

Machine Interlocks

Outline:

- ◆ Proposed architecture & locations
- ◆ Outstanding issues & requirements

- ◆ Participation to Hardware Commissioning
- ◆ Summary

1

Machine Interlock System = BEAM Interlock + POWERING Interlock

Give Beam Permit for injection

Abort Beams in case of failure

- Carry the request a.s.a.p. to the Beam Dump System

**Very Time critical ($\sim 10 \mu\text{s}$)
and must be fail-safe**

all safety/time critical signals
via fail-safe hardware links

- ❖ Provoke generation of a *Post-Mortem Event*
- ❖ Record data for P-M analysis

Give Power Permit to converters

Abort Powering in case of failure

- Stop power converter
- Open energy extraction switch

**Time critical ($\sim 10 \text{ms}$)
and must be fail-safe**

all safety/time critical signals
via fail-safe hardware links

- ❖ Record data for Post-Mortem analysis

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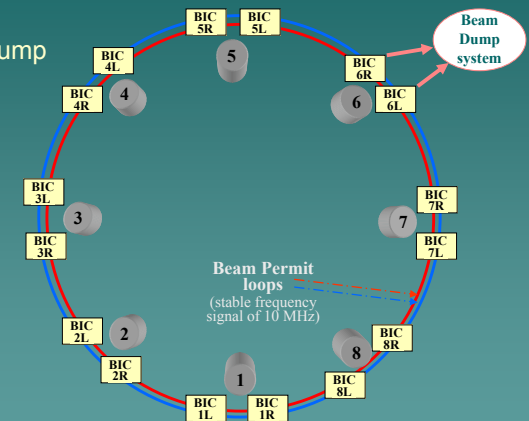
2

Beam Interlock System

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Layout of the Beam Interlock System

- ◆ 16 Beam Interlock Controllers
 - ◆ 2 fast links
 - ◆ if one loop open \Rightarrow Beam Dump
 - ◆ unique signal request per system* and per BIC
- (* with possible redundancy)

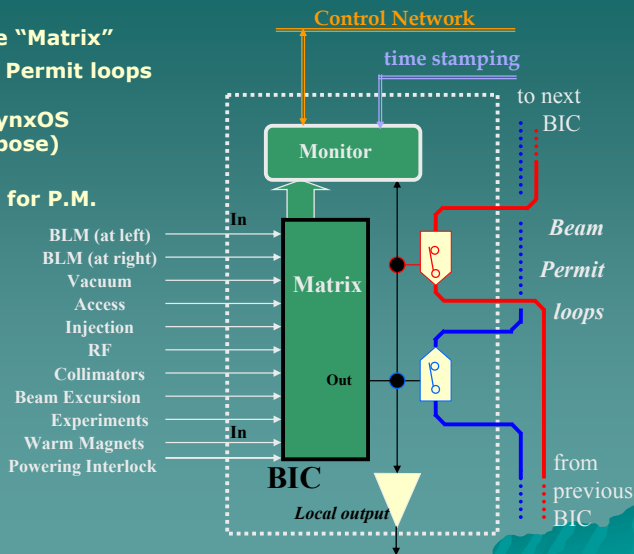


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Beam Interlock Controller

- ◆ Consists in Hardware "Matrix"
- ◆ Interrupts the Beam Permit loops
- ◆ Embedded in VME/LynxOS (for monitoring purpose)
- ◆ Time stamping input for P.M.

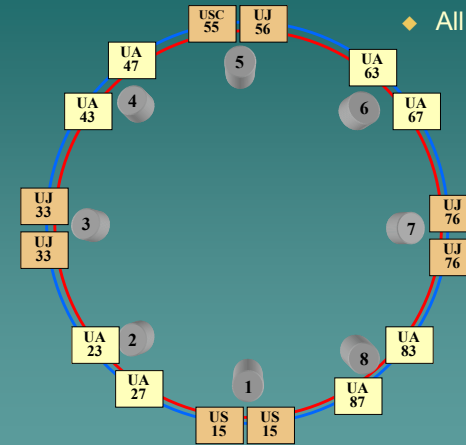


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Location of Beam Interlock Controllers

