
- **Основные результаты проекта (2015-20):**
  - Программы описания детектора, развитие Монте-Карло генераторов, вклад в развитие физической программы (Phase C) …
  - Магнит (разработка полной проектной документации на сверхпроводящий соленоид и ярмо-поглотитель) -> передача в Новосибирск (ИЯФ) для изготовления (**ярмо магнита полностью изготовлено**)
  - Мюонная система (прототип, калибровки, электроника)
  - Синергия проектов мюонных систем PANDA/FAIR и SPD/NICA -> 90-100% (детекторы, электроника, алгоритмы PID, калибровки)
  - **Получение/гарантия финансирования проекта от FAIR -> 830 К €**

- **Продление темы/проекта (2022-24)**

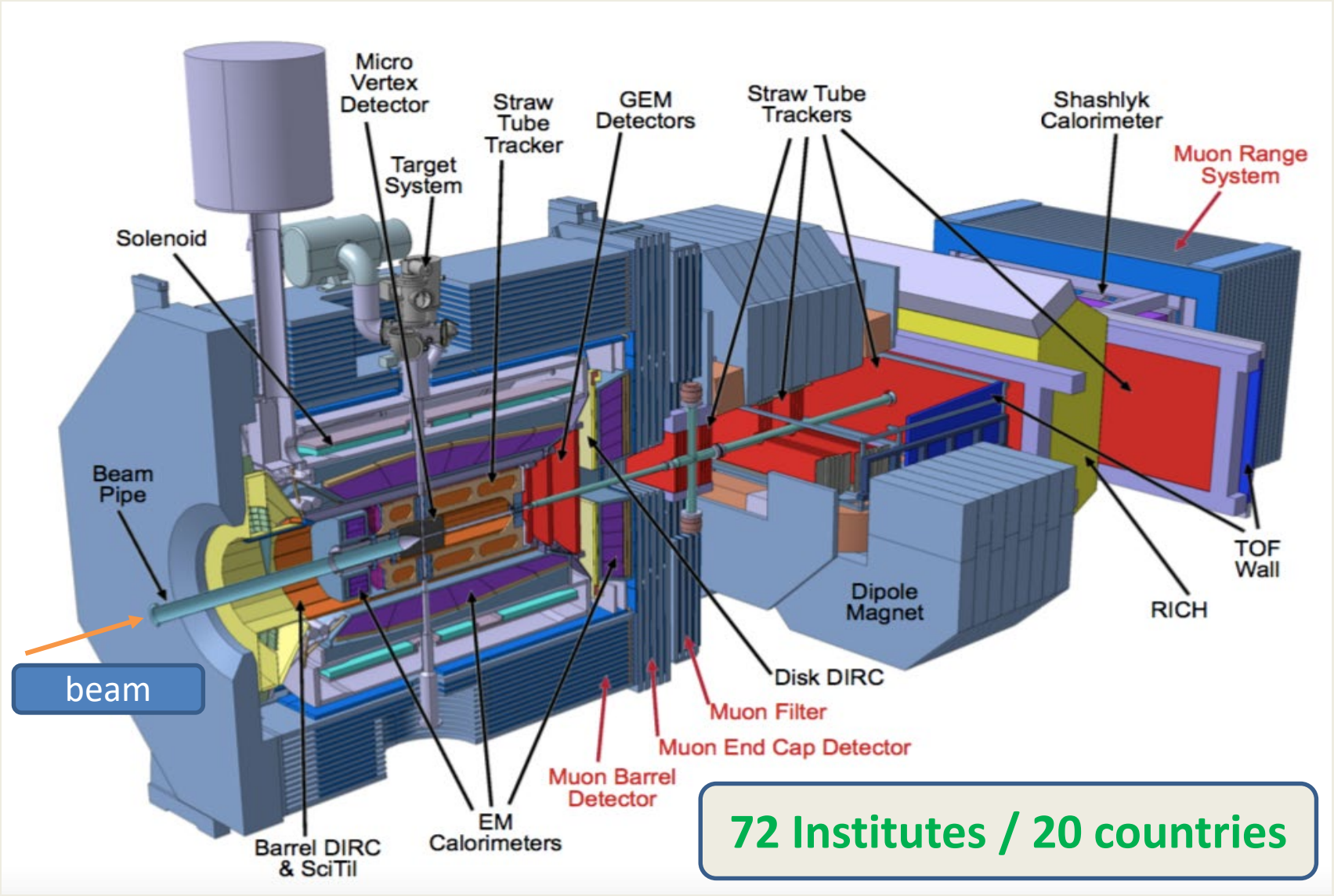
Авторы от ОИЯИ:

