Univerza v Ljubljani

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Flavour Physics at B-factories and Hadron Colliders

Part 15: Rare kaon decays

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Measurement of CP violation parameter ε' in the kaon system (2001): first evidence for direct CP violation

→superweak theory of CP violation is wrong

→strong supprot for the CKM mechanism

Interpretation of ε' in terms of CKM matrix elements is not straightforward.

→Look for very rare kaon decays with little teoretical uncertainty.

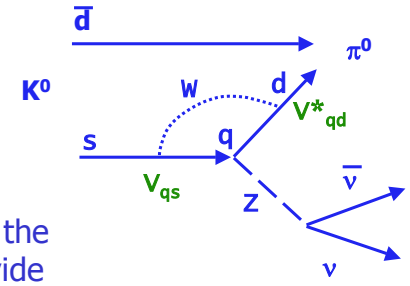
$K^0_L \to \pi^0\nu\nu$ decay

CP violating process (Littenberg PRD 39 (1989) 3322).

In SM dominated by EW penguin and box diagrams.

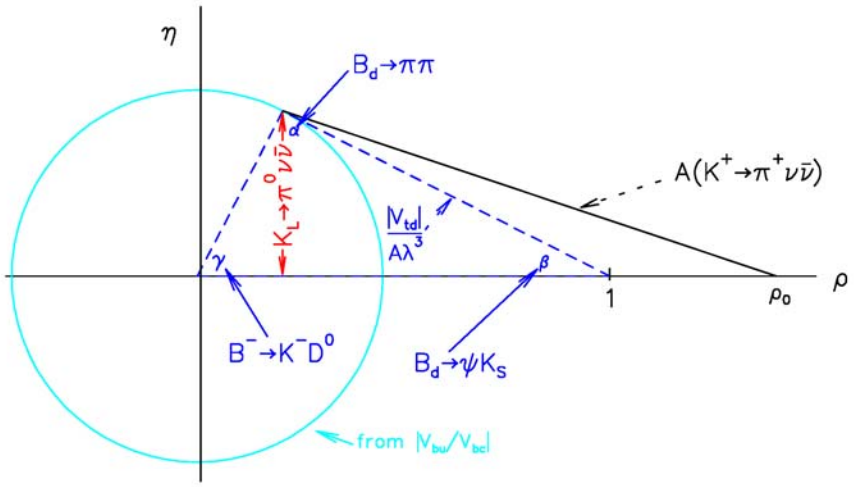
Calculable with little theoretical uncertainties (for details see A. Buras, hep-ph/0101336)

$$Br(K_L \to \pi^0 \nu\bar{\nu}) = CA^4\eta^2$$



→ measurement of this BR and of the related $K^+ \to \pi^+\nu\nu$ decay could provide excellent constraints on the parameters η and ρ, can also be used to extract sin2β.

$K^0_L \to \pi^0\nu\nu$ and $K^+ \to \pi^+\nu\nu$ decays



$K^0_L \to \pi^0\nu\nu$ and $K^+ \to \pi^+\nu\nu$ decays

$$Br(K_L \to \pi^0 \nu\bar{\nu}) = 4\times10^{-10}\, A^4\eta^2$$

Experimentally very challenging: very rare decay (SM expectation 2.5 10^{-11}) of the type ″nothing″ to ″nothing″.

Measured BR($K^+ \to \pi^+\nu\nu$)= $(1.6^{+1.8}_{0.8})\ 10^{-10}$ with 3 events…

Experiments:

$K^0 \to \pi^0\nu\nu$: KOPIO (BNL), E391a (KEK)

