ANNOTATION OF THE MATERIALS

under Art. 65 of the Regulations for the Development of the Academic Staff at Plovdiv University "Paisii Hilendarski" of Dr. Mariana Filipova Shopova

for participation in the open contest for the academic position of "associate professor" in the area of higher education 4. Natural sciences, Mathematics and Computing, 4.1. Physics (Physics of the microcosm, high energies and elementary particles) at the Faculty of Physics and Technology at Plovdiv University "Paisii Hilendarski", announced in the State Gazette, Issue 98 of Tuesday 19.11.2024.

All scientific publications, provided for participation in the contest for the academic position of "Associate professor", are published after the candidate obtained her PhD degree and started working at the academic position of "Assistant professor".

A total number of 18 publications are included in this application.

- All publications provided for this contest are published in high rated journals indexed in the world's leading scientific databases (Web of Science and/or Scopus).
- The main scientific topics of the candidate's provided publications are in the field of High-energy physics, Particle detectors, Gaseous detectors, Trigger detectors and Performance of High Energy Physics Detectors.
- A total number of 18 publications are included, all of which have IF (for all – **IF 42.17**).
- Candidate's **h-index 117** (Scopus)

Source: SCOPUS (16.01.2025)
Mariana Shopova SCOPUS account:
https://www.scopus.com/authid/detail.uri?authorId=58085747300

Publications:

- **Following V4 criteria: Habilitation work – scientific publications in journals, indexed in the world's leading scientific databases (Web of Science and/or Scopus):**

V4-1. A. Hayrapetyan, …, **M. Shopova**,…, et al., , JINST, 19 (2024) P05064, DOI: 10.1088/1748-0221/19/05/P05064, ISSN 17480221, https://doi.org/10.1088/1748-0221/19/05/P05064, **IF(2023) 1.3**, SJR (2023) 0.58

Development of the CMS detector for the CERN LHC Run 3

Since the initial data taking of the CERN LHC, the CMS experiment has undergone substantial upgrades and improvements. This paper discusses the CMS detector as it is configured for the third data-taking period of the CERN LHC, Run 3, which started in 2022. The entire silicon pixel tracking detector was replaced. A new powering system for the superconducting solenoid was installed. The electronics of the hadron calorimeter was upgraded. All the muon electronic systems were upgraded, and new muon detector stations were added, including a gas electron multiplier detector. The precision proton spectrometer was upgraded. The dedicated luminosity detectors and the beam loss monitor were refurbished. Substantial improvements to the trigger, data acquisition, software, and computing systems were also implemented, including a new hybrid CPU/GPU farm for the high-level trigger.

The CMS muon system is the largest detector system in the experiment, comprised of 4 complementary gaseous detector systems for precise triggering on, reconstruction and detecting muons. These are the drift tube (DT) system in the barrel region, providing precise spatial measurements, as well as trigger information, the cathode strip chamber (CSC) system in the endcap, providing both trigger and precision position information, the resistive plate chambers (RPCs) (both in the barrel and endcap), providing very fast response time that can be used to unambiguously identify the bunch crossing corresponding to a muon trigger candidate and the gas electron multiplier (GEM) chambers, having both a fast response and good spatial resolution.

Much of the muon system is unchanged from that used in Run 1, but there have been additions and improvements. Notably, there were three major additions to the endcap detector suite: the outer ring of CSC chambers in station four (“ME4/2”), the outer rings of RPC chambers in station four (“RE4/2” and “RE4/3”, collectively “RE4”), and the GEM system in station one (“GE1/1”).

The candidate’s personal contribution is on the editorial work for the RPC section of the paper (Main editor for Muon RPC), as well as data analysis, monitoring of the system performance, commissioning of the detectors, maintenance of the RPC system, assembly of new detectors for the planned upgrades and monitoring of the longevity studies.

