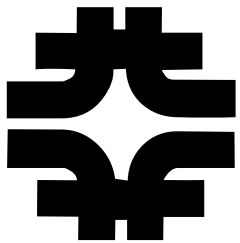
On the 150 GeV Transfer efficiency and Emittance Growth, and Beam-Beam Effect.



Paul Lebrun

Fermilab

March 15 2003

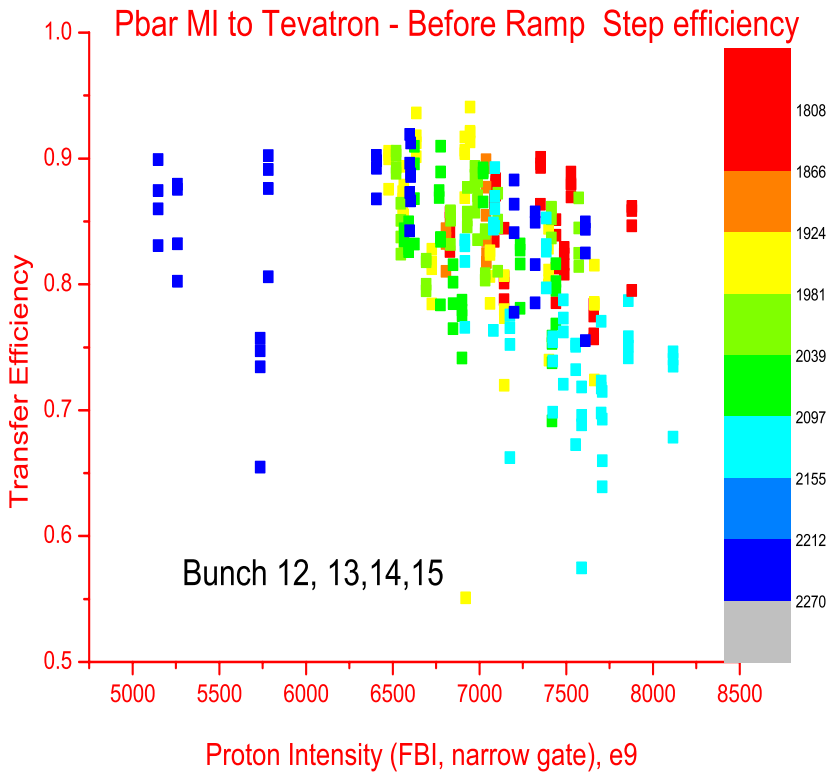
Goal & Scope: Evidence for Beam-Beam in SDA.

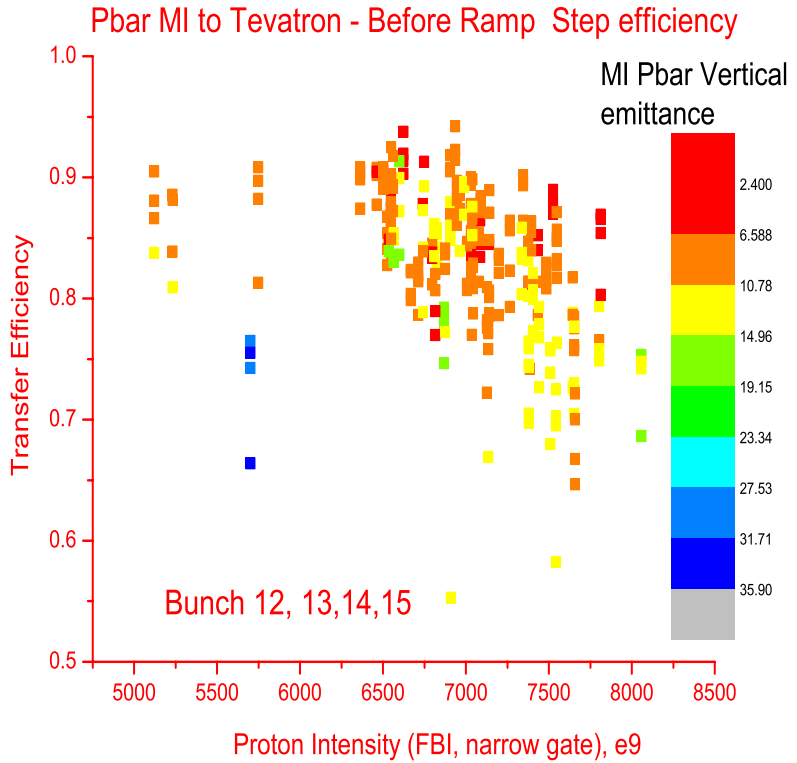
- Goals for this SDA exercise:
  - Using the SDA data, show that beam-beam effects at 150 GeV in the Tevatron adversely effect the performance of the collider.
  - Based on this phenomenology, provide guidance to the simulation proponents, so that a quantitative explanation for the poor lifetime at 150 GeV can be reached.
- Scope: Using “fairly recent data”, pre and post January shutdown.

