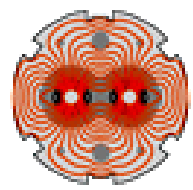


RELIABILITY OF 600 A ENERGY EXTRACTION SYSTEMS

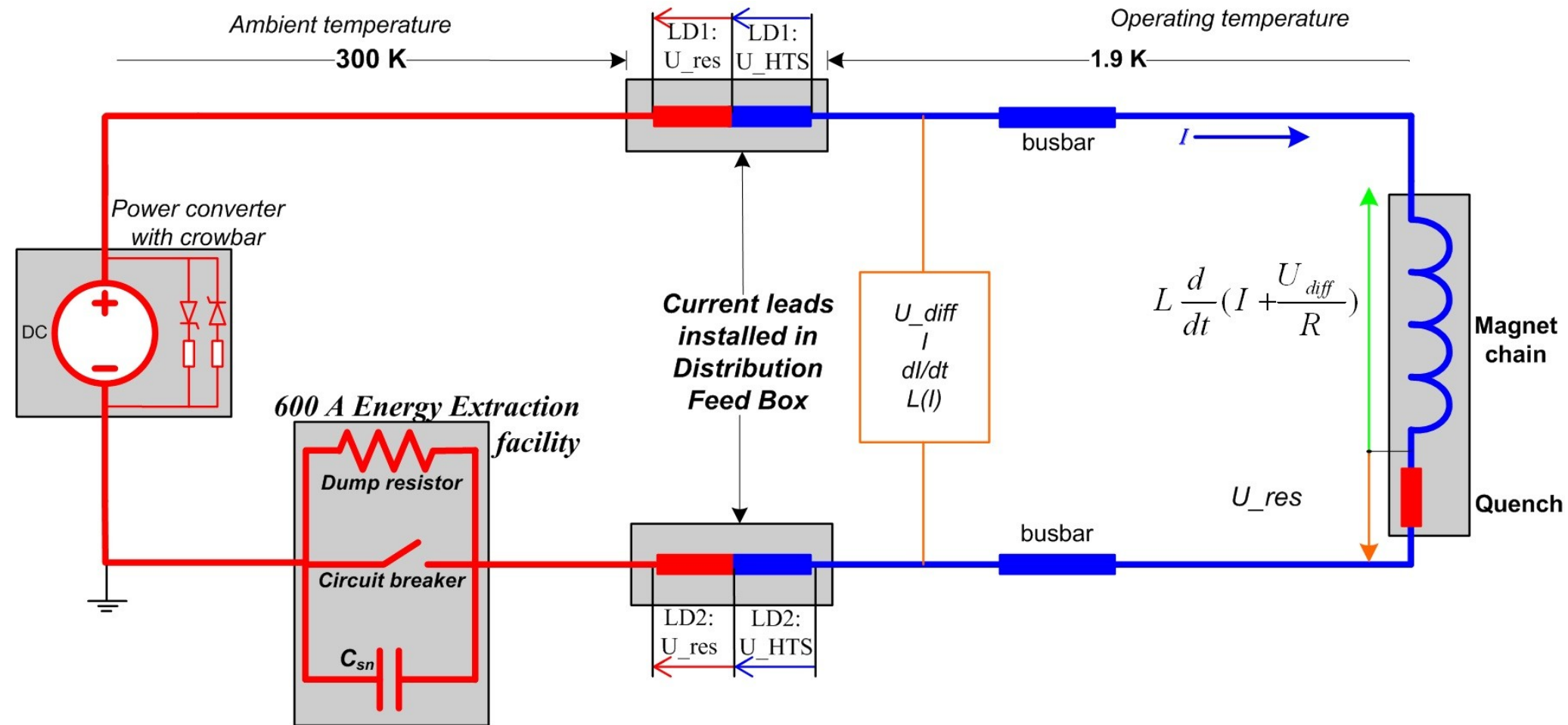
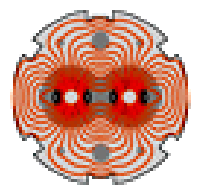
MPE work shop – December 14, 2010
G.J. Coelingh TE-MPE-CP



