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ADJUSTABLE COLLIMATION FOR THE GENERAL MATERIALS DIFFRACTOMETER (GEM)

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ABSTRACT

GEM is to be the new structured materials diffractometer for ISIS. This paper reviews its need for adjustable beam collimation to allow the incident beam to be matched to the sample size. The final solution for the adjustable collimation is also discussed.

1. *Introduction*

From the initial specification of GEM, adjustable collimation was a requirement. This instrument will serve a wide scientific community and it is predicted that sample sizes ranging from 20 x 40 mm (width x height) down to 3 x 3 mm will be investigated. With new materials often being supplied in small quantities the ability to accurately study them will be of great importance.

If very small samples are investigated with a much larger beam, the excess could scatter from sample holding equipment and increase the noise to signal ratio. As one of GEM's proposed advantages will be the range of sample sizes that it can study, it was decided that the beam profile should be adjustable. With adjustable collimation, the GEM user will be able to change the beam profile to match that of their sample whatever its size or aspect.

Most other beamlines on ISIS have fixed collimation. This consists of fixed rings of B_4C stacked along the beam tube and collimate the beam to the maximum size and cross section required. GEM has been designed with 5 adjustable apertures. These replace the fixed ring design and give GEM its flexibility.

2. *Collimation Layout.*

The apertures on GEM were to be located at various points down the beamline. Ideally to minimise the beam penumbra at the sample, a slit close to the moderator with another close to the sample would be required. There were two factors limiting the proximity of the second to the sample,

- Scatter from the aperture into the detectors (increasing the background signal).
- The Geometry of the back scattering detectors (physical fit of the detector around the aperture).

Similarly the aperture nearest the moderator could not be closer than 6.3 meters (the target station wall) as placing it within the shutter or insert shielding was not possible.

After analysis a further 3 apertures were required. These are placed at suitable points along the beam line. The collimation tubes between the apertures are lined with B_4C. The B_4C will be installed to give ≈3 mm clearance to the maximum beam size. The surface is serrated creating multiple faces normal to the neutron beam. This will ensure that any stray neutrons which are not collimated by the apertures and reach the tube wall will be absorbed and not scattered into the sample. (*see figure 1 below.*)

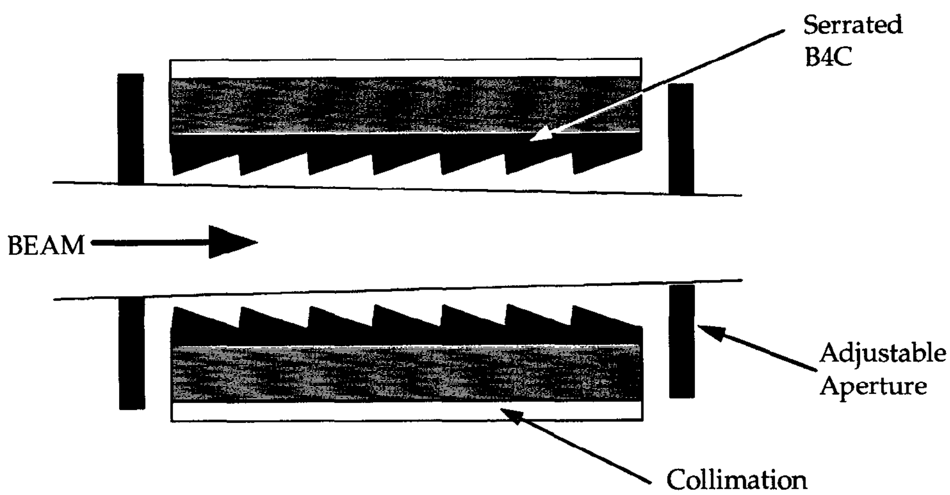

Figure 1.
Schematic of GEM beam tube design.

3. *Aperture Design.*

The GEM beam is rectangular, therefore two axis of collimation were required (vertical and horizontal). One axis of the prototype aperture can be seen below in *Plate 1.*
The system consists of a Stepper motor driven rack. This rack drives a pair of opposing B4C blades (see *plate* 2 below). The design ensures that the opposing blades are always centred around the beam axis. The 5 apertures are set using a Programmable Logic Controller (PLC) to a positional accuracy of ±0.05mm. A micro switch is incorporated for pre-run zeroing. A rotary encoder prevents the motor skipping steps and an incorrect beam profile being created.

