Fermilab

180 degree Bends

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Fermilab

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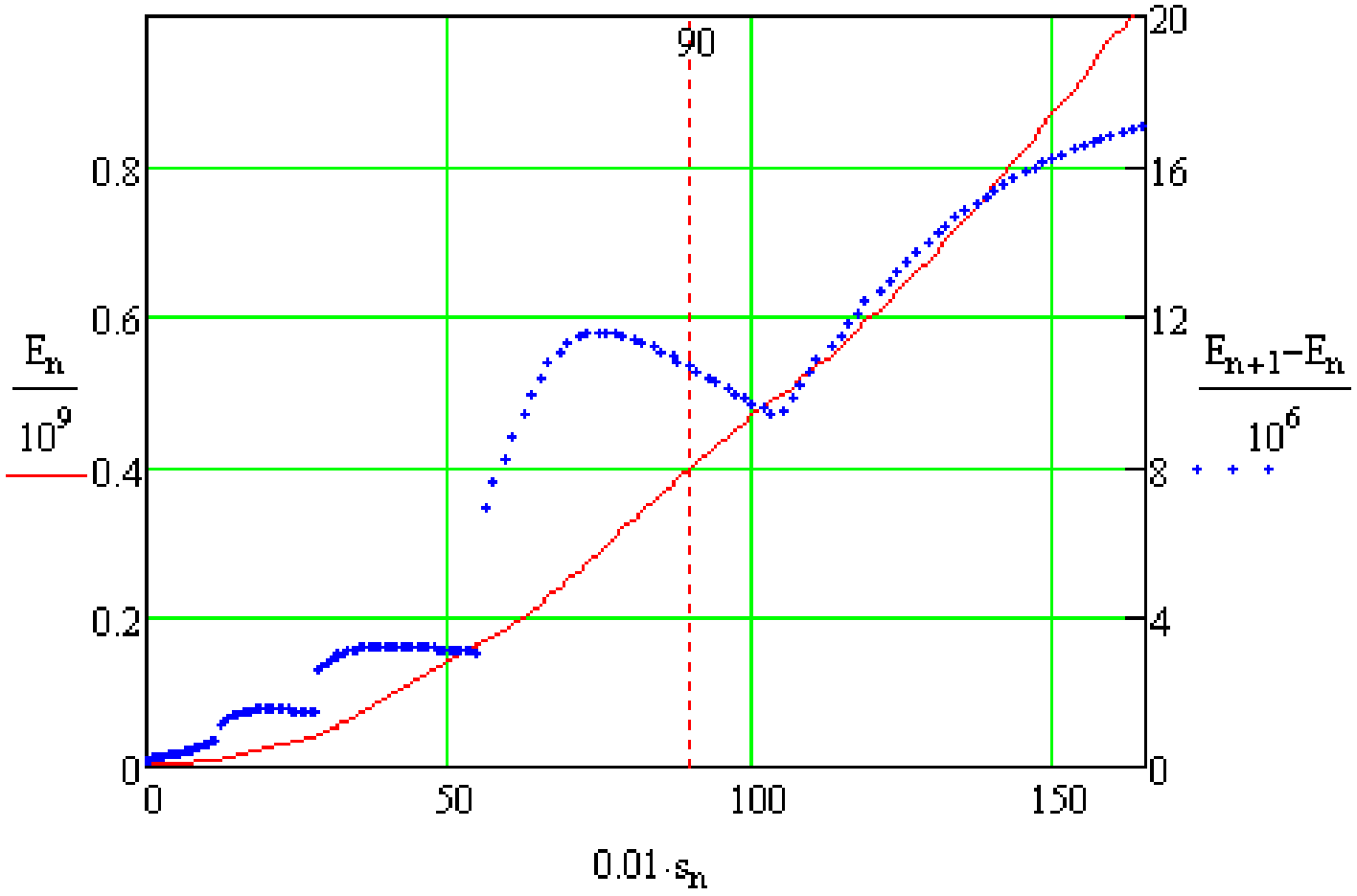
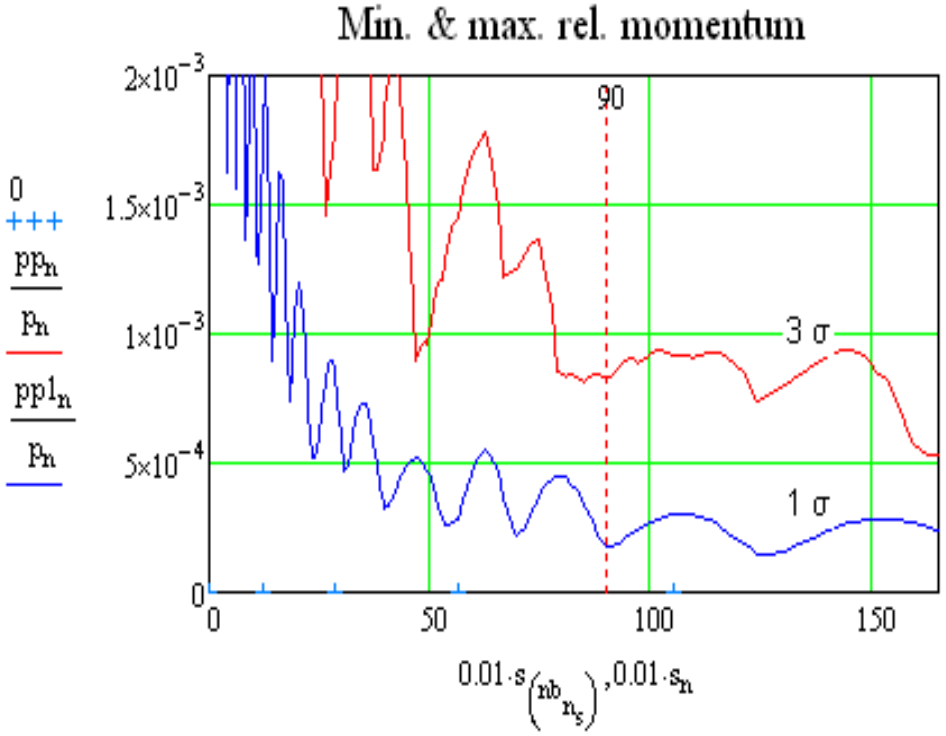
Straight linac

