Spectroscopy Class Meeting – Engineering
25th February 2020

VESPA spectrometer update

- *VESPA general update (after STAP october 2019)*
- *ESS common shielding offer received Dec 2019*
- *Secondary spectrometer development plan (test/prototype)*
- *VESPA Procurement/delivery options*
- *TG3 plan and TA*

Consiglio Nazionale delle Ricerche

Science & Technology Facilities Council ISIS

EUROPEAN SPALLATION SOURCE

Instrument team

Project Leads:
- G.Gorini (Project Sponsor, Univ. Milano-Bicocca)
- R.Senesi (Project Manager, Univ. Tor Vergata)

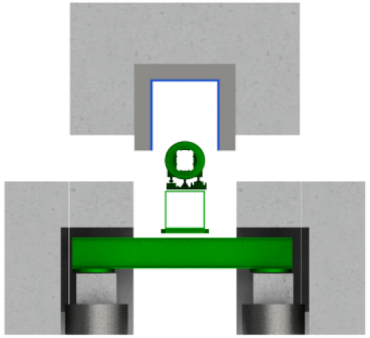
Scientific Leads:
- D.Colognesi(Lead Scientist, CNR)
- M.Hartl(Lead Scientist, ESS)
- S.Parker (Science Advisor, ISIS)

Engineering lead:
- L.DiFresco (Univ. Milano-Bicocca)

Scientists:
- L.Del Rosso (CNR)
- G.Scionti (Univ. Della Calabria)

Engineers:
- (TBD)

BEAMLINE SHIELDING



For the shielding of the VESPA guide system the total cost offered is: **780,000 €**.

based on:

- preliminary engineering design by Senad Kudumovic

- neutronics calculations performed by Jimmy Scionti.

Turn-key solution including:

• all shielding between the bunker and the instrument cave, including the two chopper pits

• integrated shielding between the bunker wall and guide shielding and between the guide shielding and cave

• preliminary engineering design (already performed)

• detailed engineering design

• neutronics work during the detailed design phase

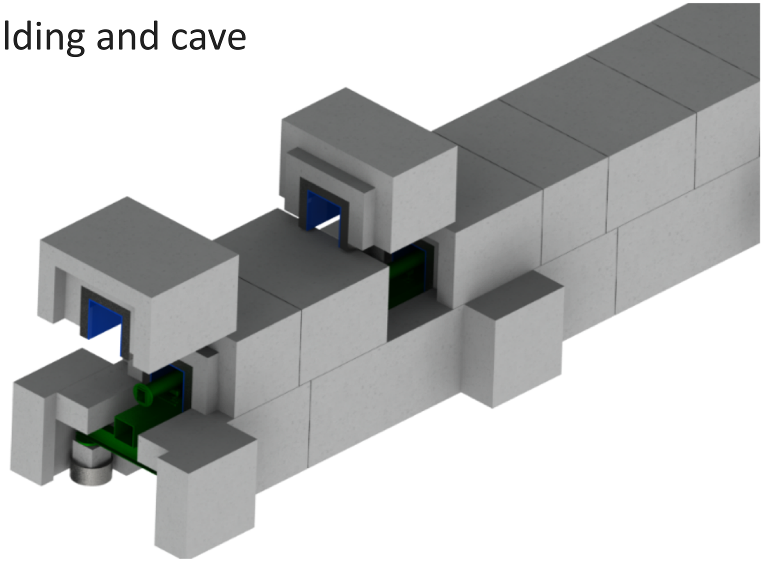
• raw materials cost

• procurement and fabrication

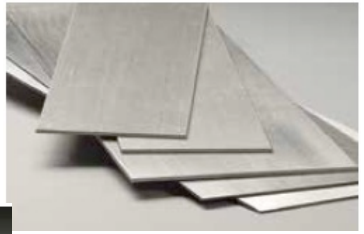
• transport to ESS site

• installation of all components, including tooling and manpower

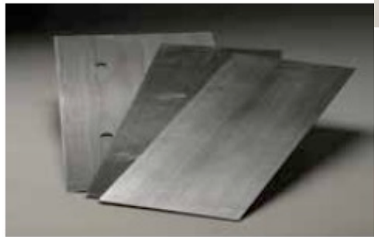
• full documentation



➢ Neutron Absorber Composite (Boral 3M™)
  - B4C loading up to 67% in the core (W)
  - Manufacured in flat sheet



