Luminosity measurement with the two-photon process at the LHC

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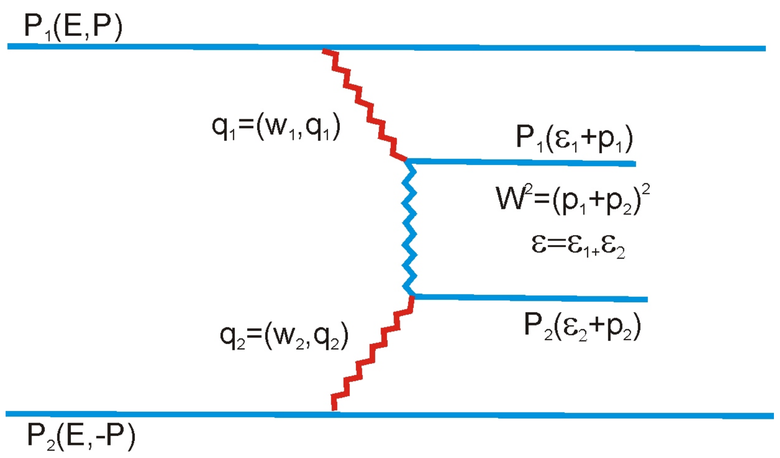
The two-photon process pp→pp+e⁺e⁻



The parameters characterizing the process:

- **small angle between e^+e^- (~few mrad)**
- **very small pair p_T(~few MeV)**
- **invariant mass (~few MeV)**
- **large cross section (~few mb)**

Abstract

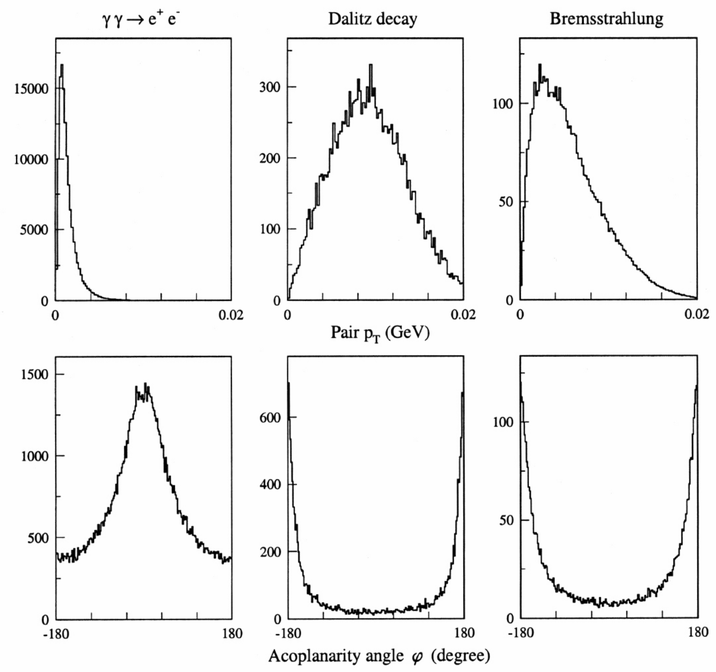
The luminosity measurement of pp colliders based on the QED process of two-photon e^+e^- pair production is investigated. In this process e^+e^- pairs are produced in collisions of virtual photons surrounding the proton. The cross section of this process is calculated with high accuracy with QED. The total cross section is very large (~10 mb). The main signatures of this process are small transverse momentum and acoplanarity angle.

Signal events are generated with LPAIR program and PYTHIA 6.2 provides the background events. The modeling program simulates luminosity measurement using a dedicated detector (LUMI). That program calculates experimental environment effects. The first is the vertex smearing which is simulated from a general expression for the luminosity. It takes into an account the fact that we don't know precisely the vertex position. The spread of protons momenta inside bunches is also taken into account. The most important effects, which can contribute to the electron transversal momenta are electromagnetic effects. The trajectory of the electron, which was produced inside the bunch, can be curved in the electric field of this bunch. The contribution of this effect to transversal momenta strongly depends on the e^+e^- vertex position inside the bunch. The next part of the modeling program is to simulate the bending magnet and the LUMI detector, which consists of a position detector and electromagnetic calorimeter.

