**2018 Helmholtz – OCPC – Program**

**for the involvement of postdocs in bilateral collaboration projects**

**DESY\_OCPC\_2018-18**

**PART A**

**Title of the project:**  Drell-Yan production at very high masses in high energetic proton-proton collisions at the Large Hadron Collider with the CMS experiment

**Helmholtz Centre and Research Group:** DESY, Hamburg

**Project leader:** Hannes Jung, DESY

**Web-address:** http://cms.desy.de/

**Description of the project** (max. 1 page)**:**

Drell-Yan (DY) production in proton-proton collisions is a process which originates from high energetic collisions of a quark and an antiquark from the colliding protons. DY production allows to study in very detail the production mechanism and to test the theoretical description. DY production has been a *standard candle* process since many years.

With the high luminosity recorded at the Large Hadron Collider (LHC) run2 (> 100 fb-1) a new region of phase space can be accessed, which was never possible before: the region of highest DY mass MDY. In the region of small transverse momentum pT of the DY lepton-pair, fixed-order calculations in perturbative QCD become un-stable and contributions from soft gluons to all orders in the strong coupling need to be included (resummation). The procedure of resummation is known and available in different forms for Drell-Yan production from analytic resummation to predictions including parton showers. In a new approach soft gluon resummation can be achieved within the formalism of transverse momentum dependent (TMD) factorization and TMD parton densities, which forms a bridge from small to highest energies. Much progress has been achieved in the last years, with a breakthrough recently with the determination of a complete set of TMDs for LHC energies using a parton branching method [1,2].

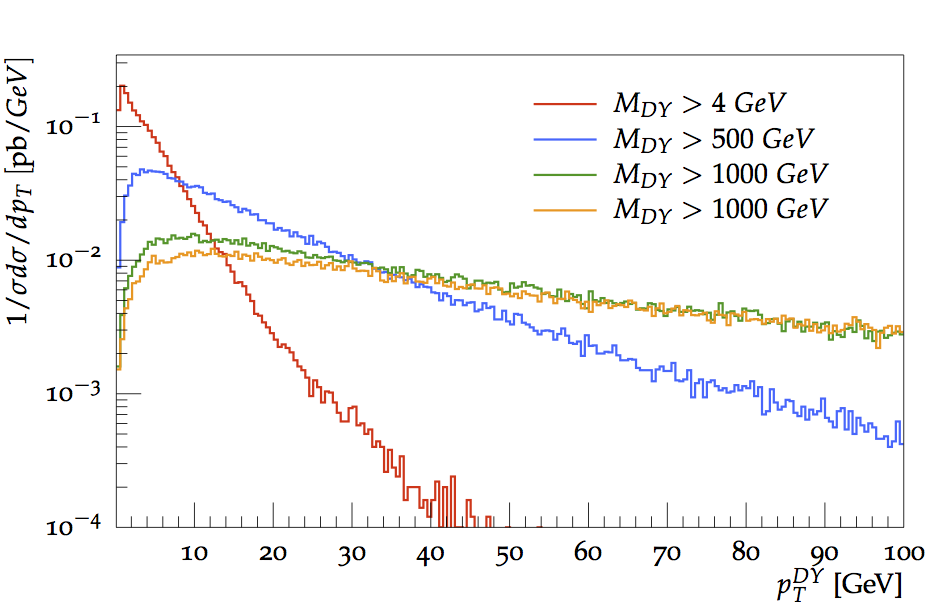


Fig 1: Transverse Momentum of DY pair for different values of the DY mass MDY obtained by PYTHIA8.

The transverse momentum pT as well as the variable φ\* (a combination of transverse momentum and azimuthal angle for better resolution) will be measured with the CMS detector at the LHC. Since the pT resolution at high masses MDY is rather poor (the decay leptons have very high transverse momentum), methods to improve the pT resolution have to be developed (for example with deep-learning methods). We will measure pT and φ\* as a function of the DY mass MDY (Fig. 1). Special emphasis will be put on the measurements from lowest and highest mass, in order to provide the largest possible lever arm for the evolution.

With the measurement of Drell-Yan production a systematic study of a color-neutral final state can be performed. The newly developed approach for determination of TMD parton densities [1,2] will be used for predictions of the DY pT spectra. Theoretical and phenomenological development is needed to provide predictions using TMD parton densities to the same accuracy as available in standard collinear calculations. Those calculations need to be implemented in a full hadron level Monte Carlo event generator based consistently on TMD factorization. The development of the TMD MC generator is part of the project.

References

[1] Hautmann, F. and Jung, H. and Lelek, A. and Radescu, V. and Zlebcik, R., Soft-Gluon Resolution Scale in QCD Evolution Equations, Phys. Lett. B772, 446, 2016

[2] Hautmann, F., Jung, H., Lelek, A., Radescu, V., Zlebcik, R., Collinear and TMD Quark and Gluon Densities from Parton Branching Solution of QCD Evolution Equations, JHEP 1801,070, 2018

**Description of existing or sought Chinese collaboration partner institute** (max. half page)**:**

The High Energy Physics group at Peking University (Beijing) is member of the CMS collaboration and already involved in Vectorboson analysis. The experience of the group is essential in performing the very demanding and challenging analysis of the transverse momentum spectrum of high mass DY production. The experimental as well as theoretical involvement of the group is of great value for the successful completion of the project. The experience gained during this project will be of great benefit for the participating institutes.

The CMS Collaboration authorship fees have to be covered by the Chinese home Institution.

**Required qualification of the post-doc:**

* PhD in experimental particle physics with emphasis on the analysis of DY processes in the dimuon channel and vector boson resonance search.
* Experience with in data analysis and Monte Carlo event generators.
* Additional skills in muon reconstruction and in the CMS trigger system.

**PART B**

**Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station:**

* Detailed description of the interest in joining the project (motivation letter)
* Curriculum vitae, copies of degrees
* List of publications
* 2 letters of recommendation
* Proof of command of English language

**PART C**

**Additional requirements to be fulfilled by the post-doc:**

* Max. age of 35 years
* PhD degree not older than 5 years
* Very good command of the English language
* Strong ability to work independently and in a team