

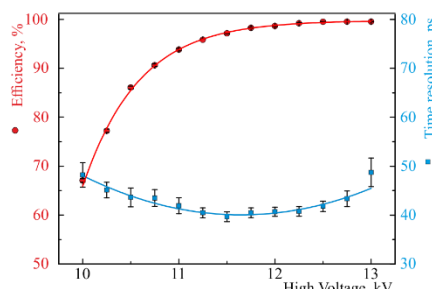
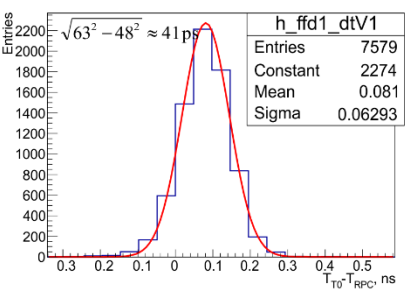
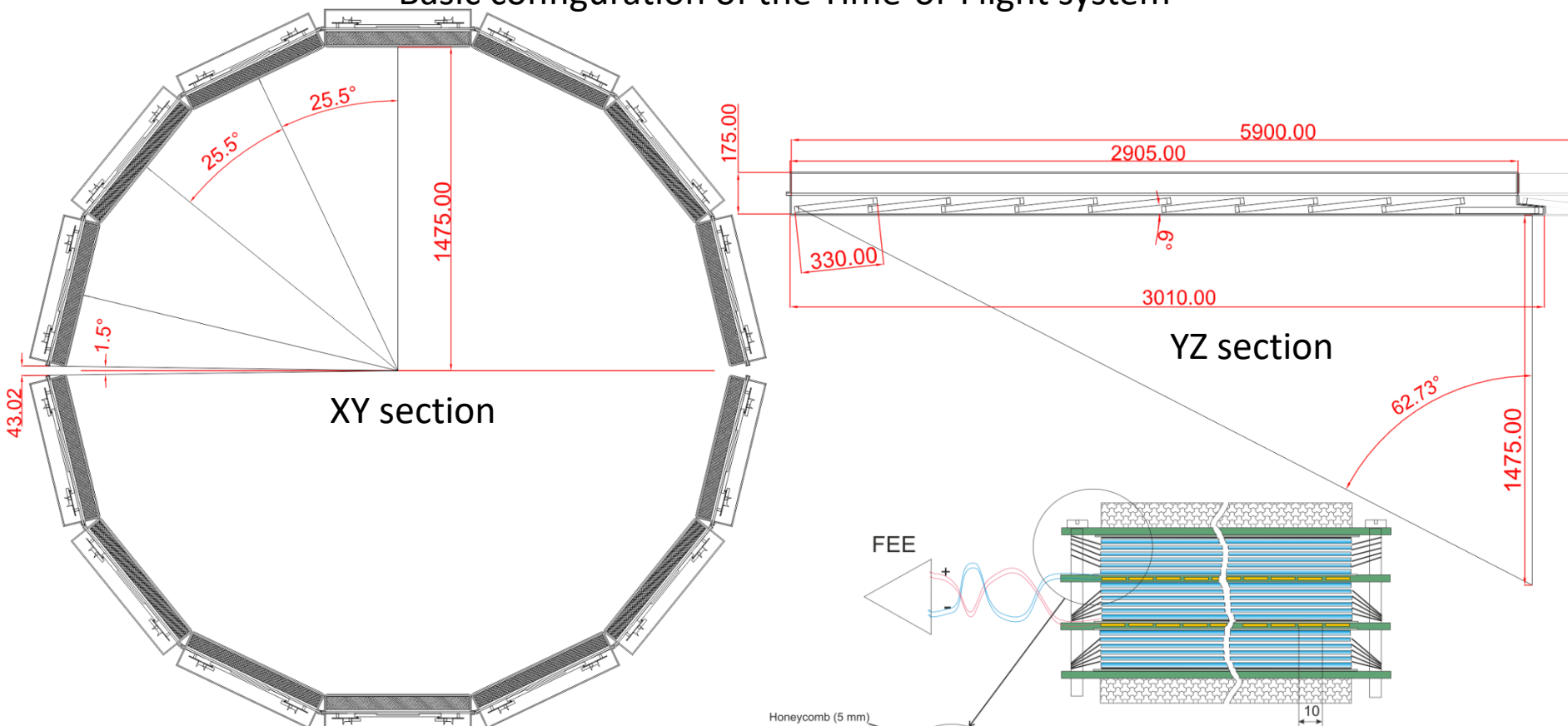
# Status of the Time-of-Flight system of the MPD

Vadim Babkin on behalf of the TOF group of the MPD collaboration

# Contents

1. MPD TOF overview
2. TOF assembling and testing
3. Actual time schedule of the TOF production
4. Installation, cabling, cooling
5. Conclusions

# Basic configuration of the Time-of-Flight system



	Number of detectors	Number of readout strips	Sensitive area, m <sup>2</sup>	Number of FEE cards	Number of FEE channels
MRPC	1	24	0.192	2	48
Module	10	240	1.848	20	480
Barrel	280	6720	51.8	560	<b>13440</b> (1680 NINO)

Time distribution between T0 and MRPC

Time resolution (■) and efficiency (●)

