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Investigation of atoms, consisting of $\pi^+\pi^-$, $K^+\pi^-$ and π^+K^- at DIRAC experiment in order to check predictions of QCD at low energies

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The lifetime of $\pi^+\pi^-$ mesons and difference of S-wave pion-pion scattering lengths with isospin 0 and 2 have been measured in experiment DIRAC at CERN with accuracy 4.3% on the base of 21000 atomic pairs collected in 2001-2003.
In 2010 the DIRAC collaboration has finished data taking in order to observe $K^+\pi^-$ and π^+K^- and to make estimation of their lifetime. This opens possibility to check prediction of QCD at low energy for S-wave pion-kaon scattering lengths.
Also essential amount of pi+pi- atomic pairs ($\sim$22000) was taken. Now they used for calibration of the experimental setup, but in future we intend to improve accuracy of pion-pion scattering length measurement. In 2012 data sample for search of long-lived pi+pi- atoms has been collected. Observation of such atoms allows to investigate possibility to measure Lamb shift in pi+pi- atoms. DIRAC experiment has been performed at PS CERN (proton beam energy 24 GeV). Results of simulation shows that essential gain in yield of pi+pi- and piK atoms could be achieved if measurement would be performed at 450 GeV proton beam (SPS CERN).

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1. Introduction

Chiral Perturbation Theory (ChPT) describes QCD processes at low energies. In ChPT the effective Lagrangian, which describes the $\pi\pi$ interaction, is an expansion in (even) terms:

$$L_{eff} = L^{(2)}_{(tree)} + L^{(4)}_{(1-loop)} + L^{(6)}_{(2-loop)} + \dots . \tag{1.1}$$

Pion-pion $S-$wave scattering lengths with isospin 0 and 2 have been predicted, using 2-loop terms and Roy-Steiner equation, to be [1]:

$$a_0 = 0.220 \pm 2.3\%,\ a_2 = -0.0444 \pm 2.3\%,\ a_0 - a_2 = 0.265 \pm 1.5\%. \tag{1.2}$$

These results (precision) depend on the low-energy constants (LEC) l_3 and l_4. Because l_3 and l_4 are sensitive to the quark condensate, precision measurements of a_0, a_2 are a way to study the structure of the QCD vacuum. Since 2006 lattice gauge calculations provided values for these l_3 and l_4. Lattice calculations in near future will obtain values of low-energy constants with an accuracy 10%. To check the predicted values of l_3 the experimental relative errors of $\pi\pi$ scattering lengths and their combination are to be at the level $0.2 \div 0.3\%$. It means that improvement of experimental accuracy for $\pi\pi$ scattering lengths is an actual.

Pionium ($A_{2\pi}$) is a hydrogen-like atom consisting of π^+ and π^- mesons. Atomic properties of $A_{2\pi}$ are:

$$E_B = -1.86 keV,\ r_B = 387 Fm,\ p_B \approx 0.5 MeV/c.$$

Here E_B is bounding energy, r_B and p_B are Bohr radius and Bohr momentum, correspondingly. The $\pi^+\pi^-$ atom decays by strong interaction mainly into $\pi^0\pi^0$. The branching ratio of the alternative decay mode $A_{2\pi} \to 2\gamma$ is at the level of $4 \cdot 10^{-3}$. There is a relation [2, 3] between the width of $A_{2\pi}$ decay $\Gamma_{1s,2\pi^0}$ and $\pi\pi$ scattering lengths for isospin 0 and 2 (Eq. 1.2):

$$\Gamma_{1s,2\pi^0} = R \cdot |a_0 - a_2|^2. \tag{1.3}$$

ChPT at next-to-leading order in isospin breaking provides coefficient R at Eq. (1.3) is known with accuracy $\Delta R/R = 1.2\%$ [4]. It allows to predict $A_{2\pi}$ lifetime to be:

$$\tau = (2.9 \pm 0.1) \times 10^{-15} s \tag{1.4}$$

Taking into account Eq. (1.3), a measurement of the pionium lifetime with 6% precision provides, in a model independent way, the difference between the $S-$wave $\pi\pi$ scattering $|a_0 - a_2|$, with 3% accuracy. Therefore, such a measurement will be a sensitive check of ChPT prediction and understanding of chiral symmetry breaking in QCD.

πK-atom ($A_{\pi K}$) is a hydrogen-like atom consisting of K^+ (K^-) and π^- (π^+) mesons. Its features are:

$$E_B = -2.9 keV,\ r_B = 248 Fm,\ p_B = 0.8 MeV/c.$$

The K-atom lifetime (ground state 1S), $\tau = 1/\Gamma$ is defined by the annihilation process into $K^0\pi^0$:

$$A_{K^+\pi^-} \to \pi^0 K^0,\, A_{\pi^+K^-} \to \pi^0 \overline{K}^0 .$$

Width of $A_{\pi K}$ decay $\Gamma_{1s,K^0\pi^0}$ is proportional to squared difference of S-wave πK scattering lengths for isospin 1/2 and 3/2 [5]:

$$\Gamma_{1s,K^0\pi^0} = R_K |a_0^{1/2} - a_0^{3/2}|^2, \frac{\sigma_{R_K}}{R_K} = 2\%. \tag{1.5}$$

