Gas Filled Study 2A Front End

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Abstract

In *Study 2A* the cooling cell is significantly simpler with an almost constant beta function; this suggests that the LiH absorbers at the windows may be replaced by an uniformly distributed high pressure hydrogen gas (GH). We present results of simulations carried out using ICOOL.

I. INTRODUCTION

In the present U.S. Neutrino Factory design [1], the so-called *Study 2A*, we have relaxed the requirements on the cooling channel by doubling the assumed acceptance of the acceleration section, i.e.,

$$\begin{aligned} A_T &= 30\,\pi mm - rad \\ A_L &= 150\,mm \end{aligned} \tag{1}$$

The cooling cell is significantly simpler and therefore, less expensive, as compared with the one discussed in *Study 2* [3], [2]. In particular, the beta function is almost constant, about $\approx 80\,cm$ all along the cooling channel. Figure 1 shows an schematic of a cooling cell. This

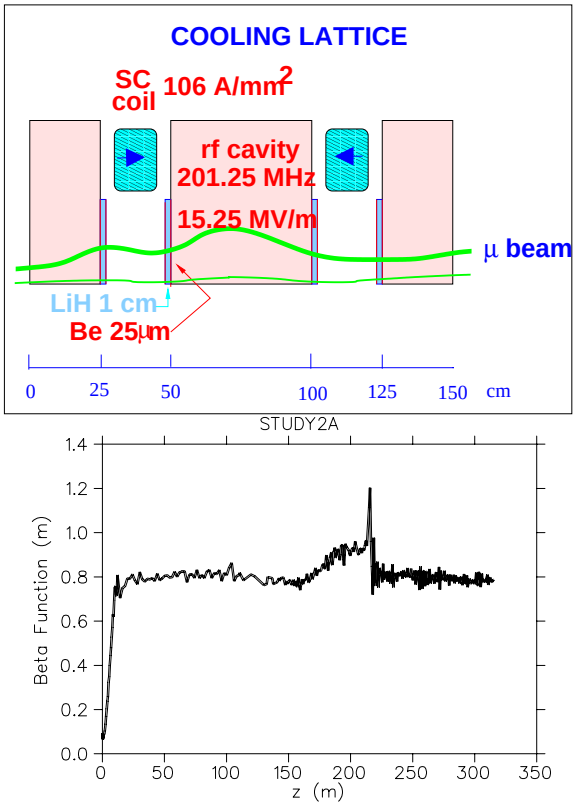

FIG. 1: (color) Top: Schematic of one cell of the cooling section. Bottom: Beta function along the front-end.

suggests that the LiH absorbers at the windows may be replaced by an uniformly distributed high pressure hydrogen gas (GH) [4]. We have performed ICOOL simulations to ascertain the performance of such a channel

II. CALCULATIONS

The cooling channel consists of 66 cells with 4 LiH windows of 1 cm thickness each. The minimum of the energy loss for both GH and LiH are:

$$\begin{aligned} \frac{dE}{dx}|_{GH} &= 4.103\,\frac{MeV}{g}cm^2 \\ \frac{dE}{dx}|_{LiH} &= 2.038\,\frac{MeV}{g}cm^2 \end{aligned} \tag{2}$$

The total energy lost of the muon beam in the LiH window is

$$\Delta E|_{LiH} = 2.038 \times \rho_{LiH} \times 66 \times 4 \approx 420\,MeV \tag{3}$$

At 25°C and 1 atm, GH gives

$$\Delta E|_{GH} = 4.103 \times \rho_{GH} \times 66 \times 150 \approx 3.4\,MeV \tag{4}$$

where $\rho_{LiH} = 0.78\,\frac{g}{cm^3}$ and $\rho_{GH} = 8.38 \times 10^{-5}\,\frac{g}{cm^3}$. This implies we have to increase the density (pressure) of the GH by a factor of 124.

We have substituted the absorber LiH by GH and filled all the colling section with GH, but we have not included GH containment windows at the beginning nor at the end of it. The results are shown in the figures below.

III. CONCLUSIONS

These preliminary simulations seems to indicate that we do not achieve the desired performance of No.μs/p= 0.176. with a gas filled cooling channel.

