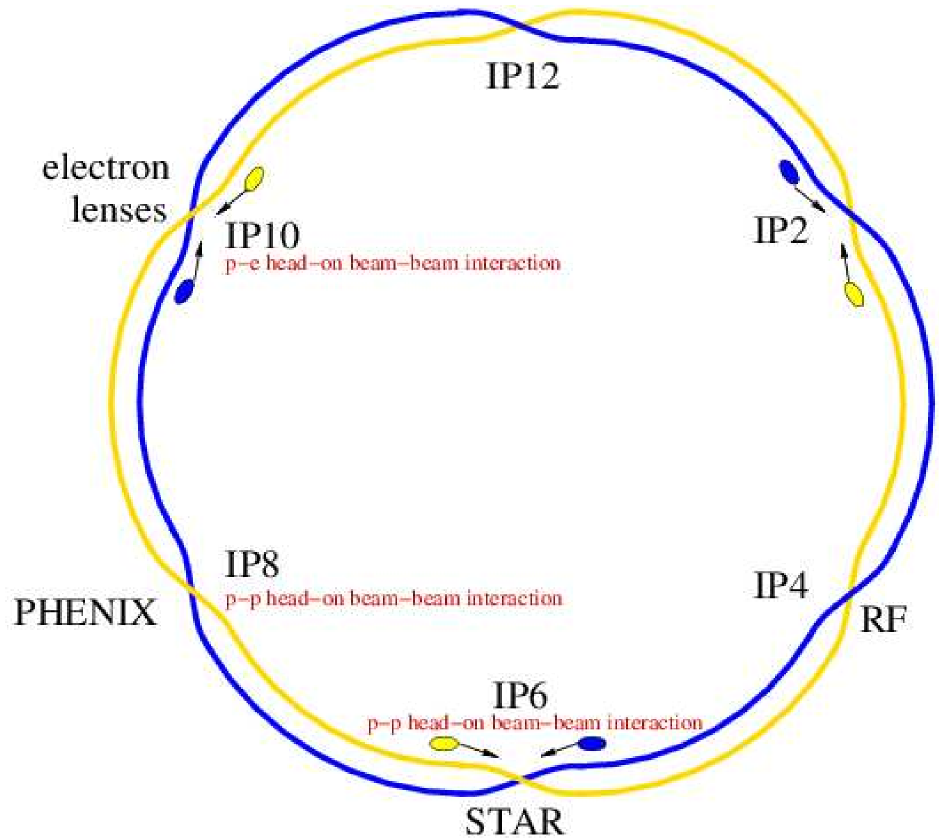
Beam-beam compensation studies for RHIC

Christoph Montag
Brookhaven National Laboratory

Tevatron Accelerator Studies Workshop, January 13 – 14, 2010

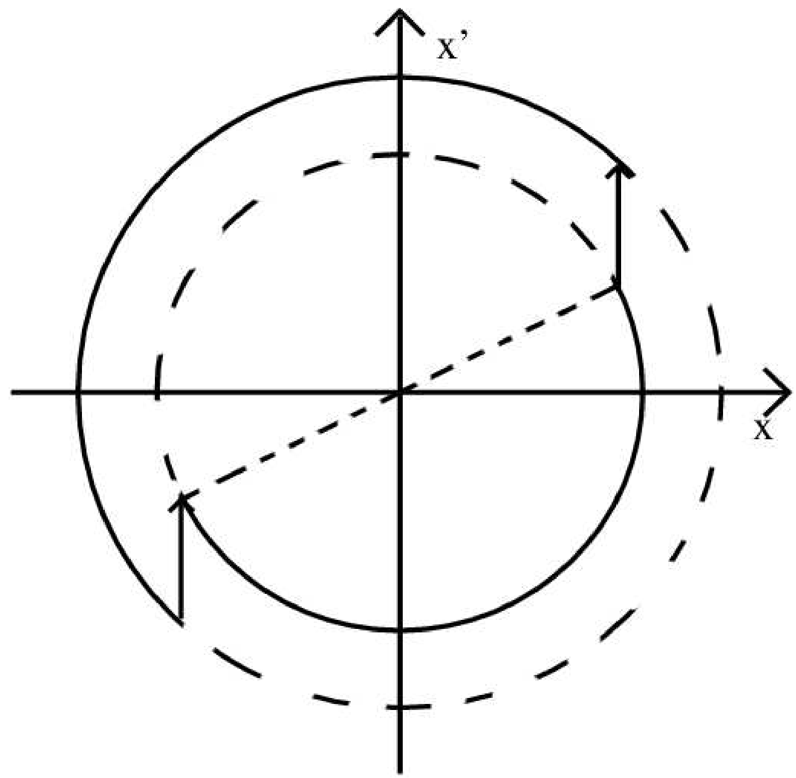
RHIC beam-beam compensation scheme



Nonlinear beam-beam kick at IP8 is compensated by opposite kick at IP10

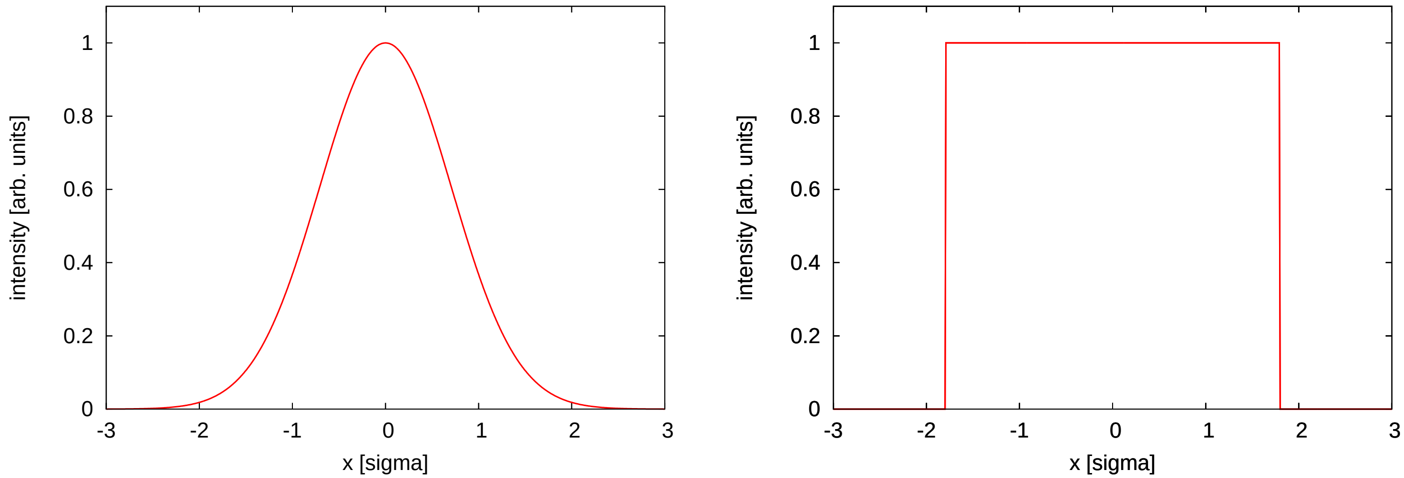
Requirements

- Betatron phase advance of $k \cdot \pi$ between IPs 8 and 10



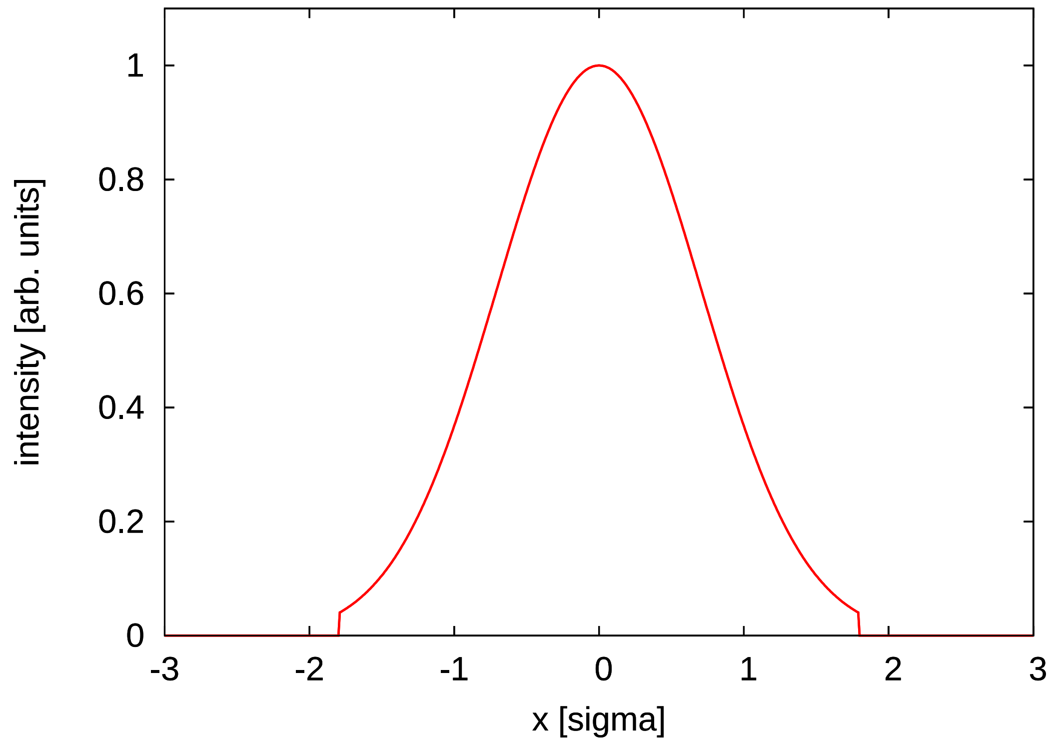
Requirements (cont.)

- Gaussian electron beam profile



Gaussian profile would be ideal, rectangular profile disastrous

Electron lens profile has a sharp cut-off at 2.8σ due to limited cathode size:



Sharp edges are generally dangerous, but intensity in the tails is very low

(Cut-off shown at 1.8σ for illustrative purposes)