Straight forward exercise…

- We have shown that Luminosity is linearly proportional to the number of pbar per bunch. The Pbar emittance tends to be smaller that the proton emittance, so it is less of a factor.
- We have calibrated the Fast Bunch Integrator of the M.I. And TeV, relatively well, to a few percent.
- So, let us look at the combined transfer efficiencies from the M.I (just before transfer) up to the TeV state, just before we ramp the Tevatron, versus the total number of protons circulating in the TeV.

Correlation between 150 TeV Efficiency and Total number of circulating proton.





MI –> TeV at 150, before Ramp FBI (Pbar) efficiency vs the Number of proton, before ramp.

Correlation between 150 TeV Efficiency and Total number of circulating proton, Discussion

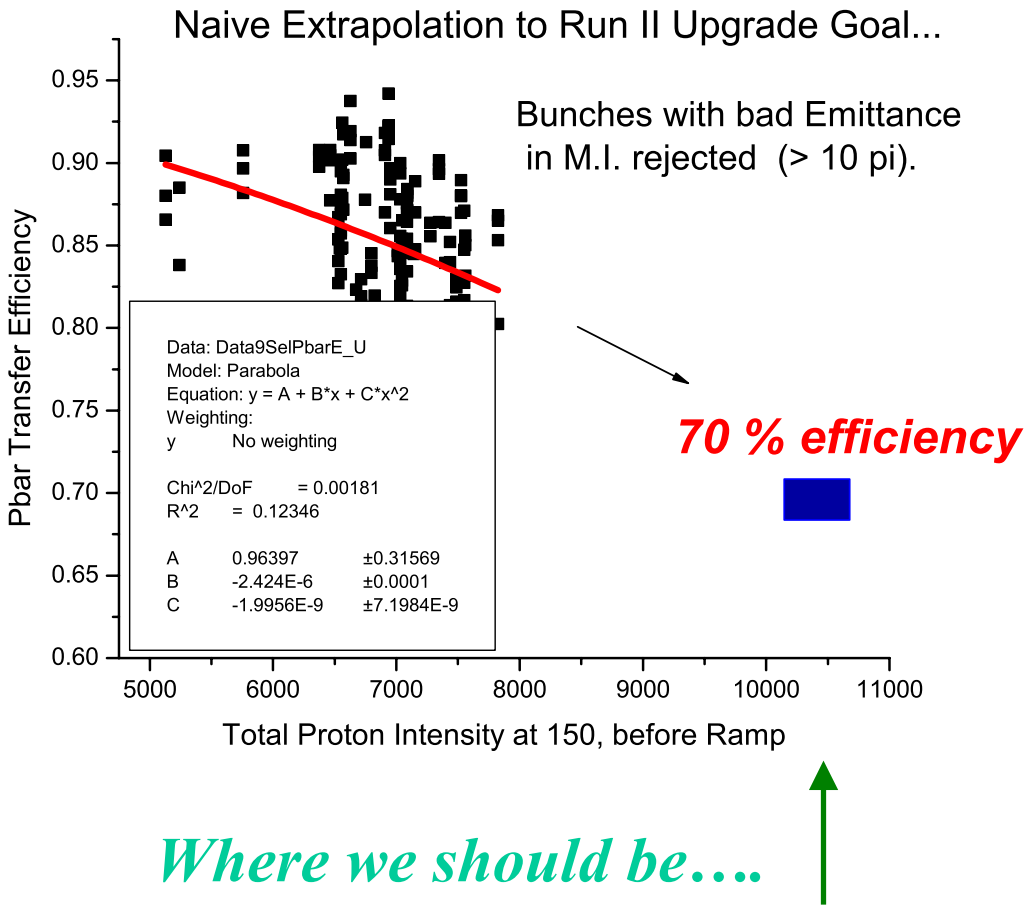
We considered the bunches that stayed in the TeV at 150 for the longest time, and for which we have data for a large number of stores (an earlier, pre-Jan shutdown SDA bug prevent us for collecting data for the first transfer. So let us look at the 2nd transfer, for which the beam line tuning might have improved..)

The correlation between these two quantities is statistically significant. However, there are a few bunches with poor transfer efficiency at relatively low proton current (around 5.75 e12) These bunches had a large emittance in the Main injector to start with. The poor efficiency is due to this.

Note: the pbar vertical emittance must be greater that 2 pi and less than 50 pi to enter the plots. This rejects missing data sets and extremely diffused bunches.