V.M. Abazov[1)], G.D. Alexeev[1)], V.A. Aref'ev[2)], V.I. Astakhov[2)], M.Yu. Barabanov[2)], B.V. Batyunya[2)], V.К. Dodokhov[2)], A.A. Efremov[2)], A.V. Efremov[3)], A.A. Feshchenko[2)], A.S. Galoyan[2)], G.A. Golovanov[1)], E.К. Koshurnikov[2)], V.S. Kurbatov[1)], S.A. Kutuzov[1)], V.I. Lobanov[2)], Yu.Yu. Lobanov[2)], P.V. Nomokonov[2)], I.A. Olex[2)], A.A. Piskun[1)], I.К. Prokhorov[1)], A.M. Rozhdestvensky[1)], A.G. Samartsev[1)], A.V. Semenov[1)], S.S. Shimansky[2)], A.N. Skachkova[1)], N.B. Skachkov[1)], A.S. Sorin[3)], E.A. Strokovsky[2)], O.V. Teryaev[3)], V.V. Tokmenin[1)], V.V. Uzhinsky[4)], A.Yu. Verkheev[1)], L.S. Vertogradov[1)], Yu.L. Vertogradova[1)], A.S. Vodopyanov[2)], V.P. Volnykh[1)], N.I. Zhuravlev[1)]

1) Dzhelepov Laboratory of Nuclear Problems (DLNP)
2) Veksler and Baldin Laboratory of High Energy Physics (VBLHEP)
3) Bogolyubov Laboratory of Theoretical Physics (BLTP)
4) Laboratory of Information Technologies (LIT)

Total FTE = 21.7. The average age of the JINR PANDA team is 63.4 years. There are: 1 young scientist preparing PhD, 10 engineers, 18 staff members with PhD degree and 9 professors.

The view of PANDA setup: the Muon System elements (Barrel, End Cap, Filter and Range systems) are indicated in red



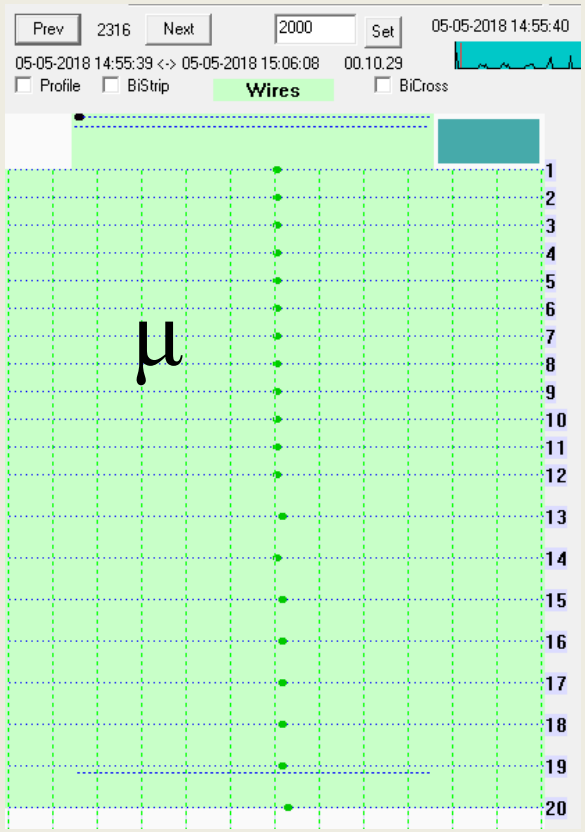
Магнитное ярмо, изготовленное на новосибирском заводе: (а) «бочка», (б) полная сборка с торцевой частью

