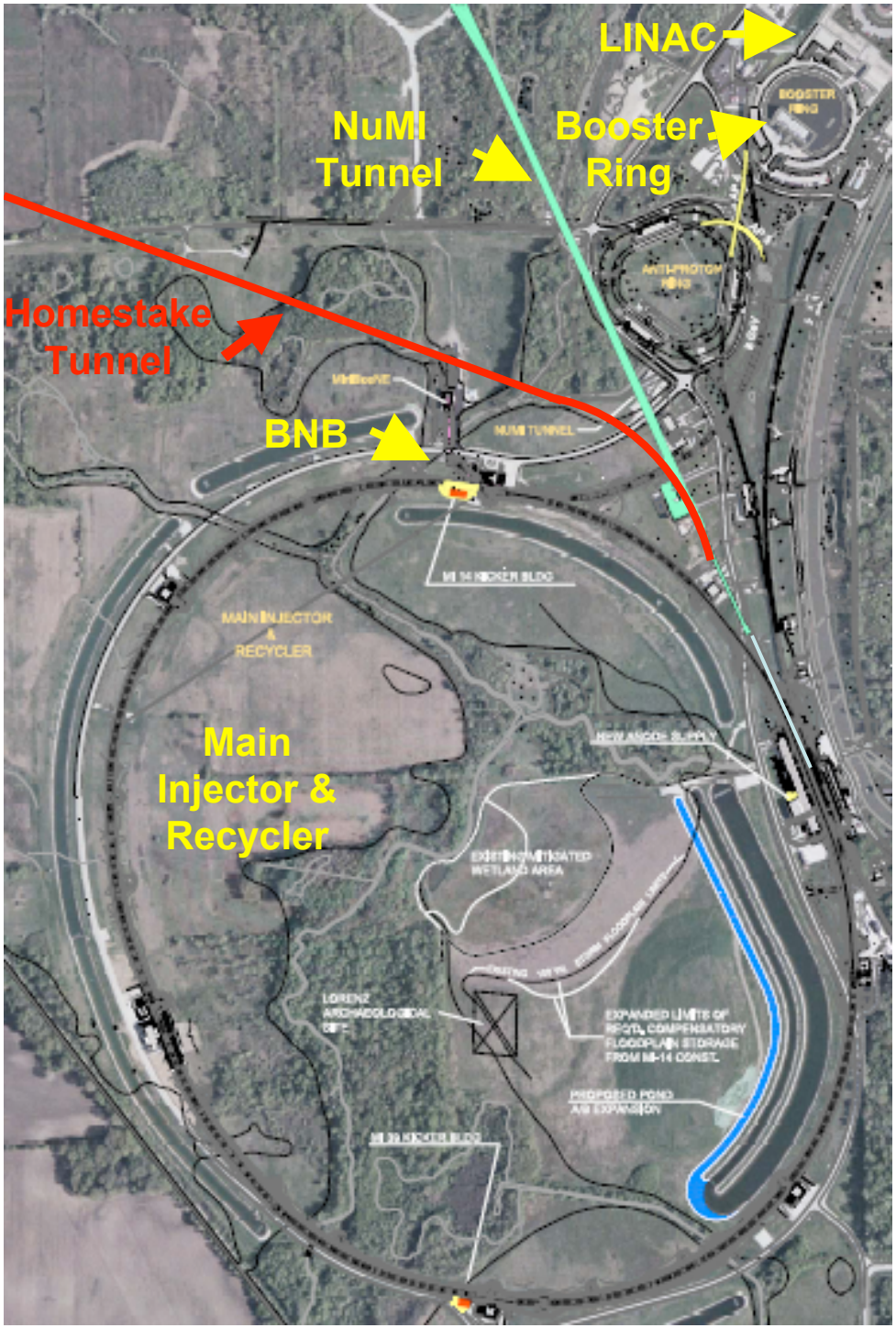

NuMI/Homestake

Discussion of a proposed location for a new Main Injector neutrino beamline sharing the existing MI-60 extraction system

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Homestake Detector Discussion

Overview of the Homestake Beamline

This is an attempt to lay out a neutrino beam line towards the selected DUSEL site at Homestake in Lead South Dakota.

