# 2 - 6 First Isochronous Mass Measurements with Two Time-of-Flight Detectors at CSRe*

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In conventional isochronous mass spectrometry (IMS), single time-of-flight (TOF) method is adopted to measure the ions' revolution times in a storage ring which can then be used to calculate the ions' masses. However, the mass-to-charge ratio ($m/q$) is only related to the revolution time ($T$) under the condition that $\gamma$ is equal to $\gamma_{\rm t}$ according to the following equation:

$$\frac{\Delta T}{T}=\frac{1}{\gamma_{\rm t}^2}\frac{\Delta(m/q)}{m/q}-(1-\frac{\gamma^2}{\gamma_{\rm t}^2})\frac{\Delta v}{v} \quad . \tag{1}$$

In fact, heavy-ion storage ring allows for storing ions in a broad range of momentum. So only a small range of nuclides with $\gamma$ close to $\gamma_{\rm t}$ are selected for further mass determination. In order to get a broad range of useful revolution time spectra and high resolving power, one should measure the ions' velocity information. For this purpose, two new TOF detectors[1] were installed in one of the straight sections of experimental Cooler Storage Ring (CSRe) in Lanzhou near the end of 2013.

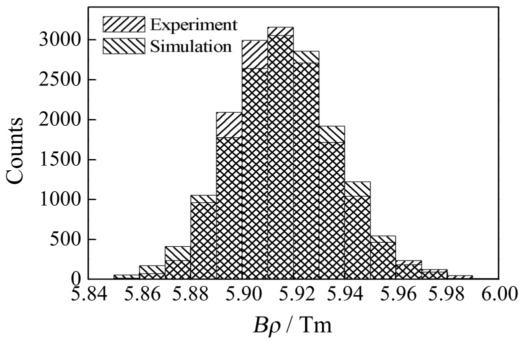


Fig. 1 The distribution of magnetic rigidities $B\rho$.

In this experiment, a primary beam of $^{78}$Kr$^{28+}$ with an energy of 456.8 MeV/u was employed. The projectile fragments produced on a 15 mm beryllium target were separated and transported through the fragment separator RIBLL2, and then injected into CSRe for further mass determination. The distance between the two detectors is 18 m. Long signal cables not only introduce high frequency parasitic signal but also can attenuate the experimental signal and sequently reduce the time resolution[1]. To avoid this, two oscilloscopes were employed to record data separately from the two detectors.

The velocity of the ion is directly proportional to its magnetic rigidity. In this experiment, the experiment obtained magnetic rigidity spread as shown in Fig.1 is $\sigma(B\rho)/B\rho\approx 0.34\%$. However, a spread estimated from the revolution time distributions (see Ref. [2]) amounts to only about 0.02%. So the velocity directly measured from the experiment is hard to help improve the mass accuracy. This large velocity spread can arise from time jitter $\Delta t$ between the start times of the two oscilloscopes. In Fig. 1, the simulation (More details about the codes are given in Ref. [3] is based on the hypothesis that $\Delta t$ satisfies the normal distribution $\Delta t\sim N(220\ \text{ps}, 170\ \text{ps})$, where 220 ps is the mean value and 170 ps is the standard deviation. The experimental result agrees very well with the simulation. More details on the present work can be found in Ref. [4].

## References

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