(а)

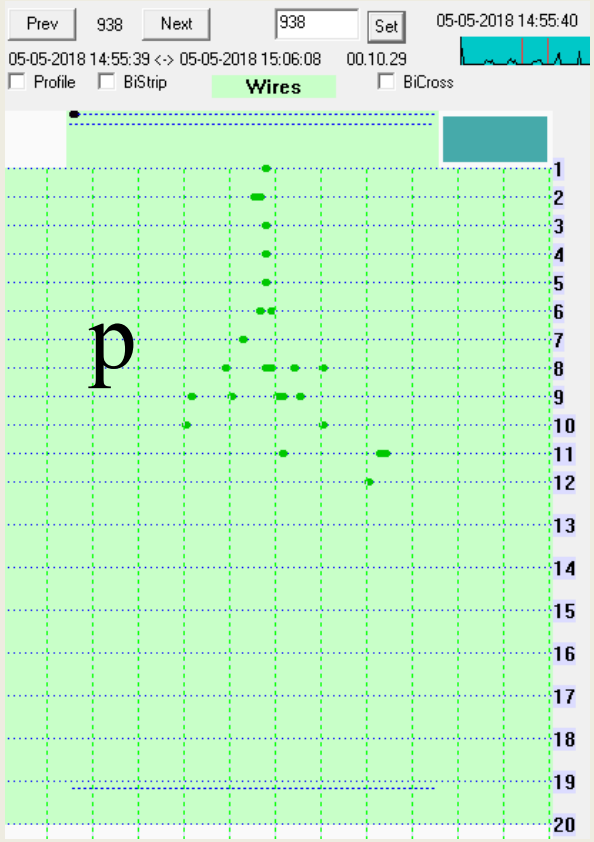
(б)

Event Examples (P = 5 GeV/c)

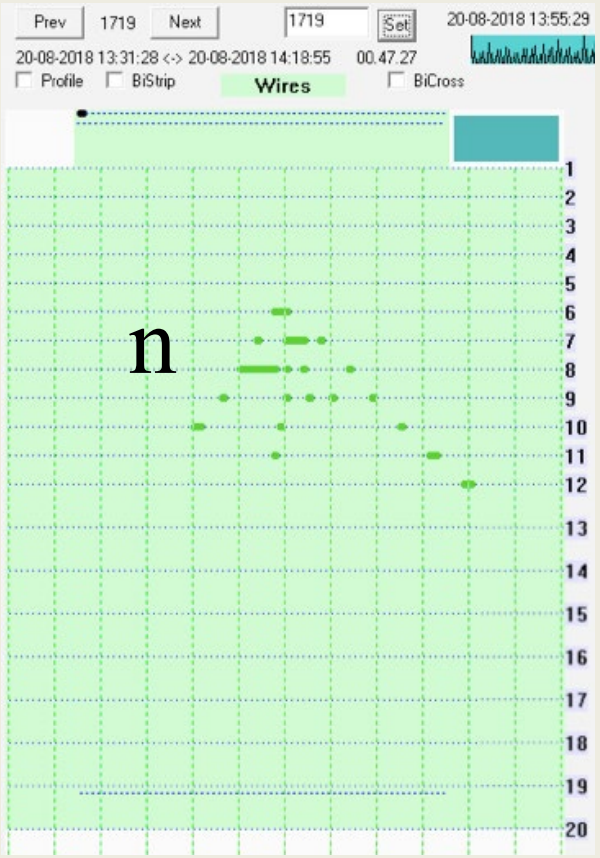
Range System will also be used as a coarse hadron calorimeter – >
very important for neutron registration (the only system in PANDA)!



