Purification of Beams with MR-TOF-MS at IGISOL

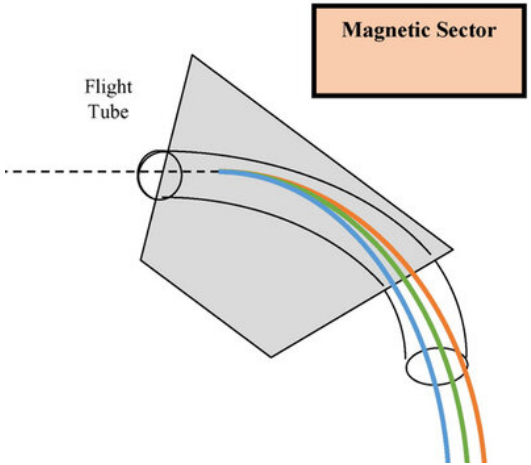
Brian Kootte for the
ACCLAIM MORA Kick-off meeting 2025

Overview

- General and specific motivation for isobaric purification
- Principle of isobar purification with MR-TOF-MS
- Results of the separation achieved in ^{23}Mg run
- Caveats for implementing the technique

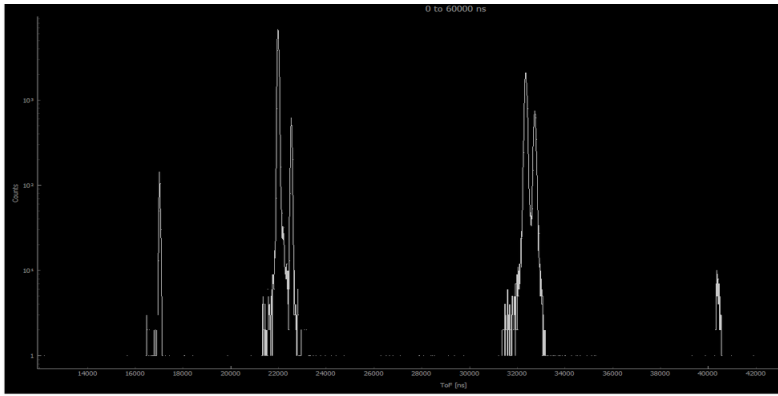
Isobars

- IGISOL dipole magnet (mostly) selects one mass-to-charge ratio
- Isobars include anything with same A/q
  - $A_{contaminant} = A_{ion\ of\ interest}$
  - Molecules (oxide, hydride, etc.)
  - 2+ ions with $A_{contaminant} = 2 \times A_{ion\ of\ interest}$

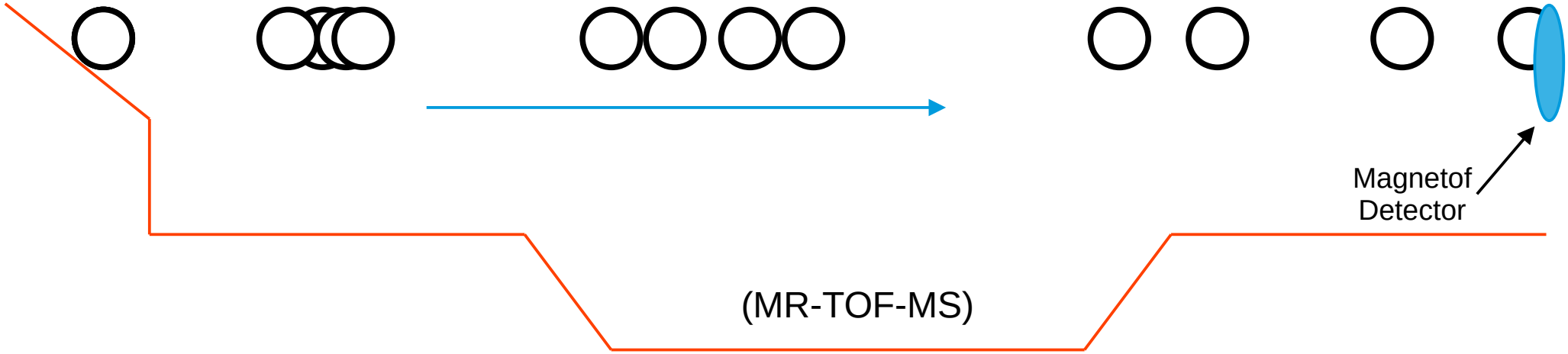


TOF Separation of Different Mass Units (A)

