



Review of Recent Tevatron Operations



Ron Moore

Fermilab – Tevatron Dept.



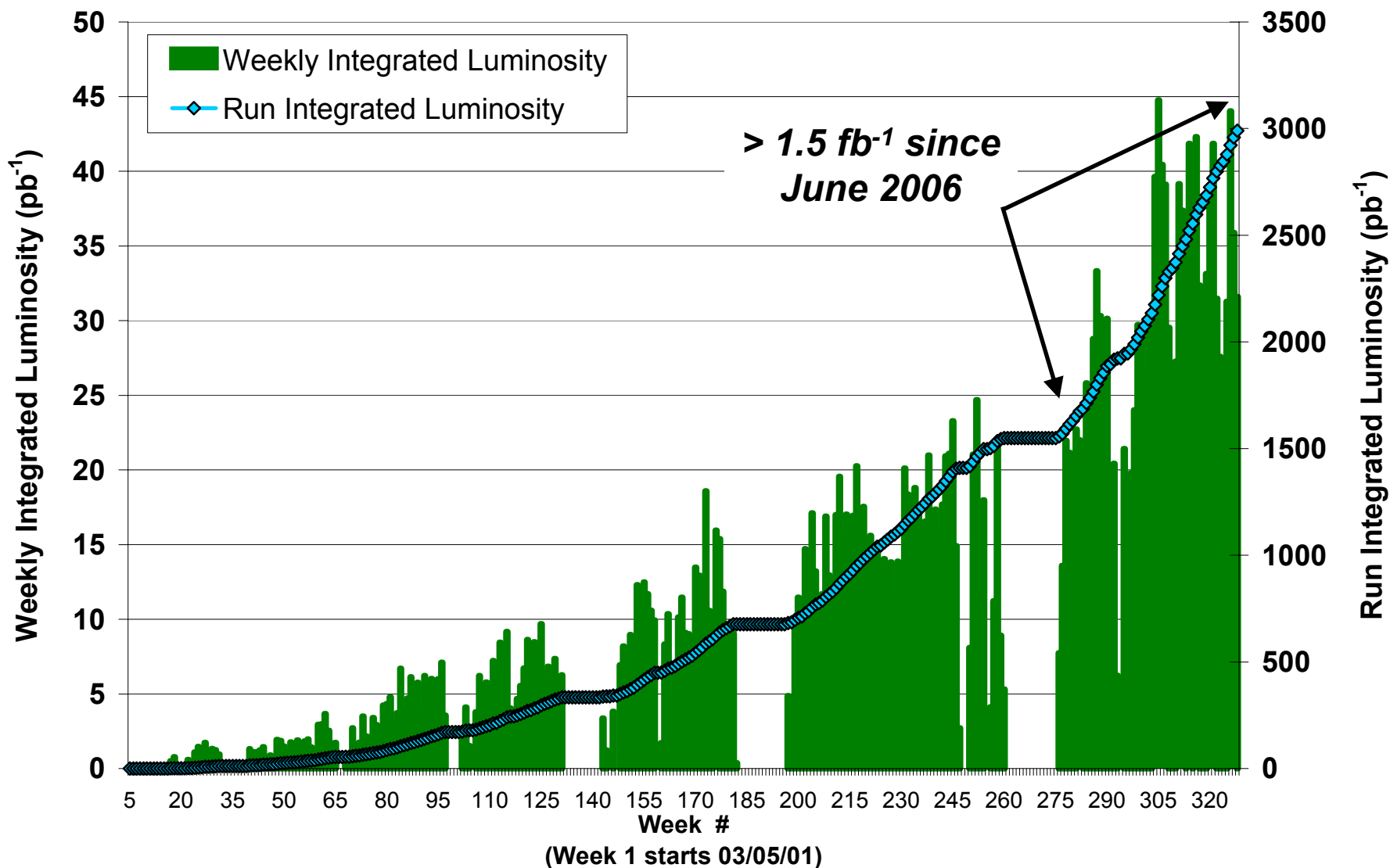
Overview



- Tevatron
 - 1 km radius superconducting synchrotron at 980 GeV beam energy
 - Tevatron 36×36 proton-antiproton collisions to CDF & D0 experiments
 - 3 trains of 12 bunches each with 396 ns separation
 - Protons and antiprotons circulate in single beam pipe
 - Electrostatic separators keep beams apart except where/when desired
 - Beam-beam interactions (head-on & long range) play major role

