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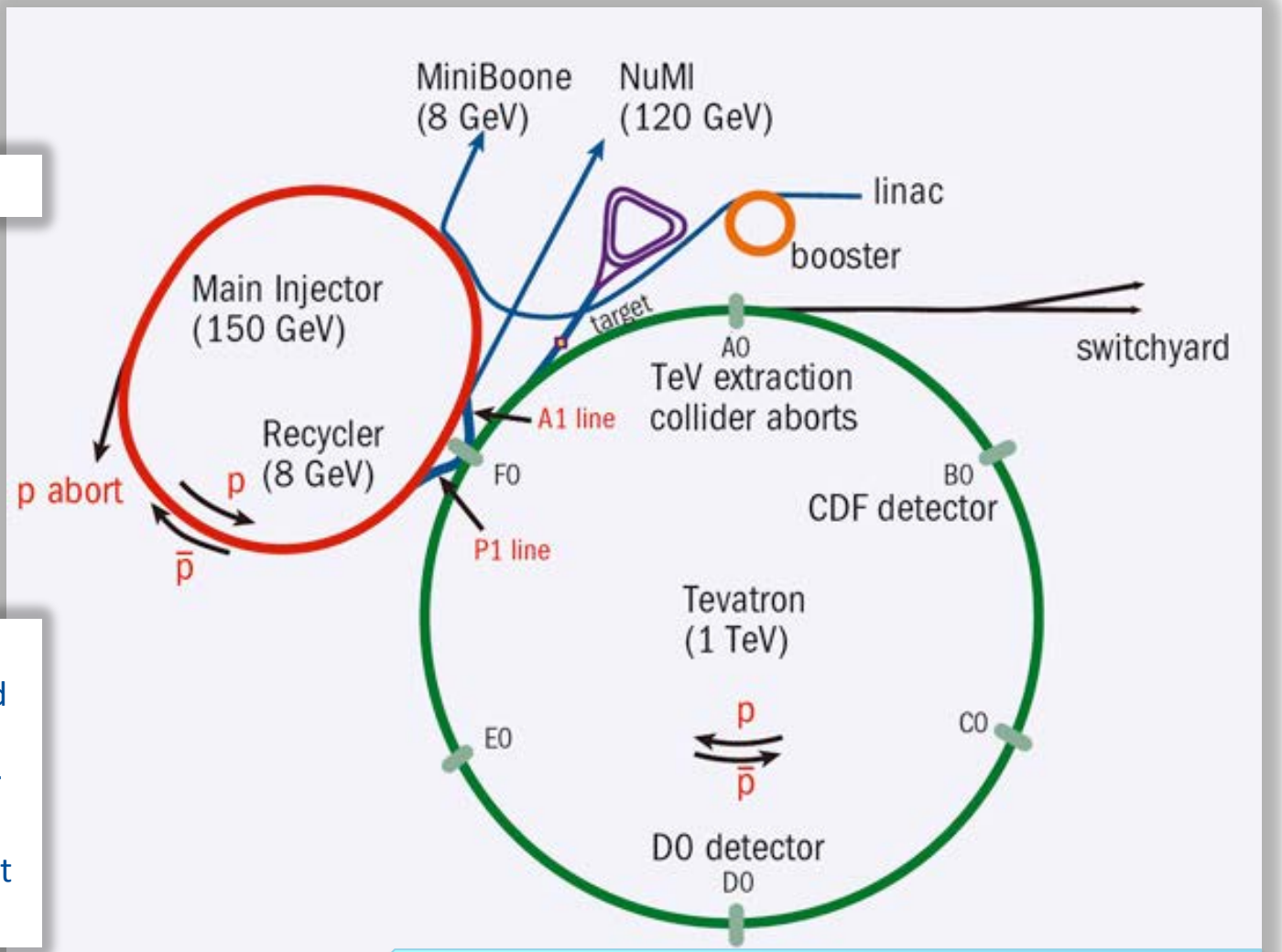
Tevatron Lessons: Machine Availability and Reliability

Vladimir Shiltsev
Accelerator Physics Center, Fermilab
XBEAM Meeting, 15 Feb 2017

Tevatron Collider Run II 2001-2011

7 accelerators

16 km of accelerators and beamlines, two high power targets, several low power target stations…



Tevatron Collider
shut down Sep 30, 2011

Tevatron Statistics 2001-2007

Tevatron operation first 6 years of RunII[&]: [&](Cons Gattuso)

1292 stores in total

932 stores were terminated intentionally; average store length: 22.4h

360 stores ended due to failures; average store length: 10.23h

Top 10 causes:

-cryogenics	49 → 13%
-lightening	40 → 11%
-quench protection	33 → 9%
-controls	29 → 8%
-separators	25 → 7%
-RF	25 → 7%
-low β quadrupoles	24 → 7%
-corrector magnets	20 → 5.5%
-human error	20 → 5.5%
-PC	20 → 5.5%

