Improving the luminosity at injection energy

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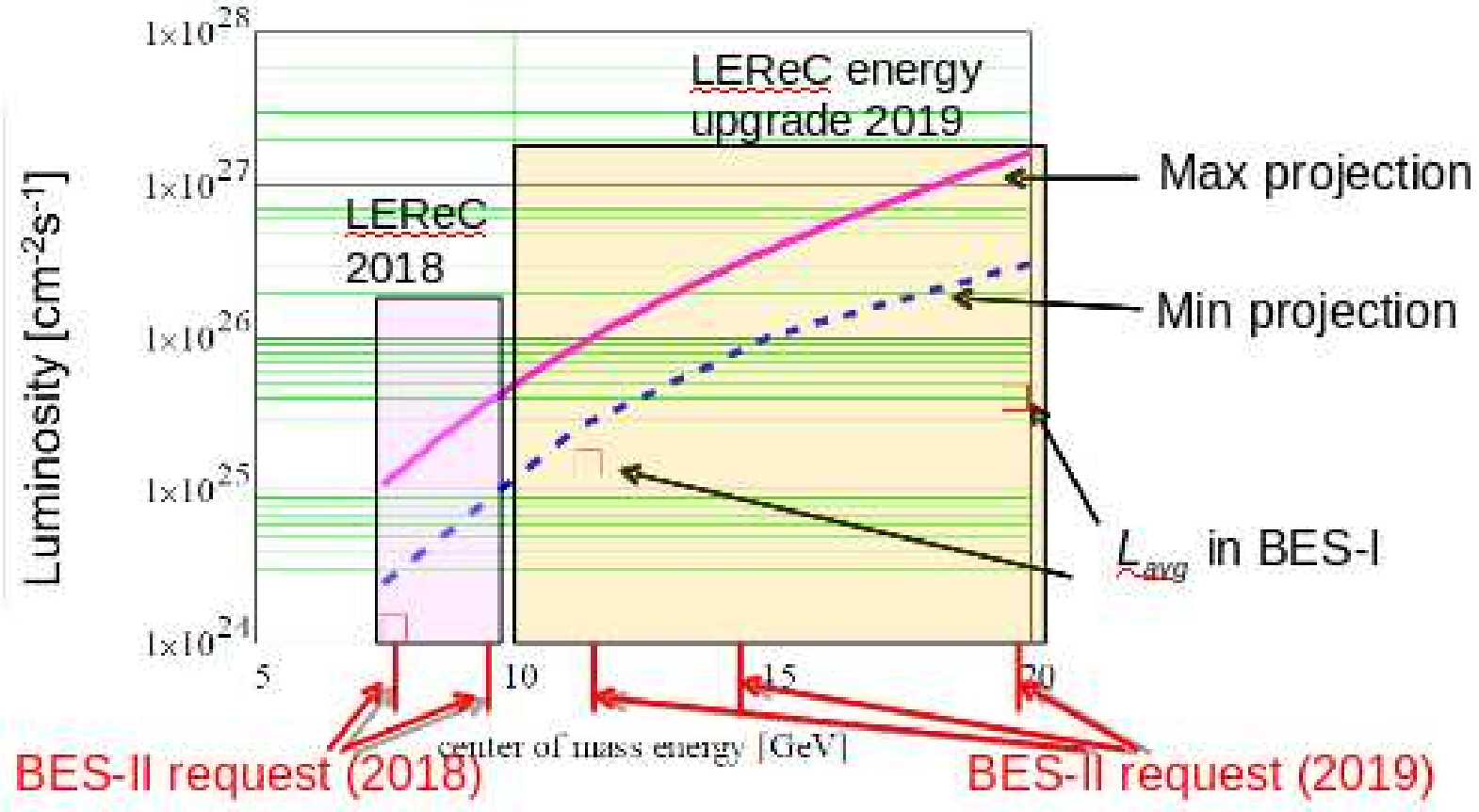
APEX March 9, 2016

Motivation



• BES-II requires much higher luminosity for a meaningful low-energy physics program, up to factor 10

- Low Energy RHIC electron Cooler (LEReC) will cool Au beams up to 5.75 GeV/n

- Cooling at higher energies would require energy recovery - extremely difficult

- Luminosity improvements above this level have to be accomplished by different machine parameters (β^*, intensity, luminosity lifetime)

