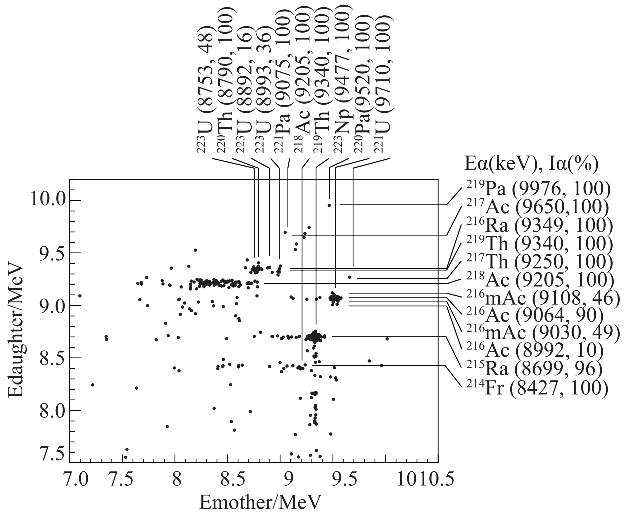

Fig. 1 α-particle energies of mother-daughter coincidences observed in the time windows of 200 ns ≤ $\Delta T(ER-\alpha_1)$ ≤ 10 ms and 200 ns ≤ $\Delta T(\alpha_1-\alpha_2)$ ≤ 10 ms, position window of ≤1 mm.

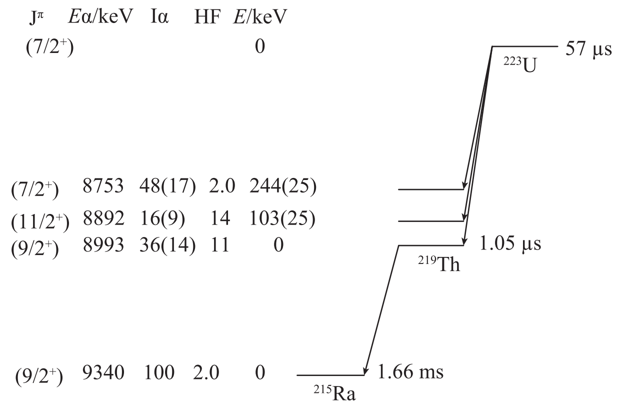

Fig. 2 A schematic representation of α transitions from ground state of ^{223}U into few levels of ^{219}Th. See text for details.

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2 - 23 Study of the Octupole Deformation Properties in ^{224}U Using the RDT Method

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The nuclear reflection asymmetry is attributed to octupole correlation, *i.e.* the coupling between single-particle orbits with opposite parities and $\Delta l = \Delta j = 3$ near the Fermi surface. The strongest correlations tend to occur just above closed shells, namely at particle (proton or neutron) numbers 34 ($g_{9/2}\otimes p_{3/2}$ coupling), 56 ($h_{11/2}\otimes d_{5/2}$ coupling), 88 ($i_{13/2}\otimes f_{7/2}$ coupling) and 134 ($j_{15/2}\otimes g_{9/2}$ coupling). An overview of the experimental and theoretical evidence for octupole correlations is given in Ref. [1]. The strongest octupole correlations are predicted by the HFB calculation to be in the uranium isotopes with $N\sim$134. Improved total Routhian surface calculations[2] show that the ground states of ^{222,224,226}U have static octupole deformations and the most favorable case for stable octupole deformation appears to be ^{224}U, which is consistent with previous predictions[3]. An experiment for studying the octupole properties in ^{224}U was carried out at ANL(Argonne National Laboratory).

The ^{20}Ne(^{208}Pb,4n) reaction at 109 MeV was used to populate the excited states of ^{224}U and the digital GAMMASHERE + FMA + MCP +DSSD[4] setup was used to identify the strongest γ-rays of ^{224}U in this experiment. The production cross-section of ^{224}U was expected to be around 1 μb based on the HIVAP calculations. A 0.4 mg/cm^2 thick ^{208}Pb target was used. The average beam current was about 30 pnA and lasted 6 d.

