PAUL SCHERRER INSTITUT

PSI

Stavros Samothrakitis :: Applied Materials Group :: Paul Scherrer Institute

Considering Instrumentation for a High Intensity Moderator at the European Spallation Source

ESS ILL Joint User Meeting 2022

stavros.samothrakitis@psi.ch

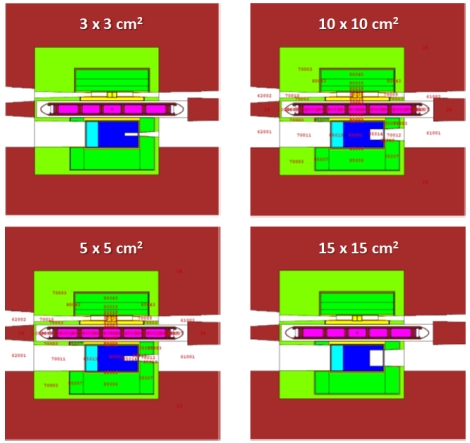
HighNESS – High Intensity Neutron Source @ ESS

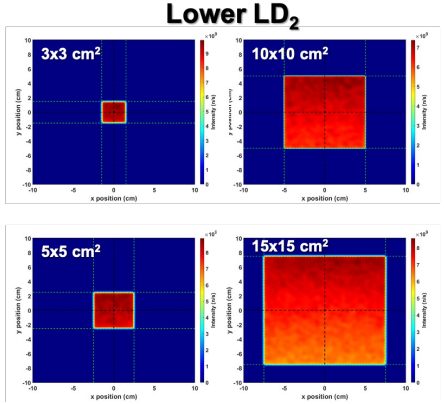
Instrumentation **Engineering**

Software **Design**

Simulations **Neutronics**

- **HighNESS: Development of High Intensity Neutron Source at the European Spallation Source.**
- **Design study of a second moderator, offering high intensity of cold neutrons.**
- **The moderator can potentially serve research on Condense Matter and Fundamental Physics.**





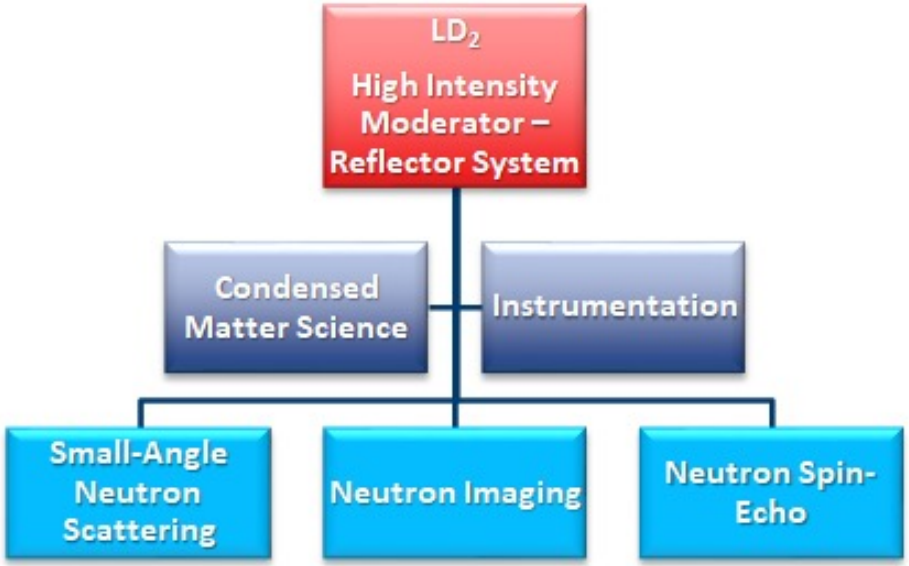
HighNESS – High Intensity Neutron Source @ ESS

Deliverables

D7.1 Definition of instrument concepts (M6)
This report is the main output of Task 7.1 and will be delivered in month 6. It will list the instrument concepts selected for optimization, together with a brief justification for their selection and a preliminary definition of the FoM for each instrument concept.

