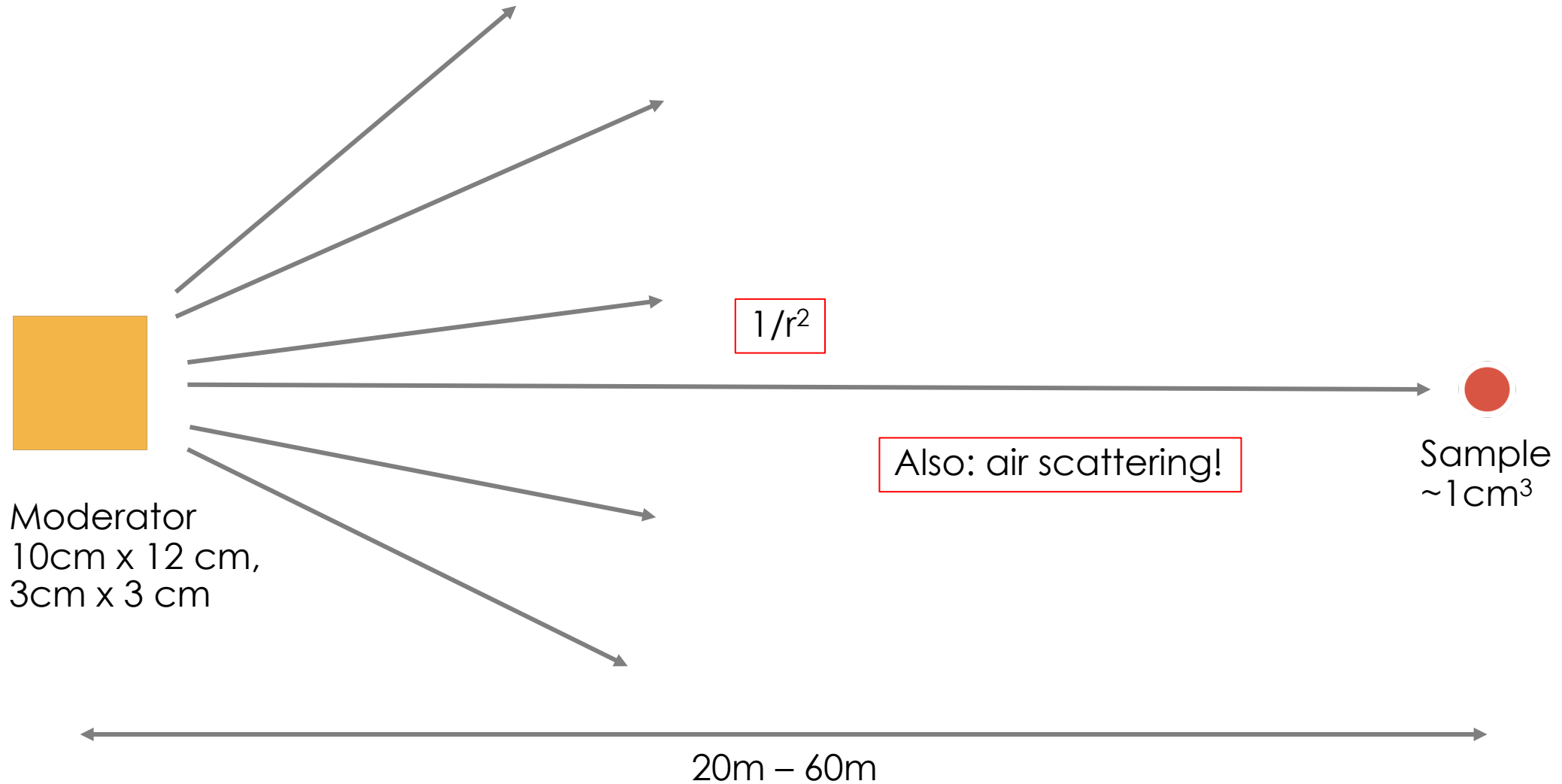


# Neutron Generation and Detection/Neutron Optics and Instrumentation - Part 2

Thomas Huegle  
Neutronics Scientist

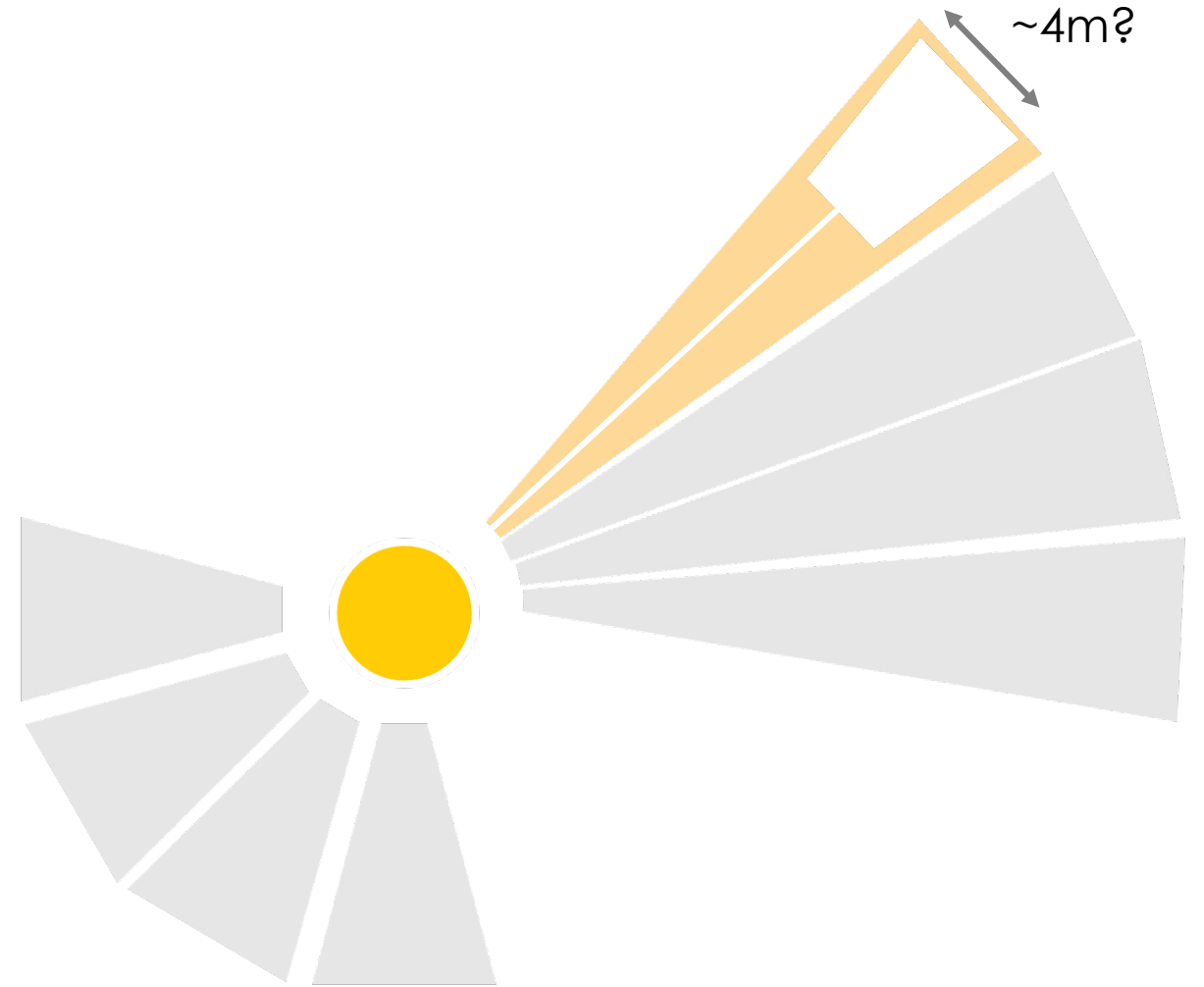
