Prompt photons

JINR

The (un)polarized gluon content of the proton at intermediate and high values of Bjorken x will be investigated at the SPD using three main probes:

- the inclusive production of charmonia;
- the inclusive production of open charm;
- the prompt photons production

The study of these processes is complementary to the usual approaches to access the partonic structure of the nucleon in hadronic collisions such as the inclusive production of hadrons at high transverse momentum and the Drell-Yan process.

Prompt photon production in hadronic collisions, defined as the production of photons not issuing from the electromagnetic decays of hadrons, appears as an excellent observable to determine the gluon PDF, since at leading order (LO) it probes the gluon directly through the quark–gluon «Compton» process.

To subtract background photons contributions - the prompt-photon contribution with $p_T \leq 2$ - 3 GeV is usually unreachable in the SPD experiment.

There are two main hard processes for the production of prompt photons:

- gluon Compton scattering, $g(q/\bar{q}) \rightarrow \gamma(q/\bar{q})$;
- quark-antiquark annihilation, $q\bar{q} \rightarrow \gamma g$.

Contribution of the latter process to the total cross-section is small.

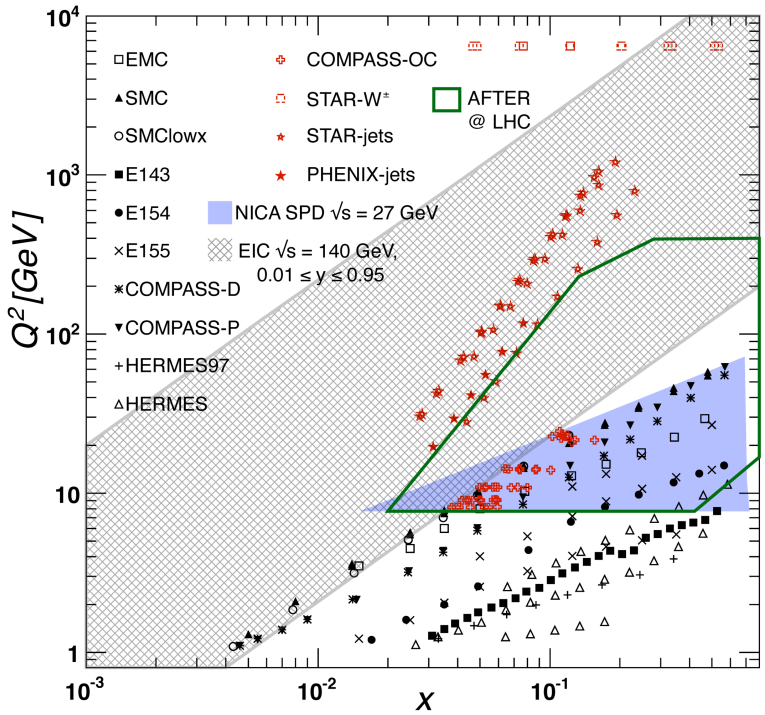


Figure: The kinematic coverage, in the (x, Q^2) plane, of the hadronic cross-section data used for determination of the NNPDFpol1.1 set of the polarized PDFs. The kinematic domains expected to be covered by the NICA SPD at $\sqrt{s} = 27$ GeV and AFTER by charmonium, open-charm and prompt-photon production are shown.

