CDF/D0 Luminosity Ratio and LowBeta Optics Correction

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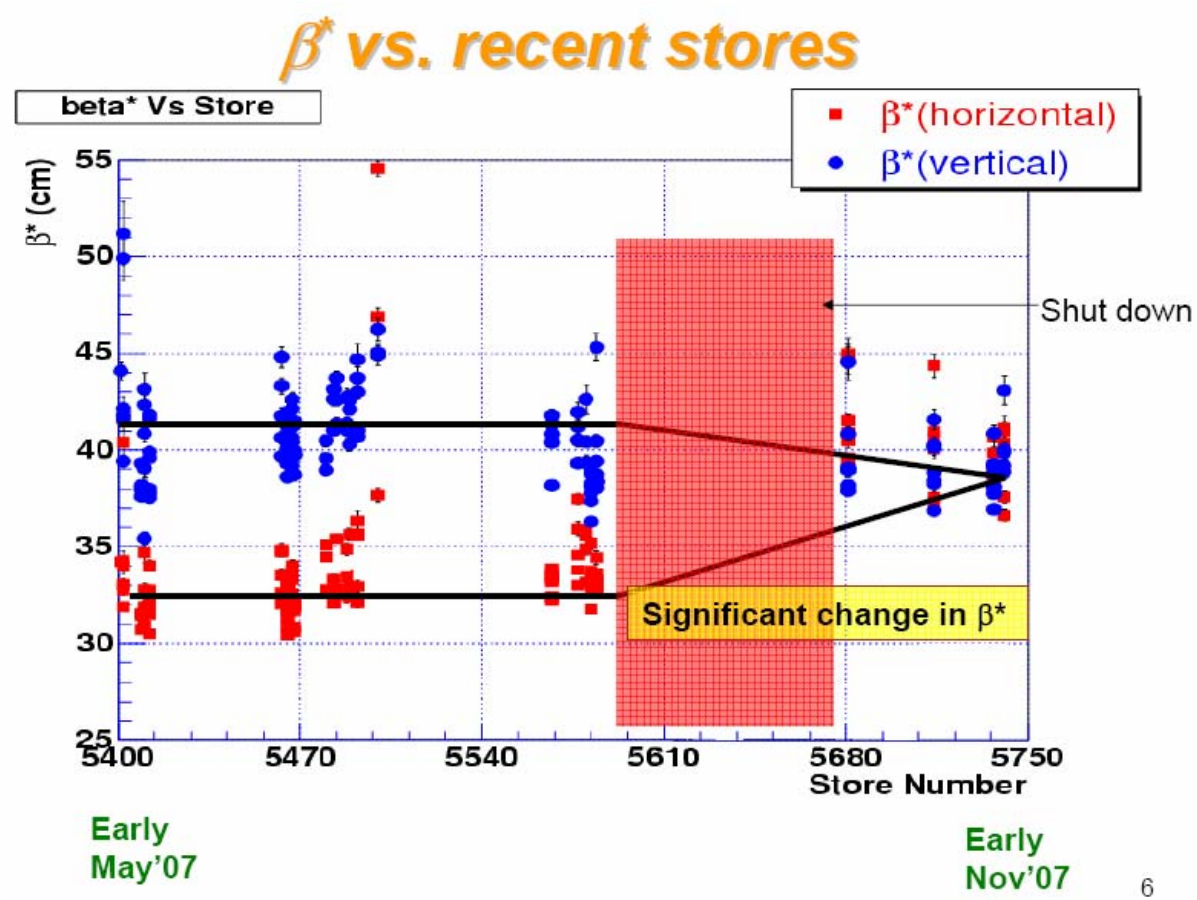
Luminosity Task Force Meeting 2/13/2008

Recent β^* Measurements

	β_x^* (cm)	β_y^* (cm)
CDF	28.4 (26.7)	29.6 (na)
D0	28.2 (25.1)	30.8 (na)

Orbit Response Method
11/24/07
(Turn-by-turn Method)



