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1 ISOLDE

The ISOLDE facility uses the 1.4 GeV proton beam from the PS-booster (four rings which can be operated independently) at CERN to bombard a target and produce a wide range of isotopes. Ions are extracted in a $1^+$ state (possibly as molecules) and separated using one of two separators: the high-resolution separator (HRS) and the general-purpose separator (GPS).

1.1 Ion sources

Chemistry plays an important role in the extraction of these species and a variety of techniques have been developed to enhance the extraction of particular species. Consequently different ion sources are used, depending on the species of interest.

- Surface ioniser
- Hot plasma source
- Cold plasma source
- Laser ion source


1.1.1 The Surface Ion-source

The surface ion source is the simplest set-up for ionizing atoms produced in the target. The ionizer consists only of a metal tube ("line"), for example tantalum or tungsten, which has a higher work function than the atom that should be ionized. Depending on the line’s material it can be heated up to 2400° C. Surface ion sources have been used in combination with most of the different target materials.

1.1.2 Hot plasma source

The plasma ion source is used to ionize elements that cannot be surface-ionized. The plasma is produced by a gas mixture (typical Ar and Xe) that is ionized by electrons being accelerated between the transfer line and the extraction electrode by supplying an anode voltage of about 130 V. For the optimization of this process an additional magnetic field is used (SRCMAG). Plasma ion sources have been used in combination with most target materials.

1.1.3 Cold plasma source

For the production of noble gas isotopes the set-up has been modified in the way that the transfer line between target and gas plasma is cooled by a continuous water flow to suppress the transport of less volatile elements and reduce via this mechanism the isobaric contamination in the ISOLDE ion beams.
Another technique which is used is the resonance ionisation laser ion-source (RILIS) where a laser beam is tuned precisely to the energy of an atomic ex-
citation in the element of interest and a second laser beam is used to excite an electron from that excited state into the continuum, thereby ionising the atom. Since only the ions of a given element are influenced by the first beam and the second one doesn’t have enough energy to excite an electron from the ground state to the continuum, only atoms of the selected element are ionised. In fact, the RILIS facility at ISOLDE can use three beams, going through two intermediate states for further selectivity. The laser system consists of copper vapour lasers, tuneable dye lasers and non linear crystals for frequency doubling or tripling offering the possibility for most efficient two or three step ionization.

1.2 The ISOLDE Targets

In order to get a beam out of ISOLDE, we have to have the ISOLDE target under high voltage. Sometimes this trips and has to be reset using a control window like the one shown in figure 6. This one is for the HRS which is to be found on the consoles to the right as you come into the control room. There is a similar one for the GPS on the left-hand consoles.

1.3 The Separators

ISOLDE has two separators, the GPS and the HRS.

1.3.1 The General-purpose Separator (GPS)

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.
Figure 6: The HRS high voltage control while running at 30 KV pulsed.

The magnet is double focussing H-magnet with a bending angle of 70° and a mean bending radius of 1.5 m. The mass resolving power is M/DM=2400.

1.3.2 The High-resolution Separator (HRS)

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/DM=5,000, can be separated routinely with the HRS separator.

1.4 ISOLDE beam and signals

The ISOLDE setup is typically set at 30 or 60 kVolt, so that is the extraction energy of the beam. Sometimes, however, it runs at a lower voltage though usually this is only when there is some problem.

The four rings of the PS boster facility deliver protons at 1.4 GeV in a supercycle lasting 14.4 seconds. During this time, 12 pulses are delivered, each containing 4 bunches of particles. The length of a pulse is 1.25 µs and they are 1.2 seconds apart. The bunches are 230 ns with a gap of 120 ns.
Figure 7: The general-purpose separator (GPS)

Figure 8: The high-resolution separator (HRS)
Figure 9: The high-resolution separator mass control display

We get several signals from ISOLDE. These are sent to a patch panel in rack RA02 of the ISOLDE control room (on the left as you enter). This patch panel is marked “Physics network links with control room” and it has several columns of BNC connectors with five connectors per column, each of which goes to a different patch panel. The patch panel for the Miniball platform is P13 which is the rightmost column of connectors. On the Miniball platform, the other end of these connections is labelled “Links to control room RA02” and is in the patch panel on the wall marked P13.