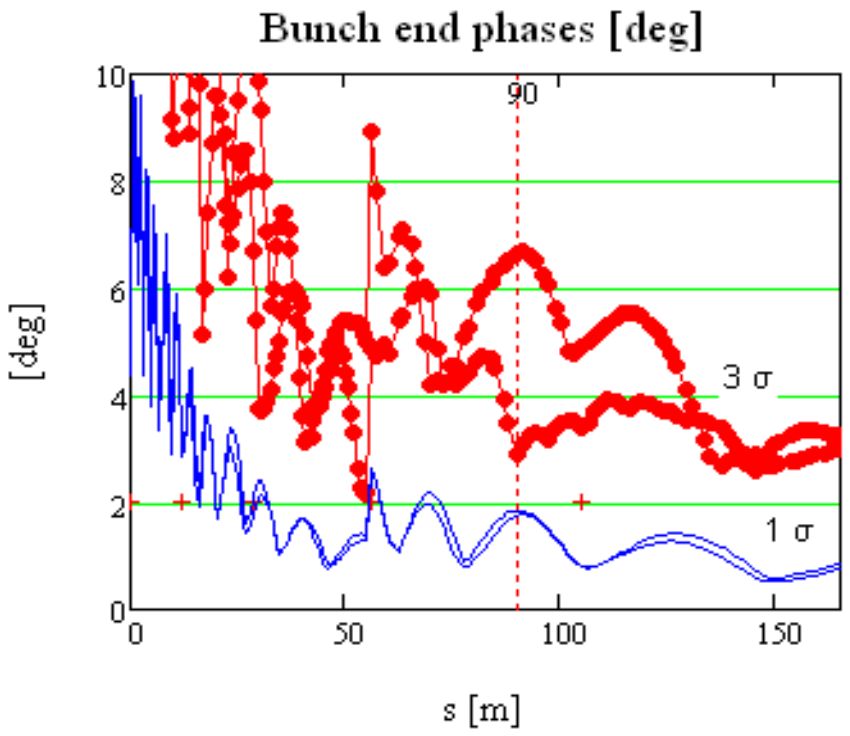
L≈165 m (ΔE_{LB} = 11.7 MeV/cav, ΔE_{HB} = 17.7 MeV/cav)



