Commissioning and First Experiments with TITAN's Multiple-Reflection Time-of-Flight Isobar Separator and Mass Spectrometer

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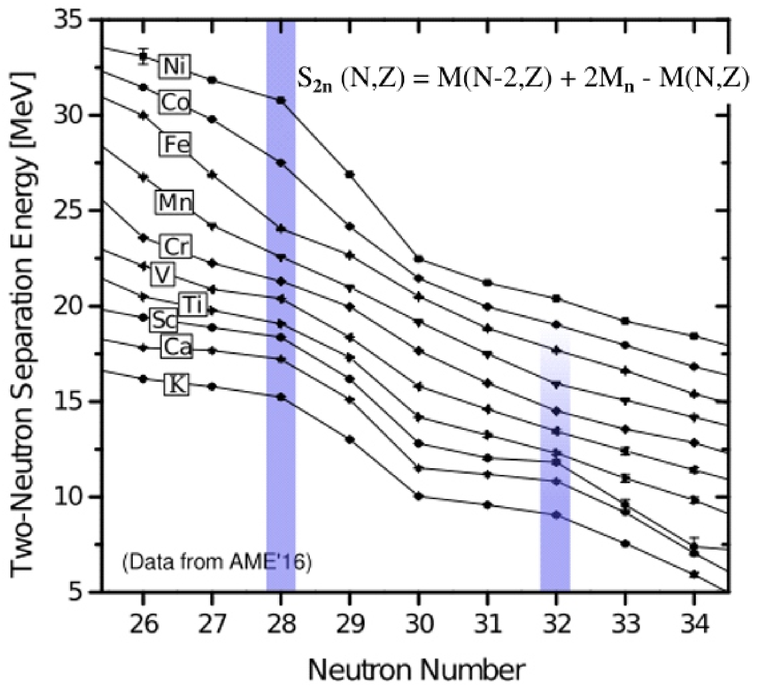
Introduction

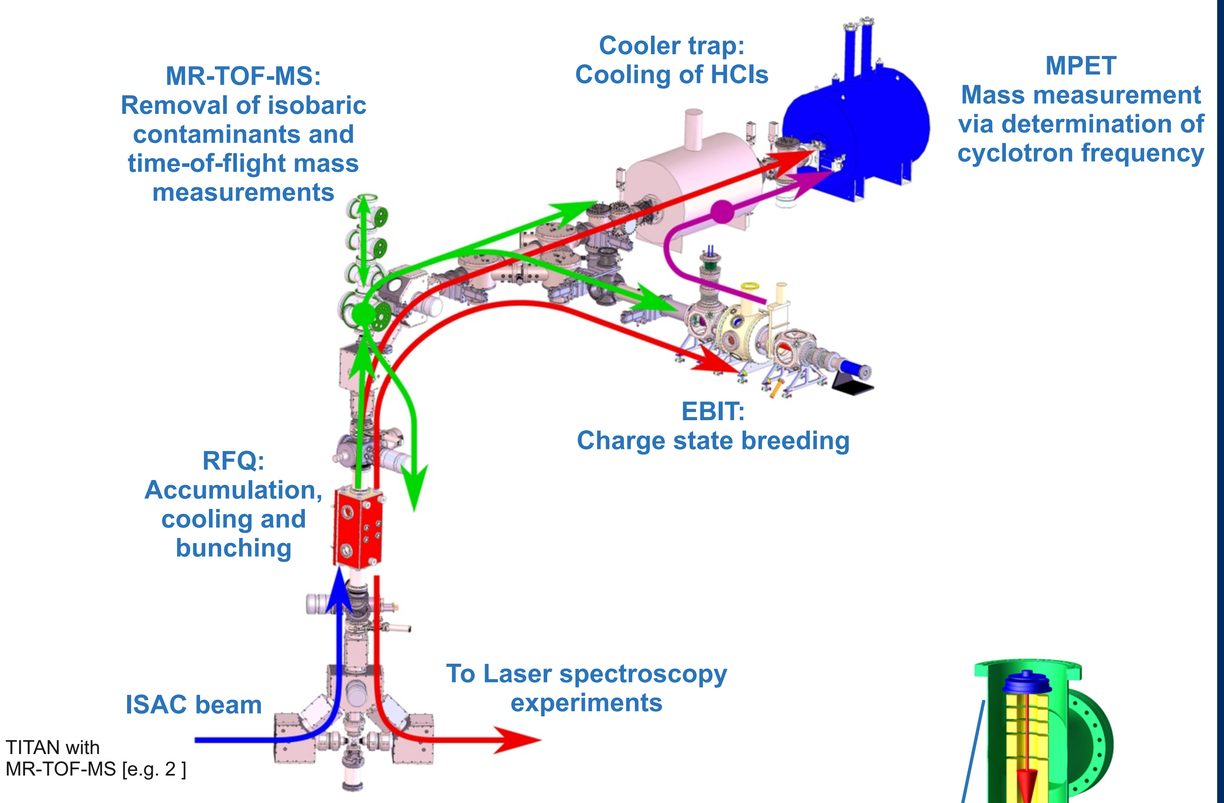
TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) [1] is a multiple ion-trap system for high-precision mass measurements and in-trap decay spectroscopy located at the Isotope Separator and Accelerator (ISAC). There, exotic nuclei can be produced with very high rates. However, these beams often suffer from strong isobaric background. Recently a Multi-Reflection Time-of-Flight Mass Separator and Spectrometer (MR-TOF-MS) has been installed and commissioned at TITAN to overcome this problem [2].