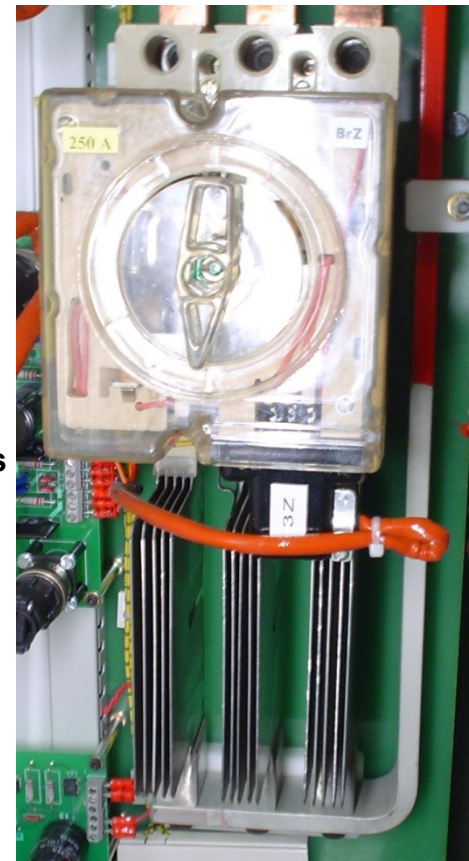
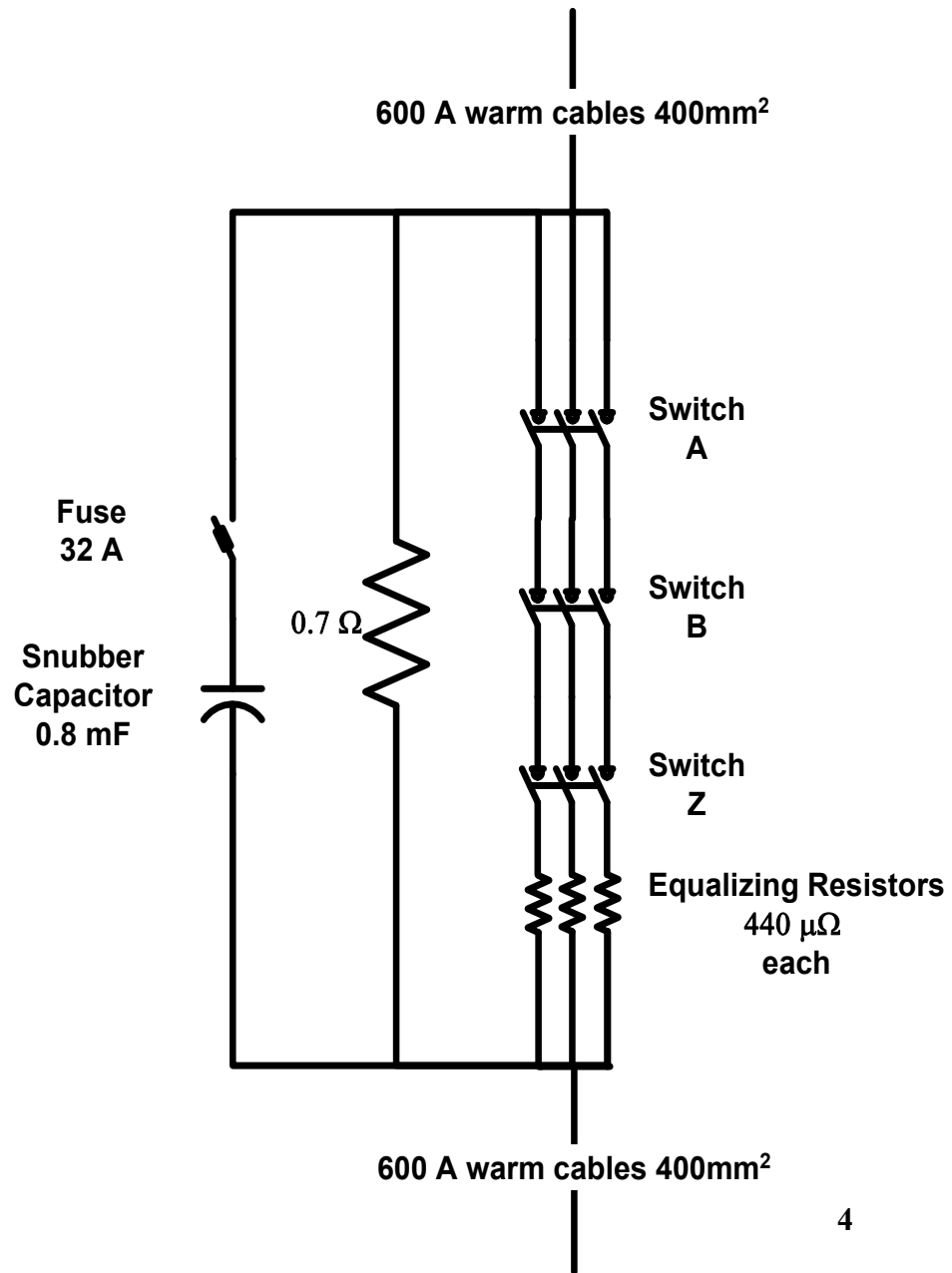
