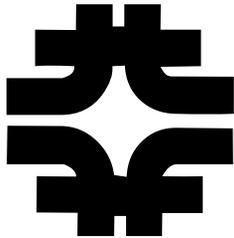


On Longitudinal Emittance dilution during HEP



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Fermilab

July 29-31 2002

3 Questions from Vladimir:

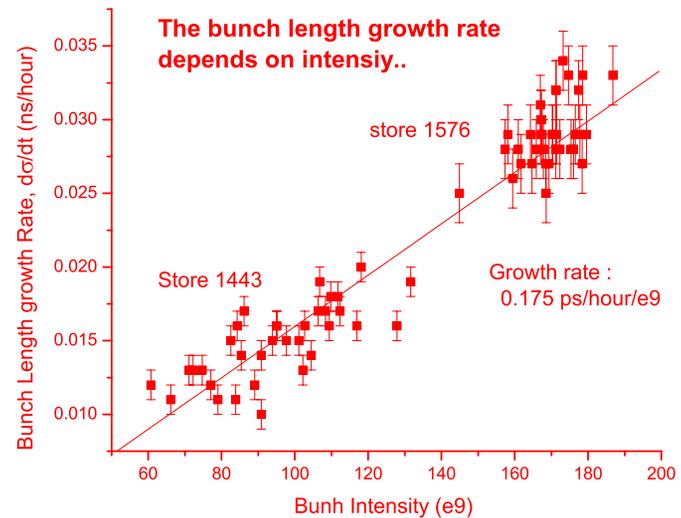
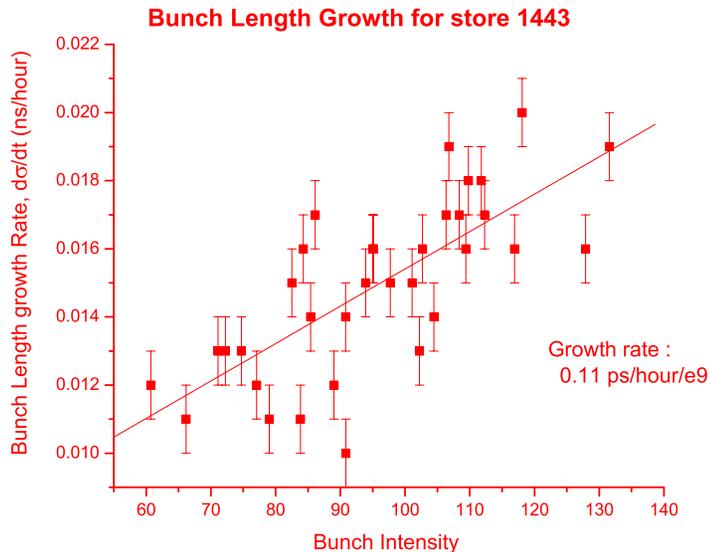
- Q1: does $d\sigma_s/dt$ depend on bunch #?
- Q2: does dN_p/dt depend on bunch#?
- Q3: is there correlation between dN_p/dt and $d\sigma_s/dt$?

- Notes :
 - This is during HEP
 - The new longitudinal damper was ON starting on Store 1563. No improvement on $d\sigma_s/dt$ was observed..
 - does $d\sigma_s/dt$ depend on bunch intensity?

Does $d \sigma_s/dt$ depend on bunch intensity?

- Previous analysis done by Vladimir, from store 1028: NO! I could not reproduce this result, no SDA data, D44 data missing for this time period (using the D44 Web page).
- New analysis of store 1443 : the answer is yes!
- This discrepancy is still unresolved.. Yet, we will now assume the the bunch intensity does matter, and start making plots on the bunch length growth rate divided by the bunch intensity.

Does $d \sigma_s/dt$ depend on bunch intensity?