D0 Measurement,
A. Chandra
Lumi. Mtg. 12/5/07

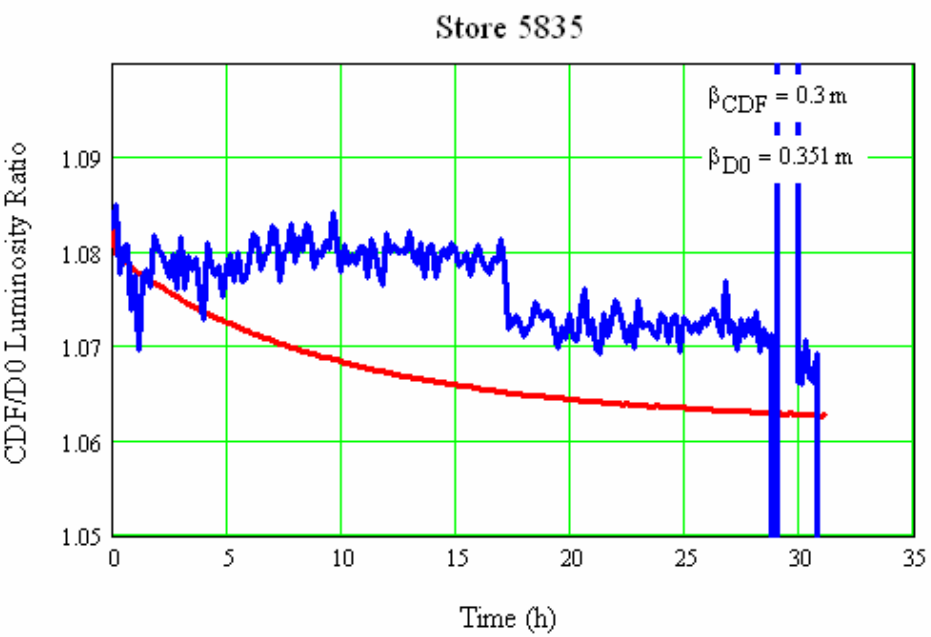
Basic Formula

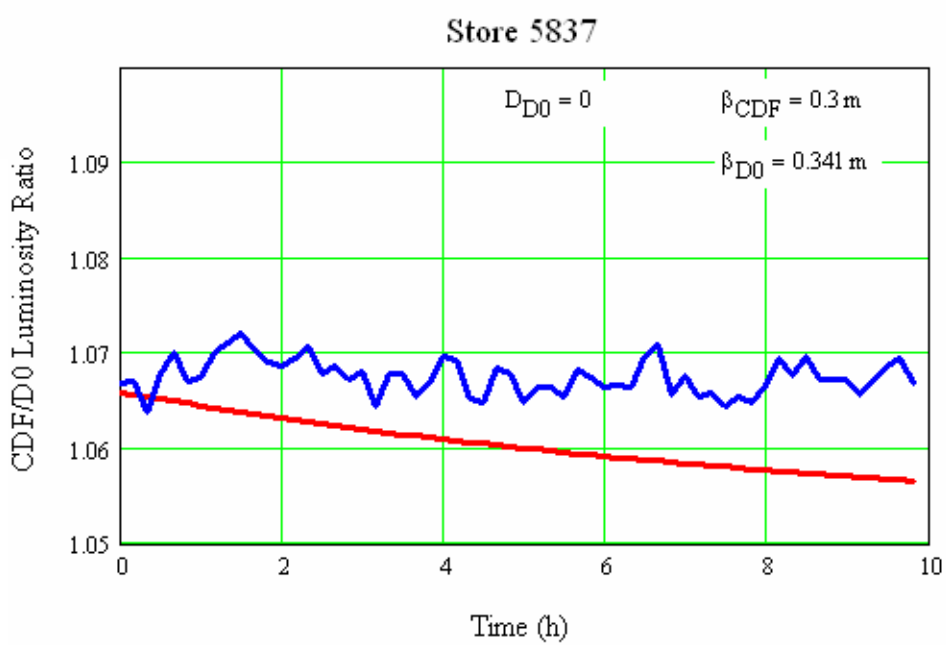
$$L = \frac{N_p N_a}{4\pi\left(\varepsilon\beta^* + D^{*2}\sigma_\delta^2\right)} \cdot f \cdot H\left(\frac{\beta^*}{\sigma_z}\right) \rightarrow \quad L = N_p N_a \cdot f \cdot F\left(\varepsilon, \beta^*, D^*, D'^*, \sigma_z, \sigma_\delta, \theta\right)$$

$$F = \frac{1}{(2\pi)^{3/2}\sigma_z}\int ds \frac{1}{\sigma(s)^2} \frac{1}{\sqrt{2+\theta^2\left(\frac{\sigma(s)^2}{2\sigma_z^2}-1\right)}} \times \exp\left(-\frac{s^2\frac{2\sigma(s)^2}{\sigma_z^2}+\theta^2 s^2\left(\frac{1}{2}-\frac{\sigma(s)^2}{4\sigma_z^2}\right)}{2\sigma(s)^2+\theta^2\sigma(s)^2\left(\frac{\sigma(s)^2}{2\sigma_z^2}-1\right)}\right)$$

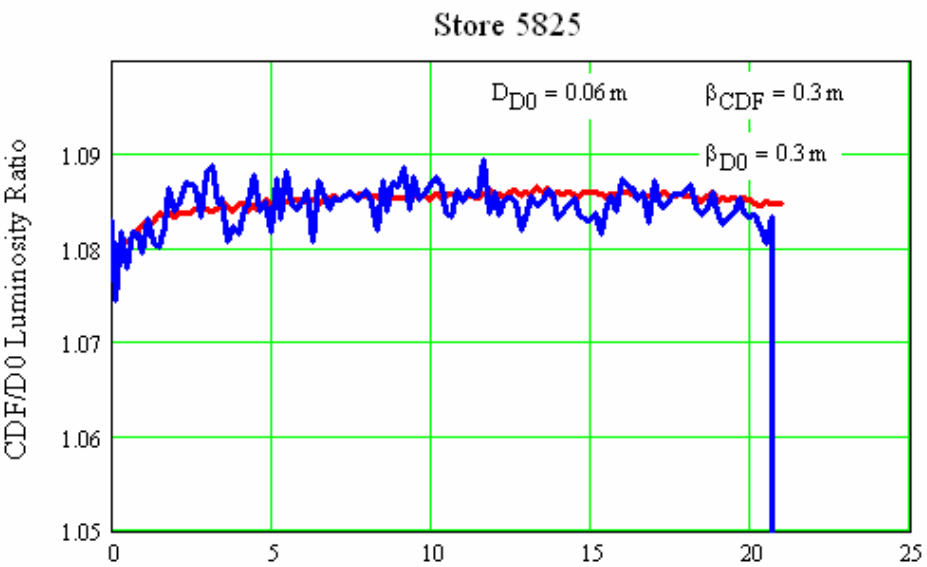
- Measured parameters
  - N_p, N_a - FBI
  - σ_z, σ_δ - SBD
  - ε - SyncLight (recalculated from sigmas)
- Free parameters
  - β^*
  - D^*, D'^*
  - θ

