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UNIVERZITET CRNE GORE

SENATU

CENTAR ZA DOKTORSKE STUDIJE

U prilogu akta dostavljam Odluke sa LXXV sjednice Vijeća Prirodno-matematičkog fakuteta održane 24.12.2021. godine.

D e k a n,

Prof. dr Predrag Miranović

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Na osnovu člana 64 Statuta Univerziteta Crne Gore, a u vezi sa članom 34 stav 1 Pravila doktorskih studija, Vijeće Prirodno-matematičkog fakulteta je na LXXV sjednici od 24.12.2021.godine uvrdilo

PREDLOG ODLUKE

o imenovanju komisije za ocjenu prijave doktorske disertacije

I

Imenuje se komisija za ocjenu prijave doktorske disertacije pod nazivom "Produkcija naelektrisanih leptonskih parova kroz Drel-Jan process u proton-proton sudarima na LHC-u" kandidatkinje Itane Bubanja, u sljedećem sastavu:

1. Prof. dr Nataša Raičević, redovni profesor na Prirodno-matematičkom fakultetu (naučna oblast: fizika elementarnih čestica),mentor;
2. Prof. dr Ivana Pićurić, redovni profesor na Prirodno-matematičkom fakultetu (naučna oblast: fizika elementarnih čestica), član;
3. Prof. dr Slobodan Backović, redovni profesor PMf-a u penziji, akademik CANU (naučna oblast: Fizika elementarnih čestica) član;
4. Dr Laurent Favart (komentor), senior istraživač u F.R.S- FNRS (Fond de la Recherche Scientifique), IIHE (Interuniversity Institute for High Energy Physics) i predavač na Univerzitetu ULB (Universite libre de Bruxelles) u Briselu (naučna oblast: fizika elementarnih čestica) i
5. Dr Hannes Jung, senior istraživač u Institutu DESY (Deutsches Elektronen Synchrotron) u Hamburgu (naučna oblast: Fizika elementarnih čestica).

II

Zadatak komisije je da podnese Izvještaj o ocjeni prijave doktorske disertacije Vijeću fakulteta u roku od 10 dana od dana javnog izlaganja studenta. Ukoliko komisija u navedenom roku ne podnese Izvještaj, imenovaće se nova komisija.

DEKAN
Prof. dr Predrag Miranović

PRIJAVA TEME DOKTORSKE DISERTACIJE

OPŠTI PODACI O DOKTORANDU	
Titula, ime i prezime	Itana Bubanja
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Radno iskustvo	01.10.2020 – 01.10.2022 – University Research Assistant – Faculty of Natural Sciences and Mathematics, University of Montenegro 2017 – CURRENT – Trainee researcher, member of CMS group of University of Montenegro and Université libre de Bruxelles (ULB) - CERN, Geneva, Switzerland 09.08.2019 – 14.08.2019 - Assistant at Summer Science School Ivanova Korita – Montenegrin Science Promotion Foundation PRONA 08.2018 - Assistant at Summer Science School Ivanova Korita – Montenegrin Science Promotion Foundation PRONA 09.10.2017 – 11.10.2017 - Lecturer at Open Science Days 2017 (Art@CMS) – Ministry of Science 26.06.2017 – 18.08.2017 - Summer student – CERN, Geneva, Switzerland 15.01.2017 – 15.10.2017 – Laboratory assistant – Faculty of Natural Sciences and Mathematics, University of Montenegro 26.09.2016 – 30.09.2016 - Lecturer at Open Science Days 2016 – Ministry of Science 16.08.2016 – 21.08.2016 - Assistant at Summer Science School Ivanova Korita – Montenegrin Science Promotion Foundation PRONA 21.09.2015 – 25.09.2015 - Lecturer at Open Science Days 2015 (CERN's exhibition) – Ministry of Science

Popis radova	/
NASLOV PREDLOŽENE TEME	
Na službenom jeziku	Produkcija naelektrisanih leptonskih parova kroz Drel-Jan proces u proton-proton sudarima na LHC-u
Na engleskom jeziku	Production of charged lepton pairs through the Drell-Yan process in proton-proton collisions at the LHC

Obrazloženje teme

The work of the thesis is in the field of particle physics i.e. high energy physics. The production of charged lepton pairs through the Drell-Yan (DY) process [1] from proton-proton (pp) collisions at a center of mass energy of 13 TeV is analysed. The focus is on transverse momentum distributions of the pairs. Transverse momentum is momentum projection on the plane perpendicular to the beamline. Protons with equal energies which collide head-on are accelerated at the Large Hadron Collider (LHC) [2] – the world's largest collider situated at CERN in Geneva. The experimental data to be analysed are obtained by the experimental apparatus of Compact Muon Solenoid (CMS) [3] – a complex multi-purpose detector system.

Protons are not pointlike particles but have many constituents: electrically charged quarks and antiquarks and neutral gluons (quarks and antiquarks are particles with fractional electric charge, $\pm 2/3e$ or $\pm 1/3e$). The gluons inside the proton hold the charged partons together via the strong force and the (anti)quarks interact themselves by exchanging gluons which are mediators of the strong force, described in detail within quantum chromodynamics (QCD) theory. Together, all constituents of the proton are called partons. The high-energy collision of protons is actually the collision of partons they are made of.

In the collision, a quark and an antiquark from the interacting protons can annihilate and create a boson. If their net charge and total flavor are zero, a virtual photon (γ^*) or Z boson is created and if this is not a case a W boson is created. The γ^* or Z boson decaying in a charge lepton and its antiparticle (l^+l^-) is called the Drell-Yan (DY) process. Such a lepton pair is produced after brief propagation of created neutral boson, γ^*/Z, after which it splits to an l^+l^- pair. Since in this process momentum has to be conserved, the momenta of l^+ and l^- add up to the momentum of γ^*/Z boson. If the lepton pair is created via virtual photon then it corresponds to an electromagnetic process while if it is created from the Z boson the process which occurs via the weak interaction has taken place. The invariant mass of the lepton pair corresponds to the mass of the γ^*/Z. For masses well below the rest energy of Z, the electromagnetic process is the dominant one while at masses around this value, the dominant mechanism is the creation of DY via the weak interaction. In this work, the creation of electron pairs (e^-e^+) and muon pairs ($\mu^-\mu^+$) will be analysed.

However, the DY mechanism, in reality, is not as simple as explained above. Real collisions also include the underlying events (UE) which consist of the beam-beam remnants (BBR) and particles that arise from multiple-parton interactions (MPI). The BBR is what is left after a parton is knocked out of each of the two initial proton beams. The MPI are additional soft or semi-hard parton-parton interactions that occur within the same pp collision.

Before their annihilation, quark-antiquark pairs that participate in the DY process can radiate gluons. Also, the interacting quark and antiquark from the protons can come not directly from the protons but produced by gluons of the protons. So, together with the dilepton pair (coming from a neutral boson which is created from one quark and one antiquark) there can be emission of additional partons. According to the QCD, through the process called hadronisation such partons materialize into several hadrons that are emitted within a narrow cone whose axis is along the direction of the initial parton. Such structures in high-energy physics are called hadronic jets.

Although less common, from time to time energetic jets (created from quarks and gluons) will be emitted alongside a neutral boson. Since the cross section, which is a measure of the process production rate, decreases with additional emissions (because of a small value of the strong coupling constant at high energy), producing a boson with more energetic jets is less likely than having fewer jets. Concerning the low energy jets (soft jets), the situation is different. DY pairs are easily accompanied by soft jets.

To gain in statistics, nowadays accelerators operate in the condition of high luminosity which provides a huge number of interactions per second and the experiments deal with the problem that the interaction i.e. the hard process of interest cannot be completely separated. The process of interest is contaminated by particles coming from another interaction – so-called pile-up. At the LHC the protons are accelerated in so-called bunches and each bunch consists of more than a billion of protons. The proton-proton collisions occur in the two bunch crossing. There are about 20 interactions per bunch crossing i.e. within 25 ns so the influence of the pile-up is significant. Since particles and jets emitted from pile-up are rather soft, their contribution is reduced by defining cuts on the energy of the detected objects to be considered. Hence, experiments are insensitive to very low energy products, and not everything from a pp collision will be recorded. Soft gluons, even if they cannot be individually reconstructed, still affect the process. Because the gluons carry away energy, due to momentum conservation the system will be slightly pushed and somewhat kicked in different directions. Therefore by measuring the momentum of the emitted γ^*/Z boson we can get information about soft processes even if undetected and identified them experimentally.

The perturbation theory is the tool used to calculate the probability of some process happening during a pp collision. It assumes that the emitted objects (particles and jets) have much higher energy than the proton at rest and is therefore not applicable to the situation where we have an emission of soft gluons. Therefore, for this low-energy part, the modeling of the soft processes has to be done and compared with experimental results.

Pregled istraživanja

Because of its great importance and significant scientific relevance for the Standard Model physics and physics Beyond the Standard Model, the analysis of emission of DY has been performed in experimental and in theoretical particle physics research for many years.

In this part, the recent experimental research obtained from LHC experiments will be mentioned, also the CMS conclusion results will be reviewed in more detail.

Several measurements of the DY process have been performed by the LHC experiments at the different center of mass energies $\sqrt{S}$: CMS [4–10], ATLAS [11–15], and LHCb [16–20].

CMS collaboration performed measurements of the inclusive Z production cross sections using data samples from pp collision events at $\sqrt{S}$ = 7 TeV collected in 2010 and corresponding to an integrated luminosity of 36 pb^{-1} [4]. The inclusive production cross sections of W^+ and W^- have also been measured separately as well as the ratios of the W^+/W^- and W/Z production cross sections. The measurement of the W/Z cross-section ratio also leads to an indirect determination of the W width, Γ (W), which is in agreement with the current world average.

CMS collaboration reported the measurements of the Drell–Yan differential cross section in pp collisions at $\sqrt{S}$ = 7 TeV from a data sample collected with the CMS detector, corresponding to an integrated luminosity of 36 pb^{-1} [5]. The cross section measurement, normalized to the measured cross section in the Z region, is reported for both the dimuon and dielectron channels in the dilepton invariant mass range 15-600 GeV. The normalised cross section values are quoted

both in the full phase space and within the detector acceptance. The results are found to agree with theoretical predictions.

