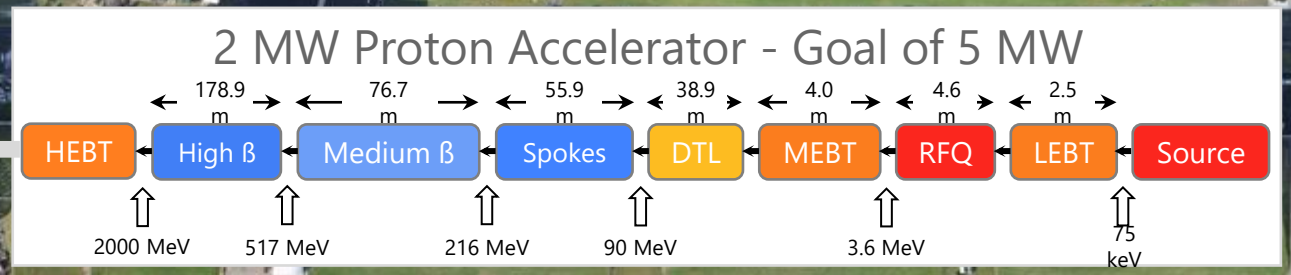
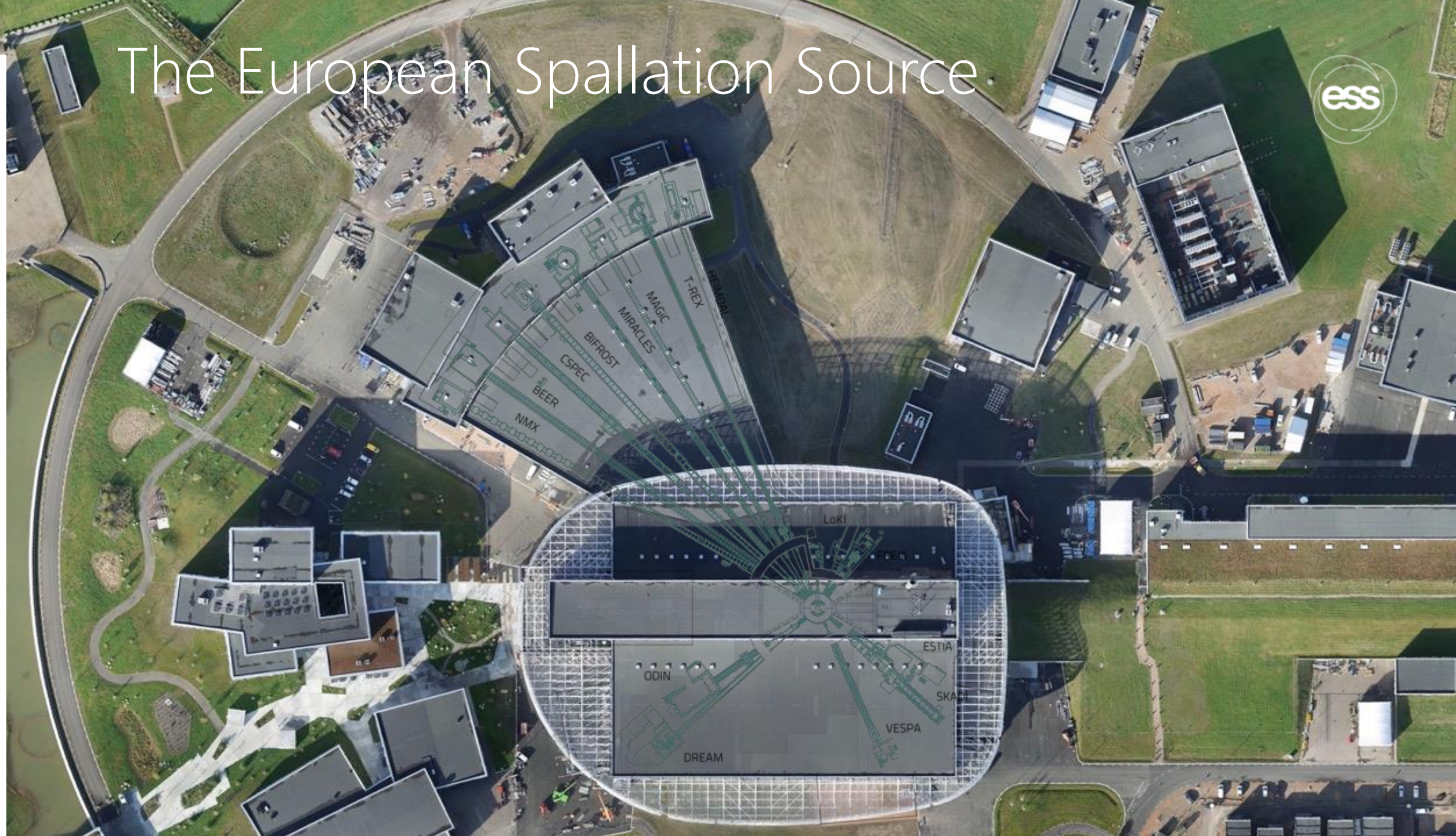
