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THE DESIGN, CONSTRUCTION AND OPERATION OF THE BEAM INSTRUMENTATION FOR THE HIGH INTENISTY AND ENERGY ISOLDE UPGRADE AT CERN

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ABSTRACT

The High Intensity and Energy (HIE) upgrade to the on-line isotope separation facility (ISOLDE) facility at CERN is currently in the process of being commissioned. The very tight space available between the superconducting acceleration cavities used and a challenging specification led to the design of a compact 'diagnostic box' (DB) with a number of insertable instruments on a common vacuum chamber. The box was conceived in partnership with the engineering firm AVS and produced as a completed assembly in industry. 14 diagnostic boxes have been installed and are now operational. This paper will describe the design, the construction and first results from operation of these HIE-ISOLDE diagnostic boxes

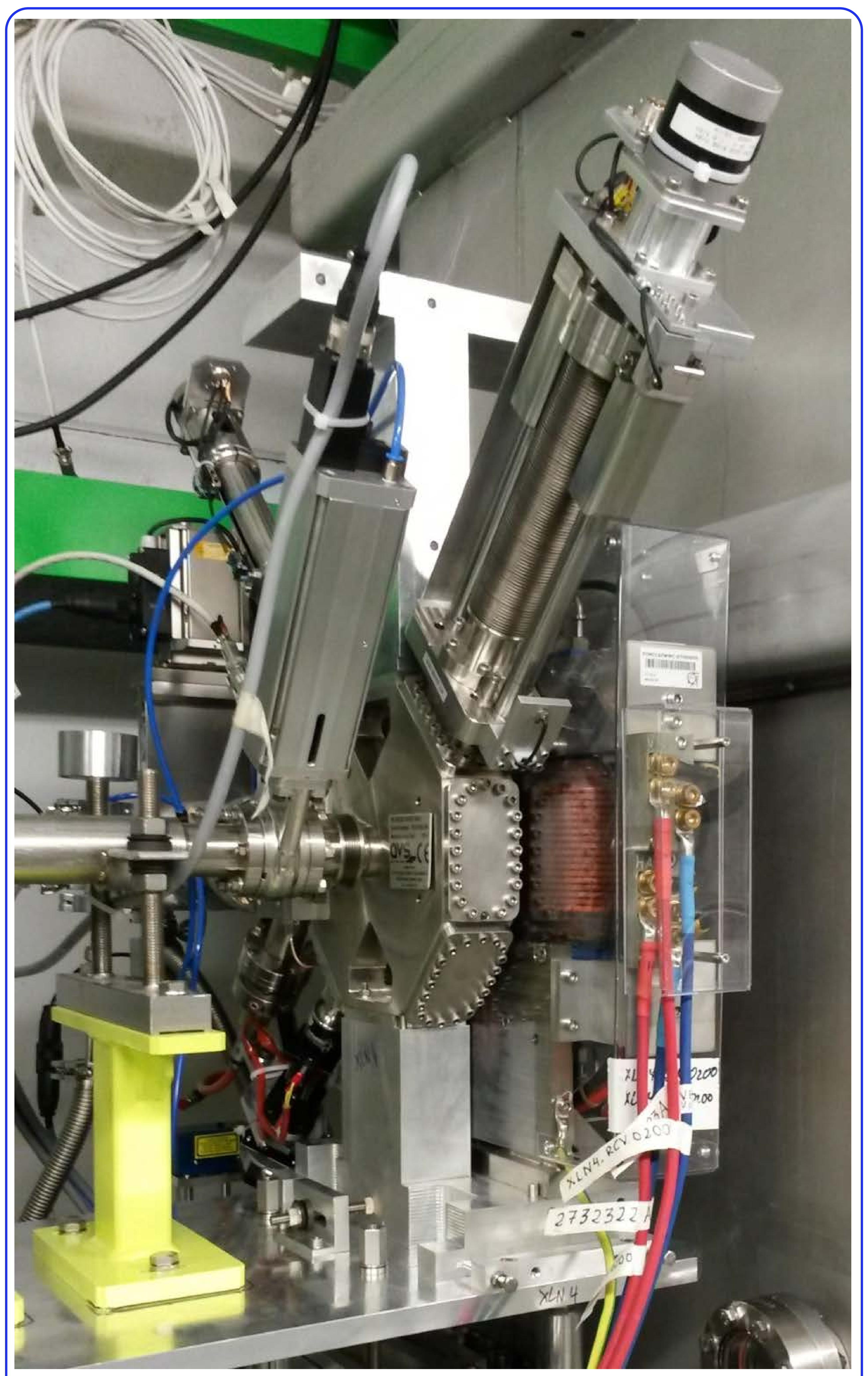


Figure 1: a short DB installed in the HIE ISOLDE LINAC

BEAM DIAGNOSTIC REQUIREMENTS

The beam diagnostic system must provide a wide range of possibilities for measuring properties of the beam during set-up and operation of the HIE-ISOLDE facility, specifically: measurement of beam intensity using a Faraday cup; measurement of beam transverse profile and beam position using a Faraday cup in parallel with a scanning slit; collimation of the beam using collimator slits, charge-state cleaning using stripping foils; measuring energy and longitudinal profile using silicon detectors[1].

FARADAY CUP

A very compact Faraday cup (fig.2) was designed and tested to cope with the very limited space available. The length of both the collector plate and the repeller were severely reduced compared to a standard Faraday cup and optimised to keep a good accuracy [2]. Reduced secondary particle loss and selection of structure materials was optimised for electrical properties. This design was built and tested at the TRIUMF facility in Canada. Although the geometry of the HIE short FC is particularly different to what is used in standard cups that difference did not influence significantly the results. The current ranges from 1 to 100 pA for stable beams while for radioactive beams ranges from a few pA down to a few particles per second.

Figure 2: a short FC

SCANNING SLIT

In order to measure the transverse position and beam profile a customized UHV Linear Shift Mechanism was developed (fig. 3) to precisely move a scanning slit located in front of a faraday cup or silicon detector. It consists of a metallic blade with a V shaped slit of 1 mm width that moves at 45° across the beam to allow reconstruction of both the horizontal and vertical profiles. The required accuracy for the measurement of the transverse position was 100 µm. The system has guiding rods that surround a high precision ball bearing screw connected to a stepper motor, the stroke is 135 mm. An acceptance test of the new prototype was performed at the AVS headquarters in February 2014. With the instrument performing to specification the design was approved for production.