CMS collaboration presented measurements of the Drell–Yan differential cross section on invariant mass of the pair, $d\sigma/dm$, in the dimuon and dielectron channels for the mass range $15 < m < 1500$ GeV based on integrated luminosity of 4.5 (4.8) fb^{-1} in the dimuon (dielectron) channel of proton-proton collisions at $\sqrt{S} = 7$ TeV [6]. The double-differential cross section $d^2\sigma/dmd|y|$ (y being rapidity of the pair) was also measured in the dimuon channel for the mass range $20 < m < 1500$ GeV. The inclusive Z cross section measurements in the mass range $60 < m < 120$ GeV are also presented and these were the most precise measurements of the Z cross section at a hadron collider at that time.

CMS collaboration performed measurements of the Drell–Yan differential cross section $d\sigma/dm$ and the double-differential cross section $d^2\sigma/dmd|y|$ with proton-proton collision data collected with the CMS detector at the LHC at a center-of-mass energy of 8 TeV corresponding to an integrated luminosity of 19.7 fb^{-1} [7]. In addition, the first measurements of the ratios of the normalized differential and double-differential cross sections for the DY process at center-of-mass energies of 7 and 8 TeV in bins of dilepton invariant mass and absolute rapidity are presented.

Using the channel of Z bosons decaying to muons, CMS collaboration measured the double differential Z boson fiducial cross section in transverse momentum, p_T, and the absolute value of rapidity $|y|$ in pp collisions at 8 TeV corresponding to an integrated luminosity of 19.7 fb^{-1} [8]. The results are compared to the next-to-next-to-leading-order predictions and they agree within the scale uncertainties. Deviations from the data of up to 20% at high transverse momentum are observed in comparison with theoretical predictions. The results are presented along with the full covariance matrix to enable their use in future fits of the momentum distribution functions of partons from protons.

The first paper from the CMS collaboration presenting results of DY pair distributions at 13 TeV was published in 2019 and corresponding to an integrated luminosity of 2.8 fb^{-1}[9]. The paper presents measurements of the total and fiducial Drell–Yan differential cross sections $d\sigma/dm$ in the dimuon and the dielectron channels as well as their combination, in the dilepton invariant mass range $15 < m < 3000$ GeV.

CMS collaboration in 2019 reported the measurements of the differential cross sections for Z bosons produced in proton-proton collisions at $\sqrt{S} = 13$ TeV and decaying to dimuons and dielectrons. The data set used corresponds to an integrated luminosity of 35.9 fb^{-1} [10]. Distributions of the transverse momentum p_T, the angular variable ϕ^* (a variable which is highly correlated with p_T and is used to probe the low p_T region in a complementary way – will be discussed below), and the rapidity of lepton pairs are measured. The uncertainties in the normalized cross section measurements are smaller than 0.5% for ϕ^* in the region $\eta < 0.5$ and for transverse momentum of Z boson smaller than 50 GeV.

The CMS collaboration has new preliminary results on the measurement of mass dependence of the transverse momentum of Drell Yan lepton pairs in proton-proton collisions at $\sqrt{S} = 13$ TeV. University of Montenegro participated in this analysis. The double differential cross sections of the Drell-Yan lepton pairs production (e^+e^- and $\mu^+\mu^-$), as a function of its invariant mass (from 50 GeV to 1 TeV), transverse momentum, p_T, and ϕ^* are measured. Drell-Yan masses from 50 GeV up to 1 TeV are investigated. Additionally, a measurement is performed requiring at least one jet in the final state. To benefit from partial cancellation of the systematic uncertainty, the ratios of the differential cross sections in p_T and ϕ^* for the mass bins around the Z mass peak over the one on the Z mass peak are also obtained. The collected data correspond to an integrated luminosity

of 36.3 fb^{-1} of proton-proton collisions recorded with the CMS detector at the center-of-mass energy of 13 TeV in 2016. Measurements are compared to several theoretical predictions based on QCD including soft gluon emission.
As said above, the p_T distribution of dilepton pairs i.e. the created boson is sensitive to the soft parton emission processes. Theoretical predictions make certain approximations about the calculation of the contribution of processes with a low energy gluon radiation called soft gluon factorization which includes the generalization to an arbitrary number of emitted gluons [21]. Such a process is named soft gluon resummation and was first described in the work of Collins, Soper, and Sterman in 1985 [22].

Cilj i hipoteze

The main goal of the thesis is to obtain DY differential cross section measurements as a function of the transverse momentum and ϕ^* of the pair in a wide range of pair invariant mass using complete statistics of data collected by CMS during the Run II period of LHC running. Therefore, this is expected to be the highest precision measurement of the DY differential cross sections obtained so far in CMS collaboration.
The measurements to be obtained in this thesis are the following:

1. Detector distributions for all relevant variables of the DY pairs for both dielectron and dimuon channels: lepton momentum, lepton rapidity, invariant mass of the pairs, pair rapidity, transverse momentum of the pairs (p_T), variable $\phi*$ of the pairs.
2. Comparison of the above detector distributions obtained from data and the full Monte Carlo (MC) simulation. The MC simulation includes a detailed simulation of all CMS detector component responses including simulation from physics contribution of lepton pairs and all significant sources of background from pp collisions.
3. Measurement of inclusive differential cross sections in dilepton transverse momentum in different invariant mass intervals for 2016, 2017, and 2018 data and their combination.
4. Ratios of inclusive differential cross section in dilepton momentum in different invariant mass intervals and the inclusive differential cross section in the Z peak region for each year and the combined ones.
5. Measurement of inclusive differential DY cross section in variable ϕ^* in different invariant mass intervals for 2016, 2017, and 2018 data and their combination.
6. Ratios of inclusive DY differential cross section in variable $\phi*$ in different invariant mass intervals and the inclusive differential cross section in the Z peak region for each year and the combined ones.
7. Measurement of inclusive one energetic jet differential cross sections in dilepton transverse momentum in different invariant mass intervals for 2016, 2017, and 2018 data and their combination.
8. Ratios of inclusive one energetic jet differential cross section in lepton pair momentum in different invariant mass intervals and the inclusive differential cross section in the Z peak region for each year and the combined ones.
9. Comparison of the above measurements with most recent theoretical predictions including different scenarios in QCD and the soft gluon resummation.
10. Comparison of the above measurements with theoretical predictions including different tunings for underlying events available at CMS.

Hypothesis 1: The detector distributions for e^+e^- and $\mu^+\mu^-$ pairs are well reproduced by the full Monte Carlo simulation.

Hypothesis 2: The total uncertainty of inclusive DY differential cross section measurements and the ratios are improved in comparison to the previous measurements from CMS.

Hypothesis 3: Three times larger statistics provide finer binning of inclusive DY differential cross section measurements and the ratios in comparison to the previous measurements from CMS.

Hypothesis 4: The inclusive DY differential cross section measurements and the ratios are reproduced by theoretical models which include QCD and different scenarios of soft gluon resummation.

Hypothesis 5: The inclusive DY differential cross section measurements and the ratios depend on the set of CMS tunes of underlying events.

Hypothesis 6: The DY differential cross section measurements where at least one energetic jet in the final state is required and the ratios are reproduced by theoretical models which include QCD and different scenarios of soft gluon resummation.

Hypothesis 7: The DY differential cross section measurements where at least one energetic jet in the final state is required and the ratios depend on the set of CMS tunes of underlying events.

Materijali, metode i plan istraživanja

Material

The experimental material used in this thesis is obtained by using CMS detector at CERN in Geneva from 2016 to 2018 (Run II period of data collection).
For the simulation of DY signal created through the Z/γ^* process, including also the $\tau^+\tau^-$ background, MADGRAPH5 at NLO, AMC@NLO, with the FxFx merging scheme [23] is used. The parton shower, hadronisation, and QED final state radiation will be performed with PYTHIA8 [24] using the CP5 or CUETP8M1 tune for underlying events [25]. The matrix element (ME) includes Z + 0, 1, 2 jets at NLO, giving a leading order accuracy for Z + 3 jets. The next-to-leading-order NLO NNPDF 3.0 [26] is used for the ME calculation. The native cross section obtained directly from the generator will be used to normalise the prediction in control plots and for comparing to the measurement.
Experimentally reconstructed lepton pairs are not coming only from DY process but will contain pairs from other processes - background processes.
Several physical and instrumental backgrounds contribute. The main backgrounds in the region of high invariant masses (above the Z peak) are due to $t\bar{t}$ and diboson production followed by leptonic decays, while the DY production of $\tau^+\tau^-$ pairs is the dominant source of background in the region just below the Z peak. At low values of the dimuon invariant mass (up to 40 GeV), most of the background events are due to QCD events with multiple jets. The situation is slightly different for electrons in the final state. At low values of dielectron invariant mass, most of the background events are from $\tau^+\tau^-$ and $t\bar{t}$ processes, whereas the contribution from the QCD multijet process is small due to the tighter selection for electrons compared to muons. The pairs from such background processes have to be estimated and subtracted from the measured sample.

For each set of the MC samples, the detector response on particle passage through it is simulated using a detailed description of the CMS detector material and acceptance based on the GEANT4 package [27]. The simulated events are reconstructed using the same software as the real data.

Methods

CMS detector has a compact structure with many subdetectors systems. The central part of CMS detector is a large superconducting solenoid with a length of 12.5 m and a radius of 6 m. The value of the magnetic field that can be produced using this solenoid is 4T. The tracking detector, the electromagnetic calorimeter (ECAL), and the hadron calorimeter (HCAL) are all installed inside the solenoid. Outside the solenoid, the iron return yoke of the magnet is placed, interleaved with layers of muon detector.
Particle Flow algorithm (PF) is used by CMS collaboration for reconstruction and identification of particles. PF combines the information of all the CMS subdetectors. It ensures the best possible identification and energy measurements for all types of objects. From tracker and muon system information about tracks of particles are taken and from the ECAL and HCAL, the position, energy and time of arrival of particles can be determined. PF algorithm is used for the identification and reconstruction of electrons, muons, photons, neutral and charged hadrons. It also plays role in jet reconstruction and missing transverse momentum determination. The reconstruction process of some of the particles used in this analysis can be described shortly as follows:

- Electrons and photons – They deposit all their energy only in the ECAL. As they propagate through the material of the detector they interact with the material. As a result of these interactions, they may no longer be detected as a single particle but they can form a shower of multiple electrons and photons. The energy deposits these particles leave in the ECAL are called super-clusters. In addition, electrons leave hits in the tracker layers.
- Charged and neutral hadrons – These particles are identified inside the HCAL and ECAL. Although they initiate a shower in ECAL, it is fully absorbed in the HCAL. Charged hadrons leave hits inside the tracker and corresponding clusters in the HCAL are used to determine their position and energy. Neutral hadrons are identified as energy deposits in the ECAL and HCAL that cannot be matched with hits in the tracker. For each event, hadronic jets are clustered from these reconstructed particles using the anti-k_T algorithm with a distance parameter of 0.4. Jet momentum is determined as the vector sum of all particle momenta in the jet.
- Muons – They ionize the gas in the muon chambers, thus the electric signal is produced on wires and strips. This signal together with the signal obtained from the tracker is used for the determination of muon properties.

The position along the beam axis where the pp interaction happens is called a vertex. For high pile-up, many vertices belong to the main event, but one is called a primary vertex. The candidate vertex with the largest value of summed physics-object transverse momenta squared is taken to be the primary vertex of pp interaction. The physics objects are the jets, reconstructed using the jet-finding algorithm with the tracks (also including electrons and muons) assigned to candidate vertices as inputs, and the associated missing transverse momentum, taken as the negative vector sum of the transverse momenta of those jets.
Events of interest are selected using a two-tiered trigger system. The first level trigger, consisting of hardware processors, uses signals from the calorimeters and muon detectors to select events.

The rate of the L1 is at around 100 kHz within a fixed latency of about 4 μs. The second level trigger, known as the high-level trigger (HLT), contains information from a farm of processors running a version of the full event reconstruction software optimized for fast processing. HLT reduces the event rate to around 1 kHz before data storage.

In this analysis, the event selection proceeds via several steps:

- The two most energetic lepton candidates of the same flavor, but different electric charge signs are selected. The cuts on the lepton transverse momenta depend on available triggers. The leptons are required to be well reconstructed i.e. identified and isolated and to achieve this, additional cuts are applied;
- The lepton candidate must be emitted within the detector acceptance so the lepton pseudorapidity is limited to $|\eta| < 2.4$;
- Tracks not belonging to the primary vertex are identified as pile-up contribution and are not considered for jet energy and momentum;
- The two selected leptons are not taken into account in the jet collection if they are enough separated from it. A separation $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$ is measured with $\Delta\eta$ and $\Delta\varphi$ being differences in pseudorapidity and azimuthal angle between lepton candidate and jet directions. ΔR between the reconstructed jets and the lepton candidates is required to be larger than 0.4;
- The pile-up contamination is further reduced by requiring the jet to have a minimum transverse momentum and good quality of the track reconstruction. Selected jet has to be in a rapidity range of $|y| \leq 2.4$;
- Identified so-called b tagged jets are vetoed to reduce the contribution from the $t\bar{t}$ background.

Monte Carlo simulation of the detector responses, resolution, and efficiencies has to be as close as possible to the experimental situation which also means that the efficiencies of the applied cuts have to be reproduced. To achieve this, the additional scale factors will be applied to Monte Carlo simulated events.
The overall detector resolution and efficiency will be corrected by the unfolding procedure.
Reconstruction of simulated events will be done in the same way as for the experimental data. In order to analyse both experimental and simulated data, the programming languages C++ and Python in CMS software environment will be used. The analysed distributions will be plotted in ROOT [28] which is a widely used software package in particle physics.

Research plan

To obtain each of the above-listed cross section measurements, a common set of steps will be performed. The steps are the following:

- Event selection;
- Efficiency corrections implementation;
- Backgrounds estimation;
- Background subtraction;
- Yield unfolding;

- Correction for the effects of the migration of events among different bins of measured variables due to the detector resolution;
- Application of the acceptance and efficiency corrections;
- Correction of the migration of events due to final state radiation;
- Evaluation of systematic uncertainties associated with each of the analysis steps;
- Comparison with several theoretical predictions.

Očekivani naučni doprinos

Since the DY production of lepton pairs in hadronic collisions proceeds as a result of the collision of hadron constituents (partons), the expected high precision measurement will provide very important insights into the internal structure of hadron as well as the parton evolution.
The lowest order or the leading order (LO) DY production is described as a so-called s-channel exchange of Z and γ^* bosons. In such a process, a quark from one proton and an antiquark from another proton annihilate to a neutral vector boson by the electroweak process. The Z/γ^* exchange factorises to collinear quark and antiquark proton parton distribution functions (PDF). In this case, the DY pair transverse momentum is equal to zero. If there is initial state radiation (ISR) then we are dealing with higher-order processes. This ISR is QCD radiation since it is connected with radiation of gluons from incoming partons which gives rise to sizable DY pair p_T. The contribution of an additional emission contains multiplication with the coupling constant which is sizable for low energy or soft processes. Hence, the region of large pair p_T which is the result of hard QCD radiation is expected to be described with fixed-order calculation in perturbative QCD (pQCD) due to the small value of running strong coupling constant while the region of small pair p_T requires the soft gluon resummation to all orders. Also, the small p_T region includes the effect of internal transverse motion of the partons inside of the colliding protons which should be extracted from data and modeled using parameterizations. Hence, the pair p_T measurements provide a test of the validity of the general approach and the precision of the different model predictions. Inclusive DY production calculations can be performed as a function of pair invariant mass and pair p_T and are available up to next-to-leading-order (NLO) in the electroweak coupling and up to next-to-next-to-leading-order (NNLO) in pQCD [29–32]. Therefore, a precision measurement of the DY mass and p_T differential cross sections at the LHC provides an important test and input for the perturbative framework of the Standard model. In a complementary way, the experimental measurements can also be used to constrain the PDFs.
The leptons from the final state pair can radiate photons (radiation of Quantum Electrodynamics – QED) which will certainly affect the DY p_T spectrum. This radiation is called QED final state radiation. Such radiation will also have an impact on pair mass distribution, especially for masses below Z boson mass where migrations from the Z peak can be significant. MC simulations that perform parton showering, such as Pythia8, include QED radiation from Z boson decay at leading order which could be confirmed with high statistics sample of Z bosons recorded at LHC. This study is also important to evaluate the NLO electroweak corrections available in MadGraph5_aMC@NLO.
High statistics of DY production of dileptons is also a major source of background for rare processes from the Standard Model as well as searches for physics beyond the Standard Model. Therefore, it is important to measure the DY production rate accurately up to the largest accessible energy.

Spisak objavljenih radova kandidata

There has not been a publication yet. There are several preprints in which the candidate is a coauthor.

Popis literature

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10. CMS Collaboration, „Measurements of differential Z boson production cross sections in proton-proton collisions at $\sqrt{S}$= 13 TeV", JHEP 12 (2019) 061.
11. ATLAS Collaboration, „Measurement of the inclusive W± and Z/γ * 536 cross sections in the electron and muon decay channels in pp collisions at $\sqrt{S}$ = 7 TeV with the ATLAS 538 detector", Phys. Rev. D 85 (2012) 072004.
12. ATLAS Collaboration, „Measurement of the high-mass Drell–Yan differential cross-section in pp collisions at $\sqrt{S}$ = 7 TeV with the ATLAS detector", Phys. Lett. B 725 542 (2013) 223.
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14. ATLAS Collaboration, „Measurement of the transverse momentum and φ* distributions of Drell–Yan lepton pairs in proton–proton collisions at $\sqrt{S}$= 8 TeV with the ATLAS 548 detector", Eur. Phys. J. C 76 (2016) 291.
15. ATLAS Collaboration, „Precision measurement and interpretation of inclusive W+ , W– and Z/γ* production cross sections with the ATLAS detector", Eur. Phys. J. C 77 (2017) 367.
16. LHCb Collaboration, „Inclusive W and Z production in the forward region at $\sqrt{S}$= 7 TeV", JHEP 06 (2012) 058.
17. LHCb Collaboration, „Measurement of the cross-section for Z → e^+e^- production in pp collisions at $\sqrt{S}$ = 7 TeV", JHEP 02 (2013) 106.

18. LHCb Collaboration, „Measurement of the forward Z boson production cross-section in pp collisions at $\sqrt{s}$= 7 TeV", JHEP 08 (2015) 039.
19. LHCb Collaboration, „Measurement of forward W and Z boson production in pp collisions at $\sqrt{s}$ = 8 TeV", JHEP 01 (2016) 155.
20. LHCb Collaboration, „Measurement of the forward Z boson production cross-section in pp collisions at $\sqrt{s}$ = 13 TeV", JHEP 09 (2016) 136.
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30. S. Catani et al., „Vector boson production at hadron colliders: a fully exclusive QCD 499 calculation at NNLO", Phys. Rev. Lett. 103 (2009) 082001.
31. S. Catani and M. Grazzini, „An NNLO subtraction formalism in hadron collisions and its 502 application to Higgs boson production at the LHC", Phys. Rev. Lett. 98 (2007) 222002.
32. K. Melnikov and F. Petriello, „Electroweak gauge boson production at hadron colliders through O(α 2 s 505)", Phys. Rev. D 74 (2006) 114017.

SAGLASNOST PREDLOŽENOG/IH MENTORA I DOKTORANDA SA PRIJAVOM

Odgovorno potvrđujem da sam saglasan sa temom koja se prijavljuje.

Prvi mentor	Nataša Raičević	N. Raičević
Drugi mentor	Laurent Favart	Laurent Favart
Doktorand	Itana Bubanja	Itana Bubanja

IZJAVA

Odgovorno izjavljujem da doktorsku disertaciju sa istom temom nisam prijavio/la ni na jednom drugom fakultetu.

U Podgorici,
21.12.2021.

