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Tracking and Plotting a High-intensity, Low-energy Muon Beam

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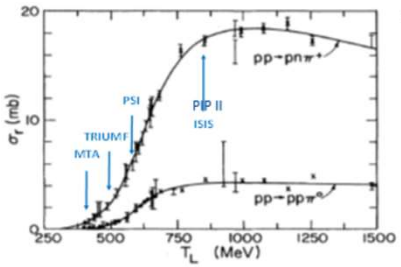
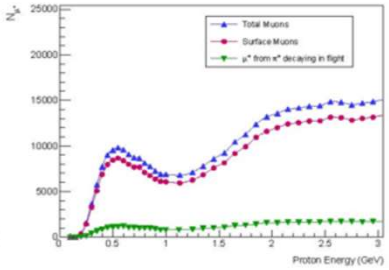
Overview

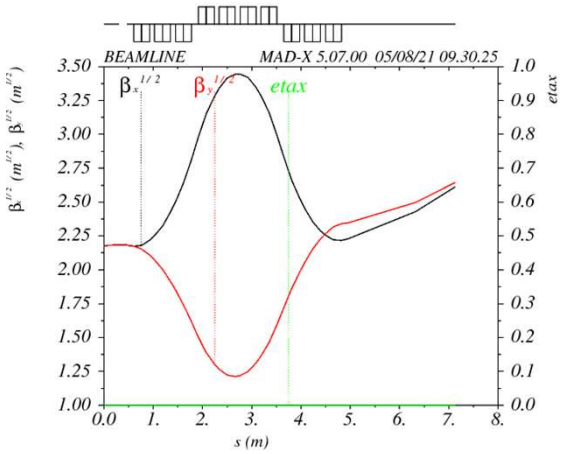
The high-intensity, low-energy muon beam will be used for a variety of experiments at Fermilab. The very design and construction of the beam moves us forward in our understanding of muon production. Among other things, the muons produced give us the opportunity to explore muon catalyzed fusion, charged lepton flavor decays, and forces weaker than the weak force.



Total single mu+ production cross section dependence on proton energy



Variation of mu+ yield with incident proton energy for muons with momenta <= 30MeV/c



Beam envelope optics for the muon beamline

This is a plot made using MADX. It is representative of the stability of the beamline as it moves through the beam pipe. As we can see from the plot, this beamline is extremely stable. Even taken at a deltap of +-.1, the beam continues to be stable throughout. This is a great sign for minimum particle loss in the beam.

Table 1: Comparison of Surface Muon Facilities and Mu2e

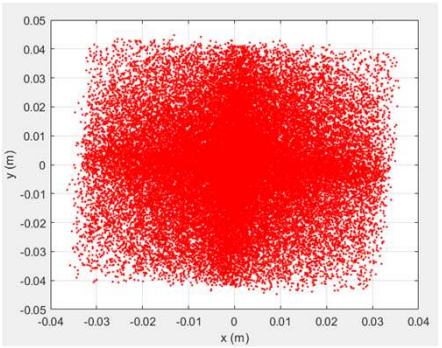
Facility	Max. (surface) μ rate (Hz)	Type	Comments
PSI [14]	9×10^8	CW	
TRIUMF [15]	2×10^6	CW	
MuSIC at Osaka [16]	10^8	CW	
J-PARC [17]	6×10^7	pulsed	
ISIS [17]	6×10^5	pulsed	
HIMB at PSI [13]	10^{10}	CW	(design goal)
Mu2e at Fermilab	10^{11}	pulsed	Not surface muons: $p_\mu \approx 40\,\mathrm{MeV}/c$
Mu2e with PIP-II	10^{12}	pulsed	Not surface muons: $p_\mu \approx 40\,\mathrm{MeV}/c$

Comparison of Surface Muon Facilities and Mu2e

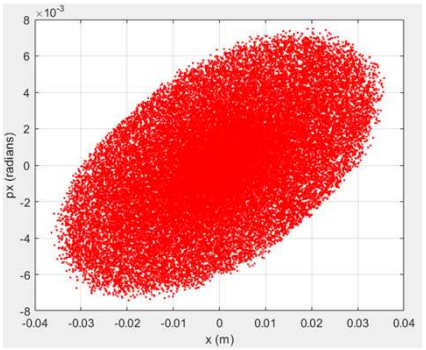
What's special about this beam?

This beam is an excellent step forward in our understand of the universe we live in. It is of note that there are no other facilities on the planet that achieve close to the same pion production as this beamline will. This will be achieved through using a high Z, tungsten target. Further, research is being done into target optimization including angling and even slicing the target into sections.

Muons that reach the end of the beamline



Phase space of the beamline



Success rate

From the tracking and plotting done, represented above, around 99% of the 50000 initial muons made it from the production target through the secondary beamline. This is an excellent production rate, and huge success.

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