Vacuum Data Analysis and Improvement Plan

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Outline

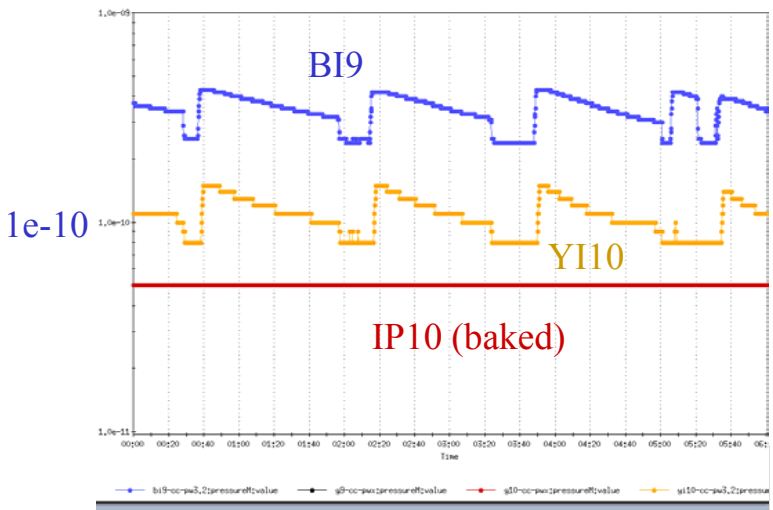
- Pressure Rise During Au Runs
  - Stable Stores
  - Inj. and Ramps
- Beam Abort Events due to Vacuum BPL
- Analysis Summary and Improvement Plans

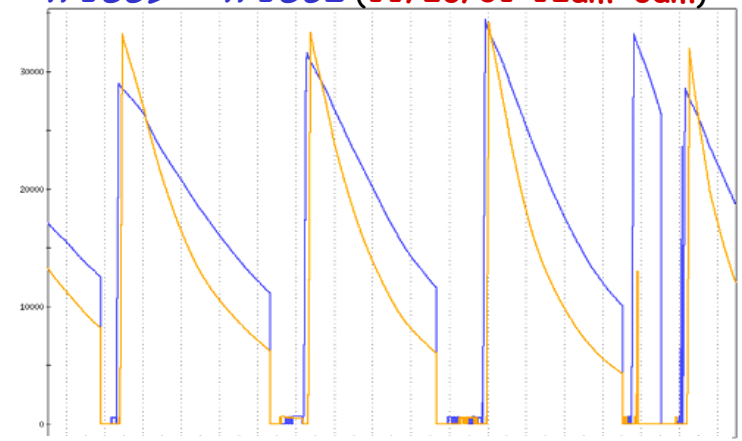
Warm Bore Pressure Rise Vs. DCCT During Au Runs

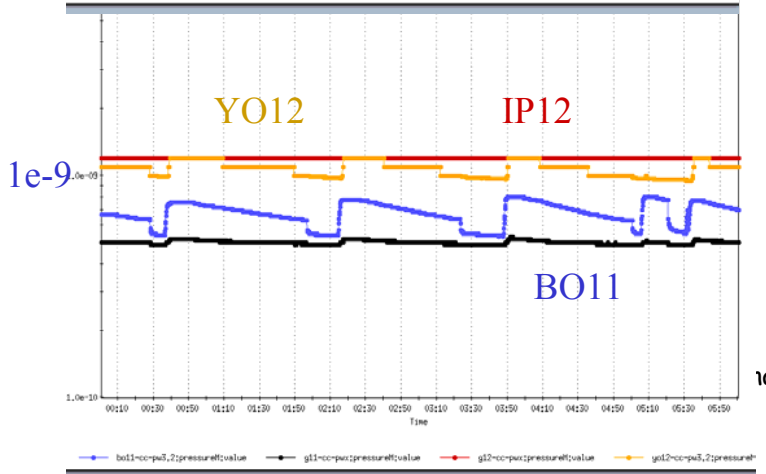
Pressure increase (ΔP) proportional to beam intensity

