

*Interplay of space-charge and beam-beam
effects (with protons)*

APEX

April 4, 2012

Experimental studies in RHIC with protons:

- Mostly relevant for eRHIC parameters & luminosity
- also some input for RHIC (near-integer operation)

First relevant studies with protons were done in 2009:

- Accelerator Physics Experiments (APEX) May and June 2009:

p+p: at beam $\gamma=25$ (large space-charge, large beam-beam)

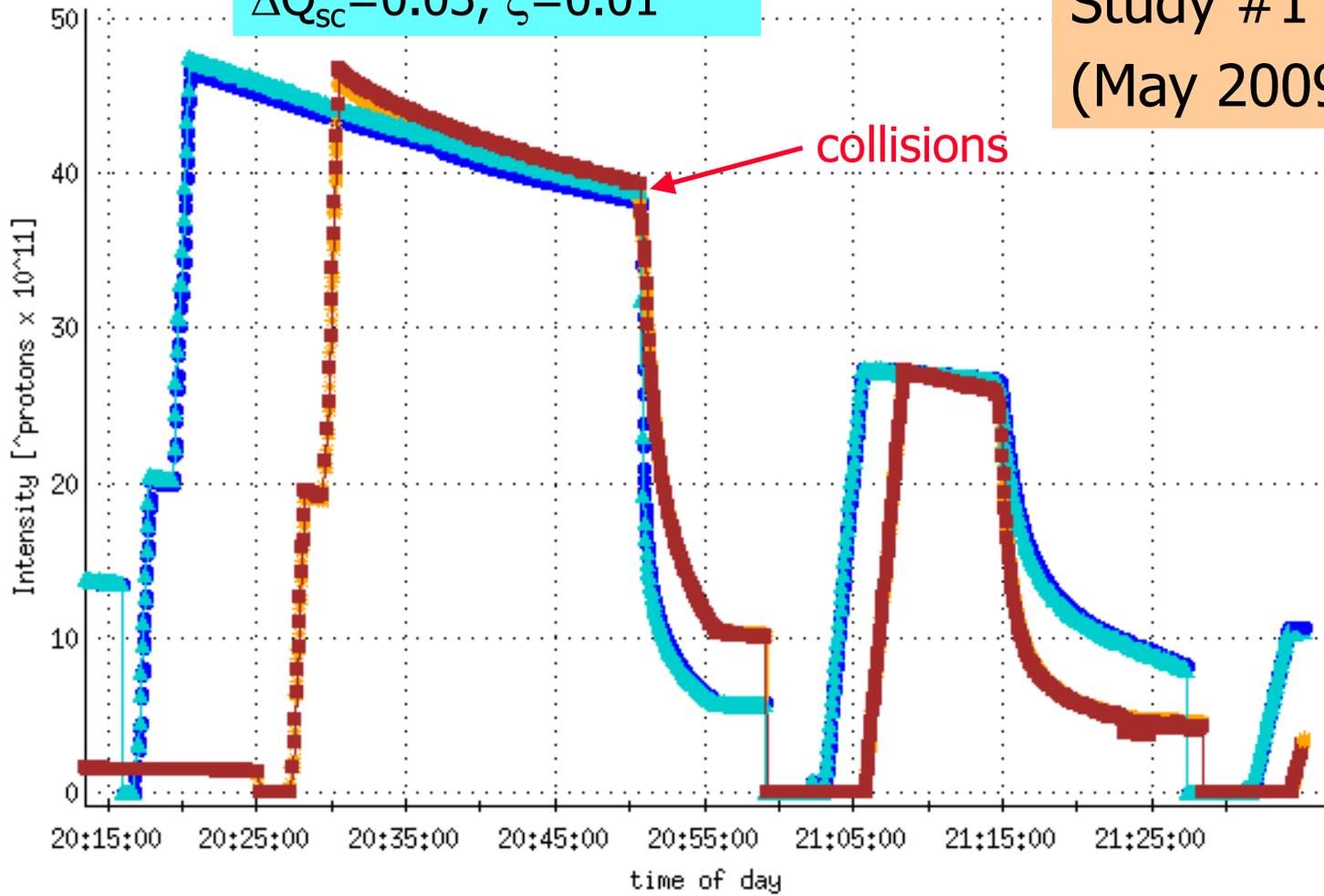
$$\Delta Q_{sc} > \xi$$

- With heavy ions (large space-charge, very small beam-beam), these APEX studies were completed in 2011.

