A.5 Development of efficiently cooled drift-tubes for high energy SFDTL RF cavities

The drift tubes are very important components of a typical SFDTL type of accelerating structure, as the beam passes through the center of the drift tube and the beam accelerates between the gaps of two drift tubes. The drift tube receives the maximum heat flux; hence development of efficient cooling schemes for drift tubes needs a combined approach of thermal design and fabrication feasibility. Different types of hydraulic channels for increasing over all heat transfer coefficient were studied at Advanced Accelerator Module Development Division of RRCAT. A six cooling channel drift tube was fabricated using hydrogen brazing and subsequently vacuum brazed and tested for UHV compatibility. The brazing of such drift tube is difficult because of six precision components are to be joined simultaneously to meet UHV requirement. Fig.A.5.1 shows cut section of the optimized design for six channels cooling in one brazing step fabrication.

Fig.A.5.1 Cut view of the six-channeled drift-tube.

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A.6 Experimental setup for RF characterization of pillbox cavity

Most cavity resonators used in electron and proton accelerators are derived from the simple cylindrical or pillbox cavity. Comparison of the results for RF frequencies and other parameter are done between numerical techniques and experiments at Advanced Accelerator Module Development Division of RRCAT. Further, a piston tuner arrangement as shown in Fig.A.6.1 is attached to this cavity through vertical port. This tuner system has 50 mm diameter piston attached to the stepper motor. This arrangement can give 25 micron movement in one step. Total stroke length is 70 mm. Here 50 mm inward and 20 mm outward movement is set. Results of fundamental frequency perturbation and theoretical magnetic field calculations are shown in Fig.A.6.2.

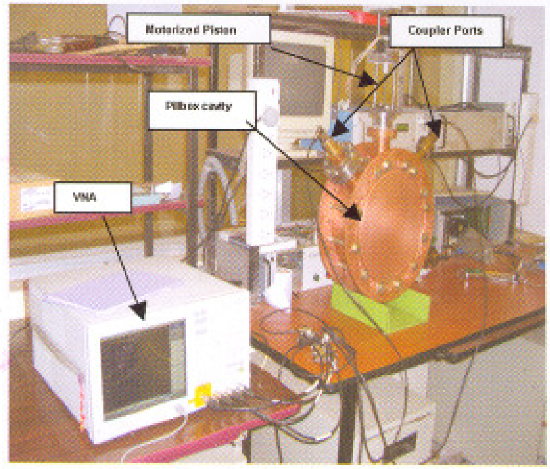

Fig.A.6.1: Experimental setup of Pillbox cavity RF testing.

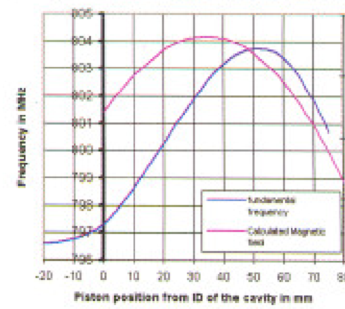

Fig.A.6.2: Displacement of piston tuner vs. fundamental frequency in pillbox cavity compared with calculated magnetic field inside the cavity.

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A.7 Prototype compound motion compact precision jacks

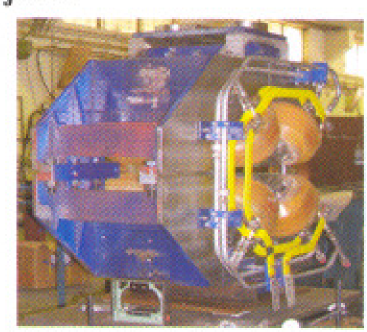

Fig.A.7.1: Performance testing of prototype precision movement compact jack system, mounted below a quadrupole magnet.