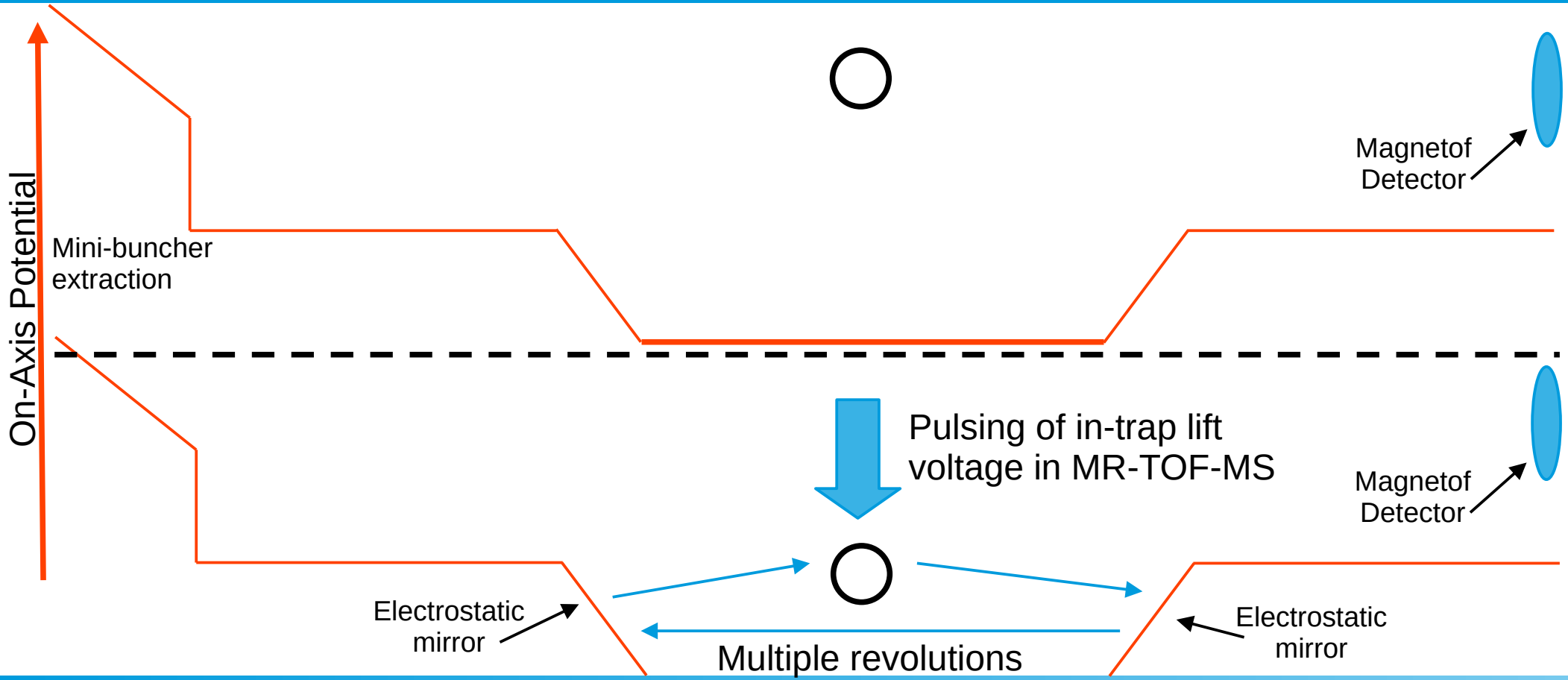
$$TOF \propto \sqrt{A/q}$$



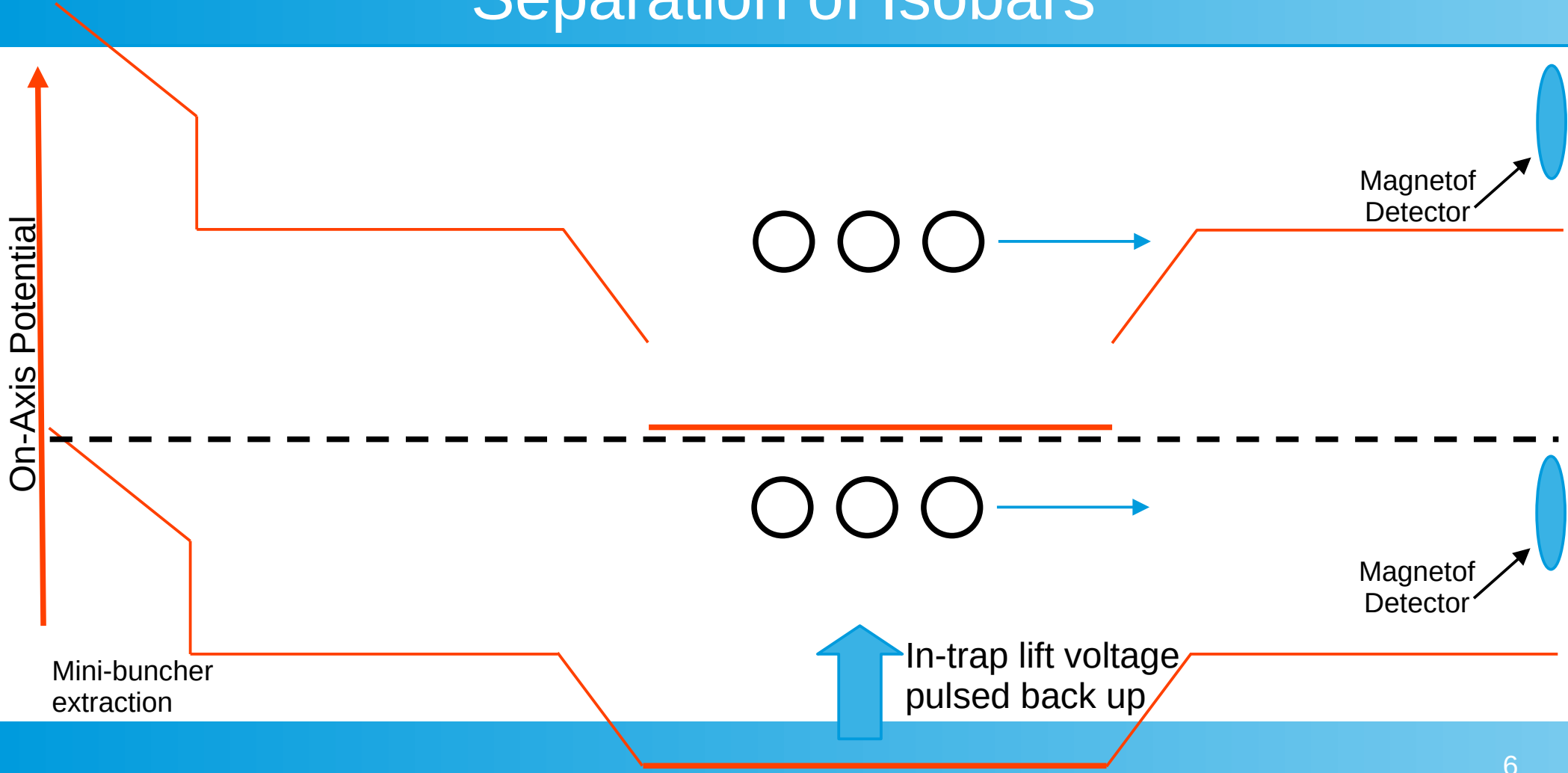
Mini-buncher
extraction



Trapping in MR-TOF-MS

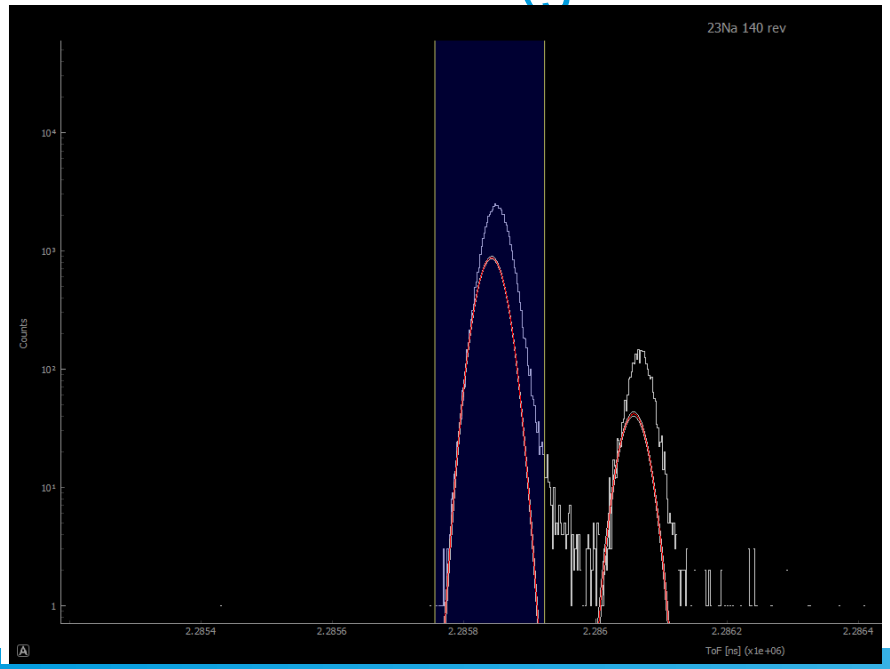


