Tevatron vs. RHIC from beam-beam perspective

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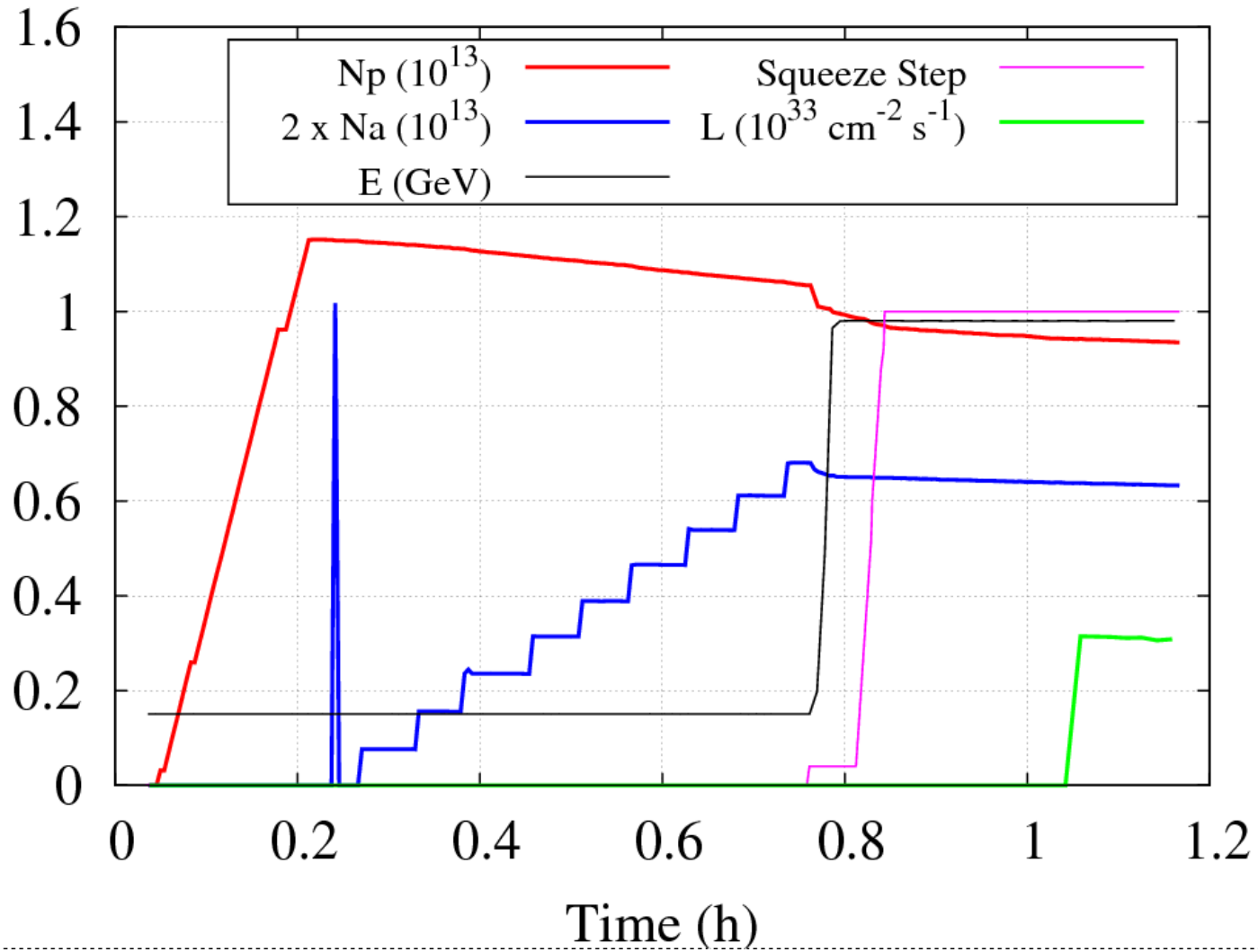
RHIC APEX Workshop 2010