High-accuracy mass measurements of neutron-rich titanium isotopes were performed by the MR-TOF-MS to probe the existence of the N=32 sub-shell closure above calcium.



The TITAN Experiment

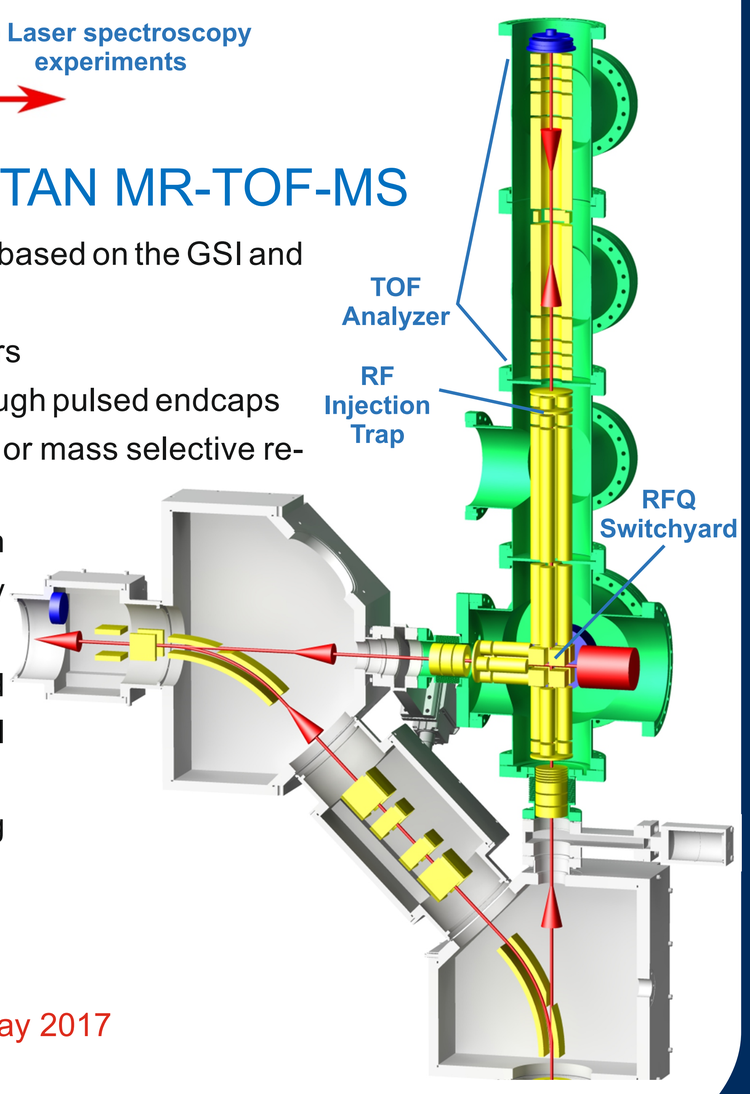
High accuracy mass measurements and in-trap decay spectroscopy