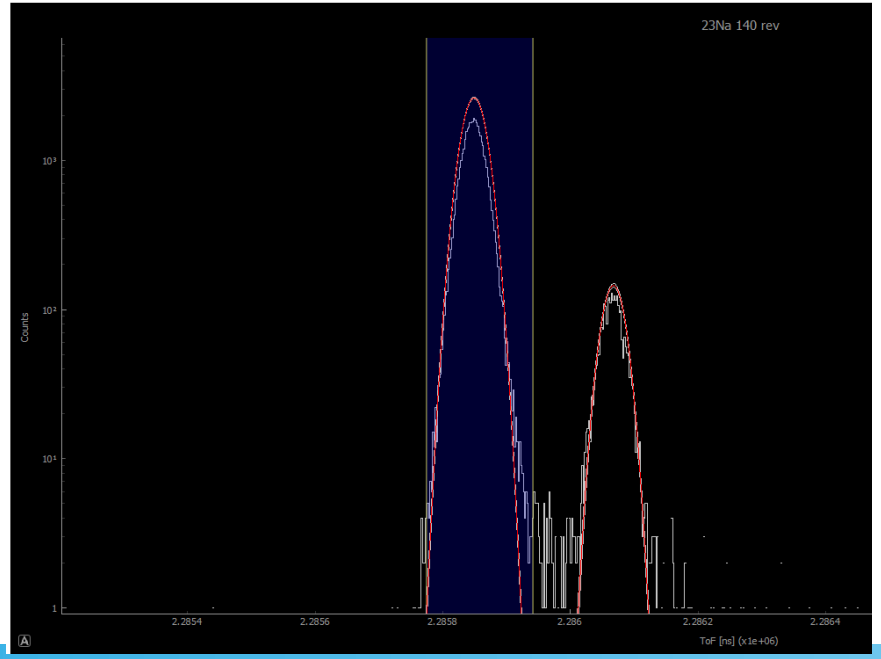
Separation of Isobars



Optimizing 23Mg/23Na Ratio

- Instant feedback from MR-TOF-MS
- Proton beam steering optimized
- 200 revolutions (good balance)