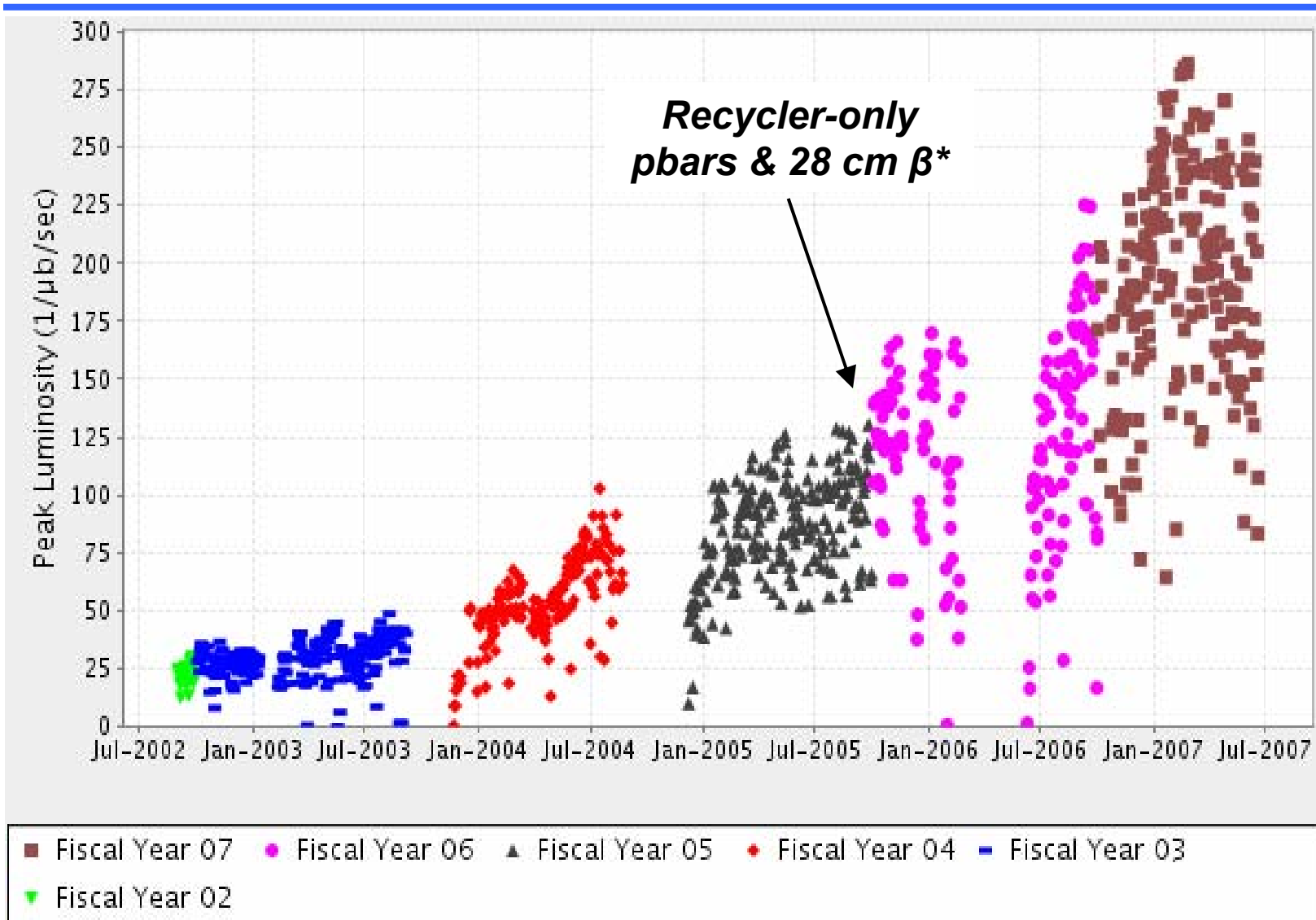


Tevatron Delivered Luminosity





Tevatron Run 2 Peak Luminosities





2006 Tevatron Shutdown Tasks



- Fixed known cold leaks in E2, A3, B4; replace failed dipole in F4
- Installed 2 new separators (B48, A17), replace 3 separators (A49)
- Completed reshimming on remaining 228 dipoles
- Replaced all ≈ 1200 helium relief valves (Kautzky) on magnets
- Repaired TEL-1 and installed TEL-2 (electron lenses)
- Pulled cables for new sextupole circuits (2nd order chromaticity correction)
- Unrolled quads in A3 (~ 10 mrad); unroll ~ 60 magnets with small rolls
- Completed IPM detector installation
- Completed ring-wide hydrostatic level sensor installation
- Many smaller tasks, lots of maintenance...
- ***Tevatron Run II upgrades effectively complete!***



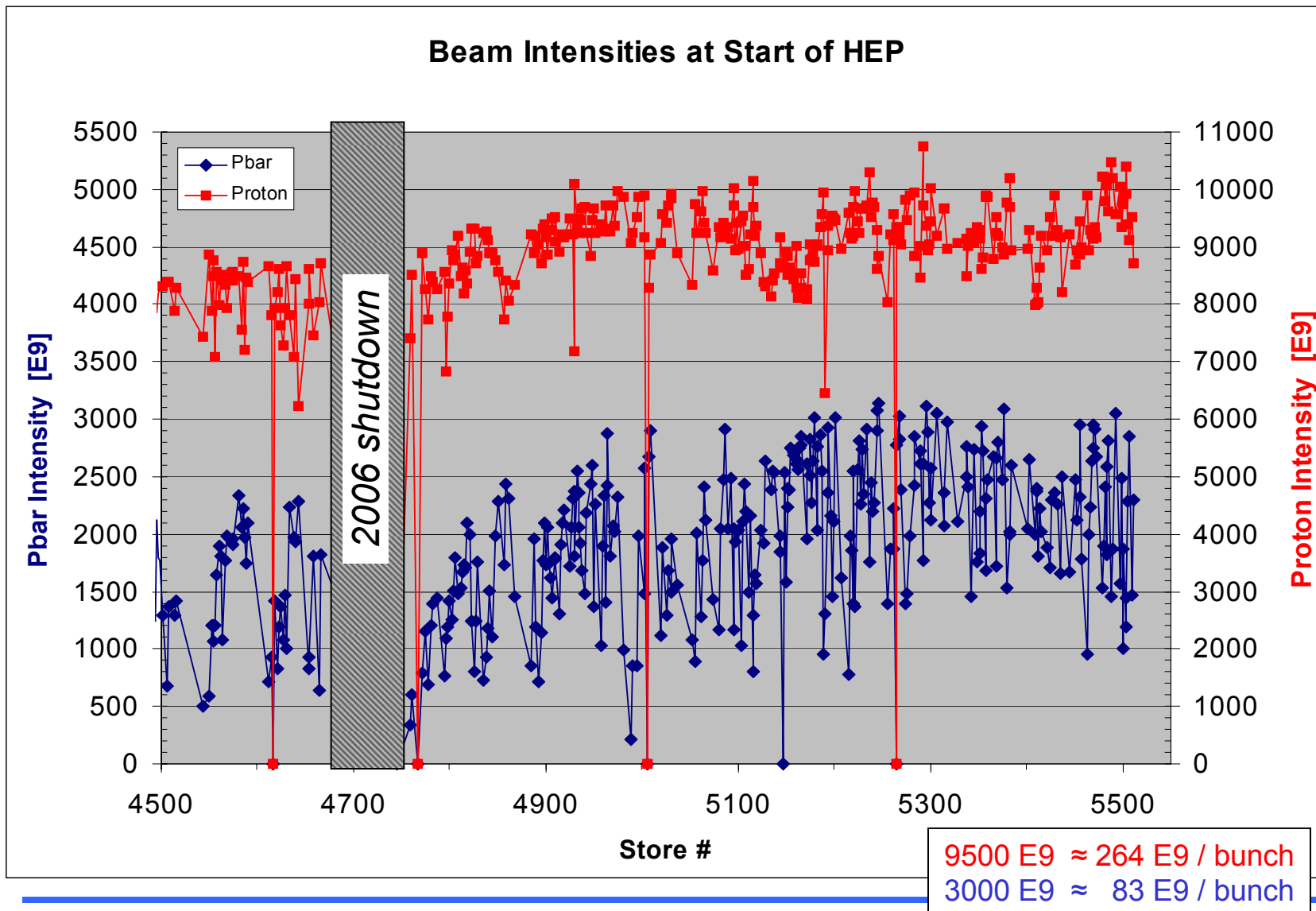
Highlights since 2006 shutdown...



