Recent results on CP violation and rare kaon decays by the NA48 experiment at CERN

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Abstract

Since more than a decade, the NA48 Collaboration has been carrying out at CERN an extensive experimental programme dedicated to the study of CP violation and rare decays in both neutral and charged kaon sectors. The most recent results obtained in this field by the NA48 experiment are presented with emphasis on charged kaon decays. Prospects for measuring at CERN the very rare decay $K^+ \to \pi^+ \nu\overline{\nu}$ are discussed.

1 Introduction

The investigation of CP violation is of major importance in particle physics as it addresses fundamental questions linked to the matter-antimatter asymmetry observed in the Universe. Since 1964, when CP violation was first discovered in $K_L \to \pi^+\pi^-$ decays [1], large experimental and theoretical efforts have been devoted to better understand the source of this symmetry violation. The NA48 Collaboration has carried out over the last decade an extensive experimental programme at CERN dedicated to the study of CP violation and rare processes in both neutral and charged kaon decays.

NA48 is a fixed target experiment located at the CERN Super Proton Synchrotron complex near Geneva. The NA48 experiment started data taking in 1997 using simultaneous K_L and K_S beams with the aim of establishing the existence of direct

CP violation in $K^0 \to 2\pi$ decays through the observation of a non-zero value of the $Re(\epsilon'/\epsilon)$ parameter. This parameter provides the relative size of CP violation occuring in the decay itself (direct CP violation) as compared to the one in $K^0 - \overline{K^0}$ oscillations (indirect CP violation). After five years of experimental effort, the NA48 Collaboration obtained the value $Re(\epsilon'/\epsilon) = (14.7 \pm 2.2) \times 10^{-4}$ [2] which differs from zero by more than six standard deviations. This result confirmed thus the existence of direct CP violation which is responsible for the tiny, $O(10^{-5})$, particle-antiparticle asymmetry observed in the decay rates into 2π between the K^0 and the $\overline{K^0}$.

In 2002, the physics programme of the NA48 experiment (NA48/1) was primarily devoted to the study of rare K_S decays. It resulted in the first observation of the $K_S \to \pi^0 e^+ e^-$ [3] and $K_S \to \pi^0 \mu^+ \mu^-$ [4] channels. These decays, which have branching ratios in the 10^{-9} range, provide valuable information on the CP violating amplitudes in the analogue $K_L \to \pi^0 e^+ e^-$ and $K_L \to \pi^0 \mu^+ \mu^-$ processes.

In 2003, the NA48 beam line underwent major modifications in order to accomodate high intensity charged kaon beams to search for direct CP violation in charged kaon decays into three pions. During this data taking phase (NA48/2) which lasted two years, many other physics topics were also covered, including the study of $\pi - \pi$ interaction at low energy, radiative decays, the measurement of V_{us} through semileptonic decays, etc.

Throughout this experimental effort, the NA48 physics programme has benefited from a detection system that was designed specifically for precision measurements of kaon decay parameters [5]. The NA48 detector comprises two major components: a magnetic spectrometer used as a tracking system for charged particles and a quasi-homogeneous liquid krypton calorimeter (LKr) for the measurement of electromagnetic showers. Both elements allows high-resolution detection with very high efficiency. Additional detection elements, like the charged hodoscope, the hadronic calorimeter, the muon veto system and the large angle photon vetoes, provide time information, particle identification and background rejection (Figure 1).

Since 2005, the new collaboration P326/NA62 that has emerged from NA48, is investigating the possibility to measure with a precision of about 10% the branching ratio of the very rare $K^+ \to \pi^+ \nu \overline{\nu}$ decay. Such a measurement constitutes an opportunity to look for new physics processes beyond the Standard Model.

In the following sections, recent results obtained by the NA48 Collaboration are presented with emphasis on charged kaon decays. Prospects for measuring at CERN the decay $K^+ \to \pi^+ \nu \overline{\nu}$ are also discussed.

