REVIEW

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Regarding: the competition for the academic position "**Associate Professor**" in the field of higher education ***5. Technical Sciences***, professional field ***5.2. Electrical Engineering, Electronics and Automation***, *specialty „**Biomedical Equipment and Technologies**"*, for the needs of the Department "Medical Equipment, Electronic and Information Technologies in Healthcare", Faculty of "Public Health" at the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, according to a competition announced in State Gazette No 15/21.02.2025 r.
Candidate: **Eng. Nikolay Tinkov Dukov, PhD**.

1. General information and brief biographical details of the candidate

The only candidate in the announced competition – PhD. Eng. Nikolay Tinkov Dukov was born in the city of Veliko Tarnovo. The candidate successfully graduated in 2012 with a Bachelor's degree in *Electronics*, in 2014 with a Master's degree in *Electronics* and in 2025 with a Master's degree in *Medical Radiation Physics and Technology*.

In 2019, he defended his dissertation for the Doctor's degree on the topic "Study on the design and implementation of biologically motivated neural structures".

Nikolay Dukov began his professional activity at the Technical University of Varna in 2014 as a full-time doctoral student at the Department of Electronics and Microelectronics, professional field 5.2. "Electrical Engineering, Electronics and Automation", Technical University of Varna.

During the period 2014-2017 he was a part-time lecturer in the same department. During the period 2017-2020 he was an "assistant", Department of "Computer Science and Technology", Technical University - Varna.

Since 2020 he has been an assistant, and since 2021 he has been a chief assistant in the Department of "Medical Equipment, Electronic and Information Technologies in Healthcare", Medical University "Prof. Dr. Paraskev Stoyanov" - Varna.

He completed specializations in 2013-2014 at Ghent University, Belgium, and in 2015 at the University of Patras, Patras, Greece.

The total work experience as a lecturer is over 7 years.

PhD Eng. Nikolay Dukov has lectured in 9 academic disciplines and given exercises in 21 academic disciplines. He is a proven researcher with a record of participation in 13 national and 2 international scientific and educational projects.

He speaks English at an excellent level. He has in-depth knowledge in the field of programming, computer signal and image processing, statistical analysis software, 3D printing and artificial intelligence as applicable in biomedical equipment and technologies. He works freely with standard and specialized software.

2. General description of the presented materials

The candidate, Eng. Nikolay Dukov, PhD, has submitted all documents required by the Law on the Development of the Academic Staff in the Republic of Bulgaria, Regulations for the application of the Law on the Development of the Academic staff in the Republic of

Bulgaria and Regulation for the development of the academic staff at Varna Medical University for participation in the competition, and in particular:

• Academic certificate issued by the library of the Medical University of Varna, including:

- ✓ Publications and citations covering the minimum national requirements;
- ✓ Full-text publications and citations, beyond the minimum scientometric requirements;
- ✓ List of scientific works and citations used for the acquisition of PhD degree and for the occupation of the previous academic position "chief assistant";
- ✓ Application for active profiles in Google Scholar and ORCID (as well as other profiles in scientific networks, e.g. Research Gate);
- ✓ Application for Impact Factor.

• A separate list of selected publications equivalent to a habilitation thesis.

• Publications - Group B, equivalent to a habilitation thesis.

• An extended habilitation reference for scientific contributions.

• Summaries of scientific publications from Group B, equivalent to habilitation thesis, in Bulgarian and English.

• Publications - Group G.

• Summaries of scientific works from Group G in Bulgarian and English.

• Reference for original scientific contributions, signed by the candidate (word and pdf).

• List of participations in national and international scientific events.

• Reference for similarity of scientific works submitted under the procedure for occupying the position of Associate Professor with scientific works available online, including scientific databases and websites, issued by MU-Varna.

• Other documents related to the candidate's scientific and teaching activities: certificate of "Master" degree, specialty "Medical Physics"; certificate of English language proficiency level B2; certificate of legal capacity SIR; certificates from specialized training.

• List of participations in national and international scientific and educational projects.

• Publications beyond the minimum requirements and their summaries.

The candidate for the competition for the position of „Associate Professor" - Nikolay Dukov, submitted a total of **29 scientific papers** for review. Of these:

- **11 scientific publications** equivalent to a monographic work in publications that are referenced and indexed in world-renowned databases of scientific information (Web of Science and/or Scopus) – according to **indicator B4;**

- **18 scientific publications** printed in publications referenced and indexed in world-renowned databases of scientific information (Scopus and/or Web of Science) - to **indicator G7;**

- **5 citations** in scientific publications in referenced and indexed in world-renowned databases of scientific information (Scopus, Web of Science) - by indicator **D12**;

The submitted works are directly related to the current competition for the position of "Associate Professor" and they are in the professional field 5.2. Electrical Engineering, Electronics and Automation in the scientific specialty "Biomedical Equipment and Technologies". According to the reference submitted by the candidate in the competition,

the scientometric indicators are shown in Table 1.

Таблица 1.

Indicators	Minimum required points	Points of the candidate	Number of points by main indicators of a group	
Group A	50	50,00	Diploma for PhD" №ТУВ-НС-2019-114 / 21.03.2019 г.	
Group B	100	108,48	B4	108,48
Group G	200	204,37	G7	204,37
Group D	50	50	D12	50
Total:	***400***	***412,85***		***362,85***

The Scientometric indicators presented in Table 1 show that the minimum national requirements for holding the position of „Associate Professor", as well as those of the Regulations for the Development of the Academic Staff of the Medical University - Varna, have been met.

3. General characteristics of the candidate's research and applied scientific activities.

The research and applied scientific activities of PhD. Eng. Nikolay Dukov are in the field of new advanced technologies in imaging diagnostics.

3.1. Publications from group B4 are closely related thematically and support the candidate's research and development activities in this area, with five of these publications being in the highest quartile level - Q1 and three of them in quartile Q2. The candidate divides these publications into three main topics:

- ✓ "Computational models of the breast and lesion modeling"
- ✓ "Physical phantoms of the breast and manufacturing technologies"
- ✓ "Radiological evaluation and characterization of materials".

The publications can be divided as follows:

Computational breast models and lesion modeling [B4-01, B4-02, B4-03, B4-08, B4-09]

The research presents advances in the field of computational breast phantoms and lesion modeling. The work contributes methodologies for phantom and lesion creation, from software tools to databases [B4-01, B4-03]. Approaches are demonstrated that allow rigorous validation of imaging technologies, providing controlled environments for studying variables such as lesion size, location, and image parameters [B4-02, B4-09].

Obvious benefits for clinical practice and industry are found. The ability to simulate different breast structures and lesions [B4-01, B4-03] supports the training of radiologists who can practice interpreting complex cases without patient involvement. At the same time, these phantoms and lesion models facilitate the development and validation of imaging systems [B4-08, B4-091, ensuring that new technologies meet clinical needs. The integration of real patient data into phantoms [B4-01, B4-02] ensures clinical relevance, while the development of databases [B4-03] promotes scalability and reproducibility. These efforts pave the way for personalized medicine, where phantoms tailored to individual patient profiles can optimize diagnostic protocols. Meanwhile, innovations in lesion modeling [B4-

09] improve the realism of simulations, supporting the evolution of artificial intelligence in diagnostics.

Physical Breast Phantoms and Fabrication Technologies [B4-04, B4-05, B4-06, B4-08, B4-09]

The reviewed papers make significant contributions to the field of physical breast phantoms and fabrication techniques. They contribute to the understanding of tissue-equivalent materials and anatomical modeling and translate the results into imaging tools and provide application benefits through practical, scalable solutions for clinical use. The focus on the realism and functionality of the phantoms and the use of innovative manufacturing methods improves the quality and safety of medical images. The emphasis on 3D printing demonstrates the increasing reliance on additive manufacturing to achieve greater personalization and precision. However, challenges remain, such as the need for materials that more closely match the properties of certain tissues, such as those with low density.

Radiological Evaluation and Characterization of Materials [B4-01, B4-02, B4-05, B4-06, B4-07, B4-09, B4-10, B4-11]

These articles focus on the creation, evaluation, and application of breast phantoms, lesion models, and novel materials adapted for radiographic imaging.

The collective contribution of the articles [B4-01, B4-02, B4-05, B4-06, B4-07, B4-09, B4-10, B4-11] provides a framework for the advancement of radiological evaluation and characterization of materials. They advance knowledge of material interactions and tissue equivalence, laying the foundation for innovation in medical imaging. The development of computational and physical phantoms [B4-01, B4-02, B4-05, B4-06] improves the ability to simulate complex biological structures, while new materials and contrast agents [B4-07, B4-09, B4-10, B4-11] expand the toolkit available for phantom design and image optimization. This research establishes methodologies for phantom creation, material suitability verification, and image validation, ensuring reproducibility and standardization. The results are improved diagnostic tools, improved training platforms, and safer imaging practices that directly impact clinical workflows and patient care. The broader impact of the research extends beyond radiology, reaching interdisciplinary fields such as biomedical engineering and materials science. By integrating computational modeling methods [B4-01, B4-02], advanced manufacturing [B4-06, B4-11], and composite nanomaterial research [B4-07], these studies demonstrate and promote interdisciplinarity, stimulating innovation in healthcare technologies. The emphasis on realism and patient specificity [B4-06, B4-09] is consistent with the trend toward personalized medicine, potentially transforming diagnosis and treatment. In addition, the development of cost-effective materials and methods [B4-10, B4-11] addresses accessibility, making advanced imaging technologies more usable in resource-limited settings.

3.2. Publications from group G7

The candidate for the competition for the position of "Associate Professor" Nikolay Dukov, presents **18 scientific publications** under indicator G7, printed in refereed publications and indexed in world-renowned databases of scientific information (Scopus and/or Web of Science).

This group of publications can be divided into **four main thematic areas**, as follows:

Development and evaluation of anthropomorphic phantoms for X-ray imaging diagnostics [G7-04, G7-06, G7-10, G7-11, G7-12, G7-13, G7-14, G7-16, G7-17, G7-18].

Articles G7-04, G7-11 validate various manufacturing techniques, balancing cost, precision and realism and provide practical tools for optimizing imaging systems.

Their applied science focus is on coupling computational designs with physical phantoms, with potential for clinical application and research.

G7-12 develops bone phantoms of the humerus, and in G7-13 a 3D-printed phantom for QCT with calcium chloride solutions mimicking cancellous bone densities was designed.

Publications G7-10, G7-17, G7-18 evaluate the radiological characteristics of phantoms from X-ray images, for optimization of techniques and quality assurance.

The emphasis in G7-06, G7-13, G7-14, G7-16, G7-17 is on the practical use of phantoms in education, and quality control, improving clinical and academic outcomes.

An overview and technologies for simulation research of phantoms was made in G7-17.

Segmentation and modeling of breast lesions [D7-04].

G7-04 discusses the development of new algorithms for segmenting breast lesions from clinical imaging data, increasing the accuracy of the created models. The creation of mathematical models of breast lesions is necessary to generate realistic, irregularly shaped objects for simulations and phantoms.

Development and characterization of materials and novel contrast agents for imaging diagnostics [G7-07, G7-10, G7-12, G7-16].

In G7-07, 3D printing materials were systematically characterized to determine their radiological suitability for tissue-mimicking phantoms.

G7-16 investigated dental materials, including silicones and composites, measuring their Hounsfield units for different energies (70–150 kV), identifying silicones such as Temp silic as possible bone-mimicking materials, finding new applications related to phantom fabrication.

G7-10 validated new contrast agents for improving X-ray images in phantom studies related to improving the visibility of certain objects.

In G7-12, G7-16, the characterized materials in phantom fabrication are related to checking their performance in the context of the obtained images.

Advanced imaging methods, validation systems and their implementation [G7-01, G7-02, G7-03, G7-04, G7-05, G7-08, G7-10, G7-15, G7-18].

G7-18 develops a software module for obtaining an image based on phase-contrast with a grating. Four computational phantoms are simulated to compare the improvement of edge highlighting compared to methods based on absorption and diffusion.

Publications G7-10, G7-18 consider the optimization of X-ray techniques with enhanced contrast using phantoms to improve diagnostic accuracy.

Publications G7-02, G7-15 develop optical systems for validating X-ray imaging processes without the use of ionizing radiation, which supports the testing of new algorithms.

Publications G7-01, G7-18 establish frameworks for validating imaging and simulation software, ensuring reliability.

G7-03, G7-05 are related to the creation of web-based platforms to optimize imaging and health research by improving data accessibility.

G7-09, G7-14 transform research results into educational resources, improving the training of medical professionals.

4. Assessment of the candidate's pedagogical training and activities.

PhD. Eng. Nikolay Dukov is an established lecturer, with more than seven years of teaching experience. As can be seen from the attached reference for the number of hours of lectures given in the Department of "Medical Equipment, Electronic and Information Technologies in Healthcare" at the Faculty of Public Health at MU-Varna, for the last three years, the candidate has been a leading lecturer in the following disciplines: "Programming Part II" "3D Printing", "R Statistics and Software for Statistical Analysis", "Computer Processing of Medical Signals and Images", "Artificial Intelligence for Medical Image Processing" in the Bachelor's and Master's Degrees.

