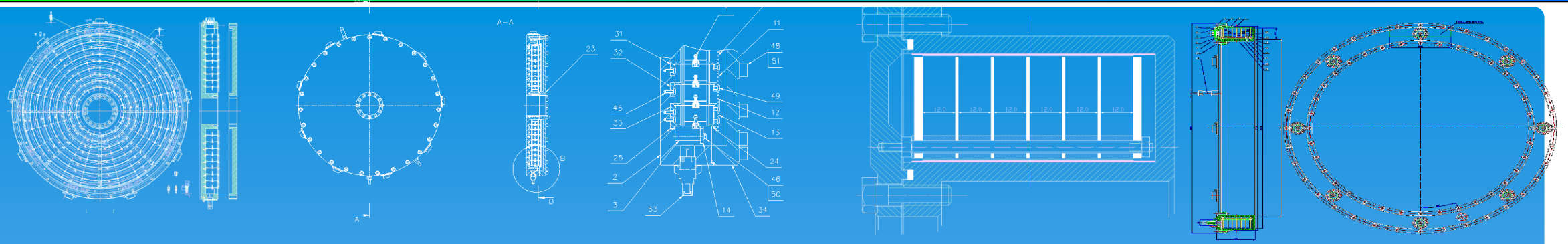
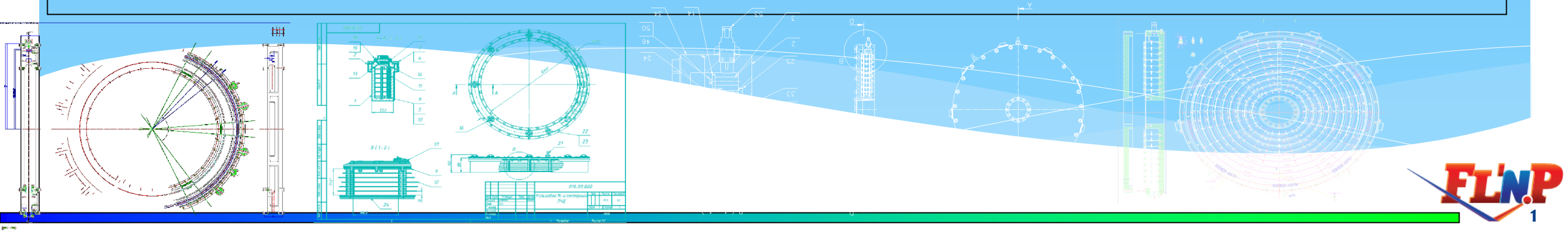


Development and application of ^{3}He and ZnS(Ag)/^{6}LiF scintillation neutron detectors at instruments at the IBR-2 reactor

Joint Institute for Nuclear Research (JINR), Joliot-Curie 6, 141980 Dubna, Moscow region, Russia

Milkov Vasil Mihaylov – Sector №1 Dectors and Electronics group, Department of Spectrometers Complex, Frank Laboratory of Neutron Physics.

milkov@nf.jinr.ru



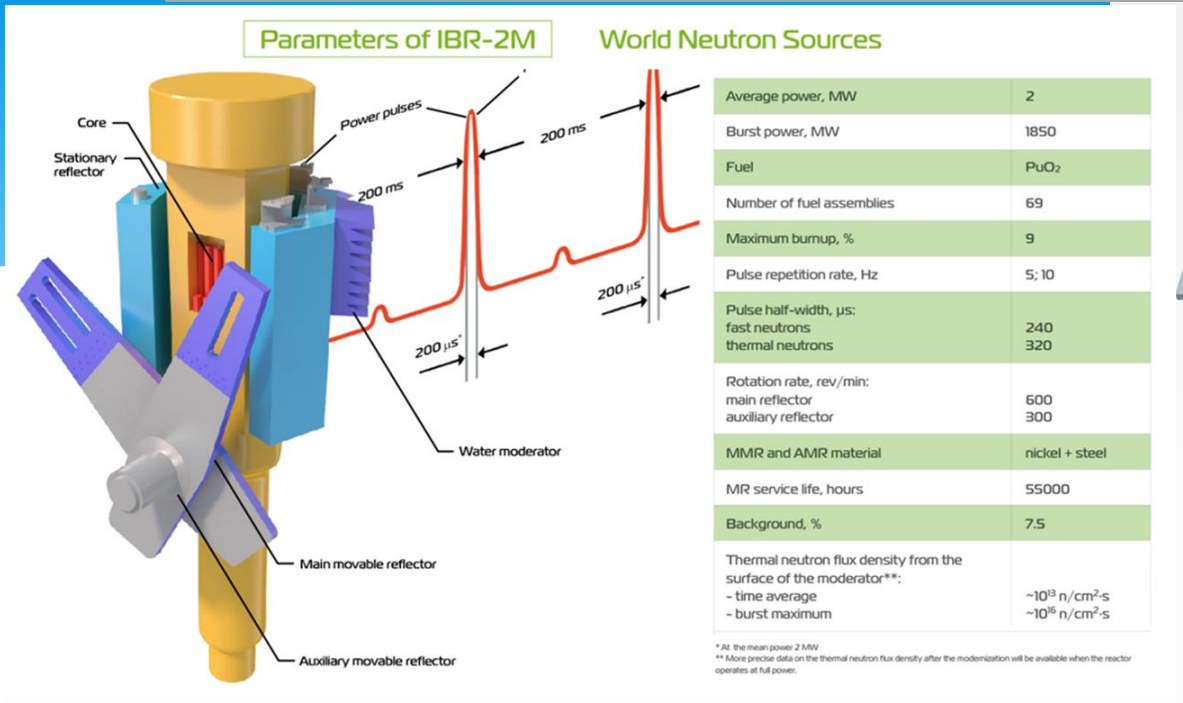
Department of Spectrometers Complex (DSC)

