National research center “Kurchatov institute” –
Petersburg Nuclear Physics Institute

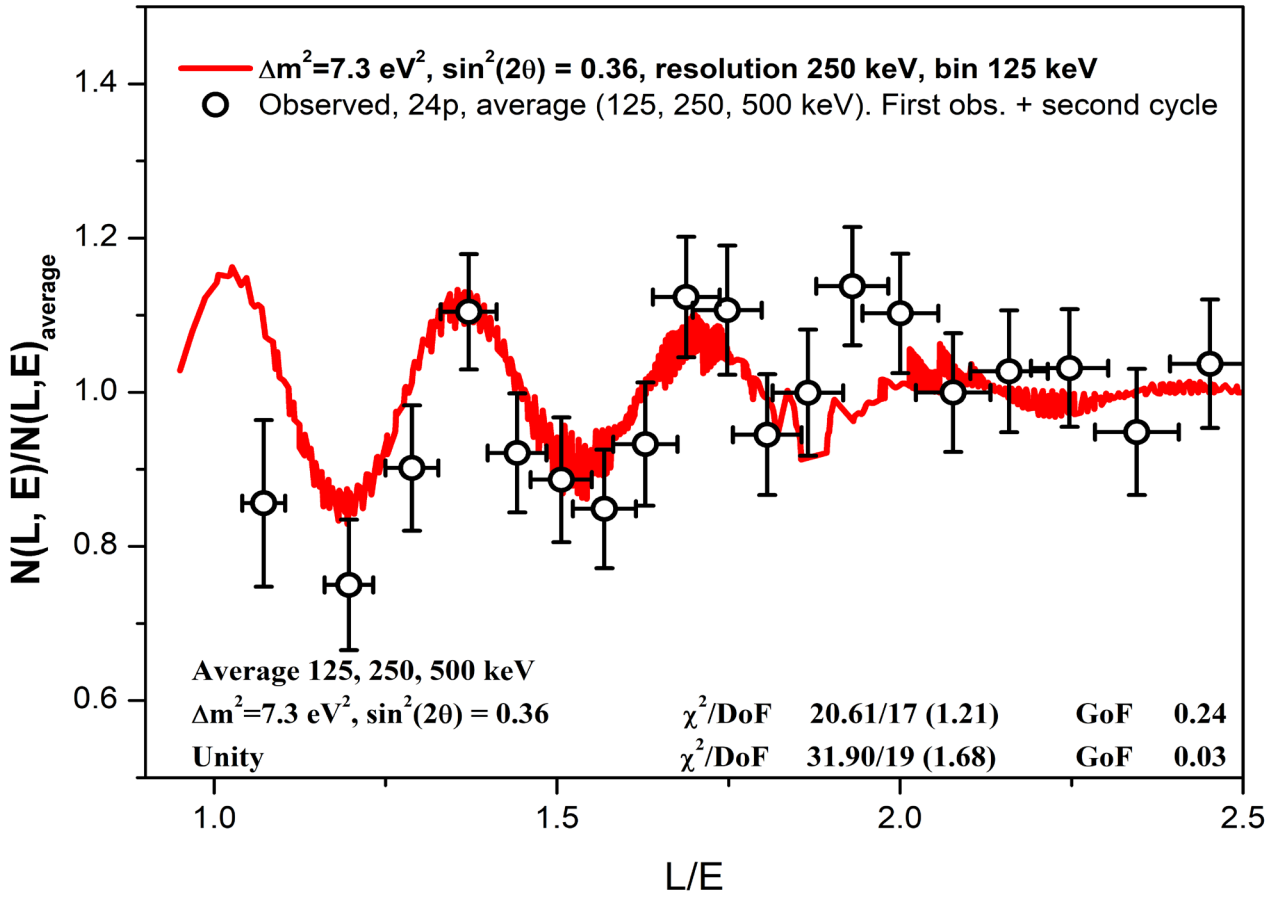
Preparation of the Neutrino-4+ experiment at the SM-3 reactor

Serebrov A.P., Ivochkin V. G., Samoilov R.M., Fomin A.K., Neustroev P.V., Golovtsov A.V., Volkov S.S., Gruzinsky N.V., Fedorov V.V., Gerasimov A.A., Zaytsev M.E., Chaikovskii M.E.

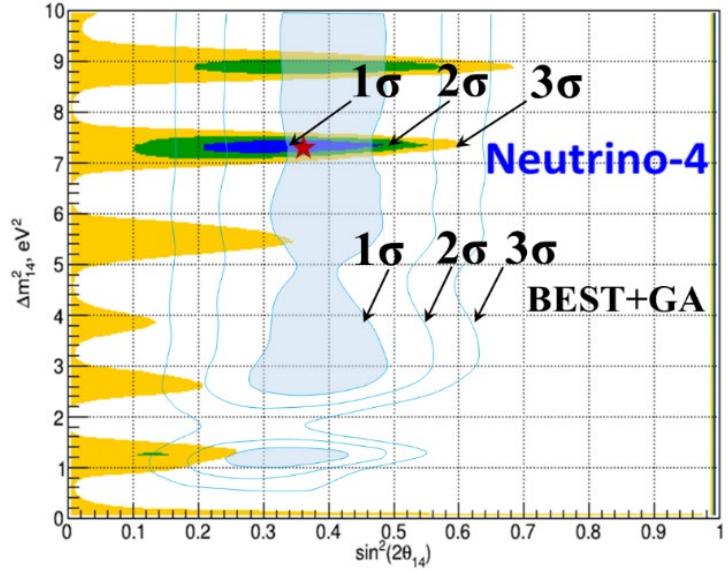
XXI LOMONOSOV CONFERENCE ON ELEMENTARY PARTICLE PHYSICS 2023

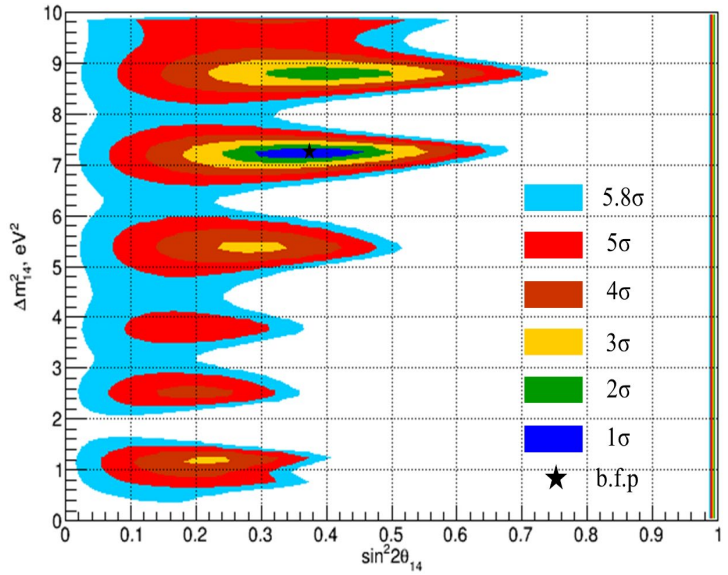
Search for sterile neutrino

$\Delta m^2_{14} = 7.3 \pm 1.17\ eV^2$, $\sin^2 2\theta_{14} = 0.36 \pm 0.12$ CL 2.9σ



