

The TITAN- EBIT (Electron Beam Ion Trap)

Introduction

- Motivation
- Principle

A Status Report

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Setup

- Requirements
- Status

Outlook

- Schedule
- Measurements

Motivation

EBIT meets rare isotope facility

- High precision mass measurements

$$v_c = \frac{1}{2\pi} \cdot \frac{q}{m} \cdot B \quad \left| \quad \frac{\delta m}{m} \approx \frac{m}{T_{RF} \cdot q \cdot B \cdot \sqrt{N}}\right.$$

- Higher q (or B) allows for
 - better accuracy or $\frac{\delta m}{m}$
 - shorter observation times or T_{RF}
 - smaller count rate N
- “EBIT physics”: Spectroscopy on HCl → Test QED
 - Calculations for heavier systems limited by
 - » applicability of perturbation theory
 - » nuclear effects

→ J. Braun (this workshop)

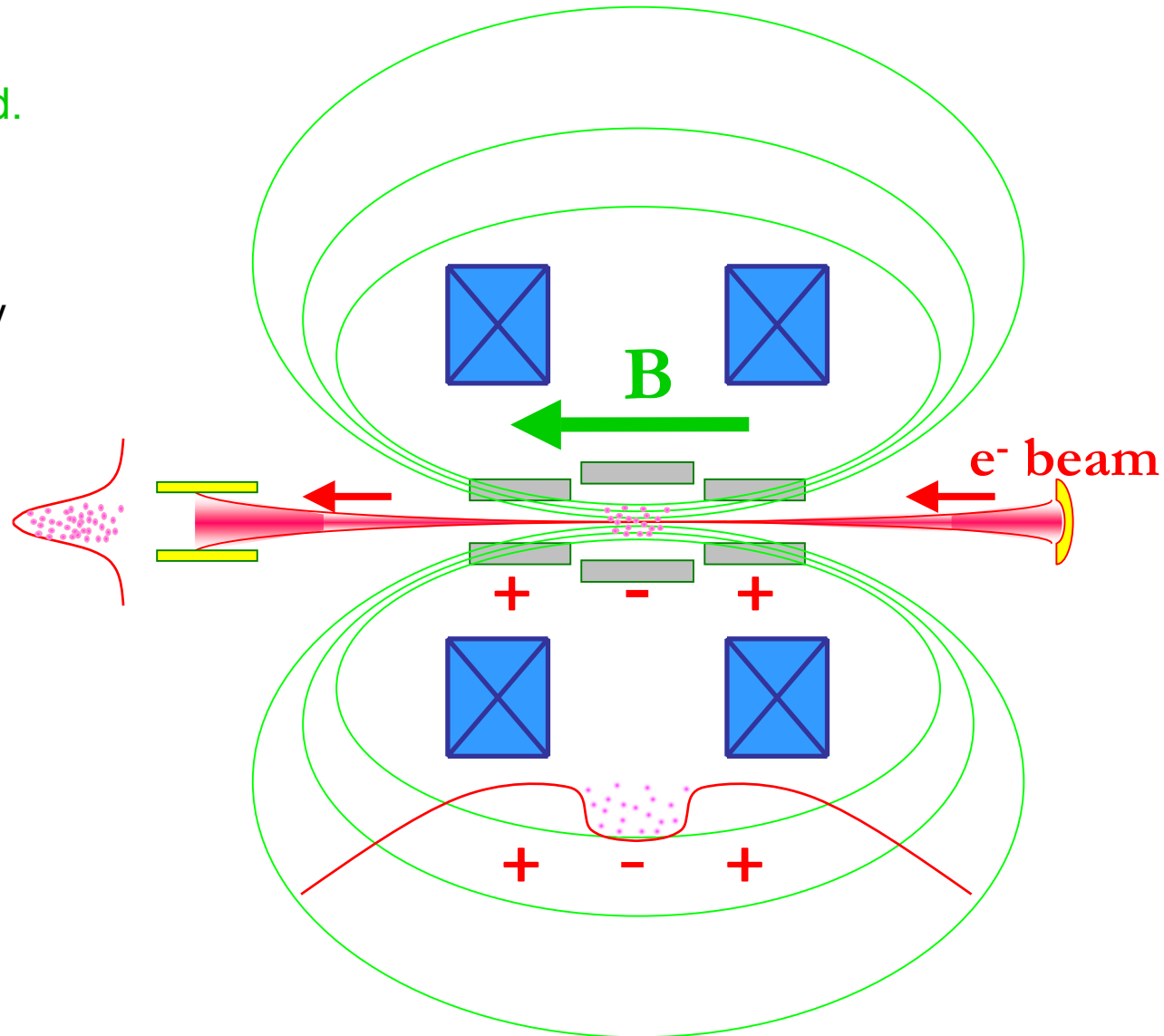
The principle of an EBIT

The electron beam is compressed by a magnetic (Helmholtz) field.

Ions are trapped radially by space charge potential, longitudinally by external field.

Creation of highly charged ions by multiple subsequent electron impact

$B \approx 6 - 8 \text{ T}$,
 $I_e \approx 0.1 - 1 \text{ A}$
 $d_{eb} \approx 100 \mu\text{m}$,
 $\phi_{sc} \approx 0.1 - 1 \text{ keV}$
 $T_{ion} \approx 100 - 500 \text{ eV}$
 $t_{ionize} \approx 1 \text{ ms} - 10 \text{ s}$



Charge breeding of Radionuclides

Charge state (10 – 50)

'medium' high voltage; design value: $E = 20\text{keV}$

Rapid charge breeding (5 – 50 ms)

High electron current; design value: $I = 5\text{ A}$

Injection + Extraction **with high efficiency**

open apertures + **improved ion optics**

Handling **isobaric contaminations**

large trap, deep space charge potentials

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Further Requirements

Capture into a Penning trap

injection into a strong magnetic field
(more critical for HCl)

deceleration to rest

short bunches,
small emittance,
small ΔE

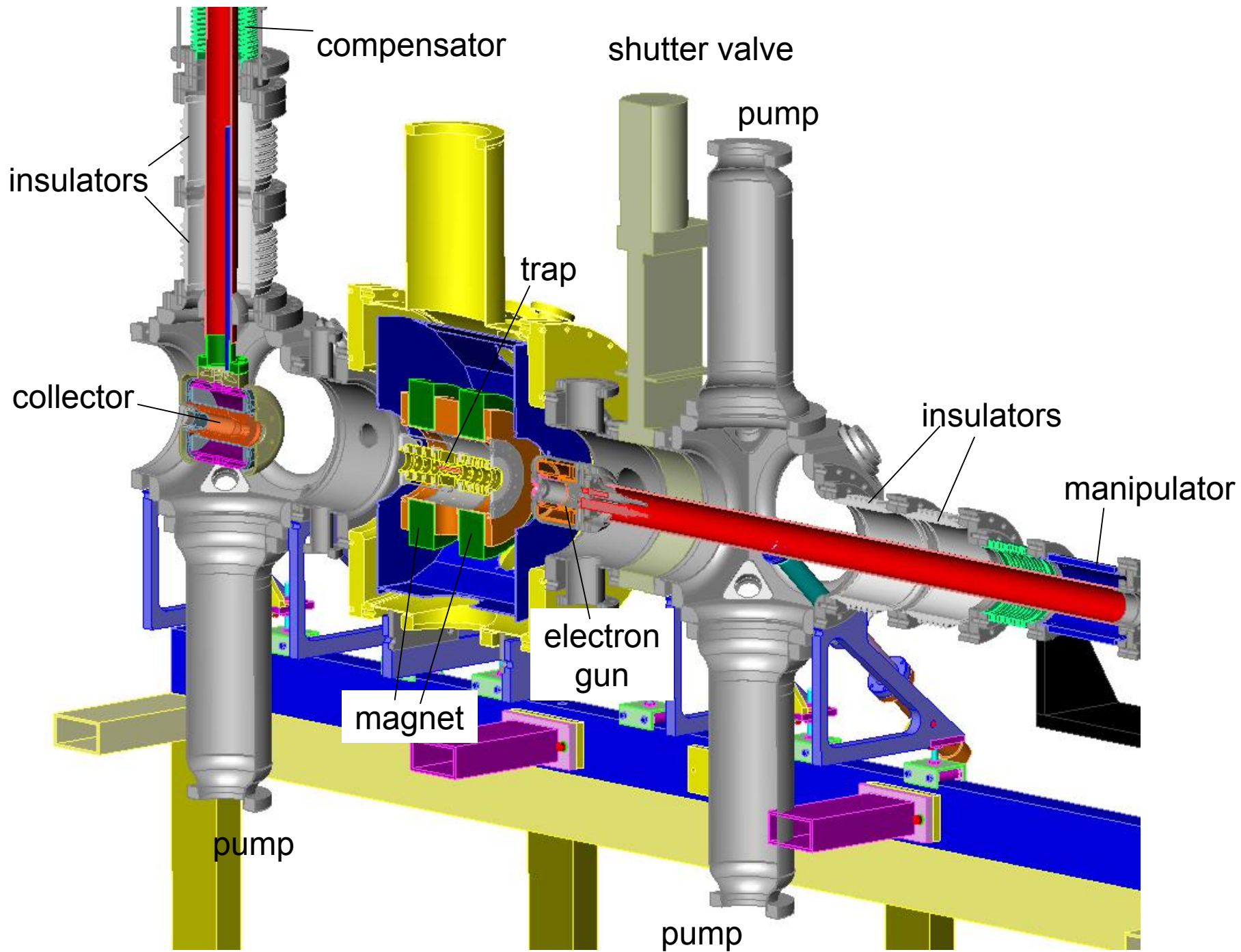
Extraction of ions in well-defined charge state

