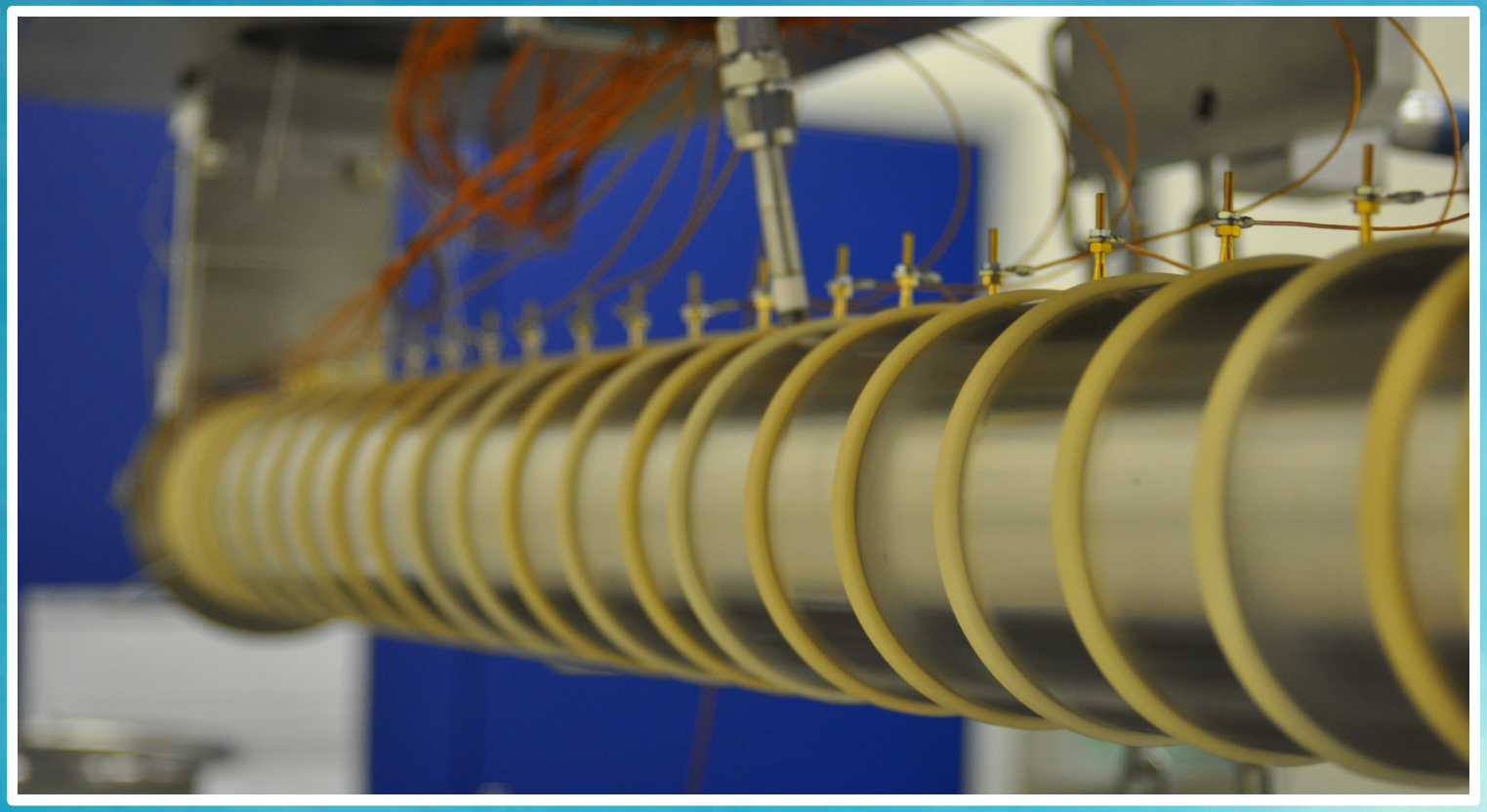
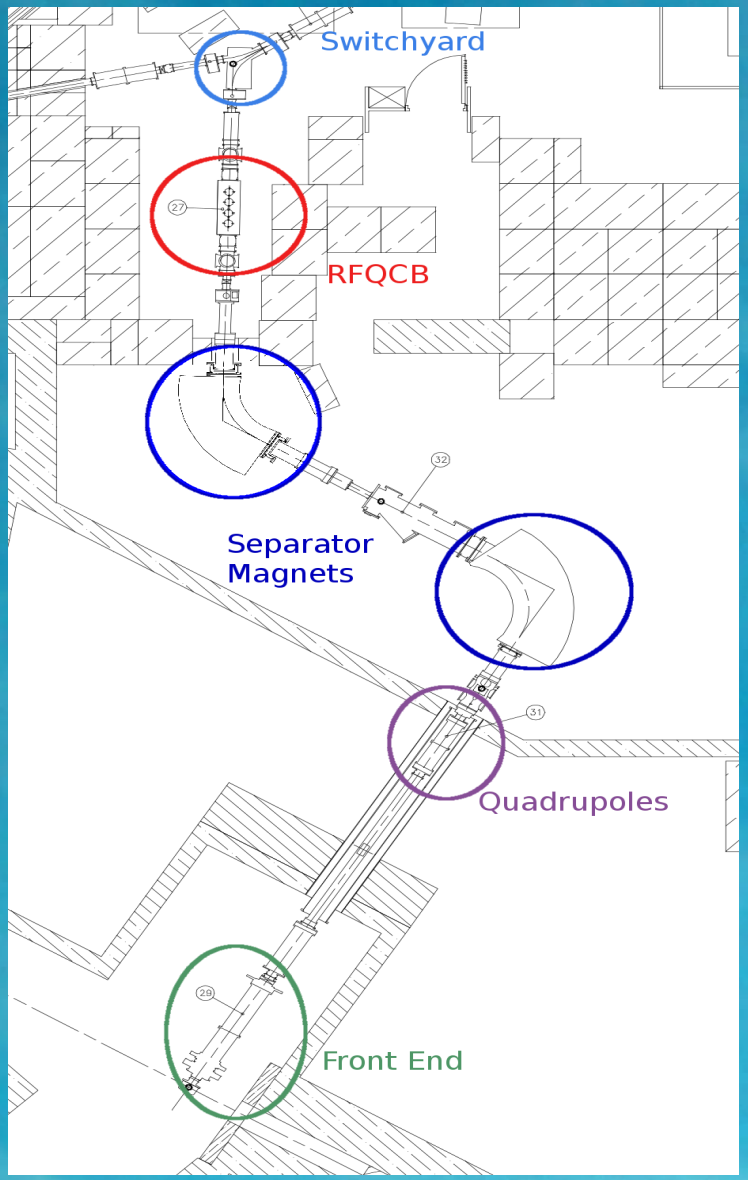
ISOLDE's RFQCB: Improvements and Upgrades



Carla Babcock

Nov. 29, 2013

What is the RFQCB?



- ISOLDE's Radio-Frequency Quadrupole Cooler and Buncher (RFQCB) is a helium-filled Paul trap used to reduce the beam emittance and give it a time structure

What is the RFQCB?

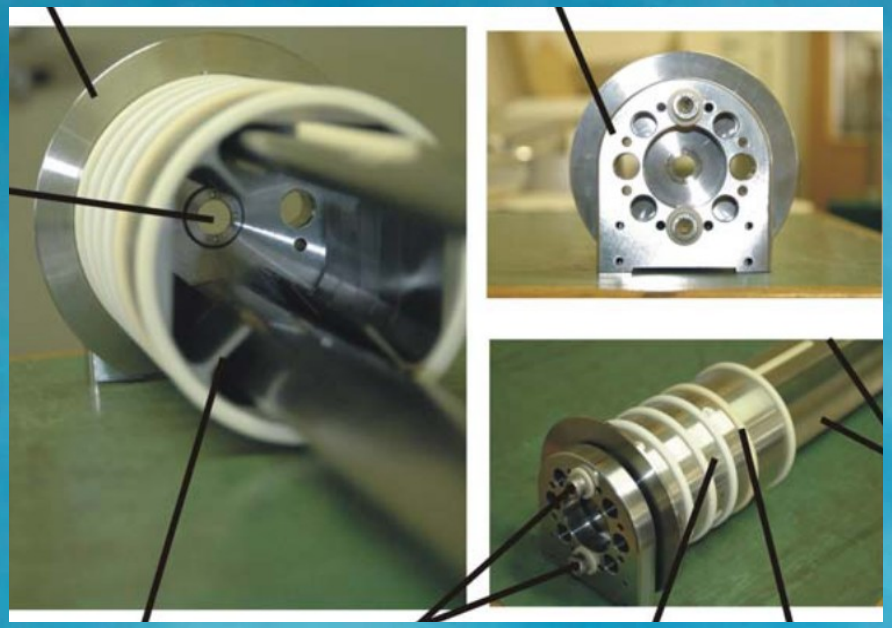
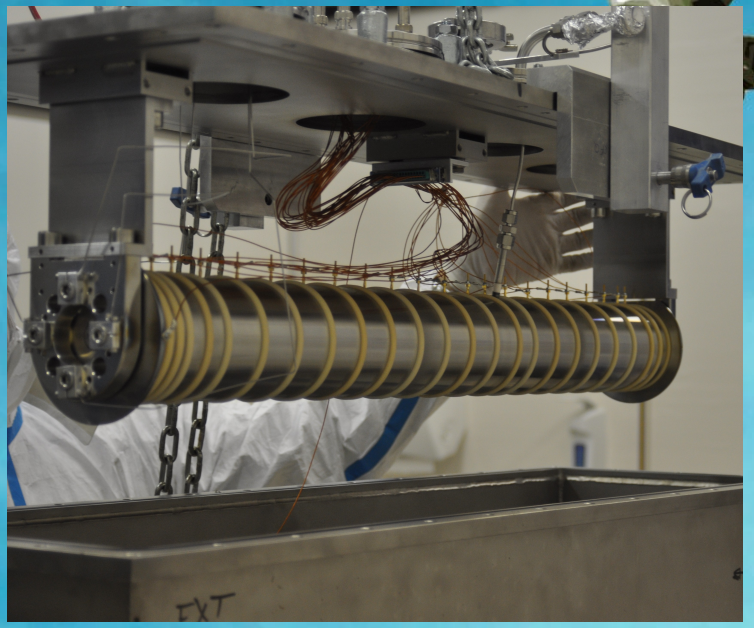
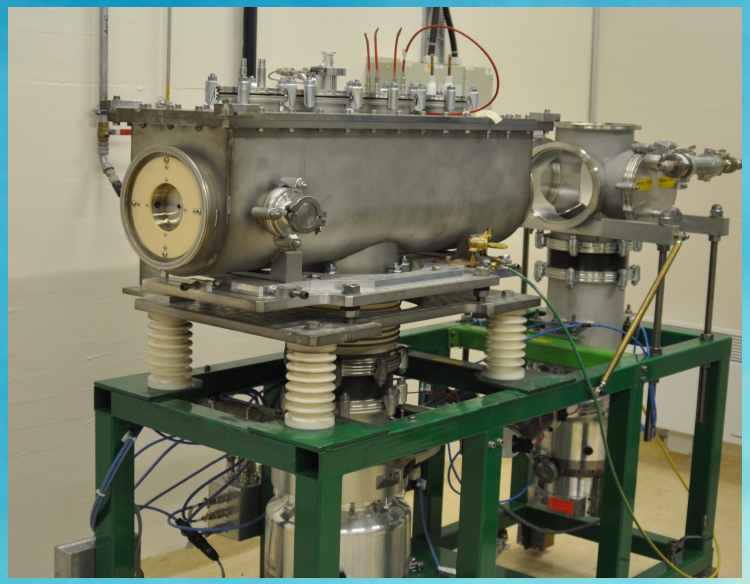


