
CERN

R2E Annual Meeting 2018

Results of Functional Radiation Tests of QPS Equipment (to be installed during LS2) at CHARM

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On behalf of TE-MPE-EP

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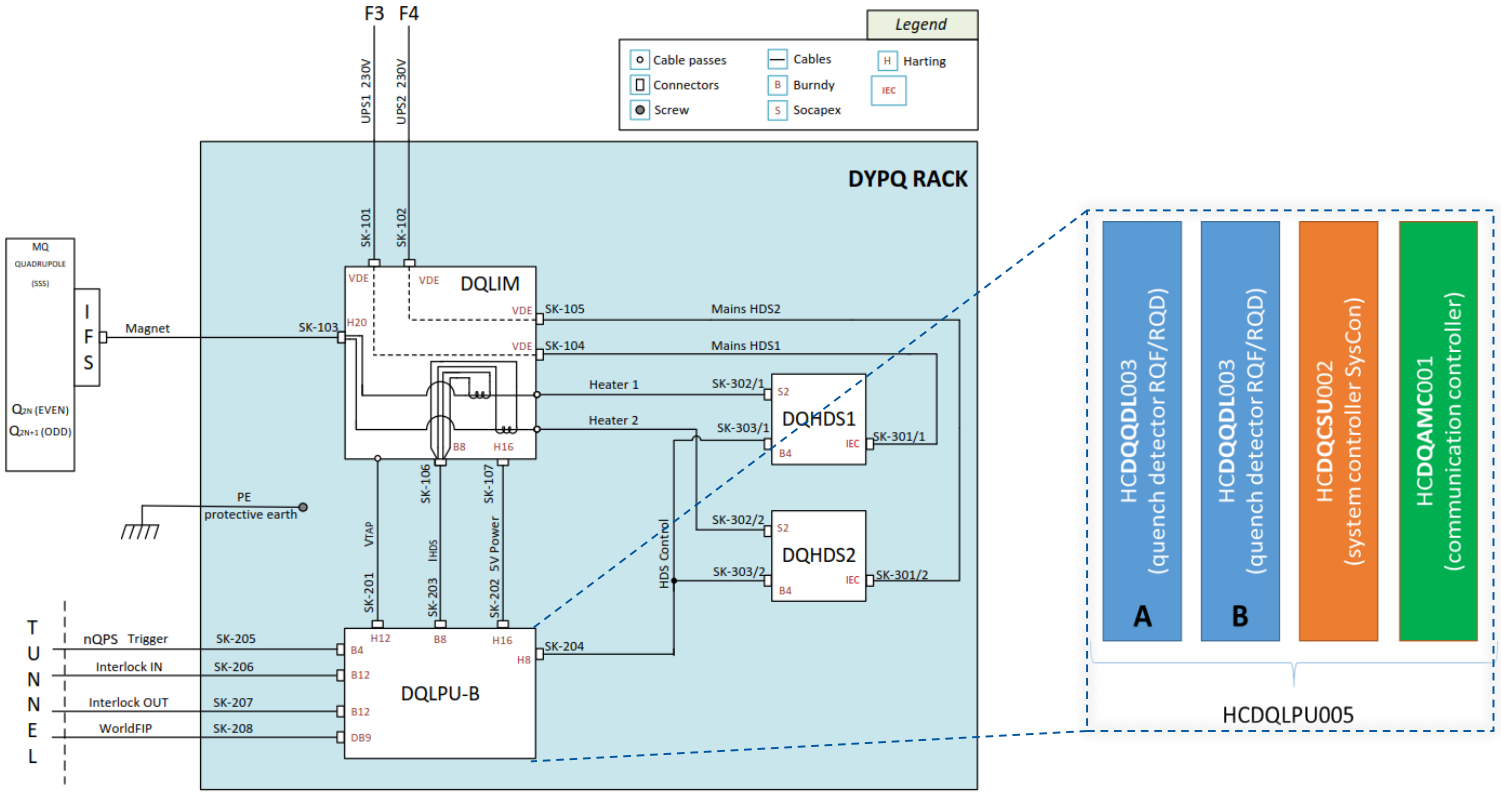
- DQLPUBv2
  - About, test setup, results, summary
- uQDS
  - About, test setup, results, summary
- Conclusions

Quench Protection Systems to be installed in LS2

	DQLPUBv2	Universal QDS (UQDS)
		
Location	DYPQ rack	RR73/RR77
Protection of	Main quadrupole	11T magnets
No. of Units	392 (+48)	4
Expected dose rate	<1 Gy/y .. 10+ Gy/y	~1 Gy/y
Expected Dose	200 Gy	30 Gy
Components	Commercial out of the shelf (COTS), tested in PSI	Commercial out of the shelf (COTS), tested in PSI

