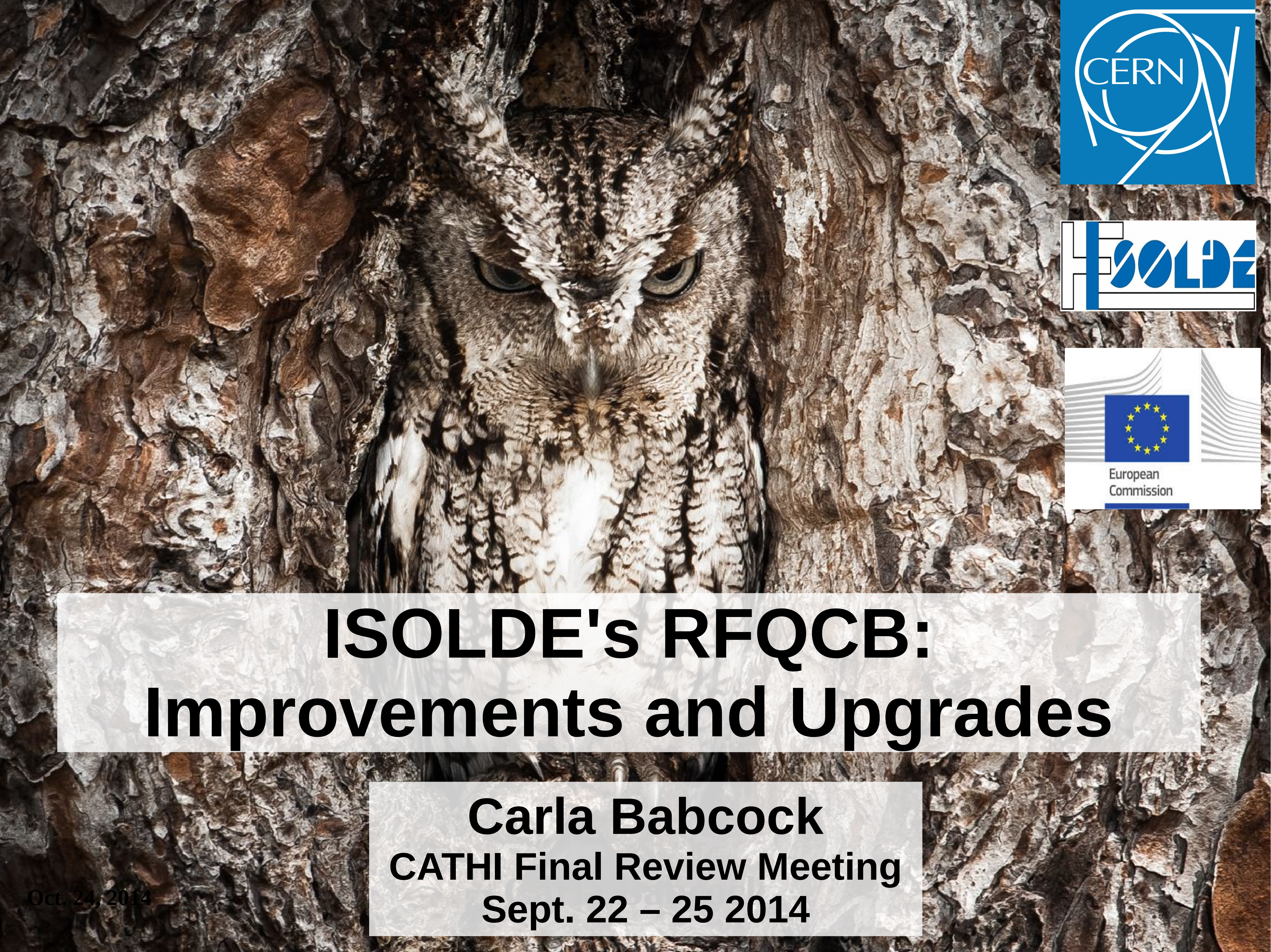


ISOLDE's RFQCB: Improvements and Upgrades

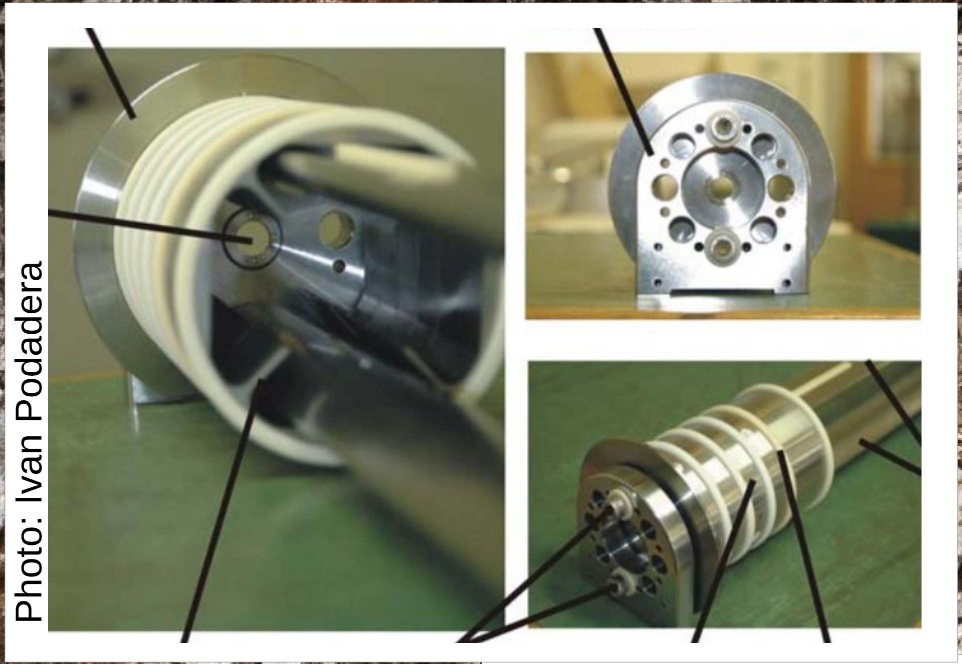
Carla Babcock

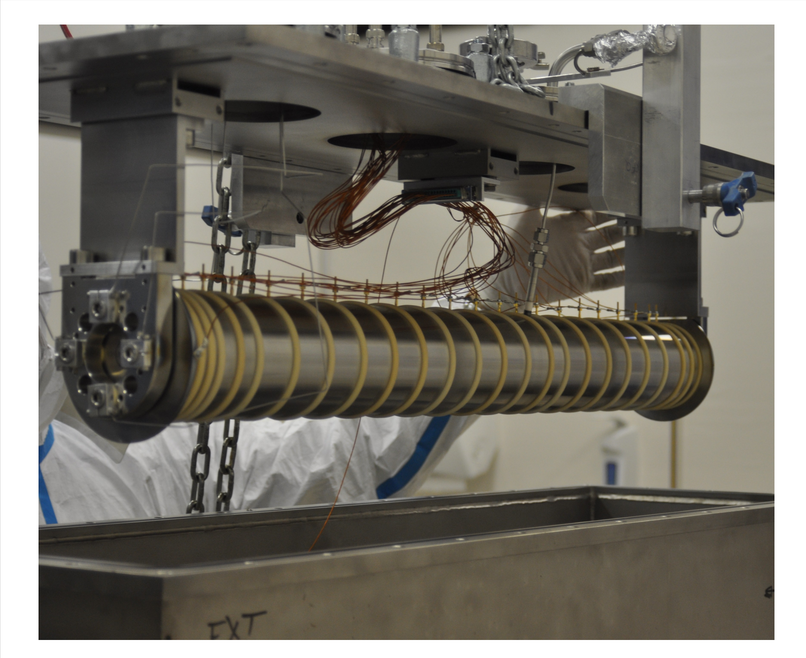
CATHI Final Review Meeting

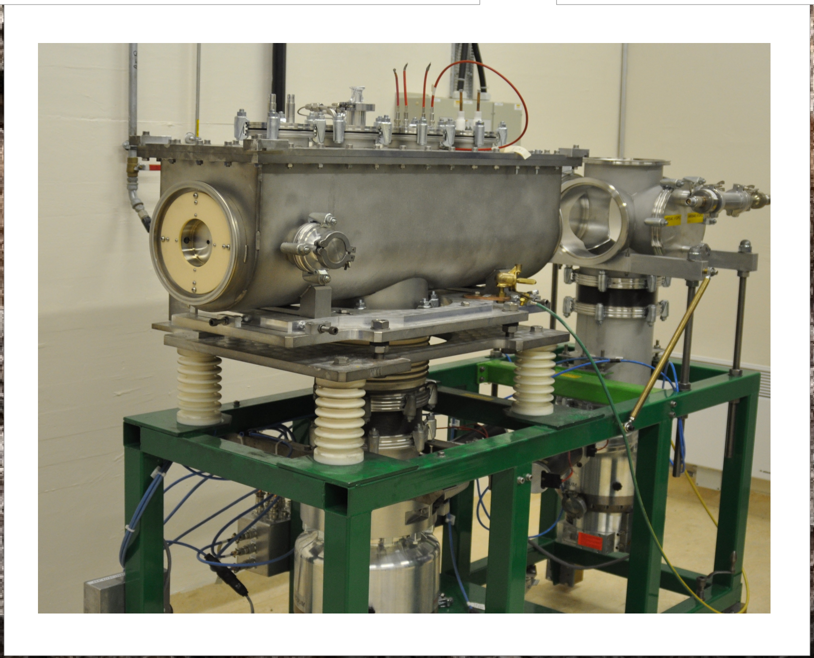
Sept. 22 – 25 2014

Oct. 24, 2014

What is the RFQCB?





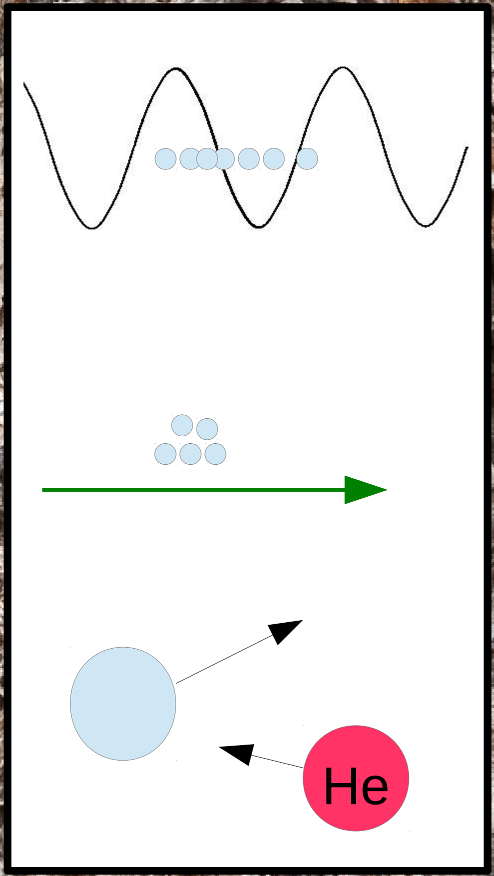


How does it work?

