The Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences

www.ifj.edu.pl

Instytut kategorii A+

HR EXCELLENCE IN RESEARCH

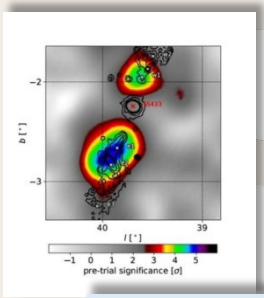
Kraków, April 4, 2023

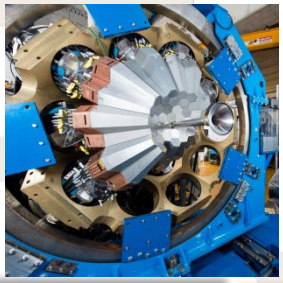
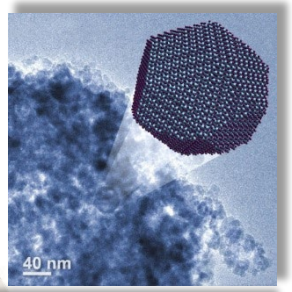
Prof. Tadeusz Lesiak

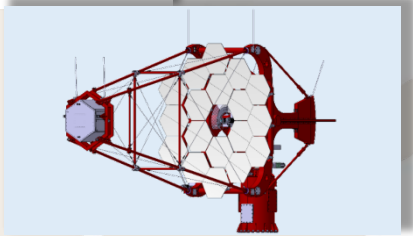
Director General

General Information about IFJ PAN

- Personnel: 572; Prof. 30, Assoc. Prof. 62, Ph.D. 98, engineers 122
- Scientific Divisions:
  - Division of Particle and Astroparticle Physics
  - Division of Nuclear Physics and Strong Interactions
  - Division of Condensed Matter Physics
  - Division of Theoretical Physics
  - Division of Interdisciplinary Research
  - Division of Applications of Physics
- Researcher Departments:
  - Cyclotron Centre Bronowice
  - Division of Scientific Equipment and Infrastructure Construction
  - Four accredited laboratories
- Education:
  - International Ph.D. Studies
  - Interdisciplinary Doctoral Studies
  - Kraków Interdisciplinary Doctoral School
- Scientific output: > 650 publications annually

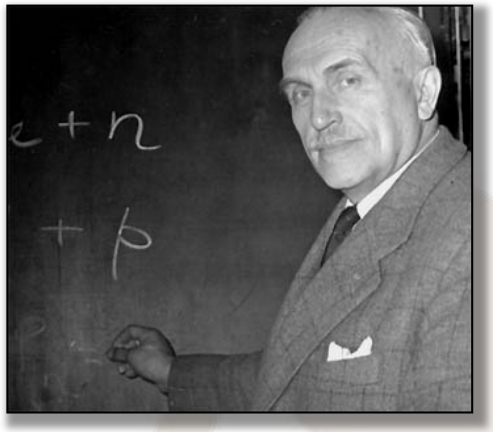






Genesis and History

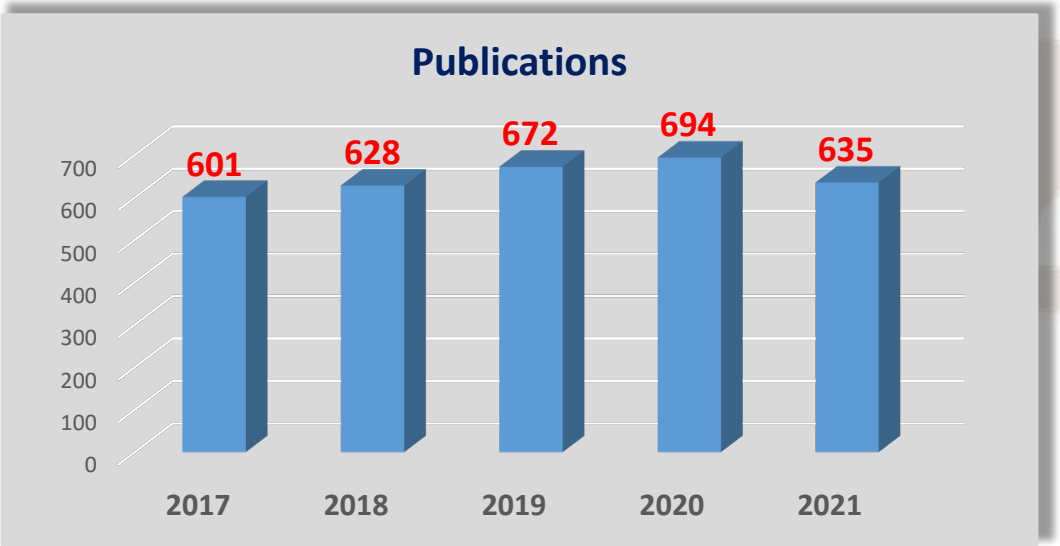


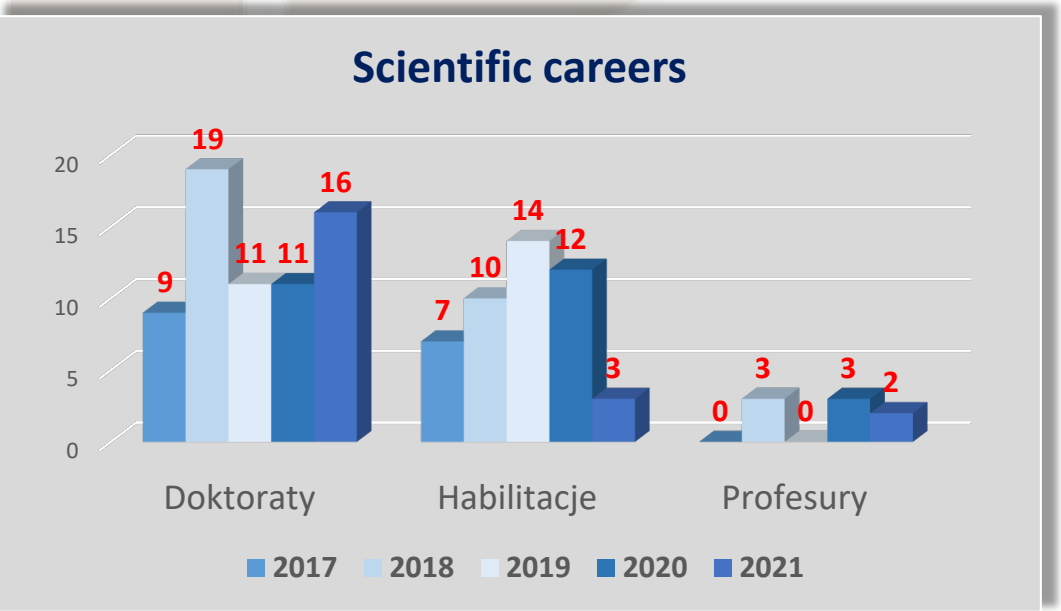
(Fot. Archiwum of the IFJ PAN)

- **1955 – foundation of the IFJ – as a branch of the Institute of Nuclear Research – Prof. Henryk Niewodniczański (1900-1968)**

