OKA:
An experimental program with RF-separated $K^{\pm}$ beam @ U-70.

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Current main experiments with K$^{\pm}$

- E949 AGS BNL

  E$\times$B separated ~ 700 MeV K^+ beam (LESB3);

  3.2/5.4 sec. ; $4 \times 10^6 K^+$/cycle; $70\% K^+$

  Main task: $K^+ \to \pi^+ \nu \bar{\nu}$; sensitivity $1.9 \cdot 10^{-11}$ (2 years of AGS).

- NA48 -2 CERN SPS

  Unsep., simultaneous $K^{\pm}$ 60 GeV ;

  $7 \cdot 10^{11}$ 400 GeV ppp; 4.8s/16.8 sec. $5.5\% K^{\pm}$

  $3.8(2.6) \cdot 10^7 + (-)$/cycle $\to$ $2.2(1.3) \cdot 10^6 K^+(K^-)$/cycle

  100m decay volume; 80 days in 2003

  $\to 5.5(3.1) \cdot 10^{10} K^+(K^-)$

  Search for CP in $K^{\pm} \to \pi^{\pm}\pi^+\pi^-(\tau)$ and $\tau^{'}$; $1.3 \cdot 10^9 \tau^{\pm}$; $5 \cdot 10^7 \tau^{'\pm}$

- ISTRA+ U-70 IHEP

  Unsep. 17-37 GeV; 2/9 sec.

  $1.5 \times 10^5 K^-$/cycle $3\% K^-$

  Tests of SM and χPT in K_{l3}(1M K_{e3}; 1M $K_{\mu 3}$) and $K^- \to \pi^-\pi^0\pi^0$ (250 K) decays; sgoldstino search in $K^- \to \pi^-\pi^0 P$.

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Current main experiments with K$^{\pm}$

- TNF U-70 IHEP

  Unsep. ~ 35 GeV; 2/9 sec. $2.5\% K^{\pm}$; $4. \cdot 10^6 + (-)$/cycle

  $\rightarrow 10^5 K^{\pm}$/cycle

  $\sim$ 60 m decay volume.

  search for CP in $K^{\pm} \rightarrow \pi^{\pm}\pi^0\pi^0(\tau^{'})$ (.5 M) events.

- KLOE $e^+e^- \phi$-factory DAΦNE

  Project: L=$5 \cdot 10^{32}$, achieved: L=$8 \cdot 10^{31}$ cm^2 sec^{-1},

  $\int L \cdot dt \sim 400 pb^{-1}$; $\sigma(e^+e^- \rightarrow \phi) = 3\mu b \rightarrow$

  $\sim 6 \times 10^8 K^+K^-$ and $\sim 4 \times 10^8 K_L K_S \rightarrow$ 1M K_{l3} decays.

  Precise measurement of Br($K_{L,S}; K^{\pm} \rightarrow l\nu\pi$); study of

  $K \rightarrow 3\pi$; $\rightarrow$ CP in perspective.

No high energy separated beams !

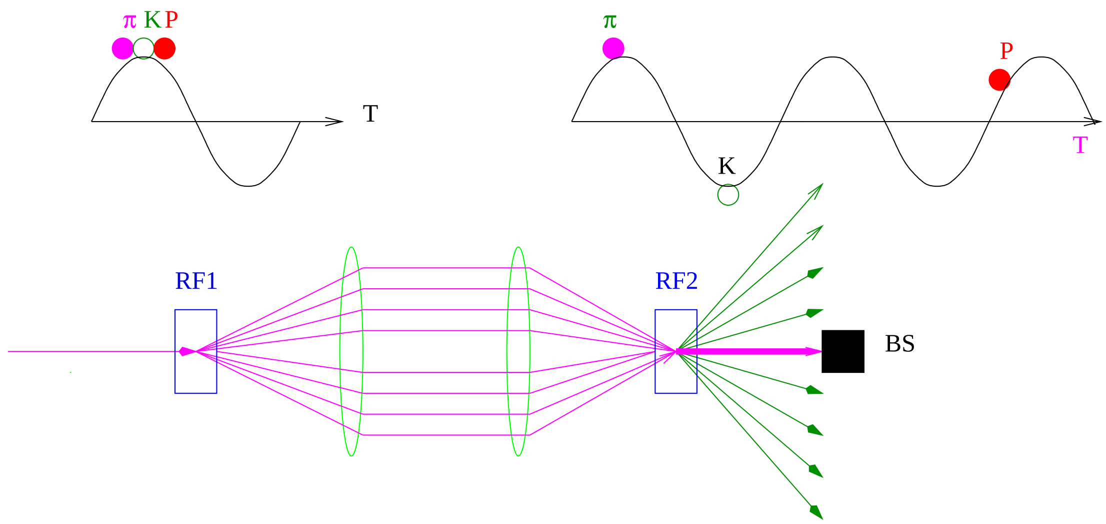
Karlsruhe-CERN superconducting RF separator

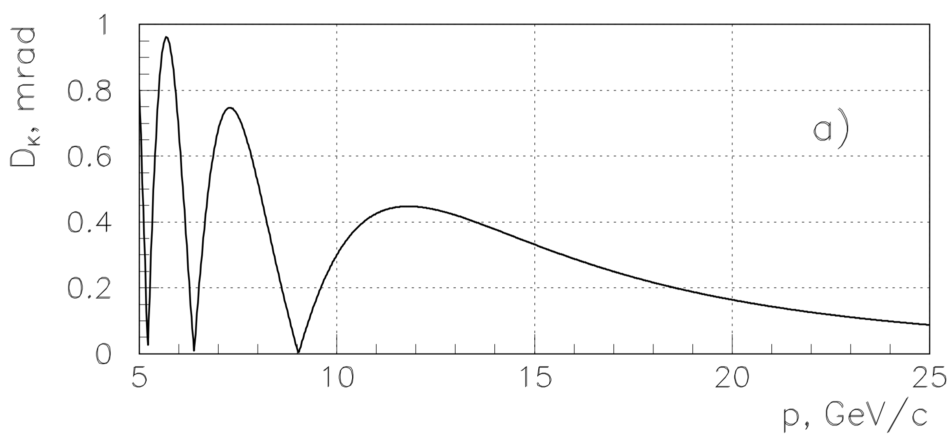
The only existing superconductive RF separator was built in Karlsruhe(Germany) and used at CERN SPS in 1978-1981. The main parameters of the deflectors:

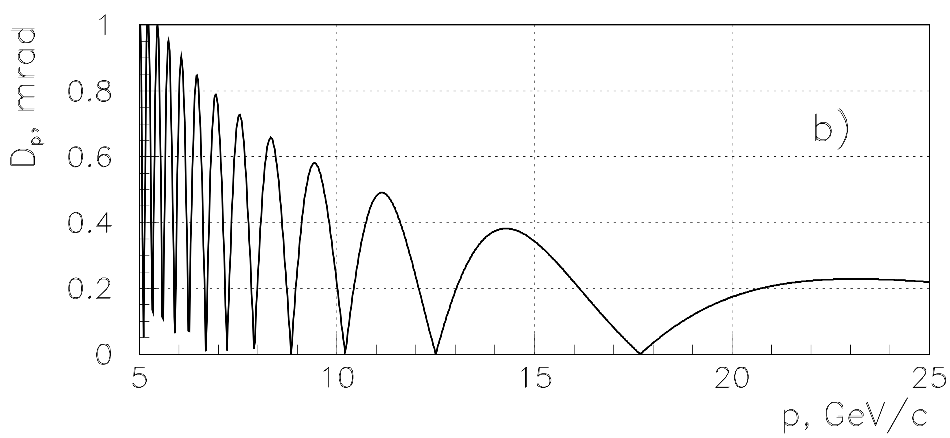
Operating frequency, (S-band)	2865 MHz
Wavelength, λ	$\sim$ 10.5 cm
Iris opening, 2a	40 mm
Effective deflector length	2.74 m
Number of cells/deflector	104
Mean deflecting field	1 MV/m
Working temperature	1.8 K

The separators were used to provide $K^{\pm}$ and $\bar{p}$ 3-37 GeV beams for the Ω spectrometer.
In 1996 the negotiations IHEP-CERN started and in 1998 the separators were transported from CERN to IHEP.