Photo: Ivan Podadera

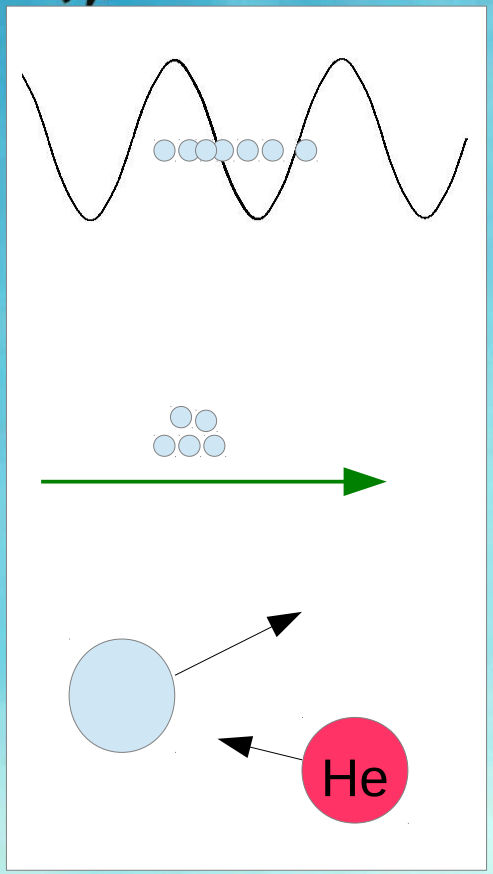




How does it work?

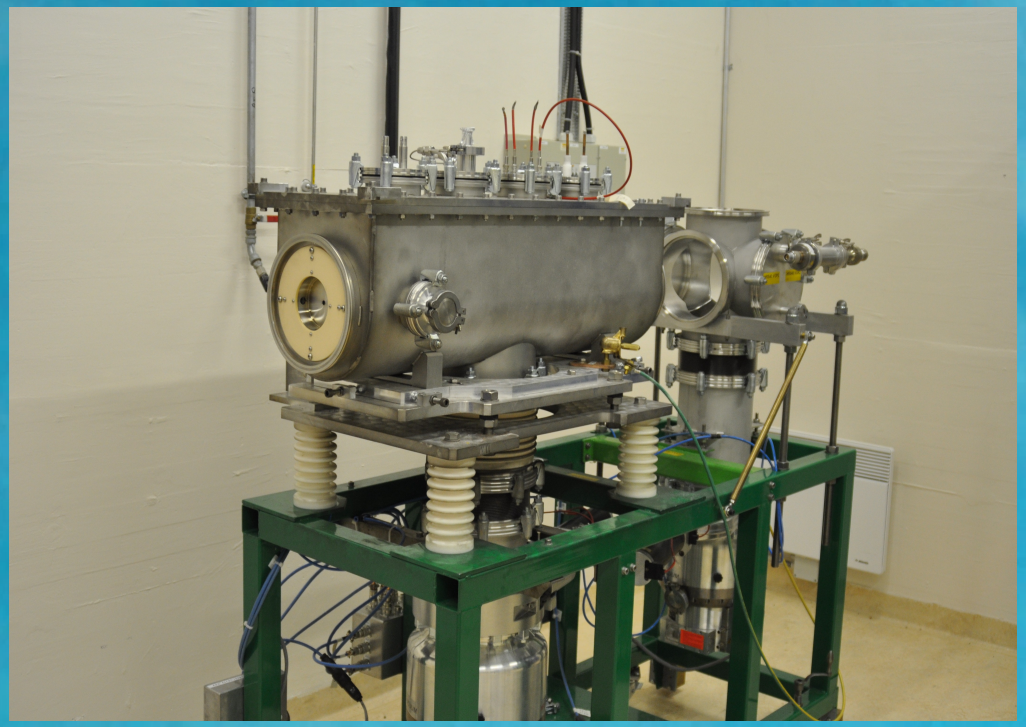
3 Components:

- Quadrupole electric field oscillating +V to -V to confine the ions
- Longitudinal electric field to pull the ions through the trap and bunch them at the end
- Helium gas for collisional cooling to reduce transverse motions and energy spread