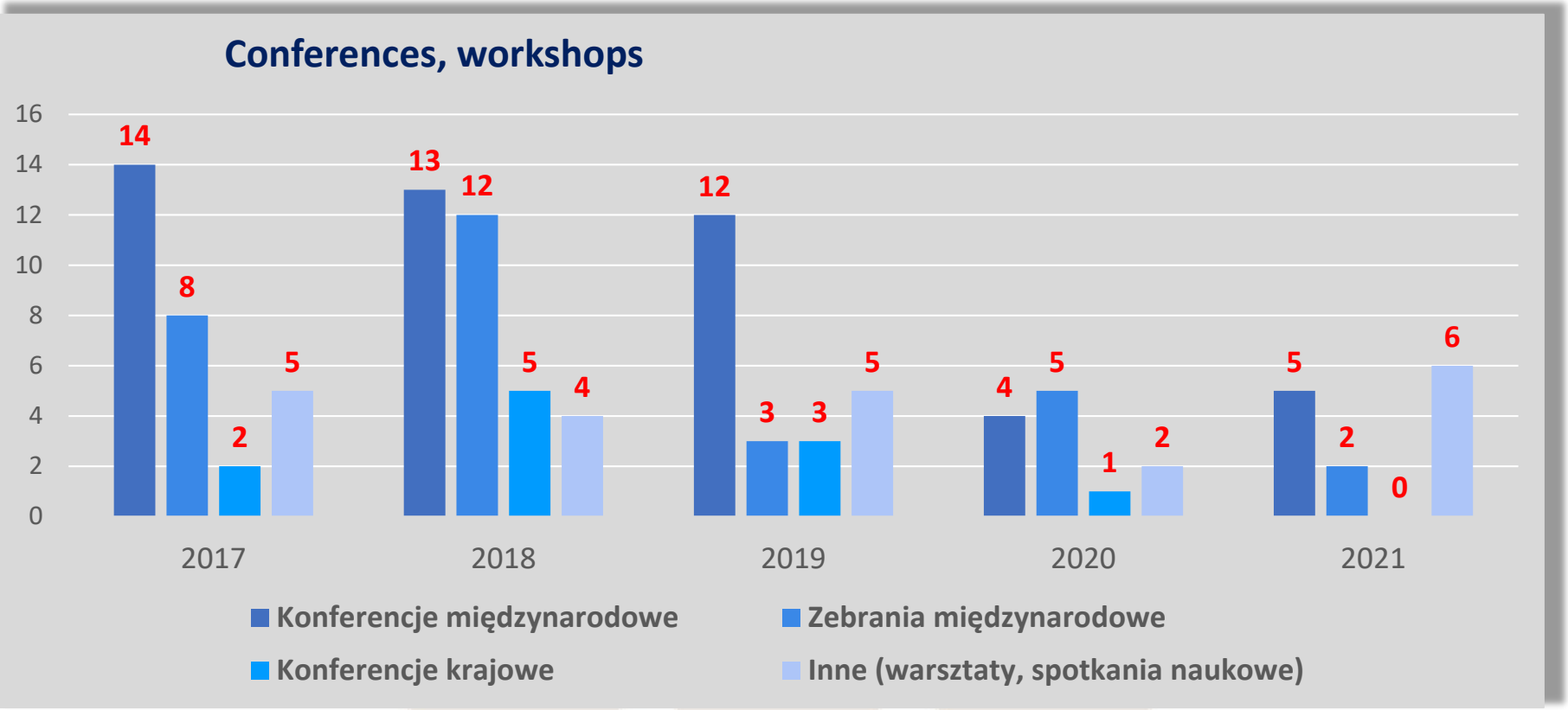
- **1960 – IFJ as a standalone unit**
- **1970 – Particle physics enters – Prof. Marian Mięsowicz (1907-1992)**
- **1988 – IFJ gets the name of its patron – Henryk Niewodniczański**
- **2003 – IFJ gets the status of a research institute of Polish Academy of Sciences**

Scientific Activity (2017-2021)





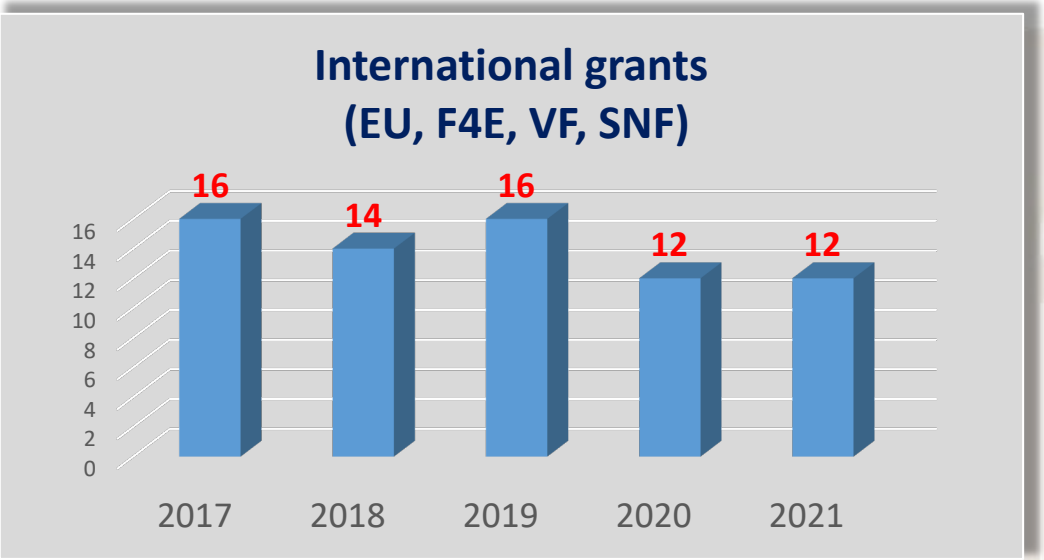
Conferences and Workshops (2017-2021)

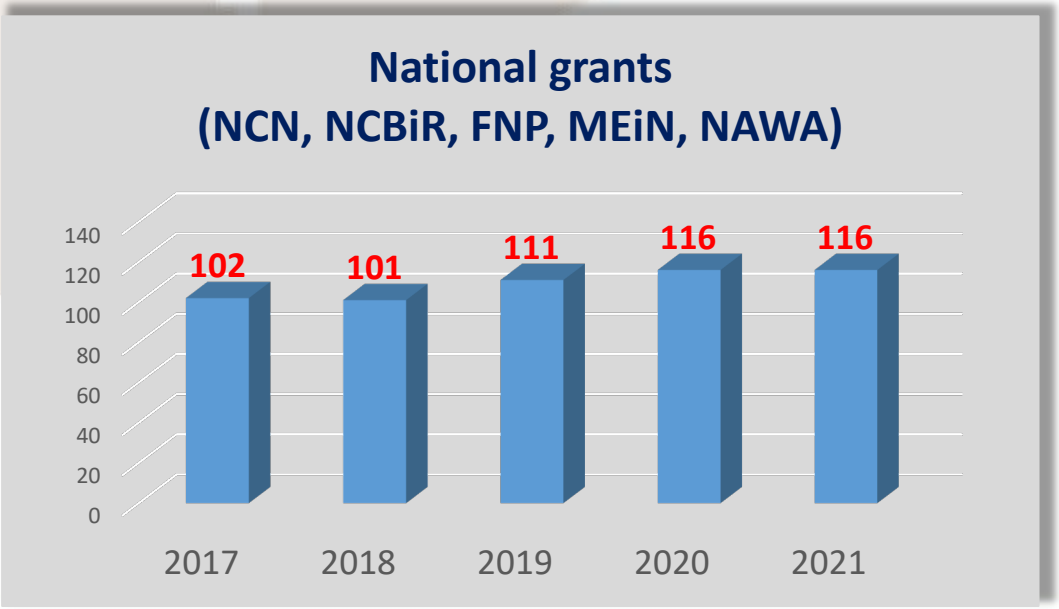


- **International, periodic conferences**:
  - Cracow Epiphany Conference
  - Zakopane School of Physics
  - Cracow School of Theoretical Physics
  - Multiscale Phenomena in Molecular Matter – MULTIS

