

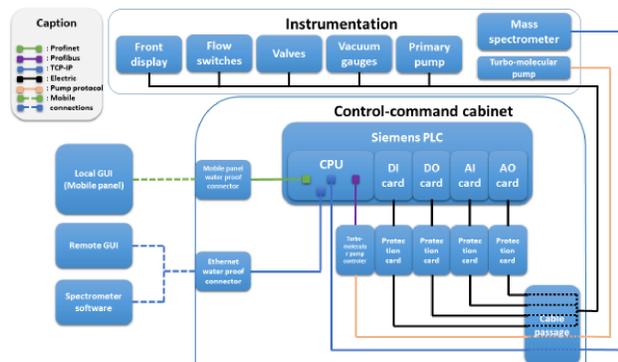
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Abstract Commissariat à l’Energie Atomique et aux Energies Alternatives (CEA) is in charge of providing cryomodules for European Spallation Source (ESS). This collaboration leads CEA to design, build and provide cryomodules with industrial quality requirements and challenging mile-stones. One critical element for cryomodules efficiency is vacuum quality and more specifically lack of particles. To reach this particle free beam vacuum, pumping units were specifically designed, built and are still used at CEA Paris-Saclay.

Control Architecture Control system base technology is PLC and more specifically Siemens solutions. Siemens is widely use at CEA Paris-Saclay because of is reliability, matching local control standards and control team skills. In order to be up to date and grant a long time available hardware, we chose Siemens last PLC generation: 1500 references.

3 Cavity is inside clean room and operator connects it to outside connection. Mobile pumping unit is connect to it and starts slow pumping,

1 Cavity is built outside clean room where particles quantity is high.



2 Cavity is prepared to enter in clean room.

3 Clean room

4 Cavity is under slow pumping automatic procedure via a mobile pumping unit, particles quantity decrease.

Automatic Procedures Preliminary pumping, slow pumping to prevent particle generation, leak check and back to automatic pressure is managed by automatic procedures functions developed in correlated development language: Grafcet. Operator interactions is limited to a start and stop but-ton. Once started, automatic procedure manages itself and can detect and reacts to unexpected behaviors.

Mobile Pumping Unit

Pumping units are connected to pumping slots. CEA Paris-Saclay have height pumping units use for multiple purpose of clean pumping in different locations: three clean rooms and one cryomodule test stand.

Analog and digital valves are used for slow pumping process.

Primary pump and turbo-molecular pump are integrated.

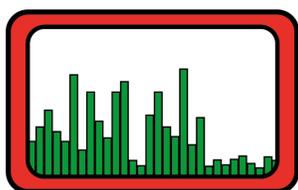
Mass Spectrometer is connected to control system

Front electrical cabinet

Local and mobile touch panel

Remote control interface

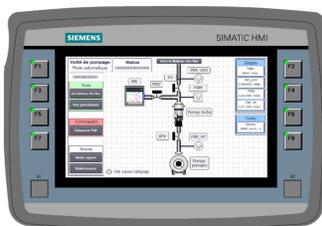
5 Vacuum quality is checked inside cavity with mass spectrometry.



Mass Spectrometry Vacuum quality and composition can be check with a RGA device providing one hundred particle mass and enabling fine pollution diagnostic. Therefore it also could be used for leak check by scanning mass number 4 associated to Helium.

6 Manipulation or hardware issue happened, mobile pumping unit protects cavity and vacuum quality by isolating it. Errors and status are displayed on local and remote control interfaces.

Local Control Mobile aspect of pumping units require a local control interface to provide system status, automatic procedures and manual commands to operator when pumping unit location change. This is especially true when new position is out of network range for experiments occasional use. This functionality is granted by local industrial touch panels connectable to pumping unit.



7 Cavities are assembled to build to a cavities train. This will be part of cryomodule.

8 Cryomodule is ready and connect to other parts of particle accelerator. Beam accelerates inside it.

