Status quo of the mechanical construction at PIK

Vladislav Tarnavich

Roadmap of the instrumental case of PIK neutron facility:

	2018	2019	2020	2021	2022	2023
Reactor PIK is operational	Start-up	Operation	Operation	Operation	Operation	Operation
Neutron guide system	Design financially supported	Construction financially supported	Operation	Operation	Operation	Operation
Cold neutron source	Design financially supported	Construction financially supported	Operation	Operation	Operation	Operation
Instrumental suite: Stage 1 (7 instruments)	Commissioning (modernisation by HZG BMBF)	Commissioning (modernisation by HZG BMBF)	Operation (by INRC)	Operation (by INRC)	Operation (by INRC)	Operation (by INRC)
Instrumental suite: Stage 2 (20 instruments)	Design (financially approved)	Technical drawings (financially approved)	Construction (financially approved)	Construction (financially approved)	Commissioning (financially approved)	Commissioning (financially approved)
Instrumental suite: Stage 3 (5 instruments)	Tbd by Germ. partners	Tbd by Germ. partners	Tbd by Germ. partners	Tbd by Germ. partners	Tbd by Germ. partners	Tbd by Germ partners

Cold neutron source

Technical projects of cryogenic helium facility and equipment of CNS + contract

ТЕХНИЧЕСКОЕ ЗАДАНИЕ
Изготовление и поставка нестандартизированного оборудования криогенной гелиевой установки для здания 100Е объекта капитального строительства «Реконструкция лабораторного комплекса научно-исследовательского реакторного комплекса «ПИК» (2 этап).

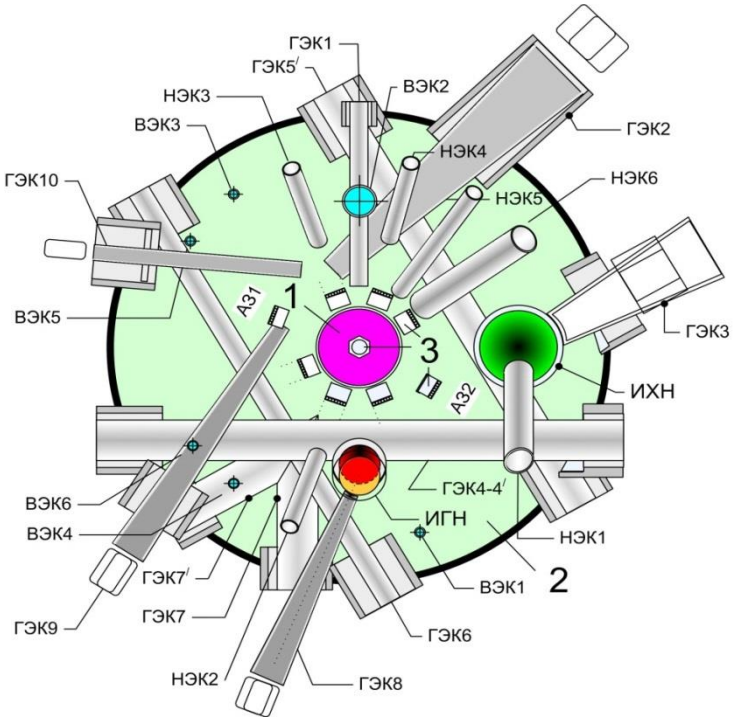
ТЕХНИЧЕСКОЕ ЗАДАНИЕ
Изготовление и поставка нестандартизированного оборудования комплекса ИХН для здания 100Е объекта капитального строительства «Реконструкция лабораторного комплекса научно-исследовательского реакторного комплекса «ПИК» (2 этап).

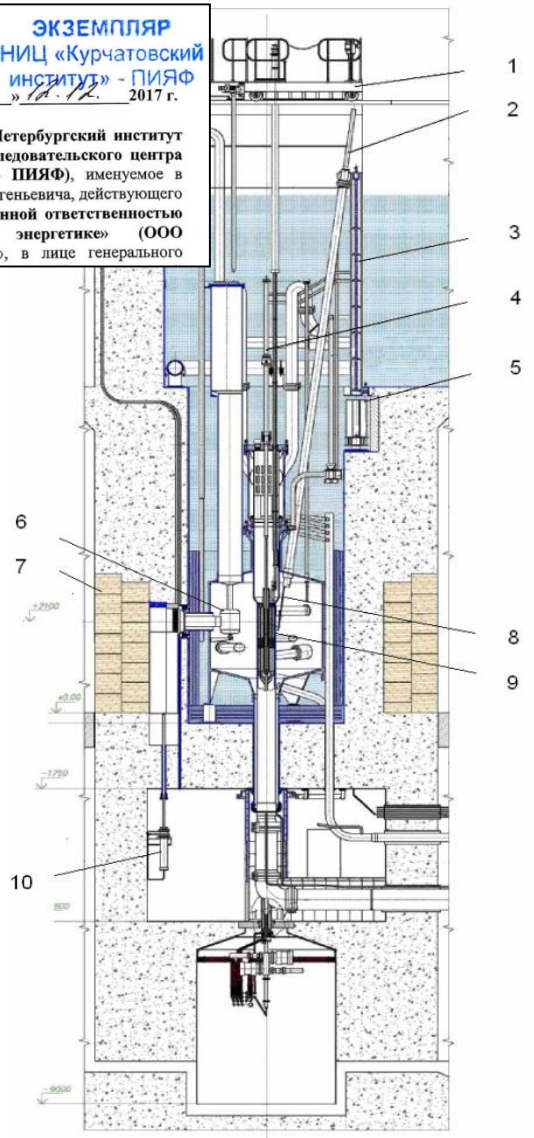
Договор № 0834

ЭКЗЕМПЛЯР
НИЦ «Курчатовский институт» - ПИЯФ

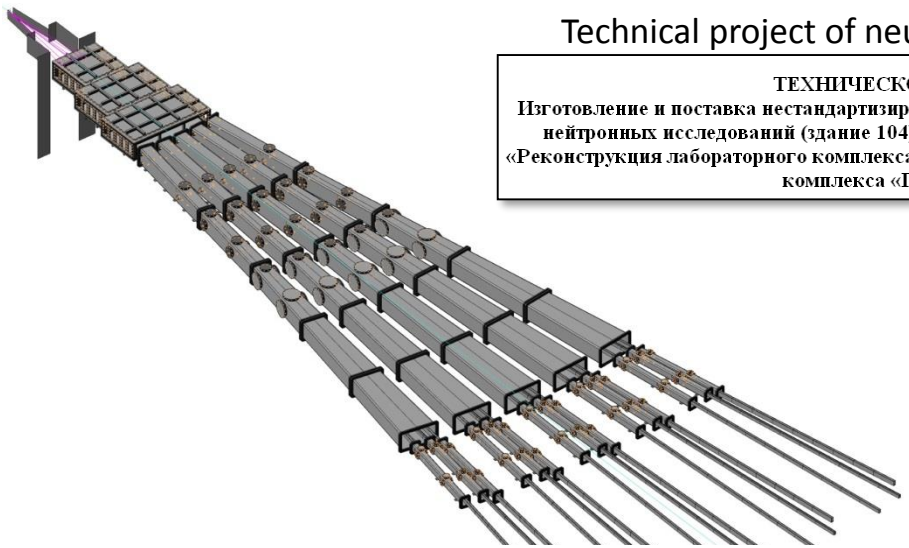
г. Гатчина Ленинградской области «__» 12. 12. **2017 г.**

Федеральное государственное бюджетное учреждение «Петербургский институт ядерной физики им. Б.П. Константинова Национального исследовательского центра «Курчатовский институт» (НИЦ «Курчатовский институт - ПИЯФ), именуемое в дальнейшем «Заказчик», в лице и.о. директора Горчакова Сергея Евгеньевича, действующего на основании Устава, с одной стороны, и **Общество с ограниченной ответственностью «Финансово-производственная компания в атомной энергетике» (ООО «ФИНПРОМАТОМ»)**, именуемое в дальнейшем «Поставщик», в лице генерального





