Overview of 11 T Protection Equipment from WP7

- Quench detection
- Quench Heater Powering
- Trim lead protection & Trim circuit in PIC
- Reliability requirements for 11 T protection equipment

Daniel Wollmann for WP7

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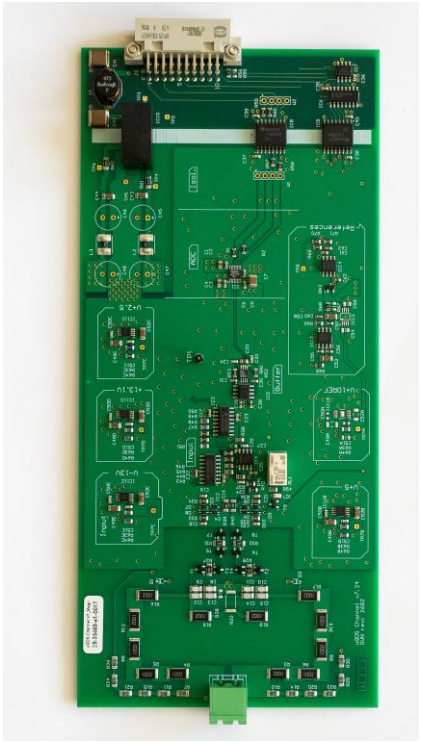
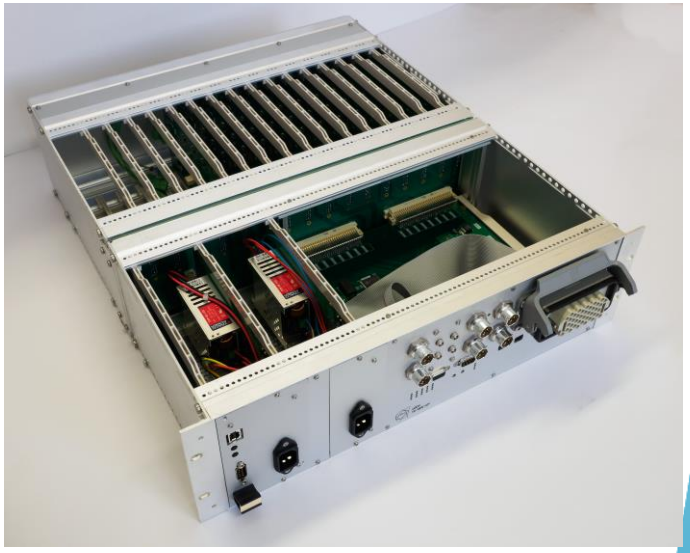
Quench Detection and Data Acquisition systems for 11 T dipole

- Several **uQDS** units are currently under extensive **type testing**
- One uQDS unit is under test in CHARM
- Supervision layer for 11 T protection systems is currently **under definition**

