Status and progress of instrument modernization at the IBR-2 reactor

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59th Meeting of the PAC for Condensed Matter Physics 24-25 June 2024

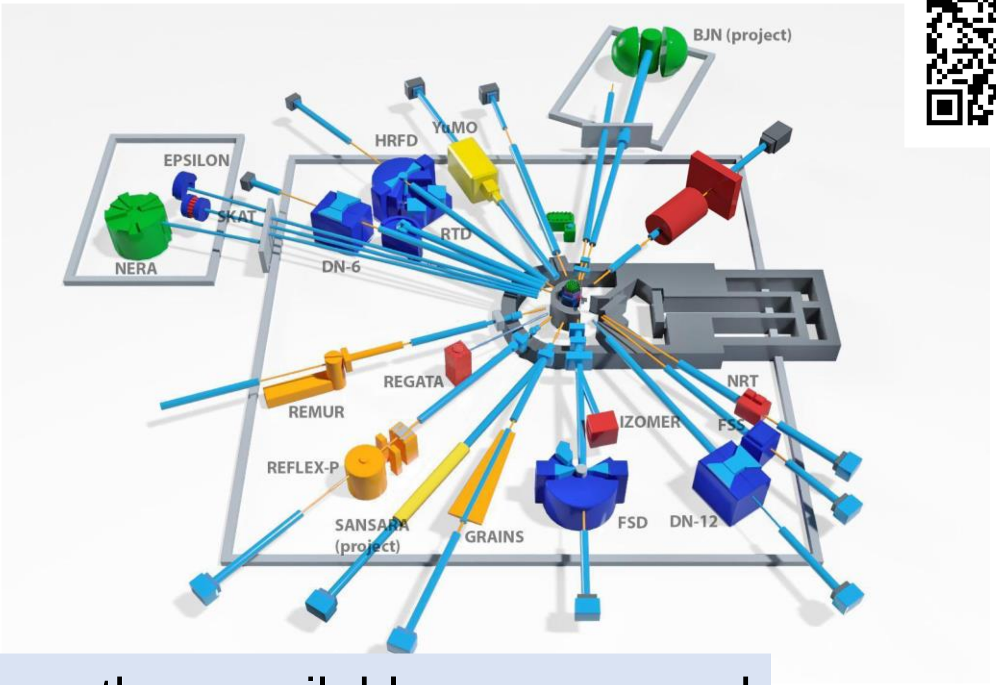
Outline

1. Status of new instruments
    a) Inelastic spectrometer BJN
    b) SANS spectrometer SANSARA
2. Status of new detectors
    a) BSD for HRFD
    b) ASTRA-M for FSD
3. Readiness of detector systems and electronics
4. Readiness check of mechanical choppers and control systems

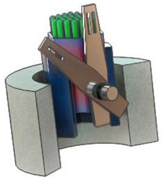
BJN Spectrometer

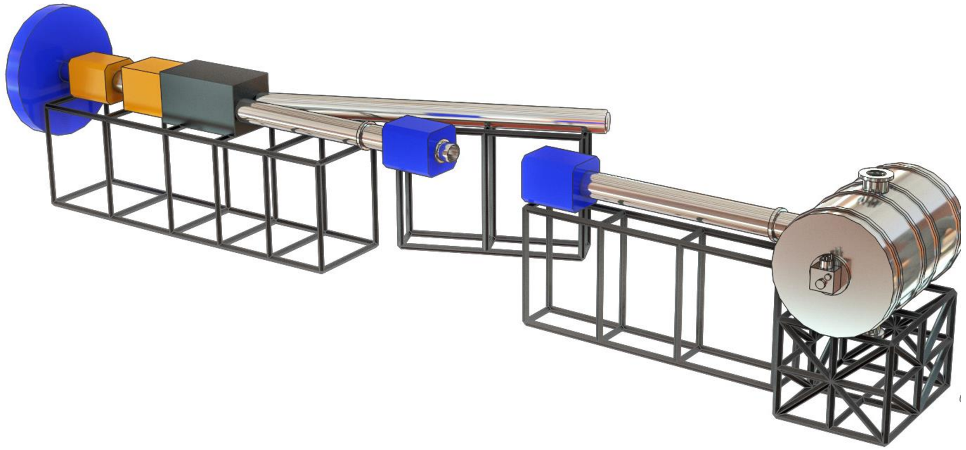
New inelastic neutron scattering spectrometer in inverse geometry

BJN (Bajorek-Janik-Natkaniec)



OPENNING of the PROJECT: January 2021



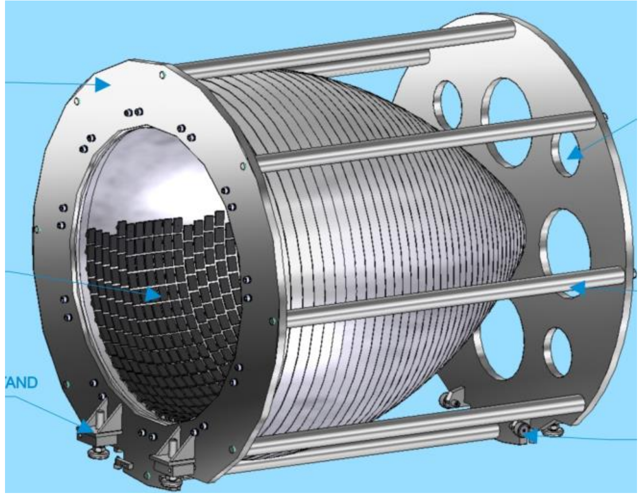


Based on the available space and needed time resolution and energy range the distance between the source and the sample of new spectrometer was chosen equal **105 m.**

BJN Spectrometer

The main concept for the secondary spectrometer is to place a set of **HOPG** (higly oriented pyrolytic graphite) analyser plates resembling together **a bell shape**, on both sides of sample.