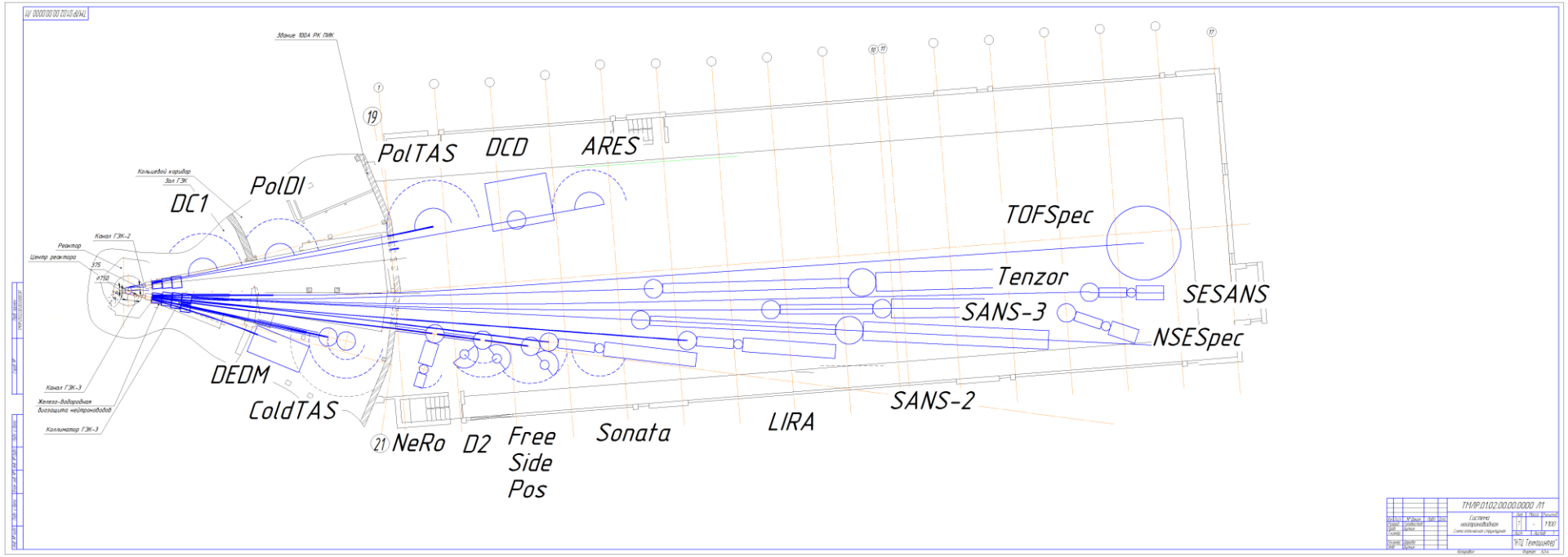
Neutron guide system

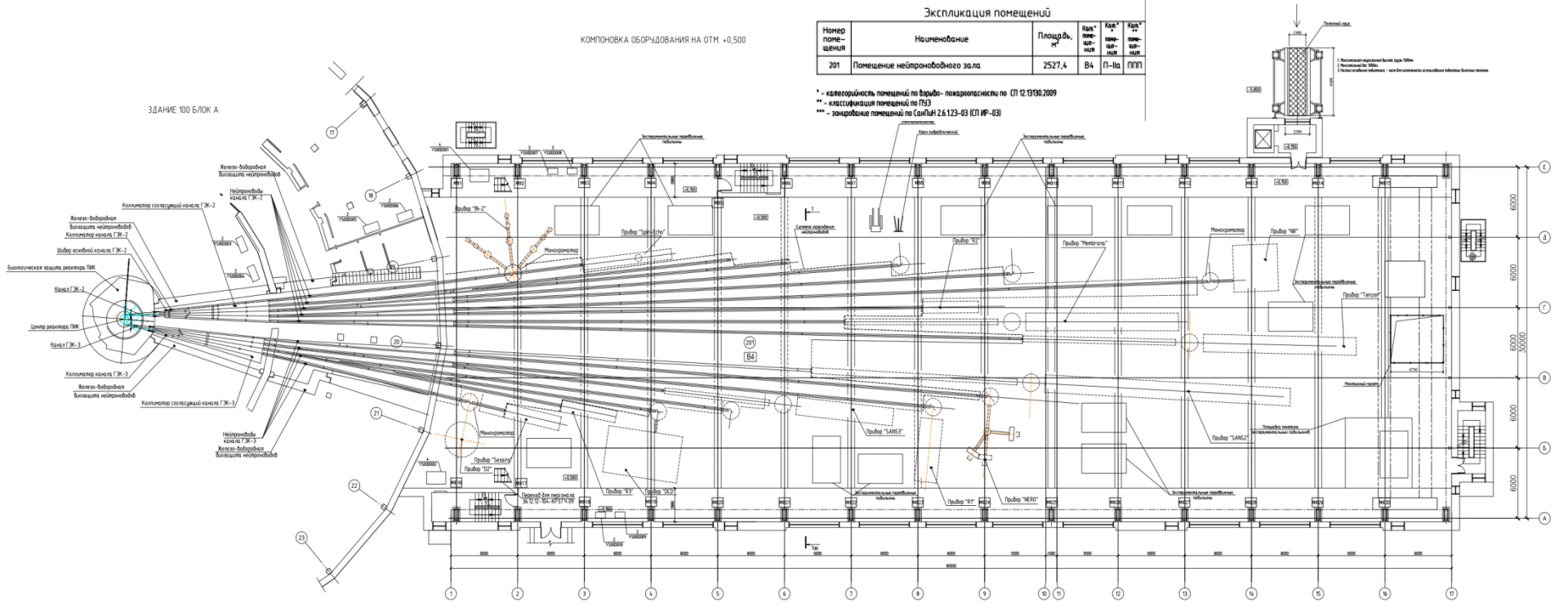


Technical project of neutron guide system

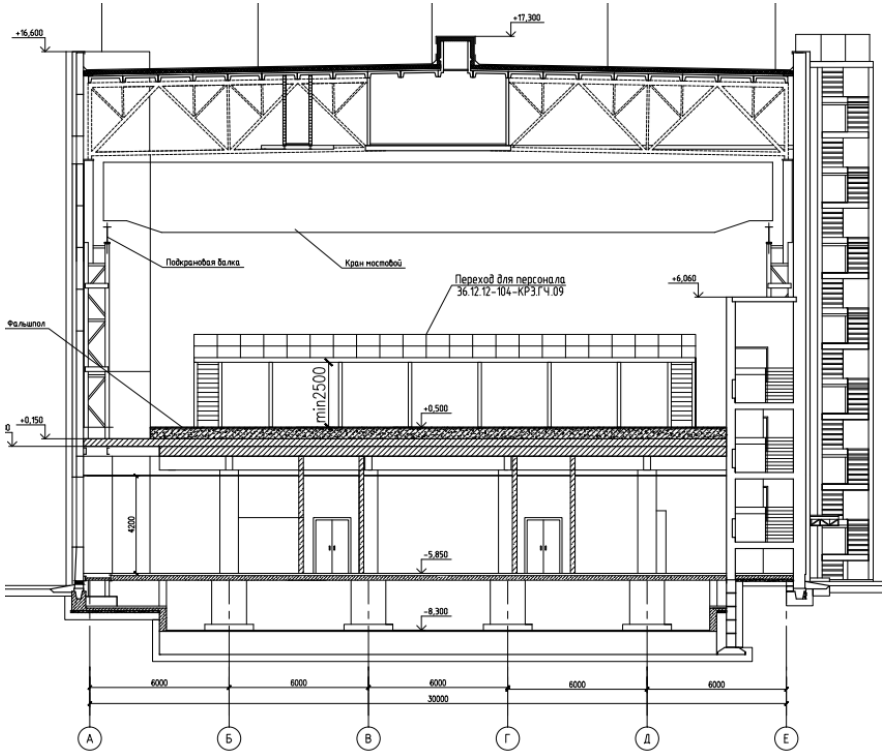
ТЕХНИЧЕСКОЕ ЗАДАНИЕ
Изготовление и поставка нестандартизированного оборудования для лаборатории нейтронных исследований (здание 104) объекта капитального строительства «Реконструкция лабораторного комплекса научно-исследовательского реакторного комплекса «ПИК» (2 этап)

		gain in intensity (relative)
№	Прибор	2014
1	TAS	6.3(5Å), 8.9(3Å)
2	D2	1.83
3	NeRo	2.5
4	DCD	21.4
5	Реверанс	неправ. геометрия
6	Соната	12.25(20Å), 25(4Å)
7	SANS-2	0.95
8	SANS-3	2.3
9	Тензор	0.8
10	Мембрана	1.9
11	TOF	4.8–9.5