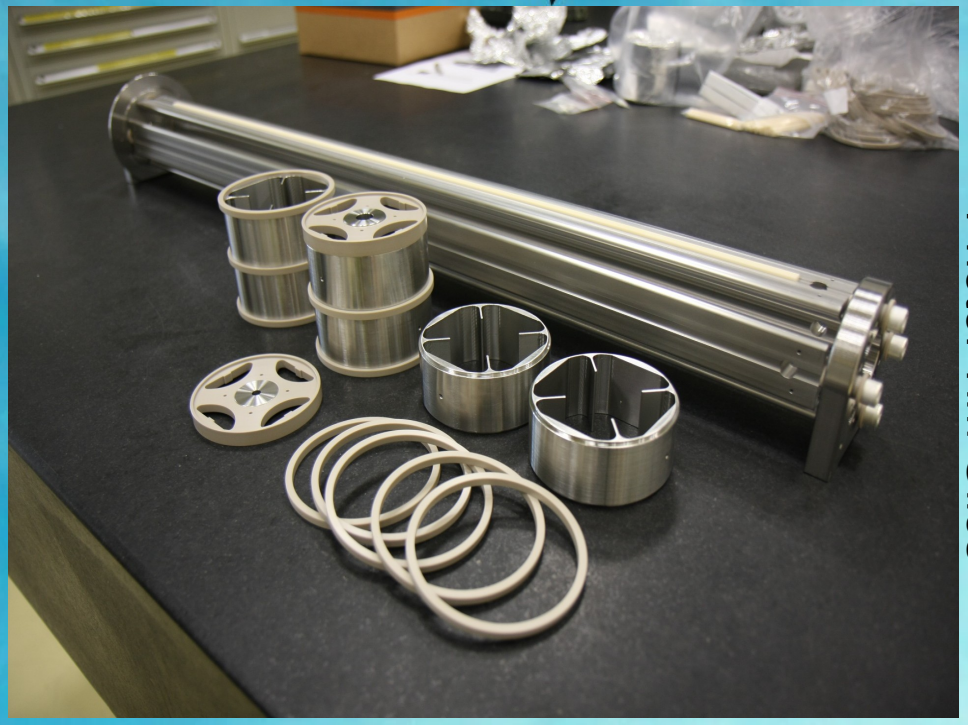


Plus the injection and extraction electrodes

ISCOOL vs New RFQCB



ISCOOL is being modified

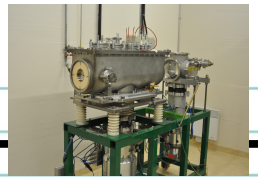


The new RFQCB is being built for the test stand

Photo: Tim Giles

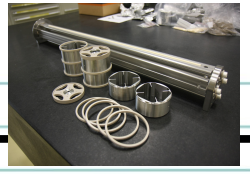
Improvements to be made

- ISCOOL



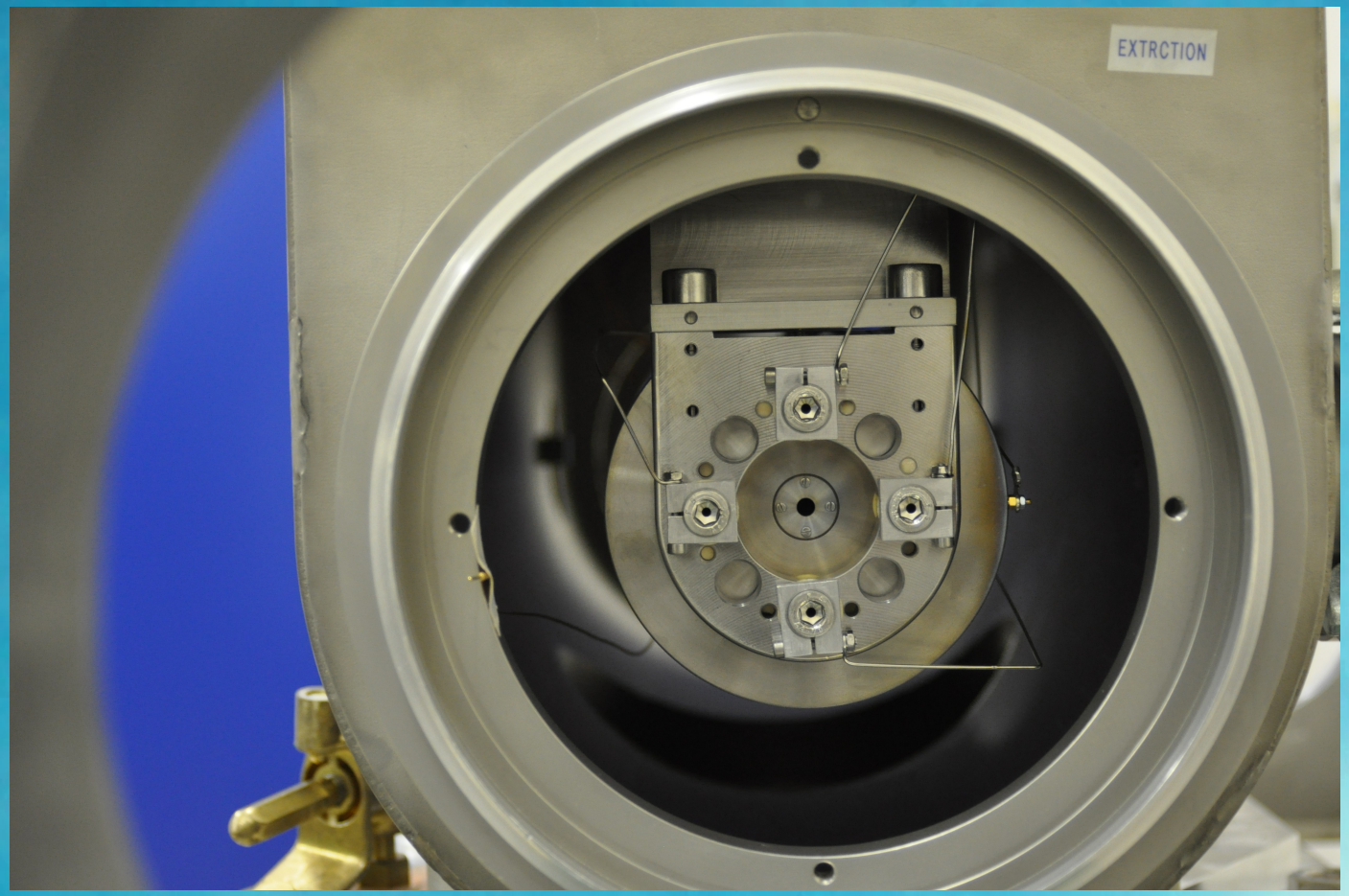
  - New supports for alignment
  - New He injection system to accurately measure flow
  - Re-wiring to separate high and low voltages

- New RFQCB

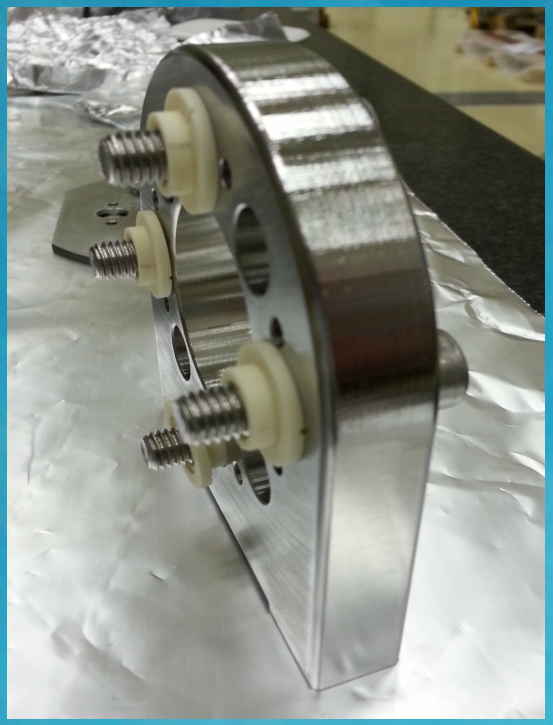


  - Pressure measurement
  - Barriers for division into pressure regions
  - Laser entry into RFQCB cylinder
  - Test stand

Status of ISCOOL



Status of New RFQCB



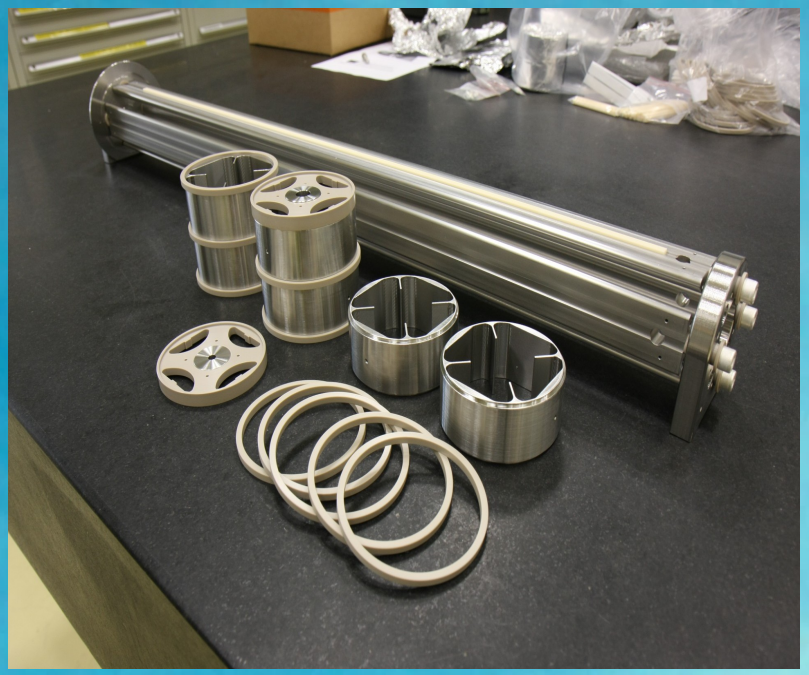
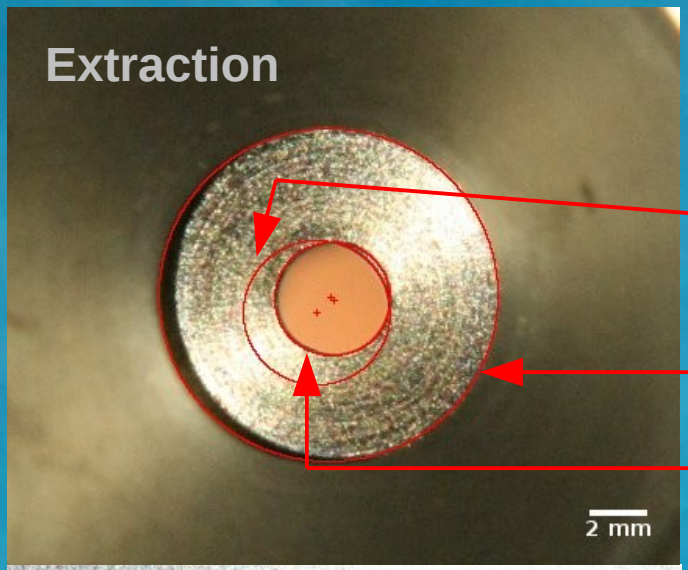
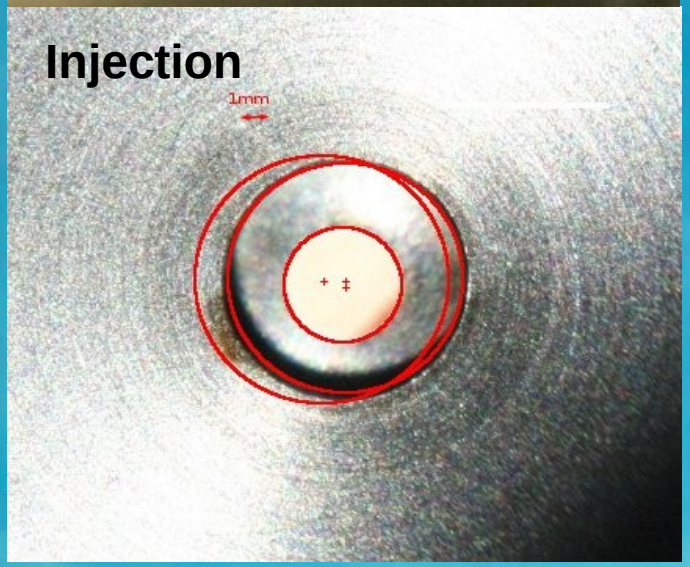
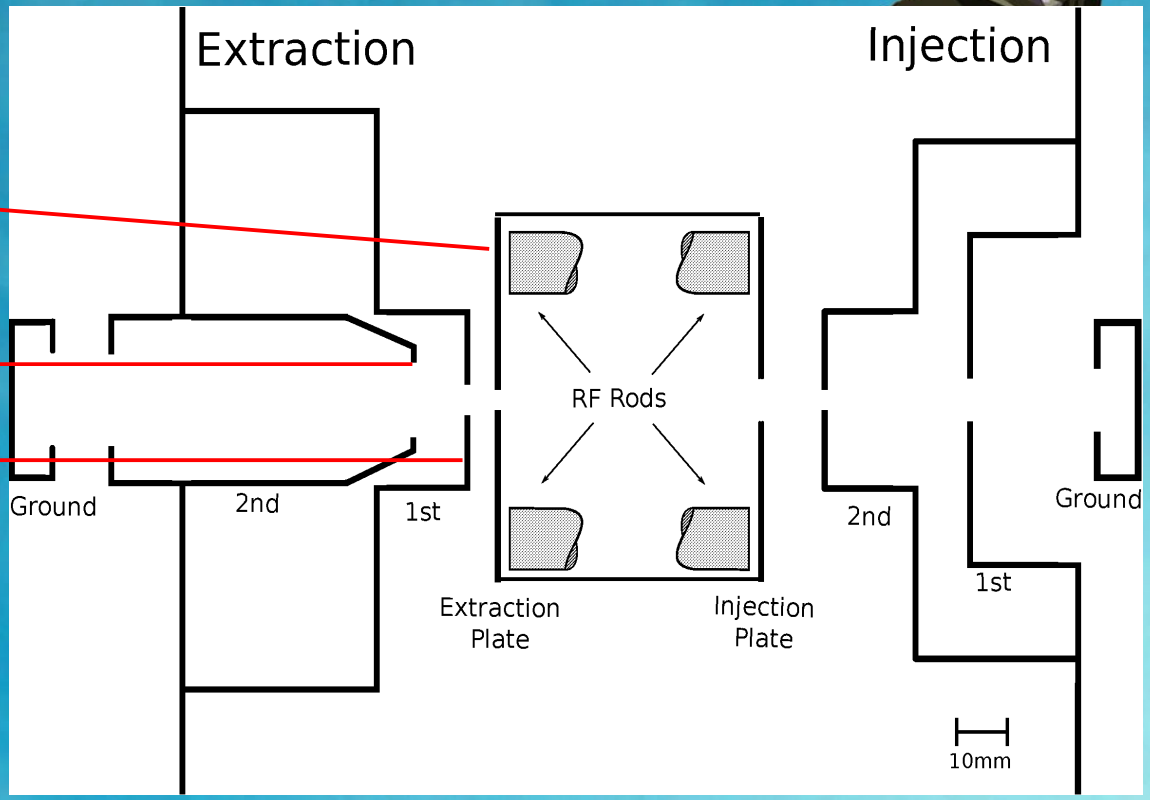


