**Enclosure 1** **List of topics for FRRC fellowship applications**

1. High intensity heavy ion and hadron synchrotrons . Investigation of space charge effects, dynamic vacuum, limiting beam intensities.
2. Investigation of heavy ion beam losses and radiation hardness and life-time of the accelerator ring elements.
3. Optimization of the accelerator lattice.
4. Investigation of beam dynamics, optimal working points, necessary correction and corrector elements.
5. Researches of RF acceleration and bunch compression regime.
6. Investigation of heavy ion beam extraction from synchrotrons: efficiency, reliability, optimal schemes.
7. Storage rings and colliding beams. Electron-Ion Collider - investigation of nonlinear effects, final focus, beam-beam interaction and detector background. AIC –Antiproton-Ion Collider - investigation of final focus, beam-beam interaction, minimal of EIC ring reconstruction for AIC mode operation. Polarized proton-antiproton colliding beams in HESR. - investigation of antiproton polarization, polarized proton acceleration at SIS18, Siberian snakes for polarization control
8. Investigation of heavy ion beam cooling (problems of electron and stochastic methods). Electron cooling for NESR, AIC, HESR.
9. Research & Development of superconducting magnet technology: fast-ramped, fast-cycling magnets for the magnetic field range of 1.5 – 4.5 T and the field ramp from 4 to 1 T/s. Research & Development of specific magnets for SIS100, SIS300, SSFRS (superconducting dipole and quadrupole magnets and septum-magnet with magnetic field up to 30 T).
10. Magnet design: including optimization of 2D and 3D geometries, mechanical and thermal calculations, cryogenic calculations etc.
11. Research & Development of superconducting cables and helium cooling schemes, heat load and heat transfer
12. R&D of theoretical basis for experiments in atomic physics, nuclear structure-, heavy ion-, nuclear astrophysics, hadron physics and accelerator physics in FAIR international collaborations.
    1. Physics of quark-gluon plasma;
    2. Physics of high-energy density in matter;
    3. Ion and laser beam interaction with matter;
    4. Beam and accelerator physics;
    5. Specific structure of the drip-line nuclei;
    6. Mechanisms of nuclear reactions with the drip-line nuclei;
    7. Scattering of electrons on the exotic nuclei;
    8. The equation of state for an asymmetric nuclear matter;
    9. Exotic nuclei, astrophysics and nuclear synthesis in the Universe;
    10. Prerequisites for tests of fundamental theories and determination of fundamental constants, nuclear magnetic moments, and nuclear charge raddii at the FAIR facilities.
    11. Study of relativistic quantum dynamics in strong fields, kinetics of stopping, charge exchange and excitation of fast highly charged ions in matter for the FAIR experiments.
    12. Study of radiative properties of multicharged ions in storage rings and dense matter for FAIR facilities: anomalious radiative recombination and radiative cascades, coherent polarization radiation.
    13. Glueball spectrum and search for other exotic states.
    14. Spectroscopy of charmonium, new heavy-light mesons, and heavy barions.
    15. Physics of hypernuclei and charmnuclei.
13. New generation of installations and detectors for experiments in atomic physics, nuclear structure-, heavy ion-, nuclear astrophysics and hadron physics in international collaborations at FAIR.

13.1.1. Development of CBM detector concept. Preparation and writing of the technical design report (TDR)

13.1.2. Work on prototype of CBM subdetectors, read-out electronics and DAQ.

13.1.3. Development of CBM subdetectors concept. Preparing technical documentation.

13.1.4. Manufacturing of subdetectors and read-out electronics. Creation of the mass production quality control system. Commissioning of subsystems in CBM detector.

13.1.5. Development and manufacturing of superconducting dipole magnet for CBM detector.

13.2.1. Research and development of electromagnetic calorimeters for PANDA (PWO, Shashlyk and avalanche photodiods of large area);

13.2.2. Research and development of tracking and particle identification detectors for PANDA (muon system, quartz radiators, solenoid, time-of –flight system, silicon pixel vertex detector)

13.2.3. Optimization of PANDA sub-detectors using MC simulation

13.2.4. Research and development of Pellet Target for PANDA

13.3.1. Development of NUSTAR physics program (projects: R3B, EXL, ELISe, AIC, ILIMA and MATS), detailed modeling of the chosen experiments, an estimation of experimental opportunities of setup, possible changes in the experimental installation.

13.3.2. Research and development of Super FRS scientific and technical details.

13.3.3. Electron spectrometer for the e-A collider.

13.3.4. R&D and manufacturing of coordinate detector systems (silicon micro-strip detectors with the large area; parallel-plate avalanche chambers; resistive-plate chambers for the neutron detectors; vertical drifts chambers; detector systems on the basis of straw-tubes).

13.3.5. R&D and manufacturing of details for scintillation detector systems (blocks of scintillators for γ-spectrometers on the basis of CsI (Tl), BaF2 and PbWO4 crystals; larger-area avalanche photo diodes for reading the information from scintillators; the mechanical systems fixing components of the γ- spectrometers; systems for the temperature stabilization of γ – spectrometers).

13.4. Research, development and design of FLAIR/SPARC experimental area (Low-energy Storage Ring (LSR), Ultralow energy Storage Ring (USR), Positron Cooler Storage Ring (PCSR) and the ion trap facility (HITRAP))

1. High-energy density in matter with highly compressed heavy-ion beam bunches in unique combination with powerful lasers
   1. Research, development, design and manufacturing of beam line details for plasma physics experiments;
   2. Research and development of novel diagnostic methods for measuring the basic physical parameters of the HED matter under the specific conditions of ion-beam heating.
   3. Development, design and manufacturing of the rf-beam rotator (wobbler) for the LAPLAS experiment;
   4. Research, development and construction of the ion/proton radiography system for high-energy density in matter experiments;
   5. Design and construction of vacuum target chambers for High-energy density in matter experiments;
   6. Design and construction of the cryogenic target preparation setup for the plasma physic experiments;
2. Development of software packages for simulation, reconstruction and data analysis for FAIR accelerators and experimental collaborations (EC).
3. Support and development computing resources of Russian institutes participated in FAIR EC. Participation in the development of GRID for FAIR EC purposes;
4. Radiation safety aspects at FAIR.
   1. Characterization of radiation from selected components of the beam line of FAIR accelerators: production rates of radioactive nuclides;
   2. Long time prediction of radioactive inventory around the critical points of beam transport system;
   3. Characterization of the hazard from secondary neutrons for intense heavy ion beam facilities;
   4. Optimization of radiation shielding and design of radioactivity monitoring systems for FAIR accelerators and experimental collaborations.
5. Technical developments and applied research with ion beams for materials science, medicine and biology.