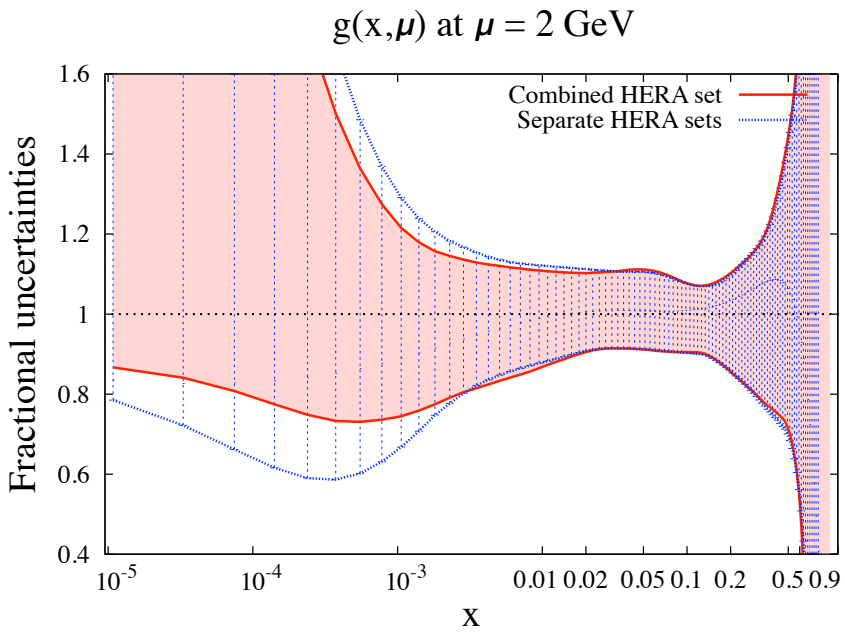


Figure: Uncertainty of unpolarized gluon PDF based on HERA data ($\mu = 2$ GeV).

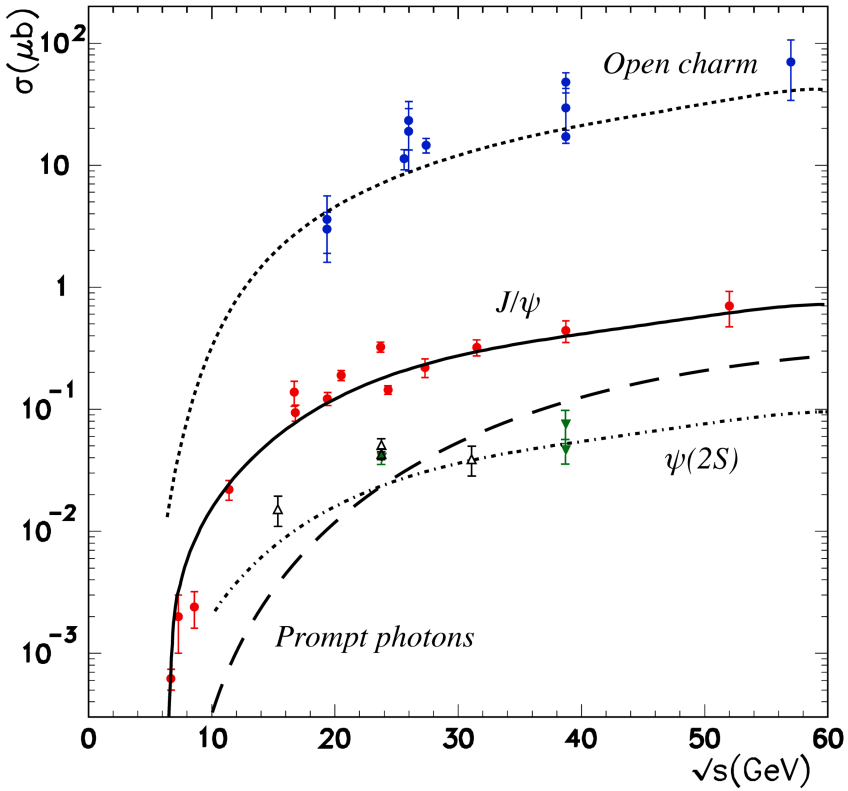
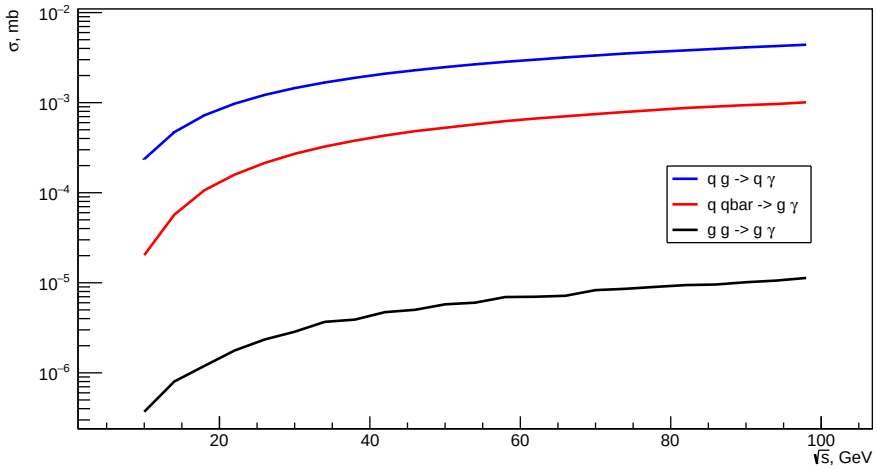