- Last injection energy run in 2011 had a peak luminosity of $8 \cdot 10^{25}\,\mathrm{cm}^{-2}\mathrm{sec}^{-1}$ at $\beta^* = 2.5\,\mathrm{m}$ and $N = 0.9 \cdot 10^9$ Au/bunch, with 35 min stores. Two collision points

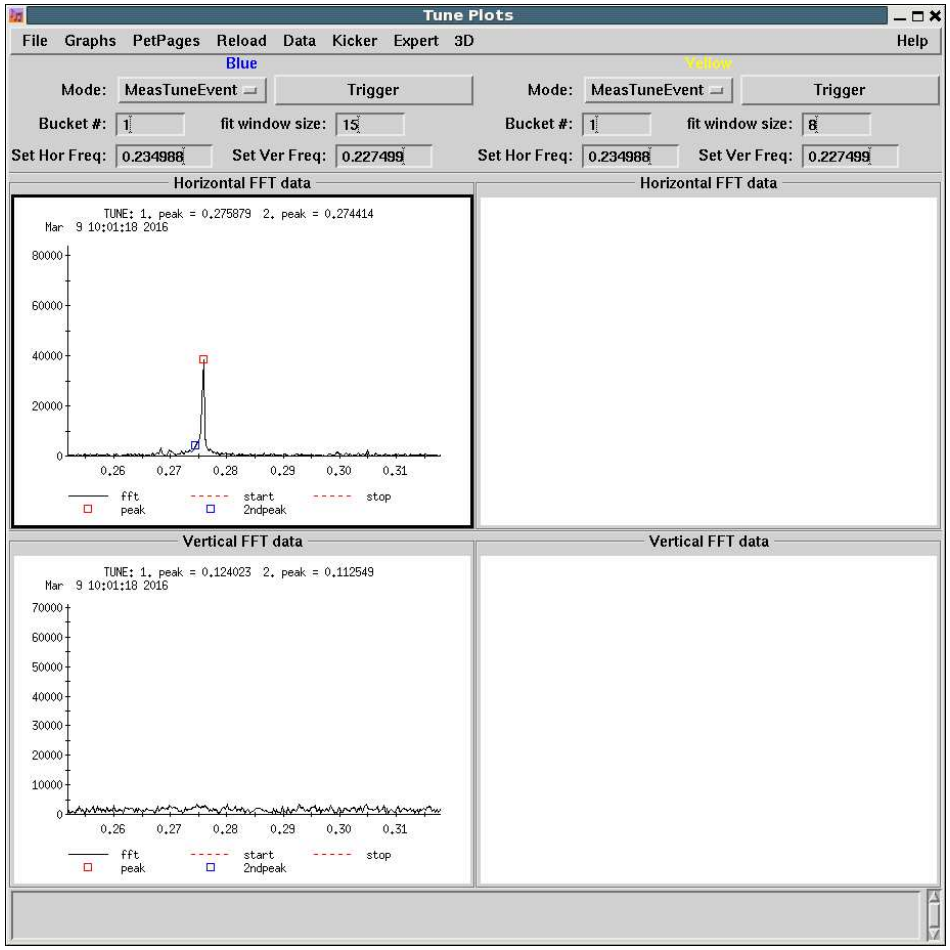
APEX on March 9, 2016

- Prepared three injection lattices with $\beta^* = 2.5$, 3.0, and 3.5 m at STAR only (PHENIX will not run at low energy in 2019-20)

