

## TPC status (12.04.2018)

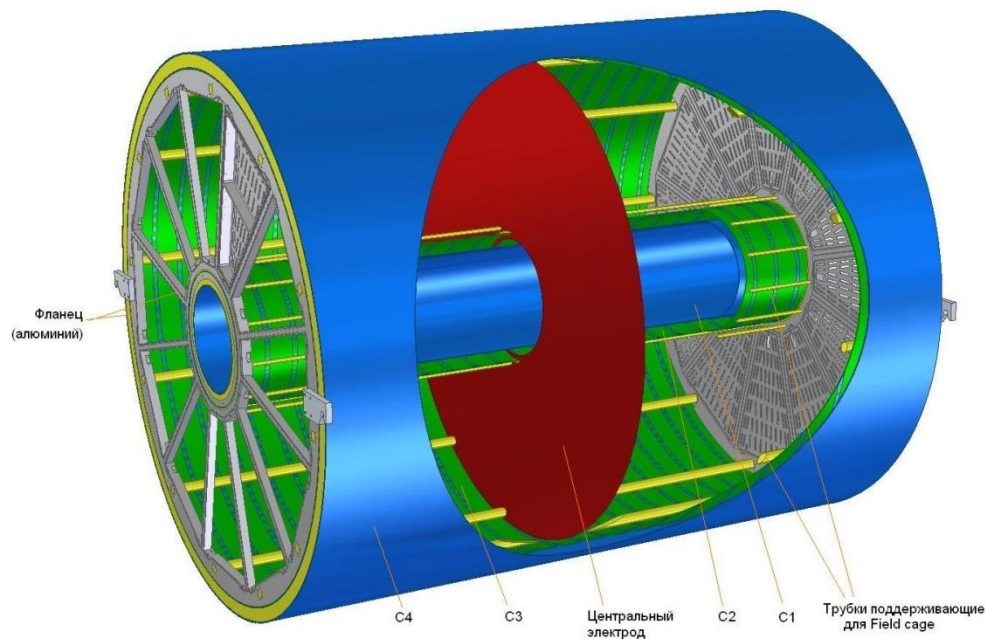
- TPC assembly hall
- tooling for TPC assembly
- ROC chambers
- front end electronics: SAMPA and analog options
- sub-systems: gas, cooling and laser calibration
- integration TPC to MPD
- time schedule

**Presented by Sergey Movchan**

**TPC TDR rev.06 - [http://mpd.jinr.ru/wp-content/uploads/2017/05/TDR\\_TPC\\_v6\\_2017.pdf](http://mpd.jinr.ru/wp-content/uploads/2017/05/TDR_TPC_v6_2017.pdf)**

# MPD TPC parameters

Корпус TPC/MPD



Item	Dimension
Length of the TPC	340cm
Outer radius of vessel	140cm
Inner radius of vessel	27 cm
Outer radius of the drift volume	133cm
Inner radius of the drift volume	34cm
Length of the drift volume	170cm (of each half)
HV electrode	Membrane at the center of the TPC
Electric field strength	~140V/cm;
Magnetic field strength	0.5 Tesla
Drift gas	90% Ar+10% Methane, Atmospheric pres. + 2 mbar
Gas amplification factor	$\sim 10^4$
Drift velocity	5.45 cm/ $\mu$ s;
Drift time	< 30 $\mu$ s;
Temperature stability	< 0.5°C
Number of readout chambers	24 (12 per each end-plate)
Segmentation in $\phi$	30°
Pad size	5x12mm <sup>2</sup> and 5x18mm <sup>2</sup>
Number of pads	95232
Pad raw numbers	53
Pad numbers after zero suppression	< 10%
Maximal event rate	< 7 kHz ( Lum. 10 <sup>27</sup> )
Electronics shaping time	~180 ns (FWHM)
Signal-to-noise ratio	30:1
Signal dynamical range	10 bits
Sampling rate	10 MHz
Sampling depth	310 time buckets

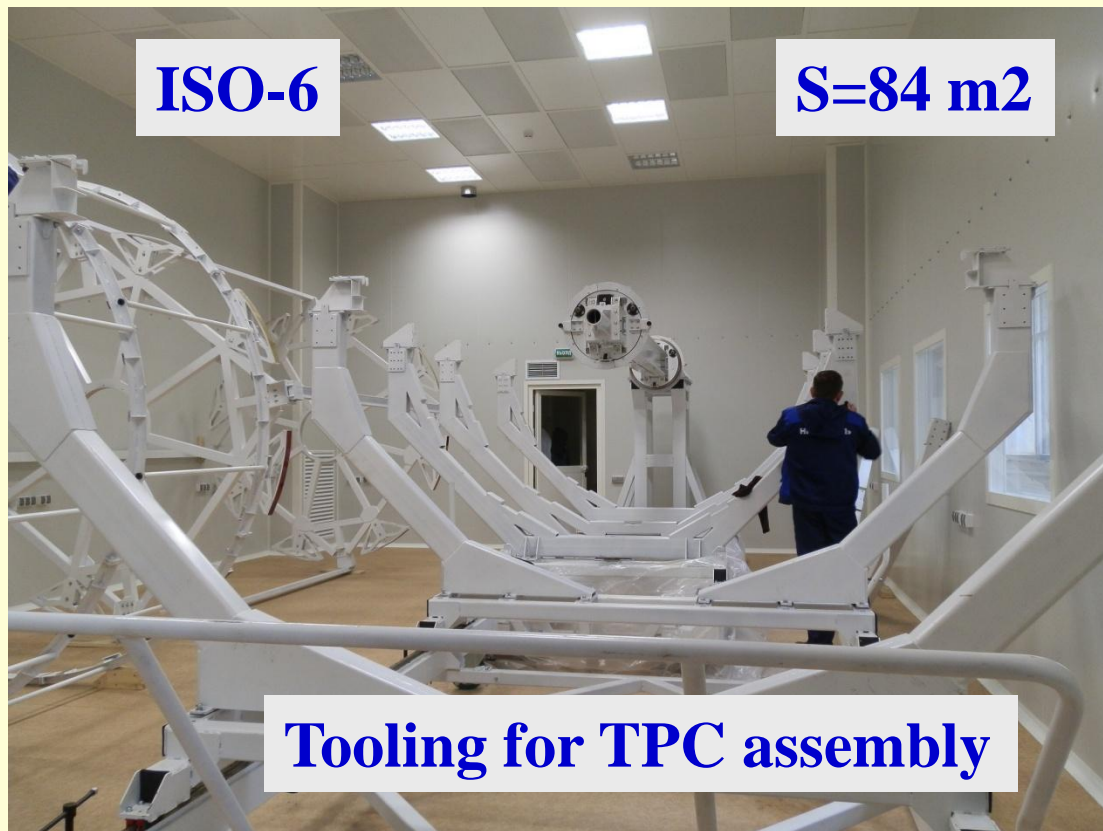
# TPC assembly hall (LHEP, bld.217) – common view



Clean room

ISO-6

S=84 m<sup>2</sup>



Tooling for TPC assembly

Ready



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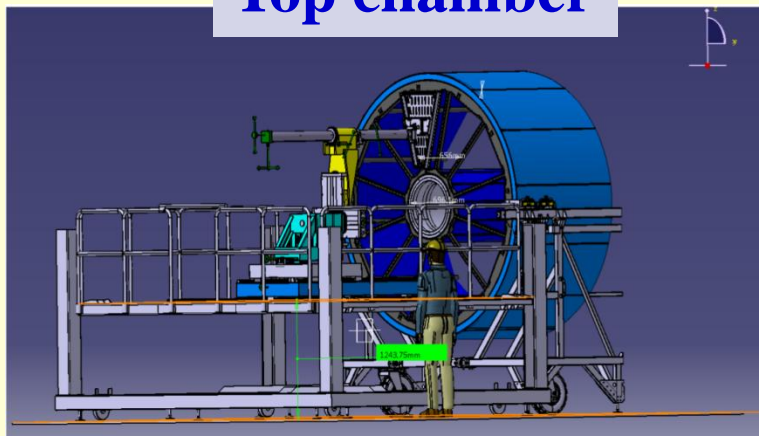
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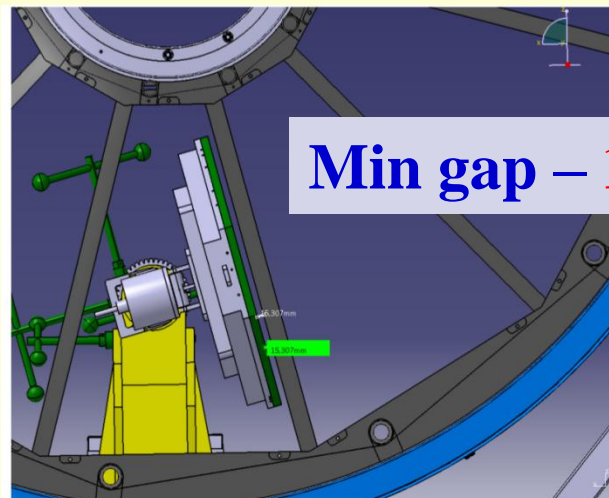


# Briansk: **manipulator** for ROC chamber installation

## Top chamber

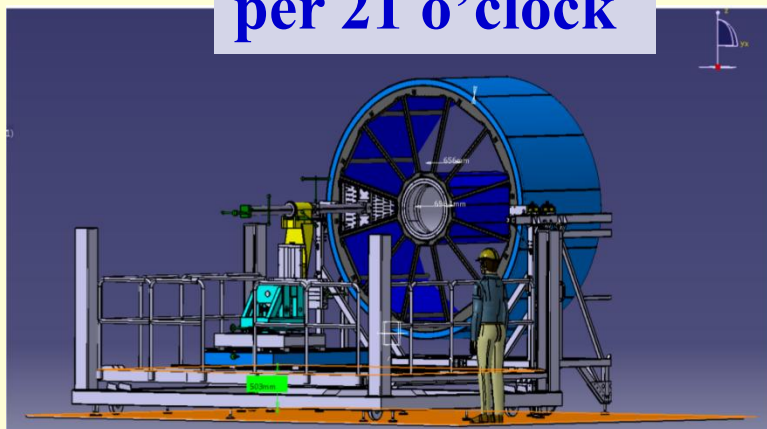


Высота от пола до подъемника составила примерно 1243 мм.