D7.2 Optimization study of instruments, moderator and reflector (M34)
This report covers the work of Tasks 7.2, 7.3 and 7.4 and will be delivered in month 34, marking the end of the WP. For each instrument concept, it will describe the FoM used for the optimization and the iterative optimization process involving moderators, reflector and instrument design. It will then assemble the optimization of all the instrument concepts into a single global optimum and evaluate and present the resultant instrument concepts and their performance. For an example of a similar optimization effort, see Ref.“

Work Package 7



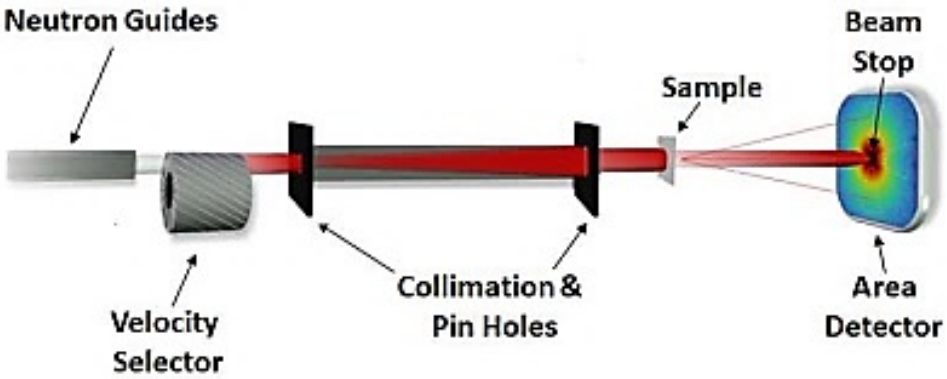
Objectives

There are three high-level objectives to this WP:

1. Assemble an instrument suite for condensed-matter science viewing the ESS lower moderator
2. Evaluate the optimum configuration of the moderator-reflector system and instrument designs which achieves the best performance over the full set of instruments.
3. Quantify the instrument performance of that configuration, so as to provide a basis for estimating the scientific impact of such a facility.

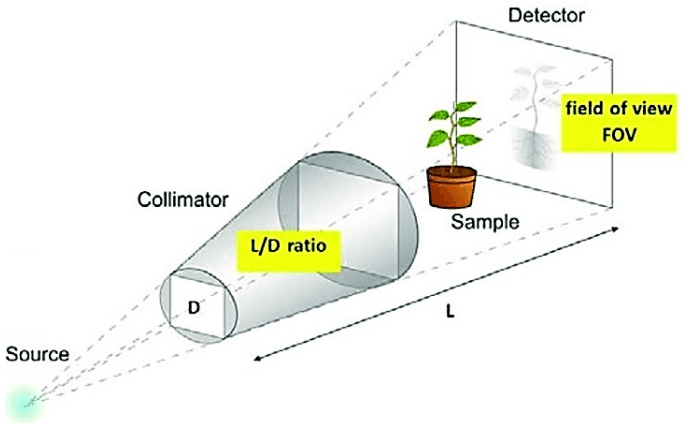
SANS Motivation and Benefits

- **Longer wavelength neutrons can be used to access larger structures/greater length-scales.**
- **Potential overlap with the length-scale regime of neutron imaging.**
- **Higher intensity at longer wavelengths allows to measure smaller samples.**
- **Higher intensity will allow for time-resolved SANS as well as scanning SANS with small beams for probing inhomogeneities more locally.**



