Referee report

for the competition for an Associate Professor in the Faculty of Physics of Sofia University "St. Kl. Ohridski" in Professional Field 4.1 "Physics, (Elementary particle physics)" announced in the "State newspaper" No 93/26.11.2019.

Candidate: **Senior Assis. Prof. Dr Peicho Stoev Petkov** from the Faculty of Physics. of SU

Referee: **Prof. D.Sci. Ekaterina Christova** from INRNE -BAS

1. Dr Peicho Petkov is the only candidate in the competition. He has applied with all necessary documents for the competition -- CV, certificates for his master and Ph.D degrees, list of publications and citations, a document for satisfying the minimal requirements for an Assis. Professor according to NACID, etc.

2. Biography and professional employment:

P. Petkov was born on 03.11.1978. in Shumen, in 2001 he graduated Physics and received his master's degree at the Sofia University "St. Cl. Okhridski ". In the same 2001, being a diploma student at the Faculty of Physics, the applicant's work was noticed and he was included in the CMS collaboration - one of the two biggest detectors for new particles at CERN. Since that time, all his activities and responsibilities have been related to the CMS collaboration and have been carries on both in Sofia, in the Faculty of Physics of the SU, and in Geneva, CERN.

CMS is an abbreviation for "Compact Muon Solenoid" and as suggested by its name, the goal of CMS is to register new particles through their decays into muons. Three types of detectors are used for identification of muons -- drift chambers (DC), cathode strip chambers (CSC) and resistive plate chambers (RPC). The activities of D-r P. Petkov have been totally related to the RPC detectors that he started with at the time when he was a diploma student. His PhD thesis were defended successfully in 2009 at the Faculty of Physics and were based on the construction and tests with cosmic rays of the RPC-chambers before installing them into the CMS detector, his scientific advisor was Leander Litov. He is employed first at a half-time job in INRNE-BAS as a physicist, 2006-2008 and in the Institute for Parallel Information Processing as a Computer and Network Analyzer, 2006-2007. Later he had a full-time job in the Faculty of Physics as a physicist in 2009-2013 and in 2013 is elected as a senior assistant.

Since that time all his activities and responsibilities are related to the CMS collaboration and carried on both in CERN in Geneva and in the Faculty of Physics in Sofia.

3 Numbers related to science:

Total number of publications:

а) a list of 692 publications in Elementary Particle Physics and High Energy Physics
б) 8 publications with IF in Modeling the interaction of biological molecules

Total number of citations: 17451 (SCOPUS), h-index: 61 (SCOPUS).

These numbers are extremely high and evidently several times exceed the requirements for an "Assoc. Prof." This is not strange recalling that since 2001 the candidate is a member of the CMS collaboration -- one of the biggest collaborations in CERN, that performs the most interesting experiments in High Energy Physics today.

It's enough to recall that the two collaborations CMS and ATLAS received the prestigious prize "The High Energy and Particle Physics Prize" for 2013 for observation of the Higgs boson.. Though the participation of the candidate in the CMS is a very good recommendation, it does not characterize his contribution, as the presented publications and citations present only an overall estimate for all members of the collaboration.

4. Dr. P. Petkov applies for an Assoc. Prof. with 20 scientific publications in the following journals:

- Physical Rreview Letters – 3
- Journal of Instrumentation – 8
- Physics Letters B – 3
- Nature – 1
- Journal of High Energy Physics – 3
- Nuclear Instruments and Methods A – 2 .

According to the rating of the journal they are:
1. Q1 – 17
2. Q2 – 3

He has presented a list of 159 independent citations for only 6 of these papers as this already saturates the minimal requirements of NACID. I'll note that just one of them has more than 100 citations.

5. As I noted above, these scientometric data do not yet determine the applicant's qualification and contribution, since in publications of the CMS Collaboration, the co-authors' names are listed on several pages, not ordered according to the contribution of the individual participants, but in alphabetical order of their countries. According to the rules of the ZRACRB, if there are more than 30 co-authors in some of the presented publications, as it is here, the applicant should have

a proven significant contribution for each one. This can be verified in different ways. Here this will be notified by the attached letter of the team leader - the RPC Project manager Dr. Gabriella Pugliese.