- Record delivered luminosity / week 24.4 → 44.9 pb⁻¹
- Record peak luminosity 180 → 292 10³⁰ cm⁻² s⁻¹
- Delivered > 1.5 fb⁻¹ to CDF and D0 (Run 2 total delivered now > 3 fb⁻¹)
- More antiprotons with smaller emittances to HEP
 - Thanks to Antiproton Source and Recycler
 - See K. Gollwitzer's talk tomorrow afternoon (WEZAKIO1)
- More protons to HEP
 - Injecting ≈10% more protons
 - Better lifetime @ 150 GeV from new helical orbit, reduced beam-beam
- Improved luminosity lifetime
 - Additional separators increase separation (up to 20% at parasitic crossings)
 - Beam-beam effects reduced
- Commissioned TEL-2 and demonstrated beam-beam compensation on protons
 - See V. Shiltsev's talk later this session (TUOCKI04)



Beam Intensities in HEP Stores

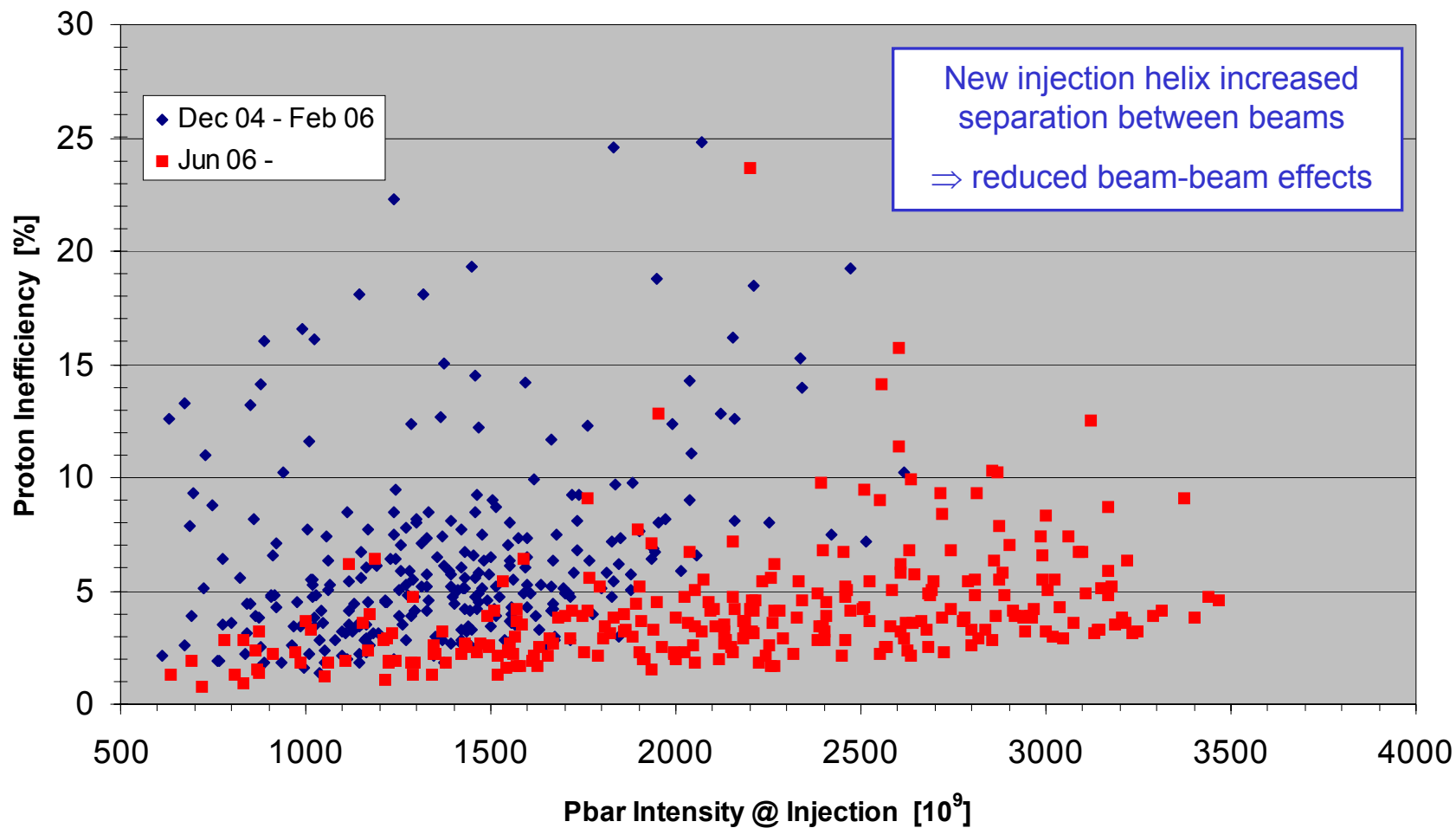




Improved Proton Efficiency vs Pbar Intensity

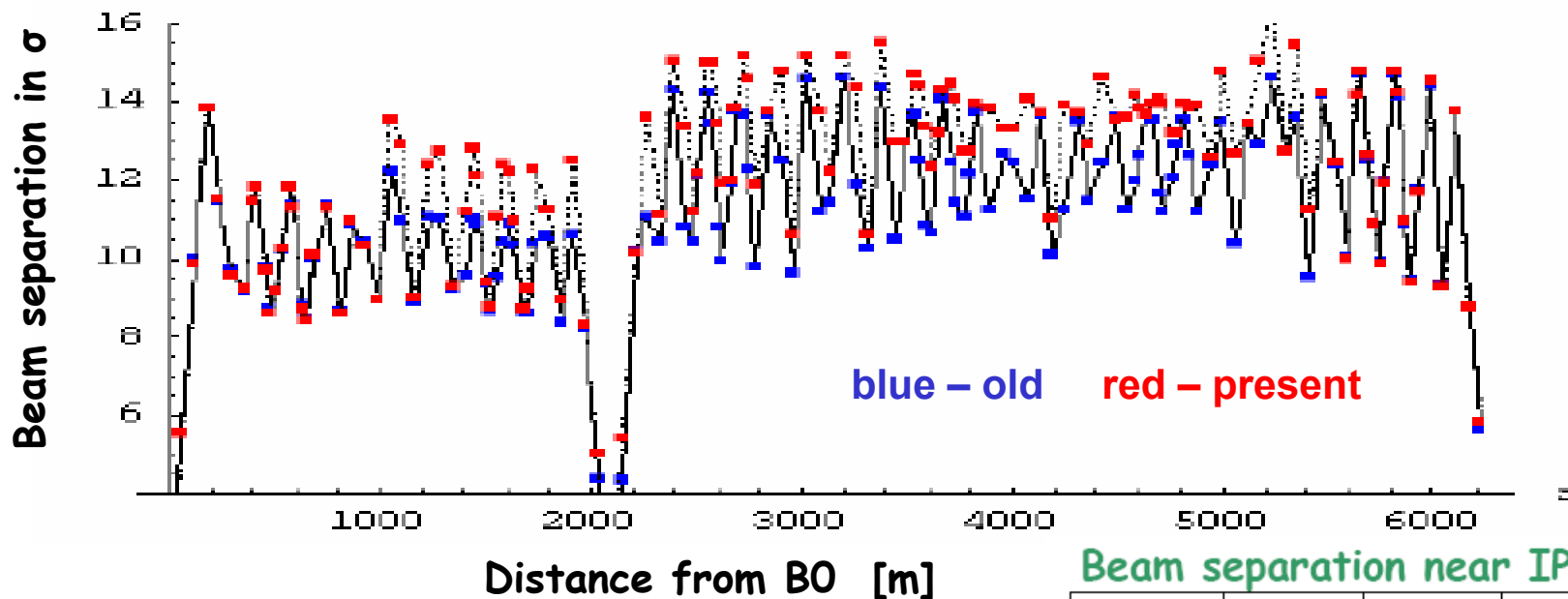


Proton Inefficiency @ 150 GeV





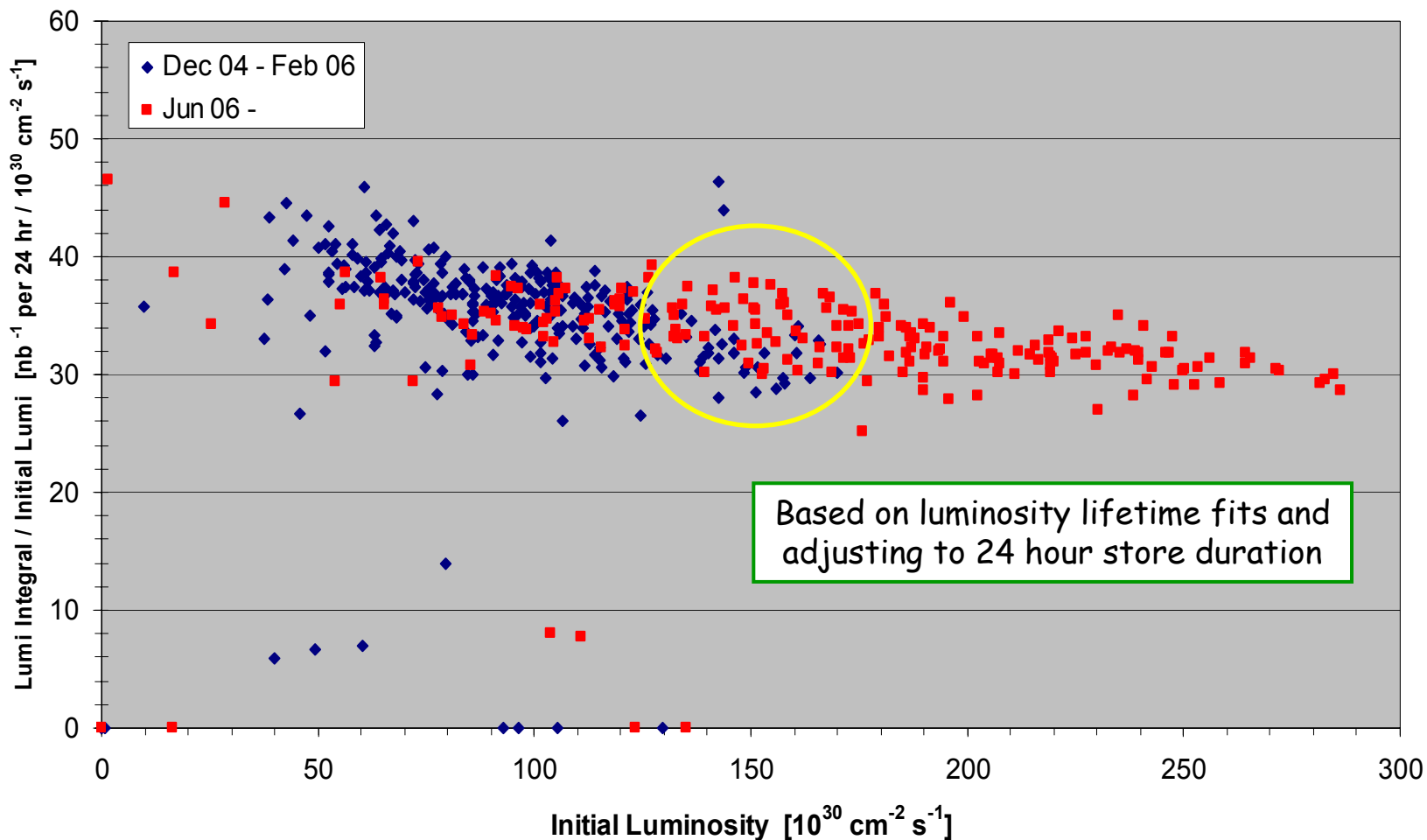
Larger Separation with New Collision Helix



