Recommendations of the Programme Advisory Committees

PAC for Nuclear Physics

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Programme
of *32nd meeting PAC NP*
(17–18 June 2010)

- Applied research and innovative activities at JINR
  A. Olshevskiy
- Report on the theme to be completed in 2010 “Nuclear Physics with Neutrons — Fundamental and Applied Investigations” V. Shvetsov
- New theme:“Investigations in the Field of Nuclear Physics with Neutrons ”- V. Shvetsov
- Nucleon-nucleon interactions at intermediate energies with formation of $^1S_0$ diproton final states (project SPRING)- A. Kulikov

(Continuation)

- Proposal of a new project: “Investigation of the interaction of polarized muons with matter (MUON)”

  V. Duginov

- New set-ups of FLNR proposed in the seven-year plan for 2010–2016

  -Fragment separator ACCULINNA-2

  A. Fomichev

  -Universal gas-filled separator for studies of heavy nuclei

  A. Popeko

  Scientific report “Multimodal nuclear fission”

  V. Pashkevich

  Poster presentations of new results and proposals by young scientists

JINR Policy for Innovation Activities

The goal - increase efficiency of JINR cooperation with member states in the field of innovations and technology transfer through the concentration on realization of competitive technologies and expertise

- **Technology standard presentation**
- **Focusing on advanced technologies most important for industry and society development**
- **Providing services on the basis of high technology equipment**
- **Providing information about the applied research activities**

Applied Research and Innovation Activities

(A. Olshevskiy)

- Wide program of applied research complements the fundamental investigations performed at JINR
- The innovation policy of JINR is based on the use of its unique technology offers, services and R&D opportunities
- Partnership in innovation activities should be extended especially taking into account requests of JINR Member States

R E C O M M E N D A T I O N

Applied research and innovative activities at JINR

The PAC heard the report of A. Olshevskiy.

It emphasizes the considerable importance and impact of this area of JINR work and highly appreciates JINR's experience and potential in a wide range of applied fields. The PAC considers that such kind of activities should continue and their possible development and extension arising from the basic research should be followed.

Completation of the theme "Nuclear Physics with Neutrons Fundamental and Applied Investigations"and new theme "Investigations in the Field of Nuclear Physics with Neutrons" (V. Shvetsov)

The PAC appreciates the results obtained within the framework of the theme "Nuclear Physics with Neutrons — Fundamental and Applied Investigations", in particular experiments on neutron optics,asymmetry of α particles and γ-quanta emission in neutron capture by light nuclei, the start-up of Phase 1 of the IREN facility and first experiments with it.

