New Bubble Chamber Design Studies

Meeting No. 3 held on January 11th, 1966

Present: Mr. M. Snowden (Chairman)
Mr. L. B. Mullett
Mr. W. Walkinshaw
Dr. D. B. Thomas
Dr. R. W. Newport
Dr. P. R. Williams
Dr. C. M. Fisher
Dr. P. F. Smith
Mr. J. D. Lewin

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1. Fast cycling bubble chambers

Dr. Newport had no recent information to report on the Princeton-Penn fast cycling chamber and would contact Dr. Shoemaker for up to date information. It had, however, been reported at the 1964 Dubna Conference by Prof. H. Filthuth that this chamber had achieved a cycling rate of 19 cycles/second at a vapour pressure of 68 psia, for several hours. The duration of the period for which the pressure was below the compressed value was 15 mseconds/cycle and tracks had disappeared in 30 mseconds, no trace of tracks being seen in the next cycle. At the time no systematic investigation of stability and turbulence had been made. — Dr. Newport

2. Proposal for Experimental Study of Bubble Chamber Operating Conditions

Dr. Newport reported that he had recently visited Liverpool University and examined the 10" bubble chamber. The chamber, radiation shielding, vacuum tank and expansion system were mechanically complete as also were the optics. None of the control equipment, nor vacuum and filling system were in existence. This was not thought to be too serious since modifications would have been necessary and it would probably be possible to borrow some of the equipment anyway.

A proposal including effort and cost estimates would shortly be produced. This would also include the beam requirements. — Dr. Newport

3. Superconducting Magnet

3.1 6" Model magnet

Dr. P. F. Smith made some comments on the design of the 6" superconducting magnet which is to be built in the laboratory. He emphasised that this would not be a scaled down version of the large bubble chamber magnet pointing out that the 6" magnet would probably be manufactured from a combination of Nb Zr in the low field region and Nb Sn in high field region and it was probable that the Nb Sn tape would be unstabilised though the coil would be partly stabilised by the presence of liquid helium. For the bubble chamber magnet we should aim for a fully stabilised system since the performance could be more readily predicted. Dr. C. M. Fisher commented that he had seen some fully stabilised Nb Sn tape at RCA during his recent visit to the U.S.A. but that no coil had yet been produced using this material.

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Commenting on item 1 (Superconducting Magnet) of the minutes of the previous meeting, Dr. Smith said that although it might seem desirable to get rid of the liquid helium from the system it was in fact necessary to have liquid for full stabilisation of the coil system.

3.2 Field uniformity

Dr. Fisher stated that knowledge of the field was more important than uniformity, though he added that uniformity to within 2 - 3% may be advantageous for certain experiments in which particles could be distinguished by scanning, e.g. the separation of electrons and pions below 500 MeV in the leptonic decay of polarised hyperons for which the branching ratio is ~ 1000 to 1. Dr. Schutt of Brookhaven had, however, suggested that quite large non-uniformity may be an advantage for measurements on sharply dipping tracks.

Dr. Fisher has written to Mr. Steckly of AVCO for information on the field uniformity for the two coils for which his company had quoted; he has not yet received a reply.

Dr. Thomas produced a copy of a drawing of the proposed Brookhaven large bubble chamber (Dwg. No. HH/0/12, 14/9/1965). This drawing shows the magnet coils to have non-uniform distributions of superconductor, presumed to be in order to obtain a uniform field. Dr. Smith commented that such a conductor distribution would be very expensive. Regarding our own proposal he thought that a coil (or pair of coils) appreciably longer than the chamber would probably be necessary for uniformity and enquired if the chamber design would allow such a coil design. Dr. Williams thought that there might be some limitation on the coil design due to the optical system particularly if a large window were used. It was agreed that the chamber design must be well defined before fixing the design of the magnet.

Dr. Rangan of HEP is currently engaged in determining the effects of field non-uniformity on measurements and also the stray field fall off for an unshielded superconducting magnet.

3.3 Magnetic Shielding

Since the proposed chamber is not significantly larger than existing chambers (though the field is ~ 3 times the fields for these chambers) the feasibility and cost of providing iron to limit the extent and magnitude of the stray field are not prohibitive. Dr. Thomas produced a sketch showing very roughly what the dimensions of an essentially cylindrical shield would be. The amount of iron required would be approximately 300 tons and might cost £50,000. The inclusion of such a shield in the design would make the field calculations more difficult but might improve the uniformity of the field and also increase its magnitude. Dr. Smith expressed doubt about this last point since the field would undoubtedly be limited by the field generated at the superconductor.

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Mr. Mullett asked if superconducting shielding were feasible but Dr. Smith thought the scale was such as to preclude this.

Mr. Snowden enquired if information might be obtained from the 6" model magnet by adding shielding. Dr. Smith thought this might well be possible.

Mr. Walkinshaw raised the question of time scale and thought that we ought to produce a detailed design of the magnet before discussing with possible manufacturers.

