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 -

We propose to extend at high energies the data basis for proton and neutron analyzing powers on CH2, CH and other targets. Such data are necessary for the experiments that require the measurement of the polarization of protons and neutrons in nuclear reactions.

During the measurements, we are planning to investigate three new approaches to the development of polarimetry, namely: a) turning on the hadron calorimeter to select high-energy nucleons in the final state, b)

using the charge exchange reaction, and c) replacing the hydrogen-rich light target with heavier nuclei, that opens the way to simpler and more efficient measurements of nucleon polarization

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

The availability of polarized electron beams of energy up to 12 GeV will open the way for new measurements of hadron form factors that require *the measurement of the polarization of the recoiling particle in elastic eN scattering with longitudinally polarized electrons.* The optimization of hadron polarimetry and the extension of the analyzing power database is urgently needed, both for protons and for neutrons. This is possible only in Dubna, where polarized proton and neutron beams are available, by breakup of accelerated deuterons.

The results will complete and extend data on analyzing powers, in frame of a coherent program, recently performed in Dubna, and earlier at other laboratories, in particular in France, USA, and Japan. The experiment will use a polarized deuteron beam that is present only in Dubna. No competition is expected from other laboratories, because few GeV energy polarized proton and neutron beams are available only in Dubna. The results are of great interest for all those experiments that need to measure the polarization of protons and neutrons in the GeV range, at hadron and electron accelerators worldwide.

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.

From JINR side:

- On-line polarimeter
- Upgrade of the polarized neutron line
- ZDC calorimeter
- Specific DAC for on-line and off-line analysis
- Dedicated wire chambers (together with Slovak Republic)

JINR side is also responsible for providing the measurements, software development and physics analyses.

JINR should also organize the contribution of collaborators to the experiment.

From USA side:
- Polarized ion source parts from Indiana Univ.
- Physics analysis and preparation publication

From France side:
- On-line and Off-line physics analyses, publication preparation

From United Kingdom side:
- On-line physics analyses, MC simulation

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.

The following Table lists ALPOM2 JINR group members with their roles and participation.

№	Name	Responsibilities	FTE
1	Piskunov N.M.	Project leader, analysis, data taking	0.8
2	Kirillov D.A.	Analysis, data taking	0.8
3	Sitnik I.M.	Analysis, data taking	1.0
4	Gavrishchuk O.P.	ZDC, data taking	0.2
5	Shindin R.A.	ZDC, polarimeter, data taking	0.8
6	Livanov A.N.	ZDC, polarimeter, data taking	0.1
7	Druzhinin A.A. (25 years)	ZDC, polarimeter, data taking	0.8
8	Kiryushin Yu.T.	Drift chambers, data taking	0.2
9	Kostayeva N.V.	Drift chambers, data taking	1.0
10	Legostaeva K.S. (27 years)	Data taking	1.0
11	Bushuev Yu.P.	ZDC, data taking	0.5
12	Povtoreiko A.A.	Counters, data taking	0.2
		TOTAL FTE	**7.4**

Three of them (Piskunov N.M., Kirillov D.A. and Sitnik I.M.) took part in spin experiments at JINR, Saclay (France), COSY (Germany) and Jlab (USA).

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.

1. **Measurement of neutron and proton analyzing powers on C, CH, CH2 and Cu targets in the momentum region 3-4.2 GeV/c,**
Eur.Phys.J.A 56 (2020) 26 Special Article - New Tools and Techniques, e-Print:1908.06159 [nucl-ex]
S.N. Basilev, Yu.P. Bushuev, O.P. Gavrishchuk, V.V. Glagolev, D.A. Kirillov, N.V. Kostayeva, A.D. Kovalenko, K.S. Legostaeva, A.N. Livanov, I.A. Philippov, N.M. Piskunov, A.A. Povtoreiko, P.A. Rukoyatkin, R.A. Shindin, A.V. Shipunov, A.V. Shutov, I.M. Sitnik, V.M. Slepnev, I.V. Slepnev, A.V. Terletskiy, K.Hamilton, R. Montgomery, J. R.M. Annand, D. Marchand, Y. Wang, E. Tomasi-Gustafsson, C.F. Perdrisat, V. Punjabi, G. Martinska, J. Urban, and J. Mušinsky

A publication in Special Article - *New Tools and Techniques* is a high assessment of the research done.

