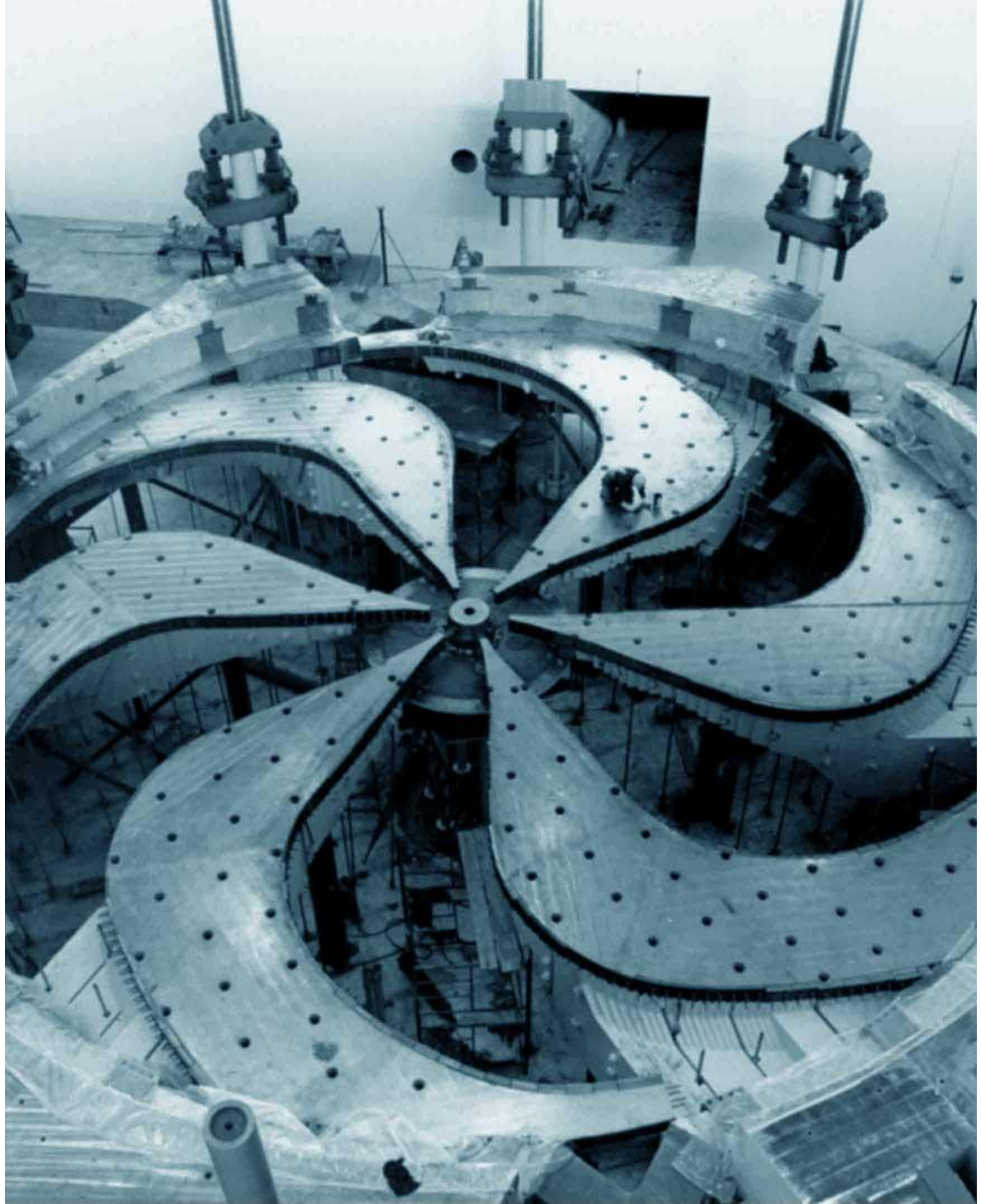
TRIUMF

Mass Measurements around *N* = *32* - *34* and Upgrades for TITAN MPET

Sam Porter

2021 WNPPC -- February 10th, 2021

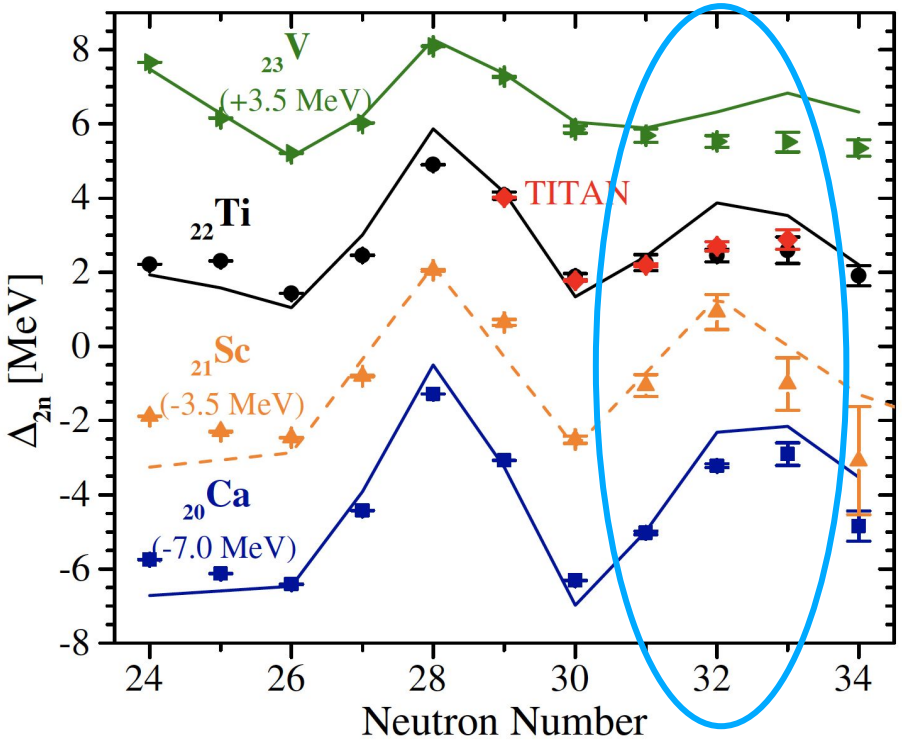


Discovery, accelerated

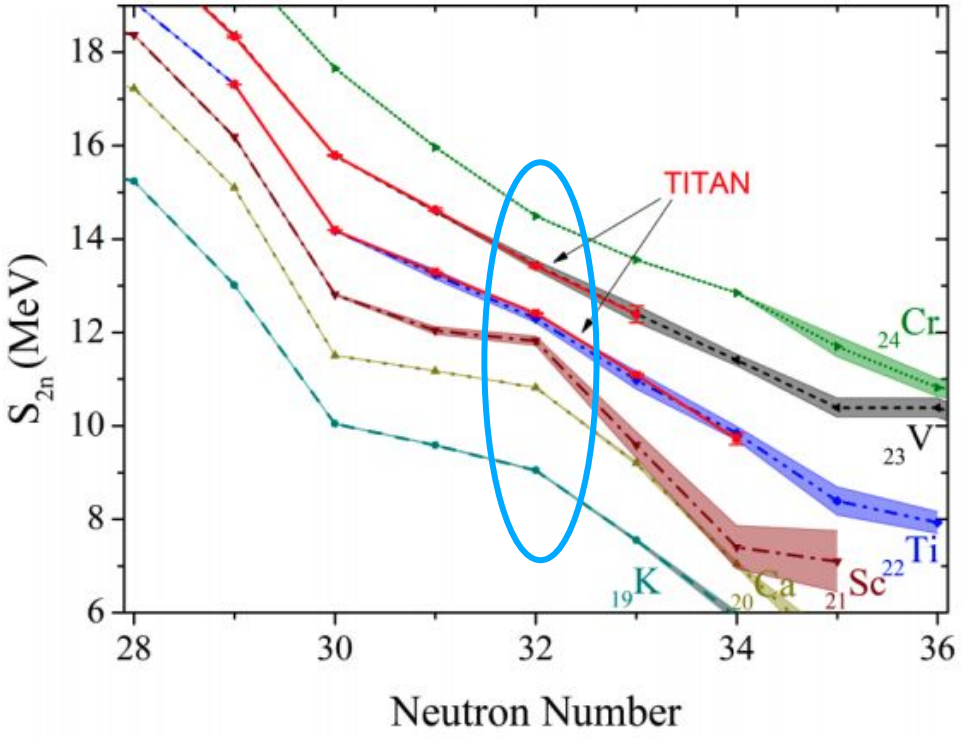
Overview

- Motivation for N ~ 32-34 mass measurements
- Masses at TITAN MR-ToF-MS
- Probing shell closures with mass results
- CryoMPET Upgrades

Why N ~ 32 - 34 Masses?



