



DUSEL Primary Proton Line Options

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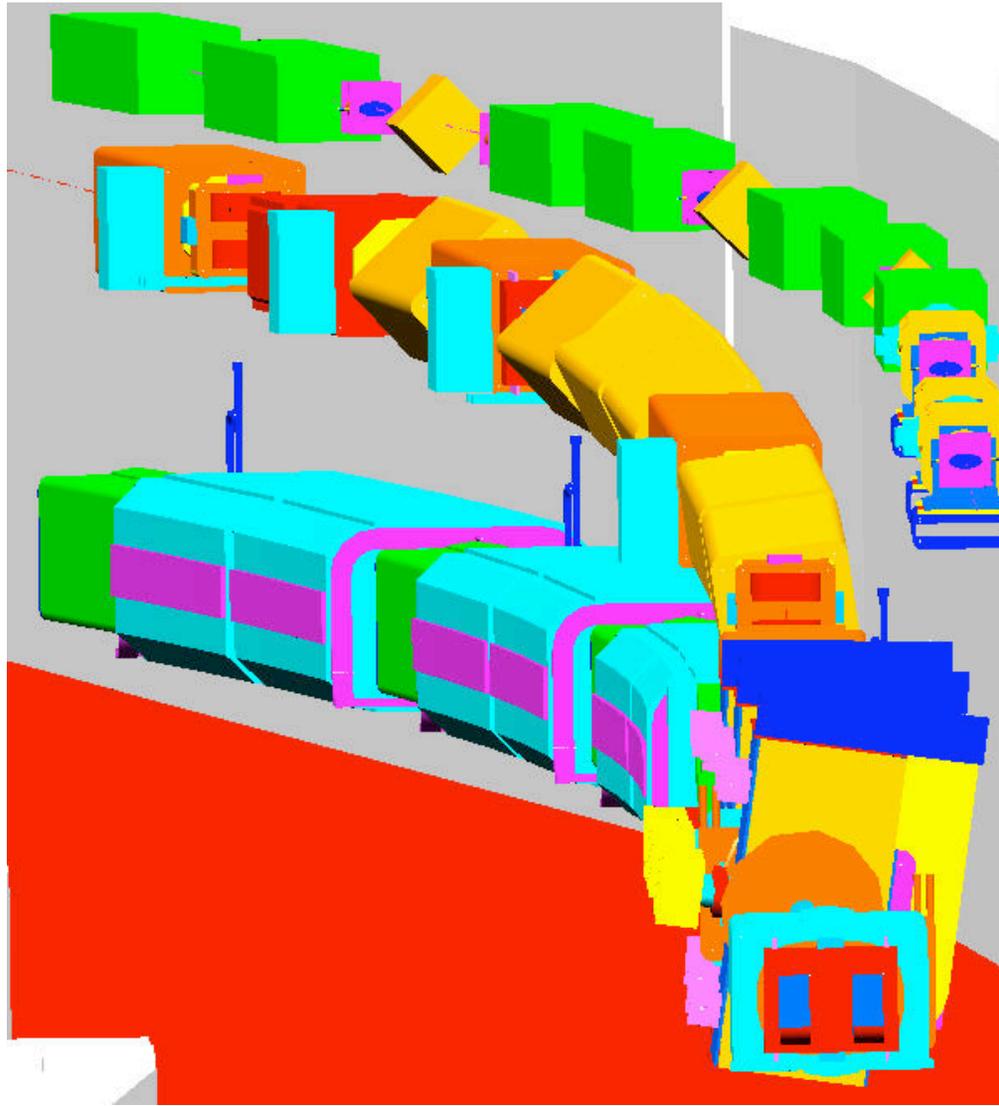


Assumptions/Ground Rules

- Will utilize NuMI kicker and extraction channel
 - No other MI straight sections are available
- Considerable advantage in making use of existing NuMI extraction stub
- Beam on target must point at DUSEL (or maybe a little off-axis)
 - Bend horizontally 844 mrad (48.3 degrees)
 - Bend vertically 102 mrad (5.8 degrees)
- Line has strong focusing FODO lattice over essentially its entire length



Schematic of Extraction Region





WHAT TRAJECTORY TO FOLLOW?



I. Horizontal Bend in MI Tunnel

- Advantage
 - Minimizes the amount of tunnel to be excavated
- Disadvantages
 - Interference with infrastructure over a long distance (We did deal with this in the small region of NuMI shown above.)
 - Too close to MiniBooNE, 8 GeV line, Project X
 - Extended MI shutdown



II. Helical Line

- Horizontal and vertical bends simultaneously
- Advantage
 - Minimal number of magnets and length of excavation
- Disadvantages
 - Not easily constructible, too many magnets on a slope



III. Shallow Option

- Description
 - Start with horizontal bend at MI depth or less
 - Bend down just enough to hit DUSEL
- Perceived advantage
 - Minimize bedrock excavation
- Disadvantages
 - Need a quite long straight section to get to a ‘greenfield’ area for considerable cut/cover
 - Since target hall must be in bedrock, very long soil excavation to get there
 - No structural mining for decay region



Present Best Choice, Similar to NuMI

- Put horizontal bend first, in soil at about MI depth
 - If go deeper need more cut/cover volume
 - If go shallower will need a berm over entire bend region
 - Must pass nearby 8 GeV and Project-X lines
- Bend steeply down, as for NuMI, to go through the soil/rock interface quickly, get to appropriate target hall depth sooner
 - Do not compromise the strong focusing lattice
- Bend up (less down) to target at DUSEL angle

