

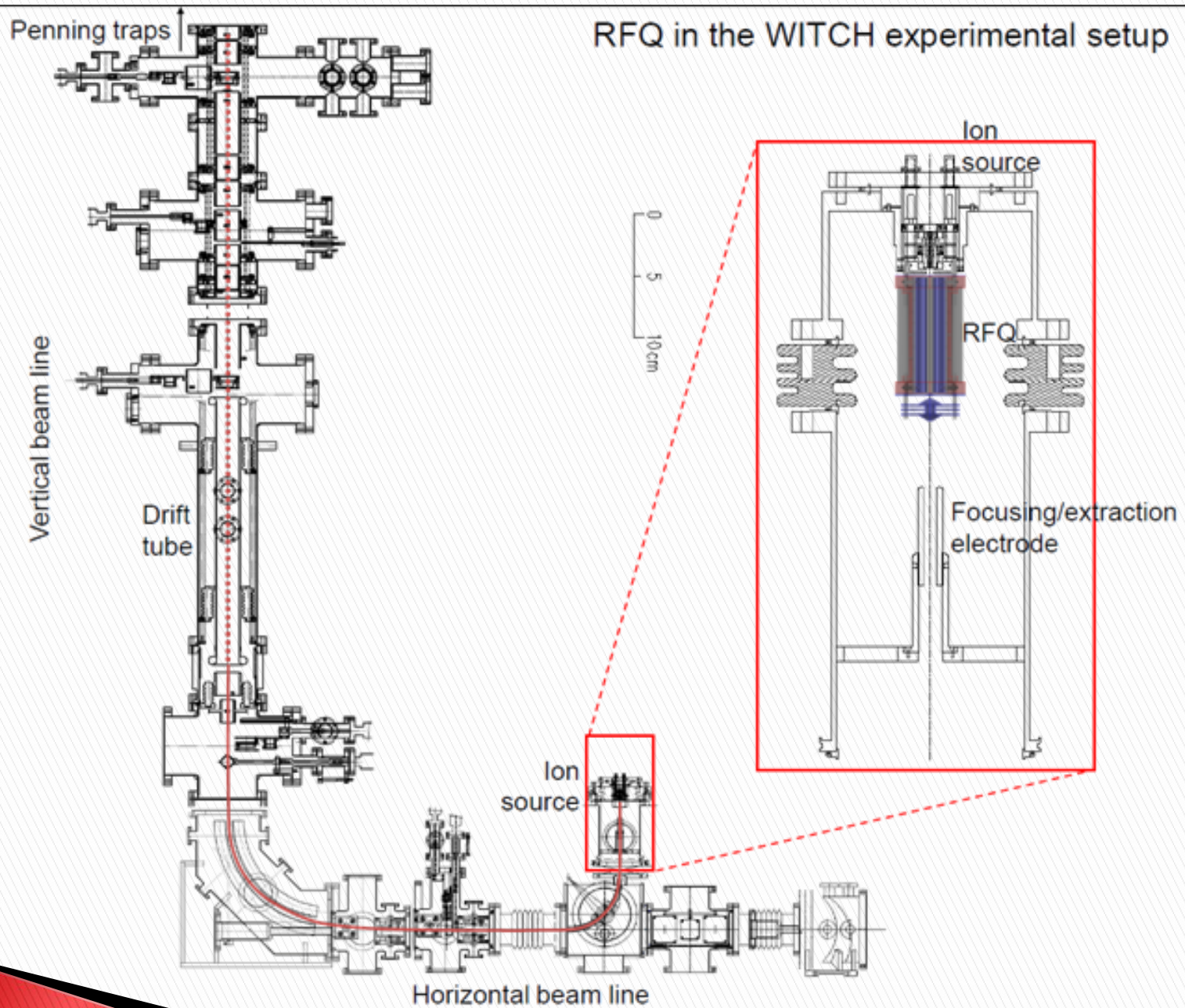


Installation and optimization of a RFQ for WITCH-ISOLDE

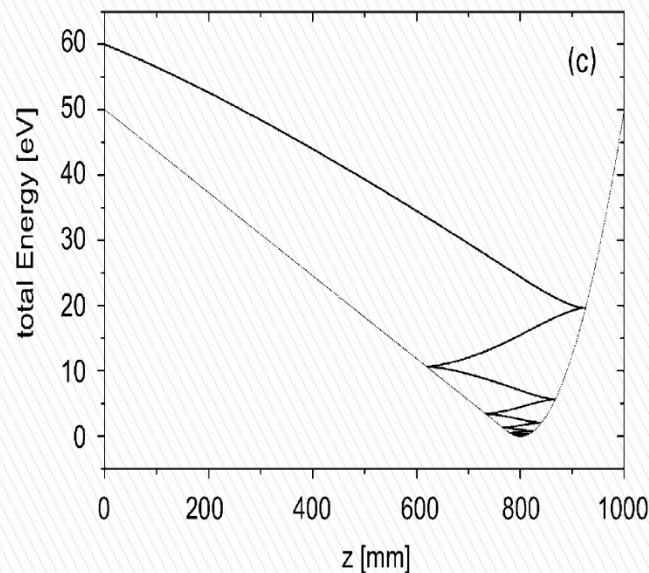
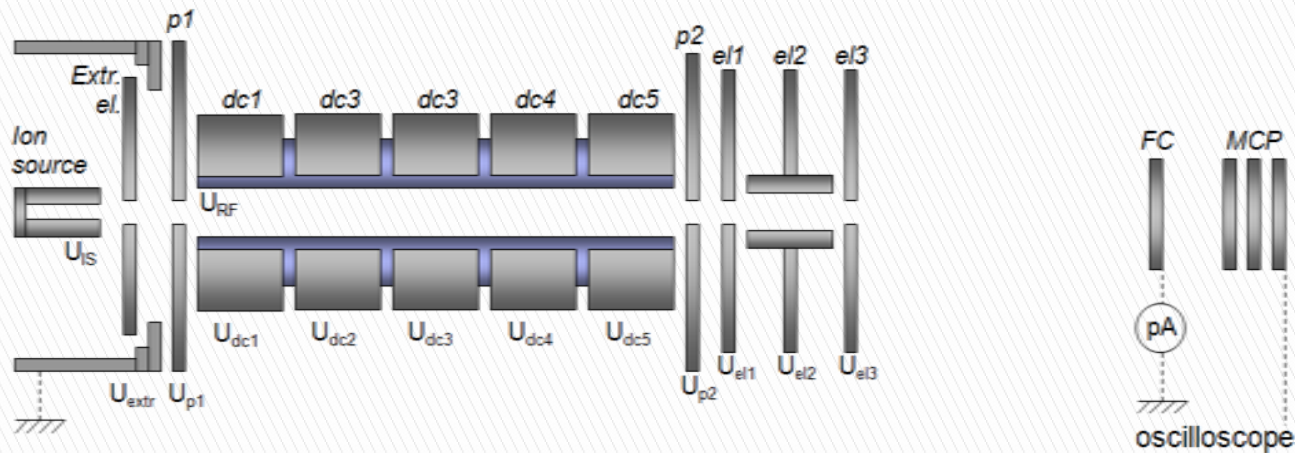
Per-Ivar Lønne
University of Bergen, Norway



RFQ in the WITCH experimental setup



Schematics of RFQ with Ion Source (IS), Faraday Cup (FC) and Microchannel Plate Detector (MCP)