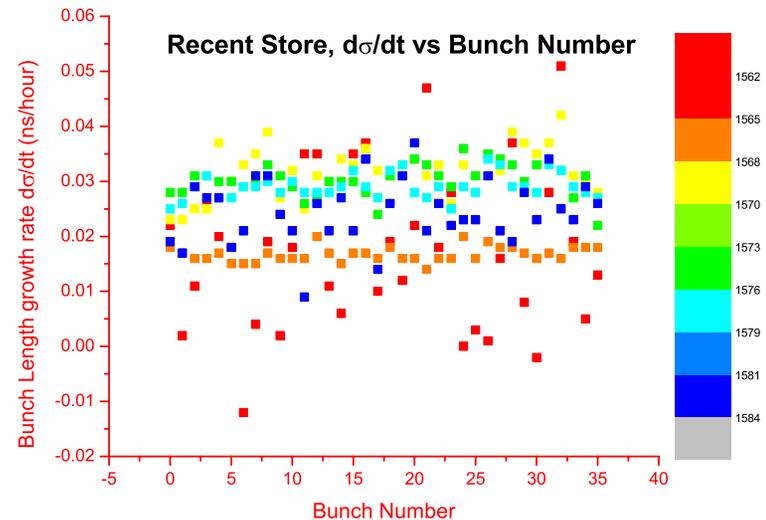
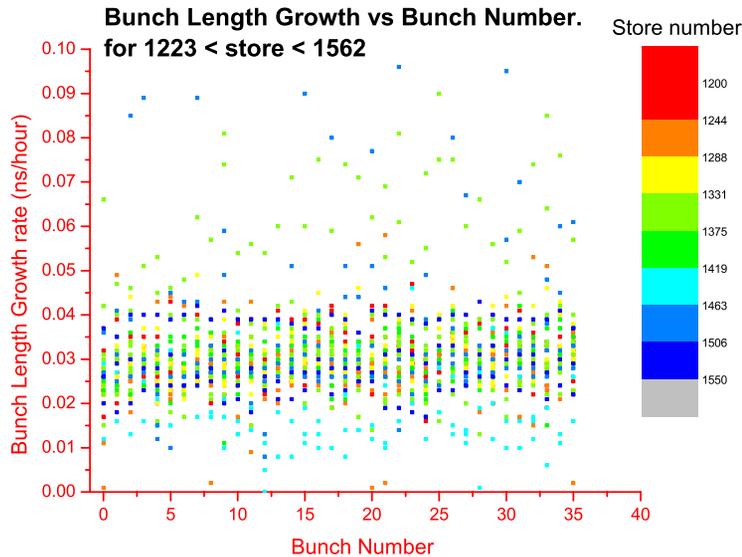
The slope seems to vary a bit on a store basis.

Indeed, store to store (unexplained!!!) variation of $d \sigma_s/dt$
Masks the other possible correlations..

Q1: does $d \sigma_s/dt$ depend on bunch #?

