IMPROVEMENTS IN RF INPUT UNIT FOR INJECTOR MICROTRON FOR INDUS SRS COMPLEX

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Abstract

A 2.5GeV Synchrotron Radiation Source (SRS) Indus-2 and a 450 MeV SRS Indus-1 are in operation at RRCAT. Electrons are injected into these machines with the help of a common injector system consisting of a 20 MeV microtron and a 450/543 MeV booster synchrotron. In this paper we report the work done towards the development of an improved RF input unit for the 20 MeV injector microtron. The RF input unit is a multifunctional unit and provides arrangements for alignment and positioning of the RF cavity, in-vacuum wave-guide connections, cavity cooling arrangement & cathode powering leads. A microwave window provides isolation of waveguide pressure to the microtron vacuum. While feeding microwave through a WR 284 waveguide, RF input unit provides water circulation to remove heat generated by the cavity losses as well as the cathode heating so as to keep cavity temperature stabilised. The alignment features provide anti-backlash features. Bellow seals as well as rotary O-ring seals have been used to provide various degrees of freedom for the alignment. The new unit consists of kinemetically designed adjustable columns and has robust design features to hold the cavity position under changing loads during evacuation and operation. The new design also reduces the overall installation time significantly. The prototype RF input unit has been manufactured and tested. This paper presents the test results of the prototype, design, components and status of actual unit which is under manufacturing.

INTRODUCTION

Microtron is a cyclic accelerator which accelerates electrons using a RF cavity located in uniform magnetic field between the microtron poles. The RF cavity is a cylindrical "pillbox" cavity made of OFE copper and has Lanthanum Hexaboride single crystal cathode which emits electrons. The electrons move in circular orbits under action of magnetic field and re-enter cavity to gain energy and move in a larger diameter orbit. While feeding microwave through a WR 284 waveguide, RF input unit provides water circulation to remove heat generated by the cavity losses as well as the cathode heating so as to keep cavity temperature stabilised. The alignment features provide anti-backlash features. Bellow seals as well as rotary O-ring seals have been used to provide various degrees of freedom for the alignment. The RF Input unit has to operate in vacuum of 1×10^{-7} mbar and in magnetic field of about 1800 Gauss. The cavity installation time and alignment accuracy has been enhanced in the new design as compared to the old unit which is currently in operation.

DESIGN

The important design requirements of RF input unit are that it should have provision for positioning RF cavity in x, y & z directions in ±1 mm range with position repeatability of 0.2 mm. The angular positioning about vertical axis is also a requirement and positioning with a resolution of 2 mrad can be obtained. The cavity position is held firm against changing loads during evacuation. The stable and repeatable positioning of RF cavity is very important for repeatable operation. The kinematic design scheme is based on three adjustable height columns [1]. The upper part of columns have spherical joint. A fully constraint movement with five degree of freedom is provided to RF cavity using these columns and remaining rotation about waveguide axis is produced using rotary seal between the intermediate flange and fixed flange. All the three columns are pre-loaded with the disc springs to minimize the effect of vacuum force on the aligned position. The AutoCAD drawing of RF input unit is shown in Fig. 1 and the solid model is shown in Fig. 2. Dial indicators are mounted integrally on adjustable columns to indicate their position. The RF input unit has provision for mounting Fiducials so as to measure and record the cavity position.

The RF cavity is mounted at lower extremity of the waveguide and the microwave power coupling to the cavity is provided with an aperture. An edge welded bellow is used to impart the flexibility required in the alignment while maintaining vacuum integrity.

Two replaceable circular copper tubes circulate cooling water to remove the heat from RF cavity surface. The cooling tube to flange joint is designed as demountable joint using Wilson seals at tube ends so as to permit easy disassembly in case of cooling tube replacement. The current to cathode is fed using two electrical feedthrough having ConFlat flange connections. Both water and current feedthrough are mounted on upper flange of RF input unit.

The design reduces installation time of RF Input unit significantly.

Vacuum compatible materials with low magnetic permeability were chosen. Material of construction of most of the components of RF input unit is Stainless steel grade 304L. Waveguide is made of OFE copper. Tin Bronze is used for screw pair of anti-backlash assembly in columns.

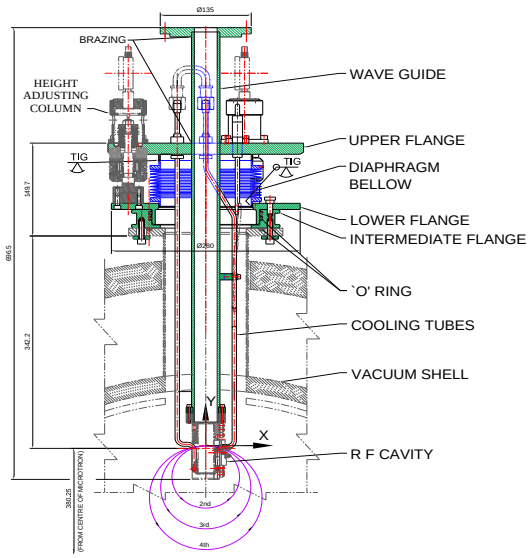

Figure 1: Schematic drawing of RF input unit

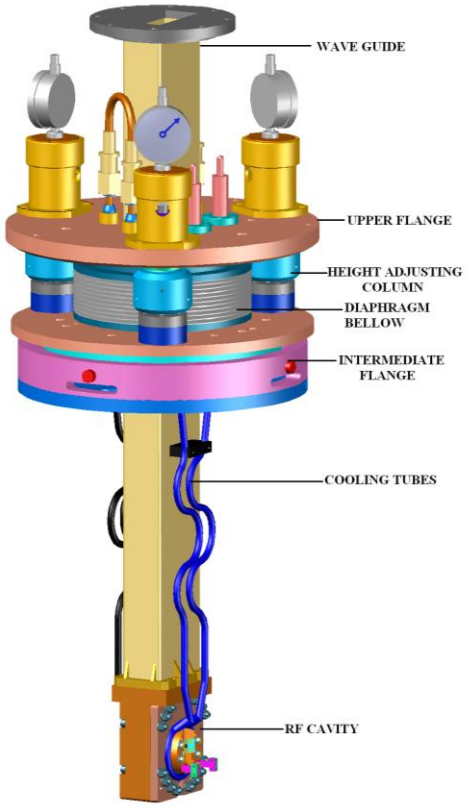

Figure 2: Solid model of RF Input unit

QUALIFICATION

A prototype unit was made to test design functionality. The movement range and functionality was tested and found as per design specifications. Some design improvements were incorporated in actual unit based on test results of prototype. All components of actual RF input unit have been manufactured and stage leak testing of vacuum joints has been completed. Final welding and brazing of RF input unit is in progress.

Figure 3: Mock-up assembly of RF Input unit on support

REFERENCES

[1] Handbook of Optomechanical Engineering, Anees Ahmad, CRC Press Inc.