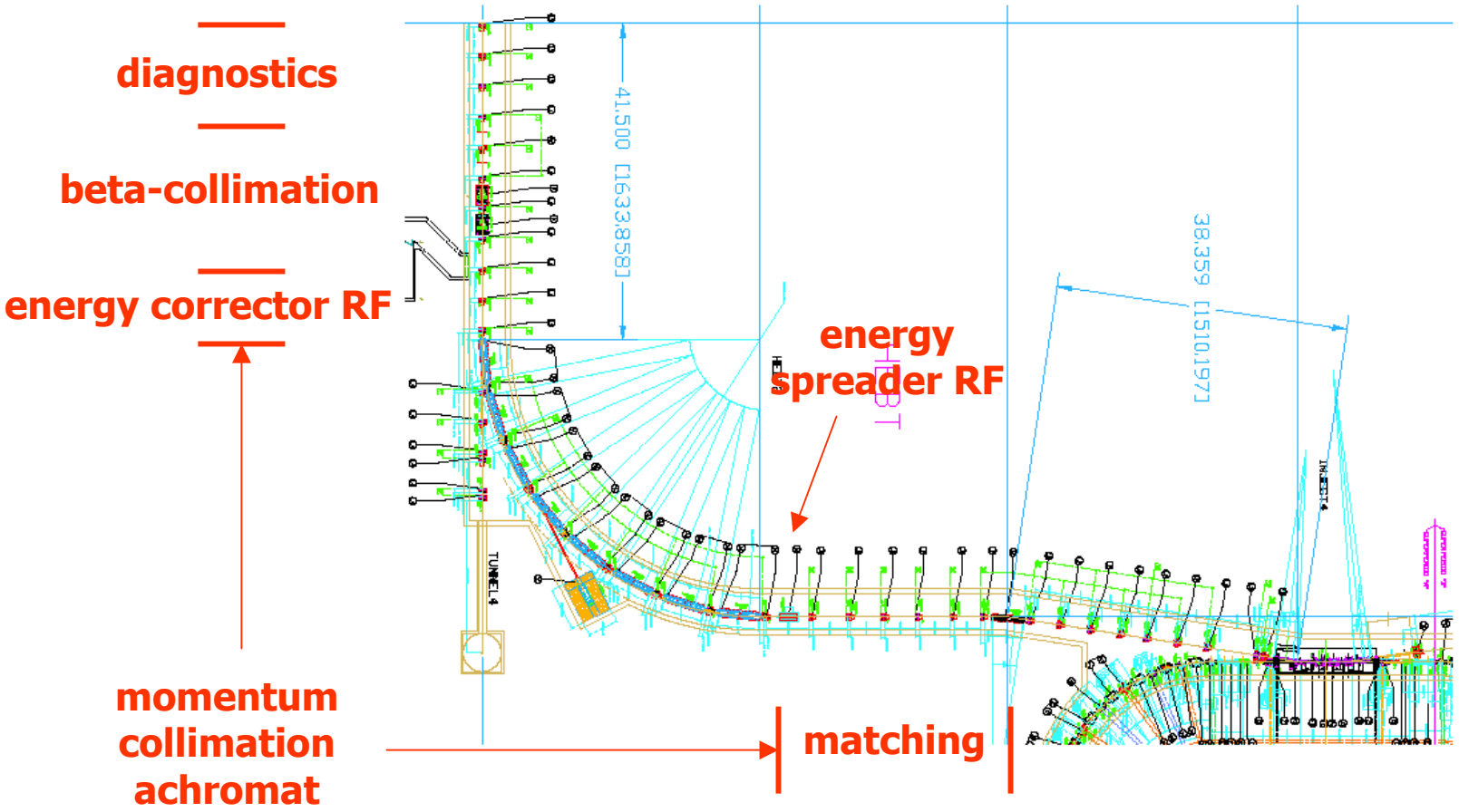
1 GeV Transport Line (SNS HEBT)

