TASW:
Subjects We Always Wanted to Understand But Did Not Have a Chance to Study

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with input from Yu.Alexahin and V.Lebedev

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The List (V.S., Yu.A.)

- Beam-Beam:
  - -lifetime vs helix size
  - -lifetime vs beta* (small sigma_s/beta*)
  - -losses vs dPhi_IP (betatron phase)
  - - coherent BB (excite 1 bunch and watch others)
  - - head On only vs LR only tune scans
- Instabilities:
  - - longitudinal instability study
  - -e-cloud dEmm/dt vs tune
- IBS vs vacuum vs noise:
  - -dEmm/dt vs N_p/bunch at 150 and at 980
- Acceptance at FT/LB on c-orbit (for future use)
- Space-charge compensation (Giulio)
- DA vs Q':
  - - tune scan of losses at 150 vs Q';

The List (V.L.)

1. Operation with 18x18 bunches. It will have reduced long range collisions and potentially can yield larger tune shifts and luminosity per single collision.
2. Operation with zero chromaticity and low noise transverse damper. It requires investment into damper hardware. The present one is not good enough.
3. Why the longitudinal damper is not good enough
4. Instrumentation tests: OTR, ODR, IPM, Schottky

1. Tune Scan

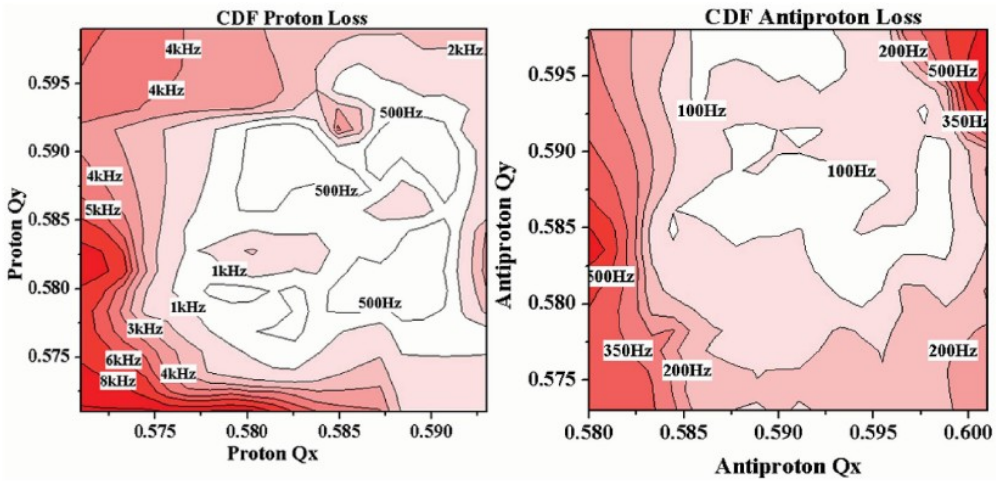
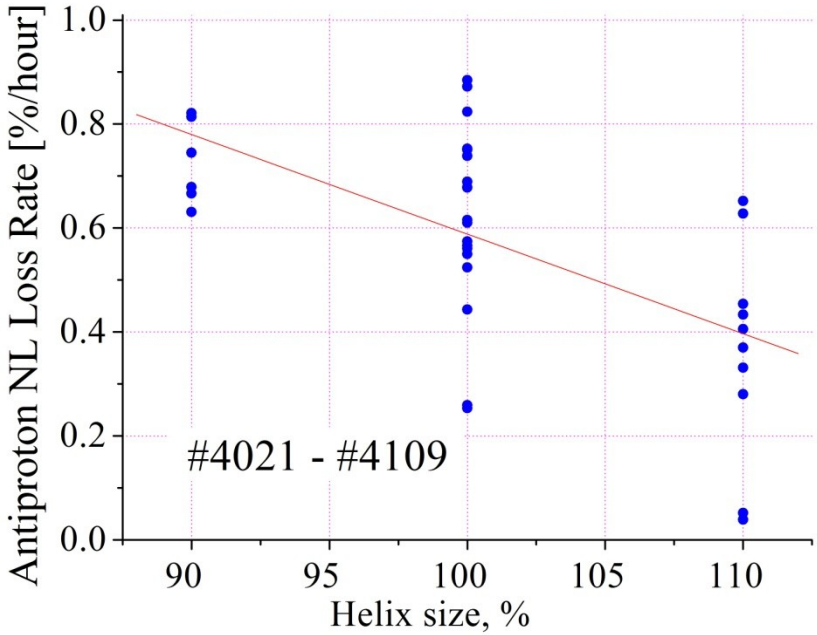