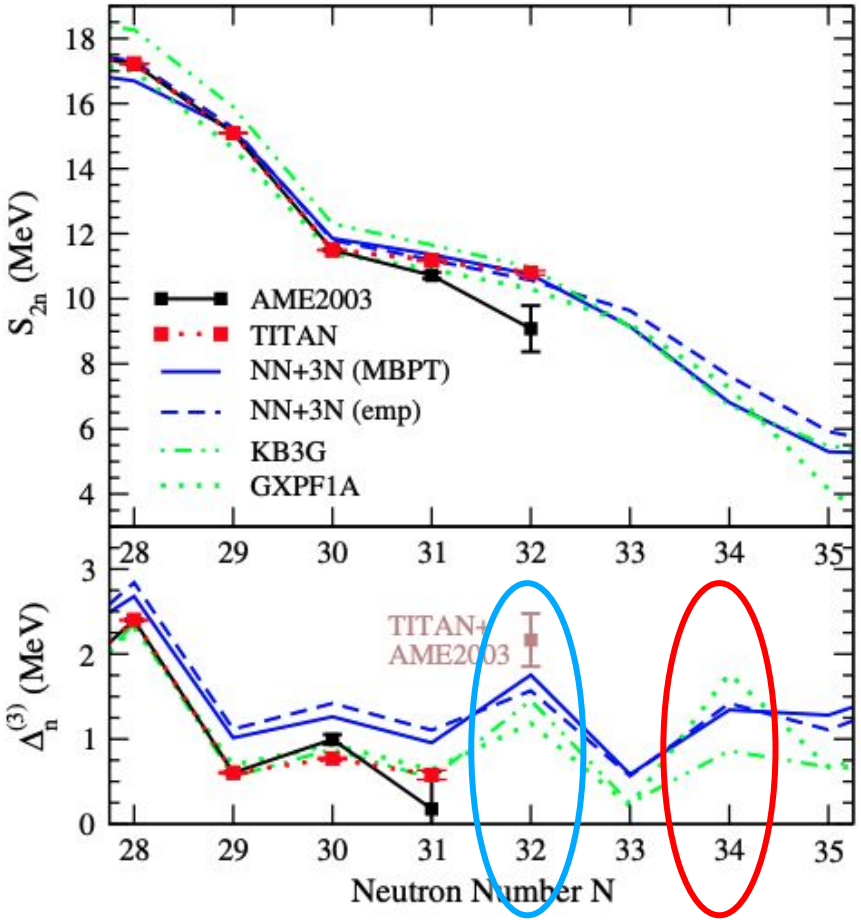
E. Leistenschneider *et. al.*, PRL **120**, 062503 (2018)



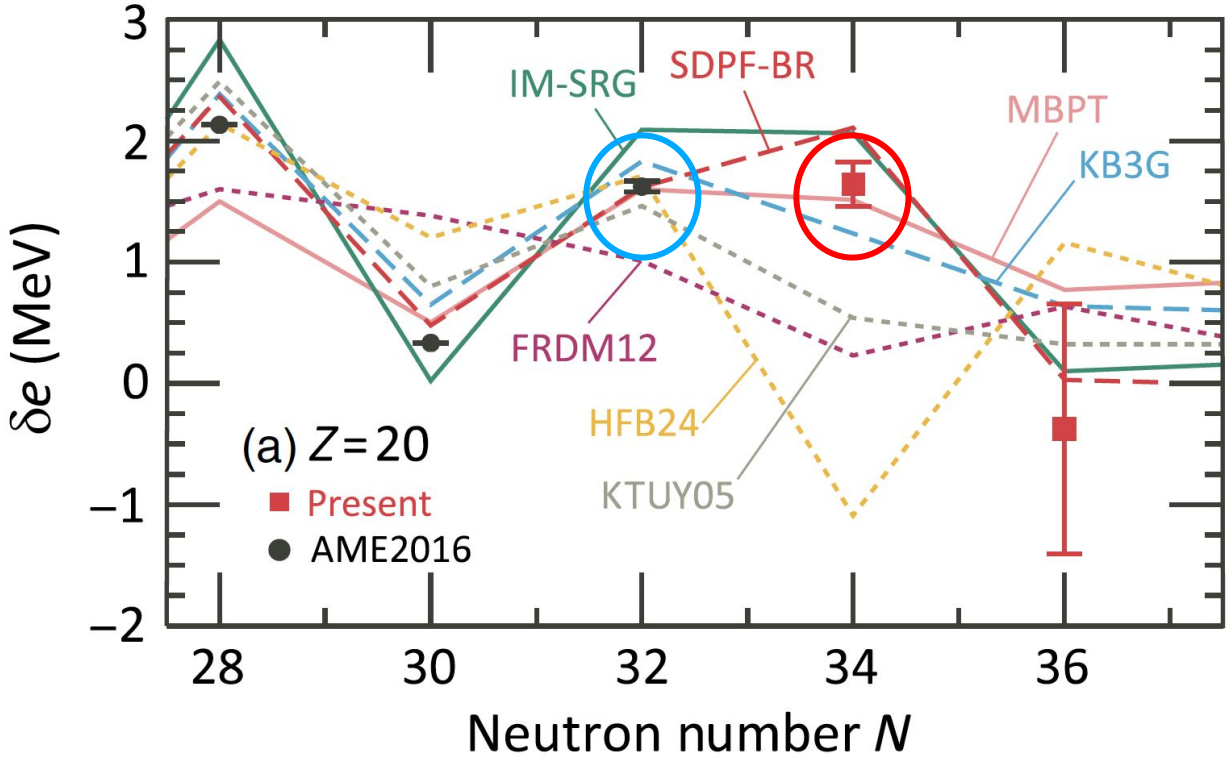
M.P. Reiter *et. al.*, PRC **98**, 024310 (2018)

N = 32 closed-shell behavior

Why N ~ 32 - 34 Masses?



