A CLASSICAL STREAMER CHAMBER IN
THE EUROPEAN HYBRID SPECTROMETER

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ABSTRACT
A streamer chamber situated inside the supraconducting spectrometer
magnet complements very well a small high-resolution bubble chamber
situated a bit further upstream. In the bubble chamber the very
short-lived particles will be detected, and in the streamer chamber
and the rest of the EHS spectrometer the momenta and identity of the
majority of the produced particles will be determined.

1. INTRODUCTION

The European Hybrid Spectrometer (EHS) has been optimized with a relatively large
visual detector (RCBC) placed inside the spectrometer magnet MI. For the high-resolution
experiments, both planned and in progress, a small bubble chamber of the HOBBC and HOLEBC
type is placed a few metres upstream of MI. In order not to seriously affect the event re-
construction, track detectors have to be placed between the small bubble chamber and the
rest of the existing spectrometer.

A streamer chamber is very well suited for this task. Being a visual detector it has
excellent pattern recognition properties, so important when it comes to identify strange
particles such as K⁰ and Λ⁰ through their decays. These particles are very frequently pro-
duced in the decay of charm particles. The decay of these short-lived particles should be
seen in the small bubble chamber.

2. THE STREAMER CHAMBER

The streamer chamber, positioned inside MI, is shown in Fig. 1. The dimensions are
limited by the MI iron structure to a diameter of 1.4 m and a depth of 0.6 m.

The high-voltage pulse, with an amplitude of 600 kV and a duration of about 10 ns, will
be generated by Marx power supplies and a Blumlein line. The repetition rate will be
10-15 Hz depending on the running conditions.

The chamber will be operated in the avalanche mode, and consequently the ionization
centres will be much smaller than those of streamers. Therefore image intensifiers have to
be used. The rather large 90 mm diameter ITT tubes would be well suited for this detector.

The chamber will be filled with a He (30%) + Ne (70%) mixture. More details about the
technical aspects of the detector can be found elsewhere¹.

3. EXPECTED STREAMER CHAMBER PERFORMANCES

3.1 Two-track separation

There are several factors that determine the two-track separation [1]: the real ava-
lanche diameter, the optical resolution, and the depth of field.

The relatively high field inside which the detector will be situated, will limit the
diffusion of the electrons during the avalanche process, thus reducing the real avalanche
size. It is mainly the rather poor resolution of the film and the image intensifiers that contribute to the expected two-track separation of 0.5-1 mm.

3.2 Momentum accuracy

For low momenta the momentum accuracy is limited by the multiple scattering. For high momenta it is mainly the precision of the position measurement (the so-called setting error) that dominates the uncertainty in the momentum determination. For a 3.5% radiation length and a 100 μm setting error in space, the momentum accuracy shown in Fig. 2 is obtained for an integrated field of 2 T·m. The Δp/p is smaller than 1% up to a momentum of about 30 GeV/c.

3.3 Particle identification

The primary ionization can be estimated just by counting the avalanches. Assuming the number of detected avalanches to be around 400, it will be possible to obtain a FWHM of the ionization determination of 11%. Figure 3 shows the expected particle separation as a function of the momentum. The particle identification will be particularly useful in the momentum range 3-80 GeV/c.

4. THE TRIGGER

One of the advantages with the streamer chamber is its triggering ability. The minimum time between the occurrence of an event and the application of the high-voltage pulse is around 1 μs. This delay should be kept small to reduce the effect of electron diffusion and the background due to late incoming particles. This latter effect can be reduced by applying the beam kicker at an early stage. The optimal running conditions might very well be different for different experiments.

With a more restrictive event selection there will be fewer pictures to inspect; but for these one would, on the other hand, like to have the most complete information possible.

5. SUMMARY

A streamer chamber in MI will have:
- good pattern recognition capacity;
- excellent momentum determination;
- good two-track separation;
- good particle identification, in particular the identification of neutral strange particles via their decays.

The combination of a small high-resolution (holographic) bubble chamber and a streamer chamber filling the MI magnet seems to be a very efficient one.

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REFERENCE

Fig. 1 The streamer chamber placed inside the M1 iron structure

Fig. 2 The error in the momentum determination for an integrated field of 2 T·m

Fig. 3 The particle separation as a function of momentum for 1.4 m tracks in a He-Ne gas mixture giving about 400 avalanches; $\Delta n_p$ is the difference in number of avalanches and $\sigma$ is the standard deviation.