The TITAN MR-TOF-MS

Build at the University of Gießen based on the GSI and JLU Gießen MR-TOF-MS [3]

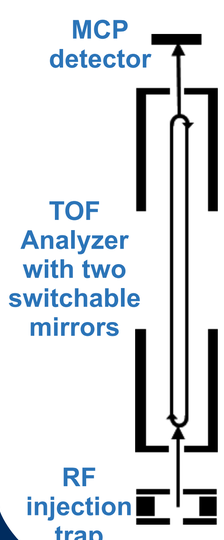
- Two gridless electrostatic mirrors
- Analyzer injection/ejection through pulsed endcaps
- Direct mass measurements [4] or mass selective re-trapping [5, 6] can be performed
- Transport and cooling of ions in buffer gas filled Radio Frequency Quadrupoles (RFQ)
- Merging of ions of interest and calibrant ions from the internal source in an RFQ switchyard [7]
- Minimal impact on the existing TITAN beamline



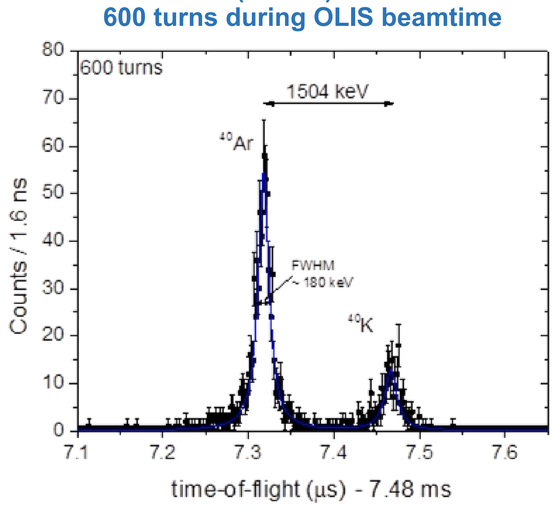
TITAN MR-TOF-MS with connection to the existing TITAN beam line [2]

Commissioned in beamline May 2017

Mass Measurement Mode



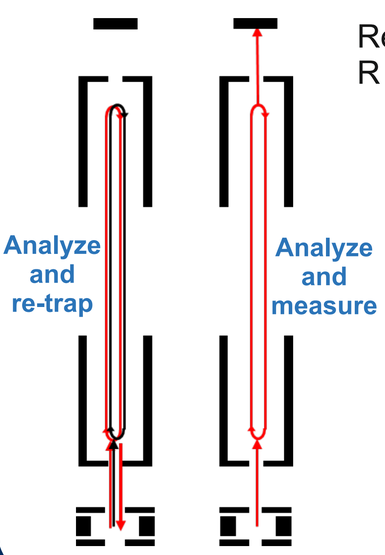
Mass resolving power of up to 200.000 (FWHM) reached in 600 turns during OLIS beamtime