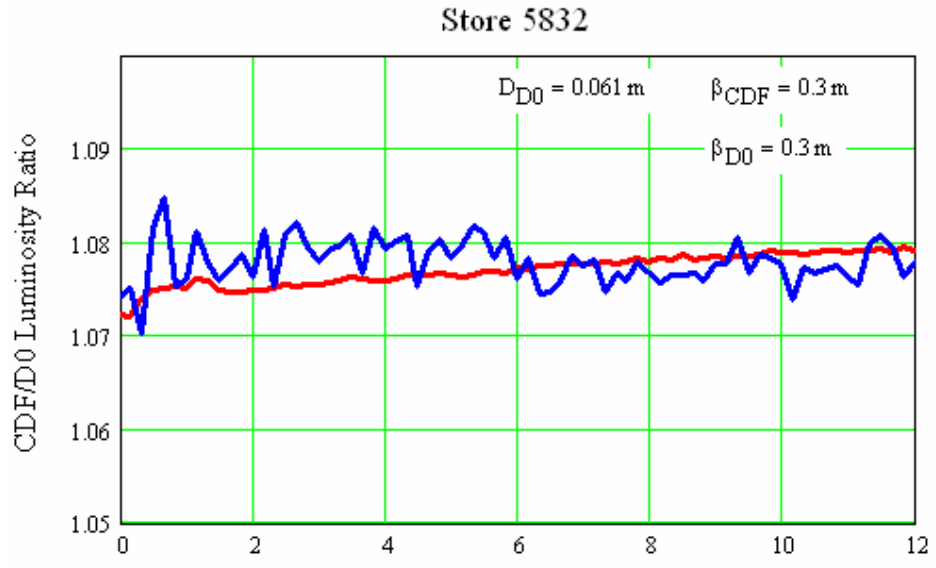
CDF/D0 Lumi Ratio – Unequal β^*

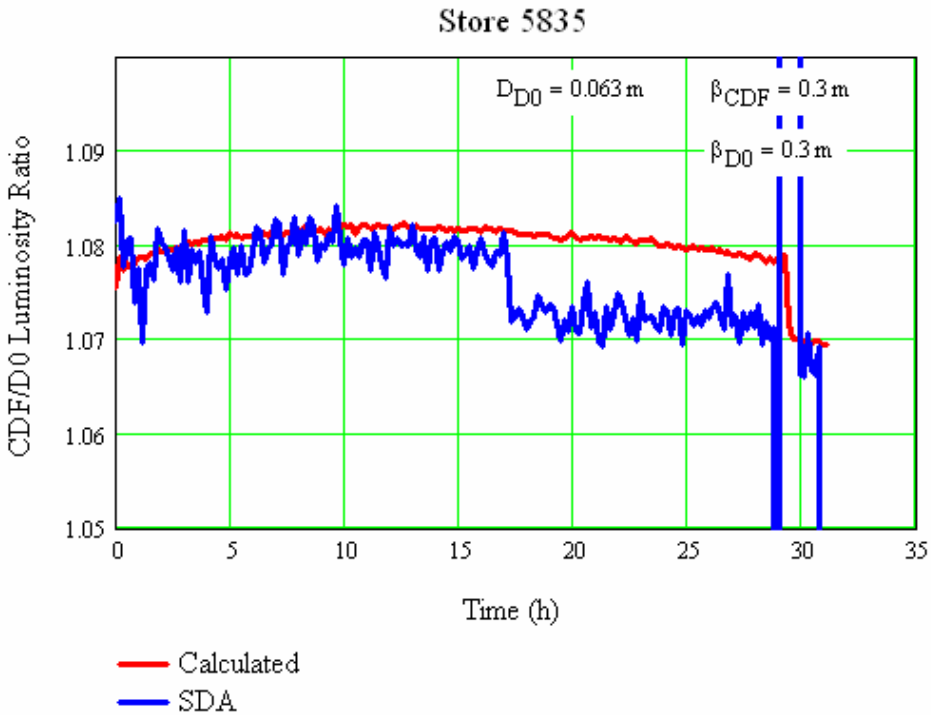


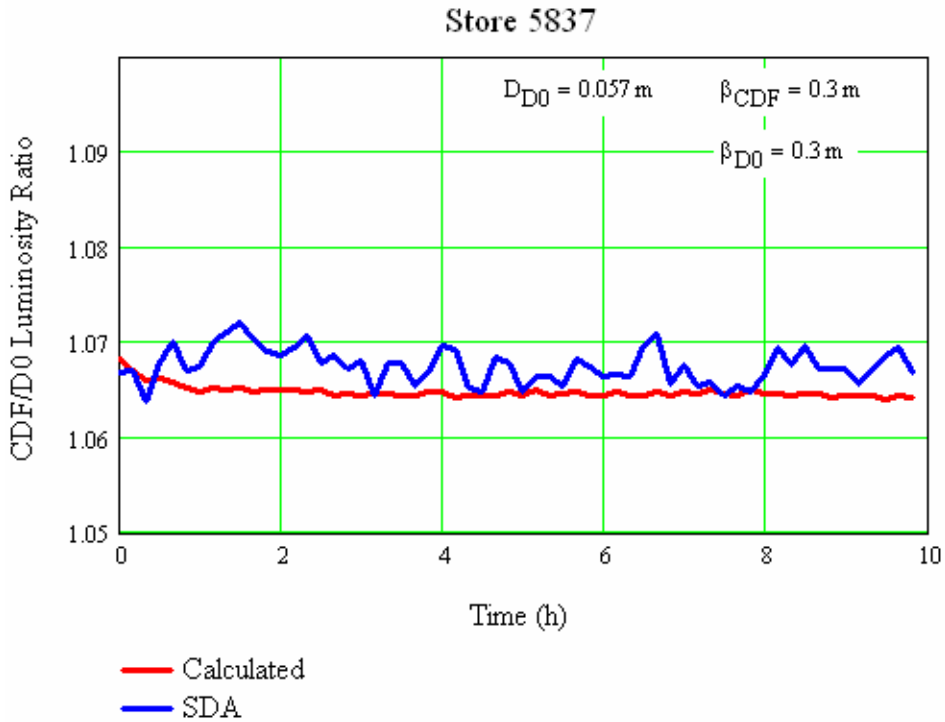


CDF/D0 Lumi Ratio – D* at D0

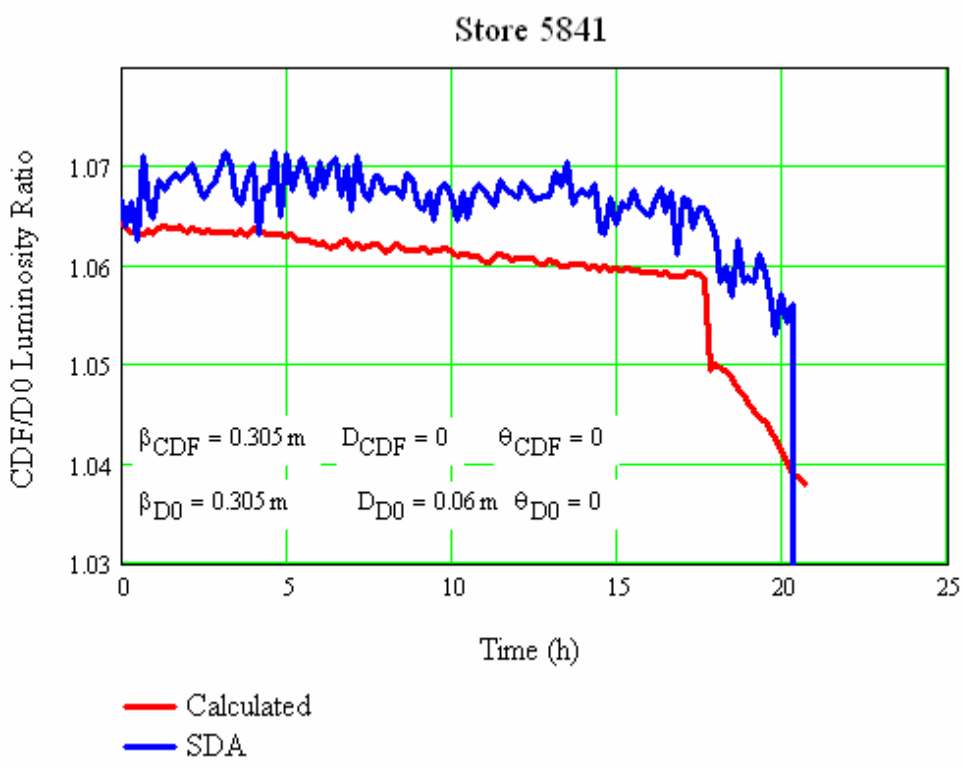


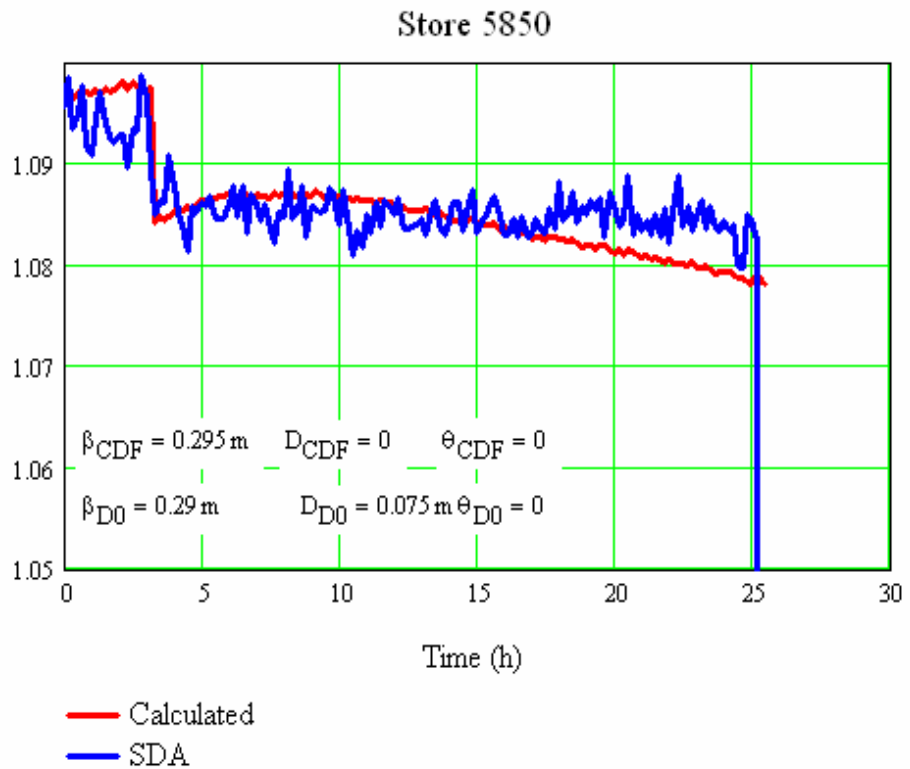






RF Station Trips Stores 5841, 5850



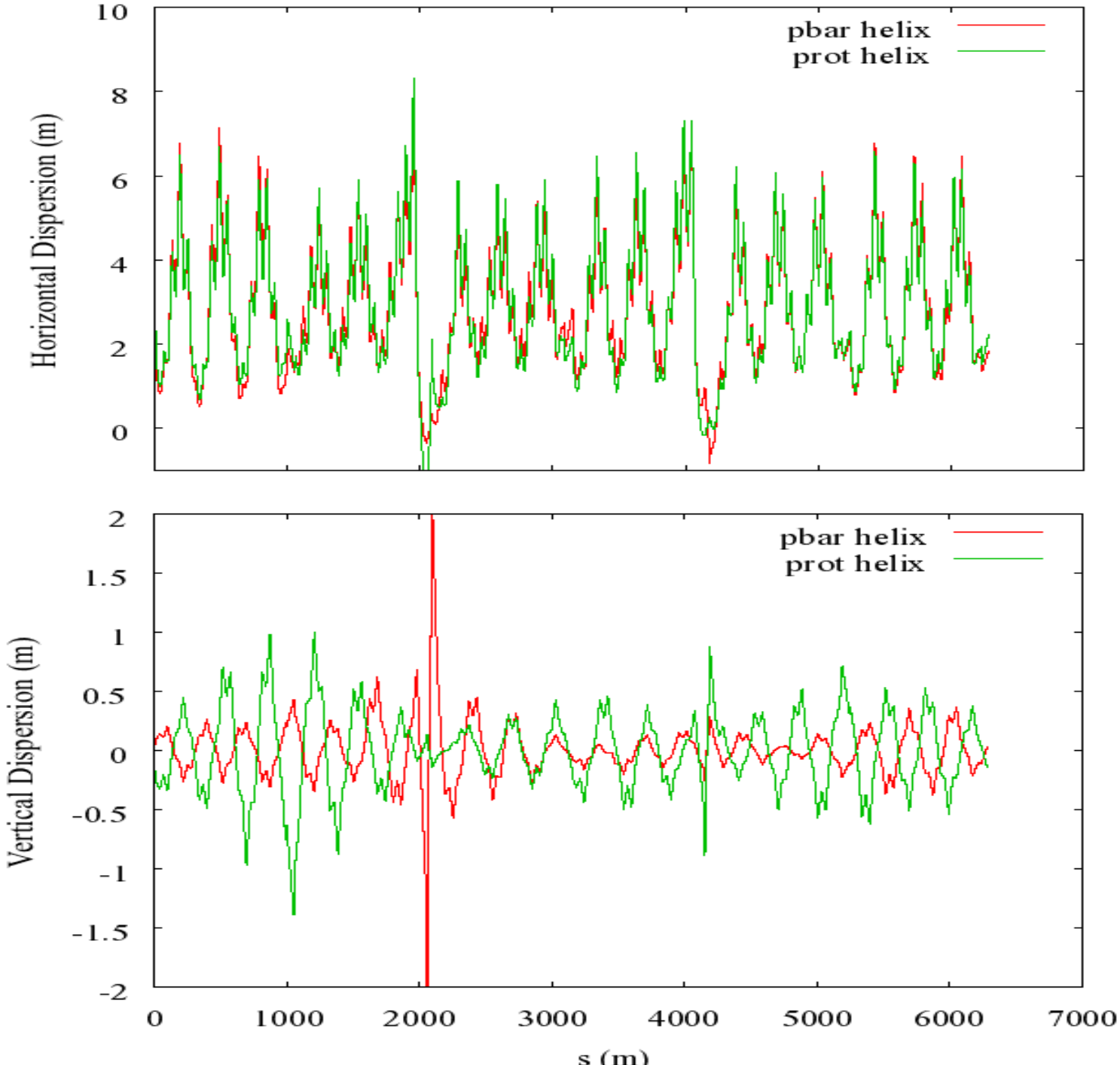


Conclusion 1

