SOFTWARE APPLICATIONS USED AT THE REX/HIE-ISOLDE LINAC

E. Fadakis et al., CERN, Switzerland

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Abstract

The HIE-ISOLDE Linac (High Intensity and Energy) is a recent upgrade to the ISOLDE facility of CERN, increasing the maximum beam energy and providing means to explore more scientific opportunities. The main software tools required to set up the new superconducting post-accelerator and to characterise the beam provided to the experimental stations will be presented in this paper. Emphasis will be given to the suite of applications to control all beam instrumentation equipment which are more complex compared to the ones in the low energy part of ISOLDE. A variety of devices are used (Faraday cups, collimators, scanning slits, striping foils and Silicon detectors). Each serves its own purpose and provides different information concerning the beam characteristics. Every group of devices required a specific approach to be programmed.

Introduction

ISOLDE is one of the leading research facilities in the field of nuclear physics. Radioactive Ion Beams (RIBs) are produced when 1.4 GeV protons impact in a target.
The RIB of interest is extracted and transported to different experimental stations either directly or after being accelerated in the post-accelerator. In the latter, RIBs are transported to the REX-TRAP, charge-bred in the REX-EBIS and accelerated to 2.85 MeV/u in the REX normal conducting section of the linac before being accelerated further (9.3 MeV/u for beams with A/q = 4.5 and to 14.3 MeV/u for A/q = 2.5) in the HIE-ISOLDE superconducting section of the linac. The software applications mentioned on this paper enable the Engineers In Charge (EIC) to set up the desired beam regardless if it is stable (e.g. 39K) or radioactive (e.g. 76Zn).

Silicon Detector measurements performed at HIE-ISOLDE

The Silicon detectors have a list of dedicated applications since they have many functionalities. The acquisition capabilities are divided into two different modes which are explained on the two screenshots below.

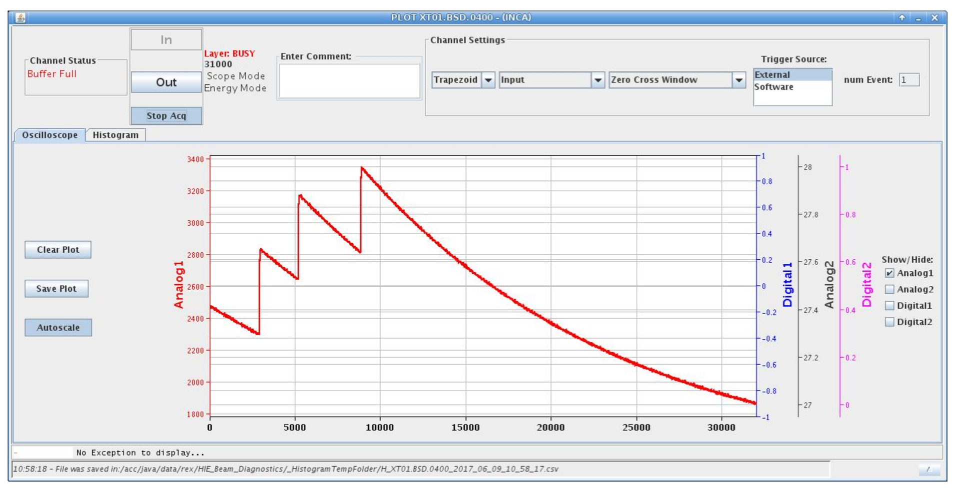

Figure 1: Silicon detector measuring few consecutive ions.

In the oscilloscope mode as seen on Figure 1, a voltage signal proportional to the beam energy deposited, is shown as a function of time.

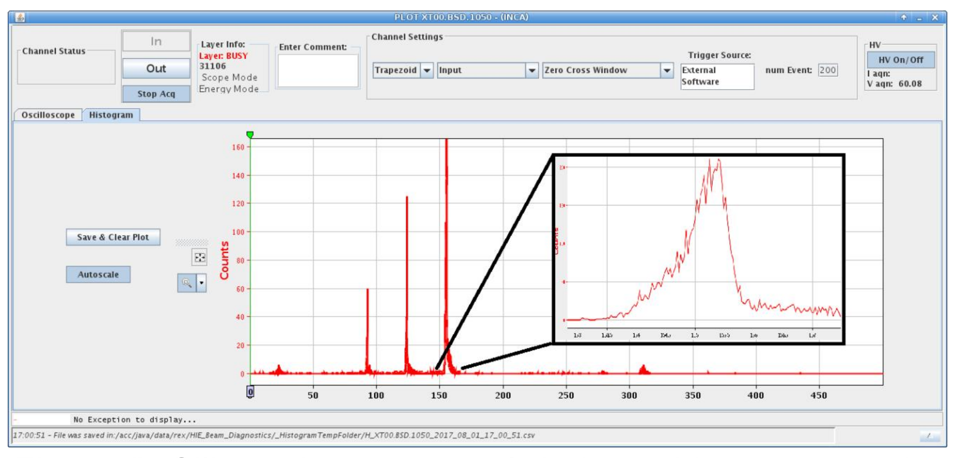

Figure 2: Silicon detector panel during a histogram mode. Zooming in to better distinguish the energy

In the histogram mode the high level application accumulates events as seen in Figure 2. This functionality creates a histogram with the energy distribution of the beam allocated onto the Silicon detector so that all isotopes can be identified.

