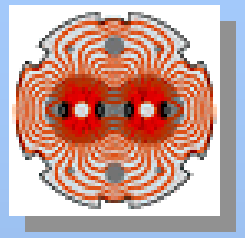
QUENCH PROTECTION SYSTEM

QUENCH DETECTION
QUENCH HEATER POWERING
ACQUISITION & MONITORING

R. Denz LHC/ICP

Main Magnet (MB, MQ) Protection



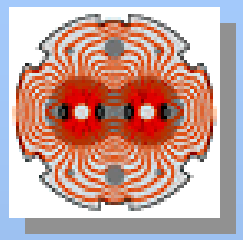
- **Protection of LHC main magnets MB & MQ provided by:**
  - Local quench detectors DQQDL
  - Quench heater power supplies DQHDS
  - Cold by-pass diode(s) inside cold mass
  - Energy extraction system ?
- **DQQDL, DQHDS & DQAMC based on in-house designs using COTS**
- **Minimum required radiation tolerance:**

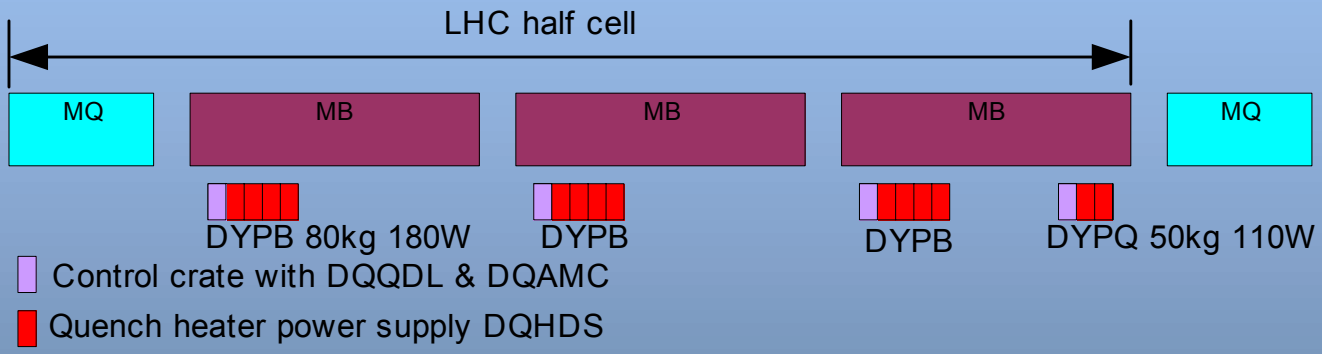
  200Gy

  $2 \times 10^{12} ncm^{-2}$

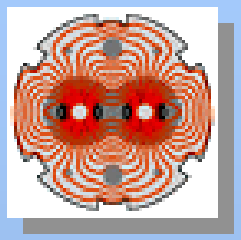
  SEU free
- **Successful test in TCC2 area mandatory**

