The Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences

www.ifj.edu.pl

Instytut kategorii A+

HR EXCELLENCE IN RESEARCH

World University Rankings 2023

Discover the world's top 2000 universities

CWUR

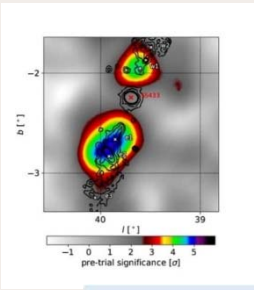
Place 670 (3.3%)

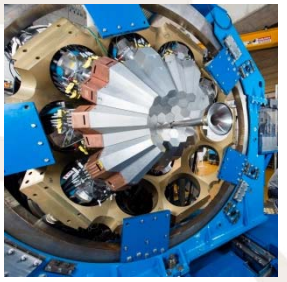
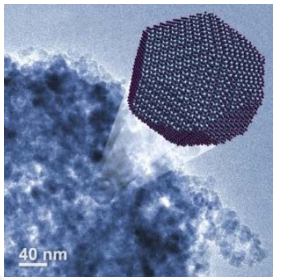
Prof. Tadeusz Lesiak

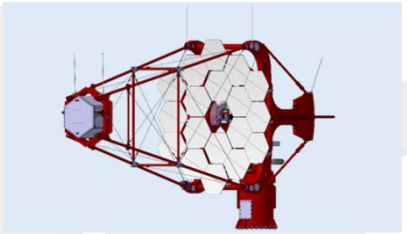
Director General

General Information about IFJ PAN

- **Personnel: 561; Prof. 30, Assoc. Prof. 61, Ph.D. 101, engineers 117**
- **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**

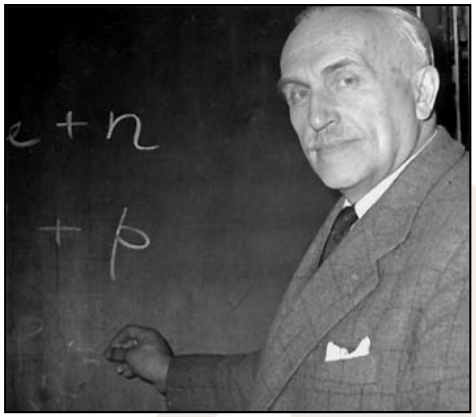






Genesis and History

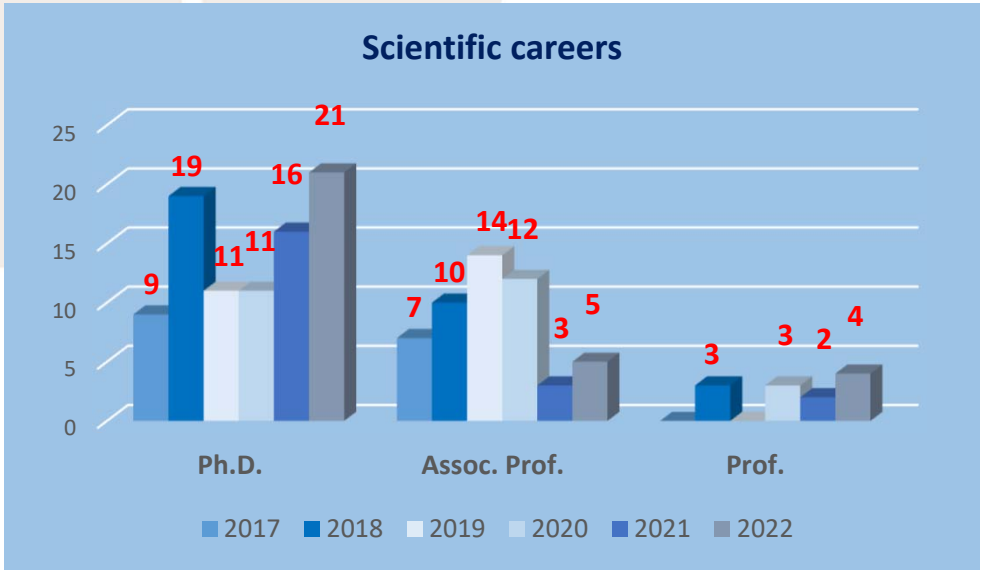


(Fot. Archiwum of the IFJ PAN)