Ime i prezime doktoranda

Itana Bubanja

UNIVERZITET CRNE GORE
PRIRODNO-MATEMATIČKI FAKULTET
FIZIKA
Broj dosijea: **1/2020**

Na osnovu člana 33 Zakona o upravnom postupku ("Službeni list CG", br. 56/14, 20/15, 40/16 i 37/17), člana 115 Zakona o visokom obrazovanju("Službeni list CG", br. 44/14, 52/14, 47/15, 40/16, 42/17, 71/17, 55/18, 3/19, 17/19, 47/19, 72/19, 74/20 104/21) i službene evidencije, a po zahtjevu studenta Bubanja Miloje Itana, izdaje se

UVJERENJE O POLOŽENIM ISPITIMA

Student **Bubanja Miloje Itana**, rođena **23-05-1994** godine u mjestu **Cetinje**, opština **Cetinje**, Republika **Crna Gora**, upisana je studijske **2020/2021** godine, u **I** godinu studija, kao student koji se **samofinansira** na **doktorske akademske studije**, studijski program **FIZIKA**, koji realizuje **PRIRODNO-MATEMATIČKI FAKULTET** - Podgorica Univerziteta Crne Gore u trajanju od **3 (tri)** godine sa obimom **180** ECTS kredita.

Student je položio ispite iz sljedećih predmeta:

Redni broj	Semestar	Naziv predmeta	Ocjena	Uspjeh	Broj ECTS kredita
1.	1	EKSPERIMENTALNE METODE U FIZICI VISOKIH ENERGIJA	"A"	(odličan)	10.00
2.	1	METODOL.NAUČNOG RADA I PREDSTAVLJANJE EKSPERIM.REZ	"A"	(odličan)	10.00
3.	1	VIŠI KURS FIZIKE ELEMENTARNIH ČESTICA	"A"	(odličan)	10.00
4.	1	VIŠI KURS KVANTNE MEHANIKE	"C"	(dobar)	10.00

Zaključno sa rednim brojem **4**.

Ostvareni uspjeh u toku dosadašnjih studija je:
- srednja ocjena položenih ispita **"A" (9.50)**
- ukupan broj osvojenih ECTS kredita **40.00** ili **66.67%**
- indeks uspjeha **6.33**.

Uvjerenje se izdaje na osnovu službene evidencije, a u svrhu ostvarivanja prava na: (dječji dodatak, porodičnu penziju, invalidski dodatak, zdravstvenu legitimaciju, povlašćenu vožnju za gradski saobraćaj, studentski dom, studentski kredit, stipendiju, regulisanje vojne obaveze i slično).

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ODLUKU
O IZBORU U ZVANJE

Dr NATAŠA RAIČEVIĆ bira se u akademsko zvanje **redovni profesor** Univerziteta Crne Gore za predmete: Elektromagnetizam i Fizika elementarnih čestica, na **Prirodno-matematičkom fakultetu.**

REKTOR
Prof.dr Predrag Miranović

Curriculum Vitae

Lični podaci

Ime i prezime: Nataša Raičević

Datum i mjesto rođenja: 12.08. 1970. Srbija

Djevojačko prezime: Saveljić

Strani jezici: engleski – aktivno znanje
ruski – dobro razumjevanje i čitanje

Kontakt

Adresa: Univerzitet Crne Gore, Prirodno-matematički fakultet, Džordža Vašingtona BB, 81000 Podgorica, Crna Gora

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Obrazovanje

1993 **Diplomirani fizičar**, Univerzitet Crne Gore, Prirodno-matematički fakultet (prosječna ocjena na studijama 9.90)

1997 **Magistar fizičkih nauka**, Univerzitet u Beogradu, Fizički fakultet (prosječna ocjena na studijama 10.0)

2000 **Doktor fizičkih nauka**, Univerzitet u Beogradu, Fizički fakultet

Studentske nagrade i priznanja

1990 Decembarska nagrada za najboljeg studenta Prirodno-matematičkog fakulteta

1993 Nagrada Univerziteta Crne Gore za najboljeg studenta završne godine Prirodno-matematičkog fakulteta Univerziteta Crne Gore za školsku 1992/93. godinu

Profesionalne pozicije

1993–1997 **Saradnik u nastavi** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

1997–2000 **Asistent** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici,

Crna Gora

2000–2005 **Docent** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

2005–2010 **Vanredni profesor** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

2010–danas **Redovni profesor** na Prirodno-matematičkom fakultetu Univerziteta Crne Gore u Podgorici, Crna Gora

Nastava

Vježbe na matičnom i nematičnim fakultetima (u zvanju saradnika i asistenta)

Elektromagnetizam, Optika, Statistička fizika, Fizika čvrstog stanja, Nuklearna fizika (PMF), Eksperimentalne vježbe na nematičnim fakultetima

Predavanja na predmetima (u zvanju docenta, vanrednog i redovnog profesora)

Elektromagnetizam – osnovne studije na Prirodno-matematičkom fakultetu

Fizika elementarnih čestica – specijalističke studije na Prirodno-matematičkom fakultetu

Računari i programiranje – osnovne studije na Prirodno-matematičkom fakultetu
Teorijska elektrodinamika - osnovne studije na Prirodno-matematičkom fakultetu

Viši kurs fizike elementarnih cestica 1 - magistarske studije na Prirodno-matematičkom fakultetu

Eksperiment u savremenoj fizici čestica - magistarske studije na Prirodno-matematičkom fakultetu

Viši kurs fizike elementarnih čestica - magistarske studije na Prirodno-matematičkom fakultetu

Biofizika na Medicinskom fakultetu

Poglavlja iz fizike u okviru predmeta Fiziologija na Medicinskom fakultetu

Oblast istraživanja

Eksperimentalna fizika elementarnih čestica

1995 – 1999 Član međunarodne istraživačke kolaboracije eksperimenta CERES u laboratoriji CERN u Ženevi (akcelerator SPS)

1995–1996 Testiranje performansi trigera prvog nivoa na eksperimentu CERES
Ujedinjeni institut za nuklearna istraživanja u Dubni, Rusija

1996-1997 Unapređenje softvera za analizu događaja sa eksperimenta CERES – rekonstrukcija verteksa za interakciju jezgara olova sa segmentisanom metom od zlata
Ujedinjeni institut za nuklearna istraživanja u Dubni, Rusija

1996–1999 Proučavanje emisije e^-e^- parova u interakcijama teških jona
Fizički institut Univerziteta u Hajdelbergu, Njemačka
Univerzitet Crne Gore

2002– Član međunarodne istraživačke kolaboracije eksperimenta H1 u laboratoriji DESY u Hamburgu, Njemačka (akcelerator HERA)
Ova istraživanja realizovana su na Univerzitetu Crne Gore i kroz veći broj višemjesečnih boravaka godišnje na institutu DESY u Hamburgu i Berlinu.

2002-2005 Analiza podataataka za mjerenje efikasnog presjeka za duboko neelastično rasijanje elektrona (pozitrona) na protonu pri malim i srednjim vrijednostima kvadrata predatog kvadri-impulsa

2004-2005 Rad na unapređenju softverskog rješenja za simulaciju kaskada čestica u kalorimetru H1 eksperimenta koji detektuje elektrone sa malim uglom rasijanja

2005-2007 Analiza podataataka za mjerenje efikasnog presjeka za duboko neelastično rasijanje elektrona (pozitrona) na protonu pri velikim vrijednostima neelastičnosti interakcije

2006-2007 Učešće u priprema seansi za e^-p interakcije sa redukovanim energijama protona sa HERA akceleratora (kroz analizu tada postojećih eksperimentalnih podataka)

2007-2011 Mjerenje longitudinalne strukturne funkcije protona

2017- Član međunarodne istraživačke kolaboracije eksperimenta CMS u laboratoriji CERN u Ženevi, Švajcarska (akcelerator LHC)

2017 – Analiza produkcije Drell-Yan parova u proton-proton interakcijama.

Projekti (sa rukovodećom ulogom)

2004–2007 Učesnik na međunarodnom projektu finansiranom od strane DFG-a (Deutsche Forchungsgemeinschaft): **„Präzisionsmessungen und Analyse der Elektron-Quark-Wechselwirkung bei höchsten Energien sowie suche nach Phänomenen außerhalb des Standardmodels"**, broj **GZ:436JUG113/3/0-1**, odobren 2007. godine (partnerske strane: Univerzitet Crne Gore, institut DESY u Hamburgu, institut DESY-Zeuthenu u Berlinu i institut Max Planck u Minhenu).

2007–2010 Produžetak prethodnog projekta od DFG, pod brojem **GZ:436JUG113/3/0-2**

2005–2007 Rukovodilac naučno-istraživačkog projekta odobrenog od Ministarstva prosvjete i nauke Crne Gore **„H1 eksperiment na HERA akceleratoru"**

2008–2011 - Rukovodilac naučno-istraživačkog projekta odobrenog od Ministarstva prosvjete i nauke Crne Gore **„Duboko neelastično rasijanje elektrona (pozitrona) na protonu"**

2012-2015 - Rukovodilac naučno-istraživačkog projekta odobrenog od Ministarstva nauke Crne Gore **„Završna faza analiza H1 kolaboracije"**.

2019 – 2023 – Ključni partner u projektu odobrenog u program **HORIZONT2020 „The strong interaction at the frontier of knowledge: fundamental research and applications".**

Učešće u radu upravljačkih struktura velikih kolaboracija

2004–2012 učešće u radu Upravnog odbora H1 kolaboracije koji donosi najvažnije odluke za kolaboraciju

2007–2009 član Izvršnog odbora H1 kolaboracije

2012-2014 član Upravnog odbora H1 kolaboracije

2017- član Upravnog odbora CMS kolaboracije

Učešće u radu tijela/centara čiji je rad povezan sa obrazovanjem

2015-2017 – član Nacionalnog savjeta za obrazovnje Crne Gore

2015-2017 – član Odbora za obrazovnje Crne Gore

Od 2015 – član Centra za studije i kontrolu kvaliteta Univerziteta Crne Gore

Od 2015 – član Odbora za monitoring magistarskih studija Univerziteta Crne Gore

Od 2016 – član Vijeća za prirodne i tehničke nauke Univerziteta Crne Gore

Informatička pismenost

Operativni sistemi: UNIX i WINDOWS

Programski jezici: fortan, C, python

Nataša Raičević

Bibliografija

Odabrani radovi

1. Fast simulation of electromagnetic and hadronic showers in SpaCal calorimeter at the H1 experiment, AIP Conf.Proc. 1722 (2016) 210003. **

2. Combination of measurements of inclusive deep inelastic $e^{\pm}p$ scattering cross sections and QCD analysis of HERA data, Eur.Phys.J. C75 (2015) no.12, 580.

