Operational Efficiency

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LHC Beam Operation Workshop - Evian 7-9 December 2010

Outline

- Quick run through the run
- Definitions and method
- Fault statistics
- Dump statistics
- Technical stops
- Tools
- Operational efficiency

> *“Now, what I want is, facts. Teach these boys and girls nothing but Facts. Facts alone are wanted in life. Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon Facts: nothing else will ever be of any service to them. (…) Stick to Facts, sir!”*

> *"a little inaccuracy saves a world of explanation"*

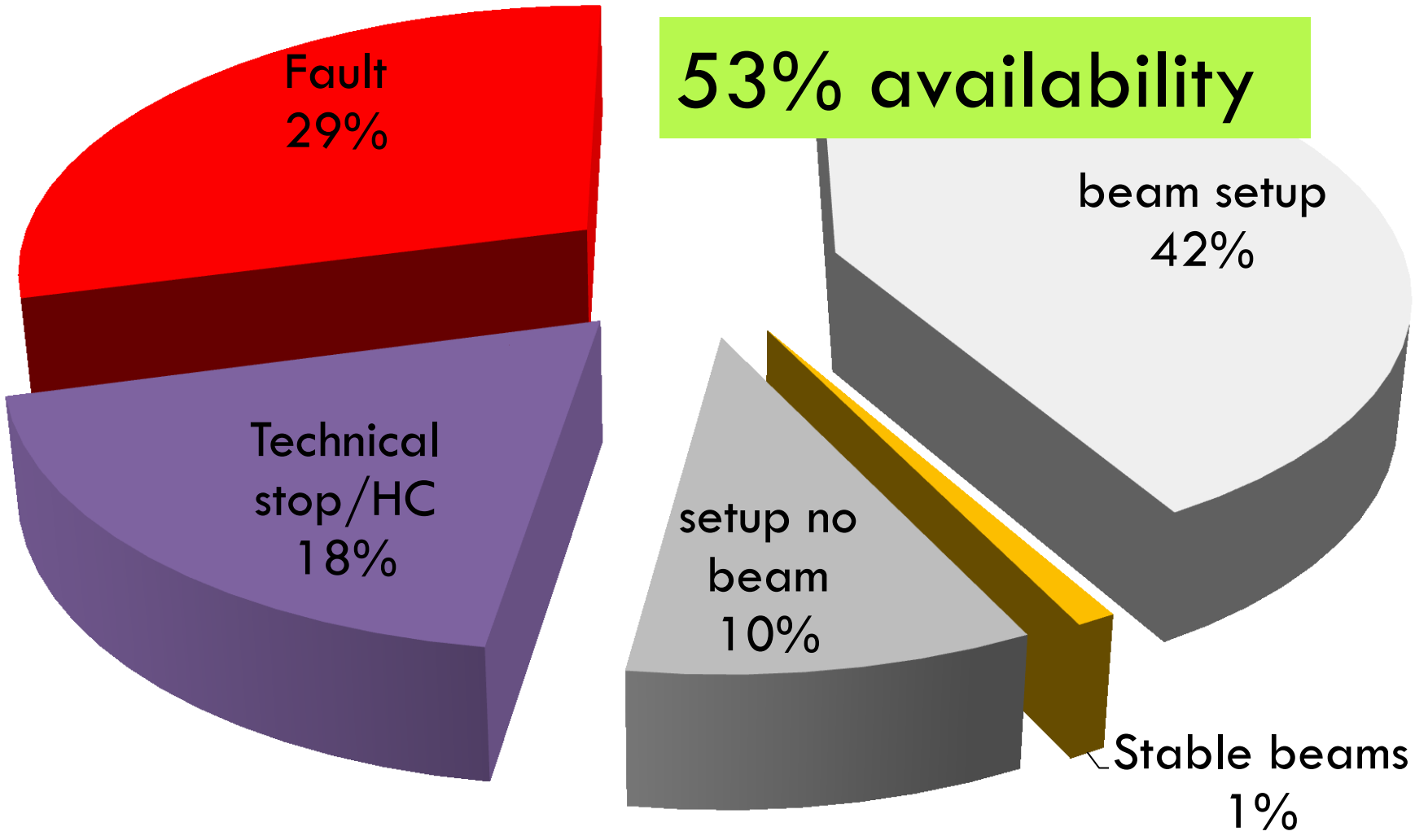
Quick run through the run

- 1-30 March: ramp commissioning, first collisions
- 1-16 April: squeeze commissioning, then Physics
- May: increasing N_b and k_b, Physics
- Intense summer: pushing & Physics
- Canicular Physics
- September: resuming commissioning
- Bunch harvest
- Heavy November

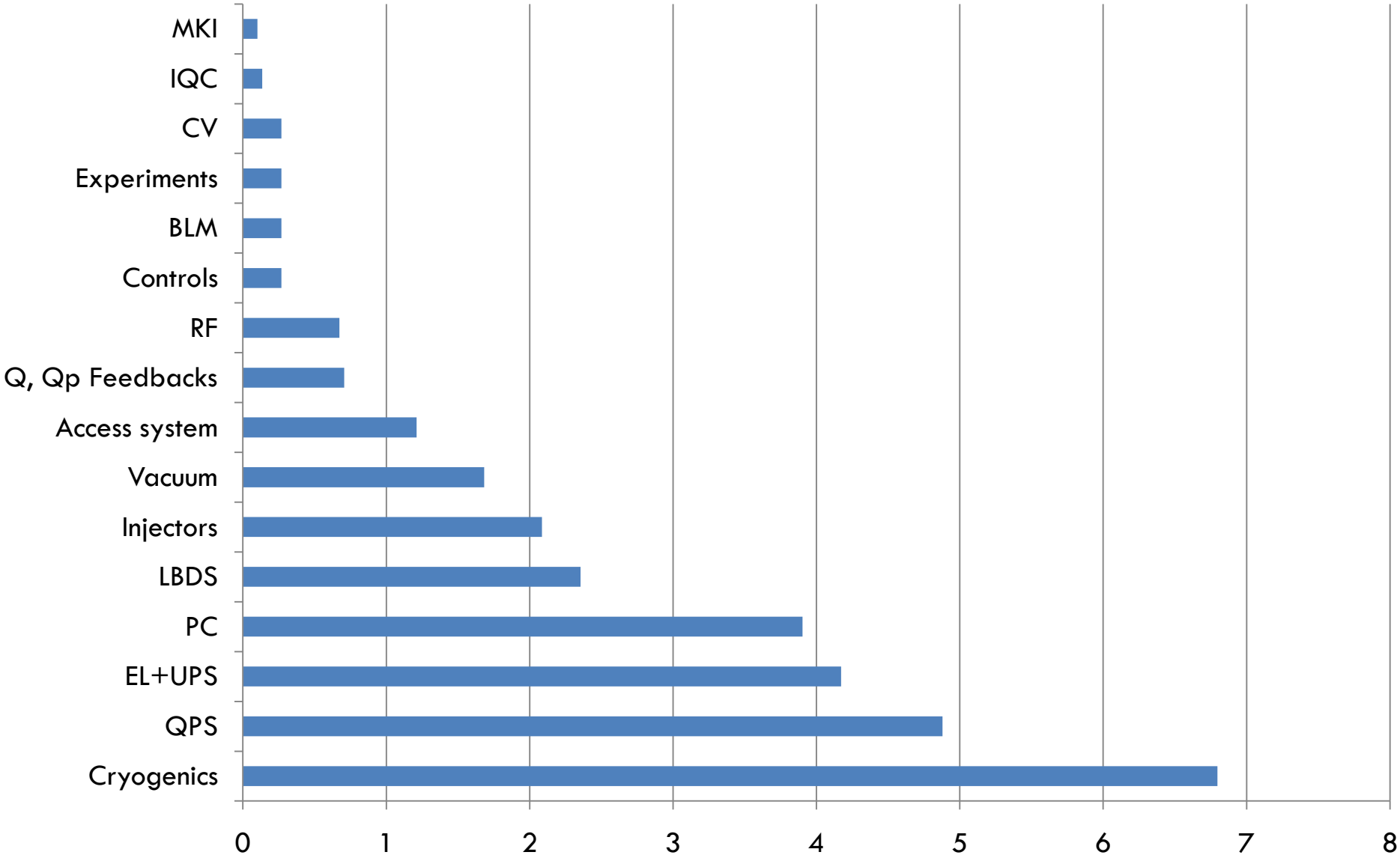
Method and Definitions

- From 1 March to 30 November: 6600 hours
- From the logbook, cross checked with status reports of coordination and Timber for the beam presence
- Grid: Setup no beam (grey), beam setup (silver), stable beams (gold), TS/HC (purple), Fault (red)
- Availability = Beam presence + Setup no beam
- Downtime=Fault + TS/HC
  - Additional setup time after faults credited to the faulty system
  - Not straightforward (coupled faults)
- … Shake and pie it up

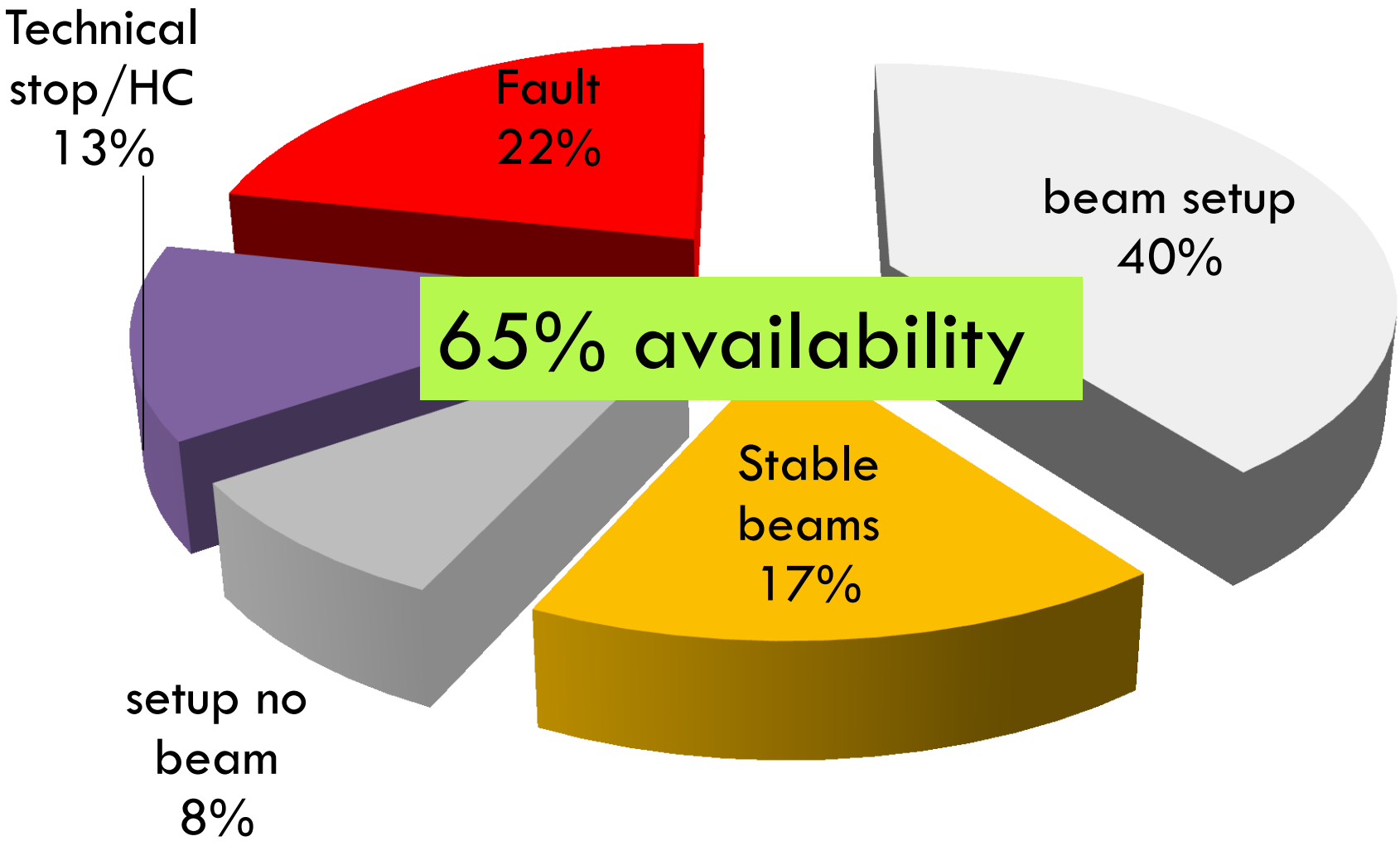
Initial commissioning (March pie)