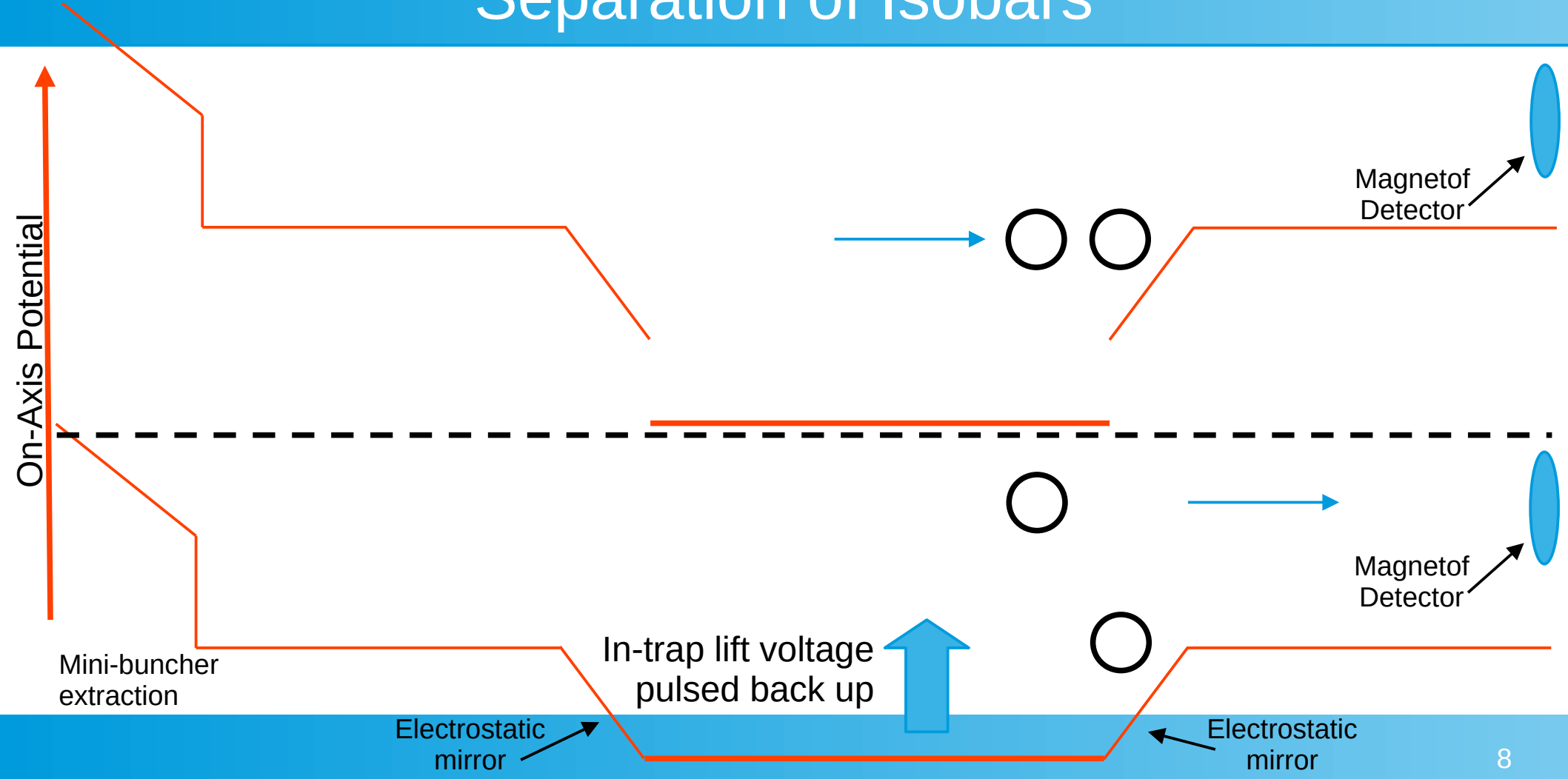




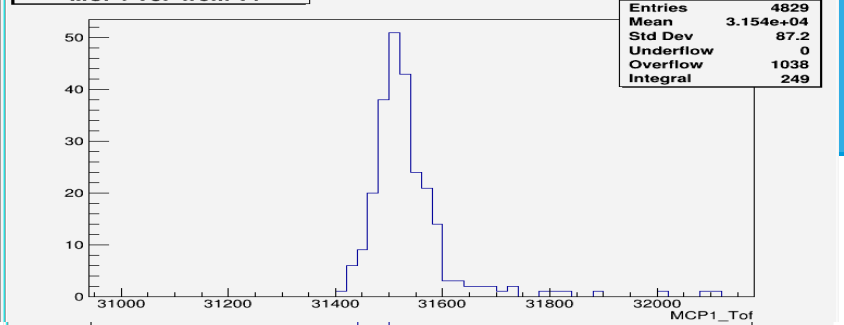
Counts

Time of Flight

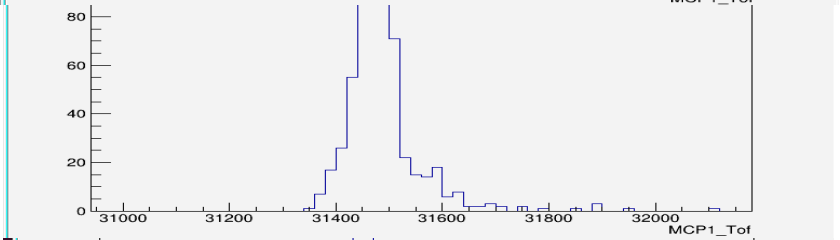
Separation of Isobars



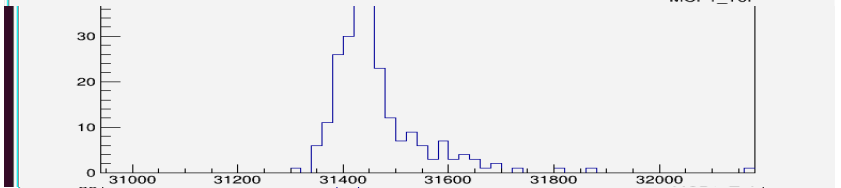
Increasing Mg Purity with Lift Timing



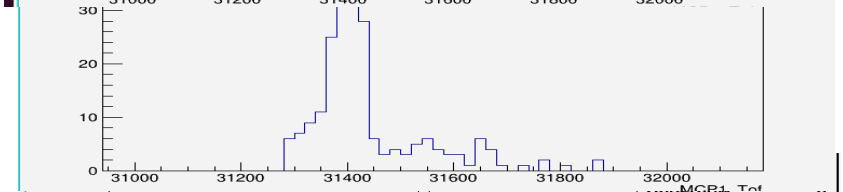
986 microsecond In-Trap Lift



