EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
ORGANIZATION EUROPEENNE POUR LA RECHERCHE NUCLAIRE

CERN-AB DIVISION

AB-Note-2003-035 (OP)

An application for the On-Line Isotope Mass Separator ISOLDE facility: the Mass Control

Ernesto Ovalle Gonzalez

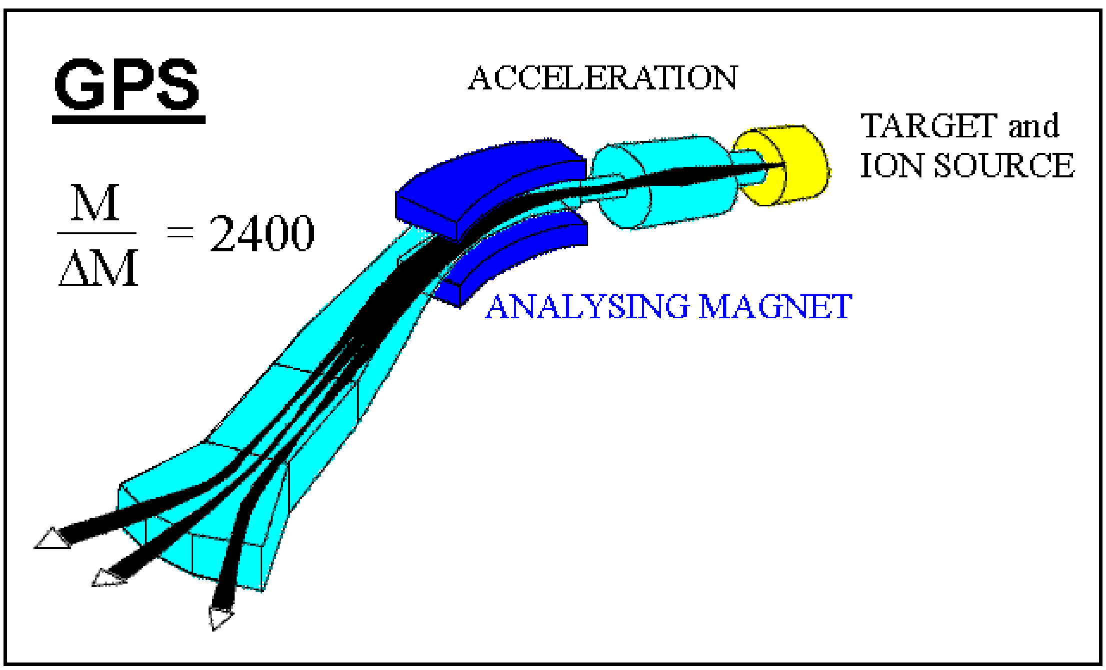
12 May 2003
CH-1211 Geneva 23, Switzerland