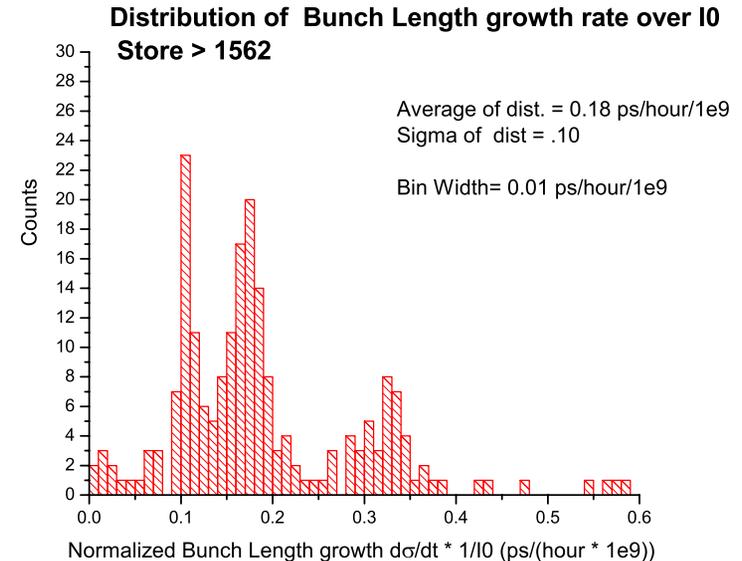
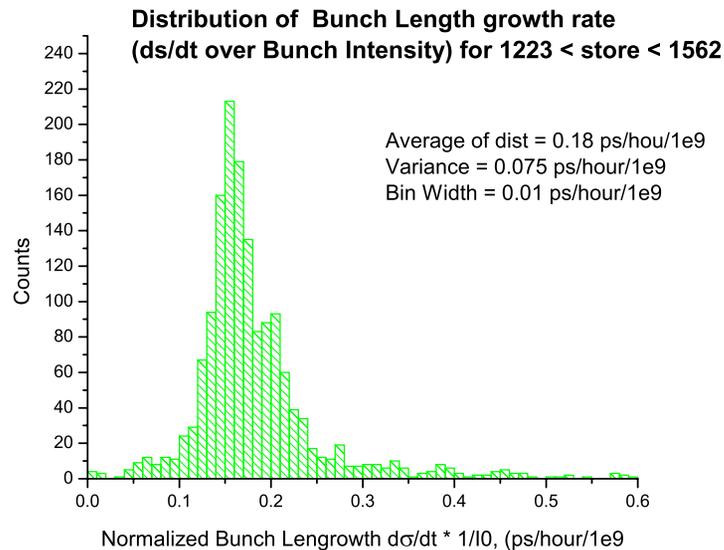
- No, not really: Although the first bunch has a slightly lower growth rate (about 10% relative, in average), this first bunch tends also to have a lower intensity, because it has been shaved at 150 GeV (as it has a bigger transverse emittance.) So, the bunch length growth normalized by the beam intensity, (at moderate intensity), does not depend on the bunch number.
- This is true before and after the store 1563.

Bunch Length Growth rate and Bunch Number



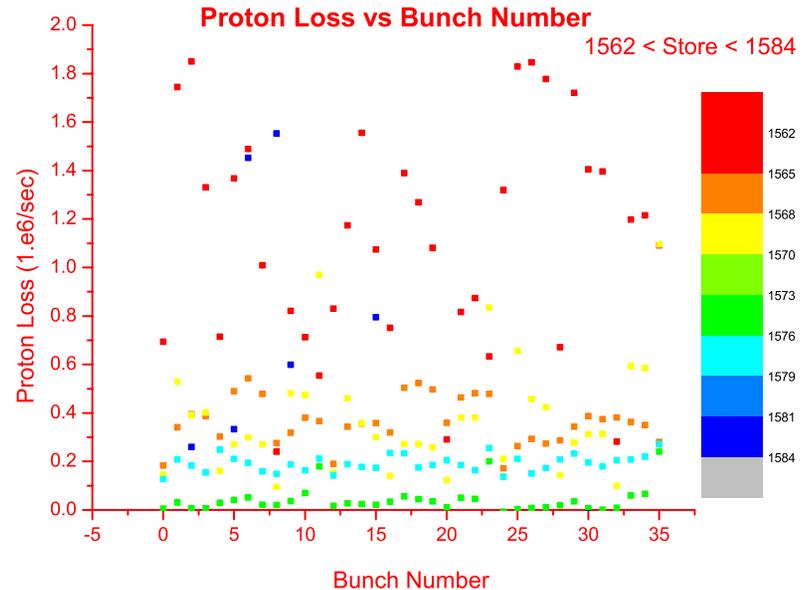
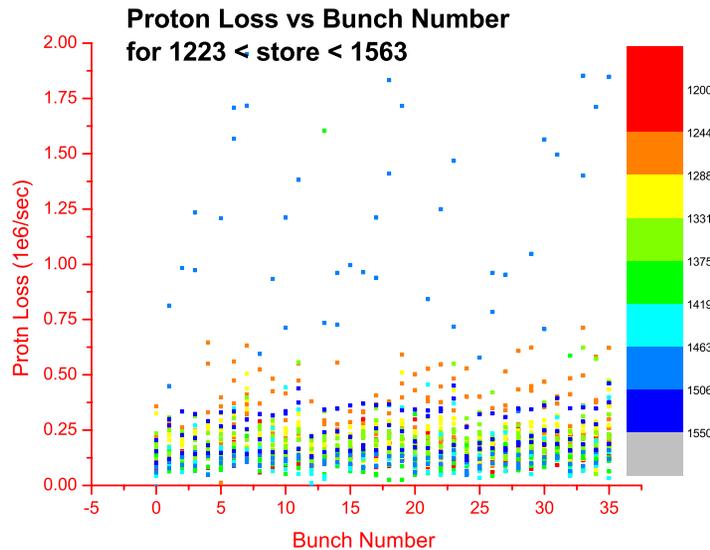
For store 1565 and some bunches of store 1563, $d\sigma/dt$ is significantly lower.