The DSC of IBR-2 plays an important role in maintaining the efficiency and development of the experimental facilities. One of the most important activities of DSC is the development and creation of detector technologies, on the basis of which detectors for experimental installations are created.

Sector №1 Dectors and Electronics

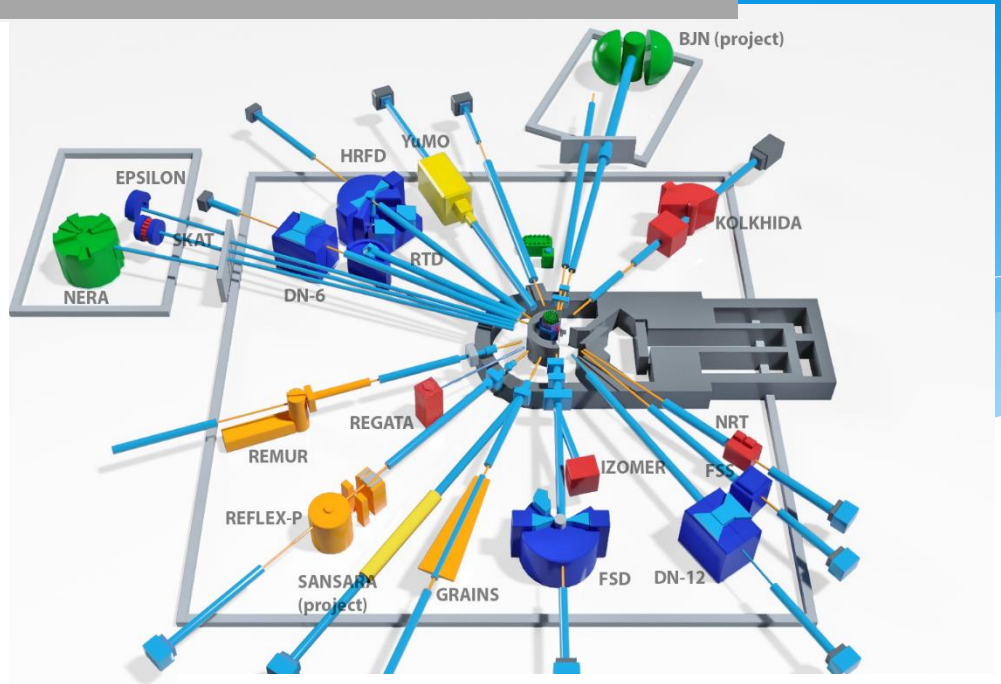
- **Development and creation of ^{3}He gas position-sensitive detectors (1D and 2D PSD based on multiwire proportional chambers with delay line data readout, different gas filled ring detectors and other types of gas detectors.**
- **Development and manufacturing of specialized scintillation detectors for neutron diffractometry (thermal neutron counters based on scintillation screens comprised of mixture of ZnS(Ag)^{6}LiF and with light collection by photomultipliers using spectrum-shifting fibers, scintillation PSD, data acquisition electronics).**
- **Development detectors based on ^{10}B.**
- **Developments and manufacture different detector electronics (preamplifiers, shaping-amplifiers for all types of detectors, discriminators, ADC, etc.)**
- **Data acquisition and accumulation systems (time encoders, intermediate and incremental memories, event code formers, devices to control accumulation time and beam characteristics, special-purpose processors for filtering and preliminary data processing, interfaces, etc.)**

IBR-2 reactor FLNP (JINR)



Average power, MW	2
Burst power, MW	1850
Fuel	PuO_2
Number of fuel assemblies	69
Maximum burnup, %	9
Pulse repetition rate, Hz	5; 10
Pulse half-width, μs: fast neutrons thermal neutrons	 240 320
Rotation rate, rev/min: main reflector auxiliary reflector	 600 300
MMR and AMR material	nickel + steel
MR service life, hours	55000
Background, %	7.5
Thermal neutron flux density from the surface of the moderator**: - time average - burst maximum	 ~10^{13} n/cm²·s ~10^{16} n/cm²·s

* At the mean power 2 MW
** More precise data on the thermal neutron flux density after the modernization will be available when the reactor operates at full power.



