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## **Progress on direct mass measurements with the FRS-ESR facility at GSI**

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Heavy ion storage rings operated in an isochronous mode and/or equipped with the phase-shape cooling devices can be used for high-precision, high-sensitivity and high-efficiency mass measurements of stored nuclei. This has been achieved at GSI Darmstadt, where two complementary methods, Schottky Mass Spectrometry (SMS) and Isochronous Mass Spectrometry (IMS) were developed based on the combination of the fragment separator (FRS) and the storage ring (ESR). So far the storage ring spectrometry has been successfully used in covering more than 1/3 of known nuclei in mass measurements [1]. In this contribution, we will discuss the progress on mass experiments, with emphasis on the new isotopes ( $^{236}\text{Ac}$ ,  $^{224}\text{At}$ ,  $^{221}\text{Po}$ ,  $^{222}\text{Po}$ , and  $^{213}\text{Tl}$ ) discovered [2] and the first extension of IMS in isomeric investigation [3]. Recent developments in the instrumentation like the application of resonant Schottky pick up will also be briefly reported.

References:

- [1] B. Franzke, H. Geissel, and G. Muenzenberg, Mass Spectrom. Rev. 27 (2008) 428.
- [2] L. Chen, et al., Phys. Lett. B 691 (2010) 234–237; L. Chen, PhD thesis, JLU Giessen, 2008.
- [3] B. Sun, et al., Phys. Lett. B 688 (2010) 294–297

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