➢ Enriched Borated Aluminium 3M™
  - Up to 4,5% B4C (W)
  - Sheet manufactured

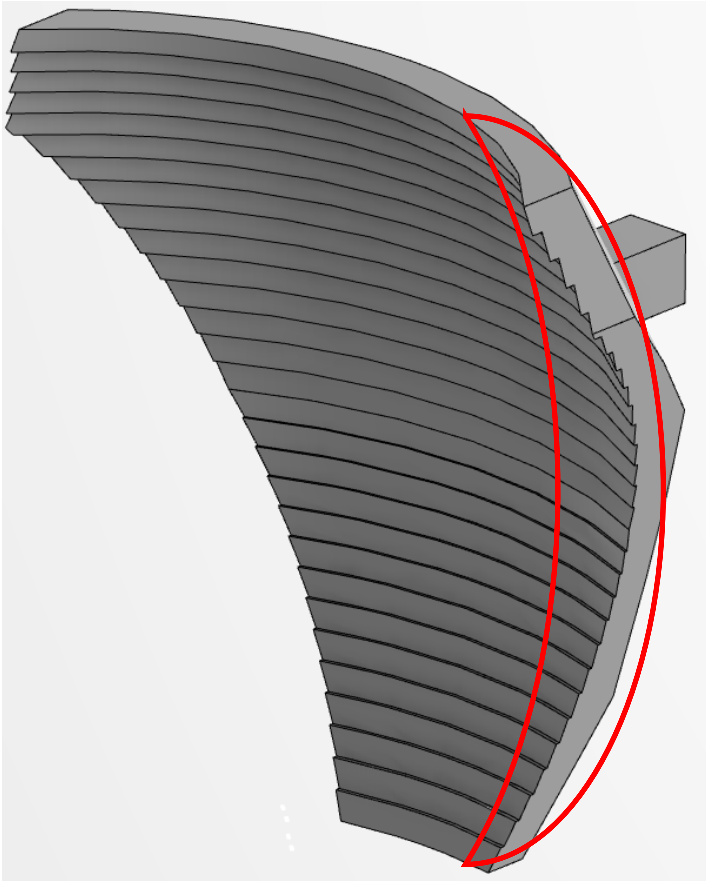


➢ Boron Carbide
  - 3D print
  - Tolerances and roughness (?)

➢ Borated Polyethiline
  - 5% Boron (W)
  - High in Hydrogen
  - Close tolerances
  - Custom shape

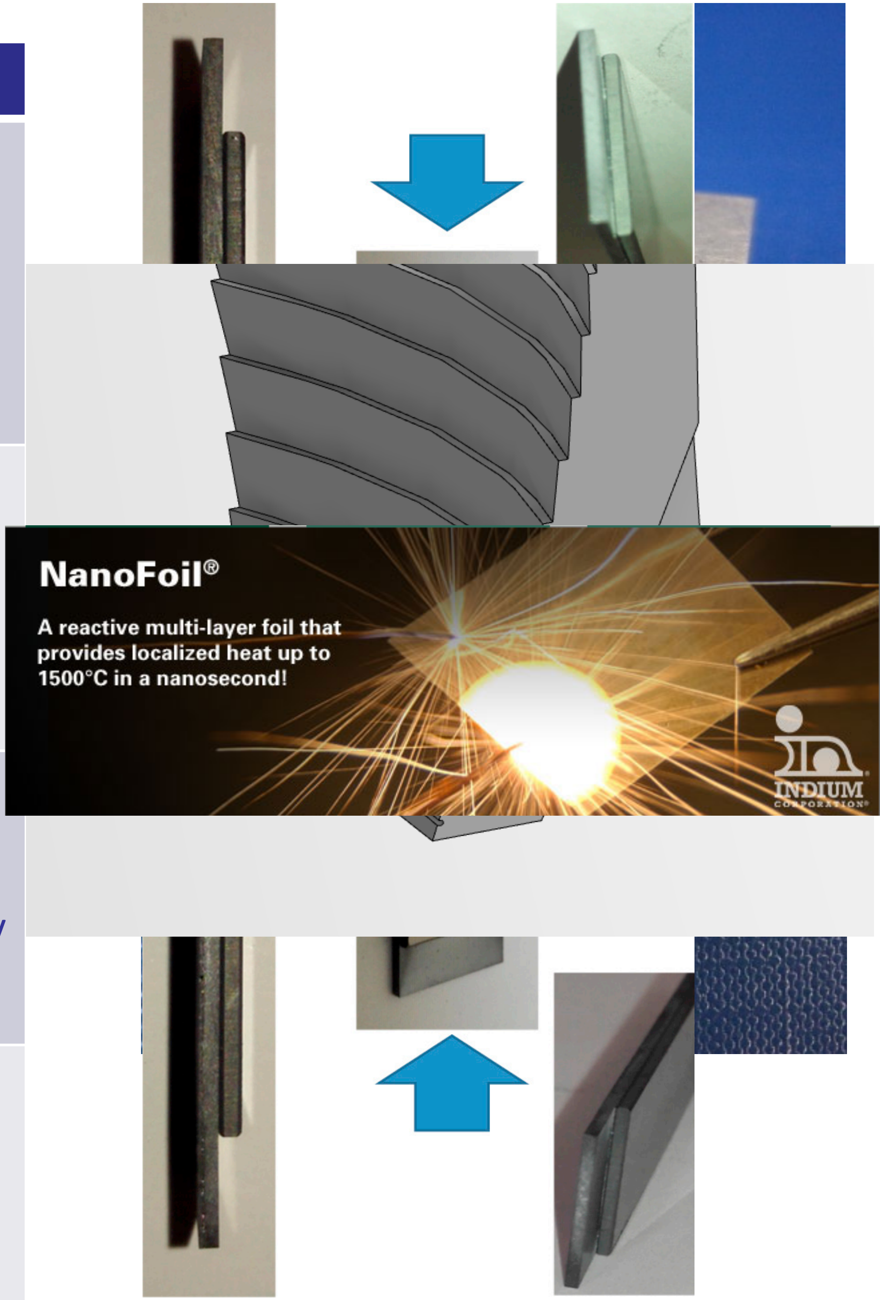
➢ Boron Nitride
  - Ceramic material
  - Powder or solid form
  - Good tolerances