28 times greater analyzer area

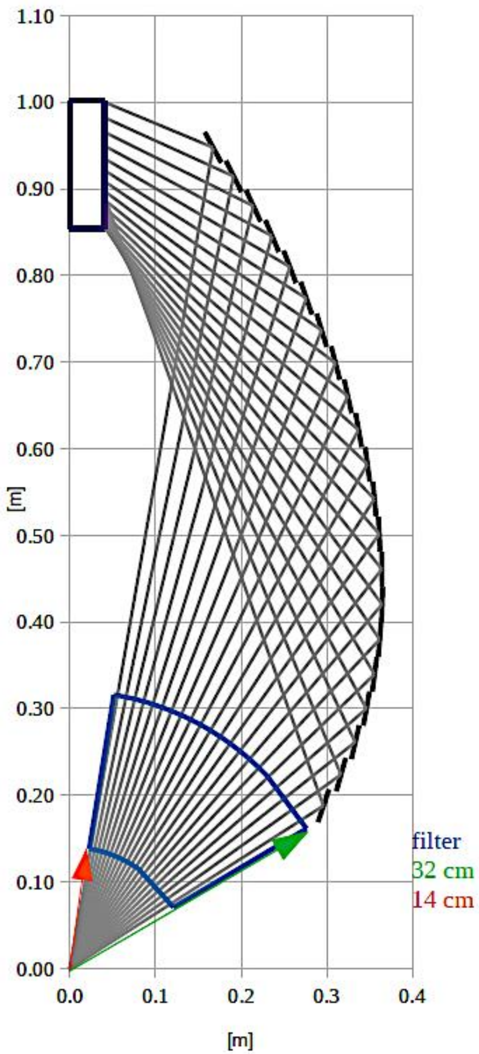


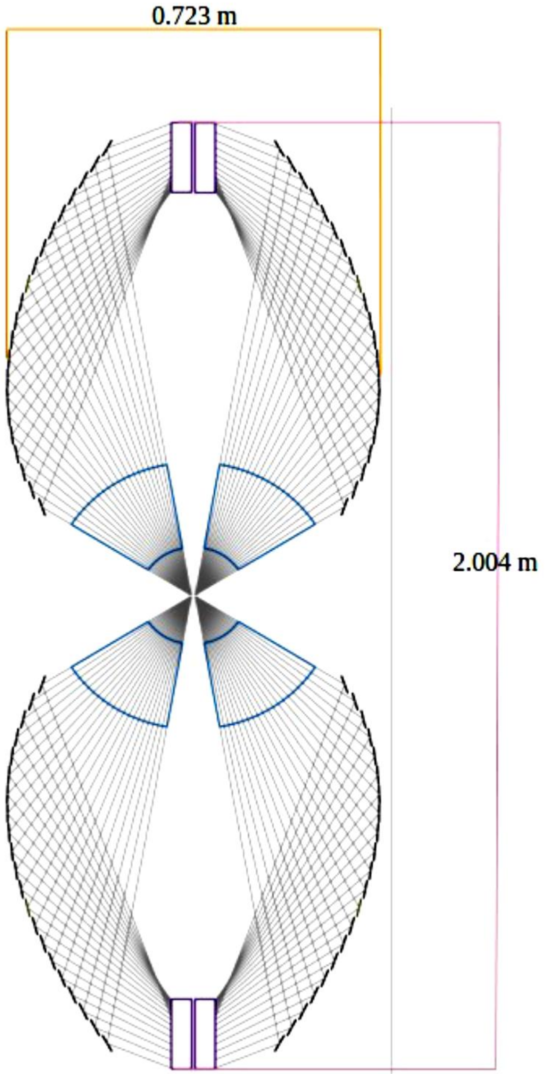
Solid angle ~ 5.8 sr

Ratio of luminosity of new spectrometer and NERA:

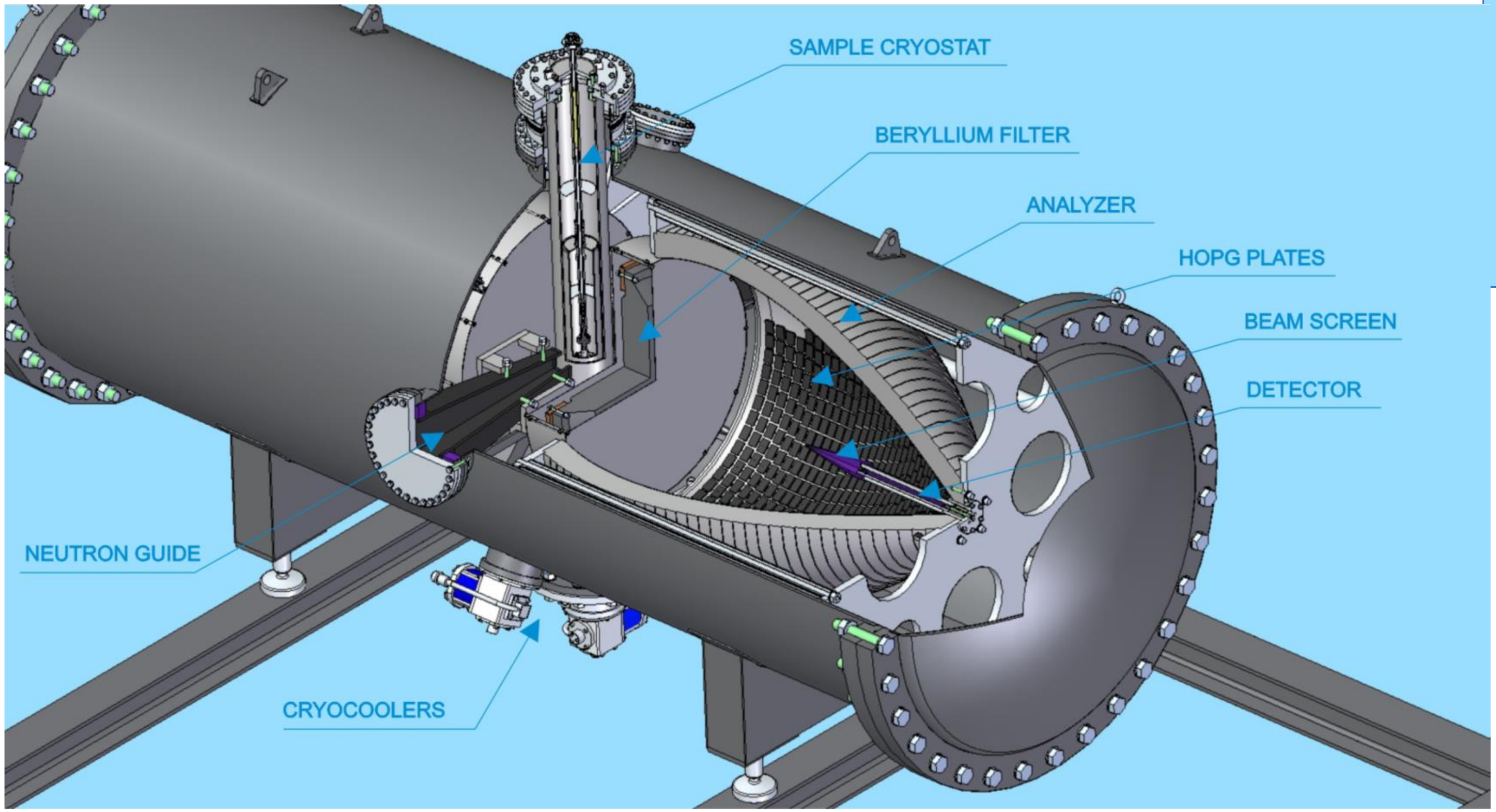
<u>Almost 400 times higher</u>

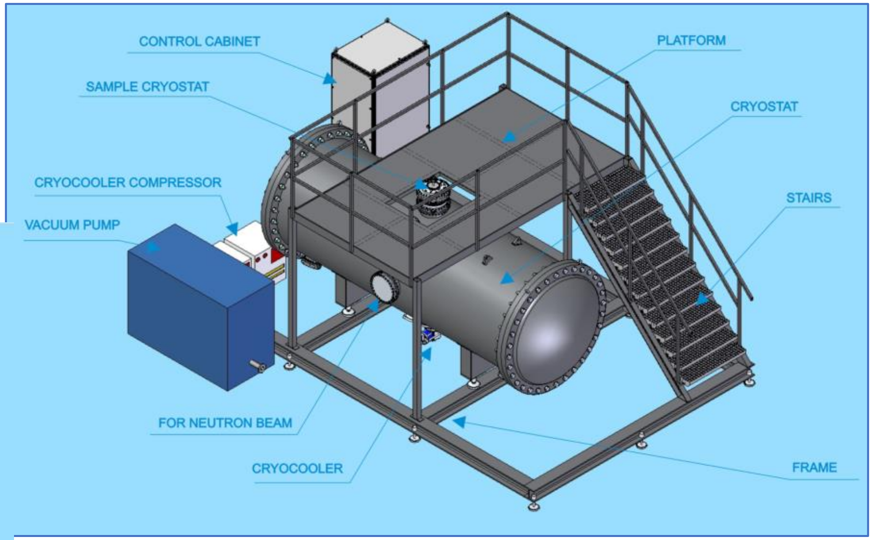
i.e. **measurements** of a sample with the mass of **10-20 mg will be possible**.





BJN Spectrometer





BJN Spectrometer

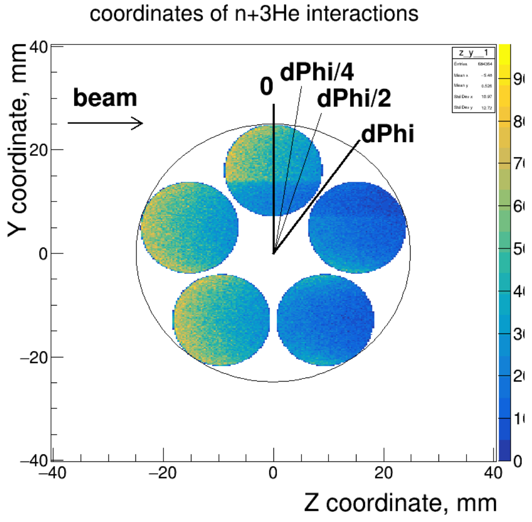
Detector mounting systems

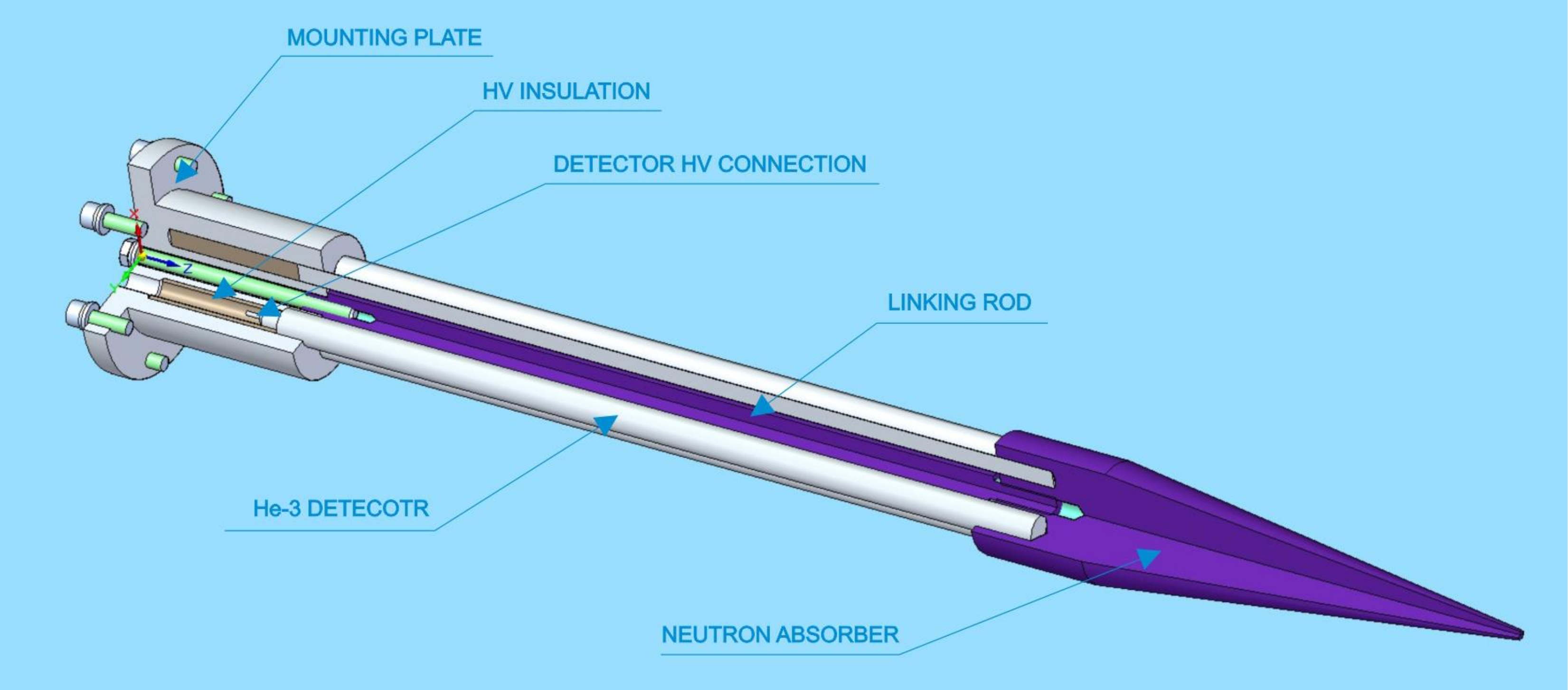
5 tubes of He^3 detectors for one bell

The counter wall thickness is 0.2 mm

^{3}He pressure is 8 atm.