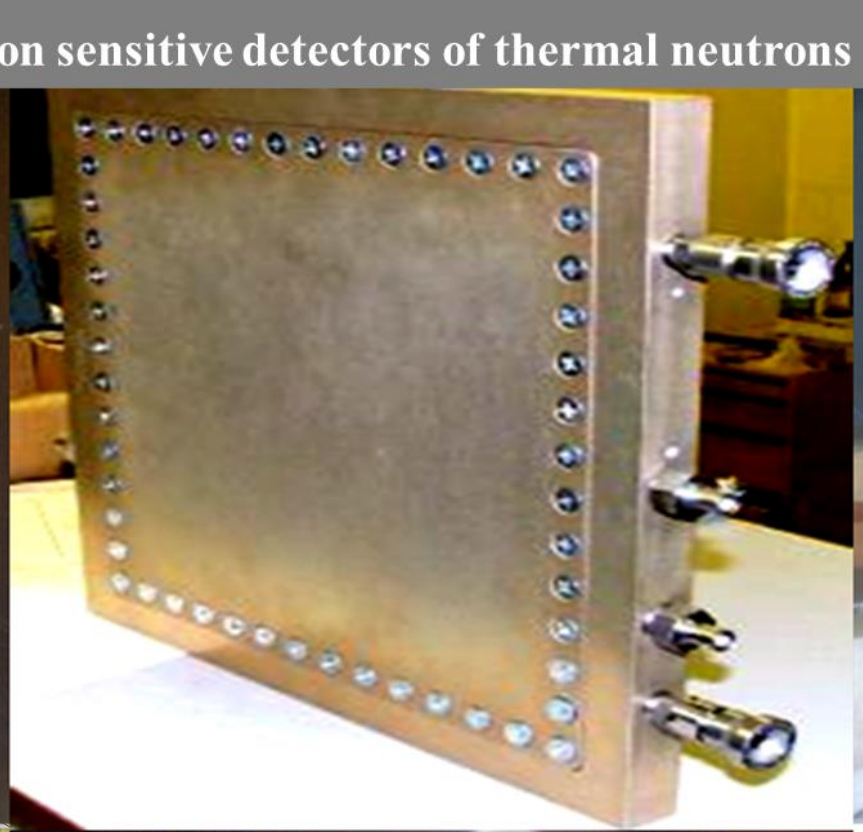
The IBR-2 reactor has 16 research instruments, designed to conduct studies of condensed matter and biological systems by neutron scattering methods.

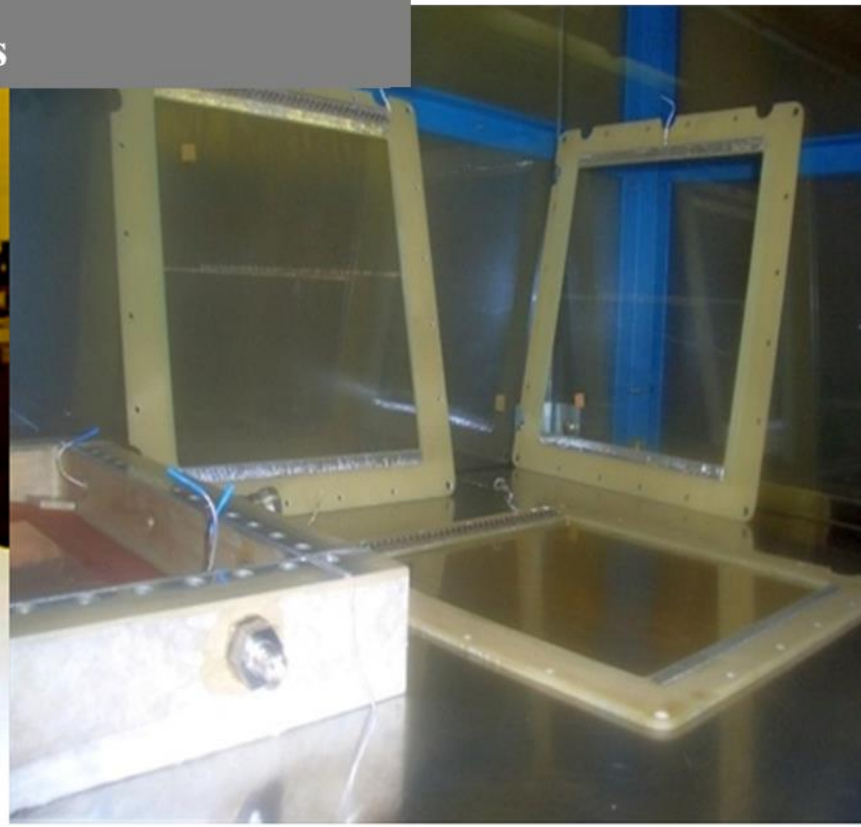
Each instrument is equipped with a neutron radiation detection system adapted to the measurement technique used at the instruments.