FIG. 32. (Color) Contour plots showing background halo rates at the CDF detector for protons (a) and antiprotons (b) vs the measured horizontal and vertical tunes for each beam. The experiment was performed at the end of store #3972 (February 10, 2005). The tunes were measured by the 1.7 GHz Schottky monitor gated on all bunches for each beam.

V.S., XLZ, et al
PRSTAB 2005

- **Objective: Understand losses vs Tunes, use for benchmarking simulations**
- **Study: do Qx Qy tune scan at Collisions; may be with/without Head-On**
- **Type and Duration: about 4-8 hours, BOS, mb dedicated, need pbars**

2. Lifetime vs Helix size



R.M., V.S., PRSTAB 2005

- Objective: Understand losses vs separation, other machines have S^5
- Study: change Helix in collisions, (sepration?) and see effect
- Type and Duration: either ~8 hours dedicated, or in store studies (limited), or at 150 ~4 Hrs

3. Confirm Phase Averaging

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Bunch-length effects in the beam-beam interaction

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Newman Laboratory of Nuclear Studies, Cornell University, Ithaca, New York, 14853
(Received 25 September 1989)

The Hamiltonian analysis of the beam-beam interaction is extended, for round beams, by including its finite longitudinal extent. For small synchrotron amplitudes resonance strengths are derived that are smaller than those obtained in the impulse approximation. This is a consequence of averaging over the betatron phase during the collision. Results of simulations that reproduce this feature are also presented. More complete simulations, relevant to storage-ring colliders, argue for bunch lengths comparable to the value of the amplitude function (β) at the interaction point.

iap FERMILAB-Conf-00/124-T

Beam-beam studies for the Tevatron

Tanaji Sen, FNAL, Batavia, IL 60510

Smaller sigma_s/beta*
worse lifetime
K.+S.
T.Sen
Yu.Alexahin

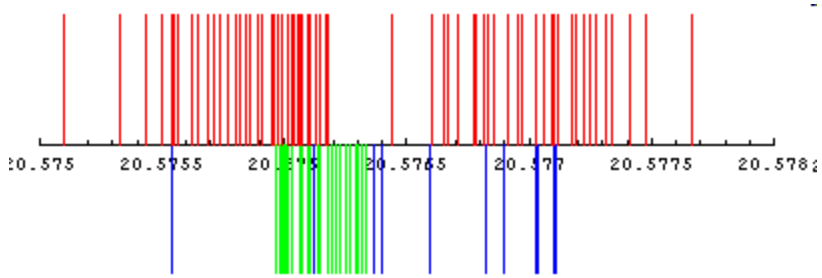
- **Objective: Confirm that smaller sigma_s/beta* is worse**
- **Study: collide at FT(no LB), beta*=1.5m (instead of 0.3m), mb 1x1 bunch? (head on only effect)**
- **Type and Duration: either ~4 hours dedicated**

4. Confirm optimal IP-Phase Effect

CDF and D0 betatron phase difference should strongly affect the lifetime; current dPhi can be varied, is not far from optimum Yu.Alexahin

- Objective: confirm better lifetime at optimum dPhi_IPs
- Study: change optics, then collide, mb 1x1 bunch?
- Type and Duration: ~2-4 hours dedicated to tuneup optics; then normal store; then return

