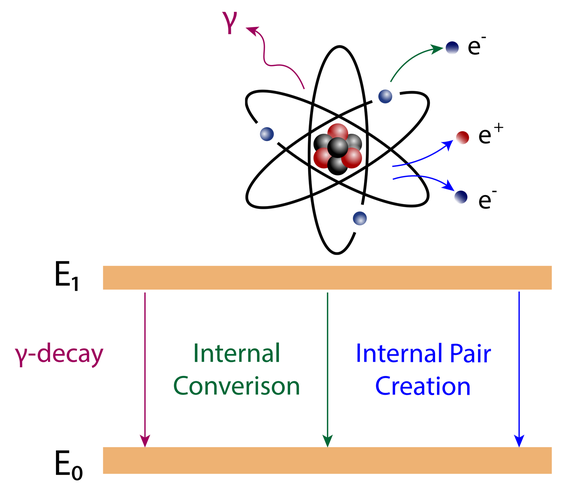
Search of the Exotic Nuclear Two-Photon Decay in Isochronous Heavy Ion Storage Rings

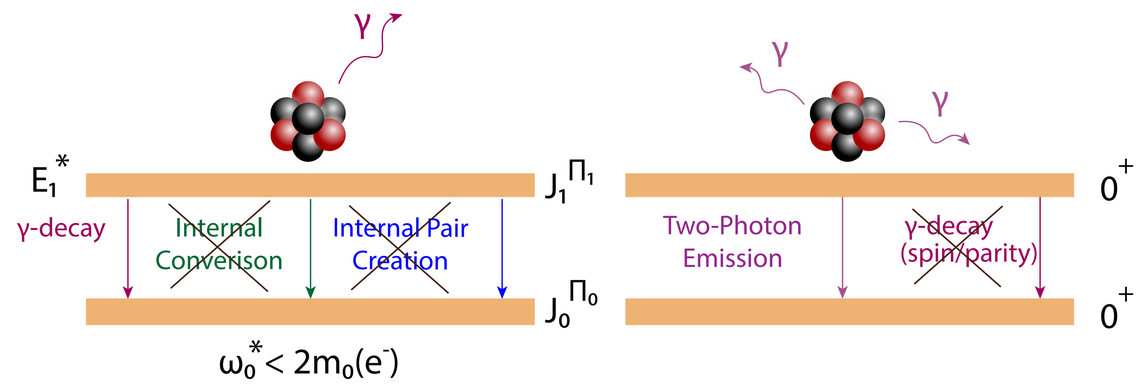
D. Freire-Fernández[1,2,3,4], C. Akinci[3,5], K. Blaum[1,2], W. Korten[4], Yu. A. Litvinov[2,3], S. Sanjari[3,6], and the E143 Collaboration

[1]Max-Planck-Institut für Kernphysik, [2]Universität Heidelberg, [3]GSI Helmholtzzentrum für Schwerionenforschung, [4]CEA-Saclay, [5]İstanbul Üniversitesi, [6]Aachen University of Applied Sciences