Location of radiation tolerant equipment

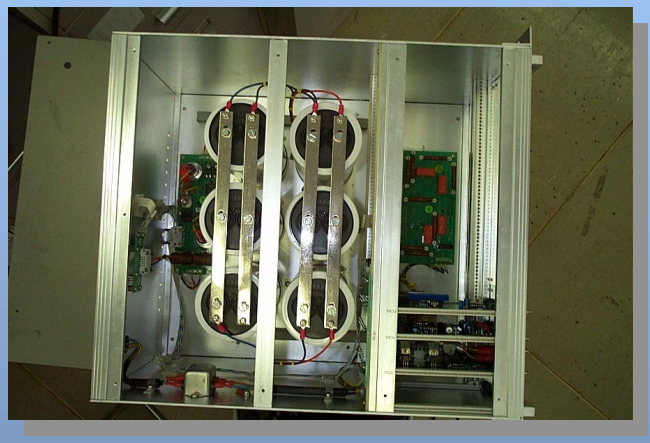




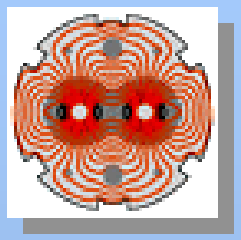
Quench heater power supply DQHDS

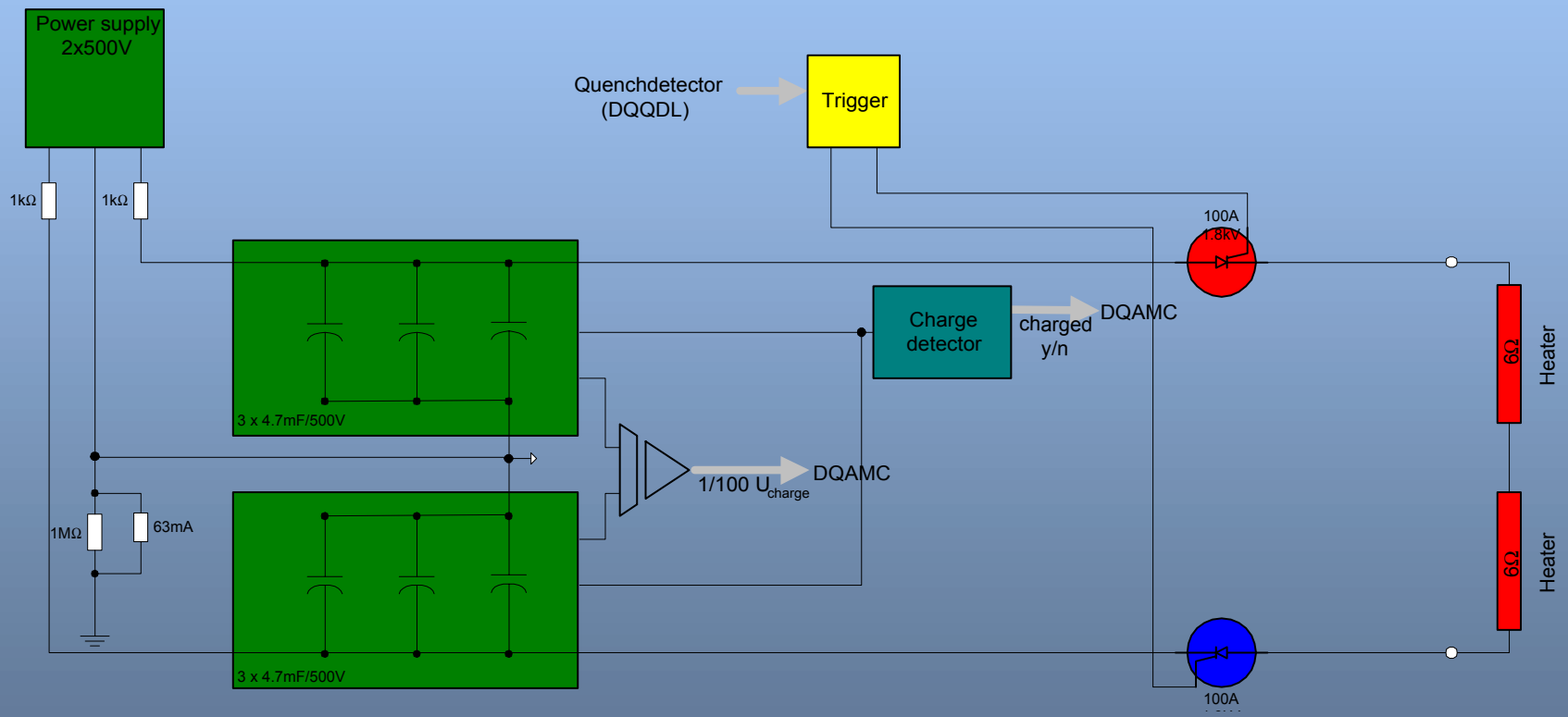


- **About 6200 units in LHC**
  - Energizes quench heater strips in case of a magnet quench.
  - 4 units per MB, 2 units per MQ
  - ~ 6000 to be installed under the main dipoles in the regular arc and the dispersion suppressors
  - ~ 200 in UA, UJ …
- **Useful lifetime ~15 to 20 years**

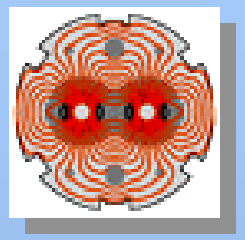


DQHDS: functional diagram





Radiation tests I: Components

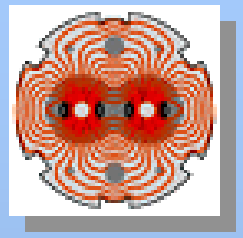


- **Online monitored tests started in 1999 in TCC2 test area**
- **Aluminium electrolytic capacitors (4.7mF / 500V)**
  - Only minor effects observed, radiation tolerant
- **NE556 bipolar timers & linear voltage regulators**
  - Slight reduction in current consumption, radiation tolerant
- **Voltage references**
  - Radiation tolerant devices identified , i.e. REF102, LT1236
- **AD210BN isolation amplifier**
  - Increased offset voltage but still usable for DQHDS
- **Phase control thyristors**
  - Most sensitive components, two different failure modes depending on the construction of the device:
    - Type A: inhibited firing
    - Type B: short circuit after discharge
    - Type B dose limit: 350 – 400Gy

Radiation tests I: Devices

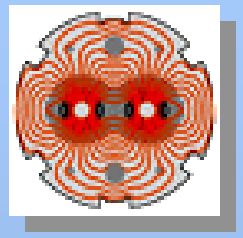
- Test started in 2000 with a CERN prototype
- “Mass” testing in 2001 with 5 pre-series devices from industry
- Radiation tolerance linked to thyristors (350-400Gy) all other components and sub-circuits >1kGy
- Test to be continued in 2002

