

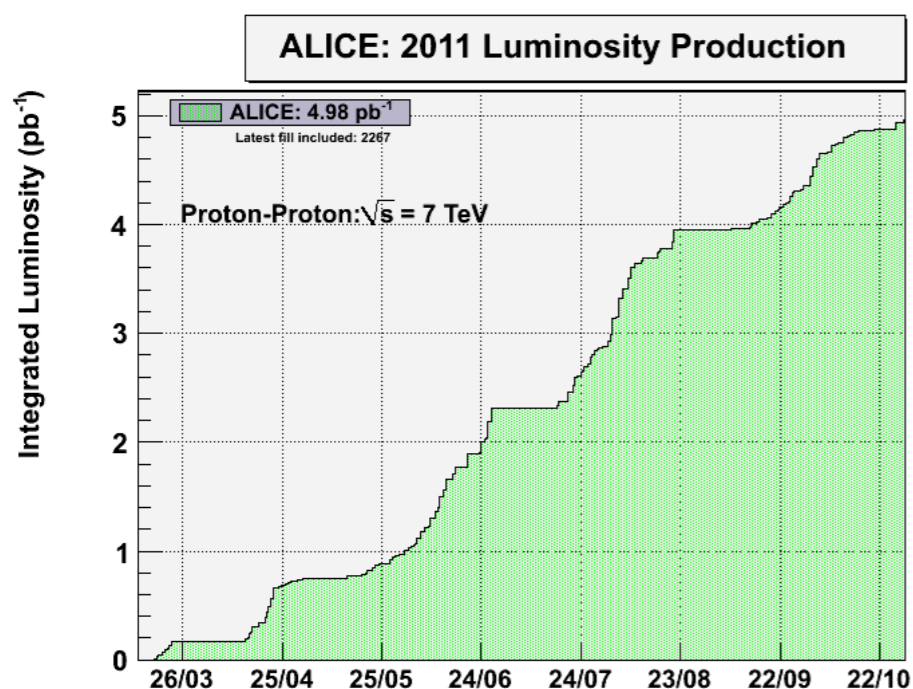
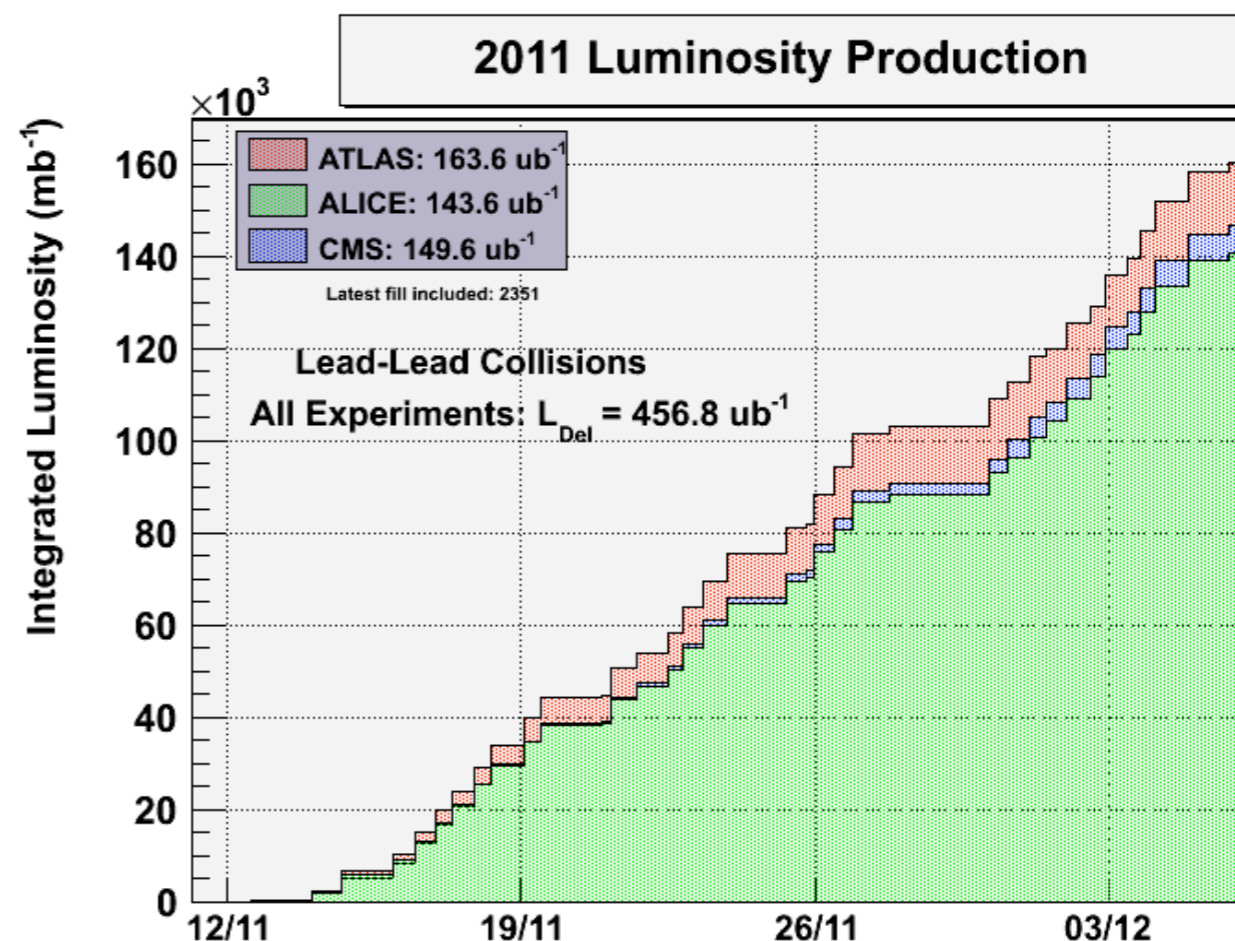
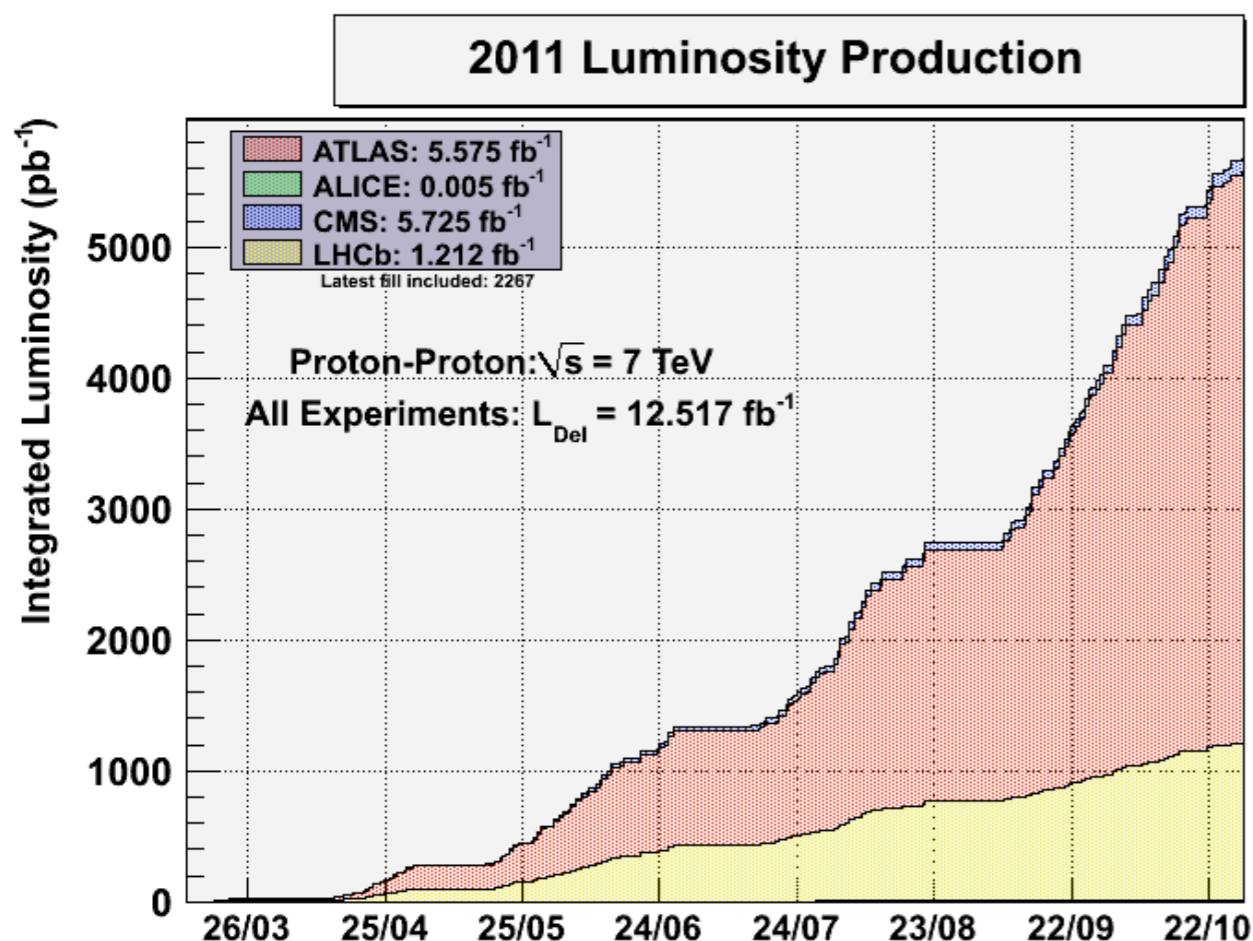
The 2011 Run: Availability and Statistics

Alick Macpherson

Evian 2011

12 December 2011

Luminosity Production



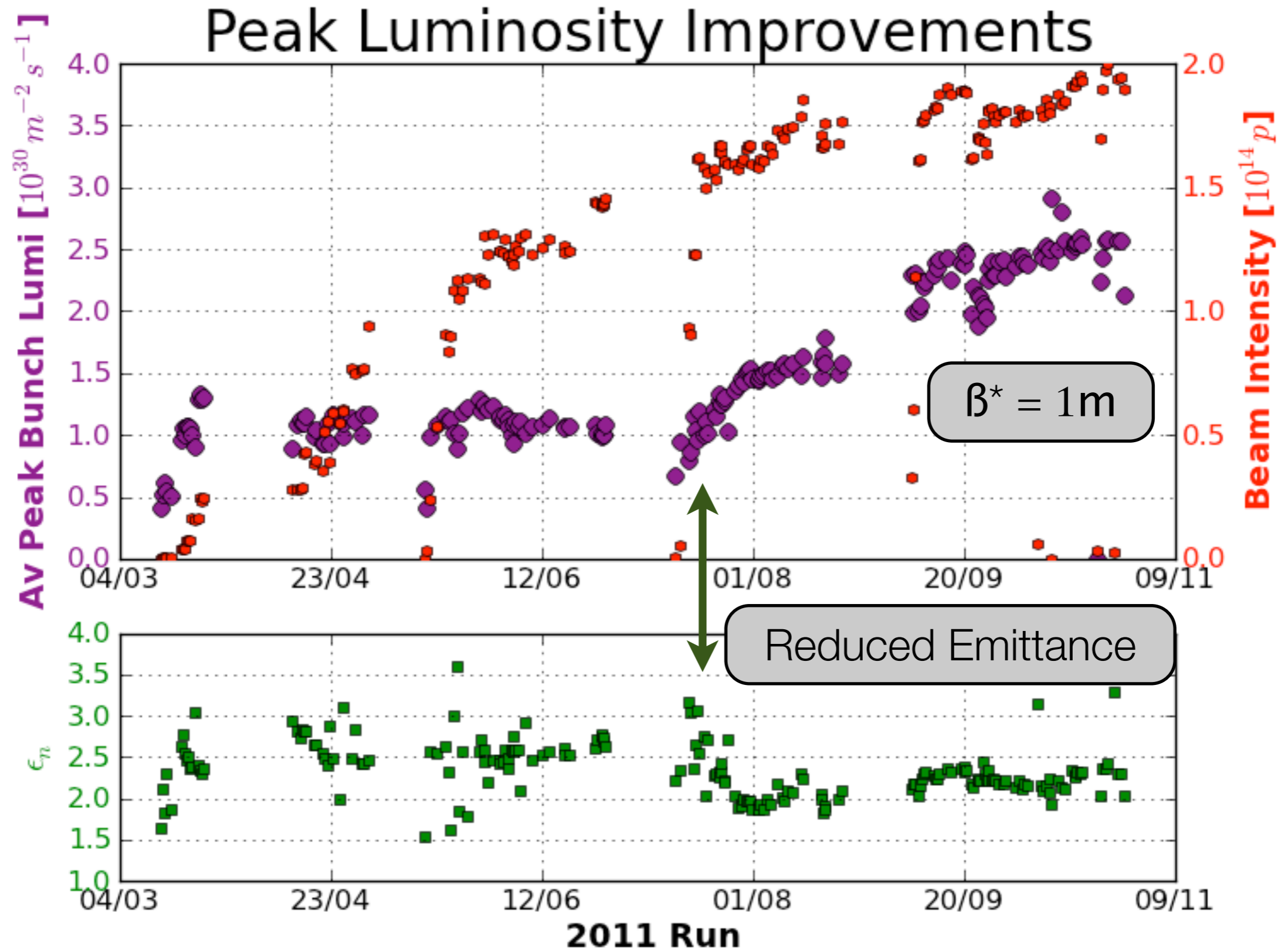
Luminosity Production

- **Well above Targets set in Evian 2010**
- 2011 Proton Run: **156.6 days** [53.0 days of SB]
 \Rightarrow **123** x (2010 Del Lumi)
- 2011 Ions Run: **28.9 days** [8.0 days of SB]
 \Rightarrow **16.6** x (2010 Del Lumi)
- 1.38 TeV Proton Run: **3.15 days**, $L_{\text{Del}} = 345.1 \text{ } \mu\text{b}^{-1}$

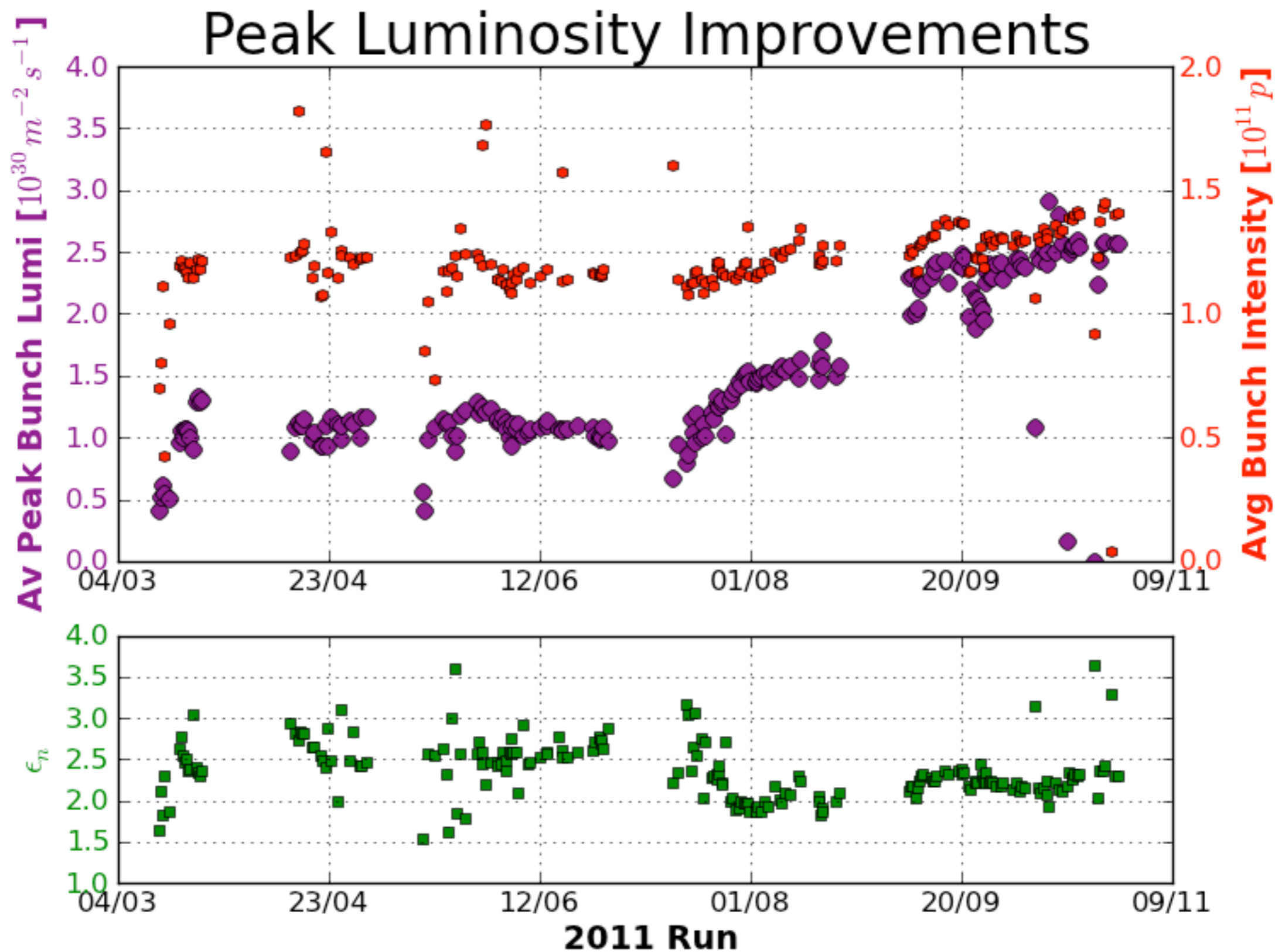
2011 Run Records

- **Proton Run: From Fill 1542 - 2267 [15th Feb - 30th Oct]**
 - Most Luminosity delivered in a single Fill: $L_{DEL} = 123.3 \text{ pb}^{-1}$ in Fill 2219
 - Highest Peak Luminosity: $L_{PEAK} = 3693.88 (\mu\text{b}\cdot\text{s})^{-1}$ in Fill 2208
 - Longest Stable Beams period: **25 hrs 23 min**
 - Shortest Stable Beams period: **3 min 47 sec**
 - Fastest Turn around [SB->SB]: **2 hrs 7 min**
 - Fastest Turn around with 1380 bunches [SB->SB]: **2 hrs 7 min**
- **Ion Run: From Fill 2289 - 2352 [11th Nov - 6th Dec]**
 - Most Luminosity delivered in a single Fill: $L_{DEL} = 6960.0 \text{ mb}^{-1}$ in Fill 2330
 - Highest Peak Luminosity: $L_{PEAK} = 2010.0 (\text{b}\cdot\text{s})^{-1}$ in Fill 2294
 - Longest Stable Beams period: **8 hrs 4 min**
 - Shortest Stable Beams period: **20 min 48 sec**
 - Fastest Turnaround [SB->SB]: **2hrs 37min**

