MSC230

– JINR's new superconducting cyclotron for proton FLASH therapy

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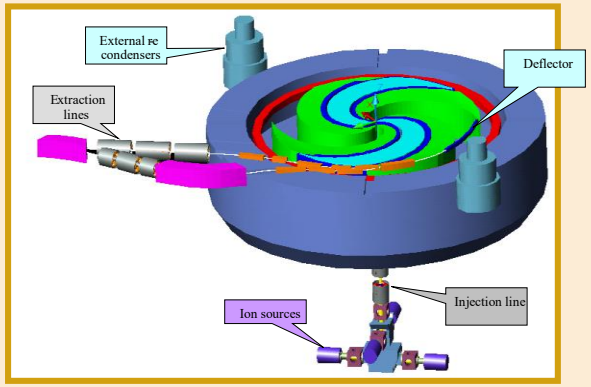
Presenter: Dmitry Popov

Proton accelerator Phasotron

SC200 cyclotron

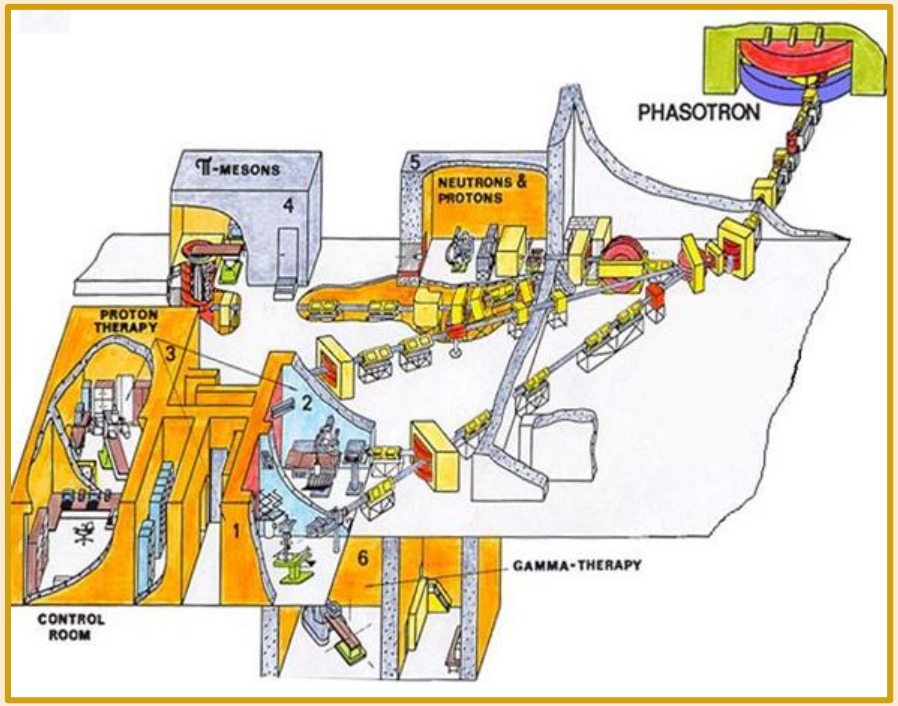
C235-V3 DLNP JINR cyclotron



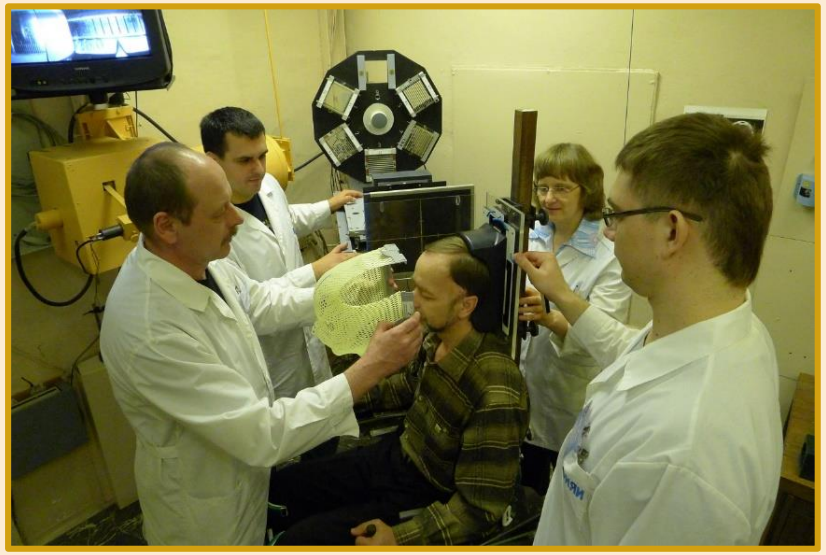
C400 for carbon therapy

JINR's experience in cyclotron production

- Old good Phasotron with the parameters necessary for radiation therapy was created in 1967.