VESPA Analyser



VESPA Analyser

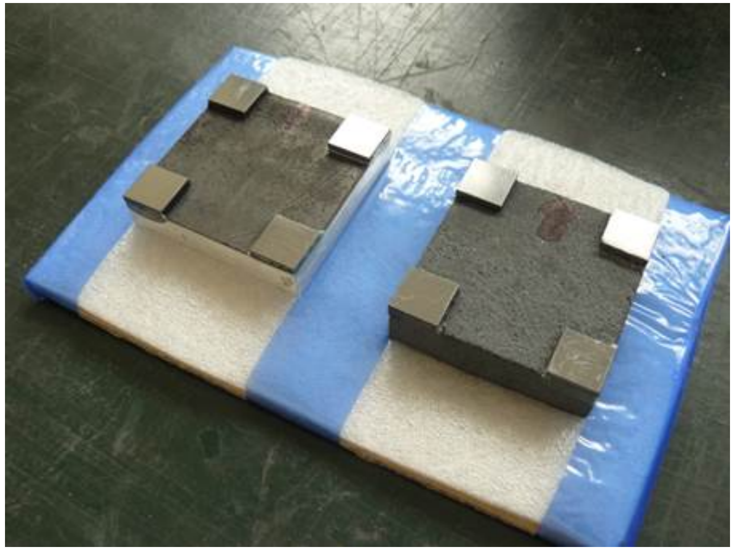
	PROS	CONS
Golden pins	•Used on OSIRIS •Durable •No added stresses on tiles •Easy replacement of broken tiles •Good control on misalignment •Works with all materials	•Not suitable for stepped holder •Reduction of the effective area •Not tested in vacuum
H-free glue	•Used on VISION •No H ➔ no scattering •Suitable for vacuum •May work for different materials •To be tested in 2019	•Build-up misalignments •Grooves nedeed to avoid tiles floating •Baking at 200C, 4 hours •Need to keep tiles in position during the baking ➔ potential stresses
Soldering (Indium)	•Tiles supplier solution (SNAG) •Tested in vacuum •Reliable (mechanical tested)	•Works only on metal •More expensive tiles (Si layer) •Hot and press ➔ difficult on our geometry •Risk of tile breaking during the soldering
Nanofoil	•No risk tile breakage •Tested in vacuum	•Si layer or metallization •1500C could modify graphite structure •Not tested •Only for metal holder



ANALYSER : holder substrate and HOPG tiles of a given mosaicity.

Tiles tied to the holder with golden pins, not possible for the stepped-geometry.

Soldering unpractical for curved geometry



Gluing can be used to hold the HOPG crystals in place.

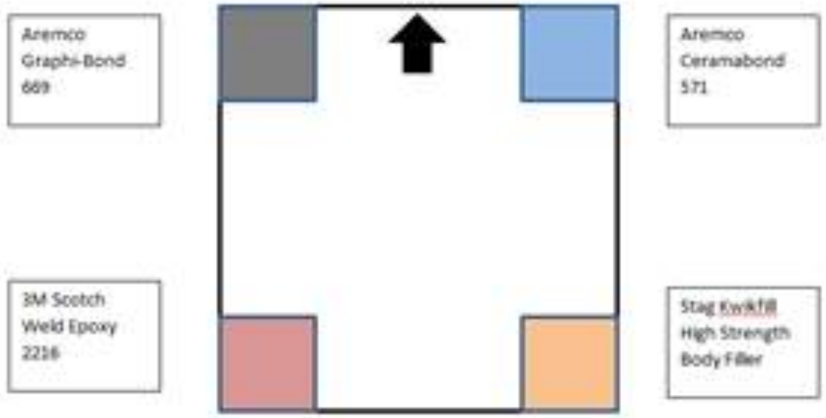
- **test of neutronic response** of candidate materials for the glues and the substrate,
- identify possible **contribution to background** and defining a ranking for the designer choices.

Glues

- Kwikfill polyester resin filler – used in automotive;
- 3M epoxy resin;
- AREMCO Graphi-Bond 669 – Graphite based low hydrogen content glue;
- AREMCO Ceramabond 571 – Magnesium Oxide based low hydrogen content glue

Substrates

o Boron Nitride (BN);
o Boron Carbide mixed with 20%wt. Epoxy (B4C);
o Borated (5%) Polyethylene (BPE);
o Aluminium 6028;
o Aluminium 6028 with 200 µm absorbing layer. The layer is 10B+36% wt.resin, which is the standard composition and thickness used by RAL Tech.
o Borated Aluminium 4.4% in wt.
o Flexible B4C (not a substrate, used for shielding)



Analyser: test on materials

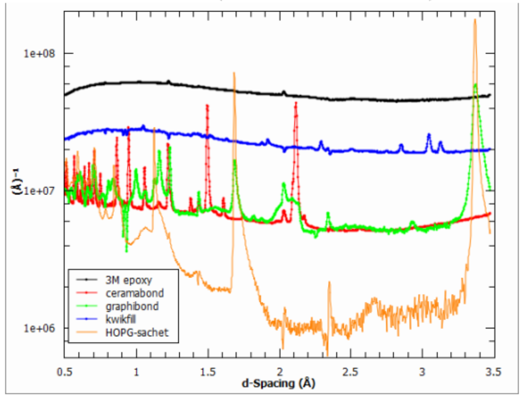
Transmission: describes how much is it possible for a neutron to go undisturbed through the material (mainly interesting for Be or substrate as shielding); Given a model for absorption, it can indicate how much the material will scatter neutrons around.