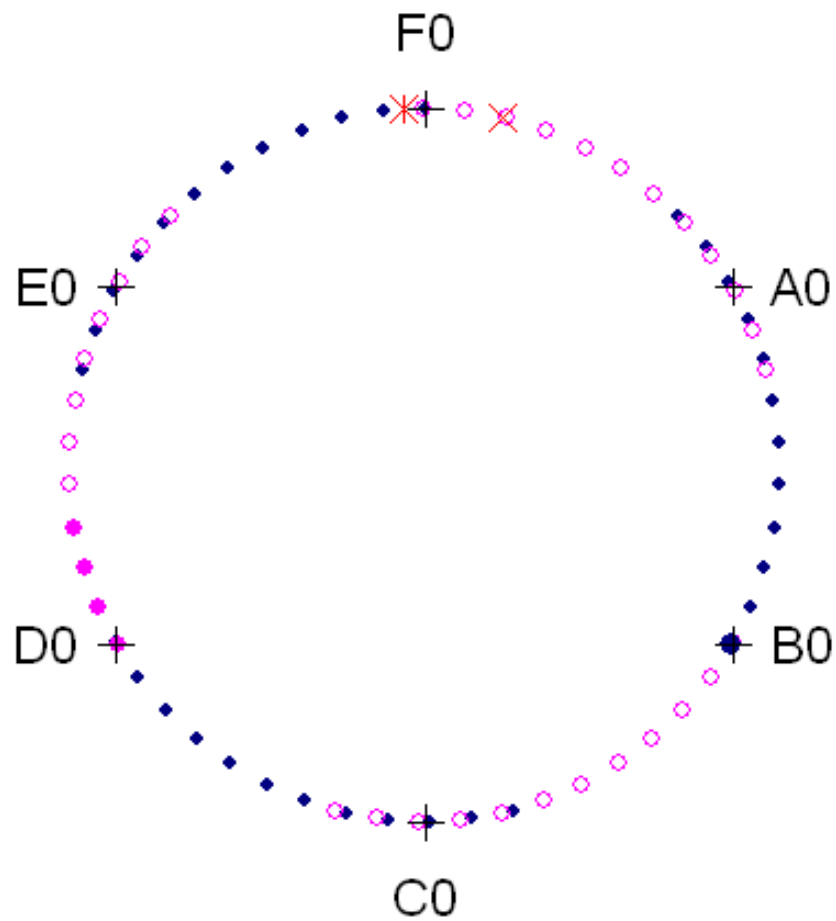
October 18-19 2010

Typical good Tevatron Store
5989 L_0=3.15x10^{32}

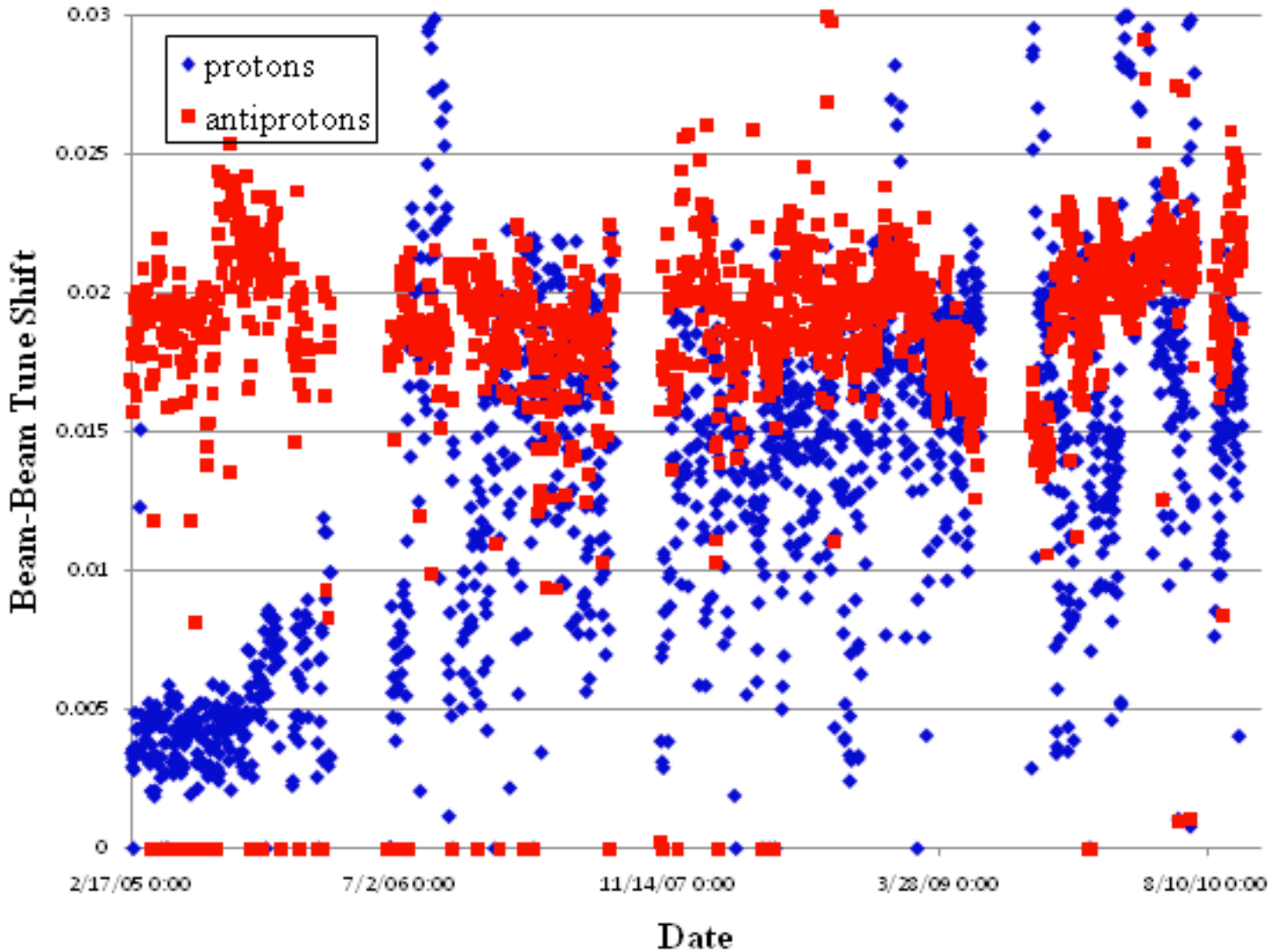


Tevatron parameters

Beam energy	0.98 TeV
Circumference	6.28 km
Number of bunches	36 (3x12)
Number of head-on IPs	2
Number of long-range IPs	70
Np	2.9×10^{11}
Na	0.8×10^{11}
Initial normalized transverse emittance	$\varepsilon p=20\ \mu m$
	$\varepsilon a=8\ \mu m$
Initial momentum spread	1.2×10^{-4}
Bunch length (σ)	50 cm
Beta-function at IP	0.3 m



