Overview of the ESSnuSB accumulator ring

Abstract
The European Spallation Source (ESS) is a research center based on the world’s most powerful proton driver, 2.0 GeV, 5 MW on target, currently under construction in Lund. With an increased pulse frequency, the ESS linac could deliver additional beam pulses to a neutrino target, thus giving an excellent opportunity to produce a high-performance ESS neutrino Super-Beam (ESSnuSB). The focusing system surrounding the neutrino target requires short proton pulses. An accumulator ring and acceleration of an H− beam in the linac for charge-exchange injection into the accumulator could provide such short pulses. In this paper we present an overview of the work with optimizing the accumulator design and the challenges of injecting and storing 1.1·10^15 protons per pulse from the linac. In particular, particle tracking simulations with space charge will be described.

ESSnuSB at the ESS site

Two simulation campaigns
...in pyORBIT to evaluate the accumulator ring design and the injection painting procedure.
1) Worst-case scenario: track at full accumulated intensity
2) Include injection painting

Simulation parameters
- Gaussian distribution in transverse, matched to lattice.
- RMS geometric emittance 8.5 mm mrad (100 mm mrad norm., 86.5%).
- Gaussian energy distribution, 0.02 % rms spread.
- Uniform distribution in z with 15% gap for extraction.
- 100'000 macro particles
- 128x128x128 space charge bins (2.5D trans. model + 1D long. model)

Selected results
- Horizontal emittance evolution
- Vertical emittance evolution
- Tune spread roughly 0.22 for all three working points, consistent with calculations based on the Laslett tune shift.
- Some halo formation, in particular in vertical for working point c.

Simulation parameters
- Gaussian distribution in transverse, matched.
- RMS geometric emittance 0.04 mm mrad (linac).
- Gaussian energy distribution, 0.02 % rms spread.
- Uniform distribution in z with 15% gap for extraction.
- 2'000 macro particles per macro-bunch, 110'000 mp in final state.
- 128x128x128 space charge bins (2.5D trans. model + 1D long. model)

Selected results
- Amplitude of close-orbit bump for the injection painting
- Horizontal profile
- Vertical profile

Conclusions and Outlook
- Re-model injection to remove asymmetry and generate more flat profiles.
- Change working point below low-order resonances?