At present there are two predictions for pion-kaon scattering lengths. ChPT in 1-loop approximation predicts $S-$wave scattering lengths to be [6, 7]:

$$a_{1/2} = 0.19 \pm 0.2, a_{3/2} = -0.05 \pm 0.02, a_{1/2} - a_{3/2} = 0.23 \pm 0.01 .$$

ChPT with $L^{(2)}, L^{(4)}, L^{(6)}$ in 2-loop approximation predicts $S-$wave scattering length difference to be [8]:

$$a_{1/2} - a_{3/2} = 0.267 .$$

Another prediction for scattering length difference have been obtained, using Roy-Steiner equations [9]:

$$a_{1/2} - a_{3/2} = 0.269 \pm 0.015 . \tag{1.6}$$

With prediction from Eq. (1.6) lifetime of $A_{\pi K}$ in ground state estimated to be:

$$\tau = (3.7 \pm 0.4) \times 10^{-15} . \tag{1.7}$$

From Eq. (1.5) it is seen that a measurement of $A_{\pi K}$ lifetime with accuracy 20% allows to measure pion-kaon scattering lengths difference with accuracy 10%.

The measurement of the $S-$wave πK scattering lengths would test our understanding of the chiral $SU(3)_L \times SU(3)_R$ symmetry breaking of QCD (u, d and s quarks), while the measurement of $\pi\pi$ scattering lengths checks only the $SU(2)_L \times SU(2)_R$ symmetry breaking (u, d quarks). This is the principal difference between $\pi\pi$ and πK scattering. Experimental data on the K low-energy phases are absent now.

2. Method of $\pi^+\pi^-$ and πK atom observation and investigation

The $A_{2\pi}$ are produced by Coulomb interaction in the final state of $\pi^+\pi^-$ pairs generated in proton-target interactions from fragmentation and strong decay ("short-lived" sources). For this cases the region of production being small as compared to the Bohr radius of the atom [10].

Other $\pi^+\pi^-$ pairs from short-lived sources are generated in free state. Such pairs ("Coulomb pairs") are affected by Coulomb interaction, too. The number of produced atoms (N_A) is proportional to the number of "Coulomb pairs" (N_C) with low relative momentum ($N_A = K \cdot N_C$). The coefficient K is calculated with an accuracy better than 1%.

Also there are $\pi^+\pi^-$ pairs from long-lived sources (electromagnetically or weakly decaying mesons or baryons: $\eta, \eta', K_s^0, \ldots$). Such pairs, which are not affected by final state interaction, are named "non-Coulomb pairs".

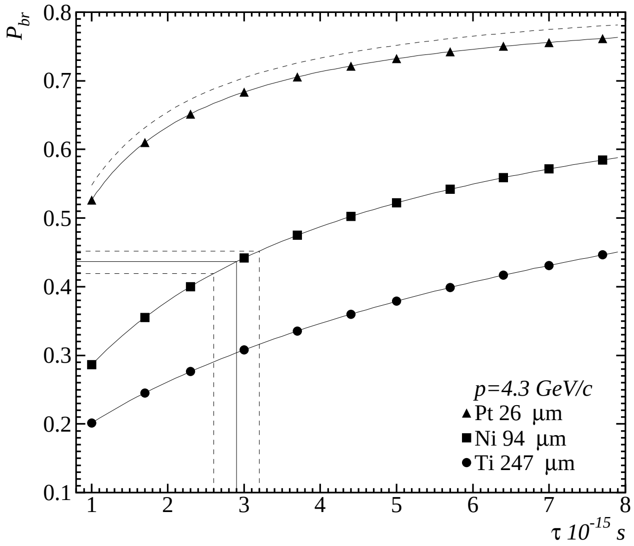

Figure 1: *Dependence of the breakup probability $P_{\rm br}$ on $A_{2\pi}$ lifetime for three targets used in the DIRAC experiment: platinum of 26 μm, nickel of 94 μm and titanium of 247 μm thickness.*

Another type of background is "accidental pairs" consisted of pions generated in two different proton-nucleus. They are also not affected by final state interaction.

After production, $A_{2\pi}$ travel through the target and some of them are broken up due to their interaction with matter: "atomic pairs" are produced, characterized by small pair c.m. relative momentum $Q < 3$ MeV/c. These pairs are detected by the DIRAC setup. Other atoms annihilate into $\pi^0\pi^0$. Using experimentally measured number of "Coulomb" pairs it is possible to measure breakup probability $P_{\rm br}(\tau) = n_A/N_A = n_A/(K \cdot N_C)$.

Breakup probability is defined by a two competition process: annihilation and breakup. Probabilities of breakup (ionisation), excitation, de-excitation at interaction of pionium with atoms of the a target matter and annihilation (taking into account current atomic state of $A_{2\pi}$) are calculated for any path length interval. It allows to define a system of differential transport equations [11, 12]. Solving of this system has provided the dependence of $P_{\rm br}$ on the lifetime τ. In Fig. 1 the lifetime dependence of $P_{\rm br}$ is presented for three different targets used in the DIRAC experiment. The nickel target provides the best statistical accuracy for the same running time.

