A promising neutron source based on the EG-5 accelerator at FLNP JINR

Doroshkevich Aleksandr at al.

E-mail: doroh@jinr.ru

Dubna
2023

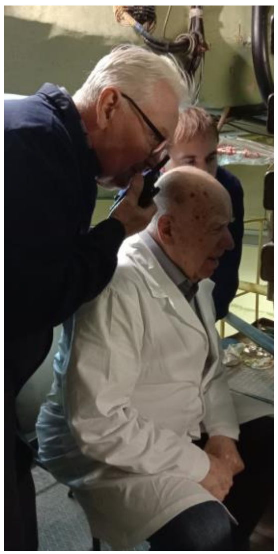
The report will contain:

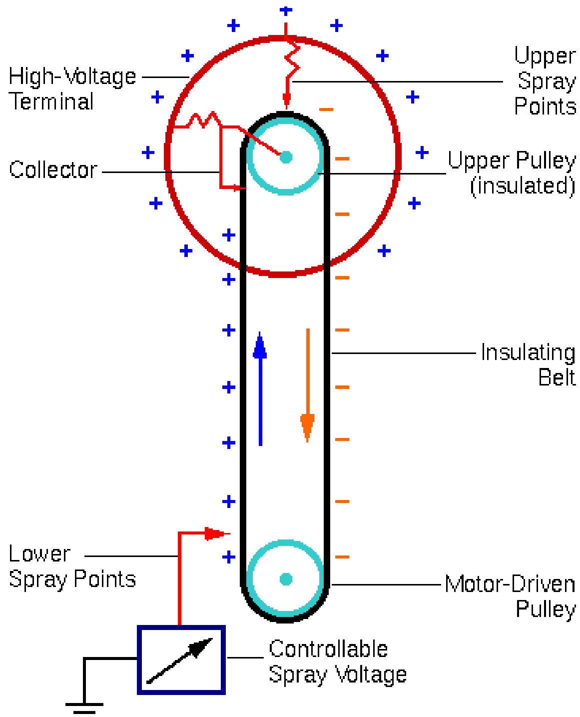
1. Current neutrons research using EG-5 facility;
2. Information about the modernization of the EG-5 accelerator in relation to neutron options;
3. Perspective neutrons capabilitys on the EG-5 facility.

The purpose of the report is to inform colleagues with the current and future capabilities of the neutron generator based on the EG-5 accelerator at JINR.

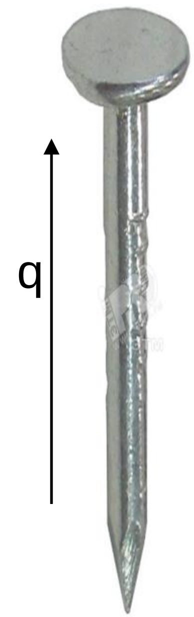
Operating principle

Robert Jemison Van de Graaff





Schematic representation and principle of operation of an electrostatic accelerator



EG-5 - without hood

A constructor of EG-5 -Prof. V.A., Romanov and V.N. Tkachenko study the parameters of the ion beam of the EG-5 accelerator. (2021).

The EG-5 accelerator is classical single stage Van de Graaff electrostatic generator. Van de Graaff generator makes it possible to achieve energies of charged particles of the order of 20 MeV. Using the EG-5 accelerator, it was possible to achieve energies of up to 4.1 MeV at a beam current (in tube) of up to 100 μA.

Unique features of the EG-5

A significant advantage of direct-acting accelerators is:
- high energy stability of
- high intensity and

the accelerated beam (0.01%).

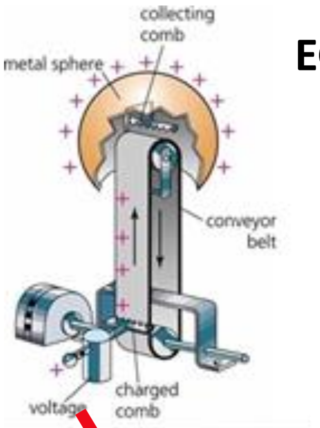
Fast neutron reactions

Ion Beam Spectrometry

Due to the complex of unique features, the EG-5 is capable fo solving a wide range of tasks from various fields of science and technology.

EG-5 in the global accelerator infrastructure

EG-5



IREN

The colliders of protons and heavy ions

NICA (***N****uclotron-based* ***I****on* ***C****ollider* ***A****cility*)

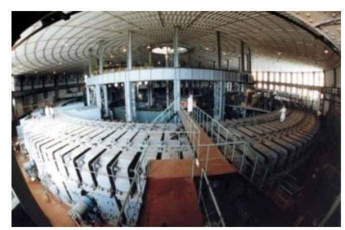
LHC **C**ollider

EG-5 | **IREN** | **NICA** | **LHC** | **E, eV/n**

0 **4 MeV/n** **200 MeV/n** **11 Г eV/n** **14 TeV/n**

EG-5 provides a relatively low level of particle energies

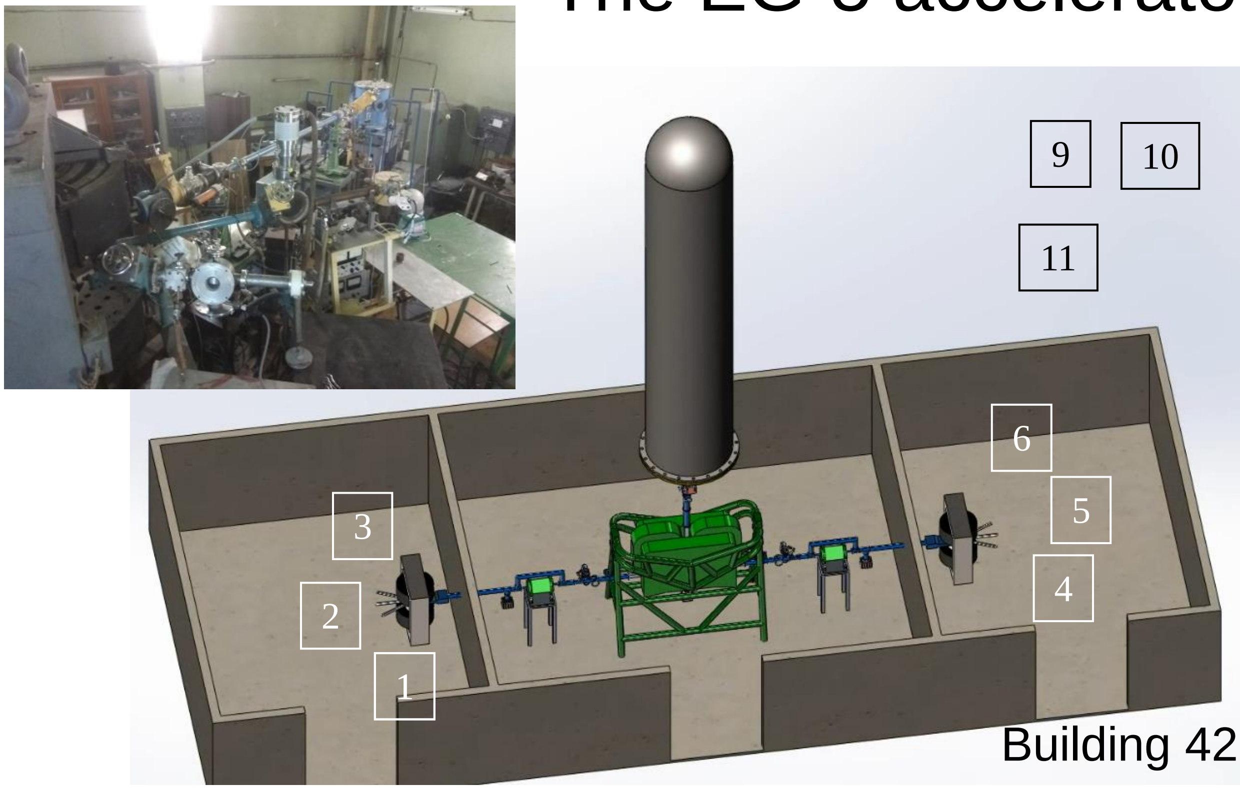
Isochronous cyclotron 80 MeV/n

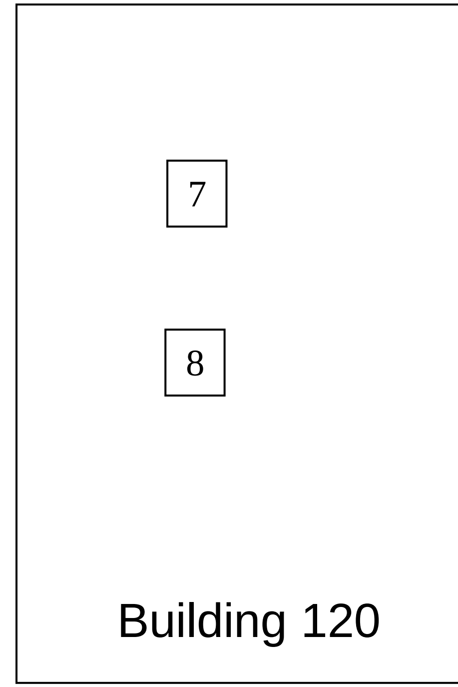


The synchrophasotron - a 10 GeV/n (JINR)

The range of tasks for EG-5 is no less extensive than for the Hadron collider!!!

The EG-5 accelerator complex





1 - Installation for the study of helium porosity;

2 – Ion irradiation chamber;

3 – Ion Beam Spectrometer Chamber;

4 – Installation of NAA (lithium target);

5 – Installation for the study of reactions with the departure of charged particles;

6 – Installation for channeling research;

7 – Besides IBT : Chemical Laboratory;

8 – Engineering Laboratory;

9 - Spectral ellipsometer;

10 – Impedance Meter;

11 – Potentiostat.

Group "Installation of EG-5"

Group staff: 23 employees

15 – ETS (6 – ESU operators)

6 - researchers and senior researchers.