August 2023

# Transport neutrons!



# Why not build closer to the source?

- Real estate
- Background
- TOF Resolution:

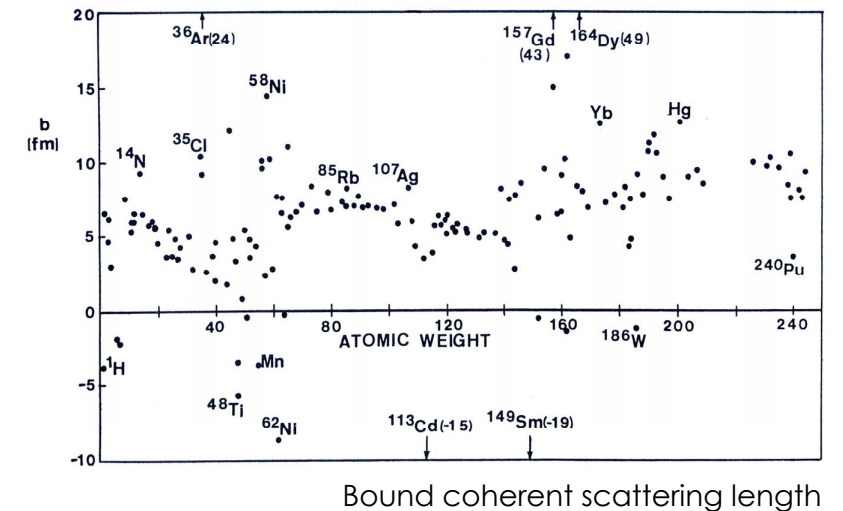
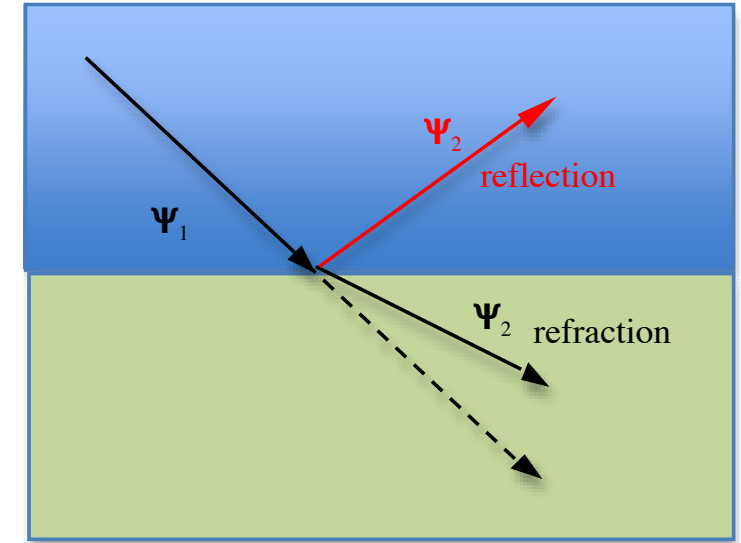