Photo:Tim Giles

Status of ISCOOL: Alignment



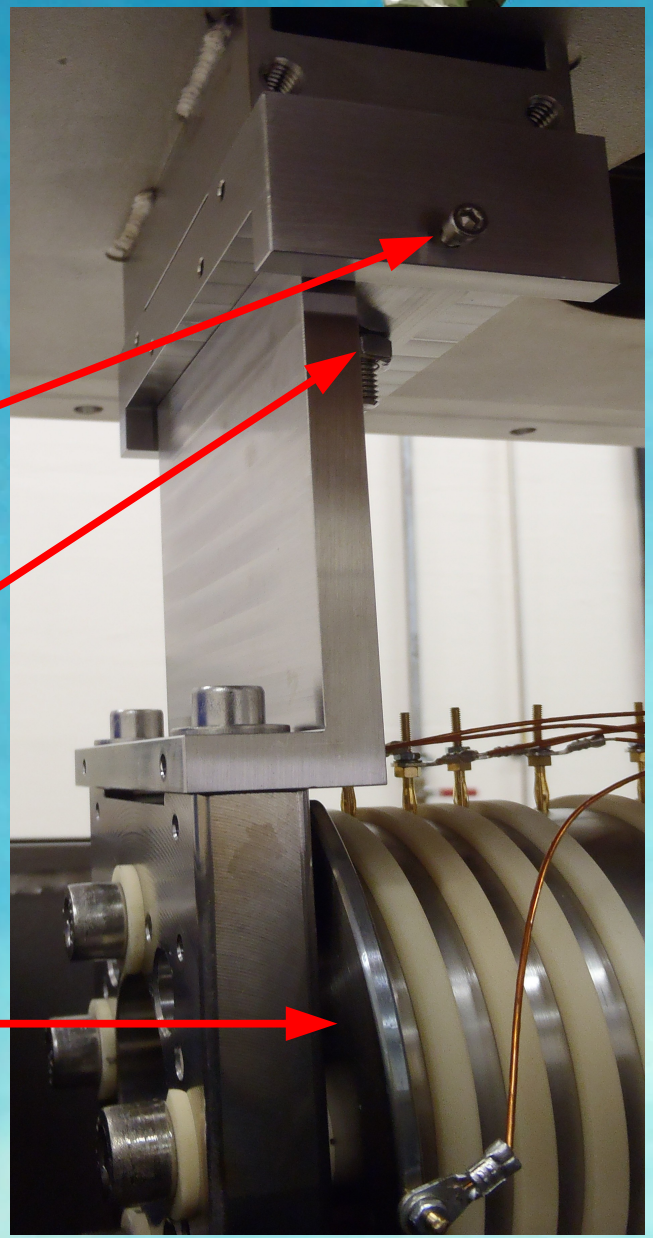




- Misalignment of the injection/extraction electrodes was measured to be 0.75mm

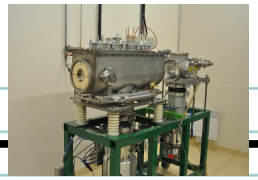
Status of ISCOOL: Alignment

- Solution: adjustable supports which allow movement in horizontal by 0.1mm and in vertical by 0.2mm



Improvements to be made

- ISCOOL



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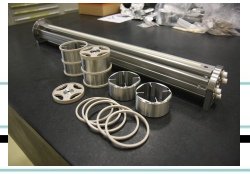
- New RFQCB



  - Pressure measurement
  - Barriers for division into pressure regions
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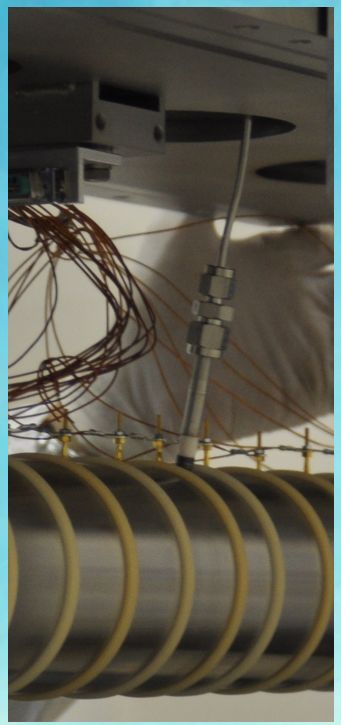
Status of ISCOOL: Pressure

- He pressure inside cylinder is unknown, as is the flow rate of He into the cylinder
- A new mass-flow controlled meter will show how much He is flowing in, leading to more accurate ideas of the pressure



Improvements to be made

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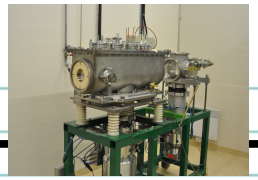

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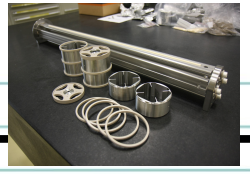

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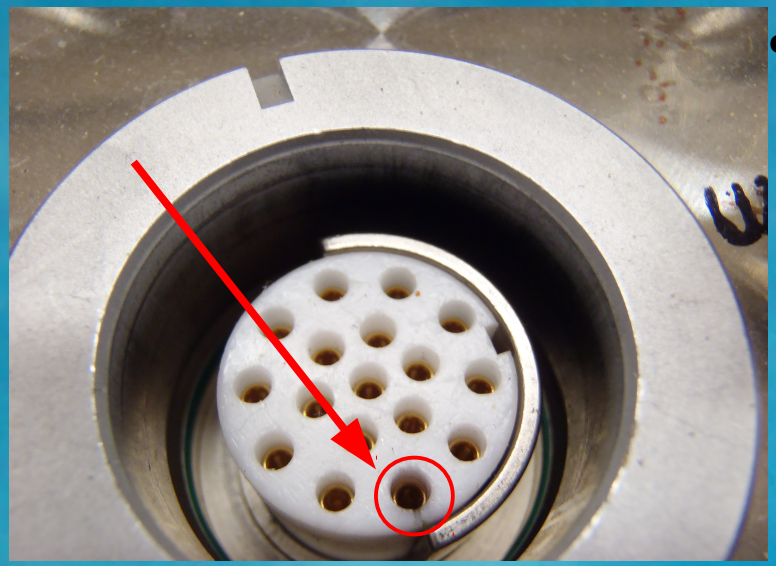
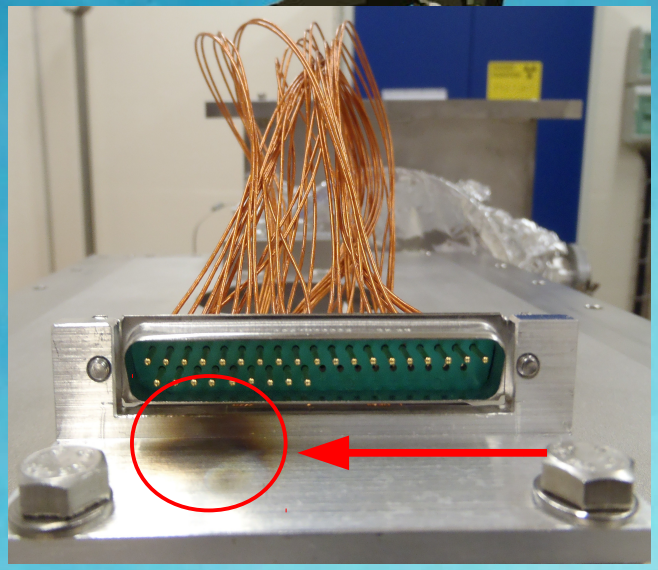
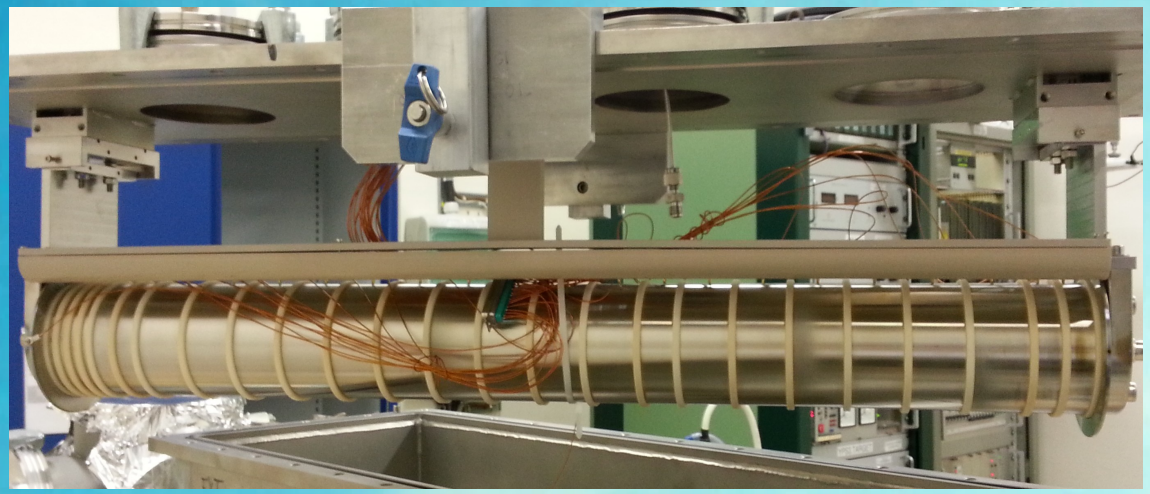
Status of ISCOOL: Wiring