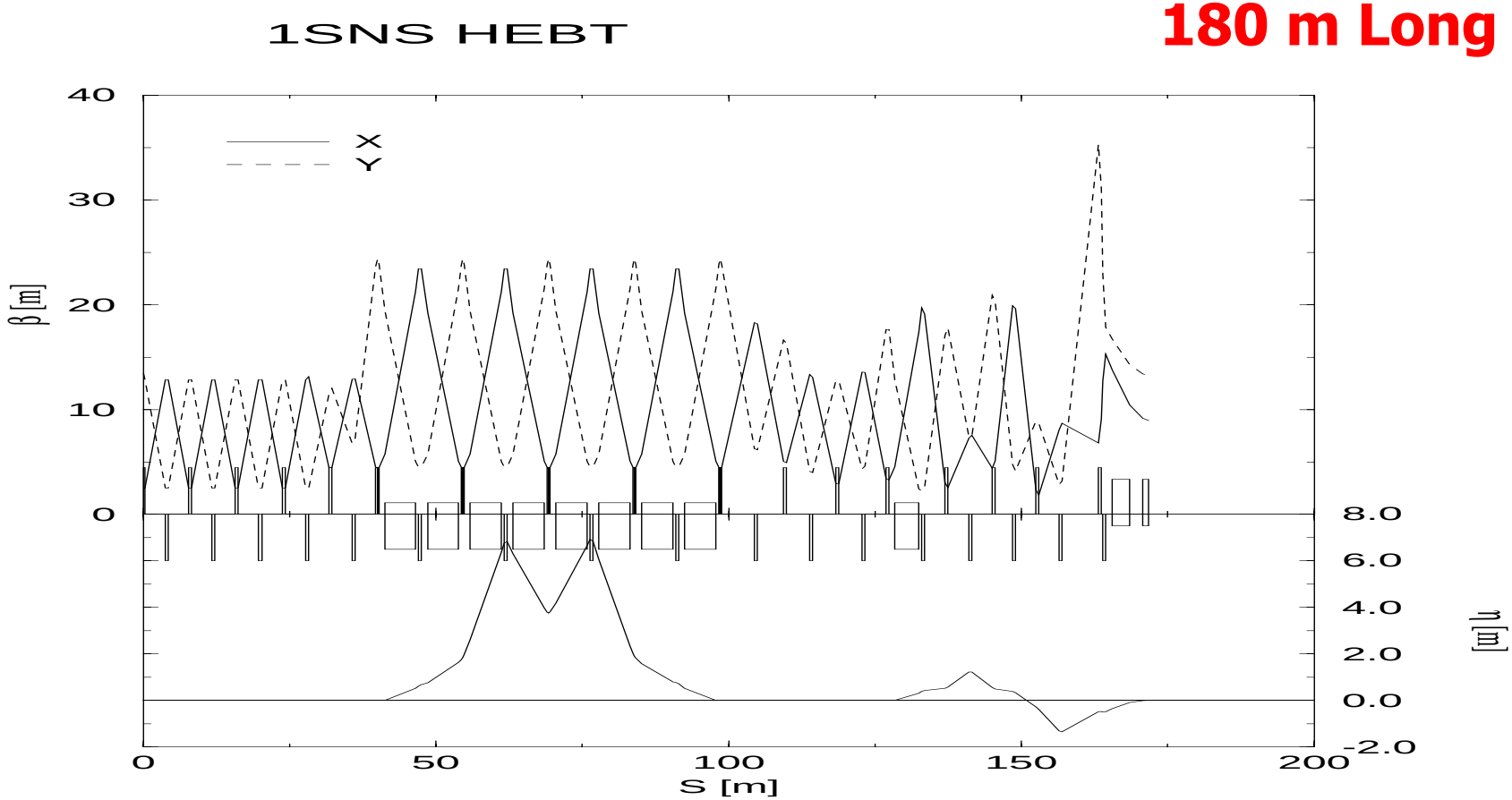
(D. Raparia)

180 m Long



Transport Output for 1 GEV HEBT

180 m Long



8 GeV HEBT Example

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Assumptions

- E = 8GeV, $\beta\gamma = 9.5$, $\beta = 0.994$, $\gamma = 9.5$
- Emit (rms,nor) = 1 π mm-mrad
- Emit(rms,unnor) = 0.105 π mm-mrad
- Ring energy acceptance = $\pm$10 MeV
- Max Magnetic Field 500 Gauss
- Have all belts and suspenders for now
- Functions are separated as much as possible

Design

- 2 cells for diagnostics
- 2 cells for beta-collimation
- Achromat for cleaning anything more than ±10 MeV
- 2 cell for matching into the ring