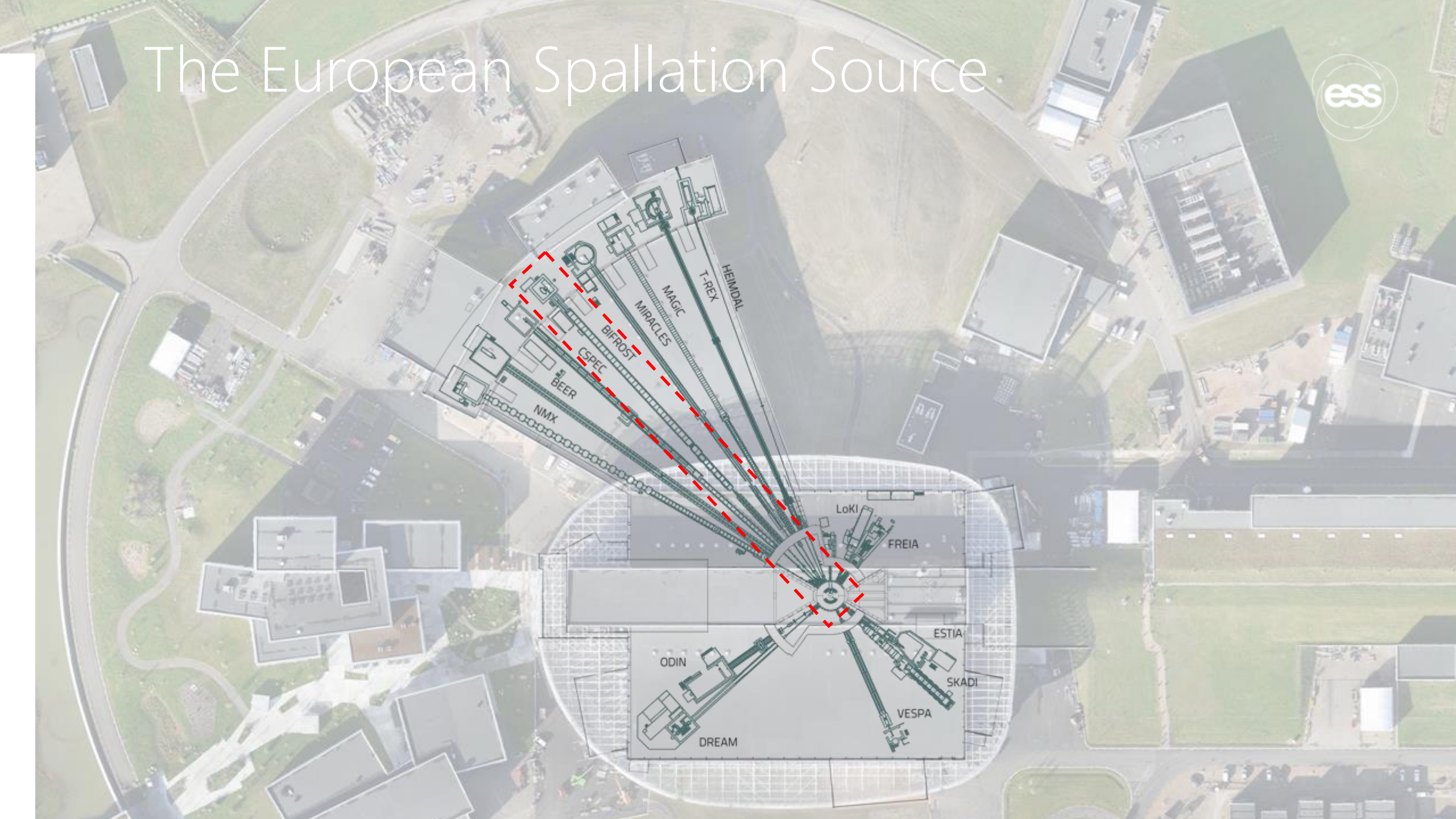
The European Spallation Source



