Run II luminosity projections Matching FY07 and prospects for FY08 and FY09

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6 September, 2007

Beams-doc-2864

Introduction

❖ 1. The model used is the one described in Beams-doc-2022, 2680.

❖ 2. The model predicts weekly integrated luminosity on the basis of 16 input parameters described in the following page.

❖ 3. The original model was extended to cover a period of three years (FY07-FY09) allowing for a variation of the input parameters every 3 months.

❖ 4. The inputs were selected in most cases by looking at the current performance of the machine.

❖ 5. I am assuming two shutdowns, starting on a) August 6, 2007 and b) August 24, 2008. For both shutdowns I am assuming 10 weeks of no luminosity.

❖ 6. For both shutdowns I am assuming that after the 10 weeks of no luminosity, the first week we deliver no luminosity, the second 60% of the expected integrated luminosity and the third week 90% of the expected integrated luminosity.

Selected Inputs for the model with the goal to compare expected and delivered luminosity in FY07

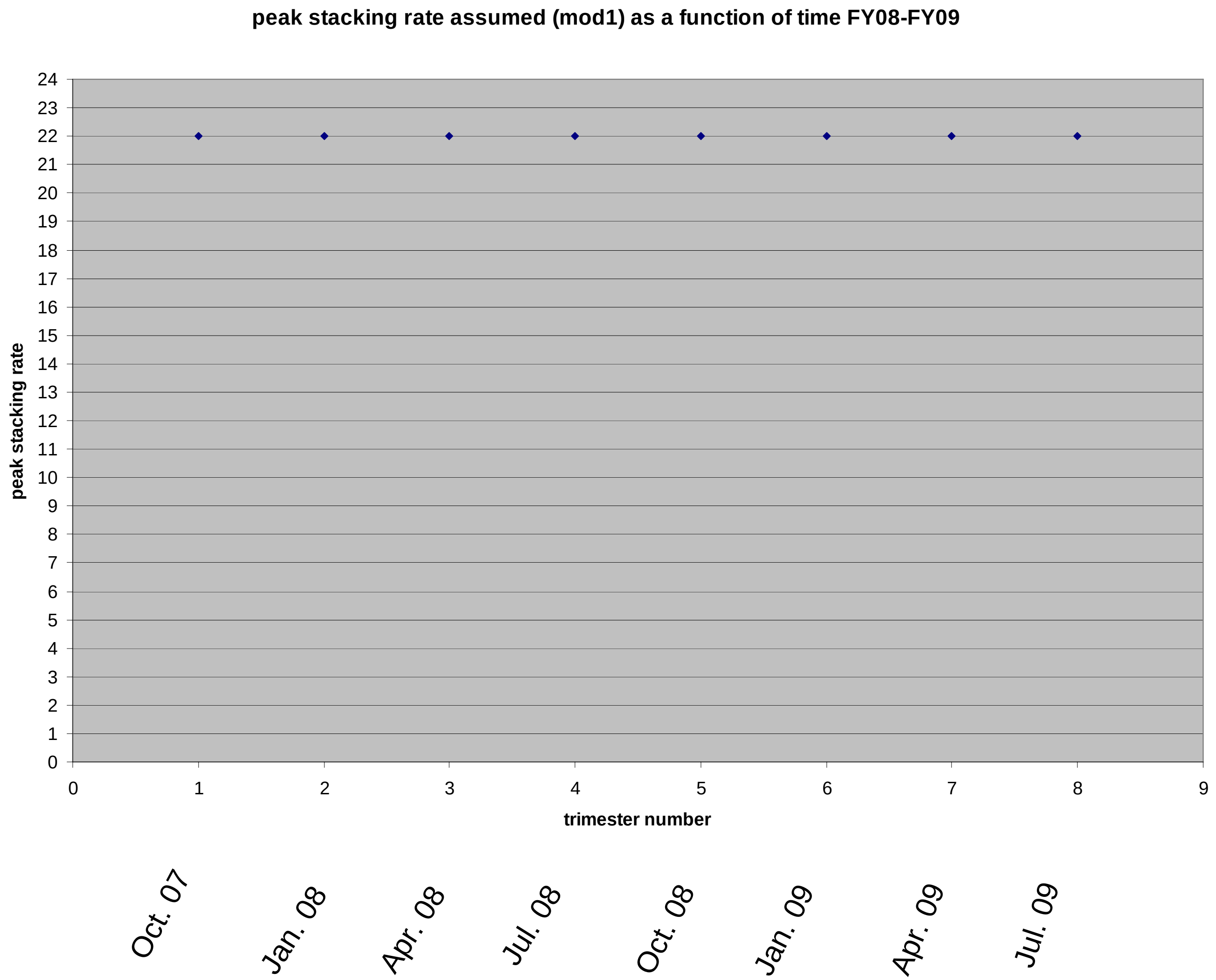
Assuming 20.6 hour long stores and 6 pbar transfer shots between stores

- Number of protons per bunch 256 x 10^9
- Luminosity Density @ 100 x 10^{10} 90.32 μb^{-1} / sec
- Luminosity Density @ 300 x 10^{10} 190.34 μb^{-1} / sec
- Init Tevatron Lifetime @ 80 μb^{-1}/sec 7.07 hours
- Init Tevatron Lifetime @ 160 μb^{-1}/sec 6.59 hours
- HEP store hours per week 109.94 hours
- Acc-Rec Transfer Efficiency @ 0x10^{10} 87.4%
- Acc-Rec Transfer Efficiency @ 300x10^{10} 87%
- Acc-Rec transfer time (0.395, 0.268, 0.206, 0.195) hours
- Recycler lifetime 500 hours
- Recycler mining efficiency 93.8%
- Peak stack rate (18, 21, 21, 22) x10^{10}/hour
- Half rate stack size 200x10^{10}
- Maximum stack size 400x10^{10}
- Timeline Utililization Factor (73, 74, 74, 74) %
- Accumulator leftover factor (11, 10, 10, 10)%

