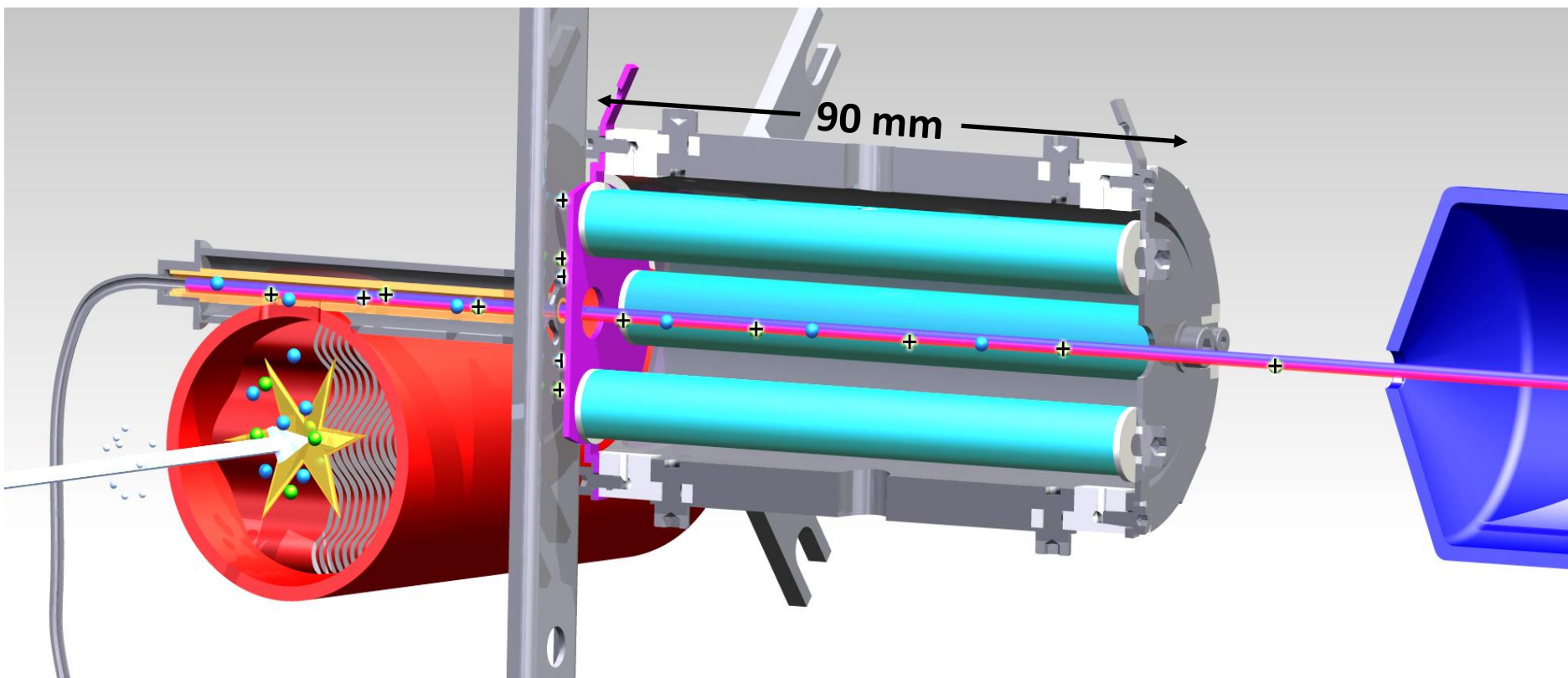


LIST Development @ JGU Mainz

Evolution since last on-line run
and
current status

Slides provided by
R.Heinke
Mainz University

HFS studies of polonium / suppression of francium (IS456, September 2012)