Histograms of ds/dt , before and after store 1563



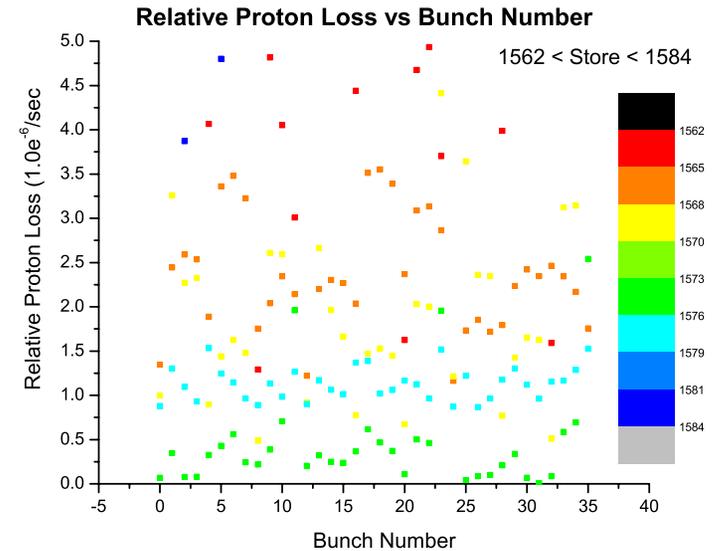
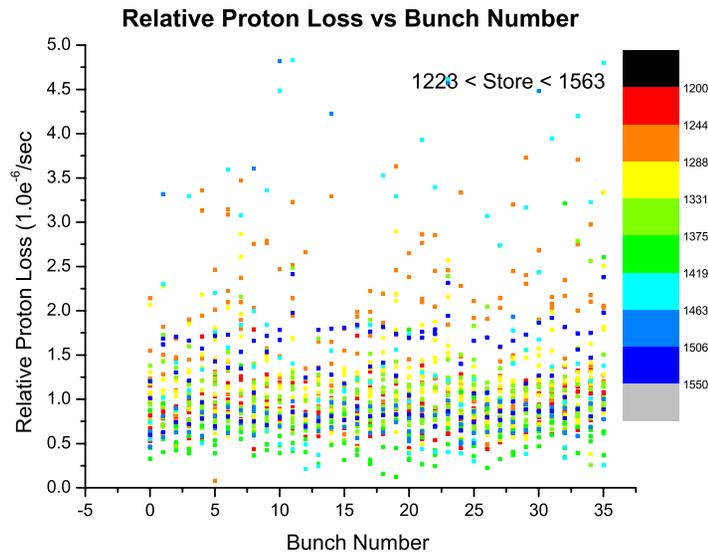
The bin size and horizontal scales for these two plots are identical. Possibly, some damping occurred for store 1563, and some heating for store 1583...

Q2: does dN_p/dt depend on bunch#?