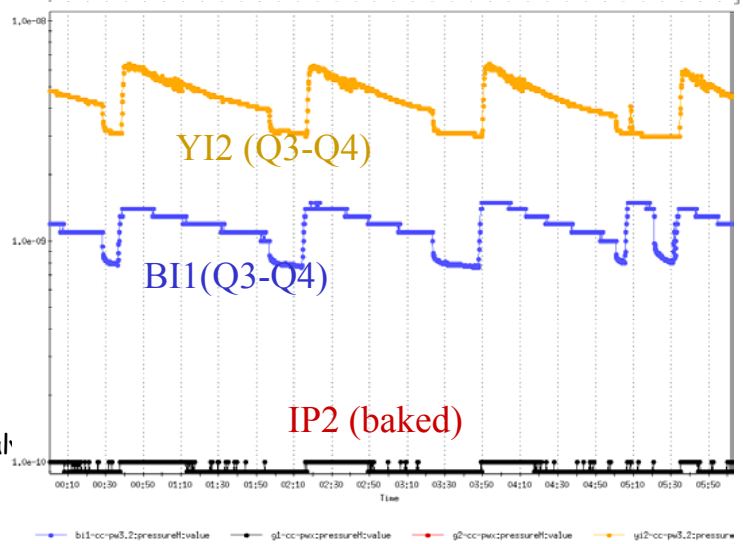
- Occurred at most warm sections for every fill
- Much less or none at baked sections (IP2 & IP10)
- Greater at incoming than outgoing (why?)
- Not the intensity limiting factor

#1859 - #1862 (11/26/01 12am-6am)





