Proposal for opening a new project

Development of an inelastic neutron scattering spectrometer in inverse geometry at the IBR 2 reactor

In the frame of Theme

Studies of functional materials and nanosystems using neutron scattering

Theme code: **04-4-xxxx-2021/2025**

Dorota M. Chudoba

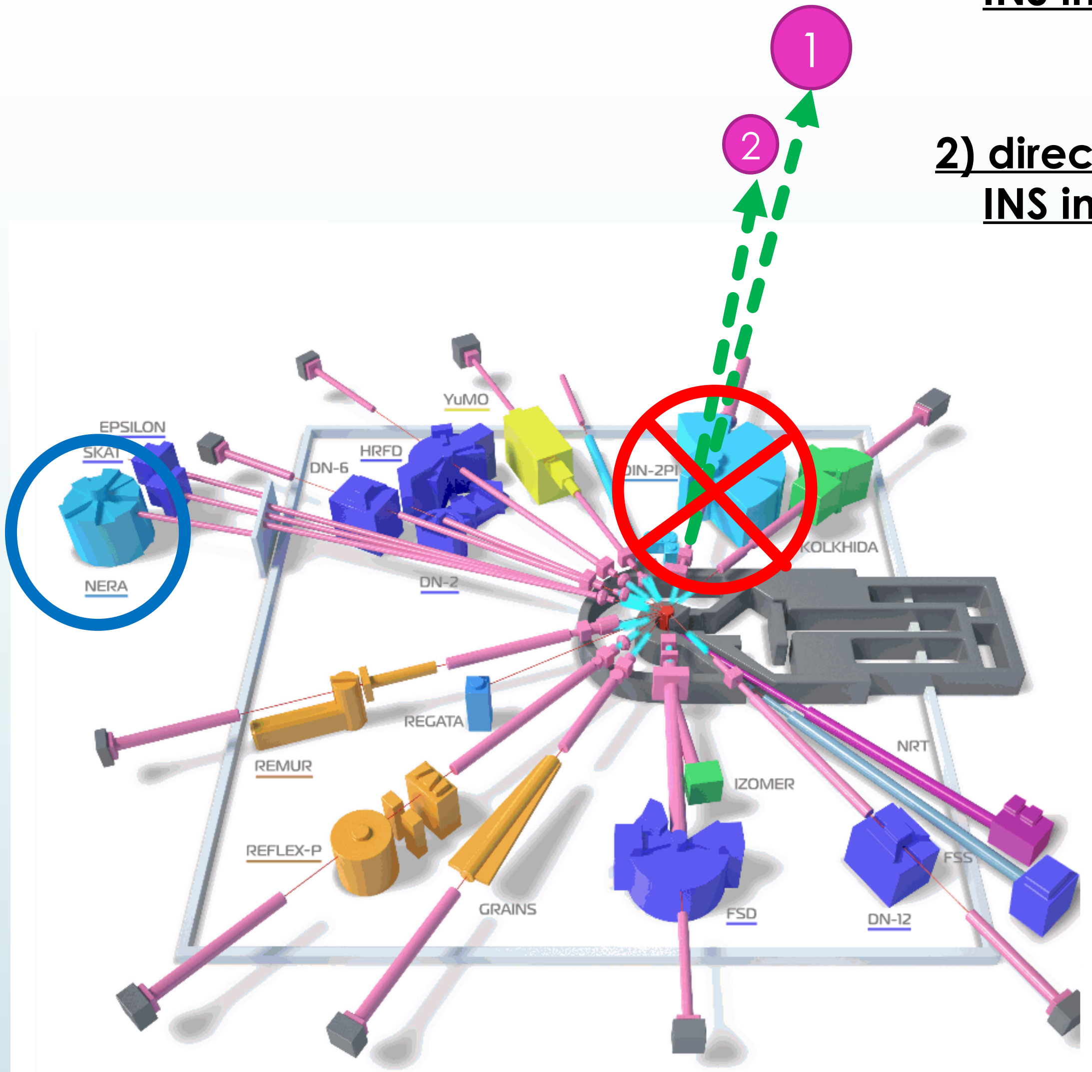
Introduction

28 – 29.03.2019
Workshop on the Construction of a new Inelastic Neutron Scattering Spectrometer

17 – 18.06.2019
50th meeting of the PAC for Condensed Matter Physics

20 – 21.01.2020
51th meeting of the PAC for Condensed Matter Physics

23.03.2020
FLNP Science and Technology Council



1) inverse geometry INS instrument

2) direct geometry INS instrument

Scientific motivation

- ❖ **Research directions realizing on NERA spectrometer**
- ❖ **New research directions**

Slightly oversubscribed

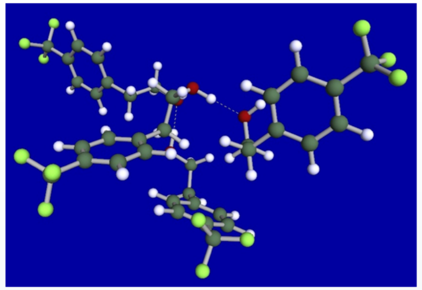
2016	2017	2018
20	13	18
PL/RU/RO	PL/RU/DE	PL/BU/RU/DE

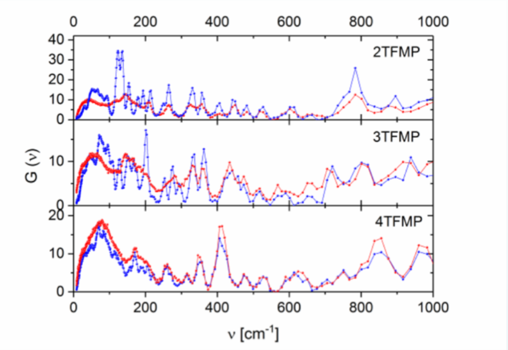
Reasons: - low luminosity → large samples or long counting time
- limited energy transfer range
- high background

Scientific motivation

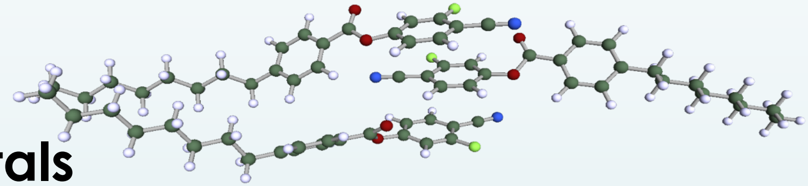
Research directions realizing on NERA spectrometer