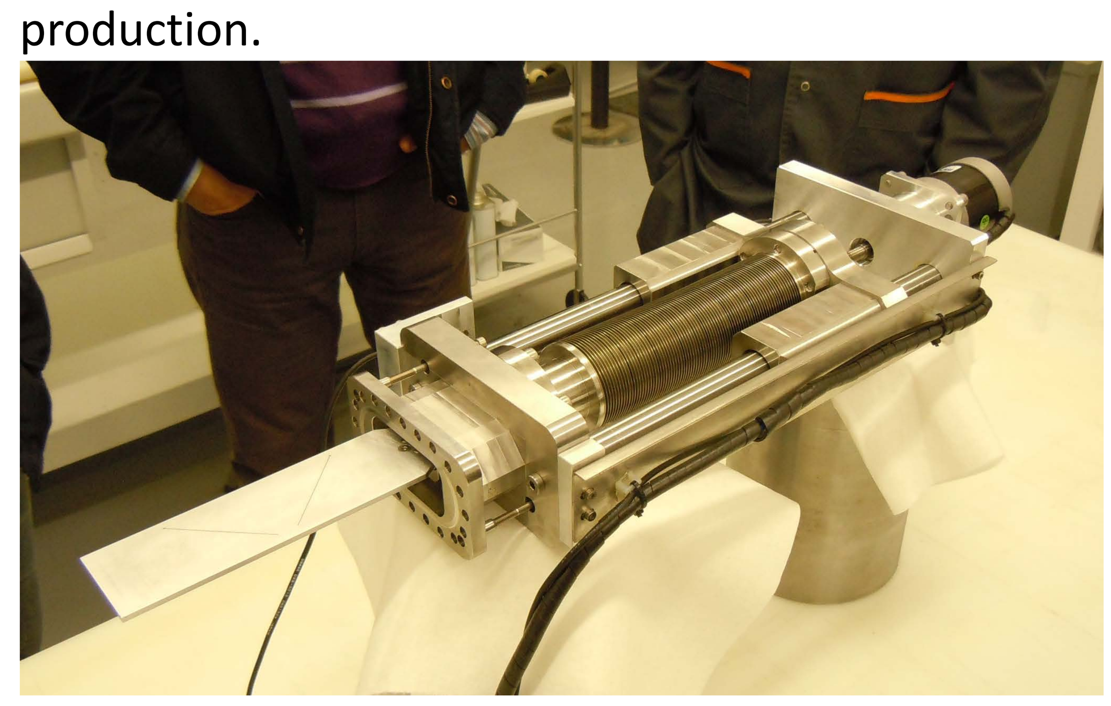


Figure 3: a scanning slit

OPERATIONAL EXPERIENCE

Figure 4 shows beam profiles obtained by scanning the scanning slit in front of the Faraday cup. The vertical axis shows the intensity of the beam that impinges on the FC after passing through the slits, while the x axis shows the position of the blade. The profile on the left corresponds to the vertical plane while the one on the right to the horizontal plane

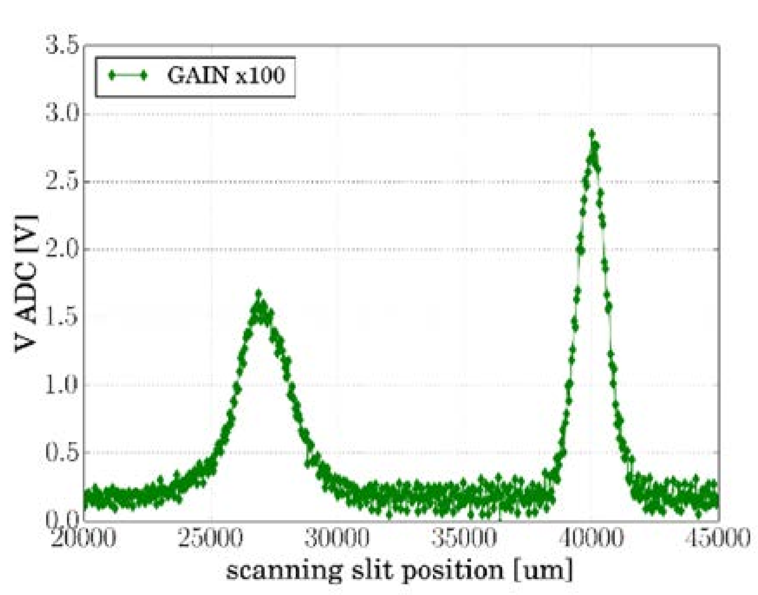


Figure 4: beam profile measurement

Figure 5 shows the energy spectrum of the beam for two different operational configurations measured with the silicon detector. The blue curve shows the spectrum obtained when the ISOLDE target is irradiated with protons while the red curve is obtained when the proton beam is turned off. The picture shows that when protons hit the ISOLDE target the beam is made predominantly of $^{76}Zn^{22+}$, while the main contaminant (protons off) is $^{38}Ar^{11+}$.

Such measurements can be used to study and optimise the composition and purity of the beams.

