Progress on Schottky mass spectrometry of ^{152}Sm projectile fragments at ESR *

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Time-resolved Schottky Mass Spectrometry [1] was employed to the mass measurements of neutron-deficient ^{152}Sm projectile fragments at the FRS-ESR facility. Exotic nuclei were produced by fragmentation reaction of 615 AMeV ^{152}Sm primary beam impinging on a 4.009 g/cm^2 Be-target placed at the entrance of the fragment separator FRS. The fragments were separated in-flight by the FRS and then injected and stored in the storage ring ESR where electron cooling was applied to the stored ions. After cooling, the initial velocity distribution of the stored ions was reduced to typically $\sigma_v/v \approx 1.4 \times 10^{-7}$, thus the ions' revolution frequencies are a direct measure of their mass-to-charge ratios. An example of the measured frequency spectrum is shown in Fig 1.

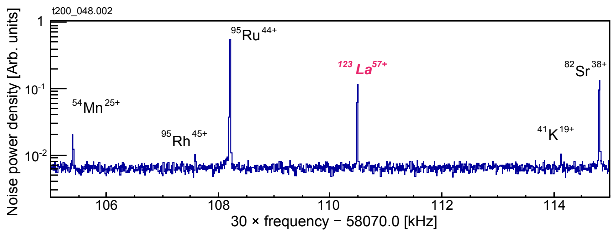

Figure 1: Part of the measured frequency spectrum. The mass of ^{123}La is previously unknown due to AME2012 [2].

The experiment was performed in 2005 [3,4]. The data analysis is now finished and a new mass evaluation method has been developed to reduce the systematic error [5]. Firstly, the input data were carefully prepared, only distinct peaks were taken into account in the mass calibration of the frequency spectra. Then, a local mass calibration was performed in the selected frequency range where the momentum compaction factor α_p of ESR was nearly constant, see Fig. 2. The α_p-values in Fig. 2 were deduced (approximately) from the well-known mass-to-charge ratios of ion-pairs who have neighbouring peaks in the frequency spectra, while the orbital length L was calculated from the ions' velocity, which was defined by the electron-cooler's accelerating voltage, and the ions' revolution frequency:

$$(\alpha_p)_i = \frac{[\frac{f_i - f_{i+1}}{f_i}]_{exp}}{[\frac{(m/q)_{i+1} - (m/q)_i}{(m/q)_i}]_{AME}} \quad \text{and} \quad L_i = v_i/f_i. \quad (1)$$

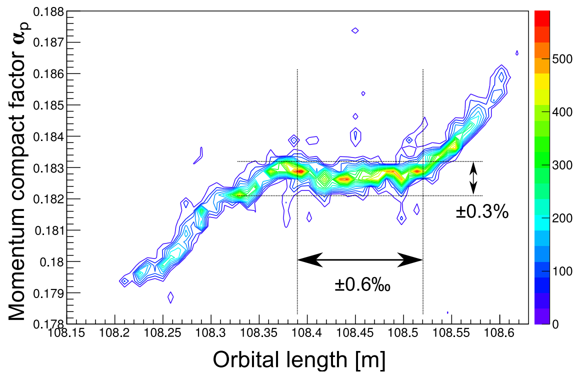

Figure 2: 2-D histogram of the momentum compaction factor deduced in the experiment [6]. The colour code is the count number. Mass calibration of the frequency spectrum has only been done in the selected orbital length range.

After the first step of evaluation, the deviation of the re-calculated mass-to-charge ratios from the tabulated values in AME2012 was found to be a linear function of the ion charge-states for the reference masses [5]. The origin of this systematic deviation is still under discussion. This observation was similar to the finding in ref [7]. After correction of this linear deviation, a typical mass uncertainty of 20 keV has been achieved in our experiment and ten new masses have been determined experimentally for the first time [8]. The mass surface measured in this experiment largely overlapped with our previous measurements [1], and could be used for the consistency check of the data.

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