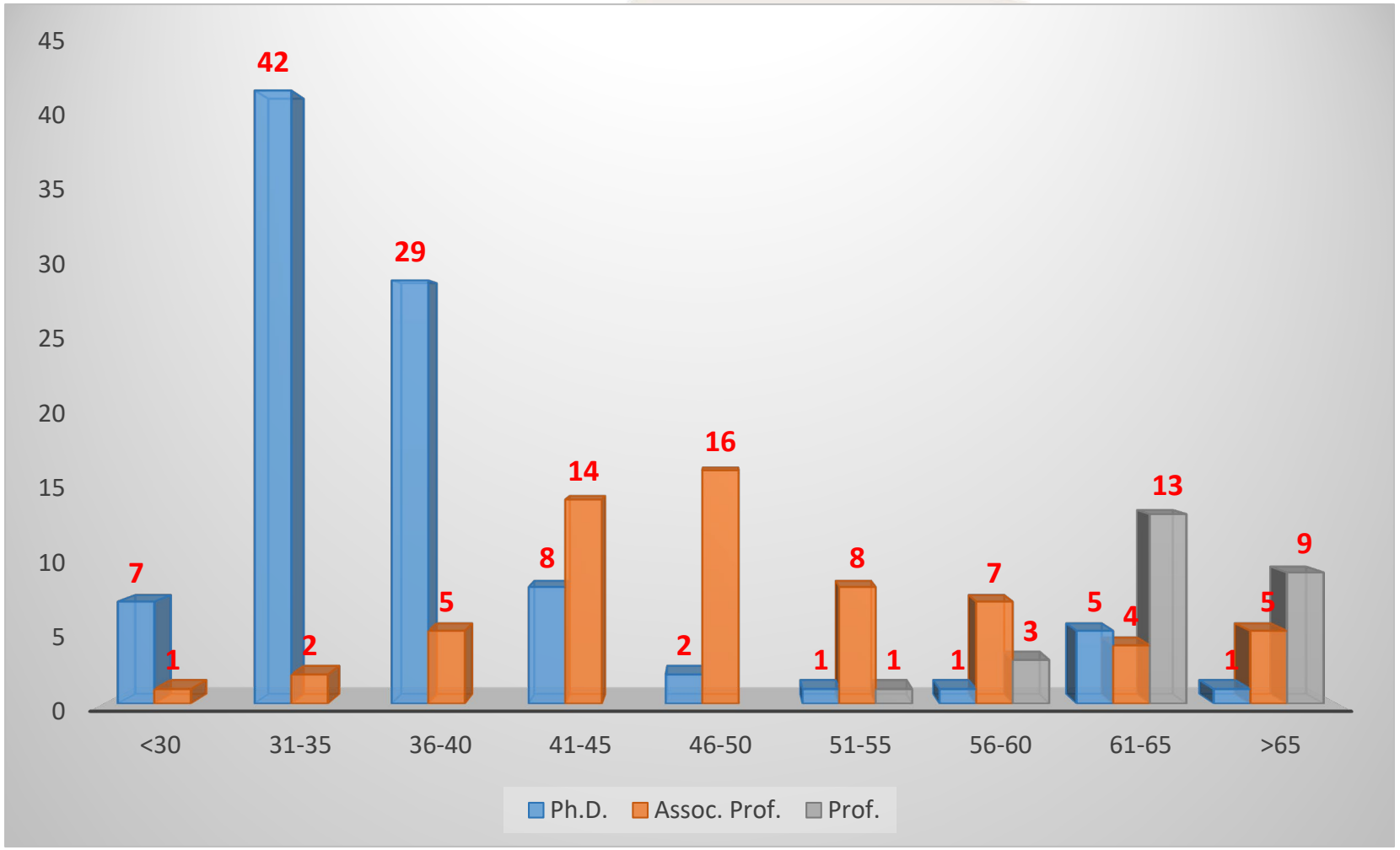
- **Two recent prestigious conferences in 2022: QuarkMatter 2022 i IM2022/NEUDOS-14**

International and Polish Grants (2017-2021)





Age Profile of the Personnel



IFJ PAN on Polish Roadmap for Scientific Infrastructure

Projects coordinated by the IFJ PAN

1. CCB – Cyclotron Center Bronowice (development, next phase)
2. Centrum of Engineering of Cryogenic Materials
3. ESS
4. SPIRAL2
5. Research in particle physics at CERN

Projects with IFJ PAN as a partner, correlated with the national contribution to ESFRI:

1. **E-XFEL**
2. **ELI**
3. **CTA**
4. **FAIR**
5. **ESRF** – European Synchrotron Radiation Facility

Governing Bodies

Directoriate

- Prof. Tadeusz Lesiak - General Director
- Prof. Bogdan Fornal - Scientific Director
- Assoc. Prof. Dariusz Bocian - Scientific & Technical Director
- LL.M. Magdalena Zydek - Administrative & Economic Director
- M.Sc. Eng. Małgorzata Jasiówka - Chief Accountant

Scientific Council

- Prof. Antoni Szczurek - Chairman

Deputy Chairmen

- Prof. Wojciech Kwiatek
- Prof. Paweł Olko
- Prof. Piotr Zieliński

- **Scientific Secretary:** Assoc. Prof. Przemysław Piekarz

Division of Particle and Astroparticle Physics (NO1)

Division Head: Anna Kaczmarska

- **The Belle II Experiment Department (NZ11, Andrzej Bożek)**
- **The ATLAS Experiment Department (NZ14, Ewa Stanecka)**
- **The LHCb Experiment Department (NZ17, Mariusz Witek)**
- **Department of Diffractive Processes (NZ13, Janusz Chwastowski)**
- **Department of Cosmic Ray Research and Neutrino Studies (NZ15, Dariusz Góra)**
- **Department of Gamma-Ray Astrophysics (NZ12, Jacek Niemiec)**

Eksperiments at CERN: LHC, HL-LHC **Japan: KEKB, SuperKEKB** **ν T2K** **BNL: EIC**

Astroparticle observatories

Projects for future accelerators

Staff: about 60 people

Results: about 300 publications/yr

Division of Particle and Astroparticle Physics (NO1)

