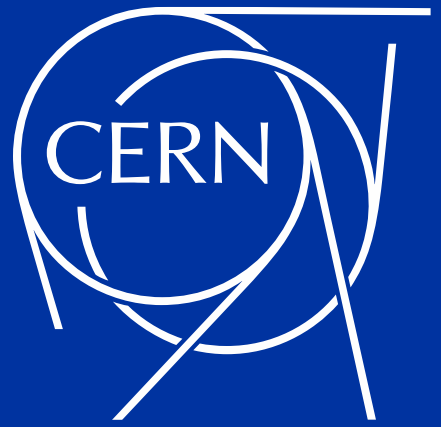


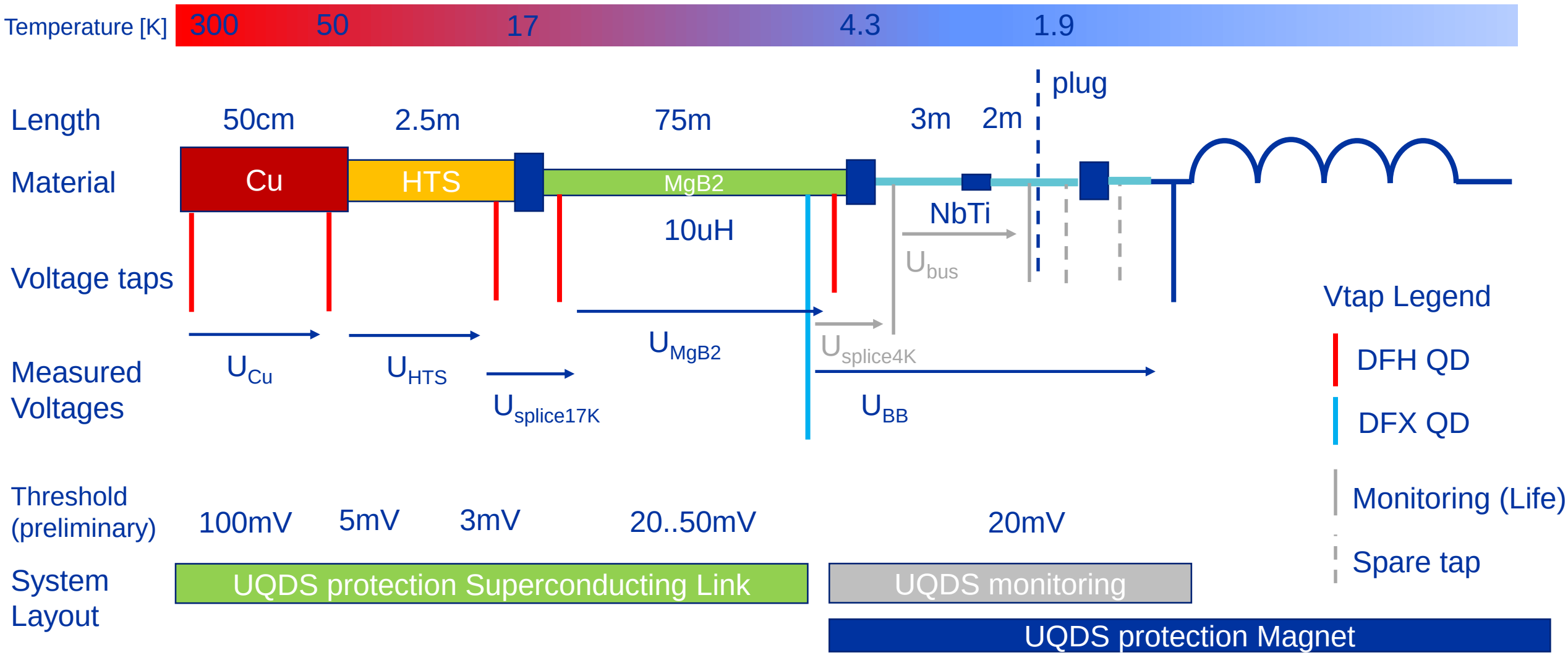
Deliverables for SC Link protection & current lead heater controls

Jens Steckert, Jelena Spasic, Tomasz Podzorny, Reiner Denz & colleagues – TE-MPE-EP

Outline

- **HL-LHC SC link protection**
  - System description
  - Voltages and thresholds
  - System size
  - Summary
- **Current lead heater controls**
  - System overview
  - Proposed solution
  - System size
  - Summary

SC link overview



SC Link QDS

- **Standard UQDS v2x crate with up to 16 measurement channels**
- **QD algorithm: Absolute Threshold**
  - Voltages over link elements show little dependence on di/dt, very low inductance
  - Element of highest inductance is MgB2 part which totals to ca 10uH
- **First large scale test of UQDS for SC link in cluster F2 in SM18 during spring next year**

