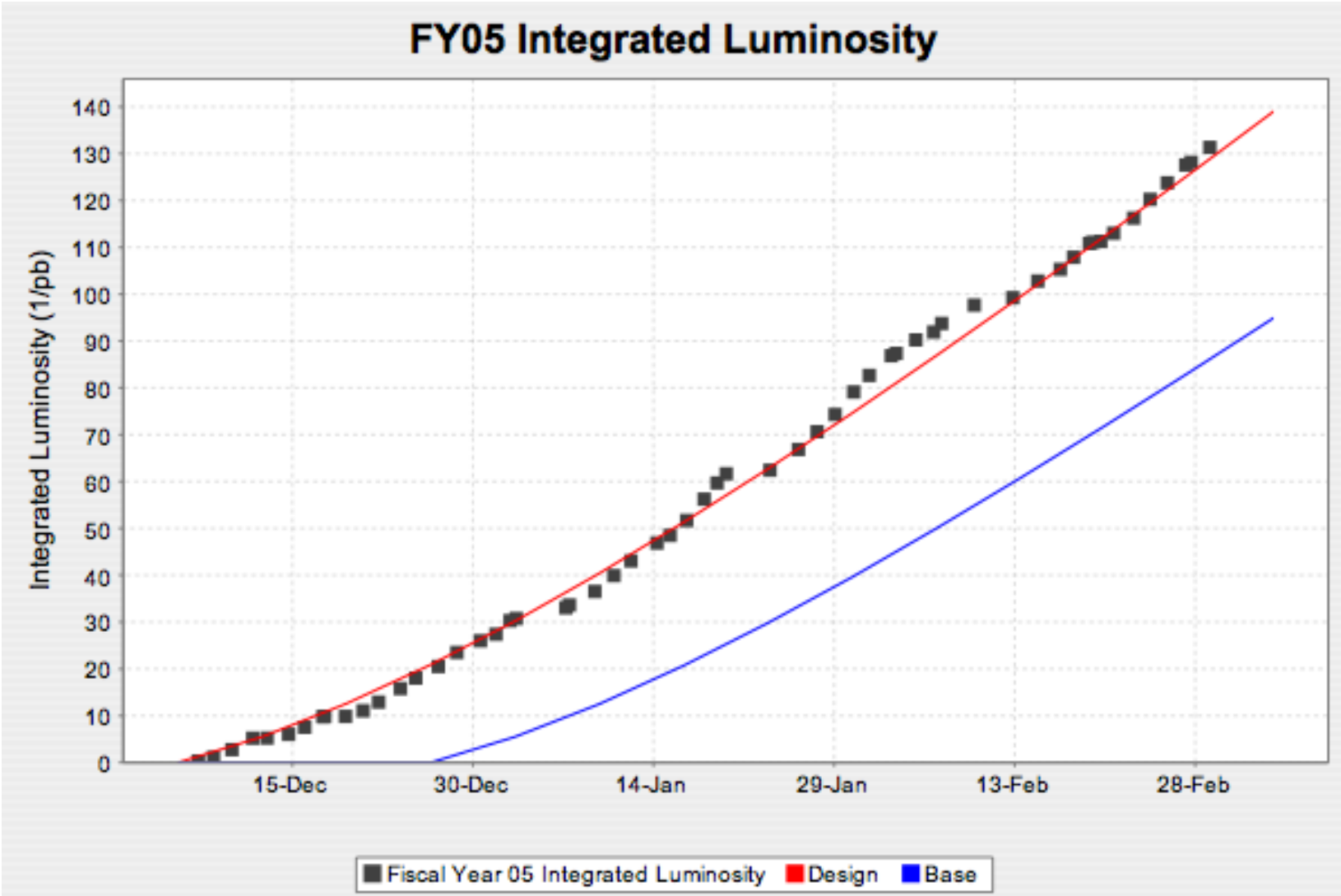
Run 2 PMG

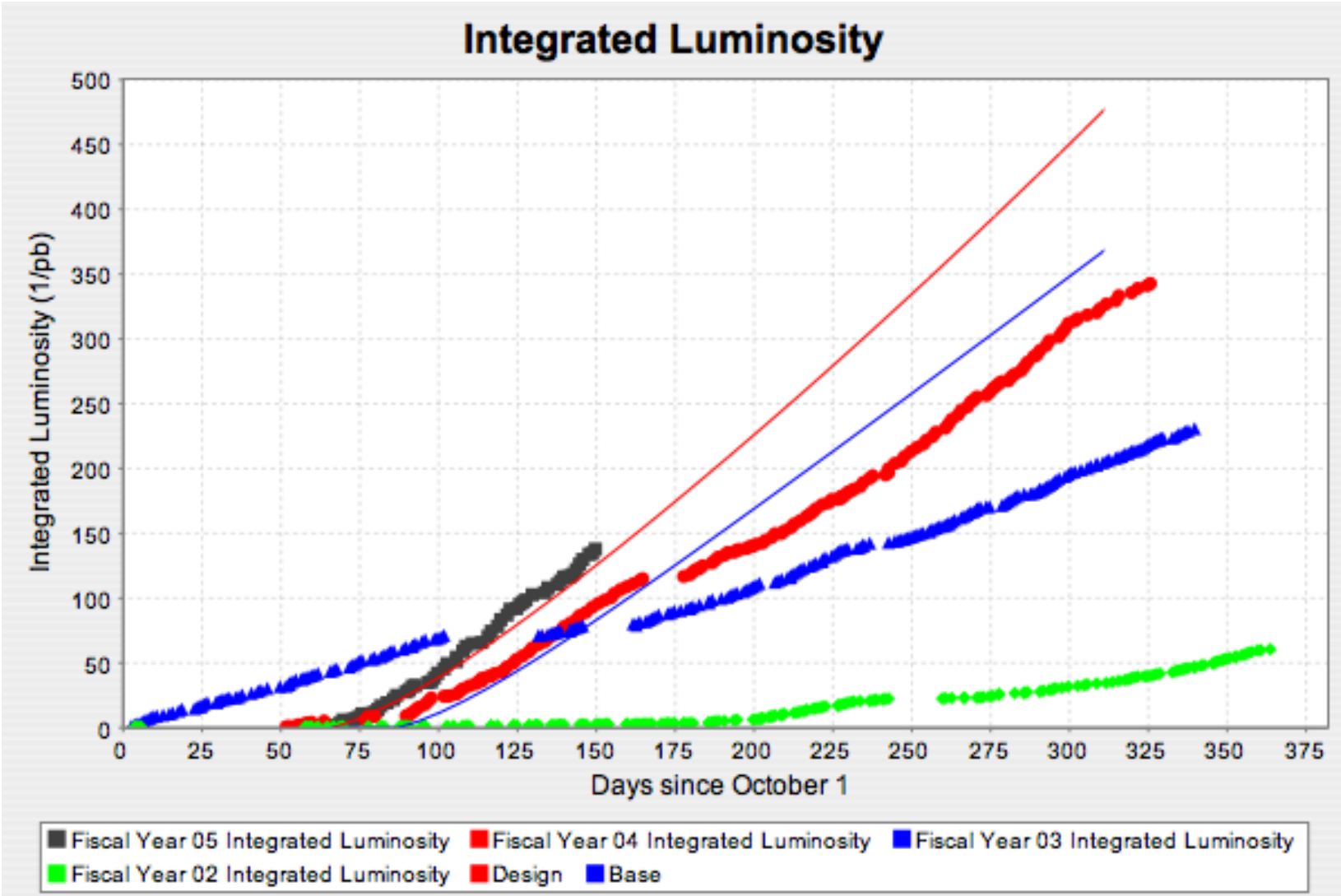
Dave McGinnis

March 3, 2005

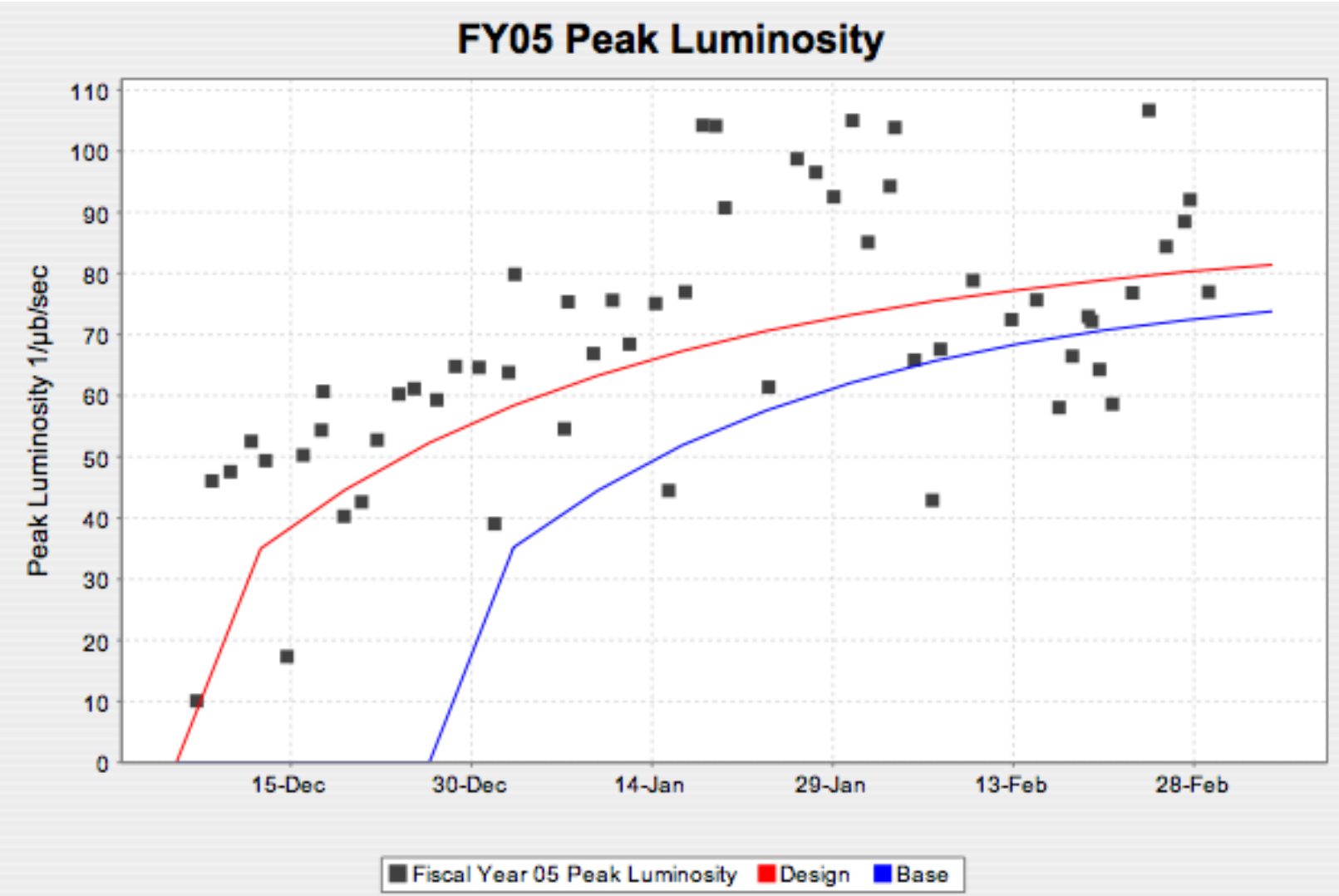
FY05 Integrated Luminosity



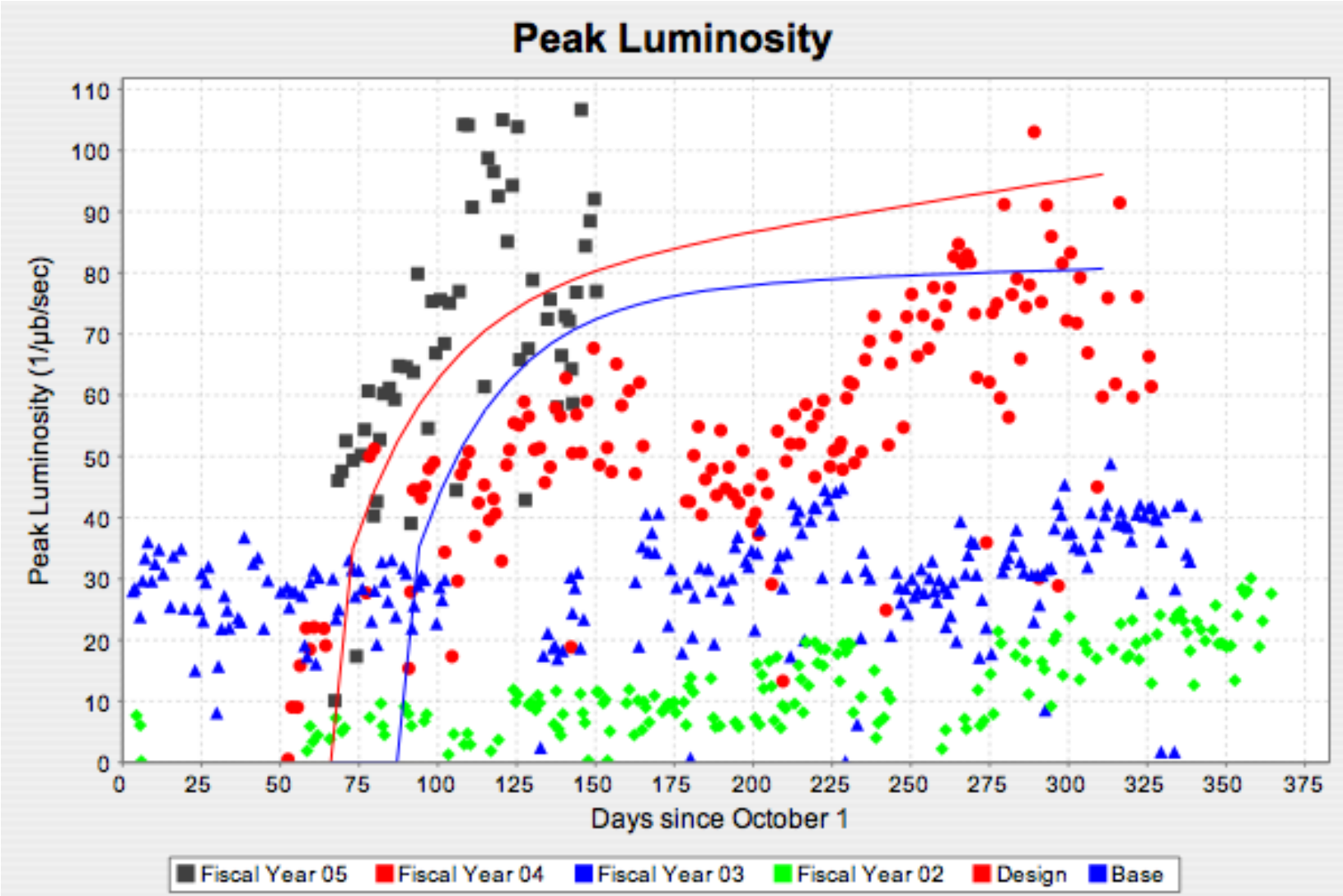
Integrated Luminosity



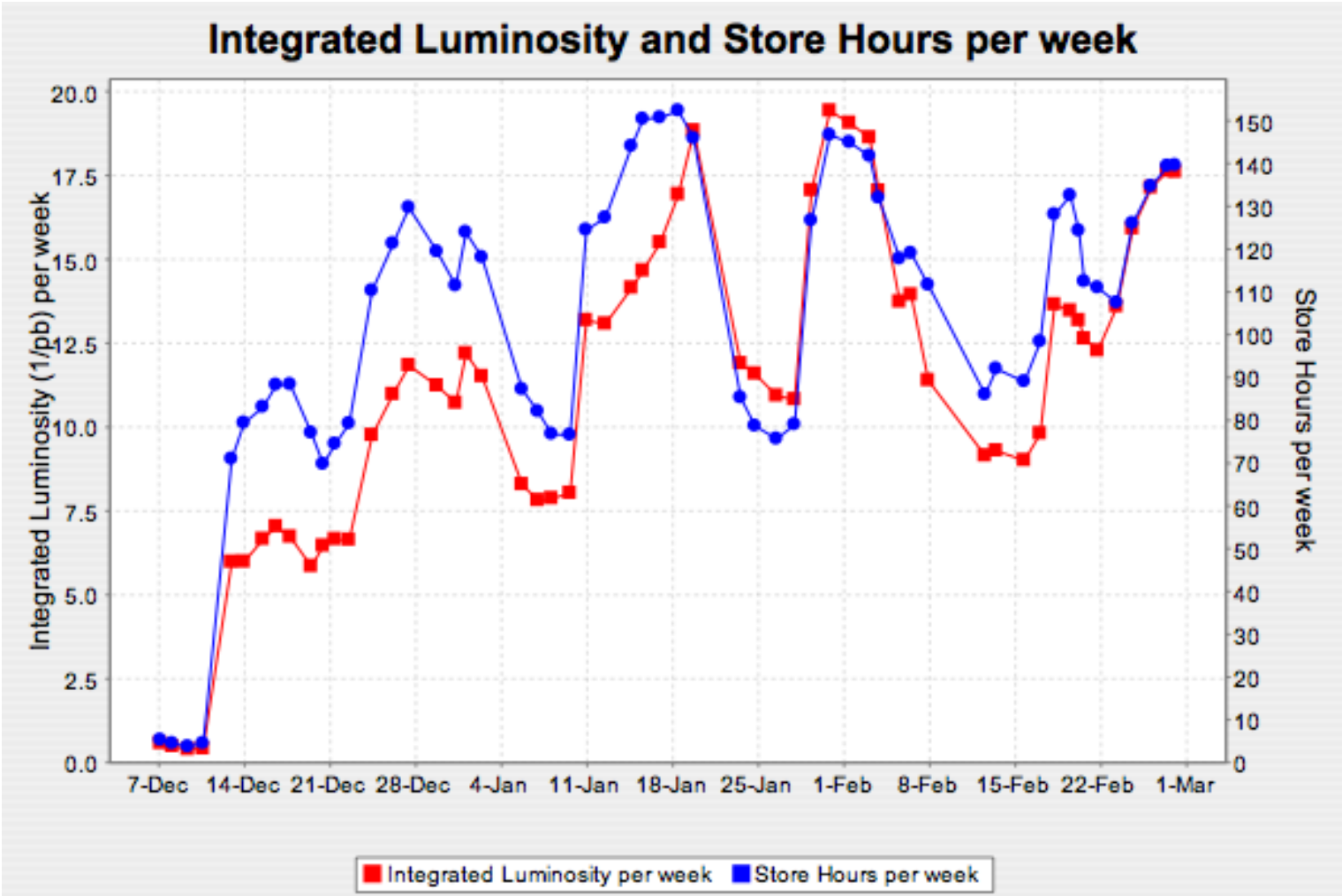
FY05 Peak Luminosity



FY05 Goals Peak Luminosity

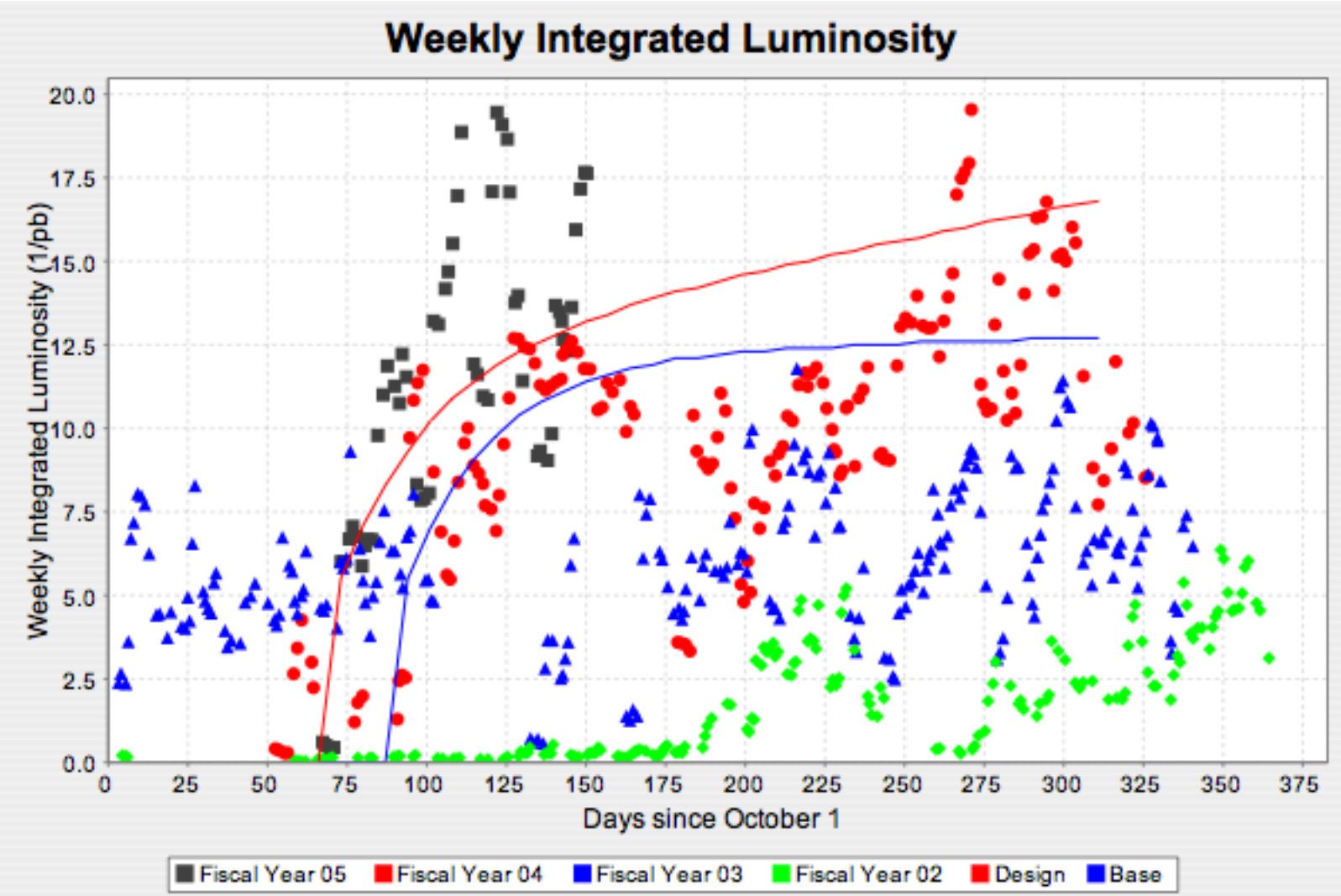


Integrated Luminosity and Store Hours per Week



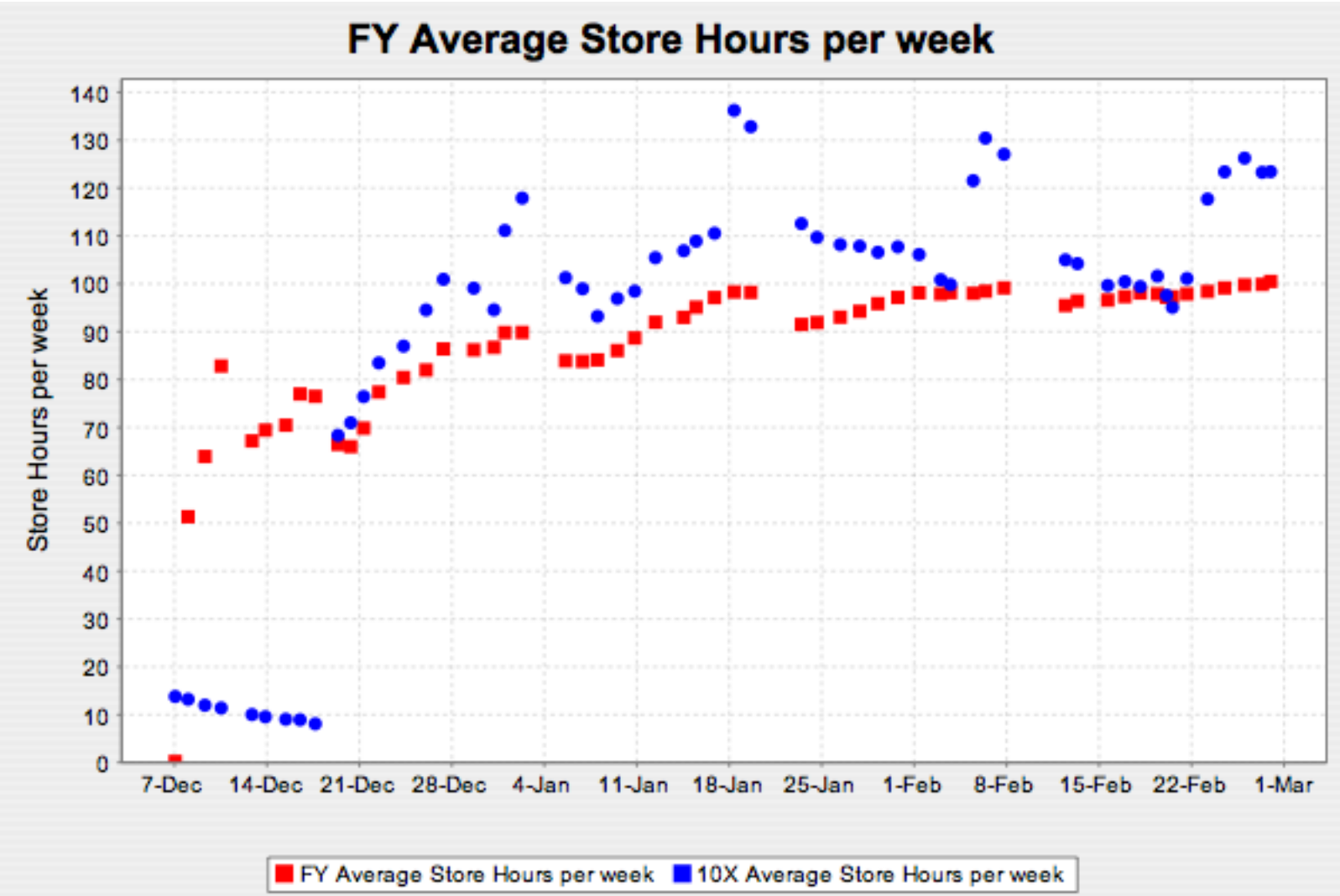
5 Store Running Average

FY05 Goals Weekly Integrated Luminosity

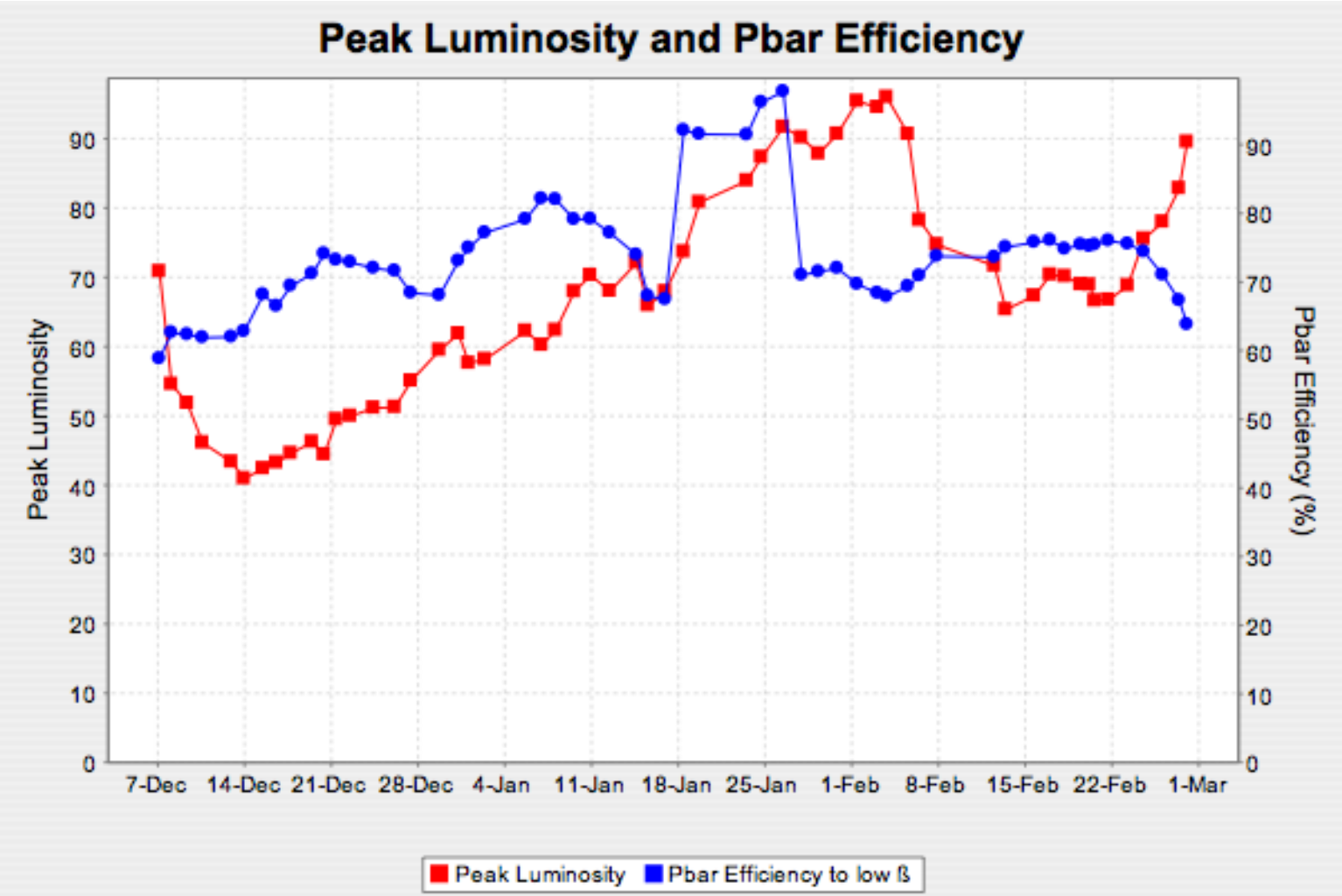