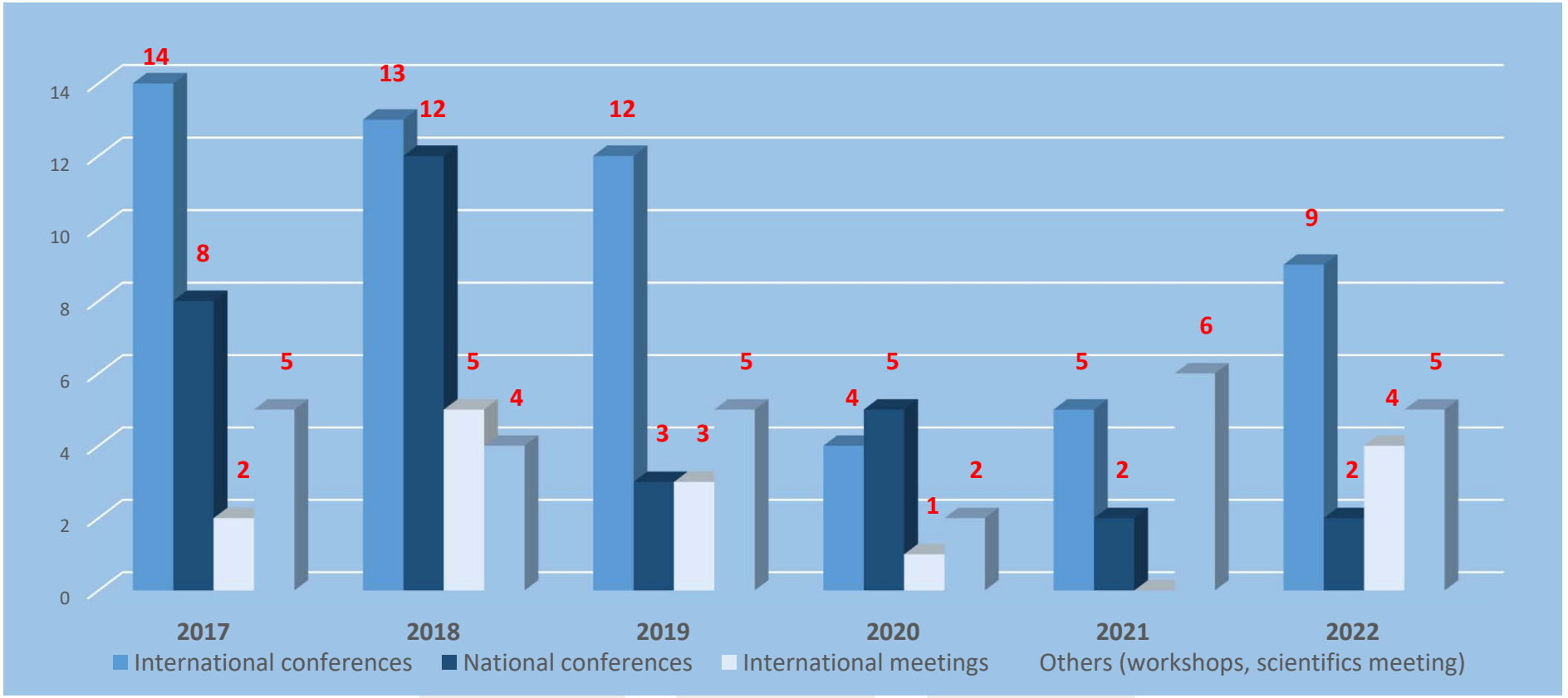
- **1955 – foundation of the IFJ – as a branch of the Institute of Nuclear Research – Prof. Henryk Niewodniczański (1900-1968)**

- **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 (2017-2022)



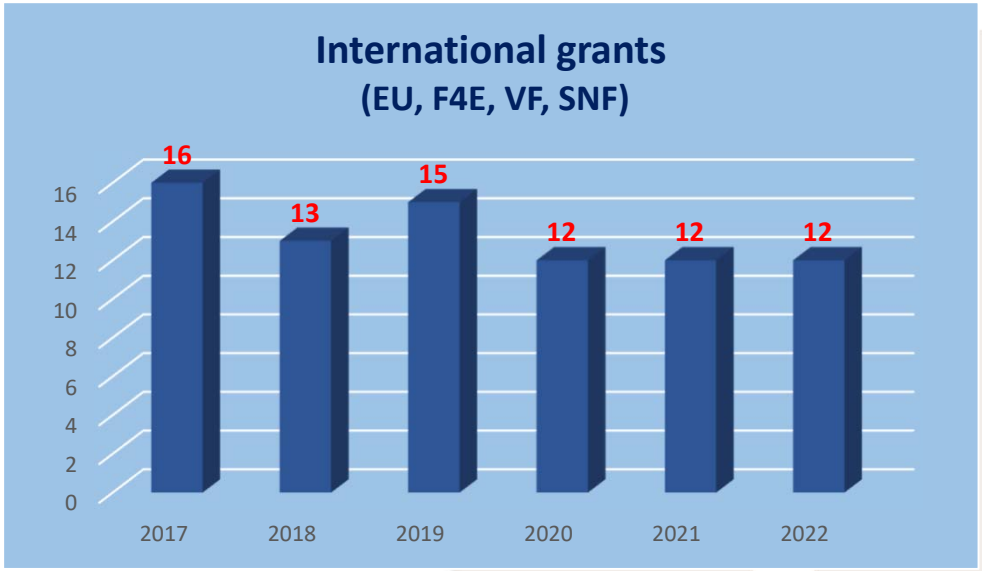
Conferences and Workshops (2017-2022)

