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A triple axes multiple target holder assembly

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Abstract. A triple axes multiple target holder assembly has been designed and fabricated to accommodate 27 targets to be used inside a high vacuum scattering chamber. This target holder assembly has been used satisfactorily in ion solid collision experiments using heavy ion beams from an accelerator.

Keywords. Multiple target holder; heavy ion accelerator; atomic collision; inner shell ionization.

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1. Introduction

In several experiments using particle accelerators where measurements on a large number of targets are required in a limited time, it is desirable to have a multiple target holder for efficient beam time utilization. In addition, one should be able to change the target position quite accurately as well as bring back any target in the required position by remote control with high reproducibility. Such a system is very essential in several atomic collision experiments. For example, to measure target and projectile X-ray production cross sections with heavy ion beams using thin solid targets it is necessary to investigate a large number of targets of varying thicknesses. Since the X-ray yield is a strong function of initial charge state of the ion beam (Gray 1980) the measurements have also to be performed with beams of different initial charge states at a given energy. It is further desirable for a systematic study to investigate these cross-sections, as a function of target atomic number. Hence targets of various materials each having a few different thicknesses are to be studied preferably during the same run.

The targets used generally are very thin (about 1 to 50 μg/cm^2) and fragile in nature. As the measurements have to be performed inside a high vacuum scattering chamber frequent changing of these targets as well as the tilting angle with respect to the beam axis (to generate more thicknesses from a given target) have to be performed very efficiently and without breaking the vacuum. A multiple target holder assembly having various degrees of freedom therefore becomes very handy and convenient. A conventional target holder in the form of a ladder is not suitable for accommodating a large number of targets for various reasons including the difficulties of the fabrication of such a long assembly. The long assembly also restricts the reproducibility of the target position and orientation. The automation of a rotatable target holder is simpler compared to a linear one. We have therefore designed and

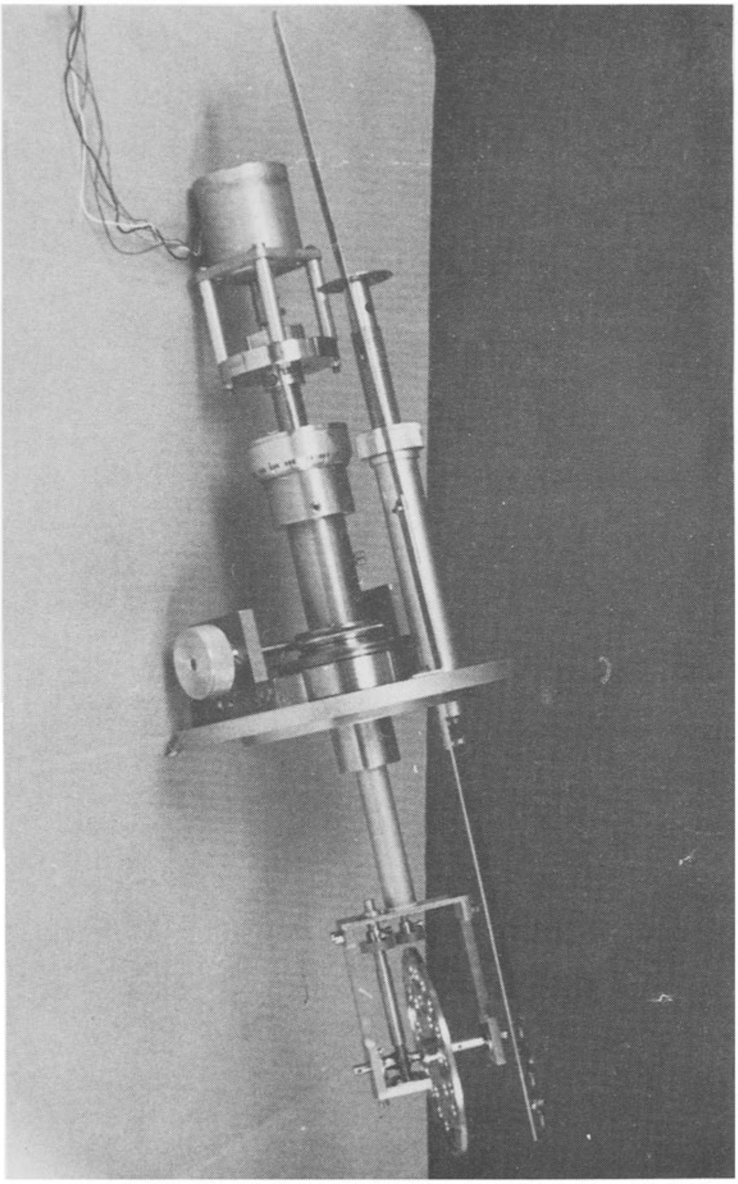

Figure 1. A photograph of the target holder assembly. A ladder (fixed on the flange) for mounting Au foils for beam current normalization (Tribedi *et al* 1991c) can also be seen.

