Using the new mass excess of ^{51}Co, we investigate the Coulomb displacement energy for $|T_z|=3/2$ in the sd- and lower fp-shell nuclei. Fig. 1(b) illustrates the comparison between the experimental data and theoretical results obtained from the FRDM[3], HFB-21[4] and WS3.6[5] mass models. It is striking that all considered mass models fail to describe the feature that the staggering of the ΔCDE values is washed out for $A=45-51$ nuclides. However, by performing the shell-model (SM) calculations as in Ref.[6] including the isospin-nonconserving (INC) nuclear interactions for the $f_{7/2}$-shell, the description of staggering of the experimental ΔCDE is improved considerably, while without the INC forces some staggering of ΔCDE values for $A=45-51$ still exists. This results are consistent with the recent calculation for the $T=1/2$ chain [6], pointing to the necessity to include INC interactions in the calculations of fp-shell nuclei.

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2 - 8 SimCSR Program for the Simulation of the Isochronous Mass Spectrometry at the HIRFL-CSR*

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Until now, several isochronous mass spectrometry (IMS) experiments have been successfully performed using various primary beams at the HIRFL-CSR and masses of both proton-rich and proton-deficient exotic nuclei have been measured. In order to improve the performance of the IMS experiments and to provide a reliable tool for designing and preparing the future experiments, a simulation code, named SimCSR is developed.

Presently, six-dimension phase-space linear transmission theory is applied to simulate the transmission of ions in the experimental storage ring (CSRe). The basic algorithm is $B_\mathrm{f}=MB_\mathrm{i}$. The B_i and B_f are six-dimension phase-space vectors of ions at the entrance and exit of each element of the CSRe lattice, respectively. M is a 6-by-6-dimension first-order transfer matrix of each element. M is calculated using formulas described in Ref.[1]. In the simulations, the ring lattice is considered in detail, and the same magnetic setting as in our previous experiment with ^{58}Ni projectile fragments[2] is considered. The ions are assumed to circulate 300 turns inside the CSRe.

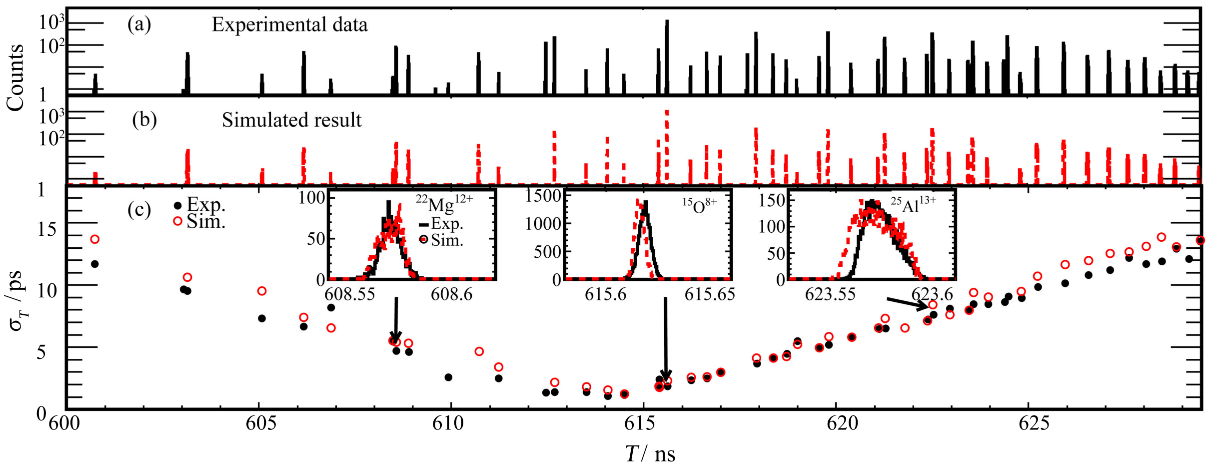

Fig. 1 (color online) Experimental (a) and simulated (b) revolution time spectra. The comparison of the standard deviation of revolution time (σ_T) between the experimental and simulated results is shown in (c). The inserted figures in (c) are the zoomed revolution time spectra for ^{22}Mg^{12+}, ^{15}O^{8+} and ^{25}Al^{13+} ions.