Versatile digital platform



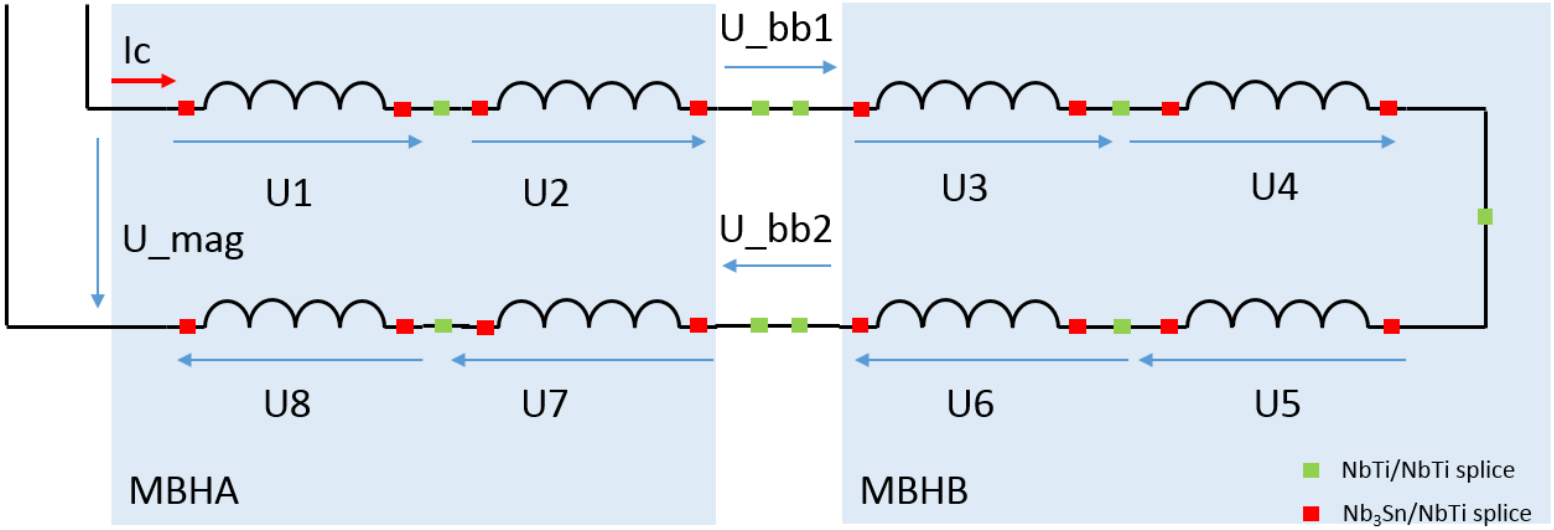
Frontend input channel



UQDS crate v2.1

See talks by
- J. Steckert
- E. De Matteis
- T. Podzorny

11T instrumentation/channel distribution



- 8x pole voltages for asymmetric and symmetric quench detection
- 2x interconnection bus-bar for bus-bar protection
- 1x total magnet voltage
- 1x circuit current (for current dependent settings)

