

The 2012 Run: Performance and Availability

Alick Macpherson

Evian 2012

17 December 2012

Many thanks to

Eric Duret, Georges-Henry Hemelsoet, Isabelle Laugier, Sergio Pasinelli, Ben Todd,
Daniel Wollman, Markus Zerlauth, and LHC_OP

2012 at the LHC

ML

2012 LHC Schedule
Approved by the Research Board, December 2011.

October 24, 2012
V2.6

	Jan			Feb			Mar		
Wk	1	2	3	4	5	6	7	8	9
Mo	2	9	16	23	30	6	13	20	27
Tu									
We					01-Feb				
Th	Technical stop								
Fr									
Sa									
Su									

	Apr			May			June		
Wk	14	15	16	17	18	19	20	21	22
Mo	2	Easter	9	16	23	30	7	14	21
Tu									
We				TS1					
Th							VdM scans [48 h]		
Fr	G. Friday								
Sa									
Su									

	July			Aug			Sep		
Wk	27	28	29	30	31	32	33	34	35
Mo	2								
Tu		Floating MD [48 h]							
We			VdM scans [48 h]						
Th		90 m [24 h]							
Fr	90 m [24 h]								
Sa									
Su									

	Oct			Nov			Dec		
Wk	40	41	42	43	44	45	46	47	48
Mo	1								
Tu									
We									
Th									
Fr									
Sa									
Su									

2012 Physics Run

35 days of HWC

21 days Beam Commissioning

257 Days of running

228 Days of Physics running

3 Technical Stops

Physics Program

202 days p-p Lumi Production

4 MD periods

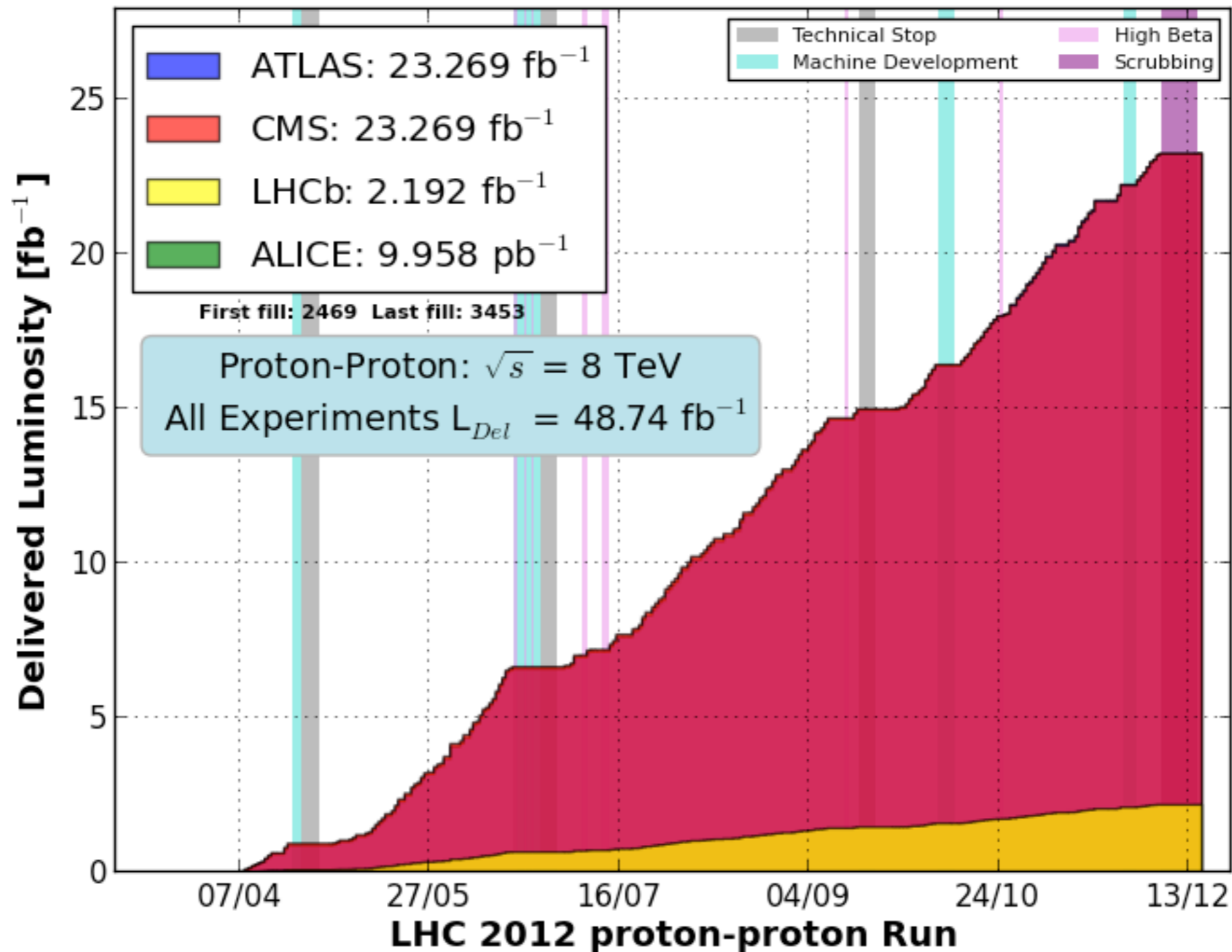
High beta program

p-Pb Validation Program

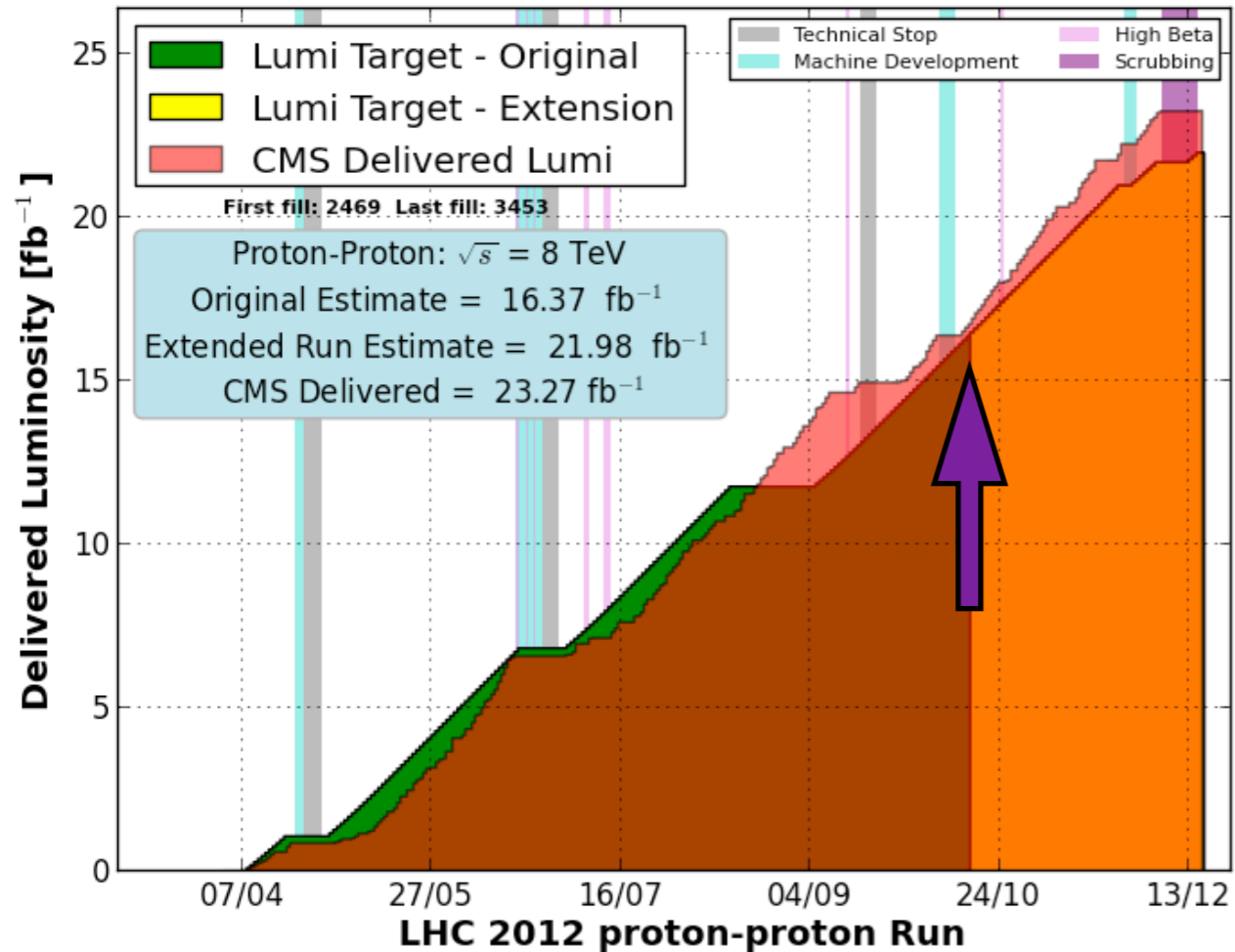
25ns Scrubbing + Physics

Physics Run: Fill 2465- Fill 3457

2012 - Luminosity Delivered

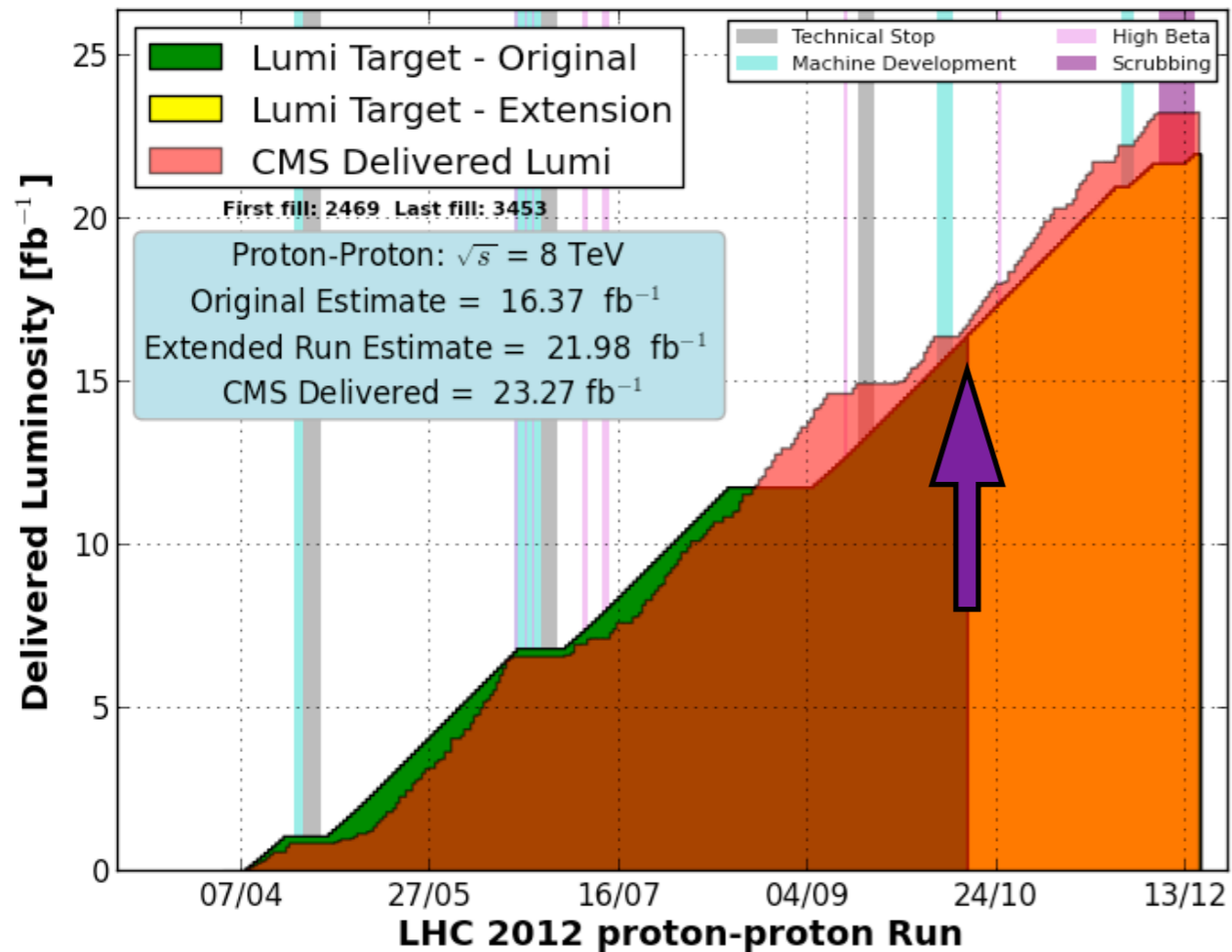


LHC Luminosity Performance

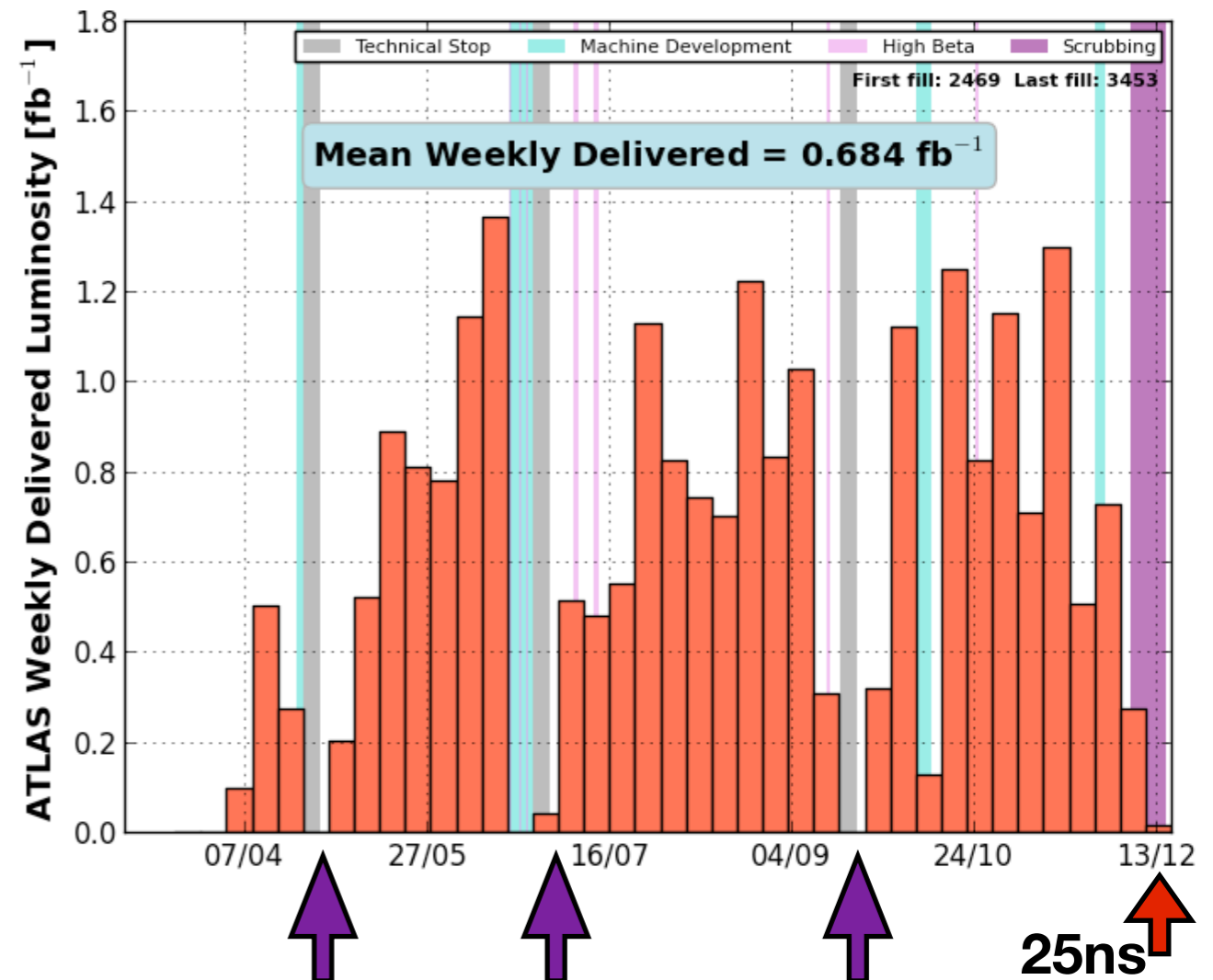


- Steve's Original Estimate - spot on
 - but with 1 MD period suppressed
- Overall Performance exceeds prediction by ~ 1.3 fb⁻¹