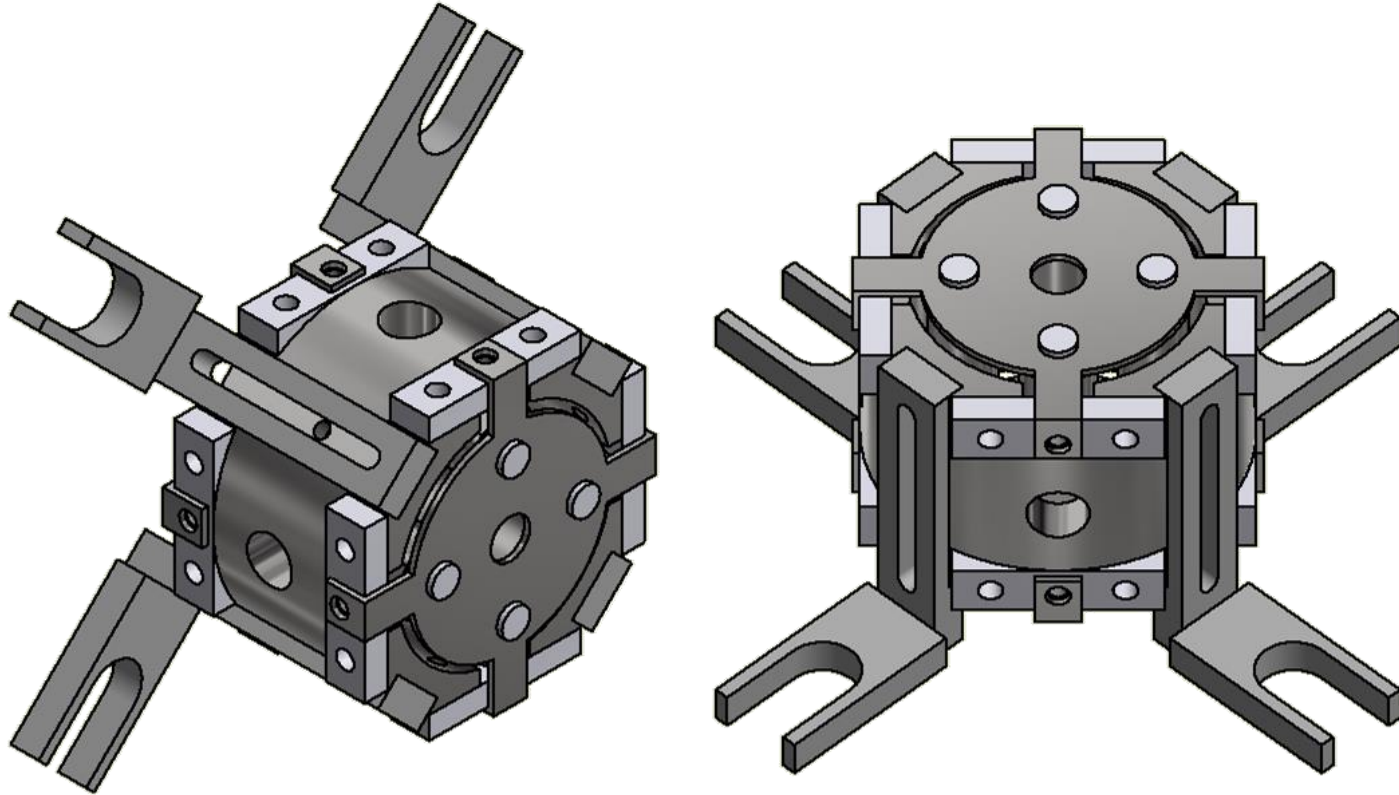


Isobaric suppression > 1000 , efficiency loss ≈ 50

- On-line implementation and first operation of the Laser Ion Source and Trap at ISOLDE/CERN, D. Fink et al., NIMB 344, 83-95 (2015)
- In-Source Laser Spectroscopy with the Laser Ion Source and Trap: First Direct Study of the Ground-State Properties $^{217,219}\text{Po}$, D. Fink et al., PRX 5, 011018 (2015)

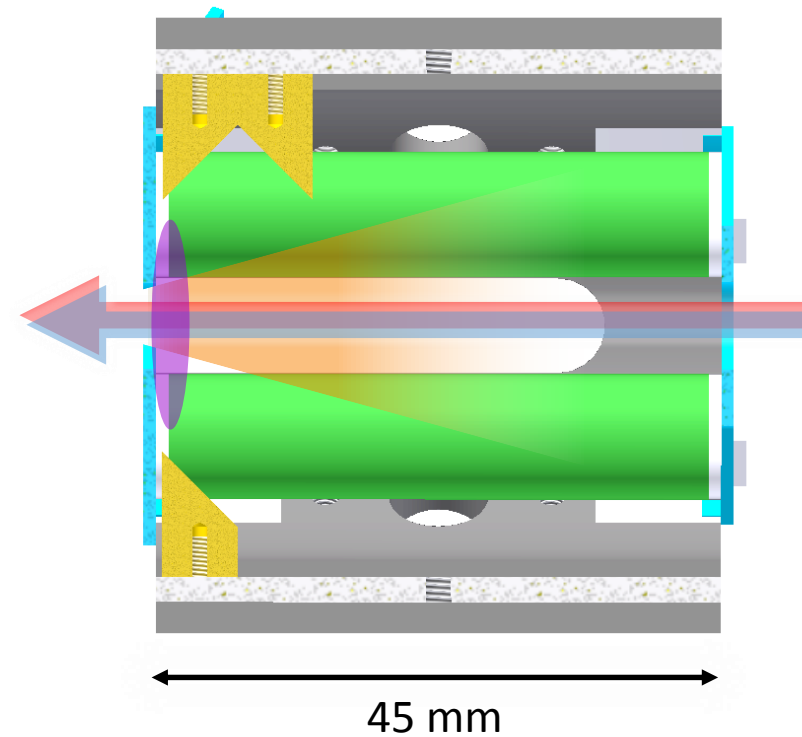
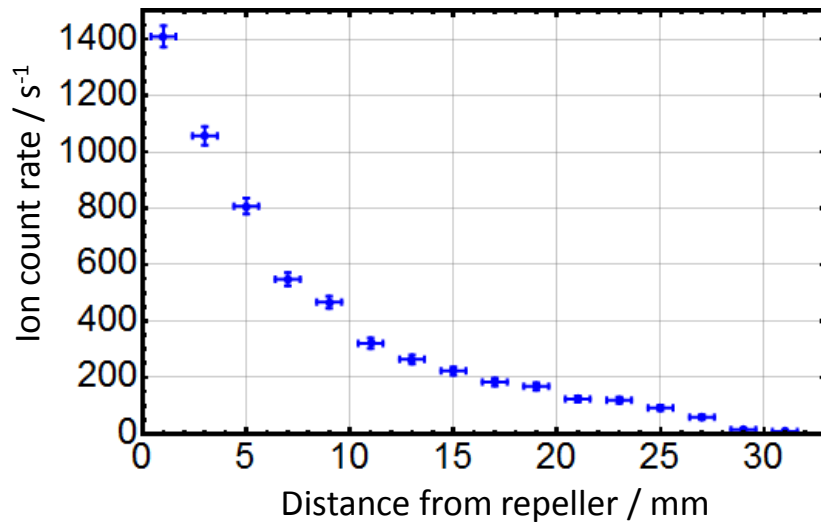


- *Transducer box* on target unit:
Oscillator circuit to transform, phase match and split RF voltage on quadrupole rods
- Transport of pre-amplified RF voltage from HV platform to target area
- Remote control of repeller voltage and RF amplitude on HV platform
- LabView-based serial communication



- 45mm length: Improved handling and compatibility to extraction region
- Simplified parts: Easier machining and construction, improved stability
- Machined at mechanical workshop of the Institute of Physics @ JGU Mainz
- Operation-ready

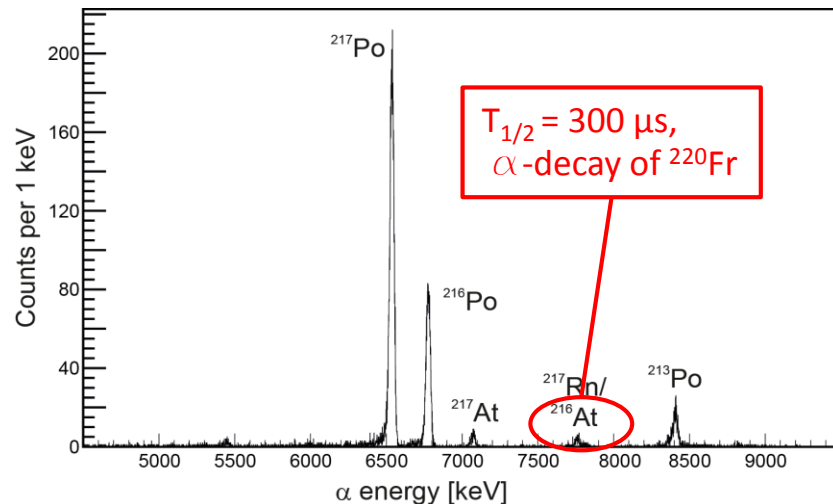
- Atom density measurements on central axis
- Perpendicular laser beam scan



- Significant opening angle of atom beam
- 45 mm length sufficient
- Cavity – LIST spacing and laser spot size crucial parameters
- Method for evaluation of atomizer design