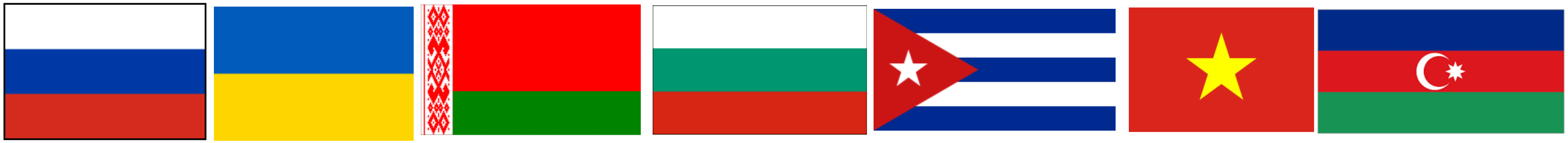
2 - Doctor of Sciences

3 - Ph.D.

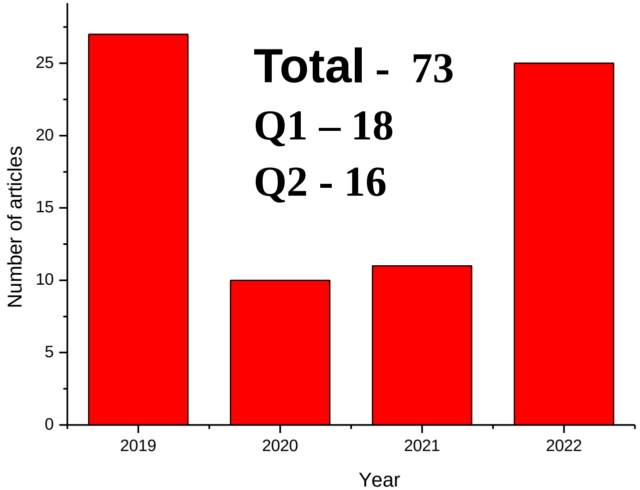
3 – students (bachelors / masters)

1 – graduate student

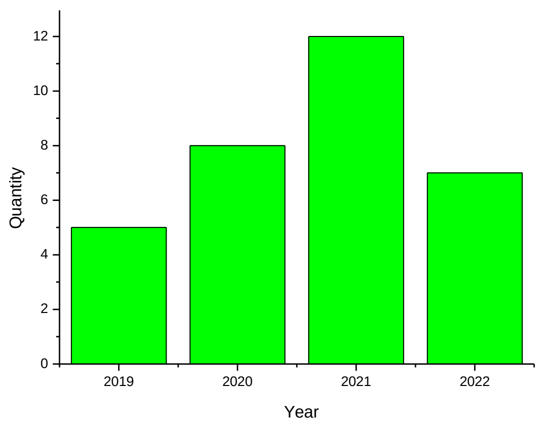
3 – applicants. The average age is 43 Freelance employees: 4 students 1st year,2 students 2nd year.



Statistics of scientometric indicators of publications



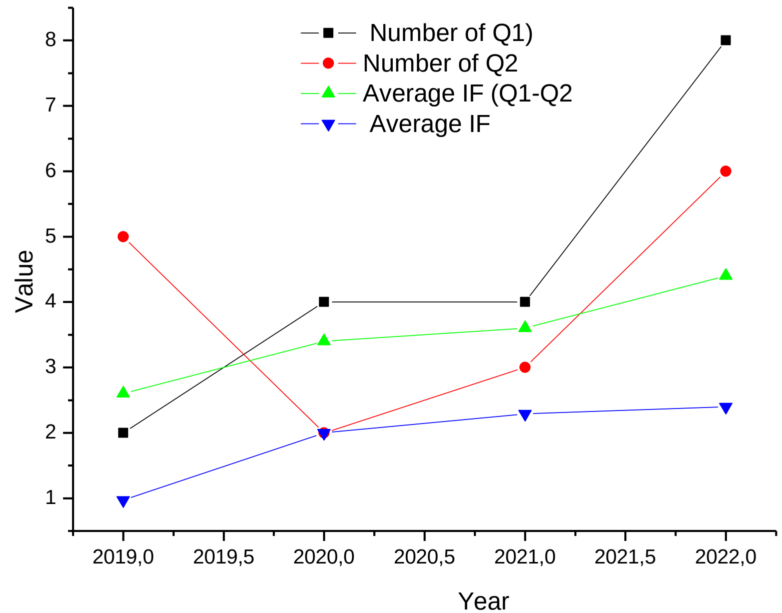
Number of publications



Number of scientific projects

Indicators 2022г

- 26 publ. 25 reports,
- 14 publ: Q1-Q2
- (<IF>= 4,3)



IF of publications

Collaboration within JINR

1. ”Gheorghe Asachi” Technical University of Iasi (TUIASI), Iasi Romania;
2. Donetsk Institute for Physics and Engineering named after O.O. Galkin, Kiev, РФ;
3. Institute of Physics, Maria Curie-Skłodowska University, Lublin, Poland;
4. National Center for Nuclear Research, Baku, Azerbaijan;
5. Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH), Bucharest Romania;
6. National institute of materials physics, Măgurele, Romania;
7. West University of Timisoara, Timisoara, Romania;
8. Graduate University of Science and Technology, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, CauGiay, Ha Noi10000, Vietnam;
9. Institute of Physics, Vietnam Academy of Science and Technology, 10 Dao Tan, Ba Dinh, Ha Noi10000, Vietnam;
10. Vietnam Atomic Energy Institute, 59 Ly ThuongKiet, HoanKiem, Hanoi, Vietnam;
11. University of Belgrade, INN Vinča, Laboratory of Physics;
12. University of Belgrade- Archaeology Department, Serbia;
13. National Institute of Materials Physics, Magurele, Romania;
14. ”Alexandru Ioan Cuza” University of Iasi, Faculty of Physics, Iasi, Romania;
15. Kazakh Rice Research Institute named after I. Zhakhaev;
16. NUST – MISIS;
17. Budker Institute of Nuclear Physics SB RAS;
18. Dubna University;
19. INSTITUTE OF ION-PLASMA AND LASER TECHNOLOGIES AN RUz - Tashkent,
20. Belarusian State University (Minsk, Belarus);
21. Joint Institute of Solid State Physics and Semiconductors of the National Academy of Sciences of Belarus, Minsk, Belarus

Industrial partners

JSC "Micron".
State Corporation "Rosatom"

External collaboration

HORIZON 2020

European Commission

The EU Framework Programme for Research and Innovation

НАН УКРАЇНИ

ІФН

ISP

NAS UKRAINE

ДонФТИ НАНУ

Nanotechcenter

the Project ***Self-sufficient "humidity to electricity" innovative radiant adsorption system toward net zero energy buildings***, with acronym **SSHARE** and number ***871284,***

Belarusian State University

UIB

Universit de les Illes Bal

THE MINISTRY OF TRANSPORT, COMMUNICATIONS AND HIGH TECHNOLOGIES OF THE REPUBLIC OF AZERBAIJAN

FCT FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

Departamento de Química

NOVA id FCT

Associação para a Inova... e Desenvolvimento da FC...

INSTITUTE OF ION-PLASM AND LASER TECHNOLIGIES NAMED AFTER U.A. ARIFOV

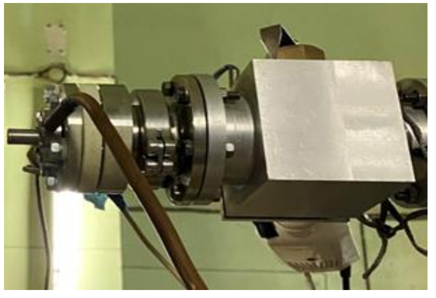
ACADEMY OF SCIENCE OF UZBEKISTAN

BLUEORIZON

Beam parameters of EG-5 accelerator

GasTarget

$D(d,n)^3He$



Neutron beam parameters

-Neutrons flow – 5 10^7 pat/s sm^2
Max. neutrons energy - 5,5±0,1 MeV (Deutron current – 2mkA, deutron energy – 2,5MeV);

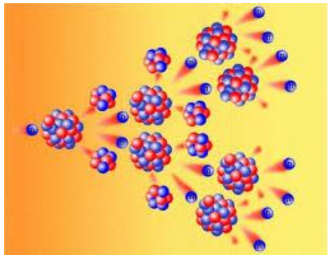
Ion beam parameters

Range of ion beam currents - 0,01 - 3 мкА (100 – 250mkA*);
- Real ion beam energy range - 800 keV – 2,5MeV (4,1 MeV*);
- Energy resolution (H^+, He^{2+}) - not worse than 15keV;
- Charged particles flow (H^+, He^{2+}) – 10^{12}–10^{13} part /s sm^{-2}

Scientific program

Based on the JINR PTP, there are two main directions that we plan to develop using an electrostatic accelerator

1. Nuclear physics. The study of the properties of excited nuclei, reactions with the emission of charged particles, nuclear fission, obtaining relevant data for astrophysics, nuclear energy and the problem of transmutation of nuclear waste using neutron reactions.



