

CNGS Radiation Test Campaign 2008 – Results from the QPS System

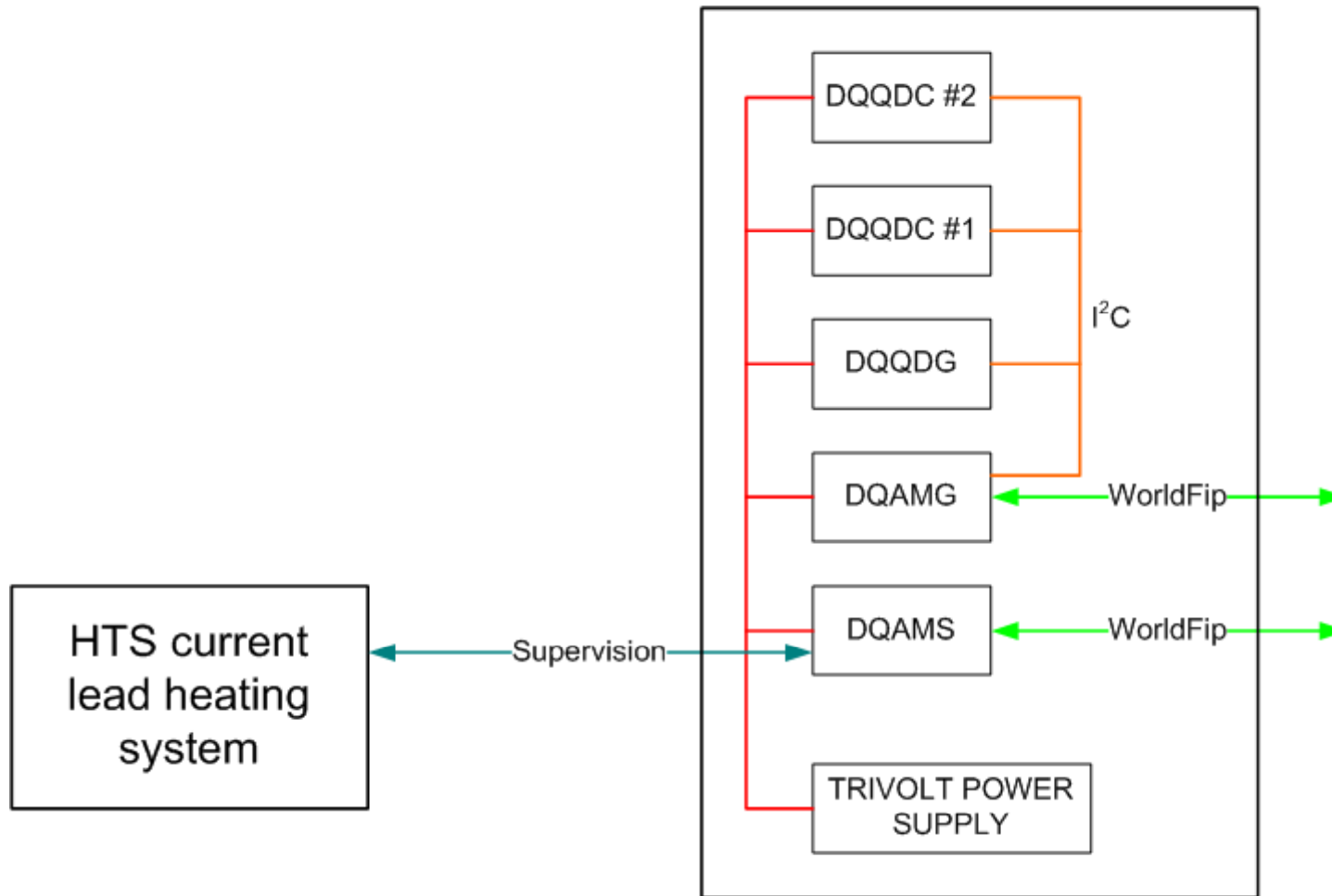
R .Denz AT-MEI-PE

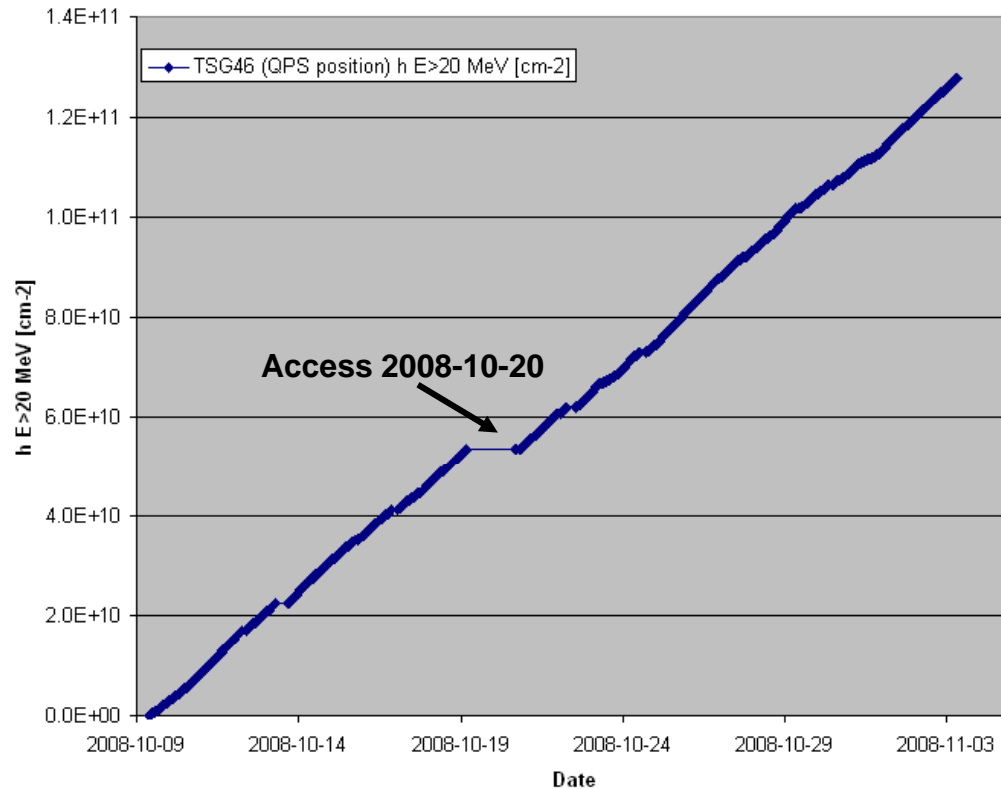


- AT-MEI-SD equipment (A. Ballarino, A. Gharib)
 - Solid state relays used for the HTS current lead heating system
 - Devices installed in all RR, UJ and UA
 - 2 different types under test
 - Both failed after some days of operation in CNGS
 - Detailed analysis still to be done
 - Further proceeding to be discussed with equipment owner
 - Development of radiation tolerant device feasible



- Equipment of the LHC quench protection and energy extraction systems
 - Quench detectors for current leads and corrector magnet circuits
 - Data acquisition systems
 - Supervision of quench detection systems
 - Supervision of energy extraction systems
 - Systems currently installed in RR, UJ and UA
 - New requirements after September 19th – some of these equipment types will be installed in the LHC tunnel as well (mid dipole position)
 - Systems are partly hardened and critical components have been previously tested at CERN and at PSI
 - e.g. fieldbus couplers, power supplies, DC-DC converters





Hadron target figures per nominal year (see presentation by M. Maury last meeting):

RR73/77: 10^8 cm^{-2}
 Arc dipole: $10^9 - 10^{10} \text{ cm}^{-2}$

➔ Irradiation test position TSG46 (RadMon data → T. Wijnands)