3. N. Raičević, Recent Results from HERA on the Proton Structure, Acta Phys.Polon.Supp. 7 (2014) 3, 439. **

4. N. Raičević, Precision Tests of QCD at HERA, Acta Phys.Polon.Supp. 6 (2013) 3, 985. **

5. N. Raičević, A. Glazov and A. Zhokin, Shower library technique for fast simulation of showers in calorimeters of the H1 experiment., Nucl.Instrum.Meth. A718 (2013) 104.

6. N. Raičević, Measurement of the diffractive DIS cross section at the H1 experiment, Rom. Rep. Phys. 65 (2013) 427. **

7. N. Raičević, Precision measurement of the proton structure at HERA, Rom.Rep. Phys. 65 (2013) 103. **

8. H1 Collaboration (F. D. Aaron,..N. Raičević *et al.*), Measurement of the Inclusive ep Scattering Cross Section at High Inelasticity y and of the Structure Function FL, Eur. Phys. J. C71 (2011) 1579.

9. A. Glazov, N. Raičević and A. Zhokin, Fast simulation of showers in the H1 calorimeter, Comput. Phys. Commun. 181 (2010) 1008.

10. N. Raičević, Measurements at high Q^2 and searches at the ep energy frontier, Nucl. Phys. Proc. Suppl. 207-208 (2010) 125. **

11. N. Raičević, HERA results and their impact for LHC, Nucl. Phys. Proc. Suppl. 198: (2010) 75. **

12. N. Raičević, Measurement of proton structure and parton density functions from HERA, AIP Con. Proc. 1203 (2010) 85. **

13. N. Raičević, Measurement of the proton structure function $F_L(x, Q^{**2})$ with the H1 experiment, AIP Con. Proc. 1203 (2010) 79. **

14. H1 Collaboration (F. D. Aaron,..N. Raičević *et al.*), A Precision Measurement of the Inclusive ep Scattering Cross Section at HERA, Eur. Phys. J. C64 (2009) 561.

15. N. Raičević, Proton structure and QCD dynamics at low x, Nucl. Phys. Proc. Suppl. 181-182 (2008) 57. **

16. N. Raičević, Measurement of the neutral current DIS cross section at H1, J. Phys. Con. Ser. 110 (2008) 022042. **

17. H1 Collaboration (F. D. Aaron,..N. Raičević *et al.*), Measurement of the Proton Structure Function $F_L(x, Q^2)$ at Low x, Phys. Lett. B665 (2008) 139.

18. N. Raičević, Measurement of the longitudinal structure function from e p collisions with the H1 detector at HERA, AIP Con. Proc. 899 (2007) 575. **

19. N. Raičević, Measurement of the inclusive e p deep inelastic scattering cross section at low Q^2 with the H1 detector at HERA, AIP Con. Proc. 899 (2007) 217. **

20. CERES/NA45 Collaboration (G. Agakichiev,..N. Saveljić et al.), e+e- pair production in Pb-Au collisions at 158-GeV per nucleon, Eur. Phys. J. C41 (2005) 475.

21. CERES/NA45 Collaboration (G. Agakichiev,..N. Saveljić et al.), Recent results from Pb - Au collisions at 158-GeV/c per nucleon obtained with the CERES spectrometer, Nucl. Phys. A 661 (1999) 23.

22. CERES/NA45 Collaboration (G. Agakichiev,..N. Saveljić et al.), CERES results on low mass electron pair production in Pb Au collisions, Nucl.Phys.A638 (1998) 159.

23. G. Agakishiev,.. ,..N. Saveljić *et al.*, A New robust fitting algorithm for vertex reconstruction in the CERES experiment, Nucl. Instrum. Meth. A 394 (1997) 225.

Odabrani radovi u zbornicima međunarodnih konferencija

24. N. Raičević, High y DIS cross section measurement with H1, Proceedings of 15th International Workshop on Deep-Inelastic Scattering and Related Subjects, Munich, Germany, April 2007, vol. 1, 293, editors: G. Grindhammer, K. Sachs. ISBN 978-3-935702-23-2. **

25. N. Raičević, Structure functions and extractions of PDFs at HERA, Proceedings of 41st Rencontres de Moriond: QCD and Hadronic Interactions, La Thuile, Italy, 18-25 March 2006, 181, editors: Etienne Auge and Jean Tran Thanh. e-Print: hep-ex/0605050. **

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Svi navedeni kolaboracioni radovi su radovi sa preko 100 citata tzv. **TOPCITE:100+** u bazama podataka.

Kompletna lista od oko 140 referentnih radova u kojima je N. Raičević autor ili koautor nalazi se u bazi podataka na web-stranicama

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DR IVANA PIĆURIĆ bira se u akademsko zvanje **redovni profesor** Univerziteta Crne Gore za predmete: Fizička mehanika, na Studijskom programu Fizika na Prirodno-matematičkom fakultetu i Fizika na nematičnim fakultetima.

REKTOR
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CURRICULUM VITAE

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Obrazovanje

2002 Univerzitet u Beogradu, Beograd
PhD Eksperimentalna fizika elementarnih čestica

1996 Univerzitet u Beogradu, Beograd.
MSc Eksperimentalna fizika elementarnih čestica

1990 Univerzitet Crne Gore, Podgorica
Prirodno-matematički fakultet,
Odsjek za fiziku

Nastava i istrživački rad

1991-2002 Asisitent saradnik na PMF Univerziteta Crne Gore.

2002-2007 Docent na Univerzitetu Crne Gore.

2007-2013 Vanredni profesor na Univerzitetu Crne Gore.

2013 Redovni profesor na Univerzitetu Crne Gore.

2009-2016 Rukovodilac Studijskog programa Fizika na PMF-u Univerziteta Crne Gore.

2006- Član međunarodne istraživačke kolaboracije H1 iz oblasti fizike visokih energija

Projekti:

2006-2008 **Prazisionsmessungen und Analyse der Electron-Quark-bei Wechselwirkung The highest Energien sowie suche nach des Phanomenen auerhalb Standardmodel financed by the German Research Foundation DFG (Deutschen Forschungsgemeinschaft).**

2006-2008	H1 eksperiment na HERA akceleratoru
2008-2012	Duboko neelastična elektron (pozitron) proton rasejanja
2012-2016	Završna faza analiza H1 kolaboracije

Reference **2000-2019**:

1. *Determination of electroweak parameters in polarised deep-inelastic scattering at HERA*

H1 Collaboration (V. Andreev (Lebedev Inst.) et al.). Jun 4, 2018. 36 pp. Published in **Eur.Phys.J. C78 (2018) no.9, 777**

2. *Combination and QCD analysis of charm and beauty production cross-section measurements in deep inelastic epep scattering at HERA*

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NA OSNOVU ČLANA 97. ZAKONA O UNIVERZITETU ("SL.LIST RCG" 37/92), ČLANA 18. ZAKONA O IZMJENAMA I DOPUNAMA ZAKONA O UNIVERZITETU ("SL.LIST RCG" 6/94) I ČLANA 94. STATUTA UNIVERZITETA CRNE GORE, NAUČNO-NASTAVNO VIJEĆE UNIVERZITETA NA SJEDNICI ODRŽANOJ 30. 06. 1994. GODINE, DONIJELO JE

O D L U K U

O POTVRDJIVANJU IZBORA Dr SLOBODANA BACKOVIĆA

U ZVANJE REDOVNOG PROFESORA UNIVERZITETA CRNE GORE

ZA PREDMETE Fizika I i Nuklearna fizika

ZA RAD NA NEODREDJENO VRIJEME SA PUNIM RADNIM VREMENOM NA Prirodno-matematičkom fakultetu u Podgorici

PRAVNA POUKA: Protiv ove Odluke lica koja smatraju da su im povrijedjena prava imaju pravo žalbe Naučno-nastavnom vijeću Univerziteta Crne Gore u roku od 15 dana.

R E K T O R

PROF. DR BOŽIDAR NIKOLIĆ

UNIVERZITET "VELJKO VLAHOVIĆ"
PRIRODNO-MATEMATIČKI FAKULTET
Broj: 651
Titograd, 21.05.1991. godine

Na osnovu člana 60. Statuta Prirodno-matematičkog fakulteta u Titogradu, Savjet ovog Fakulteta na sjednici održanoj dana 29.05.1991. godine donio je sledeću -

O D L U K U

Dr SLOBODAN BACKOVIĆ, bira se u zvanje redovnog profesora za predmete FIZIKA I i GRUPU PREDMETA IZ NUKLEARNE FIZIKE na Odsjeku za fiziku, za rad na neodredjeno vrijeme sa punim radnim vremenom.

- SAVJET PRIRODNO-MATEMATIČKOG FAKULTETA -

DOSTAVLJENO:
- Imenovanom
- Dosije
- a/a

PREDSJEDNIK SAVJETA,
Mr.Aleksandar Mardjokić

SLOBODAN BACKOVIĆ

Rođen je 3. septembra 1946. godine u Nikšiću gdje je završio osnovnu školu i gimnaziju. Prirodno-matematički fakultet, Odsjek za fiziku, završio je u Beogradu. Od 1969. do 1972. godine radio je u gimnaziji u Nikšiću kao profesor fizike. Na postdiplomske studije, na PMF-u u Beogradu (Odsjek za fiziku – smjer Eksperimentalna nuklearna fizika), upisao se 1973. godine, kada je počeo i da radi u Institutu za fiziku Univerziteta u Beogradu (Laboratorija za fiziku visokih energija). U to vrijeme radio je honorarno kao asistent-pripravnik Odsjeka za fiziku PMF-a i Farmaceutskog fakulteta. Magistarski rad "Multiplicitet naelektrisanih čestica nastalih u interakciji protona od 200 GeV sa jezgrima nuklearne emulzije" odbranio je u januaru 1976. godine, poslije čega odlazi na naučnu specijalizaciju u Ujedinjeni institut za nuklearna istraživanja (Laboratorija za fiziku visokih energija), u Dubnu (Rusija).

