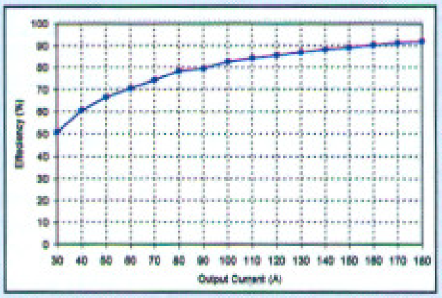
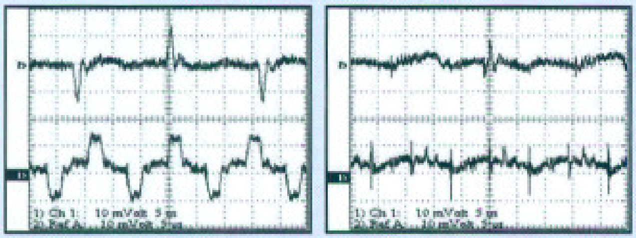


Fig.A.3.2 Conversion efficiency of Indus-2 Q3 magnet power supply



(a) (b)

Fig. A.3.3 CM current injection observed on (a) before, and, (b) after cancellation. Upper traces are for I_o=180A and Lower traces for I_o=40A

(Contributed by M.B.Borage.S.R.Tiwari; sunil@cat.ernet.in)

A.4 Laser profile cutting for quadrupole magnets of Indus-2

Particle accelerators utilize different types of magnets in limited number. Quite often prototype magnets have to be developed and tested before finalizing the design. It is not always practical to make die and punch for developing these magnets. High precision profile cutting of metal sheets could be exploited to have flexibility in magnet design and its prototype development. Indigenously developed high power CW CO_2 laser was utilized for profile cutting of 1200 numbers of 1.5mm thick steel sheets for the fabrication of Quadrupole magnets of Indus-2. Dimensional accuracy of dross-free profile cut was within ±50µm limited by the CNC workstation and the surface roughness of the cut edge was less than 5µm.

Fig.A.4.1 Laser cut-profile

(Contributed by: Dr. AK Nath; aknath@cat.ernet.in)

A.5 Open-type quadrupole magnets for Indus-2

The open-type quadrupole magnets for Indus-2 are slowly ramped from 3.84T/m to 16T/m in 300 seconds and require stringent magnetic field quality. In these magnets both of the outer vertical sections of the steel are removed in order to take out the emerging synchrotron radiation beam lines, in the region immediately adjacent to the main dipole magnets. In addition, a group of magnets, which are powered by a single power supply, need to be uniform. To meet these specifications, the critical features (pole aperture diameter and symmetry of poles) of the magnet geometry were precisely controlled. The magnet cores were made from 1.5mm thick decarburized steel sheets and their excitation coils were made from hollow oxygen free copper conductors. The core is an assembly of four pole pieces, which are made by laser-cut laminations, using 1kW-CO_2 laser and consolidated into laminated core by welding.

Fig. A.5.1 Open- type quadrupole magnet assembly

The pole tip profile was machined to finish by wire-EDM. The excitation coils were made using a semi-automatic coil-winding machine. The wound coils were consolidated with vacuum pressure impregnation followed by epoxy encapsulation for ground insulation. All open type quadrupole magnet cores and coils have been made successfully and the variation in magnet core geometries are within ± 0.05mm. The variation in the electrical parameters among the coils is within 3%. Few magnet assemblies (assembly of magnet core with coils) were completed and the balance magnet-assembly work is in progress.

(Contributed by: K. Sreeramulu; sreeram@cat.ernet.in)

A.6 Beam profile monitor for Indus-2

A fluorescent screen beam profile monitor (BPM) has been designed and fabricated for electron storage ring Indus-2. This monitor is an interceptive device, which serves as useful tuning aid during the initial commissioning stage or re-commissioning after a major shutdown of Indus-2 ring. Critical design features of the monitor are: minimum beam coupling impedance, UHV compatibility, uniform internal geometry of vacuum envelop, adjustable orientation of monitor, removal of fluorescent screen without breaking vacuum.