1. **The ATLAS experiment**
   - physics analyses of proton-proton and heavy ion collisions
   - design, construction and maintenance of SCT, TRT, AFP, ALFA and ZDC detectors, ITk for HL-LHC
2. **The LHCb experiment**
   - physics analyses and RTA (Real Time Analysis), on-line event reconstruction and selection, monitoring
   - involvement in RICH, scintillator based trackers (Magnet Stations, Sci-Fi for Upgrade II), interests in calorimeters
3. **The Belle II experiment**
   - physics analyses (B decays with missing energy)
   - already collaborating with IJCLab on new readout system currently being deployed
   - long time contacts with prof. Emi Kou and prof. Karim Trabelsi
4. **Cosmic Ray Research**
   - project Pierre Auger – construction and data analysis
   - project Cosmic-Ray Extremely Distributed Observatory (CREDO) – search for cosmic ray ensembles spread over very large surfaces using smartphones ("citizen science")
5. **Neutrino studies**
   - T2K – neutrino oscillation studies
   - P-ONE - search for very-high-energy neutrinos of astrophysical origin (under construction)
6. **High energy Gamma-Ray Astrophysics**
   - H.E.S.S. (High-Energy Stereoscopic System) experiment
   - HAWC (High Altitude Water Cherenkov) experiment
   - Cherenkov Telescope Array (CTA) observatory (under construction)
7. **Involvement in other projects**
   - preparation of MUonE experiment at CERN and ATHENA experiment at future Elektron Ion Collider (EIC)
   - Physics feasibility studies for future accelerators ILC/CLIC/FCC
   - experiment STAR at RHIC, BNL
   - development of "Clould Computing" and GRID computing infrastructures

Division of Nuclear Physics and Strong Interactions (NO2)

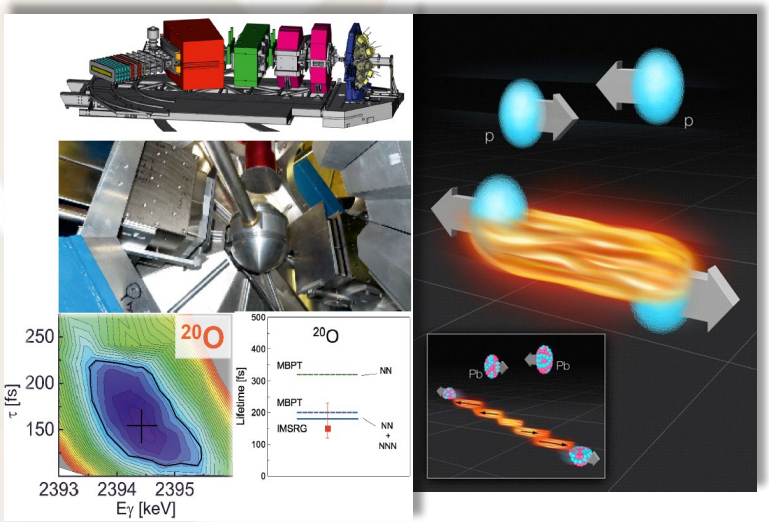
Division Head: Adam Maj

- Department of the Theory of Strong Interactions and Many Body Systems (NZ21, Antoni Szczurek)
- Department of Structure of Atomic Nucleus (NZ22, Piotr Bednarczyk)
- Department of the Ultrarelativistic Nuclear Physics and Hadron Interactions (NZ23, Marek Kowalski)
- Department of Nuclear Reactions and Hadronic Processes (NZ24, Adam Kozela)

- Major Experiments: AGATA, PARIS, ALICE, NA61/SHINE, neutron EDM…

- International cooperation in particular with IJCLAB Orsay, GANIL Caen, LNL INFN Legnaro, Milano University, GSI Darmstadt, FZ Julich, RIKEN Japan

- Local research program at the PROTEUS-235 Cyclotron at the Cyclotron Center Bronowice IFJ PAN ➔ next slide



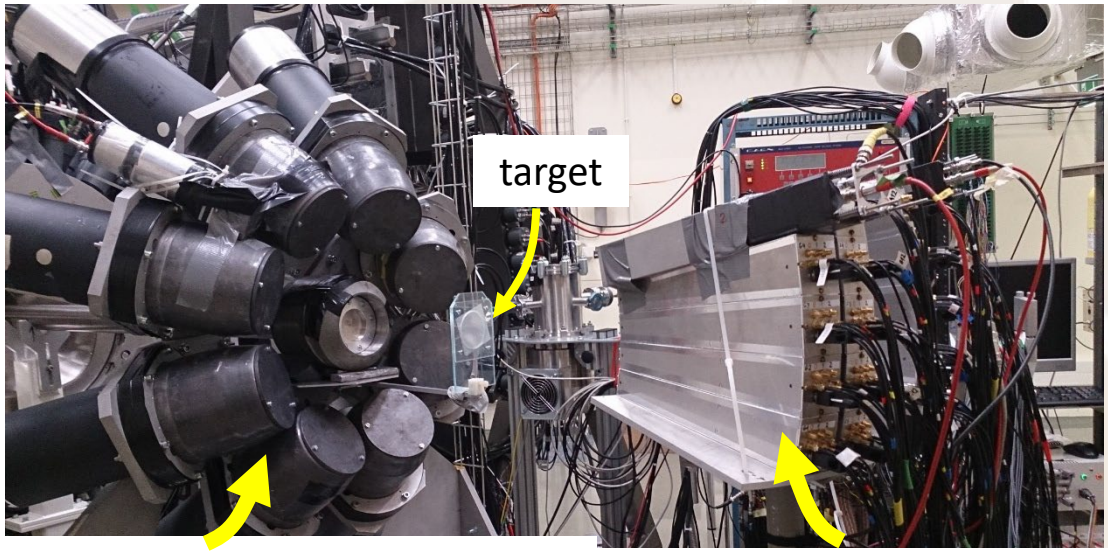
Staff: about 45 people

Results: about 140 publications/yr

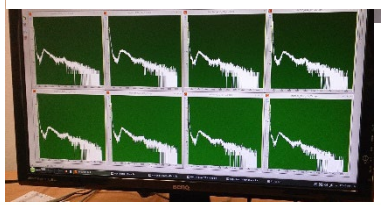
Fundamental Research at the Cyclotron Center Bronowice

Studies in nuclear physics with the PROTEUS-235 Cyclotron at the Cyclotron Center Bronowice IFJ PAN

