At least [illegible] years of experience in engineering of SCADA (preferably WinCC) systems. Knowledge of SCADA/HMI and/or PLC and DB. Experience in communication Protocols of Siemens, TCP/IP, OPC-DA/UA. Knowledge of programming languages (C, C++, VBA). Basic knowledge regarding Database Management eg: MSSQL, MySQL, ORACLE. Experience in unit testing of SCADA Developing & maintaining tools and procedures for engineering & testing SCADA. Troubleshooting skills.

Additional requirements: Great commitment and willingness to learn. Willingness to travel (worldwide). Great technical understanding, good analytical skills and precise, independent and structured way of working. Skills to analize problems in this area, propose solutions and make strategic decisions on the development of the system. Ability to work in a team and willingness to be the team leader. Functional communication level of English.

Offer: Candidates will be employed by the Joint Institute for Nuclear Research as middle/senior Engineers. They will receive a 3-year contract with a salary ranging from 120'000 to 200'000 Rub per month plus employee benefits including medical insurance for the employee and his/her family members, depending on the experience of the candidate and the need for his/her specific expertise for the team.

Application: Qualified applicants are encouraged to apply until July 1, 2021.

The application shall include:

- Curriculum vitae
- Description of the latest activities on a relevant field
- Letter of recommendation from at least one referee.

All qualified individuals are encouraged to apply without regard to age, gender or national origin.

For further information, please contact Yuri Murin:

murin@jinr.ru (Tel: +007 903 291 21 94)

Budget from grants

Major current threat to the project (The 19000 elephants in the room)

- **For political reasons Israel has blocked the export license for JIRN to TowerJazz for the ALPIDE chips (already paid and built) for being radiation-hard-grade:**
  - This is currently being addressed at diplomatic levels between the Russian Federation Ambassador to Israel and the Israeli Ministry of Foreign Affairs.

Mayor Goals 2021/2022

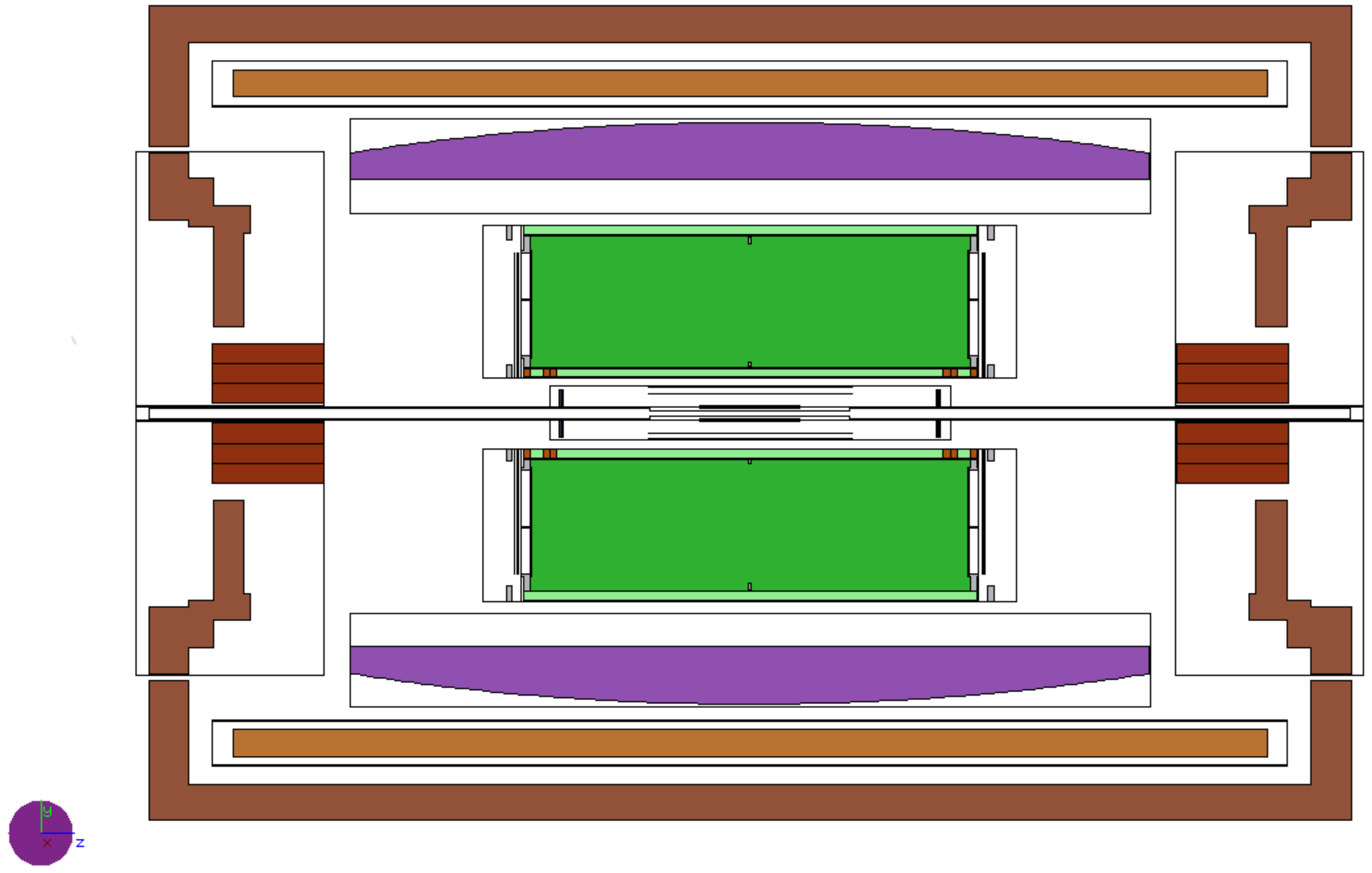
- Finishing the TDR (2021)
- Setup the full HIC assembly line and produce the first mockups (2021/1st Qt 2022)
- Produce all supporting/integration mechanics and dry-trial the integration procedure including beam pipe imitator, realistic FFD imitator and TPC bore imitator (2022).

