# THE SPARC VACUUM SYSTEM

E.Pace, F.Anelli, A.Clozza, L.Cultrera, G.Di Pirro, S.Fioravanti, INFN/LNF, Frascati, Italy

*Abstract*

The monitor of the SPARC vacuum system is fully integrated in the SPARC Control System. Heterogeneous ionic pumps and gauge systems are continuously monitored and their values stored in a database. Gauge systems can be remotely switched off or on. The system allows an easy insertion of new hardware models.

## SPARC

SPARC is the free electron laser under commissioning at the INFN (Italian National Institution for Nuclear Physics) Frascati National Laboratory. A gun driven by a laser produces an electron beam that is accelerated and injected in a modulator system in order to produce FEL radiation [1].

The electron beam coming from the photon injector will also interact with a 0.3 PW (6 J, 20 fs pulse) Ti:Sa laser beam in order to realize new plasma acceleration experiments and an X/gamma ray tunable source using Thomson back-scattering (PLASMONX project) [2].

Furthermore, terahertz coherent radiation will be extracted from the SPARC FEL radiation and used for beam diagnostic, technological applications and experiments (TERASPARC project) [3].

## THE SPARC CONTROL SYSTEM

The SPARC control system [4] is a distributed system made of some front-end CPU's (industrial PC's or embedded CPU's) connected via Gigabit Ethernet to some consoles (industrial PC's) (see Fig.1).

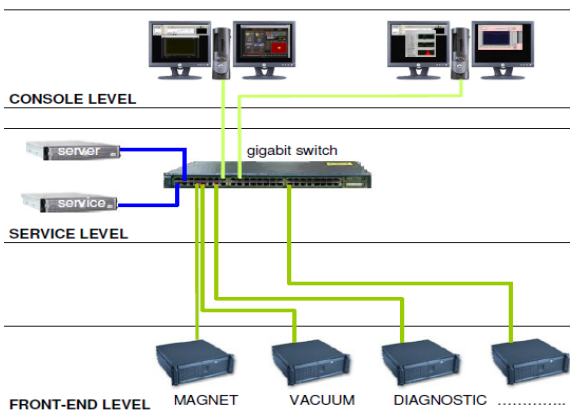


Figure 1: The SPARC control system.

Each front-end CPU controls one or few systems (e.g. ionic pumps, motors, cameras). Therefore, the control software that is running on each single front-end system has a common structure but it is specialized in acquiring a specific type of information.

Each front-end CPU controls one or few systems (e.g. ionic pumps, motors, cameras). Therefore, the control software that is running on each single front-end system has a common structure but it is specialized in acquiring a specific type of information.

At console level, clones of exactly the same program can be run on different computers. Each clone can monitor information coming from the front-end CPU's and issue commands in order to remotely operate the front-end systems (e.g. move a motor, change a power). Furthermore, some programs have been developed in order to automatize several measurements (e.g. QE gun map).

The communication between all the CPU's involved is via TCP/IP over Gigabit Ethernet.

Information coming from front-end CPU's are stored in a PostgreSQL database and are available for off-line analysis.

## VACUUM REQUIREMENTS

Different levels of vacuum are required along different parts of SPARC FEL: a vacuum level below 10-9 mbar is required in RF-gun because the high electric field gradient inside the accelerating structure; inside the LINAC acceptable vacuum levels range below 5x10-9 mbar; inside the undulators modules a 10-7 mbar vacuum level is considered acceptable.

## VACUUM HARDWARE

Different types of vacuum pumps are currently used for reaching the above levels of vacuum.

The final vacuum is achieved along the whole machine by means of sputter ion pumps, while for reaching a vacuum levels suitable to start ionic pumps several turbomolecular pumps with rough vacuum scroll pump are used. Pirani ionization gauges are used to measure the vacuum levels at different points along the photoinjector and undulator.

### *Pre-vacuum System*

Turbomolecular pumps and scroll pumps have a limited use in SPARC. As stated above their use is allowed only during maintenance period while during running shifts the vacuum levels are guaranteed by ionic pumps. Due to these limitations the control system does not control this hardware that is used manually by the staff.

### *Final vacuum System*

Varian Starcell© ionic pumps are currently used, with different nominal pumping speed (from 20 to 200 l/s), for reaching the operational vacuum along the whole SPARC machine. Ionic pumps are powered by either Minivac™ or Midivac™ controllers.

Minivac™ controllers readouts are set to a FieldPoint distributed I/O bus by National Instruments. Front-end CPU's are either industrial PC or FieldPoint modules with on-board CPU and real time system (NI FP-2010).

Midivac™ controllers having an RS232 interface are accessible by an industrial PC connected to the controllers by a Moxa's serial-to-Ethernet device in order to decrease the length of serial cables.

A rough estimation of the vacuum levels can be inferred by measuring the current flow of each ion pump, but this measure is affected by systematic errors induced by unavoidable current leakages inside the body pump.

### *Vacuum Measurements*

For precise measuring of vacuum levels two different instruments are used: for low vacuum levels, down to 10-4 mbar, thermocouple vacuum gauges while for high vacuum ionization Bayard-Alpert gauges are currently operated.

These gauges are powered and controlled by two different controller types: Stanford Research System mod. IGC100 and Varian mod. SenTorr™.

Both IGC100 and SenTorr™ controllers are connected to control system by using a dedicated industrial PC through their RS232 port and a Moxa's serial-to-Ethernet device.

## VACUUM SOFTWARE

Vacuum level is continuously monitored by the SPARC control system and vacuum data are continuously written on the SPARC PostgreSQL database [5].

At console level, it is possible to open panels for reading the vacuum level, for retrieving old data, and for easily writing data in the electronic logbook.

A synoptic panel allows the operator to see the level of vacuum in any single part of SPARC (one for ionic pumps, one for the gauges) (see Fig.2).

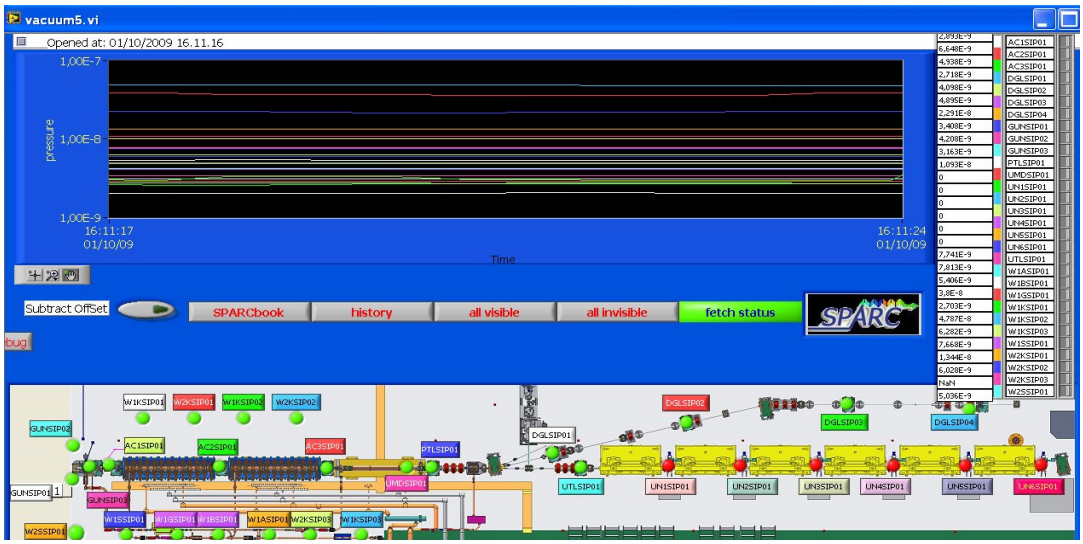


Figure 2: Ionic pumps online monitor system.

Clicking a software button it is possible retrieve old data from the database and plot them (see Fig.3)

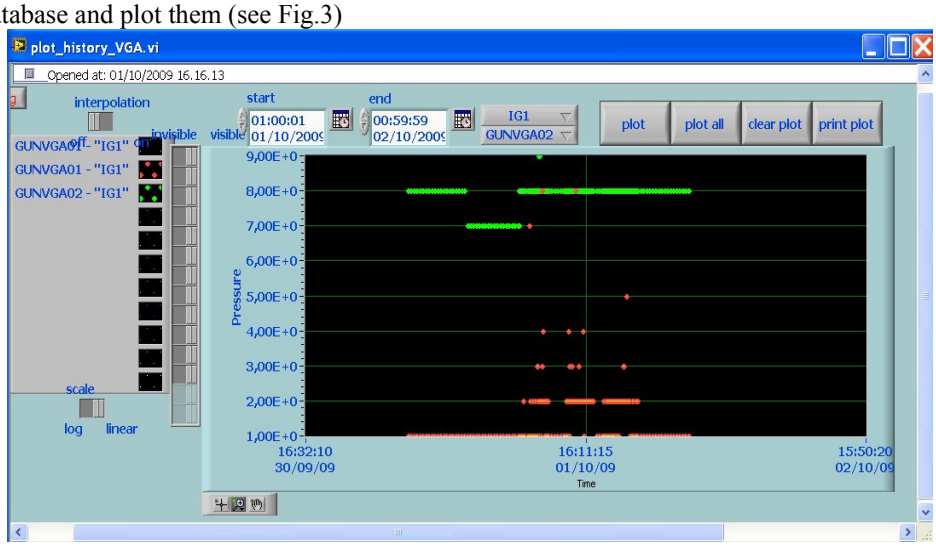


Figure 3: Vacuum gauges offline data reading.

Only for gauges, it is possible to switch on/off the filaments. A special software procedure has been implemented when filaments are switched on: they have to be switched-on really slowly in order to avoid their breakdown (see Fig. 4).

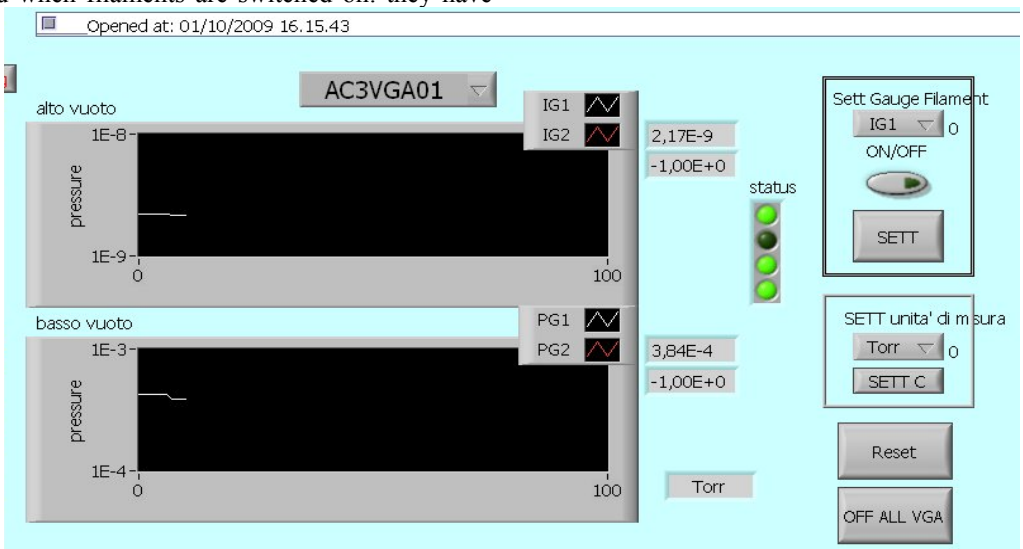


Figure 4: Gauge system: command panel.

## SPARC-BOOK AUTOMATIC ENTRIES

SPARC-BOOK is an electronic book that has been specifically developed for SPARC. In order to help people as much as possible, software buttons has been created also on vacuum control panels, that will automatically register vacuum information on the electronic book (see Fig.5).


Figure 5: Example of software button for an automatic entry to SPARC-book.

SPARC-book has been written using html and php, and the information are stored in our PostgreSQL database. Software buttons for automatic entries in the database are developed in LabView into the control system.

## REFERENCES

[1] M.Ferrario, et al., "Commissioning Results of the SPARC FEL", FEL09, Liverpool, August 2009

[2] A.Bacci, et al., "Status of Thomson source at SPARC/PLASMONX", NIM A **608** (2009) S90-S93

[3] S.Lupi, et al., "TERASPARC", INFN Commissione V, http://agenda.infn.it/subContributionDisplay.py?subContId=1&contribId=4&confId=1718

[4] G.Di Pirro, et al., "The SPARC Control System", this conference

[5] E.Pace, et al., "PostgreSQL usage within the SPARC control system", this conference