- Collaboration with IBA (Belgium). Project of carbon superconducting cyclotron C400. Proton cyclotron C235-V3 for Dimitrovgrad.
- Collaboration with ASIPP (Hefei, China). Superconducting proton cyclotron SC200, which was successfully started up recently!



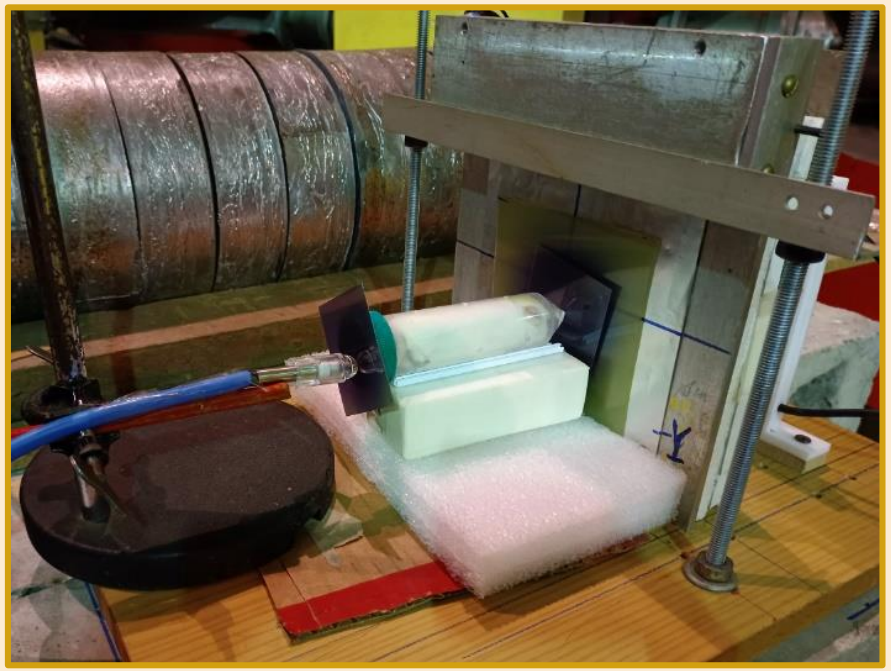
Medical technical complex of the Laboratory of Nuclear Problems, JINR



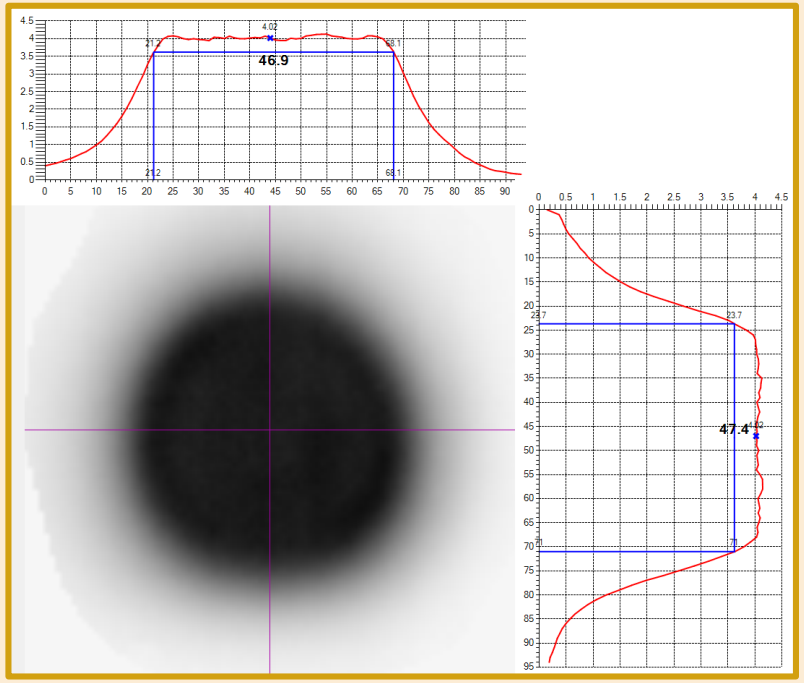
Cabin No. 1 allows proton irradiation of targets located in the head, neck and other parts of the patient's body.

