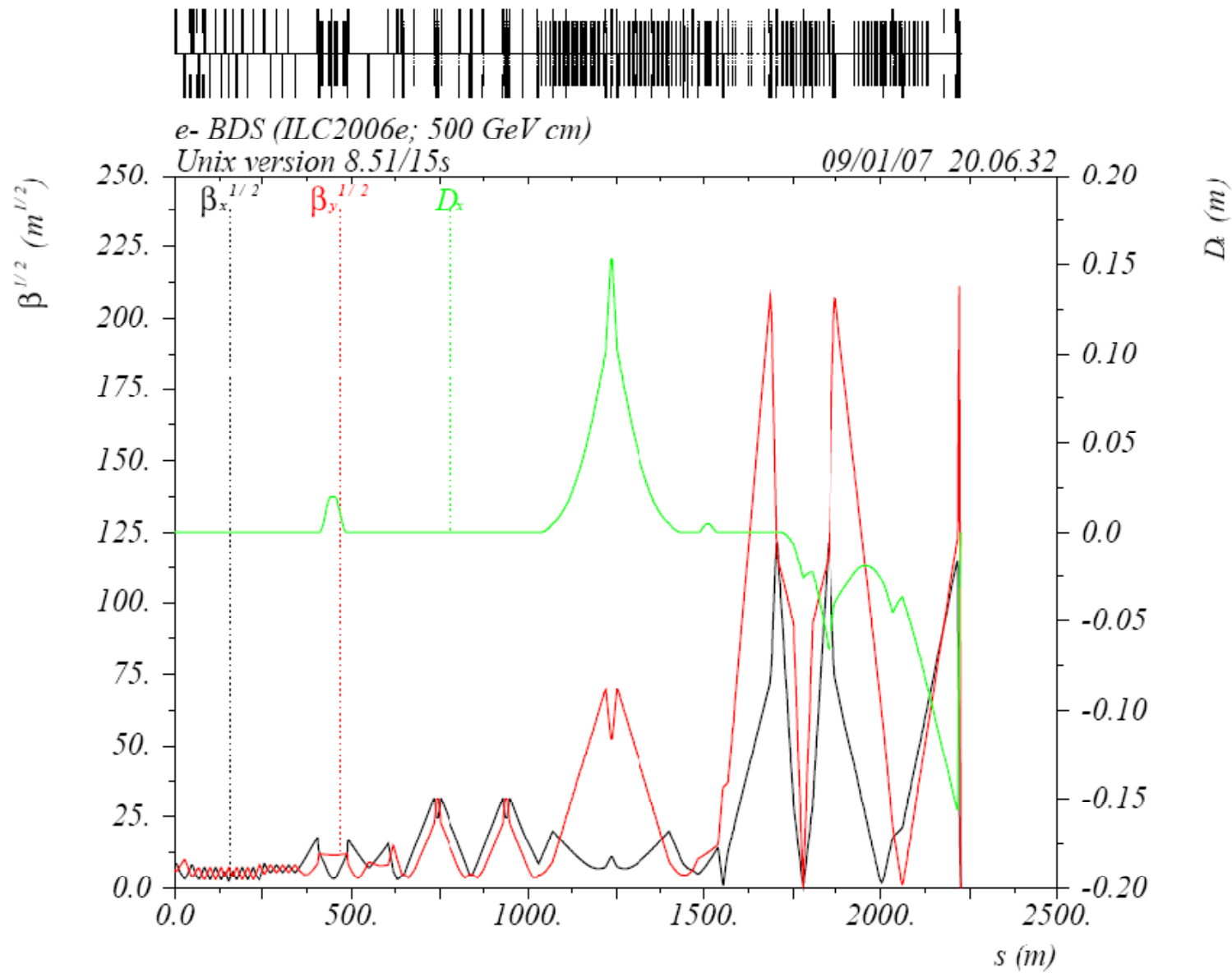
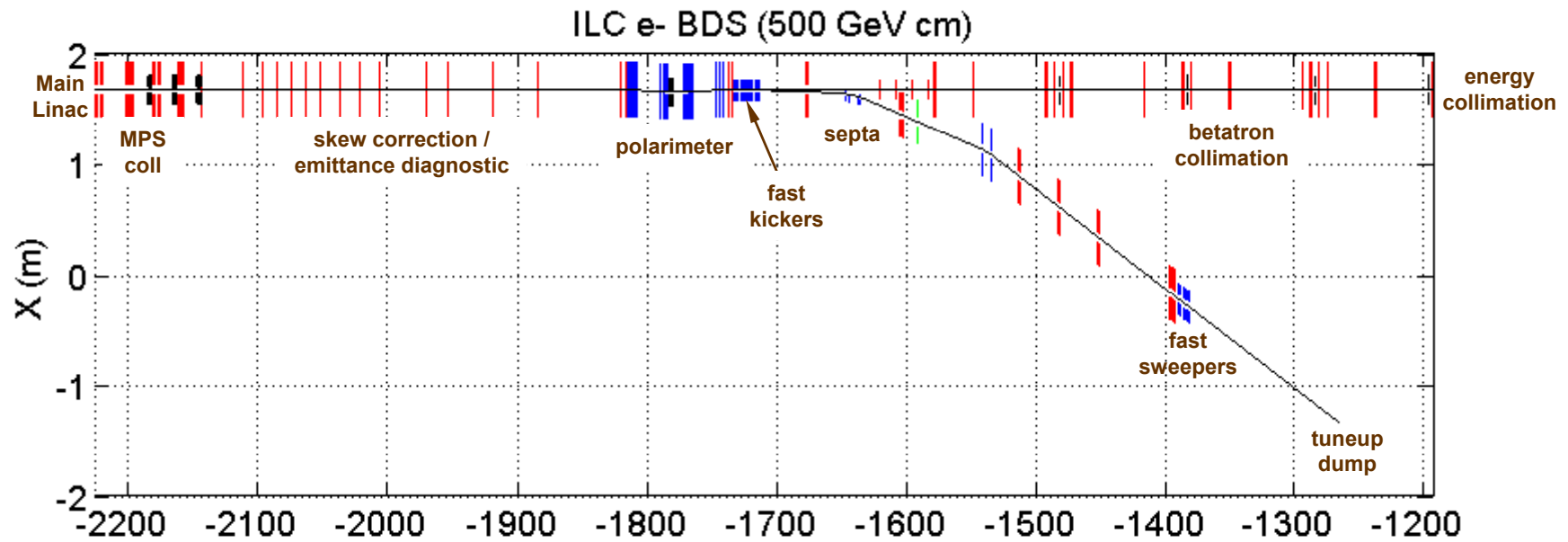