1. Introduction

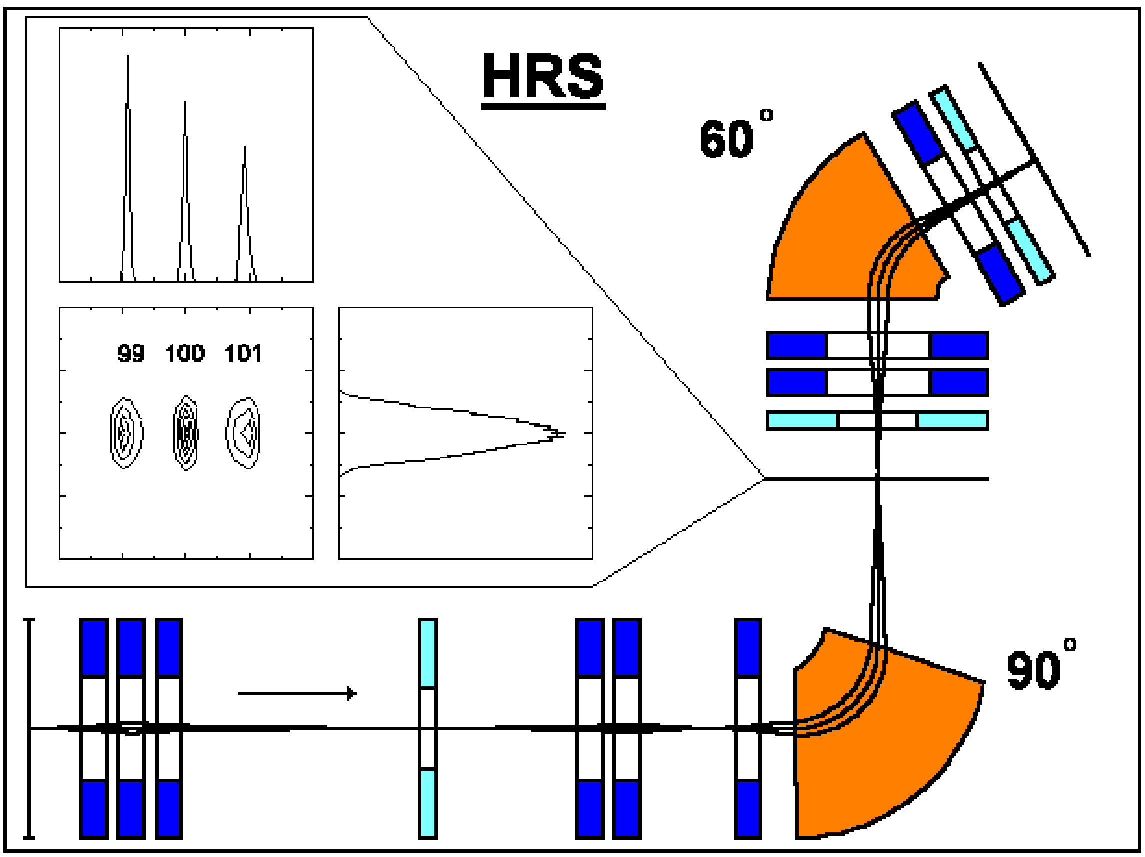
The main purpose of the Mass Control Application is to calculate the magnetic field for the magnets of both HRS and GPS separators based on a given isotope or Molecule. Also the program, in the Mass Calibration Calculator, provides the means of calculating a new field and a new Mass Factor. Subsequently the User can send these calculated values down to the hardware.

The ISOLDE Separators

The ISOLDE PS-Booster facility is equipped with two isotope separators. The General Purpose Separator (GPS) is designed to allow three beams, within a mass range of ± 15%, to be selected and delivered to the experimental hall. The magnet is double focusing H-magnet with a bending angle of 70° and a mean bending radius of 1.5 m. The mass resolving power is M/ΔM=2400.



The second separator, the High Resolution Separator (HRS), is equipped with two bending C-magnets with bending angles 90° and 60° degrees, respectively. At the moment one single mass, with a resolution of about M/ΔM=5.000, can be separated routinely with the HRS separator. The calculated beam profiles for the masses 99, 100 and 101 are shown in the figure. It will be possible to achieve a maximal resolution of more than 30.000.



2. The ISOLDE Separator Magnet controls

Layout

The layout shown in figure 2.1 shows how the HRS magnet is controlled with the new control system. However, like we had in the past, the GPS magnet does not include the Tesla-meter device.

