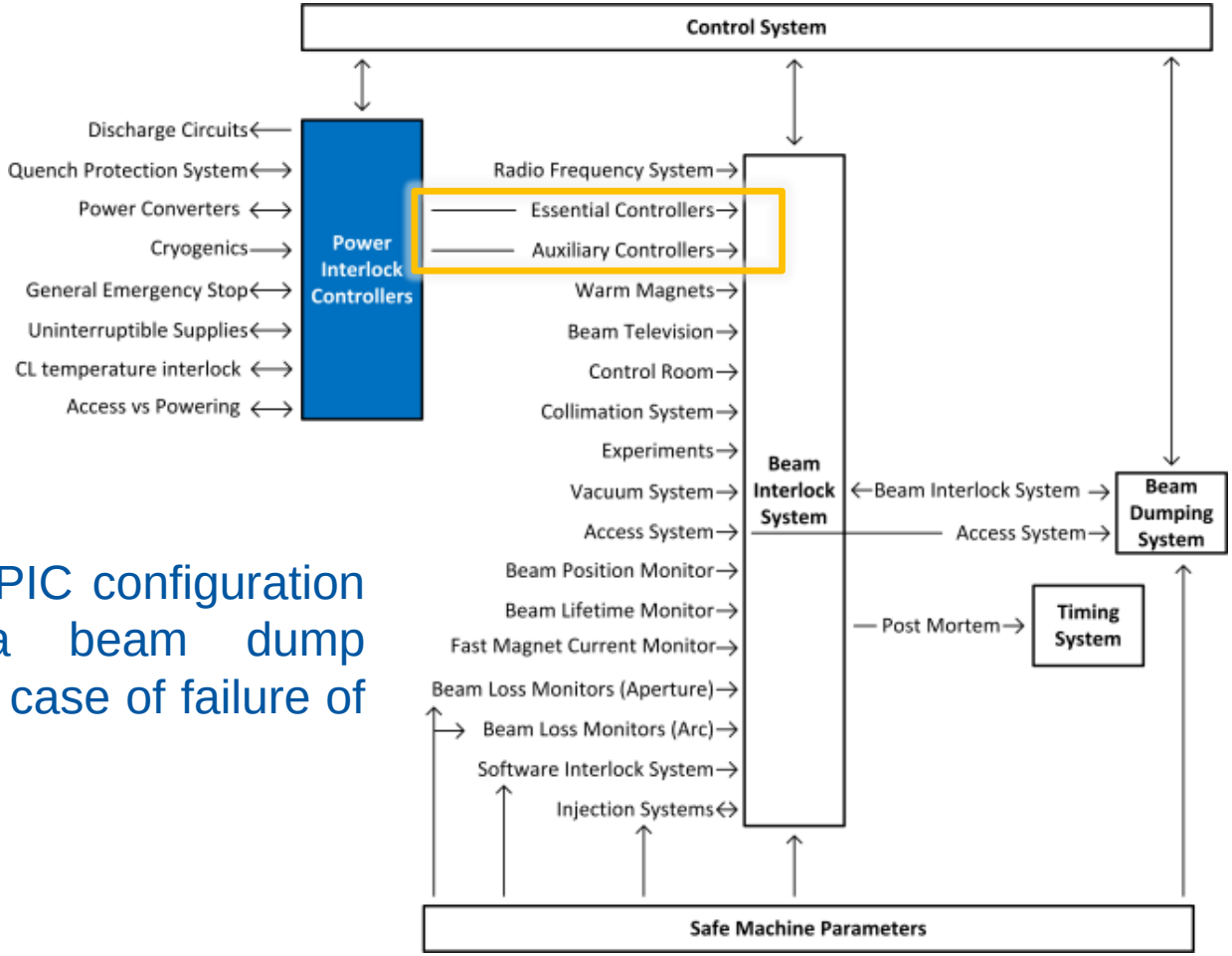
Power Interlock Controller

PIC Configuration for Skew Quadrupoles (RQS)

Outline

- Powering and Beam Interlocks
- RQS trips in 2017
- RQS trips triggering a beam dump analysis
- RQS in PIC configuration
- Recommendation