In close collaboration with TPC, FFD and NICA vacuum teams with metrology support from the factory of superconducting magnets

Thank you.

Backup Slides

MPD-ITS Radiation environment

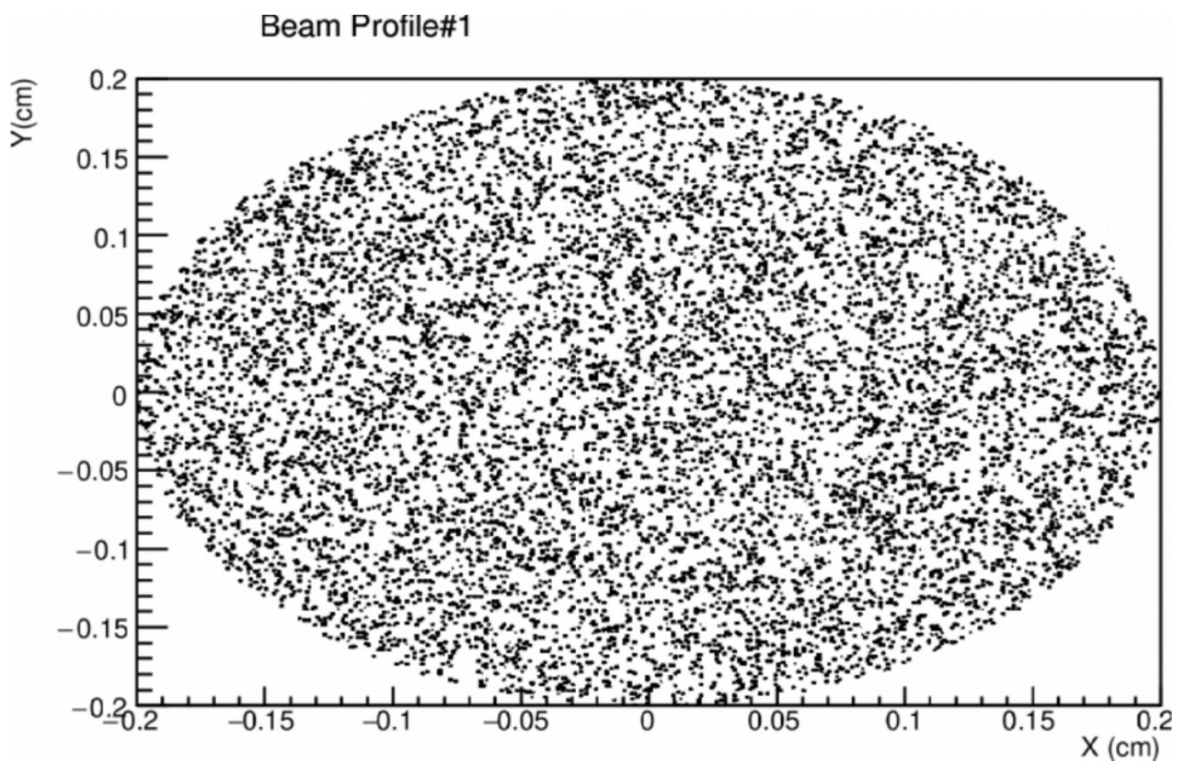


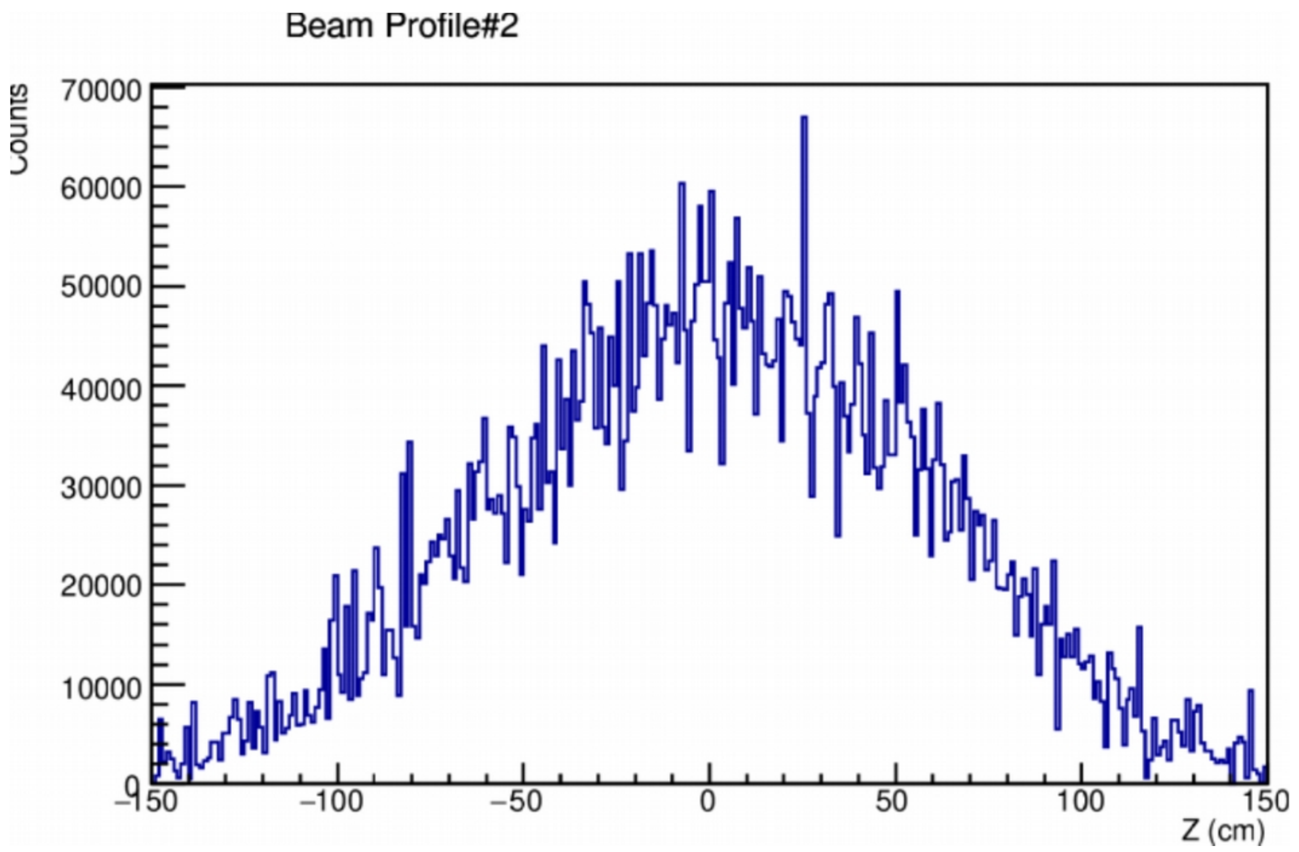
Geometry set-up:
1. Solenoid based on the MPDroot geometry.
2. Pipe:
   - middle section(150 cm in length centered at the MPD IP) was defined as a Be tube with an inner and outer radii of 1.9 cm and 2 cm, respectively;
   - outer sections defined as Al tubes with an inner and outer radii of 3.9 cm and 4 cm, respectively.
3. Simplified TPC detector based on the MPDroot geometry version v7.
4. Simplified FFD detector.
5. FHCal calorimeters with 44 modules each (each module was implemented as a single homogeneous material.)
6. ECal was implemented as a single homogeneous material.

Dose and Fluences were estimated in 5 Layers.
Each Layer was defined as a tube with a wall thickness of 100 microns centered at the MPD IP.

