MACHINE PROTECTION SYSTEM FOR SPIRAL2

Presented by C.Berthe,E.Lecorche,M-H Moscatello,G.Normand

Main functions of the MPS

- Protect the beam tubes and insertable equipment (slits, faraday cups, targets…) from beam thermal damages
- Control the operating range of the facility
- Control the activation due to beam losses (1W/m for D^+)
- Ensure a reinforced protection of the beam dumps and targets

SPIRAL2 SPM specificity

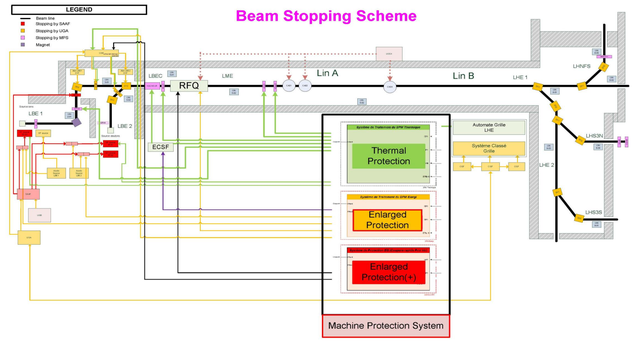
Various beams : from protons to Kr…
Various intensities: from 20μA to 5mA
Various energies: from 2 MeV/A to 33 MeV (protons) at linac exit
Beam structure: from CW to chopping 1/10000 and a single bunch mode

=> Large power range to monitor: from a few 100 W to 200 kW at linac exit

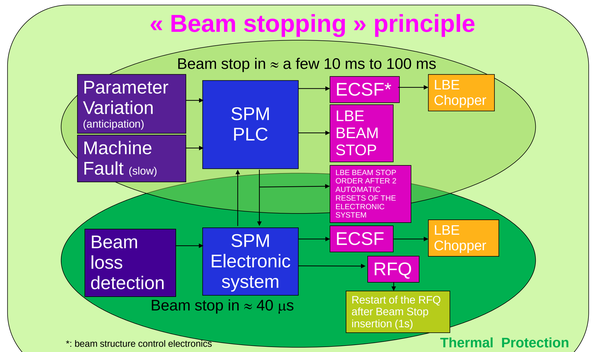
The SPIRAL2 facility under construction at Ganil will extend the possibilities for experimental nuclear physics towards more exotic beams.
The primary stable beams (deuterons, protons, light and heavy ions) accelerated by the Linac will range from a few 10 mA to 5 μA in intensities, and from 0,75 A.MeV up to 14,5A.MeV for heavy ions, 20 A.MeV for deuterons and 33 MeV for protons in energies.
The Machine Protection System (MPS) has thus to be designed to monitor a very large beam power range: a few 100W up to 200 kW.

The SPIRAL2 Machine Protection System is currently under design for a realization scheduled in 2014. The technical complexity of the SPIRAL2 system is directly linked to the large variety of accelerated beams, in terms of intensities (several orders of magnitude) and energies, and to the beam time structure, which may vary in a very large bandwidth. The MPS will have to be in operation for the second semester of 2014, when starting the SPIRAL 2 commissioning.

