MI/RR Injection Location Options and Transfer Lines

David Johnson

October 4, 2012

MI/RR Straight Sections

- MR/RR injection options
  - ✓ injection into Recycler for accumulation then single turn injection into MI (low linac current)
  - – Inject directly into MI (high linac current or long pulse injection)
- MI/RR straight sections
  - ✗ Four 3 half-cell straight (22,32,52,62)
  - – Two 4 half-cell straight (10,40)
  - – Two 8 half-cell straight (30,60)
- Would like symmetric straight for multi-turn injection (Booster, SNS,JPARC, etc)
  - – Easier to make symmetric straight at 4 or 8 half-cell straights
  - – MI/RR-30 –MI collimation system, MI/RR transfer beam line
  - – MI/RR-60 – Both rings filled with RF & MI extraction for NuMI
  - ✓ MI/RR-10 – MI filled with LBNE extraction / RR open for modification
  - – MI/RR-40 both rings filled with abort extraction systems


B
3
8
10
22
30
32
40
52
60
62
Giese Rd
Giese Rd
Holter Rd
Holter Rd
Kautz Rd
Kautz Rd
Kautz Rd
Kautz Rd
Outer Ring Rd
Outer Ring Rd
Outer Ring Rd
Outer Ring Rd
Indian Creek Rd
Indian Creek Rd
Indian Creek Rd
Indian Creek Rd
Booster Rd
Booster Rd
Fermi National
Lab Library

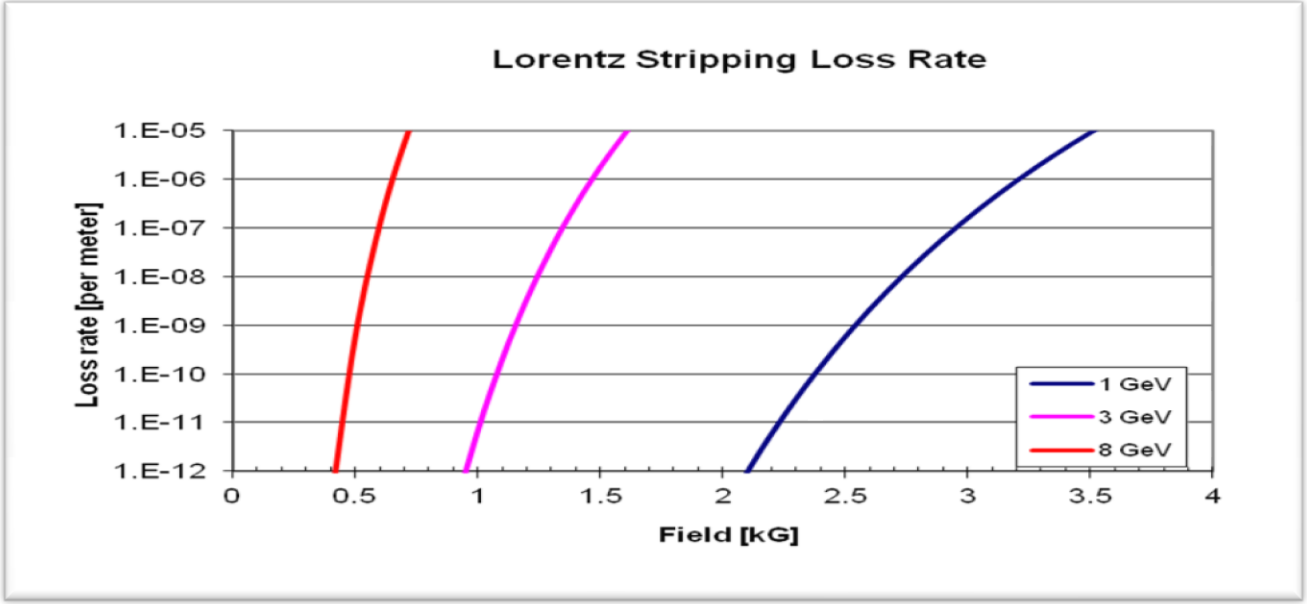
Beam Line Costs

- Technical components
  - Magnets (dipoles, quads, trims)
  - Power supplies
  - Vacuum system (pipe, gauges, pumps, etc.)
  - Instrumentation
- Installation /Alignment
  - Magnet stands/ magnets
  - Vacuum system
  - Instrumentation
  - Cabling
- Utilities and cable trays come with enclosure
- Magnet/power supply costs dependent on types of magnet design, power, cooling, half-cell length, packing fraction, etc. not easily scaled
- Instrumentation generally based on number of half-cells
- Vacuum system can ~scale with length

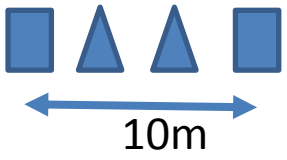
Beam Line Costs

- IDC-1 (M&S, SWF, direct) $ 12.7 M
  - 8 GeV H- to RR (1.2 km)
  - 133 perm. mag, 88 trims, 10 electro. mag ~$6.7M
- ICD-2 (M&S, SWF, direct) $ 15.1 M
  - 2 GeV to RCS/dump & 8 GeV to RR/dump
  - 295 electro magnets (dipoles, quads, trims) ~$9M
  - Total lengths 1.25 km
  - Vacuum ~ $4M/1.25 km -> ~ $1000/ft.
- Costs dominated by magnets, then vacuum

Dipole Strengths



	Loss Rate					H.C. length	10	
	10^{-6}/m	10^{-9}/m	10^{-6}/m	10^{-9}/m		P. F	0.7	
Energy[GeV]	B [kG]		Theta [deg]		Total bend ang/HC		Aveg radius [m]	
1.00	3.21	2.55	3.25	2.58	22.75	18.06	25	32
3.00	1.47	1.16	0.66	0.52	4.62	3.65	124	157
8.00	0.65	0.52	0.13	0.23	0.88	1.63	655	351



Summary

- Symmetric straight section is best
- Easier to modify 4 half-cell straight
- RR30 possible, but
  - difficult siting of linac and 3 GeV Experimental Area
  - close to Kirk Rd
  - 8 GeV linac / dump pointing to site boundary
- RR10 still best option
  - LBNE extraction from MI
  - Must approach from East
- Dipole strength limited by Lorentz stripping
- Beam line costs dominated by magnets and vacuum system, depending on beam line design