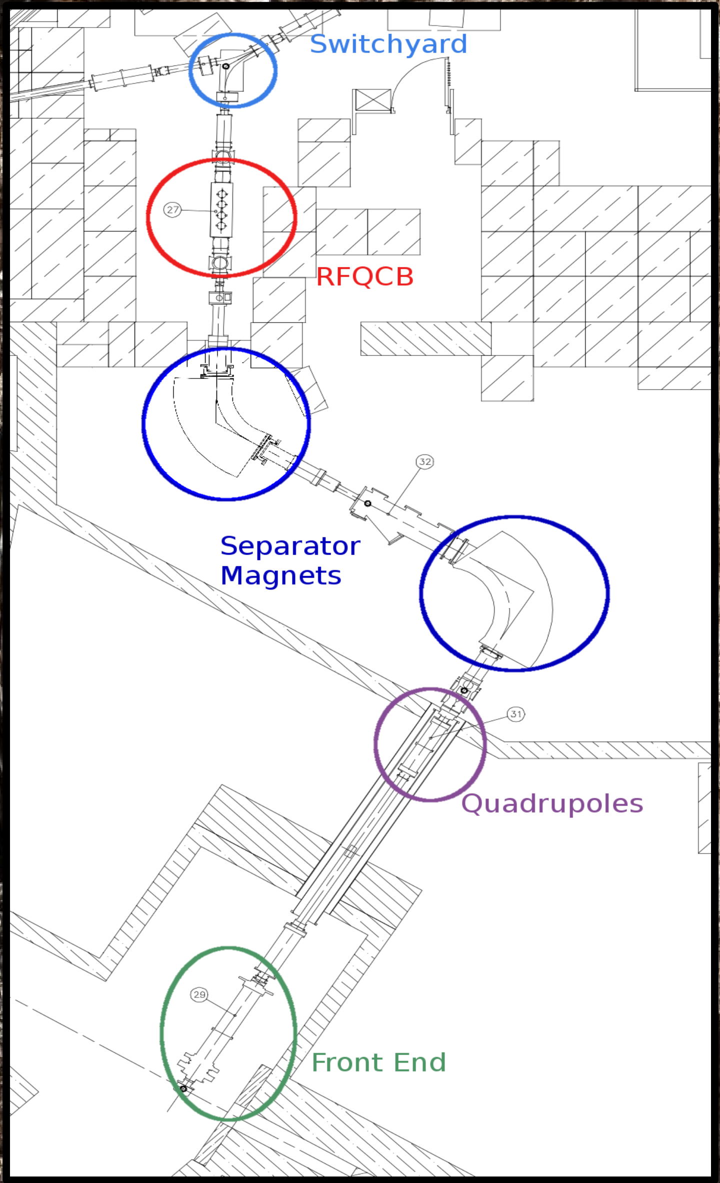
3 Components:

- 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

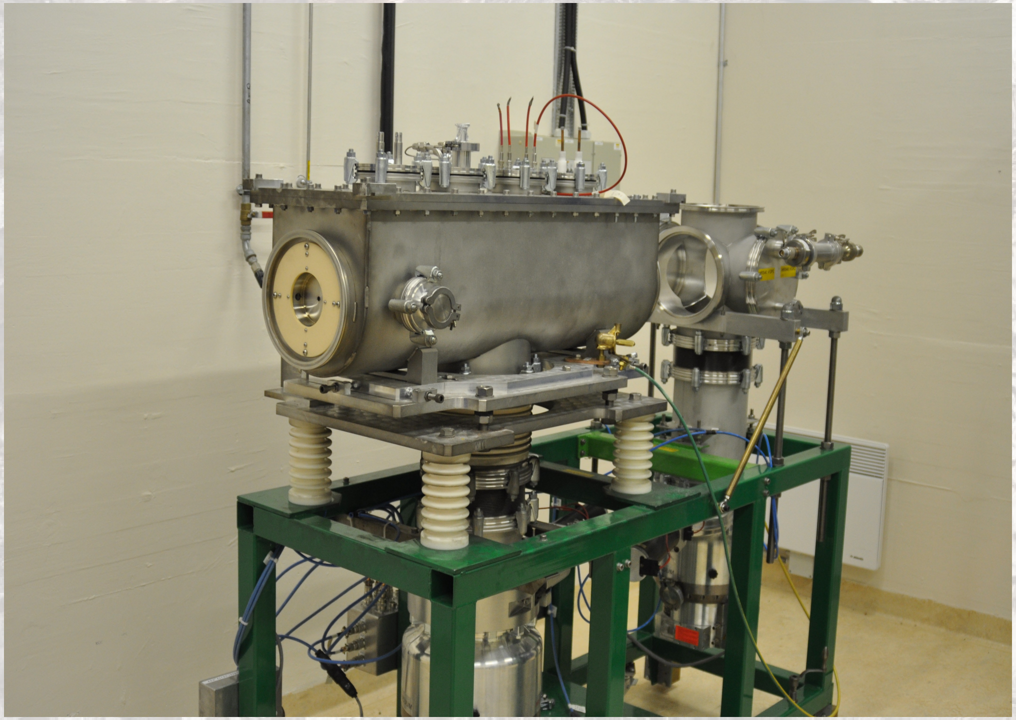
Plus the injection and extraction electrodes



Where is the RFQCB?



ISCOOL vs New RFQCB



ISCOOL has been modified

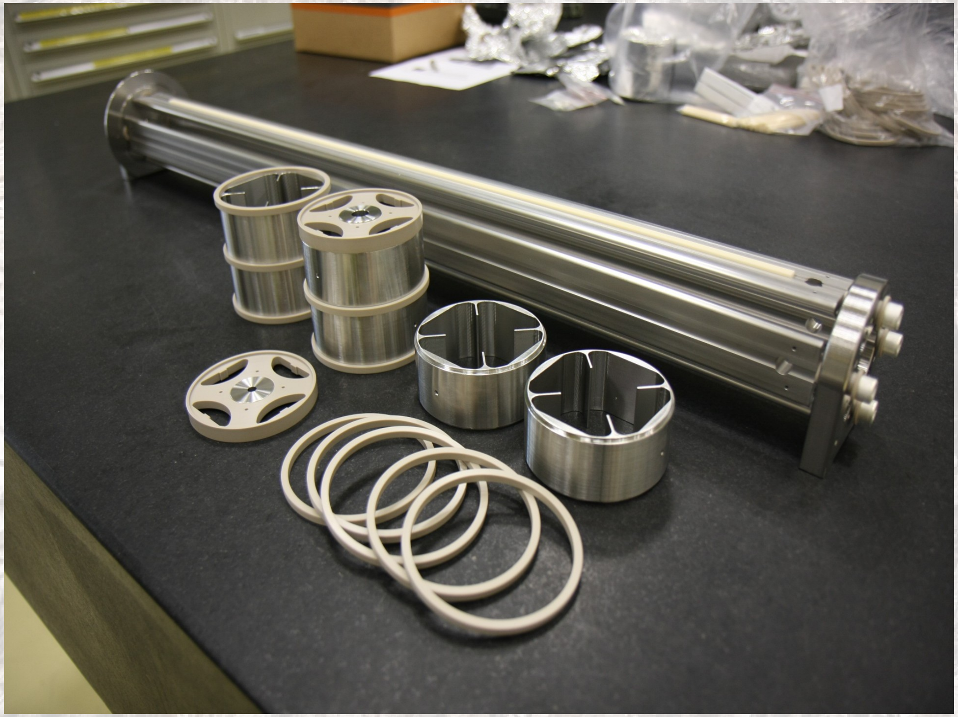
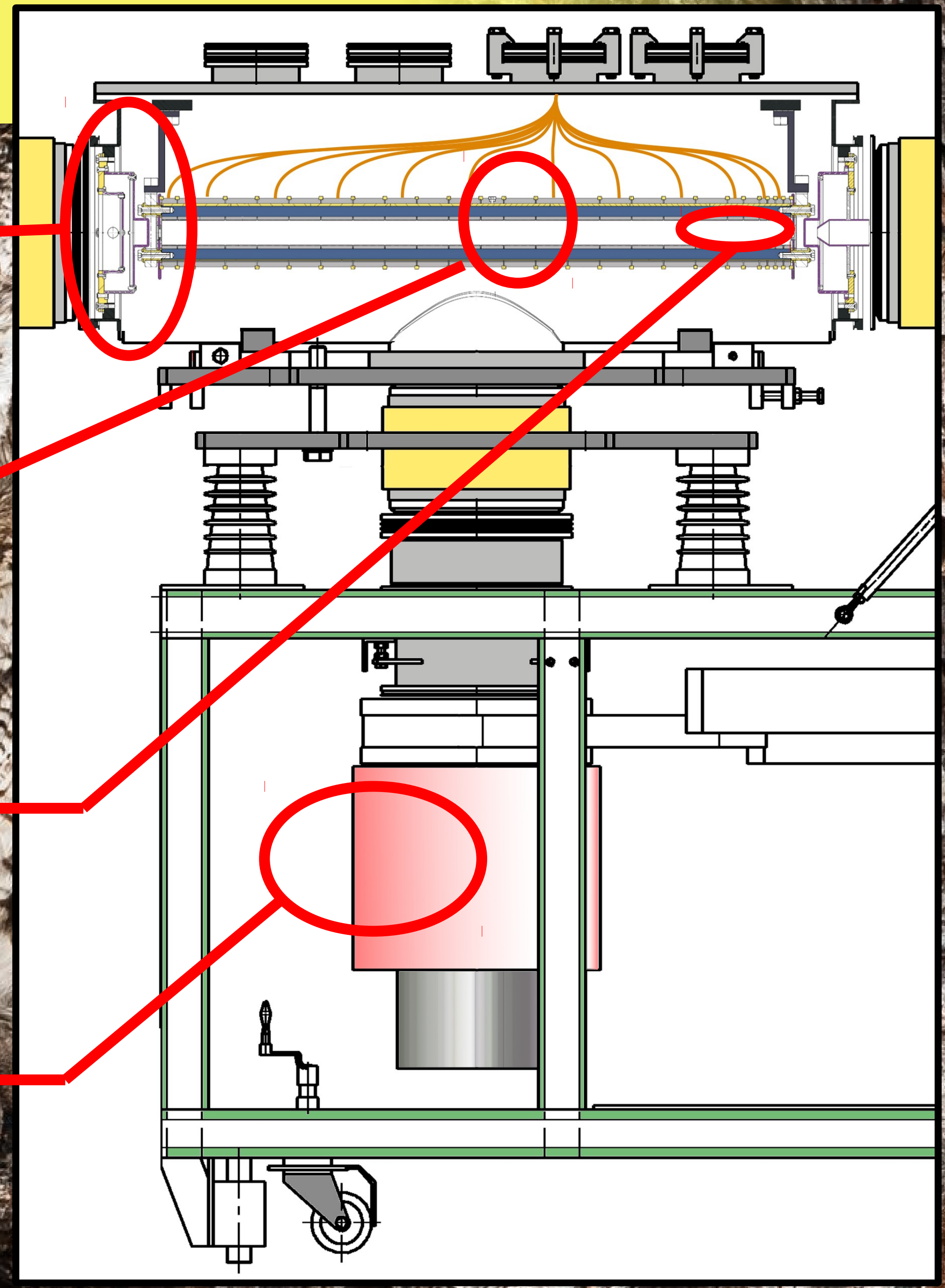