LHC Luminosity Performance

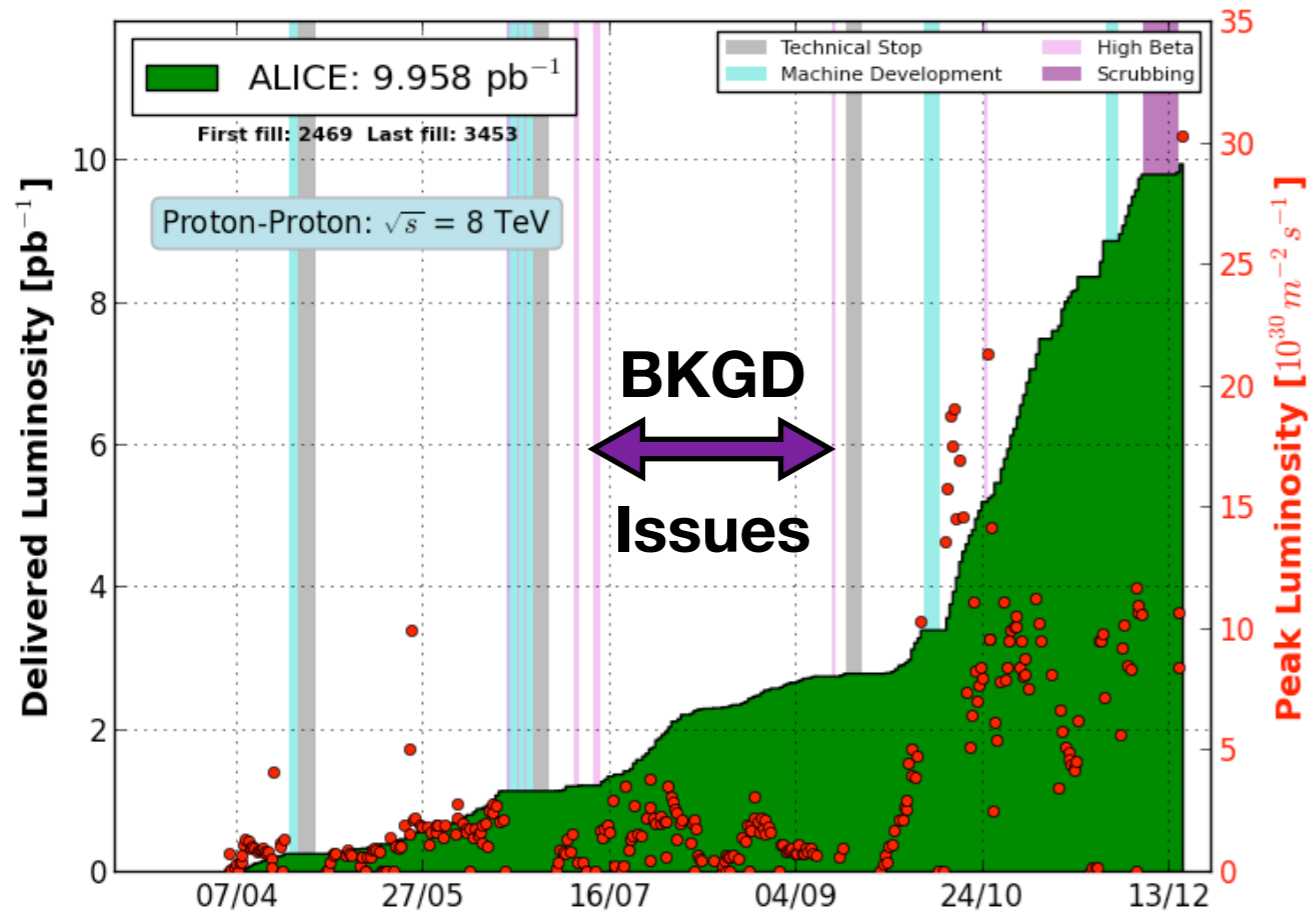


- Steve's Original Estimate - spot on
- but with 1 MD period suppressed
- Overall Performance exceeds prediction by ~ 1.3 fb⁻¹



- Max Weekly luminosity: 1.365 fb⁻¹
- Post TS: Slow lumi production recovery - no consistent reason
- 25ns Physics in the last week

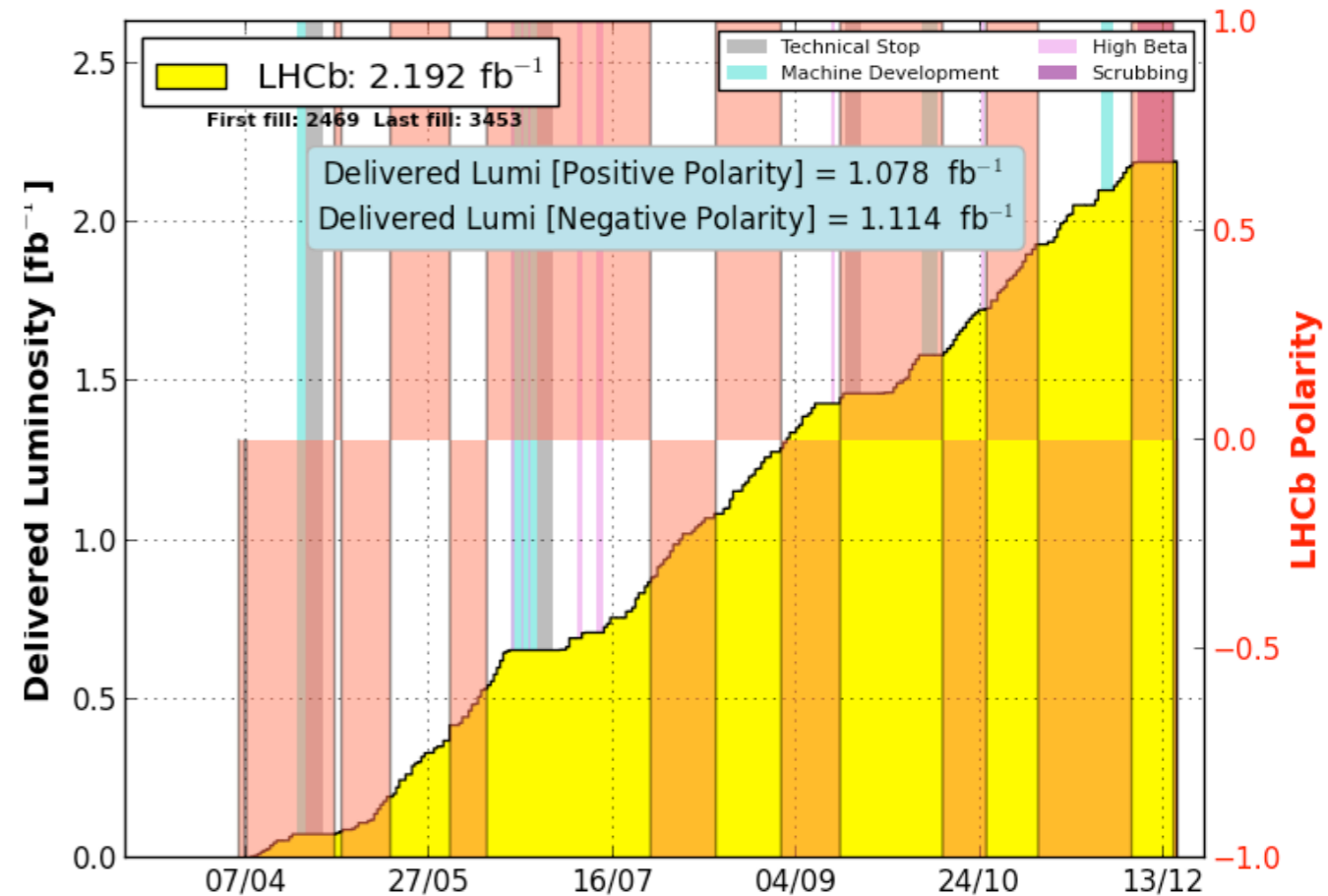
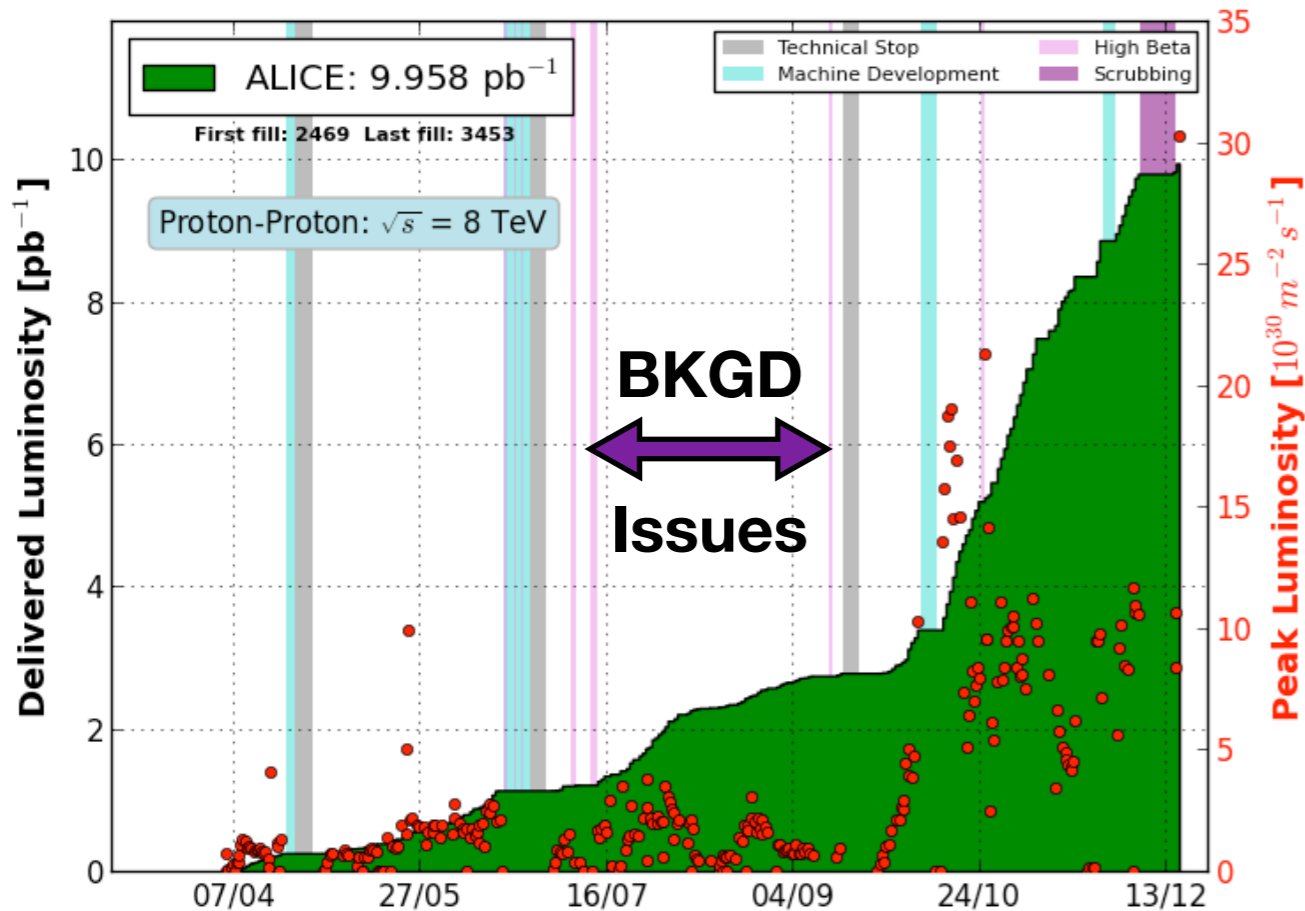
ALICE and LHCb



ALICE

- bad bkgd/high trigger rates
 - limited production till TS3
 - solved by improved beam quality from injectors
- **Enhanced Satellites**
 - explicit generation in PS