Principle scheme of RF-separation (Panofsky scheme).

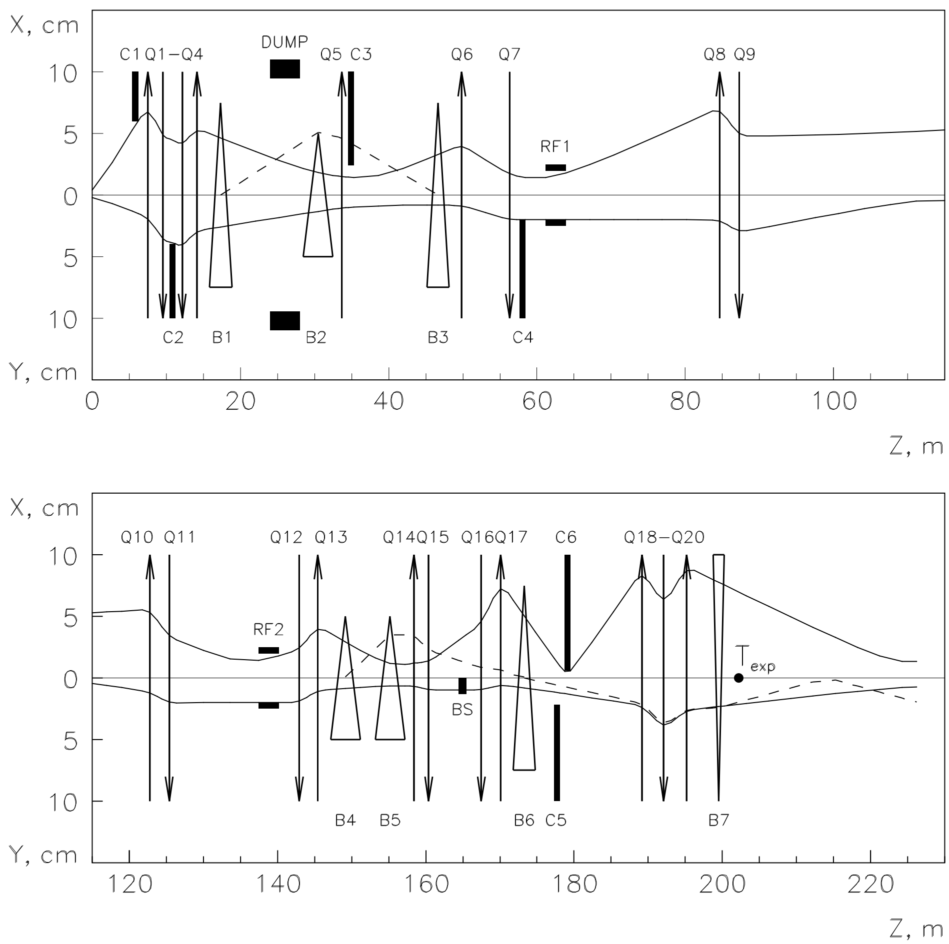




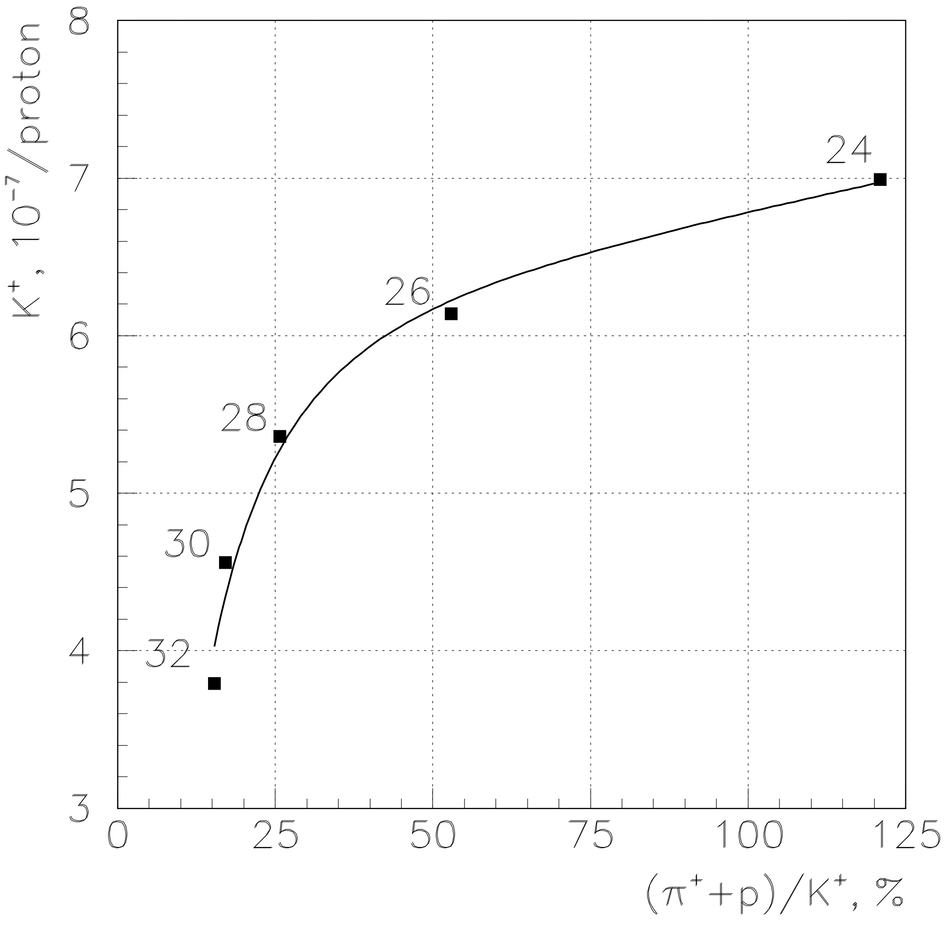


Optical scheme of the "OKA"

RF-separated beam (preprint IHEP 2003-4)



Intensity of the "OKA" K^+-beam versus $\pi^+ + p$ contamination (preprint IHEP 2003-4)