Min gap – **15 mm**

## per 21 o'clock



Высота от пола до подъемника составила примерно 503мм.



**Delivery – May 2018**

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# TPC flanges: leak test

## Set up



## Pressure drop measurement



**tested**

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# ROC chamber assembly facility

Bld.40

Gluing



Wiring



Test set up



Soldering



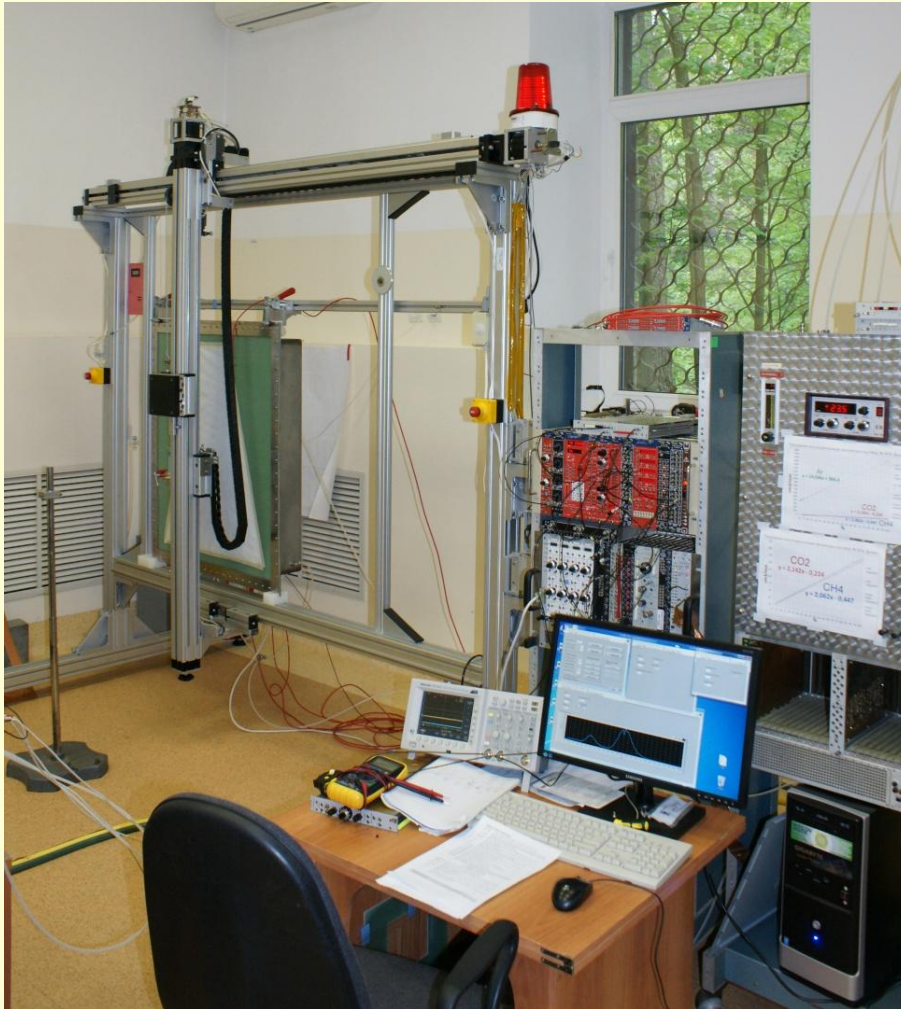
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## ROC chambers: test set up



### Test procedure:

- counting plateau
- dark current
- energy resolution (Fe-55)
- uniformity of gas gain
  - ✓ linear scan
  - ✓ area scan

pre-serial ROC chamber: **tested**

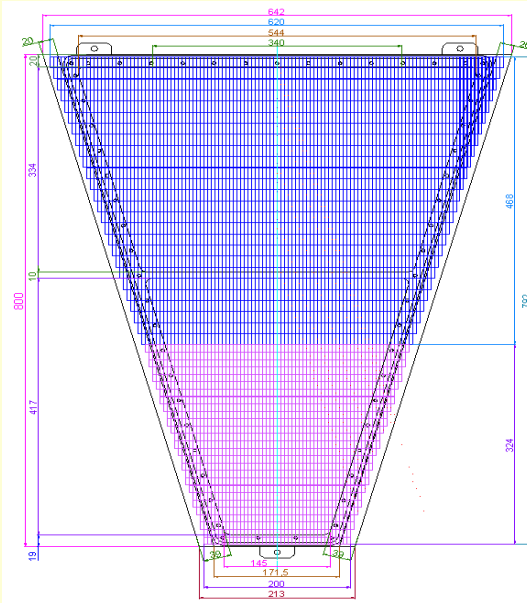
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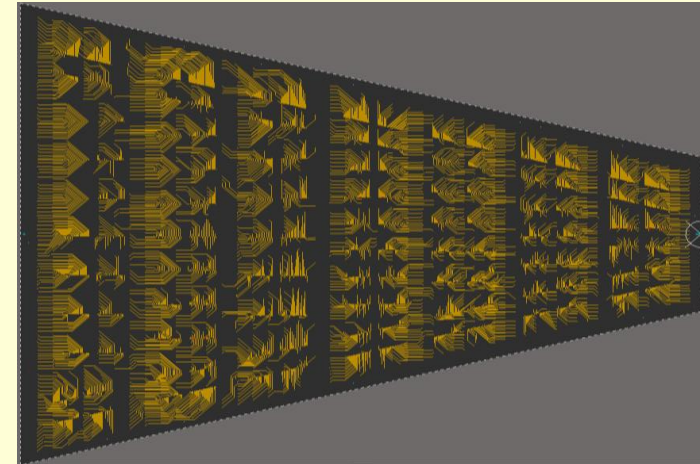
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# Pad plane



Pads dimensions and quantity are determined by experiment requirements on space and momentum resolutions.



## Pad structure:

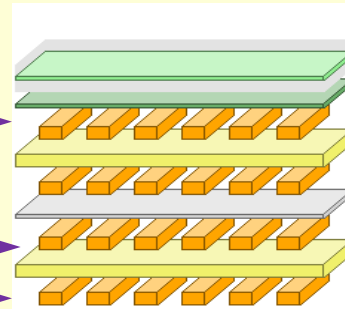
- pad row number - 53
- rectangle shape
- small pads  $5 \times 12 \text{ mm}^2$
- large pads  $5 \times 18 \text{ mm}^2$

Connectors layer

Layout layer

GND layer

Pads layer



Layer Name	Type	Material	Thickness (mm)
Top Overlay	Overlay		
Top Solder	Solder Mask/Co...	Surface Material	0.01016
Top Layer	Signal	Copper	0.018
Dielectric1	Dielectric	Core	1
Signal Layer 1	Signal	Copper	0.035
Dielectric2	Dielectric	Prepreg	1
Signal Layer 2	Signal	Copper	0.035
Dielectric3	Dielectric	Core	1
Bottom Layer	Signal	Copper	0.018

quality is no so good ... **2 new ordered** (China and Italy)

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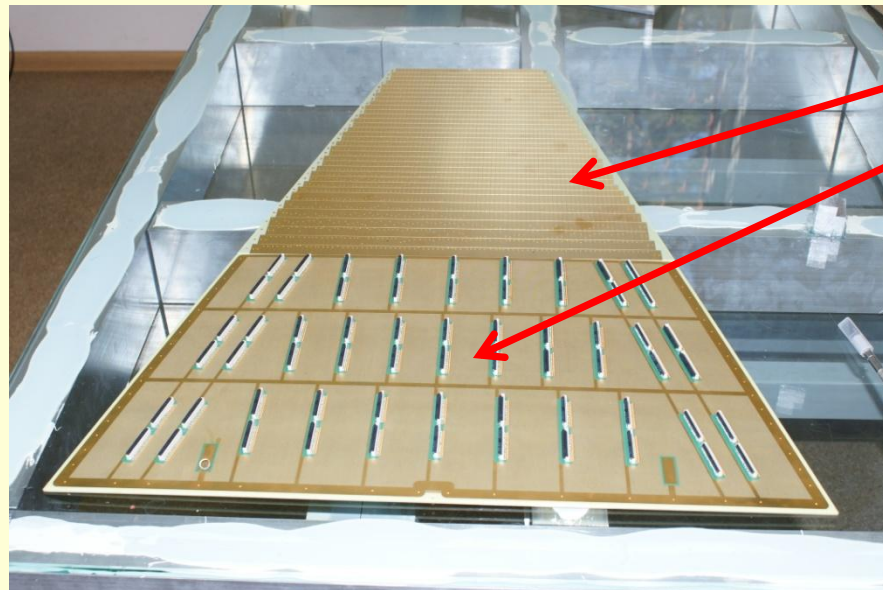
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**From PCB technology: pad plane from 2 parts**



**Pads capacitor  
measurement**



**Pad plane bending, thickness – more less ok  
Some pad capacitor – 300 pF instead 20 pF ???  
Measurements and tests – in progress**

**New pad plane from Italy – April 30 2018**

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## Read out electronics status

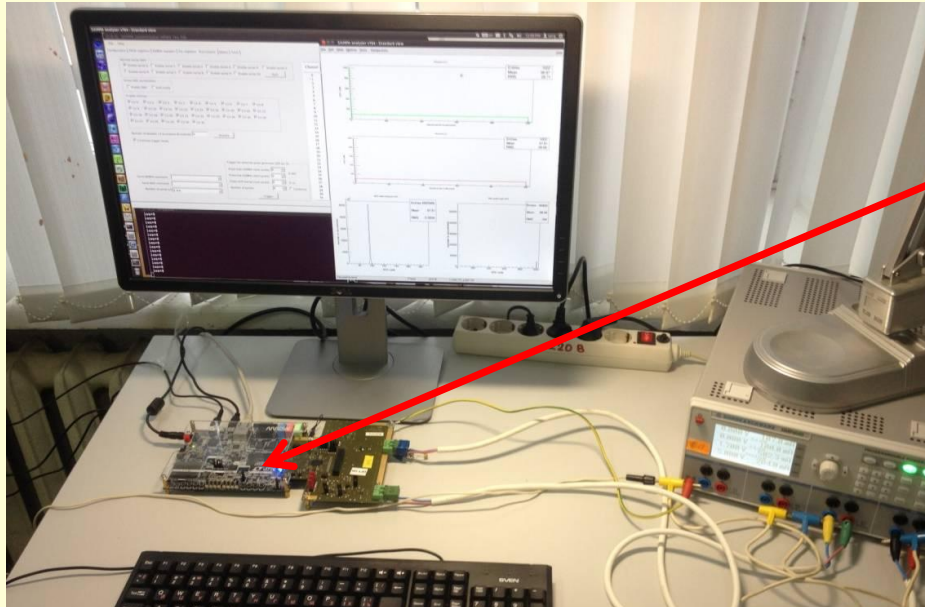
### FE electronics:

- **SAMPA - base line** option (FEC32S, FEC64SAM v1, v2)

Low voltage distribution board (LVDB)

Data concentrator and server – looking on ALICE RCU

# MPD TPC FE based on SAMPA chip

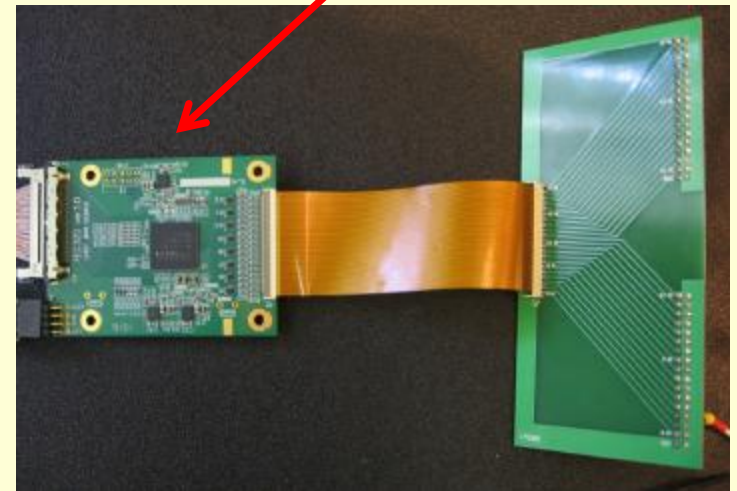


- FEC32S with SAMPA v3 tested – good PCB design
- Main tests works - good
- Measured SAMPA V3 noise is good  $< 0.8$  lsb
- Measured pedestals for all chips were in the expected range
- The Gain is inside specification (19,4 – 19,8)
- The Peaking Time is inside specification (165 – 175ns)
- POR circuit – works
- Vref average = 755; 602; 451mV for ADCTRIM=05
- Power diss.  $< 32$  mW/channel ( 1054 mW full board)

Tests of SAMPA chip (rev.2) – done

Tests of SAMPA chip (rev.3) – done,  
27 pc good

MPD TPC FEC32S board:



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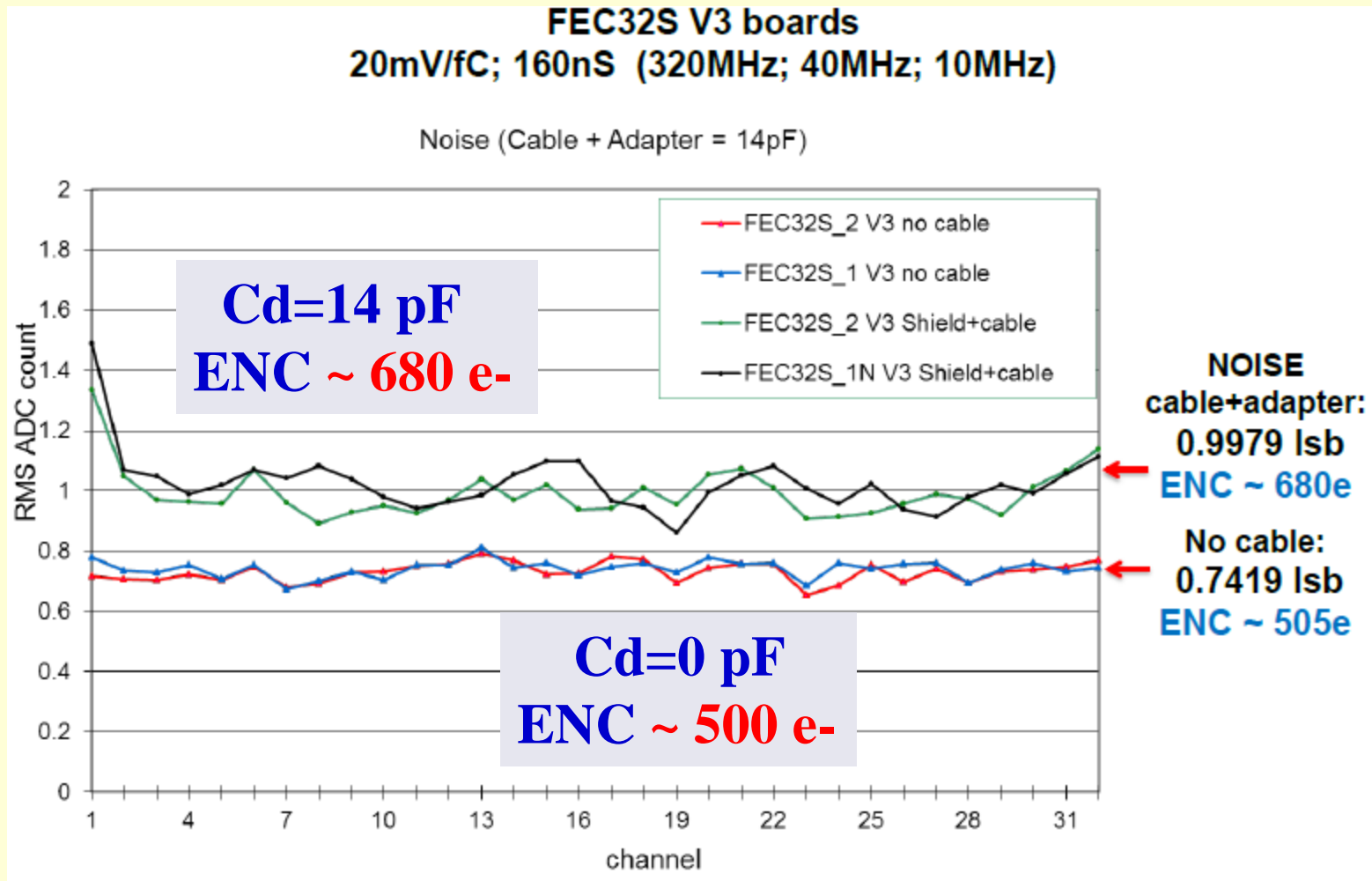
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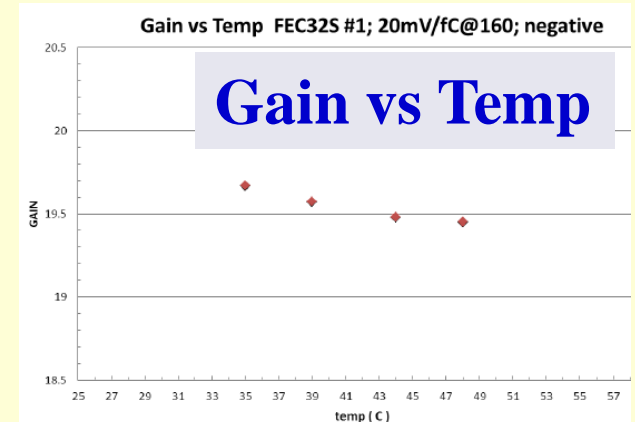
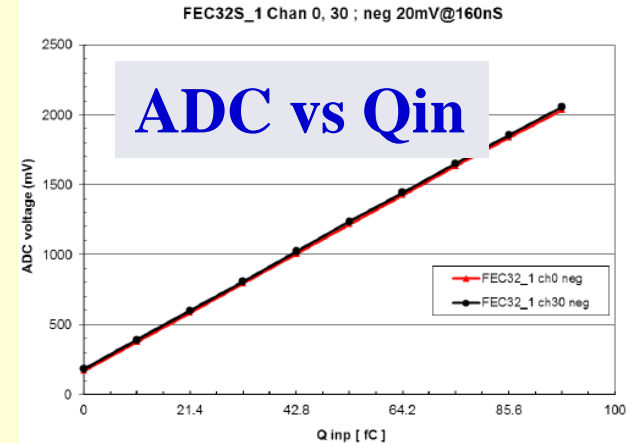
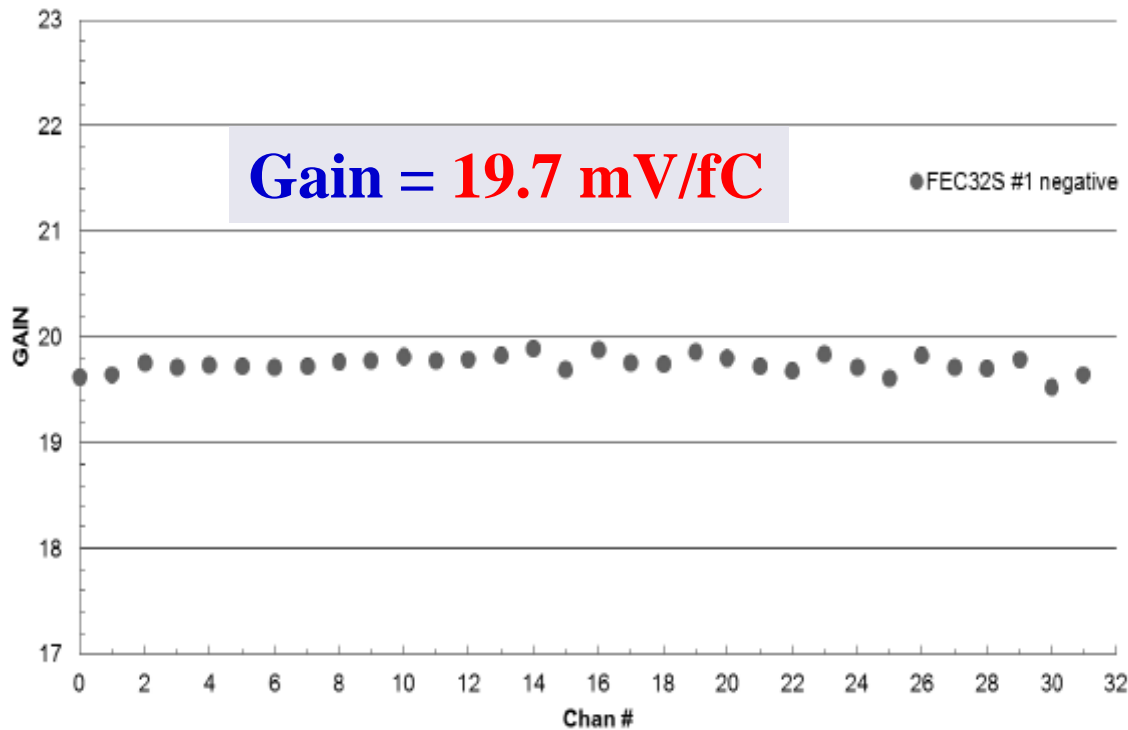
## Noise measurement (for $C_d=0$ pF): results



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## Gain measurement : results

Gain V3 FEC32S #1; 20mV/fC@160; negative



**Gain 35°C = 19,67**

**Gain 48°C = 19,45**

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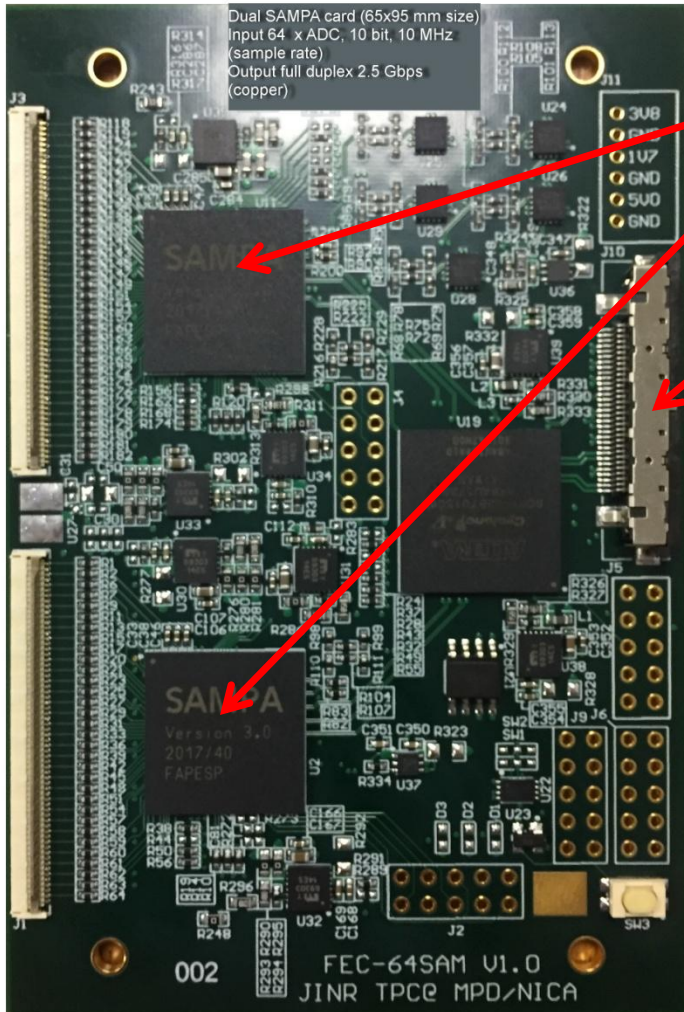
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# FEC64SAM v1.0 based on SAMPAs rev.3

Vereschagin S.V. 28.12.2017



TPC/MPD Front-end card

Dual SAMPAs card (65x95 mm size)  
Input 64 x ADC, 10 bit, 10 MHz  
(sample rate)  
Output full duplex 2.5 Gbps  
(copper)

## Status:

SAMPAs-FPGA communication – **ok!**  
Trigger and synch – **ok!**  
data transmission from FPGA to kit - **ok!**

## Plans:

- board parameters study – **in progress**
- build and test 512 ch system (8 boards)  
- **started**

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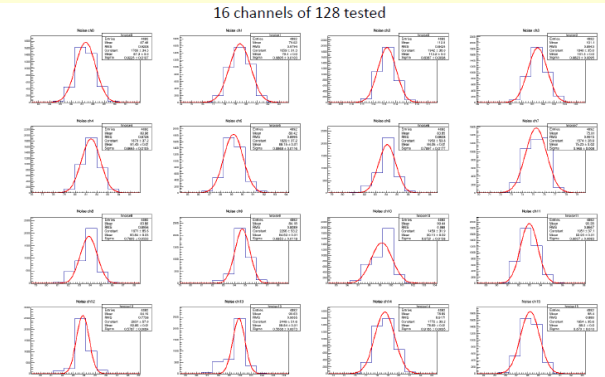
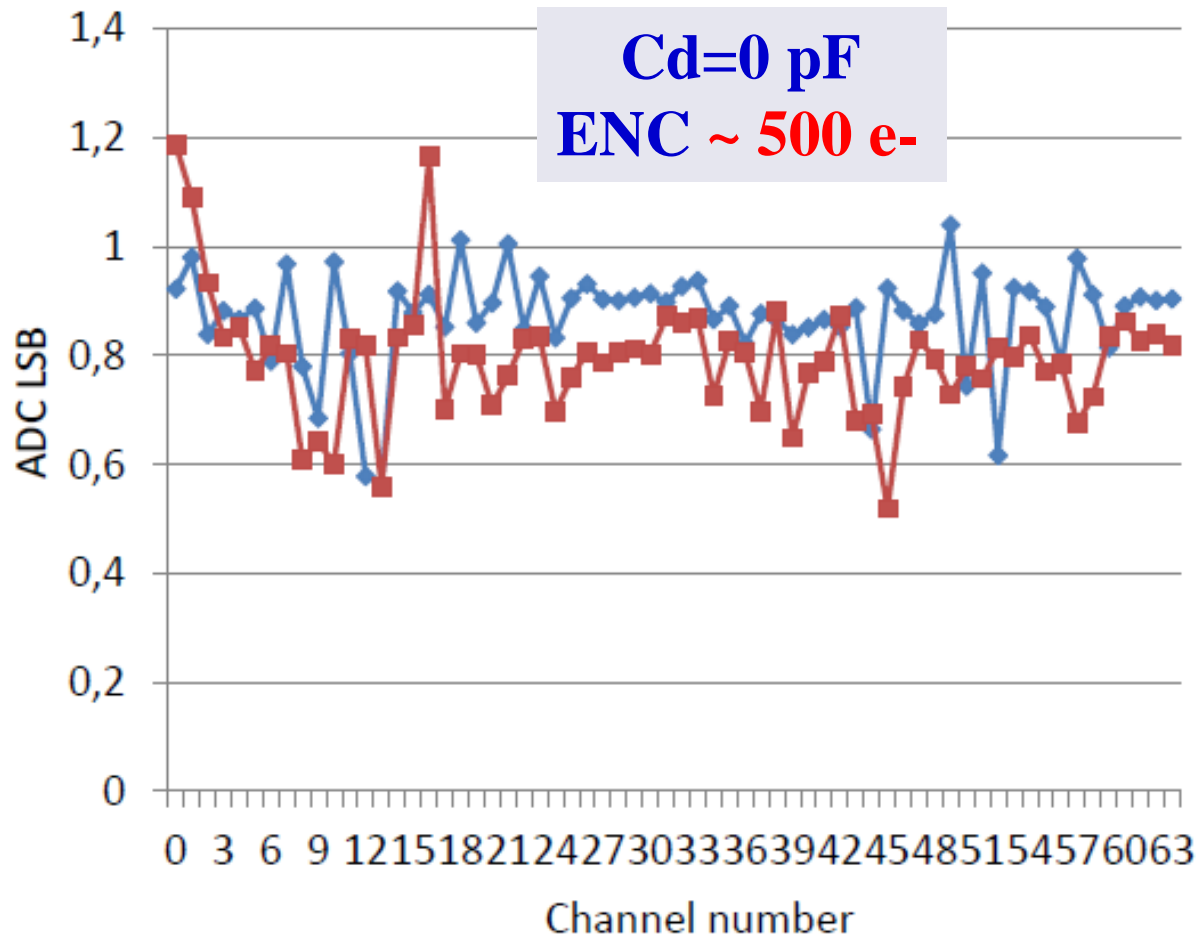
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# Noise measurement: results



—◆— Sigma noise @ FEC 1  
—■— Sigma noise @ FEC 2

1 ADC LSB = 610 e<sup>-</sup>

11.04.2018

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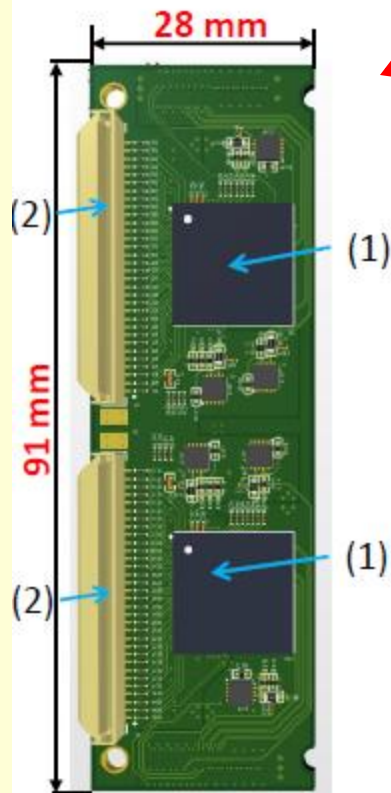
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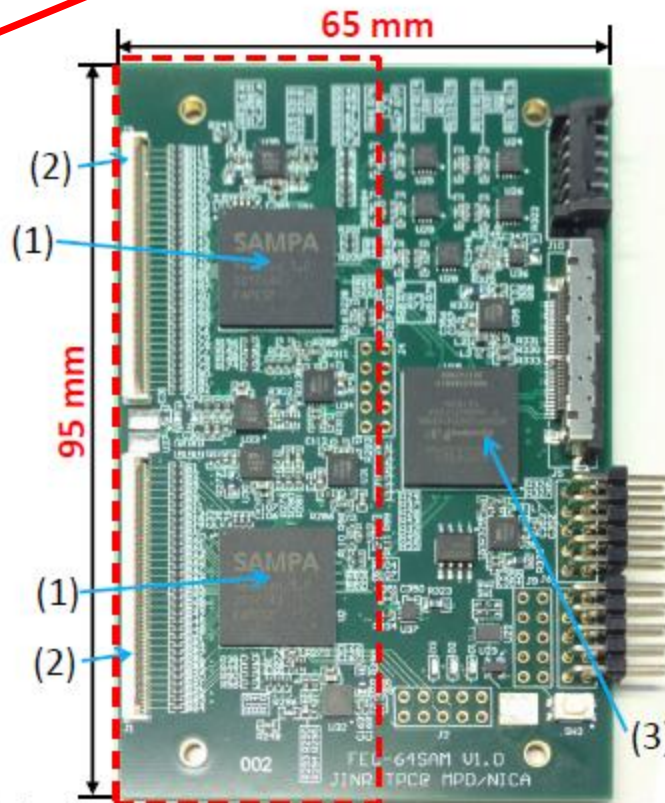
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**Size 28x91 mm**

## FE board size minimization



3-d model of SAMPA FEC v 2.0  
FEC is under designing



Picture of SAMPA FEC v 1.0  
FEC is under testing

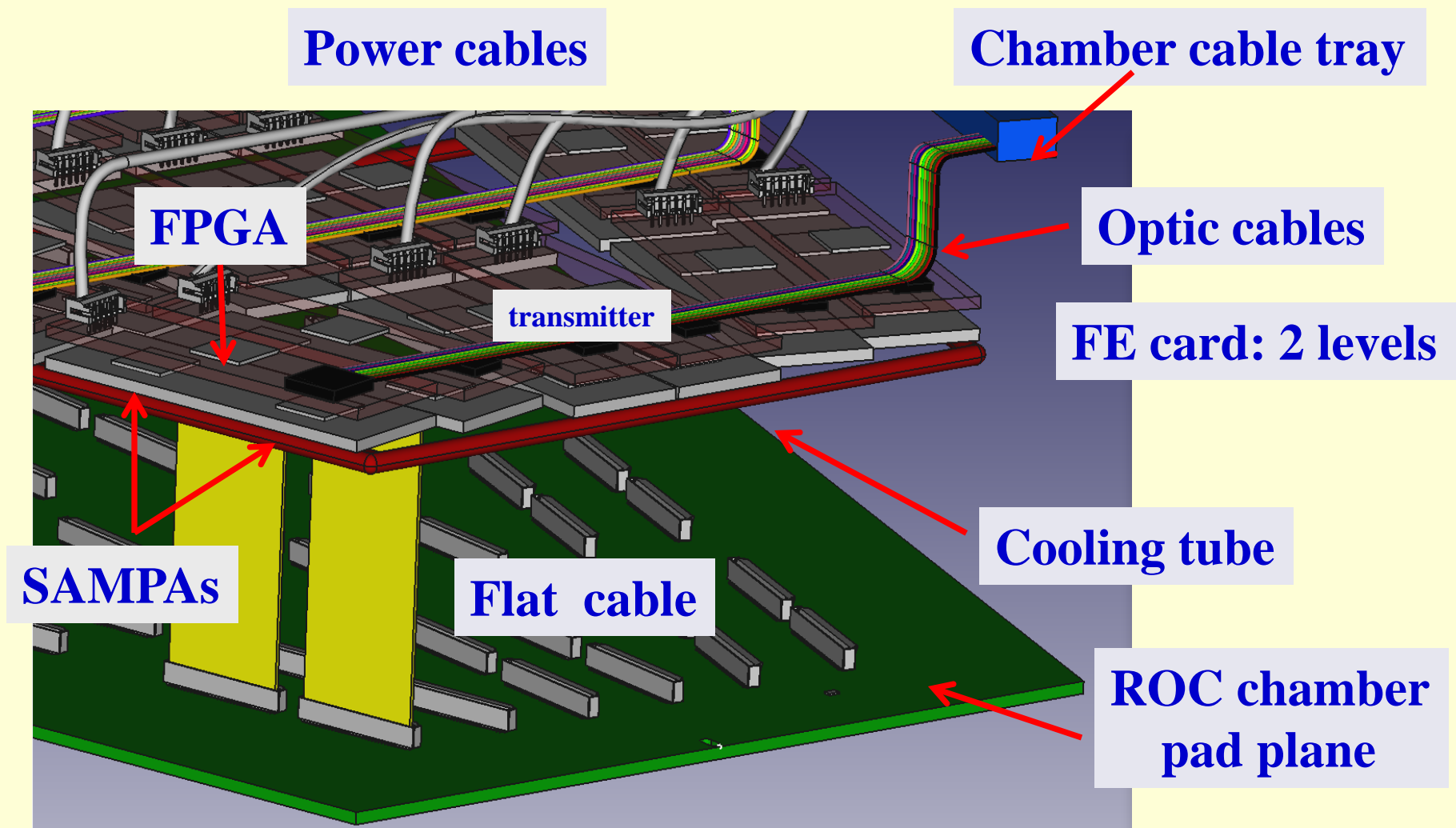
The main parameters of  
FEC-64 SAMPA:

- Total number of registration channels – 64
- Dynamic range – 100 fc
- ADC resolution – 10 bit
- ENC – less than  $1000e^-$
- SAMPA configuration and management via FPGA
- Readout serial interface – up to 2.5 Gbps

1) SAMPA ASIC - 32-channels; 2) Signal input connector; 3) FPGA with high-speed transceivers

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## ROC chamber + electronics integration: **concept**



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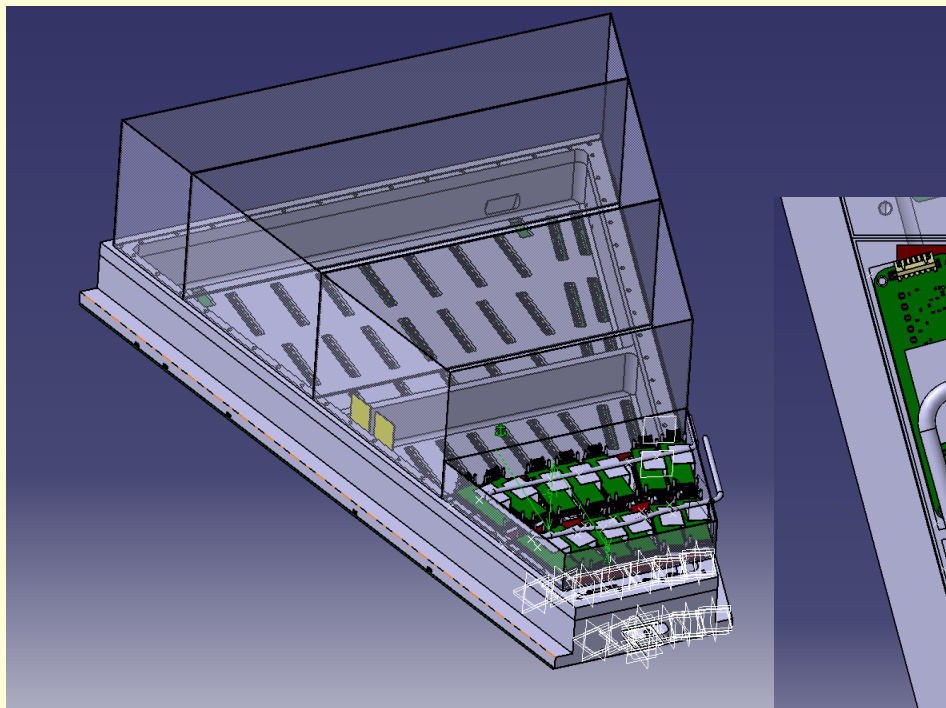
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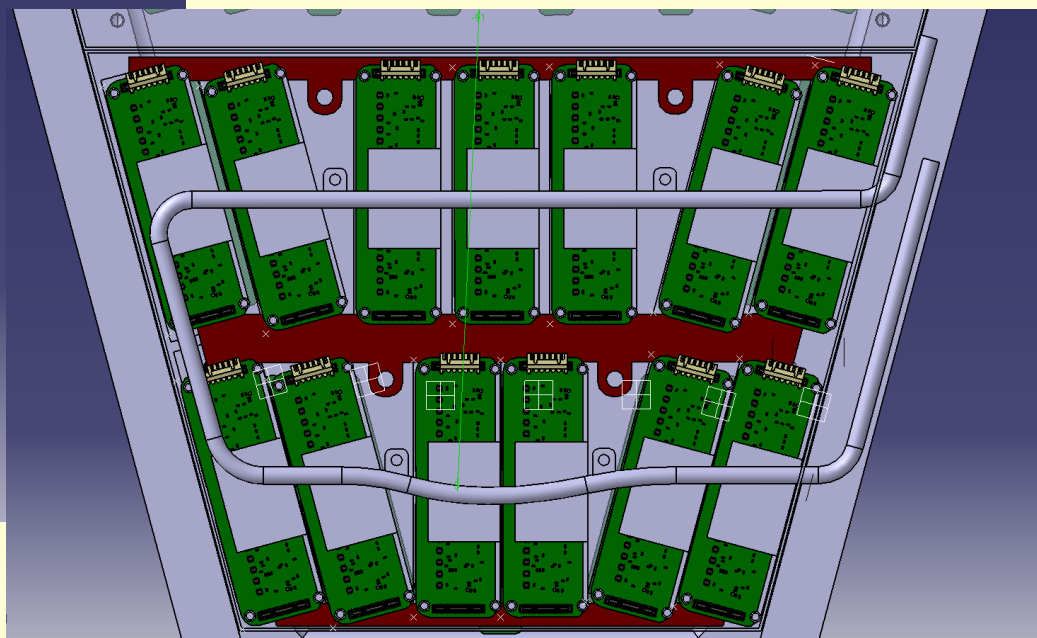


# ROC chamber + electronics integration

**Shielding: 4 boxes**



**FPGA cooling**



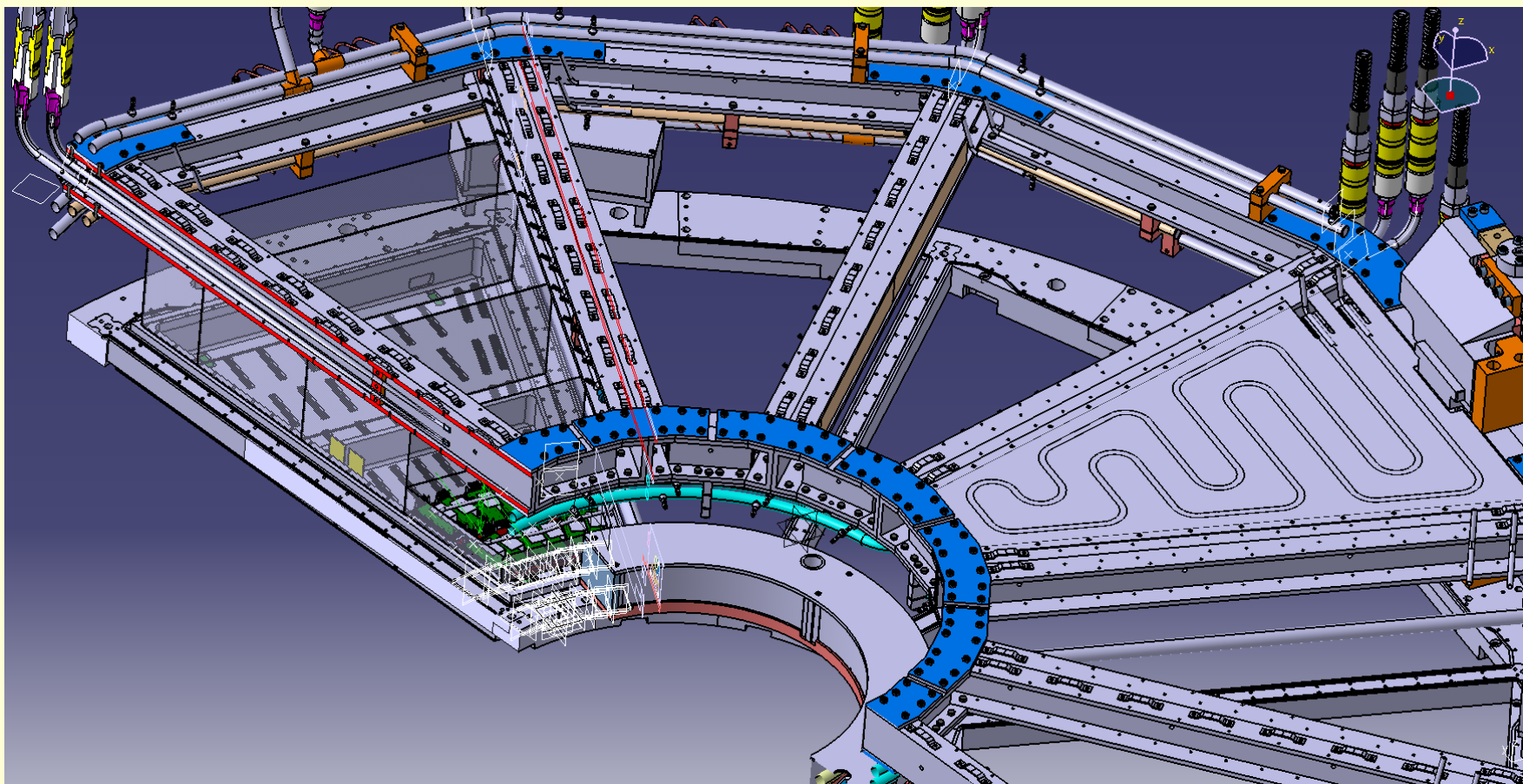
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# ROC chamber + electronics integration



