JUNO and Daya Bay experiments

1. Goals of the experiment:

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

Daya Bay

1. Precision measurement of two neutrino oscillation parameters: θ_{13} and Δm^2_{32}.
2. Precision measurement of the reactor antineutrino flux and spectrum.
3. Measurement of reactor antineutrino flux and spectrum associated with different fission chains in the reactor: ^{235}U and ^{239}Pu.
4. Search for the sterile neutrinos.
5. Seasonal muon flux modulation and cosmogenic neutron production measurement.
6. New physics searches: decoherence in neutrino oscillation, Lorenz/CPT violation, varying mass neutrino, etc.

JUNO

1. Determination of neutrino mass hierarchy.
2. Precision measurement of three neutrino mixing parameters: θ_{12}, Δm^2_{21}, Δm^2_{32}.
3. Solar, geo-, atmospheric, SN and DSNB neutrino detection and measurement.
4. Search for sterile neutrino, nucleon decay and new physics.

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

Daya Bay

1. The most precise measurement of the neutrino mixing angle θ_{13}. The final precision <3% achieved by Daya Bay in 2020 will be world's best for decades.
2. Most precise Δm^2_{32} measurement among reactor neutrino experiments. The achieved precision or 2.8% is comparable to the best results achieved with accelerator neutrino. Both neutrino sources provide consistent results. Daya Bay result is complementary to accelerator measurements due to different oscillation channel and systematics.
3. Most precise reactor antineutrino flux and spectrum measurement.
4. Up to now Daya Bay is the only reactor experiment able to measure the contribution of ^{235}U and ^{239}Pu to the total neutrino flux and spectrum.
5. Most stringent limits on the active sterile neutrino parameters in the mass splitting range $5 \cdot 10^{-4} < \Delta m^2_{41} < 0.2$ [eV^2].

JUNO

1. Determination of neutrino mass hierarchy with reactor neutrino experiment. JUNO is the only reactor experiment able to measure neutrino mass hierarchy. Therefore in addition to the mass hierarchy measurement itself JUNO result will be complementary to the accelerator/atmospheric measurements due to significantly different systematics. JUNO result is not sensitive to the CP violation and weakly dependent on matter effects and its sensitivity is limited mostly by instrumental features, such as energy resolution and energy scale.
2. Sub-percent three neutrino oscillation parameters measurement θ_{12}, Δm^2_{21}, Δm^2_{32} in the single experiment. JUNO will be the only experiment seeing ~20 oscillation cycles. Combined analysis with Daya Bay will enable us to measure 4 parameters in the same time by including θ_{13}. The expected precision of the measurement of lepton mixing parameters will be comparable to the

precision level in the quark sector of the Standard Model, thus making a breakthrough. This will allow also to test the unitarity of the lepton mixing matrix.
3. Largest statistics of geo-neutrino events and most precise geo-neutrino flux measurement.
4. Study of Supernova neutrinos, search for sterile states, non-standard interactions, etc.

2. Contributions of the JINR group:

2a. Give an itemized 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.

Daya Bay

1. Inverse beta decay (IBD) and background selection software. Our group is the only group in Daya Bay maintaining both options of IBD selection procedure which is important for cross checking.
2. Dubna group has developed and maintains its own fitter for the Daya Bay (dybOscar). The group has contributed to each Daya Bay neutrino oscillation parameters measurement (nGd) as a parallel group. Our measurement was chosen as official result of the Daya Bay collaboration in 2016.
3. Our group made a significant contribution to the development of a theory of neutrino oscillations within a wave packet (WP) model. We initiated and performed a corresponding analysis of the Daya Bay data. As a result, the first experimental limits on the parameters of the coherence of WP were obtained and published.
4. We have developed GNA[1] — a new tool for fitting comprehensive numerical models with large number of parameters. The aim of GNA is to implement the analysis of neutrino experimental data and maintain the analysis on a long term. The application scope of GNA includes: Daya Bay, JUNO, TAO (JUNO near detector), NOvA, PROSPECT and others, as well as the possibility of combination of several analyses with proper systematics treatment.