About DQLPUBv2



DYPQ Rack

DQLPU Type B

Located under *"A" or "C"* dipoles in LHC tunnel

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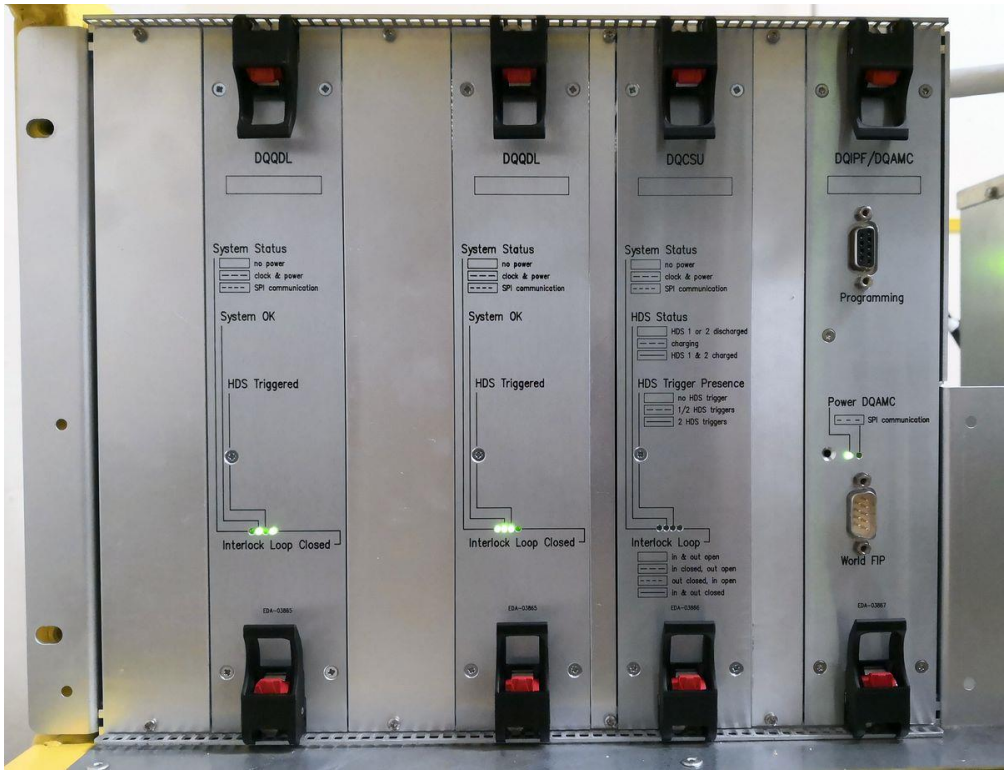
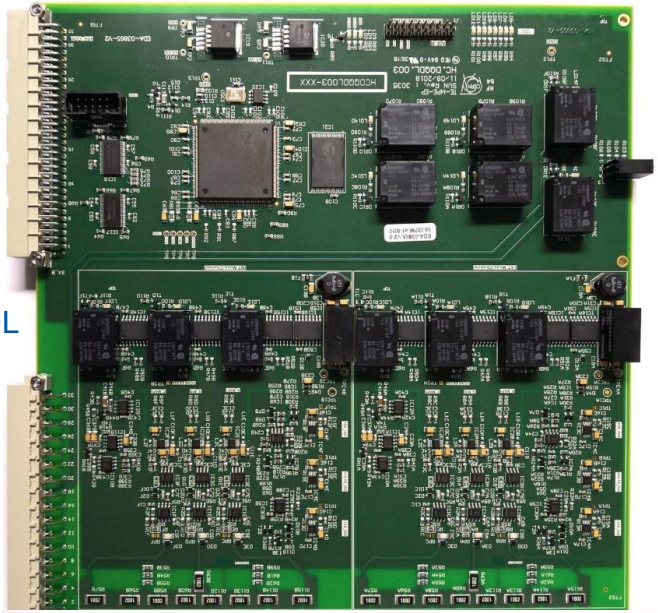
Expected annual dose: <1 Gy/y .. 10+ Gy/y