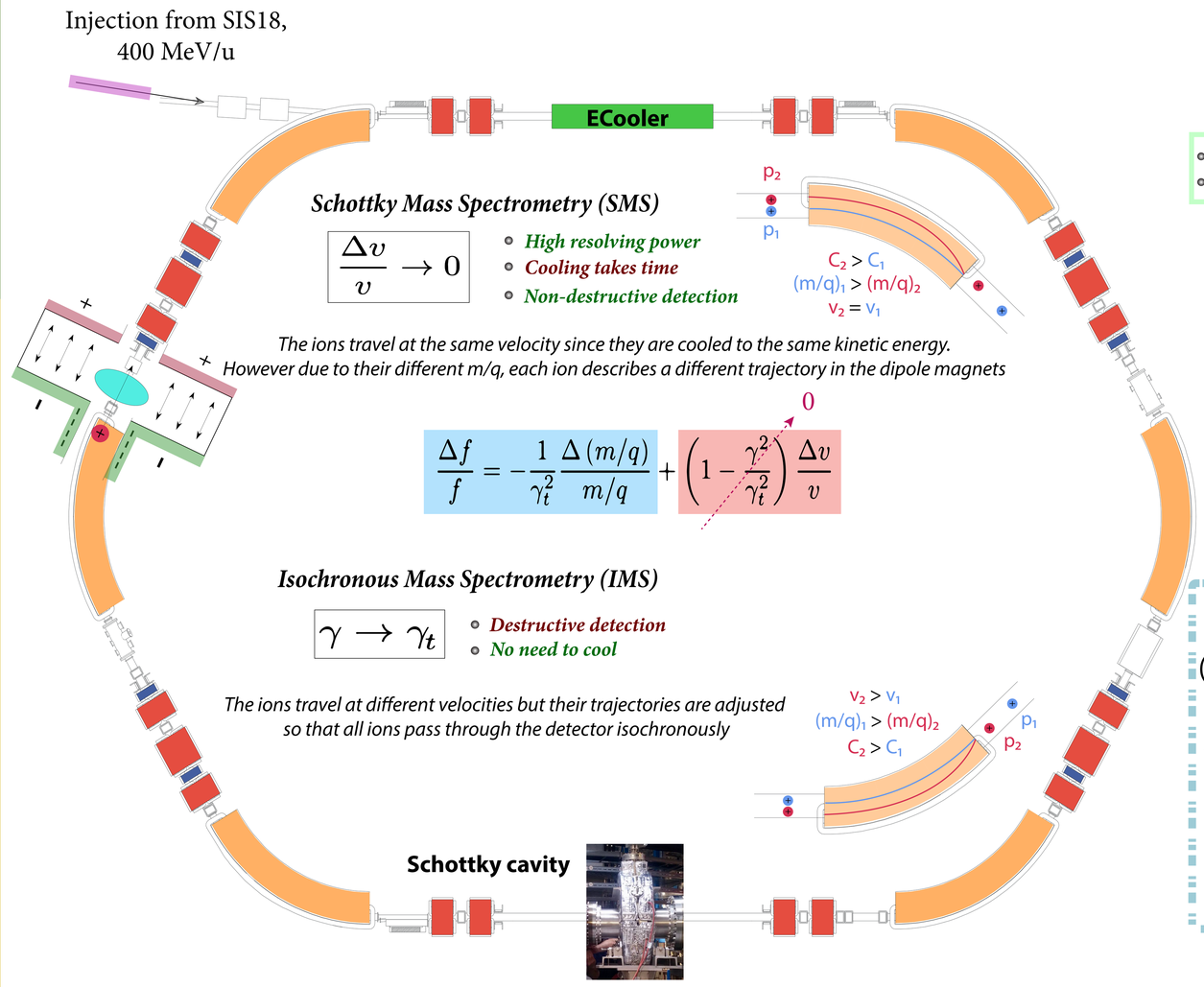
Motivation



- Nuclei in the **shape coexistence region** are of interest in nuclear structure physics
- **Two-photon decay** is a **second order process** that links observables and the **nuclear shape**
- **Low-lying 0+ isomers** may play a role in **stellar nucleosynthesis**



Methodology and Results



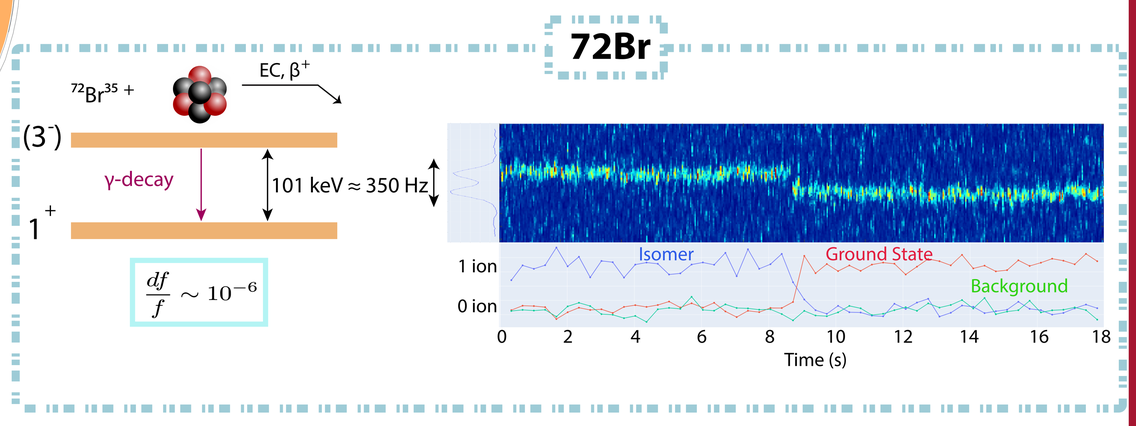
S. Sanjari et. al. Rev. Sci. Inst. 91(8), pp. 083303 (2020)

SMS
- *Not suitable for exotic nuclei*
- *Suitable for short-lived nuclei*

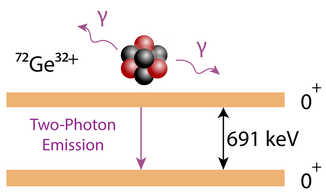
IMS
- *Not suitable for nuclei with half-lifes under a few seconds*
- *Suitable for nuclei with low-production yields*