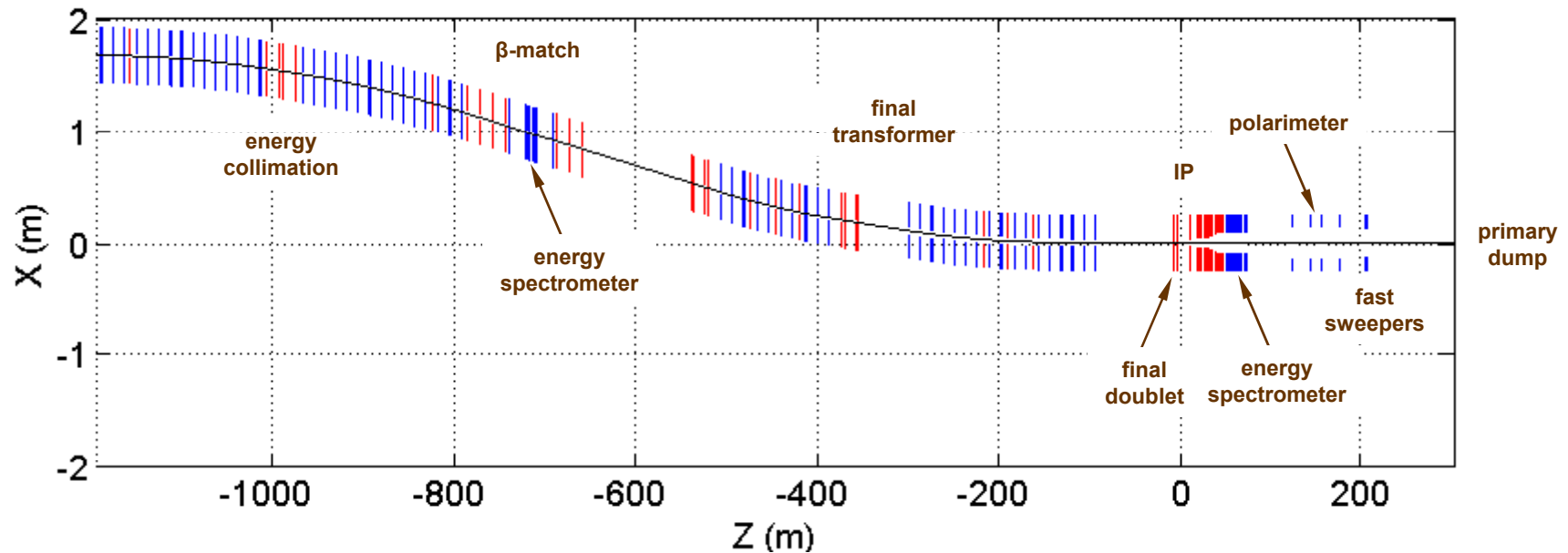
# ILC BDS Emittance Diagnostics: Design and Requirements

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### ILC2006e electron BDS schematic



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## “Legacy” BDS Design Criteria

- minimal deviation from linac axis (no net bending) ... for possible future multi-TeV operation
- emittance growth from incoherent synchrotron radiation (ISR) should be “small”
  - ILC total budgeted emittance growth from Damping Ring to IP: 20% horizontal, 100% vertical
  - BDS budget: 5% horizontal, 30% vertical
  - BDS design: emittance growth due to ISR < 1% @ 500 GeV (beam)
- bandwidth of fast abort / tuneup extraction line:  $\pm 10\%$