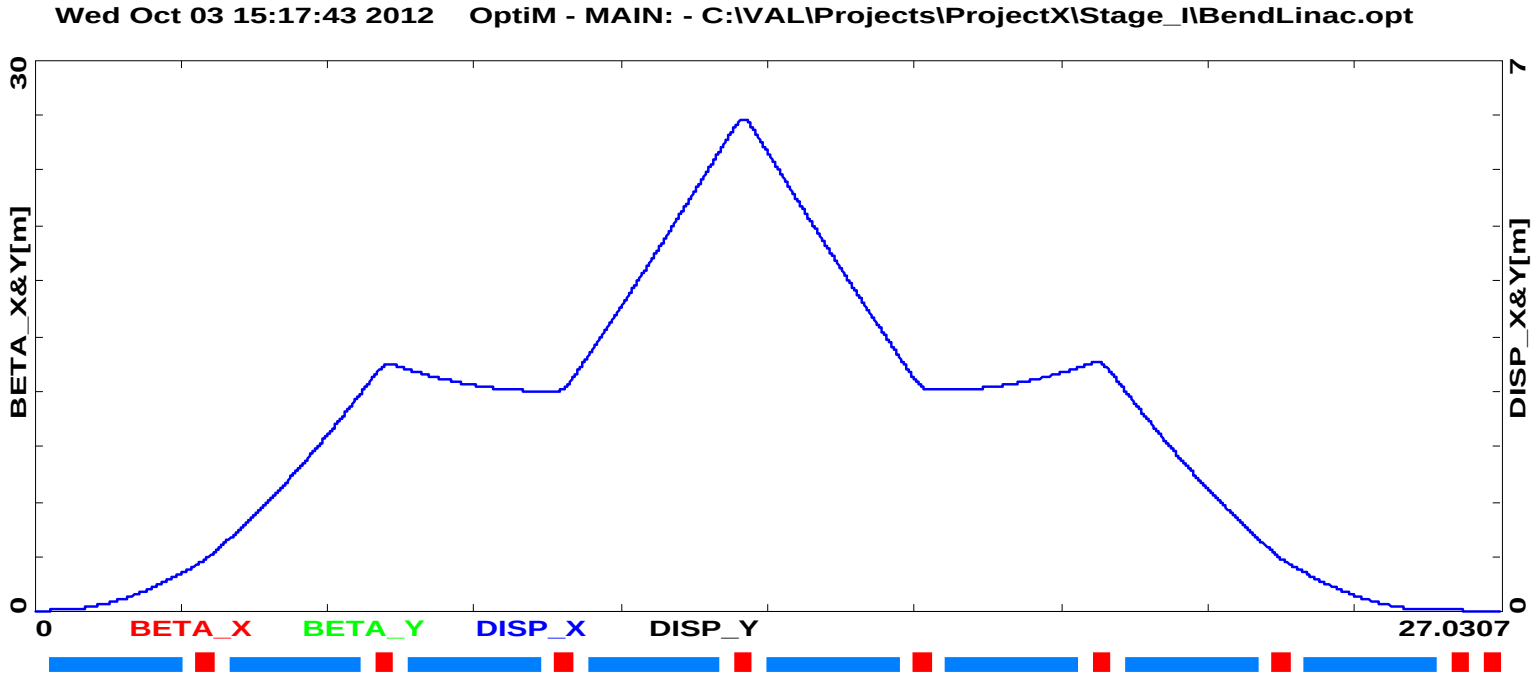
Bend Linac

- To be useful the bending has to happen at s≈90 m (E≈400 MeV)
  - Maximum magnetic field B≈5.2 kGs
    - Striping rate ≈ 10^{-7} m^{-1}
  - RMS momentum spread ≈ $3 \cdot 10^{-4}$
  - RMS bunch length ≈ 1.8 mm (1.4 deg)