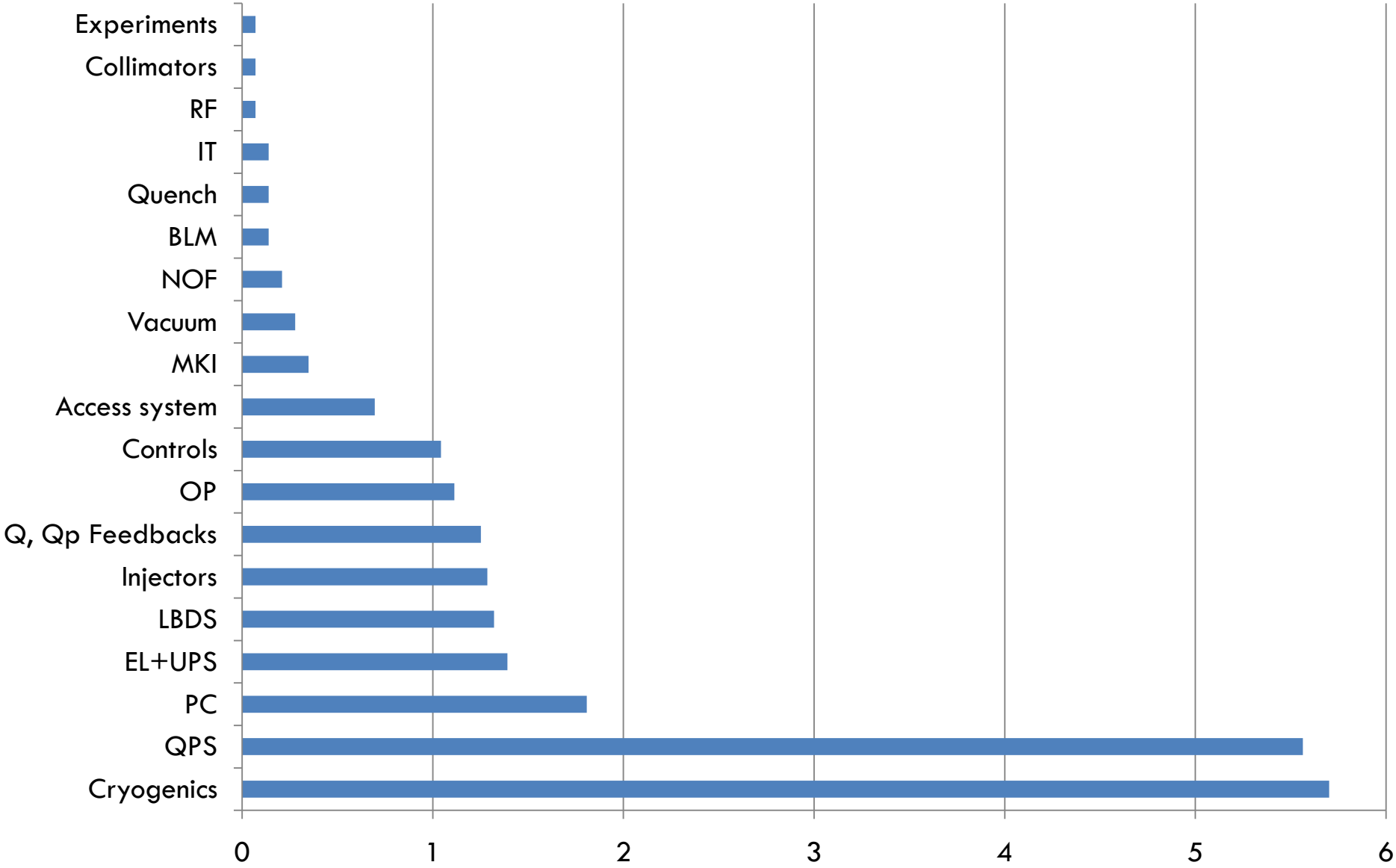
March faults distribution



April is the cruellest month…?