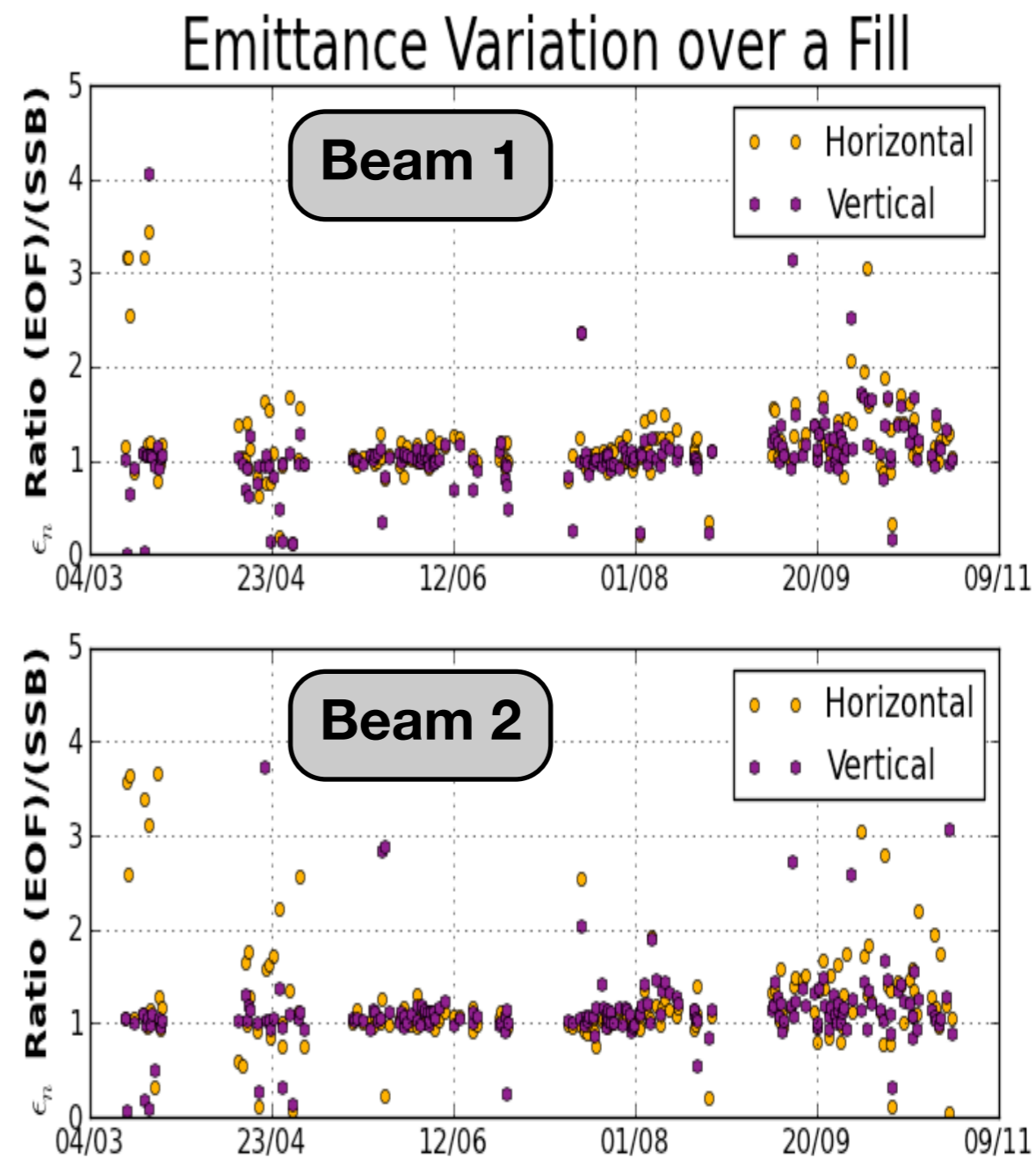
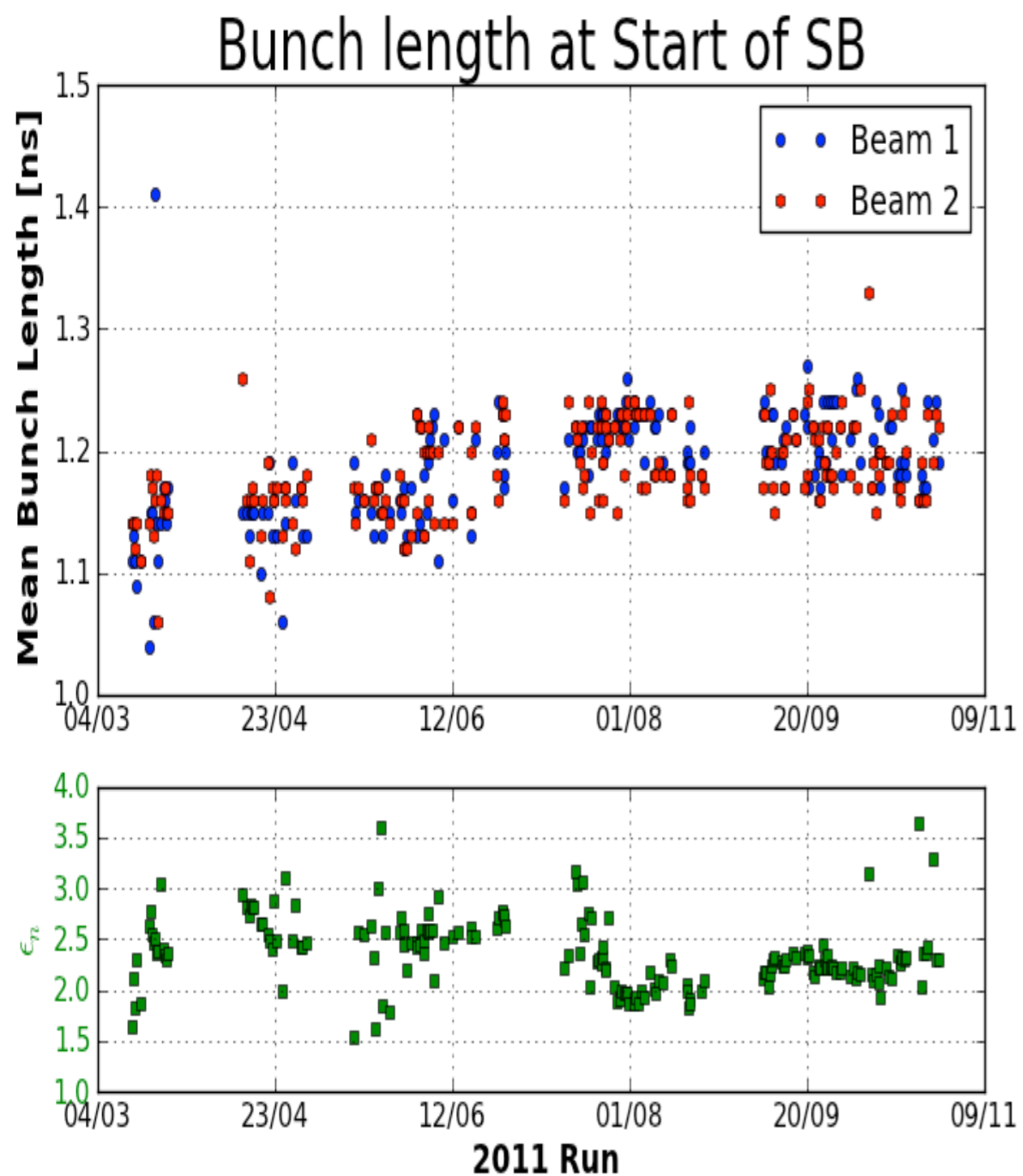
Getting More Luminosity



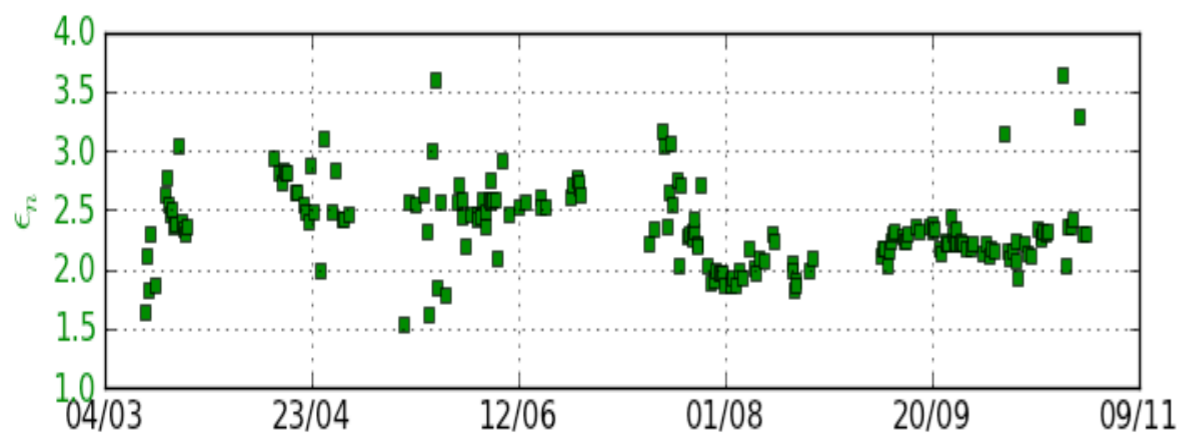
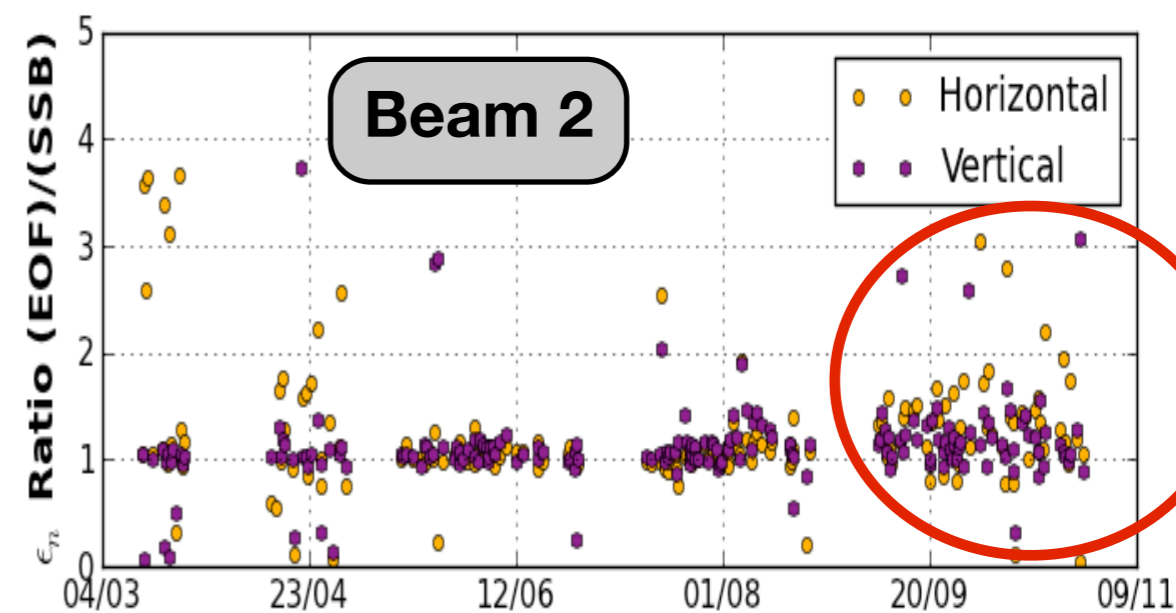
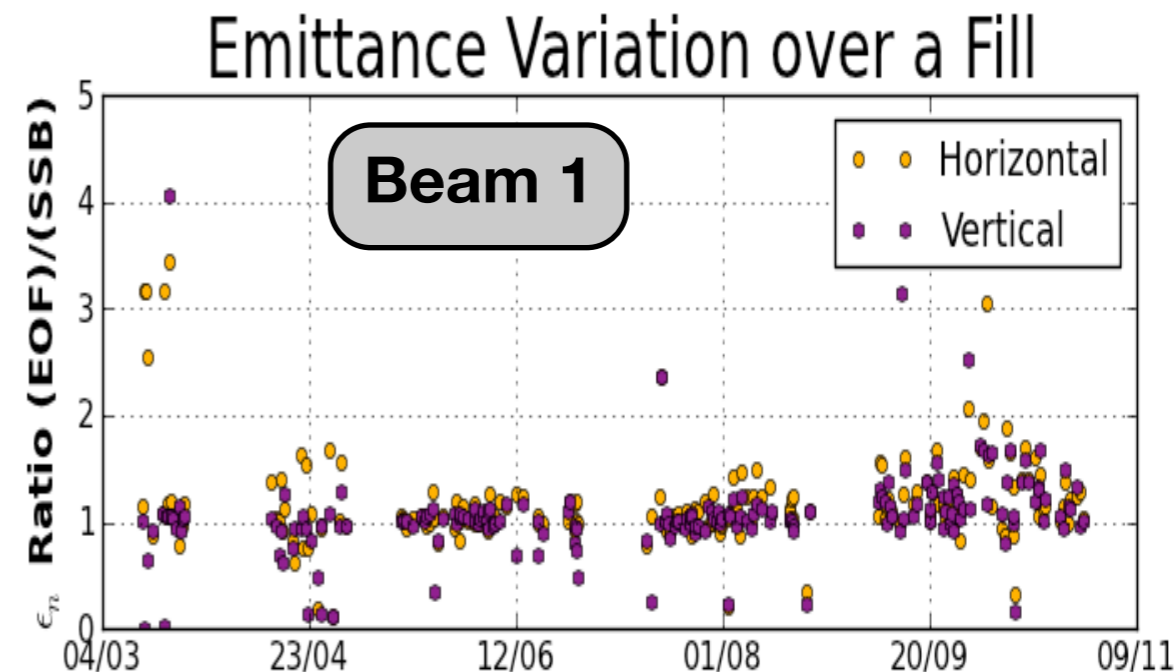
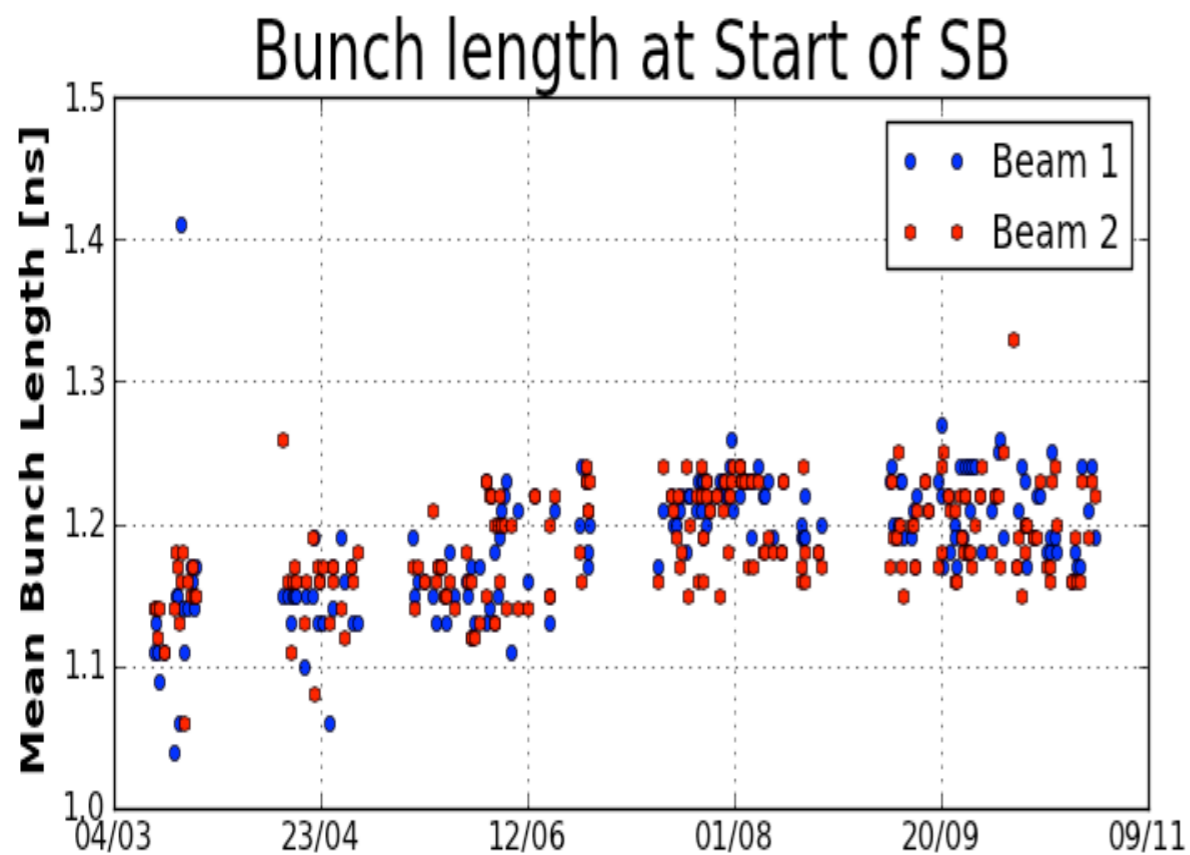
Getting More Luminosity-II



Bunch shapes over the proton run



Bunch shapes over the proton run

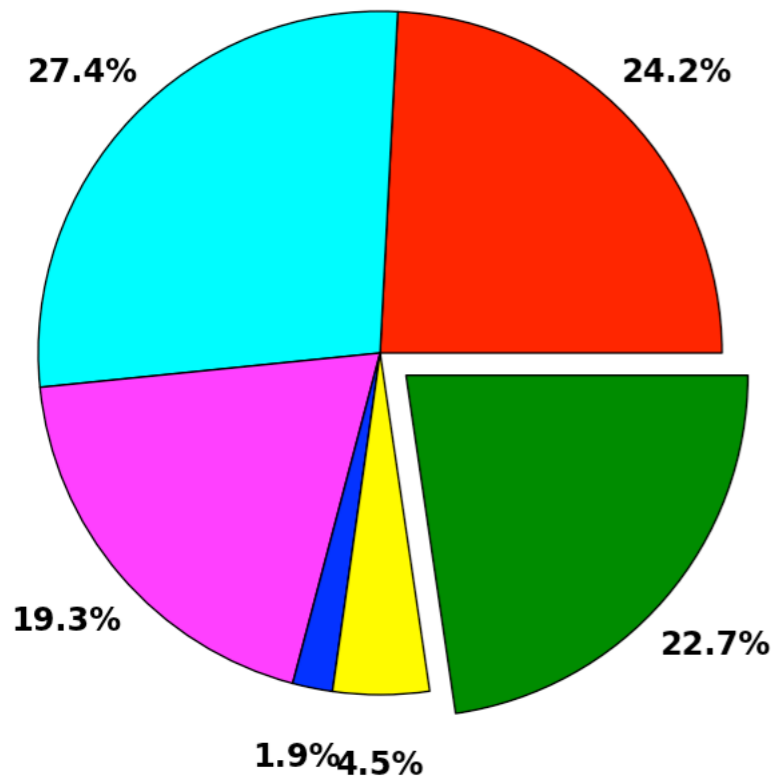


Emittance variations more prevalent for Beam 2. Both beams show variations as bunch intensities increase.

