Annex 1.

Form of opening (renewal) for Theme / Large Research Infrastructure Project

APPROVED

JINR Vice-Director

_____ /_____

"____" _____ 202 г.

THEME PROPOSAL FORM

Opening/renewal of a theme/large research infrastructure project within the Topical plan of JINR

1. General information on the theme / large research infrastructure project (hereinafter LRIP)

1.1. Theme code / LRIP (for extended themes) –

02-0-1085-2009/

1.2. Laboratory

DLNP

1.3. Scientific field

Particle physics

1.4. The title of the Theme / LRIP

Experimental tests of the fundamentals of QCD

1.5. Theme / LRIP Leader(s)

A. Guskov

1.6. Theme / LRIP Deputy Leader(s)

A. Zhemchugov

2. Scientific case and theme organization

2.1. Annotation

The theme brings together efforts to comprehensively test the fundamentals of QCD in the AMBER experiment at CERN (precision measurement of proton radius, pion and kaon structure studies, kaon spectroscopy, study of pion and kaon interactions at low energies, obtaining auxiliary results for dark matter search in astrophysical experiments) and the BESIII experiment, Beijing, IHEP (light hadron and ordinary and exotic charmonium spectroscopy, mechanisms of charmed

hadrons production). The topic also includes several activities: COMPASS, CERN (study of proton spin structure, hadron interactions, hadron spectroscopy), PANDA, GSI (hadron structure and hadron spectroscopy with antiproton beam); ANKE, COSY (spin-dependent proton-proton interactions at low energies) and ARIEL (checking fundamental interactions at future electron-positron colliders).

2.2. Projects in the Theme / LRIP subprojects

AMBER (NA66)
BESIII

2.3. Scientific case (no more than 20 pages)
Quantum chromodynamics is a true theory of strong interaction. However, despite its considerable success in describing the interaction of quarks and gluons within the perturbative approach, the question of why hadrons and nuclei are as we see them remains open. Description on the basis of basic principles of QCD of fundamental properties of hadrons, such as their masses, spins, parton distributions, form factors, spectra, etc., is one of the main unsolved problems of quantum chromodynamics. Confinement of quarks and gluons in hadrons, as well as the growth of the running constant of the strong interaction with a decrease of the characteristic scale of interaction energy does not allow direct use of the perturbative approach, which has proved itself at high energies. At present, various phenomenological models are used to quantitatively describe the hadron spectrum, their static properties, and their interactions at low energies. Certain successes have been achieved in lattice calculations. A comparison of model predictions and theoretical calculations for observables with measurement results is an important test of the consistency and applicability limits of the approaches used. The ultimate goal of research in this direction, both theoretical and experimental, is to obtain a description of the spectra, structure, and properties of hadrons from the first principles of QCD.

AMBER (Apparatus for Meson and Baryon Experimental Research) is a new experimental facility with a fixed target on the M2 beam line of CERN SPS. The facility is designed to perform a variety of measurements aimed at addressing fundamental questions of quantum chromodynamics, which are expected to lead to a significant improvement in the understanding of QCD as a modern theory of strong interactions. The proposed measurements cover physics ranging from the smallest Q2 values, such as determining the charge radius of a proton in elastic muon-proton scattering, reactions with mean Q2 values for hadronic spectroscopy, and z studies of hadronic structure with high Q2 using rigid Drell-Yan, Charmonium, and fast photon production processes. The JINR group is responsible for the modernization and operation of the HCAL1 hadron calorimeter and the MW1 (Muon Wall 1) high angle muon identification system. It is also involved, along with a group from the University of Turin, in the production and support of the Bulk Micromegas track detectors that will replace the obsolete multi-wire chambers (MWPCs) in the SAS behind the SM2 magnet.

The goals of the JINR group in the BESIII project are to study hadronic QCD spectra and search for exotic states, study the birth and decays of Charmonium states, search for exotic Charmonium states and Charmonium-like structures, and determine c-quark fragmentation functions. The JINR group's participation in the project consists of data analysis and development of algorithms for event reconstruction in the BESIII detector using machine learning methods.

The following activities are being implemented as part of the theme:

- analysis of data from the COMPASS and ANKE experiments which have completed the data acquisition stage;
- preparing a muon system for the PANDA experiment;
- development of the physical program for the future electron-positron colliders (CSTF, CERC)

The 1085 theme and the NICA SPD project (theme 1065) are mutually complementary, both in terms of physical program and experimental equipment development, and in terms of young staff training.