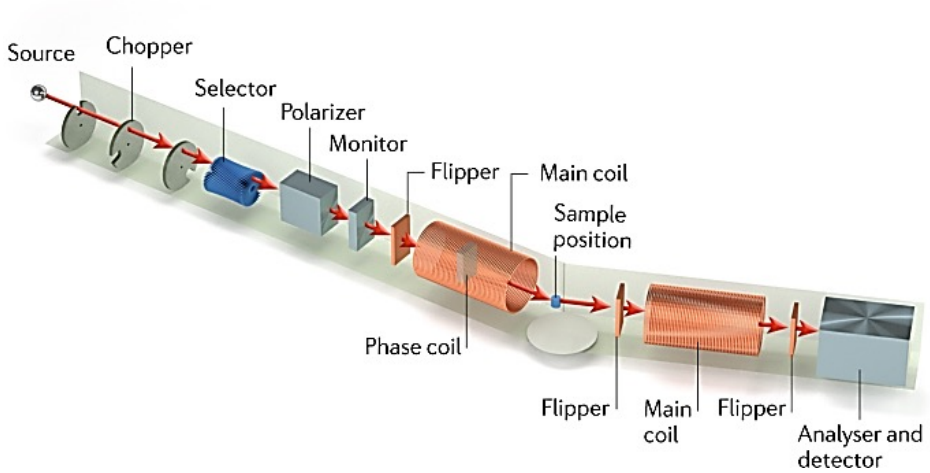
NI Motivation and Benefits

- **The moderator with a larger viewable area will allow a much larger and more uniform field of view.**
- **Measurement capability of much larger and more complex systems and industrial components or whole machinery.**
- **Increased sensitivity of polarized neutron imaging, extending the range of accessible 3D magnetic field distributions to lower fields and local electric currents, e.g. in energy conversion devices.**
- **The long-λ regime will also greatly improve quantitative high resolution imaging.**



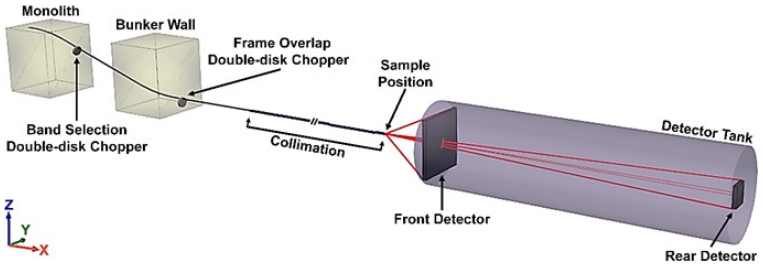
NSE Motivation and Benefits

- **Increase the longest relaxation times which the technique can access.**
- **Allow measurements at larger wave vector transfer where the scattering cross sections are lower, probing movements associated with smaller structures.**
- **Faster measurements, increasing throughput for such a flux-limited technique.**
- **Permit the study of much smaller amounts of sample, which is extremely important for e.g. biological studies.**

