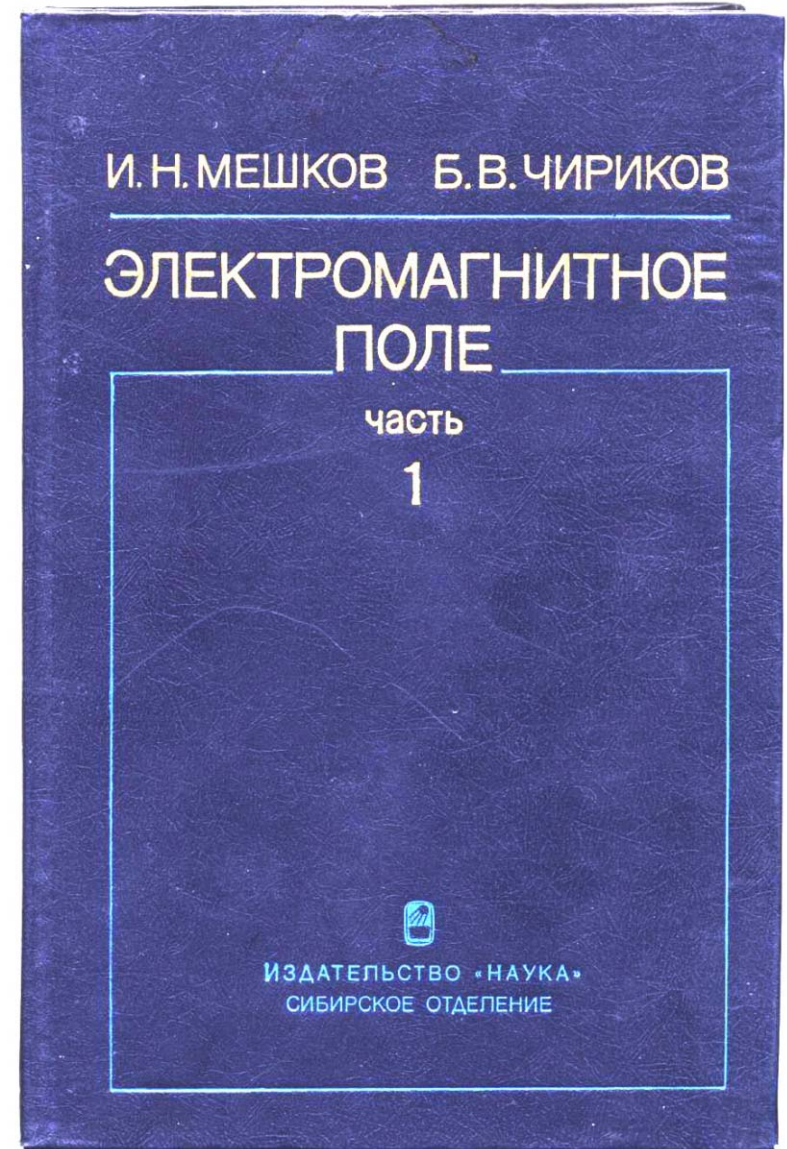


Good Company (1)

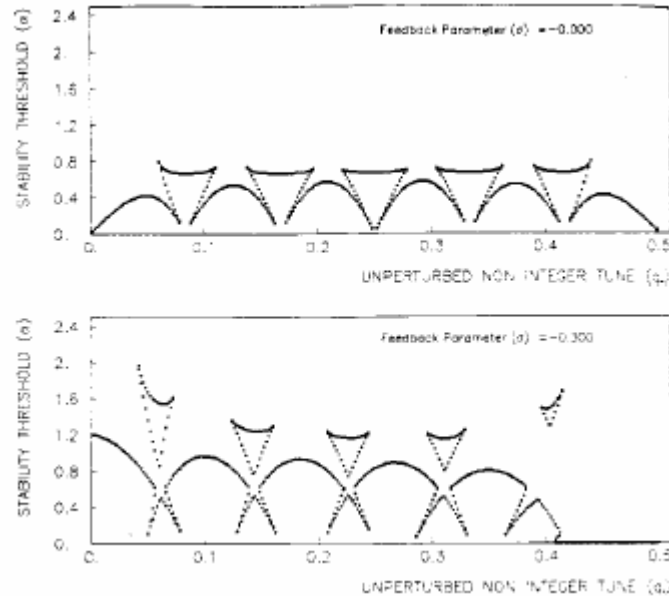


Good Company (2)

INSTABILITIES AND BEAM INTENSITY LIMITATIONS IN CIRCULAR ACCELERATORS

S. Myers

CERN, Geneva, Switzerland



FOR LIBRARY



SCAN-0006048

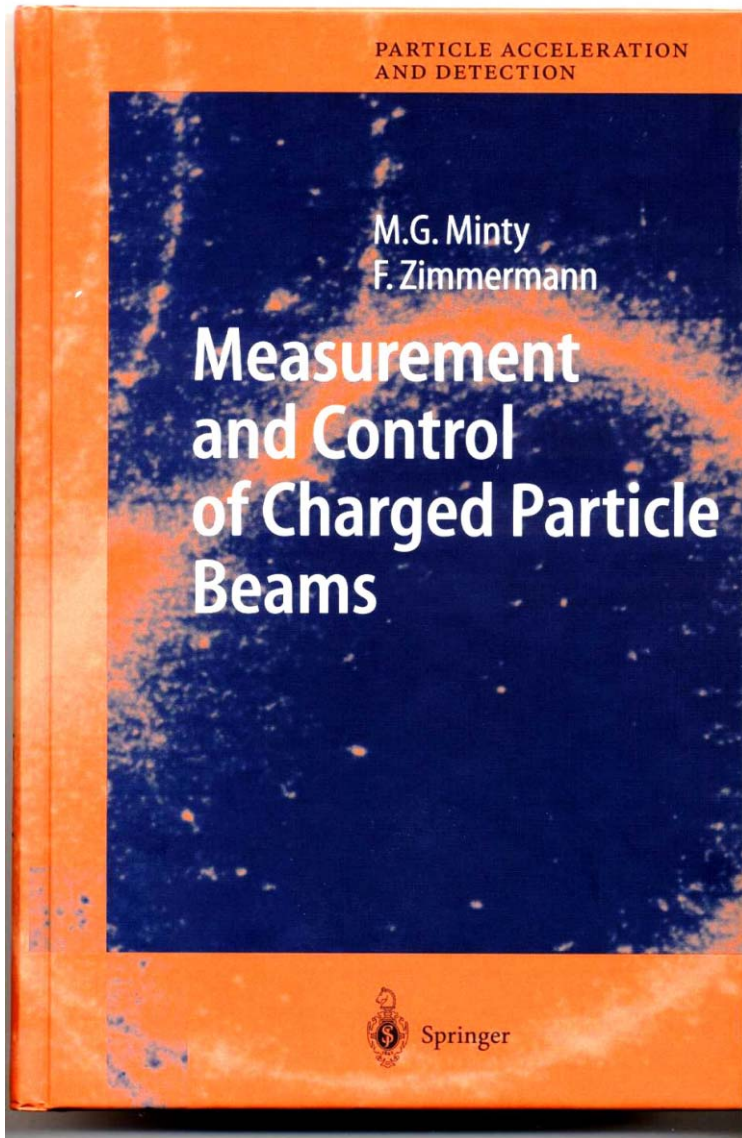
LEP Note 40

25.8.1982

INCREASE OF THE BEAM-BEAM LIMIT BY COMPENSATION
OF THE BEAM-BEAM TUNE DEPENDENCE ON AMPLITUDE

S. Myers

Good Company (3)





Fermilab

Status of Tevatron Run II and

Novel Technologies for Luminosity Upgrades

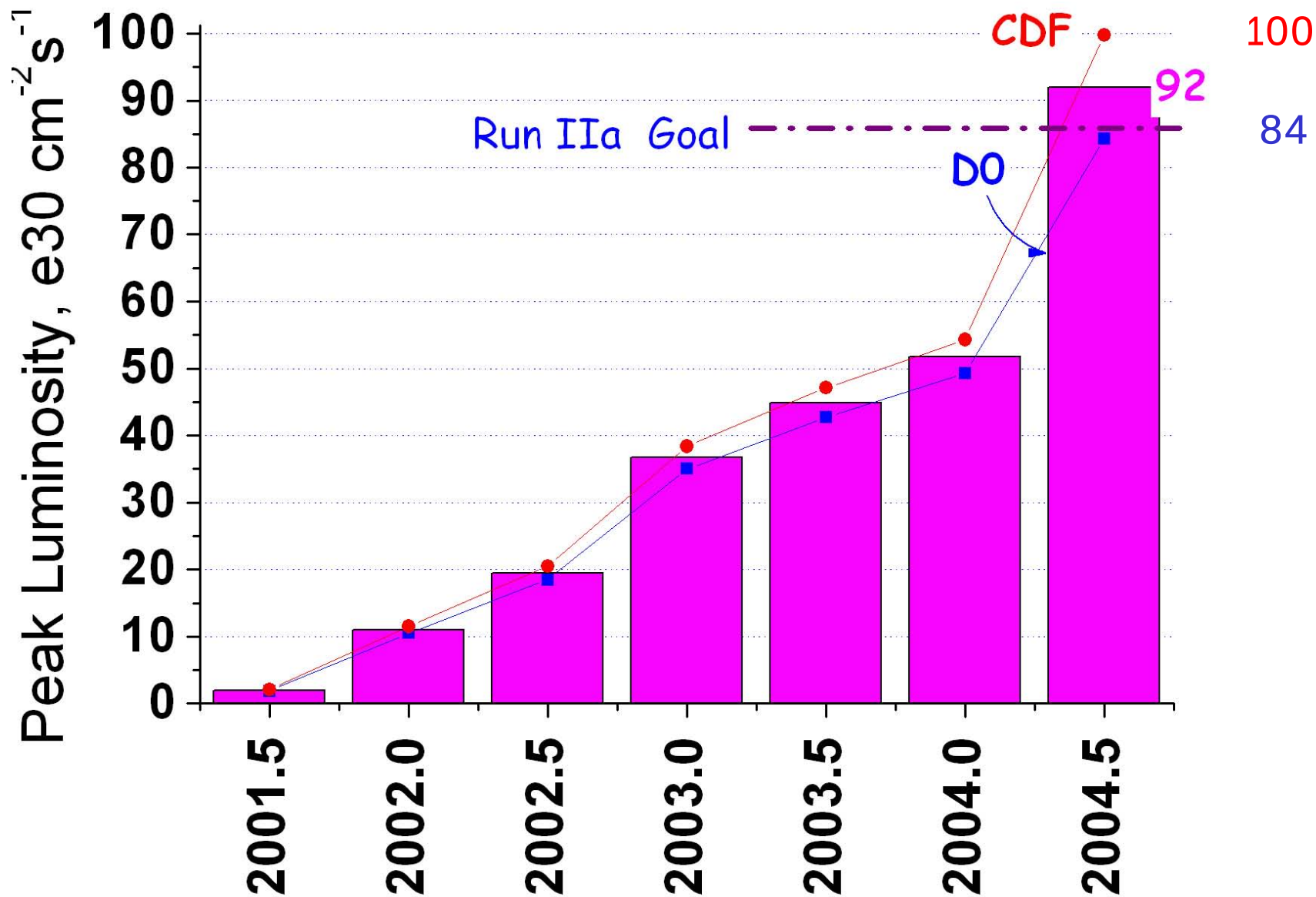
Vladimir Shiltsev

Fermilab

Content:

- Tevatron Collider Run II:
 - Luminosity exceeded Run I Ia design goal
 - Machines: Booster, Pbar Source, MI, Tevatron
 - Luminosity upgrade projects
- Novel Technologies:
 - Fast Luminous Region Analysis
 - Quad Position Monitoring
 - Electron Lens