Target lifetime dose: 200Gy

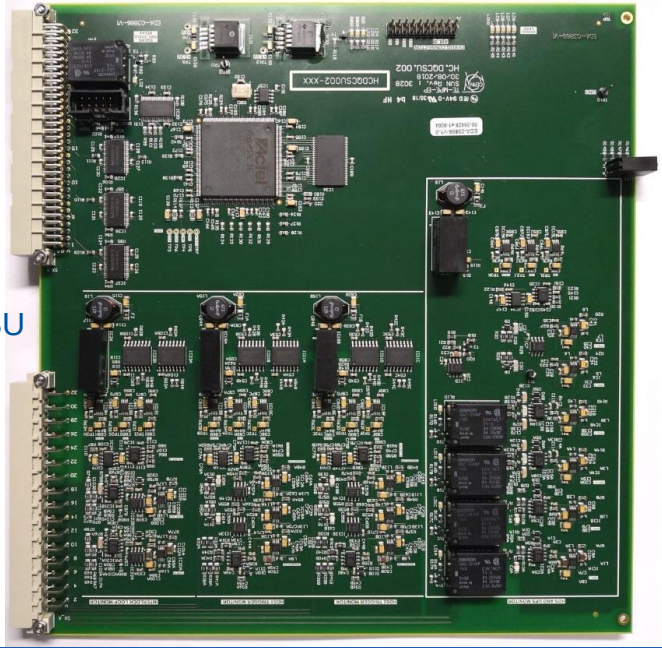
About DQLPUBv2



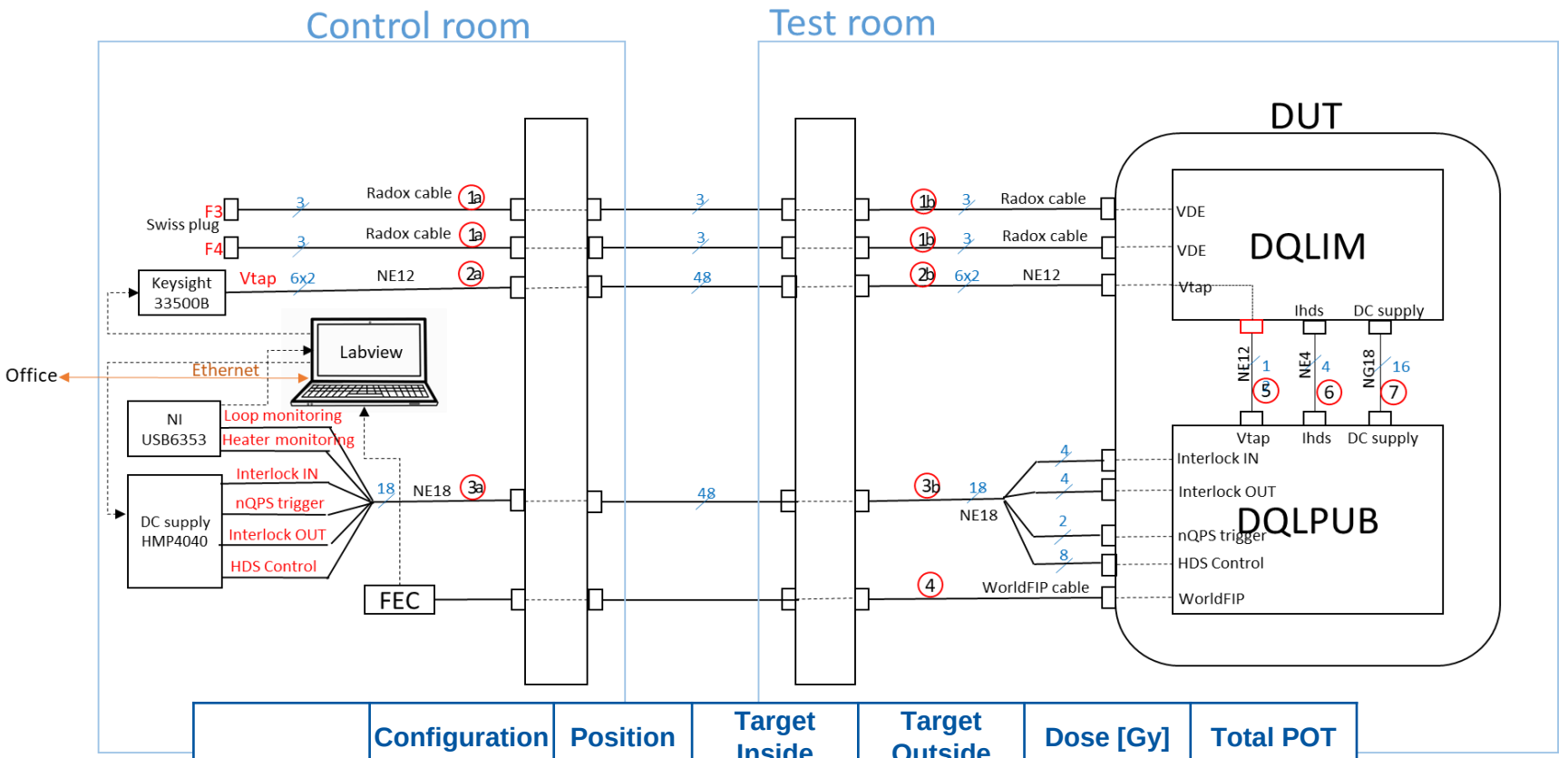
DQQDL



DQCSU



DQLUBv2: Test Setup

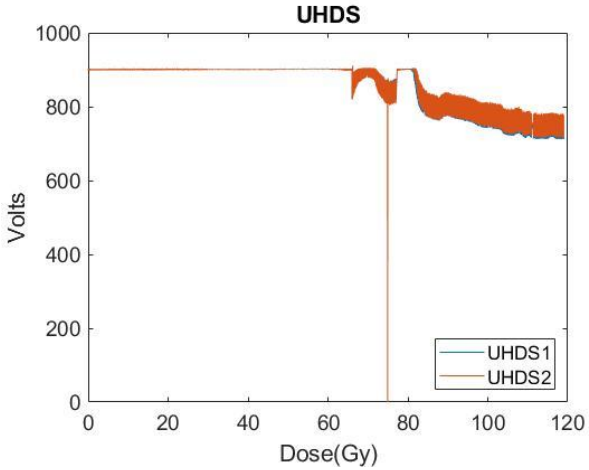


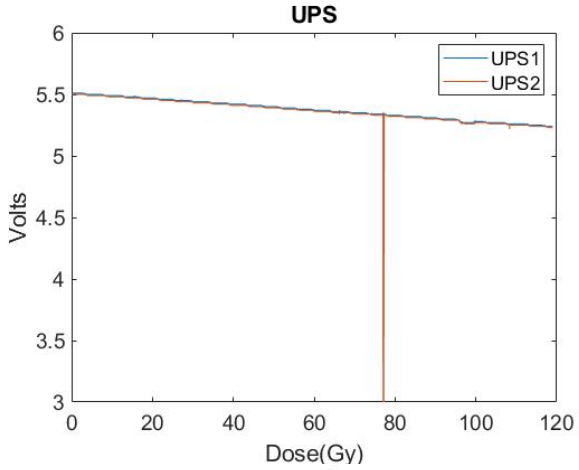
	Configuration	Position	Target Inside	Target Outside	Dose [Gy]	Total POT
Run 1	“CuOOOO”	10	2018-06-13	2018-06-18	218.69	1.27E+16
Run 2	“CuOOOO”	10	2018-06-20	2018-06-25	229.25	1.64E+16
Run 3	“CuOOOO”	10	2018-09-05	2018-09-10	156.5	1.78E+16
Run 4	“CuOOOO”	10	2018-09-12	2018-09-17	197.22	1.47E+16