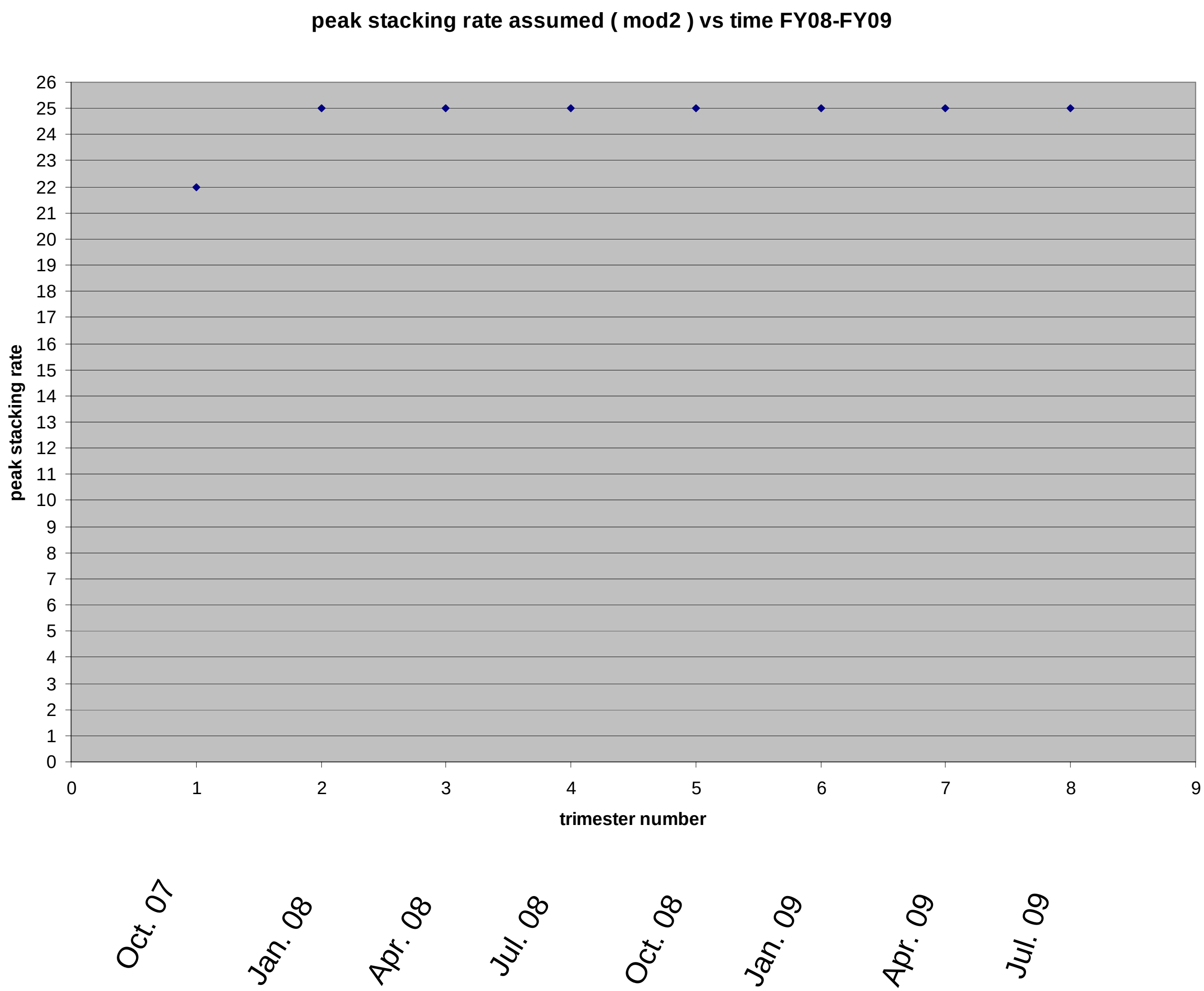
With the above inputs we should have expected for FY07 a total of ~1363 pb^{-1} for 20.6 h long stores

This is to be compared with 1311 pb^{-1} delivered in FY07

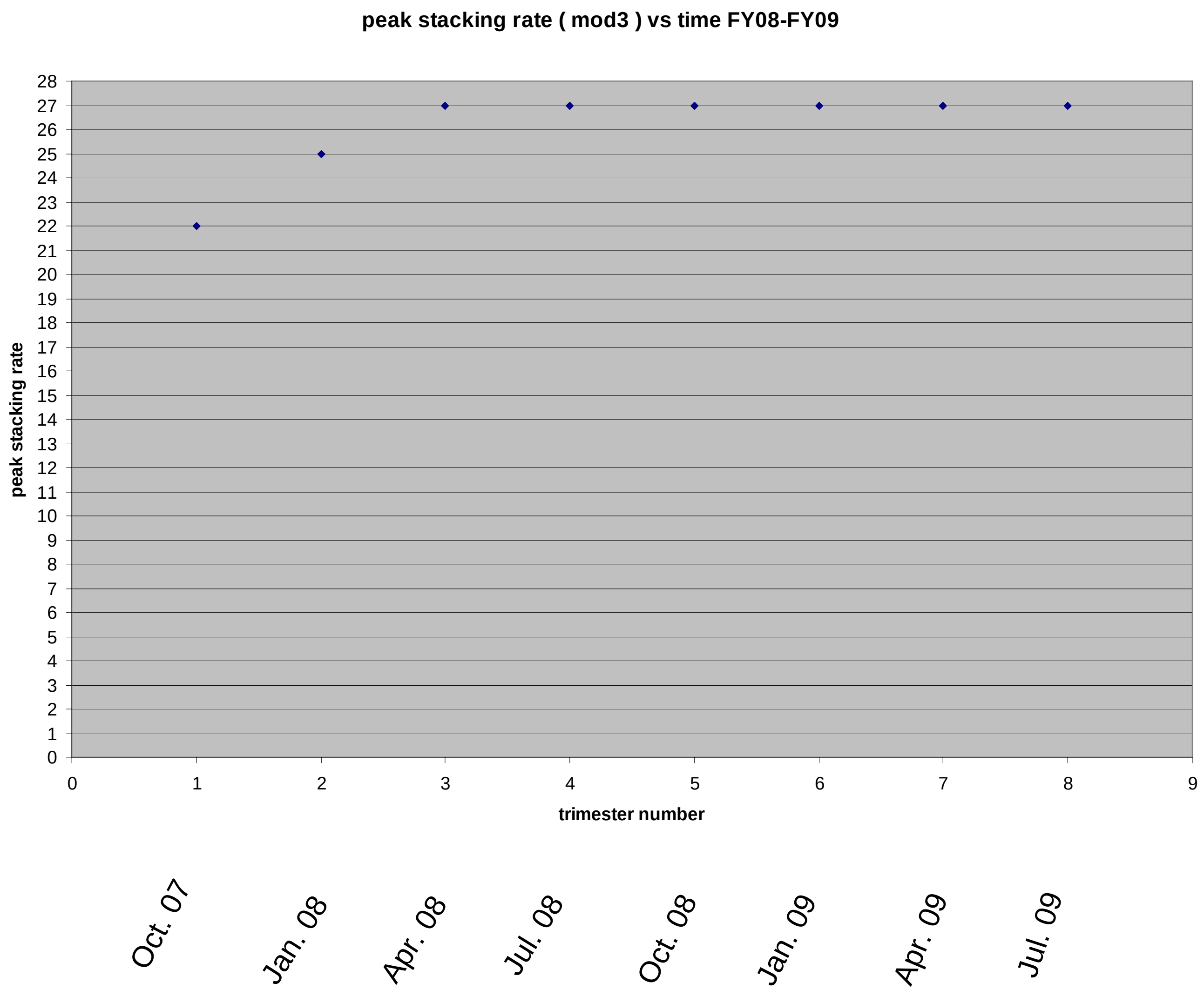
Assumed peak stacking rate profile for FY08 and FY09– mod1



