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Precision measurement of the charged Ke4(+-) decay (K+- to pi+ pi- e+- nu) and study of the charged Ke4(00) decay (K+- to pi0 pi0 e+- nu)

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The NA48/2 collaboration has analyzed 1.13 million charged kaon decays Ke4(+-) to pi+ pi- e nu leading to an improved determination of the Branching Fraction at percent level precision and detailed form factor studies. The hadronic form factors in the S- and P-wave and their variation with energy are obtained concurrently with the phase difference between the S- and P-wave states of the pi pi system. The latter measurement allows a precise determination of a00 and a02, the I=0 and I=2 S-wave pi pi scattering lengths. A combination of this result with another NA48/2 measurement, obtained in the study of K± →pi0 pi0 pi± decays, brings a further improved determination of a00 and the first precise experimental measurement of a02. These measurements bring new inputs to low energy QCD calculations and are crucial tests of existing predictions from Chiral Perturbation Theory and lattice QCD calculations.

The NA48/2 collaboration has accumulated ~66000 semi-leptonic charged kaon decays Ke4(00) to pi0 pi0 e nu, increasing the world available statistics by several orders of magnitude. Background contamination at the one percent level and very good pi0 reconstruction allow the first accurate measurement of the Branching Fraction and decay Form Factor. The achieved precision makes possible the observation of small effects such as a deficit of events at low pi0 pi0 invariant mass which can be explained by charge exchange rescattering in the pi pi system below the 2 m(pi+) threshold.

Future prospects include the observation of several ~1000 decays in similar muonic modes Kmu4(00) (never observed) and Kmu4(+-) (7 events observed). Such poorly known modes could be studied also in the forthcoming NA62 experiment currently under construction.

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