SC link signals

- **5 voltages to be measured for protection of each link connection**
  - 1 signal of those (NbTi BB) will be supervised / protected by the magnet protection UQDS
  - 4 voltages by SC-Link QDS
- **Two monitored, but not protected signals (no redundancy)**
  - 4 Kelvin splice
  - NbTi bus down to 1.9K plug
- **One UQDS can protect up to four link branches (16 channels) (PRELIMINARY might be more dense in next system revision)**
- **System partitioned to not mix circuit classes in one UQDS box**
- **Monitored signals can be grouped in one UQDS box (no interlocks)**

System size

Magnet class	Circ. cur.	# circuit	Leads/circ	Sig/Lead	Signals tot	UQDS units (redundant)
IT	18kA	1	2	4	8	2
IT	2kA trim	1	3	4	12	2
MCBXFB	2 kA	4	2	4	32	4
MCBXFA	2 kA	2	2	4	16	2
D1	13 kA	1	2	4	8	2
D2	13 kA	1	2	4	8	2
MCBRD	600 A	4	2	4	32	4
						18

Per IP side:

➔ 18 UQDS required to protect all super conducting link connections

➔ 4 UQDS for additional signal monitoring

For P1, P5:

➔ 72 UQDS for Link protection of P1/P5

➔ 16 UQDS for additional monitoring of P1/P5

88 UQDS for SC link protection/ supervision

Summary

- **Protection scheme for SC link defined**
- **System partitioning and size determined**
- **Design of UQDS v2.2 completed and 130 units produced**
- **Cluster F2 in SM18 will act as a test bed followed by String2**
- **Next UQDS version (v3) enables potential to double the number of channels per UQDS and thus reduce the number of UQDS crates.**

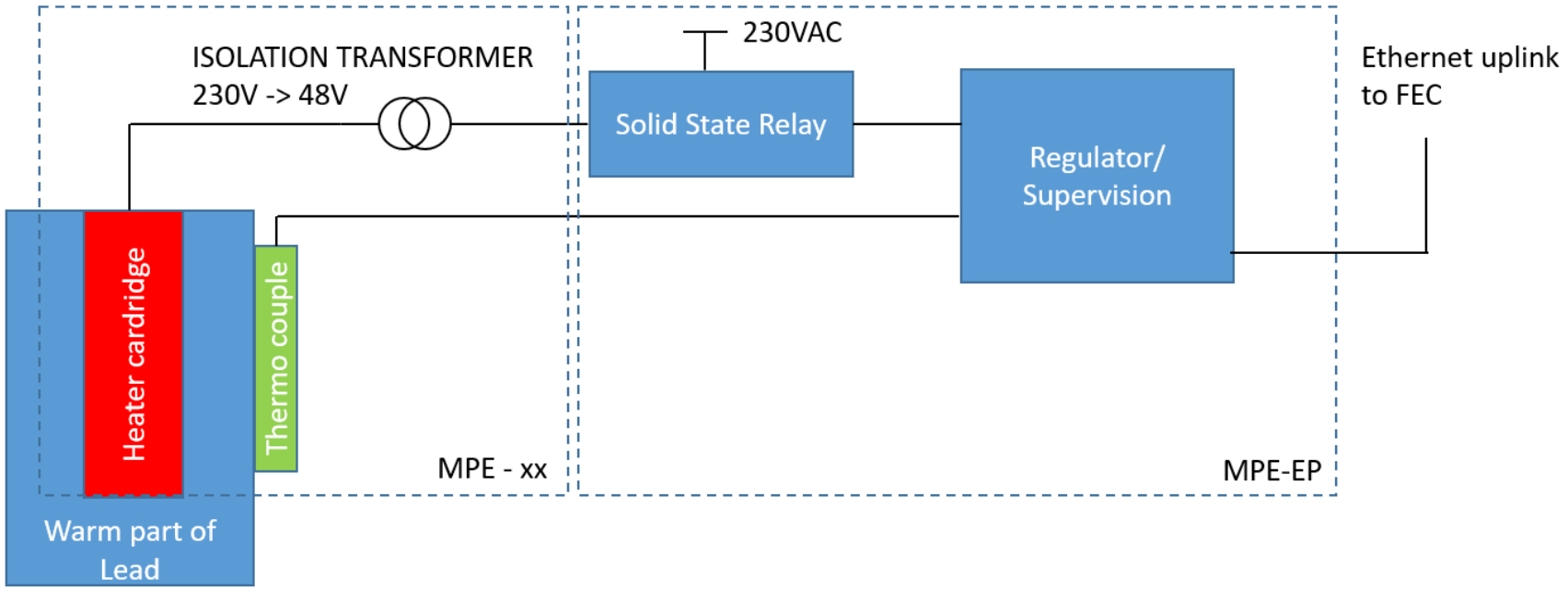
Current lead heater controls

Current lead heating system overview

- **Warm part of the current lead requires active heating to prevent icing in case of low load**
- **Heater cartridge integrated in warm part of lead, powered with 230VAC controlled by solid state relay (on/off)**

