Overview of New High Level Software Applications Developed for the HIE-ISOLDE Superconducting Linac

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Abstract:

The High Intensity and Energy (HIE) ISOLDE project consists of an upgrade of the ISOLDE facility at CERN. With the installation of 32 independently-phased, superconducting (SC) quarter-wave cavities the energy of post-accelerated radioactive beams (RIBs) will be increased from 3 MeV/u to over 10 MeV/u. The large number of cavities will increase the number of parameters to optimise. In order to ensure a fast set-up of the machine during operation and commissioning, new software applications have been developed and an upgrade of the existing software was carried out.

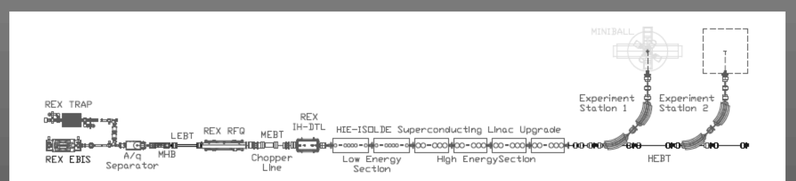
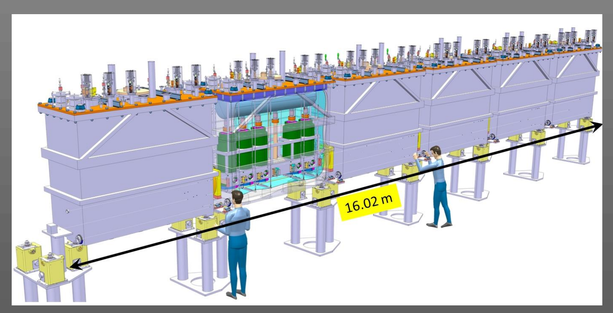
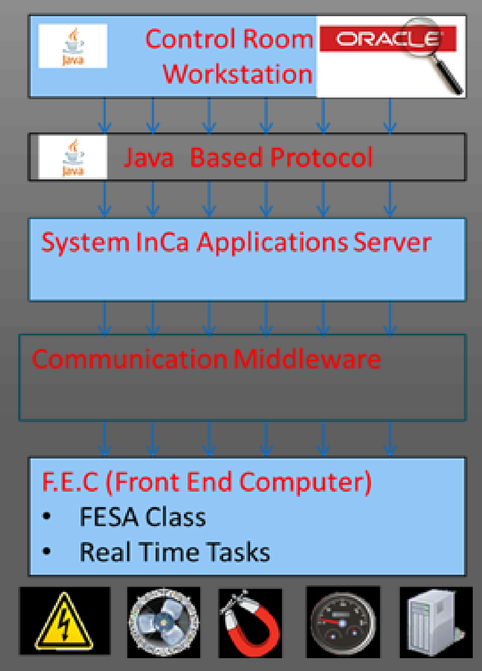


Figure 2: Schematic layout of the HIE-ISOLDE linac installation: MHB, chopper line and 6 superconducting cryomodules.



Four high level applications have been specifically developed for the SC linac. The first allows the conversion of optics settings into machine settings, and vice versa. The second will aid the phasing of the cavities using a beam energy measurements. In addition to this, a third application, which is under development, will provide a tool for help phasing the cavities by means of a time-of-flight system (ToF). A similar application was developed, tested and implemented at the ISAC-II SC accelerator at TRIUMF. The last application will automatically generate the phase and voltage settings for the cavities SC linac. In this contribution we will present the new applications and outline how these will be used in the operation of the new SC linac.

CERN Control System



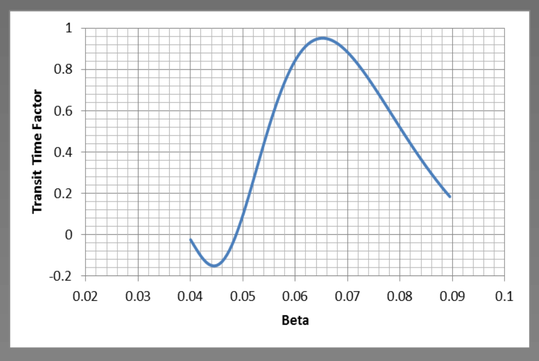
HIE – Converter

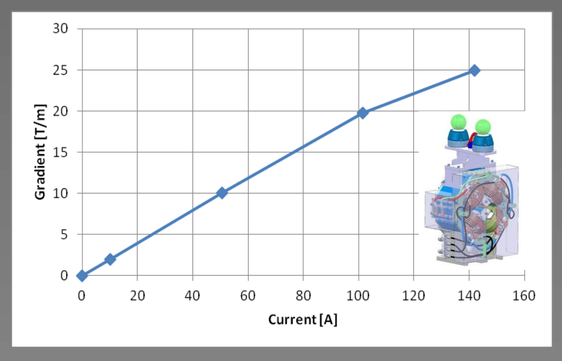
Convert optics setting in machine setting and vice versa.