Assumed peak stacking rate profile for FY08 and FY09 – mod2



Assumed peak stacking rate profile for FY08 and FY09 – mod3



Assume four (five) different scenarios

- 1. In the following we pick the three stacking profiles discussed earlier and build around them two more pesimistic and two (three) more optimistic projections for integrated luminosity in the next two years.

- 2. We are by default assuming 21 hour long stores and 6 pbar transfer shots between stores as a default (except in Scenario V).

- 3. The most pesimistic scenario (I) uses the stacking rate profile mod1 and assumes 100 store hours a week. Most of the other input parameters are the ones we ran at on average within FY07.

- 4. Scenario II uses the stacking rate profile mod2 and assumes 105 store hours per week. It also assumes more protons per bunch, better Acc-Rec transfer efficiency and better timeline utilization factor.

- 5. Scenario III uses the stacking rate profile mod2 and assumes 115 store hours per week except for the trimesters right after the shutdowns (110 h). It also assumes better Acc-Rec transfer eff. than Sc. II and smaller transfer time. It uses as well an 1% better Tevatron lifetime from January 2008 and on.

Assume four (five) different scenarios

- 6. Scenario IV uses the stacking rate profile mod3 and assumes 120 store hours per week except for the trimesters right after the shutdowns (110 h). It also assumes a better luminosity density, by 2%, and a timeline utilization factor which is a bit better than in Sc. III.

- 7. Scenario V is identical to Scenario IV but it uses 18 hour long stores for the trimesters where the peak stacking rate is 27 x 10^{10}/hour.

Inputs for FY08 and FY09 – Sc. I (pesimistic)

Assuming 21 hour long stores and 6 pbar transfer shots between stores

- Number of protons per bunch 256, 256, 256, 256, 260, 260, 260, 260 x 10^9
- Luminosity Density @ 100 x 10^{10} 90.32 μb^{-1} / sec
- Luminosity Density @ 300 x 10^{10} 190.34 μb^{-1} / sec
- Init Tevatron Lifetime @ 80 μb^{-1}/sec 7.07 hours
- Init Tevatron Lifetime @ 160 μb^{-1}/sec 6.59 hours
- HEP store hours per week 100 hours
- Acc-Rec Transfer Efficiency @ 0x10^{10} 87.4%
- Acc-Rec Transfer Efficiency @ 300x10^{10} 87%
- Acc-Rec transfer time 0.19 hours
- Recycler lifetime 500 hours
- Recycler mining efficiency 93.8%
- Peak stacking rate 22, 22, …, 22 x10^{10}/hour
- Half rate stack size 210x10^{10}
- Maximum stack size 420x10^{10}
- Timeline Utililization Factor 74,74,74,74,75,75,75,75%
- Accumulator leftover factor 10%

With above inputs we should expect ~ 2619 pb^{-1} in 2 years

Inputs for FY08 and FY09 – Scenario II

Assuming 21 hour long stores and 6 pbar transfer shots between stores

- Number of protons per bunch 260, 270, 270, 270, 270, 270, 270, 270 x 10^9
- Luminosity Density @ 100 x 10^{10} 90.32 μb^{-1} / sec
- Luminosity Density @ 300 x 10^{10} 190.34 μb^{-1} / sec
- Init Tevatron Lifetime @ 80 μb^{-1}/sec 7.07 hours
- Init Tevatron Lifetime @ 160 μb^{-1}/sec 6.59 hours
- HEP store hours per week 105 hours
- Acc-Rec Transfer Efficiency @ 0x10^{10} 90%
- Acc-Rec Transfer Efficiency @ 300x10^{10} 90%
- Acc-Rec transfer time 0.19 hours
- Recycler lifetime 500 hours
- Recycler mining efficiency 93.8%
- Peak stacking rate 22, 25, …, 25 x10^{10}/hour
- Half rate stack size 210x10^{10}
- Maximum stack size 420x10^{10}
- Timeline Utililization Factor 80%
- Accumulator leftover factor 10%

With above inputs we should expect ~ 3044 pb^{-1} in 2 years

Inputs for FY08 and FY09 – Scenario III

Assuming 21 hour long stores and 6 pbar transfer shots between stores

- Number of protons per bunch 260, 270, 270, 270, 270, 270, 270, 270 x 10^9
- Luminosity Density @ 100 x 10^{10} 90.32 μb^{-1} / sec
- Luminosity Density @ 300 x 10^{10} 190.34 μb^{-1} / sec
- Init Tevatron Lifetime @ 80 μb^{-1}/sec 7.07, 7.14,…7.14 hours
- Init Tevatron Lifetime @ 160 μb^{-1}/sec 6.59, 6.65, …,6.65 hours
- HEP store hours/week 110, 115,115, 115, 110, 115, 115, 115 hours
- Acc-Rec Transfer Efficiency @ 0x10^{10} 90,92,…92%
- Acc-Rec Transfer Efficiency @ 300x10^{10} 90, 91,…91%
- Acc-Rec transfer time 0.19, 0.16, …, 0.16 hours
- Recycler lifetime 500 hours
- Recycler mining efficiency 93.8%
- Peak stacking rate 22, 25, …, 25 x10^{10}/hour
- Half rate stack size 210x10^{10}
- Maximum stack size 420x10^{10}
- Timeline Utililization Factor 80%
- Accumulator leftover factor 10%