Photo: Tim Giles

The new RFQCB is being built for the test stand

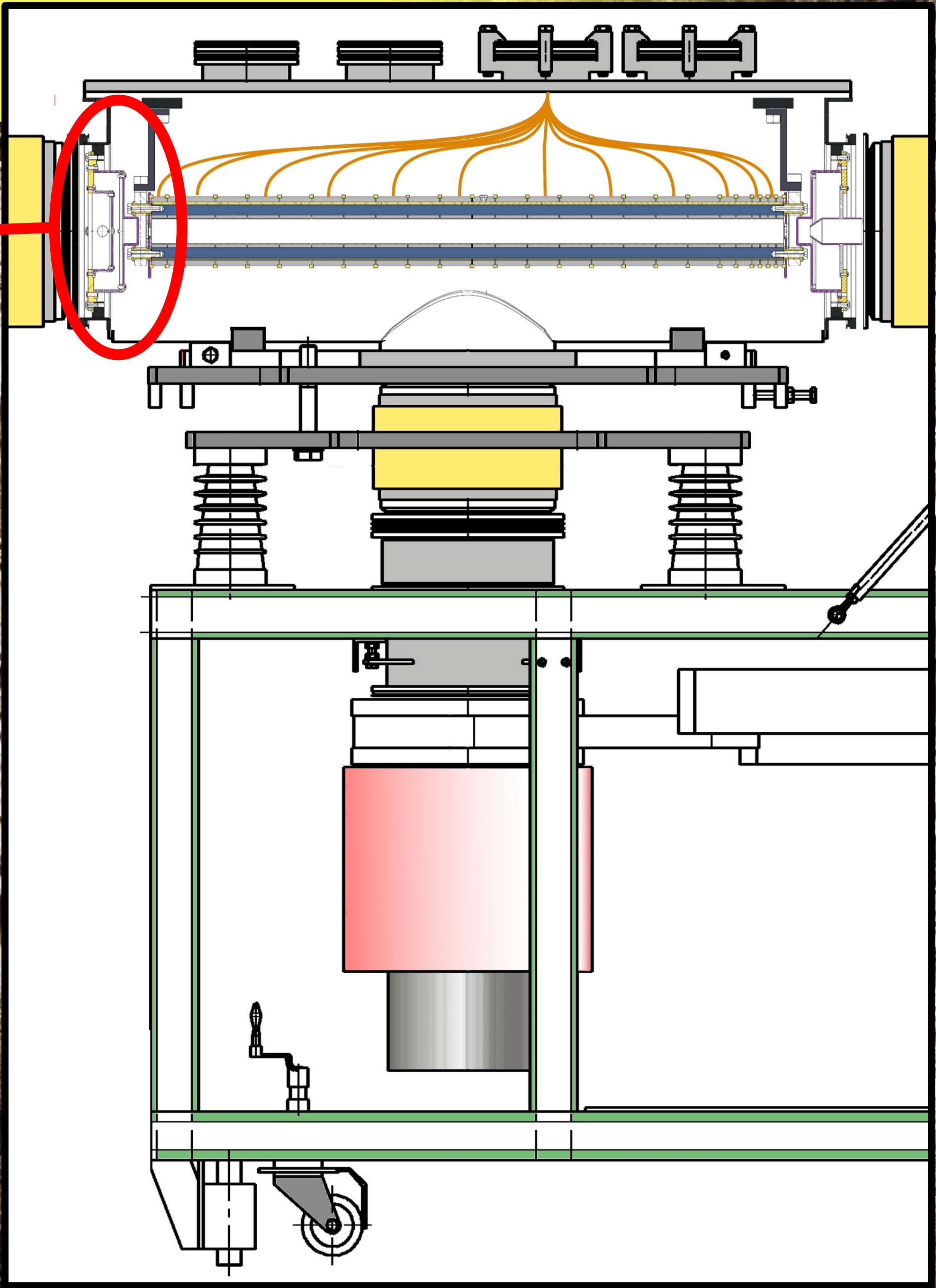
Contents



1. Alignment
3. Mechanical Design
4. Laser Pumping
2. Internal Pressure

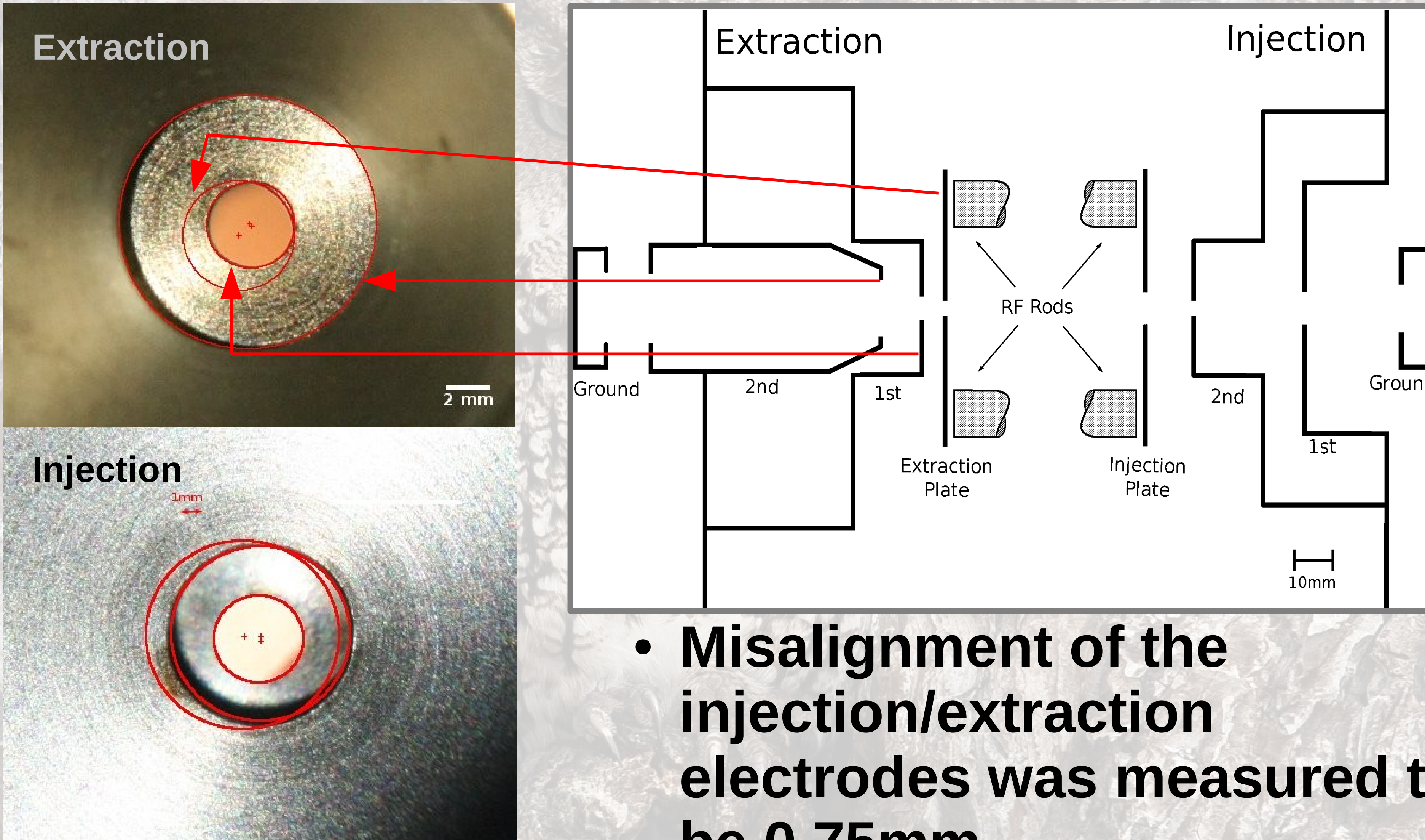
Alignment

1. Alignment



- **Misalignment of internal and external electrodes reduces acceptance and necessitates beam steering**

Alignment



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

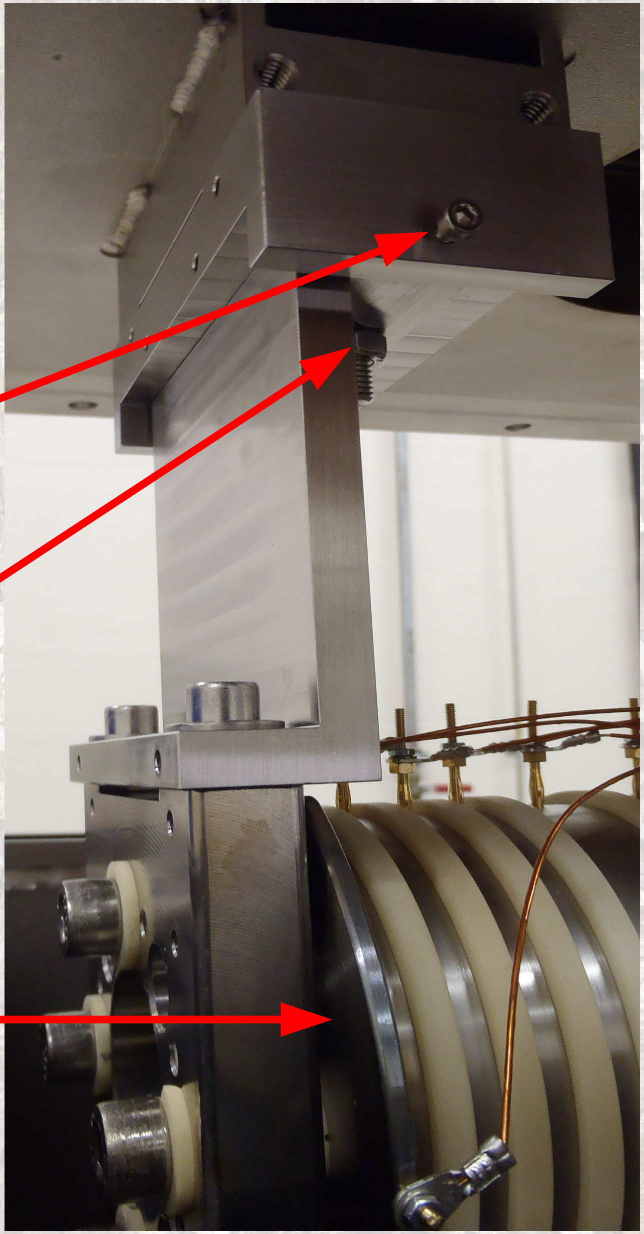
Alignment

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

Horizontal adjustments using support piece and screws

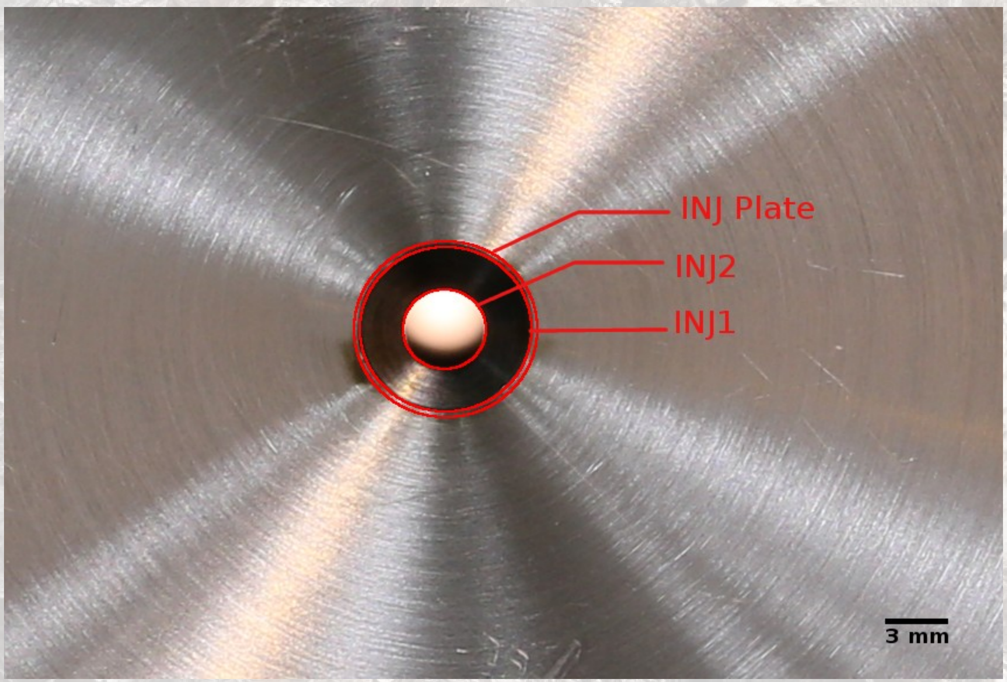
Vertical adjustments through positions of two nuts

