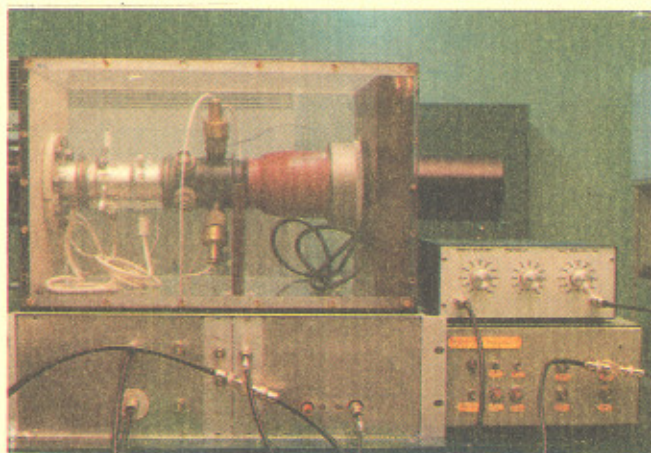


LASER PROGRAMME

A Picosecond X-ray Streak Camera

A picosecond X-ray streak camera has been developed. It provides valuable information about the temporal and spatial X-ray emission from laser produced plasma. This has a streak rate of 15 mm/nsec measured on a phosphor screen. X-ray streak and intensifier tubes for this camera were obtained from General Physics Institute, Moscow. The driving electronics viz. a fast sweep circuit, a gate pulse circuit, a trigger pulse generator and various biasing voltages for photocathode (- 12 kV), accelerating grid (- 10 kV) and focussing electrodes (- 11 kV), have been developed at CAT. Two fast and symmetrical opposite polarity pulses of ~ 1 kV amplitude and ≤ 1 ns rise time were used for deflecting photoelectrons in the streak tube. The time resolution (expected value is ~ 7 ps) of the camera depends crucially on the speed of the sweep voltage (1 kV/ns) and the spatial resolution of the intensifier (10 line pairs/mm). A pulse generator triggered by a reference signal from a fast photodiode provides a trigger to the streak sweep circuit and intensifier gate circuit. A suitable combination of optical delay in the laser beam and electrical delay in trigger signal is used to synchronize the arrival of photoelectrons with the start of the sweep voltage on the deflection plates. The streak tube has a demountable photocathode of gold (300 Å) on a thin nitrocellulose film (1000 Å). The slit has 100 μ m width and 9 mm length. The streak camera was connected to a target chamber and successfully tested using short duration X-rays, generated by focussing a laser beam of 35 picosecond duration and 75 mJ energy from a mode locked Nd:YAG laser on a copper target. A polycarbonate foil was used to block any ultraviolet emission from the plasma. The streak on the screen of intensifier was contact photographed on polaroid film. Development is underway to take the photograph of



Streak camera set-up

a streak on negative film, as well as on a PC with the help of CCD camera.

Development of Sealed-off N₂ Laser

A transversely excited sealed-off N₂ laser having glass housing has been developed. It emits 1 mW average power in 7ns pulses, with a repetition rate of 15 Hz, at a wavelength of 337.1 nm. The advantage of glass housing is that it is inexpensive and bakeable upto 350°C. One of the prototype laser tubes sealed-off six months ago, has completed 150 hours of operation without any observable deterioration in output power. The expected life of this sealed-off tube is two years, after which it can be reprocessed.

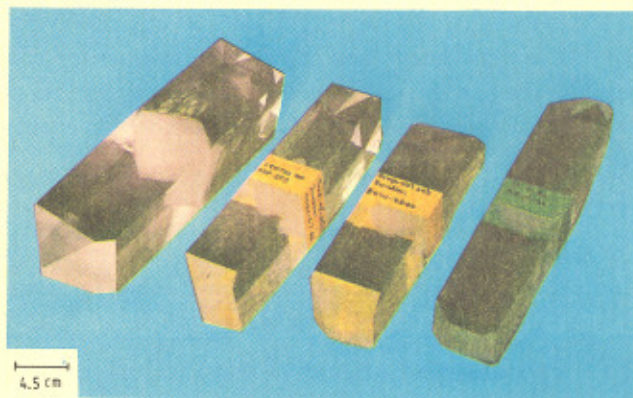
Power Supply for He-Ne Lasers

Power supplies conventionally used for He-Ne lasers are either a 50 Hz step-up transformer with a multiplier and a regulator, or an SMPS (switch mode power supply) with a step-up transformer and a PWM (Pulse width modulation) regulator. The failure rate of these supplies is high as they are sensitive to line variations and short circuit at load.