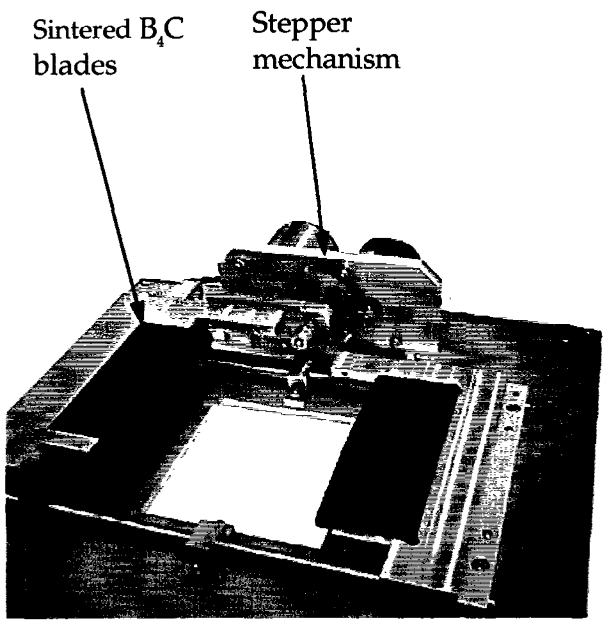

Plate 1.
GEM aperture (only one axis shown).

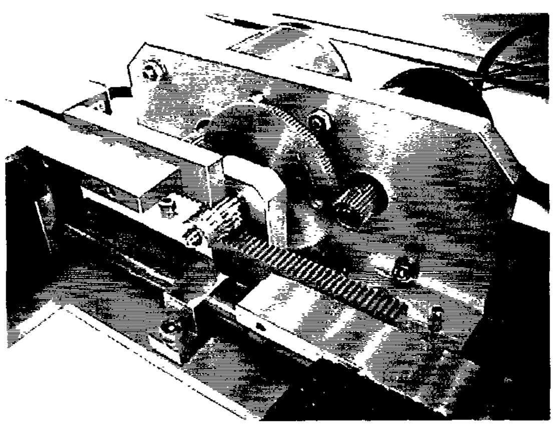

Plate 2.
GEM aperture mechanism

The blades are manufactured from 20mm thick sintered B_4C. The blade is stepped to minimise scatter. The beam is collimated by the leading face (moderator side). The step in the trailing face (sample side) then trims the beam to the required profile and absorbs scatter from the front edge (see *figure* 2. Below).

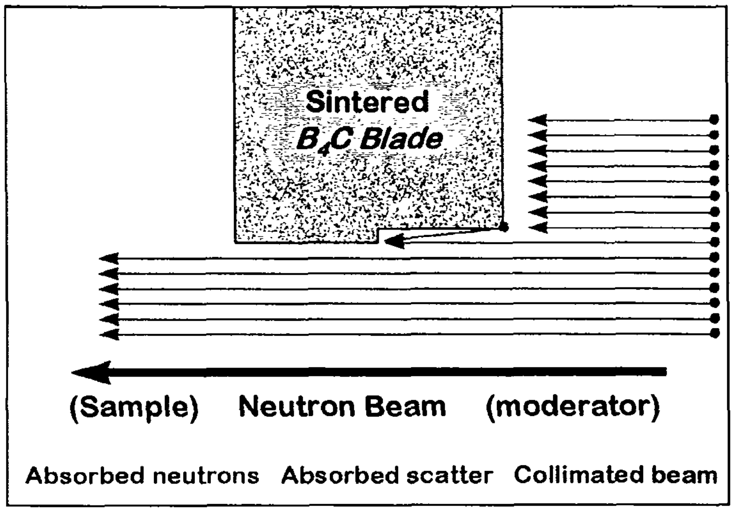

Figure 2
Aperture blade design

To reduce the number of vacuum windows the beam must pass through, several of the slits will be placed in vacuum. Components have been selected and tested to ensure reliability in vacuum and low out gassing rates. This will ensure that pump down times for the collimation tubes are low and a good vacuum can be maintained.

4. Conclusion

The first Aperture for GEM has been manufactured and is currently under bench test at ISIS. The test have shown that the required accuracy is achievable. The prototype aperture required some modification in the early phase of testing but we are now pleased with the performance of both the mechanism and drive system. We are now at a stage to procure the remaining units required for GEM.