# Actual time schedule of the MPD TOF assembling

Task Name	Cost (in k\$)	Man Power	2011-2014				2015-2018				2019-2020					
			I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>Prototyping detector&amp;electronics, tests</b>			<b>Time resolution and efficiency studies</b>													
Prototyping of the MRPC construction	80	2														
Prototyping of electronics	150	1														
Cosmic ray test setup	120	2														
Test beam facility construction	150	4														
<b>Prototype Full scale module</b>			<b>Time resolution and efficiency studies</b>													
Materials order	50	1														
Gas box production	20	3														
Electronics order (TDC, DAQ)	30	1														
TOF module assembling&test	50	3														
<b>TDR</b>			<b>Technical design report</b>													
<b>Mass production area preparation</b>			<b>Rooms and tools preparation for mass production</b>													
Workshop preparation	100	2														
Equipment and tools order	100	1														
<b>Mass production of MRPC</b>			<b>Detectors production</b>													
Material order	150	2														
Equipment order	100	2														
Team organizing		1														
Production of Barrel TOFs	400	7														
Assembling detectors in modules	150	4														
<b>Cosmics and r/source tests</b>			<b>Mass test of RPC detectors</b>													
Assembling the test setup	100	4														
Testing of MRPCs with a cosmic rays		4														
<b>FE electronics production</b>			<b>Fast preamplifiers and TDC mass production</b>													
Front End electronics development	100	3														
Assembling redout cards	500	3														
Front End electronics tests	50	2														
<b>DAQ system for TOF</b>			<b>Production of the DAQ electronics</b>													
Development of the DAQ TOF system	100	3														
Production of the DAQ TOF system	800	6														
<b>Cabling, modules assembling</b>																
Gas system construction	200	5														
<b>Slow control system construction</b>																
<b>Installation</b>			<b>Installation of the TOF modules and electronics into the MPD</b>													
Installation of the TOF modules in the MPD	100	10														
Commissioning the TOF system	50	4														

# Current situation of the MRPC mass-production

Mass production staff: 4 physicists, 4 technicians, 2 electronics engineers

All procedure of detector assembling and optical control is performed in a clean rooms ISO class 6-7.



Glass cleaning with ultrasonic wave & deionized water



Automatic painting of the conductive layer on the glass



MRPC assembling



Soldering HV connector and readout pins

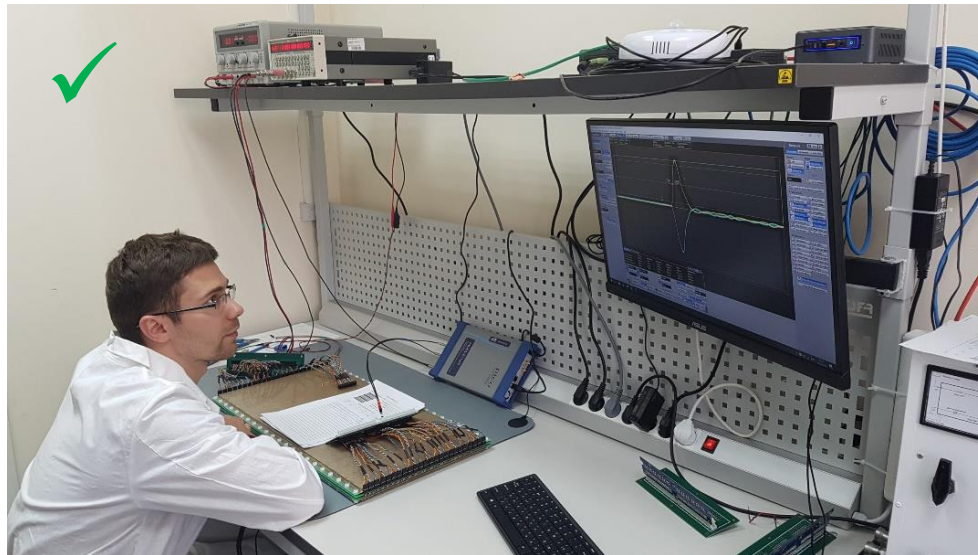
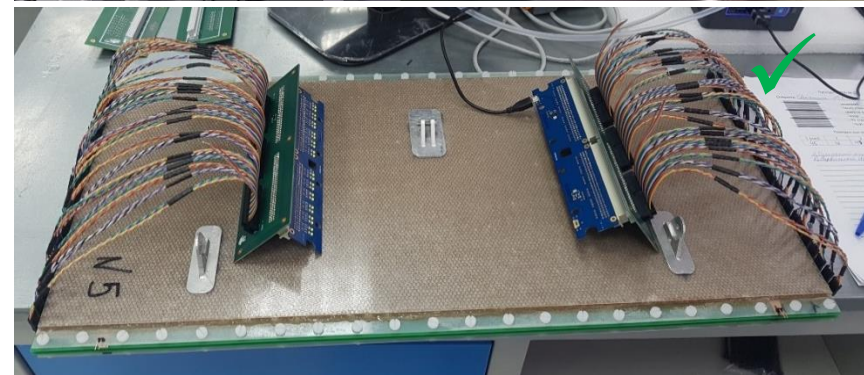
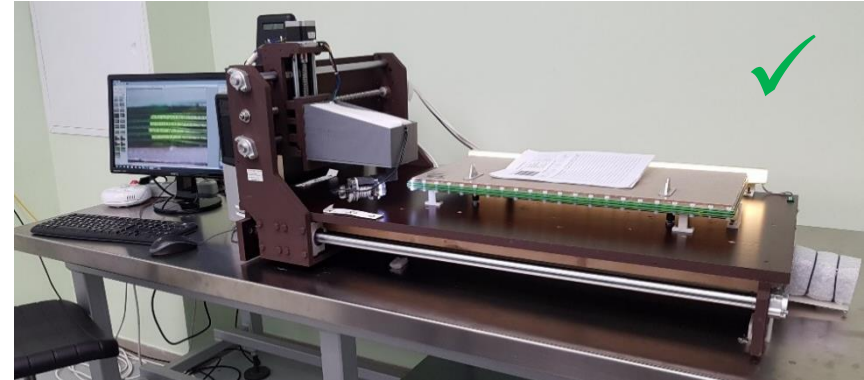
# MRPC detectors quality control

The quality control of the assembled detectors takes place in five stages.

