New INS spectrometer at FLNP JINR

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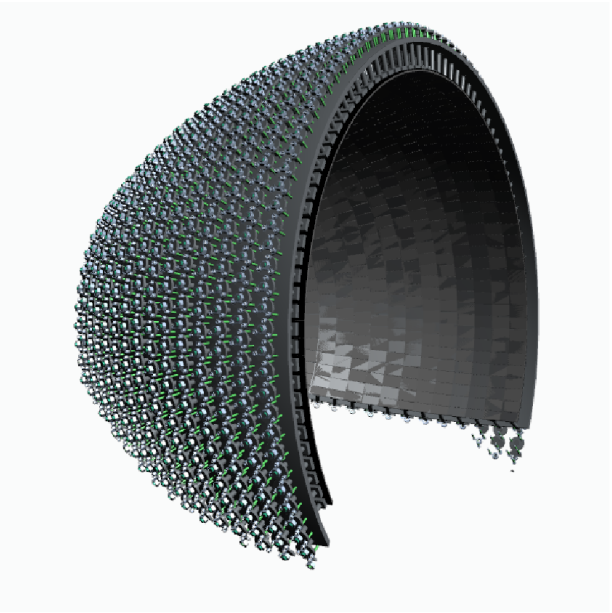
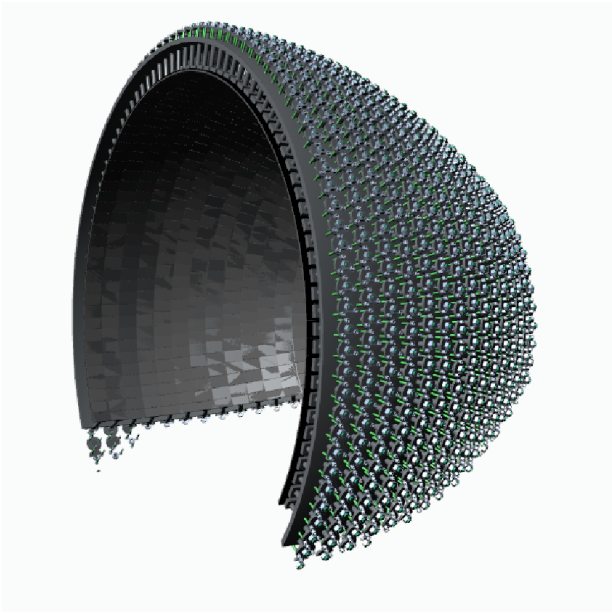
Dubna





ICANS XXIV, 2023, Dongguan, China

PROTON DYNAMICS IN MATERIALS

IS A DOMINATING SUBJECT AT THE INSTRUMENTS

ON **PULSED NEUTRON SOURCES**

OR **STEADY STATE REACTORS WITH "HOT SOURCES"**

TOF (pulsed sources)

TOSCA (ISIS)

VISION (SNS)

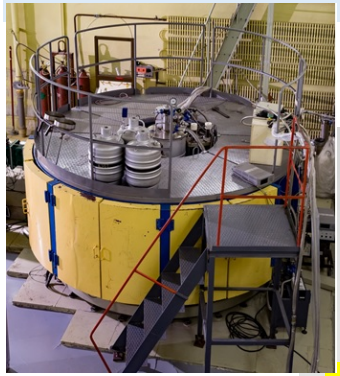
NERA (FLNP)

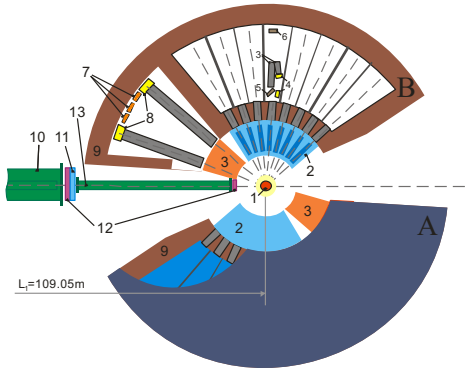
…

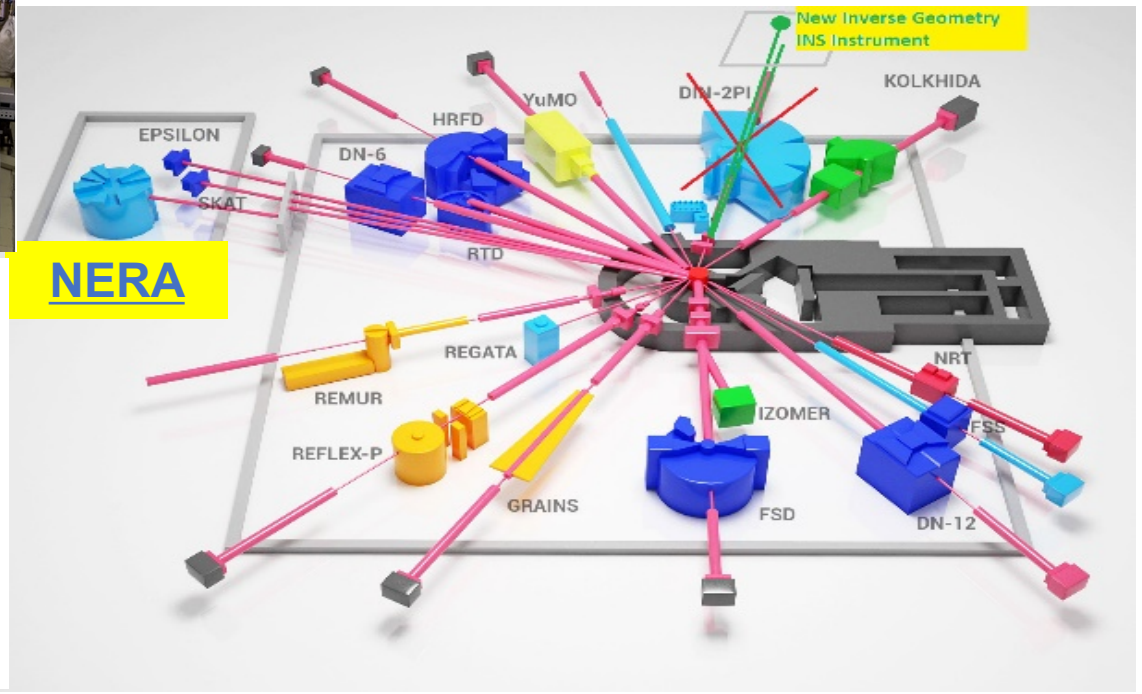
Crystal (steady state (reactor) sources)

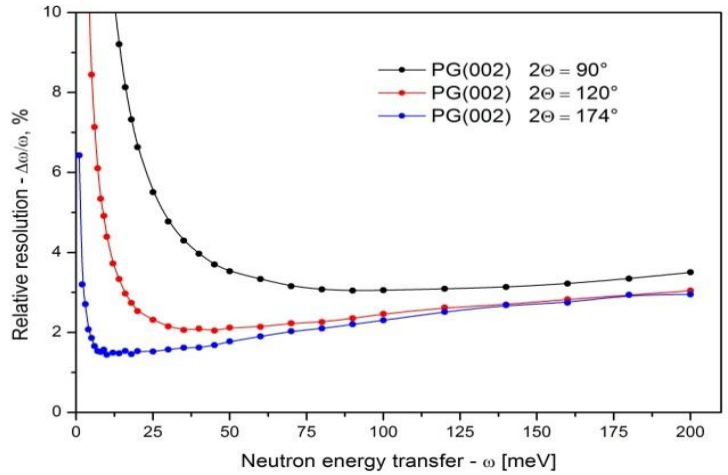
FANS (NIST)

LAGRANGE (ILL)









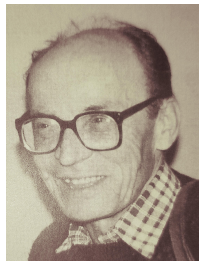
Thermal neutron flux on the sample	4.6×10^{6} n/cm^{2}/s
Wavelength range	0.8-7.0 Å

inverted (indirect) geometry *the excitation energy scanned by E_i with a fixed E_f* using filter technique

Reasons: - **low luminosity → large samples or long counting time**
- limited energy transfer range (**impossible to analyze above 100 meV)**
- solid angle 0.2 sr

New inelastic neutron scattering spectrometer in inverse geometry

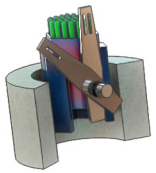
BJN (Bajorek-Janik-Natkaniec)

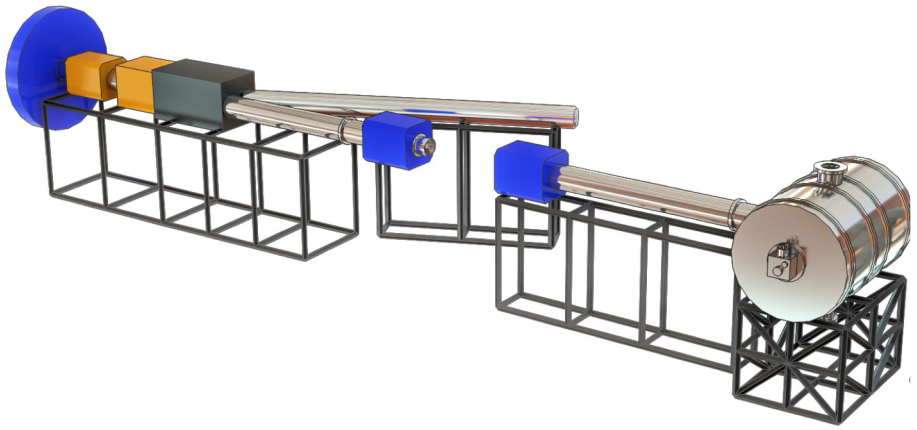


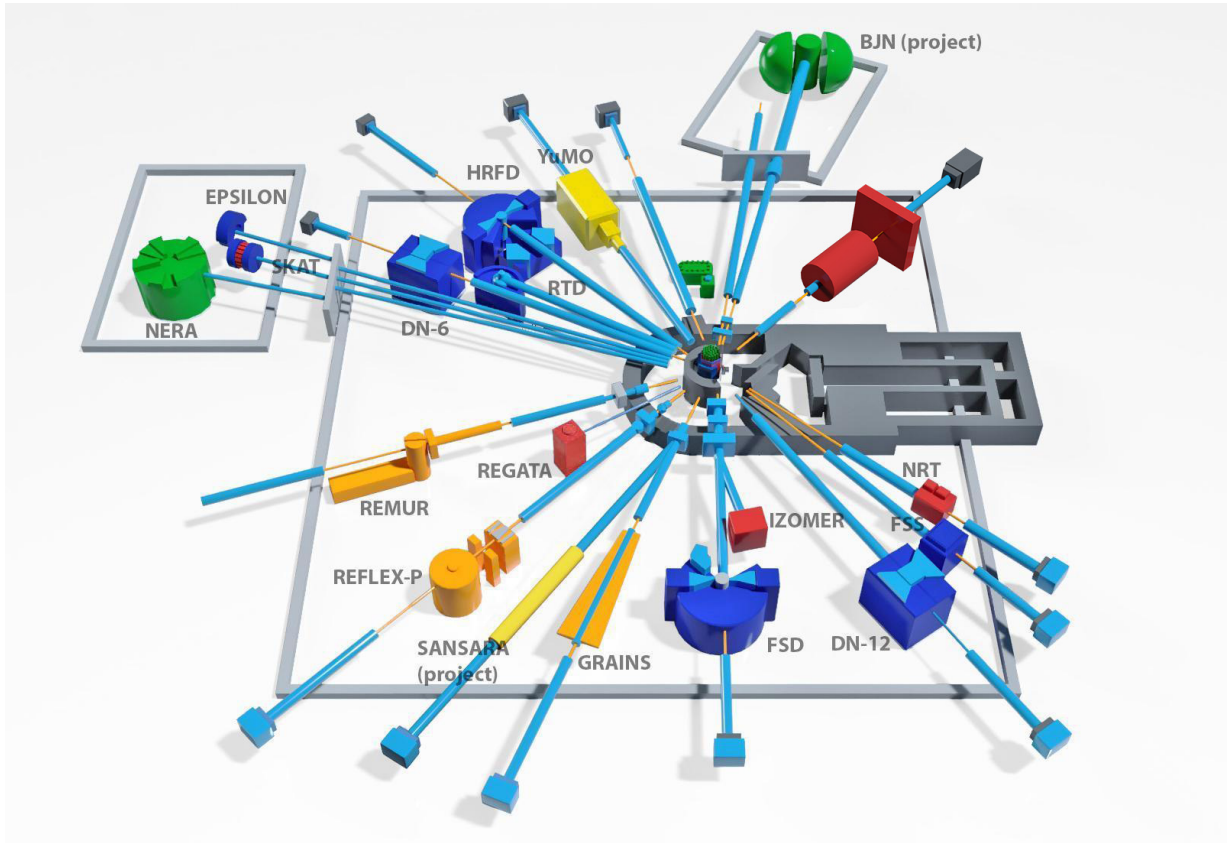
OPENNING of the PROJECT: January 2021

Authors: Chudoba D. (FLNP JINR)