6. Here I will describe the applicant's research activities. They are reflected in the presented publications and the detailed author's summary, and are characterized by solid knowledge in the fields of ionizing radiation detectors and computer modeling.

The papers submitted for the competition are entirely related to the RPC detectors -- their development and commissioning, their installation into the CMS detector, as well as all activities related to maintaining the necessary characteristics during data taking, when the collider is runnig. His scientific contributions can be grouped as follows:

1.) Publications of the RPC-CMS Collaboration that concern the performance characteristics of the RPC system: these are publications K1, K2, K4, K13, K14, K15, K19 from the presented list.

2.) Publications K9, K11, K18 on behalf of the entire CMS Collaboration, which show the performance characteristics of the muon system as a whole and the quality of the reconstructed physical objects, used in further physical analysis.

3.) Publications K3, K5, K6, K7, K8, K10, K12, K16, K17, K20, which present some of the new results with muons in the final state, that would not have been obtained if the muon system did not have its present construction.

7. Bellow I'll make a detail analysis of **the personal contributions of the applicant in the publications and mark his significant contribution**, as verified by Dr. Gabriella Pogliese.

a) **Desein and construction of the RPC detectors**

The applicant participated in the design, assembly and testing as well as in the computer support of the RPC detectors. The resistive plate chambers have a total unfolded area of about 4000 m^2, with 480 RPCs only in the barrel part of the CMS. They are designed, assembled and tested with the main participation of scientists from four Italian and two Bulgarian groups. Dr. Petkov participated in their development, commissioning and all necessary activities to reach the desired performance necessary for data collection. Research has been done at both the University of Bari, Italy and Sofia. The results are published in 1 paper by the RPC Collaboration **K1**. In it, he has made a **significant contribution**, both in design and testing in Bari and Sofia, as well as in the trigger system and software for the tests in Sofia. His significant contribution was confirmed in the attached letter from Dr. Gabriella Pugliese, University of Bari & INFN, CMS RPC Project Manager. It states:**"He was responsible for the plastic scintillators triggersystem"** и по-нататък **" he developed software tools for data quality monitoring before uploading the data**

in the database as well as event reconstruction for RPC efficiency measurements for data collected in Sofia."

b) After installing the RPC detectors into the CMS detector, the RPC system has been certified by collecting data with cosmic muons, investigating the stability of the current consumed by the RPCs and measuring their efficiency and spatial resolution - important for proper data collection. The results are published in **K2, K4**, in which P. Petkov has a **significant contribution**, which is confirmed in the letter of Dr. G. Pugliese: **"When RPC detectors were installed in the CMS experiment, Peicho was involved in commissioning the RPC system."**

c) In 2009, the proton-proton LHC collider started and data taking began. From the very beginning in 2009, when the proton collisions were at 7 TeV, and later on at RUN2 in 2015-2018, when the energy is 13 TeV, the candidate participates in collecting data, monitoring the correct operation of the RPC system and timely troubleshooting of hardware issues. The performances during these periods were published in **K13, K15 and K19**, and according to the letter from Dr. Pugliese, the **candidate participates in them as an "On Call expert"** -- „ Later with the starting of LHC, he participated on the data taking as RPC shifter first and then as **RPC Detector OnCall experts. In those periods, he was in charge to configure and operate the detector and to monitor it during the data taking.“**

d) During the planed Long Shutdown 1 (LS1) of the LHC in 2013-2014, Dr. Petkov is involved , as an expert on RPC detectors, in troubleshooting hardware issues in the RPC high voltage (HV) supply. The latter was published by the CMS RPC Collaboration in **K14**, and according to G. Pugliese's letter "In the shutdown periods he was involved in the maintenance activities **to repair all failed components (HV and LV)."**

In the last years Dr.Petkov is responsible for investigating the effect of environmental parameters on RPC currents and related analysis (so-called "non-event data analysis" according to Dr. Gabriella Pugliese's reference letter).