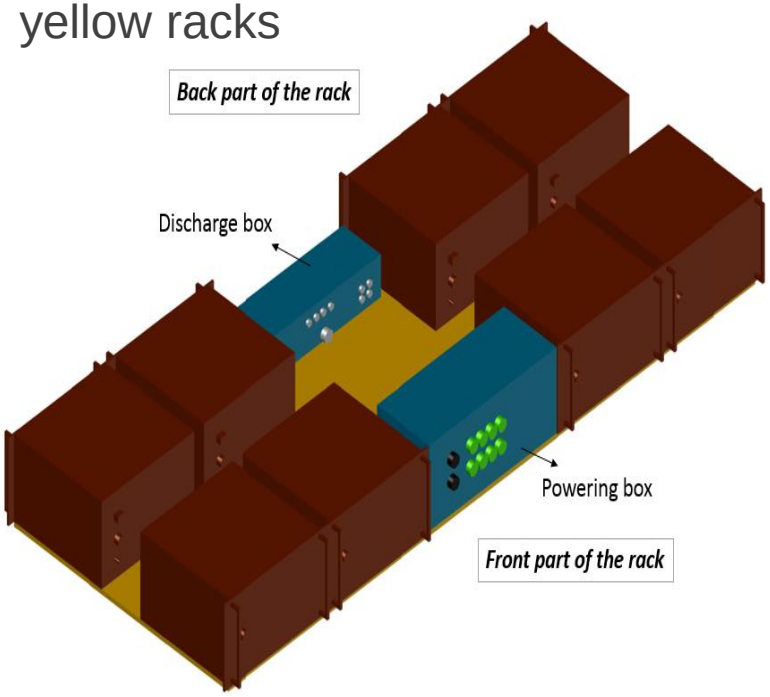
➔ 12 channels per QDS box

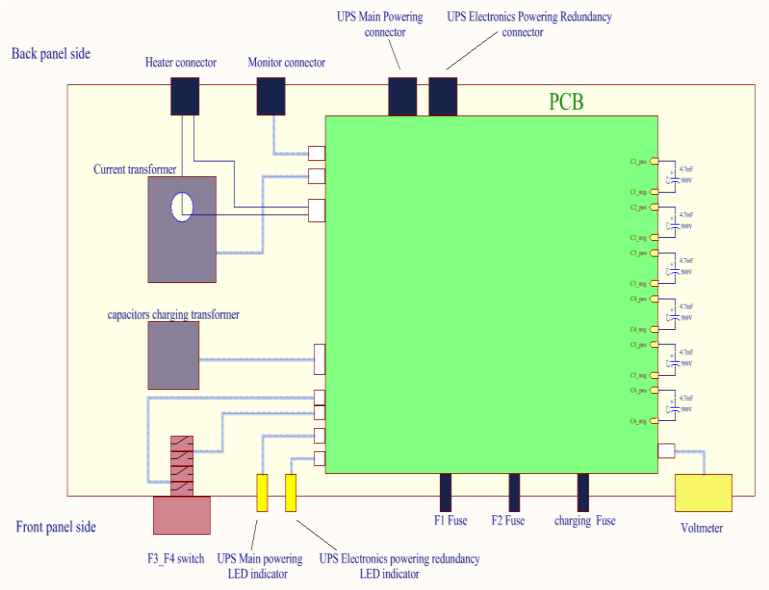
➔ Fully redundant scheme (Vtaps → cables → QDS boxes)

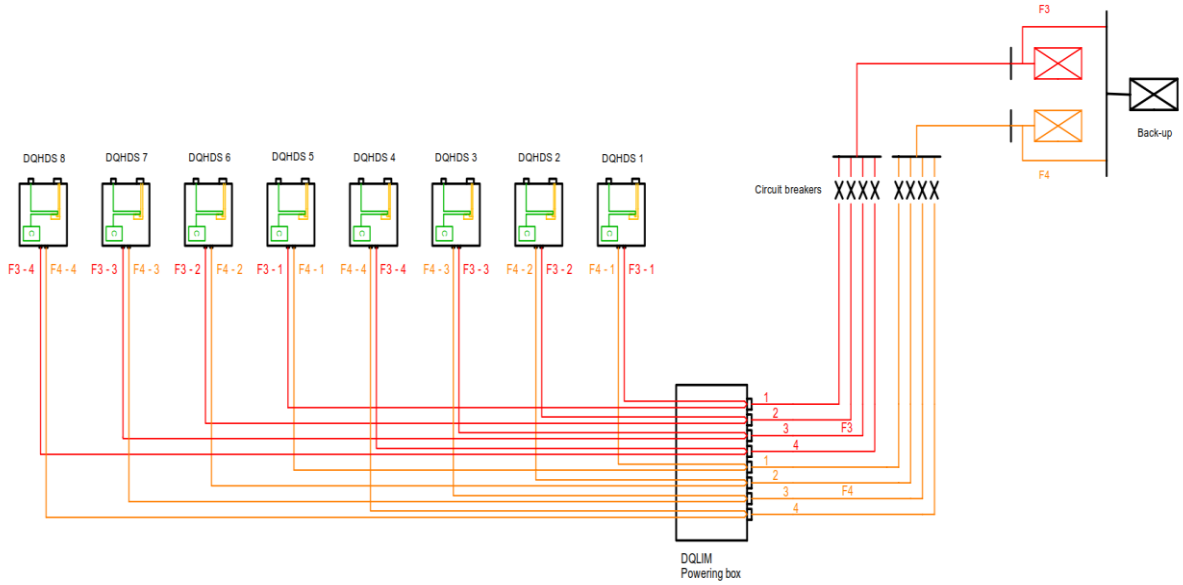
➔ All superconducting splices & bus-bars covered

Conceptual design - 11T protection rack

16 modified LHC quench heater power supplies distributed in two modified yellow racks