With above inputs we should expect ~ 3338 pb^{-1} in 2 years

Inputs for FY08 and FY09 – Sc. IV (optimistic1)

Assuming 21 hour long stores and 6 pbar transfer shots between stores

- Number of protons per bunch 260, 270, 270, 270, 270, 270, 270, 270 x 10^9
- Luminosity Density @ 100 x 10^{10} 90.32, 92.126,…,92.126 μb^{-1} / sec
- Luminosity Density @ 300 x 10^{10} 190.34, 194.147,…,194.147 μb^{-1} / sec
- Init Tevatron Lifetime @ 80 μb^{-1}/sec 7.07, 7.14 hours
- Init Tevatron Lifetime @ 160 μb^{-1}/sec 6.59, 6.65, …,6.65 hours
- HEP store hours/week 110, 120,120, 120, 110, 120, 120, 120 hours
- Acc-Rec Transfer Efficiency @ 0x10^{10} 90, 92,…92%
- Acc-Rec Transfer Efficiency @ 300x10^{10} 90, 91,…91%
- Acc-Rec transfer time 0.19, 0.16, …, 0.16 hours
- Recycler lifetime 500 hours
- Recycler mining efficiency 93.8%
- Peak stacking rate 22, 25, 27,…, 27 x10^{10}/hour
- Half rate stack size 210, 250, …,250x10^{10}
- Maximum stack size 420, 500,…,500x10^{10}
- Timeline Utililization Factor 80, 83, …,83%
- Accumulator leftover factor 10%

With above inputs we should expect ~ 3545 pb^{-1} in 2 years

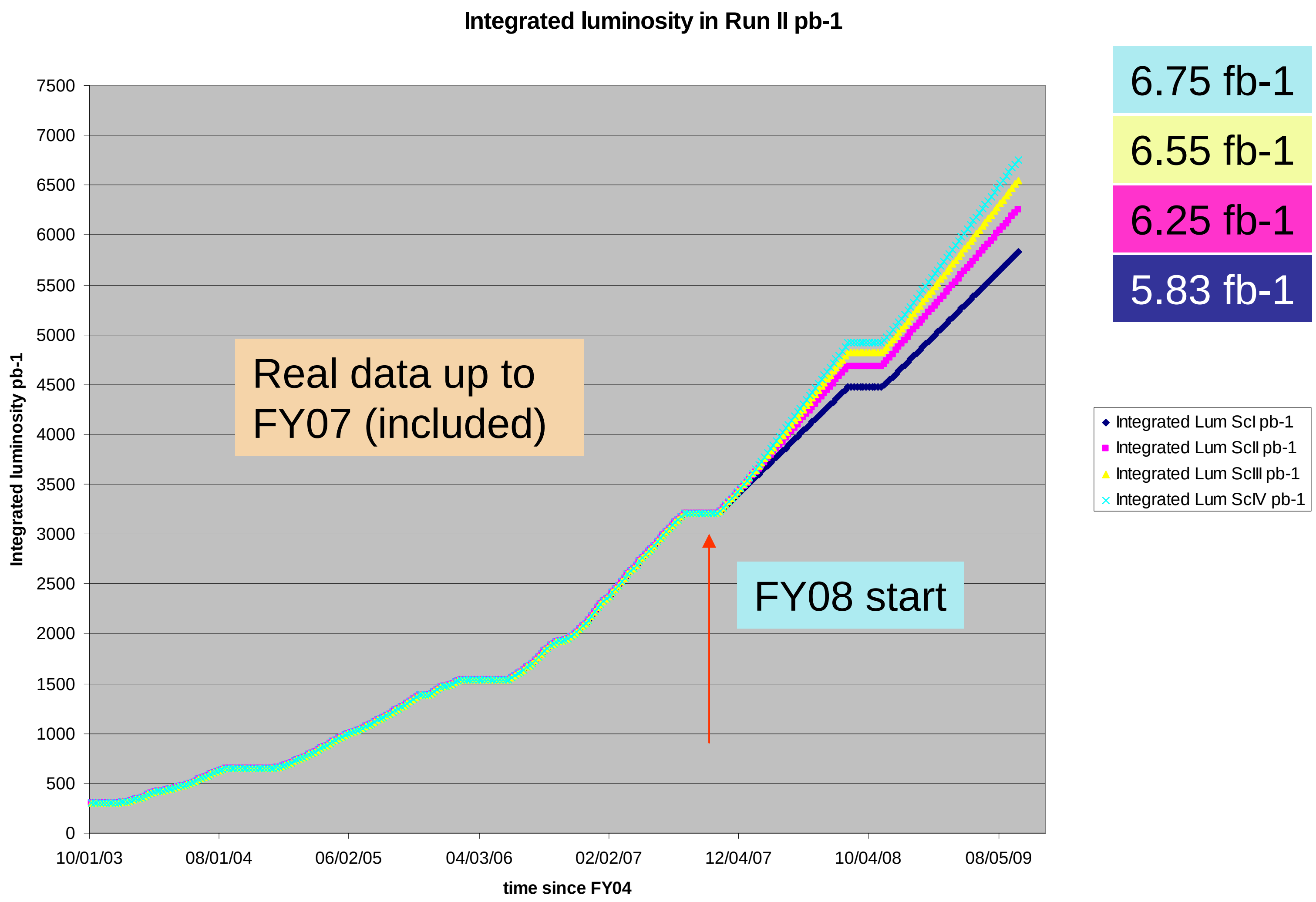
Inputs for FY08 and FY09 – Sc. V (optimistic2)

