Supervision interface of the 11 T protection electronics

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Contents

Supervision and data acquisition

Main functionalities:

- Logging of signals from protected circuit
- Logging of signals from detection devices
- Provide signals used by software interlocks
- Record post mortem data
- Provide remote diagnostics

Systems involved:

- Quench protection hardware
- Fieldbus infrastructure
- Frontend computers
- Supervision, data acquisition and archive servers

Scope of HiLumi activities

LS2 – 11 T Dipole

Highly advanced activities:

- Hardware is being finalized
- Interface to supervision declared
- Real time application renovation is ongoing

New features are introduced:

- General improvements
- No major changes

LS3 – Inner Triplet

Initial stage:

- Baseline is current 11 T development
- Considerably higher data load
- Logging time resolution to be improved

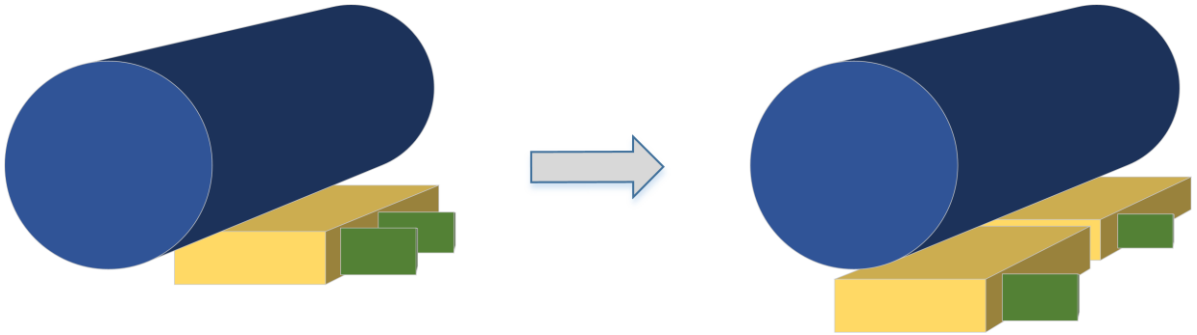
Expected changes:

- High throughput fieldbus
- High resolution logging
- Evolution of supervision system to accommodate different data nodes

Protection concepts for new installations

Enhanced redundancy level

- Redundant crates replaces redundant boards concept
- Equipment visible as separate unit in supervisory control and data acquisition
  - No data toggling
  - Facilitates automatic analysis of state of health of the units
- Provides better separation and enhances availability of the supervision



Protection concepts for new installations

Command interface – parametric commands

- Enable to perform accurately timed sequences on a crate controller level
- Downstream data resolution is significantly increased
- Enable firmware updates

Data logging

- Protection configuration continuously logged
- High definition logging can be introduced on a real time (RT) application level
- Generic supervisory control and data acquisition (SCADA) for low frequency control and supervision activities

Post mortem (PM) data – separated data sources

- Increases data availability
- Decrease of PM data acquisition time – concurrent processes

Fault recovery

- Separation enables implementation of automatic fault recovery in the RT

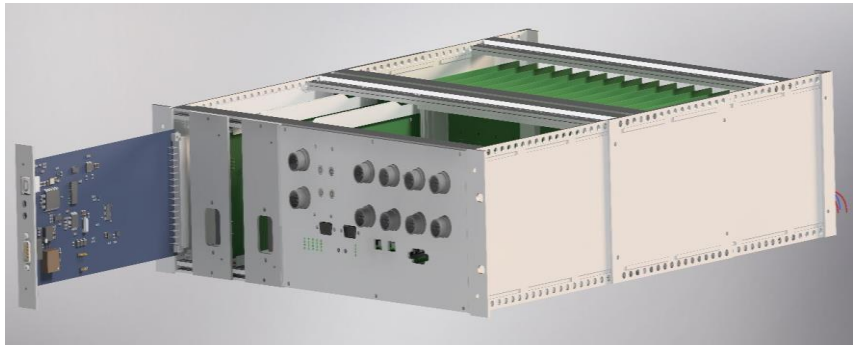
Technology solutions

Crate controller – fieldbus controller

- Local high speed communication to quench detection unit
- Based on Alstom WorldFip
- Migration possible to nanoFip or Ethernet based fieldbuses