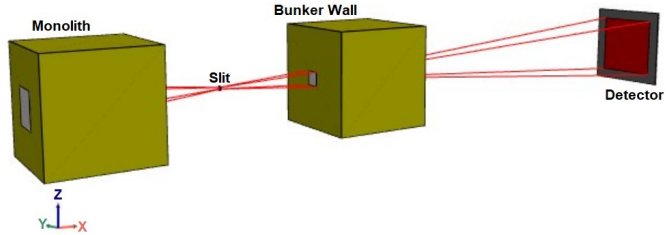


Condensed Matter - Proposed Instruments

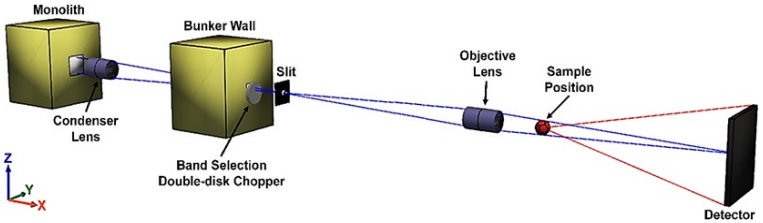
ConvSANS



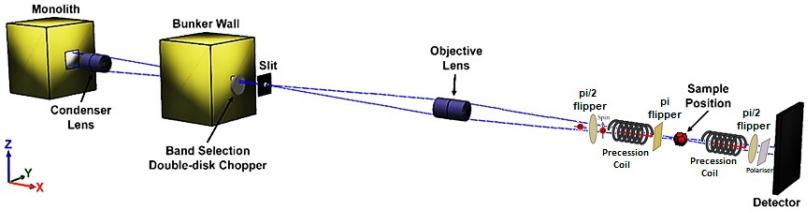
Neutron Imaging



WOF-SANS

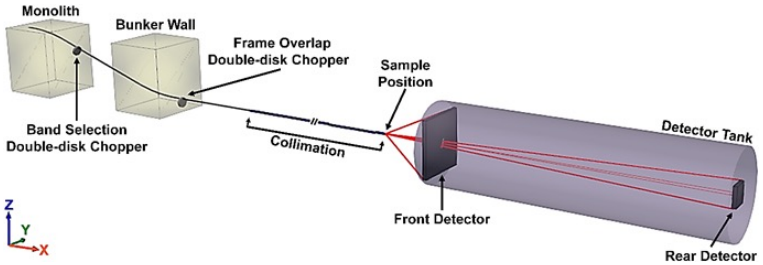


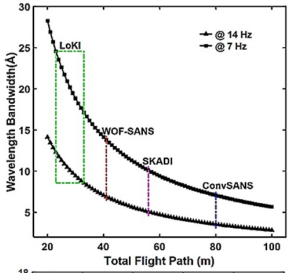
WOF-NSE

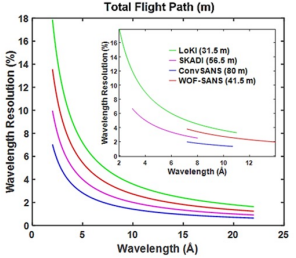


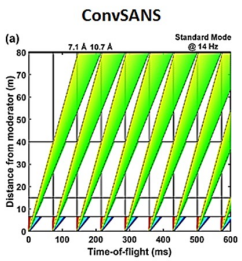
Condensed Matter - Proposed Instruments

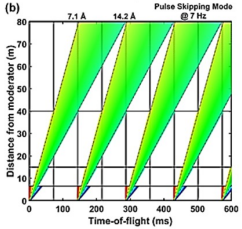
ConvSANS

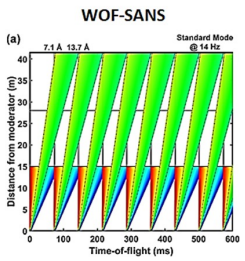


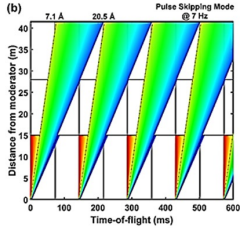




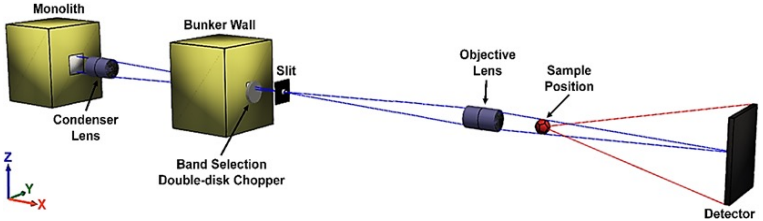


