IDS Proton Driver to Drive a Muon Collider

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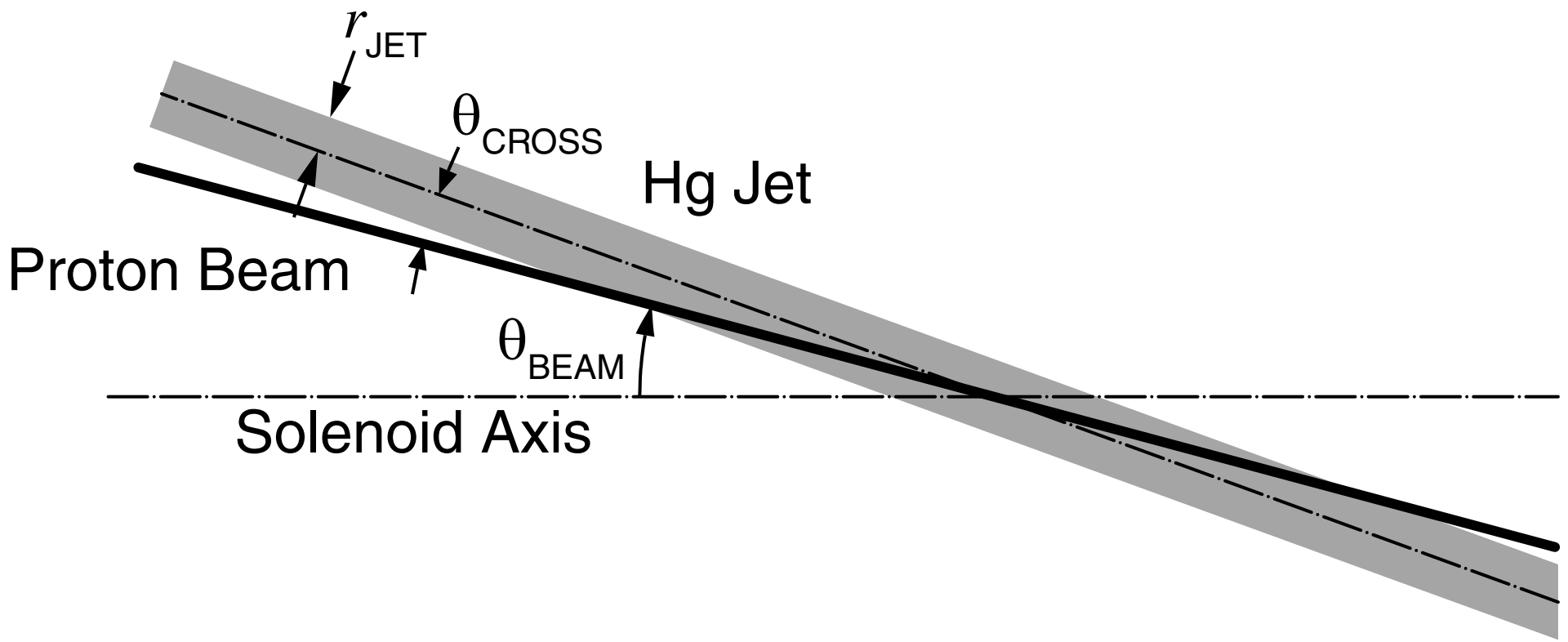
IDS Proton Driver Specifications

- 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 μs

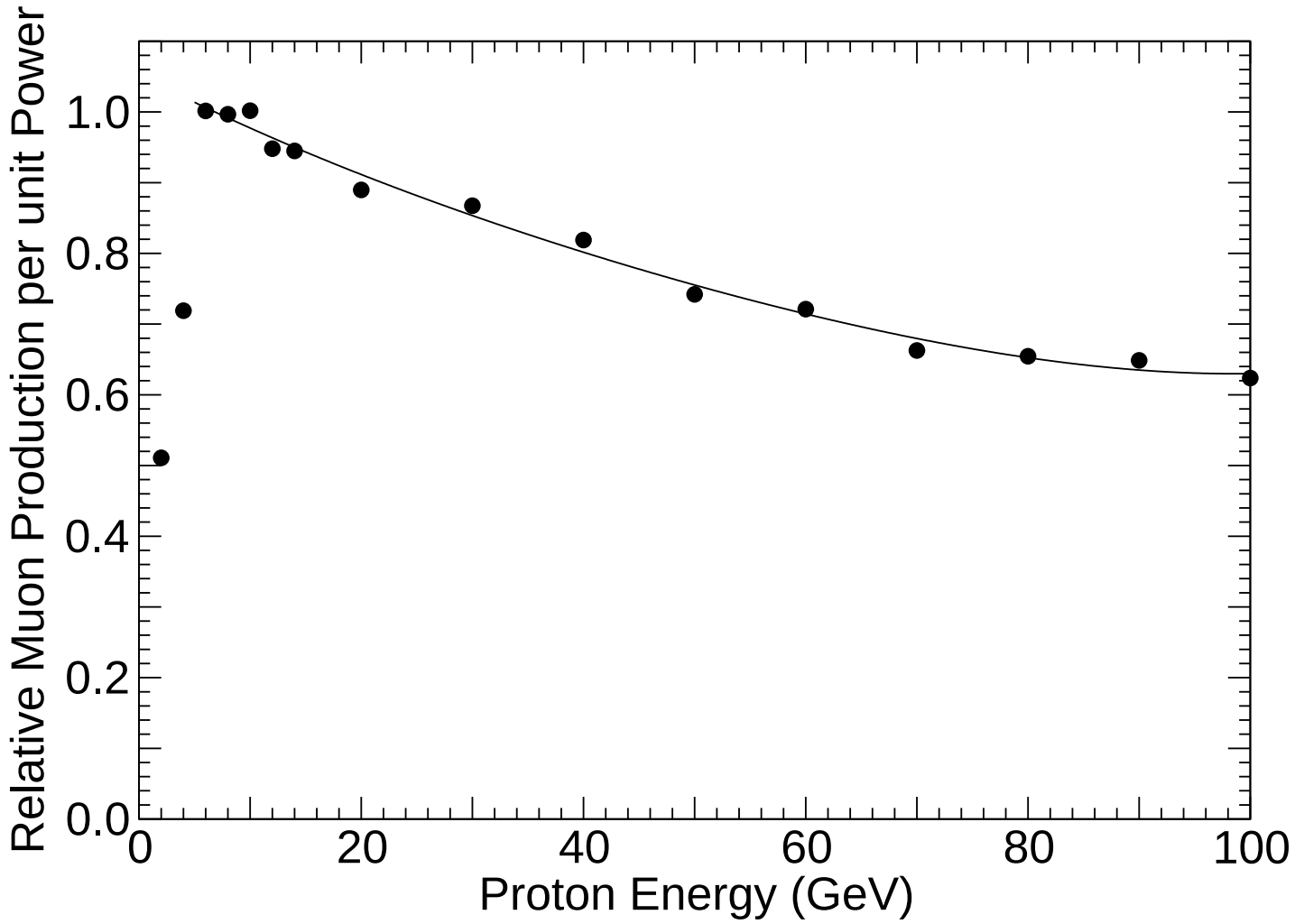
Muon Production vs. Energy

- Recent work to optimize target geometry (Ding, Kirk, Berg)
  - Vary jet radius, beam angle, crossing angle
  - Maximize muons production
- Variation with energy stronger than thought

Mercury Jet Geometry



Muon Production vs. Energy



Proton Energy

- Performance relatively 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 μs

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. . .