Veksler and Baldin Laboratory of High Energy Physics

- Staff totals ~ 900 employees
- From 11 Member States
- Territory ~ 1 km^2
JINR LHEP Scientific Links

**FNAL**

- JT exps.
- $\pi$-e, K-e
- elast. scat.

**LHEP**

- ALICE
- ATLAS
- CMS
- NA48, NA62
- NA61
- COMPASS
- LHC
- DAMPER

**STAR**

**BROOKHAVEN NATIONAL LABORATORY**

**CBM, HADES**

**PANDA, SIS100**

**FAIR GSI**

**DESY**

**H1**

**HERMES**

*Termalization Accelerator research*

A.Vodopyanov
$p+p@14\text{ TeV}$

$Pb+Pb@5.5A\text{ TeV}$
размер: 16 x 26 метров
вес: 10,000 тонн
ALICE
Study of interaction of heavy ion and proton beams at LHC

Contribution:
- Very large dipole magnet
- Drift chambers for Transition Radiation Detector;
- PWO crystals for Photon Spectrometer;

Physics tasks:
- Vector mesons;
- Heavy quarkonia;
- Particle correlations;

Computing:
ALICE-Russia GRID development.

**Nuclear-modification factors** in Pb-Pb ($R_{\text{PbPb}}$) at ($s_{NN}^{1/2}$) = 2.76 TeV and in p-Pb ($R_{\text{pPb}}$) at ($s_{NN}^{1/2}$) = 5.02 TeV (one of the first ALICE p-Pb results) (B.Abelev et al., arXiv:1210.4520, 2012)
Largest dipole magnet (850 ton, 9×7×4.5 м) and particle detectors
**ATLAS detector**

- **Diameter**: 25 m
- **Barrel toroid length**: 26 m
- **End-cap end-wall chamber span**: 46 m
- **Overall weight**: 7000 Tons
JINR contribution to ATLAS

Transition Radiation Tracker based on straw tubes assembly

Barrel Tile Calorimeter; LqAr Hadronic End-Cap Cal. Muon Chambers
Detector subsystems are designed to measure: the energy and momentum of photons, electrons, muons, jets, missing $E_T$ up to a few TeV.

- **Muon Chambers**
- **Tracker**
- **Electromagnetic calorimeter, ECAL**
- **Hadron calorimeter, HCAL**

- **Forward Calorimeter, HF**

- **Superconducting Coil**
  - Diameter: 6 m, Length: 13 m

- **Return Yoke**
  - Weight: 14500 t
  - Diameter: 14,60 m
  - Length: 21,60 m
  - B-field: 4 T

The Compact Muon Solenoid (CMS) detector subsystems are designed to measure the energy and momentum of photons, electrons, muons, jets, and missing $E_T$ up to a few TeV.
JINR participates in the CMS in a framework of the RDMS CMS Collaboration.

RDMS bears Full Responsibility.

JINR Participates

CMS
Compact Solenoidal Detector for LHC

ME1/

HE

Total weight: 12,500t
Overall diameter: 15.00m
Overall length: 21.60m
Magnetic field: 4 Tesla
Contribution: muon station ME1/1, endcap hadron calorimeter
Computing:
  Tier-2, and Remote Operation Centre in JINR

Participation in the physics analysis:
- Study of Drell-Yan processes in the large invariant dimuons mass region;
- Search for Higgs boson (4-leptons channel, and 2l-2\nu channel)
- Search for new physics beyond the Standard Model (Extended Gauge models, Extra dimensions, Black Holes, etc.)
  - Z' with standard-model-like couplings can be excluded below 2960 GeV and the superstring-inspired Z' below 2600 GeV
  - Set limits on the minimum Black Holes mass of 4.1-6.1 TeV
ALICE: Photon Spectrometer (PHOS) upgrade
The purpose of PHOS modernization is increasing the Time of Flight resolution for Improvement of photon identification. It is necessary for measurement of direct photons production.

CMS: muon detector ME1/1 and endcup hadron calorimeter upgrade
The purpose of ME1/1 modernization:
- to recover trigger up to eta=2.4;
- to minimize dead time, to remove rate worries, to guarantee readout robustness.
The purpose of hadron calorimeter modernization:
- to increase dynamic range, rate capability, to provide better timing information – resolution of ~2ns instead of 25 ns, improve muon ID;
- to update longitudinal segmentation to increase Particle Flow capability and optimize ECAL/HCAL interface.

