Shielding Options
To Address
MTA Roll Up Door Shielding Block

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with images and cost estimates from
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Introduction

The MTA roll up door provides an 8' high, 11' wide opening onto the exterior pit which is accessible by a cargo elevator and open to the sky. All other access to the experimental hall and the beam line is through the personnel door. Five rows of shielding blocks were stacked outside the roll up door, filling the 13' width of the corridor, 15' deep and 27' high matching the height of the berm. These must be unstacked with the use of a large construction crane in order to access the roll up door, costing considerable time and money. This document explores two possible mitigations for the expense of crane rental and operation: Redesign of the shielding block stack to incorporate a removable plug at the rollup door level; and replacing the shielding block stack with increased shielding inside the experimental enclosure. (See Fig. 1.)

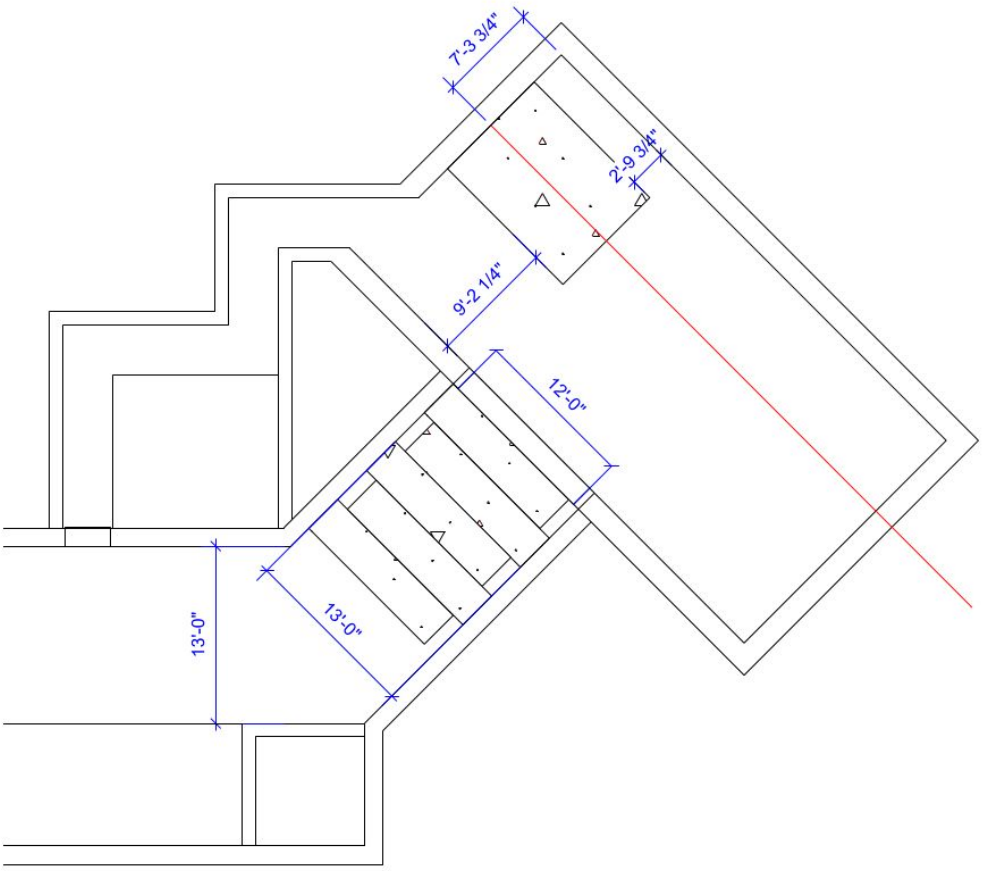

Fig. 1 Plan view of Irradiation Physics Area. Red line show beam path (lower right to top left) into irradiation cave (9' x 12' footprint) which is immediately before entering beam pipe into final absorber (not shown). Pedestrian labyrinth is the only open entrance. The 12' width of the roll up door is blocked by 5 depths of shielding blocks stacked in a staggering pattern to prevent through-cracks.

Redesigned shielding block stack

We consulted with Christine Ader, AD Engineer. Her estimated costs are shown the attached spreadsheet. Including engineering time for mechanical engineer, installation planning, installation time, as well as fabrication costs for the high-capacity Hillman rollers capable of rolling the shielding plug out of the wall (in the manner of the NuMI shielding wall), this estimate comes to just over $197,000. This is to be compared the cost saved by making all future access to the roll up door without need for a large crane operation.

Replacing external concrete blocks with additional shielding inside the enclosure

The five layers of shielding blocks (15' thick) stacked outside the roll up door represent five successive, tenfold reductions in dose. They cannot fit inside the enclosure, where the distance from the beam line to the roll up door is 13.6', but five tenth-value layers of iron is only 5' thick, and this would fit.