- Loaded 3.5 m lattice and set up the machine

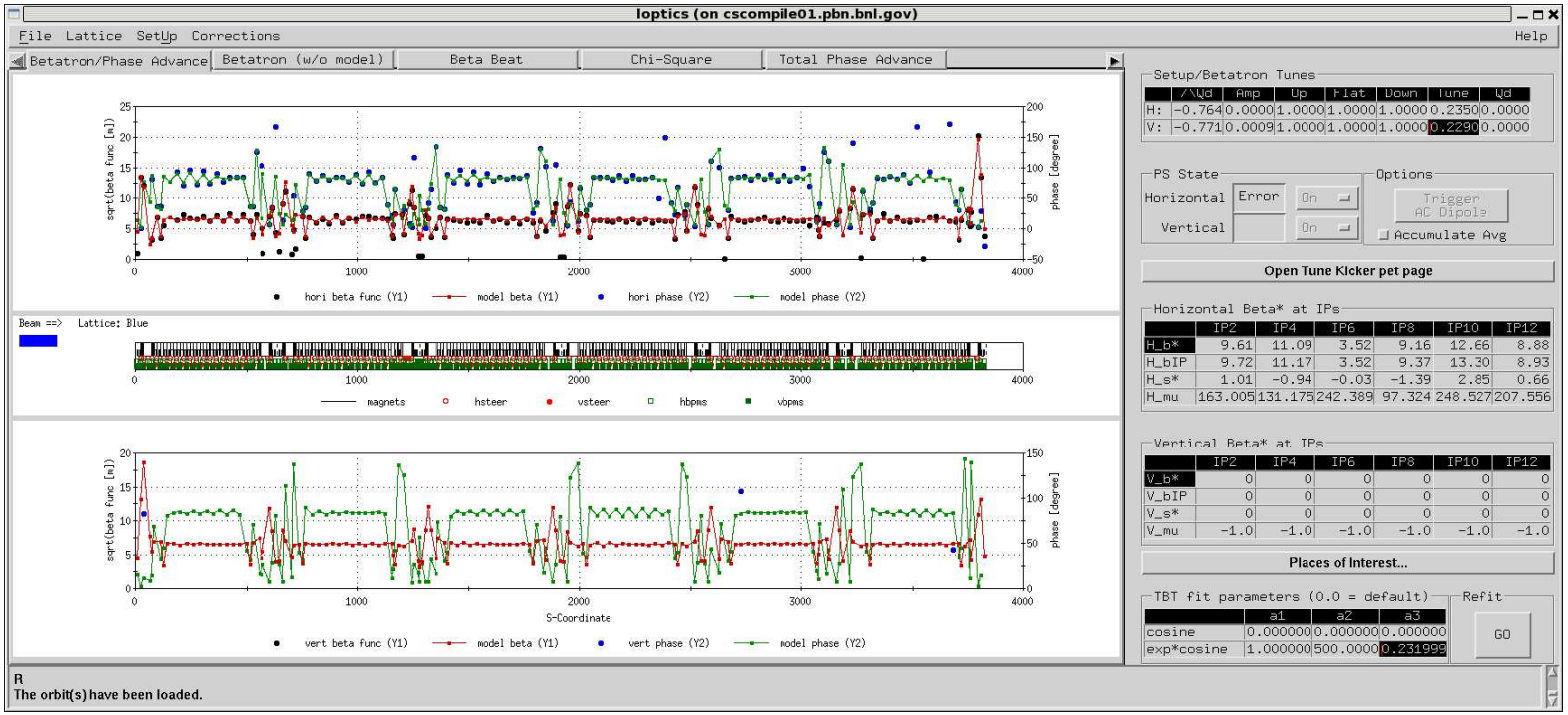
- Setup took a lot longer than anticipated. Tunes were far off, and difficult to find at all in the vertical plane

Early tune "measurements"