ATLAS: participation in upgrade of the superconducting magnet system, Muon spectrometer, Scintillating TILE calorimeter, Liquid argon hadron calorimeter, and in Irradiation tests at the IBR-2m pulsed fast neutron reactor.
**NA48/2 and NA62**

**Study of the rare charged kaon decays at SPS**

**Contribution to NA48/2:**
Participation in Liquid Krypton calorimeter production (used also for NA62), on-line monitoring system elaboration. Data taking, processing, simulation, final analysis for $K^{\pm}\rightarrow \pi^{\pm}\pi^{0}\pi^{0}$, $\pi^{\pm}\pi^{\mp}\pi^{0}$, $\pi^{\pm}/l^{\pm}/l^{\mp}\nu$ decays.

**Main results:**
- Set of the limits on CP violation in $3\pi$ decays,
- Cusp effect 1st observation in $m(\pi^{0}\pi^{0})$ spectrum of $3\pi$ decay,
- Precise $\pi\pi$ scattering lengths ($a^{0}$ and $a^{2}$) measurement,
- Precise $\pi^{\pm}/l^{\pm}$/ Br and Form Factors measurement,
- Precise $(e^{\pm}/\nu)/(\mu^{\pm}/\nu)$ ratio measurement.

**Contribution & Responsibility at NA62:**
Desing, R&D and production of the Straw tracker able to work in vacuum.

**Status of the work:**
- Design of the module (R&D are completed).
- Straws production: 4000 tubes are made and tested,
- Module 1: assembled in CERN and tested on beam,
- Module 3: assembled in JINR, tests are in progress,
- Elaboration of the straw database to trace each straw quality & position.

Straws under pressure test
Tracker module assembled in JINR

Electronics assembled on module
COMPASS: studies of the nucleon and hadron structure at SPS CERN

Contribution: Hadron calorimeter HCAL1, Straw tube detector (production), Drift tube detector “Muon wall 1”, support of the polarized target, engineering support of the experiment

Main achieved results:
1. The most precise measurement of the gluon polarization;
2. Extraction of the quark $\Delta u$, $\Delta d$, $\Delta s$ and antiquark helicity distributions;
3. Test and confirmation of the Bjorken sum rule;
4. Study of the transverse spin effect in the nucleon (Collins & Sivers asymmetries);
5. Study of the Primakoff effects.

COMPASS current programme:
1. Measurement of Drell-Yann with $\pi$ beam and polarized proton target
2. Measurement of GPD with help of the DVCS process

JINR responsibility in COMPASS upgrade: Electromagnetic calorimeter ECAL0
Contribution: TOF, data analysis

- Fixed target experiment in the north area of the CERN SPS
- Based on the upgraded NA49 detector
- Started in 2007
- Beams:
  - ions (Be - fragmentation, Ar and Xe - primary) at 13A - 158A GeV/c
  - Hadrons: p at 13 - 158 GeV, \( \pi \) at 158 and 350 GeV/c, K at 158 GeV/c

**NA61/SHINE**

Hadron production in p+p, p+A, h+A, A+A
Collaboration of JINR-CERN for CLIC and next e+e- colliders.

2. Test of RF cavities for CLIC accelerating structures in Dubna. Development of dedicated facility at JINR or serial tests.
3. Stabilization of the laser source at $10^{-8}$ rad for precision laser metrology and high-precision laser metrology to control the position of accelerating sections at complexes of future lepton linear colliders.

Collaboration in the project UA-9 Crystals for High Energy Accelerators

- The experiments performed at JINR, CERN and BNL showed that multicharged ions are successfully deflected by bent crystal.
- Collimation efficiency of 90% have been demonstrated at SPS lead beam
- Electromagnetic dissociation (ED) for well channeled Pb-ions in Si crystal at 7 TeV is estimated to about 0.01%

LHC Damper (CERN – JINR)

Stabilization of high intensity beams against transverse instabilities.
LHC Transverse Feedback System was done with strong participation of JINR team
Hadron - and Heavy Ion Physics Projects related to FAIR within the BMBF-JINR Cooperation

The fruitfull cooperation in the fields:

- Magnet development for SIS100;
- Detector development for FAIR experiments;

Experiments:

- CBM (experiment w/ proton & heavy ion beams);
- PANDA (experiments w/ antiproton beam)

Contribution under discussion (to be funded by Rusia):

- CBM – superconducting dipole magnet;
- PANDA – superconducting split coil solenoid + muon system;
THANK YOU FOR YOUR ATTENTION