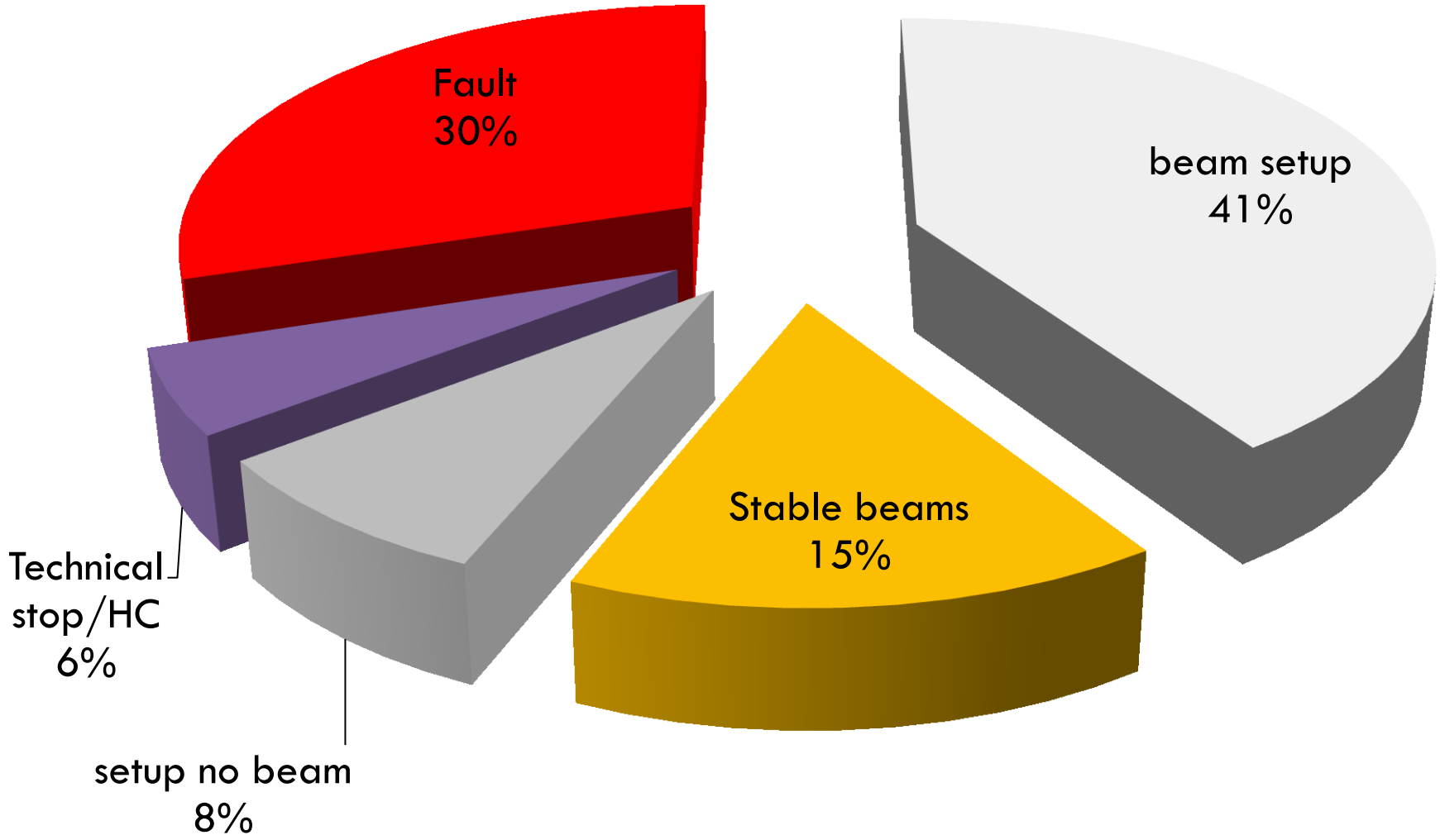


April faults distribution

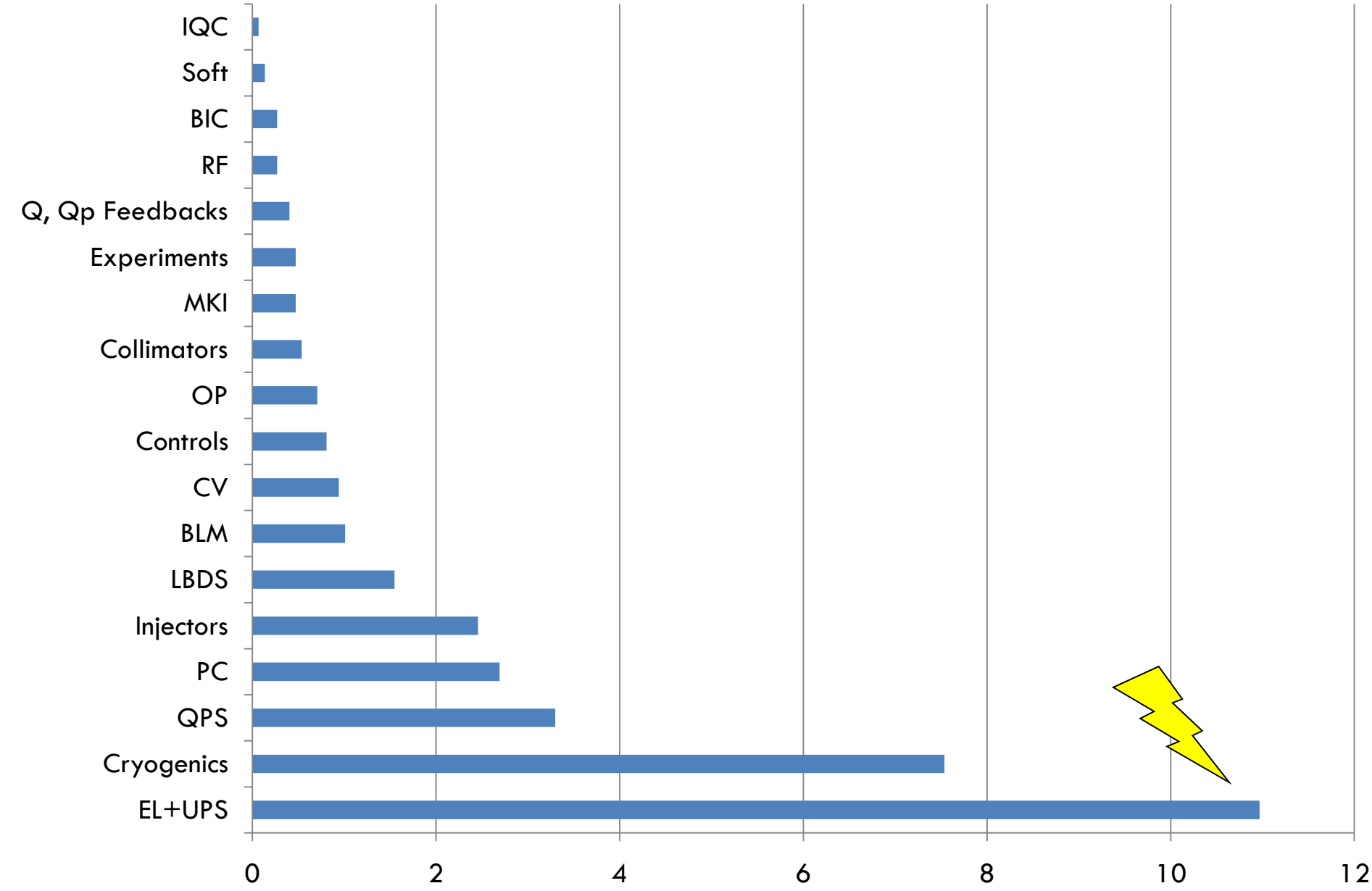


What the Thunder said

64% availability

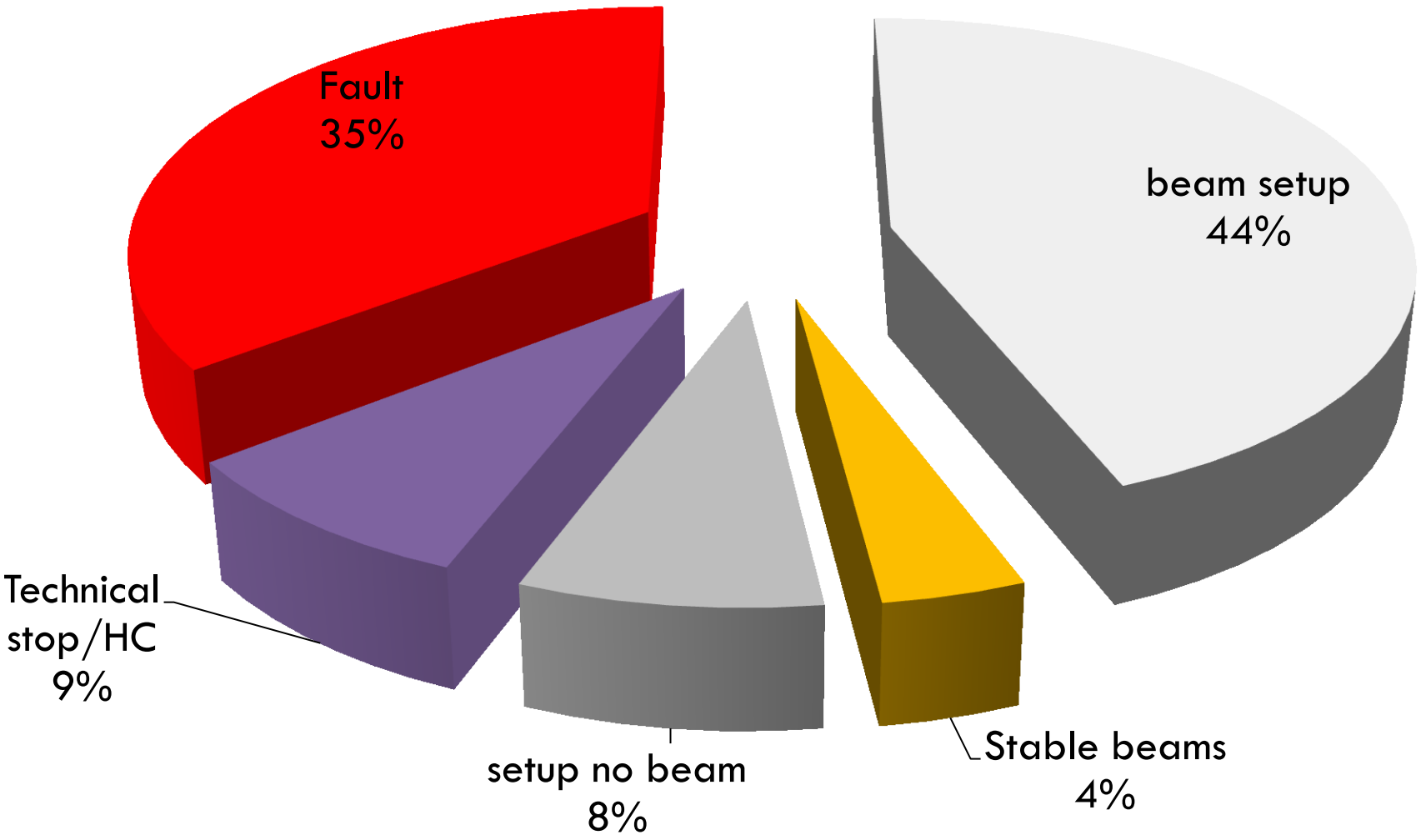


All May faults

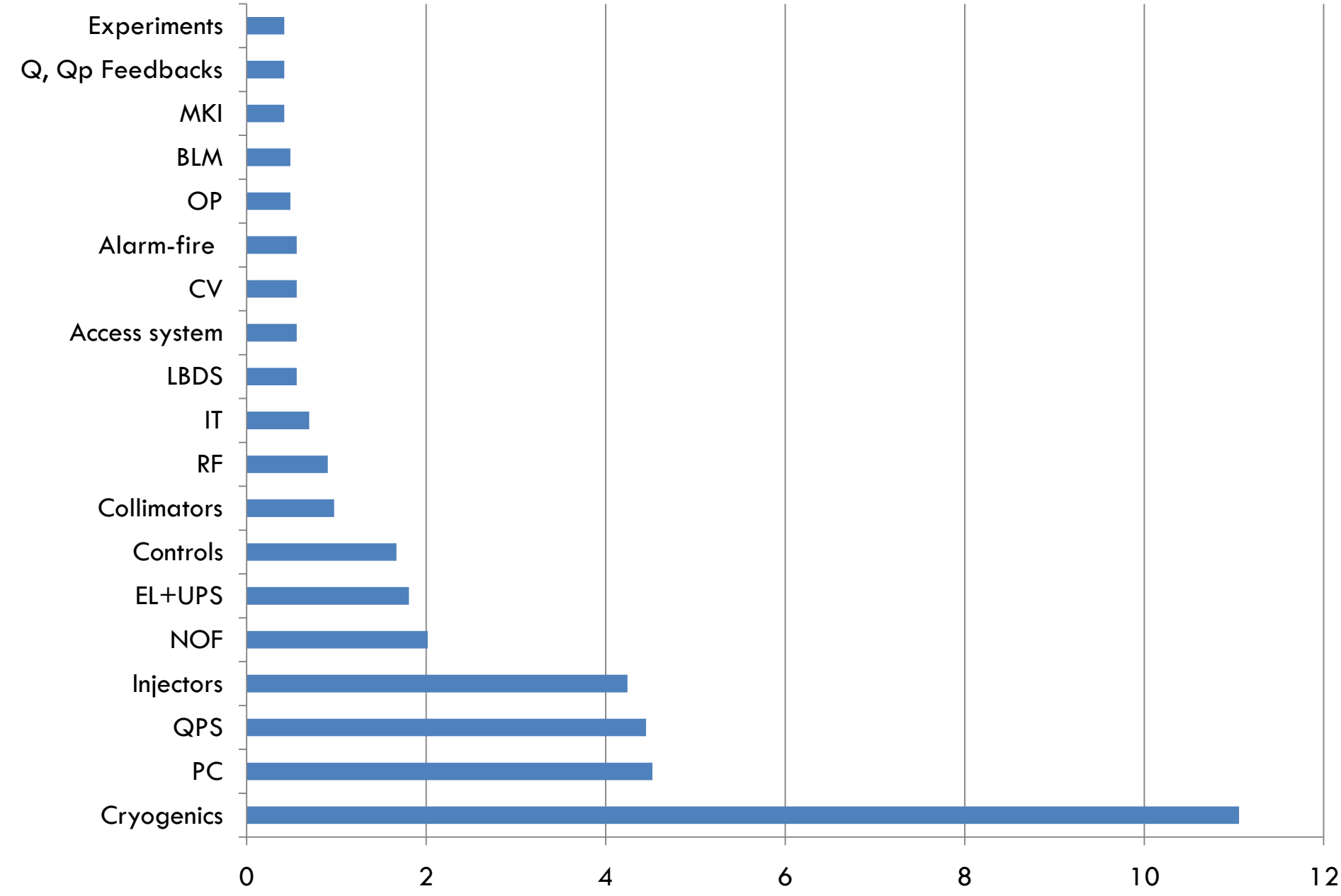


June, change of Tune