Run 829



Run 829



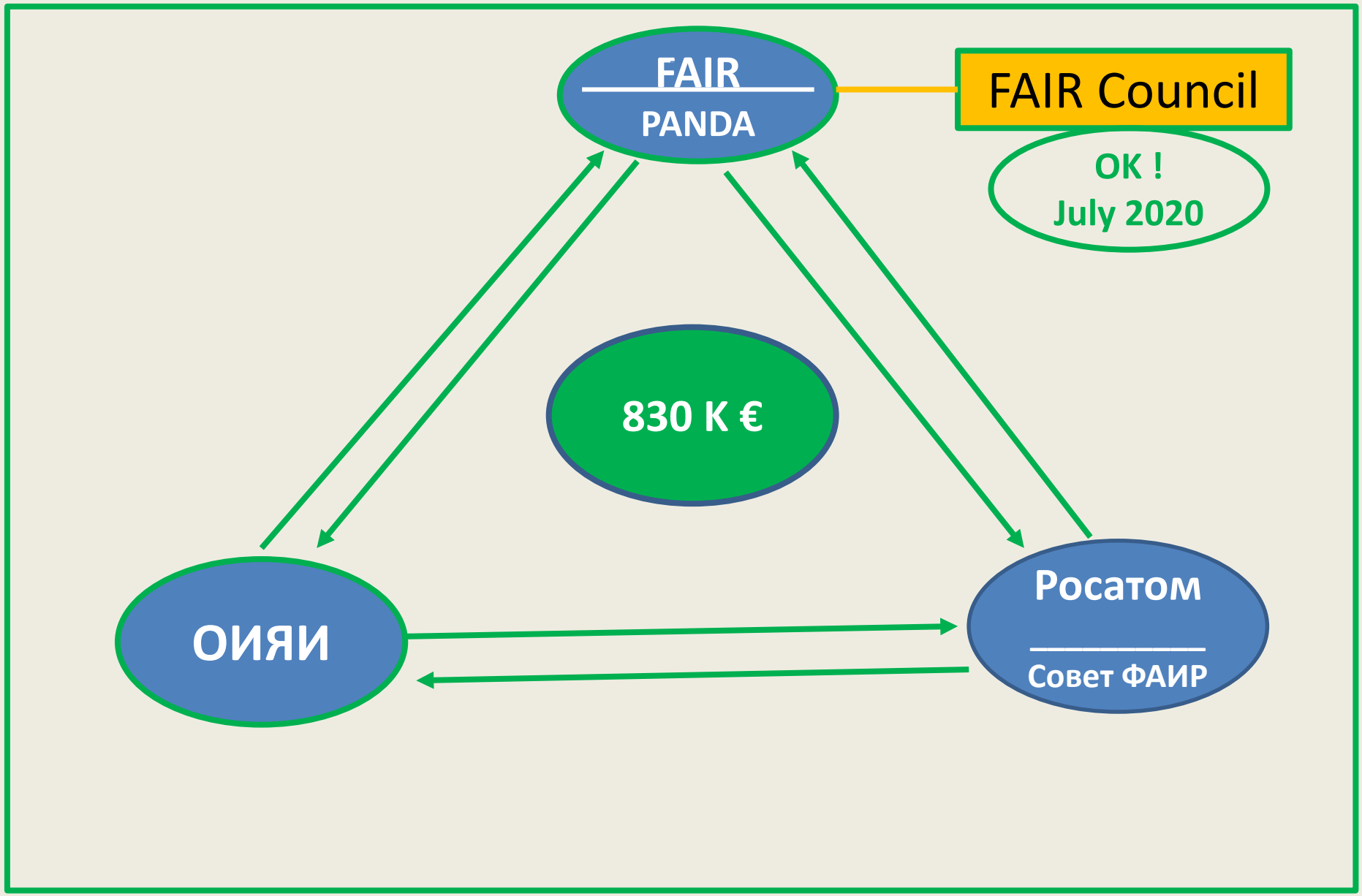
Run 951

Планы на 2022 – 2024 г:

0) Заключение контракта FAIR-ОИЯИ (830 К€) на производство детекторов …….. 2021

1) Подготовка производственного цеха для детекторов МДТ …….. 2021-22
2) Производство детекторов МДТ …… 2022-23
3) НИОКР в области электроники …… ... …….. 2021-22
4) Производство аналоговой электроники …… 2022-23
5) Пучковые испытания прототипа в ЦЕРН …… 2022-24
6) Монтаж мюонной системы (детекторов и электроники) в FAIR …….. 2023-24
7) Разработка программного обеспечения и физической программы .. 2022-24

Статус финансирования проекта PANDA/JINR



Форма № 26

Предлагаемый план-график и необходимые ресурсы для осуществления проекта PANDA

Наименование узлов и систем установки, ресурсов, источников финансирования		Стоимость узлов установки, потребности в ресурсах, тыс. €	Предложения Лабораторий по распределению финансирования и ресурсов, тыс. €		
			1 год	2 год	3 год
Основные узлы и оборудование	Создание детекторов мюонной системы (детекторы МДТ для цилиндрической части Мишенного спектрометра)	830	480	300	50
	НИОКР и командировки	170	40	50	80
	Всего	1000	520	350	130
Источники финансирования	Бюджет ОИЯИ	60			60
	Соглашение BMBF-ОИЯИ	110	40	50	20
	Контракт BMBF-ОИЯИ (по созданию детекторов мюонной системы для цилиндрической части Мишенного спектрометра)	830	480	300	50
	Всего	1000	520	350	130

Форма № 29

Смета затрат по проекту PANDA

№№ пп	Наименование статей затрат	Полная стоимость, тыс. €	1 год	2 год	3 год
1.	Создание мюонной системы	830	480	300	50
2.	НИОКР	50	30	20	
3.	Командировки: - в страны-участницы - в страны-неучастницы	5 115	5 5	 30	 80
	Итого по прямым расходам (тыс. €)	1000	520	350	130

Полный финансовый статус проекта

- Текущее/гарантированное финансирование = 1000 K€
- Возможное/дополнительное финансирование:

  - от ОИЯИ (взнос BMBF) – («долг» за 2018 -19) = 220 K€

  – (план на 2021 -24) = 440 K€

  _____

  = 1660 K€

  - от FAIR (полный контракт с ОИЯИ) = 2650 K€

  _____

  Всего: = 4310 K€

МЕЖДУНАРОДНАЯ МЕЖПРАВИТЕЛЬСТВЕННАЯ ОРГАНИЗАЦИЯ
INTERNATIONAL INTERGOVERNMENTAL ORGANIZATION

ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ
JOINT INSTITUTE FOR NUCLEAR RESEARCH

Дубна Московской области Россия 141980 Dubna Moscow Region Russia 141980
Fax: (7-495) 632-78-80 **Tel.:** (7-49621) 6-50-59 **AT:** 205493 WOLNA RU **E-mail:** post@jinr.ru http://www.jinr.ru

Professor Dr. Paolo Giubellino
Scientific Managing Director of GSI and FAIR

Date 08.06.2020
Ref. № 010-16/206

Dear Dr. Giubellino,

On behalf of JINR I am writing to you to express our readiness to share our long-term experience with GSI in constructing detectors for FAIR.
JINR is prepared to provide GSI with the Muon System of PANDA detector (presently, for the Barrel part) in the framework of the collaboration contract between FAIR and JINR (of the cost book value including an inflation correction coefficient).
This proposal has the following PSP Number: 1.4.1.13.1.1 (Target Spectrometer Barrel Muon Detector Chambers). The cost book value of this item amounts to 591,000.00 € in 2005 costs.
If you require any further information, please feel free to ask.
We look forward to your reply.

Yours sincerely,

Academician Victor Matveev
Director of JINR

The letter of JINR director, confirming the interest of JINR to participate in PANDA/FAIR project and conditions for the production of the starting part of the PANDA Muon System (detectors for the Barrel of the Target Spectrometer). The cost of this part at present (2020), including the inflation factor, equals to 830 K€. This amount is part of the full cost 3,480 M€ (see Appendix II below), and will be deducted from that cost at later stage in framework of the next contract.