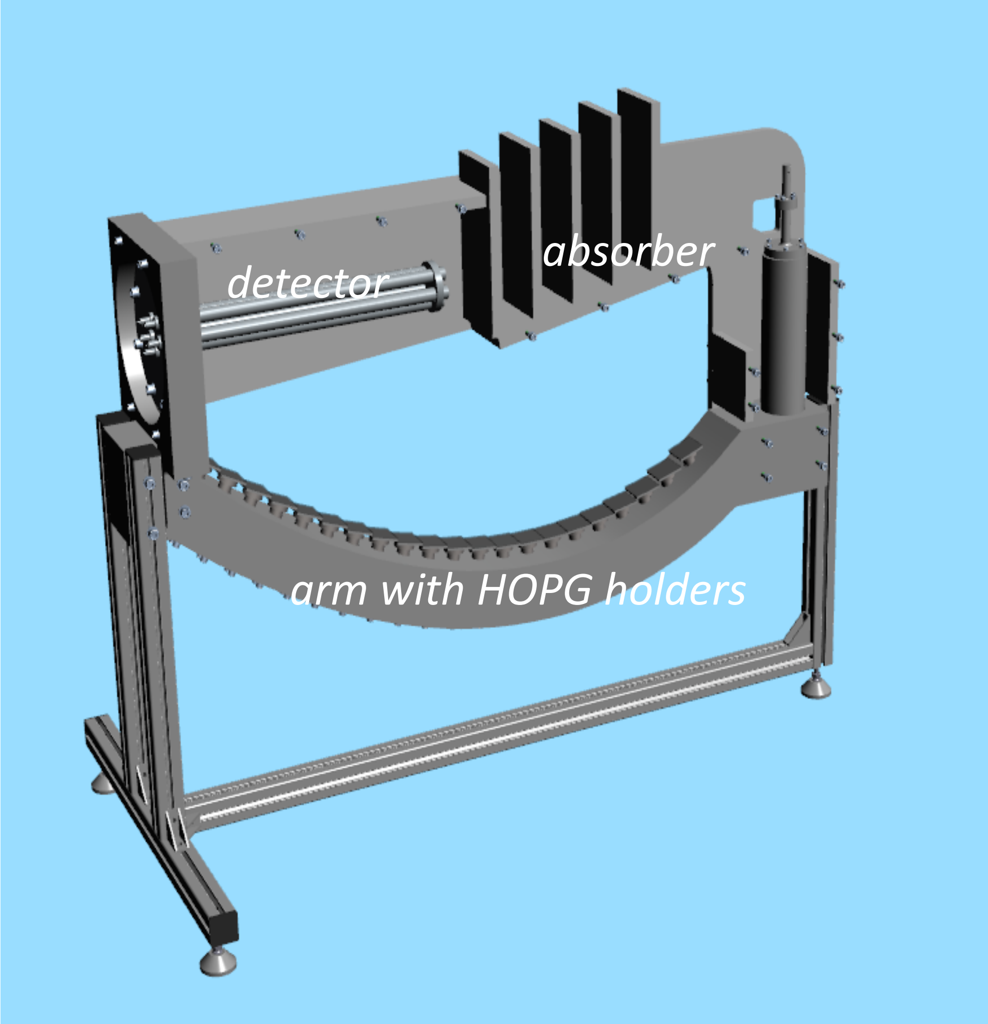
Assembly of cylindrical counters d≈18 mm (analogue of SNM-18).