- CDF/D0 luminosity ratio constant over the store is not consistent with different β^* functions at the two experiments
- The luminosity ratio dropping at RF trip AND constant over the store is consistent with dispersion at D0

LowBeta Optics Measurement

- On January 26, 2008 used ~4 hours of proton only time to take the following data
  - Orbit Response Measurement on proton helix
  - Orbit Response Measurement on central orbit
  - Orbit Response Measurement on simulated pber helix
  - Turn-by-turn on central orbit
  - Turn-by-turn on proton helix
- This was first time we ever got pbar helix data

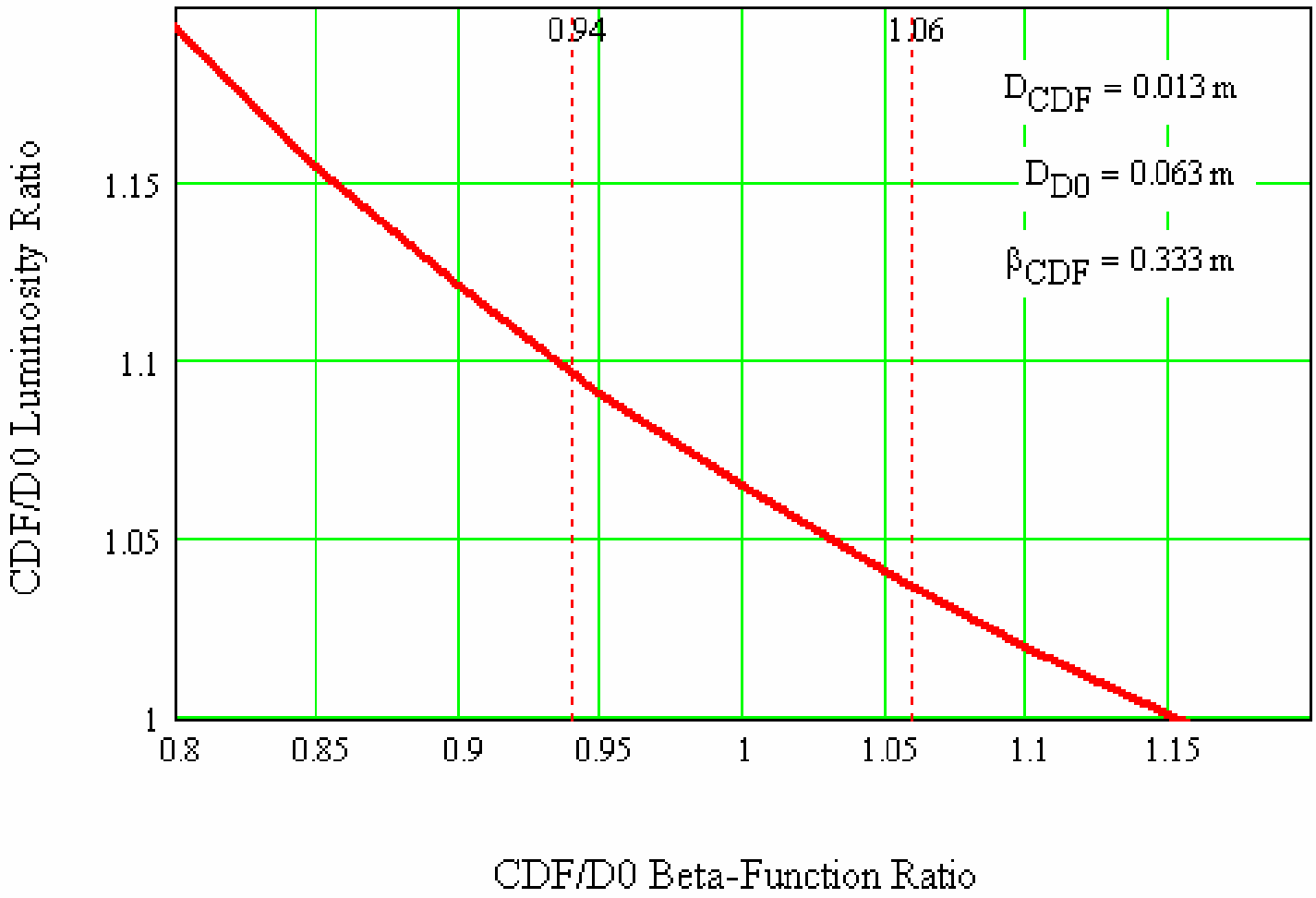

Horizontal Dispersion (m)
pbar helix
prot helix
Vertical Dispersion (m)
pbar helix
prot helix
s (m)

