Notes on the Bubble Chamber Meeting held on September 20th, 1957.

1) Present: Dr. W. Evans, Mr. M. J. Moore, Dr. L. Riddiford, Dr. Colley, Dr. D. Shaw, Dr. A. J. Croft, Dr. Bock, Mr. Egington and Dr. C. C. Butler.

2) The size of the chamber

The optimum size for the proposed chamber was discussed at length. Liverpool, Oxford and Imperial College felt that a good case had been made for designing a chamber 150 cm. long x 50 cm. high x 40 cm. deep (300 litres of photographed volume) with a magnetic field of about 13-15,000 gauss. There is no doubt that this chamber would be at least twice as valuable as the 100 cm. long chamber originally proposed. The Birmingham representative felt that it might be much easier to build a shorter chamber, say 110-120 cm. long, with a higher magnetic field - a target figure of 30,000 gauss was mentioned. Birmingham were asked to give further consideration to this suggestion to see if they could demonstrate convincingly that the smaller chamber would be equivalent, in respect both of numbers of events and ease of analysis, to the larger chamber favoured by the other University groups.

3) The shape of the chamber

It was agreed that if the chamber is to be 150 cm. long in the beam direction then the rectangular form must be used. A chamber 150cm. long x 50 cm. high with its magnet can be used anywhere in the experimental halls of the P.S. machine at CERN. The Birmingham group strongly favoured a cylindrical shape with its axis horizontal, for diameters up to about 1 m. It was decided to proceed with the rectangular shape, subject to the possibility of receiving new proposals from Birmingham (see § 2).

4) The need for uniform expansion

A short discussion took place on the need for a special design of piston to enable the liquid to be expanded uniformly. There is considerable uncertainty about the performance of hydrogen bubble chambers, in particular the amount of track distortion due to turbulence in the liquid is unknown. Following the experience of cloud chamber workers, it was felt that provision should be made for a free piston of the type suggested by the Imperial College group. It was agreed that ideally the chamber should be expanded in the direction of the magnetic field. The next best arrangement would be to expand uniformly at right angles to the field. Design I submitted by Imperial College has the expansion along the field direction but depends entirely on the use of the free piston without which the expansion would be very non-uniform. The Liverpool design and Imperial College design II are upward expanding chambers which should give fairly uniform expansion without a free piston. It was decided to use this direction of expansion for the first chamber and to provide a free piston. If for some, at present unforeseen, reason the free piston gives trouble, the chamber could be used without it and would still expand fairly uniformly.

5) Temperature control

Methods for controlling the temperature of the chamber were considered briefly. Liverpool and Birmingham favour the use of baths of liquid hydrogen boiling under atmospheric pressure connected to the chamber by copper heat paths in which electrical heaters are embedded. The Imperial College group feel that this method is not practicable for

the large chamber and advocate the use of pressurised hydrogen tanks welded to the top and bottom of the chamber. It is clear that this problem will need further detailed consideration and discussion.

6) Illumination and Photography

No detailed discussion of illumination took place. The Liverpool group agreed that their suggested arrangement of large glass windows at liquid nitrogen temperature is undesirable. They now favour extending the nitrogen shields out to the cameras on one side and to the light sources on the other side. It is clear that further very careful consideration must be given to optical arrangements. It should be possible to devise better systems than those used hitherto in order to use the light scattered by the bubbles through only 2 or 3°. If this can be done then the tracks could be photographed about 2 msec. after the passage of the ionizing particles through the chamber instead of after 10 msec. Shortening the bubble growth time should lead to markedly reduced distortion.

7) Magnet design

No detailed discussion took place on the magnet designs submitted by the various groups. The importance of using the iron as a safety screen was emphasised. From the preliminary figures available it seems that a reasonable magnetic field for the 150 cm. chamber can be obtained from a 3 MW generator although, if the generator is not to be run flat out, a 4 MW type would be preferred.

8) Further design work

It was decided to design a vacuum vessel and cryostat suitable for (a) an upward expanding chamber of basically the Liverpool design and (b) a chamber expanding along the line of magnetic force. The first chamber will be expanded by means of a row of metal bellows or pistons. A free piston will be provided. Liverpool agreed to start revising their drawing immediately. A second chamber vessel of type (b) will be designed to work in the same cryostat as the first chamber.

A preliminary discussion took place on the procedure to be adopted for the design work. It was felt to be impracticable to centralise the design staff. The interested and experienced people cannot be given leave of absence from their Universities to enable them to form a large group in one University this autumn. It was felt, however, that once a basic sketch design is agreed then detailed design work can be done simultaneously in several laboratories and coordinated satisfactorily. If this becomes the accepted policy of the consortium then the next stage will be for the working party to discuss and revise the drawings now being prepared in Liverpool. This process will have to be continued until an accepted basic design is achieved, which should be before the end of this year.

9) Staff

The University groups felt that the following existing staff could be made available for the design phase:

(a) Liverpool
  (i) 1 designer draughtsman - 80% of his time
  (ii) 1 - 1.5 postdoctoral physicists.

(b) Birmingham 1 - 1.5 postdoctoral physicists
(perhaps not for 6 months)

(c) Oxford. Uncertain at present. They wish to participate in the instrumentation work.

(d) Imperial College.

(i) 1 designer draughtsman - 80% of his time.
(ii) 1.5 - 2 postdoctoral physicists

The Harwell representative kindly offered facilities for magnet design and model magnet work at Harwell, but they could not contribute any staff.

For the immediate work only 2 draughtsmen and about 4 or 5 physicists will be available. It was suggested that 2, or perhaps 3 additional draughtsmen will be needed and 2 graduates, perhaps engineers.

10) Costs

No detailed discussion of costs was held. It was noted, however, that the 150 cm. chamber should cost appreciably less than the original cost guessed for the 100 cm. chamber. ?

C. C. BUTLER

1st Oct. 1957

Electronics of track following -
(1) Ferranti Co.
(2) CERN Co.
Kandiah to look at?