Assuming 21 hour long stores and 6 pbar transfer shots between stores, but 18 hour stores when stacking rate is 27 x 10^{10}/hour

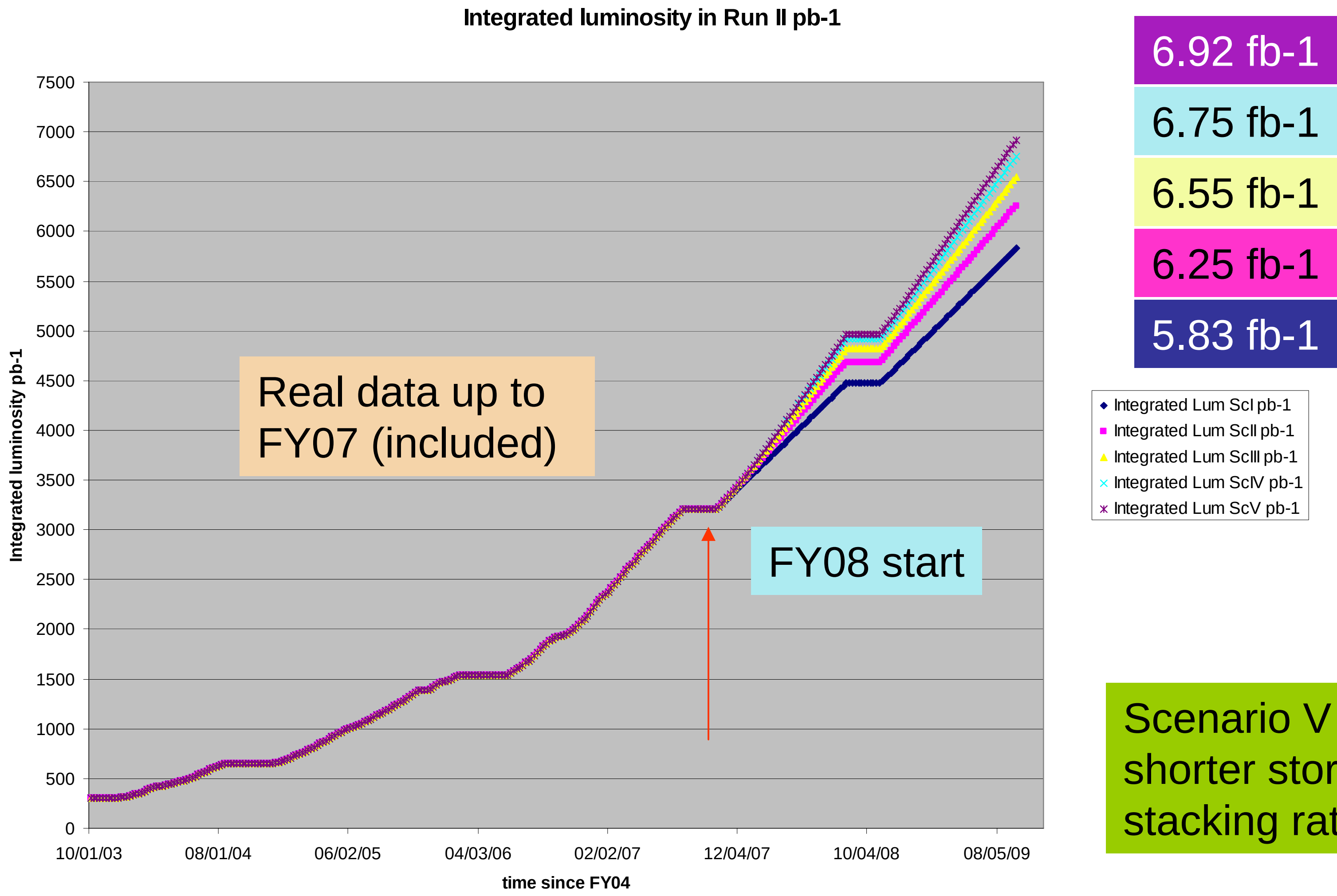
- Number of protons per bunch 260, 270, 270, 270, 270, 270, 270, 270 x 10^9
- Luminosity Density @ 100 x 10^{10} 90.32, 92.126,…,92.126 μb^{-1} / sec
- Luminosity Density @ 300 x 10^{10} 190.34, 194.147,…,194.147 μb^{-1} / sec
- Init Tevatron Lifetime @ 80 μb^{-1}/sec 7.07, 7.14 hours
- Init Tevatron Lifetime @ 160 μb^{-1}/sec 6.59, 6.65, …,6.65 hours
- HEP store hours/week 110, 120,120, 120, 110, 120, 120, 120 hours
- Acc-Rec Transfer Efficiency @ 0x10^{10} 90, 92,…92%
- Acc-Rec Transfer Efficiency @ 300x10^{10} 90, 91,…91%
- Acc-Rec transfer time 0.19, 0.16, …, 0.16 hours
- Recycler lifetime 500 hours
- Recycler mining efficiency 93.8%
- Peak stacking rate 22, 25, 27,…, 27 x10^{10}/hour
- Half rate stack size 210, 250, …,250x10^{10}
- Maximum stack size 420, 500,…,500x10^{10}
- Timeline Utililization Factor 80, 83, …,83%
- Accumulator leftover factor 10%

With above inputs we should expect ~ 3709 pb^{-1} in 2 years

Luminosity projection curves updating the FY07 projections with real data



Luminosity projection curves updating the FY07 projections with real data



Scenario V assumes shorter stores at high stacking rates

What we expect that the delivered luminosity will be in FY08

- 1. Scenario I: 1.27 fb^{-1}
- 2. Scenario II: 1.48 fb^{-1}
- 3. Scenario III: 1.62 fb^{-1}
- 4. Scenario IV: 1.71 fb^{-1}

