Two Staged Muon Synchrotrons: $63 \longrightarrow 400$ and $400 \longrightarrow 1750$ GeV for $\sqrt{s} = 0.8$ and 3.5 TeV Colliders

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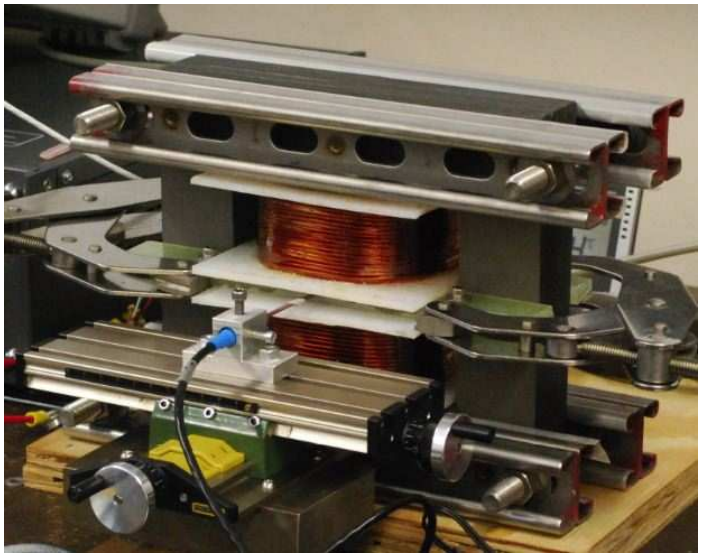
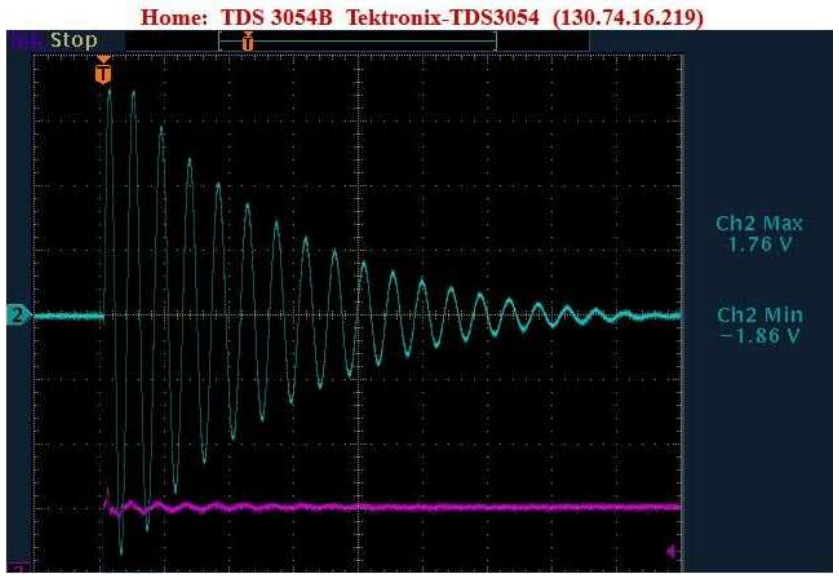
1.8 Tesla, 1410 Hz Dipoles for Muon Synchrotrons

550V, 18 turns of 12 gauge copper wire
0.28 mm thick steel laminations
Bell 5180 Hall Probe
ΔE = -15% per half cycle
LC circuit with fast IGBT switch
arXiv:1207.6730



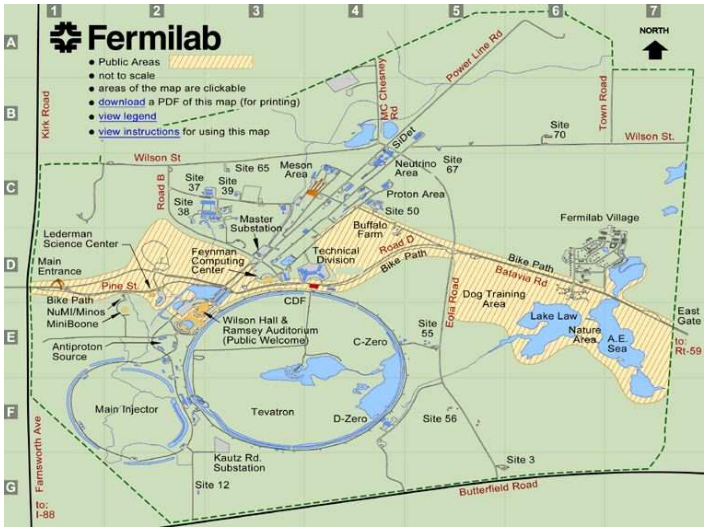


- Future: twisted Roebel cable to reduce eddy currents
  Pole face eddy current calculation of sextupole strength
  Improved field quality. Ultra low carbon steel (LEP magnets).