Studies of collective nuclear excitations by using high-energy proton beam



HECTOR high-energy γγ-ray array

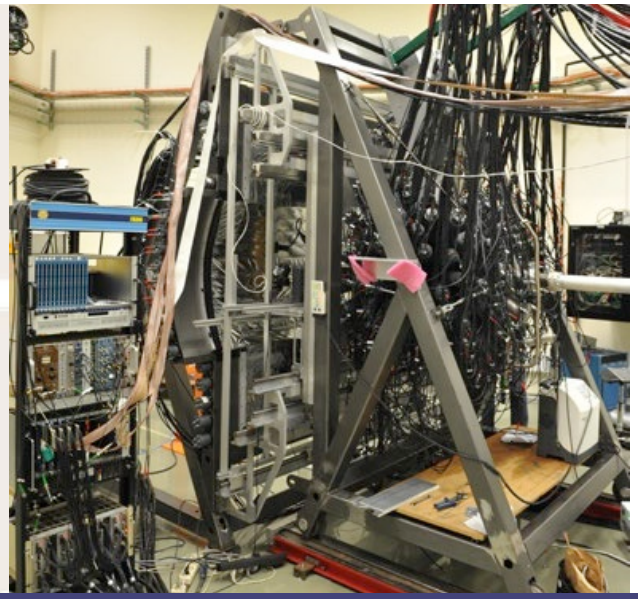


KRATTA detector system for detecting non-elastically scattered protons

Collaboration: IFJ PAN – Milano University

Studies of the dynamics of few-nucleon systems

BINA detection system for measuring *p, d, t (angular correlations)*



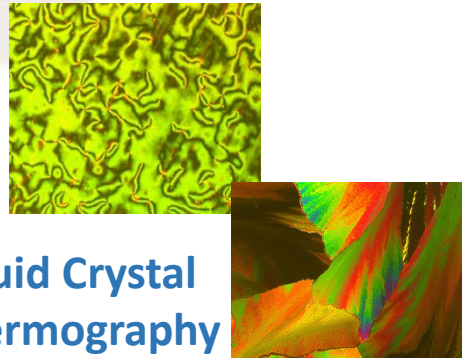
Collaboration: Jagiellonian Univ. – University of Silesia – IFJ PAN

Division of Condensed Matter Physics (NO3)

Division Head: Marta Wolny-Marszałek

- Department of Structure Research of Condensed Matter (NZ31, Mirosław Gałązka)
- Department for Functional Nanomaterials (NZ32, Magdalena Parlińska-Wojtan)
- Department of Material Research by Computers (NZ33, Przemysław Piekarz)
- Department of Magnetic Materials and Nanostructures (NZ34, Michał Krupiński)
- Department of Soft Matter Research (NZ35, Ewa Juszyńska-Gałązka)
- Department of Molecular Engineering and Nanoelectronics (NZ36, Łukasz Laskowski)
- Department of Molecular Magnetism (NZ37, Magdalena Fitta)

- **Major Studies:** new magnetic materials, thin films of metals and alloys, nanoparticles, carbon coatings, liquid crystals, glasses, polymers, molecular matter, calculations of the structure and dynamics of materials, ion transport simulations, neutron scattering techniques….



Liquid Crystal Thermography (LCT)

- **International cooperation with** DESY, EuXFEL, PSI, ESRF, EPFL, UAugsburg, HZDR Dresden, ILL,…

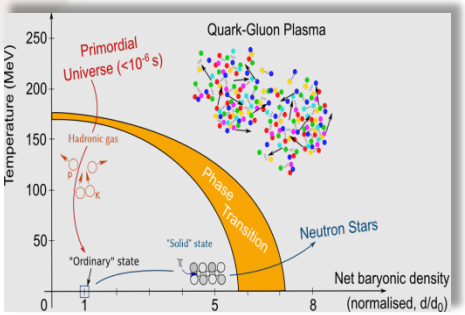
Staff: about 60 people

Results: about 100 publications/yr

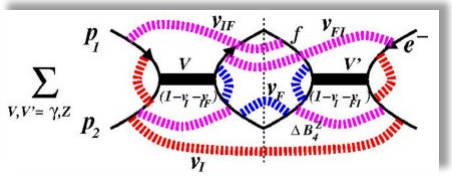
Division of Theoretical Physics (NO4)

Division Head: Maciej Skrzypek

- **Department of Theory of Structure of Matter (NZ41, Krzysztof Golec-Biernat)**
  - Phenomenological analyses of high precision rare and semi-leptonic B and D decay data from LHCb and Belle II
  - Studies of parton distribution functions of nucleon and their QCD evolution: GPDs, quasi PDFs, double PDFs, TMDs
  - Studies of q-g plasma created in heavy ion collisions: hydrodynamical description, early thermalization, plasma polarisation
    Sonification of data recording and analysis for cosmic rays under the CREDO project

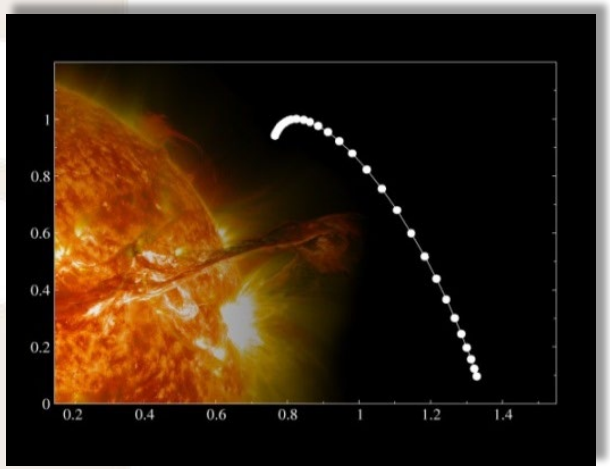


- **Department of Particle Theory (NZ42, Krzysztof Kutak)**
  - Construction of nuclear parton distribution functions and their application to LHC physics and future colliders
  - Participation in nCTEQ collaboration
  - Forward and low x physics. Construction of general framework for NLO calculations; predictions for future upgrades of LHC
  - Search for saturation effects
  - Monte Carlo development for FCC and LHC
  - Calculations of N3LO within SCET for LHC precision phenomenology
  - Jet quenching in heavy ion physics. Monte Carlo simulations cross section calculations
  - Entanglement entropy at high energies



Division of Theoretical Physics (NO4)

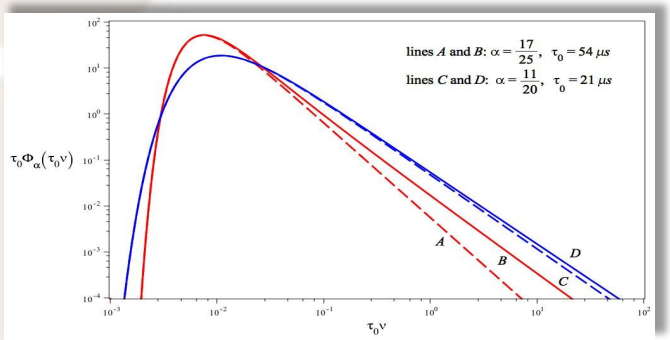
- **Dept. of Theory of Complex Systems (NZ43, Stanisław Drożdż)**



  - Identification of the general characteristics of complexity and development of related methodology
  - Quantification of long-range temporal correlations in time series in terms of multifractals
  - Study of the dynamics of fluctuations and correlations in the financial markets
  - Analysis of the brain activity with the use of machine learning methods
  - Studying the natural language in the formalism of complex systems

Group of Mathematical Physics:

  - Construction of the models of anomalous transport and their application to anomalous diffusion and relaxation processes
  - Analysis of quantization methods based on the generalized coherent states
  - Investigation of effects related to quantum entanglement