2 Measurement of the $|\eta_{+-}|$ parameter

The parameter $\eta_{+-} = \epsilon + \epsilon'$, which is defined as the ratio of $K_L \to \pi^+ \pi^-$ to $K_S \to \pi^+ \pi^-$ amplitudes, is a fundamental observable of CP violation. It involves both

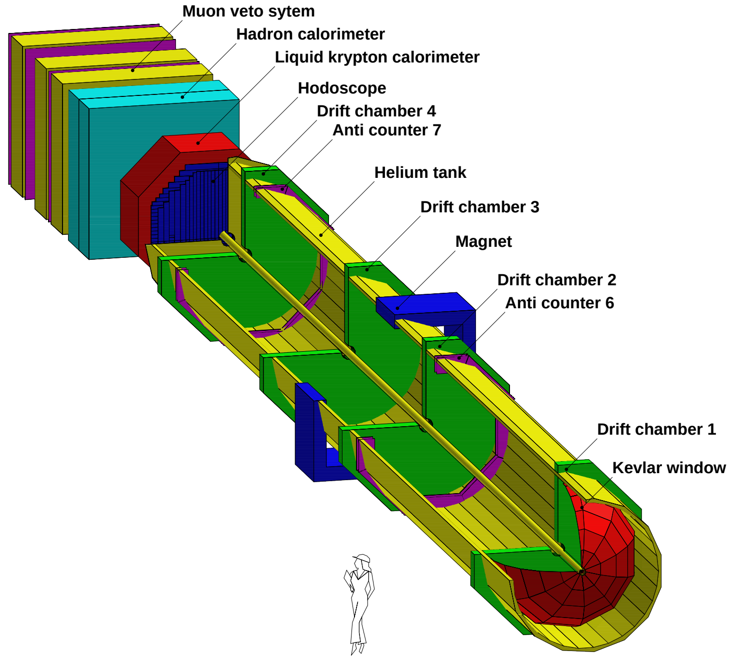

Figure 1: The NA48 detector.

indirect (ϵ) and direct(ϵ') modes of CP non-conservation and its magnitude is about 2×10^{-3}. Recent measurements of $|\eta_{+-}|$ by the KTeV [6] and KLOE [7] experiments give results which are not in good agreement with previous published values. A precise determination of $|\eta_{+-}|$ is therefore important to clarify the experimental situation.

The method used by the NA48 experiment consists in measuring precisely the ratio

$$R = BR(K_L \to \pi^+\pi^-)/BR(K_L \to \pi e \nu) \tag{1}$$

and to extract $|\eta_{+-}|$ computed as

$$|\eta_{+-}| = \sqrt{\frac{BR(K_L \to \pi^+\pi^-)}{BR(K_S \to \pi^+\pi^-)} \frac{\tau_{K_S}}{\tau_{K_L}}} \tag{2}$$

using the best single K_S [8] and K_L [9] lifetime measurements and the normalisations $BR(K_L \to \pi e \nu)$ [10] and $BR(K_S \to \pi^+\pi^-)$ [11] obtained independently by the KLOE, KTeV and NA48 experiments.

The measurement of $|\eta_{+-}|$ took place in 1999 during a 2-day run with a pure, low intensity K_L beam produced at the CERN 450 GeV/c SPS. About 80×10^6

2-track events were recorded. This statistics allowed to select 47k reconstructed $K_L \to \pi^+\pi^-$ with a small background contribution of 0.5% originating mainly from the dominant $K_L \to \pi^+\pi^-\pi^0$ and K_L semileptonic decays. As far as the normalisation channel $K_L \to \pi e \nu$ (K_{e3}) is concerned, the event selection relied on the very good e/π separation obtained by comparing the cluster energy in the LKr calorimeter with the momentum of the associated track in the magnetic spectrometer. About 5×10^6 good K_{e3} events were reconstructed with a background level of 0.5%.

The ratio R was measured to be $R = (4.835 \pm 0.022_{stat} \pm 0.016_{syst}) \times 10^{-3}$ yielding the value $(1.941 \pm 0.019) \times 10^{-3}$ for the $K_L \to \pi^+\pi^-$ branching ratio. This result takes into account radiative corrections in which the inner bremsstrahlung component (IB) is included but the CP conserving direct emission process (DE) subtracted. Finally, using the experimental inputs described above, the obtained value for the $|\eta_{+-}|$ parameter was found to be $(2.223 \pm 0.012) \times 10^{-3}$ in very good agreement with the recent measurements of KLOE and KTeV but in contradiction with the published values in PDG 2004 [12] (Figure 2).