The European Spallation Source

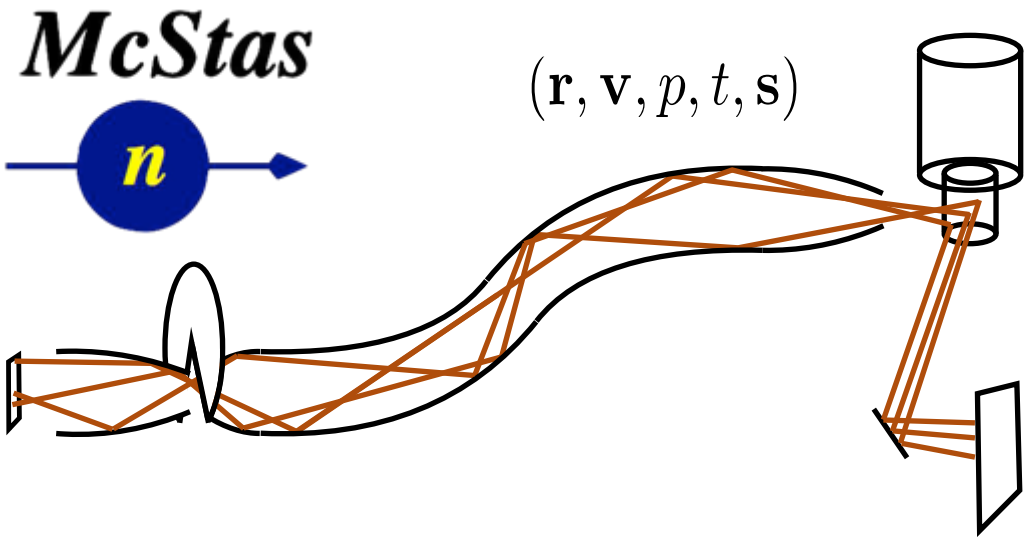


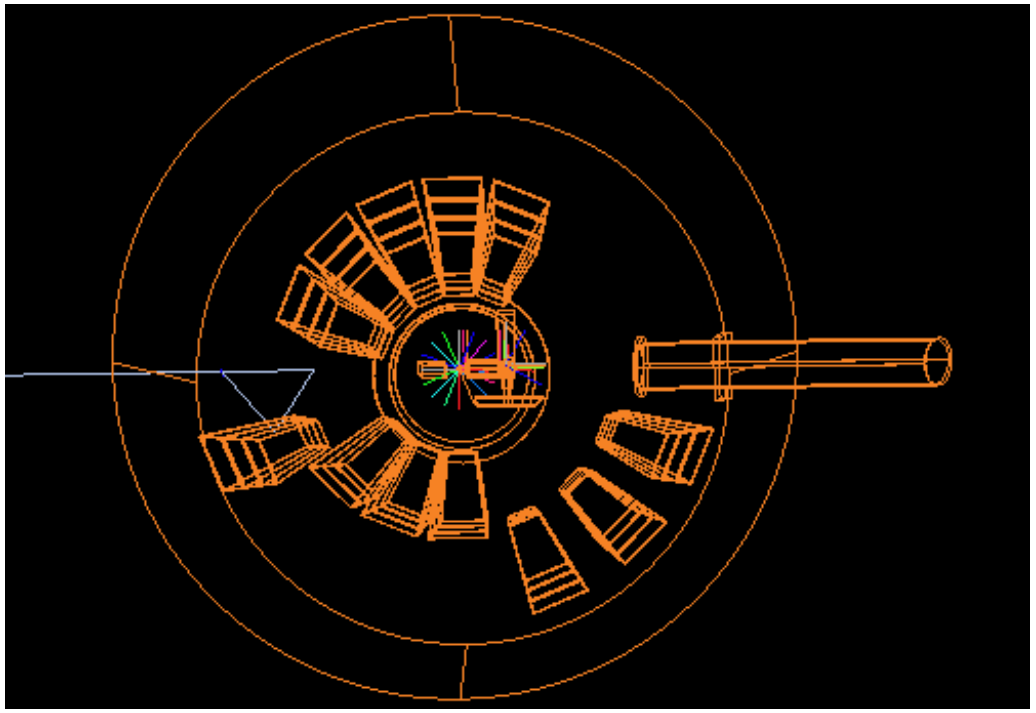
The European Spallation Source



McStas simulations

Monte Carlo ray-tracing for neutron instrumentation

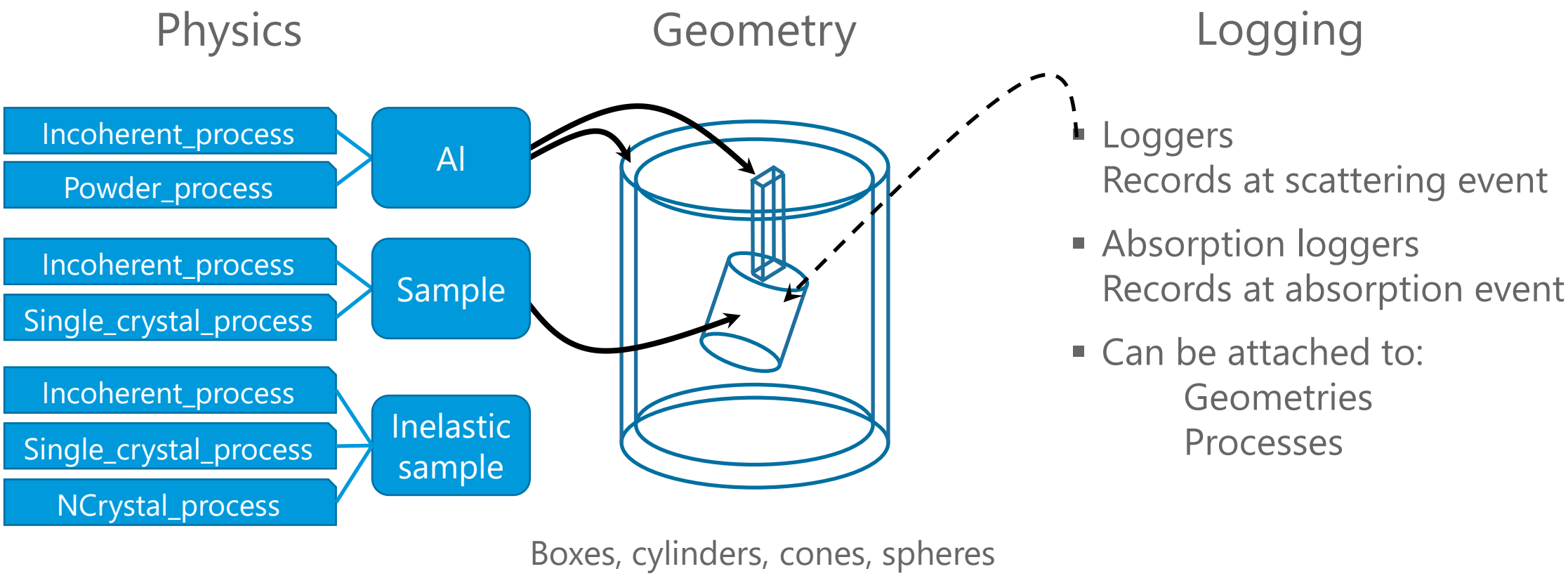




McStas Union components

Splitting the responsibilities of sample components

