

A GAS STOPPING STATION FOR IRIS

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Input from J. Dvorak and A. Yakushev

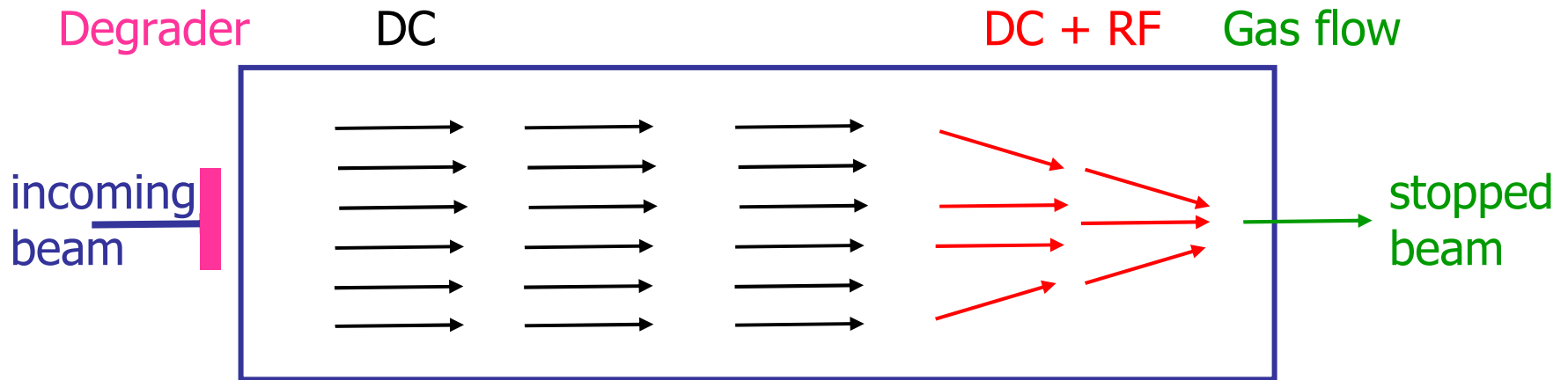
Outline

- Some requirements
- Established gas stopping concepts
- Some basics
- Stopping cells and Recoil Transfer Chambers
- Some Conclusions

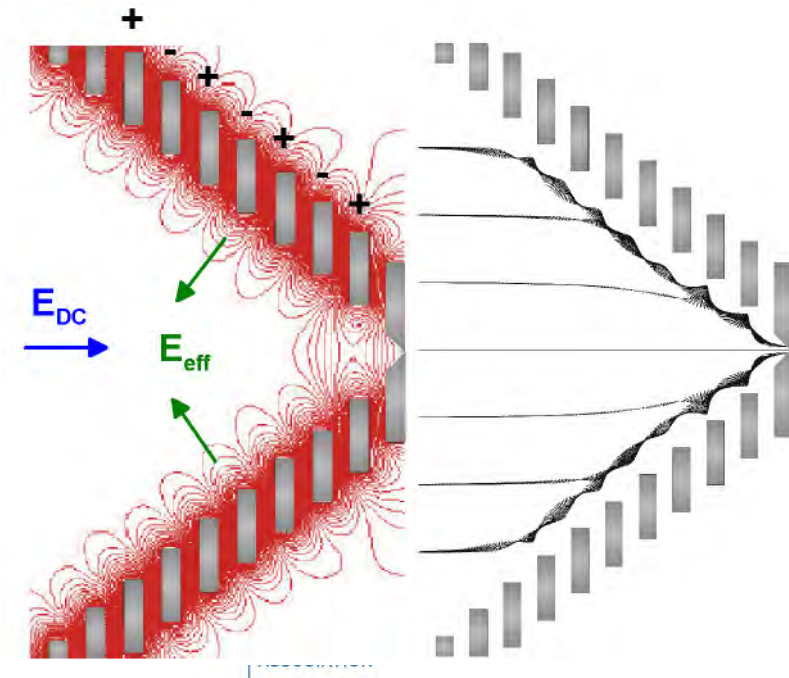
Some Requirements and Challenges

- broad energy distribution of transfer reaction products
- high overall efficiency
- high cleanliness
- (rather) fast extraction times
- interface for chemistry
- high rate capability
- no primary beam

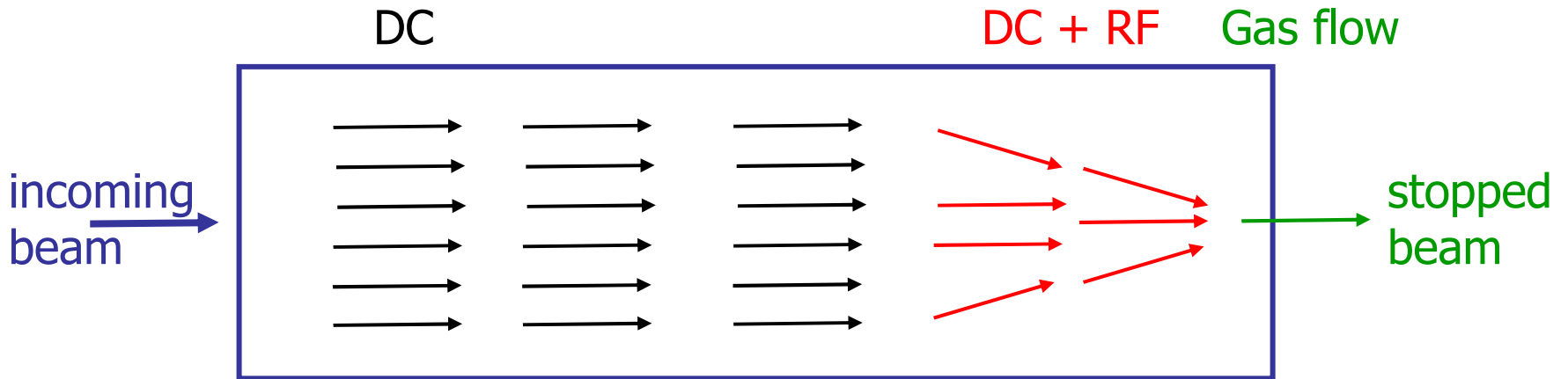
Schematic of Gas Stopper



- stopping in high-purity He or Ar gas
- DC drag field for fast extraction
- RF funnel for efficient transport
- extraction through nozzle