JUNO

1. JUNO activities in the PMT characterization:
    - We developed and built up 3 scanning stations for precise PMT-testing. Two stations have been shipped and commissioned in China on JUNO PMT testing site.
    - Our shifters performed about 2000 PMT scans and spent 20 man-months for this.
    - We developed and are managing the database for tested JUNO PMT raw and processed data.
    - Currently we are developing and arranging a method for long-term stability tests of JUNO PMT.
    - Simulation of PMT response including light transmission in the detector was performed.
2. JINR takes active part in the Top Tracker detector creation:
    - development of the mechanical support structure
    - development of the data acquisition software and slow control software
    - development of the technique of the scintillators performance monitoring in the detector storage period and providing the measurements and the analysis relevant to this task.
    - development of the tracking algorithms in the Top Tracker detector.
3. HV system
    - Design in a collaboration with dedicated companies of a brand new High Voltage Units (HVU) for both large and small photomultipliers (LPMTs and sPMTs). The proposal of JINR group to make the HVU converting low to high voltages directly on the PMT base defined the whole design of JUNO electronics with intelligent chips, digitization of the signal and read-out.
    - Development of testing facilities for quality control and long term tests of HVU.
    - Production of about 25 000 HVUs for JUNO experiment. Full financial support, supervision, tests.

[1] https://astronu.jinr.ru/wiki/index.php/GNA

4. Our group has developed JUNO model (within GNA framework) which is used for JUNO sensitivity study by several groups within JUNO collaboration:
5. Estimation of the impact of ^{14}C contamination of liquid scintillator on the accuracy of the mass hierarchy determination. Our model has been also used to quantify the quality of clasterization-based reconstruction technique designed to reduce possible pile-up with ^{14}C events developed by Juelich group.
6. Estimation of improvements for the MH determination achieved by taking into consideration spatial dependance of energy resolution done by Juelich group.

2b. Give a 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.

Daya Bay

1. Dmitry Naumov — Institutions Board, 2007-2020.
2. Dmitry Naumov — Executive Board, 2018-2019.

JUNO

1. Nikolay Anfimov — Level 3 manager in JUNO collaboration, PMT instrumentation, since 2015.
2. Yury Gornushkin — Level 3 manager (TT mechanics), since 2016 without termination.
3. Dmitry Naumov — Institutions Board, since 2015 without termination.
4. Dmitry Naumov — Executive Board, 2015-2018.
5. Dmitry Naumov — Publication Committee, 2018-2020.
6. Alexander Olshevskiy — Level 2 manager, PMT instrumentation, since 2015.
7. Andrey Sadovsky — Level 3 manager, HV system, since 2015.

3. Plans

Daya Bay

1. Finalize the implementation of the Daya Bay model within GNA framework. Cross check the model against the old fitter, prepare the analysis (nGd) of the new data, including the final analysis for the full data set after the experiment is completed in 2020.
2. Carry out Inverse Beta Decay (IBD) events selection on the updated datasets. Investigate differences between various versions of selection cuts and the corresponding systematic uncertainties. These items are especially important as soon as the final Daya Bay data set will contain more that 6M IBD candidates when the uncertainties of determination of oscillation parameters are dominated by systematics.
3. Investigate the Daya Bay sensitivity to the low energy neutron interaction cross section, which affects the neutron capture time. Study the possibility to distinguish various neutron interaction cross section models.
4. As the main goal of the GNA is to provide efficient and flexible tool shared also to the other collaborators (Daya Bay, JUNO, etc) a special attention will be payed to the framework documentation and promotion:
    a. The GNA framework will be publicly released in Spring 2019. A set of items will be done before this. We will provide tutorial, user documentation, API documentation, automated unit tests.
    b. A release will be followed by the white paper publication, describing the framework capabilities and features.
    c. Talks on the conferences, including CHEP 2019.
5. A new numerical model (GNA) will be used to implement a set of new analyses of Daya Bay data:
    a. Combined analysis of the neutrino oscillation parameters and reactor neutrino spectrum.

b. Reactor antineutrino flux and spectrum measurement with contributions of ^{235}U and ^{239}Pu decoupled.
c. Sterile neutrino search.
d. Facilitate a preparation of the oscillation analysis (nH mode) by a Daya Bay group from SDU.
e. Implement combined analysis of two modes (nGd and nH) with proper systematic uncertainties treatment.
f. A combined analysis with PROSPECT experiment is currently under consideration by Daya Bay collaboration: reactor antineutrino flux and spectrum measurement and sterile neutrino search. In case this initiative is approved by the collaboration we plan to contribute to this research by facilitating the implementation of PROSPECT model within GNA and preparation of the combined analysis.
g. All of the implemented analyses will be maintained till the end of the experiment in 2020 with final results published.