V4-2. **M. Shopova**, ..., et al., The CMS RPC system readiness for LHC Run-3 data taking, Nuclear Inst. and Methods in Physics Research, A 1052 (2023) 168272, DOI: 10.1016/j.nima.2023.168272, ISSN 01689002, https://doi.org/10.1016/j.nima.2023.168272, **IF (2023) 1.5**, SJR (2023) 0.51

The CMS RPC system readiness for LHC Run-3 data taking

During Run-3, the LHC is preparing to deliver instantaneous luminosity in the range from 5×10^{34} cm^{-2} s^{-1} to 7.5×10^{34} cm^{-2} s^{-1}. To ensure stable data taking, providing redundant information for robust muon triggering, reconstruction and identification, the CMS RPC collaboration has used the opportunity given by the LHC long shutdown 2 (LS2), to perform a series of maintenance and preparation activities for the new data taking period. The overall performance of the RPC system after the LS2 commissioning period and the activities in preparation for future data taking are presented.

The CMS RPC system performance has been closely monitored and a comparison on the main RPC detector working parameters has been carried out, based on 2018 and 2022 proton–proton collisions, to validate how the system operates after all LS2 interventions. The RPC hit efficiency is obtained using the segment extrapolation method, where the RPC efficiency is calculated as the ratio between the number of detected and the number of expected hits. Obtained results show stable performance of the RPC system with average efficiency of ~ 95% and average cluster size below 2.

The candidate's personal contribution is on the maintenance of the RPC system, its preparation for the upcoming data taking, data analysis, monitoring of the system performance, commissioning of the detectors, coordination of the different analysis tasks and obtaining the shown results on the main detector performance parameters.

V4-3. A. Samalan, ..., **M. Shopova**, ... et al., Nuclear Inst. and Methods in Physics Research, A 1060 (2024) 168272, DOI: 10.1016/j.nima.2024.169075, ISSN 01689002, https://doi.org/10.1016/j.nima.2024.169075, **IF (2023) 1.5**, SJR (2023) 0.51

Improved resistive plate chambers for HL-LHC upgrade of CMS

In view of the High Luminosity LHC, the CMS Muon system will be upgraded to sustain its efficient muon triggering and reconstruction performance. Resistive Plate Chambers (RPC) are dedicated detectors for muon triggering due to their excellent timing resolution. The RPC system will be extended up to 2.4 in pseudorapidity. Before the LHC Long Shutdown 3, new RE3/1 and RE4/1 stations of the forward Muon system will be equipped with improved Resistive Plate Chambers (iRPC) having, compared to the present RPC system, a different design and geometry and 2D strip readout. This advanced iRPC geometry configuration allows the rate capability to improve and hence survive the harsh background conditions during the HL-LHC phase. Several iRPC demonstrator chambers were installed in CMS during the recently completed 2nd Long Shutdown to study the detector behaviour under real LHC conditions. This paper summarizes the iRPC project and its schedule, including the status of the iRPC production sites, details of the

chamber quality control procedures and results of the commissioning of the demonstrator chambers.

The candidate's personal contribution is on the assembly and quality control of the detectors, as well as monitoring and studying their performance and working parameters.

V4-4. K. Mota Amarilo, …, **M. Shopova**, …et al., Nuclear Inst. and Methods in Physics Research, A 1052 (2023) 168271, DOI: 10.1016/j.nima.2023.168271, ISSN 01689002, https://doi.org/10.1016/j.nima.2023.168271 , **IF (2023) 1.5**, SJR (2023) 0.51

RPC based tracking system at CERN GIF++ facility

With the HL-LHC upgrade of the LHC machine, an increase of the instantaneous luminosity by a factor of five is expected and the current detection systems need to be validated for such working conditions to ensure stable data taking. At the CERN Gamma Irradiation Facility (GIF++) many muon detectors undergo such studies, but the high gamma background can pose a challenge to the muon trigger system which is exposed to many fake hits from the gamma background. A tracking system using RPCs is implemented to clean the fake hits, taking profit of the high muon efficiency of these chambers. This work presents the tracking system configuration, used detector analysis algorithm and results.

The implementation of the tracking system was motivated by the necessity to test the CMS RPC chambers at the conditions of the HL-LHC. The results show that the tracking system performs very well to remove fake hits from the gamma background, even at rates as high as 2 kHz/cm^2. The test chamber performed very well and showed increase on the working point of ≈650 V with efficiency loss of ≈ 7.5%, using the custom electronics with threshold of 75 fC. This system is currently being used for the ageing studies of the CMS RPC system

The candidate's personal contribution is on the assembly and quality control of the detectors, monitoring and studying their performance and working parameters, as well as ensuring the good quality of data taking by operational shifts during the test beams in CERN GIF++ laboratory.