Tevatron 2007

minimum operational Turnaround time → 2.5 h

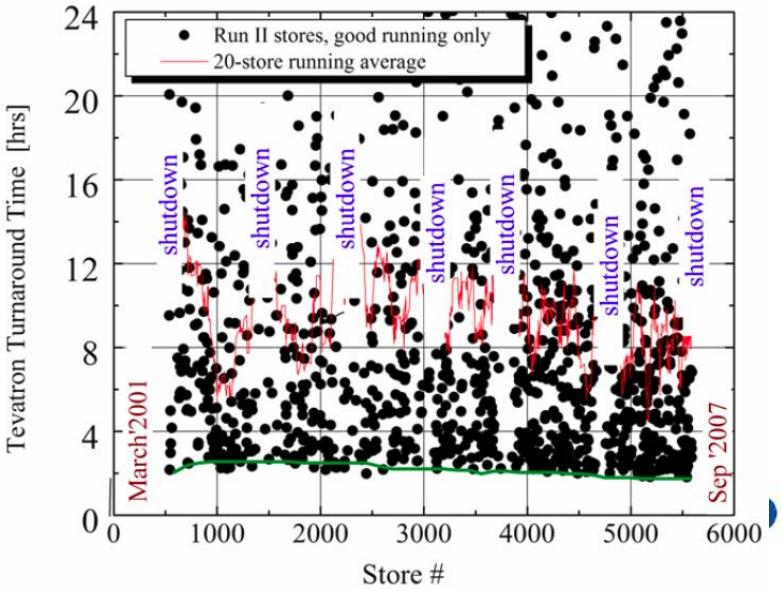
→ 2.5 * minimum after 6y RunII

average operational Turnaround time → 6 h

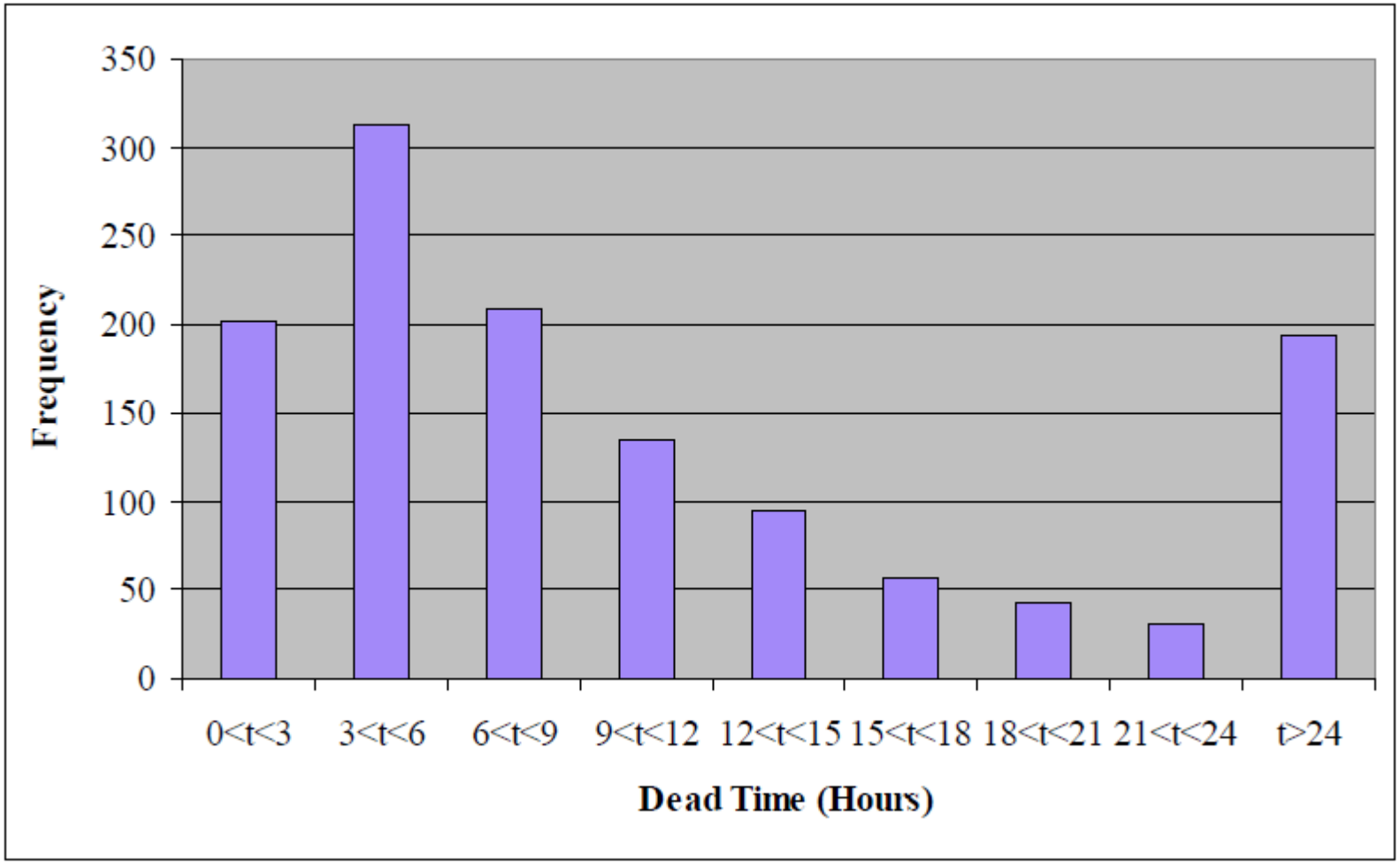
→ 6 * minimum after 6y RunII

average store length (2007) → T_{run} = 21 h

average set-up time (2007) → t = 2.4h



