

# OPINION

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**Regarding:** Competition for the occupation of the academic position "professor", announced in SG No. 102/23.12.2022 in the field of higher education: 5. Technical sciences, Professional direction: 5.2. Electrical engineering, electronics and automation, Scientific specialty: Biomedical engineering and technologies for the needs of the department "Medical equipment, electronic and information technologies in health care" at the Faculty of "Public Health" of the Medical University "Prof. Dr. Paraskev Stoyanov" - Varna. The only candidate in the competition is Prof. Dr. Eng. Kristina Stanimirova Bliznakova.

## 1. Biographical data and career development

Prof. Dr. Eng. Kristina Bliznakova was born on August 15, 1973 in the town of Shumen. He completed his higher education in 1996, majoring in "Electronics and Microelectronics" at the Technical University - Varna and obtained a master's degree in electrical engineering. During the period 1996-1998, he pursued a second master's degree in "Biomedical Technologies" at the University of Patras, Greece, which developed into a doctoral program for the period 1998-2003 as a full-time doctoral student in biomedical technologies in the Laboratory of Biomedical Technologies at the Department of Medical Physics of the Faculty of Medicine at the University of Patras, Greece. The title of the thesis defended in 2003 is "Research, development and application of a software platform for modeling and simulations of X-ray images". In the period 2004 - 2012, he was a scientific researcher in the Laboratory of Biomedical Technologies, at the Department of Medical Physics of the University of Patras, Greece. In the period 2012 - 2016, Dr. Kristina Bliznakova worked as a research assistant and part-time teacher at the Laboratory of Computer Simulations in Medicine of the Technical University - Varna, and after being elected as an associate professor in 2016, she became a member of the Department of Software and Internet technologies of the Faculty of Computing and Automation of the same university. From 2019, Dr. Kristina Bliznakova moved to work as an associate professor in the Department of "Medical Equipment, Electronic and Information Technologies in Health Care" of the Faculty of "Public Health", at the Medical University - Varna.

Assoc. Prof. Bliznakova has good foreign language training, speaks 3 foreign languages: English, Greek and Russian, which has a positive impact on her teaching and research activities.

## 2. General characteristics of scientific research and applied scientific activity

All presented scientific works are in the scientific field of the competition announced for the scientific specialty "Biomedical Techniques and Technologies".

### 2.1. Description of the monographic work

The candidate participates in the competition with 11 publications, equivalent to a monographic work, which is in accordance with the requirements of ZRASRB and PUZAD of the University of Varna. Their thematic orientation affects the solution of various tasks related to image diagnostics using X-rays. Publications equivalent to a monographic work concern the following problem areas:

### **A. Development of anatomically and radiologically realistic computer and physical models of the breast [B4-01 – B4-06].**

- Anthropomorphic mammary models for X-ray-based imaging (computer and physical models (phantoms)) realistically mimicking the anatomical and radiological characteristics of human mammary tissue. The main goal is to use these models to improve breast screening and diagnosis.
- Computer models of mammary gland tumors
- Investigation of 3D printing materials used in the creation of physical phantoms of the mammary gland.

### **B. Creation of new imaging techniques and methods related to three-dimensional mammography add the necessary 3D information [B4-07 – B4-11].**

- Validation of a software platform for 2D and 3D phase contrast imaging: preliminary subjective evaluation [B4-07]
- Hybrid simulation platform for X-ray phase contrast virtual studies [B4-08]
- Implementation of phase-contrast breast tomosynthesis on synchrotron infrastructure [B4-10]
- Mammary gland tomosynthesis implemented with a multiple projection algorithm for a stationary detector [B4-11]

The scientific works presented in this section are equivalent to a monographic work, in the field of new and more advanced technologies for screening and diagnosis of the mammary gland. The proposed novelties, such as software models and phantoms, algorithms and approaches have been tested and validated in practice with various examples. The presented materials satisfy the requirements of Art.1(2) and Appendix 1 of the Regulations for the Development of the Academic Staff (PRAS) at the MU - Varna.

### **3.2. Description of the publications other than the monographic work**

The publications outside the monographic work, which are 27 in number, concern a variety of research thematically related to the scientific specialty of the competition and can be grouped into the following groups of research and development:

- Materials for 3D printing of anthropomorphic phantoms: Simulation study [D7-01, D8-10];
- Method for creating a physical breast radiological phantom using an inkjet printer: Preliminary results [G7-02, G7-07, G7-16, G8-02, G7-06];
- Creating a physical model of lesions [G7-05, G7-14, G8-03, G8-04, G8-05, G8-09];
- Creating a physical radiological phantom for a mammary gland without lesions with a 3D printer [G7-05, G7-12, G7-13, G7-16, G8-06];
- Simulation studies of breast imaging methods [G7-09];
- Software application for extracting descriptors from medical images [G7-03];
- Design and implementation of a web-based platform to support scientific research related to mammary gland imaging [G7-10];
- Simulations and software developments in other fields of medicine [G7-04, G7-08, G7-11, G8-07];
- Application of the results of scientific research in education [G7-15];

- Application of regression analysis in computational biology [G8-1].