Published results

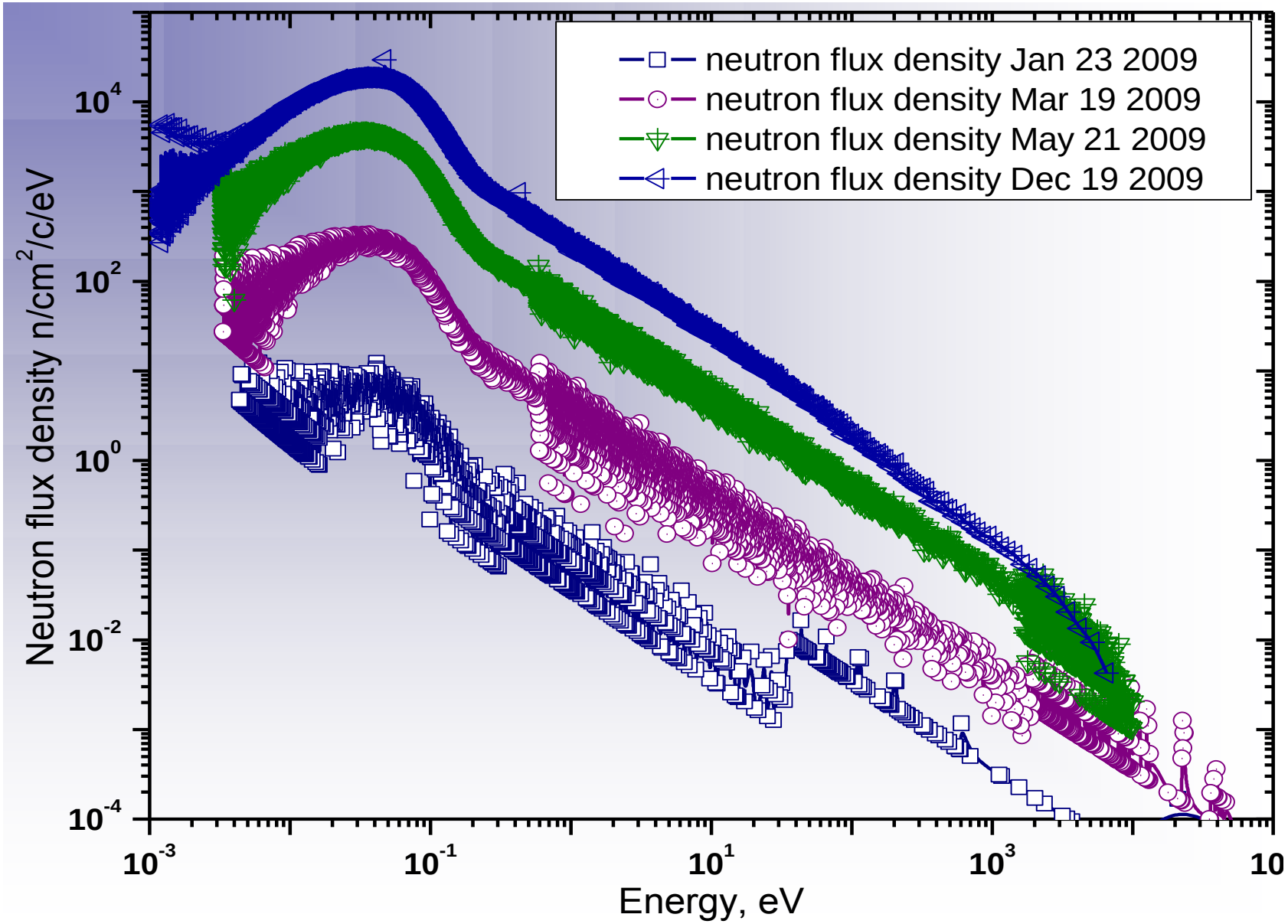
During the years 2008 -2009 were published more than 300 papers, 100 of those papers were published in peer-reviewed scientific journals

IREN Parameters by the End of 2009

- **Energy of the accelerated electrons – 30 MeV;**
- **Peak current – 3 A;**
- **Pulse width – 100 ns;**
- **Repetition rate – 25-50 Hz;**
- **Beam power – up to 400 W;**
- **Target – nonmultiplying W;**
- **Integral neutron yield – about 10^{11} n/s**