Bunch length remains constant over 2011 and no fluctuations within a fill

LHC 2011 Run: Efficiency

2011 Run - All Fills

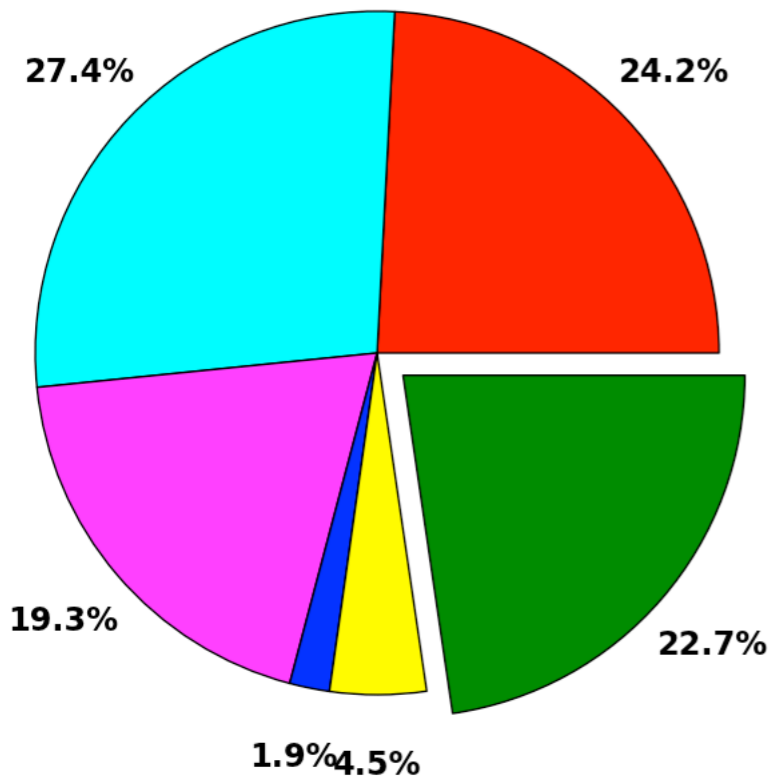


SB Time: 61.0 days Total Time: 269.3 days

- NB: based on Access (EIS Beam Status)
- All other categories use:
 - Beam mode
 - Beam presence
- Lumi Production => 1380b

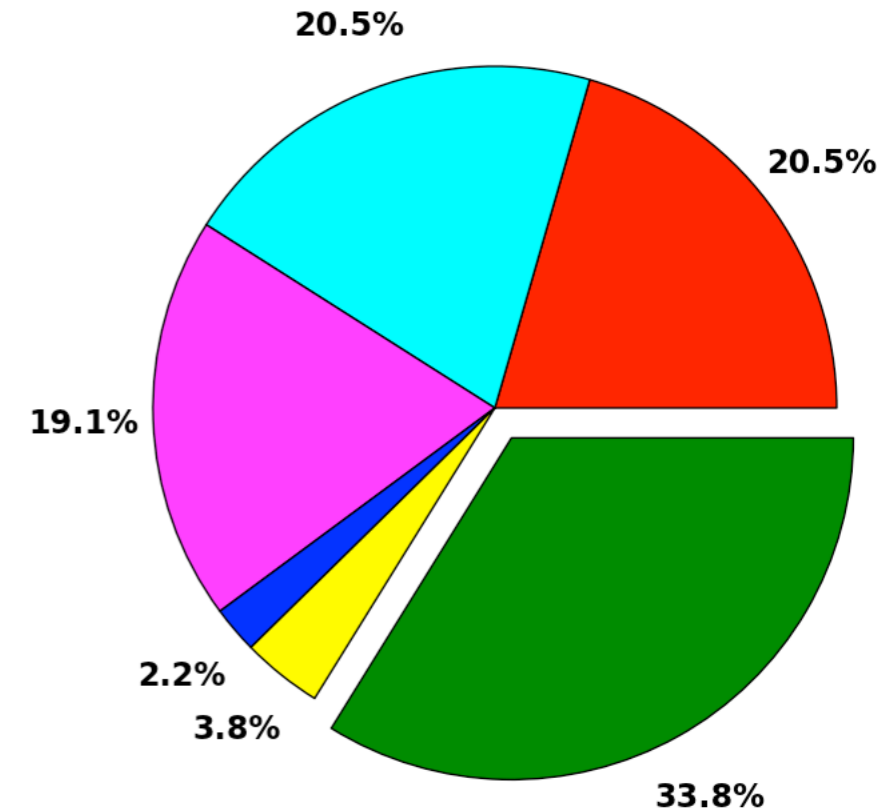
LHC 2011 Run: Efficiency

2011 Run - All Fills



SB Time: 61.0 days Total Time: 269.3 days

2011 Proton Run

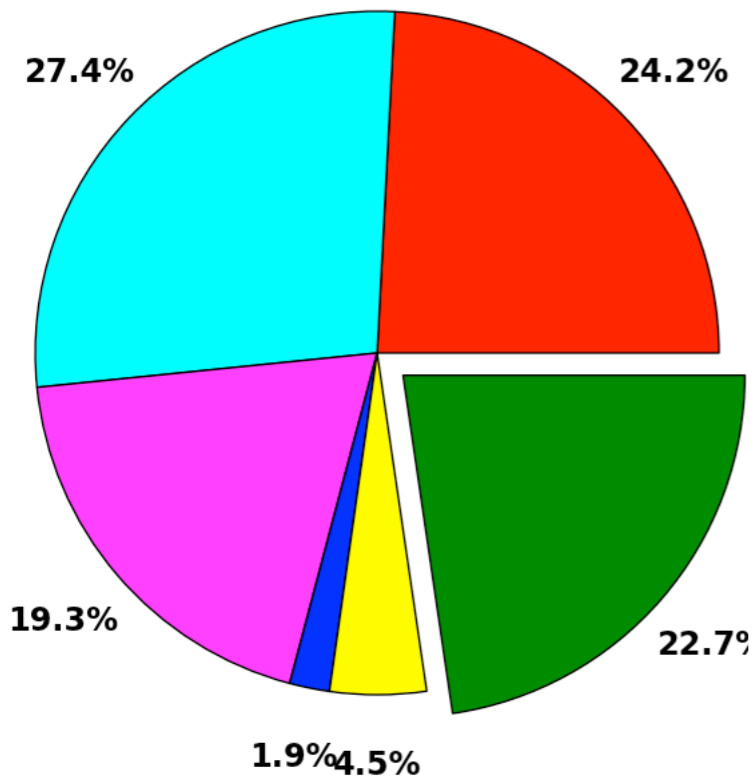


SB Time: 53.0 days Total Time: 156.6 days

- NB: based on Access (EIS Beam Status)
- All other categories use:
 - Beam mode
 - Beam presence
- Lumi Production => 1380b

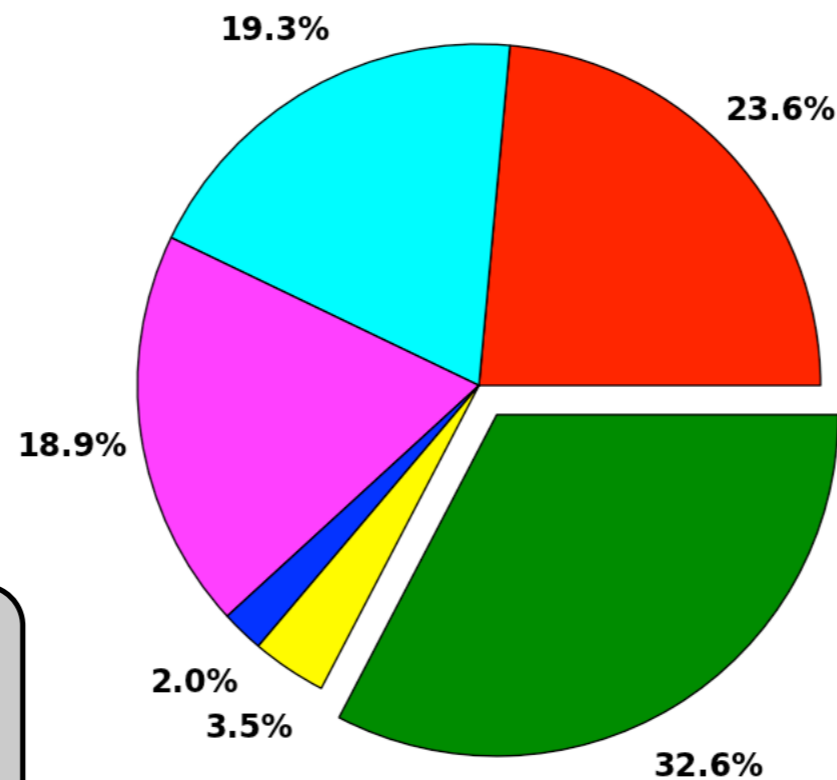
LHC 2011 Run: Efficiency

2011 Run - All Fills



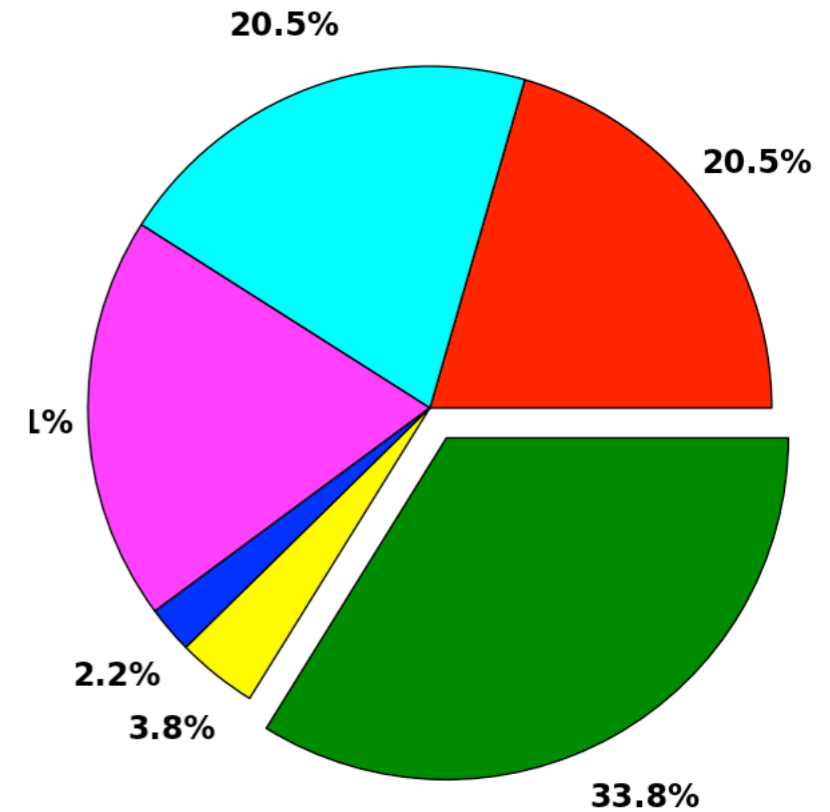
SB Time: 61.0 days Total Time: 269.3 day

2011 Luminosity Production



SB Time: 26.6 days Total Time: 81.4 days

2011 Proton Run



SB Time: 53.0 days Total Time: 156.6 days

- NB: based on Access (EIS Beam Status)
- All other categories use:
 - Beam mode
 - Beam presence
- Lumi Production => 1380b

Hubner factor

$$H = 11.57 \times L_{Del} / (D \times L_{Peak})$$

$$\Rightarrow \mathbf{H = 0.202}$$

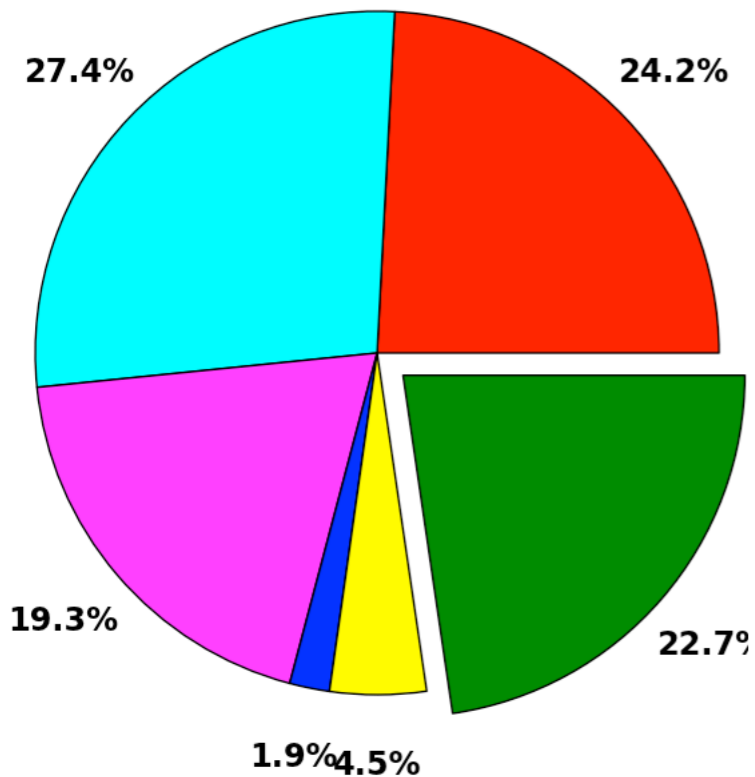
D = 89.15 days

$$L_{Peak} = 2572.0 \text{ } (\mu\text{b}\cdot\text{s})^{-1}$$

$$L_{Del} = 4.006 \text{ fb}^{-1}$$

LHC 2011 Run: Efficiency

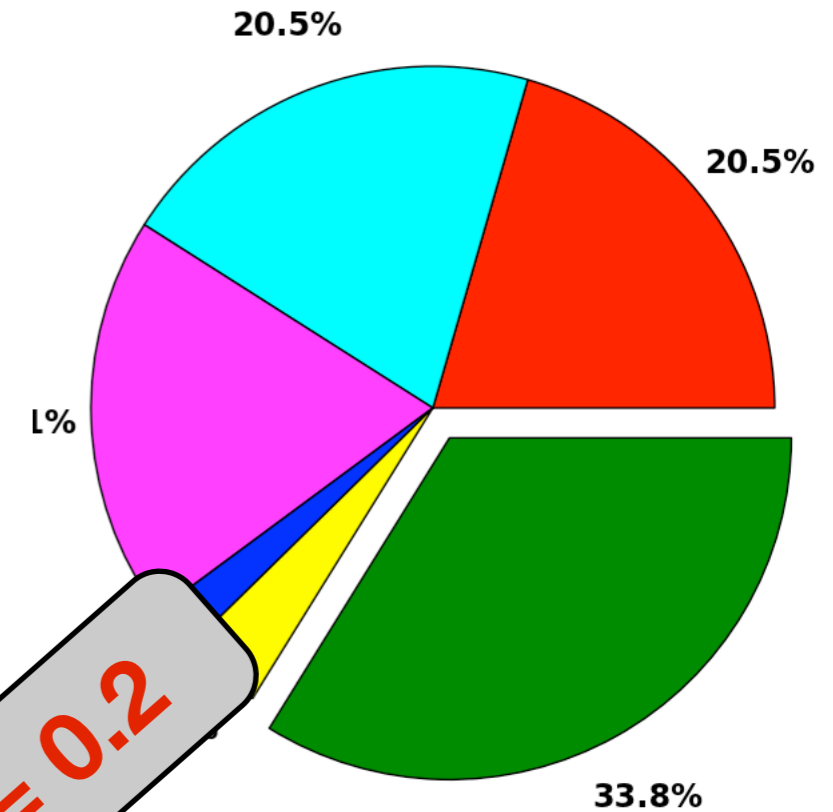
2011 Run - All Fills



SB Time: 61.0 days Total Time: 269.3 day

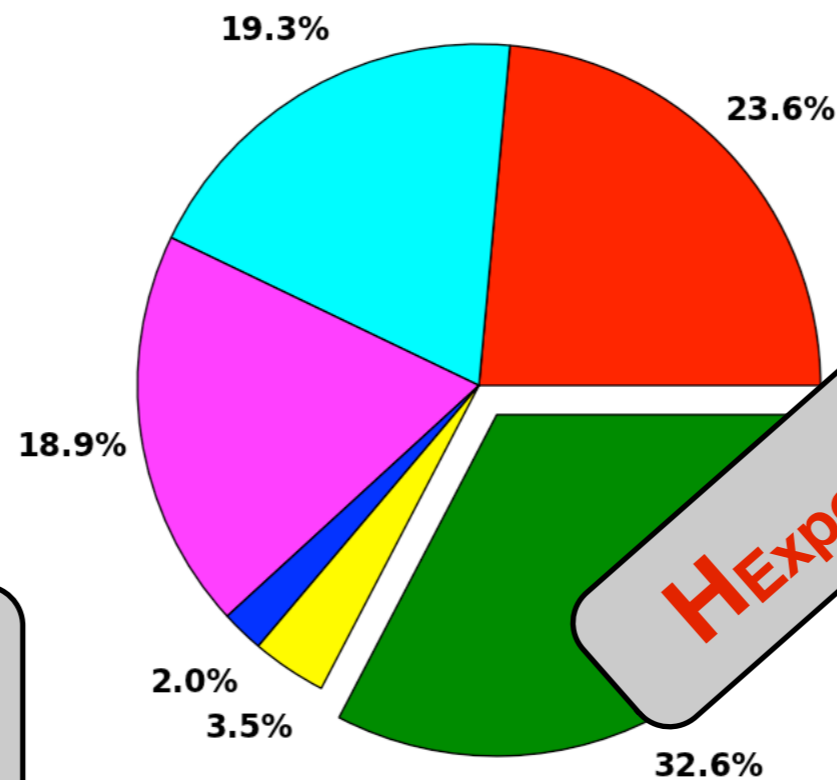


2011 Proton Run



SB Time: 53.0 days Total Time: 156.6 days

2011 Luminosity Production



SB Time: 26.6 days Total Time: 81.4 days

$H_{\text{Expected}} = 0.2$

- NB: based on Access (EIS Beam Status)
- All other categories use:
 - Beam mode
 - Beam presence
- Lumi Production => 1380b

