Dear Prof. Ereditato,

Thank you very much for your analysis of the SuperNEMO project. We would like to answer a number of your concerns in this letter.

1) **The delay of the project (Super NEMO Demonstrator) is huge. The question is how relevant the expected results will be in more that 3 years from now, taking into account the harsh international competition. Moreover, the reasons for the delay are unclear to the referee. From the reports, the date of completion of the Demonstrator was originally expected to be 2016.**

The project was delayed due to a number of specific circumstances:

1. Detected sagging of the track detector wires (since 2019). This is the major source of the problems in the last 1.5 years, that took a long time to resolve. Confirming the existence of the problem, identifying the causes, developing a plan to correct the situation and implementing it required more than a year of collaboration efforts (including delays due to Covid). Fortunately, a solution to the problem was eventually found and implemented, so currently the work plan for launching the Demonstrator is successfully moving towards the final stage.

2. Additional delays in 2018 were associated with the need to redesign the automatic calibration system and complications in the production of foil sources. We emphasize that the Demonstrator is a complex detector, the assembly of which is carried out under the most stringent requirements for the radiopurity of all materials and equipment. Because of this, all production processes take a long time to complete.

3. Large rise in prices for shielding material. Initially, the lowest possible price was almost $ 2M USA for the production of ultra-pure iron passive shielding. After lengthy negotiations, several redesigns of shielding in order to optimize the price (adjusting the sizes to the production technology), finding our own material reserves (stocks), we managed to reduce the price of iron shield down to $ 600,000 USA, which turned out still to be twice as much as the amount foreseen in the project, which required a search for additional resources. In the face of the budget deficit experienced by most of the project countries, finding resources was a real challenge. As a result, we note that by joint efforts of the parties, at the moment we have a real plan for financing this part of the project, but with significant delays in relation to the original plans.

4. Limitations due to the Covid pandemic are slowing down the progress of activity. The access to the underground laboratory was stopped during several months and current international restrictions prevent many SuperNEMO collaborators (Russian, UK, US) for travelling.

The delays in the implementation of the SuperNEMO Demonstrator work plan associated with points 2-4 amounted to up to more than one year.

As for the relevance of the results to be obtained on the Demonstrator, they remain important, fundamental and relevant, despite the delay in the implementation of the project. This issue will be discussed in more detail later, when discussing the importance of supporting the project.

2) **The group is relatively large (14 head counts) but 8 participants have an FTE lower- equal than 0.3.**

The specificity of working on projects in our department is the fact that people are involved in work on more than one project. Therefore, the calculation of FTE-involvement in implementation is to a certain extent a convention; there is great flexibility in this matter. When urgent efforts are needed within a project, we are able to attract more people and devote more time to solve urgent problems. Therefore, although the average indicators look small, in a real situation people devote as much time to work as is necessary for a high-quality and effective solution of current project tasks.

3) **The project was already reviewed in the joint PACs meeting in 2019, being ranked as second priority on a scale of three. The main concern was the impact on the data analysis with emphasis**

to the work of young people. This point is still unclear as well as the general progress of the project (Super NEMO Demonstrator) since then.

We agree with the referee that involvement of young students and workers is essential to a project. In the last year, unfortunately, due to Covid, procedures for attracting students to JINR were suspended, although this was foreseen in the plan. We are sure that in the next two years, the problems associated with restrictions due to the epidemic will be resolved, and 1-2 young employees will be involved in the work in SuperNEMO.

The above issues make the cost effectiveness of the experiment questionable. Given the information currently available the referee is not in the position of recommending the continuation of Super NEMO for the years 2022-2024. The JINR laboratory should probably first address its participation in prominent 0nbb experiments aiming at high sensitivity within a reasonable amount of time.

Here we cannot share your opinion, since we are sure that the support of the SuperNEMO project meets the tasks of supporting fundamental neutrino physics at JINR. Despite all the delays in the project schedule, the results to be obtained are still relevant, modern and of fundamental interest to the bb-community. Next, we set out a number of arguments to support our claim.

1) The demonstrator **has a unique physics program** that cannot be done in other bb experiments and which is fundamentally in demand in the field of research. The reason for this is the use of a unique tracko-calorimetric technique (TKT), which makes it possible to register the full signature (pattern) of the ββ-event — the tracks and energies of both electrons separately. This enables the solution of fundamental problems that are inaccessible in other approaches:

a. The possibility of identifying the mechanism of ββ decay has already been confirmed in NEMO-3 (on Mo-100, Se-82 and is now being investigated on Nd-150). In the Demonstrator, the result for Se-82 will be obtained with much higher precision. The ability to study the mechanism of the process is a key factor that will be required for the 0νββ mode, if it is found experimentally.

b. The ability to measure 2νββ-decay in various isotopes. Nemo-3/SuperNEMO is a world-established "factory" for the methodological study of ββ-decay (see Fig. below). The high-precision results obtained by TKT for a large set of ββ-isotopes help theorists in improving the calculations of nuclear matrix elements (NME). Reducing the spread of theoretical model calculations is the most important fundamental problem for the entire bb decay field (see Recommendation 6 of the APPEC-2019 DBR Committee https://indico.cern.ch/event/832454/contributions/3488884/attachments/1936550/3209372/APPEC -Rec.pdf). During 2018-2020 JINR, together with the company IZOTOP has done a lot of work to develop a method of enrichment of Nd-150 and Zr-96 in large quantities (kg scale). The industrial setup is almost ready to produce Zr-96 (~80%) by centrifugation. In 2021, JINR plans to receive and start measurements of the first sample of Zr-96 (weight about 0.3 kg, a world record). In the future, at the next stage of work, it is planned to install kg quantities of Zr-96 and / or Nd-150 in the Demonstrator, thereby expanding the unique physics program of the Demonstrator.

