ISHN Ion Source Control System Overview

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Introduction

The ESS-Bilbao (ESSB) light ion linear accelerator has been conceived as a multi-purpose machine, useful as the core of a new standalone accelerator facility in southern Europe giving support to local beam users and accelerator physicists. The project aims to develop significant in-house capabilities needed to support the country participation in a good number of accelerator projects worldwide. In this context, the designed modular, multipurpose accelerator should serve as a benchmark for components and subsystems relevant for the ESS project as well as to provide the spanish science and technology network with hands-on experience on power accelerators science and technology.

In this context, the development of a front-end test stand for ion sources will allow ESSB to test, develop and optimise ion sources and their working parameters. Currently an penning ion source on loan from ISIS, modified to use permanent magnet instead of an electromagnet to generate the penning field is being tested,. This project serves several goals, it generates experimental data that can be contrasted with simulations. It also serves as test stand for control systems and hardware, and a small scale test of the data acquisition, logging and analysis that will be required for the accelerator. And in general provides experience in the operation and maintenances of ion sources and the equipment associated with them.

ISHN Ion Source

ISHN project consist on a Penning ion source which will deliver up to 65 mA of H- beam pulsed at 50 Hz with a diagnostics vessel for beam testing purposes. There are several power supplies for plasma generation and beam extraction, including auxiliary equipment and several diagnostics elements.

A penning type ion source is operated applying a pulsed discharge to source's cathode, generating a mixed plasma of Hydrogen gas and Caesium vapour. Hydrogen is delivered applying a pulsed voltage to a piezovalve. Once the plasma is stabilised, a pulsed extraction voltage is applied generating an H^- beam. This pulse diagram is repeated at 50Hz. In addition a continuous power supply is needed for conditioning ion source's electrodes, which is used in the beginning of the operation.

- DC Power Supply	2A / 80V, µsec. pulse
- Pulsed Power Supply	50A / 200V
- Extraction Power Supply	25kV
- High Voltage Platform Power Supply	100kV (max.)
- H_2 Piezovalve	0 - 150V / 250 µsec. Pulse
- Cs Heaters	Boiler and Transport line
- H_2O Refrigeration	for source body
- Air Refrigeration	for source electrodes
- Vacuum pumps and sensors	10^{-6} mbar typical

Table I: main elements of ISHN ion source.

Once the beam is extracted, it goes trough the diagnostics vessel, Figure II shows a picture. The first diagnostics are the current transformers (ACCT, DCCT). Then, a quadrupole focuses the beam and a dipole is used for obtaining information about the degree of stripping and beam species components. The least beam diagnostics are a Faraday Cup for measurement of beam current, a Retarding Energy Analyzer for energy spread analysis, and, finally, a pepperpot device for obtaining emittance values These devices, cannot be activated simultaneously and are also used as beam stoppers.

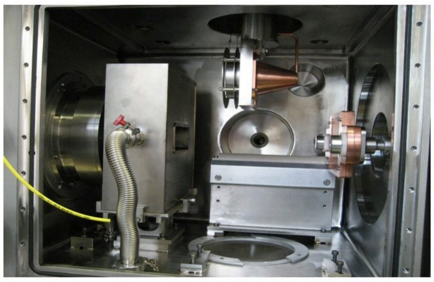


Figure II: from left to right, ACCT and DCCT (not visible), Quadrupole, Dipole, Faraday Cup, RPA (behind) and Pepperpot.