6. A further development of the GNA framework is expected. Since the goal of the GNA is to provide the tools for efficient statistical analysis of large scale models we will concentrate on High Performance Computing tasks:
    a. Provide multi-threading computations (CPU) support. Following the data flow paradigm used in GNA the end user will be able to use multi-threading with minimal effort.
    b. Provide to the end user a transparent GPU support. Provide combined version or CPU/GPU multithreading.
    c. Provide tools for replicating and scaling computational models. The goal is to implement multi-threaded synchronous minimization on GPU for computationally intensive tasks: confidence levels estimation via Feldman-Cousins and Bayesian approaches as well as for regular likelihood profiling.

JUNO

1. PMT
    a. In 2018 about 12000 (out of the total 20000) bare PMTs were tested. The test of bare PMTs will continue in 2019-2020. The last delivery of PMTs is scheduled for the first half of 2020.
    b. In 2019 the group will set up the test of potted PMTs which will continue through 2019-2020.
    c. In addition, in 2019 we will also set up the long term test of a sample of PMTs to study PMT aging.
    d. The test of PMTs with real JUNO electronics will be performed in 2020.
2. Top Tracker
   In 2019-2020 the TT detector preparation will continue:
    a. the mechanic support will be fabricated and delivered to the JUNO site.
    b. The DAQ software will be developed by JINR including the SlowControl and on-line Event Display parts.
    c. The off-line event reconstruction algorithms will be developed
    d. The TT aging monitoring by JINR will continue at Jiangmen in the ground Lab.
3. PMT HV system
    a. By the end of 2018 the design of HV Units is finalised
    b. In 2019 preparation and start of the HVU mass production is planned
    c. In 2020 the HV Units will be installed and tested with the rest of electronics
4. Analysis
    a. Sensitivity study within GNA framework
        i. Keep the JUNO model up to date with the experiment requirements and latest updates from Daya Bay experiment.
        ii. Introduce the model of TAO detector (JUNO near detector).
        iii. Update the JUNO sensitivity for JUNO+TAO measurement as well as JUNO+TAO+Daya Bay.

b. Proceed the work on primary vertex and energy reconstruction and muon track reconstruction:
   i. Study the possibility of muon track reconstruction and muon track multiplicity estimation with help of multipole expansion of PMT charge distribution.
   ii. Improve feed-forward neural network (FFNN) primary vertex reconstruction by including additional input data (multipole expansion coefficients for charge distribution, statistical moments for first hit time distribution).
   iii. Improve convolutional neural network (CNN) reconstruction by increasing the input data resolution, MC statistics. Include simultaneous energy reconstruction. Investigate possibility of using multipole expansion of the charge distribution as input for CNN/FFNN.

c. The optical model of PMT
   i. Finalize the optical model of PMT including the light interference in a thin photocathode layer, refractive and absorption indices, wavelength dependence, photocathode zonal sensitivity. The Dubna-inspired model is already implemented in the official JUNO software.
   ii. Perform the measurements of free parameters of the PMT optical model for LPMT and sPMTs.

4. Publications:

Daya Bay

In the period of 2016-2018 12 papers were published in refereed literature with 6 of them contributed by the JINR group.