Hubner factor

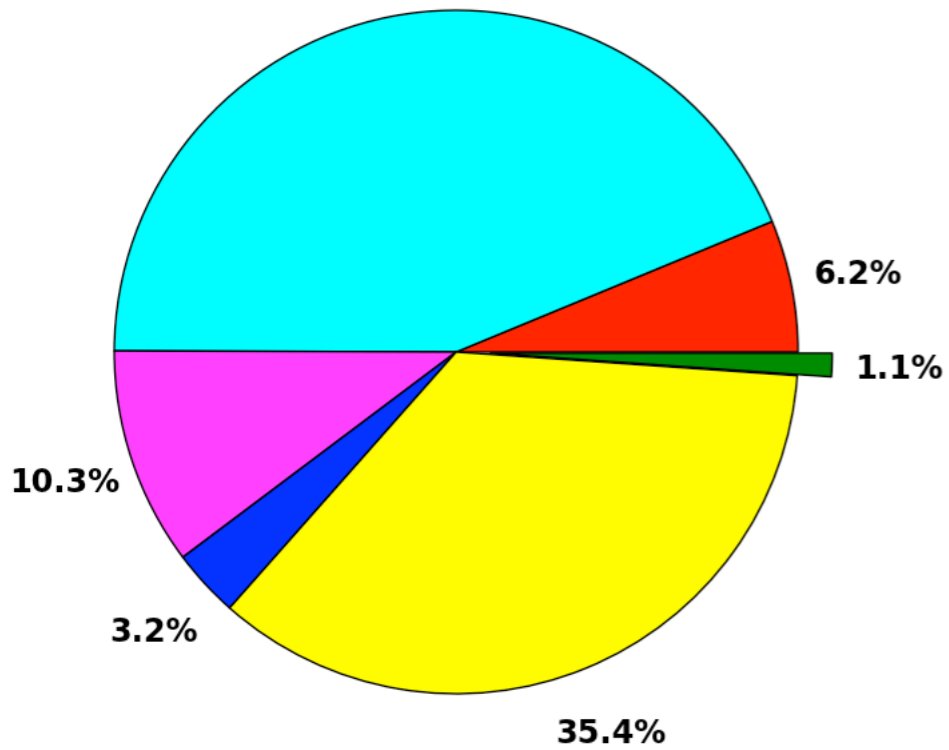
$$H = 11.57 \times L_{\text{Del}} / (D \times L_{\text{Peak}})$$

$$\Rightarrow \mathbf{H = 0.202}$$

$D = 89.15$ days
 $L_{\text{Peak}} = 2572.0 \text{ } (\mu\text{b}\cdot\text{s})^{-1}$
 $L_{\text{Del}} = 4.006 \text{ fb}^{-1}$