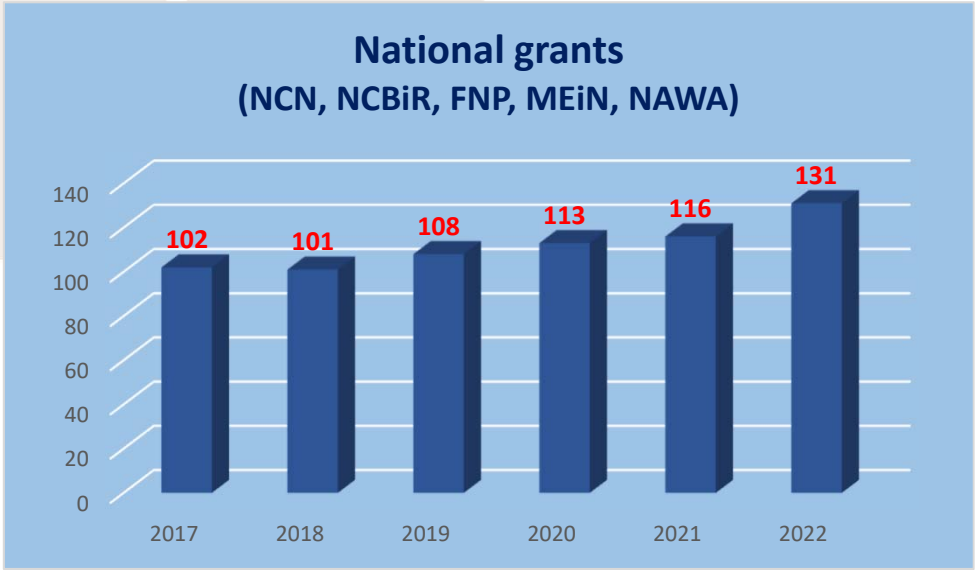


- **<u>International, periodic conferences</u>:**
  - Cracow Epiphany Conference
  - Zakopane School of Physics
  - Cracow School of Theoretical Physics
  - Multiscale Phenomena in Molecular Matter – MULTIS

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

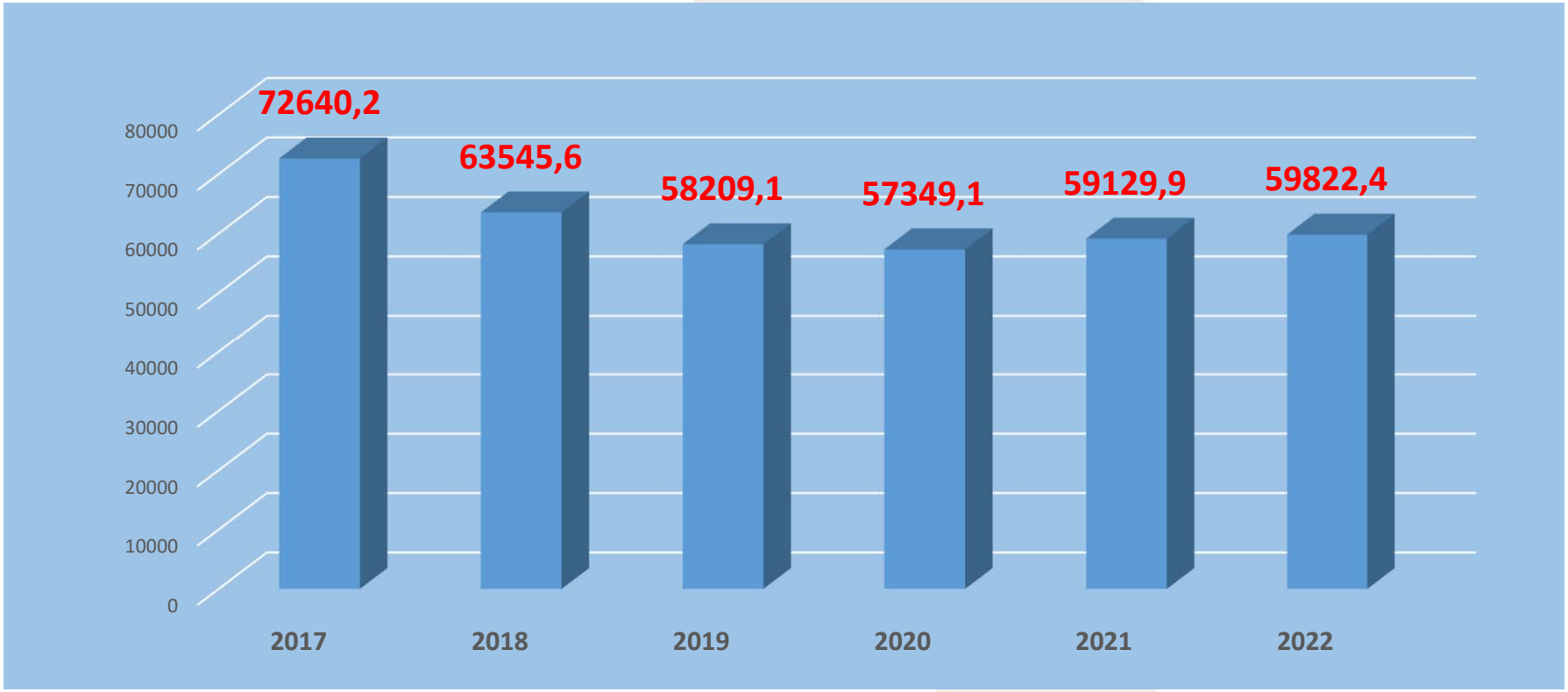
International and Polish Grants (2017-2021)