## BCD $\rightarrow$ RDR: BDS Design Criteria

- single interaction region, 14 mrad crossing angle (saves  $\sim 300$  m of tunnel) ... “push-pull” detectors
- start with design for 1 TeV cm (500 GeV beam)
- modify design for initial operation at (up to) 250 GeV; upgrade to 500 GeV to be accomplished by adding magnets only (no layout/geometry changes)
- decimate dipoles ... reduce  $\int B dl$  for 250 GeV operation by reducing lengths (i.e. number of dipoles); reserve space for additional dipoles, keeping layout fixed
- quadrupoles & sextupoles unchanged ... reduce  $\int G dl$  for 250 GeV operation by reducing strengths
- Final Doublet magnets will have to be replaced for upgrade to 500 GeV

# Emittance Measurement & Correction

- MPS collimation
  - 90° FODO cells
  - sacrificial collimators; reserve 3 m space for each (no real design yet ... tapered?)
- coupling correction and emittance diagnostics
  - after main linac
  - at entrance to BDS
  - upstream of fast abort / tuneup extraction (FATx) line
- coupling correction section
  - Paul Emma's 4 orthonormal skew quadrupole coupling correction lattice
  - as short as possible given quadrupole strength limits (9.6 kG @ 6 mm) and 500 GeV operation
- 4 station **2D** emittance diagnostic section
  - 4 laserwires
  - 45° FODO lattice
  - as short as possible given minimum measurable spot size (~1  $\mu\text{m}$ )
- bending system to separate Compton-scattered laserwire photons from primary beam for detection
  - 4 dipole chicane ... “share” upstream polarimeter chicane
  - since it's the only dispersive area upstream of the FATx system, include a sacrificial collimator to define the energy acceptance of the FATx system

## Additional Design Data

### Synchrotron Radiation Emittance Growth (DIMAD tracking; SYNC option 2)

- ILC2006c: @ 250 GeV, emit/emit0 = 1.0075 ; @ 500 GeV, emit/emit0 = 1.0137 (emit0 = 1e-5 m)
- ILC2006e: @ 250 GeV, emit/emit0 = 1.0036 ; @ 500 GeV, emit/emit0 = 1.0078 (emit0 = 1e-5 m)

### Laserwire Spot Size

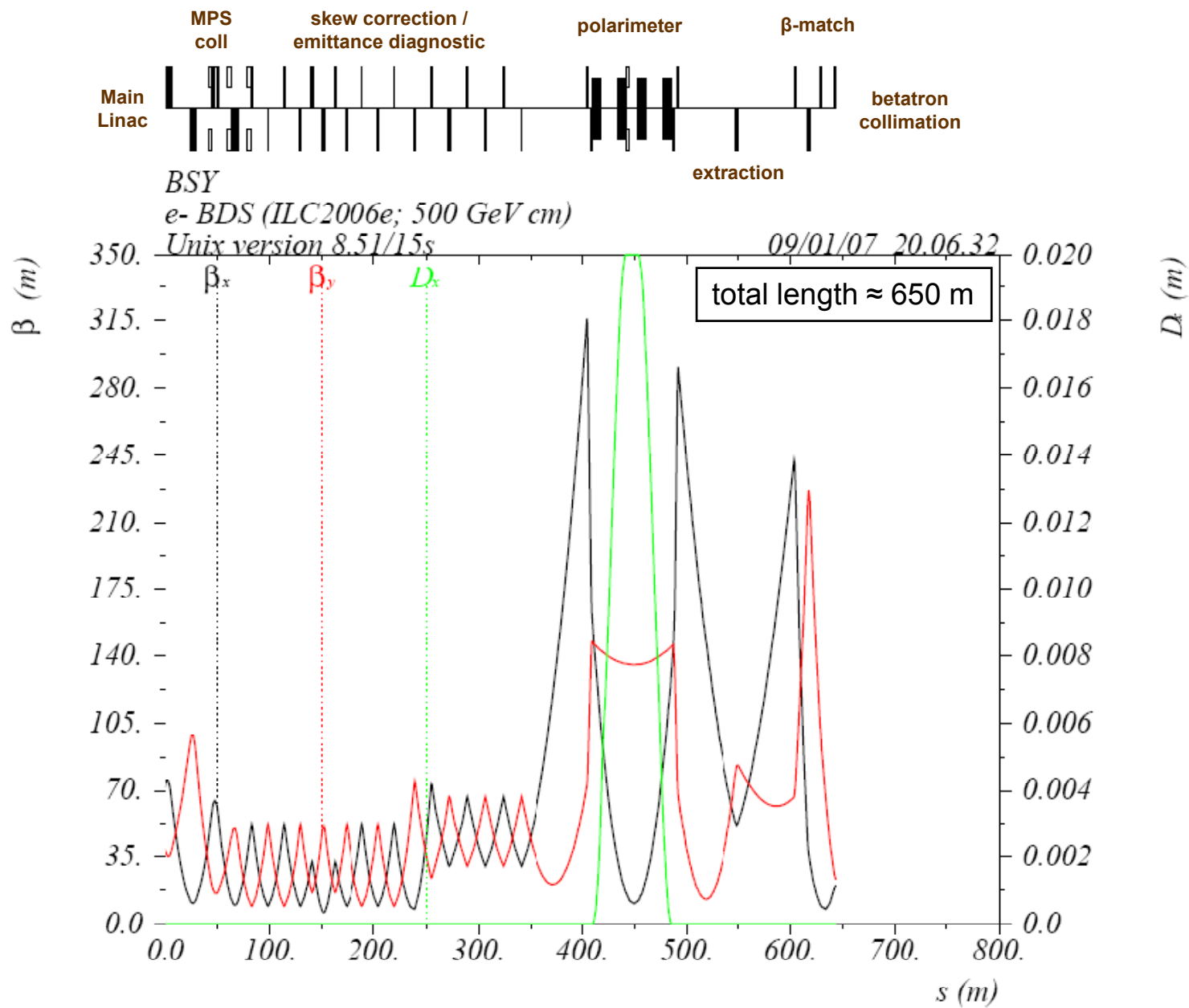
- "worst case" laserwire spot size: DR extracted emittance (2e-8 m), 500 GeV
- "nominal" laserwire spot size: BSY budgeted emittance (3.4e-8 m), 500 GeV
- emittance diagnostic FODO cell length: "worst case" spot > 1.0 um AND "nominal" spot > 1.5 um
  - L45 = 16.2 m (45° FODO cell drift length)
  - BETY(WS) = 64.752 m
  - "nominal" vertical spot size = 1.500 um
  - "worst case" vertical spot size = 1.150 um
  - skew/emit length = 247.102 m (1st skew quad to 4th wire scanner)