Tevatron Luminosity Progress



Luminosity 2002-2004: $1.15^{15} = 8$

- First 9 months Mar-Nov'01
 - Optics AA->MI lines fixed Dec'01
 - Quenches on abort fixed by TEL-1 Feb'02
 - 20% pbar loss in Sequence 13 fixed Apr'02
 - “New-new” injection helix May'02
 - Shot lattice, AA cooling reduces IBS July'02
 - Tev BLT helps at injection Sep'02
 - Pbar coalescing improved in MI Oct'02
 - C0 Lamberts removed Feb'03
 - S6 circuit tuned/SEMs removed June'03
 - “5 star” helix on ramp Aug'03
 - Reshimming/Alignment Dec'03
 - MI dampers/Longer Stores Feb'04
 - 2.5MHz AA → MI transfer/Cool shots April'04
 - Reduction of β^* to 35 cm May'04
 - Pbar shots from both AA and Recycler July'04
-

Performance Goals

- Peak Luminosity Goals:

- Now $92 \times 10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$ ($\sim 1.1 \times$ Run I Ia Goal, no Recycler)
- Upgrade/Design $\rightarrow 270 \times 10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$ ($\times 3$ over current)
- Upgrade/Base $\rightarrow 160 \times 10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$ ($\times 2$ over current)

$$L = \frac{3\gamma f_0 B N_{\bar{p}} N_p}{\pi \beta^* (\varepsilon_p + \varepsilon_{\bar{p}})} H(\sigma_l / \beta^*)$$

- Primary factors

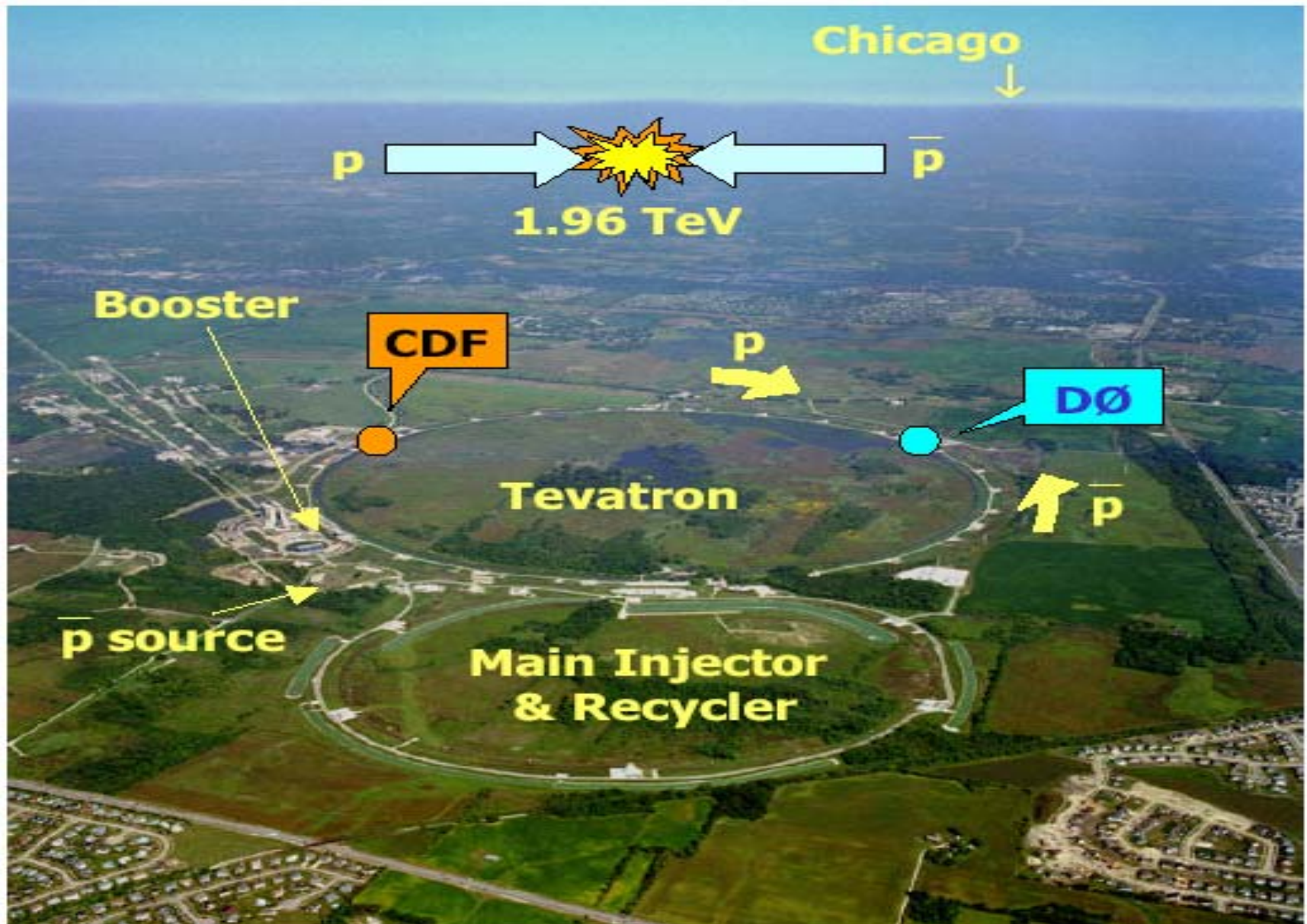
- Number of antiprotons: BN_{pbar}
 - ← major contributor to Lum. Upgrade
- Proton beam brightness: (N_p / ε_p)
 - constrained by the limit on antiproton beam-beam tune shift

Run II : Now and Upgrade

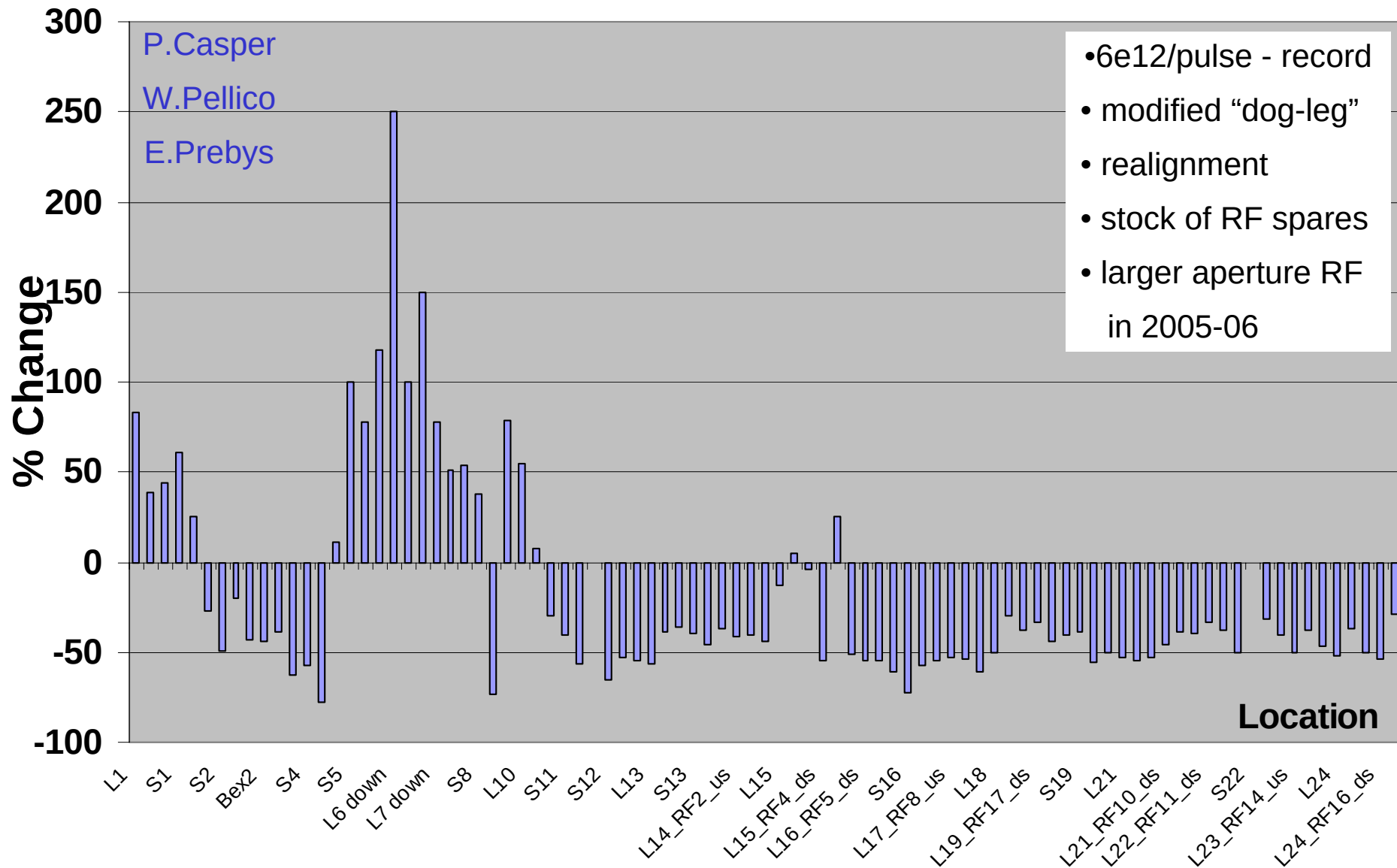
980 GeV/beam, 36 x 36

Parameter	Now	Upgrade w Recycler	
Initial Luminosity	92e30	270e30	cm ⁻² sec ⁻¹
Integrated Luminosity	13	47	pb ⁻¹ /week
Total Int. Luminosity	0.56	4.4-8.5	fb ⁻¹
Protons/bunch	260e9	270e9	
Antiprotons/bunch	38e9	127e9	
Proton emit. (95%, norm)	19	20	πmm-mr
Pbar emit. (95%, norm)	17	20	πmm-mr
Beta @ IP	0.35	0.35	meter
Hourglass factor	0.68	0.65	
Peak Pbar Production Rate	13.5e10	45e10	1/hr

