Large segmented reaction chamber for VECC superconducting cyclotron experiments

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Vacuum reaction chamber is an essential component of any accelerator based experimental setup in nuclear physics and the design of the chamber depends upon the experimental programme [1]. A large, segmented, horizontal axis, reaction chamber (SHARC) has recently been fabricated, and then installed and integrated with the beam line in the VECC superconducting cyclotron (SCC) experimental area. SHARC has been designed in-house at VECC and fabricated by M/s. Vacuum Techniques, Bengaluru. Here we report the salient features of SHARC, which will be used for general purpose charged particle based experimental studies of intermediate energy heavy-ion collisions, using the accelerated ion beams (~5-80 MeV/A) from SCC.

General description : SHARC is cylindrical, three segment, stainless steel (SS 304L) chamber of length 2.2 m, diameter 1 m and wall thickness ~10 mm; the front (beam-entry) end is hemispherical in shape of radius 500 mm and the rear end is elliptical dish (2:1) shaped (see Figs. 1&2). The segments are mounted on separate support structures on rails such that each segment can move independently on rails by automatic gear-motor control mechanism having built-in limit switch locking facility with manual override option. All three segments (and the rear part in particular) may be rolled back on rail to open up the chamber to give accessibility for the installation of users' equipments inside. There is arrangement to manually align the chamber with the beam line axis precisely in horizontal/ vertical/ rotational degrees of freedom. A number of ports (24 nos., size – 25 cm dia) are provided on different locations of the chamber body (see Fig. 1) to take the detector and other readout signals out of the chamber. Two glass windows are kept to view the target and detector positions inside. Two pairs of rails are provided within the chamber for mounting and placement of the target ladder system and the user designed detector stands at any position within the chamber. A generalized detector mounting table (made of Aluminum alloy 6061-T6) with precision alignment mechanism on manually movable stands with locking arrangement on rails is provided. There is no rotating arm inside; users are encouraged to fabricate their own detector stands as per requirement.

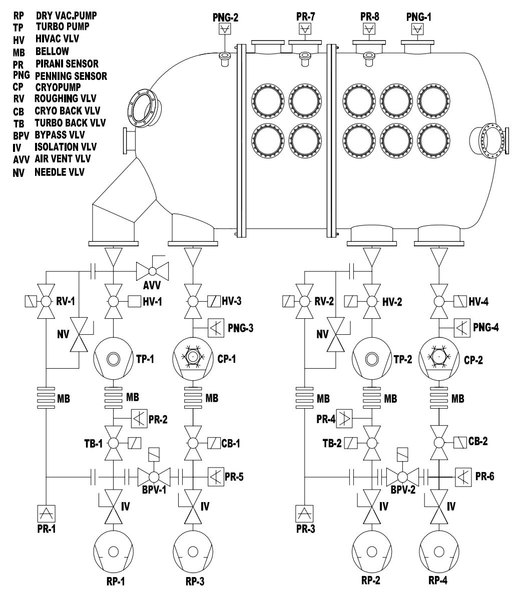

Fig.1: *Schematic diagram of SHARC with vacuum pumping system.*

Target assembly: The target ladder system has been so designed to take maximum advantage of the full length of the chamber. The whole

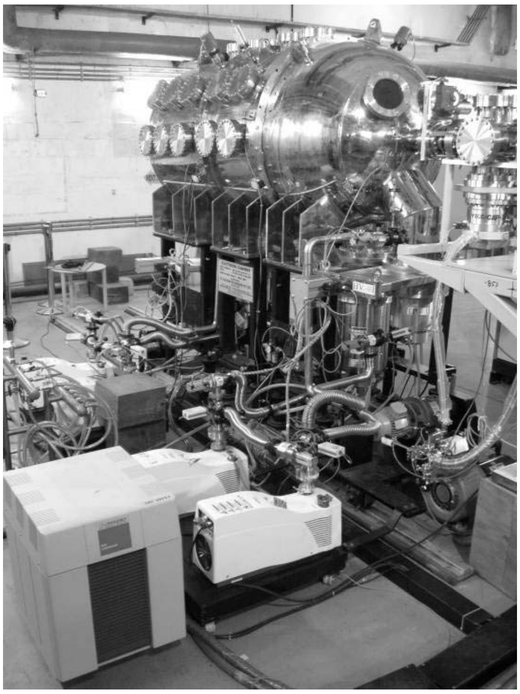

Fig. 2: *SHARC in position in SCC beam hall-1.*

assembly is mounted on one pair of internal rails and may be placed at any position within the chamber to optimize the flight path. The target assembly includes a ladder that can hold six

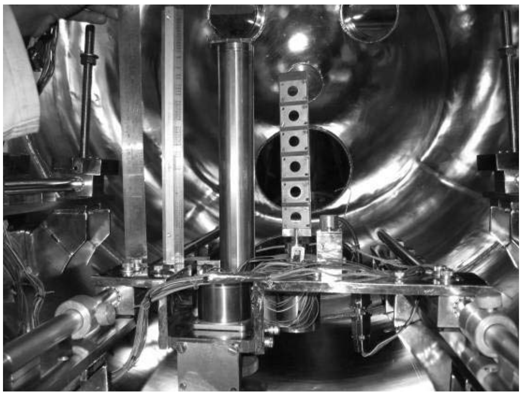

Fig. 3: *Target ladder system inside SHARC.*

targets at a time in a column (see Fig. 3). Ladder movement mechanism is constituted of programmable logic controller (PLC) driven, remote / locally operated, vacuum compatible stepper motors (2 nos.), which are used to execute (i) up/down and (ii) rotational (360^0, both clockwise and anti-clockwise, along the vertical target ladder axis) movements of the target ladder.

Vacuum pumping system: To achieve optimum vacuum performance, all the inside surfaces were given smooth granular finish and were finally electro-polished with bright finish. Clean vacuum $\sim 1\times 10^{-7}$mbar is achieved by means of two turbo molecular (1000 l/s) and two cryo pumps (2500 l/s) backed by mechanical pumps. The whole vacuum system is automated by using a PLC. The vacuum operation is controlled locally as well as remotely through a compact control unit, which provides continuous display of the status of the full pumping sequence for monitoring purpose. A typical vacuum pumping sequence is displayed in Fig. 4. Typically, vacuum (in empty chamber) $\sim 1X10^{-7}$ mbar is

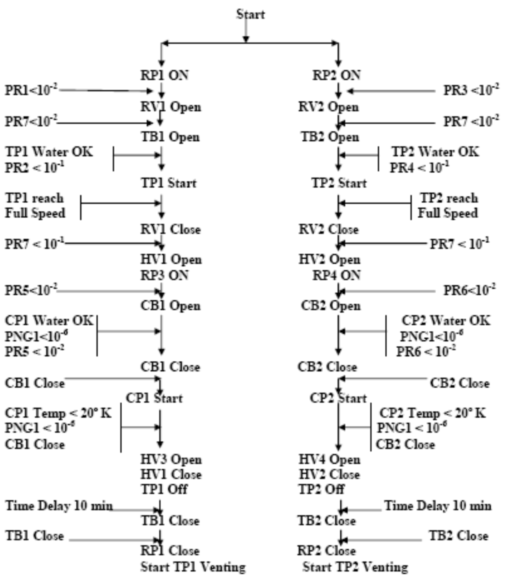

Fig. 4: *Typical vacuum pumping sequence.*

obtained in 8 hrs. There is also a provision for slow manual pumping under demanding experimental conditions.

References

1. S. Bhattacharya, Pramana, 75 (2010) 305.