Goremychkin E. (FLNP JINR)
Belushkin A. (FLNP JINR)
Klepacka M. (NTNU)

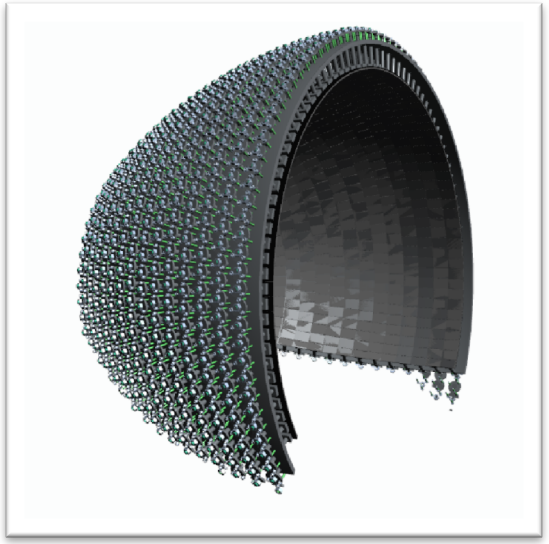


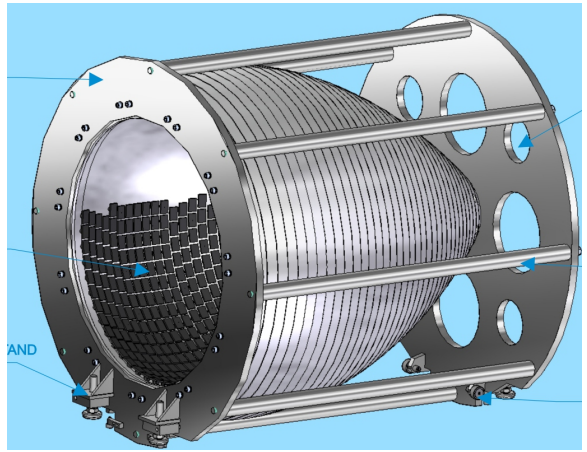




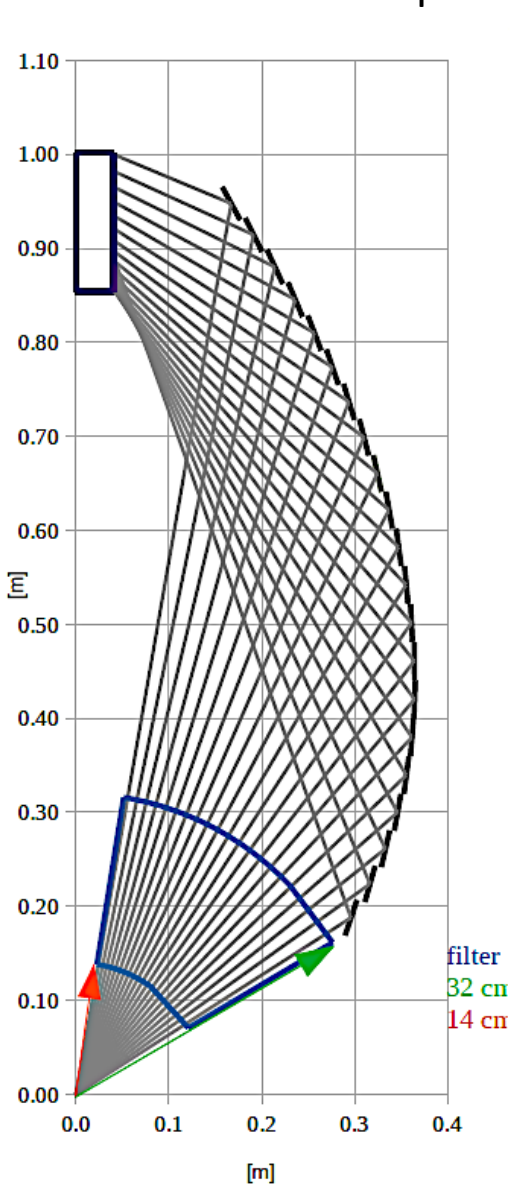
Based on the available space and needed time resolution and energy range the distance between the source and the sample of new spectrometer was chosen equal **105 m.**

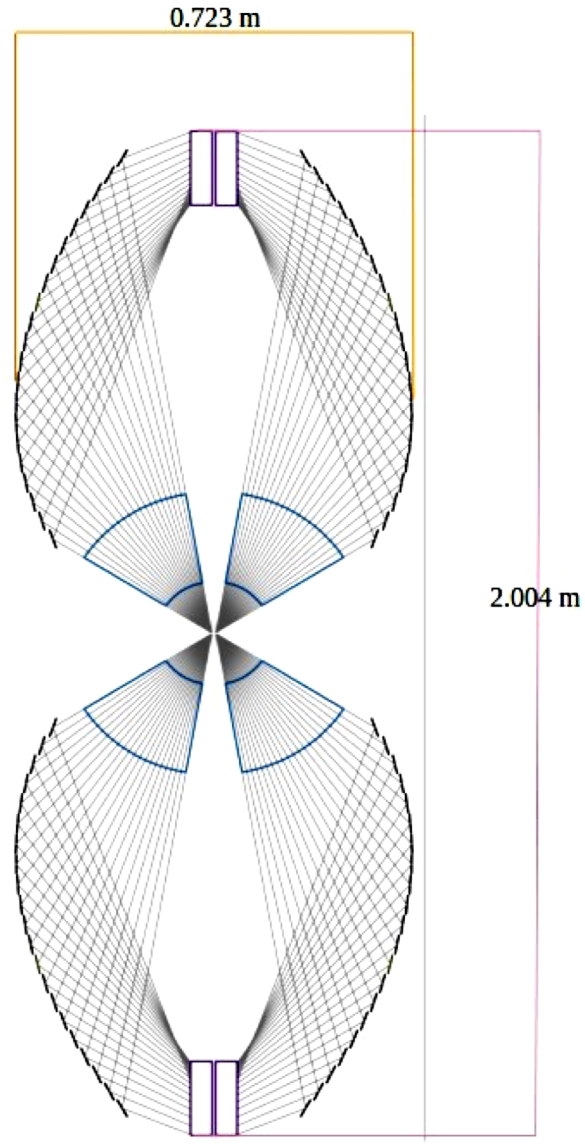
The main concept for the secondary spectrometer is to place a set of **HOPG** (higly oriented pyrolytic graphite) analyser plates resembling together **a bell shape**, on both sides of sample.