Funding

- National subsidy



- National grants, European Projects
- In-kind contributions to the construction of big research infrastructures (now ESS), protonotherapy, services of accredited labs etc.

IFJ PAN on Polish Roadmap for Scientific Infrastructure

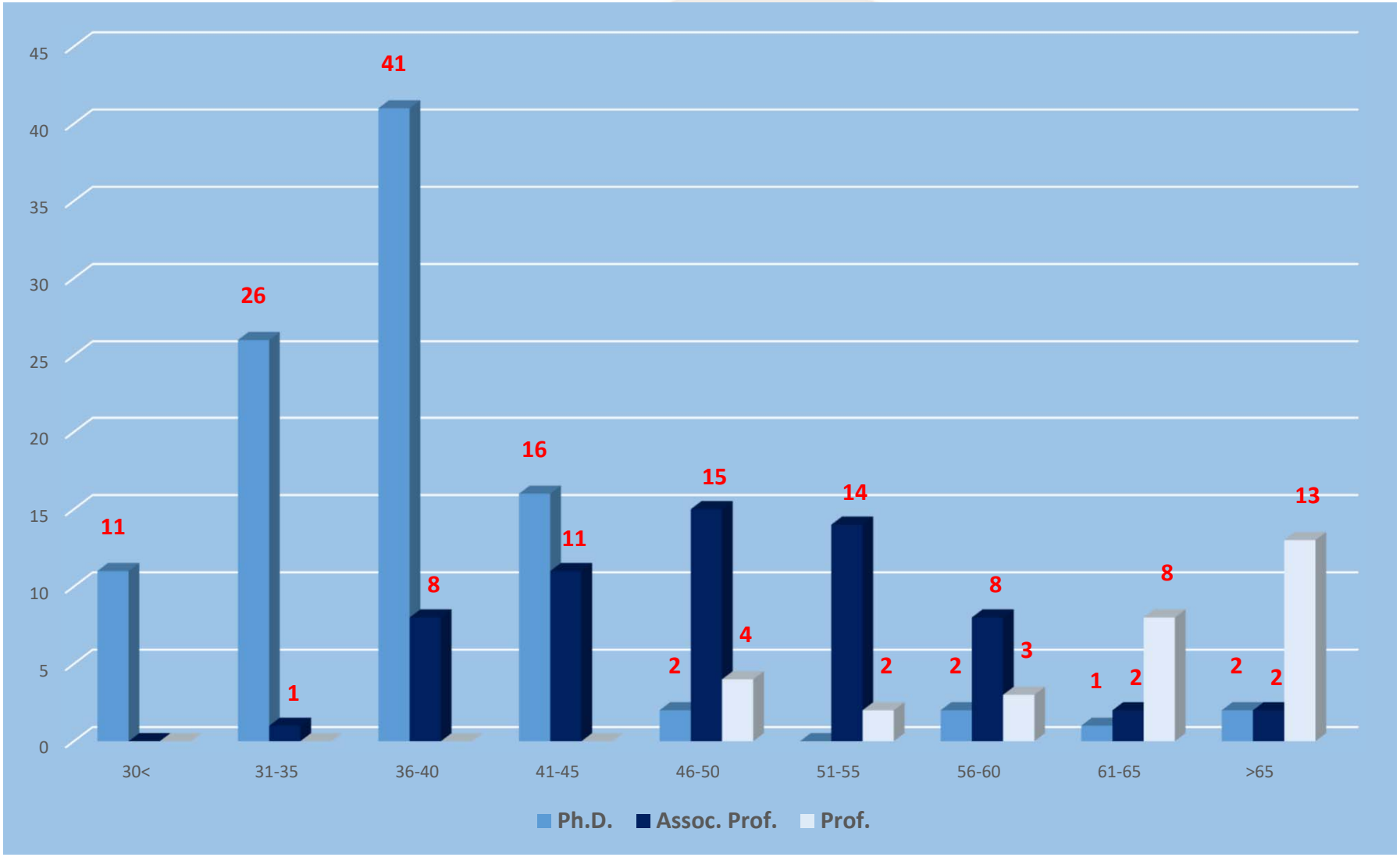
Projects coordinated by the IFJ PAN

1. CCB – Cyclotron Center Bronowice (development, next phase)
2. Centrum of Engineering of Cryogenic Materials
3. ESS - European Spallation Source
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

Age Profile of the Personnel



Division of Particle and Astroparticle Physics (NO1)

1. The ATLAS experiment
- physics analyses of proton-proton (tau physics) 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 (b→s, CKM γ, spectroscopy) 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)
