An introduction to NR beamlines and alignment

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ISIS Reflectometry Training Course, Apr 2026, Harwell Campus

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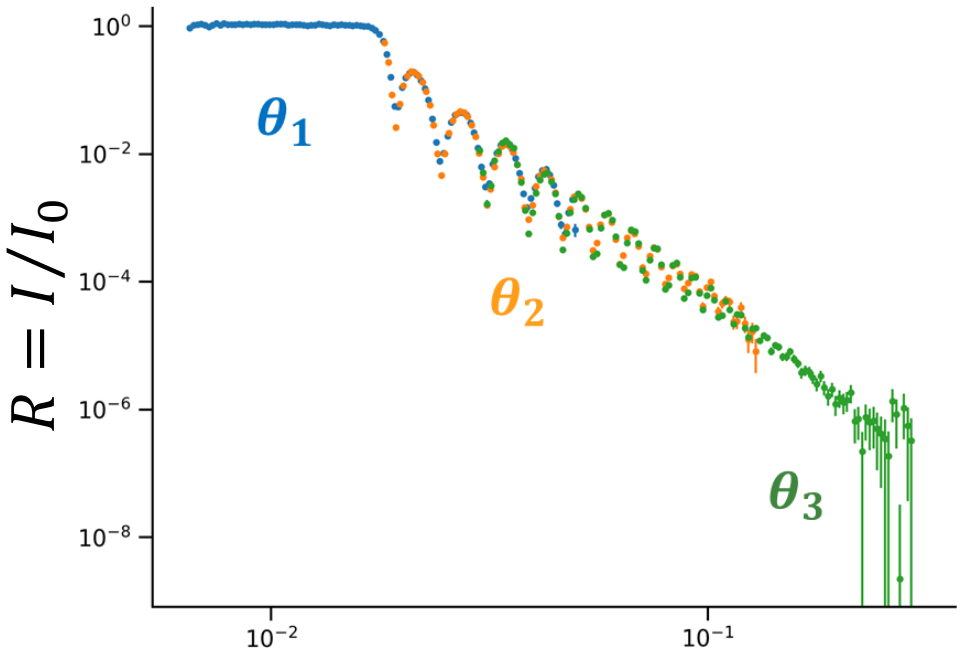
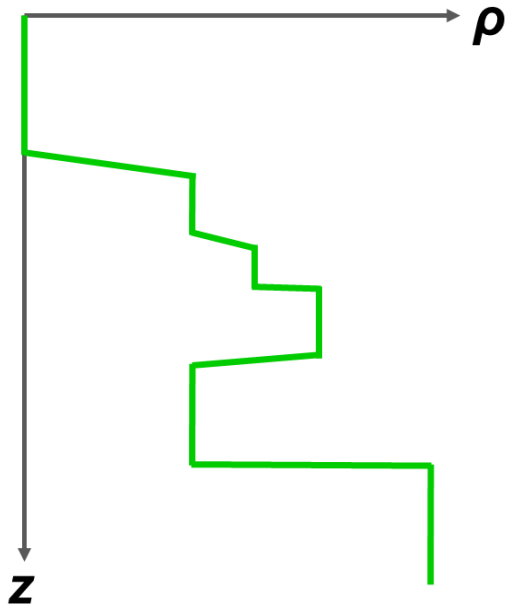
Neutron Reflectometry

Reflectivity

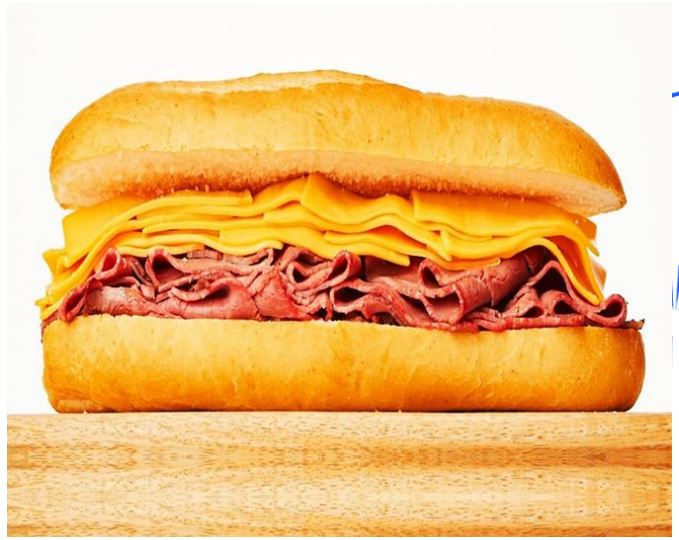


$$q_z = \frac{4\pi}{\lambda} \sin\theta$$

Depth profile

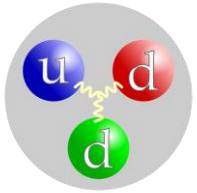


Nanoscopic sandwich-like structure



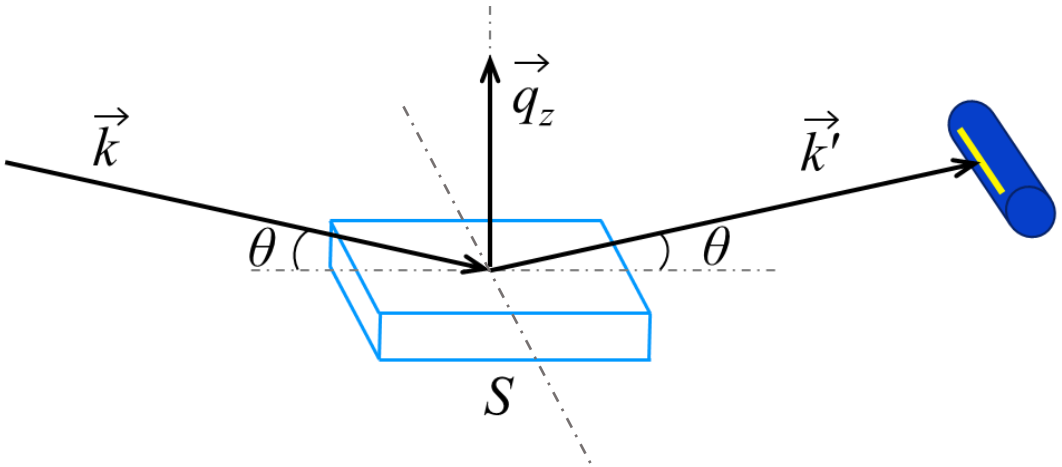
What we need for **N**eutron **R**eflectometry?

- Thermal neutrons

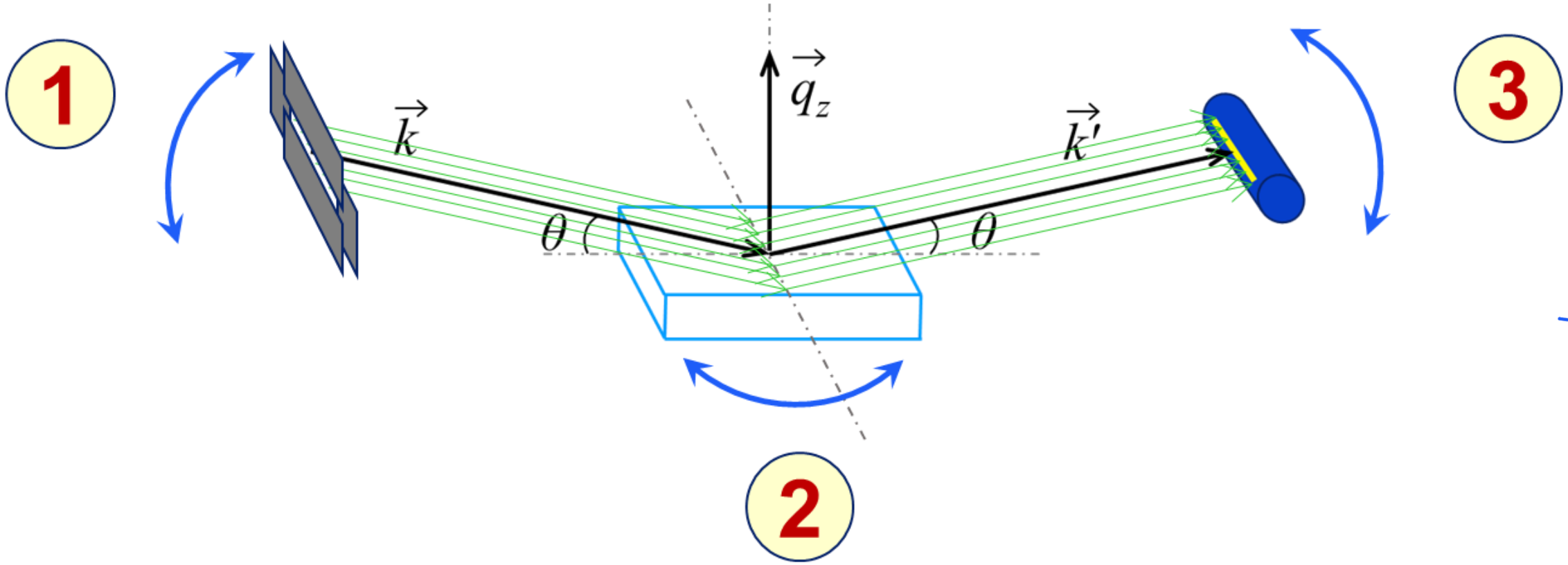


$q = 0$ C $\quad \lambda \approx 2$ Å $\quad v \approx 2$ km/s $\quad E \approx 20$ meV

- Instrument – Reflectometer

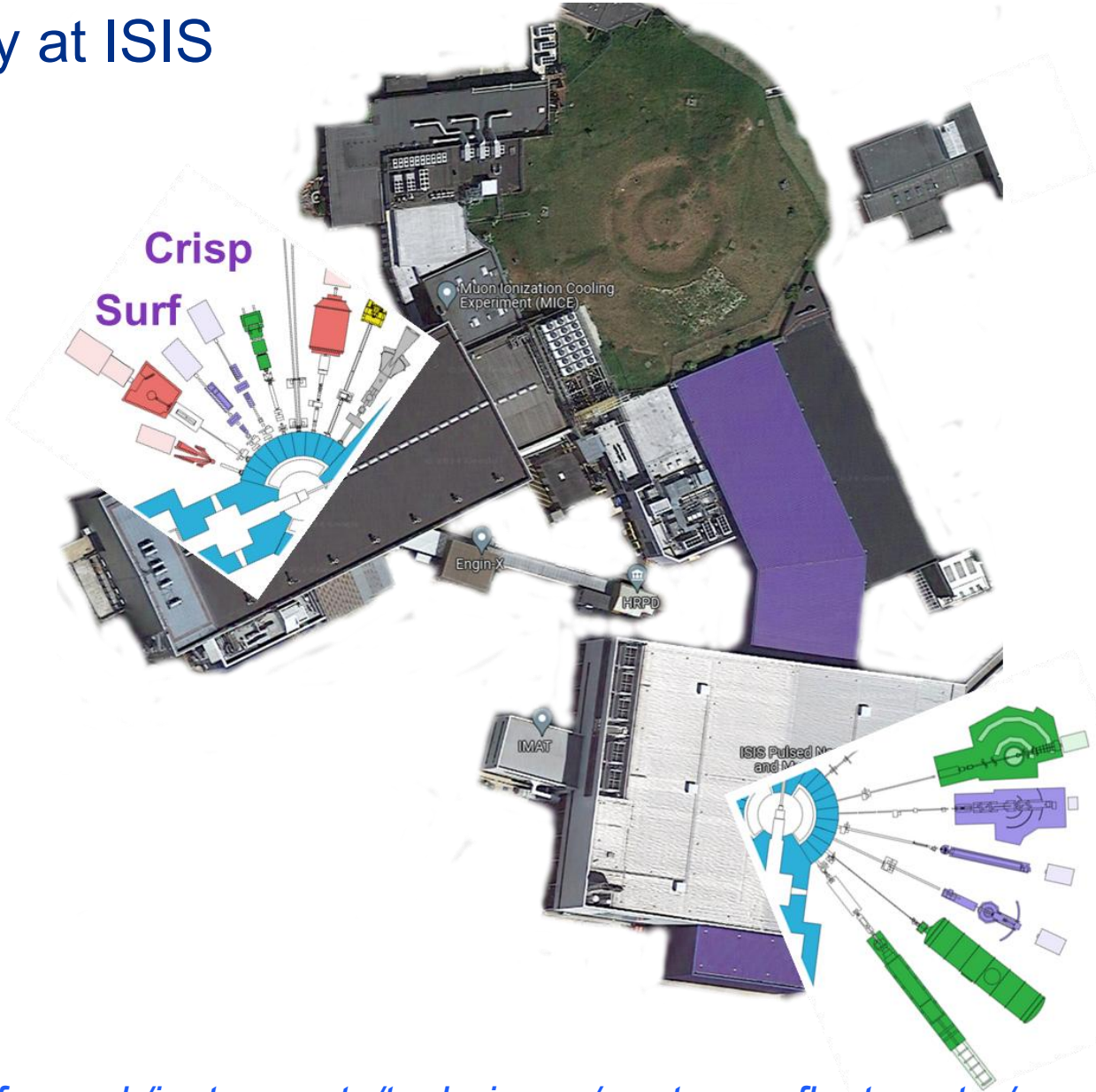


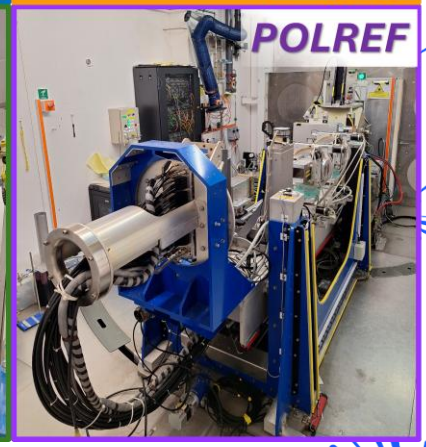
Geometry of specular neutron reflectometry