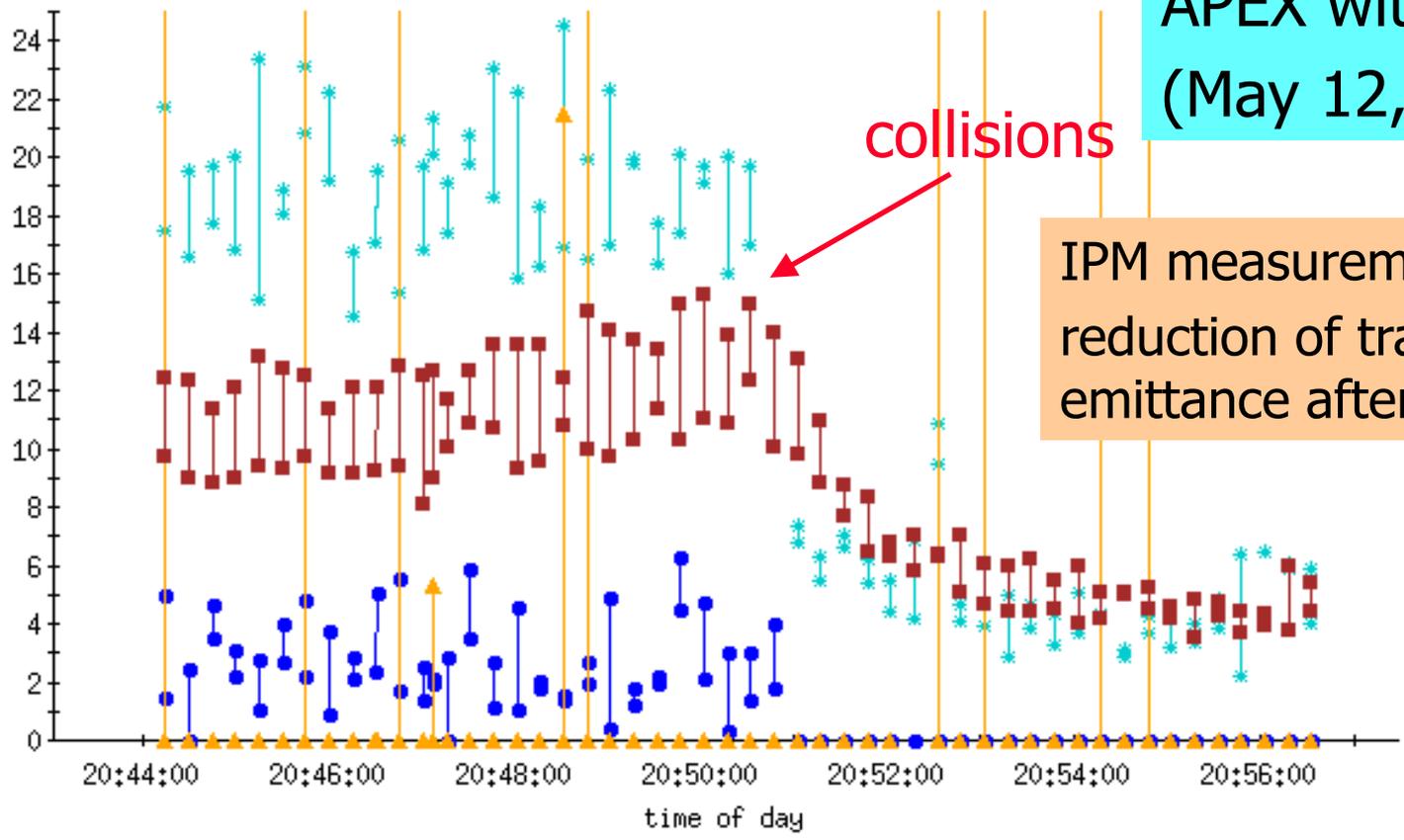
$$\Delta Q_{sc} \gg \xi$$

APEX protons at $\gamma=25$
(May 12, 2009)
 $\Delta Q_{SC}=0.03, \xi=0.01$

Study #1
(May 2009)



Tue May 12 2009



APEX with protons
(May 12, 2009)

IPM measurements:
reduction of transverse
emittance after collisions.