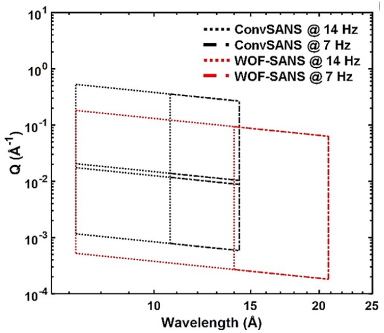


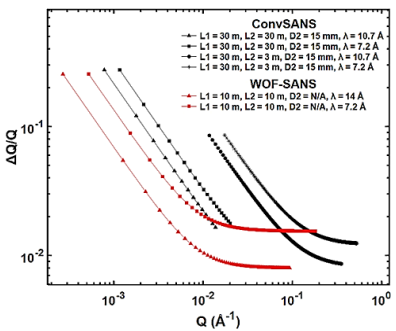




WOF-SANS

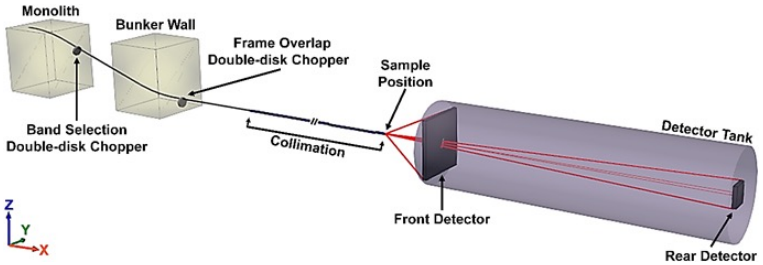


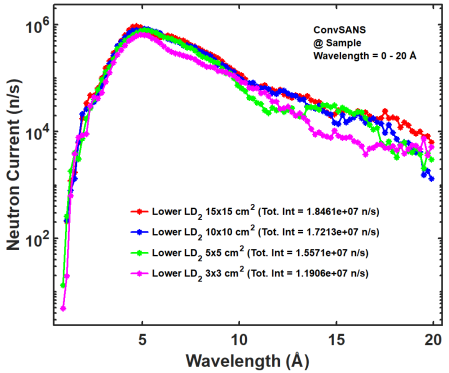


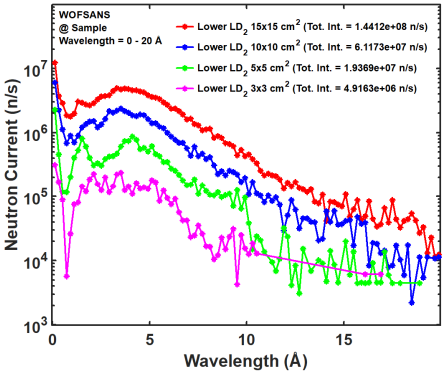


Condensed Matter - Proposed Instruments

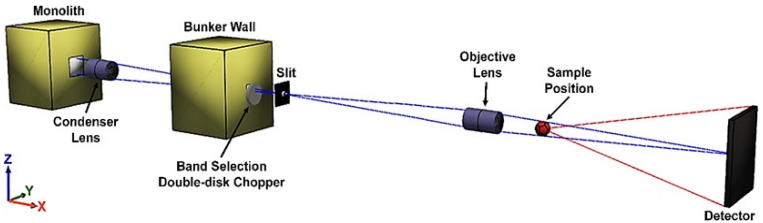
ConvSANS

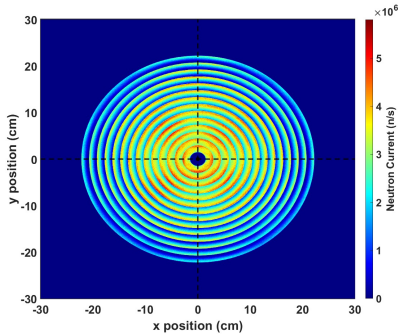


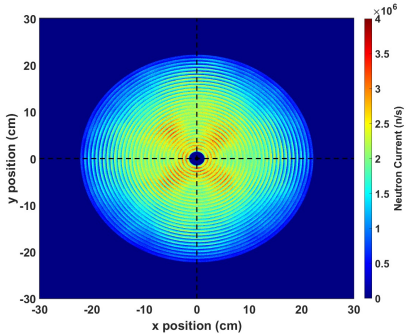




WOF-SANS

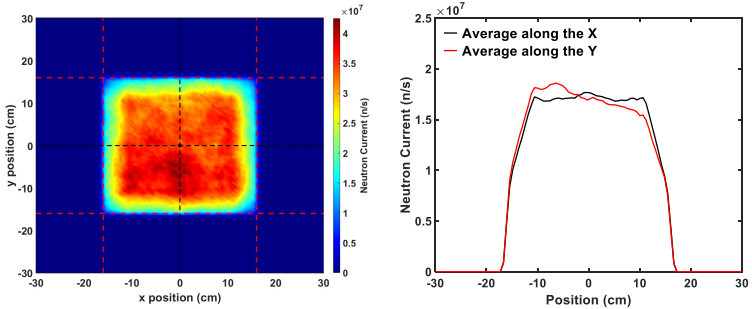




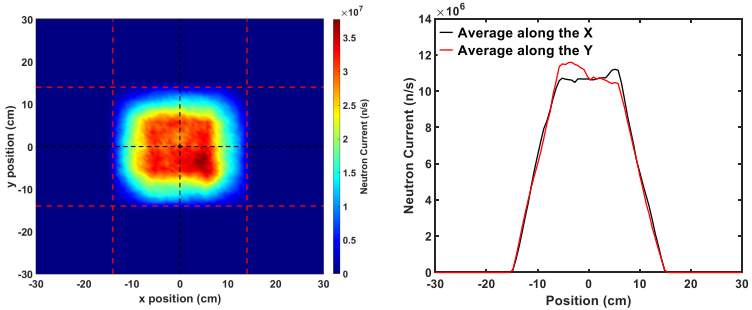


Condensed Matter - Proposed Instruments