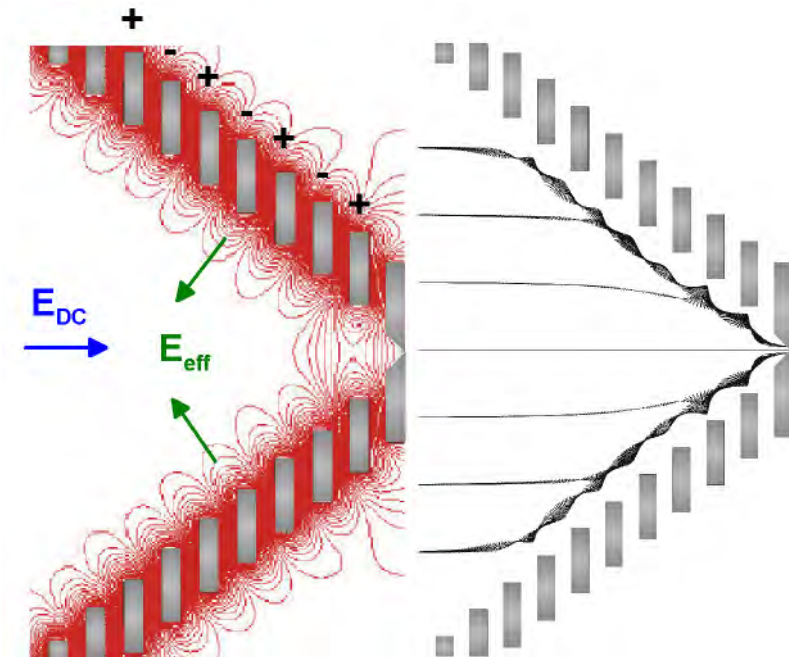


Schematic of Gas Stopper



$$\bar{F}_{\text{avg}} = m\mu^2 \frac{V_{\text{rf}}^2}{r_o^3}$$

$$\mu = \mu_o \frac{1}{\rho}$$



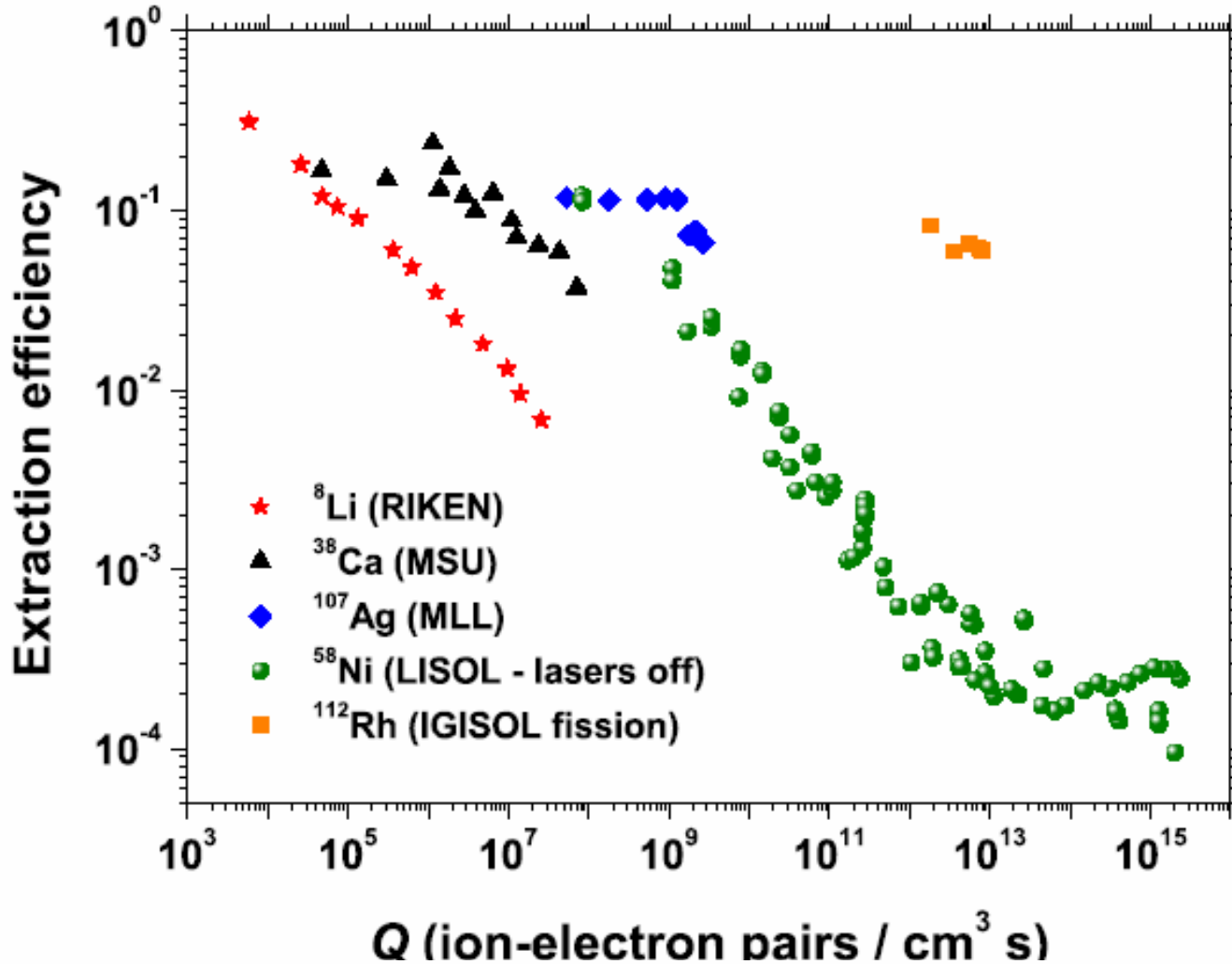
Gas Stopping Cells

- high cleanliness (UHV compatible)
- stop beams as 1+ or 2+ atomic ions
- fast extraction (few ms) by electric fields
- RF funnel / carpet / wall to avoid losses at walls/nozzle region
- extract beam through nozzle
- connection to RFQ ion beam cooler
- provide high quality low energy beams
- established for fusion reactions and fast beam fragmentation
(ANL, GSI, MSU, RIKEN, JYFL, Leuven, ...)

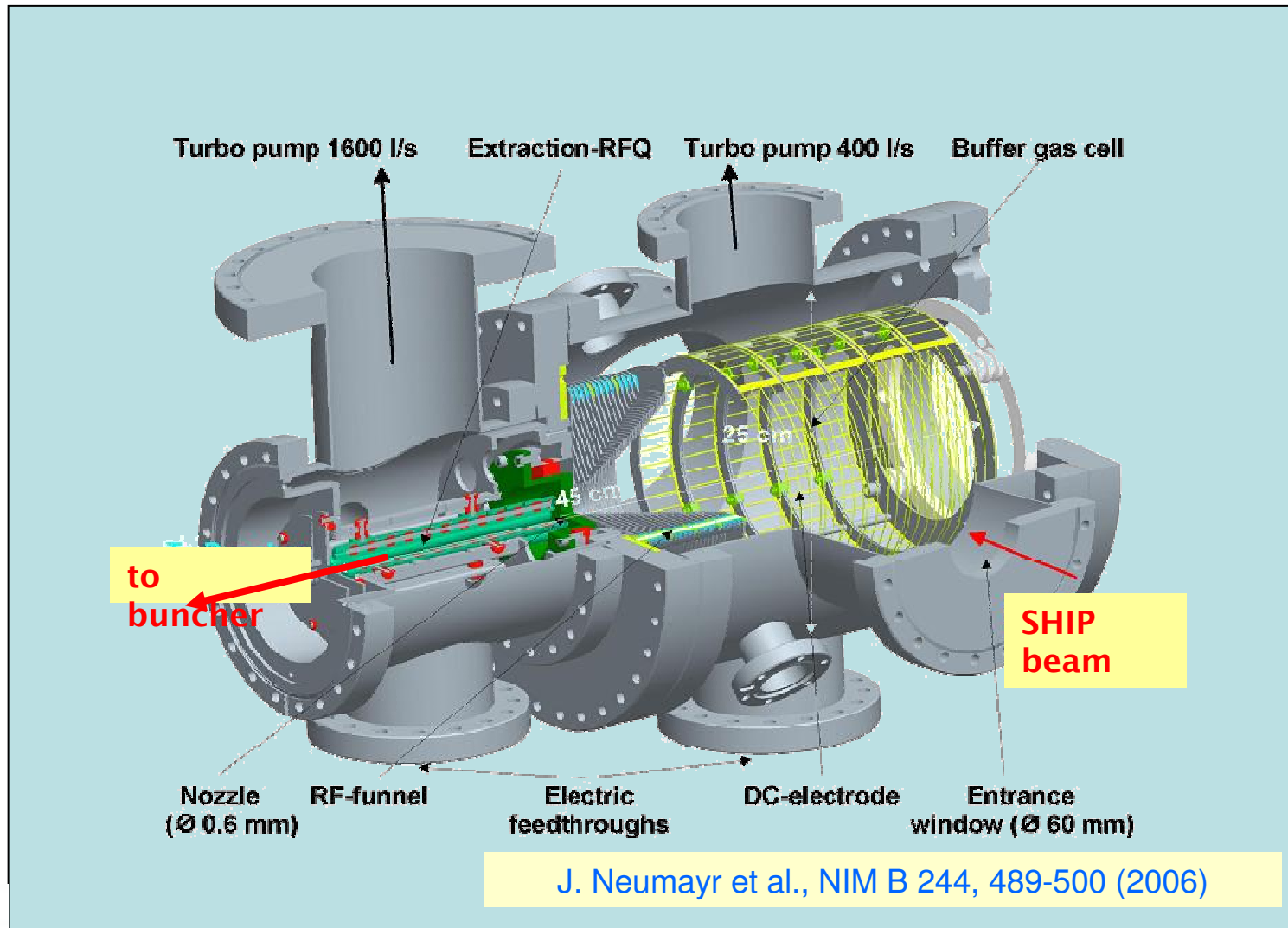
Some Issues

- high cleanliness (UHV compatible)
- formation of molecular sidebands for ions of interest
- stop beams as 1+ or 2+ atomic ions
- fast extraction (few ms) by electric fields
- RF funnel / carpet: up to about 200 mbar
- rate limitations due to space charge effects
- about 10^6 electron ion pairs for 100 MeV beam