Local quench detector DQQDL



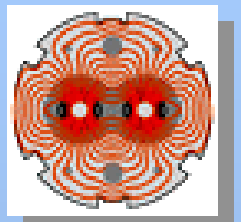
- 1 per MB, 2 per MQ, 2100 in LHC
- Based on Wheatstone bridge formed with the two apertures / coils & balancing resistors
- Detector part based on analog circuitry
- DAQ part based on ADUC812BS and CC131 MicroFip

Radiation tests

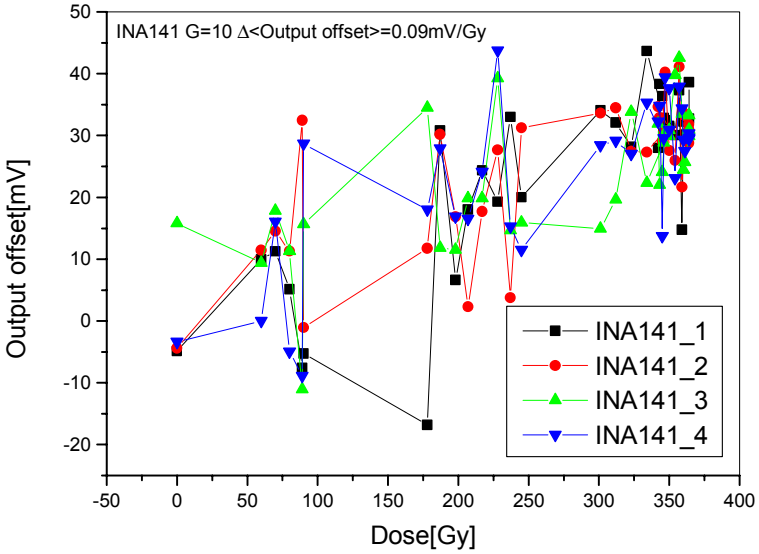


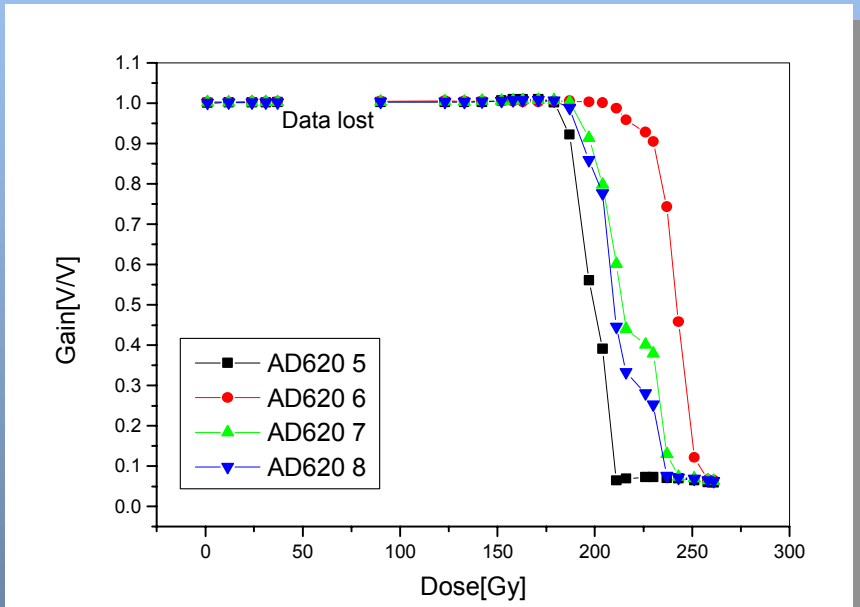
- **TRIVOLT power supplies (hardened):**
  - Batches of 5 units from 3 different manufacturers
  - Best devices reach 650-800Gy
  - Only drifts, no latch-up observed
- **ADUC812BS μConverter + CC131 μFIP**
  - ADC tested with REF102 voltage reference
  - Internal DAC tested
  - CC131 in standalone mode
  - Working up to 650Gy
- **Other components also within DQHDS test**

Radiation tests continued

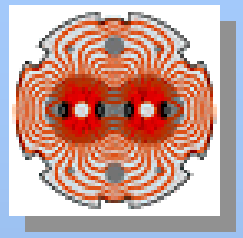


- **Instrumentation amplifiers**
  - **AD620 (4 units): 180Gy**
  - **INA141 (4 units): 360Gy still working**





Conclusions & Outlook



- Installation of quench protection electronic in the LHC tunnel preferable
- Design using COTS feasible, but thorough component & device qualification necessary
- Radiation tests to be continued at least in 2002 for qualification of components & pre-series devices
- TCC2 test area preferred
  - Existing Infrastructure
  - Dirty, LHC like spectrum, high energy hadrons