- PS (proton supercycle) - when the PS booster has its supercycle start. A supercycle typically lasts of the order of ten seconds or so and there is about one beam macropulse per second during that time. However, the pulses are used by several experiments, so we typically only get a couple of pulses. e.g. 5 pulses out of 12 in a 14.4 second supercycle. The PS signal comes at the beginning of each supercycle. This signal is available a module in the minicrate around head-height in rack RA02 in the control room and is fed from there to the patch panel in the same rack, which is connected to the one on the Miniball platform.
• T1 - this pulse occurs when the protons hit the ISOLDE target (this is for each micropulse). This signal comes from the top module in rack RA02 of the ISOLDE control room but the connector is at the back. Note that there are two T1 pulses, depending on the separator, so make sure you have T1 GPS if you are using the general purpose separator and T1 HRS if you are using the high resolution separator.

• T2 - this is when the extraction gate is opened. There is a delay between T1 and T2 which is set in the control room. Usually this is not changed during an experiment, unless optimisation is taking place, so we don’t usually acquire both T1 and T2 simultaneously. This signal comes from the second module from the top in rack RA02 in the ISOLDE control room. Like the signal for T1, there are separate signals for T2 GPS and T2 HRS and they are at the back of the module.

• laser status - this signal is part of the Leuven switching system for the laser on/off operation. It indicates whether the laser shutter is open or closed and consequently comes from the laser cabin, via a patch panel to the patch panel in rack RA02 of the control room. From there it is patched to patch panel P13 on the miniball platform, which is also available from RA02.

• laser power - this is the power output of the laser, so again it comes from the laser cabin via a patch panel to the one in RA02 of the control room and from there to P13 on the Miniball platform.

1.4.1 Beam request
There are two beam request buttons one for HRS and one for GPS. These turn on and off the request for the proton beam. They are located on a single module in the minicrate in rack RA02 in the control room (around head height). Above that rack, there are two large lights indicating whether the proton request is on or off for HRS and GPS.

1.4.2 Beam gate timing
The timing of the beam gate (T2) relative to the proton pulse (T1) is set by the electronics in rack RA10 of the control room.

2 The REXTRAP Penning Trap
In order to post-accelerate the radioactive isotopes, we first trap them in a Penning trap called REXTRAP. Here the ions are slowed down by collisions with a buffer gas (typically argon or neon). The potential in the trap is a well with one side just low enough for the 60 keV beam to enter, and the other side higher. Once the 60 keV beam enters the trap, it loses energy through collisions
with the buffer gas and no longer has enough energy to get out of the trap. At some time, we lower the potential on the outgoing side and let the ions out.

3 The REXEBIS Electron-beam Ion Source

After extraction from the REXTRAP, the ions enter an electron beam ion source (REXBIS). Here an electron gun is used to produce a beam of electrons which bombard the ions. These ions start in the $1^+$ state coming out of the EBIS and are ionised through collisions between the electron beam and the electrons of the ions, which are then kicked out. The ionisation states obtained depend on the time the ions are in the trap (charge breeding time). Longer times result in higher charge states, but if the lifetime of the isotope is short, this may be a limiting factor.

The REXEBIS has attained a current density of 150 A/cm$^2$ and beam currents of $<0.4$ A. A 1.5 m solenoid provides a trap length of 0.8 m with a magnetic field strength of 2 T. The electron beam energy is adjustable between 3 and 6 kV. For these parameters Na and K are charge bred to 8+ and 15+, respectively, in 20 ms. To obtain a high breeding efficiency, the phase space overlap of injected ions and the electron beam has to be large. Hence, a rather low extraction emittance of $<10 \pi$ mm mrad (95% at 60kV) from the Penning trap is required for a successful injection into the EBIS. Since only one specific charge state from the total charge state distribution coming out of the EBIS is
selected in the successive mass separator, the maximum breeding efficiency is about 30%. The space charge from the electron beam determines an upper limit for the maximum number of positive ions that can be stored in each pulse, for the above parameters this gives $5 \times 10^{10}$ charges. Assuming 50% neutralization, $3 \times 10^9$ number of Na$^+$ can be charge bred to Na$^{8+}$ per pulse. This is almost one order of magnitude larger than the ion number which can be accumulated in the Penning trap.

