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A simple post-accelerator foil stripper assembly for atomic collision experiments

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Abstract. A multiple foil holder for use in ultra high vacuum (UHV) environment as a post accelerator ion stripper has been designed and fabricated. It is used to produce beams of an ion in different charge states at a given energy from a 14 MV pelletron accelerator. These ions are required in several types of atomic collision experiments. The assembly is tested with ^{32}S ions at various energies.

Keywords. Multiple foil holder; heavy ion accelerator; atomic collisions.

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1. Introduction

In several atomic collision experiments it is often necessary to use beams of an ion in different charge states having same energy. This can be achieved by a post-accelerator foil stripper and subsequently selecting the desired charge state. In principle such beams could also be obtained in a tandem van de Graaff accelerator by selecting the terminal voltage and the charge state at the terminal stripper. However, in practice, due to limitations of beam intensity and quality, such combinations of voltage and charge state lead to a very restricted choice of beams at limited energy intervals. In this paper we describe a multiple foil stripper of a simple design which is recently installed at the 14 UD Pelletron accelerator at Bombay. This stripper assembly is placed immediately after the image slit of the analyzing magnet of the accelerator (Prasad 1989). Various charge states subsequently produced are selected by a switching magnet located at about 6·5 m away and directed into the target chamber or a Faraday cup at a distance of about 5 m away from it.

2. Design details

The detailed drawing of the foil stripper is shown in figure 1. The foil holder is a thin toothed wheel of 71·6 mm dia in which eight circular holes on a radius of 24 mm and radially separated by 45° are drilled. This wheel is engaged to another identical wheel on which the foil position sensing studs are mounted. This set of wheels are driven by a pair of bevel gears which in turn are driven from outside the vacuum housing by a stepper motor through a magnetic coupling (figure 1). The magnetic coupling

