Luminosity Performance and Expectations

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P5 Meeting
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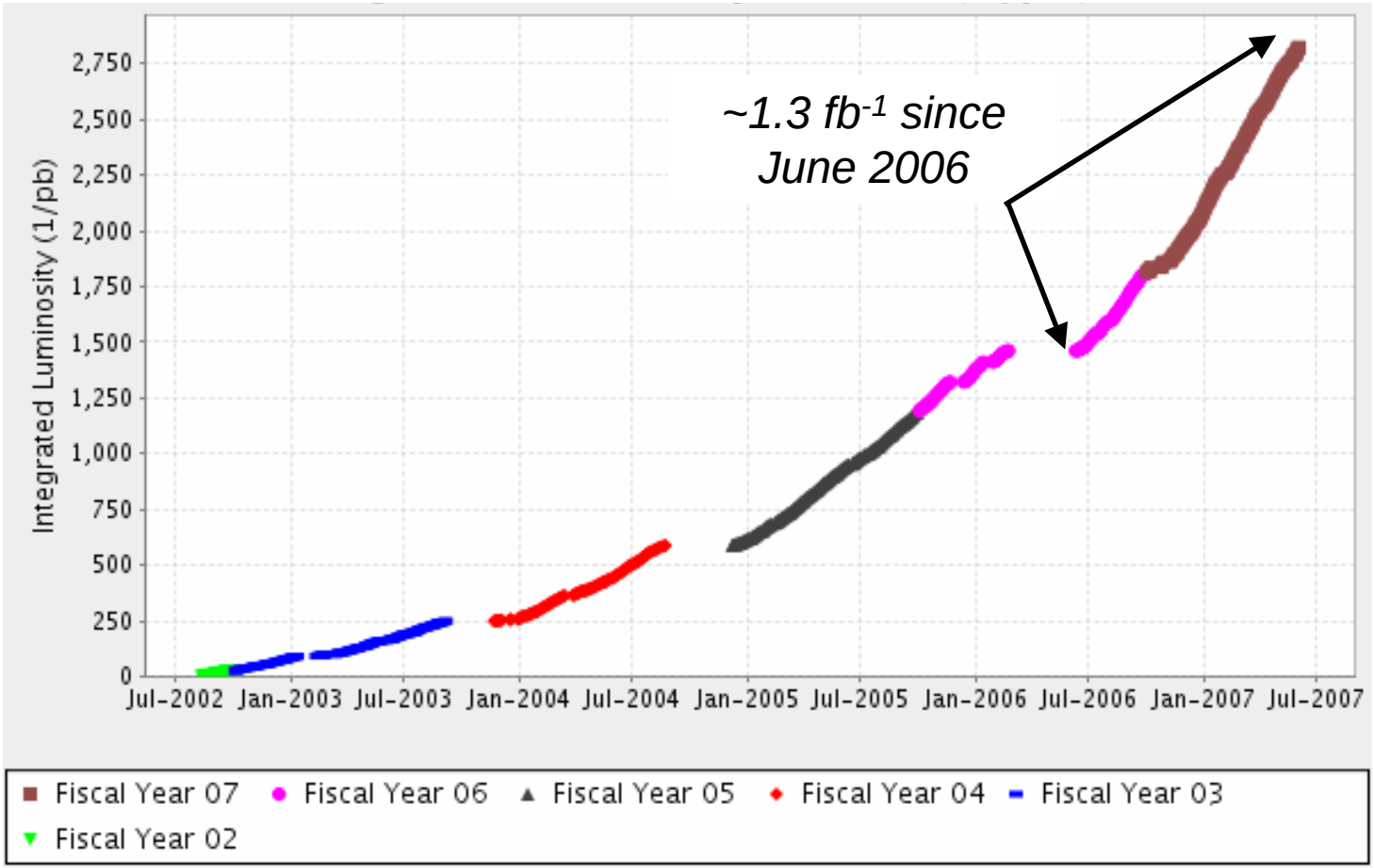
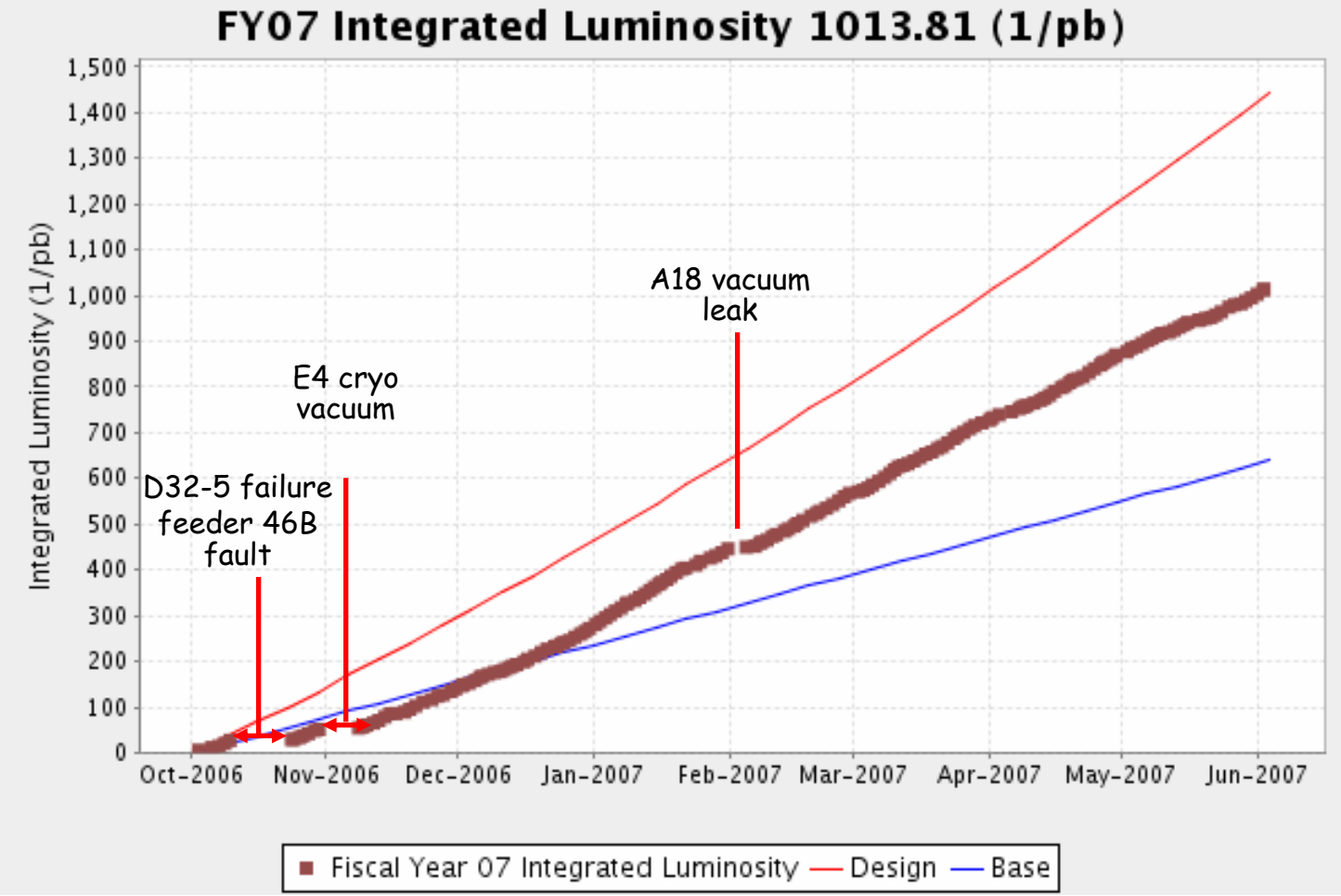
Run II Operations Goals

