# Guidelines

The goal of the PAC refereeing process is to classify all projects into three categories A, B or C. The three categories shall be based on merit, both the scientific merit (first item of the questionnaire) and the performance of the JINR group (the rest of the questionnaire).

Definition of the three categories:

-Category A: excellent project. Should be fully funded with adequate resources and encouraged to continue and expand their impact.

-Category B: very good project. There are some weaknesses. Should be funded together with a strong recommendation on where improvement is needed.

-Category C: good projects. Relatively low performance.

In a first step, the assigned referee should assess whether the PI has properly answered all questions. If changes or additional information are needed, the relevant PI will be informed with the request to present this additional information at the meeting.

In a second step, each referee should summarize his evaluation in a written report (mentioning the missing information if any), outlining strengths and weaknesses of the project, both on the scientific aspects of the project as well as on the performance of the JINR group. The report should include recommendations for improvement if any. The final assignment of the project into category A, B or C shall be done after hearing the referee’s opinion and subsequent discussion of the project at the PAC session.

**Questionnaire (for projects seeking continuation):**

**A. Scientific merit**

1.  Goals of the experiment:

1a. Give a short description of the goals of the experiment:

**The project goal is the participation in the NA62 experiment at SPS CERN, where a measurement of the very rare kaon decay K++ is planned to make a decisive test of the Standard Model (SM) by means of 10%-precision measurement of the Cabibbo-Kobayashi-Maskawa (CKM) matrix parameter *Vtd*. The project is a continuation of the four stages of NA62 project, implemented in VBLHEP JINR in 2010 – 2021.**

1b. Explain what the project adds to the international scenario:

**Prior to the NA62 experiment, most precise experimental results have been obtained by the E787 and E949 experiments at BNL by studying of stopped kaon decays [5]: B(K++) = (1.73+1.15-1.05)×10-10. Apart from the NA62 experiment described below, no other measurements of this mode are currently conducted or planned. Existing gap between the theoretical precision and the large experimental error motivates a strong experimental effort. Significant new constraints can be obtained with a measurement of the rate of this reaction at the level of 10% or better.**

**The strategy of the ongoing NA62 experiment is based on the measurement of the high energy K+ decays in flight. In this case, the kaons production cross section is optimized as a function of the proton energy, and the photons detection is efficient due to their high energies in the laboratory system. As a result, the + signal acceptance was expected to be about 20 times higher than in the stopped kaon BNL experiments.**

**B. Achievements**

2. Contributions of the JINR group:

2a. List of the specific contributions of the JINR group in hardware (including use of JINR computing resources for the project), software development and physics analyses.

**Hardware:**

**Liquid krypton calorimeter (LKr) used by NA62 is inherited from NA48. It has been built earlier with JINR participation, including delivery of 22 tons of liquid krypton circulating in the LKr up to now.**

**NA62 Spectrometer has been developed, constructed and built with a defining participation of JINR group in 2010-2014. After the Spectrometer production, experts from JINR and CERN have provided the installation of the track spectrometer detectors. Their actual position has been measured, vacuum tests of straw detectors have been performed, gas supply system has been purchased and mounted. Four power supply modules (MPOD) have been installed, and their management interface integrated into the NA62 slow control system has been developed.**

**Common NA62 software:**

**JINR group members contribute to the development of the main NA62 framework (E. Goudzovski: common analysing subroutines and MC, D. Madigozhin: LKr calibration and Spectrometer on-line data control) and to the general Detecor Control System (S. Shkarovskiy, V. Falaleev).**

**Physics analysis:**

**JINR group members participate in the ongoing analysis of the following decay modes for NA62:**

* **K+ mnmm (A. Baeva);**
* **K+ mnee (S. Shkarovskiy);**
* **K+ enmm (D. Bajgarashev);**
* **Ke3g (D. Madigozhin);**
* **K+p+ge+e-  (I. Polenkevich);**
* **K+p+p-m+n (D. Kereibay);**
* **K±p0p0m±n (NA48/2 data, A. Korotkova, D. Madigozhin);**
* **Search for the light sgoldstio signatures (D. Emelyanov);**

2b. List of the responsibilities of JINR group members within the management structure of the collaboration, if any, giving the name of the JINR member, the managerial role and the appointment period.

