Referee report
on the proposal of JINR participation in the project NA64 «Search for light dark matter at SPS CERN» (02-1-1096-2024/2026)

The Dark Matter searches, in general, have a potential of providing the fundamental breakthrough beyond our present knowledge of elementary particles and interactions. Therefore, this searches, whenever possible should be performed with an increasing level of precision by studying different processes and using different techniques.

The NA64 is a fixed-target experiment at the CERN SPS designed as a hermetic detector to search for Dark Sector physics in missing energy events from electron/positron, muon and hadrons, which are scattered off nuclei. The main focus of NA64 is Light Dark Matter interacting with the Standard Model via vector (or other) portal, such as, e.g., dark photons (A′) and a variety of scenarios.

The present experiment in electron mode, NA64e, employs optimized 100 GeV electron beam from H4 beam-line at CERN North Area. An intense program of experiment started after CERN LS2 in 2021 and by now NA64e reached a major milestone of accumulating ~ 10^{12} EOT which allow to start probing very interesting LDM benchmark models. The goal is to collect until the next long shutdown (LS3) around $5 \cdot 10^{12}$ EOT in order to probe the parameter space for light DM models suggested by some interesting New Physics options.

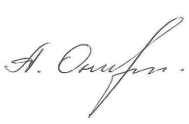
NA64 also started the program at CERN M2 beam-line (which provides unique high intensity 160 GeV muons) to explore dark sectors weakly coupled to muons. The results of the pilot runs show that with an optimized setup, one could collect > 10^{11} MOT before LS3 in order to check the proposed (Z') explanation of the g-2 muon anomaly and complement searches with electrons. After LS3 the experiment plan continueing data taking to accumulate ~ 10^{13} MOT and explore the A′ higher mass region.

Moreover, during the 2022 the data were taken also with a pion beam in order to understand the potential of experiment in exploring the dark sector particles coupled predominantly to quarks using the missing energy technique. This will extend the NA64 program if such feasibility will be demonstrated, so, an overall NA64 plans look very interesting and vital, indeed.

It is a special pleasure to underline that the JINR group is playing a key role in all aspects of the NA64 experiment. It has responsibility for the thin-wall drift tube tracking system, the experiment DAQ and is very actively participating in the data analysis.

In conclusion, taking into account the large physics potential of the project and significant visible contribution of the JINR team to the experiment construction and data analyses, I recommend extending the participation of the JINR team in experiment NA64 for the period of 2024-2026 with the highest priority.

Prof. Alexander Olshevskiy
Head of Department
JINR



Dubna, 12 March 2023