Figs. 1(a) and 1(b) show the experimental[2] and simulated revolution time spectra, respectively. The horizontal axis is the revolution time, T. The details for extracting T can be found in Ref.[2]. Fig. 1(c) is the comparison of the experimental (red open circles) and simulated (black solid circles) standard deviation of revolution time, σ_T. It is striking that the agreement between the simulated results and the experimental data is so good although only the linear component of magnetic elements is considered.

The SimCSR has been used to investigate the key contributing sources to the σ_T of stored ions. We found that there are three ways to reduce the σ_T. First, one can tune the slope of the dependence of transition point (γ_t) on the momentum difference ($\mathrm{d}p/p$) to reduce the phase slip factor (η). However, this method can only be applied to the specific ions fulfilling the condition $\gamma = \gamma_t$. Second, one may take a measure to reduce width of momentum difference ($\sigma_{\mathrm{d}p/p}$). However, a small $\sigma_{\mathrm{d}p/p}$ could lead to low statistics. This method can't be applied to the measurement of ions with low yields. Finally, one can measure the velocity of ions. This method has been tested at the HIRLF-CSR. The data analysis is currently in progress.

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* Foundation item: 973 Program of China(2013CB834401),Helmholtz-CAS Joint Research Group HCJRG-108.

2 - 9 Half-life Measurement of $^{94m}Ru^{44+}$ at CSRe*

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A radioactive nucleus is characterized with an intrinsic half-life. However, for a nuclear species, the half-lives in neutral atoms could be very different from that in highly charged ions. The half-lives of some highly charged ions have been directly measured at GSI for multiple motivations[1]. In the same case, the nuclear state(*i.e* the isomer) may be in the range of several tens of microseconds and their half-live can be measured using isochronous mass spectrometry. The $J^\pi = 8^+$ isomeric state in ^{94}Ru was chosen to test this method. The half-life of this isomer is 71 μs [2] in neutral atoms, and the excitation energy is 2.64 MeV. The internal conversion coefficient of this decay in neutral atom is 0.335. So its half-life in the bare nucleus would be modified to be 94.78 μs when the internal conversion channel is blocked.

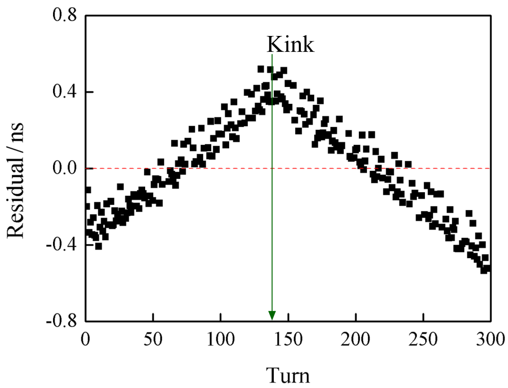

Fig. 1 (color online) Podala Palace, Tibet

The procedure of the experiment is the same as our typical IMS experiments[3]. The $^{94m}Ru^{44+}$ are produced by fragmentation of the primary $^{112}Sn^{34+}$ beam and then stored in the CSRe. The signal of the ions from the time-of-flight detector are recorded with a digital oscilloscope Tektronix DPO 71254. The recording time was set to 200 μs for each injection corresponding to ≈300 revolutions. The CSRe was tuned to be isochronous for $^{94}Ru^{44+}$, so its revolution time directly depends on its mass-to-charge ratio. If a $^{94m}Ru^{44+}$ decays during the storage in the CSRe, then the revolution time will change markedly because of the different mass. Then, by linear fitting the time stamps as a function of the turn numbers, the residual of the fitting have been obtained and shown in Fig. 1. In this figure, one can see a kink which corresponds to the decay time of the isomer. In this way, 39 decay cases were observed and their decay times were extracted. In addition, another 36 $^{94m}Ru^{44+}$ that didn't decay within the recording time were identified from their characteristic revolution times. So in total 75 $^{94m}Ru^{44+}$ were recorded.

We can extract the half-life and its error based on the exponential and binomial distribution function: