High Rate Tracking Test Beam Area Proposal

V 1.3 9/20/12

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Abstract

There is a need for a high rate tracking test facility at Fermilab. CERN is developing such a facility, but the CERN accelerators will be shut down for an extended period of time starting Spring of 2013. We can establish a test area in the meson Test beam line with the required properties with very little effort at a very low cost. Many tests in the new area will allow for simultaneous use of the Meson beamline with experiments in the Meson Test Facility.

Location

MT3 has two sections, upstream and downstream. The upstream section is approximately 50 feet of enclosure that is comprised of two quadrapole magnets one vertical trim magnet and a pinhole collimator. There is one bayonet style SWIC between the two quadrapole magnets that are spaced apart by 6 feet. Figure 1 and 2 show images of this upstream section and the proposed area for a detector table.

Figure 1 Upstream and downstream section of MT3. The 6 feet of 6" beam pipe will be adapted for a moveable table

Figure 2 Upstream section of M03 looking downstream

The Detector Table

The detector table is 4 feet long with transverse motion relative to beam trajectory. Shown in Figure 3 is a similar table proposed. With the table mounted to the floor, the maximum vertical adjustment is 6 inches. The beamline itself is 12 inches above the floor. Therefore the table cannot physically be in the path of the beam. The horizontal movement range is also 6 inches. Therefore we will position the table so the motor drives stay away from the beam trajectory if the table is driven inwards. Both movements transversally have physical motion stops and limit switches built in.

Figure 3 Actual detector table

The detector table will not be interlocked to the safety system or the nearby MT3 pinhole collimator. Whether the beamline is in 120 Gev Proton mode or either of its two Pion modes, the position of the table will not matter for beam dynamics for the downstream user at MT6. For the same reasons mentioned before the detector table will not be interlocked to the MT4 target. Thus both areas can be run simultaneously.

The Setup

In order to make room for this detector table we need to replace the 6 feet between the two quadrapole magnets with an air gap large enough for the table but minimize unnecessary beam loss. The space between the quadrapoles will then have a vacuum bypass line to have continuous vacuum around the table. Shown in Figure 4 is an example of such vacuum bypass line.

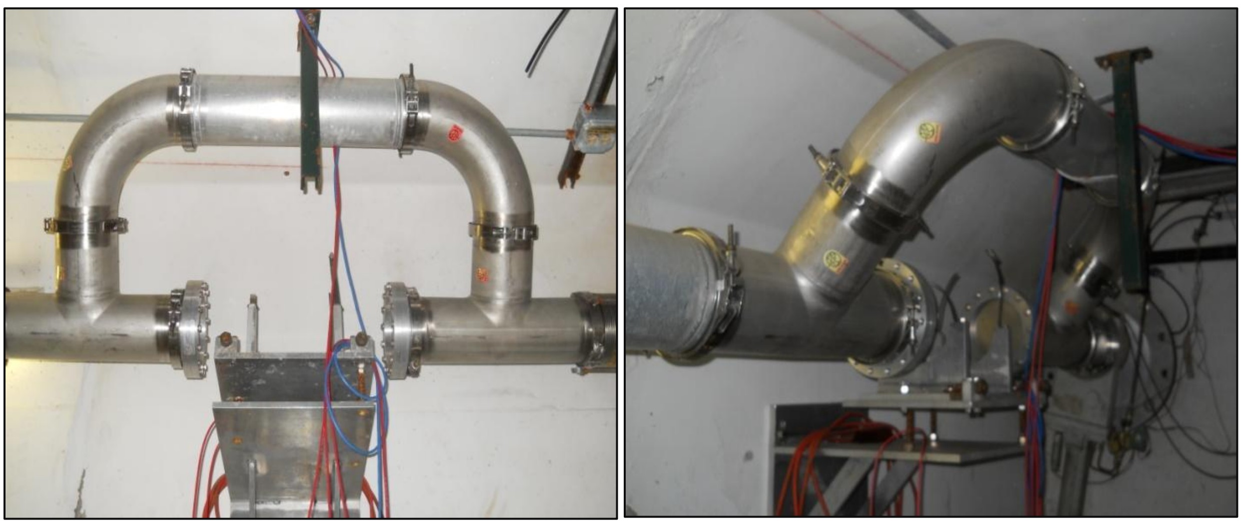

Figure 4 Example of Vacuum bypass line for continuous vacuum with an air gap

The detector table controls will be installed in the MS3 service building. There is plenty of empty rack space and available connections to the ACNET network. If additional ACNET crates are needed there is room for such crates.