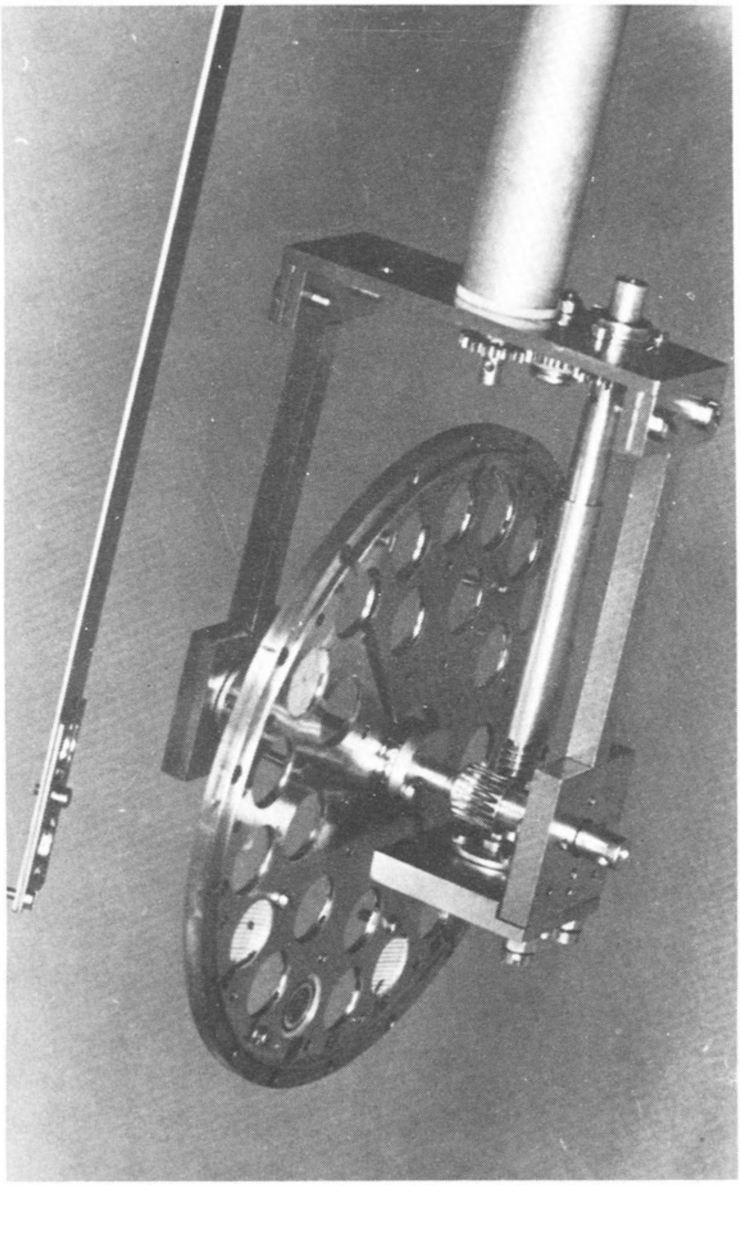

Figure 2. A photograph of the target wheel and the gear assembly. Two spur gears are seen to be coupled through a idler gear which was changed later to directly coupled gear assembly (see figure 1).

fabricated a rotatable target holder assembly capable of accommodating 27 targets on two concentric circles (figures 1 and 2). The whole assembly is mounted on a stainless steel (s.s.) flange which could be adapted onto any scattering chamber. This assembly has been tested and used in several experiments employing the heavy ion beams from the BARC-TIFR pelletron accelerator (Tribedi *et al* 1991a, b, c). We report here the design details and the main features of this assembly.