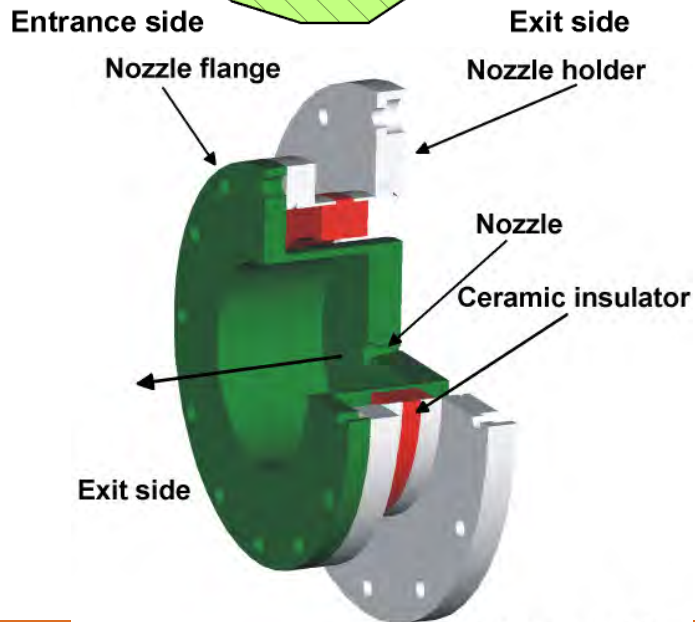
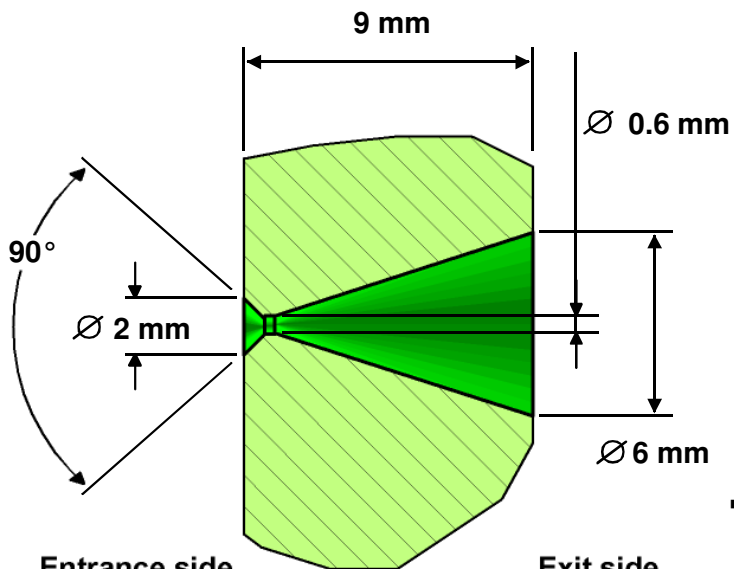
Some Issues