Deadtime stat



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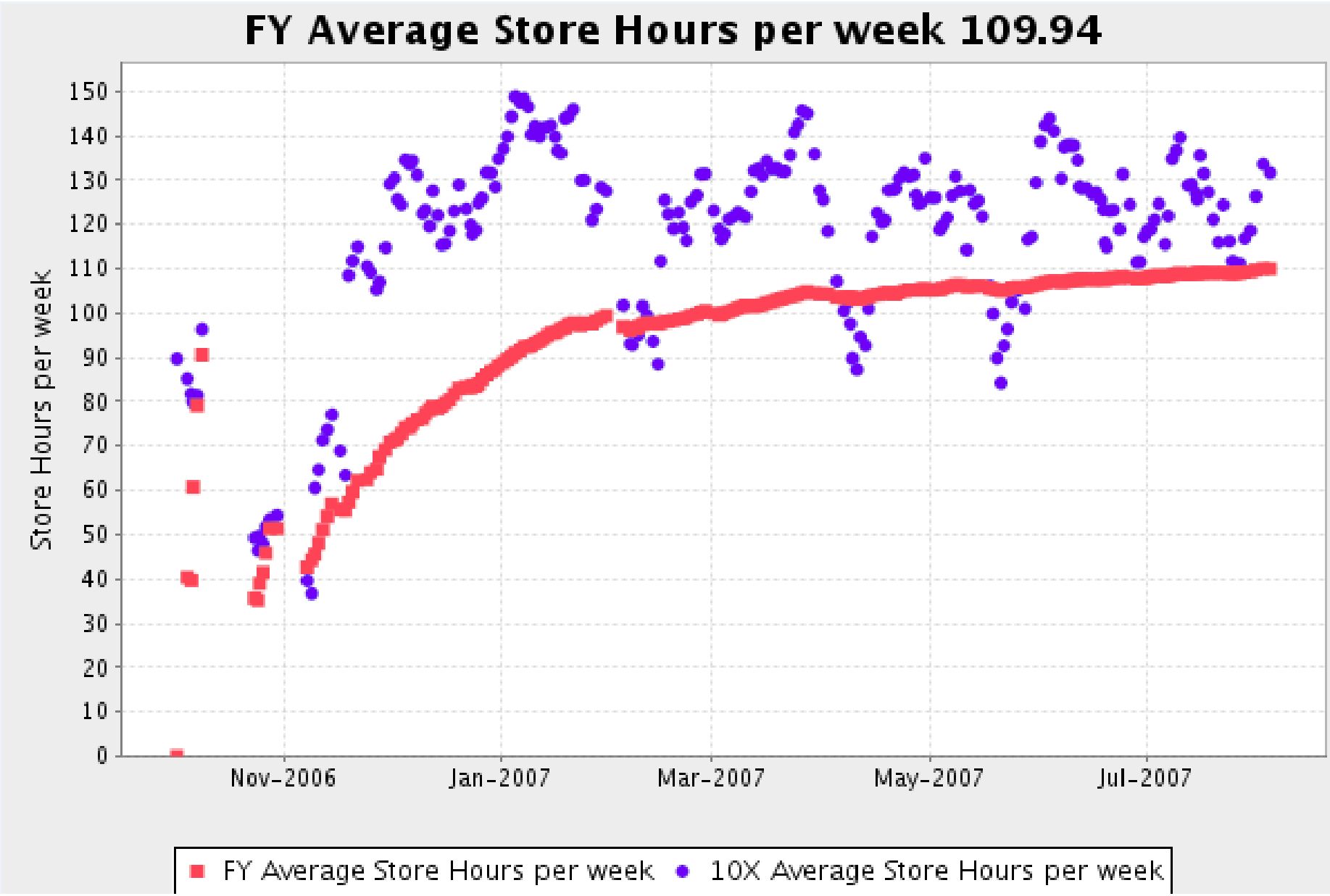
FY Average Store Hours per week 109.94
Store Hours per week
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Nov-2006
Jan-2007
Mar-2007
May-2007
Jul-2007
FY Average Store Hours per week
10X Average Store Hours per week