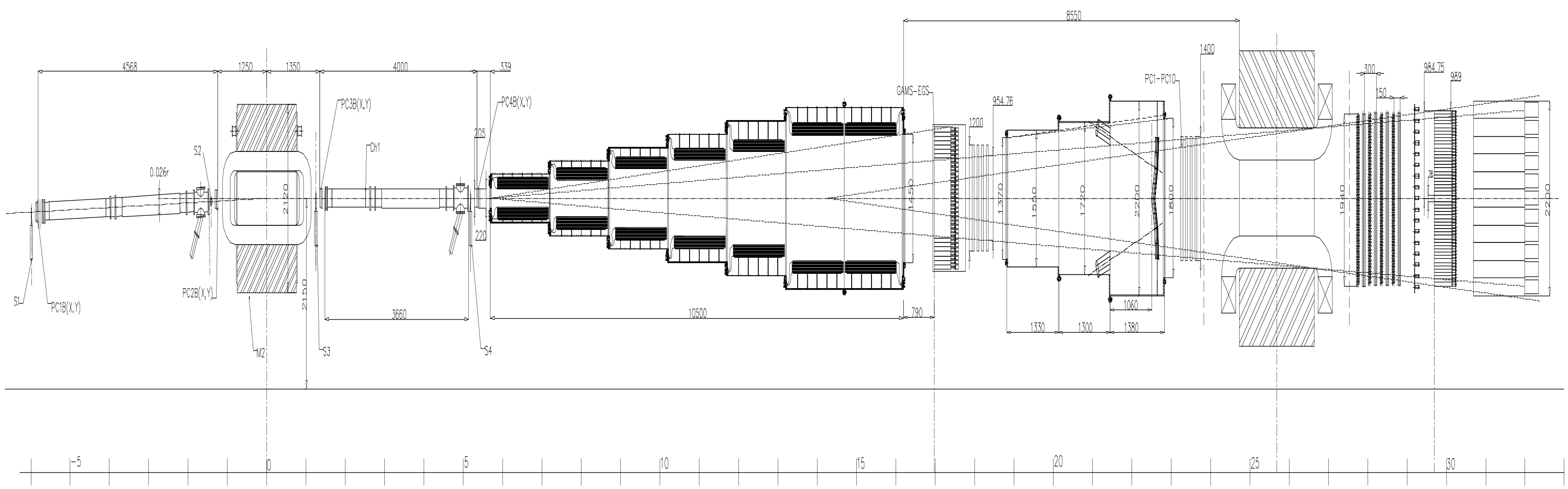


Beam parameters.

The main parameters of the RF-separated beam :

Target	50 cm Be
Primary proton beam energy	65-70 GeV
Primary proton beam intensity	10^{13} ppp
	(2s/9s)
Secondary beam momentum	12 or 18 GeV
Δp/p $\%$	± 4
Horizontal acceptance	± 10 mrad
Vertical acceptance	± 1.9 mrad
Length of the beam line	$\sim$ 200 m
Distance between separators	76.3 m
Intensity of K^+ at the end	5×10^6
π^+, p contamination	$< 25\%$
Muon halo	$< 100\%$

OKA setup at U-70 IHEP



OKA setup at U-70 IHEP

- SPHINX,ISTRA,GAMS $\rightarrow$ OKA

1. Beam spectrometer
   1mm pitch PC's ($\sigma_p/p \sim 1\%$); threshold Č + Kaon RICH; 6 trigger Sc Fi Hodoscopes.
2. Decay volume with veto system:
   12m; surrounded by ~ 670 Lead-Scintillator sandwiches 20 $\times$ (5mm Sc + 1.5 mm Pb), fiber readout
3. PC's and DT's for the magnetic spectrometer:
   $\sim$ 5000 ch. PC (2 mm pitch)+ 1000 DT (6 cm ϕ)
4. Magnet:
   $\int B \cdot ds \sim$ 1 T·m. ; aperture 200$\times$ 90 cm^2
5. Gamma detectors:
   GAMS2000, EHS-backward EM calorimeter. $\sim$ 4000 lead glass channels + ~ 100 PWO crystals.
6. Muon Identificator
   4 sections of Sc-Iron HCal+ μ range stack (30 planes of former D0 forward μ-system 3×3 m^2, $\varnothing 3$ cm DT)
7. Trigger
   - Beam K (Sc + Č counters) $\rightarrow 5 \cdot 10^6$/spill
   - K decay (ScFi Hodoscope logic) $\rightarrow 5 \cdot 10^5$/spill
   - $K \rightarrow \mu\nu$-suppression (> 1 MIP threshold in EM calorimeters) $\rightarrow 2 \cdot 10^5$/spill
   - PC farm to suppress $K \rightarrow \pi\pi^0 \rightarrow 10^5$/spill
8. DAQ $2 \cdot 10^5$/spill= 25 Mb/sec; 5000 ADC (10 μsec converting time); 1000 TDC (.8 nsec, CERN HPTDC); 10000 PC (10 nsec shift registers).

Short overview of the decay physics

3 month of U-70 operation; eff.=50 %

Decay	Br	acc.	PDG	Stat.
$K^+ \to e^+\nu_e$	$1.55 \cdot 10^{-5}$	0.45	10^3	10^6
$K^+ \to e^+\nu_e\pi^0$	$4.8 \cdot 10^{-2}$	0.18	$\sim 10^6$	$2 \cdot 10^9$
$K^+ \to \mu^+\nu\pi^0$	$3.2 \cdot 10^{-2}$	0.27	$\sim 10^6$	$2 \cdot 10^9$
$K^+ \to e^+\nu_e\gamma$	$3.8 \cdot 10^{-5}$	0.30	~ 100	$2 \cdot 10^6$
$K^+ \to \mu^+\nu_\mu\gamma$	$5.5 \cdot 10^{-3}$	0.4	$2 \cdot 10^3$	$4 \cdot 10^8$
$K^+ \to e^+\pi^0\nu\gamma$	$2.6 \cdot 10^{-4}$	0.12	~ 250	$6 \cdot 10^6$
$K^+ \to \mu^+\pi^0\nu\gamma$	$2 \cdot 10^{-5}$	0.18		$7 \cdot 10^5$
$K^+ \to \pi^+\pi^+\pi^-$	$5.6 \cdot 10^{-2}$	0.62	$3 \cdot 10^6$	$7 \cdot 10^9$
$K^+ \to \pi^+\pi^0\pi^0$	$1.7 \cdot 10^{-2}$	0.17	$2 \cdot 10^5$	$6 \cdot 10^8$
$K^+ \to e^+\nu_e\pi^+\pi^-$	$3.9 \cdot 10^{-5}$	0.26	$4 \cdot 10^5$	$2 \cdot 10^6$
$K^+ \to e^+\nu_e\pi^0\pi^0$	$2.1 \cdot 10^{-5}$	0.08	35	$3 \cdot 10^5$
$K^+ \to \mu^+\nu_\mu\pi^+\pi^-$	$1.4 \cdot 10^{-5}$	0.62	7	$2 \cdot 10^6$
$K^+ \to \mu^+\nu_\mu\pi^0\pi^0$	$0.7 \cdot 10^{-5}$	0.16		$2 \cdot 10^5$
$K^+ \to \pi^+\gamma\gamma$	$1.1 \cdot 10^{-6}$	0.30	31	$7 \cdot 10^5$
$K^+ \to \pi^+\pi^0\gamma$	$2.8 \cdot 10^{-4}$	0.21	10^4	10^7

Main directions of the experimental program

- Search for deviations from the SM

  search for new PS-, S-, T-interactions in $K^+ \to e^+\nu_e$, $K^+ \to l^+\nu_l\pi^0$, $K^+ \to l^+\nu_l\gamma$, $K^+ \to l^+l^-\pi^+$ processes $\to$ extension of the present ISTRA+ experiment at U-70

- Search for direct CP violation

  Measurement of the $\frac{\vec{p}_\gamma\cdot(\vec{p}_\pi\times\vec{p}_\mu)}{|\vec{p}_\gamma|\cdot|\vec{p}_\pi\times\vec{p}_\mu|}$-correlation in the decay $K^+ \to \mu^+(e^+)\nu\pi^0\gamma$;

  Measurement of the $\frac{\delta g_\pm}{2g}$ in the decays $K^\pm \to \pi^\pm\pi^\pm\pi^\mp$; $K^\pm \to \pi^\pm\pi^0\pi^0$

- Tests of the ChPT

  $K^+ \to \pi^+\gamma\gamma$; $K^+ \to \pi^+\mu^+\mu^-$; $K^+ \to \pi^+e^+e^-$

- Search for pseudoscalar sgoldstino(P) in $K^+ \to \pi^+\pi^0 P$ decay

  $\to$ extension of the ISTRA+ search

- Hadron spectroscopy and Coulomb processes in $K^\pm N$ interactions, rare electromagnetic decays, etc.