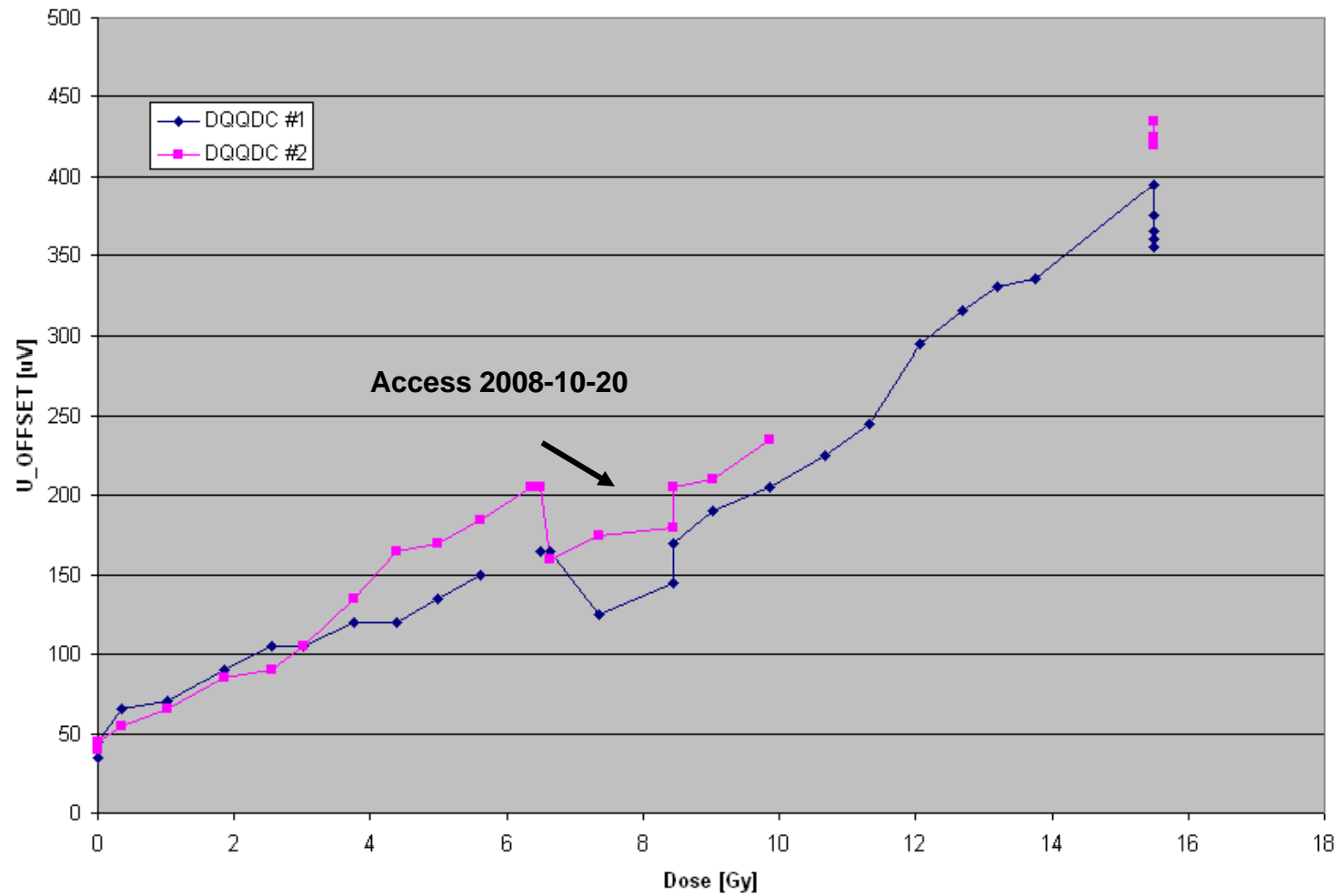
- Total dose: 15.5 Gy
- Neutron fluence (equiv. 1 MeV): $1.0 \times 10^{11} \text{ cm}^{-2}$
- Hadron fluence (E > 20 MeV): $1.3 \times 10^{11} \text{ cm}^{-2}$

- ➔ Hardware still alive → confirms previous radiation tests
 - Hardened power supplies, qualified DC-DC converters ...
 - Power cycle sufficient to re-start stalled devices properly
- ➔ Fieldbus link (WorldFip – MicroFip chip) confirms radiation tolerance shown in previous tests
- ➔ Many soft errors in local communication (I²C™ bus)
 - Auto-recovery of stalled devices observed
 - DQQDG devices more susceptible than DQQDC devices
 - Possible firmware update to be studied
 - Further testing will be required (@ CERN and abroad)
- ➔ Input stage offset voltage drift of DQQDC devices observed
 - Drift too slow to be an issue for operation of the device
 - Partial recovery after radiation stop observed

→ Periods with stable communication observed:

Device	Period	Dose [Gy]	Neutrons 1 MeV [cm-2]	Hadrons E > 20 MeV [cm-2]
DQQDG	I	0.20	1.30E+09	1.61E+09
	II	0.99	6.57E+09	8.12E+09
DQQDC #1	I	5.58	3.73E+10	4.60E+10
	II	0.73	4.90E+09	6.06E+09
	III	7.47	4.99E+10	6.17E+10
DQQDC #2	I	0.20	1.31E+09	1.62E+09
	II	4.96	3.31E+10	4.10E+10
	III	0.49	3.26E+09	4.03E+09
	IV	3.78	2.53E+10	3.12E+10

➔ Input offset voltage drift of DQQDC devices:





- ➔ Radiation tolerance exhibited by QPS devices installed in RR73 and RR73 sufficient for LHC operation with nominal beam
 - Enhanced shielding of RR73 and RR77 in place
 - Remote power cycle option to be added
- ➔ Radiation tolerance of devices to be installed under the mid dipole most probably sufficient
 - New devices within the framework of QPS upgrade
 - Not all systems tested yet
- ➔ No hardware failure of QPS devices observed
- ➔ Previously tested devices confirm radiation tolerance
- ➔ Further testing @ CERN and abroad (e.g. PSI) to be foreseen
 - This years tests didn't cover all aspects of operation
 - New firmware implementations to be tested
 - Some new devices to be submitted to test