- High voltage and low voltage connections have been wired together, resulting in damage – will be separated

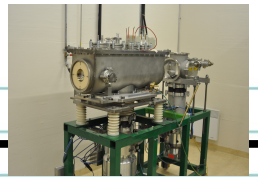


- Wire organization will reduce damage to wires



Improvements to be made

- ISCOOL



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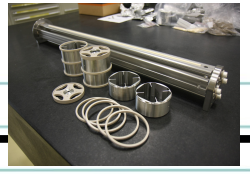

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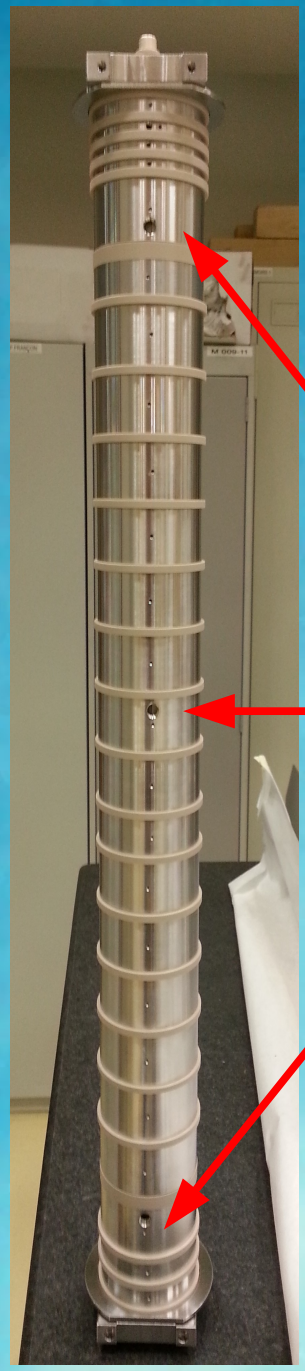
New RFQCB: Pressure

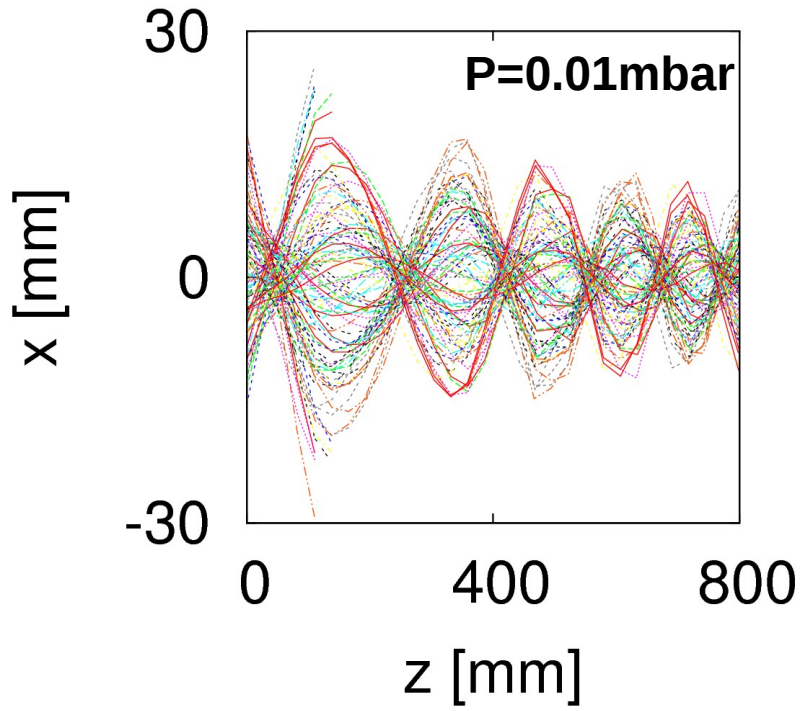
- Since pressure inside the cylinder is unknown, the new RFQCB will have:
  - Holes for pressure gauges
  - Regulated He flow
  - Extra conductances to minimize pressure outside the cylinder

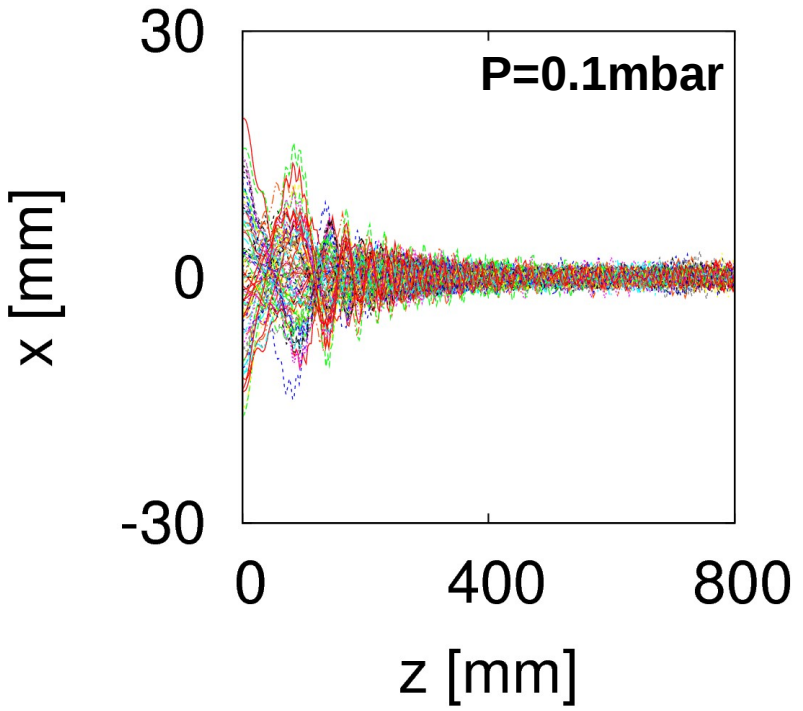


Pressure measurement modifications

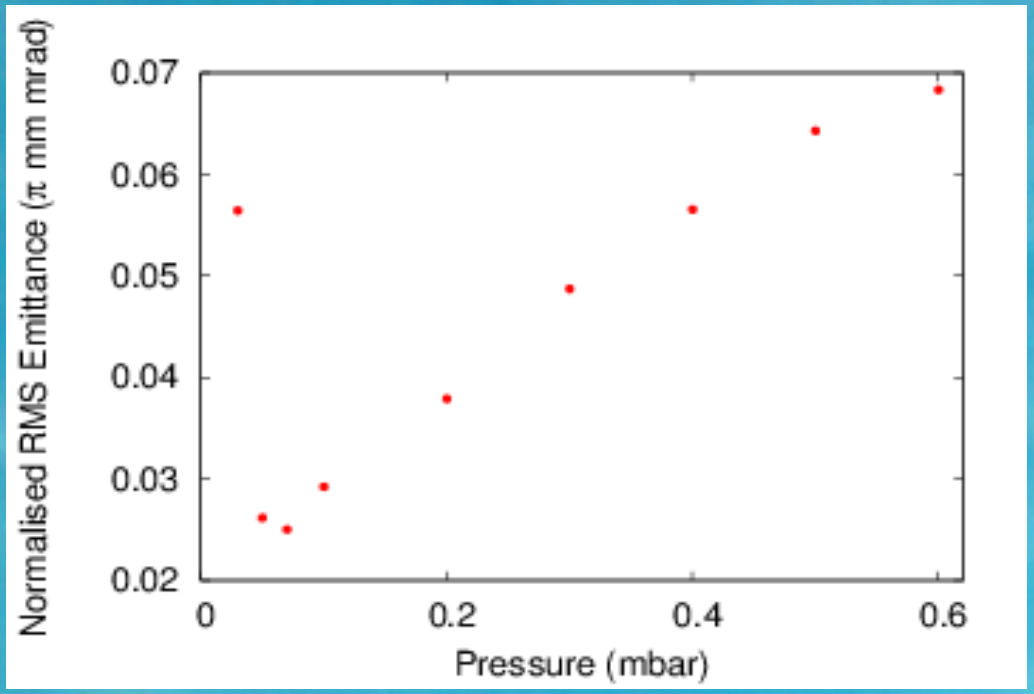
New RFQCB: Simulations

Ion trajectories in the length of the RFQCB for different pressures





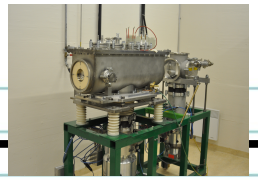
New RFQCB: Simulations



Confirmation that the ideal pressure is around 0.1 mbar

Improvements to be made

- ISCOOL



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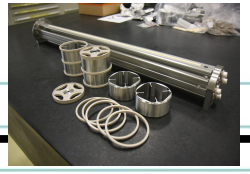