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End of Tevatron Run II

Proceedings of 2011 Particle Accelerator Conference, New York, NY, USA MOOCN2

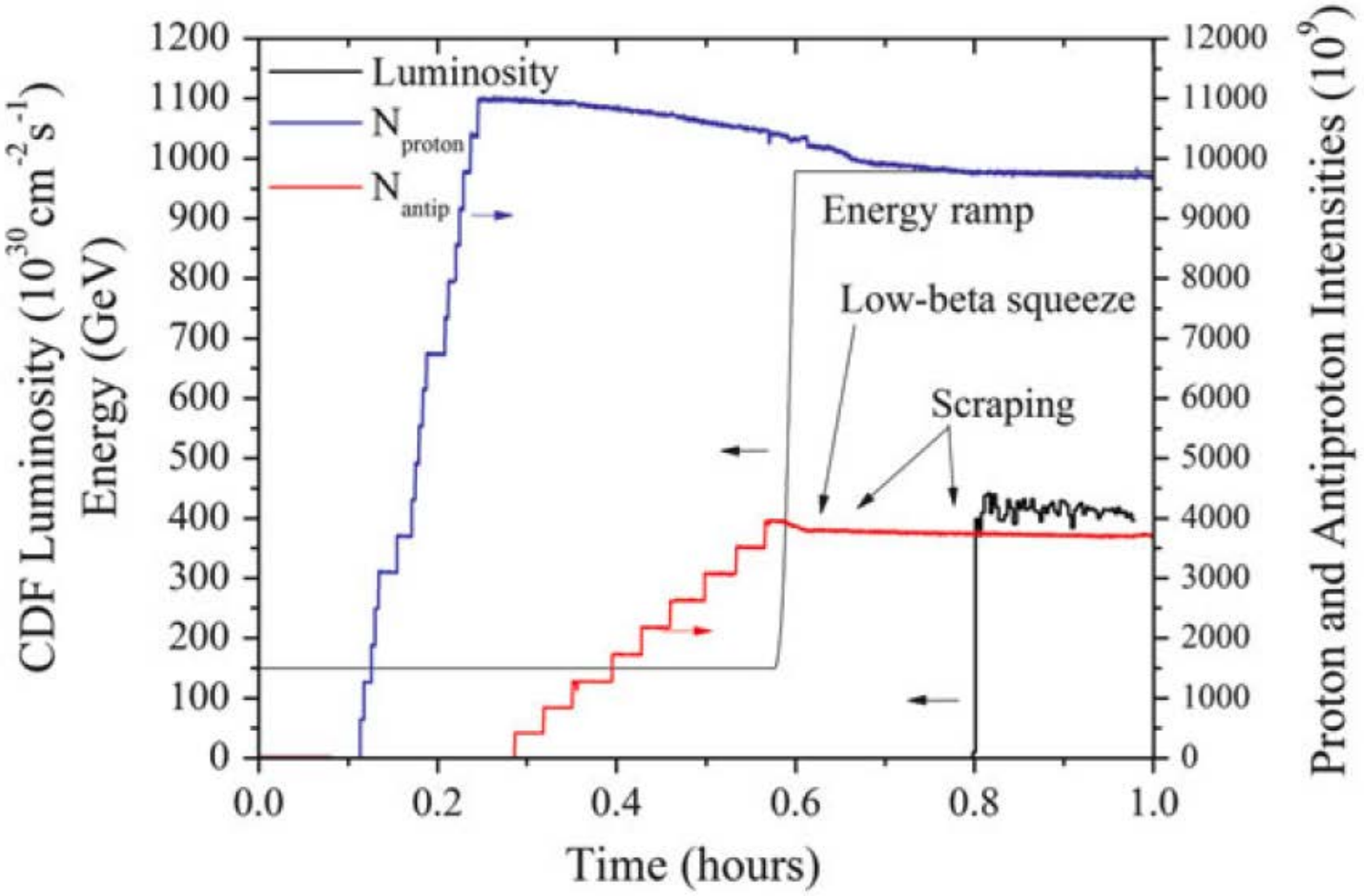
TEVATRON ACCELERATOR PHYSICS AND OPERATION HIGHLIGHTS

A. Valishev for the Tevatron group, FNAL, Batavia, IL 60510, U.S.A.

Table 2: Main Collider Parameters

	Design	Achieved
Antiproton production rate (10^{10}/h)	32	22
Stack to HEP $\bar{p}$ transfer efficiency	80%	83%
Initial luminosity (10^{32} cm^{-2}s^{-1})	2.9	4.0
HEP store duration (h)	15	15
Shot setup time (h)	2	1
Store hours per week (h)	97	120
Luminosity integral per week (pb^{-1})	55	73

Collider fill cycle for store 8709 (May 2011)