Hydrogen bonds in molecular matter (vibrational analysis)

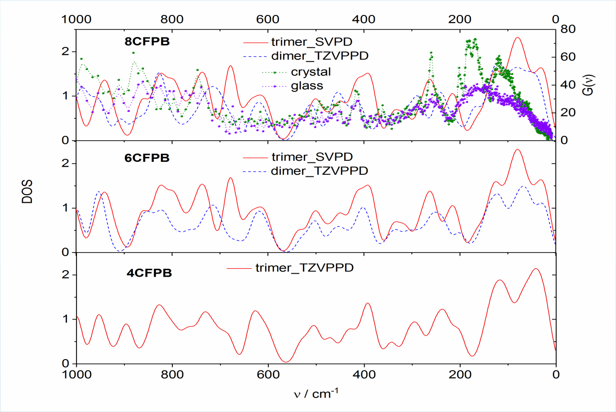




Dynamics studies of pharmaceutics with studies under pressure

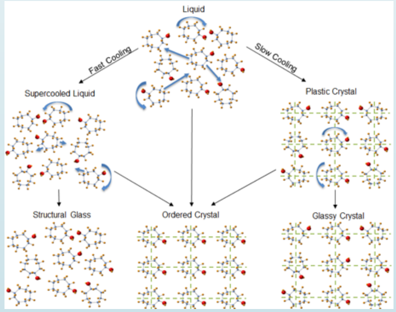


Dynamics studies of liquid crystals



Rotation-translation coupling – studies of Li – ion transportation in plastic crystals

Study of magnetic multilayers



Scientific motivation

New research directions – not possible to implement on NERA

Molecular crystals and glass-formers at low temperatures in connection with complementary studies and ab initio quantum chemical calculations.

Pharmaceuticals in bulk (native) state and as "micronized" or amorphized powders

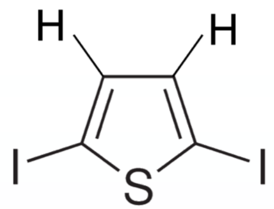
Matter under spatial confinement
- "hard" nanomatrices (e.g. membranes)
- "soft" confinement (e.g. microfibres)