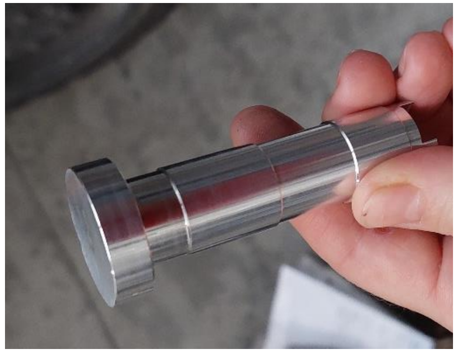


Purchase - Scientific-Production Firm "CONSENSUS " 2024

BJN Spectrometer



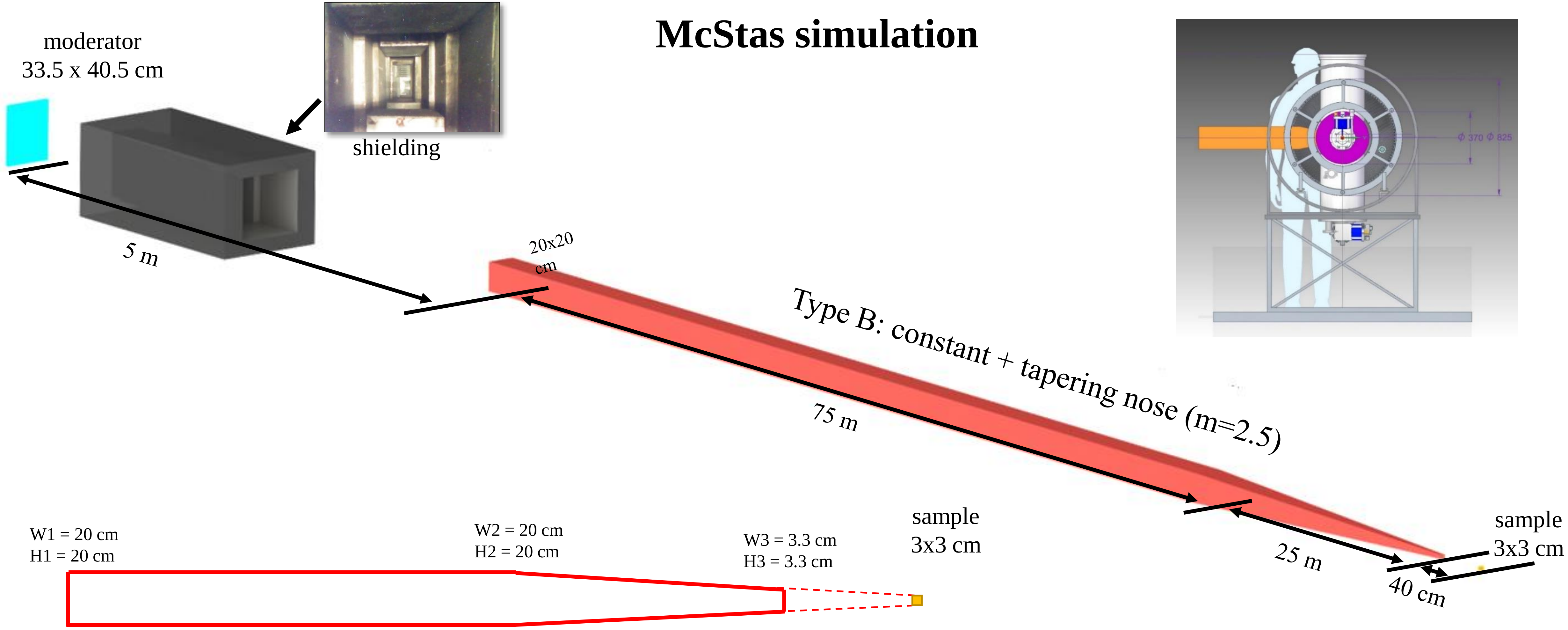
PROTOTYPE



Assembly of prototype – June/September 2024
Test measurements – December 2024/January 2025

BJN Spectrometer

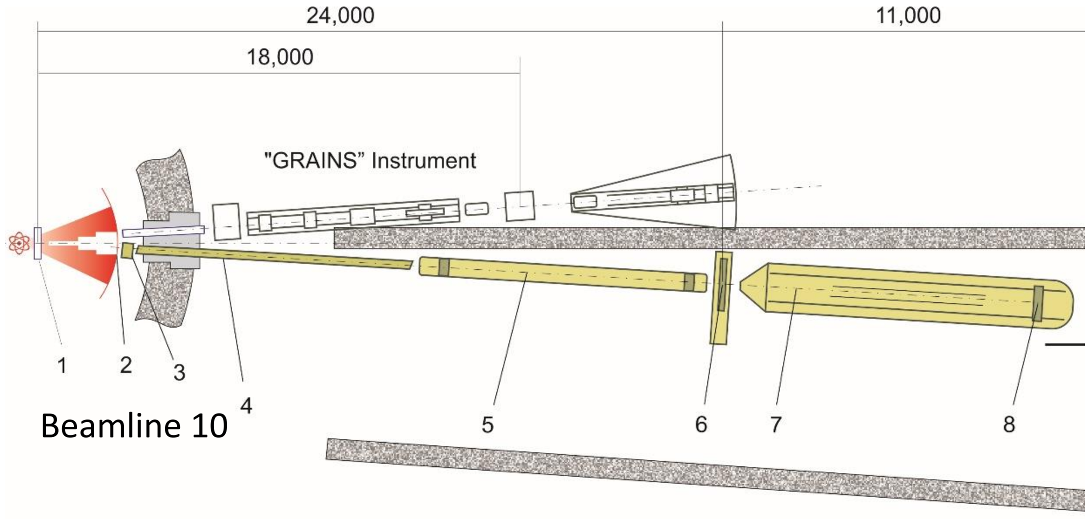
McStas simulation



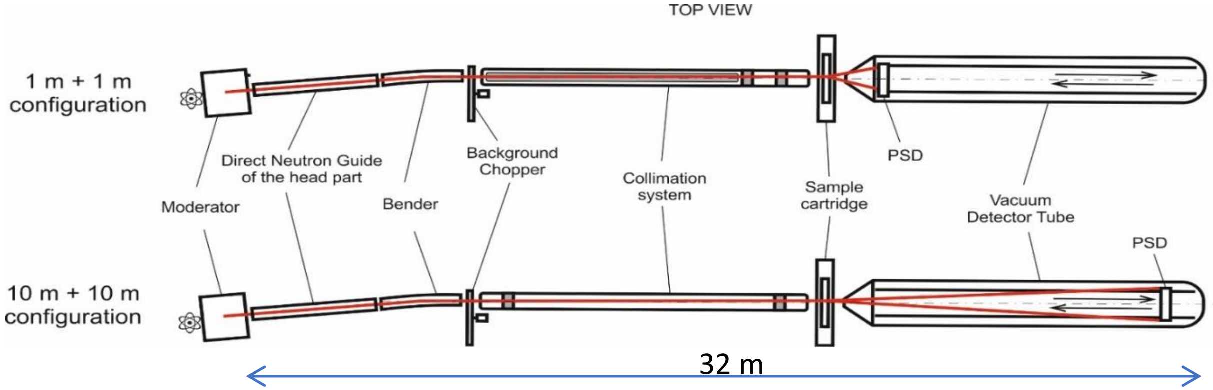
Purchase– second half of 2024/2025 Implementation – 2025/2026

SANSARA Spectrometer

SMALL-ANGLE DIFFRACTOMETER WITH CLASSICAL CONFIGURATION AT THE CRYOGENIC MODERATOR OF IBR-2 REACTOR, 2016



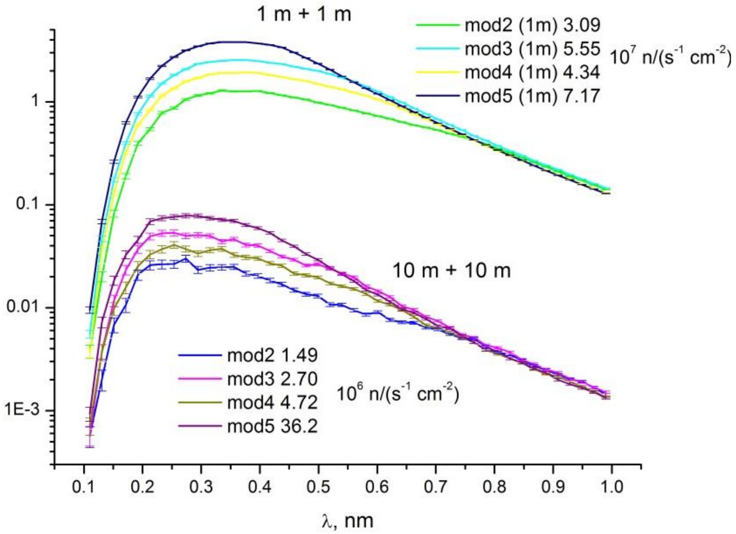
Beamline 10



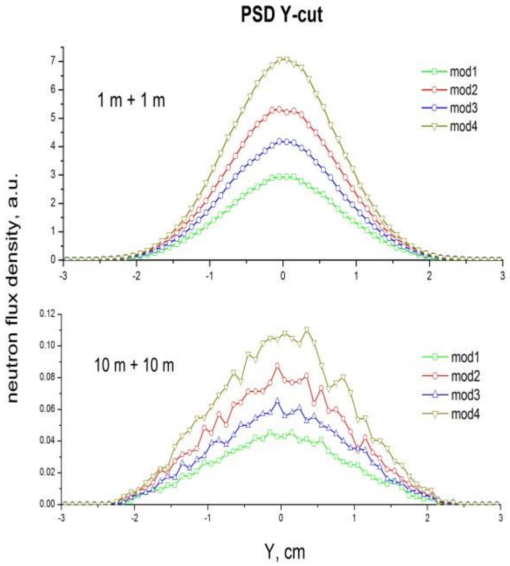
Beamline 10A

Spectrum calculations

T = 100 K



Flux distribution



Bender modifications
(m = 2, beam size 5×5 cm)