Crate controller – local data management

- Adaptation possible if higher amount of data processing is required



Technology solutions

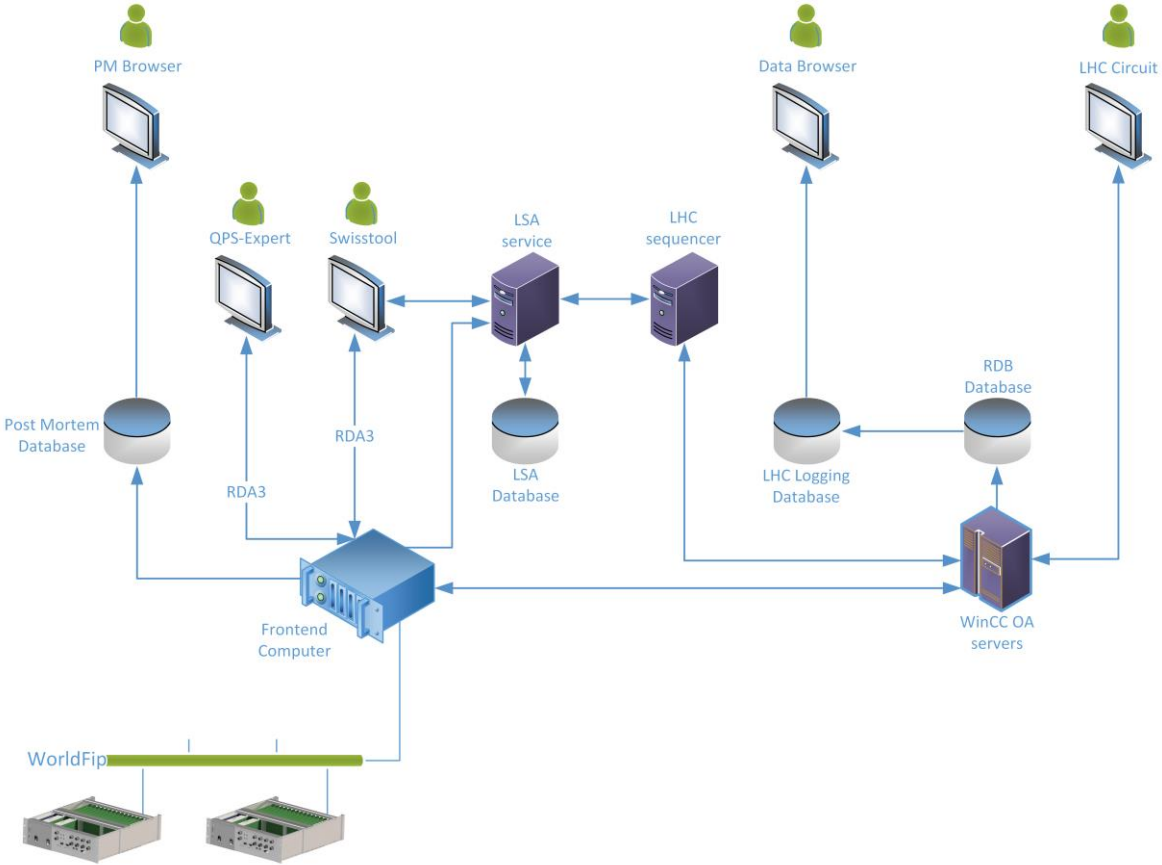
Frontend computers (FEC)

- Run fieldbus masters by specialized hardware
- Provide synchronization
- CC7 64 bit operating system
- No major changes expected in respect to hardware