  - Pressure measurement
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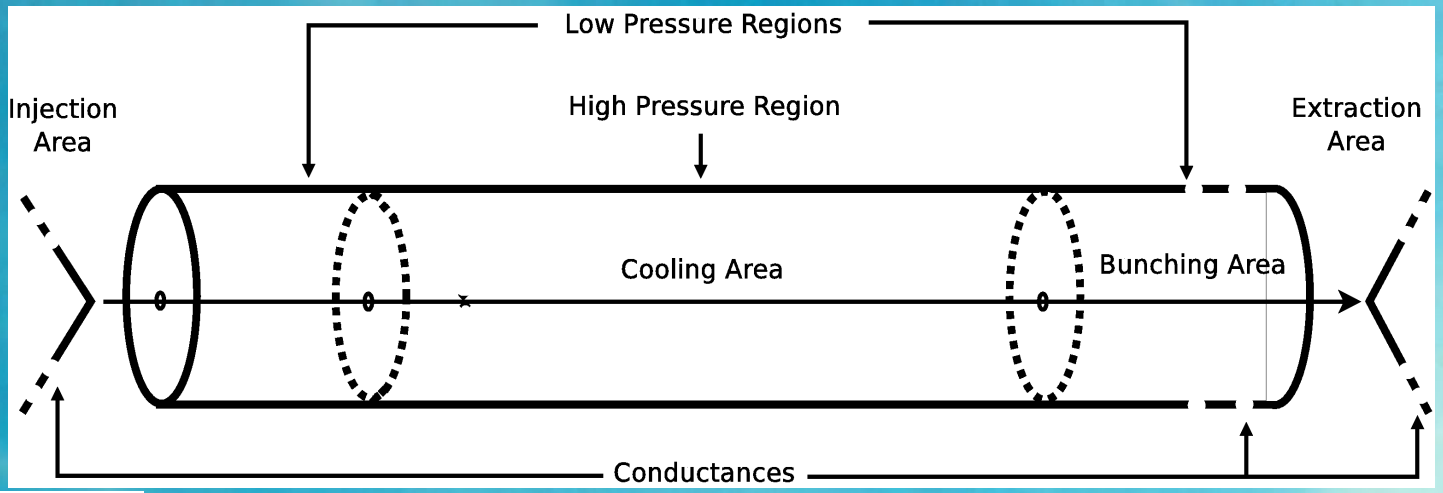
New RFQCB: Barriers

Barrier pieces added to the new RFQCB will split the length into three parts, two low pressure and one high pressure



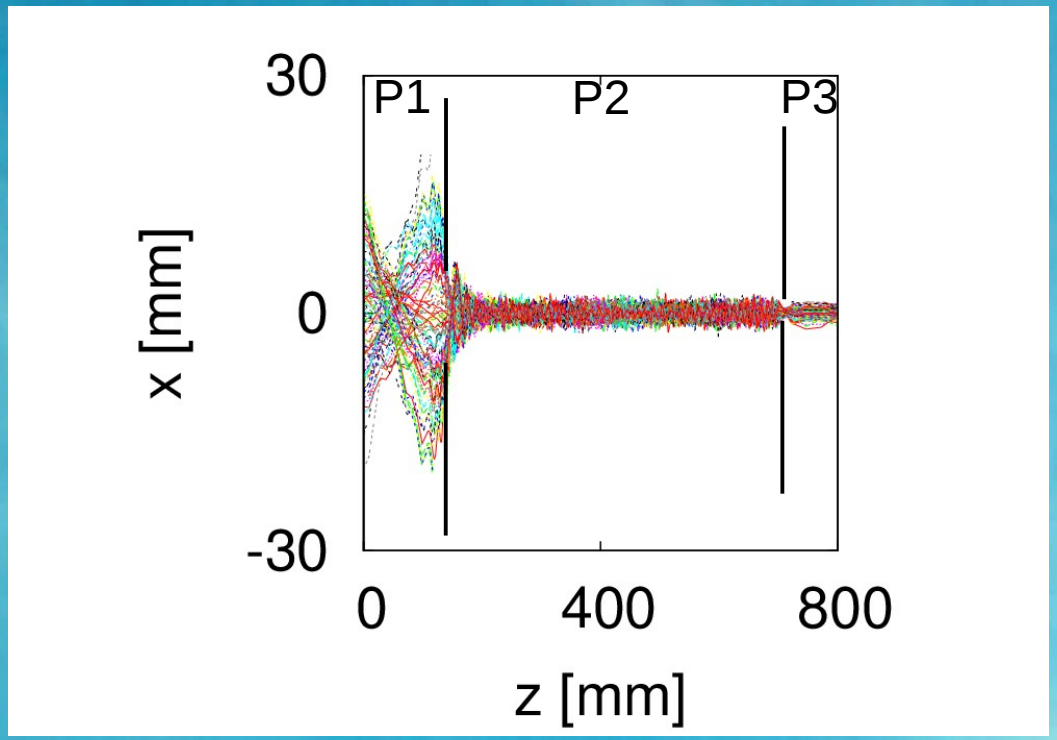
This will minimize the He escaping from the cylinder into the adjoining areas

New RFQCB: Barrier Simulations

P1= 0.01mbar

P2= 0.1mbar

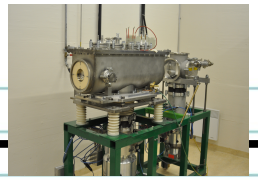
P3= 0.01mbar



Simulation with barriers included at 100mm and 700mm

Improvements to be made

- ISCOOL



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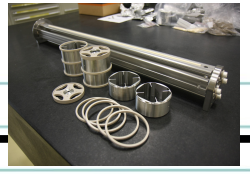

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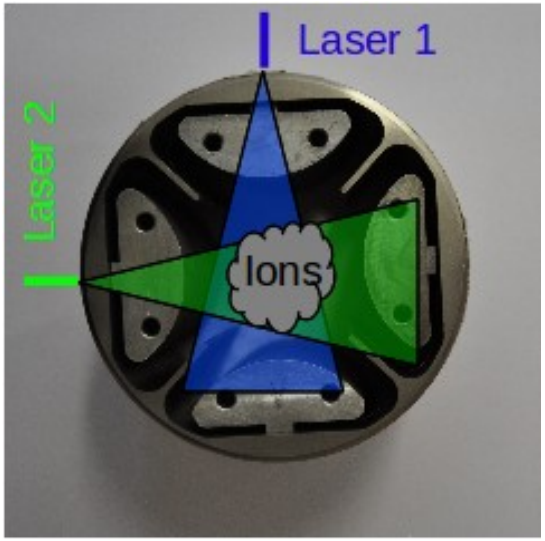
New RFQCB: Laser Pumping

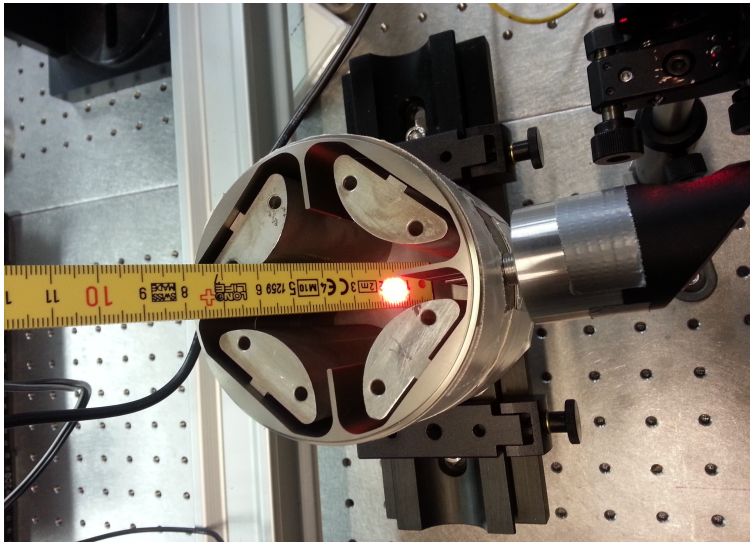
- Working with COLLAPS to demonstrate the use of laser pumping for ions like Mn, for which it is difficult to perform spectroscopy from the ionic ground state due to laser restrictions
- This will hopefully be possible with the new alignment of ISCOOL

New RFQCB: Laser Entry

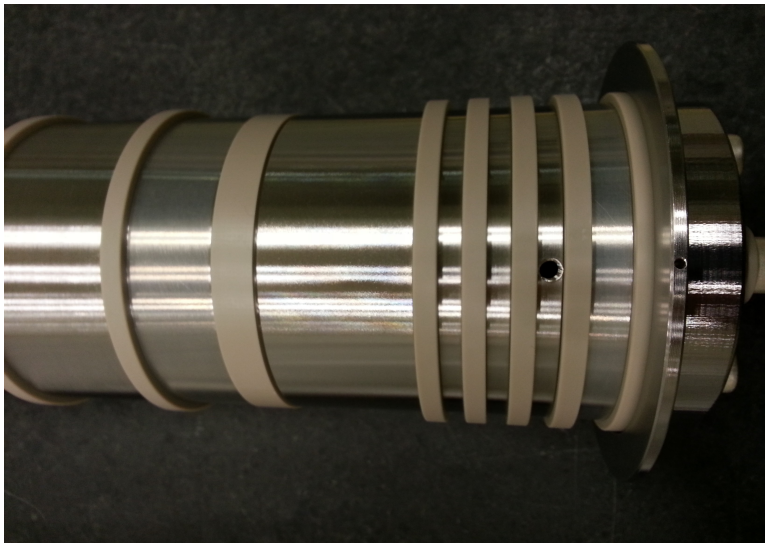
- To facilitate experiments involving in-cooler laser pumping of ions or 2+ ionization, the new cooler has laser entry ports