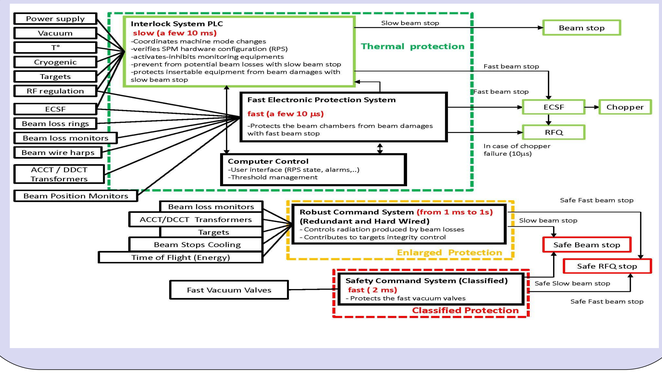
Beam Stopping Scheme



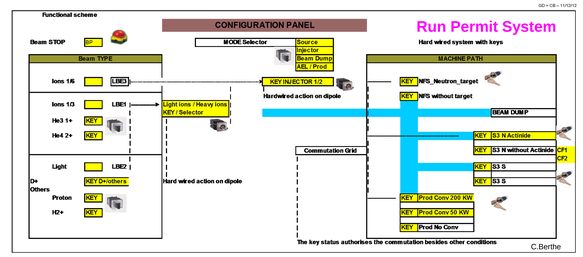
« Beam stopping » principle



Functional scheme of the SPIRAL2 MPS



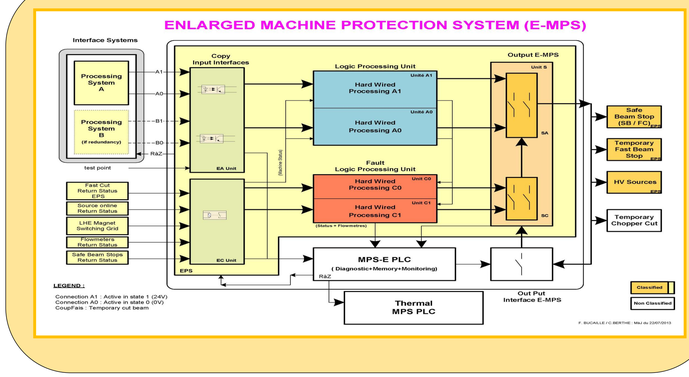
Run Permit System



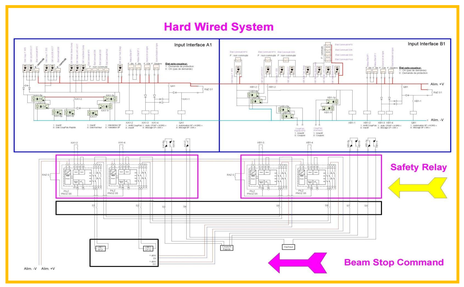
Machine mode
=
Beam type
+
Beam path
+
Beam power

TI : Deutons			Mode PF (KW) →	0,3	1	2	6	10	50	200
Type CM	CM	Mode CM								
Source	2	source ions légers	→ LIBE2-CF11	X						
Injecteur	4	source ions légers	→ LME-CF21	X	X					
	6	source ions légers	→ BTI-AF	X	X	X	X	?		
Beam Dump	8	source ions légers	→ beam dump	X	X	X	X			
Production	9	source ions légers	→ salle rouge com/S6	X	X	X	X	X	X	
	10	source ions légers	→ salle rouge com/200	X	X	X	X	X	X	X
	11	source ions légers	→ salle rouge nocomc	X	X	X	X	X		
AEL	17	source ions légers	→ NFS-cible-neutrons	X	X	X				
	20	source ions légers	→ NFS-irradiation	X	X	X				
	22	source ions légers	→ SR6	X	X	X				

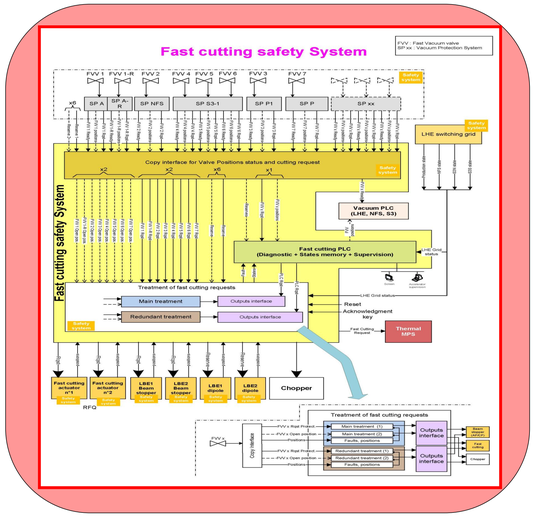
ENLARGED MACHINE PROTECTION SYSTEM (E-MPS)



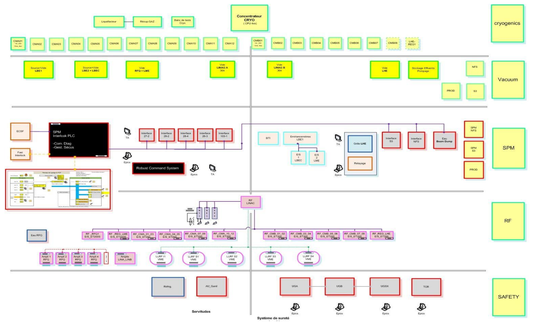
Hard Wired System



Fast cutting safety System



General scheme of SPIRAL2 protection systems



The Enlarged Protection System is based on the association of a PLC with a hard wired system.
It receives alarms from beam losse monitors, beam intensity and energy diagnostics, beam dump and targets control parameters.
Therefore, it activates the beam cut through commands sent to safe and slow beam stops in the low energy beam line in association with a temporary RF stop on the RFQ. It is based on a redundant hard wired system as shown.

The Classified Protection system is based on the association of a PLC with two redundant hard wired systems. The first one is a part of the Enlarged system, and the redundant part is an electronic device based on a 7400 series chips.
To respect the requirements of IEC 61508 standard, a Failure Mode and Effects Analysis (FMEA) was made to eliminate dangerous failures. The single failure criterion was selected as reliability criterion.

References

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[3] C.Sibley, "Machine Protection Strategies for high power accelerators", IPAC2003, Portland, USA, p.607 (2003)
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[6] C.Jamet, "Beam intensity an energy control for the Spiral2 facility", LINAC2012, Tel-Aviv, Israel, p. 537(2012)
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