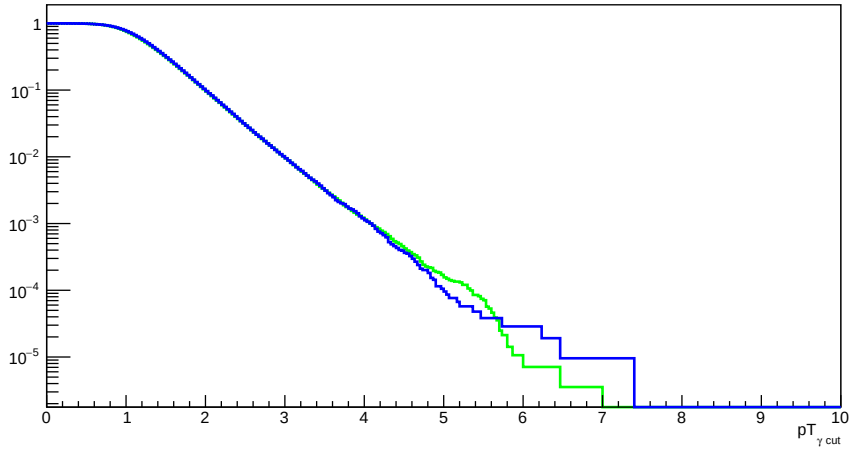
Figure: Cross-section for open charm, J/ψ and $\psi(2S)$ production from CEM-NLO model (colour evaporation model combined with NLO pQCD matrix elements) and prompt photon production cross-section for $p_T > 3$ GeV as a function of center-of-mass energy. Model-calculations are compared with available experimental data sets.

INTRODUCTION:

PROCESSES FRACTION

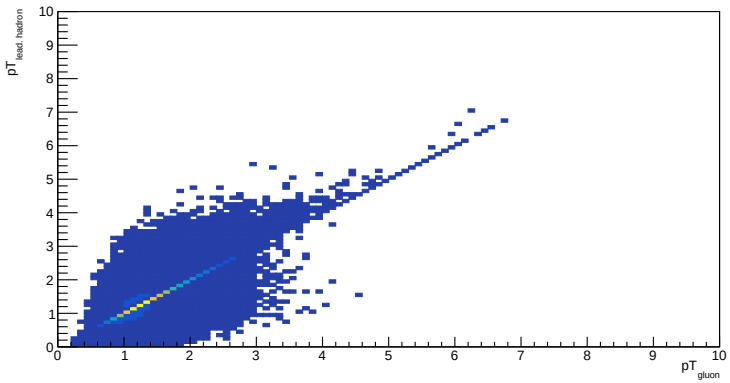


(a) Partial prompt photon production x-section as function of the proton-proton center-of-mass energy.