- Installed 2 additional separators during 2006 shutdown
- Luminosity lifetime improved $\sim 20\%$ compared to pre-shutdown
 - Increased integrated luminosity per store (for similar luminosities and duration)



Normalized Lumi Integral / 24 hr vs Initial Luminosity

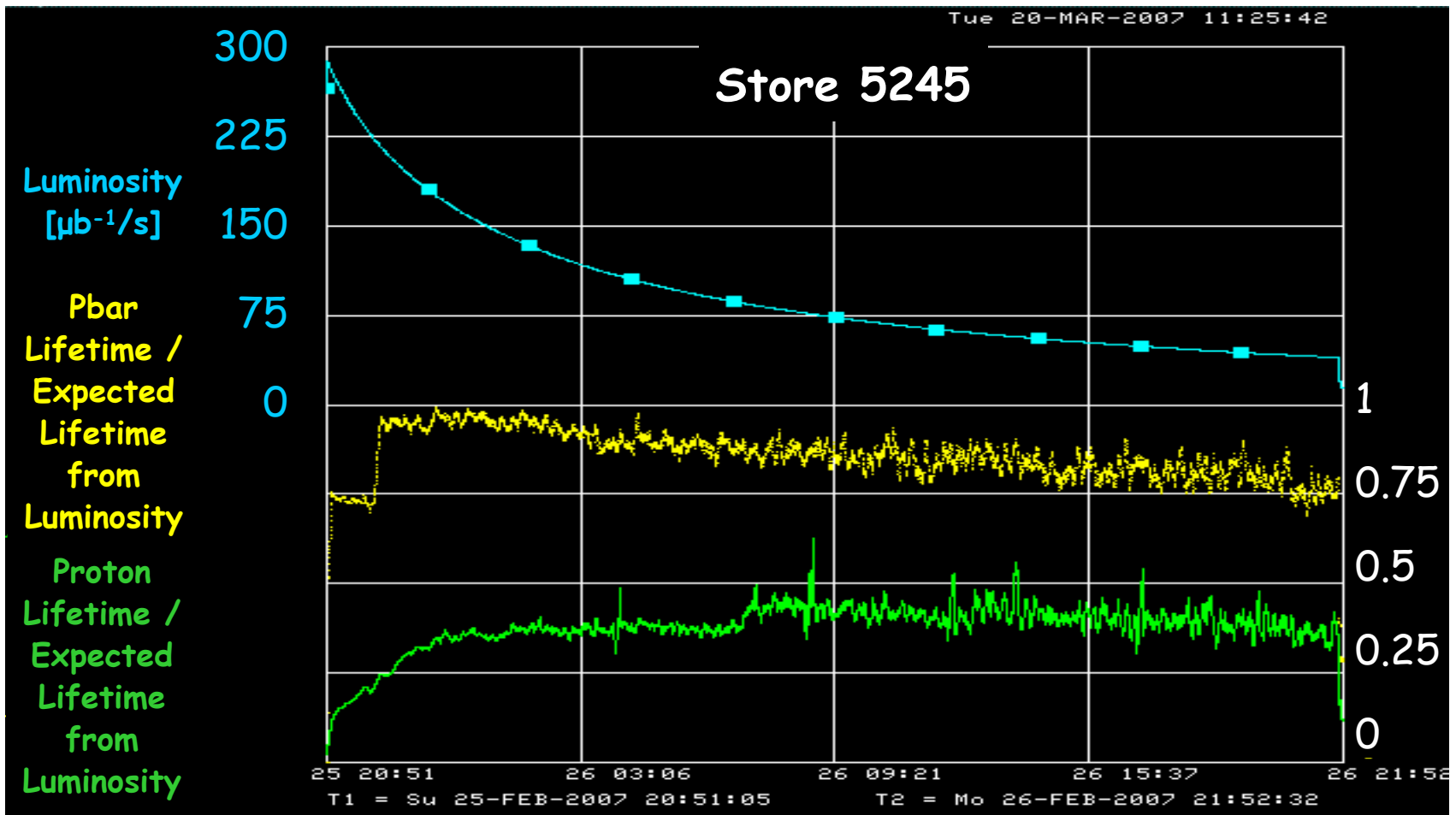




Beam Lifetimes during HEP



- Pbar lifetime dominated by luminosity – good
- Most protons lost in non-luminous processes – not so good
 - Head-on beam-beam effects from smaller emittance pbars on protons