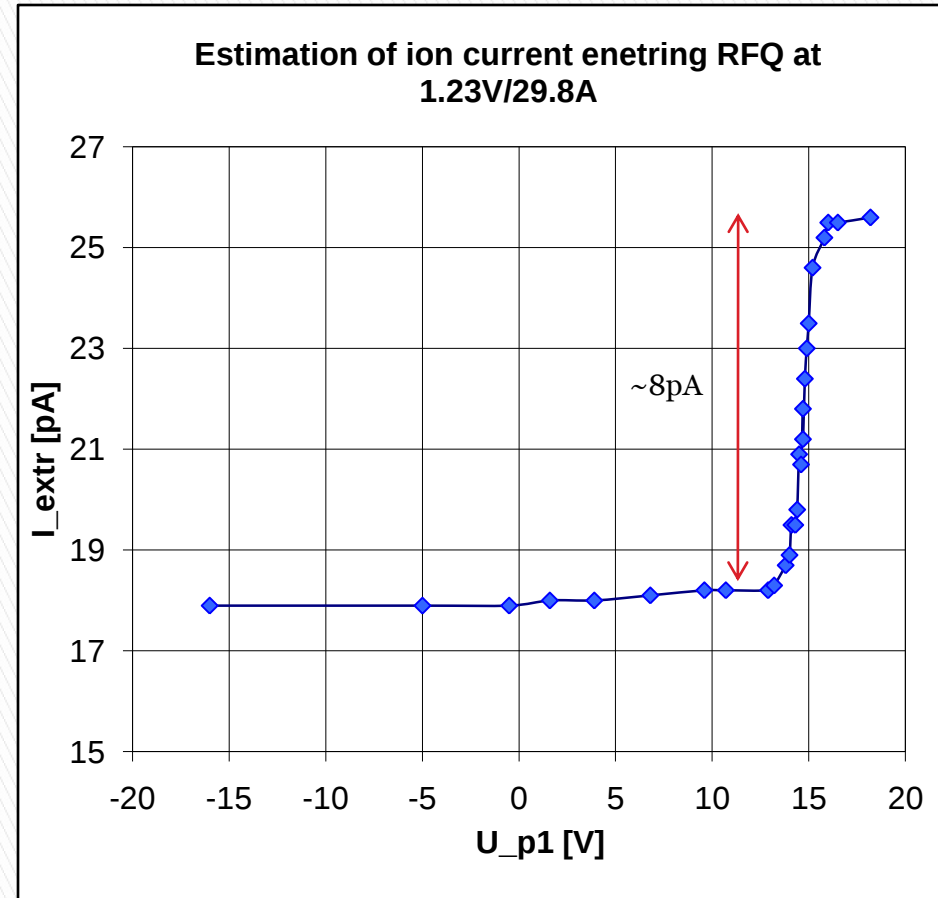
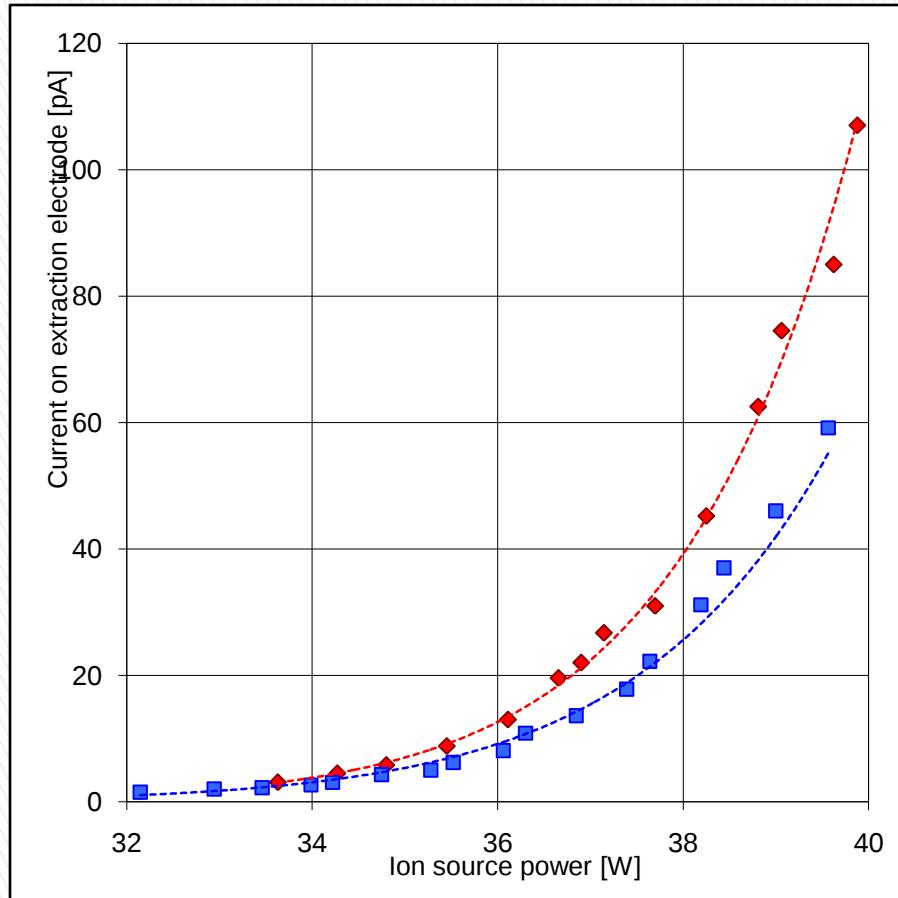