- Strategy
  - Run CDF and D0 through FY2009
    - Antiproton production is key factor for increasing luminosity
  - Run MINOS (and perhaps MiniBoone/successors) through/beyond the end of the decade
  - Operate 120 GeV slow spill beam in parallel
  - Utilize freed accelerator assets to support the post Run II neutrino program
    - NOvA, SNuMI, …
- Goals (through FY2009)
  - Run II: 8 fb^{-1} (Design goal)
  - Neutrino Program: Complete Proton Plan @ 320 kW
    - NuMI: ~3E20 protons on target/year in FY2009
    - MiniBoone: 1-2E20 protons on target/year
  - NOvA: Prepare for accelerator complex conversion to 700 kW

History of Run II (through 6/2/07)



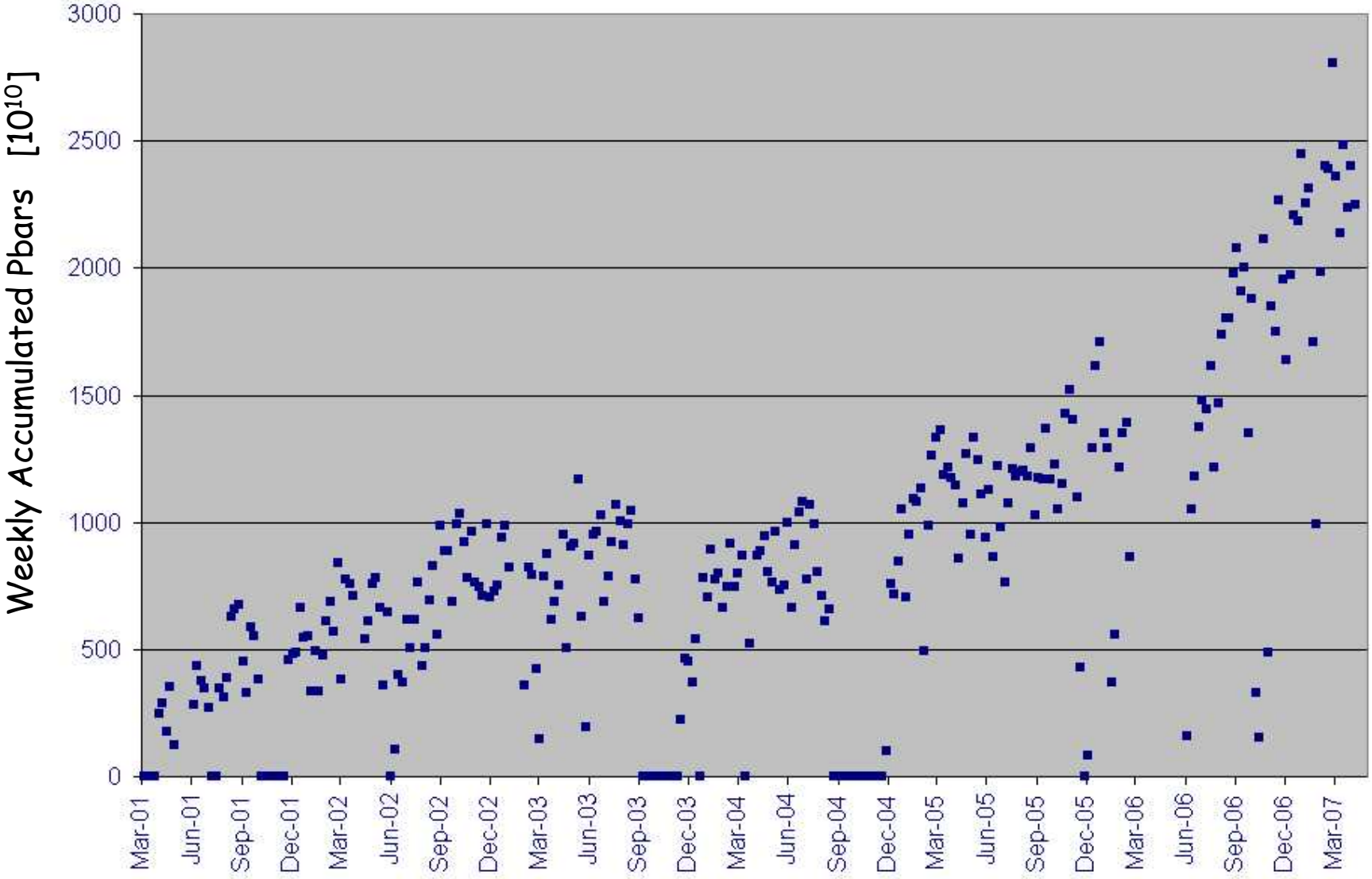
FY07 Performance (through 6/2/07)