Na specijalizaciji je radio u međunarodnoj grupi fizičara u oblasti visokoenergetske fizike (visokoenergetske interakcije čestica i jezgara sa jezgrima). U Dubni ostaje do avgusta 1978. godine. Doktorsku disertaciju "Interakcija p–mezona impulsa 40 GeV/*c* sa jezgrom ugljenika" odbranio je 1979. godine na PMF-u u Beogradu. U Titograd prelazi 1. oktobra 1979. godine gdje počinje da radi u Institutu za matematiku i fiziku. Iste godine je izabran u zvanje docenta. U zvanje vanrednog profesora izabran je 1985. godine, a redovnog 1991. godine.

U Institutu za matematiku i fiziku više godina bio je šef Odsjeka za fiziku (1980–1986. i 1994–1996), a od 1986. do 1990. i od 1998. do 2002. godine direktor Instituta, odnosno dekan Prirodno-matematičkog fakulteta. Od 1990. do 1994. godine bio je prorektor za nastavu Univerziteta Crne Gore. Od 2003. do 2008. godine godine bio je ministar prosvjete i nauke u Vladi RCG.

Naučnoistraživački rad posvećen je visokoenergetskim interakcijama čestica i jezgara i jezgara sa jezgrima i odvijao se u okviru međunarodne kolaboracije koja radi na višegodišnjem projektu "Izučavanje kvark-hadronske strukture nuklearne materije, nalaženje i izučavanje svojstava egzotičnih pojava u sudarima relativističkih jezgara". Bio je rukovodilac višegodišnjeg naučnog projekta "Nuklearna fizika sa primjenama" (1987–1990. i 1991–1995), a tema na kojoj je radio bila je uključena u jugoslovenski projekat "Eksperimantalna fizika elementarnih čestica, srednjih energija i teških jona u međunarodnim centrima". Rukovodio je projektom "Visokoenergetske interakcije jezgara" (1997–1998) kao i međunarodnim projektima koje su finasirali UNESCO"High energy nucleus-nucleus interactions" (1998–1999) i WUS "High energy nucleus-nucleus and hadron-hadron interactions" (1999). Radio je u evropskoj kolaboraciji H1 (DESY Hamburg). Na ovim projektima pod mentorstvom S. Backovića urađene su četiri doktorske disertacije i četiri magistarska rada.

Autor i koautor je preko 100 naučnih radova koji se mogu vidjeti u elektronskim bazama: http://inspirehep.net/search?ln=en&p=find+a+s+backovic&of=hb&action_search=Search;http i http://scholar.google.com/citations?user=fXGhNVwAAAAJ&hl=en i https://www.researchgate.net/profile/S_Backovic/contributions?ev=prf_act.
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http://vbcg.vbcg.me/cobiss/bibliografije/Y20141102154659-00001.html.

Koautor je zbirke zadataka i jednog udžbenika za srednje škole, koautor je prevoda

fakultetske zbirke zadataka iz fizike „Zadaci iz opšte fizike“ (I. E. Irodov) i autoruniverzitetskogudžbenika „Fizička mehanika“.

Od 1980. do 1985. godine, kao sekretar Nacionalnog odbora za fiziku, bio je član Predsjedništva Saveza društava matematičara i fizičara Jugoslavije. Bio je: predsjednik Društva matematičara i fizičara Crne Gore (1986–1998), predsjednik Prosvetnog savjeta Crne Gore, član Savjeta za nauku Crne Gore, član Izvršnog odbora RSIZ-a za naučne djelatnosti Crne Gore. Bio je član Savezne komisije za sigurnost nuklearnih objekata. Učestvovao je u organizaciji republičkih i saveznih takmičenja iz fizike za učenike srednjih i osnovnih škola (Društvo matematičara i fizičara i pokret „Nauka mladima”). Član je DANU, bio je ekspert Saveznog ministarstva za razvoj, nauku i životnu sredinu u oblasti fizike. Dobitnik je republičke nagrade „Oktoih” za 1999. godinu. U toku 2002. godine koordinirao je poslovima na reformi obrazovanja u Crnoj Gori i bio predsjednik Komisije za reformu osmogodišnje škole.

U periodu 2008–2011. bio je ambasador Crne Gore u Ruskoj Federaciji. Od oktobra 2011. do oktobra 2014. godine bio je rektor Univerziteta „Mediteran“.

Za vanrednog člana CANU izabran je 12. decembra 2003. godine, a za redovnog 29. novembra 2011. godine.

Živi i radi u Podgorici.

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By H1 Collaboration (F.D. Aaron et al.).
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By H1 Collaboration (F.D. Aaron et al.).
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By H1 Collaboration (F.D. Aaron et al.).
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By H1 Collaboration (F.D. Aaron et al.).
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By H1 Collaboration (F.D. Aaron et al.).
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By H1 Collaboration (F.D. Aaron et al.).
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Eur.Phys.J. C72 (2012) 2163, Erratum: Eur.Phys.J. C74 (2012) 2733.

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By H1 Collaboration (F.D. Aaron et al.).
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By H1 Collaboration (F.D. Aaron et al.).
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By H1 and ZEUS Collaborations (F.D. Aaron et al.).
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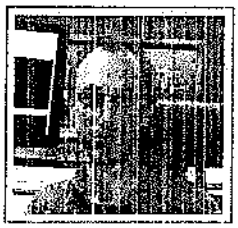

January 2021

Favart

Curriculum Vitae

Professional Situation

1995-1997 **Postdoctoral Researcher at the Laboratoire de l'Accélérateur Linéaire**, *Orsay*, France.

1997-1999 **Postdoctoral Researcher FNRS**, *IIHE*, ULB.

1999-2009 **Research Associate FNRS**, *IIHE*, ULB.

2004- **Part-time Lecturer**, *ULB*.

2009-2014 **Senior Research Associate F.R.S.-FNRS**, *IIHE*, ULB.

2013- **Director of the Particle Physics Departement**, *IIHE*, ULB.

2013- **IIHE co-director**, ULB.

2014- **Research Director, F.R.S.-FNRS**, *IIHE*, ULB.

Formal Education

1989-1990 **Master 1 in Physics**, *Université Libre de Bruxelles*, Belgium, *magna cum laude*.

1990-1991 **Master 2 in Physics**, *Université Libre de Bruxelles*, Belgium, *summa cum laude*.

1991-1995 **PhD in Physics**, *Université Libre de Bruxelles*, Belgium, summa cum laude.
Mesure de la fonction de structure F_2 du proton à HERA, utilisant les interactions profondément inélastiques radiatives (α^3).

Participation to High Energy Experiments

1992- Member of the H1 Collaboration at the HERA collider (DESY-Hamburg)

2011- Member of the CMS Collaboration at the LHC collider (CERN-Geneva)

Teaching at the University

PHYS-F305 Lecture : Introduction to Particle Physics (BA3 Physics, Th: 24h, Ex: 24h)

PHYS-F477 Lecture : Physics of Strong Interactions (MA1 Physics, Th: 24h, Ex: 24h)

University Administration

2009-2011 Secretary of the Jury - Master in Physics

2011-2014 President of the Jury - Master in Physics

2013-... Director of the Particle Physics Departement

Thesis Promotor

PhD Promotor

- Rainer Stamen : "Measurement of Deeply Virtual Compton Scattering at HERA", (cotutelle - D. Wegener - Dortmund Universität (1998-2001).
- Benoît Roland : "Mesure de la diffusion Compton à haute virtualité à HERA II" (2002-2008, Boursier FRIA)
- Tomáš Hreus : "Studies of Diffractive Scattering of Photons at Large Momentum Transfer And of the VFPS Detector at HERA" (cotutelle University Pavol Jozef Šafárik à Košice, Slovaquie, Boursier FRIA, 2004-2008)
- Julie Delvax : "Etude de la production de jets en diffraction à HERA, à l'aide du spectromètre à protons VFPS", (Bourse FNRS 2006-2010).
- Alexandre Léonard : "Measurement of Z boson production in association with jets at the LHC and study of a DAQ system for the triple-GEM detector in view of the CMS upgrade", June 2015, (Aspirant FNRS 2011-2015).
- Fengwangdong Zhang : "Measurement of jet production in association with a Z boson at the LHC and jet energy correction and calibration at high level trigger in CMS", June 2017, Co-Phd with Peking University (Bourse CSC 2014-2017).
- Qun Wang : "Measurement of the differential cross section of Z boson production in association with jets at the LHC", June 2018, Co-PhD with Peking University (Bourse CSC 2015-2017)
- Louis Moureaux, CMS data analysis, bourse FRIA 2017-
- Tomas Kello, CMS data analysis, bourse ECS - cotutelle UA 2018-
- Max Vanden Bemden, CMS data analysis and Proton Transverse Momentum Distributions, assistant ULB 2019-
- Itana Bubanja, Study of the Drell-Yan process at the LHC, cotutelle ULB-Montenegro 2020-

Master Thesis Promotor

- Alexandre Rechner : "Analyse du détecteur à fibres scintillantes prévu pour le spectromètre à protons de l'expérience H1", June 2001.
- Sandrine Cnockaert : "Production diffractive de mésons vecteurs à HERA", (co-direction avec P. Marage), June 2002.
- Tomáš Hreus : "Photon diffractive scattering off proton at high t with the H1 detector", (Erasmus 2003-2004) - June 2004.
- Julie Delvax : "Etude des interactions avec production de jets dans l'expérience H1", June 2006.
- Alexandre Léonard, "Production diffractive de mésons ρ à HERA II", June 2011, Prix A.Sc.Br. 2011.
- Rachel Simoni, "Etude de la production de Z accompagnée de jets au LHC", September 2013.
- Patrick Connor, "Etude du processus de Drell-Yan à haute masse invariante au LHC à $\sqrt{s} = 8$ TeV", June 2014
- Laurent Lenaerts, "Etude de la section efficace Drell-Yan à faible impulsion transverse du boson Z dans les interactions proton-protons à $\sqrt{s} = 8$ TeV", June 2015
- Louis Moureaux, "Etude de la production exclusive du meson ρ dans les données proton-plomb prises à CMS en 2013 à $\sqrt{s_{NN}} = 5.02$ TeV", June 2017
- Max Vanden Bemden, "Study of the Proton Transverse Momentum Distributions with the Parton Branching Method", September 2019.

