How can we reduce the “no beam„ time?

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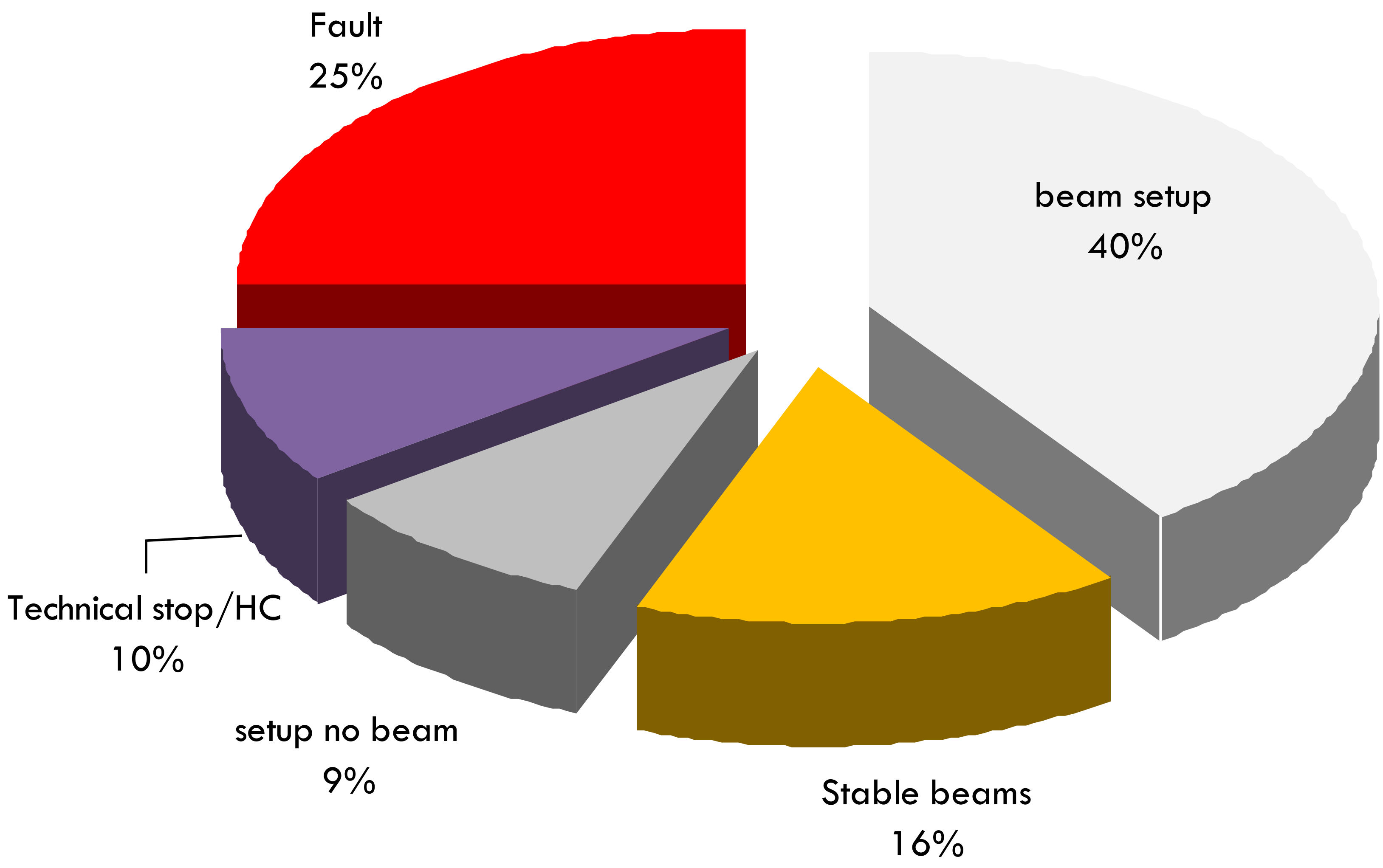
LHC Performance Workshop – Chamonix 2011

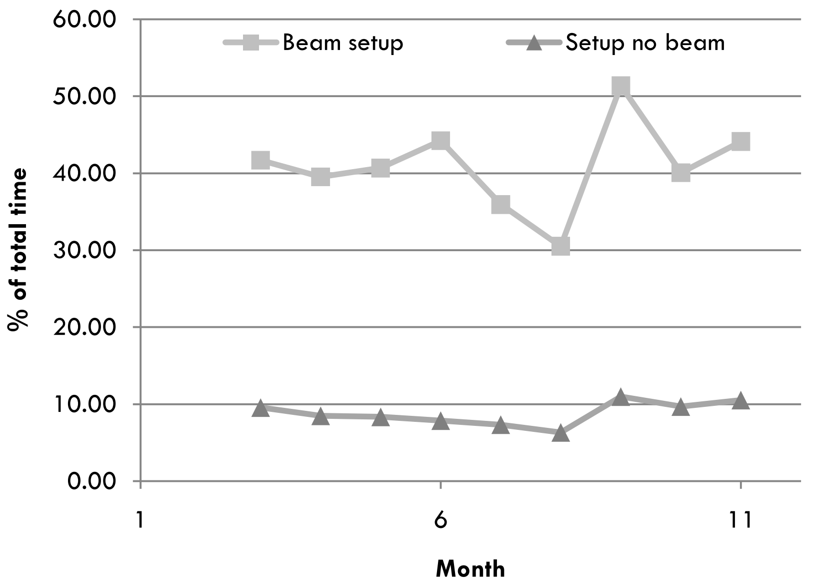
Outline

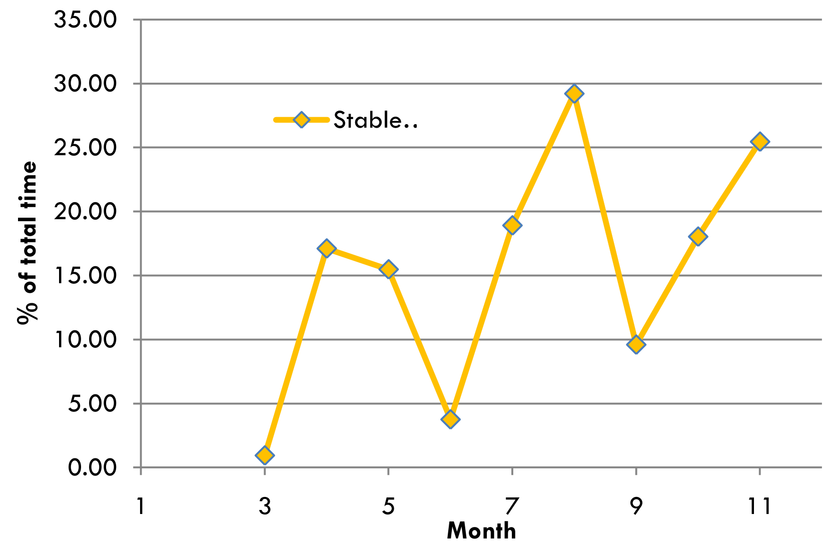
- Beam statistics for the 2010 run, H factor
- How to reduce the no beam time:
  - Faults statistics of top 4 systems (mitigation actions)
  - Review of technical stops
  - Possible gains in setup time without beam