$K^+ \to \pi^+\nu\nu$: BNL787/949, CKM

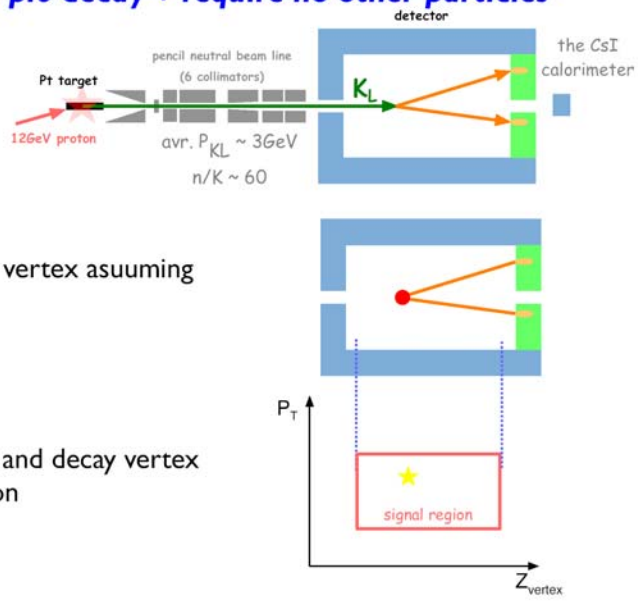
Experimental method

- ***detect 2g from pi0 decay + require no other particles***

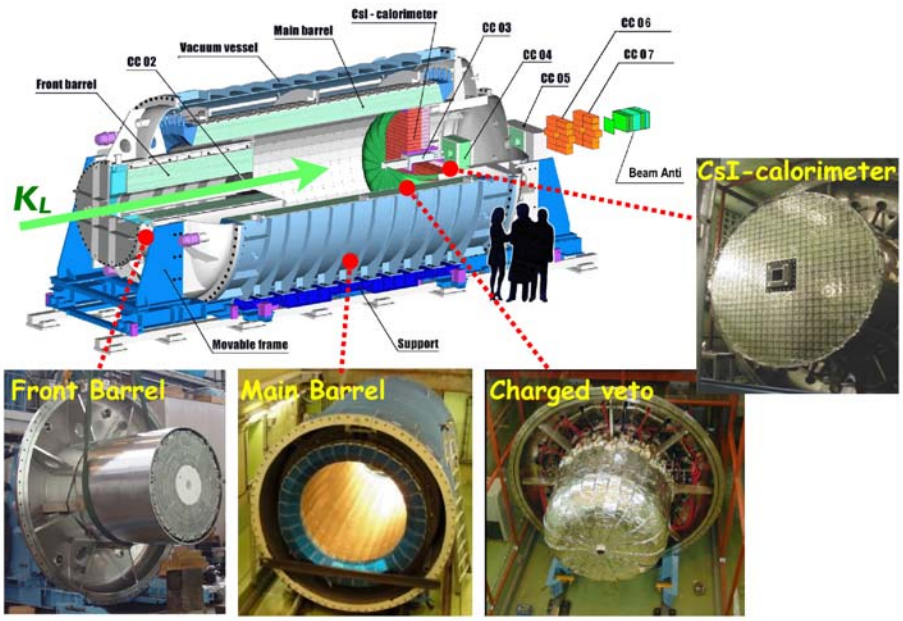
(1) measure gamma hit position and energy

(2) reconstruct decay vertex asuuming $M_{2g}=M_{pi0}$

(3) require missing Pt and decay vertex in the fidutial region



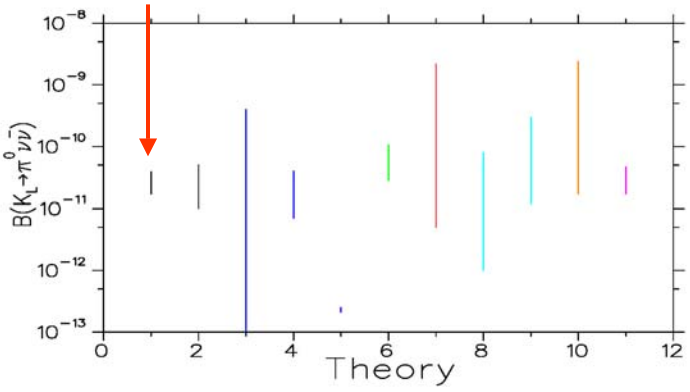
E391a detector



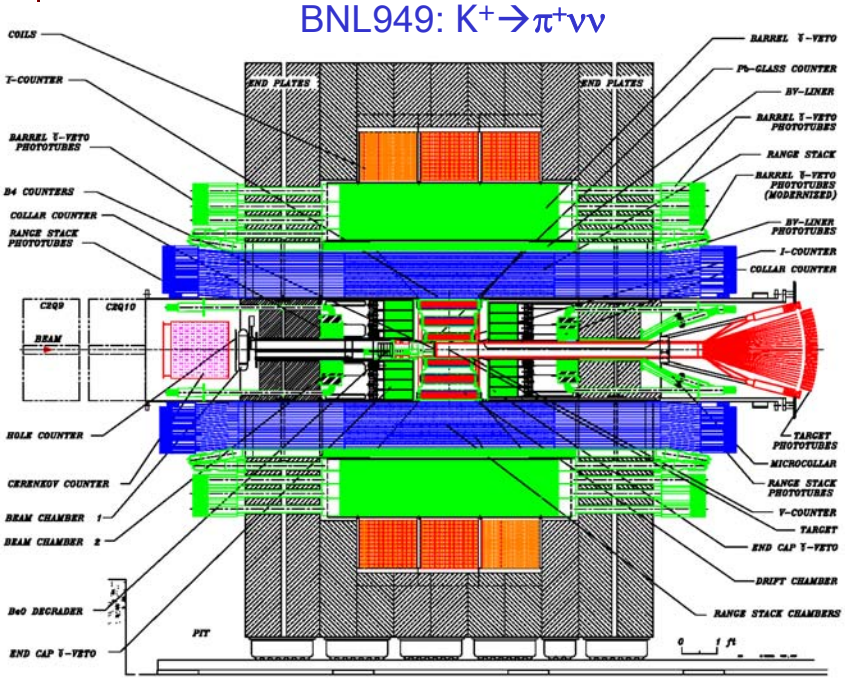
Experimental reach in $K^0_L \to \pi^0\nu\nu$

E391a: expect 3 10^{-10} single event sensitivity

(about 10x SM)



BNL949: $K^+ \rightarrow \pi^+ \nu\nu$



Experimental reach in $K^+ \rightarrow \pi^+ \nu\nu$