- **3** degrees of freedom to control **2** angles
- Slit collimation

Reflectometry at ISIS





Offspec

Inter

Polref

https://www.isis.stfc.ac.uk/instruments/techniques/neutron-reflectometry/

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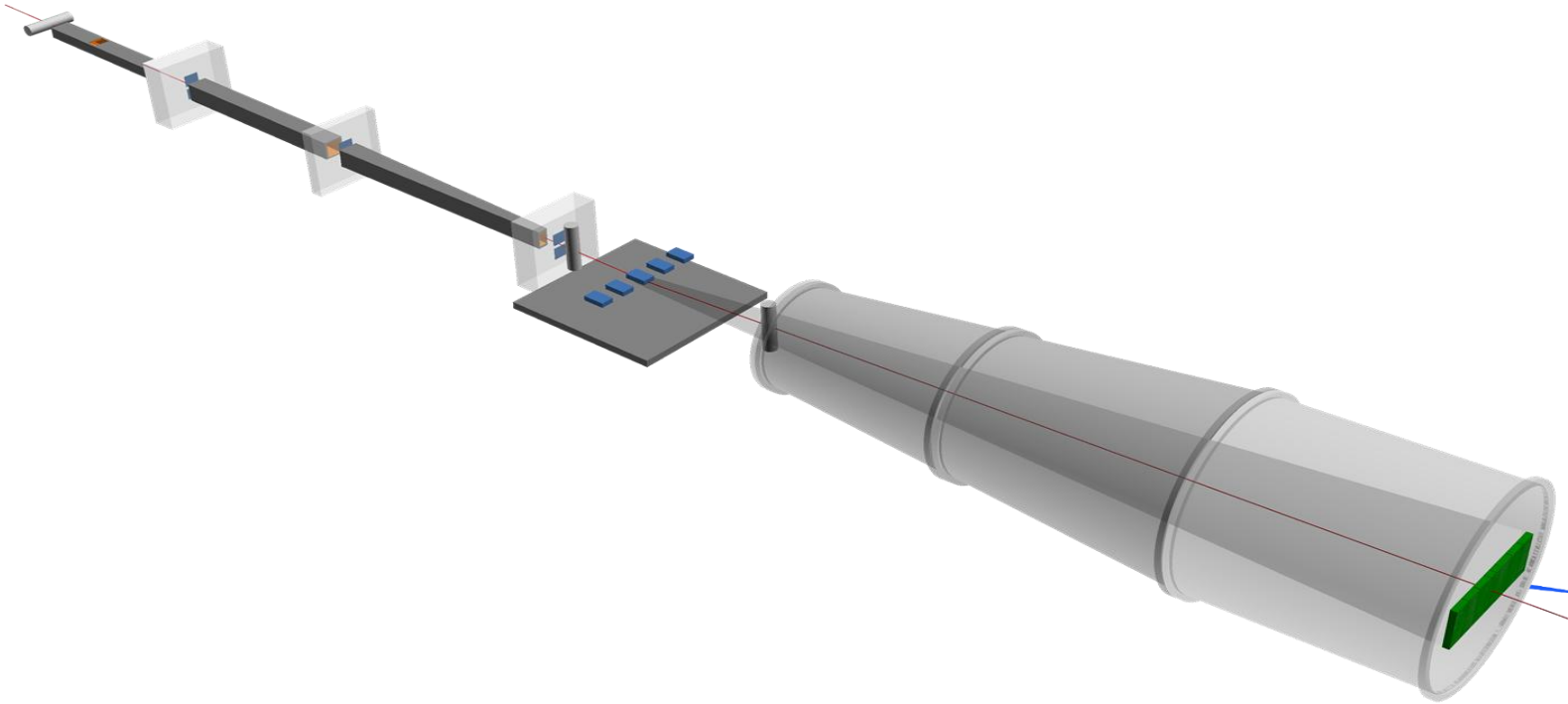
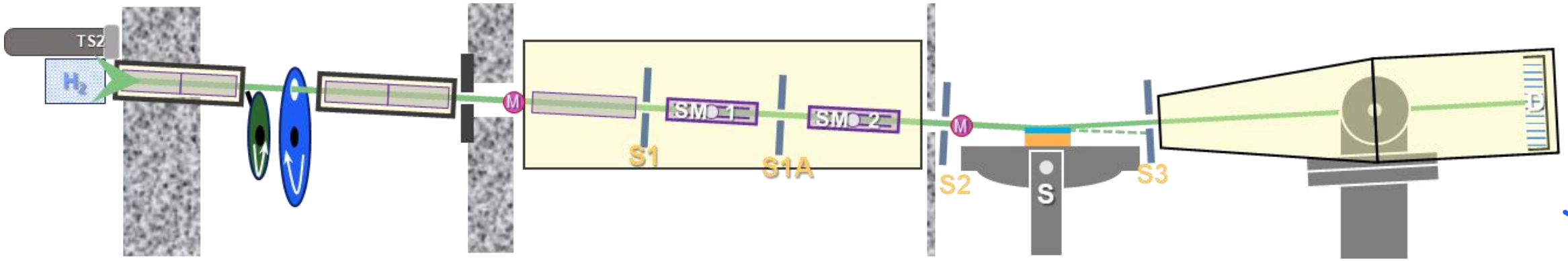
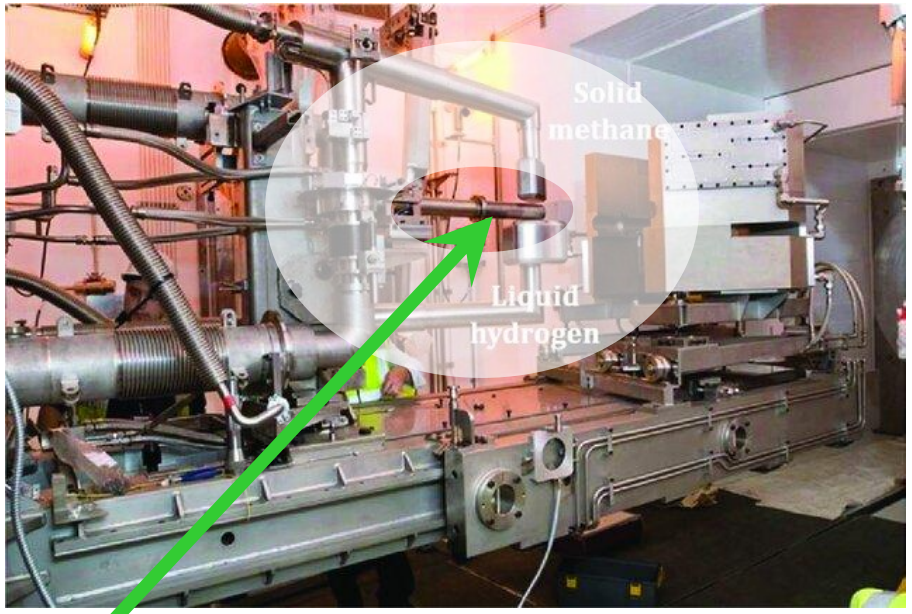
INTER beamline