# Neutron guides

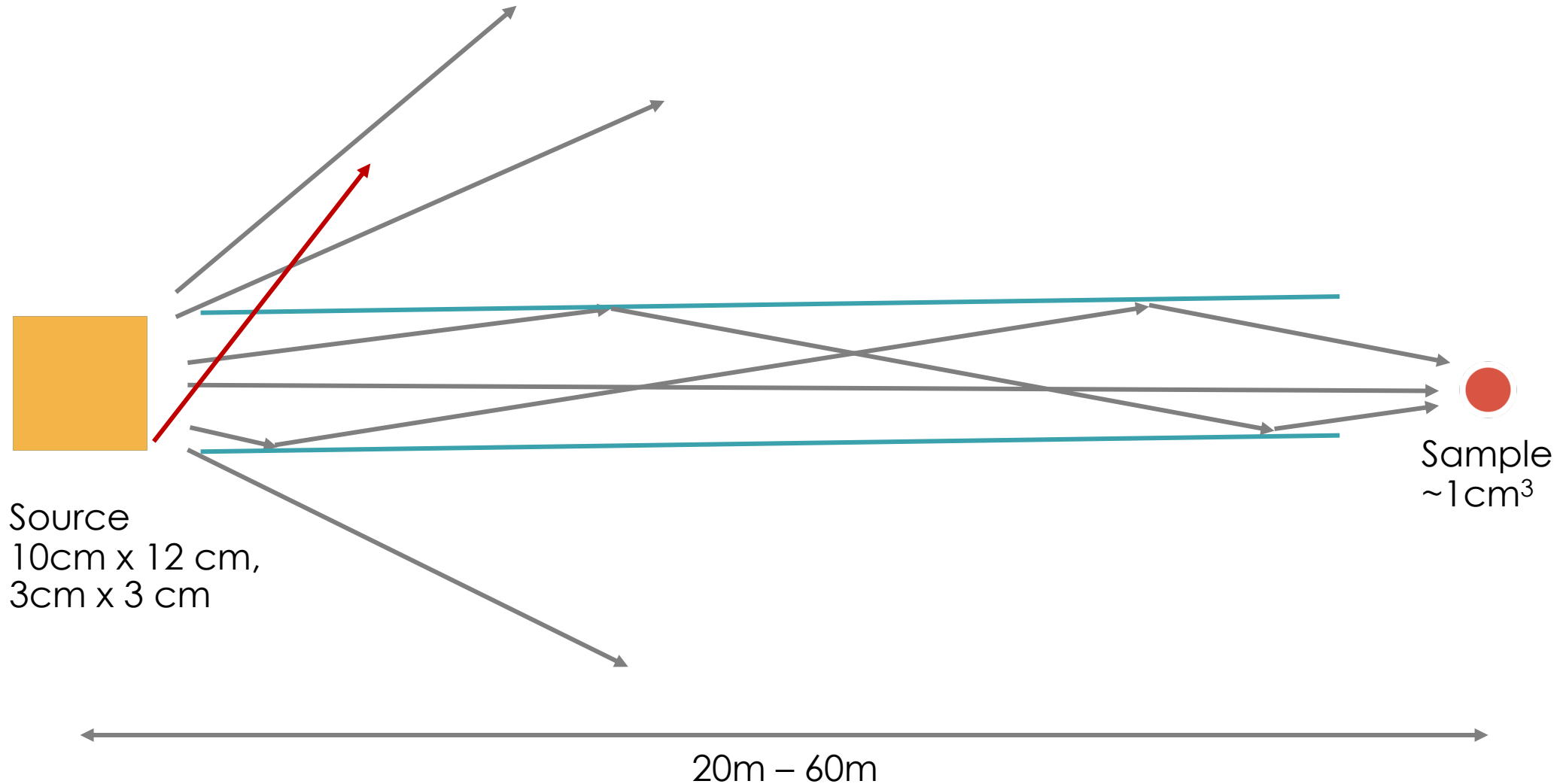
- Like any wave, neutrons can reflect off a surface under certain conditions (see reflectometry lecture!)
  - Low angles, long wavelengths
  - Ni-58 layers deposited on glass
- Invented by Heinz Maier-Leibnitz at FRM reactor



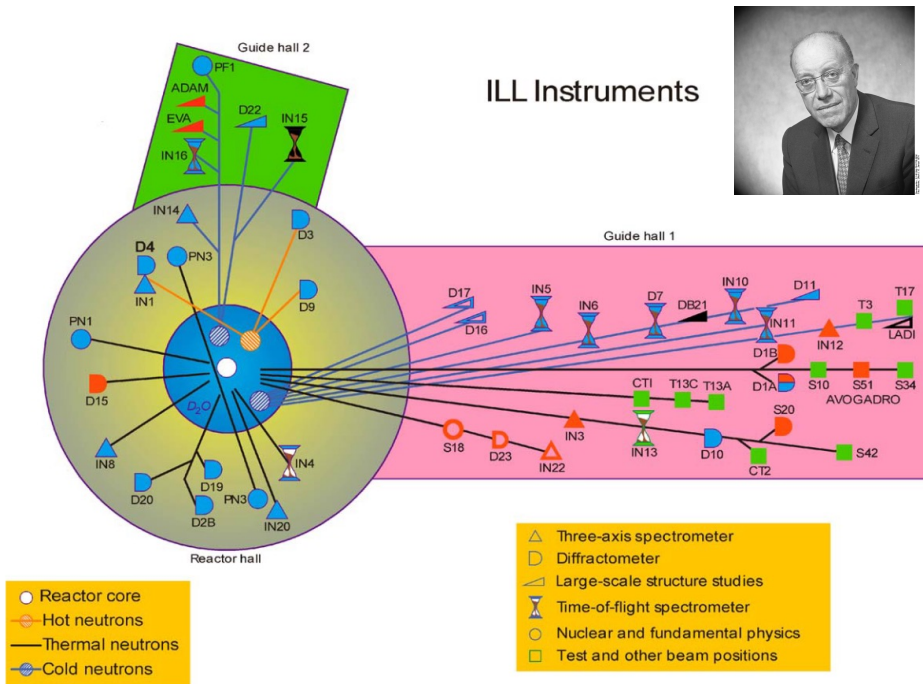
H. Maier-Leibnitz and T. Springer, React. Sci. Technol. 17, 217 (1963)