56% availability

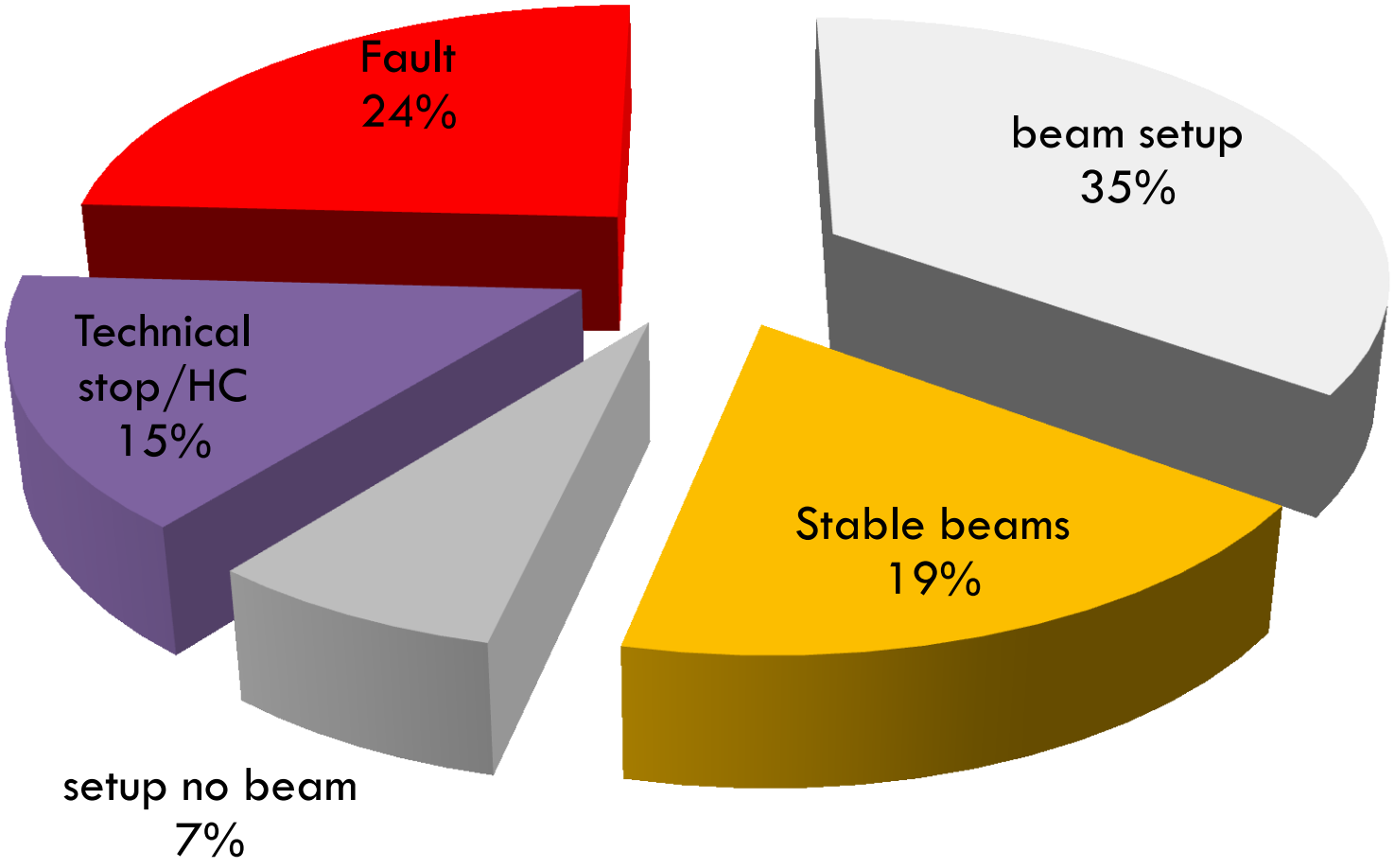


June faults

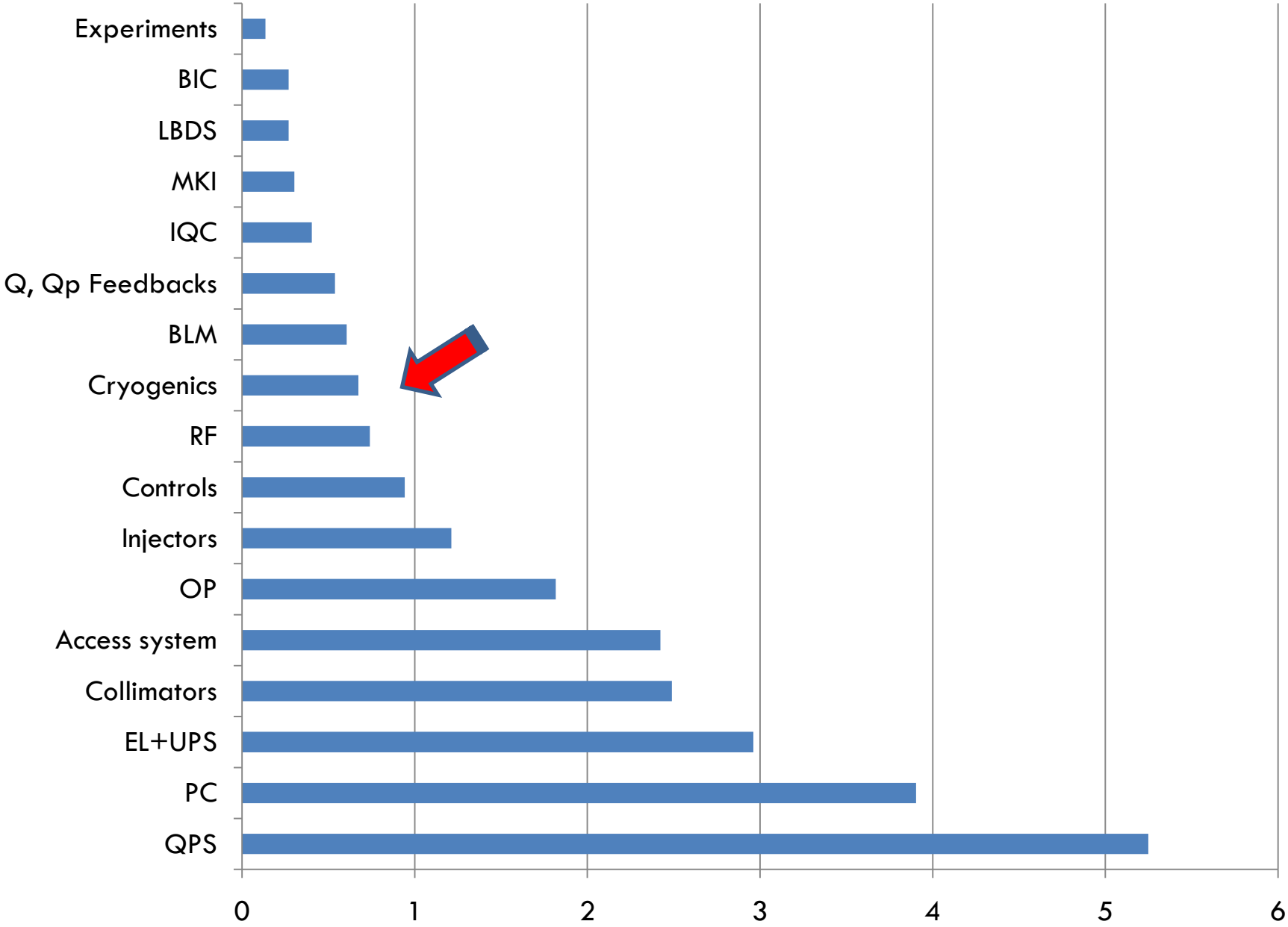

Experiments
Q, Qp Feedbacks
MKI
BLM
OP
Alarm-fire
CV
Access system
LBDS
IT
RF
Collimators
Controls
EL+UPS
NOF
Injectors
QPS
PC
Cryogenics
0
2
4
6
8
10
12