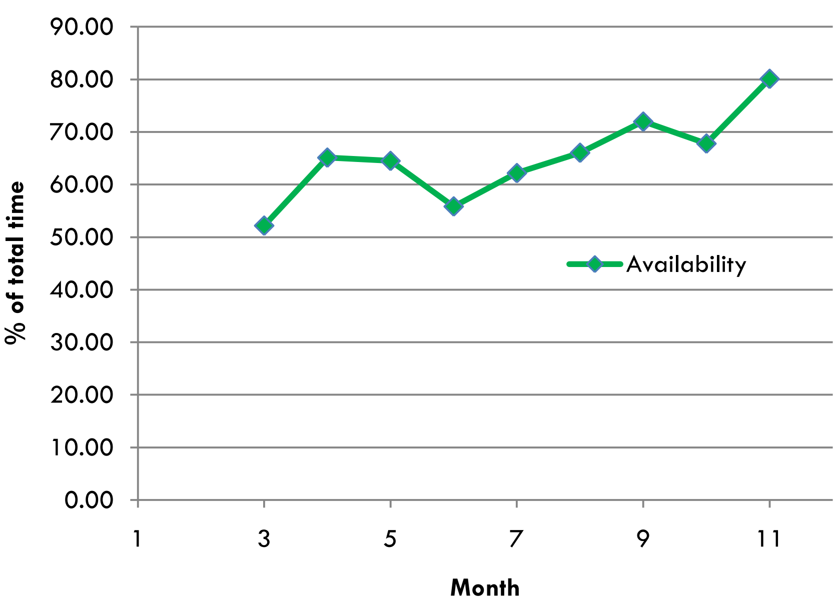
Machine statistics 2010

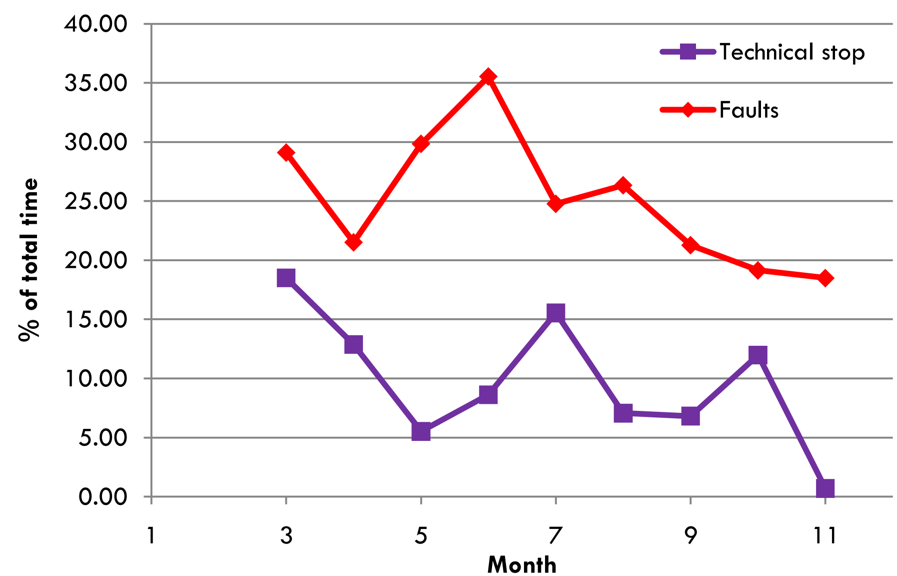


Machine statistics along the run



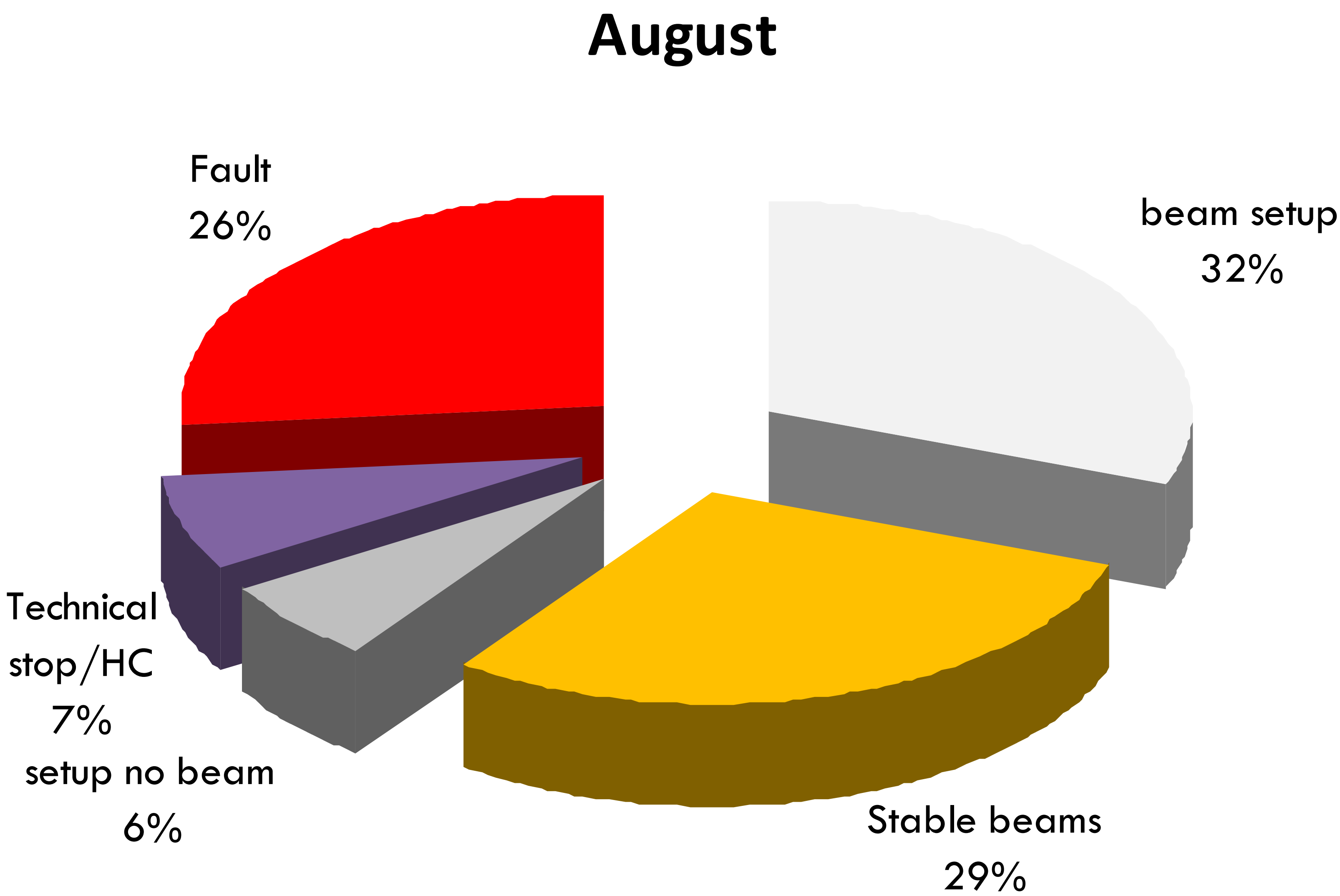




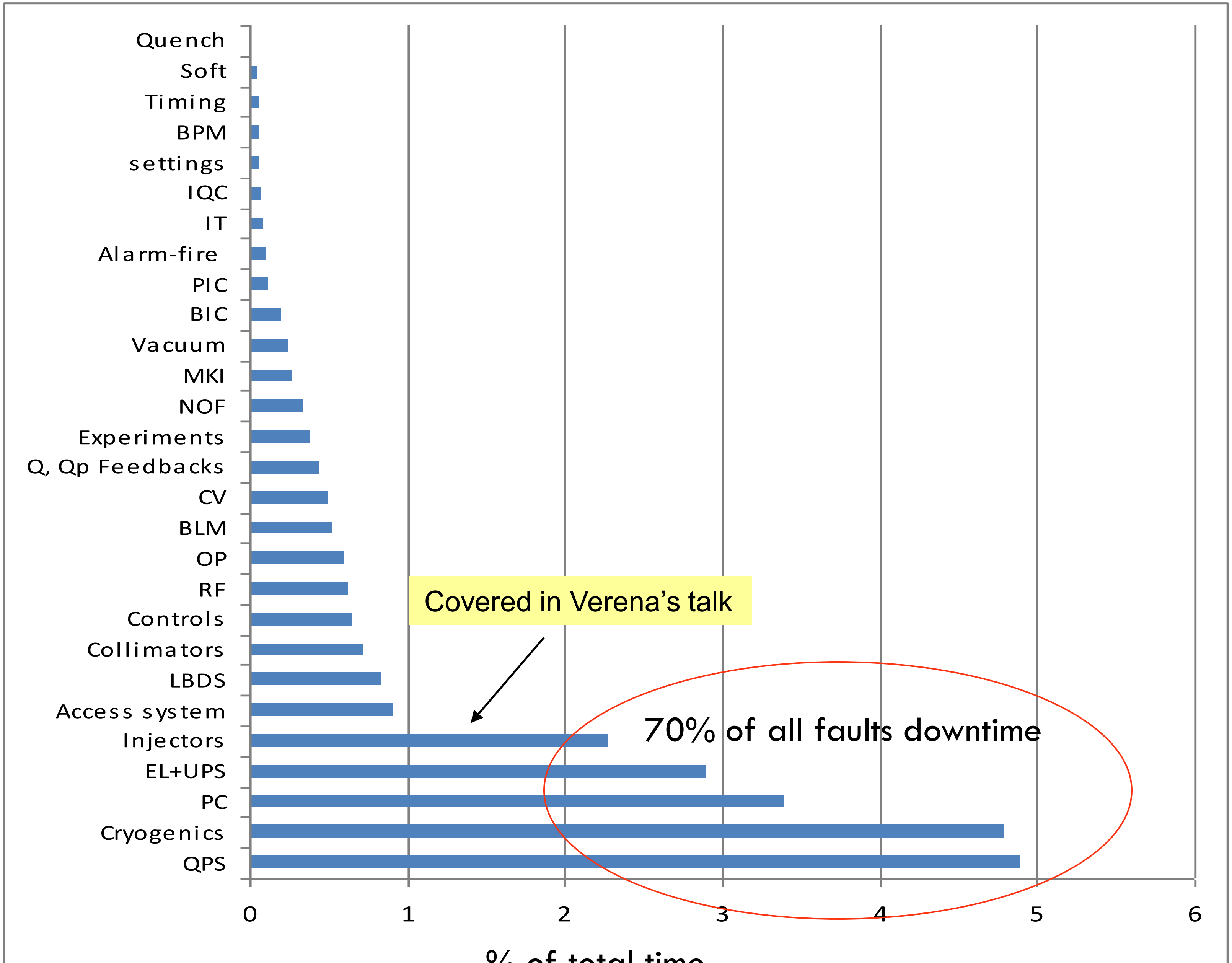


physics oriented operation

$0.2 < H < 0.3$



Faults downtime distribution



QPS detailed statistics and mitigation actions

Equipment type	Faults	Qty.	Availability [%]	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

Equipment type	Mitigation
Quench heater power supplies	Replacement of faulty switches (1000), additional software interlocks allowing to power supplies and op
Quench detection systems	rease EMC immunity re-cabling of current
DAQ caused by radiation (SEU)	

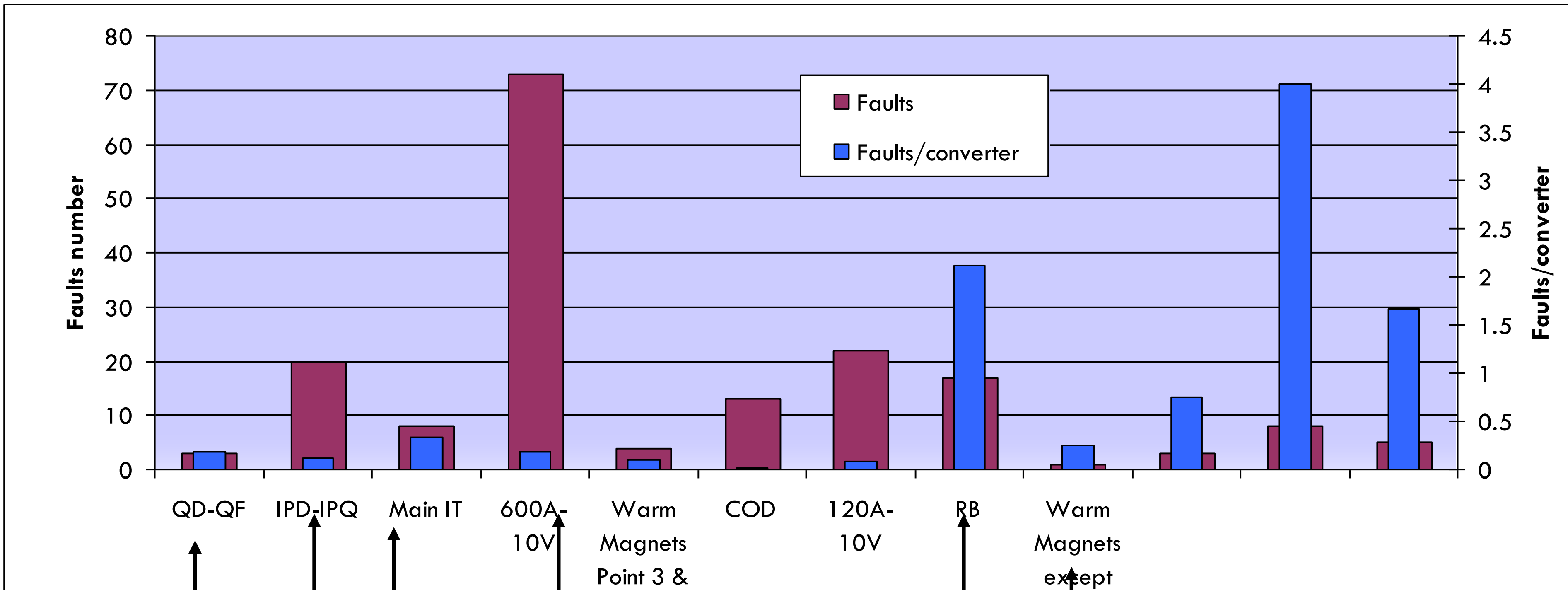
R .Denz

Cryogenics downtime and perspectives (S. Claudet)

Major causes in 2010	Forecasts 2011
Cold Compressors (bearings, drives) Consolidation done at Xmas, and new diagnostics	Less failures (1 or 2)
Sub-atm filter clogging: Last leaks (P4) identified at Xmas and treated	No perturbations (possible surprise at Beg. of the run)
Valves for flow control of current leads: 50% of valves changed with new type (flex bearings)	Almost no failure, existing mitigation program continued
Instrumentation: Fuses, old FPGA cards, non-conformity treated at Xmas	Less failures (max. 10?)
24V power supply units: Checks done all sites, long term repair under investigation	Few failures (1 or 2)
	+ 2-5 failures due to minimal preventive maintenance

PC detailed statistics and mitigation actions

Detailed analysis fault statistics of power supplies in EDMS 1109277



Spurious faults due to bad contact during the first part of 2010

3x ERD fuse blown without any problem observed on the converters (no explanation YET)