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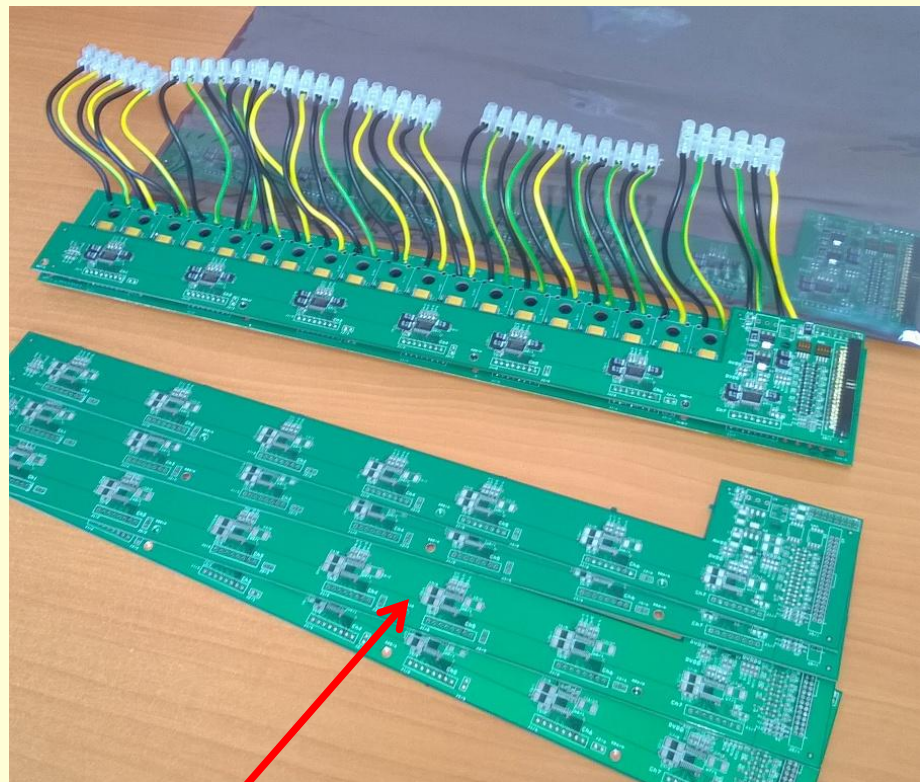
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# INP BSU (Minsk): low voltage distribution board (LVDB)

Prototype-01 (7 ch)



Slow control mezzanine board

Prototype-02 (14 ch)



Slow control integrated  
to LVDB board



# Gas, cooling and laser calibration systems: **gas**

**Rack 2**



**Rack 1**



Gas mixture	<b>Ar + 10%CH<sub>4</sub></b>
TPC gas flow, nominal	200 l/min
TPC overpressure	$(2.0 \pm 0.1)$ mBar
O <sub>2</sub> admixture	20 ppm
H <sub>2</sub> O admixture	10 ppm
External loop, refresh gas rate	30 l/min
Fresh part of gas mixture add to external loop, range	(0-50) l/min
TPC isolating gas	<b>N<sub>2</sub></b>
N <sub>2</sub> gas flow	(5-20) l/min

Status - **commissioning** (Bld.217)

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# Gas system: **commissioning** (bld. 217)

Gas supply



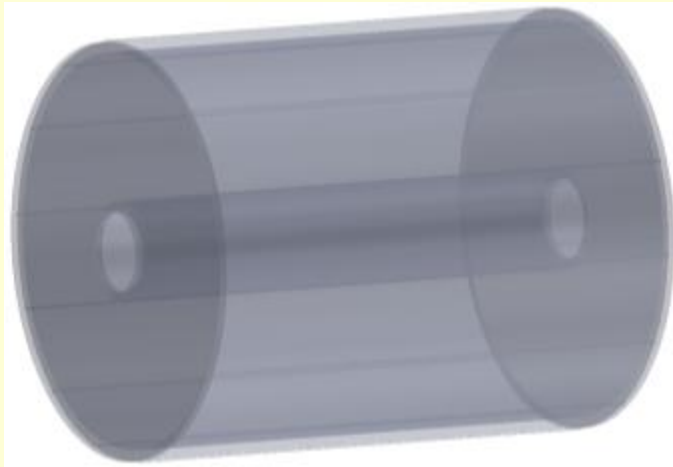
Racks

TPC volume imitator



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# Gas, cooling and laser calibration systems: **cooling**



**Sensors**

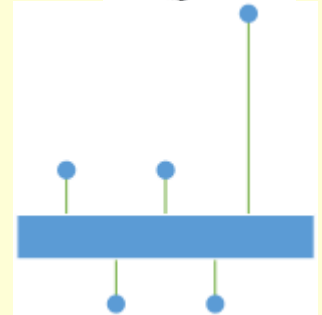
**Crate**



TANGO server



NET



Prototyping and software – in progress

Necessary to purchase: water tank, pumps, pipes, heat exchanger, control cabinet

**Cooling equipments and components **purchased** :**

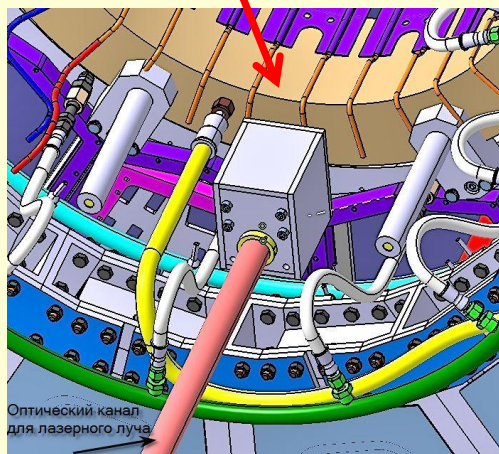
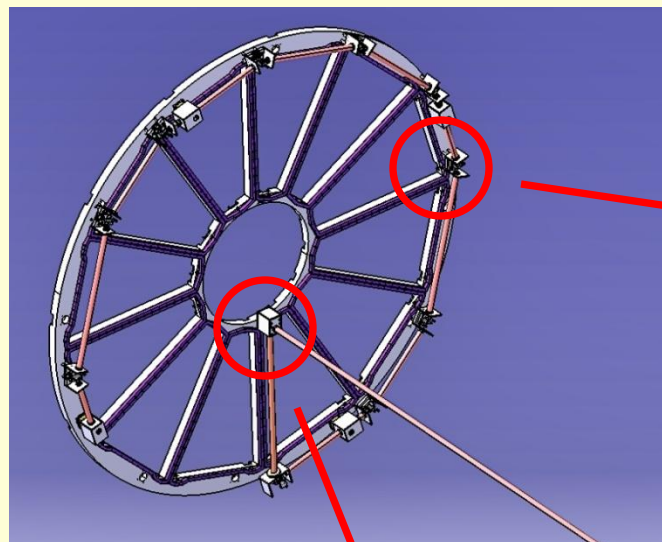
- |                            |          |
|----------------------------|----------|
| - crate NI PXle-1075       | – 1 pc   |
| - module NI TB 4357 (20ch) | – 10 pc  |
| - module NI TB 4300 (8ch)  | – 1 pc   |
| - temp. sensor             | – 200 pc |
| - pressure sensor          | – 4 pc   |

**Cooling system  
**prototype** will be  
delivered to JINR  
**April 2018****

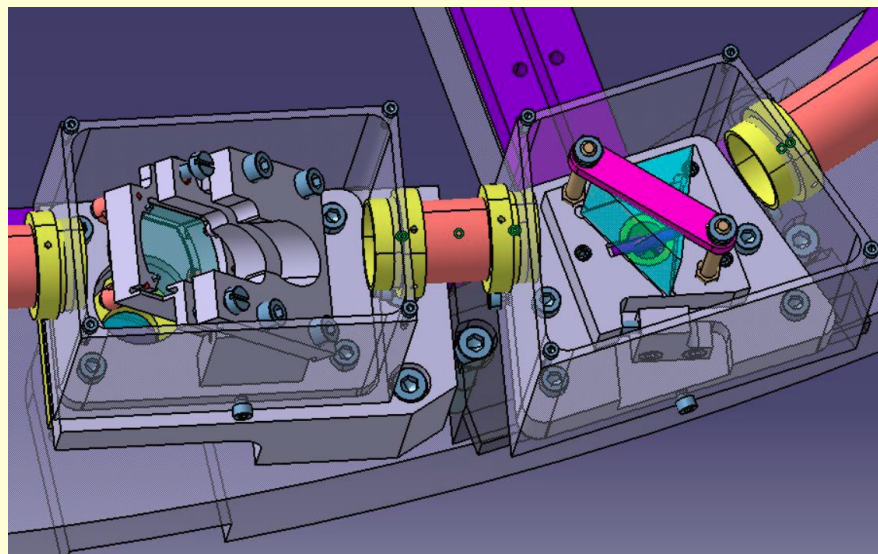
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# Gas, cooling and laser calibration systems: **calibration**