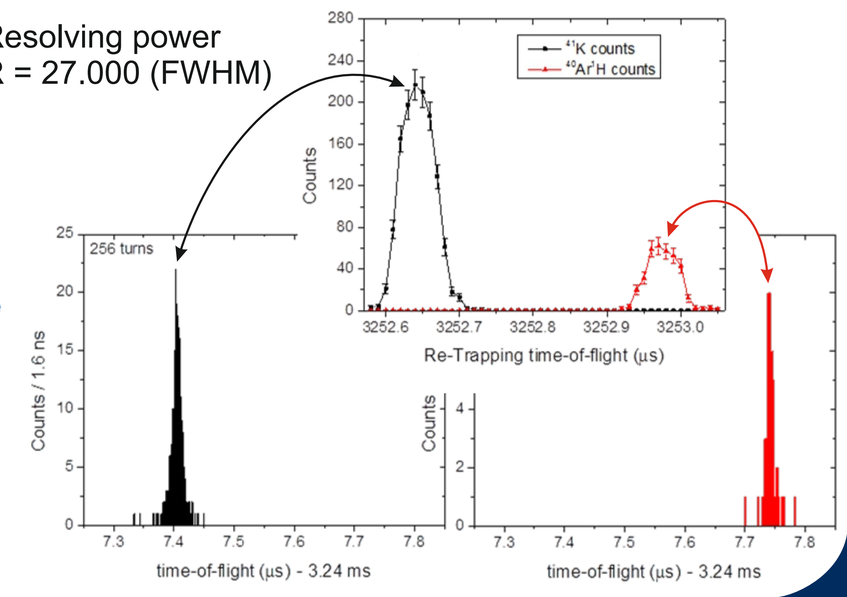
+ High accuracy
  δm/m ~ 10^{-7}
+ Fast
  access to short-lived, $T_{½}$ ~ ms isotopes
+ High sensitivity
  access to low abundance isotopes
+ Non-scanning
  measure several isotopes simultaneous

Isobar Separation Mode

Operate as its own isobar separator or as isobar separator for further experiments

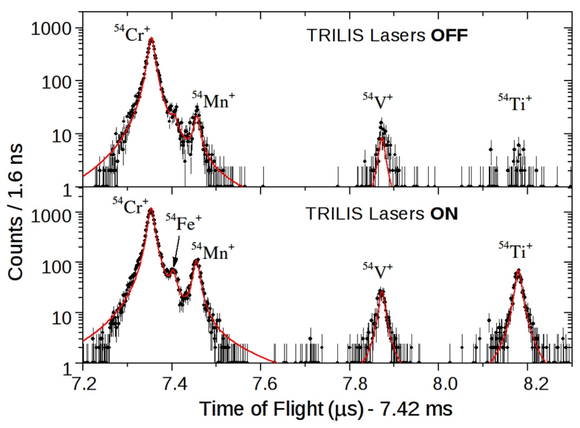


Resolving power
R = 27.000 (FWHM)



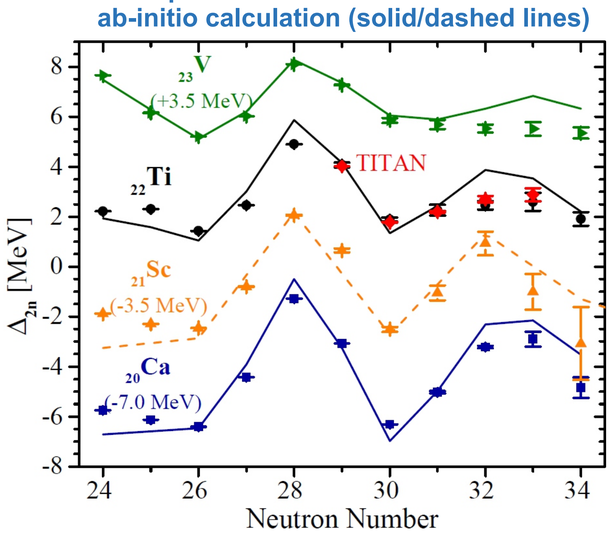
Mass Measurements of Neutron-Rich Titanium Isotopes and the Sub-Shell Closure around N = 32

Isobaric contaminants and enhanced yield of exotic nuclei by laser ionisation schemes



TOF spectra without and with laser ionization [7]

Comparison of different isotones with ab-initio calculation (solid/dashed lines)



Neutron shell gaps [8]

Accurate measurements of rare titanium isotopes with the Penning trap and MR-TOF-MS.
^{54}Ti and ^{55}Ti measured with MR-TOF-MS only.

References

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Acknowledgement

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