МЕЖДУНАРОДНАЯ МЕЖПРАВИТЕЛЬСТВЕННАЯ ОРГАНИЗАЦИЯ
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http://www.jinr.ru

To Research Director of FAIR
Prof. Dr. Günther Rosner

19. 05. 2014 010-27/171

Dear Prof. Rosner,

The Joint Institute for Nuclear Research (JINR, Dubna) is interested to implement its long term experience for the construction detectors of the Facility for Antiproton and Ion Research (FAIR).

Our Institute is ready to provide the Muon System of PANDA detector in framework of Collaboration Contract between our Institute and FAIR GmbH (for the cost-book price including an inflation correction coefficient). This proposal comprises the following PSP Number of the cost-book: 1.4.1.13.

The cost-book value for this item amounts to 2,318,000.00 €.

Kind regards,

Academician V. A. Matveev
Director

The letter of JINR director, confirming the interest of JINR to participate in PANDA/FAIR project and conditions for the production of the full PANDA Muon System. The cost of the Muon System at present (2020), including the inflation factor, equals to 3,480 M€.

SWOT Analysis

	Helpful	Harmful
Internal	**STRENGTHS** • The experience of JINR team in production and running of big muon systems for D0/FNAL and COMPASS/CERN detectors • Possibility to produce all components of the project (MDT detectors, analog and digital electronics, infrastructure elements) mostly at JINR and its Member-States • Serious theoretical support available for further development of PANDA physics program	**WEAKNESSES** • Temporary absence of free space a JINR to deploy the MDTs productior workshop • Tight time-schedule for production i Dubna and assembly of the system at FAIR
External	**OPPORTUNITIES** • Participation in excellent physical program of PANDA/FAIR • Allocation of adequate amount of money by Rosatom/Russia to FAIR budget for constructing the full Muon System • Planned start of PANDA running in 2025	**THREATS** • Absence of signed FAIR-JINR contract on production of the Muor System • Possible further delays with start of PANDA project at FAIR

Backup slides

Смета затрат ($) по теме 02-0-1108-2011/2024

Статья	1891	7667	Германия, пр.309	Всего
1. Заработная плата	195.900			195.900
2. Страховые взносы	59.200			59.200
3. Соцбытфонд	12.700			12.700
4. Международное сотрудничество	25.000		38.500	63.500
а) командирование в страны-участницы			5.500	5.500
б) командирование в страны-неучастницы	23.000		33.000	56.000
в) командирование на территории России	2.000			2.000
5. Материалы			27.500	27.500
6. Оборудование			55.000	55.000
ИТОГО:	292.800		121.000	413.800
КБ	3.900			3.900
ОЭП	22.200			22.200
Административно-хозяйственные расходы	151.800			151.800
ИТОГО без инфр.ОИЯИ	470.700		121.000	591.700
Инфраструктура ОИЯИ	283.400			283.400
ВСЕГО:	754.100		121.000	875.100

Referee report (I.A. Tyapkin)

The FAIR laboratory, now being constructed at Darmstadt, promises very large variety of studies in the field of hadron and nuclear physics. The PANDA experiment will use the unique antiproton beam of High Energy Storage Ring (HESR) with high luminosity and energy homogeneity. The experiment makes emphasis on research of possible exotic states (hybrids, glue-balls, etc.) and structure of nucleons. It is important to point out that PANDA will complement information about nuclear matter features from analyses of heavy ion collisions, which will be obtained in collider experiments MPD and SPD at NICA/JINR, as well as in the fixed target experiment CBM, also at FAIR.

The JINR group is developing several interesting tasks suggested by our scientists for the PANDA physics program: measurement of proton structure functions (quark and gluon distributions) in a new kinematical region, measurement of elastic and deep inelastic antiproton-nuclei processes (tensor glue-balls and effects of nucleon polarized strangeness and others.) It is also worth mentioning the development of Monte-Carlo generators being used in simulation with PANDAroot (improved FTF and DPM models of Geant4 toolkit).