5. Coherent Beam-beam Effect



Yu.Alexahin
Valishev, Stern

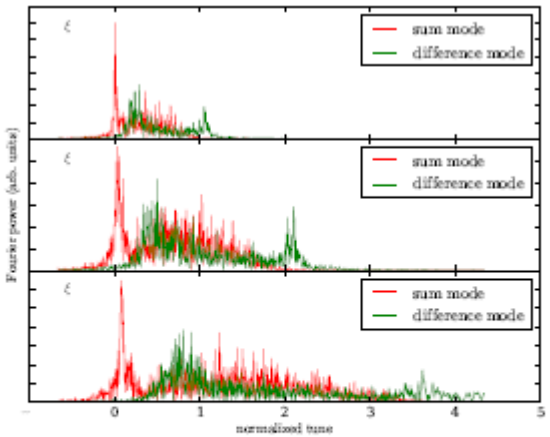


FIG. 9: Dipole mode spectra of the sum and difference offsets of two beam centroids at three beam intensities corresponding to beam-beam parameter values for each beam of 0.01, 0.02 and 0.04. The vertical scale is in arbitrary units.

- Objective: observe coherent b-b modes, pi, sigma, continuum
- Study: excite one (proton) bunch at LB, see response in all Ps and As
- Type and Duration: ~4-8 hours total, early store prefered; mb several stores, mb in stores

6. Longitudinal Instability

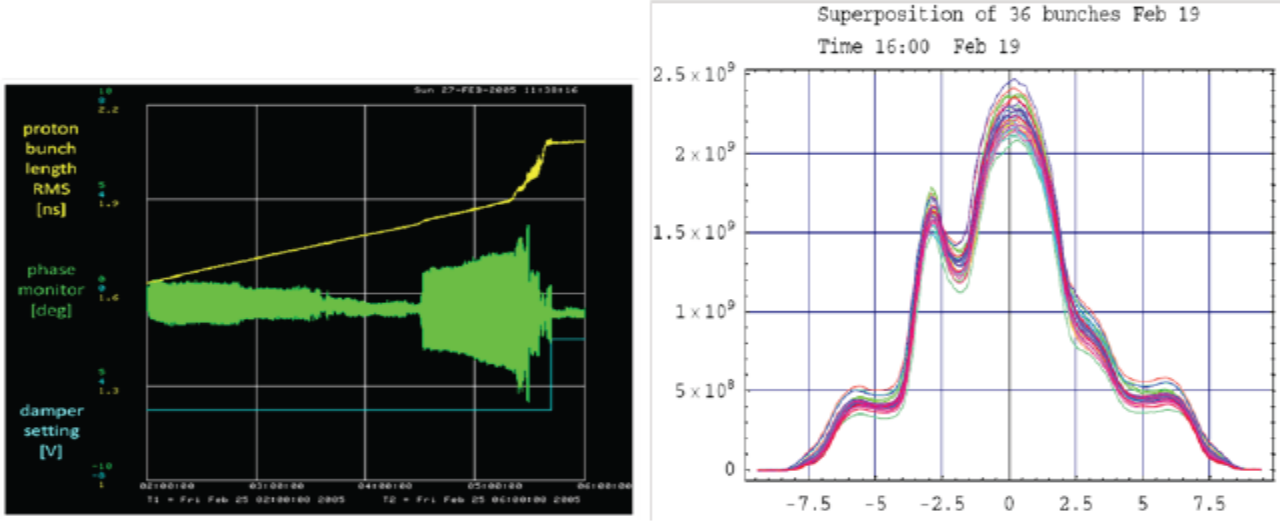
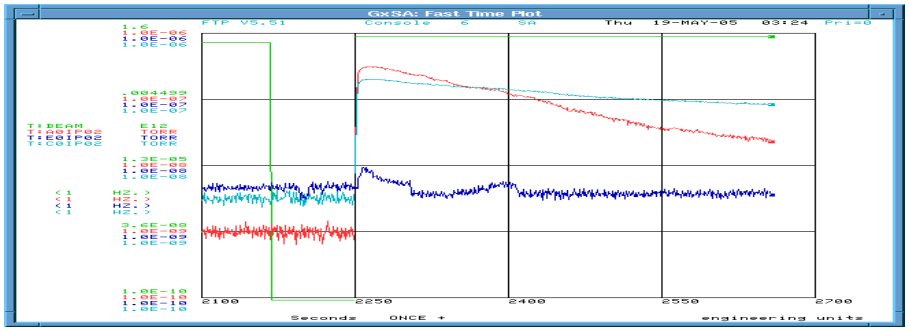


Figure 15. a) (left) Longitudinal phase monitor readings during an instability. b) (right) Longitudinal shapes (in ns) of all 36 proton bunches as detected by SBD after longitudinal instability had developed.