V4-5. R. Aly, …, **M. Shopova**, …, et al., Nuclear Inst. and Methods in Physics Research, A 1055 (2023) 168452, DOI: 10.1016/j.nima.2023.168452, ISSN 01689002, https://doi.org/10.1016/j.nima.2023.168452 , **IF (2023) 1.5**, SJR (2023) 0.51

Latest results of Longevity studies on the present CMS RPC system for HL-LHC phase

The present Compact Muon Solenoid Resistive Plate Chambers system has been worked efficiently during Run I and Run II of data taking period. In the coming years of operation with the High Luminosity LHC (HL-LHC), the expected rate and integrated charge are expected to be about 600 Hz/cm^2 and 840 mC/cm^2, respectively (including a safety factor of three). Therefore, the HL-LHC phase will be a challenge for the RPC system since the expected operating conditions are much harsher than those for which the detectors have been designed, and could introduce non-recoverable aging effects which can alter the detector properties.

Longevity studies on spare resistive plate chambers have been ongoing at the CERN Gamma Irradiation Facility under controlled conditions since 2016. Results show that the chamber performance parameters are stable up to 97% of the expected integrated charge at HL-LHC and up to the highest background rate expected at HL-LHC (600 Hz/cm2). No evidence of any aging effect has been observed so far. Therefore, the current RPC system is capable of reliable operation in the HL-LHC phase. The paper presents the latest results of the irradiation test.

The candidate's personal contribution is on the assembly and quality control of the detectors, monitoring and studying their performance and working parameters, as well as ensuring the good quality of data taking by operational shifts during the test beams in CERN GIF++ laboratory.

V4-6. A. Samalan, ..., **M. Shopova**, ... et al., JINST 15 (2020) 10, C10007, DOI:10.1088/1748-0221/15/10/C10007, ISSN 17480221, https://doi.org/10.1088/1748-0221/15/10/C10007 , **IF (2020) 1.415**, SJR (2020) 0.741

RPC system in the CMS Level-1 Muon Trigger

The CMS experiment implements a two-level triggering system composed of Level-1, instrumented by custom-design hardware boards, and a software High Level Trigger. To cope with the more challenging luminosity conditions, a new Level-1 architecture has been deployed during Run II. This new architecture exploits in a better way the redundancy and complementarity of the three muon subsystems: Cathode Strip Chambers (CSC), Drift Tubes (DT) and Resistive Plate Chambers (RPC). The role of each subsystem in the Level-1 Muon Trigger is described here, highlighting the contribution from the RPC system. Challenges brought by the HL-LHC environment and new possibilities coming from detector and trigger upgrades are also discussed.

The candidate's personal contribution is on the data analysis used for reconstruction and ensuring the good quality of the data obtained from the RPC system.

V4-7. M.A. Shah, …, **M. Shopova**, ..., et al., JINST 14 (2019) 11, C11012, DOI: 10.1088/1748- 0221/14/11/C11012, ISSN 17480221, https://doi.org/10.1088/1748-0221/14/11/C11012 ,**IF (2019) 1.454**, SJR (2019)

The CMS RPC detector performance and stability during LHC RUN-2

The CMS experiment, located at the Large Hadron Collider (LHC) in CERN, has a redundant muon system composed by three different gaseous detector technologies: Cathode Strip Chambers (in the forward regions), Drift Tubes (in the central region), and Resistive Plate Chambers (both its central and forward regions). All three are used for muon reconstruction and triggering. The CMS RPC system confers robustness and redundancy to the muon trigger. The RPC system operation in the challenging background and pileup conditions of the LHC environment is presented.

The RPC system provides information to all muon track finders and thus contributing to both muon trigger and reconstruction. The summary of the detector performance results obtained

with proton-proton collision at sqrt(s) = 13 TeV during 2016 and 2017 data taking have been presented. The stability of the system is presented in terms of efficiency and cluster size vs time and increasing instantaneous luminosity. Data-driven predictions about the expected performance during High Luminosity LHC (HL-LHC) stage have been reported.