Another pie…July

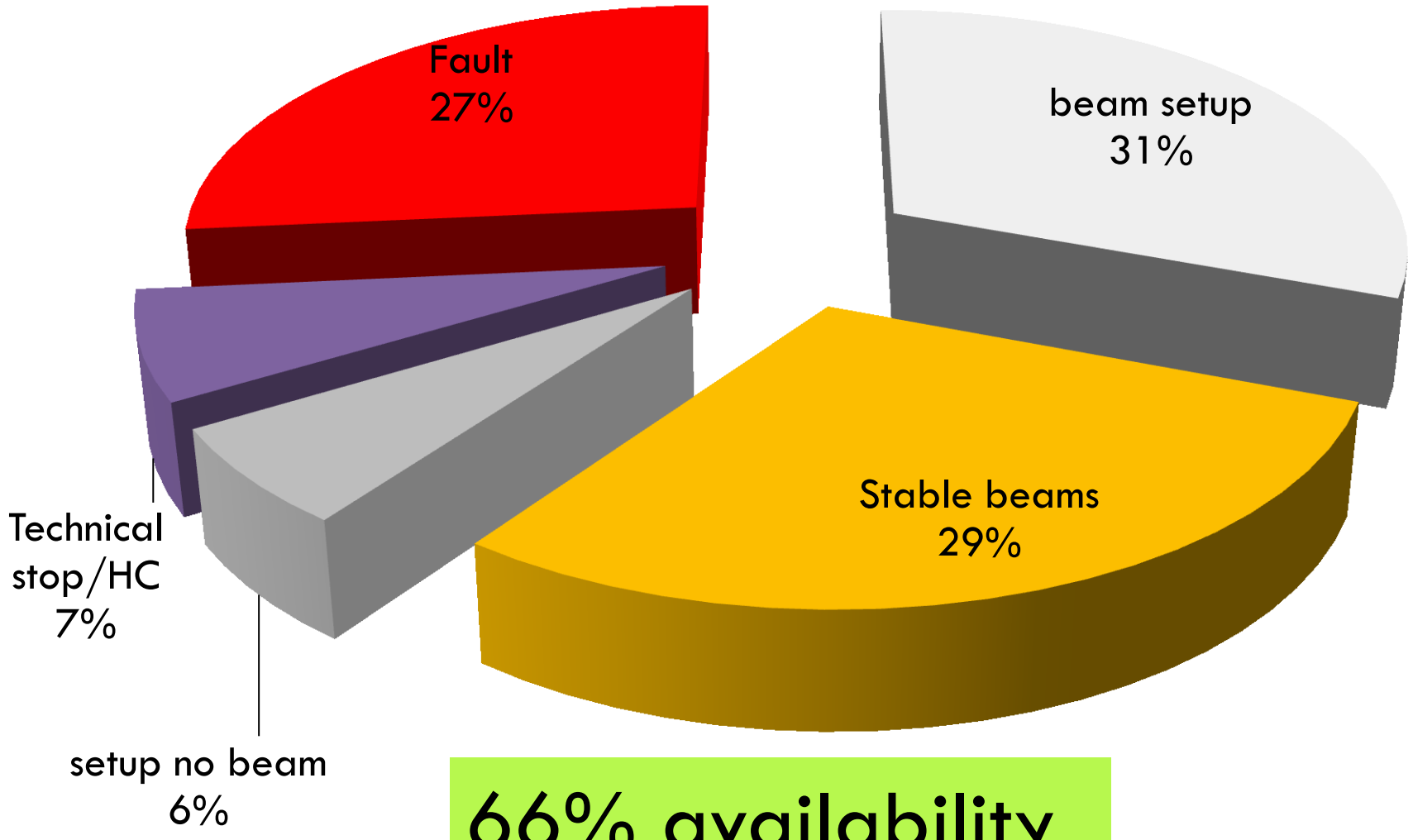
61% availability



…other testimony of summer nights

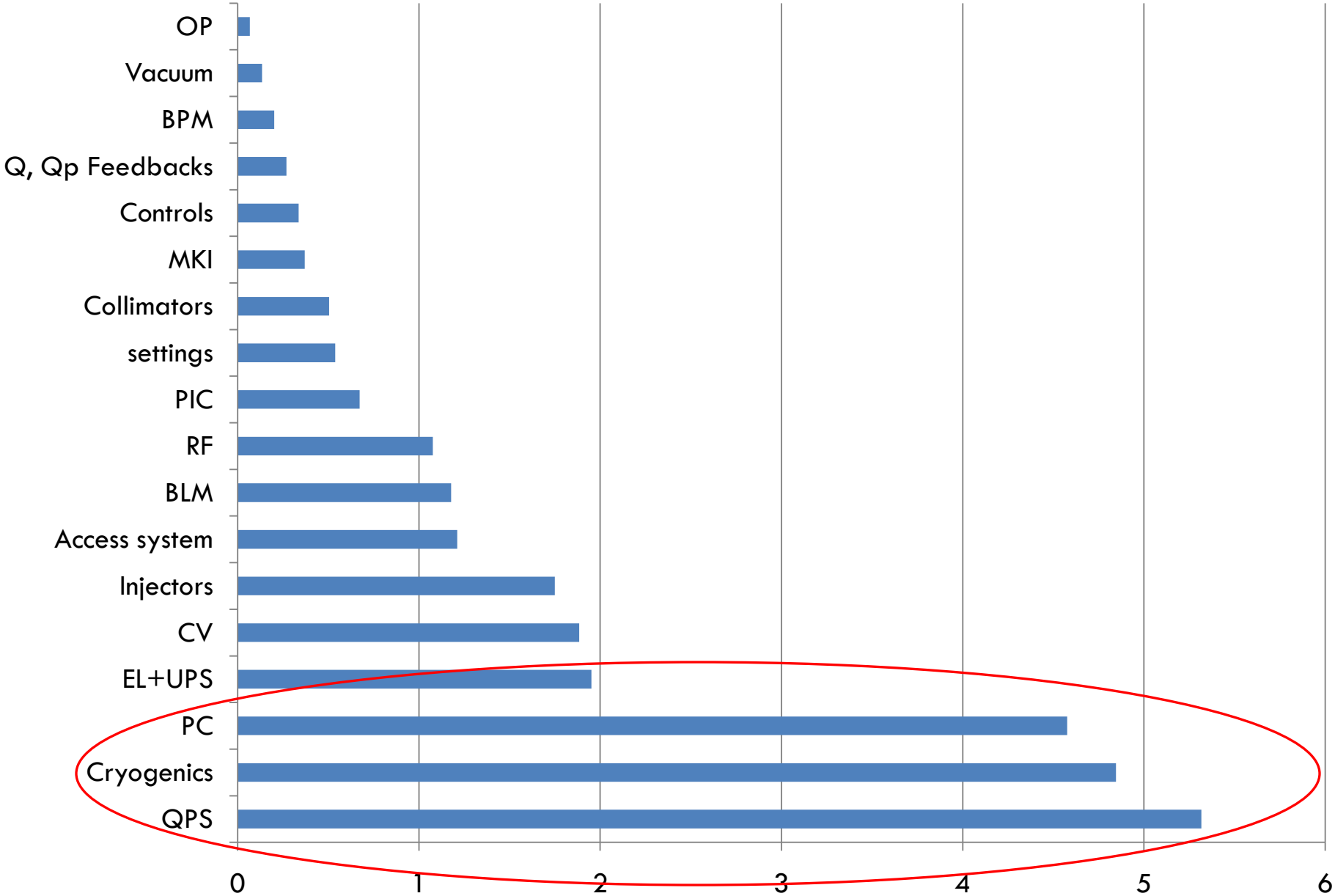


The summers corny crown

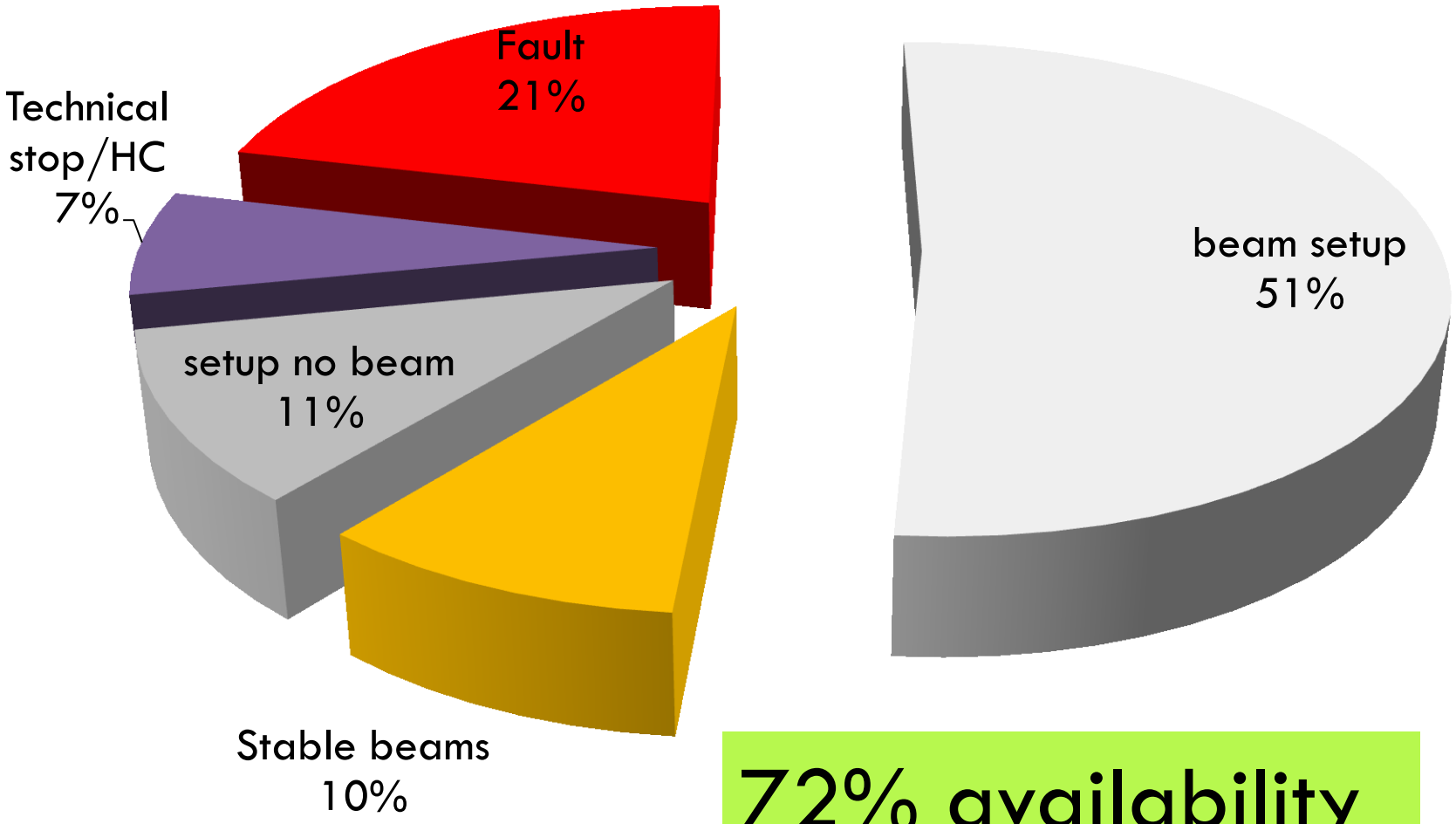


66% availability

Usual suspects

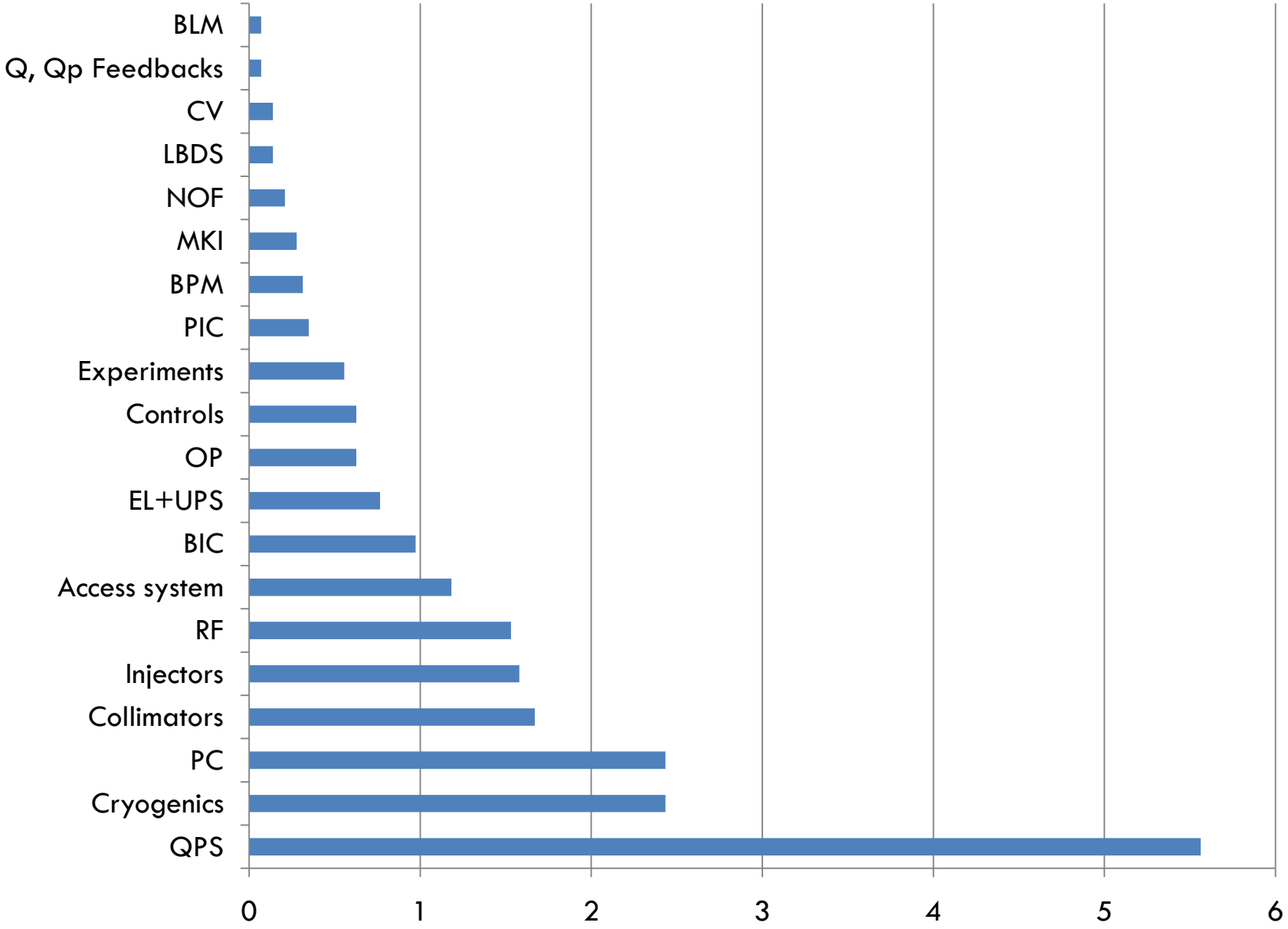


September trains