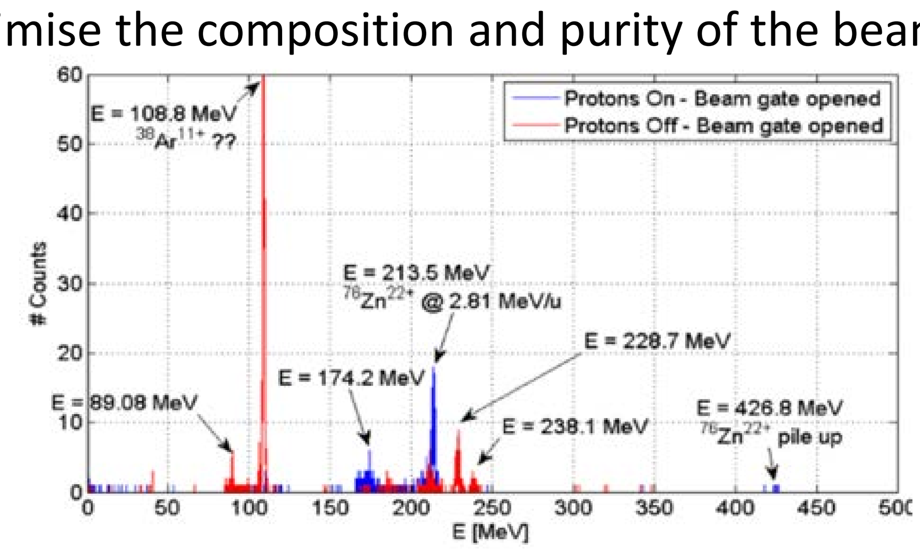


Figure 5: energy spectrum

Histograms of the particle energy as function of the phase of the RF in a superconducting cavity are shown in figure 6. Each colour refers to a particular phase setting, while the different peaks of each trace correspond to different particle species (the probe beam used contains several elements). It is evident how the average beam energy changes as function of the RF phase. This type of measurements is routinely used to adjust the RF phase to the most appropriate value.