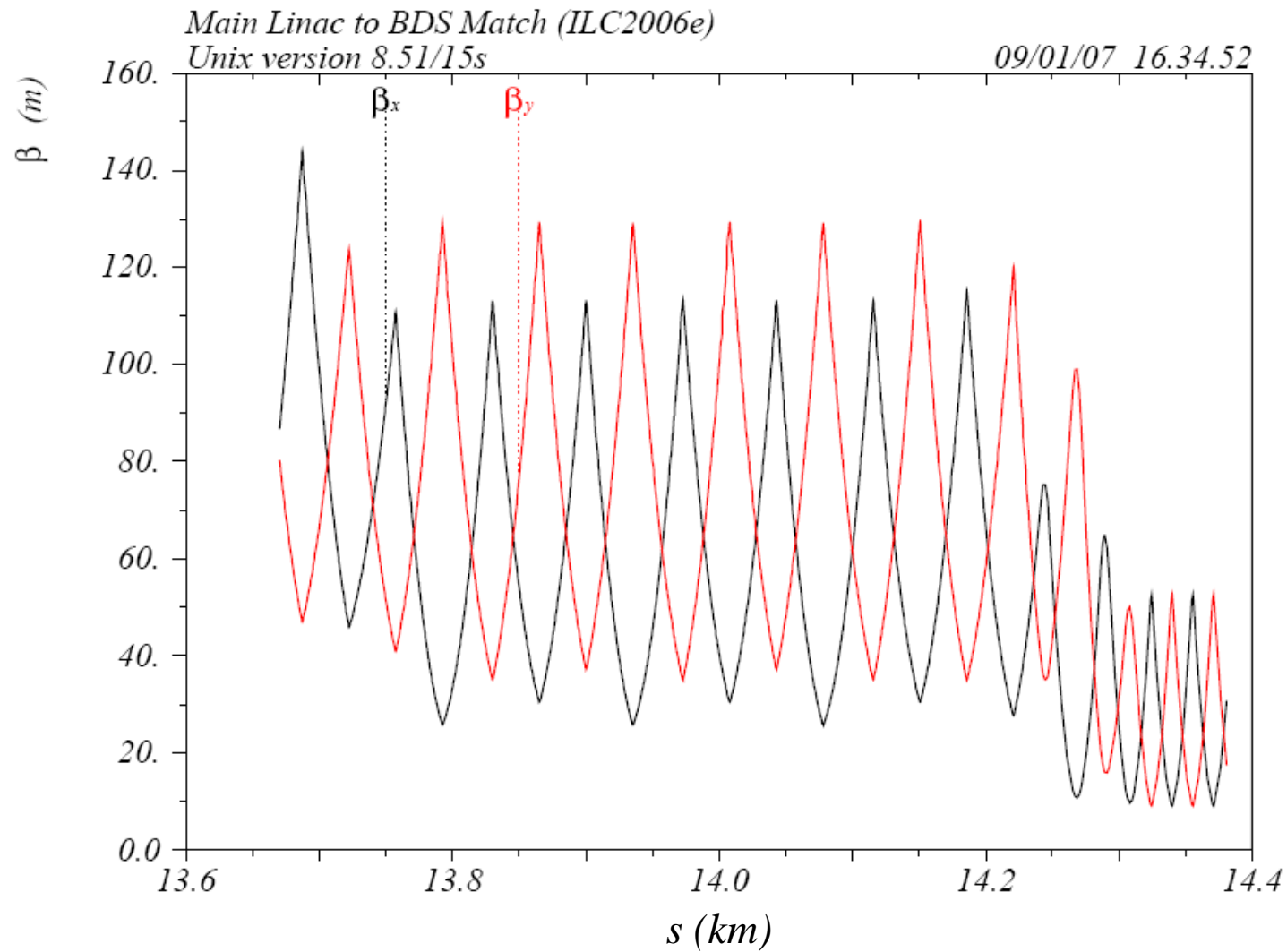
### Polarimeter Chicane

- peak dispersion = 20 mm @ 250 GeV, 10 mm @ 500 GeV ... constant B-field dipoles
- minimum center dipole separation = 8 m + 3.5 m (for MPS energy collimator)
- energy detection resolution: for dE/E = 1%, dX > 10\*sigmaX (BSY budgeted emittance)

### Extraction

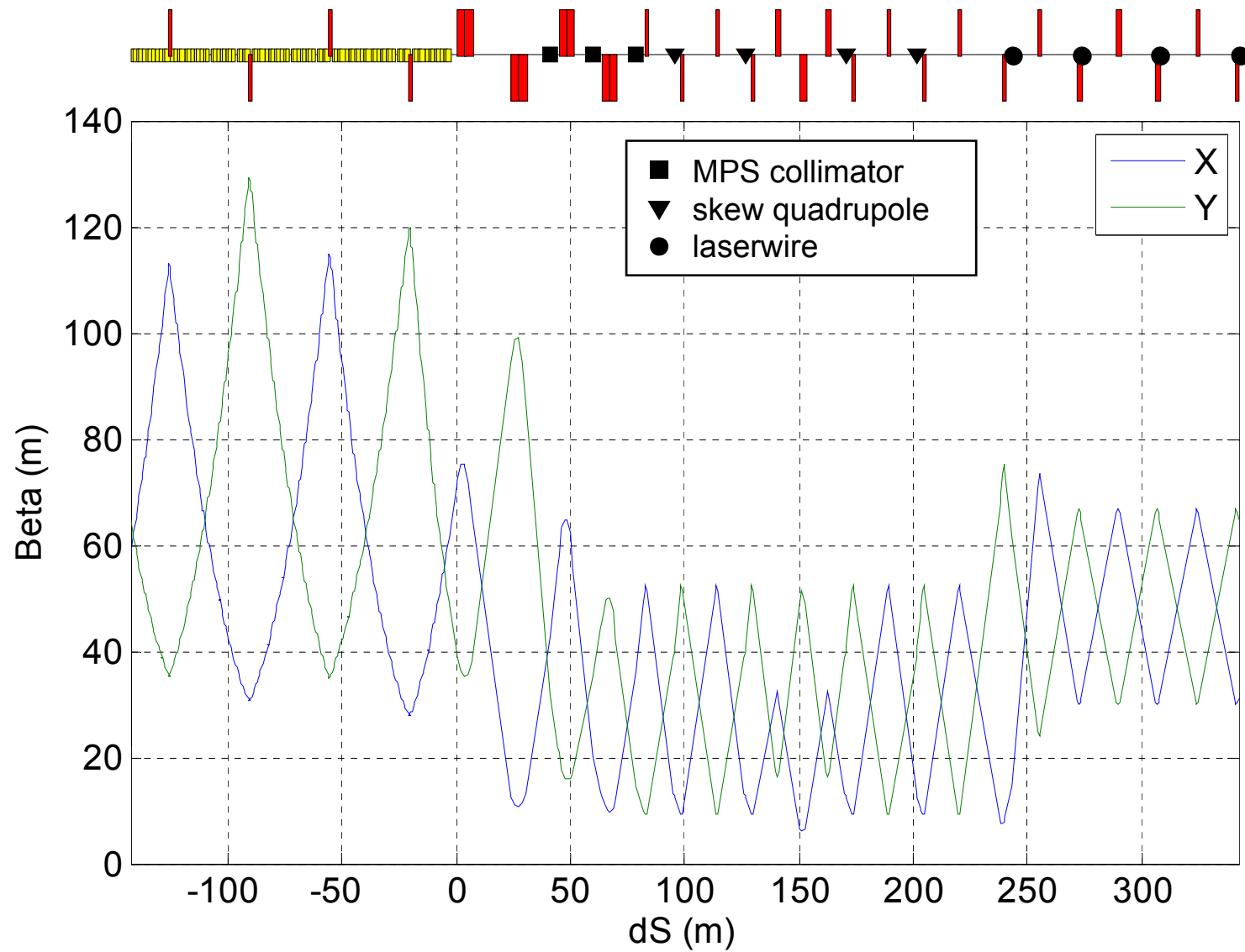
- septum aperture: R = 15 mm (+-10% dE/E acceptance)
- required offset at septum entrance: dX = 35 mm
- 9 kickers (9 × 2 m × 0.133 kG)
  - 1 TeV upgrade: 25 kickers (25 × 2 m × 0.133 kG ; Lkick/(Lkick+Ldrift) = 2/3)
- 3 septa (2 × 2 m × 5 kG + 1 × 2 m × 10 kG)
  - 1 TeV upgrade: 5 septa (3 × 2 m × 5 kG + 2 × 2 m × 10 kG)
- transverse clearance for IRT "Type B" quads: 135 mm
  - 0.5 \* 171 mm (quad half-width) + 40 mm (extraction line beam pipe radius) + 10 mm (clearance)
- transverse clearance for extraction line 8 cm bore quad QFSM1: 220 mm
  - 0.5 \* 16 inches (quad half-width) + 6 mm (IRT beam pipe radius) + 10 mm (clearance)
- 10 rastering kickers for 3 cm radius (10 × 0.8 m × 0.54 kG)
  - 1 TeV upgrade: 20 rastering kickers for 3 cm radius (20 × 0.8 m × 0.54 kG)
- required offset at dump: dX > 3 m