ALICE and LHCb



ALICE

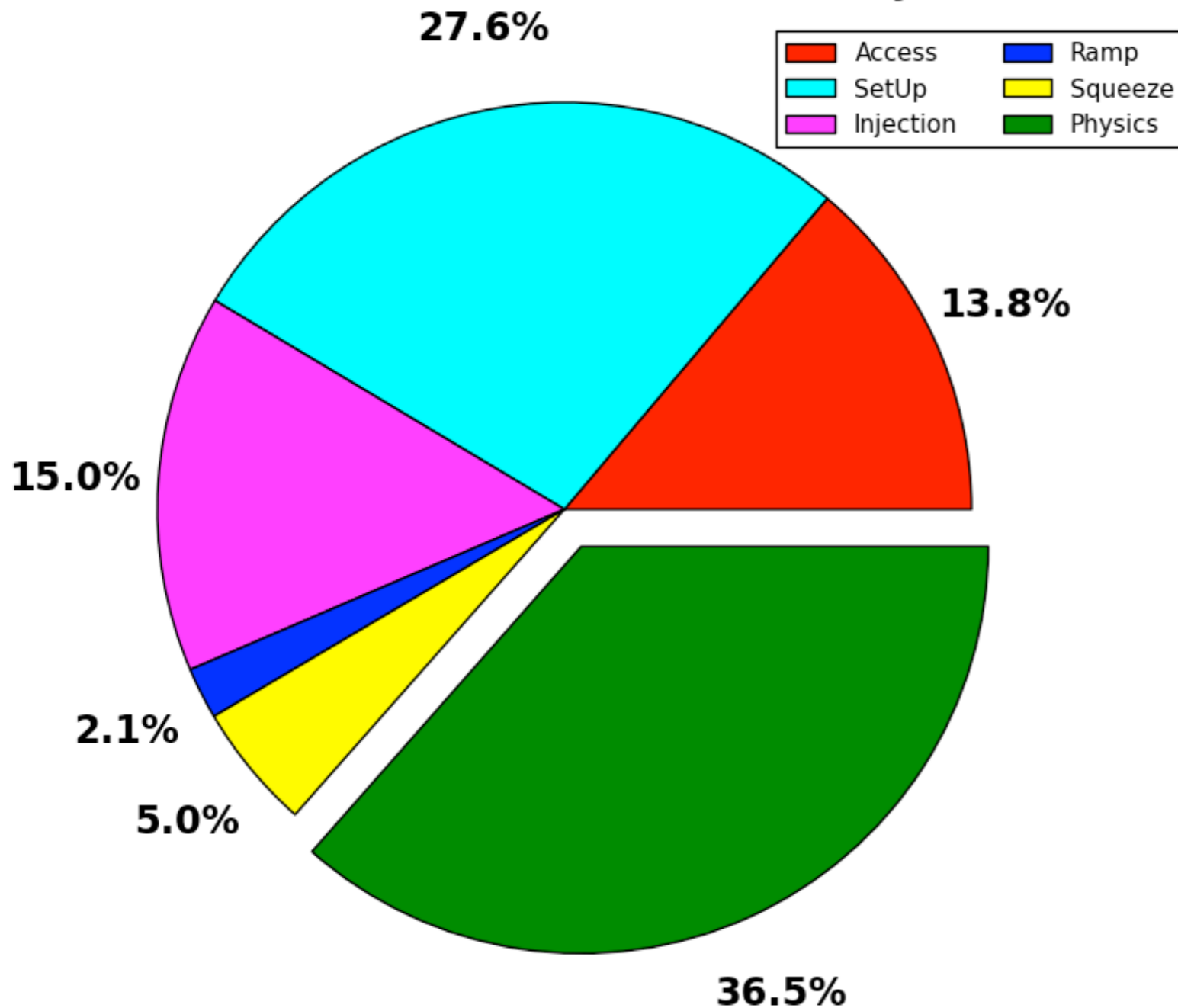
- bad bkgd/high trigger rates
 - limited production till TS3
 - solved by improved beam quality from injectors
- **Enhanced Satellites**
 - explicit generation in PS

LHCb

- Lumi leveling used routinely
- Delivered Luminosity with both dipole polarities
 - polarity ratio (+ve: -ve)
49.18%: 50.81%
- Polarity Flip: **routine operation**

2012 Physics Run: Overall Availability

2012 Proton Run Efficiency



SB Time: 73.2 days Total Time: 200.5 days

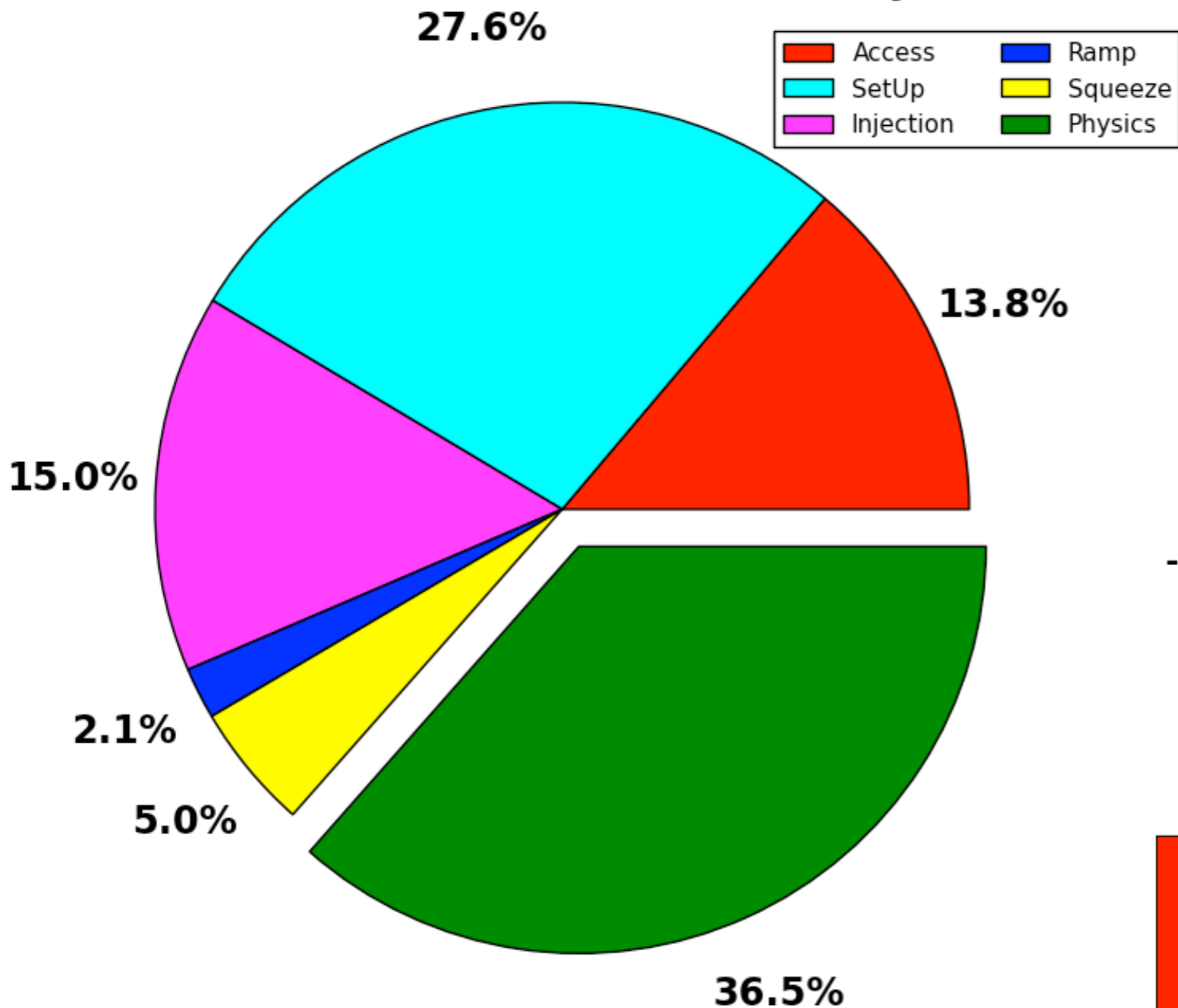
Hubner factor
 $H = 11.574 \times L_{Del} / (D \times L_{Peak})$
 $\Rightarrow H = 0.175$

$D = 200.5$ days
 $L_{Peak} = 7695 (\mu b.s)^{-1}$
 $L_{Del} = 23.269 fb^{-1}$

$H_{2011_LP} = 0.156$

2012 Physics Run: Overall Availability

2012 Proton Run Efficiency

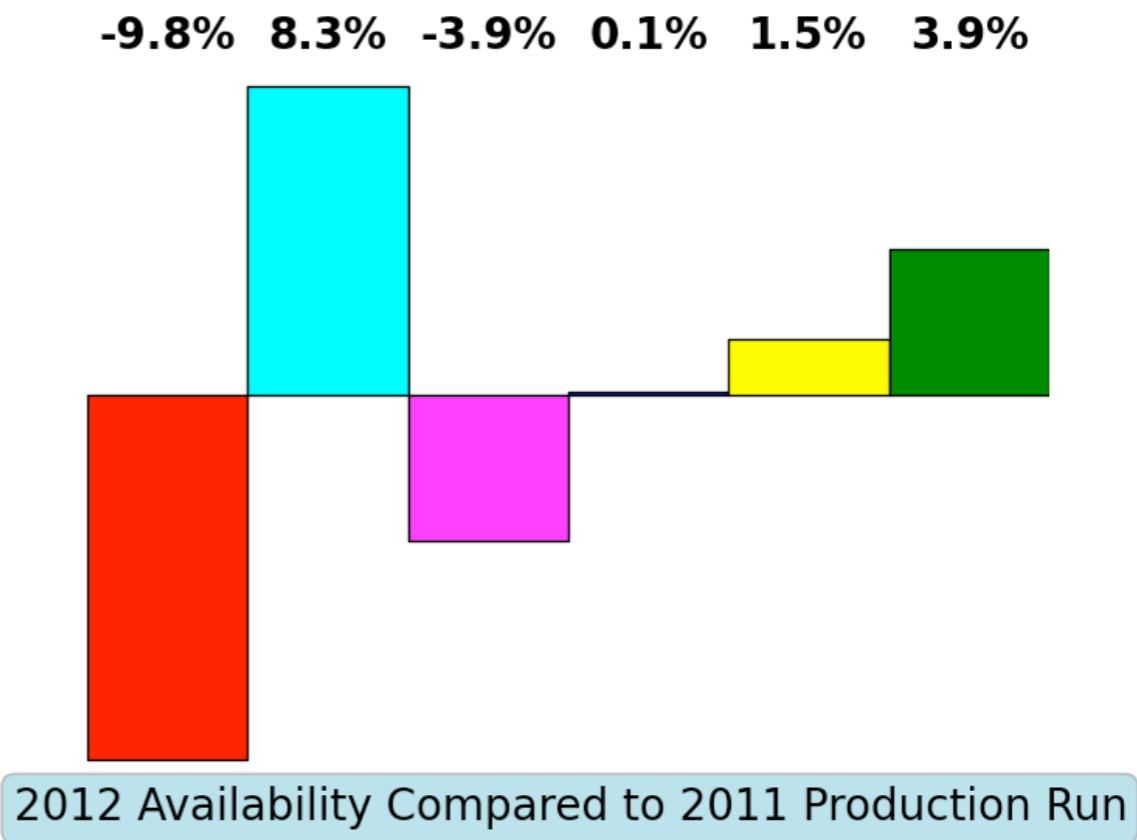


SB Time: 73.2 days Total Time: 200.5 days

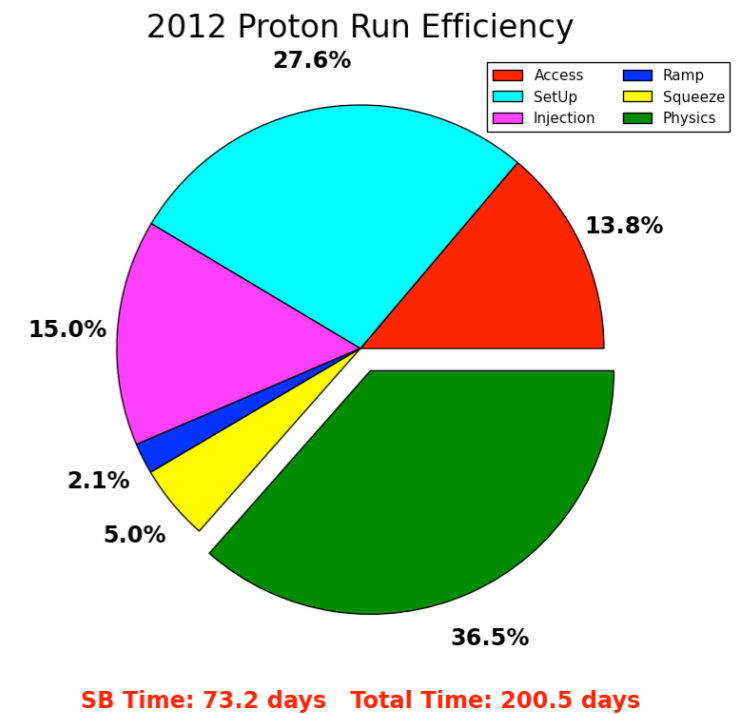
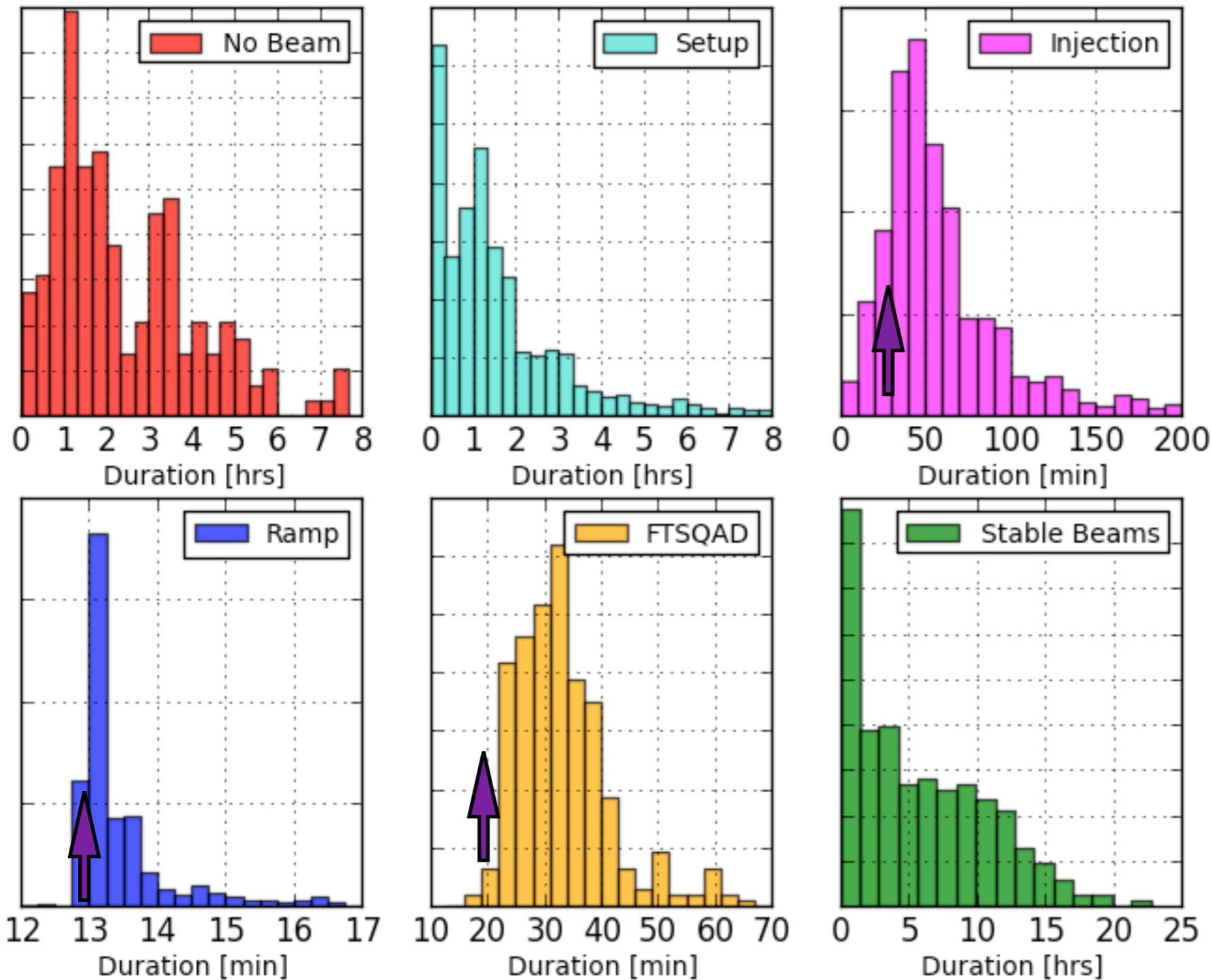
Hubner factor
 $H = 11.574 \times L_{Del} / (D \times L_{Peak})$
 $\Rightarrow H = 0.175$

