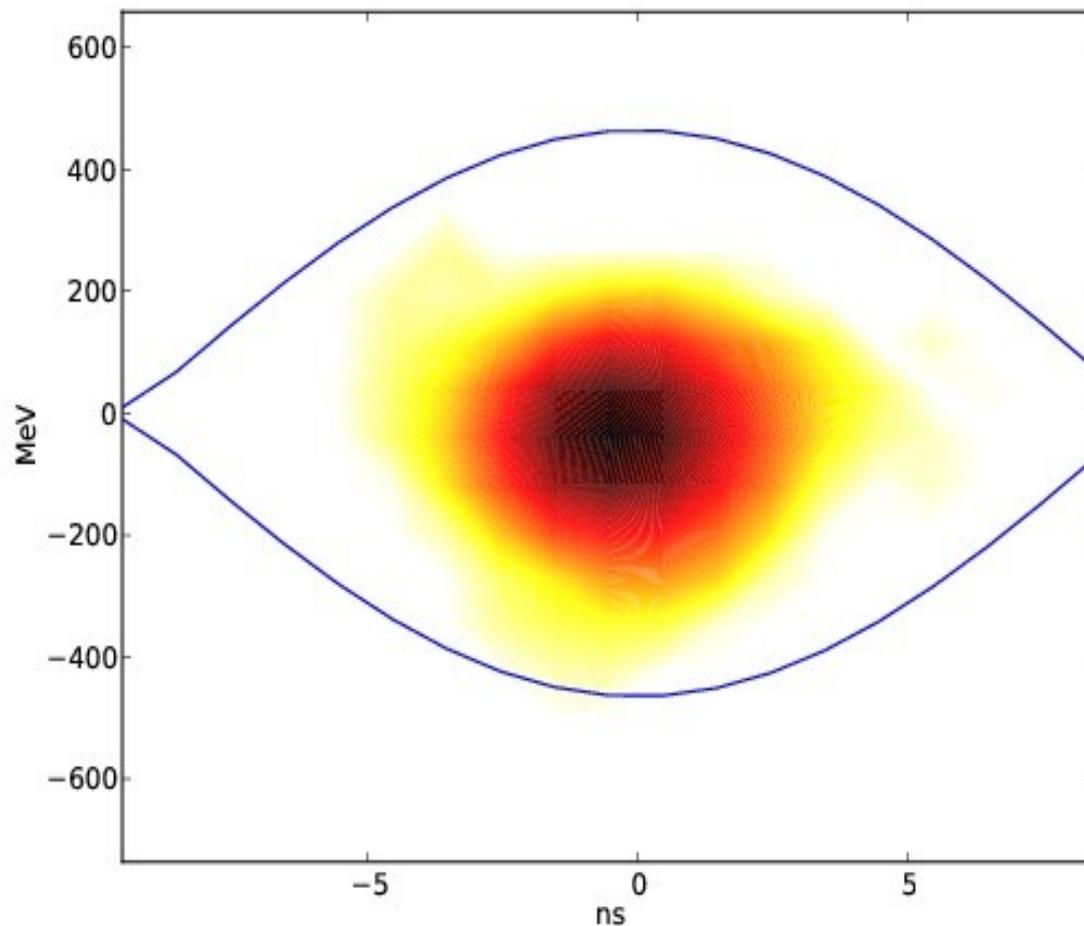


Longitudinal Dynamics in the Tevatron

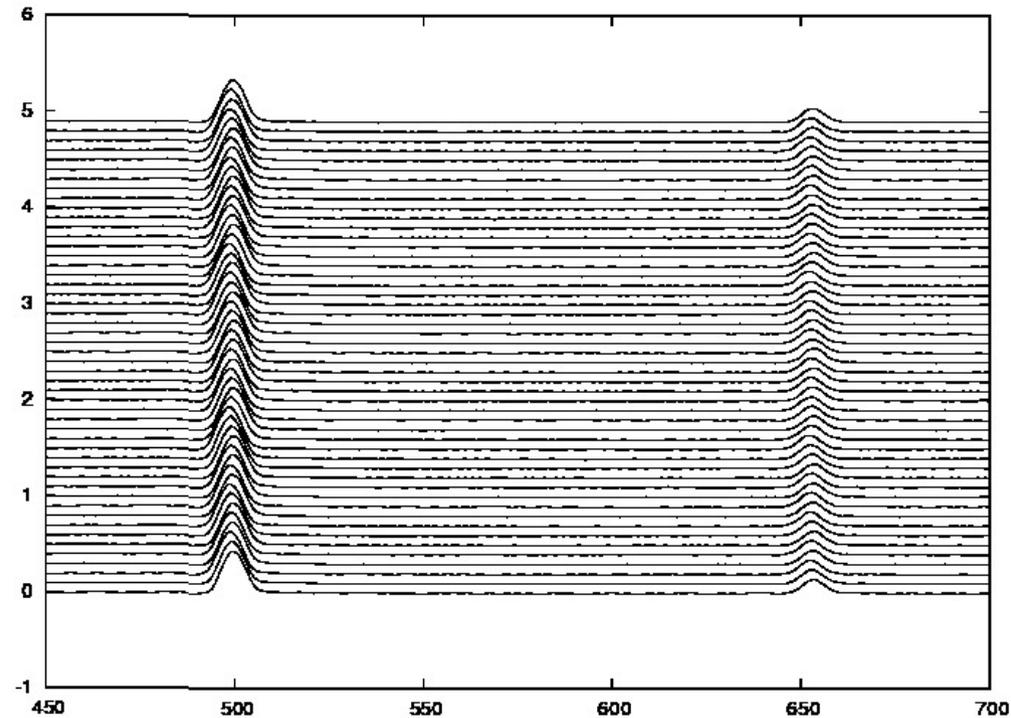
Motivation: To observe the influence of beam-beam interactions on the longitudinal dynamics in the Tevatron