- Development of electronics for SVT

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")

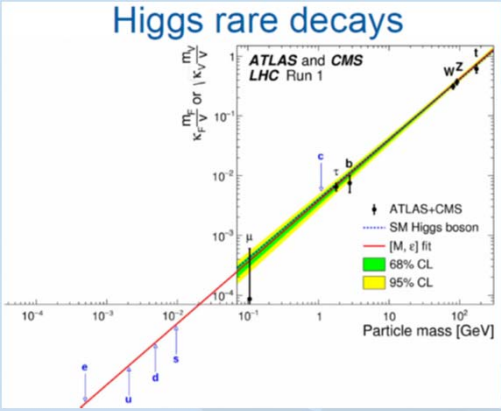
5. Neutrino studies
- **T2K** – neutrino oscillation studies; upgrade of BD200 subdetector
- **P-ONE** - search for UHE neutrinos of astrophysical origin (under construction)

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)

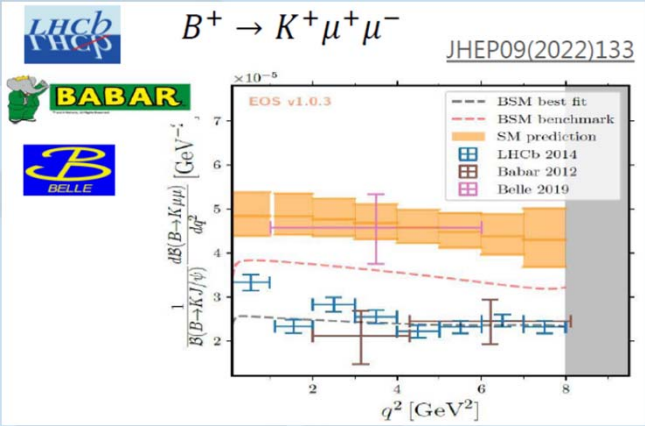
7. Involvement in other projects
- preparation of M**UonE** experiment at CERN
- Preparation of **ATHENA** experiment at future Elektron Ion Collider (EIC)
- Physics feasibility studies for future accelerators (mainly **FCC**)
- development of "Clould Computing" and GRID computing infrastructures

Division of Particle and Astroparticle Physics (NO1)

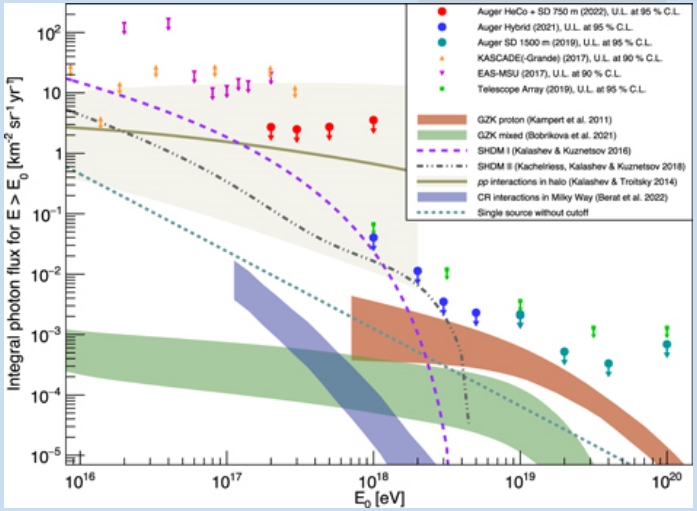
Standard Model (SM) Couplings (ATLAS)



