The Diamond Machine Protection System

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Abstract

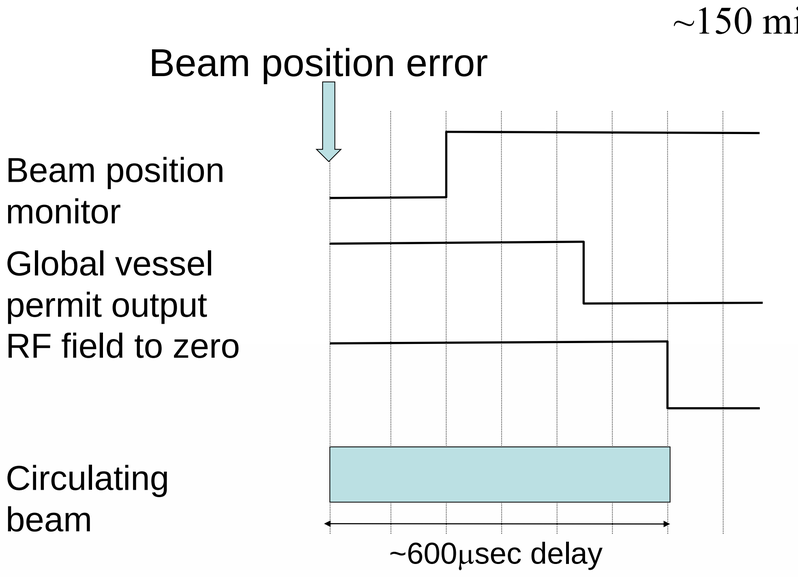
The Diamond Light Source Machine Protection System manages the hazards from high power photon beams and other hazards to ensure equipment protection on the booster synchrotron and storage ring. The system has a shutdown requirement, on a beam mis-steer of under 1msec and has to manage in excess of a thousand interlocks. This is realised using a combination of bespoke hardware and programmable logic controllers.
The structure of the Machine Protection System will be described, together with operational experience and developments to provide post-mortem functionality.

Photon Beamline Protection is realised by PLC's to manage interlocks from vacuum faults, temperature sensors and flowmeters to generate permits which allow front ends to open. Most beamline faults are managed by simply shutting the front end. A few faults on beamlines result in the Machine Protection system having to dump the stored Beam. All new Beamlines undergo a design process to ensure that they are self sufficient in terms of protections allowing reliable shutdown without to dump the stored beam.

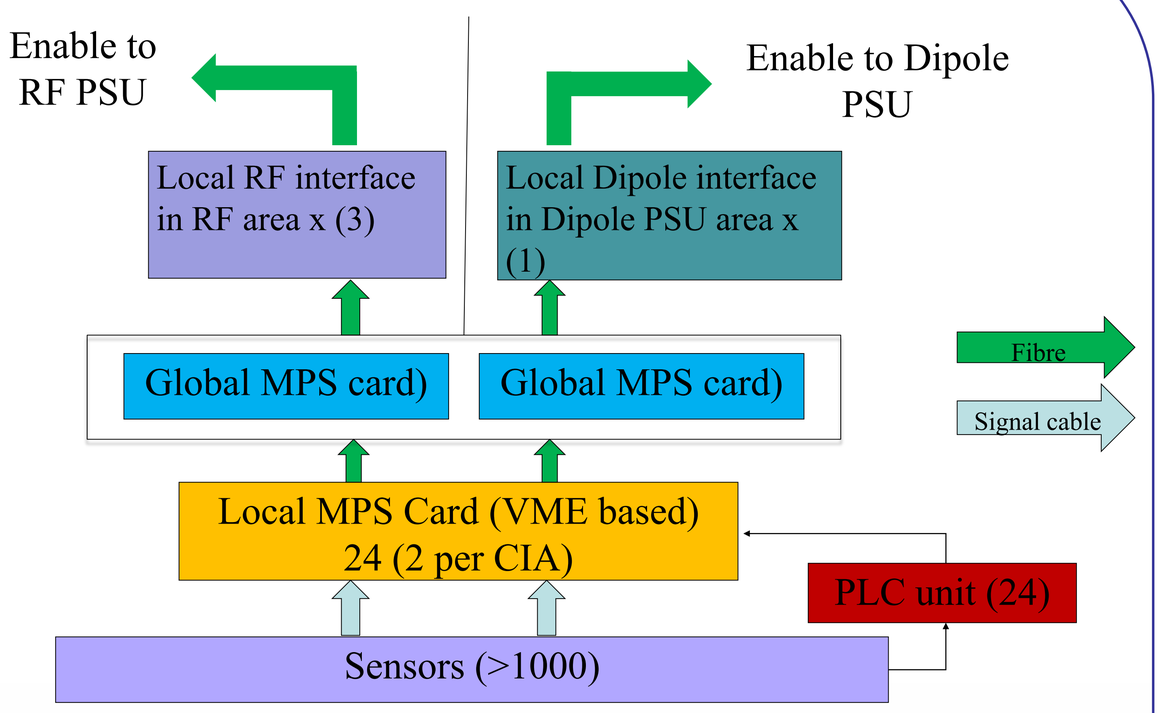
System Specification

The most critical interlocks are the **position limits** for the stored beam generated by the Libera Beam Position Monitors (BPMs).
The total BPM response time is the sum of:-

BPM detection delay ~200 microseconds
Delay between BPM output to local MPS module to Global vessel permit ~250 microseconds
Delay through RF amplifier and cavity to dumping of beam. ~150 microseconds