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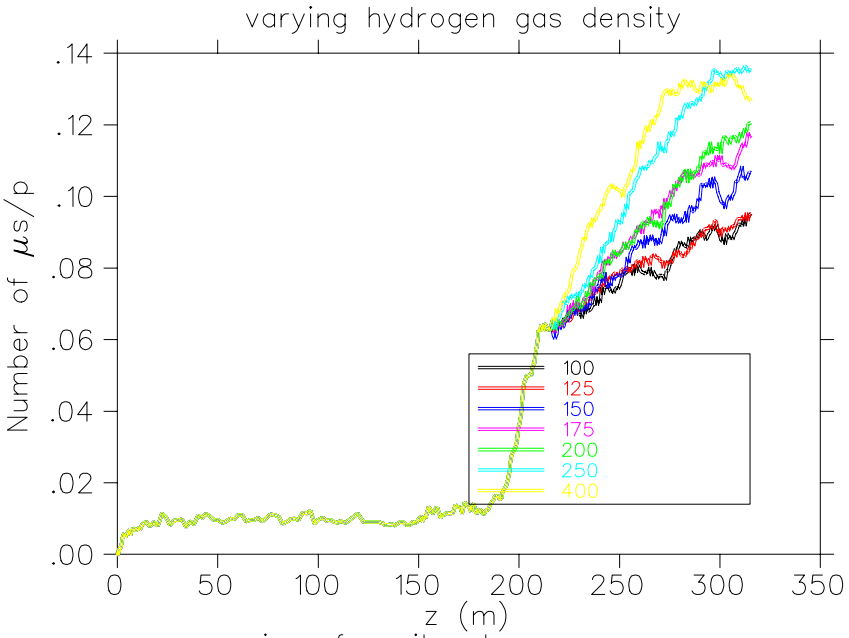
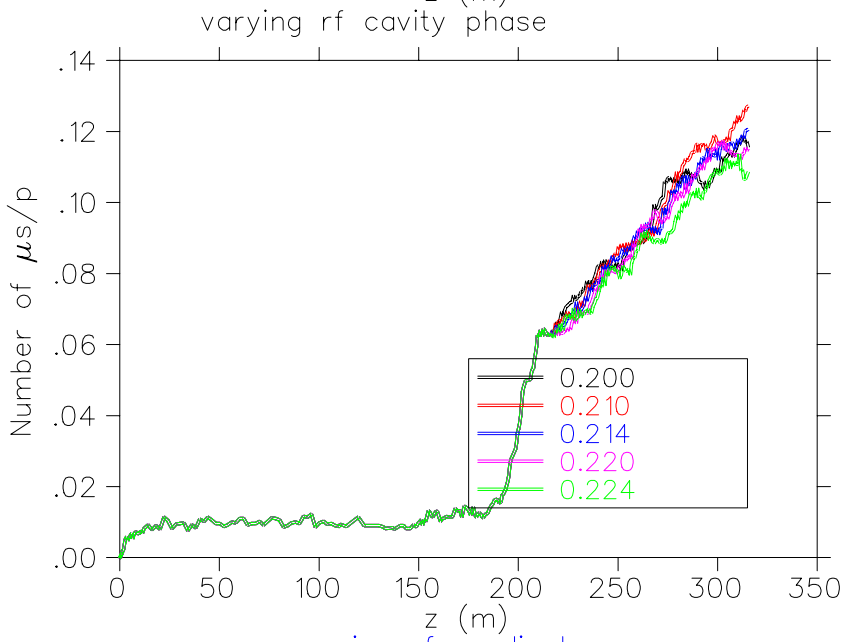
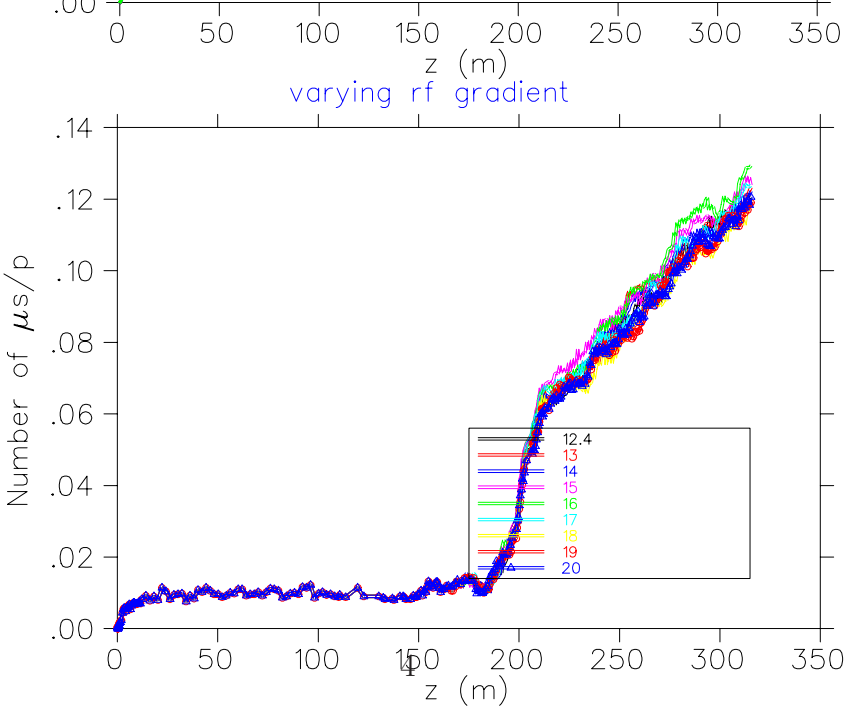
[1] The Neutrino Factory and Muon Collider Collaboration, et al., *Neutrino Factory and Beta Beam Experiments and Development*, BNL-72369-2004, FNAL-TM-2259, LBNL-55478, see also, http://www.aps.org/neutrino/.

[2] S. Ozaki, R. Palmer, M. Zisman, J. Gallardo, Editors, *Feasibility Study II of a Muon Based Neutrino Source*, BNL-52623, June, 2001.

[3] The MC Collaboration, *Recent Progress in Neutrino Factory and Muon Collider Research within the Muon Collaboration*, to be published. (http://www.cap.bnl.gov/mumu/pubs/prstab-030422/prstab.pdf)


varying hydrogen gas density
Number of μs/p
z (m)
100
125
150
175
200
250
400


varying rf cavity phase
Number of μs/p
z (m)
0.200
0.210
0.214
0.220
0.224


varying rf gradient
Number of μs/p
z (m)
12.4
13
14
15
16
17
18
19
20

[4] R. Johnson *et al.* in *Proceedings of Particle Accelerator Conference* (2003), p. 1792; Muon Inc., MUC-NOTE-247; R. Johnson *et al.*, AIP Conf. Proc. **671**, 328 (2003).