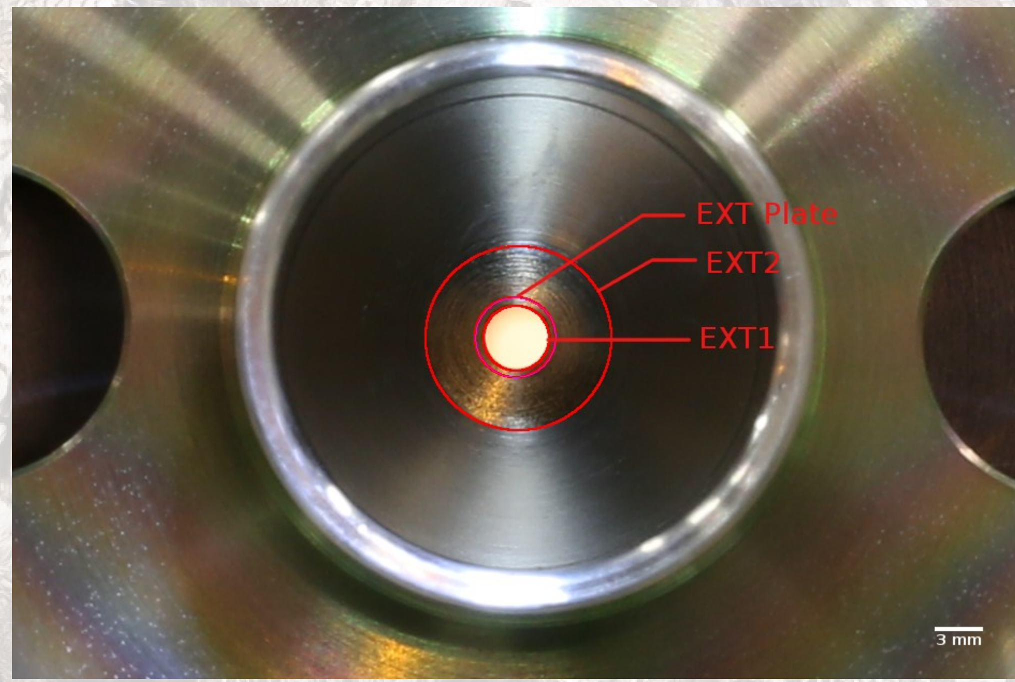
RFQCB cylinder



Alignment: Final Results

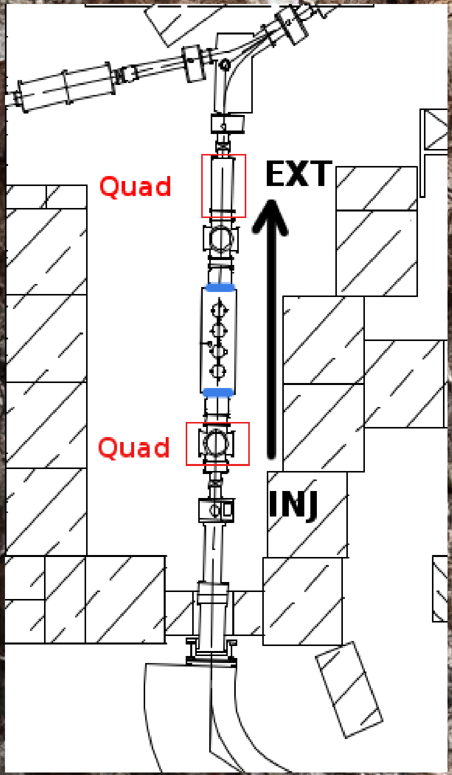
Final alignment centers apertures to within our measurement error of 0.1mm



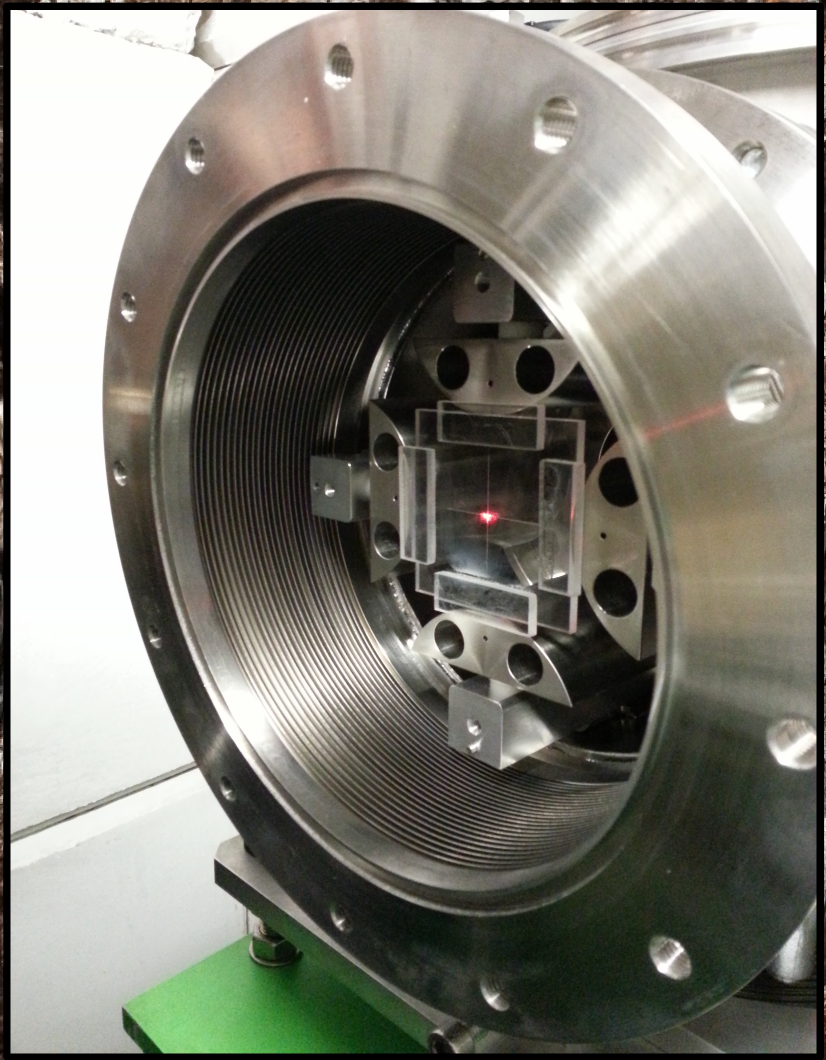


Alignment: The Beamline

- **After internal alignment, there is the need for external alignment**



- This was done using a laser which passes down the beamline, aligning ISCOOL with the quadrupoles on either side
- Accuracy approx. 0.4mm



Alignment: Improvements

- As a result of this alignment
  - ISCOOL will require less steering and will have better transmission further down
  - The acceptance of ISCOOL will improve
  - Experiments which involve getting laser light to interact with the ions inside the RFQCB will be possible, i.e. for pumping of ions to meta-stable energy states, 2+ ionization, etc.

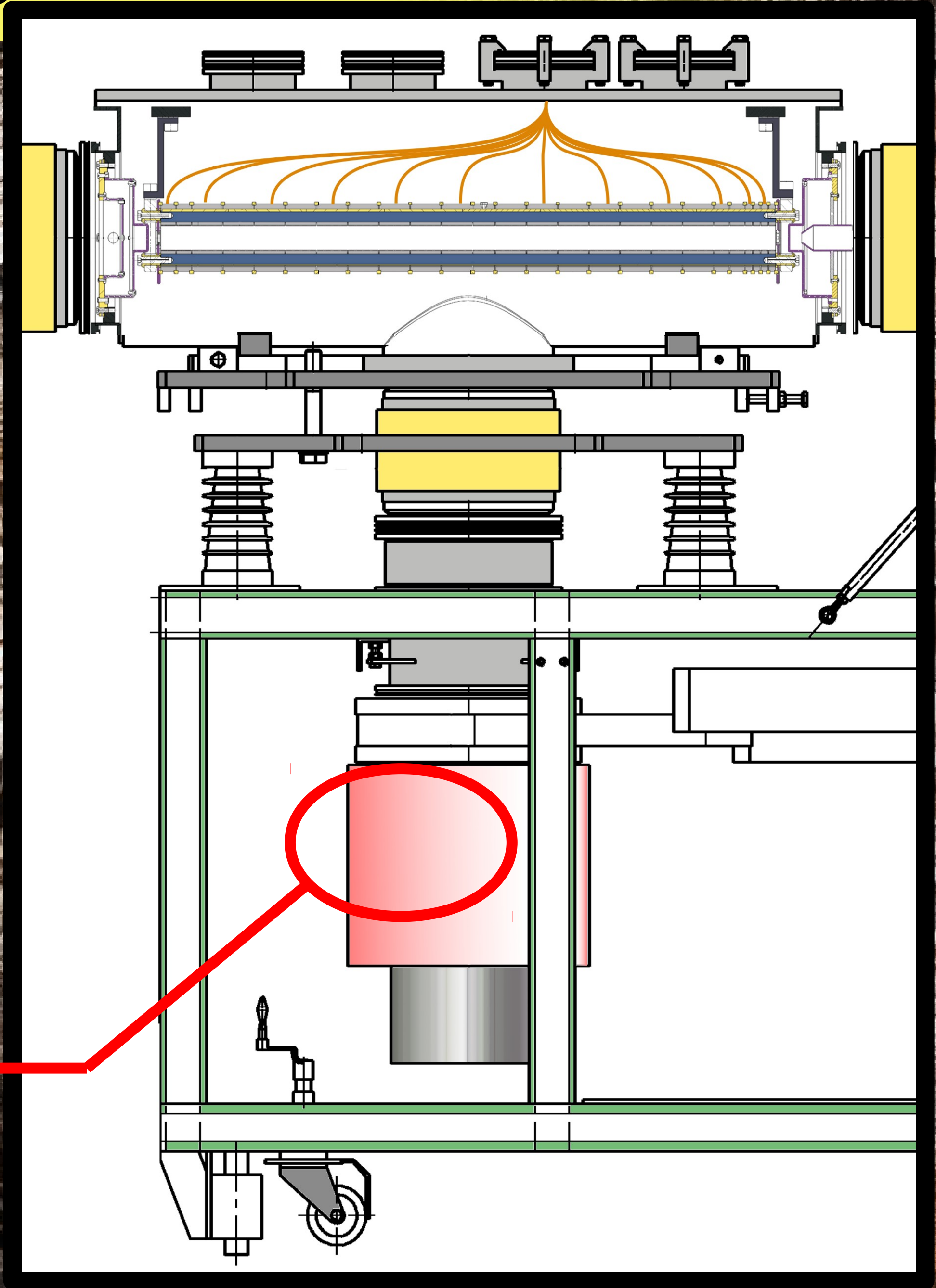
Alignment: Future Options

1. A mechanical design that allows all electrodes to be fixed to one piece, thus reducing the possibility of misalignment

2. A calibrated alignment system that is built into the cover, so can be adjusted from outside (already implemented in Orsay)