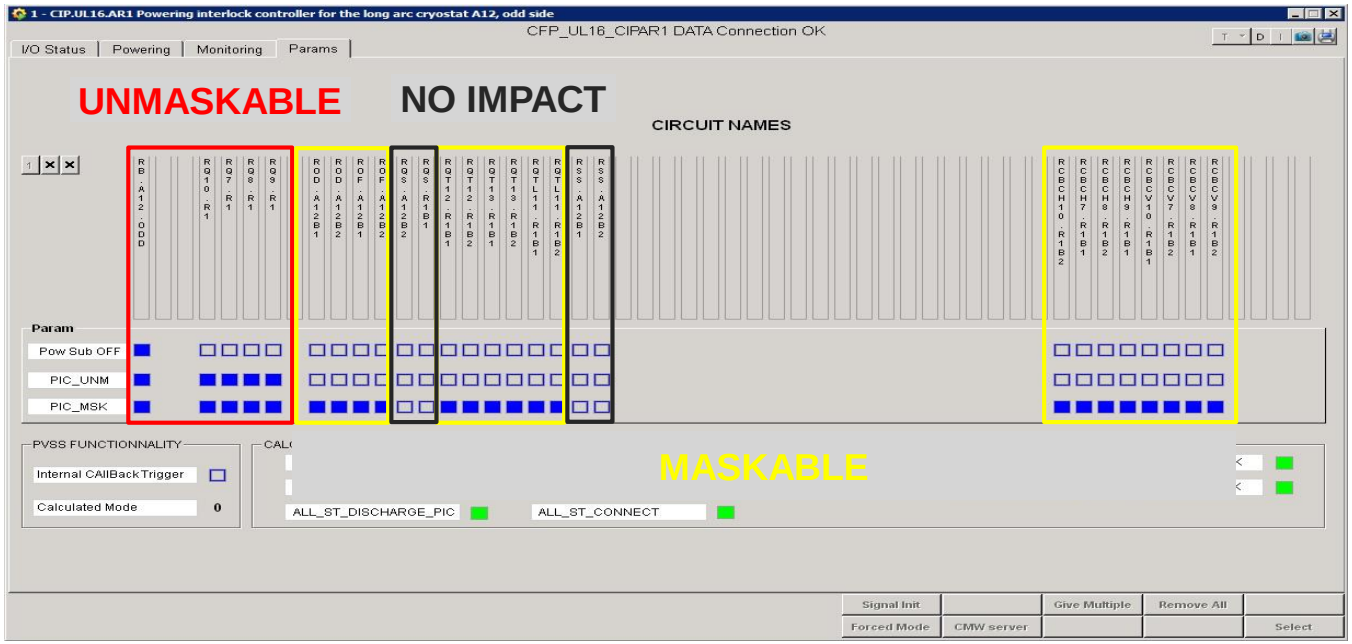
Powering and Beam Interlocks



Circuit in PIC configuration means a beam dump request in case of failure of this circuit

Powering and Beam Interlocks

- **Essential** for operation - **UNMASKABLE**:
  - RB, RQD, RQF, RQX, RD1-4, RQ4-RQ10
- **Auxilliary** for operation - **MASKABLE**:
  - RCS, RQT%, RSD%, RSF%, **RQSX3**, ROD, ROF, RCBXH/V and RCB%
- **NO IMPACT** (do not trigger the BIS)
  - RCD, RCO, **RQS.%**, RSS



RQS.[A/L/R] trips in 2017 (1)