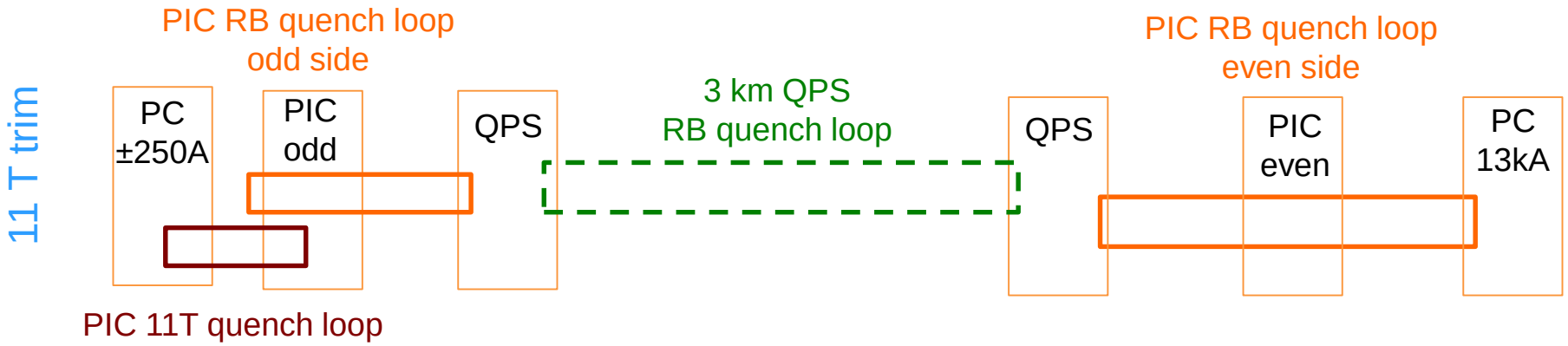


See talk by D. Carrillo

Trim lead and bus-bar protection

- Protection of 2x 120 A conduction cooled leads for trim circuit by redundant uQDS rack (one per IP side):
  - Interlocking of current sharing (max. 130 A per lead)
  - Interlocking of bus-bar voltage: 70 mV, 0.5 s evaluation time (6 redundant voltage taps per magnet assembly)

PIC connection for TRIM circuit



- Separate the 11T trim and the RB circuit → easier diagnostics in case of trip
- Fast Power Abort (FPA) of TRIM in case of main dipole circuit FPA via global protection mechanism (software link) → as other corrector circuits
- 11 T magnet self protected for currents @ 250 A

Reliability Requirements for 11 T Protection Equipment

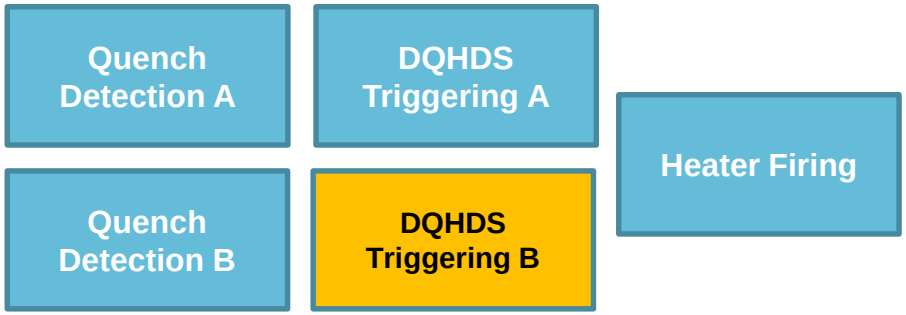
Studies with Isograph-Plus

11T Dipole: Single vs Double DQHDS triggering

- *Event:* Quench + unprotected magnet (≥ 3 oo 16 heaters are not fired)
- *Model:* From voltage taps (detection) to heaters (protection)
- *Failure rates:* Estimates by experts, derived from similar equipment or prediction standards (MIL-HDBK 217Plus)
- *Reliability target:* The probability that the event occurs in 1000 years must not exceed **10%**

➢ *Result:* probability that the event will occur in 1000 years is **0.21%**

➢ **Adding a redundant trigger link** for the quench heater power supplies will only **marginally reduce** the probability **0.21% → 0.20 %.**



See talk by D. Sollich

Conclusion

- Protection requirements for 11 T magnet and trim circuit are well defined
- LHC-MBH-ES-0001 - 1764166 v.0.9 '11T Dipole circuit-powering and protection' – needs to be updated, complemented and released
- R&D of protection hardware for the 11 T is well advanced
- Reliability studies for 11 T protection equipment provide important input for HW design & confirm reliability requirements for 14oo16 quench heater circuits

More details on 11 T protection in the following talks!

Acknowlegments

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