Comparison from Spring 2006

- Best initial luminosity up 62%: 180 → $292 \times 10^{30} cm^{-2} sec^{-1}$
- Best weekly integrated luminosity up 75%: 25 pb^{-1} → 45 pb^{-1}
- Best monthly integrated luminosity up 95%: 85 pb^{-1} → 167 pb^{-1}
- Best antiproton stacking up 15%: 20.1 → 23.1×10^{10}/hr
- Typical weekly accumulated antiprotons up 60%: 1500 → 2400×10^{10}/week

Weekly Antiproton Accumulation

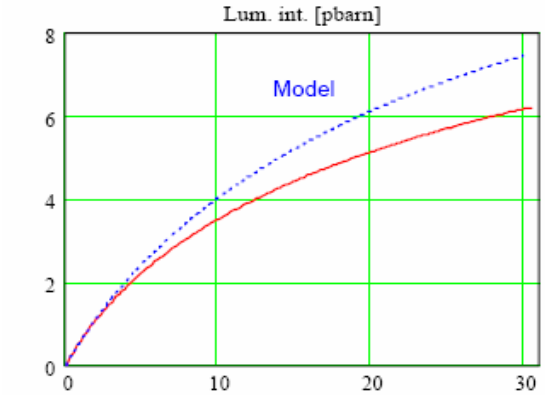


Tevatron Improvements

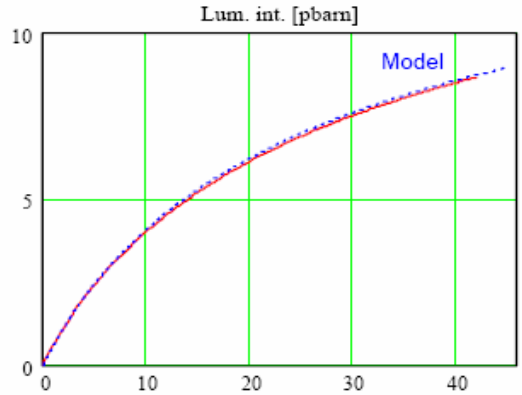
- Reliability
  - Replaced suspect component on all (1200) Kautzky valves during the 2006 shutdown (caused 2 dipole failures in FY06)
  - Modified quench protection system to decrease response time
  - Cog antiprotons out of abort gap for acceleration – prevent needless quenches
  - Completed planned buildup of 2 year inventory of linac spare 7835 tubes
- More antiprotons with smaller emittances in collision
  - New Recycler tune working point
  - Reduced stacking interruption for Accumulator to Recycler transfers
  - Increased lithium lens gradient
  - Improved AP2-Debuncher aperture
  - Improved understanding of the stochastic cooling systems

Tevatron Improvements

- More protons in collision
  - Improved proton source performance (~10%)
  - Better lifetime @ 150 GeV: new helical orbit, reduced beam-beam
- Improved luminosity lifetime
  - Additional separators increase separation (20% at first parasitic crossings) = reduced beam-beam effects
- Improved Tevatron model



Before shutdown (Jan. 6, 06)