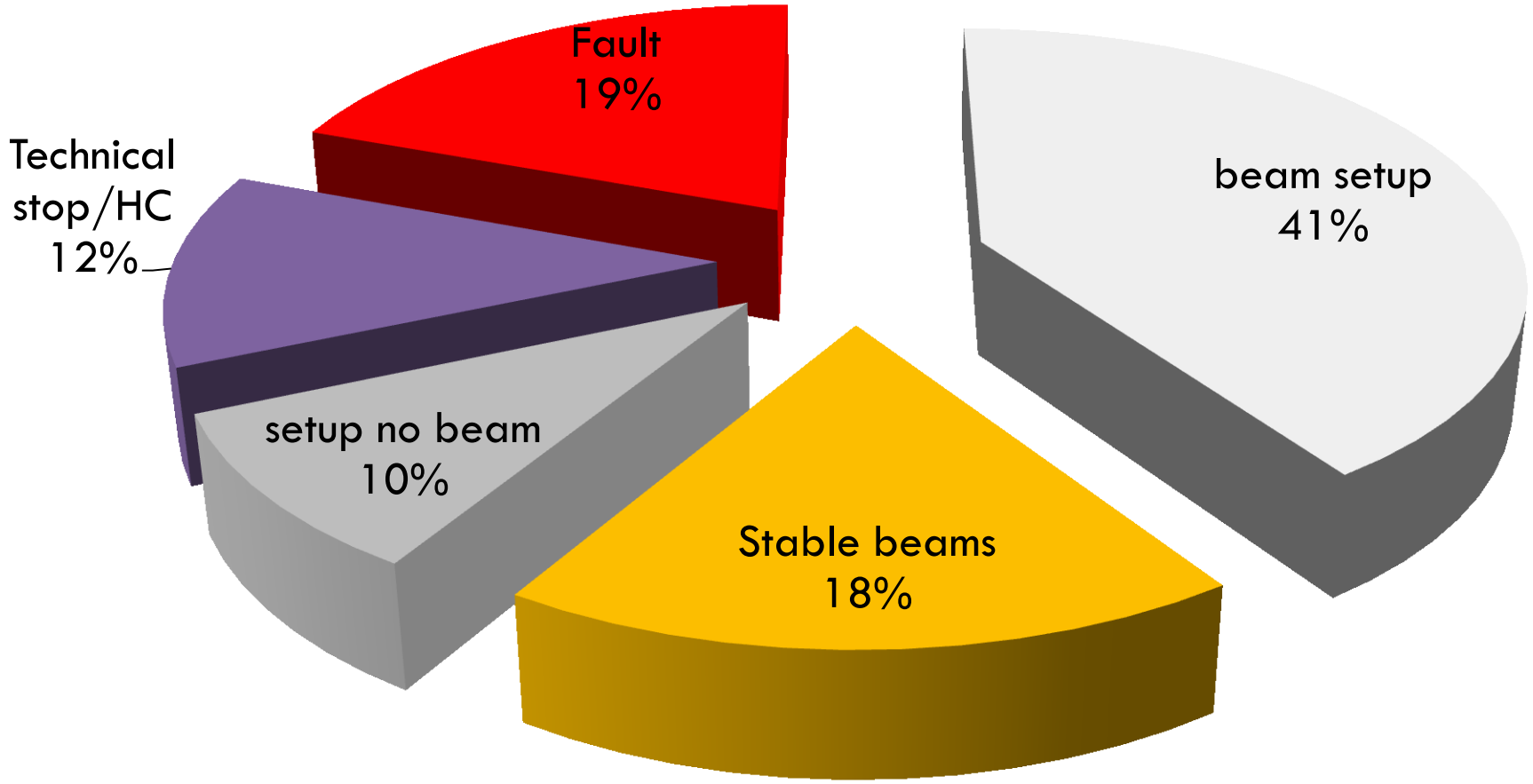
72% availability

September faults distribution

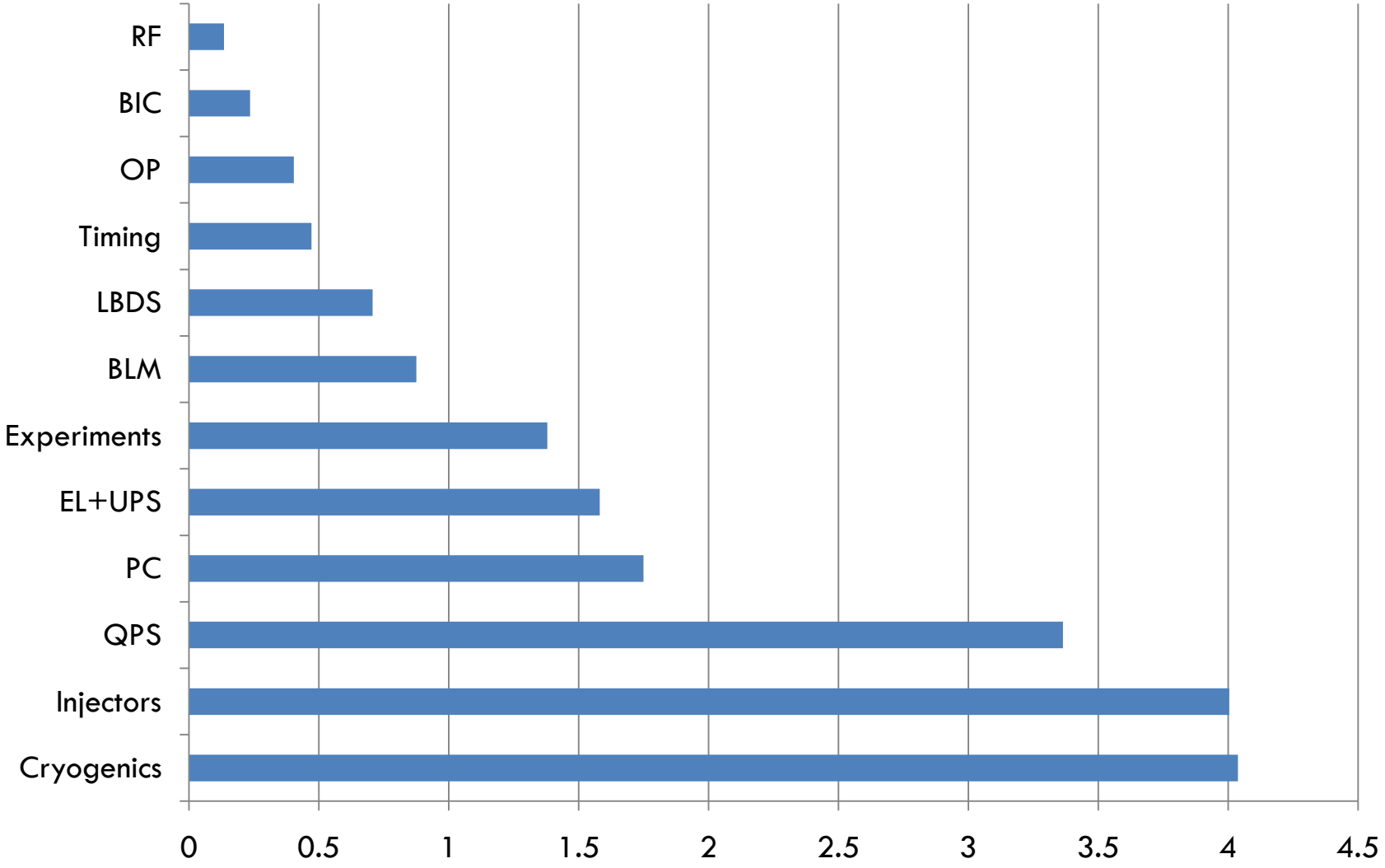


October slices

69% availability

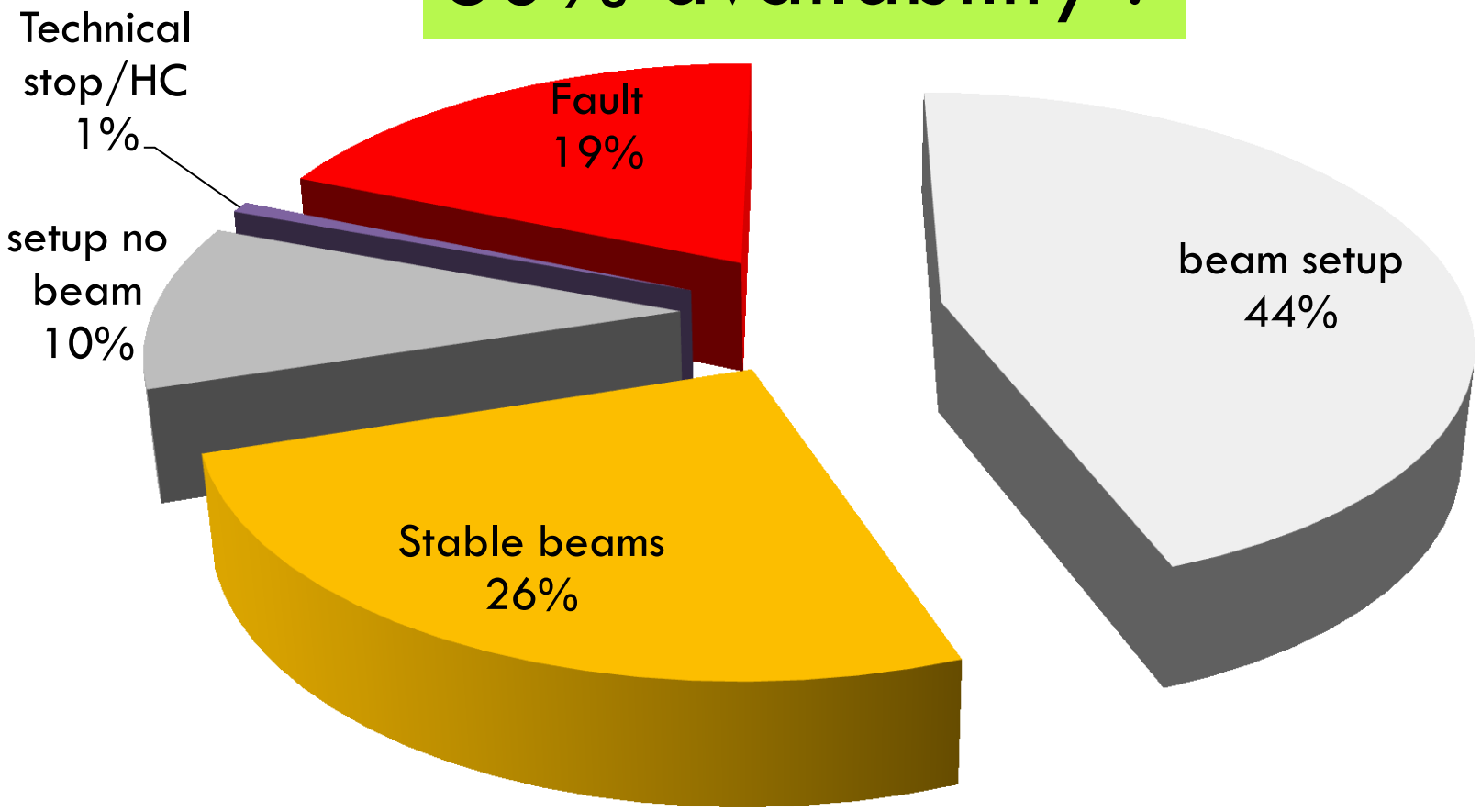


October faults distribution

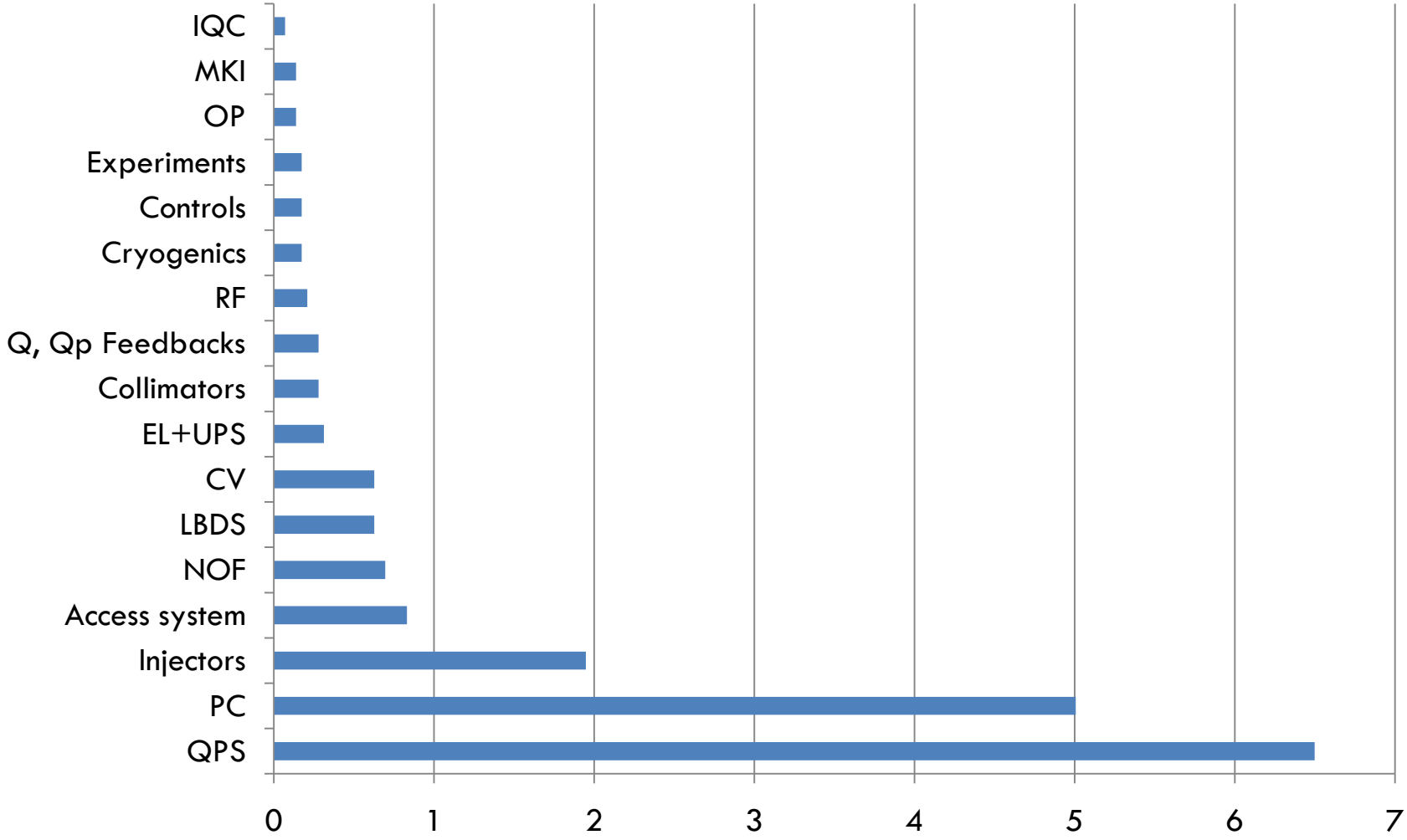


Heavy ending

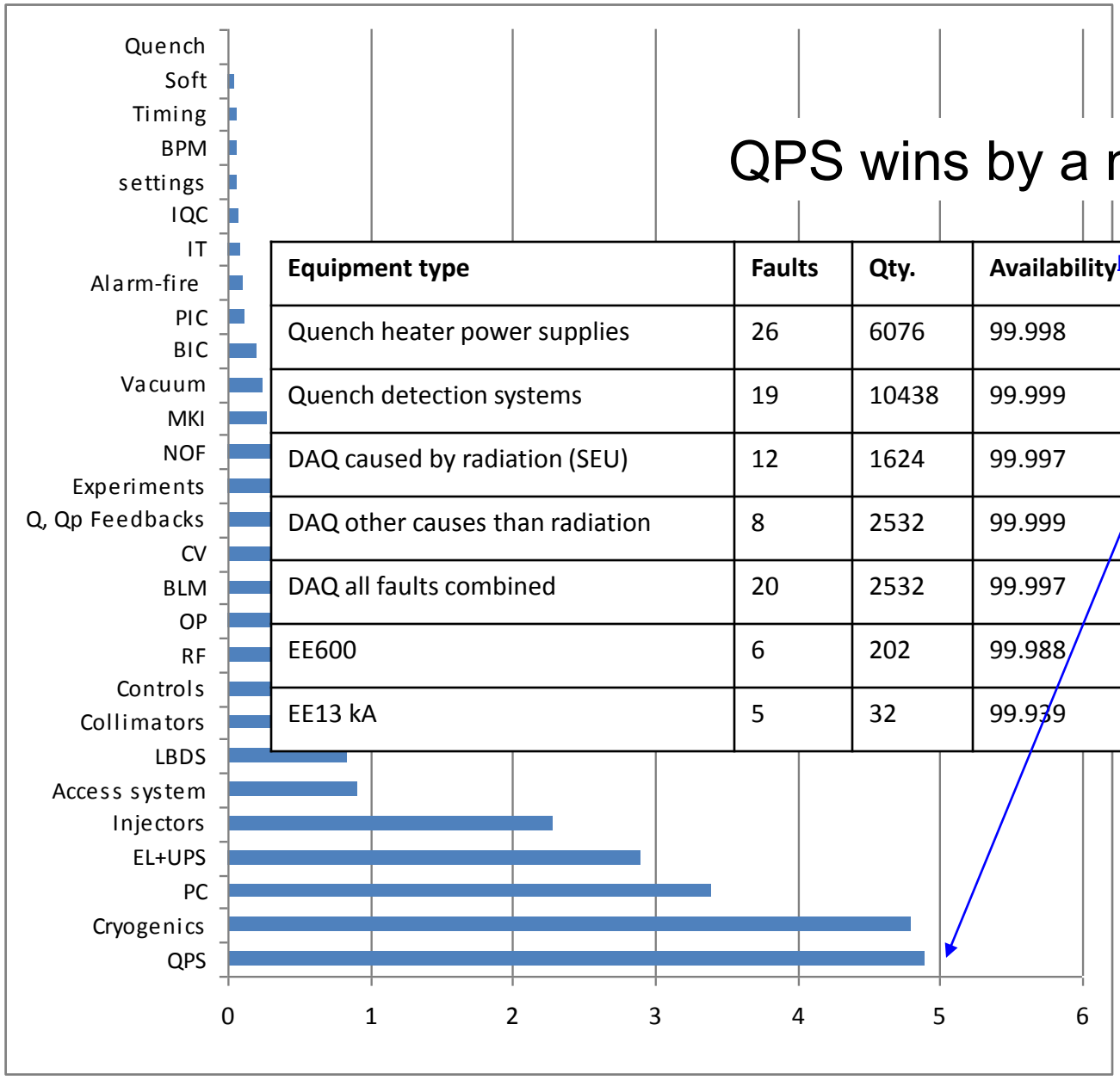
80% availability !