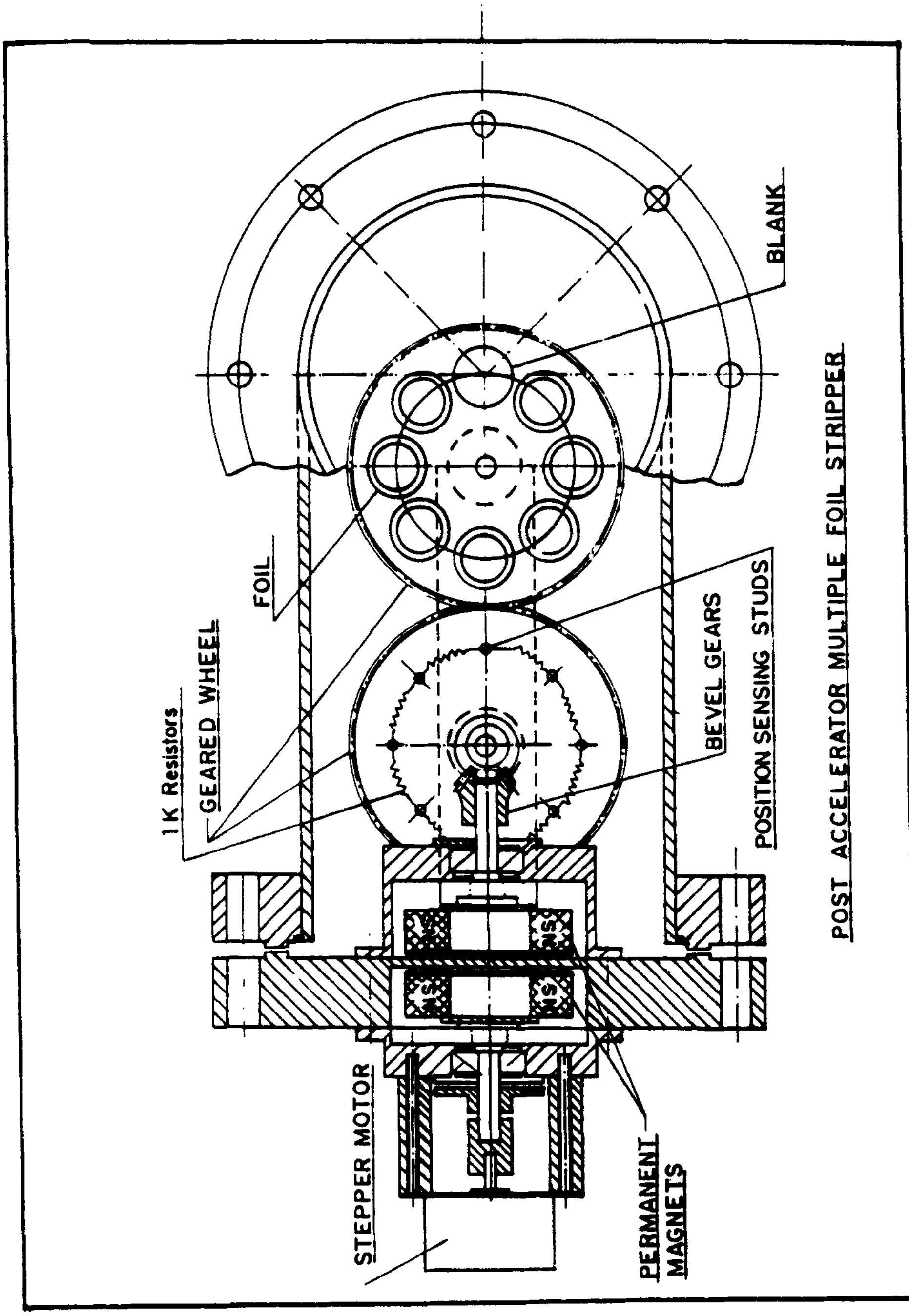

Figure 1. Assembly drawing of the multiple foil stripper.

consists of a pair of identical rings each containing four equally spaced permanent ceramic magnets. These rings are mounted facing each other on either side of the vacuum flange (figure 1). The magnets in each of the rings are axially magnetized and are arranged such that the magnetization direction of successive magnets on each ring are reversed, making it a stable configuration. This provides a strong and slip-free rotation with sufficient torque for low speed applications. The coupling is driven by a low power stepper motor which provides a 7·5° rotation per step. An electronic driver circuit is used to provide the impulses to the stepper motor. The magnetic coupling enables this system to be used possibly in UHV environment as no conventional vacuum feedthroughs or seats are involved. The entire assembly is mounted on a standard s.s. flange with a metal gasket. At each individual foil position the corresponding sensing stud makes contact with a spring loaded electrically isolated post. A resistance chain, 1 K each per position, wired in series on the studs provides the read back of the appropriate foil position via a single MHV high vacuum feed through. Figures 2 and 3 show the photographs of the assembly with all the components connected.

This stripper foil assembly is housed in a stainless steel 'Tee' and is operated at a pressure of 10^{-8} mbar. The foil position can be remotely controlled and read from

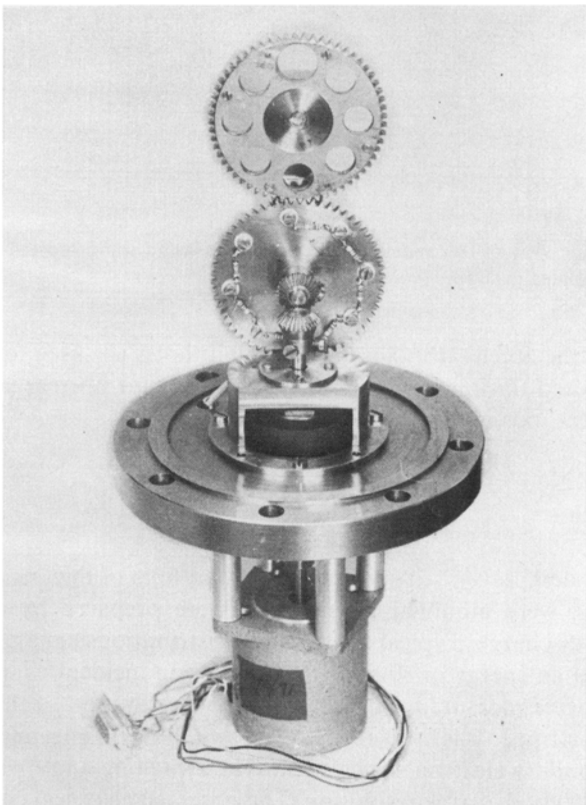

Figure 2. Front view of the stripper assembly showing the geared wheels, the resistance chain and one of the ceramic magnets. The larger size whole is used as blank for allowing the ion beam of original charge state produced in the machine.

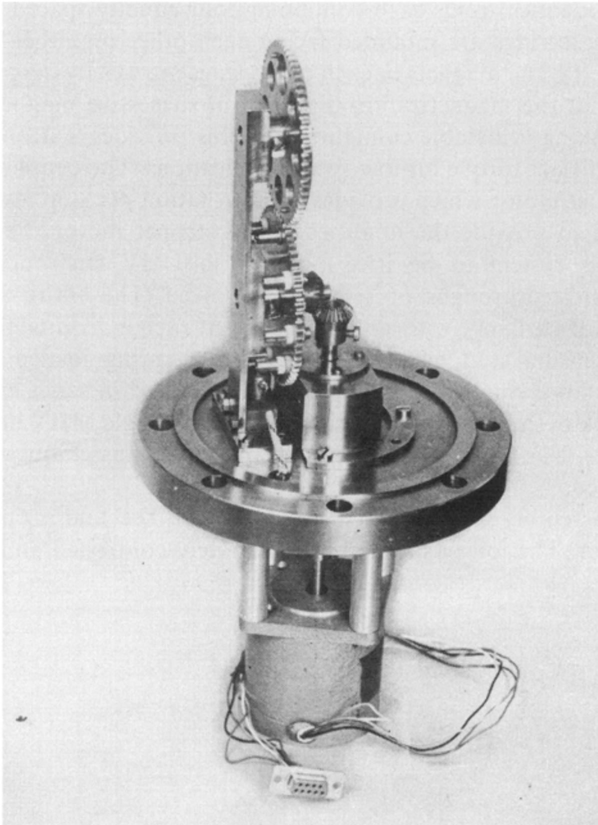

Figure 3. Side view of the assembly indicating the sensing studs and the spring loaded electrically isolated post.

the control console of the accelerator. Seven of the eight holes are used for mounting the carbon foils of desired thicknesses and one is left empty for normal use when no stripping of the incident ions is required.