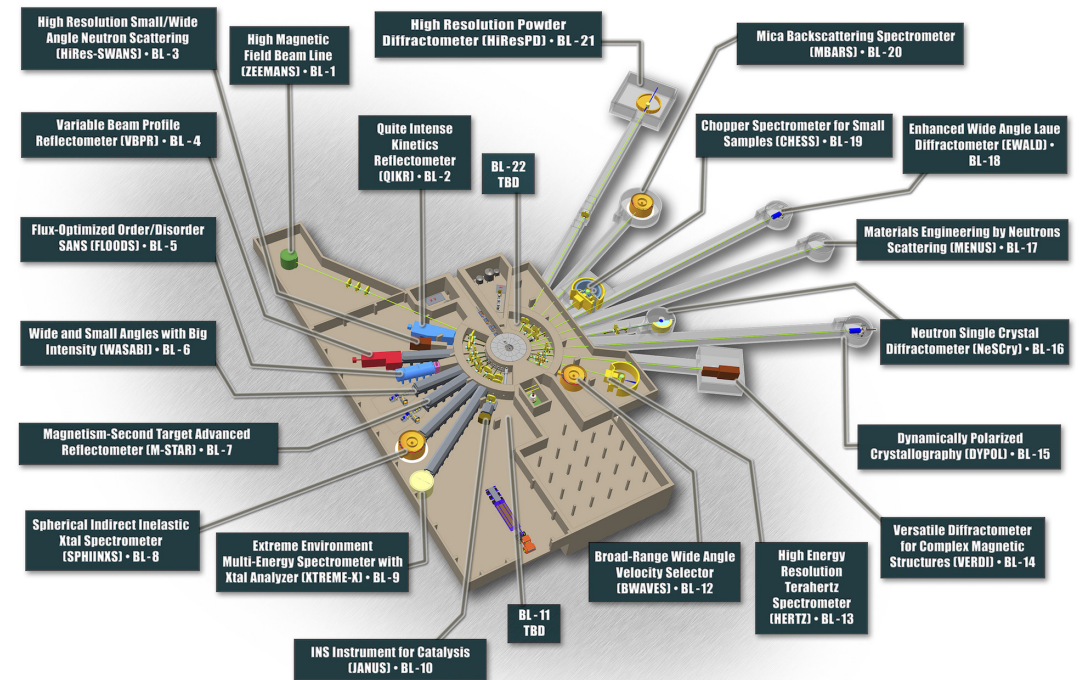
# Transport neutrons – with guides!