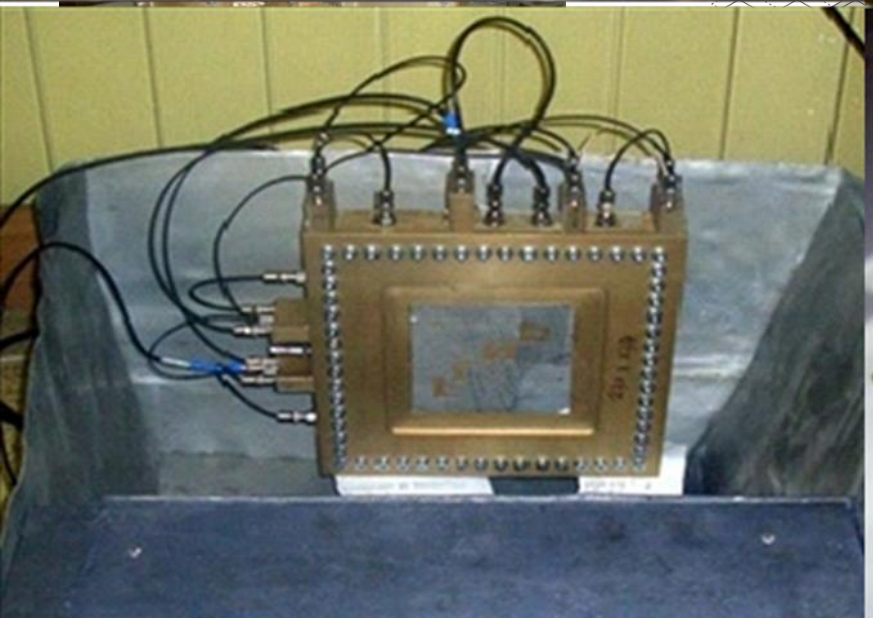
Instruments IBR-2:

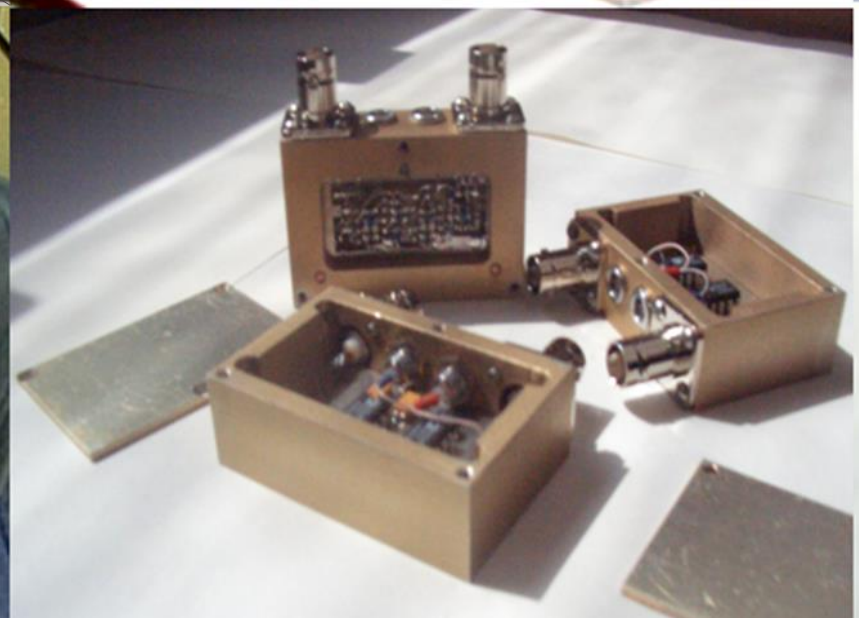
- **HRFD - ^{6}Li glass, ZnS(Ag)^{6}LiF, ^{3}He MWPSD**
- **RTD - ^{3}He counters (tube), ^{3}He ring detector, ^{3}He MWPSD**
- **DN-6 - ^{3}He counters (tube)**
- **EPSILON - ^{3}He counters (tube)**
- **SKAT - ^{3}He counters (tube)**
- **FSD -^{6}Li glass, ZnS(Ag)^{6}LiF**
- **DN-12 - ^{3}He counters (tube)**
- **FSS - ^{6}Li glass**
- **YuMO - ^{3}He ring detectors, ^{3}He MWPSD, ^{10}B detectors**
- **REMUR - ^{3}He MWPSD**
- **REFLEX - ^{3}He MWPSD**
- **GRAINS - ^{3}He MWPSD**
- **NERA - ^{3}He detectors**
- **NRT – scintillator + CCD**
- **ISOMER - HPGe detector**
- **REGATA - HPGe detector**