Staff: about 34 people

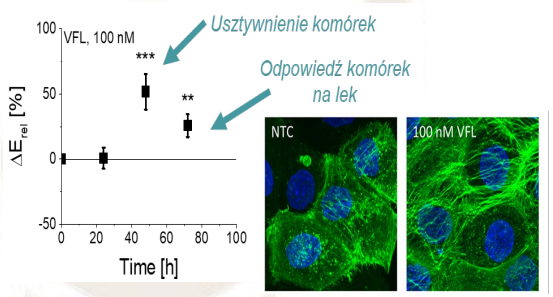
Results: about 60 publications/yr

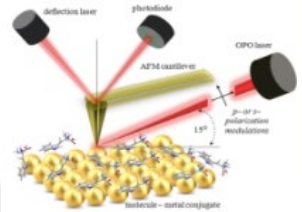
Division of Interdisciplinary Research (NO5)

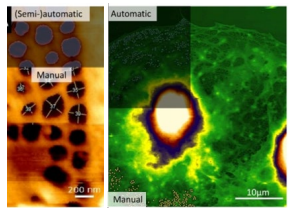
Division Head: Wojciech M. Kwiatek

- Department of Experimental Physics of Complex Systems (NZ52, Katarzyna Pogoda)
- Department of Applied Spectroscopy (NZ53, Joanna Czapla-Masztafiak)
- Department of of Biophysical Microstructures (NZ55, Małgorzata Lekka)
- Department of Magnetic Resonance Imaging (NZ56, Władysław Węglarz)

- **Major Studies:** spectroscopic imaging for therapy, diagnostics, and material research, effects of exposure of biological samples to ionizing radiation, mechanical properties of cells and tissues,...







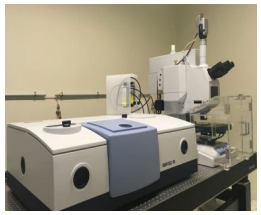
- **International cooperation** in particular with DESY, EuXFEL, PSI, SwisFEL, ELI, INFN LNF, Eletra, ESRF, Diamond, Soleil, EPFL, NUS, PennUni, UMalaga, UTromso, Umilano, Ucalgary, UVictoria

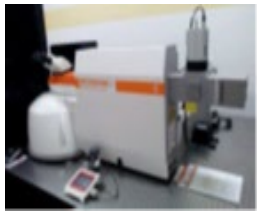
Staff: about 40 people

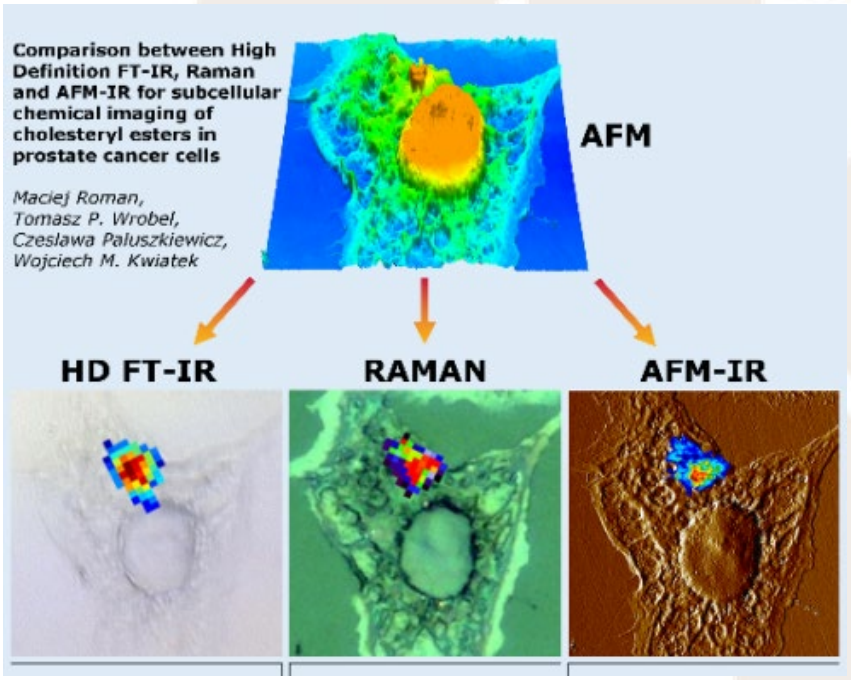
Results: about 80 publications/yr

Fundamental Research at the Cyclotron Center Bronowice

Studies of ionizing radiation influence to chemical composition imaging

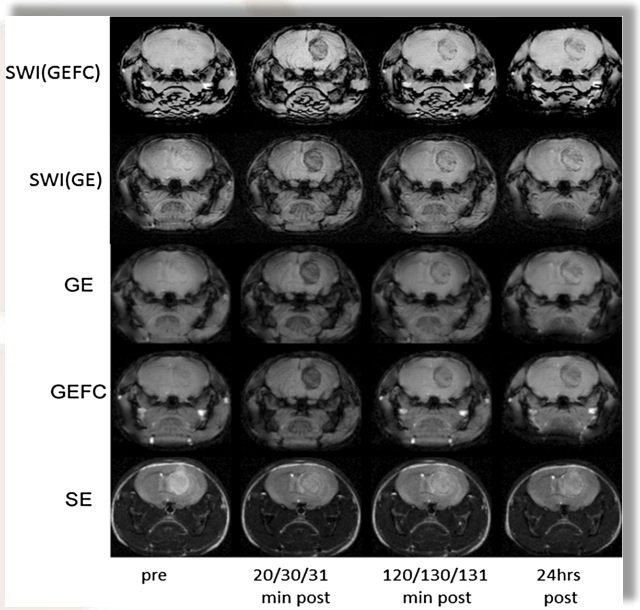






Collaboration: Jagiellonian University - IFJ PAN

Application of NMR imaging and spectroscopy to study the properties of drug carriers, modern contrast agents and porous materials



Collaboration: Jagiellonian Univ. – JCET– IFJ PAN

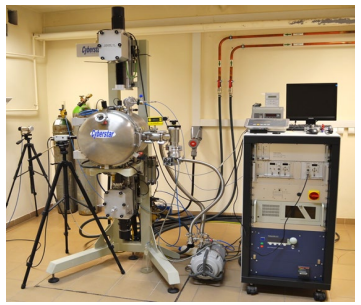
Division of Applications of Physics (NO6)

Division Head: Paweł Olko

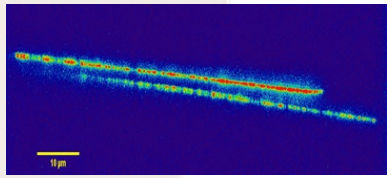
- Department of Radiation Transport Physics (NZ61, Wojciech Królas)
- Department of Radiation Research and Proton Radiotherapy (NZ62, Jan Swakoń)
- Department of Radiation Physics and Dosimetry (NZ63, Paweł Bilski)
- Department of Nuclear Physical Chemistry (NZ64, Jerzy Mietelski)
- Department of Mass Spectrometry (NZ65, Edyta Łokas)

- **Major studies:** neutron transport, neutron and ion diagnostics for tokamaks and stellarator, medical physics for proton therapy, space dosimetry, thermo- and optically stimulated luminescence, retrospective dosimetry, low-level radioactivity measurements in environment: α, β, γ spectroscopy, mass spectrometry (Arctic, glaciers, etc.)