JINR's experience in radiation therapy

The technique of three-dimensional conformal proton radiation therapy was implemented at the Mitsyn G.V. et al (MTC DLNP JINR). The maximum of the generated dose distribution most closely matches the shape of the irradiated target. Thanks to this, it became possible to conduct radiotherapy of brain neoplasms localized near critical organs.



An experiment, studying the FLASH effect on mice

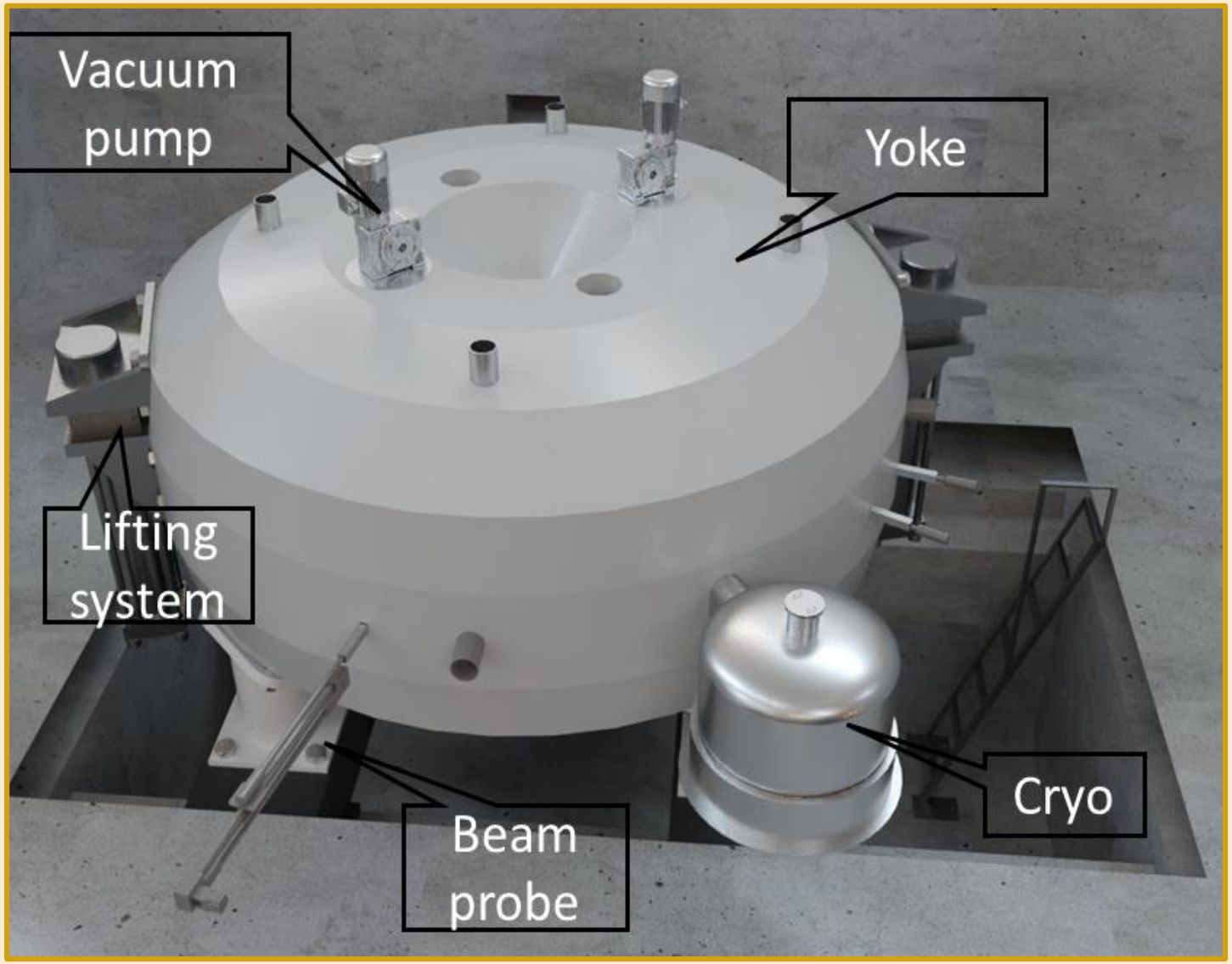


Proton beam profiles for studying the effect of FLASH therapy on biological objects. Dose field width at 90% level is ~47 mm Dose field uniformity is not worse than ±5%

FLASH therapy

FLASH is a new method of radio-therapy, requires delivery of high dose to the tumor. 50 Gy/s in less than 0.5 seconds

- Reduces the impact on healthy tissue
- Allows for more effective treatment of radioresistant tumors, as well as recurrent diseases
- Reduces the number of cases where the use of carbon ions is necessary
- Reduces the number of treatments