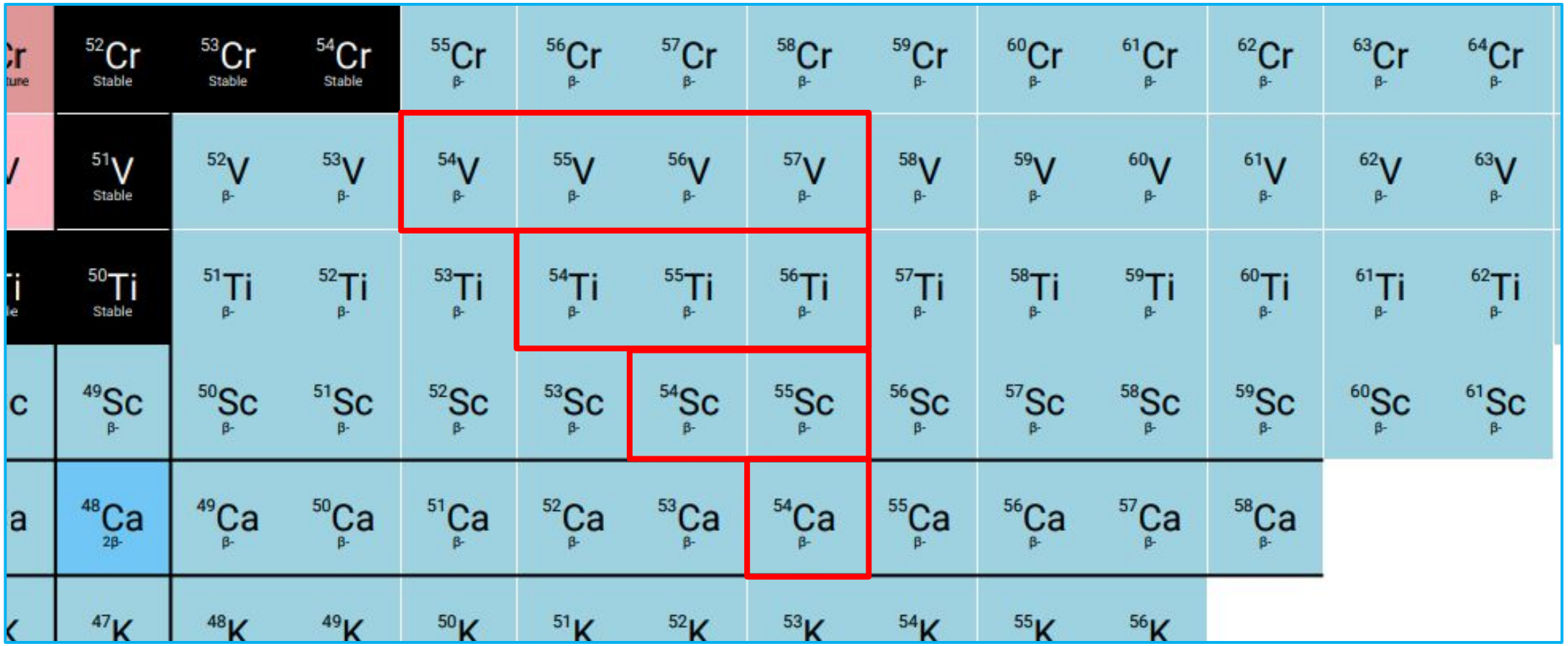
A.T. Gallant *et. al.*, PRL **109**, 032506 (2012)



S. Michimasa *et. al.*, PRL **121**, 022506 (2018)

N = 34 closed-shell behavior?

Mass Measurements around N ~ 32 - 34

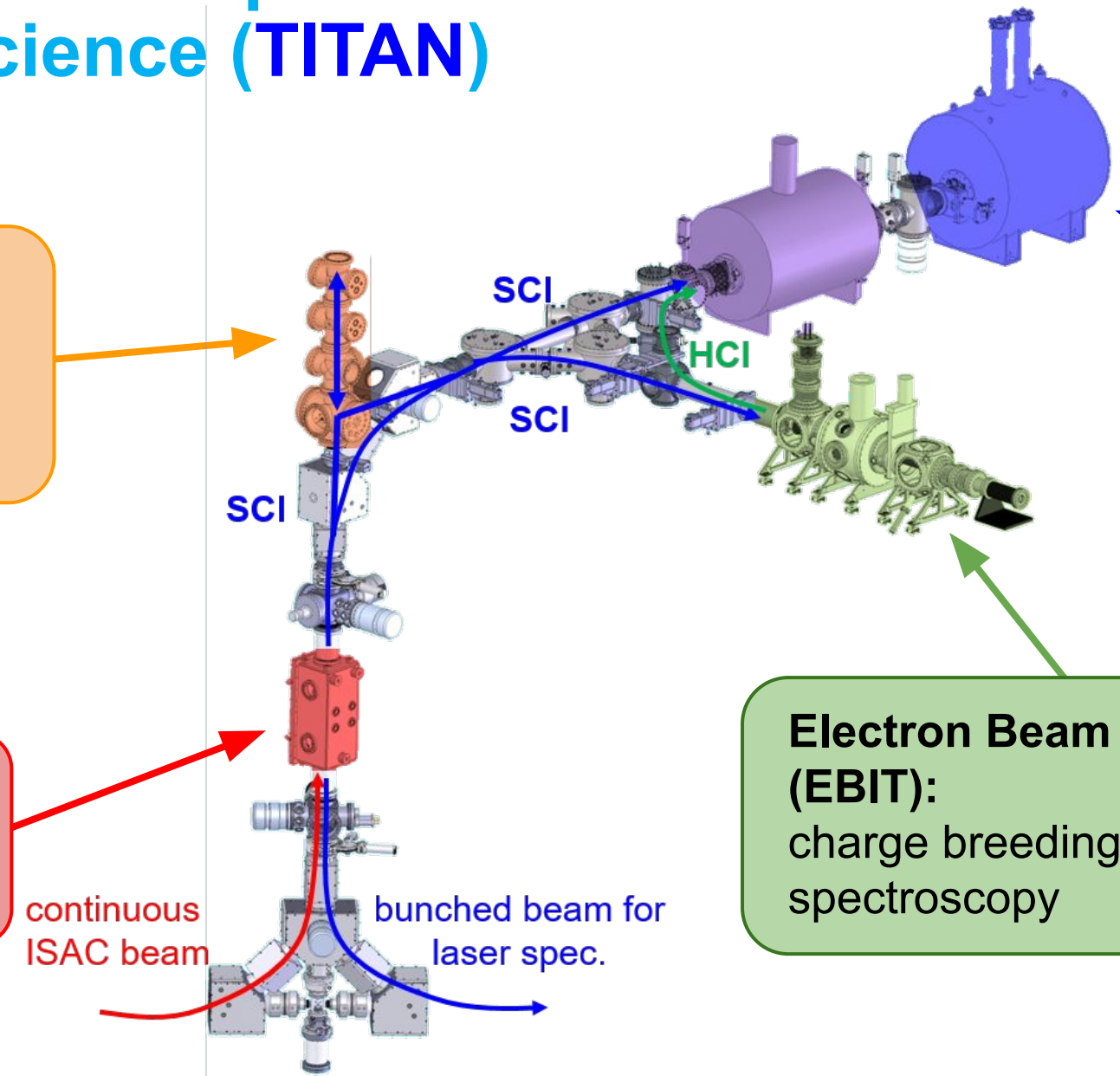


new TITAN MR-ToF-MS measurements

TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN)

