

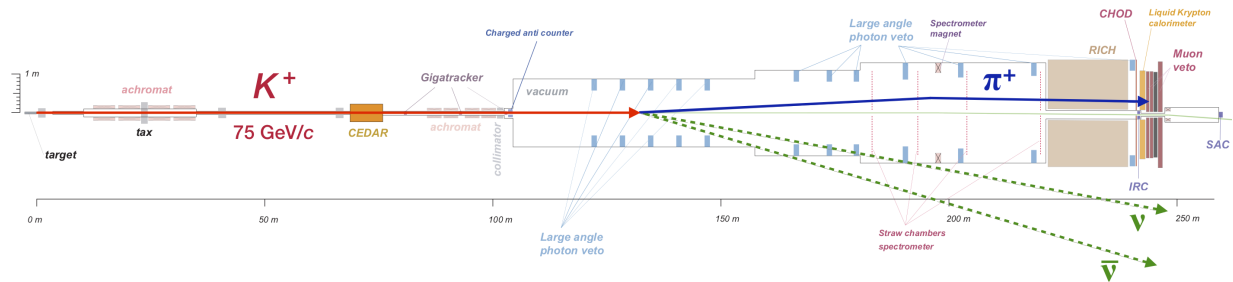
# Flavour Physics: Week: IV

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**Problem 1.** The NA62 experiment is a fix-target experiment focused on the study of charged Kaon decays. The proton from SPS at LHC collide with a fix-target, creating a bunch of hadrons. Kaons of approximately 75 GeV are selected and travel around 100 m before decaying. The golden mode of the experiment is the  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  decay, where only the entering  $K^+$  and the exiting  $\pi^+$  are detected. A powerful tool to distinguish such signal decay from potential backgrounds is the correlation between the missing mass squared ( $m_{\text{miss}}^2$ ) and the momentum of the  $\pi^+$  meson.

- (a) A potential background is the  $K^+ \rightarrow \pi^+ \pi^0$  decay. Compute what is the missing mass for this background.
- (b) Another potential background is the  $K^+ \rightarrow \mu^+ \bar{\nu}_\mu$  decay, where the  $\mu^+$  is misidentified as a  $\pi^+$ . Compute the shape of such background in the squared missing mass vs  $\pi^+$   $p$  distribution, *i.e.* compute  $m_{\text{miss}}^2(p_{\pi^+})$  (Hint: use Taylor series with the approximation  $p \gg m$ :  $\sqrt{1+x^2} \simeq 1 + x^2/2$ )



Layout of the NA62 experiment

Figure 1: Sketch of the NA62 experiment with the overlaid  $K^+ \rightarrow \pi^+ \nu \bar{\nu}$  decay.

**Problem 2.** Write the tree level feynman diagram for the following decays, identify if they are color-suppressed or color-allowed. Write also the decay amplitude as a function of the CKM Wolfstein parameters:

(a)  $B^0 \rightarrow D^+ D^-$

(b)  $B^0 \rightarrow \pi^+ \pi^-$

(c)  $B^0 \rightarrow \bar{D}^0 \pi^0$

(d)  $B^0 \rightarrow D^0 \pi^0$

(e)  $B^0 \rightarrow J/\psi K^0$