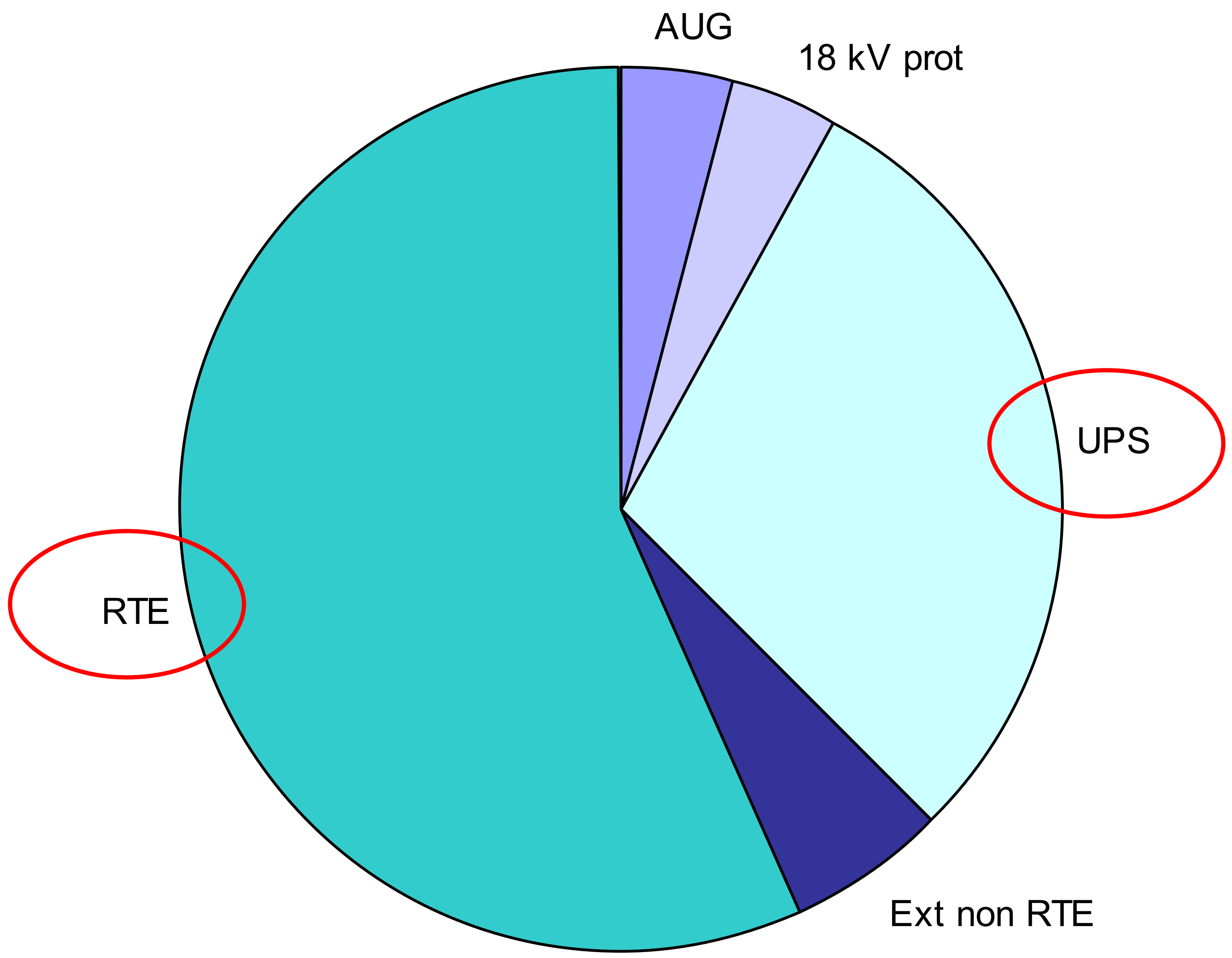
l, sensitive to Electrical perturbations

: Expertise on going on the transformer,

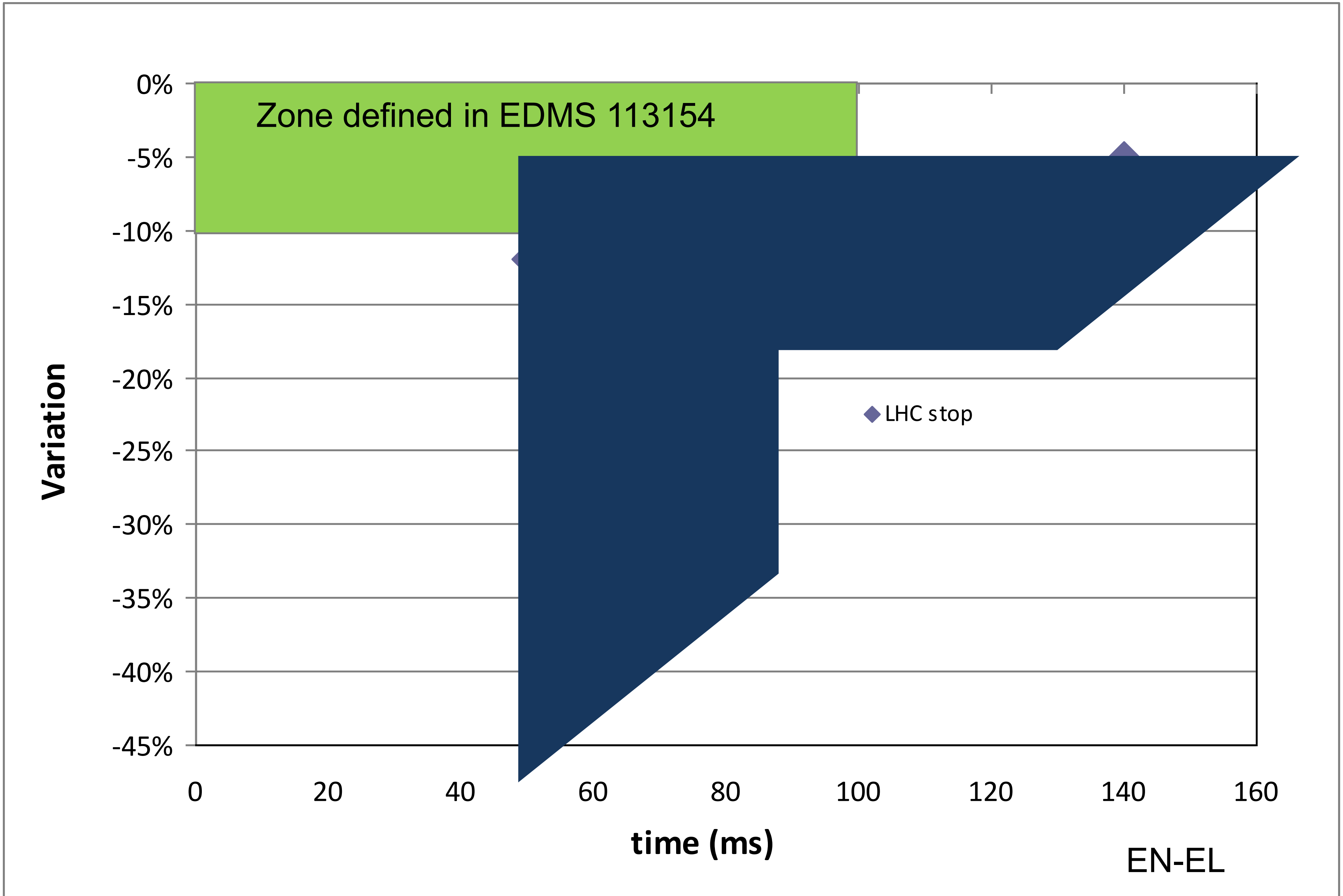
OVER RIPPLE fault threshold revisited

Converter Number	4	16	8	8	92	32	8	36	751	287	143	248	8	37	8	4	4	2	3	2	3
MTBF Global (h)	7248	28992	14496	6443	83352	21085	6443	52186	[illegible]	90442	41459	30991	19328	53635	2071	2899	4142	805	3106	100000	100000
MTBF w/o Ext & Operation (h)	7248	28992	100000	19328	95259	23194	9664	52186	[illegible]	90442	41459	35950	100000	53635	3221	100000	7248	1611	3624	100000	100000

EL-UPS (LHC downtime)