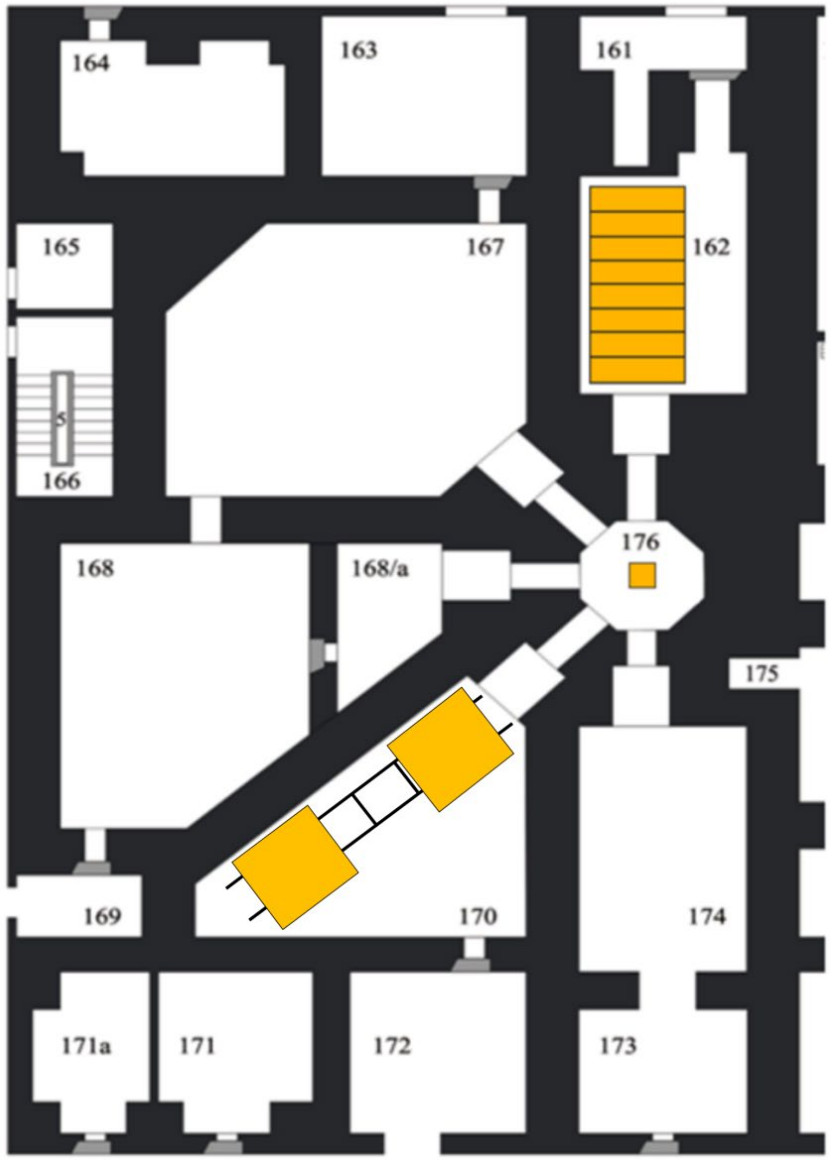
Best fit in joint analysis with GA (including last BEST result) $\Delta m^2_{14} = 7.3\ eV^2$, $\sin^2 2\theta_{14} = 0.38$





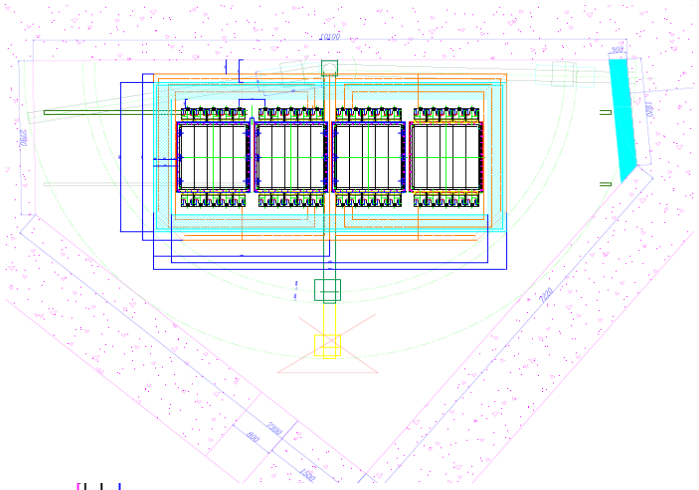
4ν hypothesis CL 5.8σ

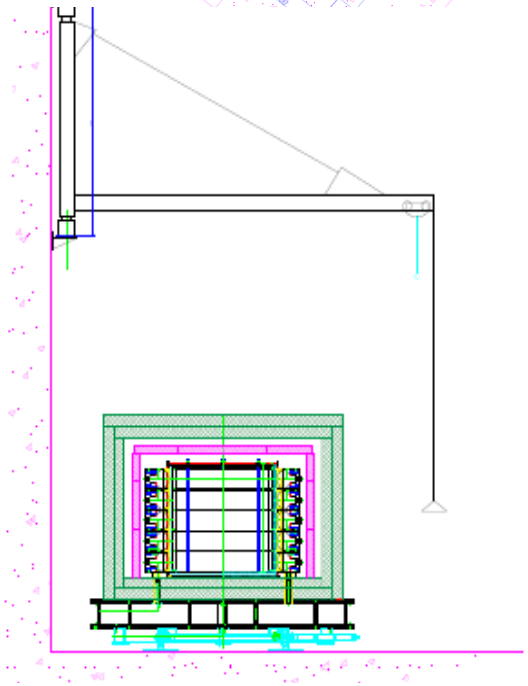
Neutrino-4+ at SM-3 reactor



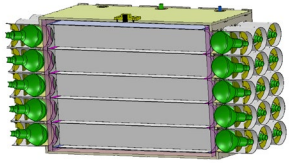
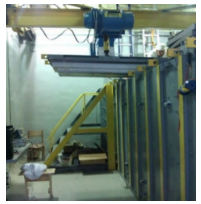
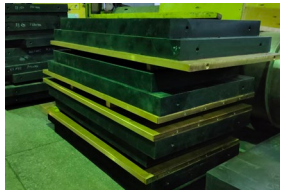
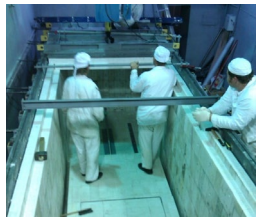
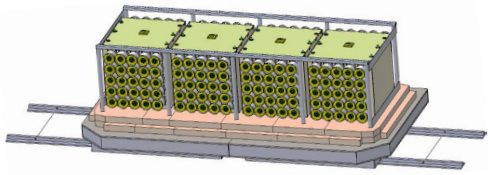
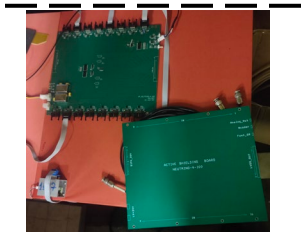
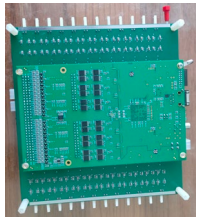
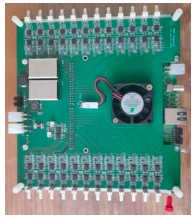
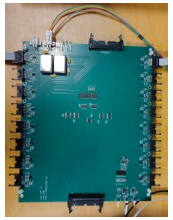
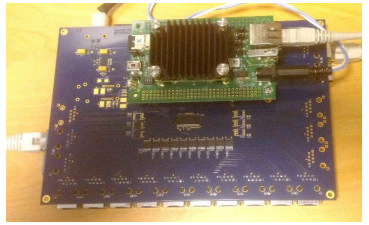
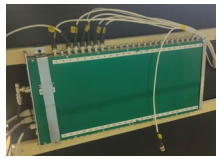
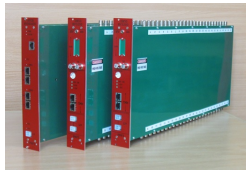
Laboratory in room 162