Internal Pressure

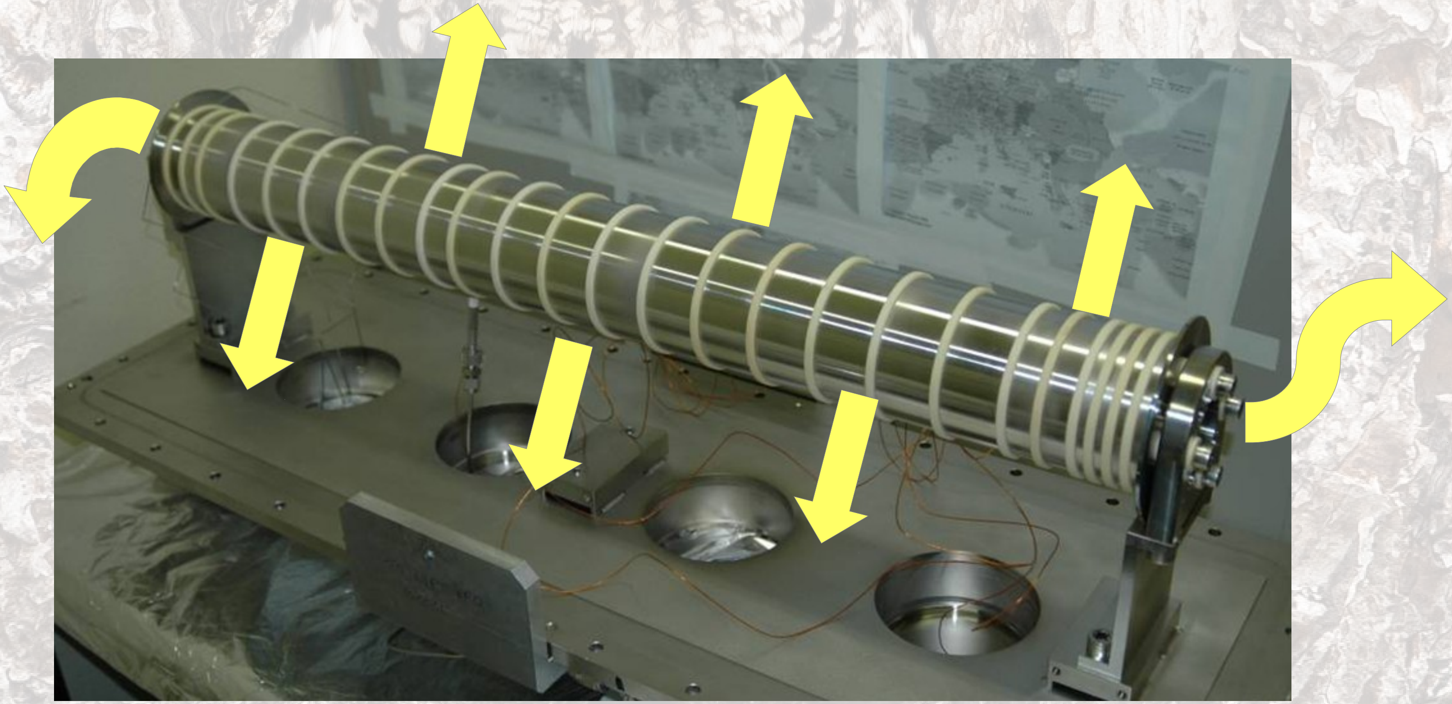
- **Helium flows into the internal cylinder and is pumped away by three turbo pumps**
- **Internal pressure is an important factor in the quality of the beam**



2. Internal Pressure

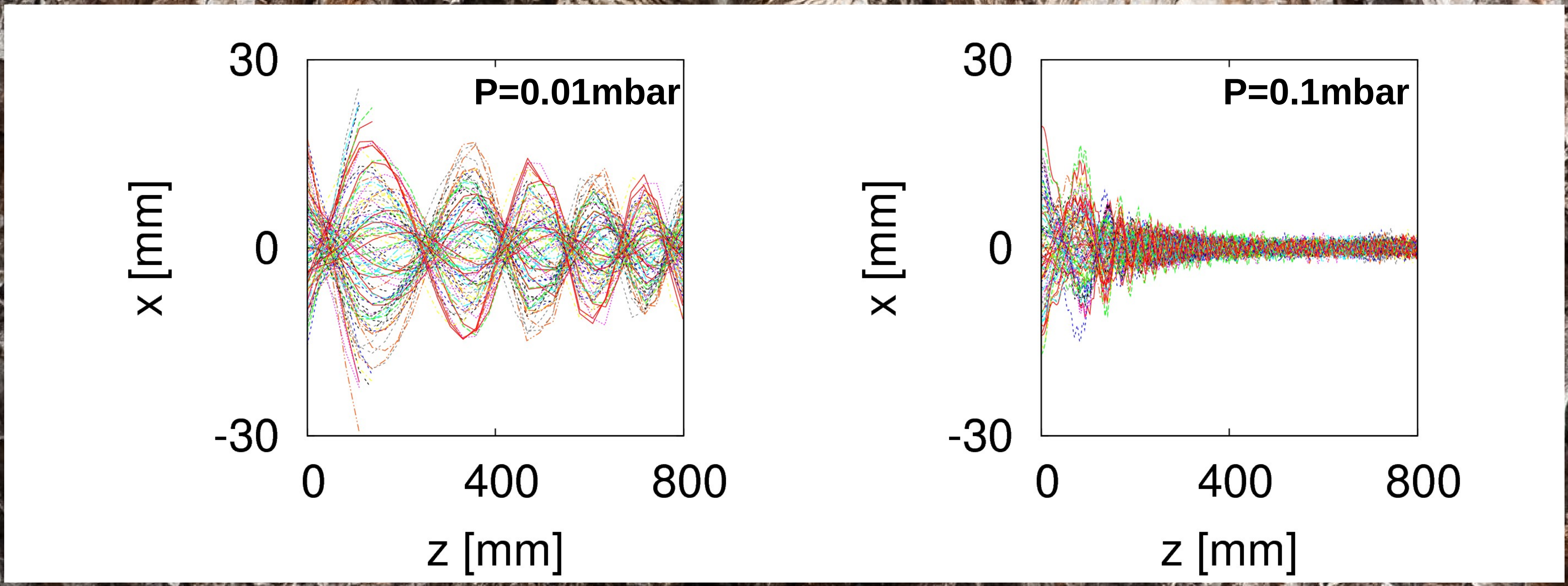
Internal Pressure

- **He pressure inside cylinder is unknown, as is the flow rate of He into the cylinder and the rate at which it escapes**

