A.15: Heat Removal in Indus-2 dipole chambers

Indus-2 vacuum envelope is made of aluminium alloys for storing the electron beam. The dipole magnet chambers are machined out of alloy 5083H321 and straight section chambers are made from extrusions of 6063T6. A vacuum of level 10^{-10} mbar is maintained in the ring by UHVTD. For this SIPs are regularly maintained by UHVTD. Synchrotron radiations produced by the circulating electrons in bending magnets are used by the users and the the unwanted synchrotron radiation are absorbed by the photon absorbers. A fraction of synchrotron radiation which are not stopped by the photon absorbers in the downstream of electrons pass towards straight sections connected to dipole chambers and falls on the end plate of the dipole chambers as well as on the straight section chambers connected to the dipole chambers. Their surface temperatures were rising above 90°C. A thermal profile of the end plate of one dipole chamber was taken during Indus operation. This had confirmed that the end plates did get heated up. The temperatures on the end plates of all the dipole chambers were measured and they all showed upto 90° C maximum at 80 mA beam current and 2.5 GeV It was calculated that a heat load of around 300 watts would fall in case of a stored beam current of 300 mA at 2.5 GeV. This heat load on the end plate had to be removed as it is detrimental for the lip welding of aluminium. The lip welding of 5083H321 is forced to thermal cycling and localized heating affects the welding to expand which might crack the welding due to stress. Hence the beam current was restricted to below 70 mA to study the problem and devise a cooling arrangement.

Different cooling options were studied and the best option was to be Oxygen Free High Conductivity copper plate/pads. The cooling can be made further effective by flowing DM water through them. Hence these cooling copper pad option was chosen. The highest thermal conductivity of copper coupled with water cooling provided an effective way of cooling. The large area covered by the pad, helped in faster heat removal. A prototype cooling pad was made out of OFC copper with water cooling tubes brazed and was fitted on one of the dipole chambers. Water from one of the photon absorbers was connected in series to cool the pad. The temperature was measured near the welding lip. It had come down drastically to 45°C at 70 mA where as the uncooled end plates were at 75°C. Similar cooling pads were fabricated, tested for brazing leaks and fitted on all the dipole chambers within a week's time and the heat produced by SR was effectively removed thus paving the way of Indus-2 operations at higher beam current. The final temperatures that were measured were in the order of less than 50°C at 100 mA stored beam current at 2.5 GeV.

Fig. A.15.1: End plate of dipole chamber where temperature was measured

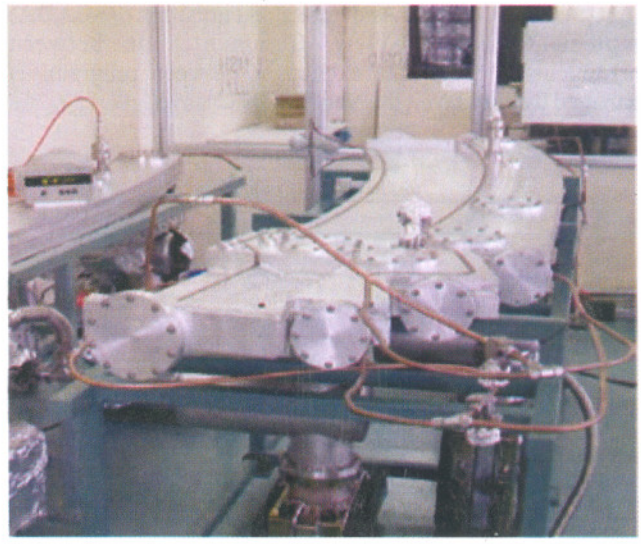

Fig.A.15.2:Copper plate mounted with cooling provisions

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