LHC 2011 Run: Efficiency - II

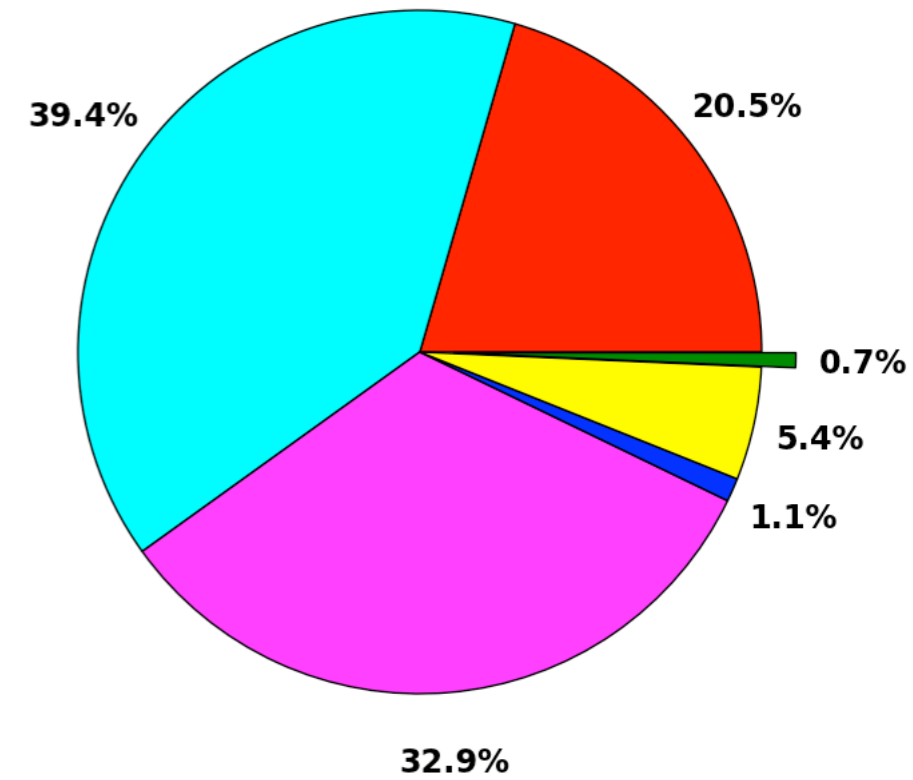
2011 High Beta Run
43.7%



SB Time: 0.0 days Total Time: 4.5 days



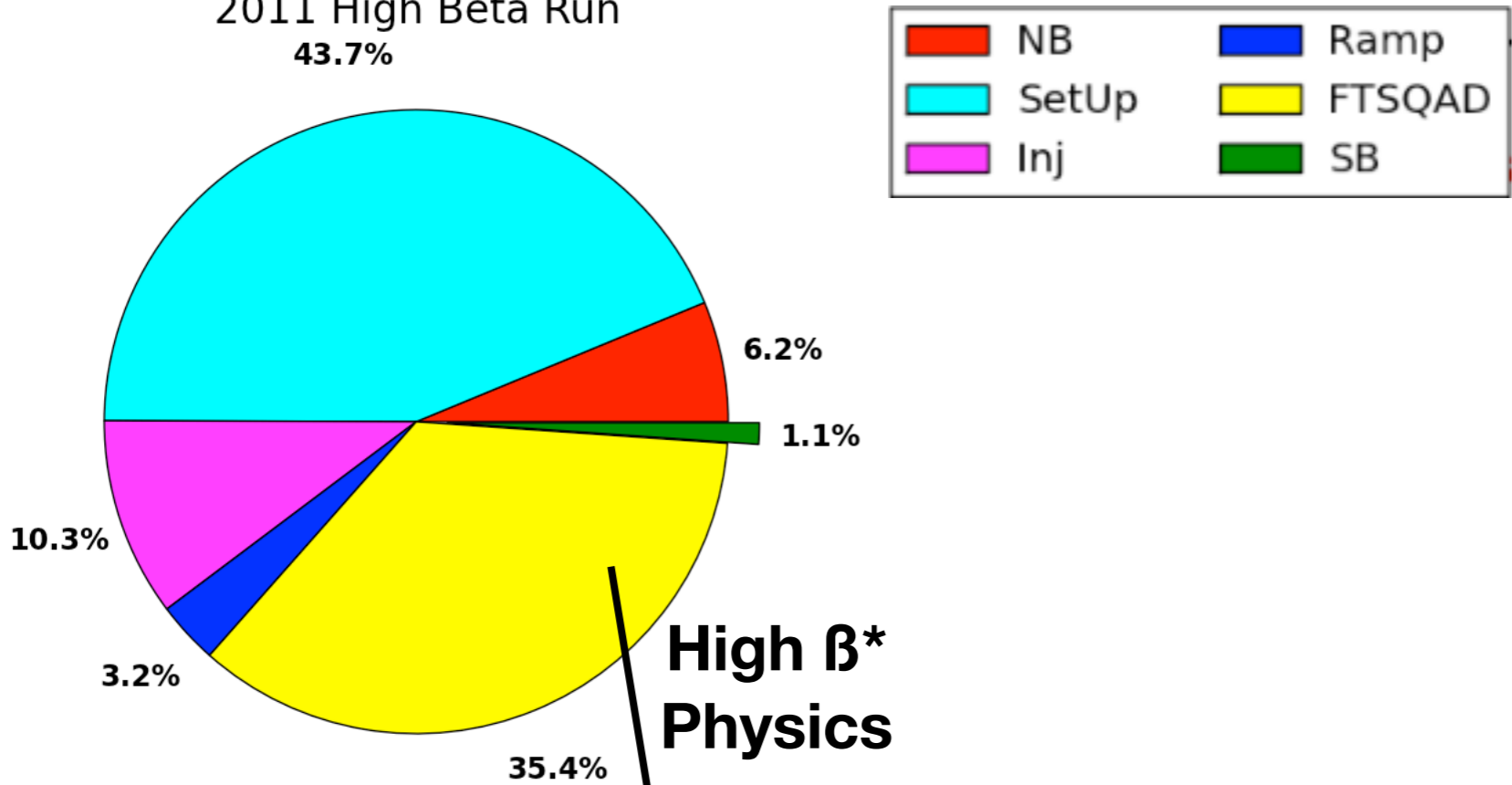
2011 Machine Development



SB Time: 0.3 days Total Time: 0.0 days

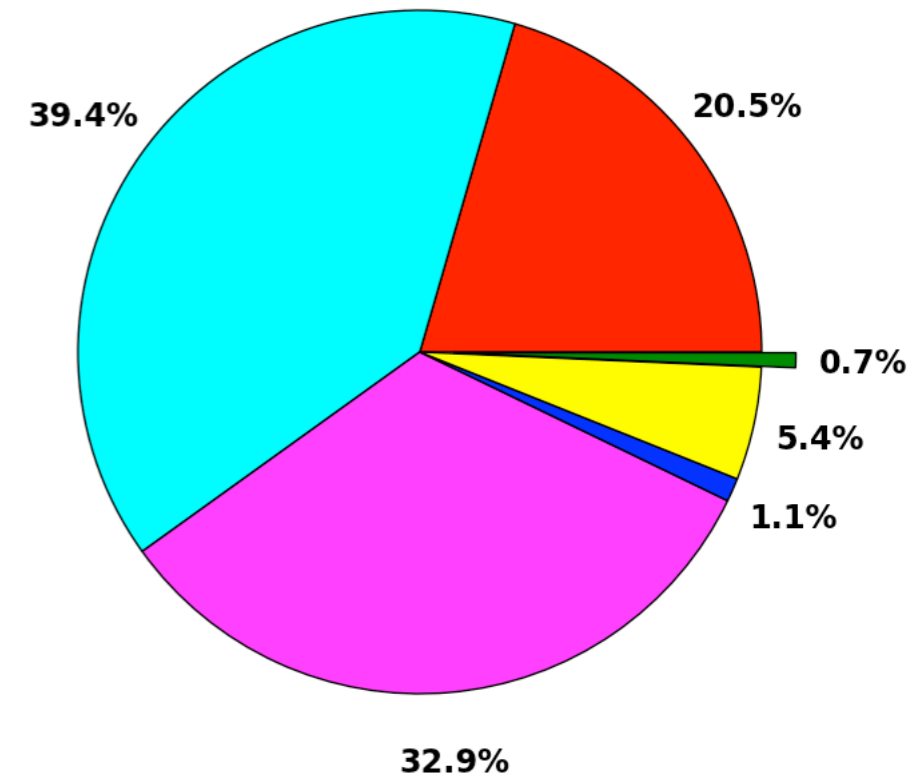
LHC 2011 Run: Efficiency - II

2011 High Beta Run
43.7%

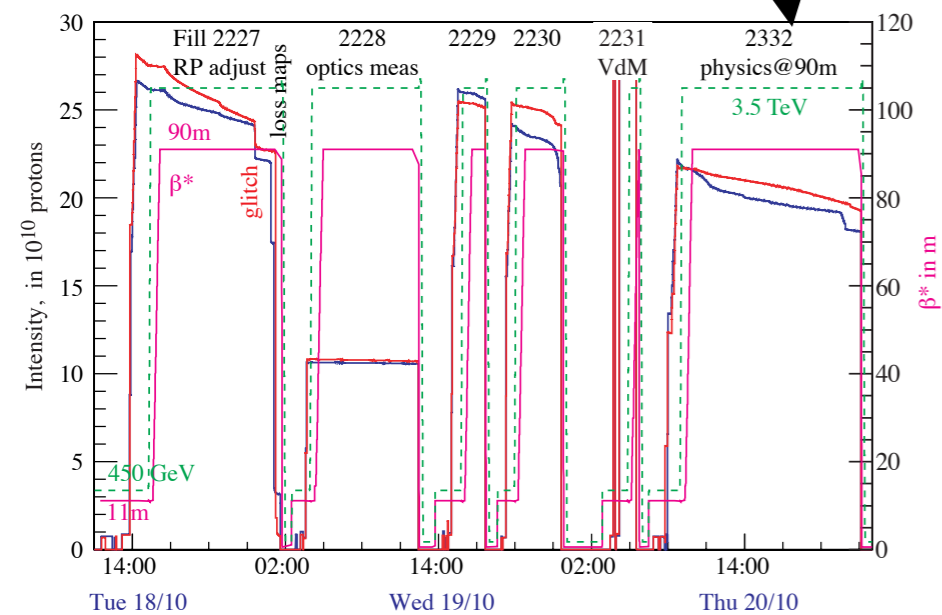


SB Time: 0.0 days Total Time: 4.5 days

2011 Machine Development

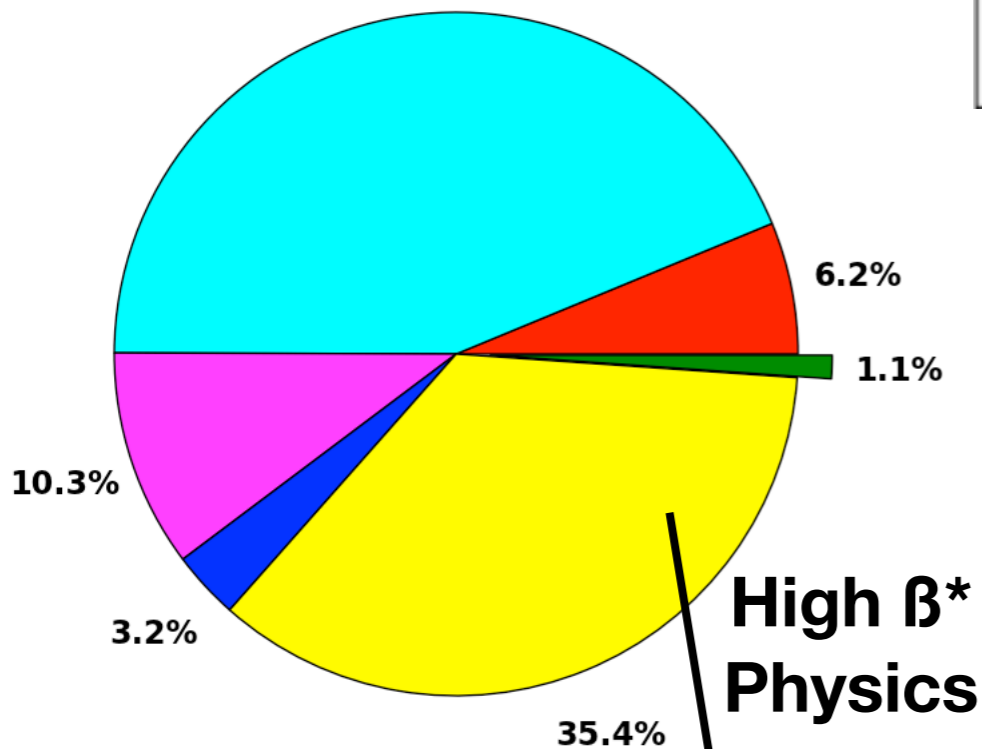


SB Time: 0.3 days Total Time: 0.0 days



LHC 2011 Run: Efficiency - II

2011 High Beta Run
43.7%

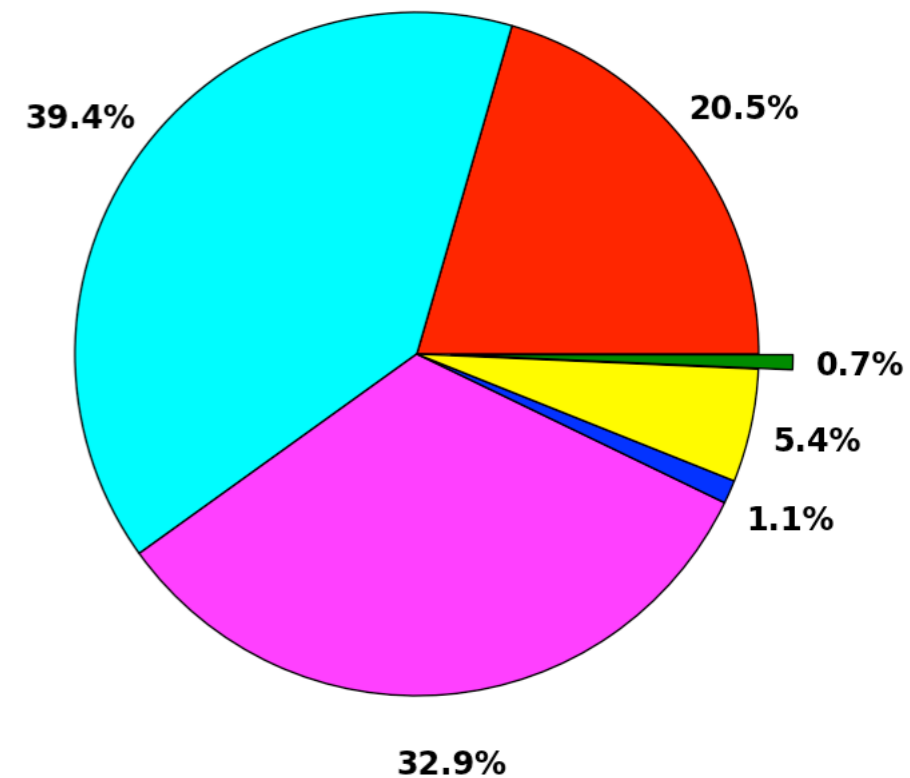


**High β^*
Physics**

SB Time: 0.0 days Total Time: 4.5 days

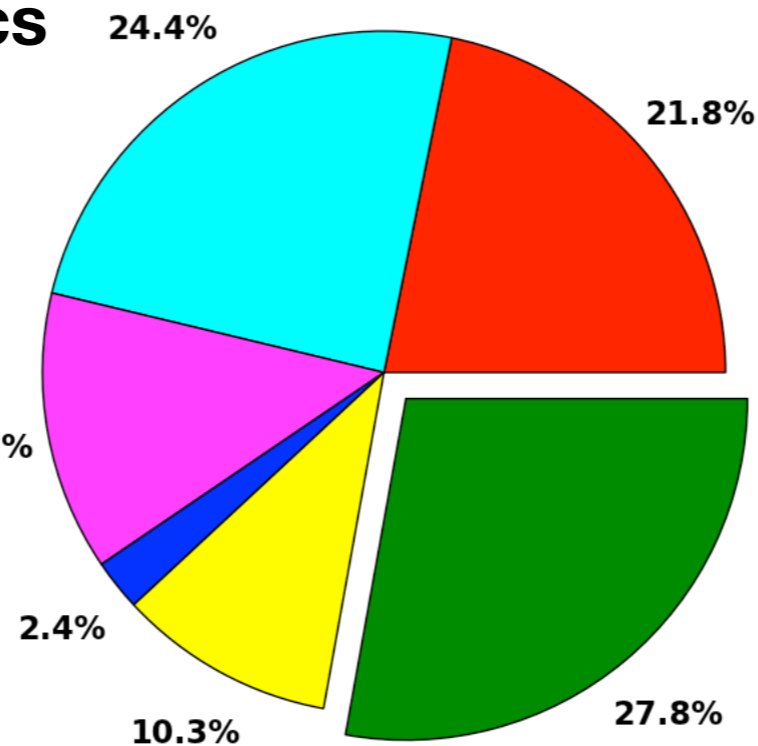


2011 Machine Development



B Time: 0.3 days Total Time: 0.0 days

2011 Ion Run



SB Time: 8.0 days Total Time: 28.9 days

Hubner factor - Ions

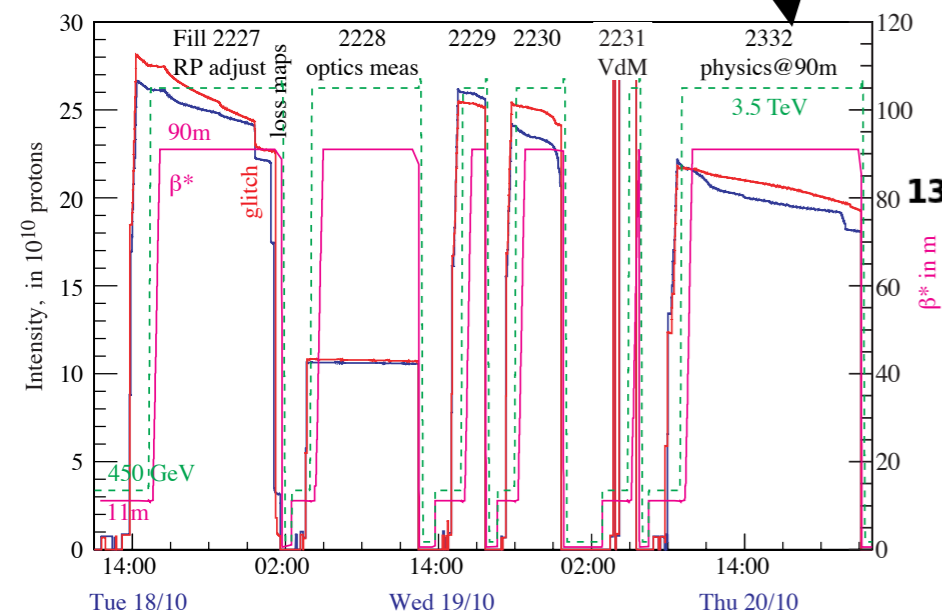
$$H = 11.57 \times L_{Del} / (D \times L_{Peak})$$

$$\Rightarrow H = 0.171$$

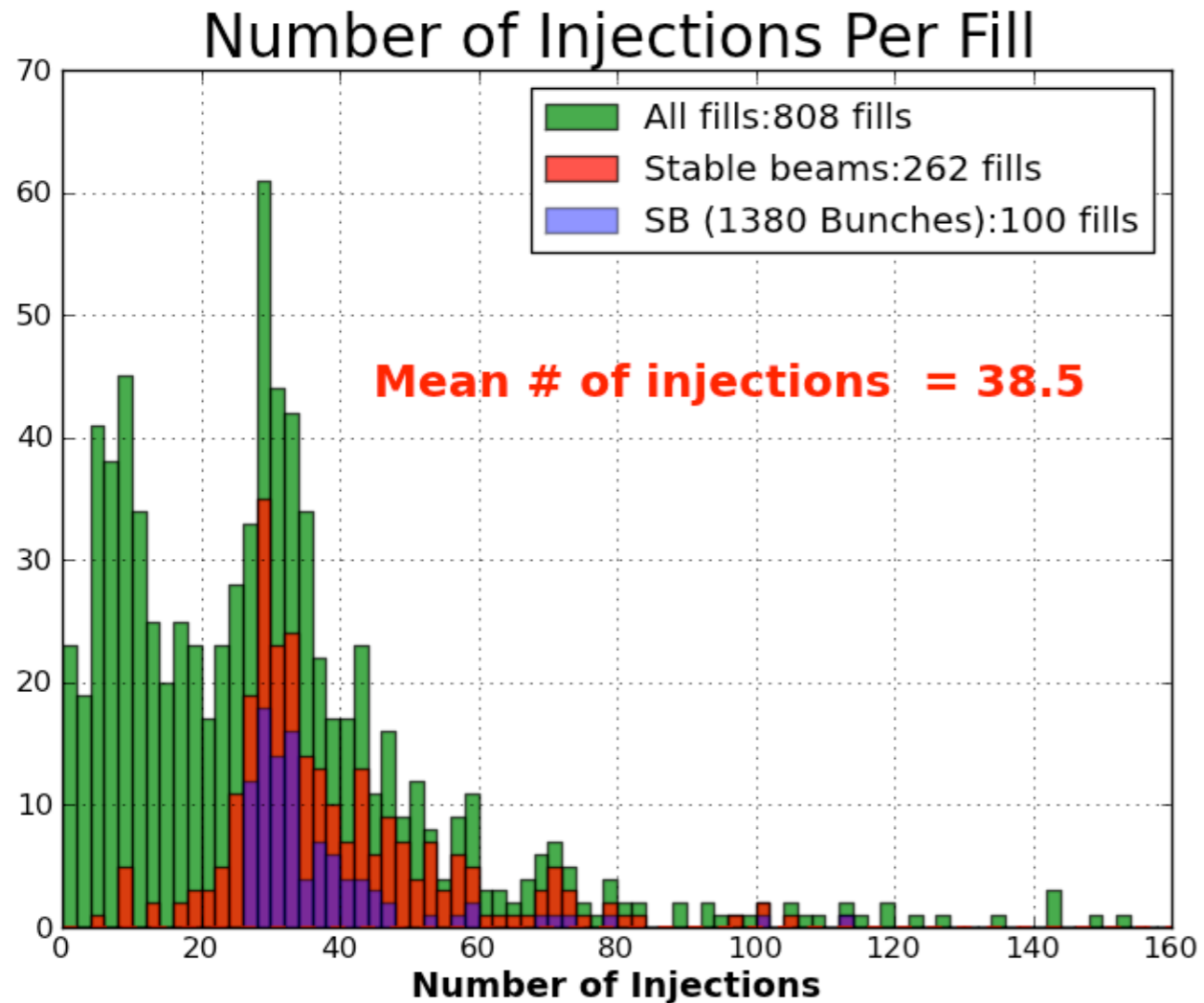
$$D = 21.75 \text{ days}$$

$$L_{Peak} = 375.0 \text{ (b.s.)}^{-1}$$

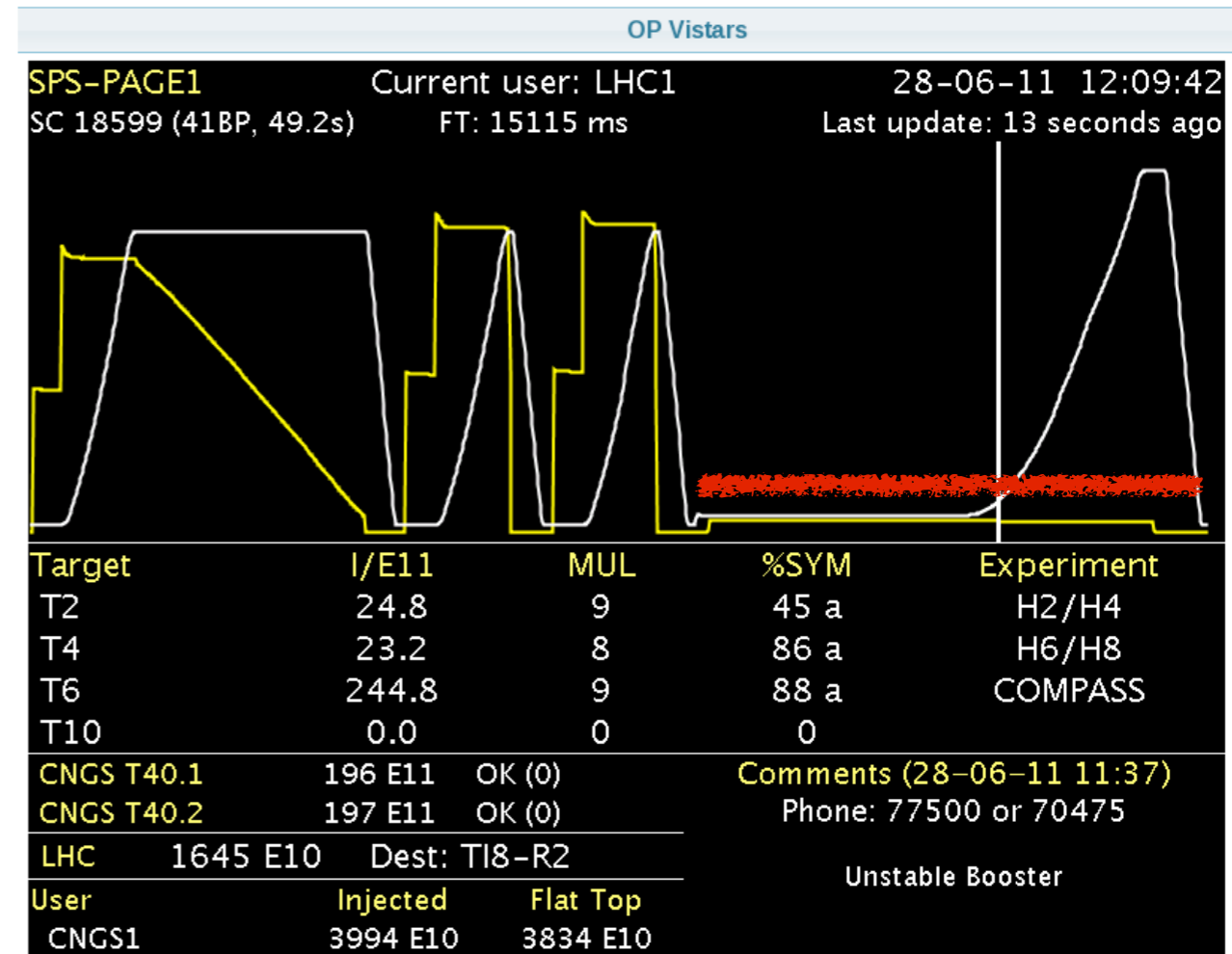
$$L_{Del} = 120.5 \mu\text{b}^{-1}$$



Injection



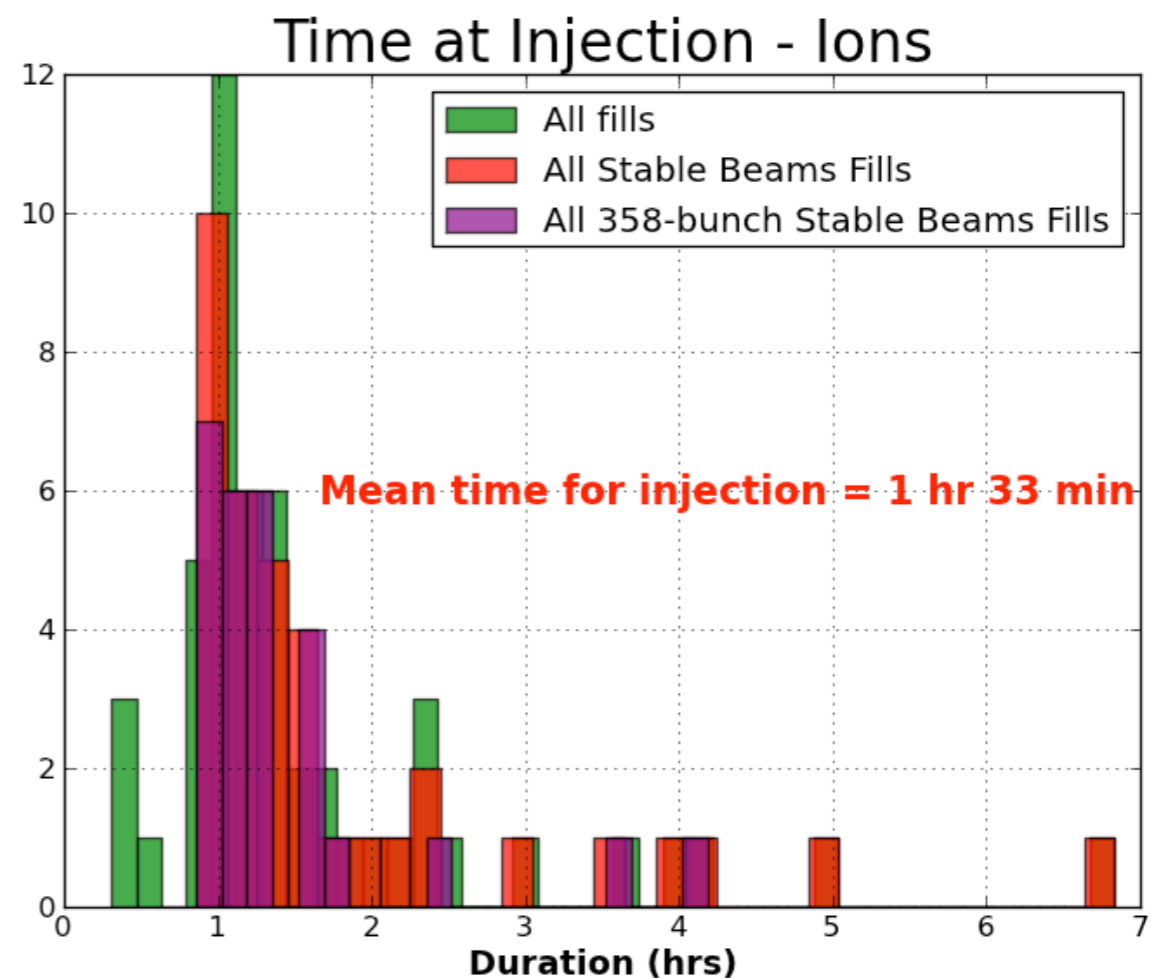
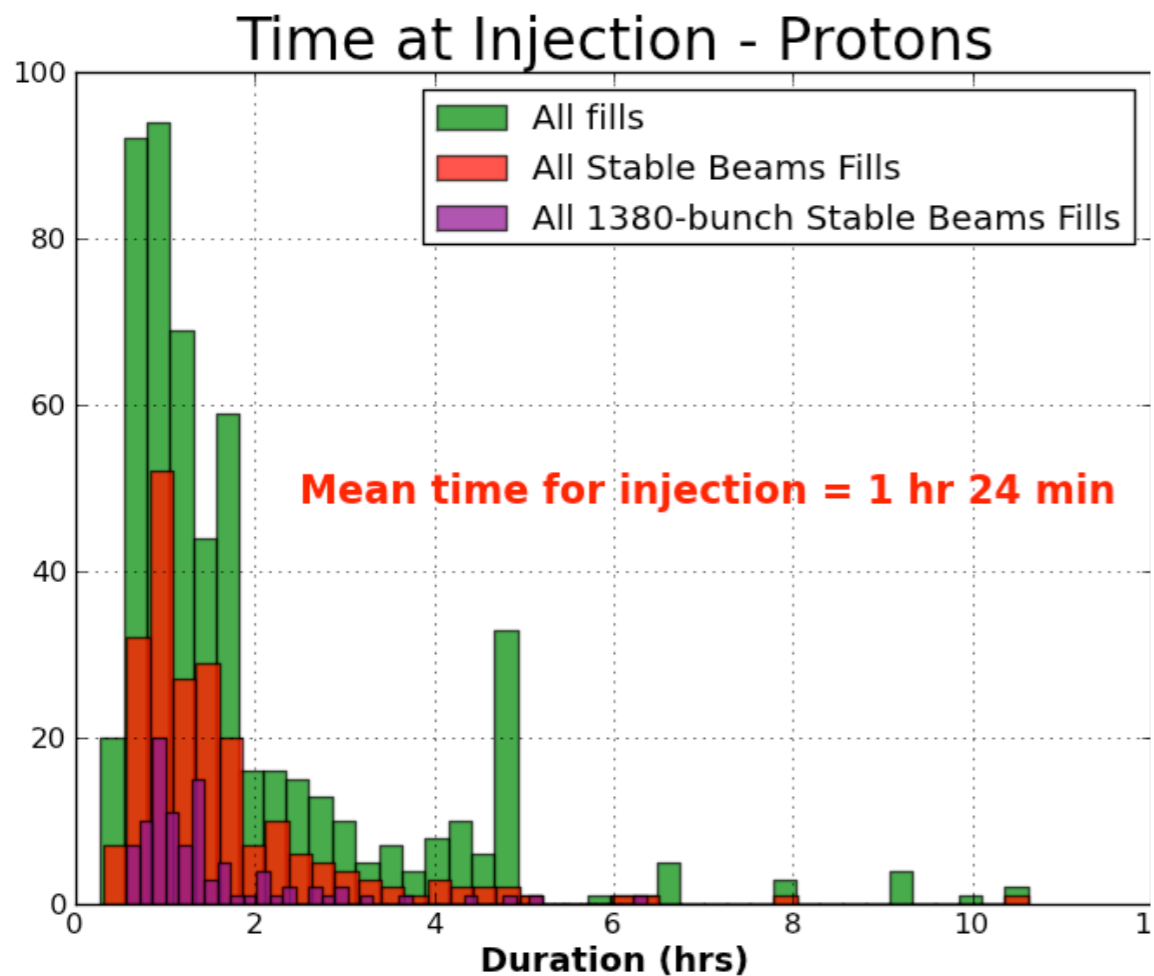
SPS supercycle: 41 BP => 49.2 sec
 Could be reduced to 28 BP