Laboratory in room 170

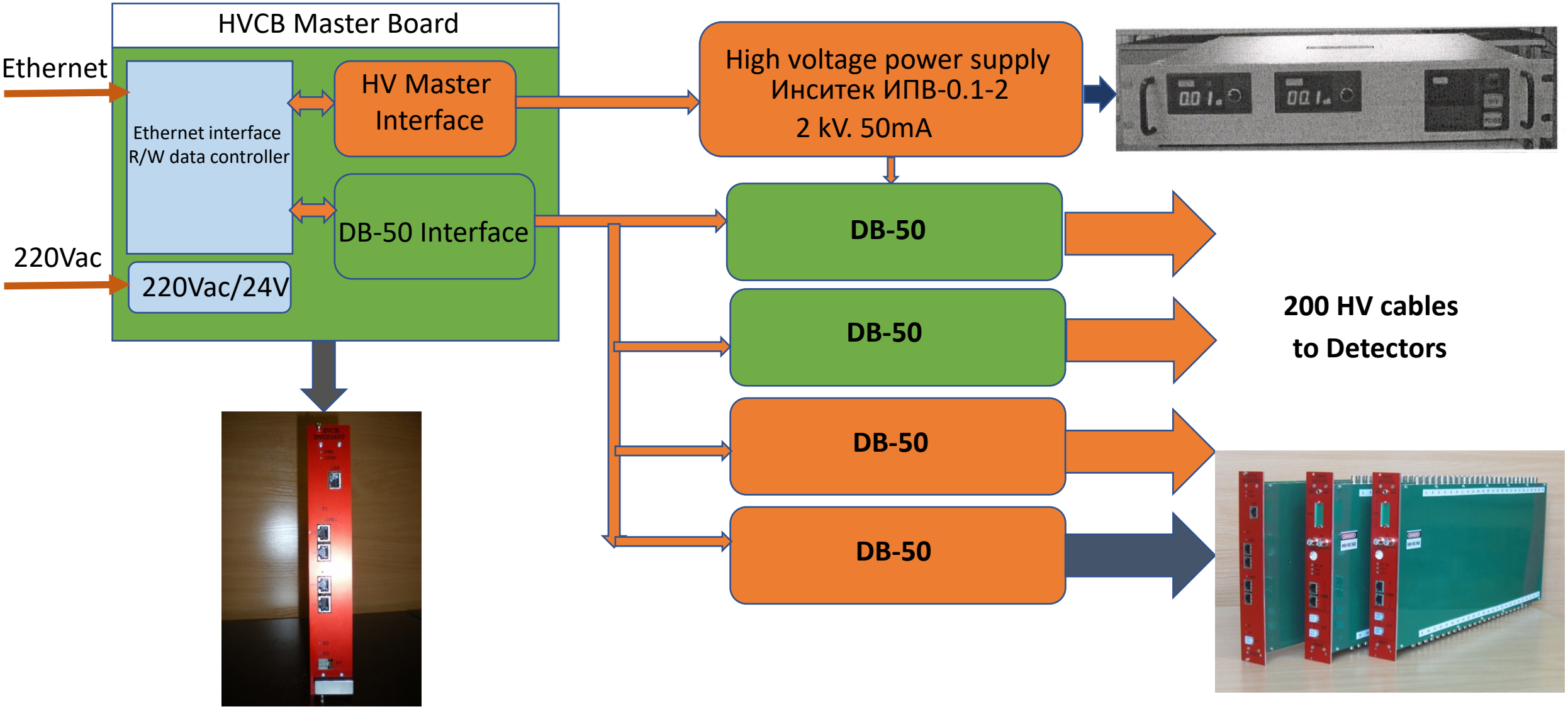




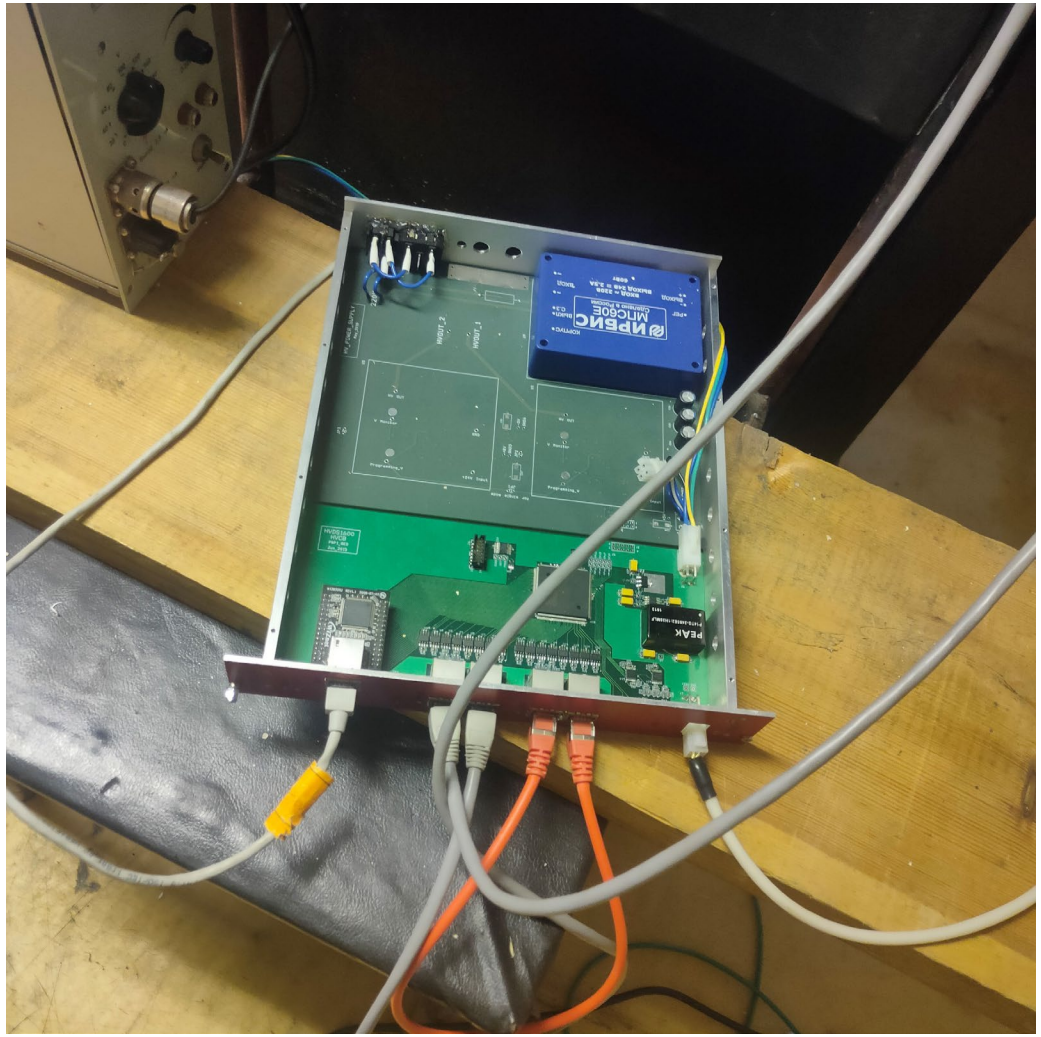
Detector design

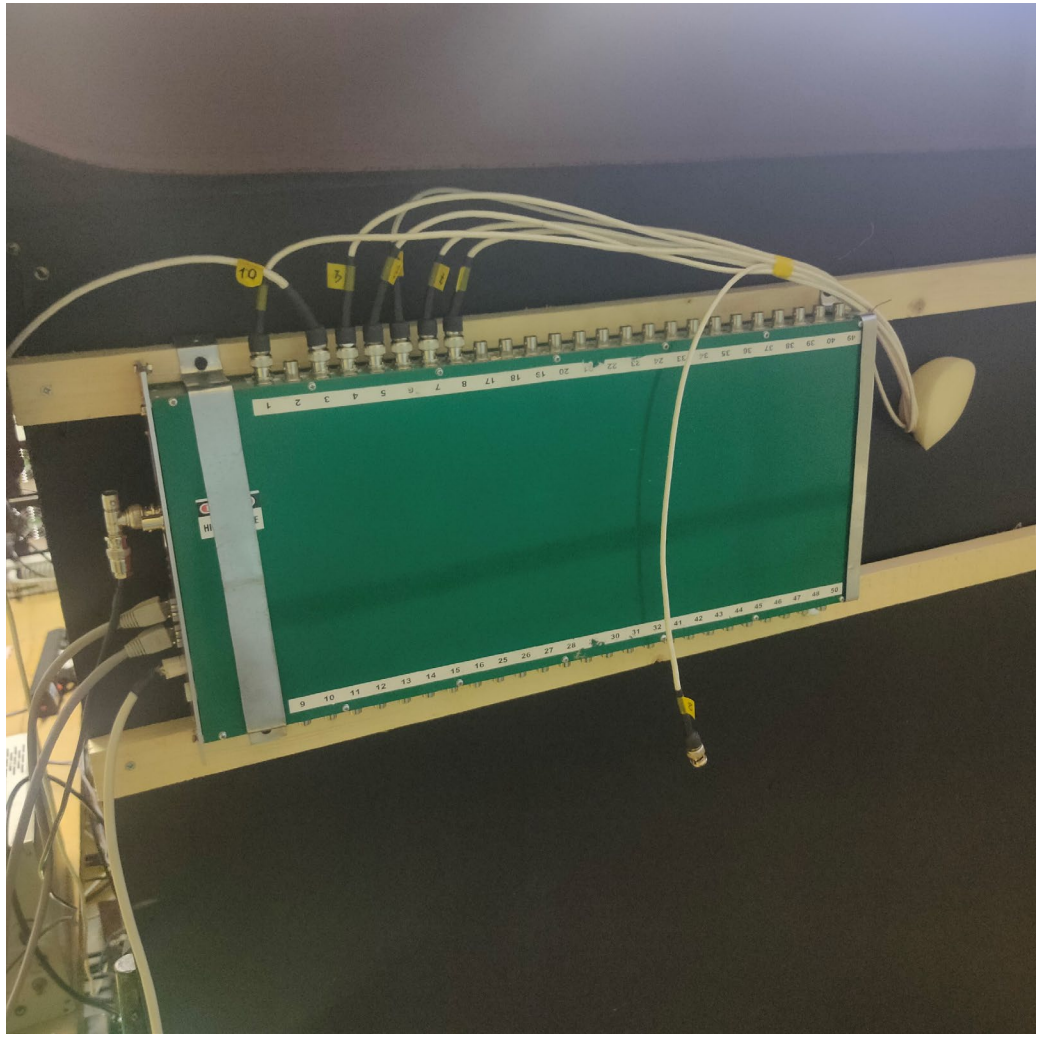
	Laboratory in room 162	Laboratory in room 170
Detector		 
Passive shielding	 	 
Transport system	 	 
Active shielding	 	
DAQ	   	
High voltage distribution	    	

