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Supporting information for article:

On design and experimental realization of a multi-slit based very small angle neutron scattering instrument at ESS

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Appendix I

Multi-slit masks VSANS collimator gets benefit of enhanced neutron intensity by placing N slits side by side on source and sample masks each, of slit widths O_S and O_{Sam} respectively. Two neighboring slits are separated by a blocked region (which is usually a neutron absorber like Gd, Li etc.) of widths B_S and B_{Sam} on source and sample, respectively (Figure14). Symbol '*L*' is the distance between the source and the sample masks. The neutron beam from each slit channel is focused on the Detector placed at distance L_2 from sample mask (not shown, figure is indicative only). To have the identical neutron collimation from each slit channel, neutrons from channel ABCD should not mix with channel starting beyond DE'. However, if the neutrons are diverging, then some of the neutrons will not get absorbed by the blocked region on the sample masks and may cross over to next slit channel, spoiling the collimation. To kill the unwanted neutrons and keep the neutrons in right channel, let us start placing the intermediate masks starting from the sample masks (Barker, 2014).

We define the blocked region (the distance between the end of any slit to start of next immediate slit edge) to slit open (slit width) ratio as R,

$$R = \frac{DD'}{DA} = \frac{CE}{CB} = \frac{B_S}{O_S} = \frac{B_{Sam}}{O_{Sam}}. \tag{1}$$

Let us impose a constraint over neutrons in channel ABCD that they won't be able to travel beyond certain fraction x of the blocked region CE, towards next immediate slit channel and hence should be absorbed by a mask placed before the sample mask. We term the factor 'x' as safety factor and x can assume any value between 0 and 1. The mask positions can easily be computed using simple geometrical scaling argument. From ΔAA'C' and ΔAA"C", the separation distance of first intermediate mask from source mask is given by,

$$L_1 = L\cdot\frac{A''C''}{A'C'} = L\cdot\frac{B'C''}{BC'} = L.\frac{O_1}{O_{Sam}+CC'} = L.\frac{O_1}{O_{Sam}(1+xR)}. \tag{2}$$

In similar fashion, n^th^ mask position from the source can be computed by progressively working backward,

$$L_n = L.\frac{O_n}{O_{Sam}(1+xR)^n}. \tag{3}$$

Here O_1 and O_n represent the slit width of the first and n^{th} intermediate masks respectively.

Slit widths can be calculated by similar scaling argument,

$$\frac{O_1}{O_{Sam}} = \frac{O_S\cdot(L-L_1)+O_{Sam}\cdot L_1}{O_{Sam}\cdot L}. \tag{4}$$

Using Eq. (2), distances can be eliminated and one arrives at

$$O_1 = \frac{O_S}{1 + \left(\frac{1}{1 + xR}\right)\frac{O_S - O_{Sam}}{O_{Sam}}}. \quad (5)$$

For nth mask, the slit size is

$$O_n = \frac{O_S}{1 + \left(\frac{1}{1 + xR}\right)^n \frac{O_S - O_{Sam}}{O_{Sam}}}. \quad (6)$$

To arrive at these formulas, we have followed the geometric procedure described by J. G. Barker of NIST and these formulas reduces to Barker formula which were derived for the special case of x=0.5.

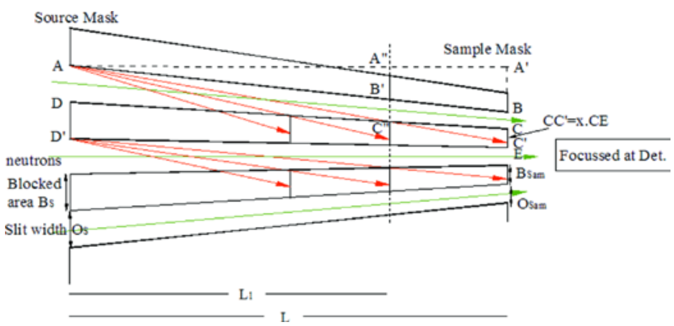

Figure 14. Placement scheme for intermediate masks proposed in multi-slit set up (Barker, 2014).