To overcome these problem a compact line operated resonant power supply has been developed. Our design has a regulator in the input stage and can work between 180 V to 270 V of mains variations. It can also withstand accidental open and short circuits. The mains voltage is rectified and switched using bipolar transistors at 25 KHz. This power supply gives a voltage of 10 kV to initiate the discharge in the tube and settles to 3 kV when discharge is established. A regulator in the input stage regulates the current in the discharge tube. These supplies have been tested on 2 mW and 5 mW He-Ne lasers.

Crystal Growth and Device Fabrication

Large good-quality crystals of a number of water-soluble materials are being grown for making devices for frequency conversion and for electro-optic modulation of laser radiation. Some of the crystals grown are : KDP (potassium dihydrogen phosphate), ADP (ammonium dihydrogen phosphate), and LAP (l-arginine phosphate)



KDP crystals grown at CAT

monohydrate). Although the largest KDP crystals grown at present at CAT are of size $4.5 \times 4.5 \times 19 \text{ cm}^3$, still larger crystals can be grown, if required. Process parameters such as the pH value of the solution, and the speed of rotation of the seed crystal during crystallisation have to be optimized for obtaining inclusion-free crystals of desired dimensions and quality. The level of trivalent impurities in the aqueous solution has also to be kept under control for ensuring that the crystals do not acquire a "tapered" growth habit, and do not have unacceptably high anomalous biaxiality.

KDP crystals grown have been used to fabricate the following devices: Type I and Type II second-harmonic generation (SHG) cells, phase-matched for Nd-YAG laser radiation; Type I SHG cell for Ar-ion laser radiation, with quartz windows; and electro-optic modulator (Pockels cell).

The efficiency of these KDP crystals for converting 1064 nm radiation to its second harmonic was measured, at Burdawan University, using a laser beam of pulse energy 17.7 mJ and a pulse width of 8 ns. For an effective crystal length of 3.39 cm and using a focussed beam of diameter 0.06 cm, the conversion efficiency was found to be 50%, against the theoretically expected value of 58%.

Gas Flow Metering Valve

A union bonnet metering valve rated for a pressure of 30,000 KPa (at 25°C) for applications in Laser systems has been developed. The flow coefficient can be varied from 0.002 for one turn of the stem to a maximum of 0.04 after

ten turns (fully open). This valve of 1.6 mm diameter orifice and swage lock type connectors at the inlet and outlet gives a precision control of gas flow. The maximum allowable stem seal leak rate is 0.1 std cc/min.



Gas flow metering valve

SQUID based Magnetometer

A commercial SQUID based magnetometer was installed and commissioned in February 1993. This highly sensitive instrument can measure magnetic moments with a sensitivity of 10^{-8} e.m.u. Furthermore, measurements can be performed in a temperature range of 2 K to 400 K with magnetic field in the range of - 5.5 Tesla to 5.5 Tesla. The high sensitivity allows accurate study of magnetisation decay in hard superconductors, from which one can infer the flux-flow resistivity. The importance and relevance of such measurements can be gauged from the example of superconducting magnets for which this resistivity is below 10^{-12} ohm cm, and cannot be measured easily by transport methods. The high sensitivity also permits detailed studies on superconducting crystals of small sizes ($<0.1 \text{ mm}^3$), and on weakly magnetic samples. This instrument is presently being used for such measurements. It requires about fifty litres of liquid helium every week which is being supplied regularly by the liquid helium plant at CAT.

Gravitational Wave Detector - CAT Participation

A direct detection of gravitational waves (GW) is one of the most challenging tasks in experimental physics today. The maximum strain amplitude ($\delta L/L$) of GW expected from astrophysical events in our galaxy is $\sim 10^{-18}$ and that too only once every decade or so, while the maximum amplitude expected from extragalactic events that might occur a few times per year is $\sim 10^{-21}$. With such small strains the distance between two test bodies separated by 1 km would change by only 10^{-18} m. For the detection of GW these small changes in the separation of test masses have to be measured against a background of other perturbing influences.

One of the most promising earth-based detection schemes is to use a Michelson Interferometer arrangement. The GW induced path difference between the two arms will lead to a fringe shift. The optimum optical length of the arm for GW detection is around 150 km. Such large optical path

lengths can be achieved by having multiple reflection in the arms of the interferometer. Refractive index fluctuations in the residual gas can cause path length changes in the two arms, and thus the detector has to be housed in ultra high vacuum (10^{-8} mbar). The large optical path lengths in the two arms lead to large beam sizes, necessitating large diameter vacuum pipes.

Sustained effort over the last four decades to detect GW has led to rather impressive advances and what previously appeared a fantasy has now turned into an expectation. Prototype multi pass laser interferometric detectors with arm length ranging from 1 to 40 m have already been operated at several laboratories and strain sensitivity of few parts in 10^{-18} has been achieved. With increase in path length and use of some recent ideas it is felt that it is feasible to make interferometric detections with sensitivity levels