High voltage distribution



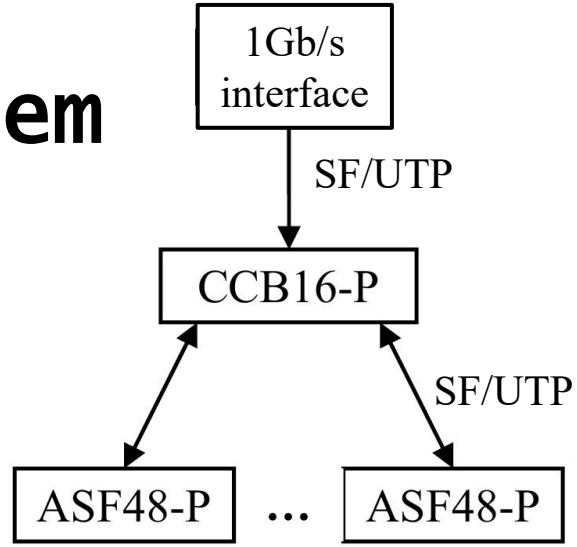
High voltage distribution

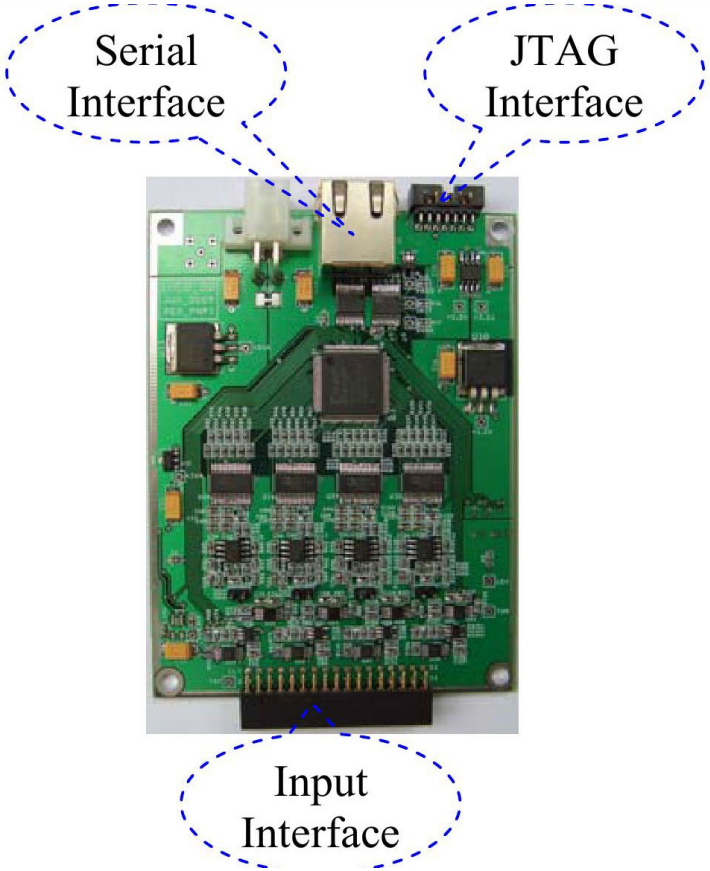


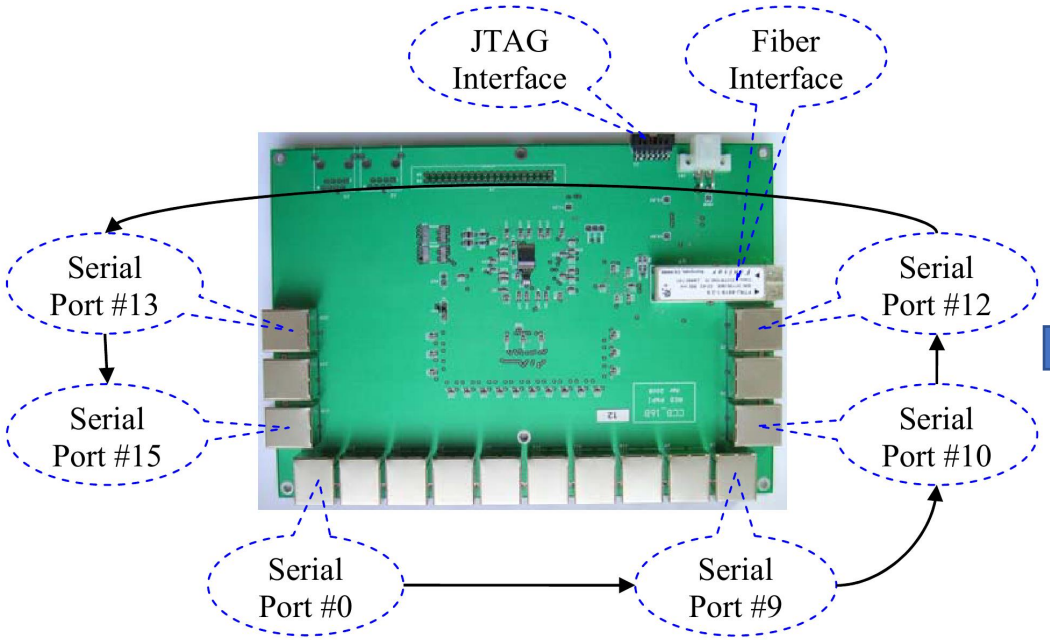


Data acquisition system CROS3

- **Sampling rate is 3 times faster**
- **Data transfer rate is 8-10 times faster**