2. Design details

A line diagram of the target holder assembly is shown in figure 3. The target foils are mounted along two concentric circles on a s.s. wheel (W) 133 mm in diameter. On the outer circle 18 targets can be mounted, each 20° apart and on the inner circle the remaining targets are positioned each 40° apart. The self supporting or carbon backed targets are mounted on thin s.s. frames and are placed concentrically at the target positions on the wheel (W). Three degrees of freedom are provided to the target holder assembly. The ϕ rotation (about the horizontal axis passing along the axis of the wheel) is used to bring any one of 27 target positions onto the beam axis. This is achieved with the help of several coupled gears and can be moved manually or remotely via a stepper motor (M1). The θ motion, which is used to tilt the target holder with respect to the beam axis, can also be done manually or by a stepper motor. This feature is utilized to generate different thicknesses from the same target. In addition, the target wheel can be raised or lowered to have access to the targets on the two different concentric rings. Each of the three motion could be accomplished in very fine steps which is very essential during alignment of the target wheel such that the lowest target on the wheel is on the beam axis.

The target wheel (W) is fixed on a shaft (H) supported on two ball bearings which are mounted on a bracket (B). This bracket is held by a thick-walled support tube (T1) which in turn is guided by long collar tubes. A double O-ring Wilson seal is provided between the tube T3 and the support tube T1 for holding vacuum inside the chamber. The thick walled s.s. tube T3 is welded to the s.s. flange (F2) which holds the bearing arrangements and the rotatable turntable. The support tube (T1) is externally threaded and can be raised or lowered by a knob mounted on a ball bearing fixed to the collar tube T2. The knob is graduated and a linear scale (S1) is engraved on the surface of the tube T1 to read out the vertical position of the target wheel. The collar guide T2 is a part of the rotating turntable mounted on a ball bearing on the flange (F2). This turntable can be rotated providing the θ motion which can be read out on the 360° graduated circular scale (S2) fixed on F2. The θ movement in fine steps is done with the help of a gear mounted on the rotatable turntable and a worm shaft mounted on a bracket which is rigidly fixed on the chamber–flange (F2) (figure 1). A locking arrangement is provided to decouple the θ and Z motions. A rod (R1) passing through the tube T1, vacuum sealed independently, drives a set of spur gears (G1) which in turn transfer the rotation perpendicularly to the target wheel via a worm gear assembly (G2) to generate the ϕ motion. A stepper motor (M1) arrangement provides the motion at the other end of the rod R1. The assembled target holder assembly is shown in figures 1 and 2.

Both the θ and ϕ motion can be controlled remotely by a stepper motor arrangement. We have at present provided for only ϕ motion for very frequent change