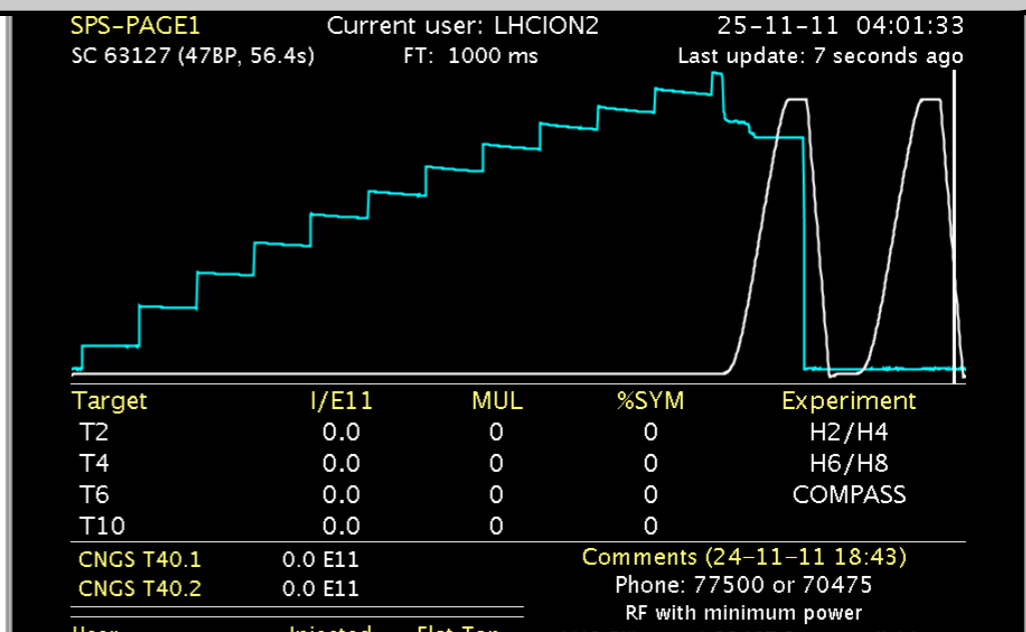
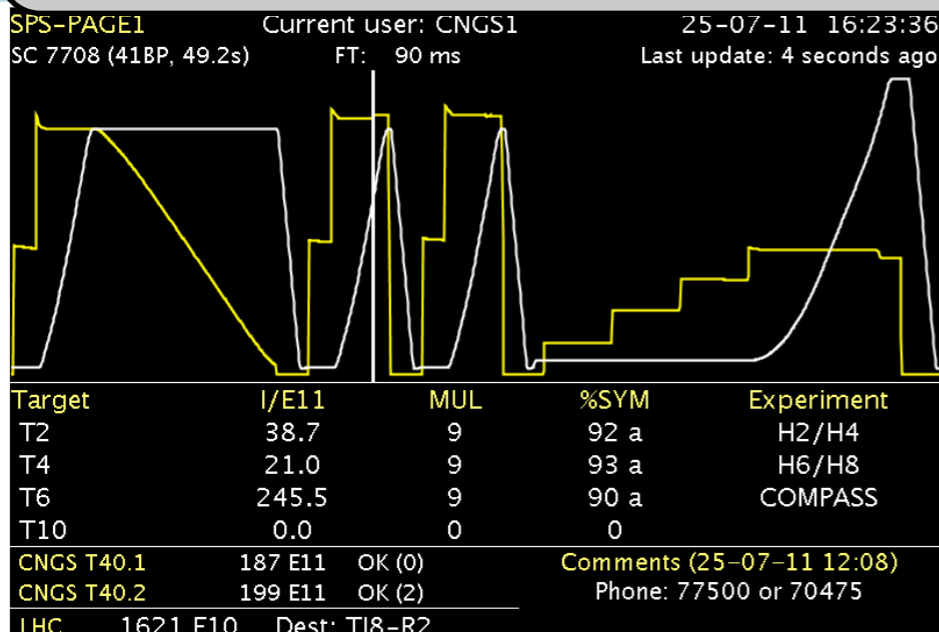
Dedicated LHC filling (SPS): 28 BP => 33.6 sec
 Recovered Time = 32 x 800 x 15.6sec
 = **5.56 days**

Dedicated LHC filling:
Not just a technical issue: Sharing with other SPS Users

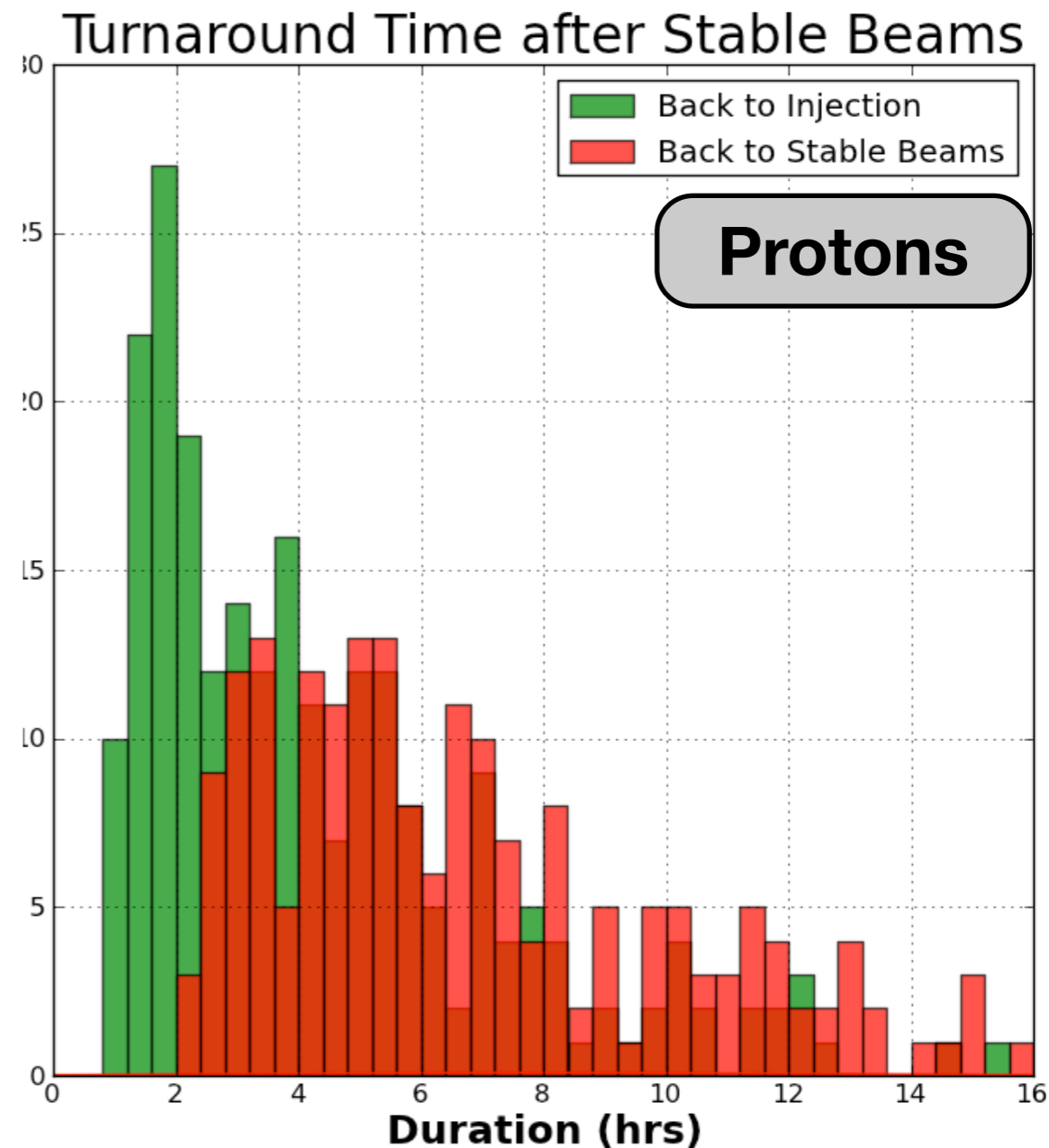
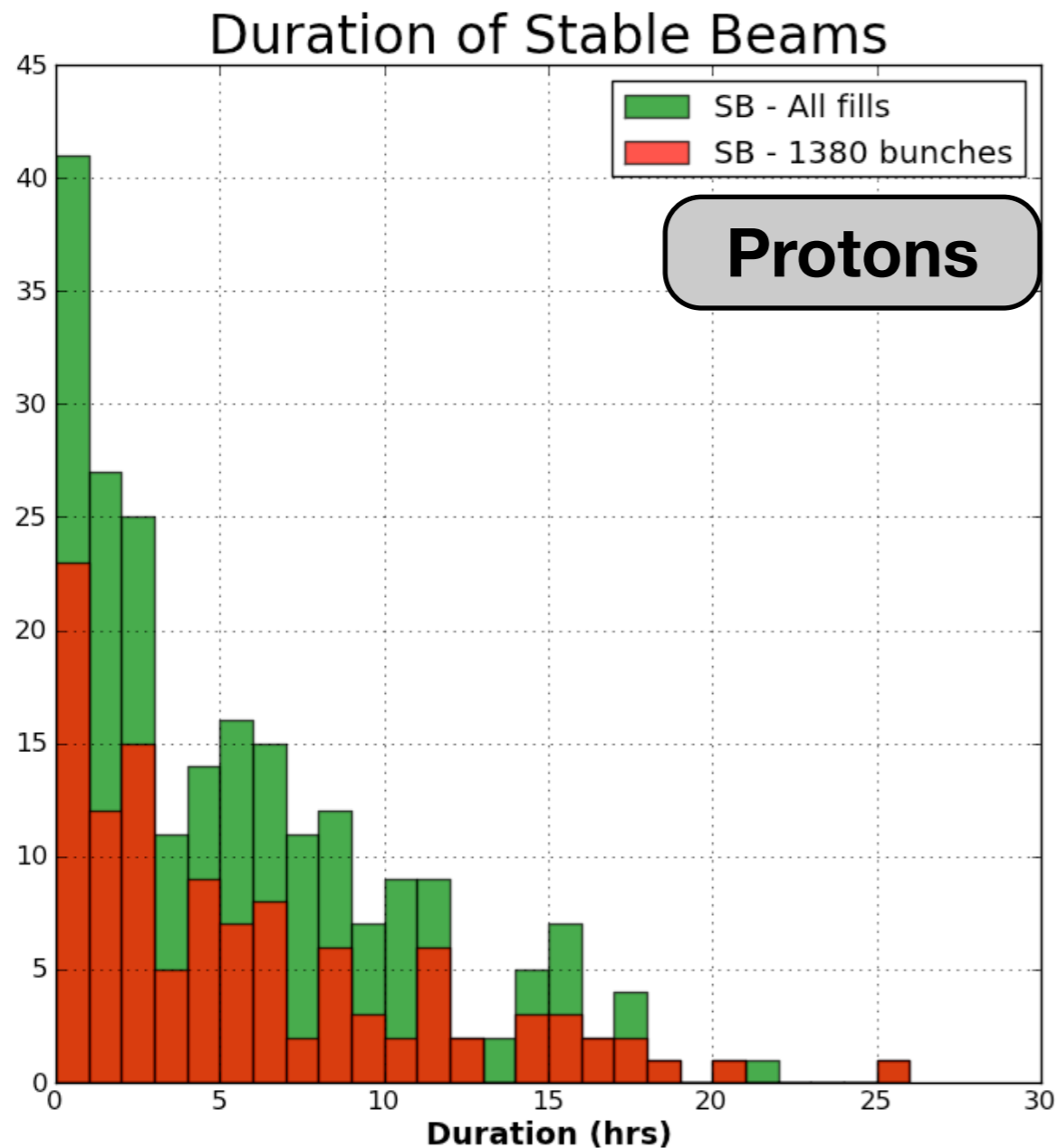
Time at Injection



It just feels like filling with Ions takes so much longer ...



Stable Beams and Turnaround



Average Turnaround SB -> Injection:

Protons: **3 hrs 42 min**

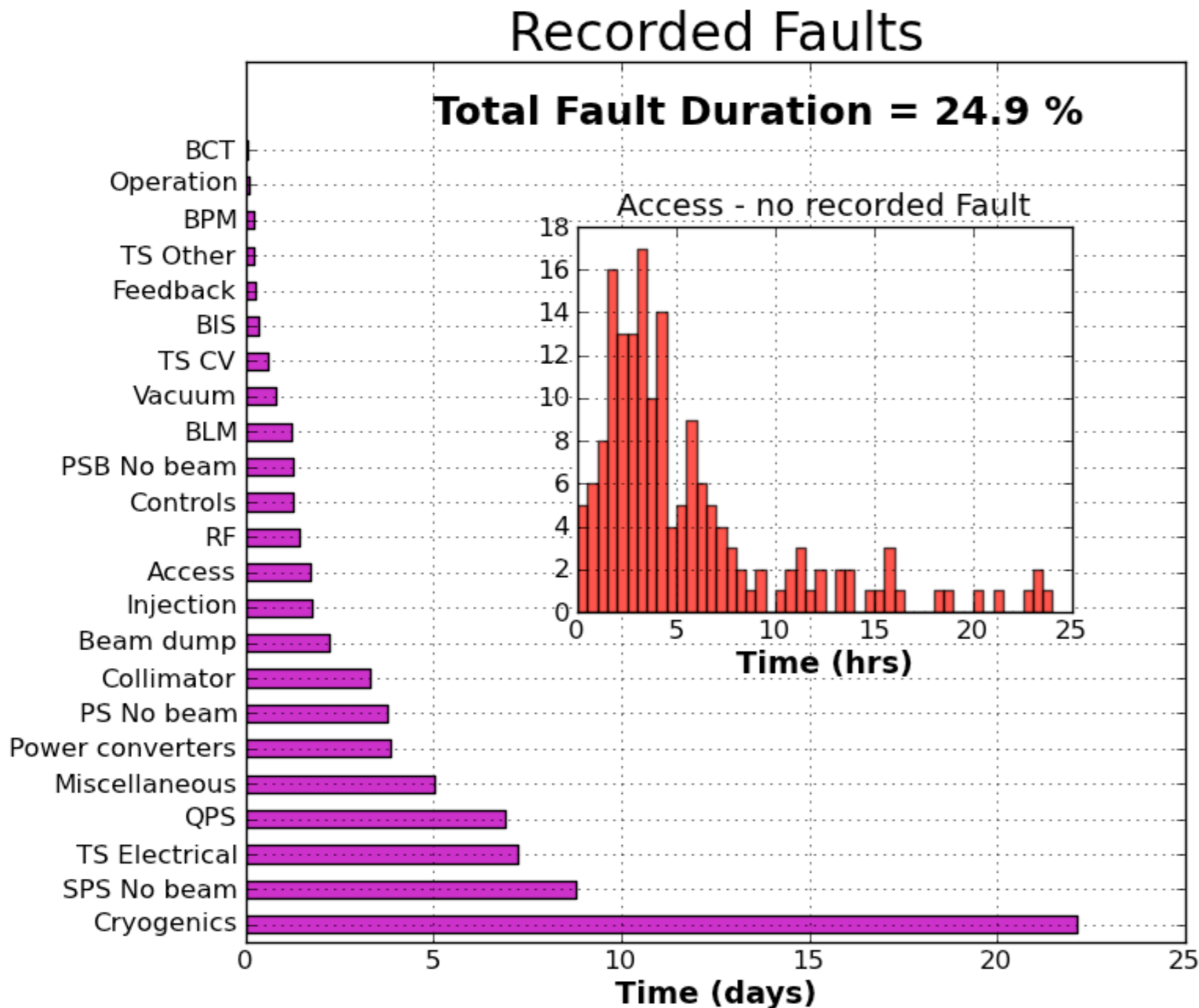
Ions: **3 hrs 23 min**

Average Turnaround SB -> SB:

Protons: **5 hrs 8 min**

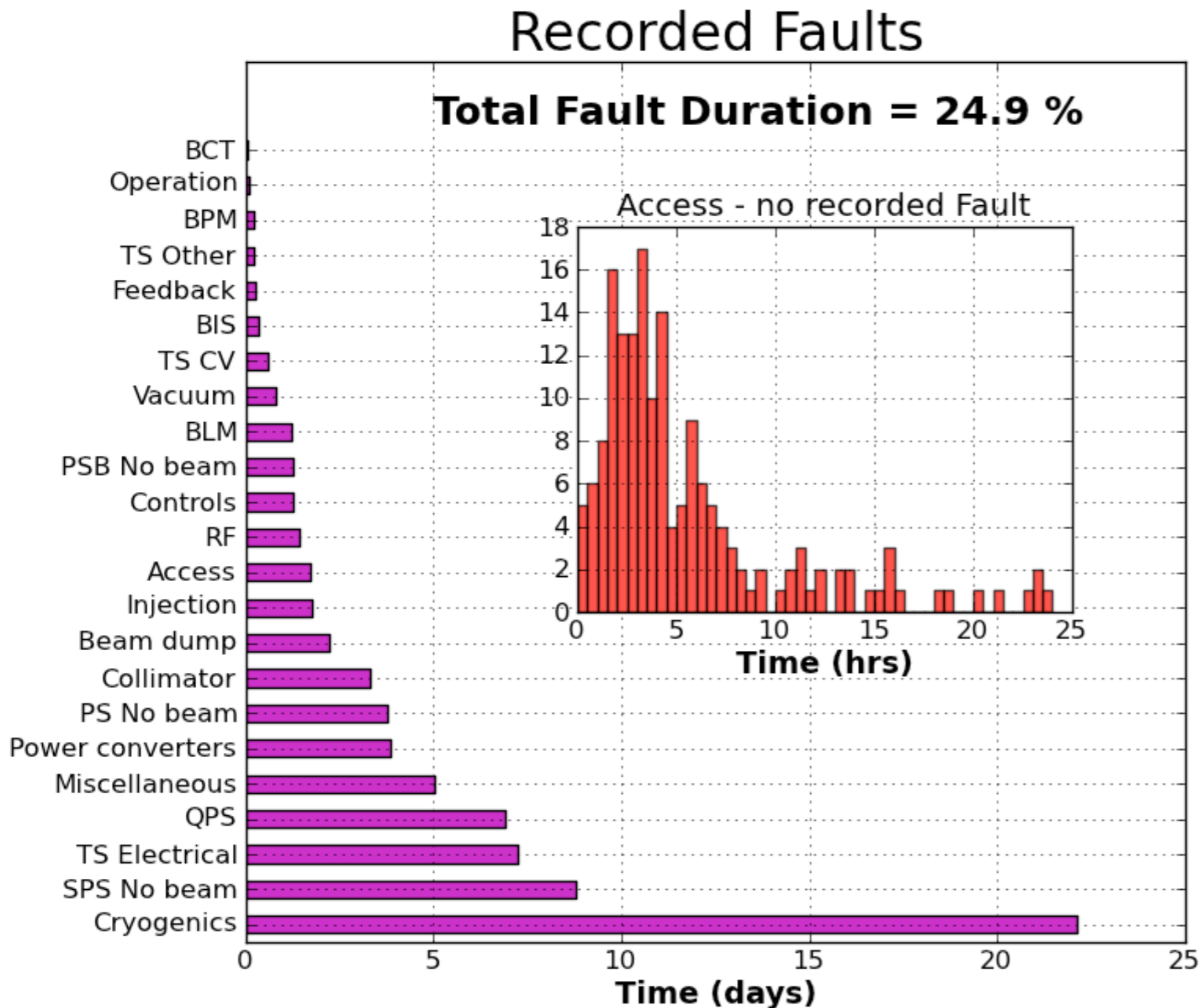
Ions: **5 hrs 25 min**

Recorded Faults - As noted in the logbook



Many non-critical faults were hidden in the shadow of cryogenics downtimes and QPS accesses