Summary Tables. ORM 1/26/08

	β_x pbar	β_y pbar	β_x prot	β_y prot	β^*
CDF	31.6	41.8	31.4	28.3	33.3
D0	28.1	35.8	31.4	29.9	31.3
	±15%		±10%		

	D_x pbar	D_y pbar	D_x prot	D_y prot	D^*	
CDF	0.5	0.0	2.1	-0.1	1.3	±10%
D0	5.7	1.1	6.6	1.8	6.3	±10%

CDF/D0 Luminosity Ratio with the Measured Optics



Conclusions 2

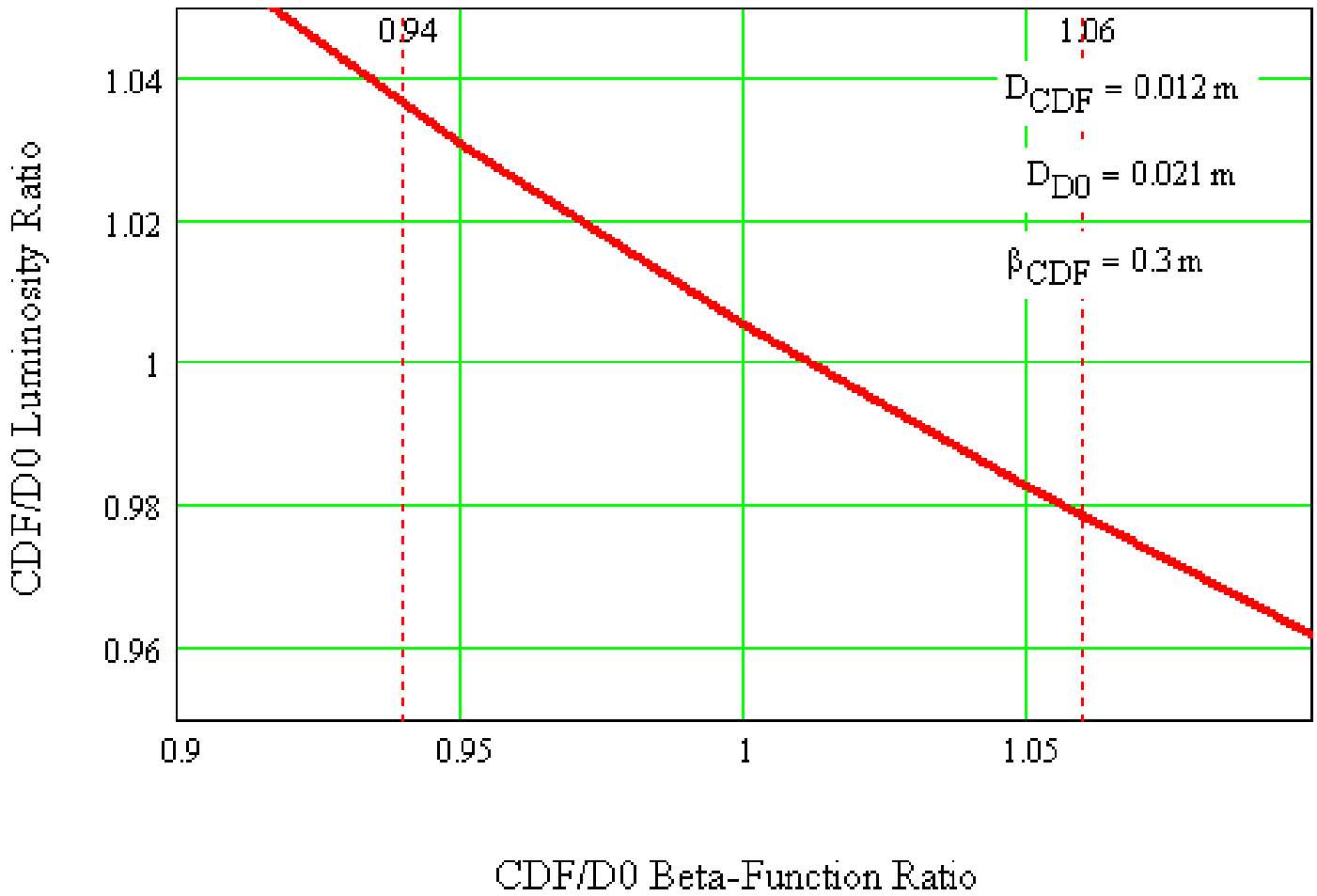
- Results of LowBeta optics measurement
  - Values of β^* at CDF and D0 are equal within the error
  - Variation of β^* between proton and pbar helix is ~20% in y and 0 in x.
  - Luminosity difference is explained by large D^*_x at D0
- These results agree with conclusions based on the analysis of luminosity ratio behavior