- ◆ All installed in underground areas



- ◆ Ethernet connection
- ◆ Timing connection
- ◆ Powered by UPS

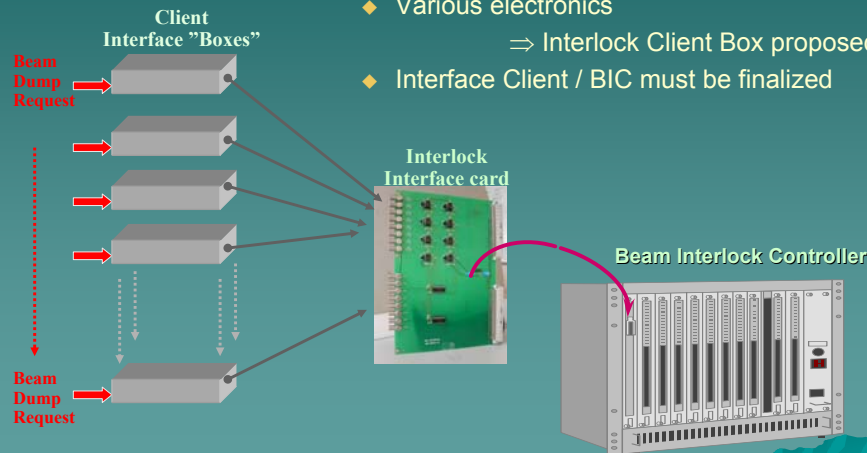
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Outstanding issues (1/2)

(1/2)

- ◆ 180 Connections for Dump requests
- ◆ Various electronics
⇒ Interlock Client Box proposed
- ◆ Interface Client / BIC must be finalized

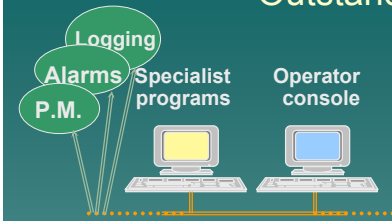


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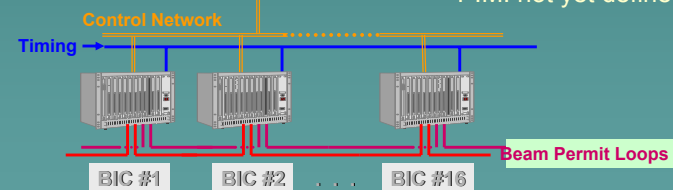
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Outstanding issues (2/2)

(2/2)



3-tier Architecture
(JAVA, J2EE + CMW)



Beam Permit Loops

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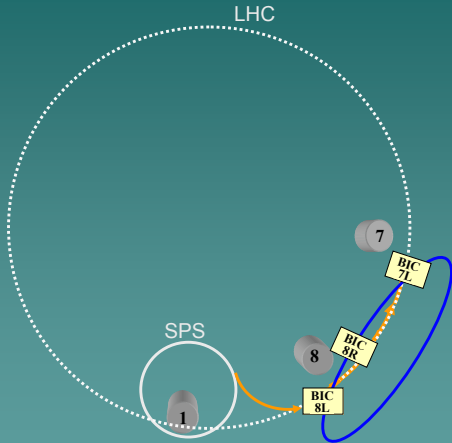
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- ◆ Safety analysis must be performed
- ◆ Solution using 3-tier Architecture proposed for equipment access
⇒ Validation after SPS Extraction Tests?
- ◆ Interfaces with Logging, Alarms, & P.M. not yet defined