Computer model

MSC230 view

- Low power consumption.
- Reasonable size.
- Minimum engineering efforts and challenges.
- Moderate conservativeness and reduced risks.
- High quality of the beam.
- Extracted beam current - at least 10 μA.
- At least 5 Grey per 1 liter target in a pulse of about 50 ms.

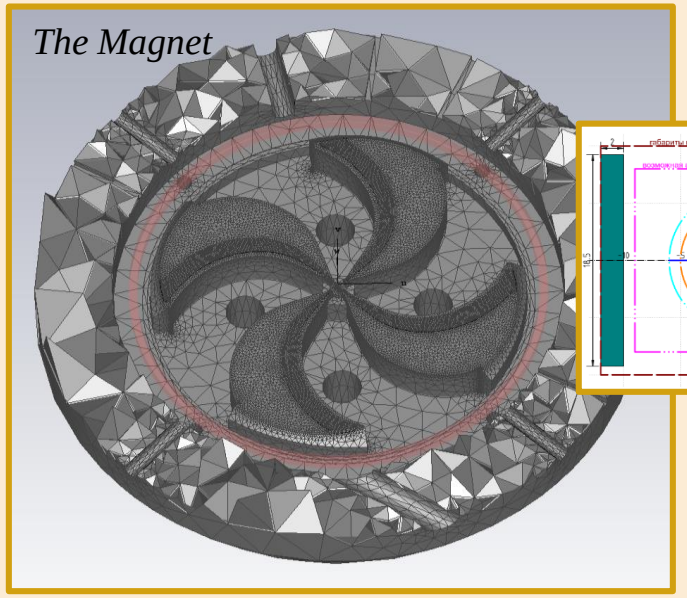
Magnet type	Compact, SC coil, warm yoke
Ion source	PIG
Final energy, MeV	230
Pole radius, mm	1070
Mean magn. field (center), T	1.7
Dimensions (height×width), m	1.7 × 3.7
Weight, tonnes	100
Hill/Valley gap, mm	50/700
A*Turn number	320 000
RF frequency, MHz	106.5
Harmonic number	4
Number of RF cavities	4
Voltage, center/extraction kV	40/110
RF power, kW	60
Number of turns	500
Beam intensity, μA	10
Extraction type	ESD

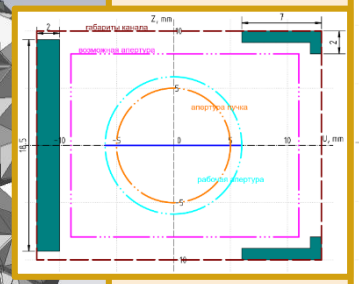
MSC230 specs

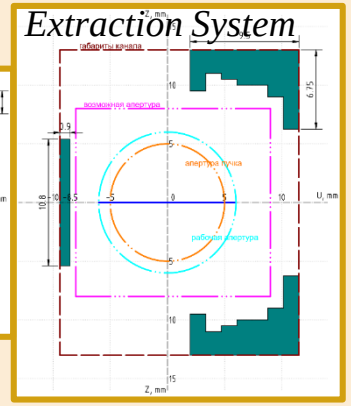
There are two most successful accelerators in the proton therapy: Varian Proscan and C235. Both cyclotrons have much smaller central field, 1.7 and 2.4 Tesla.

