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REVIEW

"Muon Ordinary capture for the Nuclear Matrix elemENTs in ββ decays MONUMENT"

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This report is an evaluation of the proposal of the MONUMENT project and reflects conclusions of the meeting of Scientific-Technical Committee of DLNP (14. April 2020) as well as two reviews prepared by F. Šimkovic (COMENIUS UNIVERSITY, Bratislava, Slovakia) and by B.A. Chernyshev (MEPhI). The proposal provides needed information about the present situation in the field of research, planned research activities in the period of 2021 - 2023, description of research team and also detailed budget of the project MONUMENT.

The main tasks of the proposed project are as follows: i) Measurements of muon capture rate of ^{136}Ba, ^{76}Se, ^{96}Mo (motivated by running and in preparation 0νββ decay experiments on ^{136}Xe and ^{76}Ge) and ^{100}Mo (associated with studies of scattering of astrophysical neutrinos and those from the Supernova explosions); ii) measurement of the ordinary muon capture rate on ^{32}S, ^{40}Ca, ^{56}Fe (relevant for testing of nuclear shell model calculation of matrix elements); iii) a preparation of the database of muonic X-rays spectra from the studied nuclei, which will be implemented into the electronic catalogue of X-rays spectra at the JINR.

At present, the search for the 0νββ-decay represents one of the most important problems of neutrino physics as its observation would mean that neutrino is a Majorana particle and would allow to conclude about the absolute scale of neutrino masses and possible CP violation in the lepton sector. However, for that the knowledge of associated nuclear matrix elements (NMEs) and of the

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effective value of axial-vector coupling constant, which govern the decay 0νββ-decay rate, is needed. A reliable calculation of the 0νββ-decay NMEs is a very important and challenging problem (as recognized by the physical community), which is not solved today (results of different theoretical approaches differ by about factor 2-3). The measurement of the total and partial ordinary muon capture rates (and supporting measurements of other nuclear reactions) can provide valuable information about nuclear structure of isotopes entering the double-beta decay transition and about quenching of g_A, which can be use by theoreticians to reduce the uncertainty in calculated 0νββ-NMEs and 0νββ-decay rates. It can play also a crucial role in selecting the most favorable nuclides for long-term 0νββ-decay searches.

The proposed project assumes international cooperation of JINR Dubna, TUM, PSI, University of Jyvaskyla, University of Osaka, University of Zurich, KU Leuven and University Teknologi (Malaysia). Experimental runs are planned at PSI Villingen in Switzerland. JINR team consist of 11 members (5,6 FTE in total, most of team members are young researchers) headed by D. Zinatulina, who is qualified researcher with already long-term expertise in the field of the project (29 publications in WOS, mainly GERDA and DANSS experiments). It is worth mentioning that several similar ordinary muon capture experiments were already performed successfully by D. Zinatulina and members of her scientific group at JINR Dubna and PSI Villingen (e.g. Ordinary muon capture studies for the matrix elements in beta beta decay. Zinatulina, D.; Brudanin, V.; Egorov, V.; et al. PHYSICAL REVIEW C 99(2), 024327, 2019).

The budget of the project is reasonable (the total budget for three years, 2021-2023, is 378 000 USD). 227 000 USD is devoted to buy equipment and materials (two HPGe detectors, target material, muon veto, electronics…), 15 000 USD to cover expenses of collaboration meetings, 100 000 USD for trip to PSI (every year 3 weeks experiments are planned), 36 000 USD for services such as transportation costs.

The presented project is ambitious. The involved physical program connects several fields of the research, namely theoretical studies (calculation of nuclear matrix elements), experimental activities (ordinary muon capture runs

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with different isotopes), neutrino physics (ββ decay) and international cooperation (JINR, PSI, University of Jyvaskyla, TUM, Osaka university etc).

As a result of this review, I suggest the PAC committee to approve the project **"Muon Ordinary capture for the Nuclear Matrix elemENTs in ββ decays MONUMENT"** and finance fully its realization within the planned period of 2021-2023 years.

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