The candidate's personal contribution is on the data analysis, monitoring of the system performance, commissioning of the detectors and maintenance of the RPC system.

- **Following G7 criteria: Scientific publications in journals, indexed in the world's leading scientific databases (Web of Science and/or Scopus), outside of the habilitation work:**

G7-1. A. Samalan, …, **M. Shopova**, …, et al., , JINST 17 (2022) 01, C01011, DOI: 10.1088/1748-0221/17/01/C01011, ISSN 17480221, https://dx.doi.org/10.1088/1748-0221/17/01/C0101 **IF (2022) 1.3**, SJR (2022) 0.65

Upgrade of the CMS resistive plate chambers for the high luminosity LHC

During the upcoming High Luminosity phase of the Large Hadron Collider (HL-LHC), the integrated luminosity of the accelerator will increase to 3000 fb^{-1}. The expected experimental conditions in that period in terms of background rates, event pileup, and the probable aging of the current detectors present a challenge for all the existing experiments at the LHC, including the Compact Muon Solenoid (CMS) experiment. To ensure a highly performing muon system for this period, several upgrades of the Resistive Plate Chamber (RPC) system of the CMS are currently being implemented. These include the replacement of the readout system for the present system, and the installation of two new RPC stations with improved chamber and front-end electronics designs. The current overall status of this CMS RPC upgrade project is presented.

The candidate's personal contribution is on the assembly and quality control of the detectors, as well as monitoring and studying their performance and working parameters.

G7-2. M.A. Shah, …, **M. Shopova**, ..., et al., JINST 15 (2020) 10, C10027, DOI:10.1088/1748-0221/15/10/C10027, ISSN 17480221, https://dx.doi.org/10.1088/1748-0221/15/10/C10027, **IF (2020) 1.415**, SJR (2020) 0.741

Experiences from the RPC data taking during the CMS RUN-2

The CMS experiment recorded 177.75 fb^{-1} of proton-proton collision data during the RUN-1 and RUN-2 data taking period. Successful data taking at increasing instantaneous luminosity with the evolving detector configuration was a big achievement of the collaboration. The CMS RPC system provided redundant information for the robust muon triggering, reconstruction, and identification. To ensure stable data taking, the CMS RPC collaboration has performed detector operation, calibration, and performance studies. Various software and related tools are developed and maintained accordingly. In this paper, the overall performance of the CMS RPC system and experiences of the data taking during the RUN-2 period are summarized.

After 9 years of LHC running with increasing instantaneous luminosity and several years from the end of RPC construction, the detector performance is within CMS specifications and stable without any significant degradation. A reversible ohmic current increase was observed in the

most exposed regions. Fine tuning of the gas flux is mandatory for further detector operation. No significant issues were found for running up to high luminosity scenarios of LHC RUN-3.

The candidate's personal contribution is on the data analysis, monitoring of the system performance, commissioning of the detectors and maintenance of the RPC system.

G7-3. W. Elmetenawee, …, **M. Shopova**, ..., et al., JINST 15 (2020) 09, C09025, DOI: 10.1088/1748-0221/15/09/C09025, ISSN 17480221, https://dx.doi.org/10.1088/1748-0221/15/09/C09025, **IF (2020) 1.415**, SJR (2020) 0.741

Effects of the electronic threshold on the performance of the RPC system of the CMS experiment

Resistive Plate Chambers have a very important role for muon triggering both in the barrel and in the endcap regions of the CMS experiment at the Large Hadron Collider (LHC). In order to optimize their performance, it is of primary importance to tune the electronic threshold of the front-end boards reading the signals from these detectors. In this paper, we present the results of a study aimed to evaluate the effects on the RPC efficiency, cluster size and detector intrinsic noise rate, of variations of the electronics threshold voltage.

The candidate's personal contribution is on the data analysis used as input to this study and ensuring the good quality of the data obtained from the RPC system.