The program will be tuned depending on the results of the current experiments: ISTRA+, E949, NA48/2

Search for new interactions in kaon decays

$K^+ \to e^+\nu_e$ (PS), $K^+ \to l^+\nu_l\pi^0$, $K^+ \to l^+\nu_l\gamma$,
$K^+ \to l^+l^-\pi^+$

General

$$A = A_{SM} + A_{NI} = |A_{SM}| + \underbrace{|A_{NI}|}_{New\ Interaction} e^{i\phi}$$

$$\begin{aligned} |A|^2 &= |A_{SM}|^2 + |A_{NI}|^2 + 2Re(A_{SM}A^*_{NI}) = \\ &= |A_{SM}|^2 + |A_{NI}|^2 + 2\cos\phi |A_{SM}||A^*_{NI}| \simeq \\ &\simeq |A_{SM}|^2(1 \pm \underbrace{|A_{NI}/A_{SM}|}_{IT}) \quad /2\cos\phi \sim 1/ \end{aligned}$$

Here, New effects $\propto IT \propto M_{boson}^{-2}$

For LFV $K \to \pi e \mu$, etc. $\propto |A|^2 \propto M_{boson}^{-4}$

In some cases the interference term *(IT)* has an additional smallness (as in K_{l3} for $l = e$, which will be discussed below) and NI might be seen only at $|A_{NI}|^2$

$K^+ \to l^+\nu_l\pi^0$ (S; T)	New “intermediate” boson ?
$K^+ \to l^+\nu_l\gamma$ (T)	M_{PS}, M_S, M_T
$K^+ \to e^+\nu_e$ (PS)	Leptoquarks ? Charged Higgs ?

Search for deviations from SM in the decay $K^+ \to e^+\nu_e$

- Theoretical predictions:

$$R(K^+ \to l^+\nu_l)_{SM} = \frac{Br(K^+ \to e^+\nu_e)}{Br(K^+ \to \mu^+\nu_\mu)} =$$
$$\frac{m_e^2}{m_\mu^2} \cdot \frac{(m_K^2 - m_e^2)^2}{(m_K^2 - m_\mu^2)^2}(1+\delta_r) =$$
$$2.569 \cdot 10^{-5}(1 - 0.0378 \pm 0.0004) = (2.472 \pm 0.001) \cdot 10^{-5}$$
$$R(K^+ \to l^+\nu_l) = R(K^+ \to l^+\nu_l)_{SM}[1 \pm \frac{|G|_{PS}}{G_F \cdot V_{us}} \cdot \frac{m_K^2}{m_s m_e}]$$

- Experiment:

Two measurements (1975,1976) CERN PS, 938 events:

$$R(K^+ \to l^+\nu_l)_{exp} = (2.44 \pm 0.11) \cdot 10^{-5} =$$
$$R(K^+ \to l^+\nu_l)_{SM} \cdot (0.987 \pm 0.045)$$

$$\downarrow$$

$|G|_{PS} < 3.5 \cdot 10^{-11}$ GeV^{-2} ; $\Lambda_{LQ} > 85$ TeV

- Prospects for OKA:

Expected statistics - 10^6 events $\to$ statistical accuracy 10^{-3}. MC study of the main background processes $K^+ \to e^+\nu\pi^0$ and $K^+ \to e^+\nu\gamma$, have shown, that it is possible to suppress background to $< 3 \cdot 10^{-7}$

$$\downarrow$$

$|G|_{PS} < 10^{-12}$ GeV^{-2} ; $\Lambda_{LQ} > 500$ TeV

K_{l3} phenomenology

$$K(P_K) \to \bar{l}(q_l) + \nu_l(q_\nu) + \pi(P_\pi)$$

Most general Lorentz-invariant matrix element for K_{l3}:

$$M = \frac{G_F sin\theta_C}{2}\bar{u}(p_\nu)(1+\gamma^5)[2m_K f_S + \frac{2if_T}{m_K}\sigma_{\alpha\beta}P_K^\alpha P_\pi^\beta - [(P_K+P_\pi)_\alpha f_+(t) + (P_K - P_\pi)_\alpha f_-(t)]\gamma^\alpha]v(p_\mu)$$

Vector term $\sim f_-$ is reduced(Dirac equation) to scalar, and tensor- to scalar+vector. After S and V redefinition we get for the Dalitz plot density $\rho(E_\pi, E_\mu)$:

$$\rho(E_\pi, E_\mu) \sim A \cdot |V|^2 + B \cdot Re(V^* S) + C \cdot |S|^2$$

$$V = f_+ + (m_l/m_K)f_T$$

$$S = f_S + (m_l/2m_K)f_- + \left(1 + \frac{m_l^2}{2m_K^2} - \frac{2E_l}{m_K} - \frac{E_\pi}{m_K}\right) f_T$$

$$A = m_K(2E_l E_\nu - m_K \Delta E_\pi) - m_l^2(E_\nu - \frac{1}{4}\Delta E_\pi)$$

$$B = m_l m_K(2E_\nu - \Delta E_\pi)$$

$$C = m_K^2 \Delta E_\pi; \; \Delta E_\pi = E_\pi^{max} - E_\pi$$

Usually $f_0(t)$ is introduced : $f_0(t) = f_+(t) + \frac{t}{m_K^2 - m_\pi^2} f_-(t)$

Usually it is assumed that :

$$f_+(t) = f_+(0)(1 + \lambda_+ t/m_\pi^2 + \lambda_+^{'} t^2/m_\pi^4);$$

$f_0(t) = f_+(0)(1 + \lambda_0 t/m_\pi^2 + \lambda_0^{'} t^2/m_\pi^4)$. Then

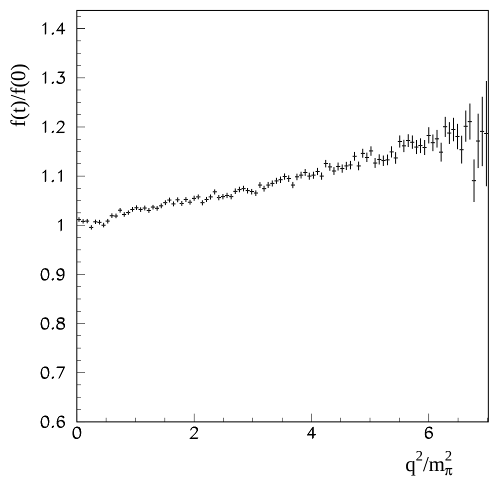
$$f_- = f_+(0)\frac{m_K^2 - m_\pi^2}{m_\pi^2}(\lambda_0 - \lambda_+ + \frac{t}{m_\pi^4}(\lambda_0^{'} - \lambda_+^{'})).$$

K_{e3}: $m_l = m_e \Longrightarrow B \sim 0$, the term at f_- vanishes:

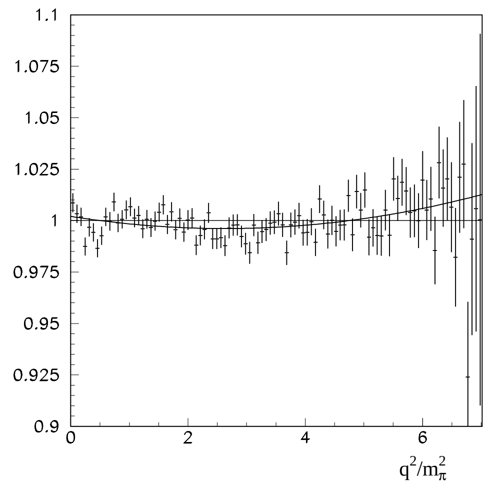
- no dependency on f_-
- reduced sensitivity (only from $C \cdot |S|^2$)

ISTRA+ ($P_{K^-} = 25$ GeV/c), 920 K events, bkg $\sim 2.1\%$

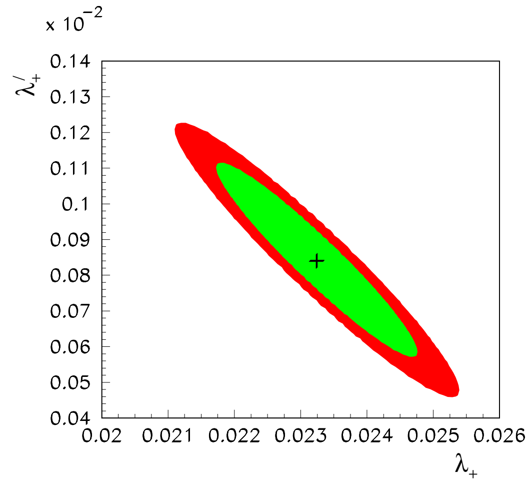
λ_+	λ'_+	$f_T/f_+(0)$	$f_S/f_+(0)$	$\Delta\chi^2$
0.02774 ± 0.00047	$0.$	$0.$	$0.$	$0.$
0.02324 ± 0.00152	0.00084 ± 0.00027	$0.$	$0.$	$-9.8.$
0.02774 ± 0.00047	$0.$	-0.012 ± 0.021	$0.$	-0.3
0.02774 ± 0.00047	$0.$	$0.$	$-0.0059^{+0.0089}_{-0.0054}$	-0.5