The digital data acquisition system which can record the signal waveforms was used, and utilized the RDT(recoil decay tagging)[5] technique and waveform analysis[6] method were utilized to identify ^{224}U unambiguously. Specifically waveform analysis can give accurate energy and half-life of α decay of ^{224}U. Contrast to traditional method, the advantage of waveform analysis method is embodied in extracting the single energy from superposition signals (waveforms). An example of superposition waveforms shown in Fig. 1. The resolved α energy spectrum is shown in Fig. 2 and obviously the statistics is very low. The statistics of the correlated γ is too low for γ-γ coincidence analysis. The much lower statistics than expected is most likely due to that the ^{224}U recoils were not transported to the focal plane of FMA. In this experiment the highest statistics was obtained for ^{221}Th. Its γ energy spectrum obtained through γ -recoil coincidence, is shown in Fig. 3, in agreement with previous results[7].

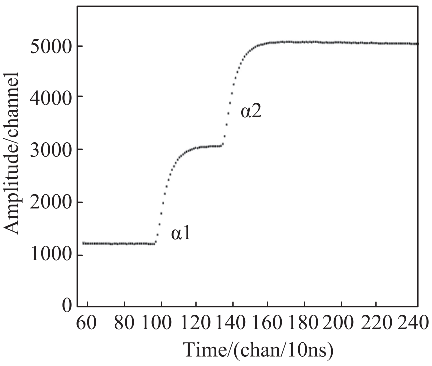

Fig. 1 An example of superposition waveforms.

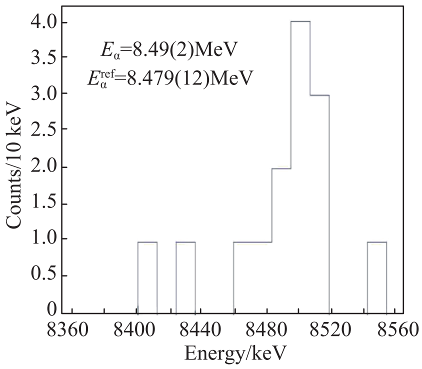

Fig. 2 The α energy spectrum of ^{224}U. The counts of it is only about 20.

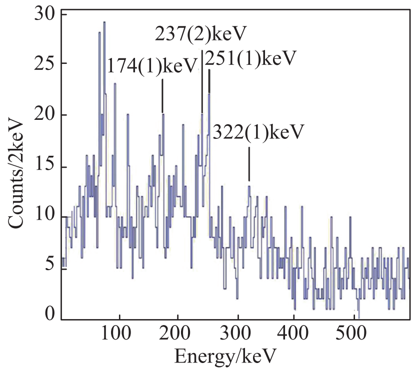

Fig. 3 (color online) The γ energy spectrum of ^{221}Th. The energy values of the strongest γ rays of ^{221}Th are marked in the figure.

We will propose to study ^{224}U again using the ^{48}Ca(^{180}Hf,4n) reaction at 207 MeV on AGFA at ANL, which is to be commissioned in 2017.

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2 - 24 Research Progress of Heavy Ion Reaction Group

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In 2016, the environment of the power supply of RIBLL1 is improved by building a closed space with air condition. It will be good for the magnetic stability which is directly affected by the stability of the power supply. There are 9 experiments, more than 1 165.5 h beam-time, carried out at the RIBLL1. The users are from Peking University, China Institute of Atomic Energy, Shanghai Institute of Applied Physics, National Space Science Center, Institute of High Energy Physics and Institute of Modern Physics. The research topics are as the following, elastic scattering of proton dripline nuclei ^{12}N and ^{13}O, transfer reaction and elastic scattering study of the mirror nuclei ^{10}Be and ^{10}C, measurement of the fusion reaction cross section of ^{16}O+^{40}Ar near coulomb barrier, experimental study of the giant resonance of the neutron-rich isotopes $^{32-34}$Al, experimental study of the analogous Holy state of ^{11}C, study of the linear molecular state of ^{14}C and measurement of the decay of ^{45}Cr and ^{49}Fe, *etc.* Two experimental results, which were performed in 2015, have been published in 2016. One is the revalidation of the isobaric multiplet mass equation at $A = 53$, $T = 3/2$[1]. Another is lifetime measurement of the first excited state in ^{37}S[2].

The different behaviors of the elastic scattering between the neutron halo nucleus ^{11}Be and the proton halo nucleus ^{8}B are investigated using the Continuum Discretized Coupled Channel (CDCC) method[3]. The Coulomb potential and centrifugal potential of the valence nucleon in ^{11}Be and ^{8}B are found to play an important role in the different angular distributions of the elastic scattering differential cross sections. A new measurement of the elastic