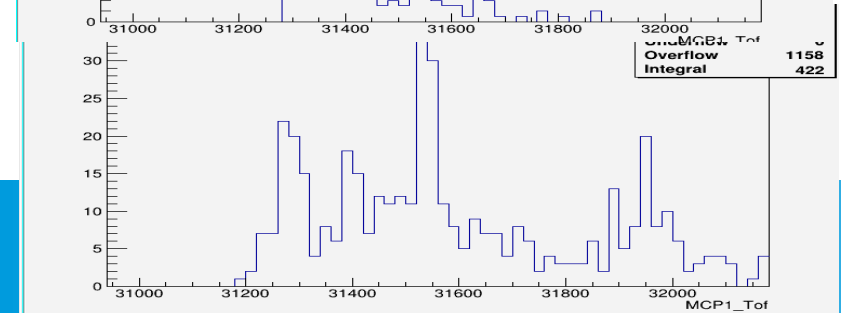
991 microsecond



996 microsecond

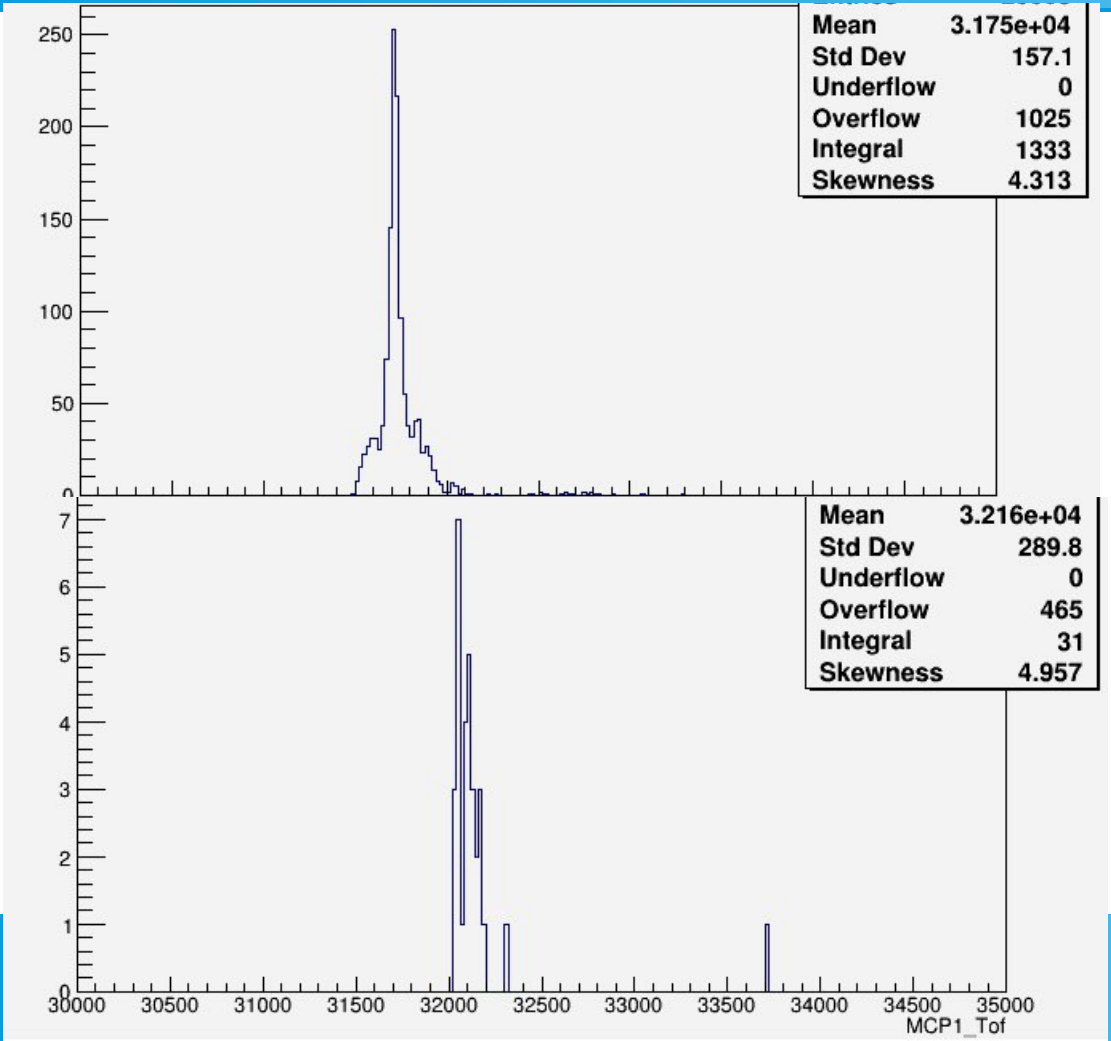


1001 microsecond



1021 microsecond

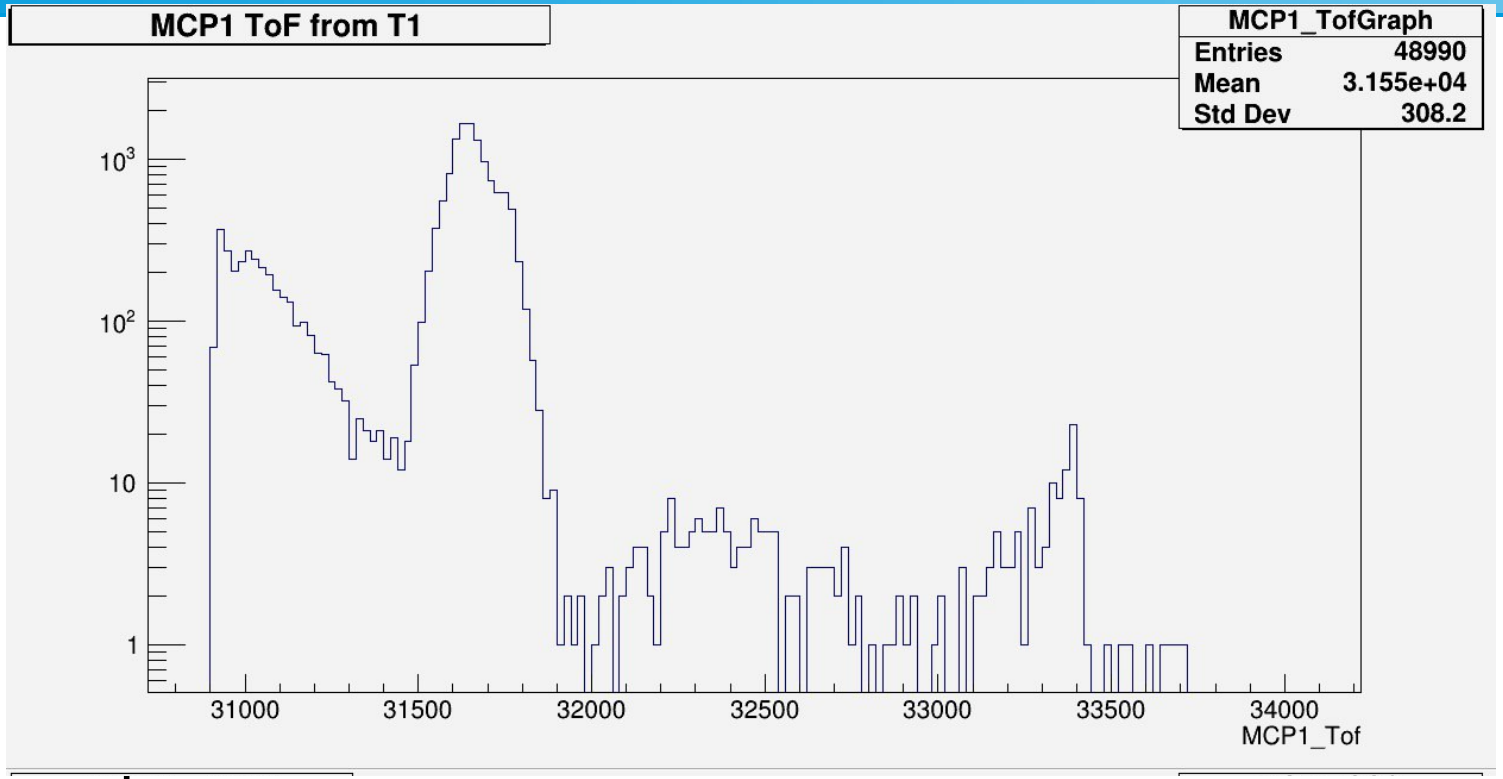
Purified Mg on MORA MCP1



^{23}Na and ^{23}Mg after 200 rev with low intensity beam on MCP1

Possibly purified Mg after adjusting in-trap lift timing

