Mass Measurements of rare Isotopes with a Single Ion



- Motivation for mass measurements with a single rare isotope
- LEBIT facility at NSCL for rare isotopes by projectile fragmentation
- Single Ion Penning Trap (SIPT) project



Single Ion Penning Trap Mass Spectrometry (PTMS) of Rare Isotopes

Towards High-Sensitivity Mass Measurements far from Stability



SIPT project at LEBIT: measure masses of exotic isotopes with very low production rates



LEBIT (Low Energy Beam Ion TRAP) The only Penning trap mass spectrometer at a fast beam facility



- Projectile Fragmentation and In-Flight Separation
 - ✓ Fast
 - ✓ Universal
 - ✓ Chemistry independent

LEBIT has successfully performed mass measurements of rare isotope produced by projectile fragmentation

M. Eibach, et al., Phys. Rev. C 92, 045502 (2015)
K. Gulyuz, et al., Phys. Rev. Lett. 116, 012501 (2016)
A. A. Valverde et al., Phys. Rev. C 91, 037301 (2015)



Penning Trap Mass
 Spectrometry
 ✓ High-precision
 ✓ High Sensitivity





Towards Detection of a Single Rare Isotope

Narrowband Fourier Transform – Ion Cyclotron Resonance (FT-ICR) to enable high-precision mass measurements of rare isotopes produced at low rates



Predicted Limit Matches Needs

Size of Nuclear Structure Effects is typically > 100keV (δm/m=10⁻⁶ for ¹⁰⁰Sn)



The Single Ion Penning Trap (SIPT) Project Advancing Sensitivity of LEBIT





Realization of the SIPT Project



SIPT Project Status Operational in 2017

➤Fabrication finished

- Modifications necessary
- Gold plating pending

Beam-line assembled and tested

- Modification of existing beam-line
- New beam-line up to the magnet set up
- Transmission of >95%





Summary

 SIPT is designed to perform mass measurement with a single ion
 Narrowband FT-ICR enables high-precision mass measurements of rare isotopes produced at very low rates
 SIPT will become operational in 2017

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Visit us at groups.nscl.msu.edu/lebit





Penning Traps







U.S. Department of Energy Office of Science National Science Foundation Michigan State University L. S. Brown and G. Gabrielse, Rev. Mod. Phys. 58 (1986) 233.