PARTICLE PRODUCTION SIMULATIONS FOR THE NEUTRINO FACTORY TARGET

(MOPZ008, IPAC11)

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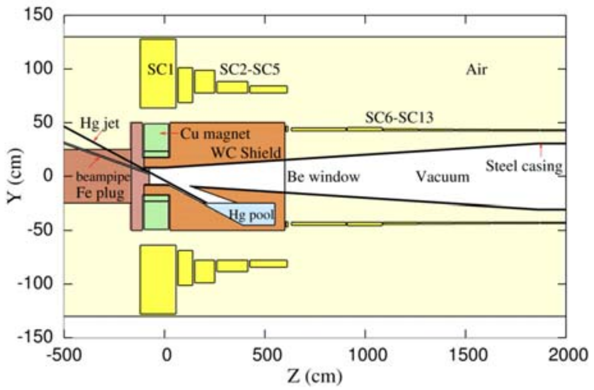
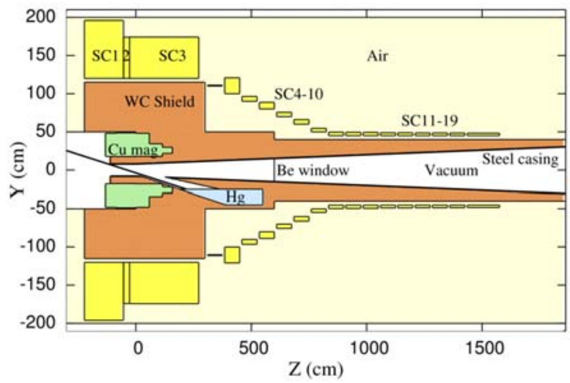
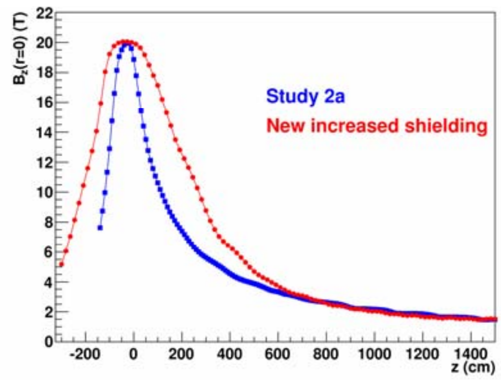
In the International Design Study for the Neutrino Factory (IDS-NF)[1], a proton beam interacts with a liquid Hg jet target in order to produce pions (π) that will decay to muons (μ), which in turn decay to neutrinos. The target is situated in a solenoidal field tapering from 20 T down to below 2 T over a length of several metres, allowing for an optimised capture of pions in order to produce a useful muon beam for the machine. We present results of target particle production calculations using the FLUKA simulation code [2].

Study 2a geometry (old baseline)



Increased shielding geometry (new baseline)



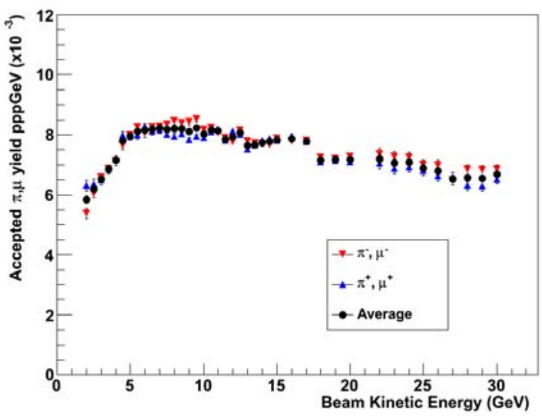


Superconducting coils (SC) in Study 2a geometry experience a radiation dose that is too high for their safe operation. Increased shielding in the new baseline geometry reduces the peak energy density in the SC coils to below 0.05 mW/g, equivalent to an integrated radiation dose of 10^6 Gy/yr, well below the maximum allowed dose of 3×10^7 Gy/yr (operational lifetime$\gtrsim$10 years) [3].

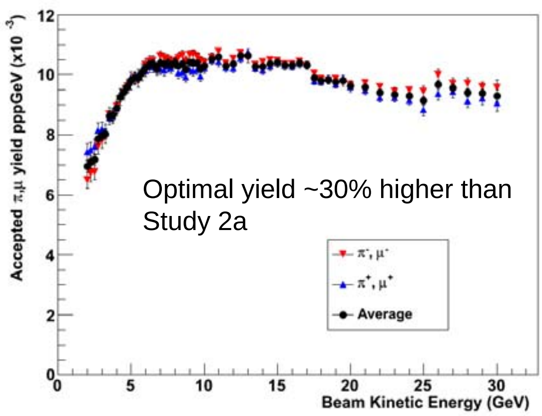
New baseline geometry coil positions/sizes changed to maintain 20 T $\underline{B}$ field in the proton beam – Hg jet interaction region. This has improved the $\underline{B}$ field profile, increasing the efficiency of capturing useful π and μ's.

π and μ with KE between 40 and 180 MeV are counted at the transverse plane z = 50 m to estimate the accepted yields for the Neutrino Factory. The extended PEANUT (Pre-Equilibrium Approach to NUclear Thermalisation) FLUKA model is used for detailed nuclear-hadron particle production simulations. This ensures consistent treatment of particle interactions for all energies, avoiding the need for 2 different models above and below 5 GeV.

Study 2a yields: optimal for E_{beam} = 5–12 GeV



New baseline yields: optimal for E_{beam} = 6–17 GeV



References: [1] International Design Study for a Neutrino Factory, IDS-NF-020 (2011), https://www.ids-nf.org
[2] C. Battistoni et al., "The FLUKA code: description and benchmarking", AIP Conf. Proc. 896 (2007) 31; A. Fasso, A. Ferrari, J. Ranft and P. R. Sala, "FLUKA: a multiparticle transport code", CERN-2005-10 (2005), http://www.fluka.org/fluka.php
[3] J. J. Back, "Energy deposition studies for the Neutrino Factory target station", JINST 6 (2011) P06002.