background studies for a soft-photon measurement with the Forward Conversion Tracker

Quark Matter 2022 - Krakow

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motivation: soft photons with ALICE 3

ALICE 3: a new compact all-silicon multi-purpose detector proposed for 2032 at LHC

- soft photons: photons with $p_T \leq 5$ MeV
  - inner Bremsstrahlung from initial and final state hadrons

theoretically via Low’s theorem:
  - relates soft-photon production and charged-hadron spectrum

soft-photon puzzle:
  - several experimental measurements show factor 2–5 enhancement w.r.t Low’s theorem prediction

background photons under study:
  - external Bremsstrahlung from material
  - decay photons

this poster: background studies for a forward soft-photon measurement with the Forward Conversion Tracker (FCT) in ALICE 3 in context of the Letter of Intent: ALICE 3
GEANT4 setup for simulation studies of background photons

propagation of particles through ALICE 3 detector system

current, default GEANT4 ALICE 3 setup:

› standard, cylindrical beam pipe
› barrel tracking layers
› forward disks

GEANT4 input:

› pp collisions at 13 TeV (PYTHIA)

inner Bremsstrahlung’s signal = soft-photon expectation (derivable from Low’s theorem) [calculation by Martin Voelkl]

external Bremsstrahlung = secondary photons from material

suppression of background from external Bremsstrahlung:

› VETO on electrons or positrons in the acceptance of FCT (1)
› minimisation of detector material in front of FCT (2)

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background reduction (1): events without e\(^{-}\) or e\(^{+}\) in FCT \(\eta\) range

all events

![Graph: 1/N_{evt} dN/dp_T (MeV^-1) vs. p_T (MeV) for all events]

- ALICE 3 Study
- pp, \(\sqrt{s} = 13\) TeV
- PYTHIA 8.304, SoftQCD:nonDiffractive
- GEANT 4.10.07 patch-01, FTFP_BERT
- 4.0 < \(\eta\) < 5.0, \(E_\gamma\) > 10 MeV

![Graph: 1/N_{evt} dN/dp_T (MeV^-1) vs. p_T (MeV) for events without e\(^{-}\) or e\(^{+}\) in FCT \(\eta\) range]

- ALICE 3 Study, events with no electrons in \(\eta\) range
- pp, \(\sqrt{s} = 13\) TeV
- PYTHIA 8.304, SoftQCD:nonDiffractive
- GEANT 4.10.07 patch-01, FTFP_BERT
- 4.0 < \(\eta\) < 5.0, \(E_\gamma\) > 10 MeV

- [Graph Legend]

a successful measurement strategy:
- event rejection based on PID of electrons or positrons in the \(\eta\) range of the FCT

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background reduction (2): utilising a shaped beam pipe

only standard, **cylindrical** beam pipe

only shaped, **conical** beam pipe

- reduction of background achievable with lowering the detector material in front of FCT
  e.g. a beam pipe optimised for FCT
motivation: soft-photon measurement could resolve soft-photon puzzle

challenging measurement
- dominant background from external Bremsstrahlung produced by electrons or positron from photon conversion

promising prospects for background reduction
- identification and rejection of events with an electron or positron in $\eta$ range of FCT
- minimisation of the material budget in front of FCT, e.g. optimised beam pipe

outlook

detailed study of a soft-photon measurement in full MC simulation
- inclusion of forward tracking and injection of a pseudo soft-photon signal