Crossing angles at injection

(...)

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What determines the crossing angle at 450 GeV ?

- **Beam-beam considerations:**
  - **As large as possible, sets lower limit, limits β^***
- **Aperture:**
  - **Small, sets upper limit, limits β^***
- **Operation:**
  - **Should make operation simple, compatible with above, e.g.:**
    - **Constant during cycle, orbit feedback**
    - **Use of magnets (e.g. MCBX, ramping, ..)**
    - **...**

What determines the crossing angle at 450 GeV ?

- **Essential input:**
  - **Emittance**
  - **Bunch spacing (Scaling rules depend on spacing !!)**
  - β^*_{inj} **(Scaling rules depend on** β^*_{inj}**)**
- **The "nominal"** $\pm$ **170** μ**rad (maximum possible in 1999)**[*)]
  - **For nominal emittance (3.75** μ**m, as assumed in 1999)**
  - **For nominal aperture (**$n1 \geq 7$**, as assumed in 1999)**
  - **Bunch spacing 25 ns**

[*)] **Nota bene:** $\beta^*_{inj} = 18$ **m in 1999**

What determines the crossing angle at 450 GeV ?

- **Other considerations:**
  - **Spectrometer magnets in IP2 and IP8**
    - **Field strength**
    - **Polarity**
  - **Solenoids (small effect)**
  - **Sign of angle (in IP5 and IP8)**

Separation for different ϵ_n, α

- **With present layout and β^*_{inj} = 11 m (IP1/5)**

ϵ_n (μm)	$\pm$ 170 μrad	$\pm$ 140 μrad	$\pm$ 120 μrad
3.75 μm (nom)	$\approx$ **9.5** σ	$\approx$ **8.0** σ	$\approx$ **7.0** σ
2.70 μm	$\approx$ **11.0** σ	$\approx$ **9.5** σ	$\approx$ **8.5** σ
2.10 μm	$\approx$ **12.5** σ	$\approx$ **10.5** σ	$\approx$ **9.5** σ

- **Minimum separation**
- **In presence of nominal parallel separation**
- **Valid for 25 ns, 50 ns, 75 ns**

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- **Minimum separation**

Arguments for/against $\alpha = \pm 170 \mu$rad

- **Works for nominal emittance and bunch spacing**
- **Plenty of separation for smaller emittances**
- **Requires more aperture**
- **Requires ramping down**

Arguments for/against $\alpha = \pm 120/140 \mu$rad

- **Works for smaller emittances**
- **Could keep same value during cycle**
- **Requires smaller emittances:**
  - **Can we keep emittance small for 25 ns ?**
  - **Do we want 25 ns (.. or 72 bunches/train) ?**
  - **We might screw up the emittance and IP8**

Recommendation

- **We do not yet know the effect of long range interactions**
- **Crossing angle of $\alpha = \pm 170$ μrad is a safer bet**
- **... but may be overkill**