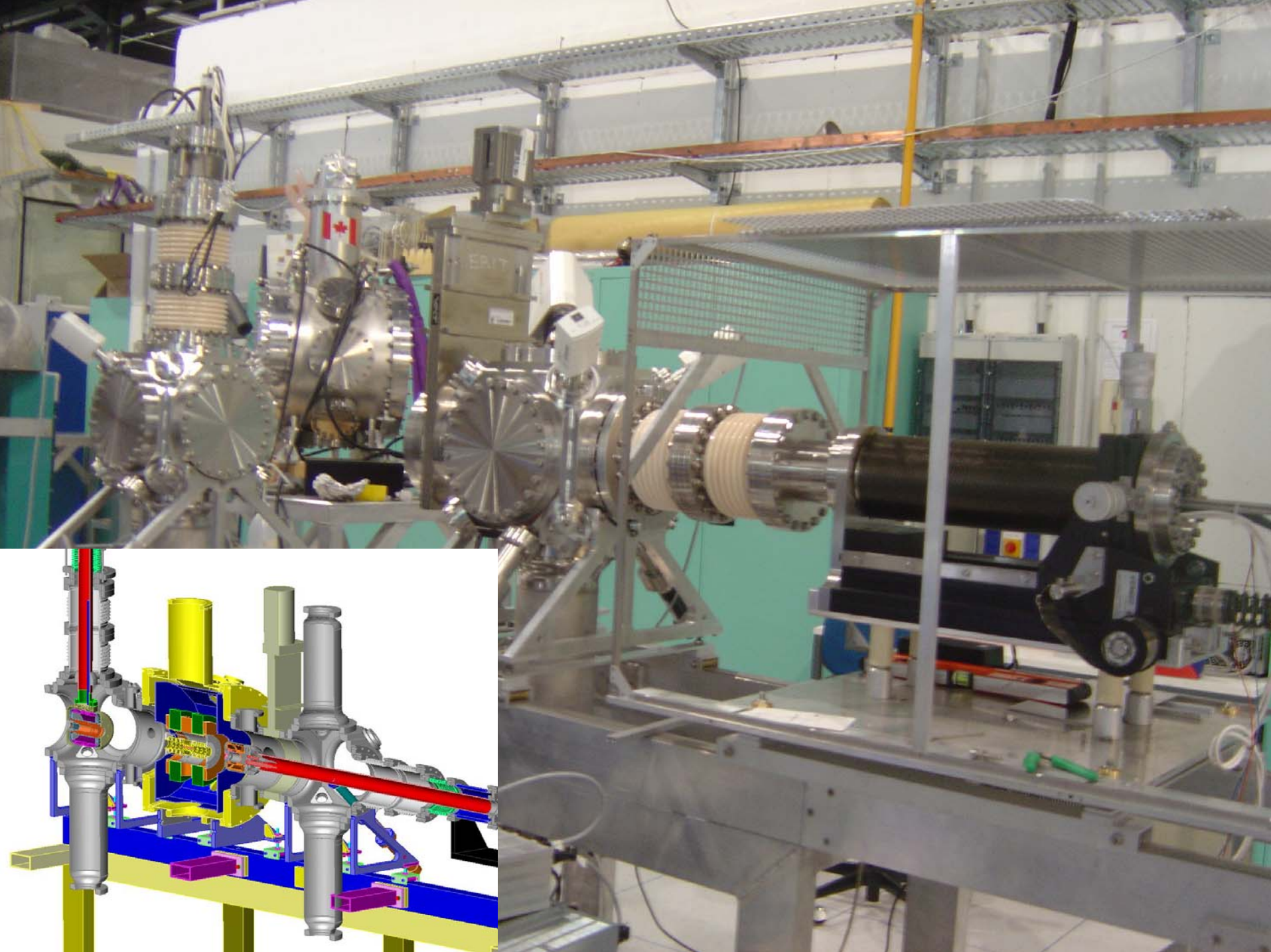
driving the cyclotron frequency of the desired species

extraction over an electrostatic barrier

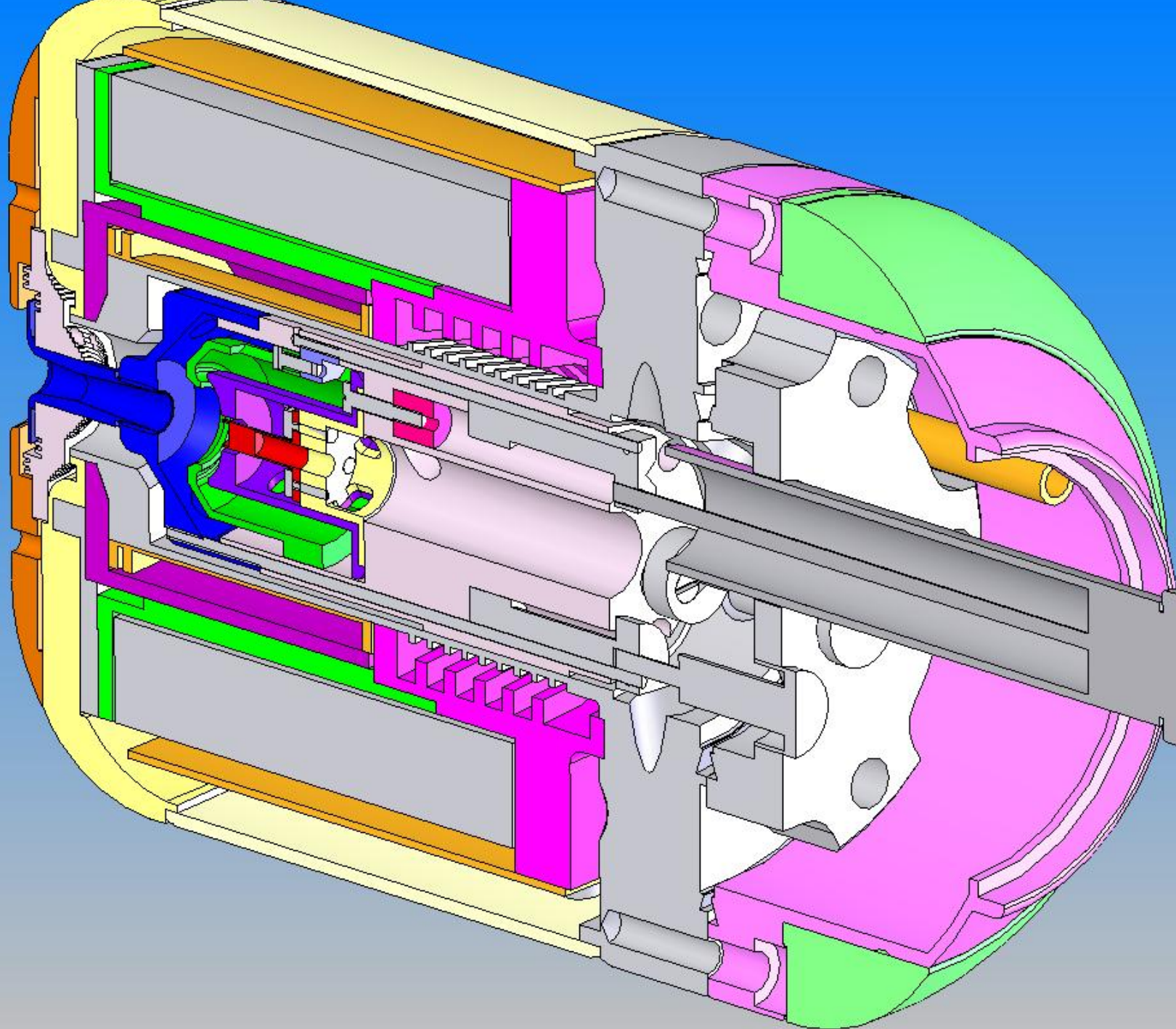
radially segmented central trap electrode

extraction\ injection path covered with electrodes

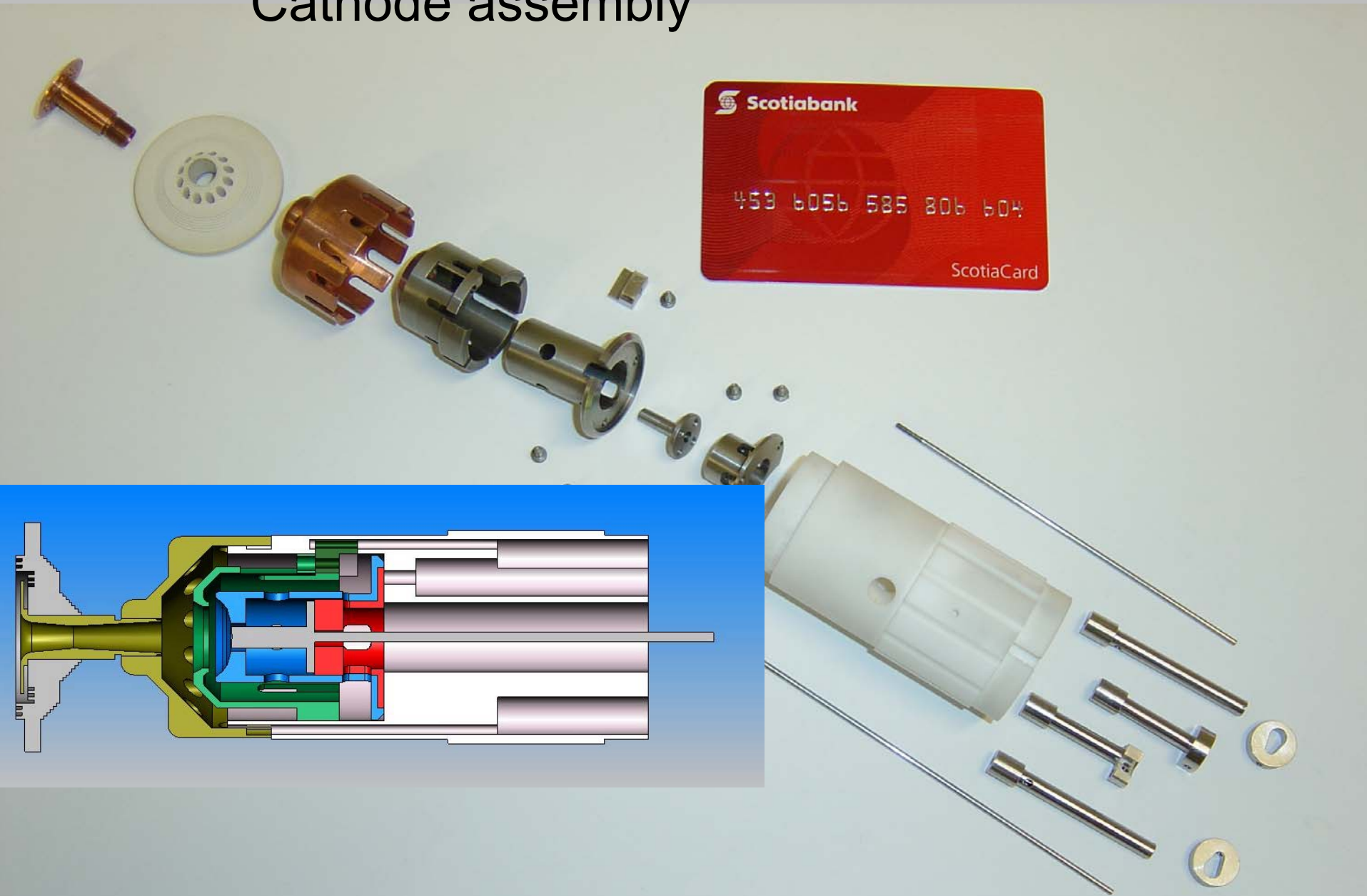


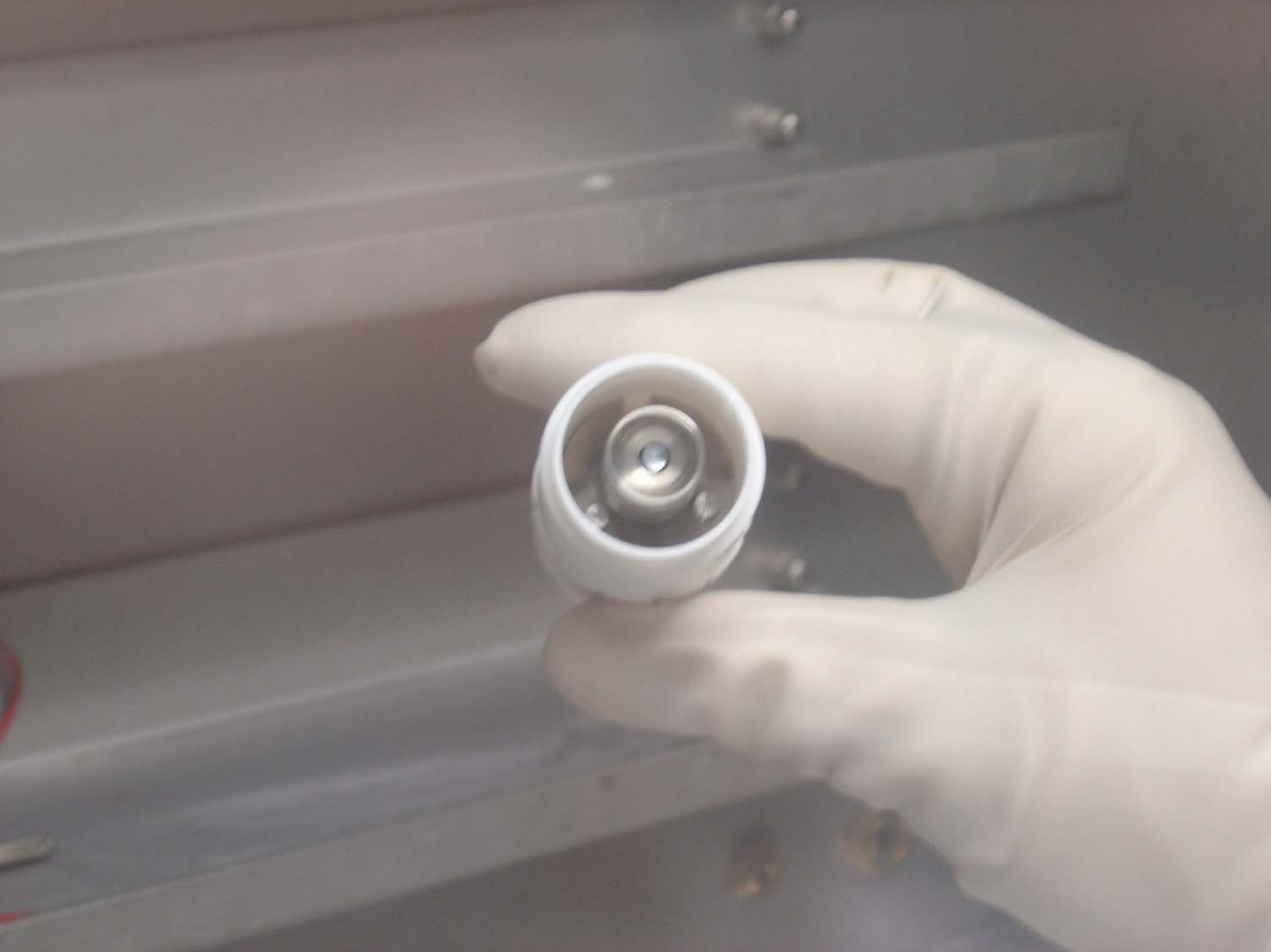


Electron Gun

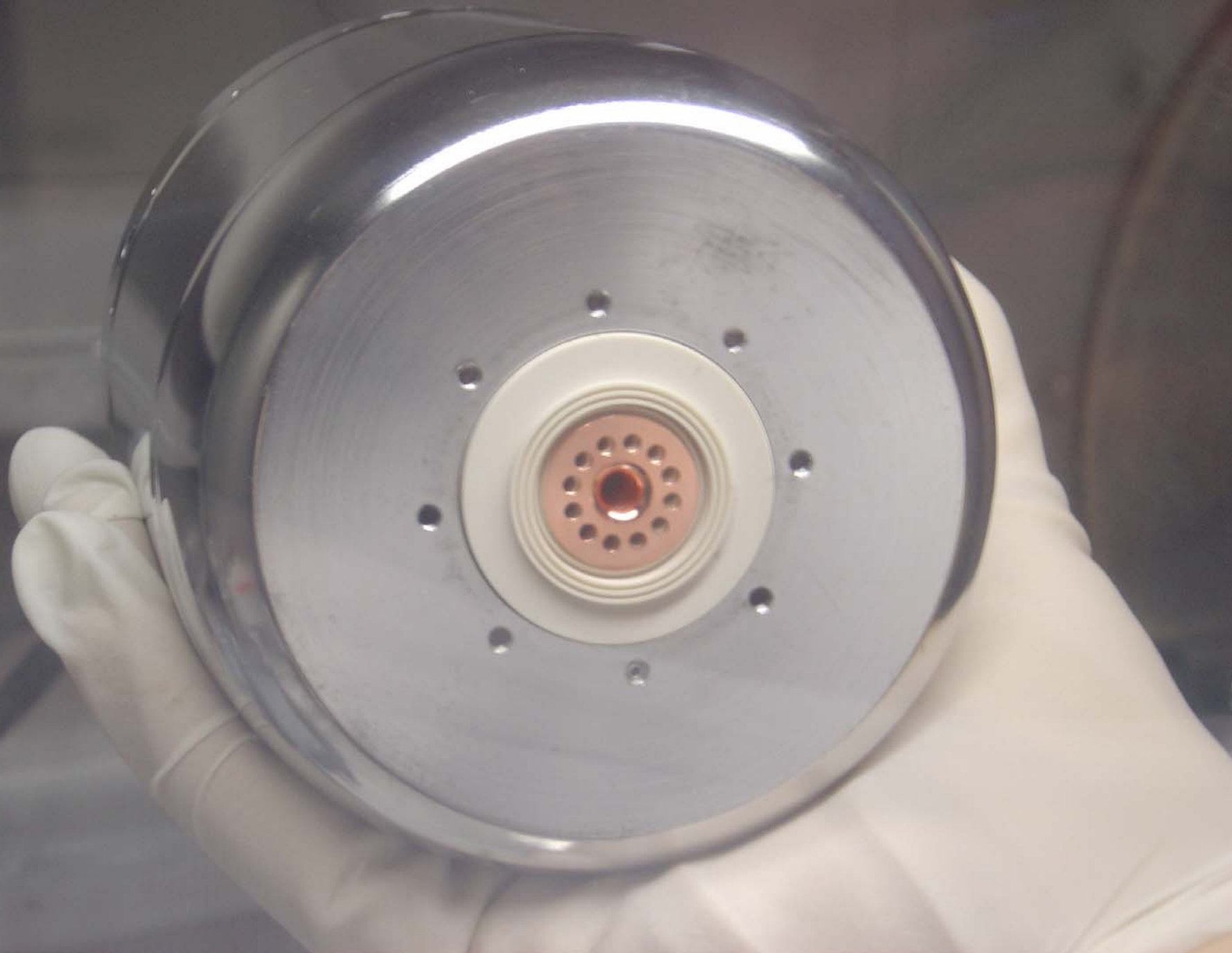


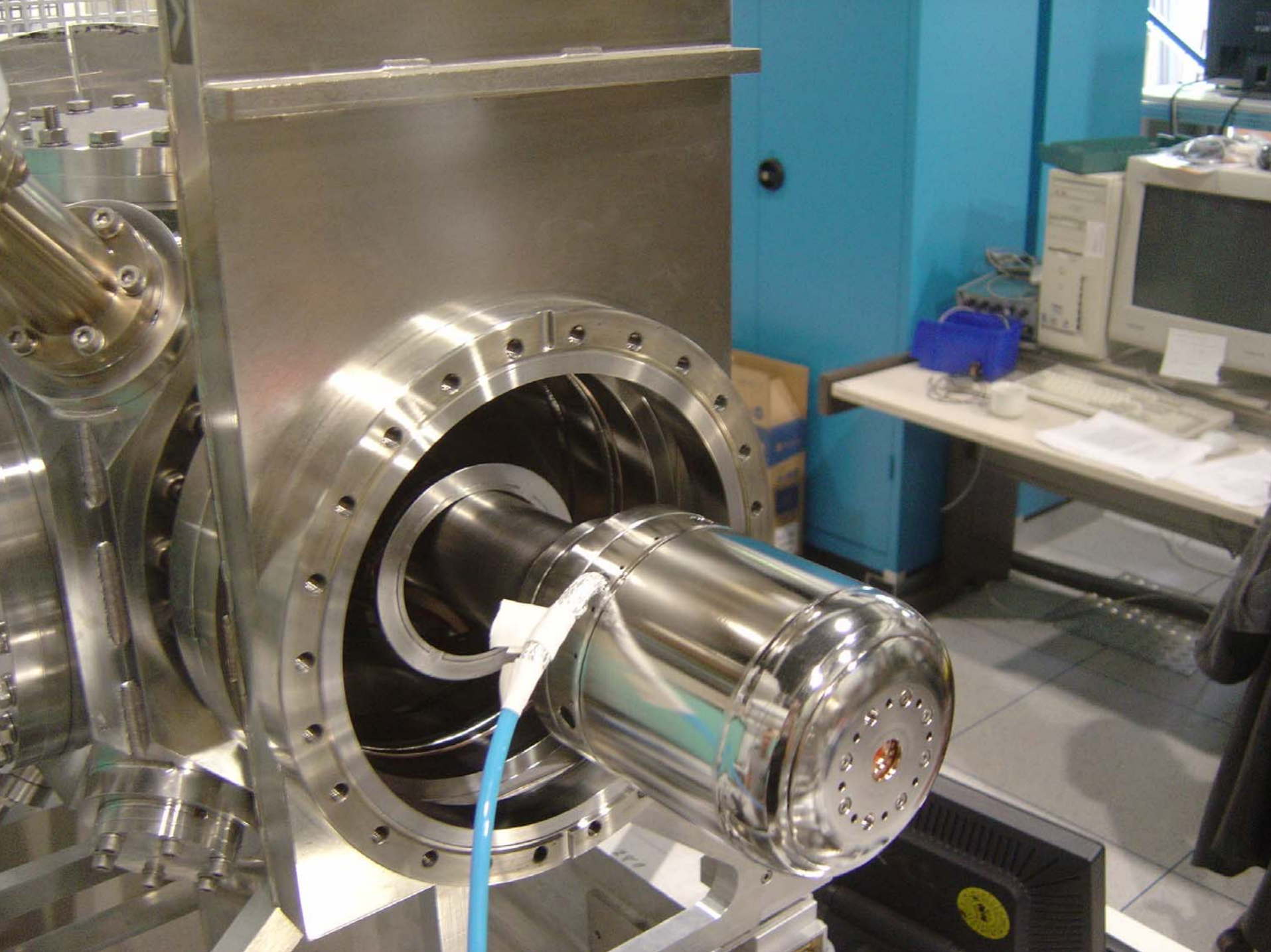
Cathode assembly