MR-ToF-MS: mass separation via time-of-flight

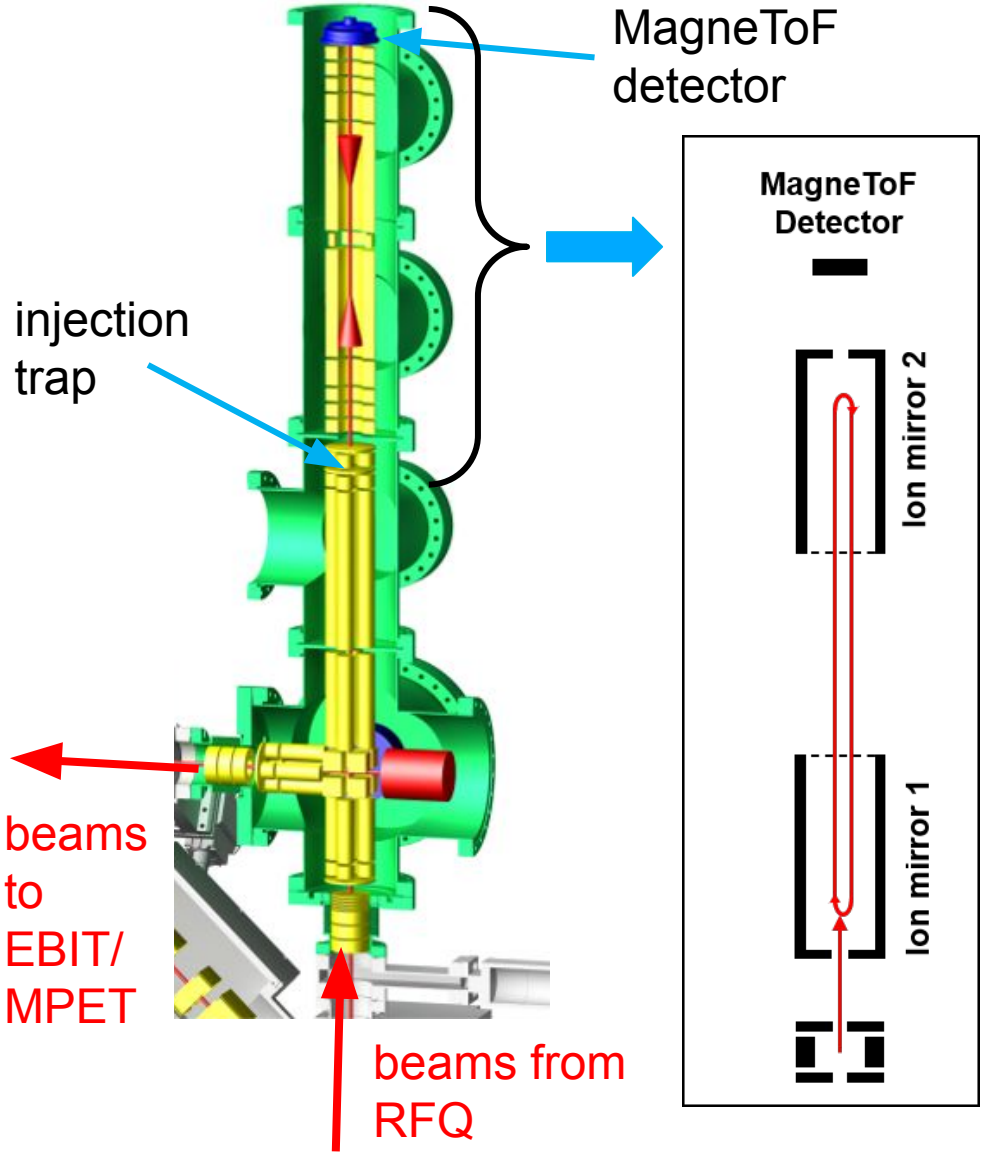
TITAN RFQ: cools and bunches beam



Measurement Penning Trap (MPET): high precision mass measurements

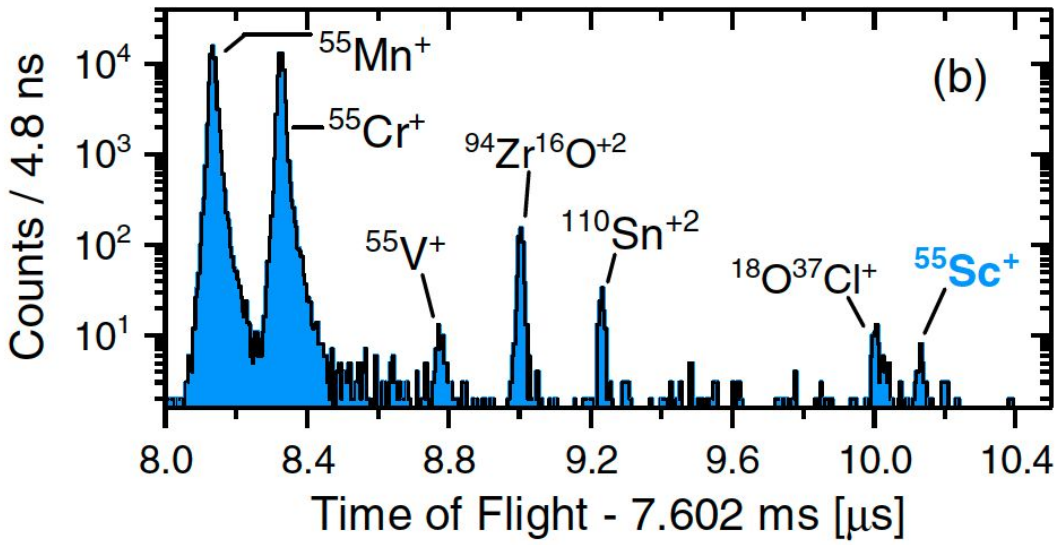
Electron Beam Ion Trap (EBIT): charge breeding and decay spectroscopy

Multiple-Reflection Time-of-Flight Mass-Spectrometer (MR-ToF-MS)



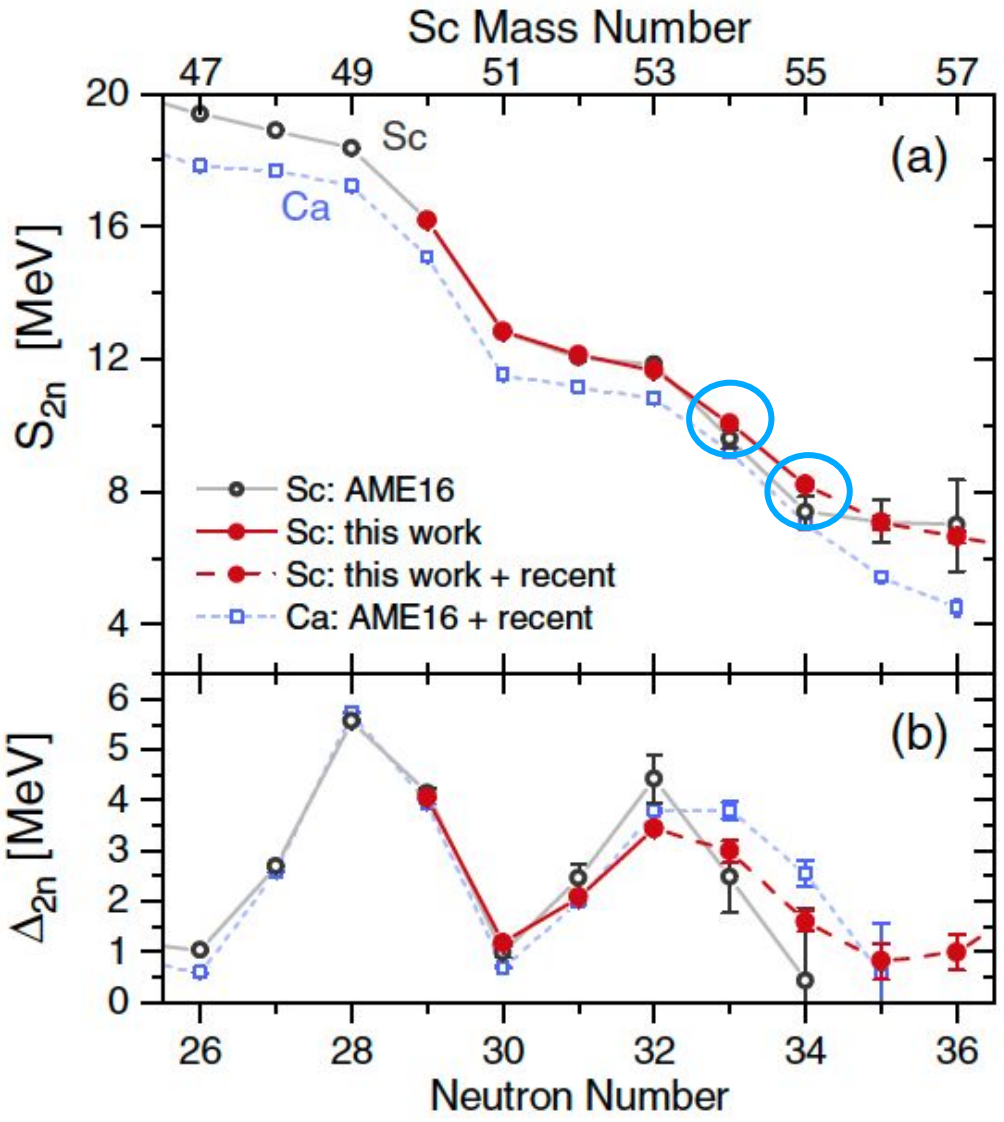
- **R ~ 500,000**
- Ion-of-Interest to background ratios up to **1:10^5**
- measure masses w/ **$t_{1/2}$ > few ms**