John Stogin
Lee Teng Intern

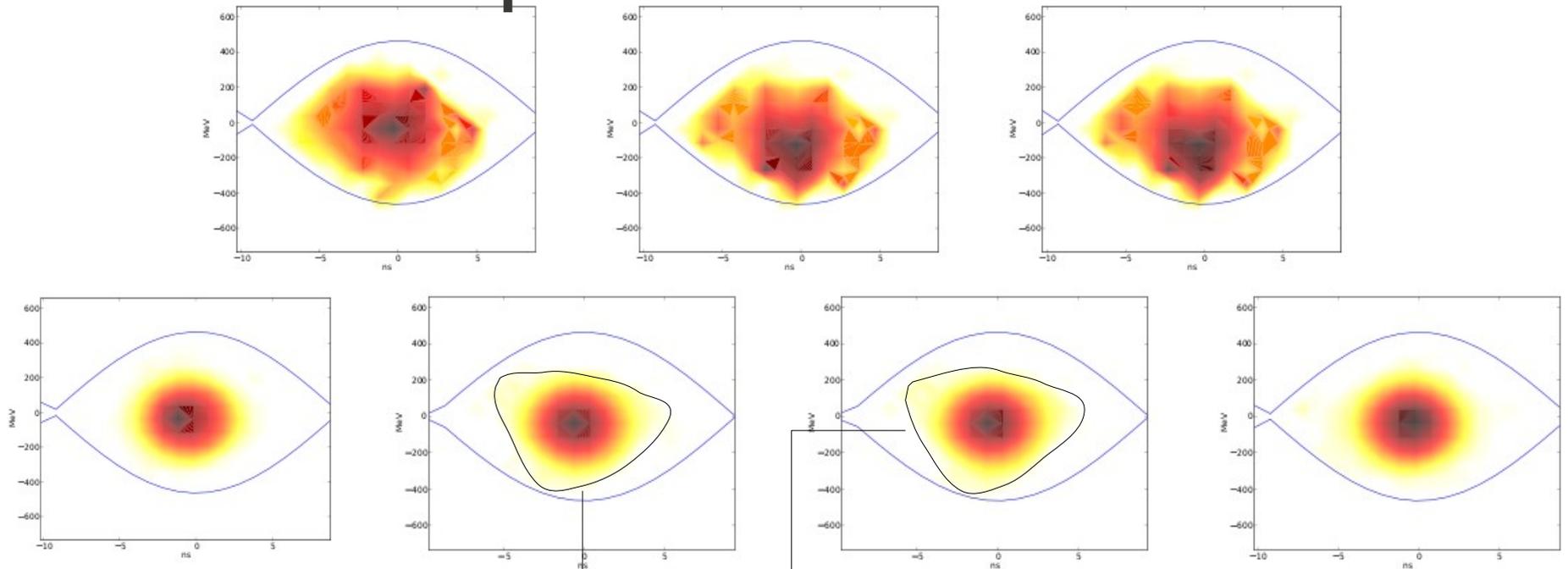
The Data

- One train of 12 protons and 12 pbars
- First three stages during injection of pbars
- Four more stages at 980GeV
 - Just after ramp
 - Start of collisions
 - Start of HEP (data taking)
 - After 1hr 47min of collisions
- At each stage, 128 turns are recorded at 1Gs/sec



- At 150GeV, a turn is recorded once every 6 actual turns. At 980GeV, a turn is recorded every 11 actual turns.
- In both cases, 128 observed turns is sufficient to cover an entire synchrotron period.

Phase Space Reconstruction

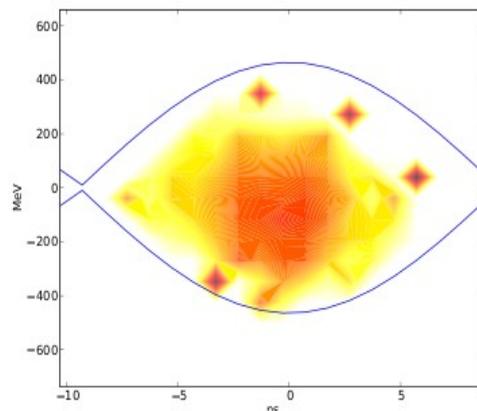


Phase Space Distribution for 12th proton bunch at each stage

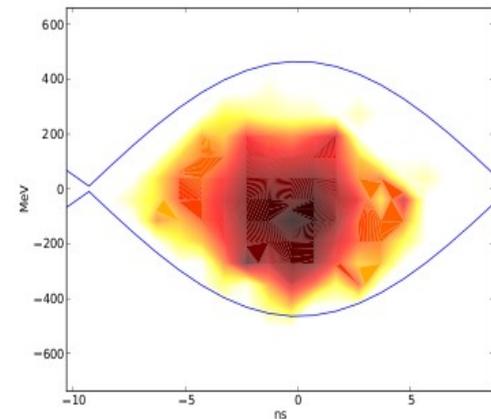
- Slight triangular shape during initial collisions
- More concentrated at 980GeV as expected
- Nothing unexpected (this is a good thing)
- Phase space does not differ greatly between bunches.

Quality of Phase Space Reconstruction

- Data capture at 1Gs/sec and bucket width is 19ns means a resolution of 19 samples.
(resolution of 19x19 for the phase space plot)
- It would be nice to have a higher resolution
(requires faster sampling)
- Raw plots often contain unwanted points, which must be filtered out:



Filter

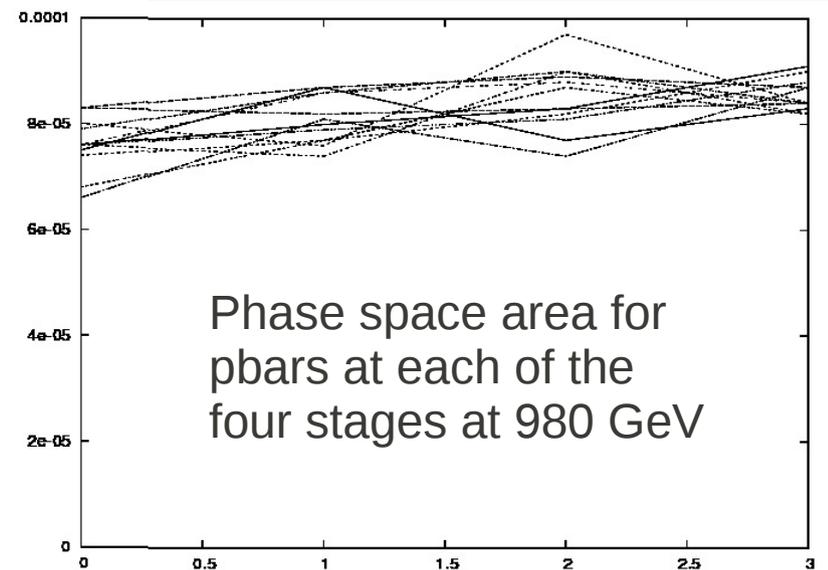
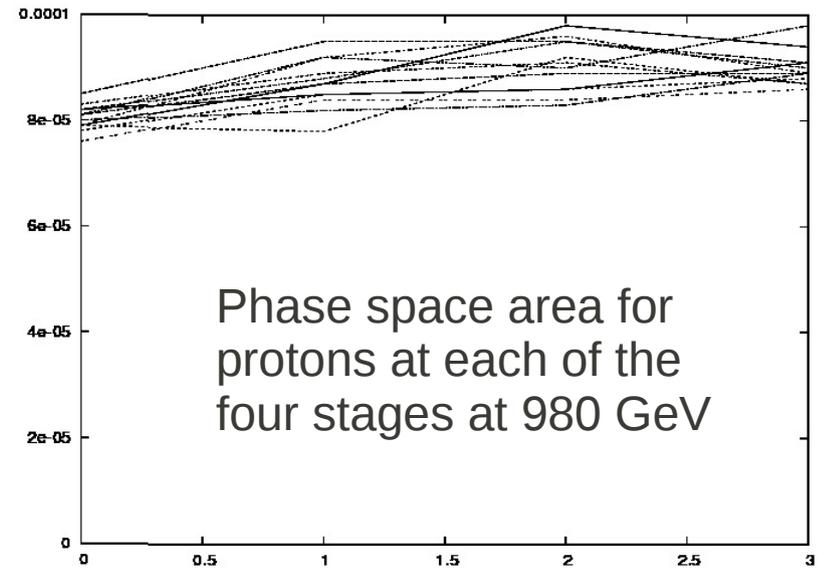


Phase Space Area at 980 GeV

- Measure of area calculated by taking product of standard deviations along horizontal and vertical axes in phase space plot
- No significant increase in phase space area between stages (although slight increasing trend)