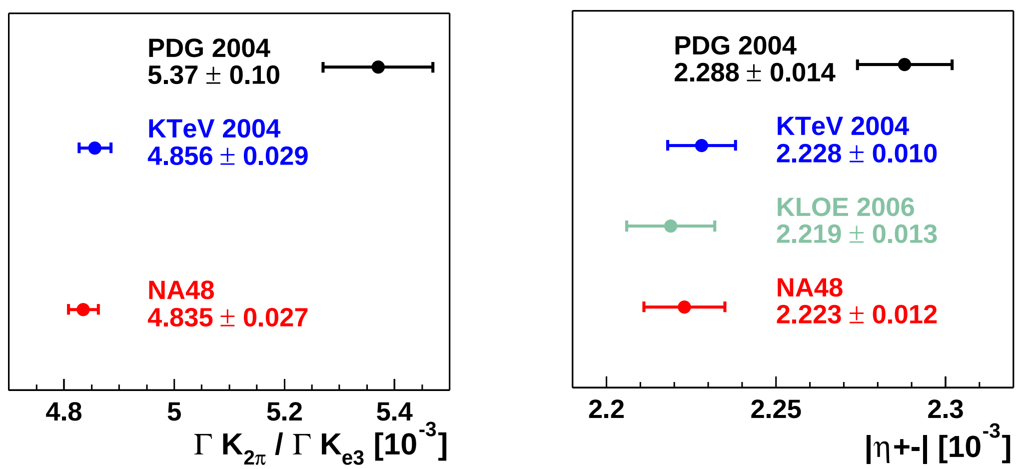

Figure 2: Comparisons for the R (left) and $|\eta_{+-}|$ (right) values between experiments and PDG 2004 [12].

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

CP violation in $K^\pm \to 3\pi$ decays can be investigated by comparing the Dalitz plot distributions for K^+ and K^-. The matrix element for such decays is parametrized by

$$|M(u,v)|^2 = 1 + g\,u + h\,u^2 + k\,v^2 + ... \tag{3}$$

where u and v are kinematical variables which are related, in the kaon centre-of-mass system, to the odd pion energy and to the energy difference between the two even pions, respectively. If CP invariance holds, the parameters g, h and k are identical for K^+ and K^- decays. Since h and k are much smaller than g, the charge asymmetry parameter

$$A_g = \frac{g^+ - g^-}{g^+ + g^-} = \frac{\Delta g}{2g} \tag{4}$$

where g^+ and g^- are the linear slope parameters for K^+ and K^- decays, respectively, provides a measurement of CP violation that can be accessible to experiments. Present experimental determinations of A_g [13] have uncertainties that are one to two orders of magnitude larger than Standard Model (SM) calculations ($A_g^{SM} < 10^{-4}$) [14]. Some extensions to the SM predict, however, larger asymmetry values which can reach a few 10^{-4} [15].

The design goal of the NA48/2 experiment is to measure the linear slope asymmetries for $K^\pm \to \pi^\pm\pi^+\pi^-$ and $K^\pm \to \pi^\pm\pi^0\pi^0$ decays with accuracies $\delta A_g < 2.2 \times 10^{-4}$ and $\delta A_g^0 < 3.5\times10^{-4}$, respectively. In order to reach such precisions, more than 2×10^9 $K^\pm \to \pi^\pm\pi^+\pi^-$ and about 10^8 $K^\pm \to \pi^\pm\pi^0\pi^0$ reconstructed events are needed.

The experimental method is based on the use of intense and simultaneous $K^\pm$ beams, superimposed in space, with narrow momentum spectra ($P_K = 60 \pm 3\,\mathrm{GeV/c}$). To keep systematic uncertainties at the required level, averaged K^+ and K^- acceptances are equalized by frequently alternating the magnet polarities of the kaon beam lines and the spectrometer. The measurement of charge asymmetries was obtained from slopes of normalized u-distribution ratios: $R(u) = N^+(u)/N^-(u) \propto (1 + \Delta g\,u)$. In this way, induced instrumental asymmetries can originate only from time-varying charge asymmetric and u-dependent effects.

Charged kaon beams were produced by 400 GeV/c protons impinging on a Be target. The momentum selection and cleaning of the charged beams was performed by two achromats which allow particles of both charges to travel simultaneously. The charged beams were focused towards the NA48 detector located downstream of a 114 m decay volume contained in vacuum. The instantaneous rate of beam particles (mainly pions) was about 20 MHz for a proton intensity of 7×10^{11} per SPS pulse.