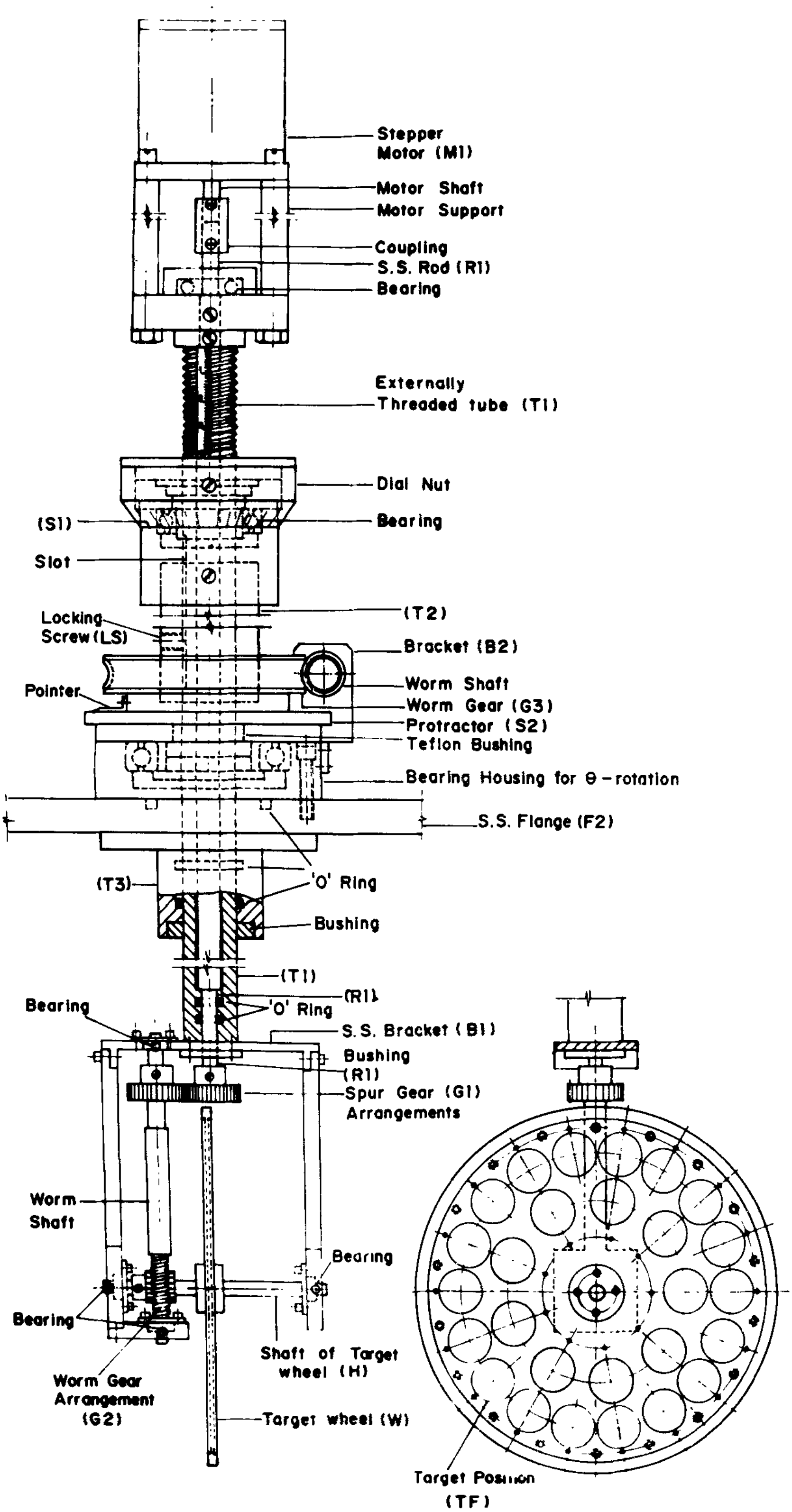

Figure 3. A line diagram of the target holder assembly showing the finer mechanical details and description of the various components.

of the targets. For convenience the gear ratio of the worm gear is chosen such that one complete rotation of the stepper motor shaft corresponds to a ϕ rotation of 20°. The stepper motor is driven by a electronic driver circuit. The 20° rotation is covered in 200 steps of the electronic counter which could be set by a thumb wheel switch in order to provide very small rotation to the stepper motor. The ϕ motion could be provided in any direction by rotating the stepper motor in forward or reverse direction. The stepper motor control is operated from the counting room by laying about 20 m long cables from the beam line.

3. Performance

This target holder assembly has been used in several experiments to measure the K-shell ionization cross-sections using light and heavy ion beams from an accelerator (Tribedi *et al* 1991a, b, c). The assembly has been used inside a chamber in a high vacuum of 10^{-7} torr. All the three motions θ, ϕ and Z could be accomplished easily without deteriorating the vacuum. The target holder assembly was found to be extremely useful and convenient in the experiments mentioned specially in measurements for K-shell population of light ions moving inside solid targets using the probe layer technique (Tribedi *et al* 1991c). Each of these measurements were of duration lasting 3 to 4 days. Because of the capability of mounting a large number of targets it was not necessary to break the vacuum in the chamber during the run thereby using the beam time with maximum efficiency.

4. Conclusion

A rotatable target holder assembly accommodating 27 targets has been designed and fabricated. This assembly has been used in high vacuum environment. It was found to be very handy and convenient to use in several atomic collision experiments.

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References

Gray Tom J 1980 in *Methods of experimental physics* (ed.) P Richard (Academic Press) vol. 17 p. 193
Tribedi L C, Prasad K G and Tandon P N 1991a *Proc. DAE Symp. Nucl. Phys. Bombay* **B34** 473
Tribedi L C and Tandon P N 1991b *Proc. DAE Symp. Nucl. Phys., Bombay* **B34** 457
Tridebi L C, Pillay R G, Prasad K G and Tandon P N 1991c *Proc. DAE Symp. Nucl. Phys., Bombay* **B34** 455