Nr	Date	Time	Circuits	Comments	Dump
1	16/05/2017	5:34	RQS.A67B1 & RQS.L7B2		No
2	02/06/2017	16:20	RQS.R2B2	while setting all PCs to STDBY in preparation of the precycle	No
3	13/06/2017	02:52	RQS.A56B2 & RQS.R5B1	A number of circuits in Sector 56	No
4	16/06/2017	18:00	RQS.A81B1	QPS Trigger. Dump on BLM TCSG in IP7 on long running sum	Yes
5	19/06/207	17:58	RQS.A56B2 & RQS.L6B1	A number of circuits in Sector 56 trip	No
6	20/06/2017	12:32	RQS.A56B2 & RQS.R5B1	A number of circuits in Sector 56 trip during rampdown...	No
7	21/06/2017	23:13	RQS.A81B1	9 Circuits had tripped in sector 81	No
8	27/06/2017	01:52	RQS.R7B1	Tripped in SB and produced some losses on B1	No
9	26/07/2017	21:14	RQS.A23B1	tripped during the precycle	No
10	31/07/2017	00:32	RQS.A56B2	3 other circuits on the same QPS controller tripped. Beam is still in	No

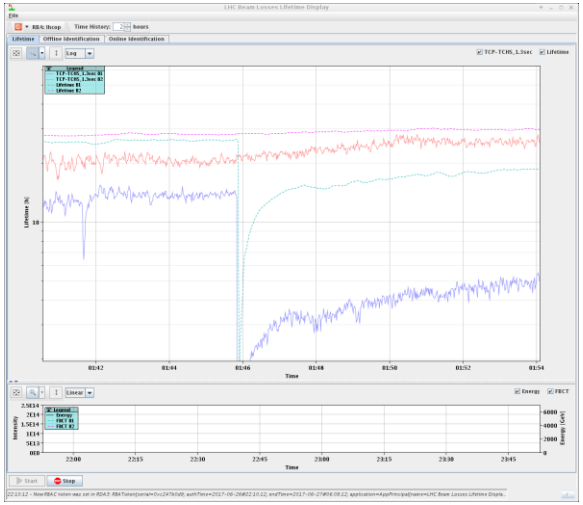
RQS.[A/L/R] trips in 2017 (2)

Nr	Date	Time	Circuits	Comments	Dump
11	07/08/2017	13:55	RQS.A81B1	Tripped in SB, beam dumped	Yes
12	10/08/2017	19:01	RQS.L1B2 & RQS.R5B2	Tripped during ramp-up of precycle	No
13	15/08/2017	23:06	RQS.R5B1	During the precycle. Together RQS.A56B2, RSS.A56B1 RSS.A56B2	No
14	22/08/2017	06:02	RQS.A81B1 & RQS.L1B2	6 circuits tripped during rampdown in sector 81	No
15	23/08/2017	11:16	RQS.L1B2	During pre-cycle. And the other 3 that are in the same crate (RSS.A81B1/2, RQS.A81B1)	No
16	23/08/2017	11:16	RQS.R5B1 &	During pre-cycle. And the other 3 that are in the same crate (RSS.A56B1/2, RQS.A56B2)	No
17	24/08/2017	00:02 02:40	RQS.A81B1 & RQS.L1B2	Circuits at S81 tripped during ramp down	No
18	24/08/2017	12:18	RQS.L1B2 & RQS.R5B1	Trip during the ramp up of precycle	No
19	24/08/2017	12:41	RQS.xxx	Trip in sector 81 & 56	No
20	12/09/2017	01:50	RQS.A78R7B1	During the ramp down	No

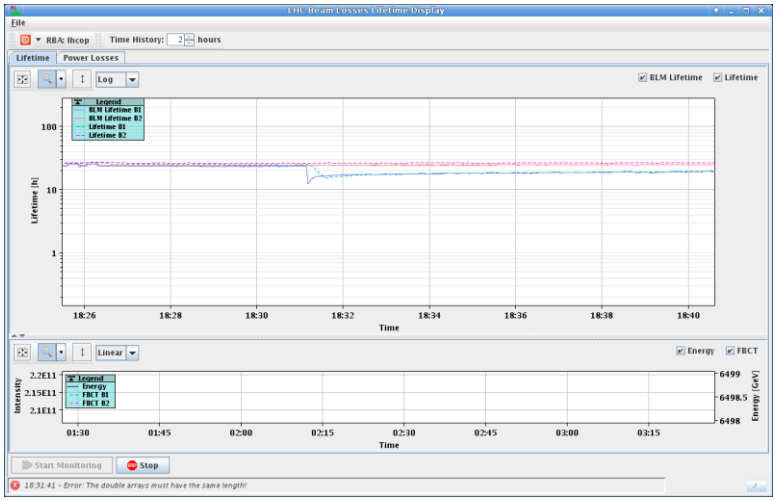
RQS.[A/L/R] trips in 2017 (3)