	Radius(cm)	Length(cm)
Layer#1	2.2	75
Layer#2	4.1	75
Layer#3	6.0	75
Layer#4	14.5	152.6
Layer#5	19.4	152.6

MPD-ITS Radiation environment





The simulation was made with FLUKA version **2-11.2x-8**

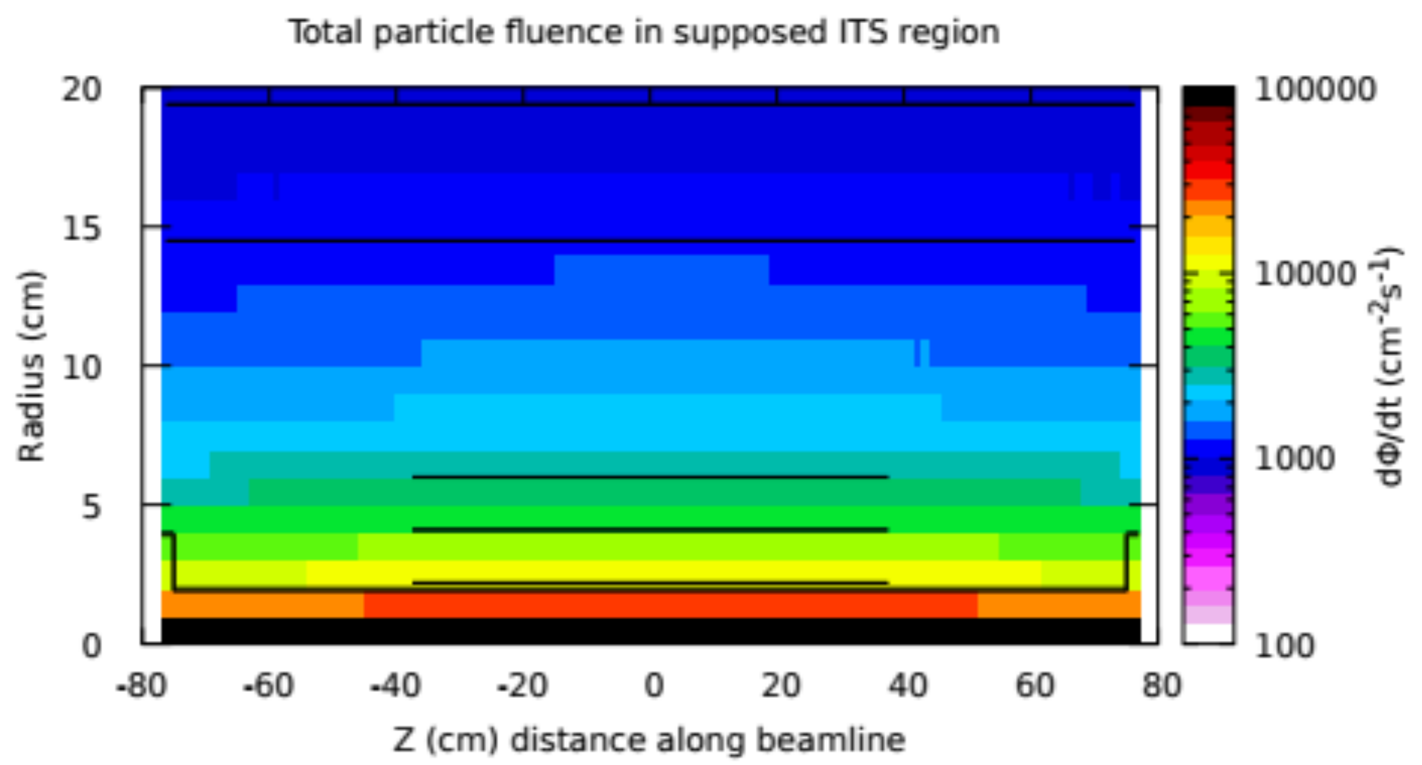
Primary events:

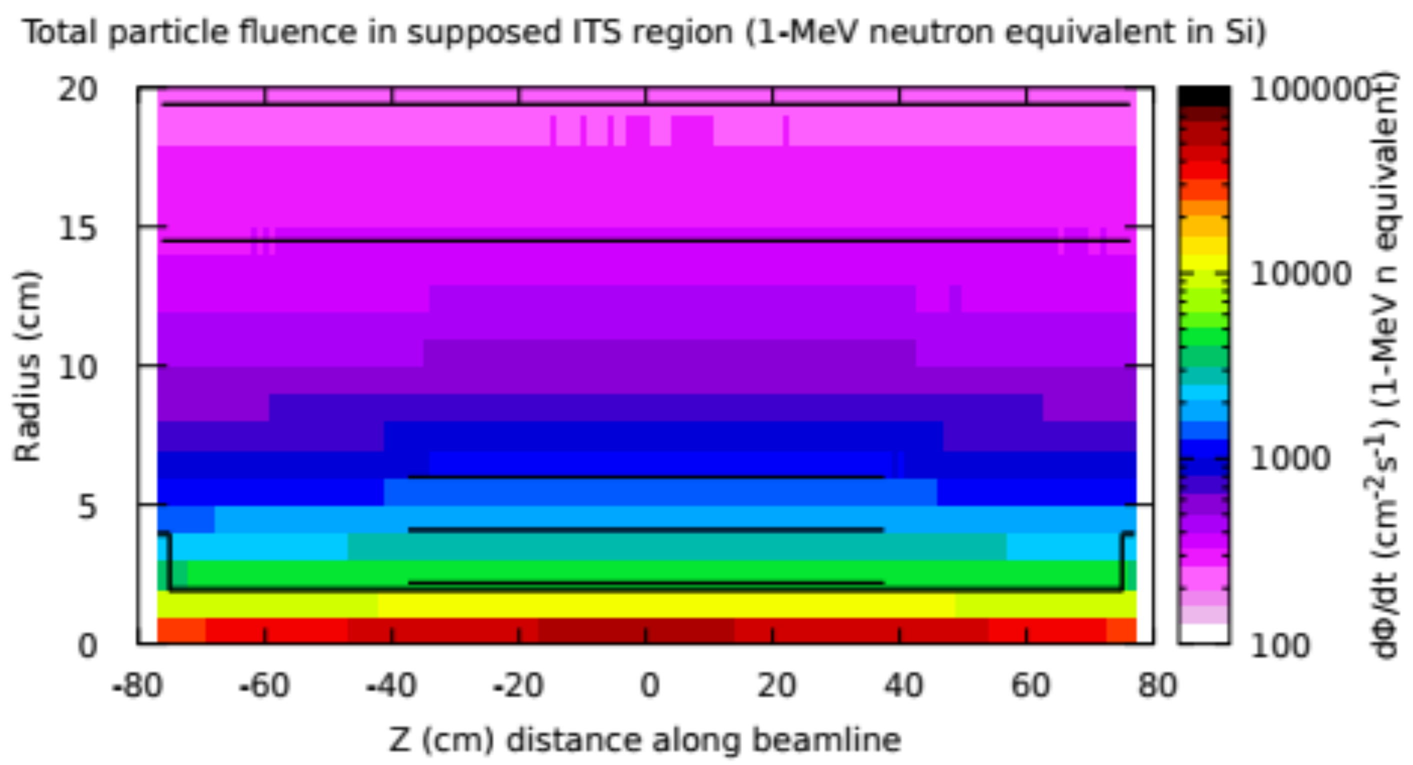
A file from DCM-QGSM event generator for minimum-bias Au-Au collision at $\sqrt{s}$=11 GeV/n was converted to be read by FLUKA as a source of primary events.
10k primary events were used in the simulation.