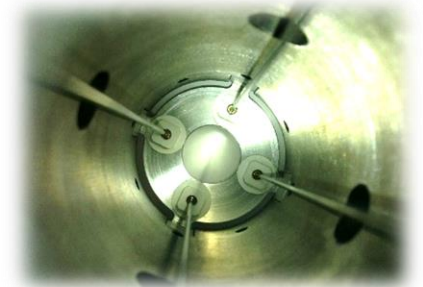
Isotope-dependent suppression factors during last on-line run

- Possibly due to condensation of neutral radioactive atoms inside LIST
- Subsequent decay and non-laser ionisation



D.A. Fink *et al.*, PRX 5, 011018
(2015)

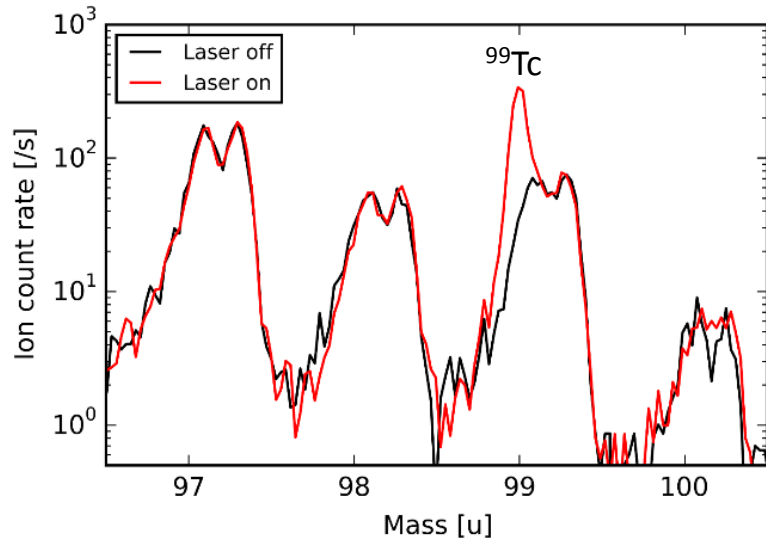
- Reduce possible deposition area:



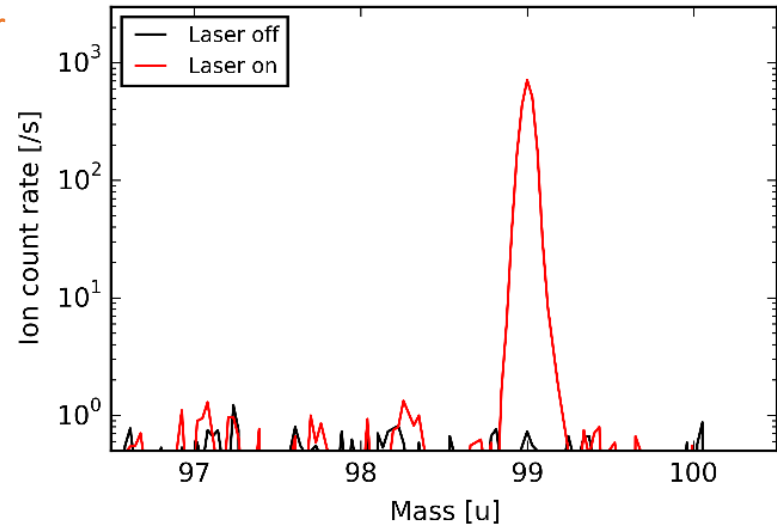
- Metal mesh exit electrode
 - Thin RF rods
 - Reduced length
- Influence on efficiency to be investigated off-line
 - Verification on subsequent on-line run

Off-line HFS structure investigations on $^{97-99}\text{Tc}$: High background signal in LIST mode

- Caused by electron impact ionization in LIST volume
- Introduction of a second negative repelling electrode



Double Repeller
Design

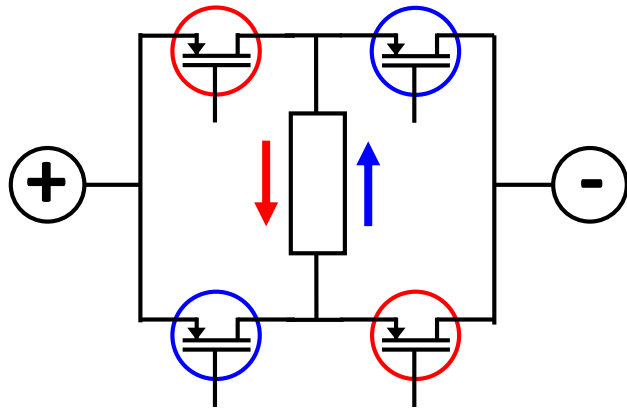


- Complete suppression of contamination
- Increased distance to atom source → Influence on efficiency to be investigated