The candidate has also participated in the development of the curricula for the specialty "Biomedical Equipment and Technologies", Bachelor's and Master's Degrees. Electronic and Information Technologies in Healthcare", Master's Degree Program, as well as in the development of curricula for the disciplines he leads.

PhD. Eng. Nikolay Dukov is the supervisor of two successfully defended Bachelor's Degree Program graduates and six successfully defended Master's Degree Program graduates.

This gives me reason to define PhD. Eng. Nikolay Dukov as a well-established lecturer with high professional and engineering-technical qualities.

5. Main scientific, scientific-applied and applied contributions.

The candidate's contributions from the submitted publications are of a scientific, scientific-applied and applied nature.

5.1. Scientific Contributions

5.1.1. Computer Modeling of Breast Phantoms [B4-01, B4-05, B4-06].

The scientific contribution of this group of publications can be defined as the introduction of a new method for creating and generating computational phantoms and the development of computational models of the breast. In this way, the limits of computational realism of phantoms are expanded, offering flexible and customizable models that reproduce clinical scenarios without physical constraints.

5.1.2. Development of a bone phantom [B4-07, D7-12, D7-13].

Bone and bone density mimicking phantoms for computed tomography have been developed using new materials and printing techniques, allowing for future innovations such as improved material properties and scaling to other skeletal structures, offering significant potential for advancement in diagnostic radiological studies.

5.1.3. Overview and technologies for simulation research of phantoms [B4-08, D7-17].

Knowledge is synthesized and phantom creation technologies are simulated to provide guidance for future developments in X-ray imaging, with a focus on simulation and review for optimizing phantoms for complex imaging scenarios, with the potential to reduce development costs and accelerate advances in imaging diagnostics.

5.1.4. Lesion segmentation based on clinical images [B4-01, B4-02, B4-06, D7-04].

New algorithms are developed for segmenting breast lesions from clinical imaging data, increasing the accuracy of the created models.

5.1.5. Mathematical modeling of lesions [B4-03, D7-04].

Mathematical models for simulations and phantoms of breast lesions have been created to generate realistic and irregularly shaped objects, with a focus on theoretical innovations that reduce the dependence on clinical data while maintaining realism.

5.1.6. Characterization of 3D printing materials [B4-09, B4-11, D7-07].

3D printing materials have been systematically characterized to determine their radiological suitability for tissue-mimicking phantoms.

These contributions advance phantom design by establishing precise radiological profiles for 3D printing materials, allowing informed choices for tissue equivalence. Their characterization supports the development of realistic phantoms with the potential to streamline manufacturing processes.

5.1.7. New tissue-equivalent materials [B4-07, G7-16].

New materials have been developed by creating and testing innovative phantom compounds adapted for medical imaging, with a focus on radiological and structural equivalence with human tissues.

5.1.8.Development of phase-contrast imaging [G7-18].

Phase-contrast X-ray imaging has been improved through new simulation techniques that improve the visualization of tissue details. The contribution consists in the creation of a computational framework that uses the phase changes of X-rays, offering a tool for optimizing mammographic imaging algorithms.

5.1.9.Optimization of contrast-enhanced imaging [G7-10, G7-18].

The optimization of contrast-enhanced X-ray techniques using phantoms to improve diagnostic accuracy has been performed. The focus on practical optimization links theoretical contrast enhancement with clinical utility, offering tools for improving CESM and related techniques.

5.1.10. Design and development of optical validation systems [G7-02, G7-15].

Innovative validation tools using non-ionizing technologies have been introduced, offering safe and reproducible platforms for algorithm development for rapid prototyping and educational applications, reducing the dependence on X-ray installations.

5.1.11. Statistical and computational validation [G7-01, G7-18].

Validation methodologies critical to ensuring the reliability of software for radiology applications have been developed, providing tools to verify complex simulations, increasing confidence in virtual studies.

5.2. Contributions of scientific and applied nature

5.2.1. Fabrication of physical breast phantoms [B4-04, B4-05, B4-06, B4-09, G7-04, G7-11].

Physical breast phantoms were fabricated using 3D printing and alternative methods, testing their feasibility for applications. Their applied scientific focus is on coupling computational designs with physical phantoms, with potential for clinical application and research.