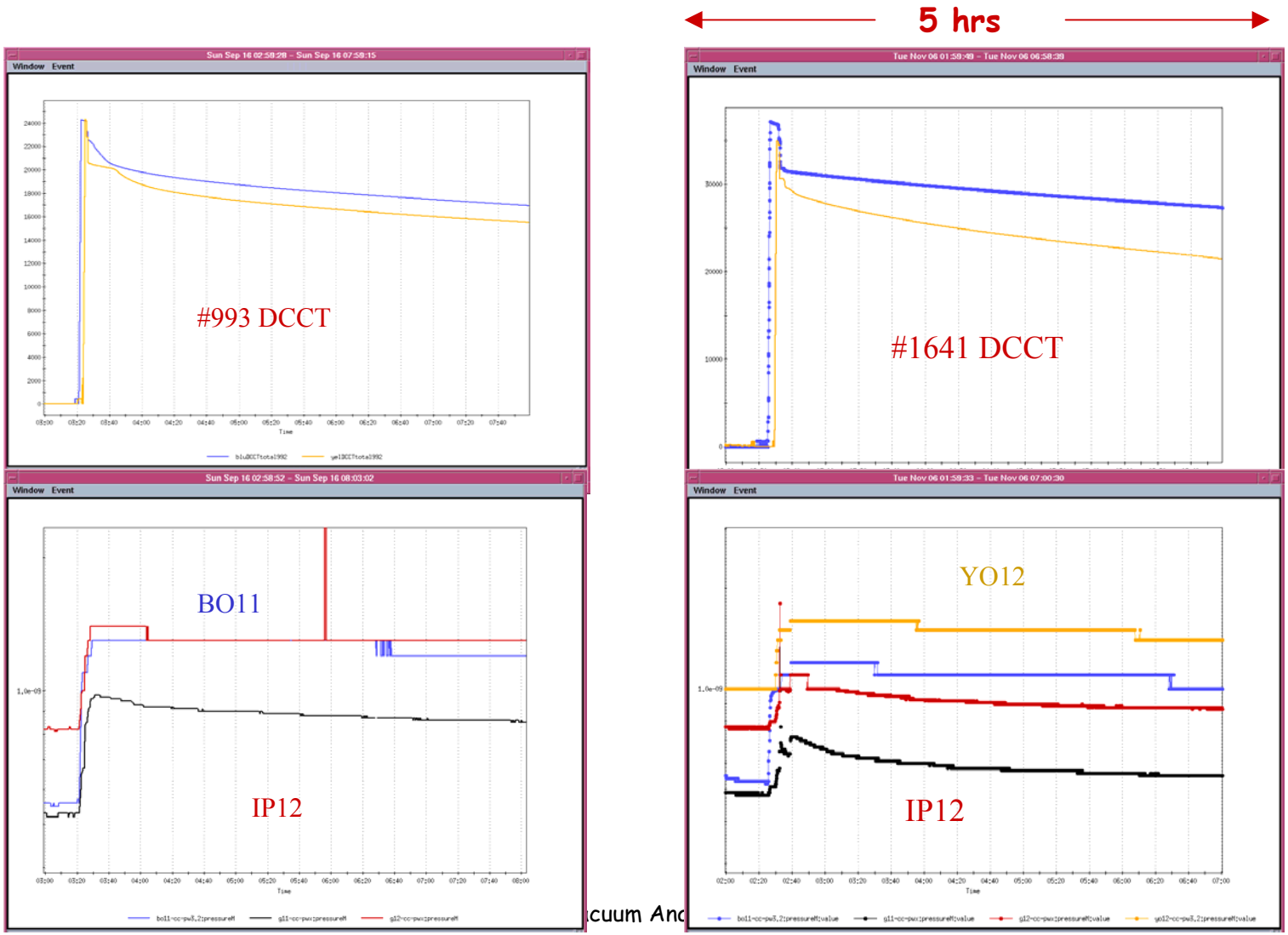




Pressure increases (ΔP) were very stable during long stores

e.g. #993 and #1641 at IP12 (both > 6 hours w/ good lifetime)