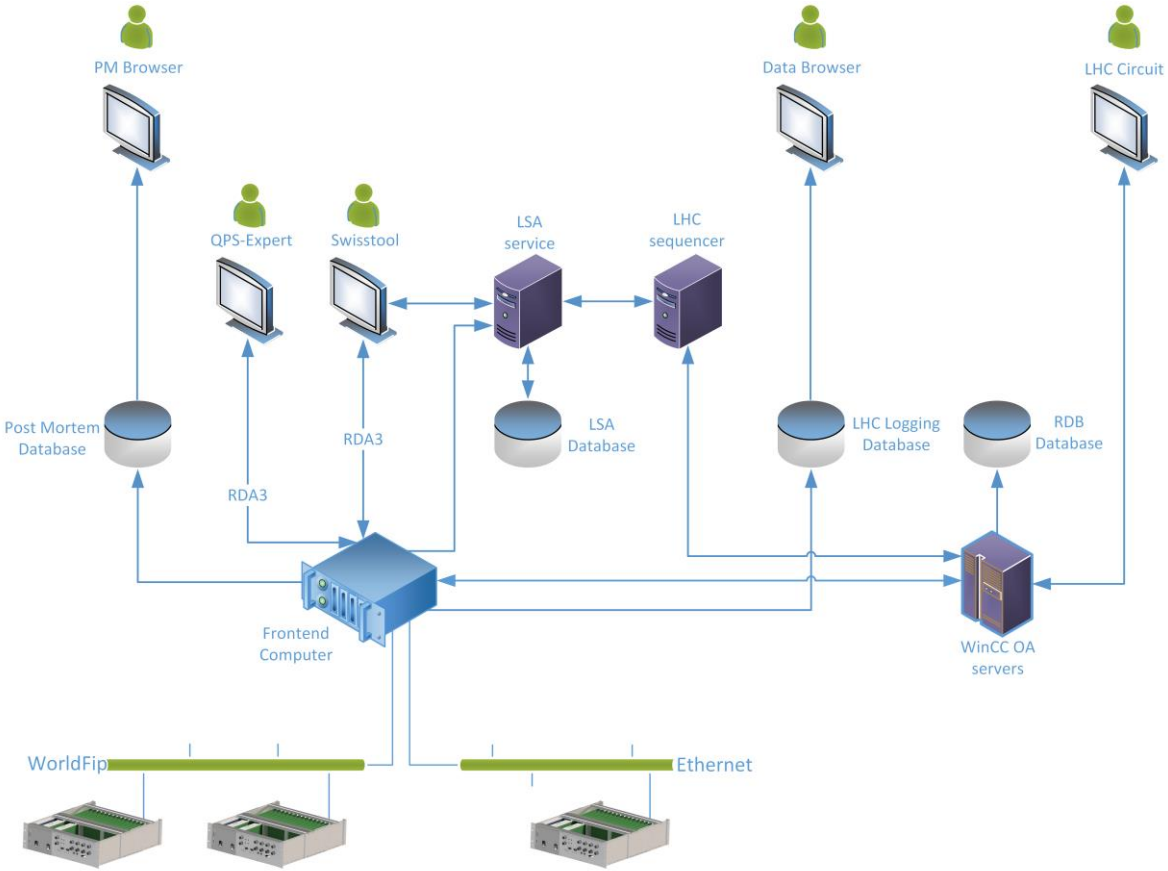
Real time application

- Support for an early UQDS agents has been already implemented
- RDA3 (remote device access) for upper layer supervision is validated
- Real time application supports CERN MFIP fieldbus master
- A general refactoring and renovation aimed on improving code quality and performance of the real time application is ongoing