# Neutron Guides allow unparalleled Utilization of Neutron Beams



<https://www.ill.eu/>



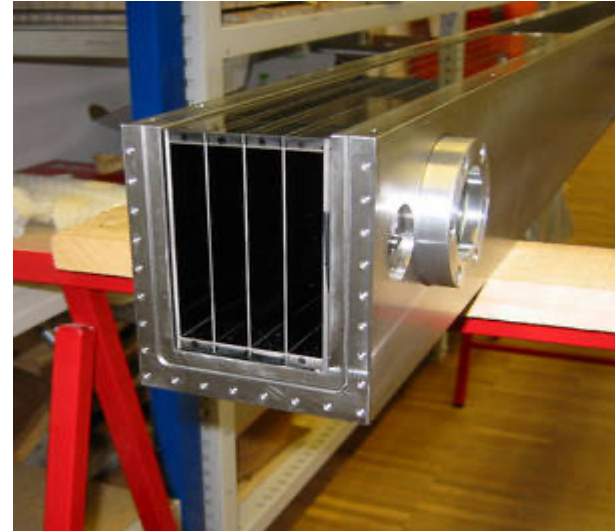
16-G00038/gjm

ORNL STS conceptual design

# Pictures!

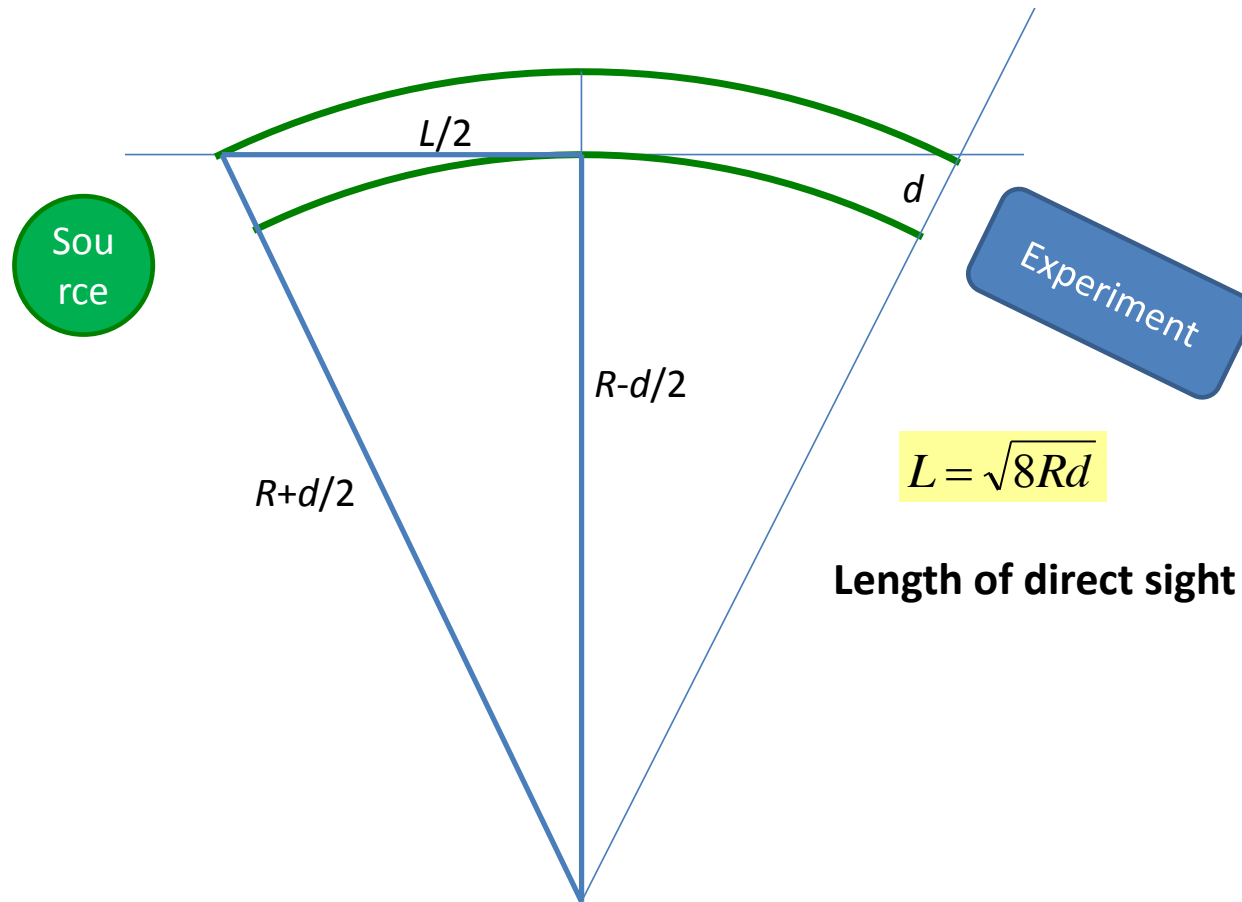


80m Guide for HRPD at J-PARC  
*Fabricated by Swiss Neutronics*



Multichannel Curved Guide  
*Fabricated by Swiss Neutronics*

# Not just straight!



Getting out of direct line of sight reduces background from source

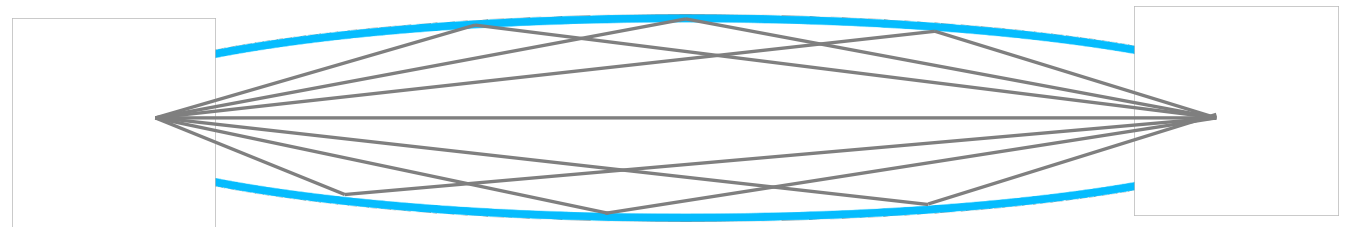


# Advanced neutron optics

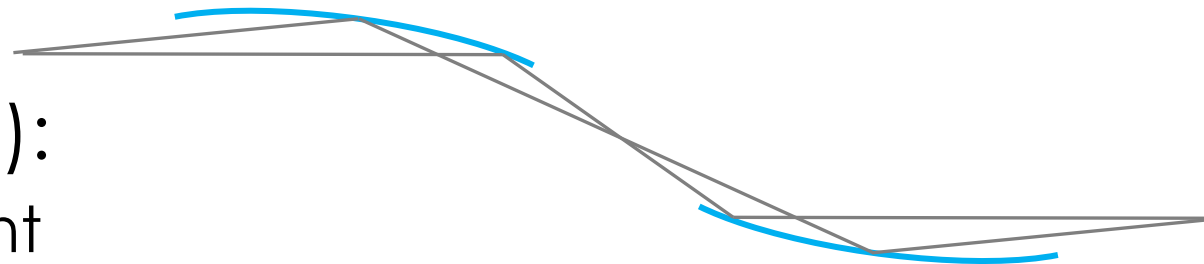
- Parabola: focusing



- Elliptic: imaging



- Zig-Zag (half ellipses):
  - Imaging + line of sight

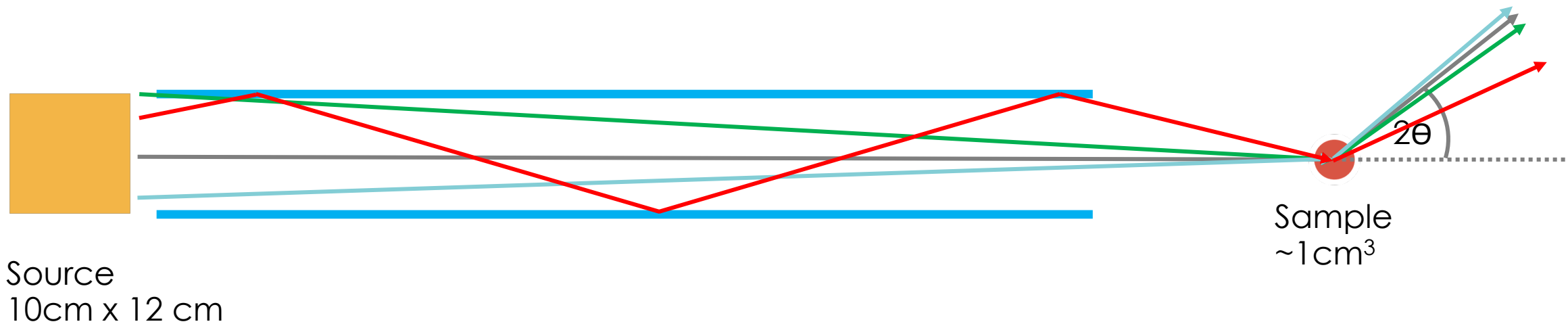


# BUT!

- Angle/wavelength limited
- Liouville is watching you!
  - No free lunches.
  - Increase in neutron flux comes with decreased resolution
  - Finding the balance is a large part of instrument design