The hardware contribution of JINR group to the PANDA experiment went through serious changes: from participation in R&D works on several technologies to concentration on two very important items (the solenoidal superconducting magnet and the muon system), and finally, the full responsibility for the muon system. Now the JINR group defines totally the design and production of the PANDA muon system. Keeping in mind that the system is based on Mini-Drift Tubes technology developed in JINR and the previous experience of the group in constructing the big muon systems (D0/FNAL and COMPASS/CERN), one may be sure that JINR group will successfully realize the PANDA muon system project.

The R&D results obtained by the group demonstrate high degree of project readiness. The following achievements should be mentioned: direct calibration of the muon system prototype response to muons and hadrons in full PANDA energy range, observation of antiproton and neutron signals, successful test of FPGA-based digital front-end electronics (for data acquisition system).

Very important feature of this project is high degree of synergy between muon systems of PANDA and SPD/NICA. Most of results obtained by the JINR group during execution of PANDA project are fully applicable to the design of SPD.

The requested resources needed to construct the muon system look adequate to the task.
I fully support this project and recommend approving its extension with high priority for the next period.

07.11.2020

I.A. Tyapkin
Doctor of physical and mathematical Sciences, Leading scientist of VBLHEP JINR

Referee report (A.E. Dorokhov)

The Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, builds on the experience and technological developments of the existing GSI laboratory, and provides unique possibilities for a new generation of hadron-, nuclear-, atomic- and plasma physics experiments. The future fixed-target experiment PANDA at FAIR, which features a modern multipurpose detector, offers a broad physics program with an emphasis on various aspects of hadron physics. The antiproton beams of High Energy Storage Ring (HESR) with momenta ranging from 1.5 to 15 GeV/c allow using a wide variety of physics channels. Understanding the strong interaction in the non-perturbative regime remains one of the greatest challenges in contemporary elementary particle physics and, to that end, the hadron beams provide several important advantages. Furthermore, the high-intensity low-energy domain of PANDA experiment will be suitable for Standard Model tests on the high-precision frontier.

Currently, the JINR physicists at PANDA develop a number of important areas. The most urgent of them are related to the detector construction and JINR has commitments on making the Muon System, very important part of PANDA detector.
PANDA Physics Pillars include study of: 1) the nucleon structure and its characteristics GDAs and TDAs, EMFFs; 2) the strangeness physics, such as hyperon production, spectroscopy and decays; 3) the physics of charm and exotics, such as glueballs, hybrids and multiquarks; 4) hadrons in nuclei: color transparency at intermediate energies, short-distance structure of the nuclear medium, influence of the nuclear potential on hadron properties.

Dubna group' studies give significant contribution to the physics program. The results obtained in the simulation of the standard benchmark process of the "muon-antimuon" pair production and its background modeling allowed to work out the requirements and geometric parameters of the proposed muon system of the PANDA detector. Currently, the more in-depth study of the backgrounds for the Drell-Yan process is being conducted to estimate the possibility of studying this process at the PANDA. A complete geometric description/model of the muon system has been accomplished and now it is ready to be implemented in the PANDARoot package. The development and improvement of the FTF model, implemented in Geant4 with cross-checking with experimental data from other experiments, allows to study charmed quark, strange quark-antiquark and diquark-antidiquark pair production, which is especially important for the initial phase of PANDA physics program. This model is also used for modeling and analyzing inelastic and elastic proton-proton interactions with 2, 4, 6 hadrons in the final states with large transverse momentum. In addition, simulation of proton interactions with C, Al, Cu and W nuclei was done using Geant4 FTF model, results of which can be useful in developing the p/bar-nucleus physical program in the energy range of the PANDA experiment. Development of research program of the exotic multiquark states at PANDA is also being carried out. JINR PANDA group as well involved in the preparation of the LoI for the 'Phase-C' of PANDA, which is devoted to the study the high Pt physics during commissioning of the PANDA setup. This list of physical activities of the JINR group complements the experimental achievements of the group on the construction of the PANDA muon system. Finally, let us hope to see the successful start of the PANDA experiment.
I suggest that the Program Advisory Committee should approve the prolongation of the proposed project on JINR group participation in the PANDA experiment for the years 2022-2024.

07.11.2020

A.E. Dorokhov

Doctor of physical and