5 Store Running Average

FY05 Average Store Hours per Week



Peak Luminosity and Pbar Efficiency

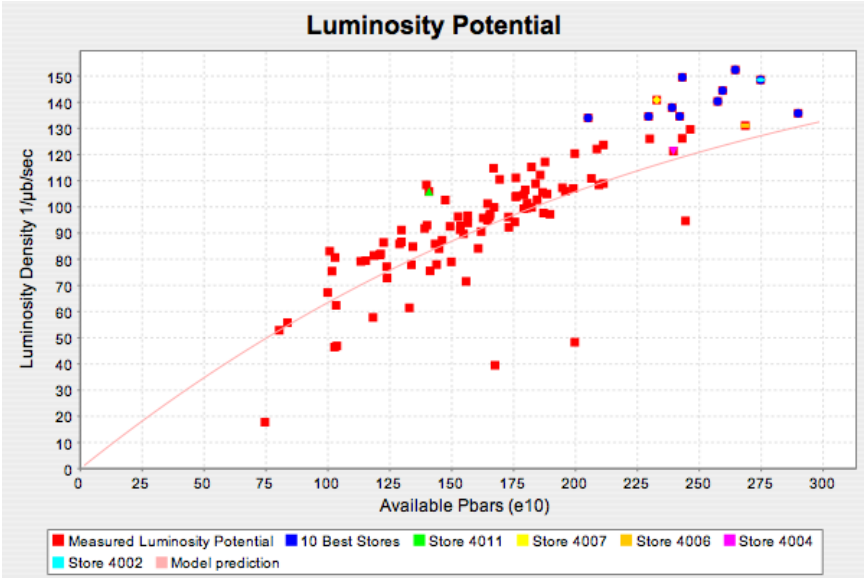


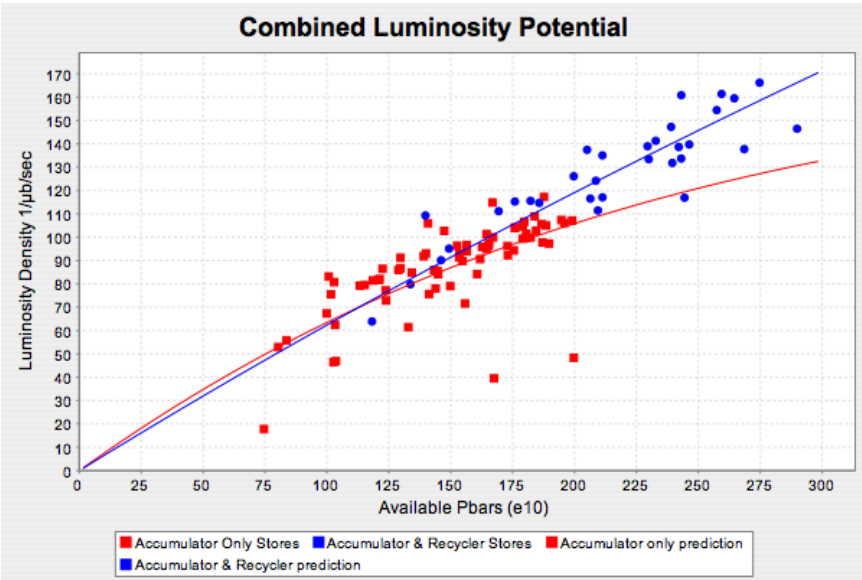
5 Store Running Average

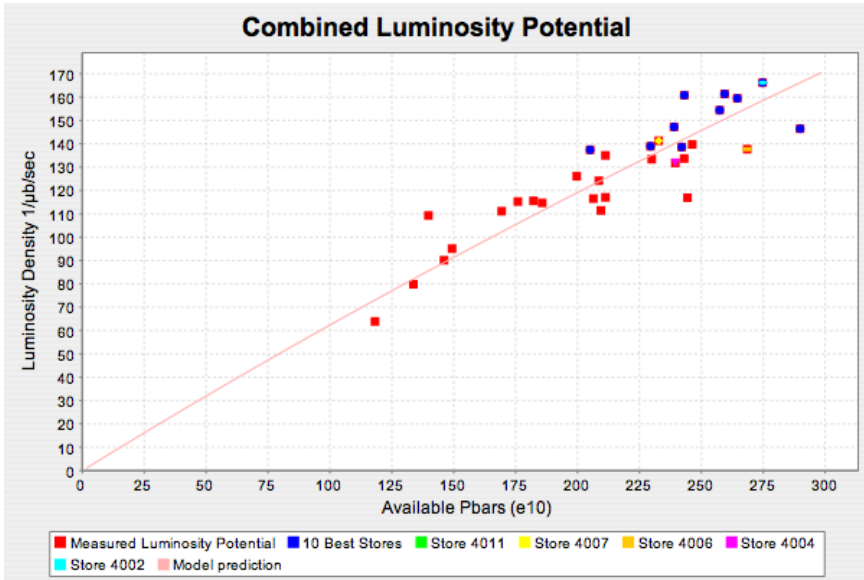
Data Summary Table

		Luminosity Parameters							
Parameter	Last Store	Best Store	Last 10 Stores (Ave)	Best 10 Stores (Ave)	FY Average	Previous FY	FY End Goal (Design)	FY End Goal (Base)	
Initial Luminosity (Average)	76.8	106.5	78.1	100.7	68.3	71.1	96.1	80.7	$x10^{30}cm^{-2}sec^{-1}$