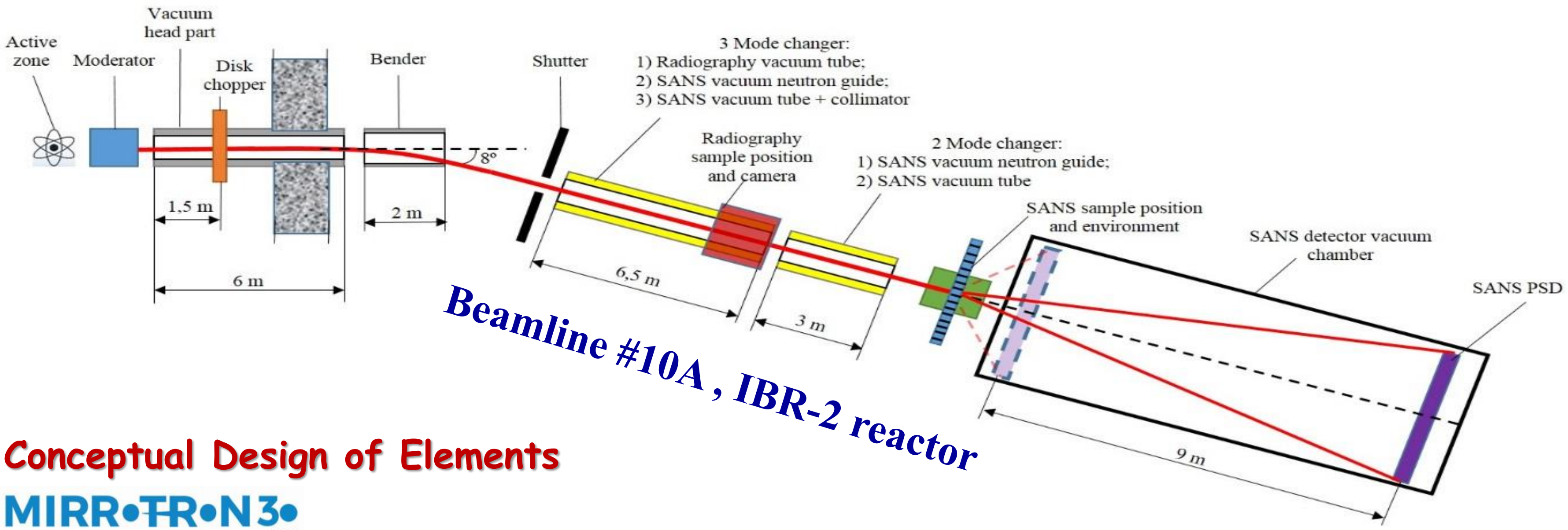
	Number of mirror channels	Length	Radius of curvature
mod1	20	1 m	7.16 m
mod2	20	2 m	14.32 m
mod3	30	1 m	7.16 m
mod4	30	2 m	14.32 m

Results of VITESS simulations 2016-2017

M.V.Avdeev, et.al.,
J. Surf. Investigation. 2018, Vol. 12, No. 4, pp. 638–644.

SANSARA Spectrometer

SANS/ Neutron Tomography



Expected parameters

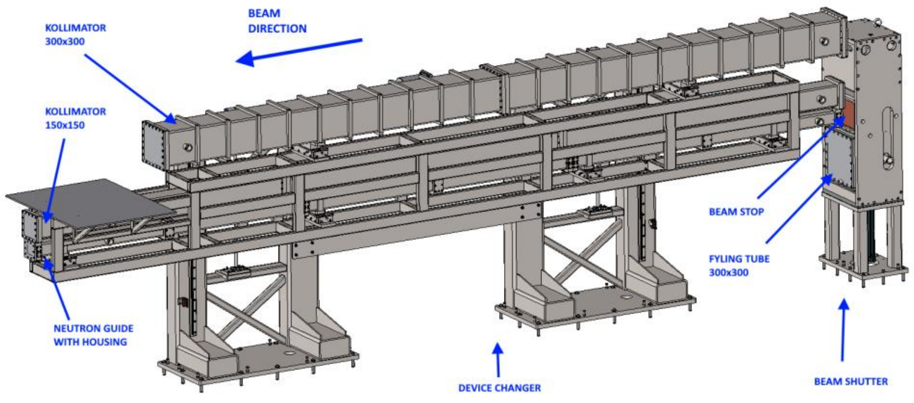
Beam size	50×50 mm^2
Wavelength range:	0.5 – 10 Å
q-range:	0.003 – 0.5 Å^{-1}
Angular resolution	5 - 20 %
Max. sample size	50×50 mm^2
Flux at sample	2.0×10^6 cm^{-2} s^{-1}
Detector, PSD	^{3}He, 70×70 cm^2, resolut. 5×5 mm^2

Conceptual Design of Elements

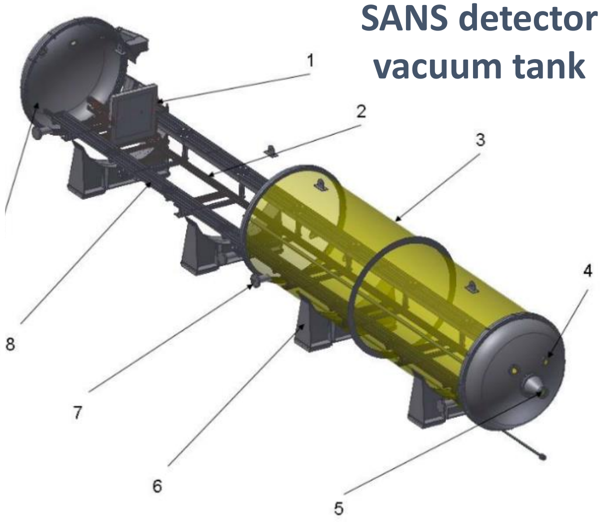
MIRROTRON 30 YEARS EXPERIENCE
THE WORLD OF NEUTRON