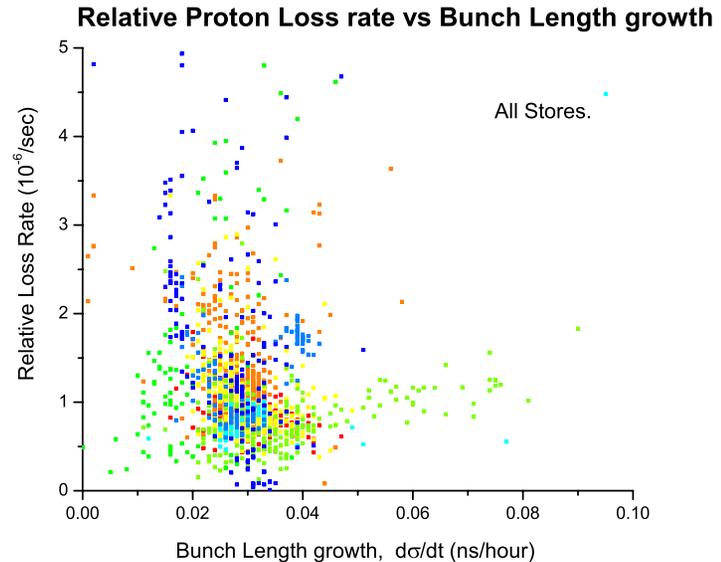
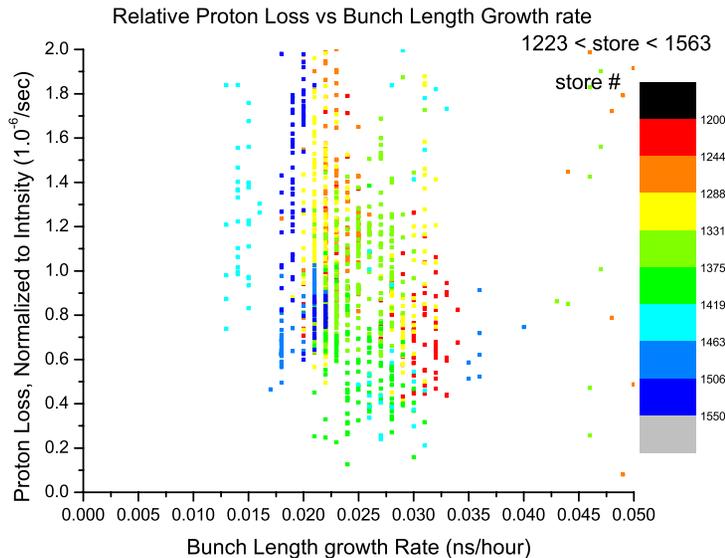
At low Proton loss rate, this loss rate does not depend on bunch number. If the rate jumps by ~ 10 or more, then not all bunches are affected. However, there are no discernable nor reproducible pattern.

Q2: dN_p/dt vs fractional loss, $(1/N_0) * dN_p/dt$



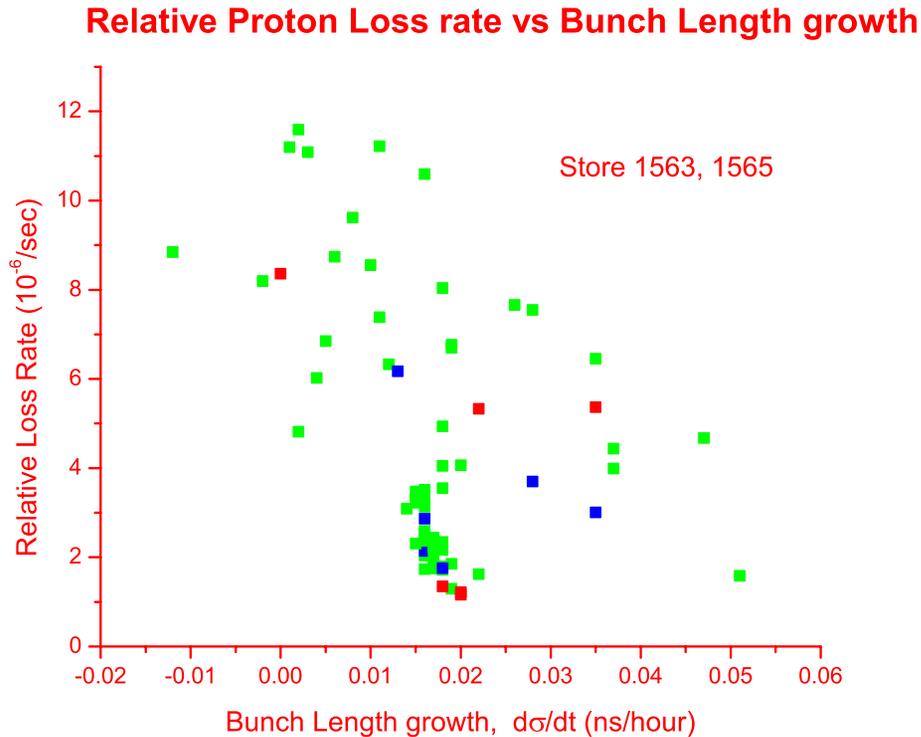
It might make more sense to talk about the fractional loss.
However, the previous conclusion stands: lots of fluctuation, no discernable pattern.