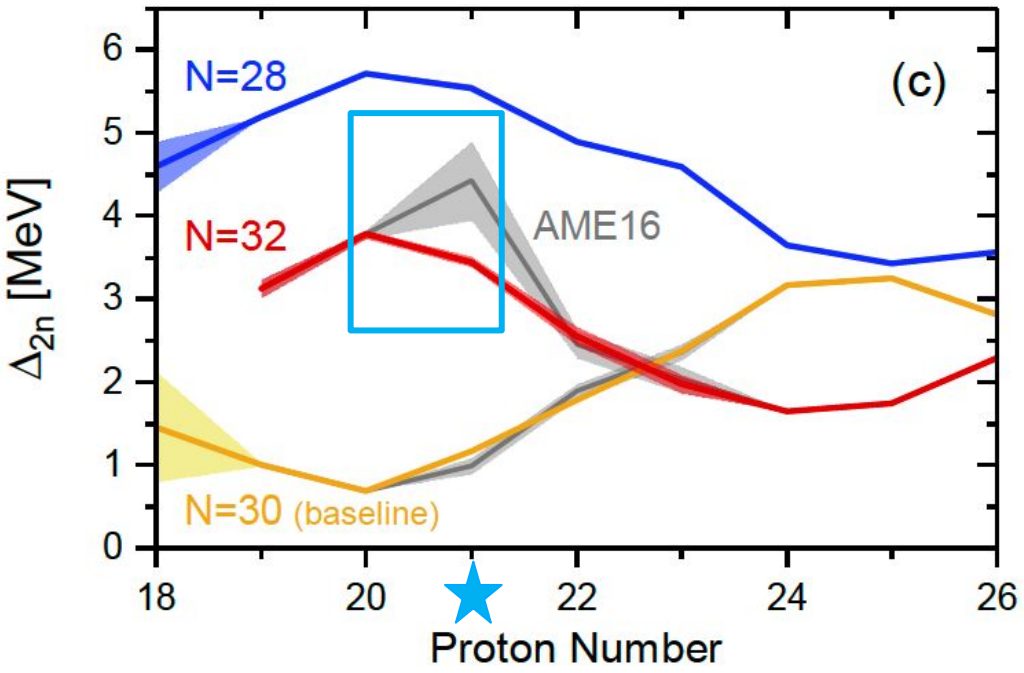
M.P. Reiter *et. al.*, Nuc. Inst. Methods B **463** (2020)



E. Leistenschneider *et. al.,* PRL **126**, 042501 (2021)

^{54}Sc and ^{55}Sc



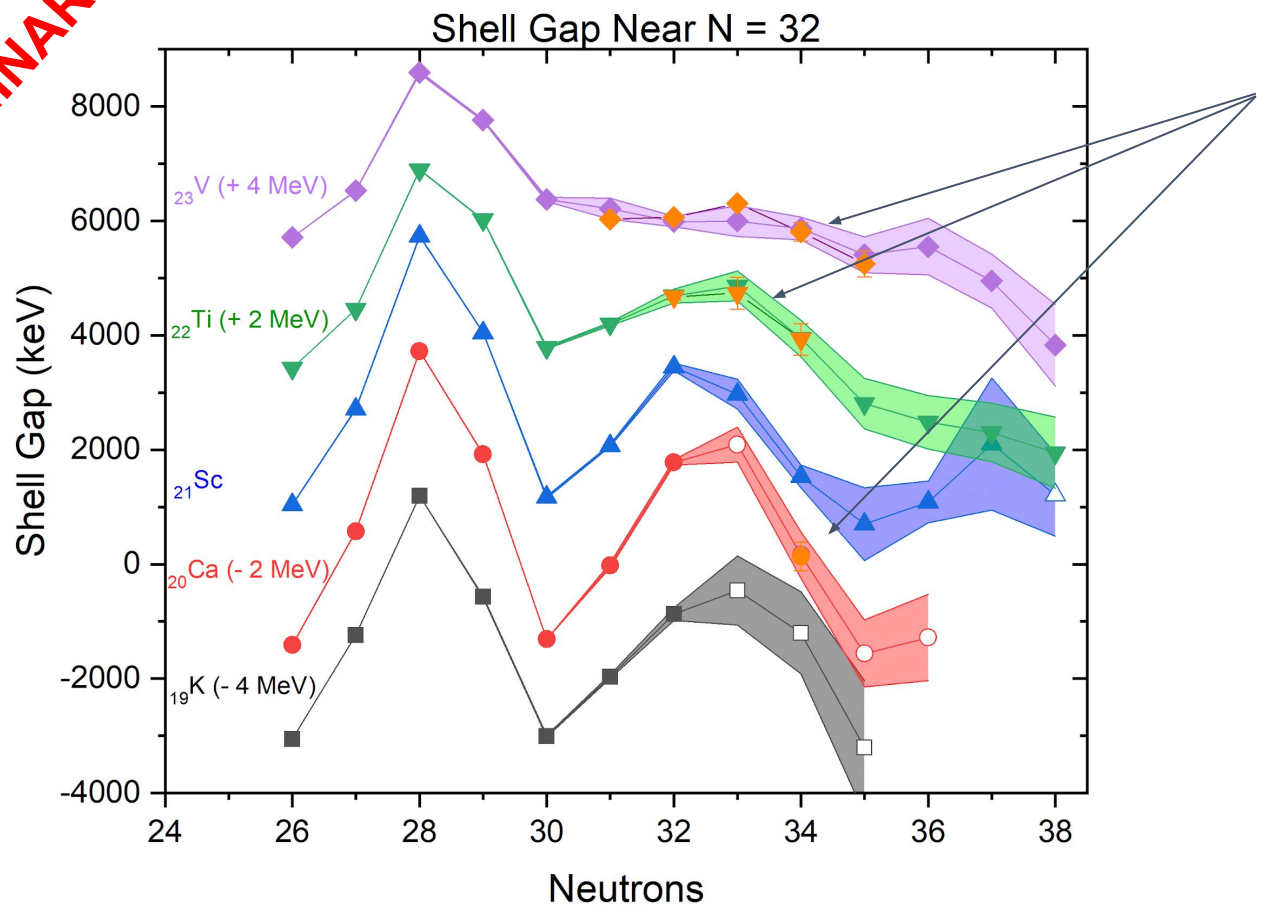


Supports doubly-magicity of ^{52}Ca

E. Leistenschneider *et. al.,* PRL **126**, 042501 (2021)

Ca, Ti and V Masses

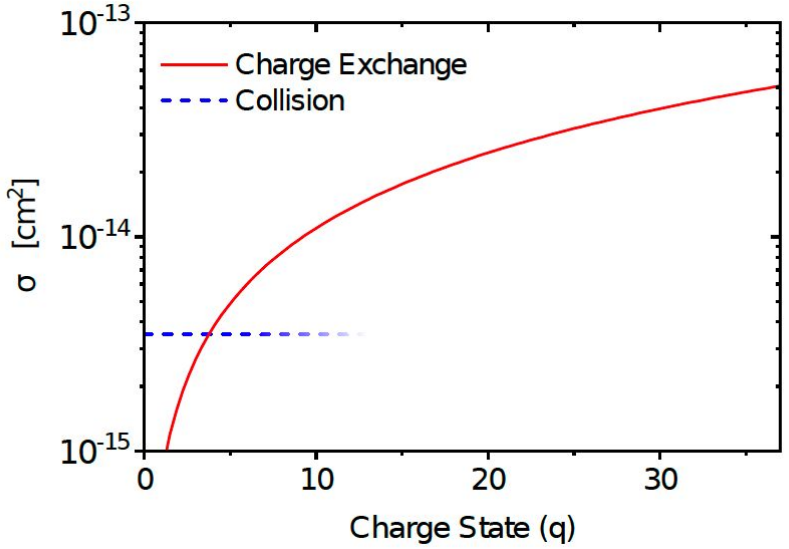
PRELIMINARY

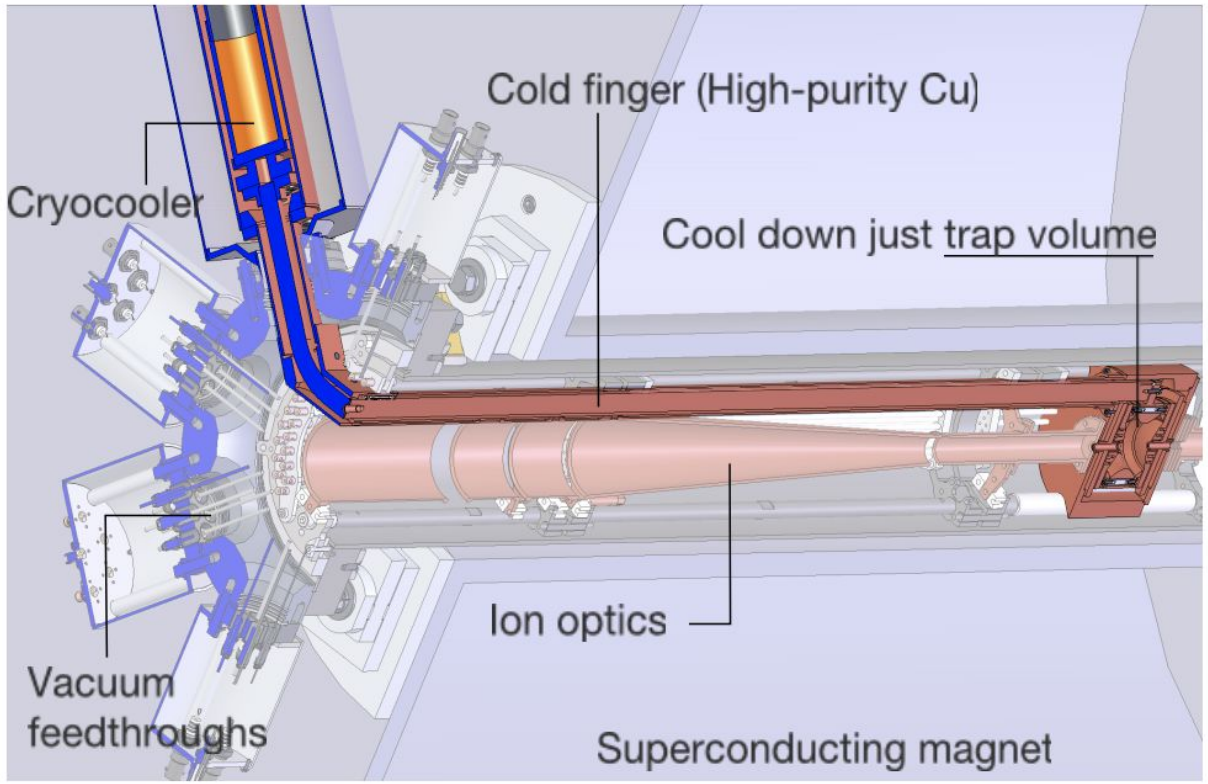


TITAN

CryoMPET Upgrade: Vacuum Considerations

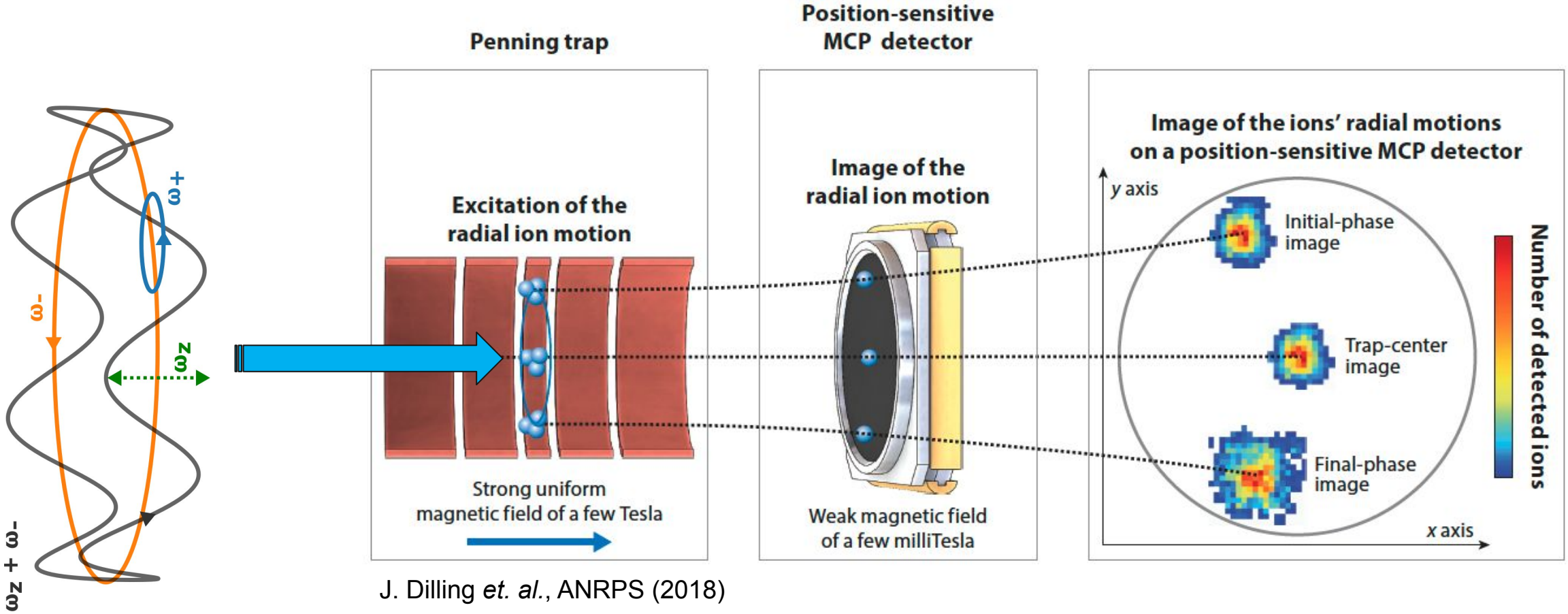
$$\frac{\delta m}{m} \propto \frac{1}{qTB\sqrt{N}}$$