Heavy faults



All faults downtime distribution



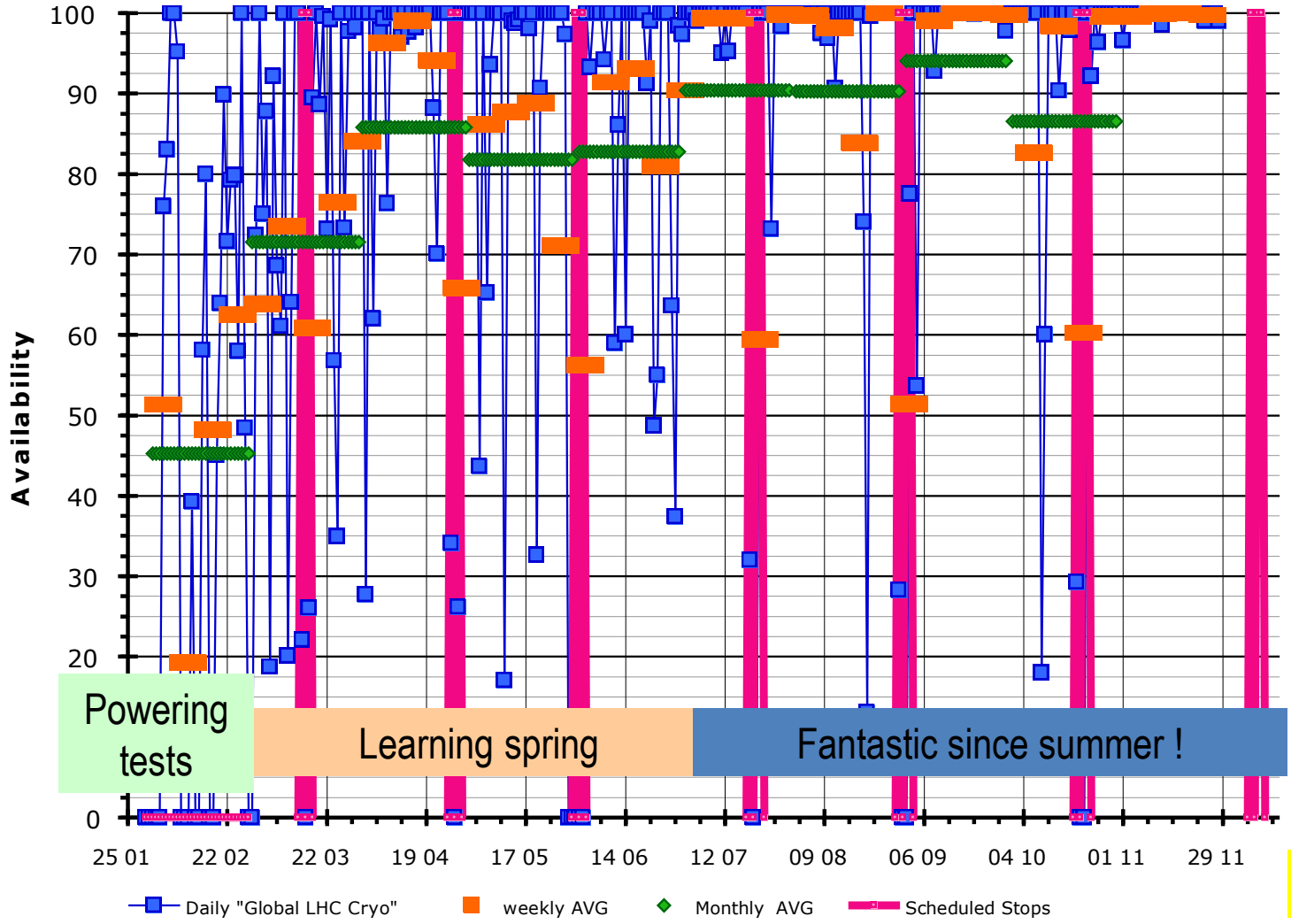
QPS wins by a neck…

Equipment type	Faults	Qty.	Availability[1] [%]	MTBF [hours]
Quench heater power supplies	26	6076	99.998	1145760
Quench detection systems	19	10438	99.999	3362135
DAQ caused by radiation (SEU)	12	1624	99.997	828240
DAQ other causes than radiation	8	2532	99.999	1936980
DAQ all faults combined	20	2532	99.997	774792
EE600	6	202	99.988	206040
EE13 kA	5	32	99.939	39168

R. Denz

Results for 2010 above expectations, thanks as well to periodic technical stops

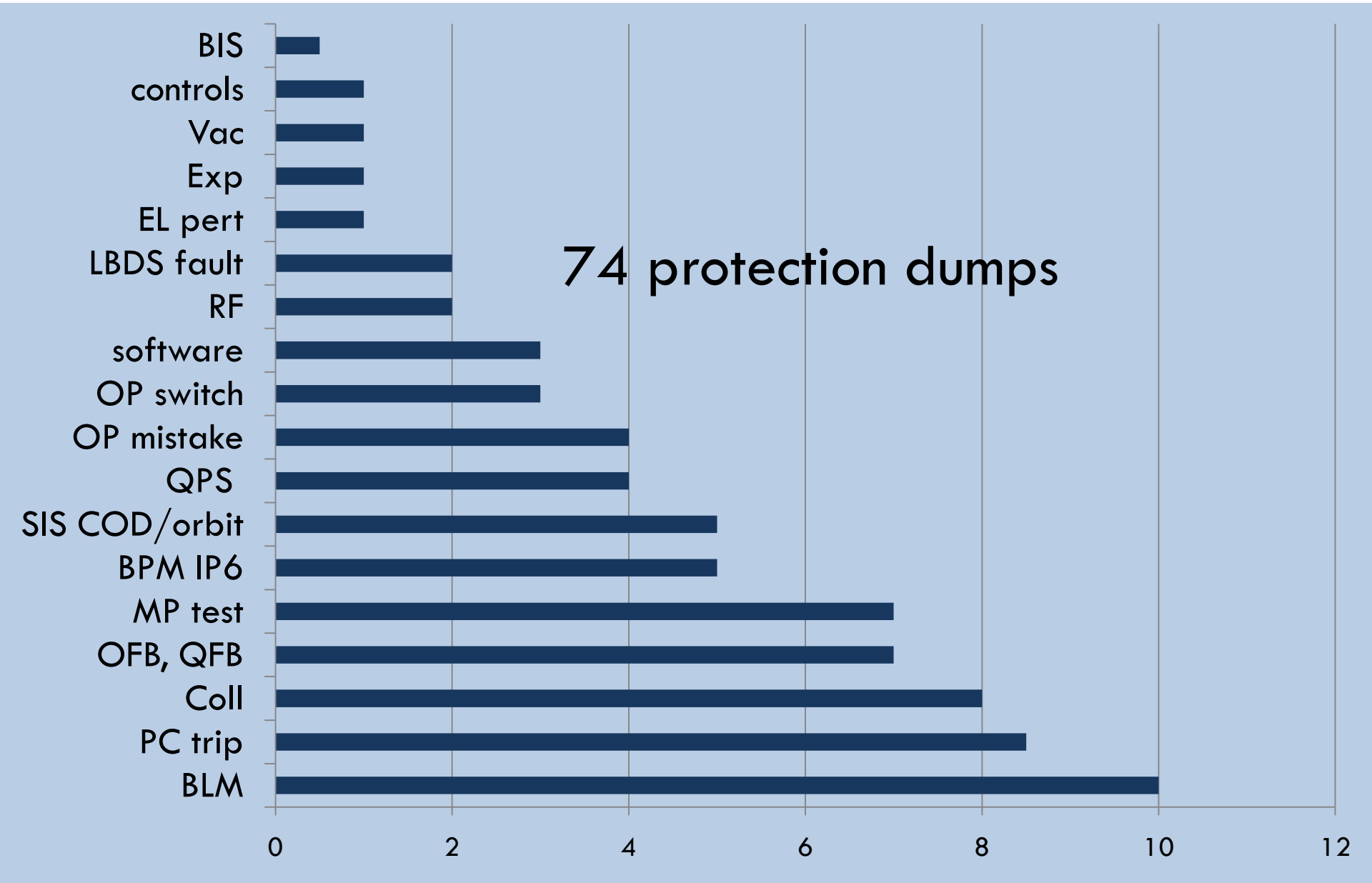
LHC Cryo global availability



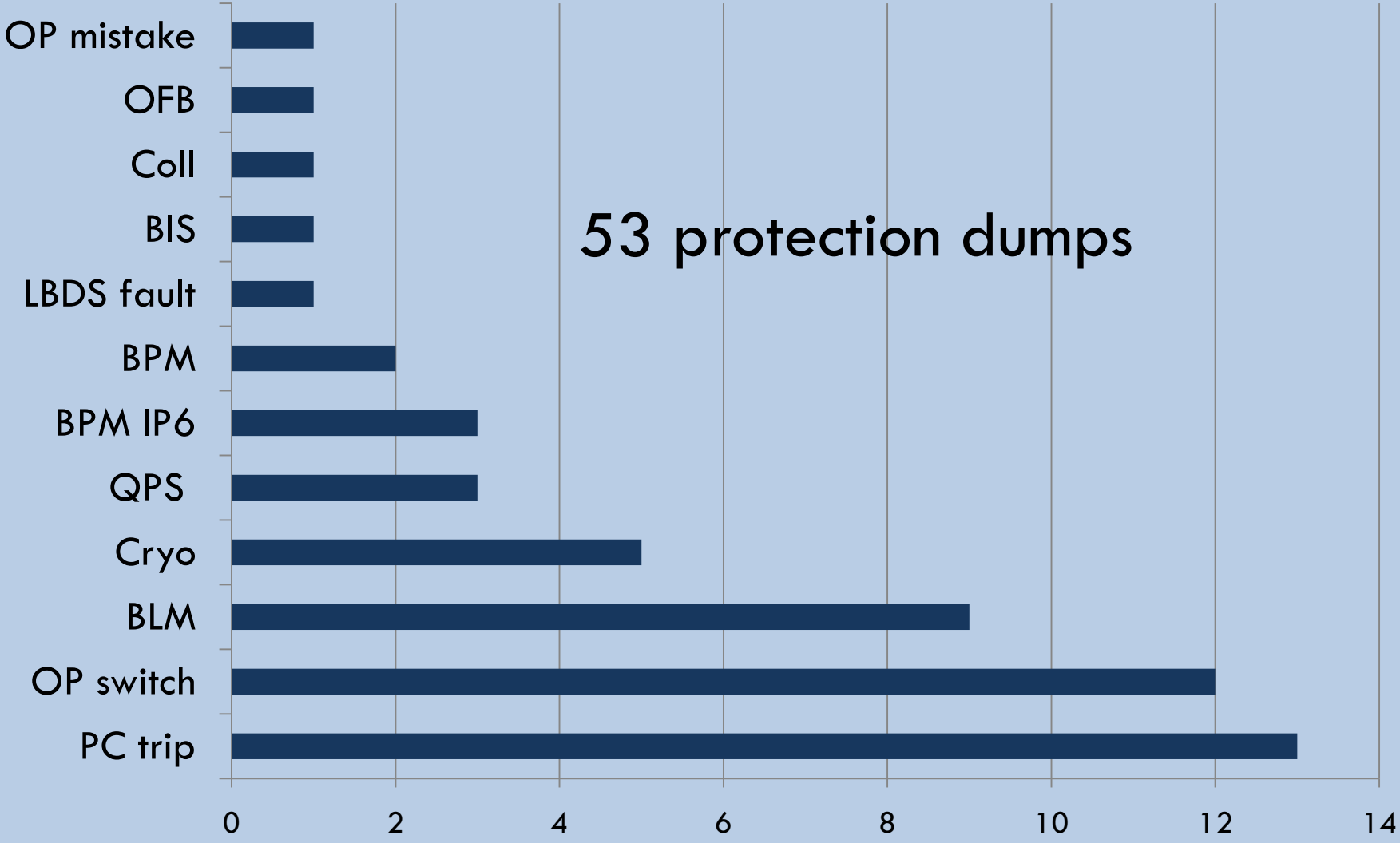
S. Claudet

Perturbations: clogging sub-atm circuits-CV891-instrumentation-Shaft seals-VFD/MB-24V