Materials for energy storage, e.g. plasticizer-SPE systems for Li batteries

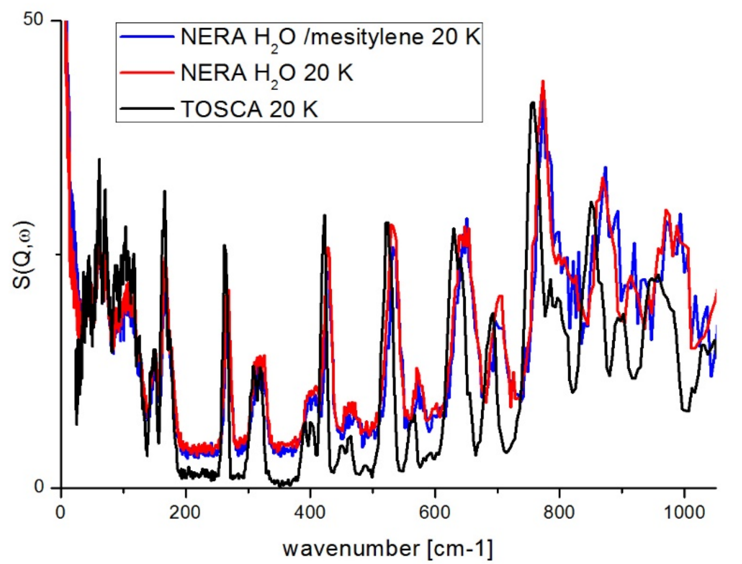
Catalysts

Photonic materials of industrial applications

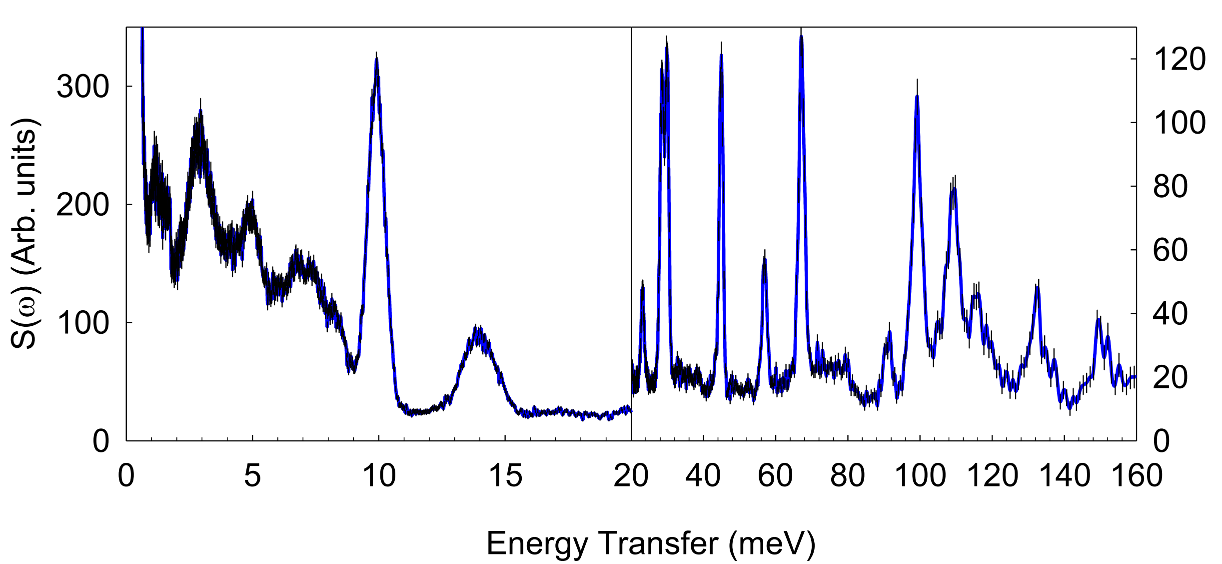
2,5 diiodothiophene
$(CH)_2(CI)_2S$



TOSCA, ISIS, England

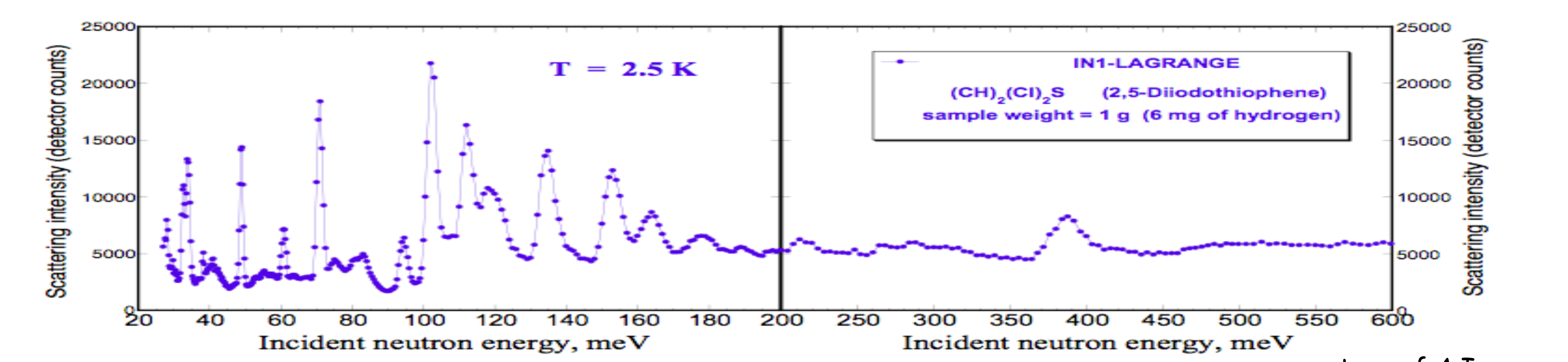


LAGRANGE, ILL, France



5K **17h 18g**

1 g / 4 hours (2+2 each panel) for raw scans

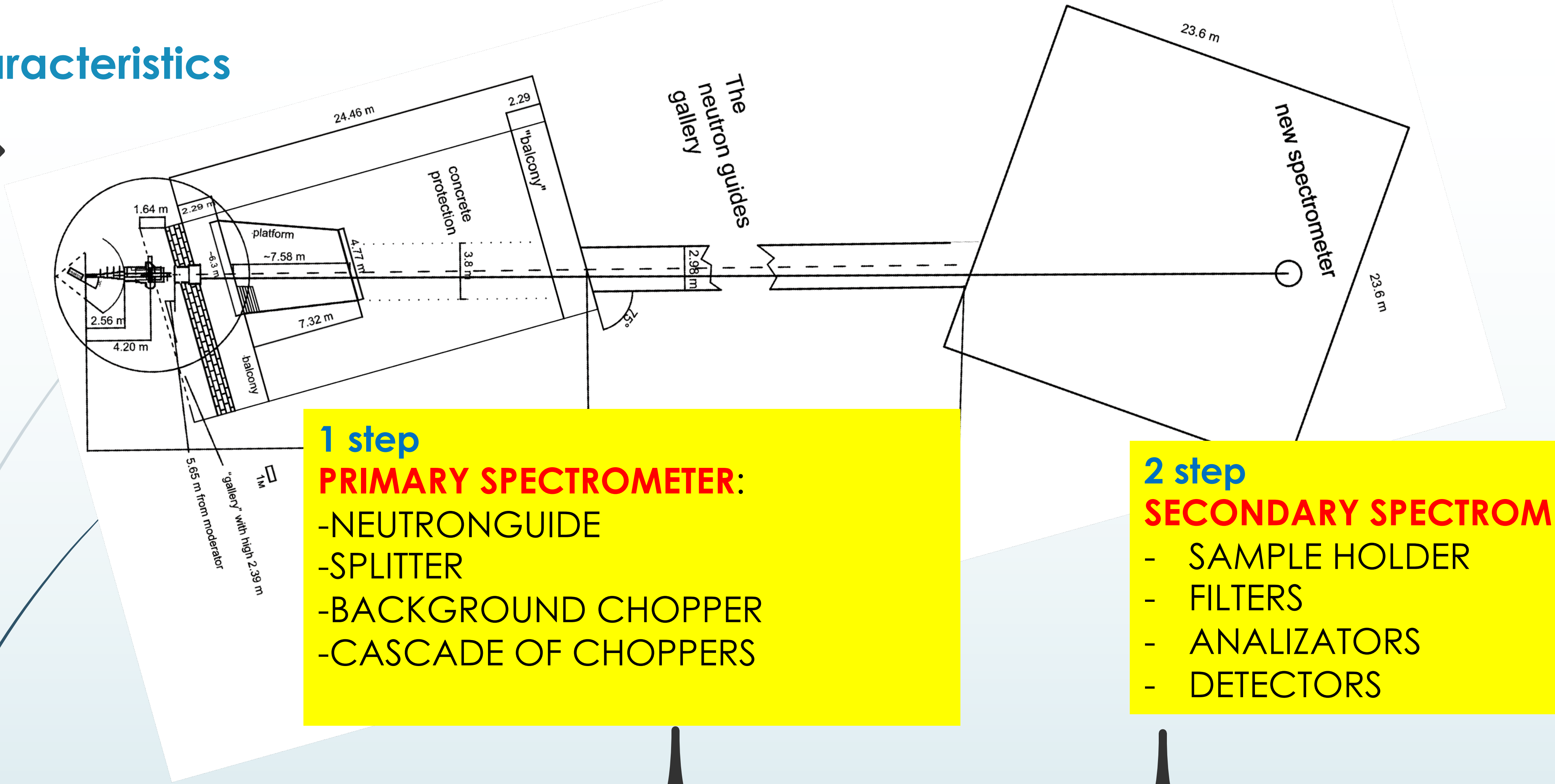


courtesy of A.Ivanov

Main characteristics

- Based on the available space and needed time resolution and energy range the distance between the source and the sample was chosen equal **105 m.**
- The optics was optimized for the **0.5 Å** wavelength band (thus for large values of transferred Energy **0-330 meV (2661 cm^{-1}); now impossible to analize above 100 meV**) .
- Two sample sizes was proposed: standard **3x3 cm^2** and small **1x1 cm^2**
- The distance between the end of optics and sample position is **0.35 m.**
- Higher luminosity – **250 times** higher than on NERA

Main characteristics



1 step

PRIMARY SPECTROMETER:

-NEUTRONGUIDE

-SPLITTER

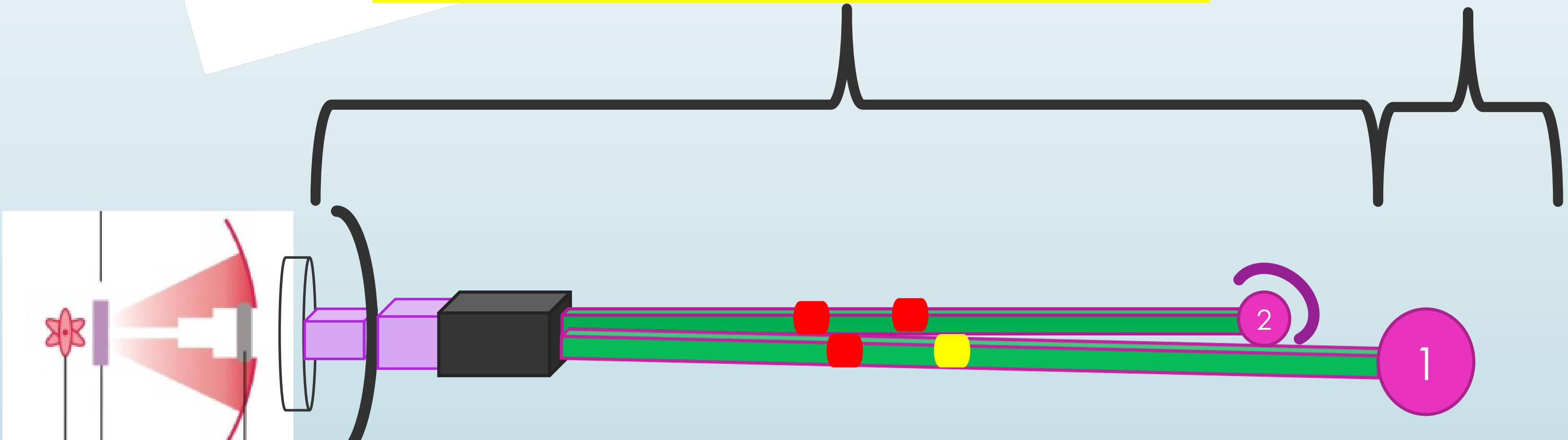
-BACKGROUND CHOPPER

-CASCADE OF CHOPPERS

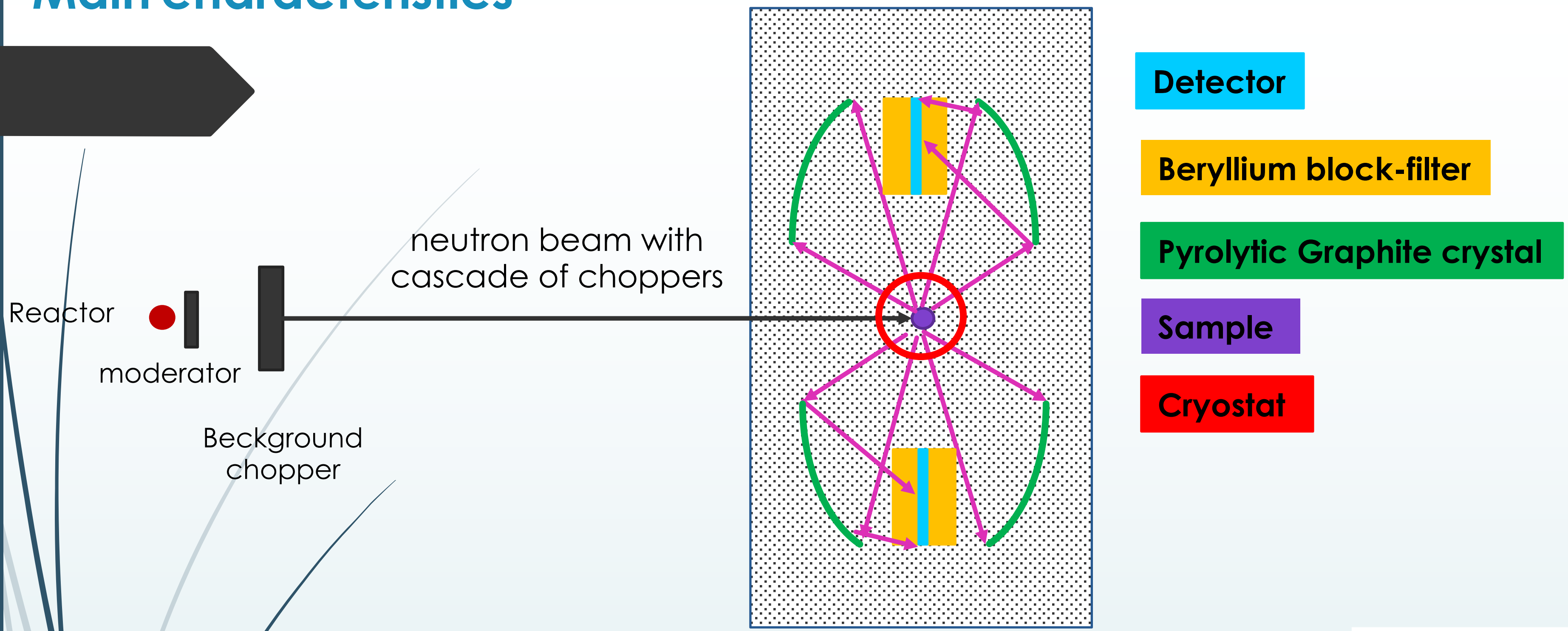
2 step

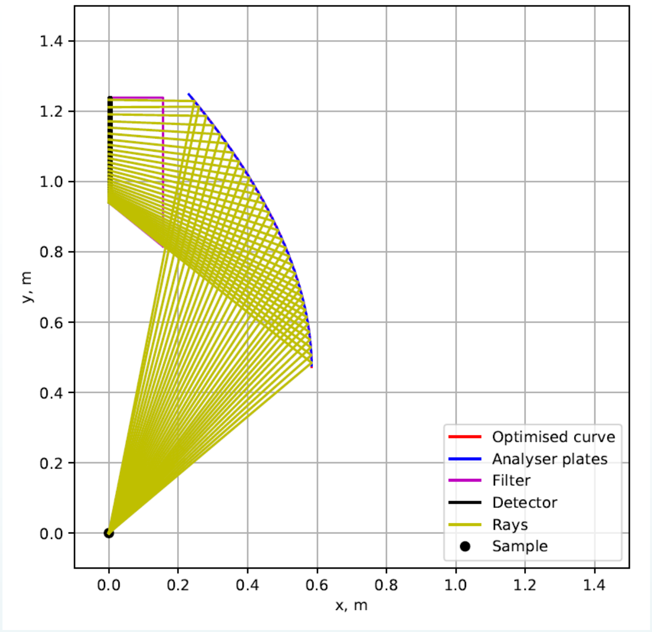
SECONDARY SPECTROMETER

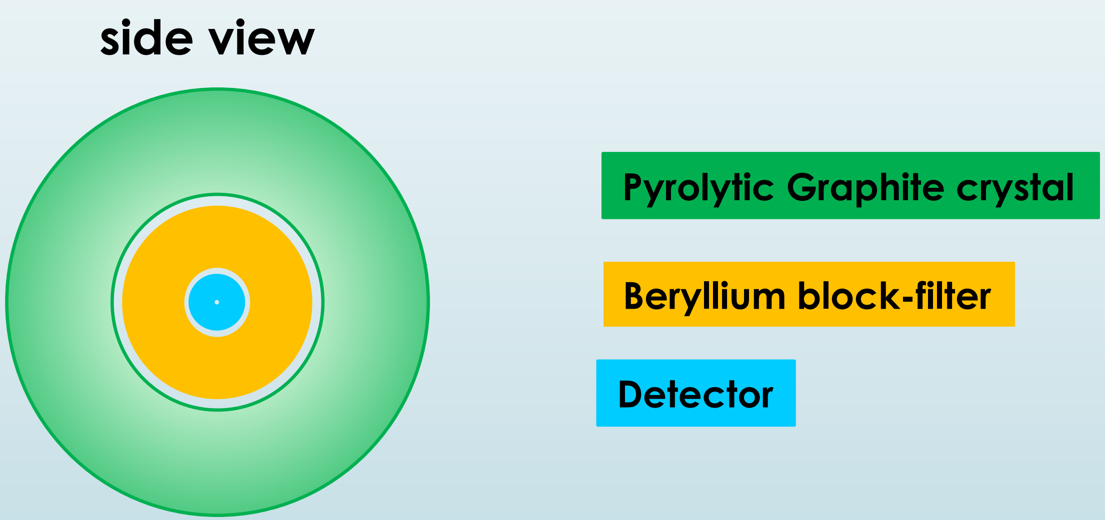
- SAMPLE HOLDER
- FILTERS
- ANALIZATORS
- DETECTORS