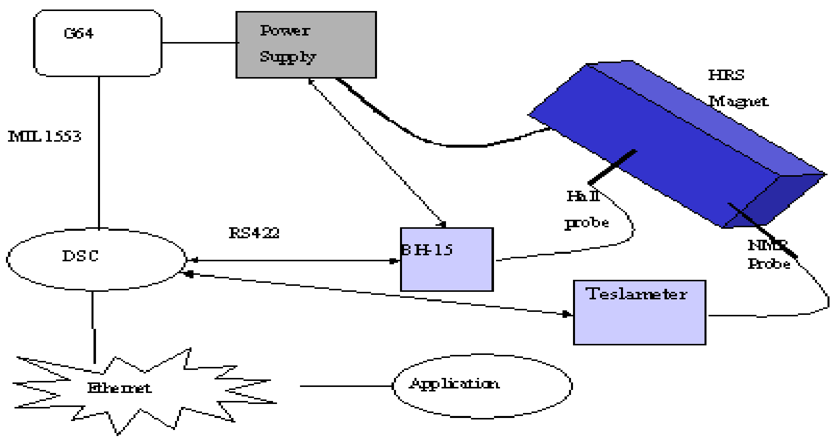


Figure 2.1

1. The FEC has been replaced with a DSC.
2. RS422 lines are used to connect the DSC to the BH15 boxes and the Tesla-meter.
3. The Power Supply is provided with a standard G64 crate. Then the G64 will be connected to the DSC with a standard Mil1553 link.
4. The role of the BH-15 will be the same as before. It will take care of setting the magnetic field and controlling the regulation loop when the system is set up to run in “mode 0”.
5. The G64 crate controls the power supply through a “PS standard” POW-V equipment module. It is used to recover the status of the power supply, to control the state of the power supply (ON/OFF/STDBY/RESET) and to set the field when running in current regulation mode.

The new control system will provide three operation modes plus a disable one:

1. Mode 0: The magnetic field is set through the BH-15, which also performs the regulation, while the Tesla-meter is used to acquire the value of the magnetic field (returned by the AQN property). This is exactly the same as "Mode 0" of the previous control system.
2. Mode 3: This mode is new and replaces the previous software regulation mode ("Mode 2"). A regulation algorithm is run to calculate the field value to be set (on the basis of the acquisition of the current field value from the Tesla-meter) in terms of a current. This will be sent to the power supply via the MIL1553 connection.
3. Mode 4: This is the "GPS compatibility mode": the control system controls a system consisting of only the BH-15, while still retrieving the status of the power supply directly from the G64 crate via the MIL1553 line.
4. Mode "-1". This mode is provided to disable the control of a given magnet. It will be used for test purposes only.

Mode	Name	BH-15	Tesla-meter	G64/Mil1553	Regulation
0	BH-15 Control	Field-setting and regulation	Acquisition of the Field Value	BH-15 control	BH-15
3	Software regulation	Not used	Acquisition of the Field value	Current setting Power supply status	Field regulation via TM feed-back + magnet Cycling. Compute value For the current
4	GPS Mode	Field setting and regulation	N/A	Power supply status	BH-15

DSC Software Architecture

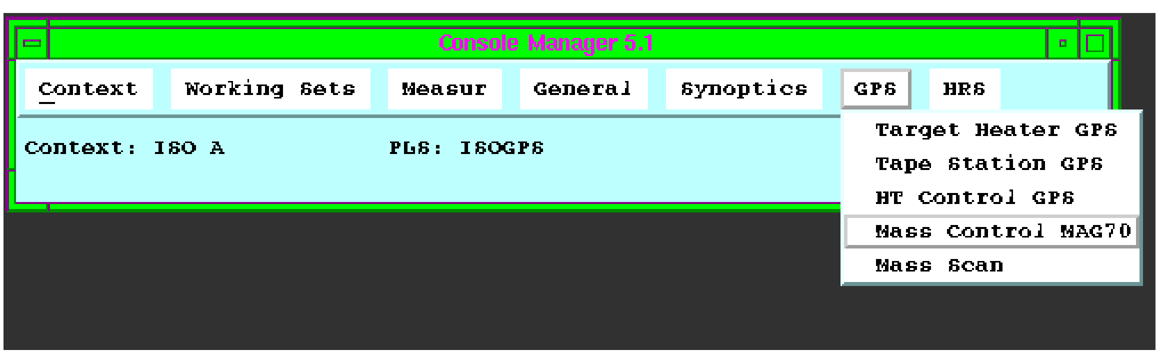
The HRS magnet control software consists of the following modules:

1. A composite equipment module: the one for the HRSMAG class which in turn calls a standard POW-V equipment module to communicate with the G64 crate via the Mil1553 line.
2. The standard powvrt real time task, responsible for the communications with the G64 crate.
3. An hrs specific real-time task (hrsmagrt) which implements
   a. The BH-15 control mode
   b. The acquisition and control of the Tesla-meter
   c. The GPS mode.
   d. The software regulation mode.