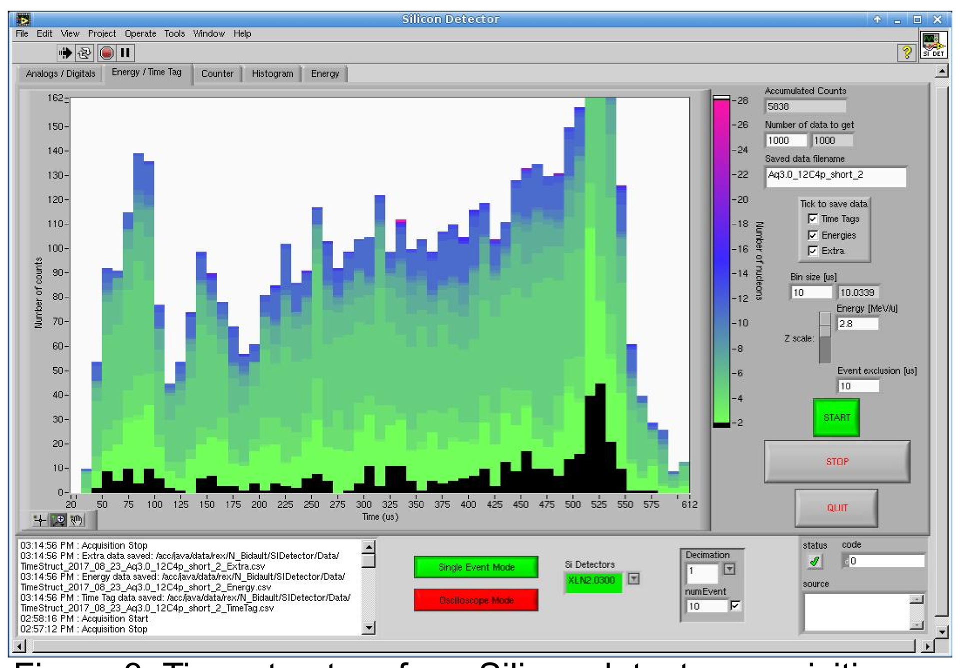

Figure 3: Time structure from Silicon detector acquisition.

The application shown on Figure 3, returns a histogram with the number of detected particles on the y-axis, the time positions of the particles in the pulse on the x-axis and a colour weight for each event representing its energy.

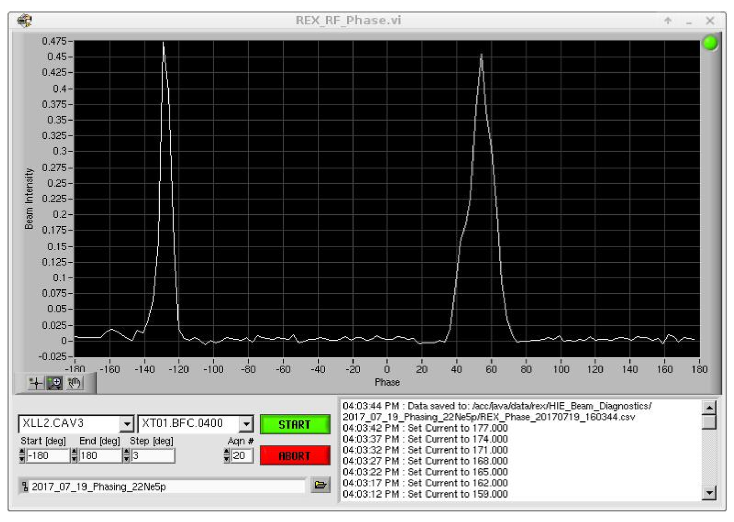

Figure 4: Two zero crossing peaks of an SRF cavity, separated by 180 degrees.

