

EQUIPMENT AND PERSONAL PROTECTION SYSTEMS FOR THE SIRIUS BEAMLINES

L.C. Arruda*, F.H. Cardoso, G.L.M.P. Rodrigues, G.T. Barreto, H.F. Canova, J.V.B. Franca, L.U. Camacho, M.P. Calcanha, Brazilian Synchrotron Light Laboratory (LNLS), Campinas, Brazil, F.A.B. Neto¹, F.N. Moura¹, Brazilian Center for Research in Energy and Materials (CNPEM) Campinas, Brazil



WEPV034 Equipment and Personal Protection Systems Overview Equipment Protection System (EPS) CALEPCS 202 System properties Systems properties HMI provides visualization: PLC based protection system with SIMATIC S7 1516-3 and 1516F-3 Siemens CPU Distributed I/O modules ✓ Main view, vacuum, utilities, and devices views ✓ Installation map with devices status and fails' locations Simplified HMI visualization and alarms ✓ Simplified view of the main protection logics Communication with EPICS using OPC UA interface □ Subsystems divided by hutches allowing faster commissioning and easier ✓ Simplified commands to reset and open gate valves ✓ Main interface signals with other subsystems maintenance PPS logics composed by: Hardware and software structure provide: ✓ Search ✓ Protection logics and devices interfaces are separated ✓ Habilitation keys Figure 1: EPS devices illustration ✓ Standard devices objects provide: Figure 3: EPS beamline HMI Screen ✓ Emergency buttons ✓ Diagnostic flags to the protection logics ✓ Servomotor door control Beamline regio ✓ Integrated alarms ✓ Specific logics ✓ Programming settings (Limits, timeout, and others) EPS logics composed by: IOC data block ✓ Standard access to external interfaces such as EPICS and HMI PROFIsafe Networ ✓ Vacuum protection system ✓ Automated code generation of IOC configuration file and ✓ Fast protection system on frontends alarms texts using Python ✓ Slow protection system ✓ Separation between hutches allowing easier maintenance and a ✓ Low vacuum protection system ✓ Temperature faster commissioning ✓ PVs to record sensor values, limits, and diagnostics flags ✓ Position ✓ PVs to command gates and reset ✓ Power outage Concentrated external subsystems interface code with EPS Figure 4: EPS software structure showing function blocks (dark blue). Figure 2: PPS devices illustration data blocks (light blue), and external interfaces (orange) k Personal Protection System (PPS) Common Topics to EPS and PPS ICALERCS 202 ICALEPCS 202 # AIMS EDS ESD System properties System properties Alarms are generated directly by the PLCs and two visualizations HMI provides visualization: modes are available, the normal mode and the buffer mode. ✓ PPS hutch overview in installation map - Normal mode shows all active alarms in real-time requiring a ✓ Simplified commands to reset and to see conditions pending to _ start the hutch search procedure user acknowledgement command Buffer mode shows all the historic data about the alarm: Time ✓ Main interface signals with other subsystems that it was active and not active and acknowledgment by the

Figure 5: PPS beamline HMI Screen



Figure 6: PPS software structure showing function blocks (dark blue), data blocks (light blue), and external interfaces (orange)

Hardware and software structure provides:

- ✓ Shutters opening logic independent and modularized by hutch ✓ Safety data interface explicit separated with data blocks interface
- ✓ Standard blocks to all beamlines:
 - Global emergency and failure monitoring ✓ Search
- ✓ Shutters
- ✓ Safety logic and not safety logics in different functions with safety
- logic being executed cyclically each 100 ms ✓ Siemens integrated hardware diagnostics
- ✓ Automated logic tests using PLCSIM Advanced API and SimTableApplication
- ✓ PVs to record installation and device status ✓ PVs to command the shutters





Figure 8: Changes in the controllers and supervisory system

adopted in Sirius beamlines' EPS and PPS.

Interface interlock signals between the EPS, PPS, and MPS are needed and should be done with care to preserve the beam in the storage ring as long as possible. As the beamlines need the Storage Ring running to perform experiments, these signals can couple the beamlines' failures.