Tevatron beam-beam parameter

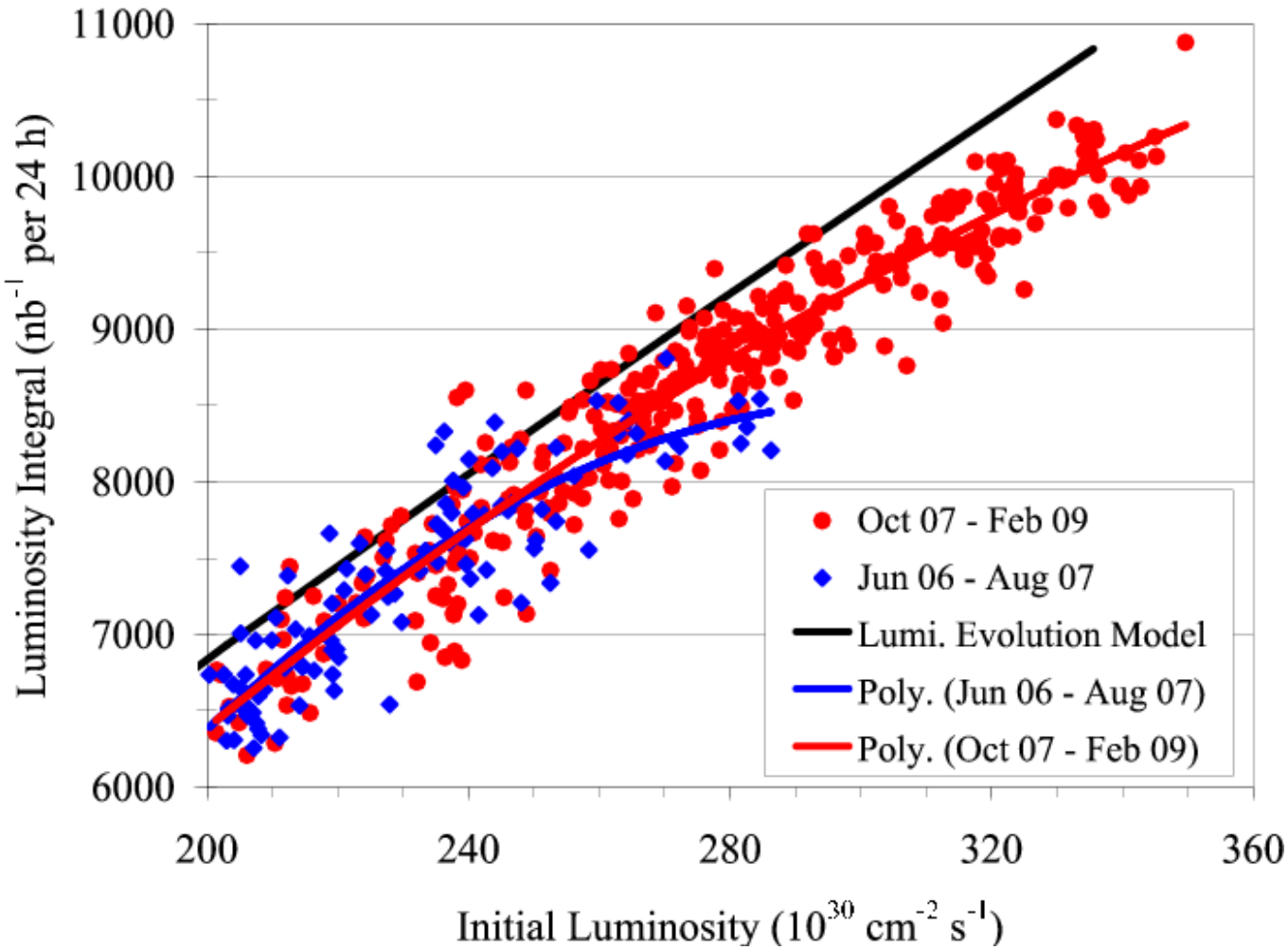


Tev. Luminosity Evolution and Integral

LARP

Usually, Tev. luminosity is well described by $L = L_0/(1 + t/\tau_L)$

We use $I = \int L dt \cong \tau_L L_0 \ln(1 + T/\tau_L)$ to characterize machine performance



Luminosity evolution model (V.Lebedev)

Numerical solution of system of equations

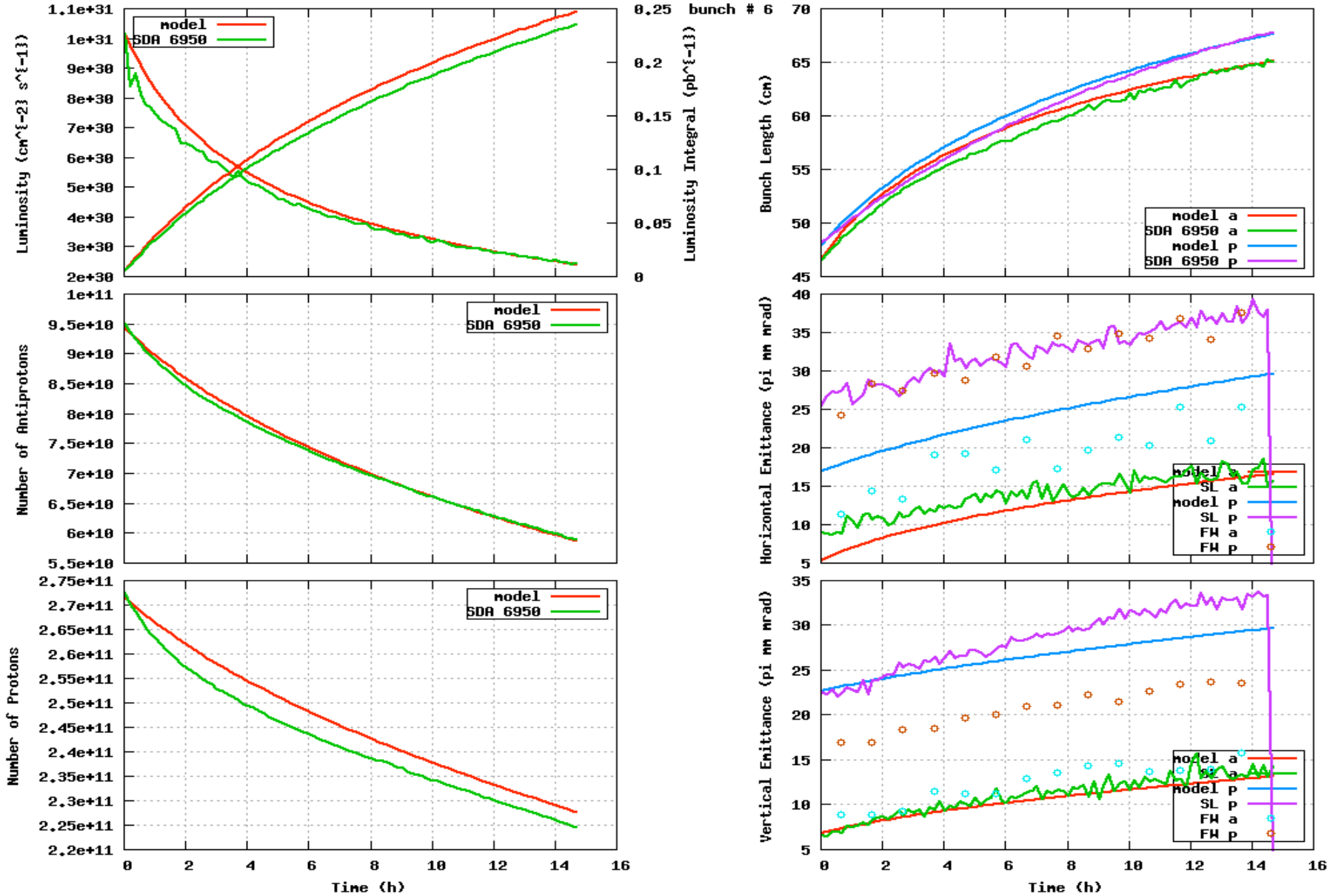
$$\frac{d\varepsilon_x}{dt} = \frac{d\varepsilon_{xIBS}}{dt} + \frac{d\varepsilon_{xIP}}{dt} + \frac{d\varepsilon_{xExt}}{dt}$$

$$\frac{d\varepsilon_y}{dt} = \frac{d\varepsilon_{yIBS}}{dt} + \frac{d\varepsilon_{yIP}}{dt} + \frac{d\varepsilon_{yExt}}{dt}$$

