

**Referee report on the Proposal of prolongation of the project
“Measurement of the rare decay $K^+ \rightarrow \pi^+ \nu \nu$ at the CERN SPS (NA62)”**

Probability of the rare decay $K^+ \rightarrow \pi^+ \nu \nu$ (of the order of 10^{-10}) is directly related to the CKM matrix parameters defining the size of CP violation. Theoretically clean, this decay gives a possibility to discover a statistically significant deviation from the Standard Model and to open a new physics domain.

NA62 experiment at CERN SPS aims to measure the branching ratio of the $K^+ \rightarrow \pi^+ \nu \nu$ decay with a precision of the order of 10%, that requires extraordinary experimental efforts. First of all, the charged pion track must be measured with a high precision in conditions of minimum Coulomb scattering. So the key element of the NA62 detector is the straw-based magnetic spectrometer, that is made of light drift tubes. JINR group together with the dedicated CERN team were responsible for this spectrometer development, design and production.

After the spectrometer installation in 2014 and commissioning in 2015, the physical data taking was done in 2016-2018. During the LHC Long Shutdown period in 2019-2020 the experiment entered the stage of the physical data analysis. And JINR group is currently participating in the extraction of the physical results from the collected data, including the additional studies of the rare four-lepton decays of charged kaons.

During the period of 2019-2021 a series of works have been done by JINR group, and some important results have been obtained. A first observation and study of the rare decay $K^\pm \rightarrow \pi^\pm \pi^0 e^+ e^-$ has been done, new upper limits have been set on the squared matrix elements $|U_{\mu 4}|^2$ and $|U_{e 4}|^2$, and new limits are set on the hypothetical dark photon coupling to the ordinary photon. Dubna group was awarded a second JINR prize in 2019 for the study of rare decays of charged kaons.

But the most important achievement is the NA62 result of the $K^+ \rightarrow \pi^+ \nu \nu$ decay study based on the data collected in 2016-2018. 17 signal candidates are observed in data collected in 2018. Together with the 3 candidates registered by NA62 in the 2016 and 2017, this leads to the most precise $K^+ \rightarrow \pi^+ \nu \nu$ branching ratio measurement $BR(K^+ \rightarrow \pi^+ \nu \nu) = (11.0^{+4.0}_{-3.5} \pm 0.3_{\text{syst}}) \times 10^{-11}$ that is in agreement with the Standard Model expectation. JINR group participates in the analysis of background decay modes, software development, detector calibration and maintaining.

During the future data taking period, starting from 2021, NA62 collaboration plans to reach its projected statistics (~ 100 events) and precision ($\sim 10\%$) for the main goal branching fraction measurement. No competition is known currently in the measurement of the same decay mode.

Dubna group includes now few more young participants working on the data analysis, that will be an excellent school for them.

Accomplished results are adequate to the financial expenses allocated for the project. I support an approval of the report related to the period of 2019-2021. The ongoing and planned works are adequate to the financing to be allocated for the project in 2022-2024, and I would recommend to prolongate the NA62 project in JINR for the next 3-year period.

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