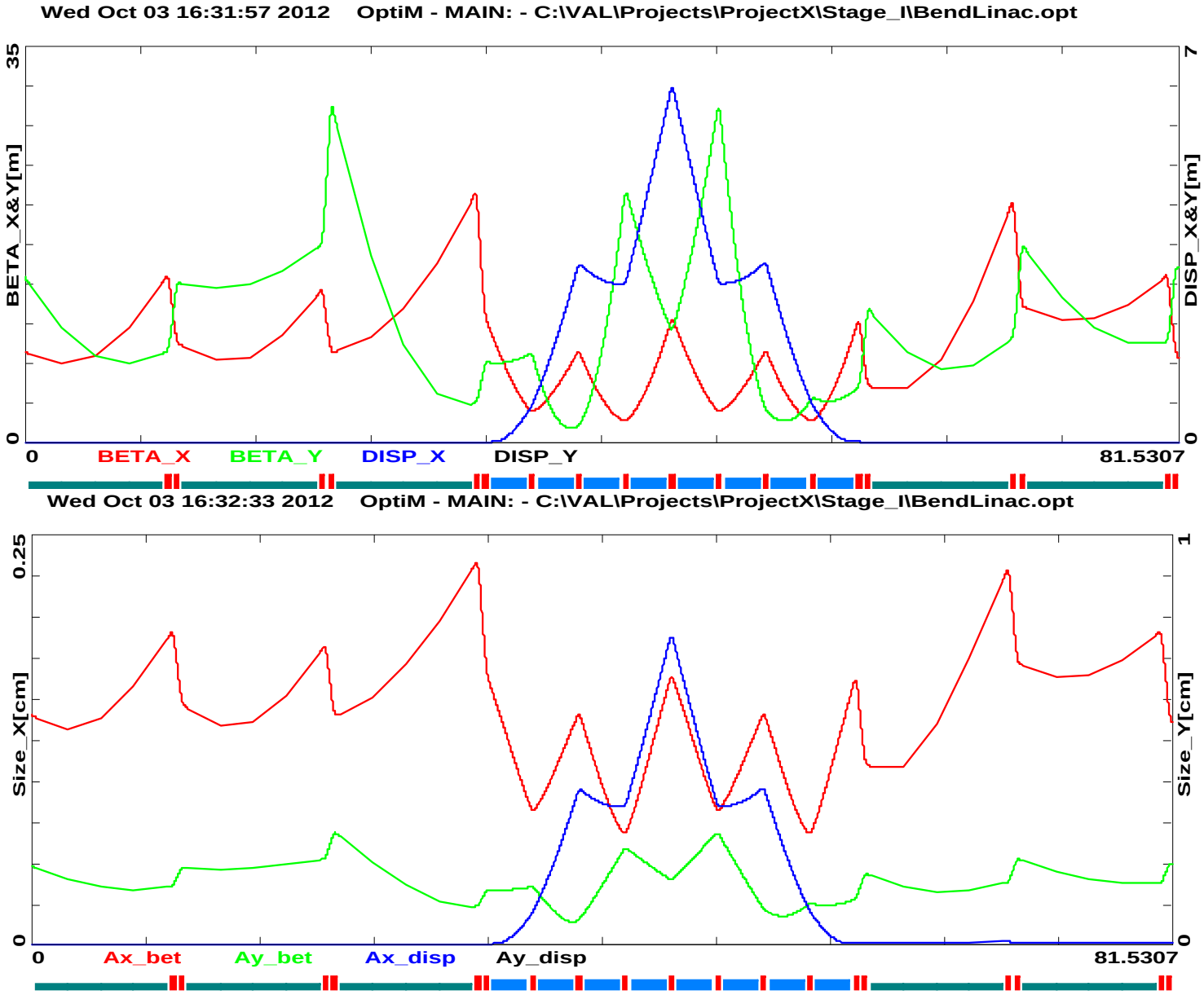


Beam Optics for 180° Bend



- Mean arc radius = 8.38 m (16.76 m beam separation)
- Momentum compaction = 0.271 instead of desired 0.491
  - M_{56} = 5.95 m (L=27.03 m, L/γ^2=13.28 m)
    - $\Delta\sigma_s = M_{56}\,\sigma_p/p$ = 1.78 mm
      - It is close to the bunch length σ_s = 1.8 mm & can be accommodated by longit. focusing with acceptable loss of accelerating gradient
- Further reduction of slip-factor (M_{56}) can be achieved if dispersion is not zeroed at the line end
  - Horizontal emittance growth

Beam Optics for 180° Bend (continue)



Twiss functions (top) and rms beam sizes (bottom) in the insert vicinity

ε_n=0.25 mm mrad, σ_p=3·10^{-4}

Conclusions for the bend linac

- Total insert length of ~60 m is comparable to the linac length of ~170 m
- Radius of the bend is quite large (~8.5 m) and implies two tunnels separate by ~17 m
- Slip-factor of the insert is not zero ($M_{56} \approx 6$m)
  - It makes the bunch lengthening of ~1.4 times and cannot be absorbed by adjustments of longitudinal focusing
- It is impossible to make an achromatic and isochronous 180° bend for ~400 MeV protons (H^-)
- Significant complications for machine tuning
- Overall does not look as a promising avenue