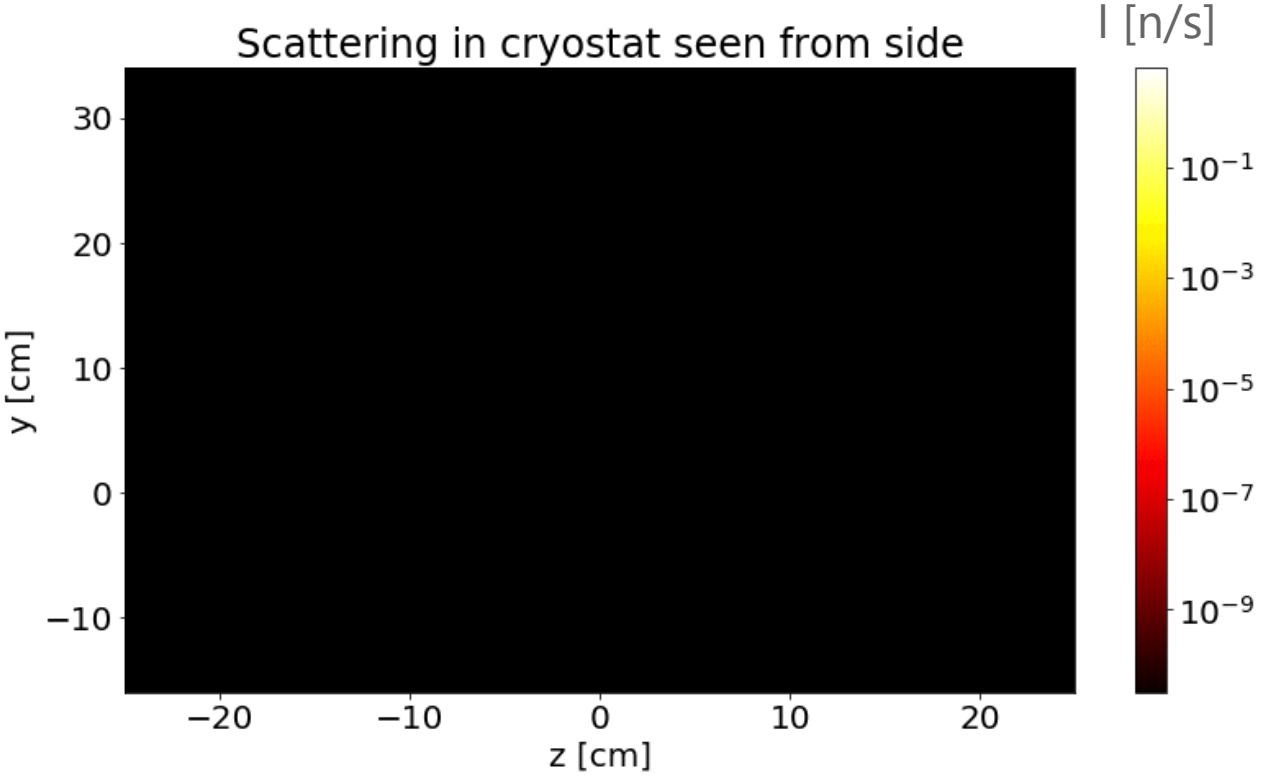
- McStas Union components combine to provide general geometry with multiple scattering, modular phyiscs descriptions and advanced logging capabilities



McStas Union components

What can you do with McStas Union components

- Simulation with multiple scattering
  - Samples
  - Sample environments
  - Filters
  - Detectors
- Large systems possible
  - Performance scaling reasonable
  - Improved greatly in newest McStas

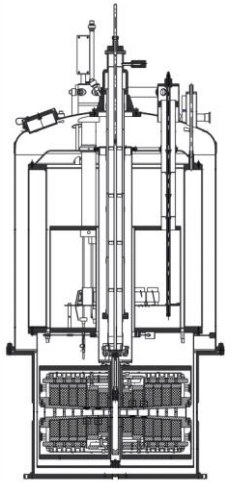


Student project

Magnet simulation

- Petroula Karacosta
- Goal
  - Estimate fraction of signal
- Model
  - McStas model of Magnet
- Data
  - Approx. 17.000 configurations
- Approach
  - Machine Learning