- RhicIpMManager.blue_horiz;normEmitM
- RhicIpMManager.blue_vert;normEmitM
- RhicIpMManager.yellow_horiz;normEmitM
- RhicIpMManager.yellow_vert;normEmitM

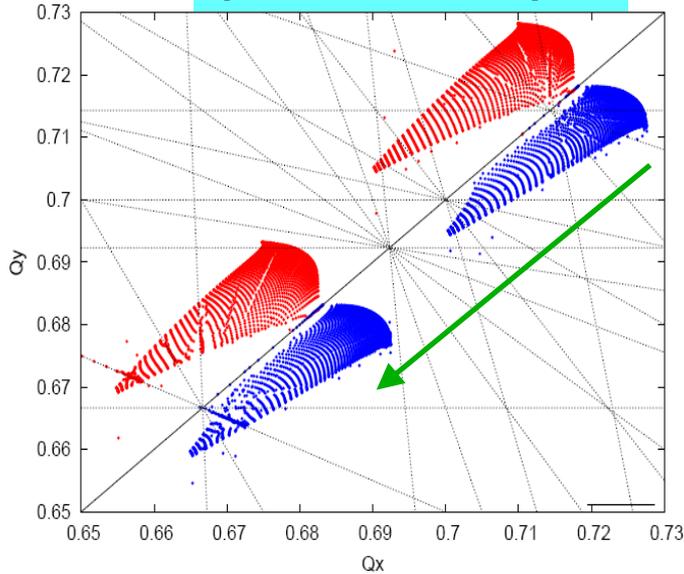
Stop



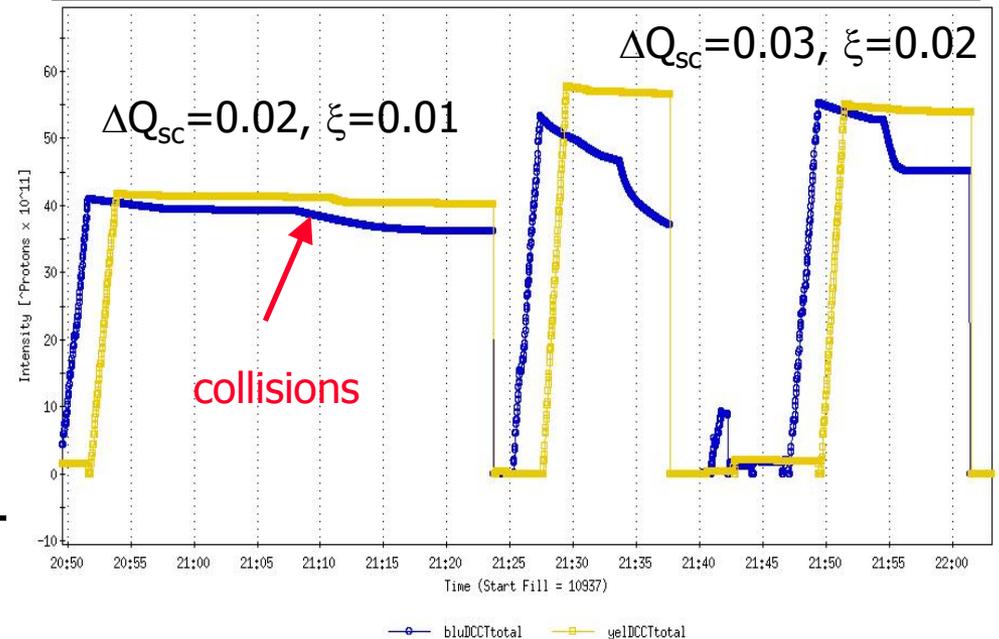
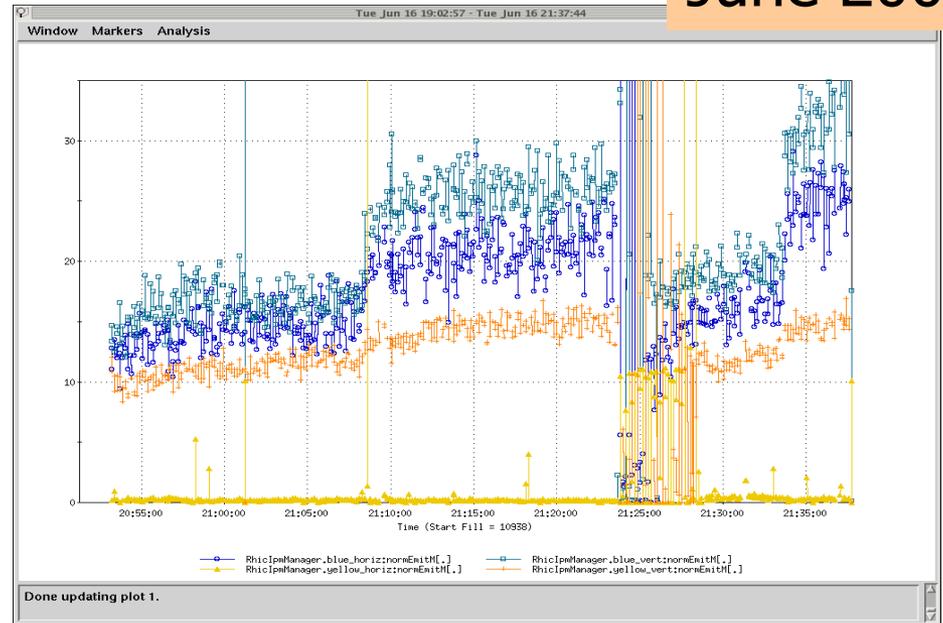
June 17, 2009 experiment with new working point

study # 2
June 2009

APEX with protons
(June 17, 2009)



Choosing different working point for regime with large beam-beam.