Reducing the distance from beam to the shielding from 13.6' down to 1.5' would match the half-width of the planned shielding cave for irradiations. This also reduces the distance factor $1/r^2$ from 3.75e-5 in^{-2} to merely 3.086e-3 in^{-2}, a ratio of 1/82.3. Thus, the shielding closer to the beam line must attenuate the radiation about another factor of 82.3. Two more tenth-value layers of iron would compensate, making the total necessary shielding 7 ft. of iron. (See Fig. 2.) The new shielding wall would displace a 3' thickness of the concrete irradiation cave, and so would have to be thickened by 1' iron in this area.

The internal shield wall of 7' thick iron would need to provide coverage in the case of a beam steering accident for an object at any point in the beam line scattering radiation to any point outside the enclosure. With the shield blocks removed this becomes the area just outside of the roll up door. This requirement implies that the iron shield wall must extend the entire length of the enclosure, cutting off all access between the beam line and the roll up door for which we are trying to improve access. Moreover a beam loss accident which happened upstream of the enclosure proper, near the final quadrupole triplet and at the bottom right corner of Fig. 1 and 2, would not be sufficiently shielded for a point outside the roll up door.

We conclude that an internal shielding wall is not a viable replacement for the external shielding block stack. To meet shielding requirements it would have to be so large as to block the access it was meant to enhance.

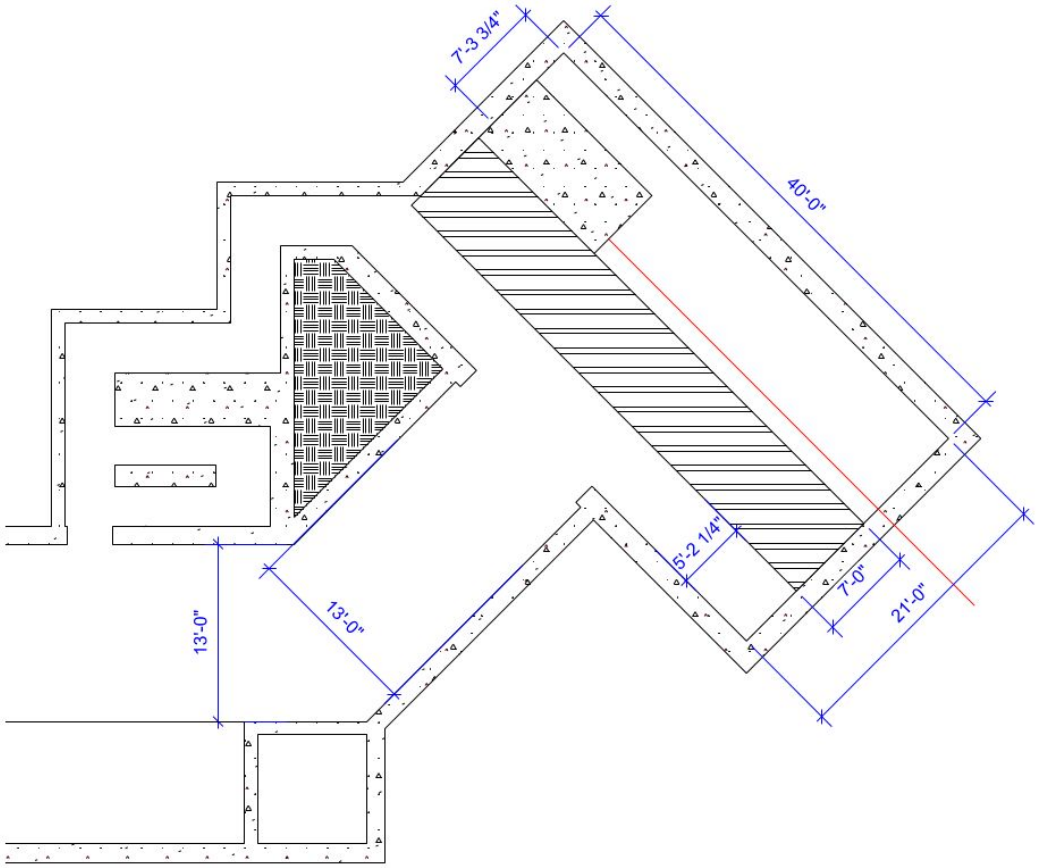

Fig. 2. External shielding block removed and an internal shielding wall, 7’ of iron, extended the full 40’ length of the experimental enclosure. A beam loss accident from the bottom, right-most point on the red beam line would reach a point at the far side of the roll up door without passing through as much attenuating distance and shielding as the original shielding block pile provides.