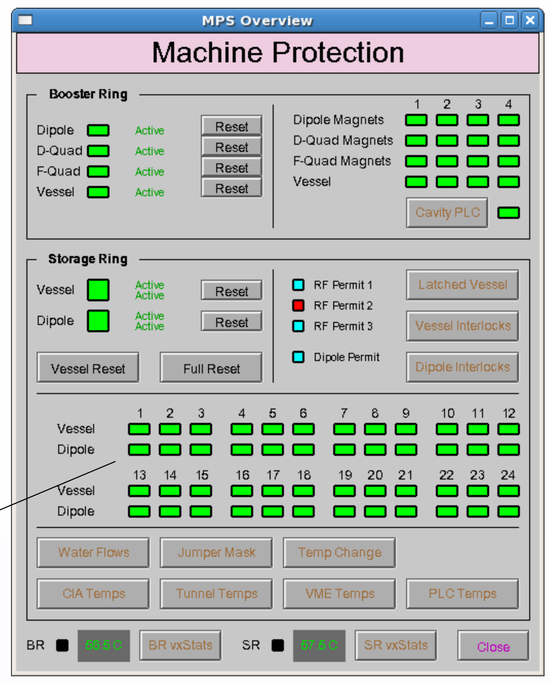
MPS Architecture

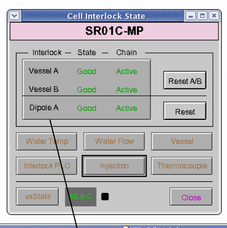


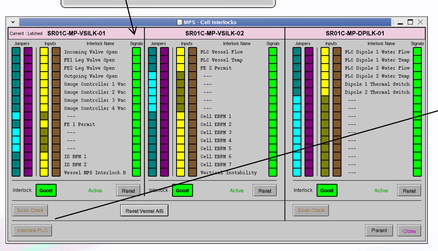
Plant sensors include:- Thermostats, PT100's, Flow meters, Valve position limit switches, Vacuum Gauge level set-points, Beam position Sensors, Beam Stability Sensors and Front End & Beamline Healthy (Beamline masked by Front End).

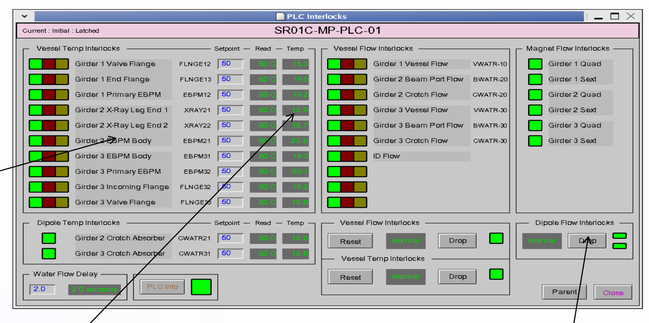
The EPICS Interface

An EPICS driver communicates with the MPS card via a Hytec 8001 64-bit digital I/O board with modified firmware.
This allows the reading of the state of the 32 inputs and jumpers directly and previously unused bits in the 8001's control and status register indicate the interlock state providing the means to generate a reset signal . An overview of the system is presented to the operator showing the status of the global permits. Further information is available from the LMPS via the IOC . It is possible to see the status of each individual input on a PLC via the serial link between the PLC and the IOC.









The PLC screen allows the operator to change the thermal trip points and add filtering to water interlock inputs to allow dips in water flow to be ignored. It also features a Beam trip test button which allows for automated testing of each sector of the MPS after a shutdown.

Photon Beamline Protection

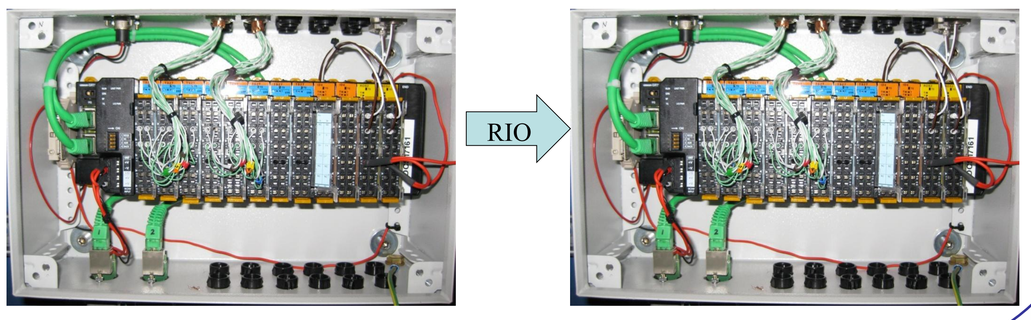
Beamline protection is managed using RIO capable DLS Valve controllers. The controller provides the EPICS interface to the Beamline Vacuum system and traditional coolant plant protection via an Ethernet connection. The system offers local interfacing and interlock connectivity to the MKS 937B Gauge controllers, Fast Vacuum Valve controllers, MPC's, Pneumatic devices, Motion Control systems, Cryo plant and PSS devices as well as remote IO connection for thermal sensors and flow indicators, Motion over travel limits and RGA equipment.

EPICS
Comms (UDP over Ethernet)

6 Pneumatic /Vac Devices
3 Sets 937B Gauge Interlocks
Fast Valve control
Cryo/Motion/PSU Enable

Remote IO Interlocks are validated via a system of Watch- dog logic. The software has been configured to clearly show differences between broken sensor wire and a failed communications connection to give the operator a true indication of the status of the system.

RIO data over Profinet
Temperatures
Flow meters
Motion Limits
Local enables



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