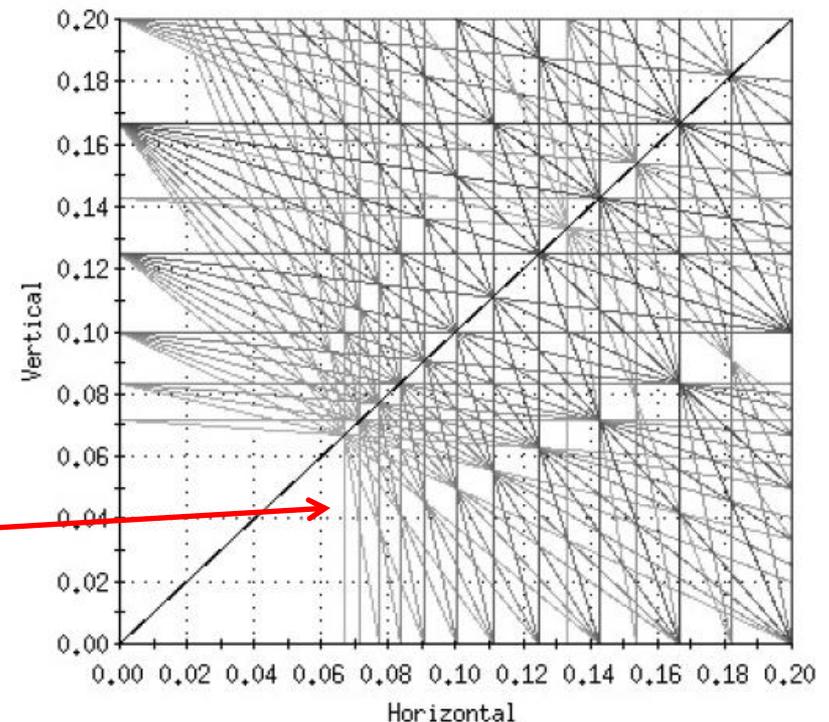
Protons at standard injection energy ($\gamma=25$):

Finding working point where effects of beam-beam are minimized for regime $\Delta Q_{sc}=0.03$, $\xi=0.01-0.02$ (this is regime of interest for eRHIC).

For small ΔQ_{sc} (~ 0.03), eRHIC:
Can we find better working point?

Already did similar study with Au ions,
in the regime of very weak beam-beam.

resonances to 15th order



APEX, April 4, 2012

study # 3
(April 2012)