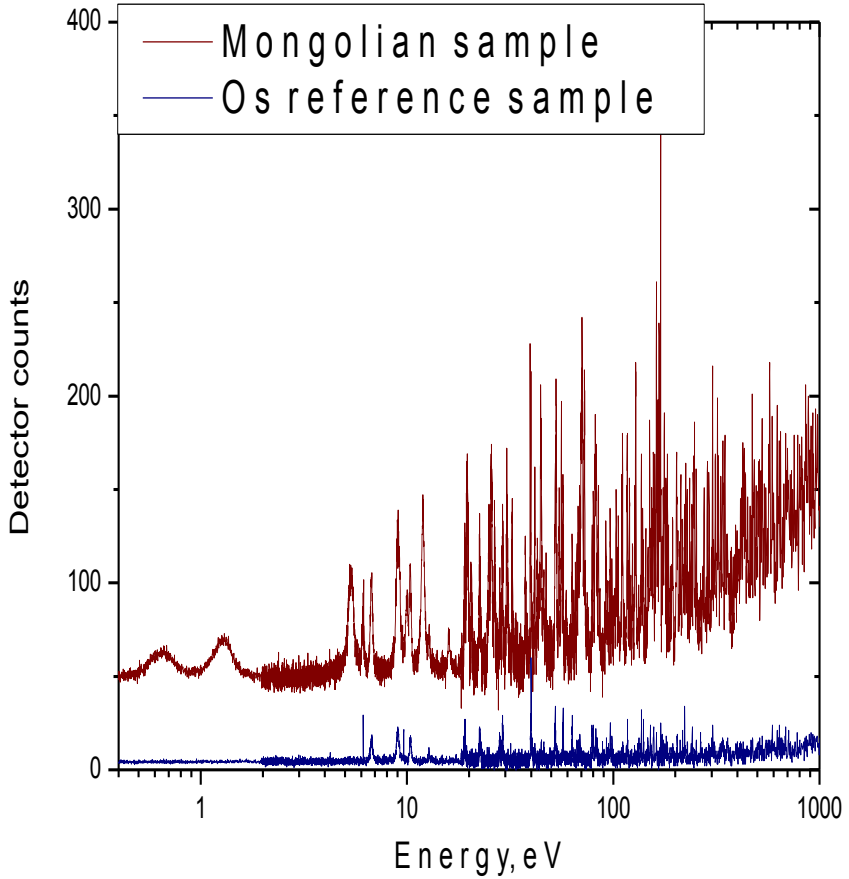
Operation of IREN beam time 470 hrs on the first experiments