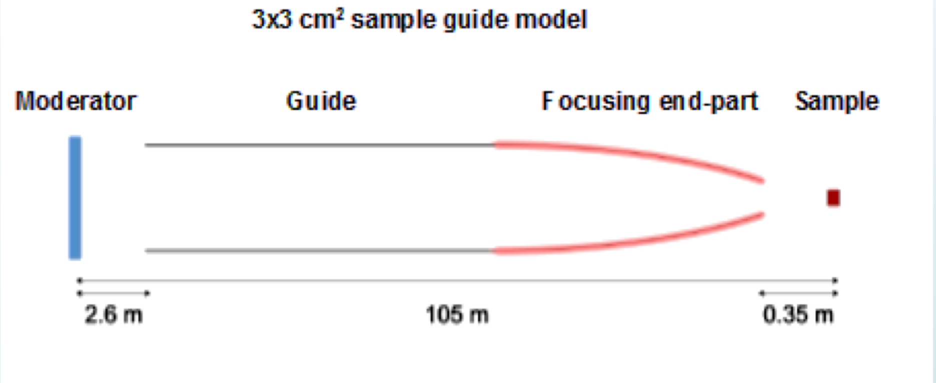


Main characteristics



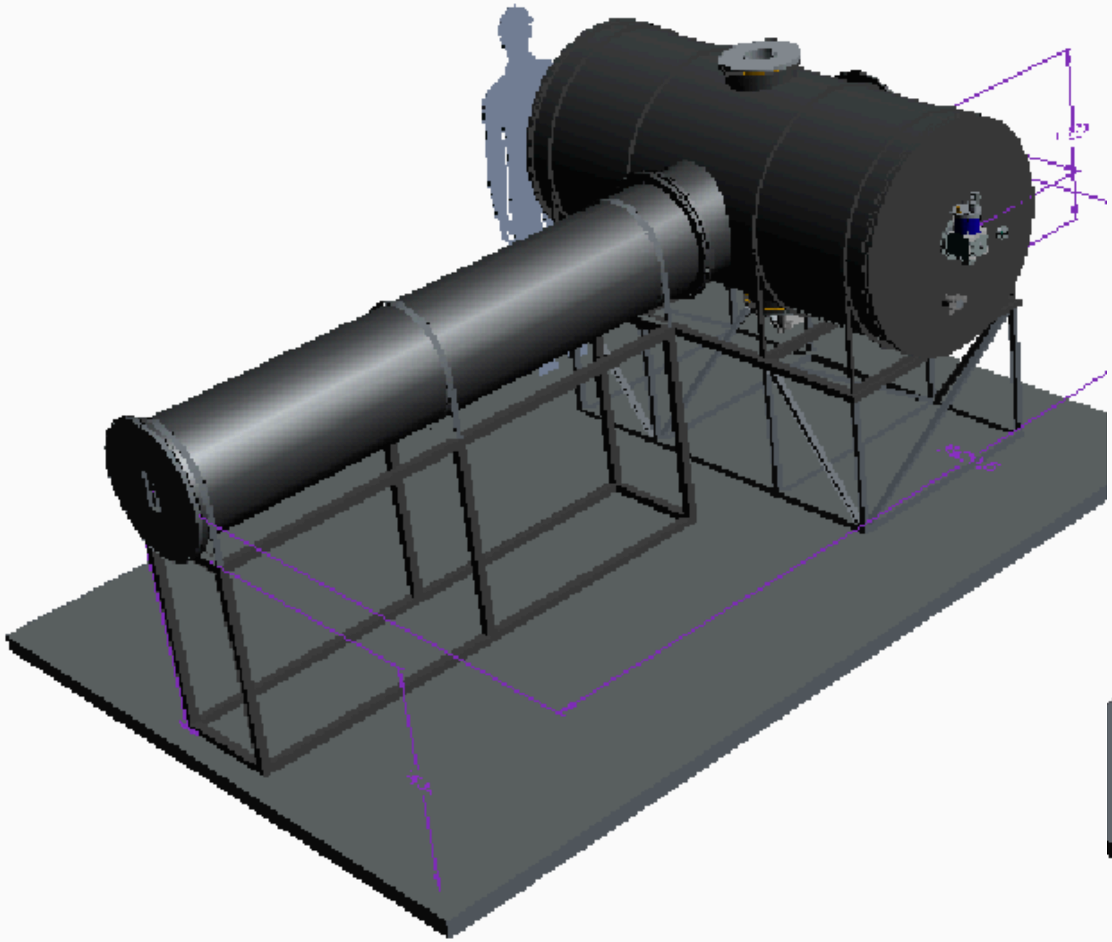


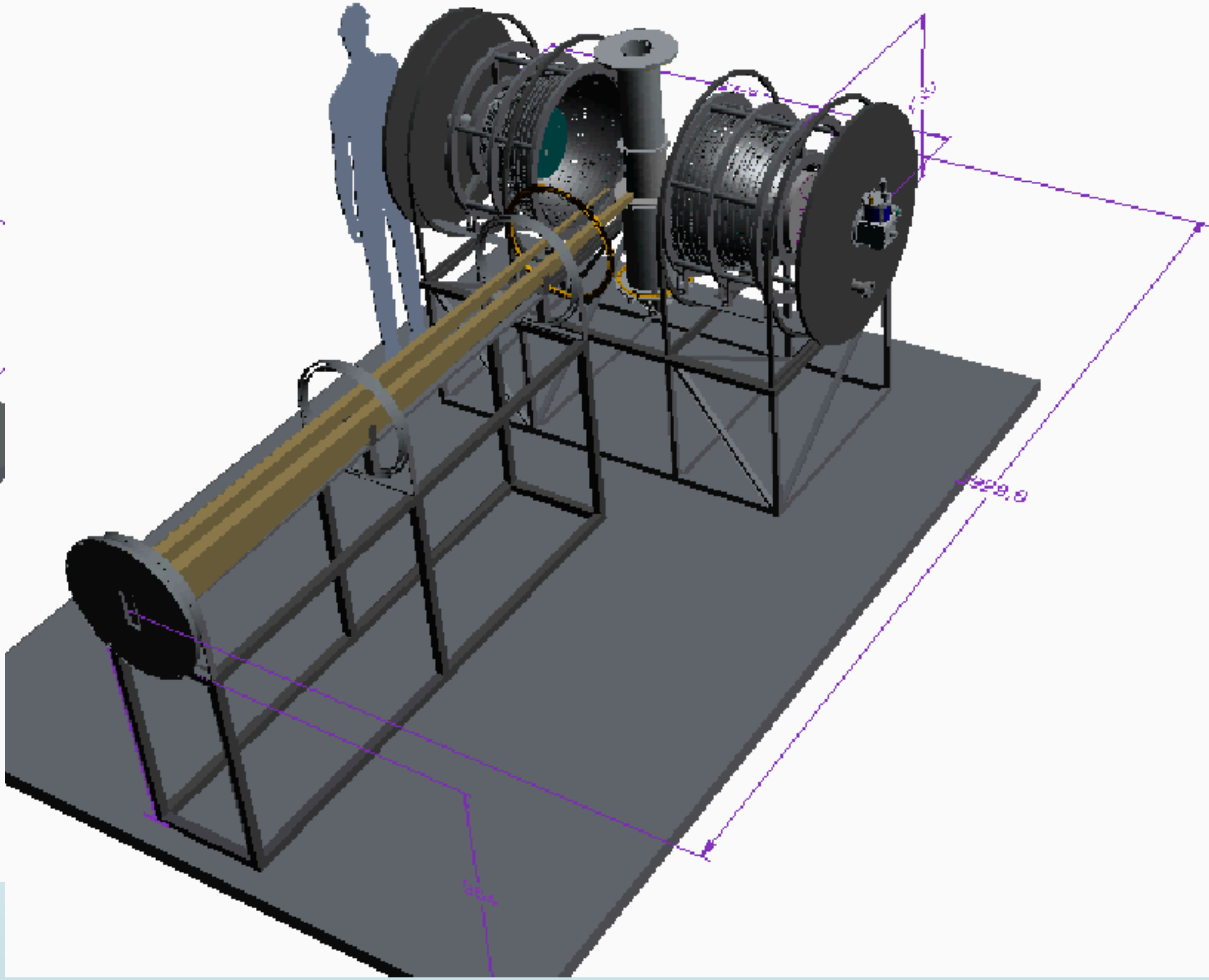




