Referee report on the NA62 experiment (JINR participation)

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The report given to the Program Advisory Committee of JINR on 18 June 2018 outlines the proposal submitted by JINR researchers to carry on activities within the NA62 experiment at the CERN SPS for the years 2019-2021.

The main goal of the experiment is the precision measurement of the very rare kaon decay $K^+ \rightarrow \pi^+ \nu\nu$, a crucial ingredient to test the CKM matrix of the Standard Model. The final accuracy in the determination of the corresponding V_{td} angle should be at the 10% level, for a total number of about 100 reconstructed signal events, more than a factor 10 w.r.t. the present worldwide statistics. In order to achieve this demanding goal, the experiment should identify 2×10^{13} K^+ decays.

One major challenge of the experiment, needed to attain the design sensitivity, is the high intensity of the beam, in turn imposing stringent conditions to the experimental setup and to its data acquisition system. In particular, one must be able to perform charged particle tracking at 1 GHz total rate. The apparatus was constructed and commissioned already in 2014, with a first run in the CERN SPS beam. JINR researchers worked on the project with grants extending from 2010 to 2018, with main hardware responsibilities in the tracking spectrometer (straw tubes).

As far as the data analysis is concerned, in addition to the work done for the precursor NA48 experiment, the JINR group has worked on some technical papers describing the general performance of the apparatus. The group also contributed to the data taking and detector operation with over 250 shifts in the period 2016-2018.

The requested extension 2019-2021 is basically aiming at reaching the experiment's goals. During the 2016 physics run the experiment run at a reduced intensity (40% of the nominal one) due to limitations in the beam time structure, not optimized for individual burst intensity. This, in turn created problems to the R/O systems for several sub detectors. Only 4×10^{11} K^+ decays were collected out of the total expected score of 2×10^{13}. The intensity rose to 60% of the nominal one in 2017, allowing gathering 3×10^{13} decays. The total expected statistics for the 2016-2018 period could amount to 20 out of the aimed at 100 signal events. Since the CERN SPS will be shut down in 2019-2020, 2021 operation will be crucial for substantially increasing the statistics. A first result based on a very limited statistics (1%, why so low?) was presented in March 2018, just to prove that the software tools and analysis strategies were available and effective.

For the prolongation 2019-2021 the JINR group is requesting to continue the experiment working on maintenance and analysis tool improvements (2019-2020) and data taking (2021), after an improved shielding will be applied to the beam line elements.

The main (realistic) risks for the new period are the beam performance and the recently discovered additional backgrounds *de facto* reducing the geometrical acceptance of the experiment. For these reasons, the referee believes that it would be very hard to actually increase the statistics by the end of the 2021 run.

Concerning the deliverables of the JINR group, so fare there were obviously no PhD theses, a limited number of technical publications and about 10 conference presentations of JINR members. The group consists of 16 people with a reasonable number of 9.1 FTEs.

The request for funding appear reasonable, apart from an excessive amount of travel money during 2019-2020 (no beam), which is 60% of what is required in 2021 (running conditions).

Despite the continuous effort of the JINR researchers over many years and the hope to improve the performance in the future, it is very realistic to expect that by 2022 the physics results on the measurement of V_{td} will not be what one would have expected already by now (2018). Having said that, the JINR NA62 group and the JINR directorate will have to take decisions about the future strategy, the level of support to the experiment and the relative priorities w.r.t. other projects in analogous fields of research, also considering the international competition.

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