PhD Jury Member outside ULB

- Grégory Soyez, "Deep inelastic scattering at small x", Universtité de Liège, January 2004.
- Thibault Frisson, "Mesure de luminosité pour l'expérience H1 et étude de la diffusion Compton élastique", Ecole Polytechnique, Paris, October 2006.
- Sylvestre Baudrand, "Mesure de la polarisation longitudinale de faisceaux de positons et d'électrons à HERA par effet Compton à l'aide d'une cavité Fabry-Perot de haute finesse", Université de Paris-Sud, Orsay, January 2007.
- Maxime Gouzevitch, "Mesure de la constante de couplage forte α_S avec les jets hadroniques en diffusion inélastique profonde", Ecole Polytechnique (Paris), September 2008.
- Ahmed Fradi, "Exclusive electroproduction of the ρ^+ meson on the proton with the CLAS detector at Jefferson Lab", IPN -Université de Paris-Sud (Orsay), July 2009.
- Deniz Sunar, "Measurement of $K^{*\pm}(892)$ Production in Deep Inelastic ep Scattering with the H1 Detector at HERA", Universiteit Antwerpen (Anvers), July 2009.
- Oldřich Kepka, "QCD and Diffraction in the ATLAS Experiment at the LHC", Université de Paris-Sud et Charles University, Orsay, November 2009.
- Séverine Ovyn, "Photoproduction of Top and Higgs Particles at the LHC", Université Catholique de Louvain, April 2010.
- Nikita Beliy, "Search for top s-quarks in bottom s-quark production in R-parity violating supersymmetric models with the CMS detector", Université de Mons, 4 December 2015.
- Laurent Forthomme, "Measurement of exclusive two-photon processes with dilepton final states in pp collisions at the LHC", PhD, Université catholique de Louvain, April 2016
- Matthias Saimpert, "Mesure de la section efficace de production de paires de photons isolés dans l'expérience ATLAS au LHC et étude des couplages à quatre photons", PhD, rapporteur, CEA/Orsay, 27 June 2016
- Alex Van Spilbeeck, "Study of the very forward jet energy spectrum in proton-proton collisions at $\sqrt{s} = 7$ TeV with the CASTOR calorimeter at the CMS experiment", PhD, Universiteit Antwerpen (Anvers), June 2017
- Bugra Bilin, "Measurements of Standard Model heavy particle production in association with jets using proton-proton collision data at 8 and 13 TeV with the CMS experiment at the LHC", PhD, Middle East Technical University, Turkey, June 2017
- Brieuc François, "Search for resonant di-Higgs production in CMS and development of a model independent approach to look for new physics at the LHC", PhD, Université catholique de Louvain, October 2017.

Expert and Consultancy Mandates

1996-	Internal Referee for the H1 and CMS Collaborations
1999-	Referee for International Journals: Eur. Phys. J, Can. J. Phys. and Braz. Jour. Phys.
2010-2012	Member of the "SPS and PS experiments Committee (SPSC)" du CERN.
2012-	Member of the H1 Physics Board
2012-	Representative of the FNRS at the "International Oversight and Finance Group" (IOFG) of the IceCube experiment.
2012-	Member of the Belgian CERN Associates and Fellows committee.
2013-2020	Official Representative of the FNRS at the "Astroparticle Physics European Consortium" (ApPEC).
2016-	Member of the CMS Publication Committee Board on Forward & Small-x QCD physics (FSQ) and Detector and reconstruction performance (PRF)

2019- FNRS representation in the Finance Board of the Pierre Auger Collaboration

2019- Membre of the FRIA jury

2021- Membre of the ULB university ranking commission

Awards and Honours

Ph.D. Award 1995 from the Friends and Sponsors of DESY DESY ("Verein der Freunde und Förderer des DESY")

Publications

Among the 500 international Journal publications with peer review since 1992, the most representative are:

- C. Adloff et al. [H1 Collaboration], "Elastic photoproduction of J/ψ and Υ mesons at HERA", *Phys. Lett.* B483 (2000), 23-35
- C. Adloff et al. [H1 Collaboration], "Deep-inelastic inclusive ep scattering at low x and a determination of α_s", *Eur. Phys. J.* C21 (2001), 33-61
- C. Adloff et al. [H1 Collaboration], "Measurement of deeply virtual Compton scattering at HERA", *Phys. Lett.* B517 (2001), 47-58
- L. Favart, M.V.T. Machado, "Deeply virtual Compton scattering and saturation approach", Eur. Phys. J. C29, 365-371 (2003).
- A. Aktas et al. [H1 Collaboration], "Diffractive deep-inelastic scattering with a leading proton at HERA", *Eur. Phys. J.* C48 (2006), 749-766
- L. Favart, M. V. T. Machado and L. Schoeffel, "An extraction of the skewing factor from DESY-HERA Data", Braz. J. Phys. 37 (2007) 798-800.
- F. D. Aaron et al. [H1 Collaboration], "Measurement of Deeply Virtual Compton Scattering and its t-dependence at HERA," *Phys. Lett.* B659 (2008), 796-805
- F. D. Aaron et al. [H1 Collaboration], "Diffractive electroproduction of ρ and ϕ mesons at HERA", *JHEP* 1005 (2010), 032
- A. Astvatsatourov, K. Cerny, J. Delvax, L. Favart, T. Hreus, X. Janssen, R. Roosen and T. Sykora, P. Van Mechelen, "The H1 very forward proton spectrometer at HERA", *Nucl. Instrum. Methods* A736 (2014), 46-65
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- V. Andreev et al. [H1 Collaboration], 'Measurement of Exclusive $\pi^+\pi^-$ and ρ^0 Meson Photoproduction at HERA" arXiv:2005.14471 [hep-ex], DESY-20-080.

Oral Communications

Among the 45 oral communications at conferences and seminars, the most representative are :

- "Diffractive Physics at HERA", review talk at the "International Nuclear Physics Conference 1998 (INPC98)", 24–28 Augustus 1998. UNESCO, Paris, France.
- "Deeply Inelastic Compton Scattering at HERA", XXX^{th} International Conference on High Energy Physics (ICHEP 2000), Osaka, Japan, 27 July -2 Augustus 2000.
- "Inelastic scattering and diffraction at high energy - HERA results", lecture for the "European Graduate School Basel-Tübingen", Universität Tübingen, 14 May 2004.
- "Experimental review of diffractive phenomena", invited plenary talk at the 10^{th} International Baryons Conference (BARYONS 2004), Paris, 25-29 October 2004.
- "Diffraction and Vector Mesons: Session Summary", WG session summary talk at the 15^{th} International workshop on Deep-Inelastic Scattering (DIS 2007), Munich (D), 16-20 April 2007.
- "Inclusive diffraction and a measurement of the diffractive longitudinal structure function F_L^D at HERA", 2009 Europhysics Conference on High Energy Physics Search (EPS HEP-09), Cracovie, Pologne, 16-22 July 2009.
- "Physics at Accelerators", RECFA - open session, Brussels, 5 March 2010.
- "Exclusive electroproduction of vector mesons", 14th Workshop on Elastic and Diffractive Scattering (EDS Blois Workshop), Quy Nhon, Vietnam - 15-21 December 2011.
- "Recent Results on Diffraction at HERA", Workshop on Multi-Parton Interactions at the LHC (MPI@LHC 2013), Antwerp, Belgium, 2-6 December 2013
- "Parton Distribution Functions and Low x Physics", lecture at the Joint Belgian Dutch German Graduate School (BND 2014)", Rolduc Abbey, Kerkrade (NL), 27-28 September 2014.
- "Recent HERA results on hard diffraction", LISHEP 2015 conference, Manaus (Brazil), 2-9 Augustus 2015.
- "Low-x and Diffraction", invited plenary talk, 24^{th} International workshop on Deep-Inelastic Scattering (DIS 2016) Hamburg (D), 11-15 April 2016.
- Workshop on Resummation, Evolution, Factorization (REF2016), member of Organizing and scientific committees, Antwerp (B), 7-10 November 2016.
- "Belgium HEP Overview", RECFA - open session, Brussels, 21 April 2017.
- "High Energy Physics in Belgium", ESS Science Seminar in Belgium, Brussels, 14 September 2017.

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Број: 08-1844
Датум, 28.10.2010 г.

УНИВЕРЗИТЕТ ЦРНЕ ГОРЕ
Природно-математички факултет
Број 2948
Подгорица 11.11.2010 год.

Ref:
Date,

Na osnovu člana 75 stav 2 Zakona o visokom obrazovanju (Sl.list RCG, br. 60/03 i Sl.list CG, br. 45/10) i člana 18 Statuta Univerziteta Crne Gore, Senat Univerziteta Crne Gore, na sjednici održanoj 28.10.2010. godine, donio je

O D L U K U
O IZBORU U ZVANJE

Dr NATAŠA RAIČEVIĆ bira se u akademsko zvanje **redovni profesor** Univerziteta Crne Gore za predmete: Elektromagnetizam i Fizika elementarnih čestica, na **Prirodno-matematičkom fakultetu.**

REKTOR

Prof.dr Predrag Miranović

UNIVERSITÄT HAMBURG

Der Fachbereich Physik der Universität Hamburg hat

HERRN
DR. RER. NAT.
HANNES JUNG

geboren am 18. Dezember 1955 in Offenbach/Queich

die Lehrbefugnis als

PRIVATDOZENT

für das Fach

EXPERIMENTALPHYSIK

verliehen.

Zum Zeugnis dessen wird diese mit dem Siegel der Universität versehene und vom Dekan des Fachbereichs unterzeichnete Urkunde ausgestellt.

Hamburg, den 7. Juli 2004

Universität Hamburg + Fachbereich Physik + 12

(Prof. Dr. Günter Huber)
Dekan des Fachbereichs Physik

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APPOINTMENT

Jan. 28, 1999

Diarienummer
MN E 33 482/98

Faculty of Science
The Subfaculty Board of Mathematics and Physics

The Subfaculty Board of Mathematics and Physics
at the Lund University appoints

HANNES JUNG

*to be Docent *) in* ***ELEMENTARY PARTICLE PHYSICS***
at the Lund University from January 18, 1999

Ingvar Otterlund
Dean of the
Subfaculty Board

Lena Engquist

*) A Docentship in the Swedish university system is an academic title that can be awarded by a faculty committee at a university to a Doctor of Philosophy (Medicine, Technology etc) from that same university who has reached a higher level of scientific competence by means of additional advanced research than is required for a doctorate.