3. Mass Control Application User's guide

The application is launched from the ISO Console Manager:

Launch Mass Control MAG70 for GPS separator.

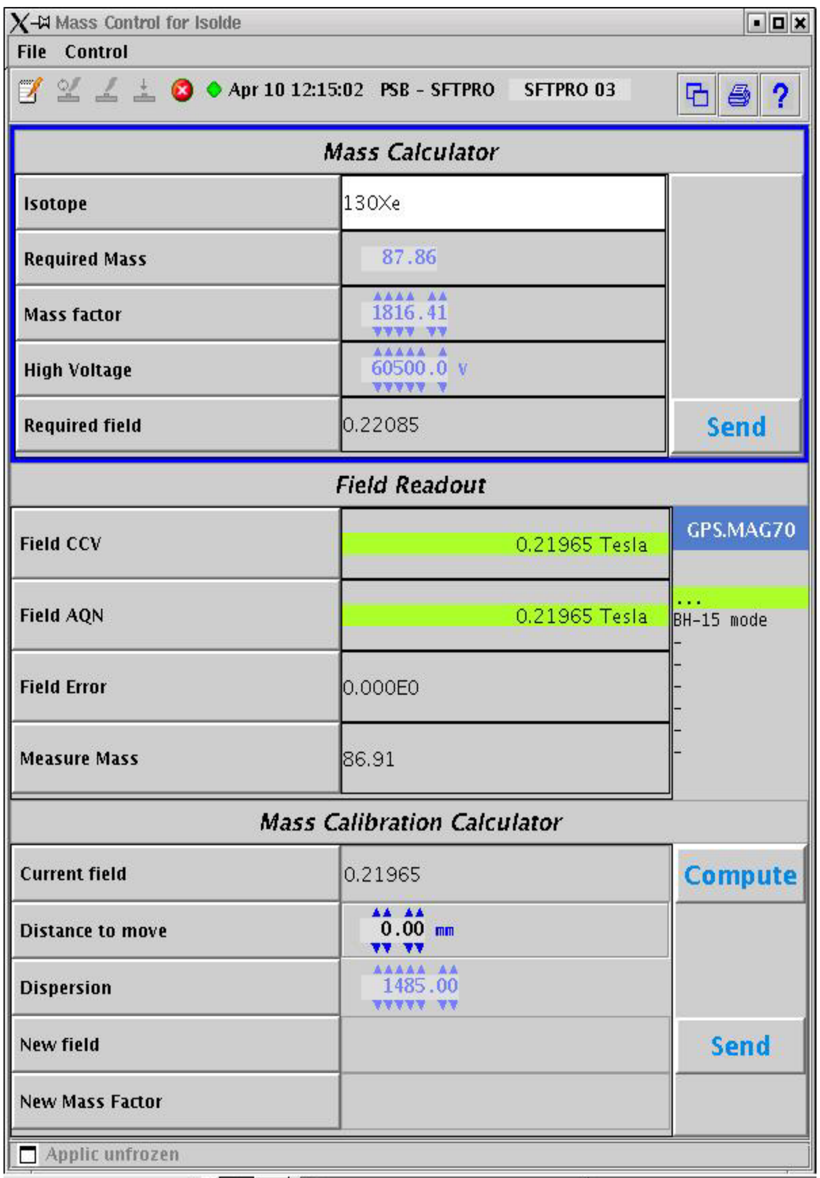


Or Mass Control MAG60 and Mass Control MAG90 for HRS separator.

You do not need to select a PLS line since the application does it automatically.

3.1 Mass Control Application Graphic User interface

The program has been entirely written in JAVA using the Application services and components control facilities, known as ASC, fully integrated into the accelerators control system.



The general layout consists mainly of three independent panels: The Mass Calculator, the Field Readout and finally the Mass Calibration Calculator panel.

3.1.1 Mass Calculator

After entering an Isotope name or Molecule the application gets the Isotope mass from the Data Base and calculates the required field to be sent to the magnet.
For Specialists you have the possibility to set the mass with the wheel switch Required Mass. Go to the Menu Control and select "Special Mass Enable". See Figure 3.1.1.