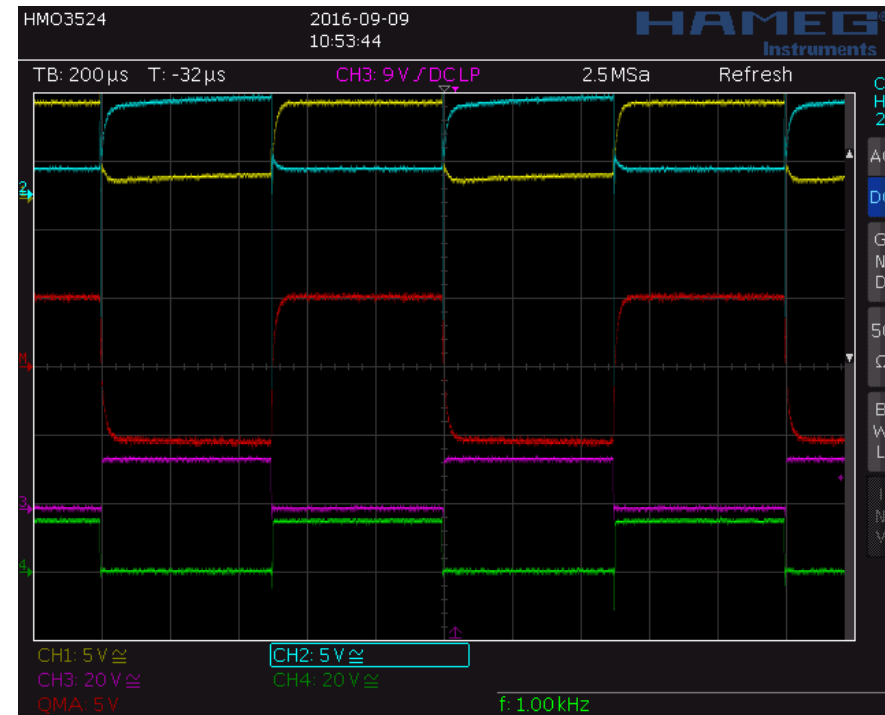
Quick in-situ switch of atomizer heating current polarity for desired potential gradient

- Ion guiding vs. additional suppression
- Improved performance with high resistance cavities as e.g. Sigradur