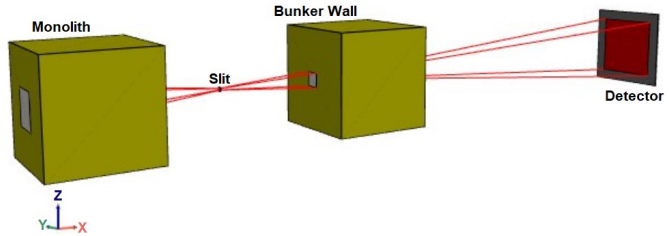
Example 1: LD_2 15x15 cm^2 moderator, 3x3 cm^2 slit @ 8 m, detector @ 24 m, L/D = 533.3



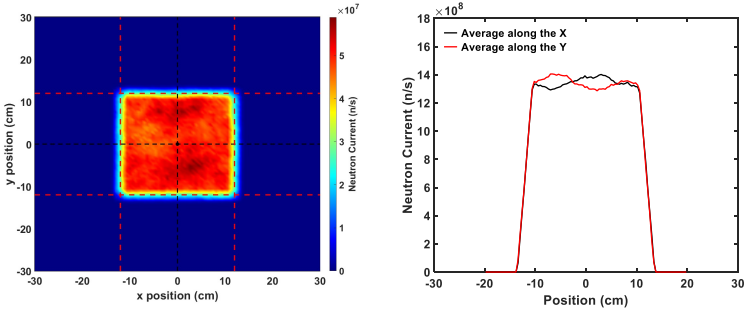
Example 2: LD_2 10x10 cm^2 moderator, 3x3 cm^2 slit @ 8 m, detector @ 24 m, L/D = 533.3



Neutron Imaging



Example 3: LD_2 5x5 cm^2 moderator, no slit, detector @ 24 m, L/D = 480



Guide optimization with guide_bot

guide_bot

- **Original MATLAB version in 2013**
- **Rewritten in python for HighNESS**

- **Full neutron guide optimization workflow**
- **Python module, easy install through pip**
- **Scalable and expandable**