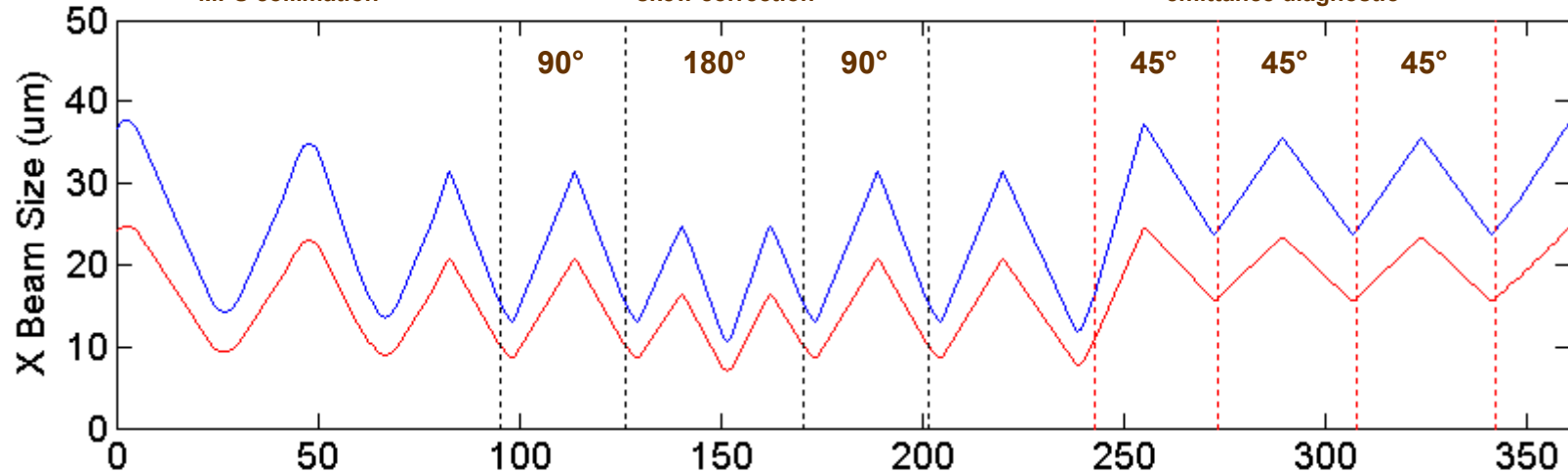
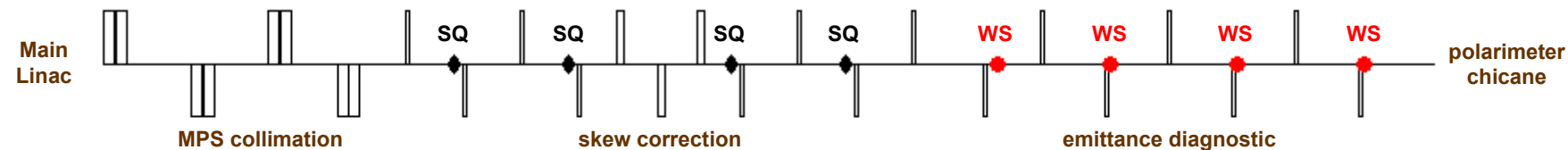