(n,α)

Reactions

(n,f)

2. Solid State Physics. Application of neutron physics methods on other fields of science and technology:

- ***Radiation materials science;***
- ***Radiobiology;***
- ***Nuclear medicine;***
- ***Solid state Physics.***

3. Applied and methodical research.

Nuclear Data High Priority Request List

ID	View	Target	Reaction	Quantity	Energy range	Sec.E/Angle	Accuracy	Cov	Field	Date
2H		8-O-16	(n,a),(n,abs)	SIG	2 MeV-20 MeV		See details	Y	Fission	12-SEP-08
3H		94-PU-239	(n,f)	prompt g	Thermal-Fast	Eg=0-10MeV	7.5	Y	Fission	12-MAY-06
4H		92-U-235	(n,f)	prompt g	Thermal-Fast	Eg=0-10MeV	7.5	Y	Fission	12-MAY-06
8H		1-H-2	(n,el)	DA/DE	0.1 MeV-1 MeV	0-180 Deg	5	Y	Fission	16-APR-07
15H		95-AM-241	(n,g),(n,tot)	SIG	Thermal-Fast		See details		Fission	10-SEP-08
18H		92-U-238	(n,inl)	SIG	65 keV-20 MeV	Emis spec.	See details	Y	Fission	11-SEP-08
19H		94-PU-238	(n,f)	SIG	9 keV-6 MeV		See details	Y	Fission	11-SEP-08
21H		95-AM-241	(n,f)	SIG	180 keV-20 MeV		See details	Y	Fission	11-SEP-08
22H		95-AM-242M	(n,f)	SIG	0.5 keV-6 MeV		See details	Y	Fission	11-SEP-08
25H		96-CM-244	(n,f)	SIG	65 keV-6 MeV		See details	Y	Fission	12-SEP-08
27H		96-CM-245	(n,f)	SIG	0.5 keV-6 MeV		See details	Y	Fission	12-SEP-08
29H		11-NA-23	(n,inl)	SIG	0.5 MeV-1.3 MeV	Emis spec.	See details	Y	Fission	12-SEP-08
32H		94-PU-239	(n,g)	SIG	0.1 eV-1.35 MeV		See details	Y	Fission	12-SEP-08
33H		94-PU-241	(n,g)	SIG	0.1 eV-1.35 MeV		See details	Y	Fission	12-SEP-08
34H		26-FE-56	(n,inl)	SIG	0.5 MeV-20 MeV	Emis spec.	See details	Y	Fission	12-SEP-08
35H		94-PU-241	(n,f)	SIG	0.5 eV-1.35 MeV		See details	Y	Fission	12-SEP-08
37H		94-PU-240	(n,f)	SIG	0.5 keV-5 MeV		See details	Y	Fission	15-SEP-08
38H		94-PU-240	(n,f)	nubar	200 keV-2 MeV		See details	Y	Fission	15-SEP-08
39H		94-PU-242	(n,f)	SIG	200 keV-20 MeV		See details	Y	Fission	15-SEP-08
41H		82-PB-206	(n,inl)	SIG	0.5 MeV-6 MeV		See details	Y	Fission	15-SEP-08
42H		82-PB-207	(n,inl)	SIG	0.5 MeV-6 MeV		See details	Y	Fission	15-SEP-08
45H		19-K-39	(n,p),(n,np)	SIG	10 MeV-20 MeV		10	Y	Fusion	11-JUL-17
97H		24-CR-50	(n,g)	SIG	1 keV-100 keV		8-10	Y	Fission	05-FEB-18
98H		24-CR-53	(n,g)	SIG	1 keV-100 keV		8-10	Y	Fission	05-FEB-18
99H		94-PU-239	(n,f)	nubar	Thermal-5 eV		1	Y	Fission	12-APR-18
102H		64-GD-155	(n,g),(n,tot)	SIG	Thermal-100 eV		4	Y	Fission	09-MAY-18
103H		64-GD-157	(n,g),(n,tot)	SIG	Thermal-100 eV		4	Y	Fission	09-MAY-18
114H		83-BI-209	(n,g)Bi-210g,m	BR	500 eV-300 keV		10	Y	ADS,Fission	09-NOV-18
115H		94-PU-239	(n,tot)	SIG	Thermal-5 eV		1	Y	Fission	08-APR-19

Most of the required neutron energies are in the range, which can be achieved in our accelerator. These tasks are difficult and expensive to solve at other types of neutron facilities.

[2] https://www.oecd-nea.org/dbdata/hprl/search.pl?vhp=on

Nuclear physics

Nuclear reactions with fast quasimonoenergetic neutrons, including:

- research of fast neutron fission: measurements of the **prompt fission neutron (PFN) spectra and total kinetic energies (TKE) in reactions** ^{235}U(n,f), ^{238}U(n,f), ^{237}Np(n,f), ^{239}Pu(n,f) in the range of neutron energies 1-5 MeV/core;

- **study of the multiplicity of PFNs in these fast neutron reactions** in geometry with high efficiency of **PFN** registration;

- measurement of the **spectra of charged particles from the reactions (n, α), (n, p)** depending on the neutron energy in the range of up to 5 MeV and higher;

- measurement of the **integral and differential cross sections** of these reactions depending on the neutron energy;

- study of the **spectrum and angular distributions of charged particles** at a neutron energy of ~ 20 MeV aimed at investigating non-statistical effects;

- investigation of reactions (α, n) and (p, n) in combination, respectively, with reactions (n, α) and (n, p);

- study of **elastic and inelastic scattering of fast neutrons** on atomic nuclei;

- using the **TOF technique** in a pulsed accelerator mode (f~ 1 MHz, dt~1-10 ns).

Scientific Background of EG-5 in Nuclear physics

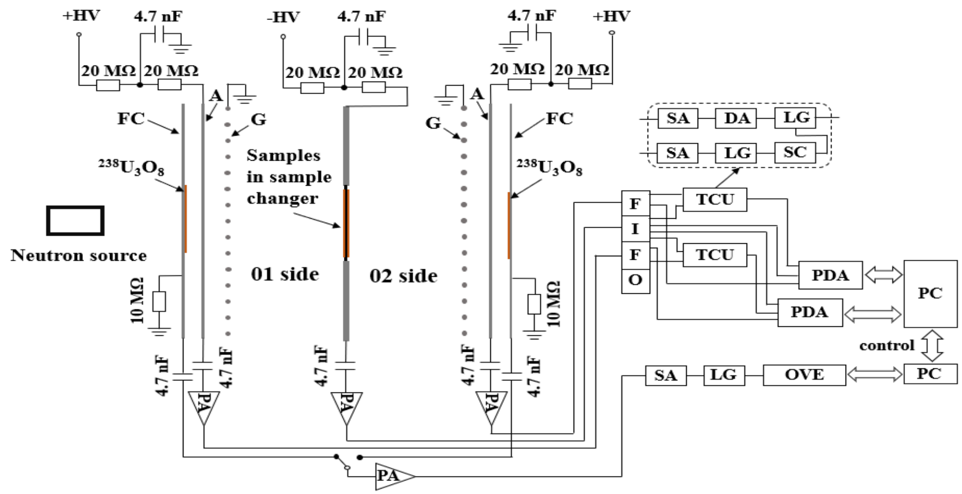
Prof. Gledenov Yu.M.

Group of Yu.M. Gledenov

1. Developed methods and unique research equipment

1.1 A charged particles - spectrometer was created on the basis of an ionization chamber with a grid and an electronics module based on PIXIE-4 and PIXIE-16.

1.2. The calibration of the neutron monitor which is necessary for measuring of the absolute neutron flux in the nuclear reaction was carried out.



2. Unique results were obtained

Recent results obtained at EG-4,5 at Peking University, the technique was created at FLNP and tested at EG-5:

During three years it was measured **cross sections of (n,α)** with fast neutrons at listed below nuclei:

- ^{144}Sm, ^{66}Zn, ^{10}B, ^{25}Mg, ^{54,56} Fe,
- $^{58, 60, 61}$Ni are analysis;
- ^{6}Li, ^{14}N, ^{35}Cl, ^{91}Zr and ^{56}Fe are planned for Russian Library BROND

Experimental Hall EG-5, FLNP, JINR

Group of Yu.M. Gledenov

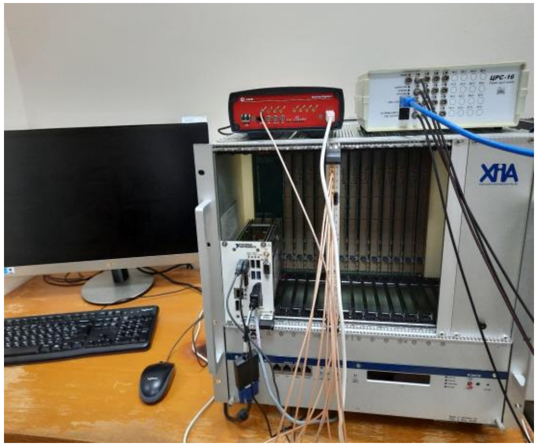
Unique results have been obtained

The recent results have been obtained at EG-5, FLNP, JINR, the technique has been developed at FLNP and tested at EG-5:

Cross sections of (n,α) reaction with fast neutrons have been measured

A charged particles - spectrometer

Neutron generator



Data Acquisition System

Scientific potential of EG-5 in nuclear physics

Group of Yu.M. Gledenov


Magazine Help/Feedback Journal, vol, page, DO

PHYSICAL REVIEW C
covering nuclear physics

Highlights Recent Accepted Authors Referees Search Press About

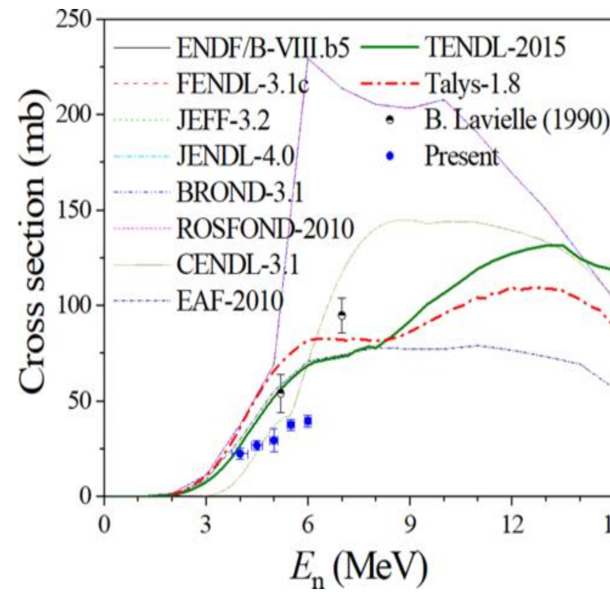
Access by Joint Institut for Nuclear Research - Dubna Go Mobile »

Measurement of the cross sections of the ^{25}Mg(n,α) ^{22}Ne reaction in the 4–6 MeV region

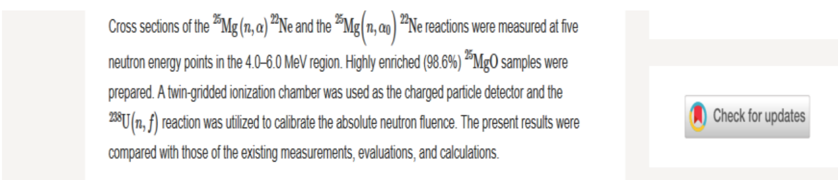
Yu. M. Gledenov, M. V. Sedysheva, G. Khuukhenkhuu, Huaiyong Bai, Haoyu Jiang, Yi Lu, Zengqi Cui, Jinxiang Chen, and Guohui Zhang

