Initial Notes on

A Permanent Magnet Stretcher

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Motivation

- Cost to operate the Tevatron as a Stretcher Ring
  - cost estimates range from $6M - $15M/year
    - Kaon experiment wants ~5 years running -- ~$30-75M or so in operating costs
- How much would a *Permanent Magnet* Stretcher cost? Presumably very low operating costs...

Scaling from the Recycler

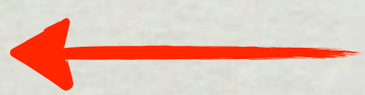
- Suppose use Recycler technology in Tevatron tunnel
  - circumference of Tev ~2x that of Recycler
  - however, beam momenta:
    - REC: 8.89 GeV/c TEV: 120 GeV/c
- Note: would not wish to use combined function gradient magnets as in Recycler; opt for separated function (dipoles and quads) for ease of operation

Scaling Exercise

- The Tevatron tunnel was designed for the old Main Ring, which had a field strength of 1.8 T when run at 400 GeV
- The Recycler combined function dipole magnets operate with a central field value of 0.145 T
  - max pole tip field is about 0.16 T
  - can do better, but for now use something close to this
    - Jim Volk is looking into some details pertaining to state-of-the-art permanent magnet material

Scaling Exercise -- 2

- Assume we have the same trajectory and optical layout as the Main Ring / Tevatron
  - Note: *geometry* **must** be the same or very nearly so
- If wish to run the PM Stretcher at
  - 150 GeV/c: 0.68 T
  - 120 GeV/c: 0.54 T
  - 60 GeV/c: 0.27 T
  - 40 GeV/c: 0.18 T



Scaling Exercise -- 3

- The packing fraction of the Main Ring is ~ 75% (of 6.28 km)
  - (fraction of circumference filled with bending)
  - add another 5-6% for the quads
- The packing fraction of the Recycler is ~39% (of 3.32 km)
  - includes bending and focusing
- Thus, the total length of bending and quads needed in this new application is almost 4x that used for the Recycler

Beam Power

- Although the cycle time of the Main Injector to reach, say, 40 GeV/c is maybe ~1/3 the 120 GeV/c cycle time, the spill time will still be determined by NO*v*A cycles (1.333 s) and the hit on their program.
- As an exercise, use 96 Tp from MI to Stretcher, scale the kaon MI cycle with final momentum, and assume we keep to a 10% hit on NOvA, 95% duty factor to Kaons:

- 150 GeV/c --> P_{ave} = ~70 kW, total cycle time = 32.7 s ***n* = 22**
- 120 GeV/c --> P_{ave} = ~69 kW, total cycle time = 26.7 s ***n* = 18**
- 60 GeV/c --> P_{ave} = ~68 kW, total cycle time = 13.3 s ***n* = 9**
- 40 GeV/c --> P_{ave} = ~68 kW, total cycle time = 8.9 s ***n* = 6**

2 MI cycles to fill Tev for Kaon program, n MI cycles to neutrino program

Rough Cost Scaling

- If assume can scale the costs of REC permanent magnets and related hardware to 4x the REC quantities

assume about $7M for REC 1998, no cooling systems; 3% inflation per year

  - Stretcher = 4xREC ~$40M (?) for ~40 GeV/c

- If also desire to have 120 GeV/c, to tie into SY120 program, say, then must scale again (maybe ~3x?)

- But suppose we keep 40 GeV/c, and suppose the field can be raised by ~x2, say, for much less than twice the REC cost per magnet, then takes ~1/2 the space around the circumference

  - can it be a *winner* ?

Some Issues

- What do permanent magnets of this scale cost today? Jim Volk is investigating; will have a rough idea in next few days
- How much other infrastructure from Tevatron (corrector power supplies, BPMs, pumps, etc.) could possibly be salvaged/retrofit to work in this new ring?
- What beam pipe size is desired?
  - remember: slow spill works better with ***aperture !***
  - Tev intensity would be much greater than Recycler intensity
    - total: 100 Tp / (4-5 Tp) = 20-25 x
- What energy best serves kaon *plus* other future experimental programs?
- ...

***MI gap height* = 2 in.**