Correcting the Optics: Predicted β^* and D^*

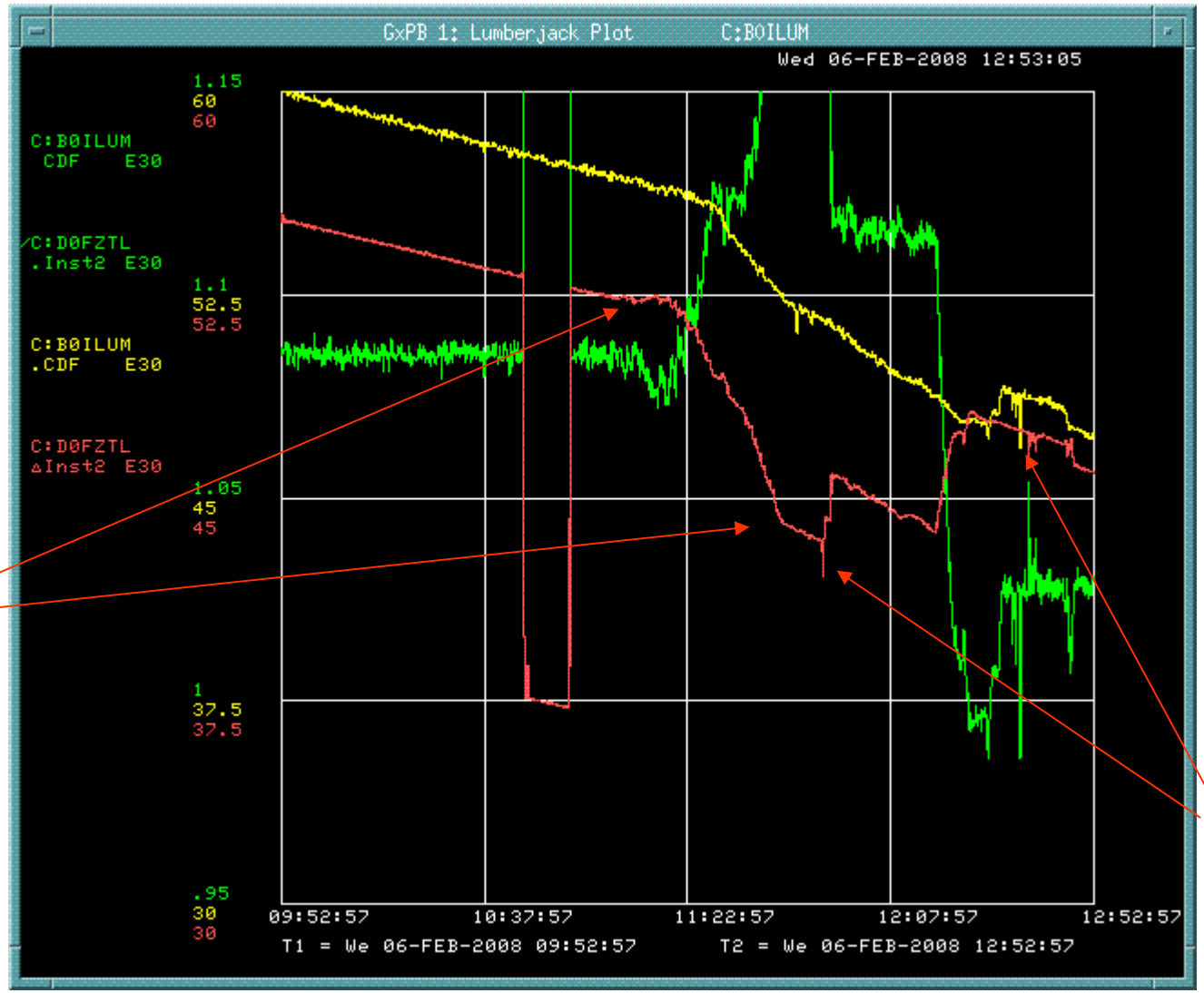
	β_x pbar	β_y pbar	β_x prot	β_y prot	β^*	β^*
CDF	28.5	42.2	30.5	27.5	32.2	29.0
D0	24.5	31.6	29.1	29.1	28.6	29.1

	D_x pbar	D_y pbar	D_x prot	D_y prot	D^*
CDF	0.0	1.0	1.2	0.8	1.2
D0	1.1	1.7	1.4	-1.6	2.1

