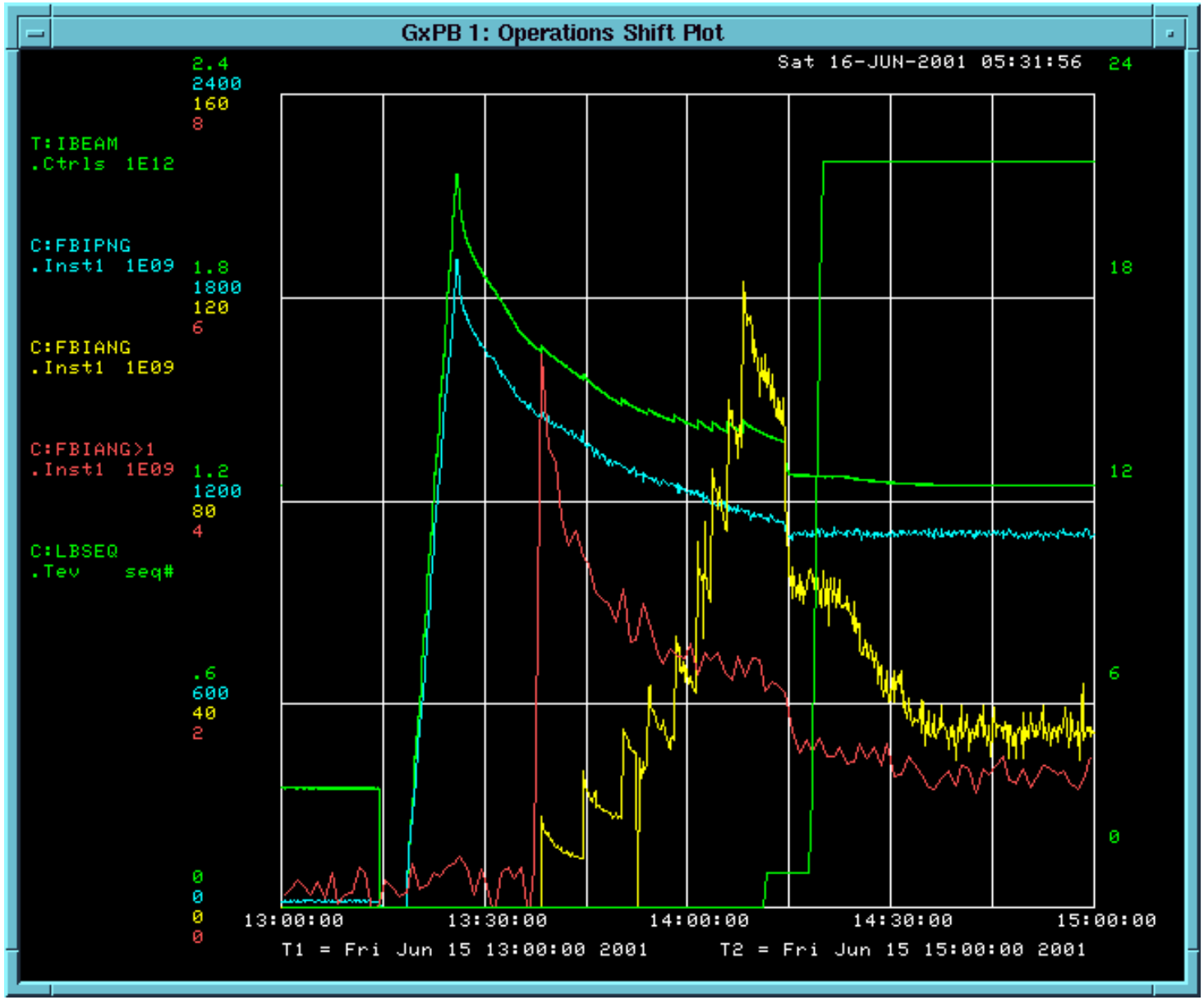
Fermilab

# Beam-Beam Effects and Tevatron Inefficiencies: Past, Present and Future

from "Beam-Beam Paper"