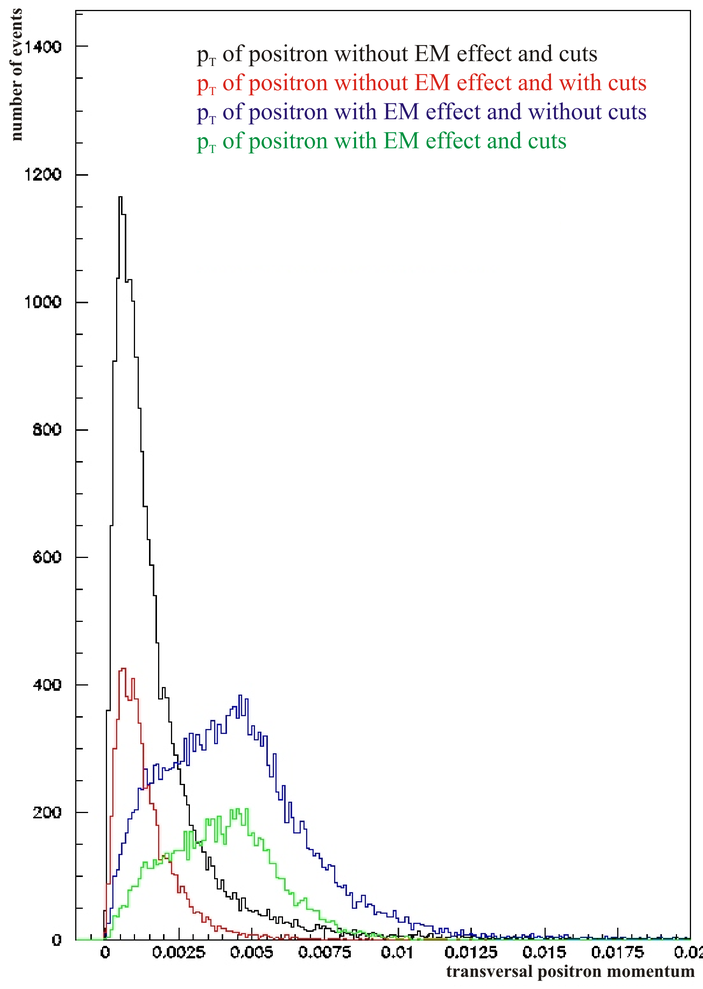
The process of the two photon e^+e^- pair production can be used for calibration of luminosity at the LHC. The expected precision of the measurement is 1-3%. For this it is necessary to build a dedicated detector.

Histograms

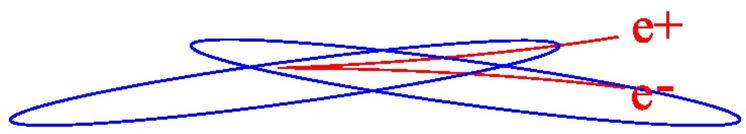
Most important distributions for the signal and the backgrounds (Dalitz decay, Bremsstrahlung)



Electromagnetic effect (p_T of positron)

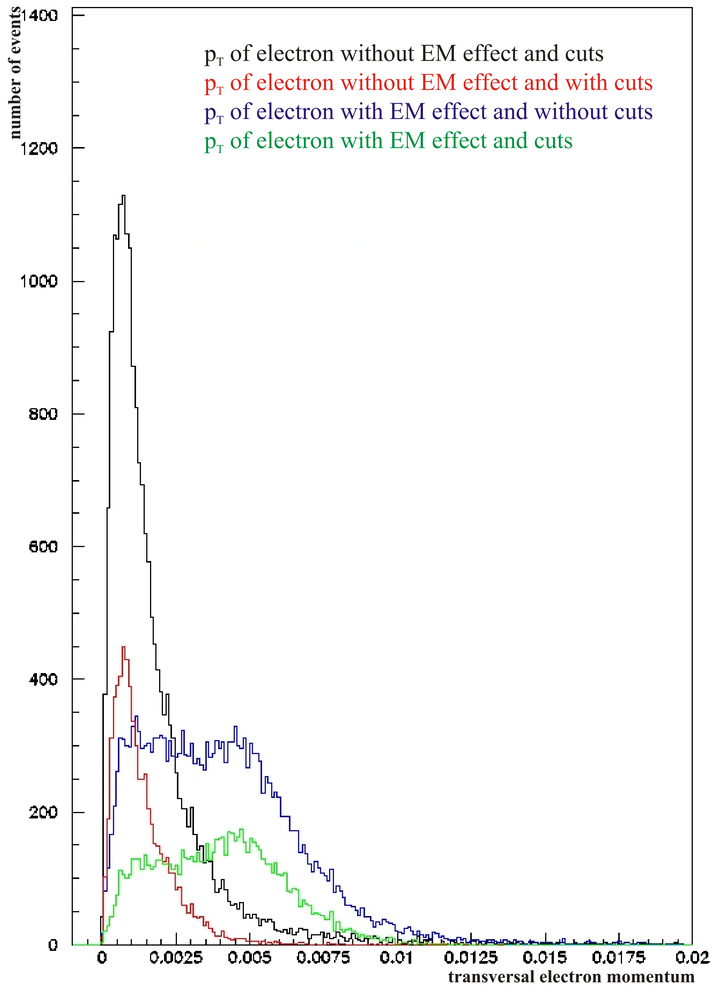


Electromagnetic effect



- **charged particle (e^+e^-) change trajectory in bunch field**
- **strong dependence on e^+e^- vertex position inside bunch**
- **big contribution to p_T**
- **interactions with next bunch are considered**

Electromagnetic effect (p_T of electron)



Proposed beam pipe layout for IP1 at LHC