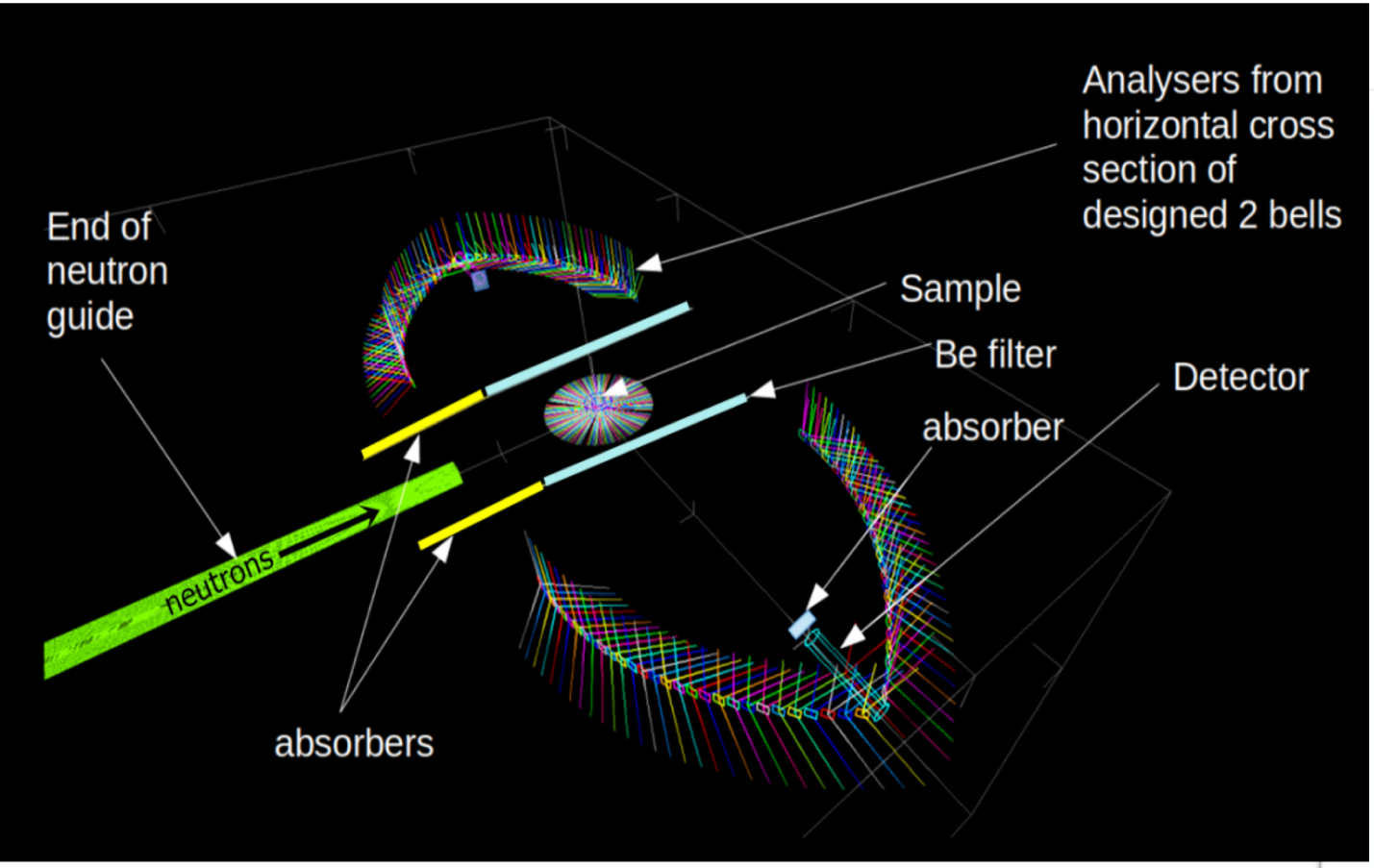


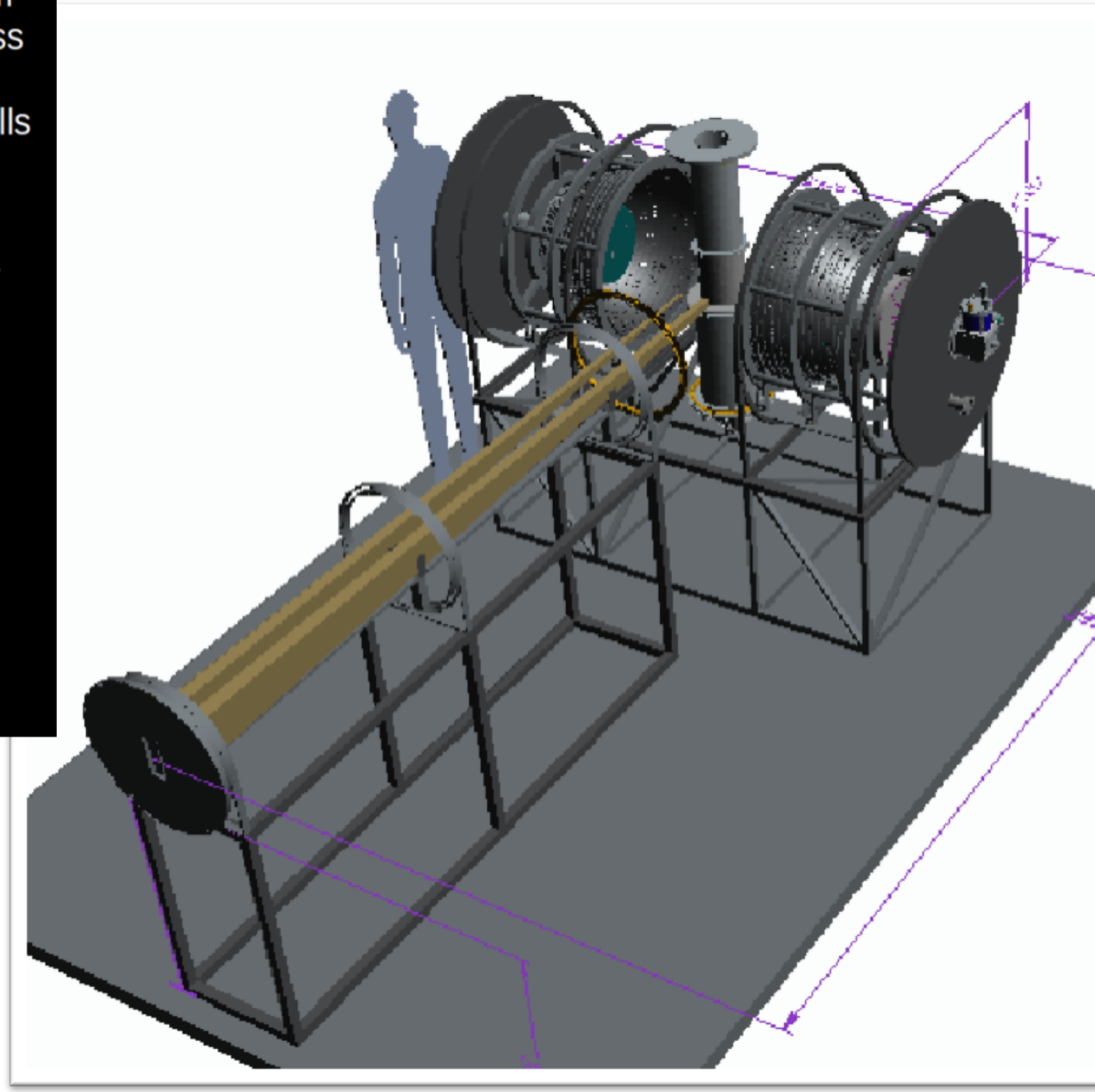


Top view



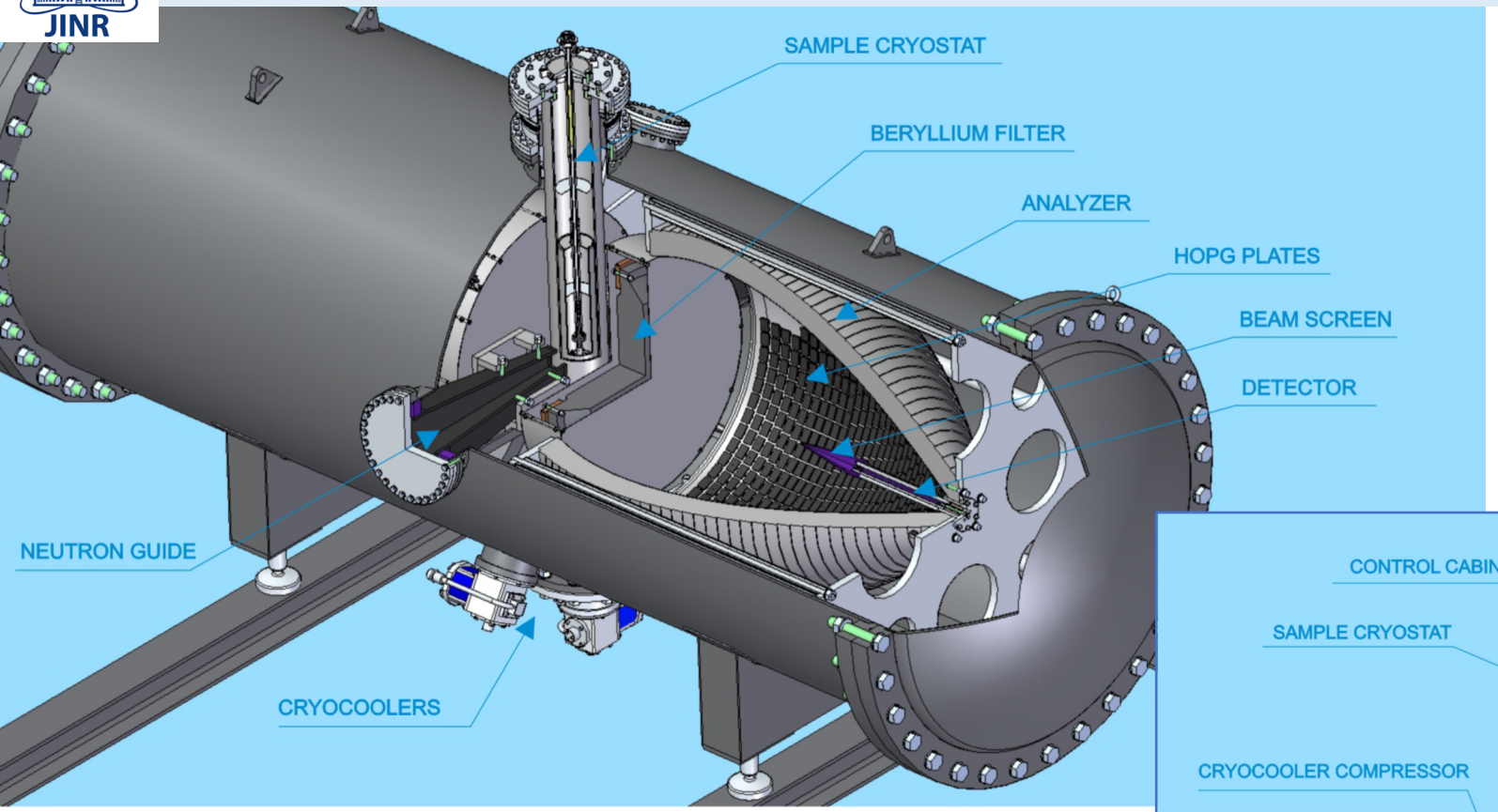


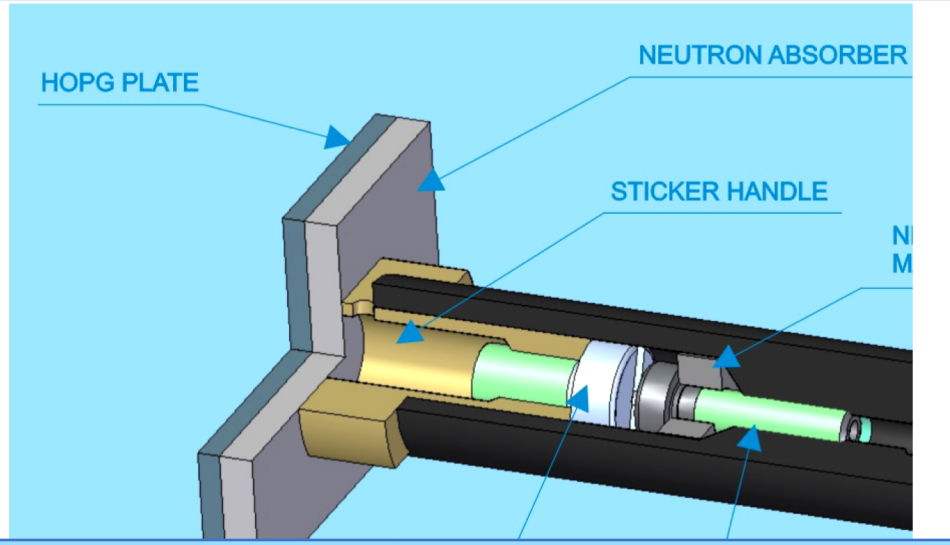


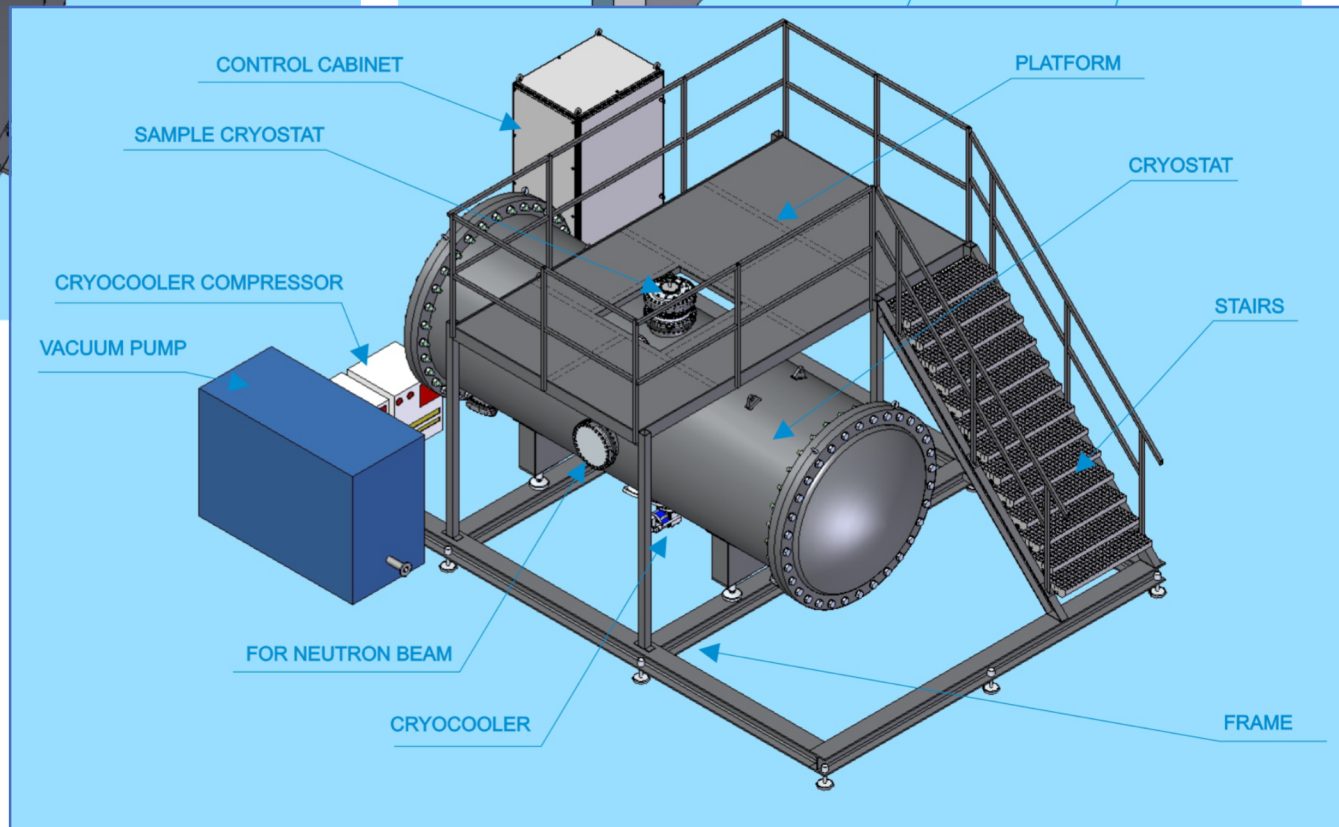


The scattering angle range from **28 deg** to **80 deg.**

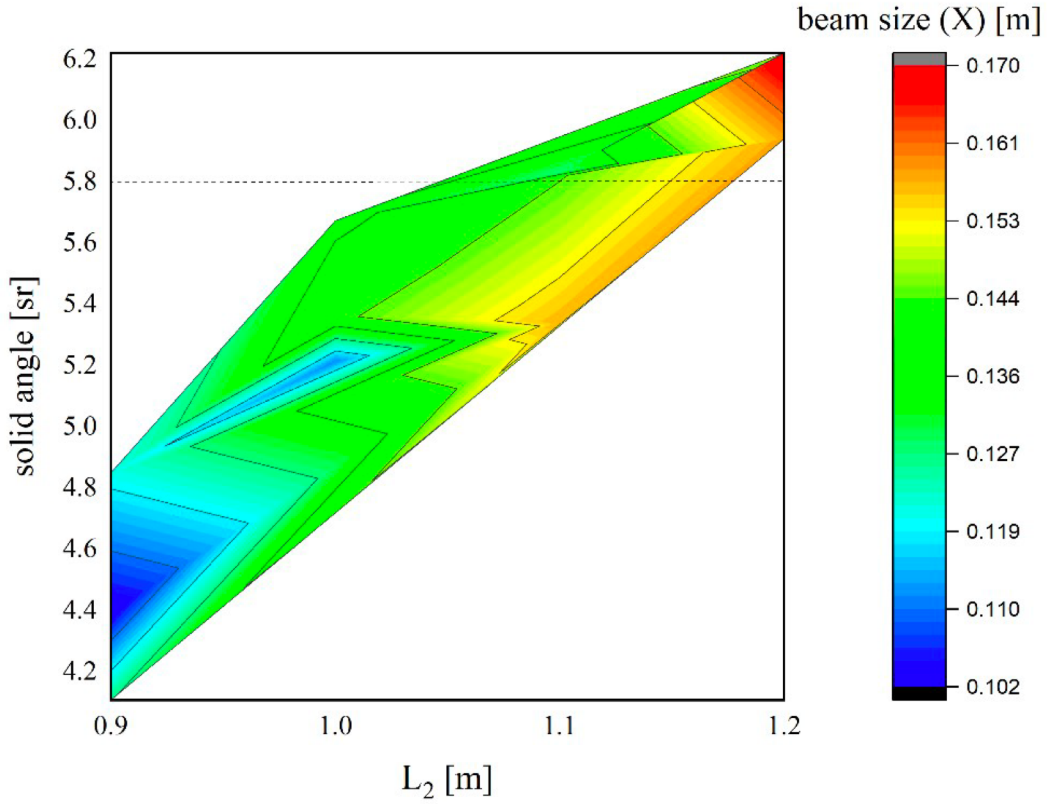
conceptual design

