Rutherford Laboratory

Technical leaflet

C2.3

SACLAY 82 cm LIQUID HYDROGEN BUBBLE CHAMBER

This chamber, designed, built and operated by teams from C.E.N. Saclay, France, is at present visiting the Rutherford Laboratory and being used in a research collaboration between French and British physicists.

The aluminium alloy body with inside dimensions 82cm long by 50cm wide and 50cm high, contains 200 litres of liquid. The openings either side are closed by optical glass windows 15cm thick. The top of the chamber terminates in a cylinder forged integral with the body which is closed by a piston capable of rapid movement up and down. In this way the pressure in the chamber is reduced for a short period so bringing the liquid into a temporary state of superheat when bubbles will form on the paths of charged particles.

The movement of the piston is controlled to give the required pressure pulse by a pneumatic actuator situated on the top platform above the chamber. The actuator, working at room temperature, is connected to the piston by a stainless steel rod which provides thermal insulation between the parts at 27°K and room temperature 300°K.

To control the temperature of the liquid in the chamber a copper liner cooled with liquid hydrogen is fitted around the inside of the chamber. A similarly cooled heat exchanger is fitted in the cylinder below the piston to remove heat input due to expansion. The main cooling of the chamber is by heat exchangers linking the hydrogen reservoirs to the chamber body. Heat inleak due to radiation is reduced by surrounding the chamber with a liquid nitrogen cooled copper shield.

The chamber, together with its surrounding shields, liquid hydrogen reservoirs, complex lighting system, windows and piston hangs inside a vacuum vessel so the chamber can be thermally insulated using high vacuum.

Liquid hydrogen used in the reservoirs above the chamber is produced by a liquefier in a separate building some distance from the experimental area. The liquefier is of the the high pressure type with an output of 80 litres of liquid hydrogen per hour, employing liquid nitrogen pre-cooling and Joule Thomsom expansion.

Recording of the particle tracks is on 50mm single perforated film using three cameras for stereoscopic reconstruction. Dark field illumination is by six linear flash tubes mounted on the other side of the chamber to the cameras, direct light is prevented from entering the camera lenses by use of a complex optical system.

The chamber is surrounded by an electromagnet with an accurately known field so the momentum of charged particles can be determined by the curvature of their tracks. The coils of the magnet are fitted to the outside of the vacuum tank.

The steel yoke pieces fit next to the coils and all these pieces can slide away from the centre section of the vacuum tank for servicing the chamber. When powered by 3 Megawatts the field in the chamber volume is about 20 Kilogauss.

Operation of the chamber is organised round the panel at one side of the chamber; here all the control valves are situated and opposite this are all the electronic control racks for controlling the expansion, timing, flash tubes and for initiating camera operation.

While visiting the Rutherford Laboratory development work has been carried out to enable two expansions of the chamber each time a beam is available from Nimrod so doubling the output of the chamber in a given time.