The EBIS is located vertically above the REXTRAP.

You can check the beam going into the EBIS by putting in the injection plate and reading the value. However, make sure you actually hear it go in and out, because it sometimes sticks.
You can also click on the “read all” button at the top of the EBIS console (The computer on the far right in the control room) to read all the values to check that nothing has tripped.

4 The Mass Separator

The ISOLDE separators (HRS, GPS) perform an accurate separation by mass on the $^1\text{+}$ beam, which combined with element-sensitive ionisation (e.g. the RILIS) gives quite good selection of a particular isotope. However, at the exit from the EBIS, there are also other components in the beam such as the residual gases which are left despite pumping to high vacuum. The main contaminants are: $^{14}\text{N}$, $^{15}\text{N}$, $^{16}\text{O}$, $^{18}\text{O}$, $^{20}\text{Ne}$, $^{22}\text{Ne}$, $^{12}\text{C}$, $^{13}\text{C}$, $^{36}\text{Ar}$, $^{40}\text{Ar}$. Furthermore, we have a variety of charge states. So after the EBIS, we have a mass separator which performs an A/q separation with $\Delta(q/a) / (q/A)$ of $1/150$.

The separator is built with two magnets, one bending the beam downwards (since the EBIS is up on a platform) and the other bending the beam back to the horizontal at the level of the beam line.

5 The REX Linac

The REX linac consists of six accelerating elements:

- A radio-frequency quadrupole (RFQ) to accelerate from 5 keV/u to 300 keV/u.
- An interdigital H structure (IH) to accelerate up to about 1.1-1.2 MeV/u.
- Three seven-gap resonators (7GAP) to accelerate to 2.2 MeV/u.
- A nine-gap resonator (9GAP) to accelerate to 3.0 MeV/u.
There is also a buncher between the RFQ and the IHS.

All of these elements operate at 101.28 MHz, except for the 9-gap resonator which works at exactly twice this frequency. The amplifiers for these radiofrequency devices in the amplifier room on the first floor (not far from the EBIS platform).

This can then deliver a beam of up to 3.0 MeV per nucleon to the Miniball target. Note, however, that there is another limit on the beam energy which is imposed by the bending magnet. This limit depends on the charge state, but the charge state we use is largely determined by the EBIS. Too high a charge state requires too long a breeding time (if the half life is short) or gives too low a yield. Consequently, most measurements are currently limited to about 2.7 MeV per nucleon.

5.1 REX beamline elements

![Figure 13: REX beamline elements](image)

The REX beamline is divided into six sections with valves between each section:

- **SEP** - the separator area (between V1 and V2)
- **RFQ** - the radio-frequency quadrupole area (between V2 and V3)
- **IHS** - the interdigital H structure area (between V3 and V4)
- **7GP** - the 9-gap resonators area (between V4 and V5)
- **9GP** - the 7-gap resonators area (between V5 and V6)
- **BEN** - the bending magnet area (between V6 and either V7 or V8)

Then there are two separate beam lines: the Miniball one at 65° and the second one at 20°.

5.1.1 The SEP area

The elements are as follows:
Figure 14: REX beamline elements in the separator area

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Gate valve</td>
</tr>
<tr>
<td>SEP.QP10/20</td>
<td>Electrostatic octupole doublet</td>
</tr>
<tr>
<td>SEP.QS20</td>
<td>Electrostatic steerer</td>
</tr>
<tr>
<td>SEP.BE30</td>
<td>Electrostatic bender of separator</td>
</tr>
<tr>
<td>SEP.QP40/50/60</td>
<td>Electrostatic quadrupole</td>
</tr>
<tr>
<td>SEP.QS60</td>
<td>Electrostatic steerer</td>
</tr>
<tr>
<td>SEP.FC80</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>SEP.BO90</td>
<td>Beam diagnostics</td>
</tr>
<tr>
<td>SEP.MD100</td>
<td>Magnetic dipole bender of separator</td>
</tr>
</tbody>
</table>

