Report on the project
"Measurement of the Rare Decay $K^+ \to \pi^+ \nu\nu$ at the CERN SPS"

In general, the project is implemented in VBLHEP JINR starting from the year 2010. In its current form, it consists of the formulation and specification of participation of scientists and engineers of VBLHEP JINR in NA62 experiment at SPS in the framework of wide international collaboration in CERN for years 2019-2021 after realization of three stages during the period 2010-2018.

At the very beginning of the project it was planned to measure the Cabibbo-Kobayashi-Mascawa matrix elements with 10% precision in order to test the validity of Standard Model or, if present, to observe the deviations from it. This objective led to the formulation of the central goal of NA62 experiment, which is to register approximately 80-100 events of very rare decay $K^+ \to \pi^+ \nu\nu$ assuming 10% signal acceptance or better and 10^{-10} branching ratio.

In the sections "Physical motivation" and "Additional physical goals" the authors of the project emphasize that large scale statistics of kaon decays together with high accuracy measurements make it possible to search for other rare kaon decays with aims to check the existence of supersymmetry particle sgolstino, to search the new light candidates to the dark matter, to study possible heavy neutral lepton production and to check the validity of the Chiral perturbation theory.

The core sections of the project are devoted to the description of main parts of the NA62 experimental setup. It is stressed that the setup has been constructed and tested during the autumn 2014 run with CERN SPS beams. The experts from JINR participated in the construction and installation of the track spectrometer detectors designed and built during the two NA62 project stages completed in JINR Dubna during time periods 2010-2012 and 2013-2015. The experimental setup has to ensure the fulfilment of two main tasks – desired suppression of the background and the usage of a high intensity unseparated K^+ beam. Main steps on how to do it are presented as well.

The main results achieved during the time period 2016-2018 are presented in three separate sections: namely, results concerning the installation of some parts of experimental setup in 2016-2017, the analysis of the 2003-2010 data from NA48/2 and NA62 experiments performed in 2016 – 2018, and some theoretical and methodical results including problems with backend electronics of some detectors. For example, the experimental data for the new rare decay $K^{\pm} \to \pi^{\pm}\pi^0 e^+ e^-$ were analyzed, which were obtained for the first time in NA48/2. About 5 × 10^11 K + decays have been taken to study the K + → π+νν decay. Preliminary results from the K+ → π + ν ν analysis based on about 5% of the 2016 statistics are summarized in the project.

Results obtained in 2016-2018 were presented in many international conferences by the JINR participants. The JINR group gave substantial contribution to the construction of NA62 experimental setup, brought significant methodological contribution to the experiment, which resulted in two patents.

I observe that at present time the activities of the JINR group are highly visible in intellectual, technical, methodological and scientific areas. Based on the facts presented in the project I arrived at the conclusion that **t**he JINR team is at the present moment fully integrated into the preparation of the NA62 experiment and data collection and analysis. Many of the key hardware components were developed and installed by the JINR team.

I consider the required financial support, which should ensure the trouble free activity of JINR group and should cover the expenses for the realization of the experiment by the JINR side, to be justified and adequate.

I have following comments and questions concerning this project:

1. The weaknesses and potential risks of this project are not presented. Consequently, there are no prepared strategies on how to handle the risk scenarios.
2. Experiment is running from 2015 - for 3 years. Why the aim of the experiment (to gather 80-100 events) was not achieved yet? When it is expected this main goal of the experiment will be achieved?
3. It is not clear to me what fraction of accumulated data was analyzed up to now (5% ? - what is the reason for such a low fraction?)?
4. Why is there a scheduled break in data collection for next two years?
5. From the prolongation of the proposal it is not clear to me what main physics goals will be addressed (improvement of BR($K^+ \to \pi^+ \nu\nu$)?)? What is the target precision, what kind of conditions should be met (e.g. how many hours/month of running at what luminosity etc.)?
6. When are expected the first results related to the supersymmetric sgolstino, or when there will be statistically enough collected data needed for the analysis of the given process?
7. I would appreciate more detailed description of how the group will participate in this experiment (technical support in hardware, software, data analysis?). Are there participating JINR scientists who could be the principal authors responsible for writing the publication? It should be addressed why is there a plan to accept two new PhD students into group?

I consulted these questions with one of the team leaders Yu.K. Potrebenikov, who already answered them. I advise that his answers, which I consider to be very well thought out, will be incorporated into the project.

Despite these objections the benefits of this project are undeniable. It will contribute to the success of NA62 experiment in a significant manner and consequently to the success of JINR on the international scale. I fully support its approval and financing.

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