Nr	Date	Time	Circuits	Comments	Dump
21	21/09/2017	03:21 04:26	RQS.A45B1 & RQS.L5B2	Multiple trip in sector 45 at the end of the precycle	No
22	24/09/2017	07:22	RQS.A81B1 & RQS.A81B2	And RSS.A81B1, the other in the same crate	No
23	14/10/2017	18:34	RQS.A56B2 & RQS.R5B1	RSS.A56B1 also tripped but beams are still in; lifetime drop on B1	No
24	22/10/2017	00:16	RQS.A23B1	Trip during ramp down	No
25	28/10/2017	09:55	RQS.A81B1 & RQS.A81B2	RSS.A81B1/2 also tripped. Lifetime dip when RQS tripped.	No
26	09/11/2017	03:49	RQS.R7B1	Also the trip of the other three circuits on the same controller. Lifetime dip when losing the RQS.	No
27	15/11/2017	13:12	RQS:R8B2	During rampdown, lots of other circuits trip in S8	No
28	20/11/2017	00:23	RQS.R7B1	RQS.A78B2, RSS.A78B1, RSS.A78B2 followed 10 afterwards.	No
29	20/11/2017	08:13	RQS.A78B1 & RQS.R7B1		No
30	21/11/2017	15:13	RQS.R5B1	Aux power supply	No

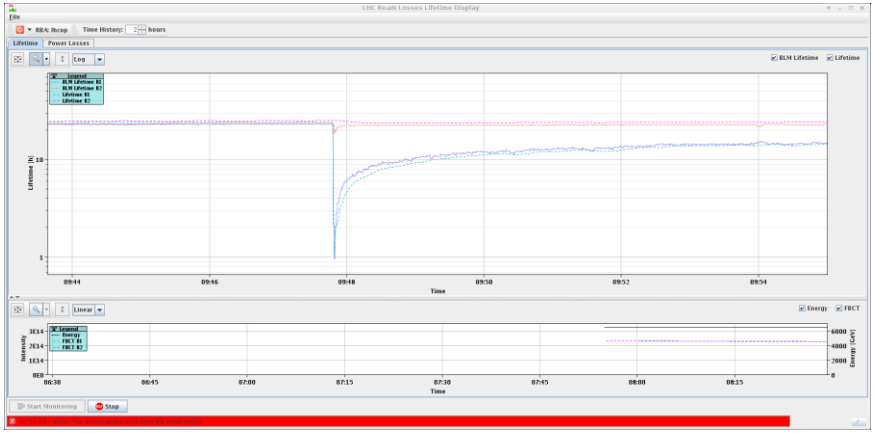
27/06/2017 RQS.R7B1



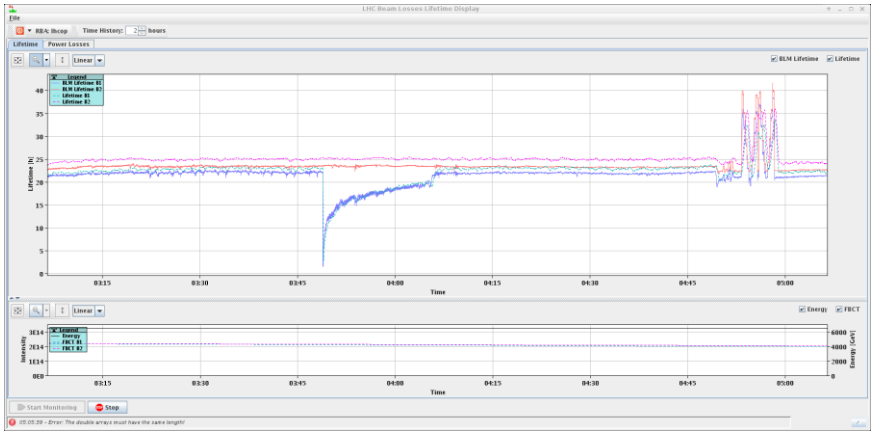
14/10/2017 RQS.A56B2 & RQS.R5B1



28/10/2017 RQS.A81B1 & RQS.A81B2



09/11/2017 RQS.R7B1



RQS.[A/L/R] trips in 2017 (4)