Recorded Faults - As noted in the logbook

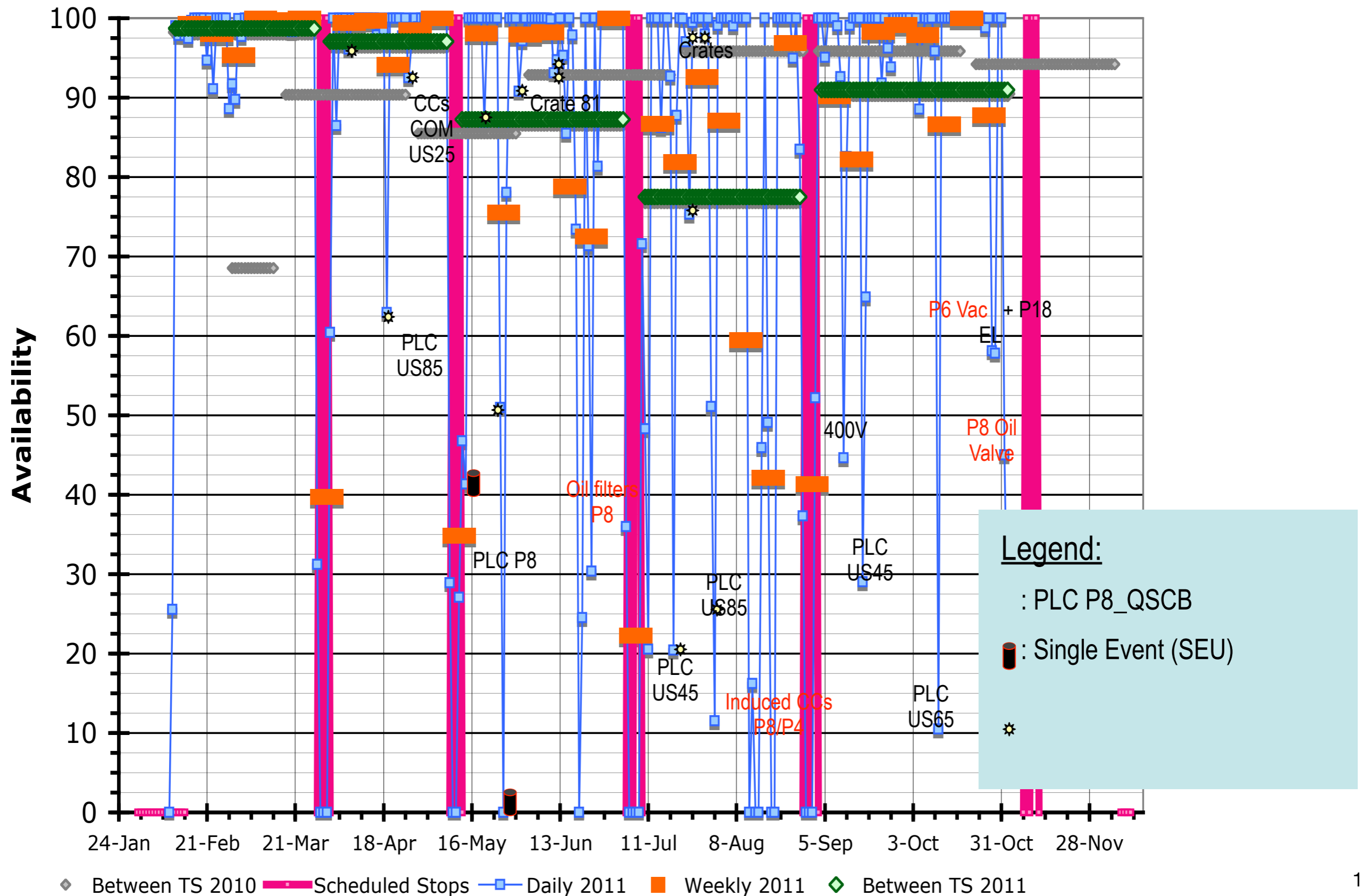


Issues

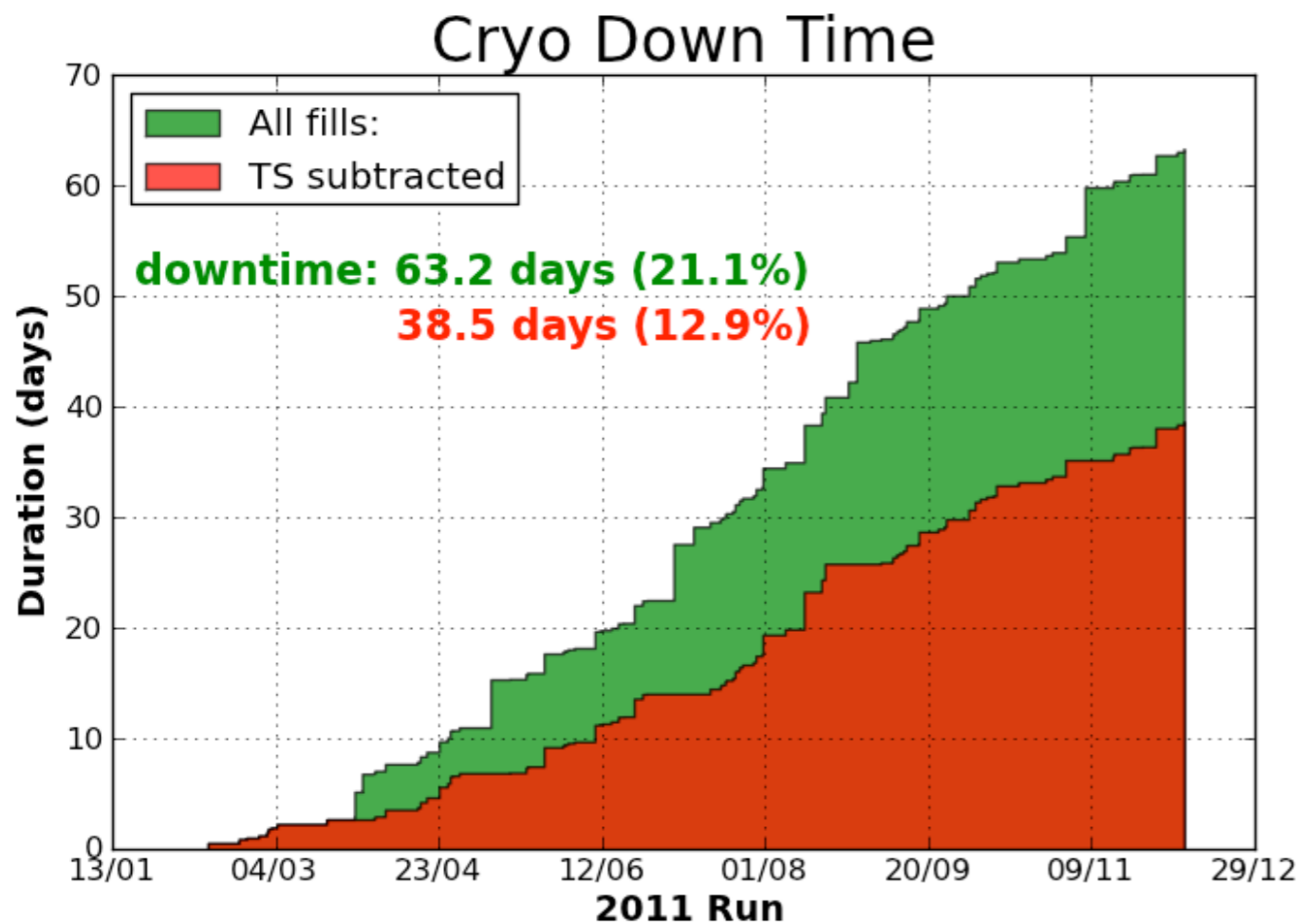
- **Not all faults recorded**
- We need to revise the reporting mechanism
- Significant number of accesses for things not listed as faults (eg QPS)
- “OP rule” of not having concurrent faults => **some faults are hidden in the shadow of others.**
- We need to revise our fault tracking mechanism
- **Proposal: Regular and systematic evaluation of faults for 2012.**

Many non-critical faults were hidden in the shadow of cryogenics downtimes and QPS accesses