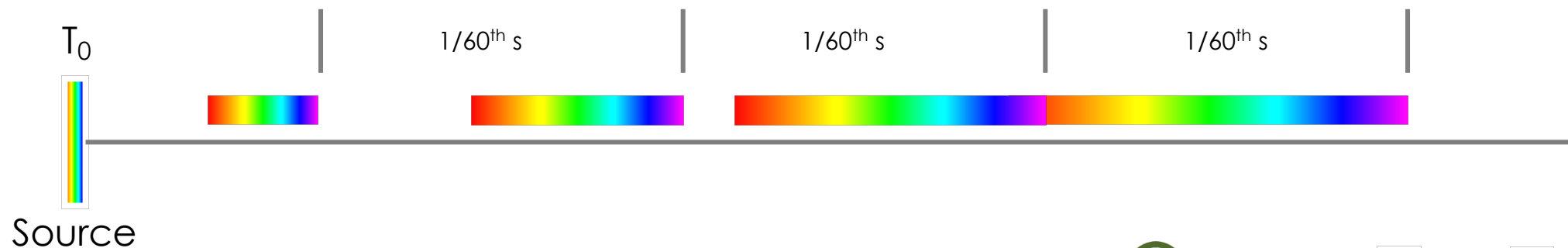


Joseph Liouville

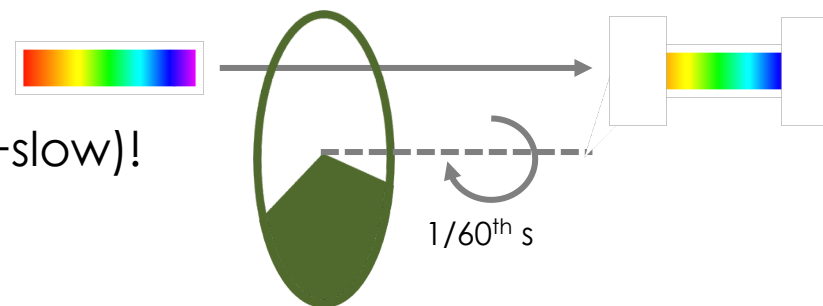


# Other problems: Frame overlap

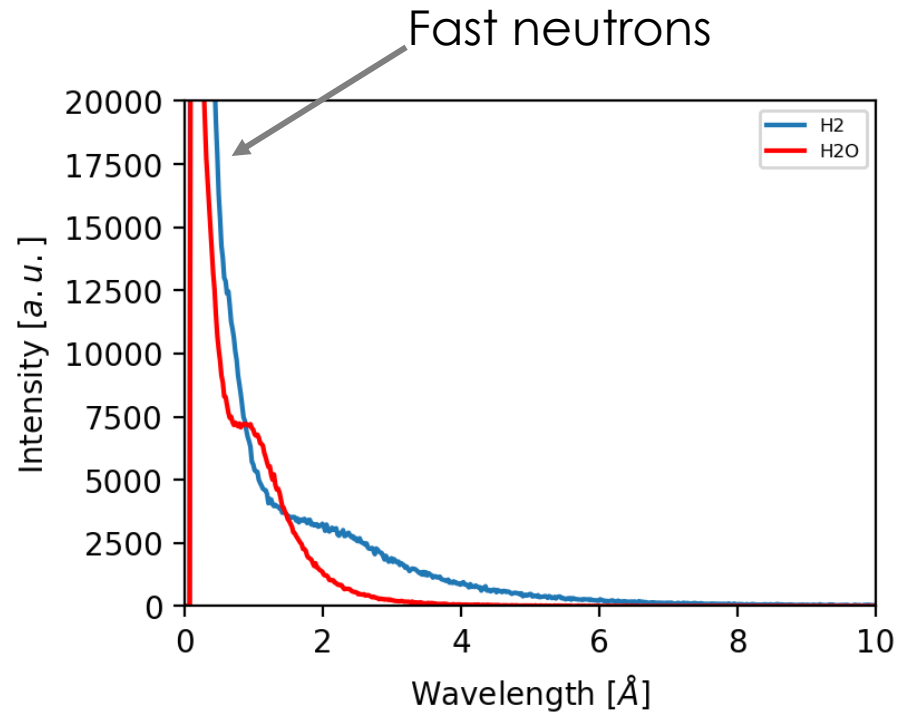
- There is usually more than one pulse in a beam line
- It is important (and difficult) to keep track of which pulse started when for TOF analysis
- Fast neutrons from one pulse can overtake the slow ones from the previous pulse “Frame overlap”
- TOF analysis becomes impossible
- The longer the beam line and the higher pulse frequency the worse



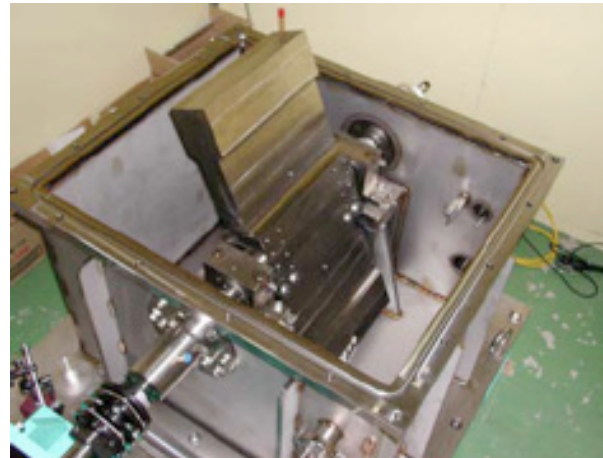
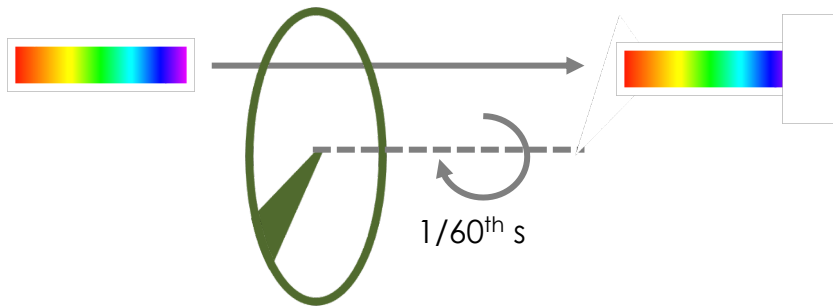
- Solution: Get rid of those neutrons (fast/slow/fast+slow)!
- Use a chopper in phase with the pulsed source
- Select time offset to chose spectrum
- Might need to measure twice for full spectrum



# T0 choppers



- Fast neutrons and gammas arrive first after proton pulse delivery
- 20-50 cm thick steel blade attenuates these
- Requires well-balanced flywheel for good lifetime and prevention of vibrations