Note that SEP.FC80 sees all the residual gas beam from the EBIS, even if there is no beam coming from ISOLDE. So seeing something at SEP.FC80 and not seeing anything at the next cup (RFC.FC20) doesn’t necessarily mean there is beam up to SEP.FC80. It could be that this cup is just seeing the residual gas beam, which doesn’t make it round the magnet SEP.MD100.
5.1.2 The RFQ area

The elements are as follows:
Figure 16: REX beamline elements in the RFQ area

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2</td>
<td>Gate valve</td>
</tr>
<tr>
<td>RFQ.FC20</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>RFQ.BO30</td>
<td>Beam diagnostics</td>
</tr>
<tr>
<td>RFQ.QP40/50/60</td>
<td>Electrostatic quadrupole triplet</td>
</tr>
<tr>
<td>RFQ.QS50</td>
<td>Electrostatic steerer</td>
</tr>
<tr>
<td>RFQ.QP70/80/90/100</td>
<td>Electrostatic quadrupole quadruplet</td>
</tr>
<tr>
<td>RFQ.QS100</td>
<td>Electrostatic steerer</td>
</tr>
<tr>
<td>RFQ</td>
<td>The radio-frequency quadrupole acceleration element</td>
</tr>
<tr>
<td>RFQ.MD110/120/130</td>
<td>Magnetic quadrupole triplet</td>
</tr>
</tbody>
</table>

Note that up to the RFQ itself, the focusing and steering is electric, but after, the focusing and steering has to be magnetic.

5.2 The REX amplifiers

The acceleration units at REX are radio-frequency cavities, where a high frequency oscillation is sent between electrodes, synchronized with the passage of the bunch of beam particles, so that they always see an accelerating potential. To achieve this, high-power radio-frequency amplifiers are needed to produce the necessary RF. These are located in a room on the floor above REX, accessible from the same platform that goes to the EBIS.

Each amplifier has two racks. The leftmost is for the control and generation of the RF.
This rack has a panel of lights at the top. Normally only one green light in the bottom right hand corner of the panel lights up, but if an error occurs, one or more red lights come on and the two yellow buttons above the green light light up. Pressing these buttons (the upper one first) resets the error condition.
Below the lights is a Siemens simatic control system. It has lots of lights and controls the logic, but there is nothing that can be done with it.

Under that are gauges indicating the power.

Below that is the control unit. In normal operation the “Lev1” and “Lev2” lights should be on and the $P_F$ final (forward power) should be indicating tens of kilowatts, while the $P_K$ final (reverse power) should be zero. The “Lev1” and “Lev2” buttons are used to switch on the system, first to level one by pressing “Lev1” and then to level 2 by pressing the other button.

Underneath that are the filament, grid1, anode, grid2 and preamp units. They should all be “ON” in normal operation. There is normally no reason to touch anything on any of these units, since the turning on is done via the “Lev1” and “Lev2” buttons on the control unit.

The second rack is for the tuning.

At the top is another Siemens simatic control unit, which has many lights but nothing to control.

Under it is the tuning control. There are three modes set by a knob on the top left of this section:

- remote - the system is controlled by the computers from windows in the control room, via the simatic.
- local - the system is controlled from this panel in the amplifier room.
- open loop - also controlled from this panel.

Under that knob is the open-loop gain potentiometer which sets the amplitude. On the same panel there is a tuning select knob (automatic or manual) and tuning in and out buttons for manual mode. There is also a green “Tuning OK” light, which lights up when it is in tune. Finally, there is a display which the simatic uses to display messages, though these are not always helpful as it sometimes displays very old messages.

Below that, there is an oscilloscope showing the tuning signals and under that the tuning electronics. This electronics receives a signal from a pickup in the cavity and uses it to determine the amplitude of the signal, so as to tune the phase of the RF.

