1.5 Capture flux estimates

- *Definition of capture flux*
- *Measurement and accuracy*
- *McStas simulation*

1.6 Guide losses

- *Mechanisms involved*
- *Simulation*

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Disclaimer: in case of errors and uncertainties, please correct me...

Capture flux: definition

The *'capture flux'* is the standard way to measure an integrated flux in facilities. A white beam is absorbed into a gold foil, in an energy range up to 500 meV neutrons. Then this is normalized to the thermal neutron absorption cross section for λ=1.8 Å (2200 m/s), and finally:

$$\Phi_c = \int_0^{0.5eV} \frac{d\Phi}{d\lambda} \frac{\lambda}{\lambda_{2200m/s}} d\lambda$$

Even though the formula is valid for thermal neutrons, it has been extended to cold and hot neutrons.

So, in a few words, the real integrated flux $\Phi = \int \frac{d\varphi}{d\lambda} d\lambda$

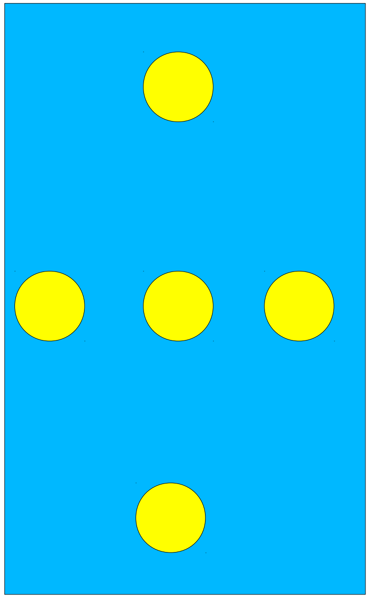
is roughly $\Phi_c \sim \Phi$ for a peaked flux around 1.8 Å

$\Phi_c \sim 2.2\,\Phi$ for a peaked flux around 4 Å

Capture flux = integrated, wavelength weighted flux

Capture flux: measurement and accuracy

The health physics/guide staff put 1 cm^2 gold foils in the beam, and they measure their activity after irradiation. The procedure is very standard, and unchanged for a long time.



$\sigma_{abs}=98.65$ $\sigma_{coh}=7.32$ $\sigma_{inc}=0.43$ [barns]

The intrinsic measurement accuracy of the method is of the order of 10 %.

Simulating capture flux measurement with McStas:

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Monitor_nD(options= “capture per cm2”, …)
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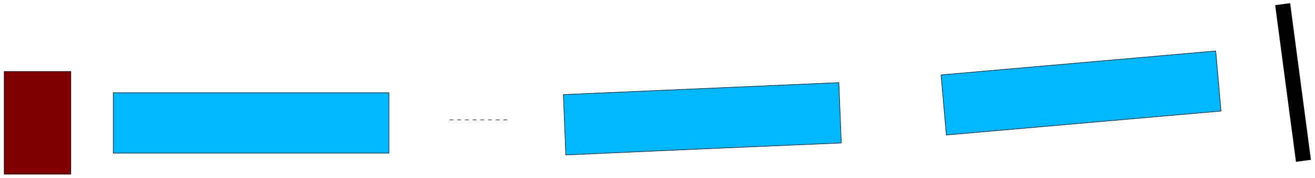
Capture flux: let's simulate !

Aim: Build a guide fed by a continuous thermal-cold source.

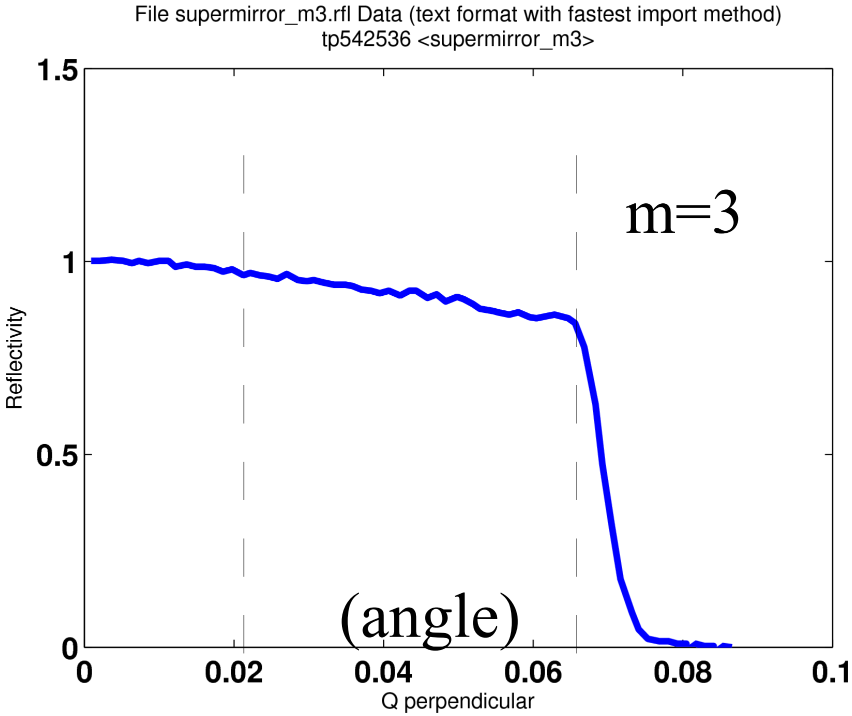
1) Re-use Ex 1.2 (curved guide)
2) At 50 cm from the end of the guide, add a *capture flux monitor*.
3) Simulate
4) Re-simulate with a reduced wavelength range, and then again with shifted range towards hot and cold neutrons. *What do you notice ?*



Guide losses: total reflection

Guides transporting neutrons are not 100 % efficient.

Their reflectivity depends on the material, number and quality of the multi-layers deposited on top of the glass or metal substrate surface.



Non reflected neutrons are either absorbed or scattered. In both cases, this creates background and radiation to protect from with proper shielding.

A rule of thumb says that maximum divergence transmitted by a guide is:

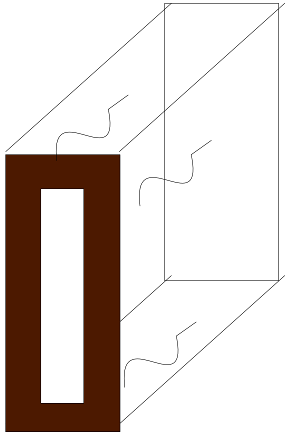
$$\alpha\ [deg] = m * lambda\ [Angs] * 0.1$$

Guide losses: causes for losses

Some causes of non reflection:

- too high divergence, above total reflection angle (depends on material cross section and *m*-value)
- low angle incoherent scattering
- poor waviness of surfaces (poor polishing)
- dirty surfaces (dust, grease, …)

In addition to radiations, the losses damage materials by creating He bubbles which propagate cracks. Glass turns dark and brittle.



Guide losses: estimating neutron losses

From the curved guide assembled previously:

1.Re-use Ex 1.5
2.Insert capture flux monitors in between guide elements
3.Run simulation with *m*=1 and *m*=3
4. *Estimate the losses per meter* (in absolute and percentage)
5. *Does super mirror coating increases background at the end of the guide ?*