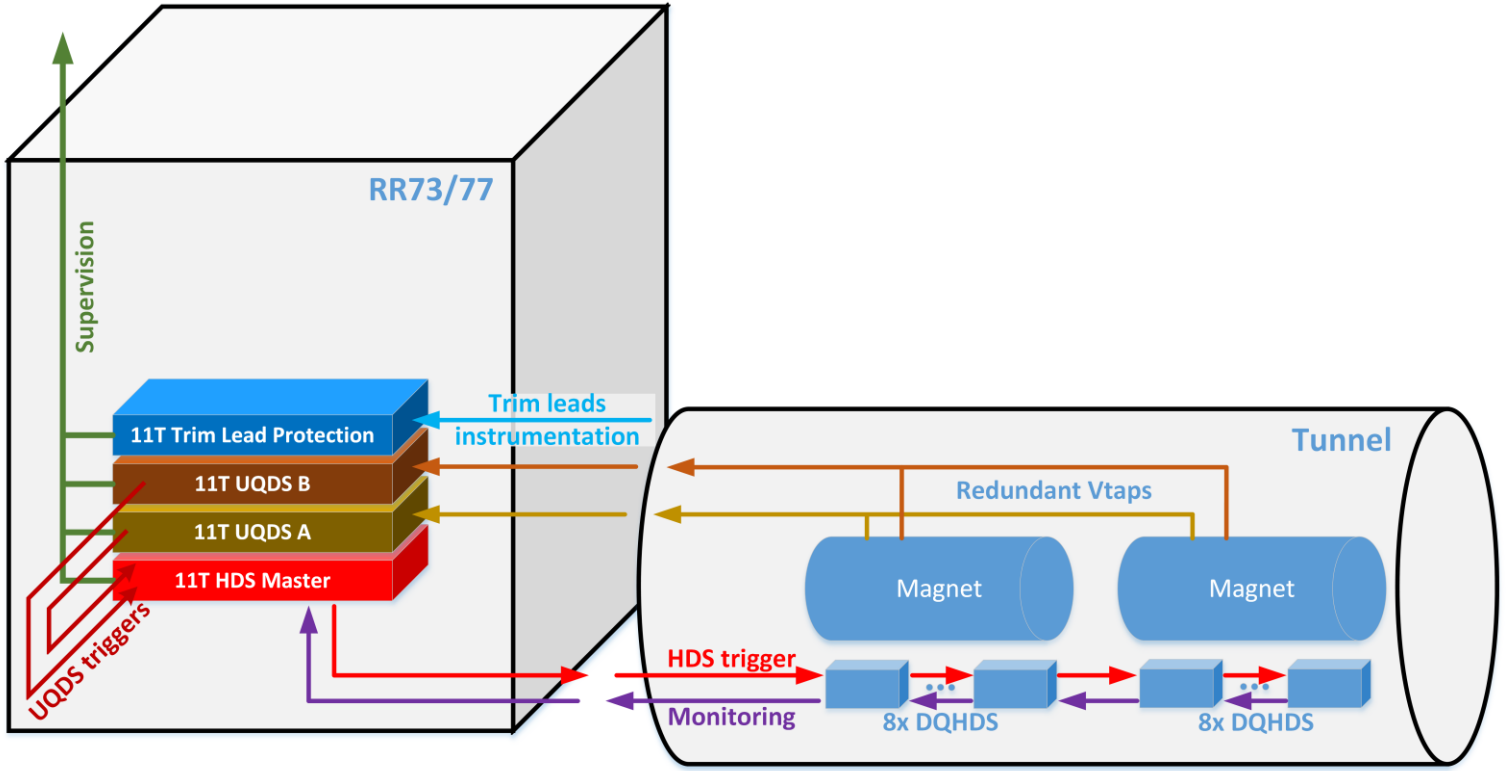
Supervision architecture



Supervision architecture – high definition data

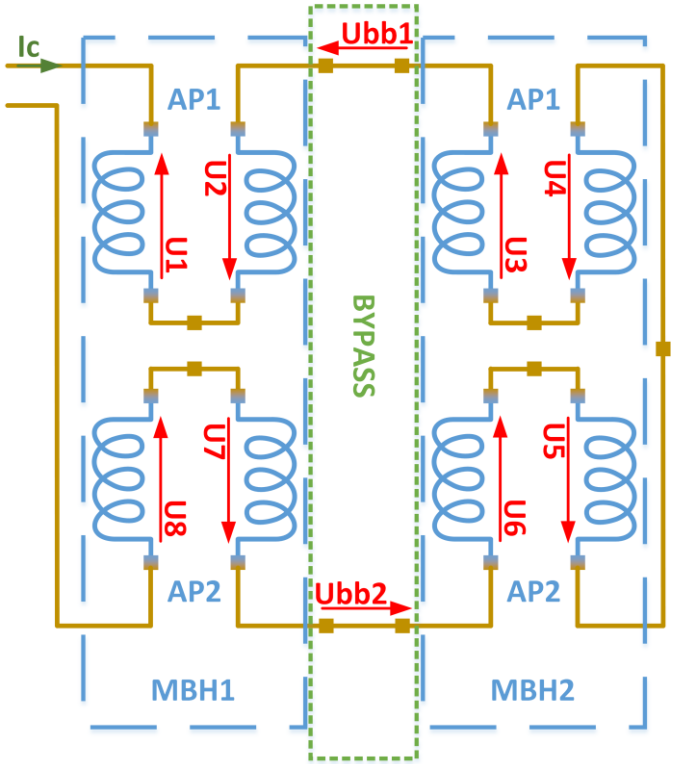


Protection structure of 11 T dipole



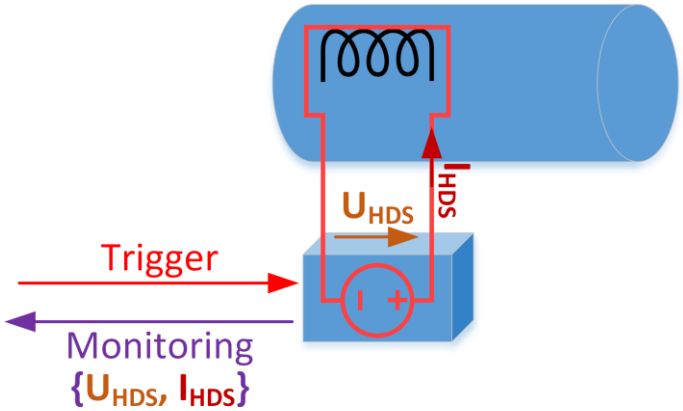
Data structure of single UQDS unit

Signal	Origin	Width
8 coils voltages	Measured	32 bit
1 magnet voltage	Measured	32 bit
1 circuit current	Measured	32 bit
4 coil quench voltages	**Calculated, QD**	**16 bit**
2 aperture symetric voltages	**Calculated, QD**	**16 bit**