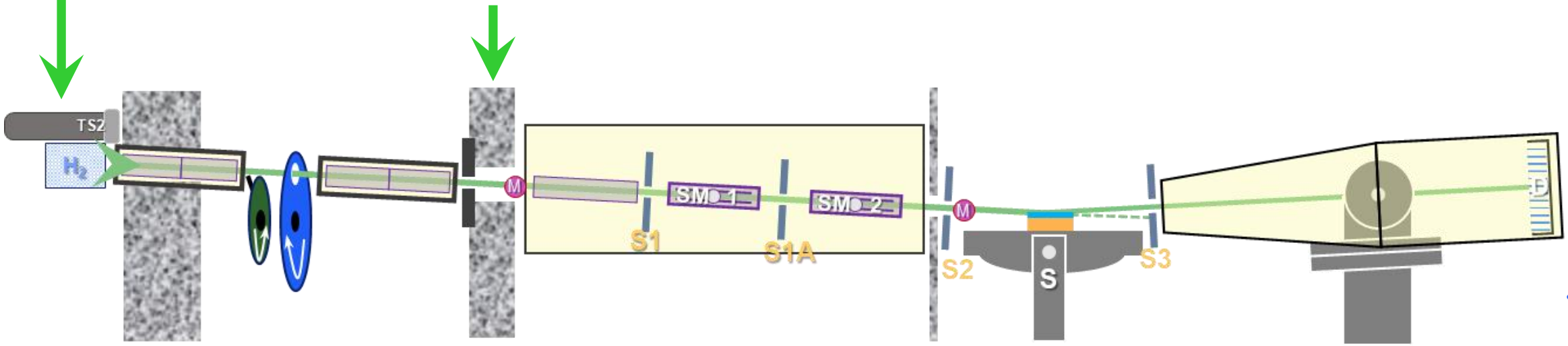


INTER beamline. Source

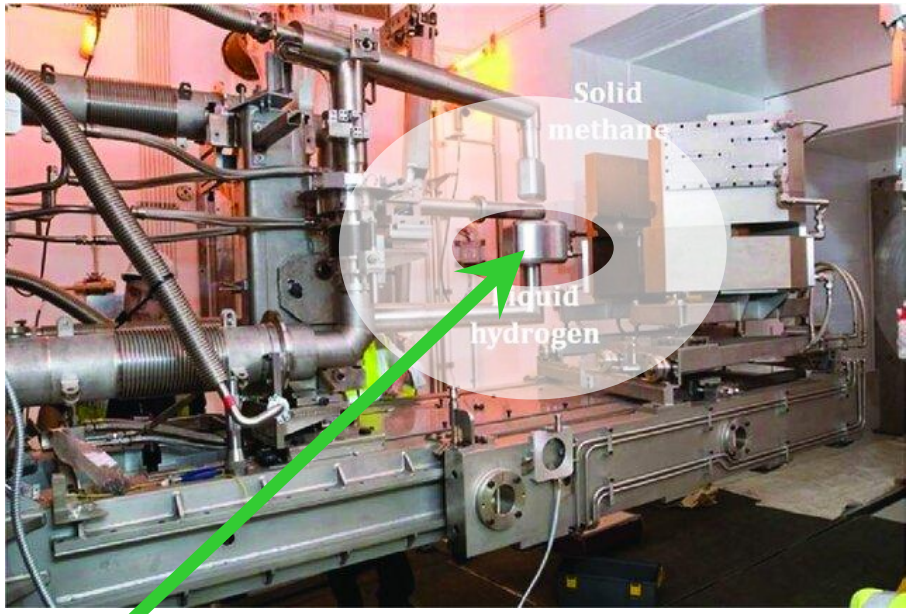


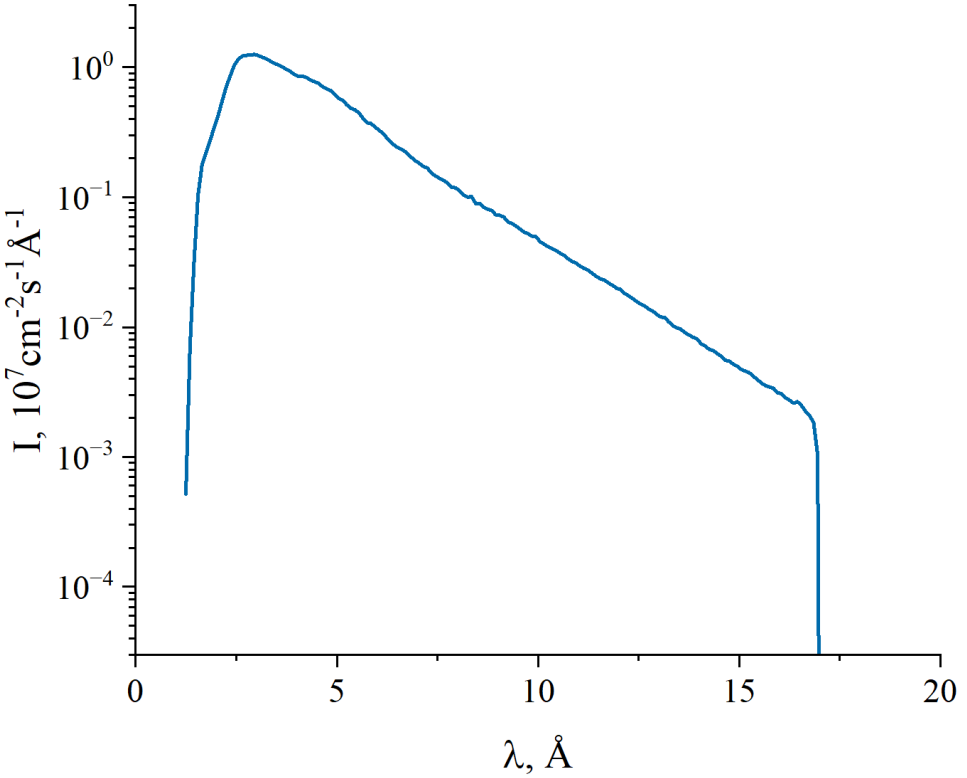
Spallation source

Heavy-metal target

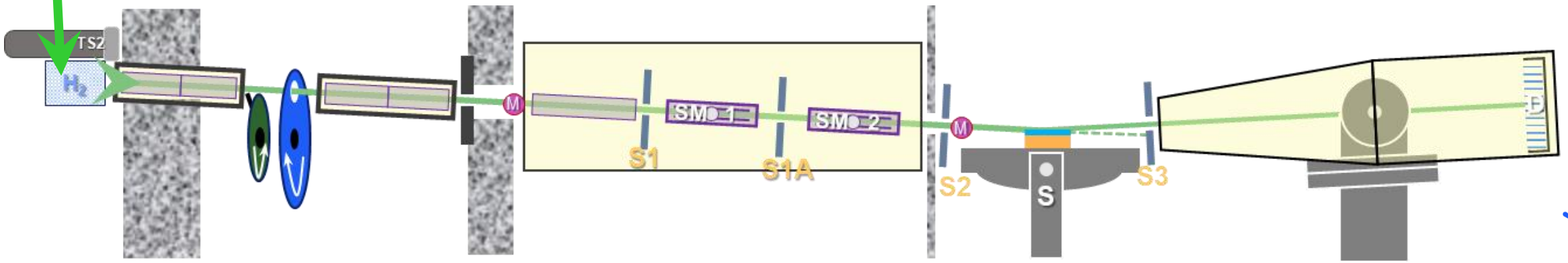


INTER beamline. Moderator



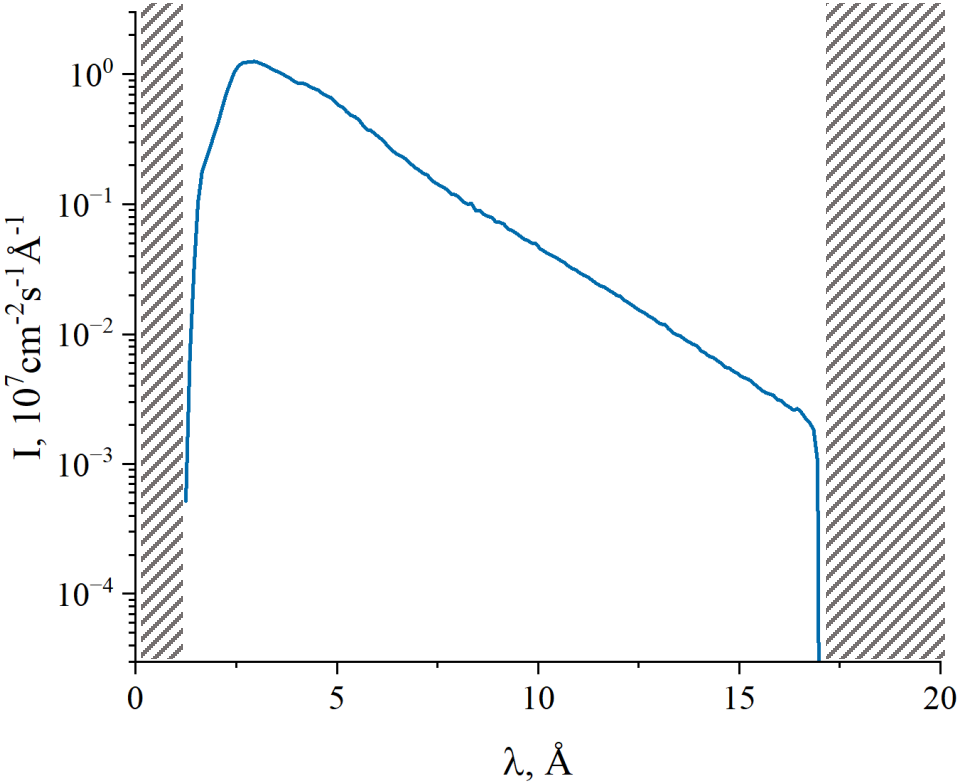


Liquid H2 moderator

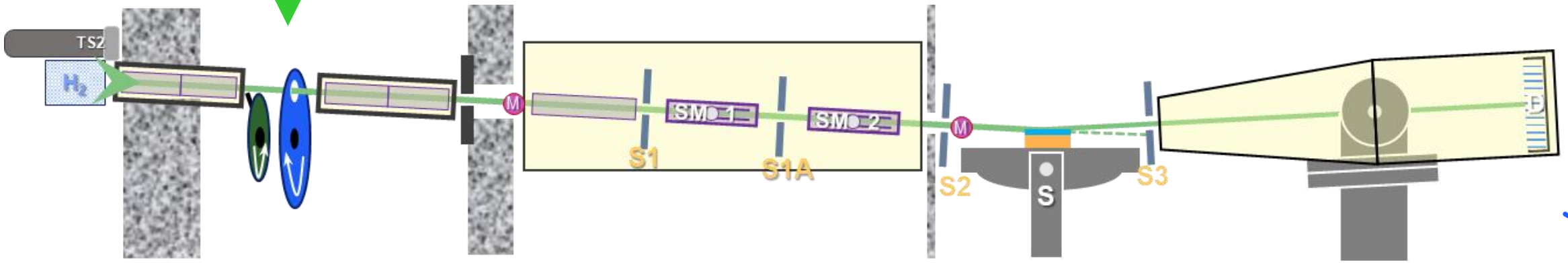


INTER beamline. Choppers

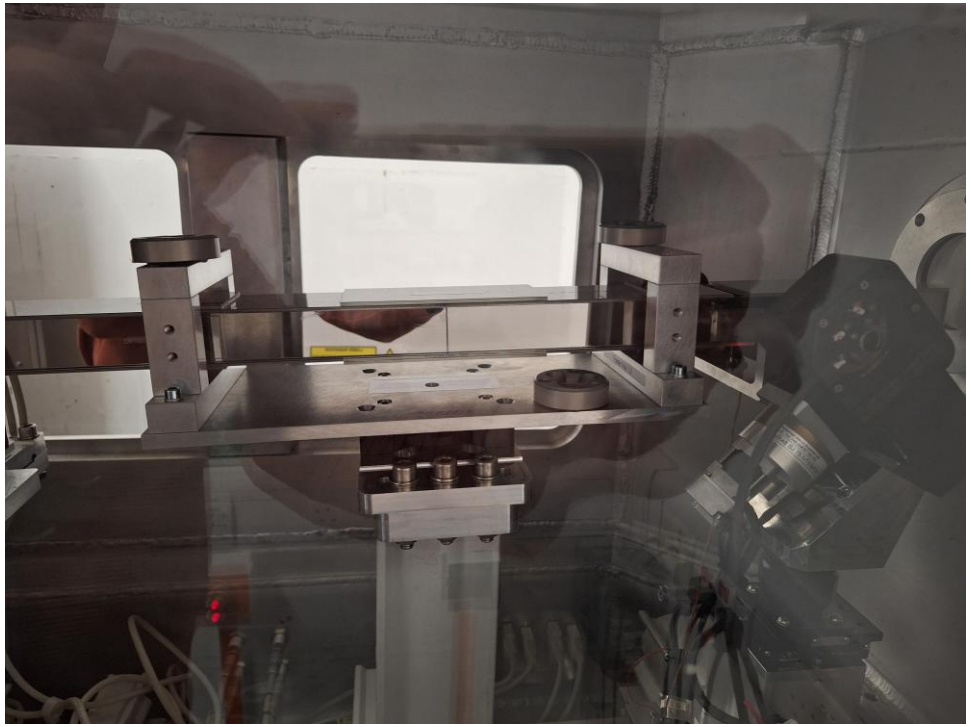
Cutting tails of every pulse



Disc chopper

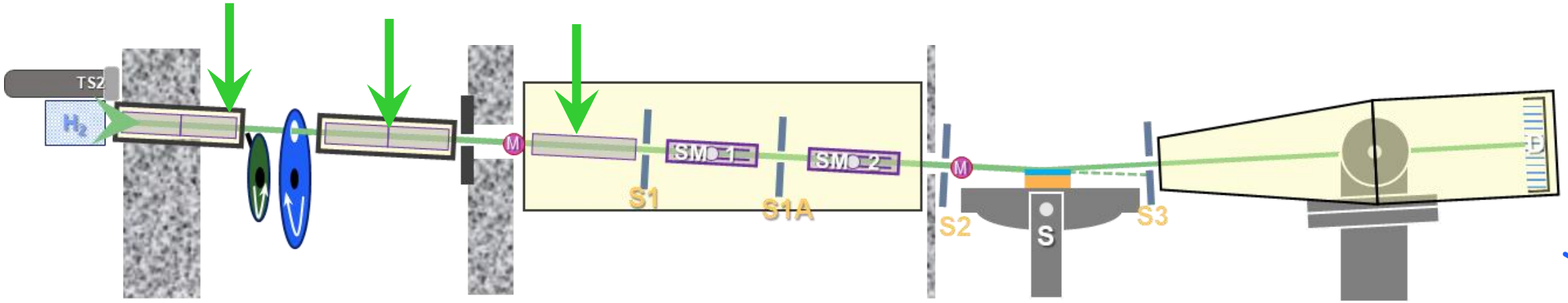


INTER beamline. Neutron guides

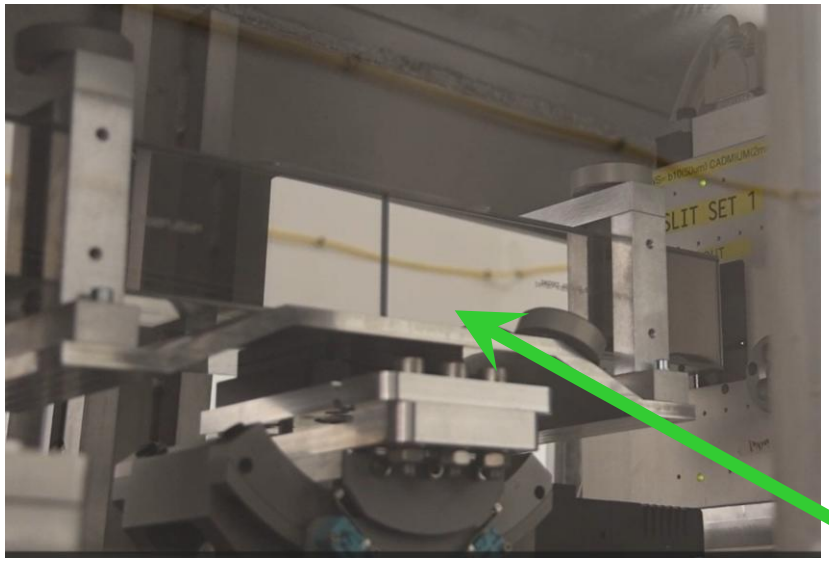


Guiding system delivers neutrons

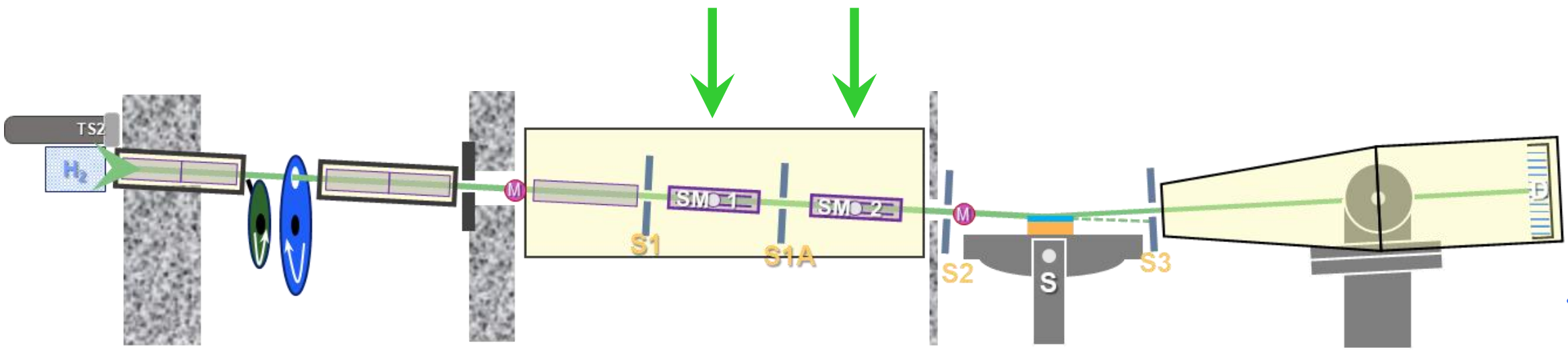
to the end-station