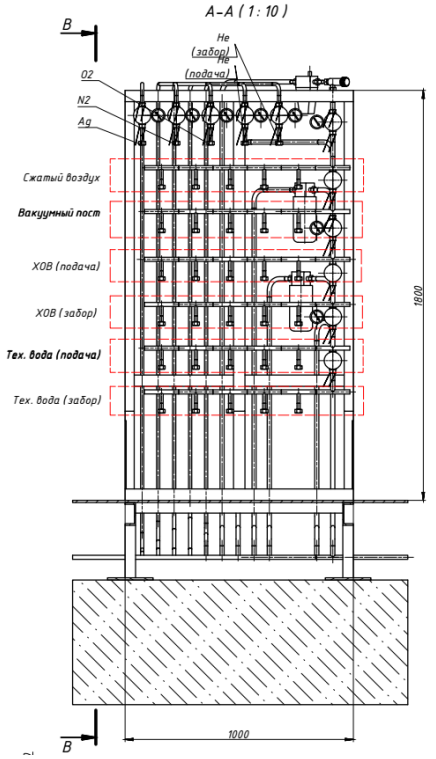




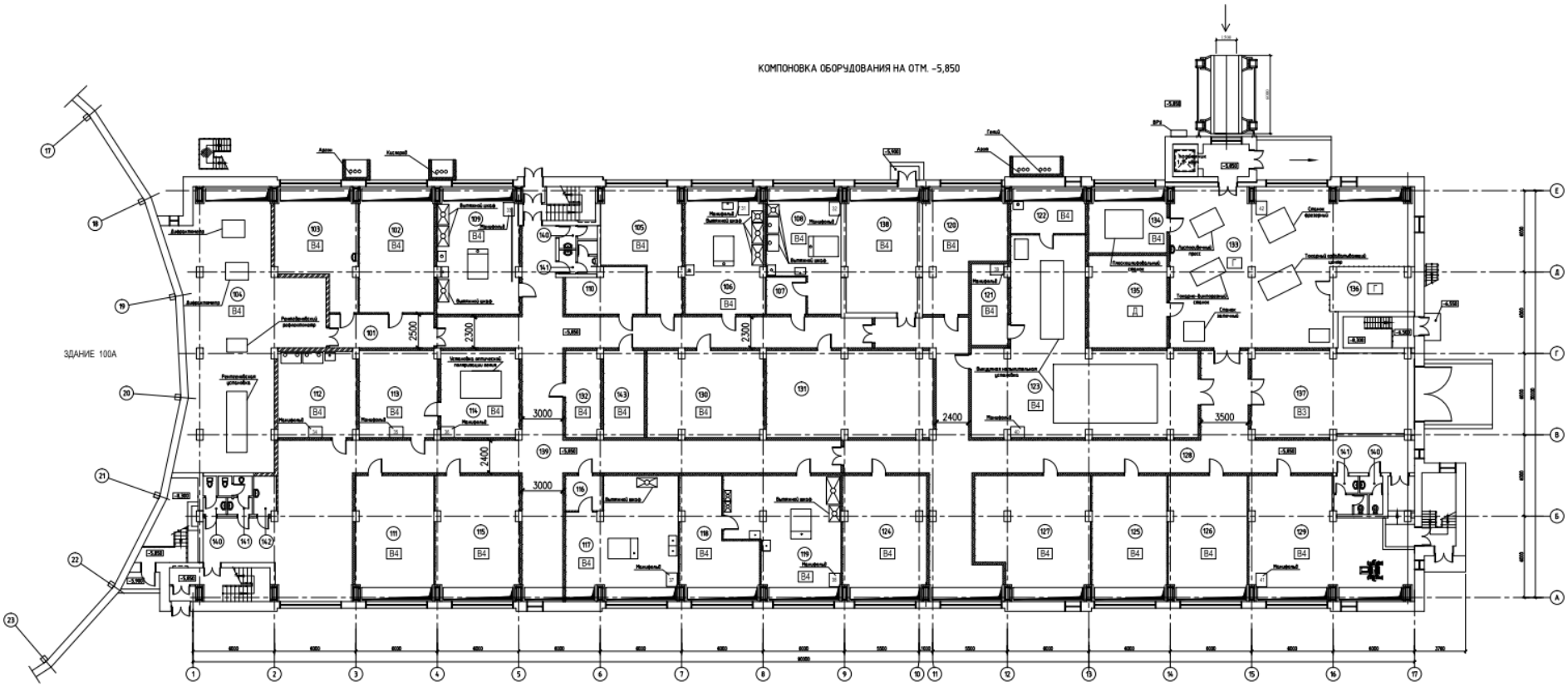
Explication of neutron guide hall



Sectional elevation: crossing over the neutron guide system



Manifold



Explication of laboratory floor

Instrumentation base

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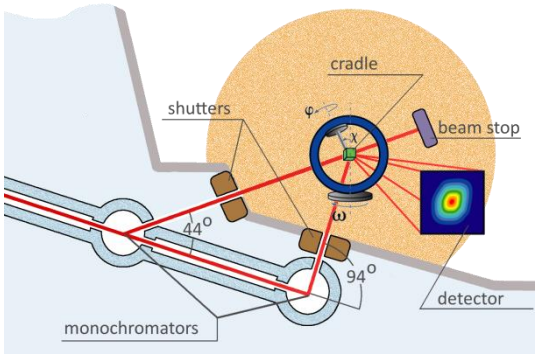
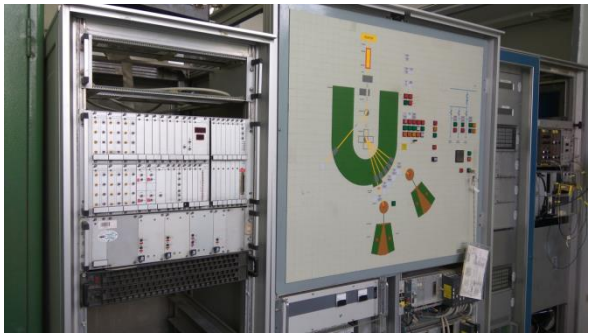
Project PIK-GGBase: assembly of the neutron scattering instruments transferred from HZG to PNPI for subsequent commissioning

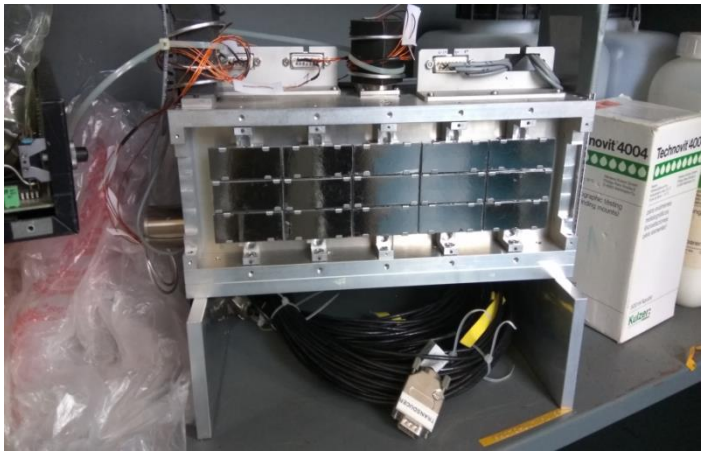
Polarized Neutron Reflectometer NERO
Small Angle Diffractometer SANS-2
Small Angle Diffractometer SANS-3
Small-angle Diffractometer DCD
Stress-Diffractometer ARES
Texture Diffractometer TEX-2
Polarized Diffractometer POLDI

The special federal programme 14.616.21.0004 The Ministry of Education and Science RF by lot 2014-14-588-0001.
«Formation of the Gatchina-Geesthacht platform of neutron stations for research with neutron scattering techniques at the reactor PIK (PIK-GGBase)».
17.09.2014 - 31.12.2017

