JYFLTRAP-assisted beta-decay studies of exotic fission products around A ~ 110

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Introduction

Nuclear decay studies of neutron-rich nuclei becomes difficult at conventional ISOL facilities when going far from beta-stability due to high background generated by the nuclei within the same isobaric chain. Therefore, when studying the properties of the most exotic nuclei, the background level can be significantly reduced by using the Penning trap as a high-resolution mass filter to separate the nuclei of interest from the isobaric contaminants.

The unique possibilities of the IGISOL mass separator [1] coupled to the JYFLTRAP Penning trap setup [2] have been used for nuclear spectroscopic studies at the University of Jyväskylä. The fission products have been isobarically purified by the purification Penning trap of JYFLTRAP and sent forward to subsequent beta and gamma spectroscopy studies.

Experimental

Ions of interests are produced typically by 30 MeV proton-induced fission of a natural uranium target. After stopping the fission fragments in the ion guide, the radioactive ions are accelerated to 30 keV energy and mass-separated with a 55 degree dipole magnet. The separated beam is then injected to gas-filled radio frequency cooler/buncher (RFQ) [3], where the beam is cooled and bunched before injecting it to the purification Penning trap of JYFLTRAP. The schematic layout of the IGISOL-facility is presented in figure 1.

The JYFLTRAP setup consists of two Penning traps placed inside one 7 T superconducting magnet. In the first Penning trap [4], called the purification trap, the mass-selective buffer-gas cooling technique [5] is used for isobaric cleaning. In this technique the isobaric purification is achieved by first exciting all ions in the trap to larger radius using a dipole excitation with a mass-independent magnetron frequency. After this excitation the ions of interest are centered onto the trap axis by applying a quadrupole excitation with the true cyclotron frequency

$$\nu_c = \frac{1}{2\pi} \cdot \frac{q}{m} \cdot B \,.$$

Finally, extraction through a narrow channel of 2 mm diameter removes all the unwanted ions from the ion bunch. With this technique the mass resolving power of few times 10^5 can be achieved, which is enough to separate the studied isotopes from the neighboring isobars.

The purified ion sample can be either captured to the second Penning trap, called precision trap, for precise mass measurement of atoms using time-of-flight ion-cyclotron resonance (TOF-ICR) technique [6]. Another possibility is to send the ion sample to the spectroscopy setup located after the traps. The ions are implanted into a movable tape surrounded by the detector setup, which typically consists of a scintillation detector for detecting beta particles and Ge-detectors for detecting gamma rays and X-rays.

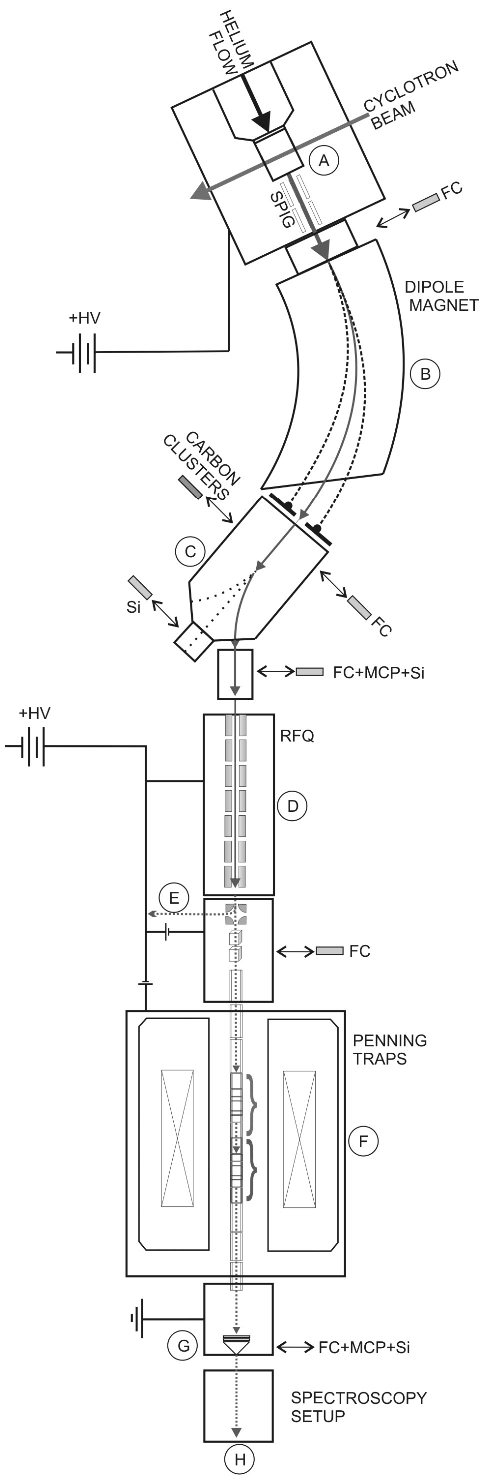

Fig. 1 Schematic drawing of the JYFLTRAP setup together with the IGISOL facility

General motivation

The studied exotic, neutron-rich nuclei around mass A = 110 are located in the region of rapid nuclear shape changes and close to the path of the astrophysical r-process. These studies are motivated by the question of very neutron-rich nuclei in this region, which located close to the path of the astrophysical r-process. The region of interest is famous of different deformations and shape co-existence. Since the r-process path depends on the nuclear deformation, it is important to collect more experimental information about the nuclear structure in this region.

In the latest trap-assisted spectroscopy experiments, the beta decay of ^{114}Tc, ^{109,111}Mo and ^{115}Ru has been studied. The first decay scheme of ^{115}Rh has been constructed [7] based on the experiment performed in 2006. After the two experiments in 2008 the decay scheme has been extended. In addition, new spectroscopic information has been gathered on the decay of ^{114}Tc and ^{109,111}Mo isotopes and the beta decay Q-values and half-lives of ^{114}Tc and ^{111}Mo has been measured. The results of the latest trap-assisted spectroscopy experiments will be presented in this contribution.

References

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