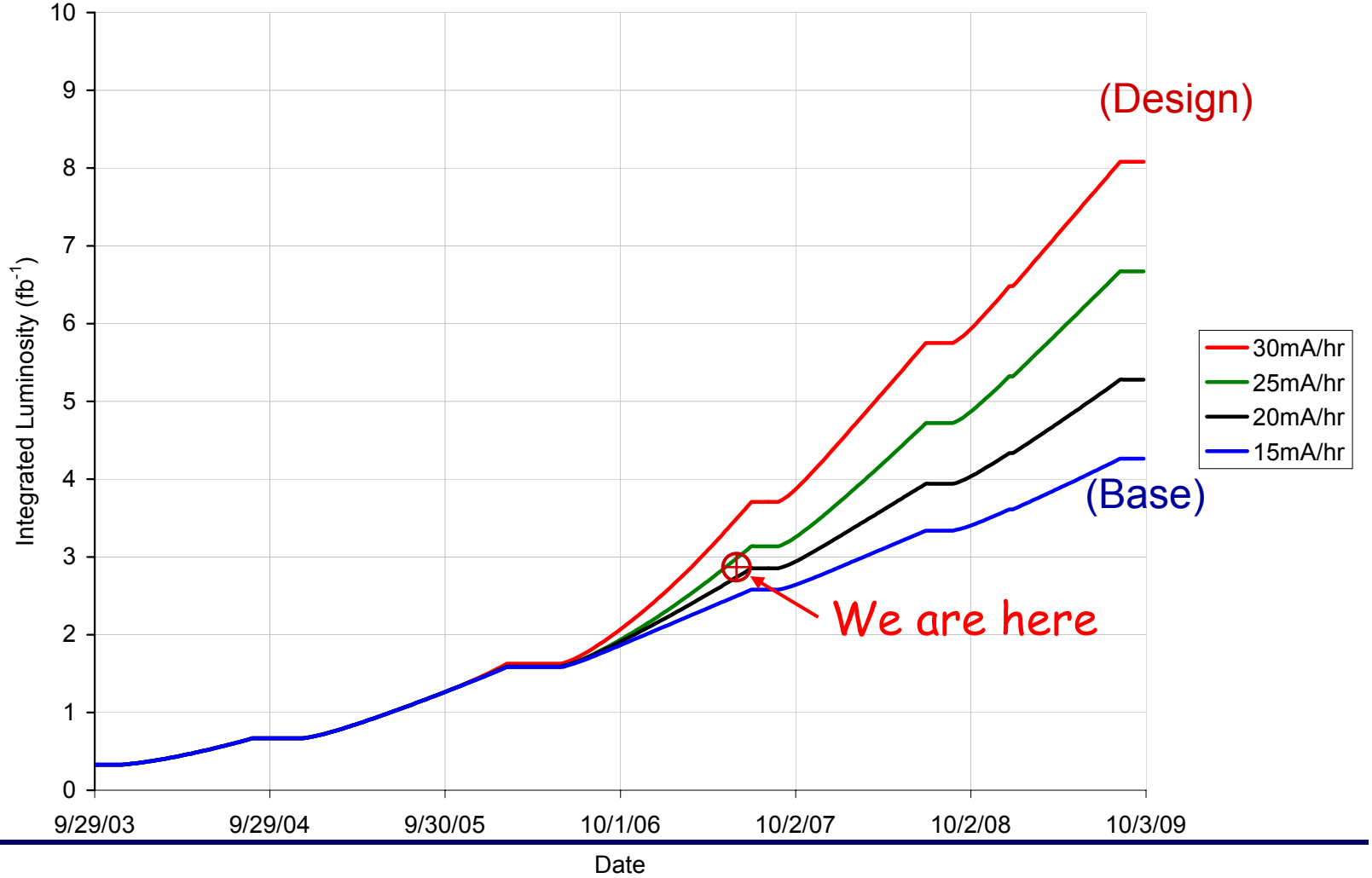
After shutdown (July. 27, 06)

Next Steps

- Antiproton stacking rate is the key
  - Increase stacktail bandwidth
  - Modify stacktail gain slope
  - New Accumulator lattice

  All in process
- Slowly increase stash size in the Recycler
  - 300E10 is typical, have operated stably above 400E10
- Use TELs (electron lenses) for beam-beam compensation
  - Control tunes of individual (proton) bunches to improve lifetime
- 2nd order chromaticity correction in Tevatron in process
  - Simulations show improved lifetimes during HEP
- Optimize peak vs integrated luminosity with experiments
  - As exceed $300 \times 10^{30} cm^{-2} sec^{-1}$
- Maintain reliability in all machines