The same method is applied to πK atoms. In Fig 2 dependence of $A_{\pi K}$ breakup probability is shown for two nickel target are used in experiment.

3. DIRAC setup

DIRAC setup was created to detect $\pi^+\pi^-$ with small relative momenta [13]. In 2004-2006 it has been modified in order to detect both $\pi^+\pi^-$ and πK pairs from broken atoms. New detectors for particle identification have been added: Cherenkov counters with heavy gas and Aerogel. Taking into account kinematic of πK "atomic pairs", new detectors cover only internal parts of each arm (see Fig. 3).

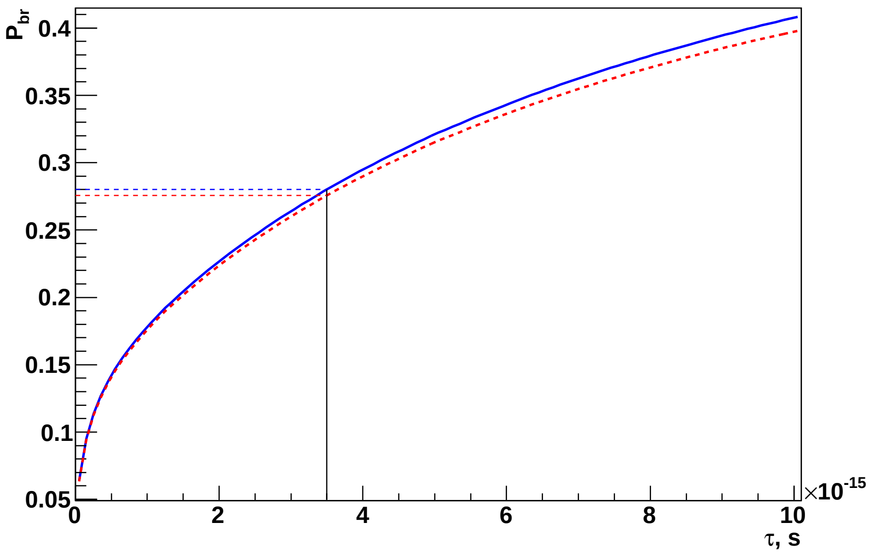

Figure 2: *Dependence of the breakup probability $P_{\rm br}$ on $A_{\pi K}$ lifetime for 108μm (solid blue line) and 98μm (dashed red line) nickel targets used in the DIRAC experiment with an example how lifetime could be obtained from experimentally measured breakup probability in momentum range* $4.8 \div 7.6$ *GeV/c.*

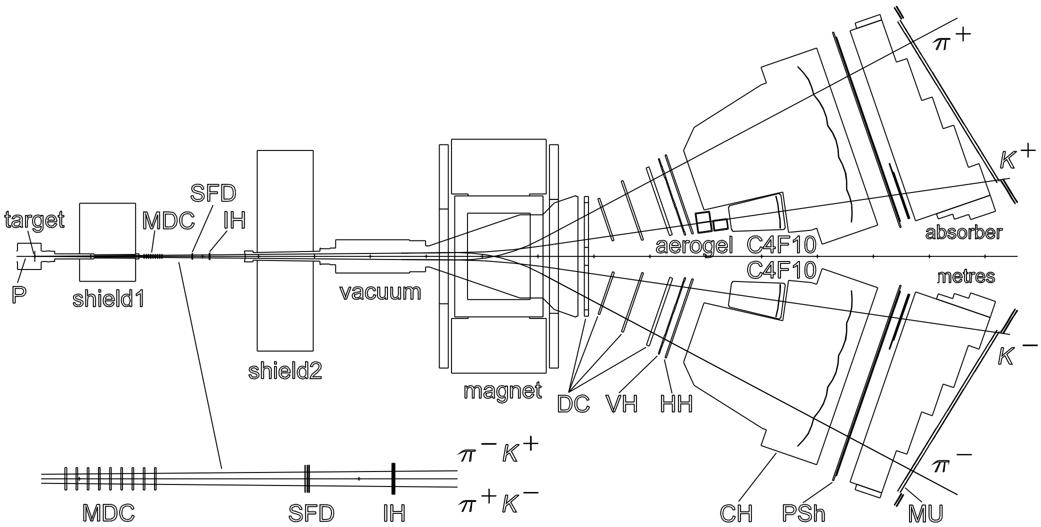

Figure 3: Upgraded DIRAC setup: MDC are microdrift gas chambers, SFD is a scintillating fiber detector and IH is a scintillation ionisation hodoscope. Downstream the spectrometer magnet there are drift chambers (DC), vertical (VH) and horizontal (HH) scintillation hodoscopes. Cherenkov detectors contain nitrogen (CH), heavy gas C4F10 and aerogel radiators. Shower detectors (PSh) and scintillation muon detectors (MU).

Properties of coordinate detectors of DIRAC setup provides high resolution for relative momentum Q of pair in pair center of mass system:

$$\sigma_{Q_X} = \sigma_{Q_Y} = 0.5 MeV/c \tag{3.1}$$
$$\sigma_{Q_L}^{\pi^+\pi^-} = 0.5 MeV/c \tag{3.2}$$
$$\sigma_{Q_L}^{\pi K} = 0.9 MeV/c \tag{3.3}$$

It is seen that resolution over relative momentum Q and its projection is compatible with Bohr momentum of corresponded atoms, which character parameter for a width of "atomic" and "Coulomb" pair distributions. This allows to investigate "atomic" and "Coulomb" pairs without big losses in effect-to-background ratio.