E. Leistenschneider, Ph.D Thesis (2019)

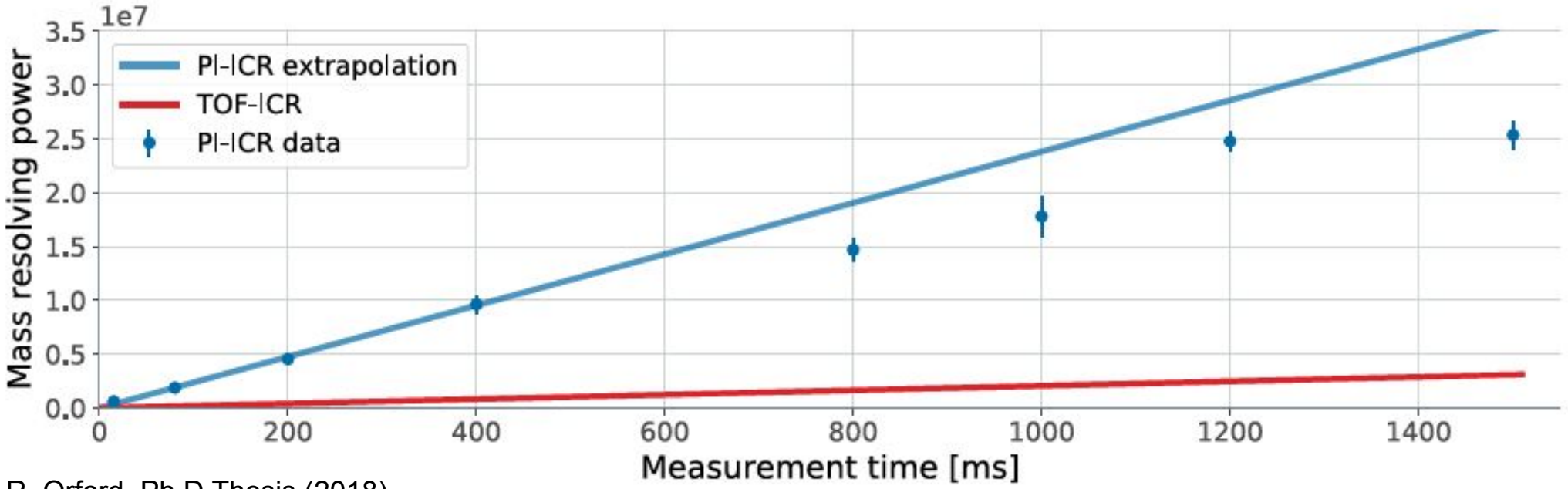
CryoMPET Upgrade: PI-ICR



J. Dilling *et. al.*, ANRPS (2018)

$$\nu_c = \frac{\phi + 2\pi n}{2\pi t}$$

CryoMPET Upgrade: PI-ICR

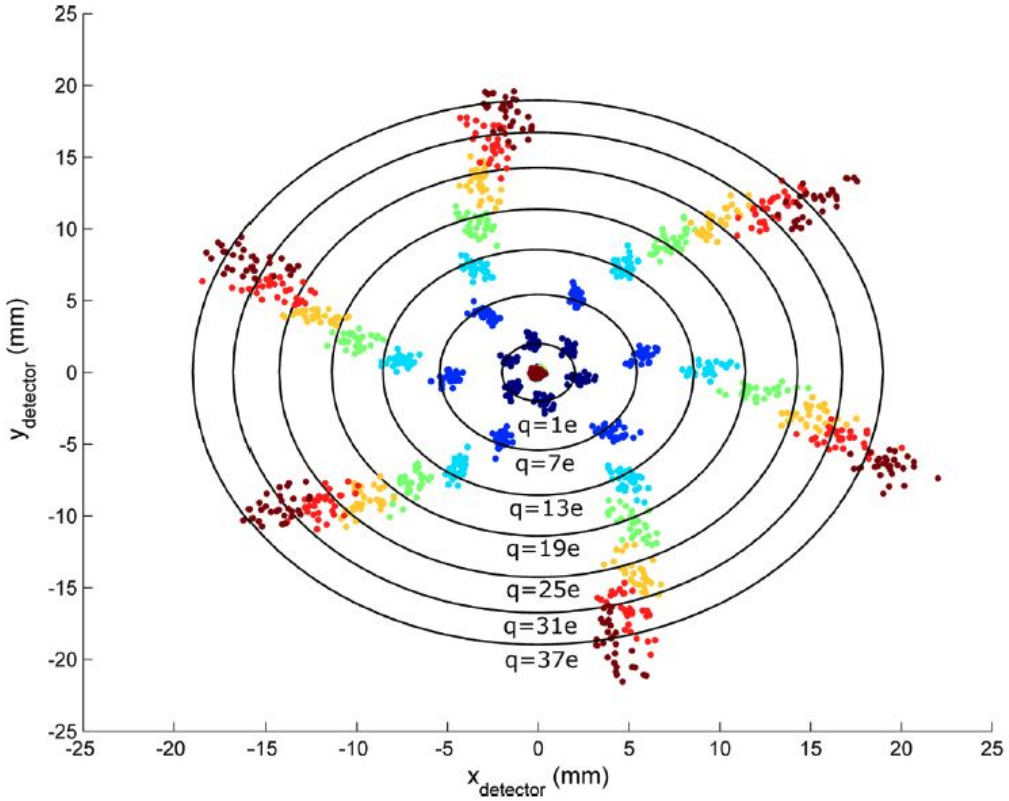


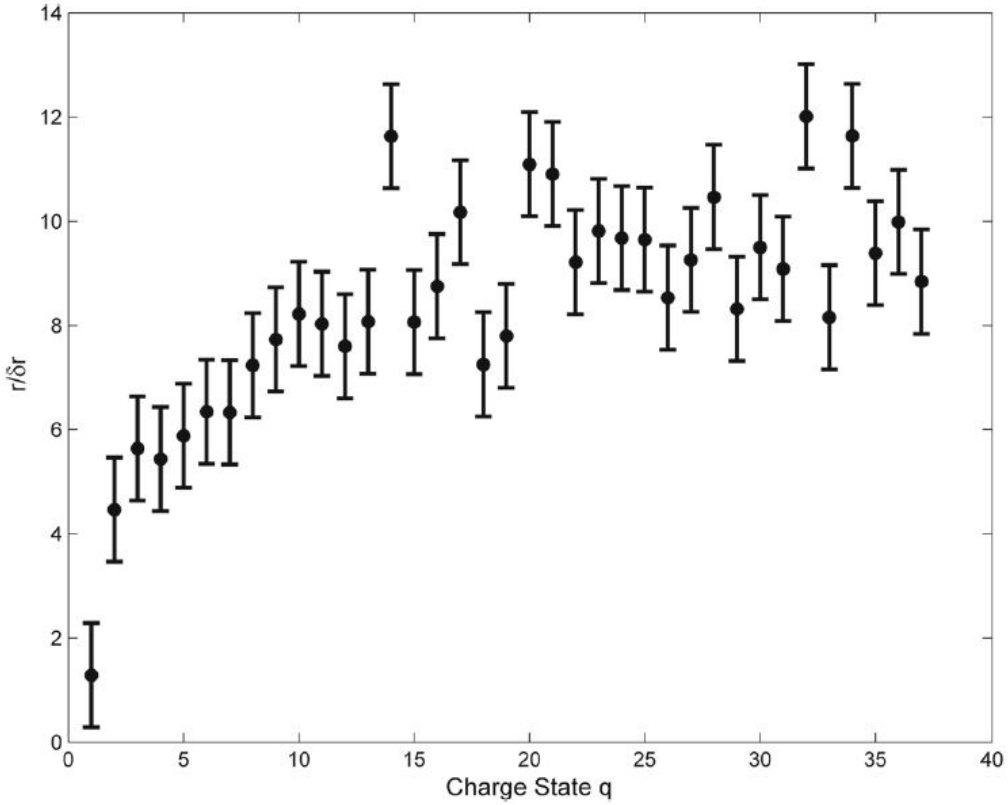
R. Orford, Ph.D Thesis (2018)

ToF-ICR: $\delta\nu \approx 0.8\frac{1}{\sqrt{nt}}$

PI-ICR: $\delta\nu \approx \frac{0.234\sigma_{FWHM}}{r}\frac{1}{\sqrt{nt}}$

CryoMPET Upgrade: PI-ICR with HCIs





E.M. Lykiardopoulou, Hyperfine Inter. **241** (2020)

- NEW 40mm Roentdek MCP to allow for maximal orbit radius
- NEW 25ps TDC for improved positional accuracy

Conclusions

- **Ca, Sc, Ti and V mass measurements around *N = 32-34***
  - via **TITAN MR-ToF-MS**
  - More n-rich measurements needed to refine mass surface

- **CryoMPET Upgrades**
  - Will enable precise measurements of **radioactive HCIs**
  - **PI-ICR technique** will allow for increased resolution, precision

