Polarized Protons

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The goal

- Double the luminosity (to $40 \cdot 10^{30}\,\mathrm{cm}^{-2}\mathrm{sec}^{-1}$)
- Preserve (or even improve) polarization (65 percent)

How can we get there?

Luminosity formula:

$$\mathcal{L} = \frac{N^2 f_c}{4\pi\epsilon\beta^*}$$

Collision frequency f_c is already maximized (111 bunches). Remaining "free" parameters are intensity N, emittance ϵ, and β^*.

What are the limitations on these?

Beam-beam formula:

$$\xi = \frac{r_0 N \beta^*}{4\pi\gamma\sigma^2} = \frac{r_0 N}{4\pi\gamma\epsilon}$$

Beam-beam is independent of β^*.

$\Rightarrow$ squeeze β^* as much as possible.

Limitations on β^* :

- magnet strength and triplet aperture
- hourglass effect (need shorter bunches $\rightarrow$ M. Brennan)

Main luminosity improvement has to come from higher intensity ($2 \cdot 10^{11}$/bunch). Fortunately, AGS polarization seems largely intensity-independent.

But: higher intensity (or smaller emittance) increases beam-beam tuneshift.

Large tuneshift parameters make working point search very delicate. Working points in the two rings need to be different to avoid coherent beam-beam effects.

FY06 pp-run was already largely beam-beam limited.

What can (and needs to) be done?

- Provide more tune space by compensating $Q_x = 2/3$ resonance ($\rightarrow$ Y. Luo): 10 percent

- Reduce tune spread from nonlinear chromaticity by $\Delta Q = 0.003$, then increase intensity until total tune spread $\Delta Q = 0.015$ is restored ($\rightarrow$ S. Tepikian): 40 percent

- Eliminate 10 Hz beam-beam modulation ($\rightarrow$ C. Montag): 10 percent

- β^* reduction: 10 percent

- hourglass effect reduction ($\rightarrow$ M. Brennan): 10 percent

- Search for a better working point (polarization issues $\rightarrow$ T. Roser): ???

Total: 205 percent luminosity increase

Run-6 developments (to be kept)

- low-γ_t injection lattice
- reduced IR dispersion at store (to be attempted also at smaller β^*)
- tune/decoupling feedback
- don't seem to need the tune swing – but it doesn't seem to hurt us either
- beam-based alignment ($\rightarrow$ J. Niedziela)

Polarized Protons Run Plan

- A new working point should only be tested for a very limited time (days); if it doesn't seem beneficial, forget about it.

- If we decide to keep the Run-6 working point, we should start using the latest Run-6 settings (never done before, always started from scratch).

- Achieved 3 weeks between end of cooldown and start of physics in Run-6. This approach should be even faster (2 weeks).