Bothers all since ~2004 V.S., Yu.A., John Reid

- **Objective: finally find what's the reason/nature of longitudinal beam blowup**
- **Study: try few ideas – change FB loops, detune cavities, move orbit in RF, etc**
- **Type and Duration: several ~1-2 hour attempts ; can we excite it at 150? Need pbars?**

7. e-cloud in Tevatron

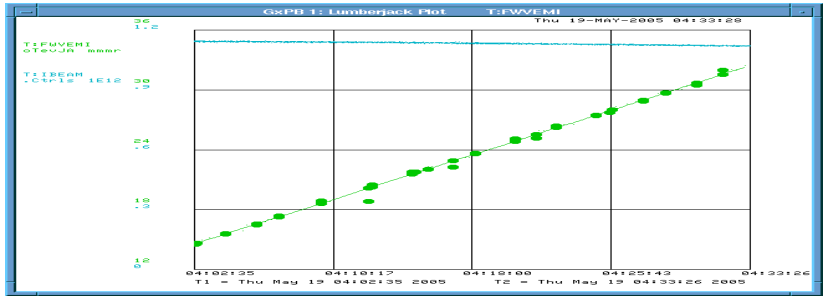


Tevatron 150GeV, 116e10/30bunches

ZXL, VS, R.Zwaska, Bruce H

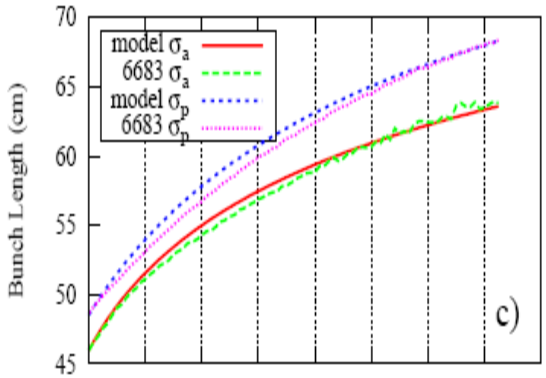
Beam lifetime 24.4hrs

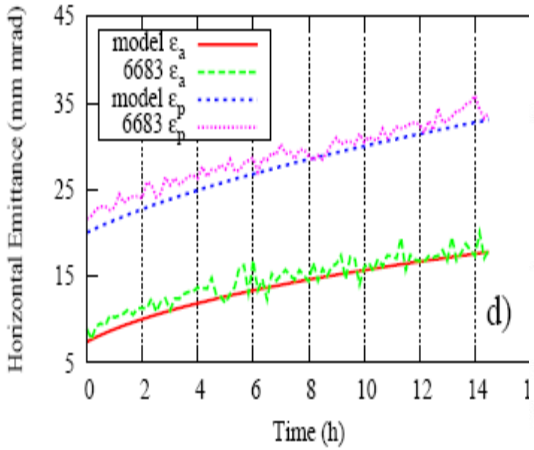
Emittance growth 34.8π/hr



- Objective: further undesrtand e-cloud phenomena, see dEmm/dt , is it tune dependent?
- Study: raise uncoal beam intensity (mb # of bunches), change tunes, observe Emm growth
- Type and Duration: several ~1-2 hour attempts ; mb with intentional vacuum worsening at A0