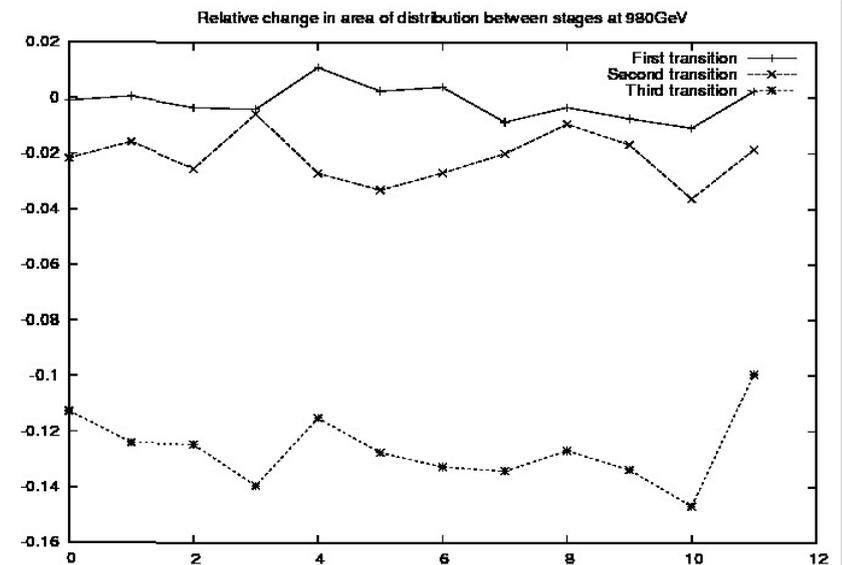
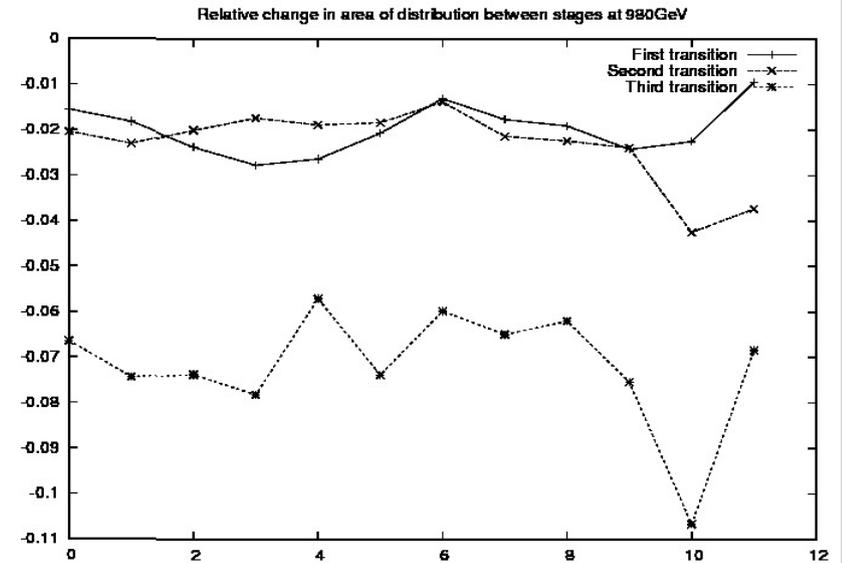
Average percent increase in area