ref: F. Herfurth et al. / Nuclear Instruments and Methods in Physics Research A 469 (2001) 258

Several stages of operation:
 1st stage performed at $\sim 15\text{V}$
 2nd stage performed at $\sim 115\text{V}$
 3rd and final stage will be at $\sim 30\text{kV}$



Ion Source (IS) Characteristics



- Decrease in IS-output over time
- Non-linear IS-output with increasing power
- Maximum ~30% of ions enter the RFQ
- The IS works, time to optimize the RFQ and focusing!



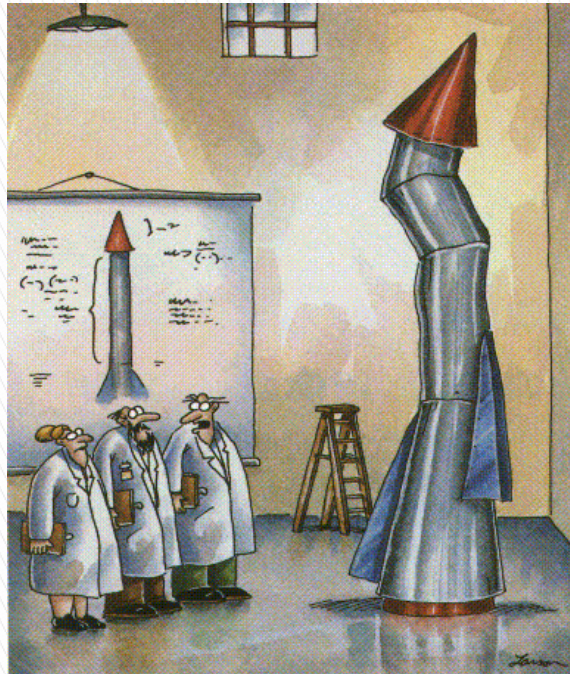
Optimization of the RFQ

Three modes of operation:

- Ion Guide Mode
- Continuous Cooling Mode
- Bunching/Pulsed Mode

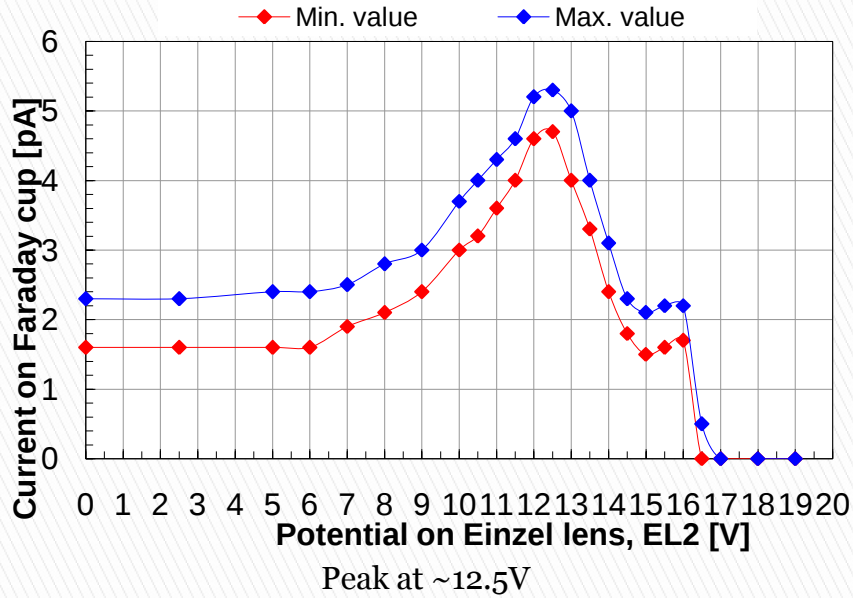
Parameters to optimize:

- Focusing electrodes (Einzel lens)
- Buffer gas pressure
- Timing parameters of RFQ

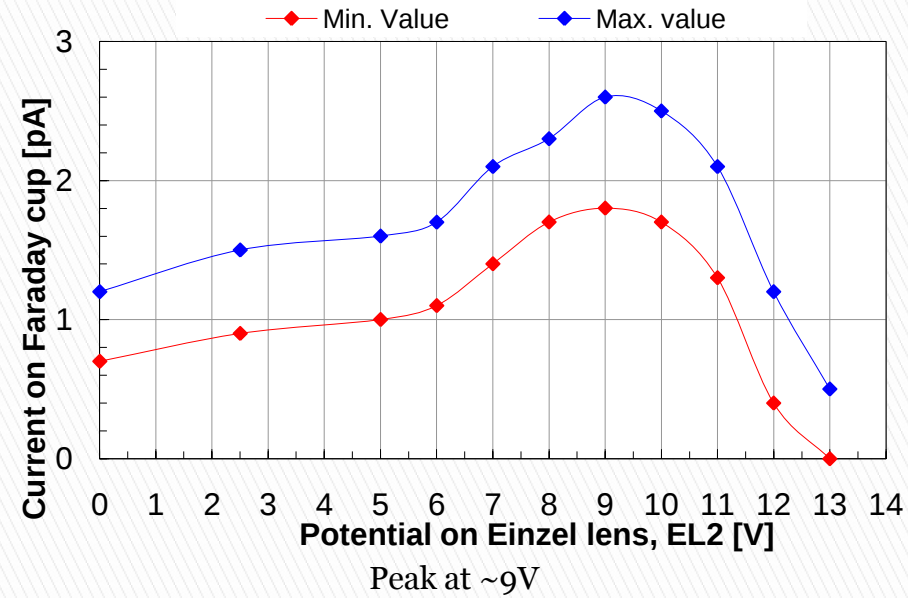


Einzel lens Focusing

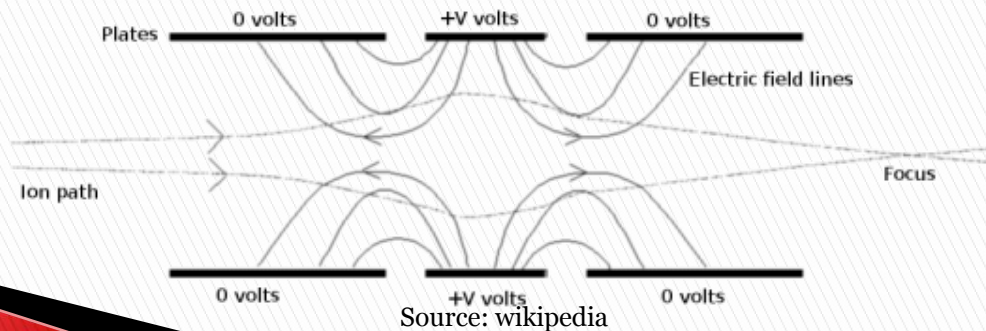
Ion Guide Mode (no buffer gas)



Continuous Cooling Mode (with buffer gas)