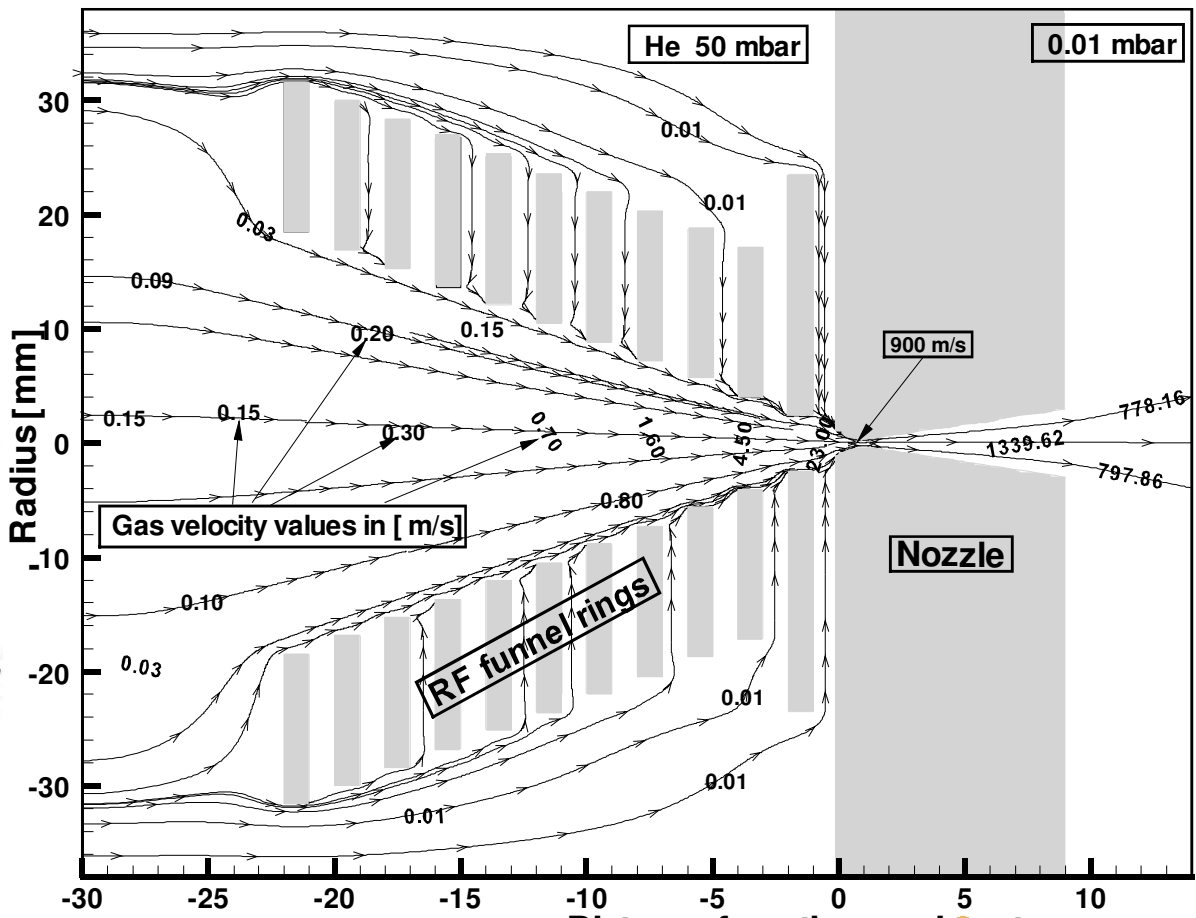
The SHIPTRAP Gas Cell



SHIPTRAP Extraction nozzle

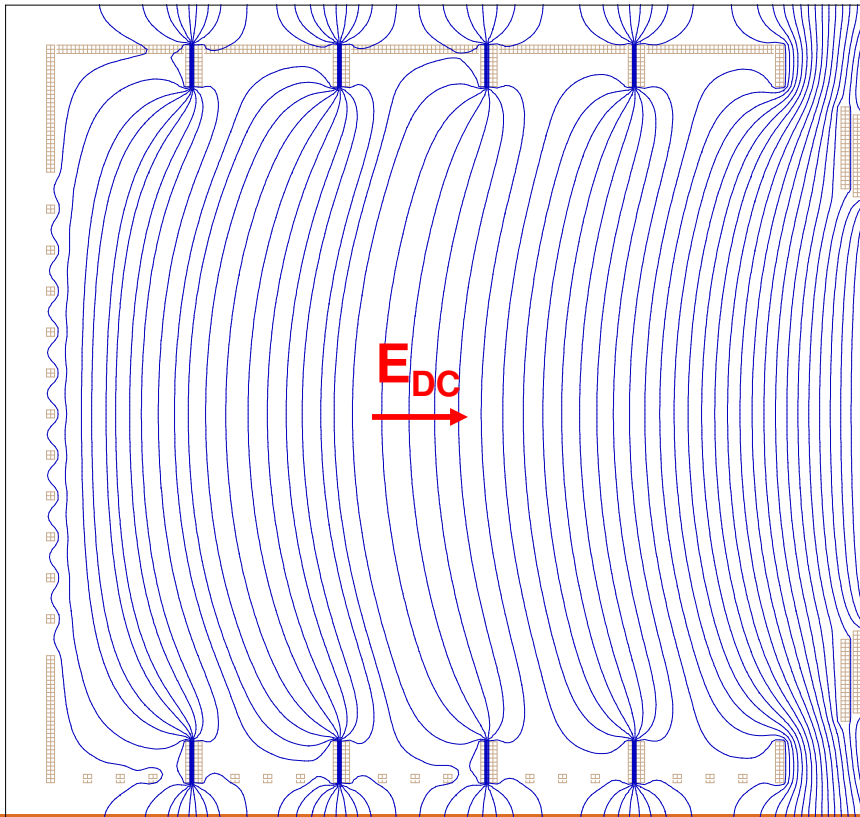


VARJET gas-dynamical simulations V. Varentsov



SHIPTRAP DC electrode cage

- 100 – 350 V DC (4 – 15 V/cm)
- \varnothing 18 cm x 18 cm



SHIPTRAP Setup

≈ 50 MeV



≈ 1 eV

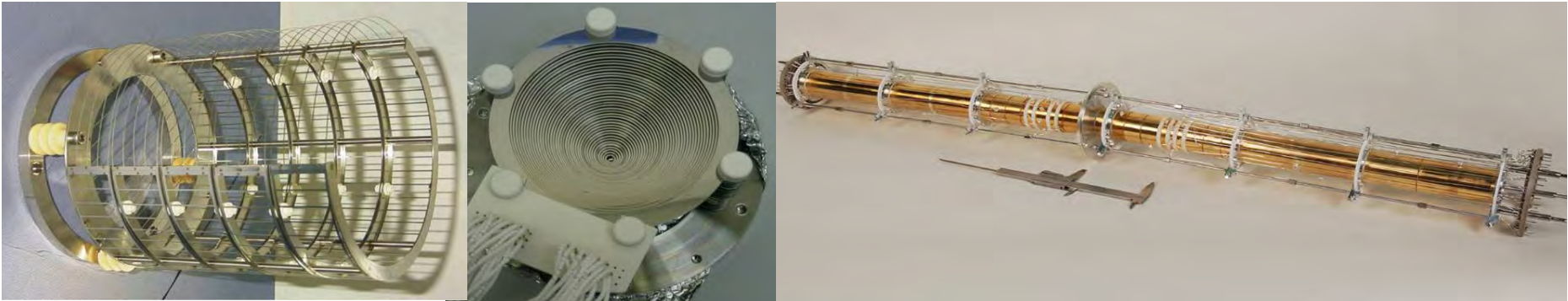
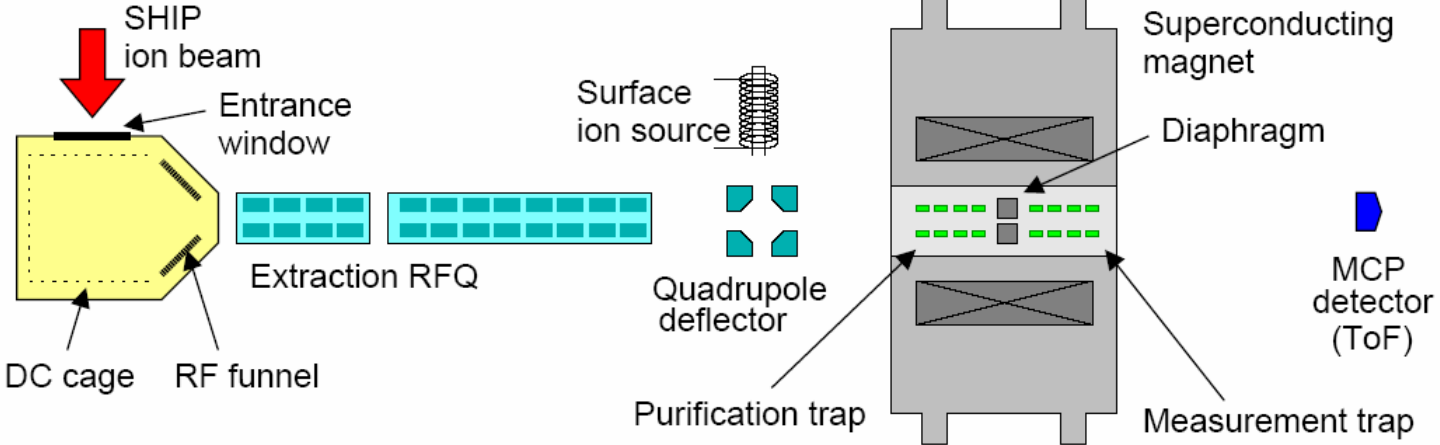
Gas Cell

Buncher

Transfer

Penning Traps

Detector



SHIPTRAP Setup

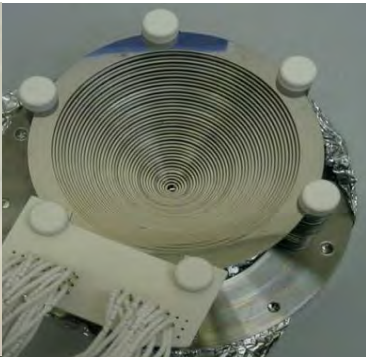
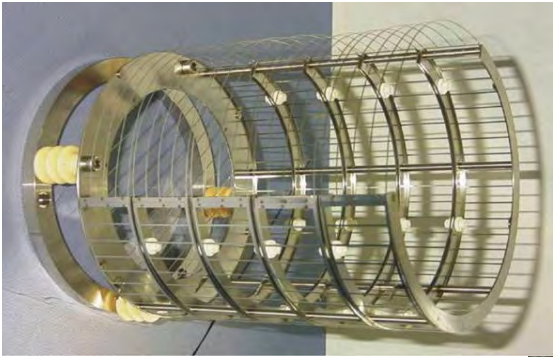
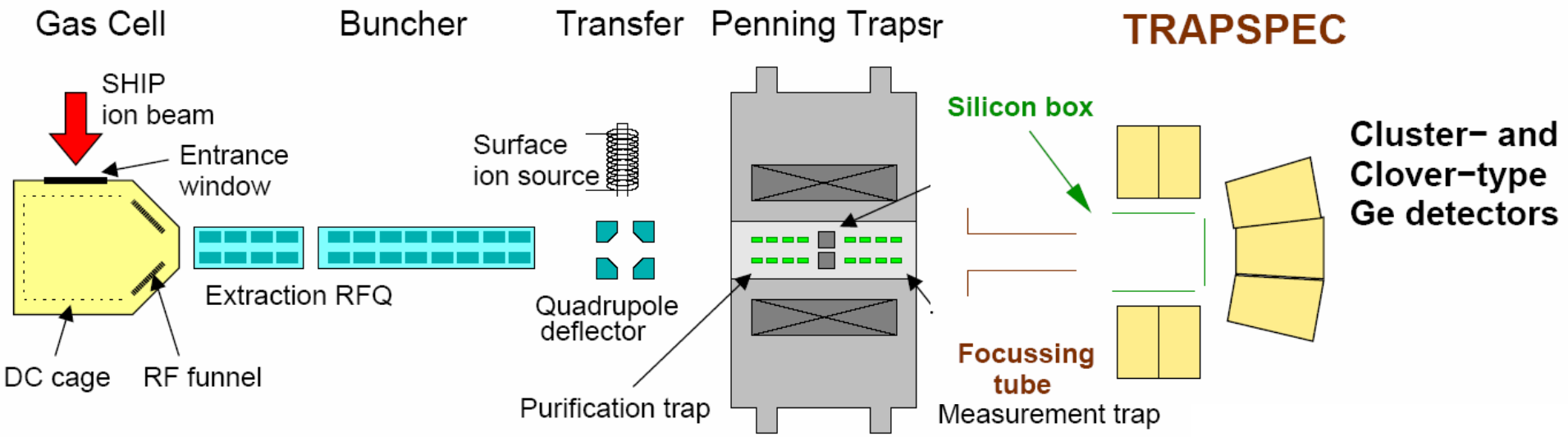
$\approx 50 \text{ MeV}$