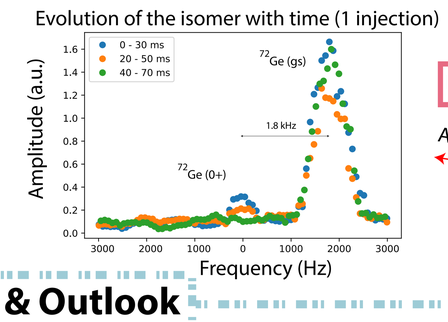
Isochronous Schottky Mass Spectrometry (ISMS)
- **Novel technique:** Combination of SMS and IMS
- Best suited for the study of **exotic short-lived** isomers and nuclear states

72Br



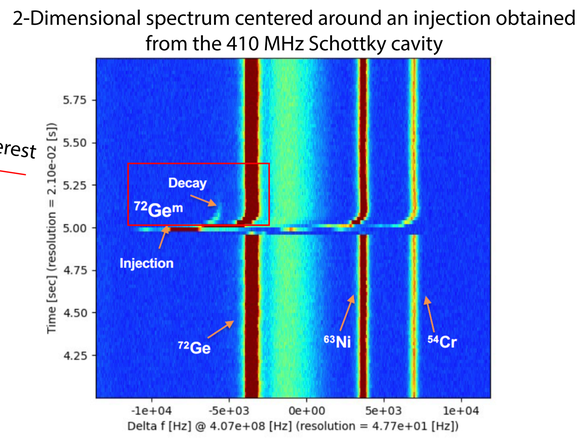
72Ge

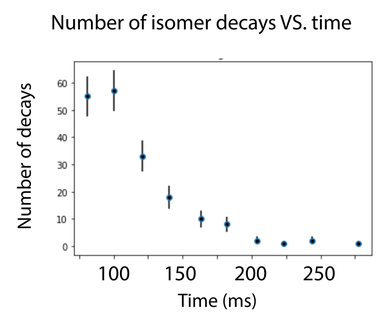




Decay time < 80 ms

Analysis of the region of interest

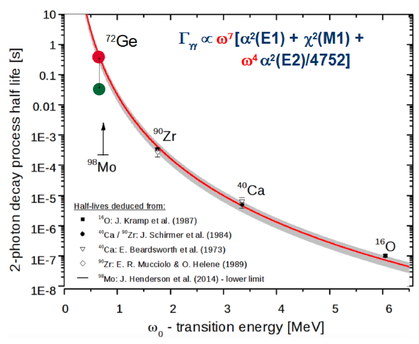




Conclusions & Outlook

- **Proof of principle - *Isochronous Schottky Mass Spectrometry (ISMS):***
  - Feaseability of a **novel technique** for **exotic short-lived** mass spectrometry. It uses a **combination** of Schottky Mass Spectrometry (SMS) and Isochronous Mass Spectrometry (ISMS).
- **Highly suited** for the study of **exotic short-lived low-lying nuclear isomers** with a resolving power of 10^{-6}, allowing the resolution of **100 keV isomers**
- *Preliminary results* indicate that the lifetime of the first excited state in 72Ge is **considerably shorter** than expected from previous experiments Therefore, further **theoretical studies are necessary**

(Analysis still ongoing!)



Acknow ledgements

F. C. Akinci, D. Freire-Fernández, M. S. Sanjari, Yu. A. Litvinov, S. A. Litvinov, H. Weick, K. Blaum, C. Brandau, H. ALbers, R. Chen, H. Geissel, J. Gerl, J. Glorius, M. Gorska, A. Gumberidze, C. Kozhuharov, M. Steck, R. Singh-Sidhu, T. Stöhlker, et al., **GSI, TU Darmstadt and MPIK, Germany ;** W. Korten, D. Kalaydjieva, **IRFU, CEA Paris-Saclay, France ;** T. Yamaguchi, et al., **Saitama University, Japan;** A. Ozawa, **Tsukuba University, Japan;** Ph. Walker, Zs. Podolyak, **University of Surrey, UK;** C. Bruno, J. Marsh, **University of Edinburgh, UK;** A. Görgen, **University of Oslo, Norway;** F. G. Kondev, **Argonne Natiaonal Laboratory, USA;** J. J. Carroll, C. J. Chiara, **US Army Research Laboratory, USA;** I. Dillmann, C. Griffin, G. Leckenby, **TRIUMF, Canada;** and the **ILIMA collaboration**