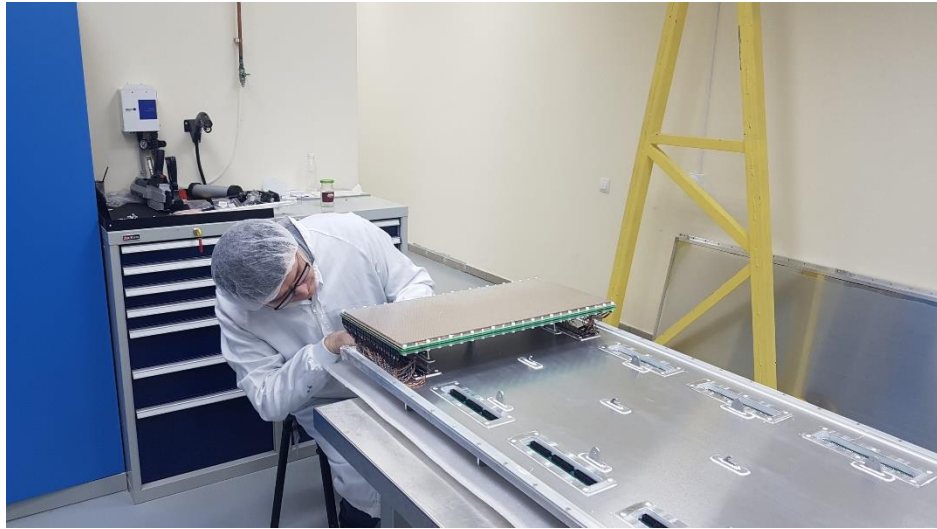
## Check list

- ✓ 1) Optical control (gap uniformity, cracks in glass)
- ✓ 2) Primary HV testing (without gas) - up to 6 kV
- ✓ 3) Readout pins and cables break, short-circuit and reversed polarity control
- ✓ 4) Full HV testing (after fast pumping and filling with working gas mixture) – up to 12 kV
- ✓ 5) Transmission line impedance (reflection) control

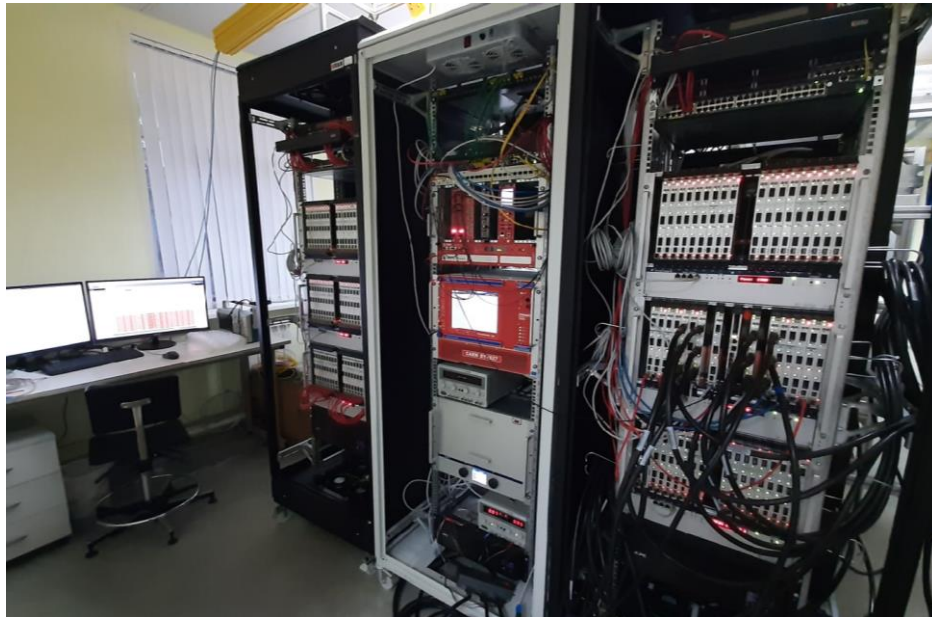
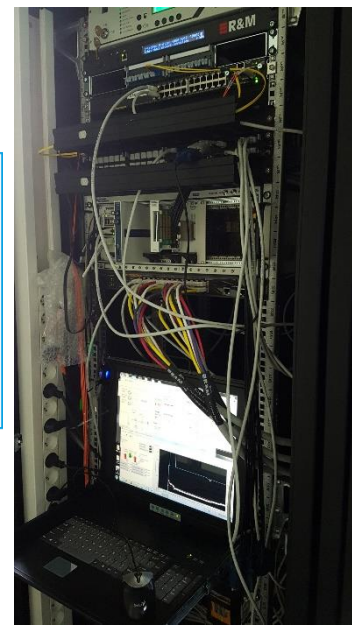
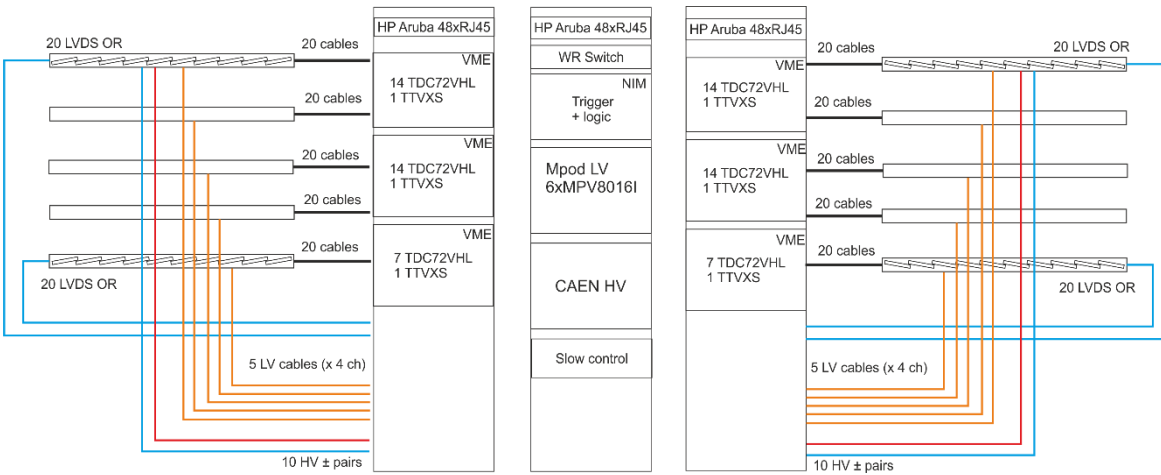
✓ Ready for installation!