63 to 400 GeV, 200 Hz Synchrotron: FNAL Tevatron Tunnel

- 63 $\rightarrow$ 400 GeV in 56 orbits (1.2 ms) Muon survival = 73%
  6 GV of Superconducting RF (can be refilled during orbits)
  Dipoles ramp from 0.28 to 1.8 Tesla.
  Flat top and collide in the Tevatron tunnel: $\sqrt{s} = 0.8$ TeV
- 1 mrad/yr dose dist. $= 5 \times 10^{-7} \sqrt{\mu/\mathrm{year}}\ E(\mathrm{TeV})^{1.5} = 3$ km

$$L = \frac{\gamma N^2 f_0}{4\pi \epsilon^N \beta^*} = \frac{3800\,(2\times 10^{12})^2\ 48000}{4\pi\,(25\times 10^{-4}\,\mathrm{cm})\,0.6\,\mathrm{cm}} = 4\times 10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$$

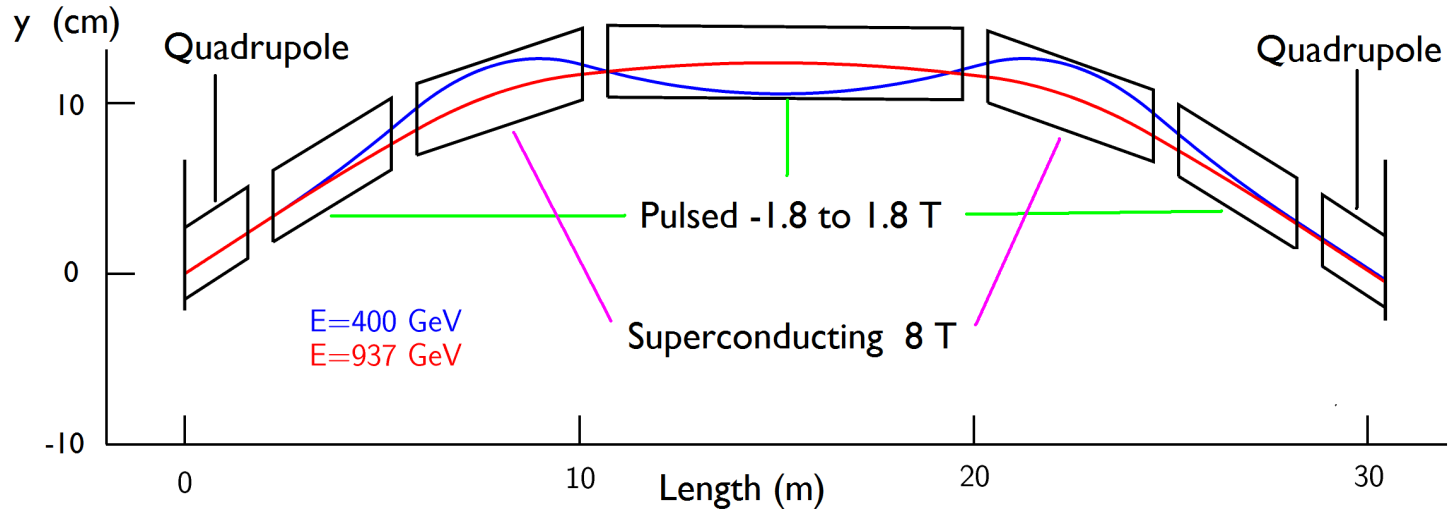


Tunnel exits.
Little civil construction.
RF needed similar to LEP200.
High $\gamma = 600$ injection leads to small magnets.
arXiv:0707.0302
Physics: top, 3 Higgs coupling

Dipole energy	4 MJ	vs. 40 MJ	@Main Ring
RF needed	6 GV	vs. 3 GV	@LEP200
$\sqrt{s}$	0.8 TeV	vs. 0.5 TeV	@JLC

400 to 1750 GeV, 200 Hz Synchrotron in a Site Filler Tunnel

- 30 GV of SRF, 45 orbits (2.4 ms). 88% muon survival
  A 16 kilometer circumference ring fills the Fermilab site
- Interleave 200Hz ramping / fixed 8T superconducting dipoles;
  Ramp from -1.8T to 1.8T for twice the usual swing;
  Dipoles oppose, then act in unison. Lattice: MAP-Doc-4335



Tunnel circumference	16 km	vs. 27 km	@LHC
8T dipole bore length	2.4 km	vs. 32 km	@LHC
RF needed (21 GV to get to 400 GeV)	51 GV	vs. 500 GV	@JLC
Center of Mass Energy	3.5 TeV	vs. 0.5 TeV	@JLC