Position sensitive detectors of thermal neutrons

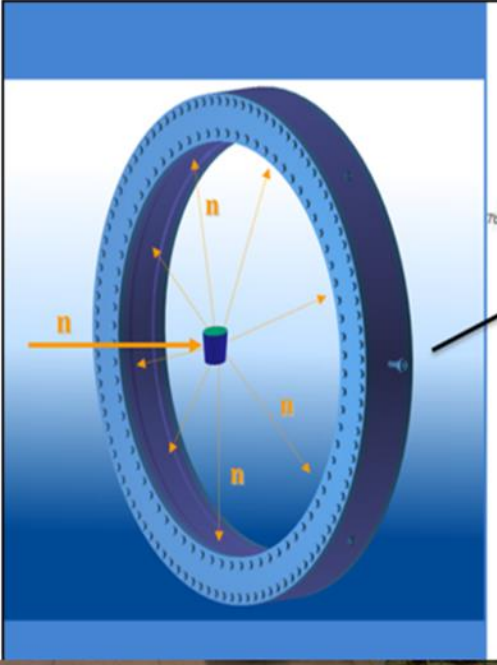


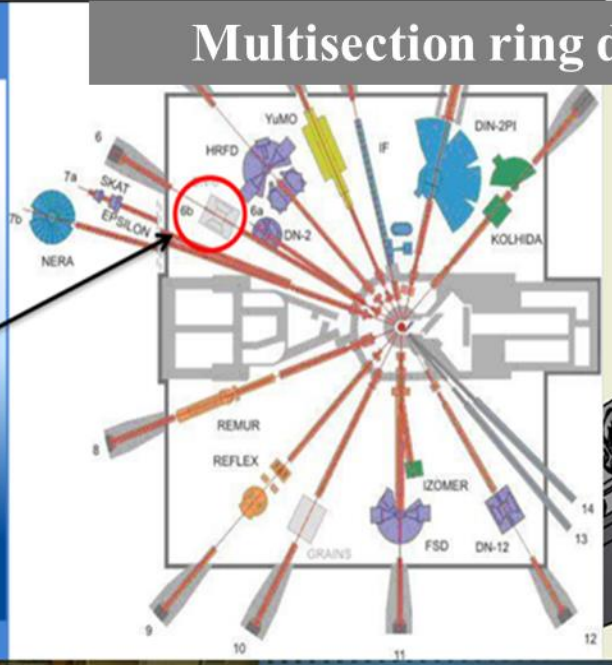


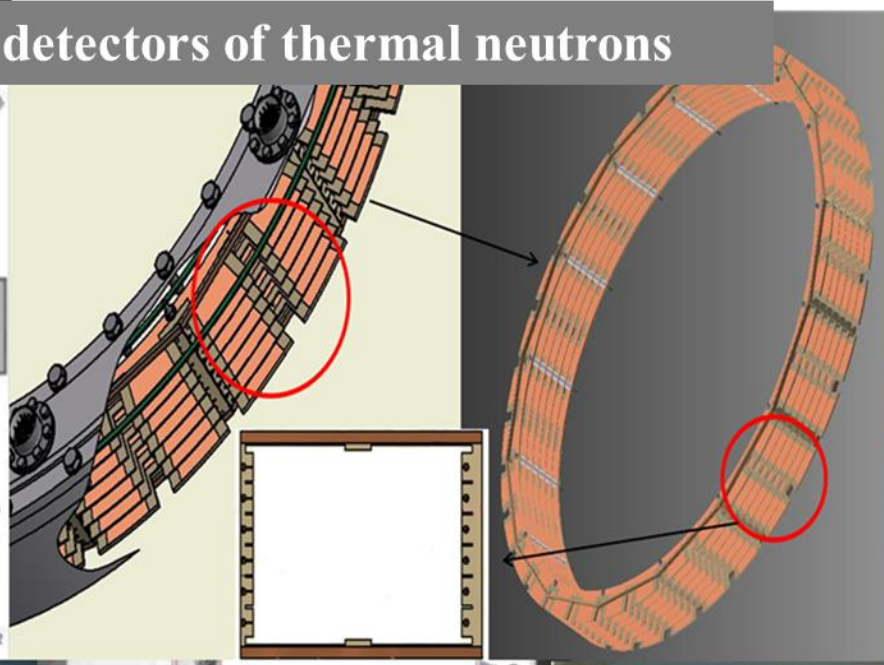


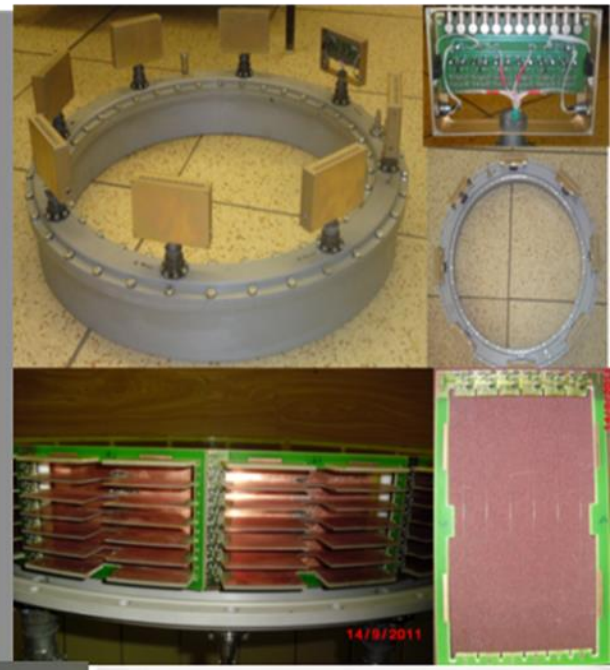


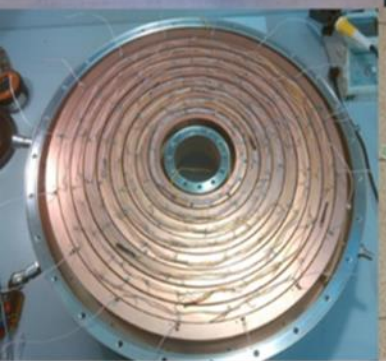
Multisection ring detectors of thermal neutrons