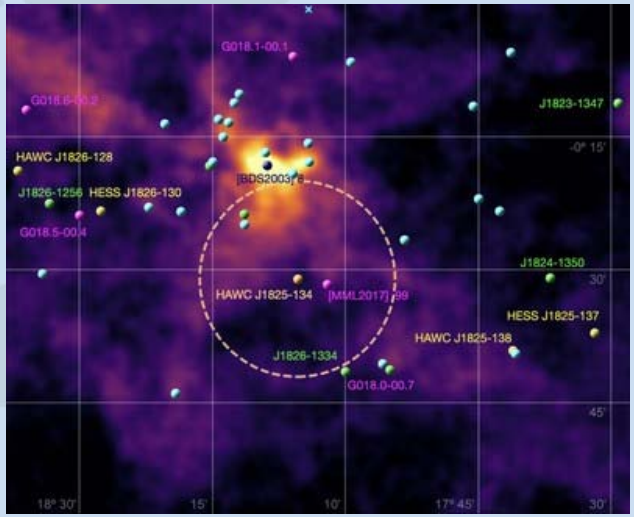
Search for deviation from the SM in b→s transtions (LHCb)



Energy spectrum of UHE cosmic rays (Pierre Auger)



Cosmic accelerators seen in UHE photons (HAWC)



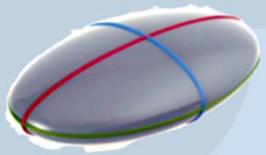
Division of Nuclear Physics and Strong Interactions (NO2)

- **Major expts:**
  - AGATA
  - PARIS
  - ALICE
  - NA61/SHINE
  - neutron EDM
  - …
- **International cooperation:**
  - IJCLAB Orsay
  - GANIL Caen
  - LNL INFN Legnaro
  - Milano University,
  - GSI Darmstadt
  - FZ Julich
  - RIKEN Japan
- **Local research program at Cyclotron Center Bronowice IFJ PAN**
  ➔ next slide

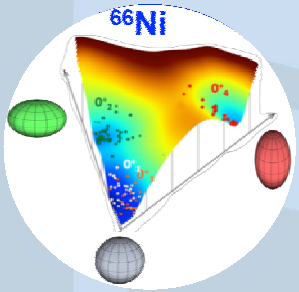
Staff: about 45 people

Results: about 140 publications/yr

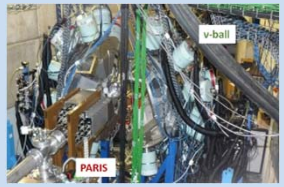
Superdeformed and triaxal states in Ca-42