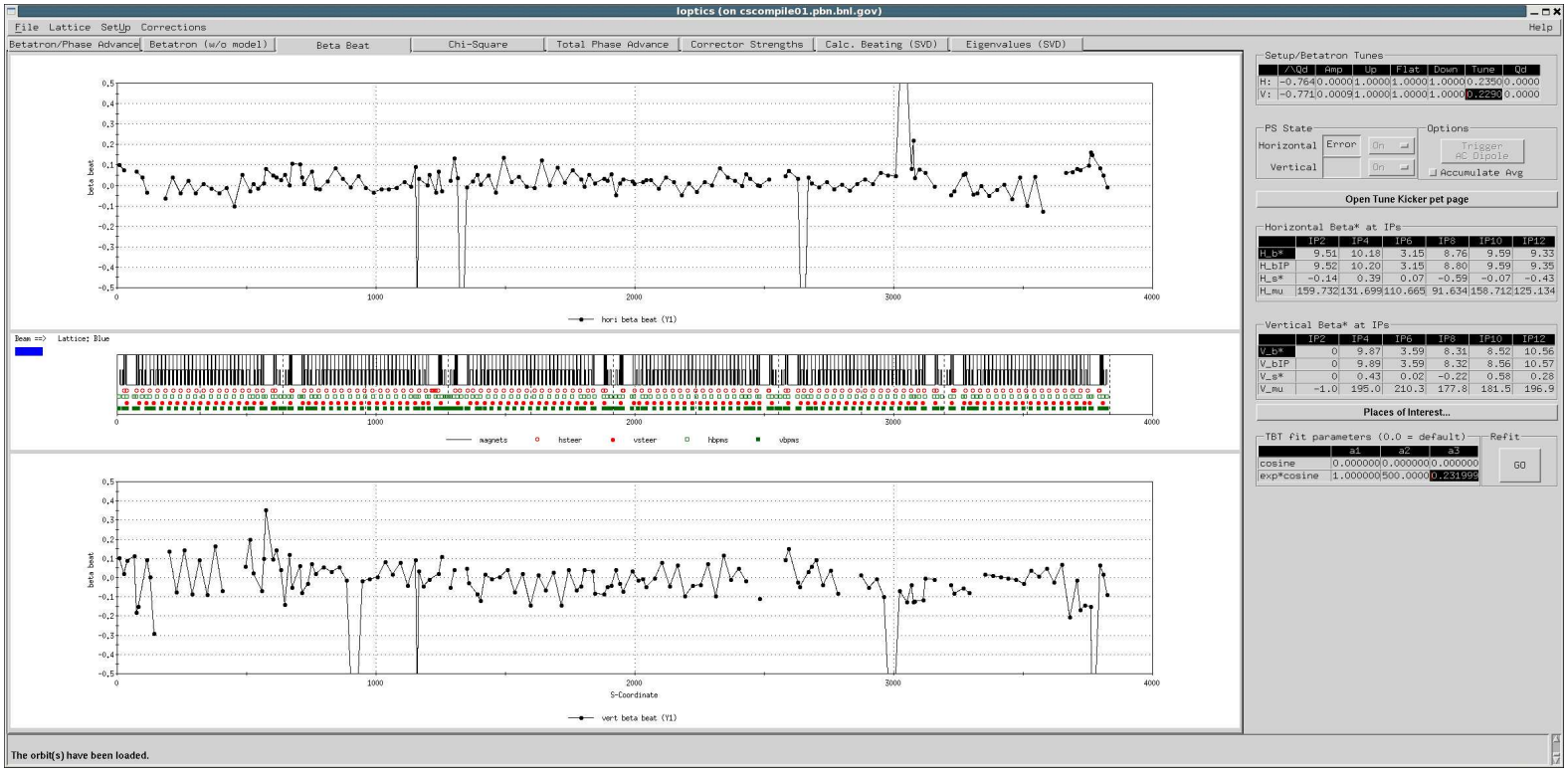
No vertical tune peak at all

Early turn-by-turn optics measurements



Vertical data non-existent