Diffraction: identifies the presence of preferred direction of scattering, peaks near the graphite one might mean increased background

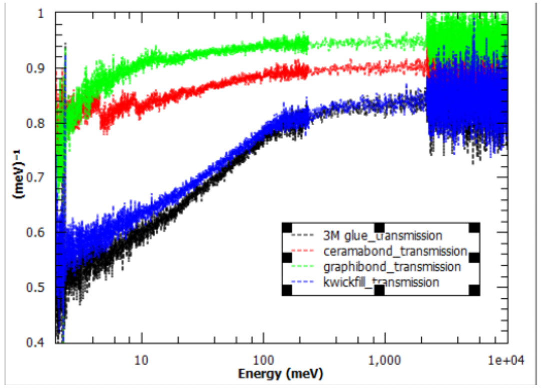
DINS: Deep Inelastic Scattering, in our case it is interesting to identify the presence of Hydrogen.

INS-TOSCA: for glues only (and Be but a different sample), Hydrogen sensitive, shows spectral features that can contribute to an uneven background in the recorded spectra, possibly sample dependent.

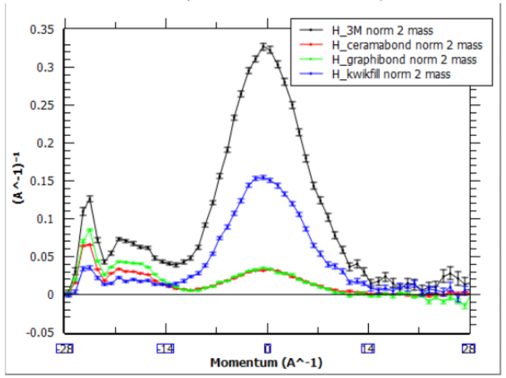
Diffraction (normalised to mass)



Transmission



DINS (normalised to mass)

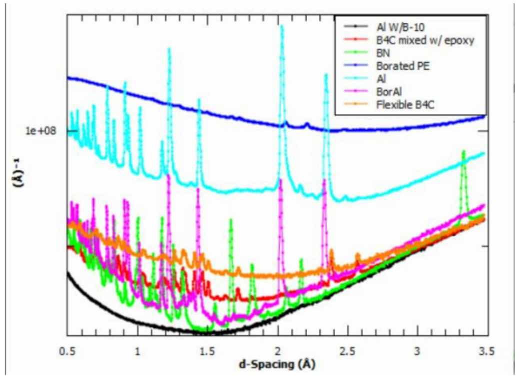


Material Ranking - Glues:

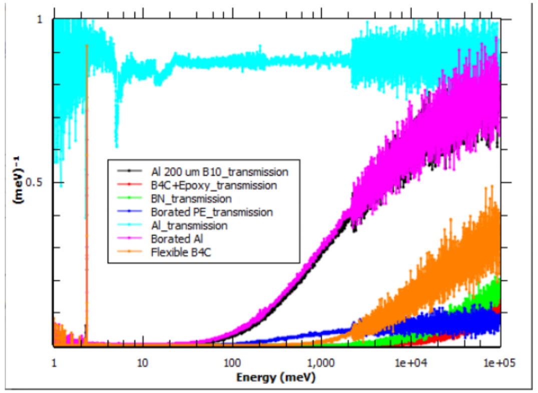
1. Direct bond with B10
2. Ceramabond;
3. Graphibond;
4. Kiwkfill;
5. 3M.

But it depends on how much glue is needed to hold the tiles in place.

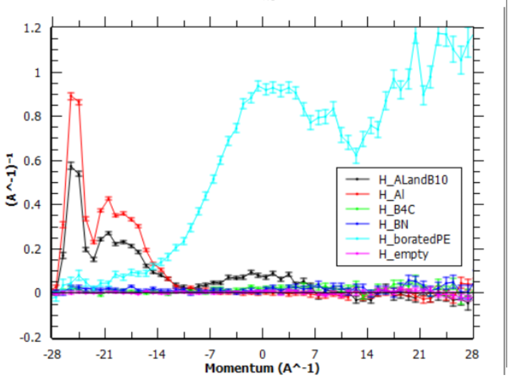
Diffraction



Transmission



DINS



Material Ranking - Substrates:

1. Al with 10B;
2. B4C;
3. BN;
4. Al;
5. BPE.

Beryllium

- two qualities of Beryllium from Materion tested in order to check the effect of material purity on
- ***MATERION* S-65** and **S-200-F** vacuum pressed **Be** sintered powder
- ***S-65*** is higher quality and **35% higher cost**

- BeO is detectable in diffraction
- ***S-65*** is slightly (1.5-3.5%) **brighter** than S-200-F between 2 and 5 meV

Be slice geometry

efficiency of the Be filter :

- how many "good" neutrons transmitted and
- how much "bad" neutrons are prevented to pass through