guide_bot workflow

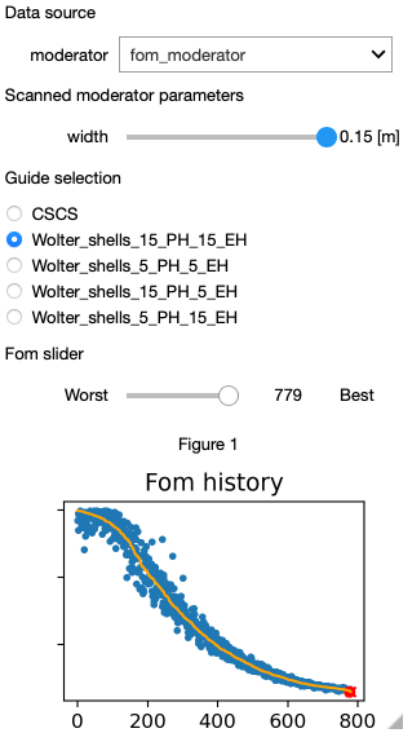
Guide optimization with guide_bot

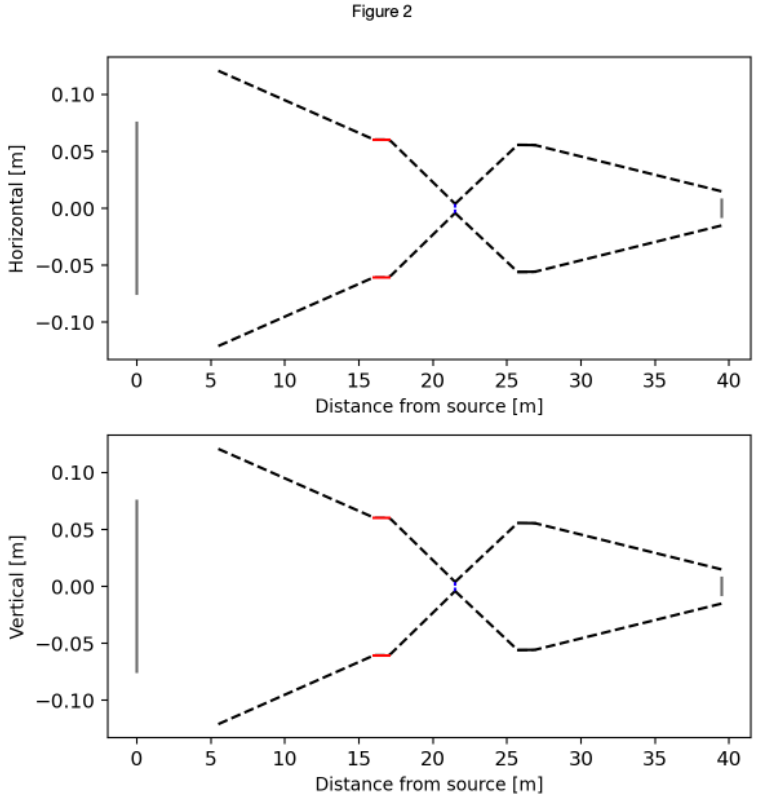
Explore data

demo

Widgets

- **Use interactive widgets to explore data**
- **Visualize guide at each step of the optimization**



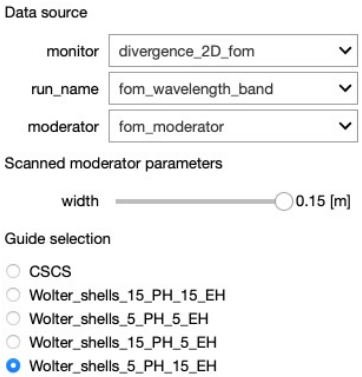


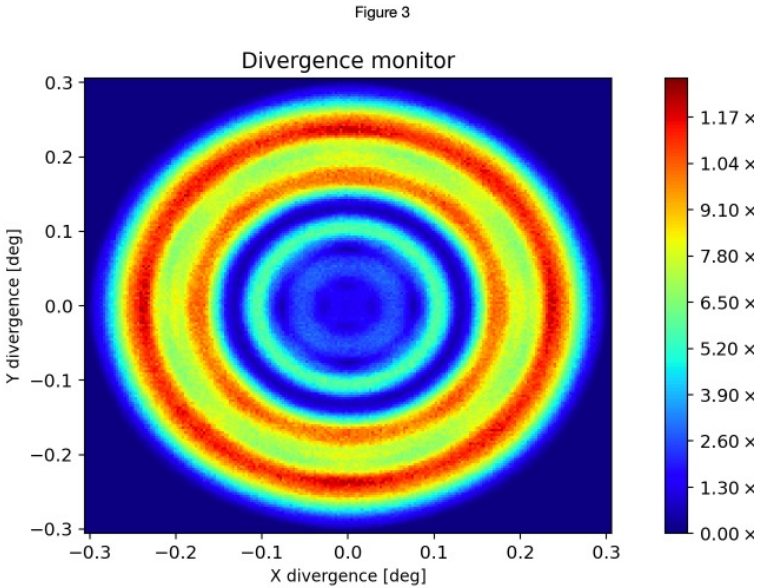
Guide optimization with guide_bot

Explore data

demo

Widgets





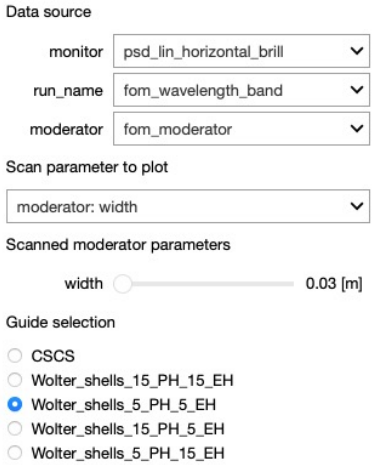
- **Use interactive widgets to explore data**
- **Visualize guide at each step of the optimization**
- **View results from any monitor**