Caveat: High Intensity of Ions

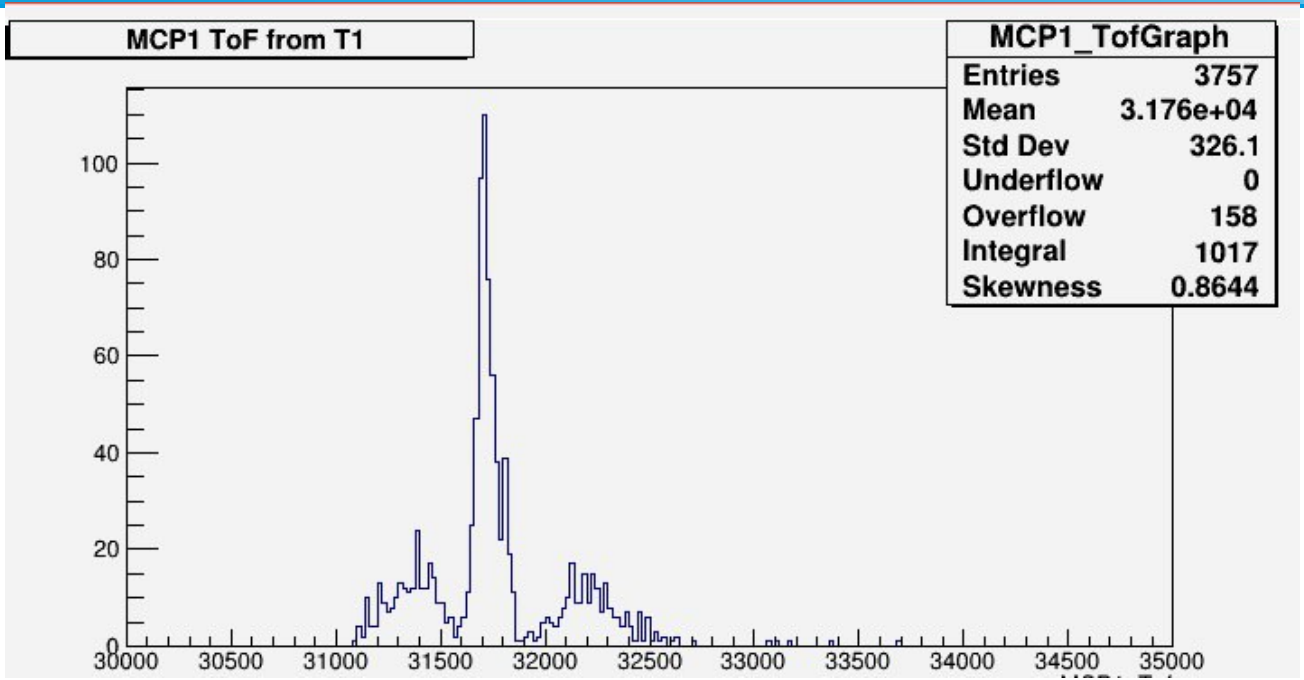


- Distorted spectrum
- ~0.7% trap efficiency

Caveat: High Intensity of Ions

~3000 ions per bunch

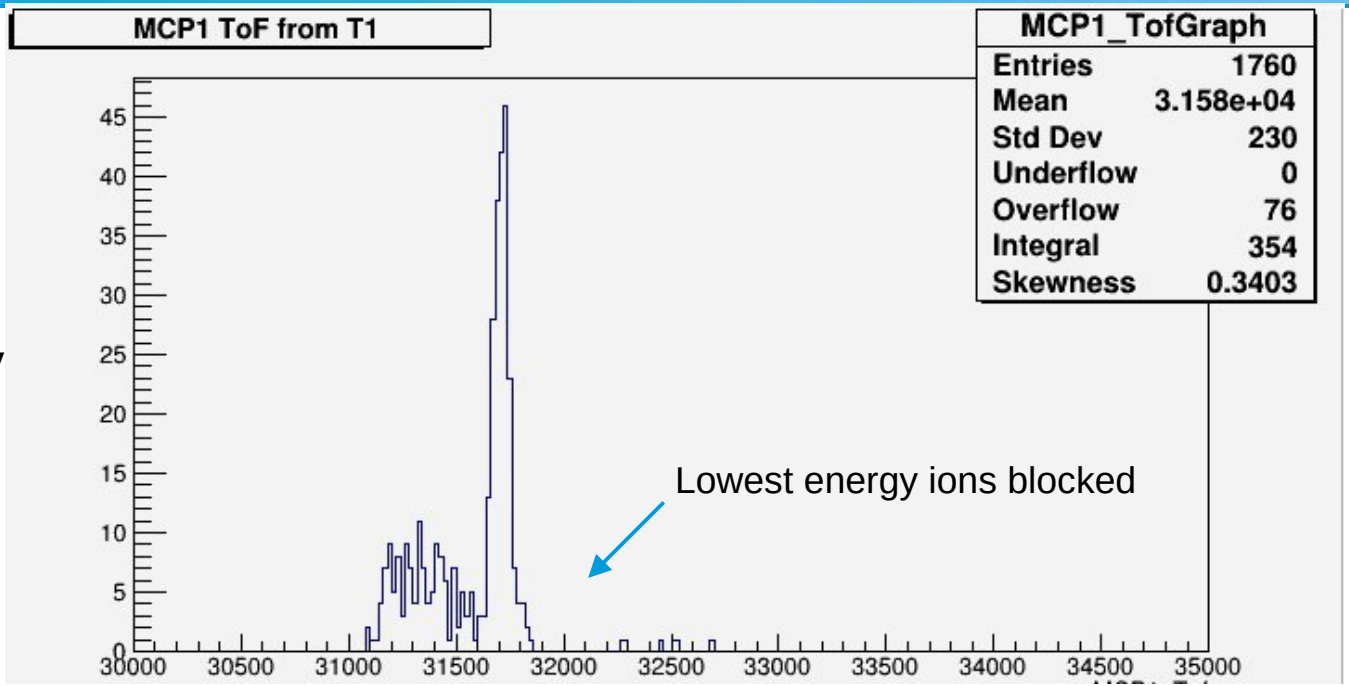
Peak develops “wings”



Three peak structure at 200 rev with high beam intensity (Na + Mg)