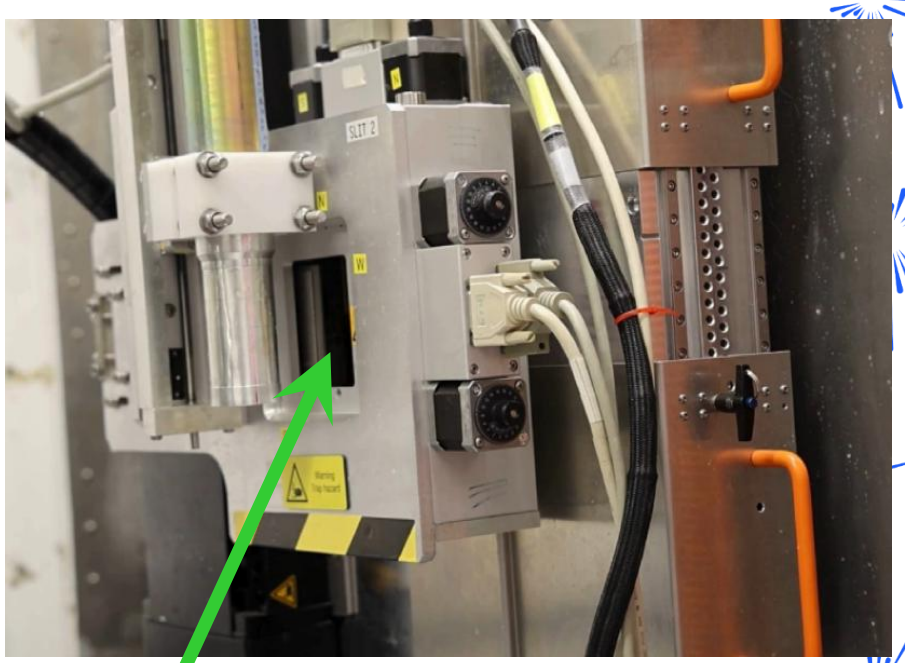
INTER beamline. Supermirrors



Neutron supermirrors allow control of the incident angle



INTER beamline. Collimation

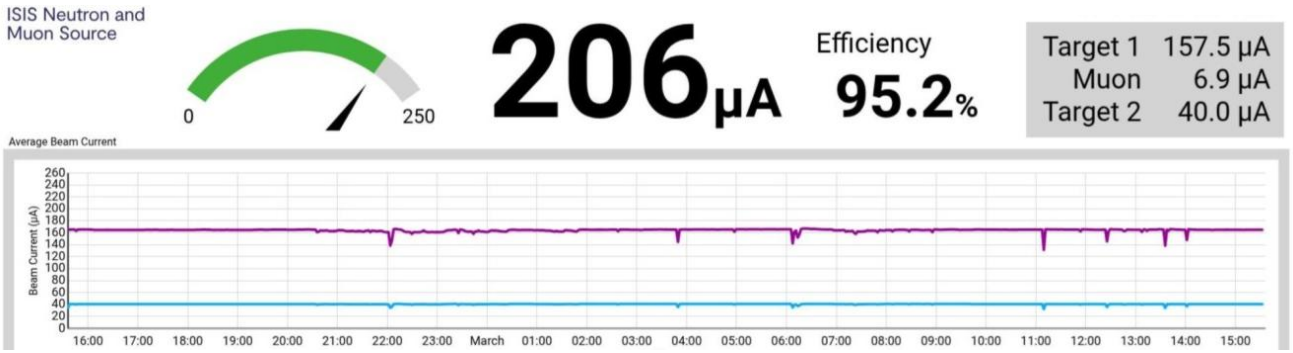


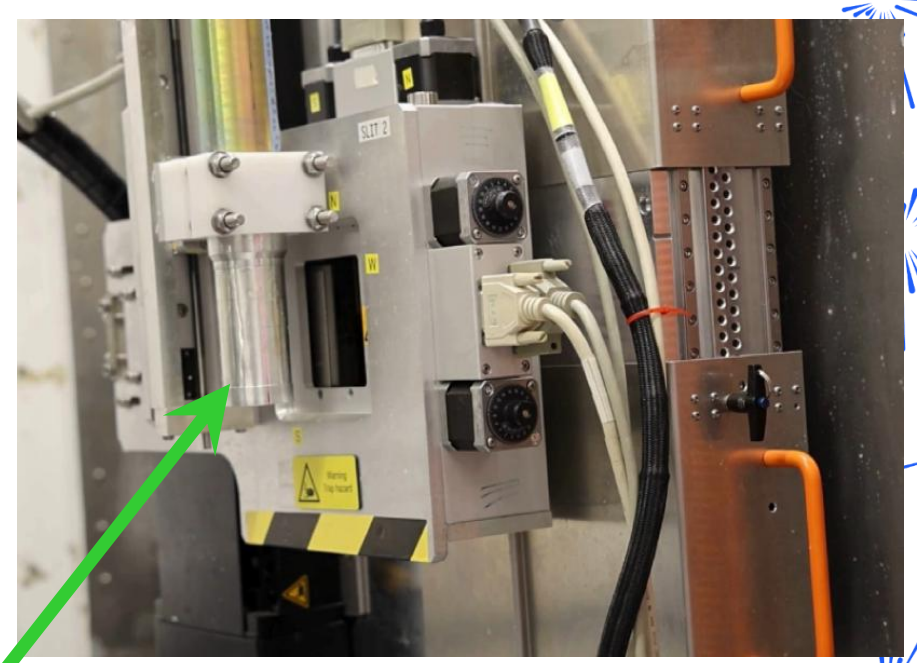
Slit 1

Slit 2

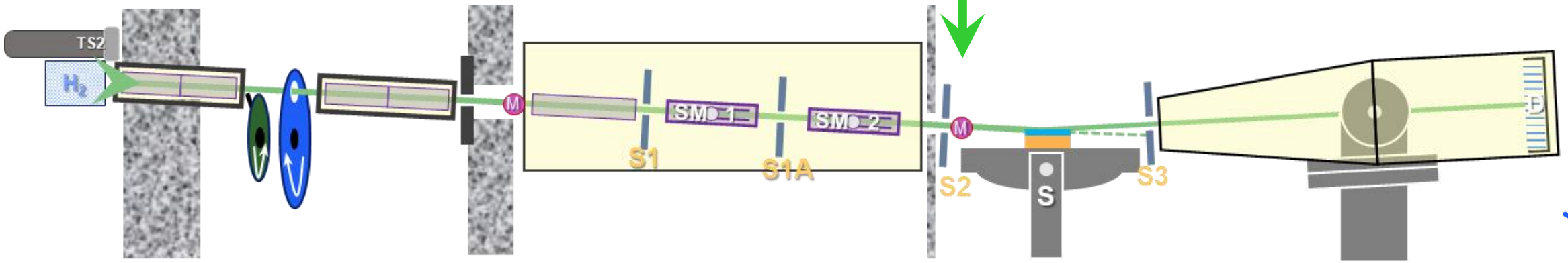
INTER beamline. Monitor

Low-efficiency detector prevents influence of the source brightness fluctuations

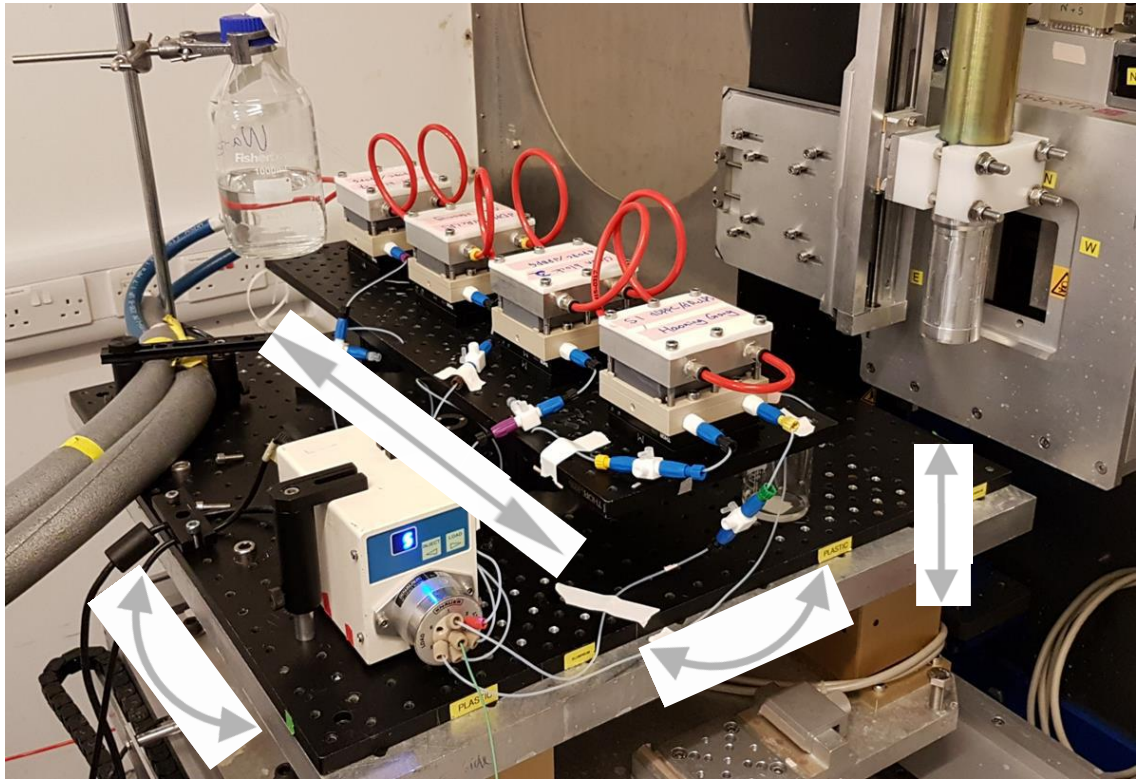




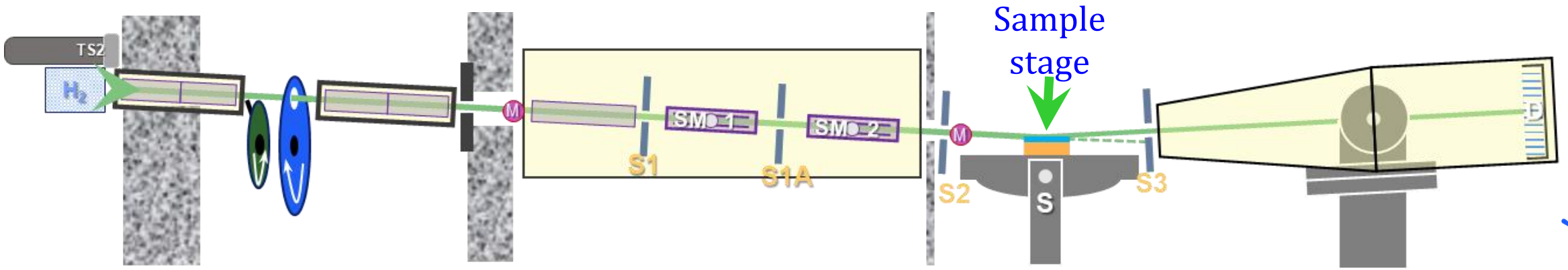
Beam monitor



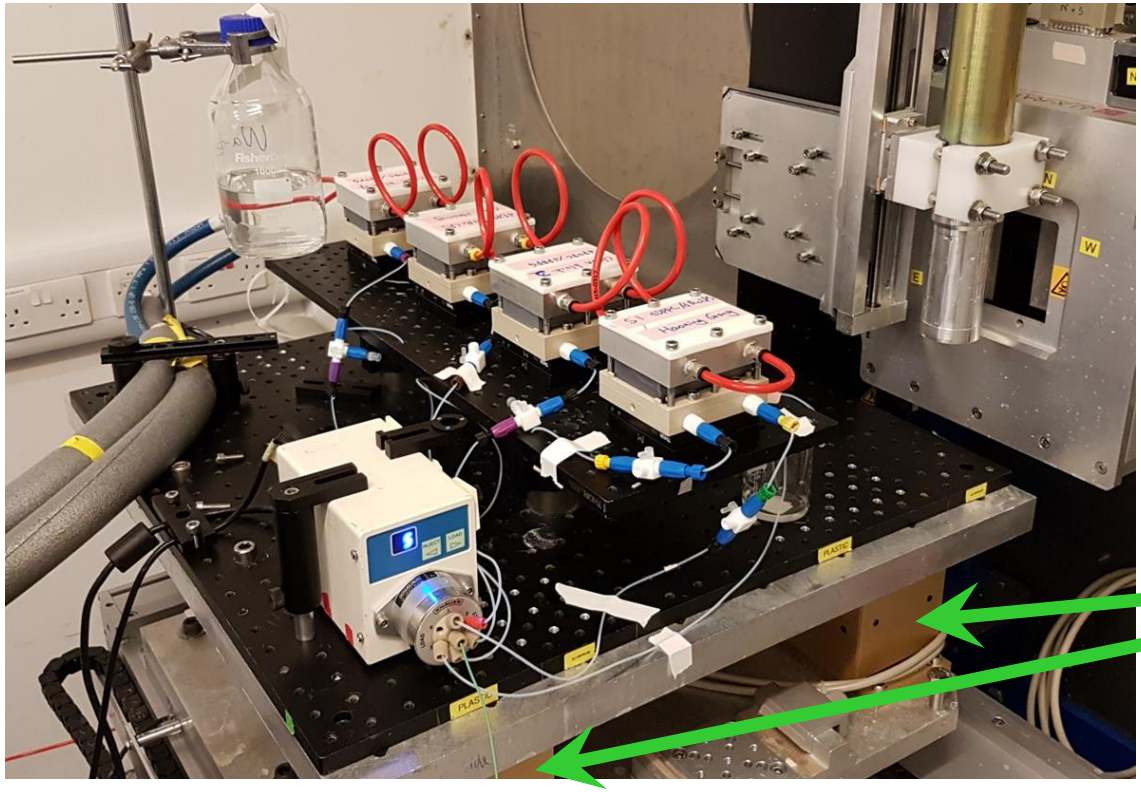
INTER beamline. Sample position



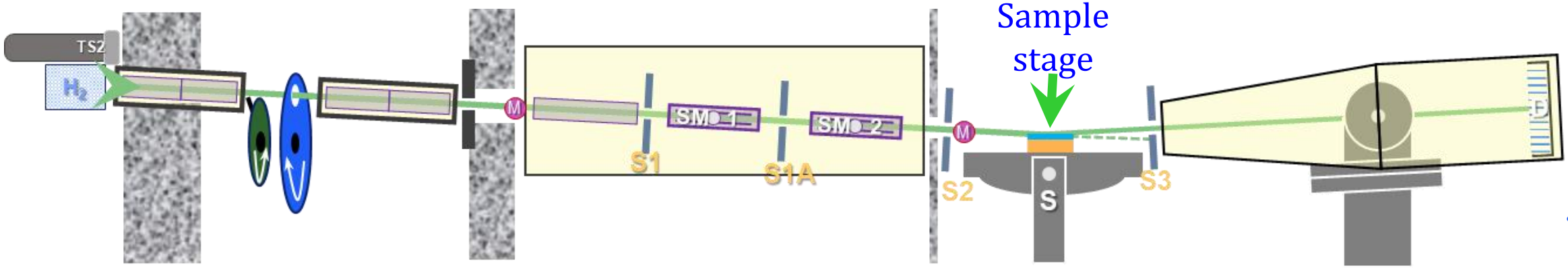
4-axes goniometer:
2 rotations
2 translations



INTER beamline. Anti-vibrational tables

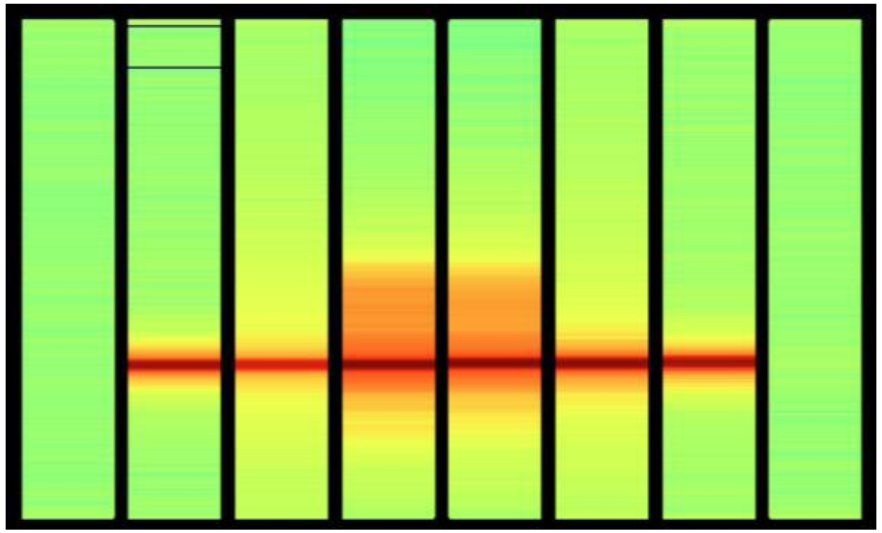


AVTs

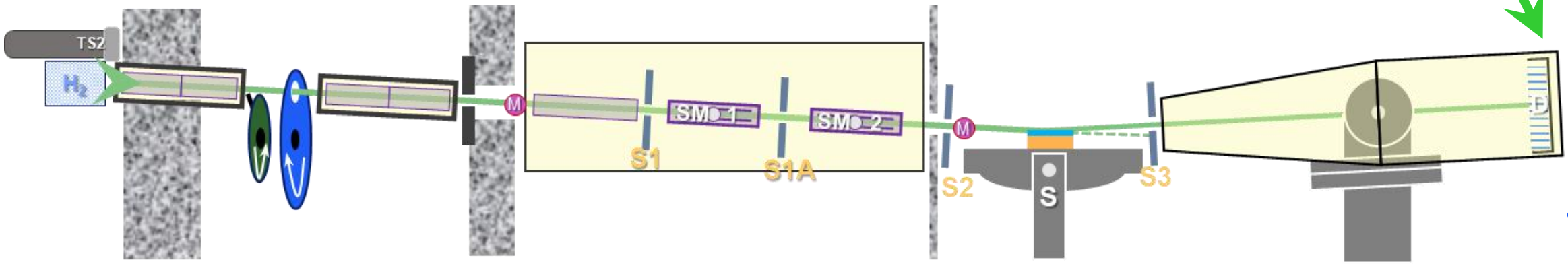


INTER beamline. Detector

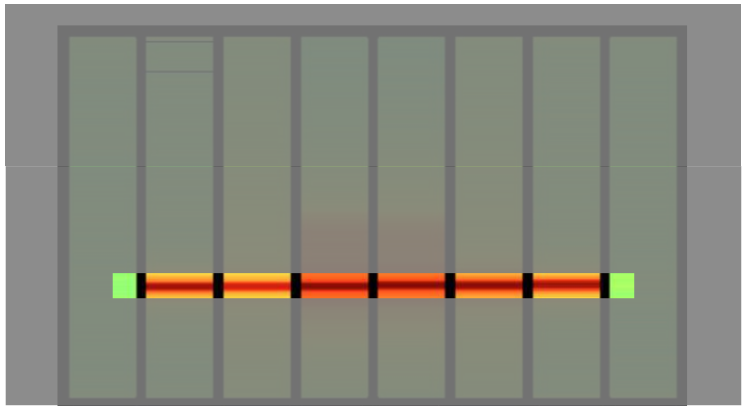
quasi-2D position-sensitive detector

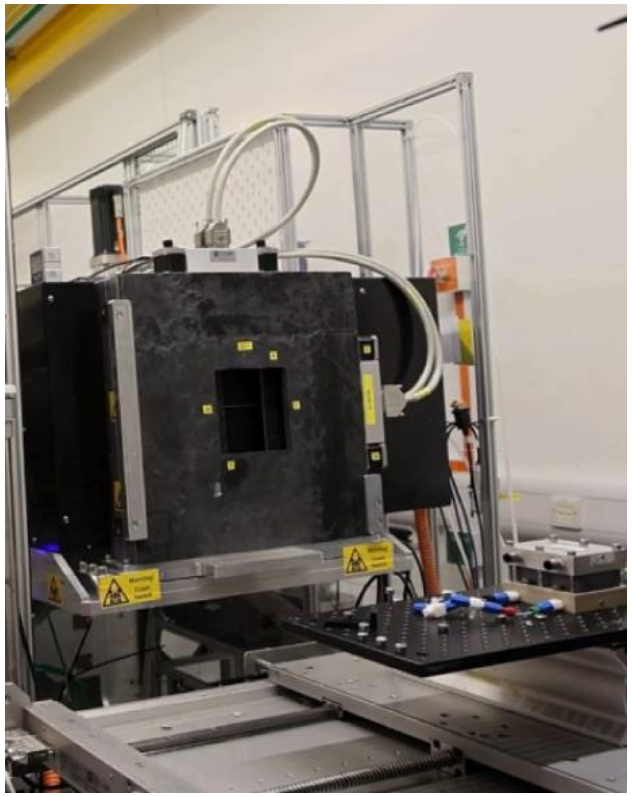


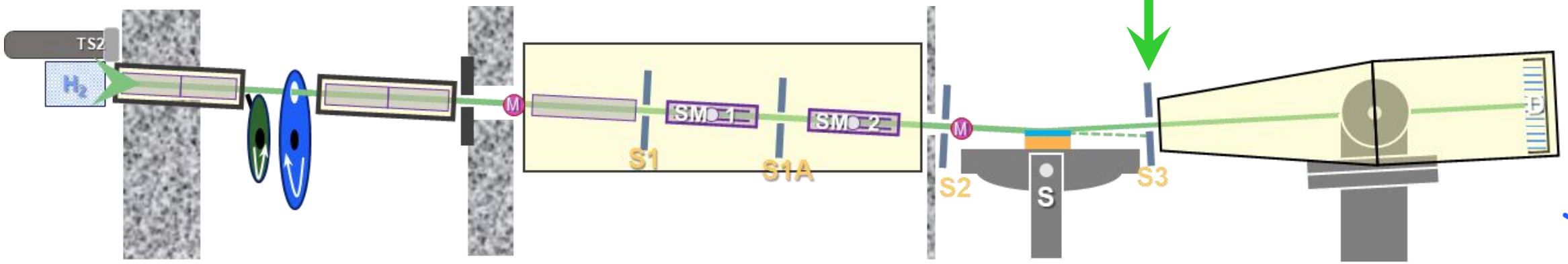
Detector



INTER beamline. Bkg supression

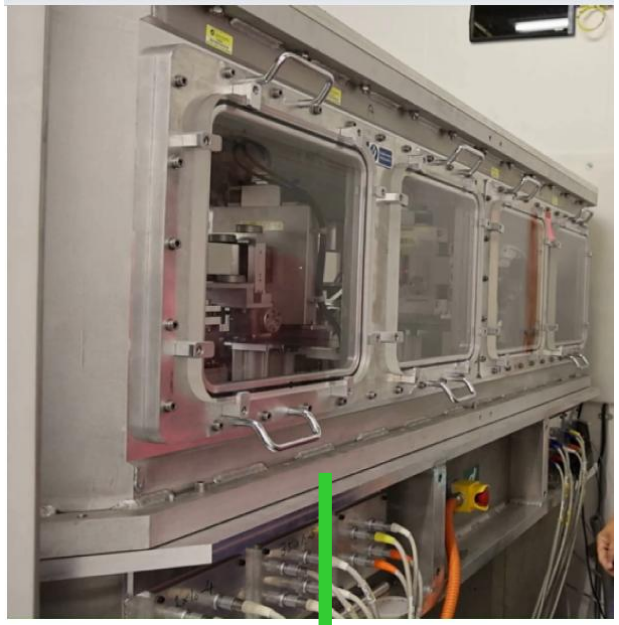


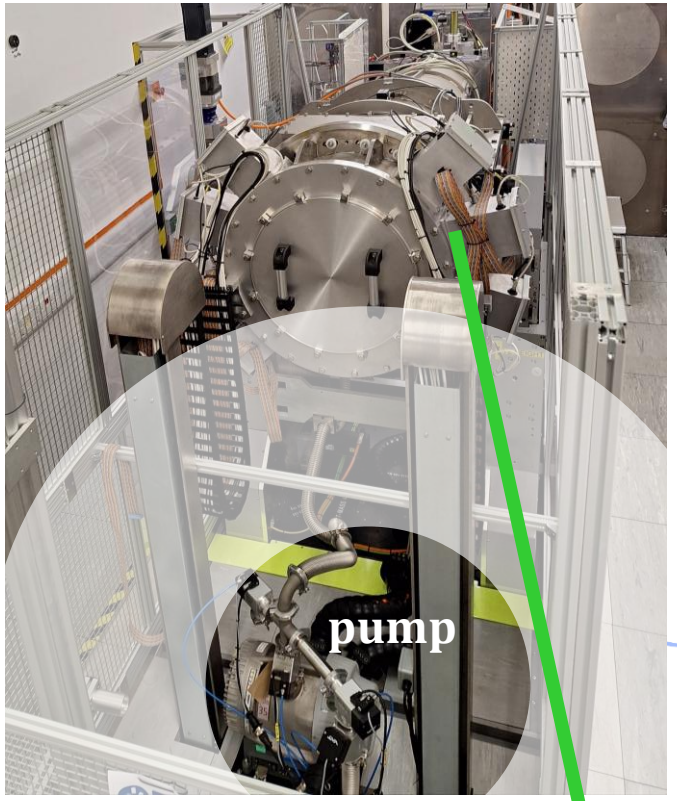


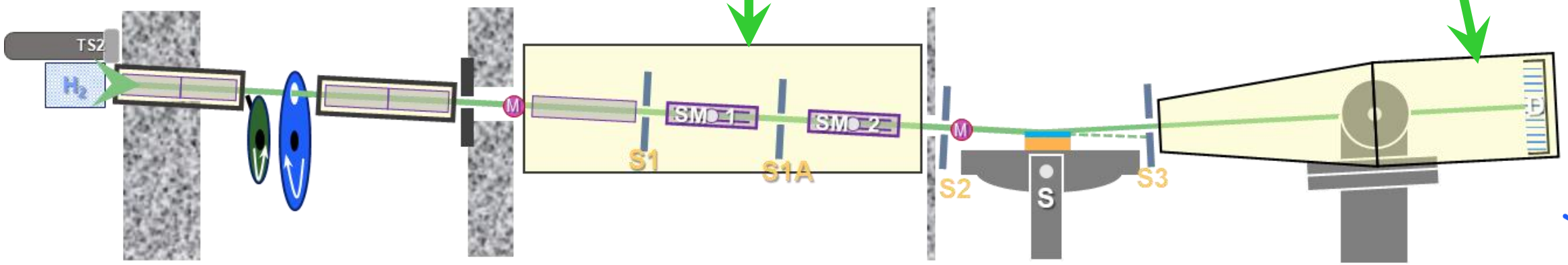


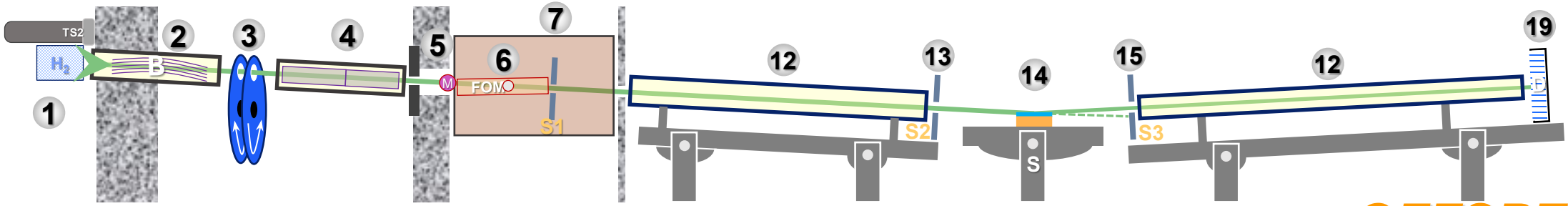
INTER beamline. Vacuum

under vacuum

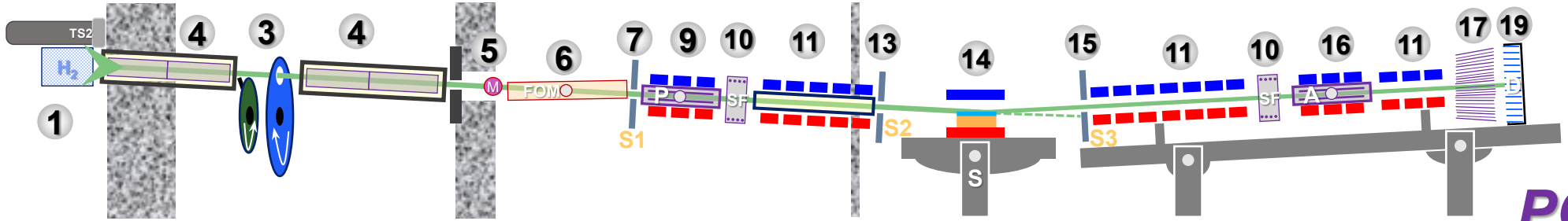




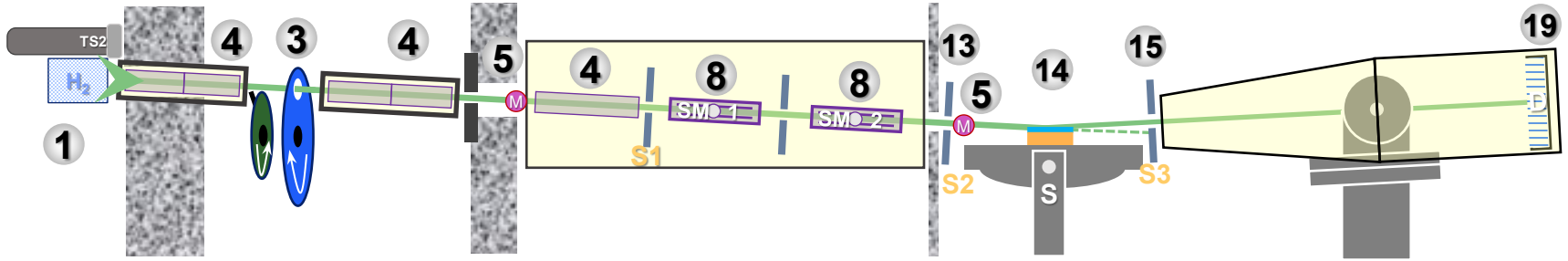




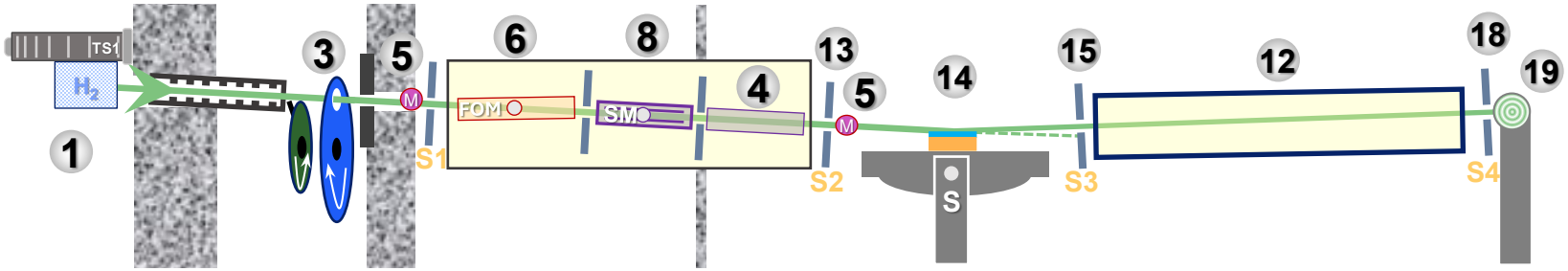
OFFSPEC



POLREF



INTER



SURF

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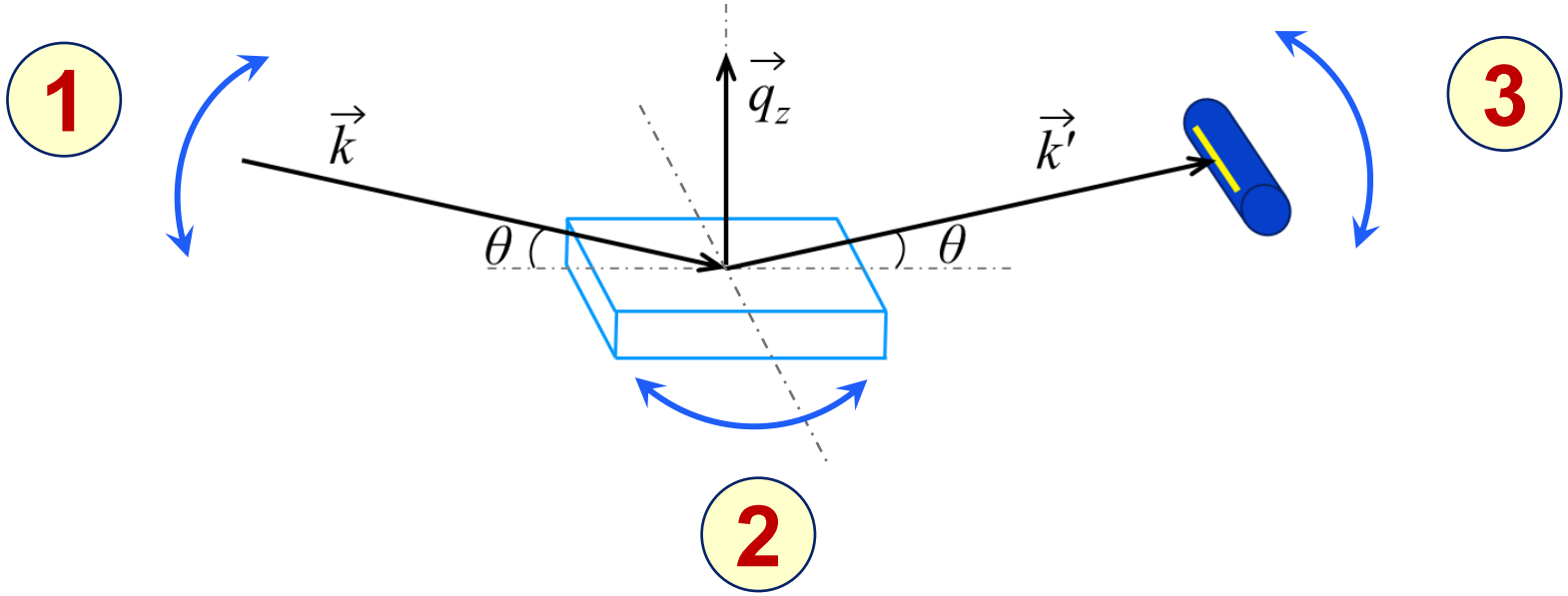
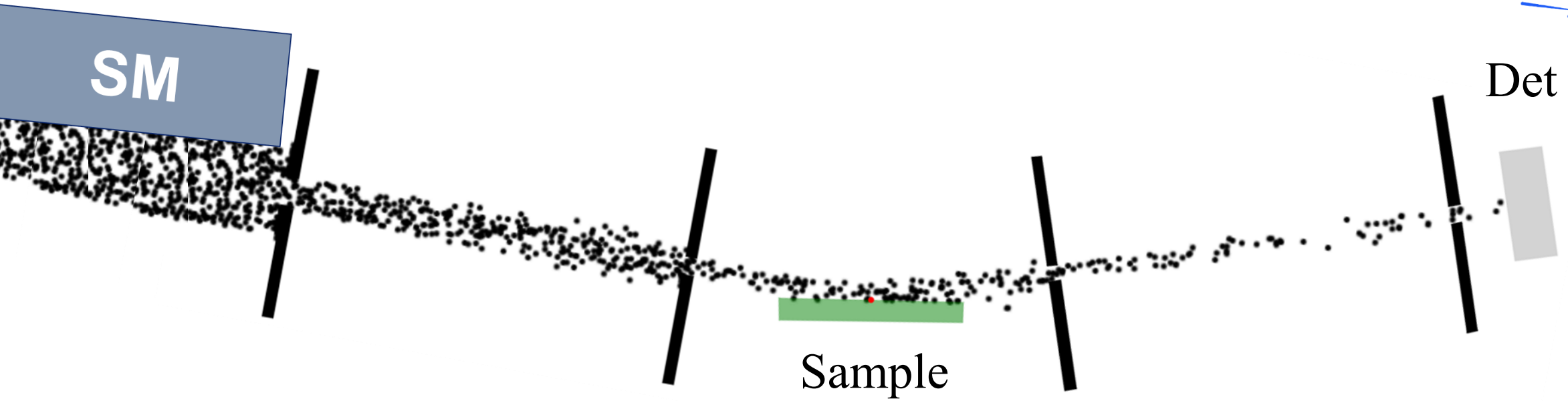
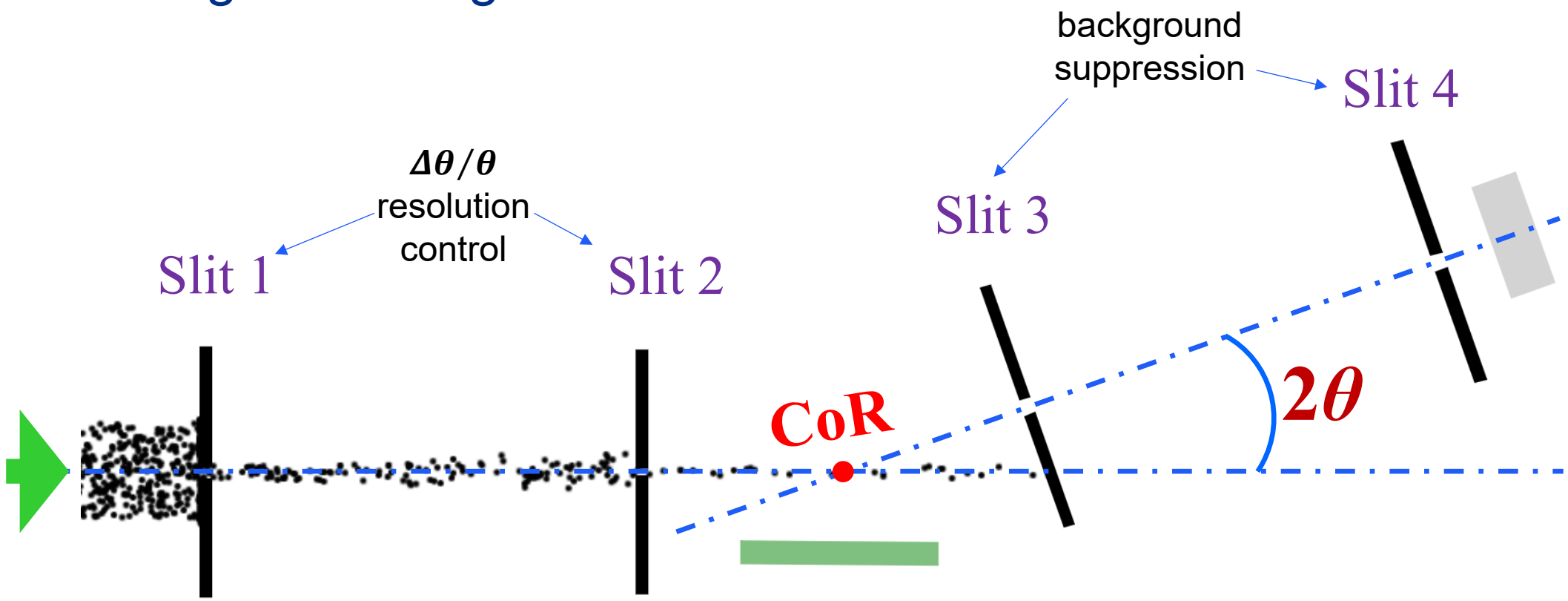
Specular neutron reflectometry. Alignment





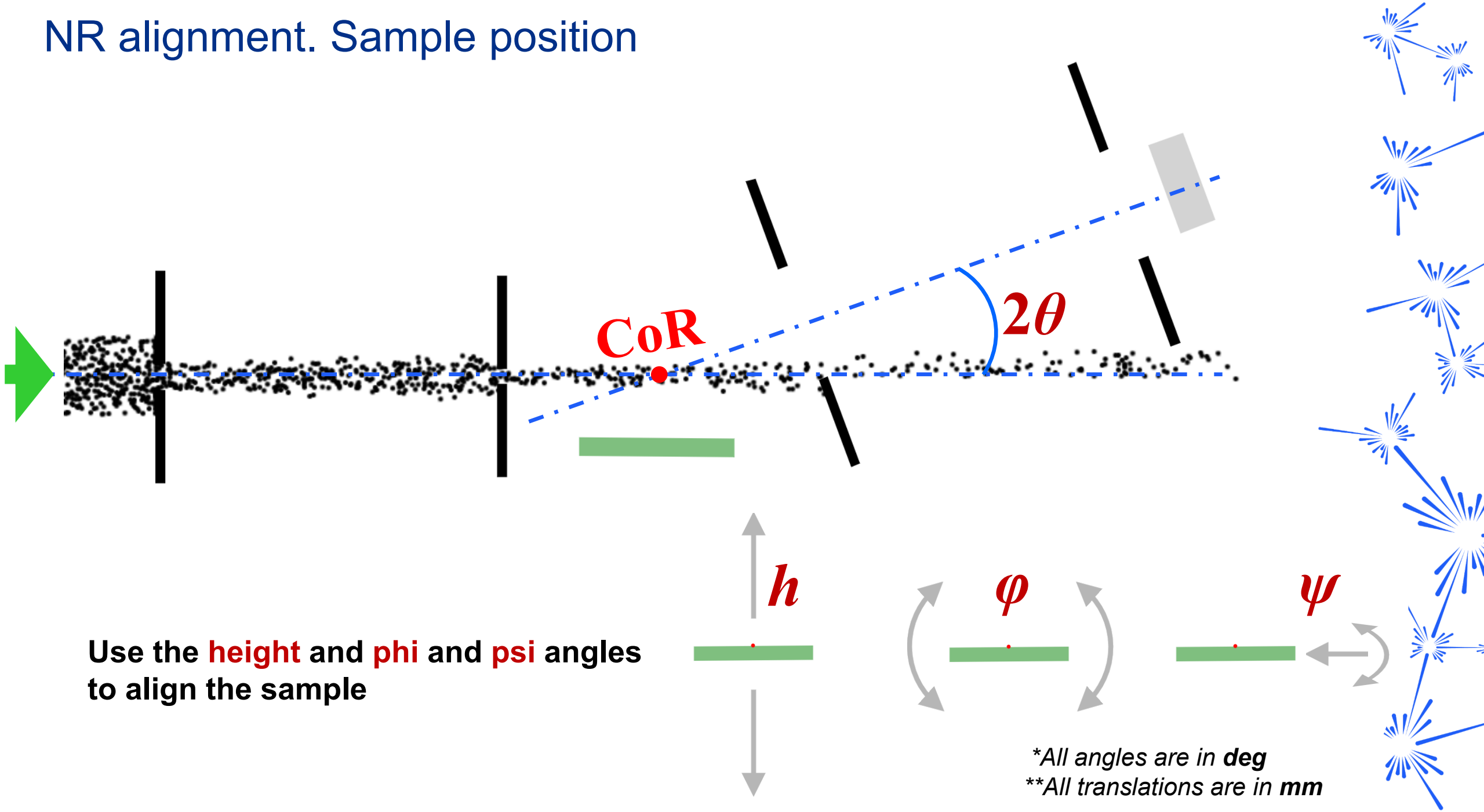
NR alignment begins



Don't worry about the centre of rotation, slit openings, and theta angle.
We've already determined them for you.