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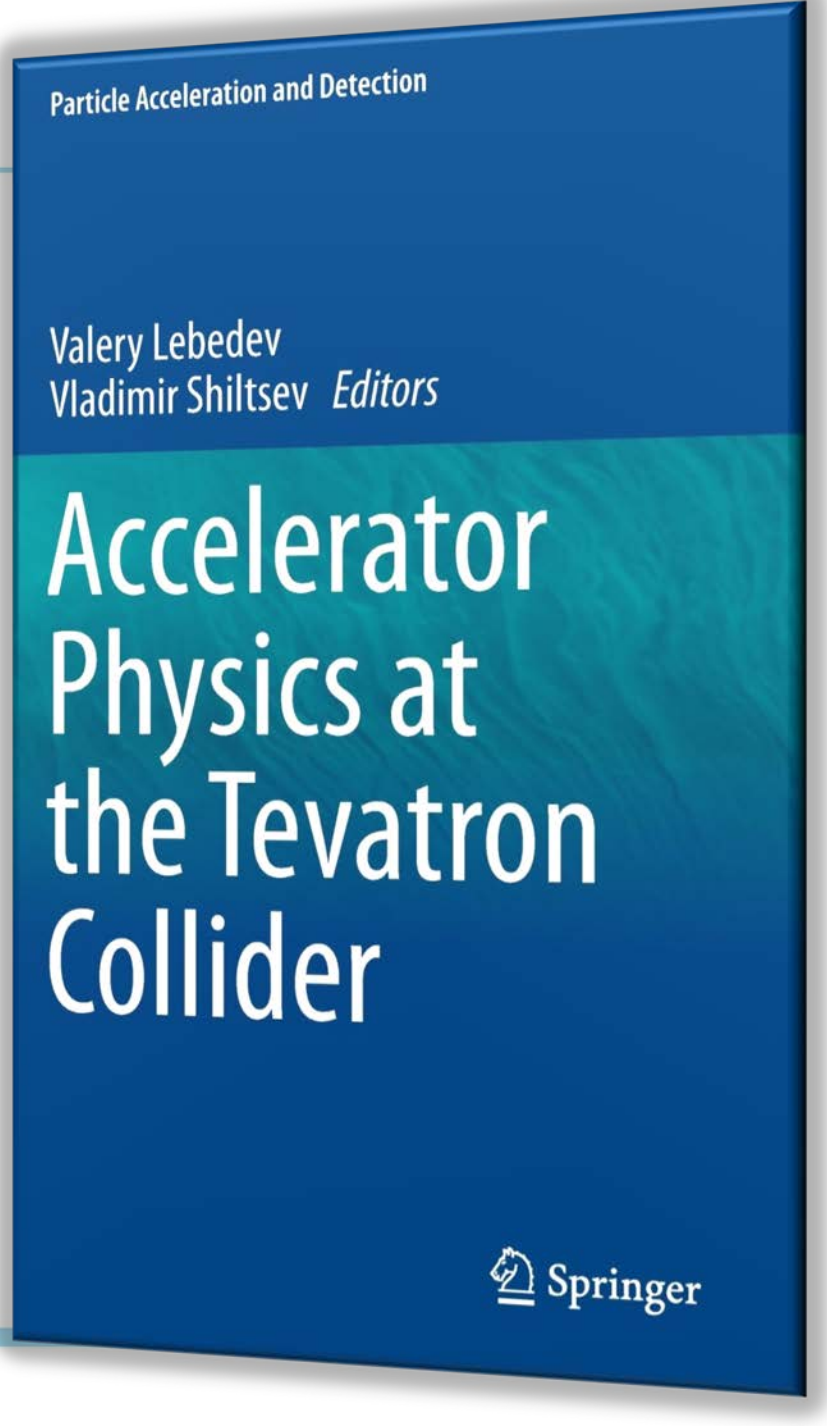
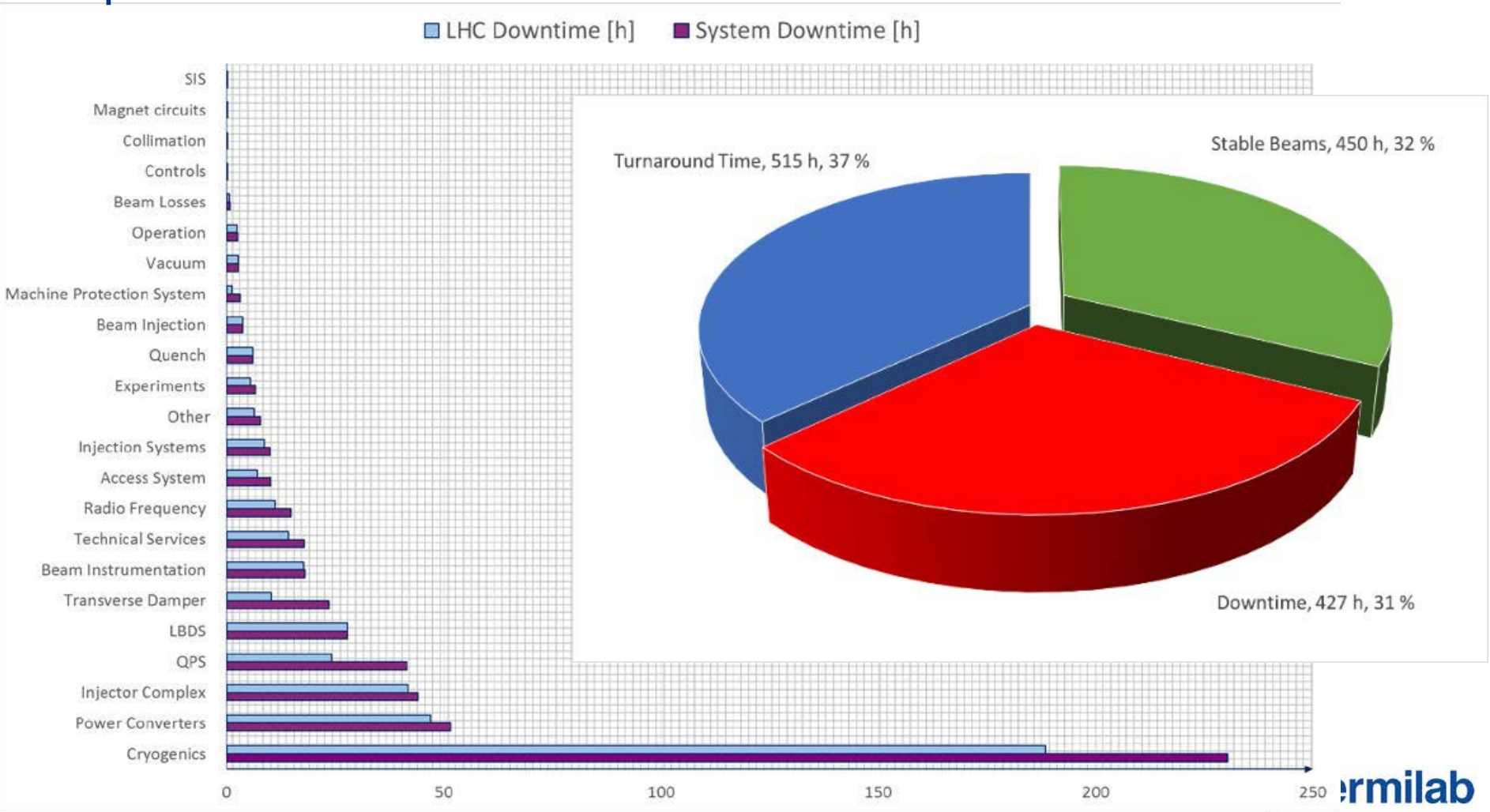
- It is all described in detail here:

Accelerator Physics at the Tevatron Collider - by V.Lebedev and V.Shiltsev, Springer (2014)

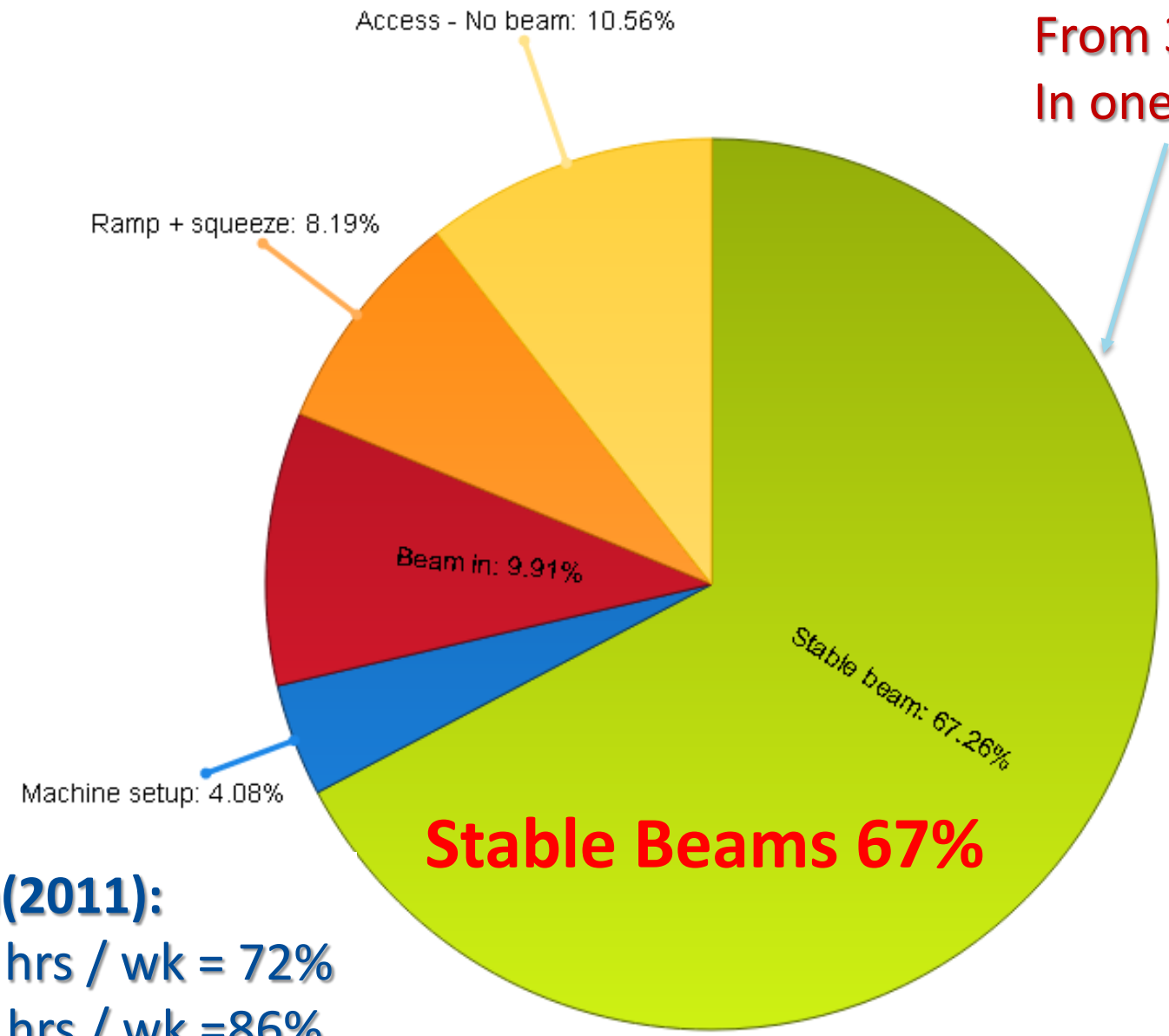


LHC Machine availability -2015

Statistics for 25 ns run from
September 7 to November 3