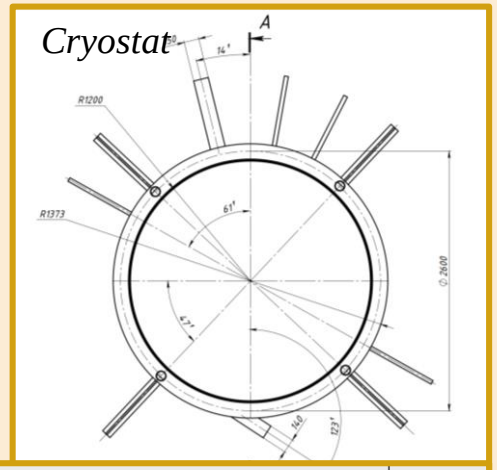
Both Varian and C235 have been designed in 1990s, both have problems.

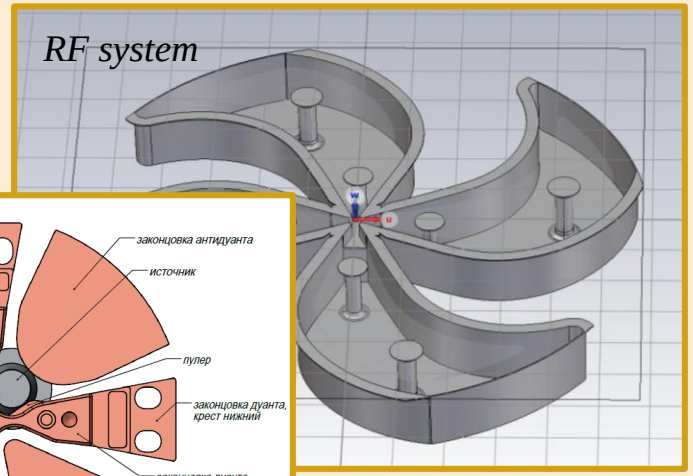
We have combined best solutions and avoided the problems of those cyclotrons.

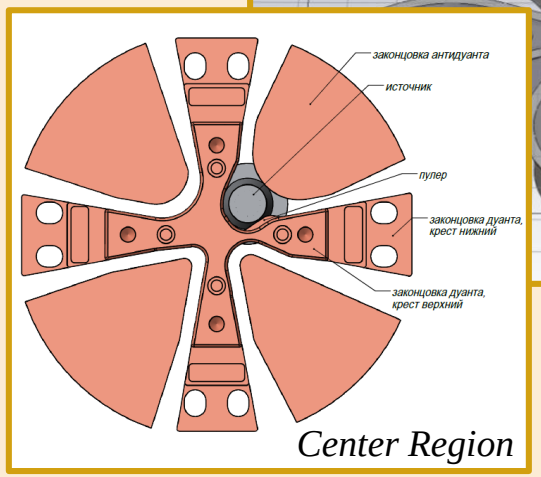


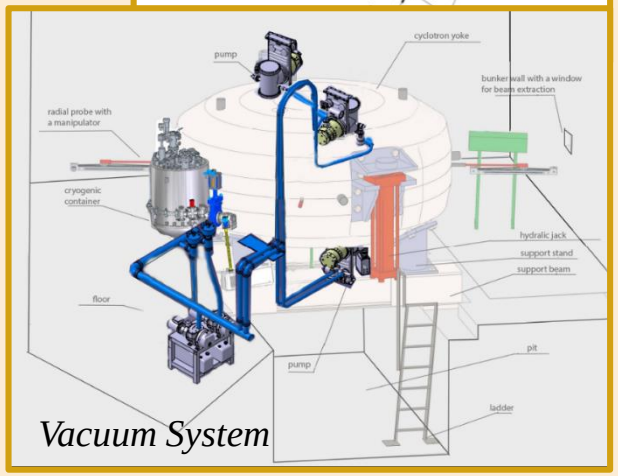












Current Status

All cyclotron systems were designed, simulated for beam dynamics, optimized, etc…

Design report was fully done.

It successfully passed the assessment and discussion of FLNR.