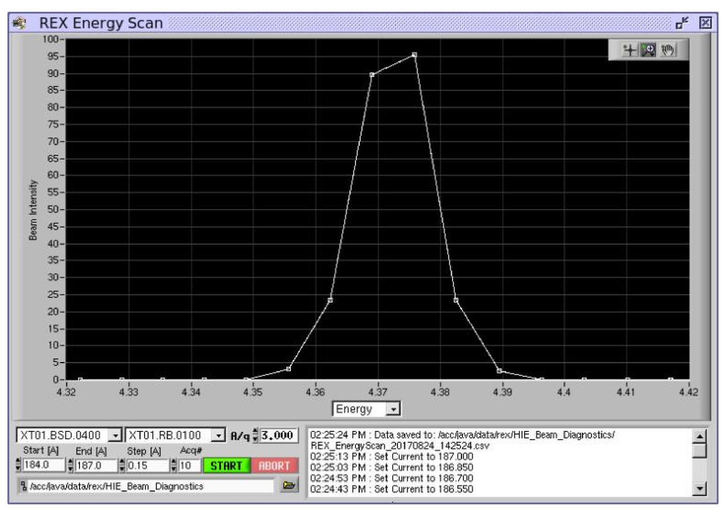

Figure 5: Energy measurement using a Silicon detector.

The measurement shown on Figure 4 can be performed using either a Silicon detector or a Faraday cup.

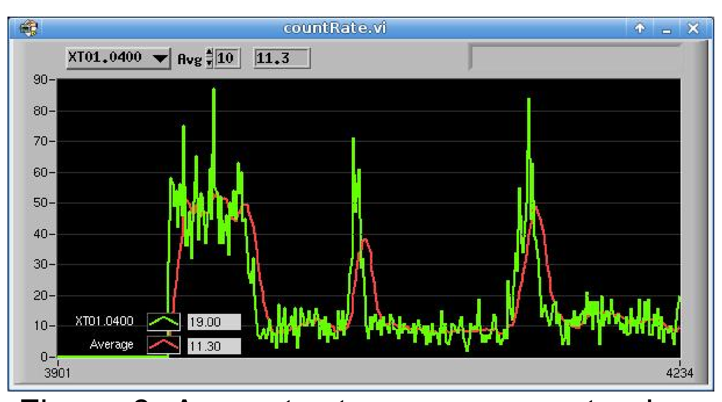

Figure 6: A count rate measurement using a Silicon detector.

The Silicon detector can be used as a very low intensity Faraday cup. As an example the Count Rate application shown in Figure 6, is utilised to identify beam instabilities.

HIE-ISOLDE Beam Diagnostics Suite of Applications

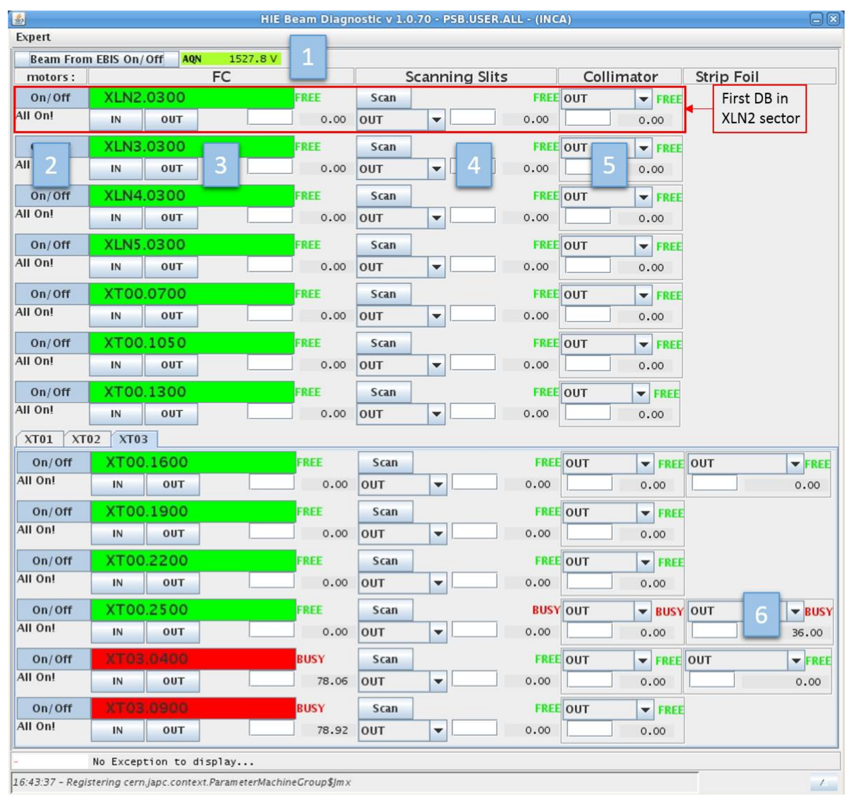

Figure 7: The Beam Diagnostics suite of applications main panel.