Phys. Rev. C **98**, 034605 – Published 10 September 2018

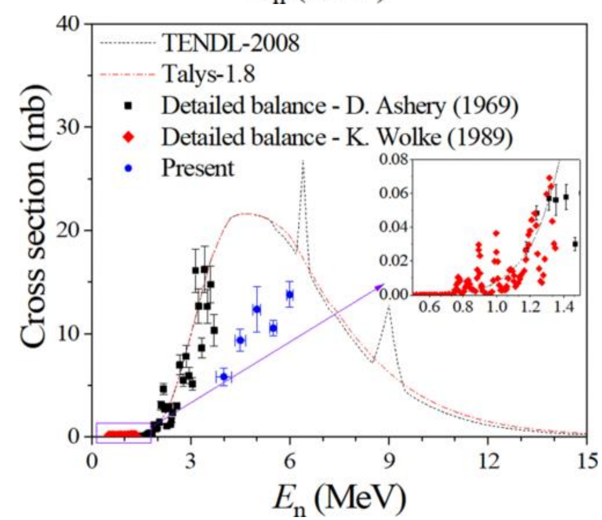
More



According to the detailed balance principle, the present results can also provide new information about the ^{22}Ne$(\alpha,n)^{25}$Mg reaction, which is one of the main neutron sources for the astrophysicals process


Cross sections of the ^{25}Mg(n,α) ^{22}Ne and the ^{25}Mg(n,α_0) ^{22}Ne reactions were measured at five neutron energy points in the 4.0–6.0 MeV region. Highly enriched (98.6%) ^{25}MgO samples were prepared. A twin-gridded ionization chamber was used as the charged particle detector and the ^{238}U(n,f) reaction was utilized to calibrate the absolute neutron fluence. The present results were compared with those of the existing measurements, evaluations, and calculations.

Check for updates

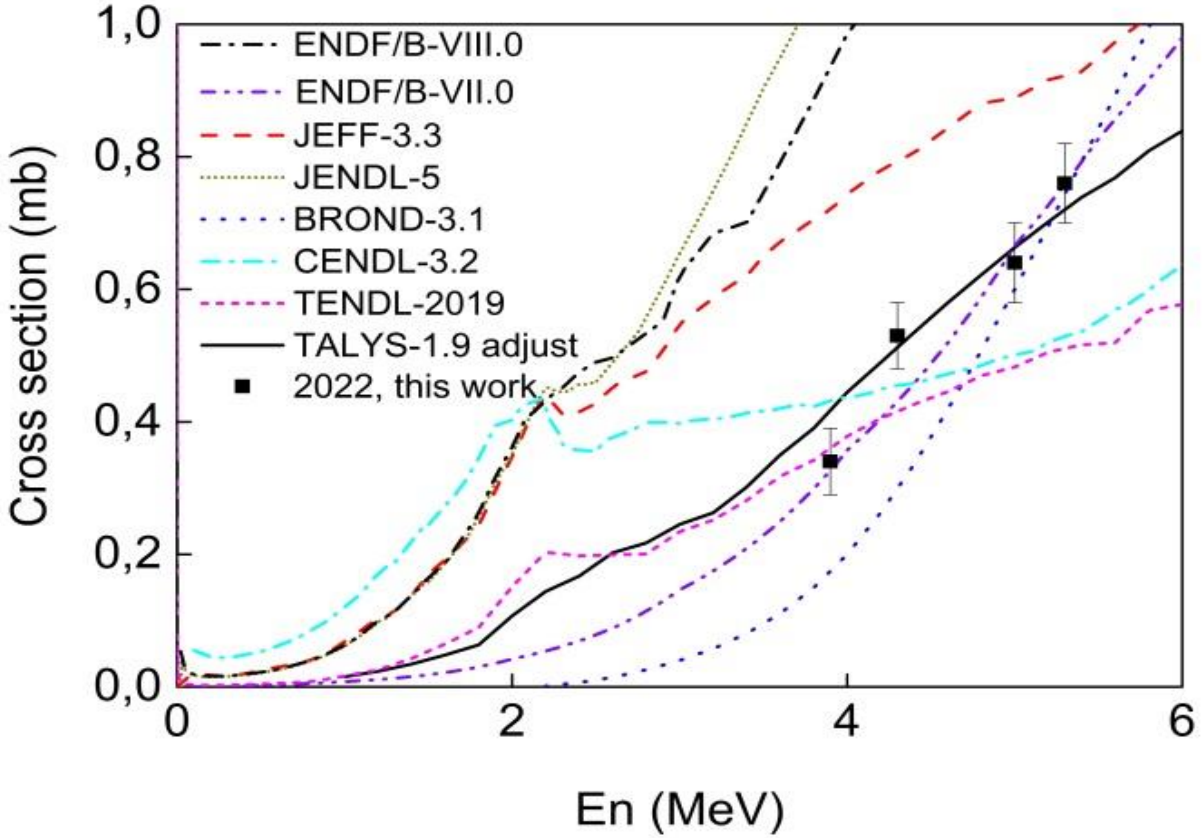


Present cross sections of the ^{25}Mg$(n,\alpha_0)^{22}$Ne reaction compared with existing measurements, evaluations and talys-1.8 code calculations.

$^{91}Zr(n,\alpha)^{88}Sr$ reaction in the 3.9 - 5.3 MeV

Zhang G., Sansarbayar E., Gledenov Yu. M., et al. ***Phys.Rev.*** C. 106, 064602 (2022)

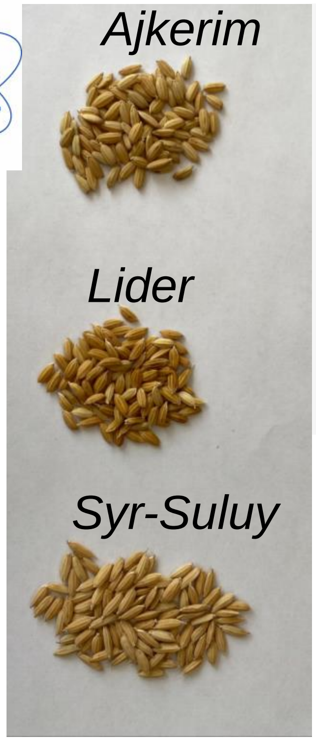
Group of Yu.M. Gledenov



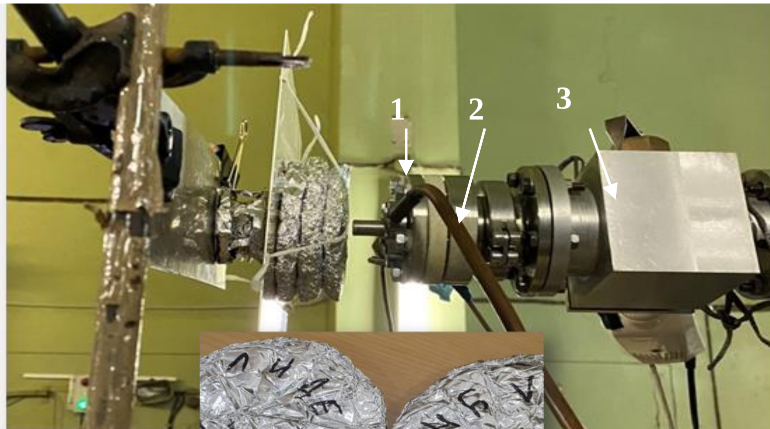
Experimental and evaluated cross sections for the $^{91}Zr(n,\alpha)$ ^{88}Sr reaction and calculated results by TALYS-1.9

The use of ionizing neutron radiation for mutagenesis of rice crops

Zhakhaev Kazakh Research Institute of Rice, Kyzylorda, Kazakhstan



Irradiation installation



1 – Irradiated samples;
2 – neutron emitter;
3 - Ion conductor of the accelerator.

- The prolonged biological effect of neutron irradiation was established;
- Mutants resistant to drought and diseases have been selected.

Corresponding member of the Kazakh Academy of Sciences Prof. K.B. Bakiruly

Alekseyenok Yu.V.

Kruglyak A.I.

Radiation Neutron Materials science

materials MDPI

Article

Distribution of Hydrogen and Defects in the Zr/Nb Nanoscale Multilayer Coatings after Proton Irradiation

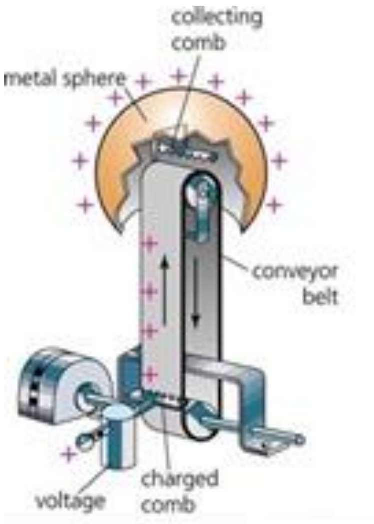
Roman Laptev [1,*], Ekaterina Stepanova [1], Natalia Pushilina [1], Leonid Svyatkin [1], Dmitriy Krotkevich [1], Anton Lomygin [1], Sergei Ognev [1], Krzysztof Siemek [2,3], Aleksandr Doroshkevich [4] and Vladimir Uglov [5]

Рафаэль Исаев

[1] Division for Experimental Physics, National Research Tomsk Polytechnic University, 634050 Tomsk, Russia; enstepanova@tpu.ru (E.S.); pushilina@tpu.ru (N.P.); svyatkin@tpu.ru (L.S.); dgk7@tpu.ru (D.K.); lomyginanton141@gmail.com (A.L.); soo1@tpu.ru (S.O.)
[2] Department of Structural Research, Institute of Nuclear Physics Polish Academy of Sciences, 31342 Krakow, Poland; krzysztof.siemek@ifj.edu.pl
[3] Dzhelepov Laboratory of Nuclear Problems, Joint Institute for Nuclear Research, 141980 Dubna, Russia
[4] Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia; doroh@jinr.ru
[5] Department of Solid State Physics, Belarusian State University, 220006 Minsk, Belarus; uglov@bsu.by
* Correspondence: laptevrs@tpu.ru; Tel.: +7-913-852-3733

The article is devoted to the experimental study of changes in the defective structure and mechanical properties of nanoscale multilayer radiation-resistant coatings (NMCs) with alternating layers of Zr and Nb under irradiation.