3.4 Further Work on the Magnet Design

The following topics will be investigated -

1. Uniformity of the field.

   (a) Requirements. — Dr. L. K. Rangan

   (b) Superconductor distribution for uniformity, without shielding. — Dr. P. F. Smith

Although the Brookhaven programme can be used for these calculations, some extra computational effort will be needed and will be provided by Mr. Walkinshaw. — Mr. Walkinshaw

2. Stray Field.

   (a) Requirements, for instrumentation.

   (b) Fall off, for unshielded coil. — Drs. Newport, Thomas, Williams, Dr. Rangan

3. Structural Design, including supports and vacuum tank.

4. Cryogenics. — Drs. Newport, Thomas, Williams

5. Separation of coils, for beam entry. — Dr. Fisher

For this and any other work the chamber parameters will be assumed to be those listed in HFBC/1, Notes for the Meeting of December 9th to discuss the High Magnetic Field Bubble Chamber Project by Dr. C. M. Fisher.

4. Optics

4.1 Resolution and Associated Topics

The paper, AF/DS/HFC/3, "Some Optical Considerations in the Design of a High Field Bubble Chamber" by Dr. P. R. Williams, was distributed.

Dr. Williams expressed doubts about obtaining bubbles of sufficient size for a bright field illumination system, but said that the hologram system devised by Dr. W. T. Welford of Imperial College may overcome this objection. It was agreed that Dr. Welford should be invited to the next meeting

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to discuss his new system and also that Dr. J. Burren should be invited to discuss the effect of using such a system, which would be more complex than present camera systems, on measuring a scanning equipment.

Mr. Walkinshaw enquired about the relationship between resolution and measuring accuracy. This was not clearly established.

(Secretary's Note: Reference to the Minutes of The High Magnetic Field Bubble Chamber Project Meeting No. 3, HFBC/P/M/3 item 3, shows errors of measurement on film from the 80 cm bubble chamber at CERN to be 7.5 microns using conventional measuring machines and ~ 2.5 to 3 microns when using the HPD. This clearly indicates that at present the measuring error is much more dependent on the method of measurement than on the resolution in the chamber. It is, however, important to discover if the HPD measurements are limited by the resolution in the chamber. It may well be that film resolution and contrast are more important than the chamber resolution.

It is also important to note that resolution in the chamber has a significant effect on bubble density measurements but film contrast is important in this case, too).

Dr. Newport noted that depth measurements would become more important if the momenta of dipping tracks were to be more accurately determined by the use of non-uniform fields (see item 3.2) and asked that the effect of stereo angle on such measurements should be considered along with other effects on accuracy of measurements. — Dr. Fisher

4.2 Type of Optical System

Whether the design should incorporate a single large window or a number of small windows has yet to be resolved. Much depends on the effects of turbulence both in the liquid and at the windows, particularly the latter. It was agreed that until more information becomes available, work should continue on both systems in parallel. — Drs. Thomas & Williams

The design employing a large window indicates the use of a chamber with the axis horizontal whereas a small window system would allow either a vertical or a horizontal axis. It was agreed that the beam entry problem (for essentially on axis particles) is considerably effected by the chamber orientation and that this would affect the building requirements.

5. Programme of Work and the Effort Required

July 1966 was agreed to be the date by which a proposal suitable for presentation to the Nuclear Physics Board should be prepared.

Mr. Mullett thought that in relation to its likely priority this time was none too early.

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The Chairman suggested that as far as possible the estimates (of effort and cost) should be accurate to within 20%.

It was agreed that while we must be sure of the practicality of the project, we should allow for developments in techniques, e.g. in the superconducting field.

Work topics listed in HFBCP/M/2, The High Magnetic Field Bubble Chamber Project, Meeting No. 2 held on 14th December, 1965, were discussed with respect to the Applied Physics Group. It was thought to be important that building requirements should be considered soon so that any other discussions on buildings could take account of these requirements. Counter control would be investigated from the physics point of view first and the requirements would then be discussed with the Applied Physics Group. Dr. Thomas (David Bugg)

It was agreed that more effort, drawing, engineering and computing is essential and also that additional accommodation would be needed for new people. Laboratory space would also be needed, e.g. for the 10" Liverpool bubble chamber.

The Chairman also pointed out that any increase in generator capacity for bubble chambers would reduce the size of the present workshop and assembly area.

6. General

It was agreed to extend the circulation of minutes and papers to include those listed in HPBC/P/M/3.

The next meeting will be on Friday, February 4th at 10.30 a.m.

The prelimary agenda for this meeting is

1. Matters arising from minutes of the previous meeting.

2. The Programme of Work and Effort required.

3. The Optical system, in particular the effects of using the Welford system.

Drs. W. T. Welford and J. Burron will be invited to this meeting to discuss item 3.

R. W. Newport

Building R.50,
Bubble Chamber Group,
Applied Physics Division.

18th January, 1966.