Trigger system provides efficiency better than 98% for events in region where effect is investigating: $Q_X < 6$ MeV/c, $Q_Y < 4$ MeV/c, $Q_L < 28$ MeV/c and suppress flux of events with high Q by factor more than 7.

4. Published results of $\pi^+\pi^-$ lifetime and scattering lengths

Analysis of data collected by experiment DIRAC in 2001-2003 allows to obtain $A_{2\pi}$ lifetime to be [14]:

$$\tau = (3.15^{+0.20}_{-0.19}|_{stat} \; ^{+0.20}_{-0.18}|_{syst}) fs = (3.15^{+0.28}_{-0.26}|_{tot}) fs\,. \tag{4.1}$$

It follows with a measurement of pion-pion scattering length difference with an relative accuracy 4.3%:

$$|a_0 - a_2| = 0.2533^{+0.0078}_{-0.0080}|_{stat} \; ^{+0.0072}_{-0.0077}|_{syst} = 0.2533^{+0.0106}_{-0.0111}\%|_{tot}\,. \tag{4.2}$$

Alternative way of pion-pion scattering length difference with "cusp-effect". In this approach NA48/2 collaboration present value of difference to be [15]:

$$a_0 - a_2 = 0.2571 \pm 0.0048_{stat} \pm 0.0029_{syst} \pm 0.0088_{theor}\,. \tag{4.3}$$

Later these data have been analysed together with an experimental data from K_{e4} decay. It provides the next scattering length difference measurement [16]:

$$a_0 - a_2 = 0.2639 \pm 0.0020_{stat} \pm 0.0015_{syst}\,. \tag{4.4}$$

It is seen that present experiments provide measurement of pion-pion scattering length with compatible accuracy but in different approaches. This increases reliability of ChPT prediction check.

5. Status of $\pi^+\pi^-$ atom investigation

Main aim of current work is investigation of πK atoms. But in parallel essential amount of $\pi^+\pi^-$ pairs have been collected. These pairs are analysed in order to check reconstruction procedure, comparing results with analysis of previous data [14].

Experimental data have been fit by a sum of simulated distributions of “atomic”, “Coulomb” and “non-Coulomb” pairs. Contributions of each distribution are free parameters of fit. Procedure, which creates simulated distributions, takes into account resolution of the setup detectors and multiple scattering in a nickel target, detector planes and partitions in order to reproduces distribution of experimental pairs over relative momentum Q and its projections. Analysis has been done for one-dimensional distribution (over Q_L projection) and for two-dimensional distribution (over Q_L, Q_T). From previous analysis [14] it is known that analysis of one-dimensional and analysis of two-dimensional distributions have different sensitivity to different sources of systematic errors. Comparing them, it is possible to obtain more information about quality of analysis procedure. Results of fit are presented in Figs. 4,5.

In Fig. 4 it is seen that estimation of breakup probability is close to expected value 0.45 [14]. Some difference is induced to an admixture of non-recognized K^+K^- and $p\bar{p}$ pairs which produces systematic shift of breakup probability value, which is different for analysis of one- and two-dimensional distributions. This admixture has not been subtracted because current version of analysis procedure is tuned for πK pairs. For them admixture of K^+K^- and $p\bar{p}$ is not essential. Comparison of Q_T distributions in Fig. 5 shows that procedure finds signal of “atomic pairs” in a region $|Q_L| < 2$ MeV/c, where it is expected, and provides absence of signal in a region $2 < |Q_L| < 15$ MeV/c, where it is not expected. It proves correctness of procedure.

Despite analysis of $\pi^+\pi^-$ pairs is preliminary, it allows to give estimation of accuracy for final result. Table 1 presents accuracy of $\pi\pi$ scattering length measurements based on data collected in 2001-2003 [14], an estimation of accuracy for data collected in 2008-2010 and for common results. Estimations of statistic, systematic and total errors are shown. Systematic error, induced by uncertainty of multiple scattering in a nickel target (main component of systematic error), is separately shown. Now average angle of multiple scattering is known with accuracy 1%. During runs of 2011 and 2012, experimental data for improving accuracy of multiple scattering description have been collected. After analysis of these data, accuracy of average angle of multiple scattering is expected to be 0.5%. Corresponded improvement of systematic and total errors is presented in Table 1.

6. Status of π^+K^- and $K^+\pi^-$ atom investigation

Experimental distributions of π^+K^- and $K^+\pi^-$ pairs have been obtained using criteria on amplitudes of heavy gas and aerogel Cherenkov detectors and on difference of time generation at the target, calculated with time mesured by arms of vertical scintillation hodoscope (VH). Time measurements take into account time-of-flight of pions and kaons from a target to planes of VH. These criteria allow to suppress background of $\pi^+\pi^-$, $p\pi^-$ and $\pi^+\bar{p}$ pairs, generated in one proton-nuclear interaction and admixture of “accidental pairs”.