DQLPUBv2: Supply Monitors

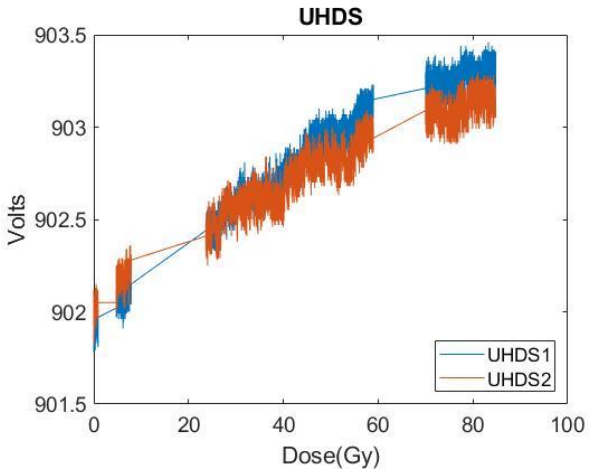
Run 1 & Run 2: June'2018

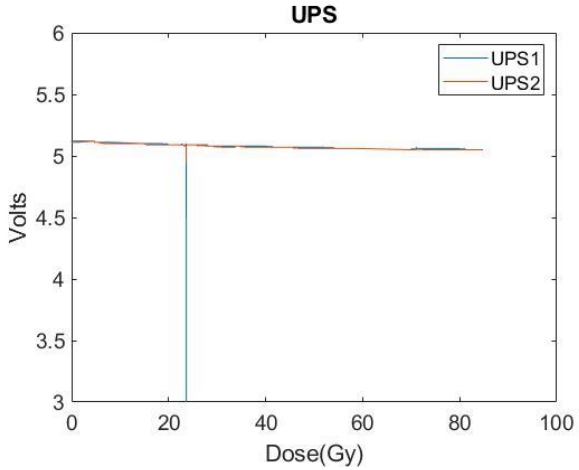
Run1 →





Run2 →

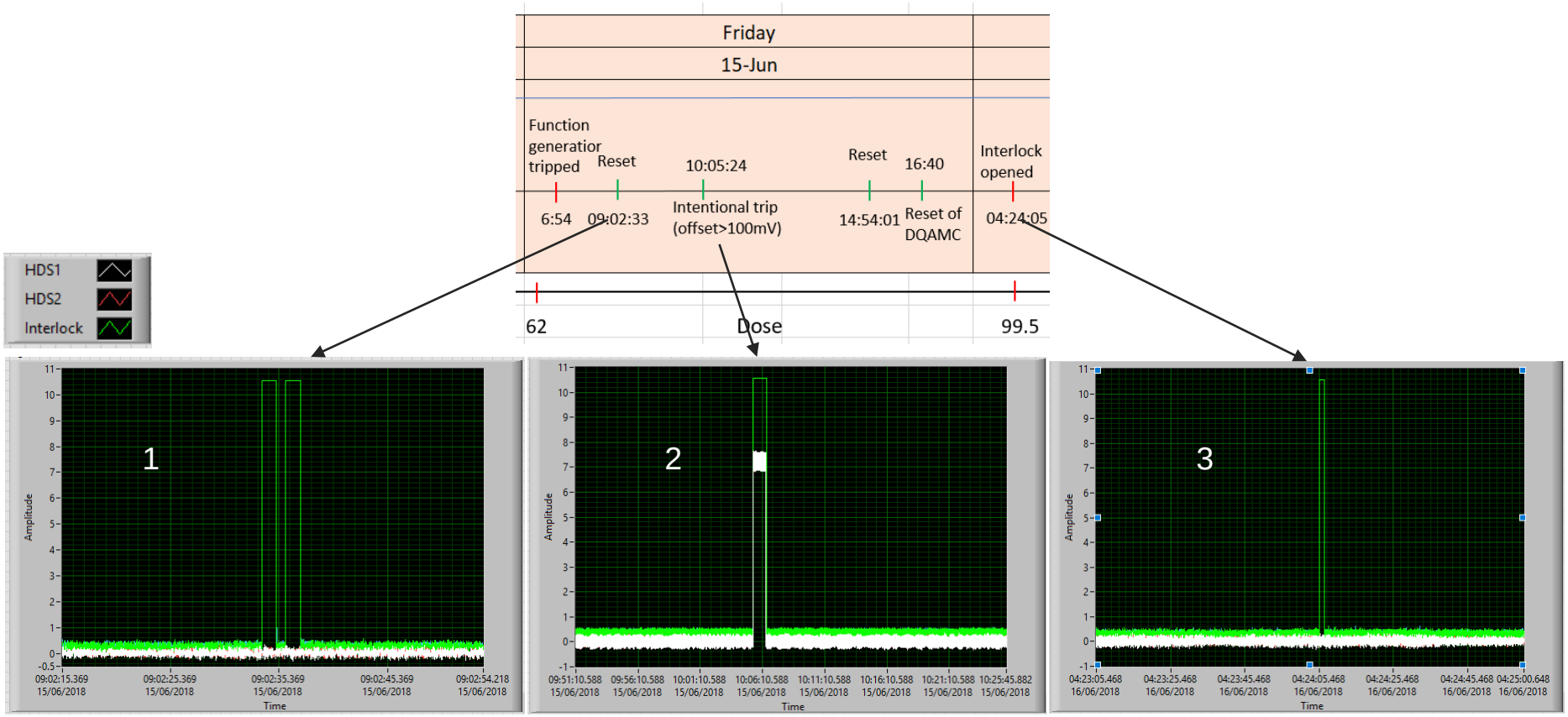




- **UHDS** shows drastic change with dose over 70Gy → change of mezannine board → small deviation in Run2
- **UPS** voltage shows constant decay through both runs

DQLPUBv2: Events Observed

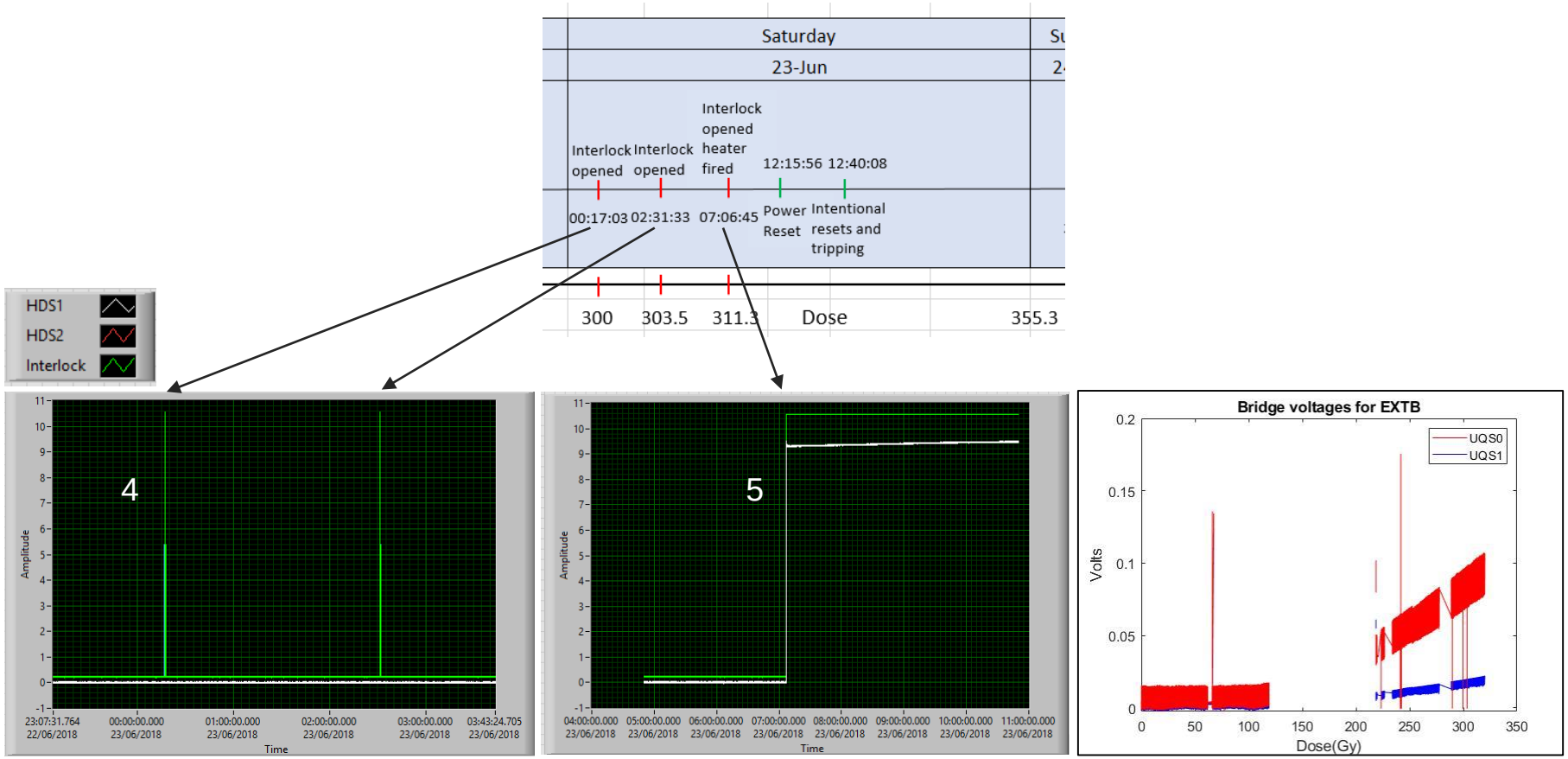
Run 1 & Run 2 : June'2018



1. System reset → DQAMC resets DQQDL → DQAMC resets itself → DQAMC resets DQQDL → **double pulse**
2. Voltage difference between Vtaps > 100mV → **interlock loop opening, heater firing**
3. Loss of communication detected by DQAMC → **single pulse**