Texture Diffractometer TEX-2





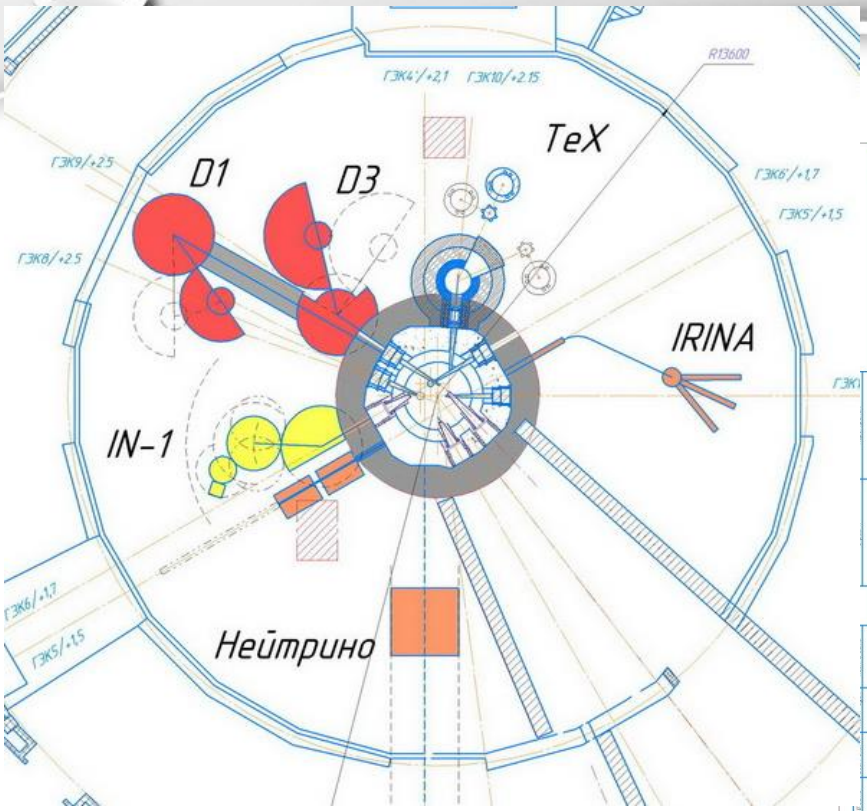


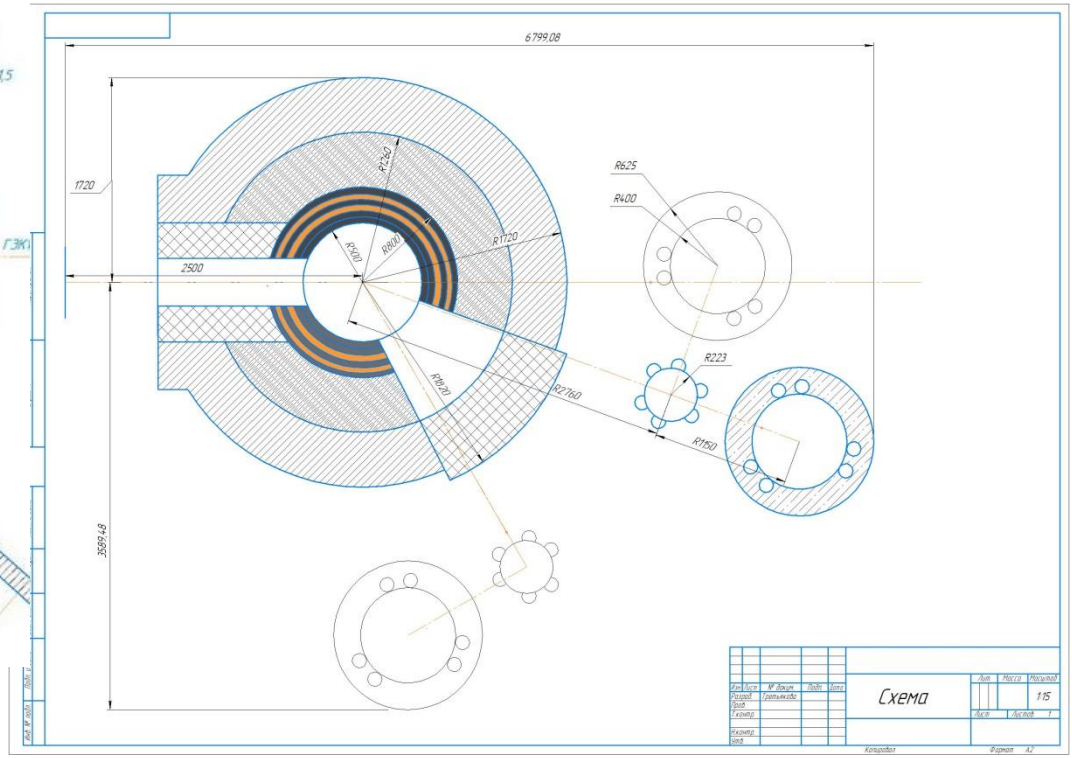
TEX-2 – Texture Diffractometer

Aleksei Sokolov (PNPI)

Science case

During the past 20 years, neutron texture analysis has become firmly established in earth and materials science and has emerged as a favorite technique for many applications. Preferred orientation (or texture) of crystallites in polycrystalline aggregates is an intrinsic feature of metals,

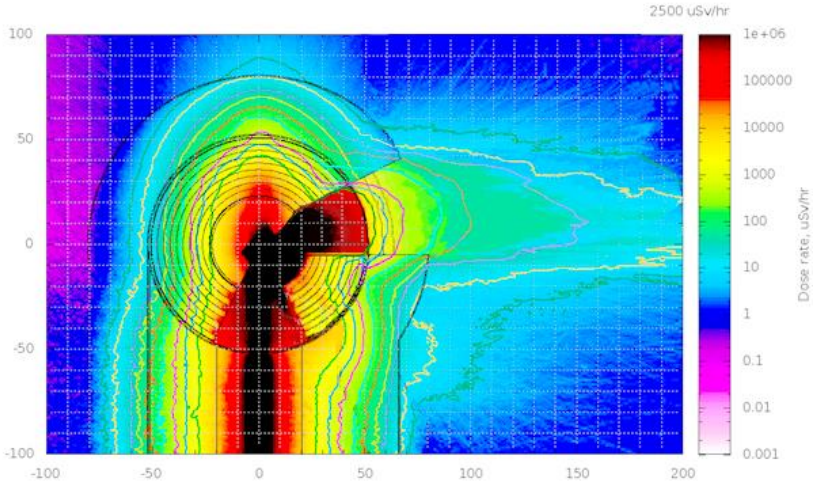




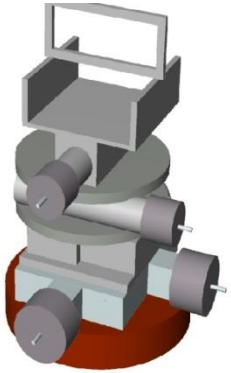
Due to the height difference FRB and PIK beams of, the Diffractometer should be placed on a platform consisting of two independent parts - 1) under the monochromator table and 2) under the sample and detector tables. In the first case, the platform is completely located inside the monochromator shielding and serves as a support for the stationary table. The second part should, in addition to its main function, provide the possibility of moving tables on air cushions and finding personnel to service the installation.

Calculation of neutron and dose fields for TEX-2

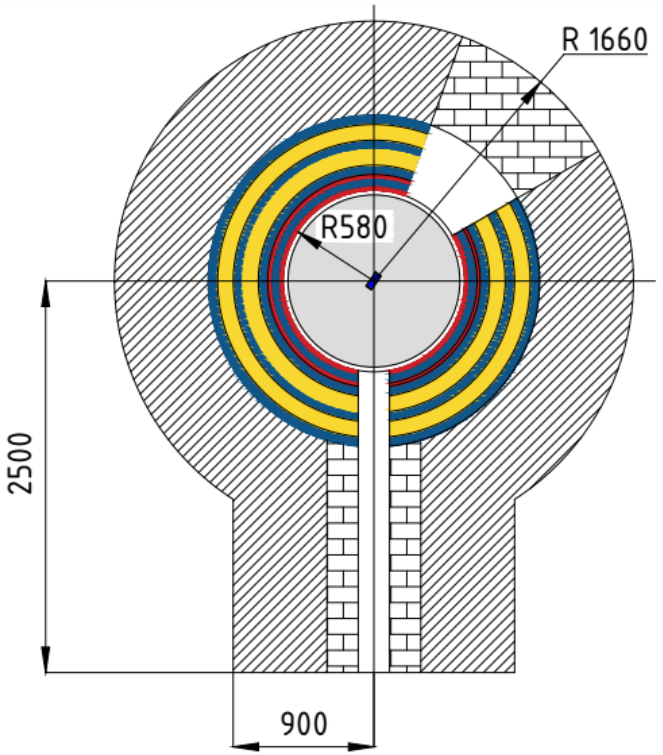
Simulation of physical calculations was carried out with programs FLUKA и MCNP.