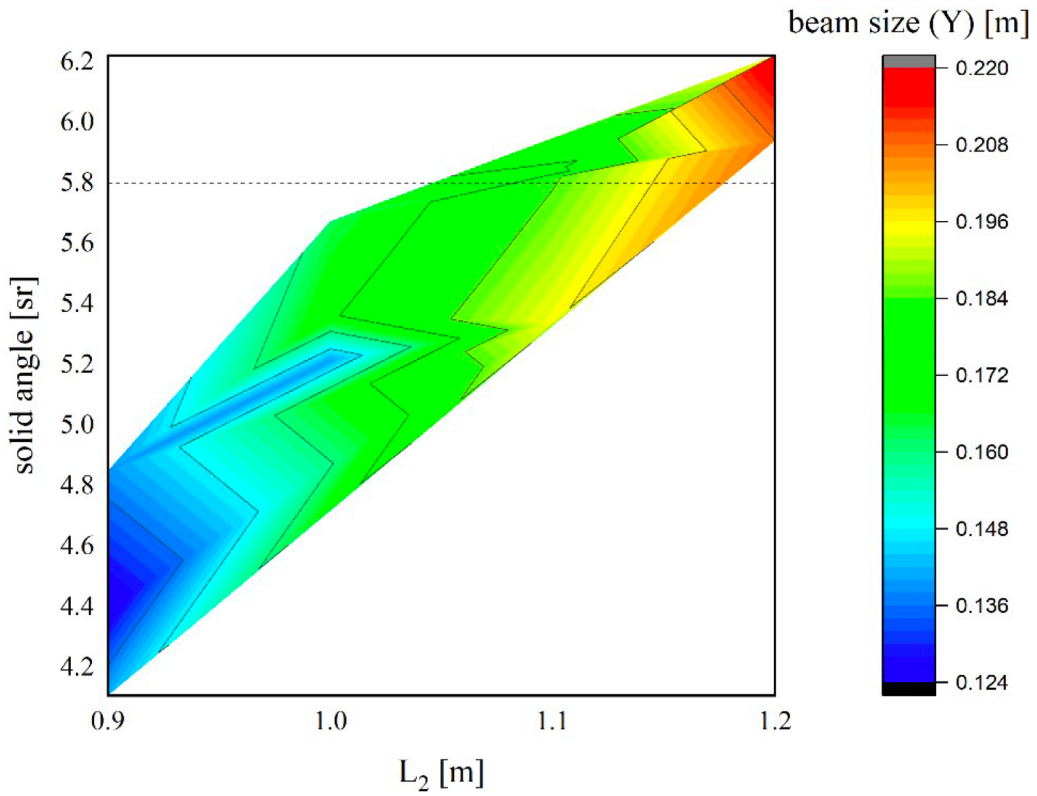






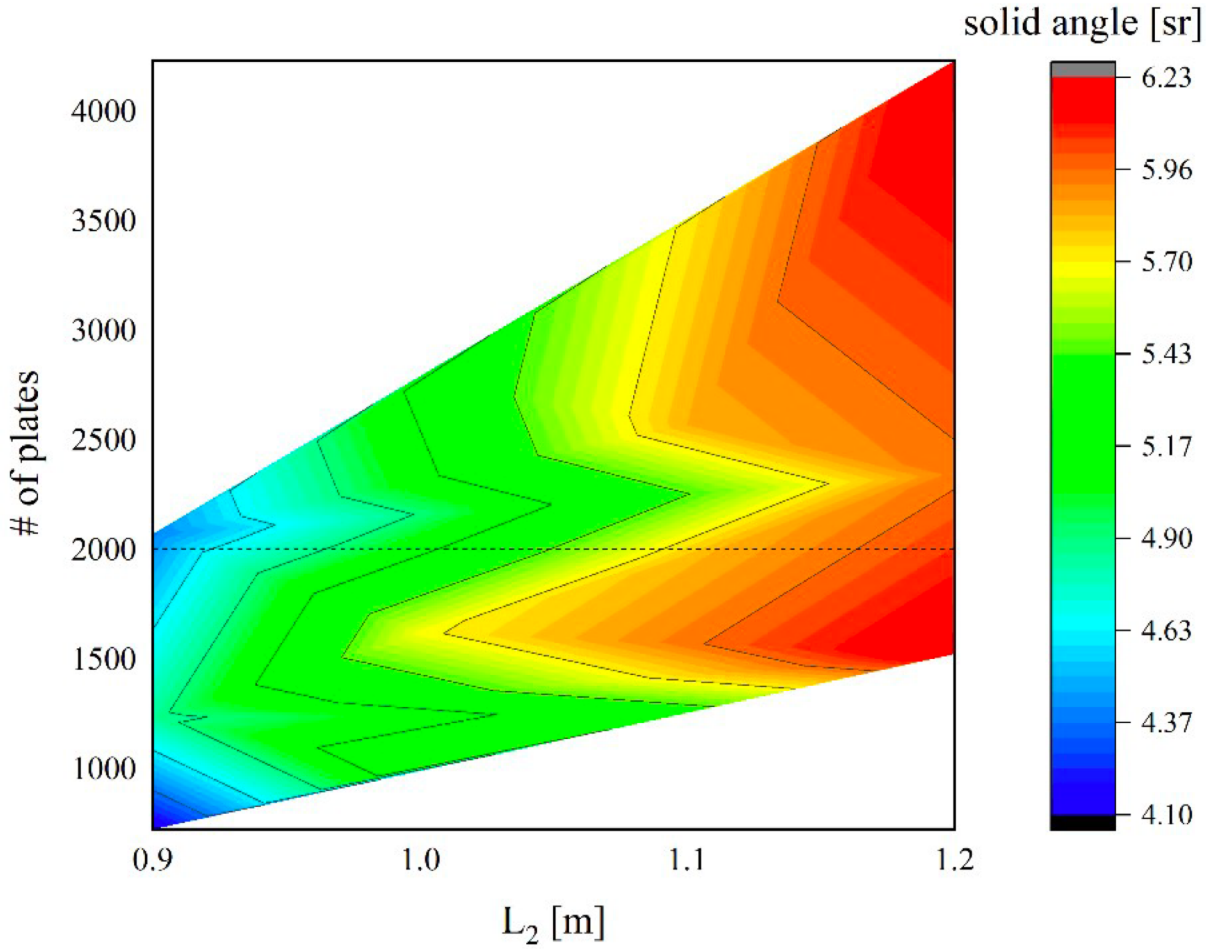
The simulated size of the neutron beam at the detector position is explored for various neutron path lengths within the secondary spectrometer, each corresponding to a specific solid angle.





The dotted line signifies the minimum accepted value of the solid angle.