Concept



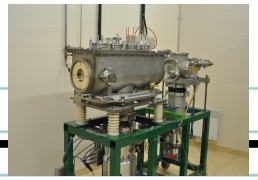
Test on mock RFQ



Implementation on new RFQCB

Improvements to be made

- ISCOOL



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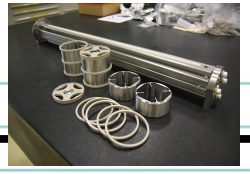

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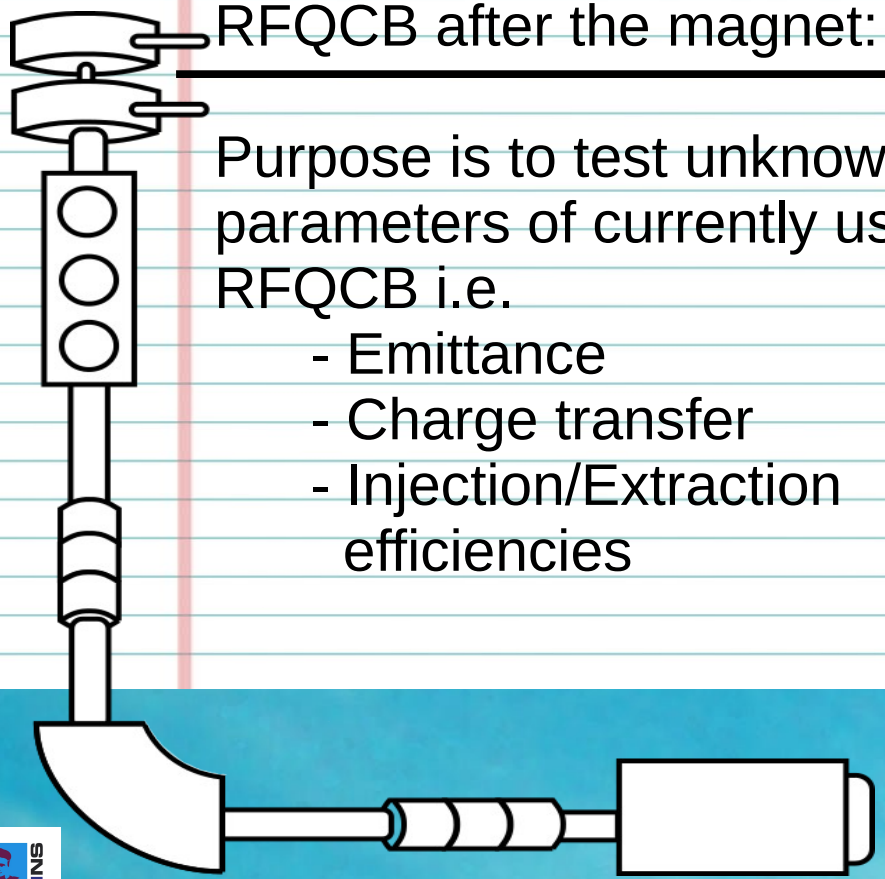
Test Stand

- Two phases of the test stand

RFQCB after the magnet:

Purpose is to test unknown parameters of currently used RFQCB i.e.

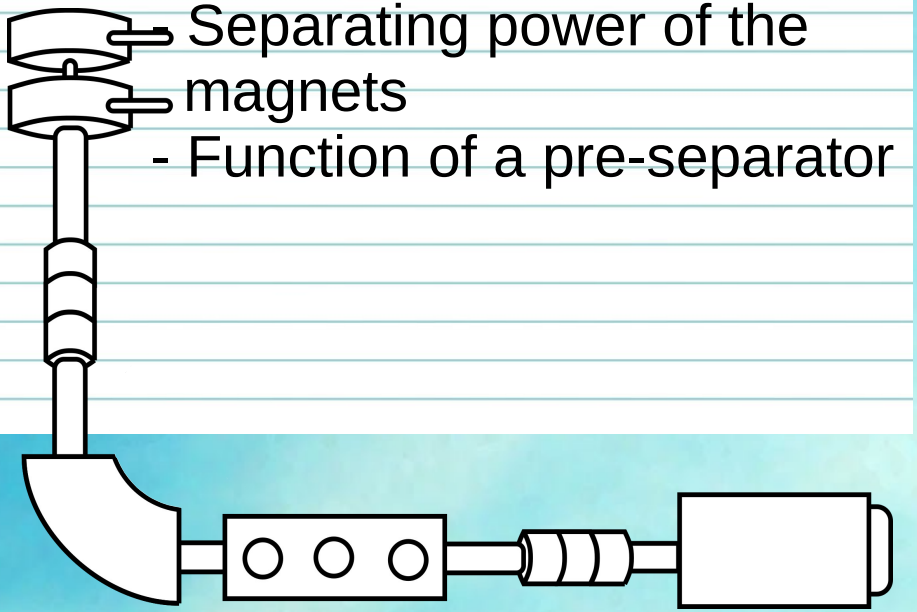
- Emittance
- Charge transfer
- Injection/Extraction efficiencies



RFQCB before the magnet:

Purpose is to test the setup for use in HIE-ISOLDE i.e.

- Separating power of the magnets
- Function of a pre-separator



Conclusions

ISCOOL

- New wiring will make the system more reliable
- New alignment will increase inj/ext efficiency and allow laser entry into the cooler
- New He injection system should make internal pressure more stable

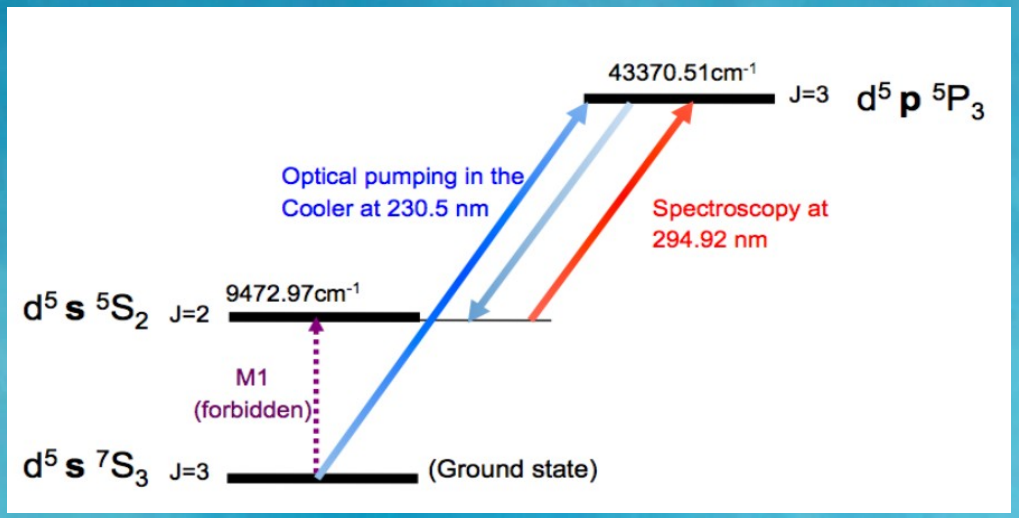
New RFQCB

- Vacuum system mods improve beam quality at inj/ext and allow us to test performance as a function of pressure
- Mods i.e. laser ports will allow different experimental techniques to be studied
- The test stand will show the feasibility of the setup for use in HIE-ISOLDE and it will give us the in-depth understanding of the RFQCB needed to make further improvements