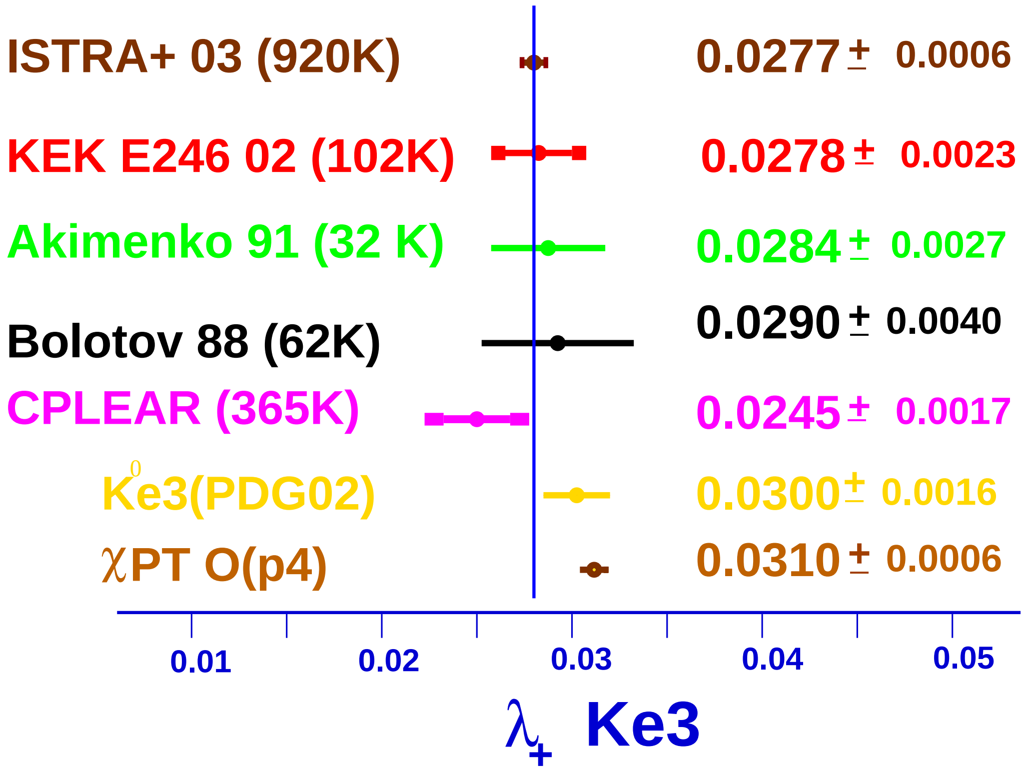
$f_+(t)/f_+(0)$

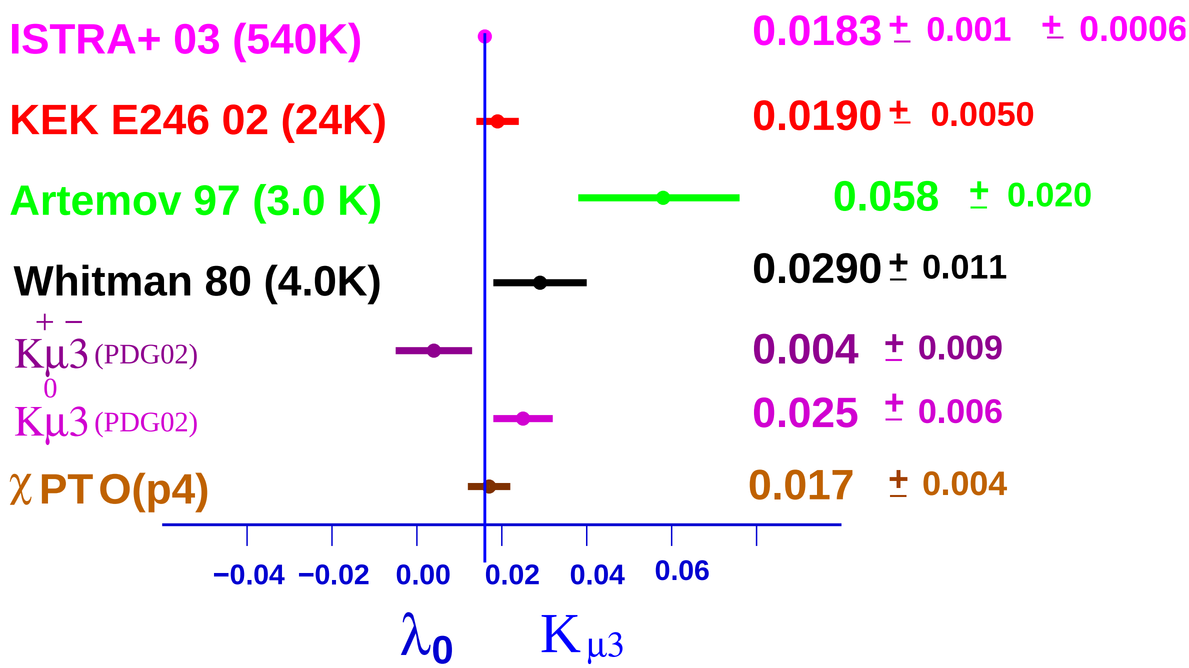


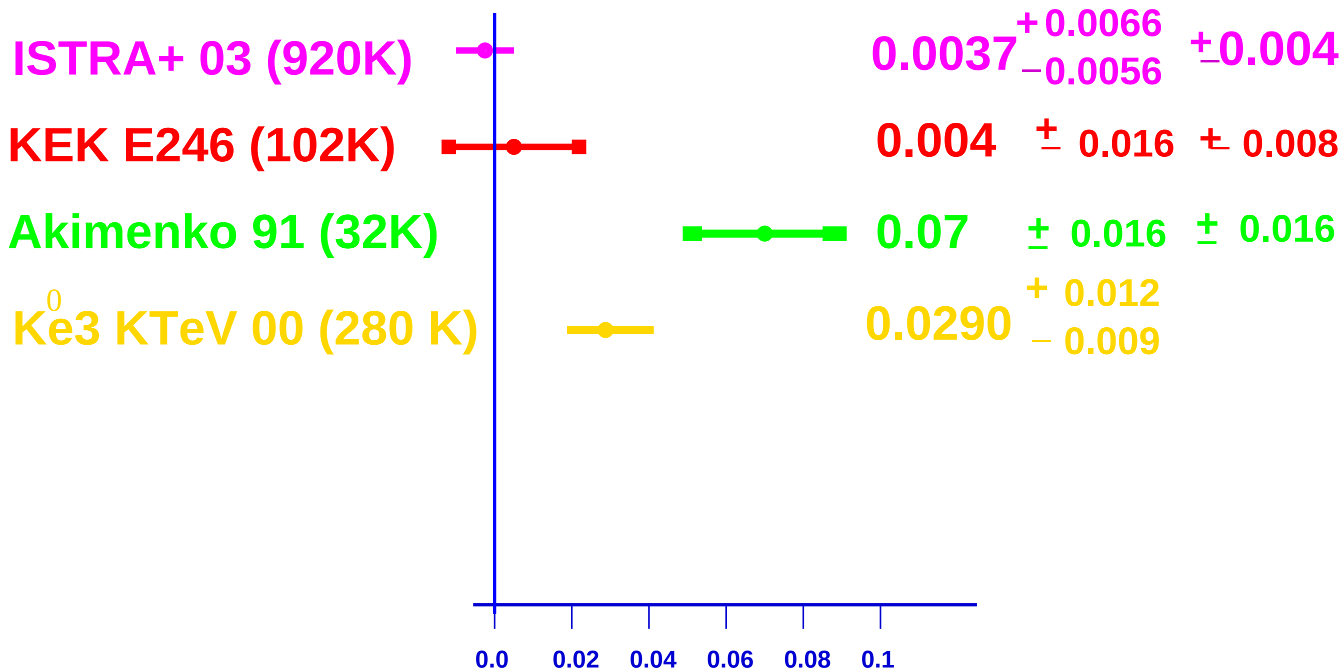
$f_+(t)$-nonlinearity



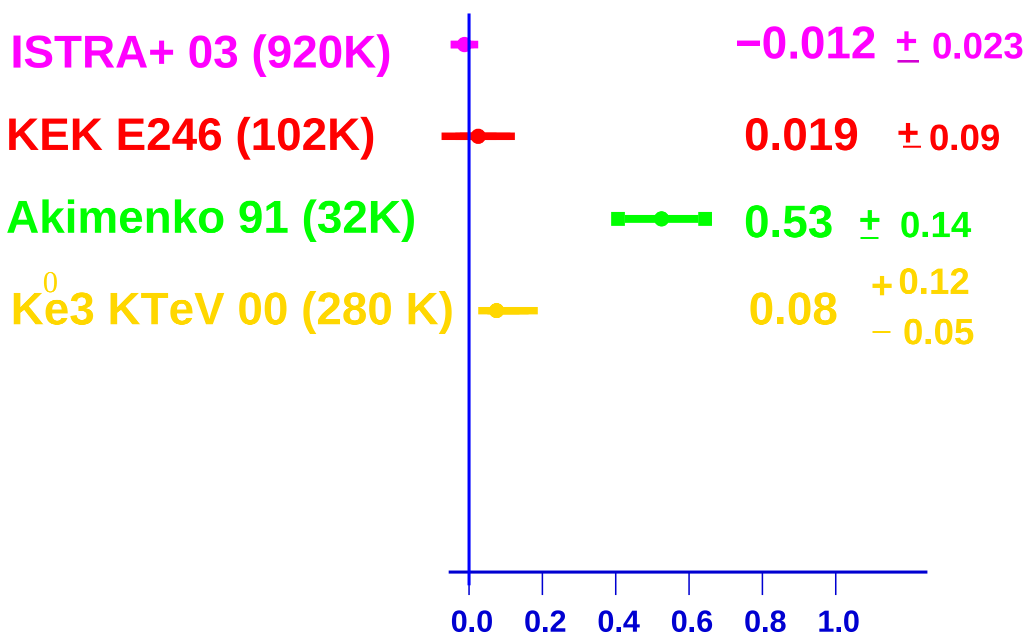
$\lambda_+ - \lambda'_+$ correlation


ISTRA+ 03 (920K) 0.0277 ± 0.0006
KEK E246 02 (102K) 0.0278 ± 0.0023
Akimenko 91 (32 K) 0.0284 ± 0.0027
Bolotov 88 (62K) 0.0290 ± 0.0040
CPLEAR (365K) 0.0245 ± 0.0017
K0e3(PDG02) 0.0300 ± 0.0016
χPT O(p4) 0.0310 ± 0.0006
0.01
0.02
0.03
0.04
0.05
λ+ Ke3


ISTRA+ 03 (540K) 0.0183 ± 0.001 ± 0.0006
KEK E246 02 (24K) 0.0190 ± 0.0050
Artemov 97 (3.0 K) 0.058 ± 0.020
Whitman 80 (4.0K) 0.0290 ± 0.011
K+−μ3 (PDG02) 0.004 ± 0.009
K0μ3 (PDG02) 0.025 ± 0.006
χ PT O(p4) 0.017 ± 0.004
−0.04
−0.02
0.00
0.02
0.04
0.06
λ0 Kμ3



$F_S / F(0)$ K_{e3}



$F_T / F(0)$ K_{e3}

$K_{\mu 3}$: $m_l = m_\mu \Longrightarrow B$ is not negligible, the term at f_- is non zero:

- independent info on f_- is needed
- better sensitivity with interference term $B \cdot Re(V'S')$

$f_- = f_-(f_+, f_0) = f_-(\lambda_+, \lambda_0)$
$\lambda_0 = \lambda_{0,theory} = 0.017 \pm 0.004$ (ChPT) and
λ_+ from K_{e3} OR from the same measurement

ISTRA+, 540K events, bkg $\sim 0.3\%$

λ_+, λ_0	λ'_+, λ'_0	$f_T/f_+(0), f_S/f_+(0)$	Fit prob.
0.0277 ± 0.0013	$0.$	$0.$	0.425
0.0183 ± 0.0011	$0.$	$0.$	
0.0215 ± 0.0060	0.0010 ± 0.00010	$0.$	0.451
0.0160 ± 0.0021	$0.$	$0.$	
0.0216 ± 0.0013	0.001063	$0.$	0.451
0.0163 ± 0.0011	$0.$	$0.$	
0.0276 ± 0.0014	$0.$	$0.$	0.421
0.0170 ± 0.0059	0.0002 ± 0.0008	$0.$	
0.0276 ± 0.0014	$0.$	-0.0007 ± 0.0071	0.422
0.0183 ± 0.0011	$0.$	$0.$	
0.0277 ± 0.0013	$0.$	$0.$	0.421
0.017	$0.$	0.0017 ± 0.0014	

ISTRA+ K_{l3} measurement: comparison with theory

A linear approximation on q^2/m_π^2, $\chi PT\ O(p^4)$ theory:

$$\left.\begin{aligned} \lambda_+^{exp} &= 0.0277 \pm 0.00057 \\ \lambda_+^{th} &= 0.0310 \pm 0.0007 \end{aligned}\right\} \lambda_+^{exp} - \lambda_+^{th} = -0.0032 \pm 0.0009$$

$$\left.\begin{aligned} \lambda_0^{exp} &= 0.0183 \pm 0.0013 \\ \lambda_0^{th} &= 0.017 \pm 0.004 \end{aligned}\right\} \lambda_0^{exp} - \lambda_0^{th} = 0.0013 \pm 0.004$$

OKA Prospects

With OKA we expect a very large statistics for K_{e3} and $K_{\mu 3}$ ($> 10^8$ events each). Thus, precision measurements will be limited only by systematic uncertainties.