CNPEM



MINISTRY O

SCIENCE, TECHNOLOGY AND INNOVATION



Equipment and Personal Protection Systems Overview





Figure 1: EPS devices illustration



Figure 2: PPS devices illustration

Systems properties

- □ PLC based protection system with SIMATIC S7 1516-3 and 1516F-3 Siemens CPU
- Distributed I/O modules
- □ Simplified HMI visualization and alarms
- □ Communication with EPICS using OPC UA interface
- Subsystems divided by hutches allowing faster commissioning and easier maintenance
- □ PPS logics composed by:
 - ✓ Search
 - ✓ Habilitation keys
 - ✓ Emergency buttons
 - ✓ Servomotor door control
 - ✓ Specific logics
- **EPS** logics composed by:
 - ✓ Vacuum protection system
 - ✓ Fast protection system on frontends
 - Slow protection system
 - ✓ Low vacuum protection system
 - ✓ Temperature
 - ✓ Position
 - Power outage







Equipment Protection System (EPS)





Figure 3: EPS beamline HMI Screen



Figure 4: EPS software structure showing function blocks (dark blue), data blocks (light blue), and external interfaces (orange)

System properties

- □ HMI provides visualization:
 - ✓ Main view, vacuum, utilities, and devices views
 - \checkmark Installation map with devices status and fails' locations
 - ✓ Simplified view of the main protection logics
 - ✓ Simplified commands to reset and open gate valves
 - ✓ Main interface signals with other subsystems
- □ Hardware and software structure provide:
 - ✓ Protection logics and devices interfaces are separated
 - ✓ Standard devices objects provide:
 - ✓ Diagnostic flags to the protection logics
 - ✓ Integrated alarms
 - Programming settings (Limits, timeout, and others)
 - ✓ Standard access to external interfaces such as EPICS and HMI
 - ✓ Automated code generation of IOC configuration file and alarms texts using Python
 - ✓ Separation between hutches allowing easier maintenance and a faster commissioning
 - ✓ PVs to record sensor values, limits, and diagnostics flags
 - \checkmark $\,$ PVs to command gates and reset
 - ✓ Concentrated external subsystems interface code with EPS





Personal Protection System (PPS)





Figure 5: PPS beamline HMI Screen



Figure 6: PPS software structure showing function blocks (dark blue), data blocks (light blue), and external interfaces (orange)

System properties

- □ HMI provides visualization:
 - PPS hutch overview in installation map
 - Simplified commands to reset and to see conditions pending to start the hutch search procedure
 - ✓ Main interface signals with other subsystems
- □ Hardware and software structure provides:
 - ✓ Shutters opening logic independent and modularized by hutch
 - ✓ Safety data interface explicit separated with data blocks interface
 - ✓ Standard blocks to all beamlines:
 - ✓ Global emergency and failure monitoring
 - ✓ Search
 - ✓ Shutters
 - ✓ Safety logic and not safety logics in different functions with safety logic being executed cyclically each 100 ms
 - ✓ Siemens integrated hardware diagnostics
 - ✓ Automated logic tests using PLCSIM Advanced API and SimTableApplication
 - ✓ PVs to record installation and device status
 - ✓ PVs to command the shutters









Common Topics to EPS and PPS



			-	
ALADMS EDS ESD	Time	Date	Status	Text
ALARMS LFS LSD	10:45:21 AM	8/18/2021	(I)O	EPS ESD GV3 - Valve is taking too long to change state GV3
EXIBITION MODE: Buffer	10:45:21 AM	8/18/2021	(I)O	EPS ESD GV3 - Valve moving without a command GV3
	5:41:24 PM	8/17/2021	(I)O	EPS ESD AIR- Low compressed air pressure detected on AIR
MAIN	5:27:31 PM	8/17/2021	I	EPS ESD GV3 - Valve is taking too long to change state GV3
VISUALIZATION MODE	5:27:29 PM	8/17/2021	I	EPS ESD GV3 - Valve moving without a command GV3
	5:22:06 PM	8/17/2021	I	EPS ESD AIR- Low compressed air pressure detected on AIR
FILTER				
CLEAR				
LEGEND				
FAILURE				
WARNING				
SOLVED				

Figure 7: Alarms screen common to both subsystems showing an application example case in buffer exhibition mode.



Figure 8: Changes in the controllers and supervisory system adopted in Sirius beamlines' EPS and PPS.

System properties

- □ Alarms are generated directly by the PLCs and two visualizations modes are available, the normal mode and the buffer mode.
 - Normal mode shows all active alarms in real-time requiring a user acknowledgement command
 - Buffer mode shows all the historic data about the alarm: Time that it was active and not active and acknowledgment by the user
- ☐ Improvements related to the UVX, the deactivated secondgeneration Brazilian light source are related to practically all subsystem aspects: Infrastructure, software structure, communication, user interface, EPICS communication, and alarms diagnostics.
- Interface interlock signals between the EPS, PPS, and MPS are needed and should be done with care to preserve the beam in the storage ring as long as possible. As the beamlines need the Storage Ring running to perform experiments, these signals can couple the beamlines' failures.