5.2.2. Evaluation of the effectiveness of phantoms for imaging diagnostics [B4-05, B4-09, G7-10, G7-17, G7-18].

The radiological characteristics of phantoms from X-ray images were evaluated, to optimize techniques and ensure quality. These developments link phantom design to practical imaging applications, ensuring that phantoms meet clinical standards for image quality and system calibration.

5.2.3..Validation and integration of lesion models [B4-02, B4-03, B4-05, B4-09].

This subsection validates and integrates lesion models into phantoms or databases, ensuring their practical utility in imaging studies. These contributions link theoretical models with practical use, confirming the realism of lesions and facilitating their application in diagnostic developments.

5.2.4. Development and evaluation of contrast agents [B4-10, D7-10].

New contrast agents have been validated to improve X-ray images in phantom studies related to improving the visibility of certain objects.

5.2.5. Use of materials in phantom fabrication [B4-09, D7-12, D7-16].

The performance of materials in the context of acquired images during phantom production has been verified, ensuring that, regardless of the original purpose of the material used, they work effectively for imaging.

5.2.6. Optimization of Contrast-Enhanced Imaging [G7-10, G7-18].

Optimization of contrast-enhanced X-ray techniques using phantoms to improve diagnostic accuracy has been performed, with a focus on linking theoretical contrast enhancement with clinical utility, offering tools for improving contrast-enhanced spectral mammography and related techniques.

5.3. Applied Contributions

5.3.1. Specialized Applications of Phantoms [G7-06, G7-13, G7-14, G7-16, G7-17].

Development of practical use of phantoms in education, and quality control, improving clinical and academic outcomes. These developments provide tools for training, diagnostics and quality assurance, making phantoms available for use in real-world settings.

5.3.2. Web-based Research Platforms [G7-03, G7-05].

Web-based platforms have been created to optimize imaging and health research by improving data accessibility, research efficiency and communication. The easy-to-use interfaces of the created applications and scalable architectures ensure utility in academic and clinical environments. The focus on their implementation positions them as valuable assets for advancement in imaging diagnostics and health research.

5.3.3. Research-based educational tools [G7-09, G7-14].

Research results have been transformed into educational resources, improving the training of medical professionals. The focus on integration into the learning process provides immediate benefits in medical education, connecting research with practice.

6. Significance of contributions to science and practice.

The significance of the contributions of the candidate in the competition, PhD. Eng. Nikolay Dukov, to education, scientific research and innovation is indisputable. The significance can be judged by the scientific reports presented, with which he participates in prestigious international and national scientific forums with international participation, and

the scientific publications, referenced and indexed in the world-famous databases of scientific information - Scopus and Web of Science.

I define the candidate's contributions to science and engineering practice as significant and representing a good basis for further in-depth scientific research and achievements in the scientific field of the competition. The candidate has published a significant number of scientific papers with scientific and applied contributions to science, innovation and education.

Therefore, the candidate's contributions to the declared scientific field are significant, and the information contained in them is useful, sought after and necessary for other authors and specialists, and most importantly - the names of the candidate and his co-authors have long been well known in scientific literature and in engineering practice.

7. Critical remarks and recommendations.

I have no editorial or scientific-technical remarks to make regarding the works submitted for review. I recommend that the candidate direct his efforts to writing a monograph both in the field of the competition and in the areas where he works and experiments.

8. Personal impressions and opinion of the reviewer.

I have known the candidate in the competition for more than 7 years and have personal impressions of the candidate's work as a competent teacher and researcher, with established criteria, with a wide range of professional and scientific interests.

CONCLUSION

The scientific works presented in the competition contain significant results, for which I give a positive assessment. Sufficient scientific, scientific-applied and applied contributions have been received. The minimum requirements have been achieved, the scientific-metric indicators have been met and PhD. Eng. Nikolay Tinkov Dukov meets all the conditions and requirements of Law on the Development of the Academic Staff in the Republic of Bulgaria, Regulations for the application of the Law on the Development of the Academic staff in the Republic of Bulgaria and Regulation for the development of the academic staff at Varna Medical University for participation in the competition.

Based on this, I find it reasonable to propose **PhD. Eng. Nikolay Tinkov Dukov to occupy the academic position of "ASSOCIATE PROFESSOR"** in professional field 5.2. Electrical engineering, electronics and automation in the scientific specialty "Biomedical equipment and technologies".

Заличено на основание чл. 5, §1, б. „В“ от Регламент (ЕС) 2016/679

Date: 10.6.2025 г. **REVIEWER:**

Assoc. Prof. PhD. Eng. Marinela Yordanova