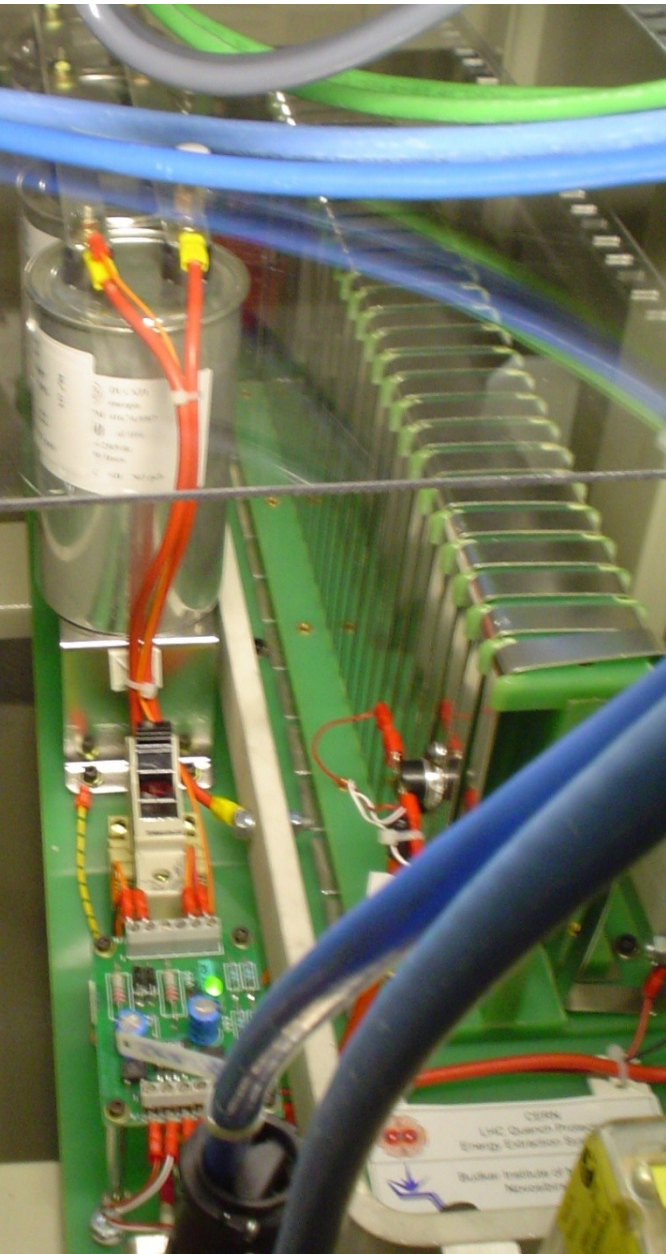
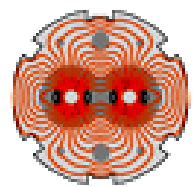
Overview

