FAST CAMERAS FOR FAST CYCLING BUBBLE CHAMBERS

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1. INTRODUCTION

Cameras for bubble chambers are an important part of the data-taking process because they can limit the data-taking rate, and the track reconstruction precision in space is very much dependent on the film positioning inside the camera.

It is clear that at time of exposure the film must be perfectly flat and stationary. This is commonly done by vacuum suck-down on a flat film back. This perfect positioning must be maintained even for fast cameras and this is one of the difficulties in camera design. It is interesting to note that the requirements of flatness for holographic cameras have been found quite similar to what is currently offered by conventional bubble chamber cameras (see Fig. 1).

Here we will not dwell on camera design but mainly study two special requirements for cameras used in fast cycling bubble chambers coupled to a spectrometer, like LEB, HOLEB, HOB, and RCB, mainly the speed requirement and the data-board printing. Some conclusions will be derived for the proposed “Charm 82” experiment (now approved as NA27).

2. SPEED REQUIREMENT

It can be said that there is a need for fast cameras because there are fast cycling chambers and there is no selective trigger available.

If we define
p: probability of having a good event per expansion,
N: number of expansions per burst,
F: frequency of the bubble chamber,
f: frequency of the maximum data-taking rate due to the camera dead-time (camera frequency ≥ f),
k: = f/f,
n: number of pictures per burst,
η: data taking efficiency = n/pN

then

\[ n = \frac{p\eta}{1 + p(k-1)} \] .

Figure 2 shows the evolution of the data yield as a function of p and k.

For the experiment NA16 using LEB we had p = 0.25, and η was around 0.85 for k = 2, i.e. a 30 Hz chamber coupled to a 15 Hz camera. Now it is clear from Fig. 2 that had a selective trigger existed to reduce p to around 0.05 then the camera speed would have been unimportant.

Figure 3 shows one RCB capstan which was used for NA16. For this format (50 mm film and 66 mm frame length) we have reached a camera speed of 24 pictures per second. However this design is not readily adaptable to a longer frame length and we are at present working on a modified system.
3. FILM LABELLING AND DATA BOARD

Another important feature of bubble-chamber cameras is the labelling of frames done using a so-called data board. In hybrid experiments the pictures have to be tied to a record on magnetic tape and the correct labelling of both the pictures and the magnetic tape record is of prime importance as late unscrambling is practically impossible\(^1\).

Thus already for RCBC it had been decided that:

i) information printed on films and magnetic tapes, even wrong, must be the same for a particular event;

ii) data boards must have an error detection scheme which also writes on the associated magnetic record what has really been printed on film.

It is interesting to see that for these reasons, if RCBC is equipped with a high-resolution channel, high-resolution pictures without the normal views (OPVT having prevented their taking) will not be numbered to keep the unambiguous correspondence between all the views and the magnetic record for a particular event.

4. APPLICATION TO THE "CHARM 82" EXPERIMENT, NA27

For the proposed experiment "Charm 82" using HOLEBC, no selective trigger will be available at the start of the experiment in spring 1982; thus fast cameras must be built up to keep the data-taking rate high enough. HOLEBC will run around 30 Hz and again a 16 Hz camera will be well adapted. Although a longer frame length will be needed here (see later) we are confident that that speed can be reached safely.

To get a data-board system with all the needed qualities or so short a time scale it has been decided to use on these cameras the full RCBC data-board system. This has also the advantage of being fully compatible with the NORD-10 data acquisition computer.

5. FILM FORMAT

Taking into account the 1 to 1 magnification ratio for HOLEBC and the requirement for the maximum measuring field for ERASME\(^2\) the frame length has been fixed at 116.5 mm (see Fig. 4).

The same film format will be used for the future RCBC high resolution channels.

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REFERENCES

1) D. Jacobs, private communication.

Fig. 1 General view of the holographic camera used in HOBC for the experiment NA25. The camera is in fact a conventional bubble-chamber camera, as the requirements for holography are very similar to what is needed for conventional stereoscopic cameras.

\[ \eta = \frac{1}{1 + p(k-1)} \]

\( p \): probability of a good event per expansion
\( k \): chamber rep. rate
\( \text{camera rep. rate} \)

Fig. 2 Data yield as a function of the trigger efficiency (p) and the camera speed (k)
Fig. 3 RCBC capstan used also for LEBC during NA16. With this frame length (66 mm) a speed of 24 pictures per second has been reached.

Fig. 4 Envisaged film format for HOLEBC and the high-resolution channel for RCBC.