Q3: Does $d\sigma/dt$ depend on dN_p/dt ?



Once again, I presume it make more sense to discuss Fractional Loss rate.

Q3: Does $d\sigma/dt$ depend on Fract. Loss Rate,



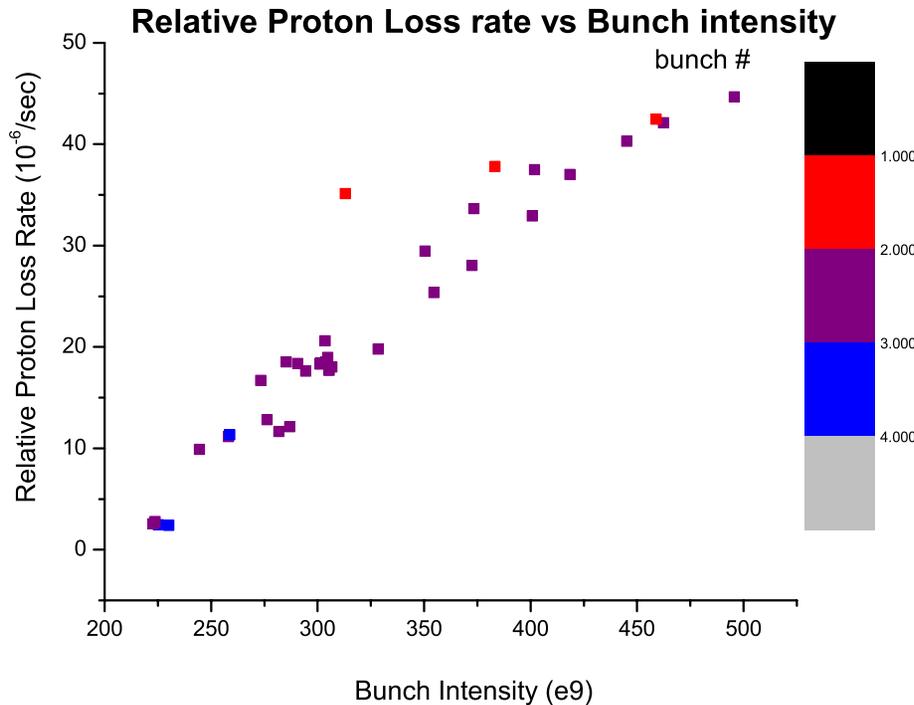
For the best stores (1565, 1563), which have lowest $d\sigma/dt$ and taken recently, there might be an anti-correlation.

This is not (yet?) statistically significant.

Which makes no sense!

Red dots are first bunches, blue are last in 12 bunch-train and green are all others.

Note : Loss rate at high intensity (store 1369)



Above 250 e9, the loss rate becomes a highly non-linear function of the bunch intensity.

Or, the FBIPNG became so non-linear that such bunch intensity are bogus..

New Calibration of FBI will help..

Conclusions.

- At modest intensity and modest loss rate, we have no indication of any significant correlation between bunch length growth rate, bunch number and/or loss rate.
- For Store 1565, with new damper ON, the $d\sigma/dt$ was anomalously low, while the proton intensity was about normal. This performance could not be reproduced. For Store 1565, the proton transverse emittances were "awful"... ($> 30 \text{ pi}$)