Unit running at JPARC

# Detectors...

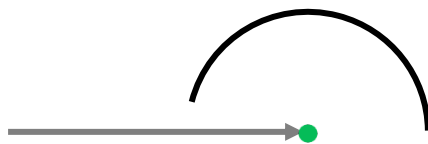
- Several types of detectors
- Idea: trigger a nuclear reaction that releases an energetic charged particle that can then be detected (e.g. through an ionization event)
- Requirements:
  - Position resolution
  - Timing resolution
  - Not sensitive to background
  - Cheap

# ... and where to put them

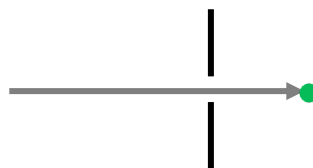
SANS:



Wide Q range:



High resolution powder diffraction:

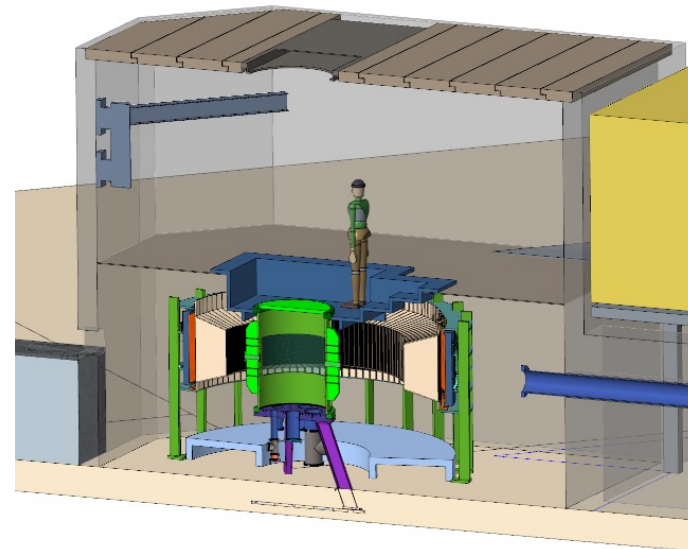
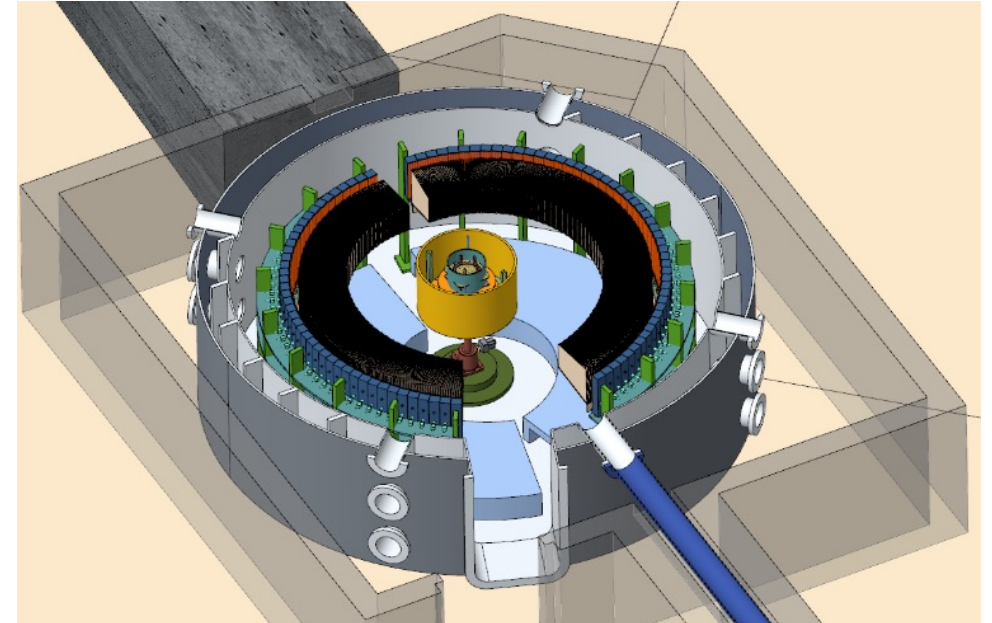
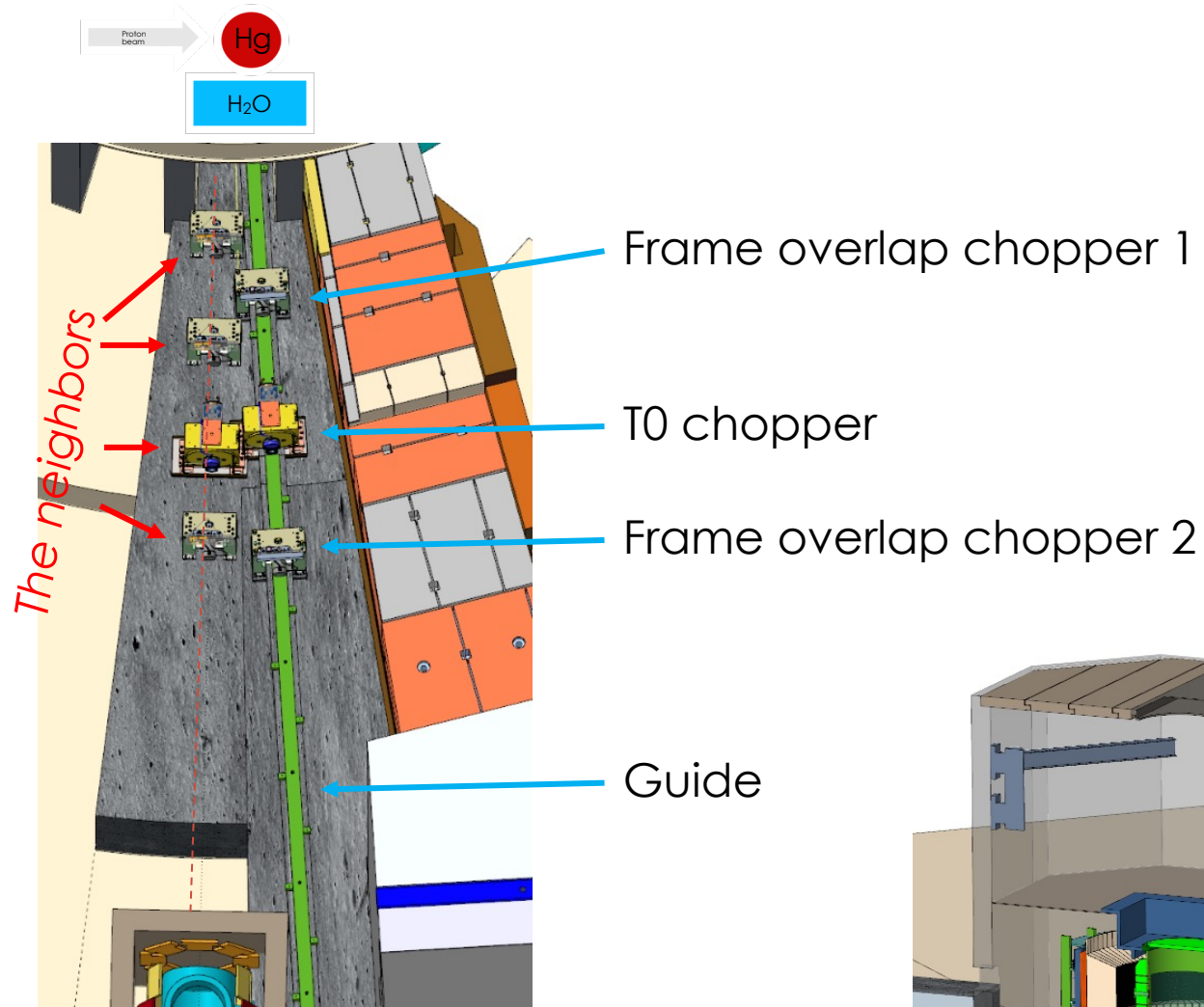