The selection of $K^\pm \to \pi^\pm\pi^+\pi^-$ events was based only on hodoscope and magnetic spectrometer information. At the trigger level, fast signals from the scintillator hodoscope and hits from the spectrometer drift chambers were used to identify kaon decays. In the offline analysis, good events were selected by reconstructing 3-track vertices in the decay volume. The geometrical acceptance for $K^\pm \to 3\pi^\pm$ was limited mostly by the beam pipe traversing the drift chambers. About 3.11×10^9 total events were reconstructed in the 2003 and 2004 data samples with negligible background due to $\pi \to \mu\nu$ decays . The ratio of K^+ to K^- decays was about 1.8.

In order to equalize acceptances for K^+ and K^- decays, the quadruple product of K^+ to K^- ratios was performed:

$$R(u) = R_{UR}(u) \times R_{UL}(u) \times R_{DR}(u) \times R_{DL}(u) \propto (1 + 4\Delta g\, u) \qquad (5)$$

where U and D denote the positions (up or down) of the K^+ beam in the achromats while R and L correspond to the deflections (right or left) of positive particles in the magnetic spectrometer. The slope difference Δg was obtained by fitting the $R(u)$ distribution which is sensitive only to the time variation of asymmetries in experimental conditions with caracteristic time smaller than the corresponding field alternation periods. The field polarity of the achromats was alternated every week while for the magnetic spectrometer, the field alternation occured on the day basis, in 2003, and every 3 hours, in 2004. A complete two-week cycle of data taking involving all four field alternations defined a super-sample.

Data were collected in nine super-samples. Time variation of acceptance due to slight transverse displacements ($< 2\,\mathrm{mm}$) of the kaon beams was reduced by applying as a function of time, kaon charge and momentum, geometrical cuts around the beam pipe, centered on averaged beam positions. Moreover, a fine tuning of the calibration of the spectrometer momentum scale and of the relative drift chambers alignment was obtained by imposing the nominal kaon mass value to reconstructed events.

Using Equation 5, the fitted Δg value over the nine super-samples was found to be:

$$\Delta g = (0.6 \pm 0.7_{stat} \pm 0.4_{trig} \pm 0.5_{syst}) \times 10^{-4}, \qquad (6)$$

consistent with zero. Table 1 gives the different sources of systematic uncertainties on the Δg measurement. The first two uncertainties are purely statistical and include contributions from trigger efficiency measurements obtained from downscaled control events. The purely systematic uncertainty on Δg was estimated to be 0.5×10^{-4} with contributions coming from acceptance and beam geometry, spectrometer alignment and magnetic field, accidental activity and background as well as from the fit method and u-resolution. The systematic uncertainty associated to trigger effects was determined to be 0.4×10^{-4}

Using the value $g = -0.21134 \pm 0.00017$ [16], the final result obtained for the asymmetry parameter is:

$$A_g = (-1.5 \pm 2.1) \times 10^{-4}, \qquad (7)$$

in agreement with Standard Model predictions. This result has a precision which is about 20 times better than previous experiments. However, no evidence for New Physics was found.

Following the same analysis approach, the asymmetry A_g^0 for $K^\pm \to \pi^\pm\pi^0\pi^0$ decays was also measured during the 2003 and 2004 run periods. The selection and

Source of systematic uncertainty	Δg (10^{-4})
Spectrometer alignment	$\pm$ 0.1
Spectrometer magnetic field	$\pm$ 0.3
Beam geometry and stray fields	$\pm$ 0.2
Resolution and fitting	$\pm$ 0.2
Accidental activity	$\pm$ 0.2
Total systematics	$\pm$ 0.5
Level 1 trigger efficiency	$\pm$ 0.3
Level 2 trigger efficiency	-0.1 $\pm$ 0.3

Table 1: Systematic uncertainties on Δg

reconstruction of the events were mainly based on the magnetic spectrometer and the LKr electromagnetic calorimeter informations. Decays into $\gamma\gamma$ were considered for the two neutral pions. This allowed to reconstruct the longitudinal kaon vertex position from the energy and the position of the showers measured in the LKr calorimeter. In order to avoid charge-asymmetric biases, no geometrical information from the $\pi^\pm$ track was used. After applying time and quality cuts on the clusters and the charged track and after imposing requirements on the reconstructed kaon momentum and the 3π invariant mass, a total of 9.13×10^7 good $K^\pm \to \pi^\pm\pi^0\pi^0$ events, subdivided into 7 super-samples, were identified. Their 3π invariant mass resolution was measured to be $0.9\,\mathrm{MeV/c^2}$.