Other possible experiments with OKA setup

- T-odd correlation in $K^+ \to l^+ \nu_l \pi^0 \gamma$

  $T_{\pi l \gamma} = \frac{\vec{p}_\gamma \cdot (\vec{p}_\pi \times \vec{p}_\mu)}{|\vec{p}_\gamma| \cdot |\vec{p}_\pi \times \vec{p}_\mu|}$

  Expected OKA statistics:

  $\sim 10^7\ K^+ \to e^+ \nu_e \pi^0 \gamma$, $\sim 10^6\ K^+ \to \mu^+ \nu_\mu \pi^0 \gamma$

  Sensitivity: $T_{\pi l \gamma} \leq 1 \cdot 10^{-3} \div 3 \cdot 10^{-3}$

  $K^+ \to \mu^+ \nu_\mu \pi^0 \gamma$ can be sensitive to nonstandard mechanisms of CP violation

- Search for CP violation effects in $K^\pm \to \pi^\pm \pi^+ \pi^-$ and $K^\pm \to \pi^\pm \pi^0 \pi^0$

  Expected sensitivity:

  $$\frac{\delta g}{2g} \leq \begin{cases} 1 \cdot 10^{-4} & (K^\pm \to \pi^\pm \pi^+ \pi^- \sim 6 \cdot 10^9) \\ 1 \div 3 \cdot 10^{-4} & (K^\pm \to \pi^\pm \pi^0 \pi^0 \sim 5 \cdot 10^8) \end{cases}$$

  g is a slope of the Dalitz plot distribution

  We plan to do such measurements if something unexpected is seen in NA48 results

(continue next page)

Other possible experiments with OKA setup

- Comparable study of $K^+ \to e^+e^-\pi^+$ and $K^+ \to \mu^+\mu^-\pi^+$

  Expected statistics: $\sim 10^4$ of each decay

  Study of formfactors and the search for anomalous interactions

- Further searches for sgoldstino in $K^+ \to \pi^+\pi^0 P$

- Hadron spectroscopy with K^+ beam

  $K^+ N \to (qqqq\bar{s})_{forw} + \pi$ (pentaquarks);

  study of chiral anomaly in $K + \gamma \to K + \pi$ reactions;

  strange meson spectroscopy;

  rare electromagnetic decays of hadrons (good photon veto system)

OKA Status

- RF-Separators
  Problem with a piece of dust found and fixed.
  Next test is scheduled on May, 2004.
- Beam line
  Test run is scheduled on fall, 2004 (with or without separators depending on results of the may test)
- Detector
  Mostly consists of existing pieces of apparatus;
  Lacking parts (veto system, electron Č) are being manufactured;
  Electronics is being manufactured.
- Commissioning phase, beginning of data taking
  2005

Backup slides

Search for T-odd violation in $K^{\pm}$ decays

"OKA" is not planing to measure $\sigma_{\perp}$ in $K \to \mu\nu\pi^0$.
Instead, we propose to search for:

- T-odd correlation in $K \to \mu\nu\pi^0\gamma$ ($e\nu\pi^0\gamma$)

$\frac{\vec{p}_\gamma \cdot (\vec{p}_\pi \times \vec{p}_\mu)}{|\vec{p}_\gamma| \cdot |\vec{p}_\pi \times \vec{p}_\mu|}$ J.Gevais, J.Iliopoulous, J.Kaplan 1966

SM FSI in V.Braguta et al., Phys.Rev.D65,2002: $K \to e\nu\pi^0\gamma$- $\sim 0.5 \times 10^{-4}$; $K \to \mu\nu\pi^0\gamma$ - $\sim 10^{-4}$

$K^{\pm}$ beam $\to$ subtraction is possible

In some extensions of SM (V.Braguta et al., Phys.Rev.D68,2003) larger effects are predicted: $\sim 3 \times 10^{-4}$

The only exp. result is from ISTRA ($K \to e\nu\pi^0\gamma$, 1986):

$\frac{\vec{p}_\gamma \cdot (\vec{p}_\pi \times \vec{p}_e)}{|\vec{p}_\gamma| \cdot |\vec{p}_\pi \times \vec{p}_\mu|} = 0.03 \pm 0.08$; 192 ev; Br=$(2.7 \pm 0.2) \cdot 10^{-4}$

($E_\gamma^{c.m.} > 10$MeV ; $0.6 < cos\theta_{e,\gamma} < 0.9$)

In the experiment with RF-separated beam at U-70 we expect $2 \cdot 10^6$ events $\to$ $\frac{\vec{p}_\gamma \cdot (\vec{p}_\pi \times \vec{p}_e)}{|\vec{p}_\gamma| \cdot |\vec{p}_\pi \times \vec{p}_\mu|} < 3 \cdot 10^{-4}$

For $K \to \mu\nu\pi^0\gamma$ about $7 \cdot 10^5$ ev. expected $\to$ $< 8 \cdot 10^{-4}$.

Search for T- odd effects

$K \to \mu\nu\pi^0; K \to \mu\nu\gamma$

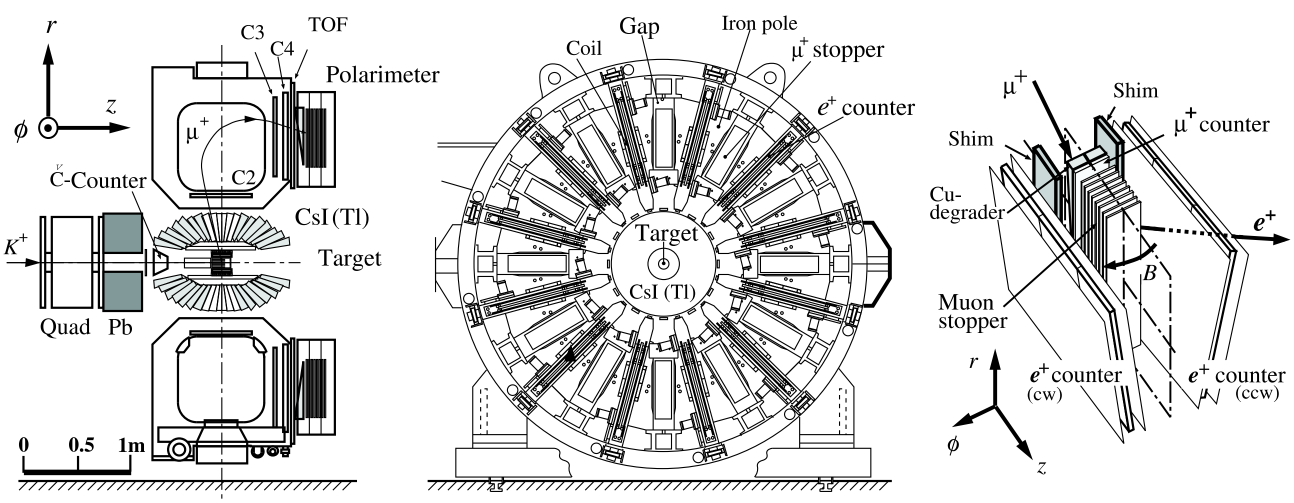
- $\sigma_\perp$ in $K \to \mu\nu\pi^0$

$$\sigma_\perp^\mu = \frac{\vec{\sigma}_\mu \cdot (\vec{p}_\pi \times \vec{p}_\mu)}{|\vec{p}_\pi \times \vec{p}_\mu|} \sim m_K \cdot m_\mu \cdot Im\xi; \xi = f_-/f_+$$

Unique feature $\sigma_\perp^{FSI} \sim 4 \cdot 10^{-6}$

In some models (Weinberg multi-Higgs), $\sigma_\perp \sim 10^{-2}$

The best present measurement (KEK E246)



(a) (b) (c)

$$\sigma_\perp^{K\mu3} < 4.3 \cdot 10^{-3}\ 90\%\text{C.L.} \to |Im\xi| < 1.3 \cdot 10^{-2}$$

$$\sigma_\perp^{K\mu2\gamma} < 3.1 \cdot 10^{-2}\ 90\%\text{C.L.}$$

Future: JPARC $\sigma_\perp < 10^{-4}$

Search for CP- odd effects in τ ($K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp}$) τ' ($K^{\pm} \to \pi^{\pm}\pi^{0}\pi^{0}$)

- $\frac{\delta\Gamma_{\pm}}{2\Gamma}$ or $\frac{\delta g_{\pm}}{2g}$

  $|M_{K\to 3\pi}|^2 \sim 1 + gY + hY^2 + kX^2 + ..$ $\quad g^{\tau} \sim .21;$

  $Y = \frac{s_3 - s_0}{m_{\pi}{}^2}$; $X = \frac{s_2 - s_1}{m_{\pi}{}^2}$; $s_i = (p_K - p_i)^2$, $\quad g^{\tau'} \sim 0.6$

  $s_0 = \frac{1}{3}(s_1 + s_2 + s_3)$; π_3 - odd pion.