### 5.2.1 Amplifier trips

Often the REX amplifiers trip. Most frequently this is due to too much reverse power, but not always. When a trip occurs, the system shuts down and one
or more red lights appear on the panel of lights at the top of the left rack. To restart follow the following procedure:

- Write down in the log book which amplifier tripped and which lights were lit on the panel top left.
- Turn the control mode from remote to open loop.
- Turn the open loop gain to zero.
- Press the upper of the two yellow buttons on the light panel at the top of the left rack (it should be lit up).
- Press the other yellow button immediately below it.
- If the “Lev1” button is not lit, press it and wait for it to come on. This takes a while, as the control unit has to power some things up. It can also make loud clicks.
- Press the “Lev2” button. This causes the control unit to switch everything else on. Again it might take a moment, depending on the state the system was in. It might also make loud clicks.
- Once the “Lev2” button is lit, slowly increase the open-loop gain. At some point, the PF final gauge on the control unit should start rising. The PK final one will probably start twitching and a signal should appear on the oscilloscope in the right rack. Also the tuning in and out lights might blink from time to time, and the “Tuning OK” light might light up occasionally. Continue slowly increasing, but don’t let the PK final go above 5 kW. Normally once there is enough power, the tuning should kick in and tune so that the PK final goes right down to zero and the “Tuning OK” light comes on. Once this happens, you can turn up a bit faster. Increase until PF final is about 30 kW.
- Switch to remote mode.

5.2.2 The IHS area

The elements are as follows:

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V3</td>
<td>Gate valve</td>
</tr>
<tr>
<td>IHS.FC10</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>IHS.BQ20</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>IHS.ST?</td>
<td>Magnetic steerer</td>
</tr>
<tr>
<td>IHS.BUN</td>
<td>Buncher</td>
</tr>
<tr>
<td>IHS.MQ30/40/50</td>
<td>Magnetic quadrupole triplet</td>
</tr>
<tr>
<td>IHS</td>
<td>The interdigital H structure acceleration element</td>
</tr>
<tr>
<td>IHS.MQ60/70/80</td>
<td>Magnetic quadrupole triplet (inside IHS)</td>
</tr>
<tr>
<td>IHS.MQ90/100/110</td>
<td>magnetic quadrupole triplet</td>
</tr>
</tbody>
</table>
5.2.3 The 7GP area

The elements are as follows:
Figure 20: A 7-gap resonator

Figure 21: REX beamline elements in the 7-gap area
### 5.2.4 The 9GP area

**9GP**

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V5</td>
<td>Gate valve</td>
</tr>
<tr>
<td>9GP.MQ10/20</td>
<td>Magnetic quadrupole triplet</td>
</tr>
<tr>
<td>9GP.ST40</td>
<td>Magnetic steerer</td>
</tr>
<tr>
<td>9GP</td>
<td>9-gap resonator</td>
</tr>
</tbody>
</table>

Figure 22: REX beamline elements in the 9-gap area

The elements are as follows:

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V5</td>
<td>Gate valve</td>
</tr>
<tr>
<td>9GP.MQ10/20/30</td>
<td>Magnetic quadrupole triplet</td>
</tr>
<tr>
<td>9GP.ST40</td>
<td>Magnetic steerer</td>
</tr>
<tr>
<td>9GP</td>
<td>9-gap resonator</td>
</tr>
</tbody>
</table>

### 5.2.5 The BEN area

The elements are as follows:
Figure 23: REX beamline elements in the bender area.

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V6</td>
<td>Gate valve</td>
</tr>
<tr>
<td>BEN.FC10</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>BEN.BO20</td>
<td>Beam diagnostics</td>
</tr>
<tr>
<td>BEN.MQ30/40/50</td>
<td>Magnetic quadrupole triplet</td>
</tr>
<tr>
<td>BEN.ST20</td>
<td>Magnetic steerer</td>
</tr>
<tr>
<td>BEN.MQ60/70</td>
<td>Magnetic quadrupole doublet</td>
</tr>
<tr>
<td>BEN.MQ80/90</td>
<td>Magnetic quadrupole doublet</td>
</tr>
<tr>
<td>BEN.FC100</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>BEN.BO110</td>
<td>Beam diagnostics</td>
</tr>
<tr>
<td>BEN.MD120</td>
<td>Main bending and switching magnet</td>
</tr>
</tbody>
</table>

WARNING although BEN.FC10 and BEN.FC100 are labelled correctly on the actual devices, they appear incorrectly on the REX control system. BEN.FC10 appears as BEN.FC100 and BEN.FC100 appears as BL2.FC10.