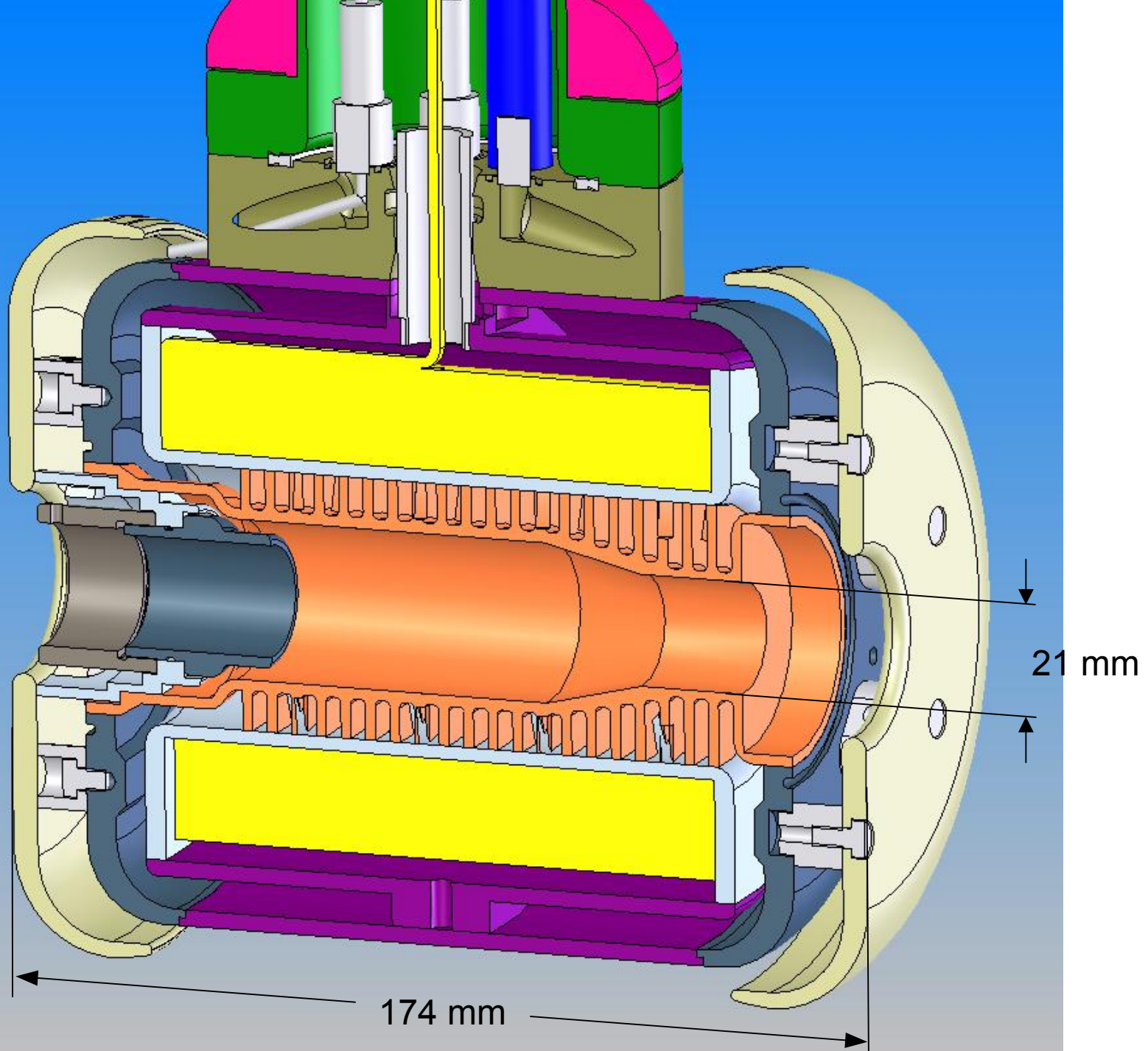


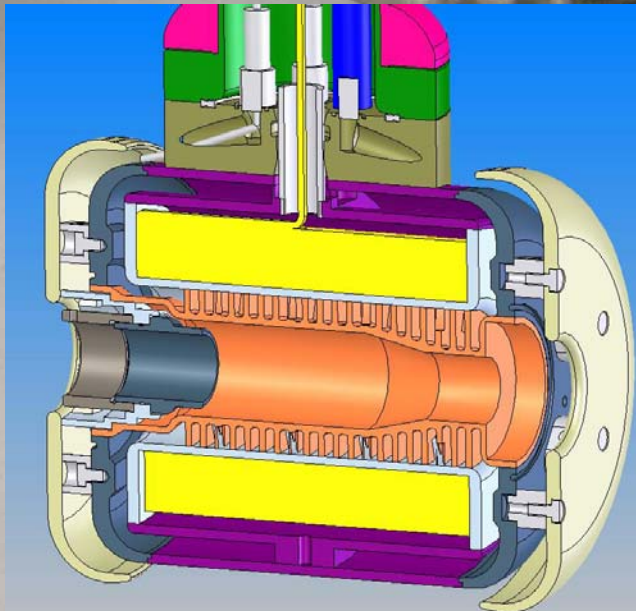
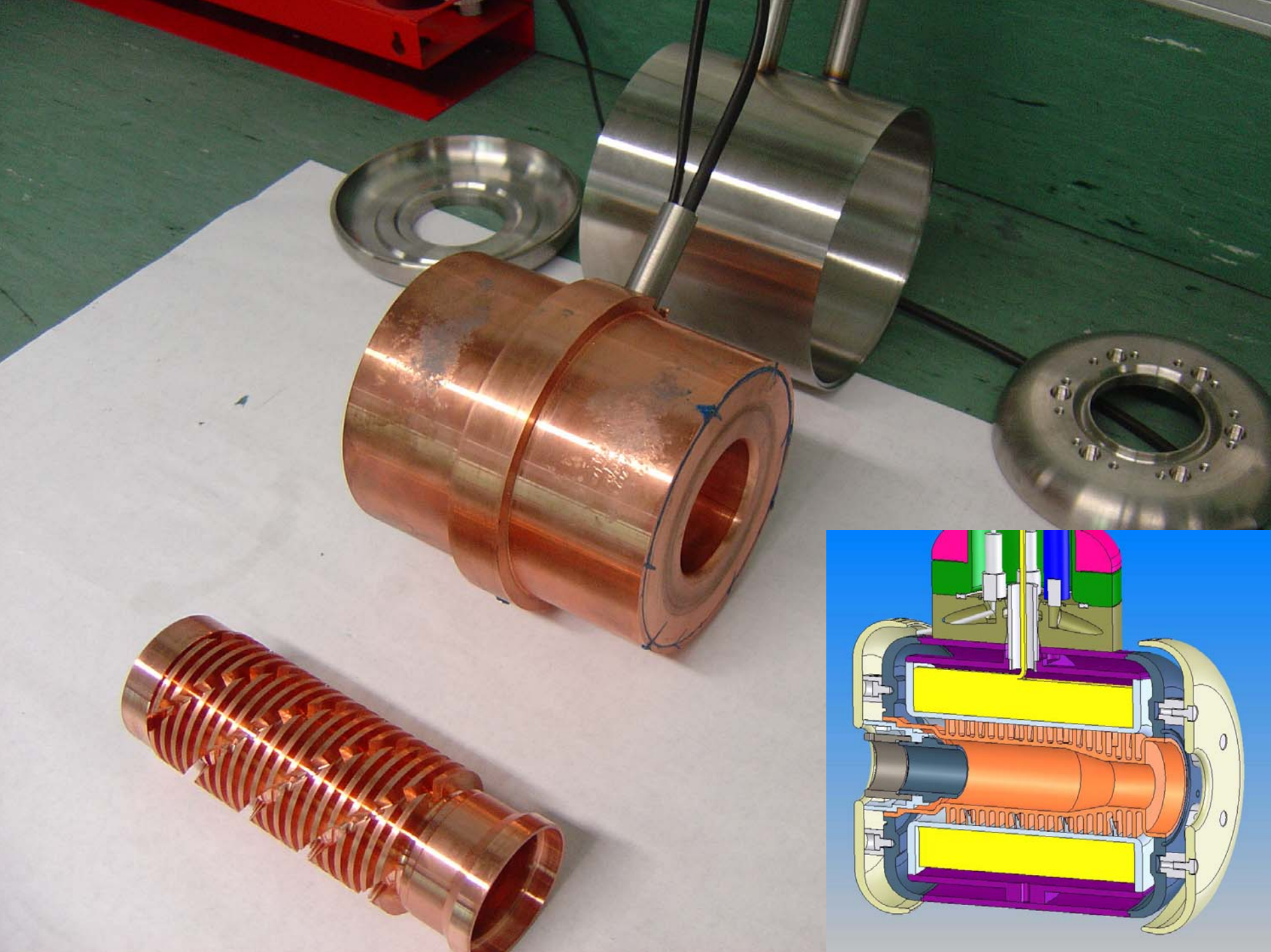