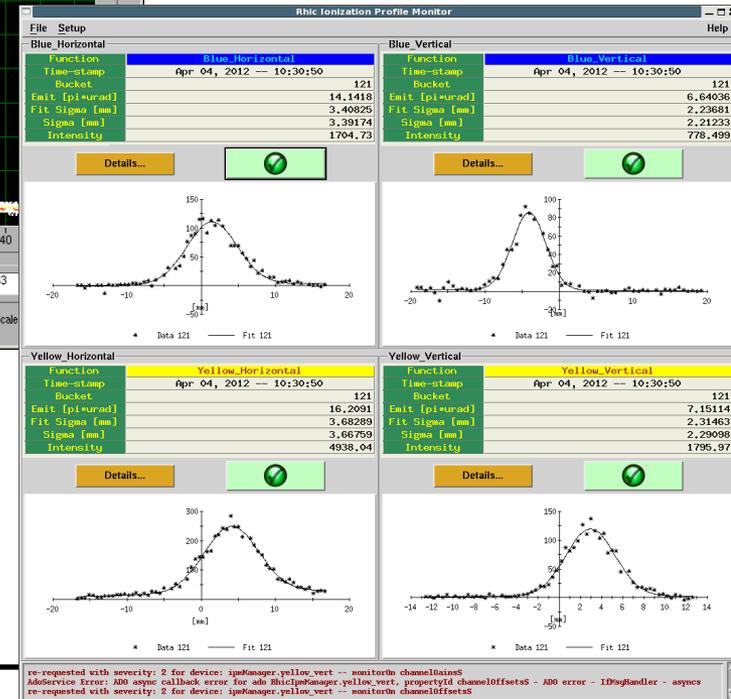
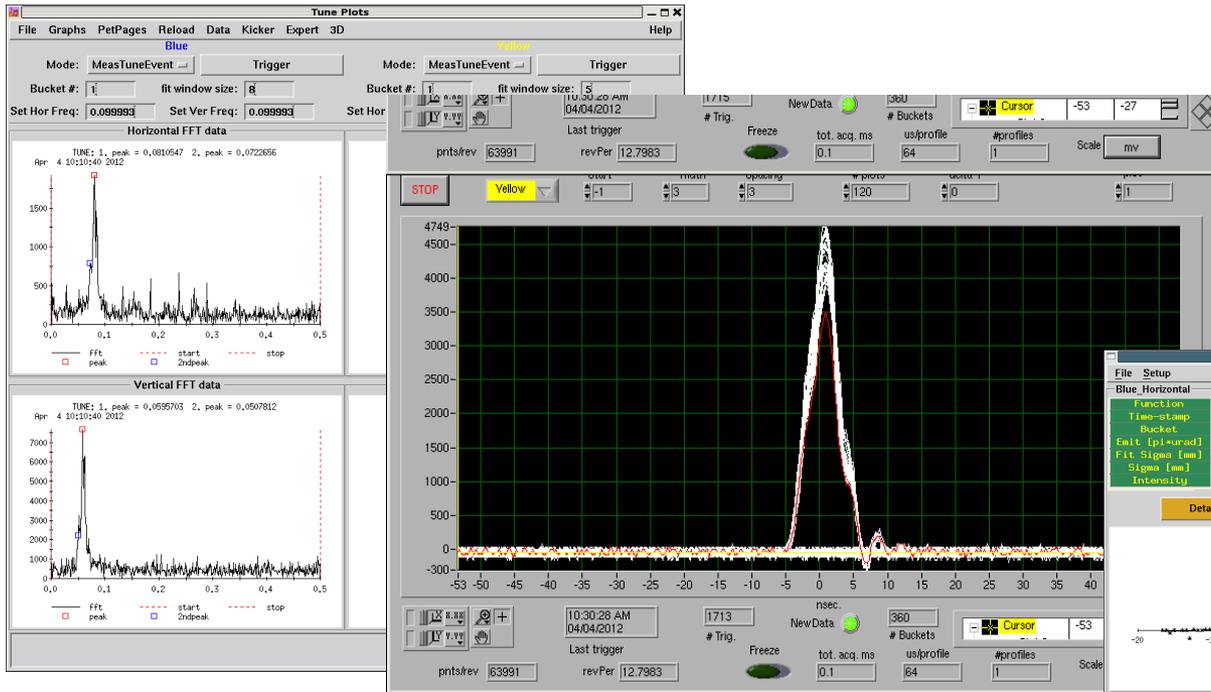
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- First attempted to set-up working point just below integer w.p. $(Q_{x,y})=(0.98,0.97)$:
 - As expected, not that easy to have well-controlled machine and be able to inject high-intensities.
- Decide to move above integer to $(Q_{x,y})=(0.08,0.07)$
 - well behaved machine
 - experiment worked nicely