The difference in the linear slope parameters for K^+ and K^- decays into $\pi^\pm\pi^0\pi^0$ was found to be

$$\Delta g^0 = (2.2 \pm 2.1_{stat} \pm 0.6_{syst}) \times 10^{-4} \tag{8}$$

Table 2 gives the various contributions to the systematic uncertainty on Δg^0. Despite a factor of about 34 less events in the $K^\pm \to \pi^\pm\pi^0\pi^0$ modes as compared to the $K^\pm \to \pi^\pm\pi^+\pi^-$ channels, the statistical precision on A_g^0 was found to be similar to the A_g one, owing to the larger magnitude of the g^0 linear slope parameter. Using the value $g^0 = 0.626 \pm 0.007$ [17], the final result for the A_g^0 asymmetry is:

$$A_g^0 = (1.8 \pm 1.8) \times 10^{-4} \tag{9}$$

consistent with Standard Model predictions.

Source of systematic uncertainty	Δg^0 (10^{-4})
Overlap of LKr showers	$\pm$ 0.5
Level 1 HOD trigger efficiency	$\pm$ 0.1
Level 1 LKR trigger efficiency	$\pm$ 0.1
Level 2 trigger efficiency	$\pm$ 0.3
Stray magnetic fields	$\pm$ 0.1
Accidental activity	$\pm$ 0.2
Total systematics	$\pm$ 0.6

Table 2: Systematic uncertainties on Δg^0

4 $K^{\pm} \to \pi^{\pm} e^{+} e^{-} \gamma$ decays

The NA48/2 Collaboration has recently observed for the first time the radiative $K^{\pm} \to \pi^{\pm} e^{+} e^{-} \gamma$ decay with a sample of 92 candidates and a background contamination of 6.1 ± 2.1 events. This process is similar to the $K^{\pm} \to \pi^{\pm} \gamma\gamma$ decay with one of the two photons internally converting into an $e^{+}e^{-}$ pair. It can be described within the framework of Chiral Perturbation Theory (χPT) in which the $O(p^4)$ dominant pion and kaon loops lead to preferred $m(e^{+}e^{-}\gamma)$ values above $2m_{\pi^+}$. Predictions from χPT for the $K^{\pm} \to \pi^{\pm} e^{+} e^{-} \gamma$ branching ratio are in the $(0.9-1.7) \times 10^{-8}$ range [18].

The NA48/2 experiment has obtained a preliminary measurement of the $K^{\pm} \to \pi^{\pm} e^{+} e^{-} \gamma$ branching ratio using a sample of 14.1×10^6 $K^{\pm} \to \pi^{\pm}\pi^{0}$ decays as normalisation: $BR(K^{\pm} \to \pi^{\pm} e^{+} e^{-} \gamma) = (1.27 \pm 0.14_{stat.} \pm 0.05_{syst.}) \times 10^{-8}$. The invariant $m(e^{+}e^{-}\gamma)$ mass distribution is found to peak above $2m_{\pi^+}$, as predicted by χPT (Figure 3).

5 Radiative $K^{\pm} \to \pi^{\pm}\pi^{0}\gamma$ decays

The radiative $K^{\pm} \to \pi^{\pm}\pi^{0}\gamma$ decays can be described by two main processes: the Inner bremsstrahlung (IB) amplitude and the Direct Emission (DE) one. While the IB amplitude is the dominant term and involves electric transitions (E1, E3,...), the DE amplitude contains both magnetic (M) and electric (E) transitions and is described by non-trivial physics (e.g. VMD) [19]. The present experimental situation suggests that magnetic transitions are the dominant contribution to the DE amplitude. The electric part is accessible through the interference between the IB and DE amplitudes