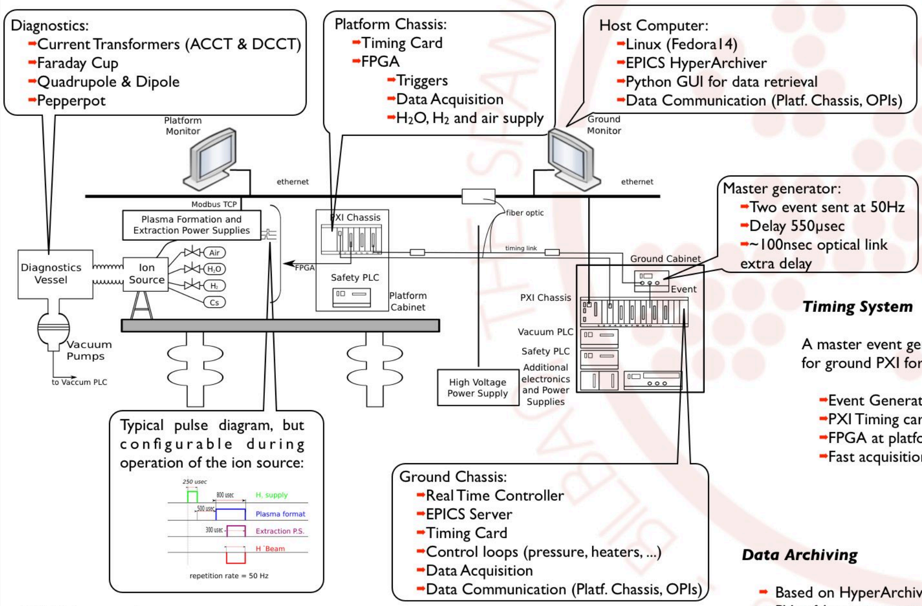
Control System

Due to the high voltage platform, the main system is divided into two control subsystem, located at ground and on the platform respectively. Each area has its own operator panel, allowing the operation of the ion source from both control desks, but not simultaneously. However, continuos monitorization of the status of the system is always active. The source is usually managed from platform panel until high voltage power supply is turned on.

Due to the different nature of the devices in the system, several communication protocols are implemented:

- Modbus/TCP for plasma power supplies
- GPIB for Quadripole and Dipole power supplies
- RS232 for vacuum sensor
- TCP for event generator

The structure of the current control system can be observed in the following figure, where the most important changes since the last upgrade are, firstly, the integration of an EPICS Server and its archiving system. And secondly, the improvement of the timing and synchronization performance.



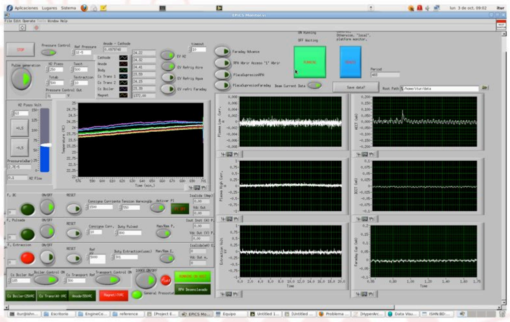


Figure II: Operator panel at ground

Both platform and ground operator's panel are similar, presenting the main information and operation parameters:

- Temperature chart
- Voltage and current waveform of plasma power supplies
- Beam current measured with different diagnostics
- Operation of plasma power supplies
- Timing setup
- Refrigeration control
- H_2 supply control
- Cs heaters
- ...

Timing System

A master event generator located at ground cabinet produces two event signals at 50Hz. One for ground PXI for triggering data acquisition, and for starting pulse generation at platform.

- Event Generator: BNC-575, multichannel high resolution timing and delaying
- PXI Timing cards: for routing event signals through chassis trigger lines
- FPGA at platform reads trigger line for starting pulse generation
- Fast acquisition cards read triggers for acquiring beam current waveforms

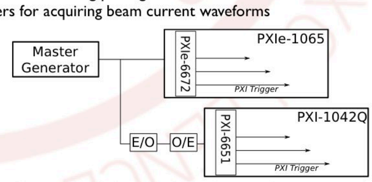


Figure III: Scheme of implemented timing and synchronization system

EPICS Integration

- EPICS Server implemented in the PXI RT Controller (NI solution as first approach)
- Host Monitor: programmed in LabVIEW but accesing PVs by means of CALab library (interface between EPICS and LabVIEW, version 1.2.1.3)
- 65 Process Variable, most of them for configuration and operation parameters
- A full IOC deployed on host computer with additional functionality
  - Alarm handling is underway
  - Gateway for accessing PV data from outside control net

Data Archiving

- Based on HyperArchiver
- PVs of Array type stored every 5 sec.
- Scalar variables every 1 sec.
- Several monitors
- Amount of data ~100MB/hour
- Python GUI for data retrieval

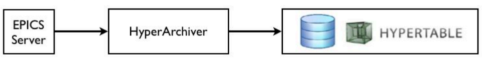


Figure IV: Scheme of EPICS data logging architecture