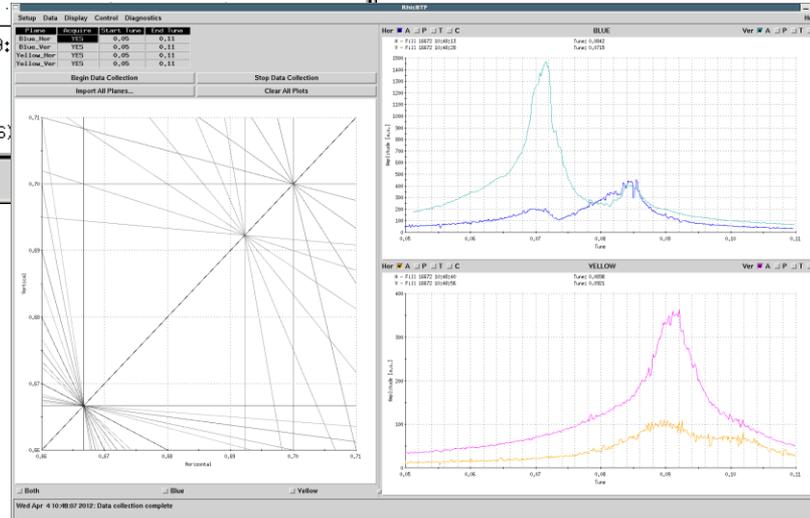
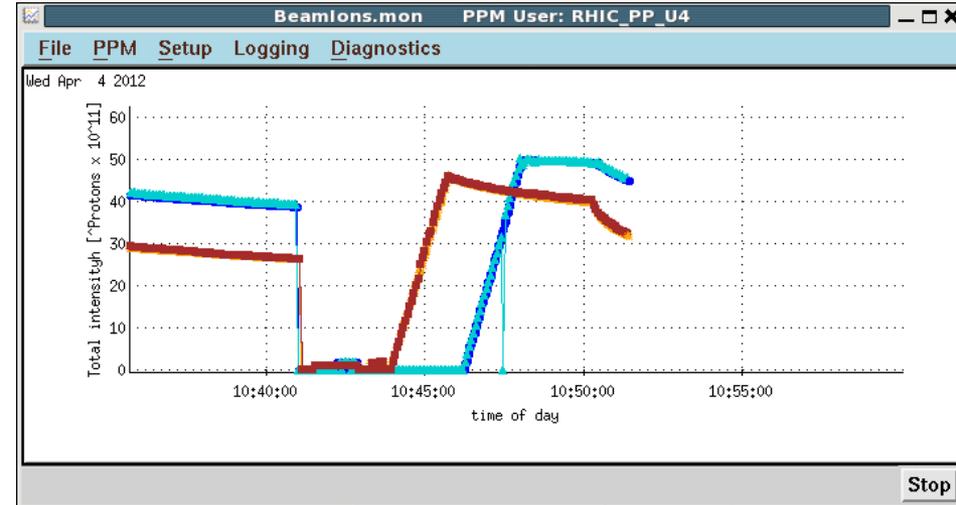
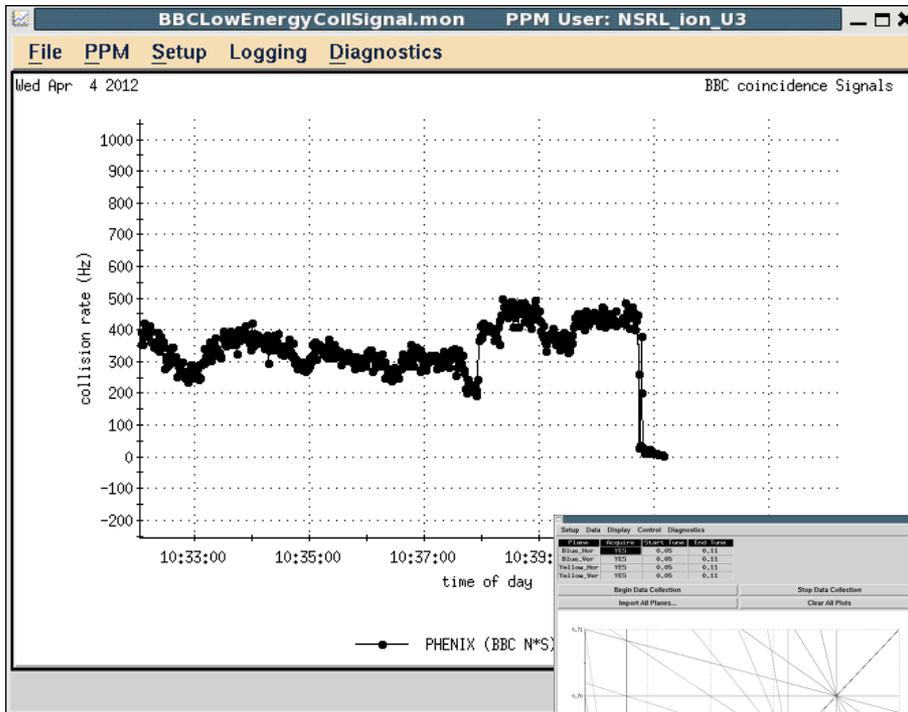
Result: not as good as has hoped, and as observed for similar working point but with very weak beam-beam.

April 4: Protons at injection w.p.=(0.08,0.07)