Injection Tests

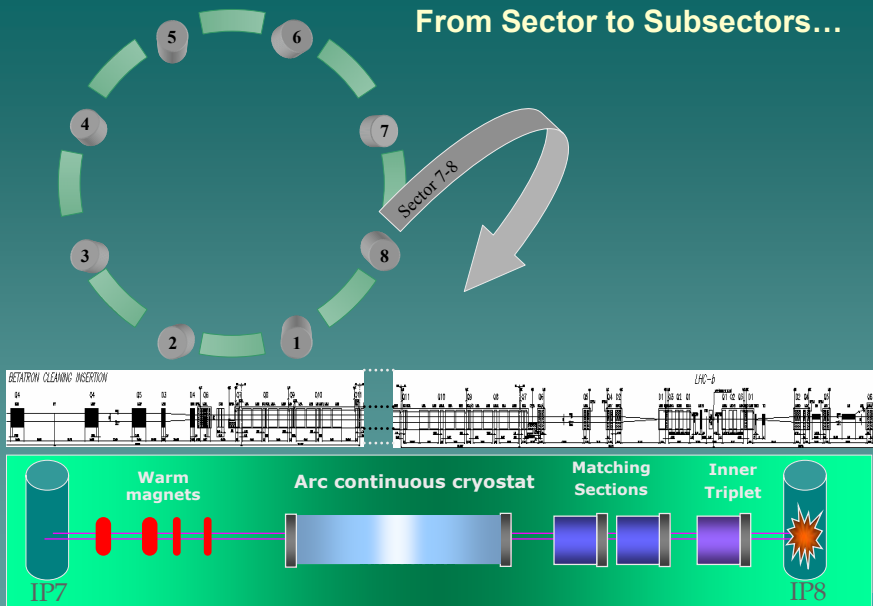
- ◆ Participation with 3 BICs
- ◆ 1 “Beam Permit Loop”
- ◆ If loop open ⇒ Injection veto
- ◆ Possible clients:

- Injection system
- Powering Interlock
- Warm Magnets
- Vacuum
- Access
- BLM ?



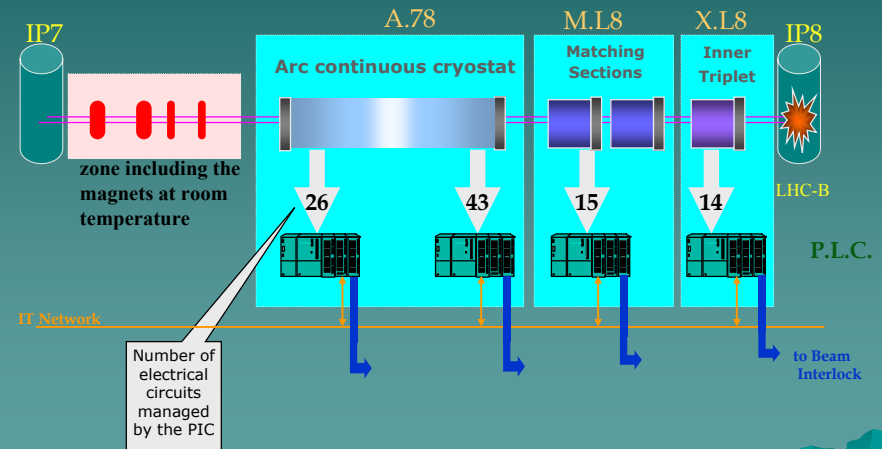
Powering Interlock System

From Sector to Subsectors...



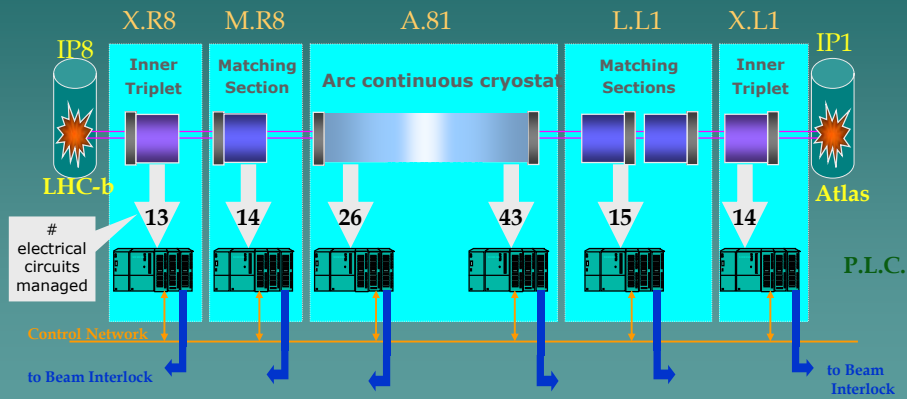
Not to scale

POWERING Subsectors in 7-8



Number of electrical circuits managed by the PIC

POWERING Subsectors in 8-1



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POWERING Subsectors

1	X.R1	L.R1	A 12	M.L2	X.L2	2
2	X.R2	M.R2	A 23			3
3			A 34	M.L4		4
4		L.R4	A 45	L.L5	X.L5	5
5	X.R5	L.R5	A 56	M.L6		6
6		L.R6	A 67			7
7			A 78	M.L8	X.L8	8
8	X.R8	L.R8	A 81	L.L1	X.L1	1