Diagnostics

- Two 90° cells for diagnostics
- 4 wire scanner for emittance (in each H-cell)
- TOF, BCM, BSM etc
- Half cell = 17 m, (same as in the Main Injector)
- Quad length = 1.5 m, aperture = 50 mm dia (given)
- Gradient = 1.8 T/m , β_{max} = 57 m
- $\sigma = (\beta_{max}\ \varepsilon)^{0.5}$ = 2.45 mm, Mag. Field at 10 σ < 500 G
- Cell length cannot be reduced too much, field will go higher than 500 Gauss at 10σ but these diagnostics can be in the last part of the linac

Beta-Collimation

- Two 90° cells for Beta collimation, cell same as diagnostics
- Two sets of carbon scrapper in each plane, at each location need two (left & right, top & bottom) total 8
- Scrapper located just before the quad, x-scrapper before focusing quad, y-scrapper just before defocusing quad, etc
- 2 collimator absorber located in 2^{nd} cell (dia 40 mm)
- SNS simulation shows particle distribution extend up to ± 10-11σ, ±3σ (99%) accepted in the ring (foil size) ±3 to ±7σ goes to injection dump(1%), ±7 to ±10σ goes to beta collimation absorber (0.01%)
- $7*(57*.105)^{0.5} = 17$ mm, scrapper aperture = ±17 mm
- Impact parameters: 14 mm, 1.6 mr

Achromat

- $\Delta E = \pm 10 MeV \Rightarrow \Delta P/P = 1.13e\text{-}3$

$$\frac{\eta \Delta P / P}{\sqrt{6\varepsilon_{rms}\beta}} \geq 2 \Rightarrow \frac{\eta}{\sqrt{\beta}} \geq 1.4$$

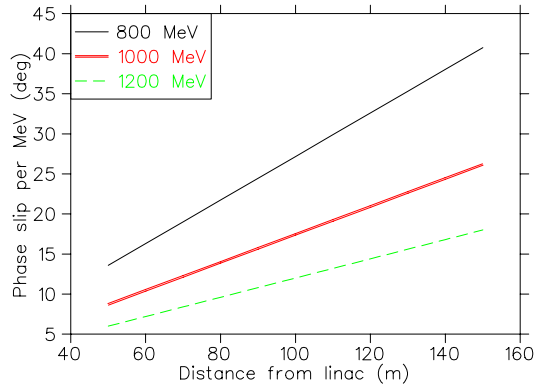
- β=111 m, phase advance 60° per cell, 6 cells
- η=~14.5 meter
- Dipole filed=500 Gauss, gap 50 mm, five 6-m long dipoles per half cell
- Quad, length 1.5m, G = 0.6 T/m. aperture = 80 mm
- WS for energy spread measurement,
- BIG to clean 6 ns notch to 1.0E-3

Energy Spread & Energy Jitter

- Energy spread at 1 GeV = ±0.3 MeV (rms)
- Energy Jitter at 1 GeV = ±1.5 MeV (95%)
- Phase Jitter at 1 GeV = ±3° (95%)
- Since the energy spread in linac ~ $(\beta\gamma)^{3/4}$
- RMS Energy spread at 8 GeV = $\pm 0.3(9.5/1.8)^{3/4} = \pm 1.0$ MeV
- Energy Jitter at 8 GeV = $\pm 1.5(384/81)^{1/2} = \pm 3.2$ MeV
- Phase Jitter at 8 GeV = $\pm 3°\ (384/81)^{1/2} = \pm\ 6.5°$

Energy Corrector Cavity

- Phase slip: $\phi_{Slip}(\text{deg}) = \frac{1}{\gamma(\gamma+1)}\frac{L}{\beta c}\frac{\Delta T}{T}360.f$
- Phase slip = 0.0018° per meter per MeV
- $\phi_{\text{Slip}} >> \phi_{\text{Jitter}} \Rightarrow \phi_{\text{Slip}} > \pm 20°$ $(\phi_{\text{Jitter}} = \pm 6.5°)$
- Required Length ~ 3360 meter $(\Delta T = \pm 3.2 \text{ MeV})$



It is not going to work, we have to think other way to correct the energy jitter.

If we are stopping every particle which have more than 10 MeV (jitter or spread) we might not need it.