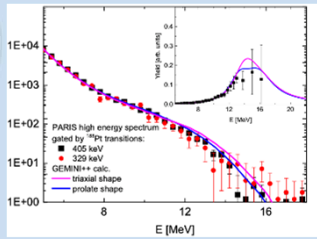


Identification of shape isomers in Ni-66 and Ni-64

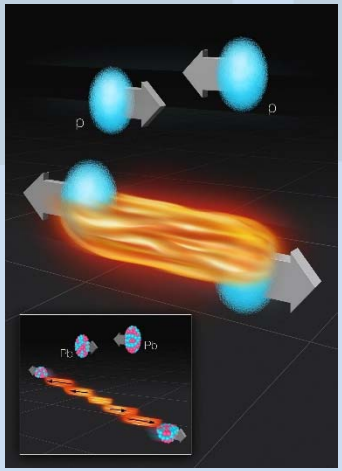


PARIS – coordinated by the IFJ PAN

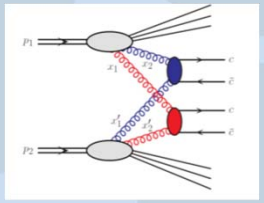


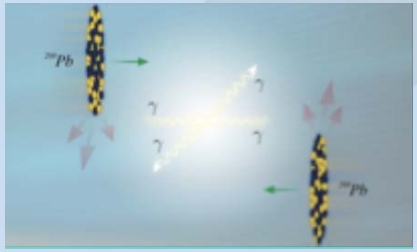


Fire streaks model of nuclei and proton collisions

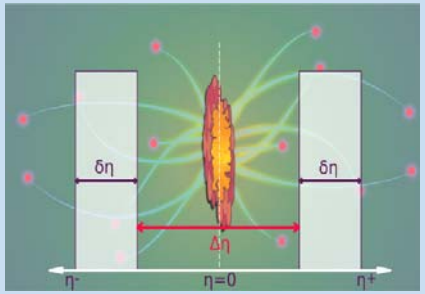


„Light-on-light" scattering in HE ultraperipherial nucleus-nucleus collisions





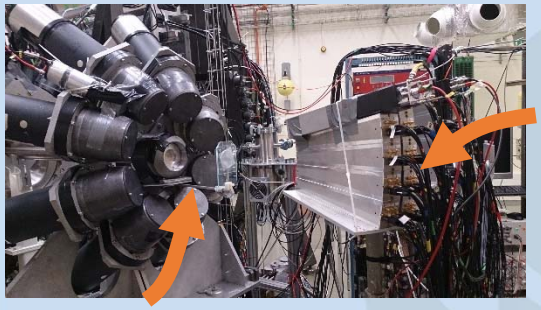
Long range forward-backward correlation in UHE nucleus-nucleus collisions @ ALICE



Fundamental Research at the Cyclotron Center Bronowice

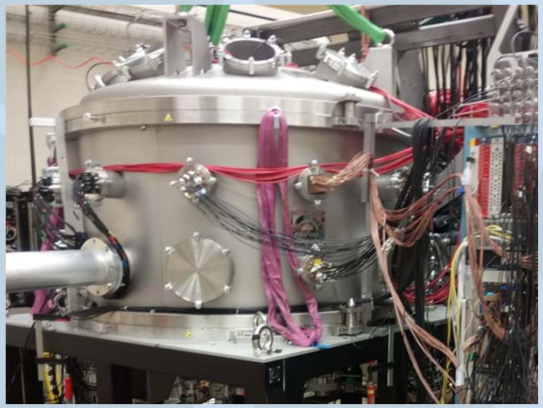
Proton beam (230 MeV) from the Proteus-235 Cyclotron at the Cyclotron Centre Bronowice

Studies of resonance excitations of nuclei

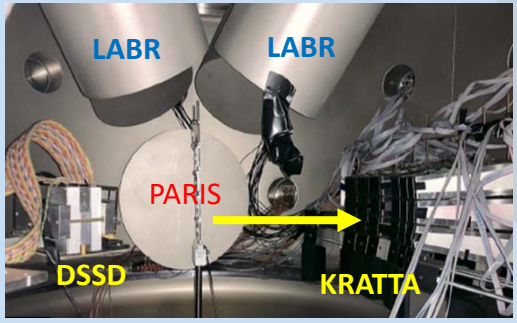


detector HECTOR
Measurements of gammas)