3-D printed compensators for kids treatment



Crystal grow for dosimetry



Novel LiF Fluorescent Nuclear Track Detectors

- **International cooperation and projects:**
  ITER, JET (EUROFUSION), EURADOS, ARTEMIS
  Transnational Access: EURO-LABS, INSPIRE
  PIANOFORTE
- **Local research program at AIC-144** ➔ next slide

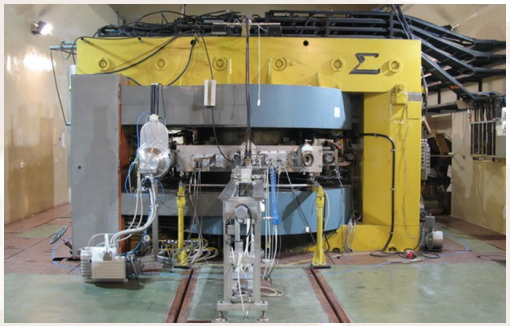
Staff: about 45 people

Results: about 100 publications/yr

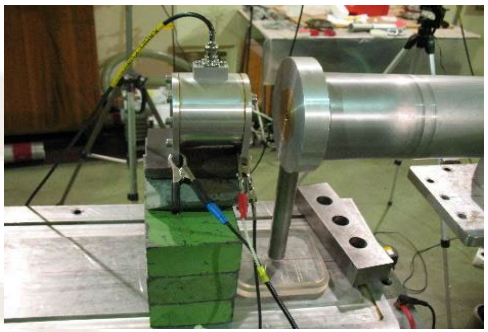
Applied research at the AIC-144 60 MeV proton cyclotron

Eye line for precise irradiation
- dose rate: 0.001 – 1 Gy/min
- beam field size: ≤ 40 mm;
- Typical flux: 10e8 – 10e9 p/cm2·s;

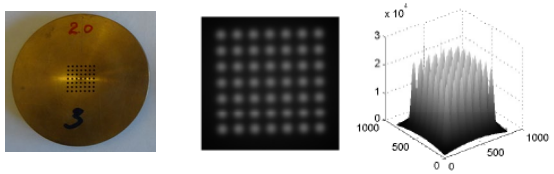
Line for isotope production
- proton current: < 100nA;



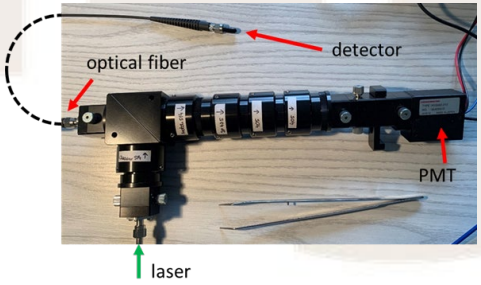
AIC-144 Cyclotron
- energy 60 MeV; RF 26,26 MHz;
- beam current 80 nA



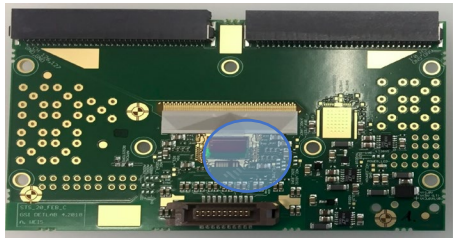
Experimental room: high beam intensity
- proton current: 2nA – 100nA;
- Dose rate up to 50 Gy/s
- irradiation field d < 12 cm;



Proton grid therapy – to reduce side effect sof treatment



Testing of detectors and dosimeters



Testing of electronics for space flights

Staff: 10 people

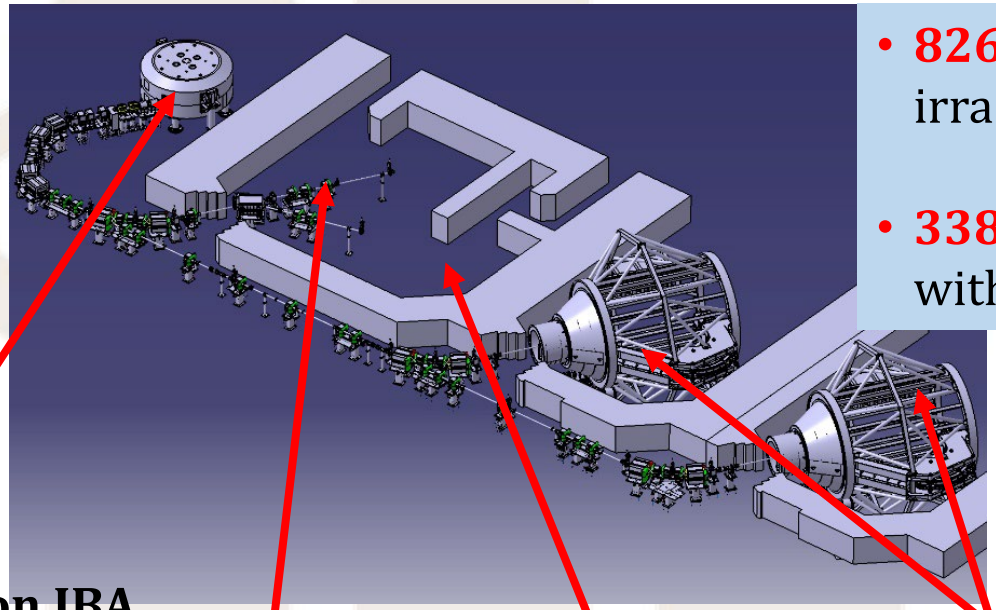
Cyclotron Centre Bronowice (CCB)

Head of the Centre: **Renata Kopeć**

Staff: about **50** people

Start of operation : 2005 – 2010
Treatment of first patient with eye melanoma

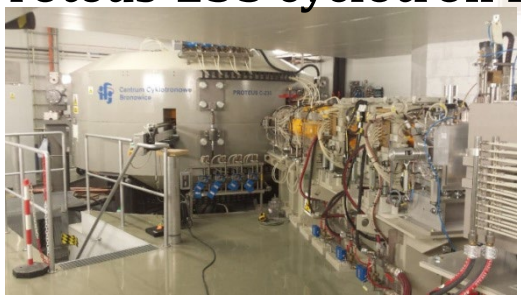
Construction 2010-2015;
the 1st patient: October 2016

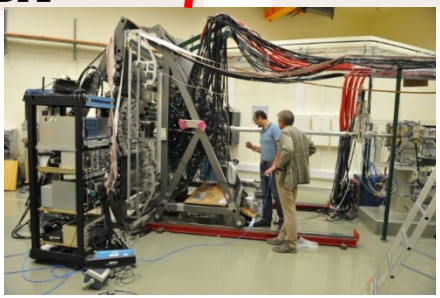


- **826** patients finished irradiation in gantries
- **338** occular patients with eye melanoma

Two dedicated scanning gantries

Proteus-235 cyclotron IBA





Division of Scientific Equipment and Infrastructure Construction (DAI)

Division Head: Jacek Świerblewski

Constructions of big external research infrastructures AND advanced plans of local research base (cryogenics, vacuum, precise mechanics, quality aspects, test of magnets, RF systems installations and tests,…)