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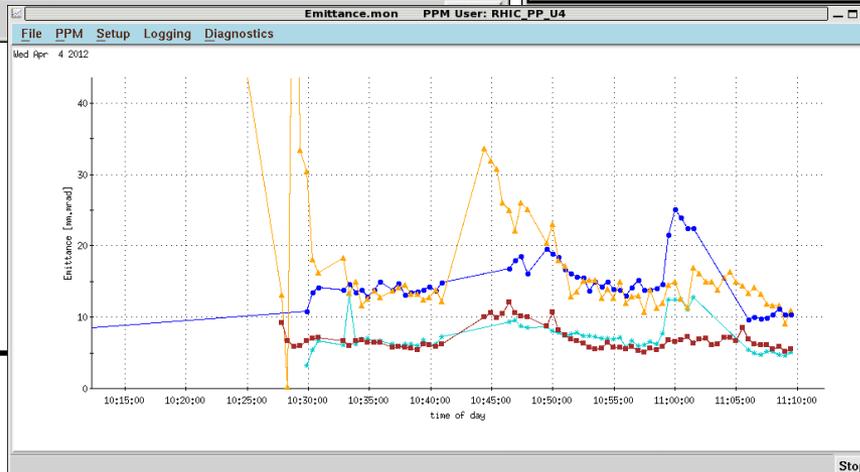
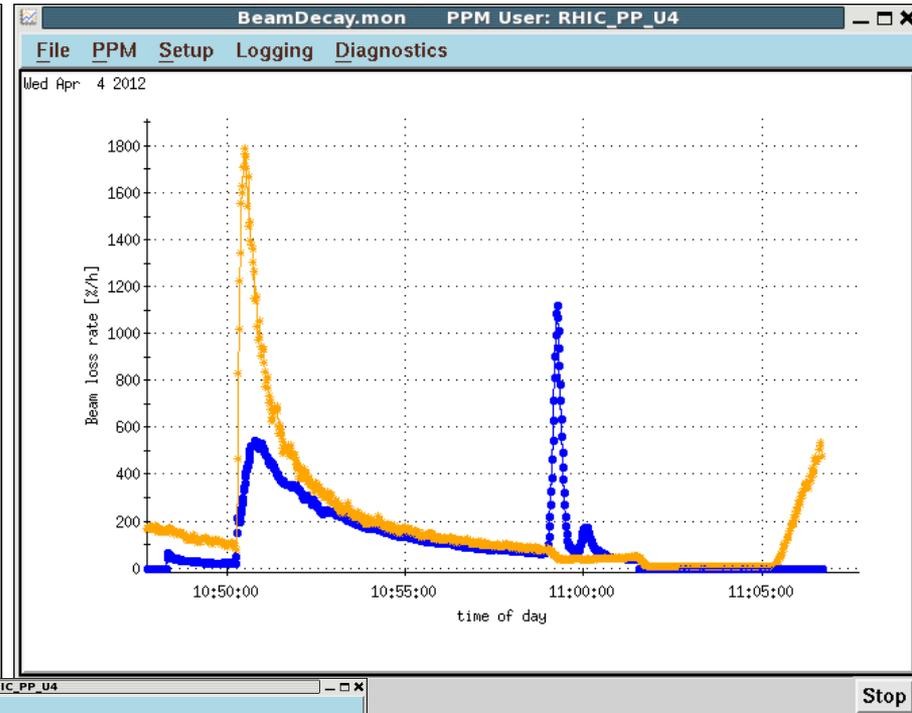
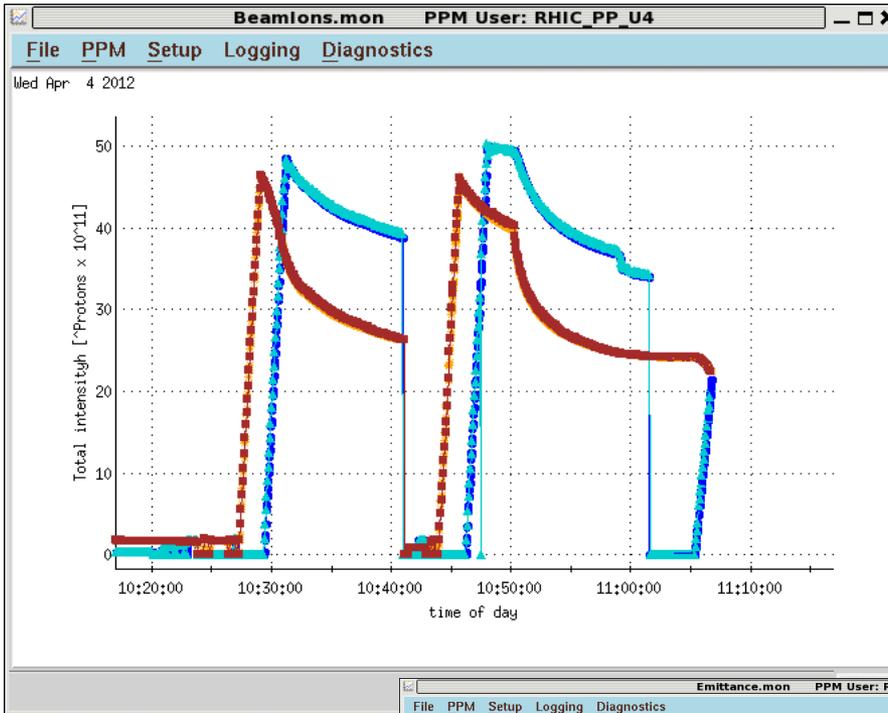