**E. Goudzovski :**

**- Lepton flavor work group coordinator (2017-2018).**

**- Rare decays analysis coordinator from 2019 until now.**

**V. Falaleev :**

**- DCS (detector control system) development coordinator in 2015-2020. In the nearest future, this management position is expected to be occupied by S. Shkarovskiy.**

3. Publications:

List the papers published in the refereed literature (no conference proceedings) in which the JINR group had a major contribution (e.g. author of the analysis, promoter of the experiment, corresponding author, realization of a key equipment etc.). Give title of paper, reference and describe in 1-2 sentences the JINR contribution. Only papers published since the last approval of the project should be listed. Mention the total number of papers published by the project in the same time period.

**Eight journal NA62 papers have been published within the project in 2019-2021 (up to 16 co-authors from JINR). Additionally, two papers have been published with major JINR contributions in 2018 after the last approval of the project. The papers with major JINR contribution are listed below:**

1. **L.Glonti et al. Longitudinal tension and mechanical stability of a pressurized straw tube. Instruments 2 (2018) 4, 27 : JINR authors of the analysis, key equipment, corresponding author.**
2. **J.R.Batley *et al.* Measurement of the form factors of charged kaon semileptonic decays. *JHEP* 10 (2018) 150 : JINR authors of the analysis, two JINR corresponding authors.**
3. **J.R.Batley *et al.* First observation and study of the K±→±0e+e- decay. Phys.Lett.B 788 (2019) 552-561 : JINR author of one of the two independent analyses, one of the two corresponding authors.**
4. **E.Cortina Gil *et al.* (NA62). Search for heavy neutral lepton production in K**[**+**](https://inspirehep.net/literature/1797041) **decays to positrons. *Phys.Lett.B* 807 (2020) 135599: Author of the analysis and the corresponding author** **has 10% participation from JINR.**
5. **E.Cortina Gil *et al.* (NA62). Searches for lepton number violating K**[**+**](https://inspirehep.net/literature/1735727) **decays. *Phys.Lett.B* 797 (2019) 134794: Author of the analysis and the corresponding author has 10% participation from JINR.**

4. PhD theses:

List the PhD theses completed within the last 3 years, or expected to be completed within one year, by JINR students within the project, giving the student name, thesis title and graduation year.

**There are 4 PhD theses expected (but not guaranteed) to be completed by JINR students within one year:**

* **S. Shkarovskiy,** “**Measurement of the form factors of charged kaon semileptonic decays”, graduation year for PhD is not applicable;**
* **A. Baeva, “Study of the K+ mnm+m- decay”, PhD graduation year is 2021;**
* **D. Bajgarashev, “Study of the K+ enm+m- decay”, PhD graduation year is 2022;**
* **D. Kereibay, “Study of the K+ mnp+p- decay”, PhD graduation year is 2022;**

5.Talks:

5a. List the invited plenary talks given by members of the JINR group at international conferences, workshops… since the last approval of the project: give name and date of the Conference, title of talk and speaker name.

1. **D. Madigozhin. Recent NA48/2 results on rare kaon decays. ISMD 2018, Singapore, 3-7 September 2018, *EPJ Web Conf.* 206 (2019) 05001.**
2. **S. Shkarovskiy. New NA48/2 results on rare kaon decays. Excited QCD 2019 , Schladming, Austria, 30 Jan-3 Feb 2019.**
3. **E. Goudzovski. Kaon System: NA62. CLFV 2019 , Fukuoka, Japan, 17-19 Jun 2019.**
4. **E. Goudzovski. HNL searches: NA62 and other experiments. NuPhys 2019, London, United Kingdom, 16-18 Dec 2019.**
5. **E. Goudzovski. Exotic searches at the NA62 experiment at CERN. KAON 2019, Perugia, Italy, 10-13 Sep 2019.**

5b. Give a similar list for parallel talks.

1. **D. Madigozhin. Latest results from NA48/2. 31st Rencontres de Blois, Blois, France, 2-7 Jun 2019.**
2. **D. Madogozhin. Latest results from NA48/2. 19th Lomonosov Conference, Moscow, Russian Federation, 22-28 Aug 2019.**
3. **N. Molokanova. Latest results from NA48/2. ICNFP 2019, Kolymbari, Greece, 21-29 Aug 2019. IJMPA V.35, N36(2020) 2044019.**
4. **A.Baeva. Searches for lepton flavour and lepton number violation in K**[**+**](https://inspirehep.net/literature/1801350) **decays. *NUFACT2019 , Daegu, Korea, 26-31 Aug 2019. PoS* NuFact2019 (2020) 077.**
5. **D. Madigozhin. New measurement of the K+ → p+m+m- decay at NA62. ICNFP 2020. Kolymbari, Creta, Greece, 4 Sep.-2 Oct. 2020.**
6. **E. Goudzovski. Search for heavy neutral lepton production at the NA62 experiment. ICHEP 2020. Prague, Czech Republic, 28 Jul-6 Aug 2020.**

**C. Plans and requests**

6. Plans

Describe the plans of the JINR group within the project, in physics analysis, data taking, software development. detector R&D, detector operation and maintenance, upgrade activities… for the period of time of the requested extension.