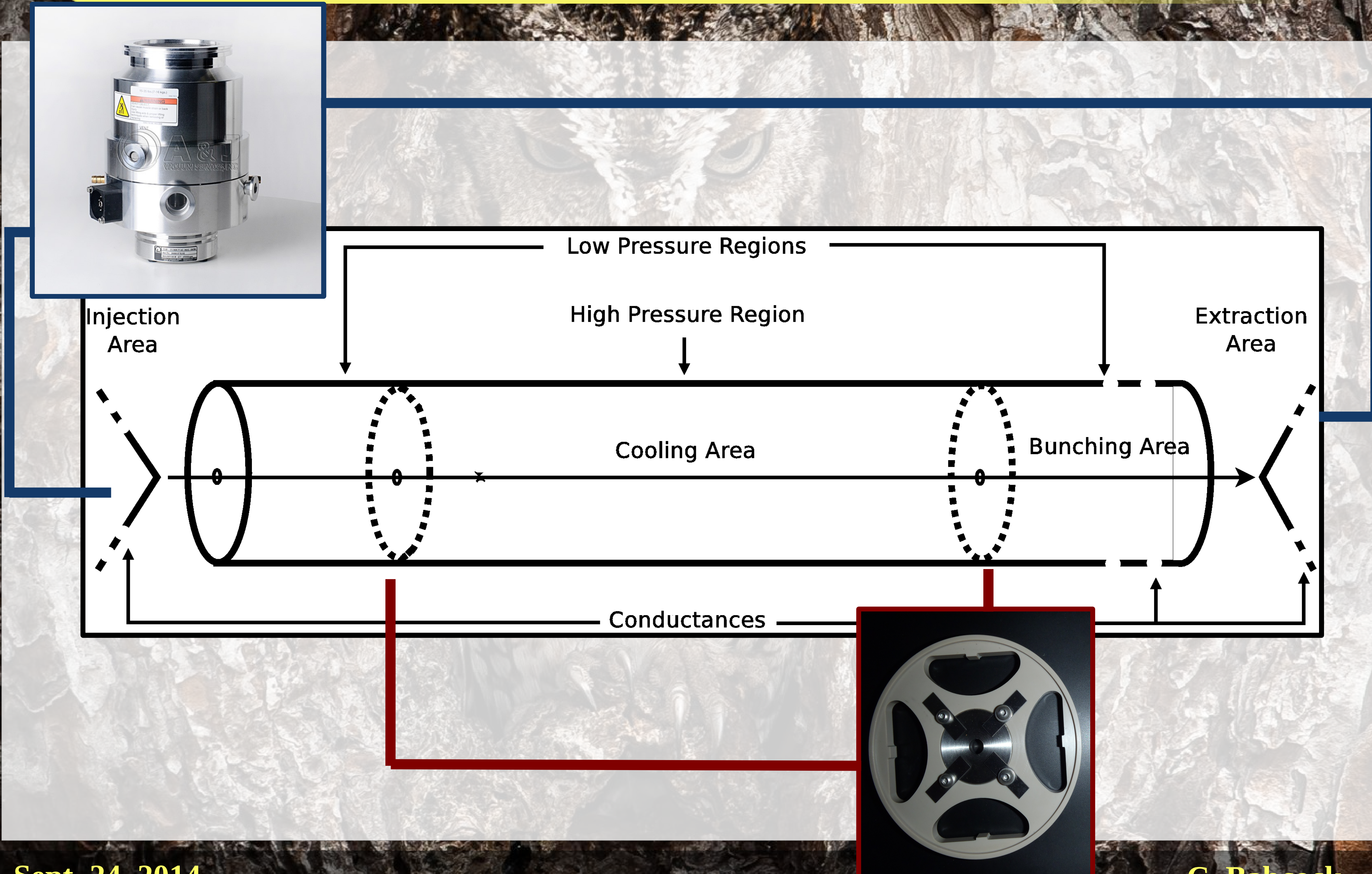


Internal Pressure: Simulations

Ion trajectories in the length of the RFQCB for different pressures

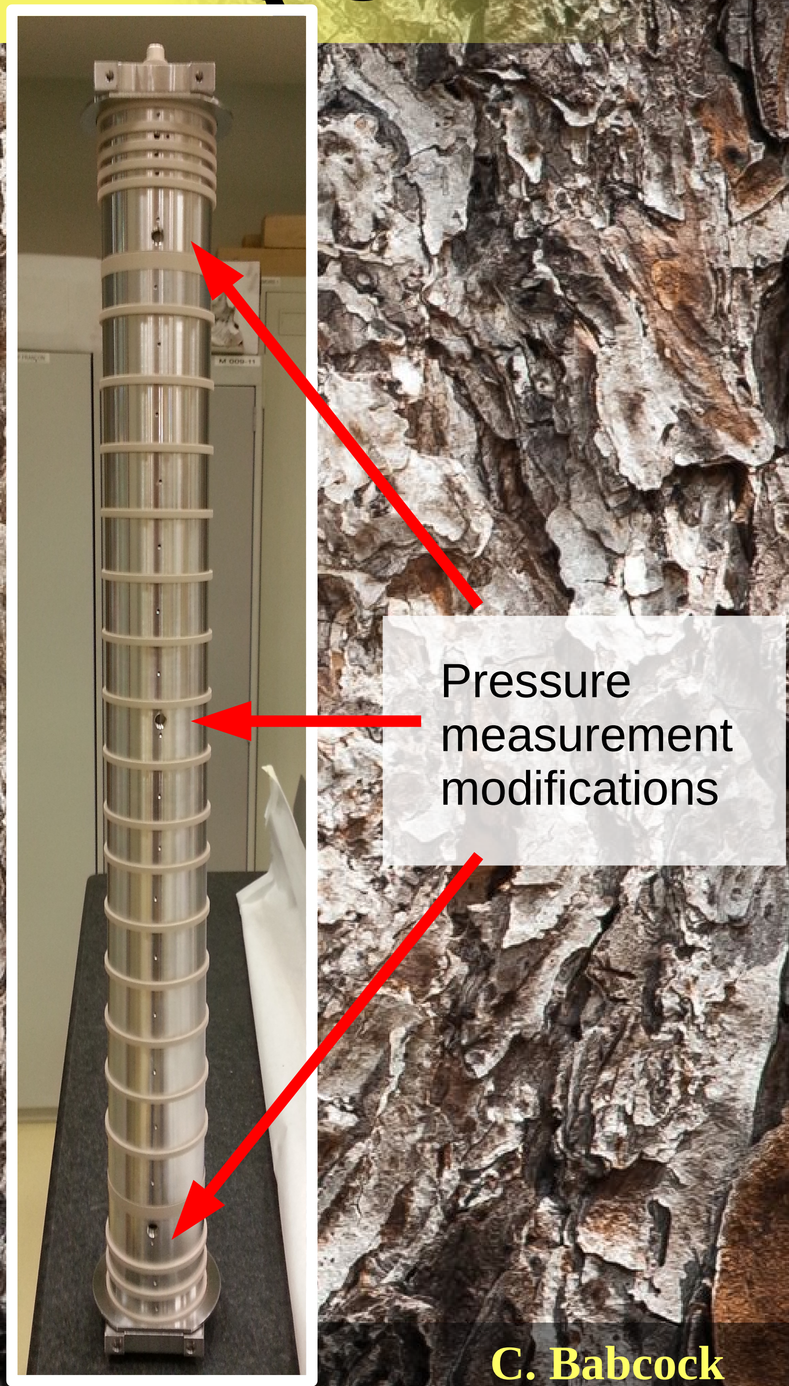


Internal Pressure:New RFQCB

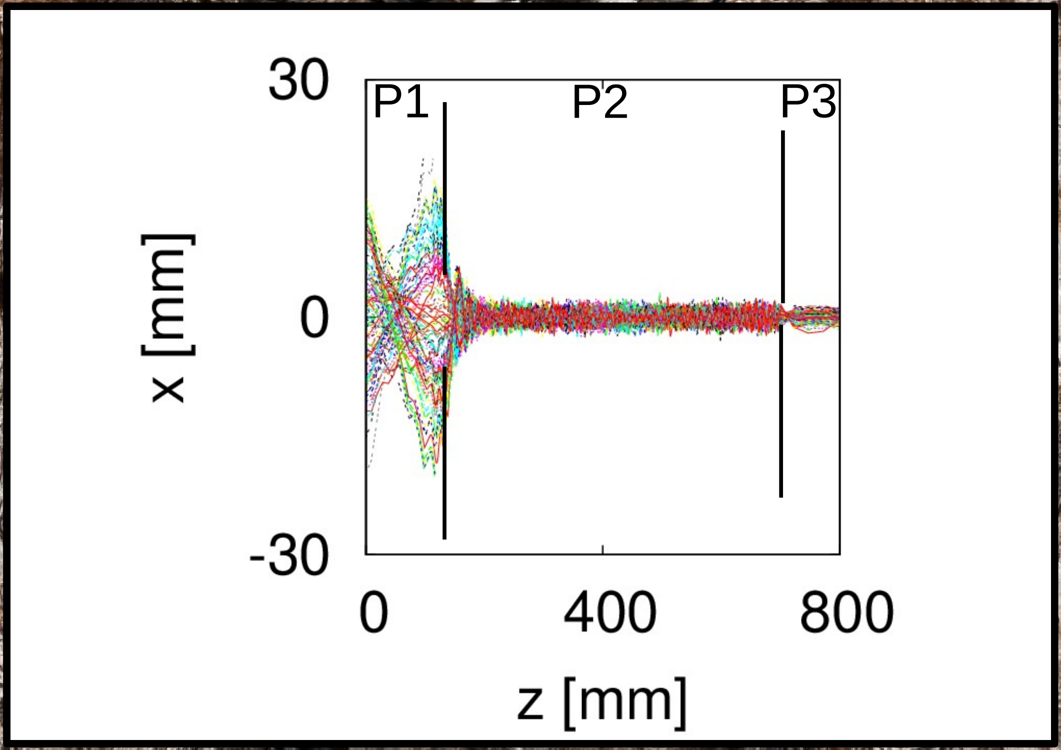


Internal Pressure:New RFQCB

- **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**



Internal Pressure: New RFQCB



P1= 0.01mbar

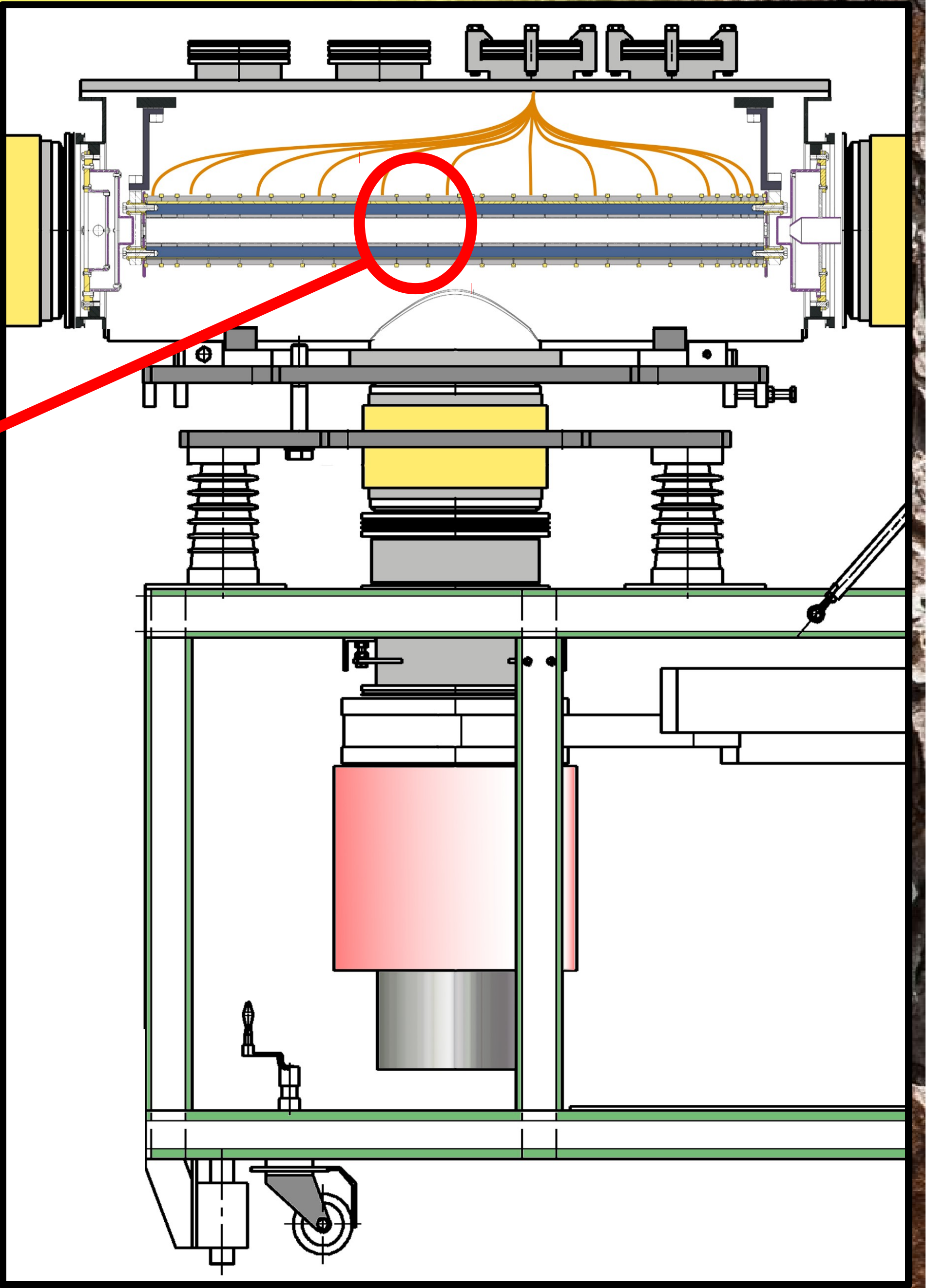
P2= 0.1mbar

P3= 0.01mbar

Simulation with barriers included at 100mm and 700mm

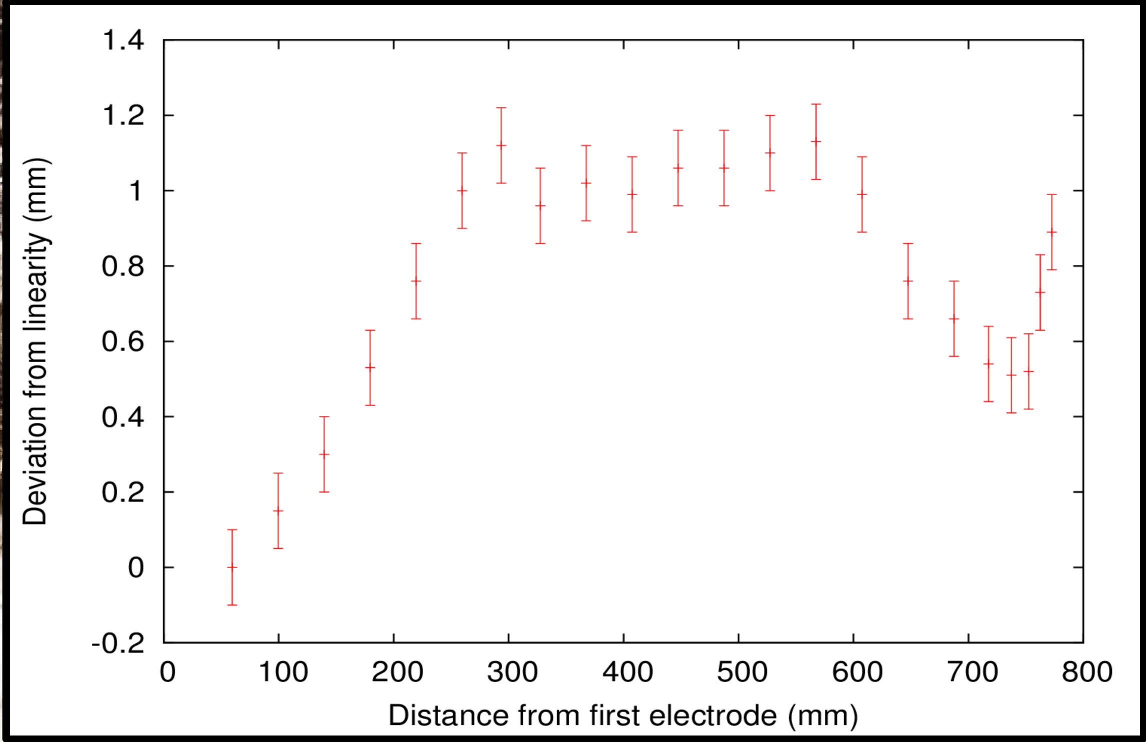
Mechanical Design

3. Mechanical Design



- **Improvements to the mechanical design suggested by construction of new machine and experience with ISCOOL**

Mechanical Design



- **Shorts are often possible, due to broken insulators, high voltages or the movement of the axial electrodes**

Several aspects of mechanical stability depend on the straightness of the RF rods, which can be manufactured warped