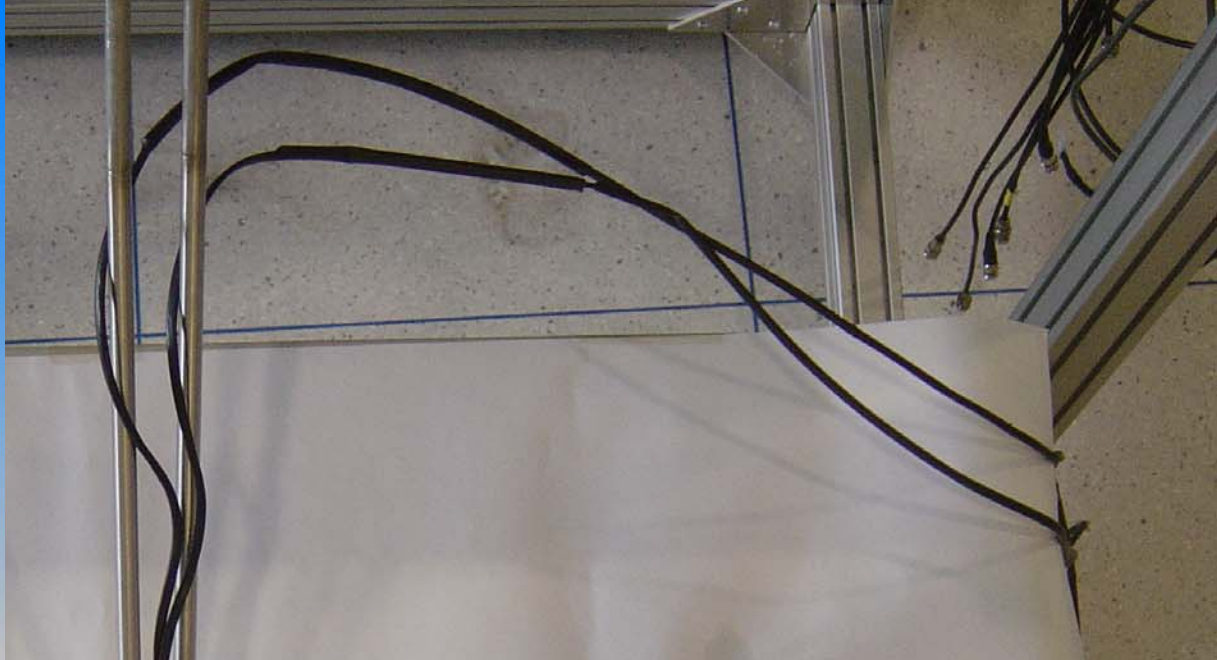
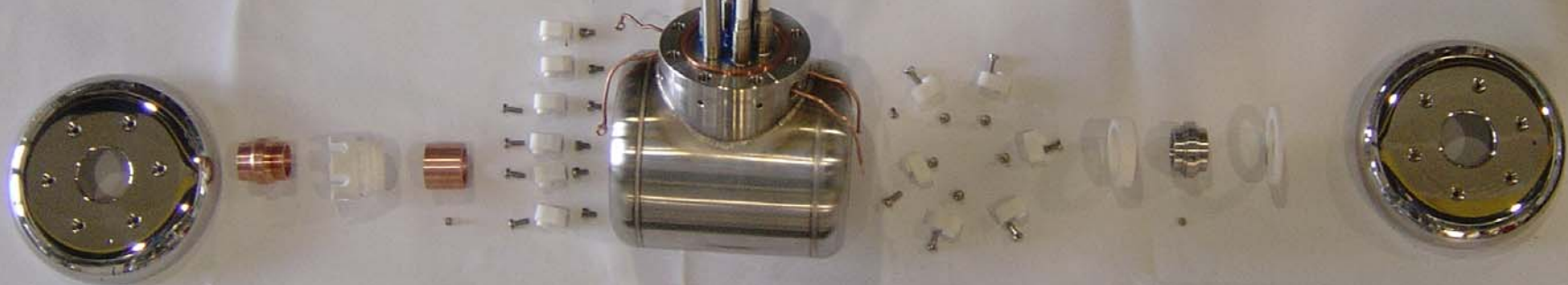
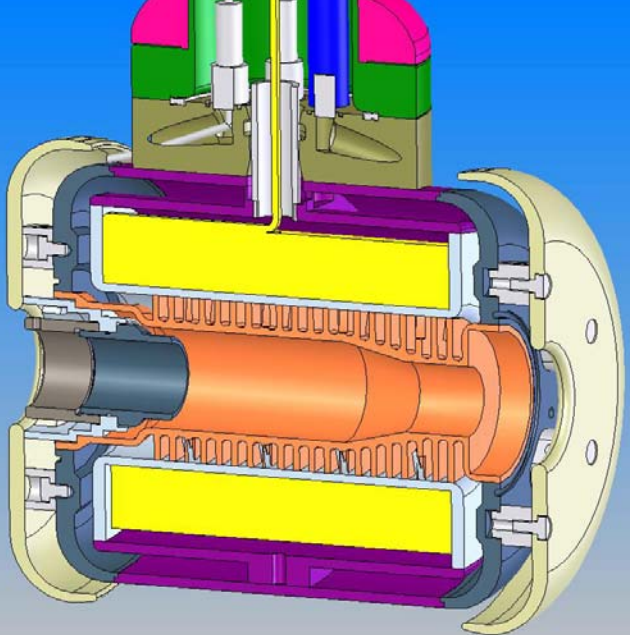