Accelerator studies at RHIC

1. Betatron phase shifter

    - Two shunt power supplies will be added to main quads in arc IP8 - 10, to allow control of betatron phase advance

    - For different values of the phase advance, measure optics with AC dipole

2. Gaussian beam profile

- Collide beams in IPs 6 and 8
- Collimate (=scrape) Blue beam aggressively, down to 2-3 σ
- Observe Yellow beam lifetime as function of Blue collimator position
- Measure beam profiles with IPM and Vernier scan (χ^2-test)

3. E-lens straightness requirement

- In the thin-lens approximation, a non-straight electron lens beam is equivalent to a "smoke ring" in phase space

- Generate "smoke rings" by single kicks of different amplitude to bunches in the "Blue" beam

- Observe lifetime and emittance evolution of corresponding bunches in the "Yellow" ring

Accelerator studies at the Tevatron

1. Measure beam lifetime as function of electron beam intensity and beam size, beginning with low currents/large beamsizes to simulate the commissioning process.

2. Study effect of finite cathode size (chopped-off Gaussian tails) on beam lifetime.

3. Study the effect of beam offsets, crossing angles, and (spurious) dispersion at the electron lens on beam lifetime.

4. Verify that at full beam-beam compensation the electron lens does not lead to beam degradation.

5. Verify tune footprint reduction due to head-on beam-beam compensation.

6. Study the effect of time-dependent parameter variations, such as electron beam size and intensity, orbit jitter, etc., as function of noise spectrum.

7. Simulate e-lens commissioning process, using Tevatron lens