$D = 200.5$ days
 $L_{Peak} = 7695 (\mu b.s)^{-1}$
 $L_{Del} = 23.269 fb^{-1}$

$H_{2011_LP} = 0.156$



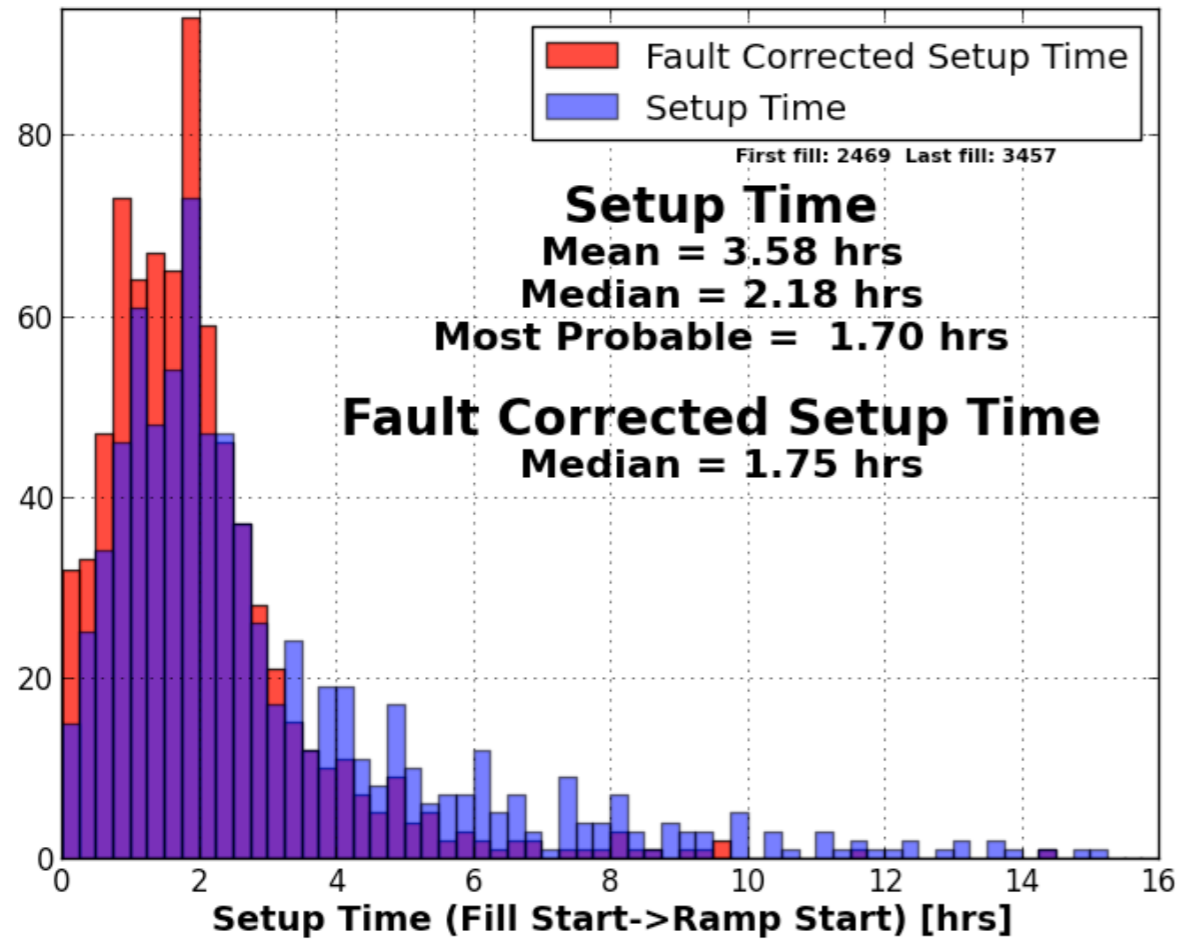
Operational cycle: Duration of the Different Phases



↑ = Theoretical Minimum

- No Beam and Setup phases with large spread
- **Injection:**
Th. Minimum 27.7 min
(28 inj, 48.8s SPS cycle)

Turnaround and Stable Beam time



Fault Corrected Time:

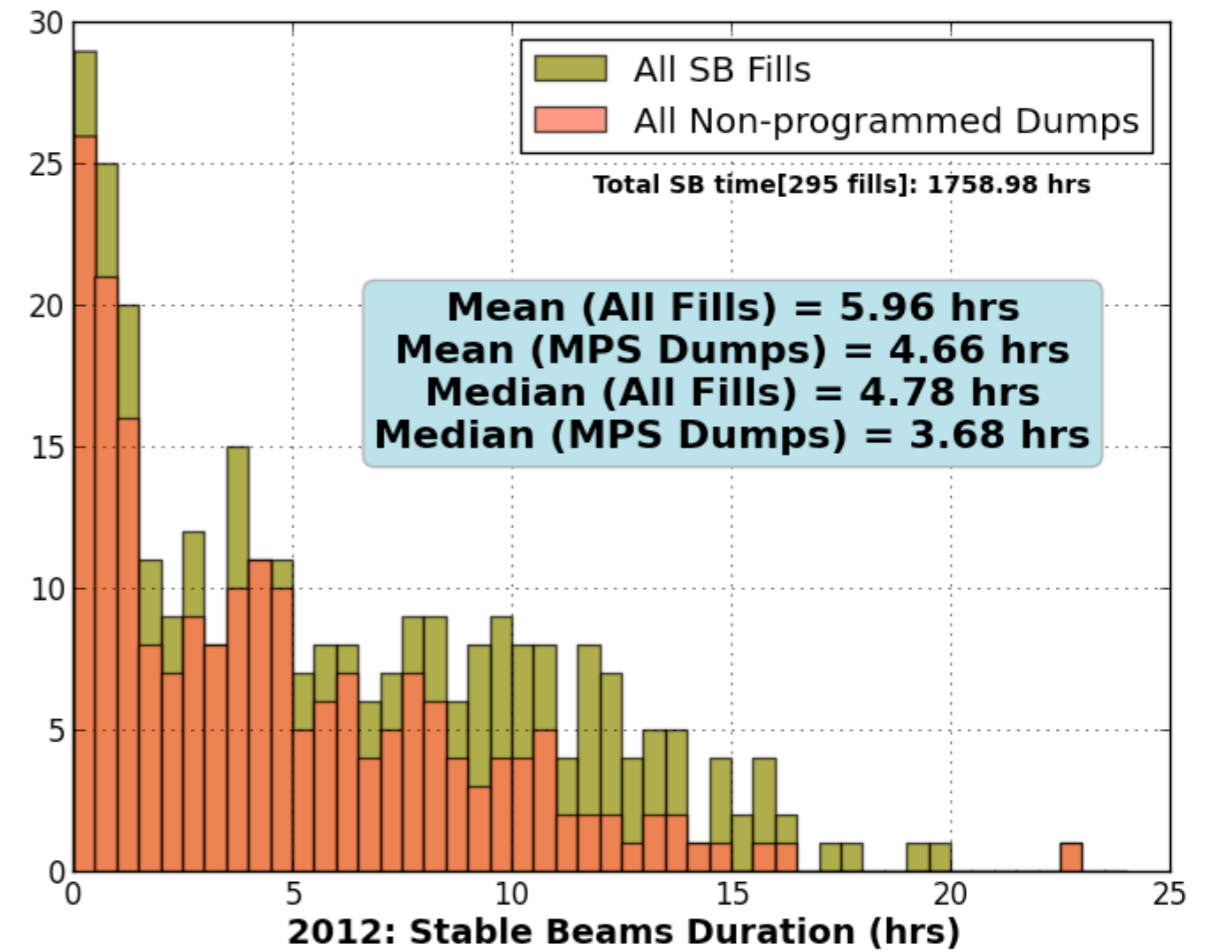
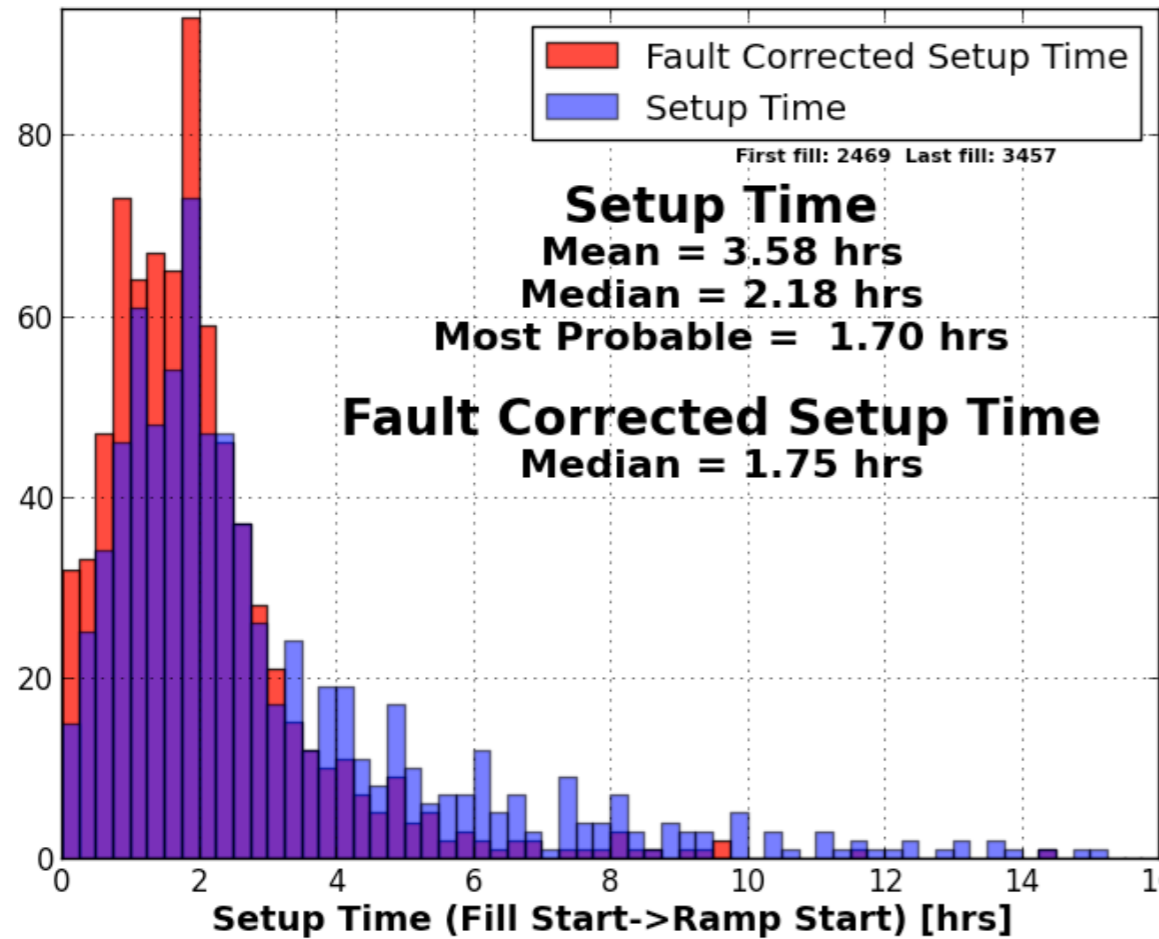
Subtract e-logbook fault times

Setup Time: 1.75 hrs = 1hr 45min

Setup Time Includes

Rampdown : 34 min Prepare Rampdown: 10min

Turnaround and Stable Beam time



Fault Corrected Time:

Subtract e-logbook fault times

Setup Time: 1.75 hrs = 1hr 45min

Setup Time Includes

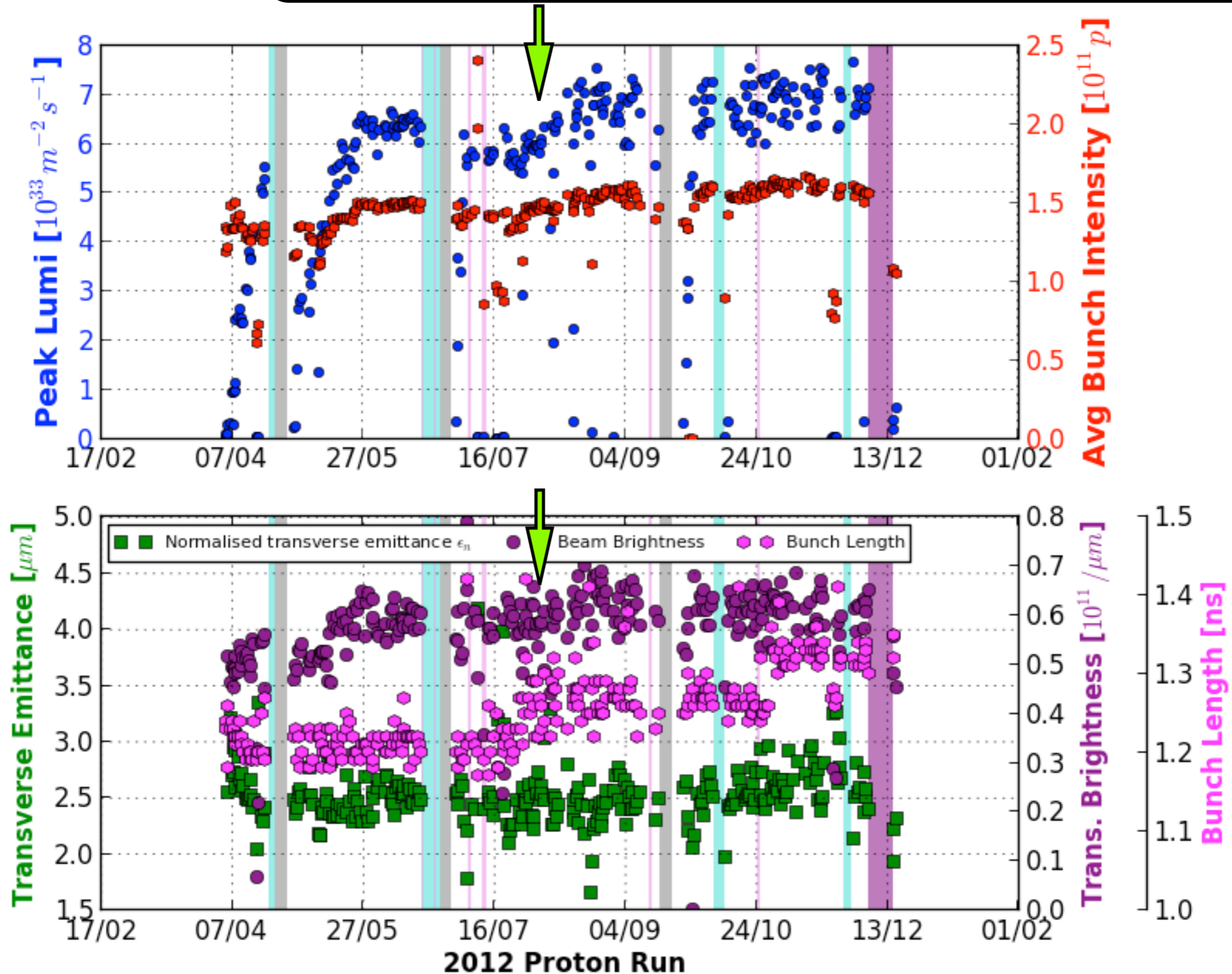
Rampdown : 34 min Prepare Rampdown: 10min

2012: Mean SB Duration = 5.96 hrs
 - Fill Lifetime with non-programmed dumps show a more exponential decay

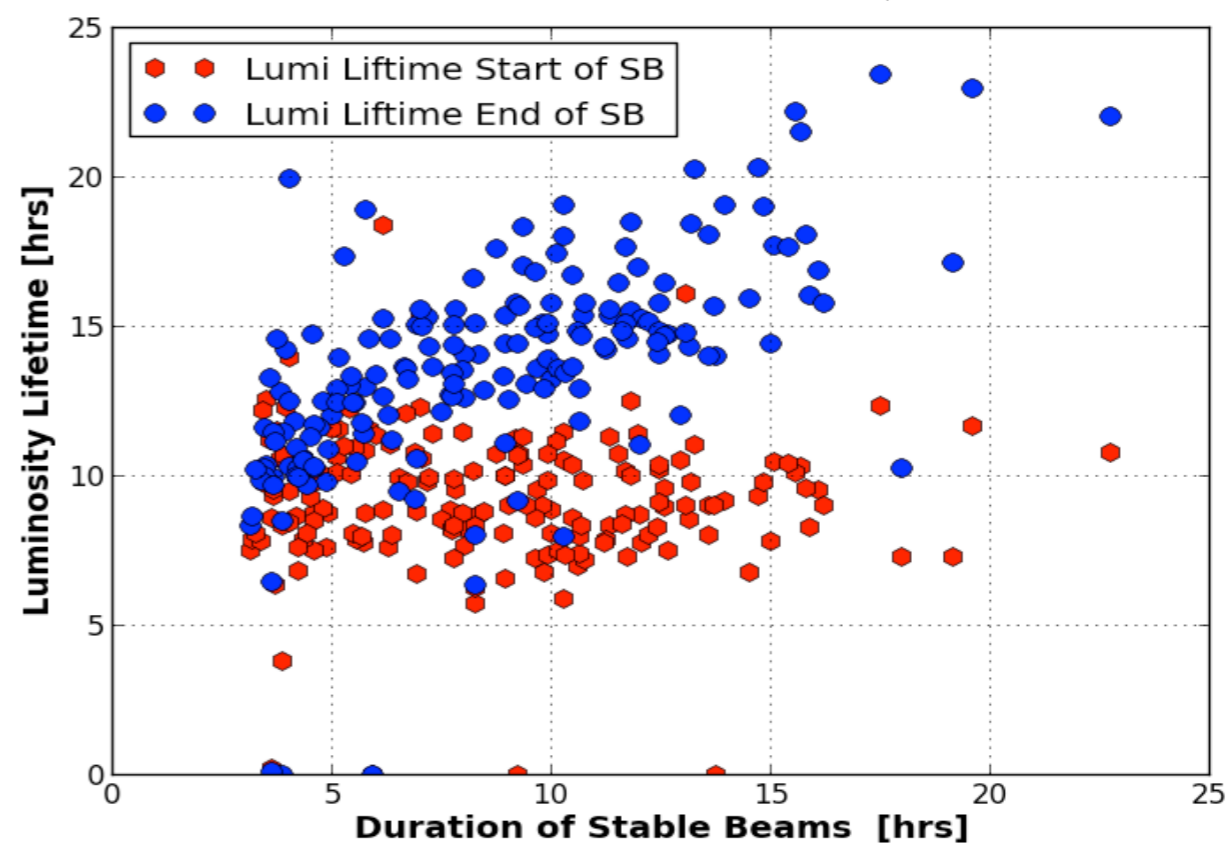
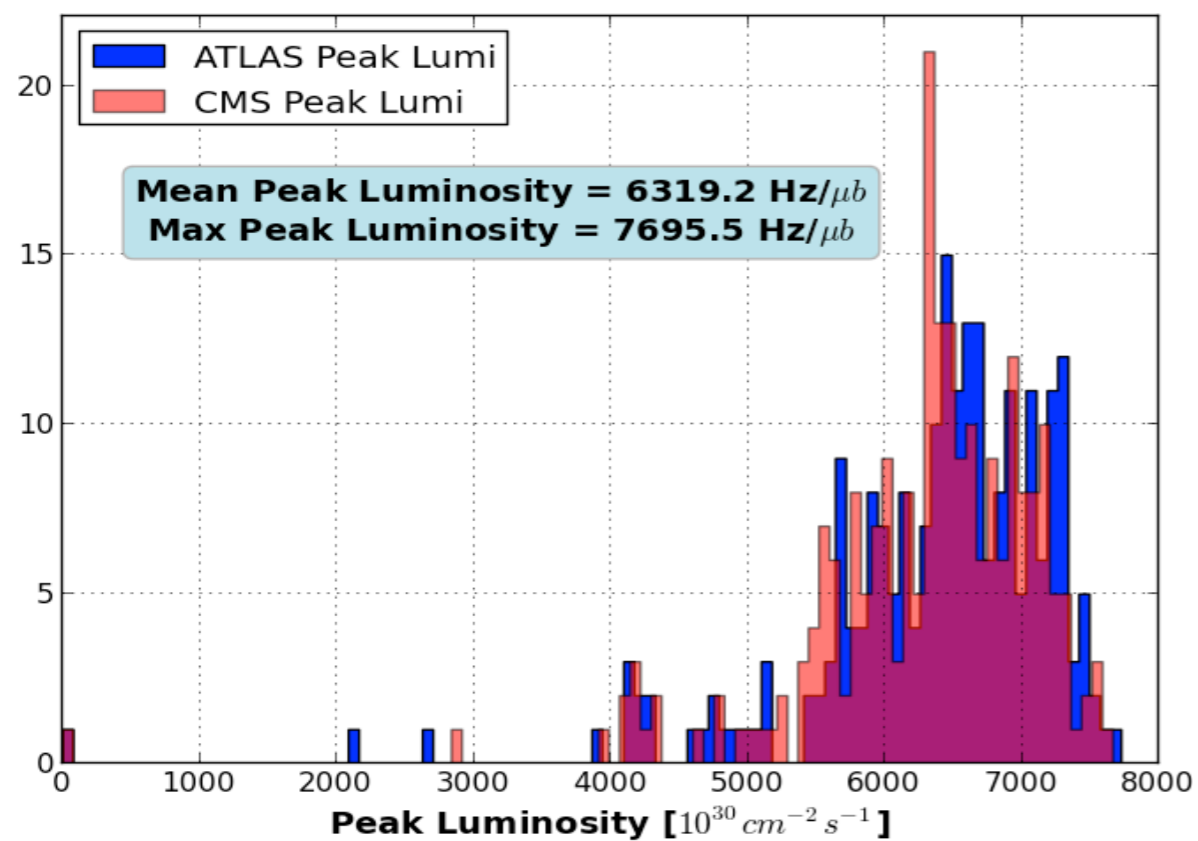
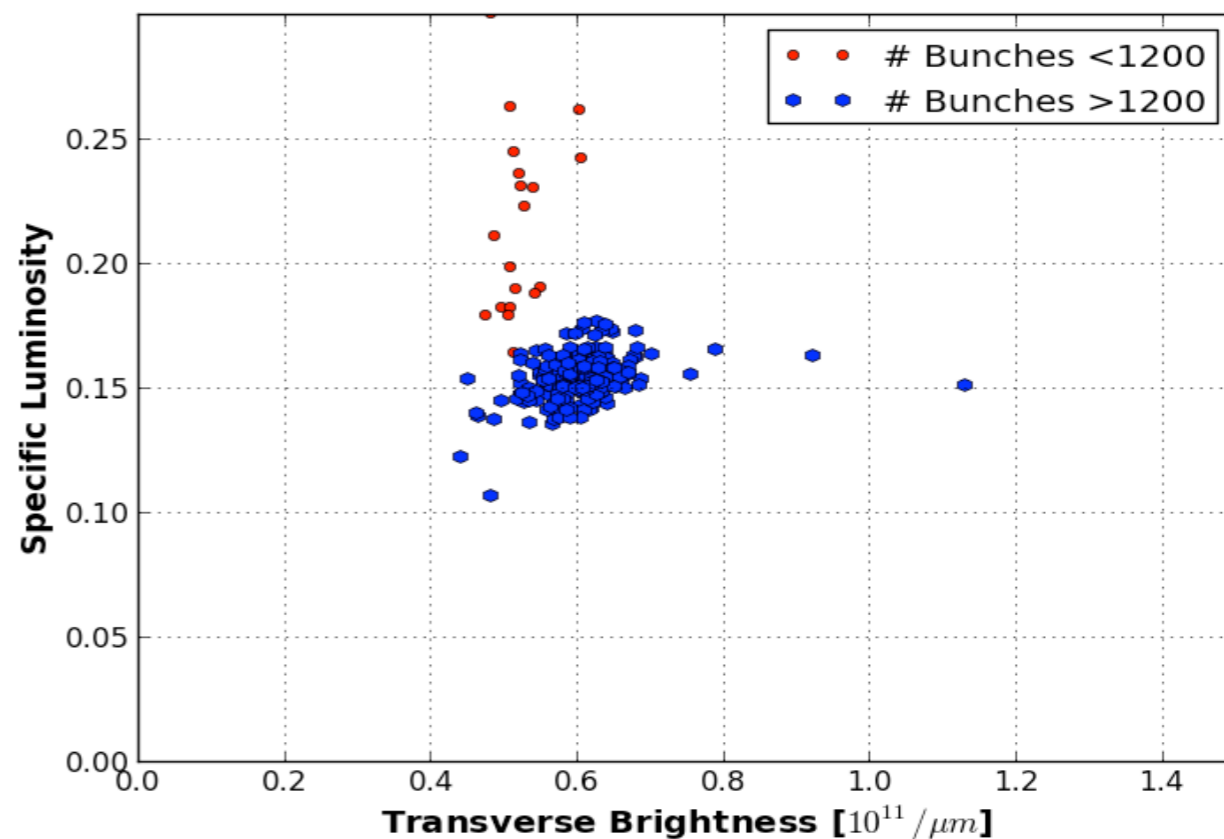
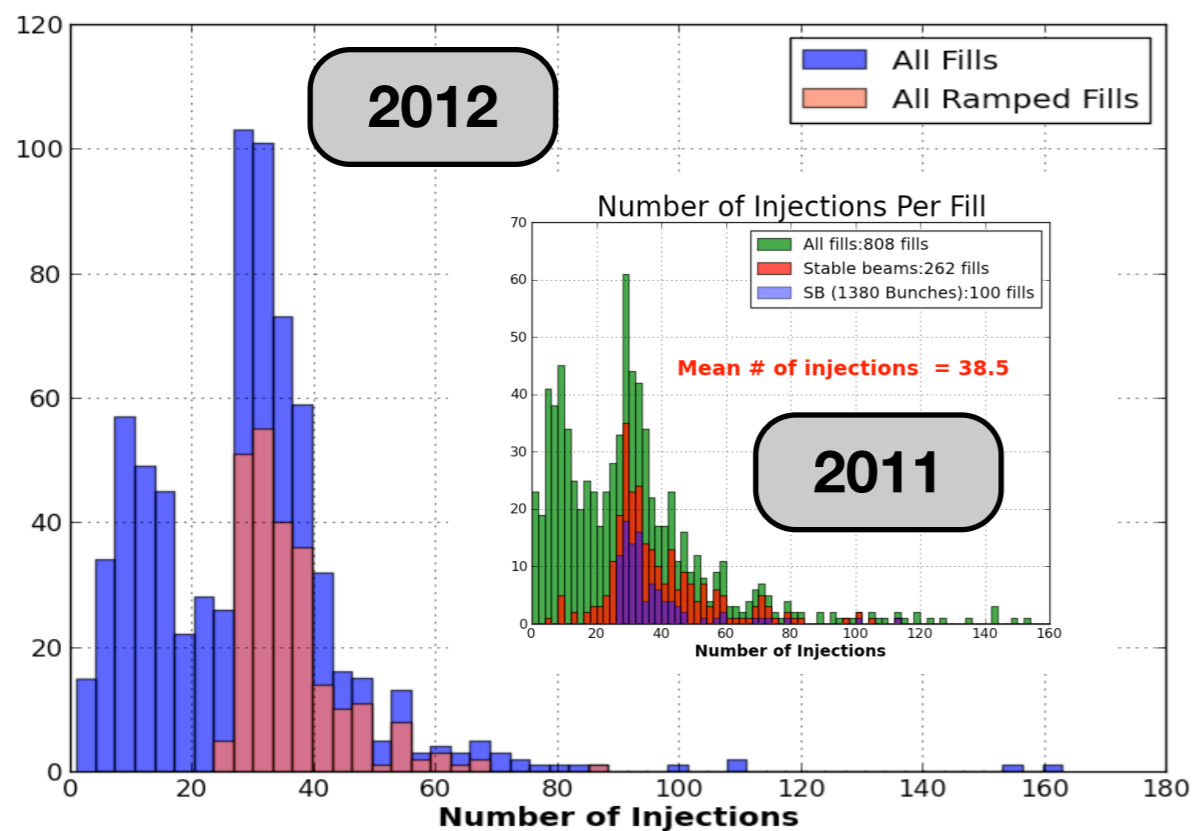
2011: Mean SB Duration = 5.76 hrs

2012 Performance evolution - in one slide

Peak lumi increases with brightness and mean bunch length



Other Performance Markers

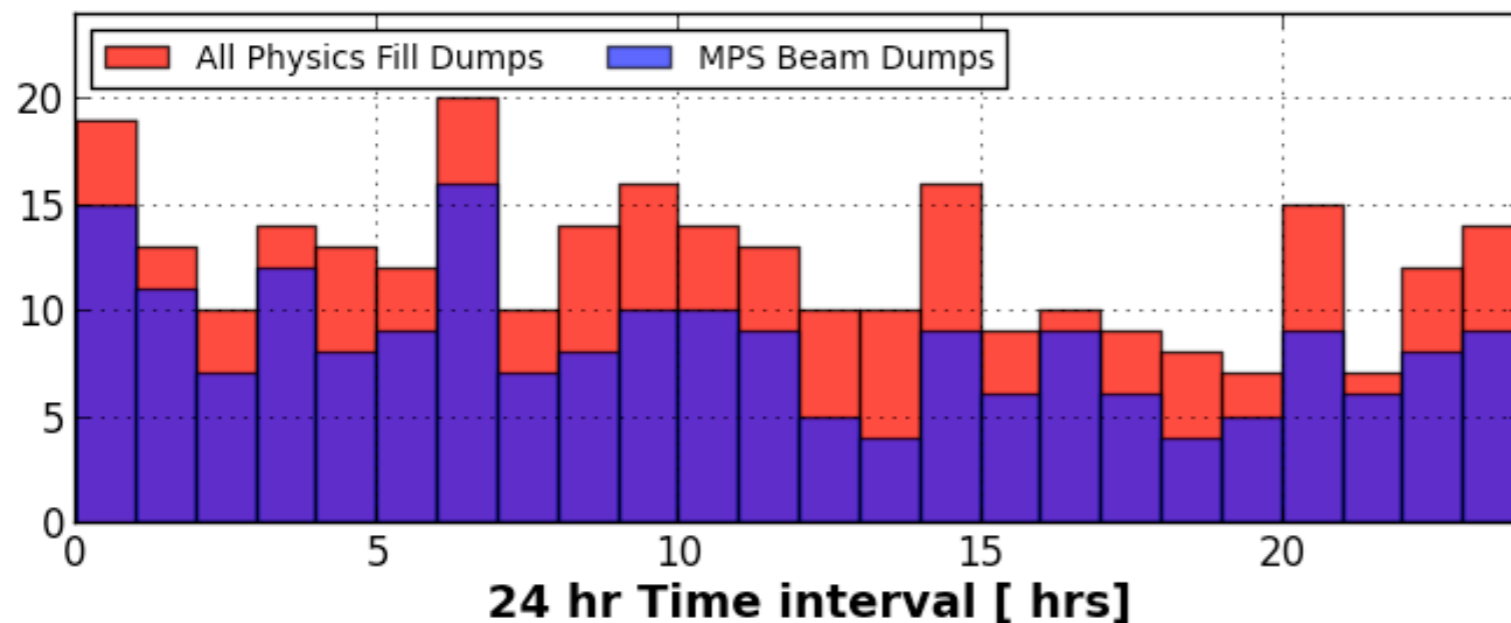
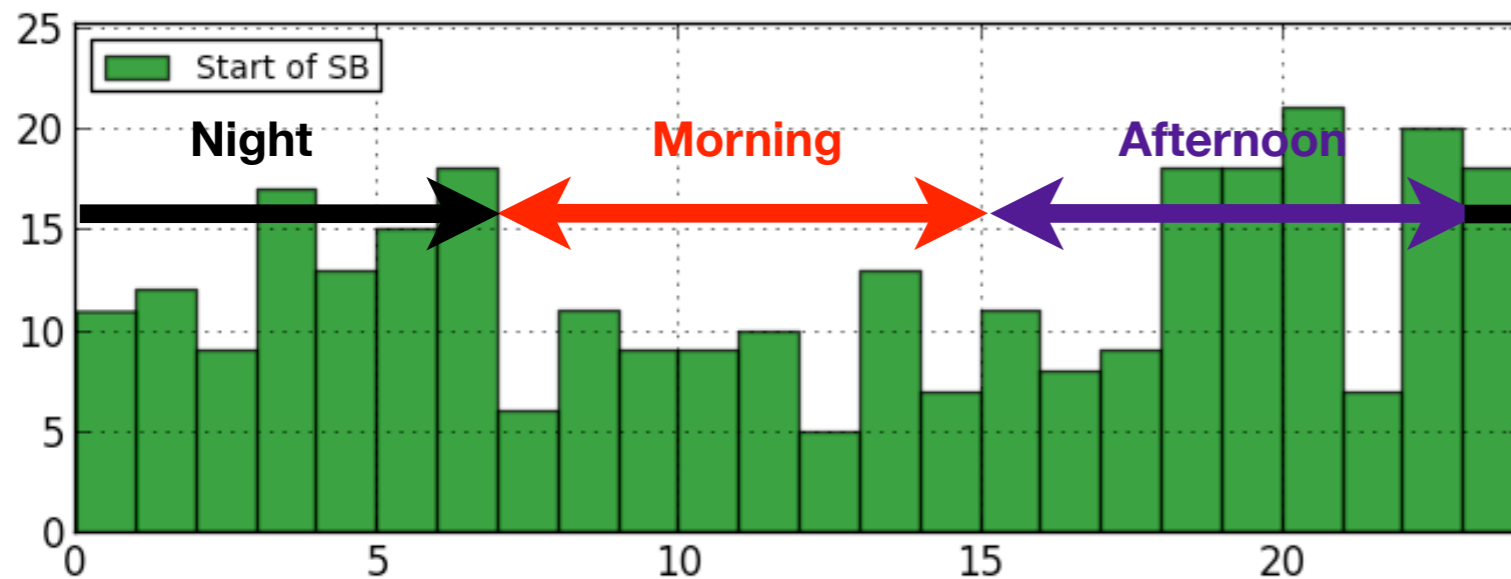


Other Operation Factors (?)

Morning shifts: Not so good at starting stable beams

Afternoon shifts: Declaring stable beams improves after 6pm

Night shifts: Good for starting and ending stable seams

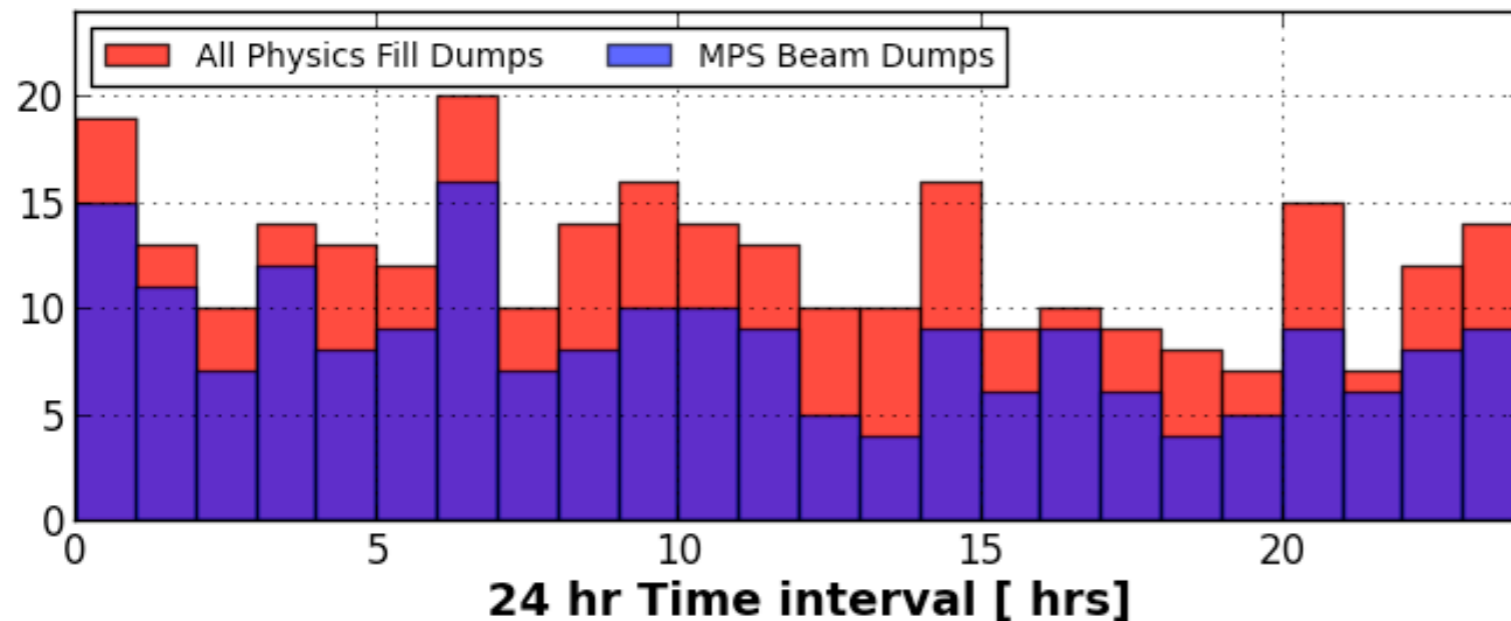
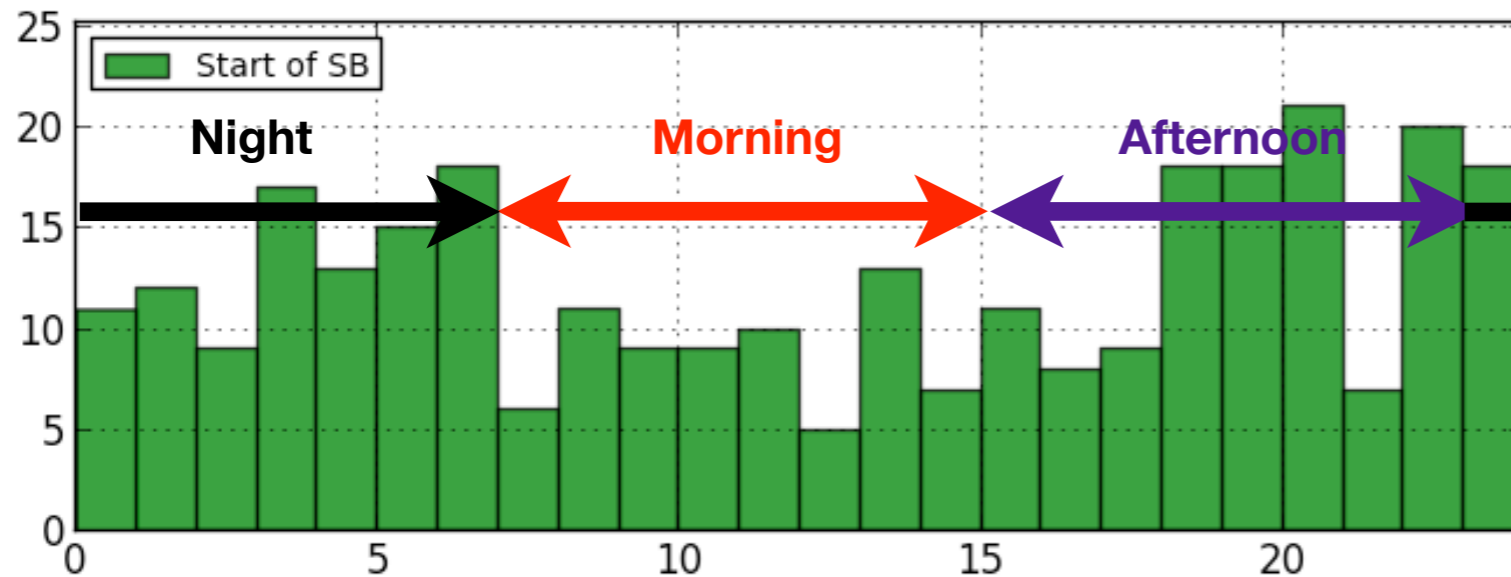


Other Operation Factors (?)

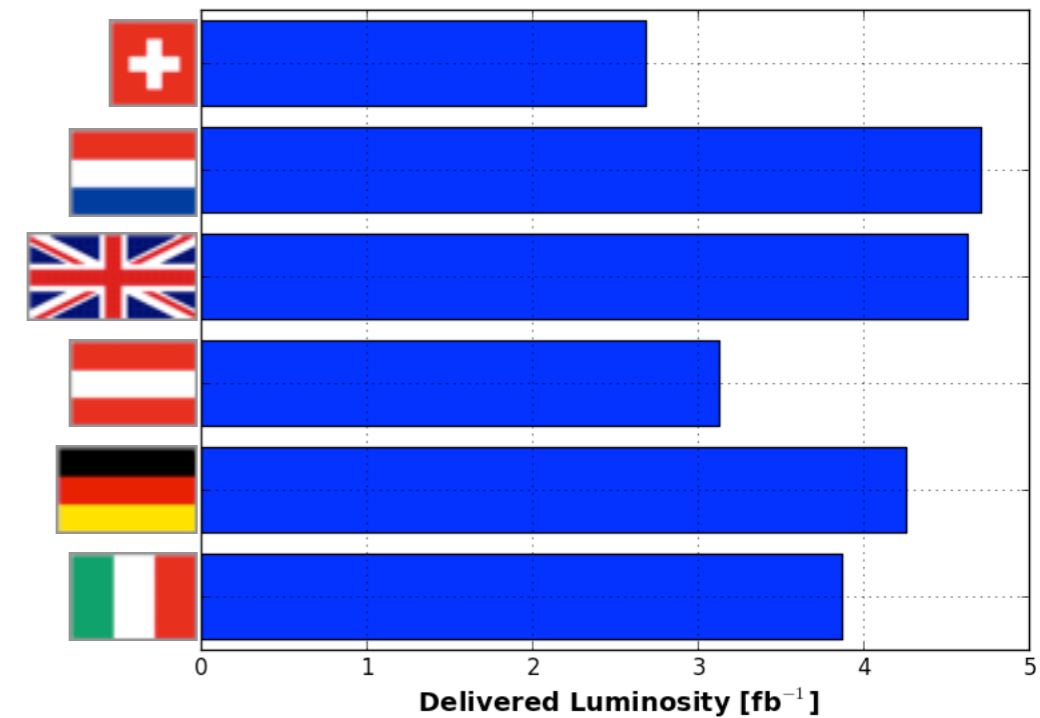
Morning shifts: Not so good at starting stable beams

