

DANSS

Detector of the reactor antineutrino based on solid state plastic scintillator

Questionnaire

for Joint session of the PAC for Particle Physics and the PAC for Nuclear Physics for the assessment of the JINR Neutrino Projects

PART A: Achievements

1. Contributions of the JINR group:

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

1. Invention of an innovative measurement technique, first applied to neutrino spectrometers.
2. Creation of a DANSSINO spectrometer prototype, on which the technique was successfully developed and the energy spectrum of reactor antineutrinos was measured.
3. Proposal and implementation of a difference measurement method (moving platform), free from a number of important systematic errors.
4. Construction, debugging and launch of long-term measurements on the full-scale DANSS detector mounted under the fourth power unit of the Kalinin NPP.
5. With regard to hardware, the entire spectrometer and shielding was made by JINR, with the exception of electronics and DAQ made by ITEP

-List 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 personal responsibilities of the group members are outlined in the attached table below. Since DANSS is a small collaboration, there are no officially approved positions (coordinators, WP leaders, etc.). In fact, JINR is responsible for maintaining the spectrometer in working conditions, carrying out calibrations and shifts to collect data (leader I. Zhitnikov), organizing work at KNPP (leader V. Belov), operating electronics (leader A. Salamatin), muon veto (leader Fomina), calibrations (leader I. Makhichilyan), data analysis and simulations (leader Yu. Shitov), organization of data storage and processing at JNR (leader V. Volnyh), preparation of calibration sources (leader D. Filosofov).

JINR member			DANSS		DANSS-2		
Surname, Name	Position	FTE portion	Types of work on neutrino spectrometers				
			Service of the spectrometer	Data analysis, simulation	R & D	Installation	Data analysis, simulation
Brudanin V.B.	leading researcher	0.1	Coordination of all works				
Shitov Yu.A.	head of sector	0.5	Management of all works				
Belov V.V.	junior researcher	0.3	+	+	+	+	+
Volnyh V.P.	leading engineer	0.1		+			+
Zhitnikov I.V.	researcher	0.5	+	+	+	+	+
Kazartsev S.V.	junior researcher	0.2	+		+	+	+
Kiyanov S.P.	senjor engineer	0.2	+		+	+	
Kuznetsov A.S.	engineer	0.9	+		+	+	+
Mamedov F.	senior researcher	0.5		+	+	+	+
Machihilyan I.V.	senjor engineer	0.5		+			+
Medvedev D.V.	researcher	0.3	+			+	
Pushkov D.S.	senjor engineer	0.3	+			+	
Rozov I.E.	engineer	0.4			+	+	
Salamatin A.V.	senior researcher	0.1		+	+	+	
Filosofov D.V.	head of sector	0.1			+	+	
Fomina M.V.	junior researcher	0.4		+	+	+	+
Shevchik EA	senjor engineer	0.2	+		+	+	+
Total FTE		5.6					

2. 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.

1. I.G. Alekseev et al., DANSS Neutrino Spectrometer: Detector Calibration, Response Stability, and Light Yield, Phys.Part.Nucl.Lett. 15 (2018) no.3, 272-283, DOI: [10.1134/S1547477118030020](https://doi.org/10.1134/S1547477118030020)

Key contribution to the spectrometer construction, tuning, calibration, and maintenance. Participation in background studies (neutron measurements), data sorting and sensitivity analysis.

2. I.G. Alekseev et al., Search for sterile neutrinos at the DANSS experiment, Phys.Lett. B787 (2018) 56-63, DOI: [10.1016/j.physletb.2018.10.038](https://doi.org/10.1016/j.physletb.2018.10.038)

Key contribution to the spectrometer construction, tuning, calibration, and maintenance. Participation in background studies (neutron measurements), data sorting and sensitivity analysis.

3. I.G. Alekseev et al., Industrial Reactor Power Monitoring Using Antineutrino Counts in the DANSS Detector, Phys.Atom.Nucl. 82 (2019) no.5, 415-424, DOI: [10.1134/S1063778819050041](https://doi.org/10.1134/S1063778819050041)

Key contribution to the spectrometer construction, tuning, calibration, and maintenance. Participation in background studies (neutron measurements), data sorting and sensitivity analysis.