Indication of an Energy-dependence

Ions appear to separate by energy after trapping in MR-TOF-MS



A retarding voltage before the MCP blocks the lowest-energy ions

Indication of an Energy-dependence

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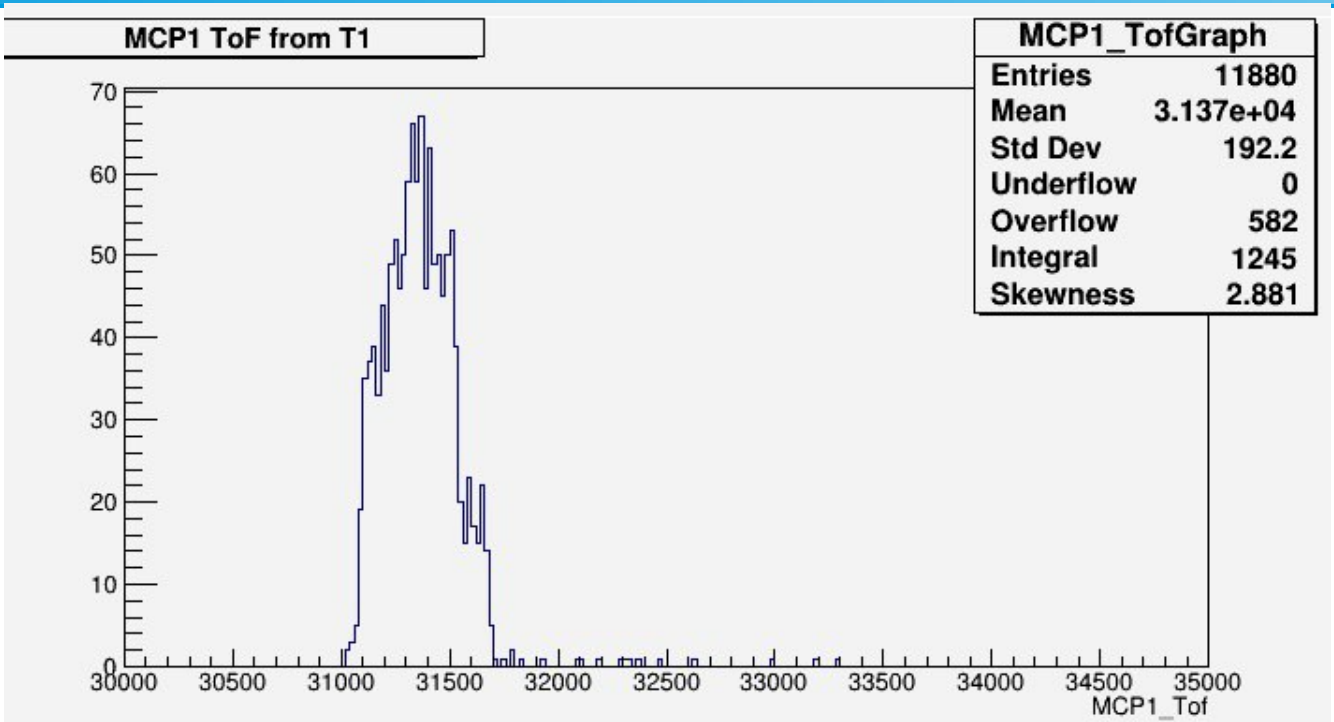
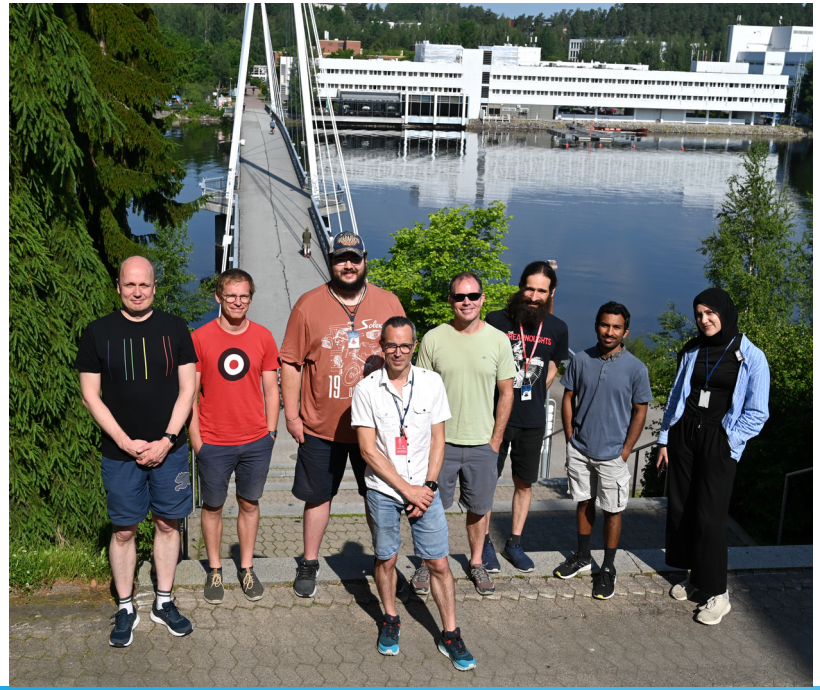


Even higher blocking potential

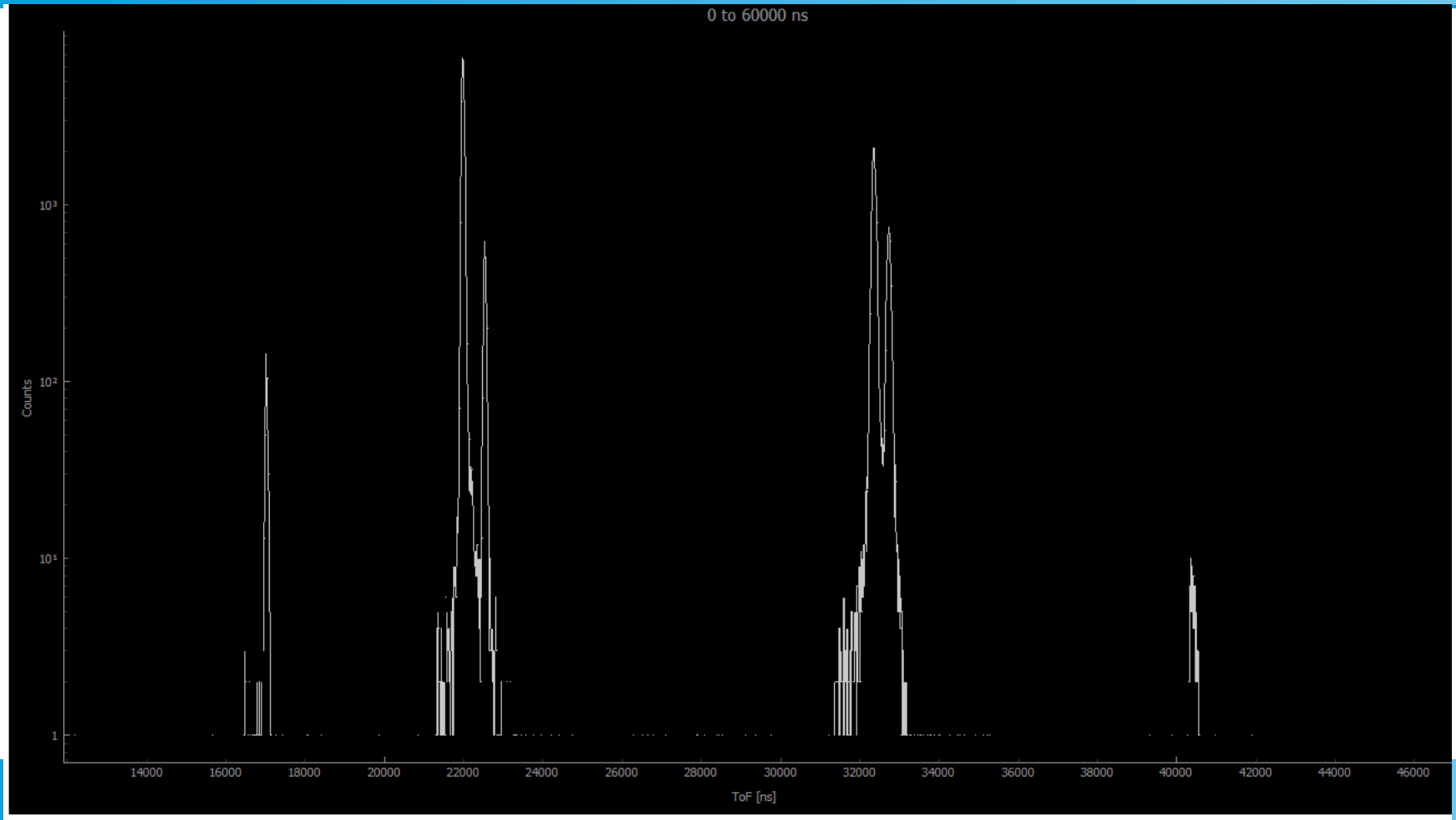
Considerations for Many Ions per Bunch

- Large space-charge changes the starting potential of the ions
- So the in-trap lift voltage needs to change for an approximately energy-independent time-focus
- Changing the in-trap lift also shifts the total TOF to MORA