DQLPUBv2: Events Observed

Run 1 & Run 2 : June'2018

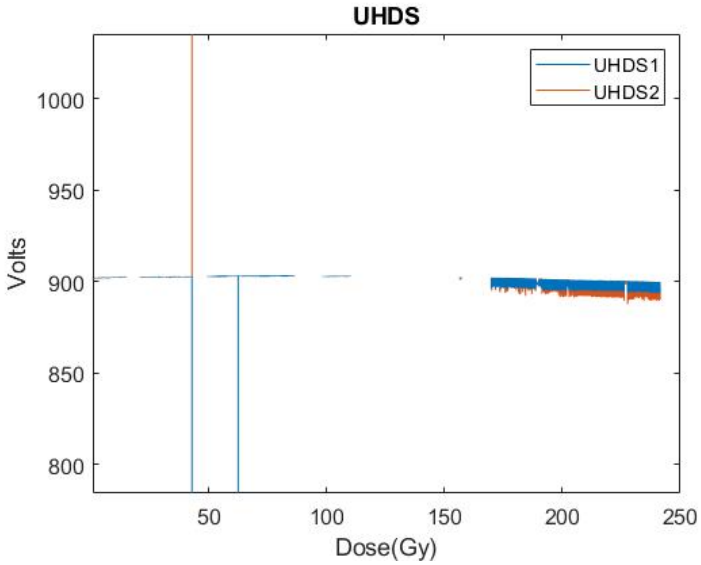


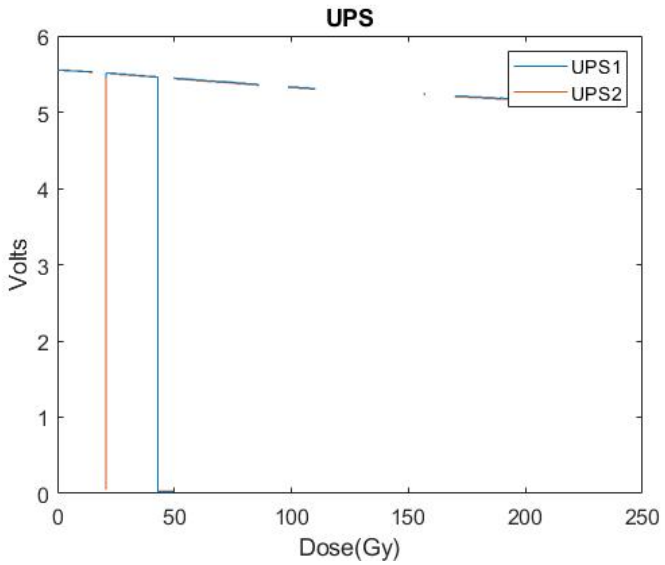
4. Loss of communication detected by DQAMC → **single pulse**
5. Variation of reference voltage with radiation → change in bridge voltage → **Automatic loop opening and heater firing**