Focusing is dependent on the energy of ions



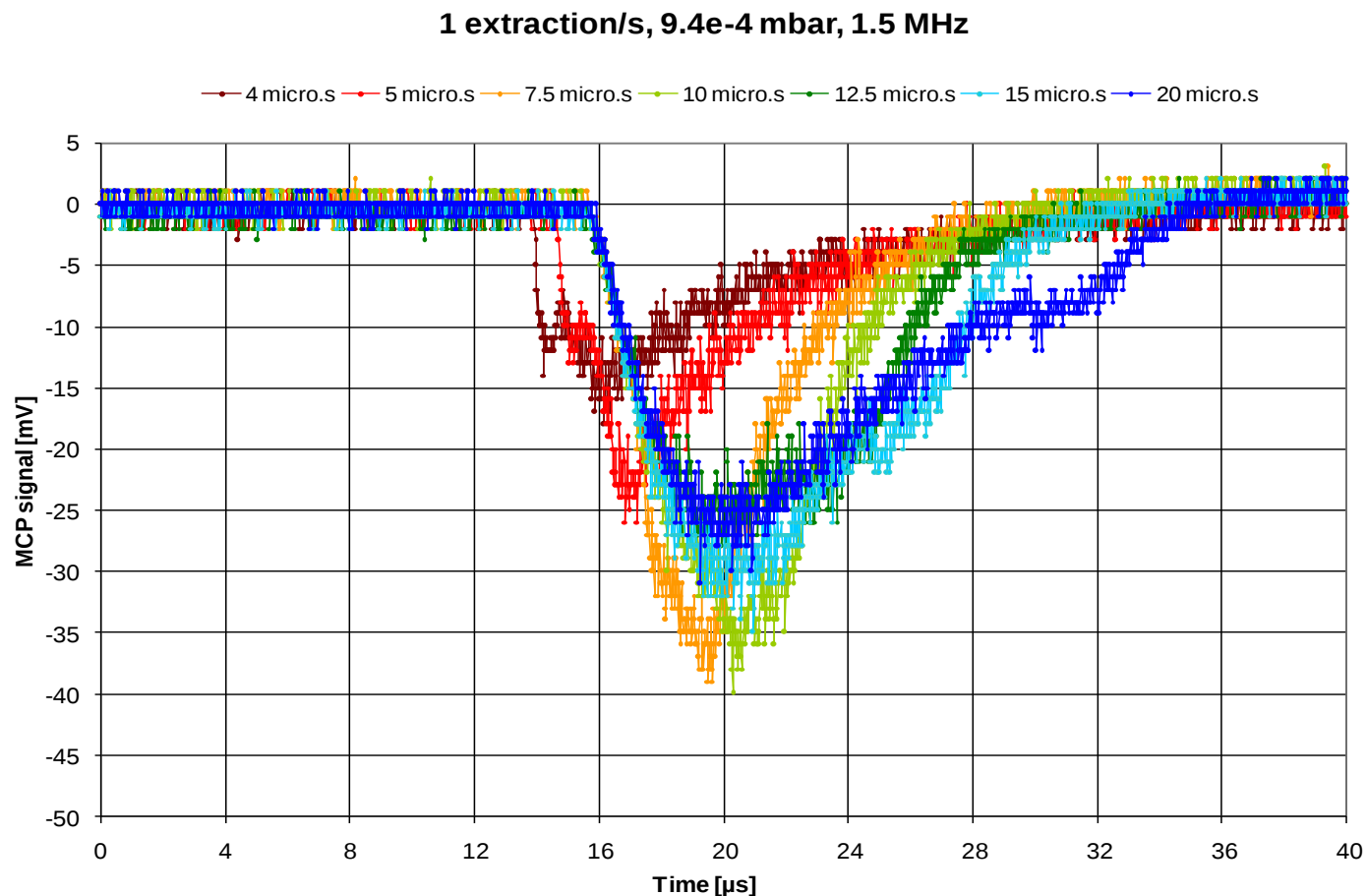
- Limited length of Pulse Drift Tube (PDT) ➡ Limited bunch size ($\sim 2.5\text{-}4\ \mu\text{s}$)
- Half life of radioactive ions limits how long the ions can be bunched
 - (Ions should not decay before they reach the trap)

Parameters to vary:

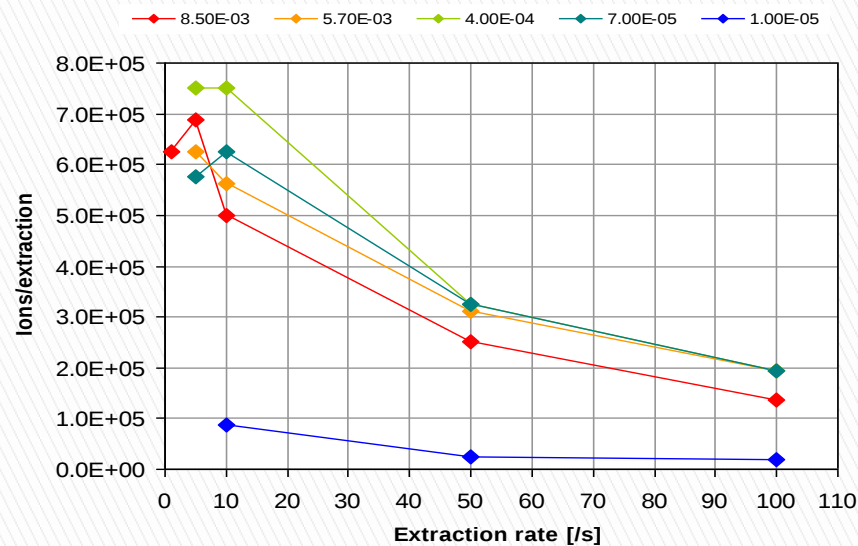
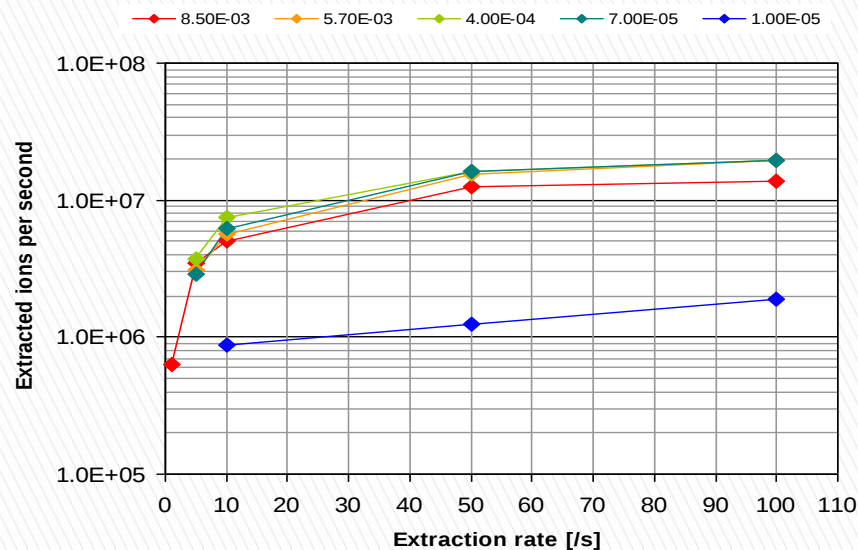
- Extraction time
 - (amount of time where P2 is open)
- Extraction frequency
 - (how often P2 is opened, or for how long the ions are cooled)
- Buffer gas pressure
 - (higher pressures will cool ions faster)



Variation in extraction time (MCP measurement)