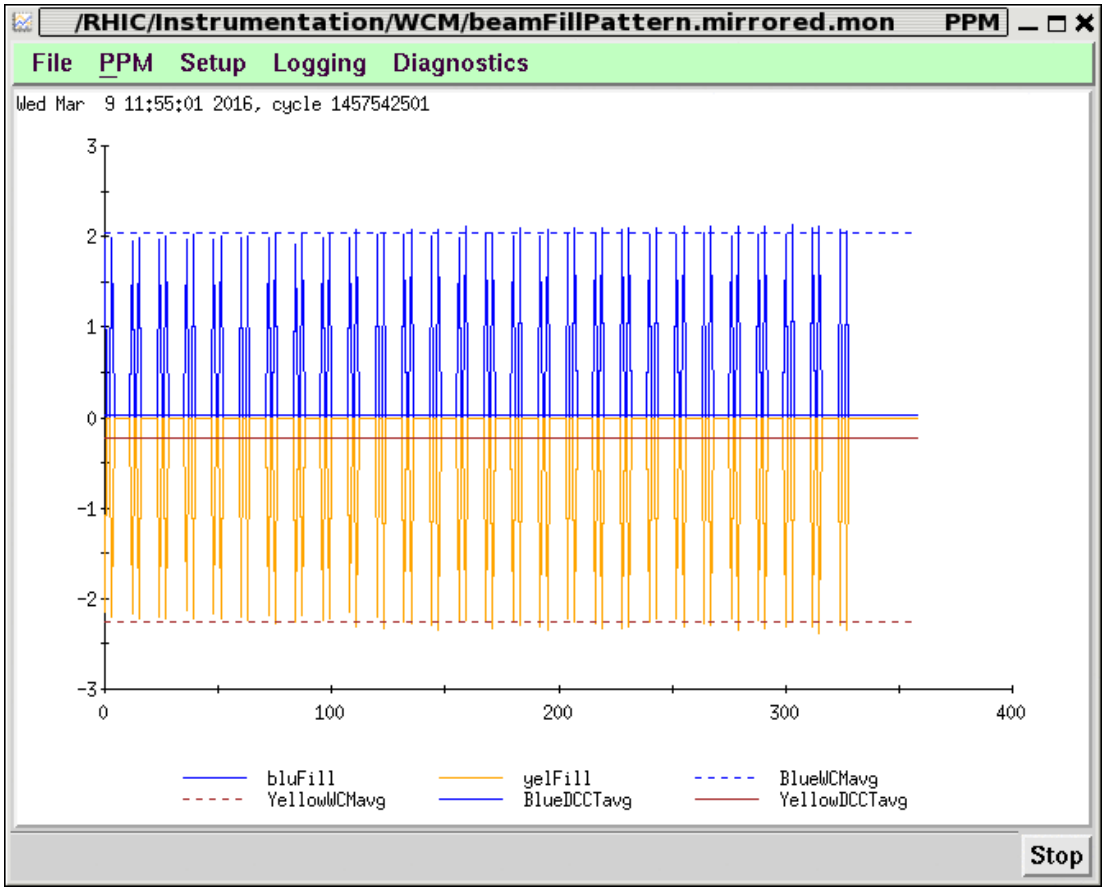
BLUE β-beat after some tuning



10 percent β-beat

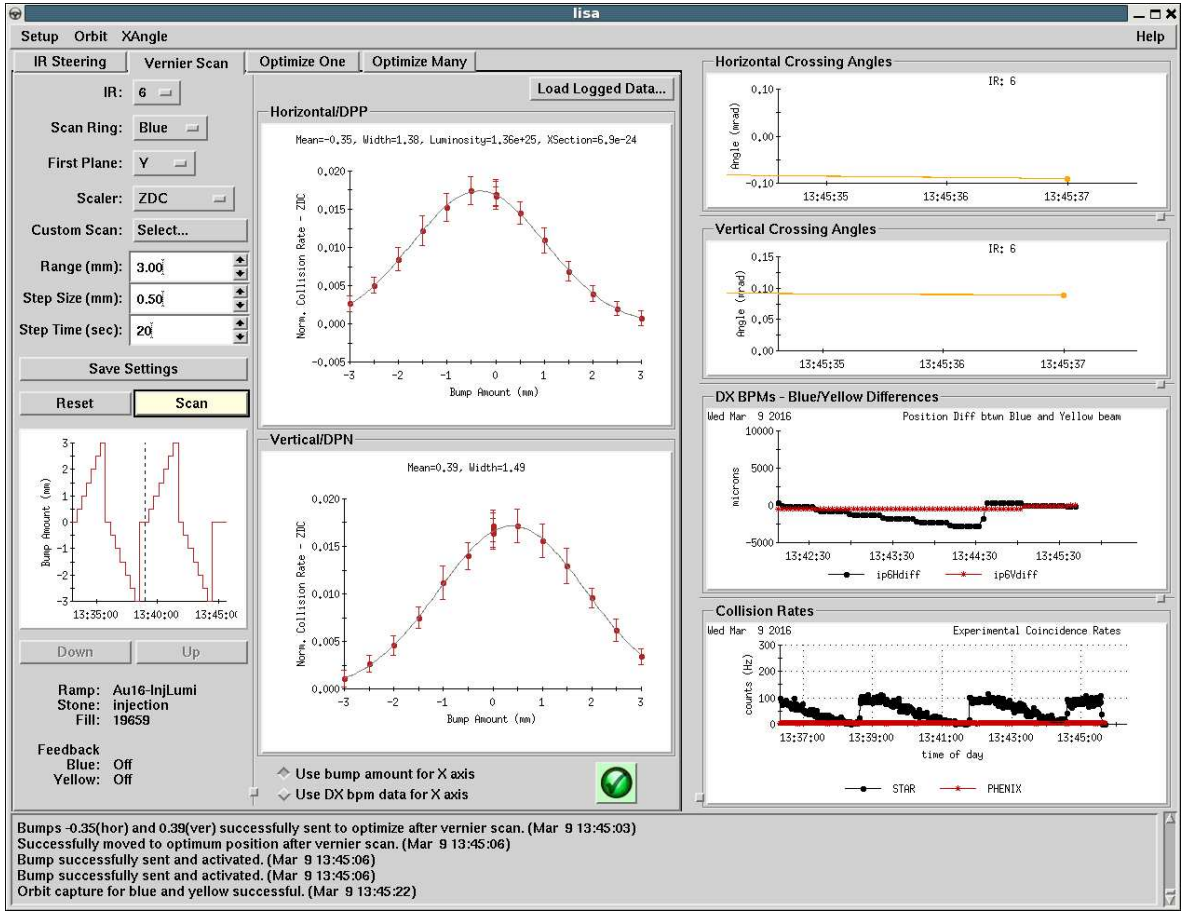
YELLOW is similar

56x56, 2.2e9 per bunch, with separation bumps