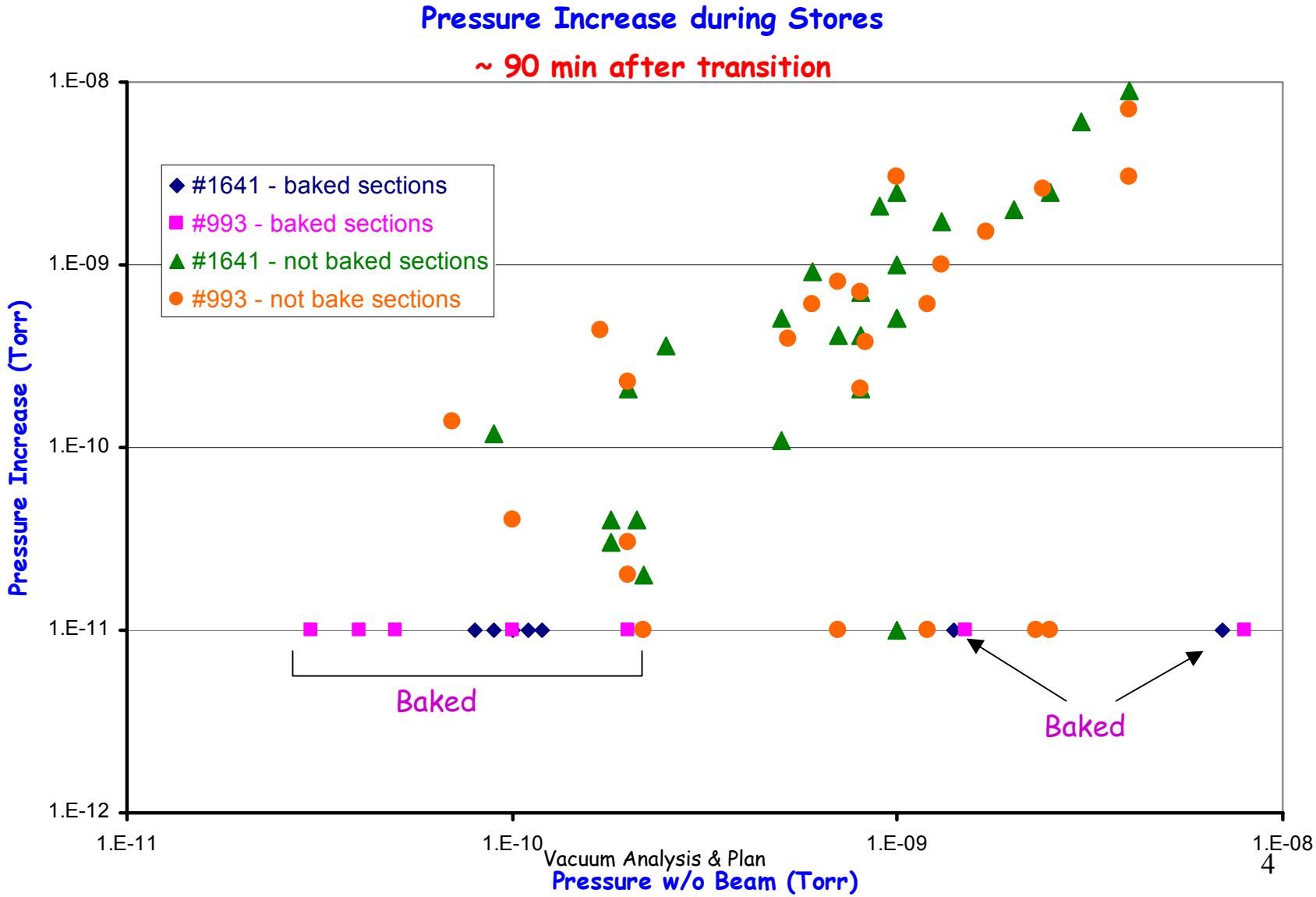
ΔP were less than one decade



For stable stores (e.g. #993 & #1641)

$\Delta P / P_o \sim 1$ for most non-baked sections (ionization, desorption..?)

No ΔP for baked sections even when P_o is high (e.g. YO9, BO10)



Injection & Ramp

Two types of pressure rises:

-Slow Pressure Increase (SP) >30 sec:

Proportional to beam intensity

Seen at every (almost!)sections

ΔP < 2-3 decades (larger than long stores)

Smaller at baked sections

Smaller w/ 55 bunches even I was higher

Similar to SPS studies

- 10^{-9} Torr ⇒ 10^{-7} Torr, ∝ I

- faster (seconds) but w/ 25ns spacing

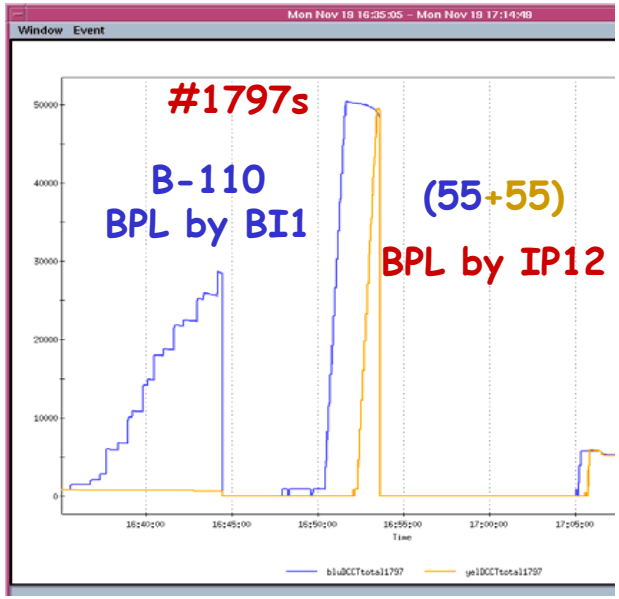
-Fast Pressure Increase (FP) < 20sec?

4-6 decades at 1-2 sections only

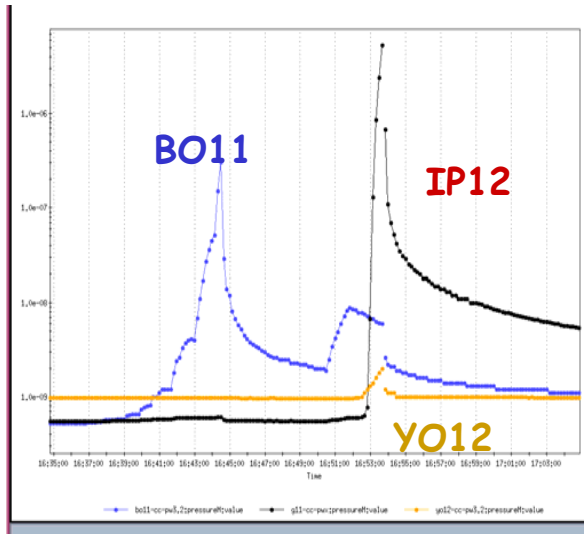
Randomly, but more at IP2, IP12…

Caused almost all vacuum BPL interlock

Beam loss related?