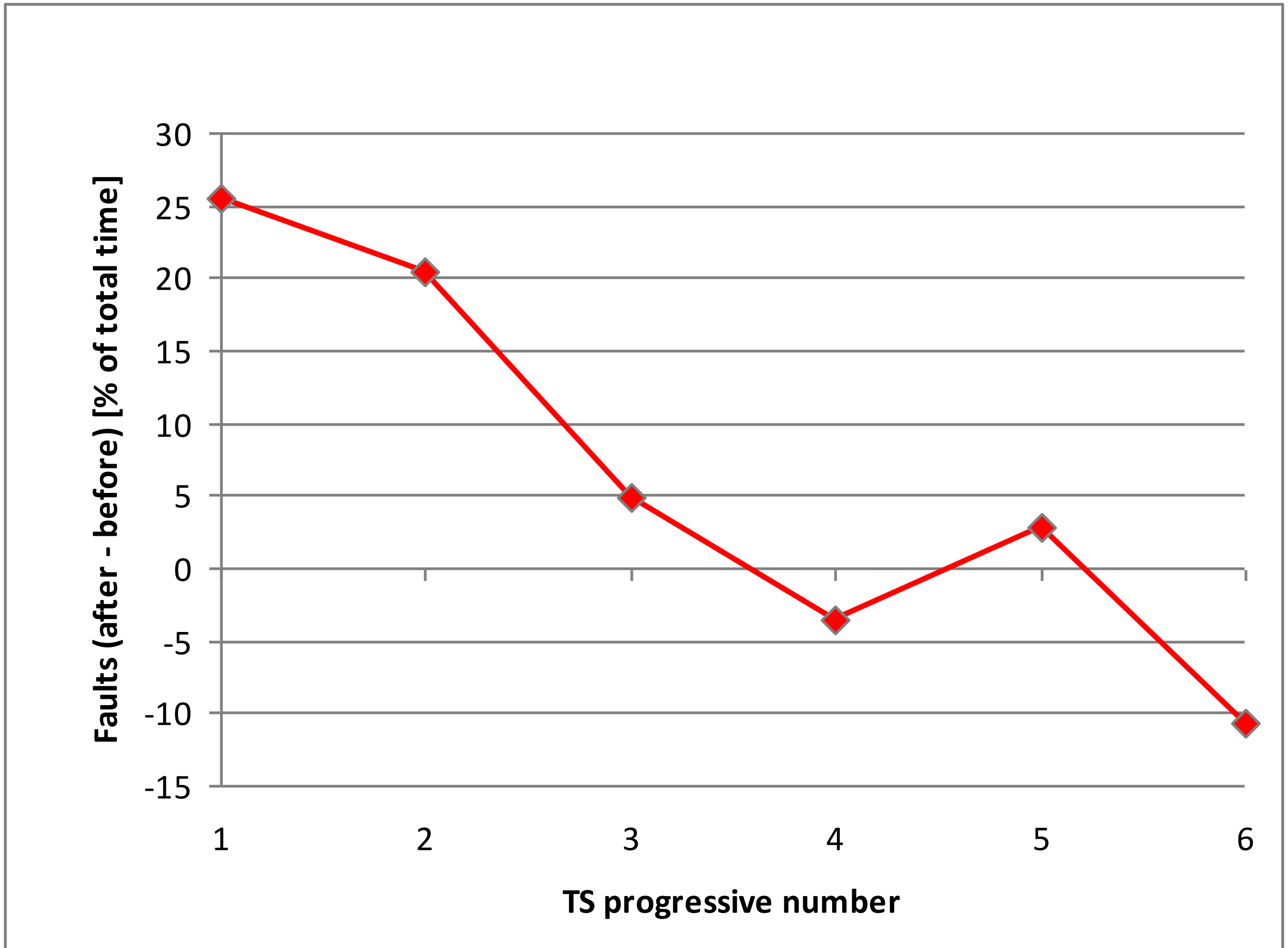


Electrical network perturbations



Technical Stops

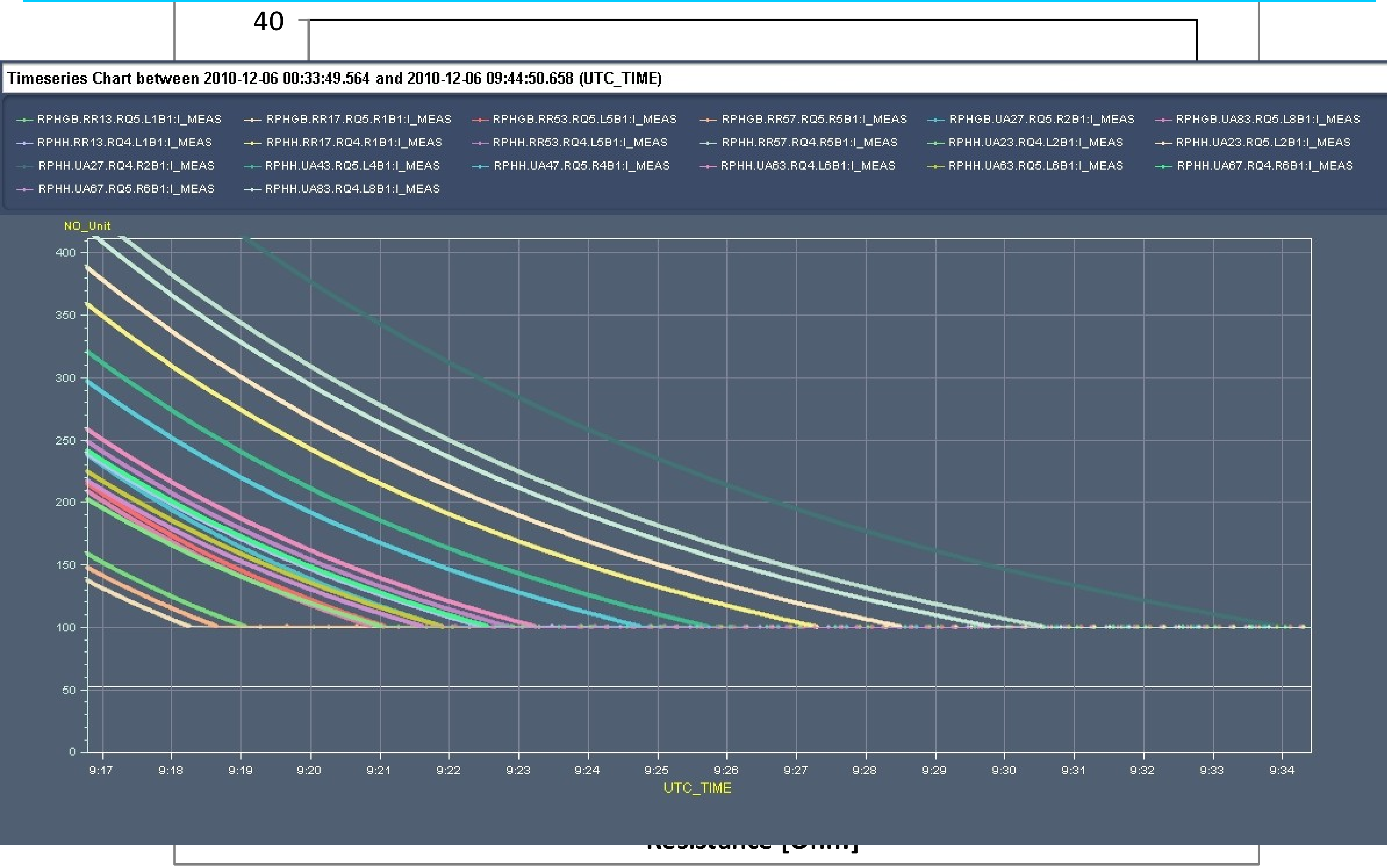
- In 2010 we had **6**, as scheduled, starting on March 15
- Pattern: 4-36-3-31-4-45-5-37-4-45-4-40+
- After TS, an increment in faults was observed. Effect is decreasing along the run



Expressed needs for TS in 2011

- Cryo: “3 TS equally spaced, 4 days each”
- QPS: “at least two, first one not too late. 4 days too short”
- EPC: “none, see how it goes with 60A”
- EL: “frequency is not important, but 4 days too short. Can reduce during the run but must recuperate during the Xmas break”
- CV: same as EL
- Experiments?
- …

Setup without beam: Q4 ramp down time is the bottleneck, due to converter topology and warm cables resistances

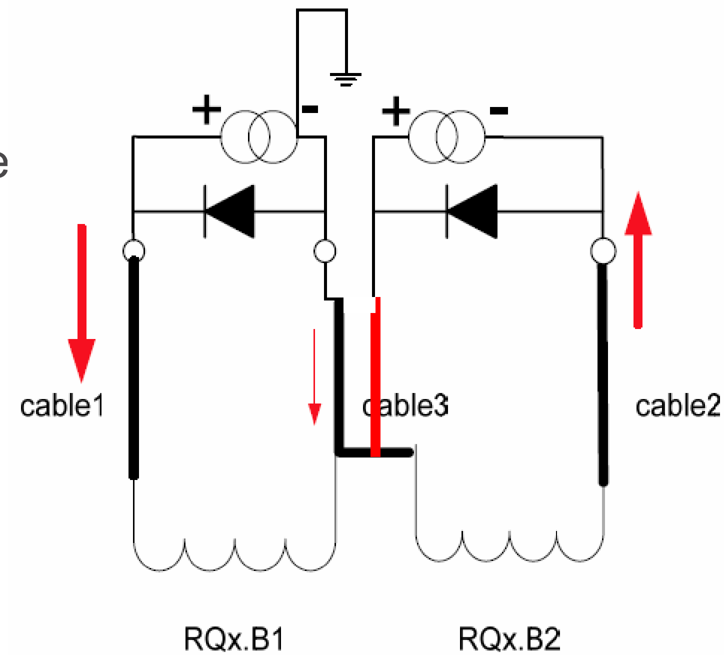


How to ramp down faster

1) Ramp down "open loop" (less precision on current with no beam)
   IT becomes the bottleneck →IT min time from 3.5 TeV to I min op ~ 25 minutes (H. Thiesen)

