A 150 cm diameter scattering chamber for Pelletron-LINAC facility at Mumbai

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Introduction

A general purpose scattering chamber [1] of 150 cm diameter is under fabrication for nuclear reaction studies with the LINAC booster of BARC-TIFR Pelletron. In this paper we describe the salient features of this chamber with emphasis on its new feature of ferro-fluid seals to ensure leak-free rotation of the detector arms and movement of the target ladder.

Mechanical Design

The chamber is a cylinder of 150 cm diameter and 50 cm height having entry and exit ports to couple to the beam line (Fig 1). It is made of non-magnetic stainless steel (SS 304) with a wall thickness of 8mm. Ten additional ports are made for gas detector feed-throughs, toughened glass for viewing, vacuum gauges and miscellaneous uses. The chamber is being fabricated by M/s Hind High Vac (Bangalore).

Vacuum System

The chamber is provided with two turbo pumps (each 1250 lts/sec) with rotary pumps for roughing and backup. The two pumping ports are located below the chamber, away from the centre and along the direction of the beam line. The ports are protected by suitable wire mesh.

It is envisaged that the chamber can be pumped down to better than $4x10^{-7}$ torr in 4 hours. Two vacuum gauges are provided and the entire vacuum system will be controlled and monitored by means of a programmable logic unit (PLU) to ensure the automatic switch from roughing to turbo pumping on reaching a set point. The logic incorporates safety features and interlocks.

Detector Arms

There are two movable arms with raised detector platforms. One of the arms has an angular span allowing 5 radial hole-lines covering 40^o (10^o apart) and the second one with 9 radial-hole lines covering 80^o. The arms are independently rotatable in vacuum from outside with a readout precision of 0.05^o.

While existing scattering chambers currently in use at BARC-TIFR and IUAC Pelletrons make use of elastomer based Wilson seals, the present design makes use of ferro-fluid seals. The problem with O-ring based rotating seals is that wear and tear takes place, resulting in vacuum leaks during the experiment. Replacing the O-rings takes time and can be done only in-between experiments. Ferro-fluid seals make use of a fluid with suspended magnetic particles and permanent magnets creating a dynamic seal. This results in rotary movement which is leak-free, frictionless and is maintenance free.

For moving the arms, 2 servo motors are coupled via ferro-seals and bevel-gears, inside vacuum in the cylindrical stem below the chamber. The weight of the arms is countered by combination thrust and radial bearings.

Arm rotation is by computer control with backlash corrections being applied in the software. Fiducial markings inside the chamber define a set of fixed angles for calibration and backlash verification. Provision in the software restricts angular movement in the range of $\pm 360^o$ with respect to the 'home' position, thereby ensuring that cables inside the chamber do not encounter more than one clockwise or anti-clockwise twist.

Target Ladder

The target ladder has the provision to mount 6 targets. It is made from hardened steel allowing the ladder to be only 2 mm thick. The mechanism to rotate and change the height of the

ladder is again achieved by means of two motors coupled via ferro-fluid seals. The first motor is for target rotation. The ladder slides in a hollow cylinder and a screw jack mechanism is used for changing the height. The two motors are also under computer control, allowing different targets to be positioned and rotated by software.

Monitor Detectors

Two rails at an elevation of 10^o are provided at the entrance and exit of the chamber where sliding detector mounts can be fitted and used as monitor detectors. The maximum monitor angle is 35^o with respect to the beam direction. The graduations on the sliding scale are made to directly give the angle with respect to the beam.

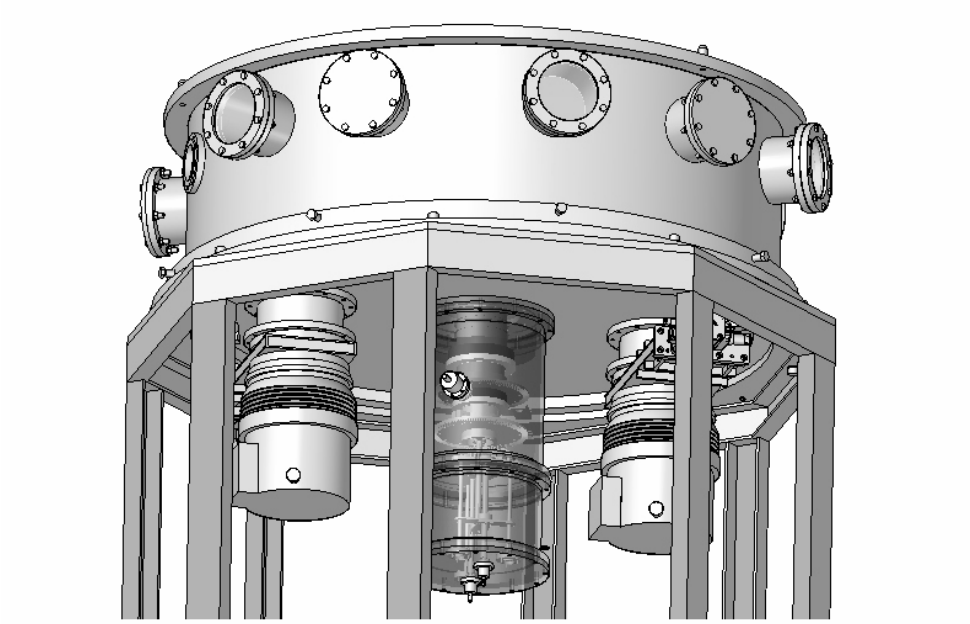

Fig 1. General view of the Scattering Chamber. The two turbo pumps and the central assembly housing the gears for arm movement and target rotation (shown transparent for clarity) are seen.

Vacuum Interlock

A target ladder vacuum interlock system is provided at the top lid of the chamber. The system makes use of 2 gate valves and a manually operated Wilson seal based plunger. Using this system it is possible to take the ladder out without having to vent the chamber to air. After being taken out, the ladder remains in rough vacuum in a cylindrical housing. This is useful in the handling of targets which cannot be exposed to air (e.g. Li metal).

Signal Feedthroughs

A provision to couple 190 output signals using ten 19-pin Lemo (SGJ.2B.319.CLLPV) feedthroughs and 36 high-voltage (3KV) electrical connections using one 36-pin feedthrough (SWH.4S.324.CLLPV) has been provided.

Summary

A 150 cm diameter scattering chamber is under fabrication for use in reaction studies at the BARC-TIFR Pelletron-LINAC facility. Aside from the usual arrangements of two movable arms, adjustable target ladder, monitor detectors etc, a vacuum interlock system is provided for replacing targets without breaking the vacuum and four ferro-fluid seals are used for arm and ladder movements, making it completely leak-free and maintenance free.

Reference

[1] Suresh Kumar and S.C.Ojha, Nat. Symp. On Vacuum Science & Technology (DAE), Mumbai, IVSNS-2003, p.170