Modernization of the EG-5 accelerator and development of its experimental infrastructure



Technical task: Restoring the technical parameters of the EG-5 accelerator:
Energy over 4,1 MeV
at beam current more 50mkA.

Ways to solve:
- Tube replacement;
- Modernization of EG -5 infrastructure;
- Young staff training.

Goal

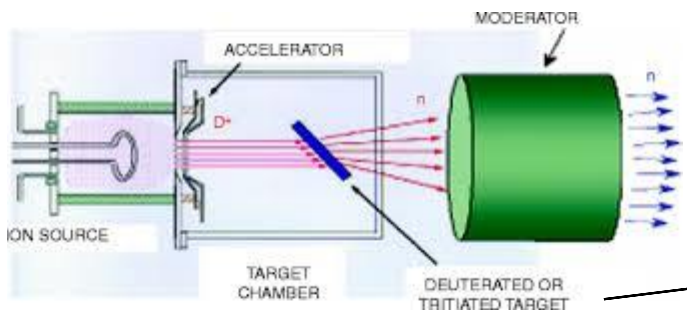
Providing technical conditions for the implementation of the scientific program of PTP DNP (Theme code: 03-4-1128-2017/2022).

Main Tasks

- Revival in JINR the research of ***reactions with fast quasimonoenergetic neutrons;***
- Providing the ***microbeam project implementation;***
- ***Development of methods*** of deep profiles elemental analysis due to:
  - Increasing the **performance of spectrometer;**
  - developing of **new methods** for elemental analysis of nanopowder and micropowder object;
- Training of **human resources.**

Perspective tasks of EG-5

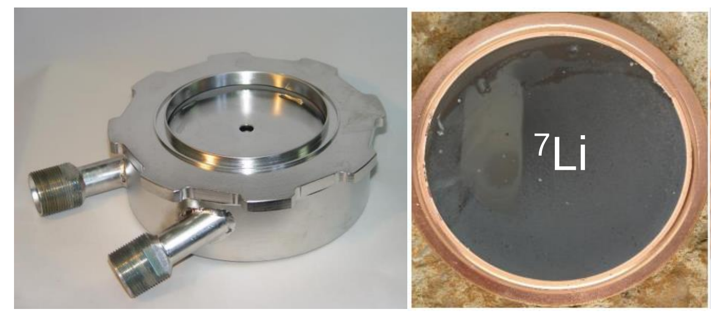
1. Powerful neutron generator



The energy of accelerated ions is up to 4.1 MeV at a beam current of up to 200-250 µA.

Solid-state target

$^{1}H + ^{7}Li - ^{7}Be + n$



- Neutrons flow – 5 10^{7} pat/s sm^{2}
- Energy region – 20 – 800keV (Max. proton current – 200mkA, energy – 4,1 MeV);

- Production of isotopes for medicine;
- Production of slow neutrons by moderators;
- Neutron activation analysis;
- Simulation of conditions in nuclear reactors, in space;
- Testing of electronics.
- Mutagenesis of biological objects.

Currently, there are no more than 11-15 accelerator complexes in the Russian Federation and JINR member countries (~18,000 in the world, 2012) [1]. Only 5 of them are intended for studies of reactions with fast neutrons (~1500 worldwide) [1].

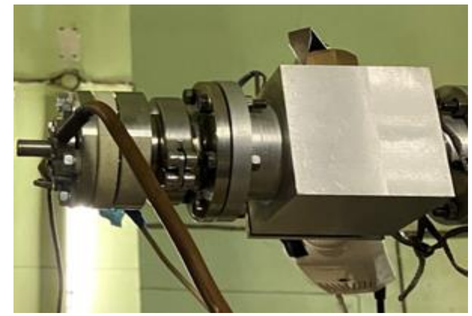
[1] Robert W. Hamm, Reviews of Accelerator Science and Technology https://doi.org/10.1142/7745 | August 2012;
[2] List of Nuclear Microprobe Facilities around the World http://w3.atomki.hu/atomki/IonBeam/icnmta/microprobefac.html

Neutron beam parameters

Lithium target
$^{7}Li(p,n)^{7}Be$

-Neutrons flow – 5 10^{7} pat/s sm^{2}
Energy region – 20 – 800keV (Proton current – 2mkA, energy – 2,0MeV);

Gas target
$D(d,n)^{3}He$

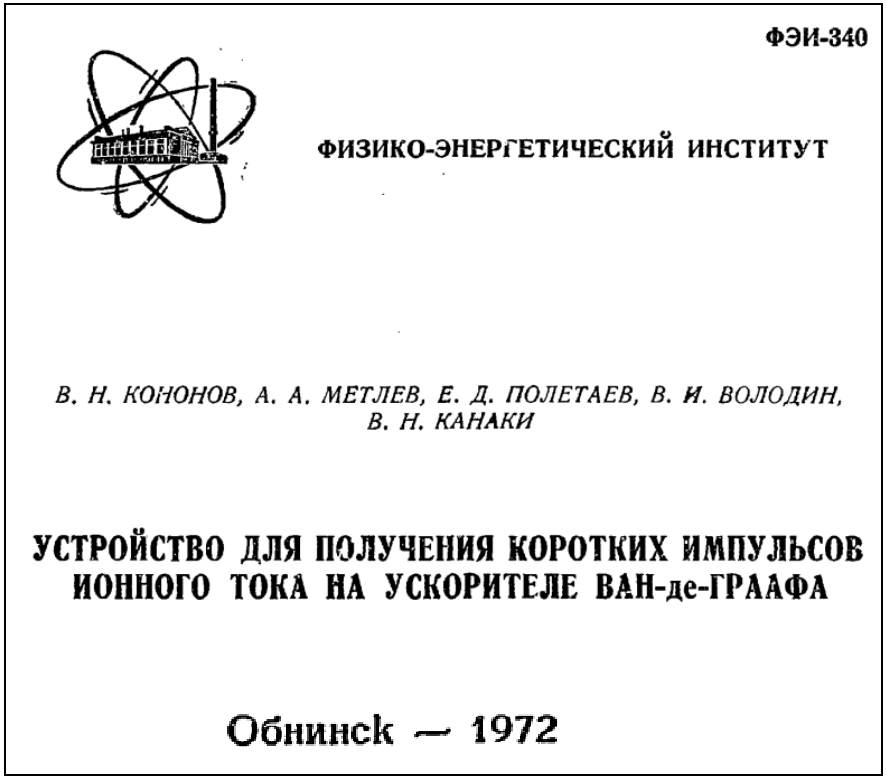


-Neutrons flow – 5 10^{7} pat/s sm^{2}
Max. neutrons energy - 5,5±0,1 MeV (Deutron current – 2mkA, deutron energy – 2,5MeV);

Studies with quasi-monochromatic neutrons in a wide range of energies will be available

- Testing the linearity of neutron detectors
- Spectroscopic studies

2. Pulse mode



ФЭИ-340

ФИЗИКО-ЭНЕРГЕТИЧЕСКИЙ ИНСТИТУТ

В. Н. КОНОНОВ, А. А. МЕТЛЕВ, Е. Д. ПОЛЕТАЕВ, В. И. ВОЛОДИН, В. Н. КАНАКИ

УСТРОЙСТВО ДЛЯ ПОЛУЧЕНИЯ КОРОТКИХ ИМПУЛЬСОВ ИОННОГО ТОКА НА УСКОРИТЕЛЕ ВАН-де-ГРААФА

Обнинск — 1972

Pulse mode of operation of Van de Graaf accelerators with the duration of current pulses on the target from units to hundreds of nanoseconds (f~ 1 MHz, dt~1-10 ns)

The paper (FEI, Obninsk) describes a device for receiving ion current pulses with a duration from 5 to 500 nsec and an independent change in the repetition frequency over a wide range (до 800 kHz).

- makes it possible to measure the energy spectrum of fast neutrons in an experiment.

- widely used in time-of-flight experiments with fast neutrons.

Practical implementation of the pulse mode in ESA

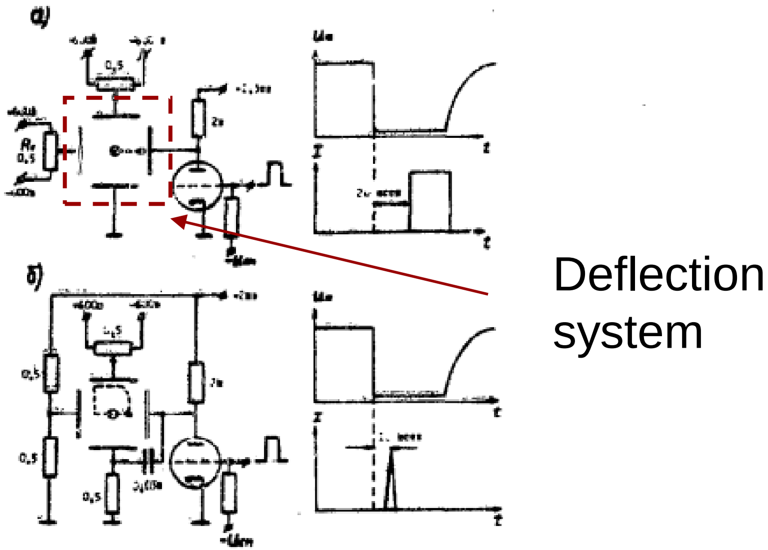


Рис. I.

Схема включения отклоняющих пластин и диаграммы импульсов ионного тока и напряжения на аноде выходной лампы генератора. Временная ось диаграммы тока смещена на величину времени пролета ионов от конца нижних пластин до диафрагмы. Пунктиром показана траектория ионного пучка в плоскости диафрагмы:

а) для получения импульсов с длительностью 20 ÷ 500 нсек;
б) для получения импульсов с длительностью 5 нсек.

