RFQ ion beam cooler and buncher (RFCB)
For ISOLDE radioactive ion beams

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http://www.cern.ch/ab-div-op-iso-rfqcb/
Summary

- Introduction
- Status of the project
- Mechanical engineering
- Cost estimation
Location beam section at ISOLDE layout

- After the HRS final focus
- Up to existing beam diagnostics box after the beam gate focus
One has to remove the existing quadrupole, the beam pipe and the beam gate.

The diagnostics box, the valve and the bellow between them could be kept.
Existing beam line section

- Diagnostics box at focal point after HRS (begin of the new section)
- Width constraint (~400-500mm)
- Length constraint (~3300mm)
- High constraint (~500mm)
Existing beam line section

Diagnostics box at the end of our section
New beam line section layout

- first quadrupole
- removable wall for the HV cage
- second quadrupole
- diagnostics box
- RFQCB with trailer
- trailer guide
- diagnostics box
Beam line section layout
RFQ cooler main parameters

Before RFQ

- mass ion beams between $10 \div 300$
- beam intensity $<10^{10}$ ions/s
- ions energy: 60 keV $\pm$ 5 eV
- emittance around $20\pi$ mm·mrad

After RFQ

- final emittance around $3\pi$ mm·mrad
- ions energy: 60 keV $\pm$ 1 eV
- efficiency (ions out/in) around 100%

- frequency of RF field: 1$\div$5 MHz
- amplitude RF field: 200$\div$1000 V
- room temperature: 18 °C +/- 2 °C
Time structure

ISOHRS  DUMP  ISOHRS

ISOLDE HV

BEAM GATE

RFQ END PLATE

RFQ SEGMENT 21

100 ms  1ms

collect

1,2 s

IP 28-08-2003

IP 26-03-2003

RFQ END PLATE
Cooler and buncher parameters

**Cooler**

- Entry ions energy: 100 eV
- Cavity total length: 800 mm

**Buncher**

- Time between bunches: 1 ms – 10 ms
- Extraction with kick or just switching off the potential

Cooler and buncher sections in the same cavity or in different cavities? Use of a miniquadrupole between them?
<table>
<thead>
<tr>
<th>Stage</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
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<td></td>
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1. **PROPOSAL**
2. **DEFINITION**
3. **CONCEPTION**
   - First drawings
   - Variants
4. **DEVELOPMENT**
   - Drawings
   - Assembly
5. **MANUFACTURE**
   - Tests off-line
6. **START-UP**
   - Beam line assembly during shutdown
   - Tests on-line
Status of the project

In progress

• Design of beam extraction electrodes for the RFQCB
• Vacuum system
• Insulators

To be worked

• Preparation tests off-line
• Control system
• Electronics system
• Balloons to store helium gas

Designed

Beam line optics (quadrupoles)

Waiting

Mechanical design
Beam extraction study

Phase space xvx/vz

Phase space yvy/vz

Beam space dimensions

Time structure z-vz

Voltage:
59995-15000-0

Simulation with 100 ions of 100 amu

Longer skimmer electrode
Control system

Main parameters to control:

- **vacuum system** (pumping speeds, pressure inside RFQ (correcting readout of gas feeding), gas feed, pressure at injection and ejection).
- **RF voltage** (frequency?, amplitude?).
- **DC voltages**.
- **diagnostics** (emittance, beam X-Y correction,...).
High voltage system

- Faraday cage for RFQ
  - Vacuum safety switch
  - HV switches: door sensor, emergency button

- Isolation transformer
  - 60 kV Power Supply

- RFQC control

- Additional cage for electronics

Line power 230 V

Vacuum safety switch

Safety distance?
Electronics system

- **power supply:**
  - operational voltage >60 kV.
  - stability: 10-5·60 kV=0,6 V.
- line power 220/230 V.
- isolation transformer:
  - voltage: 220/230 V.
  - low power.
  - voltage rate: 60 kV.
- 60 kV fast switch.
- RF field provided by a function generator:
  - amplitude: 0÷1 kV (0 to peak).
  - frequency: 100 kHz÷ 5 MHz.
- 25 DC power supplies 0÷200 V.
Trailer system

- RFQCB cavity
- HV insulators
- Trailer
- Pumps
RFQCB package

- injection electrodes
- axial electrode
- extraction electrodes
- bars
- insulator
Axial electrodes system

slots to fix angular position

axial electrode

assembly axe

RF electrodes

insulator
RFQCB cavity

top flange

DN200 CF flanges
**RFQCB cavity**

- Electrode close the cavity to create differential pumping
- Piece to support it from the top flange (simulation of the deformation of the bars)
- Top flange
- Injection electrodes
- RFQCB package
- Extraction electrodes
Beam line alignment

Need to move blocks to align

Point to align

Direction of beam alignment
Partial project cost estimation

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (CHF)</th>
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<tr>
<td>Fabrication (CHF)</td>
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<tr>
<td>Vacuum system cost (CHF)</td>
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<tr>
<td><strong>Total (CHF)</strong></td>
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<td>Unexpected costs</td>
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<td><strong>Total (CHF)</strong></td>
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The **fabrication cost includes** the designing, manufacturing and assembly of all the components of our beam line section.

It is an estimation starting from the **fabrication cost of the new ISOLDE front-end**.
# Vacuum system cost estimation

<table>
<thead>
<tr>
<th>Object</th>
<th>Quantity</th>
<th>Price(CHF)/unit</th>
<th>Price(CHF)</th>
<th>Price(€)/unit</th>
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<td>52848.6</td>
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<td>6000.93</td>
<td>12001.86</td>
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<td>VAT Series 10 DN200 with position indicator</td>
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- **CHF/€**: 1.56
- **Total (CHF)**: 140718.8
- **Total (€)**: 90204.33

Gauges and vacuum control not included
# Insulators cost estimation

<table>
<thead>
<tr>
<th>Object</th>
<th>Quantity</th>
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<th>Price(CHF)</th>
<th>Price(€)/unit</th>
<th>Price(€)</th>
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<td><strong>CHF/€</strong></td>
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<td><strong>Total (CHF)</strong></td>
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<tr>
<td><strong>Total (€)</strong></td>
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</table>

- **Insulators for the front-end => 14000 CHF**
Others cost

- Control system
- Power supplies

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