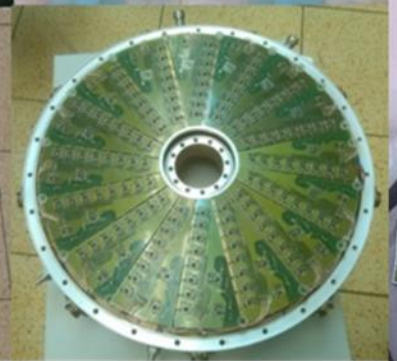


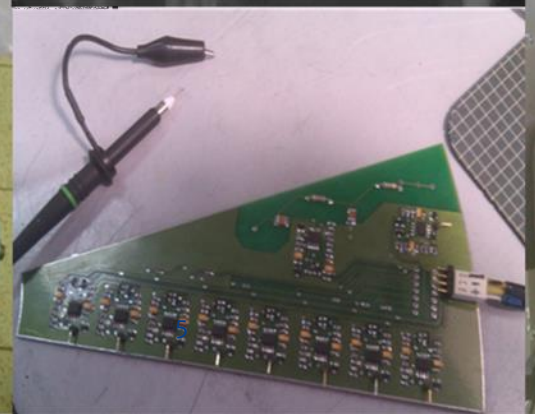












РОССИЙСКАЯ ФЕДЕРАЦИЯ

ПАТЕНТ

НА ИЗОБРЕТЕНИЕ

№ 2715898

ГАЗОНАПОЛНЕННЫЙ ДЕТЕКТОР ДЛЯ ИЗМЕРЕНИЯ МАЛОУГЛОВОГО РАССЕЯНИЯ ТЕПЛОВЫХ НЕЙТРОНОВ

Патентообладатель: *Объединенный институт ядерных исследований (ОИЯИ) (RU)*

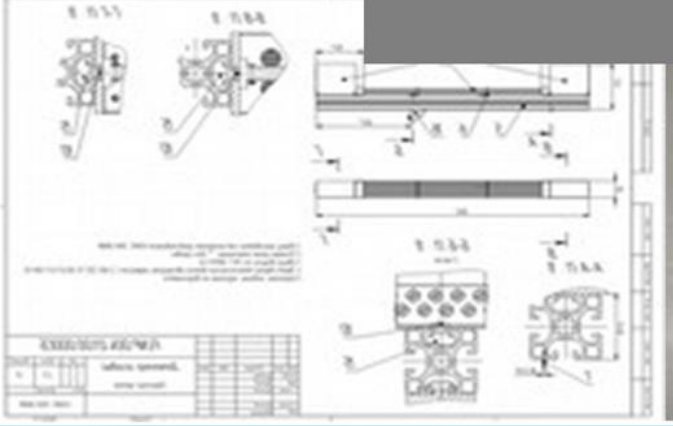
Авторы: *Бодзель Андрей Алексеевич (RU), Милков Васил Михайлов (RU), Пантелеев Цветан Ценов (RU)*

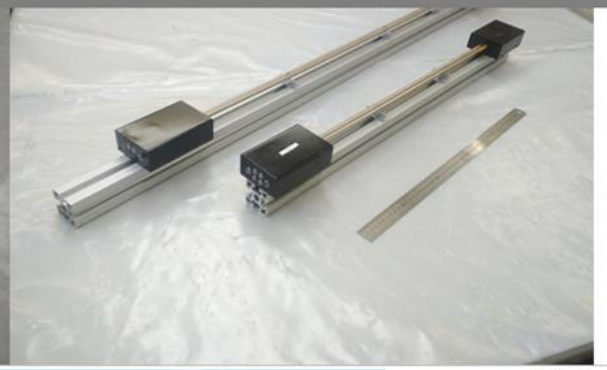
Заявка № 2018108597
Приоритет изобретения 12 марта 2018 г.
Дата государственной регистрации в Государственном реестре изобретений Российской Федерации 04 марта 2020 г.
Срок действия исключительного права на изобретение истекает 12 марта 2038 г.

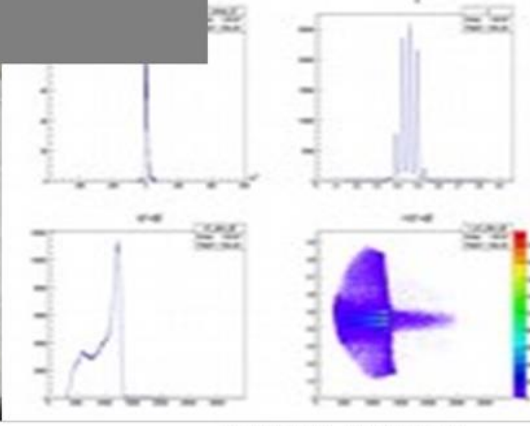
Руководитель Федеральной службы по интеллектуальной собственности

ГП. Ивлиев

^{3}He counters (tube with resistive anode)

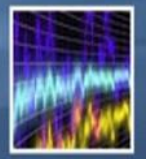






SPF «CONSENSUS»

development and production of counters used for registering alpha-beta-gamma and neutron radiation in radiometric and dosimetric devices