Single Crystal Diffractometer:

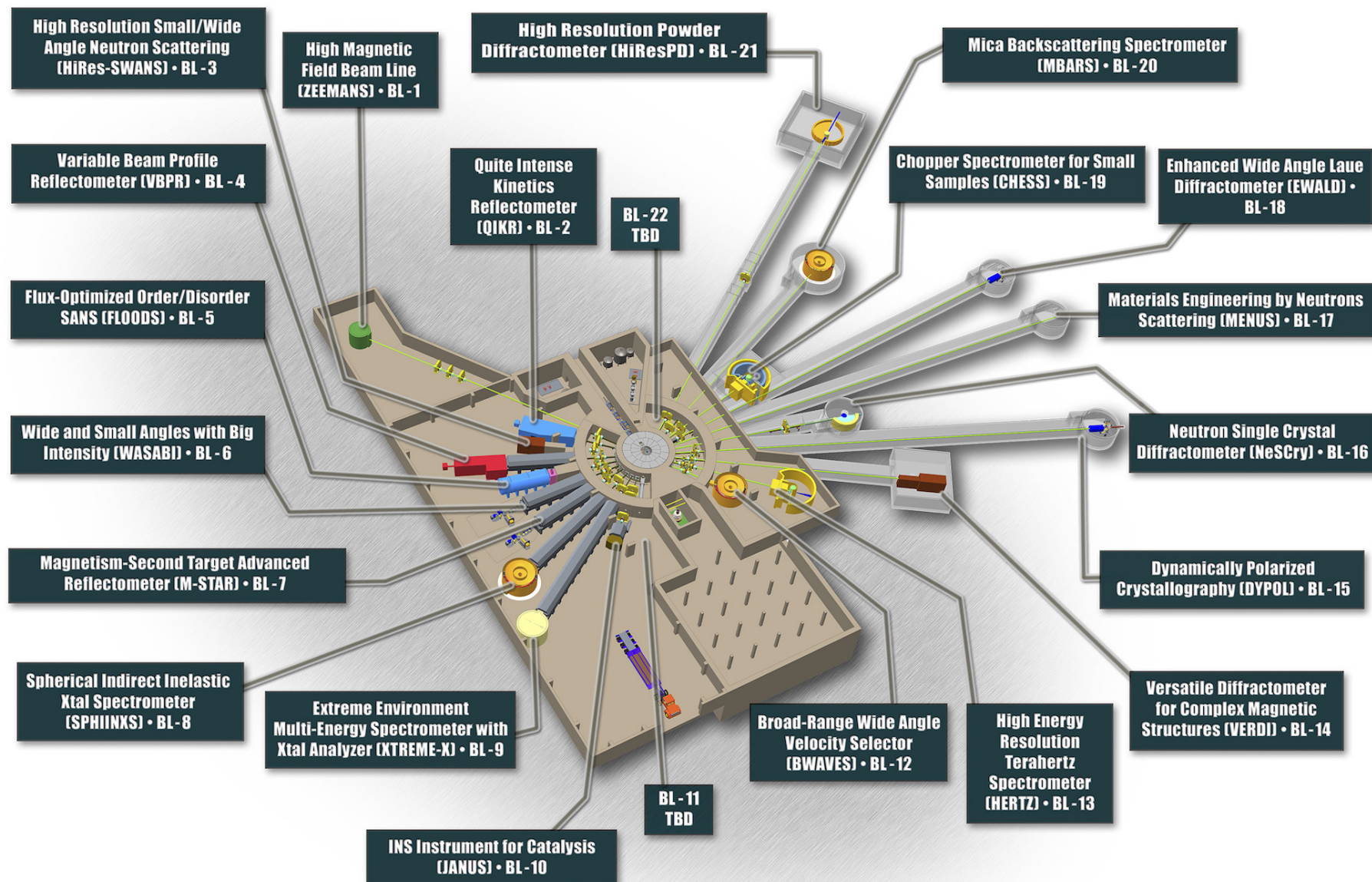


TOPAZ @ SNS

# DISCOVER (planned @ SNS)



# Second Target Station





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NXS Lecture - Neutron Generation,  
Optics, Detection, and  
Instrumentation - Thomas Hueale