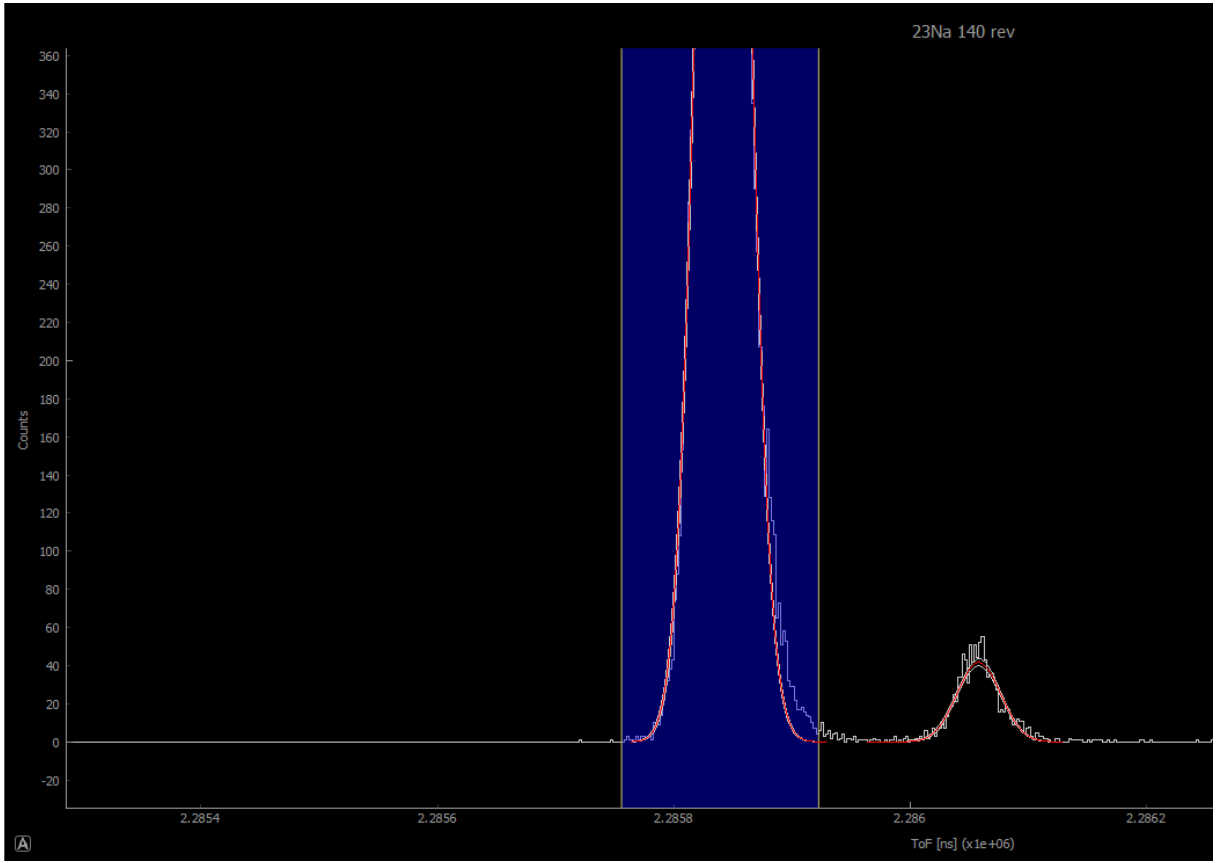
Kiitos/Merci

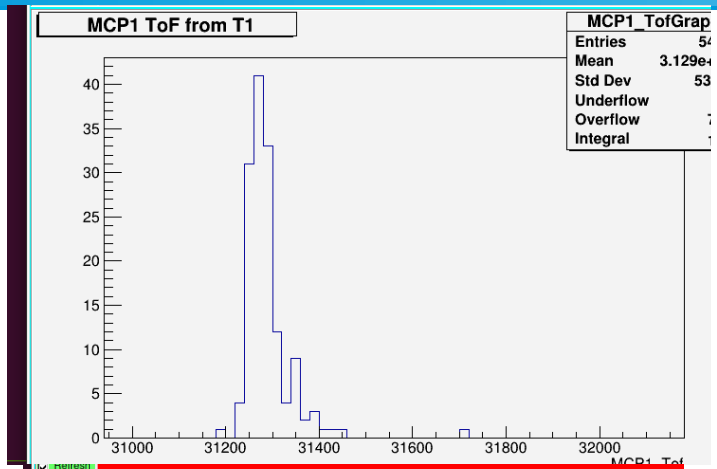


PISA Source Allows Mini-buncher tuning

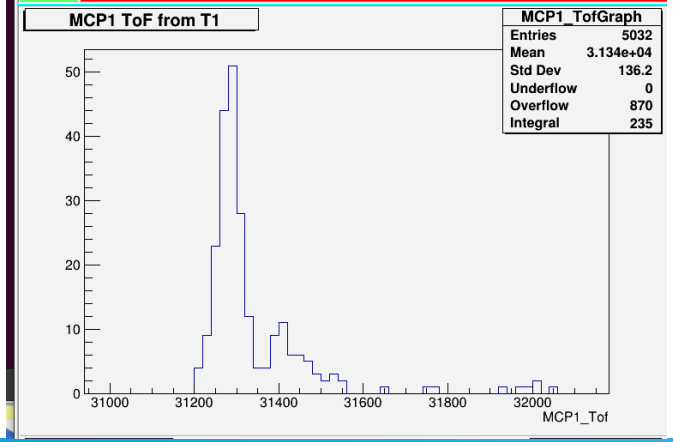


23Mg/23Na Ratio Optimization





10 ms beam gate



20 ms