Example of calculation the dose with FLUKA



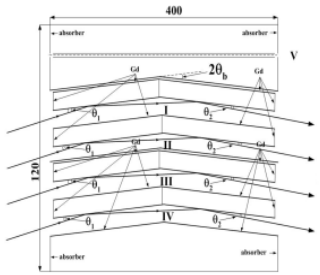
Monochromator model in SimpleGeo

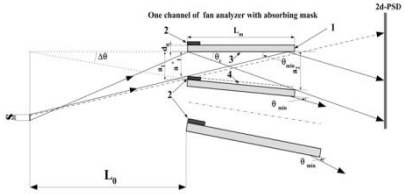


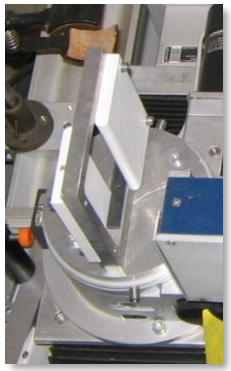
Dimension of monochromator shielding:
Height of shielding 2.8 m
Volume [м^3]:
concrete - 18, plumbum – 6, steel - 2.5,
Boron Polyethylene(3%) - 2.5,
Boron Rubber (40%) - 0.26.

The uncertainty with the neutron detector. The absence of the corresponding electronics and the data acquisition software.

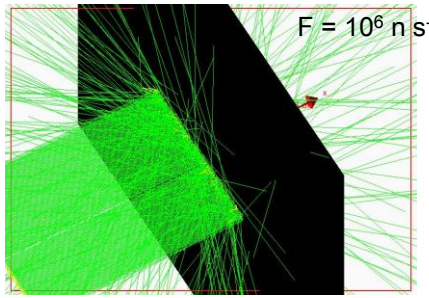
Polarized Neutron Reflectometer NERO

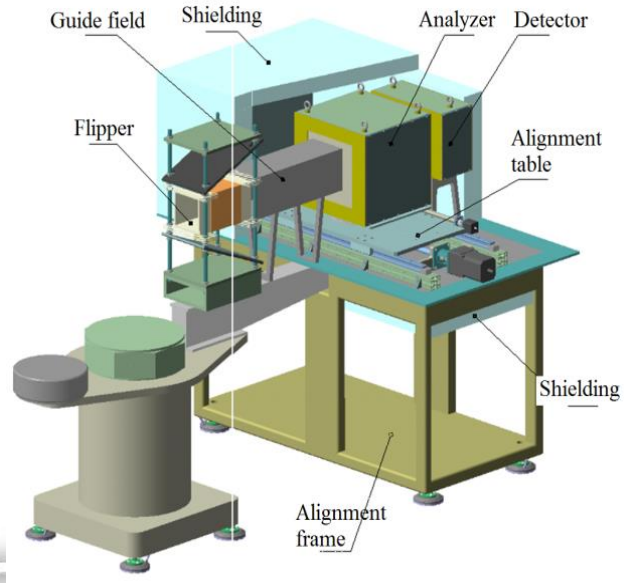






Geant4 ASSOCIATES INTERNATIONAL
Experts in Radiation Simulation



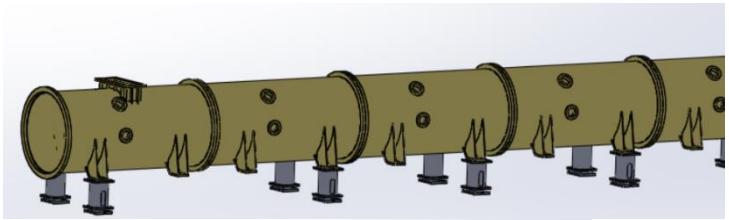


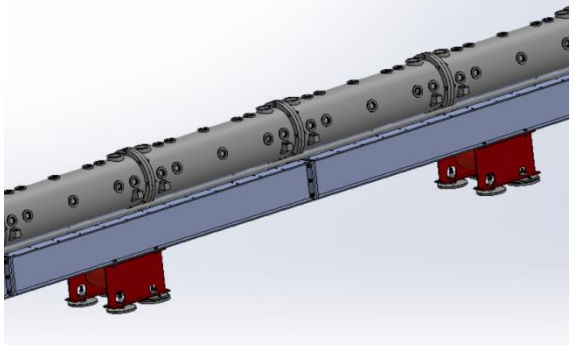
He^3 PSD

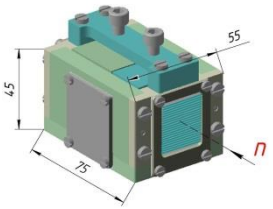
working area: 25×25 cm^2
resolution: 2×2.5 mm

The control software for the neutron experiments based on LabView enables one to carry out measurements. Mechanical control is done using IXE-A-RS и IXEα-A-RS controllers.

Small Angle Diffractometer SANS-2

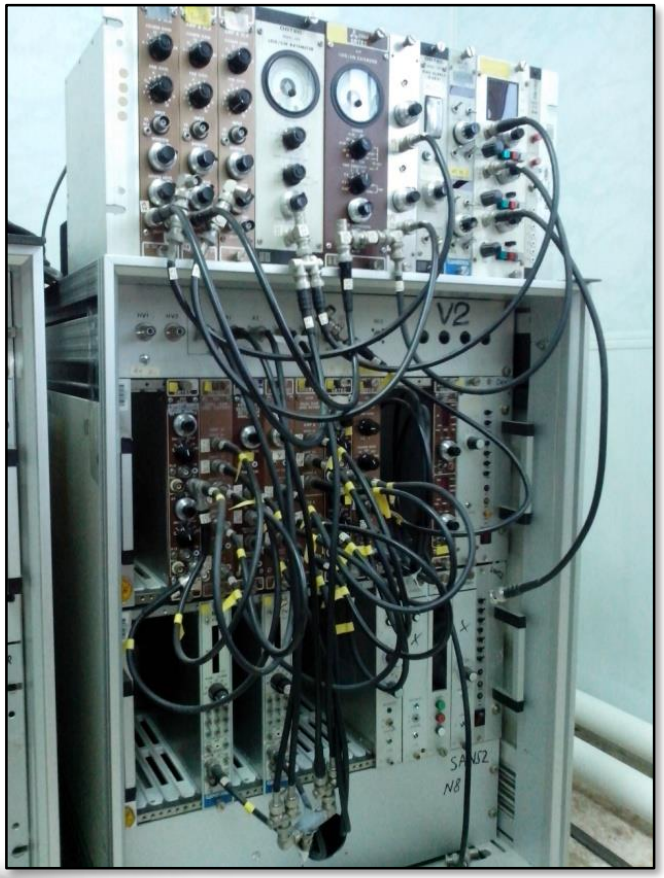


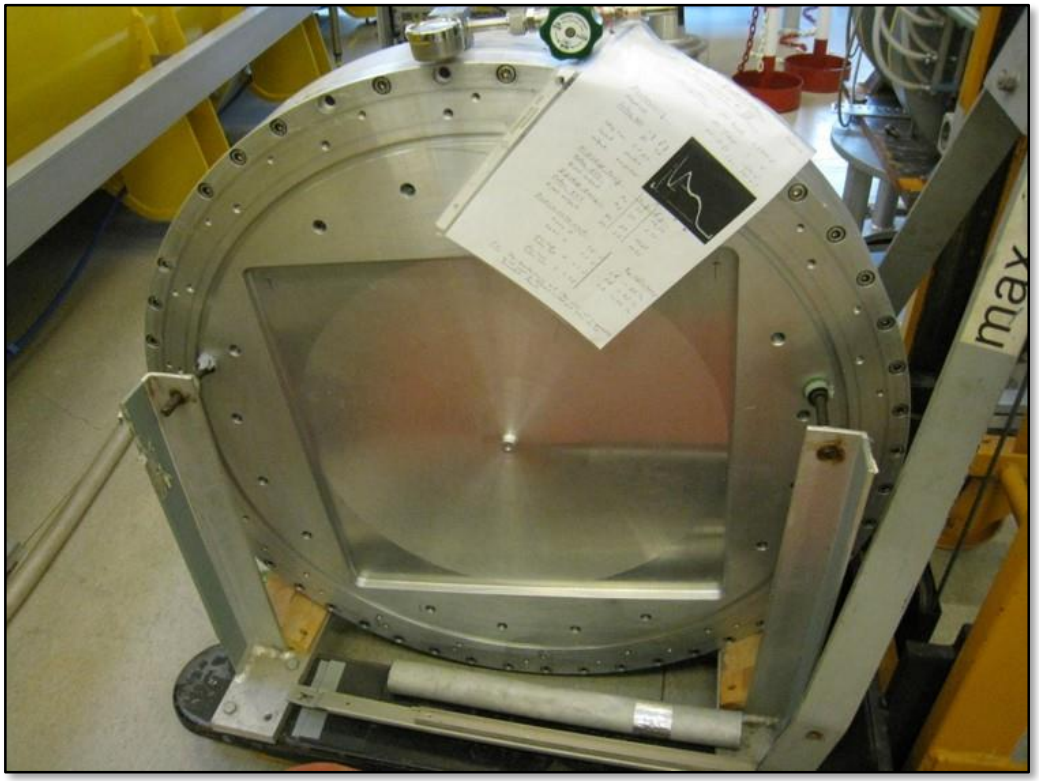




PSD:

- working area : 0.55 × 0.55 m^2
- resolution : 0.7 × 0.7 $см^2$
- Sample-detector distance : 1 m ≤ d ≤ 22 m
- Q range: 0.01 ≤ q ≤ 3 nm^{-1}





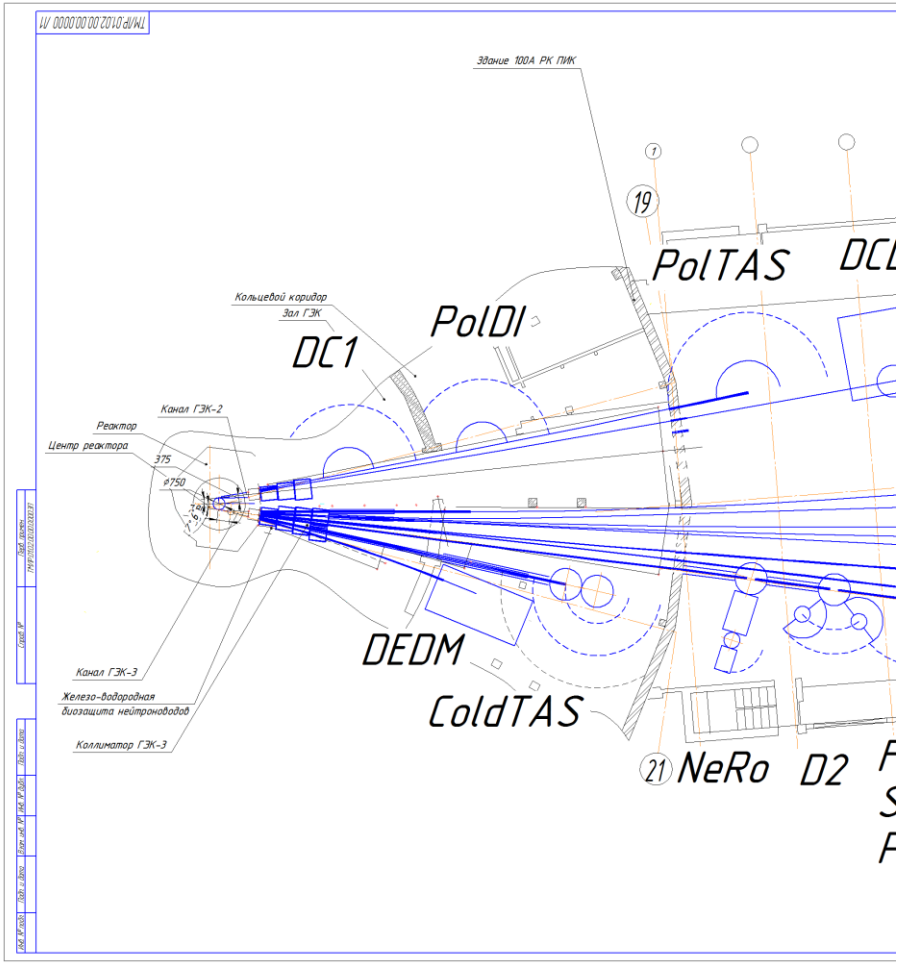
Polarized Diffractometer POLDI

Thermal neutron guide HEC2

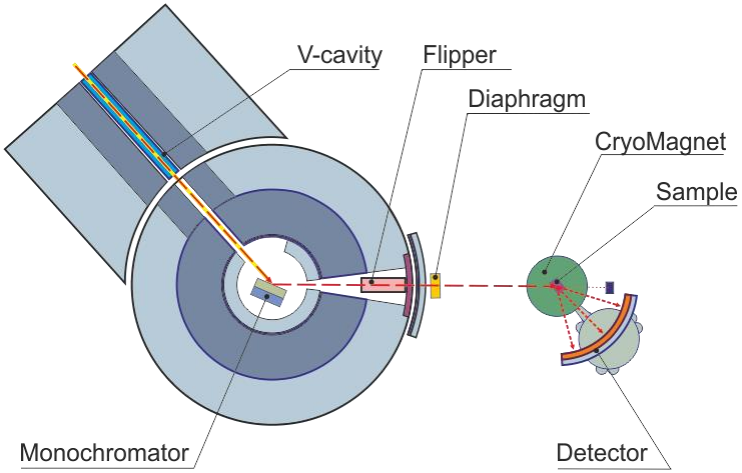
Monochromators
Cu (200) double focusing
PG (002) double focusing
Dimensions (w×h) 180×200 mm^2

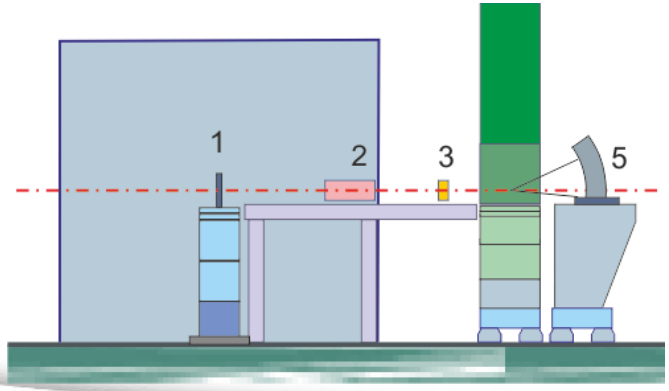
λ = 1.3 Å, 2.4 Å
Take-off angle 42°
Filter PG
Flux at sample, polarized
at 1.3 Å $(1\div2)\cdot10^8$ n/cm^{2}sec
Polarization P > 97%
Beam size at sample 1×1 cm^2 ÷ 3×3 cm^2
Detectors – 2D PSD, lifting counter