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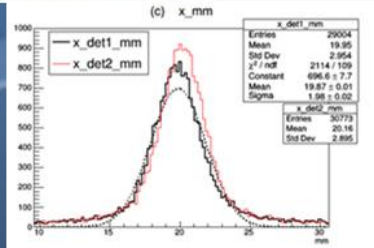
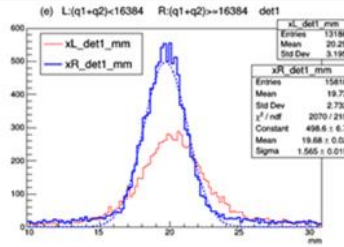
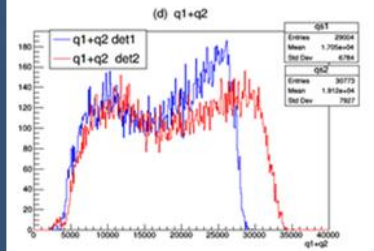
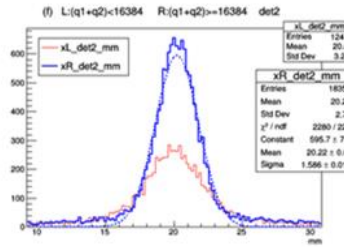
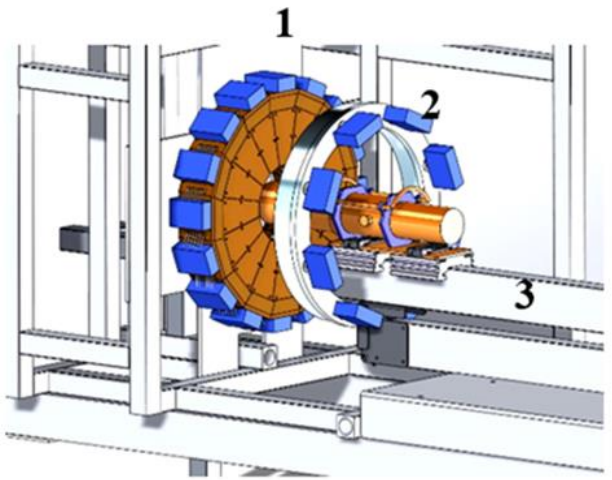




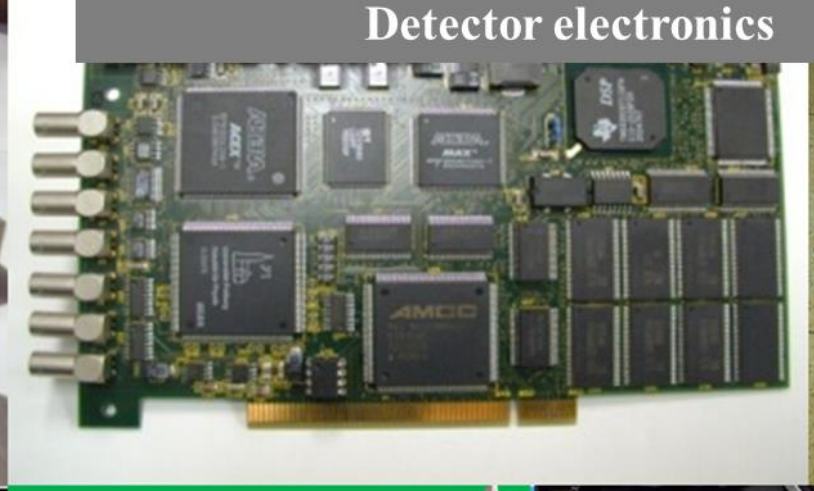


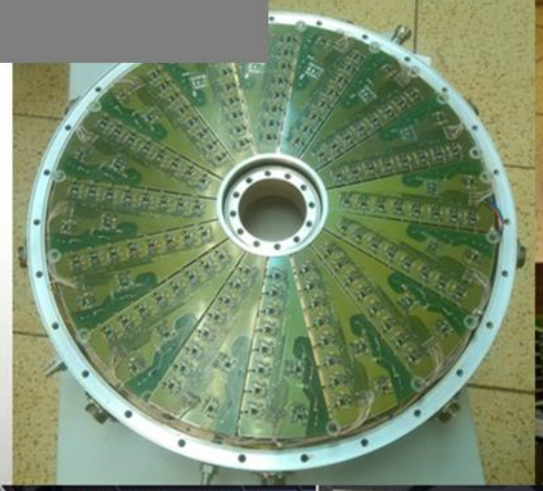


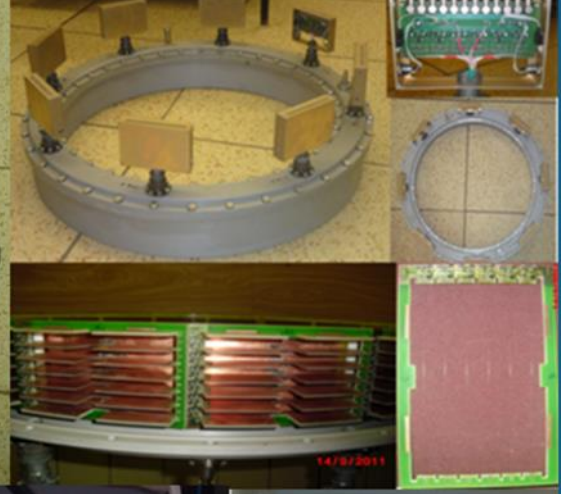


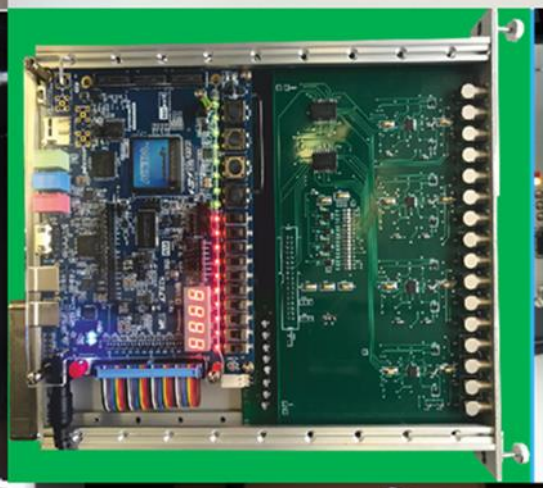
Scintillation detectors for registration of neutrons based of ZnS(Ag)/^{6}LiF, ND screen

