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Measurement of the centre-of-mass energy and of its spread with dimuon events at FCC-ee

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At FCC-ee, beamstrahlung is pushed at its limits to maximize the luminosity, which causes a large beam energy spread, from 60 MeV at the Z pole to 350 MeV at the top energies, and therefore a centre-of-mass energy spread from 90 to 500 MeV. Because the pertaining biases to the measurements of ΓZ and αQED are two-to-three orders of magnitude larger than their target precisions, the centre-of-mass energy spread must be measured to a few per mil. Dimuon events are instrumental for this purpose. The effect of energy spread is to slightly boost the two muons along the "beam axis"and modify their directions –in a way similar to the radiation of a photon (ISR) by one of the two incoming particles. This "longitudinal"boost can be determined with the help of (E, p) conservation from the muon polar and azimuthal angles, θ± and φ±. After unfolding ISR effects, the mean value and shape of the boost distribution give - with the necessary precision - the difference between the e± beam energies and the relative centre-of-mass energy spread, within a few minutes. The measurement of the centre-of-mass energy and of its spread also requires an absolute knowledge of the beam crossing angle α and of the two muon directions, and therefore an absolute alignment of the detector with respect to the beam directions. The beam crossing angle α can be determined for each event from the muon directions and (E, p) conservation, with a precision of 0.3 μrad within 5 minutes at the Z pole at FCC-ee. An absolute alignment of the detector can be achieved by minimizing the spread of the α distribution.

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Secondary track (number)

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