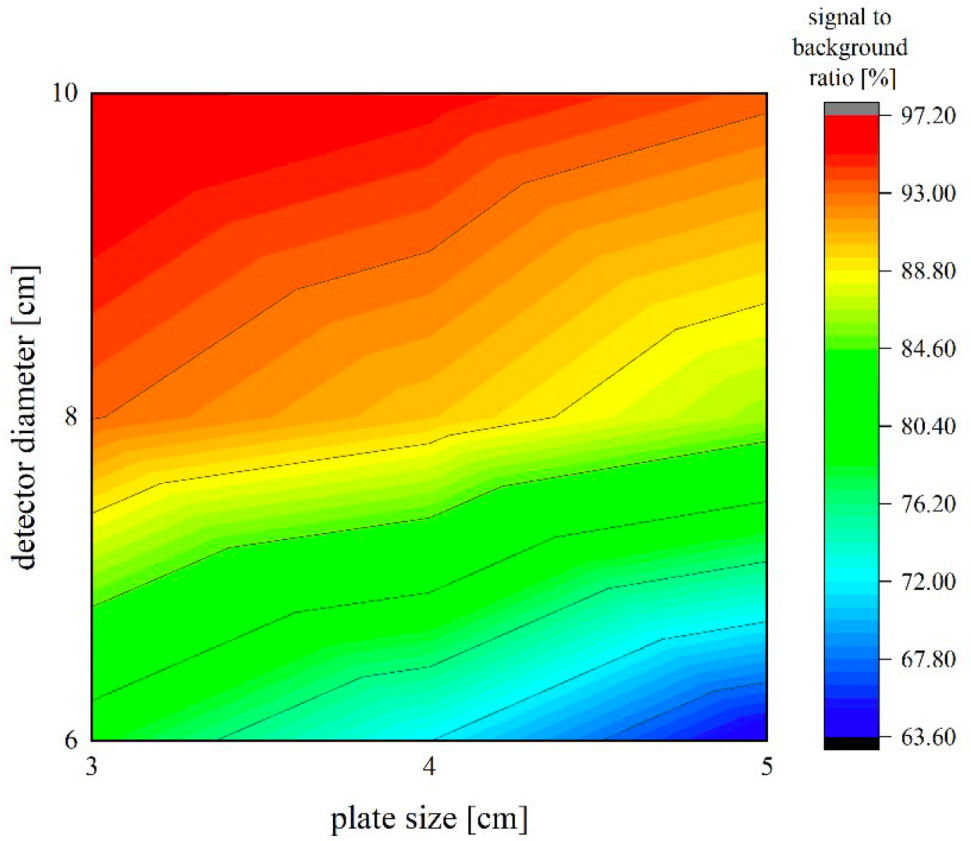
The number of analyzer plates required to cover the inner surface of the secondary spectrometer construction varies with different values of L2, corresponding to specific solid angles.

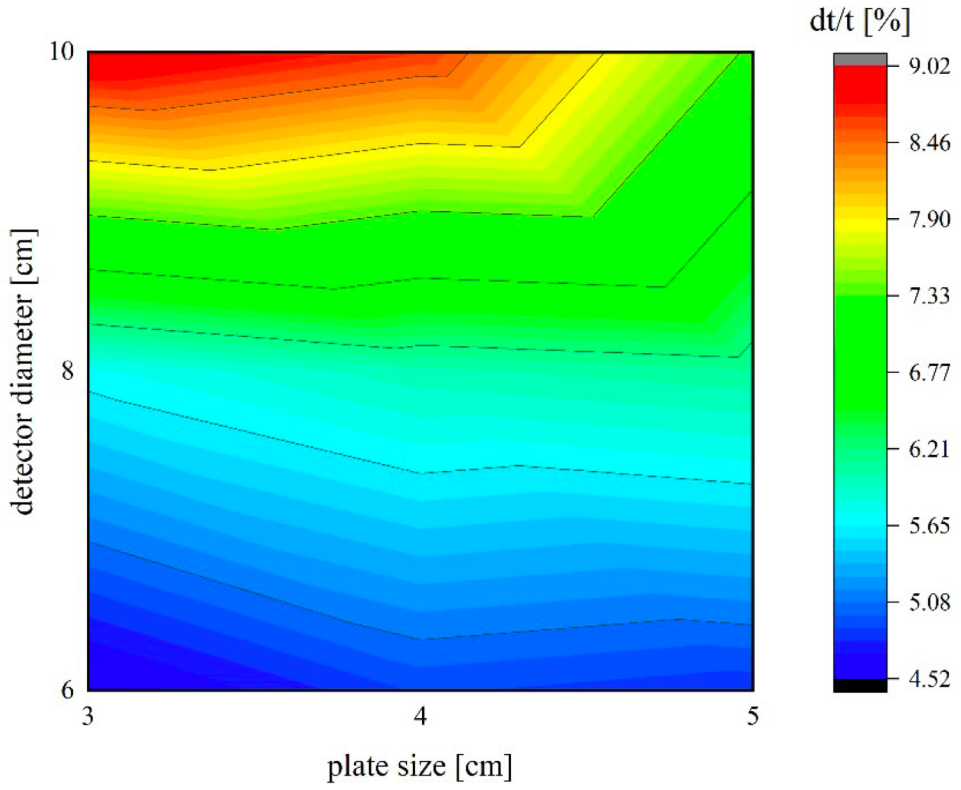


The dotted line represents the maximum acceptable **number of plates – 2000 ps.**

Path length between sample and detector was fixed to **1.1 m.**

Signal to background ratio and time resolution for considered variants of plate size and detector diameter.



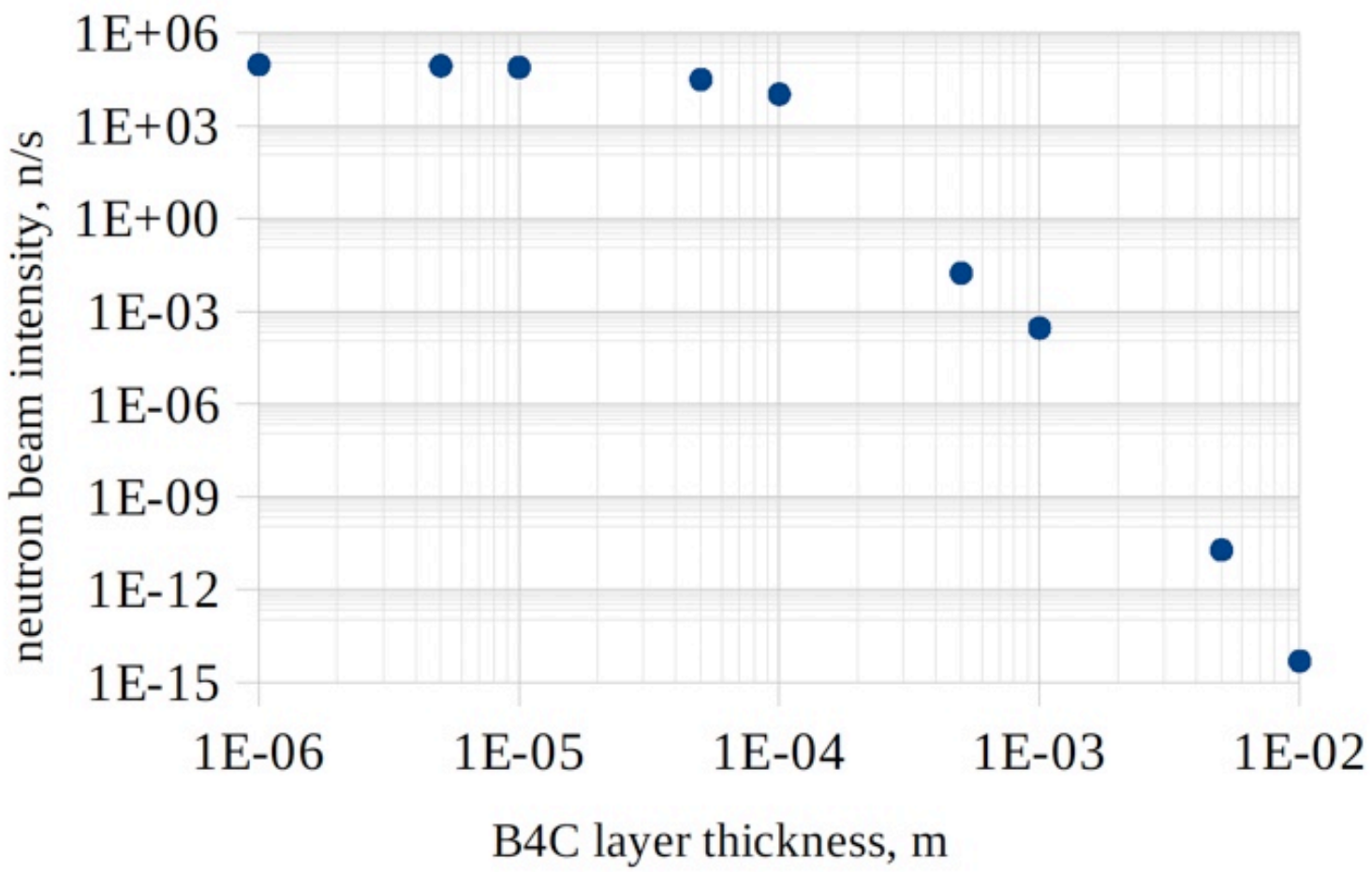


Any combination of plate and detector size that yields a signal-to-background ratio **lower than 90%** and a resolution **worse than 7%** is **discarded.**

As a result of this selection process, a **detector with a diameter of 8 cm** and a **plate size of 4x4 cm** were ultimately chosen.