➢ **Cooperation with:**

FUSION FOR ENERGY, iter, FAIR Facility for Antiproton and Ion Research in Europe GmbH, cta cherenkov telescope array, CERN, cea, vorbuchner cryogenics & gas applications, T2K, ess, DESY, Centrum Cyklotronowe Bronowice CCB

Experience example	FTE
E-XFEL – DESY, Hamburg, Niemcy	~165
ITER – Cadarache, France	~15
LHC – Long Shutdown 2	~47
European Spallation Source (ESS) – Lund, Sweden	~130

Results: about 10 publications/yr

Klystrons used at ESS

XFEL cryomodules

Staff:
specialist/engineer/technician: 40
Phd/assoc. prof./prof.: 5

Krakow School of Interdisciplinary PhD Studies (KISD)

Krakow School of Interdisciplinary PhD Studies was established in 6.05.2019

I. **The Henryk Niewodniczański Institute of Nuclear Physics PAN**
II. **Jerzy Haber Institute of Catalysis and Surface Chemistry PAN**
III. **Jerzy Maj Institute of Pharmacology PAN**
IV. **Mineral and Energy Economy Research Institute PAN**
V. **Strata Mechanics Research Institute PAN**
VI. **Institute of Metallurgy and Materials Science PAN**

VII. **Faculty of Materials Science and Ceramics AGH**
VIII. **Faculty of Physics and Applied Computer Science AGH**

Theoretical and experimental research work is carried out in the following directions:

- Particle physics and astrophysics
- Nuclear physics and strong interactions
- Solid state physics
- Interdisciplinary research:
  - medical physics,
  - physics in biological systems,
  - radiation protection,
  - environmental protection,
  - new energy sources.

Heads of the School:
Andrzej Horzela
Mariola Kłusek-Gawenda
Jakub Bielecki

Accredited Laboratories

Laboratory of Individual and Environmental Dosimetry (LADIS)

- Measurements of individual and environmental doses by thermoluminesce method
- 210 000 measurements annually
- 11 000 institutions in Poland and Europe
- 50 000 radiation workers/measurement points under dosimetric supervision
- 730 installations of Roentgen radiography under supervision
- Work in progress: implementation of the 1st in Poland Optically Stimulated Luminescence (OSL) system, based on BeO detectors

PCA Polskie Centrum Akredytacji BADANIA AB 1317

Laboratory of Calibration of Radiation Protection Instruments

- Calibration of up to 2300/yr survey meters (γ-rays)
- Calibration of 240/yr survey meters (α, β surface emission)
- 150/yr calibrations of passive dosimeters

PCA Polskie Centrum Akredytacji >o< WZORCOWANIE AP 029

Accredited Laboratories

Laboratory of Radiometric Expertise

- 695 measurements and expert opinions for external customers (materials, terrains, buildings, soil, water etc, ...)
- Calibrations of radon detectors
- Lectures and courses
- Designs of radon protection systems for buildings
- Mobile radiometric laboratory (van)

AB 788

Laboratory of Radioactivity Analyses

- Laboratory is an important ingredient of the national network of radioactive contamination monitoring
- Member of the expert network "ALMERA" (Analytical Laboratories for the Measurement of Environmental Radioactivity, IAEA)
- < 100/yr commercial measurements of concentration of ^{40}K, ^{228}Th, ^{226}Ra, ^{238}, $^{239+240}Pu$, $^{134,137}Cs$, ^{99}Tc, ^{131}I, ...
- Full-body counter (one of the two counters in Poland)

Underground Low Radiation Background Laboratory – application for funds

- Two sites – salt mines in Wieliczka and Bochnia
- Depth of 200-300 m
- Calibration of dosimetric equipment, low-level measurements of radioactivity

Outreach Activities – Promotion and Education in Science

- **Team for Popularization of Scientific Research of IFJ PAN**
- **Team for Promotion and Education in Science**
- **Coordinators of Events related to Popularization of Science**

Projects supporting popularization of science

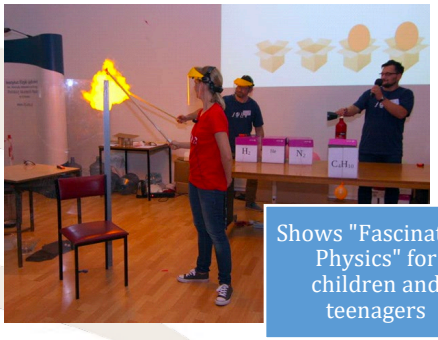
- Project „Physics is the key to understanding the world” , 2020-2022 within the Program of the Minister of Education and Science: „Social Responsibility of Science”
- Project „International Promotion of IFJ PAN by Educational Films”, 2021-2023 within the Program „Welcome to Poland” of NAWA funding institution
- Project of European Committee: *European Researchers' Night*; 2022-2023

Ongoing popularization activities undertaken by IFJ PAN are published on the social platform Facebook, Twitter and YouTube.

Outreach Activities – Promotion and Education in Science

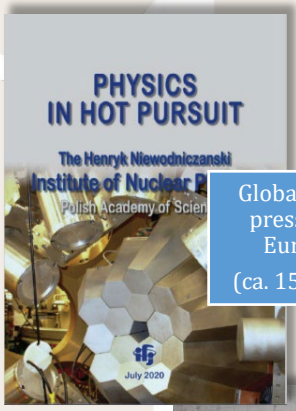
Małopolska Researchers' Night

"Physics Couch" discussion series



Shows "Fascinating Physics" for children and teenagers

Musical spectacle "At the intersection of two infinities"



Global scientific press service: EurekAlert (ca. 15 per year)

Festival of Science and Art in Krakow

Scientific Picnic of the Polish Radio and Copernicus Science Centre

Scientific Picnic of the Polish Academy of Sciences

Visits of high school students to laboratories at IFJ PAN

IFJ PAN Open Day for students

Małopolski Festival of Innovation

QuickPhysX and QuizFiz contests

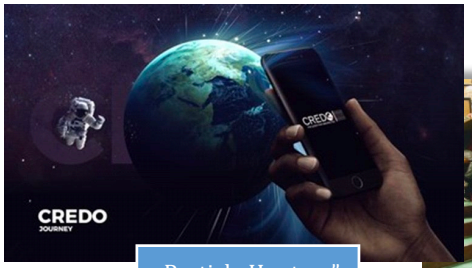
Silesian Science Festival in Katowice

Particle Physics Summer Student Program at IFJ PAN

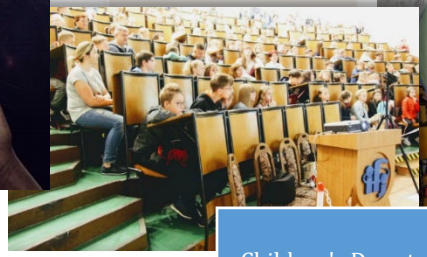
Int. Masterclasses - Hands on Particle Physics for high school students

Making popular science movies on research carried out at IFJ PAN

Activity in social media: Facebook, Twitter and YouTube



„Particle Hunters" contest with the CREDO Detector application



Children's Day at IFJ PAN

Thanks for your attention

Looking forward for our fruitful collaboration….