Distances:
Monochromator - sample
240 cm
Sample – detector
60 cm

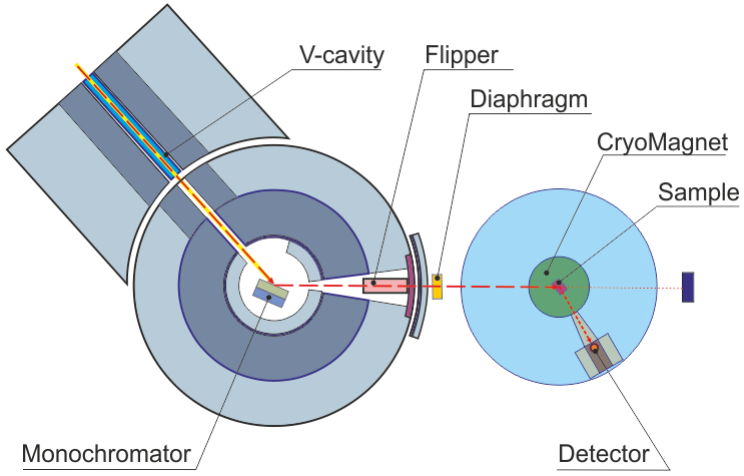


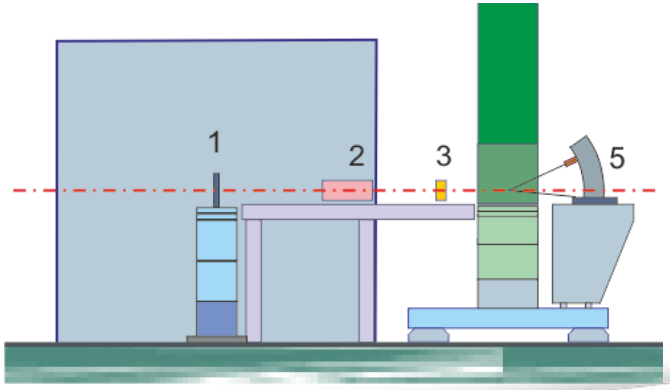
with 2D PSD



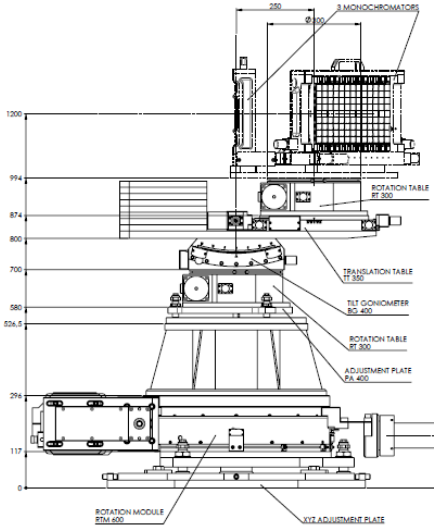


with lifting counter

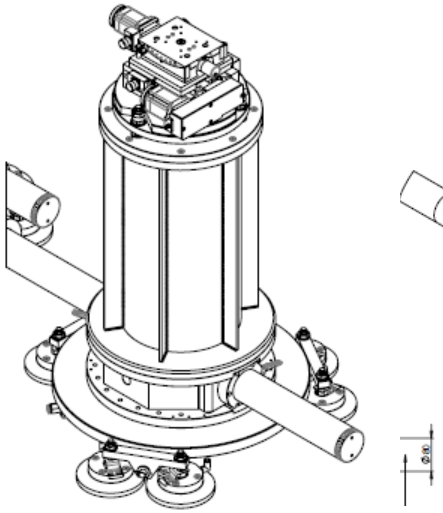




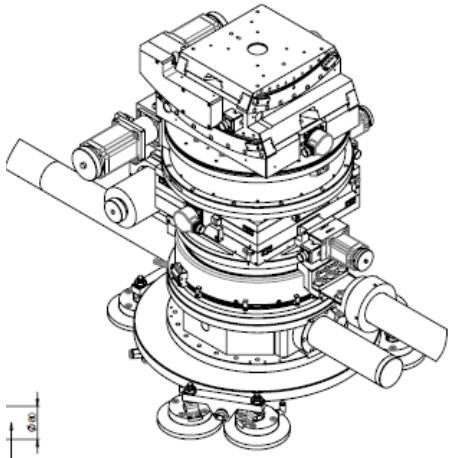
Monochromator unit



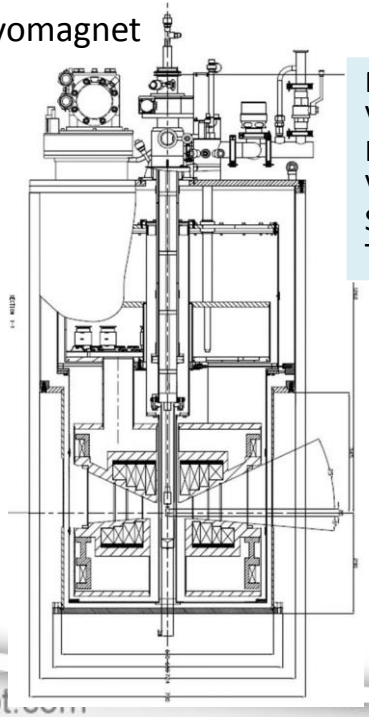
Detector unit



Sample unit



Cryomagnet



Magnetic field 9 - 10 T / Assymetric
Vertical access +25°/ -5°
Horizontal access ≥ 330°
Vertical split >10 mm
Stray field at 1 m distance <180 G
Temperature range 1.5K – 300K

POSITECNICS

Road map

#	Position	1 year 1 qr	1 year 2 qr	1 year 3 qr	1 year 4 qr	2 year 1 qr	2 year 2 qr	2 year 3 qr	2 year 4 qr
1	Polarizer V-cavity			Order, delivery, installation, testing					
2	Monochromator stage w Cu200, PG002			Positioning stages order; Crystals order		Monochromators fabrication		Delivery	
3	Monochromator shielding		Protective materials order, delivery	Manufacturing of structural elements			Assembling		
4	Sample stage			Order, delivery, installation, testing					
5'	Detector stage w 2D PSD		2D PSD Order, fabrication, delivery	Positioning stages order, fabrication, delivery				Assembling, testing	
6	Electronics, racs, computer				Order, delivery, installation, testing				
7	Beam Elements		Order, delivery, installation, testing						
8	CryoMagnet 9T Oxford Instr		Order, fabrication				Delivery, installation, on-site testing		
9	Site implementation		Equipment and materials order, delivery						
10	Design work	Technical Require.	Draft design	Det. tech. design					
11	Assembling and installation								

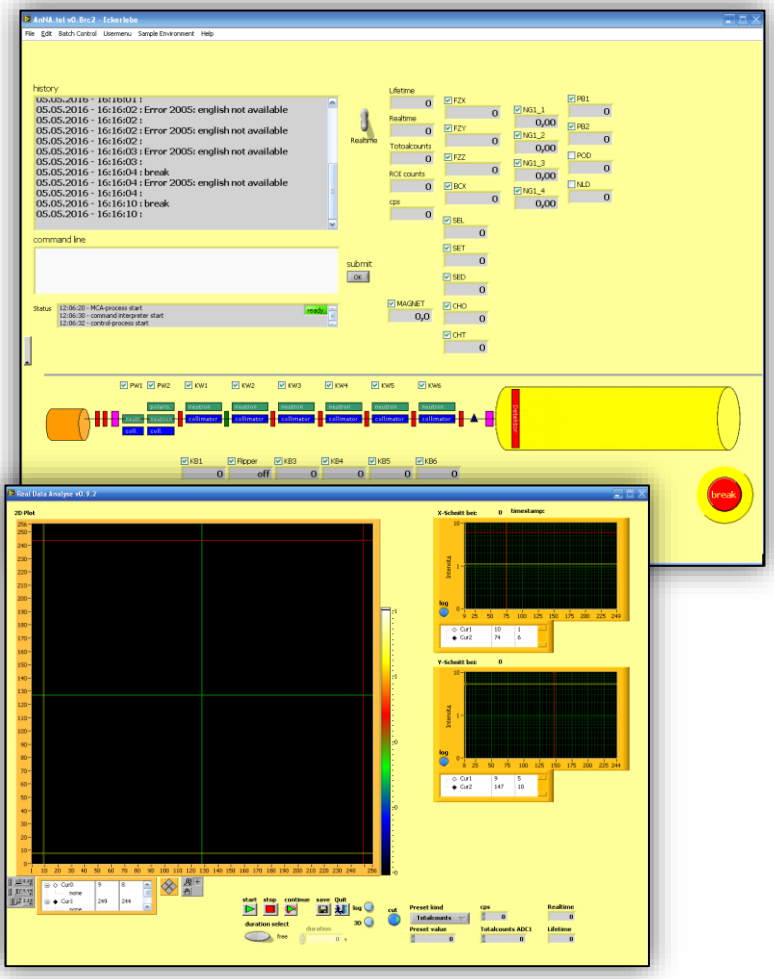
Technological environment + Energy

Neutron instrument	Chanel	Electricity, kW		chemically desalted water (B6), l/min	Compressed air (maximum flow), m3/h	Liquid helium, l/ week	Liquid nitrogen, l/ week
		220 В	380 В				
NGH (b. 104)							
NERO	ГЭК 3	10	10	5	15	45	60
D2	ГЭК3	15	15	20	30	45	60
Free position	ГЭК 3	10	8	10	15	45	60
SONATA	ГЭК 3	10	8	10	20	45	60
LIRA	ГЭК 3	10	10	10	35	45	60
SANS-2	ГЭК 3	15	10	20	15	45	60
SANS-3	ГЭК 3	15	10	20	15	45	60
NSE-Spec	ГЭК 3	15	5	6	10	45	60
SESANS	ГЭК 3	15	5	5	10	45	60
Free position	ГЭК 3	15	10	20	15	45	60
TOF-Spec	ГЭК 3	15	5	5	10	45	60
DC1	ГЭК 2	15	5	5	15	45	60
ARES	ГЭК 2	15	8	20	15	45	60
PolDi	ГЭК 2	15	5	5	10	45	60
DCD	ГЭК 2	15	5	10	10	45	60
PolTAS	ГЭК 2	10	5	5	10	45	60
RingH (b. 100A)							
ColdTAS	ГЭК 3	10	5	5	10	45	60
DEDM	ГЭК 3	10	8	2	10	45	60
RH (b. 100A)							
TAS	ГЭК 6	10	5	5	10	45	60
D1	ГЭК 9	15	8	20	15	45	60
D3	ГЭК 9	15	15	20	15	45	60
TeX	ГЭК 10	15	15	20	15	45	60
IRINA	ГЭК 5'	70	30	30	10	45	60

Additional requirements: individual ground line for detector equipment, installing water leakage sensors, etc.