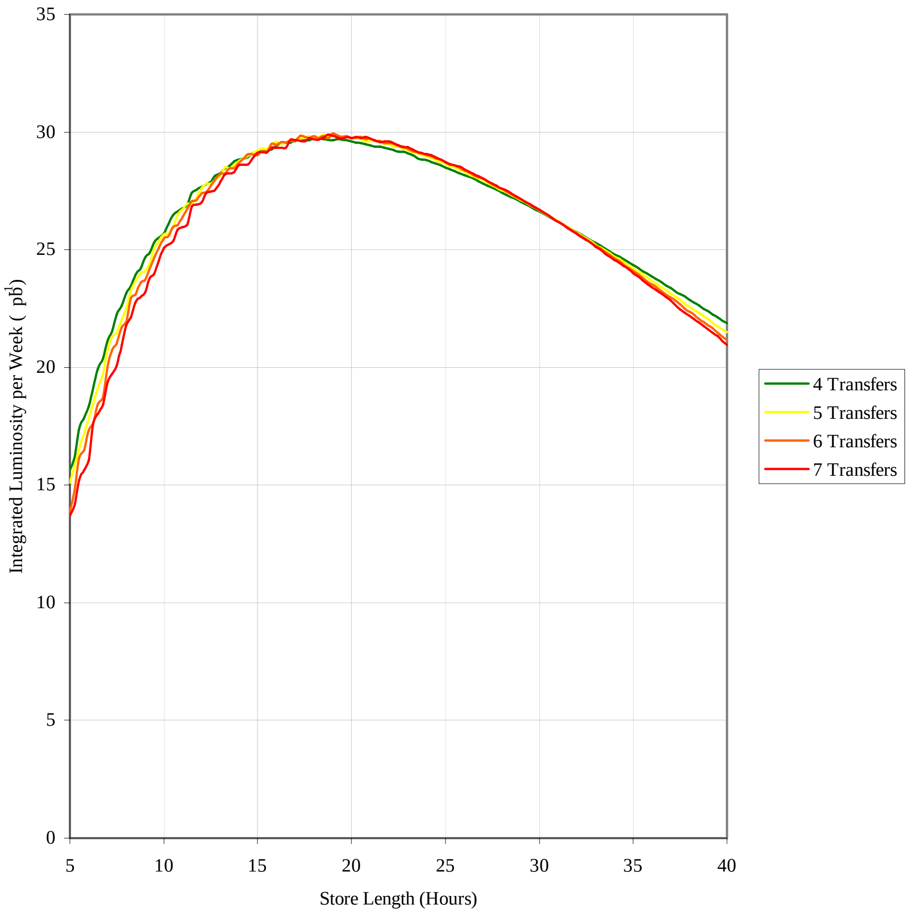
- 5. Scenario V: 1.76 fb^{-1}

There is still room to improve the Tevatron luminosity lifetime by more than 1%, to improve on luminosity density by more than 2% as well as in the more pesimistic scenarios, or to adjust accordingly the store length when the stacking rate becomes higher, even within scenarios II and III.

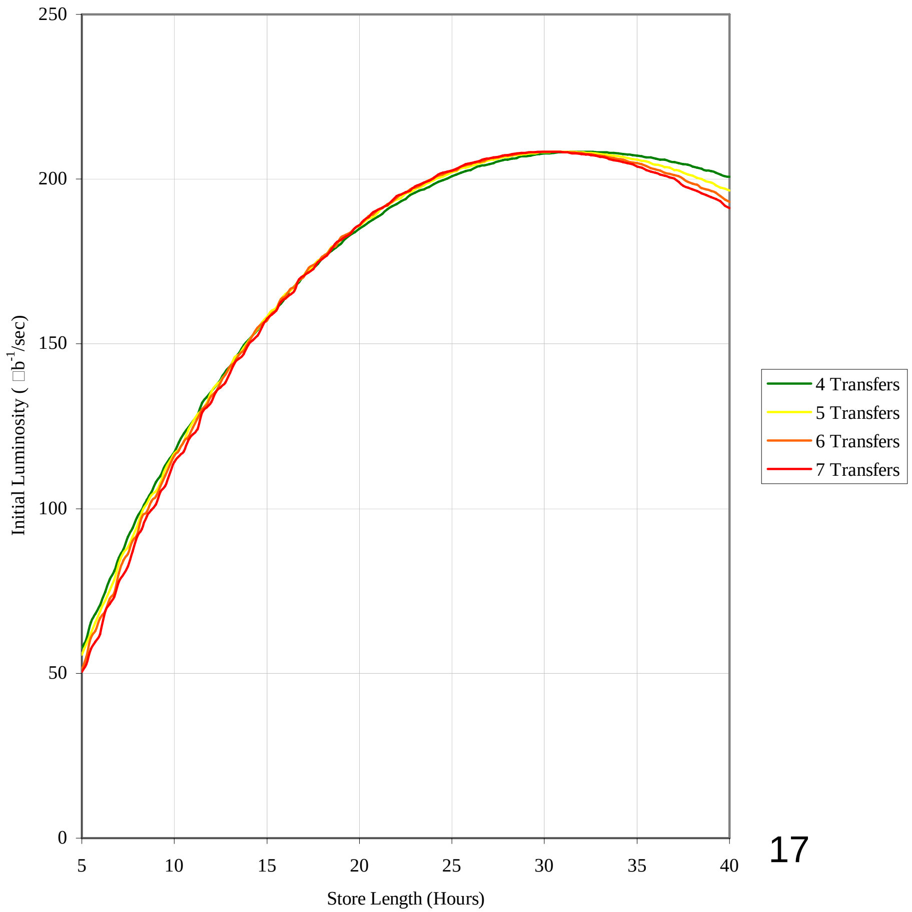
Projection of peak luminosity and luminosity delivered per week

Scenario I inputs

Integrated luminosity



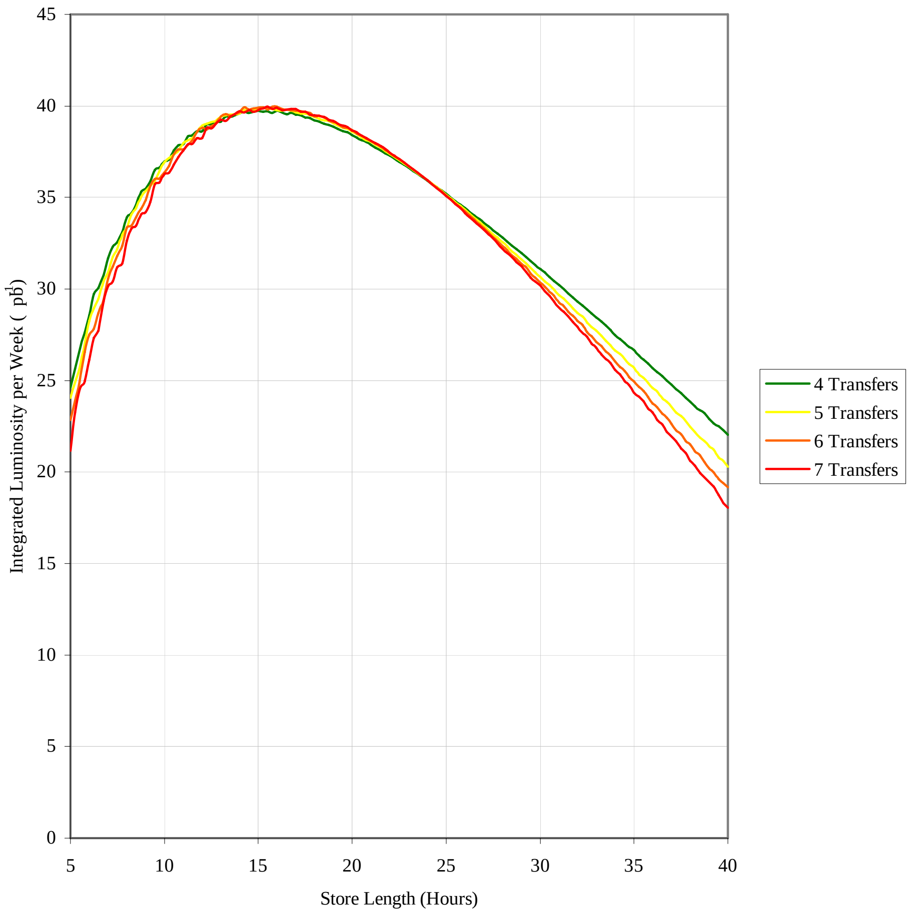
Initial luminosity



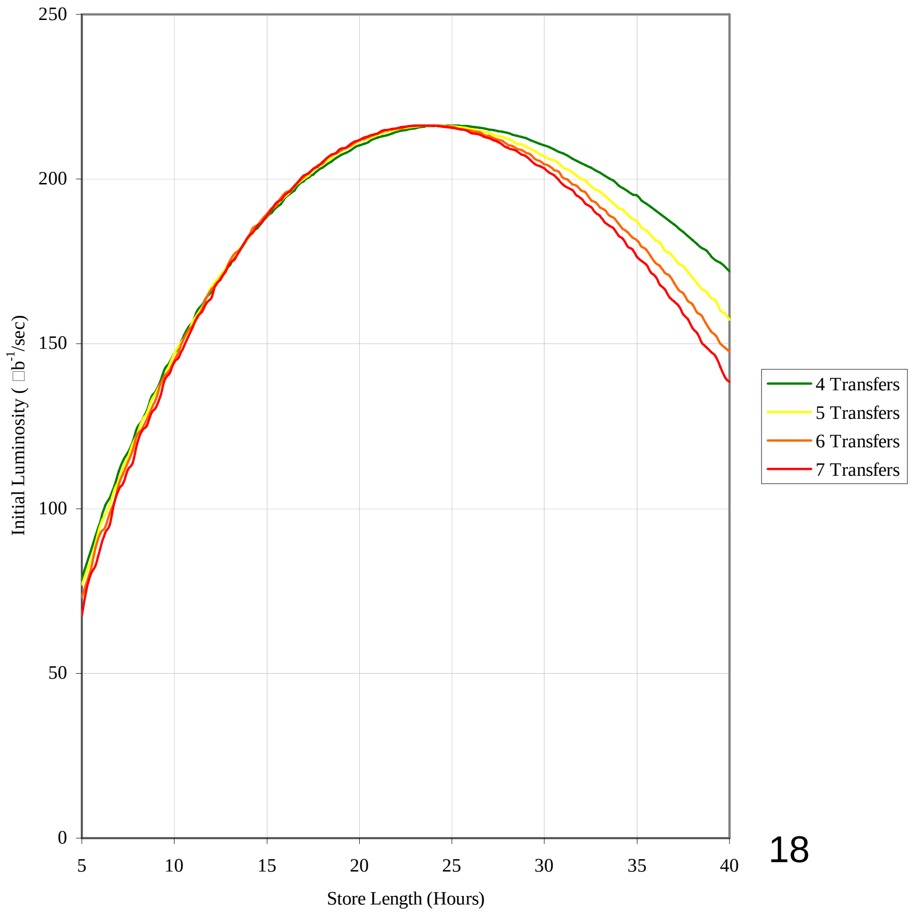
Projection of peak luminosity and luminosity delivered per week