Rejection Rate (RR or Rej rate)

the integral average of the transmission in the 0.1-5 meV

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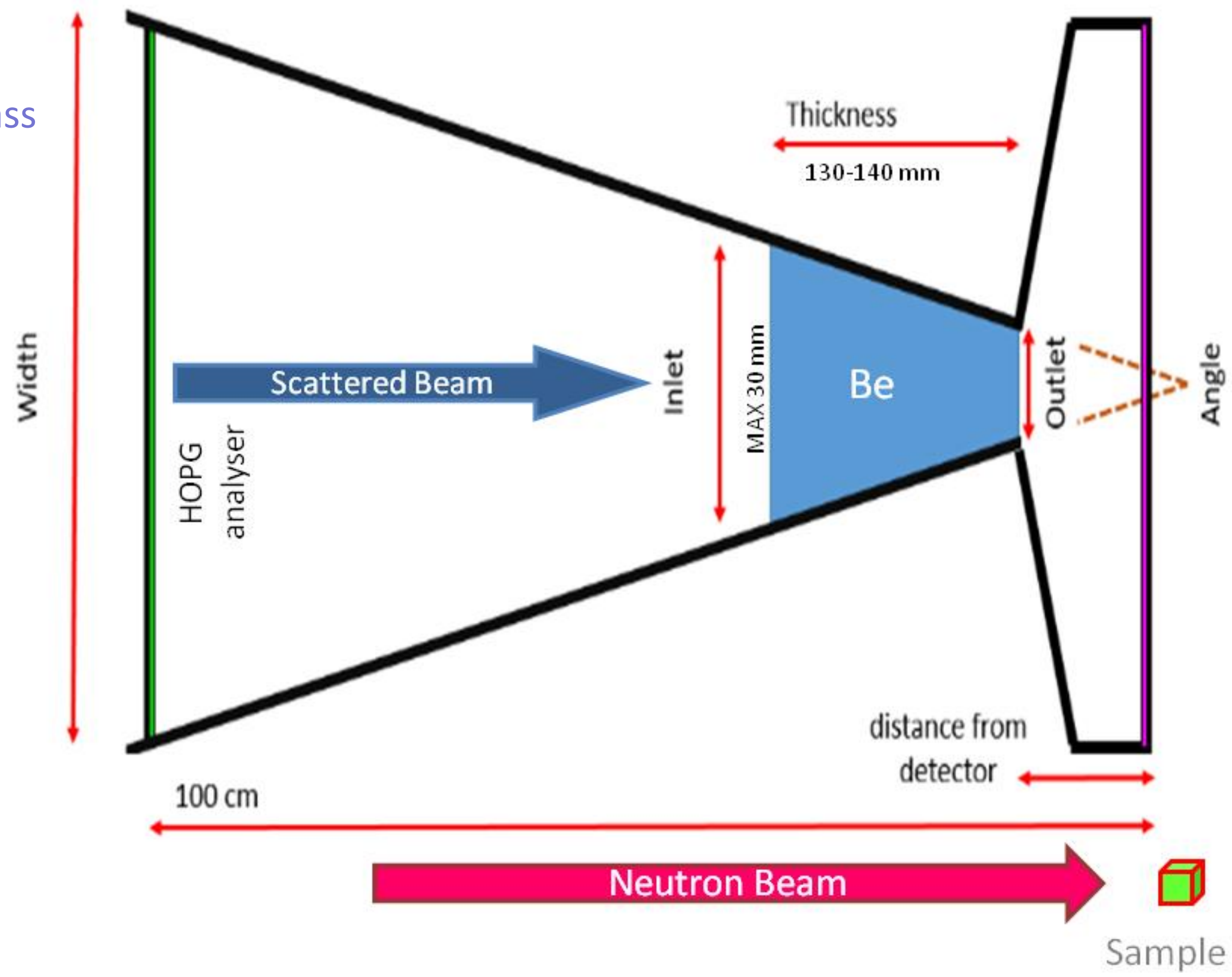
the integral average of the transmission over the >5meV region

Table1 – Wedge parameters and performance. RR in green satisfy the RR criterion.

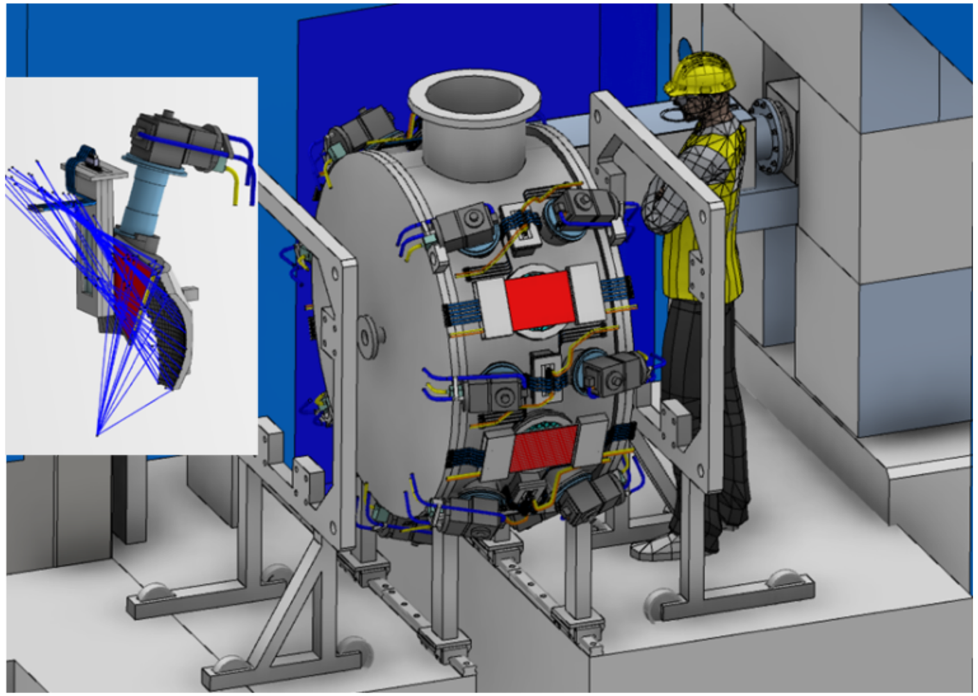
Ref.	Inlet, cm	Outlet, cm	Thick, cm	to dets, cm	Angle, °	RR, a.u.	Trans <5meV	Notes
A	4.50	1.50	14.0	3.0	12.23	4637.54	0.954	
B	6.00	2.00	14.0	3.0	16.26	1842.85	0.953	
C	6.00	2.00	14.0	3.0	16.26	3729.63	0.898	with half collimator
D	4.00	2.00	14.0	10.0	8.17	3261.73	0.944	
E	3.00	1.00	14.0	3.0	8.17	9882.03	0.925	
F	4.82	1.40	14.7	2.5	16.15	5623.72	0.957	
G	5.66	1.65	14.7	2.5	18.74	3299.58	0.956	
Opt	**5.10**	**1.50**	**14.7**	**2.5**	**17.10**	**4759.85**	**0.950**	Error 1%, 3 SD