G7-4. M.A. Shah, …, **M. Shopova**, ..., et al., , JINST 15 (2020) 10, C10027, DOI: 10.1088/1748-0221/15/10/C10025, ISSN 17480221, https://dx.doi.org/10.1088/1748-0221/15/10/C10025 , **IF (2020) 1.415**, SJR (2020) 0.741

CMS RPC activities during LHC LS-2

The second LHC long shutdown period (LS2) is an important opportunity for the CMS Resistive Plate Chambers (RPC) to complete their consolidation and upgrade projects. The consolidation includes detector maintenance for gas tightness, HV (high voltage), LV (low voltage) and slow control operation. All services for the RPC Phase-2 upgrade: improved RPC in stations RE3/1 and RE4/1, were anticipated for installation to LS2. This paper summarises the RPC system maintenance and upgrade activities. CMS RPCs have been operating very successfully during RUN-2. CMS is undergoing an intensive upgrade and maintenance program during the second LHC long shutdown. In order to ensure excellent detector performance in the subsequent physics program, the RPC detector experts are working hard to consolidate the RPC detector and its gas system for stable future operation. All repaired detectors and detector systems will be fully commissioned and certified for forthcoming data taking once the LHC resumes operation at the end of LS2.

The candidate's personal contribution is on the commissioning of the detectors, data analysis, monitoring of the system performance, re-installation of detectors at CMS and maintenance of the RPC system.

G7-5. R. Reyes-Almanza, …, **M. Shopova**, ..., et al., JINST 14 (2019) 09, C09046, DOI: 10.1088/1748- 0221/14/09/C09046, ISSN 17480221, https://doi.org/10.1088/1748-0221/14/09/C09046 , **IF (2019) 1.454**, SJR (2019) 0.805

High voltage calibration method for the CMS RPC detector

The Resistive Plate Chambers (RPC) are used for muon triggers in the CMS experiment. To calibrate the high voltage working-points (WP) and identify degraded detectors due to radiation or chemical damage, a high voltage scan has been performed using 2017 data from pp collisions at a center-of-mass energy of 13 TeV. In this paper, we present the calibration method and the latest results obtained for the 2017 data. A comparison with all scans taken since 2011 is considered to investigate the stability of the detector performance in time.

The calibrations of high voltage (HV) for the RPC detector are performed by a HV scan measurement once per year using a special calibration run or sequence of runs. Establishing the correct operational working points in HV for the individual RPC detector is of primary importance, to ensure a stable detector performance, to provide the optimal efficiency, and to keep the cluster size required for the CMS triggers. In addition, the periodic HV scan measurements enable us to study the long-term stability of the detectors and to identify the potential degradation due to "aging".

The candidate's personal contribution is on the data analysis used as input to this study and ensuring the good quality of the data obtained from the RPC system.

G7-6. J. Goh, …, **M. Shopova**, …, et al., JINST 14 (2019) 10, C10020, DOI: 10.1088/1748-0221/14/10/C10020, ISSN 17480221, https://dx.doi.org/10.1088/1748-0221/14/10/C10020 , **IF (2019) 1.454**, SJR (2019) 0.805

CMS RPC efficiency measurement using the tag-and-probe method,

We measure the efficiency of CMS Resistive Plate Chamber (RPC) detectors in proton-proton collisions at the centre-of-mass energy of 13 TeV using the tag-and-probe method. A muon from a Z0 boson decay is selected as a probe of efficiency measurement, reconstructed using the CMS inner tracker and the rest of CMS muon systems. The overall efficiency of CMS RPC chambers during the 2016–2017 collision runs is measured to be more than 96% for the nominal RPC chambers.

In this paper, we introduce new algorithm based on the TrackerMuons, *track extrapolation* method for the RPC performance measurement. The tracker muons are reconstructed by propagating tracker tracks to find the matched segments in the muon system along its trajectory, considering the magnetic field and geometrical effects.

The candidate's personal contribution is on the data analysis used as input to this study and ensuring the good quality of the data obtained from the RPC system.