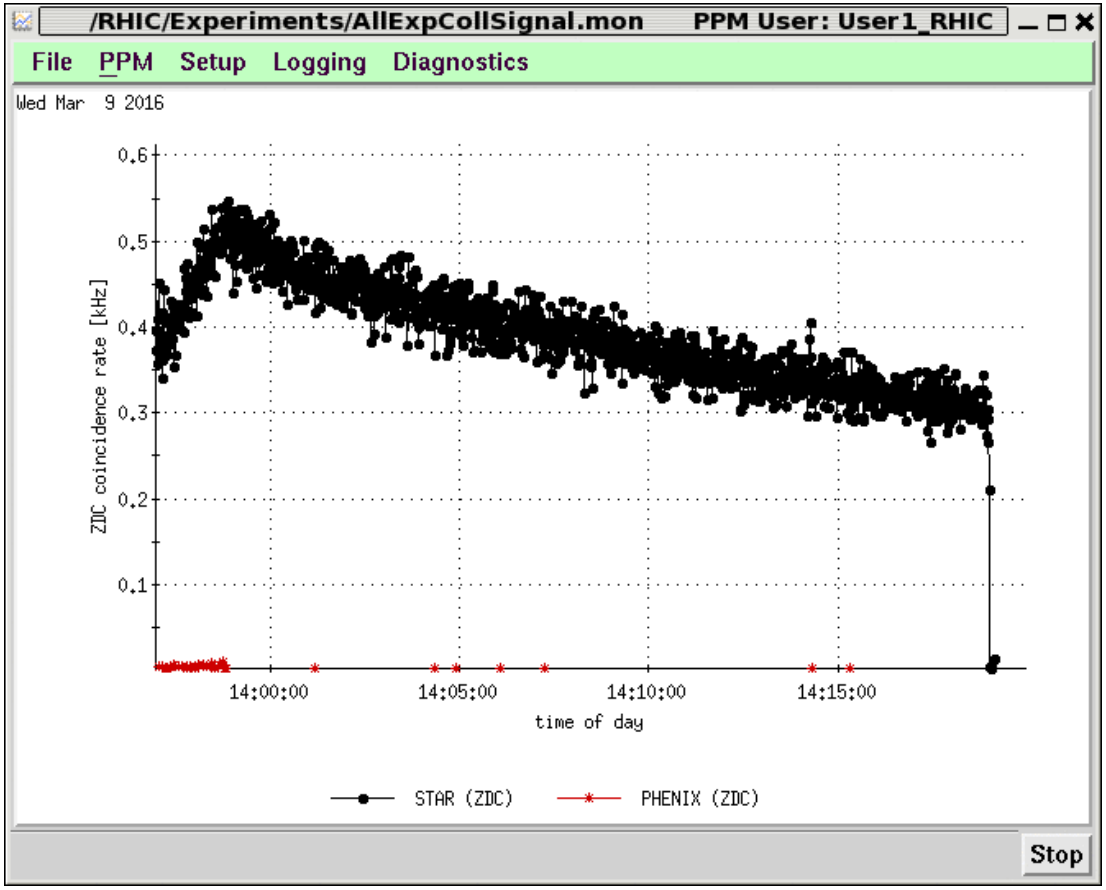
Collapsing separation bumps caused radial shift (unequal frequencies); needed to be corrected