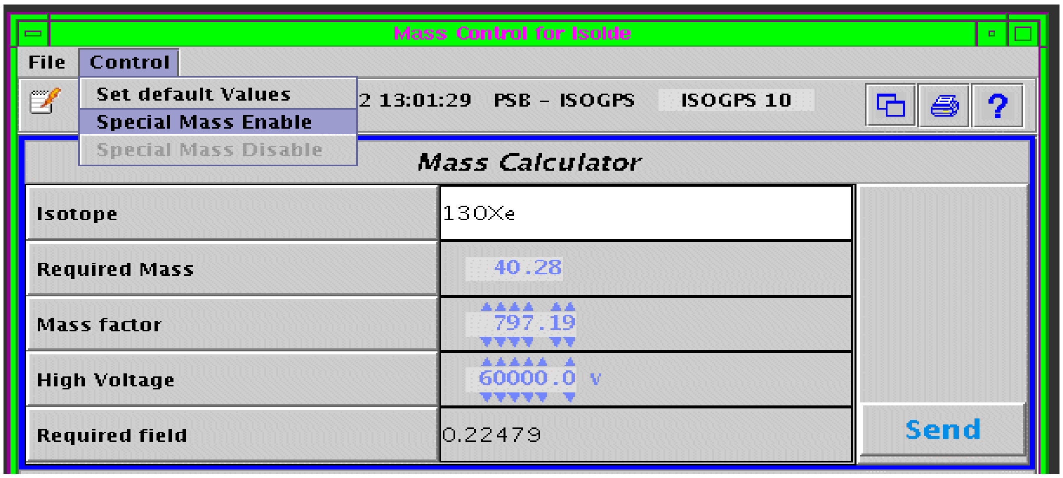


Figure 3.1.1

Also this panel offers the user the possibility to change the Mass Factor as well as the High Voltage

3.1.2 Field Readout

The main task if this panel is to show the CCV and AQN values of the selected magnet. The panel is refreshed every PSB cycle (1.2 second).
It also indicates the magnet status:

- Power supply on/off/stby/etc.
- Magnet in regulation mode
- Magnet in cycling mode.

Or shows error messages like:

- Lost communication with NMR.
- Lost communication with power supply.

The Field Readout also does a bit of calculation such as:
Field error and the Measured Mass, see Figure 3.1.2.

The Field error and the Measured Mass fields will remain blank should an error occur, like for example:
-Lost communication with the NMR.

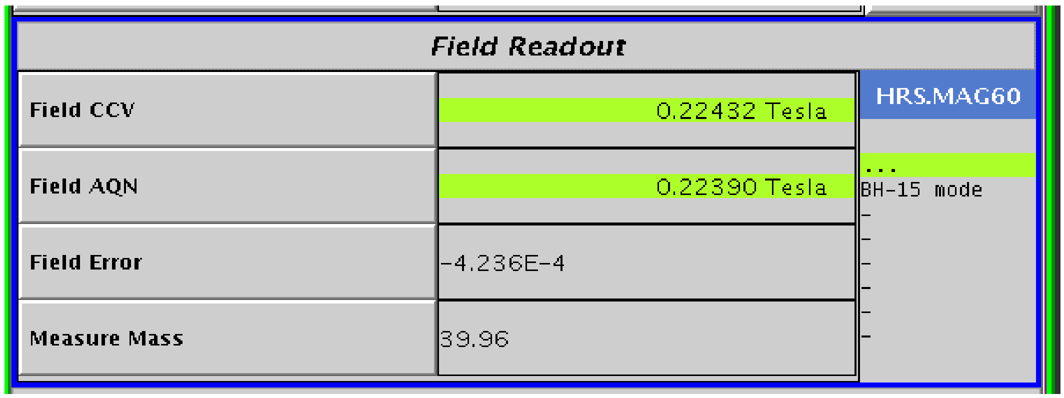


Figure 3.1.2

The knob of a given magnet can be opened doing the following:

You go over the CCV field value, for example, and you click with the mouse right button. See figure 3.1.3