### 2.3. Description of the candidate's scientific and applied activity

Document 20 presents a "List of participations in national and international scientific and educational projects" in which Associate Professor Dr. Bliznakova participated. They are 28 in total, of which 5 are ongoing, including 1 international project. 10 are international research projects, and those at the national level - 18. Associate Professor Bliznakova is the head of 2 international and 5 national projects. The thematic area of the projects coincides with the area of the announced competition "Biomedical Engineering and Technologies". The given information gives me reason to rate the scientific and applied activity of Prof. Bliznakova very highly.

### 3. Basic scientific and scientific-applied contributions

From the analysis of the candidate's scientific works, briefly presented above, the following more important scientific and scientific-applied contributions can be noted:

- The following overviews have been prepared in the problem area
  - Overview of mammary gland mathematical models [B4-01];
  - Overview of the physical implementation of anthropomorphic phantoms [B4-01];
  - Review of 150 unique mammary computer phantoms derived from high-resolution breast computed tomography patient images [B4-02].
- The following algorithms have been developed, implemented and tested:
  - Algorithm for breast compression during mammography and tomosynthesis [B4-02]
  - Algorithm for classification of the voxels of the original image to one of the three main tissues: glandular, fatty skin [B4-02]
  - Lesion segmentation algorithm [B4-03]
  - An "in line" phase contrast modeling algorithm is the basis of a new software module of the XRAYImagingSimulator software application, which module is designed to model and simulate phase-contrast projections for researcher-defined geometries [B4-07].
- The following mathematical models have been created:
  - Mathematical modeling of breast lesions based on the "random cost" method [B4-03]
  - Mathematical modeling of irregularly shaped breast lesions based on three-dimensional breast X-ray images. [B4-06] The developed algorithm includes six basic processes on each tomographic image: (a) intensity normalization; (b) noise reduction; (c) binarization of the lesion area; (d) applying morphological operations to further reduce the level of artifacts; (e) applying the "nearest neighboring voxel" technique to segment the lesion; and (f) creating a final 3D computer model of the lesion.
- A validation methodology was created, including computer modeling and the physical realization of three anthropomorphic mammary gland models made from materials obtained in research from the second major category of contributions [B4-06].
- The properties of various phantom 3D printing materials were investigated:
  - The refractive index of light of 3D printing materials was studied [B4-04]
  - A new method is proposed to evaluate the X-ray properties (absorption coefficients  $\beta$  and refraction coefficients  $\delta$ ) of twelve materials used for 3D printing for the purpose of making qualitative and adequate three-dimensional physical models of the mammary gland [B4-04].

- The light attenuation and refraction coefficient of low-density materials was studied [B4-05].
- The following new methods have been created and tested:
  - New method for obtaining phase-contrast projections by means of diffraction and absorption gratings [B4-08];
  - An approach encapsulated in a new software module (to the XRAYImagingSimulator software) is proposed for hybrid modeling of phase-contrast images obtained by adding three gratings to the in-line setup [B4-08].
  - A method for implementing three-dimensional phase-contrast imaging diagnostics for obtaining high-quality images and its application for mammary gland diagnostics [B4-10];
  - A method was developed to create computer models of mammary lesions, which lesions are irregularly shaped and segmented from patient data. For this purpose, digital tomosyntheses of the mammary gland and images of mastectomies, as well as, computed tomography of the whole breast, have been used [B4-06]. The method is implemented in the MATLAB programming environment.
  - A new method for printing 3D lesions for applications related to mammary gland imaging [G7-05, G7-14];
  - A new method based on an inkjet printer for creating a physical radiological model of a mammary gland [G7-02, G8-02];
  - New technique for lung diagnostics using dark field [G7-11];
- Physical radiological phantoms of varying complexity have been developed [B4-10].
  - Novel physical radiological mammary phantoms without lesions created with 3D printers [G7-12, G7-16, G8-10]
- A MaXIMA database has been developed with a variety of mammary gland models with and without lesions [B4-03].
- The BreastSimulator software platform has been validated for mammary computed tomography [B4-09].

#### **4. Evaluation of the pedagogical preparation and activity of the candidate**

The certificate of teaching experience (document 7) and the study load report (document 9) of Assoc. Prof. Dr. K. Bliznakova presented in the documents show that since 2010 she has participated in the educational and methodological activities of departments of three universities: the Department of Medical Physics at the University of Patras, Greece (2010 – 2012); at the Technical University - Varna (2014 - 2017) and at the Department of "Medical Equipment, Electronic and Information Technologies in Health Care" of the Faculty of "Public Health" at the Medical University - Varna (2019 - 2022), as well as at the National Center in Radiobiology and Radiation Protection.