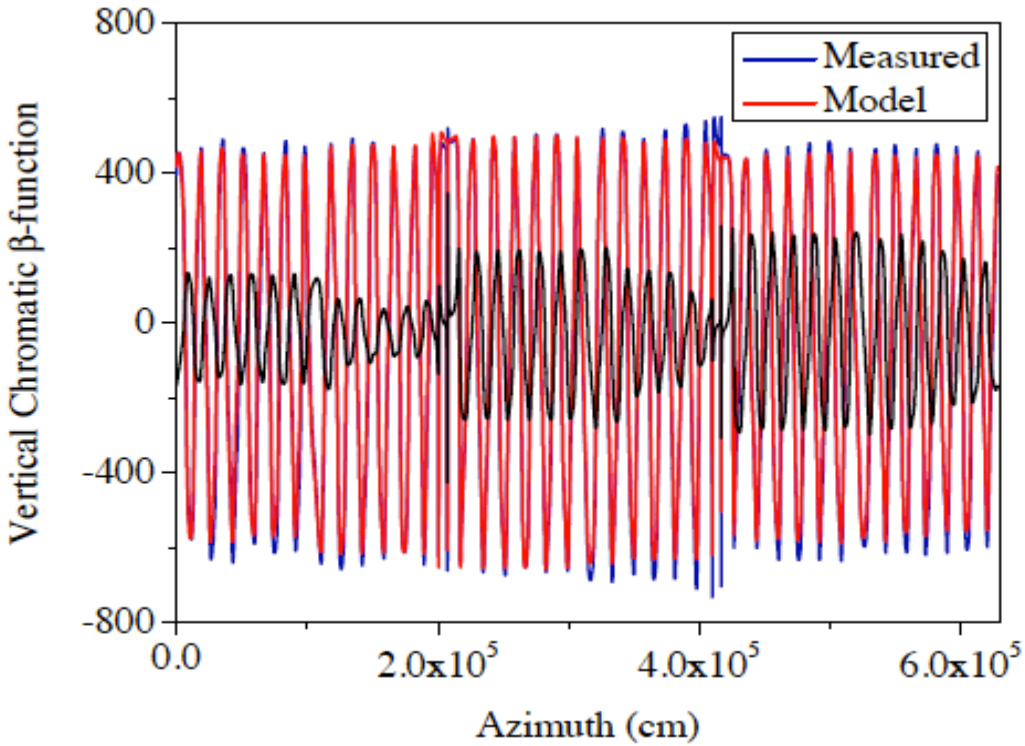
$$\frac{d\sigma_E^2}{dt} = \frac{d\sigma_{IBS}^2}{dt} + \frac{d\sigma_{IP}^2}{dt} + \frac{d\sigma_{Ext}^2}{dt}$$

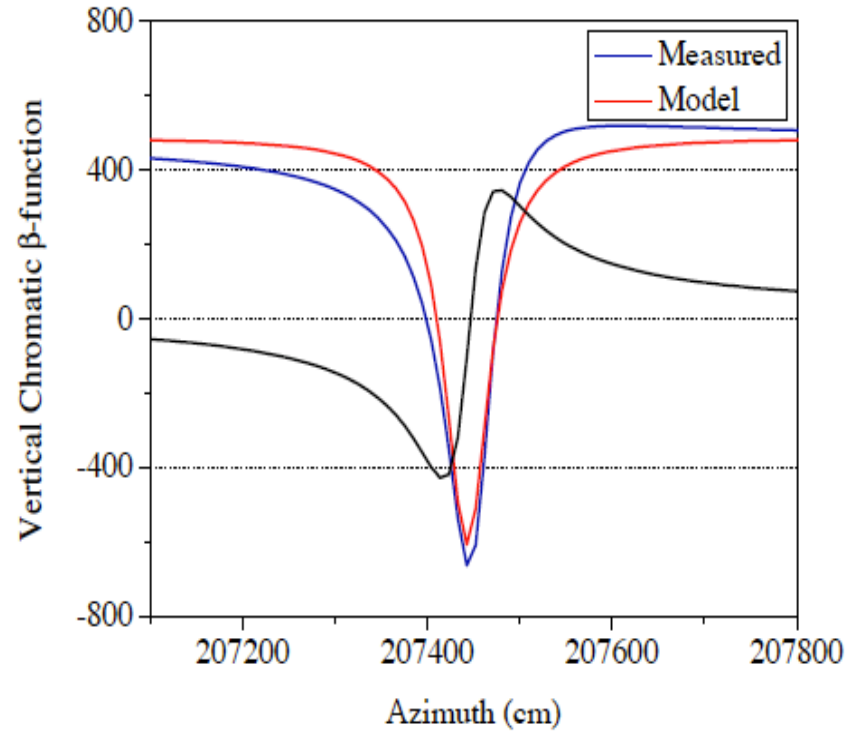
$$\frac{dN}{dt} = -N_{IP}\frac{L}{N_b}\sigma_{tot} - \frac{N}{\tau_{Ext}}$$

Luminosity evolution model example.
Tevatron store 6950 L_0=3.5x10^{32} $cm^{-2}s^{-1}$



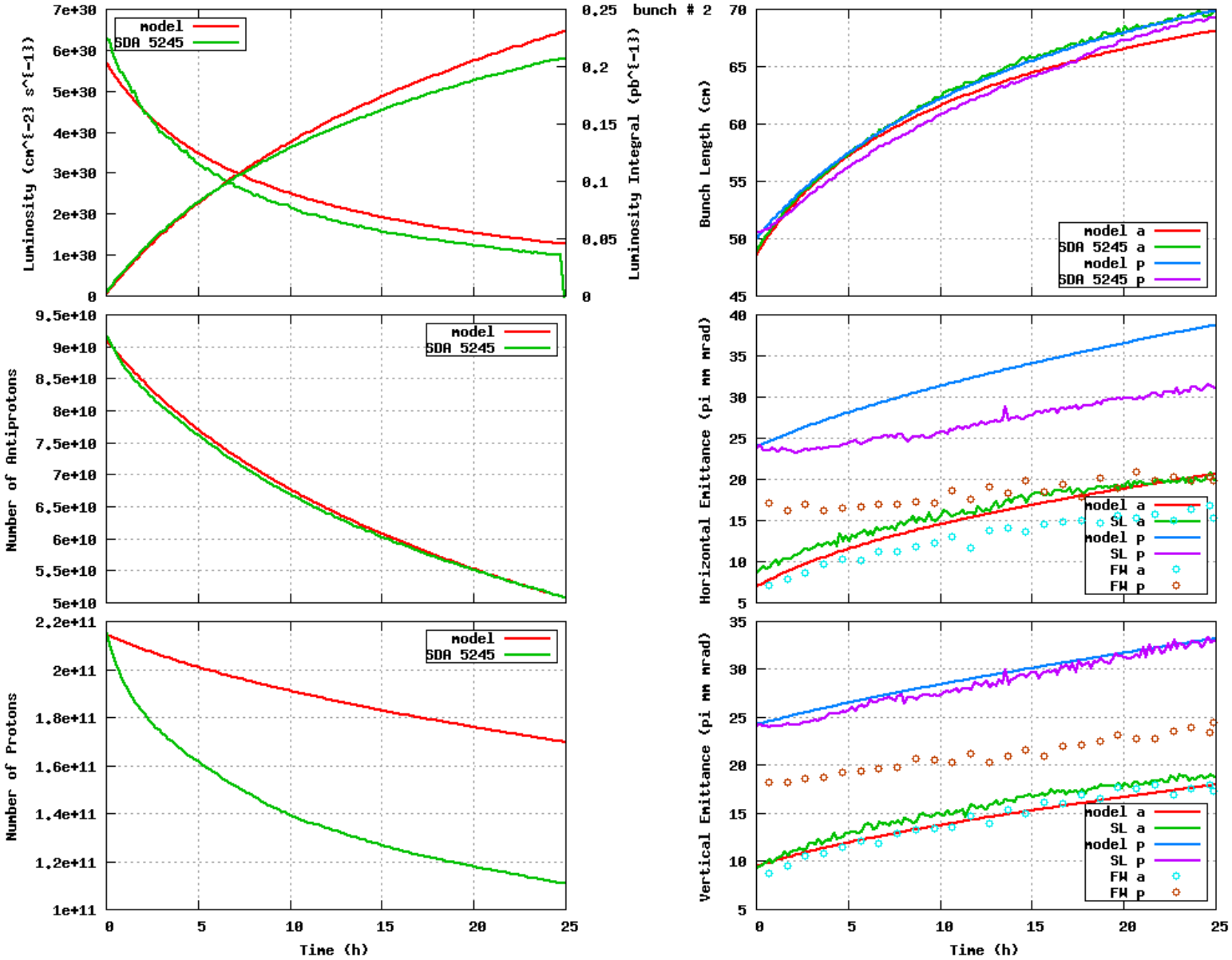
Chromatic β-function (dβ/β)/(dp/p)