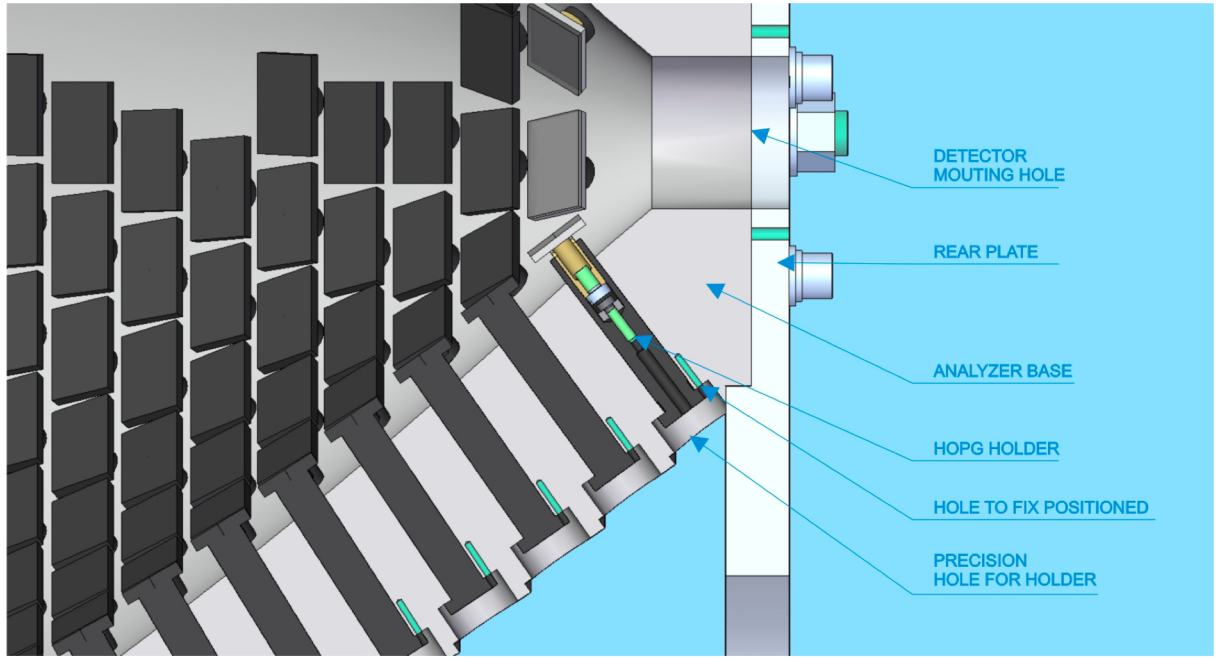
Neutron-absorbing boron-carbide layer

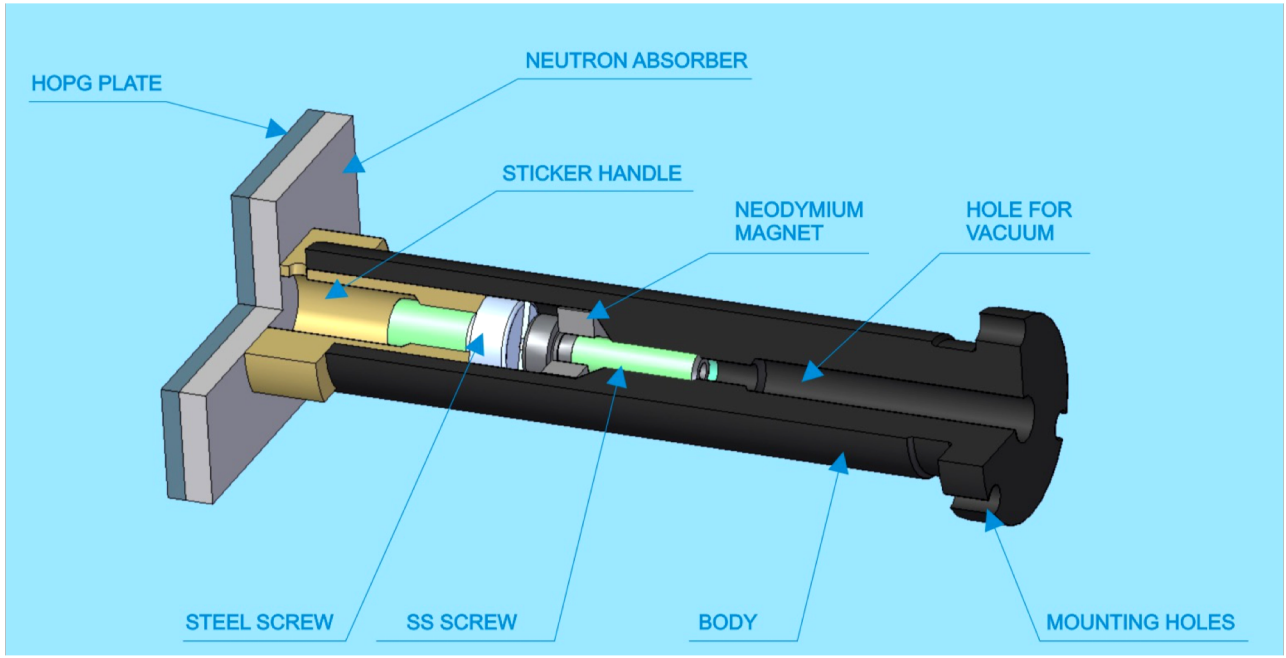
Intensity of a neutron beam transmitted through a layer of boron carbide as a function of its thickness.



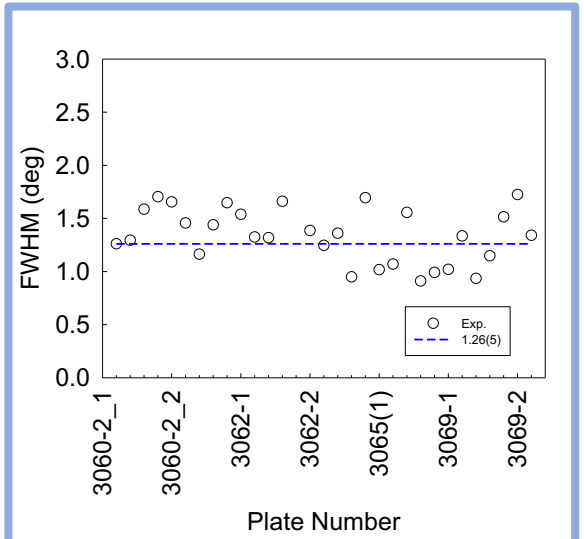
The **optimal thickness** of a natural **B4C layer** for effectively stopping the neutron beam should fall within the range of **0.5 – 1.5 mm.**

4cm x4cm x 1962

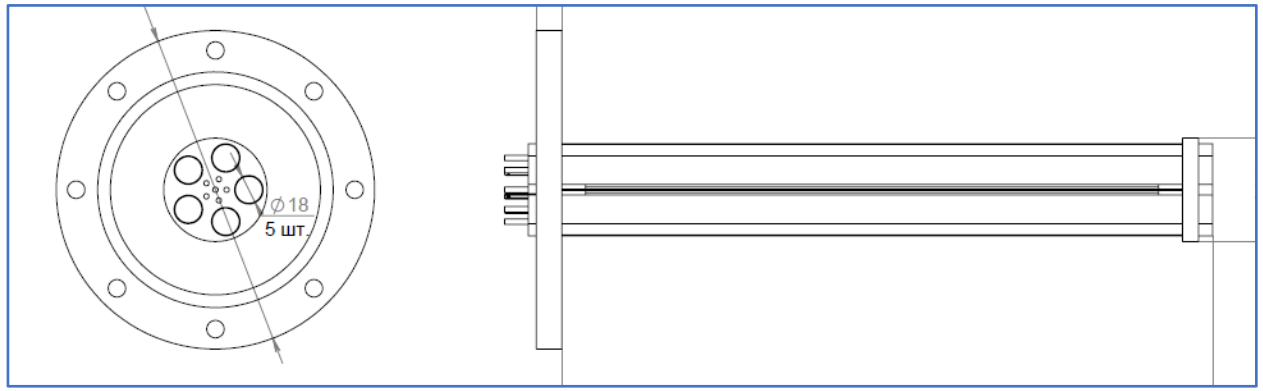




HOPG



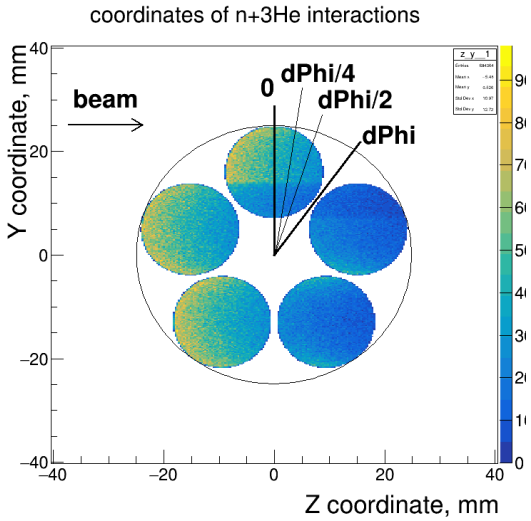
B4C



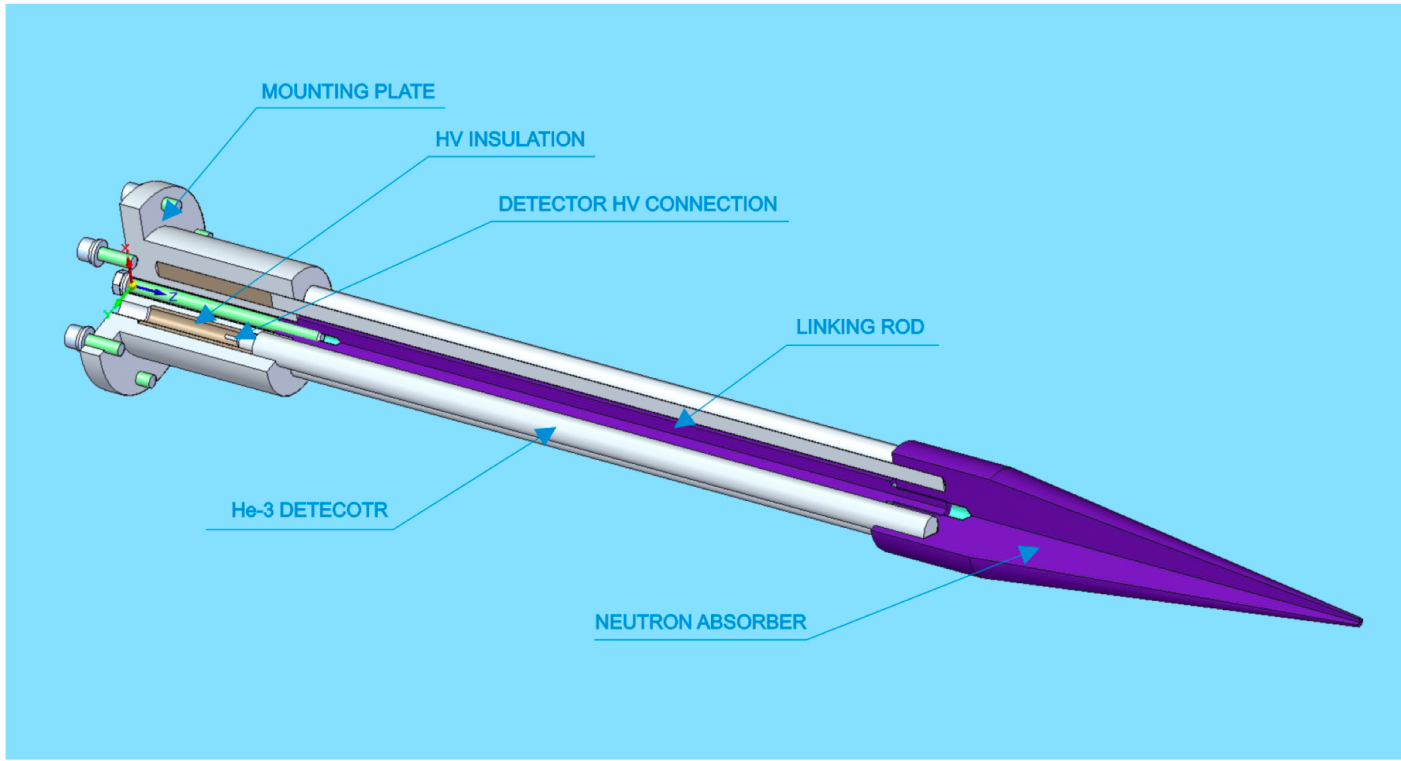
5 tubes of He^3 detectors for one bell

The counter wall thickness is 0.2 mm

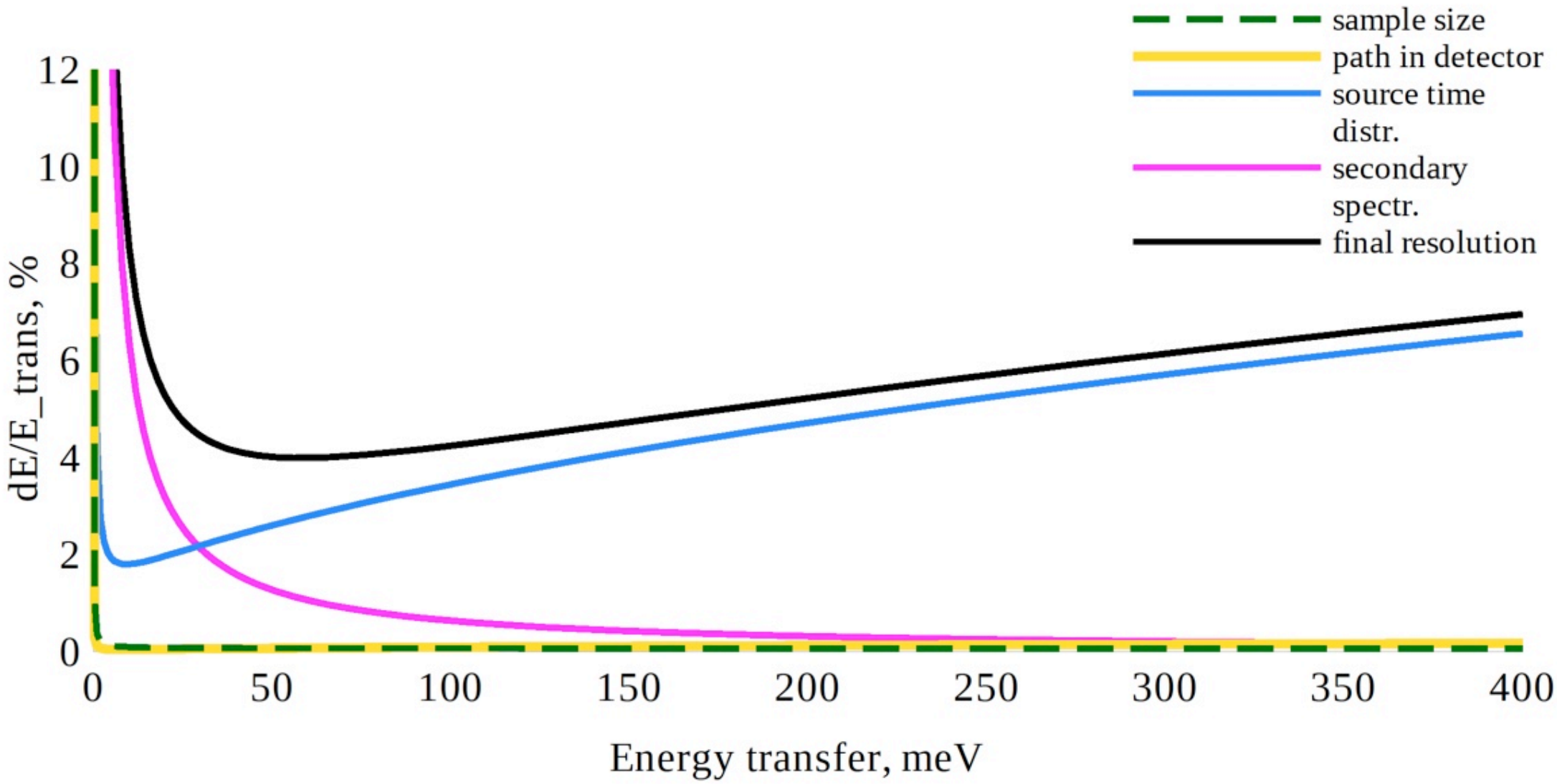
^{3}He pressure is 8 atm.