Bender

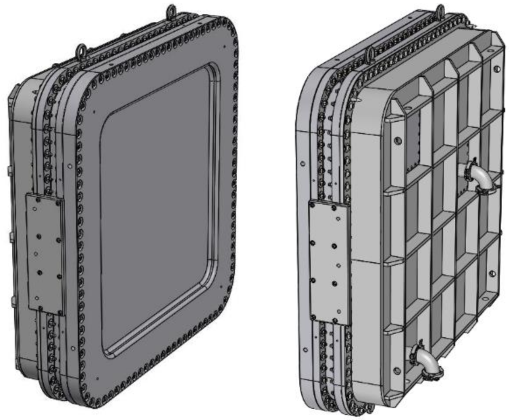
Changeable beam forming system with shutter



SANS detector vacuum tank



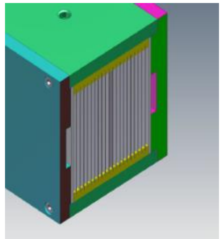
SANS position-sensitive detector

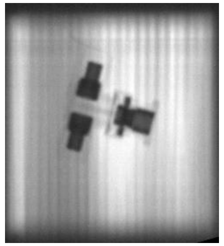


SANSARA Spectrometer

SANS/ Neutron Tomography

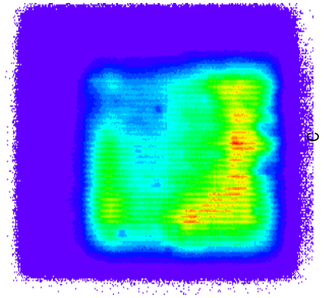
Bender

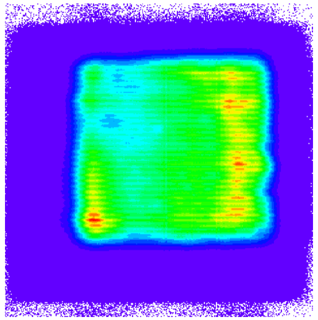


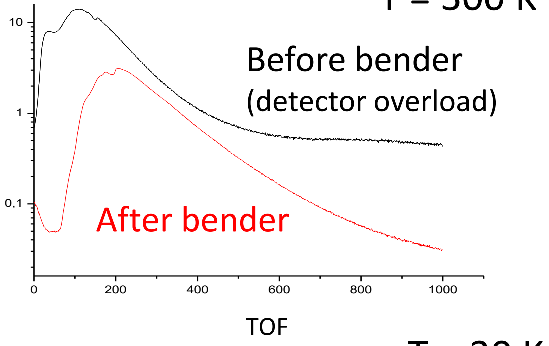


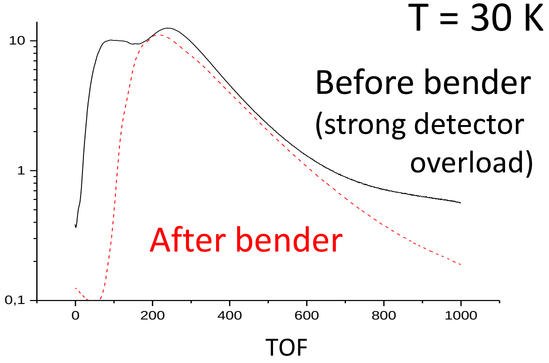
L = 2 m, R = 14 .3 m, N = 20 (m = 2)

Produced and installed at IBR-2 by MIRROTRON (2018)









Changeable beam forming system + shutter

L = 6 m   **Produced and delivered to JINR by MIRROTRON (2020)**

Total flux measurements
(monitor PSD)

Results of 2017-2019

Temperature of moderator	30 K	300 K
Before bender	> 1.0e8	~5.0e7
After bender	~5.0e7	~8.0e6

30 K – working mode (flux at sample > 10^6 cm^{-2} s^{-1})
300 K – mode for high-scattering systems
(flux at sample > 10^5 cm^{-2} s^{-1})

SANSARA Spectrometer

SANS/ Neutron Tomography

Plans for 2024-2026

- Installation of automatic beam shutter
- Installation and tests of changeable beam-forming system
- Installation and start-up of Neutron Tomography option
- Installation of vacuum detector tank for SANS including movable detector platform (manufactured)
- Development of SANS position sensitive detector including DACQ system
- Manufacturing and installation of beam stop at SANS detector

Status of new detector systems. BSD for HRFD (5th BL)

The detector BSD is designed for high-resolution Fourier diffractometer (HRFD) on the BL. №5, IBR-2 reactor. The detector has a ring structure matches the axial symmetry of neutron scattering. It contains 6 ring assemblies of ZnS(Ag)/6LiF-scintillation with a shape satisfying time-focusing geometry. The rings are divided into 12 sectors (30°). The ring assemblies cover the stated range of scattering angles $2\theta = (133-175)°$.The total solid angle of the detector is approximately Ω_d.

The current status:

1. Manufacture of 4 spare units for the data acquisition system (MPD32-USB-3) for uninterrupted operation of the detector **– in progress.**
2. Purchasing a set of spare photomultipliers (10 pcs.) **2 pcs. already purchased.**
2. Adjustment of CAEN amplifier modules in accordance with required parameters (these modules to replace the Phillips Scientific modules planned in the project). **- it's done**
4. Manufacture of a set (432 pcs.) of I/O and measuring cables. **– in progress. To be done before reactor start up**
5. Installation of BSD on regular position at HRFD. **- it's done**
6. Adjustment of analog electronics, data acquisition systems based on MPD32-USB (3 modules), as well as related software. **– in progress. To be done before reactor start up.**
7. Test of the time-focusing geometry and the position adjustment if necessary. After the IBR-2 reactor start up**.**

Status of new detector systems.

ASTRA-M for FSD (11th BL)

The detector system ASTRA-M is designed for specialized Fourier Stress Diffractometer (FSD) on the BL №11a of the IBR-2 reactor. This detector system consists of two multi-element detectors (Scintillator:ZnS(Ag)/^{6}LiF) with a combined from electron – geometry time focusing at intermediate scattering angles ± 90°. Each of the detectors include at 7 independent planes.

- The ASTRA-M detector was installed together with detector electronics and a data acquisition system on the FSD diffractometer (BL. 11 of the IBR-2 reactor). The detector system is already adjusted (2023).
- A second MPD-240 controller has been added to the data acquisition system of the FSD diffractometer, which makes it possible to separate data streams from the lithium backscatter detector and the ASTRA-M detector, as well as to carry out various digital processing of input signals.
- Currently, work on setting up the detector has been suspended due to the shutdown of the reactor IBR-2.