4. Machikhiliyan et al., Reconstruction and initial calibration of silicon photomultipliers response in the DANSS experiment, Phys.Part.Nucl. 49 (2018) no.1, 70-72.

Principal author of paper and calibration method.

3. PhD theses:

-List the PhD theses completed within the last 3 years, or expected to be completed within 2021, by JINR students within the project, giving the student name, thesis title and graduation year.

Two DANSS project participants successfully defended their dissertations in 2019. Daniya Zinatulina (http://ftp.jinr.ru/dissertation/Zinatulina_autoref.pdf) and Mark Shirchenko (http://159.93.39.20/dissertation/Shirchenko_autoref.pdf). They are currently leading their own MONUMENT project, which is now carrying on under the same theme as current project. Currently, two PhD thesis planned to be completed within 2021.

I. Zhitnikov "Development, creation and characterization of the DANSS detector based on plastic scintillators for the study of reactor antineutrinos"

V. Belov." Background studies, measurements and discrimination in the DANSS reactor neutrino experiment"

4. Talks:

-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. Yu. Shitov Status of the DANSS project / AAP 2018, 14th International Workshop on Applied Antineutrino Physics, 10-11 October 2018, Livermore, California, USA
<https://neutrinos.llnl.gov/content/assets/docs/workshops/2018/AAP2018-DANSS-Shitov.pdf>

2. Yu. Shitov New results from the DANSS experiment / LP2019 XXIX International Symposium on Lepton Photon Interactions at High Energies, 5-10 August 2019, Toronto Canada, <https://indico.cern.ch/event/688643/contributions/3429530/>

3. Yu. Shitov Search for a light sterile neutrino at SBL reactor experiments / Seminar at University of Comenius, Bratislava, Slovakia, 14 November 2018.
https://fmph.uniba.sk/detail-novinky/back_to_page/fakulta-matematiky-fyziky-a-informatiky-uk/article/translate-to-english-nuklearny-seminar-yuri-shitov-14112018/

4. Yu. Shitov, The DANSS project: resent status / Colloquium Prague v19, 24-25 October 2019, J. Heyrovsky Institute of Physical Chemistry Conference timetable:

<https://indico.cern.ch/event/802062/timetable/#all.detailed>, Report:

https://indico.cern.ch/event/802062/contributions/3505328/attachments/1932690/3201574/danss_n19_prague_shitov_1.pdf

5. Yu. Shitov, Recent results from DANSS / NuPhys2019, Prospects in Neutrino Physics, 16-18 December 2019, London, UK, Conference timetable:

<https://indico.cern.ch/event/818781/timetable/#all.detailed>, Report:

https://indico.cern.ch/event/818781/contributions/3595973/attachments/1963402/3264060/danss_nuphys_2019_london_shitov_1.pdf

6. Yu. Shitov, Recent results from the DANSS experiment, Neutrino-2020, Chicago, online, June 22-July 2, 2020 Conference timetable:

<https://indico.fnal.gov/event/43209/timetable/#20200622.detailed>, report:

https://indico.fnal.gov/event/43209/contributions/187879/attachments/130343/158766/danss_nu2020_shitov_final.pdf

-Give a similar list for parallel talks.

1. International session-conference of the Nuclear Physics Section of the Physical Sciences Division of the Russian Academy of Sciences "Physics of fundamental interactions" dedicated to the 50th anniversary of the Baksan Neutrino Observatory
International session-conference of the Nuclear Physics Section of the Physical Sciences Division of the Russian Academy of Sciences "Physics of fundamental interactions" dedicated to the 50th anniversary of the Baksan Neutrino Observatory. Igor Zhitnikov, Status of the DANSS experiment

2. Report of LXVIII International conference NUCLEUS 2018: Actual status of "DANSS" project

3. Report New Trends in High-Energy Physics 2018: Actual status of "DANSS" project Vyacheslav Belov + 1 report by Fomina M.V.

3. International Workshop on Particle Physics at Neutron Sources 2018, DANSS, M. Shirchenko.

4.6th Symposium on Neutrinos and Dark Matter in Nuclear Physics 2018.

<https://indico.ibs.re.kr/event/212/>, M. Shirchenko, DANSS status & perspectives.