In a letter of Dr. Gabriella Pugliese we read: „ all publications of the RPC CMS collaboration on performance and properties of the RPC system during the years are made with significant contribution of Peicho Petkov. He is one of the leading persons in our community, extremely reliable and competent scientist". These are ***K1, K2, K4, K13, K14, K15*** **and K19.**

e) I'll add few words on the obtained results at CMS at LHC.
The good performance of the RPC system, obtained with the efforts of the strong team of Bulgarian and Italian experts in which P. Petkov plays an essential part **("significant contribution"),** guaranties the good performance of the CMS system as a whole, (the CMS publications: **K9, K11, K18**). In **K3, K5, K6, K7, K8, K10, K12, K16, K17, K20** some impressive physical results with muons in the final state have been selected. I will mention 2 of them: In 2011 an order of magnitude upper limits on the extremely rare B-meson decays with 2 final leptons $B^0_s \rightarrow \mu^+\mu$ and

$B^0 \to \mu^+\mu^-$ were obtained (**K5**), in 2015 the combined analysis of the CMS and LHCb collaborations (another collaboration at the LHC collider for search for rare B-meson decays) lead to the observation of these decays. These decays are particularly interesting because in the SM they are extremely rare and an observed difference in the measured branching ratios and the predictions of the SM would be a clear indication for New Physics. Unfortunately, the results are compatible with the background of the SM and, despite the unprecedented accuracy achieved, so far there is no indication which direction to look for Physics beyond the SM. Although at present neither CMS nor ATLAS has reported for an observation of new particles, strong constraints have been obtained for many of them - restrictions on the existence of new gauge bosons (**K6, K8**), of new Higgs bosons (**K12, K17, K20**) and others.

8. Teaching abilities

A certificate from the Faculty of Phys. of the SU on his training employment for the academic years 2016/17, 2017/18 and 2018/20 is presented. His diverse pedagogical work with the students is impressive, which began in 2013 when he was approved at the position of a Senior Assis. Prof. at the Faculty of Phys.

Dr P.Petkov gives lectures on 3 compulsory and 4 elective specialized courses, 3 of which are in computer modeling, on "Programming in UNIX" at the Faculty of Phys. He has prepared also a completely new course "Modeling the interaction of biological molecules". He has been a scientific adviser of 5 diploma thesis related to RPC detectors and to molecular modeling. The above testifies to his erudition in Physics and his teaching abilities.

9. Organizational activities, participation in contracts, conferences and schools

Recognition of P. Petkov's authority by his colleagues is his election in 2018 in the Faculty Council of the Faculty of Physics within the quota of non-habilitated scientists.

Acknowledgment for his professionalism is his participation in a number of contracts with the National Science Foundation - he is a head of one of them, 2011 and a member of 6 others, and participates in 1 international agreement, financed by the European Commission. The contracts are both on CMS and molecular modeling topics.

Participates in a number of schools and conferences. Among them I will mention only those where he personally presented the results of the research - III National Congress in Physics, Sofia 2016, International Conference on Mathematical Methods and Models in Biological Sciences, Sofia 2014, Large-scale Molecular Dynamics Simulations on Modular Supercomputing Architecture with GROMACS, HPC Bulgaria 2019, Bulgaria / Borovets 2019 and numerous RPC-CMS Collaboration meetings.

- **CONCLUSION**

Based on the above estimates and my personal impressions, I can confidently say that Dr. **Peycho Petkov** is an internationally recognized specialist in the field of detector systems and computer simulations, who successfully participates in one of the most important experiments in high energy physics at the European Research Center, CERN and works successfully with students. Undoubtedly, his activities exceed all criteria for an "Associate Professor" defined by the Law for scientific degrees and positions in Republic Bulgaria (ZRASRB) and the regulation rules of the Faculty of Physics of Sofia University and I firmly propose to the distinguished jury that he takes up this position.

Sofia, 03.03.2020г. ***Referee:***

/Prof. Ekaterina Christova/