Integrated Luminosity per Store (Avera	3174.1	4008.9	2345.4	3766.9	2339.3	2660	3369	3190	nb^{-1}
Luminosity per week (Averaged)	-	-	14.8	-	11	11.8	16.8	12.7	pb^{-1}
Store Length	29.5	25.1	19.5	27.3	21.5	24.5	20	25	Hours
Store Hours per week	-	-	123.2	-	101.4	108.3	100	100	Hours
Shot Setup Time	2.6	2	2.6	2.7	3	2.6	2.6	2.6	Hours
		TEVATRON Parameters							
Parameter	Last Store	Best Store	Last 10 Stores (Ave)	Best 10 Stores (Ave)	FY Average	Previous FY	FY End Goal (Design)	FY End Goal (Base)	
Protons per bunch	240.7	234.2	226.5	232.9	218.1	247.3	260	260	$x10^{9}$
Antiprotons per bunch	27.8	41.8	32.3	40.9	29.5	30.1	42	34	$x10^{9}$
Proton Efficiency to Low Beta	65.2	61.9	62.1	66.3	62	72.7	-	-	%
Pbar Transfer efficiency to Low Beta	77.4	65.8	69.9	54.8	73.7	88.6	76	74	%
HourGlass Factor	0.68	0.64	0.67	0.66	0.67	0.68	0.65	0.65	
Initial Luminosity Lifetime	0	0	0	0	0	0	0	0	hours
Asymptotic Luminosity Lifetime	0	0	0	0	0	0	0	0	hours
Effective Emittance	14.6	14.5	15.5	15.5	15.9	18.1	18.5	17	π-mm-mrad
		Antiproton Parameters							
Parameter	Last Store	Best Store	Last 10 Stores (Ave)	Best 10 Stores (Ave)	FY Average	Previous FY	FY End Goal (Design)	FY End Goal (Base)	
Zero Stack Stack Rate	13.3	14.4	13.4	13.5	12.1	12.2	24.5	14	$x10^{10}$/hour
Normalized Zero Stack Stack Rate	2.5	2.4	2.3	2.4	2.2	2.3	3.1	2.3	$x10^{-2}$/hour
Average Stacking Rate	9.3	6.4	9	6.7	7	6.2	10.1	6.6	$x10^{10}$/hour
Stacking Time Line Factor	95.8	65.7	89.6	73.7	77.7	76.6	75	75	%
Stack Size at Zero Stack Rate	331.8	339.7	405.8	336.8	388.3	332.6	300	300	$x10^{10}$
Protons on Target	5.5	6.1	5.8	5.6	5.5	5.2	8	6.2	$x10^{12}$
Start Stack	141.1	275	191.1	250.8	170.3	170.7	216	181	$x10^{10}$
End Stack	12.2	46.7	21.9	32	16.4	15.8	15	15	$x10^{10}$
Unstacked Pbars	128.9	228.3	169.2	218.8	153.9	154.9	201	166	$x10^{10}$