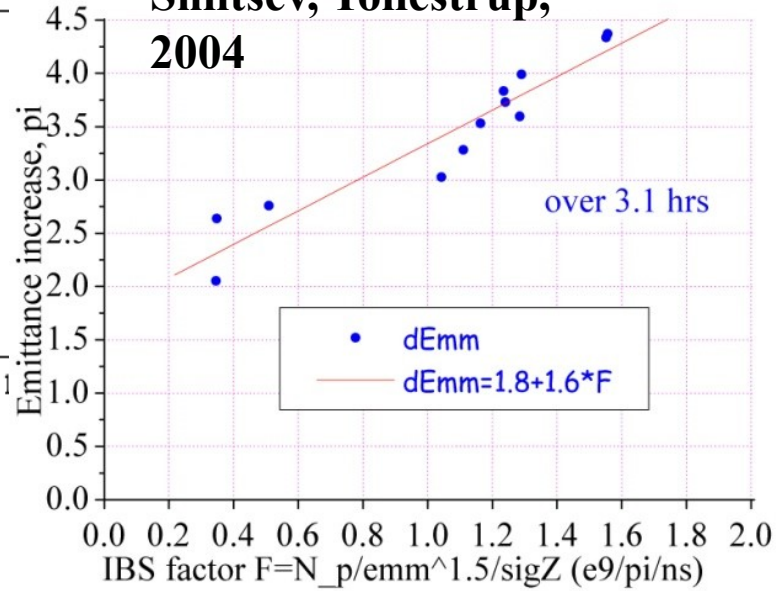
8. IBS vs Vacuum vs Noise





A, VL, have very good models

Shiltsev, Tollestrup, 2004

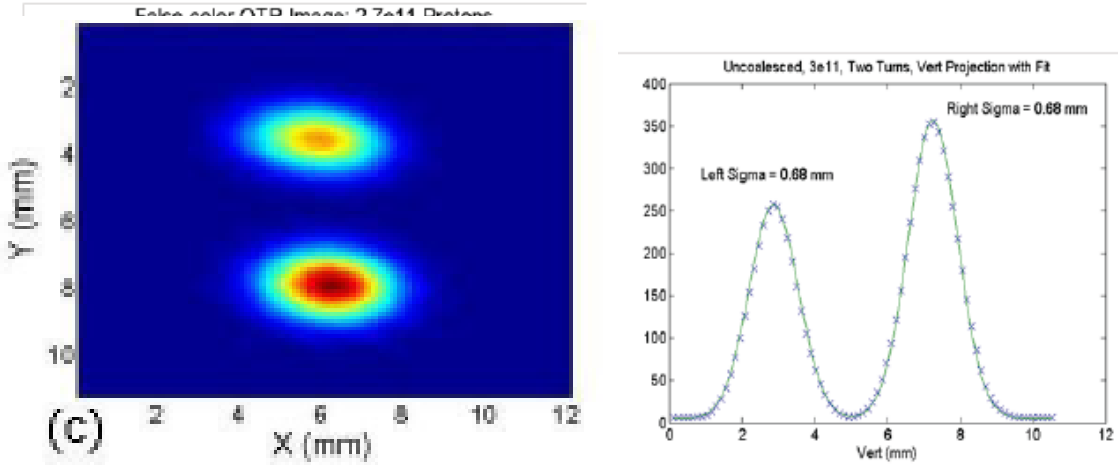


- **Objective: current models have noise as a not yet determined parameter**
- **Study: observe evolution of beam sizes and N_p at 150 and 980 for many (12) bunch intensities**
- **Type and Duration: two 4-hours studies : one at 150 GeV + one at FT**

9. Aperture at FT

- Objective: get quantitative answer on how large is transvesre and momentum aperture is at 980 at Flat –top; could be valuable for future considerations
- Study: ramp to FT, blowup the beam by noise source, see losses/lifetime; alternatively – orbit bumps
- Type and Duration: one 2-4 hours study

10: OTR Mystery



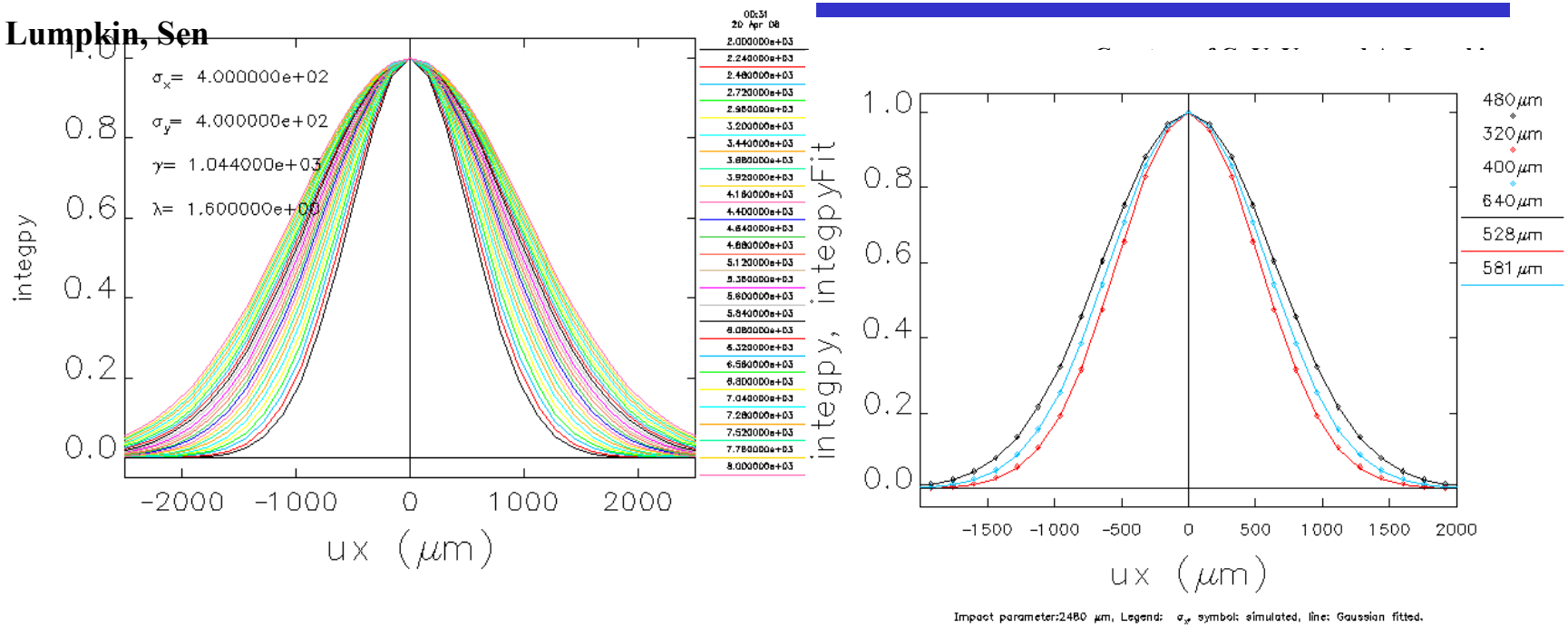
Scarpine, Lumpkin, Jansson

Figure 20. a) (left) Transverse 2D bunch profile as measured by the OTR b) (right) Vertical profiles of a single proton bunch from the OTR on two consecutive turns. The second turn profile is offset from the first, and the images are summed together by the slow camera. Note that over the two first turns, the OTR does not show evidence of the quadrupole oscillations seen in the IPM. However, from the IPM data only a 5% effect is expected between these two turns.

- Objective: understand why turn 1 and turn 2 OTR sizes were so different, compare with IPMs
- Study: inject, two (3) turns, extract
- Type and Duration: one ~ 2hours study

11. ODR test to see Beam-size Effects

Lumpkin, Sen



- Objective: can we detect ODR image and make sense of it? Use SL or modify OTR station
- Study: bring SL or OTR mirror close to beam (150 or 980), pickup ODR, measure IR image
- Type and Duration: one ~ 2-4 hours study

12. Electron Beam Profile Scanner

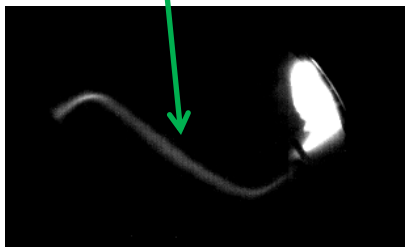
R.Thuran Keup

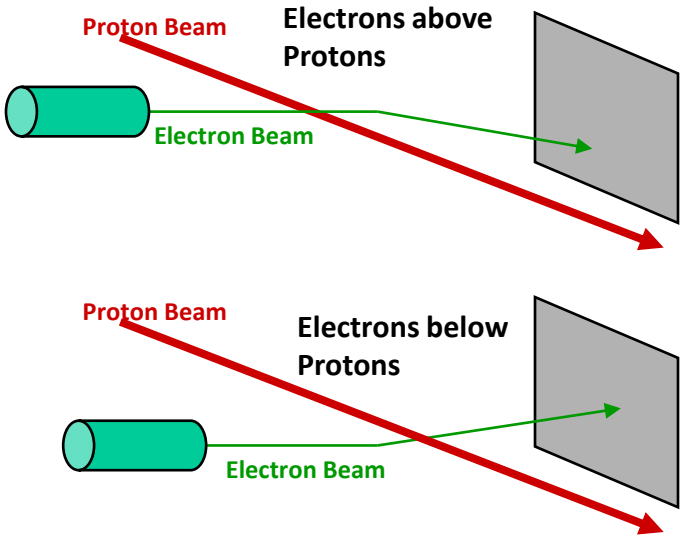
- The Tevatron beam would provide a test bed for an electron scanner at proton energies and intensities similar to Project X, and in a similar physical environment

- Objective: test e-profiler by strong field in TeV
- Study: install egun and equipm't; see effect
- Type and Duration: one ~ 2-4 hours study 150

SNS Electron Profile Scanner

Scan of electron beam showing deflection from protons





The List

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lab FERMILAB-Conf-00/124-T

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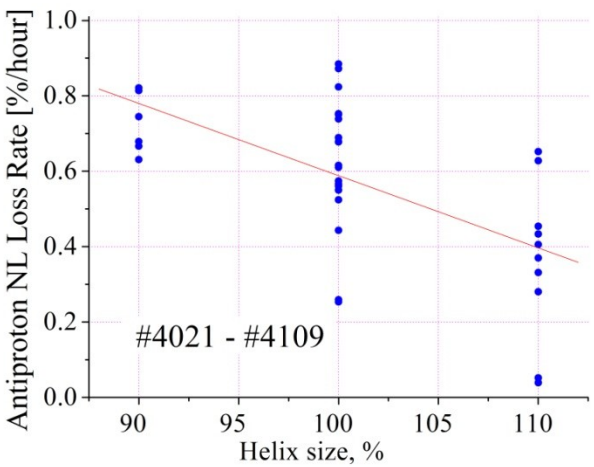
the nonluminous antiproton loss rates decreased as the helix size S increased approximately as $1/S^3$: they varied



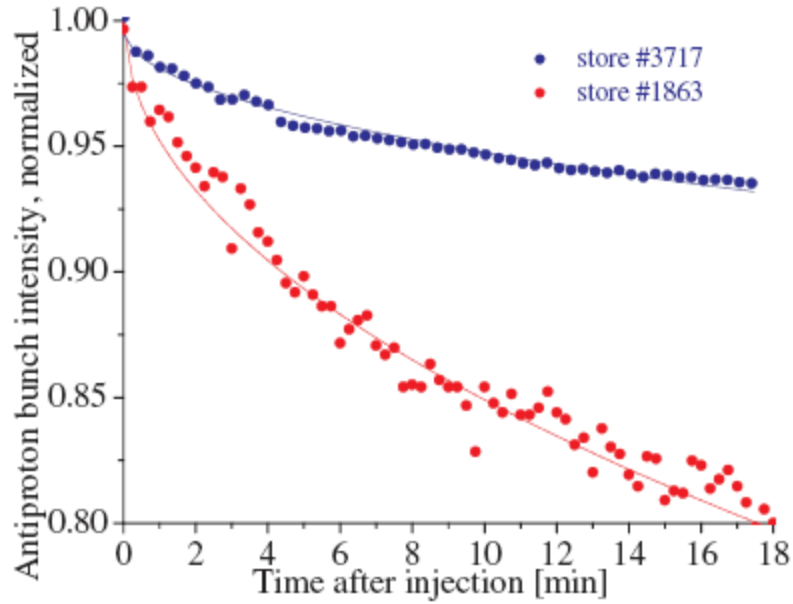


FIG. 10. (Color) Decay of (normalized) intensity for antiproton bunch #1 at injection. The red dots are for store #1863 (October 16, 2002) and the blue dots are store #3717 (August 8, 2004). The blue and red lines represent fits according to Eq. (6) with parameters $N_0 = 32.5 \times 10^9$, $t = 7.4$ h, and $N_0 = 55.7 \times 10^9$, $\tau = 69.8$ h, respectively.