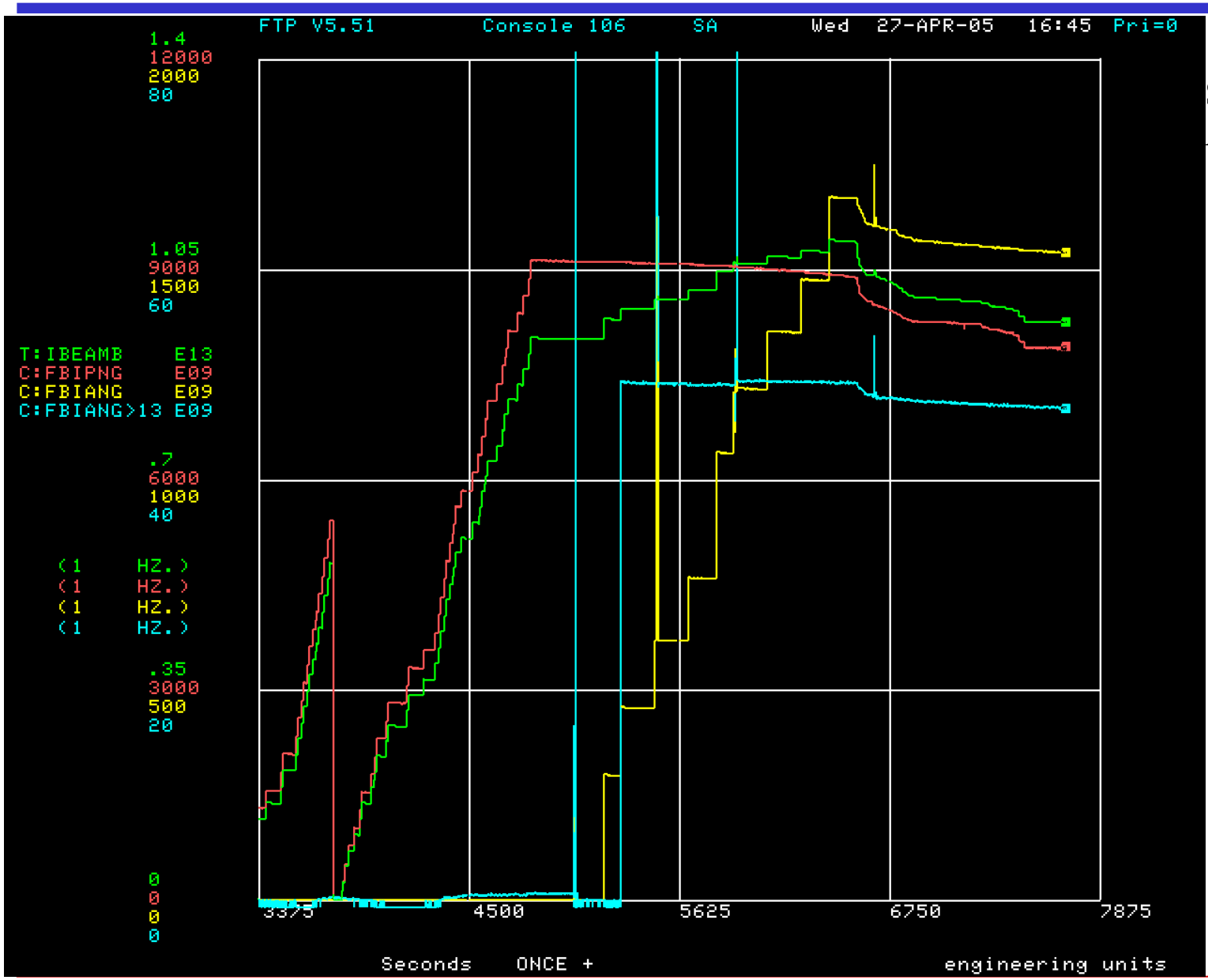
V.Shiltsev et al

# Tevatron Inefficiencies: 2001



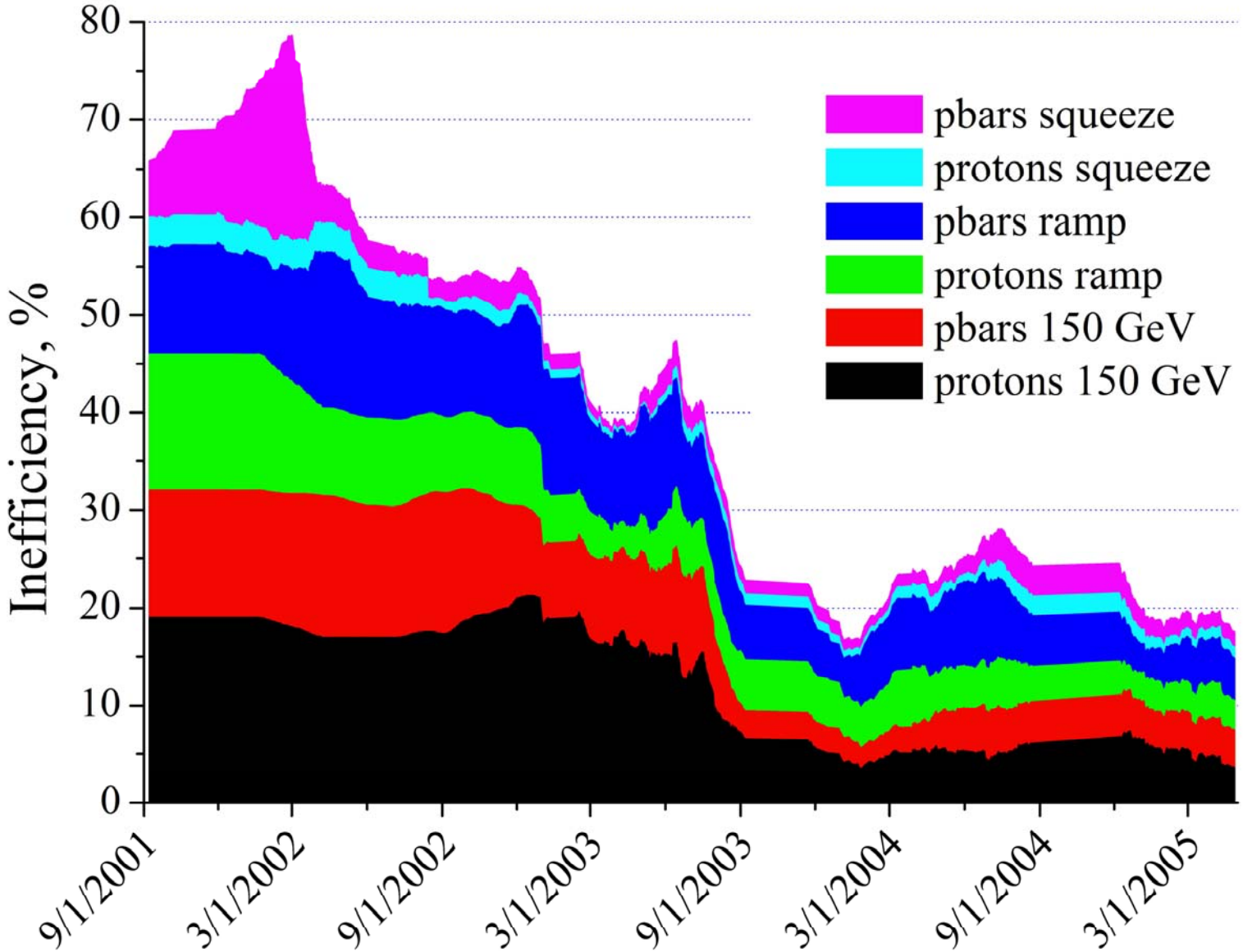

Store #535
Jun 15, 2001

# Tevatron Inefficiencies: 2005




Store #4116