Stack Size Potential







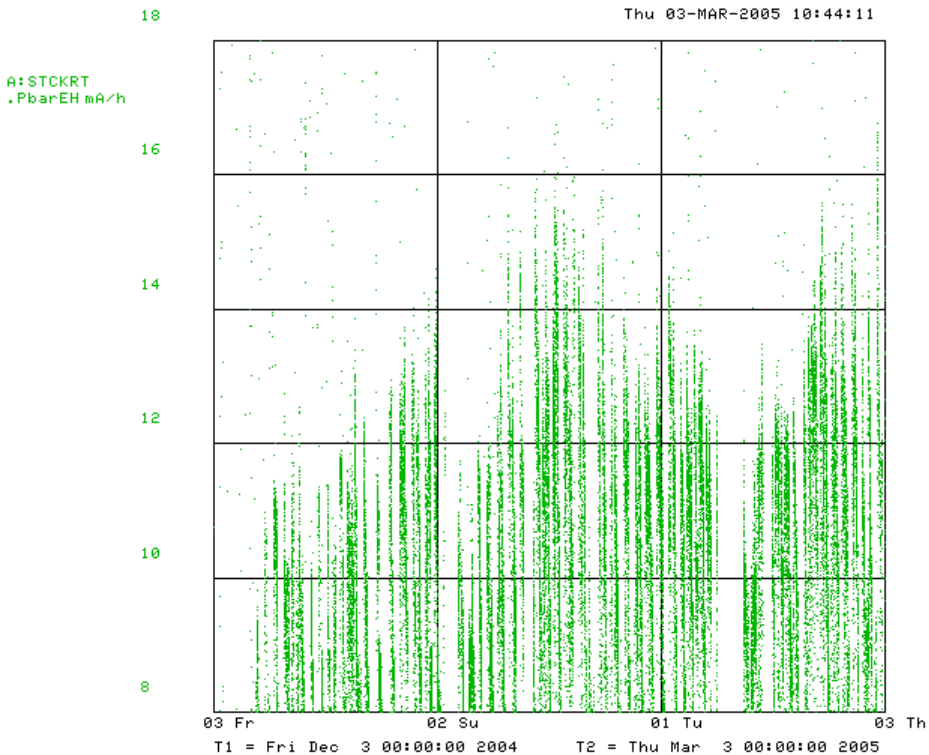
Tev Studies

Date	Duration (Hr)	Description
1/20/2005	2.2	Lattice measurements
1/21/2005	7.5	Octupole/stability
1/23/2005	2.3	Wet squeezes to verify tunes and orbit through squeeze
1/26/2005	1.3	Orbit smooth and tune adjustment through squeeze
2/3/2005	2.3	Octupole studies (differential chromaticity)
2/3/2005	2.6	Lattice measurements
2/4/2005	5.8	Octupole studies (stability)
2/5/2005	5.6	Beam check-out following quench plus octupole measurements
2/7/2005	0.3	Longitudinal damper check
2/7/2005	1.0	Chromaticity measurements
2/7/2005	2.0	Lattice measurements
2/12/2005	2.0	Wet squeeze to verify orbits etc.
2/13/2005	2.5	Tune tracker
2/15/2005	1.0	Adjust ramps during open helix to reduce tune excursion
2/15/2005	0.3	Time in B3 BPM electronics
2/15/2005	1.0	Octupole, O1/O2 circuits at 150 GeV
2/15/2005	10.0	Octupole, OD/OF circuits at low beta plus quench recovery
2/17/2005	0.0	E11 "thin" flying wires flown
2/19/2005	2.5	Longitudinal damper check-out
2/20/2005	6.0	Longitudinal damper check-out
2/21/2005	3.0	Longitudinal damper check-out
2/23/2005	0.5	End of store, pbar synch light mirror
2/23/2005	0.6	Longitudinal damper beam transfer function measurement
	4.1	Sum for Week
	154.9	Sum for Year
	13.4	Average per week

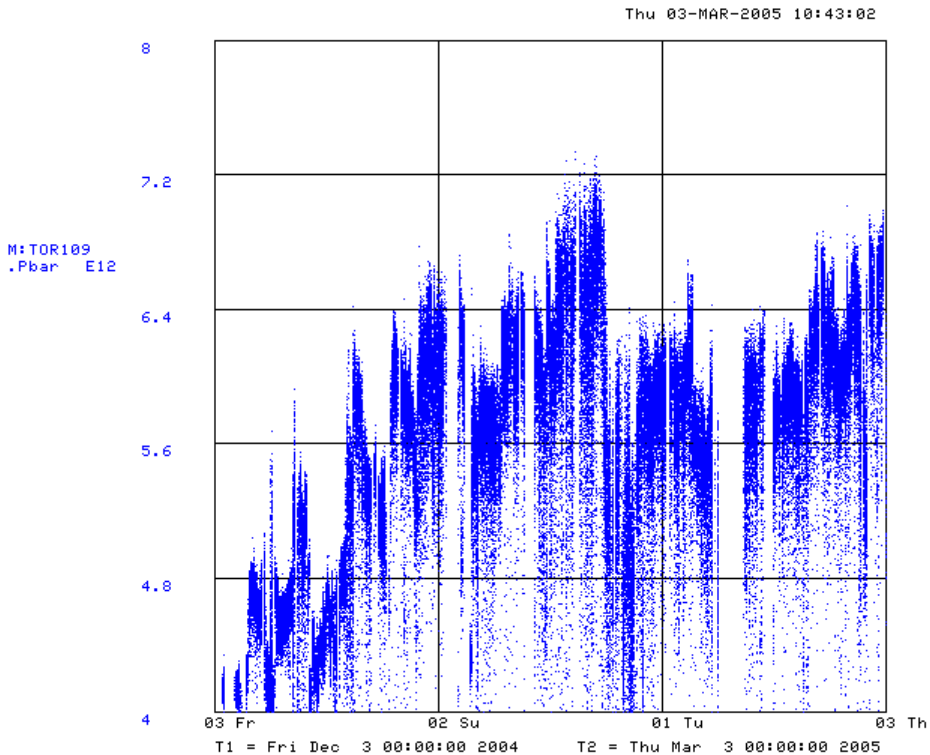
Pbar Studies

Date	Duration (Hr)	Description
1/18/2005	0.8	D:IKIK strength, beam separation
1/27/2005	0.6	AP-2 measurements
1/30/2005	1.8	Debuncher momentum cooling measurements
2/2/2005	0.2	D/A, Accumulator injection
2/4/2005	0.4	D/A, Accumulator injection
2/16/2005	0.5	Unstacking RF study to reduce phase jitter
2/19/2005	0.5	Debuncher cooling adjustments
2/21/2005	0.4	Reverse protons during shot setup to measure Debuncher orbits
2/22/2005	1.0	D/A steering
2/23/2005	0.2	D/A measurements
	1.6	Sum for week
	32.4	Sum for year
	2.8	Average per week

Pbar Stacking



Stack Rate



Beam on Target

New D/A Instrumentation

- Debuncher Beam Bunching Technique (done)
  - Debuncher Intensity measurement – middle of cycle
    - Parasitic – in all the time now
  - D/A Intensity & TBT measurement – end of cycle
    - 50% hit on production – done with one-shots
- Forward Pbar TBT (done)
  - Automatically loads RF curves
  - Code to run local on scope
- Bunched Beam intensity monitors (done)
  - In D/A line
  - In Debuncher
- Forward Pbar BPMs in Debuncher (in progress)
  - Working on position measurment at extraction septum
  - Will convert all BPMs to measure forward pbars using middle of cycle bunching technique
- X-Y plot Software (done)
  - Forward Pbar measurements are noisy
  - Developed ACNET plotting package that shows mean and std. dev. in real time
- Accumulator Injection 3 bump (needs to be commissioned)
- Accumulator Reverse Proton Beam Bunching Technique (needs to be re-commissioned)
- Debuncher Reverse Proton TBT (needs to be re-commissioned)
- DEX BUMP
  - Power supplies under construction

