Rutherford Laboratory

Technical leaflet

C2.2

80 cm HELIUM BUBBLE CHAMBER

This chamber was built as a joint project by the Rutherford Laboratory and the Oxford University Department of Nuclear Physics and it is the largest bubble chamber of its type in the world. It differs from the other large chambers at this Laboratory in that the optical and magnetic axes are vertical instead of horizontal.

The chamber body which contains 200 litres of liquid helium is made out of a special low carbon high nickel stainless steel with excellent welding and casting properties which is also non-magnetic and has good low temperature properties. The finished inside dimensions of the body are 81 cms long by 40 cms wide by 43 cms deep. It has openings top and bottom for the glass windows and on one side for the moving side wall.

The chamber is brought to a temporary state of superheat, that is in a condition to form bubbles on the paths of charged particles, by reducing the pressure in the chamber for a period of about 30 milliseconds. This is achieved by movement of the whole of one side of the chamber for a distance of about 6 mms. The moving side wall is sealed to the chamber by a flexible single convolution stainless steel bellows. The movement of the side wall is controlled by a hydraulic actuator which works at room temperature and controls the side wall through a 150 cm long stainless steel rod which provides the thermal insulation between the parts at $4^{\circ}K$ ($-269^{\circ}C$) and room temperature.

The chamber is maintained at the required temperature by a helium refrigerator designed and built specially for this project. Heat is removed from the chamber by the liquid helium from the refrigerator passing through three parallel loops inside the chamber. Heat input due to radiation is reduced by using a copper shield cooled by a refrigerator loop at about $80^{\circ}K$ ($-193^{\circ}C$). The chamber itself is also surrounded by a shield containing helium at about the same temperature as the chamber liquid, thus keeping a uniform temperature in the chamber.

The chamber together with its surrounding shields, condenser lenses and windows, hangs inside a vacuum vessel so the chamber can be thermally insulated using high vacuum. There are two identical vacuum pumping systems which can be used either separately or in parallel, connected to the vacuum tank through a 40 cms diameter duct. Normal running pressure is about 5×10^{-6} torr.

Accurate measurement and reconstruction of the particle tracks depends on good design of the optical system. For this reason dark field illumination with an angle of 4° between the light incident on a bubble and the lens bubble direction was chosen. Large condenser lenses are mounted under the chamber to illuminate the chamber volume from four flash tubes, one for each camera. The flash tubes are triggered by a pulse instigated by the beam of high energy particles. The four cameras spaced above the corners of the chamber use 35 mm unperforated film in 300m rolls, they automatically wind on after each time the flash tubes are pulsed.

The chamber is surrounded by a magnet with an accurately known field, the momentum of charged particles can then be determined from their curvature. For this chamber the magnet has a hexagonal yoke with a central hole in which the chamber fits. The horizontal coils, consisting of 6 double pancakes with 14 turns in each, are spaced 18 cms apart to allow particles to enter the chamber. Cooling is by demineralised water flowing through the centre of the conductors of the coils which when powered with 4 megawatts produce a field of about 21 kilogauss. The magnet with a total weight of 70 tons is moved on three motorised skates and its height is adjusted by hydraulic jacks.

The main operation of the chamber is controlled from a central console at which information about the state of the chamber can be seen and any faults indicated. In addition there are diagnostic and control units for the various parts of the chamber which show in more detail the state of each unit.

SECTION OF CRYOSTAT SHOWING HELIUM BUBBLE CHAMBER ASSEMBLY