2) Add an extra cable on the mid lead:
allows faster ramp down with beam (squeeze
(already studied for TOTEM high β* optics)

D. Nisbet at LMC 10



Would bring advantages in controllability,
optics flexibility (and gain time when squeezing to low β*)

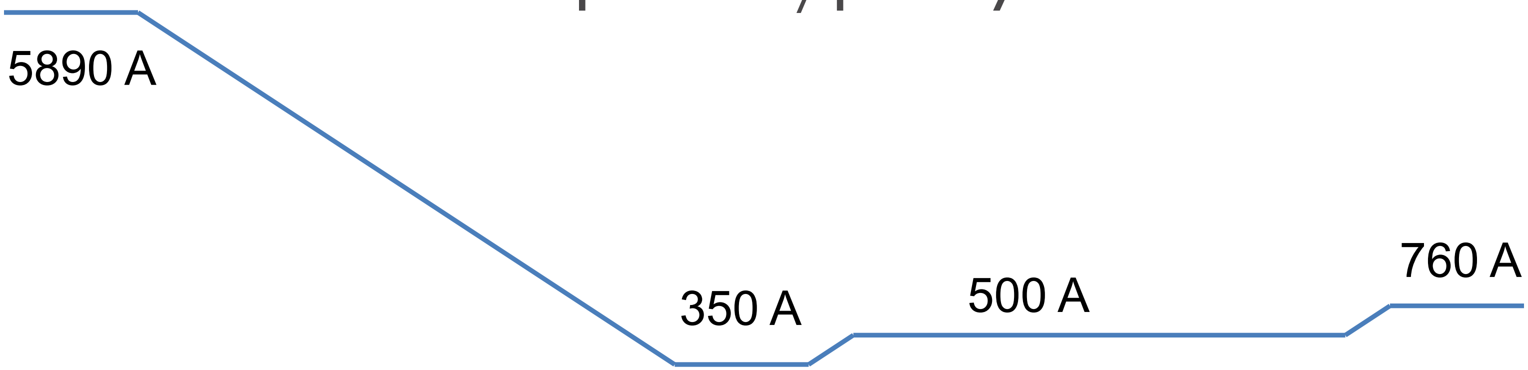
IT warm cables section "over sized", reducing it could gain ~30% in time constant while keeping reasonable margin

Hardware changes not possible before next long shutdown

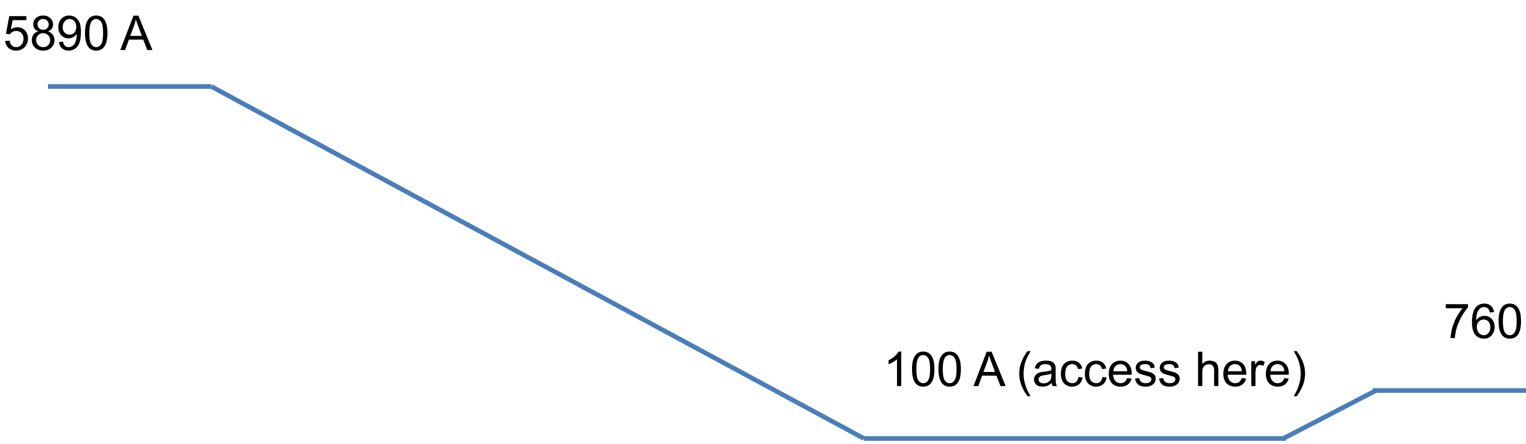
Access recovery

Today: need to pre cycle after access, as the main magnets are put off.
A new procedure (under approval) proposes to leave them at 100 A

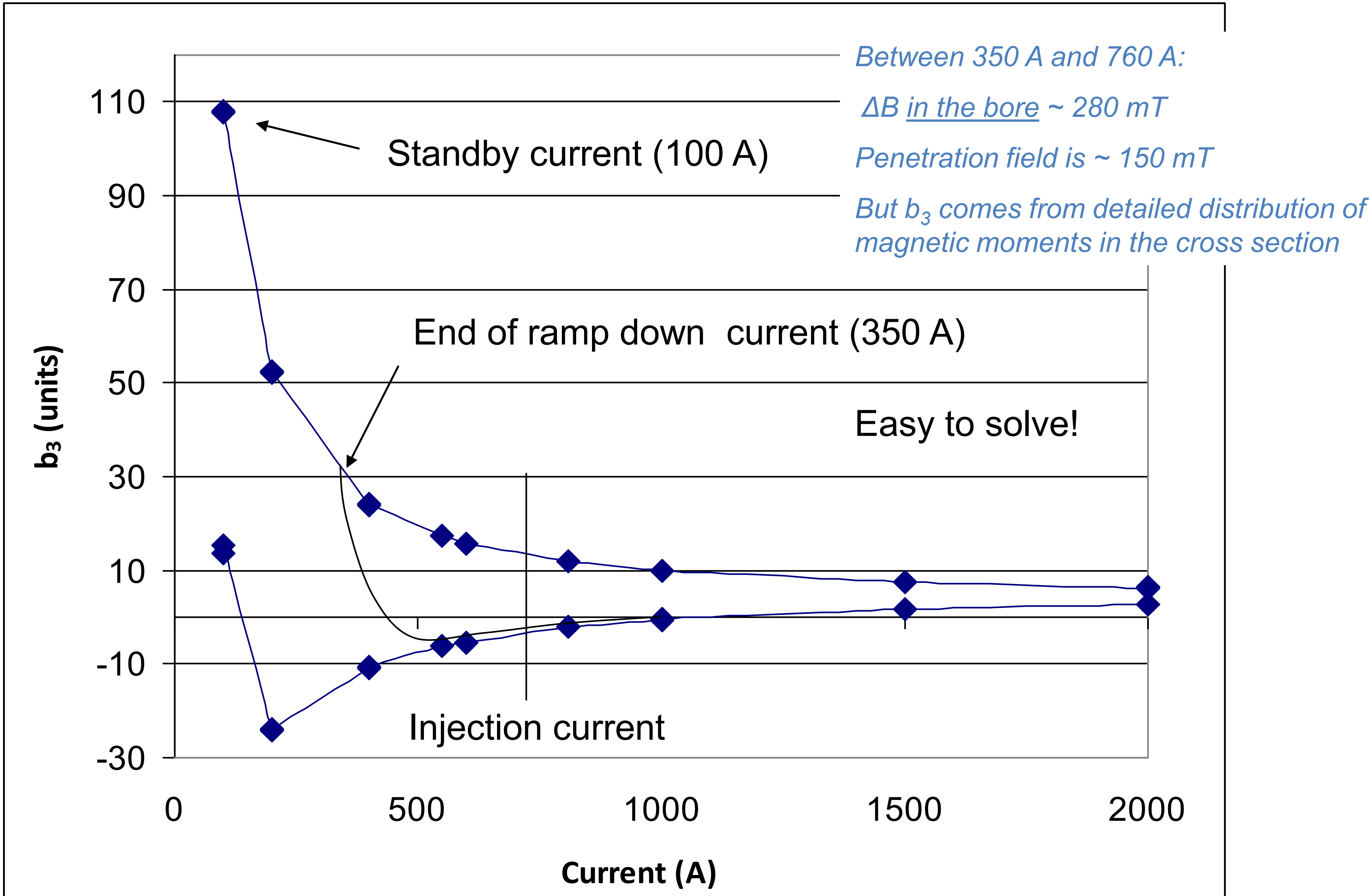
- Normal Ramp down/pre cycle



- Proposed Ramp down for short access *(EDMS 1076139)*



Magnetically almost equivalent, small effect on static b_3 (Q')