DQLPUBv2: Supply Monitors

Run 3 & Run 4 : Sep'2018

Run 3 & 4 ➔

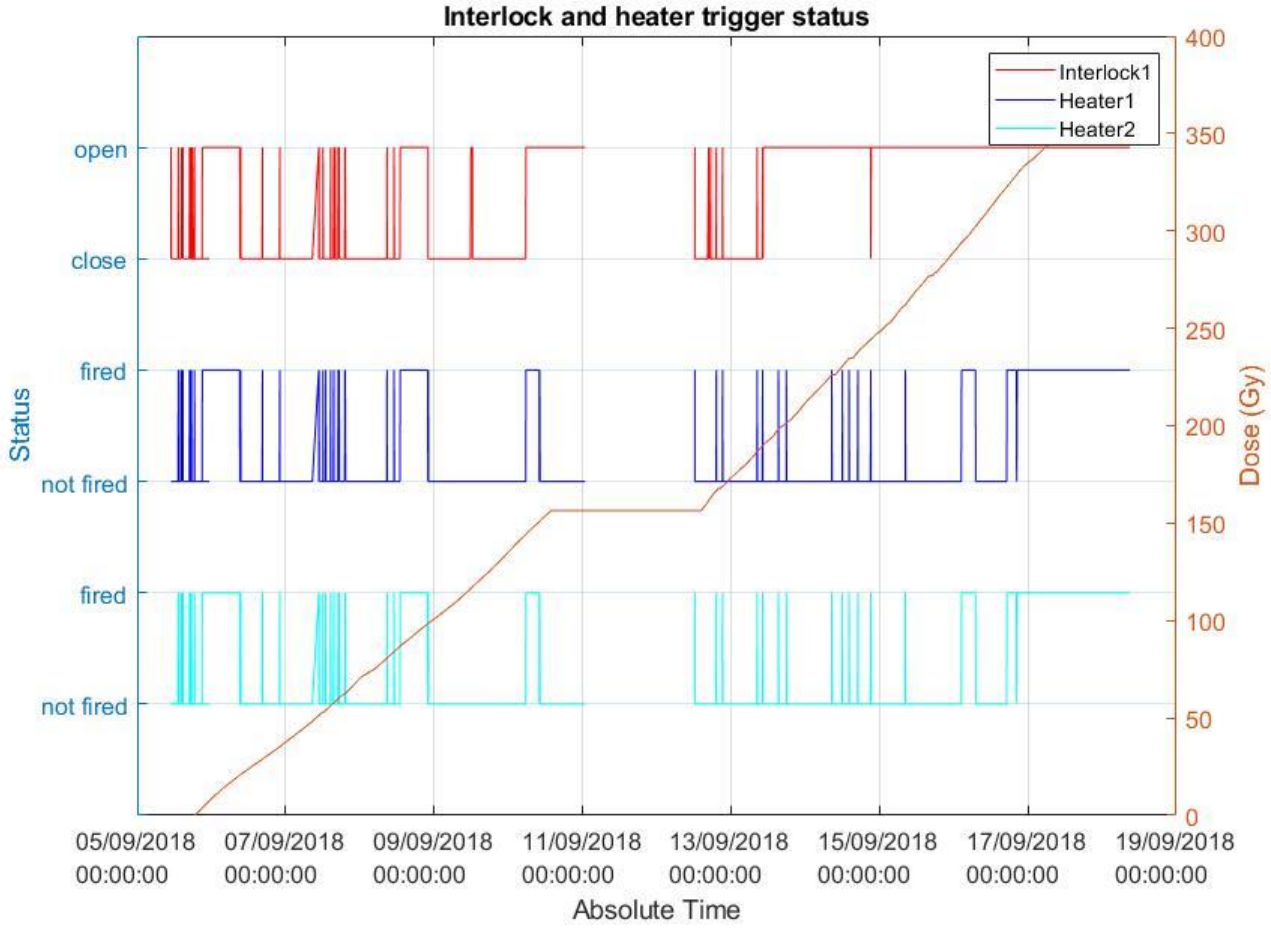




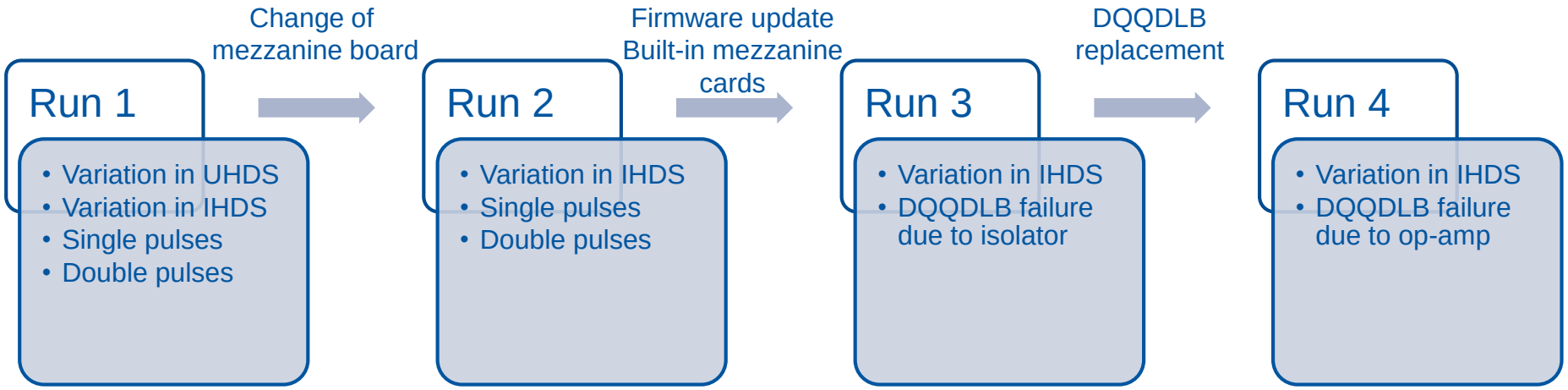
- **UHDS** showed gradual degradation and stayed close to 900V (**±20V**) till 240 Gy
- **UPS** voltage shows slow decay through both runs
- The breaks in the data are due to unavailability of WorldFIP data.
- The pulses in the data correspond to power cycles.

DQLPUBv2: Interlock and Heater Status

Run 3 & Run 4 : Sep'2018



DQLPUBv2: Test Flow



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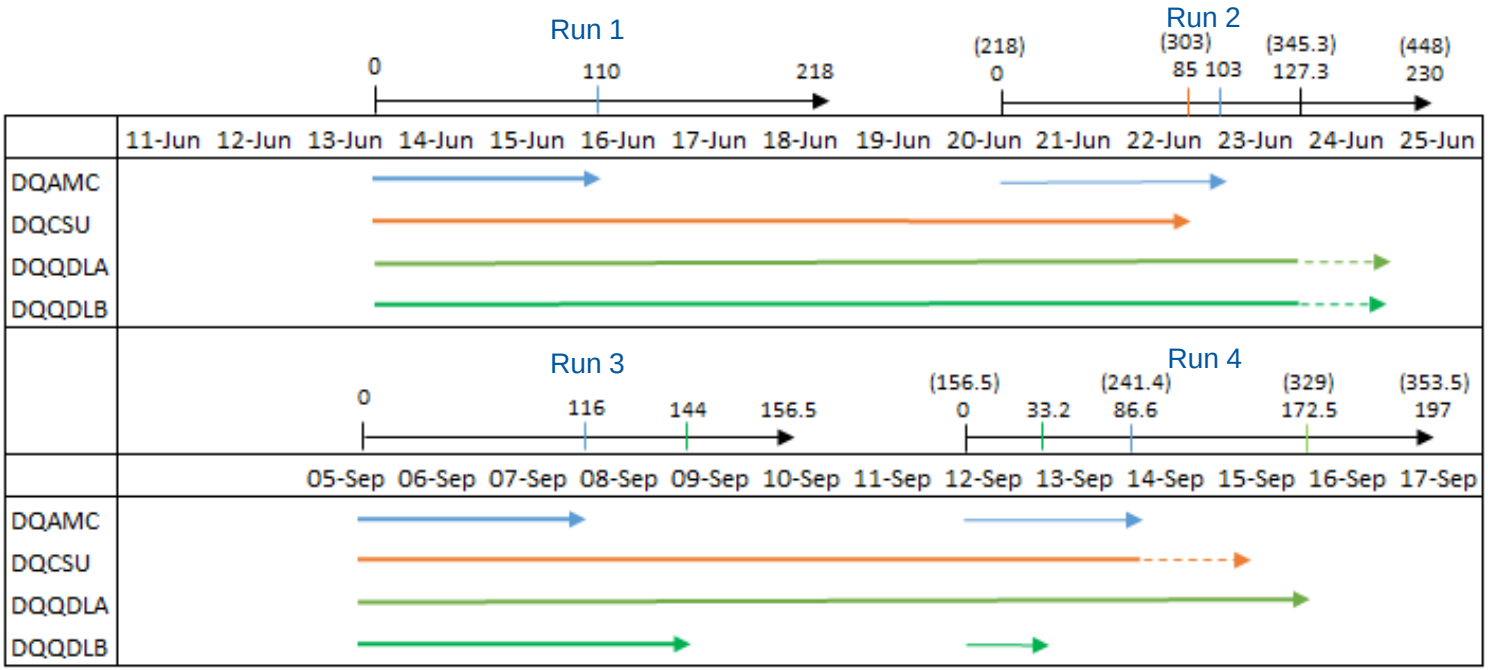
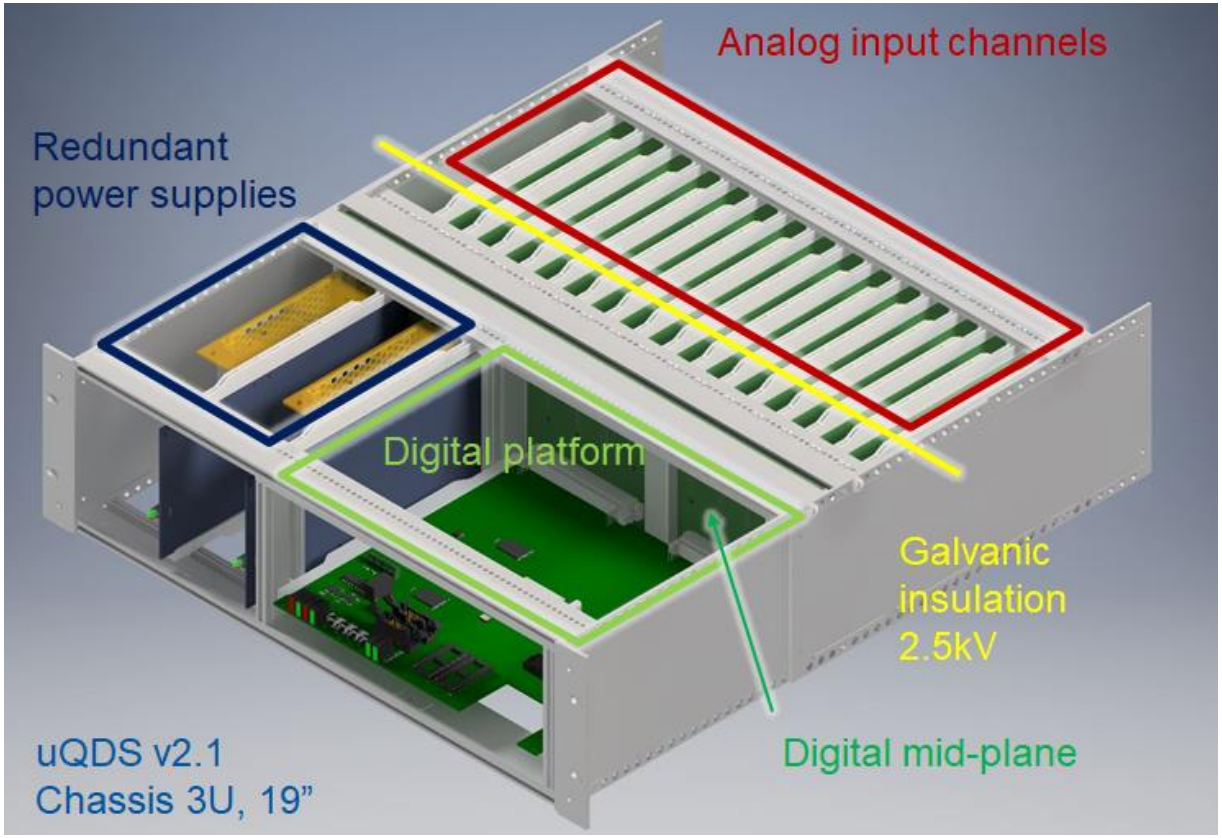
DQLPUBv2: Summary of Performance