1. Improved Measurement of the Reactor Antineutrino Flux and Spectrum at Daya Bay, Daya Bay Collaboration (Feng Peng An (East China U. Sci. Tech.) *et al.*). Jul 18, 2016. 36 pp. Published in Chin.Phys. C41 (2017) no.1, 013002 DOI: 10.1088/1674-1137/41/1/013002, e-Print: arXiv:1607.05378 [hep-ex] | PDF
   - JINR group contribution: analysis discussion, analysis review and paper internal review.
2. Study of the wave packet treatment of neutrino oscillation at Daya Bay, Daya Bay Collaboration (Feng Peng An (East China U. Sci. Tech.) *et al.*). Aug 4, 2016. 20 pp. Published in Eur.Phys.J. C77 (2017) no.9, 606 DOI: 10.1140/epjc/s10052-017-4970-y e-Print: arXiv:1608.01661 [hep-ex] | PDF
   - JINR group contribution: theory development, analysis proposal, data analysis, publication preparation.
3. Measurement of electron antineutrino oscillation based on 1230 days of operation of the Daya Bay experiment, Daya Bay Collaboration (Feng Peng An (East China U. Sci. Tech.) *et al.*). Oct 15, 2016. 46 pp. Published in Phys.Rev. D95 (2017) no.7, 072006 DOI: 10.1103/PhysRevD.95.072006 e-Print: arXiv:1610.04802 [hep-ex] | PDF
   - JINR group contribution: IBD selection (parallel), fitter development, analysis preparation, paper preparation (contribution) and review. The result of the JINR group is published as official Daya Bay result.
4. Evolution of the Reactor Antineutrino Flux and Spectrum at Daya Bay, Daya Bay Collaboration (F.P. An (East China U. Sci. Tech., Shanghai) *et al.*). Apr 4, 2017. 8 pp. Published in Phys.Rev.Lett. 118 (2017) no.25, 251801 DOI: 10.1103/PhysRevLett.118.251801 e-Print: arXiv:1704.01082 [hep-ex] | PDF
   - JINR group contribution: analysis discussion, analysis review and paper internal review.
5. Improved Measurement of the Reactor Antineutrino Flux at Daya Bay, Daya Bay Collaboration (D. Adey (Beijing, Inst. High Energy Phys.) *et al.*). Aug 31, 2018. 10 pp. e-Print: arXiv:1808.10836 [hep-ex] | PDF
   - JINR group contribution: analysis discussion, analysis review and paper internal review.
6. Measurement of electron antineutrino oscillation with 1958 days of operation at Daya Bay, Daya

Bay Collaboration (D. Adey (Beijing, Inst. High Energy Phys.) *et al.*). Sep 6, 2018. 6 pp. e-Print: arXiv:1809.02261 [hep-ex] | PDF
   - JINR group contribution: IBD selection (parallel), fitter development, analysis preparation (parallel), paper review.
7. Anna Fatkina, Maxim Gonchar, Anastasia Kalitkina, Liudmila Kolupaeva, Dmitry Naumov, Dmitry Selivanov, Konstantin Treskov. (2018) GNA: new framework for statistical data analysis. EPJ Web of Conferences.
   - Work done by JINR group.
8. Fatkina A., Gonchar M., Kolupaeva L., Naumov D., Treskov K. (2018) CUDA Support in GNA Data Analysis Framework. In: Gervasi O. et al. (eds) Computational Science and Its Applications – ICCSA 2018. ICCSA 2018. Lecture Notes in Computer Science, vol 10963. Springer, Cham
   - Work done by JINR group.

JUNO

5. PhD and Doctor theses:

1. Maxim Gonchar (PhD), "The measurement of neutrino mixing angle θ_{13} and neutrino mass splitting Δm^2_{32} in the Daya Bay experiment", 2017.
2. Dmitry Naumov (D.Sc.), "Measurement of θ_{13}, Δm^2_{32} and covariant quantum-field theory of neutrino oscillations"

6. Talks:

6a. List the invited plenary talks given by members of the JINR group in 2016, 2017 and 2018 at international conferences, workshops…: give name and date of the Conference, title of talk and speaker name.

- 2016
  a. D. Naumov, Neutrino Physics with Nuclear Reactors. Международная Сессия-конференция Секции ядерной физики ОФН РАН, 12 - 15 April, 2016, JINR, Dubna, Russia
  b. D. Naumov, Neutrino Physics with Nuclear Reactors. QUARKS-2016 19th International Seminar on High Energy Physics, Pushkin, Russia, 29 May - 4 June, 2016
  c. D. Naumov, Latest Results from the Daya Bay Reactor Neutrino Experiment. New Trends in High-Energy Physics, 2-8 October 2016, Budva, Becici, Montenegro
  d. O. Smirnov. "Geoneutrino studies with JUNO detector". International Workshop: Neutrino Research and Thermal Evolution of the Earth, October 25 – 27, 2016, Sendai, Japan. Plenary talk.
- 2017
  a. D. Naumov, New Results from the Daya Bay Reactor Neutrino Experiment. Neutrino Telescopes, 13-17 March 2017, Venice, Italy
  b. A. Olshevskiy, Neutrino Physics lectures, School on Nuclear Physics, 18 May 2017, Borovets (Bulgaria).
- 2018
  a. D. Naumov, Coherency and incoherency in elastic and inelastic neutrino-nucleus scattering. The Magnificent CEvNS Workshop. 2 November 2018, Chicago, USA

b. D. Naumov, Review of sterile neutrinos. VLVNT 2018. 2 October 2018. Dubna, Russia
c. M. Gonchar, New results from the Daya Bay experiment, New Trends in High-Energy Physics, 2-8 October 2016, Budva, Becici, Montenegro

6b. Give a similar list for parallel talks.