2016 LHC Availability: 11th June – 23rd July



From 32% to 67%
In one year!

Stable Beams 67%

Tevatron(2011):

Avg. 120 hrs / wk = 72%

Best 144 hrs / wk =86%

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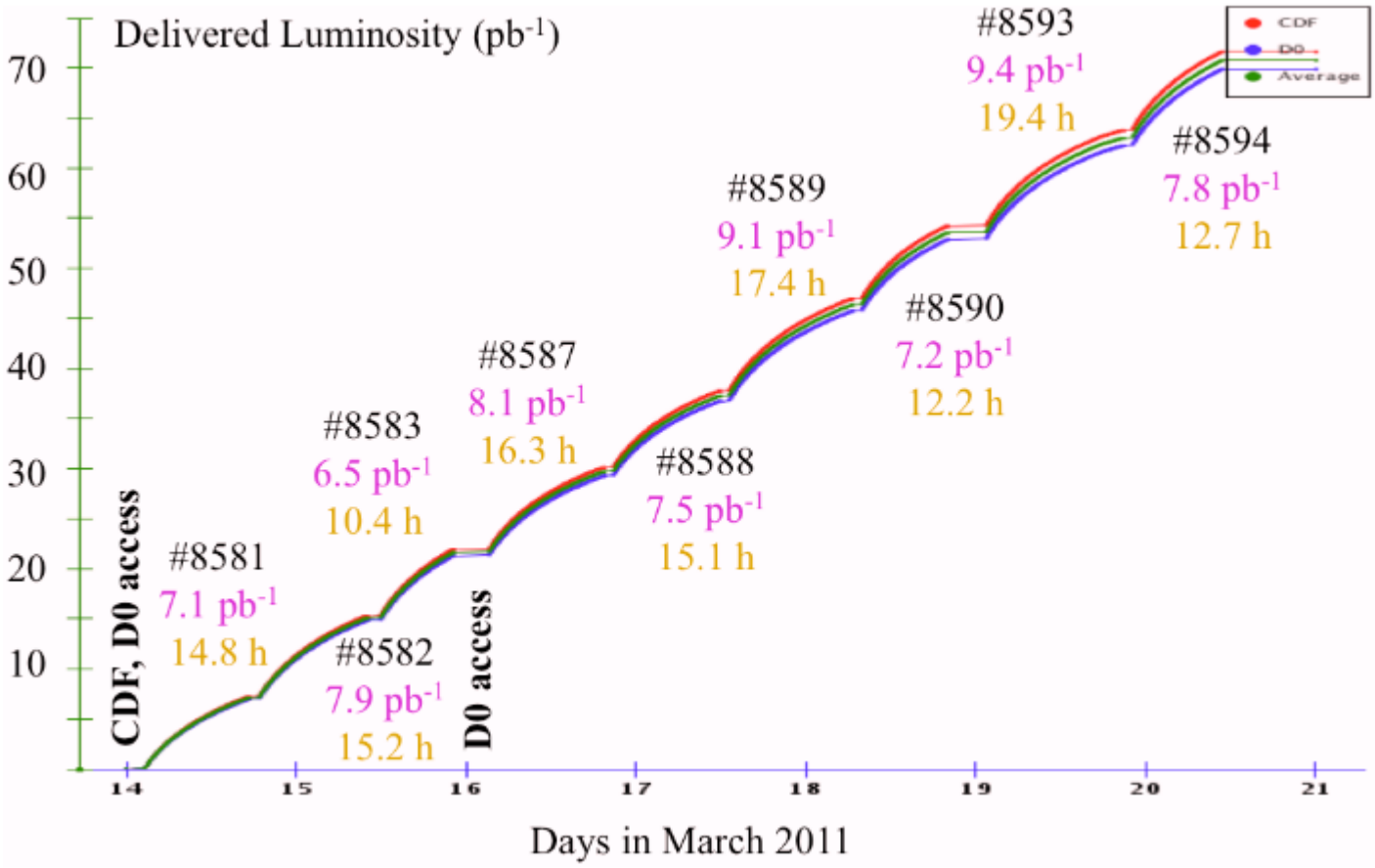
Summary