5. Irina Machikhiliyan The DANSS neutrino spectrometer: the results of reactor antineutrino studies, Nucleus-2020, <https://indico.cern.ch/event/839985/timetable/#all.detailed>

PART B: Plans and requests

5. 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.

1. Detailed design studies, tests and R&D of individual elements, final design approval of all elements, electronics development will be carried out during 2021 and will be completed by mid-2022.
2. In parallel, in 2021 and until mid-2022, 1,440 NDE will be manufactured. The process will be carried out in three stages:
 - a) making plates from a plastic scintillator, checking and certifying them for a light output. This procedure will be carried out in JINR by the Dubna group. The planned production speed is 30-60 strips per week.
 - b) cutting of grooves, gluing of fibers and applying a diffusion reflective coating on strips (matting) will be performed by a third-party commercial company in Vladimir under the supervision of representatives of the Dubna group, also responsible for the delivery of strips from Dubna to Vladimir.
 - c) equipment of strips with SiPMs and final certification of their individual characteristics will be carried out at ITEP by our colleagues, who are also responsible for transporting strips from Vladimir to Moscow.
3. "Dry assembly" of the setup in a clean room at ITEP for testing and tuning its operation is provided for six months (second half of 2022). It will be carried out by the ITEP group with the possible involvement of members of the Dubna group, if necessary.
4. Final assembly and commissioning of the DANSS-2 at KNNP is planned for the first half of 2023. Note that the work on items 1-3 will be carried out in parallel with the operation of the DANSS spectrometer. Before starting point 4, it will take 1-2 months to disassemble the DANSS.
5. Physical start-up and data collection by the DANSS-2 spectrometer is scheduled for the summer of 2023. The minimum exposure to get valuable results is ~ 2.5 years

6. Group size, composition and budget

-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.

Total number of people in the DANSS collaboration: 36. List of JINR members (17 people) is in the following table:

JINR member			DANSS		DANSS-2		
Surname, Name	Position	FTE portion	Types of work on neutrino spectrometers				
			Service of the spectro meter	Data anal ysis, simu latio n	R & D	Ins tall ati on	Dat a anal ysis, sim ulati on
Brudanin V.B.	leading researcher	0.1	Coordination of all works				
Shitov Yu.A.	head of sector	0.5	Management of all works				
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Volnyh V.P.	leading engineer	0.1		+			+
Zhitnikov I.V.	researcher	0.5	+	+	+	+	+
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Kuznetsov A.S.	engineer	0.9	+		+	+	+
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Total FTE		5.6					

-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...)

Estimated expenditures for the Project
Detector of the reactor antineutrino based on solid state plastic scintillator
DANSS

NN	Expenditure items	Units	Full cost	1 st yr	2 nd yr	3 rd yr
	Direct expenses for the Project					
1.	Computer connection	k\$	6	2	2	2
2.	Design bureau	std.h.	300	100	100	100
3.	Experimental Workshop	std.h.	600	200	200	200
4.	Materials	k\$	360	140	100	120
5.	Equipment	k\$	220	60	80	80
6.	Transportation of equipment	k\$	25	15	10	0
7.	Collaboration meetings and workshops	k\$	15	5	5	5
8.	Travel allowance, including:	\$k	90	30	30	30
	a) non-rouble zone countries	-	-	-	-	-
	b) rouble zone countries	\$k	90	30	30	30
	c) protocol-based	-	-	-	-	-
	Total direct expenses:	k\$	716	252	227	237

Expected salary of the DANSS team is 95.2 kUS\$ per year. Estimation based on 2020 data and includes spending on technical personnel not listed in the project. 1US\$ = 64RUB assumed in the estimation.

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

DANSS uses the main LIT farm, 400 TB disk space for data storage (cloud disk resources /eos/danss accessible by network). The project does not yet have its own CPU-capacity, therefore, to solve individual tasks, it uses computer resources allocated for the DLNP neutrino program at LIT (projects JUNO, BAIKAL-GVD) as well as the DLNP cluster <http://lgdweb.jinr.ru> If necessary, we plan to acquire the CPU-resources to connect their capacities within the DLNP neutrino program.