Afternoon shifts: Declaring stable beams improves after 6pm

Night shifts: Good for starting and ending stable seams



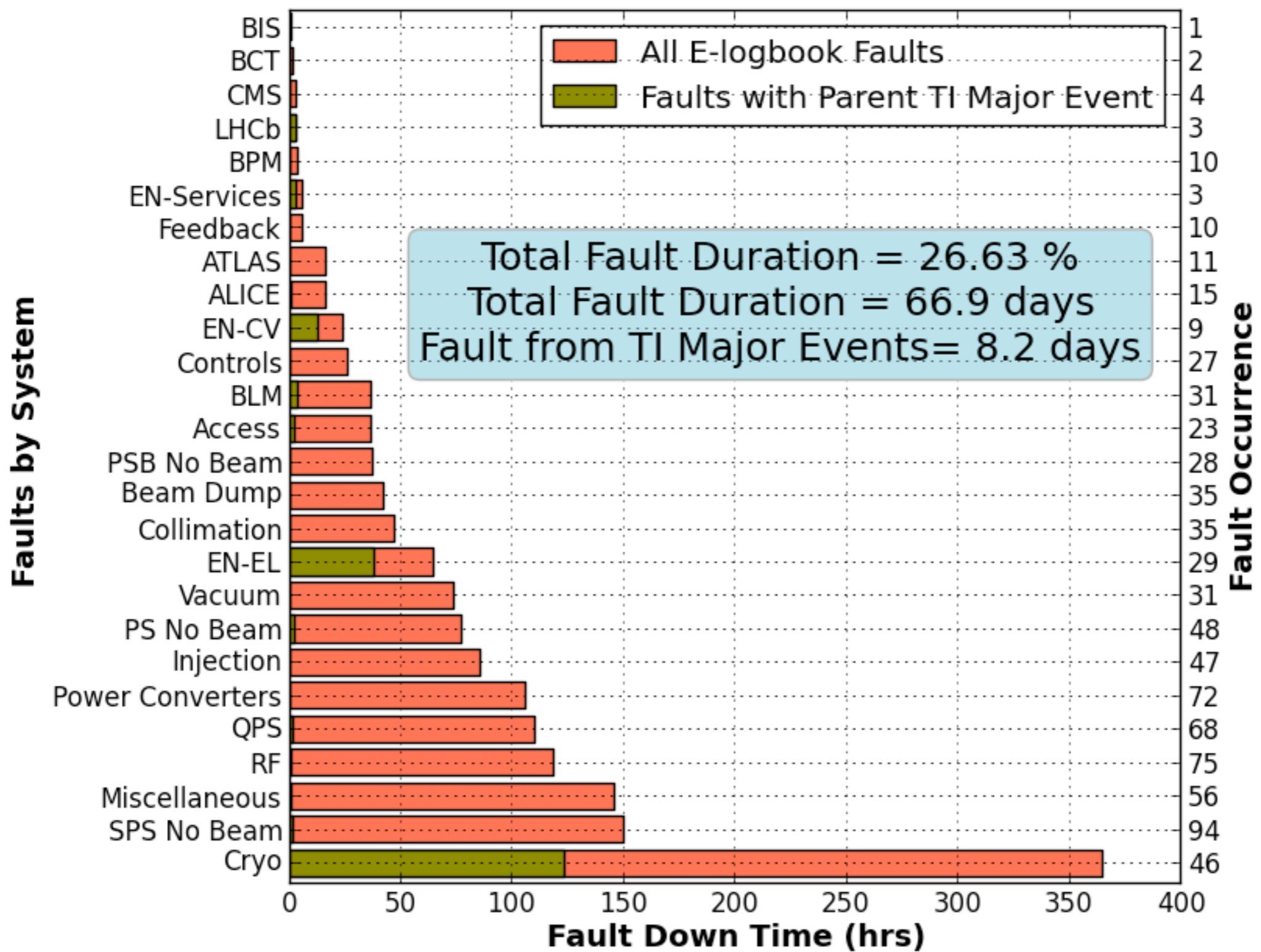
Luminosity by Coordinator



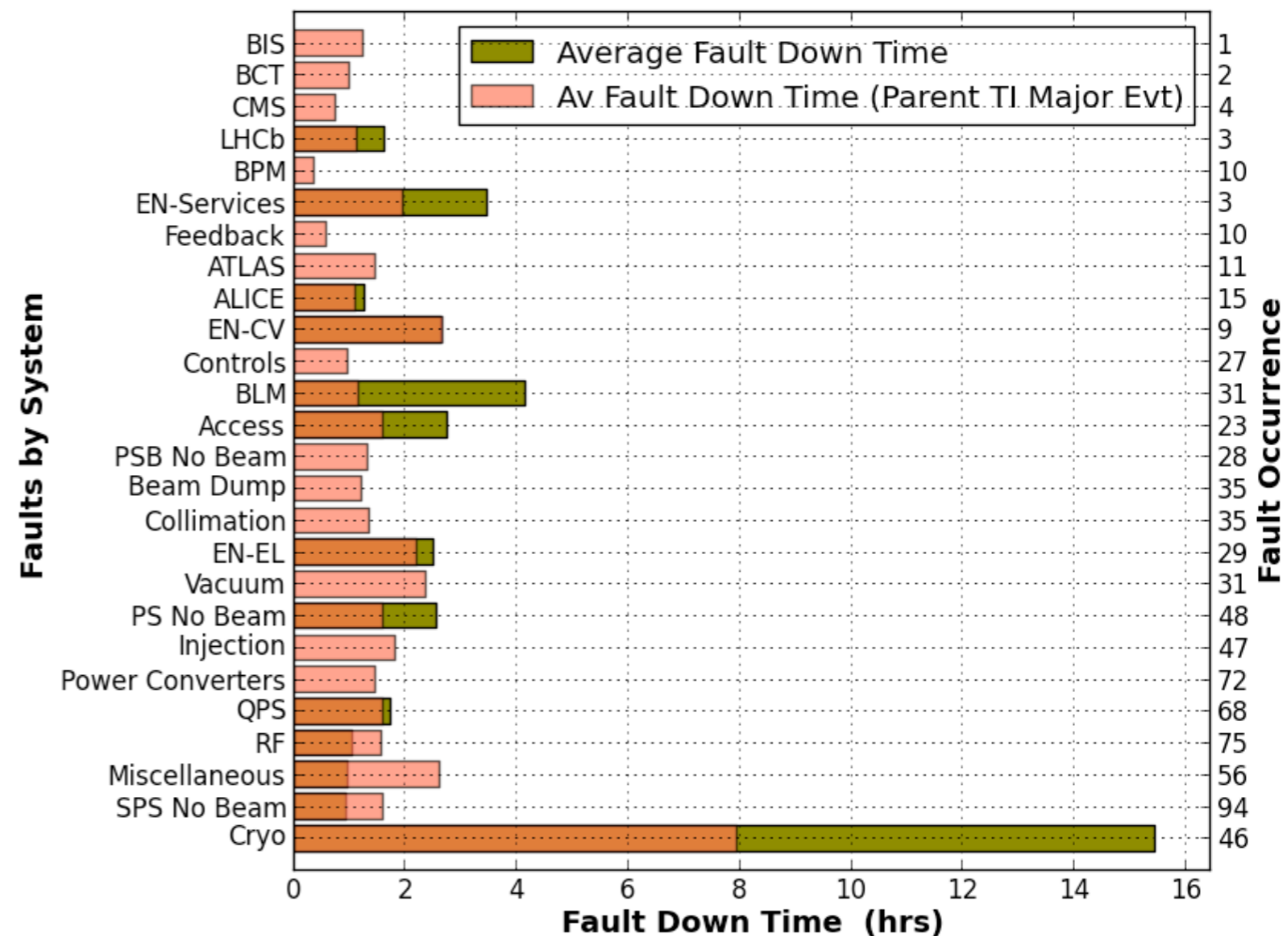
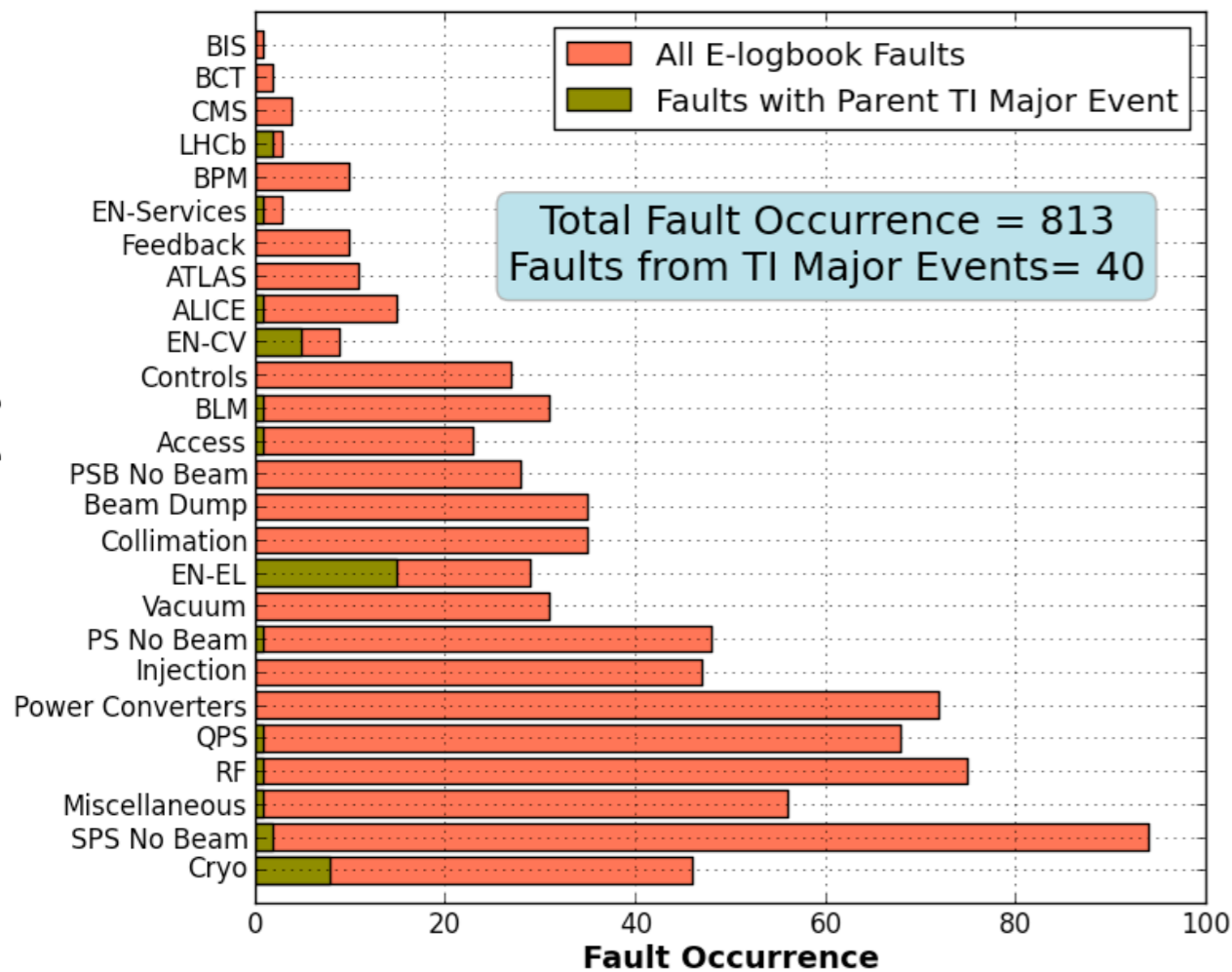
Does not take into account coordination during MD, High Beta, and TS weeks

OP Recorded Faults

Fault statistics based on fault entries in e-logbook
Faults with TI Major event Parent => cause is “external” to LHC