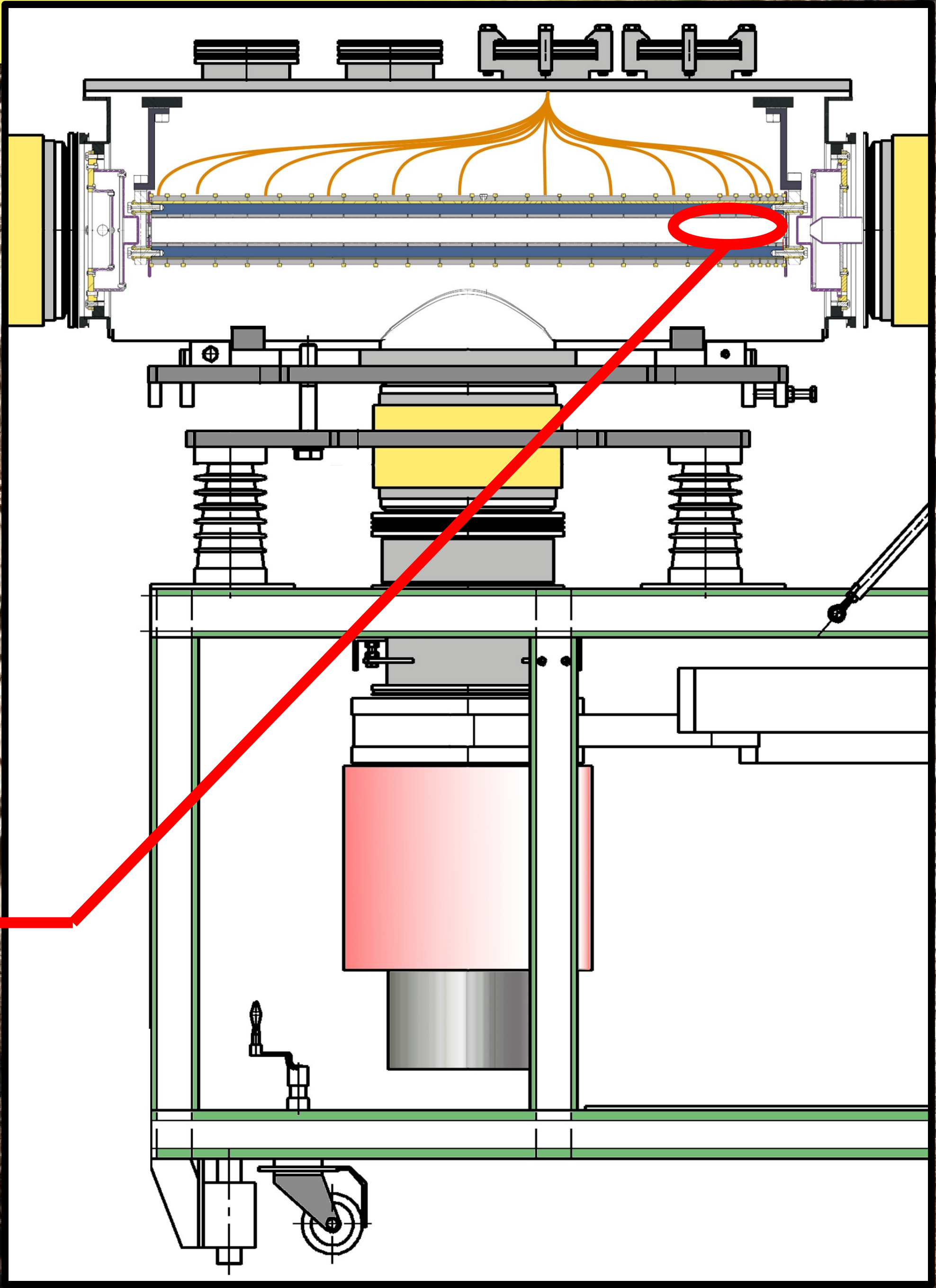
Mechanical Design: Solutions

- **Possible solutions:**
  - Replace ceramic insulators with something more robust (i.e. PEEK)
  - Build structure in a support to ensure it is straight, will reduce chance of insulators falling out and axial electrodes turning

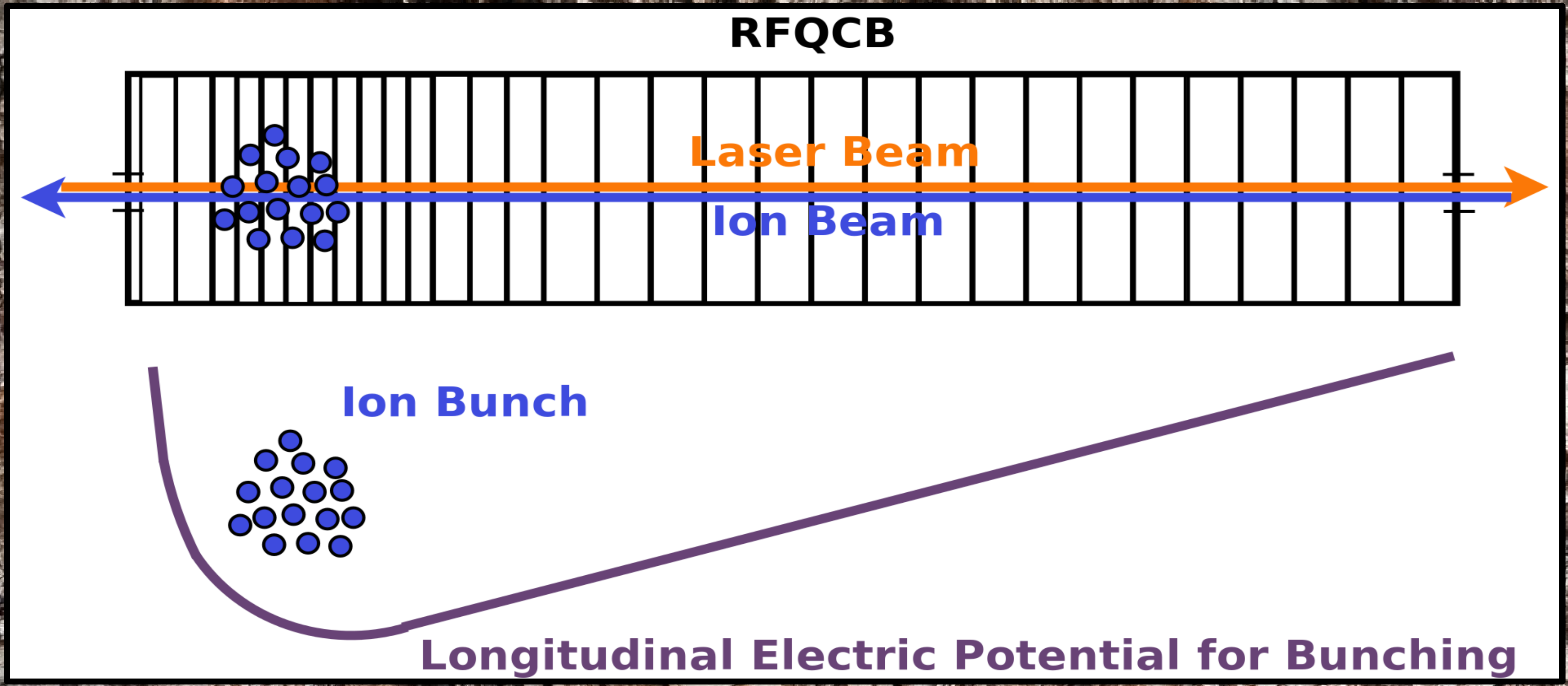
Laser Pumping

- **Introduction of lasers into the RFQCB cylinder through injection or extraction apertures, to interact with beam in the bunching region**

4. Laser Pumping

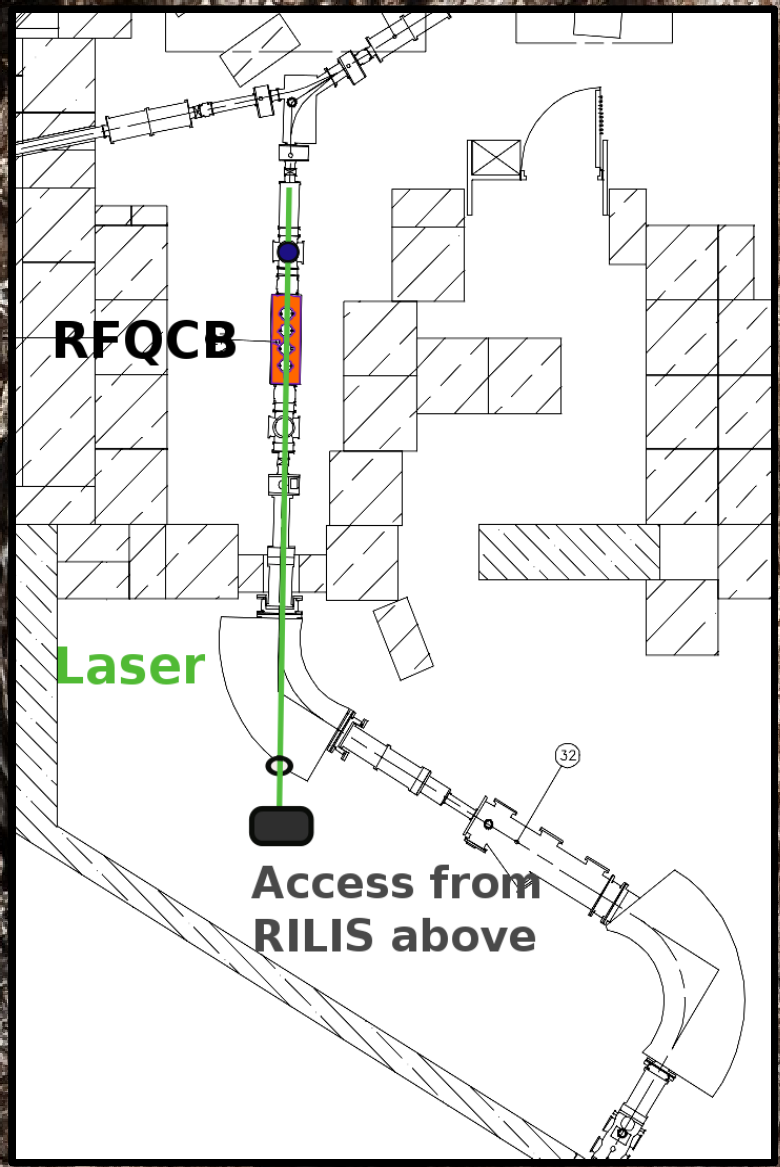


Laser Pumping



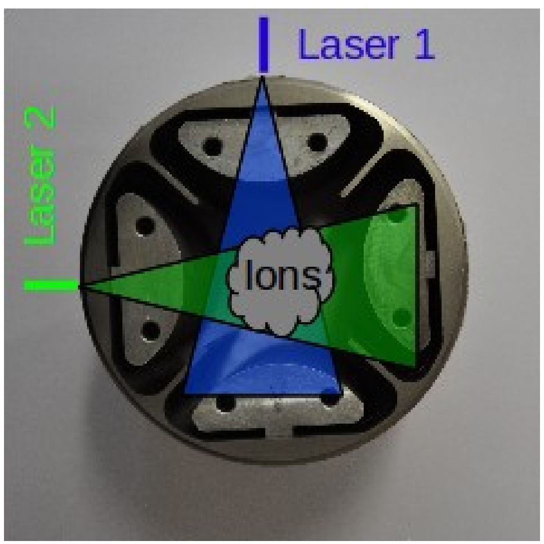
Laser pumping is useful for ions which are not accessible from the ground state, due for instance to low efficiency or laser limitations

