SCANNING INSTRUCTIONS FOR STOPPED K^- EXPERIMENT (T 5)

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I. Introduction

The purposes of the scanning in this experiment are threefold

(A) To find $\Sigma^0 \longrightarrow \Lambda^0 + e^- + e^+$ events

(B) To find $\Sigma^\pm \longrightarrow e^\pm + n + \nu$ events

(C) To find $\Sigma^\pm \longrightarrow e^\pm + \Lambda^0 + \nu$ events

The Σ hyperons are produced by stopping (or low energy in flight) K^- mesons which are then the common source of events (A), (B) and (C). In addition all three types have at least one electron or positron emitted.

All of these event types are rather rare with (B) and (C) much less frequent than (A), hence speed in scanning is important. The clues to these events lie in the combination of an electron (or positron, or both) of momentum $\lesssim$ 80 MeV/c (Radius of curvature $\sim$17 cm) and an incident slow K^- meson.

II. General Procedure

Two views should always be available when scanning. Views 1 and 3 are preferred over view 2. The scanner must look at each frame in one view and rapidly check whether any of the slow K^- reactions give rise to (A), (B) or (C). Detailed descriptions of what these events look like are given below. Any suspicious event should be checked in the second view. Furthermore if a dalitz pair (e^- e^+) is found a very careful search for a Λ^0 in at least two views should be carried out. (The same holds for a $\Sigma^\pm \longrightarrow e^\pm$ event). A discussion of Event Types (A), (B) and (C) follows.

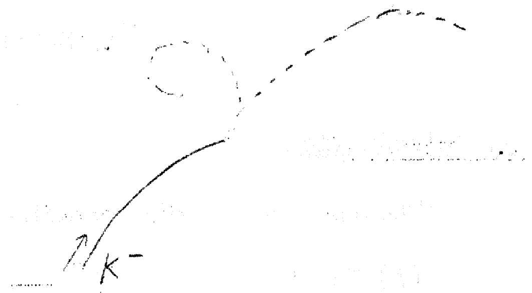
(A) $\Sigma^0 \longrightarrow \Lambda^0 + e^- + e^+$ Events.

The Σ^0 are usually produced in the reaction

$$K^- + p \longrightarrow \Sigma^0 + \pi^0$$
$$\Sigma^0 \longrightarrow (\Lambda^0) + e^- + e^+$$

Examples

(i) Visible Λ^o



(ii) Invisible Λ^o

Both of these types of events must be recorded on the scanning sheet. The roll number, frame number, scanner number and the number of tracks visible in the Dalitz pair and the Λ^o are recorded.

	D.P.	Λ^o
So (i) would have	2	2
and (ii) would have	2	0

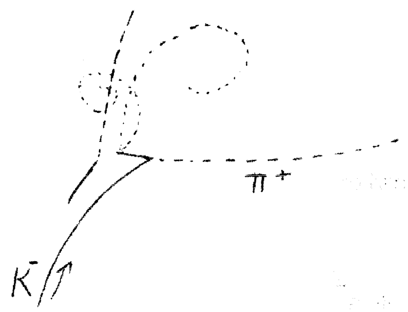
Since the $(e^- \; e^+)$ pair can share their total energy very unequally it is possible that only 1 electron or positron of the pair is clearly visible. It is also possible that only the π^- from the Λ^o is visible so that the number 1 should sometimes be written in the D.P. or Λ^o columns. Helpful criteria for finding Dalitz Pairs or for finding Λ^o's are given in special sections below. An event $K^- \longrightarrow \Lambda^o$ <u>without</u> a Dalitz decay should <u>not</u> be recorded.

There is one further source of Dalitz pairs from Σ^o's not directly from the (K^-, p) interaction but from the chain: $K^- + p \longrightarrow \Sigma^- + \pi^+$,

$$\Sigma^- + p \longrightarrow \Sigma^o + n$$
$$\hookrightarrow e^- + e^+ + (\Lambda^o).$$

The Σ^- is a short black track ($\lesssim 1$ cm).

ex.