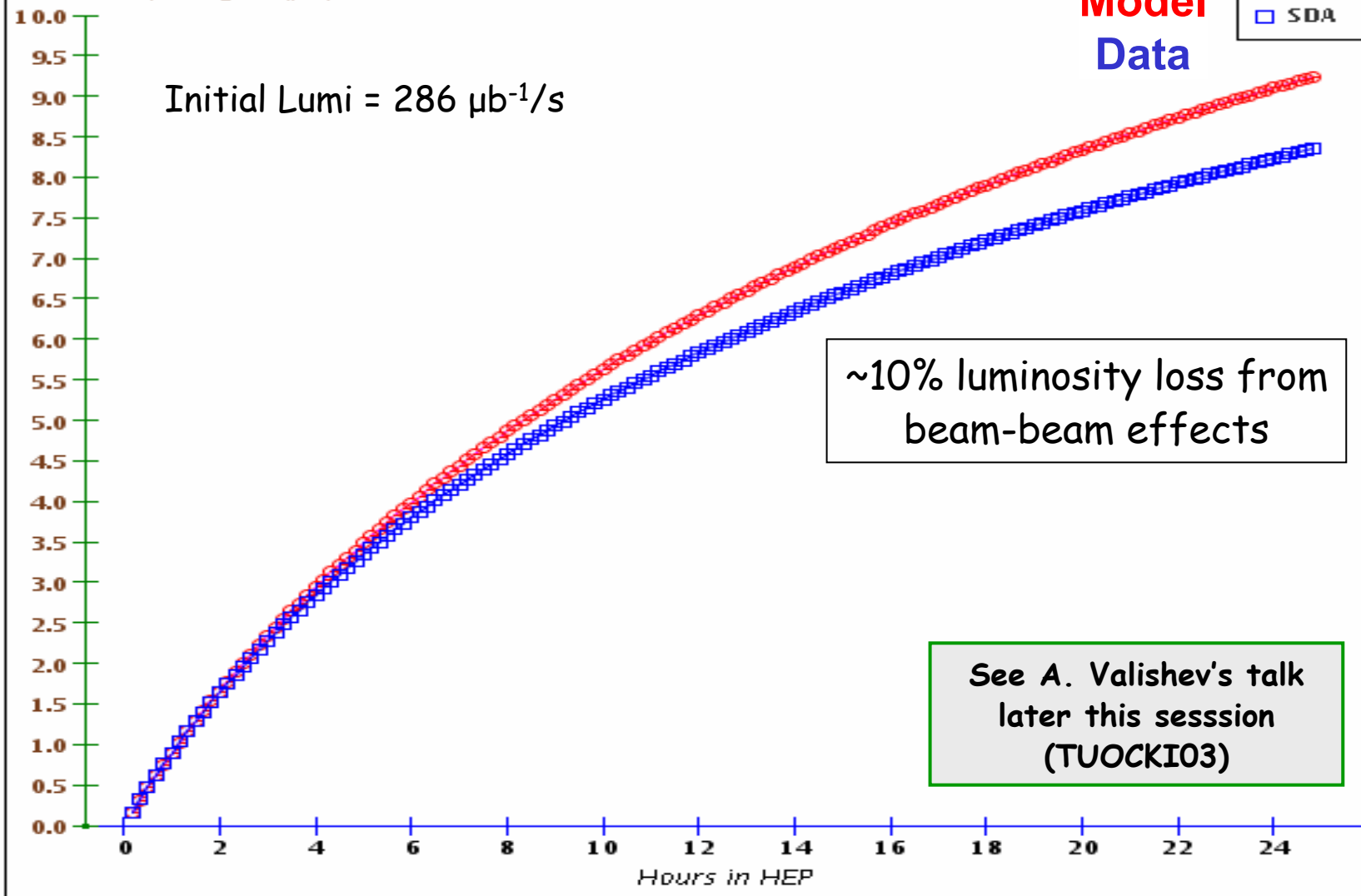




Store 5245 – Comparison to Model w/o Beam-Beam



Luminosity Integral





Reliability



- Over 280 HEP stores since June 2006 – 75% terminated intentionally
 - Slightly better than the 72% Run 2 historical average
 - Causes: power supplies \approx 24%, cryo \approx 11%, Mother Nature \approx 10%, controls \approx 9% , separators \approx 7%
- Averaging \approx 105 HEP store hours per week since October 2006
 - Includes few weeks of downtime to repair failed Tevatron components
 - Weeks of 130 store hours not uncommon
- Reliability
 - Replaced all \approx 1200 LHe Kautzky valves (cause of 2 FY06 dipole failures)
 - Modifying quench protection system to allow faster beam aborts
 - Cog pbars out of abort gap for acceleration – prevent needless quenches



