A case for the implementation of heavy type beam shutters within the target shielding monolith.

The decision on the implementation and placement of beam line shutters is an important milestone in the definition of the facilities target and neutron instrument systems. The shutter function stands at the interface between two of the facilities principal building blocks, and is determinant in numerous aspects of facilities design, performance, and operational efficiency throughout its lifetime. Due to the high degree of integration and interdependence of both target and instrument systems a decision on shutter implementation is to the large part irreversible after the end of preliminary design phase.

The current design of the target monolith fails to meet important requirements of the instrument scientific and technical stakeholders. It is strongly recommended that a design change is to the current design of the target monolith to incorporate heavy type shutters within the steel shielding (Option C) is adopted as a matter of upmost urgency.

Of all the configuration of shutter considered by the Beam extraction CFWG and the Science directorate operation group Option C (heavy shutter in monolith) is the only one to meets the requirements of both the scientific activities and technical support groups. The placement of shutters within the monolith presents numerous benefits to the facility in terms of instrument performance, availability and safety. It also presents and major operational gains during construction, commissioning and through out instruments operation.

It is acknowledged that the implementation of shutters within the monolith may reduce the irrelevant maximum number of beam port theoretically available. However, the deployment of the current scientific program of 22 instruments is not impacted and a substantial potential for upgrade to ~30 beam ports appear technically feasible[i].
Additional novel further upgrade paths are potentially possible if this opportunity to modify the design of the target monolith is seized to examine the potential of the 'big-shutter-guide-bundle' concept[ii].

Heavy shutters within the monolith are an established feature of target stations at recent spallation sources at SNS, J-Parc, both ISIS target stations, and the proposed Chinese spallation source. Extensive experience operating these sources has been acquired. Both SNS and ISIS scientific personnel underline the operational benefit of having shutters upstream of all instrument components both during operation for adjustment and running repair and technical staff indicate the extreme utility of these devices during instrument construction and commissioning[iii].

A detailed analysis of official records from ISIS[iv] of fault and instrument lost time data supports the view that shutters make a valuable day-to-day contribution to the

safe and efficient operation of instrument beam lines and significantly increase the availability and thus scientific output of the facility. The disadvantage of in-monolith shutters at spallation sources in terms of increased complexity and target maintenance requirements are known and successfully managed at current facilities. The choice of the target geometry increases the complexity of the engineering challenge but it should not prove a showstopper.

'Option E' heavy shutters - exterior to the monolith in downstream position, is currently the option supported by the target group. This design, which is common at reactor based neutron sources, places the shutter away from the source reducing its negative impact on instrument performance.

Despite the apparent attractiveness of this proposal from an instrument performance standpoint, its implementation is poorly adapted to the constraints of a high power spallation source. The placement the shutter out in the instrument hall posses a number of problems, of lateral shielding notably and on an operational level hindering instrument installation, complicating and extending commissioning activities.

However, its most serious disadvantage is that by placing instrument components upstream of the shutter, access is denied to them for the duration of the neutron production cycle of up to 100days. The serviceability of the instrument is drastically reduced and the consequences of critical component failures in are drastically increased with instrument out of operation potentially for months at a time.
The best current estimations of instrument reliability, predict that such faults will occur on 7 to 10 instruments per year with the potential loss of 100's of days of lost beam time.

The presence of shutters positioned upstream permits the optimisation of the instrument operation strategies to changing requirements and to mitigate losses in breakdown situations by shutting beams or extending source shutdowns on a case-by-case basis. This increase operational flexibility is employed at existing facilities to maximize availability and will certainly be key to meeting the ESSs challenging target of beam days delivered to the scientific community.

Summing up, In-monolith shutters (option C) represents the solution best able to meet the requirements of the majority of stakeholders, support the instrument activities, and contribute to the achievement of the facilities goals. It increases the operational flexibility of response in the case of instrument failure, permits the optimisation of operating schedules and facilitates instrument construction. The utility and value to the facility has been demonstrated at existing spallation sources. The cost is equivalent to the other solutions considered and the technical risks are known and low.

It is recommended that shutters (option C) be adopted as a design change to the target monolith.

[i] A consideration of beam separation in instrument design, I.Sutton, P.Bentley E.Nilssonn
[ii] The potential of guide bundles is large angular shutters, Arno Heiss
[iii] Private communication, S.Wakefield, ISIS operations group leader
[iv] Analysis of Instrument lost time data at ISIS, I.Sutton 2013