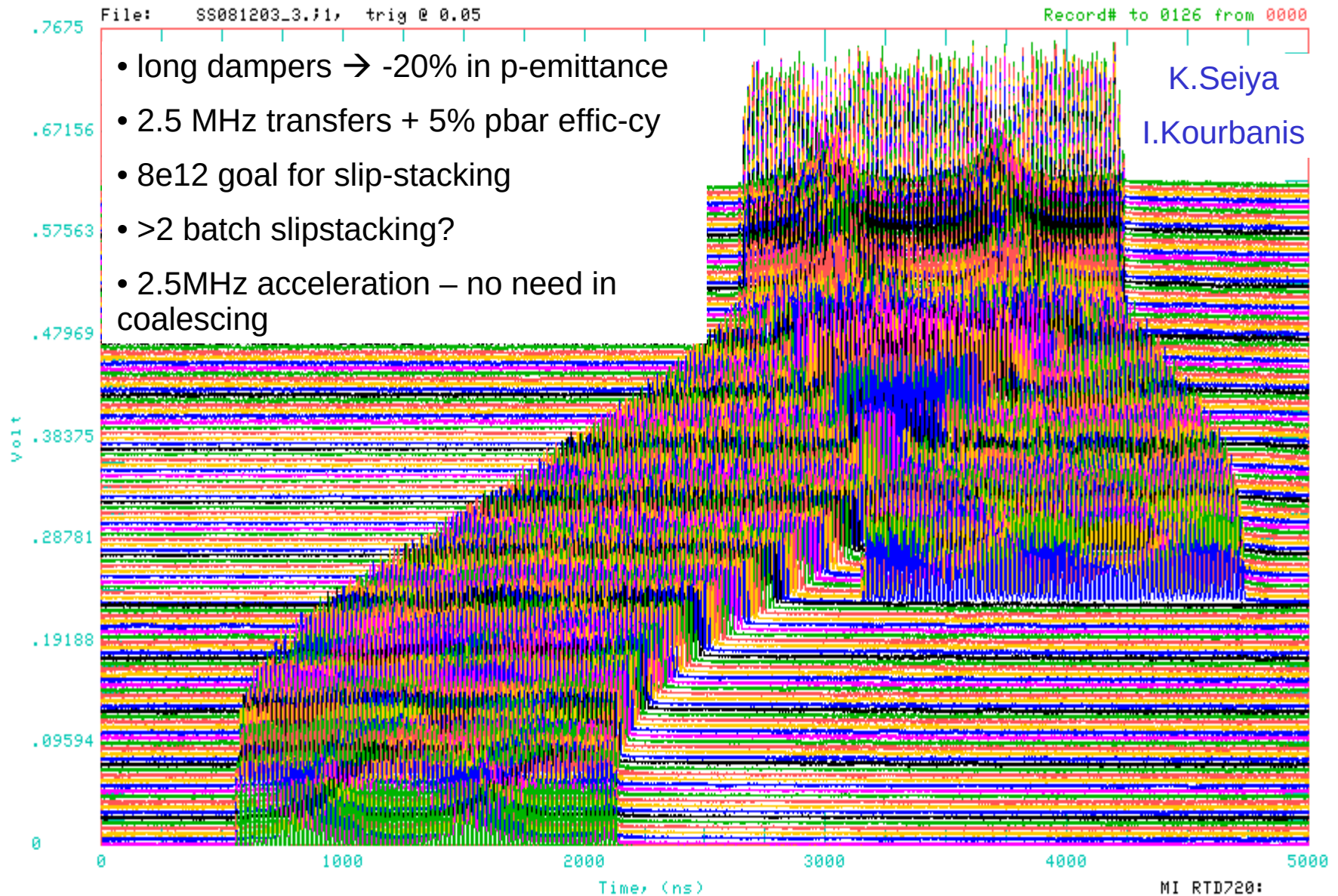
Tevatron Collider Complex in Run II



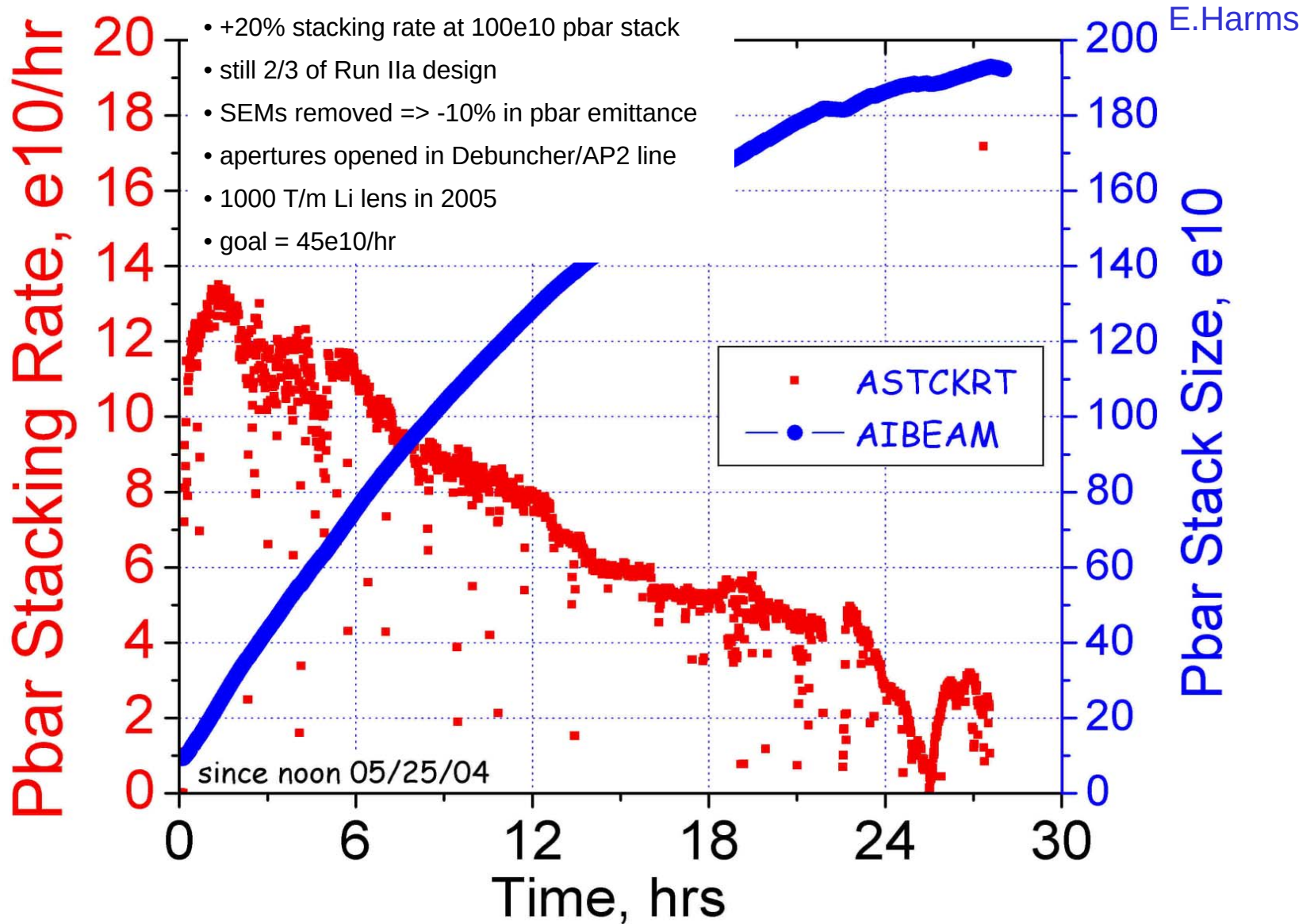
Booster Activation (since collimators)



Slip Stacking 6e12 p's in Main Injector



Antiproton Accumulator

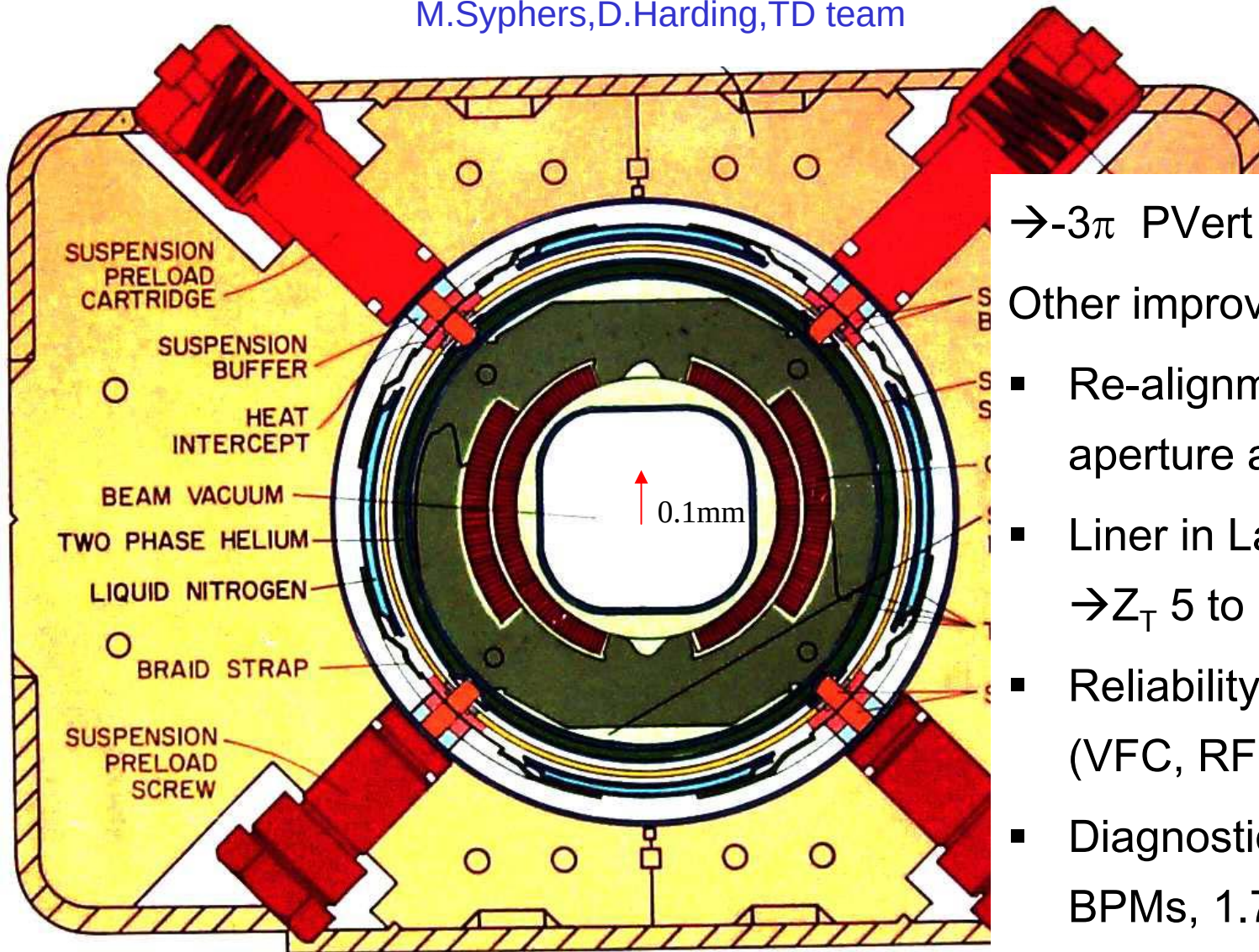


Recycler Ring = Key Upgrade

- Will serve as 2nd antiproton storage ring
- Will store up to 600e10 pbar (now 200e10 in AA)
- Will accept 40e10 pbars every hour from AA
- Will need both electron and stochastic cooling
- Stochastic cooling works now (60eVs at 150e10 pbars)
- 4.3 MeV Electron Cooling to be installed in Fall'04
- Recycler vacuum greatly improved (500hrs, <3pi/hr)
- >90% efficient transfers AA → RR and RR → MI
- 200 BPMs upgraded to 10 micron rms resolution
- Instabilities studied, MI ramp effects compensated
- RR studies take some 20% of pbar production timeline
- Currently supports “mixed source” shots AA+RR
- Talk and 2 posters at EPAC'04

Reshimming=Lifting Up SC Coils

M.Syphers,D.Harding,TD team

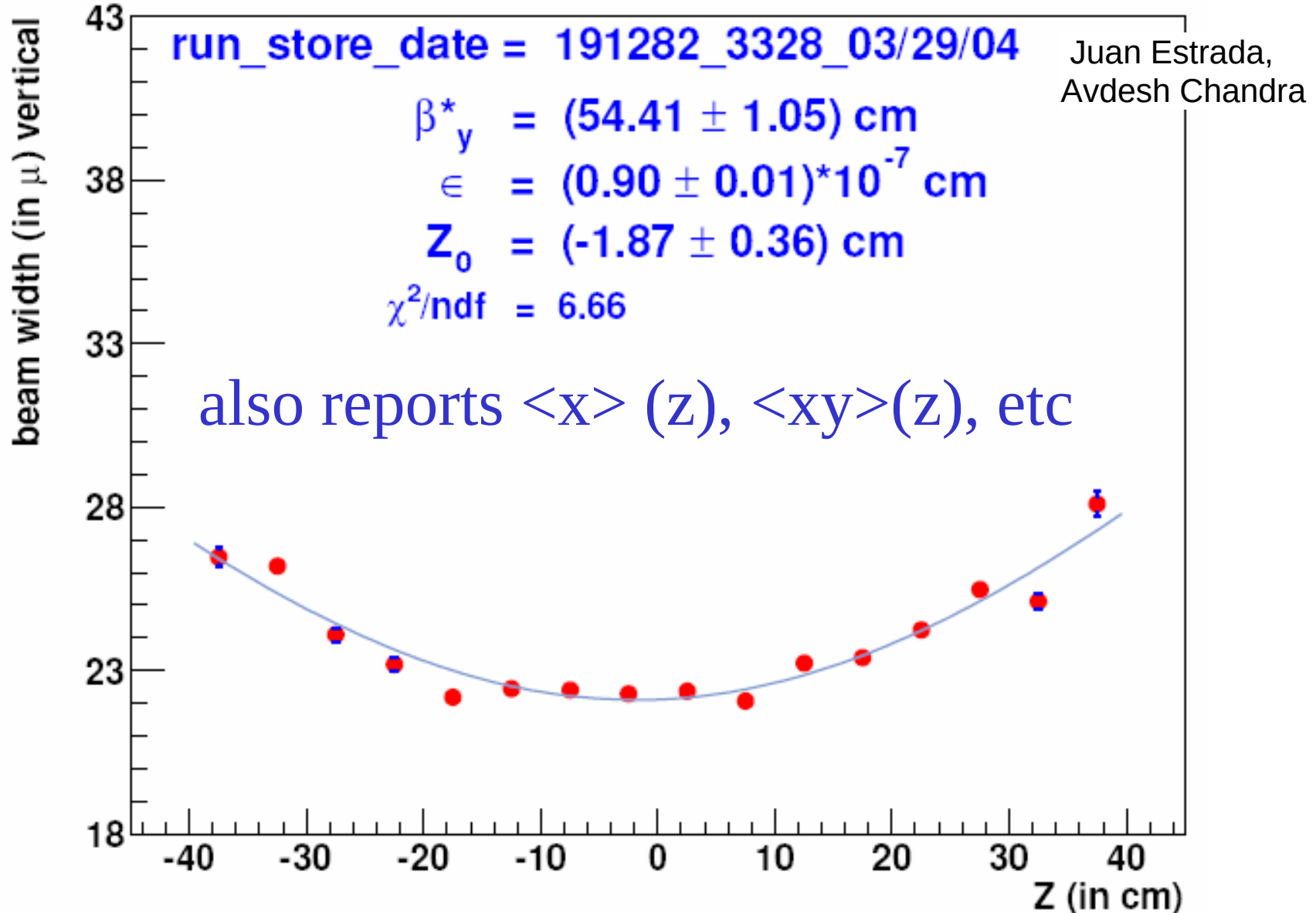


→ -3π PVert at Inj

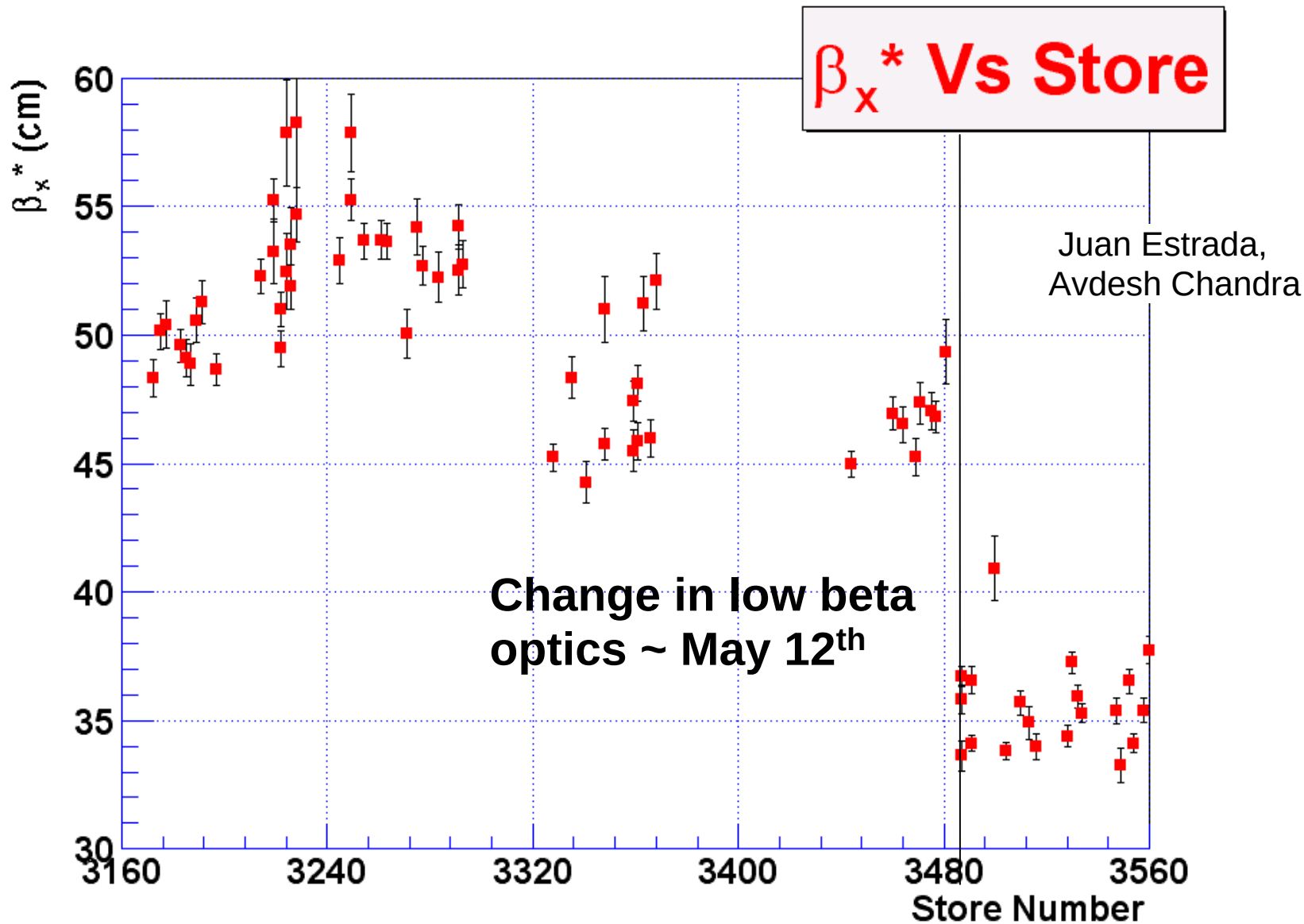
Other improvements

- Re-alignment to open aperture at 150 GeV
- Liner in Lambertsons
→ Z_T 5 to 1M/m → 20% p
- Reliability improved
(VFC, RF PA) >120 hr/wk
- Diagnostics upgrade
BPMs, 1.7GHz Schottky,
IPMs, BLMs, Abort Gap

β^* from Luminous Region Analysis



Improvement in β_x^*



Orbit Drifts

profile <| 1 mm

HORZ prot-bunch 17-FEB-2004 15:07:51 89.9

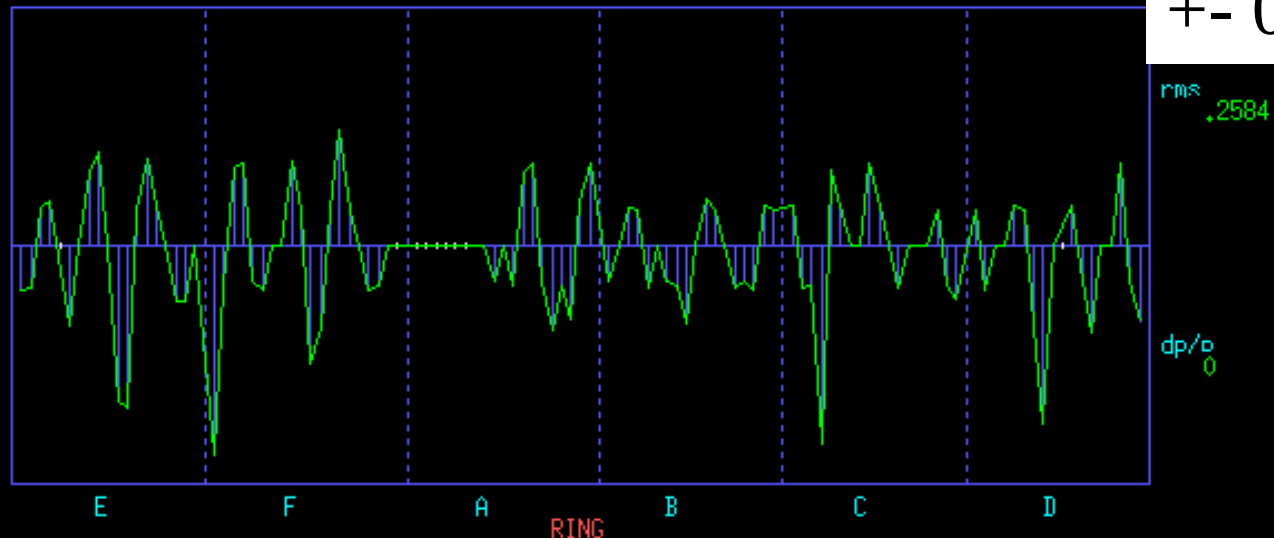
	E	F	A	B	C	D
11	-.18	-.16	NoBeam	-.15	.17	.15
13	-.17	.33	NoBeam	0	-.17	-.18
15	.16	.35	NoBeam	.16	-.16	0
17	.19	-.15	NoBeam	.15	-.83	0
19	NoBeam	-.18	NoBeam	-.17	.32	.17
22	-.33	0	0	0	.17	.15
24	0	0	0	-.15	0	-.33
26	.31	.36	-.15	-.16	0	-.74
28	.4	.15	0	-.32	.35	0
32	0	-.49	-.16	0	.17	NoBeam
34	-.65	-.34	.31	.2	0	.17
36	-.68	.15	.35	.15	-.17	-.15
38	.15	.49	-.15	0	0	-.36
42	.37	.15	-.35	-.17	0	0
44	.17	0	-.16	-.15	0	0
46	0	-.18	-.3	-.18	.15	.35
48	-.23	-.16	.19	.17	-.16	-.15
49	-.23	0	.35	.15	-.22	-.31
A0		NoBeam	NoBeam			
F0	0	-.8773				

store 3240
minus
store 3206

19 days →
0.26 mm rms
+- 0.7 mm p-p

+1 mm

-1 mm

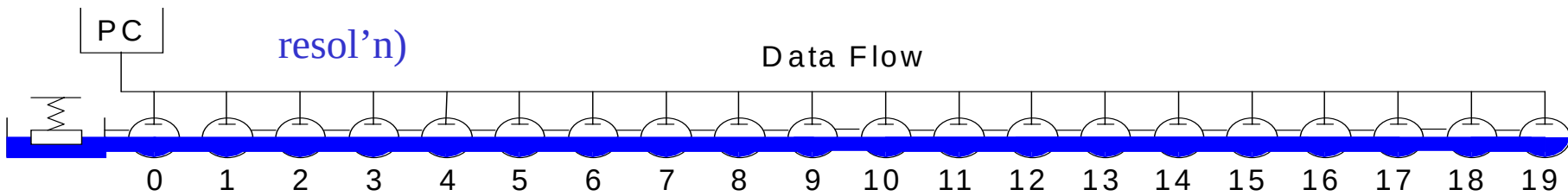
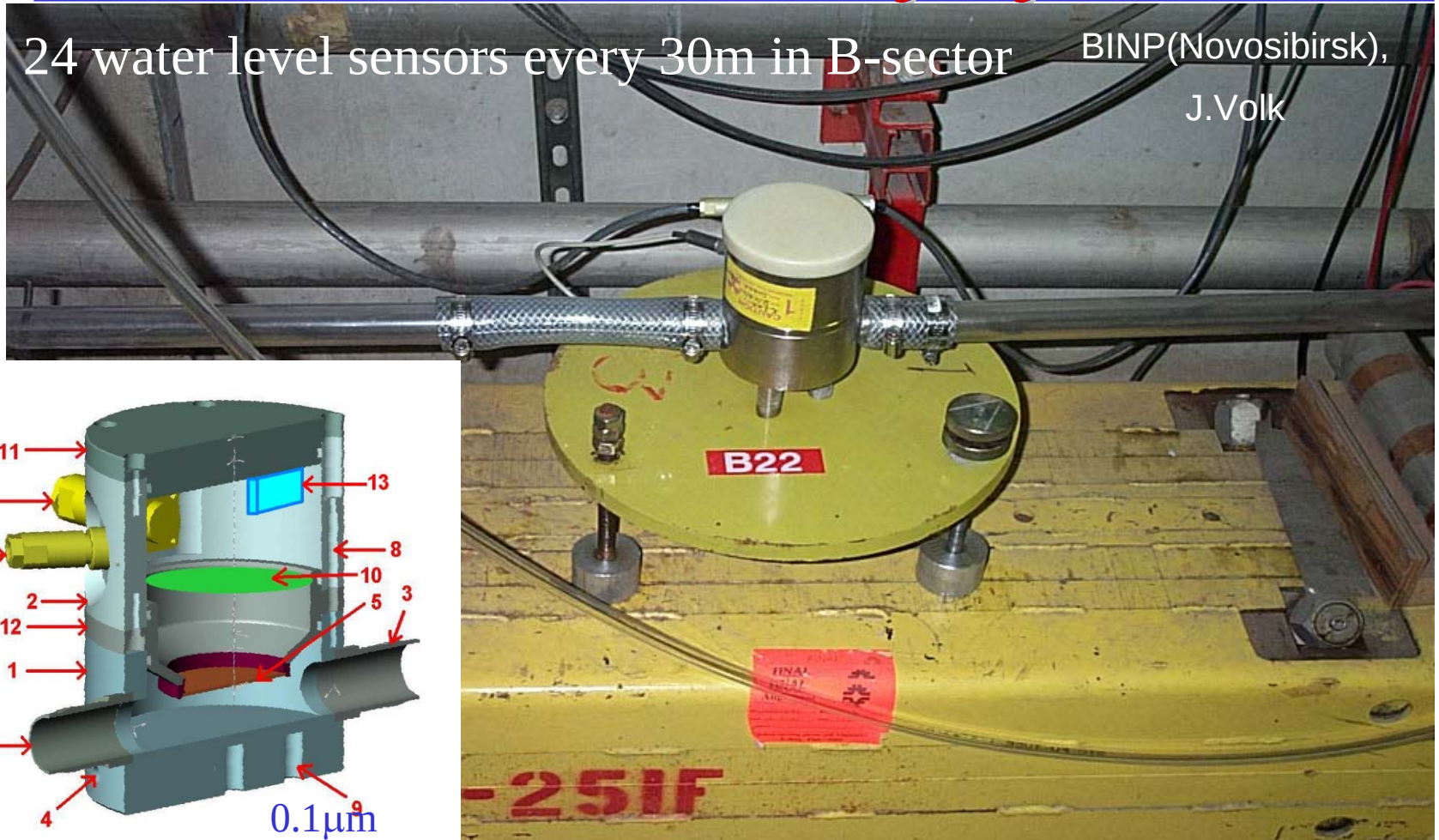


Tev On-Line Survey System

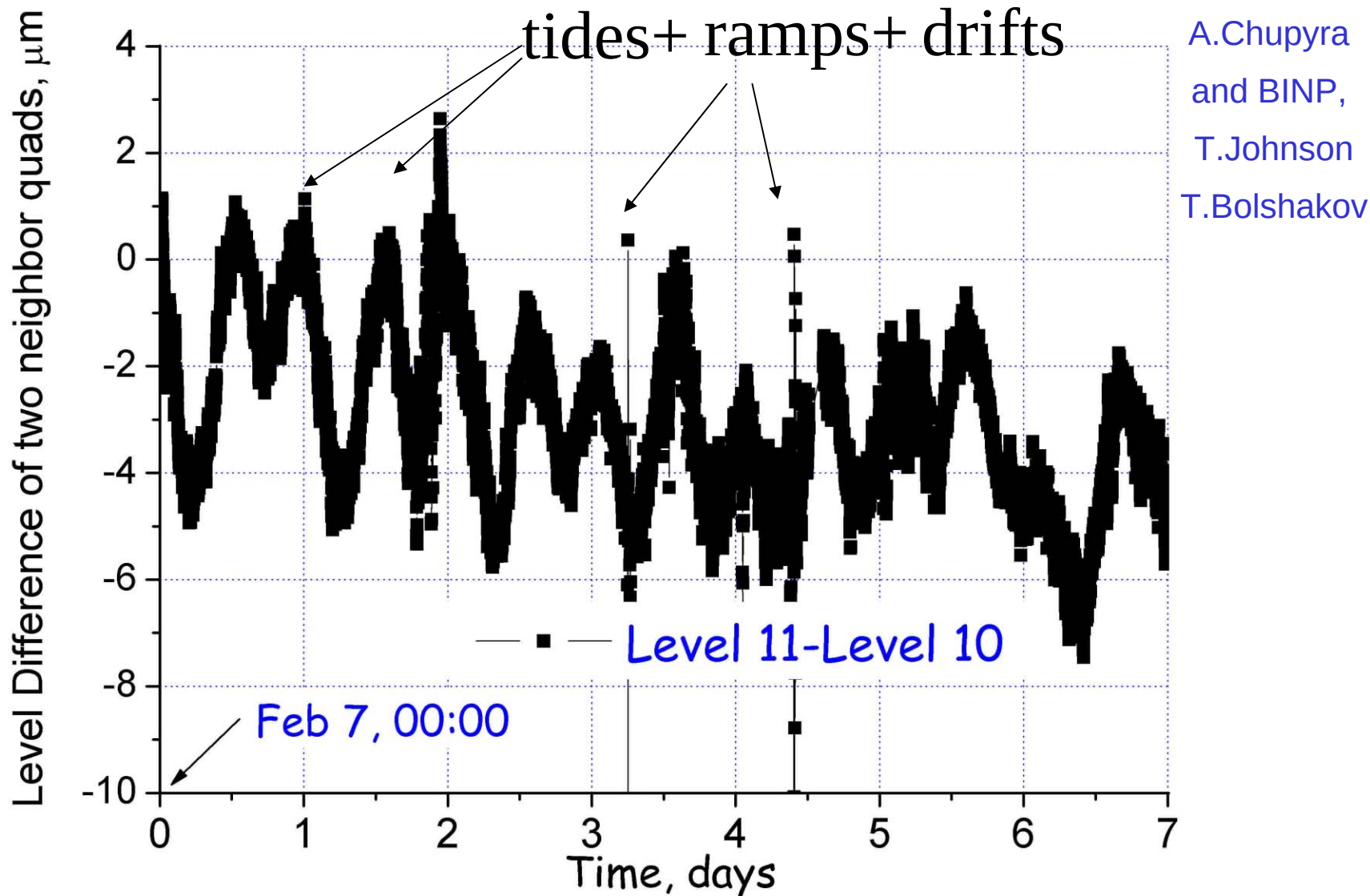
24 water level sensors every 30m in B-sector