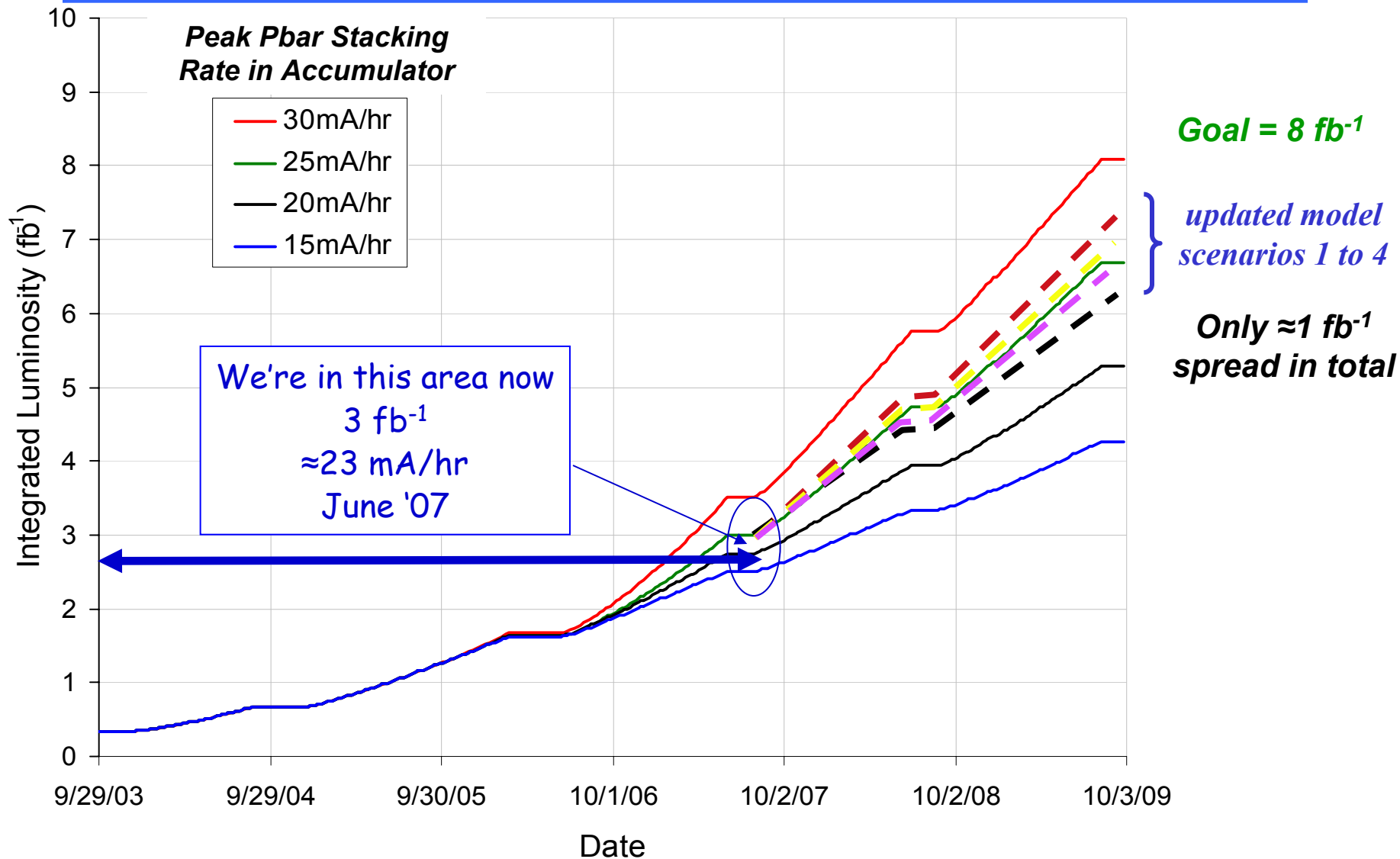
Looking Ahead in Tevatron



- Implement 2nd order chromaticity correction @ low β – in progress
 - Simulations show improved lifetimes during HEP
 - Also prerequisite to pursue possible new working point near $\frac{1}{2}$ integer
 - See A. Valishev poster (FRPMS015)
- Pursue other minor improvements (few % each) – they all add up!
 - Scrape (higher intensity) protons @ 150 GeV
 - Can reduce losses up ramp and through squeeze? Need to resume
 - Investigating new cogging between antiproton injections
 - Reduce beam-beam effects by changing locations of long-range crossings
 - Use TELs (electron lenses) on protons for beam-beam compensation
 - Raise tunes of individual bunches away from resonance to improve lifetime
 - Better helices, improved transfer line matching, faster shot-setups, etc.



Luminosity Projections with Updated Model Scenarios





Summary



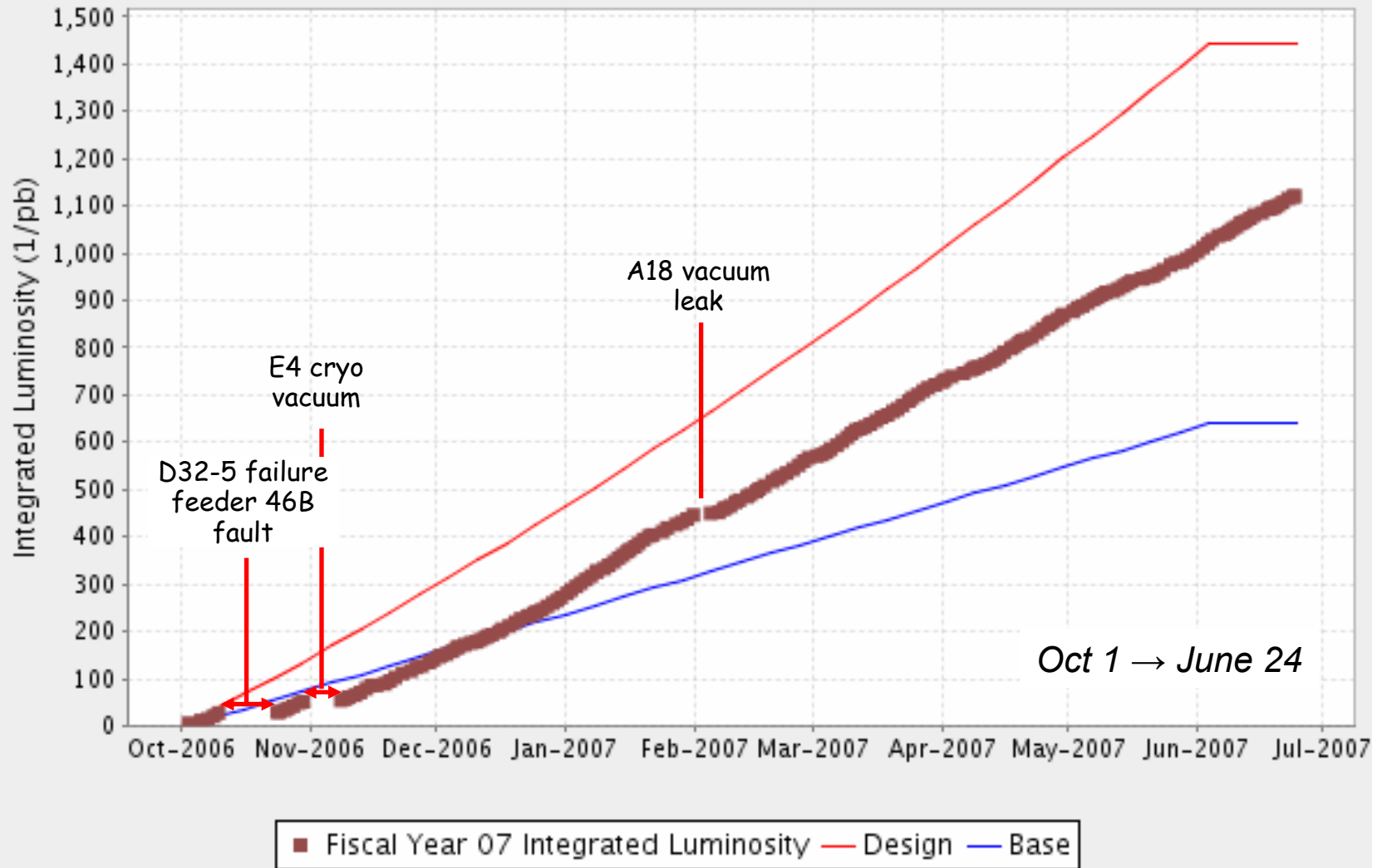
- Tevatron luminosity made great progress over past year
 - Doubled the delivered luminosity to $> 3 \text{ fb}^{-1}$
 - Higher antiproton intensities with smaller emittances
 - Improved luminosity lifetime from increased separation
- Tevatron upgrades complete, still reaping benefits
 - Continue pursuing smaller operational improvements
- On track for $6\text{-}7 \text{ fb}^{-1}$ total through October 2009
 - 8 fb^{-1} is still the goal
 - Need increased antiproton stacking rates for higher luminosity
- Make the most of the Tevatron before the end of Run 2!