Prototype compound motion compact precision jacks (each of capacity 500 kg) have been developed at Advanced Accelerator Module Development Division of RRCAT, for positioning and alignment of small accelerator components such as quadrupole and sextupole magnets, SFDTL tanks etc. These jacks can be anchored below the components and positioned (its magnetic axis and mid plane) precisely with typical accelerator alignment tolerances of 0.1 mm in linear and 0.2 mrads in rotational position w.r.t their true position in the ring. The designed movement system uses combination of three identical compound motion precision jacks similar to the support system of main dipole magnets of Indus-2. Fig.A.7.1 shows the performance testing of precision movement jack system, mounted below the quadrupole magnet

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A.8 Design and prototype fabrication of an eccentric wheels based motorized alignment mechanism for accelerator components

A remote alignment/ or alignment correction becomes essential for proton LINAC components of medium and high energy, as they become source of radiation because of residual radioactivity and hence become inaccessible. Very high order of alignment accuracy is required to meet the stringent requirement of beam loss. An eccentric wheel mechanism based alignment system has been fabricated at Advanced Accelerator Module Development Division of RRCAT as shown in Fig. A.8.1.

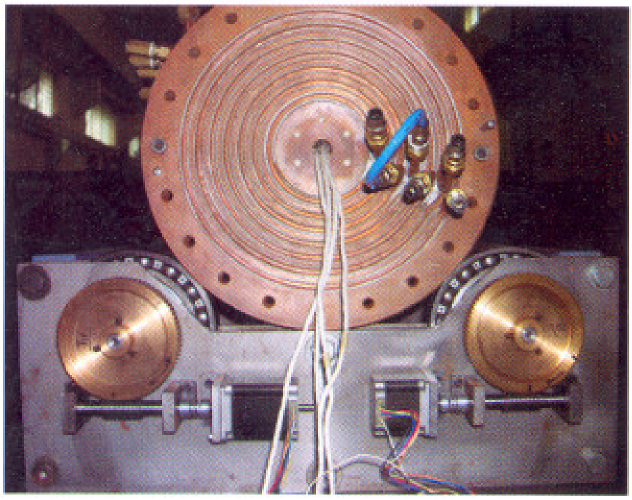

Fig.A.8.1: SFDTL supported on eccentric wheel base alignment system.

The mechanism consists of two sets of two eccentric wheels, one at each end. With the combination of the movements of these wheels it is possible to have very precise movement in a small area in front and in the back plane. With the combination of these movements, two linear (X-Y) and two rotary (pitch and yaw) degrees of freedom is achieved, which is highly suitable for such applications. The eccentric wheels are moved by stepper motor through precision worm and wheel to achieve high resolution of movement. If we operate the eccentric wheels within the range of 43.26 degree to 223.26 degree (in this combination/ design), the direction of force on the worm-wheel does not change and hence the backlash effect can be avoided.

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A.9 Stranded water-cooled cables for rapid cycling magnet coils

The presence of eddy currents in low frequency (~100 Hz) rapid cycling magnets is a source of technical difficulties and the key issue is the reduction of eddy current loss. In order to keep the magnet coil losses at reasonable levels, it is generally necessary to use a special water-cooled stranded cable for operating frequencies above 10 Hz as the macroscopic eddy current losses are proportional to the square of the frequency and the square of the magnetic field. The magnetic field inhomogeneity resulting due to eddy current loss is less and also low operating costs of magnets with stranded coils. Few prototype 6 meters length stranded water-cooled cables using bare / enameled aluminum strands for testing have been indigenously developed at Advanced Accelerator Module Development Division of RRCAT. Fig.A.9.1 shows the details of water-cooled stranded cable showing aluminum strands in various layers. The development of 50 meters continuous length water-cooled aluminum stranded cable is in progress.

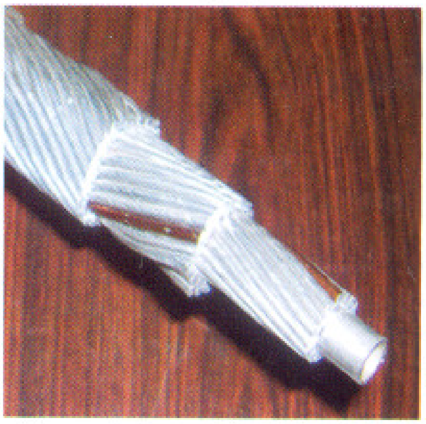

Fig.A.9.1: Water-cooled stranded cable, showing strands in various layers.

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