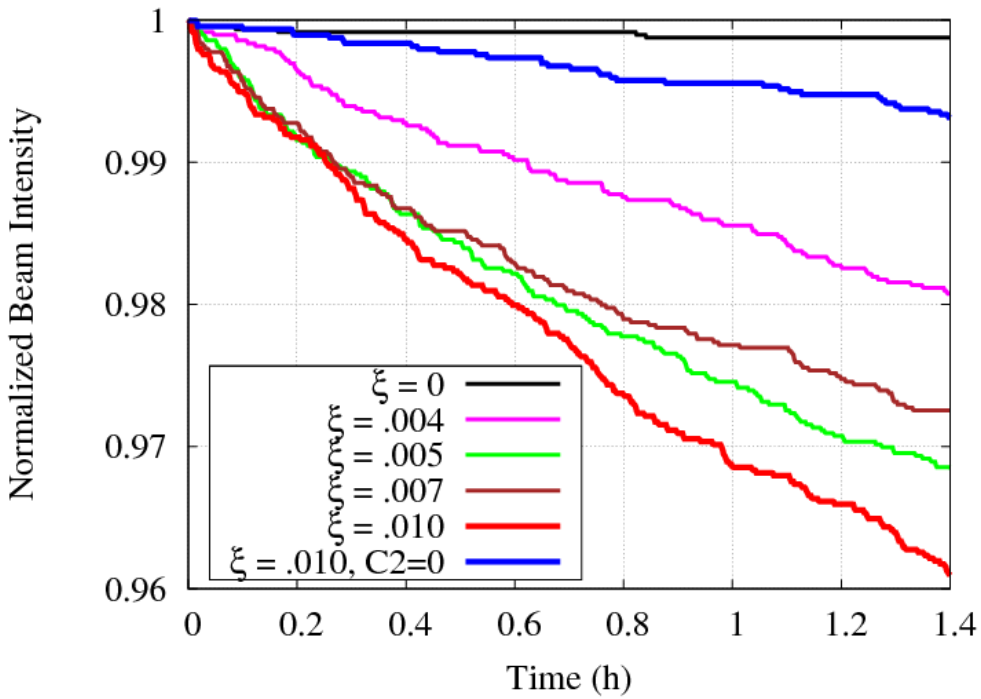


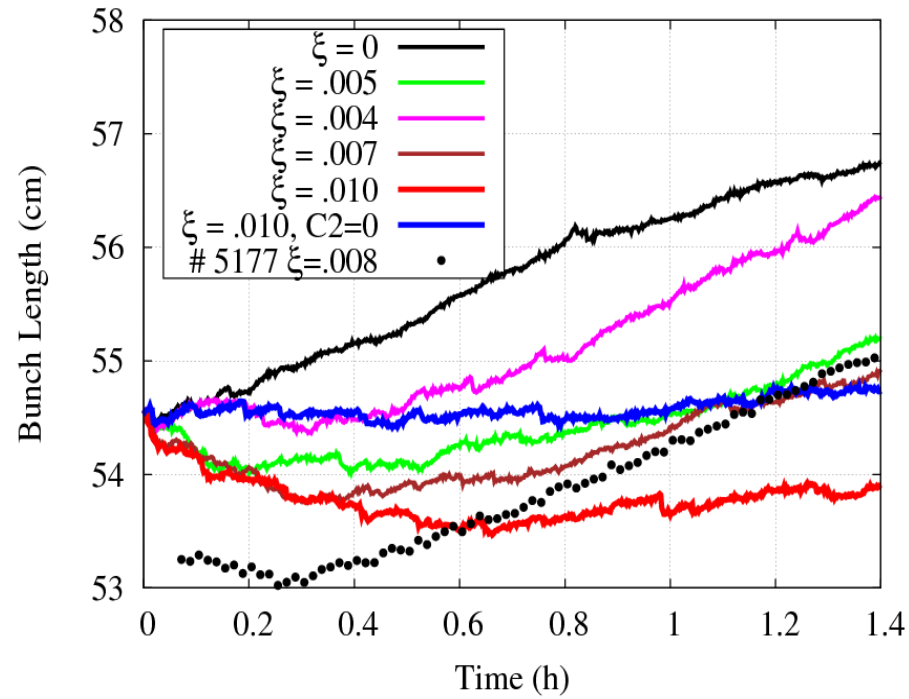
A.Valishev et al., PAC'07 FRPMS015

Effect of β-function chromaticity
Store 5245, L_0=2.92x10^{32}

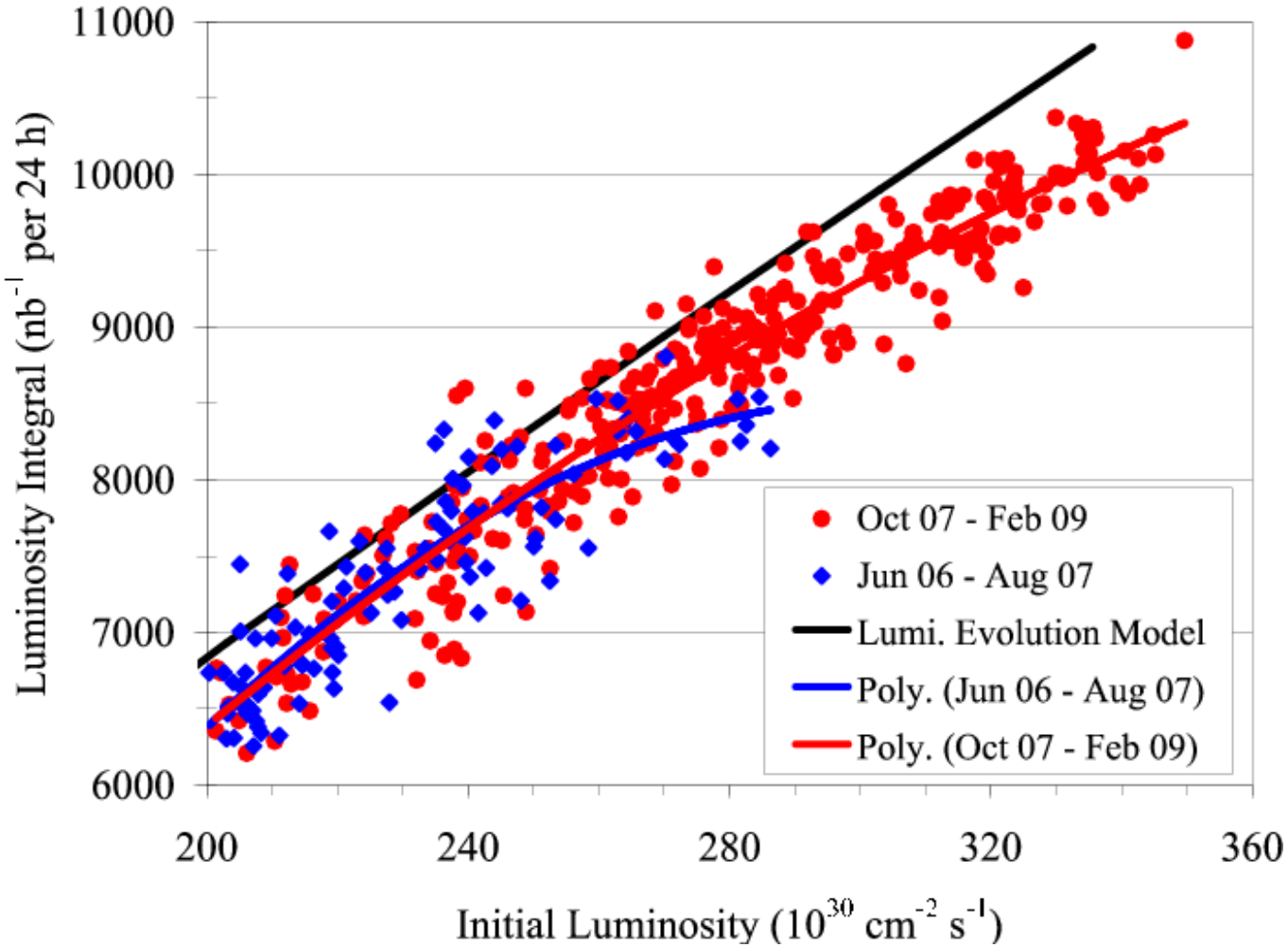


Effect of β-function chromaticity Simulation

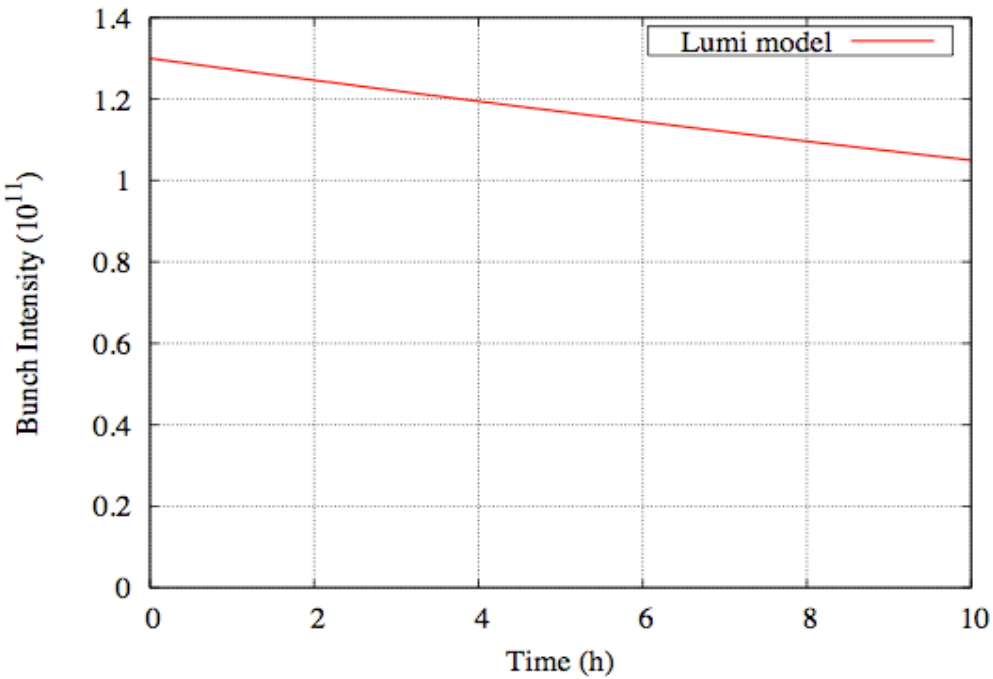


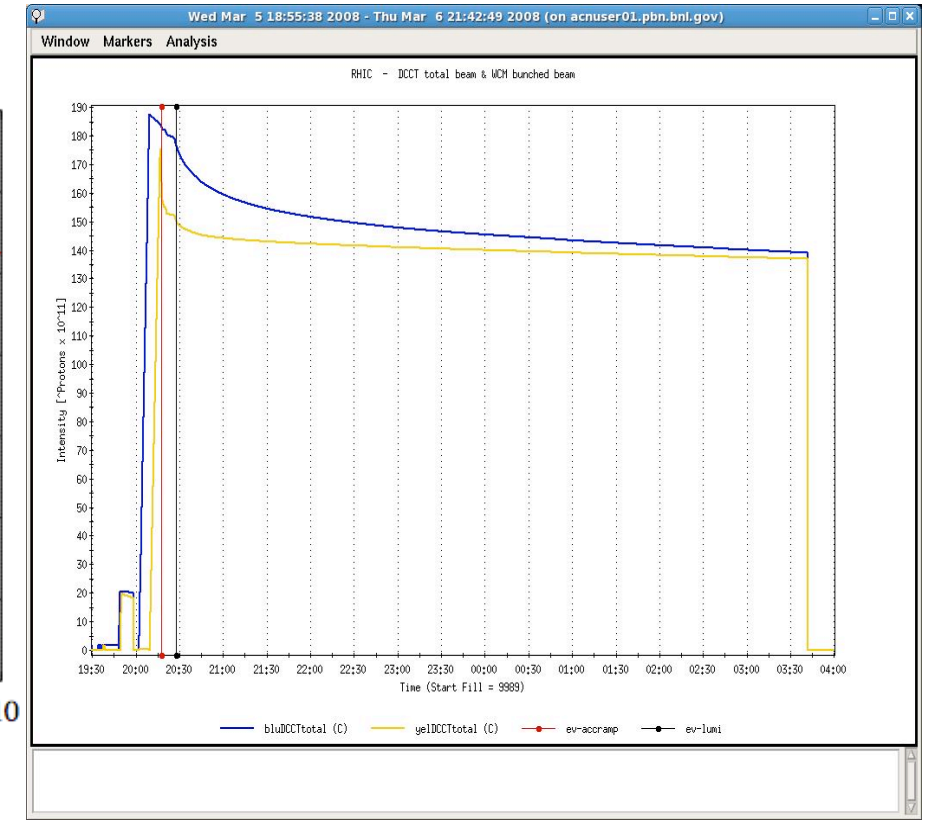