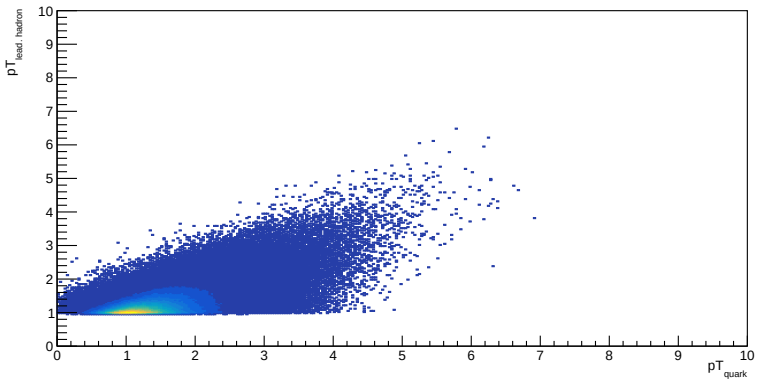


(b) The amount of events dependence on a pT cut value - the minimum transverse momentum of the prompt photon

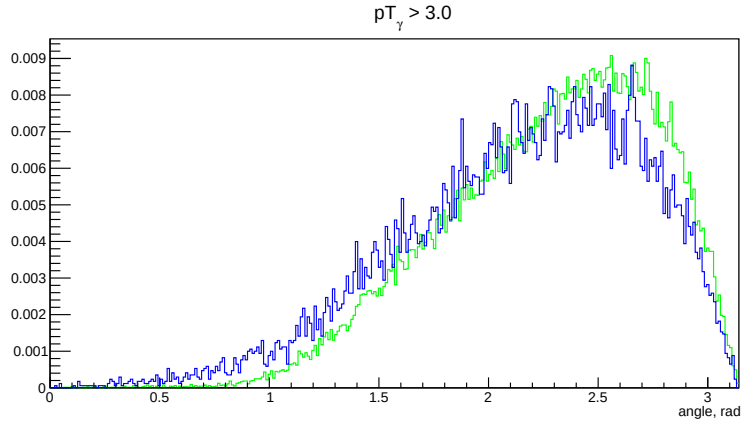
The hadron in the scattering process was selected as a hadron that contains a recoil quark.
For the annihilation process - a leading hadron in a string containing a gluon was selected.



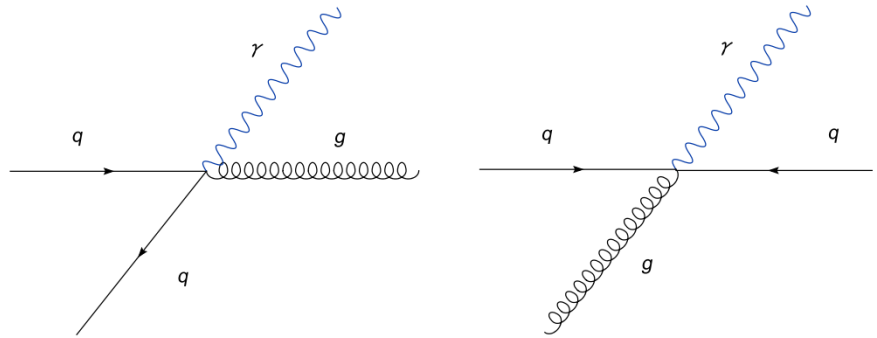
(a) Correlation between a hardon in a string containing the gluon and the gluon *transverse* momentum for $q\bar{q}$-annihilation.



(b) Correlation between the hardon which containing the quark and the quark *transverse* momentum for CGS.