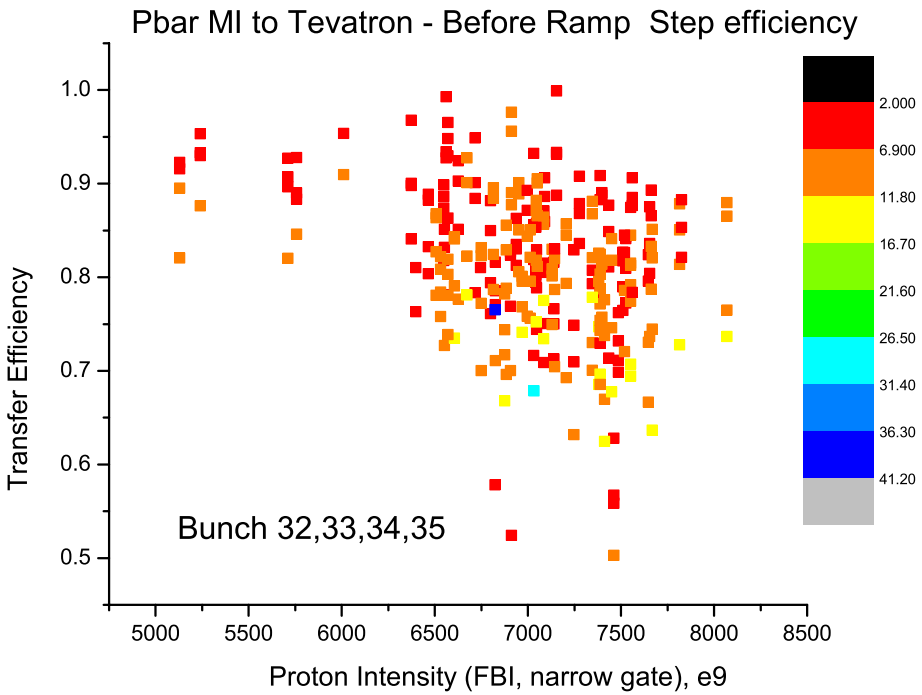
If we naively extrapolate to the required current for Run II upgrade, (270 per bunch

A naïve Quadratic fit to this selected data..



- Pessimistic extrapolation!.
- We might take action to improve the life time at 150, like opening the helix.
- Yet, based solely on this inaccurate extrapolation, we still have interest raising the proton current…

Bunches not staying for a long time at 150 in the TeV.

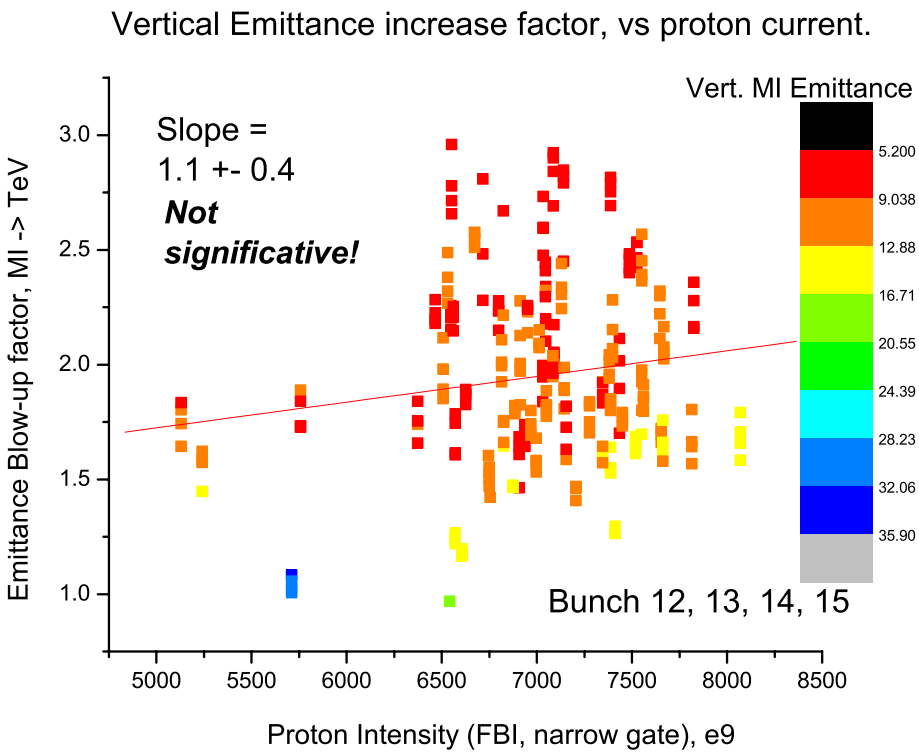


Last Pbar transfer…

There is still a correlation,
But the effect is perhaps (not signficantly) less drastic.

➔ There is a "fast loss" on pbar due to beam – beam, occurring in less than 3 minutes.

Vertical Emittance Growth.



Coming back to the bunches that stay in the TeV for a longer time..

Study the transverse emittance growth factor in the transverse plane. (Dynamics in the horizontal plane is a bit more complicated).

For the same combined steps, No strong evidence for a dependency on proton current.

For large emittances in M.I., Little or no emittance growth

Status… What are the next steps?

A clean and effective way to quantify the effect of beam beam on performance..

Improve on the large systematic errors in emittance measurement.

Are these emittance growth consistent with what Valery L. has measured during dedicated studies, using reverse protons?

Simulation studies: We are not able to keep a pbar beam with an emittance greater than 15 to 20 pi, in the TeV .. Can this be reproduced with the fancy simulation packages we have ?