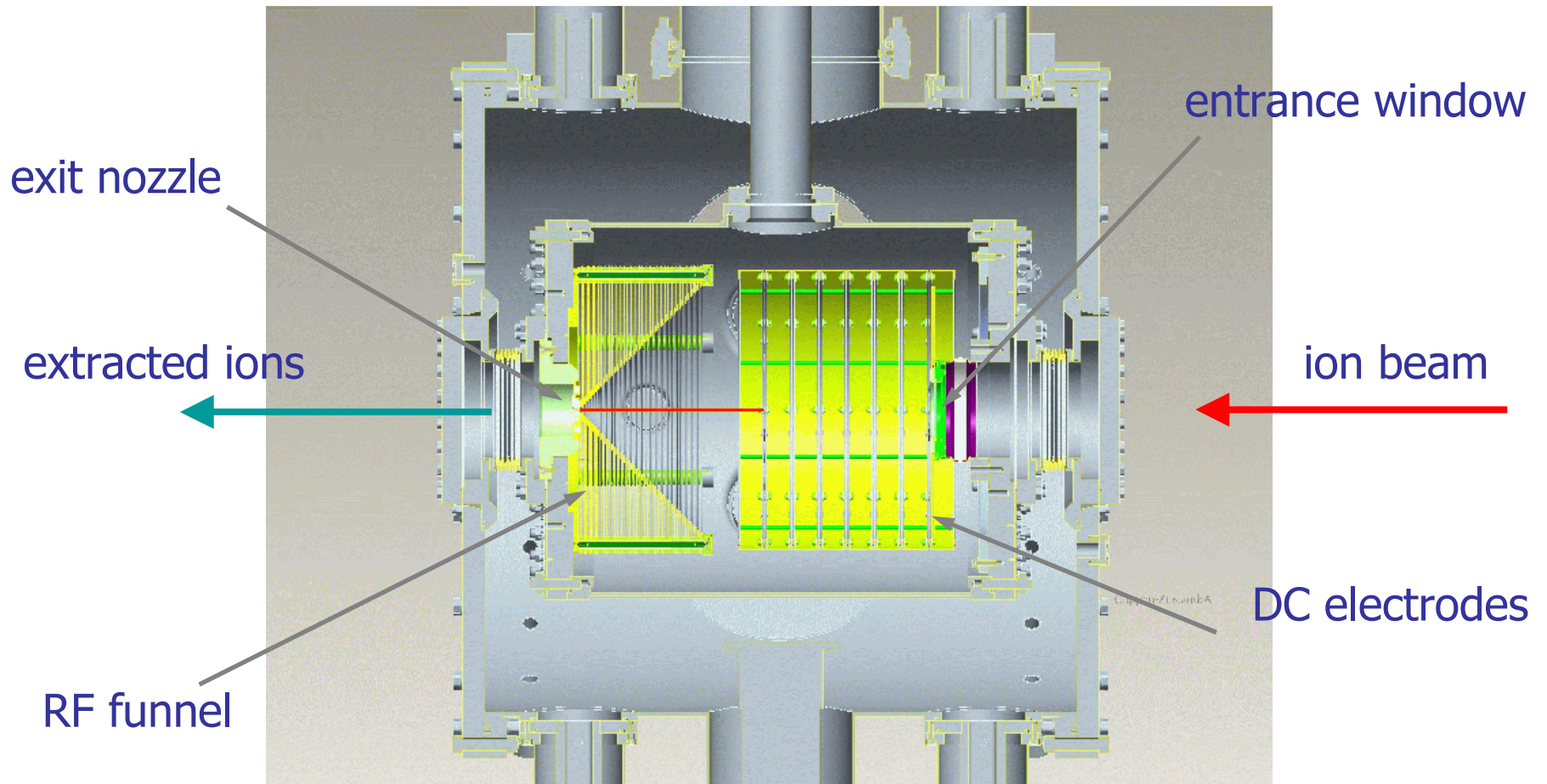
$\approx 1 \text{ eV}$



$\approx 1 \text{ keV}$

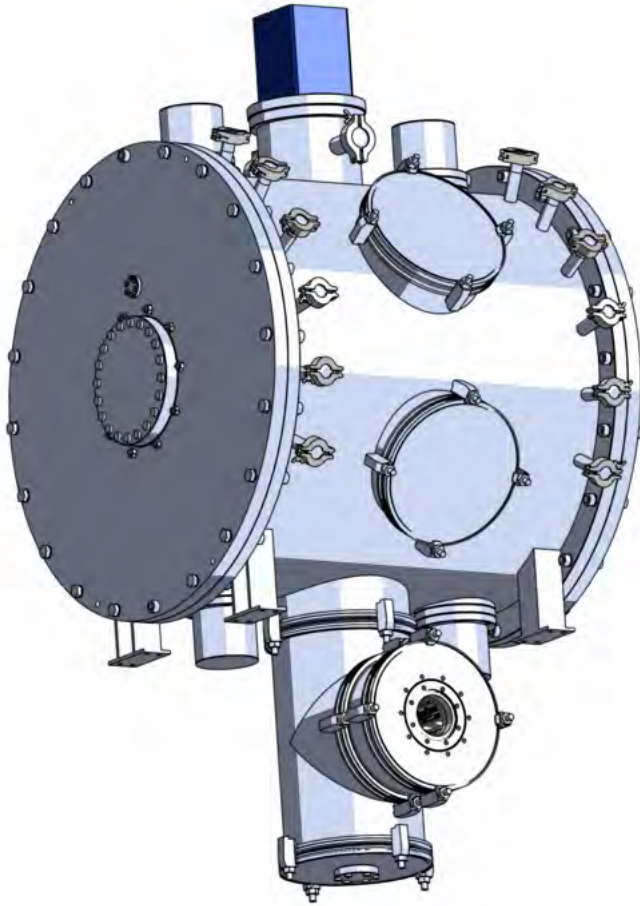


Conceptual design of a cryogenic gas stopper

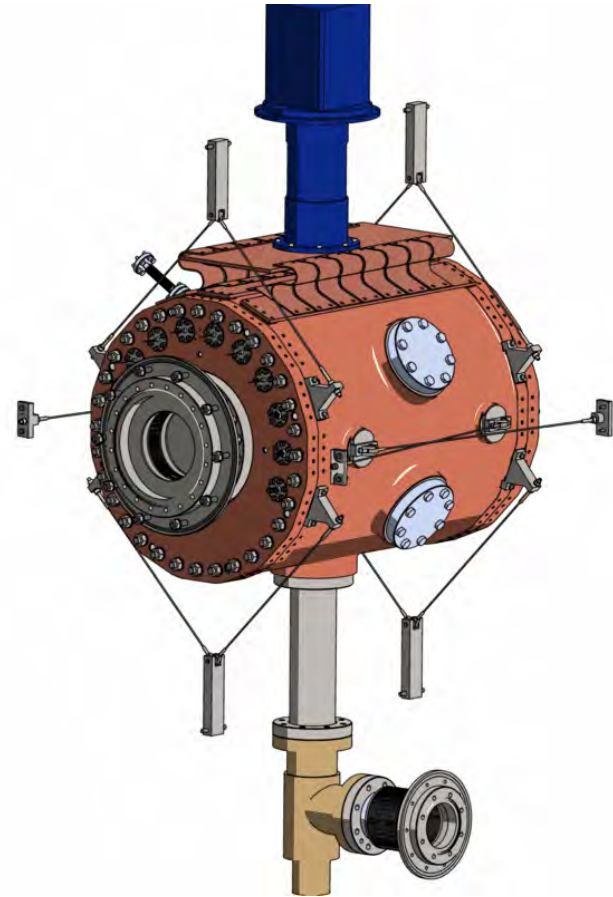


SHIPTRAP Cryogenic Gas Cell

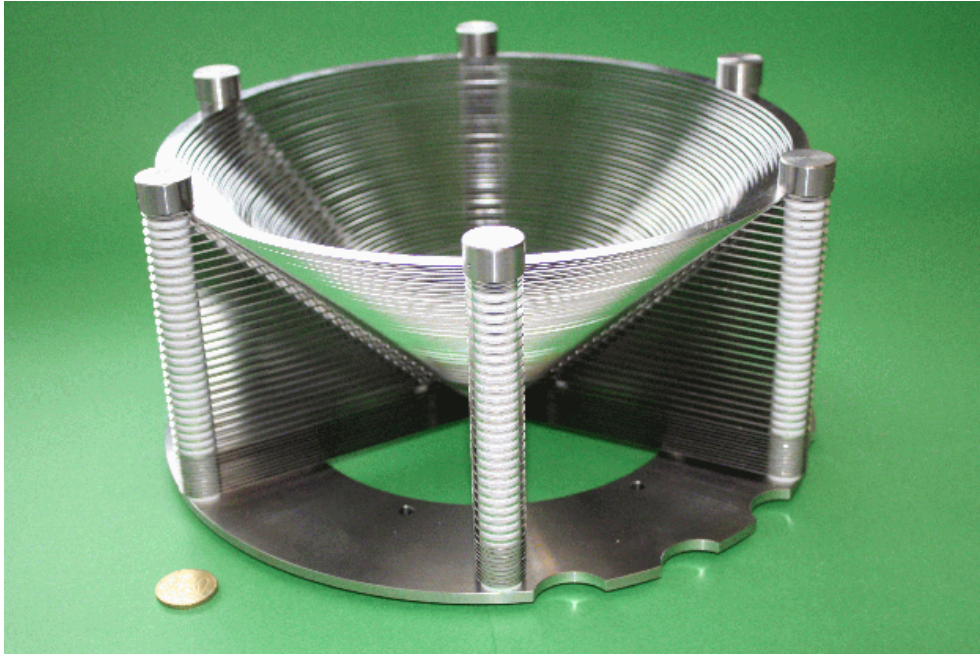
Outside



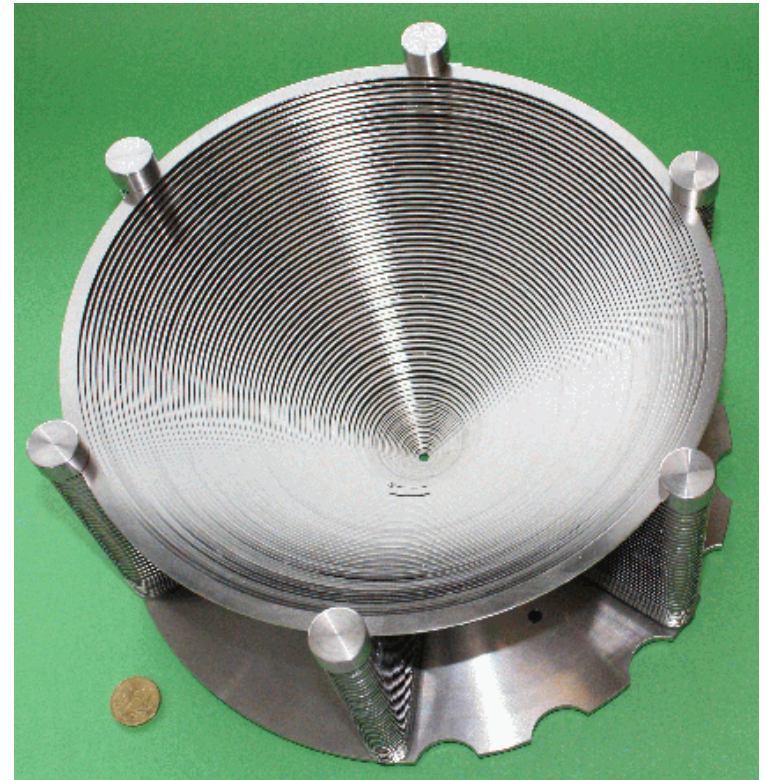
Inside



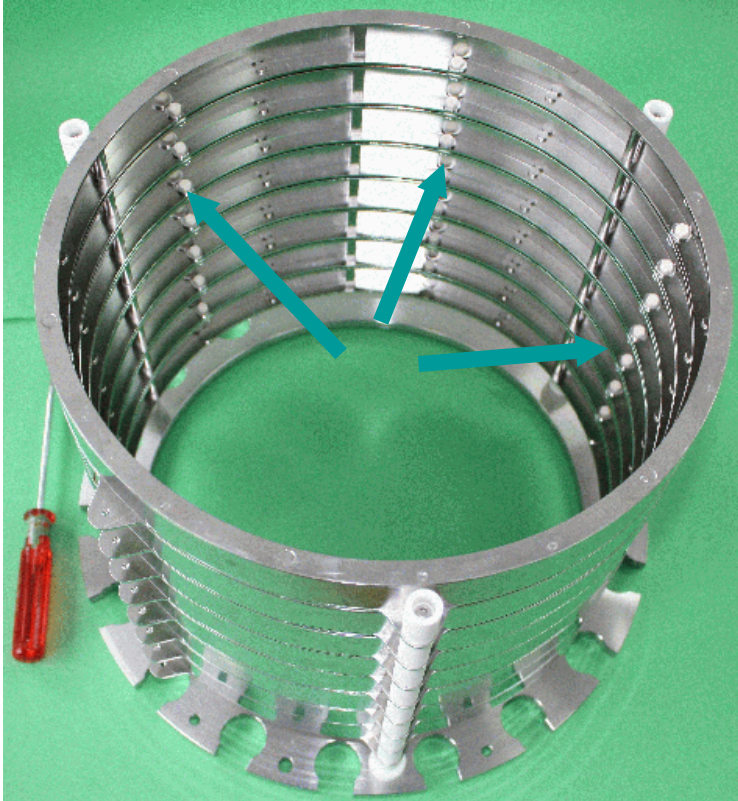
RF Funnel



electrodes: laser-cut