Cryo Global - Serge's View



Cryo Global Downtime

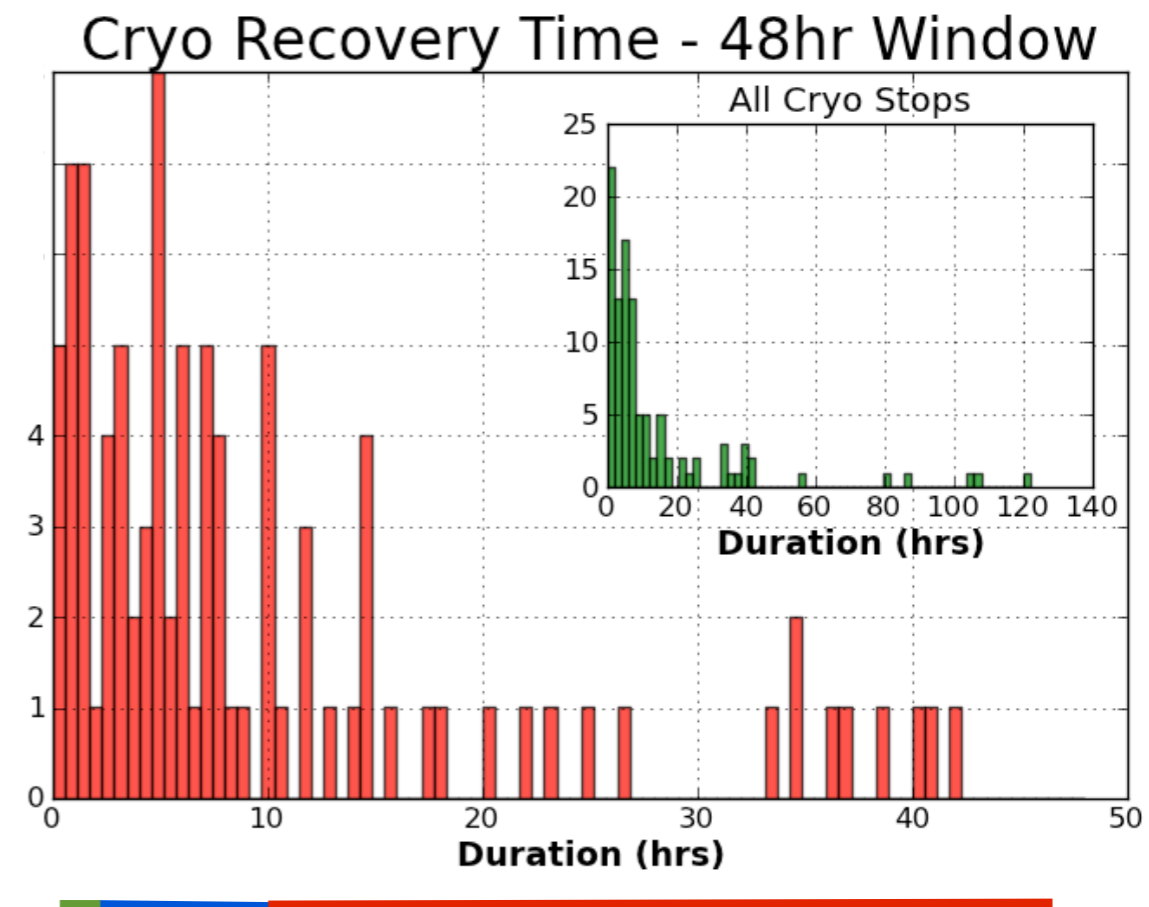


3 Time Regions of Recovery

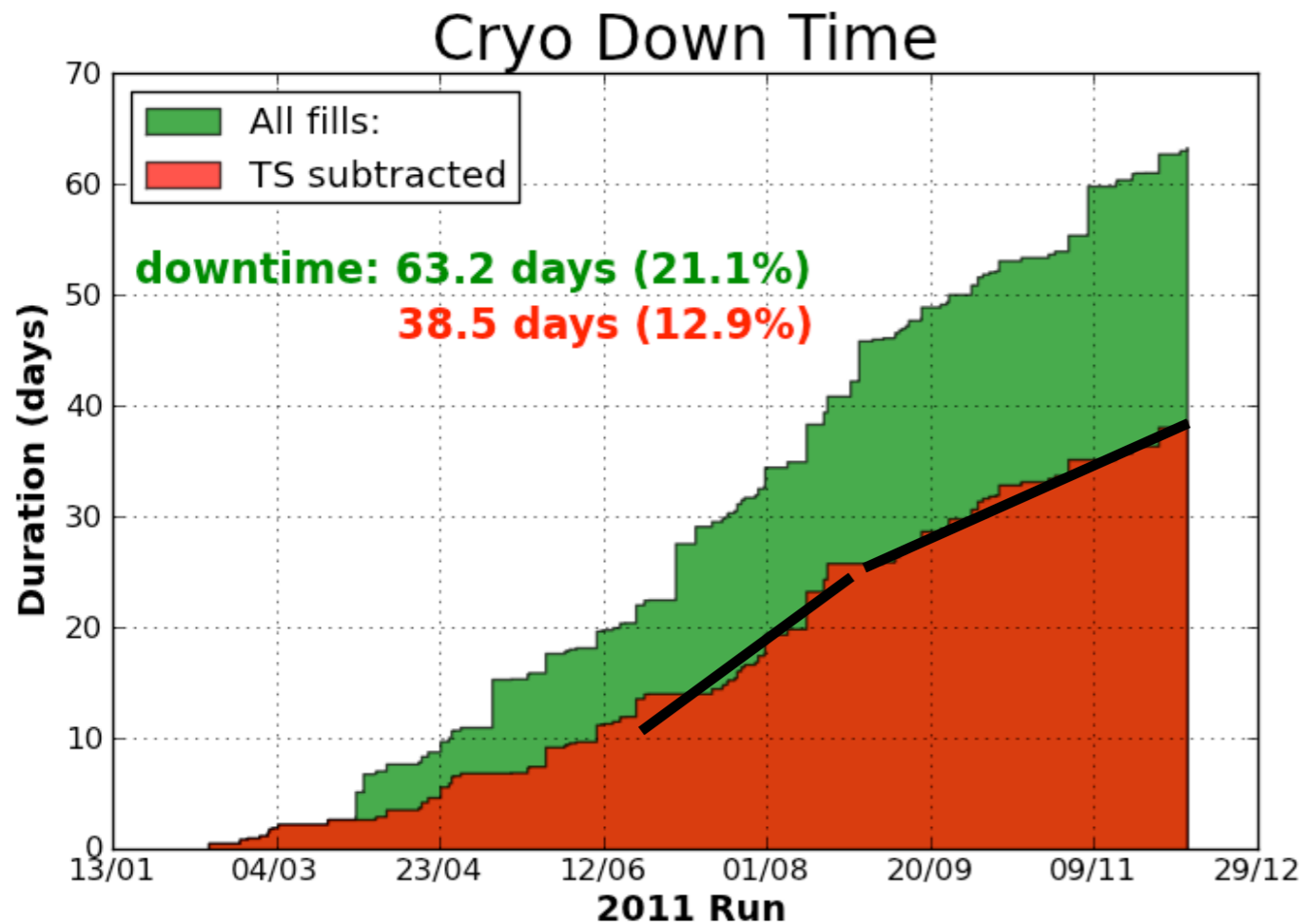
Short: less than 2 hrs

Medium: 2 hrs < recovery < 12 hrs

Long: greater than 12 hrs



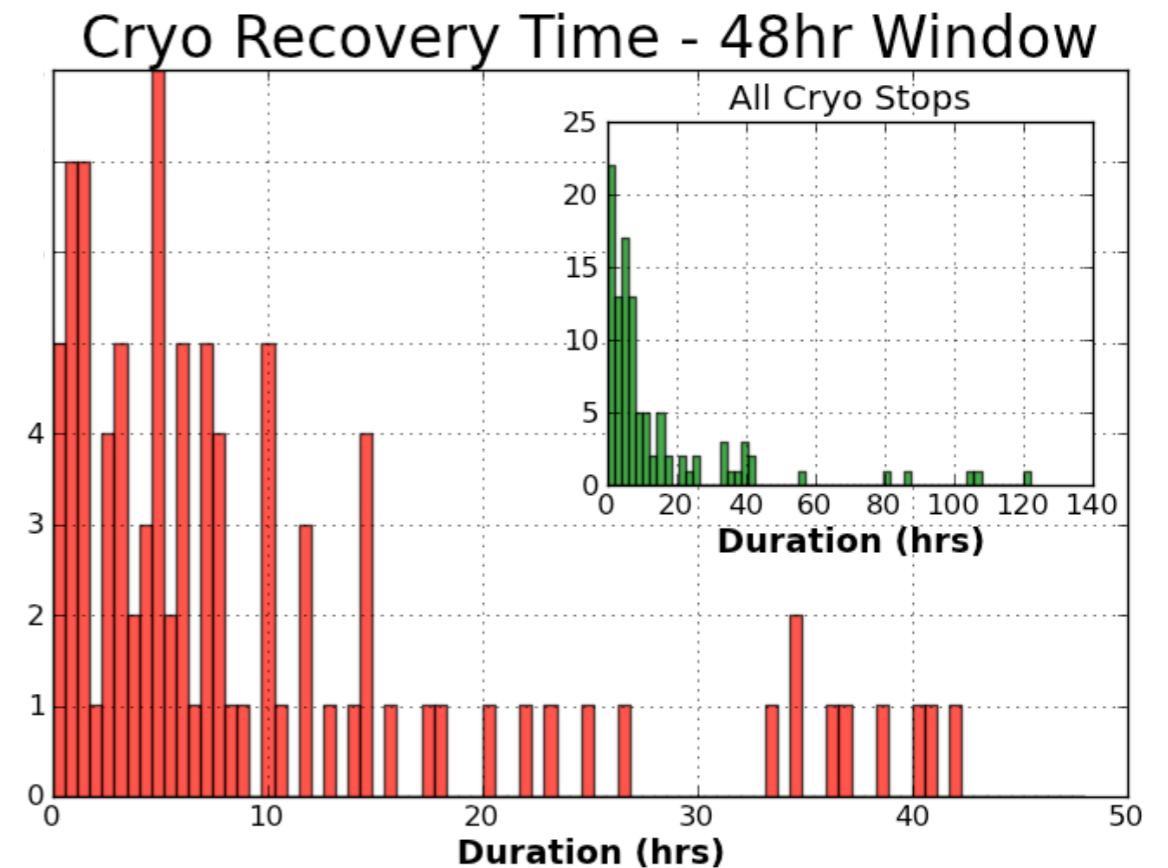
Cryo Global Downtime



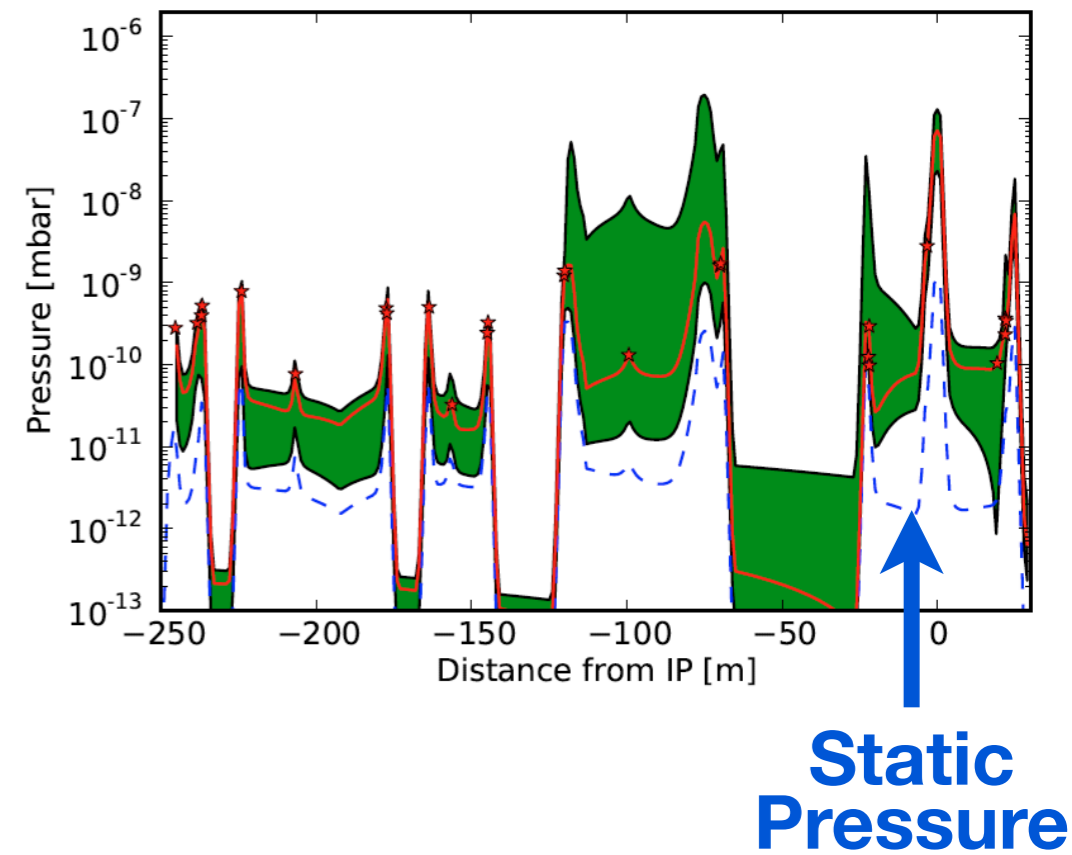
3 Time Regions of Recovery

- Short:** less than 2 hrs
- Medium:** 2 hrs < recovery < 12 hrs
- Long:** greater than 12 hrs

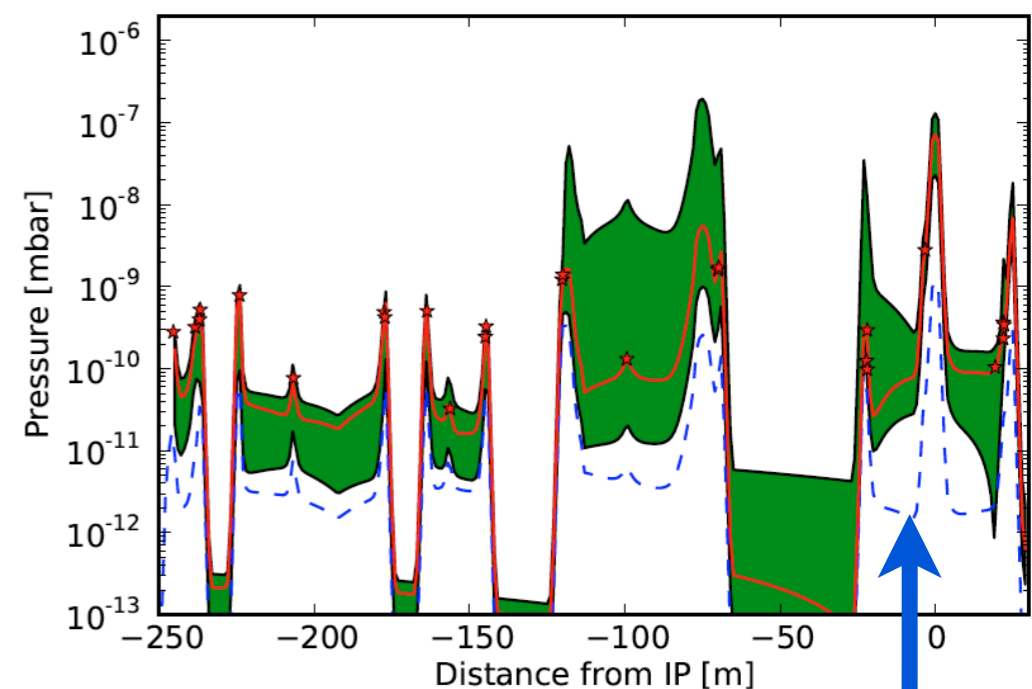
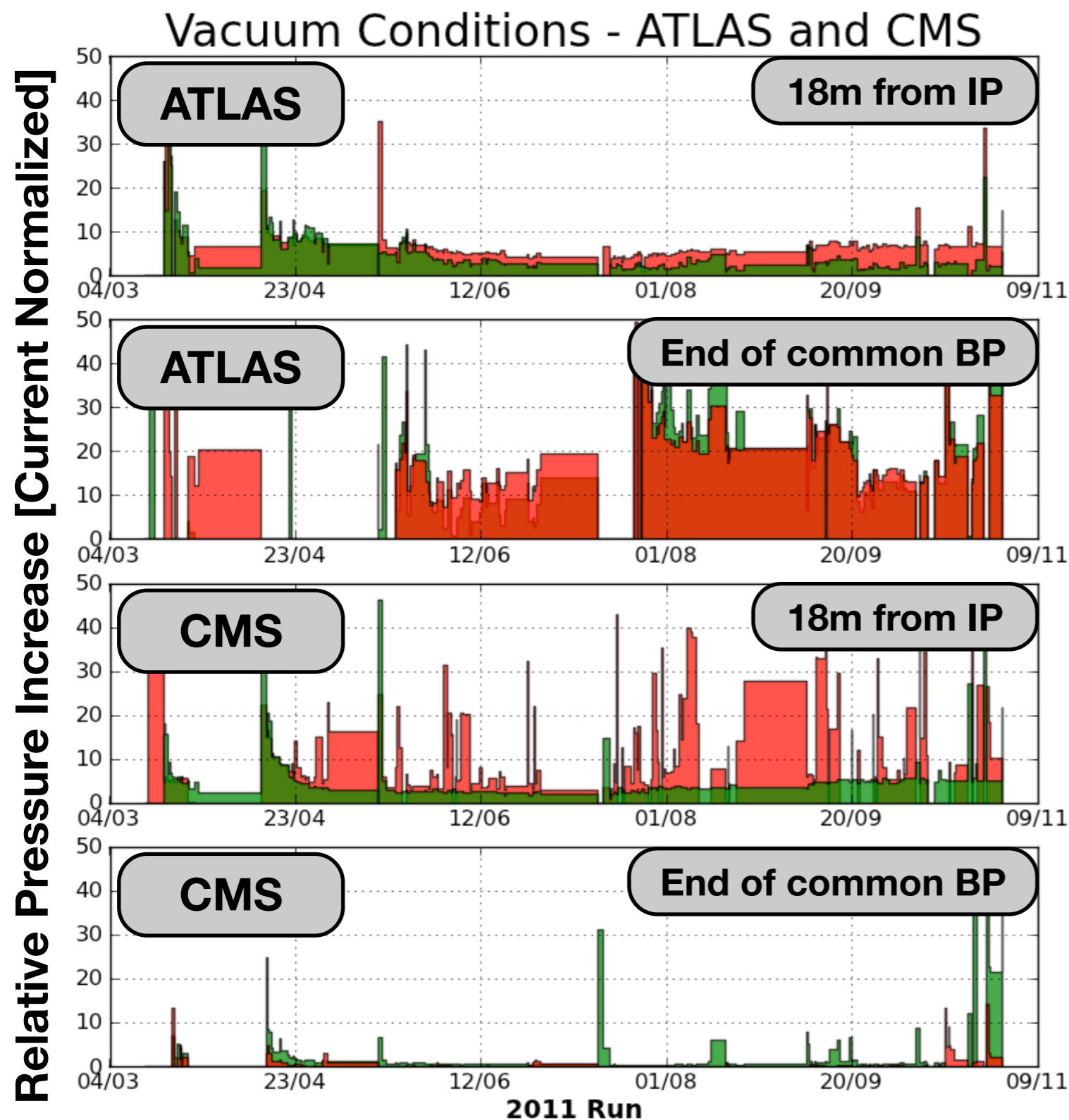
5th August Intervention to improve PLC Redundancy against SEUs may have reduced downtime!



Vacuum Conditions - an example



Vacuum Conditions - an example



← Right of IP

← Left of IP

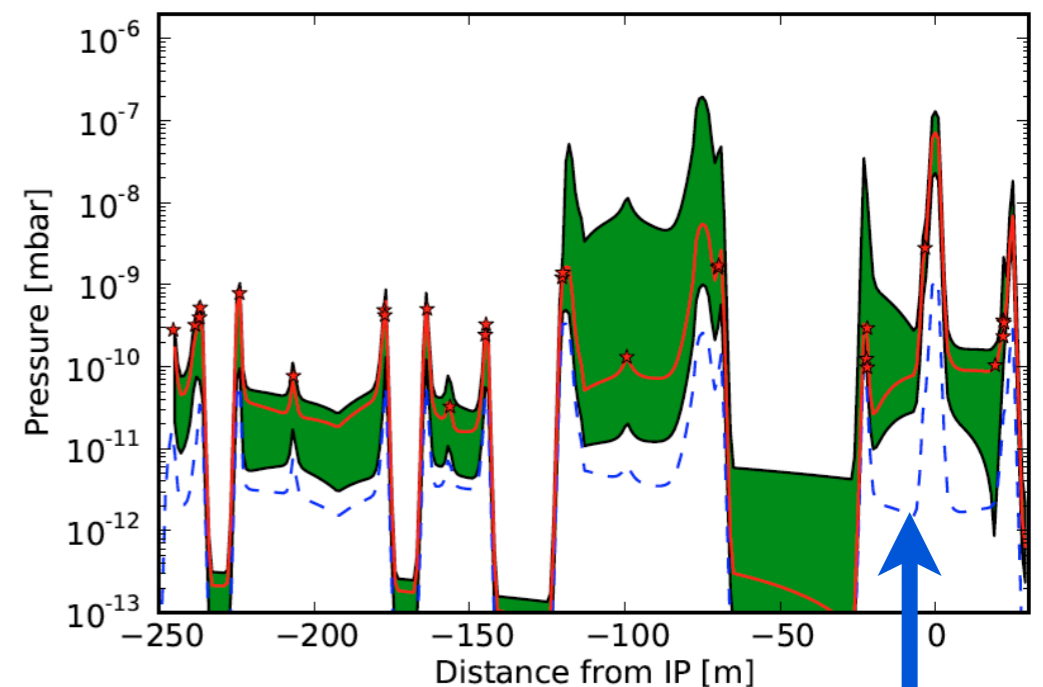
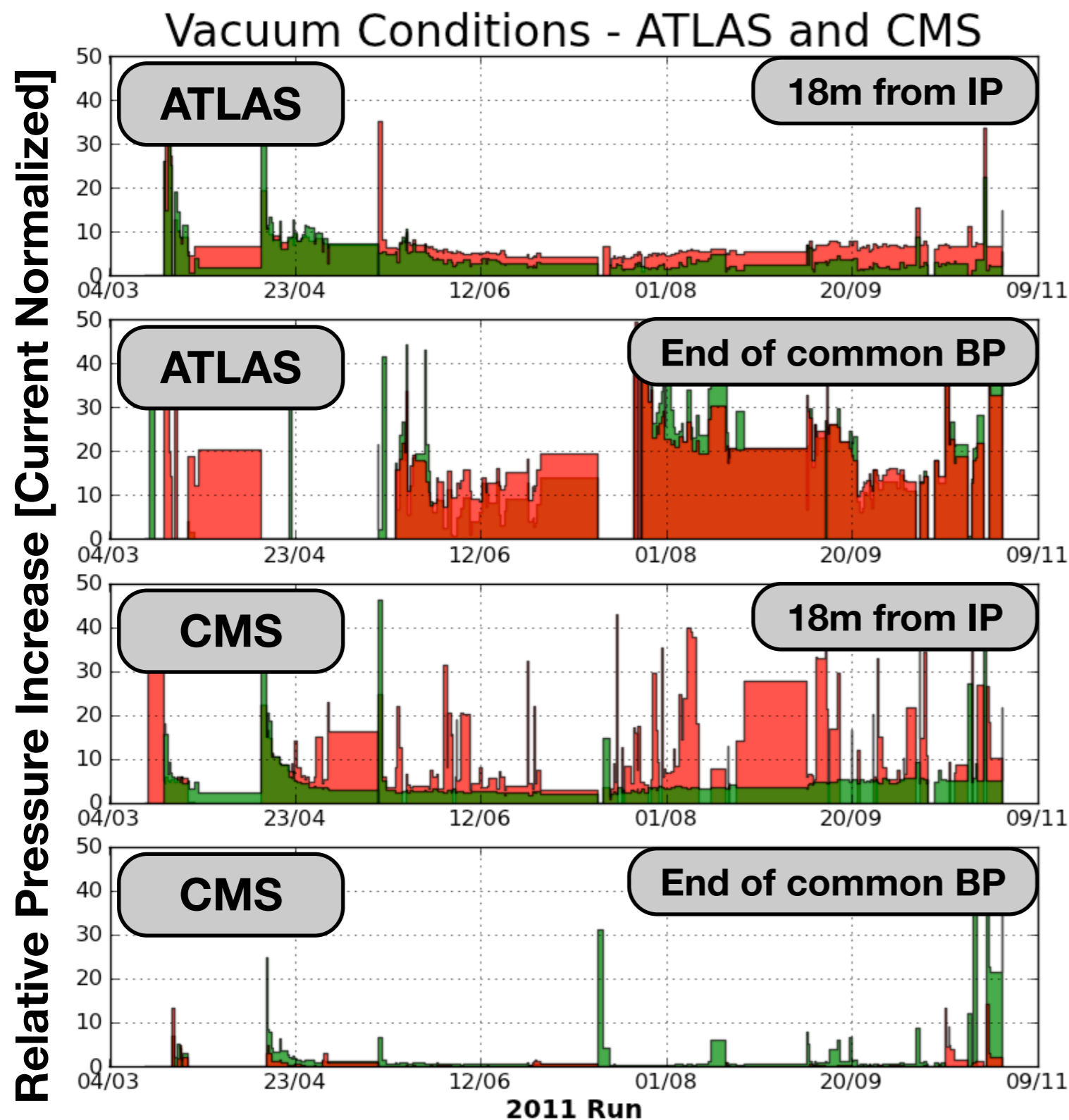
Static Pressure

$$\text{Rel. Pressure} = (\text{DP} - \text{SP}) / \text{SP} \times I_0 / I_{\text{SSB}}$$

SP = Static Pressure (No Beam)

DP = Dynamic Pressure

Vacuum Conditions - an example



← **Right of IP**
← **Left of IP**
↑ **Static Pressure**

$$\text{Rel. Pressure} = (\text{DP} - \text{SP}) / \text{SP} \times I_0 / I_{\text{SSB}}$$

SP = Static Pressure (No Beam)

DP = Dynamic Pressure

- Intermittent high pressure levels at ~18m right of CMS for all of 2011.
- Impaired detector performance when high beam intensities.
- No such asymmetry in ATLAS

Summary and Comments

- **Operational Performance of the machine has been excellent**
 - **Over ~ 30% of allocated Physics time has been in Stable Beams**
 - “Problem free” turnaround times can be well under 3 hrs
 - Injection is the obvious place to trim the turnaround time
- **Fault tracking has improved over 2011**
 - **Automatic analysis scripts are run on a fill-by-fill basis** (Supertable etc)
 - Data pulled from logging, LSA, PM ,logbook databases (soon Cryo and TI DBs)
- **Fault tracking Issues**
 - tracking is incomplete => not all faults recorded.
 - Tools and procedure not yet in place for regular and systematic evaluation of faults and issues. **Need to develop over Xmas Stop.**
- **Analysis of performance with beam**
 - Tools emerging to develop run based overviews of performance
 - **Systematic evaluation of conditions needs to established for 2012.**
 - Issues: Data quality and data surveillance needs to be addressed
 - As of 2012, we start to integrate Expt data into operation/analysis framework