Functional specification EDMS No361532: "The Powering Subsectors"

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Powering Interlock Controllers Location

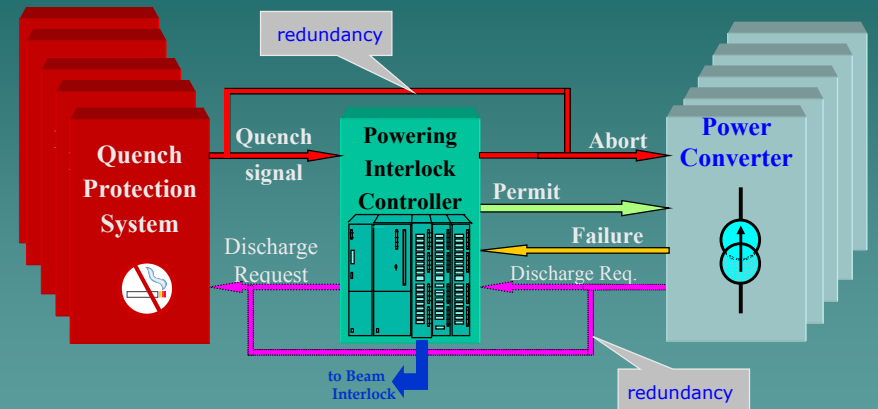
I	[Server Racks]						P
1	UJ16	RR17	RR17	UA23	UA23	UA23	2
2	UA27	UA27	UA27	UJ33			3
3			UJ33	UA43	UA43		4
4		UA47	UA47	RR53	RR53	USC55	5
5	UJ56	RR57	RR57	UA63	UA63		6
6		UA67	UA67	RR73			7
7			RR77	UA83	UA83	UA83	8
8	UA87	UA87	UA87	RR13	RR13	UJ14	1

Technical Services required: Ethernet & UPS

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Interlock signals for one electrical circuit



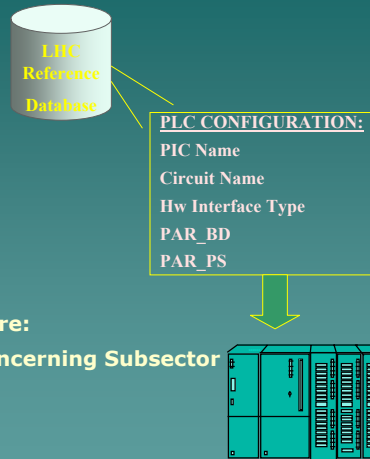
Engineering specification EDMS No368927: The Interfaces between Powering Interlock System, Power Converters and Quench Protection System

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Powering Interlock Classes

- > ~900 different converters to handle
(60 Amp. Orbit correctors not considered)

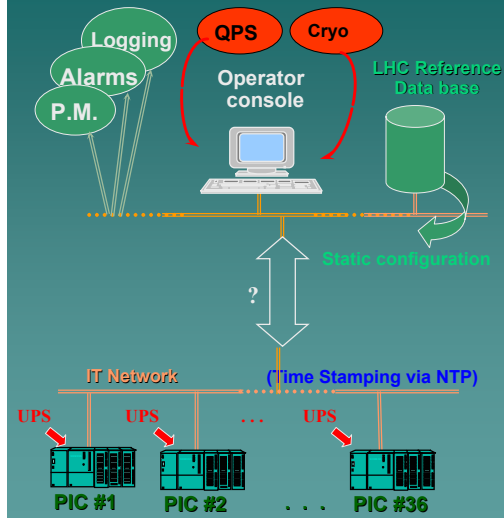


- > **Managed through Interlock Classes following the LHC Reference Database**

- > Depending of the class the attached process differs after a quench or a failure:

- Abort (or not) Powering in the concerning Subsector
- Request (or not) a Beam Dump