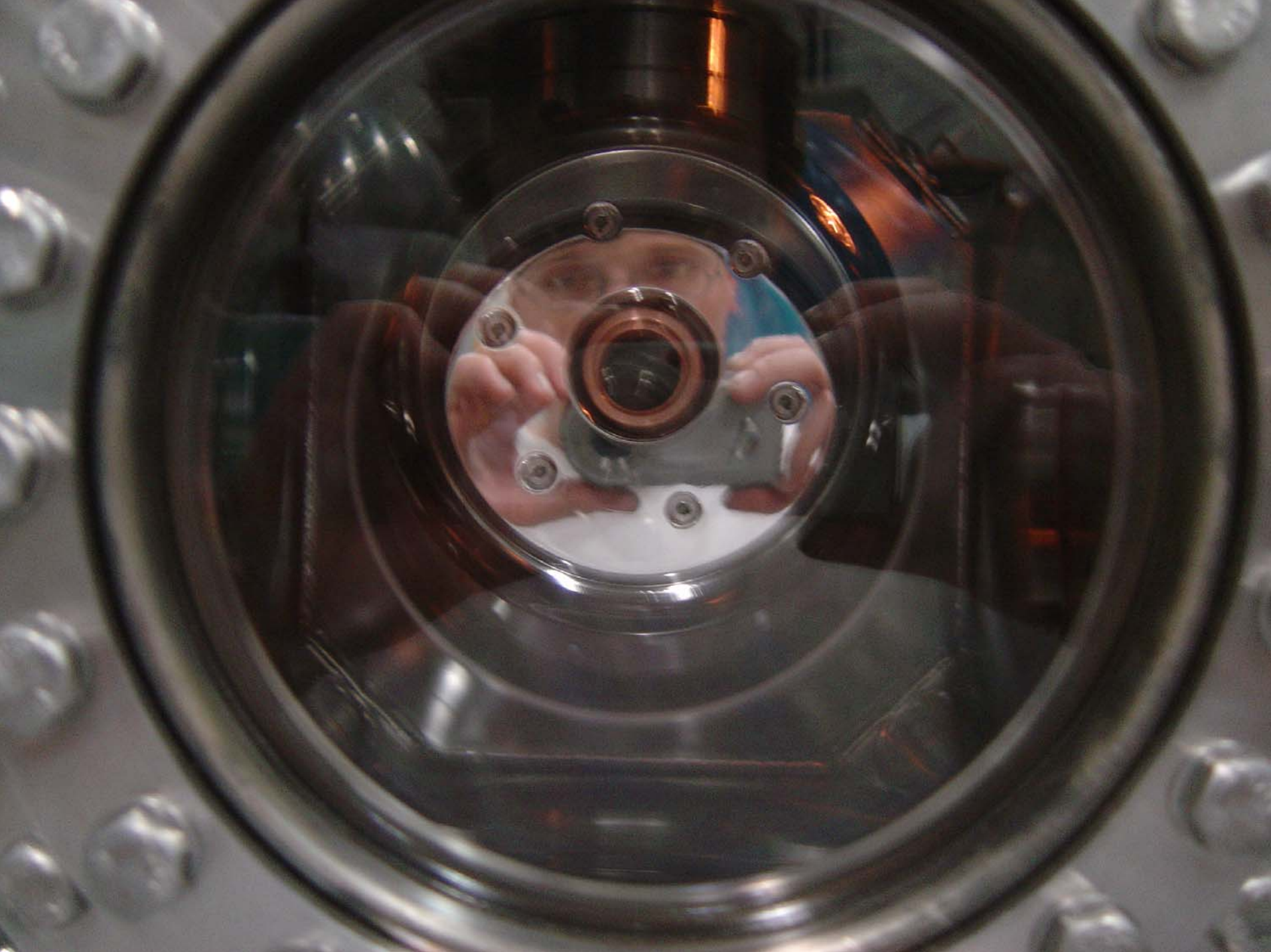


Collector

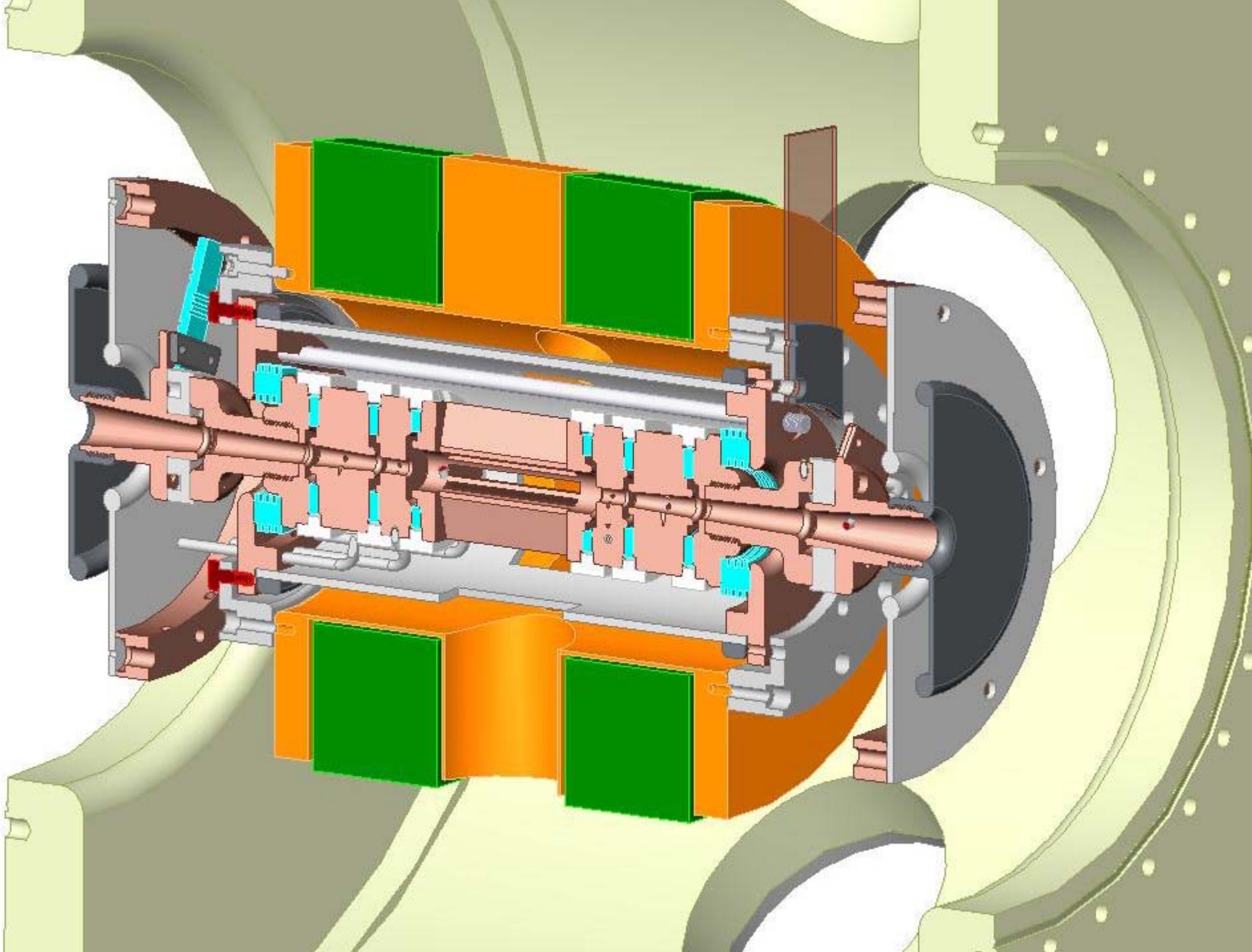






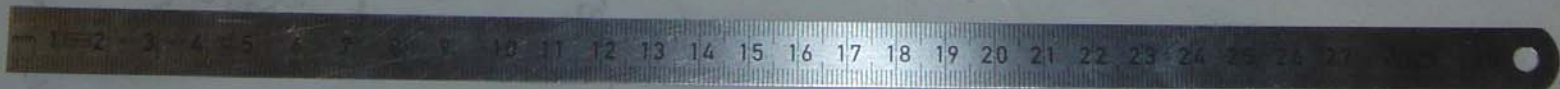


(provisional)
Trap



Handwritten signature or mark





Outlook:

- June '05: first electron beam ($I < 500\text{mA}$, $E < 2\text{keV}$)
first extraction of ions (injected as neutrals)
- July '05: advanced tests of injection/extraction optics
first injection of ions (from test ion source)
- Sept. '05: final trap setup ready for operation
last installations (electric, cooling..) complete
creeping out of the valley of tears
- q/m selection, pos. sensitive detector,
emittance meter, TOF-detection, etc...
in operation

Measurement Program:

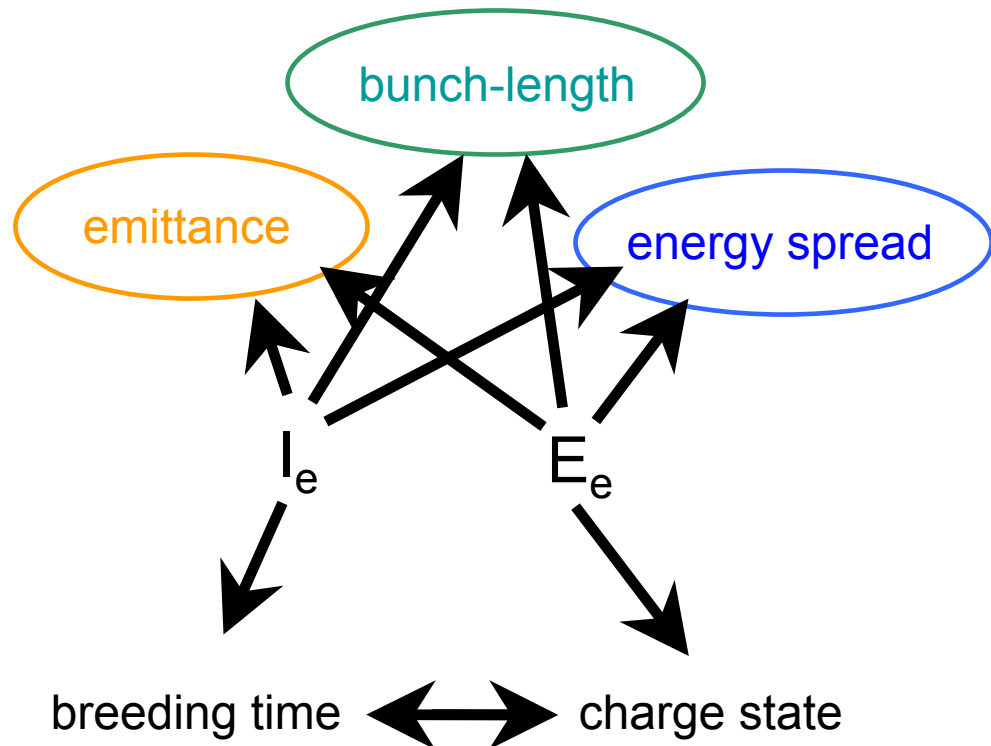
optimize electron beam

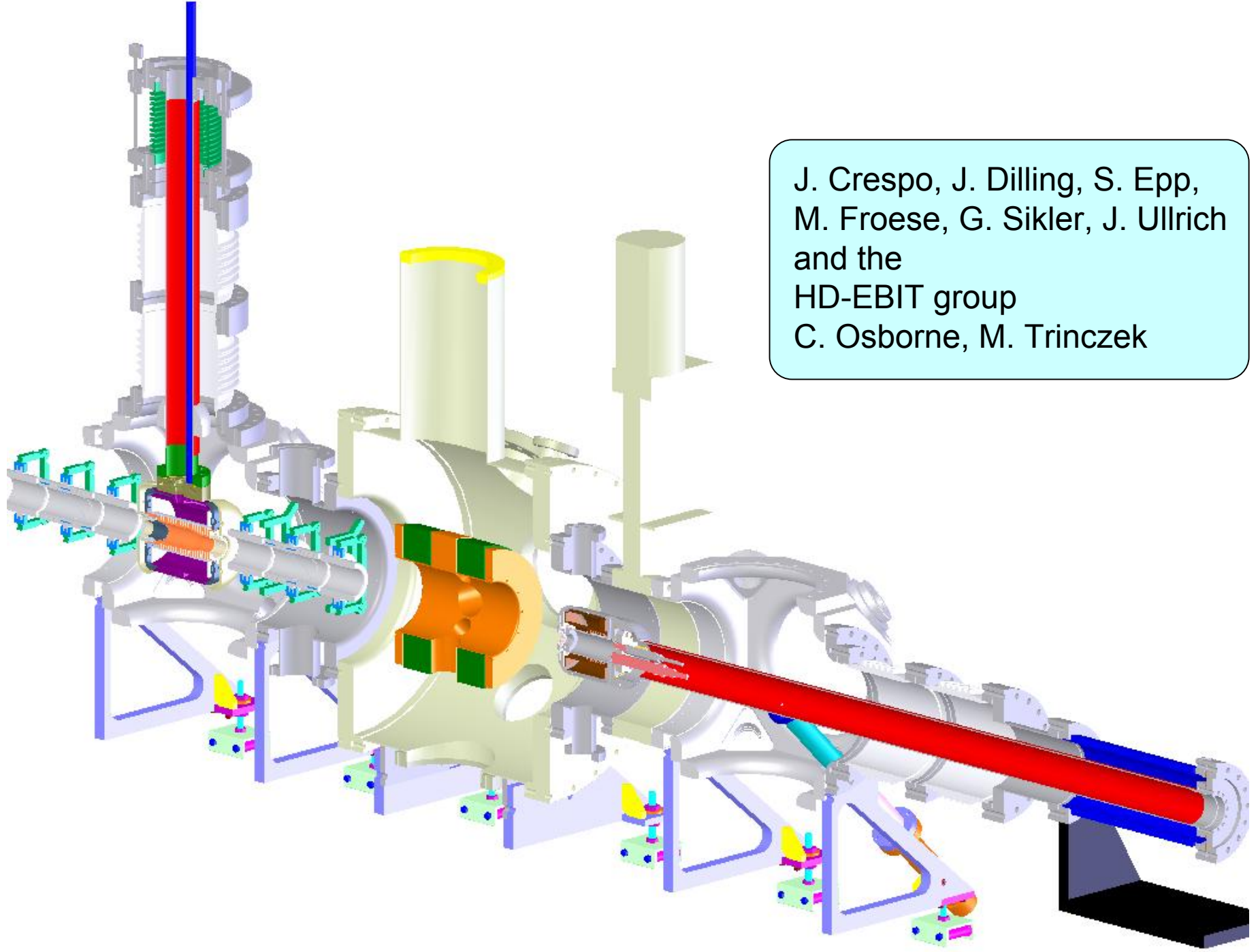
↗ current, ↘ energy spread

optimize injection and stopping

investigate cooling by admixture of 'light' gas
charge selective extraction

check characteristics:





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