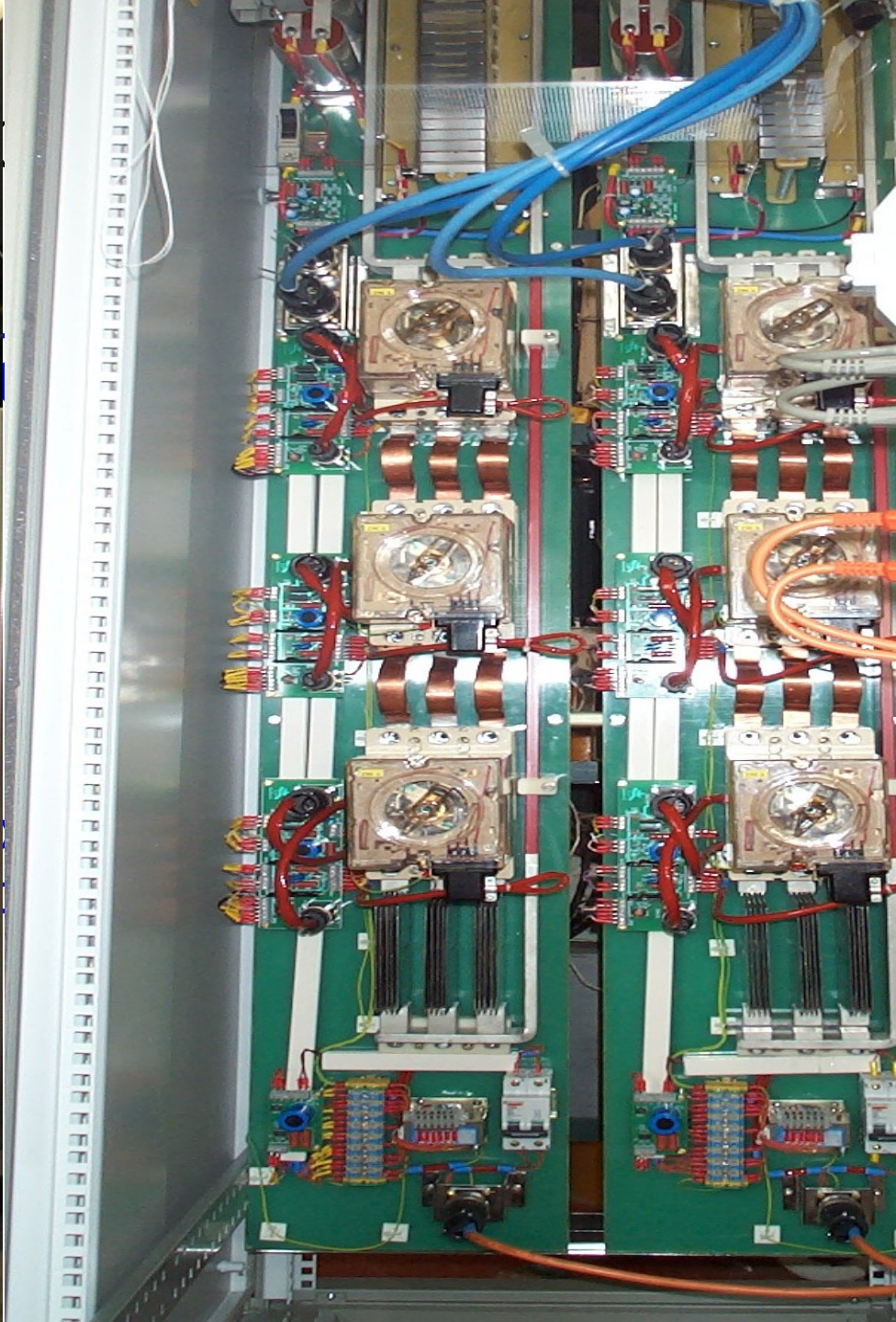
- ◆ 600 A EE; what, where, how ?
- ◆ Reliability
 - Operational reliability – protection point of view
 - Overall reliability – hardware failures point of view
- ◆ Availability and Mean Time Between Failure – MTBF
- ◆ Future
- ◆ Improvements - manpower