Summary

- 30x RQS.[A/L/R] events in 2017.
  - 23x RQS trips without beam.
  - 2x RQS trips in SB generating a beam dump via the BLMs.
  - 5x RQS trips creating beam losses / lifetime dip but no beam dump.
- *Adding RQS.[A/L/R] into PIC configuration as MASKABLE or UNMASKABLE would have led to 5 Beam Dump*

16/06/2017 RQS trips in SB

Analyse

Quench
18:00:43.074

PWR_FAILURE
18:00:43.076

1008 ms

Beam Dump
18:00:44.084

07/08/2017 RQS trips in SB

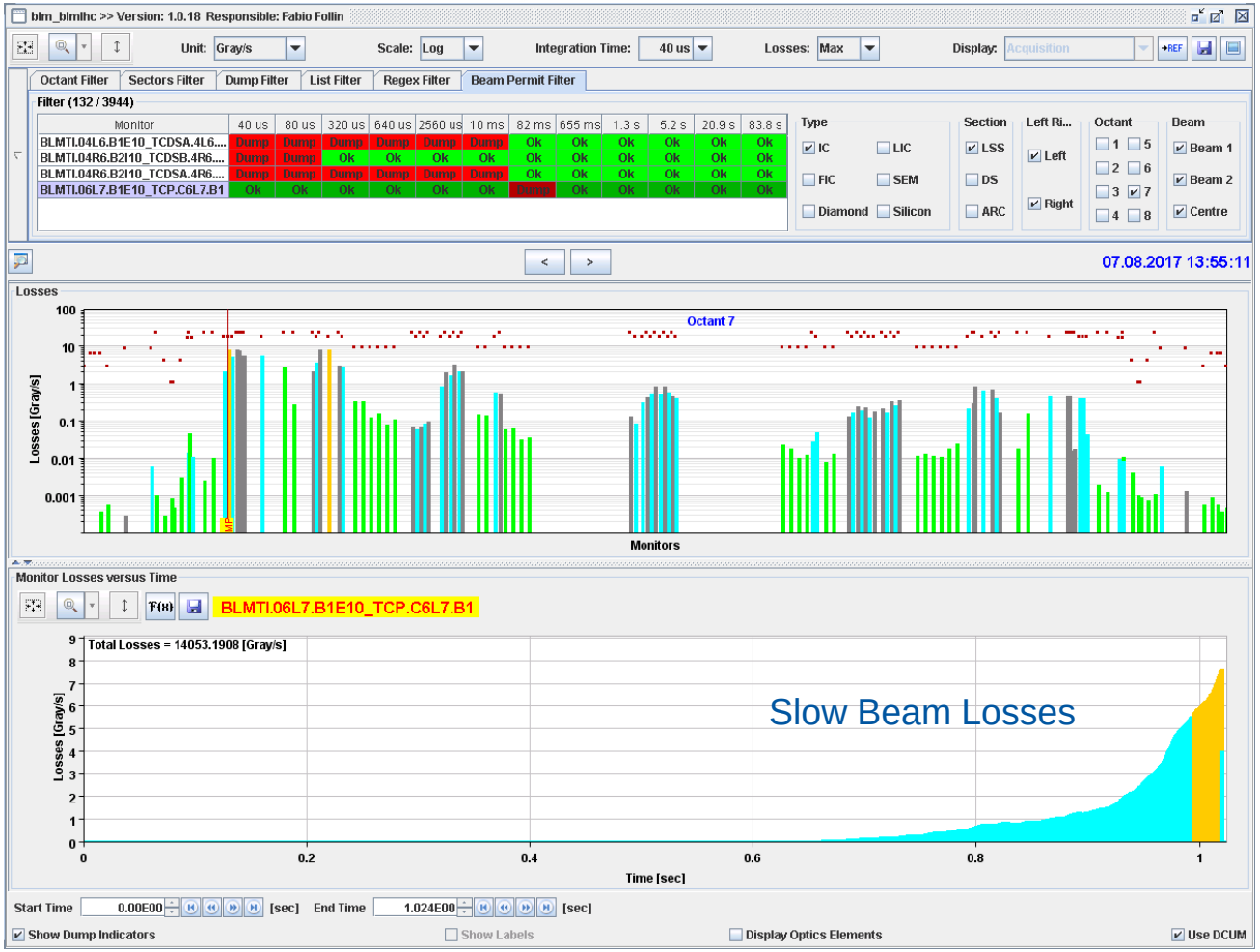
Analyse

Quench
13:55:10.696

PWR_FAILURE
13:55:10.700

466 ms

Beam Dump
13:55:11.166



RQS in PIC Configuration ?

Recommandation

- The worst case is: RQS Trip + BLM Failure
  - No beam dump requested
  - Losses will increase slowly
  - A quench could occur in case of the losses are important and the beam will be dump via QPS-PIC.