30 min



Summary of Beam Aborts due to Vacuum BPL in Sept - Nov

											Sections w/ P/Po > 10 before Aborts					
	Ramp#	Date	# Bunch	I(B)	I(Y)	BPL		BI1	IP2	BO3	IP4	IP6	IP10	BO11	YI11	IP12
MB	951	9/10	6	2.E+03	4.E+03	IP4	FP				5.E+03					
WF	959	9/12	55	2.E+04	2.E+04	IP6	FP					4.E+03				
FP	1015	9/17	55	3.E+04	4.E+04	IP2	FP		4.E+03							
DT	1169	10/2	55	3.E+04	4.E+04	IP12	FP		1.E+05							1.E+05
WF	1357	10/17	110	5.E+04	5.E+04	IP12	FP									1.E+04
WF	1384	10/19	110	4.E+04	4.E+04	IP4					N/A					
S-J	1539	10/29	55	4.E+04	4.E+04	IP12	FP									1.E+05
WF	1566	11/1	110(B60)	4.E+04		IP4					N/A					
GJM	1644	11/6	55	4.E+04	4.E+04	IP12	FP		2.E+01							6.E+04
GJM	1754	11/14	55	4.E+04	4.E+04	IP12	FP		3.E+04				1.E+02			5.E+04
GJM	1755	11/14	55	3.E+04	3.E+04	IP12	H.E.									
WF	1760	11/15	110(B63)	4.E+04		BO3	SP	6.E+02		1.E+03						
WF	1795	11/19	110(Y24)		2.E+04	YI11	FP								1.E+03	
WF	1797	11/19	110(B39)	3.E+04		BI1	FP	1.E+03		5.E+02				3.E+02		
WF	1797	11/19	55	5.E+04	5.E+04	IP12	FP			2.E+03					7.E+02	2.E+04

Identified 15 cases of beam abort caused by vacuum BPL in Sept, Oct and Nov

#951 due to Com. Cav. and possibly #1384, #1566 (no data)

Only #1760 showed a SP of ~ 3 decades

Eleven(11) cases had FP (< 20 sec)

Most happened at IP2 (Po ~ 1e-10 Torr) & IP12

#959 may not be real, P increase to mid 10^{-7} Torr after (not before) beam dump

reason(s) unknown, ΔP due to valve movement?

#1754 showed slow + fast beam loss induced FP at IP12

#1754 (11/14, 13:25)