Varied extraction frequency under different buffergas pressures



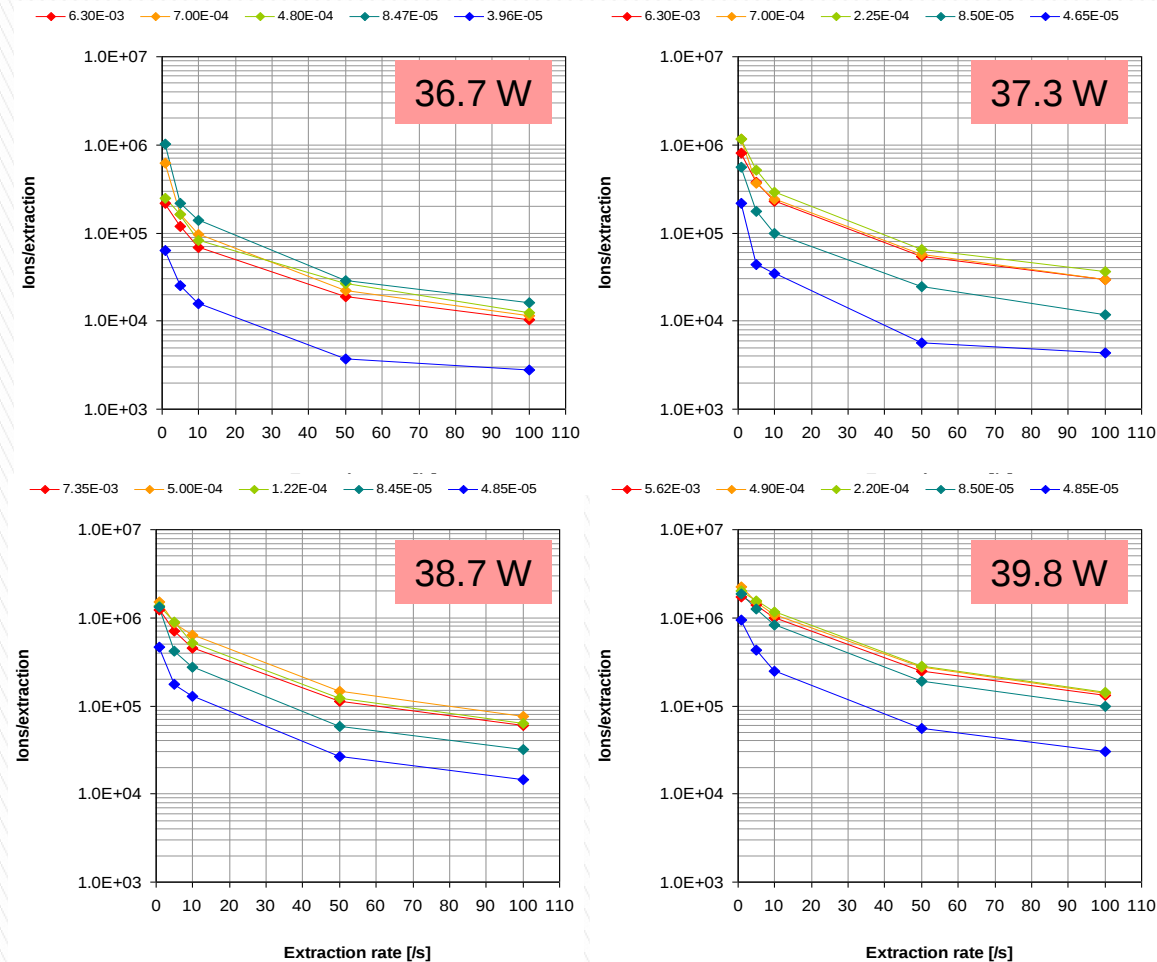
Result:

At 1Hz the highest numbers of ions per second are given at pressures of $4 \cdot 10^{-4}$ mBar (Pressure outside RFQ. This pressure corresponds to $\sim 10^{-2}$ - 10^{-3} mBar inside the RFQ from earlier measurements)

The maximum number of ions observed is $\sim 7.5 \cdot 10^5$ per extraction



Varied extraction frequency under different buffergas pressures at high voltage (115V)



- Optimal pressure range: $8 \cdot 10^{-5} - 5 \cdot 10^{-4}$ mBar
 - 2x increase of maximum number of ions at 1Hz
 - 8x increase of maximum number of ions at 100Hz
- } Space charge effects



Conclusions and future work

- The Ion Source and RFQ is functioning
- A high amount of well-bunched ions is made available for the tuning of WITCH ($\sim 3 \cdot 10^6$ ions per $4\mu\text{s}$ compared to 2400 ions from a continuous beam)
- At $f_{\text{ext}}=1\text{Hz}$, an operational pressure of $8 \cdot 10^{-5} - 5 \cdot 10^{-4}$ mBar is ideal, which is acceptable for maintaining a good vacuum in the WITCH-beamline
- 30kV platform under construction for final stage of optimization and preparation for use

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And thanks for your attention!