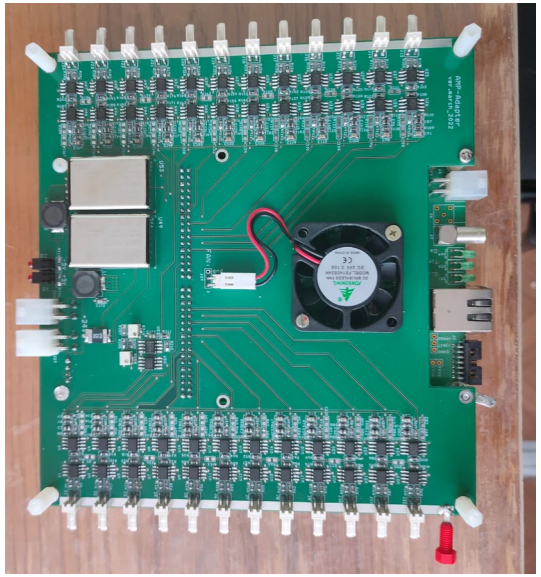


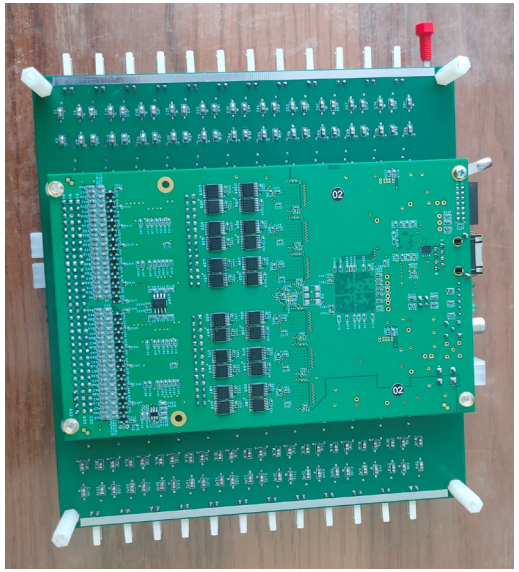




Data acquisition system CROS3

New adapter board for digitizers



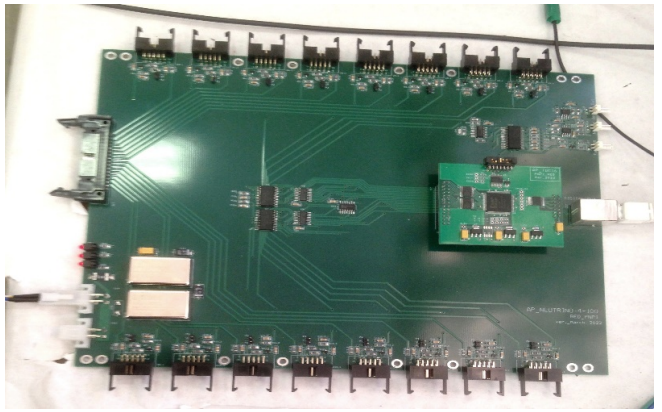


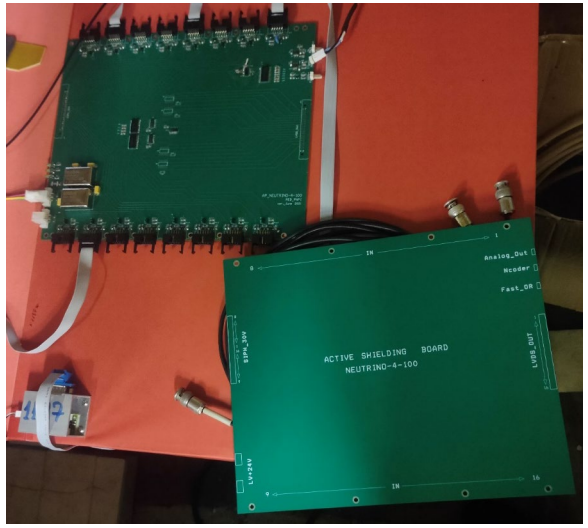
New interface board for concentrators

DAQ assembled on detector prototype

Active shielding

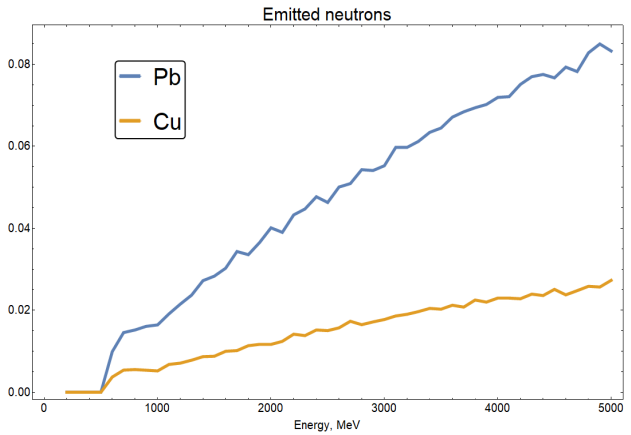
Boards of DAQ for active shielding

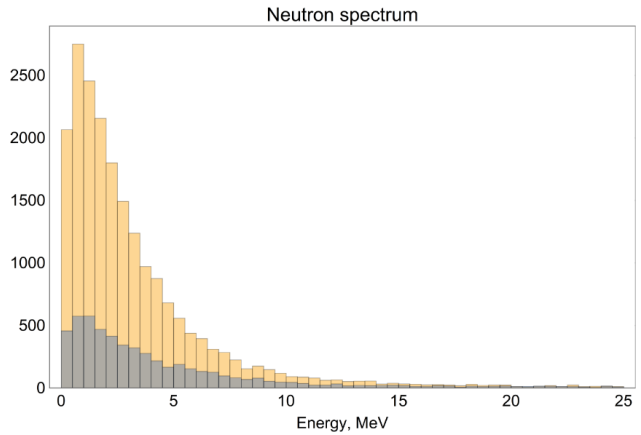


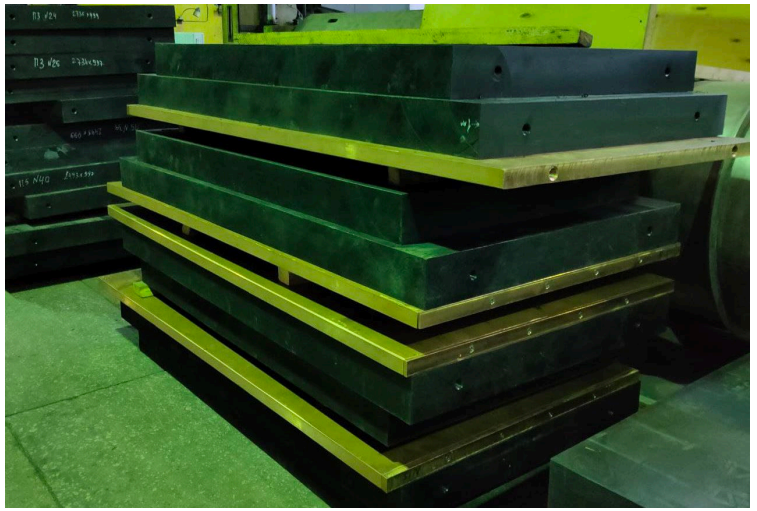


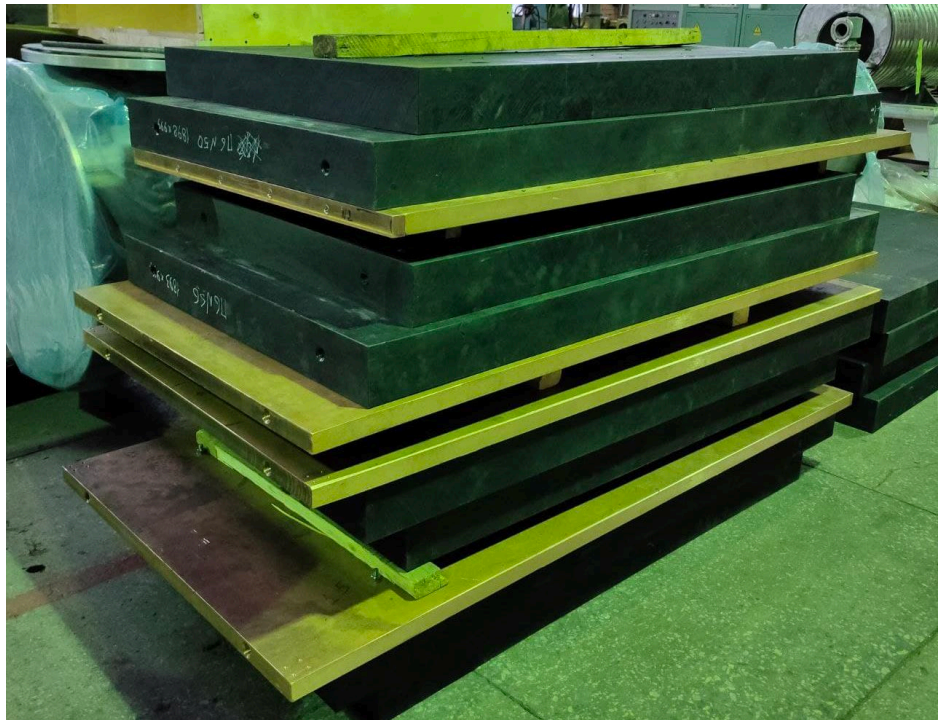
Active shielding was made in IHEP (Protvino) and received due to great support by JINR (Dubna).