Evidence of fast pressure rise caused by direct beam loss

Slow beam loss with slow pressure increase at IP12

Rapid beam loss with corresponding FP increase

$\Delta P \times V \sim 10^7$ molecules/Au ion

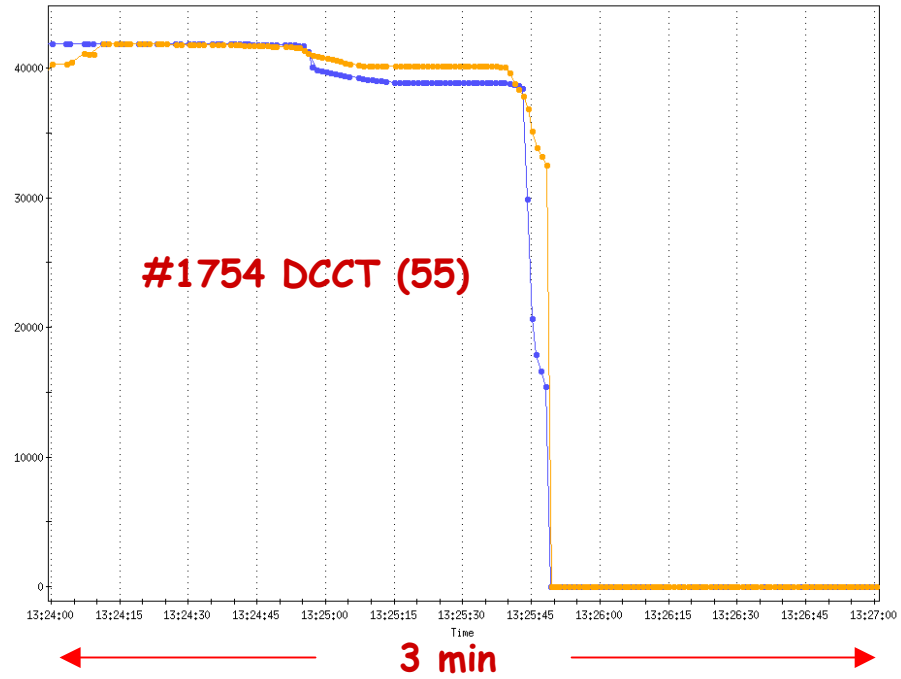
assuming all ions lost at IP12

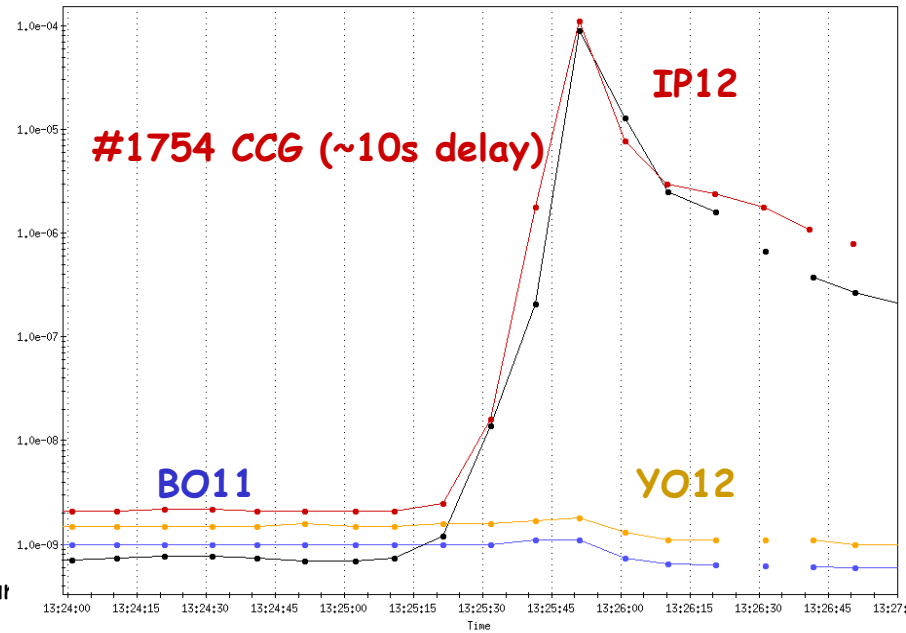
ion pumps stopped pumping at 10^{-5}

CERN measured 2×10^4 mol/ Pb ion (4.3 MeV/u, w/ bake + GD)

$\Rightarrow$ bake will not help much

Need faster vacuum data logging of ~ 1sec interval to identify more fast beam loss with FP





Summary of Vacuum Data Analysis

SP increase with beam intensity at most section: ΔP< 1-2 decades

much less or none at baked sections

occurred during inj. & ramps and at stores

possible e cloud + desorption?

similar to those observed at SPS

not limiting the beam intensity yet

FP only at injections/ramps: ΔP > 3 decades in seconds

most vacuum BPL interlocks were caused by FPs

happened at IP2 (baked) a few times and IP6, IP10

why most at IP12 (12cm ID) – will open and inspect #2 shutter

#1539 - IP12: heavy beam loss while FP rise

#1754 – IP12: solid evidence of beam loss induced FP rise

Any others due to beam loss?

Need faster vacuum logging (gauge analog voltage to ADC)

Will compare Au data with proton run data!

Vacuum Improvement Plans

Bake ~ 24 of 55 warm vacuum sections this shutdown

- Rebake Star + Phenix + …
- Bake all incoming Q3-Q4s, DX-D0s, …. (~ 18 sections)
  - 5-6 man-weeks to bake each section – TC, heating jackets, PC…
  - will reduce P_o, ΔP and SP but not help FP much
- 30% W-B can't be baked easily or at all:
  - YO1, BO2, YI2, IP4s, BI4s, YO4s, YO5s, BO6s, YO7, BO8…
- Condition TSPs (provide higher S) to ride out the FP rise
- Install electron detectors and beam pipe solenoids to study e cloud

If none of the above works:

- Increase PLC BPL delay time (at 20 sec now) to e.g. minutes
- Increase trip levels from 5e-7 to 1e-5 Torr
- Set ion pumps at "Start" mode (so they remain on at constant power)
- Can the beam loss be reduced during inj. & ramps?

If none of the above(s) work:

- Open the 3rd envelope!