S. Rothe *et al.*, Nucl. Instr. Meth. B (2016)

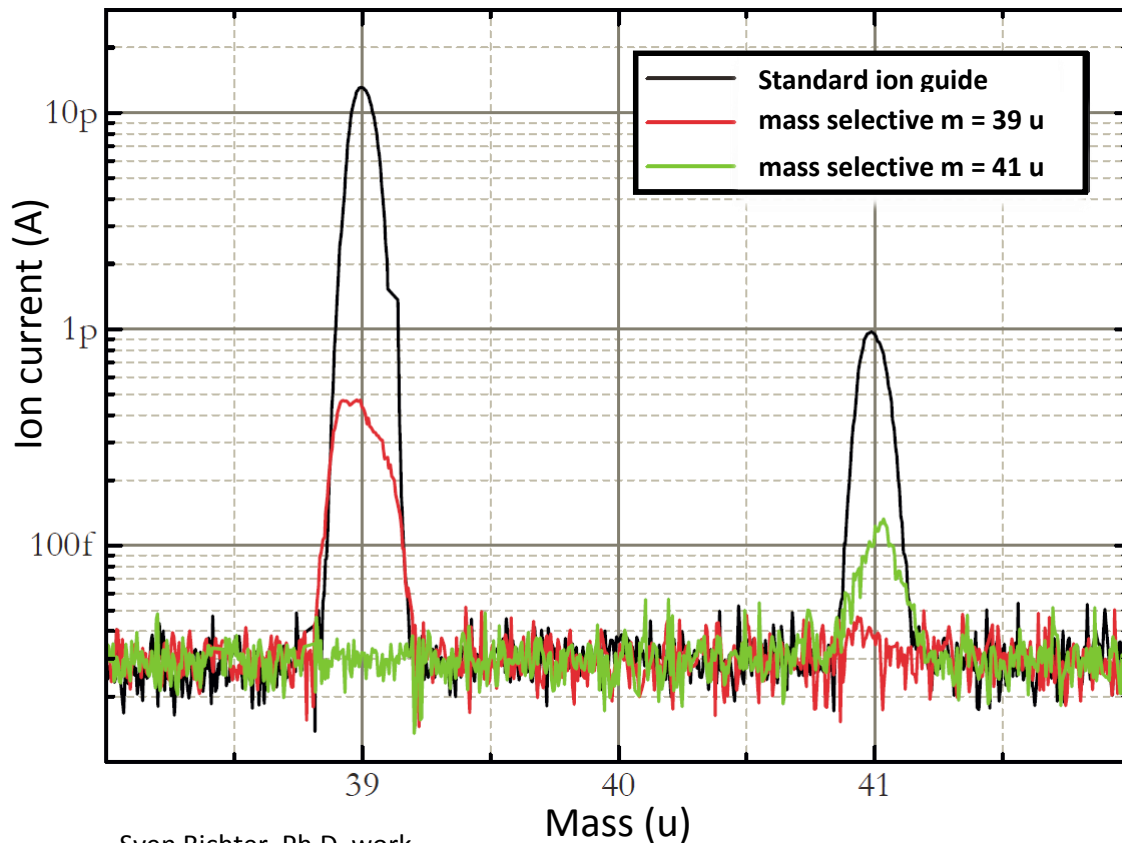


- High current IGBT switches
- Control electronics developed at the electronics workshop @ JGU
- First tests with 50 A, 1 kHz switching rate
- Duration tests at ion source test stand



Quadrupole structure as QMF: Combination of RF and DC potentials

- Increased Selectivity
- Containment of radioactive contamination in source area

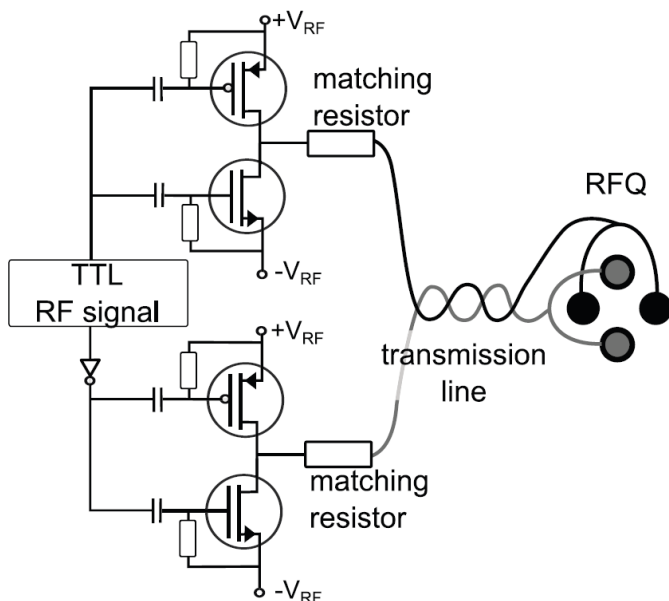
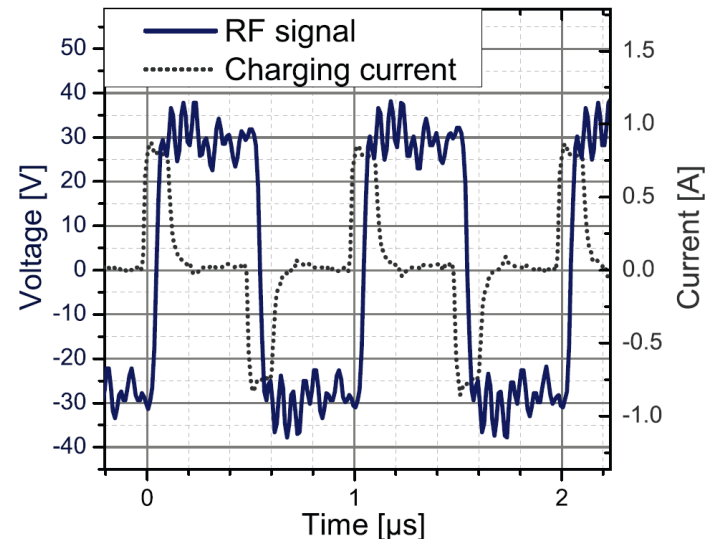


- Operated off-line at RISIKO mass separator
- Capacitive coupling of RF onto DC offset at transducer box
- Reduced transmission compared to standard ion guide operation
- Limitation by accuracy and maximum voltage of power supplies