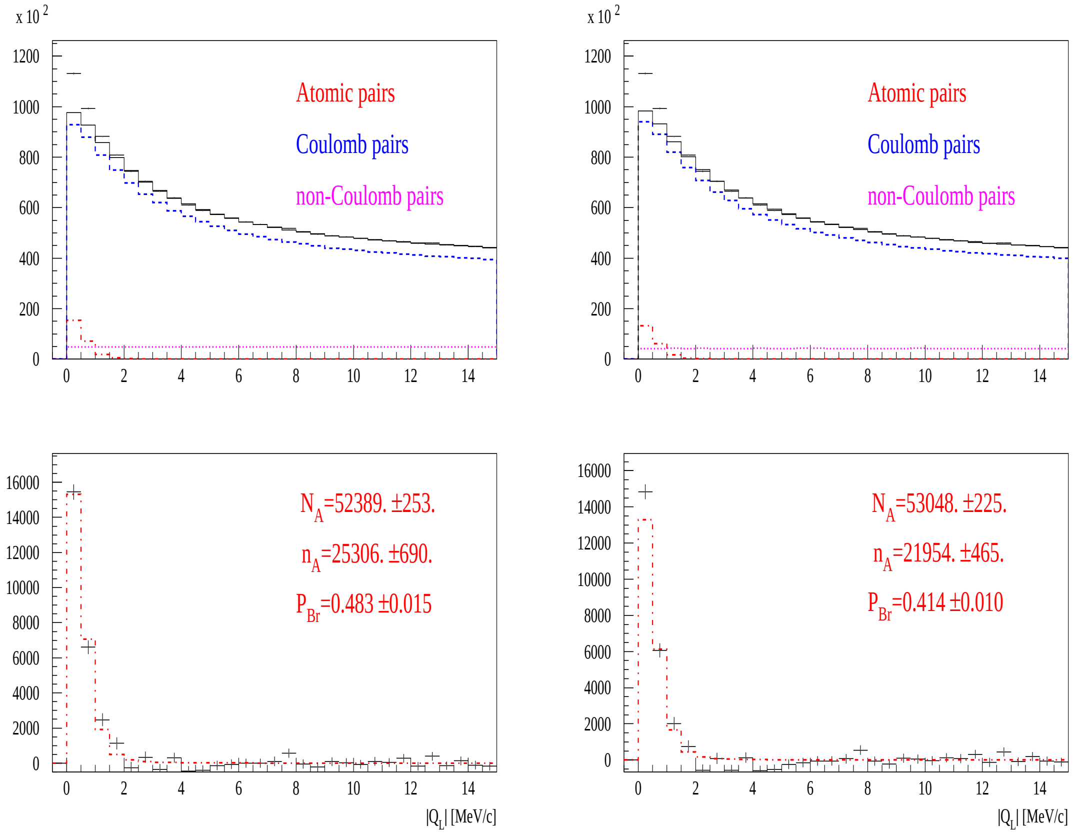

Figure 4: *Distribution of $\pi^+\pi^-$ pairs over Q_L (upper pictures), shown by points with error bars, is fitted by a sum of simulated distributions of "atomic" (red), "Coulomb" (blue) and "non-Coulomb" (magenta) distributions, using parameters of fit for one-dimensional distribution over Q_L (in left pictures) and parameters of fit for two-dimensional distribution over Q_L, Q_T (in right pictures). A sum of background distributions ("Coulomb" and "non-Coulomb") is shown by a solid black line. Differences of experimental and background distributions are shown on lower pictures together with simulated distributions of "atomic pairs".*

Year	n_A	$\delta\vert a_0-a_2\vert_{stat}$ %	$\delta\vert a_0-a_2\vert_{syst}$ %	$\delta\vert a_0-a_2\vert^{MS}_{stat}$ %	$\delta\vert a_0-a_2\vert_{tot}$ %
2001-2003	21000	3.1	3.0	2.5	4.3
2008-2010	25000	3.1	3.0	2.5	4.3
2001-2003+	46000	2.2	3.0	2.5	3.7
2008-2010			2.1	1.3	3.0

Table 1: Number of "atomic pairs" (n_A), and estimation of relative statistical ($\delta|a_0-a_2|_{stat}$), systematical ($\delta|a_0-a_2|_{syst}$) and total ($\delta|a_0-a_2|_{tot}$) errors of $\pi\pi$ scattering length difference for different data sample and accuracy of measurement of multiple scattering in a nickel target, which induces main contribution to systematic error: $\delta|a_0-a_2|^{MS}_{stat}$.