Laser Pumping: ISCOOL

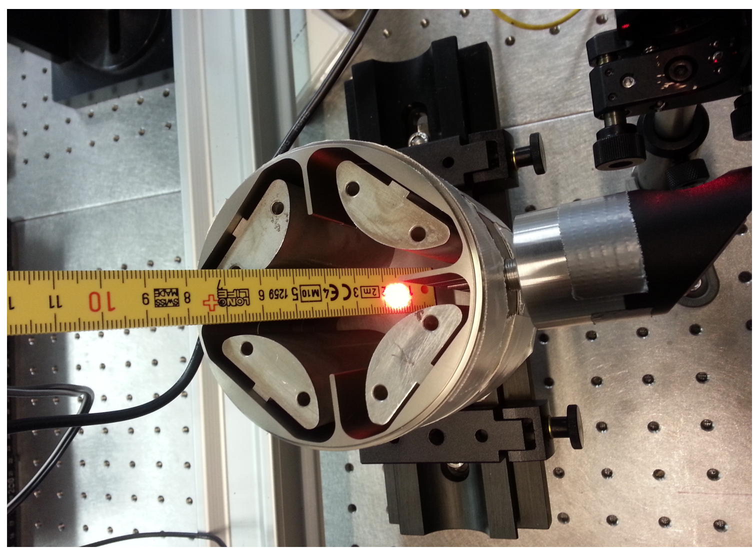


Laser Pumping:New RFQCB

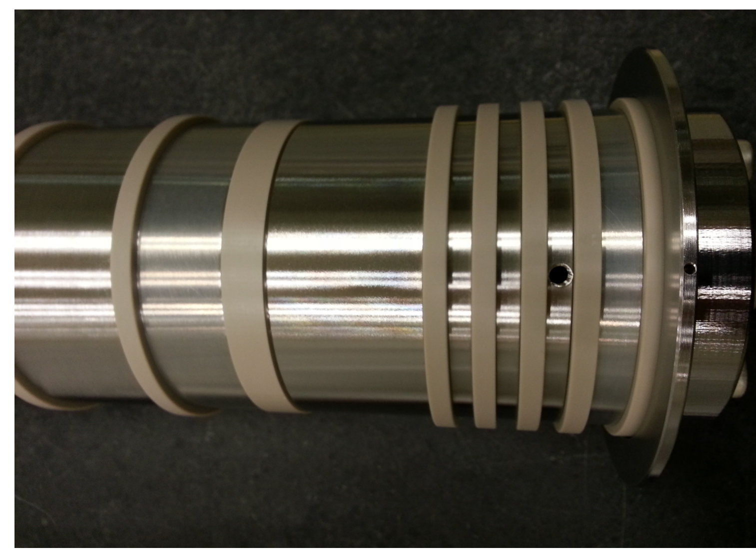
- To facilitate experiments involving in-cooler laser pumping of ions or 2+ ionization, the new cooler has laser entry ports



Concept



Test on mock RFQ



Implementation on new RFQCB

Conclusions

- Alignment has been improved and the same system is applied to the new RFQCB
- While the internal pressure cannot be monitored in ISCOOL, the new RFQCB will have several related modifications
- Some improvements to the mechanical design are possible in future designs
- Laser pumping will be attempted again with ISCOOL and will be possible with the new RFQCB

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

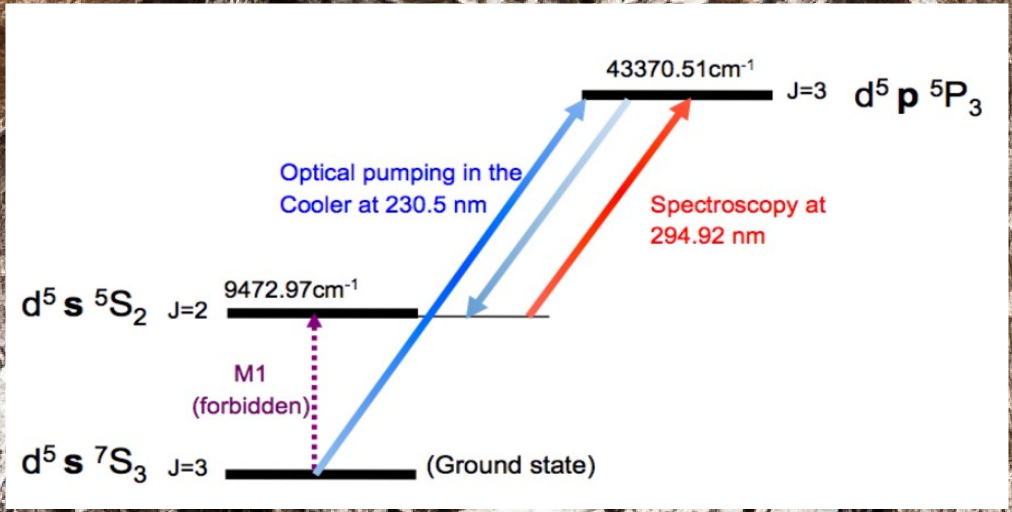
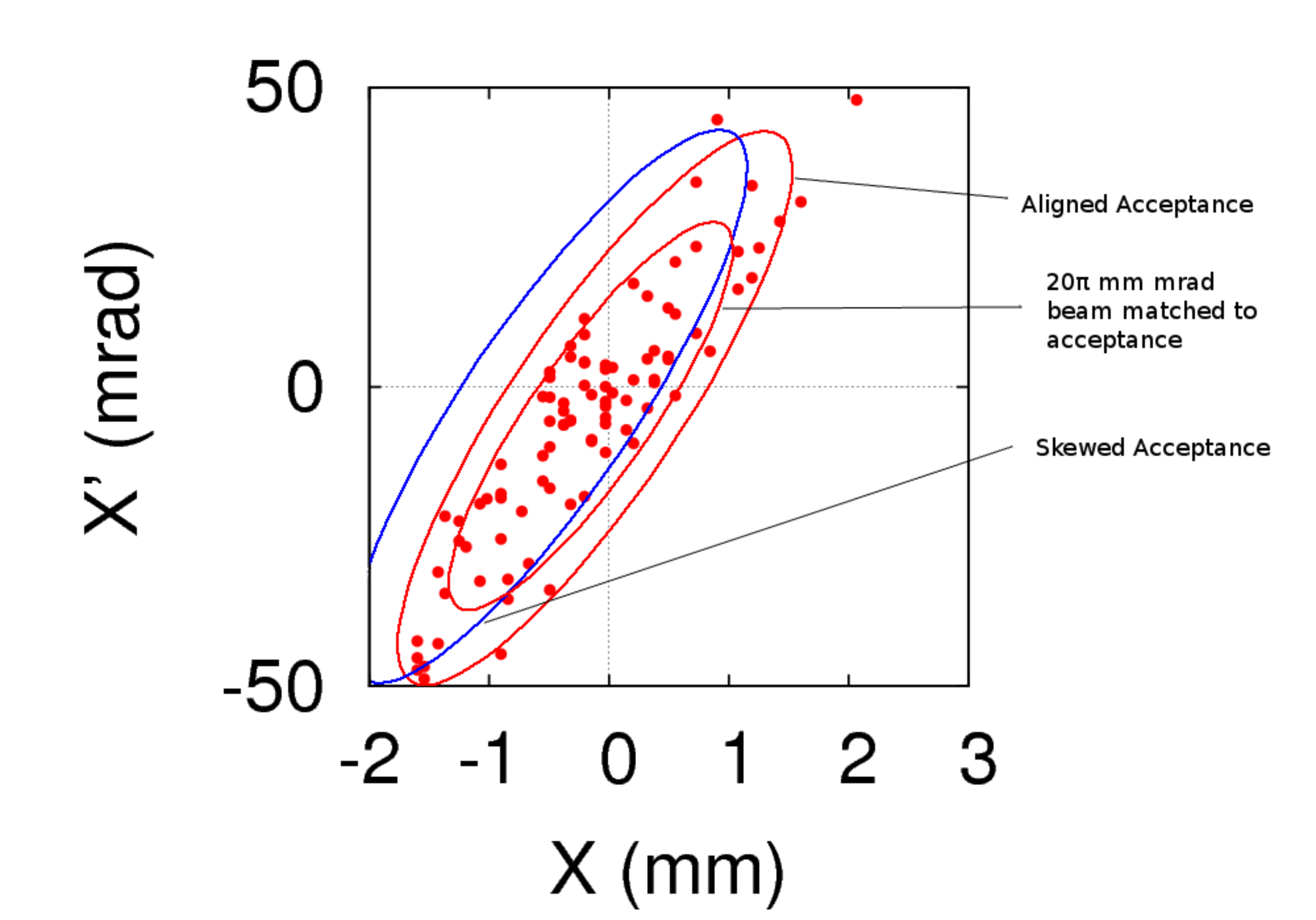


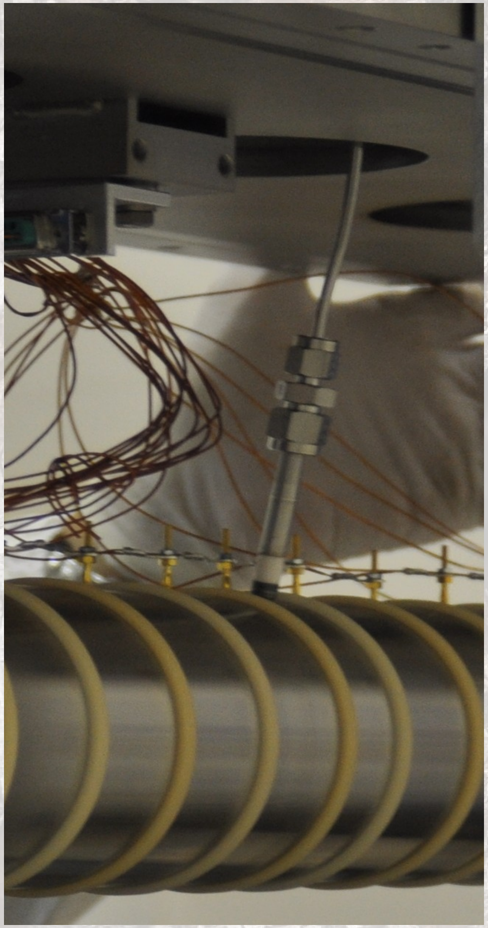
Figure: Bradley Cheal

Alignment

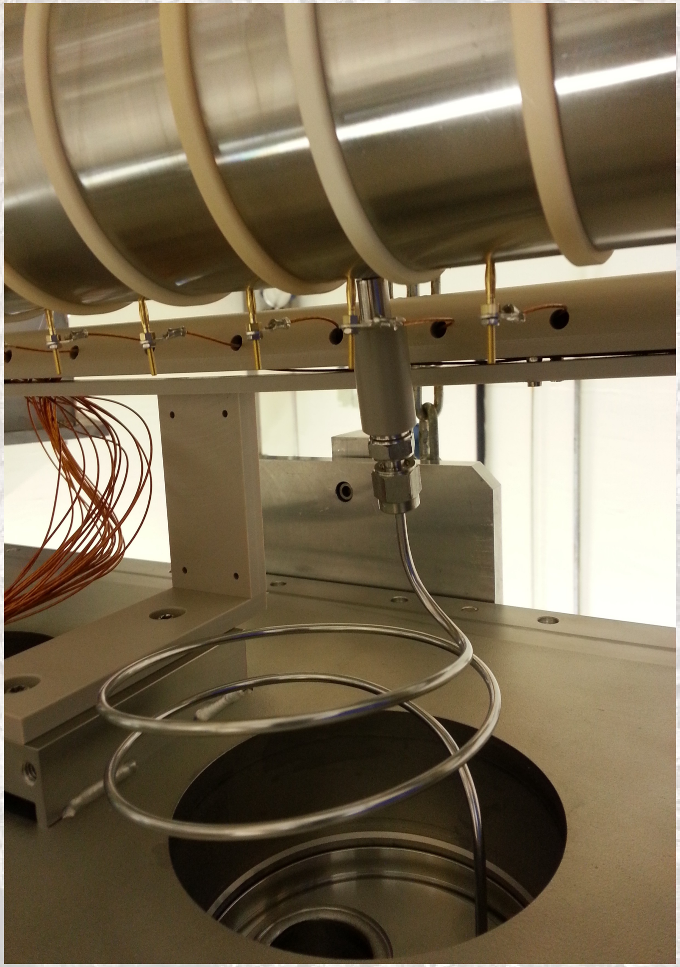


Microwave Studio was used to simulate the beam passing through the injection electrodes, to demonstrate the advantages of a realignment

Pressure: ISCOOL



Several systems were tried – final design to be installed



Laser Entry Ports