Apr 27, 2005

# Tevatron Inefficiencies: 2001-2005

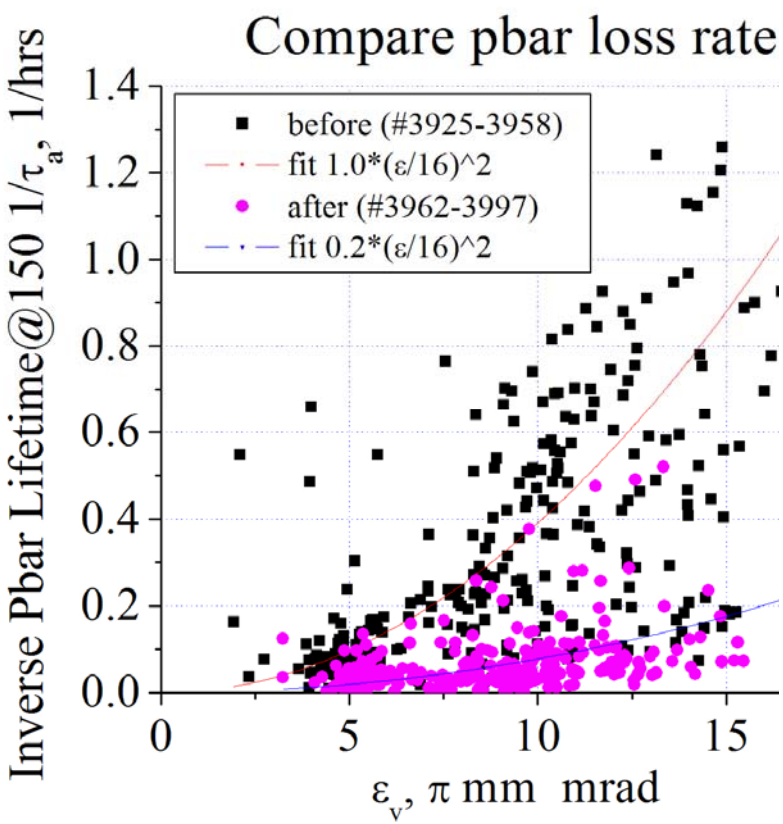


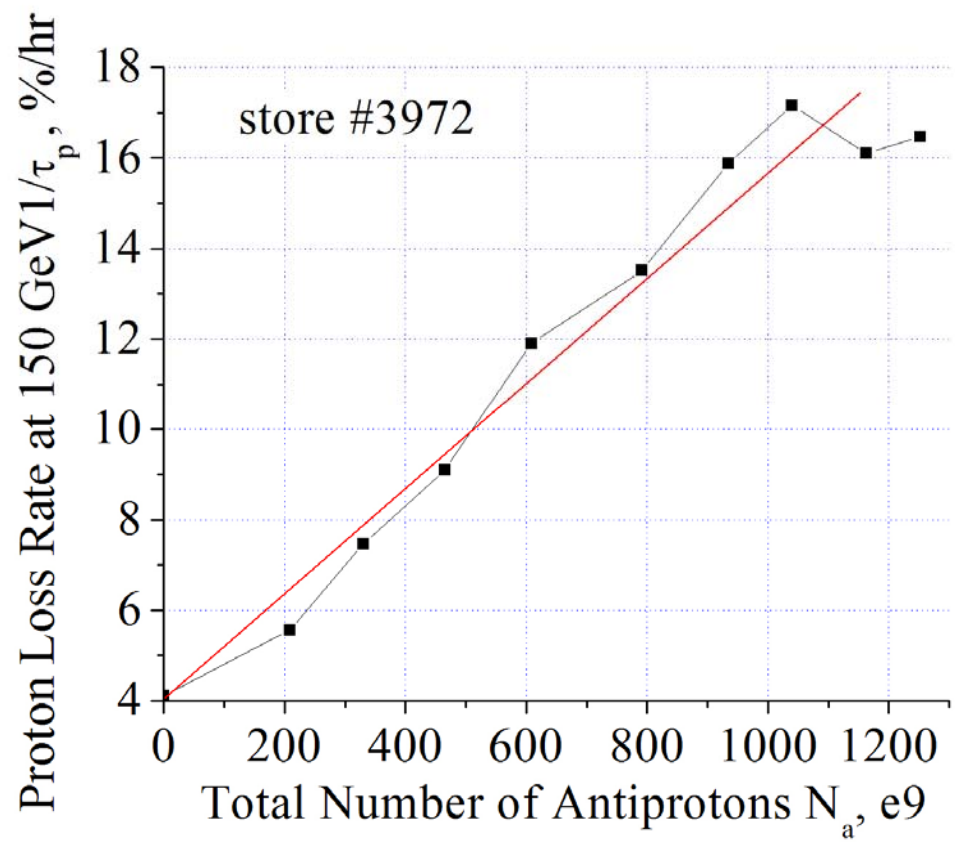

???

Jun 2009

