Dr M. Snowden.

# New Bubble Chamber Design Studies

Meeting held on December 6th, 1965

Present: Mr. M. Snowden (Chairman)
Mr. L. B. Mullett
Mr. W. Walkinshaw
Dr. D. B. Thomas
Dr. R. W. Newport
Dr. P. R. Williams

## 1. Superconducting Magnet

Concern was expressed over the time scale for the 6" superconducting coil though Mr. Walkinshaw pointed out that in view of the time required to prepare a full proposal for a new bubble chamber the programme was not unrealistic. We must, however, follow closely the design of the 6" coil to ensure that information relevent to the design of a large bubble chamber magnet would be obtained. In particular the problem of heat transfer was mentioned, since the volume of liquid required helium to immerse such magnet coils could be very large some alternative system would be preferable. Mr. Mullett enquired about field uniformity and referred to work done at the Mullard Laboratories on superconducting shields. Though field uniformity was not considered to be essential such a technique was possibly of use in the beam entry region.

Rangan

The Chairman requested a paper on the magnet design for the next meeting and that Dr. P. F. Smith should be invited to this meeting for his comments.

## 2. Optics

### 2.1 Resolution

Dr. Williams reported that a more detailed study of the problem of resolution had been made using a computer programme and reaffirmed his statement of the previous meeting, that if adequate resolution (i.e. better than 500μ) were to be obtained then an optical system with a large window and cameras about $2\frac{1}{2}$ metres away would be necessary. For the same size of chamber with 'fish eye' camera lenses the resolution would be ~ 600μ. With the present proposal for a 1.20 metre diameter chamber a stereo angle of ~ 20° would be possible. He also stated a preference for a dark field system, the disadvantage of a bright field system being that for good contrast the bubbles must be large enough to be resolved. Such a requirement may limit the operating conditions of the chamber.

Dr. C. M. Fisher has recently changed the optical resolution requirements to having ~ 400μ in the central 40-50 cm of depth deteriorating to ~ 600μ at the ends of the chamber. These requirements are to be investigated.

### 2.2 Temperature fluctuations

Dr. Thomas described the effects of temperature variations in the liquid. He said that for a volume of liquid hydrogen with a negative vertical temperature difference of 0.1°K the bulk temperature would be constant to better than 0.01°K with all the drop occurring in

boundary layers a few mm thick. Such sharp temperature gradients in the boundary layers could cause deviations of light rays passing through them of ~1' due to fluctuations at the limit of the boundary layer. One might be able to make such effects negligible by establishing a positive, stable temperature difference of ~0.01°K. He expressed doubts about maintaining such a stable state in view of the amount of energy dissipated in the liquid and referred to the damped pressure oscillations occurring in the 1.5 metre chamber. He said that he was hoping to discover whether this damping occurs in the body of the liquid or at the chamber walls.

2.3 Bubble Density Measurements

Dr. Newport reported that with resolution of ~ 500μ useful bubble density measurements would be possible from mean gap length determinations, e.g. it should be possible to distinguish $\pi$ s from $\bar{p}$ s up to 2.5 GeV and K s from ps up to 2 GeV with track lengths of ~ 60 cms.

3. Expansion Systems

The possible cycling rate of such a chamber was discussed and although 5 cycles per Nimrod cycle was considered reasonable this should be investigated thoroughly. Turbulence in the liquid was thought to be the most likely limitation on fast cycling and Mr. Mullett suggested speaking with Dr. Shoemaker of Princeton about the operation of the Princeton-Penn fast cycling bubble chamber.

19 pps
30 msec for tracks to disappear

4. Cryogenics

Dr. Newport said that no detailed investigation had begun but made the following general remarks:

a) The temperature differences between the heat exchanger and chamber fluid should be kept to a minimum to reduce temperature variations in the chamber fluid.

b) In order to achieve condition a) then whichever main refrigeration cycle is used the refrigerant in the heat exchangers must be in the liquid phase or a 2 phase mixture of gas and liquid for all the chamber operating conditions. Attention was drawn to the fact that the present hydrogen and helium refrigeration systems may have adequate capacity for a new chamber.

5. Proposal for experimental Study of bubble chamber operating conditions

Dr. Newport said that his recent investigations of bubble density measurements and of the operating conditions for deuterium in the 1.5 metre chamber had highlighted the lack of information about operating conditions in liquid hydrogen bubble chambers. He went on to say that some very useful experimental work could be done in quite a small, but well-instrumented chamber which could be operated with hydrogen, deuterium and possibly hydrogen-neon mixtures. The 10" chamber at Liverpool was suggested as a possibility. It was agreed that such information would be valuable and Dr. Newport was asked to prepare a proposal for such experiments.

The meeting finished with a discussion of staff requirements for the Bubble Chamber Group.

The next meeting will be on Tuesday, January 11th at 2.15. The preliminary agenda for this meeting is:

1. Matters arising from minutes of previous meeting.
2. Superconducting Magnet Design.
3. Factors affecting the design of the optical system.
4. Programme for further work. — High Fields B.C.

Drs. P. F. Smith and C. M. Fisher will be invited to this meeting to comment on items (2) and (3).

R. W. Newport

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14th December, 1965

Distribution: Those present
Dr. T. G. Pickavance
Dr. G. H. Stafford
Dr. L. C. W. Hobbis
Mr. J. D. Lawson
Dr. P. F. Smith
Dr. C. M. Fisher
Dr. E. Pickup