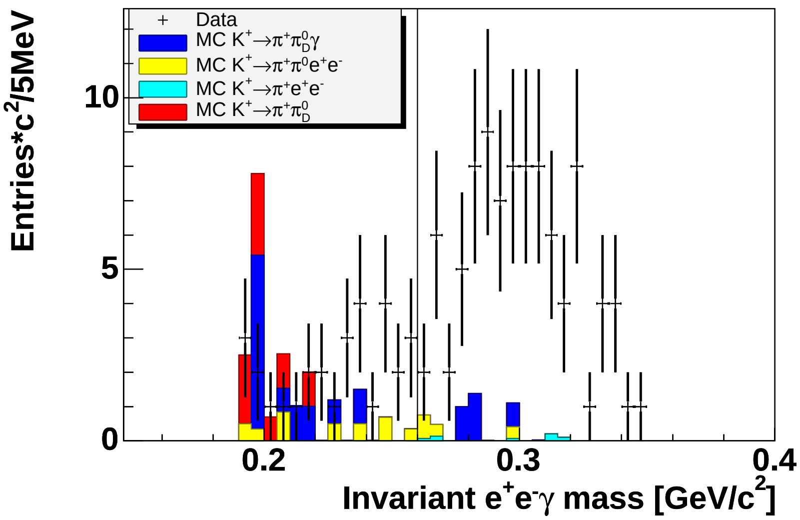

Figure 3: Invariant $e^+e^-\gamma$ mass distribution for $K^\pm \to \pi^\pm e^+e^-\gamma$ candidates. The vertical line represents the lower mass selection cut. The various background contributions obtained from MC calculations are shown in colour.

in the differential decay width:

$$\frac{d\Gamma^\pm}{dW} \simeq \left(\frac{d\Gamma^\pm}{dW}\right)_{IB}\left[1+2\left(\frac{m_\pi}{m_K}\right)^2 W^2|E|cos(\delta_1^1-\delta_0^2\pm\phi)+\left(\frac{m_\pi}{m_K}\right)^4 W^4(|E|^2+|M|^2)\right] \tag{10}$$

where

$$W^2 = \frac{(P_K\cdot P_\gamma)(P_\pi\cdot P_\gamma)}{(m_K m_\pi)^2} \tag{11}$$

with P_K, P_π and P_γ, the four-momenta of the kaon, the charged pion and the photon, respectively, and m_K, m_π, the charged pion and kaon masses, respectively. In the right-hand side of Equation 10, the first term corresponds to the IB contribution, the second one is the interference term (INT) and the third term gives the DE contribution. Each contribution to the differential decay rate in Equation 10 exhibits a characteristic dependence of the event distribution as a function of W.

Experimentally, the INT term has not been measured yet. The IB and DE contributions to the $K^\pm \to \pi^\pm\pi^0\gamma$ branching ratio for c.m. $\pi^\pm$ kinetic energies $T^*_{\pi^\pm}$ between 55 and 90 MeV are $(2.75\pm0.15)\times10^{-4}$ and $(4.4\pm0.7)\times10^{-6}$, respectively [17]. The NA48/2 experiment has obtained the first evidence for interference between Inner Bremsstrahlung and Direct Emission amplitudes by measuring the differential decay width in the extended $0 < T_{\pi^\pm} < 80$ MeV region for $0.2 < W < 0.9$ where the sensitivity to the INT term is increased. The $\pi^\pm\pi^0\gamma$ invariant mass for reconstructed

$K^{\pm} \to \pi^{\pm}\pi^0\gamma$ candidates is shown in Figure 4. The Maximum Likelihood (ML) analysis of the W spectrum, based on 124 k events, gives as a preliminary result:

$$Frac(DE)_{0<T^*_{\pi^{\pm}}<80\,MeV} = (3.35 \pm 0.35_{stat} \pm 0.25_{syst})\% \tag{12}$$

and the non-zero interference contribution

$$Frac(INT)_{0<T^*_{\pi^{\pm}}<80\,MeV} = (-2.67 \pm 0.81_{stat} \pm 0.73_{syst})\%. \tag{13}$$

The ML fit gives the correlation coefficient $\rho = -0.92$ between the two parameters Frac(DE) and Frac(INT). The systematic uncertainties quoted above are dominated by the control of trigger inefficiencies.

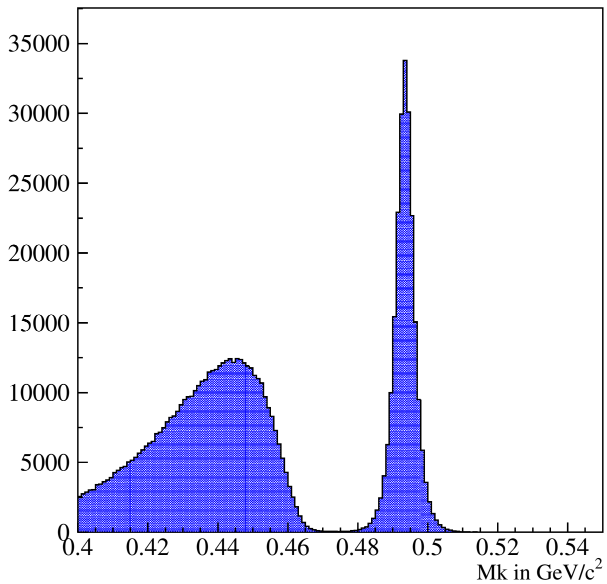

Figure 4: Invariant $\pi^{\pm}\pi^0\gamma$ mass distribution. The events corresponding to $K^{\pm} \to \pi^{\pm}\pi^0\gamma$ decays are peaked at the kaon mass value. Events located at lower mass are due to $K^{\pm} \to \pi^{\pm}\pi^0\pi^0$ decays.