# Beam Loss at Injection Helix

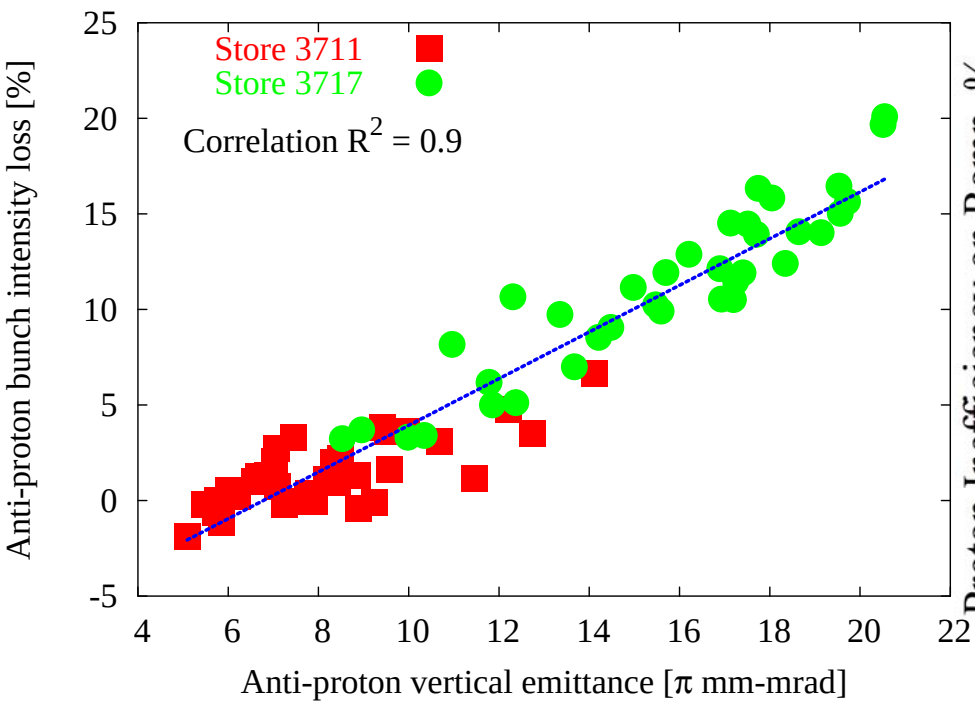
$$\frac{dN_{a,p}}{N_{a,p}} \propto \sqrt{t} \cdot \varepsilon_{a,p}^{2} N_{p,a} Q'^{2}{}_{a,p} \times F_1(S_{a-p}, Q_{a,p}, \frac{dP}{P})$$