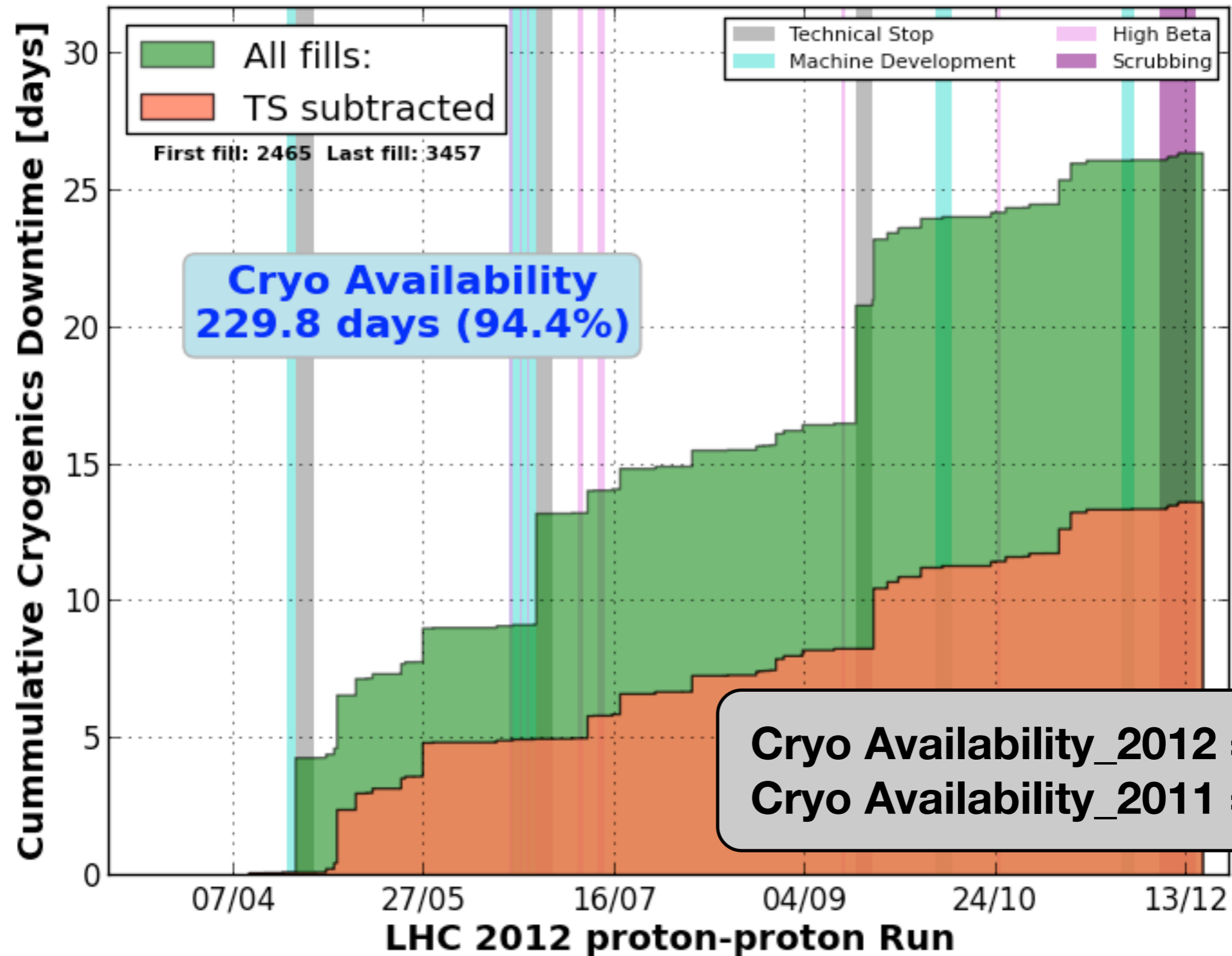


OP Recorded Faults - II

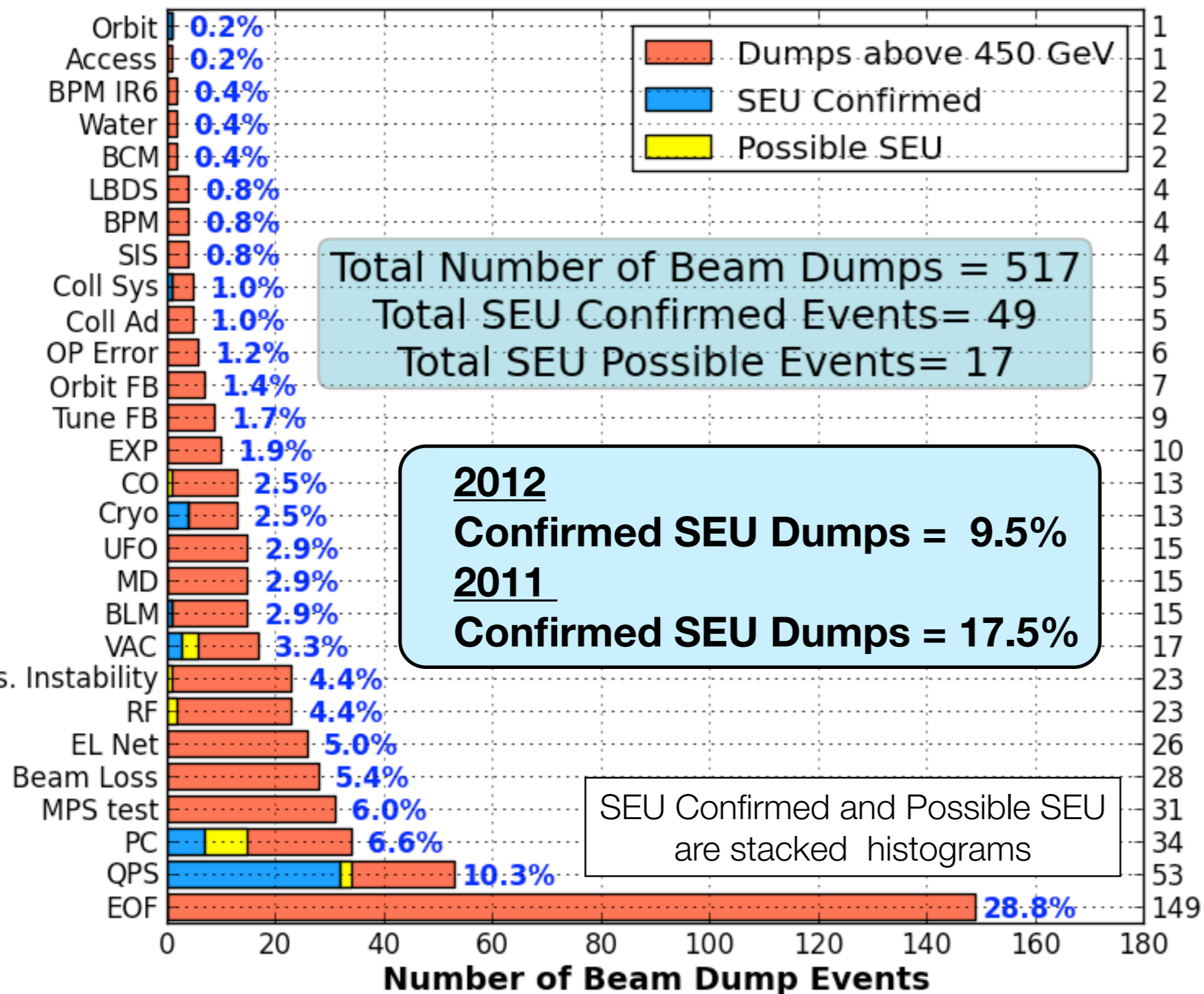


- Injector chain (SPS) is now the most frequent OP fault
- Some systems show extended recovery times due to external faults. [Cryo, EN-Services, BLM, Access ...]
- Average fault downtime for cryo is twice as long if there was a TI Major Event as parent fault (ie Electrical network glitch)

2012 Cryo Availability

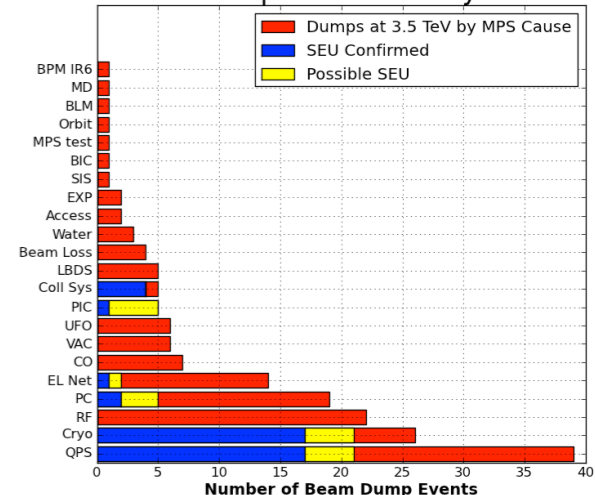


Beam Dumps Above Injection



Occurrence of MPS Cause

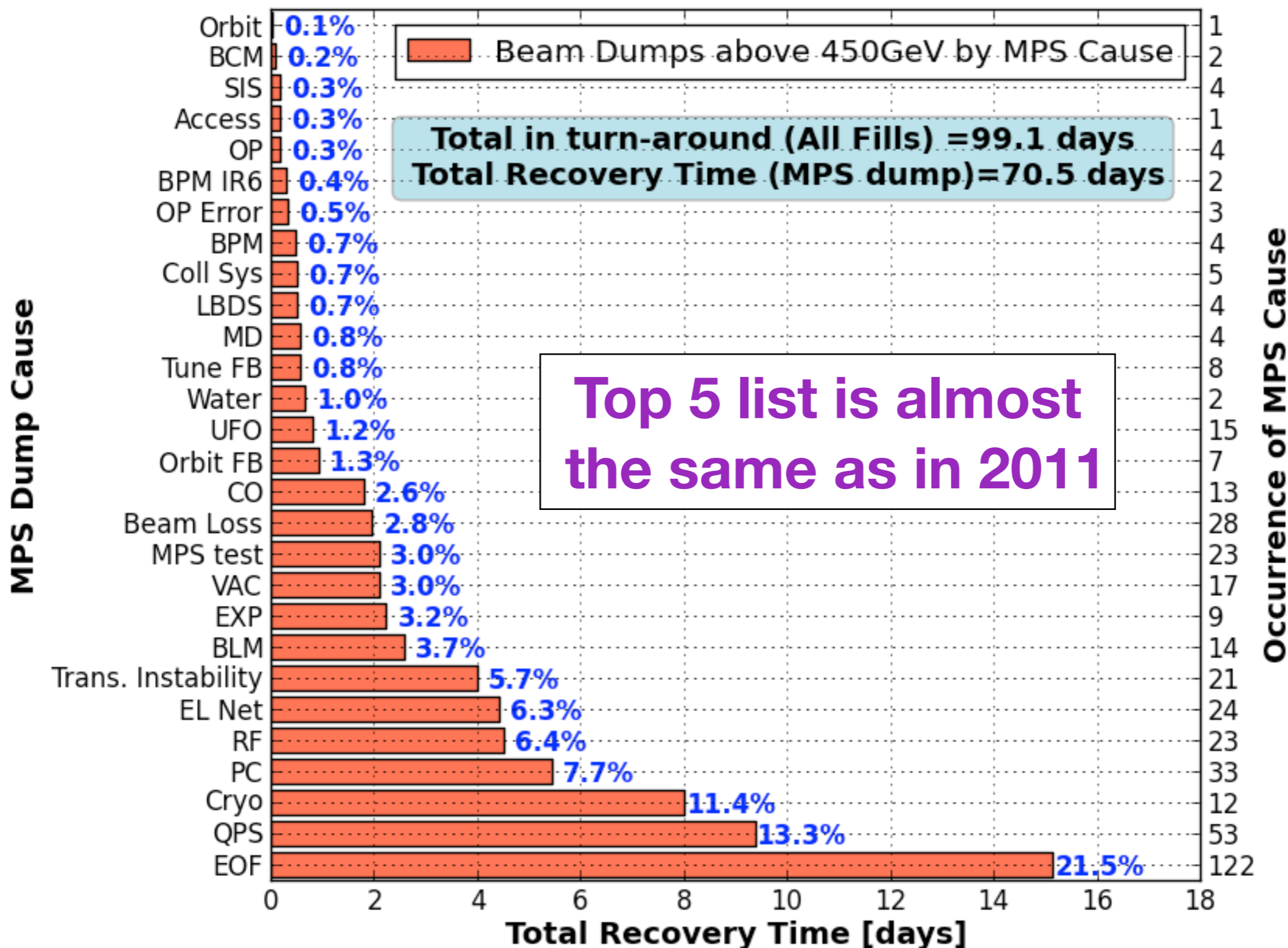
2011 Run: Dumps at 3.5 TeV by MPS Cause



QPS SEU_Confirmed dumps at ~9% level for both 2011 and 2012

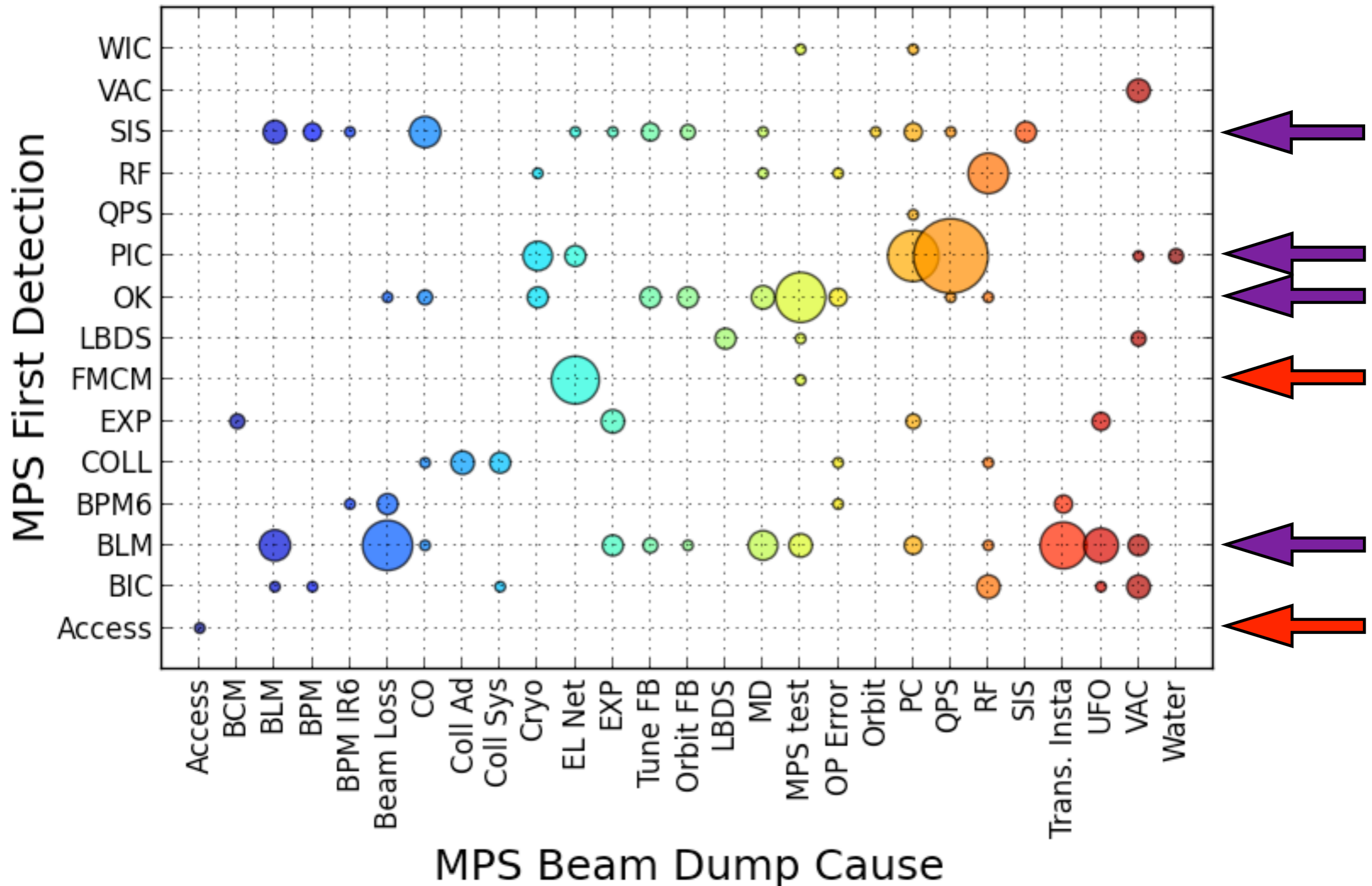
Beam dumps by Recovery Time

Recovery Time: defined as time to get back to injection after MPS Dump



MPS Detection vs Cause

MPS: A mixture of **dedicated** and **multi-purpose** detection systems



Conclusion

- **202 days of Physics Scheduled: 200.1 Days delivered**
- **Luminosity: 23.27 fb⁻¹ delivered to both ATLAS and CMS**
- **2012: Spent less time in tunnel => Availability + Hubner factor improved**
- **Cryo availability again improved to 94.4 % (p-p Physics run)**
- **Faults and downtime as seen by the OP logbook**
 - **SPS No beam is the most frequent logbook fault**
 - **Cryo has the longest total downtime**
- **Faults linked to “external” faults defined by TI Major events show extended recovery time - in line with system/site wide faults [esp. Cryo]**
- **In terms of beam dumps above 450 GeV, QPS leads in occurrence and recovery time and SEUs.**
- **2012 saw beam dumps from SEUs halved compared to 2011**
 - **However QPS SEU rate remains stable at ~9%**
- **LHC Downtime: Mix of OP e-logbook faults, TI Major events, PM data**
 - **Coherent fault/downtime tracking still to be implemented**