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Discovery, accelerated

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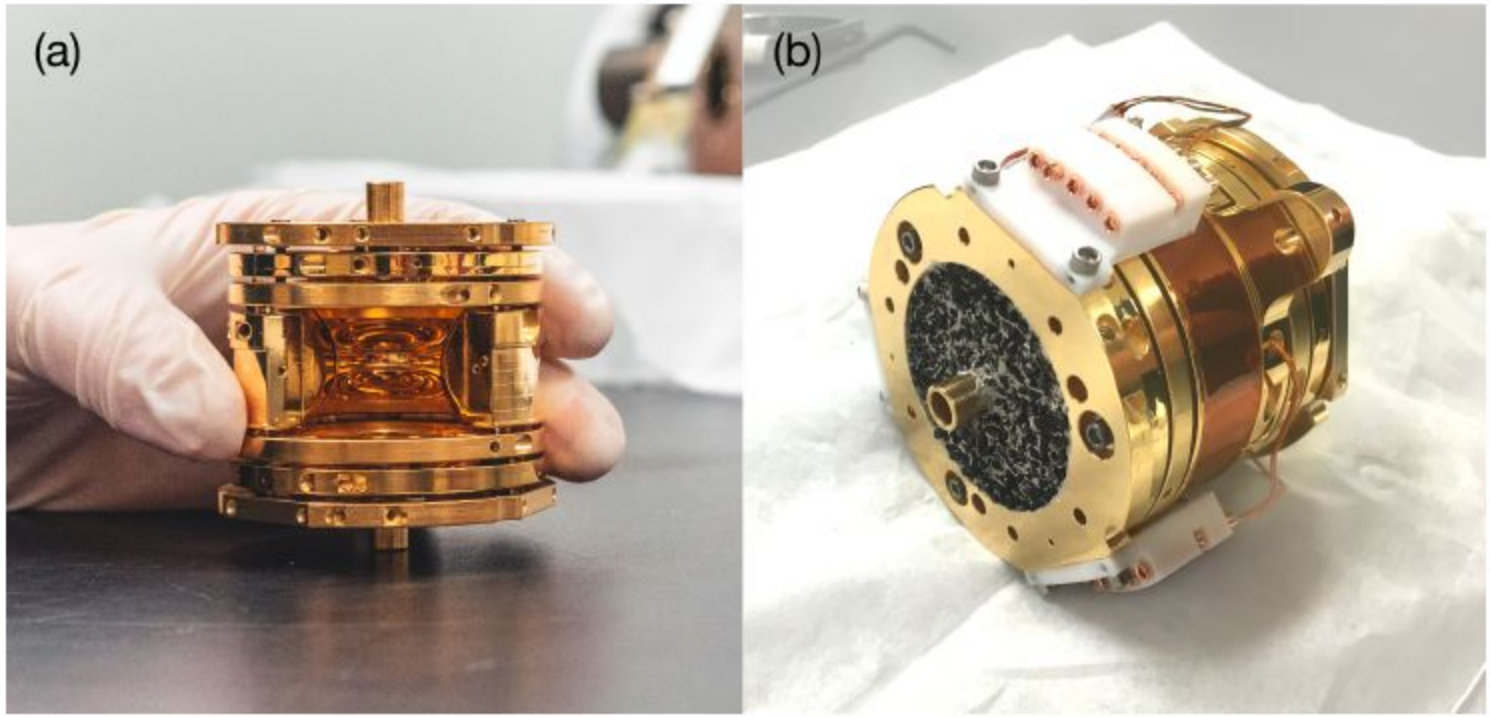
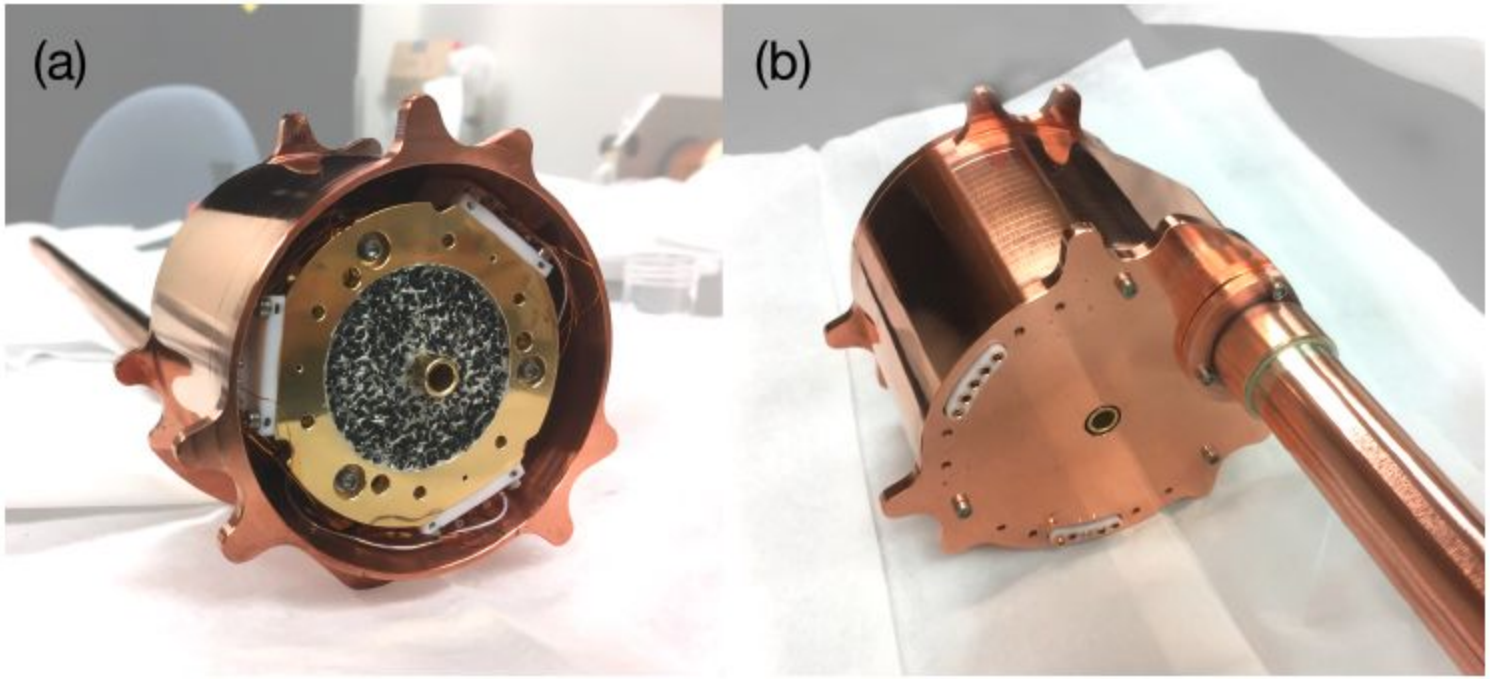
NRC·CNRC
NSERC CRSNG
DFG Deutsche Forschungsgemeinschaft

CryoMPET



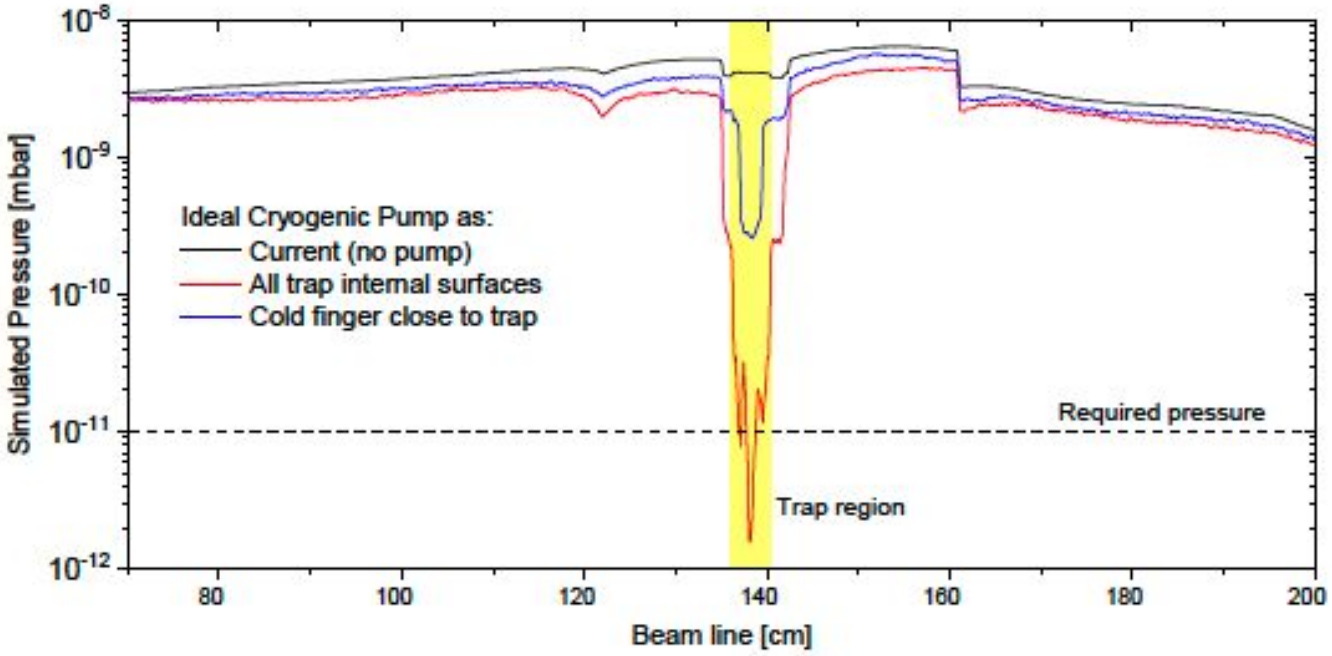
E. Leistenschneider, Ph.D Thesis (2019)

CryoMPET



E. Leistenschneider, Ph.D Thesis (2019)

CryoMPET Vacuum



E. Leistenschneider, Ph.D Thesis (2019)