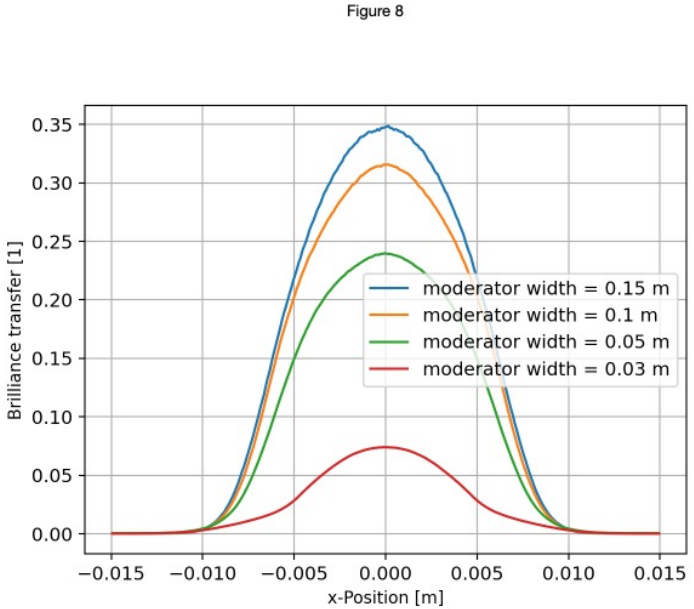
Guide optimization with guide_bot

Explore data

demo

Widgets





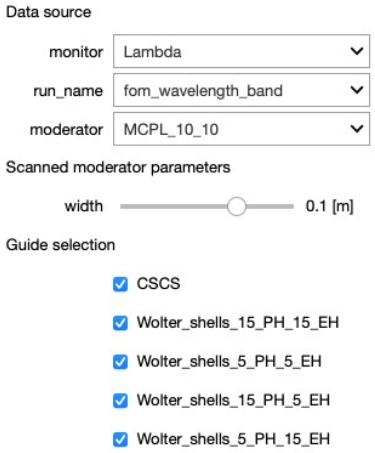
- **Use interactive widgets to explore data**
- **Visualize guide at each step of the optimization**
- **View results from any monitor**
- **Compare results from guides / scans**

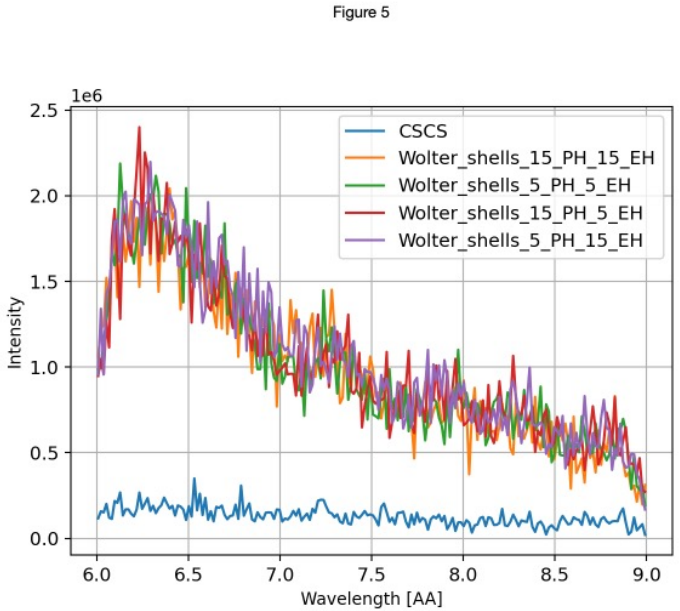
Guide optimization with guide_bot

Explore data

demo

Widgets





- **Use interactive widgets to explore data**
- **Visualize guide at each step of the optimization**
- **View results from any monitor**
- **Compare results from guides / scans**

Guide optimization with guide_bot

Select best guide

demo

- **Downloaded project folder contains McStas instrument files for all optimized guides**

guide_bot conclusion

- **guide_bot is available on ESS gitlab and a powerful tool**
- **Ideal for providing fast feedback to moderator designers**

Thank you!

Questions?