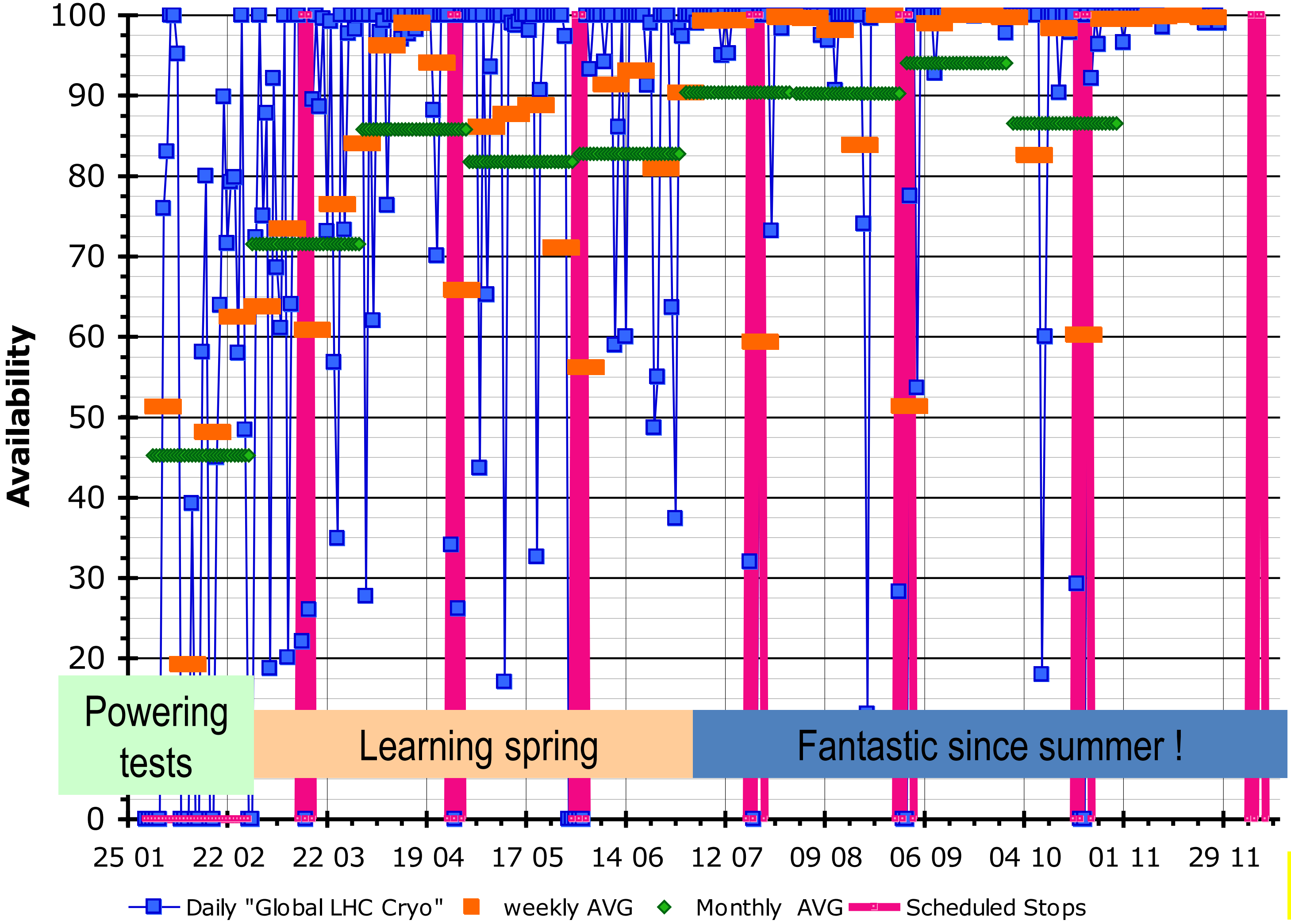
Conclusions: how can we reduce....

- Reduce fault numbers: mitigation QPS, Cryo, PC
- Review frequency and duration of TS
- Faster turnaround:
  - IPQs, IT: gain 10 mins with no hardware changes
  - Hw changes (with gains for squeeze duration and optics flexibility) possible during long shutdown
- No pre cycle after short access (needs approval of new prodedure)