Assoc. Dr. Bliznakova did not present any new textbooks issued. However, taking into account her rich theoretical and practical experience gained during the years from 2010 to now in work and engagements and as a teacher and researcher, it can be safely said that she is highly qualified and prepared in the field of the disciplines she leads. In conclusion, I believe that the pedagogical training and activities of Assoc. Dr. K. Bliznakova fully correspond to the requirements for occupying the academic position of "professor".

#### **5. Scientific indicators**

To participate in the competition for professorship, the candidate submitted 38 scientific papers, which relate as follows:

- To cover the minimum scientometric indicators in Group B, 11 peer-reviewed scientific publications in English, referenced in the international SCOPUS database, were selected with a total of 143.84 points. The total impact factor of the publications in this group is 37.16.
- - Papers published in specialized magazines and yearbooks - 10 nos. in specialized international journals, such as: *Physica Medica* (3), *Medical Physics* (1), *Physics in Medicine and Biology* (5) and *Journal of X-Ray Science and Technology* (1)
  - Proceedings from international conferences (reports published in full text) – All publications are in English, all conferences were held abroad.
- A total of 27 peer-reviewed scientific publications in English with a total of 221.41 points were selected for participation in the competition and meeting the minimum scientific indicators in Group D. 16 of the publications are referenced in the international database SCOPUS. The overall impact factor of the publications in this group is 13.24.
  - Scientific publications from Group G7, referenced in the international database SCOPUS - 16 items, of which 9 items published in specialized magazines and 7 nos. – in papers from international conferences (reports published in full text);
  - Scientific publications from Group D8, including 10 papers, 6 of which were published in specialized Journals and the remaining 4 have been published in international conference proceedings (papers published in full text). 9 of the publications are in English and 1 – in Bulgarian;
  - Scientific publications from Group G9 include 1 chapter of a book entitled "Computer models for X-ray radiography and tomography".

The candidate has also submitted 5 nos. scientific publications, beyond the minimum scientific requirements, referenced in the international SCOPUS database.

The submitted 38 scientific publications from Group B and Group G are subject to review, of which 3 are independent. The collective scientific works submitted for participation in the competition are 35, as in 10 the candidate is the first author, in 8 - on the second and in 11 - in third place.

The scientific publications submitted for participation in the competition are cited by independent authors as follows: the publications from Group B are cited in 68 publications, indexed and referenced in SCOPUS and 98 times - in other sources; Group G publications are cited in 23 publications indexed and referenced in SCOPUS and 98 times in other sources. In the competition for professorship, Assoc. Prof. Bliznakova participated with 17 citations in SCOPUS/WoS, which equal 170 points under indicator group D. Under indicator group E, the candidate collected 688 points, which significantly exceeded the specified minimum of 150 points and compensated for the smaller number points according to indicator 17 (20 nos.).

On the basis of the "Academic reference" presented in document 14 for the publications, citations and scientific profiles of Assoc. Prof. Dr. Bliznakova, prepared by the Library of the MU-Varna, in accordance with the Regulations for the ZRASRB and the Regulations for the Development of the Academic Staff at the MU- Varna, the results can be summarized quantitatively in Table 1. It is obvious that the candidate meets the requirements of PUZAD in

MU - Varna. I believe that the quantitative indicators presented in Table 1 are completely sufficient for occupying the academic position of "professor".

Table 1: Comparative table of indicators

Group of indicators	Content	Professor	Assoc. Prof. Dr. Bliznakova
A	Indicator 1	50	50
Б	Indicator 2	-	-
B	Indicator 3 or 4	100	143,84
Г	Sum of indicators from 5 to 11	200 ( $\geq 80$ points from indicator 7)	221,41
Д	Sum of indicators from 12 to 15	100	170
Е	Sum of indicators from 16 to the end	150 ( $\geq 80$ points from indicator 17)	688

### CONCLUSION

Based on the positive evaluations made of the candidate's scientific research and pedagogical activities, the relevance and significance of the contributions in the works presented and the fact that the indicators of his previous activity meet the legal requirements of ZRASRB and PUZAD of the University of Varna for this competition, I consider it reasonable to propose to the honorable Faculty Council of the Faculty of Public Health to support the proposal of **Assoc. Prof. Dr. Eng. Kristina Stanimirova Bliznakova to occupy the academic position "Professor" in the professional direction 5.2 "Electrical Engineering, Electronics and Automation" in the specialty "Biomedical technique and technologies"**.

Sofia, April 24, 2023

Prepared the opinion:



(Prof. Dr. I. Batchkova)