These events must also be recorded whether the Λ^o is visible or not.

A comment should be made in the comments column, namely, $\Sigma^- \longrightarrow e^- e^+ (+ \Lambda^o)$ event.

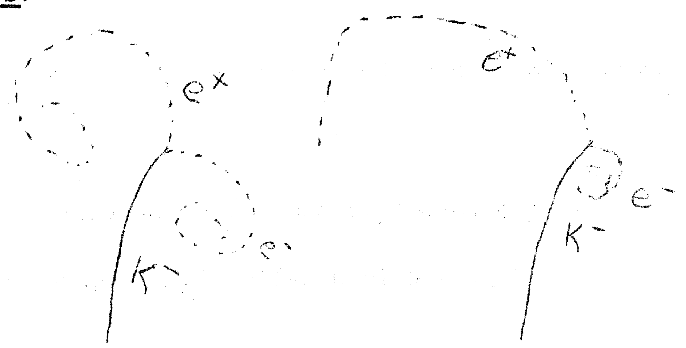
Finding of Dalitz Pairs

The following criteria should be used in order to determine if a pair of leaving tracks is a dalitz pair (e^+, e^-).

a) One curved track should have a radius of curvature less than 17 cm. In doubtful cases this can be check with the template.

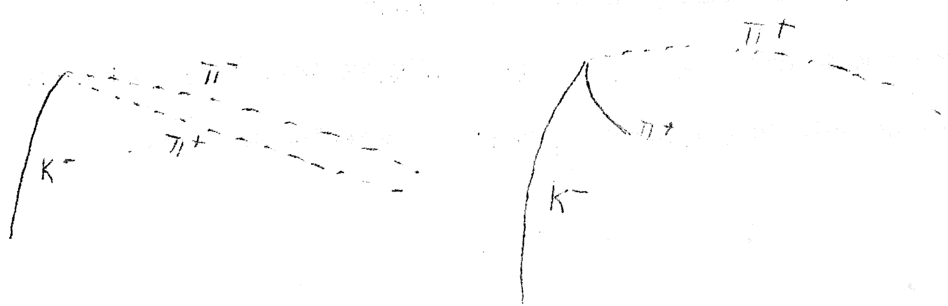
b) This same track should be light, since it is possible to have a pion of that projected curvature but then the pion will be dark. An exception to the lightness criteria is when the track spirals. Then the track is an electron even if it is dark.

Examples:



A frèquency observed "background" event will be one in which two pions come out of a K^- vertex. They will normally be rejected because one pion will be very straight. In some cases they will be very sleep, perhaps very curved, but then they will be dark and therefore rejected. The pions will never spiral.

Examples:



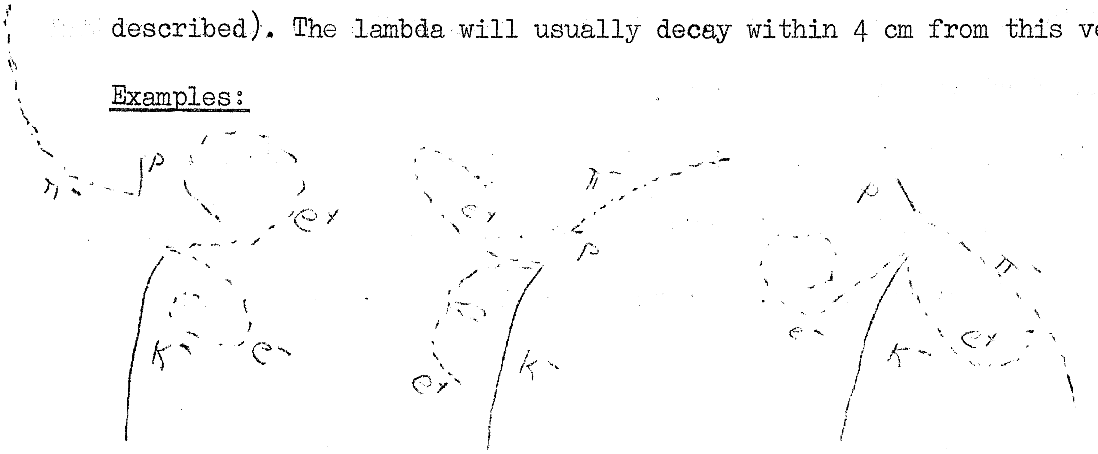
Finding of Lambdas

One observes the neutral lambda by its dominant mode of decay

$$\Lambda^0 \longrightarrow p + \pi^-$$

The lambda will be searched for after one has found an appropriate vertex with a leaving electron or Dalitz pair (these appropriate vertices have already been described). The lambda will usually decay within 4 cm from this vertex.

Examples:



In finding the V that corresponds to the decay of the lambda one should remember the following things:

1) The line joining the appropriate vertex to the Λ^0 decay vertex should lie between the π^- and the proton, and is usually closer to the proton than the pion.

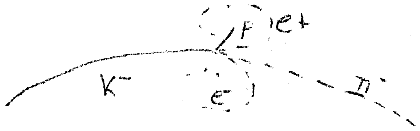
2) The positive prong of the V (the suspected proton) should be dark.

3) The positive prong of the V may be extremely short (or even gerc length) but the negative pion will always be visible.

4) The V may be opened up so that it is almost flat and then one has to judge that it is a Λ by looking for a small kink at the decay point or by a sudden change in bubble density.

5) The lambda may decay very close to the vertex in question and one may not be able to see any separation (a zero length Λ^0).

Examples:



(B) $\Sigma^{\pm} \longrightarrow e^{\pm} + n + \nu$ events.

These are the most difficult events to find, but perhaps they are the most important. The Σ hyperons are produced in the reactions

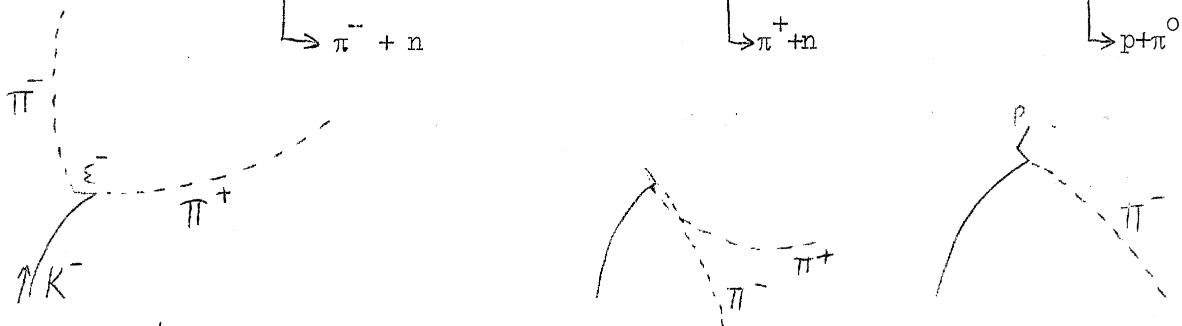
$$K^{-} + p \longrightarrow \Sigma^{\pm} + \pi^{\mp}$$

The Σ's are always "short" and black (they can also be so short as to be invisible). The Σ^{-} decays primarily in one way $\Sigma^{-} \longrightarrow n + \pi^{-}$, while the Σ^{+} can decay in two main modes

$$\Sigma^{+} \longrightarrow n + \pi^{+}$$
$$\Sigma^{+} \longrightarrow p + \pi^{o}$$

Examples:

(i) $K^{-} + p \longrightarrow \Sigma^{-} + \pi^{+}$, $\Sigma^{-} \longrightarrow \pi^{-} + n$ (ii) $K^{-} + p \longrightarrow \Sigma^{+} + \pi^{-}$, $\Sigma^{+} \longrightarrow \pi^{+} + n$ (iii) $K^{-} + p \longrightarrow \Sigma^{+} + \pi^{-}$, $\Sigma^{+} \longrightarrow p + \pi^{o}$