This project were also approved by international commission, as machine for achieving higher current.

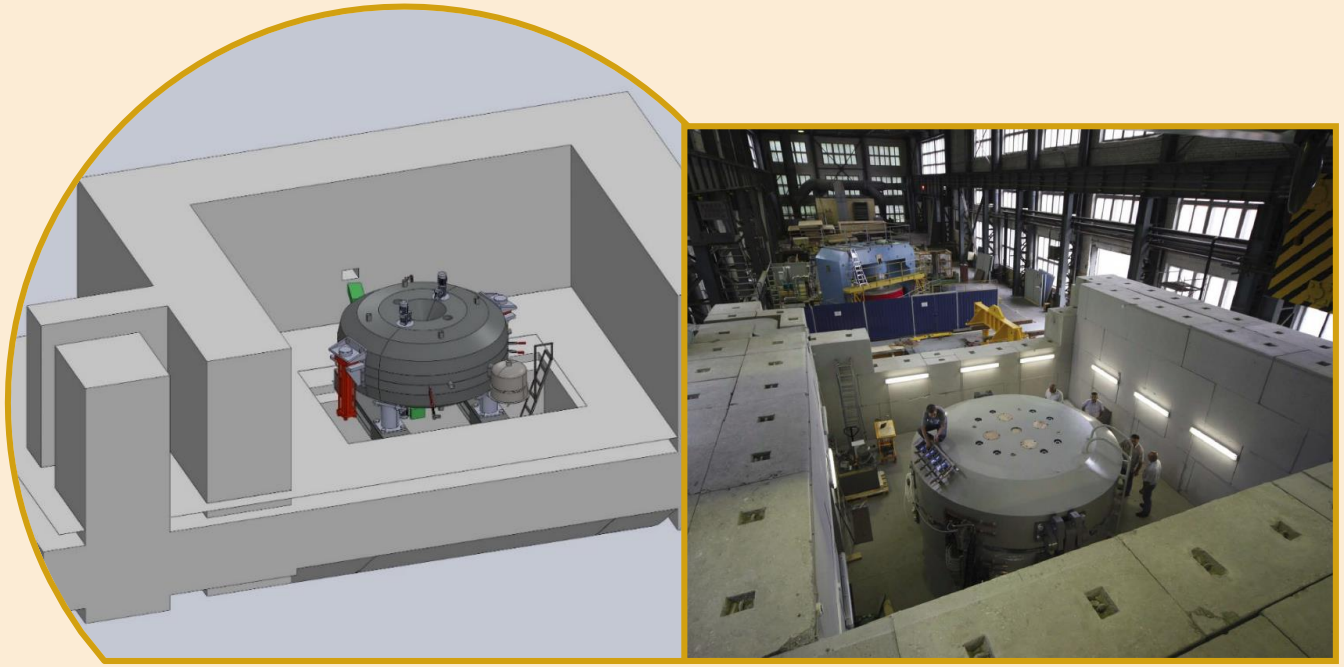
NIIEFA

D.V. Efremov Institute of Electrophysical Apparatus (NIIEFA) must provide technical design report. The agreement is signed.

SCHEDULE																																						
Month ordinal			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
WBS No.	WBS	Months	1st year									2nd year												3rd year														
SC230	SC230 cyclotron		01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12
SC230.0	Kick-off	0																																				
SC230.1	Final physical design	0																																				
SC230.2	Final engineering design	6																																				
SC230.3	Magnet System	23																																				
SC230.3.1	Cryostat/Coil	17																																				
SC230.3.2	Steel/sectors	18																																				
SC230.3.3	Lifting	8																																				
SC230.3.4	Bz mapper	8																																				
SC230.3.5	Shimming	6																																				
SC230.4	Ion Source	10																																				
SC230.5	RF system	14																																				
SC230.6	Beam extraction system	10																																				
SC230.7	Radial Probe	10																																				
SC230.8	Control System	12																																				
SC230.9	Auxiliary System	10																																				
SC230.10	Integration Assembly	4																																				
SC230.11	Beam Commissiong	9																																				

The very preliminary timetable

JINR’s international biomedical research center



MSC230 will be assembled in the building №5 DLNP

The new building for biomedical center

Thank you for your attention!

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