The solution shown on the next slide utilizes the present extraction out of the Main Injector at Q608 into the NuMI line. It requires the construction of an additional tunnel, in the proximity of the Lower Hobbit door in the NuMI line, (for this work between Q114 and Q115) in order to transport the proton beam to the west direction. The radius of curvature of this line (shown as red on the next slide) is the same as the Main Injector and so it is adequate for up to 120 GeV proton beam with conventional magnets.

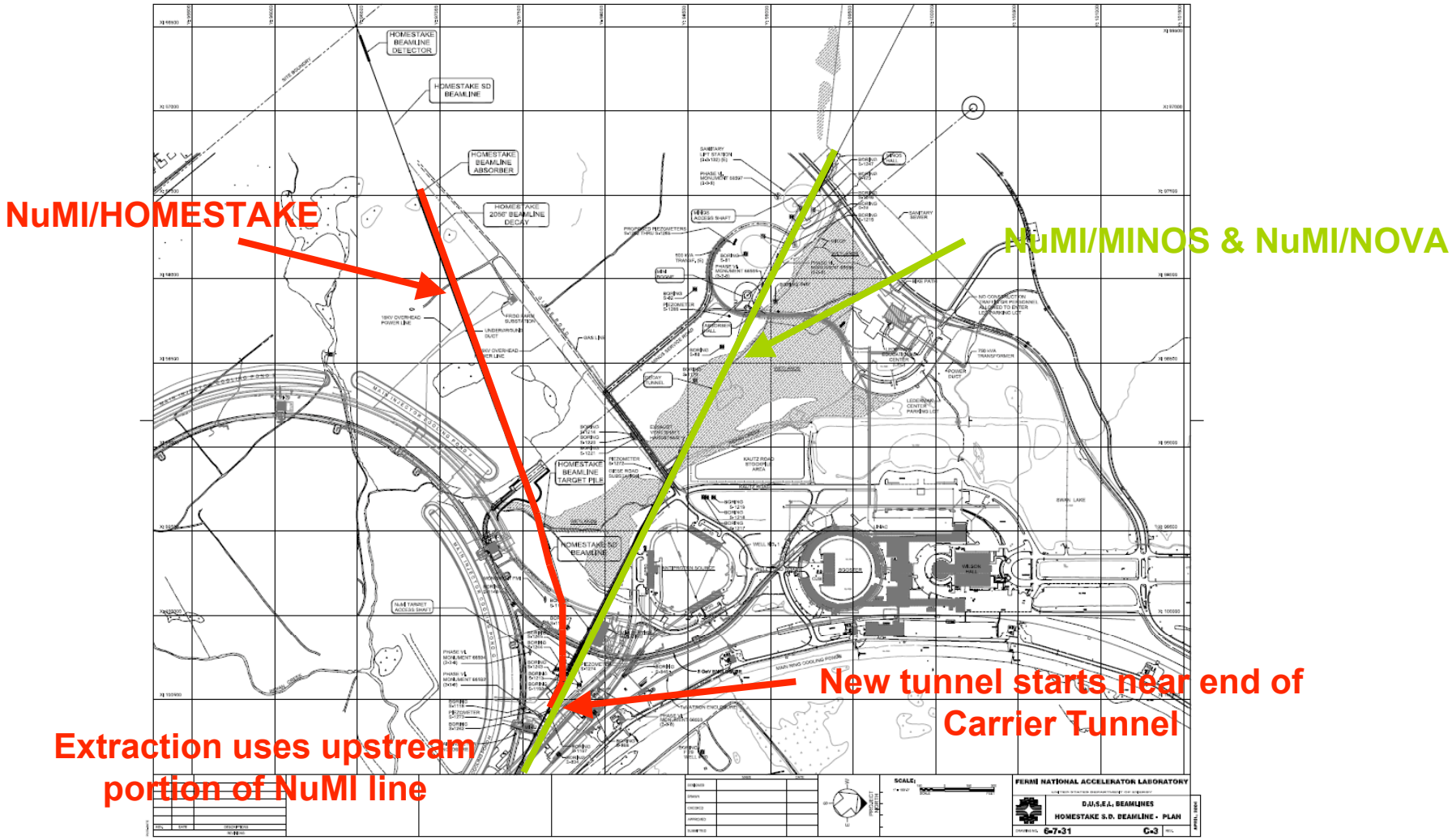
The main parameters of the Homestake line are shown in Table I.