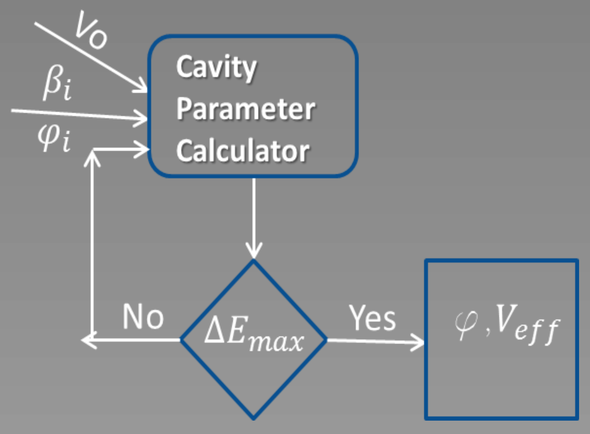
- **Visualise beam envelope.**
- **Quickly evaluate a setting**
- **Understand where the beam might be mismatched.**

Conversion:

Magnet: Calibration Curve
NCRF: Scaled according to A/q
SCRF: Routine to optimize the gap's phase and V_{eff}

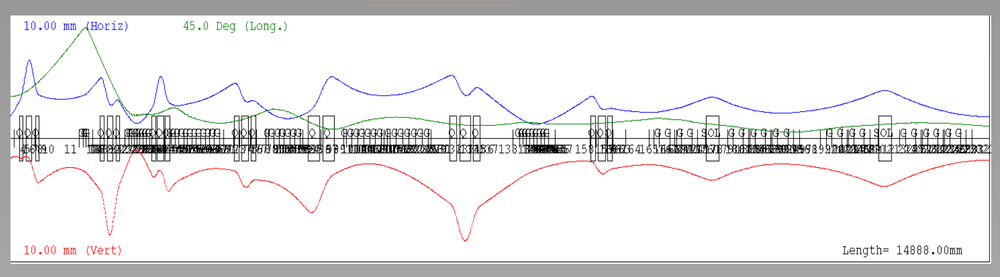






$$\Delta E = \frac{q}{A} V_0 \, TTF(\beta_i) \cos(\varphi)$$

$$TTF = \frac{\int E_z(z) \cos\frac{2\pi z}{\beta_i \lambda} dz}{\int |E_z(z)| \, dz}$$



Upgrade:

- ✓ **Use of other beam simulation code**

HIE – Phase Up

Not needed before because:

- **REX:** Fixed velocity profile -> Phase up checked once per year

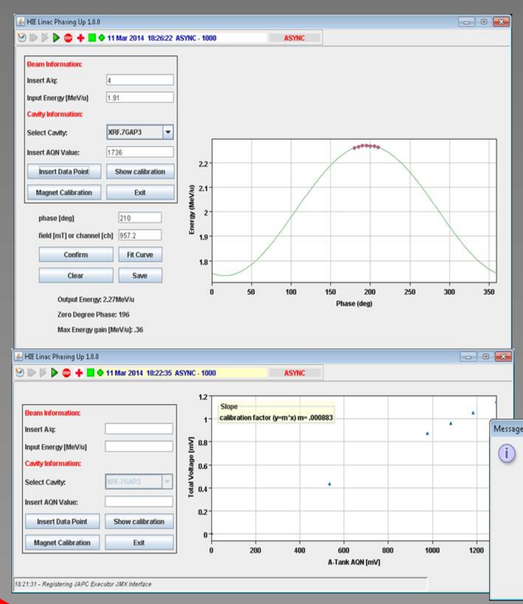
While with the accelerator upgrade

- **HIE:** 32 SC independently phased cavities -> variable velocity profile

-> Phase up for each run

Main Feature:

- ✓ **Cavity phased by finding the max ΔE as a function of cavity phase**
- ✓ **Beam based calibration between the accelerating voltage on the cavity measured with the beam, and the voltage measured on the cavity pickup.**
- ✓ **Database of cavity history**



Upgrade:

- ✓ **Automatize the acquisition process**

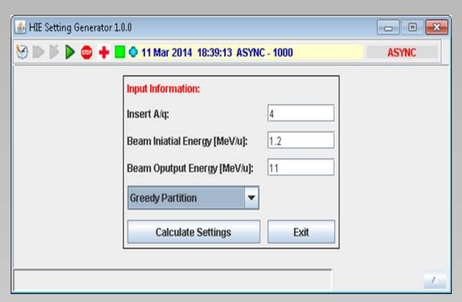
$$\cos fit: a * \cos\left(x * \frac{\pi}{180} + b\right) + c$$

Conclusion

Several tools have been developed and a general upgrade of the existing software has been carried out. The software needed for the commissioning has been identified and most of the codes' debugging has been done off-line. The applications are ready but the final commissioning will take place during dry-runs when the hardware becomes available and during beam commissioning.

HIE – Generator

Create SC - RF setting (voltage and phase)from few beam input
Error and tolerances has been studied in [2].



Input:

- Lattice
- E_{in} & E_{out}
- Voltage partition

Output:
Phase and Voltage of the SC cavities in the equipment array file format

Upgrade:

- ✓ **Insert a custom lattice of the machine**

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References

[1] D. Lanaia et all, MOPP029, these proceedings, 2014
[2] M.A. Fraser et all, TUPP031 , these proceedings, 2014