# TOF modules assembling



# Cosmic test stand



We need new gas system for MPD hall due to low maximum gas flow ( $\sim 300 \text{ cm}^3/\text{min}$ )

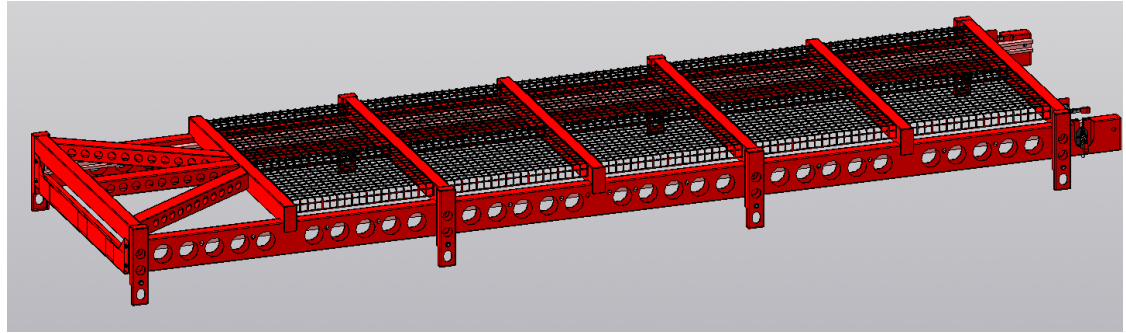
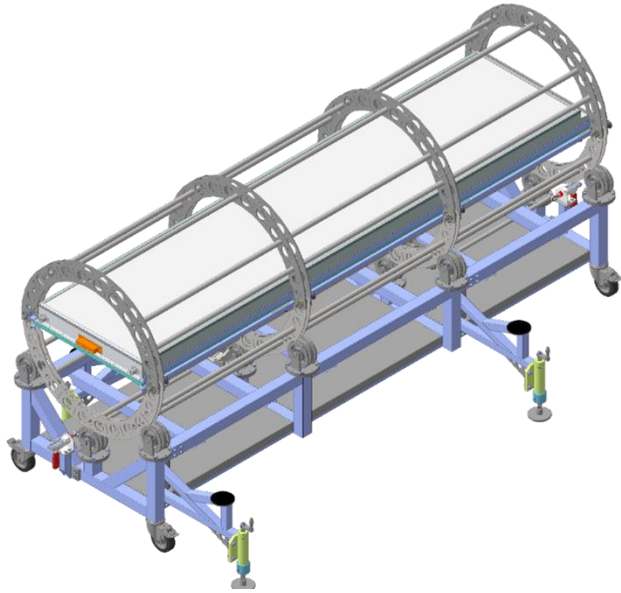


## Time schedule of the TOF detectors and modules assembling (October 2019)

Month/year	Weeks (working days)	Detectors per month (total)	Completed modules
September/19	4 (20)	20 (50) <b>50 (27/09/2019)</b>	3 <b>3</b>
October/19	5 (25)	22 (72) <b>60 (22/10/2019)</b>	5 <b>3</b>
November/19	4 (19)	23 (95) <b>70 (22/11/2019)</b>	8 <b>4</b>
December/19	4 (20)	24 (119) <b>80 (26/12/2019)</b>	10 <b>4</b>
January/20	4 (17)	20 (139)	12 <b>4</b>
February/20	4 (19)	23 (162) <b>90 (14/02/2020)</b>	15 <b>4</b>
March/20	4 (19)	22 (185) <b>98 (26/03/2020)</b>	18 <b>4</b>
April/20	4 (24)	29 (214) <b>98 (23/04/2020)</b>	21 <b>4</b>
May/20	4 (19)	23 (237)	23
June/20	4 (19)	23 (260)	25
July/20	5 (25)	30 (290)	28
August/20	4 (20)	10 (300)	30 (2 – for reserve)
<b>Total</b>		Detectors: 300	Modules: 30