6 Test of $e - \mu$ universality in $K^{\pm} \to l^{\pm}\nu$ decays

The experimental investigation of $K^{\pm} \to e^{\pm}\nu_e$ (K_{e2}) and $K^{\pm} \to \mu^{\pm}\nu_{\mu}$ ($K_{\mu 2}$) decays can provide a stringent test of $e - \mu$ universality. In the Standard Model, the ratio R_K of the K_{e2} to $K_{\mu 2}$ decay widths can be expressed in terms of the K, e and μ masses and a small contribution δR_{QED} due to radiative corrections:

$$R_K = \frac{\Gamma(K \to e\nu(\gamma))}{\Gamma(K \to \mu\nu(\gamma))} = \frac{m_e^2}{m_\mu^2}\left(\frac{m_K^2 - m_e^2}{m_K^2 - m_\mu^2}\right)^2 (1 + \delta R_{QED}) \tag{14}$$

Since δR_{QED} can be determined with accuracy ($\sim -4\%$ for $K^{\pm}$), the SM gives a very precise determination of R_K:

$$R_K^{SM} = (2.477 \pm 0.001) \times 10^{-5} \text{ [20].} \tag{15}$$

From the experimental point of view, the current PDG average value of R_K is

$$R_K = (2.45 \pm 0.11) \times 10^{-5} \text{ [17],} \tag{16}$$

at small variance with the SM calculation.

It was pointed out, however, by A. Masiero et al. [21] that the ratio R_K could substantially differ from the Standard Model expectation in the case of Super Symmetric (SUSY) Lepton Flavor Violation (LFV). These authors have predicted, in the framework of low-energy minimal SUSY extensions of the SM (MSSM) with R parity, that deviations up to 3% could be expected in the case of LFV and for some values of the model parameters (e.g. $tan\beta \sim 50$ and $M_{H^+} \sim 500\,\mathrm{GeV/c^2}$) not yet excluded by present experiments.

In 2003 and 2004, the NA48/2 experiment collected data for the measurement of the R_K ratio with a significantly better precision than the current experimental value. The good performances of the NA48 magnetic spectrometer and of the LKr calorimeter allowed more than 8000 K_{e2} events in total to be reconstructed. The main background contribution to the rare K_{e2} decay is the dominant $K_{\mu 2}$ channel with a muon loosing almost all its energy in the electromagnetic calorimeter. The preliminary results obtained by NA48/2 are:

$$R_K^{2003} = (2.416 \pm 0.043_{stat} \pm 0.024_{syst}) \times 10^{-5} \tag{17}$$

and

$$R_K^{2004} = (2.455 \pm 0.045_{stat} \pm 0.041_{syst}) \times 10^{-5} \tag{18}$$

with 4670 and 3407 K_{e2} identified events, respectively.

In 2007, the P326/NA62 Collaboration at CERN performed a dedicated run with an improved set-up to reach a relative precision of about 0.3% on the determination of the R_K ratio. The expected number of collected K_{e2} events is 150 k. This high-statistics measurement, whose analysis is in progress, should provide some sensitivity to LFV phenomena in SUSY.

7 The future of NA48

Since the end of the NA48/2 phase, a new collaboration at CERN, named NA62, has been formed. Its main goal is the study at the CERN SPS the rare decay $K^+ \rightarrow \pi^+ \nu \overline{\nu}$ with a 10^{-12} sensitivity per event on the branching ratio. As it proceeds through Flavor Changing Neutral Current effects (FCNC) and is CKM suppressed, the $K^+ \to \pi^+\nu\overline{\nu}$ decay mode is sensitive to New Physics. In addition, this decay is very clean from the theoretical point of view since short distance contributions dominate. Moreover, the hadronic matrix element can be precisely determined from the well measured $K^+ \to \pi^0 l^+\nu$ decay. The SM prediction for the branching ratio of the $K^+ \to \pi^+\nu\overline{\nu}$ decay is:

$$BR(K^+ \to \pi^+\nu\overline{\nu}) = (8.0 \pm 1.1) \times 10^{-10} \text{ [17]}. \tag{19}$$