Soft

LabView (window control)



TANGO
Connecting things together

C/C++ work with electronics (USB drivers, Ethernet, etc.. its depends from specofoc equipment)

Tango hosts

SANS

NERO

Another facilities

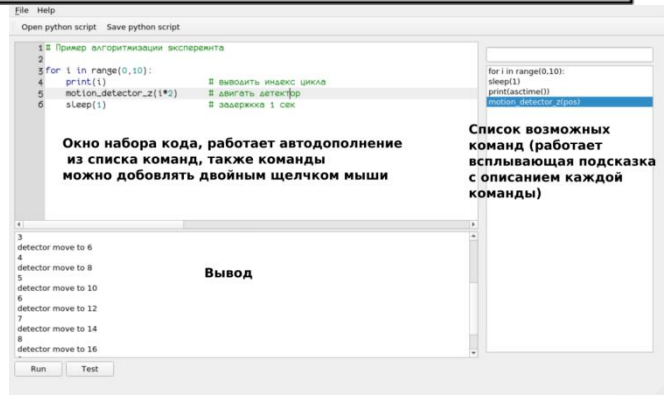
TANGO server

CORBA interface TANGO

Base of data obtained

Tango clients

The general view of the client program may look like this:
1) Block-scheme of instrument with the possibility of monitoring and parameters adjustment;
2) Meta-language of algorithmic experiment (Python)
3) Image (data) from the detector



ICNR@PIK: German in-kind Contribution (statement of S.Schmidt (11.10.2017, Gatchina)

- Refurbishment of 7 instruments from Geesthacht

- German in-kind contribution for design&construction 3-5 state of the art neutron instruments

- Suggestion on instruments:
  - Spin-echo spectrometer
  - Backscattering spectrometer
  - Small-angle facility for scattering with grazing incidence
  - Polarized three-axis spectrometer with multianalyser
  - And possibly a polarized diffractometer

PNPI – HZG meeting (Dec 2017)

Instrument	Costs [Mill.€]
Nero	0,5
SANS-2	1,5
SANS-3	1,2
ARES-2	0,8
TEX-2	0,7
DCD	0,3
POLDI	1,4
Sum	**6,4**

Sample Environment refurbishment	Costs [Mill. €]
Rotating cryostat, 1 T magnet	0,3
Magnet hor. 5T, cryostat, furnaces	0,7
Tables	0,5
Load frame	0,2
Robot, sample changer, furnace	0,5
Furnace, etc.	0,1
Magnet vert. 9T, cryostat	1,1
Sum	**3,4**

Sample Environment Group	Costs [Mill. €]
He-3 Insert (dilution stick)	0,4
Dilatometer; Hexapod	0,8
Hexapod	0,2
3-D analysis	0,1
Sum	**1,5**

Gain Factor without refurbishment: 1-3
Additional Gain Factor with refurbishment: 10-20

Personell: 2 Mill. € (3 scientists and 3 engineers for 3 years)

Phytron electronics cost estimate for moving devices:

1. SANS-2

Для диафрагм (BD300 ток до 3А) и пневматики используется крейт phyMotion на 21 место со встроенным источником питания 11 осей до 3А I1AM01.1 и 32 канала для пневматики(4 **DIOM01.1.**)

Итого 10391+414=10805 EUR.

11 осей с внутренним питанием (трансформатор) . +4 DIOMa.

Стоимость 10805 EUR с НДС.

	Function	MODULE	ArtNr	Configuration-Check	HOST Interface
Slot_00		Gehäuse 21SL-RI-c	10018036	OK	
Slot_01	Main Power Input; int. Supply	POWM03.1	10018099	OK	
Slot_02	Main Controller	MCM01.1	10015035	OK	ETH501.2
Slot_03	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_04	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_05	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_06	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_07	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_08	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_09	Secondary Power Input; int. Supply	POWM04.1	10018198	OK	
Slot_10	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_11	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_12	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_13	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_14	Indexer & Power Stage; 3,5A, 24-48V	I1AM01.1	10015051	OK	
Slot_15	Digital I/O Modul	DIOM01.1	10015052	OK	
Slot_16	Digital I/O Modul	DIOM01.1	10015052	OK	
Slot_17	Digital I/O Modul	DIOM01.1	10015052	OK	
Slot_18		emptyFP	10014784	OK	
Slot_19		NETM01.1	10017982	OK	

Для осей с MSX на 10А используется управляющая корзина phyMOTION с 3-мя I4XM01 и 12-ю EXAM01 - **5670 EUR.** Для 12 осей три корзины SLS с общей суммой 7455.8 x 3= 22367.4 EUR

Сумма 5670+22367=28037EUR

Одна управляющая корзина phyMOTION с 3-мя I4XM01 и 12-ю EXAM01 - **5670 EUR** питание 24В 10А

	Function	MODULE	ArtNr	Configuration-Check	HOST Interface
Slot_00		Gehäuse 21SL-R-s	10014625	OK	
Slot_01	Main Power Input Module	POWM01.2	10015741	OK	
Slot_02	Main Controller	MCM01.1	10015035	OK	ETH501.2
Slot_03	Four-Axis-Indexer	I4XM01.1	10015043	OK	
Slot_04	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_05	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_06	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_07	Four-Axis-Indexer	I4XM01.1	10015043	OK	
Slot_08	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_09	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_10	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_11	Secondary Power Input; external Supply	POWM02.2	10015742	OK	
Slot_12	Four-Axis-Indexer	I4XM01.1	10015043	OK	
Slot_13	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_14	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_15	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_16	Four-Axis-Indexer	I4XM01.1	10015043	OK	
Slot_17	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_18	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_19	Power Stage Carrier EXTERNAL	EXAM01.1	10015050	OK	
Slot_20		emptyFP	10014784	OK	
Slot_21		emptyFP	10014784	OK	

Общая стоимость оборудования 28037EUR+10805= 38842EUR,
необходим внешний блок питания для управляющей корзины 30Вх 10А

SANS -2	**38.842 EUR**
SANS - 3	**21.000 EUR**
NERO	**7.453 EUR**
TEX-2	**25.800 EUR**
ARES-2	**21.000 EUR**
DCD	**8.700 EUR**

DENEX - DETEKTOREN FÜR NEUTRONEN - GmbH
Stöteroggestraße 71 D-21339 Lüneburg

For TEX - 2

DENEX PSD ≈150.000 EUR + He3 (RUS) ≈ 20.000 = 170.000 EUR

In our possession:

150 L He3 (8MRub ≈ 115 kEUR)

Investment project
«Creation of the instrument base of the PIK reactor complex»

Instrumental complexes of the neutron guide hall (9 stations):
1) Three-axis cold neutron spectrometer (IN-2);
2) Time-of-flight spectrometer (IN-4);
3) Spin-echo spectrometer (SEM);
4) Small-angle diffractometer of polarized neutrons (Tenzor);
5) Small-angle diffractometer ("Membrane-2");
6) Installation of spin-echo of ultra-small-angle scattering (SESANS);
7) Neutron-optical reflectometer (SONATA);
8) Reflectometer with vector analysis of polarization (HARMONY);
9) Installation of "EDM neutron by crystal-diffraction method" (DEDM).

Instrumental complexes of the hall of horizontal channels (8 stations);
1) Superposition multi-section powder diffractometer (D1);
2) Powder multi-detector thermal neutron diffractometer (D3);
3) Four-circle diffractometer (DC1);
4) Three-axis thermal neutron spectrometer (IN-1);
5) Three-axis spectrometer of polarized neutrons (IN-3);
6) ~~«Beta-neutron decay» facility~~;
7) Mass-separator laser-nuclear complex IRINA;
8) ~~«Neutrino» facility~~.

Instrumental complexes of the hall of inclined channels (3 stations).
1) ~~Fission fragment multiplicity test setup (FISCO)~~;
2) ~~Nuclear radiation spectrometer (PROGRAS)~~;
3) ~~Installation of neutron activation analysis (INAA)~~.

Thank you for your attention!