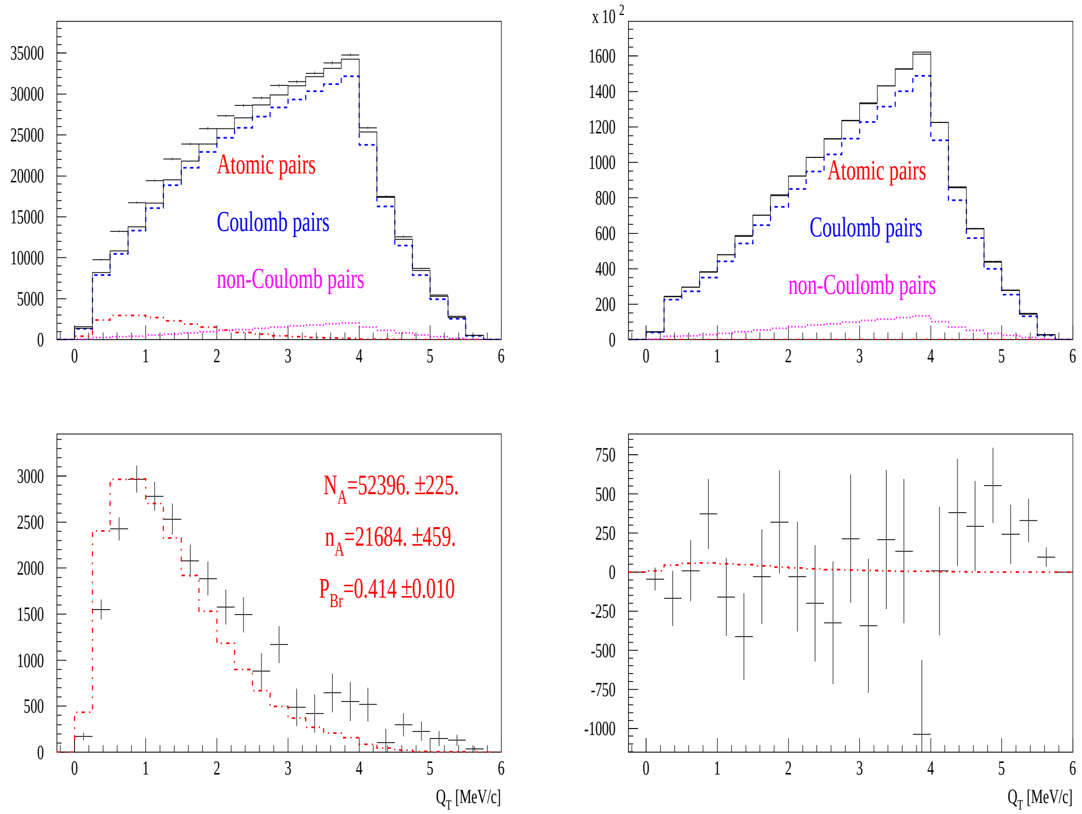

Figure 5: *Distribution of $\pi^+\pi^-$ pairs over Q_T (upper pictures), shown by points with error bars, is fitted by a sum of simulated distributions of "atomic" (red dotted-dashed), "Coulomb" (blue dashed) and "non-Coulomb" (magenta dotted) distributions, using parameters of fit for two-dimensional distribution over Q_L, Q_T. A sum of background distributions ("Coulomb" and "non-Coulomb") is shown by a solid black line. Differencies of experimental and background distributions are shown on lower pictures together with simulated distributions of "atomic pairs". Left pictures present distributions with criterion $|Q_L| < 2$ MeV/c, right pictures – distributions with criterion $2 < |Q_L| < 15$ MeV/c.*

Final distributions have been fitted by a sum of simulated distributions of "atomic", "Coulomb" and "non-Coulomb" pairs, with the same procedure which have been applied to $\pi^+\pi^-$ data (see section 5). Result are presented in Figs. 6,7.

Statistic of produced atoms (N_A) and "atomic pairs" (n_A), and breakup probability estimations are presented in Table 2

Comparison of experimental results with theoretical dependence of breakup probability on πK atom lifetime (Fig. 2) shows possibility to obtain estimation of atom lifetime, following by estimation of pion-kaon scattering length difference. This is planned to be presented in close future.

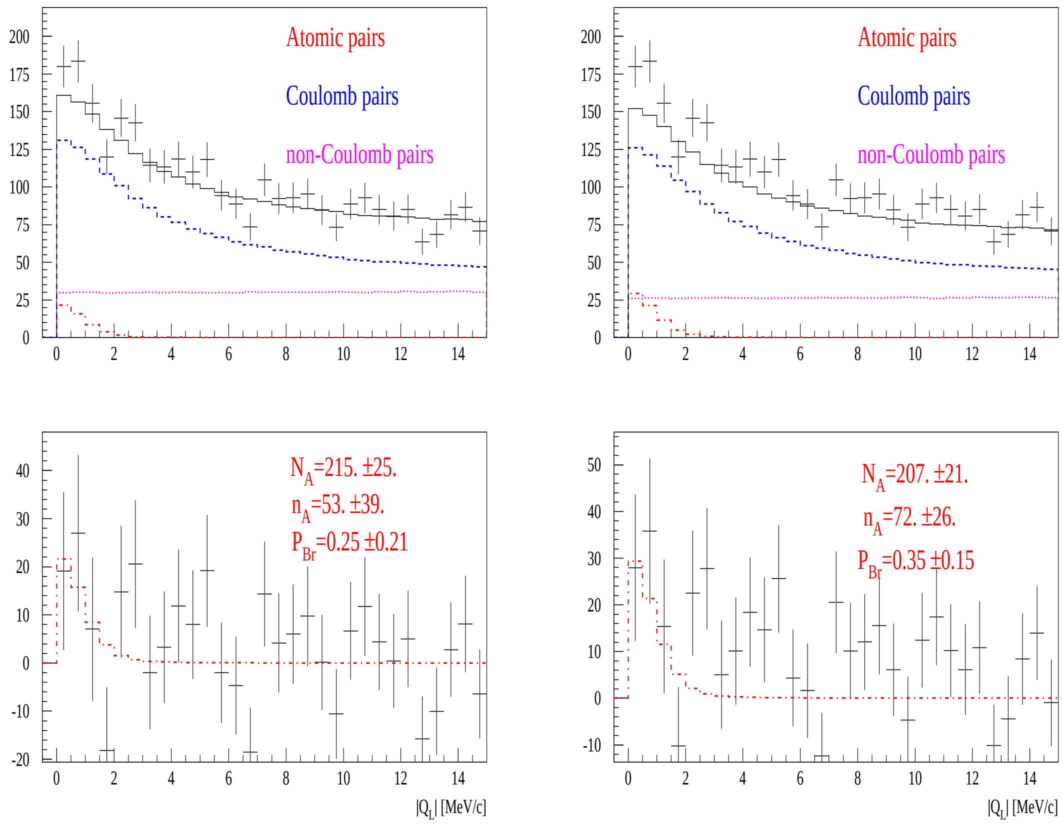

Figure 6: *Distribution of π^+K^- pairs over Q_L (upper pictures), shown by points with error bars, is fitted by a sum of simulated distributions of "atomic" (red dotted-dashed), "Coulomb" (blue dashed) and "non-Coulomb" (magenta dotted) distributions, using parameters of fit for one-dimensional distribution over Q_L (in left pictures) and parameters of fit for two-dimensional distribution over Q_L, Q_T (in right pictures). A sum of background distributions ("Coulomb" and "non-Coulomb") is shown by a solid black line. Differences of experimental and background distributions are shown on lower pictures together with simulated distributions of "atomic pairs".*

Variable	Distribution over	π^+K^-	$K^+\pi^-$	$pi^+K^- + K^+\pi^-$
N_A	Q_L	215 ± 25	511 ± 43	726 ± 49
N_A	Q_L, Q_T	207 ± 21	532 ± 36	739 ± 42
n_A	Q_L	53 ± 39	83 ± 65	136 ± 76
n_A	Q_L, Q_T	72 ± 26	61 ± 41	133 ± 49
$P_{\rm br}$	Q_L	0.25 ± 0.21	0.16 ± 0.14	0.19 ± 0.12
$P_{\rm br}$	Q_L, Q_T	0.35 ± 0.15	0.114 ± 0.083	0.180 ± 0.073
$P_{\rm br}^{theor}$				$0.278^{+0.012}_{-0.011}$

Table 2: Number of produced atoms (N_A), "atomic pairs" (n_A) and estimation of breakup probability for π^+K^- and $K^+\pi^-$ pairs, collected in 2008-2010. Values have been obtained with fit of one-dimensional (Q_L) and two-dimensional (Q_L, Q_T) distributions.

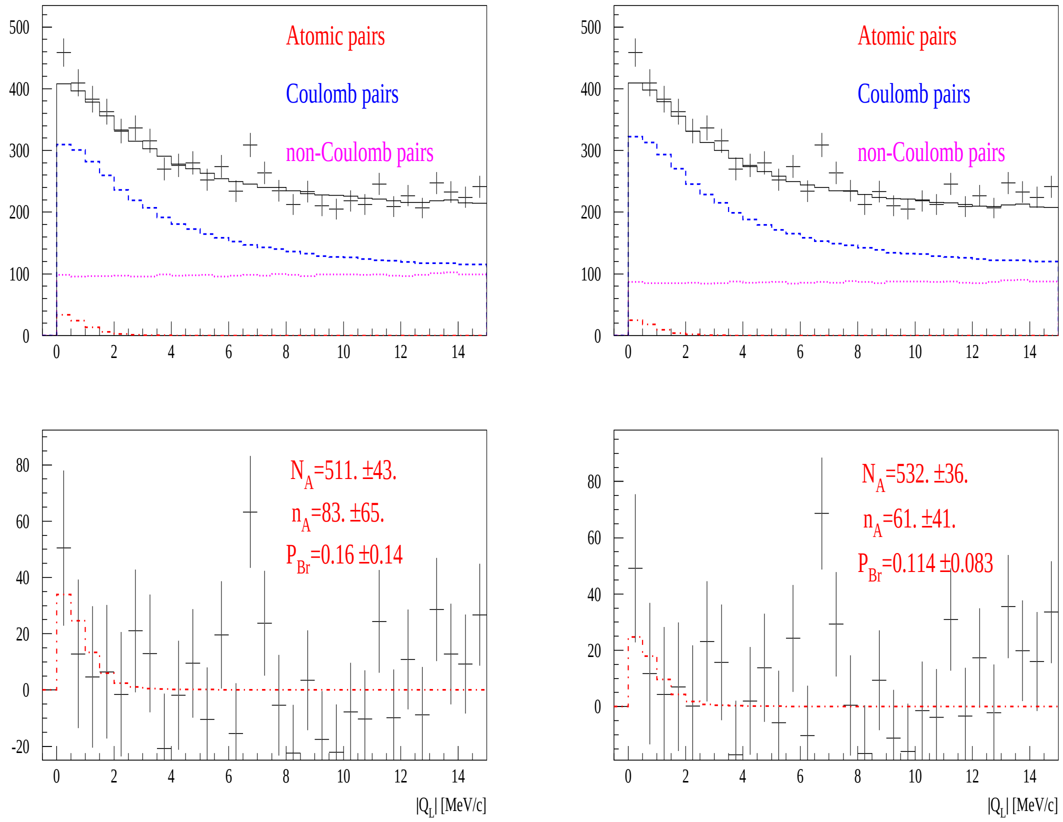

Figure 7: *Distribution of $K^+\pi^-$ pairs over Q_L (upper pictures), shown by points with error bars, is fitted by a sum of simulated distributions of "atomic" (red dotted-dashed), "Coulomb" (blue dashed) and "non-Coulomb" (magenta dotted) distributions, using parameters of fit for one-dimensional distribution over Q_L (in left pictures) and parameters of fit for two-dimensional distribution over Q_L, Q_T (in right pictures). A sum of background distributions ("Coulomb" and "non-Coulomb") is shown by a solid black line. Differences of experimental and background distributions are shown on lower pictures together with simulated distributions of "atomic pairs".*

7. Generation of $K^+\pi^-$, π^+K^- and $\pi^+\pi^-$ atoms at proton-nuclear interaction at proton beam momentum 24 GeV/c and 450 GeV/c

Analysis of present πK data shows that statistic is less than it is needed for measurement of $S-$wave πK scattering lengths with accuracy compatible with accuracy of theoretical prediction. To find a way to achieve needed accuracy, simulation of atoms yield per one proton-nuclear interaction (W_A) at different momenta of beam protons and angles between proton beam and secondary beam channel (Θ_{lab}) have been performed. Statistic, taken in certain time, also depends on beam intensity, which is limited by a flux of single particles through detectors of a setup. To take into account this limitation, yield of π mesons (W_π) per one proton-nuclear interaction have been simulated. Their combination (W_A/W_π) provides gain from experiment at certain experimental conditions. Results of simulation are shown in Table 3, together with normalized version of W_A^N

Atom	W_A	W_A^N	$\frac{W_A}{W_\pi}$	$\frac{W_A^N}{W_\pi^N}$	total gain
24 GeV					
$A_{\pi^+\pi^-}$	$1.1\cdot10^{-9}$	1.	$7.0\cdot10^{-8}$	1.	1.
$A_{\pi^+K^-}$	$2.6\cdot10^{-11}$	1.	$1.7\cdot10^{-9}$	1.	1.
$A_{K^+\pi^-}$	$4.4\cdot10^{-11}$	1.	$2.9\cdot10^{-9}$	1.	1.
450 GeV, $\Theta_{lab}=5.7^\circ$					
$A_{\pi^+\pi^-}$	$1.0\cdot10^{-8}$	9.7	$2.3\cdot10^{-7}$	3.3	13.
$A_{\pi^+K^-}$	$2.0\cdot10^{-10}$	7.5	$4.4\cdot10^{-9}$	2.6	10.
$A_{K^+\pi^-}$	$2.1\cdot10^{-10}$	4.7	$4.7\cdot10^{-8}$	1.6	6.
450 GeV, $\Theta_{lab}=4.0^\circ$					
$A_{\pi^+\pi^-}$	$1.8\cdot10^{-8}$	17.2	$2.0\cdot10^{-7}$	2.9	12.
$A_{\pi^+K^-}$	$9.3\cdot10^{-10}$	35.4	$1.0\cdot10^{-8}$	6.0	24.
$A_{K^+\pi^-}$	$1.2\cdot10^{-9}$	27.2	$1.3\cdot10^{-8}$	4.6	18.
450 GeV, $\Theta_{lab}=2.0^\circ$					
$A_{\pi^+\pi^-}$	$2.7\cdot10^{-8}$	25.8	$8.3\cdot10^{-8}$	1.2	5.
$A_{\pi^+K^-}$	$2.3\cdot10^{-9}$	86.9	$7.0\cdot10^{-9}$	4.0	16.
$A_{K^+\pi^-}$	$3.0\cdot10^{-9}$	68.7	$9.2\cdot10^{-9}$	3.2	13.

Table 3: Yield of dimeson atoms per one proton-Ni interaction (W_A), detectable by DIRAC upgrade setup at different proton beam momentum a setup angle Θ_{lab}; yield of atoms normalized on yield at proton beam 24 GeV/c (W_A^N); ratio of W_A to inclusive cross-section of charged particles W_π; normalized ratio $\frac{W_A^N}{W_\pi^N}$; total gain with SPS beam relatively PS beam, taking in to account spill frequency and duration.

and W_π^N are assumed to be 1 for present conditions of experiment DIRAC.

8. Summary

Statistic of πK pairs are processed and analysed. It gives possibility to make estimation of πK atom lifetime and to measure $S-$wave πK scattering length difference.

Data collected in 2007-2010 doubles statistic of $\pi^+\pi^-$ atoms and improve accuracy of measurement for $S-$wave $\pi\pi$ scattering length difference.

Simulation shows that investigation of πK atoms in experiment at SPS beam allows to improve accuracy of πK scattering length measurement.

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