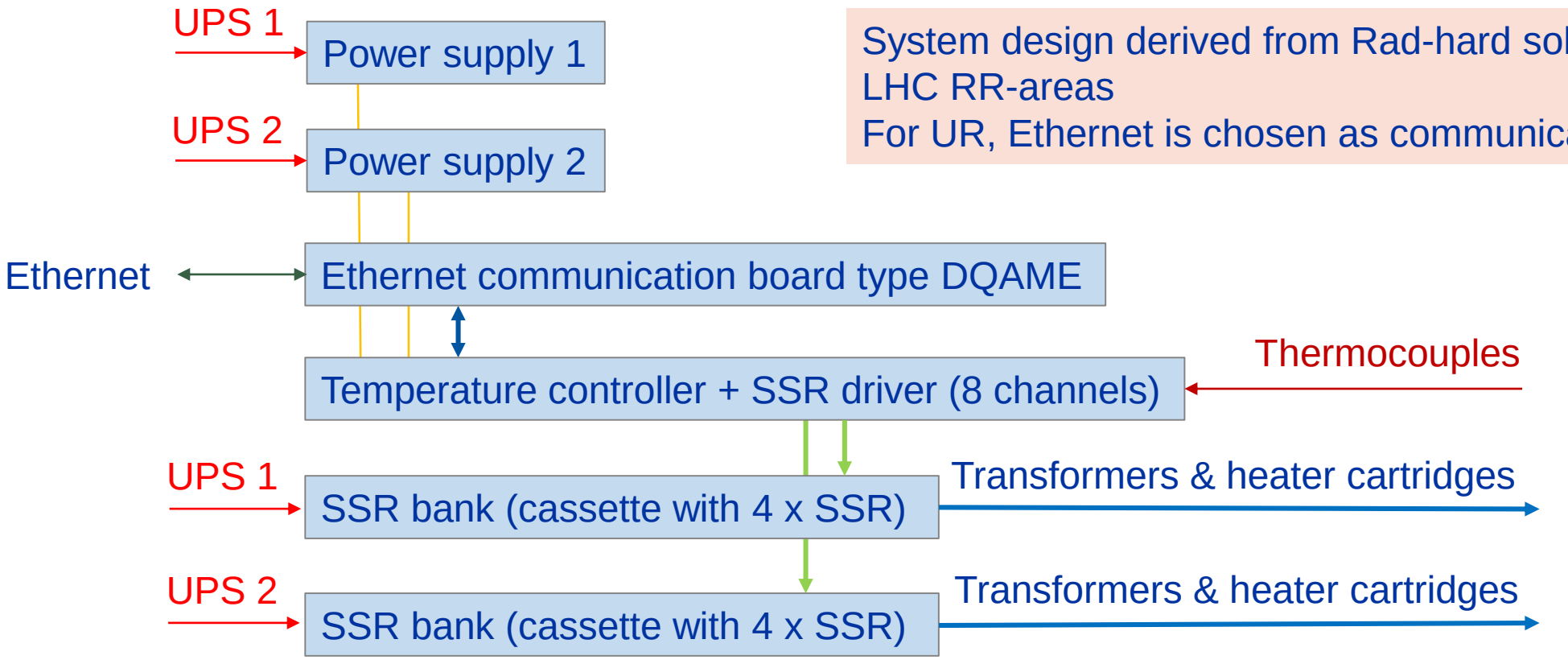
- **Simple on/off regulator powers/un-powers heater element based on temperature sensor reading**
- **Power part of the system follows the same architecture as for LHC circuits**
- **Commercial, non-supervised regulator is replaced by an in-house solution which is connected via Ethernet to the controls system**

New current lead heating system



- **48V powered heater cartridge fed with isolated voltage**
- **Thermocouple as feedback for regulator**
- **Solid state relay providing on/off capability**
- **Controller implementing regulation (on/off) and supervision**

Functional Design



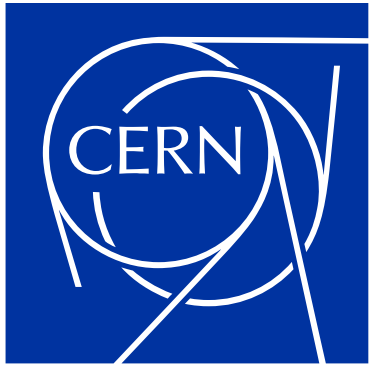
System design derived from Rad-hard solution for LHC RR-areas
For UR, Ethernet is chosen as communication link

Current lead heating system - size

- **29 super conducting links per IP side (IT + D1 + D2 + correctors)**
  → 116 controller channels for all IP
- **Each link is controlled by one controller channel**
- **System size (controllers) will not exceed one standard Rack per UR**
- **In-detail integration (# of lead ends per controller etc. still to be defined)**

Summary/Status

- **Power part of the system is defined → Talk of G. D'Angelo**
- **Basic design of controller part is defined → Derivative of R2E controller for LHC**
- **Detailed design (channels/controller) still to be defined**
- **System size per IP will not exceed one standard Rack**



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