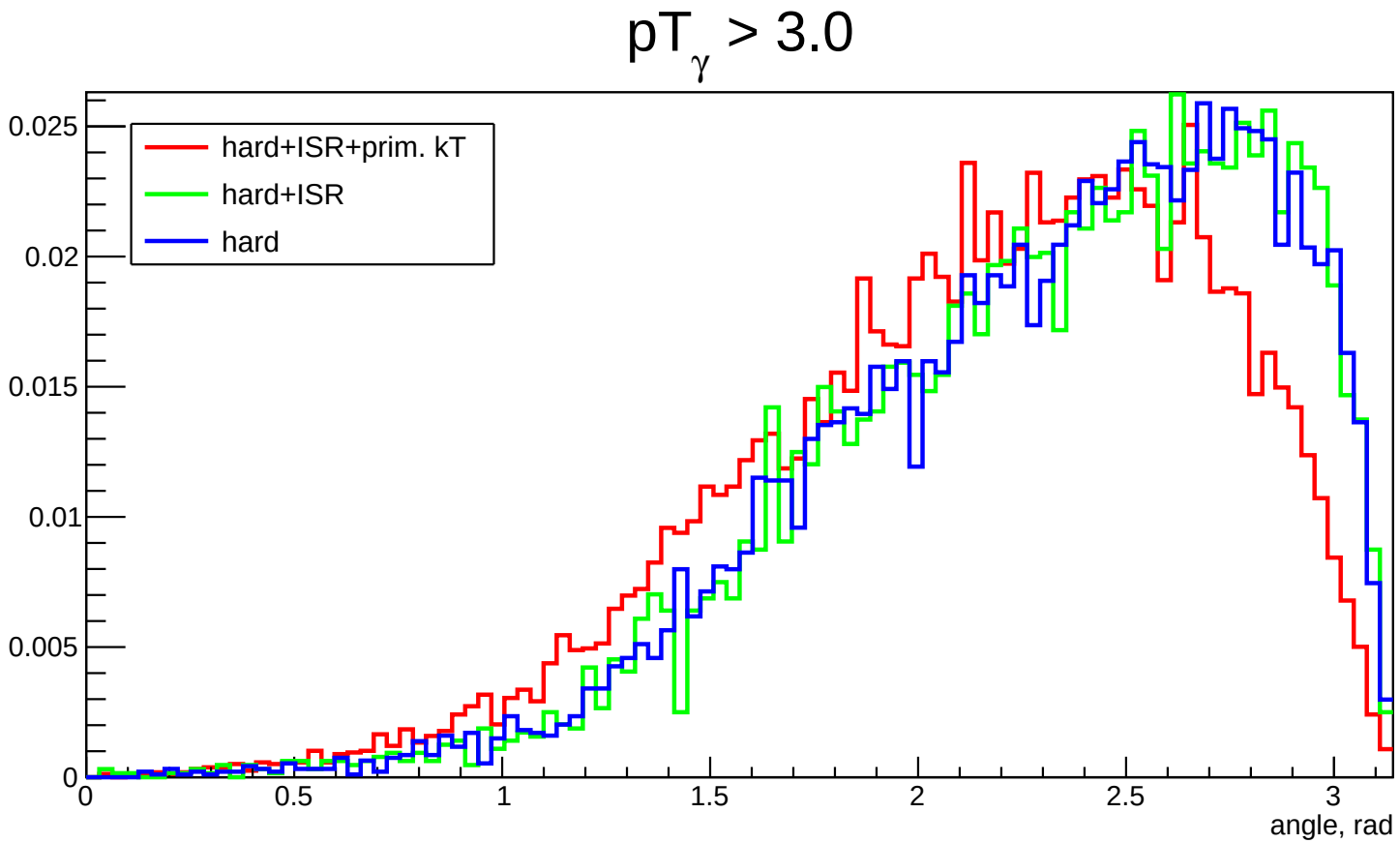
(a) An angle btw the selected hadron and a prompt photon in the lab frame.



(b) Prompt photon production for CGS process (left) and $q\bar{q}$ annihilation(right)

Figure: 6b - Parton-parton center-of-mass rest frame; 6a - An angle btw a parton and hadron in lab. frame.