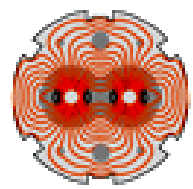
Energy Extraction 600 A EE



600 A Energy Extraction Facility

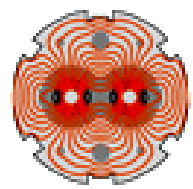






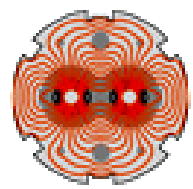
Reliability

- ◆ Systems reliability from protection point of view:
 - No failures during Fast Power Abort events
- ◆ 2 independent opening circuits per breaker guaranteeing 6-fold redundancy
- ◆ Calculated by Antonio Vergara in December 2003:
 - System Failure probability after 20 years of the 600 A EE systems: $< 0.01\%$



Reliability (2)

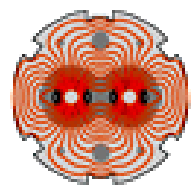
- ◆ Systems reliability from hardware failure point of view:
 - 6 hardware failures - always during closing procedure
 - FAIL-SAFE!
 - Mean Time To Recovery (LHC machine including access and travel time)
 - 4 hours/intervention = 6 failures * 4 hours
 - In total, 1 day down time for 202 systems



Availability

All systems: $\frac{280 \text{ days} - 1 \text{ day downtime}}{280 \text{ days}} = 99.643 \%$

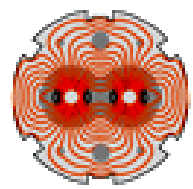
One system: $\frac{280 \text{ days} * 202 \text{ systems} - 1 \text{ day downtime}}{280 \text{ days} * 202 \text{ systems}} = 99.998 \%$



Mean Time Between Failures - MTBF

All systems:
$$\frac{(6720 \text{ hours} - 24 \text{ hours downtime})}{6 \text{ failures}} = 1116 \text{ hours} = 46.5 \text{ days}$$

One system:
$$\frac{(6720 \text{ hours} - 24 \text{ hours downtime}) * 202 \text{ systems}}{6 \text{ failures}} = 225.432 \text{ hours} = 9393 \text{ days} = 25.7 \text{ years}$$



Failures

6 failures in total:

4 cases of excessive closing failures

Loosening of holding coil mechanism

Last intervention for this on September 11, 2010

1 case of discharging Fast-Off capacitor.

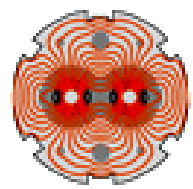
Changed breaker's PCB but no fault found.

Suspicion of a loose wire but no repetition of the problem since July 2010

1 case of broken holding coil.

Heritage of overheating during 2 heat-runs in UJ33 in 2008.

Solutions were implemented and case is considered as solved or SE (July 2010)



Actions

are on-going to decrease the number of closing failures

“Normal” closing failures: (2%) will be transparent for operation.

Excessive closing failures: In contact with manufacturer to overcome problem which is the fixation of the holding coil mechanism.

Improvements

Manufacturers conclusion

IF decided to take action on holding coil mechanism:

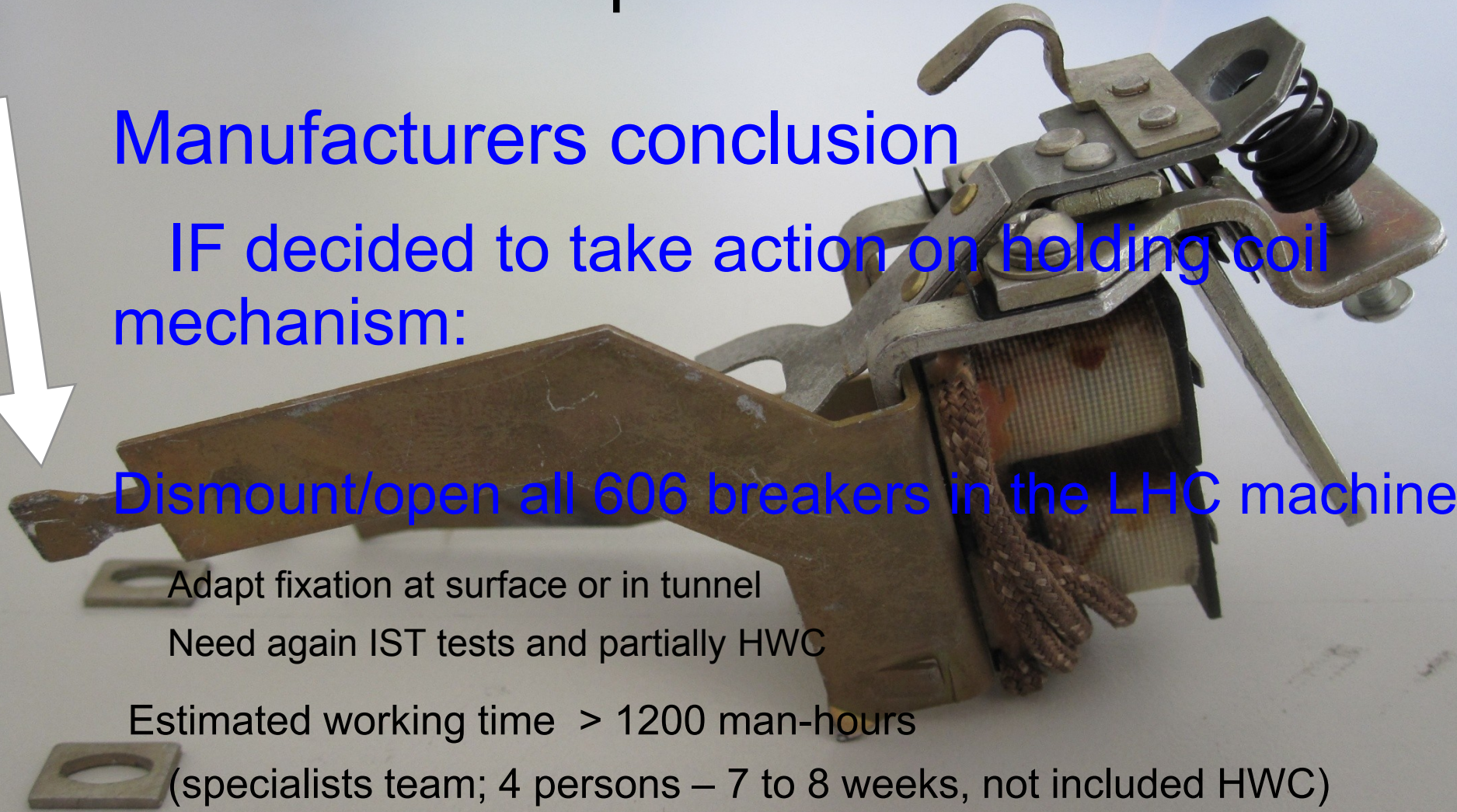
Dismount/open all 606 breakers in the LHC machine.

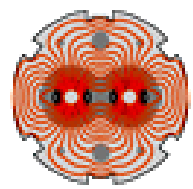
Adapt fixation at surface or in tunnel

Need again IST tests and partially HWC

Estimated working time > 1200 man-hours

(specialists team; 4 persons – 7 to 8 weeks, not included HWC)





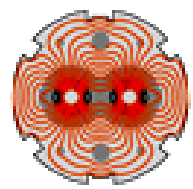
Future MTBF

MTBF after upgrade (recalculated 2010: keep 2 failures):

All systems: = 3.356 hours (approx. 5 months)

One system: = 677.912 hours (approx. 77 years)

Probably maximum reasonably achievable



Resources

Exploitation, Maintenance (interventions, scheduled and unscheduled TS)

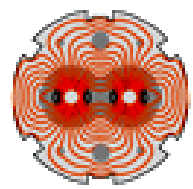
Improvement, Follow-up (scheduled TS)

CERN resources:

Specialist: 15-20%

Detailed engineering: 10-15%

Technician: 10-15%



Thank you for your attention!