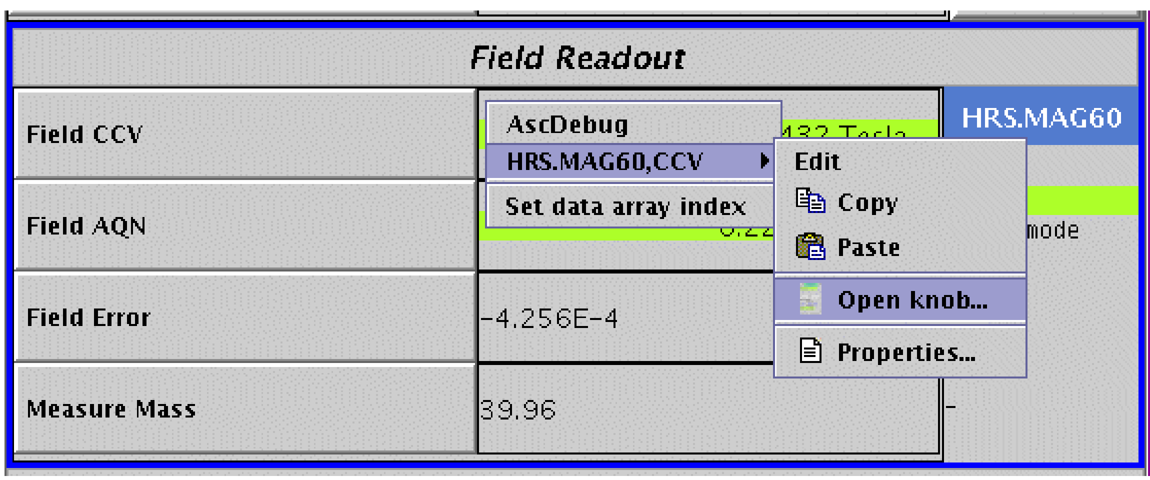


Figure 3.1.3

3.1.3 Mass Calibration Calculator

The Mass calibration calibrator offers the possibility to calculate a new field and mass factor based on the following parameters: Current Field, Distance To Move the beam, Dispersion for the New Field and Required Mass, High Voltage and Current Field for the New Mass Factor. See Figure 3.1.3

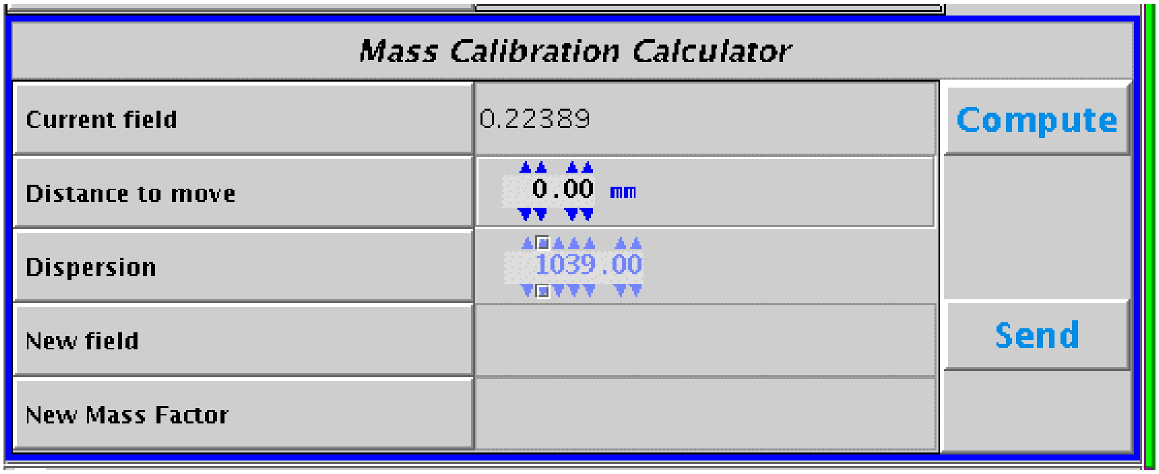
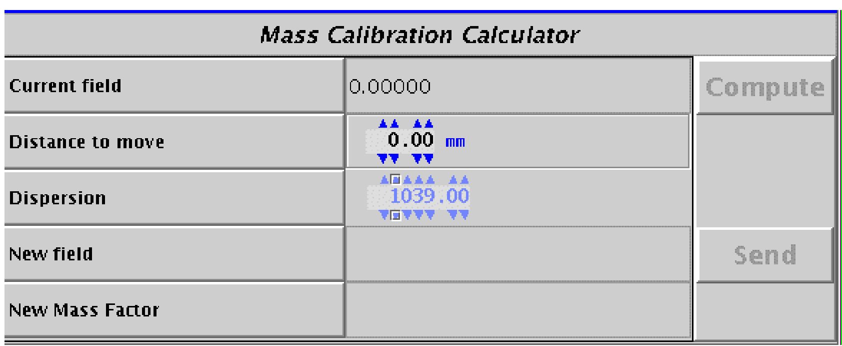