Fig.A.6.1 Profile monitor

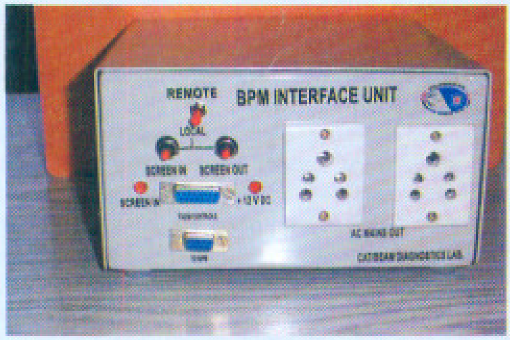


Fig.A.6.2 BPM interface unit

Fig.A.6.1 shows photograph of a profile monitor. It comprises of a chromium doped alumina ceramic screen which is to be inserted into the vacuum envelop of storage ring. When the electron beam falls on the screen it produces fluorescence, which is viewed through a CCD camera. A pneumatic cylinder actuated mechanism is used to move the screen in and out of beam path. An edge welded diaphragm bellow provides vacuum–air interface during screen movement.

It is planned to install eight BPM in TL-3 and ten BPM in the storage ring. Apart from these BPM, there will be one septum beam viewer, two hole monitors, and a synchrotron light monitor, making the total number of video signals as twenty-two. To multiplex these video signals, a VME based video multiplexer card has been designed and developed. The card takes eight video inputs and multiplexes them to one output. The multiplexer card will be housed in the VME-EIU (Equipment Interface Unit) rack of the Indus-2 control system and controlled by the VME controller. The multiplexer outputs will be transported to the control room, where the beam profile will be displayed on video monitors.

A BPM interface unit has been made which takes the commands from the control system in the form of momentary contacts as the input and actuates various components of the BPM viz. solenoid valve, the CCD camera, and the lamp power supply. It also reads the BPM status signals like screen in/out position, power supply status etc. and gives them to the control system. The circuit is housed in a small box that will be kept near each BPM(Fig.A.6.2).

(Contributed by: Anil Banerji; anilban@cat.ernet.in)

A.7 Precision magnet positioning system jacks for large hadron collider project of CERN

Under an agreement between Department of Atomic Energy (DAE) and the European Organization for Nuclear Research (CERN), Centre for Advanced Technology is developing a number of subsystems for the world's largest particle accelerator, the Large Hadron Collider (LHC). LHC is scheduled to become operational in 2007. The LHC is housed in a tunnel having a circumference of 27km about 100 meters below the ground. It has more than 1600 superconducting magnets along its circumference for bending and focusing the beams. These huge magnet assemblies, each weighing more than 32 tons with a length of 15 meters, need to be positioned with a precision of 50 micrometer all along the 27km length. CAT, has conceptualized, designed & developed precision-positioning devices that allow precise positioning of these huge magnets in the tunnel and maintenance of these devices. These devices called precision magnet positioning system (PMPS) jacks enable one person to move the huge magnet and position it with a very high setting resolution. The jacks have to maintain these positions for a long time under the action of variable transverse forces. In fact the set position should remain within 100 micrometer when the transverse force reaches a value of 0.5 ton and within 1mm under a very severe transverse load of 8 tons.

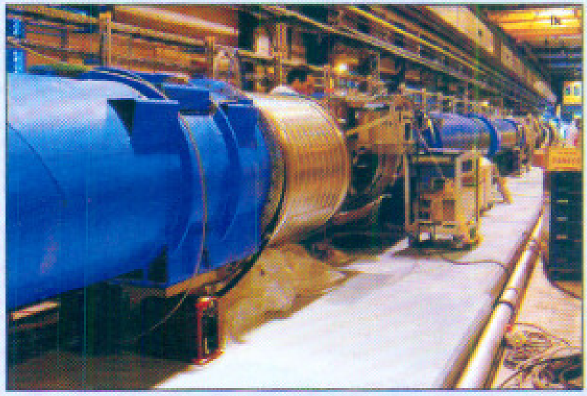


Fig. A.7.1 The prototype jacks under a cryo-dipole at LHC test string-1 at CERN