Readiness of detector systems and electronics

Instrument	Detector system	Work	Status
1. YuMO, 4th BL.	Ring detectors, monitors, 2D PSD	1) Modernization of monitor counter, 2) PSD – commissioning	1) - Done 2) - In progress
2. HRFD, 5th BL.	He-3 PSD, single counter	Test	
3. DN-6, 6th BL.	Multicounter	Test of Detector + Data Acquisition	Done
4. RTD, 6th BL	He-3 PSD, single counter	Test	Sept. 2024
5. EPSILON, SKAT, 7th BL.	Multicounter	Replacing of preamplifiers	In progress (Nov. 2024)
6. REMUR, 8th BL.	He-3 PSD, single counter	Test	In progress (Sept. 2024)
7. REFLEX, 9th BL.	He-3 PSD, single counter	Test	Done
8. GRAINS, 10th BL.	He-3 PSD, single counter	Test	Nov. 2024
9. DN-12, 12th BL.	Multicounter, Ring detector	Replacing of cables set (signal + power)	Done

Readiness of detector systems and electronics

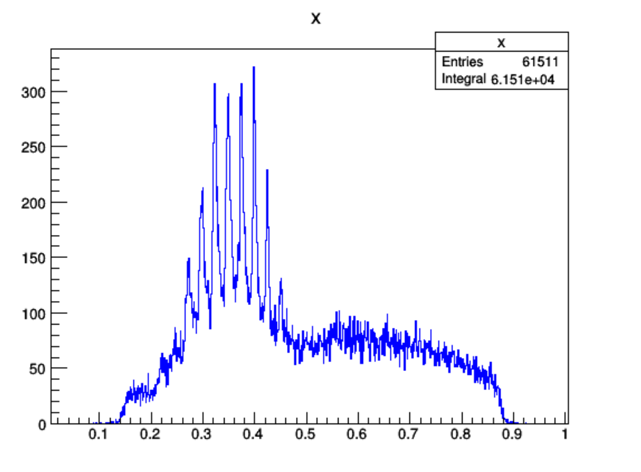
<u>Linear PSD. Baker Hughes Reuter Stokes 8-pack</u>

The work on adaptation of RS 8-pack's electronics for TOF measurements at spectrometers of the IBR-2 reactor are finished.

The detector can be installed and tested at any instrument of the IBR-2 reactor.

Most appropriate method for application is reflectometry

Similar development of FLNP. Spatial res. 0.5% of length (3 mm)



Readiness check of mechanical choppers and control systems

During May 2024 the grease was replaced in the bearings of disk choppers for the instruments: YuMO (4^{th} beabline), HRFD (5^{th} beamline), NERA, EPSILON, SKAT (7^{th} beamline), REMUR (8^{th} beamline). Next the choppers were run at nominal speed and tested for extraneous noise and frame vibrations.

During May – June 2024 A preventative launch of the automatic control systems for the rotation of beam choppers at the IBR-2 reactor was carried out. During the launch process, the accuracy of stabilization of the rotation phase was checked.

The parameters of the output current and frequency of the output voltage were checked for each of frequency converters located in the experimental halls of the reactor and used to regulate the rotation speeds of the beam choppers. The values of output currents and voltages are correct.

The freq. converters Toshiba and choppers discs	YuMO, Beamline 4	HRFD Beamline 5	NERA Beamline 7	NERA, EPSILON, SKAT Beamline 7	REMUR, Top/Bottom disks Channel 8	REFLEX Beamline 9	GRAINS Beamline 10
Output current: I	9.7	8.7	2.3	4.7	18.1/22.1	2.2	2.3
Output frequency: Hz	20.0	20.1	10.0	20.0	10.0/15.0	10.1	20.0

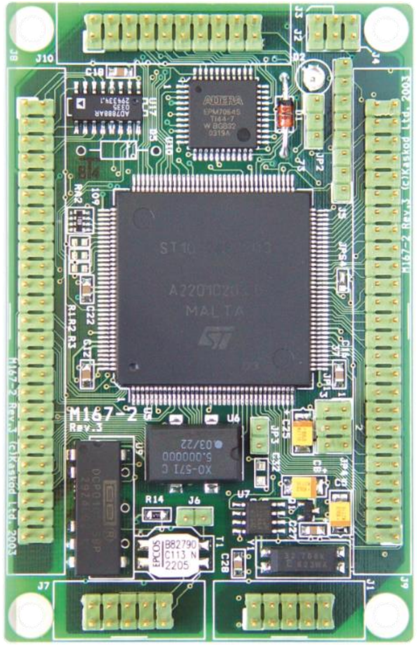
Readiness check of mechanical choppers and control systems

The list of an automatic background chopper control systems have been tested:

Control systems of background choppers	The choppers rotation speed in rpm.	The accuracy of stabilization of the rotation phase of the chopper disks.	The rated power of the “Toshiba Tosvert VF-AS1” frequency converter for an asynchronous motors kW.
1. YuMO, 4th BL. Location: ring corridor.	300 (5Hz.)	±200 μsec.	22 kW.
2. HRFD, 5th BL. Location: ring corridor.	300 (5Hz.)	±150 μsec.	22 kW.
3. NERA, 7th BL. Location: experimental hall.	300 (5Hz.)	±150 μsec.	2,2 kW.
4. NERA, EPSILON, SKAT, 7th BL. Location: experimental hall.	300 (5Hz.)	±170 μsec.	22 kW.
5. REMUR, 8th BL. Top/Bottom disks. Location: ring corridor.	300 (5Hz.)	±150 μsec.	37 kW.
6. REFLEX, 9th BL. Location: ring corridor.	300 (5Hz.)	±150 μsec.	2.2 kW.
7. GRAINS, 10th BL. Location: ring corridor.	150 (2,5 Hz.)	±200 μsec.	2,2 kW.

Readiness check of mechanical choppers and control systems

- Rotation phases of choppers are within the specified limits (±200 μs)
- Output parameters of the Toshiba Tosvert VF-AS1 frequency converters are normal, → normal operation of the power electronics and the normal condition of the mechanical part of the background choppers.



Pic. 1. The Siemens Infeneon C167 SR superviser

Pic. 2. The Toshiba Tosvert VF-AS1 frequency converter.

Pic. 3, 4. Replacing the grease of the bearings of the background HRFD chopper.

Thank you for your attention!