 electropolished
insulator: VITRONIT

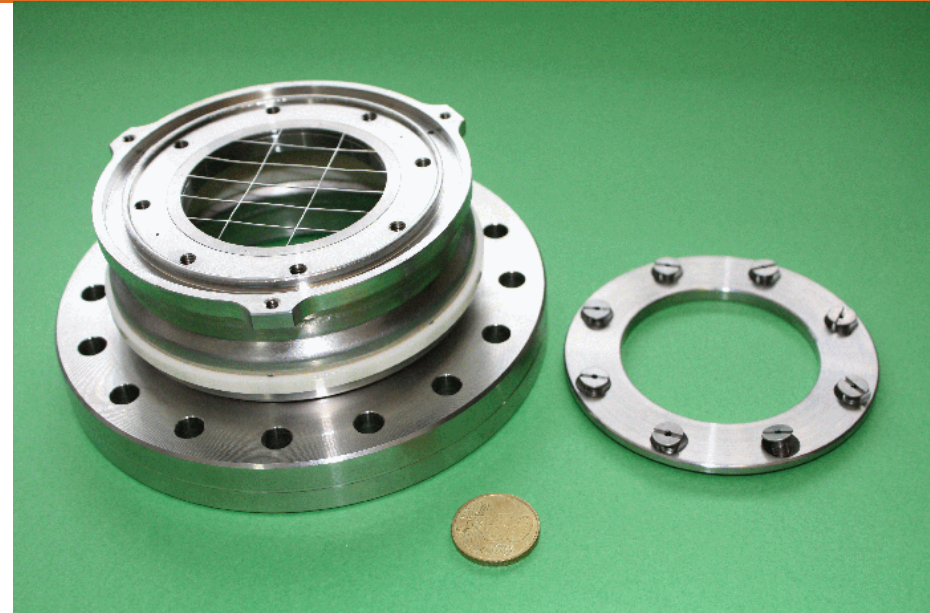
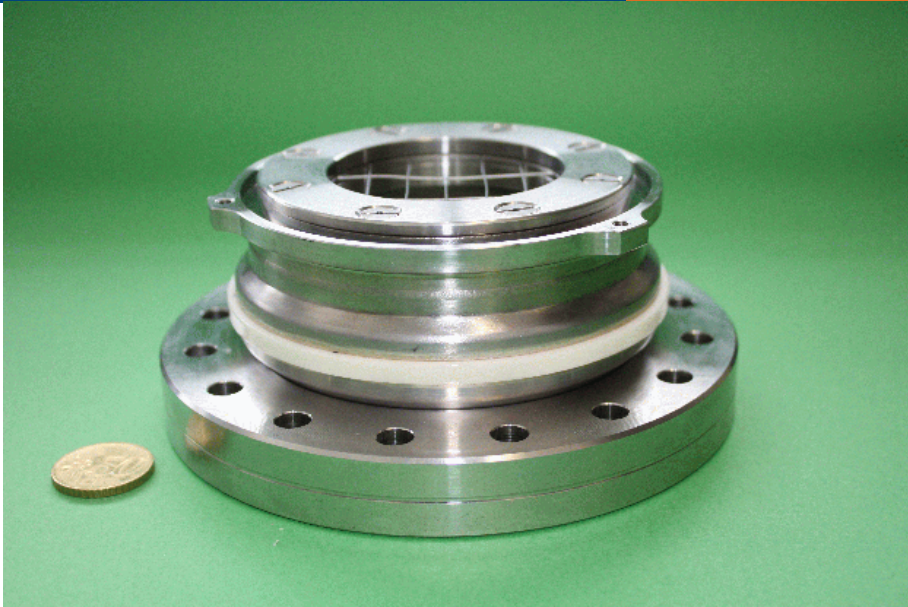


DC Cage

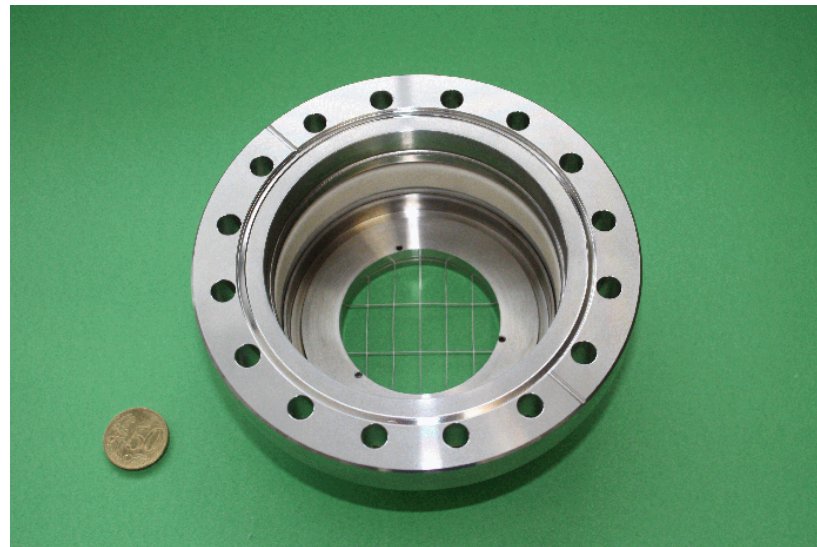


inner diameter: 280 mm
connections between segments via ceramic screws

Entrance Window

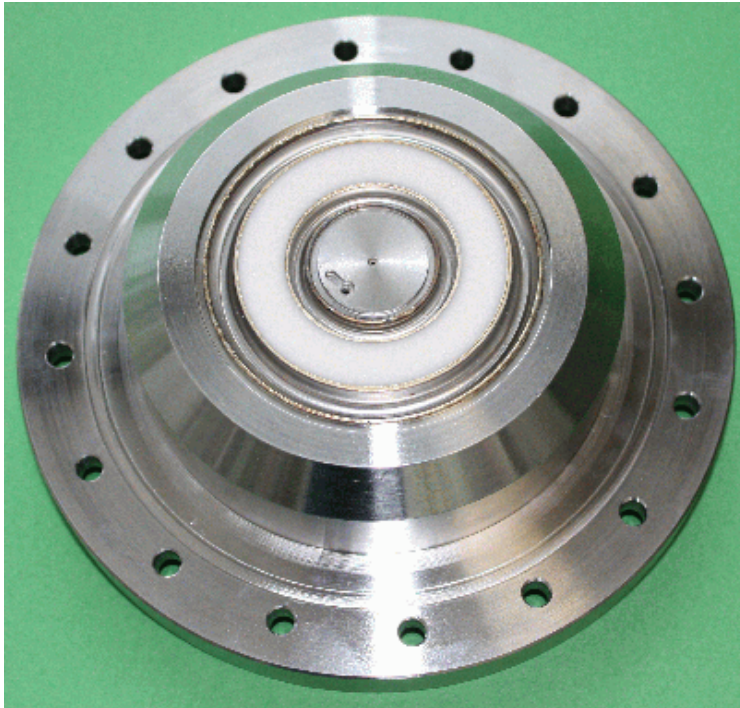


- flange: DN150CF
- manufacturer: FRIATEC
- specified for cryo temperatures
- sealing: 1 mm gold wire