You just need to align the sample interface under study.

NR alignment. Sample position



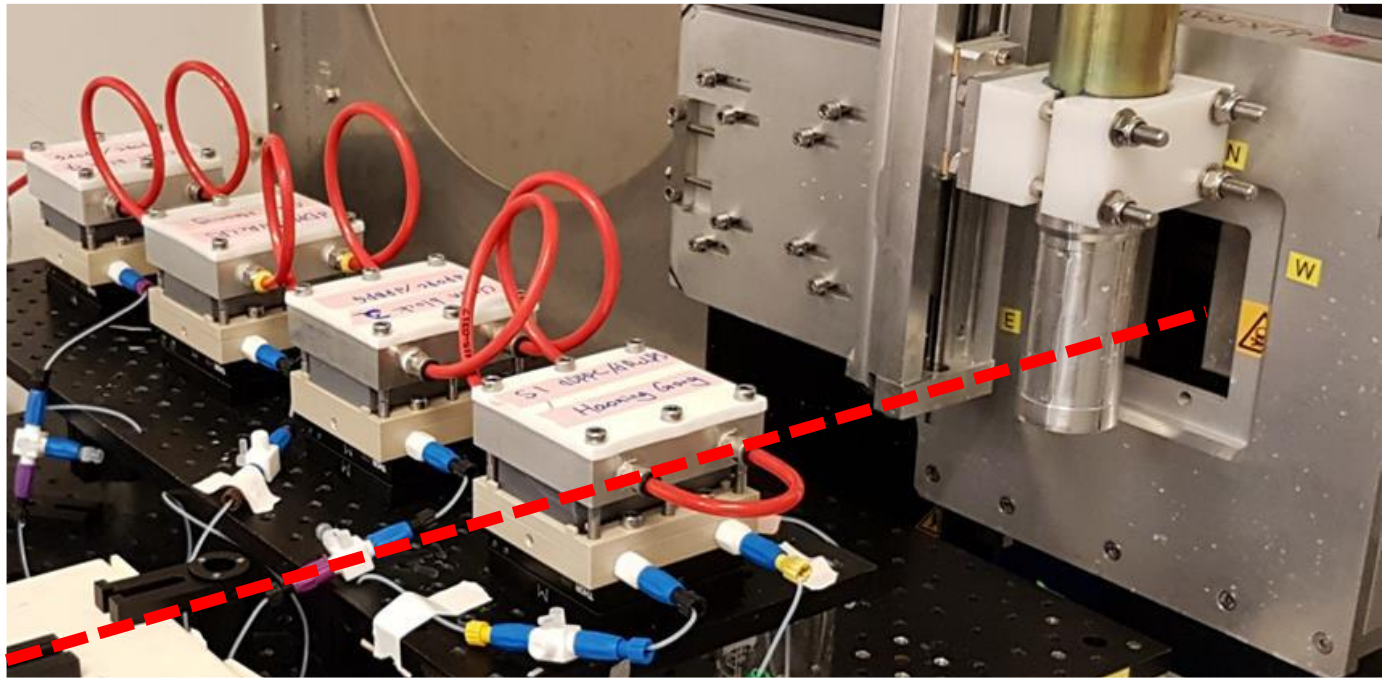
Use the height and phi and psi angles to align the sample

*All angles are in **deg**
All translations are in **mm

NR alignment algorithm

Stage 0. Laser mode

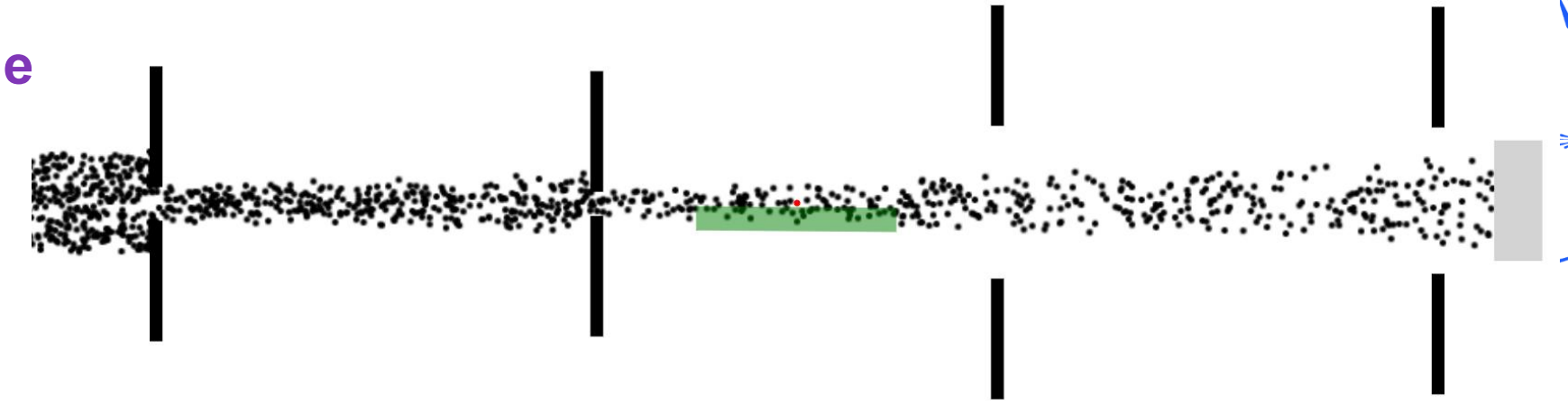
install the sample using laser spot



Stage 1. Transmission mode

Set *theta*=0

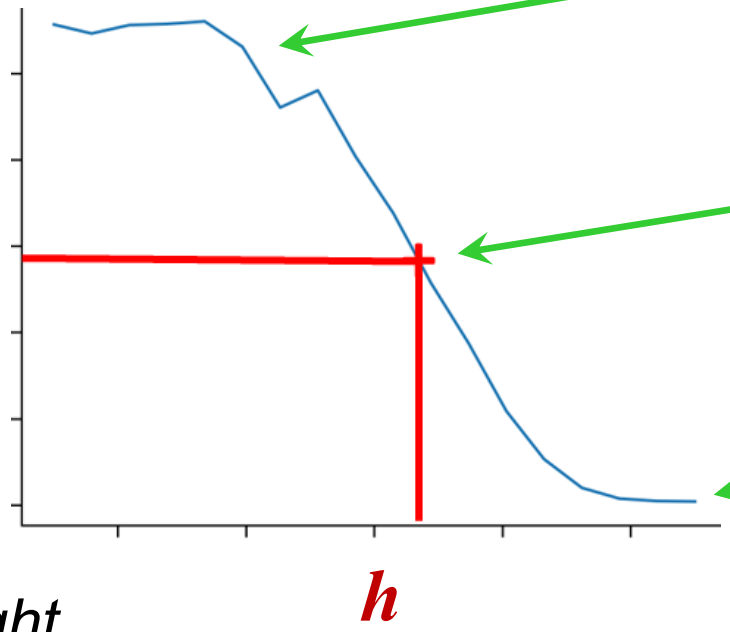
Set *slit gaps*

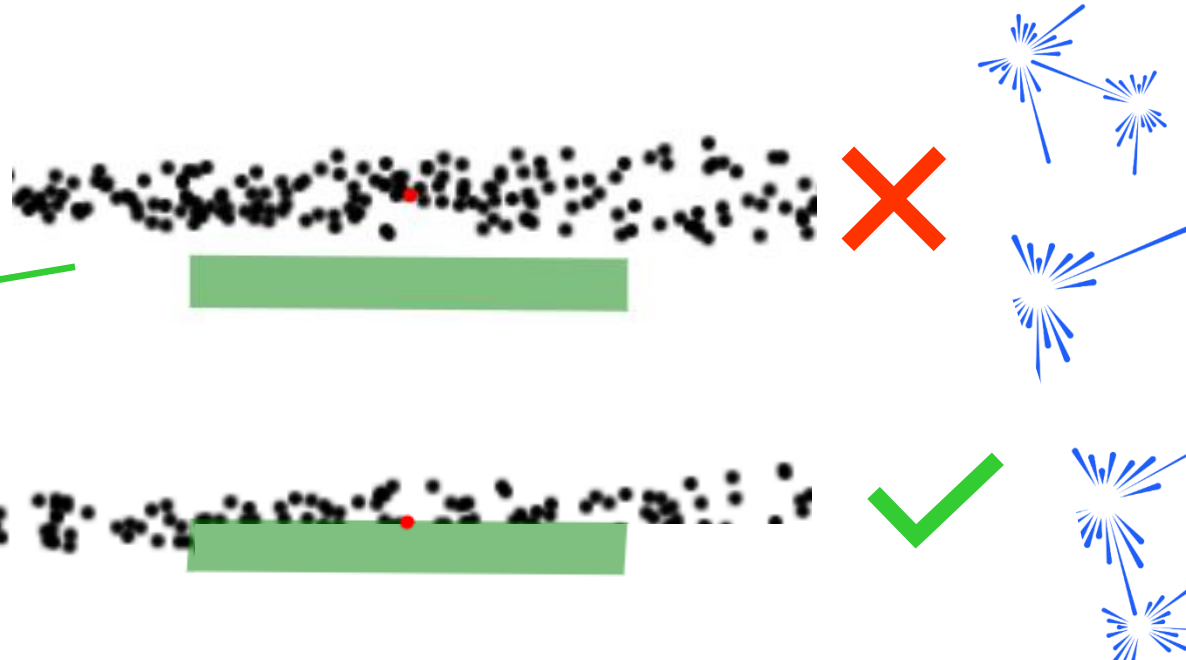


NR alignment algorithm

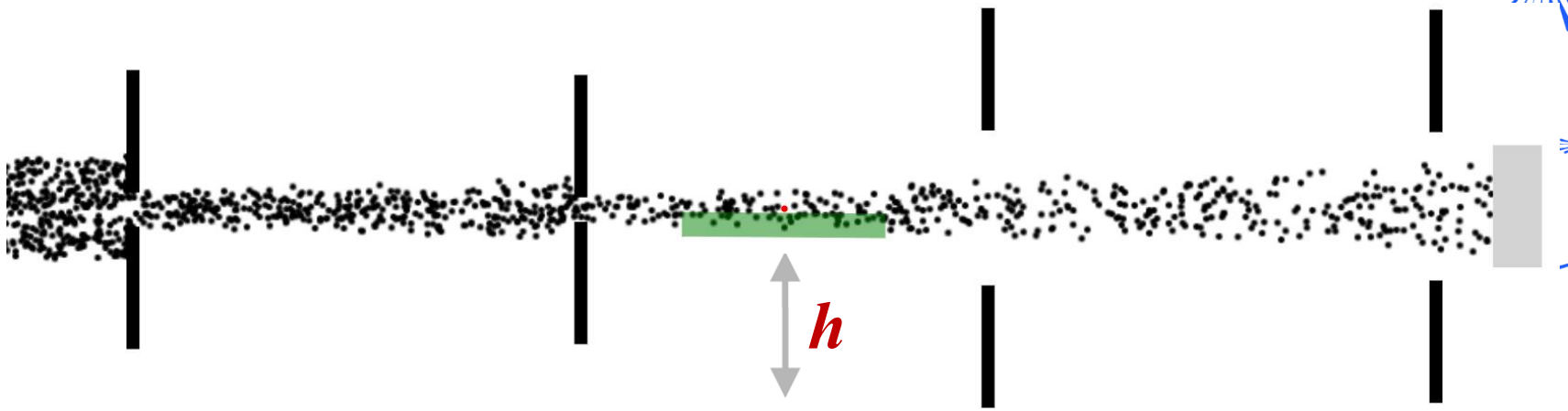
Stage 1. Transmission mode

height scan (step-like dependence expected)