Neutron Flux Density Measured at 10m Flight Path



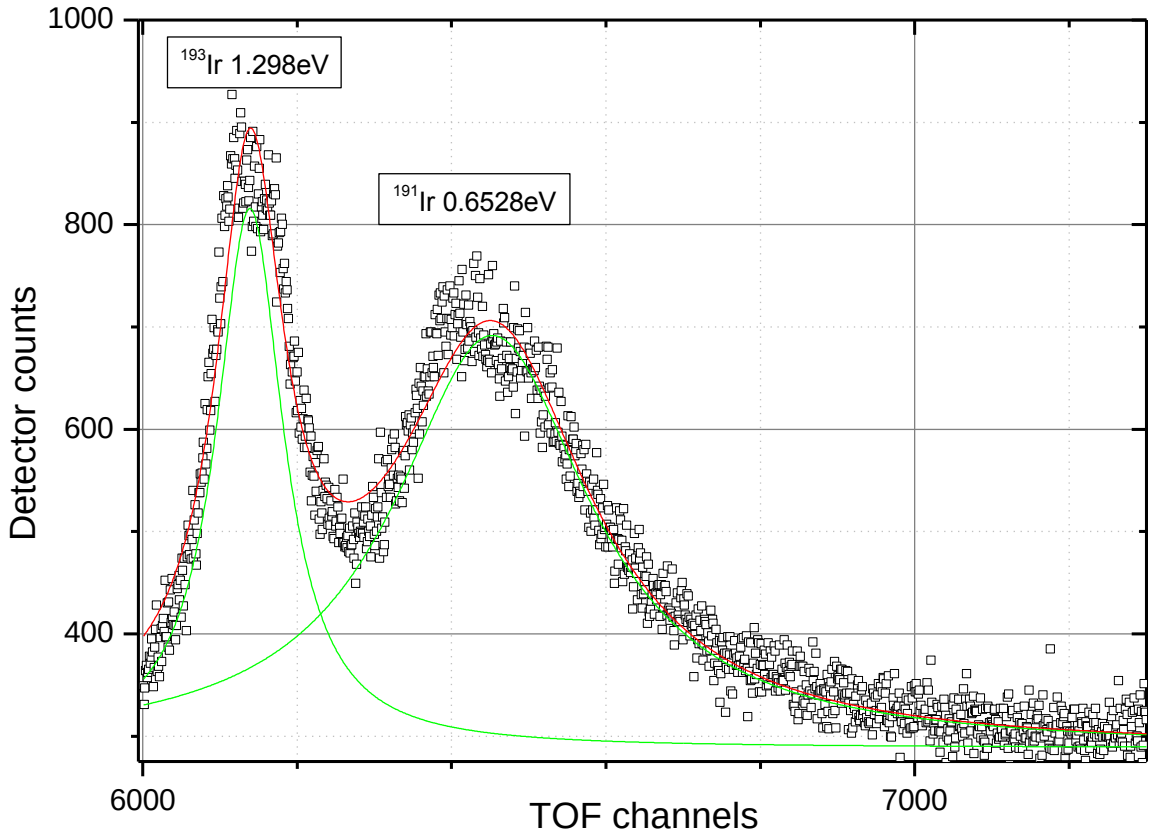
Neutron Resonance Capture Analysis

Liquid scintillator detector
Six 35 L sections
Electronics which is able to work at different multiplicities of gamma quanta 60 m flight path



Experimental TOF -> energy spectra registered from Mongolian and Os reference samples

Neutron Resonance Capture Analysis



From experimental TOF spectra we can obtain the area of the resonance in the reference sample and sample under investigation, then from ratio $(A^{ref}/\Delta)_{calc}/(A^{ref}/\Delta)_{exp} = (A^{sample}/\Delta)_{calc}/(A^{sample}/\Delta)_{exp}$ we can obtain $(A^{sample}/\Delta)_{calc}$

New theme: ”Investigations in the Field of Nuclear Physics with Neutrons”

Implementation stages

- Development and modernization of the IREN facility;
- Investigations of the neutron induced nuclear reactions;
- Investigations of the fundamental properties of the neutron, UCN physics;
- Applied and methodical research;

New theme: ”Investigations in the Field of Nuclear Physics with Neutrons”

Development and modernization of the IREN facility

Upgrade of the IREN systems, increasing beam power/neutron yield;

Providing stable operation for the experiment;

Investigations of the neutron induced nuclear reactions

- Nuclear fission;
- Nuclear structure;
- Properties of the neutron resonances;
- Nuclear data

  - Construction materials for fission/fusion reactors;
    - Nuclear waste management;
    - Astrophysics