Nozzle Flange

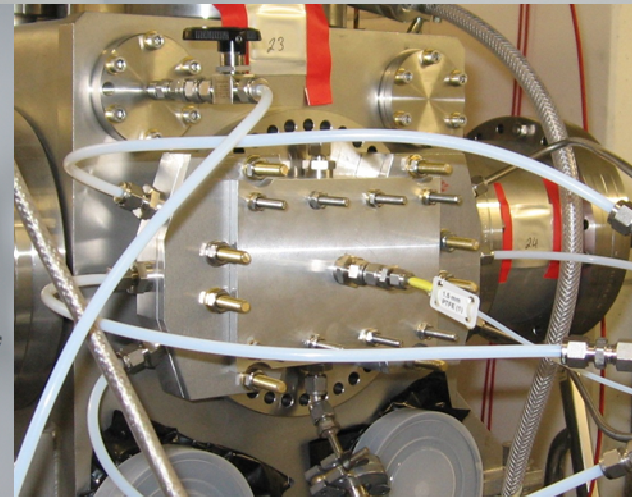
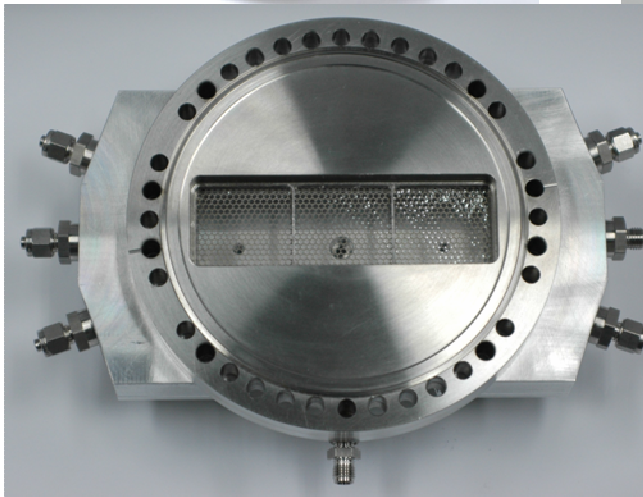
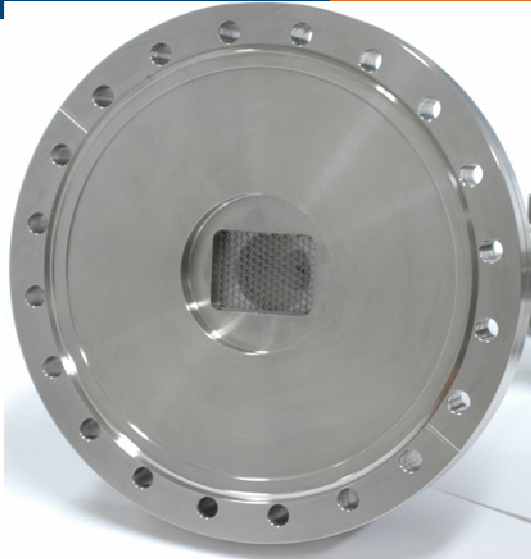
manufacturer: FRIATEC



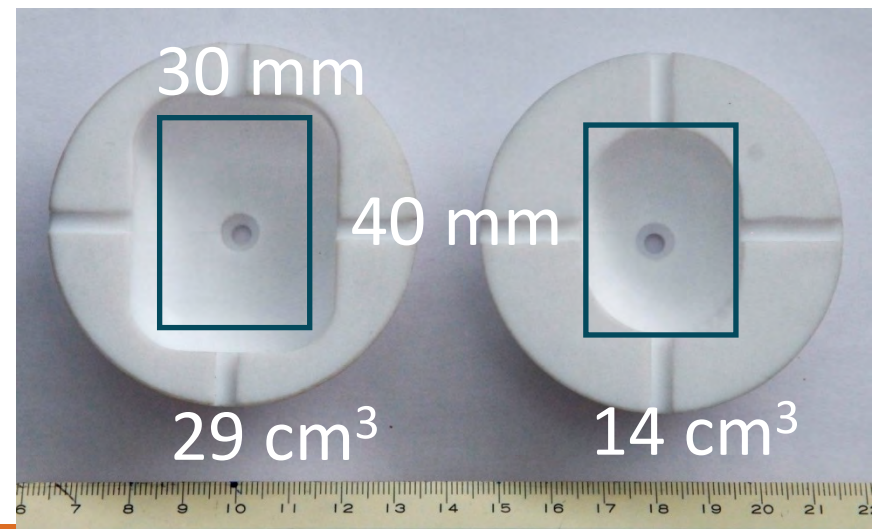
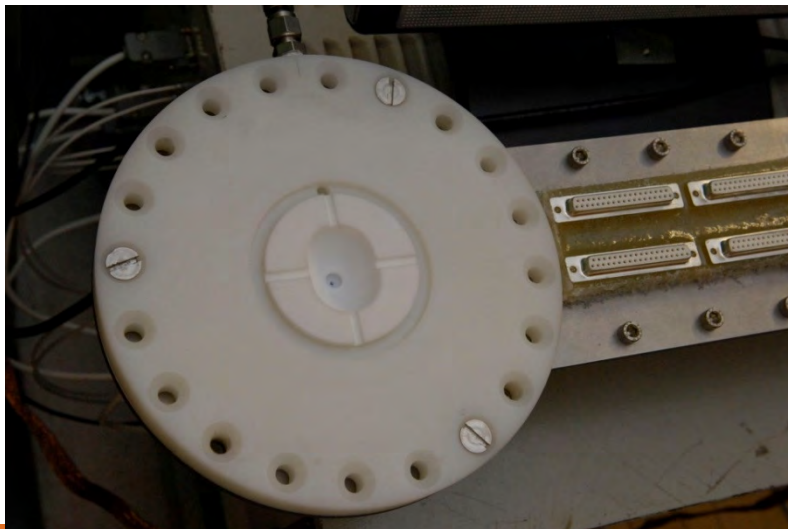
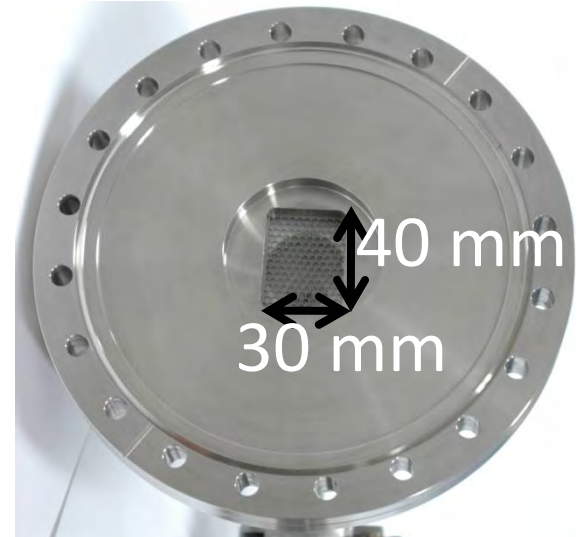
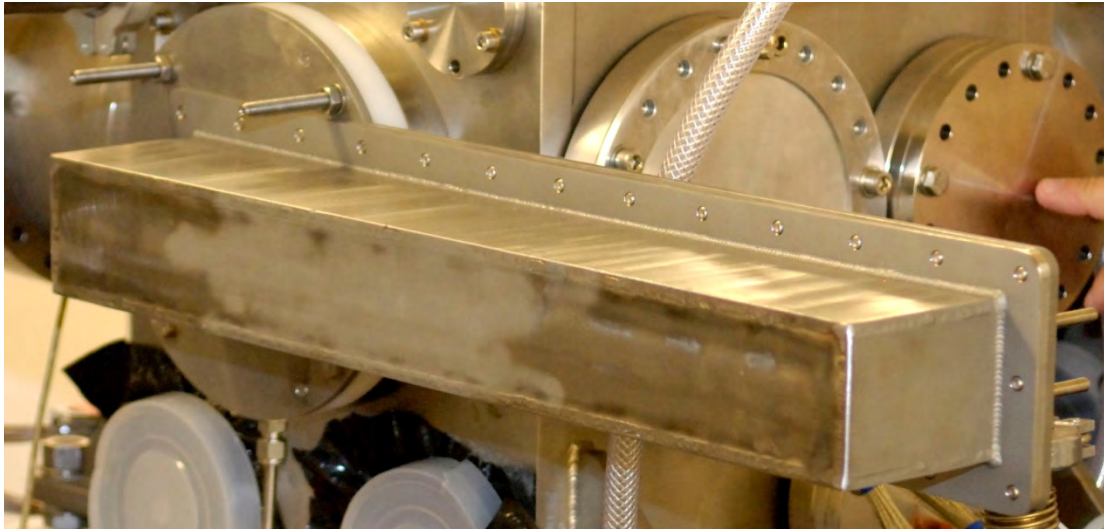
RTCs

- established for chemistry
- stopping in He gas at high pressure
- typical extraction time about 1 s or more
- different volumes to change the extraction time
- connection to gas jet systems / aerosol transport
- good efficiency

