Referee report by Hans H. Gutbrod on

Measurement of the Rare Decay K+→ π+nn at the CERN SPS

NA62 Project (prolongation for 2022-2024)

Theme 02-1-1096-2010/2022

The primary goal of the four stages of the NA62 experiment is the measurement of the very rare kaon decay K+→ π+nn. This measurement is planned to make a decisive test of the Standard Model (SM) by means of the 10%-precision measurement of the Cabibbo-Kobayashi-Maskawa (CKM) matrix parameter Vtd.

The chosen strategy of the ongoing NA62 experiment is based on the measurement

of the high energy K+ decays *in flight* in a very long vacuum tube.

**Scientific merit:**

The referee must confess that he is not expert enough to check the validity of the stated single event sensitivity of 1.11x 10 -11, nor to see the validity of the 17 signal candidates in view of understanding all systematic errors, nor to be able to judge whether a 10% precision measurement could be achieved by identifying 100 *golden* signal candidates and how this would be precision enough for testing the validity of the SM.

He assumes that referees of the SPSC are more able to judge the proposal for its scientific value and contribution.

**Experimental questions:**

JINR experts together with those from CERN have contributed to the NA62 set-up by providing the construction and installation of the track spectrometer detectors (STRAW tracker) designed and built during the two NA62 project stages completed in JINR earlier (in 2010-2012 and in 2013-2015).

The referee fully respects the experimental difficulties in observing and measuring 2x1013 well identified K+ decays. The authors report past difficulties of beam spill structures which did not allow running at the full requested intensity. Additional unforeseen back ground problems increased among others the halo. The last problem has been solved by the NA62 collaboration by improving shielding upstream of the experiment, by adding special halo detectors, and optimizing the DACQ system. The referee assumes that all detectors are now able to stand the high rate in this experiment, including the slower calorimeters.

An open question is the observed micro structure of the high intensity beam of the SPS during slow extraction. Usually that is caused by jitter of some power supplies but could also have more serious causes due to the high beam intensity. Has it been solved?

**Human resources:**

The JINR-NA62 group member list shows a good number of scientists and technicians fully dedicated to the experiment. The list of presentations however, states that E. Goudzovski, a 0.1 FTE member, was giving the last 4 talks in 2019 and 2020. E. Goudzovski is listed in the NA62 organizational structure as *Responsible for* *Rare Decays* and is the only person from JINR mentioned in the management structure of NA62. Why is he involved only with 10% of his time? Why could these talks not be given by members more involved into the experiment NA62? Why is JINR not better recognized for its contributions to NA62?

During the NA62 experimental runs in 2016-2018, the JINR group member S. Shkarovskiy was an official expert responsible for the Spectrometer performance and for the Spectrometer part of the Detector Control System (DCS). Why is he not listed any longer as such? Does JINR has an obligation for servicing the tracking chambers?

**Risks:**

The authors state that the NA62 has not yet the go-ahead of the SPSC for further running. One should not speculate if SPSC would stop a high quality experiment due to Covid-19.

The authors point out that there may be not enough manpower for analyzing the data. They state that work on NA48/2 data collected in 2003/2004 is still going on, but what has caused the delay of 17 years?

Furthermore the authors point out a main weakness caused by the temporary difficulties of transition from the mainly hardware activity to the data analysis stage that is overlaid with the lasting NA62 Spectrometer-related duties. The JINR team sees the need to attract young researchers able to do the analysis of the new data.

**Summary:**

The JINR NA62 team proposed a Prolongation of Measurement of the Rare Decay K+→ π+nn at the CERN SPS. The JINR team made substantial instrumental contributions to the experiment but is unfortunately not recognized as a *leading player* in this collaboration. However, the JINR team intends to increase substantially its contribution in the data and physics analysis by searching for new young talents. The potential for more discoveries in K-decay exists.

This extension of NA62- if approved by CERN SPS -will bind the JINR team for a much longer period that the requested period from 2022 to 2024, especially in view of the intended strong participation in data analysis. The authors state that the participation in software development and detector calibration for NA62 will increase the qualification of young participants that may be needed in other JINR experiments. Here one needs to look at the colliding interests in in-house experiments and CERN participation.

Finally, I rate this proposal as a good project which requires -however- success in hiring excellent junior scientists and approval by the CERN-SPSC.