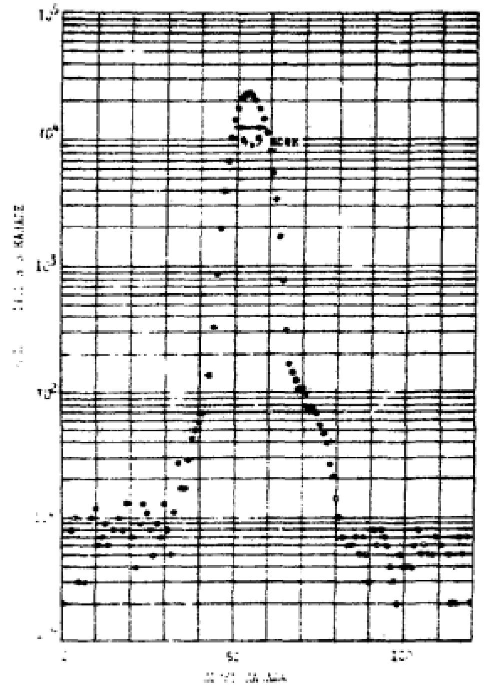


Рис. 3.

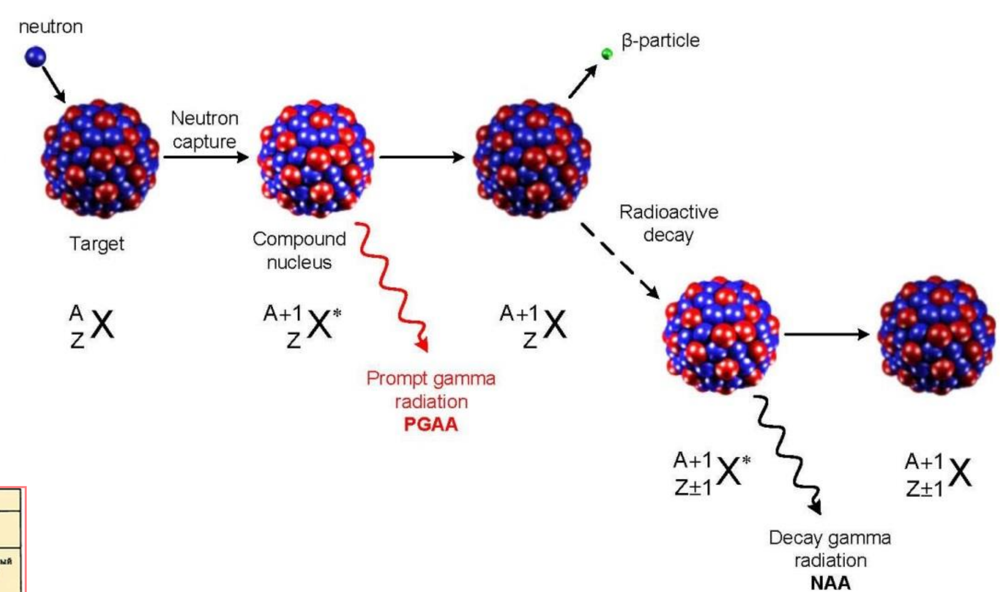
Форма импульсов ионного тока. Цена канала 0,I92 нсек/канал. Отсчет времени справа налево.

It is proposed to use electrostatic deflecting coils to interrupt the ion beam

3. Developing PGAA methods for determining the elemental composition of materials using EG-5

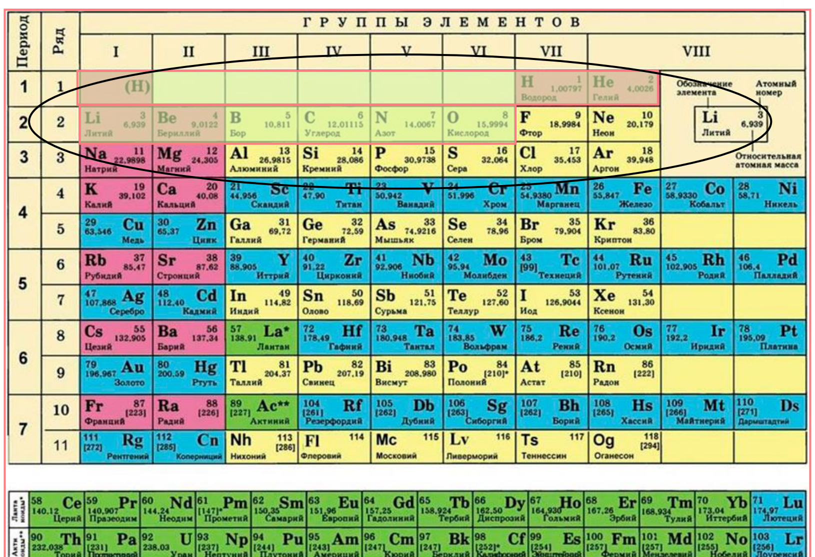
We planned to create the following research areas and develop promising works:

- Determination of the elemental composition by the reaction of inelastic neutron scattering.



Main advantages

- Lack of residual activity in samples, the ability to examine samples in the future (which is very important in the case of expensive items)
- Both directions, unique for JINR and the Russian Federation, will add to the spectrum of available NAA methods at JINR.



PGAA complements existing methods of analysis by working with the determination of isotopes of light particles, combining all the advantages of the described methods, such as: completely indestructible sample, simple sample preparation, as well as an extremely low degree of activation with the possibility of further work with the material.

Setup for prompt-gamma measurements at EG-5

К. Храмко

И.А. Чепурченко

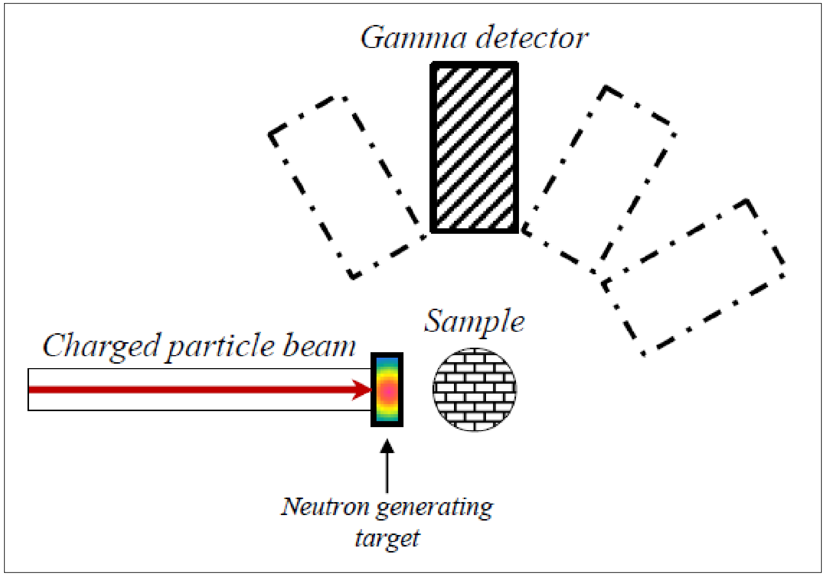


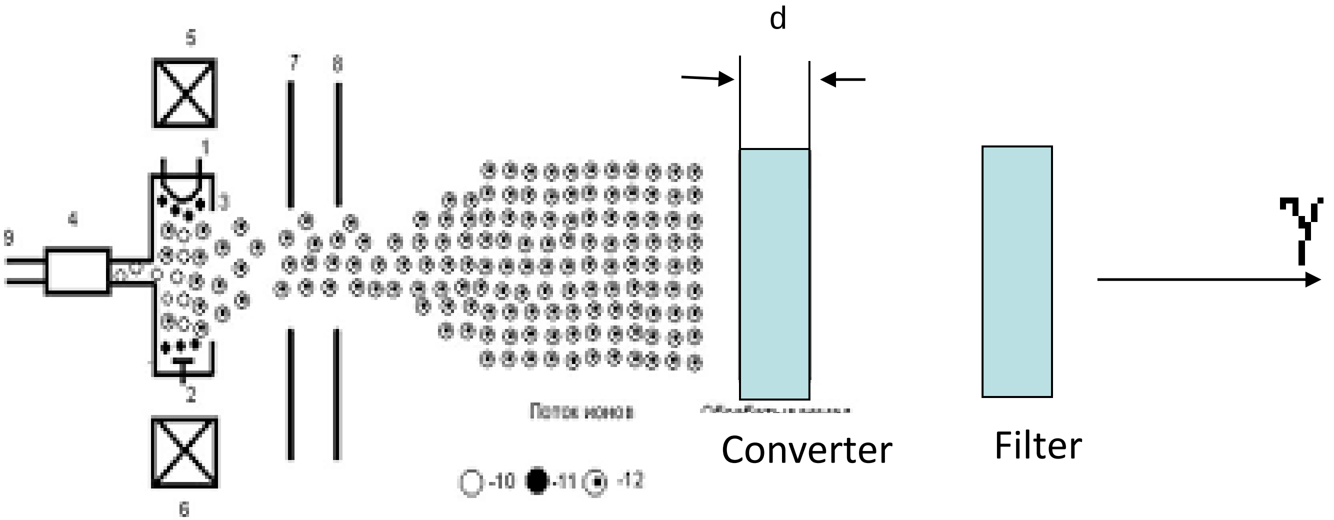
Figure Scheme of the setup for prompt-gamma measurements

Allow measurements in different ranges of neutron energies (depending on the target):

- Refinement and addition of nuclear data (interaction cross-sections for fast neutrons, catalog of prompt gamma radiation);
- Accurate data on reactions will help in the development of portable installations using neutrons, improved calculations for the creation of protective materials for fast neutron reactors, refinement/improvement of theoretical models;
- Possibility of elemental analysis of bulk samples;