New passive shielding for room 170

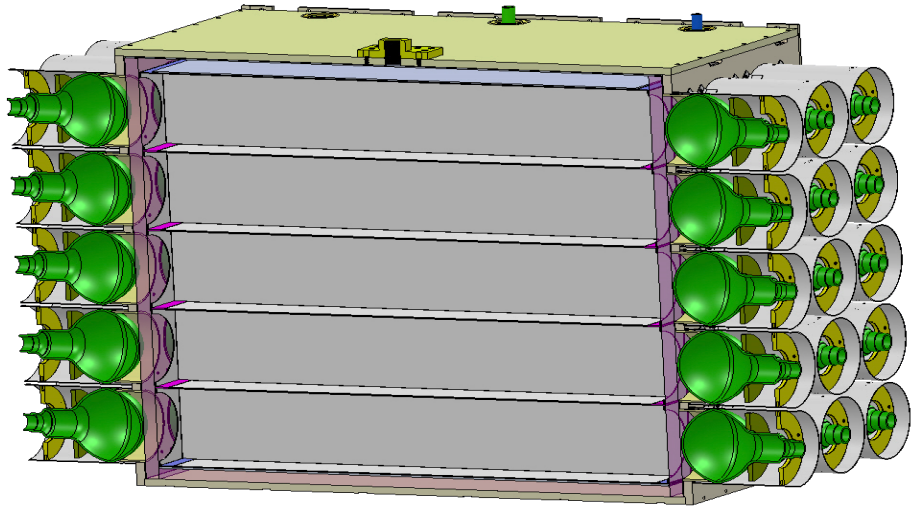








Detector for room 170

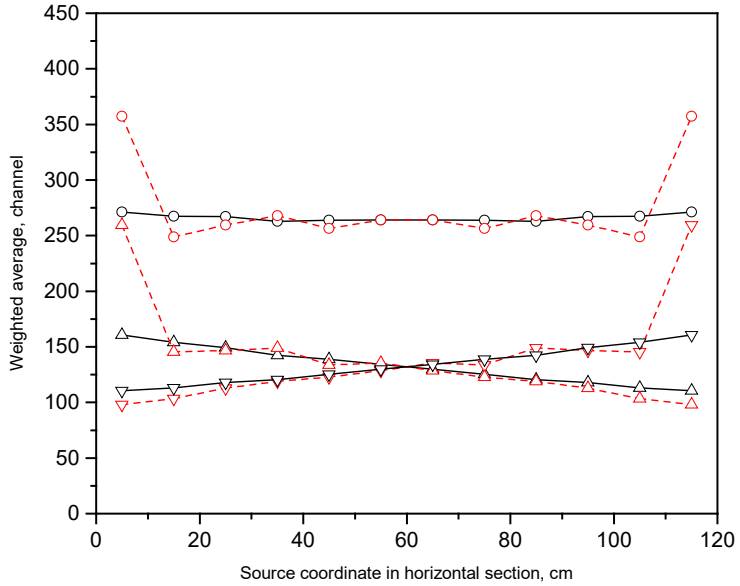


Serebrov, A.P., Ivochkin, V.G., Samoilov, R.M. *et al.*

Creation of neutrino laboratory for carrying out experiment on search for a sterile neutrino at the SM-3 reactor.

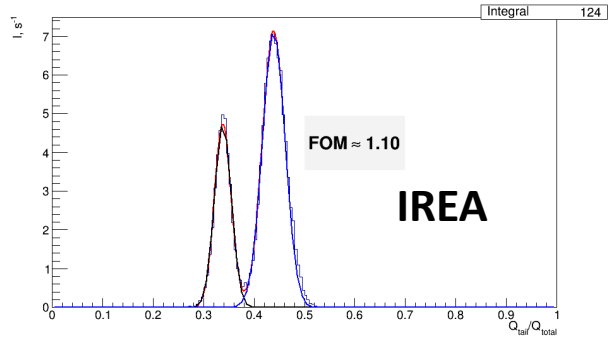
Tech. Phys. **60**, 1863–1871 (2015).

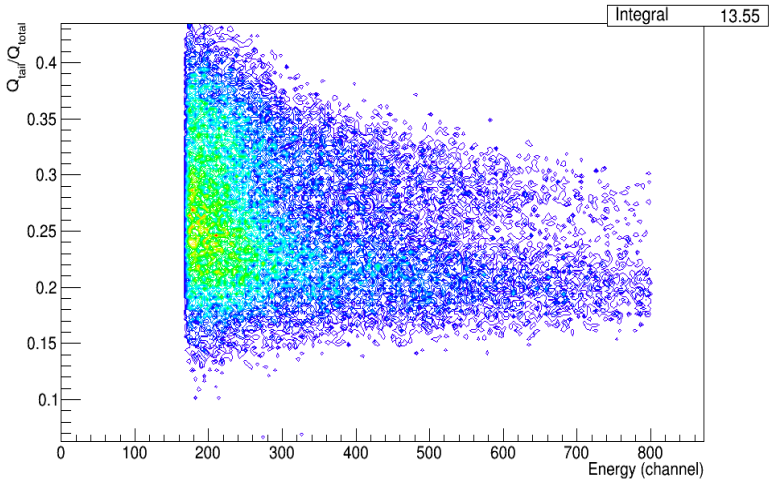
https://doi.org/10.1134/S106378421512018X

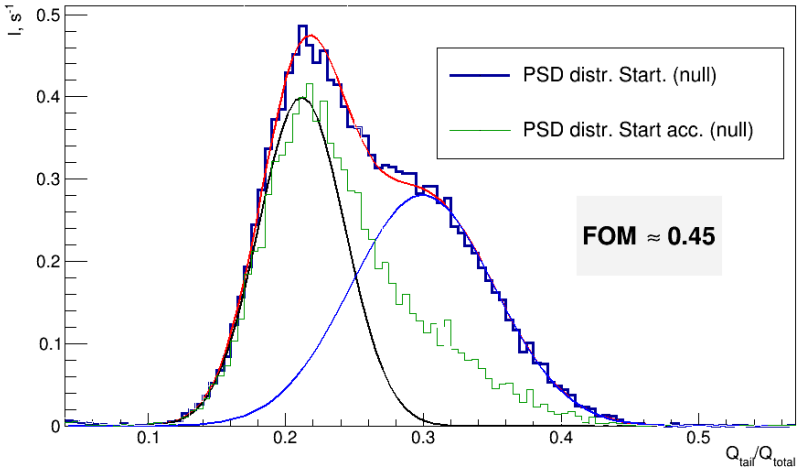


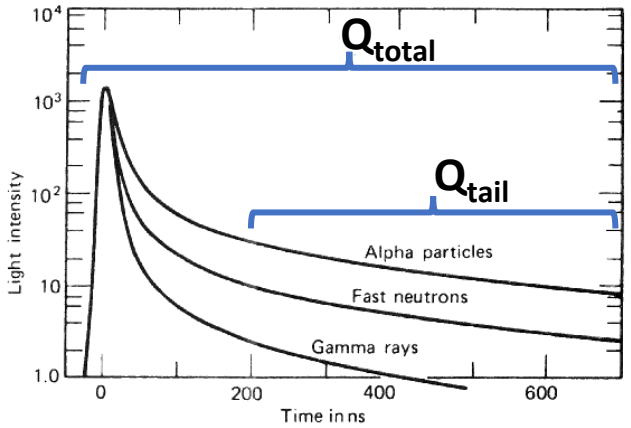
Scintillator

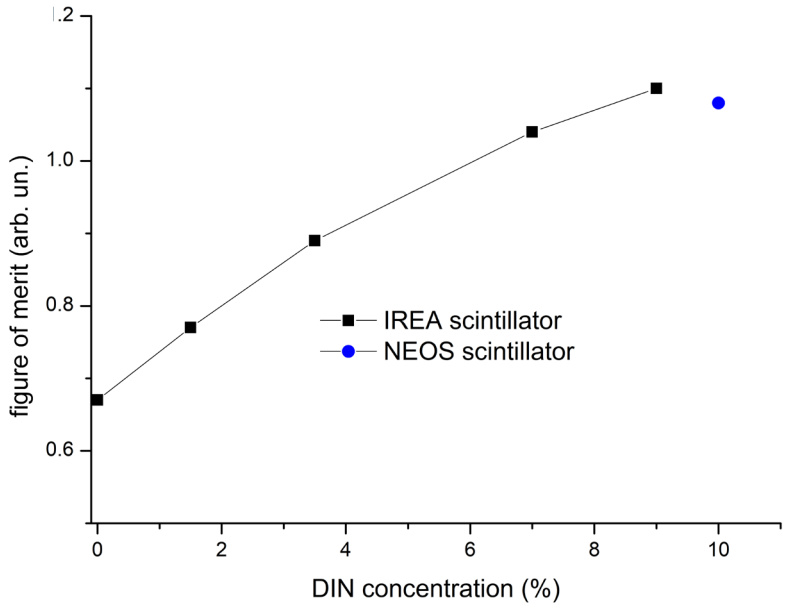
Q_{tail}/Q_{total} resolution for 1 section











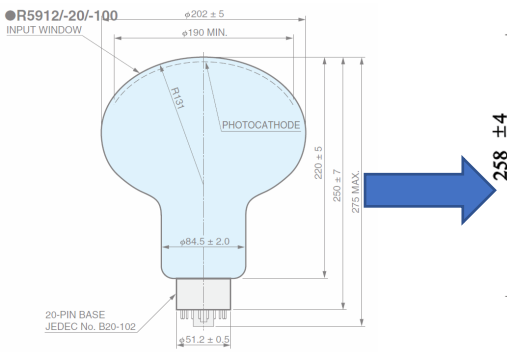
Photomultipliers

Hamamatsu R5912 PMTs were replaced by new PMTs with MCP N6082

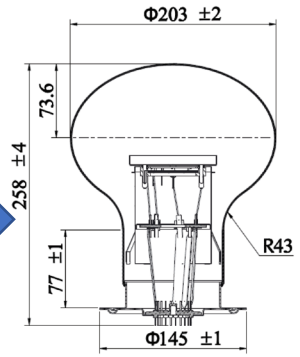
Noise, spectral and PSD characteristics are very close