Effect of β-function chromaticity correction on Luminosity Integral



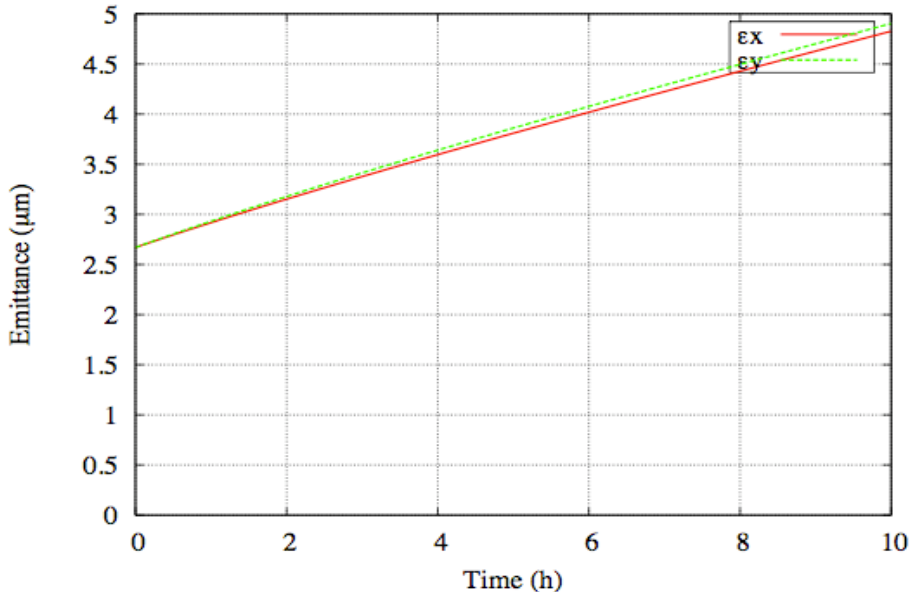
RHIC luminosity evolution model

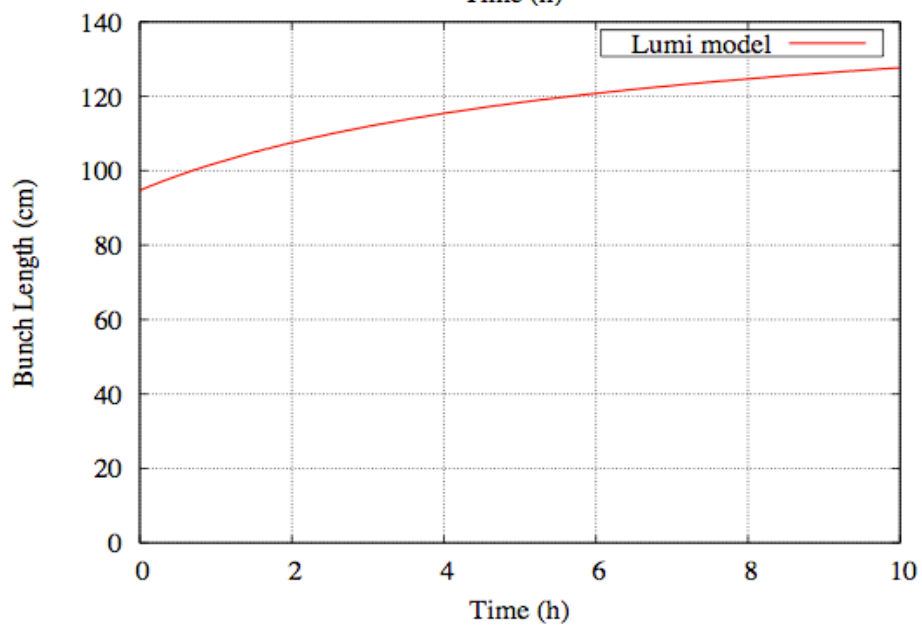


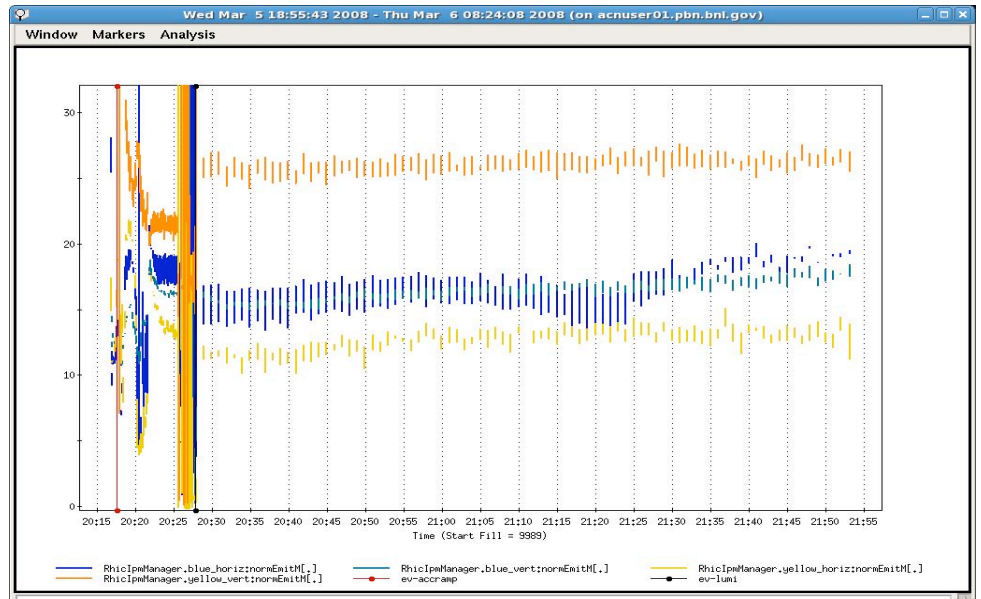


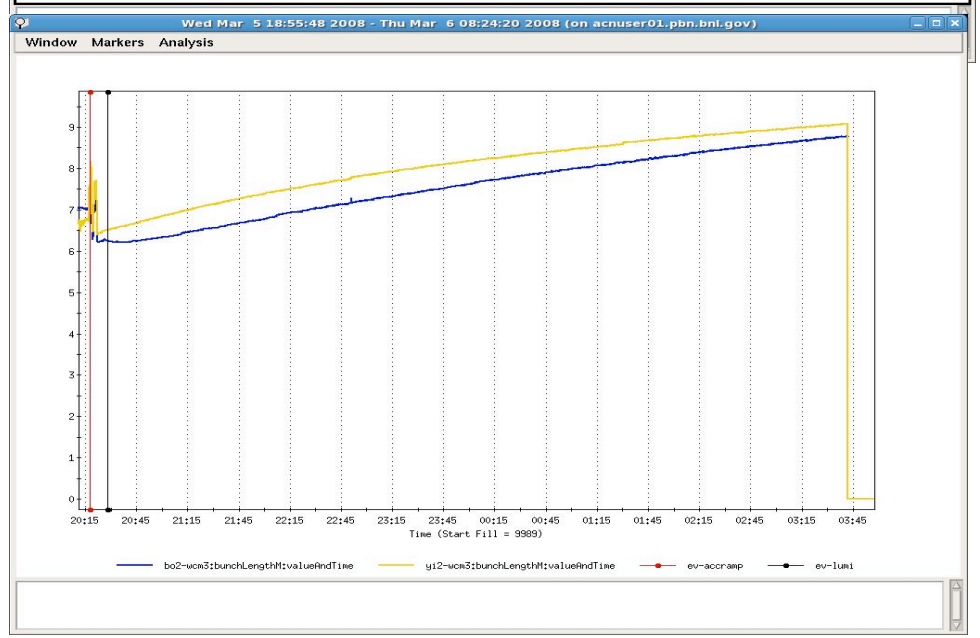
Initial parameters from Store 9989 (2008, 100GeV)