Backup slides

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

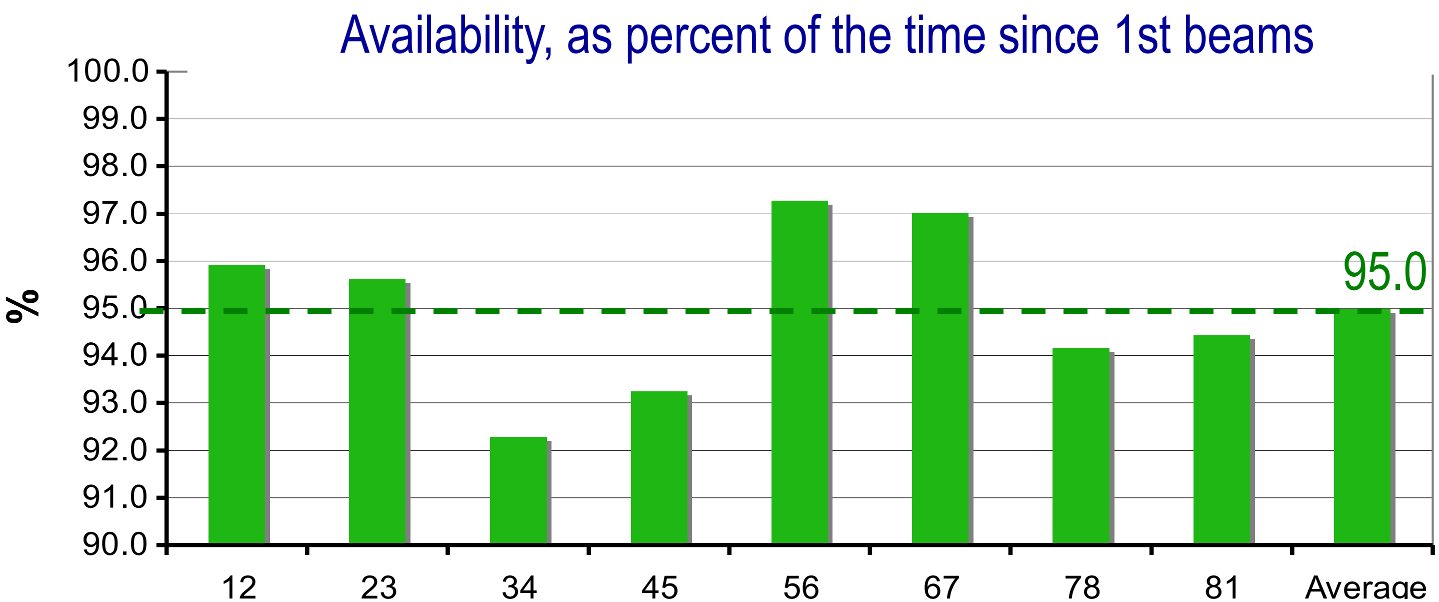
LHC Cryo global availability



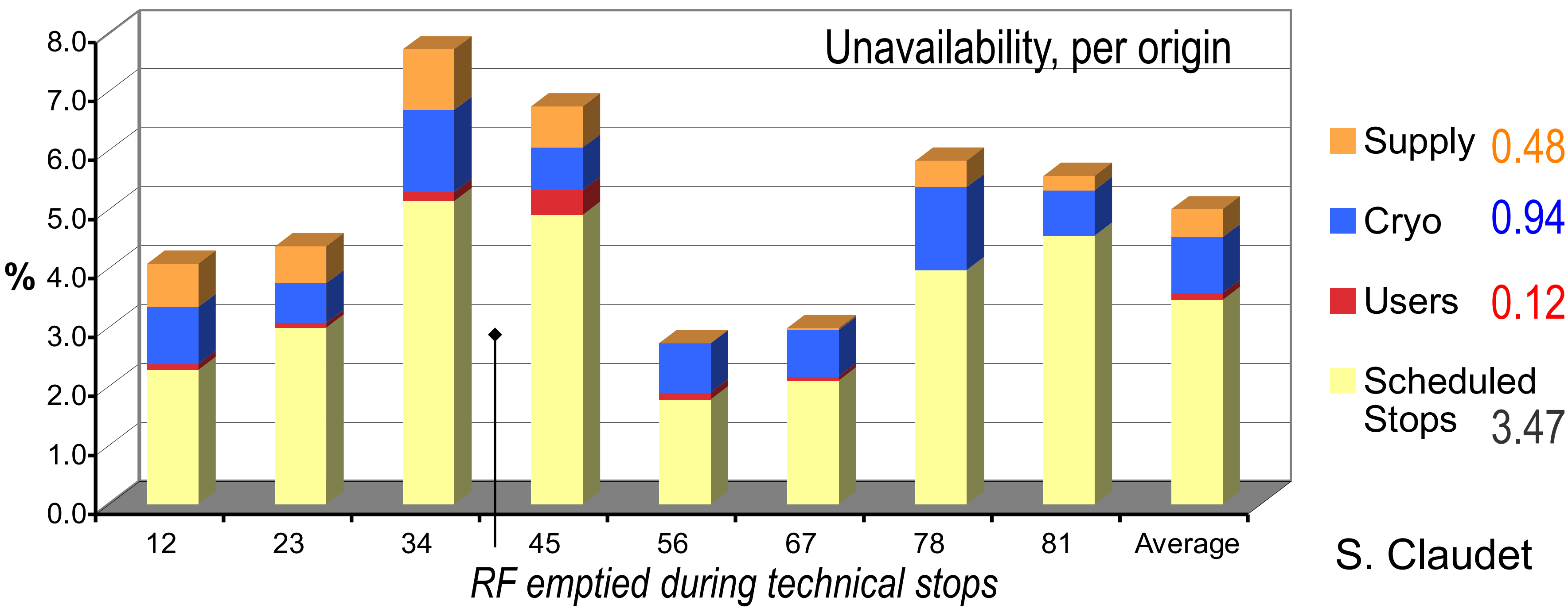
S. Claudet

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

Cryogenics detailed statistics

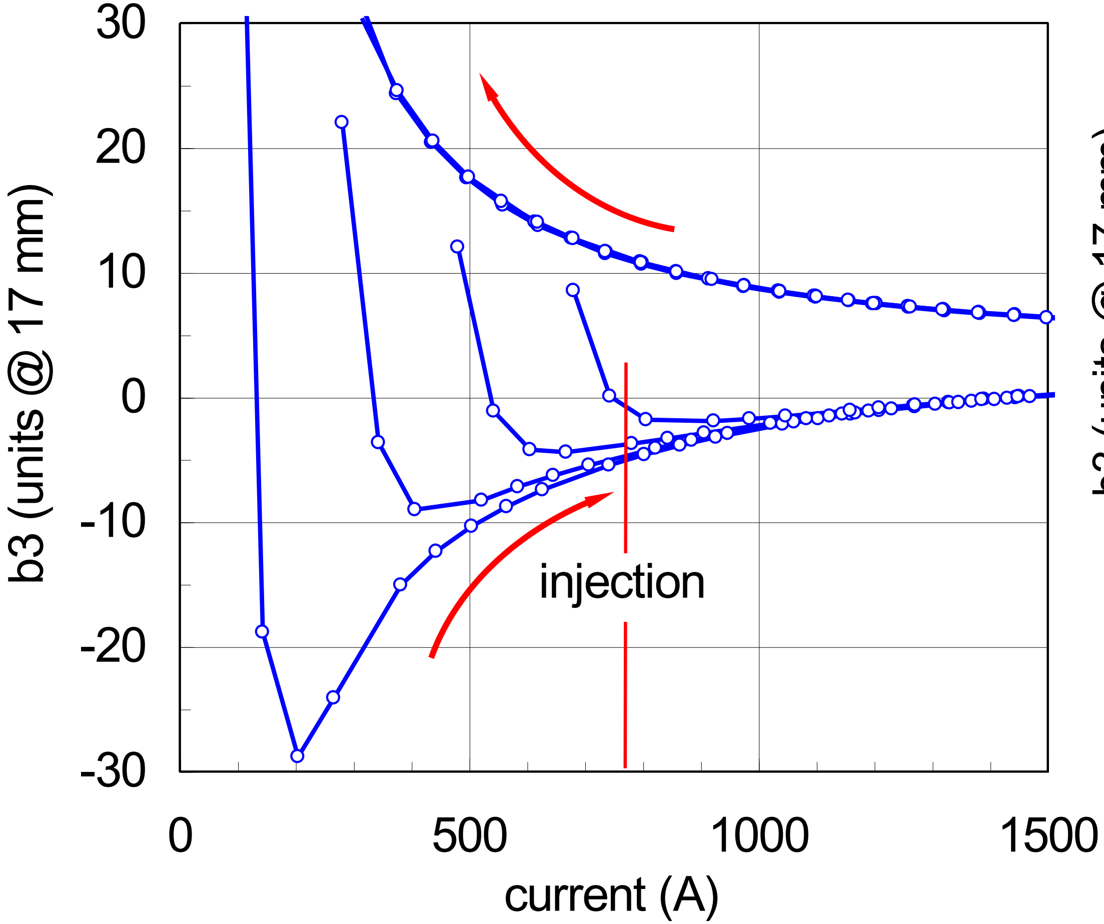


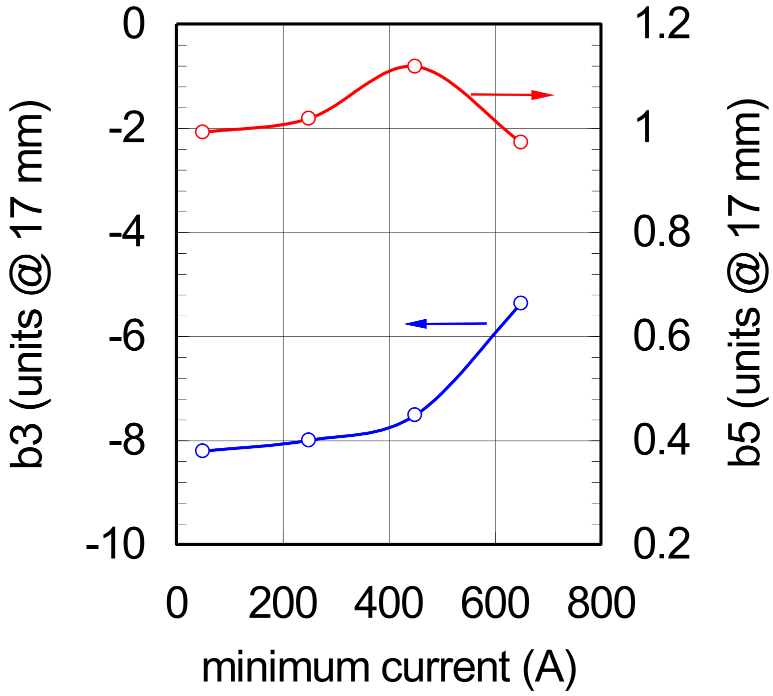
No visible impact of "1 Ref. for 2 sectors"



S. Claudet

Measurement in MBP2O1 - Aperture 1





L. Bottura