Review of the Proposal to Extend the Theme 1119 during 2017-2019

The theme **05-6-1119-2014/2019**, "Methods, Algorithms and Software for Modeling Physical Systems, Mathematical Processing and Analysis of Experimental Data" is implemented under the direction "Networking, Computing, Computational Physics" of the "Topical Plan for JINR Research and International Cooperation" and aims to provide mathematical and computational support for a wide range of research conducted at JINR according to the 7–year JINR development plan for 2017-2023. The fulfillment of works inside the theme assumes conducting fundamental prospective advanced research in computational mathematics and computational physics aimed at the creation of new mathematical methods, algorithms and software for the solution of actual problems arising in experimental and theoretical studies by means of the newest computational hardware resources. These objectives are related to the strategic directions of the JINR research, such as the NICA project, the neutrino programme, IBR-2M, etc., asking for the development of new mathematical methods and approaches for modeling complicate physical processes, the processing and analysis of large arrays of experimental data.

The research done within the theme 1119 is divided into four basic directions:

1. **Mathematical and computation methods for simulation of complex physical systems**: development and use of mathematical and computational methods for modeling new experimental setups and accelerating complexes (NICA, IBR-2M, and others); mathematical modeling of nuclear-physical processes, of complex physical systems together with the development of parallel algorithms and software packages for these tasks enabling computations on the modern many-core and hybrid computing clusters.
2. **Software complexes and mathematical methods for processing and analysis of experimental data**: the development of new mathematical methods for processing and analysis of data obtained in experiments performed at JINR and with the JINR participation; development of algorithms and software complexes for solving problems in high-energy physics, including the data from the accelerator facilities LHC, NICA, FAIR, as well as from the experimental facilities of the JINR neutrino programme, in nuclear physics, in condensed matter physics, and in radiation biology.
3. **Numerical methods, algorithms and software computationally adapted to multicore and hybrid architectures**: development of numerical methods, algorithms, and program packages based on parallel programming techniques aimed at efficient use of the many-core and hybrid architectures, particularly the heterogeneous cluster HybriLIT. In addition this activity comprises the solution of practical engineering-physical problems using both program packages already tuned for parallel computing, e. g., COMSOL Multiphysics, CATIA-GDML geometry builder, EPOCH, and the creation of parallel implementations of newly developed software packages.
4. **Methods, algorithms and software of computer algebra**: the development of methods of computer algebra for numerical solution of differential equations and for simulation of quantum information processes; creation of algorithms and program packages for symbolic-numerical solution of problems arising in experimental and theoretical studies, using the latest computational hardware resources.

The outcome of the theme will be the creation of mathematical and computational tools for modeling physical systems, the mathematical processing and analysis of experimental data subject to the newest developments of the computational architectures that will allow the Institute to carry out its tasks at the highest level.

In conclusion I would like to mention that the LIT staff has accumulated a significant expertise in the development of mathematical methods and algorithms for solving the defined tasks inside the theme as evidenced by the publications and lectures at various conferences given under the theme 1119 during the last three years: 284 articles in refereed journals; 66 articles in

scientific monographs and periodicals; 33 invited lectures and 91 oral presentations at international conferences; 58 electronic publications. It is also worth mentioning that during 2014-2016, the activity of the LIT scientists inside theme 1119 was distinguished with four JINR prizes, while several young scientists have received prizes of the gubernator of the Moscow region awarded to young scientists working in science and innovation.

The key to successful implementation of the proposed theme is the development in LIT of the Multifunctional Information and Computing Complex (MICC), which provides computational resources for activities done in the framework of the theme 1119. A component of the MICC is the heterogeneous cluster HybriLIT. This incorporates the latest computer accelerators that enable the development of parallel applications for conducting resource-intensive computations. Its software-information environment allows effective use of the cluster resources as well as the training of the JINR staff in mastering parallel programming techniques and the use of modern packages of applied programs.

On the whole, the proposal to extend the theme 1119 for the 2017-2019 is well prepared. It covers the mathematical support for all the key activities of the JINR and takes into account the modern tendencies of the development of top methods of the mathematical modelling as well as approaches to the solution of theoretical and experimental topics of the highest interest to the JINR. This support will allow the JINR to solve its tasks at the highest level.

I consider that the extension of the topic "Methods, Algorithms and Software for Modeling Physical Systems, Mathematical Processing and Analysis of Experimental Data" deserves full approval and support with the first priority.

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