5.3 The Miniball beam line ($65^\circ$)

Note, that the quadrupole triple for this beam line has to share a power supply (i.e. you have to disconnect the power supply from the triplet on one beam line and connect it to the other one, in order to use it) with the $20^\circ$ beam line that Miniball uses, so the name is common to both.
Note also that in spite of the numbering, the steerer is before the magnetic quadrupole triplet, not the other way round as it is shown on some plans.

Also, the gate valves for the Miniball beamline are V7 and V7A and those on the second beam line are V8 and V8A. On some plans this is shown the wrong way round!

The elements are as follows:

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V7</td>
<td>Gate valve</td>
</tr>
<tr>
<td>L65.ST40</td>
<td>Magnetic steerer</td>
</tr>
<tr>
<td>L20-65.MQ10/20/30</td>
<td>Magnetic quadrupole triplet</td>
</tr>
<tr>
<td>L65.FC50</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>L65.BO60</td>
<td>Beam diagnostics</td>
</tr>
<tr>
<td>V7A</td>
<td>Gate valve</td>
</tr>
</tbody>
</table>

5.4 **The second beam line (20°)**

Note, that the quadrupole triplet for this beam line has to share a power supply (i.e. you have to disconnect the power supply from the triplet on one beam line and connect it to the other one, in order to use it) with the 65° beam line that
Miniball uses, so the name is common to both.

Note also that in spite of the numbering, the steerer is before the magnetic quadrupole triplet.

The elements are as follows:

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>V8</td>
<td>Gate valve</td>
</tr>
<tr>
<td>XL20.ST40</td>
<td>Magnetic steerer</td>
</tr>
<tr>
<td>XL20-65.MQ10/20/30</td>
<td>Magnetic triplet</td>
</tr>
<tr>
<td>XL20.FC50</td>
<td>Faraday cup</td>
</tr>
<tr>
<td>XL20.BO60</td>
<td>Beam diagnostics</td>
</tr>
<tr>
<td>V8A</td>
<td>Gate valve</td>
</tr>
</tbody>
</table>

## 5.5 Beam diagnostics

The various faraday cups are housed within Leuven diagnostic boxes. These have a wheel with a selection of apertures which can be chosen remotely, a cup to measure the current and other diagnostics such as a micro-channel plate.

The available apertures and slits are: 1 mm, 3 mm, 5 mm, 15 mm apertures, 1 mm, 5 mm slit in X direction, 1 mm, 5 mm slit in Y direction.
5.5.1 Restarting the beam diagnostics

Sometimes the computer program controlling the cups crashes. This computer is located at the entrance to the ISOLDE building just after the turnstile at the bottom (near the car park), to the left. It is the third rack along and the computer is labelled “FEC Beam diagnostics”. The user name is rexdev and the password is the same as the REX password (at least it was in September 2007). Two programs have to run on this computer. One is the “Front End Computer Main” program (FECMain) and the other is the “RPC gateway”. The former is a windows application, the latter is MS-DOS.

If the cup control crashes, the status goes from being either “IN” or “OUT” to “UND” (in red) and stays that way (note that it may be briefly “UND” when putting a cup in or out, but when the system crashes it stays that way. The error window on the REX console usually gives “communication error” messages.
for each faraday cup and beam diagnostics box.

In this case, use the windows task manager to kill FECMain and also kill RPCGateway. Then restart FECMain (it should end up with the message “Initialisation completed successfully”. Then start RPCGateway. Both of these programs have icons.

It should then be possible to control the cups from the control room.