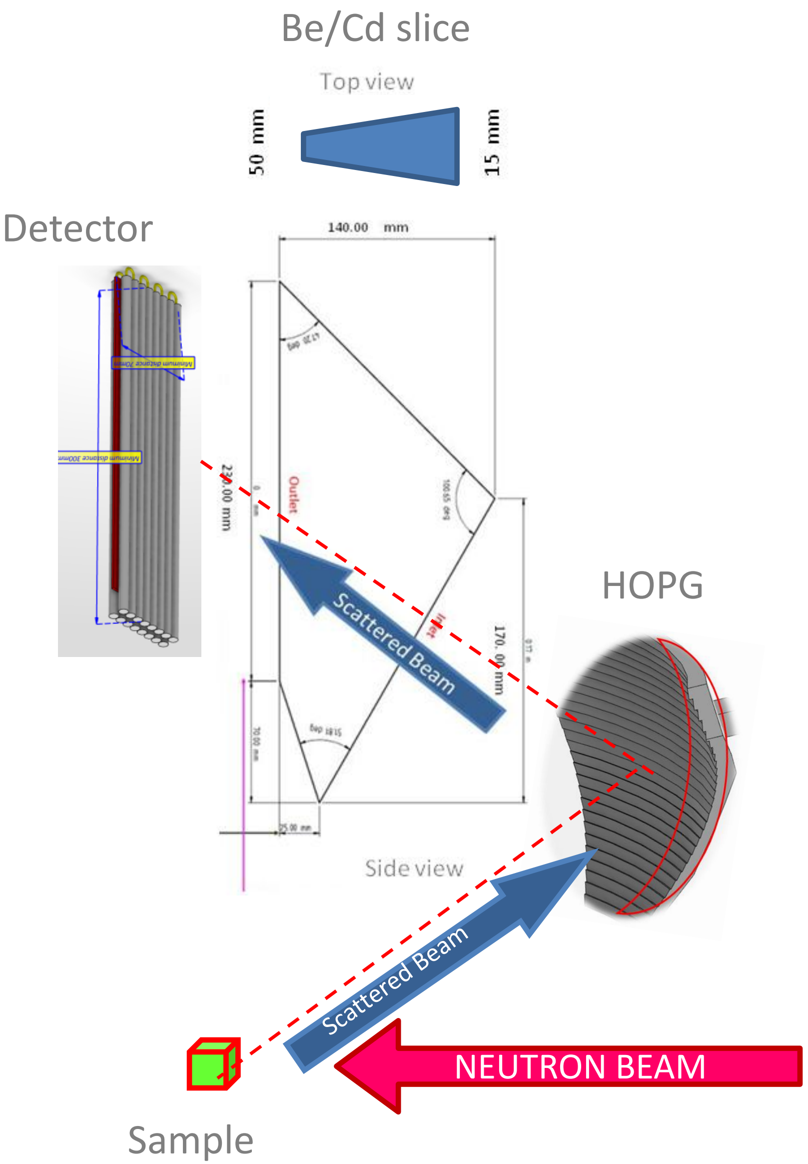


Further tests

- manifacturability for the holder shape;
- compatibility of substrate+glue+HOPG;
- glue degassing
- HOPG-Be-Detector mock-up alignment test
- Beamline measurement on HOPG-Be-Detector mock-up

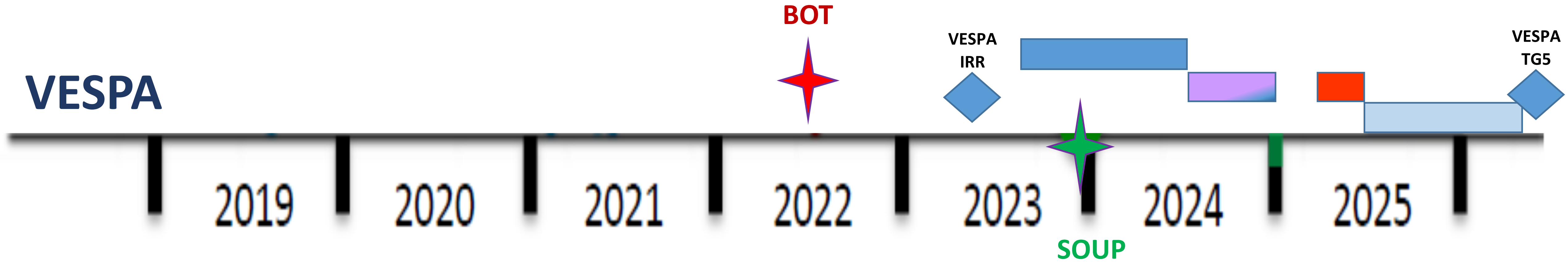
Detail Engineering





VESPA PLAN

Instruments Installation (TG4 – TG5)