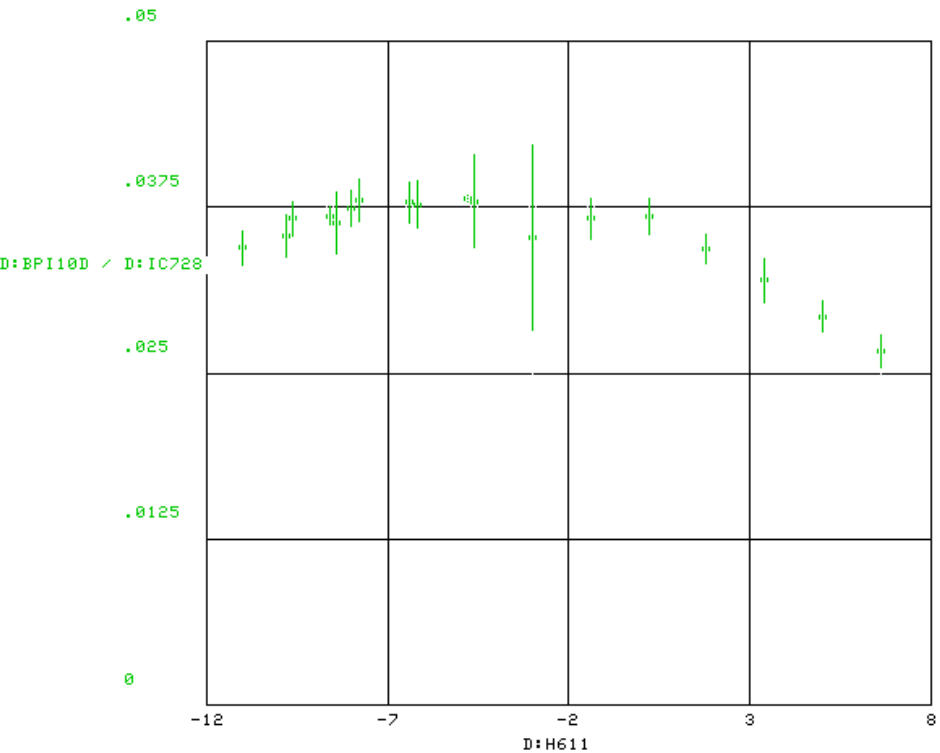
D/A Steering Procedure (without DEX BUMP)

- Forward Pbar turn by turn (completed but needs BPM at Debuncher extraction)
  - Set D:EKIK to max kick
  - Scan Debuncher Extraction 3 bump
    - Maximize Circulating beam and Extracted Beam
  - Scan D:ESEP to minimize quad steering at D:Q803
  - Scan D:HT804 to minimize quad steering at D:Q805 & D:Q806
  - Scan D:H807 to minimize quad steering at D:Q807
  - Adjust A:ISEP and A:IKIK to close in Accumulator
- Reverse Protons
  - Bump Accumulator Injection orbit to Injection Septum wall without sacrificing aperture (7π-mm-mrad)
  - Scan Accumulator injection kicker to find minimum kick needed to pass 7π-mm-mrad beam to D:Q807
  - Adjust Injection septum current to center beam on D:Q807

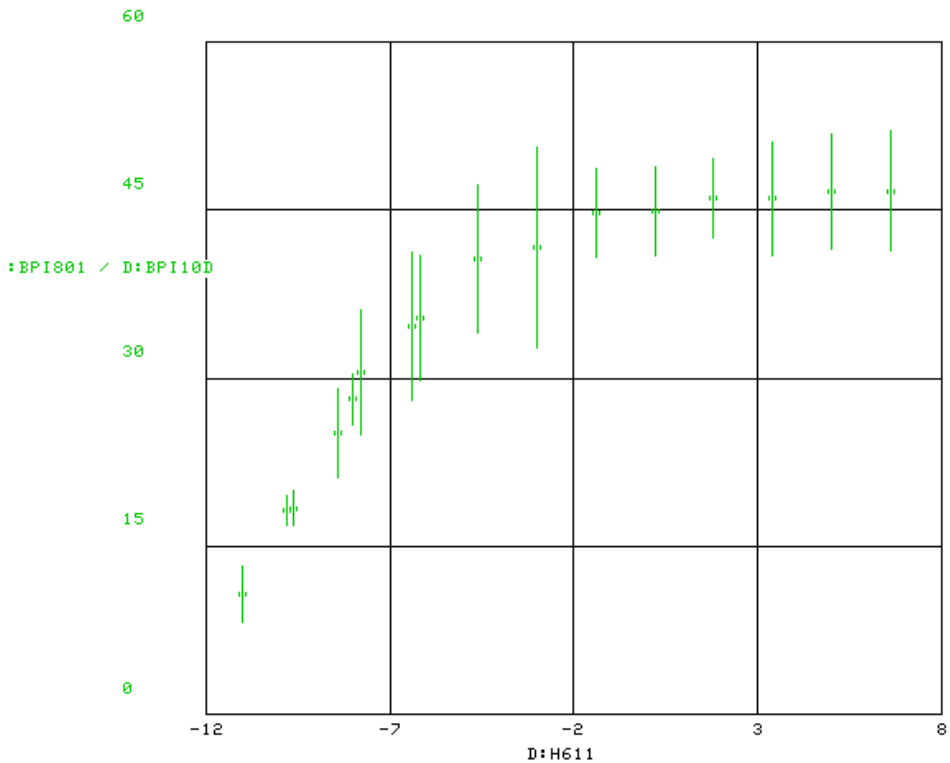
D/A Steering Procedure with Dex Bump

- Reverse Protons
  - Set Debuncher DC Extraction bump to pass 35π-mm-mrad through circulating channel
  - Bump Accumulator Injection orbit to Injection Septum wall without sacrificing aperture (7π-mm-mrad)
  - Scan Accumulator injection kicker to find minimum kick needed to pass 7π-mm-mrad beam to D:Q807
  - Adjust Injection septum current to center beam on D:Q807
- Forward Pbar turn by turn
  - Adjust DEX bump to move cooled beam at extraction to nuzzle up against septum
  - Adjust D:EKIK to maximize beam in extraction channel
  - Scan D:ESEP to minimize quad steering at D:Q803
  - Scan D:HT804 to minimize quad steering at D:Q805 & D:Q806
  - Scan D:H807 to minimize quad steering at D:Q807
  - Adjust A:ISEP and A:IKIK to close in Accumulator