  - The likelihood to create any damage is very limited because the losses are expected to be very slow.
- **We recommend not to change PIC configuration for the RQS.[A/L/R] circuits**

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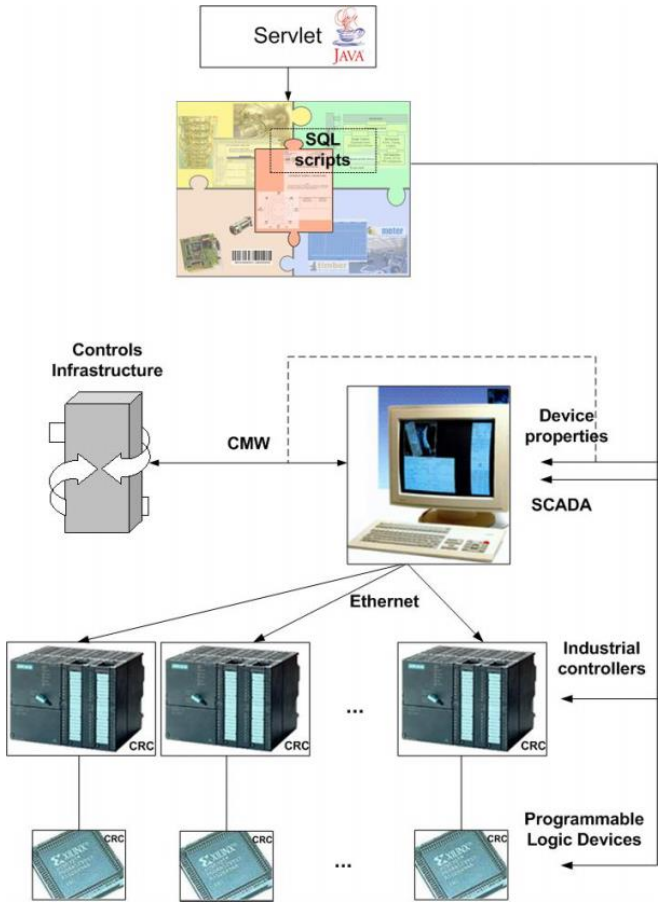
How to deploy new configuration…

- Apply changes to **reference DB**
- Generate **configuration data** (script)
- **Download new configuration** to PLC

- Time estimated for changes: 4 hours

- Time estimated for validation: 2 hours
  - Run a few powering tests
  - Run PIC-BIC interface sequences



Potential modification for LS2

- **RQS.%:** Propose to include in **MASKABLE** configuration to avoid dump on beam losses
  - Event on 16.06.2017: Trip of RQS.A81B1 provoked beam losses in R7.
  - Several families: RQS.A% (8 circuits), RQS.L/R% (8+8 circuits)
  - Currently studying the expected kicks from RQS circuits