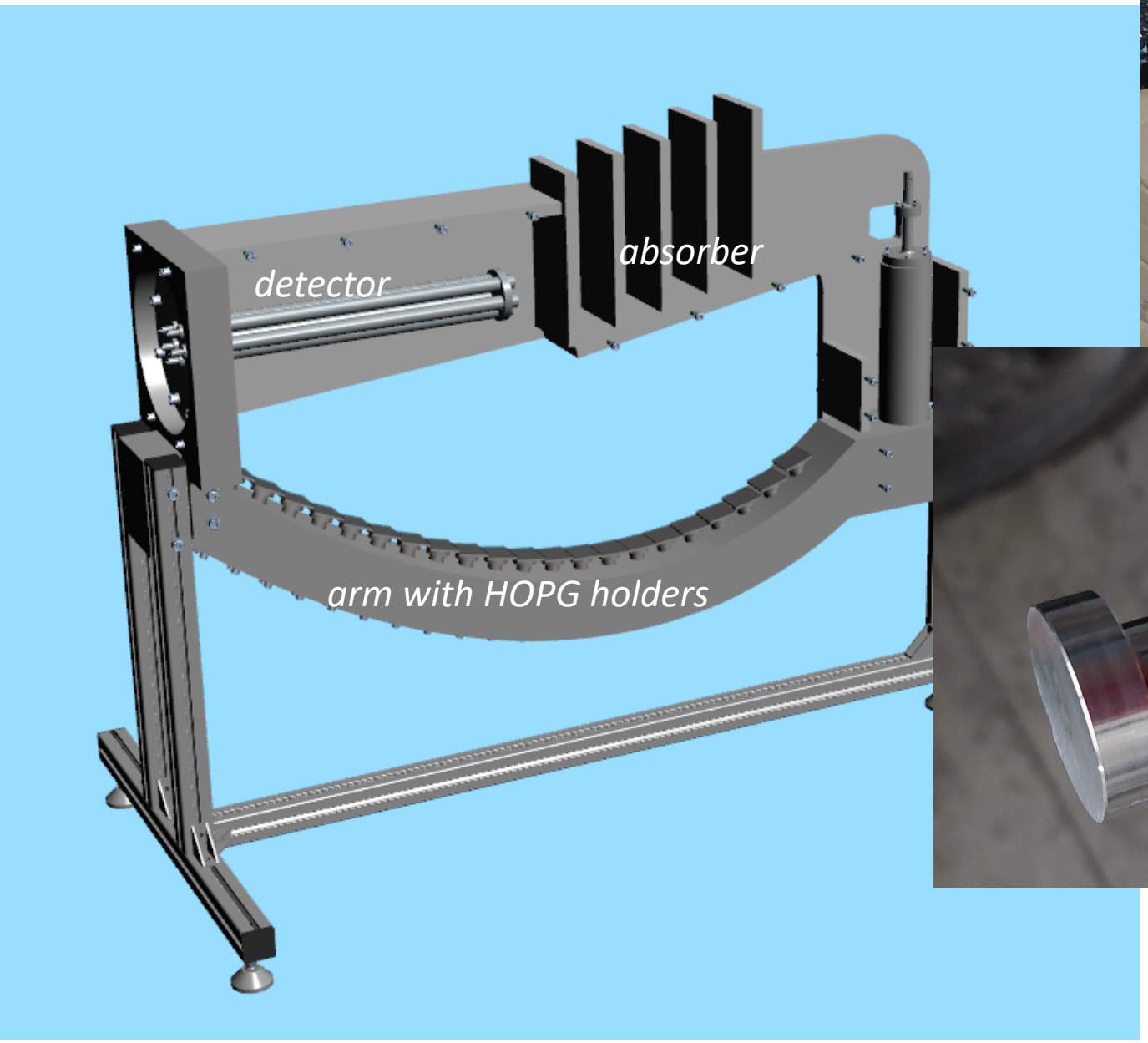


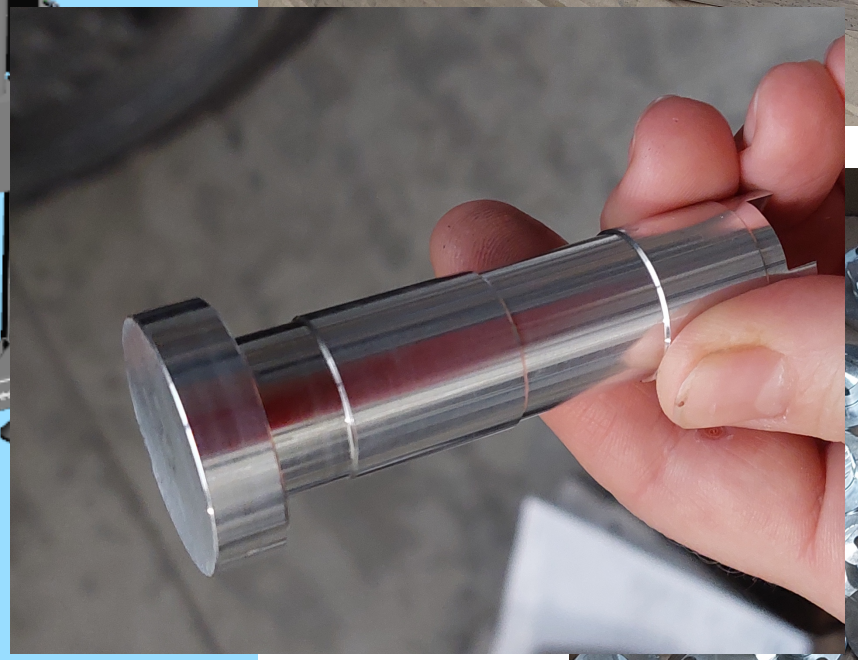
Assembly of cylindrical counters d≈18 mm (analogue of SNM-18).



Contributions to the final **resolution** of the BJN spectrometer




detector
absorber
arm with HOPG holders



McStas simulation

moderator
33.5 x 40.5
cm

shielding

5 m

20x20 cm

Type A: tapering (m=2.5)

100 m

20x20 cm

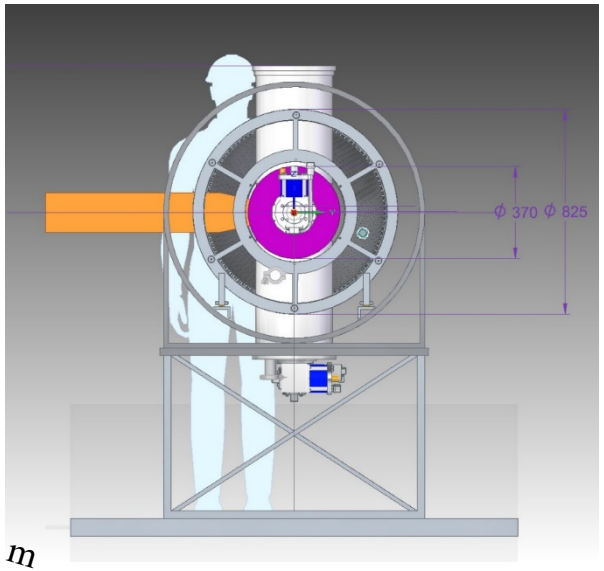
Type B: constant + tapering nose (m=2.5)