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Curriculum vitae

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Researcher unique identifier (ORCID Id) 0000-0002-2964-9845
Date of birth: 18. December 1955
Nationality: German
E-mail: hannes.jung@desy.de;
URL: www.desy.de/~jung

Education

2004	Docent in particle physics, University of Hamburg, Germany
1999	Docent in particle physics, University of Lund, Sweden
1989	PhD in particle physics, University of Hamburg, Germany
1983	Diploma in physics, University of Freiburg, Germany

Current position

since 2004	Senior researcher at DESY, Hamburg, Germany
since 2004	Docent in particle physics at University of Hamburg, Germany
2014 – 2020	Leader/co-leader of the Standard Model Physics group at CMS-DESY (> 20 members: seniors, postdocs and PhD students)
2009 – 2017	Guest Professor at University of Antwerp, Belgium

Previous positions

1996 – 2004	Researcher, University of Lund, Sweden
1995 – 1996	Visiting Scientist at CEA, DSM/DAPNIA, CE-Saclay, Gif-sur-Yvette, France
1994	Visiting Scientist University Paris VI, France
1994	Researcher, DESY, Hamburg, Germany
1988 – 1993	Research Associate, University of Aachen, Germany
1987 – 1988	Research Associate, DESY, Hamburg, Germany
1984 – 1987	Research Associate, University of Karlsruhe, Germany

Impact

more than 1200 citable papers in peer-reviewed high-impact journals.
The h-index is 155 (http://inspirehep.net).
High citation rate publication (in addition to publications from experimental collaborations):
Renowned papers (with citations of 500+)
Hard diffractive scattering in high-energy ep collisions and the Monte Carlo generator RAPGAP.
Comput. Phys. Commun. 86 (1995) 147. Cited by 537 records in INSPIRE on 13 June 2019
Famous papers (with citations of 250-499)
Hadronic final state predictions from CCFM: The hadron level Monte Carlo generator CASCADE
Eur. Phys. J. C19 (2001) 351. Cited by 267 records in INSPIRE on 13 June 2019
Very well-known papers (with citations of 100-249)
The CCFM Monte Carlo generator CASCADE
Comput. Phys. Commun. 143 (2002) 100. Cited by 244 records in INSPIRE on 13 June 2019
The CCFM Monte Carlo generator CASCADE version 2.2.03
Eur. Phys. J. C70 (2010) 1237. Cited by 162 records in INSPIRE on 13 June 2019

Fellowships and Awards

2016 – 2018	Alexander von Humboldt Polish Honorary Research Fellowship by the Foundation for Polish Science (FNP) (in collaboration with the German Humboldt Foundation)
2011 – 2012	Paid Associate, CERN, Geneva
2007 – 2009	DAAD-STINT grant (with University of Lund) on *Multi Parton Interactions and small x*

effects at HERA and the LHC

Supervision of graduate students and postdoctoral fellows

Since 1995 Supervisor of 28 PhD Theses and 15 diploma (master) theses, out of which are 20 PhD theses at University Hamburg, 5 PhD theses at Lund University and others at Aachen University, Freie Universität Berlin, CEA, DSM/DAPNIA, Saclay, Paris (France)

present Leader of the QCD group at DESY with 4 PhD students, 3 postdocs and regular visiting scientists from Cracow (Poland), Havana (Cuba), Moscow (Russia) and Oxford (UK).

Teaching experience

2018 Exercise lectures at Monte Carlo school of the Terascale Alliance (DESY, Hamburg)
2015 Exercise lectures at Monte Carlo school of the Terascale Alliance (DESY, Hamburg)
since 2008 Lecture Courses: QCD and Monte Carlos, Universities Antwerp, Hamburg and DESY
2005 – 2007 Lecture Courses: QCD and collider physics, University Hamburg
since 2005 Summer-student lectures on Monte Carlo simulations, DESY Hamburg
1998 – 2001 Lecture Courses: Cosmology and particle physics, University Lund

Reviewer Responsibilities

2012 European Research Council (ERC) referee in peer review evaluations
since 2000 Regular peer reviewer for European Journal of Physics C, Physics Letters B , JHEP

Institutional Responsibilities

2017 – Leader of the LHC wide working group on "Jets and electroweak bosons"
2016 – 2018 Leader of the Standard Model Physics-Jet group (SMP-J) in CMS (ca 30 members)
2013 – 2015 Leader of the Monte Carlo generator group "Physics Comparison and Generator Tunes" in CMS (ca 25 members)
since 2013 Chair of the board "Theorists in CMS"
2013 – 2014 Chair of the CMS publication committee for forward physics and detector performance
2012 – 2014 Member of the CMS publication committee for Higgs and forward physics results
2010 – 2011 Leader of the "Forward Physics" analysis group in CMS
2007 – 2009 Leader of the Monte Carlo group at the Analysis Center of the Helmholtz Alliance "Physics at the Terascale" at DESY, Hamburg.

Membership of scientific societies

2010 – Member of the International Advisory Board for the LISHEP (Brazil) workshops
2009 – 2014 Chair of the International Advisory Board for the MPI@LHC workshops
since 2008 Member of the International Advisory Board for the MPI@LHC workshops
2008 – 2012 Member for the Scientific Committee at DESY
since 2007 Member of International Advisory Committee for International Symposium on Multi-particle Dynamics (ISMD)
since 2007 Member of International Advisory Committee for International Conference on Elastic and Diffractive Scattering (Blois Workshop)

Organization of international conferences

2021 Chair of Monte Carlo school of the Terascale Alliance (DESY, Hamburg)
2018 Chair of Monte Carlo school of the Terascale Alliance (DESY, Hamburg)
2015 Chair of Monte Carlo school of the Terascale Alliance (DESY, Hamburg)
since 2013 Co-chair of the annual TMD-workshops (Antwerp, Amsterdam, Hamburg, Madrid, Cracow)
2012 Chair of the workshop "MPI@LHC" (CERN, Geneva)
2011 Chair of the workshop "MPI@LHC" (DESY, Hamburg)
2008 – 2009 Chair of Monte Carlo school of the Terascale Alliance (DESY, Hamburg)
2008 Chair of "International Symposium on multiparton dynamics " ISMD08 (DESY, Hamburg)
2007 Chair of "Elastic and diffractive scattering - forward physics and QCD (DESY, Hamburg)
2003 – 2008 Chair and initiator of the workshop "HERA and the LHC " (CERN, Geneva and DESY, Hamburg) (with more than 150 regular participants)

Major Collaborations

2008 – 2018 MCnet network (http://www.montecarlonet.org) (via the node in Lund, Sweden)
since 2007 CMS collaboration (experiment at the LHC, CERN, Geneva)
since 1987 H1 Collaboration (experiment at HERA, DESY, Hamburg)
since 1984 CELLO Collaboration (experiment at PETRA, DESY, Hamburg)
1982 – 1984 EMC/NMC Collaboration (experiment at SPS, CERN, Geneva)

Summary of my achievements

I am an expert in Monte Carlo techniques. Since 2005 I am giving lectures on Monte Carlo techniques and QCD at the Universities of Antwerp and Hamburg. I have developed and maintained Monte Carlo event generators which are used in large particle physics collaborations. I wrote the first Monte Carlo event generator (RAPGAP) to simulate hard diffractive events, which were observed at HERA (DESY). This event generator was further developed to become the main MC generator for deep-inelastic scattering at HERA, including all standard (non-diffractive) processes. The citation index of 524 citations of the manual is a clear indication of this. In 2001 I published the first Monte Carlo event generator (CASCADE) based on TMDs (in the high-energy limit un-integrated gluon distributions), which was then applied to HERA as well as Tevatron and later LHC measurements. The CASCADE manuals have in total 392 citations. CASCADE is part of the standard CMS and ATLAS software packages, and comparison with predictions are included in collaboration publications.

I have supervised 29 PhD thesis, one was dedicated to TMD evolution, 3 were in the field of Monte Carlo generators. In 2015 two of my PhD students graded with the highest distinction (summa-cum-laude) at Hamburg University. One of my PhD students published his thesis in the Springer Theses Series. I have been very successful to promote the postdocs of my group, some of them holding leading positions in science and education and others in start-up enterprises, finance sector and industry. At present I am supervising 4 PhD students, one has just completed a PhD on TMD determination, the others on experimental topics, as well as 2 postdocs.

From 2015 - 2017 I led the CMS Standard Model Physics-Jet group, where many very relevant publications were released, and now I am leading the LHC wide working group on Jets and electroweak bosons. In 2013 I created (and led for 2 years) the CMS Monte Carlo group "Physics Comparison and Generator Tunes", which is concerned about the global description of measurements at the LHC as well as providing new parameter sets (tunes) for the standard Monte Carlo event generators for the best description of LHC data. The results are now the basis for the whole CMS Monte Carlo simulation, which is used in cross section measurements but is also important for all searches. Under my guidance we published a paper on tunes within the CMS collaboration (Eur. Phys. J. C 76 (2016) 155), which is the first CMS paper on generator tunes and serves as a benchmark and legacy reference for results from LHC run1.

I was leading the DESY QCD group with more than 20 scientists. This group is well embedded in the general CMS physics program; alone from the PhD students and postdocs I am supervising, more than 10 CMS publications were released since 2011.

I have excellent collaborations with theorists: I was initiator of the Lund Small x workshop series (with more than 350 citations for the proceedings). The HERA-LHC workshops which I initiated and led over 5 years (with more than 370 citations for the proceedings) had more than 150 participants. The HERA-LHC workshops were also a basis for the participation of DESY in LHC experiments. More than 50 publications in phenomenology (both on HERA and LHC physics) I have written together with theorists. Due to my experience in both phenomenology and experiment, I became a respected expert and translator between experimentalists and theorists, and therefore was chosen by the CMS collaboration board as the chair of the committee "Theorists in CMS" to motivate theorists to join CMS.

In 2016 I won the award of a "Humboldt research scholarship" from the Foundation of Polish Science (FNP) in collaboration with the German Humboldt society. The peer-reviewed award was given on the topic of TMD evolution and Monte Carlo generators.