	MCP-PMT N6082			Hamamatsu R5912		
	Min	Typ	Max	Min	Typ	Max
Spectral range		300-650			300-650	
Peak wavelength		380			420	
Cathode luminous		90		40	80	
Quantum efficiency		30			25 (390nm)	
Supply voltage	1500	1750	2000		1500	2000
Gain		$1x10^7$			$1x10^7$	
Anode sensitivity		900			800	
Dark count rate		5	25		4	8
Peak to valley ratio	3	7		1.5	2.8	
Rise time		1.4			3.6	
TTS		1.5			2.4	

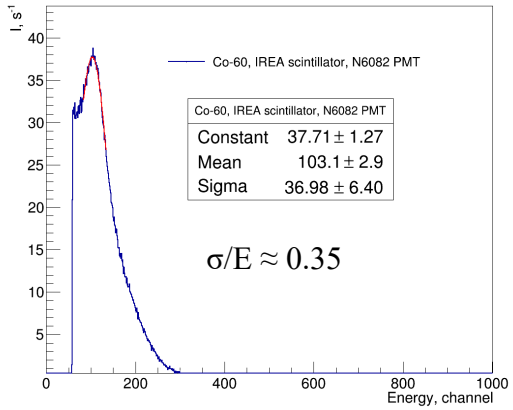
Hamamatsu

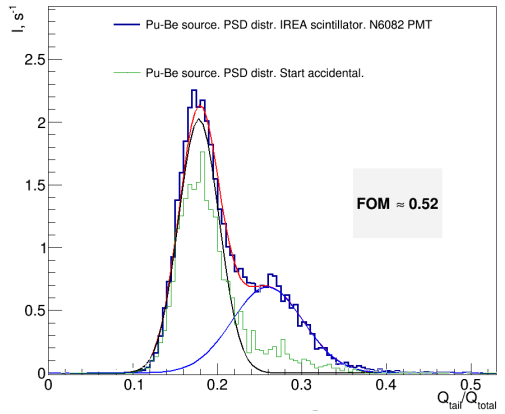


IHEP&NNVT



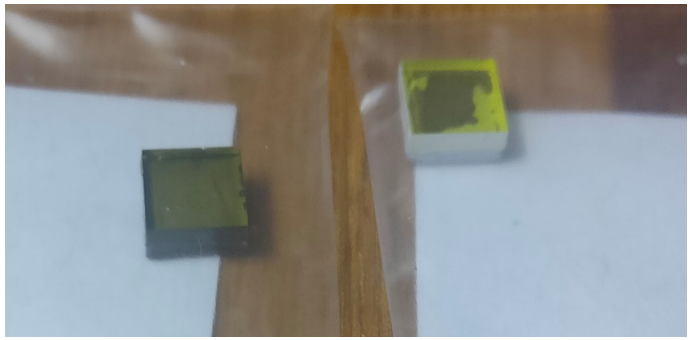
N6082
(GDB-6082)

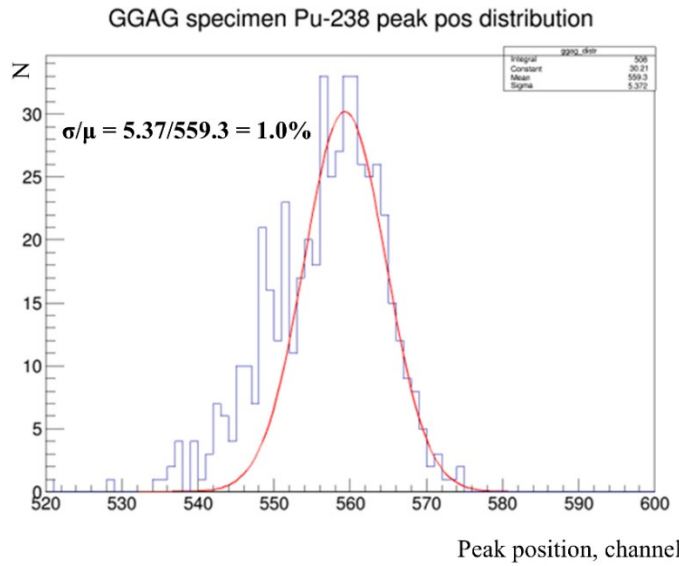


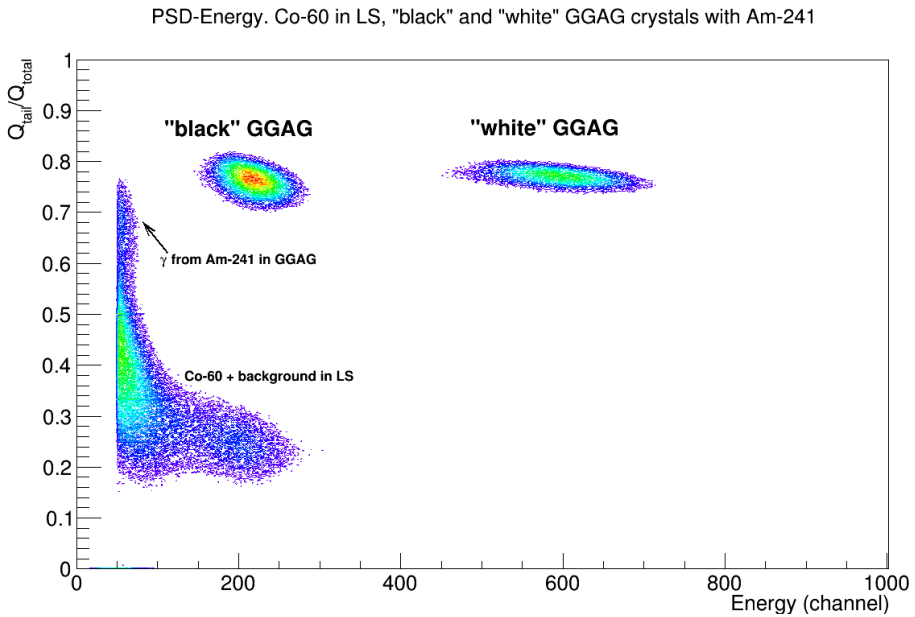


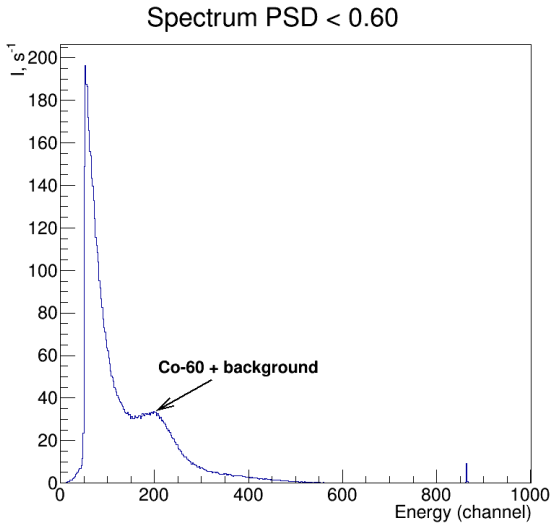
Optical calibration and monitoring system

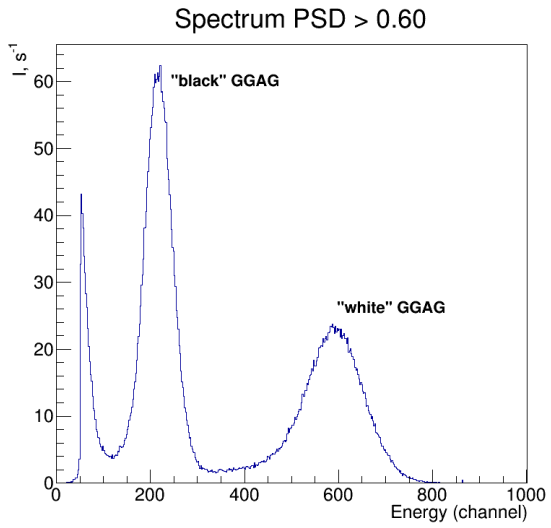
GGAG (Gadolinium Aluminium Gallium Garnet) with ^{241}Am





