Electron Scattering for exotic nuclei
- *The SCRIT electron scattering facility* -

T. Suda[1]*
[1]*Research Center for Electron-Photon Science, Tohoku University, 1-2-1, Mikamine, Sendai, 982-0826, JAPAN*

An electron scattering facility is under construction in RIKEN RI Beam Factory, JAPAN, which is dedicated to the structure studies of short-lived nuclei. This is the world's first and currently only facility of its type. The construction is nearly completed, and the first electron scattering experiment off short-lived nuclei will be carried out in the beginning of next year. The charge density distributions of short-lived nuclei will be precisely determined by elastic electron scattering for the first time. In my talk, I will discuss on physics pursued at this facility including future perspectives.

1. Introduction

Electron scattering provides the most reliable structure information for atomic nuclei. This is due to the fact that the electron is an elementally particle and probes atomic nuclei through the fairly weak and well-understood electro-magnetic interaction.

It has been, however, strictly limited to stable nuclei and unstable nuclei having quite long lifetime. No experiment has ever been tried for highly unstable nuclei.

To target short-lived unstable nuclei, a novel experimental technique, named SCRIT (**S**elf-**C**onfining **RI T**arget), was proposed [1], and was proved in proof-of-principle studies [2] [3] that the collision luminosity over 10^{26}/cm^2/s is achievable with small number of target nuclei, an order of 10^6. Note that the luminosity of an order of 10^{26-27}/cm^2/s is at least required to perform elastic electron scattering for atomic nuclei.

2. The SCRIT electron scattering facility

The SCRIT technique is inspired by the well-known ion trapping phenomenon observed at electron storage ring facilities, which is harmful for the performance of electron storage rings.

SCRIT uses this phenomenon in a positive way to form a target of short-lived nuclei, as trapped ions, on the electron beam. The success of the SCRIT feasibility studies [2] [3] gave a green light to start construction of the world 's first electron scattering facility for short-lived nuclei.

A. Facility overview

Figure 1 shows the layout of the SCRIT electron scattering facility. It consists of an electron accelerator with the SCRIT system, an ISOL (Isotope Separator On-Line) system and an electron spectrometer system. The electron accelerator consists of a 150-MeV injector racetrack microtron and a 700-MeV electron storage ring. The stored electron

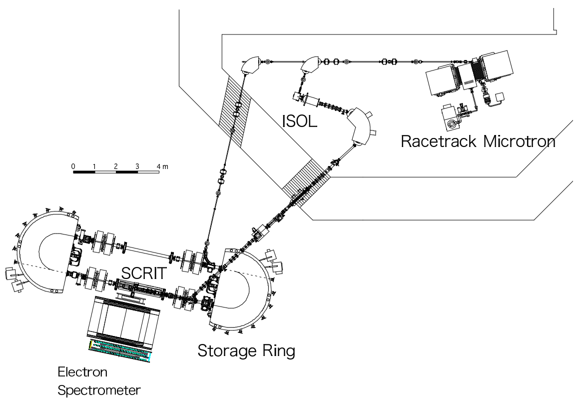

FIG. 1: The SCRIT Electron Scattering Facility.

*Electronic address: suda@lns.tohoku.ac.jp

beam energy is variable from 150 MeV to 700 MeV. The stored beam current as of today is over 250 mA, with a beam lifetime of over 200 minutes.

The commissioning of the electron accelerators equipped with the SCRIT system has been already completed. The constructions of the ISOL and the electron spectrometer are underway.

The ISOL is to produce neutron-rich nuclei via the photo-fission process of uranium. The long beam lifetime of the stored electron beam, a few hours, enables us to use the microtron as a driver for the ISOL after injecting electron beam to the storage ring.

The electron spectrometer is to measure scattered electrons with a good momentum resolution. A large solid angle coverage is essential due to expected low luminosity, the momentum resolution of $\Delta p/p$ ~1 x 10^{-3} is inevitable to identify elastic scattering.

The facility will be ready for an experiment soon, and the first electron scattering off short-lived nuclei will take place in the beginning of the year 2014.

3. Physics motivations

Should electron scattering become feasible for short-lived nuclei, elastic scattering will be first measured as in the case for stable nuclei. This is because the elastic cross section is the largest among the other scattering processes at the low momentum transfer region, and one determines the charge density distribution, which is one of the basic ground-state properties of the nucleus.

A. Day-one experiment

The target nuclei for the world's first electron elastic scattering will be unstable Sn isotopes including ^{132}Sn. The ^{132}Sn nucleus is a doubly magic nucleus whose life time is 40 seconds.

The Sn nucleus has the largest number of *stable* isotopes among the elements, *i.e.* ^{112}Sn - ^{124}Sn, whose charge density distributions have already been determined precisely by elastic electron scattering [4]. Extending the target Sn isotopes to unstable ones, ^{126}Sn - ^{132}Sn, we will study how the charge distributions, *i.e.* radius and surface diffuseness, change along the isotopic chain over 20 additional neutrons, ^{112}Sn - ^{132}Sn. Precise measurements about how the charge density distributions change as a function of the neutron number will shed light on the isospin dependent term of the potential.

4. Physics opportunities beyond elastic scattering

Since the structure studies of short-lived nuclei by electron scattering has been a longstanding dream for the structure studies of short-lived nuclei, impact of any researches to be performed at this facility will be quite strong for nuclear physics. What follows is a list of additional research opportunities beyond elastic scattering currently being discussed [5].

- Inelastic scattering including quasi-elastic (e,e'p) at higher luminosity, $\sim 10^{29-30}$ /cm^2/s.
- Photonuclear reaction (total photo-absorption measurement) at the luminosity of currently achieved $\sim 10^{27}$ /cm^2/s.

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