- Theoretical predictions:

  SM $\frac{\delta g_{\pm}}{2g} = 2. \times 10^{-6} \div 10^{-3}$

  (L.Maiani, N.Paver The 2^{nd} DAΦNE Ph. Han. $\div$ A.Belkov et al., Phys.Lett.B300,283,1993)

  Has converged to $\sim 2 \cdot 10^{-5}$ SM

  SM-extensions $\sim 2 \cdot 10^{-4}$

  (E.P.Shabalin ITEP preprint 8-98, 1998). CP violation due to Weinberg model; 3 Higgs doublets.

- Experiment:

  For τ there exists old (1970) measurement:

  $\frac{\delta g_{\pm}}{2g} = -0.70 \pm 0.53\%$ 3.2 M events.

  For τ' $\frac{\delta\Gamma_{\pm}}{2\Gamma} = (0.0 \pm 0.6)\%$

  ISTRA(1986) 40K $g_{-}^{\tau'} = 0,582 \pm 0,021$

  HYPERON(1996) 32K $g_{+}^{\tau'} = 0,736 \pm 0,02$

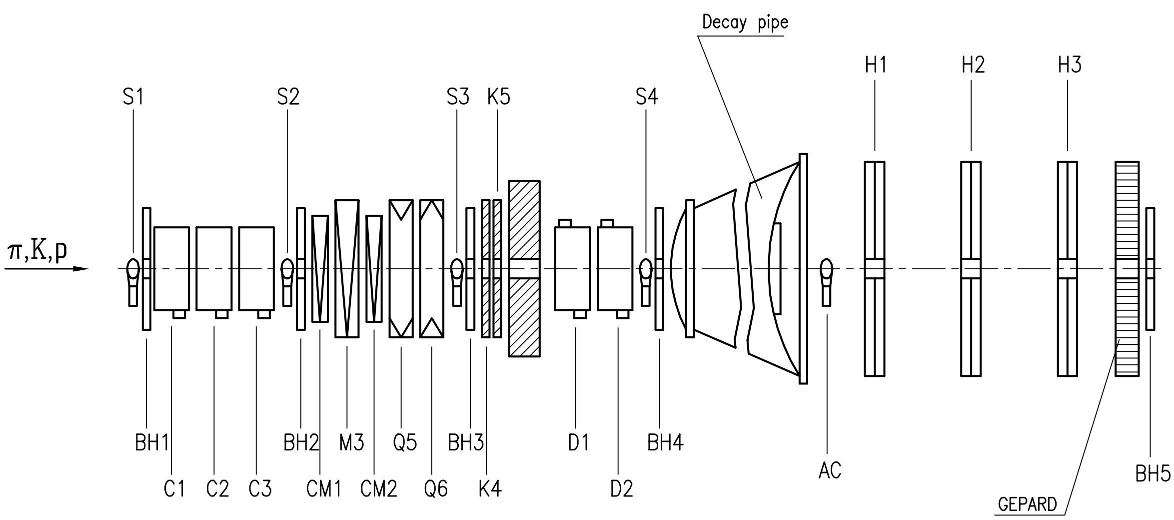
  $\to \frac{\delta g_{\pm}}{2g} = 0.1 \pm 0.02$

  ISTRA+(2003) $g_{-}^{\tau'} = 0,697 \pm 0,019 \to \frac{\delta g_{\pm}}{2g} = 0.03 \pm 0.02$

Search for CP-violation in $\tau\ (K^{\pm} \to \pi^{\pm}\pi^{\pm}\pi^{\mp})$ $\tau'\ (K^{\pm} \to \pi^{\pm}\pi^{0}\pi^{0}\ )$ decays.

For the exp. error: $\frac{\delta g_{\pm}}{2g} = R \cdot \frac{\sqrt{n_{+}+n_{-}}}{2\sqrt{n_{+} \cdot n_{-}}}; R_{\tau} = 7.56; R_{\tau'} = 3.0$

Current experiments



- TNF(IHEP U-70) τ'
  Unsep. ± 35 GeV; $10^5\,K^{\pm}$/cycle; 2% K ;
  59m decay. volume, nonmagnetic detector.
  Total statistics 278K K^{+}; 340K K^{-}

$$\frac{\delta g_{\pm}^{KMH}}{2g} = -0.0005 \pm 0.0015 \pm 0.0005$$

Search for CP-violation in τ , τ' decays.

Current experiments

- NA48 -2 CERN SPS

  Unsep., simultaneous $K^{\pm}$ 60 GeV ;

  $7 \cdot 10^{11}$ 400 GeV ppp; 4.8s/16.8sec cycle; 5% K

  $3.8(2.6) \cdot 10^{7} + (-)$/cycle $\rightarrow$ $2.2(1.3) \cdot 10^{6} K^{+}(K^{-})$/cycle

  100m decay volume; 80 days(2003 .)

  $\rightarrow 1.3 \cdot 10^{9} \tau^{\pm}$; $5 \cdot 10^{7} \tau'^{\pm} \rightarrow \frac{\delta g_{\pm}}{2g} \sim 3(6) \times 10^{-4} \tau(\tau')$

- KLOE τ, τ'

  $e^{+}e^{-}\phi$-factory. For L=$5 \cdot 10^{32} cm^{2} s^{-1}$ for 1 year

  $N_{\tau} \sim 1.5 \cdot 10^{8}$; $N_{\tau'} \sim 0.6 \cdot 10^{8}$

  $\rightarrow \frac{\delta g_{\pm}}{2g} \sim 6.3 \times 10^{-4} (\tau); 4.4 \cdot 10^{-4} (\tau')$

  Status: waiting for high luminosity.

- HyperCP(FNAL,1997) τ

  Unsep. $\pm \sim 170$ GeV 20 MHz Hyp. beam Status: data processing

  $N_{\tau+} \sim$ 204M ; $N_{\tau-} \sim$ 75M $\rightarrow \frac{\delta g_{\pm}}{2g} \sim 6 \times 10^{-4}$

Search for CP-violation in τ , τ' decays.

Future experiments

- OKA U-70 IHEP

  10^{13} 70 GeV ppp; 2s/9s cycle. RF-sep., $K^{\pm}$ 12.5 GeV ;

  $\geq 50\%$ K $\rightarrow$ $5(2) \cdot 10^{6} K^{+}(K^{-})$/cycle. ;

  12m decay volume; 120 days 50% eff.

  optimal strategy: $T^{-} = \sqrt{3} \cdot T^{+} \rightarrow 10(6) \cdot 10^{10} K^{+}(K^{-})$

  $\rightarrow (3.8 + 2.1) \cdot 10^{9} \tau$; $(3.3 + 1.9) \cdot 10^{8} \tau'$

  $\rightarrow \frac{\delta g_{\pm}}{2g} \sim 1.(1.3) \times 10^{-4} \tau(\tau')$

  Status: beam-line at the end of 2004 .