G7-7. M. Abbas, …, **M. Shopova**, …, et al., Nuclear Inst. and Methods in Physics Research, A, 1034, (2022), 166716, DOI: 10.1016/j.nima.2022.166716, ISSN 01689002, https://doi.org/10.1016/j.nima.2022.166716 , **IF (2022) 1.4**, SJR (2022) 0.685

Quality control of mass-produced GEM detectors for the CMS GE1/1 muon upgrade

The series of upgrades to the Large Hadron Collider, culminating in the High Luminosity Large Hadron Collider, will enable a significant expansion of the physics program of the CMS experiment. However, the accelerator upgrades will also make the experimental conditions more challenging, with implications for detector operations, triggering, and data analysis. The luminosity of the proton–proton collisions is expected to exceed 2–3 × 10^{34} $cm^{-2}s^{-1}$ for Run 3 (starting in 2022), and it will be at least 5 × 10^{34} $cm^{-2}s^{-1}$ when the High Luminosity Large Hadron Collider is completed for Run 4. These conditions will affect muon triggering, identification, and measurement, which are critical capabilities of the experiment. To address these challenges, additional muon detectors are being installed in the CMS endcaps, based on Gas Electron Multiplier technology. For this purpose, 161 large triple-Gas Electron Multiplier detectors have been constructed and tested. Installation of these devices began in 2019 with the GE1/1 station and will be followed by two additional stations, GE2/1 and ME0, to be installed in 2023 and 2026, respectively. The assembly and quality control of the GE1/1 detectors were distributed across several production sites around the world. We motivate and discuss the quality control procedures that were developed to standardize the performance of the detectors, and we present the final results of the production. Out of 161 detectors produced, 156 detectors passed all tests, and 144 detectors are now installed in the CMS experiment. The various visual inspections, gas tightness tests, intrinsic noise rate characterizations, and effective gas gain and response uniformity tests allowed the project to achieve this high success rate.

The candidate's personal contribution is on the assembly and quality control of the GEM detectors, as well as monitoring and studying their performance and working parameters.

G7-8. A. Hayrapetyan, A., …, **M. Shopova**,…, et al., J. High Energ. Phys. 2024, 47 (2024), DOI: 10.1007/JHEP05(2024)047, ISSN 10298479, https://doi.org/10.1007/JHEP05(2024)047 , **IF (2023) 5.4**, SJR (2023) 0.83

Search for long-lived particles decaying to final states with a pair of muons in proton-proton collisions at sqrt{s}=13.6 TeV

An inclusive search for long-lived exotic particles (LLPs) decaying to final states with a pair of muons is presented. The search uses data corresponding to an integrated luminosity of 36.6 fb^{-1} collected by the CMS experiment from the proton-proton collisions at $\sqrt{s}$ = 13.6TeV in 2022, the first year of Run 3 of the CERN LHC. The experimental signature is a pair of oppositely charged muons originating from a secondary vertex spatially separated from the proton-proton interaction point by distances ranging from several hundred μm to several meters. The sensitivity of the search benefits from new triggers for displaced dimuons developed for Run 3. The results are interpreted in the framework of the hidden Abelian Higgs model, in which the Higgs boson decays to a pair of long-lived dark photons, and of an *R*-parity violating supersymmetry model, in which long-lived neutralinos decay to a pair of muons and a neutrino. The limits set on these models are the most stringent to date in wide regions of lifetimes for LLPs with masses larger than 10 GeV.

The candidate's personal contribution here is on the data analysis and ensuring the good quality of the RPC system recorded data used for muon identification and reconstruction within the CMS muon system.

G7-9. A. Tumasyan, ..., **M. Shopova**, …, et al., J. High Energ. Phys. 2022, 62 (2022), DOI: 10.1007/JHEP04(2022)062, ISSN 10298479, https://doi.org/10.1007/JHEP04(2022)062 , **IF (2022) 5.4**, SJR (2022) 0.859

Search for long-lived particles decaying into muon pairs in proton-proton collisions at sqrt{s}=13 TeV collected with a dedicated high-rate data stream