D/A Extraction Septum Channel Scan

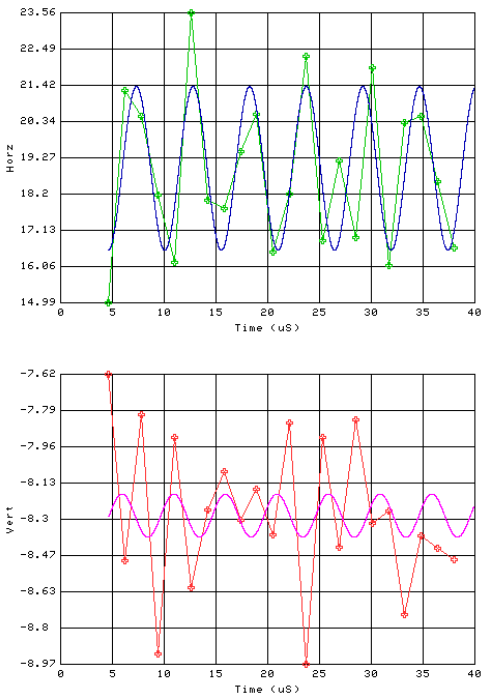


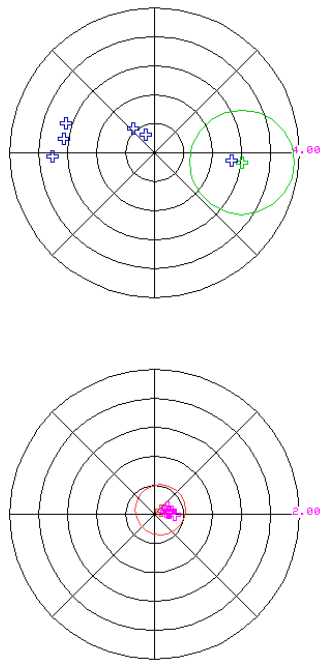
Circulating Channel



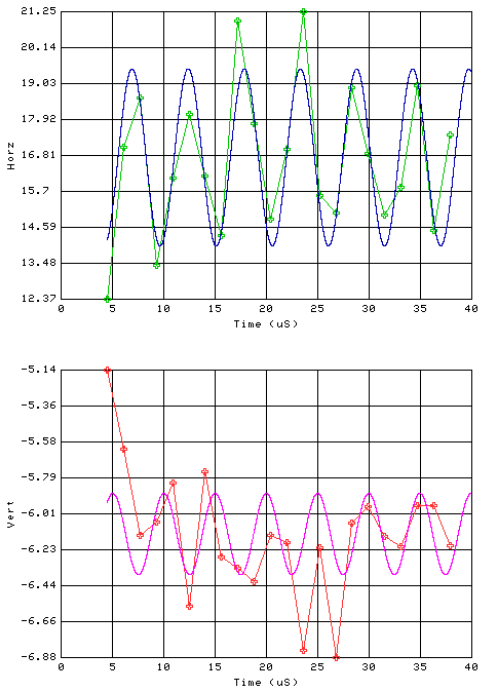
Extraction Channel

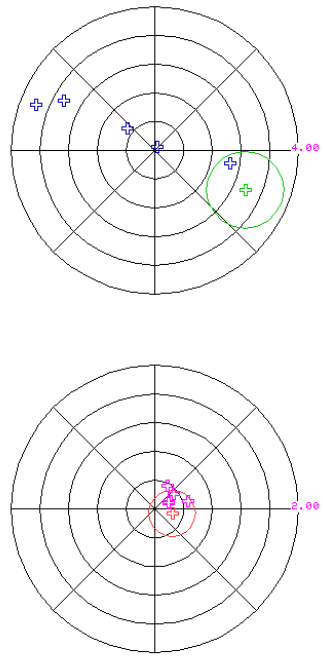
D/A Quad Steering





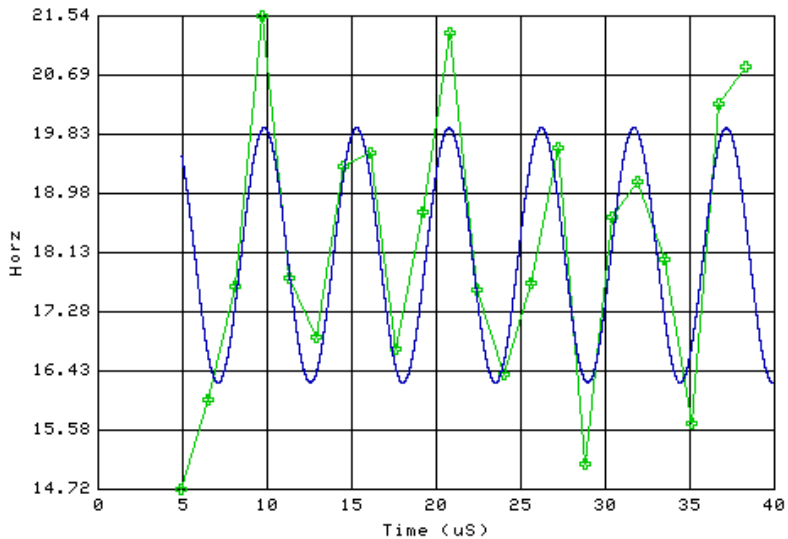
D:ESEP Scan D:QS803 0 A

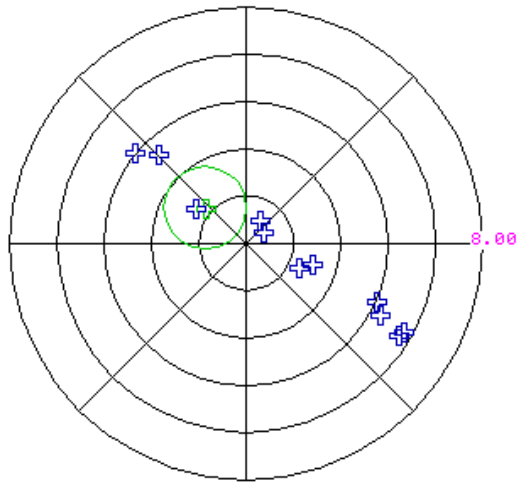


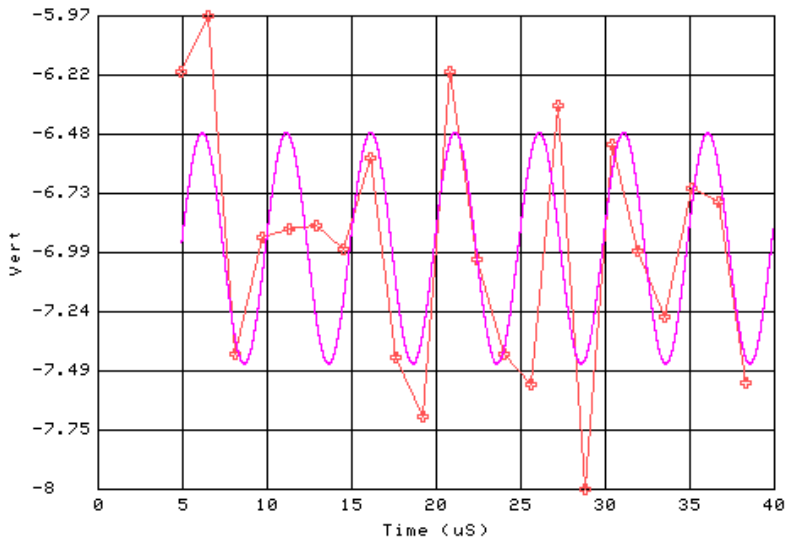


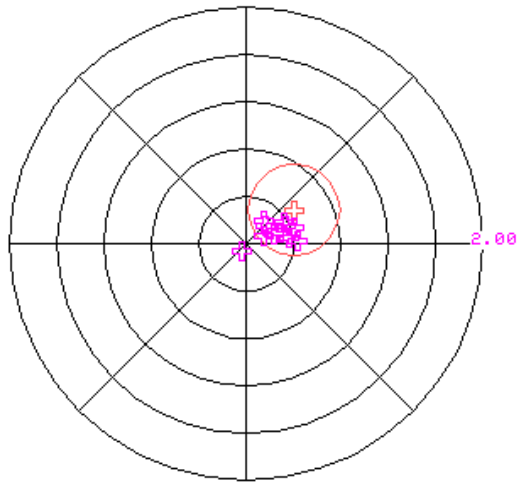
D:ESEP Scan D:QS803 20 A

D:HT804 Scan & D:QS806 Scan









Accumulator Extraction Curves

- Experimental Facts
  - There is significant longitudinal emittance dilution of the core during the extraction process
    - For no dilution, the average value of the h=4 longitudinal emittance should be 0.6 eV-sec
    - We measure an average of about 1.2 eV-sec for Accumulator only shots
  - For large stacks, there is a relatively large error in the amount of beam requested and the amount of beam actually extracted
- Probable Cause
  - There is a high level phase feedback loop around the ARF4 power amplifier and cavity
    - Used to keep phase between drive and fanback constant as a function of power
  - This loop is active as beam is bunched and extracted from the core
    - At low voltages the phase is undefined which results in an erroneous correction signal applied to cavity
    - At large stacks, the bunched beam leaves a wake in the cavity that is 90 degrees out of phase with the drive signal which results in the bucket running away from the beam
- Cure - Turn off phase feedback
  - If we request a large amount of voltage out of the cavity, the power amp phase shifts by over 30 degrees
  - We need to design RF curves that keep the power amp from saturating – in progress

Plan for the Week

- Proton Source
  - Work on slip-stacking beam loss
    - Cogging
    - Bunch rotation at extraction
  - Be reading for NUMI operations by March 7, 2005
    - Cogging
- Main Injector
  - Be reading for NUMI operations by March 7, 2005
    - Slip Stacking and NUMI on the same cycle
      - High intensity slip stacking
      - Low intensity NUMI
    - Follow the natural cycle time of stacking
  - Work on slip-stacking beam loss
- Pbar
  - Implement new pbar extraction curves without high level phase feedback
  - Beam Based Alignment
    - Debuncher 3 bums
    - Forward Pbar AP2
    - Forward Pbar D/A line
  - Optimize Accumulator/Recycler pbar transfers - Clean-up or minimize reverse proton tune-up
- Recycler
  - Optimize Accumulator/Recycler pbar transfers
    - Transfer merging
  - Investigate stochastic cooling limitations
- Tevatron
  - Understand Longitudinal Mode 0 blowups
  - Finish operational implementation of octupoles
    - 150 GeV
      - Evaluation of lifetime improvement at 150 GeV
      - Implemetation of additional circuits
      - Measurement of chromaticity at 150 GeV
    - 980 GeV
  - Store-to-store orbit corrections