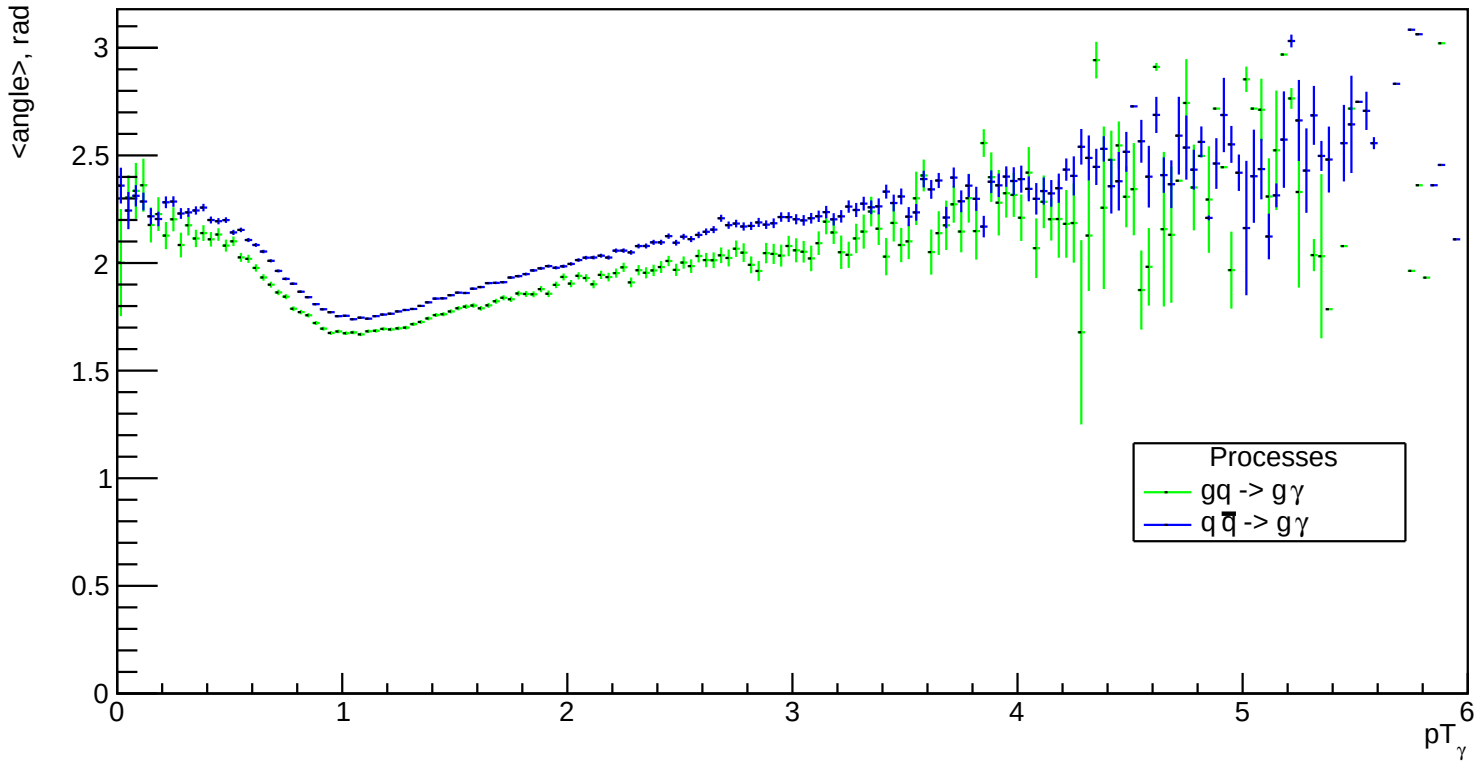
The distribution of an angle between the hardon and a gamma photon, taking into account the contribution of ISR and primordial k_T. CGS only.