The moderator area for 2 channel: 33.5x40.5 cm^2 (WxH).

Main characteristics





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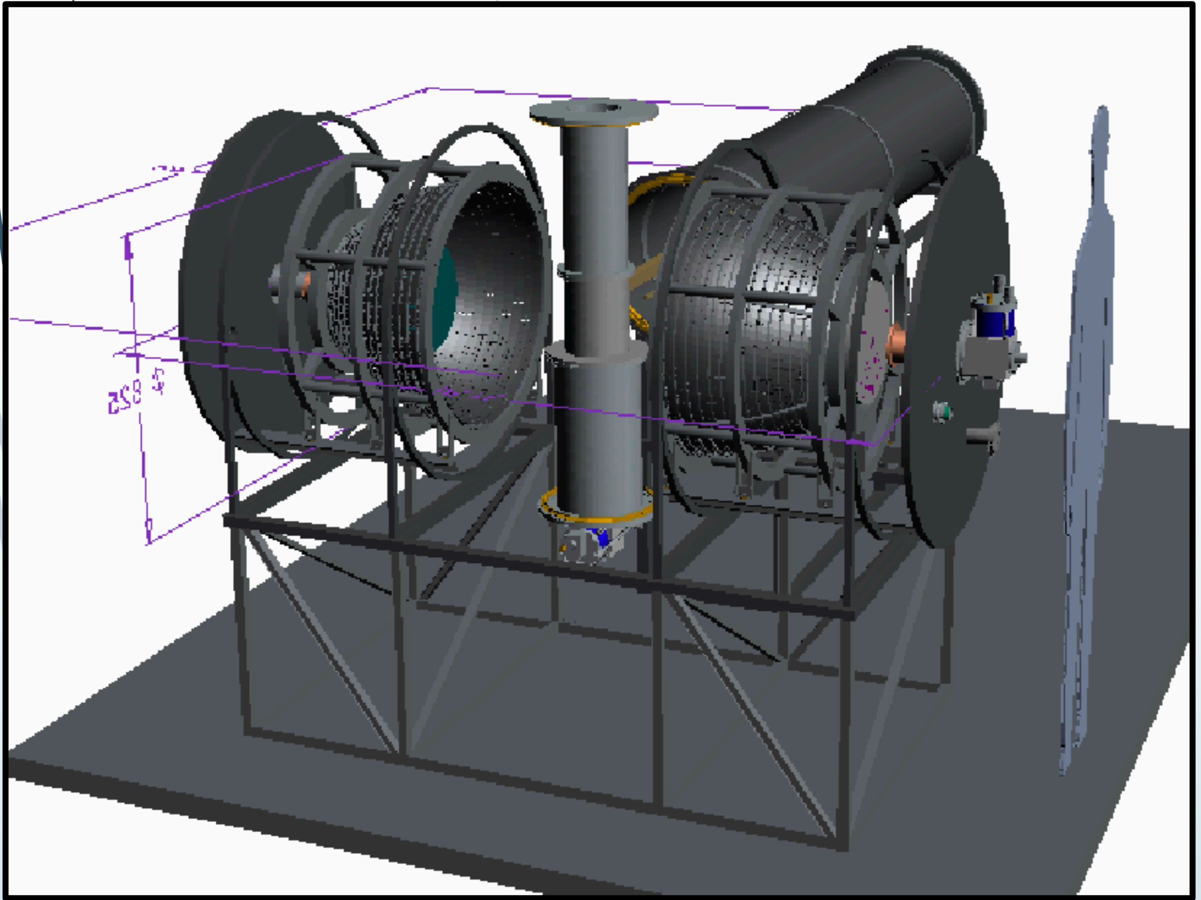