BINP(Novosibirsk),

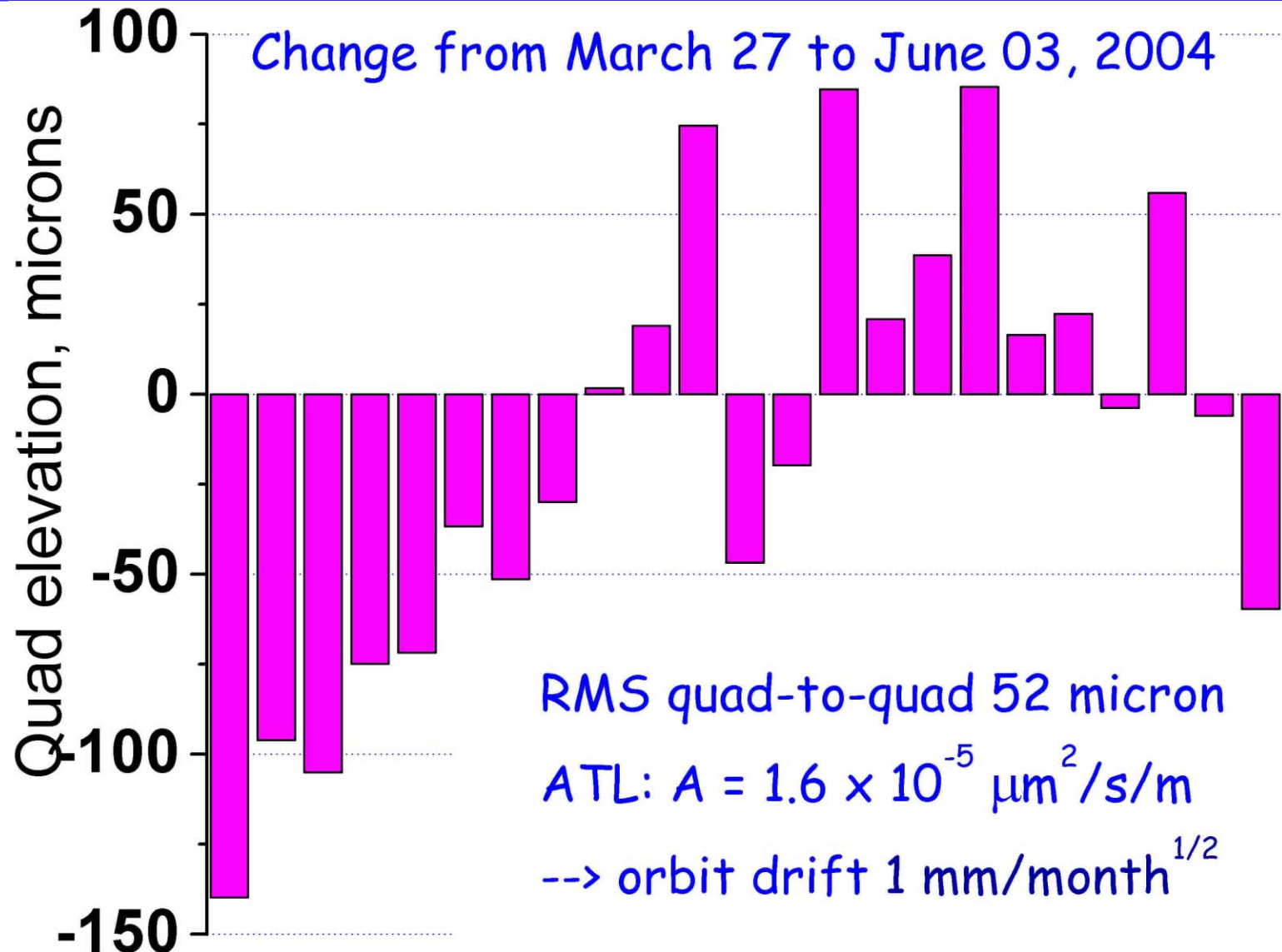
J.Volk



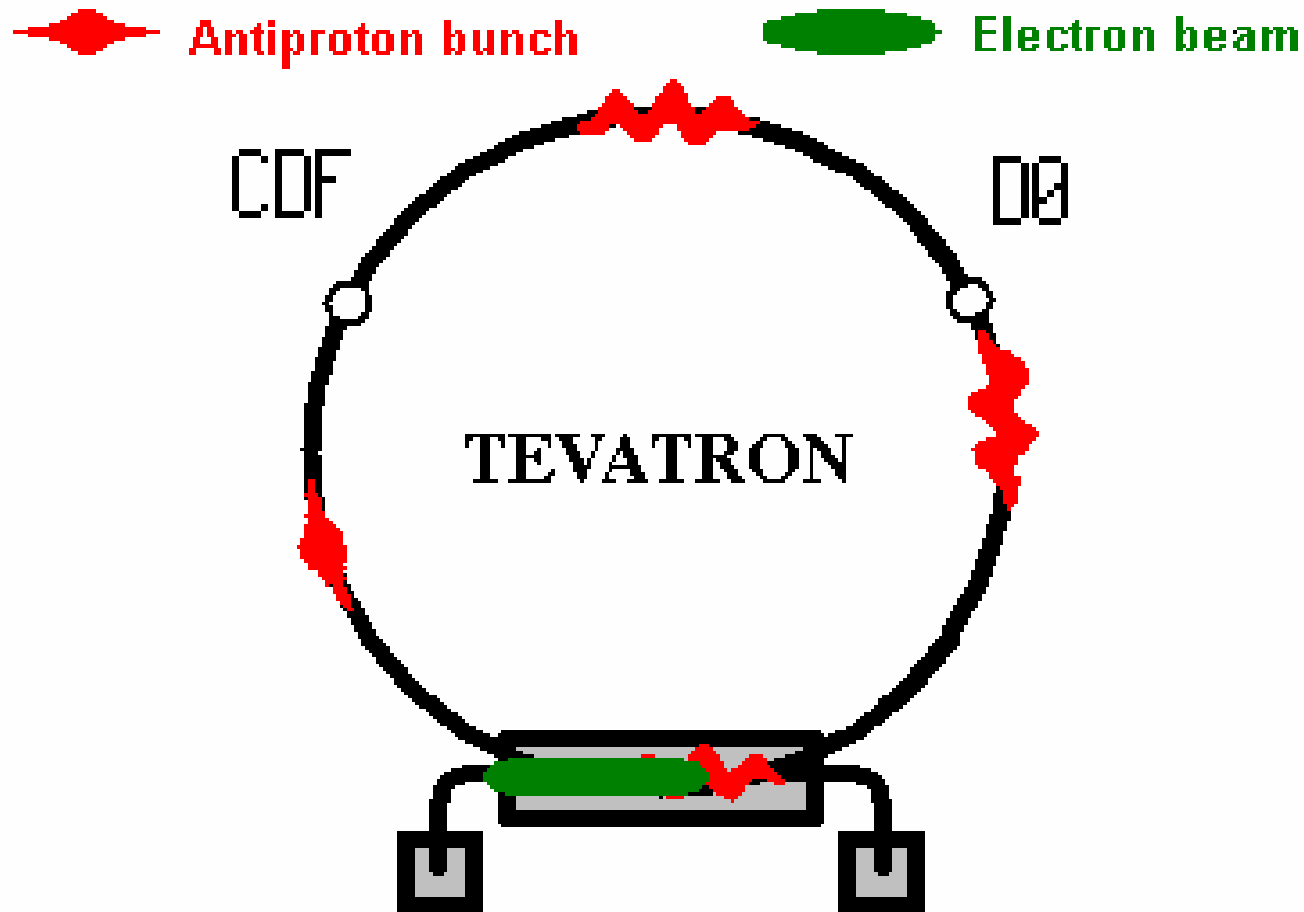
Drift of Quad Positions : 1 week



Drift of Quad Positions : 2 mos

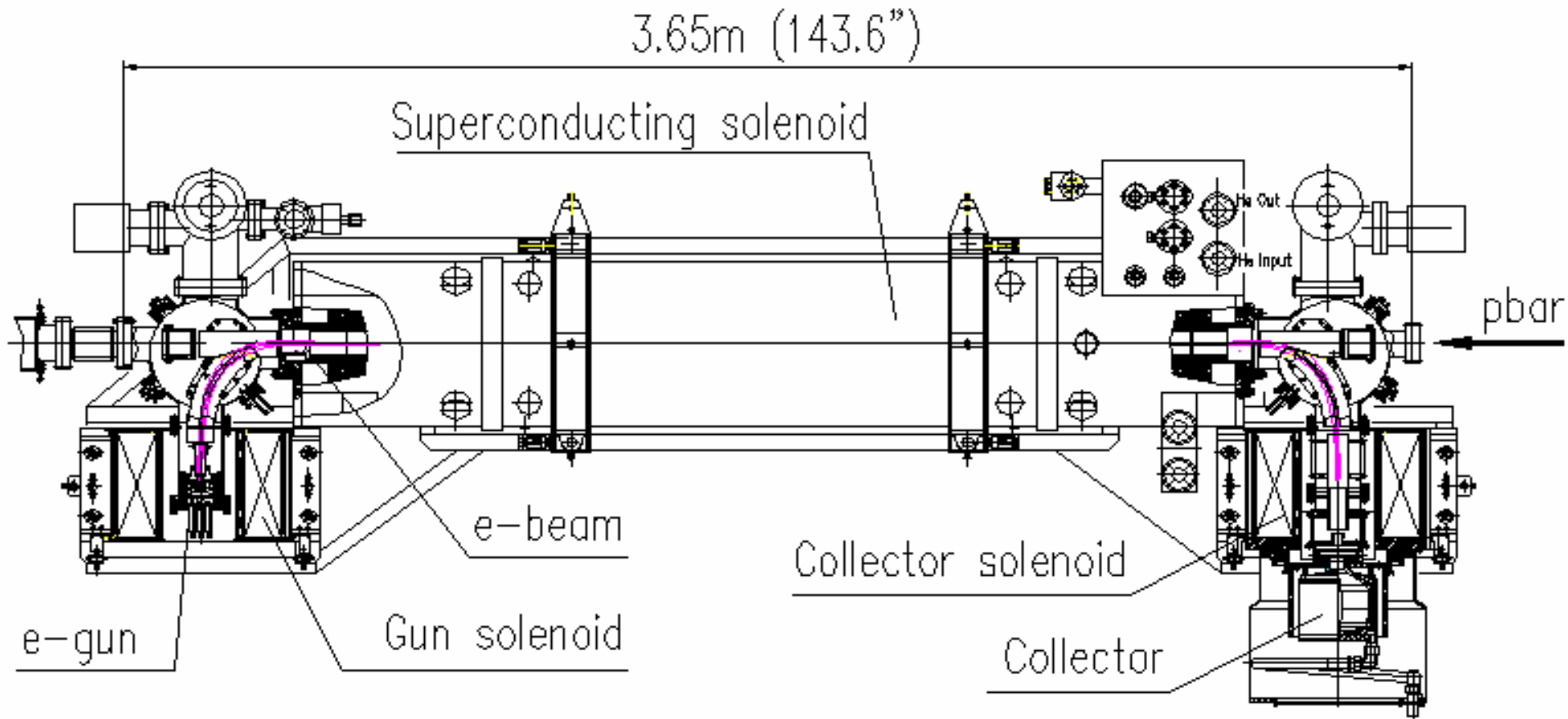


Beam-Beam Compensation Idea



“...to compensate (in average) space charge forces of **positively** charged protons acting on **antiprotons** in the Tevatron by interaction with a **negative** charge of a low energy high-current electron beam “ (1997)

Tevatron Electron Lens (TEL-1)