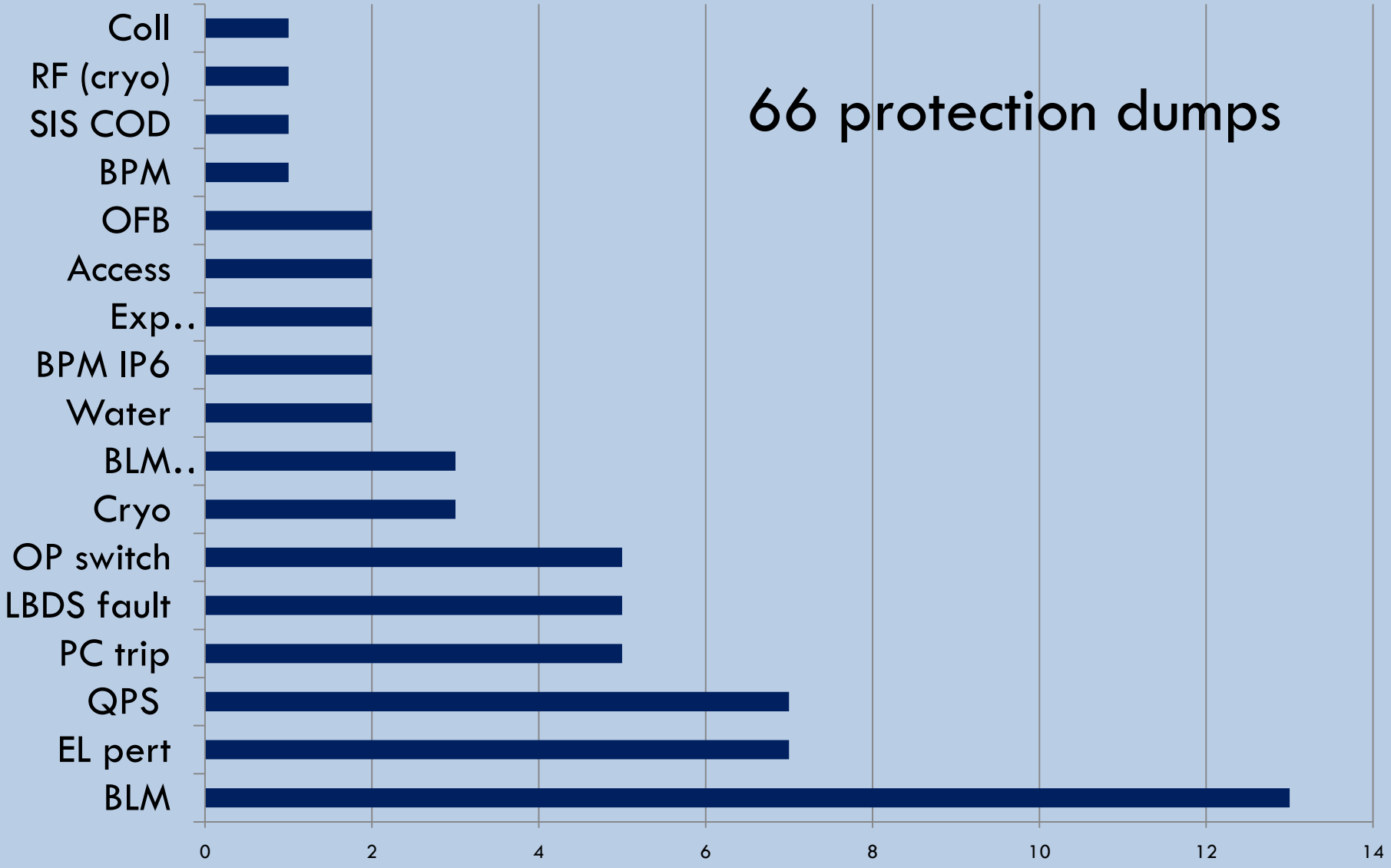
Dump statistics during ramp



Dump statistics during squeeze



Dump statistics: from stable beams

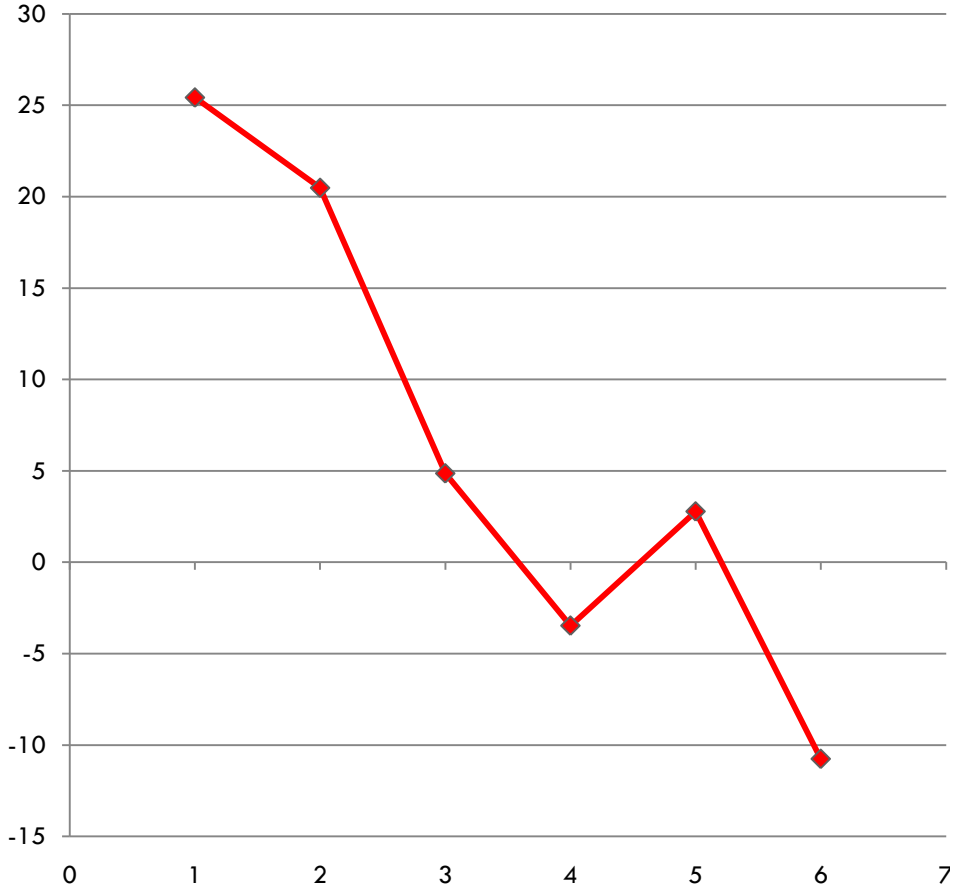


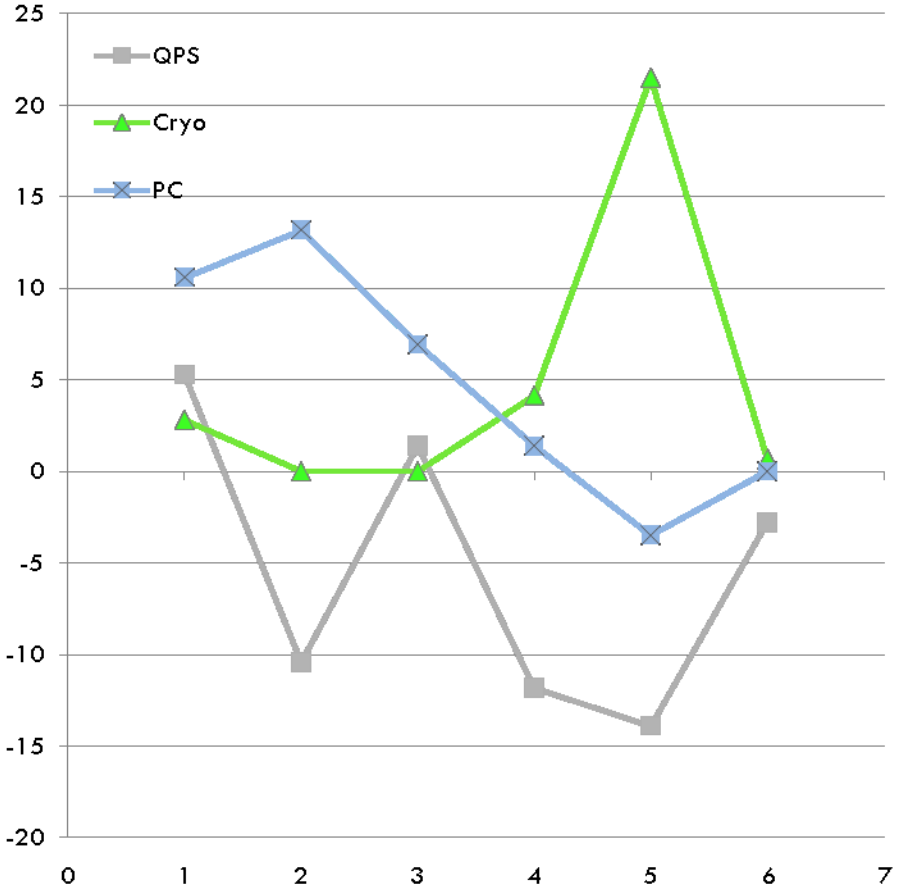
Technical Stops

- A total of 6 were done as scheduled
- First started on March 15
- Pattern: 4-36-3-31-4-45-5-37-4-45-4-40+
- Naive question: is the machine availability more or less after a TS ?
- Consider the 72 hours preceding and the 72 hours following a TS, and compare pies...
- Compare faults for the various systems

	BEAM (%)	STABLE Beams	Setup no beam	TS-HC	Access	FAULT (%)
before TS	**75.00**	0.00	13.89	8.33	6.94	**5.56**
after TS	**55.63**	0.00	14.79	0.00	8.45	**30.99**
DELTA	-19.37	0.00	0.90	-8.33	1.51	25.43
before TS	**70.14**	48.61	9.03	0.00	11.11	**22.22**
after TS	**49.65**	0.00	11.81	0.00	24.31	**42.71**
DELTA	-20.49	-48.61	2.78	0.00	13.19	20.49
before TS	**61.81**	1.39	9.03	0.00	6.94	**29.86**
after TS	**51.39**	5.56	15.28	0.00	5.56	**34.72**
DELTA	-10.42	4.17	6.25	0.00	-1.39	4.86
before TS	**63.19**	28.47	5.56	0.00	5.56	**31.94**
after TS	**45.14**	0.00	27.78	0.00	11.11	**28.47**
DELTA	-18.06	-28.47	22.22	0.00	5.56	-3.47
before TS	**64.58**	39.58	8.33	0.69	22.22	**29.17**
after TS	**54.86**	0.00	14.58	0.00	0.00	**31.94**
DELTA	-9.72	-39.58	6.25	-0.69	-22.22	2.78
before TS	**67.71**	15.28	20.14	0.00	2.78	**14.93**
after TS	**80.56**	29.86	16.67	0.00	0.00	**4.17**
DELTA	12.85	14.58	-3.47	0.00	-2.78	-10.76

Trends of “TS messing up” effect…





Tools

- Logbooks to get the fault attributions
- Measurement and Logging DB: a lot of information, JAVA API available to do specific searches, already used by some people (C. Roderick)
- Web-based Post Mortem Data Extraction (M. Zerlauth)

For next year: try at least to copy SPS: automatic entries in the logbook when there is a fault, for LHC it is more difficult, one has to take into account machine modes, etc. (more in Oliver's talk). Also we need to agree on conventions.

Several people are working to applications for the Fill statistics (e.g. SUPERTABLE, and others), using the same API used by TIMBER

Wrap up

- Machine availability for the run: 65%
- Faults: 25% (TS 10%)
- Beam presence: 56%, setup no beam: 9%
- Stable beams: 15.7 % (e_1)
- e_2=Physics/Available: 23.7%
- For most of the 2010 run, e_2 is not a good indicator of operational efficiency, as it rejects all the beam commissioning time
- Last two weeks of August: $e_2 \sim 50\%$.
- Max $e_2 = 83$ % (with 10.6 hs fill time and minimum turnaround)
  - With 65% machine availability and only trying to do phyics:

  Max $e_1 = 54\%$, or 32% if we had the same efficiency as in August

Conclusions

- 2010 run was driven by commissioning, not physics
- Machine Availability was satisfactory and steadily increasing
- Equipment performs above expectations (MTBF etc)
- Equipment groups are aware of the weak points and are working to improve them
- Less mixing of Physics and beam commissioning in 2011
- TS to be reviewed for 2011, can probably be less frequent
- More tools for statistics to be developed, also with discussions with equipment groups
- Margin to improve operational efficiency (→ see Stefano' talk)