FY07 Tevatron Performance



FY07 Integrated Luminosity 1120.89 (1/pb)

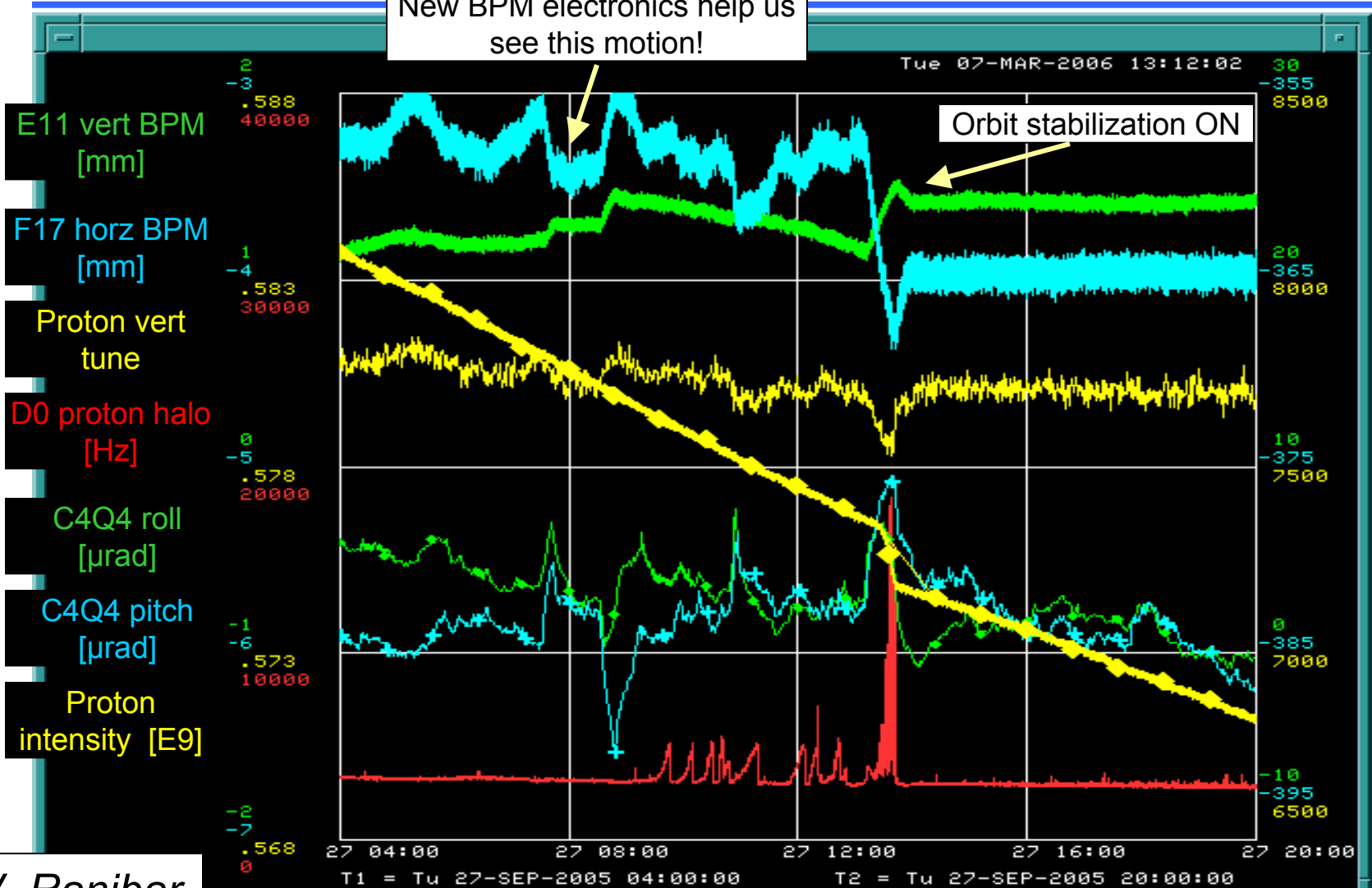




Magnet Motion / Orbit Stabilization



New BPM electronics help us see this motion!



V. Ranjbar

Store 4402



Integrated Luminosity and Store Hours per week

