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Two-photon exchange contribution in elastic electron-proton scattering, experiment at the VEPP-3 storage ring

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The study of the electromagnetic form factors of the proton is crucial for the understanding of its structure. Additionally, reliable knowledge of the form factors plays an important role in many areas of the nuclear physics. However, there is a large discrepancy between the ratio of the proton electric and magnetic form factors (G_E/G_M) measurements using the old Rosenbluth separation (RS) method and ones using polarization transfer [1]. One of the most probable explanations is the contribution from two-photon exchange (TPE) effects to (ep) elastic scattering. Common practice of the analysis of RS experiments was in approximate taking into account of TPE contribution, believing this contribution to be small. Currently there are no accurate calculations of the TPE contribution, what is related to difficulties in accounting of the intermediate states of proton. But recent calculations, which take partial account of the proton structure, show importance of TPE contribution for RS analysis. The TPE contribution can be determinated directly by the measurement of R, the ratio of the (e^+p) to (e^-p) elastic scattering cross sections. But only old (in the 1960's) measurements of R exist, where the TPE contribution was found with low precision and for a limited kinematics coverage.

Present experiment [2] was performed at the VEPP-3 storage ring, Novosibirsk with the two energies of positron/electron beams: 1.6 GeV (the run was finished in 2009) and 1.0 GeV (the run was finished in 2012). The electron/positron scattering angles were $\theta = 15 \div 25^\circ$ and $\theta = 55 \div 75^\circ$ for the first case and $\theta = 65 \div 105^\circ$ for the second case. Electron and positron beams replaced each other regularly, one cycle with two beams required about one hour. In the first run 1100 of such cycles with the integral of luminosity $L = 324\ pb^{-1}$ were performed, in the second run we had performed 2350 cycles with $L = 600\ pb^{-1}$. The thickness of internal hydrogen gas target was about $10^{15} at/cm^2$.

The data analysis, besides the other things, includes small corrections related to the energy and position differences of electron and positron beams as well the radiative corrections. Radiative corrections significantly reduce the raw R and they should be calculated accurately [3].

Description of the experiment and results of the data analysis will be presented.

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