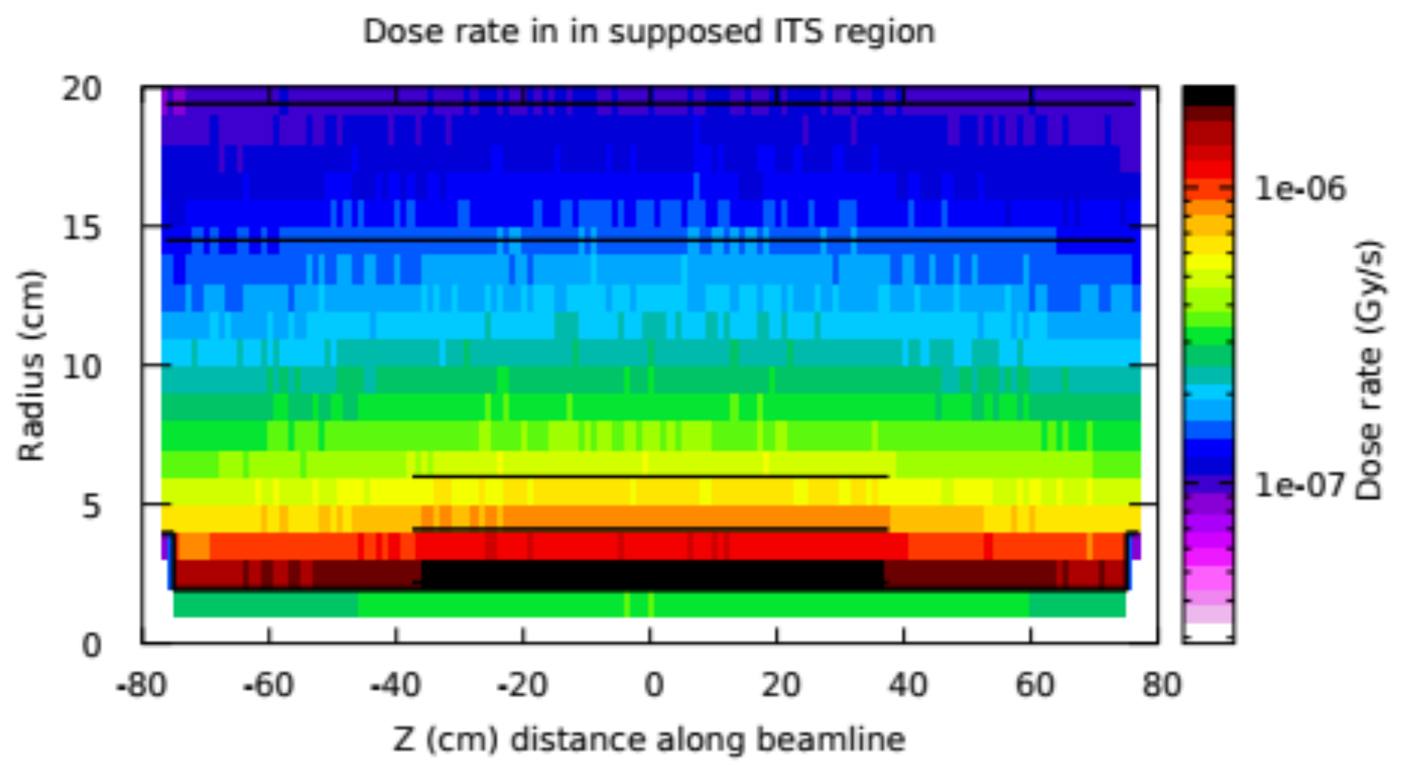
The beam was specified to have the Gaussian profile defined by standard deviation σ=60 cm in beam-line direction (z) with beam particles uniformly distributed over a 2 mm-radius circle in the x-y plane at the MPD IP.