Vernier scan



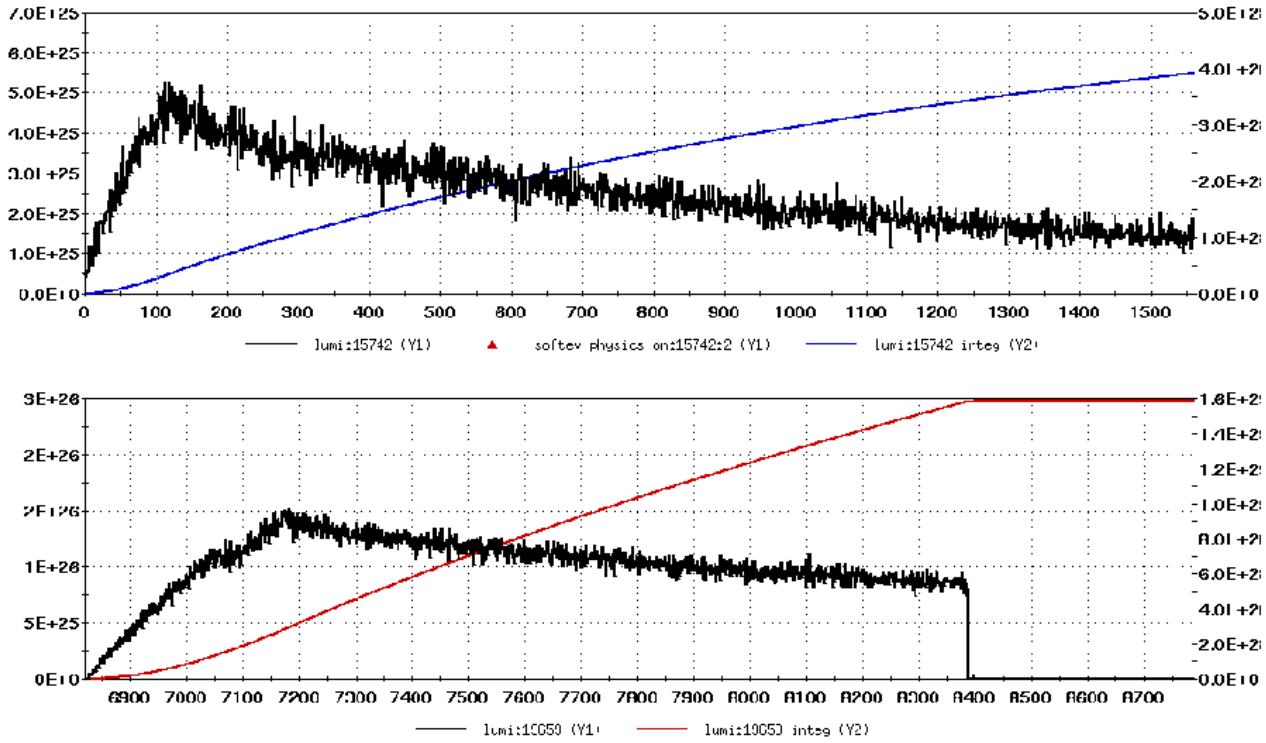
Cross section is 3.6 barn (plot shows 6.9; that's wrong)

ZDC rates during 20 min "physics" store



Peak rate is factor 2 higher than in Run-11, and lifetime is much better

Integrated luminosities during 20 min store



Top: Run-11

Bottom: APEX 2016

$\Rightarrow$ Factor 4 integrated luminosity improvement (Comparison with better 2011 stores shows factor 3)

Conclusion

- Achieved factor 3-4 integrated luminosity increase over Run-11 - the minimum goal

- Setup took much longer than anticipated; only tested $\beta^* = 3.5\,\mathrm{m}$

- Should test smaller $\beta^* = 2.5\,\mathrm{m}$ and $3\,\mathrm{m}$ during future APEX sessions

Recombination monitor experiments should have prioriy before testing smaller β^*