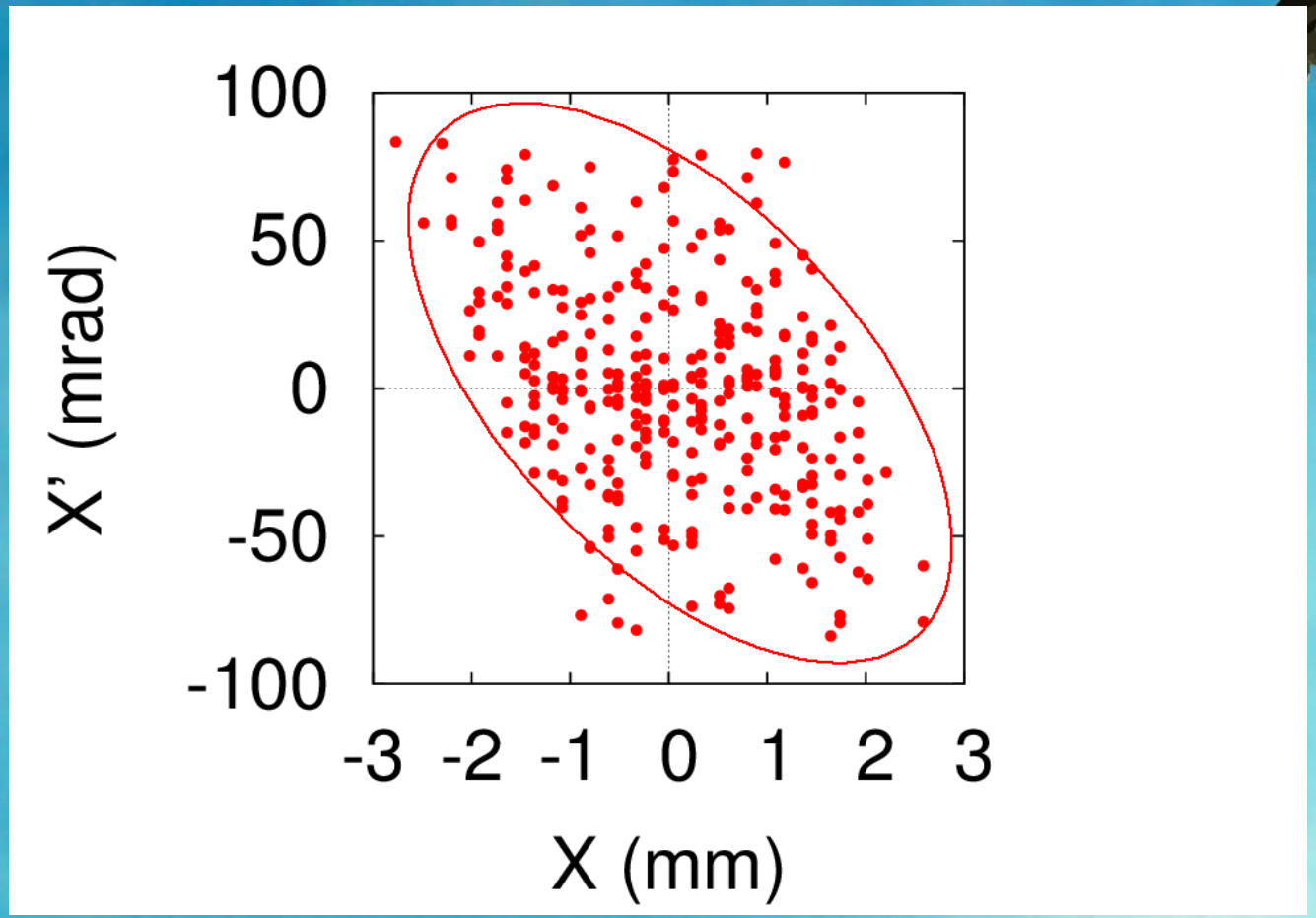
Thank you for your attention

This research project has been supported by a Marie Curie Initial Training Network Fellowship of the European Community's FP7 Programme under contract number (PITN-GA-2010-264330-CATHI).

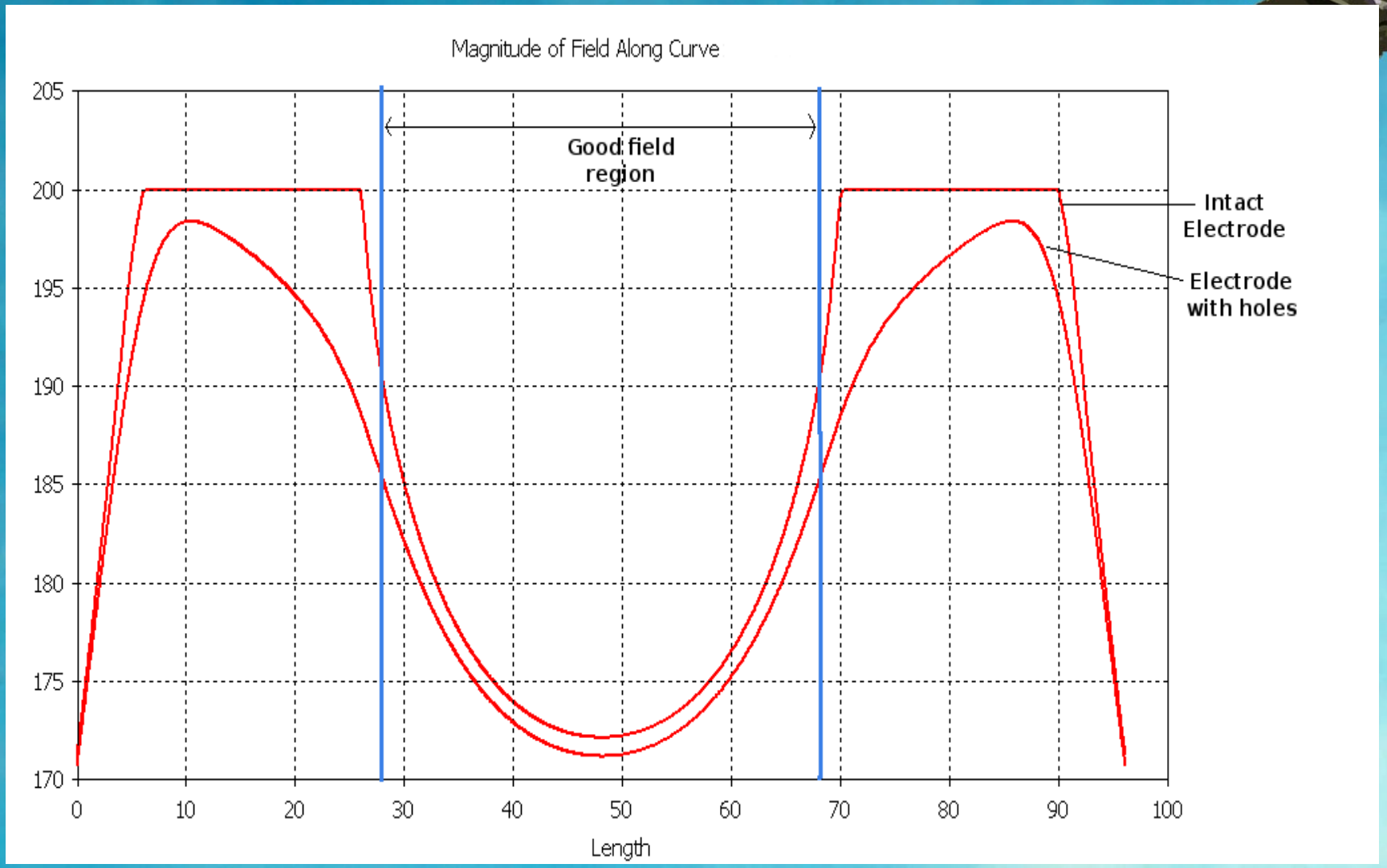
Laser pumping with Mn ions



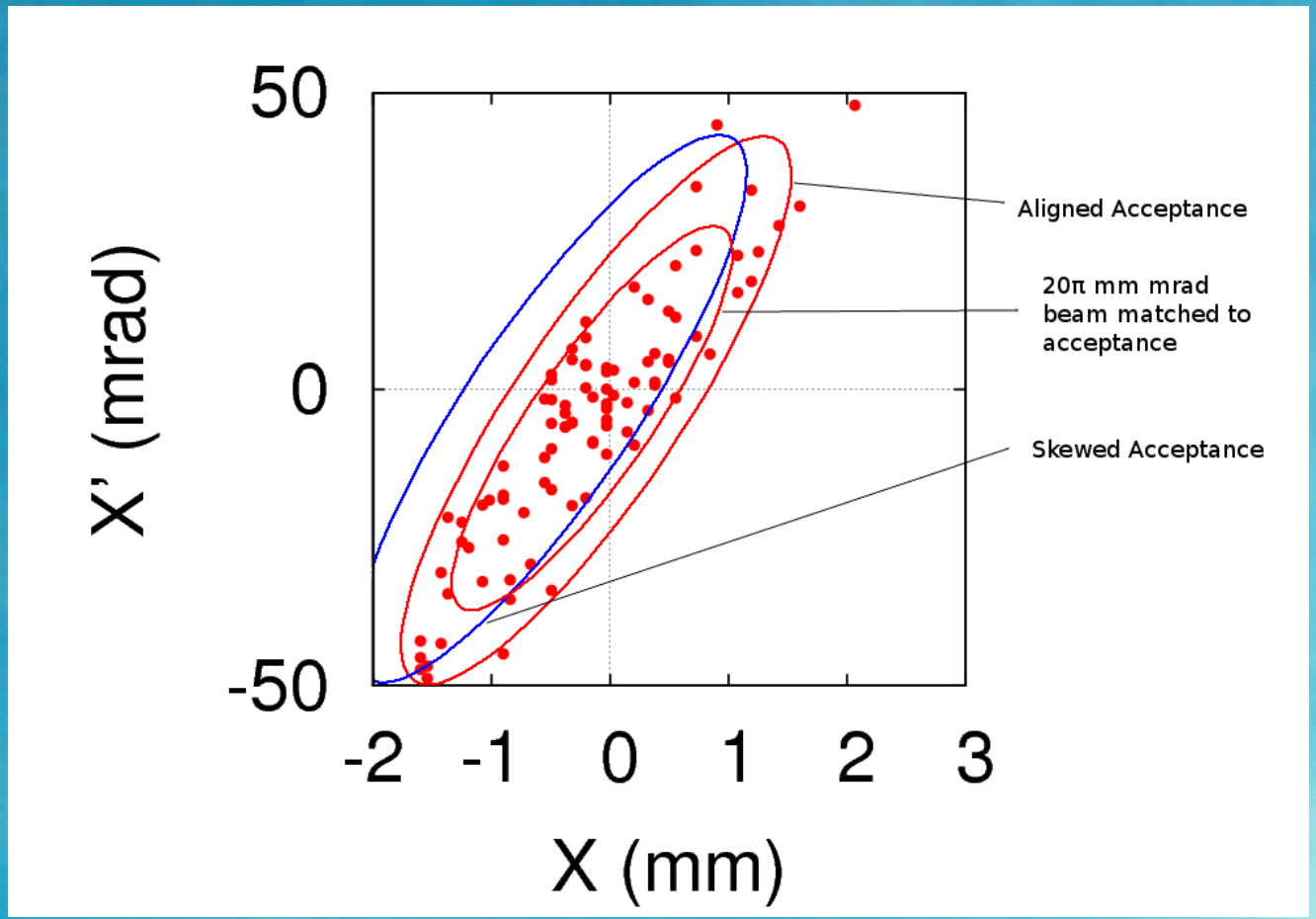
Extraction Acceptance



Laser Entry Ports



Status of ISCOOL: Alignment



Microwave Studio was used to simulate the beam passing through the injection electrodes, to demonstrate the advantages of a realignment