- **DQAMC** survives for **100 Gy** on average, then it fails due to the microFIP IC
- **DQCSU** works at least up to **241 Gy**
- **DQQDL** performs well up to **330 Gy**
- For Run 3 and Run 4, failure of DQQDLB was attributed to failure of one digital isolator and one op-amp respectively. However
  - 20 digital isolators used in DQLPU B unit, 1 failed out of 47 tested within Run 1-4;
  - 58 operational amplifier used in DQLPU B unit, 1 failed out of 140 tested within Run 1-4

About UQDS



Located at RR73 / RR77

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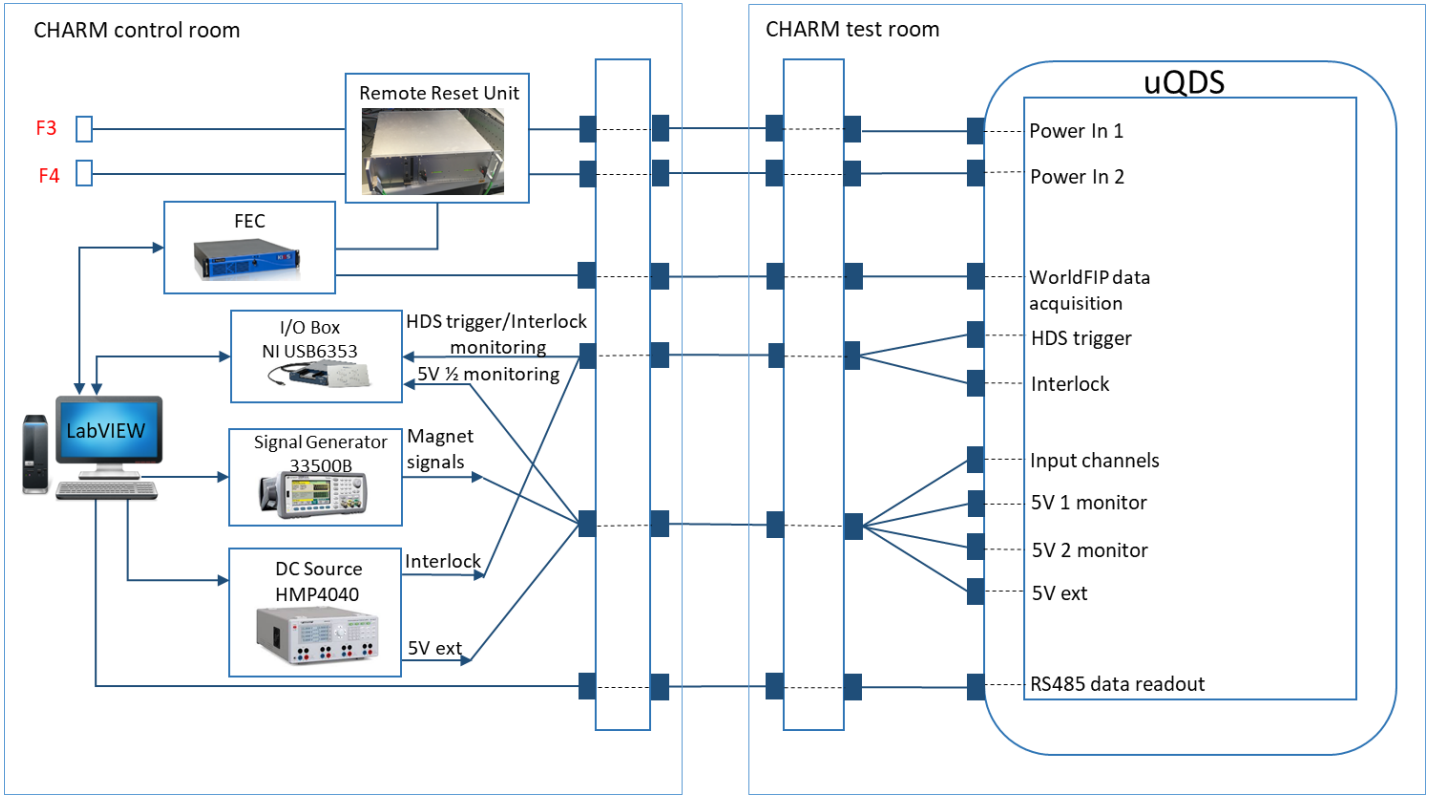
Expected annual dose: ~1 Gy/y