2 bus-bars voltages	**Calculated, QD**	**16 bit**
Several interlocking status signals	Digital status	1 bit
Several internal status signals	Digital status	1 bit
3 configuration integrity signals	Digital word	8 bit



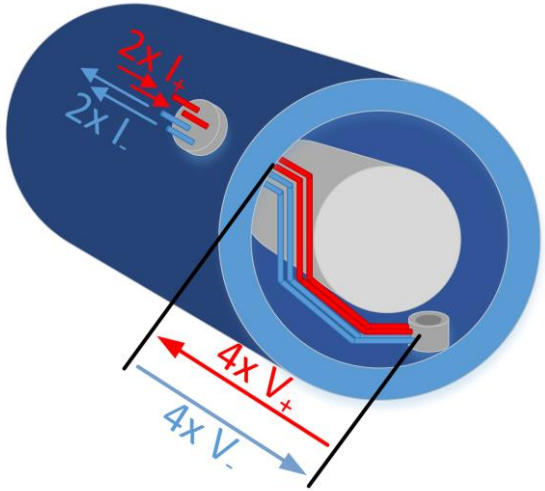
Data structure of HDS supervision unit

Signal	Origin	Width
16 heater power supplies voltages	Measured	16 bit
16 heater power supplies currents	Measured	16 bit
Several interlocking status signals	Digital status	1 bit
Several internal status signals	Digital status	1 bit