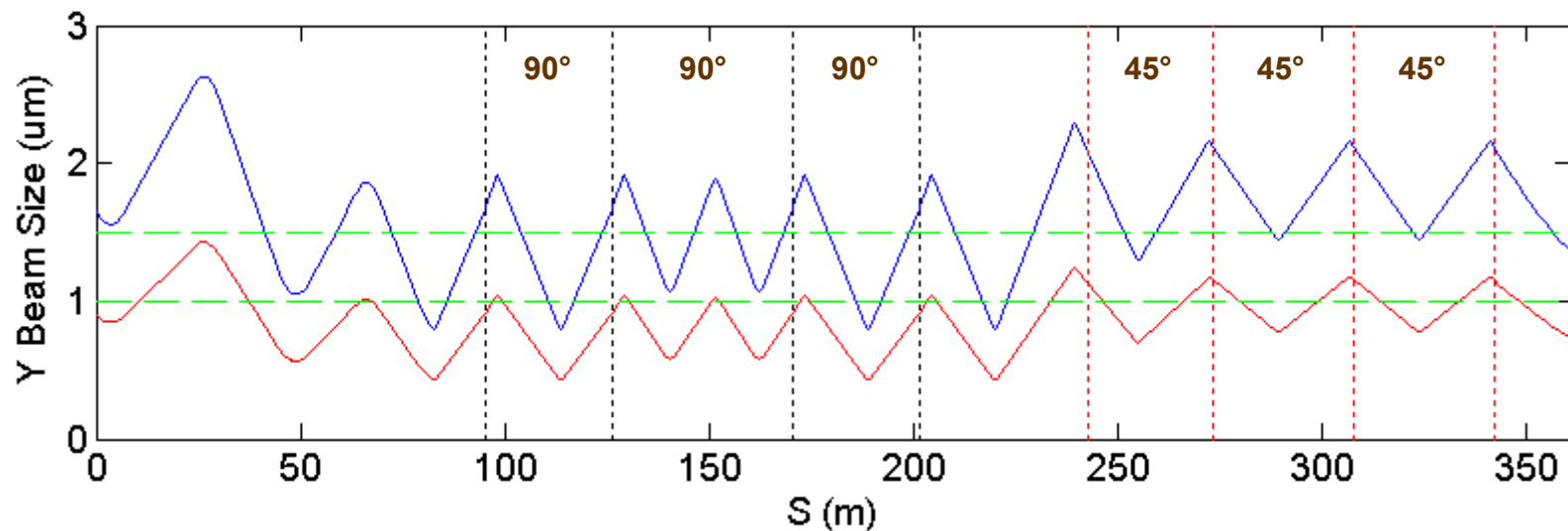
# Last Cryo String / MPS Collimation / Skew Correction / Emittance Diagnostic



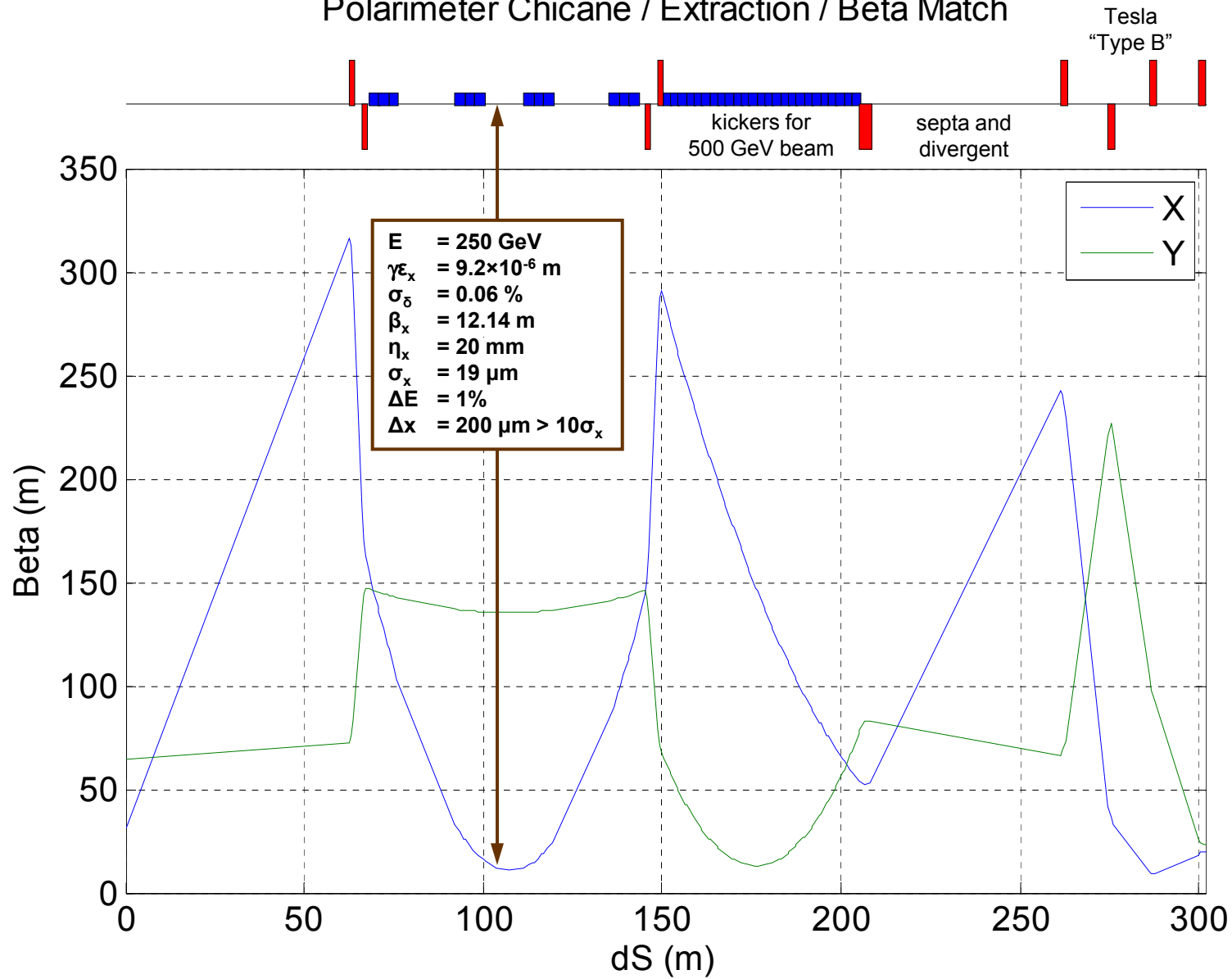
MPS / skew correction / emittance diagnostic