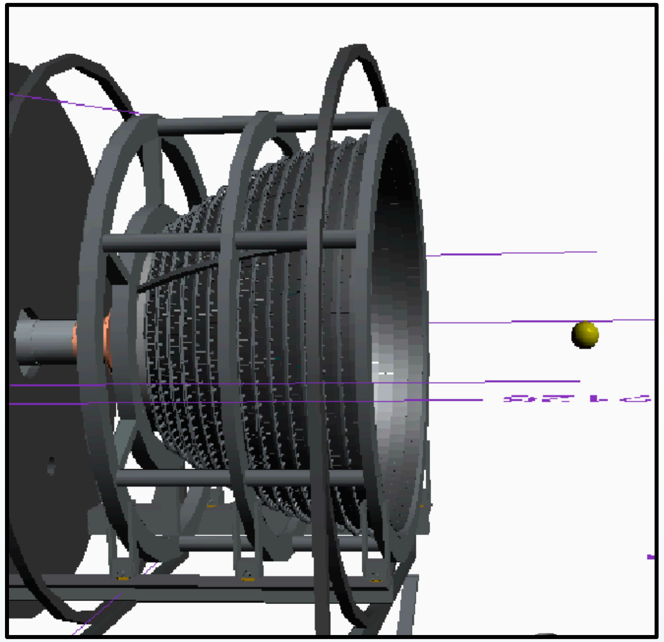

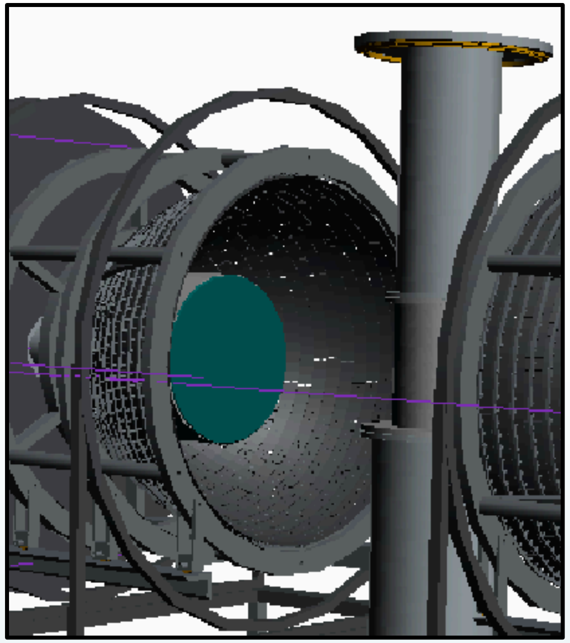

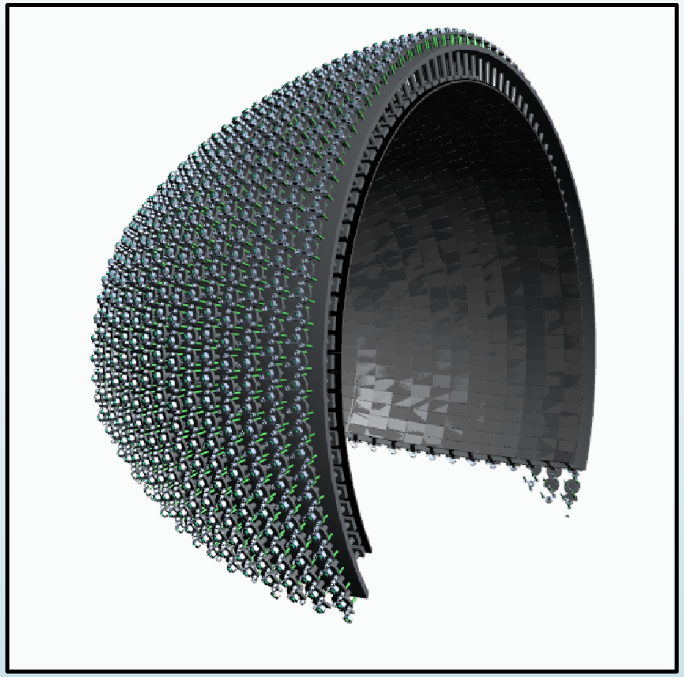

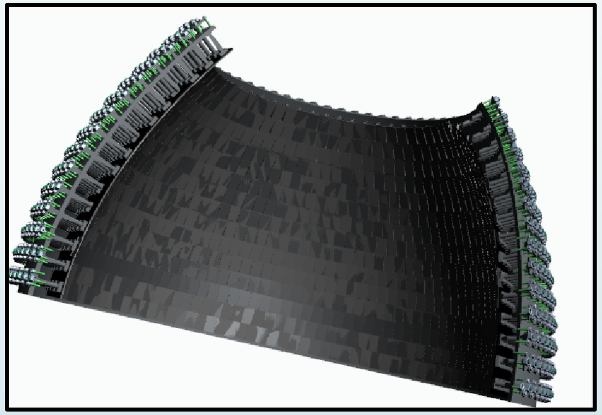

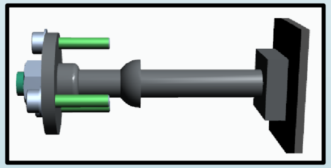

Expected characteristics

	NERA	New INS Spectrometer	
Analyzer area	15x3X25 **1125cm²**	10000x2 **20000cм²**	
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	~ 2 sr (1 pc of new spectrometer)	Solid angle gain **18**
Ratio of luminosityof new spectrometer and NERA			18x14 = **250** times higher i.e. measurements of a sample with the mass of 10-20 mg will be possible.