RESULTS:

ANGLE VS. SCALE

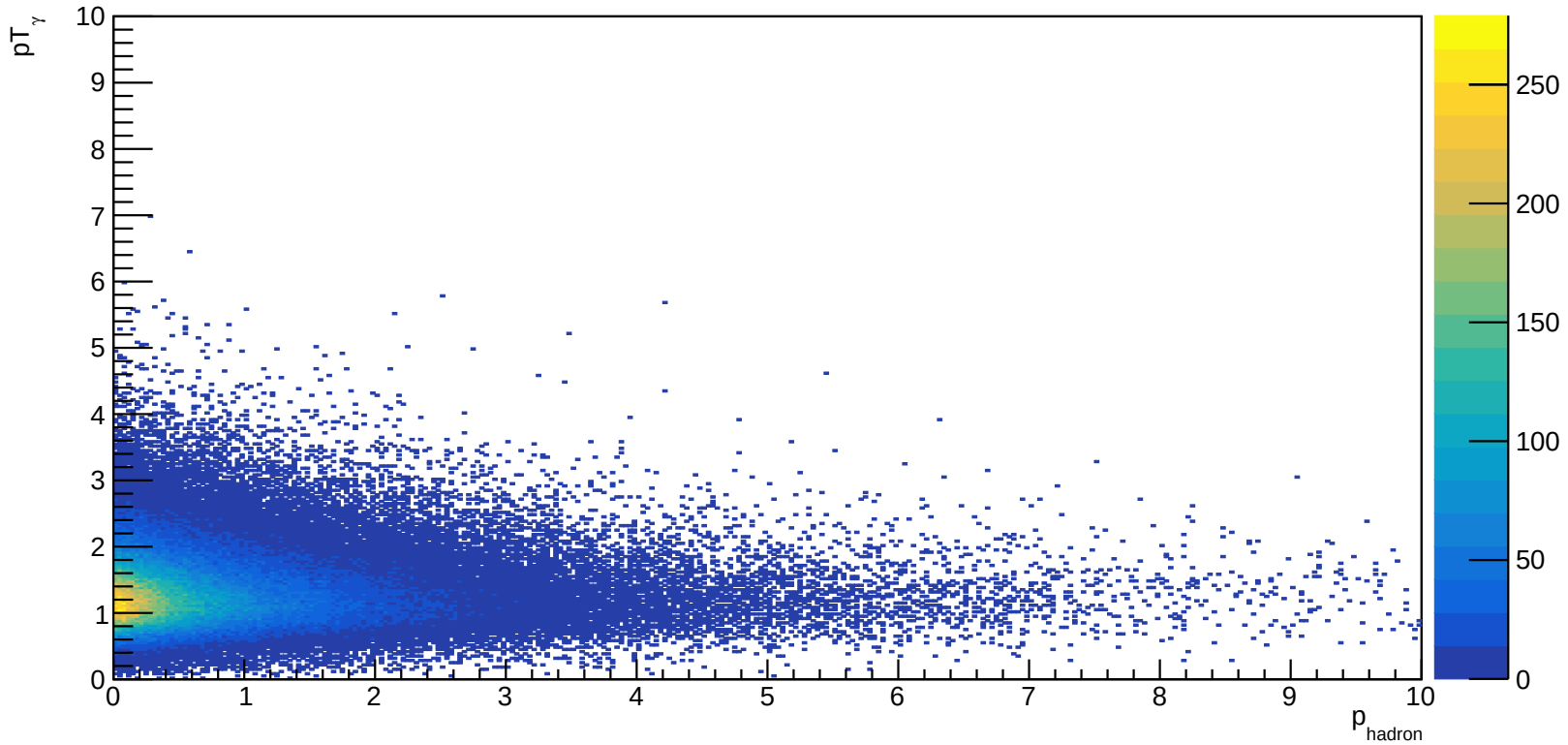
The mean angle between selected hadron and a prompt photon as a function of a gamma photon transverse momentum.



