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Beam energy measurement by resonant depolarization method

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High precision measurement in high energy physics requires accurate knowledge of initial state of colliding particles. In particular, precise measurement of the mass of elementary particles requires precision measurement of the beam energy. For example, beam energy calibration system allow one to perform new measurement of tau lepton or psi meson masses at Super c-tau Factory.

The most accurate method of beam energy calibration is resonant depolarization technique. It is based on measurement of spin precession frequency which is connected to Lorentz factor of the beam and well known normal and anomalous part of magnetic moment of electron due to Tomas precession. Spin precession frequency is determined from frequency of resonant destruction of beam polarization.

My report is devoted to the experience of beam energy calibration of VEPP-4M collider by resonant depolarization method using polarimeter based on intra-beam scattering. The accuracy achieved is about 10^-6 and limited by width of spin line. Between energy calibrations beam energy is reconstructed by using NMR and temperature sensors of storage ring with accuracy 10-30 keV.

Beam is depolarized by TEM wave which created by frequency synthesizer controlled by computer. The synthesizer is stabilized by rubidium frequency standard. Polarization degree is measured by intensity of process of intra-beam scattering. Scattered particles are registered by plastic scintillator counters located inside the accelerator vacuum chamber at different ring azimuth. Routine count rate is about 200 kHz/mA^2.

We use a compensation technique by normalizing the counting rate from a polarized beam by the counting rate from an unpolarized one. This technique allows us to suppress count rate fluctuations related to the beam orbit or beam size instabilities.

More then thousand energy calibrations were used in the KEDR detector precise experiments on measurement of J/psi, psi(2S), psi(3770), D+, D0 mesons and tau lepton masses.

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