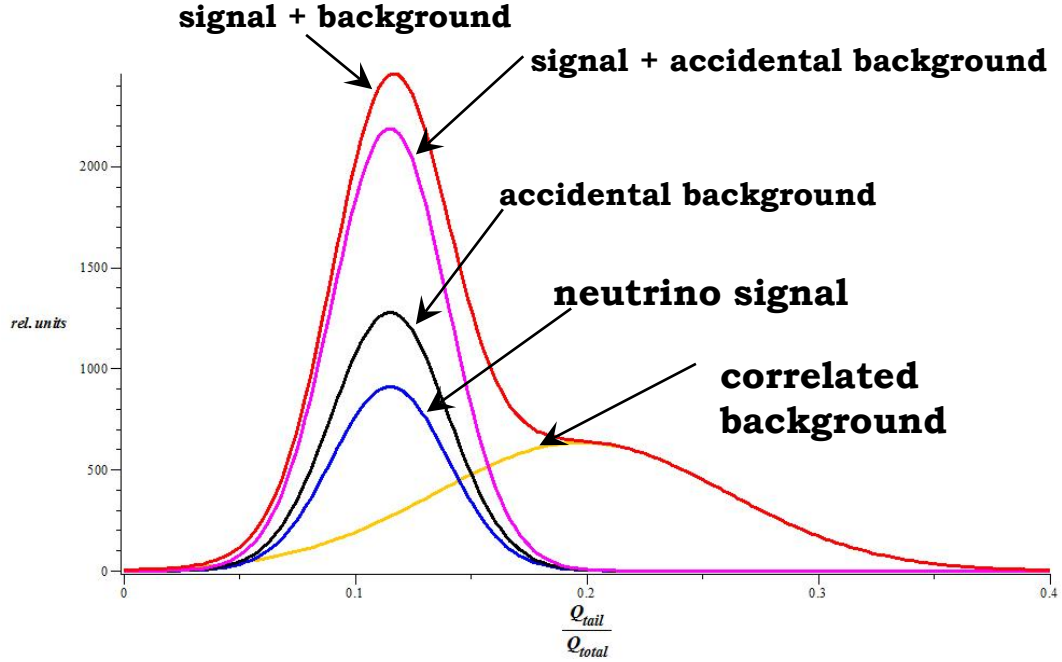






Summary

- New scintillator for both laboratories is developed and manufactured
- Equipment for first laboratory modernization is ready. Installation will start in September 2023
- Transport system and part of passive shielding for new laboratory in 170 are assembled.
- Manufacturing of DAQ and HV distribution are in progress.

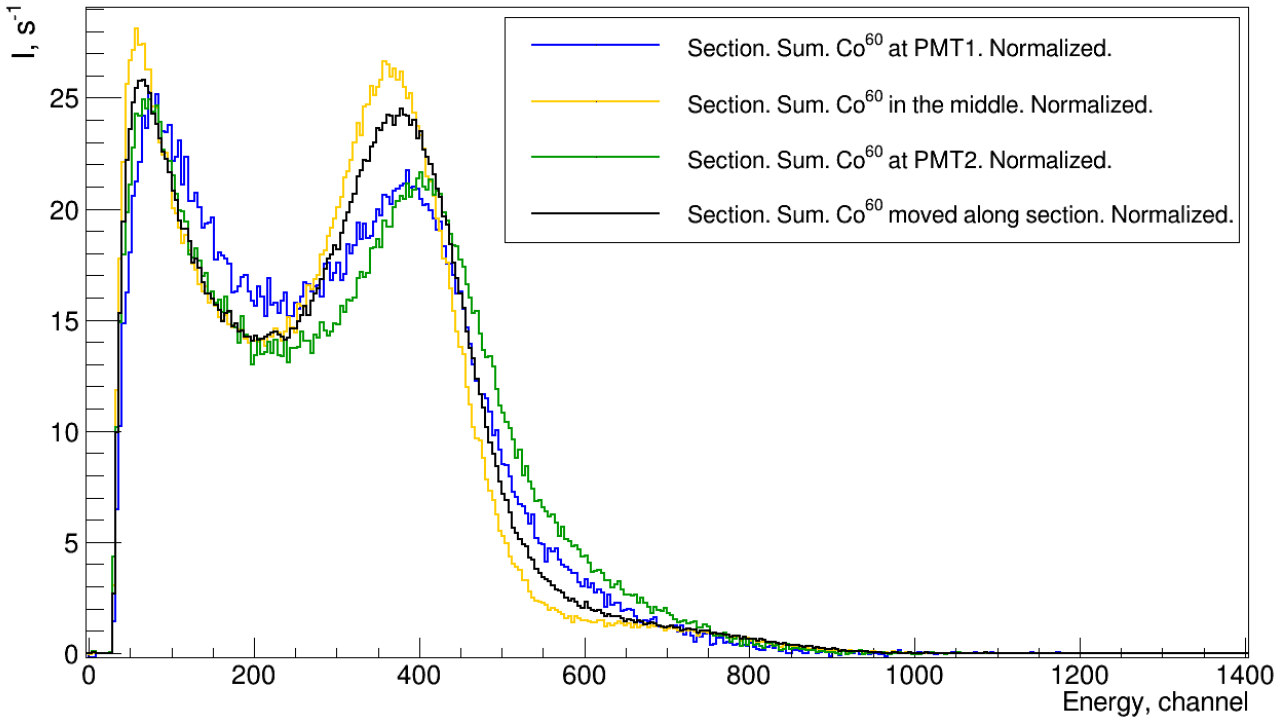


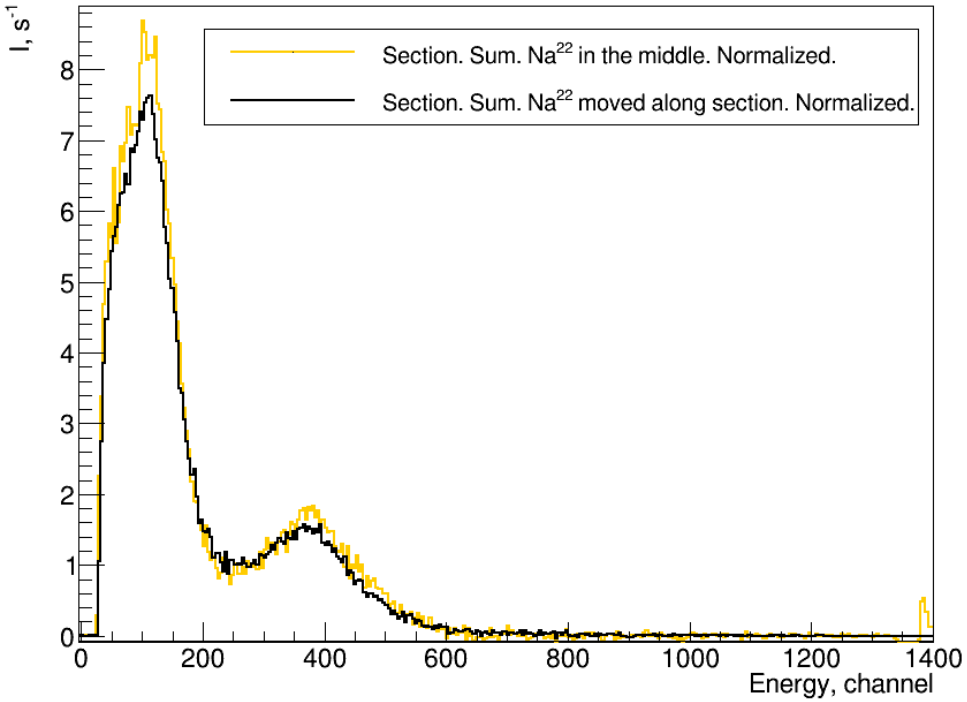
Method	Consequence	Increasing accuracy factor
4 detectors	3x larger volume	**1.6**
Gd concentration	2x less accidental background	**1.5**
PSD	4x less correlated background	**1.3**
Total		**2.7**

Thank you for your attention!

Backup

Old passive shielding for room 162


I, s^{-1}
Section. Sum. Co^{60} at PMT1. Normalized.
Section. Sum. Co^{60} in the middle. Normalized.
Section. Sum. Co^{60} at PMT2. Normalized.
Section. Sum. Co^{60} moved along section. Normalized.
Energy, channel


I, s^{-1}
Section. Sum. Na^{22} in the middle. Normalized.
Section. Sum. Na^{22} moved along section. Normalized.
Energy, channel