## Actual time schedule of the TOF detectors and modules assembling

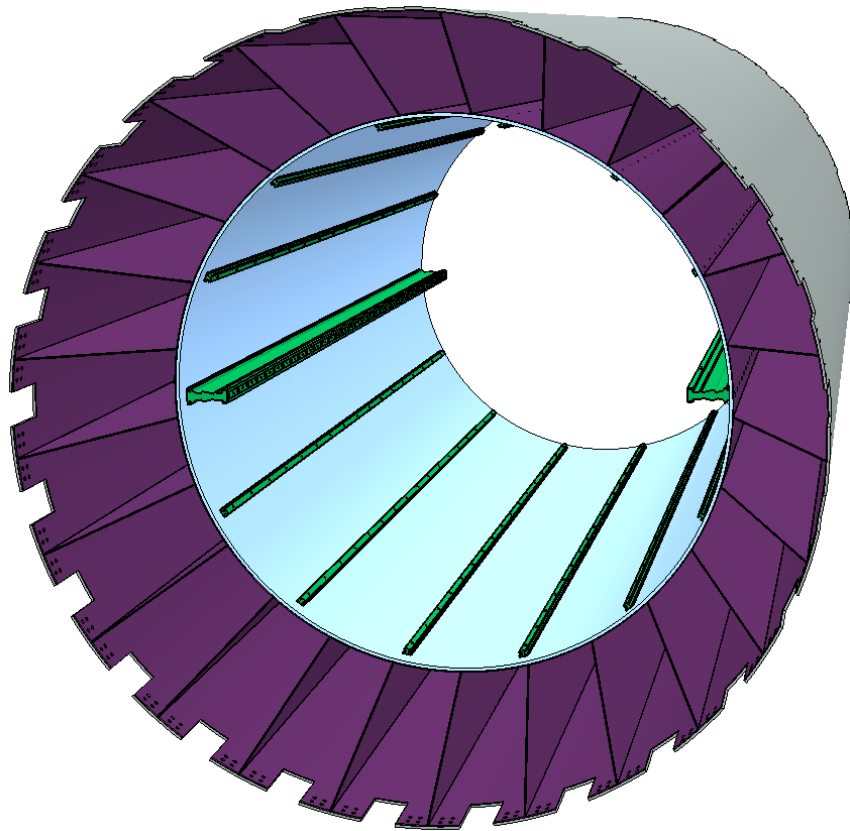
Month/year	Weeks (working days)	Detectors per month (total)	Completed modules
April/20	5 (24)	0 (98) <b>98 (26/03/2019)</b>	4
May/20	3 (10)	12 (110) ?	6
June/20	4 (19)	15 (125)	8
July/20	5 (25)	20 (135)	10
August/20	4 (20)	16 (151)	12
September/20	4 (20)	16 (167)	14
October/20	5 (25)	20 (187)	16
November/20	4 (19)	15 (202)	18
December/20	4 (23)	17 (219)	20
January/21	3 (15)	12 (231)	22
February/21	4 (19)	15 (246)	24
March/21	4 (19)	15 (261)	26
April/21	5 (24)	20 (281)	28
May/21	3 (16)	12 (292)	29



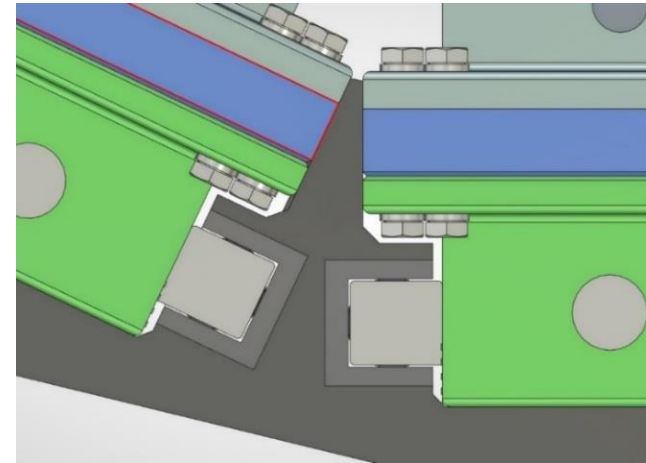
First TOF transportation cartridge (10/02/2020)