The NA62 experiment aims at observing of the order of 100 events with a background level of about 10%. It will use the intense proton beam from the SPS and rely on the in-flight kaon decay technique. The average momentum of the produced kaon beam is foreseen to be 75 GeV/c. The NA62 experiment will use most of the existing NA48 infrastructure but, clearly, new state-of-the-art detectors will be needed in order to reach a 10^{12} background rejection (e.g. from $K_{\mu 2}$ and $K_{\pi 2}$ decays) as well as excellent particle ID. These include a 800MHz beam tracker for kaon identification, a CEDAR to separate pions, kaons and protons in the hadron beam, a tracker with a double magnetic spectrometer, a RICH detector for $\pi/\mu/e$ separation and γ/μ veto detectors. Figure 5 shows a schematic view of the future NA62 detector. The R&D phase with the design, construction and tests of detector prototypes is in progress. The NA62 experiment could start taking data in 2011.

8 Conclusion

Over the past decade, the NA48 experiment at CERN has carried out an extensive physics programme devoted to the study of CP violation and rare decays in both neutral and charge kaon sectors. Kaon experiments still continue to produce very interesting and exciting results in particle physics. They contribute to our understanding of symmetries in Nature and provide fundamental ingredients to the present theory. The near future and very challenging $K^+ \to \pi^+\nu\overline{\nu}$ experiment at CERN (NA62) provides a real opportunity to discover new physics beyond the Standard Model.

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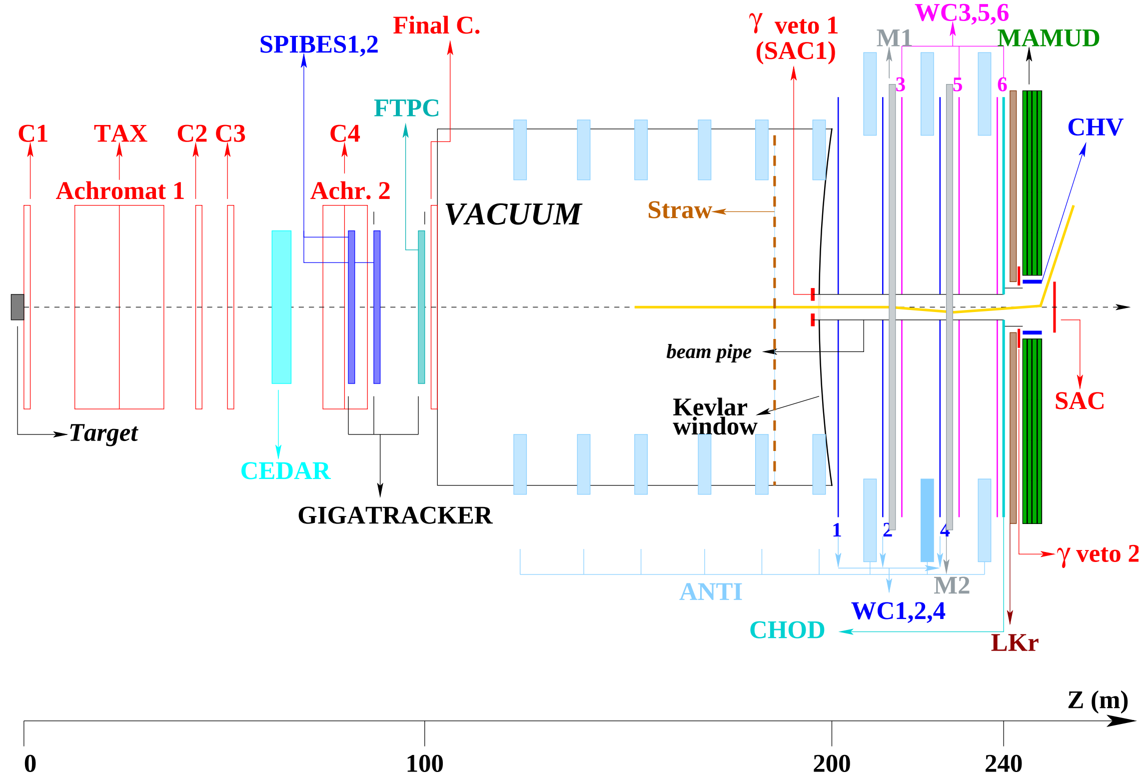

Figure 5: The NA62 proposed detector layout.

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