3. System performance

In order to test the system, seven self-supporting carbon foils of thicknesses varying between 10–70 $\mu g/cm^2$ were mounted. These films were prepared by cracking of ethylene by DC-glow discharge. Typical charge state distributions emerging after the foil using ^{32}S beams at an energy of 80 and 100 MeV for an incident charge state 7^+ and 9^+, respectively, were measured. The charge state distribution of the ion beam emerging from the foil stripper was measured using a switching magnet and a Faraday cup with suitable secondary electron suppression. The switching angle was 30°, thus providing a reasonably good charge resolution. The observed electrical currents were converted to particle current in each case for proper normalization. The measured relative yields of various charge states are shown in figure 4 and are in good agreement with the available data (Scharfer *et al* 1977). As is obvious from the figure for a larger

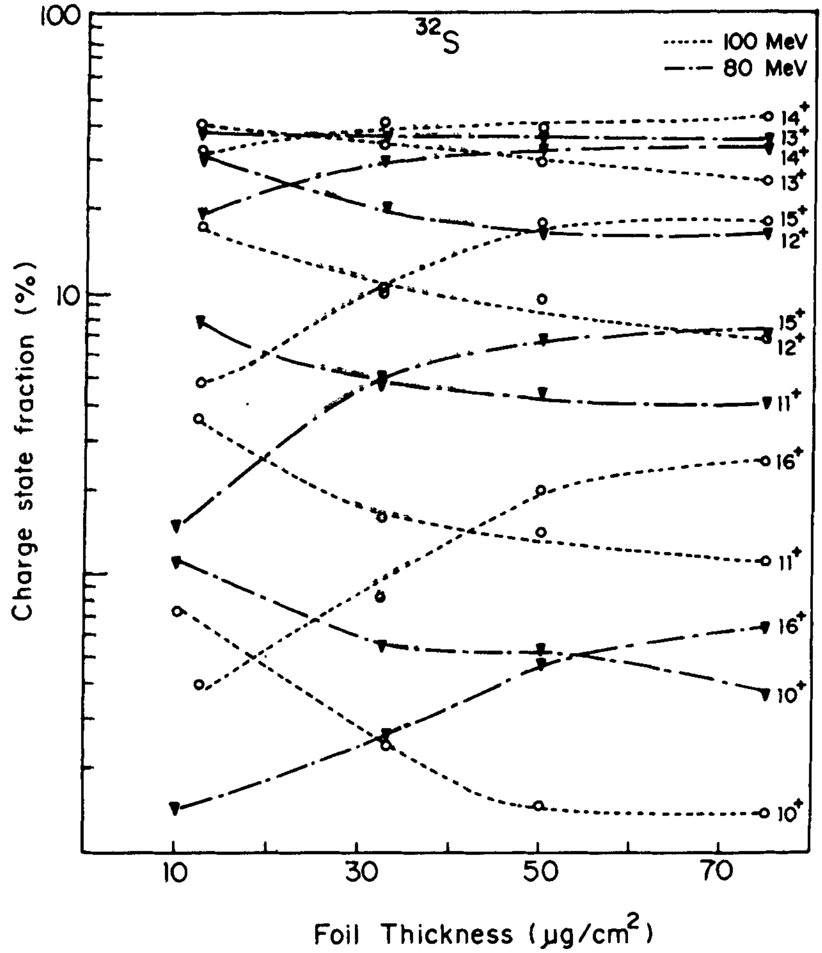

Figure 4. Normalized yields of ^{32}S ions of different charge states measured on emergence from thin carbon foils of varying thicknesses. The incident beams were of 80 and 100 MeV with incident charge state of 7^+ and 9^+, respectively.

yield of the higher charge state thicker foils have to be used. However, a compromise has to be reached between the yield and the losses in the beam transmission due to the poorer beam quality when thicker foils are used. This assembly has been used recently for obtaining completely stripped oxygen and sulphur ions in measurements of K-shell vacancies at these ions inside solid targets (Tribedi *et al* 1991a, b).

4. Conclusion

A post foil stripper has been designed and fabricated. Its performance in very high vacuum environment has been checked. It has been used along with a 14 MV pelletron accelerator to provide completely stripped light ions up to sulphur for atomic collision experiments.

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