**The list of JINR group contributions and responsibilities includes:**

* **Fine calibration and alignment of straw detector on the basis of collected data;**
* **Participation in the LKr fine calibration based on p0 decays;**
* **Improvement of the straw detector Monte Carlo simulation used for the main NA62 analysis;**
* **Participation in the analysis of rare background sources for K++;**
* **K+ mnmm analysis;**
* **K+ mnee analysis;**
* **K+ enmm analysis;**
* **Ke3g analysis;**
* **K+p+ge+e- analysis;**
* **K+p+p-m+n analysis;**
* **K±p0p0m±n analysis (NA48/2 data);**
* **Search for the light sgoldstio signatures;**
* **Diagnostics and necessary repair of the Spectrometer straw chambers and their low and high voltage power supply;**
* **Participation in R&D for a new straw module creation;**
* **Participation in the NA62 data taking runs in 2022-2024;**
* **Support the NA62 Spectrometer during the data taking runs in 2022-24.**

7. Group size, composition and budget.

7a. List the JINR personnel involved in the project, including name, status (e.g. PI, researcher, post-doc, student, engineer, technician…) and FTE. Mention the total number of people in the collaboration.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **status** | **FTE** | **Work in addition to common duties (shifts)** |
| **D. Baygarashev** | **researcher** | **1.0** | **Data quality control, calibration, physical analysis** |
| **A. Baeva** | **researcher** | **1.0** | **Physical analysis** |
| **A. Belkova** | **technician** | **0.5** | **Documentation preparation** |
| **S. Gevorkian** | **researcher** | **1.0** | **Theory of rare decays, MC models development** |
| **L. Glonti** | **engeneer** | **0.2** | **Spectrometer calibration and performance checks.** |
| **V. Gorbunova** | **technician** | **0.5** | **Documentation preparation** |
| **E. Goudzovski** | **researcher** | **0.1** | **MC development, analysis, coordination** |
| **D. Emelyanov** | **researcher** | **1.0** | **Software tools development, analysis** |
| **T. Enik** | **researcher** | **0.3** | **Hardware development and support** |
| **V. Kekelidze** | **PI** | **0.1** | **Project leader** |
| **D. Kereibay** | **researcher** | **1.0** | **Physical analysis** |
| **A.Korotkova** | **researcher** | **0.7** | **Physical analysis** |
| **D.Madigozhin** | **researcher** | **1.0** | **MC development, data quality control, analysis** |
| **T. Mauei** | **engeneer** | **1.0** | **Detector calibration** |
| **M. Misheva** | **researcher** | **0.2** | **Physical analysis** |
| **N. Molokanova** | **researcher** | **0.9** | **Data quality control, detector calibration** |
| **S. Movchan** | **researcher** | **0.2** | **Hardware development and support** |
| **I. Polenkevich** | **researcher** | **0.5** | **Physical analysis** |
| **Yu. Potrebenikov** | **PI** | **0.5** | **Project leader** |
| **S. Shkarovskiy** | **researcher** | **1.0** | **DCS development, hardware support, analysis** |
| **V. Falaleev** | **engeneer** | **0.2** | **Slow control, DCS development, hardware support** |
| **TOTAL FTE** |  | **12.9** |  |

**In total, the latest NA62 papers have 202 co-authors, including 15 JINR co-authors.**

7b. Present the JINR group budget for the period of time of the requested extension, specifying the main budget items (equipment, computing, salaries, common funds, travel…)

**Salaries 690 k$ for 3 years (460 k$ for the first 2 years)**

**Computer connection 15 k$ for 3 years (10 k$ for the first 2 years)**

**Design bureau 780 hours for 3 years (all 780 h for 2 years)**

**Experimental workshop 1000 hours for 3 years (all 1000 h for 2 years)**

**Materials 70 k$ for 3 years ( 65 k$ for 2 years)**

**Equipment 35 k$ for 3 years ( 25 k$ for 2 years)**

**Common funds 105 k$ for 3 years ( 70 k$ for 2 years)**

**Travels 290 k$ for 3 years (230 k$ for 2 years)**

7c. Indicate the use or needs of JINR computing resources for the group and for the project if any.

**3000 hours for 3 years (2000 hours for 2 years).**