A search for long-lived particles decaying into muon pairs is performed using proton-proton collisions at a center-of-mass energy of 13TeV, collected by the CMS experiment at the LHC in 2017 and 2018, corresponding to an integrated luminosity of 101 fb^{-1}. The data sets used in this search were collected with a dedicated dimuon trigger stream with low transverse momentum thresholds, recorded at high rate by retaining a reduced amount of information, in order to explore otherwise inaccessible phase space at low dimuon mass and nonzero displacement from the primary interaction vertex. No significant excess of events beyond the standard model expectation is found. Upper limits on branching fractions at 95% confidence level are set on a wide range of mass and lifetime hypotheses in beyond the standard model frameworks with the Higgs boson decaying into a pair of long-lived dark photons, or with a long-lived scalar resonance arising from a decay of a b hadron. The limits are the most stringent to date for substantial regions of the parameter space. These results can be also used to constrain models of displaced dimuons that are not explicitly considered in this paper.

The candidate's personal contribution here is on the data analysis and ensuring the good quality of the RPC system recorded data used for muon identification and reconstruction within the CMS muon system.

G7-10. A.M. Sirunyan, ..., **M. Shopova**, …, et al., J. High Energ. Phys. 2021, 148 (2021), DOI: 10.1007/JHEP01(2021)148, ISSN 10298479, https://doi.org/10.1007/JHEP01(2021)148, **IF (2021) 5.81**, SJR (2021) 0.895

Evidence for Higgs boson decay to a pair of muons

Evidence for Higgs boson decay to a pair of muons is presented. This result combines searches in four exclusive categories targeting the production of the Higgs boson via gluon fusion, via vector boson fusion, in association with a vector boson, and in association with a top quark-antiquark pair. The analysis is performed using proton-proton collision data at sqrt(s) = 13 TeV, corresponding to an integrated luminosity of 137 fb-1, recorded by the CMS experiment at the CERN LHC. An excess of events over the background expectation is observed in data with a significance of 3.0 standard deviations, where the expectation for the standard model (SM) Higgs boson with mass of 125.38 GeV is 2.5. The combination of this result with that from data recorded at sqrt(s) = 7 and 8 TeV, corresponding to integrated luminosities of 5.1 and 19.7 fb-1, respectively, increases both the expected and observed significances by 1%. The measured signal strength, relative to the SM prediction, is 1.19 +0.40 −0.39 (stat) and +0.15 −0.14 (syst). This result constitutes the first evidence for the decay of the Higgs boson to second generation fermions and is the most precise measurement of the Higgs boson coupling to muons reported to date.

The candidate's personal contribution here is on the data analysis and ensuring the good quality of the RPC system recorded data used for muon identification and reconstruction within the CMS muon system.

G7-11. A.M. Sirunyan, ..., **M. Shopova**, ..., et al., J. High Energ. Phys. 2021, 208 (2021), DOI: 10.1007/JHEP07(2021)208, ISSN 10298479, https://doi.org/10.1007/JHEP07(2021)208 , **IF (2021) 5.81,** SJR (2021) 0.895

Search for resonant and nonresonant new phenomena in high-mass dilepton final states at sqrt{s}=13 TeV

A search is presented for physics beyond the standard model (SM) using electron or muon pairs with high invariant mass. A data set of proton-proton collisions collected by the CMS experiment at the LHC at sqrt(s) = 13 TeV from 2016 to 2018 corresponding to a total integrated luminosity of up to 140 fb^{-1} is analyzed. No significant deviation is observed with respect to the SM background expectations. Upper limits are presented on the ratio of the product of the production cross section and the branching fraction to dileptons of a new narrow resonance to that of the Z boson. These provide the most stringent lower limits to date on the masses for various spin-1 particles, spin-2 gravitons in the Randall-Sundrum model, as well as spin-1 mediators between the SM and dark matter particles. Lower limits on the ultraviolet cutoff parameter are set both for four fermion contact interactions and for the Arkani-Hamed, Dimopoulos, and Dvali model with large extra dimensions. Lepton flavor universality is tested at the TeV scale for the first time by comparing the dimuon and dielectron mass spectra. No significant deviation from the SM expectation of unity is observed.

The candidate's personal contribution here is on the data analysis and ensuring the good quality of the RPC system recorded data used for muon identification and reconstruction within the CMS muon system.

Date: 17.01.2025 г.
Plovdiv

Applicant: .....
/Assist. Prof. Mariana Shopova/