The complementary methods

Gamma-quantum generator based on ESA



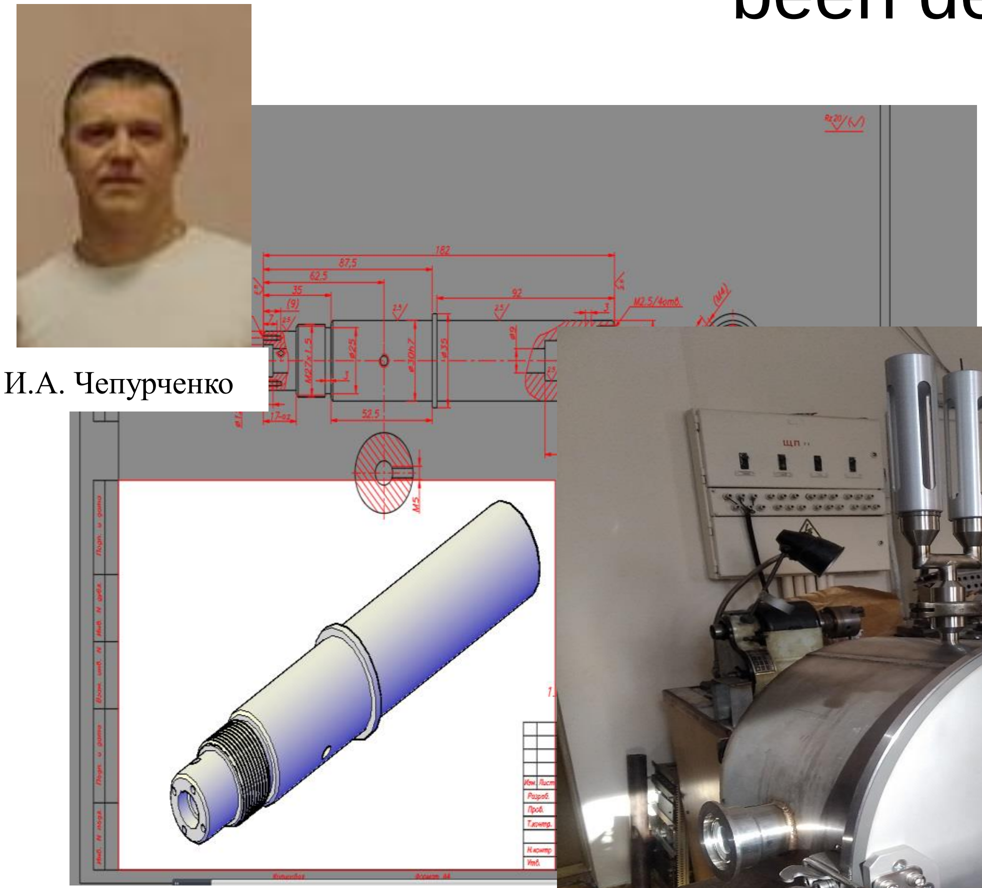
The number of interactions is determined by the ratio $N = N_0\sigma n$, where σ is the total capture cross section. The size of the cross-section may differ from the geometric cross-sectional area of the core by several orders of magnitude.

$$n = \frac{\rho d N_A}{A}$$

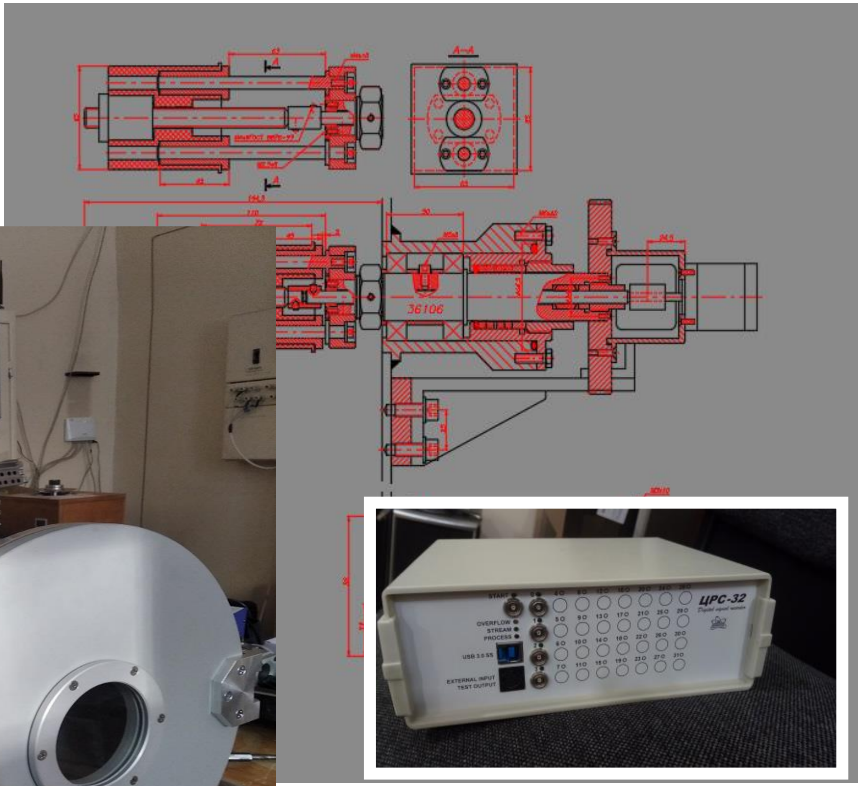
1 barn = 10^{-24} sm^2.

The number of nuclei per unit area n is determined by the thickness of the targetwhere p is the density of the target substance, d is the thickness of the target, NA is the Avogadro number,A is a mass number.

A new module of ion-beam spectrometers has been developed



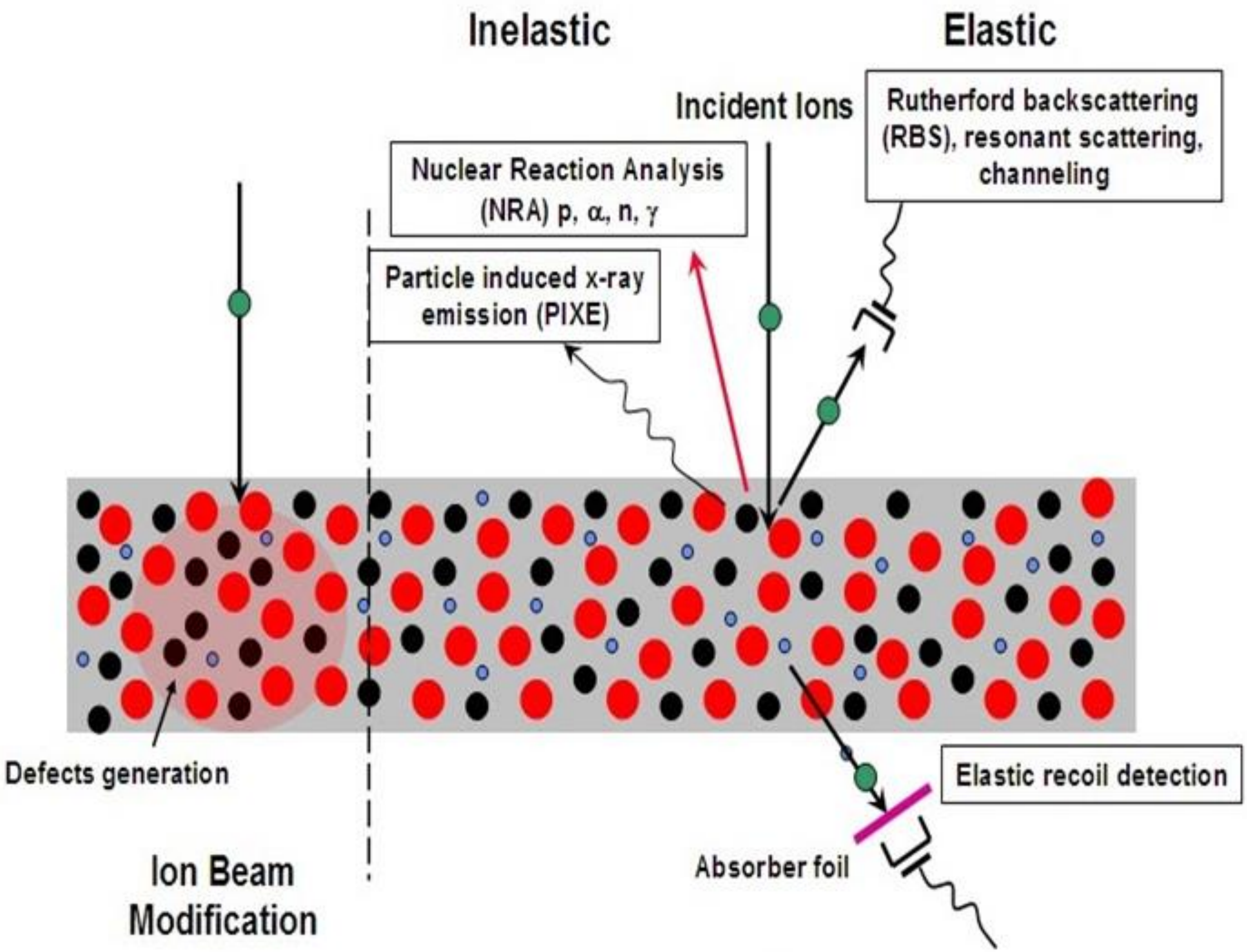
И.А. Чепурченко



+ Pumping station purchased at TMP

+ Signal processing module purchased

Ion beam analysis («IBA»).
Methods RBS, ERD, PIXE



Set of complementary methods for studying the surface layers of materials

-Ellipsometer (optical and electronic devices),
-Impedance meter and
-Potentiostat,
-Microweights,
-Optical Microscope,
-General laboratory equipment.