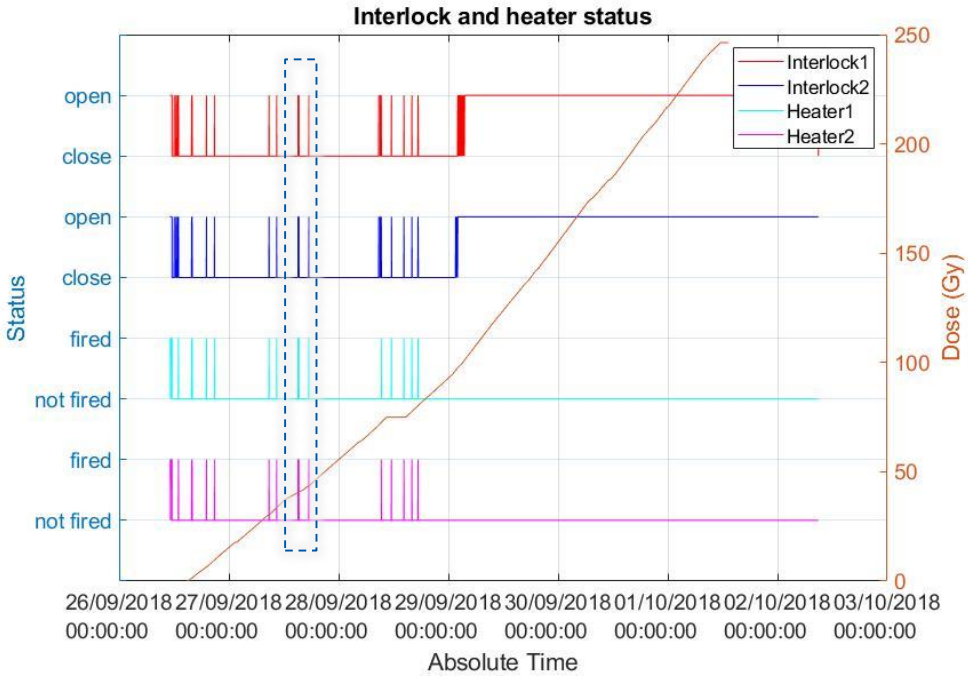
Target lifetime dose: 30Gy

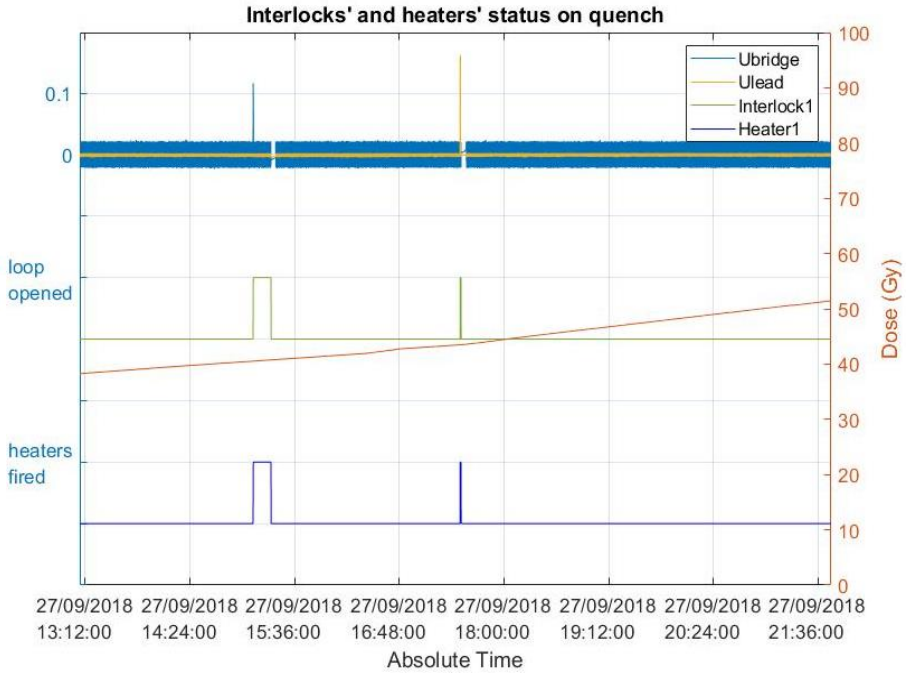
UQDS: Test Setup



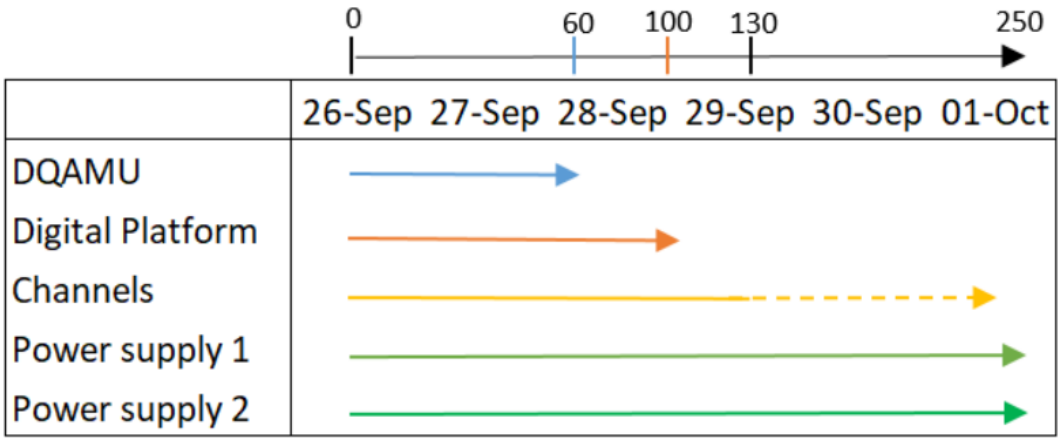
	Configuration	Position	Target Inside	Target Outside	Dose [Gy]	Total POT
Run 1	"CuOOOO"	10	2018-09-26	2018-10-01	247.7	1.98E+16

UQDS: Results





UQDS: Summary of Performance



- WorldFIP interface card stopped working at 60 Gy
- At ~100 Gy Interlock loop opened and could not be closed
- Analog channels worked well (at least) up to 130 Gy (RS485 reading was stopped at 130Gy, unable to resume at 250 Gy)
- Power supply survived 250 Gy!

Conclusions

- 392 DQLPUBv2 units and 4 UQDS units to be deployed in LS2
- CHARM provides radiation environment similar to LHC but at higher rate
- DQLPUBv2
  - Expected total dose is **200 Gy**
  - 4 weeks of irradiation campaigns, @1.5 Gy/hr
  - **Survives > 300 Gy** with change of DQAMC
- UQDS
  - Expected total dose is **30 Gy**
  - 1 weeks of irradiation campaigns, @1.5 Gy/hr
  - **Survives > 100 Gy** with change of DQAMU
  - More research on photoMOS required

Thank you !