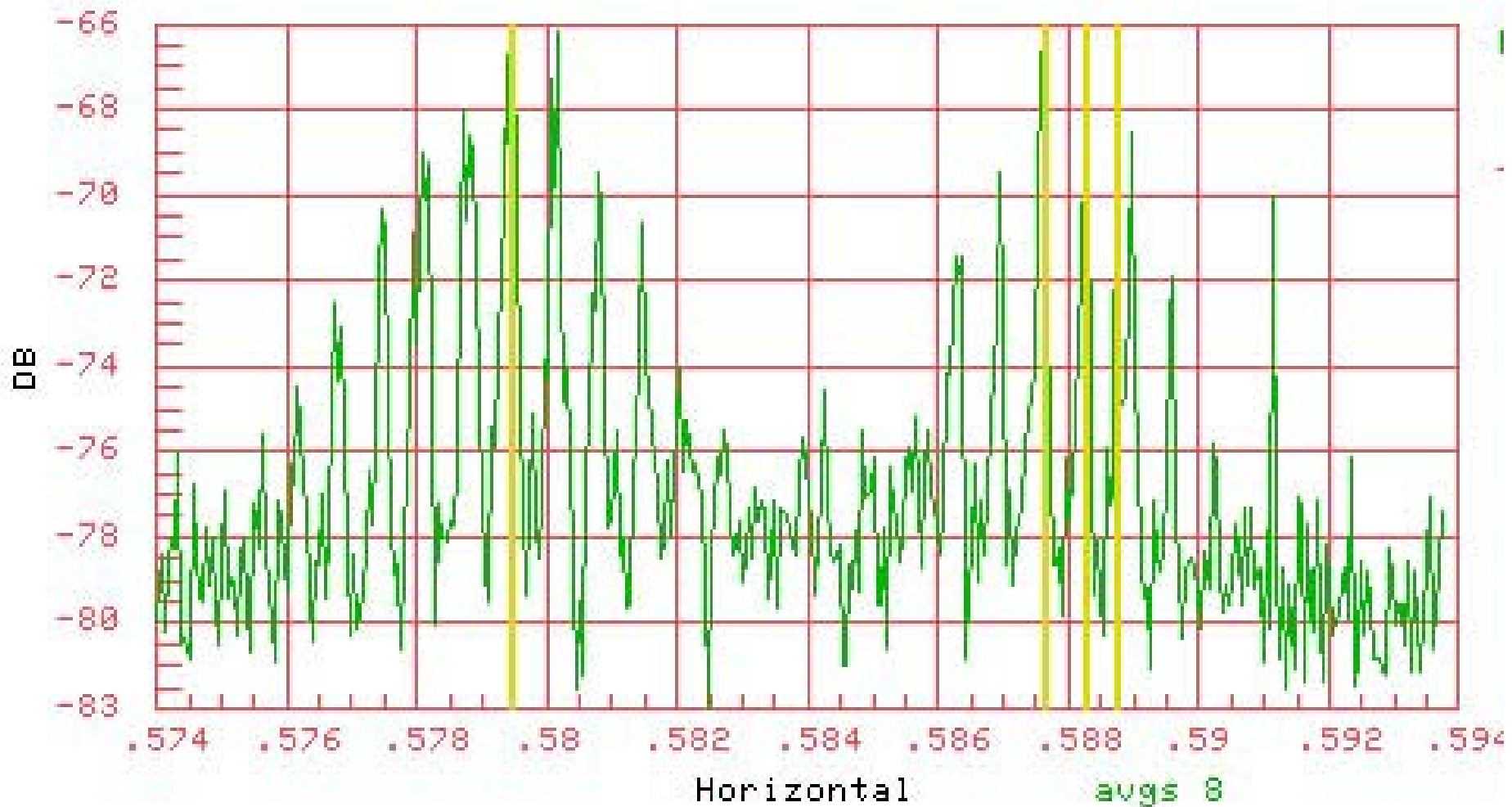


+ HV Modulator, HV+HC PSs, Cryo, QPs, Vacuum, Controls, Diagnostics, Cables

Tevatron Electron Lens #1



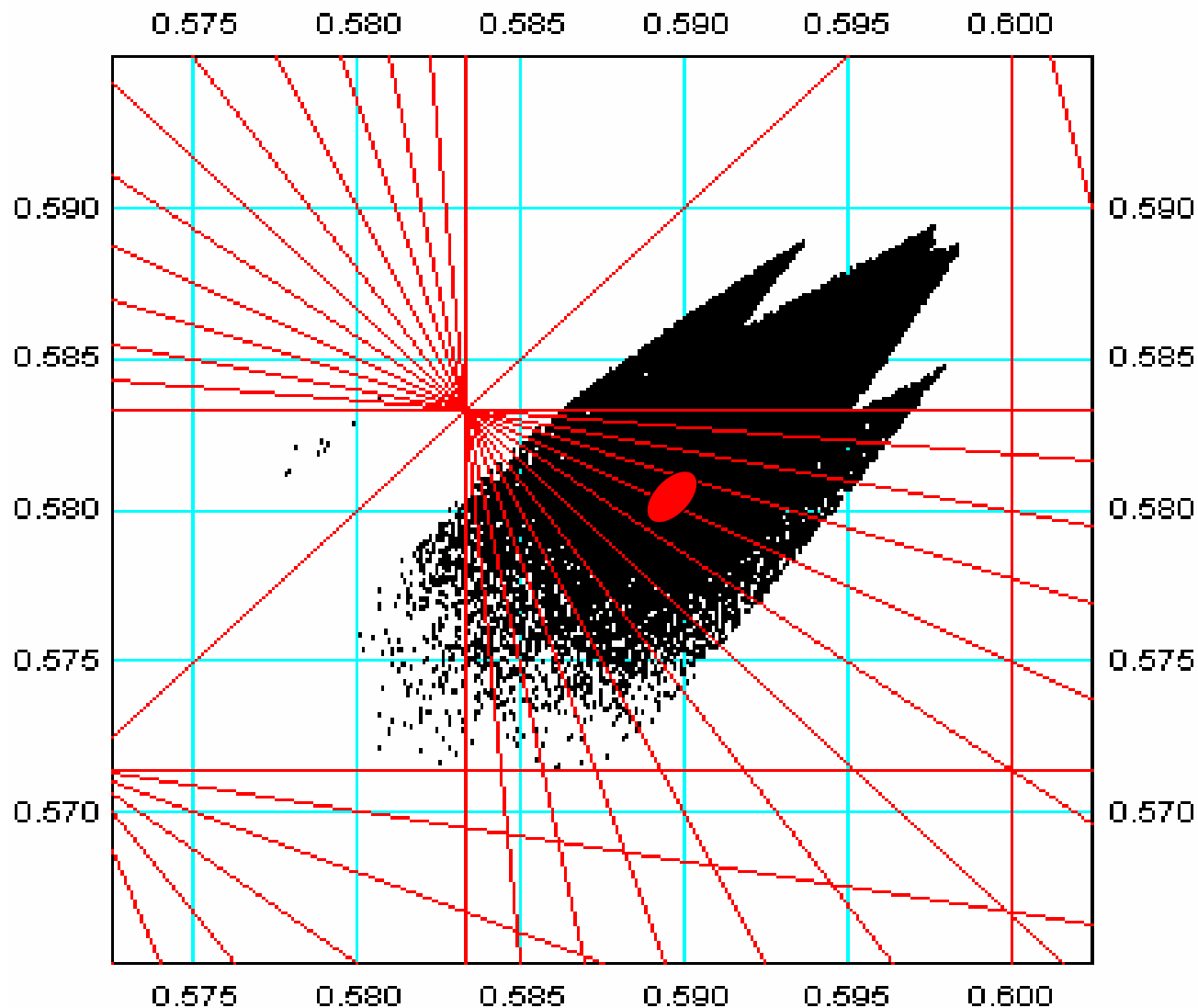
Tuneshift $dQ_{\text{hor}} = +0.009$ by TEL



Three bunches in the Tevatron, the TEL acts on one of them

Antiproton Tune Distribution

Yu.Alexahin



36x36

36=3x12

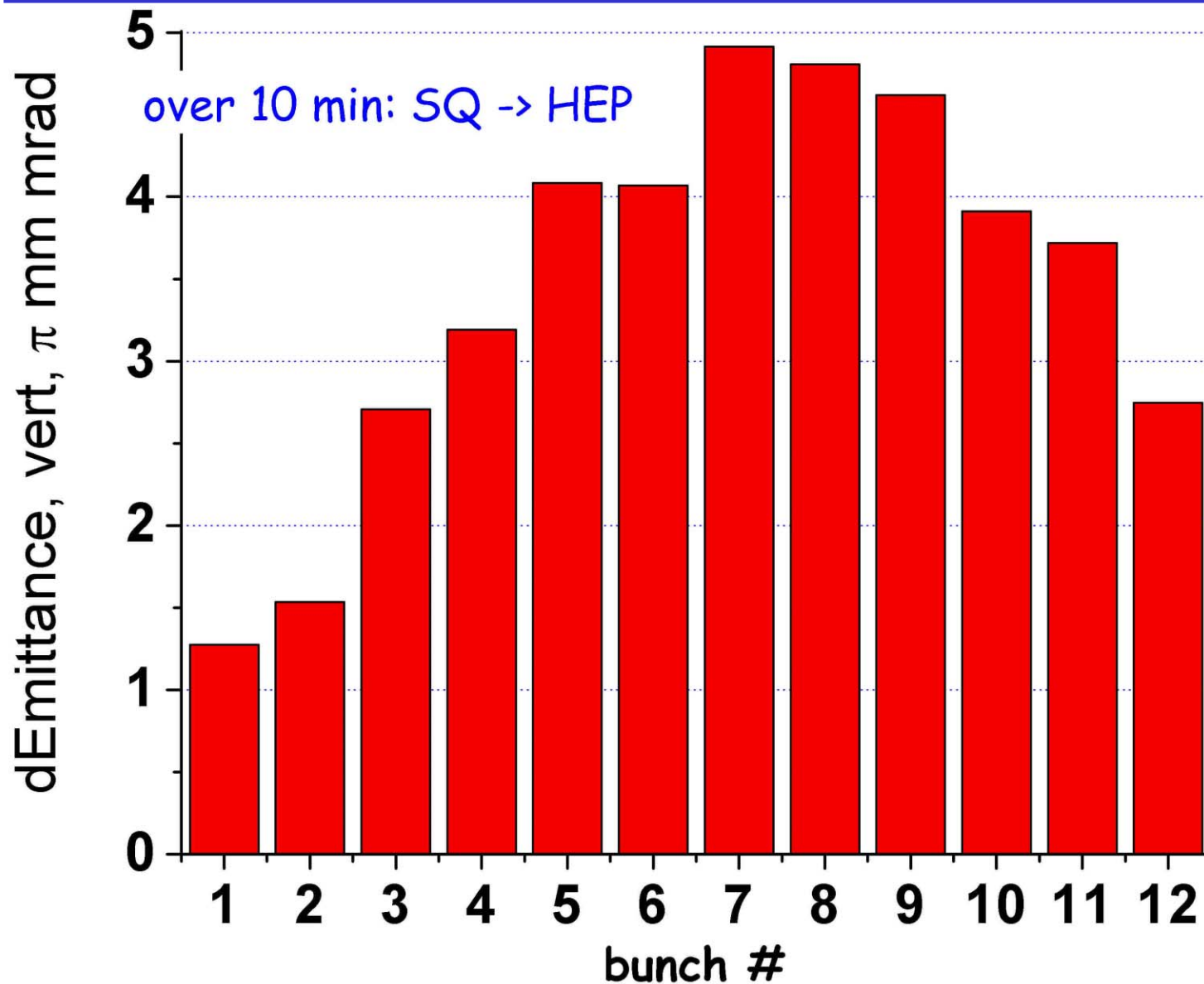
Head-On 2 IPs

$\xi=0.019$

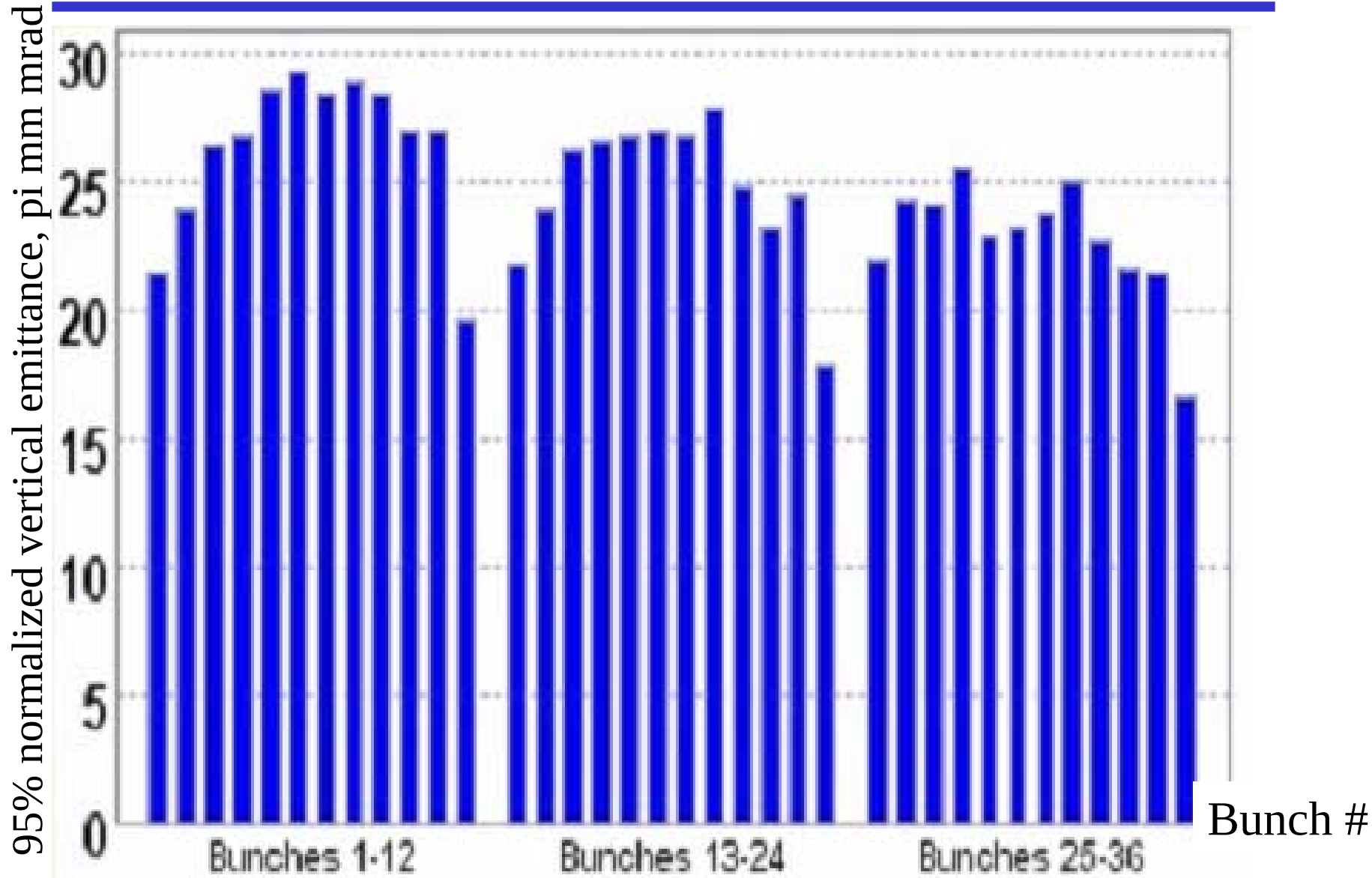
Bunch-by-bunch
(parasitic IPs)

