NewsLetter

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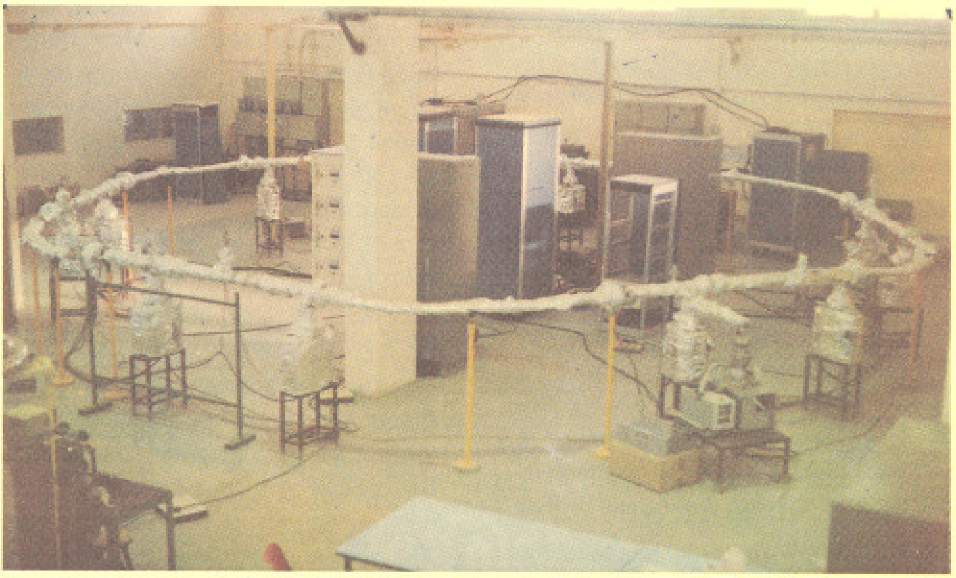

RESEARCH AND DEVELOPMENT

LASER PROGRAMME

Picosecond Laser System

A picosecond neodymium glass oscillator-amplifier system has been developed. The system provides a single pulse of 6 ps duration with an energy output of 3 mJ at a repetition rate of 0.1 Hz. An important featuie of the system is the use of active-passive mode locking technique. This enables the system to provide a picosecond laser pulse on every shot with an energy jitter of 10%, whereas, the conventional passive mode locking technique results in many "no lase" shots and a pulse energy jitter of more than 30%.

The laser oscillator is actively mode locked by an acousto-optic modulator and is simultaneously Q-switched and mode-locked by a saturable absorber. A picosecond pulse is switched out from the oscillator by monitoring the build up of laser radiation using a photodiode. When the laser radiation reaches its maximum, the signal from the photodiode triggers an avalanche transistor circuit (ATC). The fast ATC developed indigenously gives a 3.5 kV step pulse with a rise time of 1.5 ns to the Pockell's cell for rotating the polarization of the laser pulse by 90°. An intracavity polarizer then deflects the pulse out of the oscillator resonator. The laser pulse from the oscillator has an energy of 0.5 mJ. This is amplified to 3 mJ by two passes through a Nd:Phosphate glass laser amplifier. For temporal characterization of the pulses a Two Photon Fluorescence (TPF) setup using a vidicon camera read out system has been developed. In the retro-reflection geometry of TPF a 6 ps pulse was observed.

The picosecond laser system has been used to measure the rather low two photon absorption coefficients in composite materials like colour glass filters.

CO_2 Laser

A high repetition rate transversely excited (TE) CO_2 laser has been developed providing laser pulses of 200 kW peak power at 500 Hz. The 100 W average power output of the system is presently limited by the capacity of the roots blower which is used for removing heat from the laser gas mixture by circulating it through a heat exchanger. The laser utilizes a single row of resistance ballasted multiple pin electrode as anode and an oil cooled copper tube as cathode for electrical discharge. An electrical pulser system which gives 20 kV peak voltage pulses at upto 500 Hz repetition rate is used for laser excitation. Presently this laser is being used for studying laser power coupling to highly reflecting materials such as copper and aluminum. This laser will also be used for scribing, cutting and drilling holes in ceramics.

Another development is a 20 W cw CO_2 laser excited by capacitively coupled high frequency (50 kHz) pulses. The high frequency excitation allows smooth variation of the laser output power from 10% to 100%. Such a smooth variation is required for many applications notably in laser surgery. A further advantage of this excitation scheme is that contamination of laser gas by internal discharge electrodes is eliminated, facilitating operation of the CO_2 laser system in sealed-off mode.

Copper Vapour Laser (CVL)

A 30 W average power CVL with 38 mm beam diameter and an energy conversion efficiency of 0.9% has been developed. Copper Vapour Lasers with average power varying from 10 W to 30 W are now being routinely made at CAT and several of these units have been supplied to other DAE units.

For many applications, it is desirable that the CVL oscillator provide a low divergence beam. Towards this objective several unstable resonator configurations were investigated. In particular, self filtering unstable resonators were applied to the CVL for the first time. The best results were obtained using a positive branch self filtering unstable resonator. This allows more than 70% of the oscillator output energy in diffraction limited divergence angle as compared to only about 10% with a positive branch unstable resonator CVL. The low divergence has allowed focusing of the beam to very small spot sizes. The laser has been used to drill holes with a diameter of 50 μm (1/20th of a mm) in 0.5 mm thick copper plate.

ACCELERATOR PROGRAMME

Microtron

A 20 MeV microtron is being developed for its use as an injector for the 700 MeV booster synchrotron. A microtron for beam injection has the advantage of smaller beam emittance and energy spread, and a lower cost compared to linear accelerators of the same energy. The microtron being developed is of classical type. It has been designed to provide a 20 MeV electron beam with a current of 30 mA in pulses of 1 to 2 μs duration at a repetition rate of 1 to 2 Hz. The transverse emittances and the energy spread of the beam are expected to be 3 πmm mrad and 0.2% respectively.

The salient design parameters of the machine include dipole magnet of 1.4m diameter (weighing 2 MT). The magnet has been designed to provide a nominal magnetic field of 2 kG with a uniformity of 0.2 % over a diameter of 0.8m encompassing 22 orbits of the accelerating electrons. The acceleration occurs in a 20mm long cylindrical RF cavity energized to 980 kV by a 5 kW klystron at 2856 MHz. The electron emitter would be a Lanthanum hexaboride (LaB_6) pin of 3mm diameter mounted in the flat face of the cavity with a capability to provide peak emission current of more than 3 A.

Fabrication of major components of the microtron viz main magnet, vacuum vessel and the RF cavity is well underway. Prototypes of other subsystems like LaB_6 emitter, electron current probe, extraction tube and high voltage power supply for the Klystron are also being developed. In addition to this ongoing programme, it is planned to develop microtrons for other specific applications such as radiotherapy and activation analysis.

Magnets

A wide variety of magnets - dipole, quadrupole, sextupole, septum and kicker, are used in synchrotrons and