Tevatron experience shows that:

- Hadron (in particular proton-antiproton) colliders can run
- They can run pretty reliably
- Their reliability usually improves with time
- Moreover, it improves in parallel with improvements in performance (luminosity)

Overall – hadron colliders are interesting toys, fun to play with… just a bit too expensive!

Back up slide



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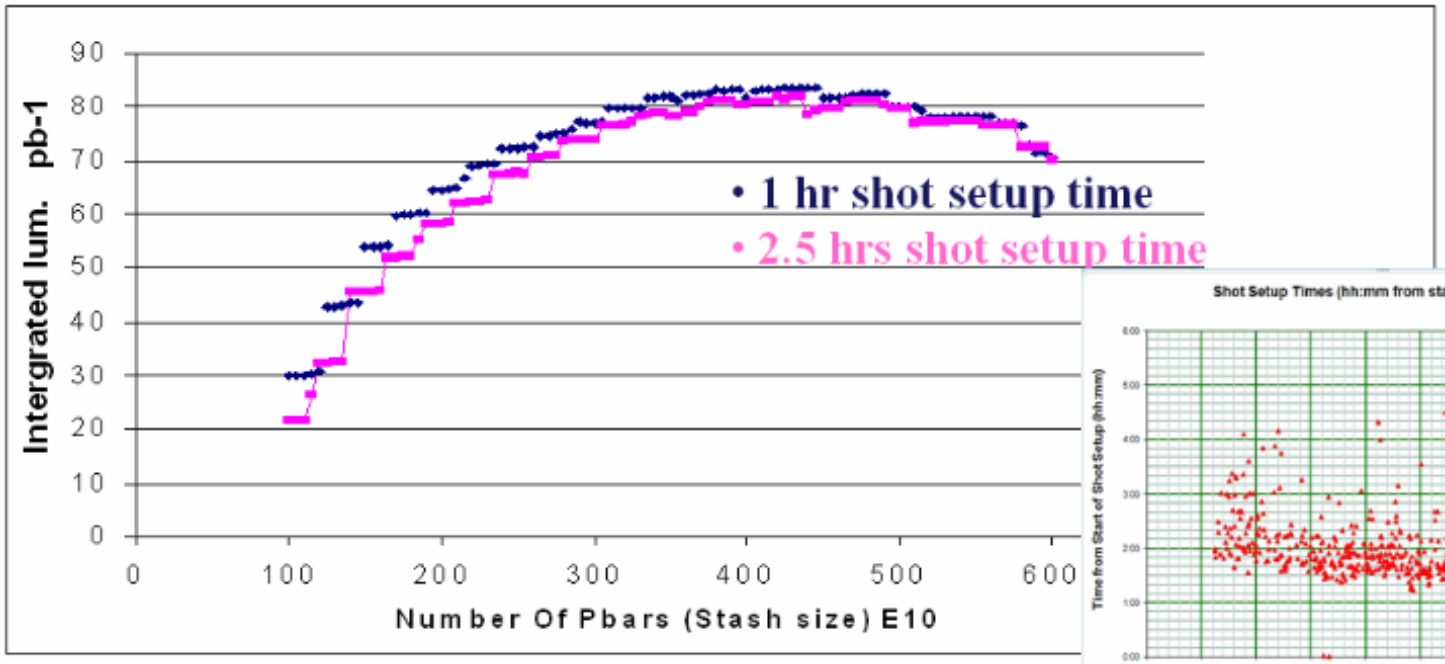
Back up slide



- By shortening the shot setup time, greatest improvement when shooting from a smaller Stash.
- Collider Shot Setup Time has been Reduced from 2.5 to 1 hour.

PAC 2009 -Gattuso

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