Progress of modernization

Calculations of the HV-tube have been carried out

Budker Institute of Nuclear Physics (Novosibirsk)

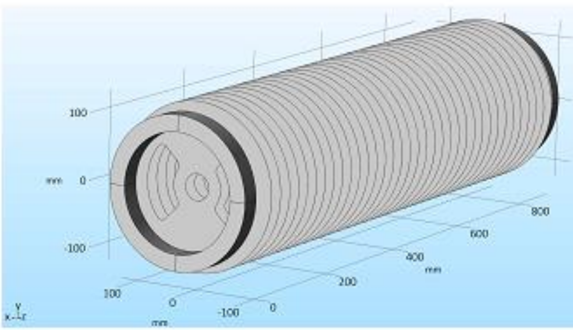
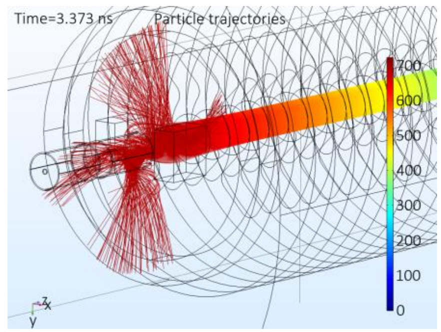
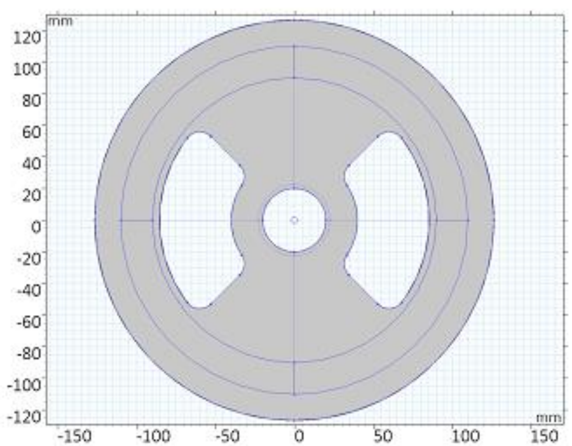
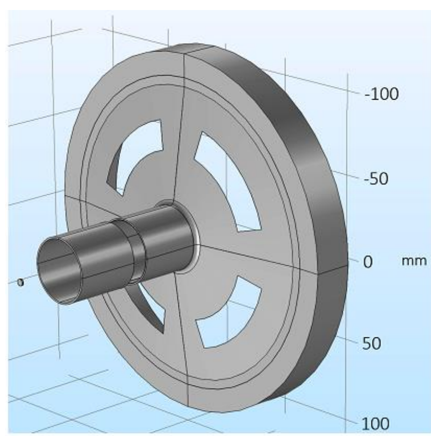


Рис. 1: Ускорительная секция



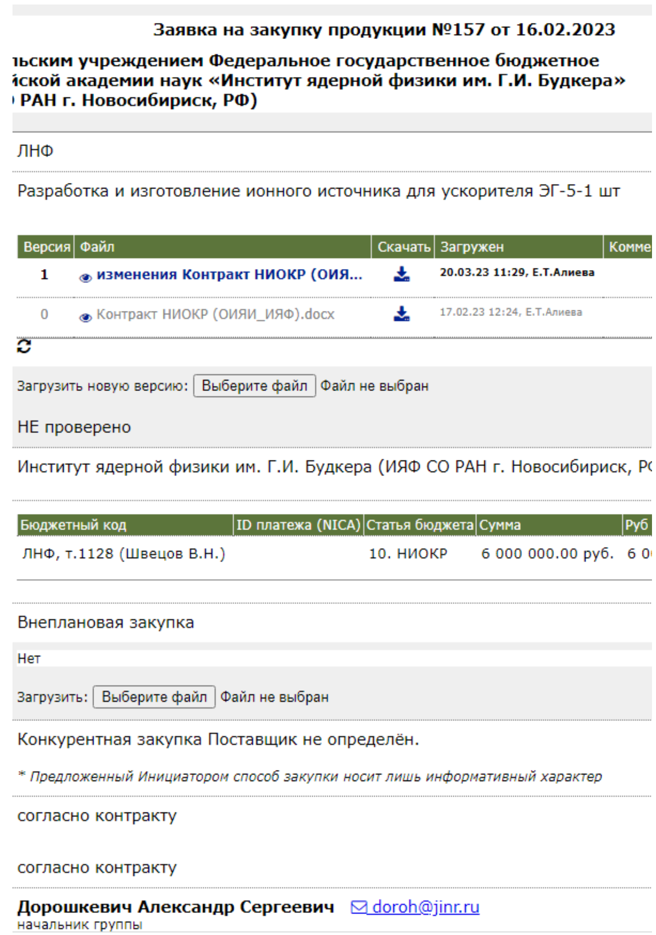


ıспользуемого электрода с апертурой 40 мм и отверстия



Q-snout линза с креплением на фланец ускорительной трубки ЭГ-5. Вид со стороны пучка, входящего в ускоритель.

Contract for the manufacture of a new RF source



Заявка на закупку продукции №157 от 16.02.2023

ıьским учреждением Федеральное государственное бюджетное
ıской академии наук «Институт ядерной физики им. Г.И. Будкера»
ı РАН г. Новосибирск, РФ)

ЛНФ

Разработка и изготовление ионного источника для ускорителя ЭГ-5-1 шт

Версия	Файл	Скачать	Загружен	Комме
1	**изменения Контракт НИОКР (ОИЯ...**		**20.03.23 11:29, Е.Т.Алиева**	
0	Контракт НИОКР (ОИЯИ_ИЯФ).docx		17.02.23 12:24, Е.Т.Алиева	

Загрузить новую версию: Выберите файл Файл не выбран

НЕ проверено

Институт ядерной физики им. Г.И. Будкера (ИЯФ СО РАН г. Новосибирск, РС

Бюджетный код	ID платежа (NICA)	Статья бюджета	Сумма	Руб
ЛНФ, т.1128 (Швецов В.Н.)		10. НИОКР	6 000 000.00 руб.	6 0

Внеплановая закупка

Нет

Загрузить: Выберите файл Файл не выбран

Конкурентная закупка Поставщик не определён.

** Предложенный Инициатором способ закупки носит лишь информативный характер*

согласно контракту

согласно контракту

Дорошкевич Александр Сергеевич doroh@jinr.ru
начальник группы

Experimental premises have been prepared

I.A. Chepurchenko

K.E. Studnev

The accelerator hall has been prepared for the replacement of the HV-tube, the left experimental hall has been repaired

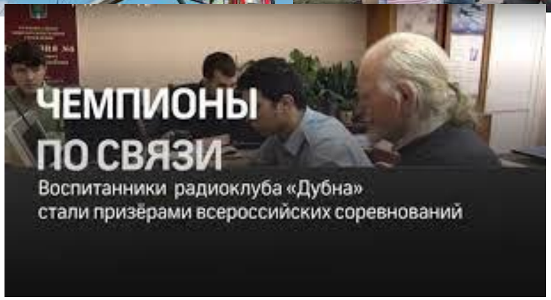
Floors are filled with epoxy enamel, walls are painted, trash is removed.

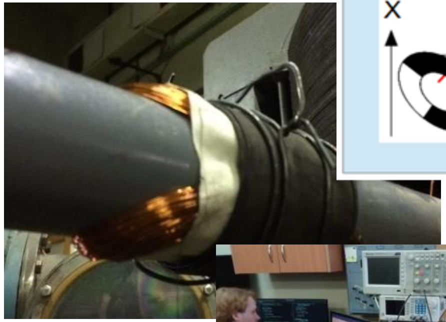
Ion beam positioning and position stabilization system

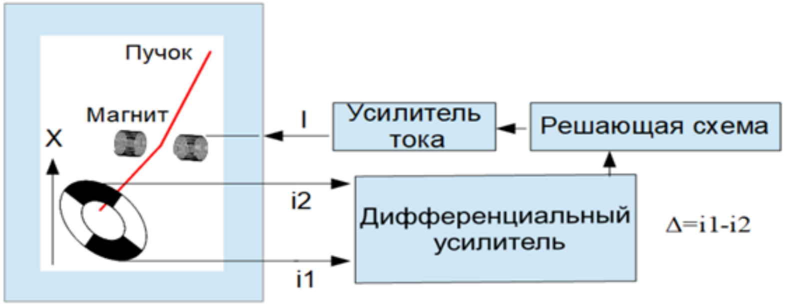
В.Н. Семенов

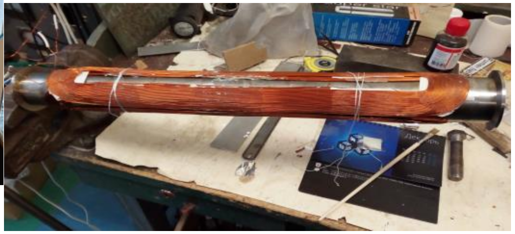
A well-known electronics engineer V.N. Semenov is developing an ion beam positioning system.

These same system can be used to generate nanosecond pulses of ion current. Calculations, modeling of processes in electrical circuits, prototyping were carried out, the necessary parts were manufactured.









Conclusion

The EG-5 low-current direct-acting accelerator is a relatively inexpensive and reliable tool for solving a wide range of unique scientific problems in the field of nuclear physics and solid state physics.

1. **Research in the field of neutron physics.**
2. **Analysis of the elemental composition and depth profiling.**
3. **Radiation Materials Science.**
4. **Radiobiological direction.**
5. **Elemental analysis using inelastic fast neutrons**.

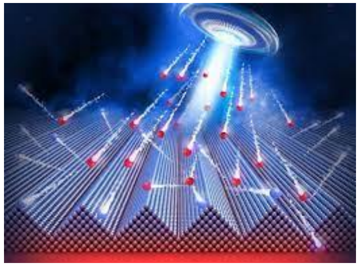
Thank you for your attention!

Significant advantage

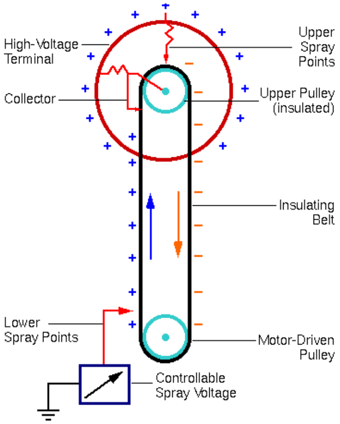
- high energy stability of ion beam;
- high intensity of ion beam;
-accelerated particles (H^+, He, D);
-accelerated voltage (from 800 keV to 3MeV).
-possibility of obtaining of high-intensity ion beams.

ESA EG-5

Areas of use



- Nuclear reactions with fast quasimonoenergetic neutrons;
- Ion Beam Spectrometry (Multilayer structures, isotope determination, elemental depth profiling);
- Radiation technologies (Science, technology, medicine, etc.).



Ion beam parameters

Range of ion beam currents - 0,01 - 3 мкА (100 – 150mkA*);
- Real ion beam energy range - 800 keV – 2,5MeV (4,1 MeV*);
- Energy resolution (H^+, He^{2+}) - not worse than 15keV;
- Charged particles flow (H^+, He^{2+}) – 10^{12}–10^{13} part /s sm^{-2}

-Neutrons flow – 5 10^7 pat/s sm^2

- Max. neutrons energy - 5,5±0,1 MeV (Deutron current – 2mkA, deutron energy – 2,5MeV);

*- will be after modernization

Contact E-mail: doroh@jinr.ru Aleksandr Doroshkevich