A target hall length of ~45 m is assumed (same as NuMI for this fir st layout, shorter may be adequate), a decay pipe of 400 m (adequate for a low or medium energy beam) and a distance of ~300 m from absorber at the end of the decay pipe to a Near Detector (same as NuMI).

	Latitude	Longitude	Vertical angle from FNAL (deg)	Distance from FNAL (km)
Homestake	44.35	-103.77	-5.84	1289

Table 1: Main parameters of the Homestake DUSEL site

Location of the Homestake Beamline



Homestake/DUSEL Neutrino Beam

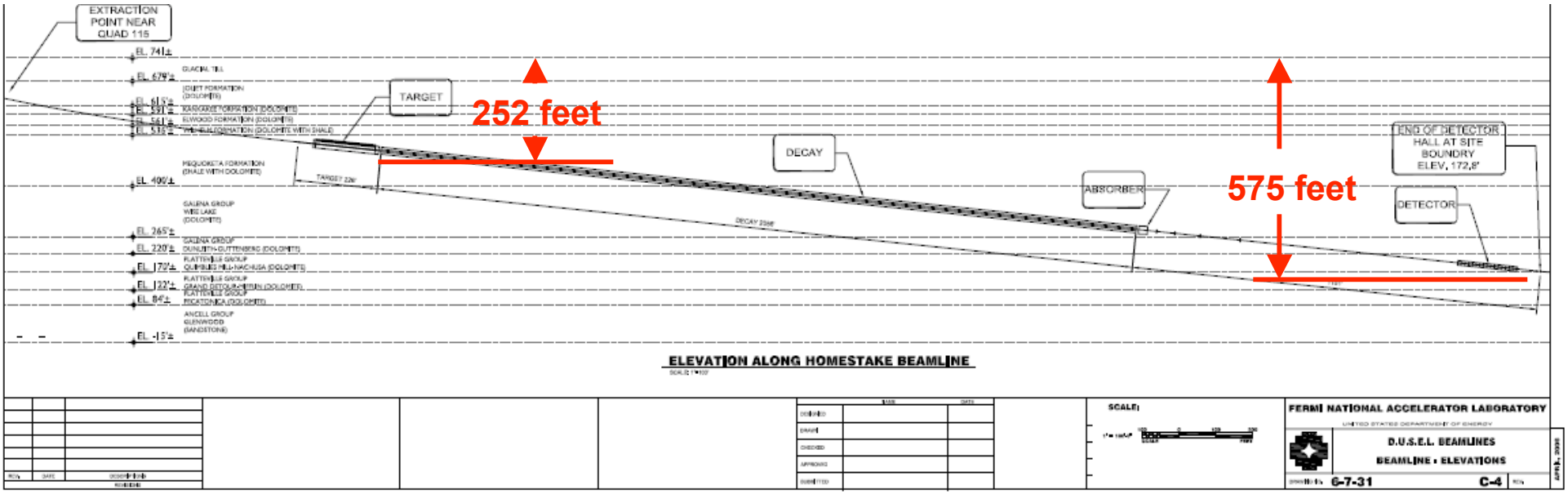
Location of the Homestake Beamline

Homestake/DUSEL Neutrino Beam

Location of the Homestake Beamline

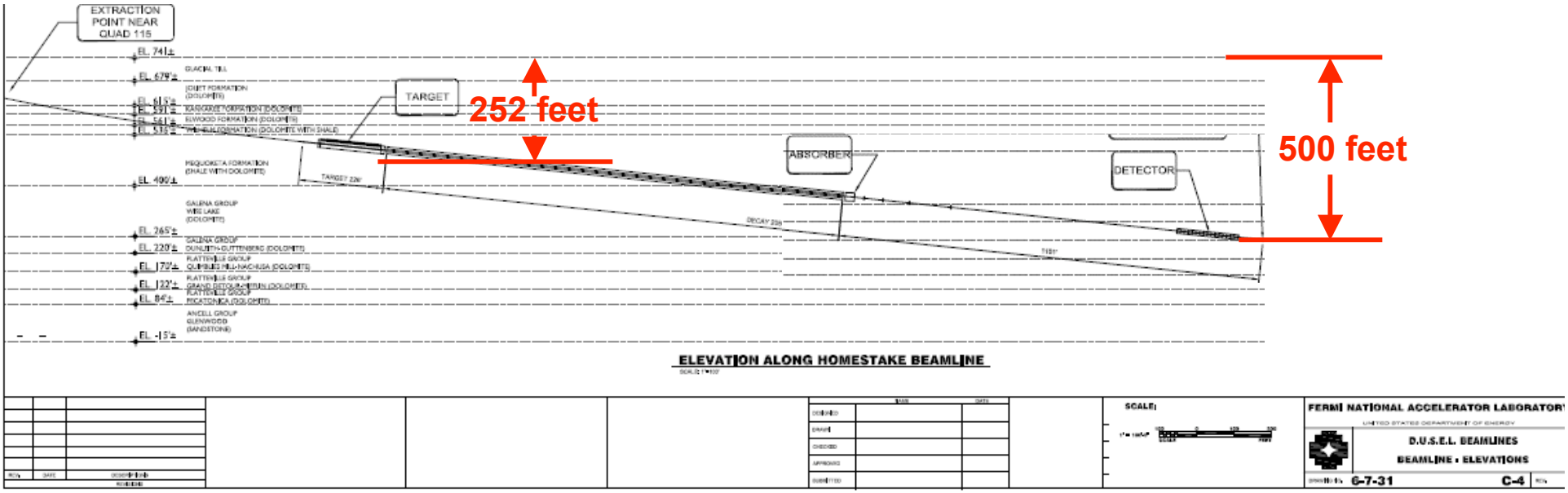
Homestake/DUSEL Neutrino Beam

First Elevation View of the Homestake Beamline



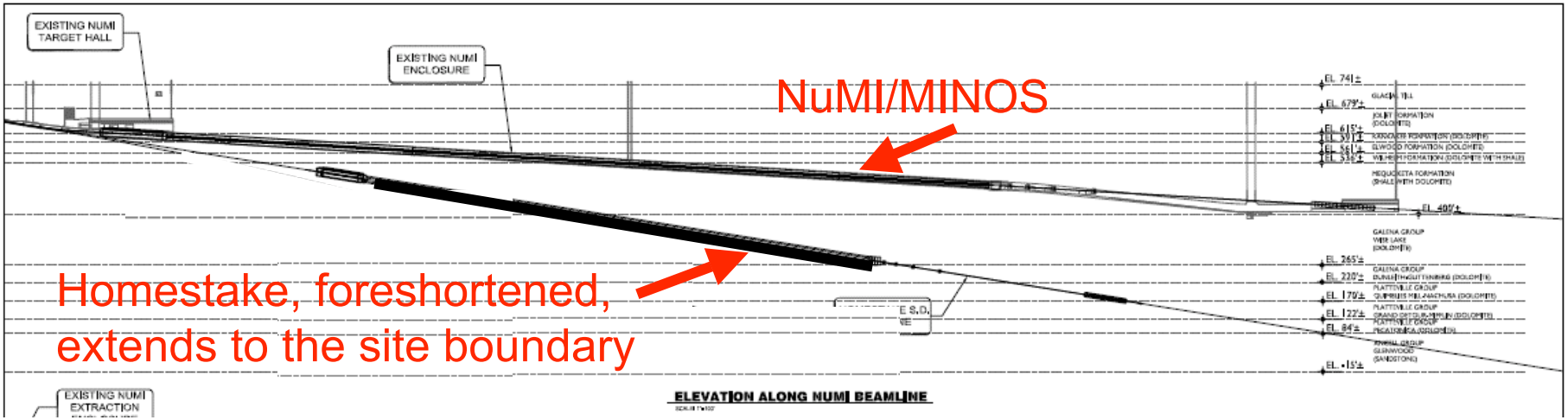
This elevation view of the Homestake Beamline (-5.84^{o}) is drawn to take the detector to the site boundary at Kirk Road. The maximum decay pipe length available in this configuration is about 627m (compare to NuMI at 675m). The detector hall (and shaft) is about 575 feet deep (compare to MINOS at about 336 feet). This is still in the Galena-Platteville but deep.

Second Elevation View of the Homestake Beamline



This elevation view of the Homestake Beamline (-5.84^{o}) is drawn with the decay pipe limited to 400m. This shortens the beamline by 741 feet, and lifts The detector hall (and shaft) by about 75 feet (500 feet deep). Overall, this configuration will be cheaper to build and is probably adequate.

Elevation View of the NuMI/MINOS Beamline



This elevation view of the NuMI/MINOS&NOVA (existing) beamline has superimposed upon it the Homestake beam, but projected into the NuMI beamline plane, thus the Homestake line is foreshortened. But it does show the relative depths, and also is meant to demonstrate (but at this resolution you can't actually make it out, that it passes under the NuMI Target Hall shaft, but not by much!!!

Comments on the Homestake Decay Tunnel

The NuMI/MINOS Decay pipe is 6'6" (about 2m) in diameter. The design was shielded for about $4x10^{13}$ protons at 2 second cycles, but it is now believed that it may be o.k. to about 1 megawatt. It has been suggested that the DUSEL beam be designed for full "proton driver" Main Injector beam at 2 megawatts and for a low or medium energy beam at 120GeV, scaling to lower energies appropriately. A 4 or 5 meter diameter decay pipe has been suggested. Put all together, this probably implies:

1) Helium filled decay pipe. (Vacuum volume simply too large!)
2) Decay tunnel excavation approaching 35' diameter.

The construction section for ground water diversion would otherwise be the same as NuMI/MINOS decay tunnel. This would include the "dimple mat" pressure break around the shield mass.

Comments on the Homestake West Bend

The west bend radius is set so that B-2 dipoles can be used. It is shown as a rolled dipole track, both bending west and up, since the existing carrier tunnel downslope is greater than 6 degrees. The track leaves “some” shielding at the base of the NuMI/MINOS Target shaft, but this may be a thin spot.

Note that it is very useful to use the MI-60 Main Injector long straight for extraction, sharing the existing extraction point, because if one considers using the Main Injector to turn west, there is not enough room to get “down into the rock” for the targeting and still have room on site for a 400 meter decay line. In addition, extraction near MI-10 would be almost impossible because the lattice is so crowded with other necessary beam functions.

Summary

A DUSEL neutrino facility based upon the Main Injector, hopefully with Proton Driver like intensities, is certainly technically possible at this site.

The design shown is similar in many respects to the NuMI/MINOS-NOVA facility already in existence, so most issues have been demonstrated to be manageable (rock tunneling, etc. etc.)

I expect costs (inflation adjusted) to be similar to NuMI/MINOS costs:
The decay tunnel is larger diameter but shorter. The shafts are deeper, but the extraction system and carrier tunnel exists. The west bend is necessary for several reasons, but is not a large tunnel cross section. The new target hall could be shorter if there is no requirement for a high energy 2-horn configuration.