Semi transparency mirror & prism



- inner beam distribution system design – **done**
- 2 lasers (special option) – **delivered to JINR**

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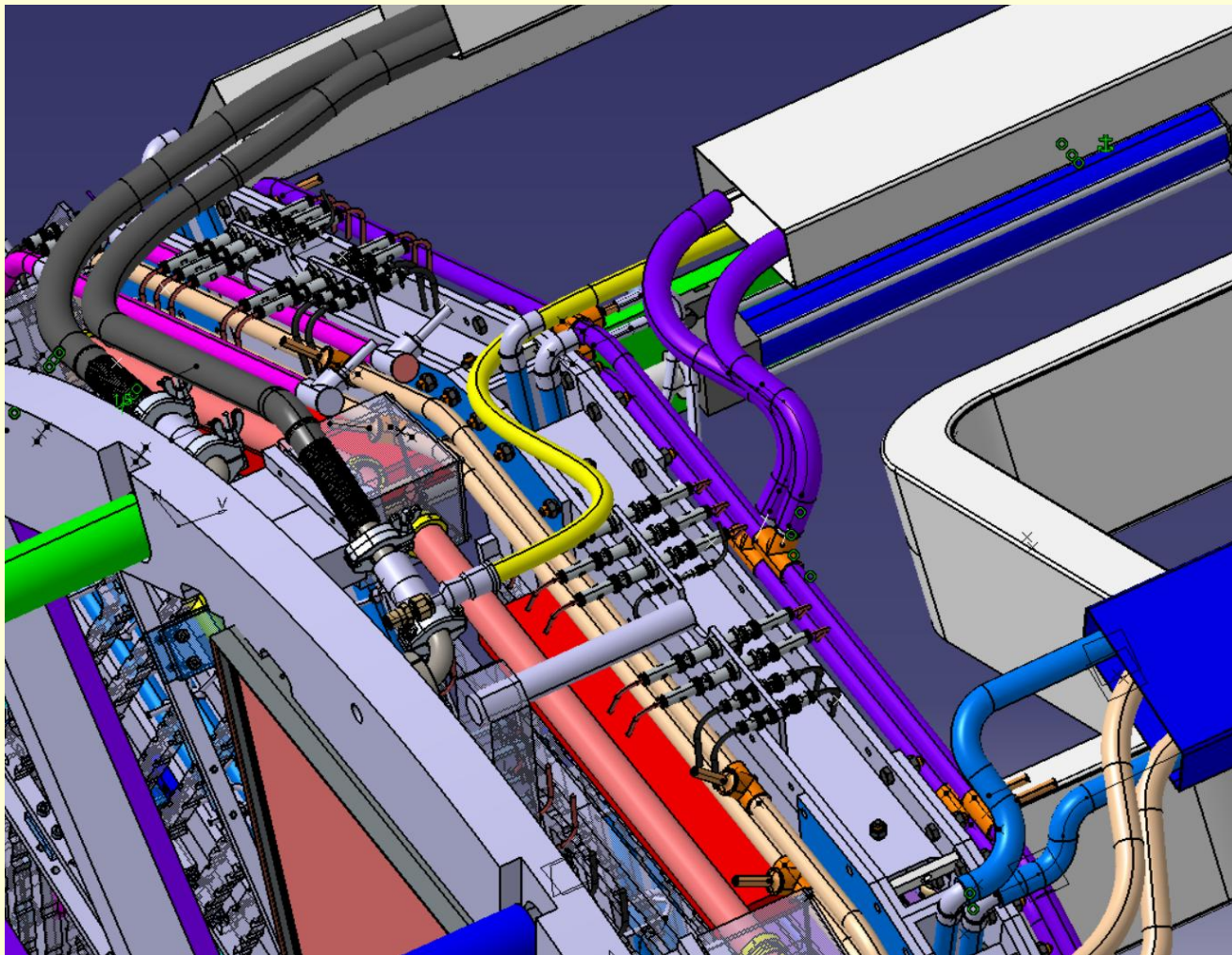
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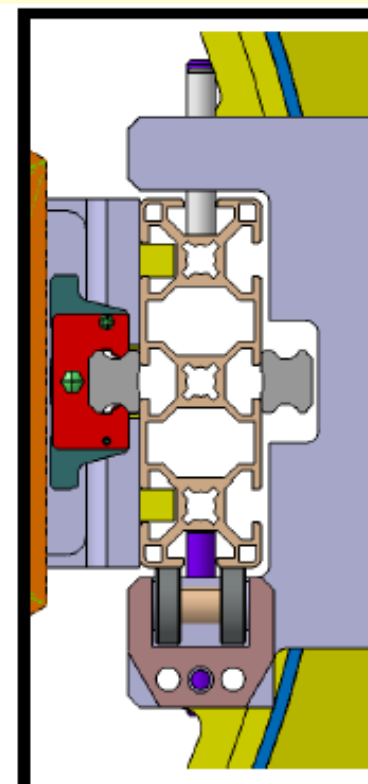
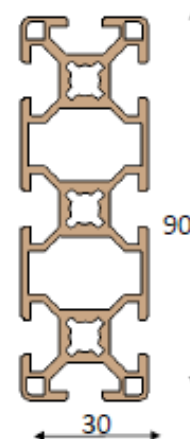
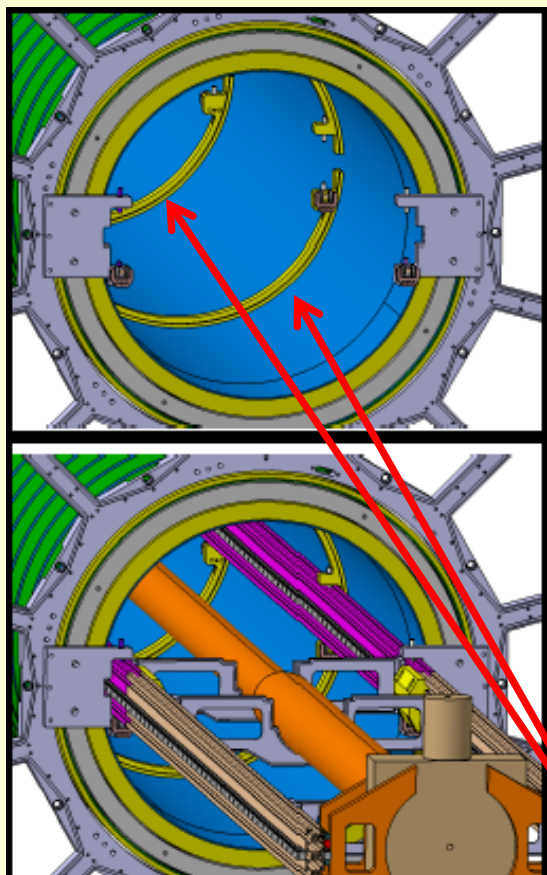


## TPC services: example of **integration**



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## MPD beam pipe concept: rail supports















**2 inner support rings** can be installed to C1 cylinder after finish TPC body assembly due to conflict with existing TPC assembly tooling

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# TPC time schedule

22.01.2018

## Time schedule

Task Name	2016	2017	2018	2019	2020
	I II III IV	I II III IV	I II III IV	I II III IV	I II III IV
TPC assembly hall ready					
TPC parts assembly: HV electrode + field cage + 2 flanges + C1÷C4					
TPC body assembly and leak test					
ROC chamber manufacture (26 pc)					
24 ROCs Installation to TPC					
TPC electronics manufacture (FEC64SAM&RCU)					
FEC cards installation to ROC chambers					
TPC tests with cosmic and laser calibration system, Bld.217					
TPC transportation from Bld.217 to the MPD hall					
TPC installation to MPD					
TPC sub-systems installation (gas and cooling - MPD hall)					
TPC commissioning					

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# Conclusion

- TPC assembly hall – **ready**
- TPC:
  - tooling for TPC body assembly – **ready**
  - manipulator for ROC chamber installation – **May 30 2018**
  - TPC parts: 4 cylinders –**ok**, 2 flanges – **ok**, HV electrode – **May 2018**
  - tooling for field cage manufacture and assembly – **June 2018**
  - assembly of ROC chambers (26 pc) – **waiting for serial padplanes**
  - **Pad plane:** quality is no so good ... **new pre-series samples ordered**  
PCB technology – **March 2018, under tests**  
Italy – **March 30 -> April 30 2018**
  - pre- serial ROC chambers: **1 pc - tested**
  - SAMPA rev.03 chips (30pc) – **tested** (good - 26 pc)
  - FEC32S board - **tested**
  - **FEC64SAM** board with 2pc SAMPAs –**tests started (ENC~500 e-)**
  - new concept of FE electronics integration with ROC chamber - **in progress**
  - gas system - **commissioning**
  - cooling and laser calibration systems – **in progress**
  - integration TPC to MPD – **in progress**

**TPC commissioning - 2020**

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