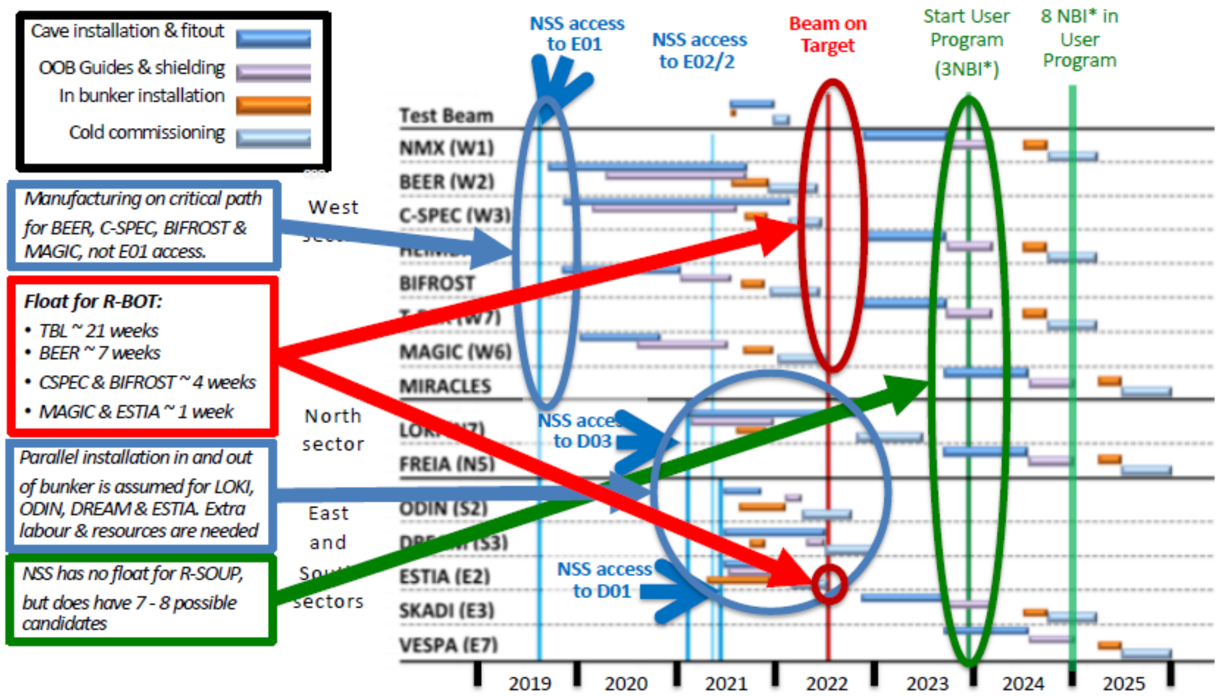


Cave installation Q4 '23 – Q2 '24

Cave & Shielding Q3 '24 – Q4 '24

In bunker Q2 '25

Cold commission Q3 '25 – Q1 '26



BOT: Q3 2022

SOUP first 3 instr.: December 2023

Delivery Option A
ISIS approach

This delivery model is for a **team of engineers to carry out complete engineering design** and manage procurement,
supported by **relevant in-house experts** (e.g. detector scientists, chopper engineers, motion control engineers, vacuum technicians, operations staff)

Delivery Option B
Procure and Build companies

The concept of this model is that **the Instrument team undertakes most of the detailed design and drawings**.
Integration companies then take these designs and procure the many components to deliver a working assembly.

Delivery Option C
Design-build procurements

Suppliers delivering turn-key solutions,
the supplier is responsible for the design and meeting specification, is a more realistic and lower risk procurement method. Using this methodology means the Vespa team only need to provide concepts and requirements specifications and it is the supplier who is responsible for engineering a solution.

RISKS | TIME | COSTS | QUALITY

VESPA sub-systems

(the various components are grouped according to their functionality and /or suppliers availability)

- Guide system
- Chopper system
- Secondary spectrometer
- Beamline shielding
- Infrastructure and cave

Technical Annex agreement

Design Priorities
Staff /resources availability
TG3-TG4 plan

Spectroscopy Class Meeting – Engineering

25th February 2020

VESPA spectrometer update

THANK YOU

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Science & Technology Facilities Council ISIS

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Spectroscopy Class Meeting – Engineering