BIFROST 15 T Magnet



Largest diameter:
721 mm

Height:
1531 mm

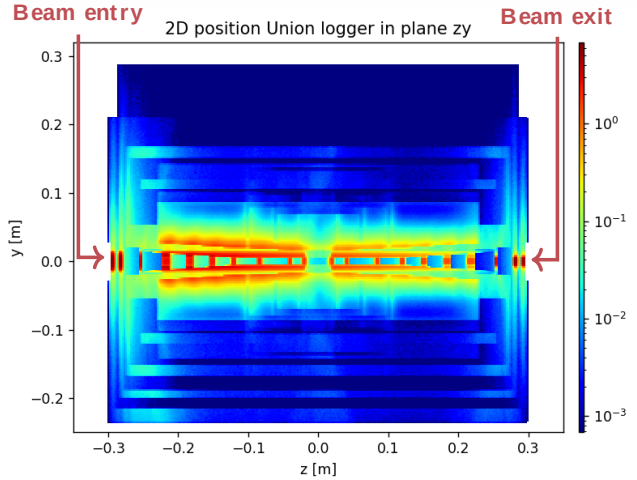
Beam path angle:
$\pm 2^{o}$

Relevant Information:

Sample volume:
$1 \times 1 \times 1$ cm^3

Sample at 162 m from source [1]

Magnet Sample Environment Simulation



Simulation Tools
[2, 3, 4]

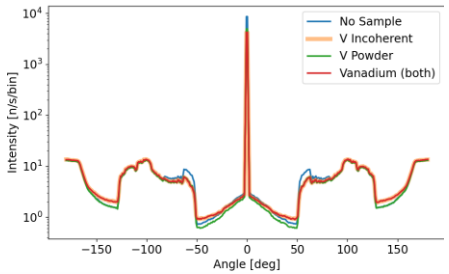
McStas Union
components used:

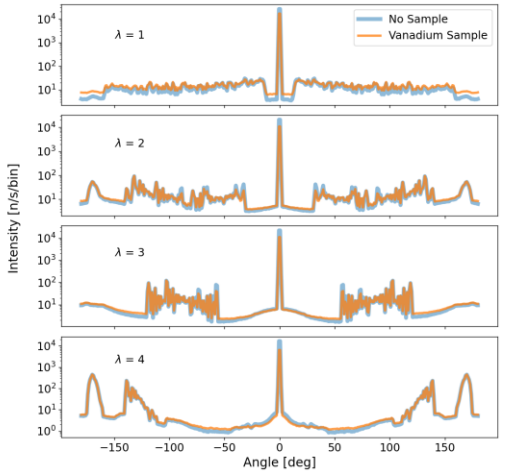
Processes: Incoherent, Powder
Make material: Cu*, Al, Vacuum
Geometry: Cylinder, Box, Cone, Sphere
Master, Loggers

McStasScript
A python API

* Coil material: to be replaced with NbTi, Nb3Sn

Primary





Data shows neutrons scattered by the magnet sample environment, as seen by a cylindrical detector placed 740 mm from the magnet's centre.
Data for different sample configurations (above) and different wavelengths (right).

Addition of sample reduces intensity, as beam leaves the sample environment

What's next

Investigate background due to multiple scattering

Optimise the sample environment: minimize background scattering

Classify background features: develop machine learning algorithm

References

[1] K.H. Andersen et al. "The instrument suite of the European Spallation Source". In: *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 957 (2020), p. 163402. issn: 0168-9002. doi: https://doi.org/10.1016/j.nima.2020.163402. url: https://www.sciencedirect.com/science/article/pii/S0168900220300097.

[2] Mads Bertelsen. "Software for simulation and design of neutron scattering instrumentation". PhD thesis. University of Copenhagen, Faculty of Science, Niels Bohr Institute, Nano ..., 2017.

[3] Peter Kjær Willendrup and Kim Lefmann. "McStas (i): Introduction, use, and basic principles for ray-tracing simulations". In: *Journal of Neutron Research* 22.1 (2020), pp. 1–16.

[4] Peter Kjær Willendrup and Kim Lefmann. "McStas (ii): An overview of components, their use, and advice for user contributions". In: *Journal of Neutron Research* 23.1 (2021), pp. 7–27.