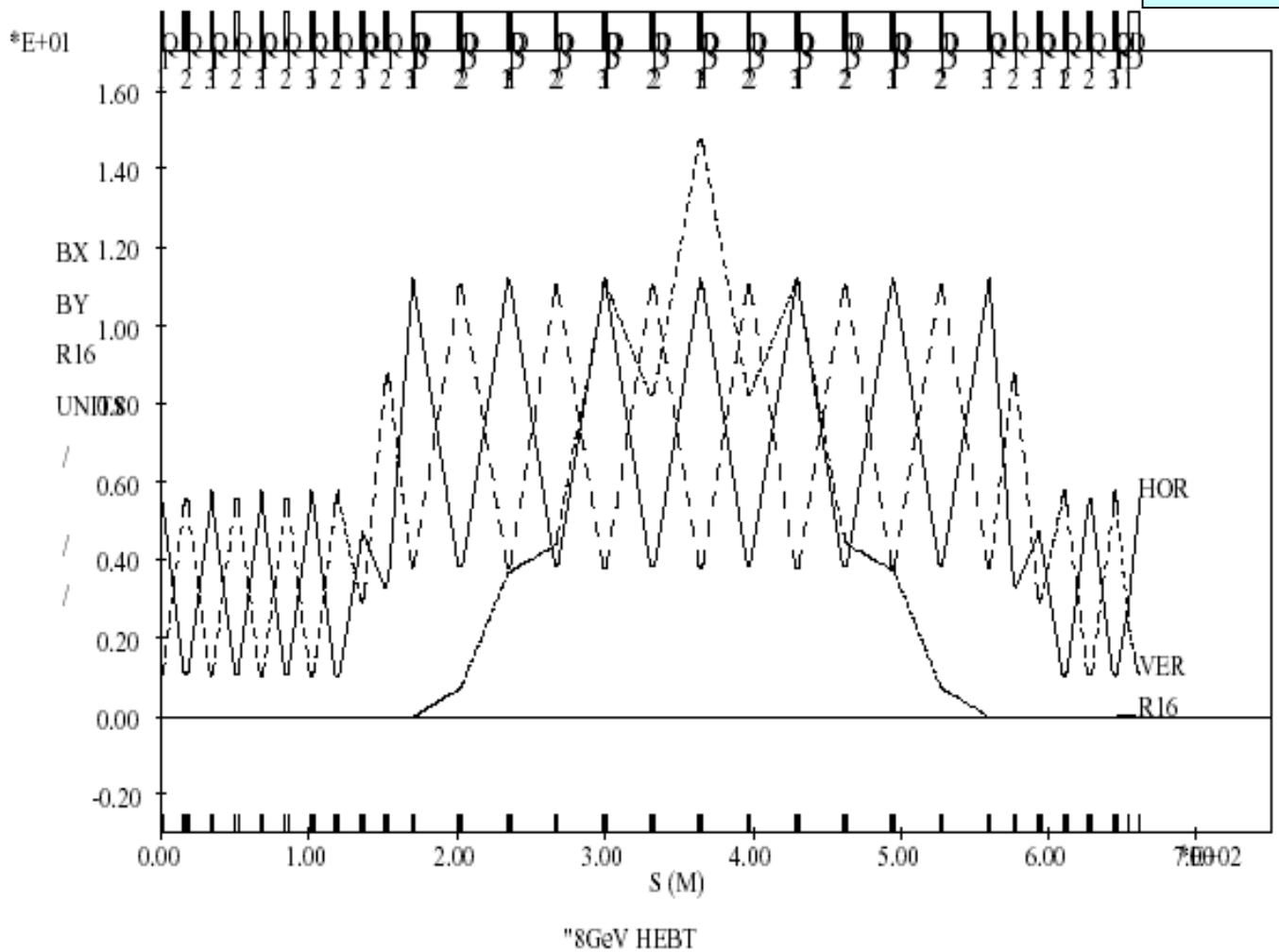
For laser injection to reduce the energy spread we might use rotator or linac cavities as buncher

Matching into the Ring

- 2 cells same as diagnostic (half-cell=17 m)
- 6 meter long dipole (B=500 Gauss) give only 0.02 meter of dispersion , too small to worry about it

8 GeV Transport Line

661.25 m Long (won't work)



Linac dump

- Beam size at window 3 cm dia
- Use quad for spreading the beam, at the time of commissioning energy can start at very low energy compare to 8 GeV,

8 GeV Linac Beam Dump

585.75 m Long