Experimental investigation of atoms consisting of $\pi^+\pi^-$, $K^+\pi^-$ and $K^-\pi^+$ mesons

L. Nemenov CERN – JINR

In the report will be presented the experimental results and plans of the DIRAC experiment at CERN. The main task of the DIRAC is to check precise predictions of low-energy QCD.

At present, theory predicts the $\pi\pi$ s-wave scattering lengths with a precision of 2.5-1.5% for a_0, a_2, $a_0 - a_2$. The precision of $\pi\pi$ scattering lengths measurements are worse than the theoretical precision. The DIRAC experiment take data to obtain a precision of about 3% for $|a_0 - a_2|$, measuring the life-time of $\pi\pi$ atoms.

Theory predicts πK scattering lengths with a precision of about 10%. The direct measurements of πK scattering lengths do not exist. The DIRAC experiment plans to observe πK atoms, to measure their lifetime and to obtain the first evaluation for the scattering length combination $|a_{1/2} - a_{3/2}|$.

The DIRAC collaboration is planning to continue the experiment in the near future, aiming to observe the long-lived states of $\pi\pi$ atoms and to measure the Lamb shift $\Delta E(2s - 2p)$ in these atoms. The measurement of $\Delta E(2s - 2p)$ allows to determine in a model-independent way the combination of $\pi\pi$ scattering lengths $2a_0 + a_2$.

These new possibilities of checking the predictions of the low-energy QCD will be available installating the DIRAC setup on the 450 GeV/c SPS proton beam. The simulation, based on FRITIOF6, gives correct π and K meson spectra in the dynamic range of the DIRAC spectrometer.

If we assume the same intensity for the secondary particles across the forward detectors, the obtained number of detected $\pi\pi$ atoms will be 15 times higher than the one that can be obtained at 24 GeV, while the number of $K^+\pi^-$ atoms will be 25 times more and the number of $K^-\pi^+$ atoms 32 times higher. This enhancement in atom yields will allow to give the decisive checks for low-energy QCD predictions.