2.4. Participating JINR laboratories

DLNP, BVLHEP, LIT

2.5. Participating countries, scientific and educational organisations:

Organisation	Country	City	Participants	Type of agreement
Albert Ludwigs Universitaet	**Germany**	Freiburg	**H. FISCHER +3**	**MoU**
Czech Technical University in Prague	Czechia	Prague	J. NOVY +11	MoU
Charles University	Czechia	Prague	J. MATOUSEK+5	MoU
University of Bonn	Germany	Bonn	B. KETZER +10	MoU
Institute for High Energy Physics	Russia	Protvino	S. DONSKOV +1	MoU
Institute of Experimental Physics	Poland	Warsaw	B. BADELEK	MoU
Laboratorio de Instrumentação e Física Experimental de Partículas	Portugal	Lisbon	C. QUINTANS+2	MoU
Los Alamos National Laboratory	USA	Los Alamos	L. BAUDINO	MoU
NRC Kurchatov Institute PNPI	Russia	Gatchina	A. DZUBA +5	MoU
National Centre for Nuclear Research	Poland	Warsaw	A. SANDACZ +1	MoU
Lebedev Institute of Physics	Russia	Moscow	M. ZAVERTYAEV +1	MoU
School of Physics and Astronomy	UK	Glazgow	B. SEITZ +1	MoU
Technische Universitaet Muenchen	Germany	Munchen	S. PAUL +7	MoU
Tel Aviv University	Israel	Tel Aviv	J. LICHTENSTADT	MoU
Trento Institute for Fundamental Physics and Applications	Italy	Trento	P. ZUCCON + 3	MoU
Universita e INFN Torino	Italy	Turin	D. PANZIERI +3	MoU
Universita e INFN Trieste	Italy	Trieste	A. MARTIN +4	MoU
University of Aviero	Portugal	Aviero	C. AZEVEDO +1	MoU
Yamagata University	Japan	Yamagata	J. HIRUMA	MoU
Warsaw University of Technology	Poland	Warsaw	R. KURJATA	MoU
BESIII collaboration	China, USA, Germany, Italy, Russia, Netherlands,	Beijing	IHEP CAS (the host institution)*	MoU

	Sweden, Korea, Japan, India, Pakistan			

*****The full list of participating institutes is available at the BESIII Collaboration webpage bes3.ihep.ac.cn.

2.6. Key partners *(those collaborators whose financial, infrastructural participation is substantial for the implementation of the research program on the theme. Example – JINR participation in the LHC experiments at CERN).*

CERN, IHEP CAS

3. Manpower
3.1. Manpower needs in the first year of implementation

No.	Personnel category	JINR staff, FTE amount	JINR associated personnel, FTE amount
1.	research scientists	**21.7**	**0.3**
2.	engineers	**3.6**	
3.	specialists	**2.2**	
	Total:	**27.5**	**0.3**

3.2. Available manpower
3.2.1. JINR staff (total number of participants)

No.	Personnel category	Division	Position	Amount FTE
1.	research scientists	DLNP +VBLHEP		21.7
2.	engineers	DLNP		3.6
3.	specialists	DLNP+ LIT		2,2
	Total:			27,5

3.2.2. JINR associated personnel

No.	Personnel category	Partner organization	Amount of FTE
1.	research scientists		
2.	engineers		
	Total:		

4. Financing
4.1. Total estimated cost of the theme / LRIP

No.	Items of expenditure	Cost	Expenditure per year (thousands of the US dollars)				
			1st year	2nd year	3rd year...	4th year...	5th year...
1.	International cooperation	450	125	155	120	25	25
2.	Materials	100	35	35	30		
3.	Equipment, Third-party company services	280	100	100	60	10	10
4.	Commissioning						
5.	R&D contracts with other research organizations						
6.	Software purchasing						
7.	Design/construction						
8.	Service costs (*planned in case of direct affiliation)*						
TOTAL:		830	260	290	210	35	35

4.2. Extra funding sources

Expected extra funding from partners/customers (total for all projects).

AGREED:

Chief Scientific Secretary
_____/_____/
"_____"_____ **202_г.**

Head of BEPD
_____/_____/
"_____"_____**202_г.**

Head of DSOA
_____/_____/
"_____"_____ **202_ г.**

Head of HRRMD
_____/_____/
"_____"_____ **202_г.**

Laboratory Director
_____/_____/
"_____"_____**202_г.**

Scientific Secretary of the Laboratory
_____/_____/
"_____"_____ **202_г.**

Laboratory Economist
_____/_____/
"_____"_____**202_г.**

Theme leader
_____/_____/
"_____"_____ **202_г.**

Project leader (project code) / (LRIP subproject code)
_____/_____/
“_____“_____**202_г.**

Project leader (project code) / (LRIP subproject code)
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