9th October 2019

VESPA spectrometer update

BACKUP SLIDES

VESPA Analyser

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NBOA complete

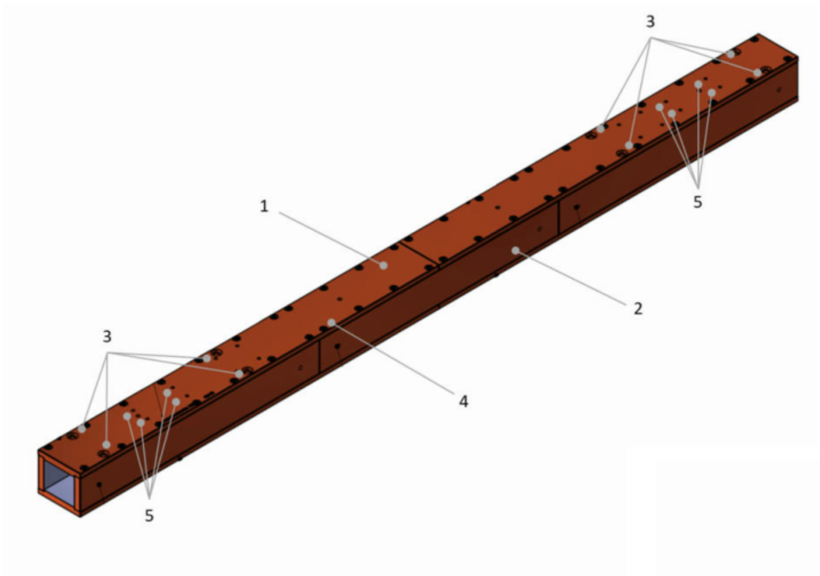
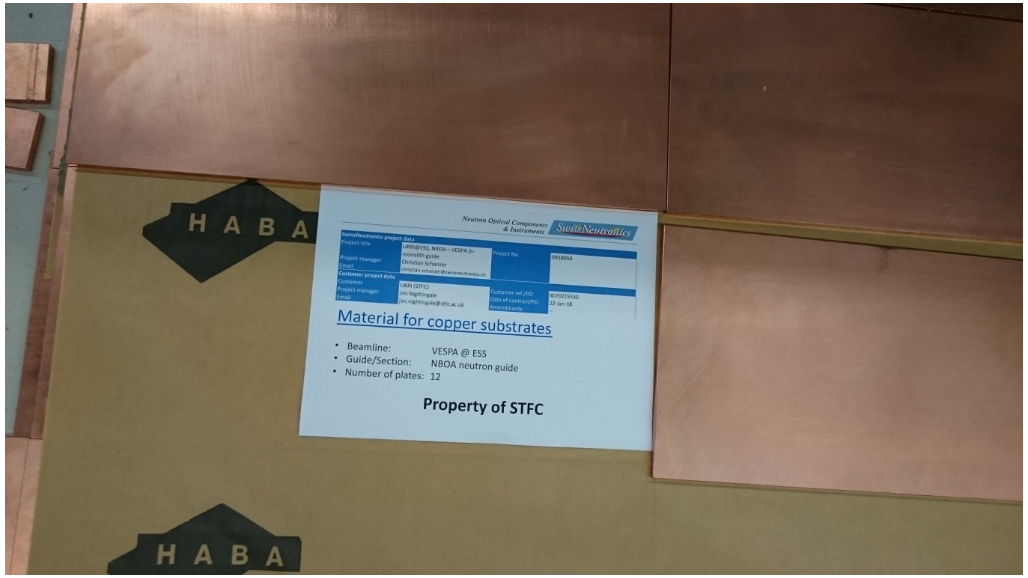


Figure 1 Neutron guide unit for NBOA at ESS. The guide unit is made from multiple parts and compris
of those are given in Table 3.



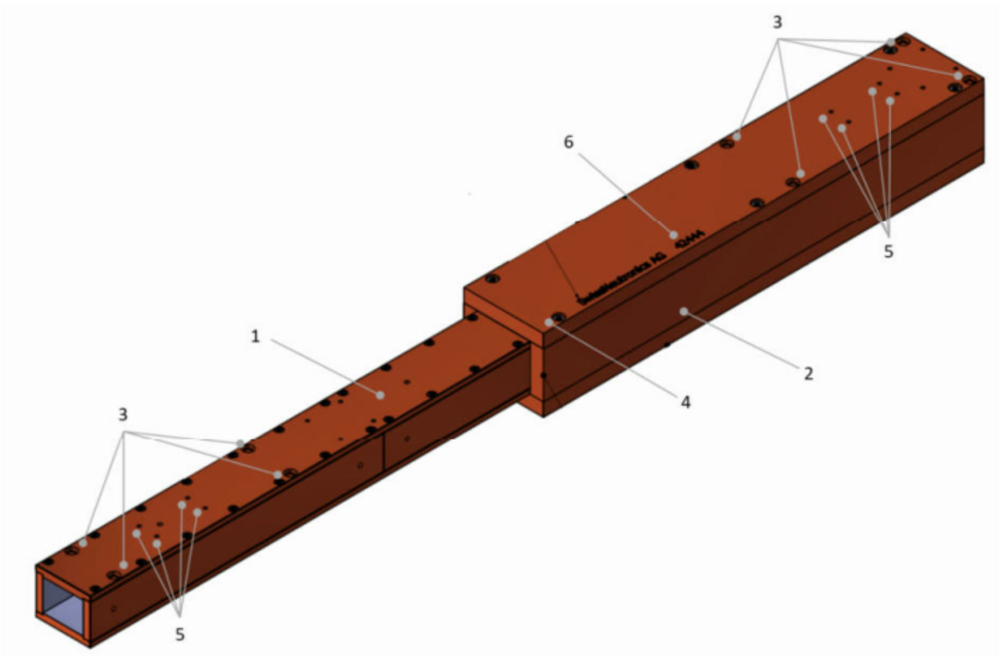


Figure 2 NBOA neutron guide unit for Vespa with shielding jacket.