RESULTS:

HADRON MOMENTUM VS. GAMMA MOMENTUM

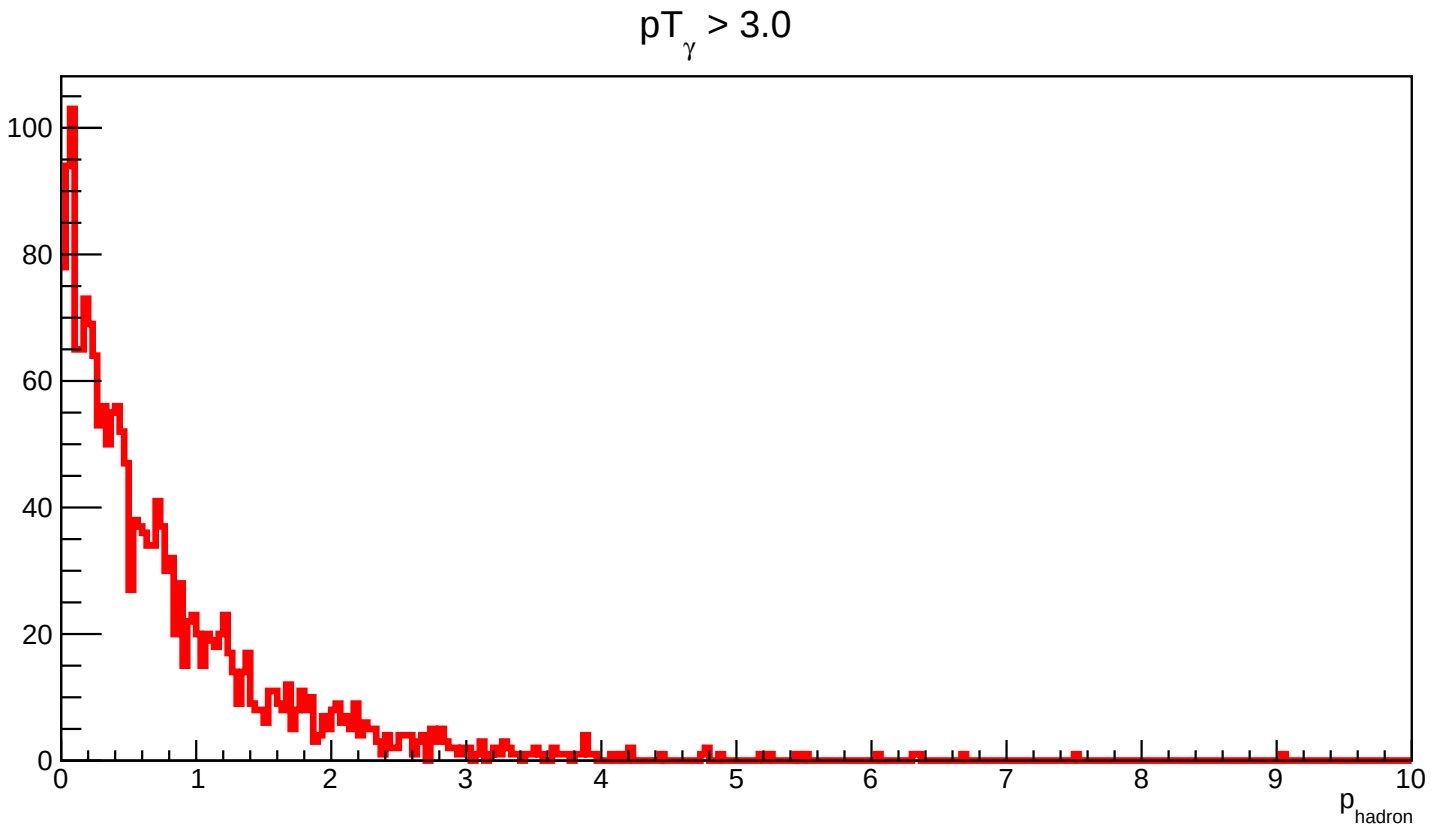
Recoil hadron and a prompt photon kinematic coverage.



RESULTS:

HADRON MOMENTUM FOR SCALE

Distribution of the recoil hadron momentum for the transverse momentum cut.



RESULTS:

HADRON MOMENTUM VS. SCALE

The recoil hadron momentum as function of the prompt photon transverse momentum.