All the equipment should be commissioned in July 2020

## Installation of the TOF modules into the MPD yoke



Rails on the carbon mounting frame

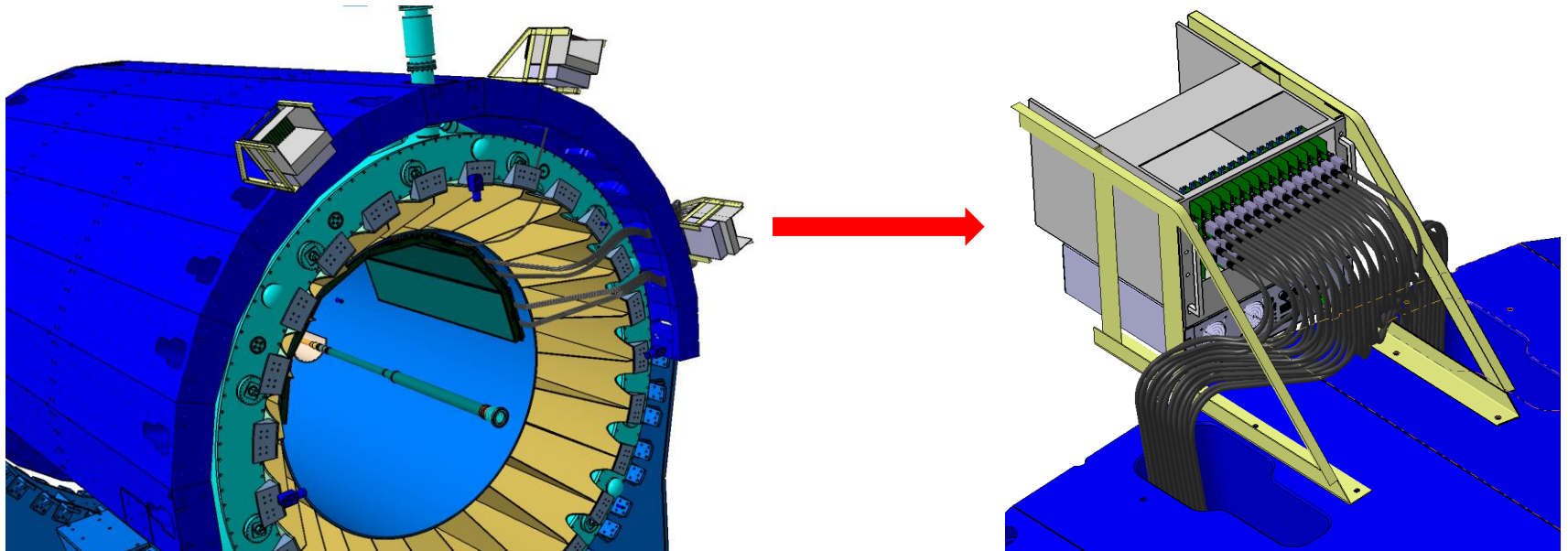


Carriages for TOF module sliding into the MPD



The design of equipment for installation and detail procedure not yet completed. But it should be similar to the ECal installation procedure due to the similar dimensions. We already work for tof installation with «TSNIISM» (Hotkovo) where ECal installation equipment is designed.

# Cabling (LV, HV, signal)



In real life we have fixed lengths of cables. Therefore we need to reel them somewhere.



98 HV cables and 28 distribution boxes for 28 TOF modules

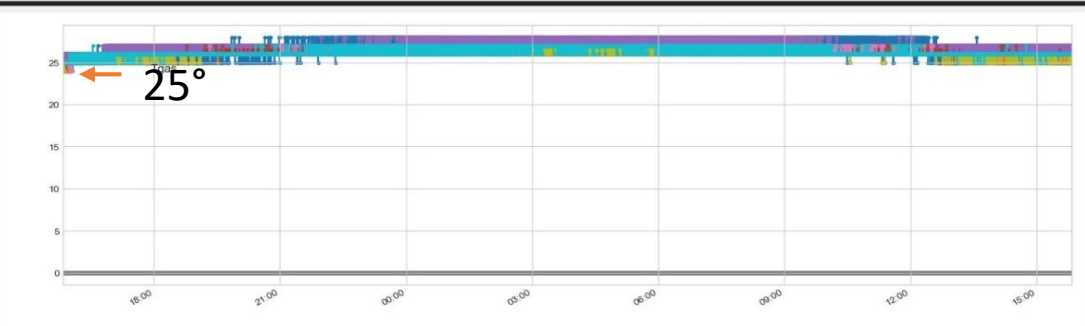
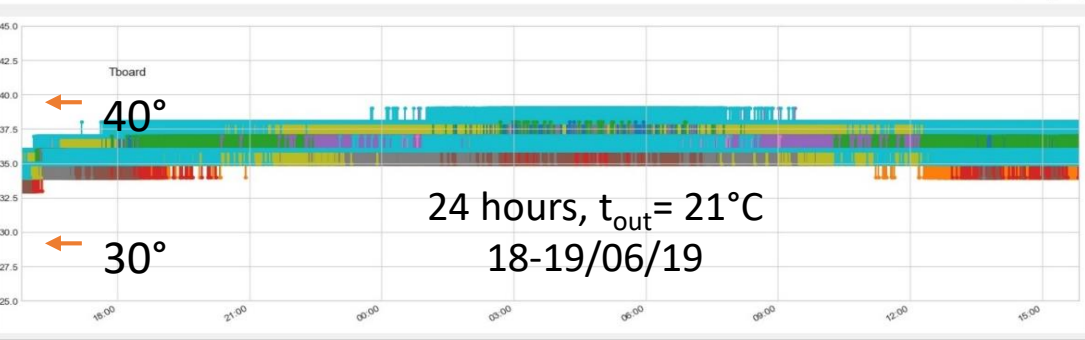
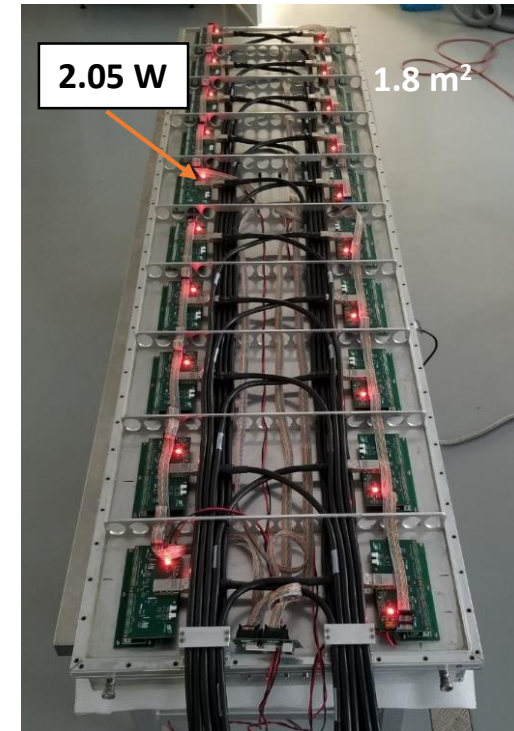
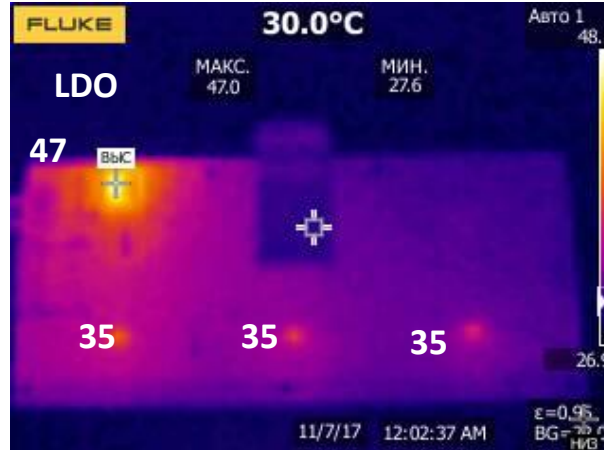


28 LV power cables needed

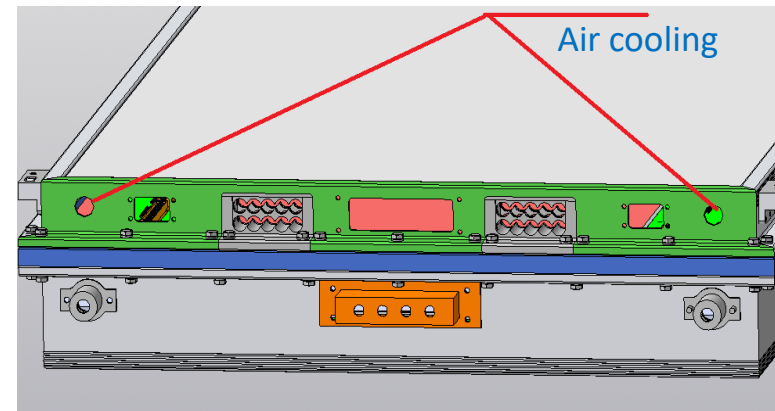
# Cooling

## TOF subsystems power consumption

Part	Power, W
Power of FEEs with LV cables heating	<b>1120</b>
LV modules, crates	400
Power of Readout Electronics (TDC)	4200
Power of HV modules	600
Power of slow control devices	800
Power of the gas system	1000
<b>Total</b>	<b>8000</b>



## Temperature test of the TOF module



## Current status of production and equipment purchasing

Task	Current status	Readiness
<b>TOF modules</b>		
Materials for detectors	Purchased all the materials and components. The production of detectors is started at the beginning of March.	100%
TOF module box	In stock – 21 pcs of 28. The last shipment was due in April.	75%
<b>TOF cosmic test stand</b>	In operation.	100%
<b>TOF front-end electronics</b>	In stock – ~600 (560 needed).	100%
<b>DAQ system</b>		
Signal cables	In stock – 680 pcs (560 needed).	100%
VME64x VXS crates	In stock – 16 pcs (14 needed).	100%
TDC72VHL modules	In stock – 166 pcs (v4) + 50 (v4) ordered (196 needed).	85%
<b>Gas system</b>	In operation. We need to produce new gas system for building 17.	100%
<b>TOF integration</b>	The production of first part of equipment in the final stage. A tender for design of the installation equipment of TOF inside MPD has been announced.	50%
<b>HV &amp; LV systems</b>		
Mpod LV+HV power crate	In stock – 6 pcs (6 needed).	100%
LV	In stock – 16 pcs (14 needed).	100%
HV	In stock – 32 pcs (28 needed).	100%
HV&LV cables	First samples of new HV and LV cables are purchased and tested.	0%

## Conclusions

1. Most of the equipment for the TOF system was purchased with a reserve.
2. Mass production of detectors has been ongoing since April 2019. At the moment 35% is ready. We need to speed up production corresponding to plan.
3. Four TOF modules are assembled and two of them are on the test stand. The cosmic test stand is in operation and continuously upgrading.
4. A new closed-loop gas system for MPD hall is necessary. It should provide a maximum gas mixture flow of up to 10 liters per minute.
5. The equipment for TOF modules installation to MPD is designed. Electronics cooling and cabling problems are discussed and solved.



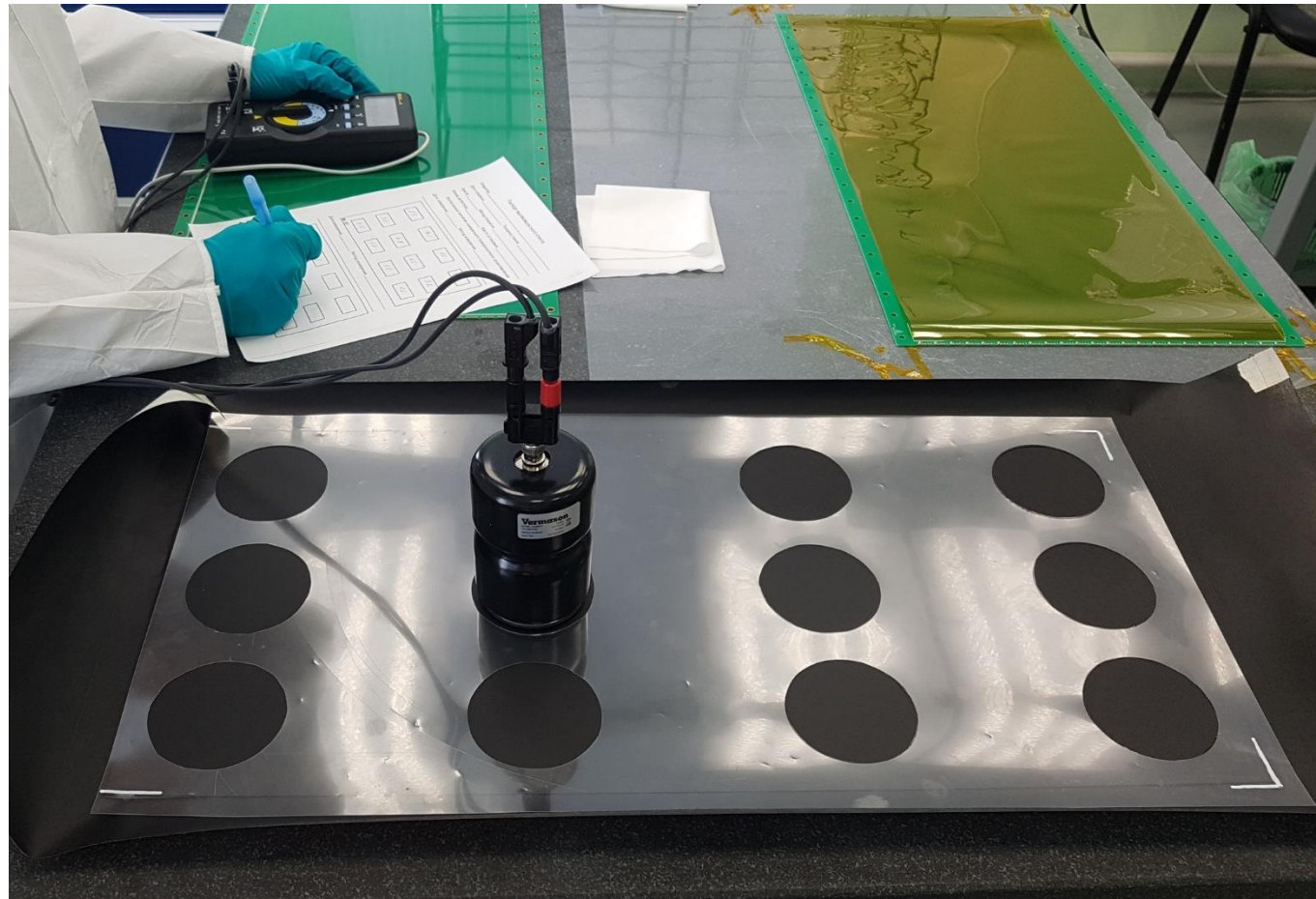
Thank you for the attention!

# Backup

# MRPC detectors quality control

Preliminary materials control (before assembling):

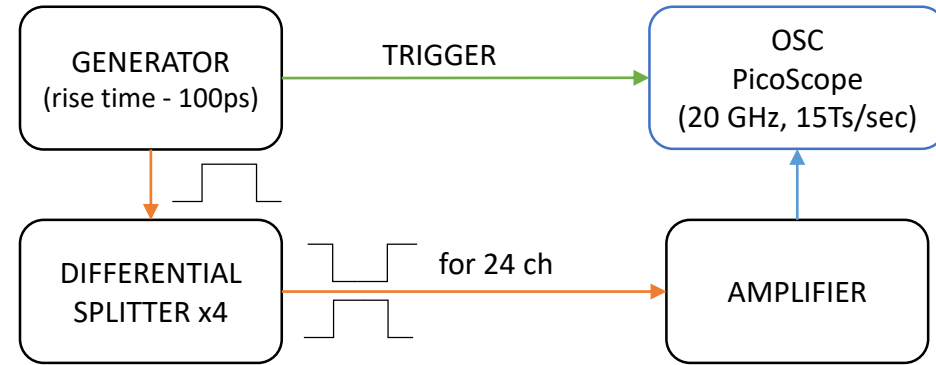
- ✓ glass integrity & thickness
- ✓ honeycomb & PCB flatness
- ✓ HV layer surface resistivity



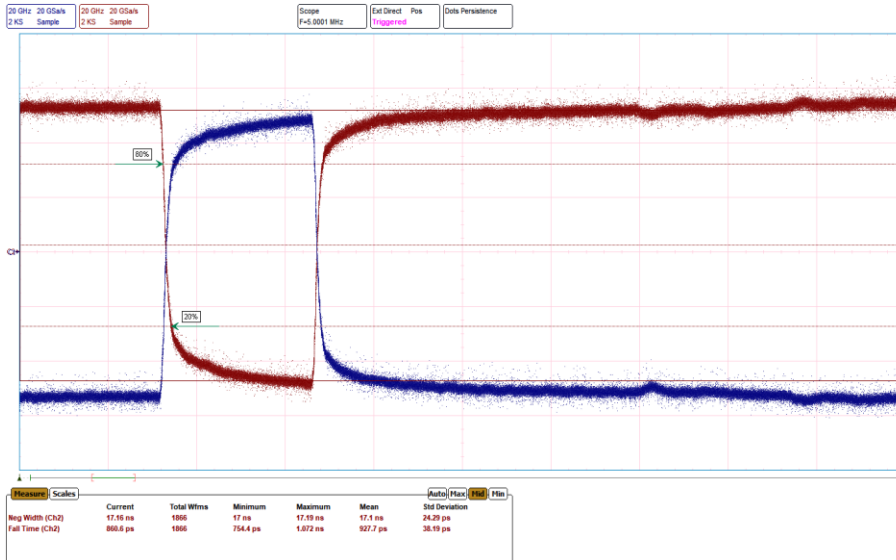
# Readout electronics and transmission line control

- ✓ Visual test
- ✓ Electrical test: +2V5, +3V3, thresholds, biasing
- ✓ Electrical signal test (Picoscope 20GHz 15GS/s):
- ✓ 1) Mask test (OSC)
- ✓ 2) Stability rise time & width
- ✓ 3) The level of reflected signal

If it's all fine: adding serial number, addressing, flashing firmware, adding to the database and labeling



Electronics test bench scheme



Output signal from the preamplifier

23.04.2020



Transmission line impedance control

Vadim Babkin, TOF status

20