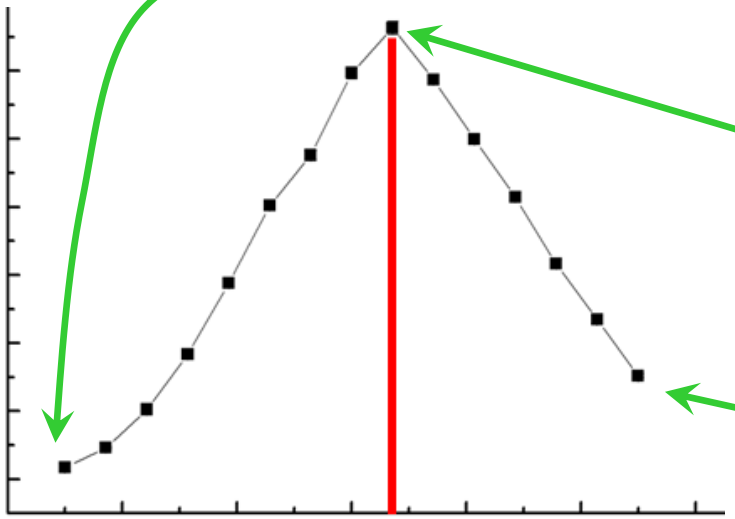
reposition *height*



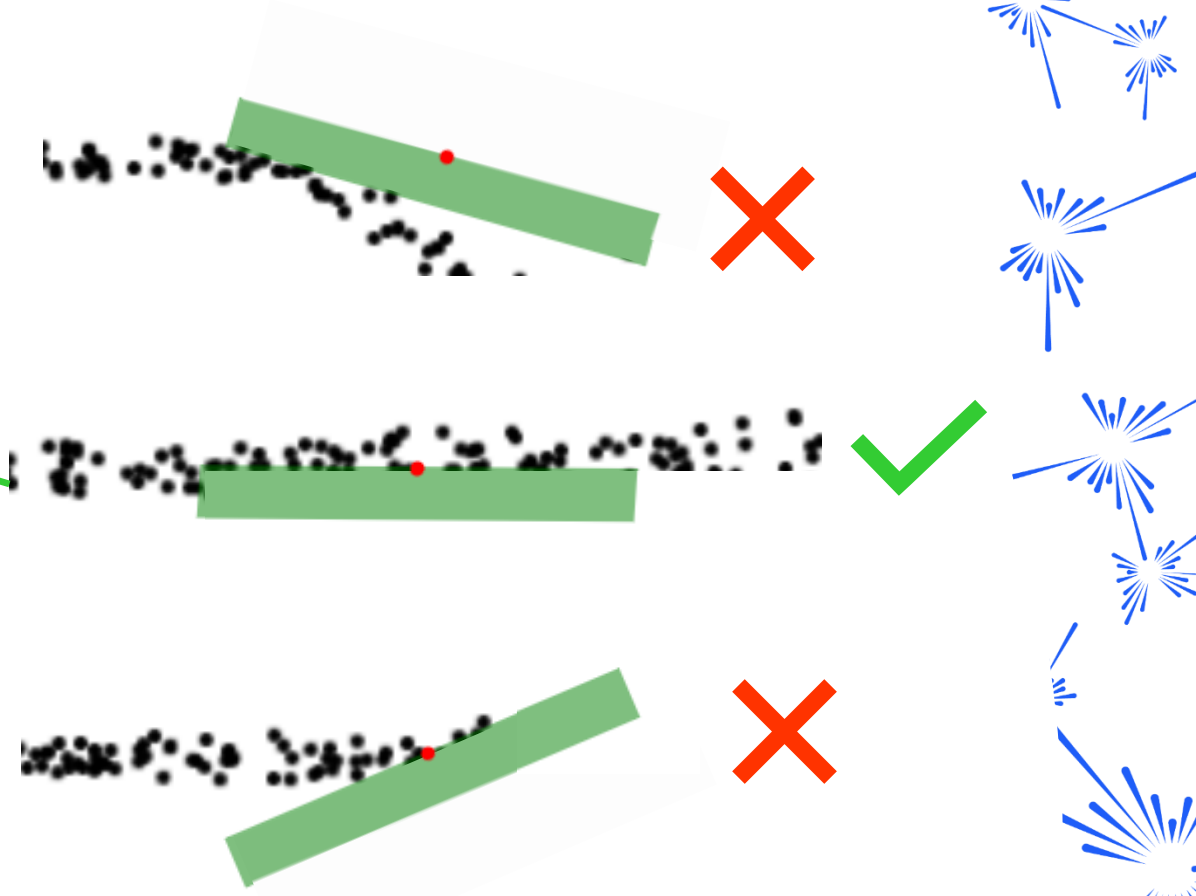
NR alignment algorithm

Stage 1. Transmission mode

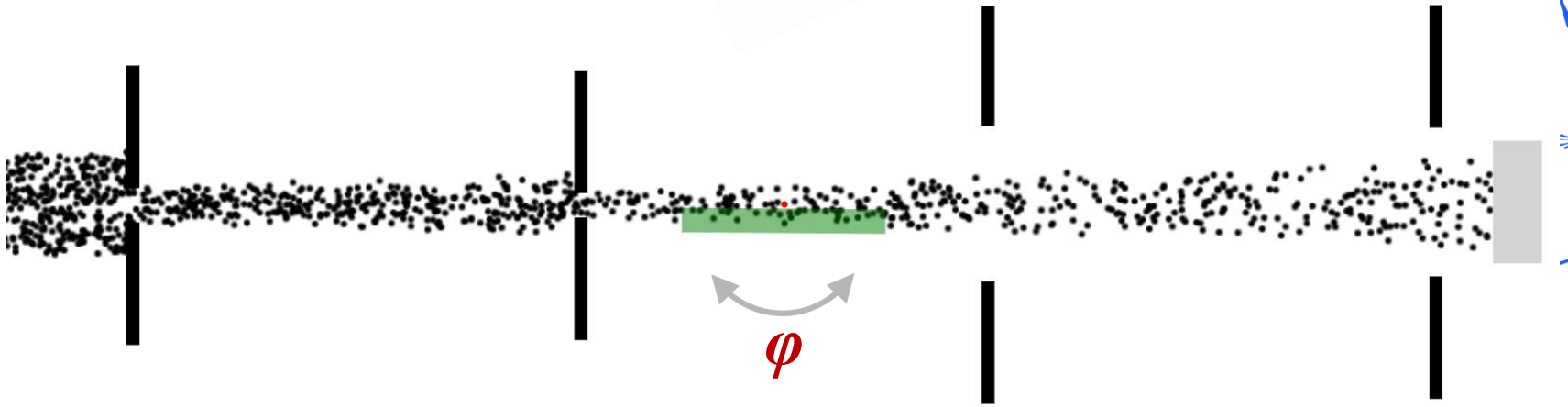
phi “shadow” scan



φ



reposition *phi*

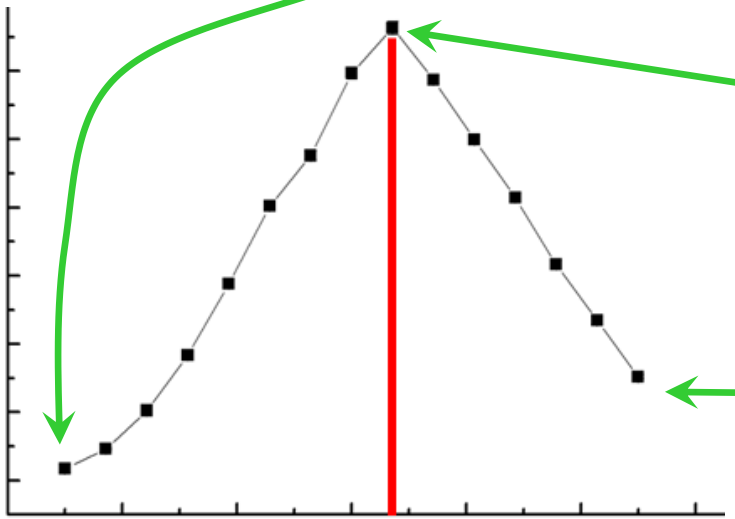


NR alignment algorithm

Stage 2. Reflection mode

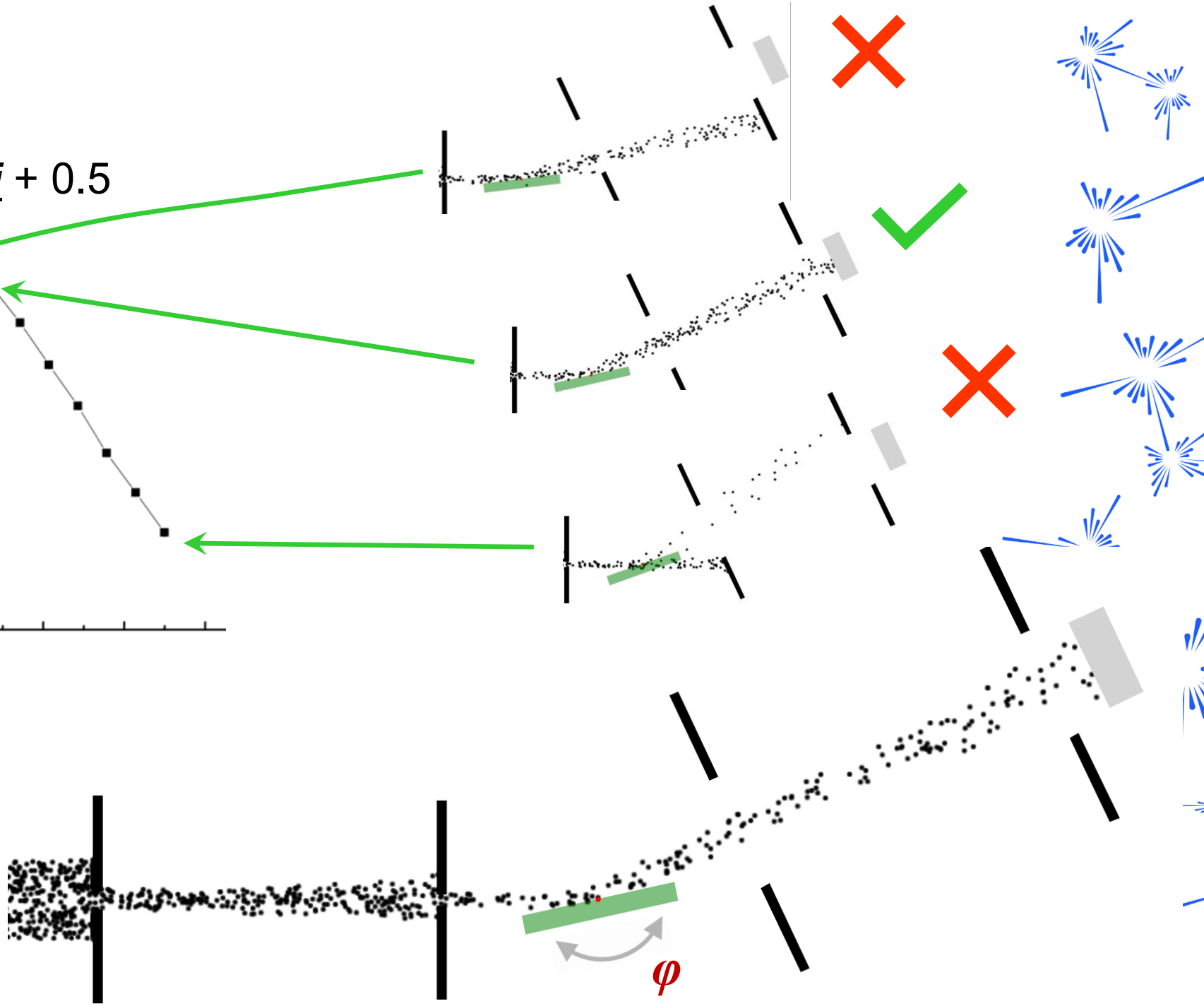
Set *theta* = 0.5; Set *phi* = *phi* + 0.5

phi rocking scan



φ

reposition *phi*

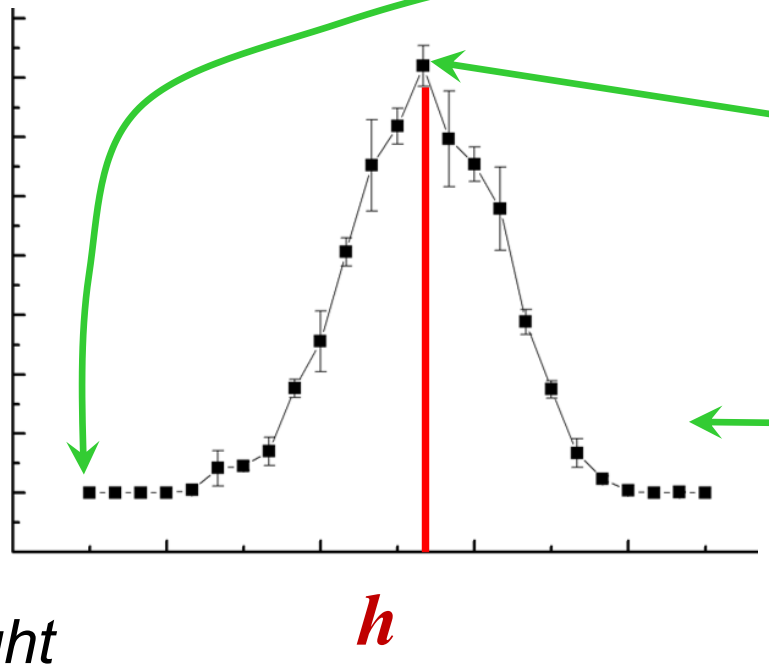


φ

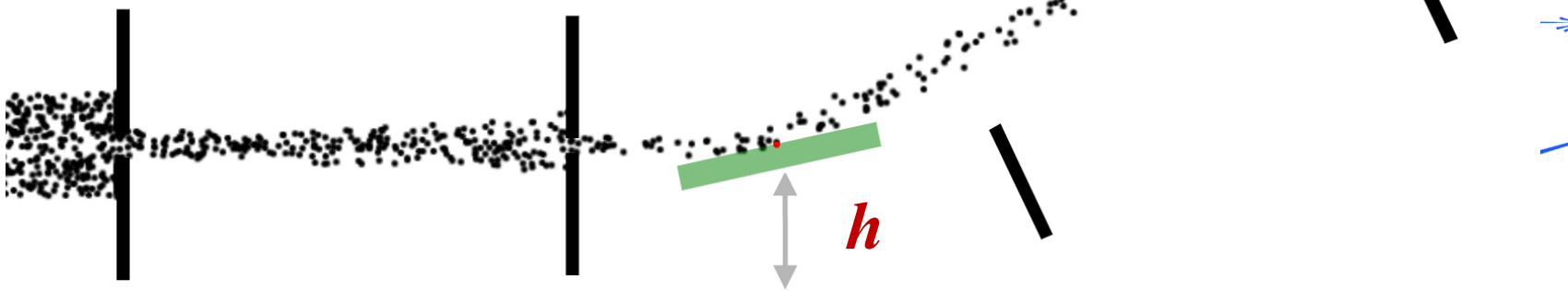
NR alignment algorithm

Stage 2. Reflection mode

height scan



reposition *height*



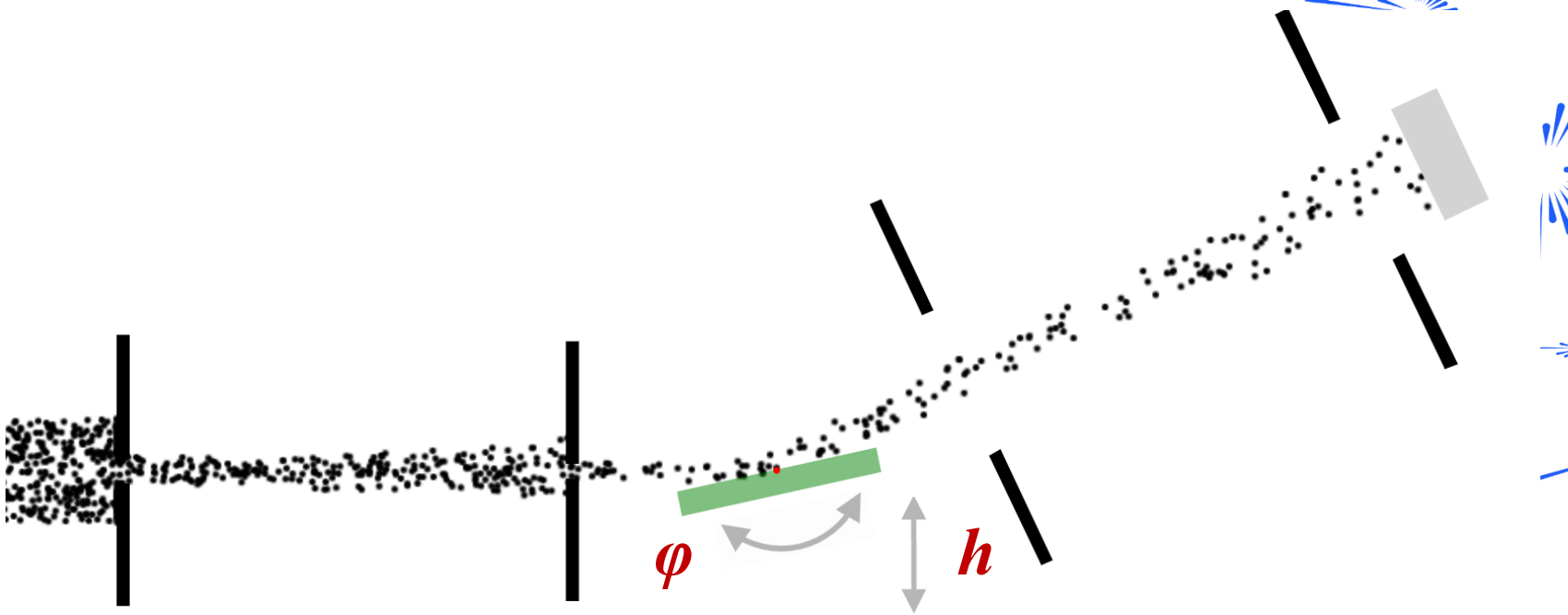
NR alignment algorithm

Stage 2. Reflection mode

1. *phi* scan; reposition *phi*
2. *height* scan; reposition *height*

(gaussian-like dependencies expected)

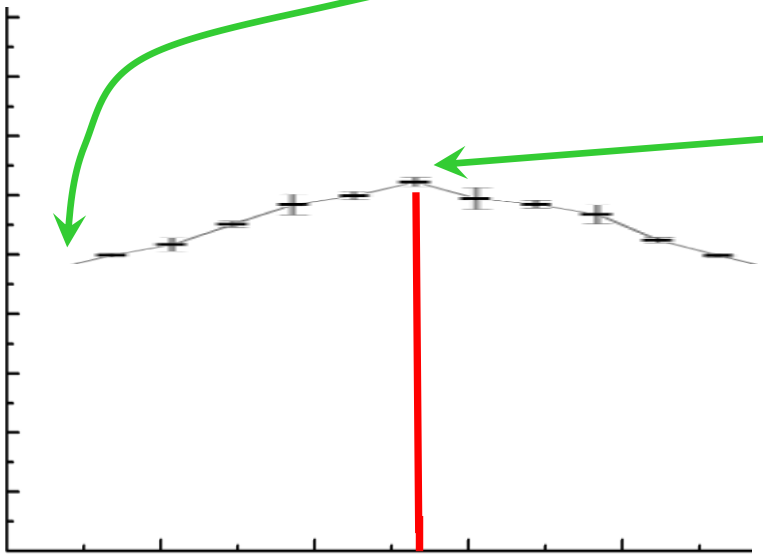
Repeat iteratively until you find the optimum within the error limits