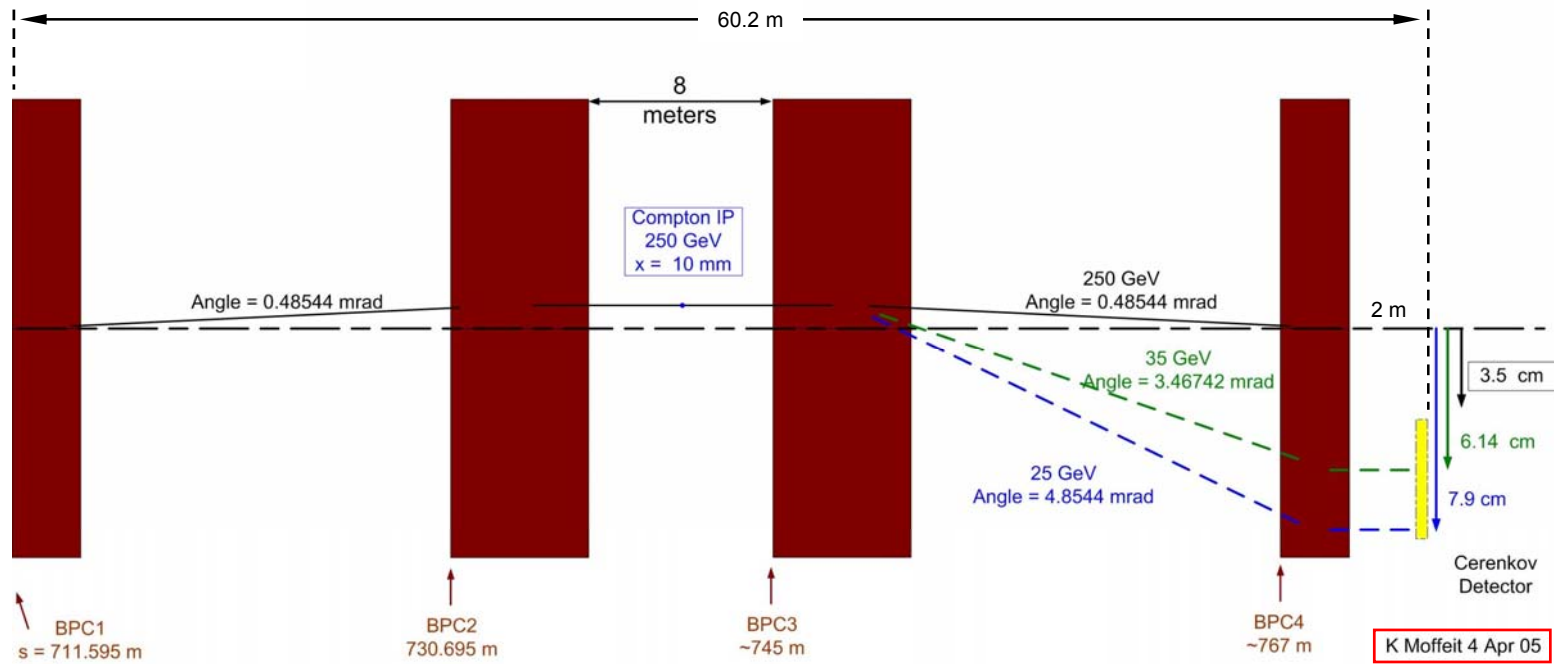
worst case (500 GeV) ; nominal (250 GeV) ; phase advance



# Polarimeter Chicane / Extraction / Beta Match



# Original Upstream Polarimeter Chicane



# New Upstream Polarimeter Chicane

- constant integrated strength dipoles ( $B = 0.97 \text{ kG}$ )
- dispersion = 20 mm @ 250 GeV, 10 mm @ 500 GeV
- dispersion scales inversely with energy (= 110 mm @ 45 GeV)
- transverse space for laserwire detector @ 500 GeV? (< 5 mm)
- magnet and vacuum chamber engineering issues?