Scenario III inputs

Integrated luminosity

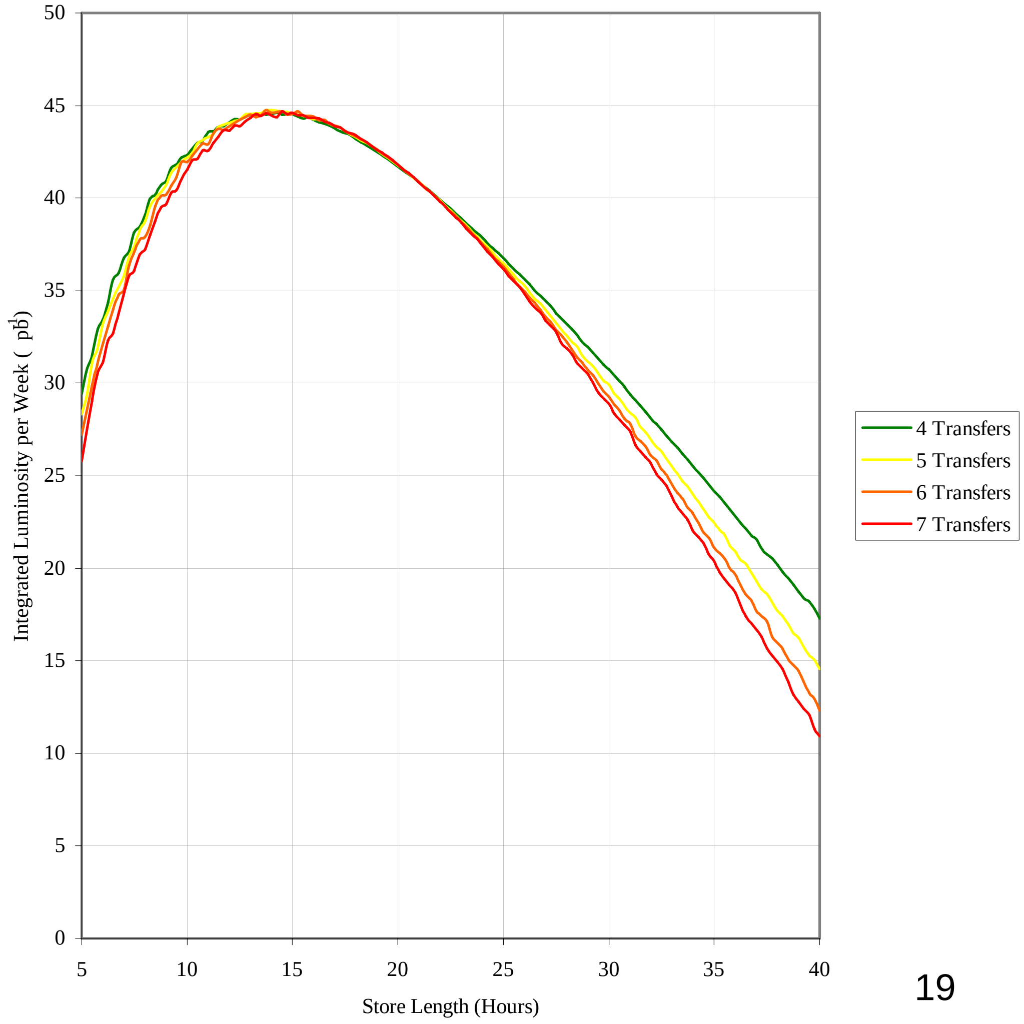


Initial luminosity

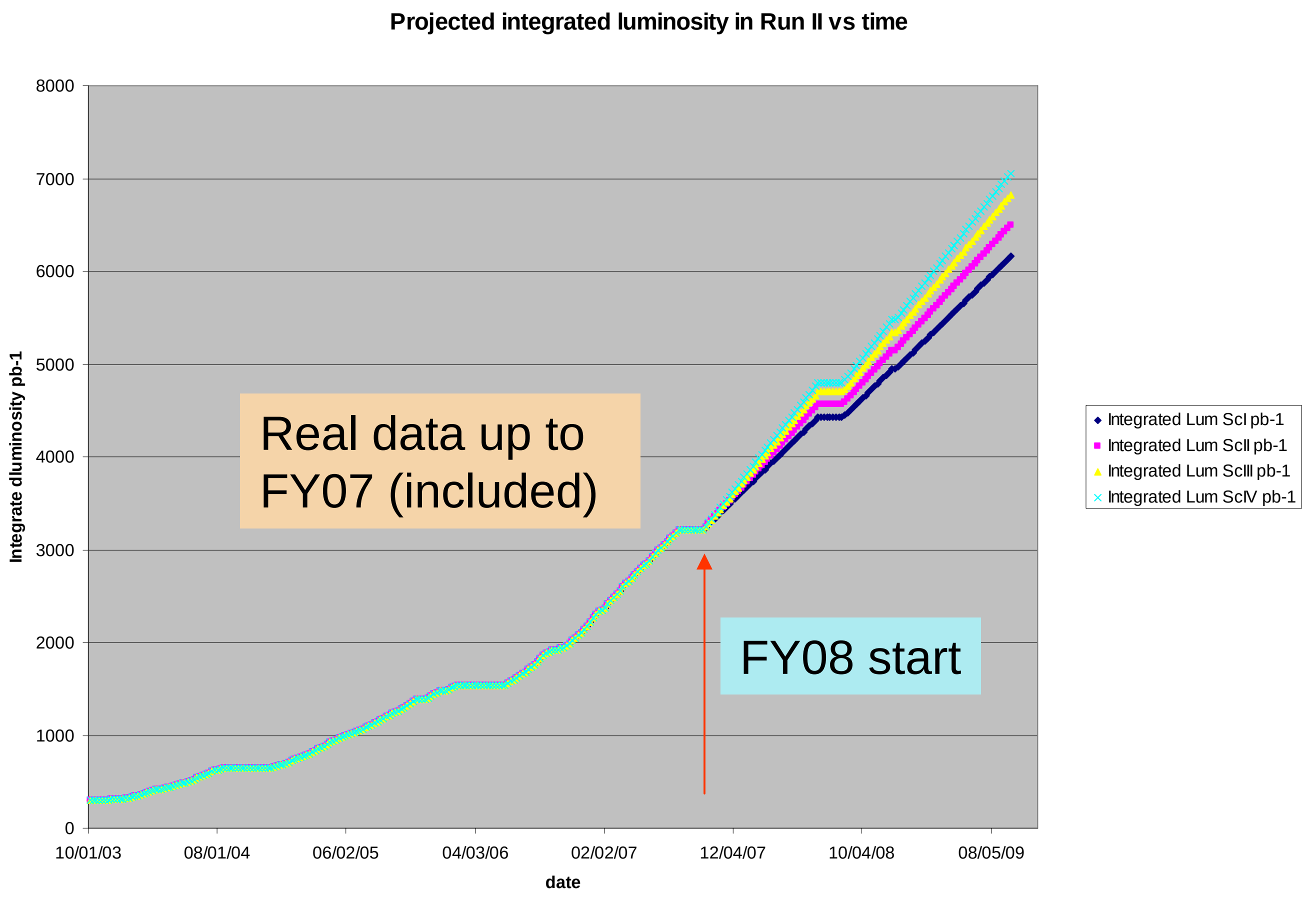


Projection of luminosity delivered per week

Scenario IV inputs: They point to shorter stores for maximum delivered luminosity



Last year's luminosity projection curves updating the FY07 projections with real data



The shutdown assumptions were a bit different last year and this year, both in start time and in length.