April 4, 2012: effect of collisions



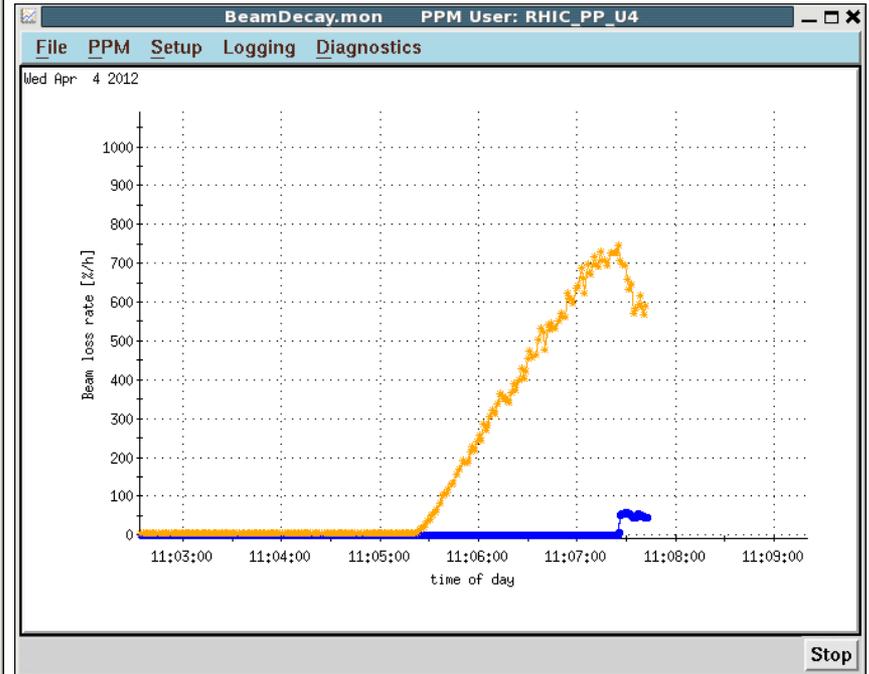
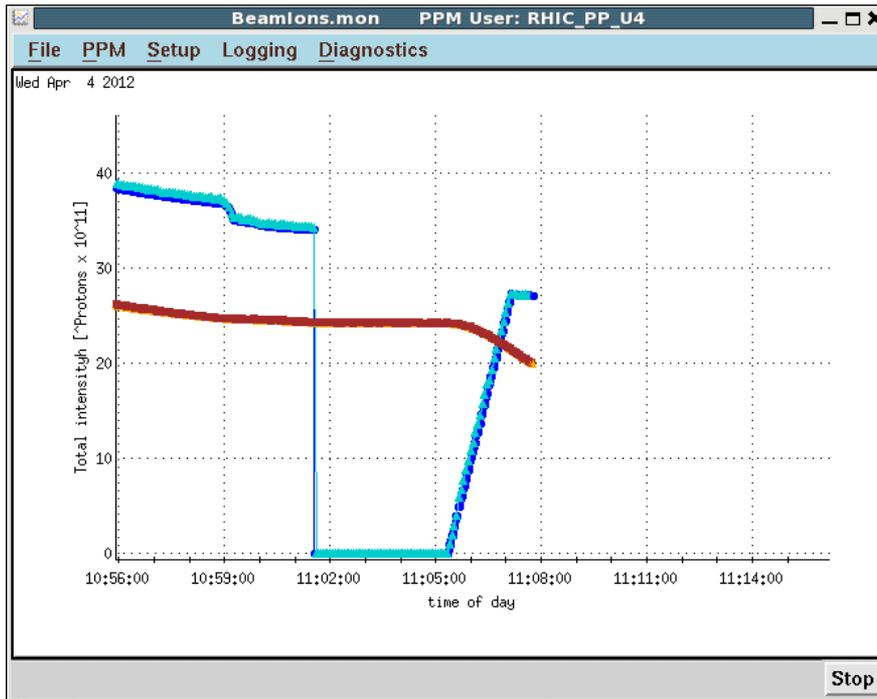
April 4, 2012: effect of collisions

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Reduced intensity:

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Injecting directly in collisions:
lower intensity beam was kept in Yellow and
fresh low intensity beam injected in Blue

Summary

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- We are done with “beam-beam and space-charge”.
- If better control of machine, optics etc. becomes available (perhaps as part of near-integer w.p. RHIC set-up), one can repeat this experiment below integer w.p., for completeness.