- 2016
  a. T. Antoshkina, AYSS-2016, “Studying of zonal characteristics of PMT”, Dubna, Russia.
  b. M. Dolgareva, AYSS-2016, “A study of the wave packets approach to the neutrino oscillations based on Daya Bay and KamLAND data”, Dubna, Russia
  c. M. Gonchar, Neutrino Oscillations in QFT with relativistic wave packets. International session-conference of the section of nuclear physics of PSD RAS, 12 - 15 April, 2016, JINR, Dubna, Russia
  d. D. Naumov, Recent results from Daya Bay experiment. International session-conference of the section of nuclear physics of PSD RAS, 12 - 15 April, 2016, JINR, Dubna, Russia
  e. Yu. Gornushkin, “Status of the JUNO experiment”. International session-conference of the section of nuclear physics of PSD RAS, 12 - 15 April, 2016, JINR, Dubna, Russia
  f. O. Smirnov, “Geoneutrino flux measurement: current status and future prospects”, DLNP seminar, 11 November 2016.
  g. O. Smirnov, “Measurement of the geo-neutrino fluxes: status and future”, LNGS seminar, November 28, 2016.
  h. O. Smirnov, “Measurement of the geo-neutrino fluxes: status and future”, seminar at Cagliari University, November 30, 2016.
  i. K. Treskov, AYSS-2016, “Fast neutron background in the Daya Bay experiment”, Dubna, Russia.
- 2017
  a. N. Anfimov. Large photocathode 20-inch PMT testing methods for the JUNO experiment. The International Conference "Instrumentation for Colliding Beam Physics", Poster, Novosibirsk, Russia, from 27 February to 3 March, 2017.
  b. N. Anfimov. Light collection module for Liquid Argon TPC. 3rd DUNE Near Detector workshop @CERN. 6-7 November 2017.
  c. M. Gonchar, “JINR neutrino programme. Daya Bay and JUNO: precision measurements with reactor neutrinos”. 46th meeting of the PAC for Particle Physics. Dubna, 16-17 January, 2017.
  d. M. Gonchar, “The measurement of neutrino mixing angle θ_{13} and neutrino mass splitting Δm^2_{32} in the Daya Bay experiment (based on thesis)”, seminar, Izmiran, Troitsk, June, 15, 2017.
  e. M. Gonchar, “The measurement of neutrino mixing angle θ_{13} and neutrino mass splitting Δm^2_{32} in the Daya Bay experiment (based on thesis)”, seminar, INR, Troitsk, June, 19, 2017.
  f. K. Treskov, International School of Subnuclear Physics, Eriche, Italy, 14-23 June 2017.
  g. K. Treskov, VII International Pontecorvo Neutrino Physics School, Prague, Czech Republic , 20 August – 1 September 2017.
  h. K. Treskov, AYSS-2017, October 2-6, 2017, Dubna, Russia.
- 2018
  a. A. Olshevskiy, “JUNO Project: Measurement of Neutrino Mass Hierarchy”, Seminar at Moscow state university, 27 March 2018. Moscow, Russia.
  b. M. Gonchar, "Oscillation analysis in Daya Bay experiment", International School of Subnuclear Physics 56th Course: From Gravitational Waves to QED, QFD and QCD, Erice, Italy, 14-23 June 2018.

c. A. Fatkina, “GNA: new framework for statistical data analysis”, CHEP 2018, July 2018, Sofia, Bulgaria.
d. A. Fatkina, “CUDA Support in GNA Data Analysis Framework”, ICSSA, July 2018, Melburne, Australia.
e. A. Fatkina, “GNA: Data Analysis Framework for Neutrino Experiments”, AYSS-2018, April 2018, Dubna, Russia.
f. K. Treskov, “The latest results from Daya Bay”, IV International Conference on Particle Physics and Astrophysics, October 22-26 2018, Moscow, Russia.
g. K. Treskov, “Experimental study of decoherence effects in neutrino oscillations in Daya Bay”, NEUTRINO 2018, 4-8 June, Heidelberg, Germany.
h. A. Olshevskiy, “Neutrino Mass Ordering: JUNO Status and Plans”, VLVNT 2018. 2 October 2018. Dubna, Russia

7. Group size, composition and budget.

7a. Present in a Table the list of 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.