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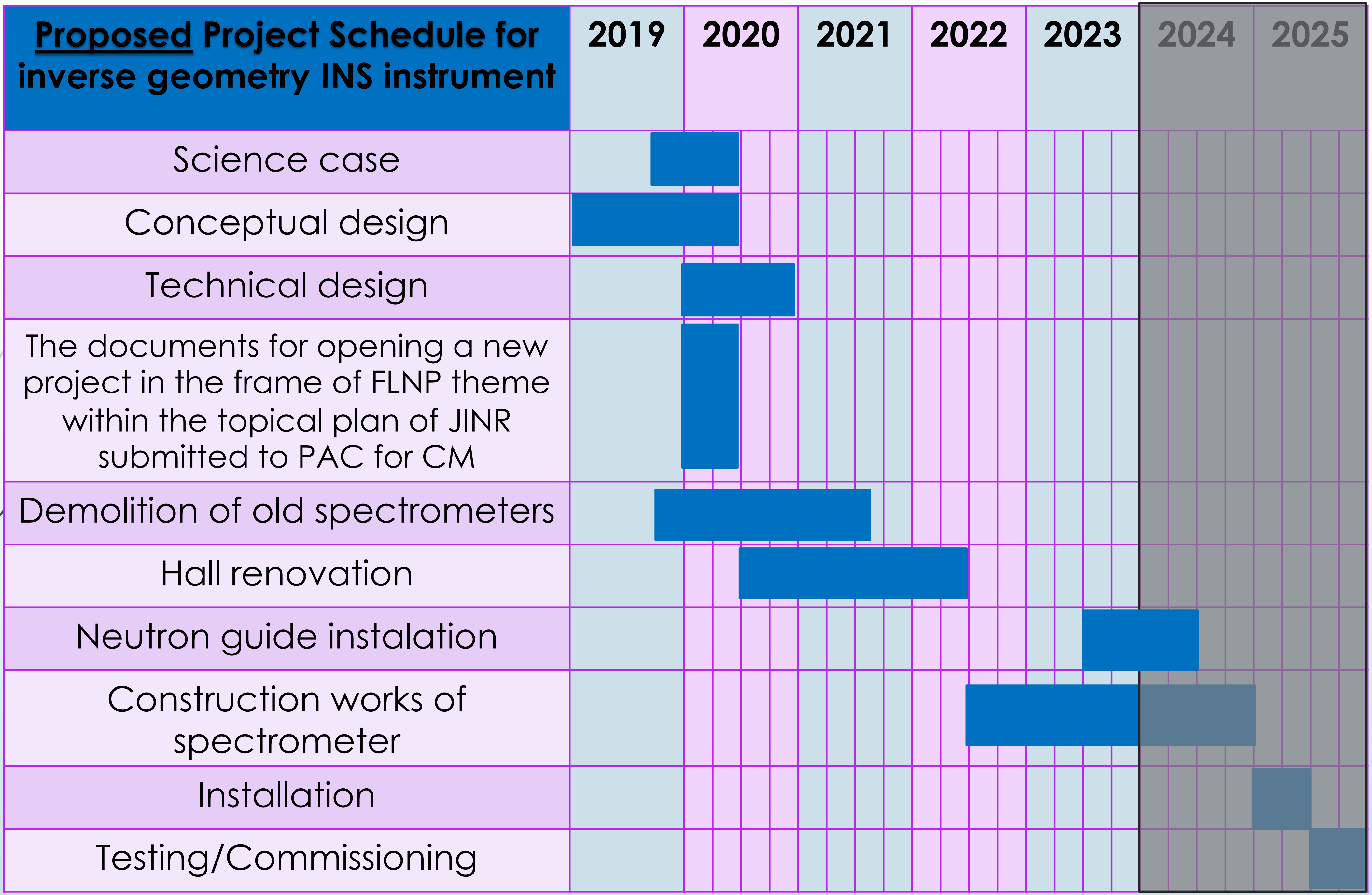
Authors:

Chudoba D. M.	- Dubna, JINR
Goremychkin E.	- Dubna, JINR
Belushkin A.	- Dubna, JINR
Bodnarchuk V.	- Dubna, JINR
Kruglov A.	- Dubna, JINR
Zając W.	- Kraków, INP PAN

Project leader: Chudoba D. M.

Due to the regulations, it is possible to open the project for 3 years with the possibility of extension for another period (1-3 years).

Time schedule



Time schedule & Cost estimate

Description of units and systems, resources, funding sources	Cost of units (k$). Resource requirements for 1st part of the project	Proposals of the Laboratory for distribution of funds and resources		
		2021	2022	2023
Neutron guide	2500	600	900	1000
Construction design and technical specification	250	250	-	-
Highly Orientated Pyrolytic Graphite	550	150	250	150
^{3}He Detectors and electronics	50	-	-	50
Manufacture of vacuum, cryogenic systems and beryllium filters	350	250	50	50
Total	**3700**	1250	1200	1250

The second part of the project (2024-2025) is planned to cover rest costs for neutron quide system, manufacture of vacuum, cryogenic systems and beryllium filters (~2000k$).

Time schedule & Cost estimate

№	Description of cost items	Total cost	2021	2022	2023	
Direct expenses						
1	Design	k$	250	-	-	**250**
2	Materials	k$	150	250	200	**600**
3	Equipment	k$	850	950	1050	**2850**
4	Payment for research performed under contracts	k$	40	40	40	**120**
5	Travel expenses	k$	10	10	10	**30**
Total		**k$**	**1300**	**1250**	**1300**	**3850**

Partner companies and equipment suppliers

AMU, Poland

INP PAN, Poland

PNPI NRC «KI», Russia

ILL, France

FRAKOTERM, Poland

SwissNeutronics, Switzerland

Kompozit, Russia

Thanks for your attention !