MPD-ITS Radiation environment

ITS Region





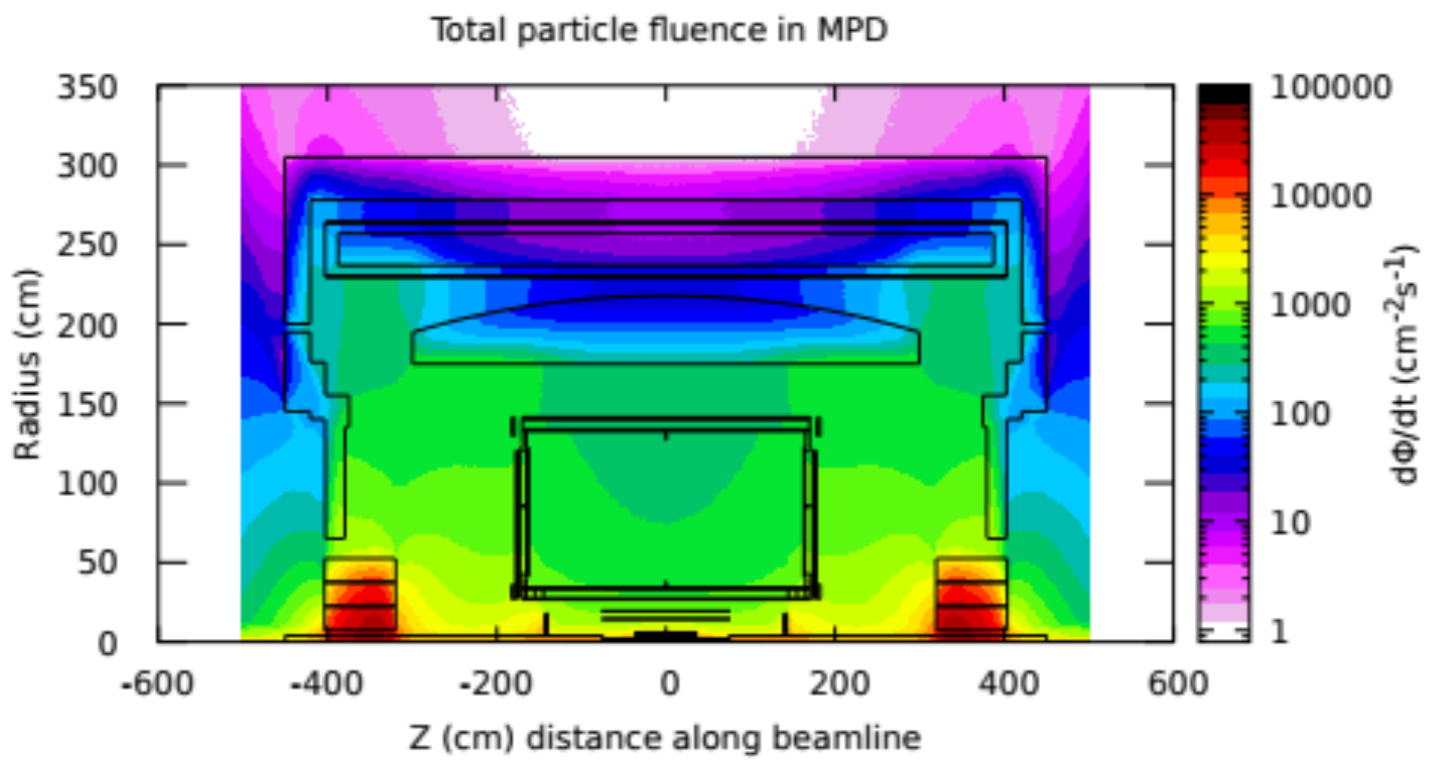


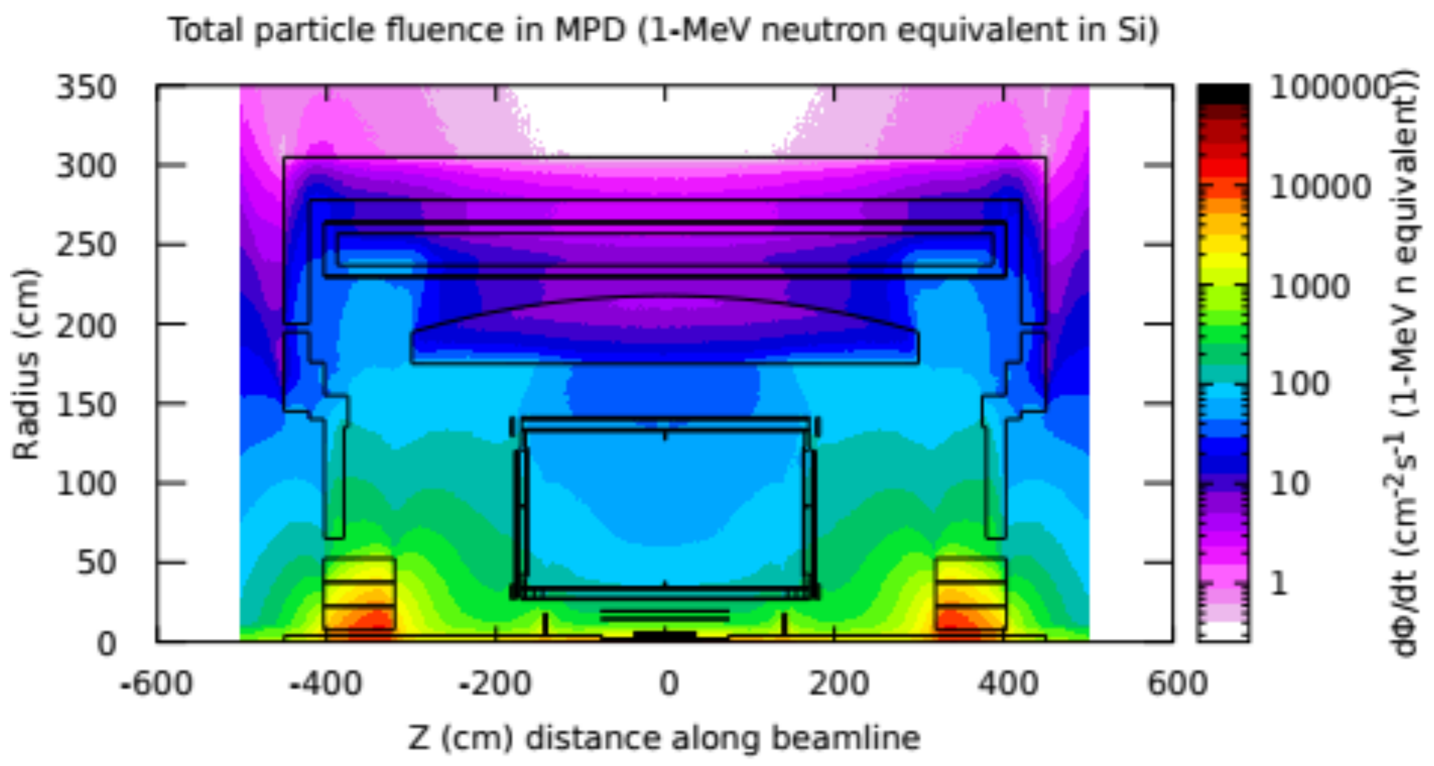
TID rate for the two OB layers is of the order of 5×10^{-5} Rad/s