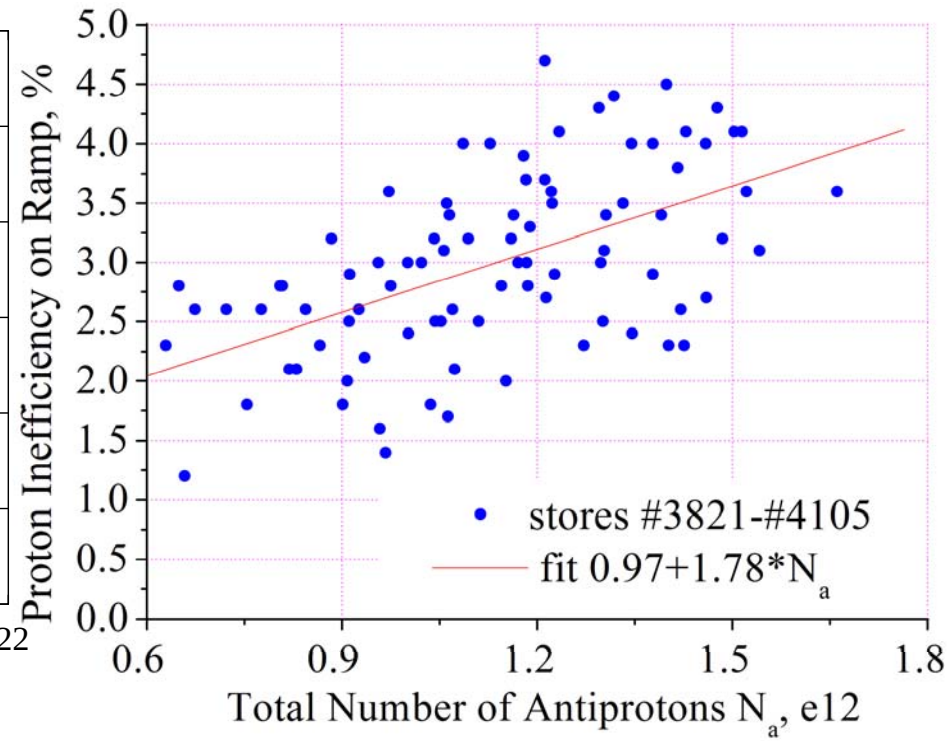


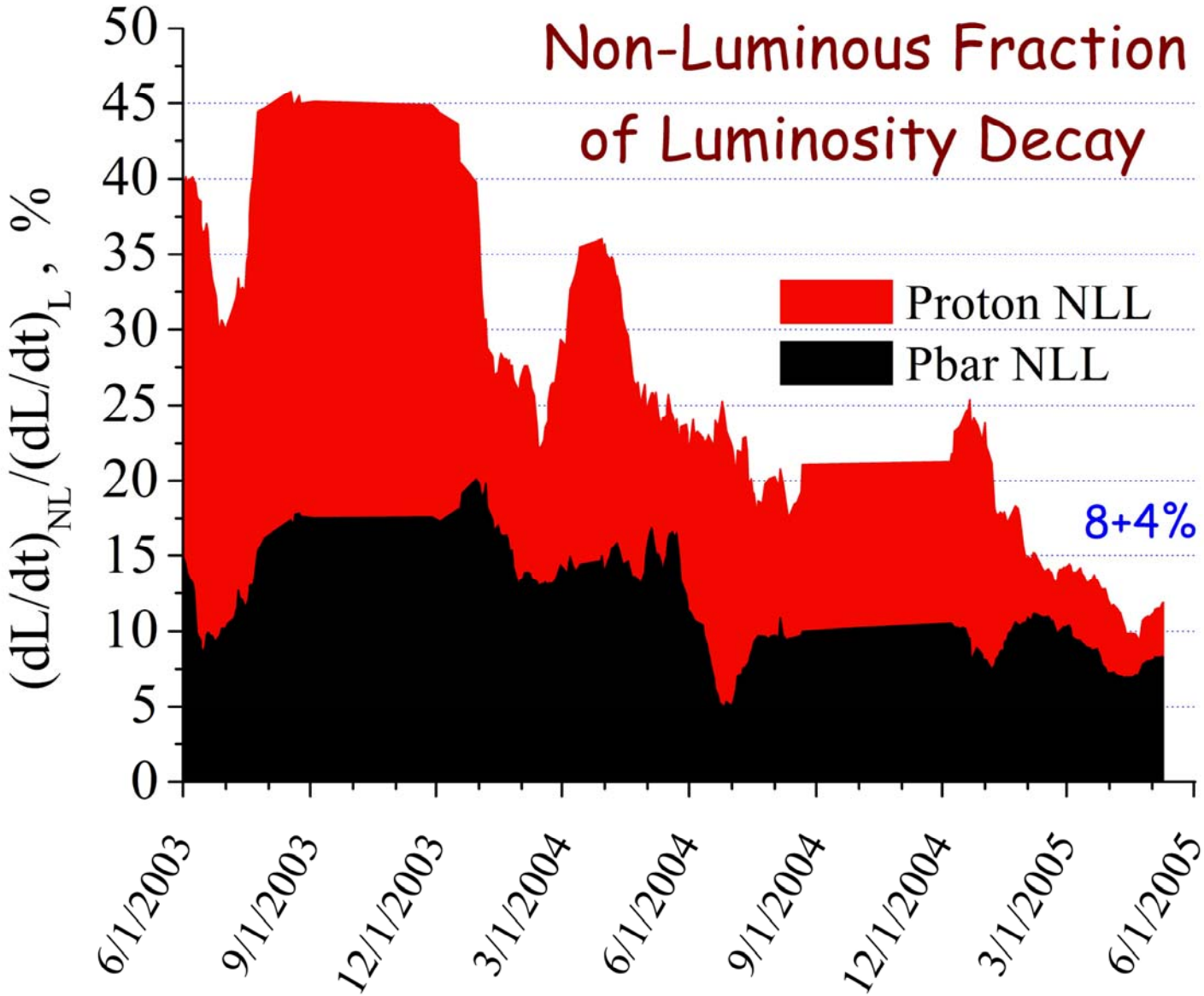
# Beam Loss on Ramp

$$\frac{dN_{a,p}}{N_{a,p}} \propto \varepsilon_{a,p}^{2} N_{p,a} \times F_2(S_{a-p}, Q_{a,p}, Q'_{a,p})$$



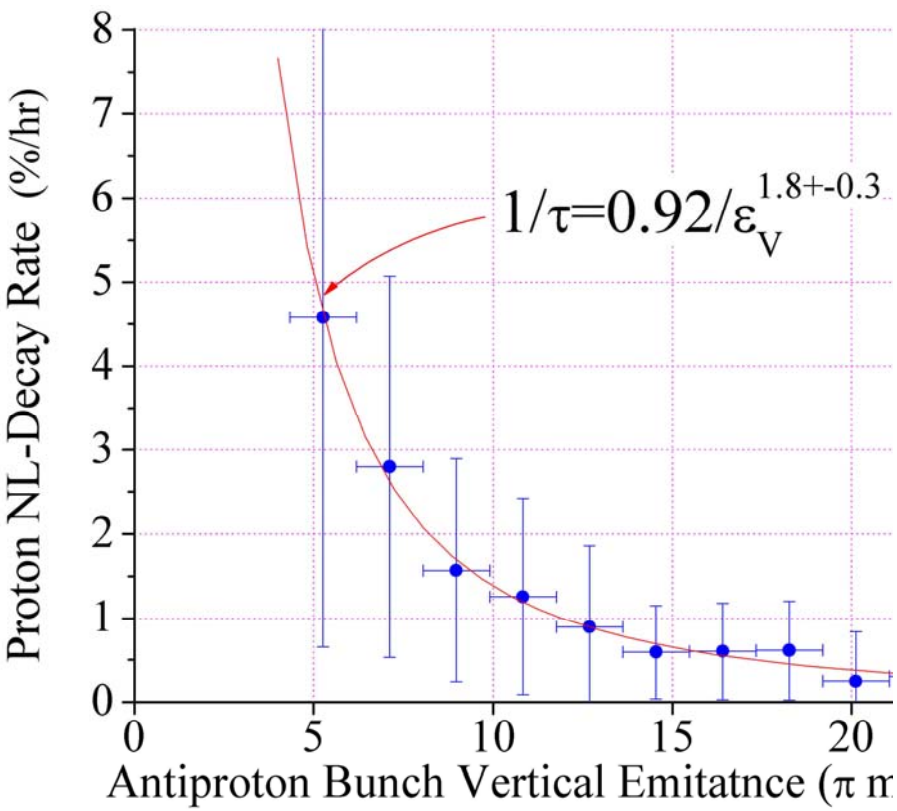
# *L*-Lifetime Affected by Beam-Beam

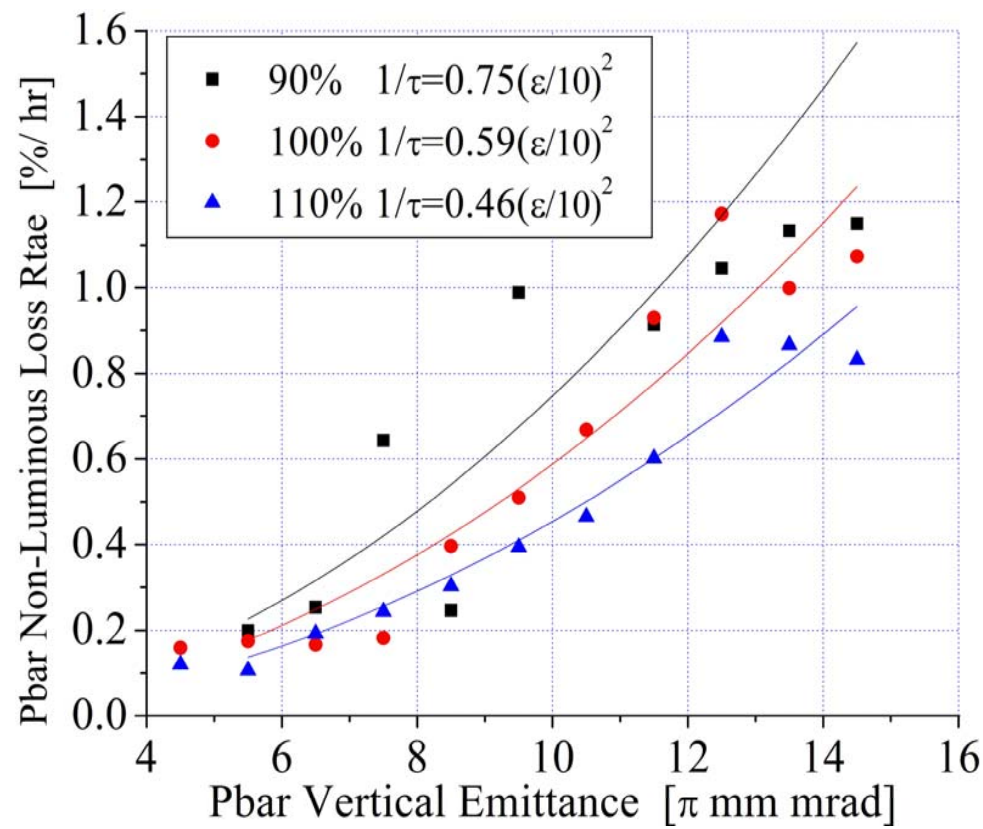


# Beam Loss in Collisions

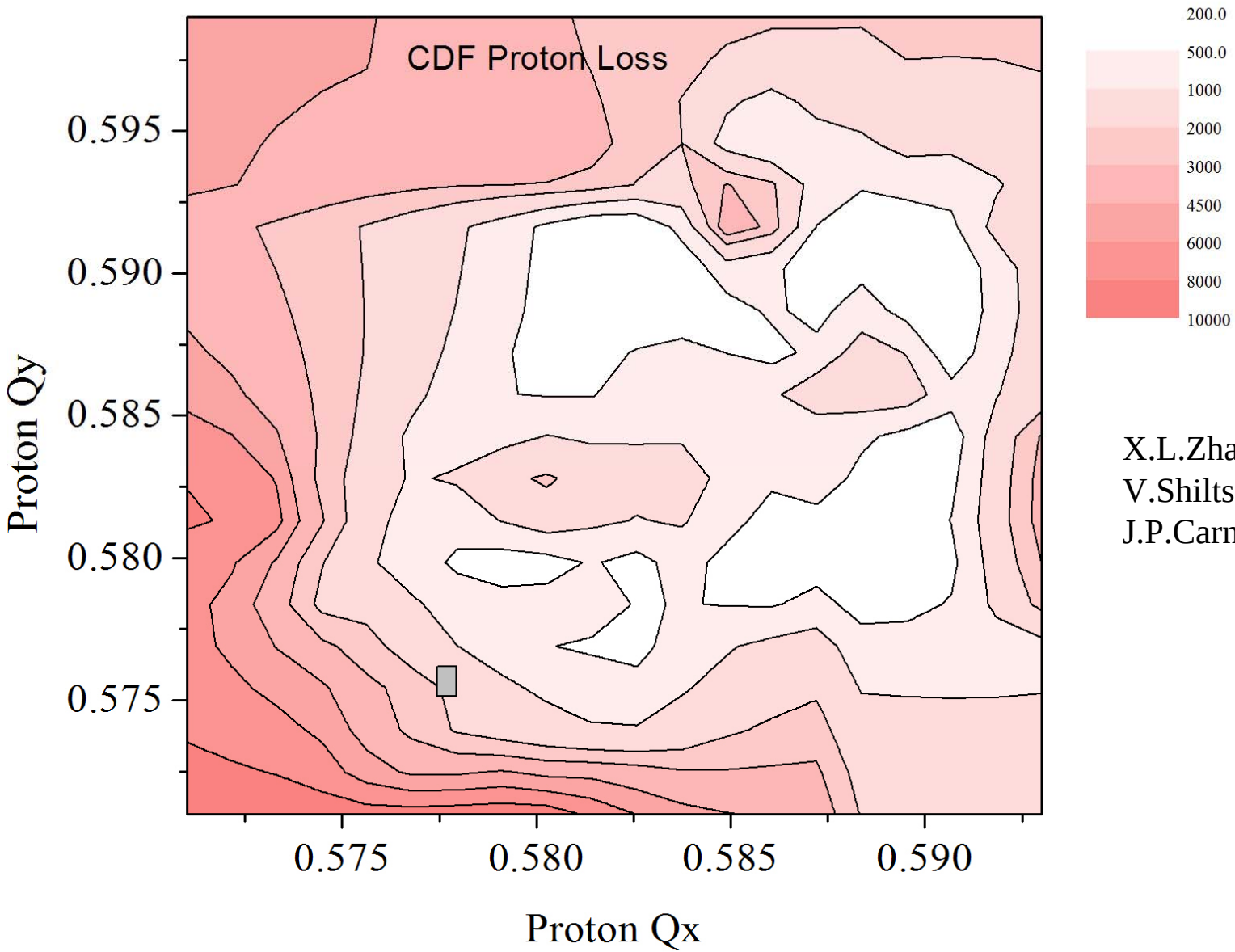
$$\frac{dN_p}{N_p dt} \propto \frac{N_a}{\varepsilon_a^2} \times F_3(Q_p, Q'_p)$$

$$\frac{dN_a}{N_a dt} \propto N_p \frac{\varepsilon_a^2}{S_{a-p}^3} \times F_4(Q_a, Q'_a)$$



# For Example: Function $F_3\ (Q_{x,y})$




X.L.Zhang
V.Shiltsev
J.P.Carneiro

# Tev Inefficiencies: Projections for FY09

| | | IF RUN "AS NOW"! | |
|---|---|---|---|
| | Now | 3xN_a | 3xN_a 1.4xEmm |
| P at 150 | 4.4%±2.8 | 13.2 | 13.2 |
| A at 150 | 3.9%±2.2 | 3.9 | 7.8 |
| P ramp | 3.4%±0.9 | 8.2 | 8.2 |
| A ramp | 4.7%±1.2 | 4.7 | 8.4 |
| P squeeze | 1.0%±0.4 | 3.0 | 3.0 |
| A squeeze | 1.5%±0.5 | 1.5 | 2.0 |
| *Total before LB* | *18.9%±3.9* | *34.5* | *42.6* |
| Tau_p at LB | 160 hr ± 60 | ~60 | ~100 |
| Tau_a at LB | 160 hr ± 60 | ~160 | ~80 |
| *Total in Tau_L* | *10%±5* | *~13%* | *~13%* |
| ***Total Int-L*** | ***28%±7*** | ***44%*** | ***50%*** |

# What Can Be Done:

- Better WP for protons at 150, ramp and at LB: 7/12<Q<3/5
- Stabilize pbar tunes in collisions
- Increase helix on ramp and at LB (higher voltage seps, more)
- Drop Q' on ramp and in collisions (octupoles, FB?)
- Reduce beam emittances (inj dampers, MI, RR, AA, Booster)
- Adjust betatron phase advance between two IPs
- Beam-Beam Compensation with TELs