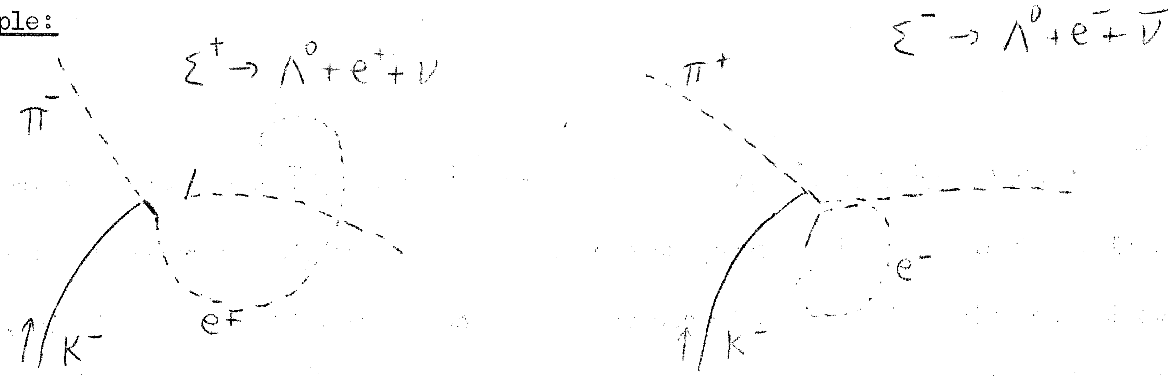
Both the $\pi^{\pm}$ from $K^{-}p$ production and the $\pi^{\mp}$ from $\Sigma^{\mp}$ decay have momenta ~ 180 MeV/c. For a flat track, this corresponds to a radius of curvature $R \sim 35$ cm. On the scanning table these tracks can have much lower R if they are dipping, but then they will also have a higher bubble density. The $\Sigma^{\pm} \longrightarrow e^{\pm}$ events that we are looking for essentially resemble (i) and (ii) above, except that the decay track from the $\Sigma^{\pm}$ is an $e^{\pm}$ instead of a $\pi^{\pm}$. The $e^{\pm}$ can have momenta ranging from 0 to ~ 220 MeV/c. On the scanning table one can only hope to distinguish from pions those electrons which have $p_{\text{electron}} \lesssim 80$ MeV/c. Any decay pion of apparent momentum ~ 80 MeV/c ($R \sim 17$ cm) will be steep and hence much darker than a minimum ionizing electron. Somewhat lower momenta electrons will spiral and hence clearly identify themselves. Some of the Σ decay tracks will be long and flat. An experienced eye might be able to distinguish an electron from a pion by its smaller radius of curvature and its lighter bubble density if $R \lesssim 20$ cm ($p \lesssim 100$ MeV/c) for such favorable tracks. Finally, a high energy knockon delta ray is another clear characteristic of an electron, not a pion. Speed of scanning is essential, so that only one glance can be cast at each Σ decay, and only the suspicious ones carefully examined.

These events should be recorded in Red, Green and Blue pencils with asterisk on the scanning sheets, and all available physicists called to the scanning table tout de suite !!

(C) $\Sigma^{\pm} \longrightarrow e^{\pm} + \Lambda^{0} + \nu$

In the case the $e^{\pm}$ must have momentum $\lesssim 80$ MeV/c ($R \lesssim 17$ cm) so that all of these decays should be easily distinguished by the appearance of the electron track. In addition a Λ^{0} in the vicinity of the Σ decay vertex would be present.

<u>Example:</u>



These events should be recorded in similar spectacular fashion on the scanning sheets, and physicists called tout de suite !!

An example of the scanning sheets to be used in this experiment is attached. All comments should be limited to the comments column, not the Decisions column. The "beam track number" refers to the number of the K^{-} track producing the events in question. The K^{-} tracks are counted from left to right.