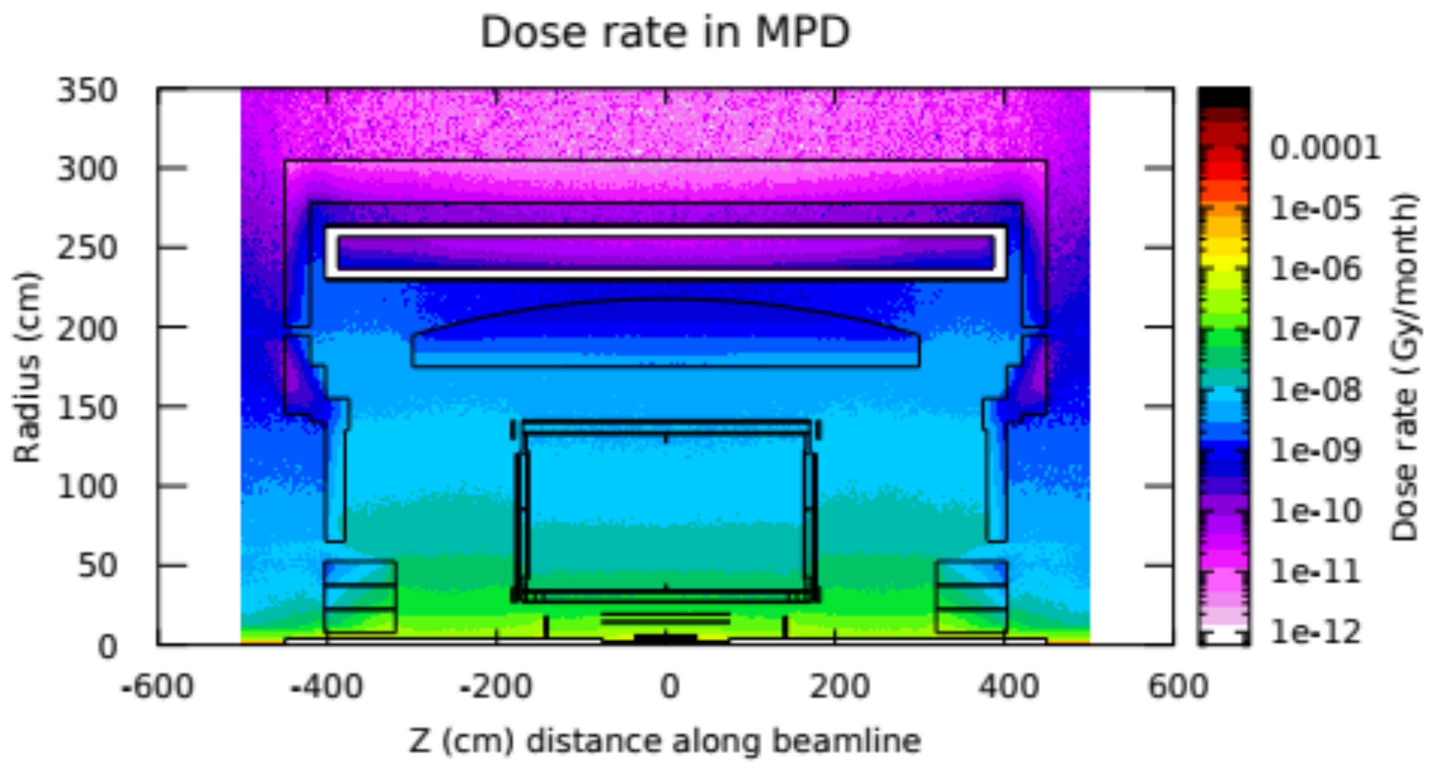
Assuming a yearly running time for the MPD of 50%, this amounts only to around 10 kRad over 10 years.

MPD-ITS Radiation environment

Full MPD Region







Very low dose rate of about 10^{-9} Rad/month on the zone just above the MPD yoke, where the ITS readout electronic will be placed.