MHz-switched DC voltages (instead of sine wave)

on quadrupole rods

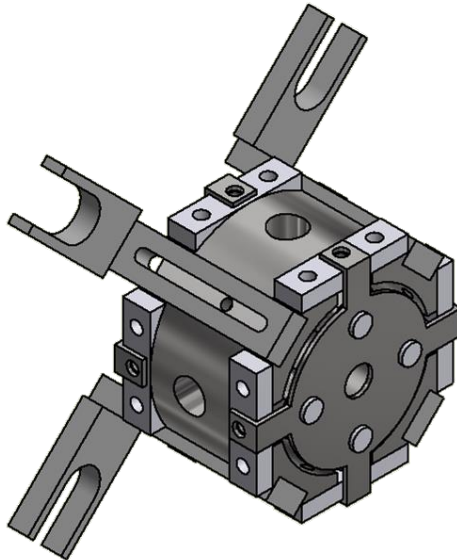
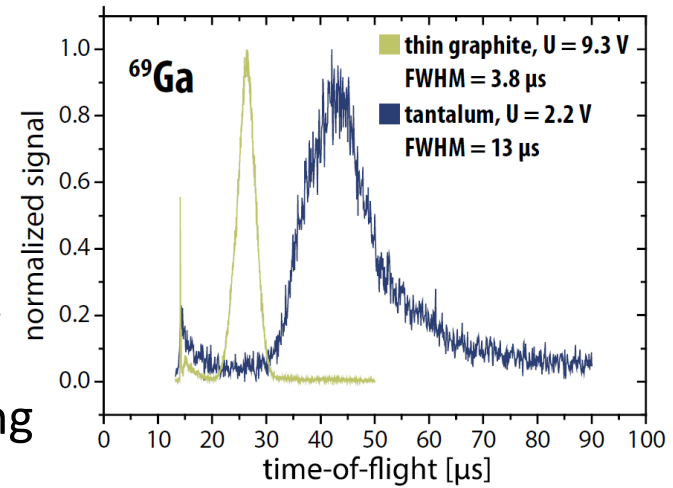
- Transducer box obsolete
- Easy implementation of DC offset on rods
 - DC Offset LIST
- Method successfully used at TRIUMF



- High switching currents
- Low capacity transmission cables to target
- Impedance matching to reduce power dissipation
- Cooling of switching units on HV platform
- TRIUMF implementation currently refined by electronics workshop @ JGU
- Easy commercial solution with Behlke switches?

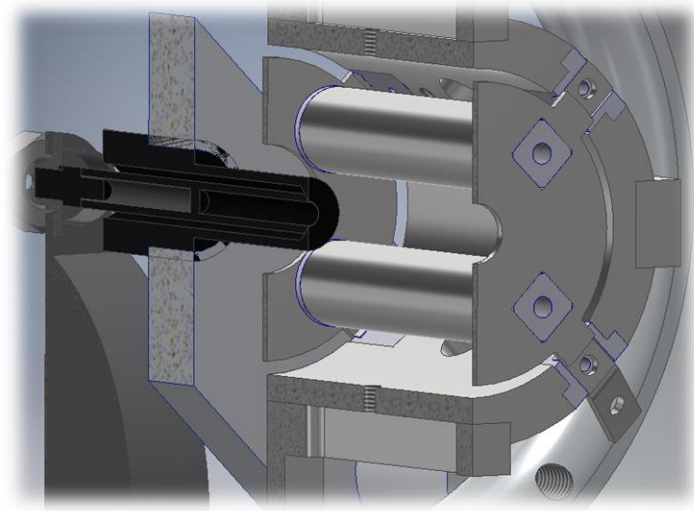
Concept: Time-focused laser ion bunches

- high ionizer potential gradient
- Subsequent field-free drift region
- Laser repetition rate synchronized ion beam gating
- Temperature independent gradient by pulsed heating