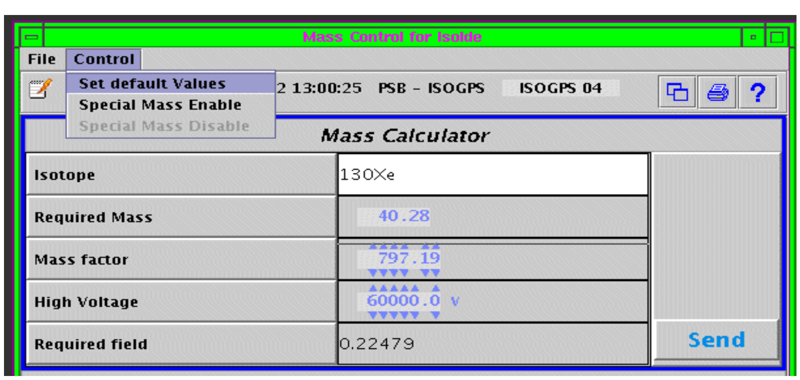
Figure 3.1.3

If the disable mode is activated, the Compute and Send buttons look like the picture below. New field and New Mass Factor will remain blank until the magnet is ready again to get new values.



Another possibility for the User is to restore default values: Proceed as shown below.

From the control Menu the user can select "Set Default Values " Dispersion, Mass Factor and High Voltage reasonable values will then be sent back to the control system.



4 Calculations

4.1 Calculations in Mass Calculator

M1: Required Mass
F: Mass Factor
V: High Voltage
B1: Required Field

$$B_1 = \sqrt{\frac{M_1 \times V}{6E4 \times F}} \quad \text{[Tesla]}$$

4.2 Calculations in Field Readout

Ba: Field AQN
Bc: Field CCV
dB: Field Error
Mm: Measured mass

$$dB = B_a - B_c \quad \text{[Tesla]}$$

$$M_M = B_a^2 \times F \times 6E4 / V$$

4.3 Calculations in Mass Calibration Calculator

M1: Required Mass
Ba Field AQN
V: High Voltage
B2: New Field

$$B_2 = B_a \times \left(1 + \frac{X}{(2 \times D)}\right) \quad \text{[Tesla]}$$

$$F_2 = M_1 \times \frac{V}{(B_a^2 \times 6E4)}$$

3.1.4 Log files

Every time the user sends new values from the Mass Calibration Calculator some parameters are automatically recorded into a file.

AQN value, New Field, Displacement and New Mass Factor will be recorded

References:

Documentation from the AB-CO web site done by J.Cuperus, A. Gagnaire and A.Risso

Acknowledgements

I specially thank Jose Luis Sanchez Alvarez (AB/OP) for scrutinizing my work. He took a great deal of his time in working in collaboration with the CO group in order to adapt the control system to meet the requirements of the Mass Control Program.

I am also extremely grateful to Tim Giles for clearly defining the requirements of the application and helping me in shaping the Mass Control application to meet the user needs.

My gratitude also to Michel Arruat AB/CO and Eric Roux for their precious help in programming under the ASC environment.