75 m

25 m

40 cm

sample
3x3 cm



W1 = 20 cm
H1 = 20 cm

Type A

W2 = 3.1 cm
H2 = 3.1 cm

W1 = 20 cm
H1 = 20 cm

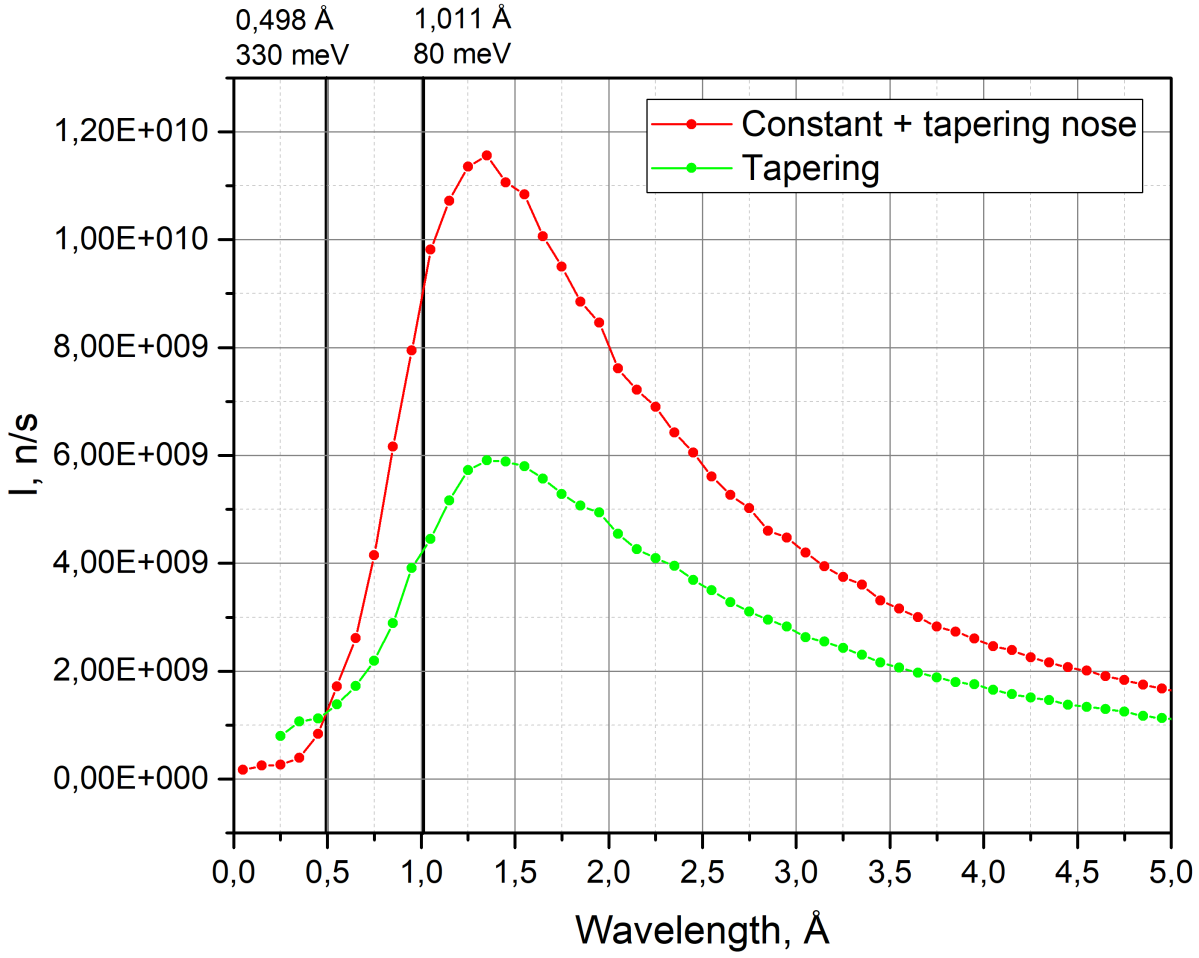
Type B

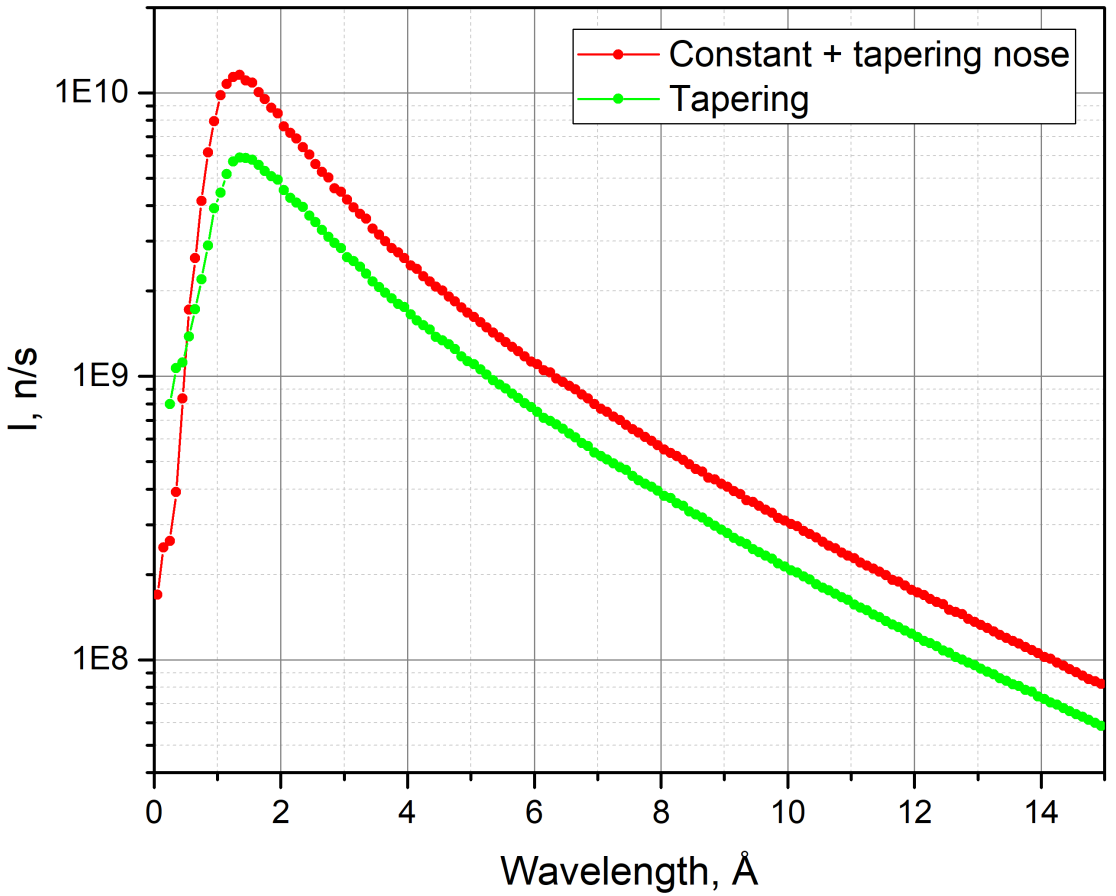
W2 = 20 cm
H2 = 20 cm

W3 = 3.3 cm
H3 = 3.3 cm

sample
3x3 cm

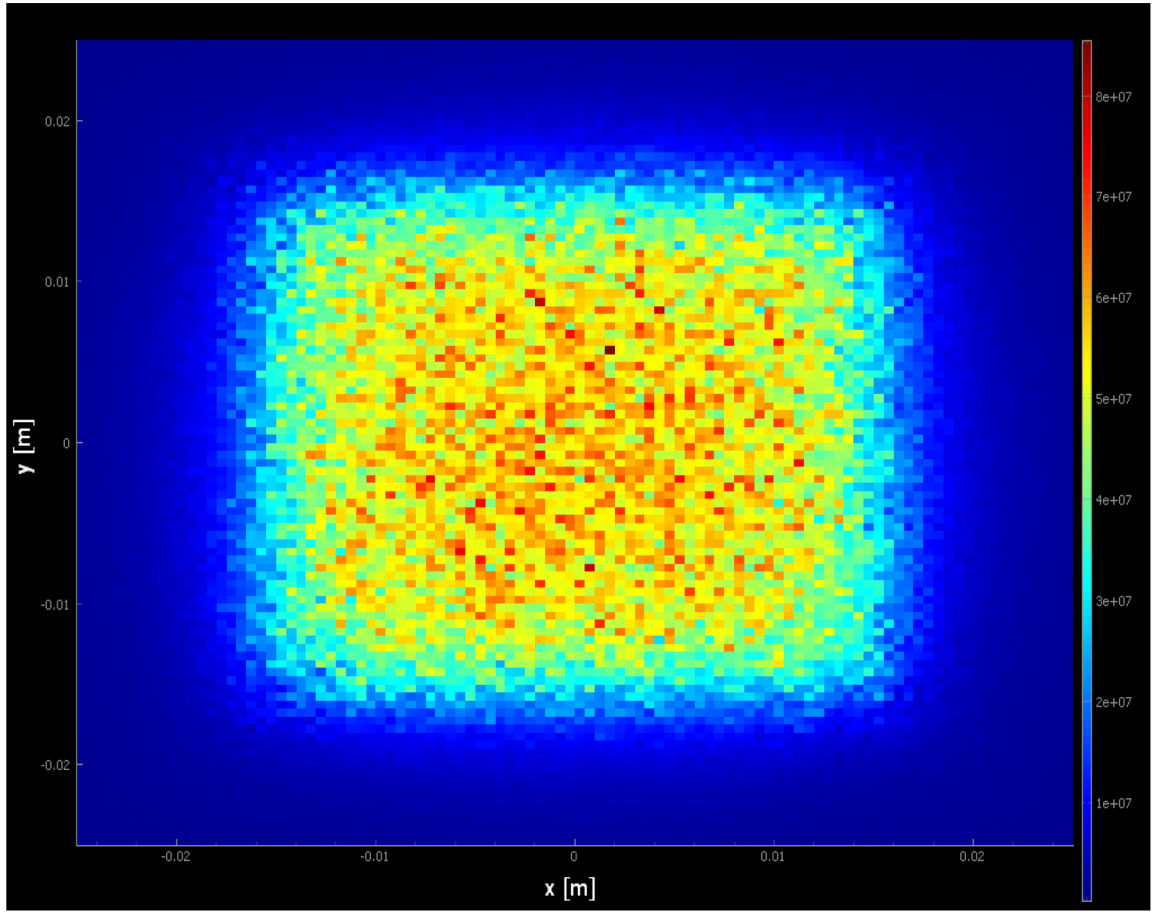
Intensity at sample 3x3 cm position



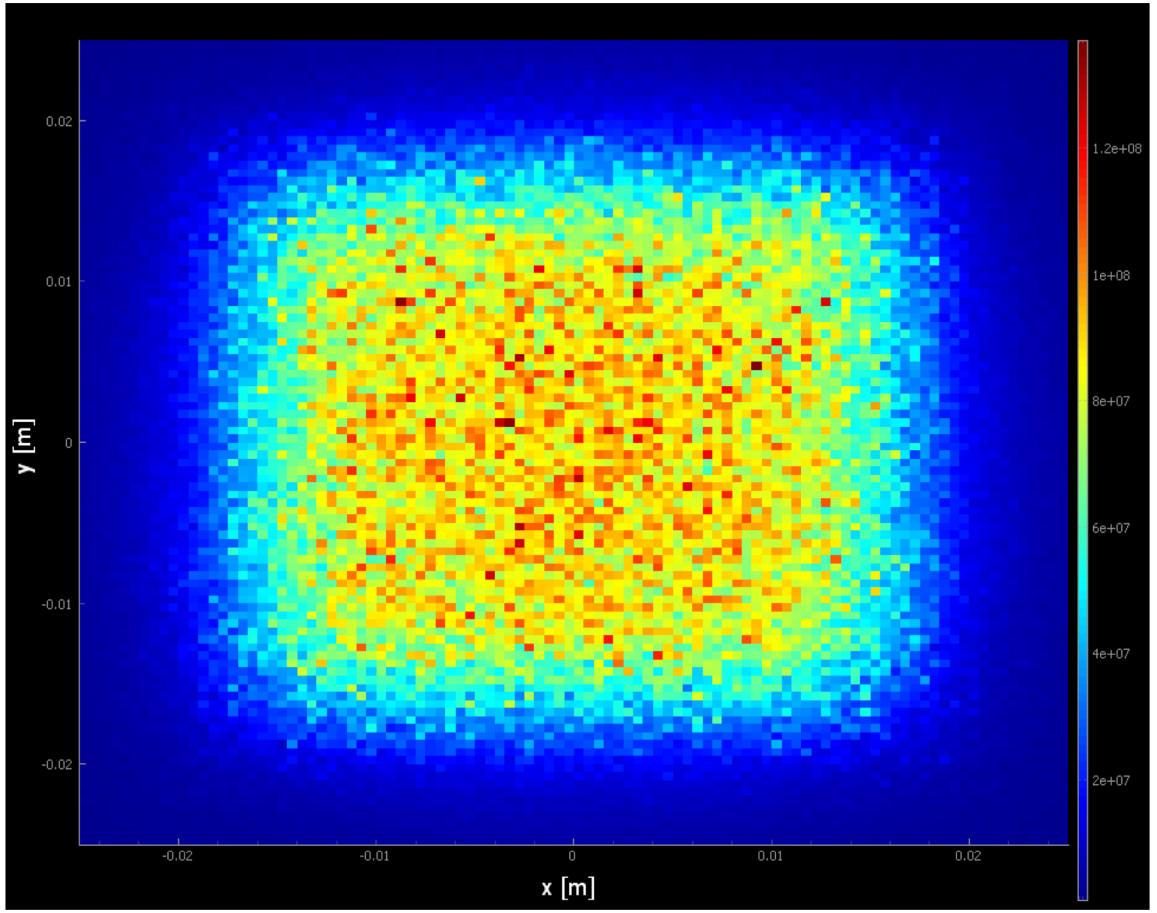


PSD monitor at sample position

Type A: tapering



Type B: constant + tapering nose



	NERA	**BJN**	
Analyzer area	15x3X25 **1 125 cm²**	4x4x1962 **31 392 cm²**	**28 times** greater analyzer area
Energy transfer	**Below 100 meV**	**Up to 300 meV**	
Ratio input/output to neutronguides	16x5cm²/5x5cm² **3.2**	20x20cm² / 3x3cm² **44.44**	**a gain in flux density** (without taking into account the higher quality of the neutronguide) 44.44/3.2 = **14**
Solid angle	~ 0.2 sr	~ 5.64 sr	Solid angle gain **28**
Ratio of luminosity of new spectrometer and NERA			28x14 = **392** times higher i.e. **measurements** of a sample with the mass of **10-20 mg will be possible**.

Thank you for your attention!