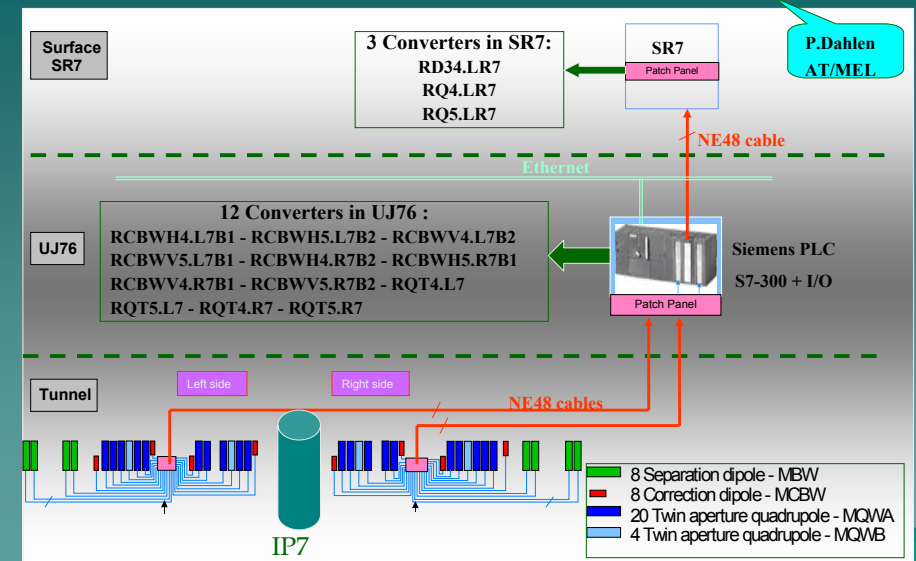
Outstanding issues & Requirements



- ◆ Radiation tolerant Hw solution must be finalized for RR
- ◆ "A.U.G" Interface
- ◆ UPS Interface
- ◆ Safety analysis
- ◆ Interface with Supervision has to be chosen
- ◆ Interfaces with Logging, Alarms, & Post-Mortem not yet defined
- ◆ Interfaces with Cryo & QPS
- ◆ "Accurate" Time Stamping via NTP (~1ms)

Warm Magnets Interlock System

Schéma de principe des interlocks des "aimants chauds" au point 7 du LHC



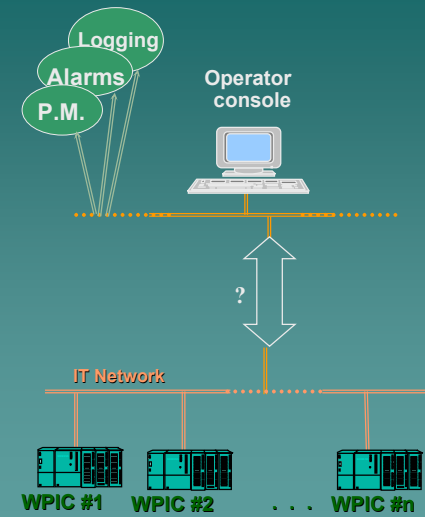
Récapitulatif du nombre d'aimants « chauds » dans lignes de transfert et LHC

Zone	# Aimants	# Conv.
TI2	308	33
TI8	401	28
CNGS-TT41	108	18

Point 1	12	1
Point 2	3	3
Point 3	44	15
Point 5	12	1
Point 6	30	2
Point 7	40	15
Point 8	3	3

P.Dahlen
AT/MEL

Outstanding issues for Warm Magnets Interlock



- ◆ Interface with Supervision has to be chosen
- ◆ Interfaces with Logging, Alarms, & Post-Mortem not yet defined

Machine Interlocks Systems & Hardware Commissioning

Hardware Commissioning

Beam Interlock:

- ◆ Dedicated Beam Interlock commissioning could be partially done.
- ◆ Two phases:
 - 1) Single test for client/BIC interface
 - 2) Before injecting beams: mandatory test of the whole system with all Interlock clients and the closed Beam Permit Loops.
- ◆ Strategy discussed into MPWG ⇒ Sketch proposed to HCWG

Powering Interlock:

- ◆ "PIC test system" for Q4/03
- ◆ Tests procedures " similar as " the String2 one
- ◆ Commissioning dates according HCWG schedule

Warm Magnets Interlock:

- ◆ Procedure & dates must be discussed in the HCWG...

Conclusions

- ◆ Started late but ...
- ◆ Thanks to...
- ◆ Participation to the Hw Com. according to HCWC procedures and proposals
- ◆ Outstanding issues rely on AB/CO competence and skills...
- ◆ Confidence...

- ◆ Questions?...