34 mm LIST

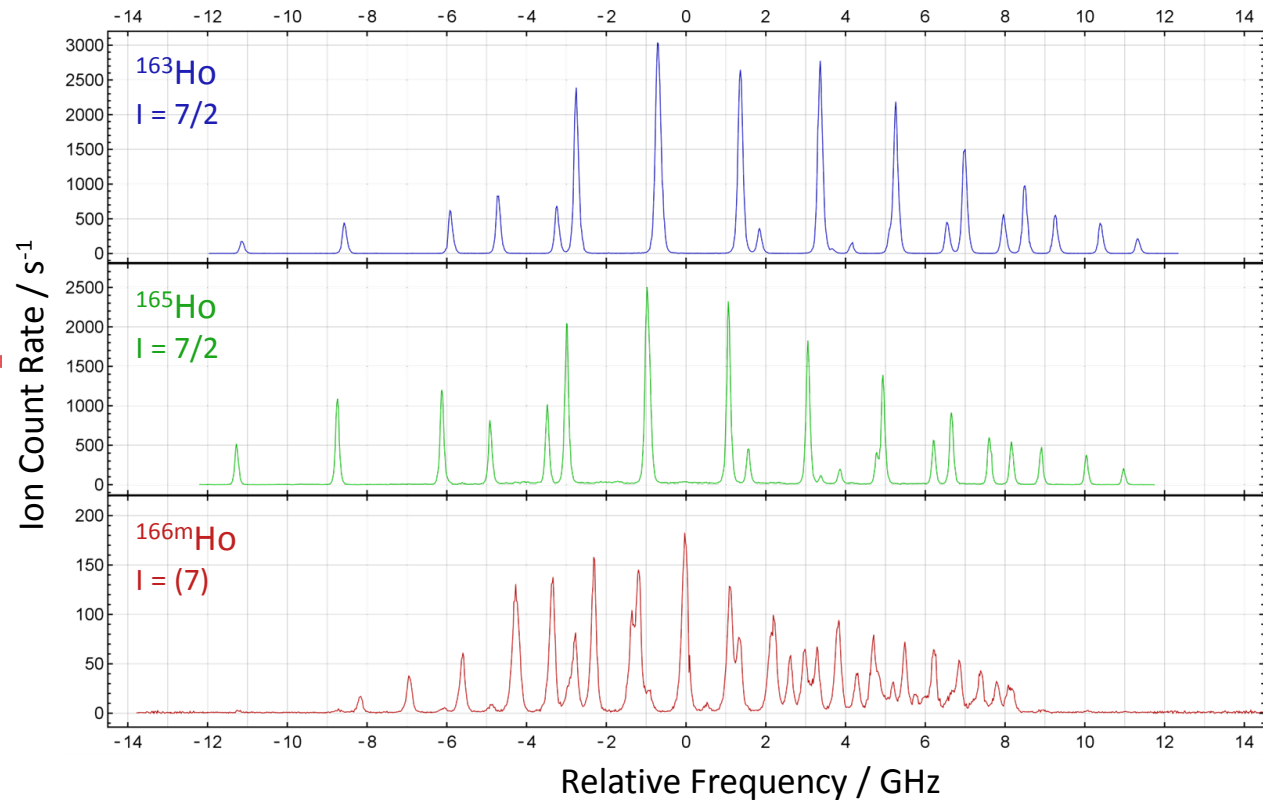
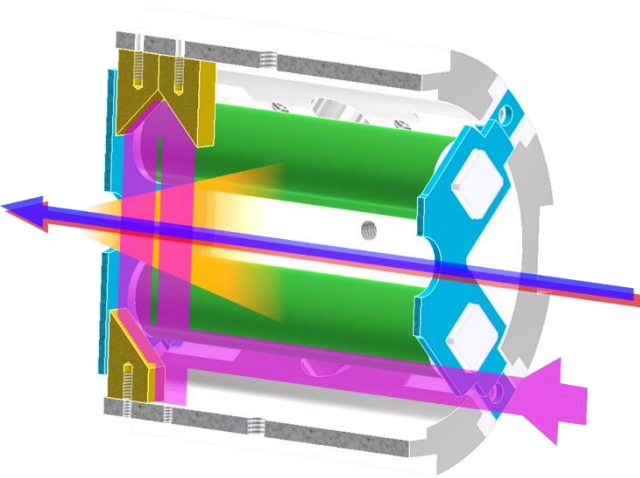
- Matched to ion source length
- Machined @ JGU



Cavity inside LIST structure

- Adjustable length of drift region
- Inversed polarity: Already sufficient suppression?

Reduction of Doppler broadening via perpendicular laser / atom beam geometry



- Below 100 MHz FWHM experimental linewidth
- Isomere-selective ion beam production
- Efficiency in the 0.1 % region
- Adaption of extraction electrodes



LIST developments since last on-line run

- Refined standard LIST
 - 45 mm LIST machined and operational
 - Simplification of parts, easier machining, robust operation
 - Operation analogous to previous run
- Ongoing developments
 - Reduced deposition surface: Narrow rod and mesh electrode
 - Electron impact ionization suppression: double repeller
 - In-situ hot cavity polarity switching
 - Mass selective operation mode
 - Square wave RF driver
 - Quartz line for additional suppression
 - ToF-LIS compatibility
 - High resolution perpendicular beam geometry