A future experiment at Jefferson Lab, requiring recoil neutron polarimetry, has already integrated the results into the approved experiment E12-07-109 measuring neutron electromagnetic form factors; below see some remarks from Jlab PAC:
"Compared to the previously approved experiment E12-11-009 that will use the same general technique, the present experiment uses ***a different method for neutron polarimetry that also provides access to the charge-exchange channel np→pn.*** *As the latter dominates at high neutron energy and hence at higher Q^2, the proposed method would provide an avenue for future high-Q^2 measurements of the form factor ratio via recoil polarimetry.*
The case for polarimetry via ***np→pn*** *has recently been strengthened significantly by preliminary data* ***from JINR/Dubna showing a sizable analyzing power for n+A→p+X.*** *Since most of the equipment is standard Hall-A equipment and the polarimeter mainly consists of a simple copper analyzer, no technical issues are foreseen."*

A series of scientific works *"Measurement of analyzing powers for nucleon-nucleus scattering at momentum range from 1.75 to 5.4 GeV/c", that includes this article, was awarded* a first JINR prize (2020) in the nomination of Physics Instruments and Methods.

2. The final version of the FUMILIM minimization package,
I.M. Sitnik, I.I. Alexeev, O.V. Selugin,
Computer Physics Communications 251 (2020) 107202

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.

PhD is completed:

Yi Wang (Paris-Saclay) 2018

On going PhD to be completed in two-three years:

R.A. Shindin
A.A. Druzhinin

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. 23rd International Symposium on Spin Physics (SPIN 2018), 10-14 September 2018, Ferrara, Italy
   Measurement of analysing powers for neutron scattering on CH2, CH, C and Cu target for momenta from 3.0 to 4.2 GeV/c, PoS SPIN2018 (2019) 151,
   N. Piskunov

2. 18th Workshop on High Energy Spin Physics (DSPIN-19), 2-6 September 2019, Joint Institute for Nuclear Research (JINR), Dubna, Moscow region, Russian Federation,
   Results of Measurements of the Analyzing Powers for Polarized Neutrons on C, CH 2 and Cu Targets for Momenta Between 3 and 4.2 GeV/c,
   I.M. Sitnik

5b. Give a similar list for parallel talks.

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.

We upgrade the ALPOM2 setup (new drift chambers and the hadron calorimeter), analyze the existing data to better understand and minimize systematics as well as improve software.

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.

The JINR personnel is specified in the table above. The collaboration includes 35 people from 10 Laboratories and 6 countries.

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…)

Form № 29

Estimated cost of the project: ***Measurement of analyzing powers for the reaction p+CH2 up to 7.5 GeV/c and n+A up to 6.0 GeV/c at the Nuclotron (ALPOM2 proposal)***

№№	Cost item	Full price	1 year	2 year
	Direct costs for the Project, kUSD	42.0	21.0	21.0
1.	Accelerator, Nuclotron, hours	336	168	168
2.	Computer (type)			
3.	Computer connection			
4.	Design department			
5.	Workshops, hours	1000	1000	
6.	Materials	8.0	4.0	4.0
7.	Equipment	14.0	7.0	7.0
8.	Payment of research carried out under contracts	6.0	3.0	3.0
9.	Travel expenses including:	14.0	7.0	7.0
	a) non-Russian ruble zone in the country	10.0	5.0	5.0
	b) in the cities of the ruble zone			
	c) reception collaborators	4.0	2.0	2.0

Project Manager — N. Piskunov

Director of the Laboratory — V. Kekelidze

Leading engineer-economist of the Laboratory — G. Volkova

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