For phase 2A of the HIE-ISOLDE project, In the HIE section of the linac and the High Energy Beam Transfer lines there are 18 diagnostic boxes housing 70 devices.
In the applications main panel every row represents a diagnostic box and every column is a different type of device.
Some functionalities available from the main panel are to:

1) Allow or stop the beam out of the EBIS, from going to the HIE-ISOLDE linac
2) Enable or disable the stepping motors of each device in a certain diagnostics box.
3) Open the dedicated Faraday Cup panel.
4) Open the dedicated Scanning Slits panel
5) Move a Collimator to a predefined position.
6) Move the Carbon Foils to a predefined position.

The REX-EBIS Slow Extraction application

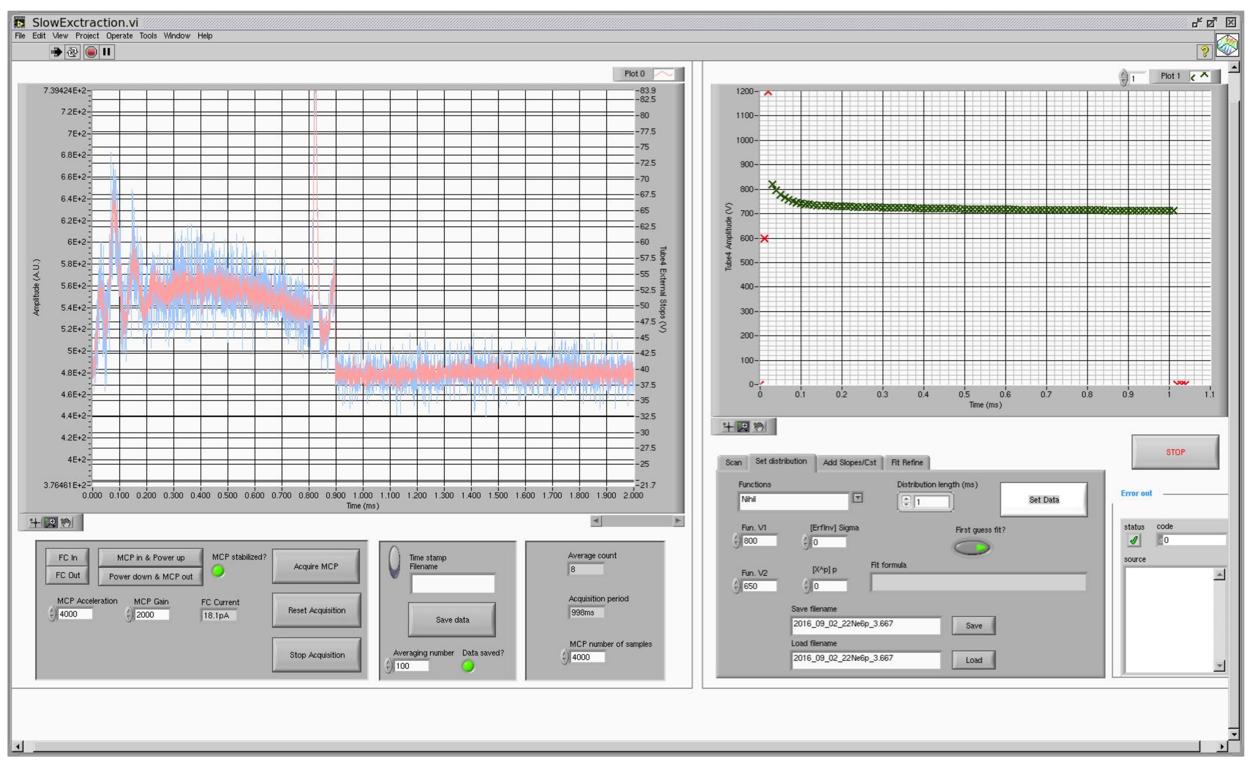

Figure 8: Slow Extraction application panel. MCP signal on the left graph and voltage modulation on the right.

A prerequisite to the injection in the linear accelerator is to enhance the charge state of the ions in the REX-EBIS charge breeder. After a certain confinement time in the REX-EBIS, corresponding to the time needed to reach the suited charge state, the ions are extracted accordingly to the voltage modulation of the extraction tube.
A slow extraction scheme has been developed to achieve a lengthening of the time structure of the ion beam from 0.2 ms to 2 ms and consequently allow a reduction in the instantaneous beam current and a more efficient event discrimination at the experimental stations in comparison to the fast extraction mode for which all ions are condensed in a ~0.1 ms pulse.
The Slow Extraction application, made with LabVIEW, is divided into two parts as seen on Figure 8. The extraction tube's voltage modulation on the right and a Micro-Channel Plate (MCP) scope displaying the time structure of the beam, on the left.

Conclusion

Higher energies and super conducting cavities are essential if the variety of physics possible from the ISOLDE facility is to be broadened. Many high level applications have been developed in order to properly and efficiently operate the facility and satisfy the new physics requests from users around the world.