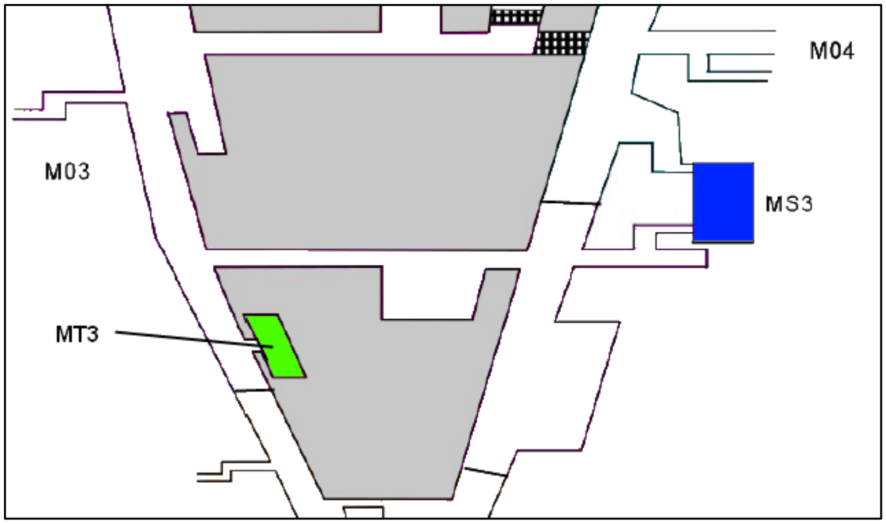

Figure 5 Map of MT3 and MS3 Service building

Typical Test Devices

Typically, the devices to be tested will be silicon detectors and wire chambers. Conservatively the most massive detector being tested is a system of prototype CMS pixel detectors. Each detector plane could be as thick as 1.5 mm silicon equivalent. A 10-plane system could be equivalent to 1.5 cm of silicon. This air gap and detector setup though will induce a small percentage in beam loss. Table 1 has a calculated total sum of that percentage loss.

Air Gap w/ Ti Windows & Detector Planes		Air	Ti	Ti	Si	Total
density (g cm-3)	ρ	0.0012931	4.54	4.54	2.33	
thickness (inches)	l	48	0.003	0.003	0.59	
thickness (cm)	l	121.92	0.00762	0.00762	1.4986	
Nuclear interaction length (gm cm^{-2})	λ_I	90	126.2	126.2	108.4	
Interaction Lengths = Thickness/(λ_I/ρ)		0.175%	0.027%	0.027%	3.221%	3.451%

Table 1 Calculation of combined interaction length of air gap and titanium windows

Adequate Shielding

In the April 8th 2003 Shielding Assessment for the Switchyard 120 Project, there are calculations done for the amount of beam losses acceptable for the current shielding. This shielding in the M03 section is done by looking at the transverse direction and longitudinal direction as depicted in the shielding assessment. Both of these calculations are completed by also specifying the type of beam loss. In this proposed change we will assume a loss on a magnet, which is the most severe case.

Transversally in M03, the current shielding has 18.13 effective feet of dirt, or e.f.d. and longitudinally there is 15.51. For a category 4A in the Shielding Assessment[1], beam loss on a magnet, the required amount of e.f.d. is 13.8. Both transversally and longitudinally there is an adequate amount of shielding for a loss on a magnet. Table 2 summarizes this.

	Cossairt Category	Current Shielding (e.f.d.)	Required (e.f.d.)	Difference (ft)
Transverse	4A	18.13	13.8	4.33
Longitudinally	4A	15.51	13.8	1.71

Table 2 Shielding requirements for MT3, and adequate shielding measurements

Users and Procedures

The High Rate Tracking area will have multiple users as predicted in the abstract. These users will follow a similar process as the Fermilab's Test Beam Facility users. This process is managed by the FTBF coordinator. Additional training will be required as indicated by the Memorandum of Understanding (MOU).

Summary

Fermilab has titanium windows in stock and available beam pipe in old enclosures that are easy to assemble in M03. With known dimension and movements of usable tables we will be able to keep costs down even further by reusing this device. With slight modifications to the current M03/MTest beam line we can provide versatility to potential users.

[1] Shielding Assessment for the Switchyard 120 Project April 8th 2003 Table GK-7 and GK-8