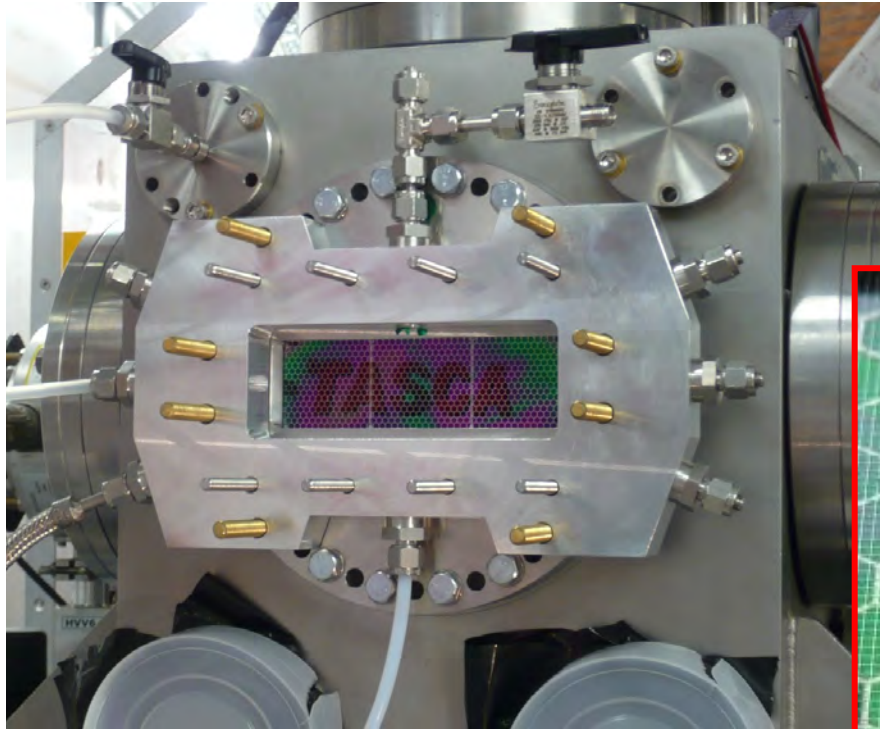
TASCA – RTCs



TASCA – COMPACT connection

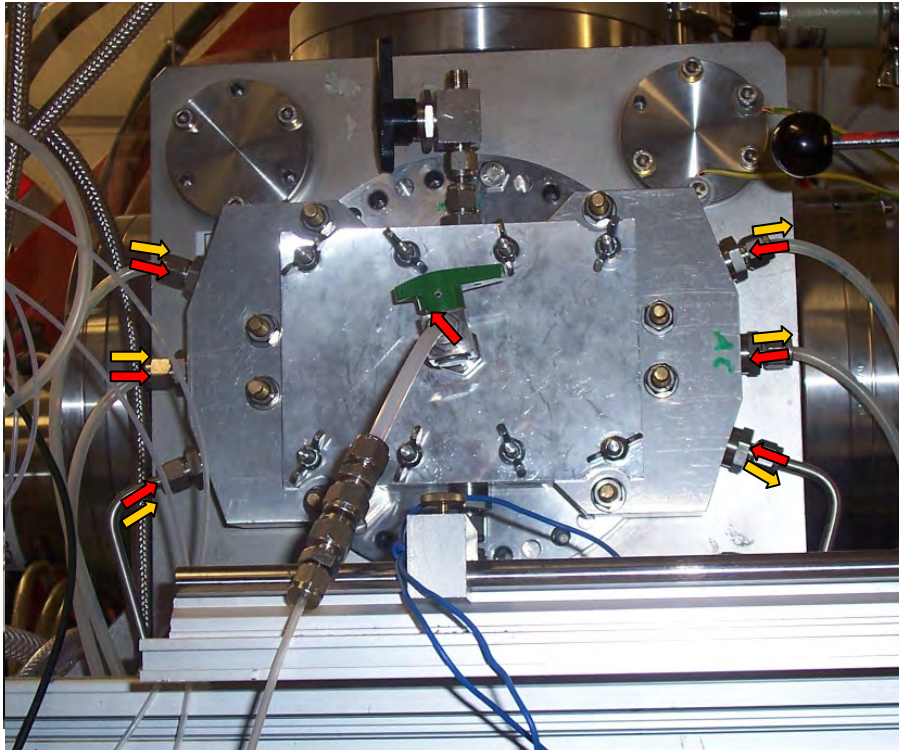


The Recoil Transfer Chambers - RTCs



Photos taken by Ch.E. Düllmann and J.P. Omtvedt

The Recoil Transfer Chambers - RTCs



Photos taken by Ch.E. Düllmann and J.P. Omtvedt

Tasca

Cave X8

ROMA

RTC

Capillaries:

length \varnothing

RTC → HotLab

PE 10 m 2.0 mm

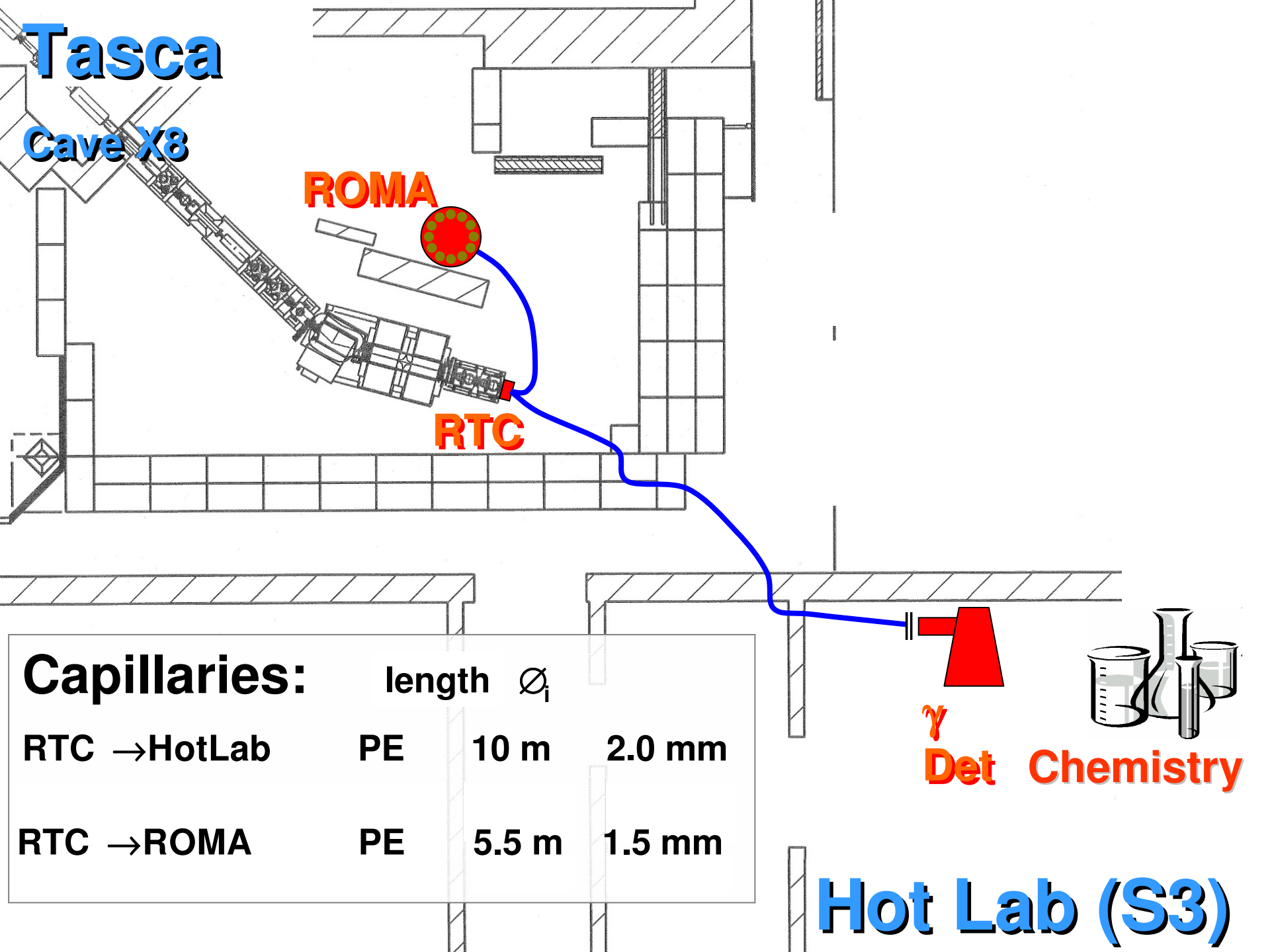
RTC → ROMA

PE 5.5 m 1.5 mm

γ

Det Chemistry

Hot Lab (S3)



Summary

- established gas stopping techniques exist (Physics and Chemistry)
- use electric field for fast extraction
- with connection to RFQ ion beam cooler provide high quality low energy beams
- adoption to IRIS needs will be feasible
- detailed simulations can start once IRIS configurations are fixed