c. Our data allows to access important constrains of theoretical models, like the critical question of g_A suppression. In this perspective, a new study of 2νββ decay of Nd-150 and Mo-100 using NEMO-3 data has started and will be continued with SuperNEMO data, Se-82 being particularly favored for this study. Dubna physicists are leading this effort.

d. In addition to the standard mechanism (exchange of light neutrinos), the Demonstrator is sensitive to a number of other neutrino models - majoron emission, heavy composite Majorana neutrino, bosonic neutrino, Lorentz invariance violation, quadrupole beta decay, stable massive particles (monopoles), Dark photons, etc. Most of these mechanisms can be accessed only with TKT.

e. If any of the 0nbb-experiments will show a sign of a signal, then TKT will be required to study its mechanism. The unique expertise that exists within the SuperNEMO collaboration will be essential for planning extended TKT experiments capable of exploring a signal claim.

2) We especially want to object to the remark that "**the cost effectiveness of the experiment questionable**". An analysis of the situation shows that, on the contrary, support for SupeNEMO is **extremely cost effective** for a number of reasons:

a. The demonstrator is ready. Despite all the delays, it will be launched soon without massive financial investments.

b. In the next three years, the Demonstrator will carry out a unique physics program, produce unique physics results and publications without significant financial investments.

Thus, the support of the SuperNEMO project has a lot of advantages at low additional financial cost.

Half-life measurements of the two-neutrino double-β decay

The measured half-life values for the transitions (Z,A) $\rightarrow$ (Z+2,A) + $2e^-$ + $2\overline{\nu}_e$ to the 0^+ ground state of the final nucleus are listed. We also list the transitions to an excited state of the final nucleus (0_i^+, etc.). We report only the measuremetnts with the smallest (or comparable) uncertainty for each transition.

$t_{1/2}(10^{21}$ yr)			ISOTOPE	TRANSITION	METHOD	DOCUMENT ID	
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 0.87			^{134}Xe		EXO-200	[1] ALBERT	17C
0.82	±0.02	±0.06	^{130}Te		CUORE-0	[2] ALDUINO	17
0.00690	±0.00015	±0.00037	^{100}Mo		CUPID	[3] ARMENGAUD	17
0.0274	±0.0004	±0.0018	^{116}Cd		NEMO-3	[4] ARNOLD	17
0.064	$^{+0.007}_{-0.006}$	$^{+0.012}_{-0.009}$	^{48}Ca		NEMO-3	[5] ARNOLD	16
0.00934	±0.00022	$^{+0.00062}_{-0.00060}$	^{150}Nd		NEMO-3	[6] ARNOLD	16A
1.926	±0.094		^{76}Ge		GERDA	[7] AGOSTINI	15A
0.00693	±0.00004		^{100}Mo		NEMO-3	[8] ARNOLD	15
2.165	±0.016	±0.059	^{136}Xe		EXO-200	[9] ALBERT	14
9.2	$^{+5.5}_{-2.6}$	±1.3	^{78}Kr		BAKSAN	[10] GAVRILYAK	13
2.38	±0.02	±0.14	^{136}Xe		KamLAND-Zen	[11] GANDO	12A
0.7	±0.09	±0.11	^{130}Te		NEMO-3	[12] ARNOLD	11
0.0235	±0.0014	±0.0016	^{96}Zr		NEMO-3	[13] ARGYRIADES	10
0.69	$^{+0.10}_{-0.08}$	±0.07	^{100}Mo	$0^+ \rightarrow 0_1^+$	Ge coinc.	[14] BELLI	10
0.57	$^{+0.13}_{-0.09}$	±0.08	^{100}Mo	$0^+ \rightarrow 0_1^+$	NEMO-3	[15] ARNOLD	07
0.096	±0.003	±0.010	^{82}Se		NEMO-3	[16] ARNOLD	05A
0.029	$^{+0.004}_{-0.003}$		^{116}Cd		$^{116}CdWO_4$ scint.	[17] DANEVICH	03

Figure. ββ-spectrometry from the NEMO-3 in the PDG table.

3) In conclusion, we would like to say that JINR and other collaborating institutes have invested a huge amount of funds and human efforts in the development of the NEMO-3/SuperNEMO projects that have been successfully developing for more than 30 years. Let us also stress, that the SuperNEMO project has now serious support not only in Russia (both from JINR and RFBR), but also in scientific foundations of France, UK, Czech Republic, Slovakia, etc. Termination of project support at JINR at the final starting

point of the next stage will lead to the loss of the JINR financial investments and accumulated experience and now-how. In our opinion, this would be a very damaging decision in the current circumstances.

Based on the above, we believe that the support of the SuperNEMO project meets the scientific interests of JINR particularly and is important for fundamental neutrino physics in general.

Yours faithfully,

Victor Tretyak on behalf of the SuperNEMO collaboration.