Data structure of Trim circuit supervision unit

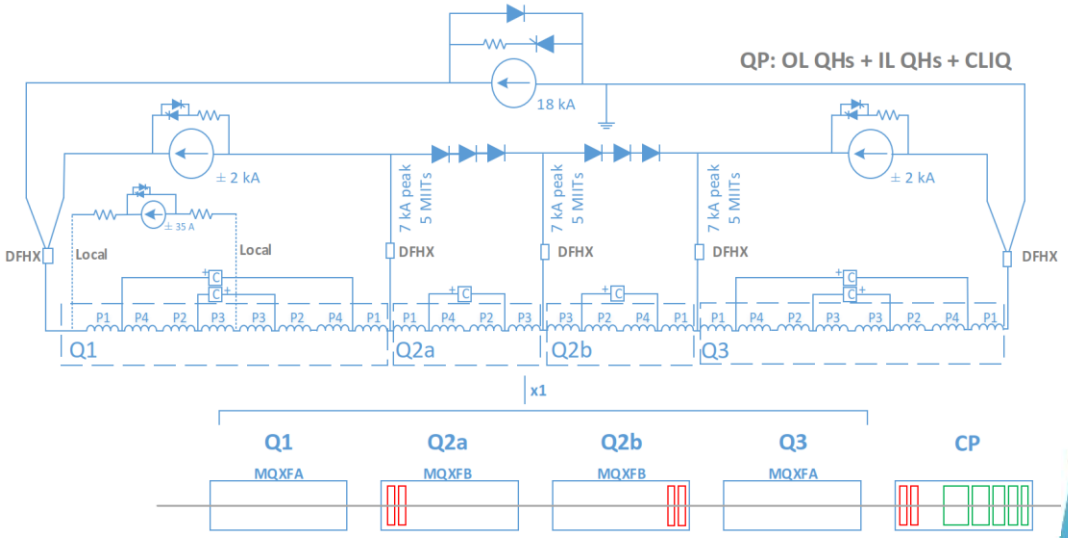
Signal type	Origin	Width
4 lead voltages (redundant A)	Measured	16 bit
4 lead voltages (redundant B)	Measured	16 bit
4 lead currents	Mesaured	16 bit
2 x 2 current balance signals	**Calculated, QD**	**16 bit**
2 x 4 tresholds on voltage leads	**Calculated, QD**	**16 bit**
Interlocking status signals	Digital status	1 bit
Internal status signals	Digital status	1 bit



Insight into supervision of inner triplet

Baseline:

- Inner triplet instrumentation is demanding
  - Definition of triggering signals is pending – depends on an outcome of magnet tests
- Superconducting links need protection
- 48 HDS units to supervise
- 6 CLIQ units likely to supervise



Insight into supervision of inner triplet

Signal type	Redundancy	Number of Vtaps	Channels
Pole voltage	A	48	24
Pole voltage	B	48	24
Bus-bar voltage	A	20	10
Bus-bar voltage	B	20	10
Corrector voltage	A	12	8
Corrector voltage	B	12	8
Corrector bus-bar	A	8	8
Corrector bus-bar	B	8	8
Total		**176**	**100**

Conclusions

Supervision of 11 T dipole protection will be ensured by ongoing evolution of the LHC/QPS system

- Data availability improvement
- Continuous configuration validation
- Simplified fault recovery

Supervision of inner triplet will be a natural evolution of the system

- More devices required to ensure protection of the circuit
- Considerable data load
- New fieldbus and data processing solutions to be implemented

Thank you for your attention

Acknowledgments to many members of TE-MPE and BE-ICS groups