$dQ=0.006$

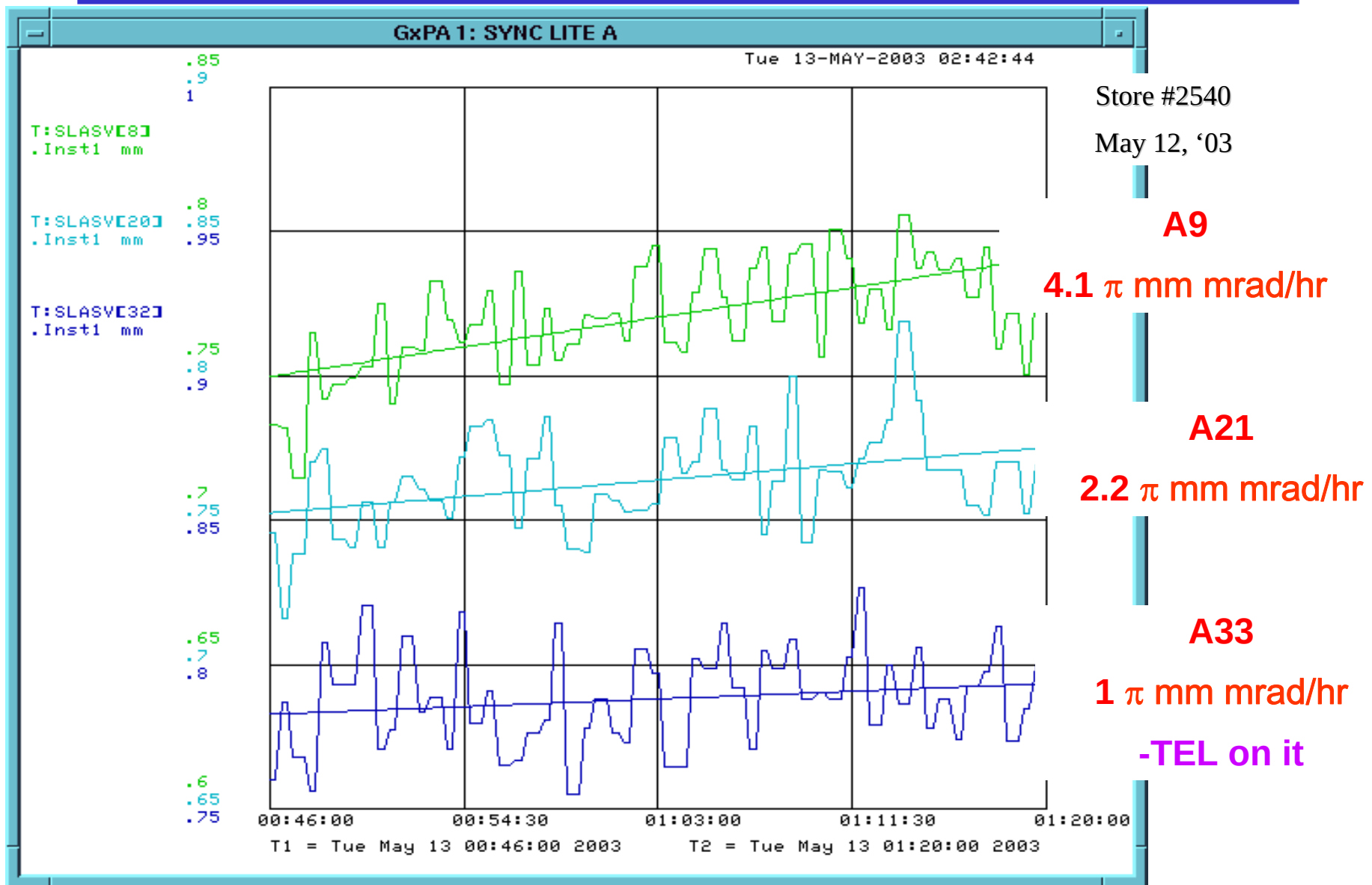
Pbar Bunch Emittance Growth



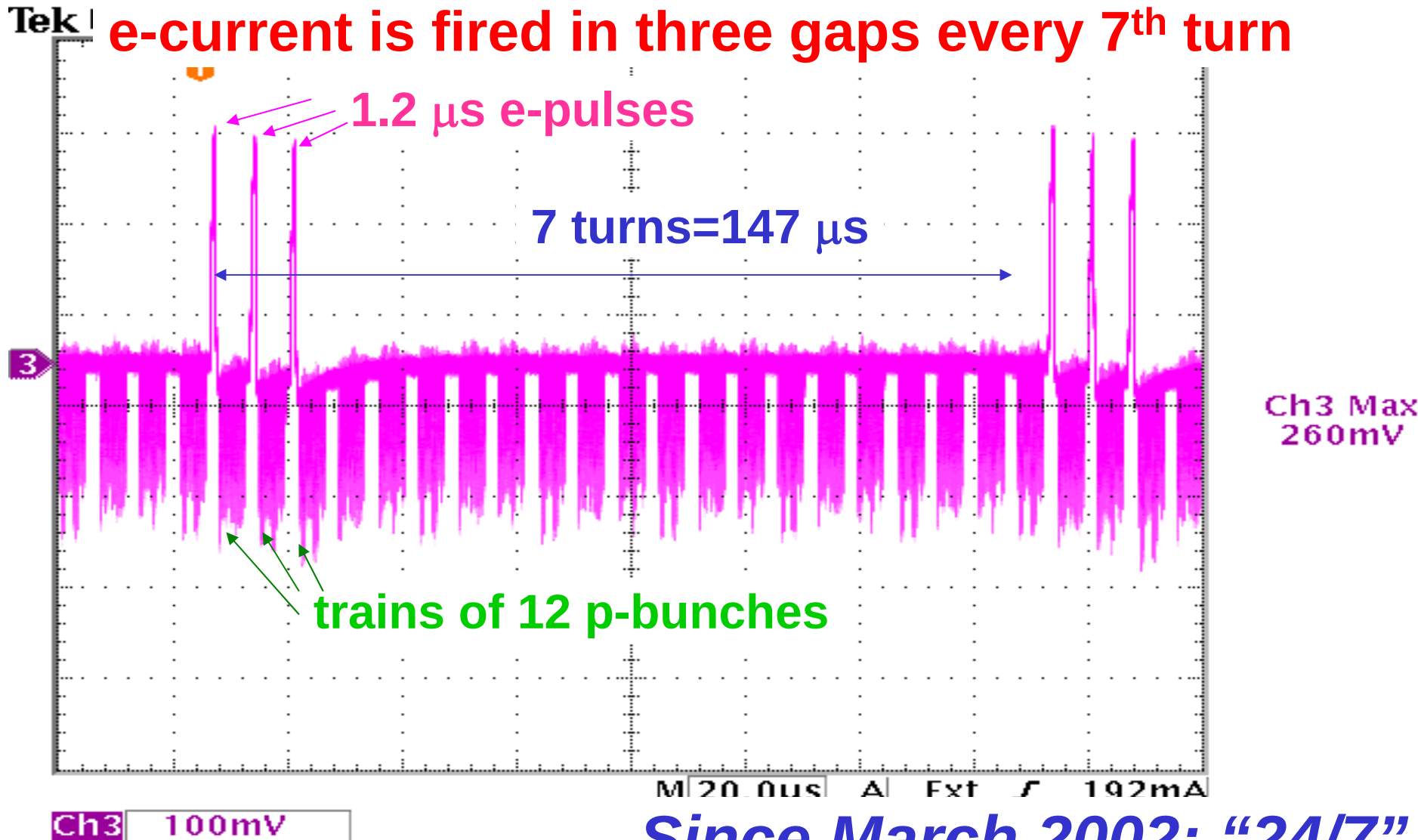
“Scallops” in Pbar Bunch Emittances



Emittance Growth of A33 Suppressed by TEL

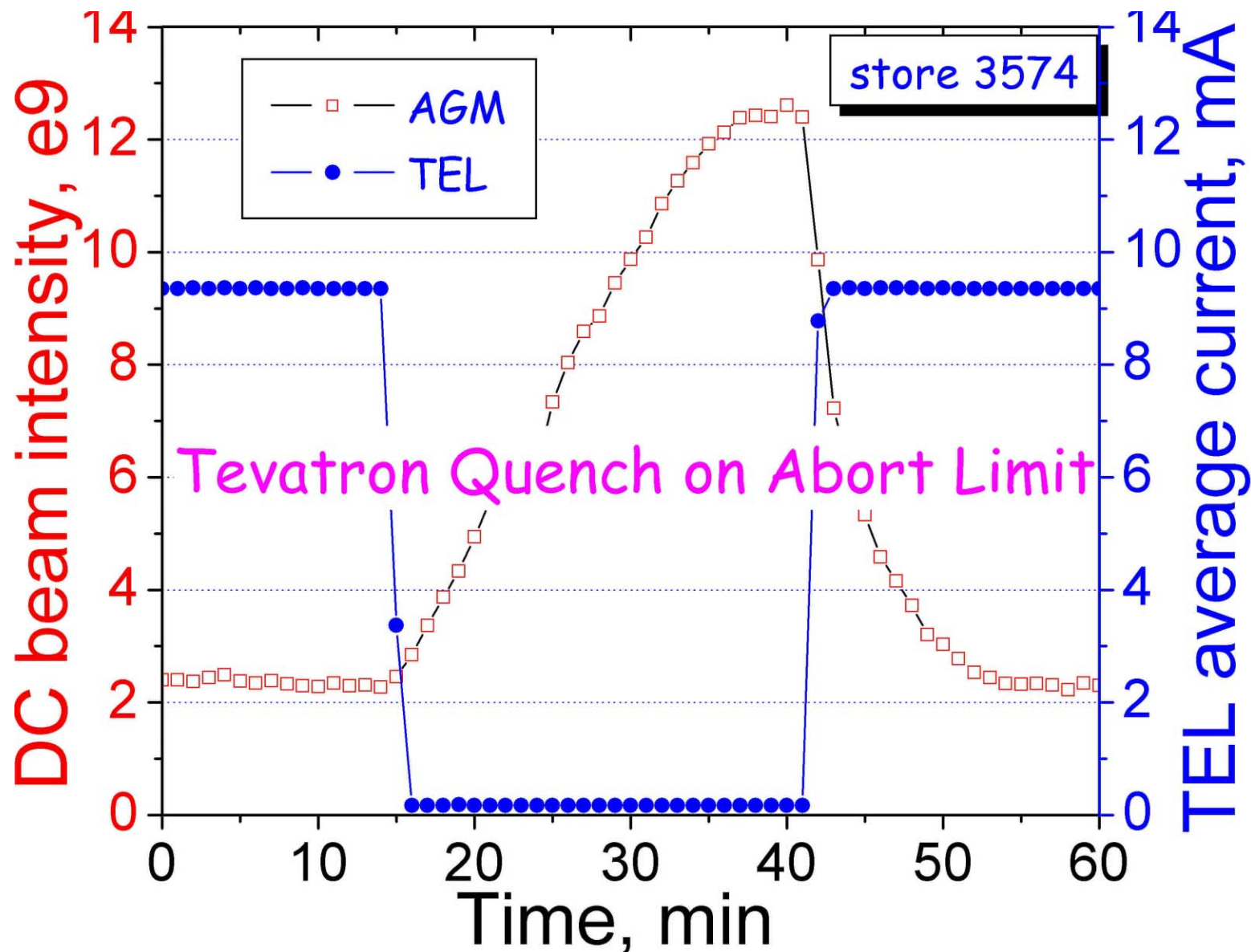


Another Function: “DC Beam Killer”



Since March 2002: “24/7”

DC Beam in Abort Gap: TEL On/Off/On



Conclusions

- **Tevatron luminosity:**
 - Great progress in recent years, Run I Ia goal exceeded
 - 3-fold luminosity upgrade needs e-cooling in Recycler
- **Upgrade projects ongoing in all machines :**
 - Booster, Main Injector and A-Accumulator –
to generate 3x higher antiproton flux
 - Recycler - install Electron Cooling system in 2004
 - Tevatron – accommodate more antiprotons:
 - Better diagnostics
 - Larger beam-beam separation
 - R&D on Beam-Beam Compensation with Electron Lenses