MRTOF質量分析器による超重核研究@JAEAタンデム

Research on Superheavy Nuclei @JAEA-Tandem via an MRTOF Mass Spectrograph

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Island of Stability of Superheavy Nuclei



- Questions
 - really exist?
 - where and how stable?
 - how to synthesize?
 - how to identify?

- To answer
 - understand nuclear structure (shell effect) of SHE
- inspect and establish reliable mass models
- new identification technique

via high-precision mass spectroscopy with an MRTOF

Shell Effect in Superheavy Region



Atomic Mass and Required Precision



Binding energies (B.E.) reflect all forces acting in the atom(nucleus)

	$\delta m/m$
Chemistry: Identification of molecules	$10^{-5} - 10^{-6}$
Nuclear structure: shell, pairing	10^{-6}
Astrophysics : r-process, rp-process	$10^{-6} - 10^{-7}$
Nuclear fine structure: deformation, halo	$10^{-7} - 10^{-8}$
Nuclear mass model	10^{-6}

e.g. $A = 100 \approx 100 \text{ GeV}/c^2$, $\delta m/m \approx 10^{-6}$ @ $\delta m = 100 \text{ keV}/c^2$

Multi-Reflection Time-Of-Flight Mass Spectrograph





(1) Cool ions in He buffer-gas filled ion trap

(2) Open front end of MRTOF and eject from trap

(3) Close front end

(4) Ions will reflect between isochronous mirrors

(5) Open back end at time-focus lap and detect at MCP

Multi-Reflection Time-Of-Flight Mass Spectrograph



Online Results with MRTOF@RIKEN



MRTOF Facilities Worldwide

As of 2013 (first year online results published)



MRTOF@JAEA-ISOL/Tandem Accelerator



MRTOF Setup



Experimental Plans with Light Primary Beam@ISOL



- 14 new masses with 9 new isotopes
- Mass precision: <100 keV with 1-2 weeks BT</p>
- No (Z = 102) and Lr (Z = 103) approach N ~ 162





пз



Independent fission yield map: how strong shell effect of ¹³²Sn in fission process?

Summary

- Systematic mass information around deformed shell closures N = 152 and 162 is indispensable for exploring "Island of Stability"
- MRTOF offers fast, efficient, and wide-band high-precision mass spectroscopy
- At JAEA-ISOL, new MRTOF will be functional in FY2020, planning mass measurements and new isotope searches for neutron-rich actinides along $N \sim 162$
- MNT reaction with heavy nuclei such as ²³⁸U + ²⁵⁴Es/²⁴⁸Cm will open a new frontier toward "Island of Stability"
- Application for fission study coupled with MRTOF will reveal a detail fission mechanism for unique symmetric fission

