

IDS Proton Driver to Drive a Muon Collider

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Muon Collider Design Workshop

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IDS Proton Driver Specifications

- Proton driver power: 4 MW
- Proton driver repetition rate: 50 Hz
- Proton driver energy: around 10 GeV
- 3 proton bunches in train
 - 1.7×10^{13} protons per bunch at 10 GeV
- Bunch length: 1–3 ns
- Train length at least 200 μ s

Proton Energy

- Performance relative flat for 6–15 GeV protons
 - Performance declines above that
 - Performance declines very rapidly below that
- Lower energy: tough to get short bunches
 - Space charge prevents rotation to short
 - More current early in accelerating cycle
- Machine cost at higher energy

Repetition Rate

- Tough to get rep rate from proton driver
 - Easier at lower energy
- Muon machine
 - Beam loading with low rep rate
 - Average power consumption with high rep rate
 - ✦ Energy stored in cavities wasted
- 50 Hz was compromise

Bunch Length

- Performance flat below 1 ns
- 7% loss at 3 ns
- Achieving short bunches easier with
 - High rep rate
 - High energy
 - More bunches accelerated

Proton Bunches in Train

- Proton driver accelerates several bunches together
- Reduction in charge per bunch
- Must hit target in rapid succession
- All muon bunches accelerate to same energy
- Replace energy extracted from cavities
 - Power at input coupler limited
- Result: train length at least $200 \mu\text{s}$

Bunches in Train

- More bunches gives less beam loading
- Must store all bunches in storage ring
 - Circumference of storage ring

Comparing to Muon Collider

- Muon collider wants significantly lower average rep rate
 - Neutrino factory effectively proposing 150 Hz!
- Low emittance lets you up this rep rate
 - A factor of 10 is probably challenging...
- How to bridge this gap?

Muon Collider Higher Energy



- Advantages:

- Reduce space charge issues
- Easier to get short bunches
- Power with low rep rate

- Disadvantages

- Target performance hit
- Muon beam loading/collective effects
- Machine cost

Conclusions

- Gap to bridge between NF and MC
- Get a little from everyone
 - Squeeze as much current into PD as we can
 - ◇ Easy to say...
 - ◇ Multiple-beamline systems? Duplication
 - Higher energy PD
 - Maximize cooling for more rep rate
 - ◇ Easy to say...