Compatibility of RF for Proton and Muon Beams

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Overview

- Costs
- Issues:
  - The yield of muons per proton is about 10% which implies beam loading is due to protons – focus on 650 MHz operating at 60 Hz
  - H- stipping in the focussing fields in the linac

Costs

- Use LCLS II as the basis
- 4 GeV electron linac based on ILC Cavities operating at 16 MV/m and $Q^o = 2 \times 10^{10}$
- Accelerator systems total = 427 M$
- Linac systems = 100 M$
- Cryomodules (38) = 165 M$
- Controls = 50 M$
- Cryoplant = 50 M$
- Cryo distribution = 26 M$
- Miscellaneous = 36 $
- The Nb costs for the cavities ~ 10 M$ ($200/lb)

Issues

- Yield of muons/proton = 0.1
- Protons drive the beam loading of the cavities
- 650 MHz @ 30 MV/m -> stored energy = 116 joules for R/Q = 100
- Need ~ 3 x 10^{13} protons to produce 2.2 x 10^{12} muons (NUMAX+) per pulse (60 Hz)
- High Q -> only stored energy in cavity is available for acceleration for each pulse
- Beam loading is then 30 joules
- Since muons follow protons gradient will be down by ~ 12% for the muons

Issues

- H^- stripping
- General rule of thumb is that for 5 GeV particles magnetic field should be less than 0.1 Tesla
- This field limit is much less than the focussing fields that have been used for the muon linac designs

Conclusions

- Nb costs: Going from 1300 MHz to 650 Mhz implies 4 x as much Nb
- This implies 10 M$ -> 40 M$ on a 427 M$ project coupled with likely higher accelerating gradient making the linac shorter compared to CuNb cavities
- Focusing fields needed for muons are a problem for H^- stripping