Recommendation

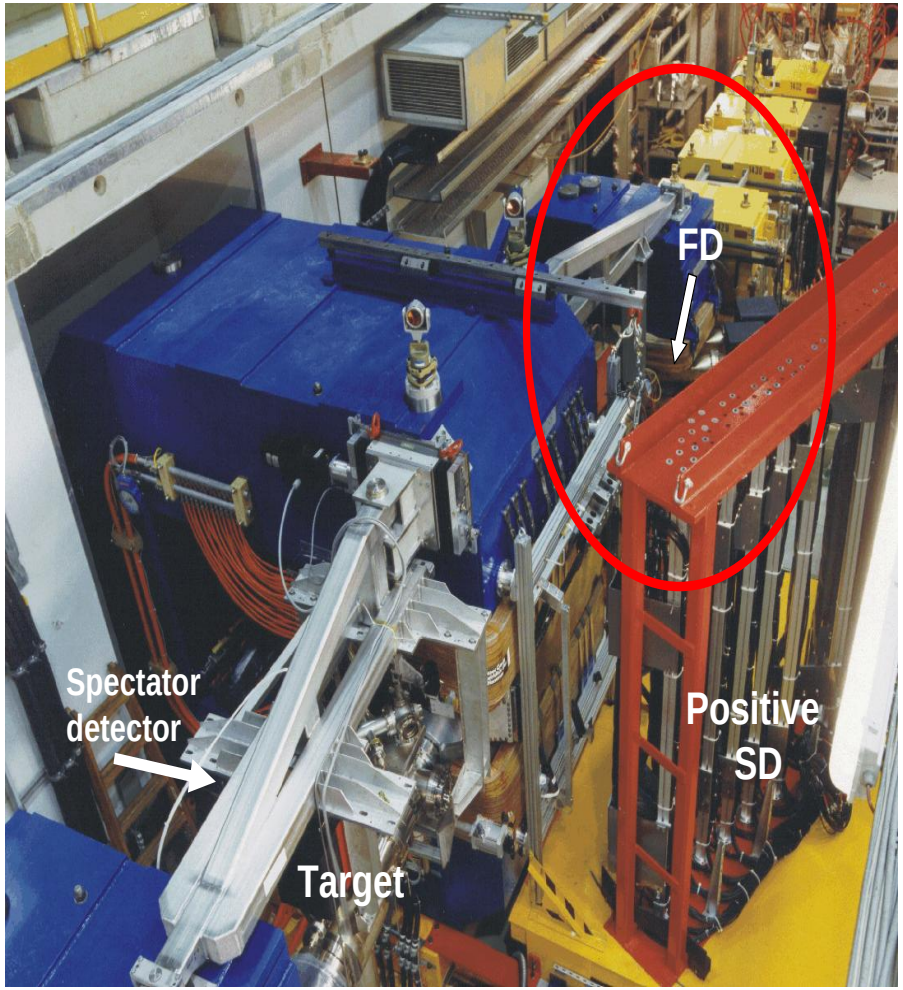
The PAC recommends completion of the theme “Nuclear Physics with Neutrons — Fundamental and Applied Investigations” by the end of 2010.

The PAC supports continuation of the FLNP research programme in neutron nuclear physics under a new theme “Investigations in the Field of Nuclear Physics with Neutrons” during 2011–2013 with first priority.

The upgrade of IREN should be accelerated in order to rapidly reach the project intensity of 10^{14} n/s. The improvement of the experimental base at the IREN and IBR-2M facilities is strongly supported. The development of the programme for nuclear data measurements for innovative reactor technologies in the IREN facility is also recommended.

Project SPRING
(A. Kulikov)

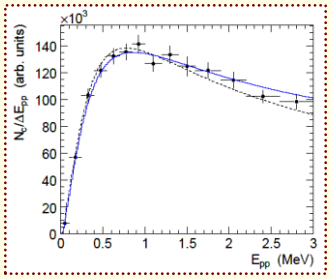
The PAC heard with interest a report about studies of nucleon-nucleon interactions at intermediate energies 0.5–2.0 GeV with formation of $^1S_0$ proton pairs in the final state, carried out with the ANKE set-up at COSY (Jülich).



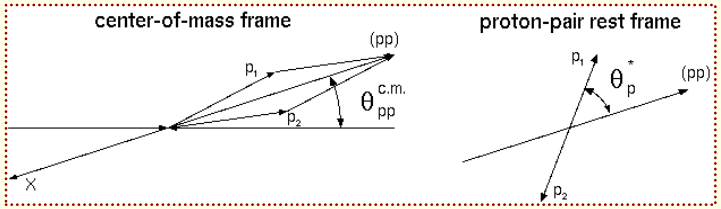
How do we know that a proton pair is in the $^1S_0$ state?

If the selected proton pairs with $E_{pp} < 3$ MeV are indeed in the $^1S_0$ state, then the following should be true:

– ***a shape of the distribution over E_{pp} looks like it is expected for interaction in the final $^1S_0$ state (e.g. Migdal-Watson distribution)***



– ***distribution over the proton angles in the rest frame of the pp pair is isotropic***



Conformity of the experimental distributions with those expected for $^1S_0$ state we always check in the data analysis

Study of reactions $pp \rightarrow \{pp\}_s\pi^0$, $pp \rightarrow \{pp\}_s\gamma$, $pp \rightarrow \{pp\}_s(2\pi)$ *and* $pd \rightarrow \{pp\}_s n$ at intermediate energies with detection of $^1S_0$ diproton pairs in the final state has been done. Almost collinear kinematics provided favorable conditions for detection of processes with high transferred momenta.