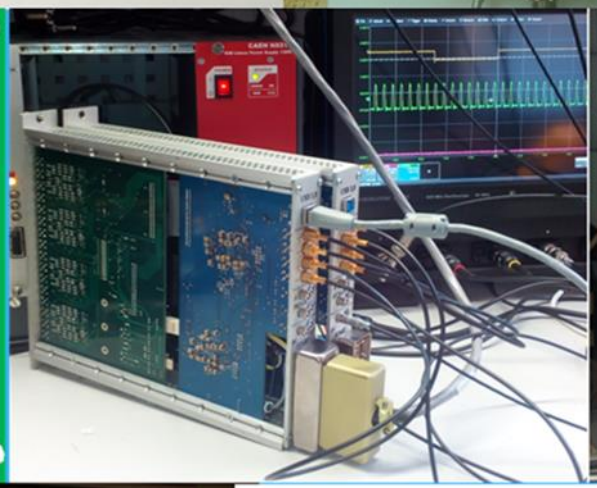
Detector electronics

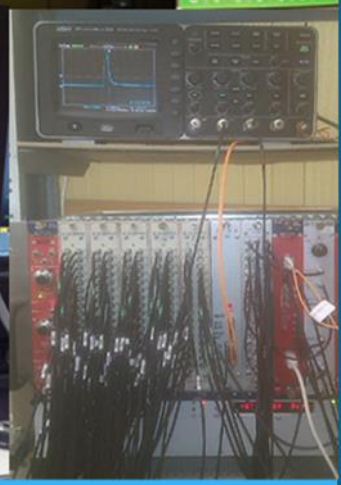






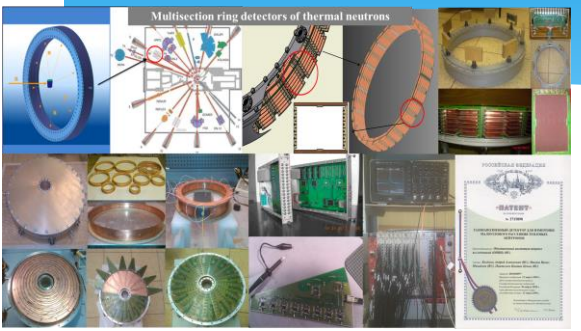


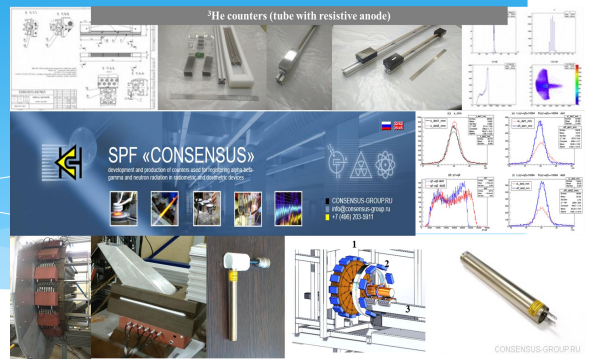




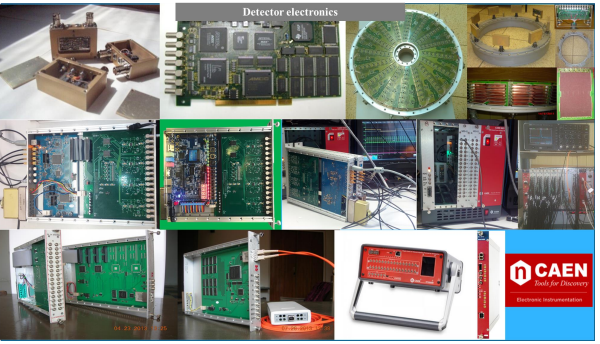
CAEN
Tools for Discovery
Electronic Instrumentation

Future plans





- Creating Position sensitive detectors (MWPC with delay line) based of ^{3}He or gas with low cross section for monitors (250 x 250 mm).
- Detector axial geometry based of ^{3}He counters (tube).
- Position-sensitive counters (PSC) based of ^{3}He counters with a resistive anode 1 m long (diameter = 6mm), 1 m²



- Detector based of scintillator ZnS(Ag)^{6}LiF with a combined from electron – geometry time focusing at intermediate scattering angles ± 90° “ASTRA-2M“
- 2 PSD based of scintillator ZnS(Ag)^{6}LiF and SiPM – 300 X 300 mm (collaboration with Tomsk Polytechnic University).

Thank you for your attention!