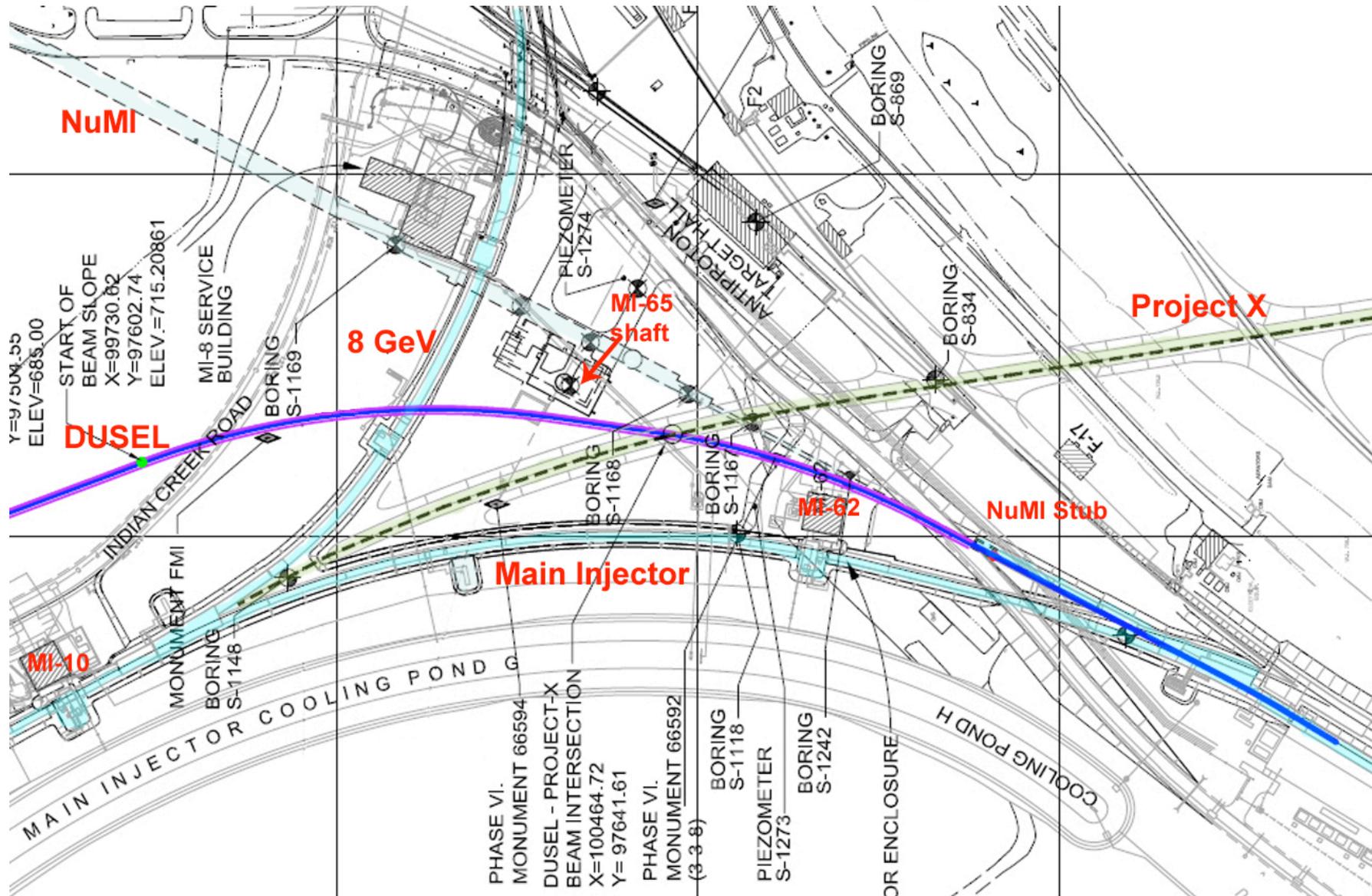


Magnet Counts for this Option

- 42 twenty foot dipoles; available in old Main Ring
- 43 ten foot quadrupoles; some old ones available, can probably scrounge some, but must presume that the majority will have to be constructed, matching existing design
- 40 Main Injector trims; the majority must be constructed, built ~20 for NuMI



Extraction Region



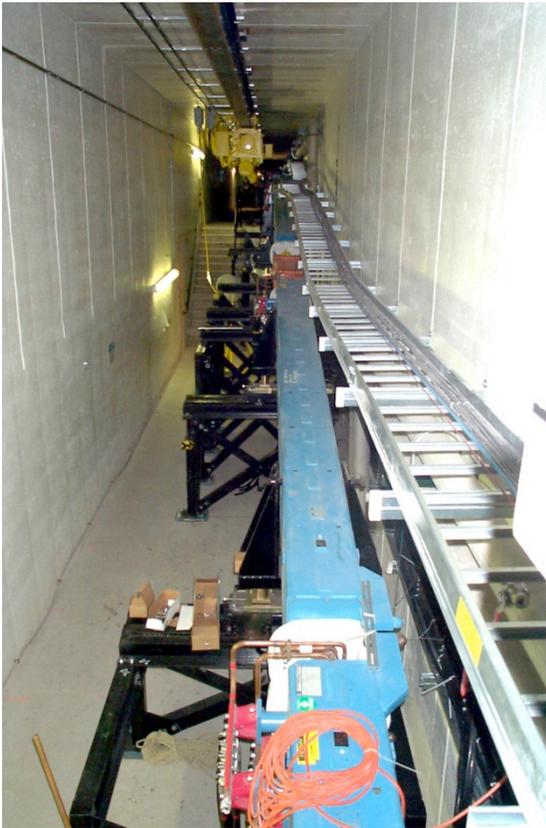


A New Requirement: Keep NOvA Line Intact

- Solution: Use two wide-aperture 10 foot dipoles as a switch
 - These go in the space currently used for delivering antiprotons to the Tevatron
 - Bend DUSEL beam horizontally
 - Turn off for NOvA
 - To get the separation needed, must modify strong focusing lattice somewhat, this is still under study



View looking upstream and uphill.
DUSEL beam above and slightly
left



Looking downstream and
downhill. DUSEL beamline
(mostly just pipe) near ceiling