NR alignment algorithm

Stage 2. Reflection mode

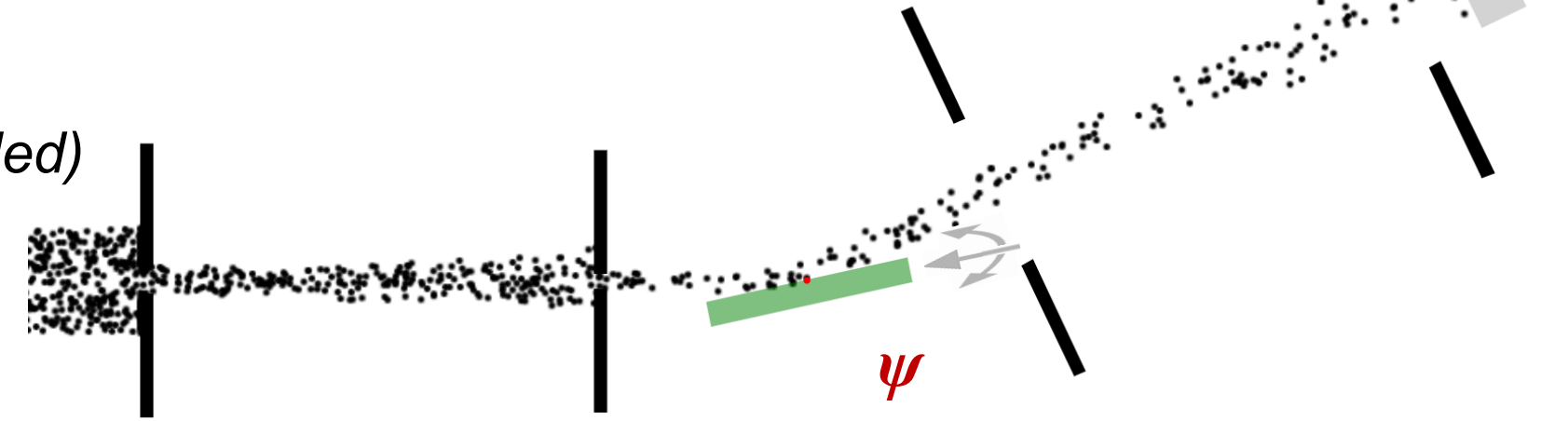
psi pitch scan



ψ

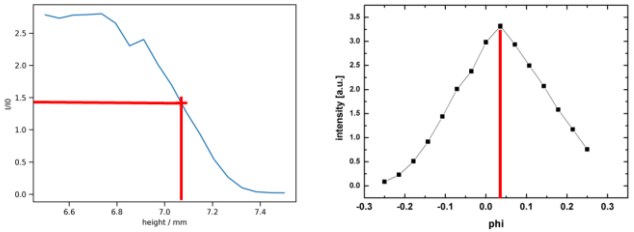
reposition *psi*

(rescan phi and height if needed)



ψ

NR alignment algorithm



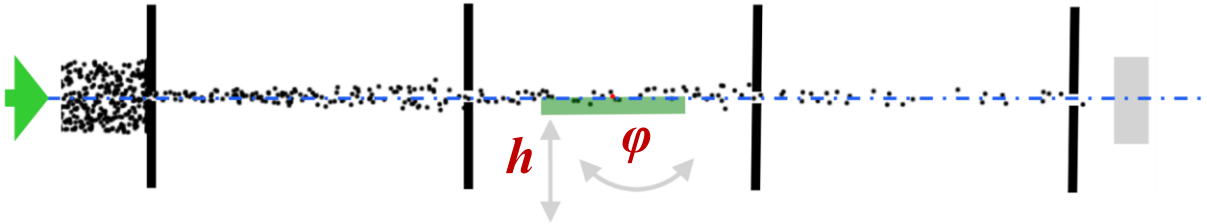
typical scans

Stage 0. Laser mode

install the sample using laser spot

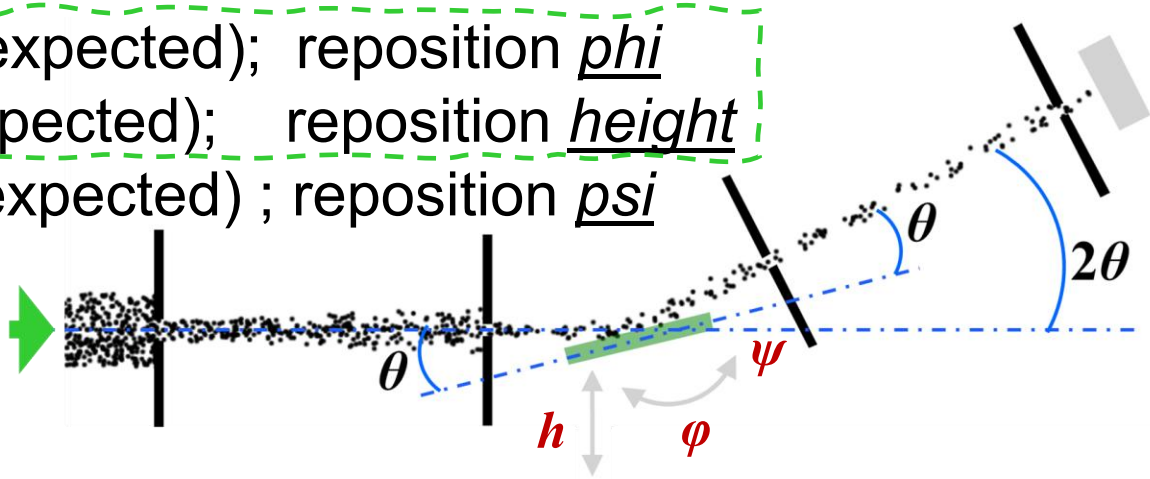
Stage 1. Transmission mode

0. Set *theta*=0
1. *height* scan (step-like dependence expected); reposition *height*
2. *phi* scan (gaussian-like dependence expected); reposition *phi*
3. *height* scan (step-like dependence expected) ; reposition *height*



Stage 2. Reflection mode

0. Set *theta* = 0.5; Set *phi* = *phi* + 0.5
1. *phi* scan (gaussian-like dependence expected); reposition *phi*
2. *height* scan (step-like dependence expected); reposition *height*
3. *psi* scan (gaussian-like dependence expected) ; reposition *psi*



Repeat iteratively until we find the optimum within the error limits.

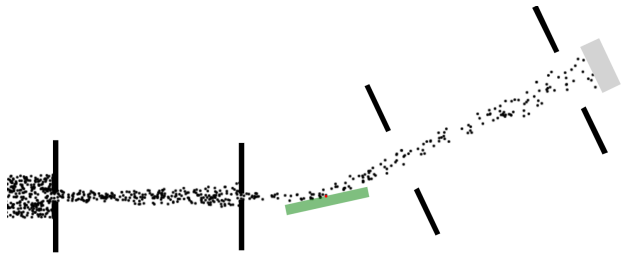
Some virtual practice

NIST

Web-based (html and javascript) calculators for neutron scattering

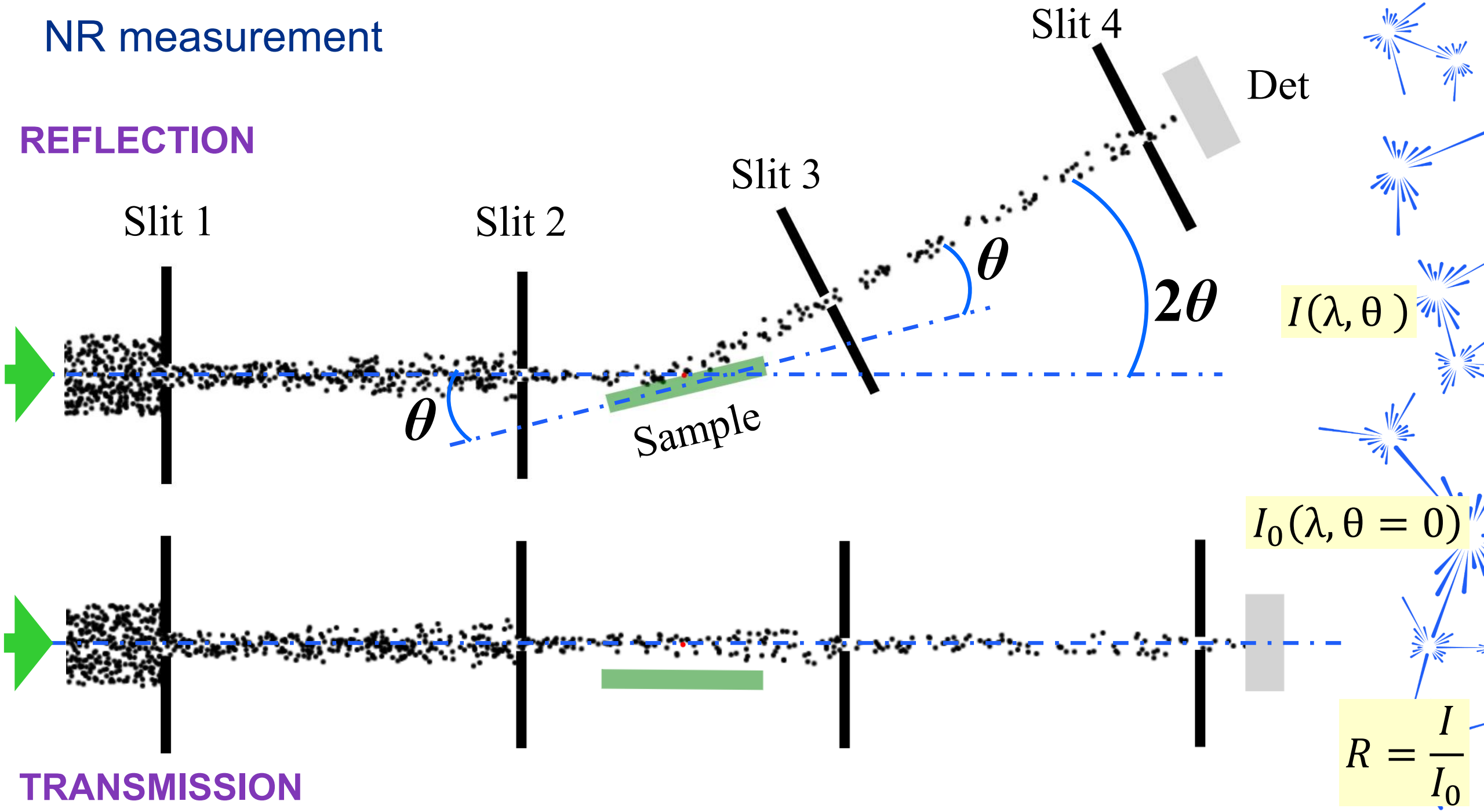
Examples:

- X-ray and neutron reflectivity calculator
- Polarized neutron reflectivity calculator
- Wavelength and velocity distributions of thermal neutrons
- Off-specular experiment planner (Qx-Qz space to Th-2Th coords)
- Beam divergence from slits
- Reflectometer alignment simulation
- Scattering periodic table

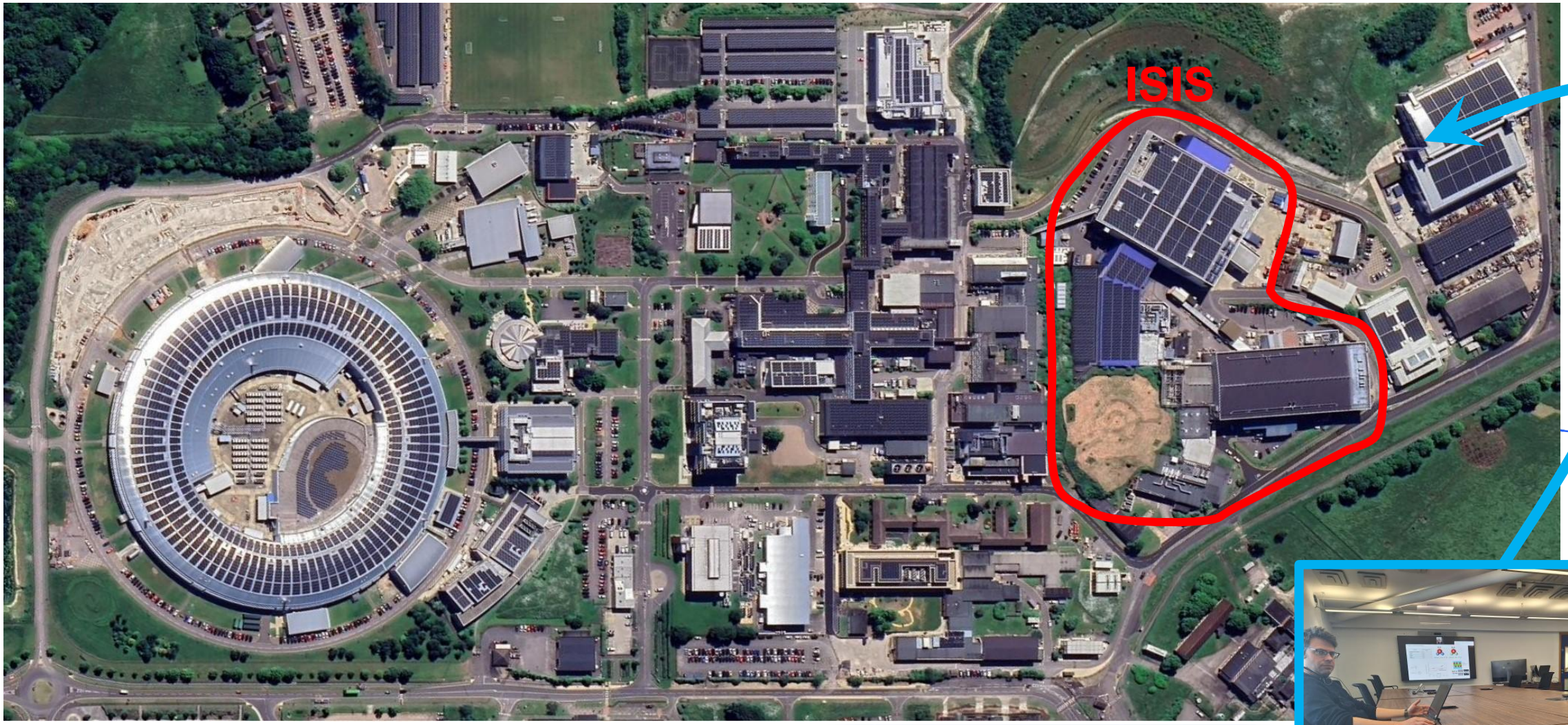


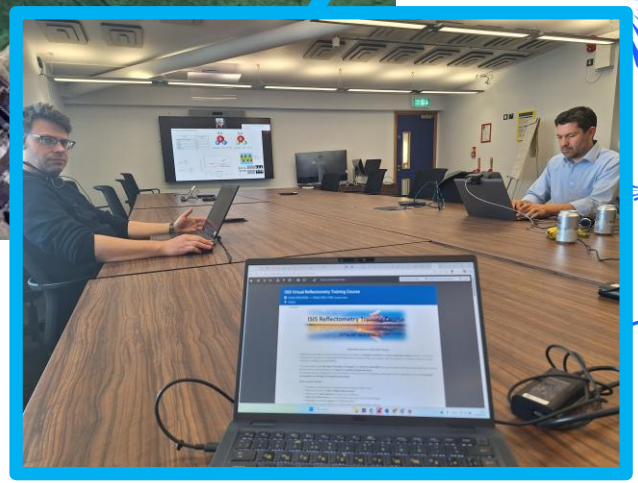
https://pages.nist.gov/reflectometry-calculators/reflectometer-alignment.html

NR measurement



Rutherford Appleton Lab, Harwell Campus





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ISIS Reflectometry Training Course

23rd to 28th April 2026