CDF/D0 Luminosity Ratio with the Predicted Optics



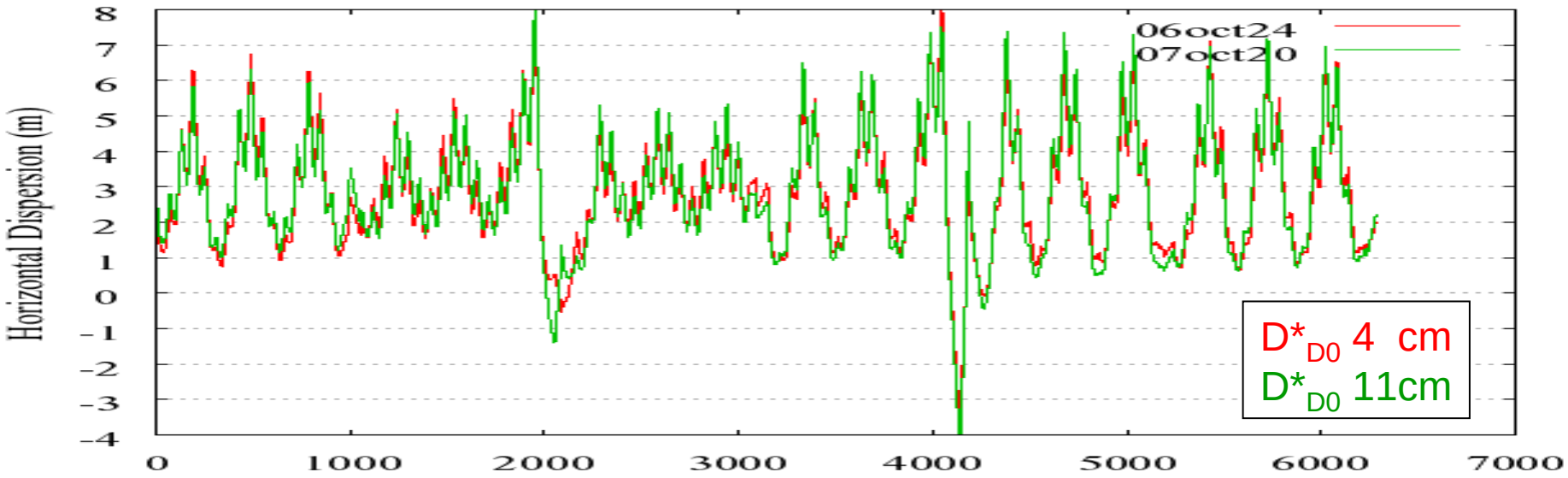
Luminosity During Correction

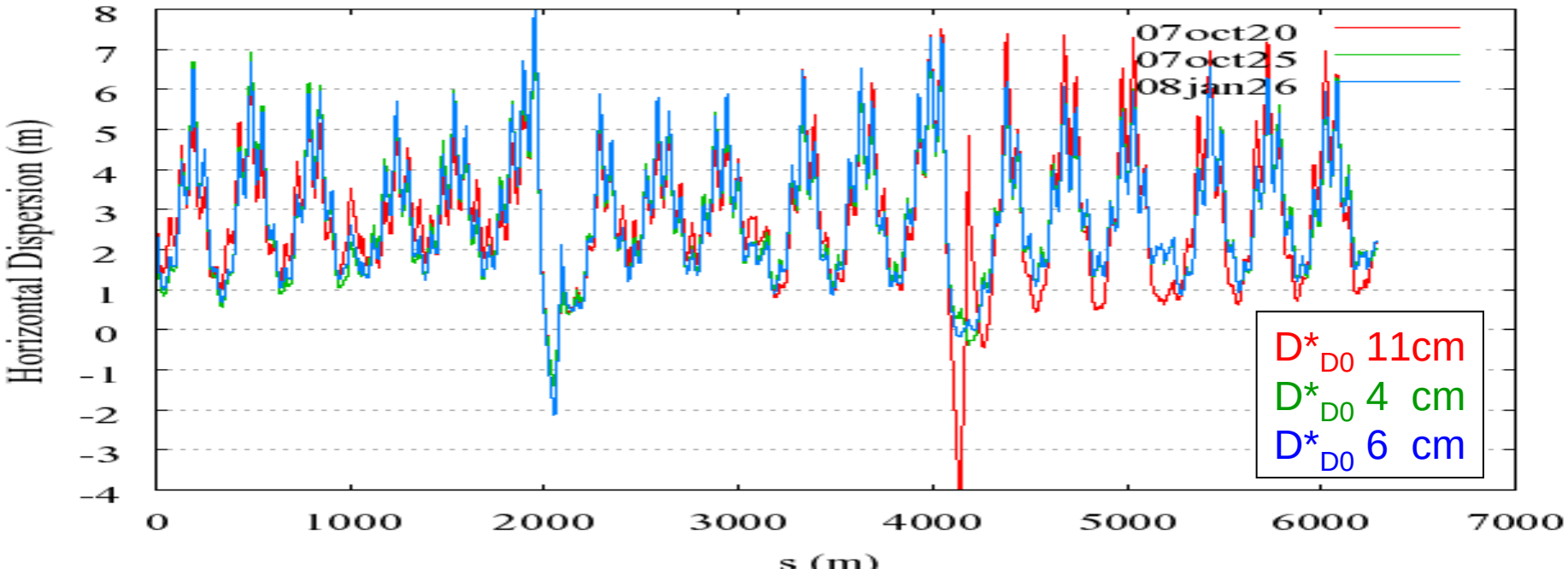


Dispersion Correction

Separator adjustments

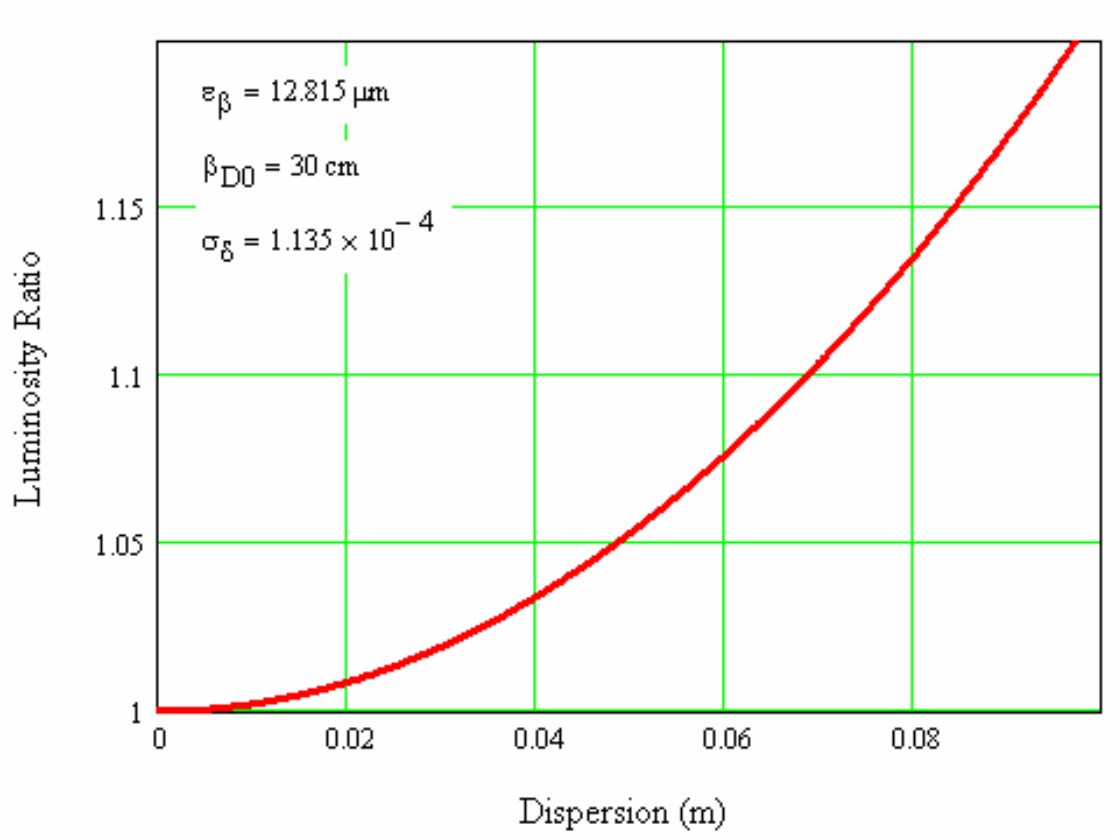
Why? Dispersion History





CDF/D0 Luminosity Ratio vs. D^*

$$R = 1 + \frac{D^{*2}\sigma_\delta^2}{\varepsilon\beta^*}$$



Summary

- Based on the results of LowBeta optics measurement a correction was developed with the following conditions
  - Keep values of β^* at CDF and D0 equal
  - Reduce D^*_x at D0
  - Keep the required tune changes minimal
  - Avoid large helix changes
- The correction has been implemented EOS 5887 and Store 5891. Luminosity ratio in store 5891 was between 2 and 3%
- More improvement may be gained from
  - Finer separation adjustment
  - Z* correction at D0 (? question to D0)
  - Correction of z* change between proton and pbar helix at D0 (need more analysis).

Other Possibilities: z* Shift at D0