RHIC luminosity evolution model

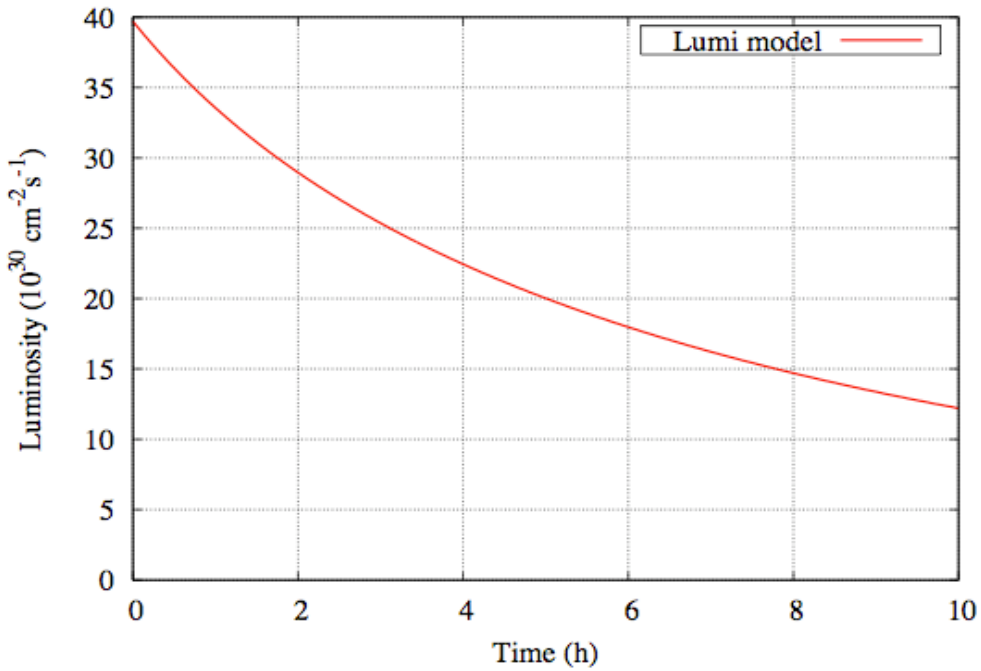


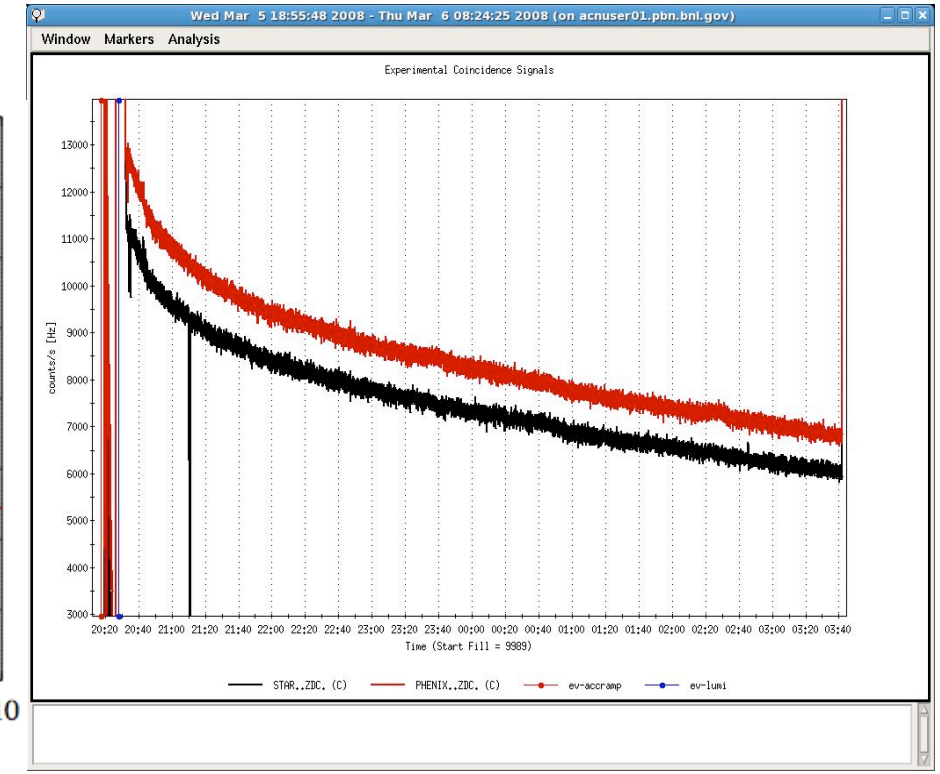






RHIC luminosity evolution model





Summary / Todo list

1. RHIC luminosity model can provide quantitative information on the beam-beam effect
   - Need direct comparison with logged store data
   - Analyze many stores/many bunches. Best if analysis is running online
2. To be included into numerical simulations
   - Beam and machine parameters for a chosen store analyzed with lumi. Model
   - Realistic lattice, including β^* chromaticity, dispersion at the IPs
3. Based on 1 and 2 develop a program of beam studies for benchmarking with simulations (tentatively January 2011)