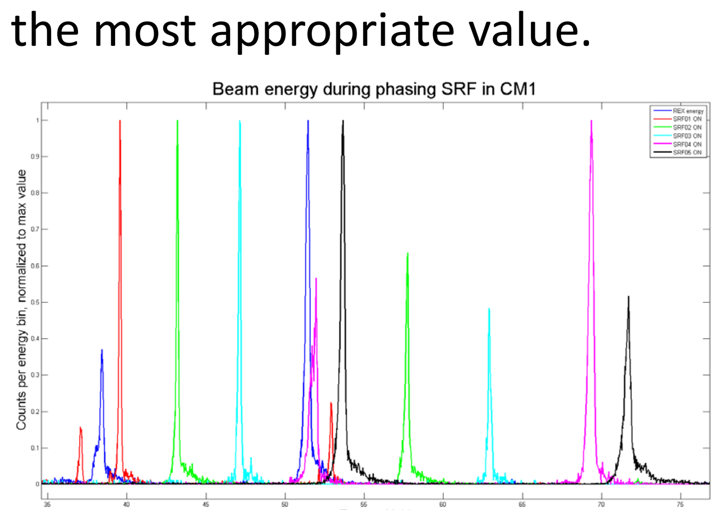
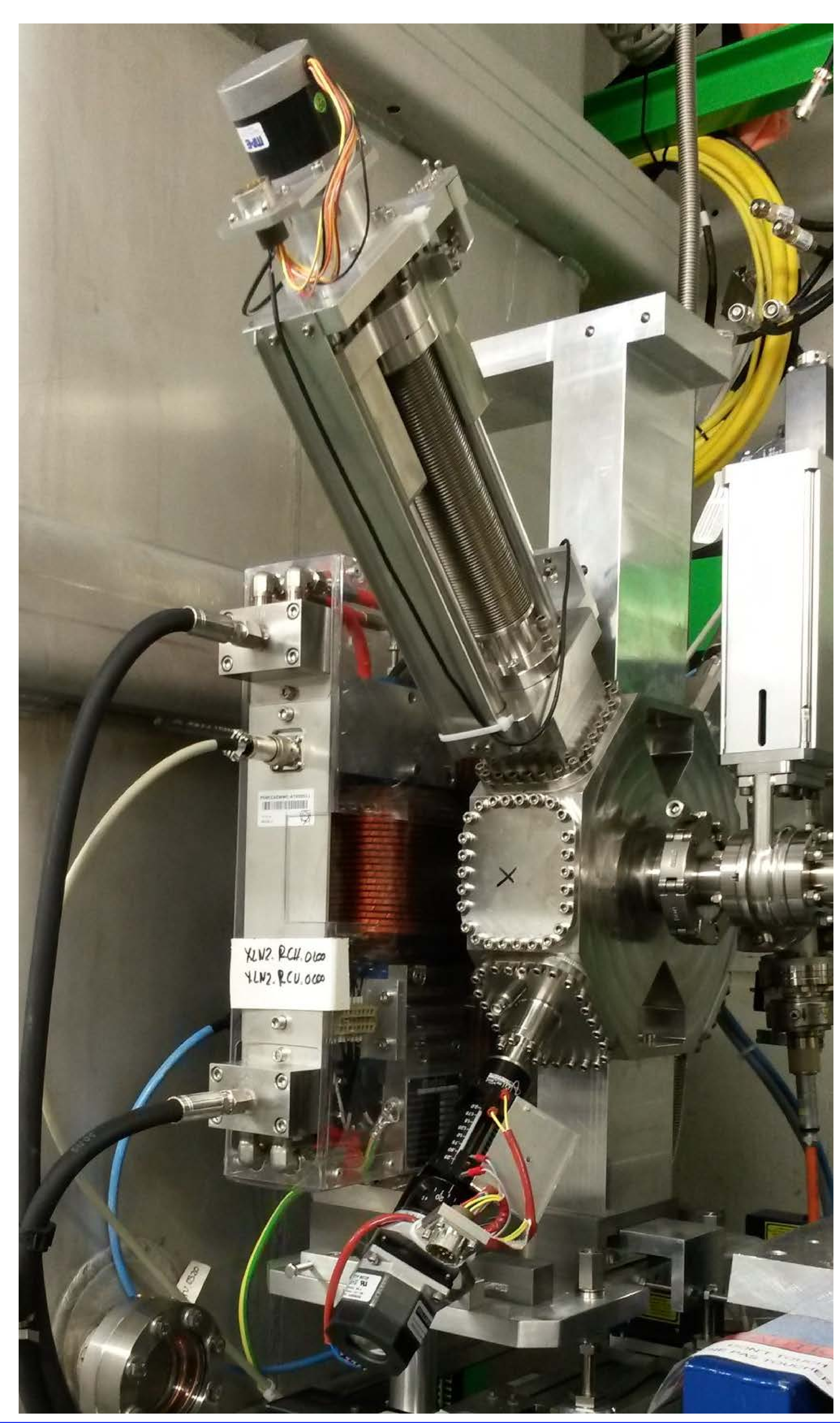


Figure 6: RF cavities phasing

CONCLUSIONS

Two types of diagnostic boxes were designed and produced in collaboration with private industries and 14 units are installed at the HIE ISOLDE facility. After a first period of commissioning the DBs have shown that their behaviour is within the required specification and have been used during regular machine operation since the summer of 2015. The beam instrumentation has shown very good accuracy and reliability and is very appreciated by the HIE ISOLDE operation team.



REFERENCES

[1]M.Fraser and al, Beam Diagnostic boxes for HIE-ISOLDE, HIE-BDB-ES-0001, CERN, Geneva, Switzerland
[2] E.Cantero and al, HIE-ISOLDE Faraday cups tested with ion beams at TRIUMF, HIE-BDB-NOT-0006, CERN, Geneva, Switzerland
[3] E.Cantero and al, Acceptance test for the linear motion actuator for the scanning slit of the HIE-ISOLDE short diagnostic boxes, HIE-BDB-NOT-0003, CERN, Geneva, Switzerland