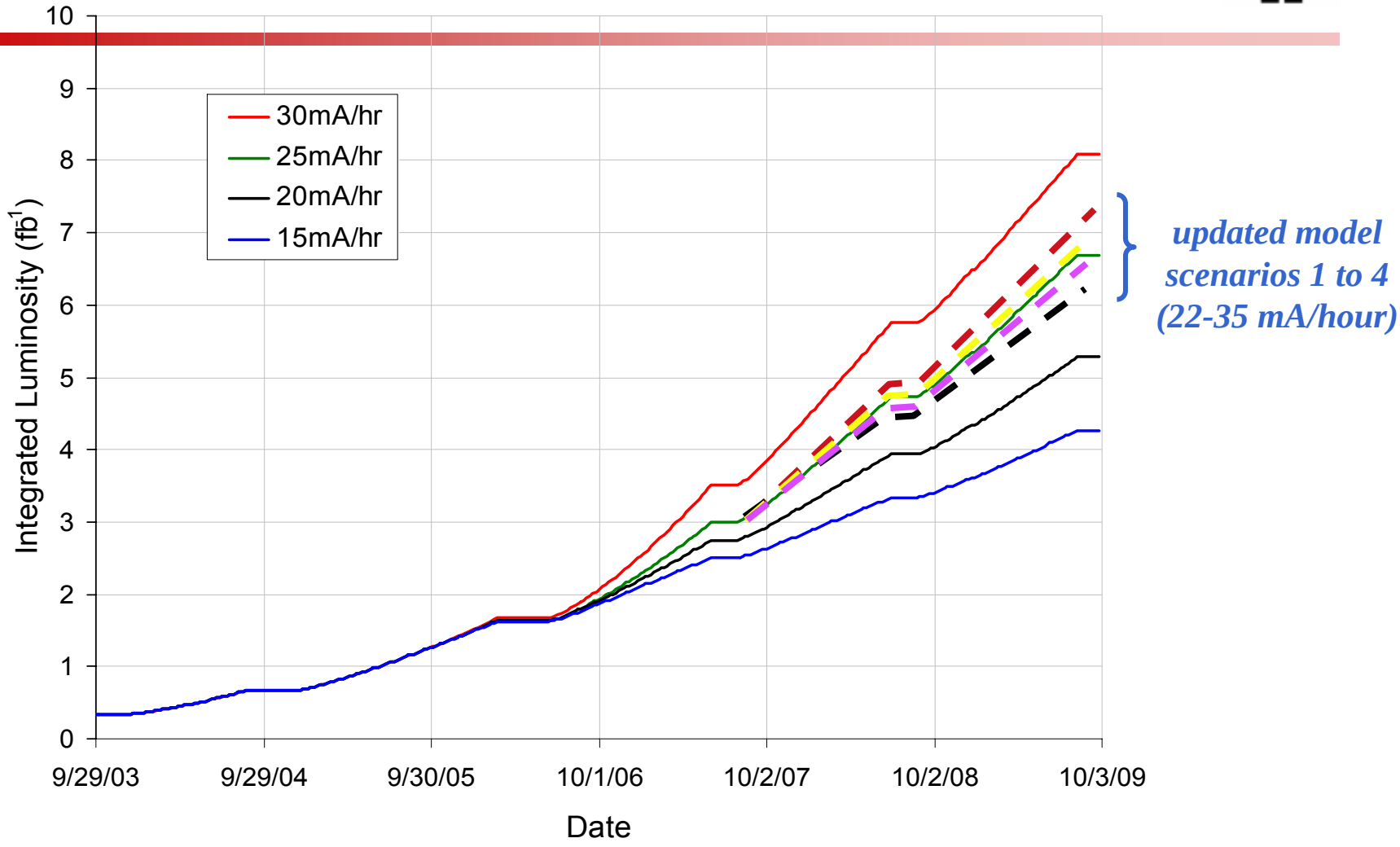
Luminosity Projections
(from spring 2006)



Luminosity Projections

- Updated model based on current conditions and using various operational scenarios
  - Pbar stacking rate, store lengths, lifetimes, transfer efficiencies, etc
  - Vetted by reproducing FY2006 numbers
  - 44 weeks of operation planned in both FY08 and FY09
- Expected range of delivered luminosity through FY2009:
  - 6.3-7.3 fb^{-1}
  - For initial stacking rate of 22-35 mA/hour
- To go beyond this will require
  - Stacking rates beyond 35 mA/hour; and/or
  - Significant (>50%) increase in luminosity lifetime

Luminosity Projections with Updated Model Scenarios



Summary

- Run II luminosity has made dramatic progress over the past year
  - Tevatron in FY07 will likely deliver twice the luminosity as in FY06
  - Performance is still improving
  - Antiproton stacking rate has improved and work continues on further improvements
- Most likely outcome for delivered luminosity through FY09 is:
  - 6.3 – 7.3 fb^{-1}
  - Higher numbers will require a breakthrough in stacking rate and/or luminosity lifetime