Beam Stacking Motivation

International MUON Collider Collaboration

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Luminosity

$$\mathfrak{L} \approx \underbrace{\frac{e\tau_\mu}{(4\pi m_\mu c)^2}}_{K_L} \frac{f_{hg}\sigma_\delta \bar{B}}{\varepsilon_\perp \varepsilon_L n_b f_r} \underbrace{\eta_+\eta_-(\eta_\tau P_p \gamma m_\mu c^2)^2}_{P_+P_-}$$

1) Luminosity increases with the square of muon energy/power
   - Number of collisions per bunch increases as muon lifetime increases
   - Beam size decreases as energy increases (geometric emittance)
2) High field, low circumference collider ring → more luminosity
   - Shorter path length, more collisions before muon decay
3) Low repetition rate, few bunches is best
   - Assume that the bottleneck is in the number of protons
   - Fewer collisions, but each collision is more intense
4) High quality muon source is essential
   - Low emittance, good capture efficiency
5) Good efficiency acceleration is essential
   - High voltage systems

- The whole muon collider is designed to maximise luminosity!

Parameters

LDG Report:

Based on MAP calculations, the average proton beam power required in the target is in the range of 2 MW, but this needs to be fully validated by an end-to-end design of the facility. The proton beam energy should be in the range of 5 to 15 GeV. The power appears feasible; spallation neutron sources like SNS and J-PARC already operate in the MW regime and others like ESS and PIP-II are under construction. The Superconducting Proton Linac (SPL), an alternative injector complex considered for the LHC, would have provided 4 MW of 5 GeV protons. The collector and compressor system merges the beam into 2 ns-long pulses with a repetition rate of 5 Hz. Alternatively, the use of an FFA or fast-pulsed synchrotron could be considered, profiting from synergies with the next generation of spallation neutron sources in the UK and experience in Japan. In this case, the optics, magnet design and collective effects needs to be studied. The challenge of generating a high-intensity, short bunch at low repetition rate should be investigated. In particular, designs for an accumulator and compressor system should be developed, taking into account existing H^- ion sources and capability of H^--stripping systems for injection into the ring.

Nb: it's up to this group to decide what it should really be, in liaison with targets

One strategy: ring acceleration to high energy (above collective effect limits) then merge longitudinally using stacking