High resolution of the experimental setup and peculiarities of its acceptance made possible for the first time to fulfill measurements of a number of reactions which are spin-isospin partners of classical processes with final state deuterons.

The obtained data require thorough theoretical analysis because many results cannot be explained within existing theoretical approaches.

New measurements, especially with a polarized beam and/or polarized target, would be very helpful.

Recommendation. The PAC highly appreciates the results of investigations of the reactions with formation of proton pairs and recommends continuation of the SPRING project in 2011–2012, including experiments with polarization.

New project "Investigation of the interaction of polarized muons with matter" (MUON)

PLAN

1.Experiments with negative muons

- the hyperfine interactions of accepter impurities in semiconductors by polarized negative muons.

2. Experiments with positive muons

- property of the systems with magnetic nanoparticles;
- property non-conventional magnetic compounds (heavy fermion systems, systems with the incommensurate magnetic and crystal structures).

GOAL

Study the possibility of the application of muonic technique for:

Measurement of the magnetic field inside the nanoclusters

Measurement of the magnetic field between the clusters

Study of the dynamical behavior of magnetism in nanoparticles

Investigation of the features of the magnetic fluids with different "cores" (Me-Fe2O4, Me - Mg, Zn, Co, …)

MUON

Recommendation. The PAC notes that the MUON project is an almost pure solid-state physics programme that should be addressed by the PAC for Condensed Matter Physics. It should be presented there at the next opportunity. For the meantime– given the high international reputation of the MUON collaboration – the PAC recommends continuation of this project and its financing.

New set-ups of FLNR proposed in the seven-year plan for 2010–2016

Fragment separator ACCULINNA-2

The ACCULINNA collaboration has been quite successful and productive for the last 15 years. They have obtained high-quality resultson the proton-rich ^{6}Be and ^{26}S nuclei that clearly demonstrate how the in-flight RIB separation technique is a competitive method. Due to the moderate size of the team and financial restrictions of FLNR, the PAC would appreciate a scientific programme more focused on a couple of experiments to be unique around the world and possible in the low-energy domain.

Recommendation. The PAC recommends starting a more detailed technical design of the fragment-separator ACCULINNA-2 by reconsidering its initial broad scientific programme at its next meeting.

New set-ups of FLNR proposed in the seven-year plan for 2010–2016

Universal gas-filled separator for studies of heavy nuclei

The PAC heard with greatest interest a report about R&D of a new multi-purpose gas-filled on-line electromagnetic recoil separator for investigation of heavy-ion induced reactions, spectroscopic studies and chemical investigations. The PAC appreciated the high efficiency (for both symmetric and asymmetric entrance channels), its simplicity and the relatively low costs of the chosen design.

Recommendation. The PAC strongly supports approval of the project of this universal gas-filled separator and recommends continuation of discussions on the final project at its next meeting.

Scientific report “Multimodal nuclear fission”

The PAC heard with interest a scientific report on the description of the symmetric and asymmetric fission valleys in ^{226}Th. This theoretical study is closely connected with the experimental research of the mass distribution of fission fragments performed at FLNR.

Poster session

The PAC was particularly pleased with the presentations of new results and proposals by young scientists in the field of nuclear and particle physics research and looks forward to such type of presentations at its future meetings.

Next meeting of the PAC

The next meeting of the PAC for Nuclear Physics will be held on 20–21 January 2011.

Its tentative agenda will include:

- Reports and recommendations on themes and projects to be completed in 2010 (LIT)
- Consideration of new projects
- Poster presentations of new results and proposals by young scientists in the field of nuclear physics research
- Scientific reports.