		Daya Bay	JUNO	Total
Total members		189	627	
Members (JINR)		9	29	29
FTE (JINR)		3.5	12.55	15.65
Naumov D.V.	PI	0.5	0.5	1
Olshevsky A.G.	PI	0	0.5	0.5
Gonchar M.O.	PI	0.5	0.5	1
Antoshkina T.A.	researcher	0	1	1
Biktemerova S.V.	researcher	0	0.5	0.5
Dolzhikov D.A.	student	0.2	0	0.2
Zavadsky V.S.	student	0.2	0	0.2
Naumova E.A.	researcher	0.8	0.2	1
Selivanov D.A.	student	0.2	0.2	0.4
Treskov K.A.	researcher	0.5	0.5	1
Fatkina A.I.	student	0.2	0.2	0.4
Chukanov A.V.	researcher	0.4	0.6	1
Nemchenok I.B.	researcher	0	0.25	0.25
Anfimov N.V.	PI	0	0.3	0.3
Butorov I.V.	researcher	0	0.5	0.5
Gromov V.O.	researcher	0	1	1
Korablev D.V.	researcher	0	0.2	0.2
Kuznetsova K.I.	researcher	0	0.2	0.2
Rybnikov A.V.	researcher	0	0.5	0.5
Sadovsky A.B.	researcher	0	0.8	0.8
Selyunin A.S.	researcher	0	0.5	0.5
Sokolov S.A.	researcher	0	0.5	0.5
Fedoseev D.V.	researcher	0	0.4	0.4
Sharov V.I.	researcher	0	0.5	0.5
Smirnov O.Yu.	PI	0	0.25	0.25

Gorchakov O.E.	researcher	0	0.3	0.3
Sotnikov A.P.	researcher	0	0.2	0.2
Gornushkin Yu.A.	PI	0	0.5	0.5
Dmitrievsky S.G.	researcher	0	0.5	0.5
Krasnoperov A.V.	researcher	0	0.25	0.25
Sadygov Z.Ya.	researcher	0	0.2	0.2

7b. Indicate the expected changes in the group size, if any, till the end of the currently approved project.

We will attract students and researchers whenever possible. No definite schedule on group size modification may be done though.

7c. Present the JINR group budget from 2018 till the end of the currently approved project in a Table specifying the main budget items (equipment, computing, salaries, common funds, travel…)

<table>
<tr><th colspan="3" rowspan="2">Budget items</th><th rowspan="2">Total cost k$ (required resources)</th><th colspan="3">Cost per year</th></tr>
<tr><th>2018</th><th>2019</th><th>2020</th></tr>
<tr><td rowspan="5">Materials and equipment</td><td colspan="2">PMT HV production</td><td>2000</td><td>1000</td><td>1000</td><td>-</td></tr>
<tr><td colspan="2">TT supply (in-kind contribution)</td><td>750</td><td>250</td><td>250</td><td>250</td></tr>
<tr><td colspan="2">TT support production</td><td>180</td><td>90</td><td>90</td><td>-</td></tr>
<tr><td colspan="2">PMT testing equipment and data storage</td><td>100</td><td>40</td><td>30</td><td>30</td></tr>
<tr><td colspan="2">PMT magnetic shield prototyping</td><td>30</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td rowspan="3">Required resources</td><td>norm. hours</td><td>JINR Workshop
DLNP Workshop
DLNP design bureau</td><td>2100
2400
2400</td><td>700
800
800</td><td>700
800
800</td><td>700
800
800</td></tr>
<tr><td rowspan="2">k$</td><td>Missions</td><td>500</td><td>153</td><td>151</td><td>196</td></tr>
<tr><td>Daya Bay operation fee</td><td>180</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td rowspan="2">Sources</td><td>Budget</td><td></td><td>2990</td><td>1353</td><td>1341</td><td>296</td></tr>
<tr><td>Non-budget</td><td>“In-kind” contribution (TT)</td><td>750</td><td>250</td><td>250</td><td>250</td></tr>
</table>

7d. Indicate the use of JINR computing resources for the group and for the project if any.

1. JINR Cloud service:
    a. 70 TB of disk space, 40 of which are funded by the project.
    b. 96 CPU cores, funded by the project.
2. Hybrilit/Govorun is used for the Neural Network reconstruction.