Transition	Protons	Pbars
1	8.2	6.6
2	3.9	5
3	-0.6	0.5



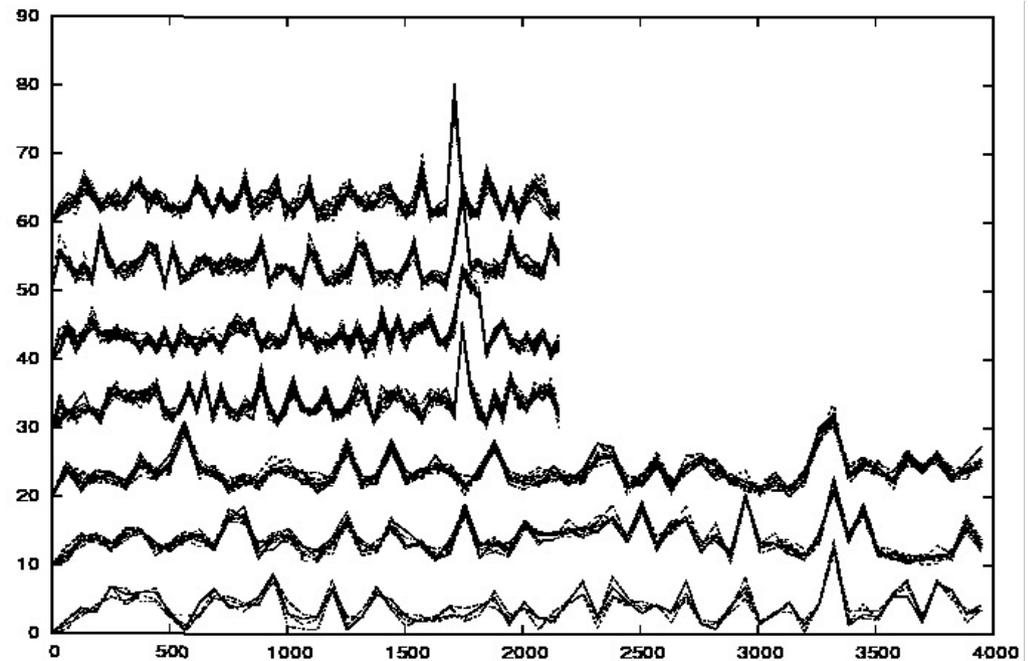
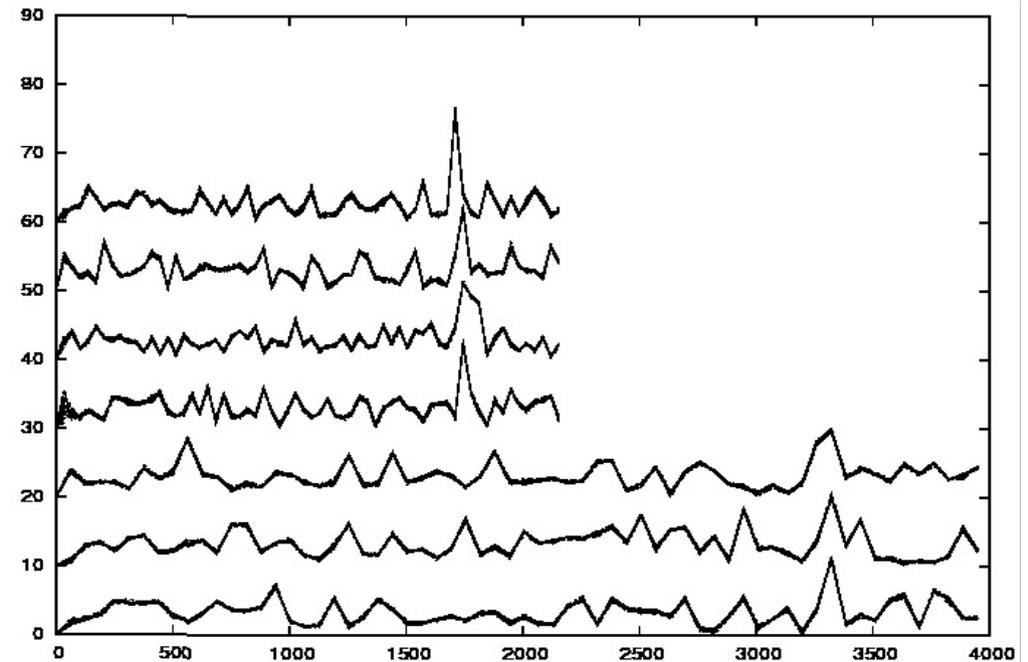
Particle Loss

- Low ($\sim 1\%$) loss occurs between the initial stages at 980GeV
- Most proton bunches lose about 7% and most pbar bunches lose about 12% after 1hr 47min of collisions
- The 11th proton bunch seems most sensitive to particle loss, which is seen from the beginning



FFT Spectrum

- FFT of bunch mean
- Resolution is 60hz at 150 GeV and 33hz at 980 GeV
- Consistent among bunches (variation is greater among pbars)
- Strongest frequency
 - 3322hz at 150 GeV
 - 1744hz at 980 GeV
 - Peak broadens during initial collisions
 - Drops by 33hz (resolution size) after 1hr 47min of colliding



Conclusions

- The phase space plots do not reveal anything unusual, but it would be nice to have a better resolution.
- Bunch Area does not significantly change during collisions.
- About 7% of protons are lost in 1hr 47mins of collisions compared to 12% pbars. A bunch may lose significantly more, which can be seen at the beginning of collisions.
- Bunch spectra have the largest peaks at 3322hz at 150GeV and 1744hz at 980GeV. The peak at this frequency widens during initial collisions and the frequency decreases over time.
- Data accuracy would be improved by recording more turns and increasing the sampling rate.
- Performing a similar analysis on multiple stores would show whether these findings are consistent.

Thank you

- Tanaji Sen – Advisor
- Ron Moore – Provided Data
- Eric Prebys – Director of Lee Teng program

Questions? (Because I have one...)