Detector KRATTA
Measurement of proton's inelastic scattering



„Big" scattering chamber

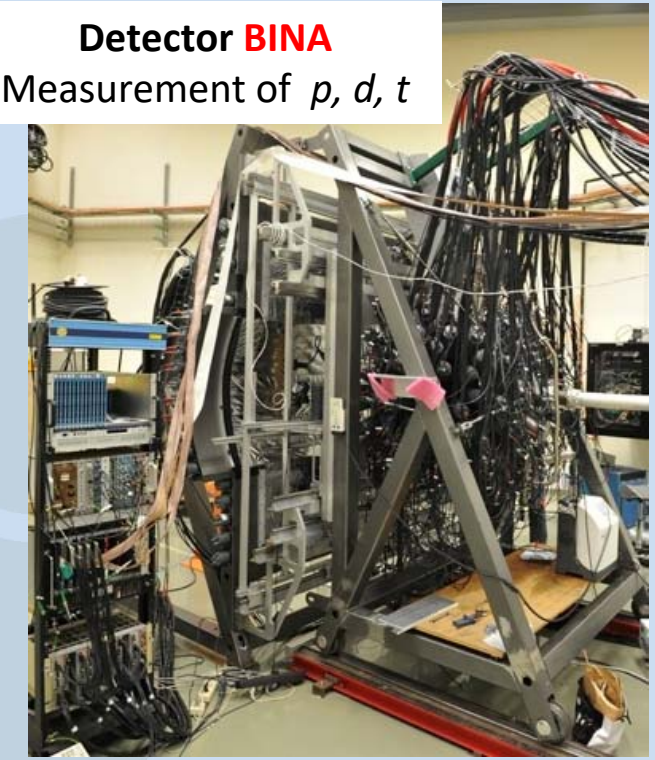


Detectors inside the scattering chamber

PARIS and LaBr3
high-energy γ-ray array

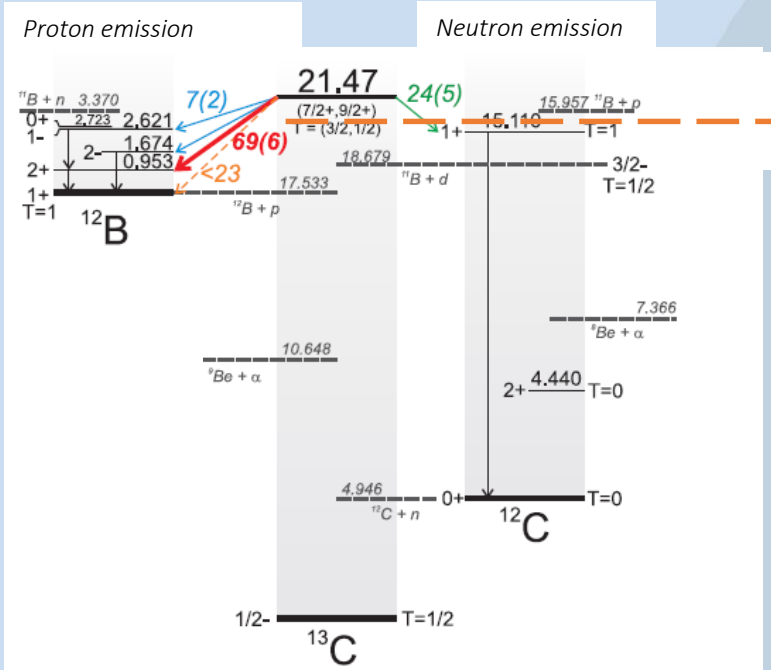
Studies of triple nucleon dynamics

Detector BINA
Measurement of *p, d, t*



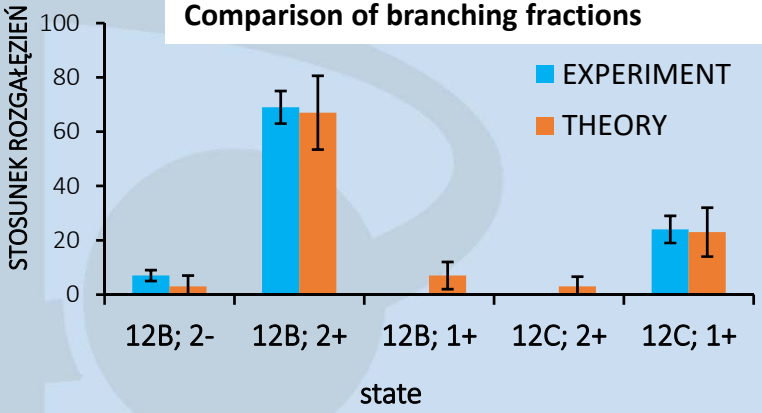
Fundamental Research at the Cyclotron Center Bronowice

The decay of the 21.47-MeV stretched resonance in C-13

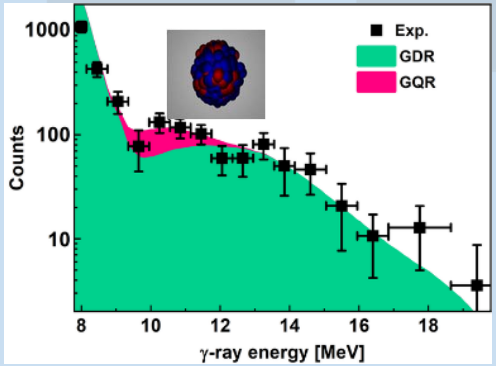


J = 7/2+ **20.9(5)** T = 3/2

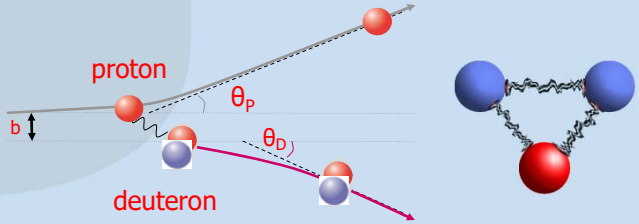
Comparison of branching fractions



Observation of the isoscalar giant quadrupole resonance in it gamma decay to Pb-208



Studies of 3-body nuclear forces



Measurement of neutrons produced in the deutron break-up induced by protons

Division of Theoretical Physics (NO4)

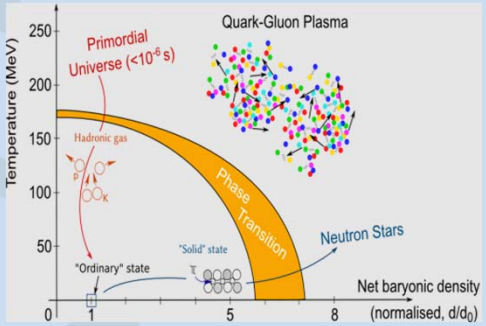
➢ **Major studies**

Staff: about 34 people

Results: about 60 publications/yr

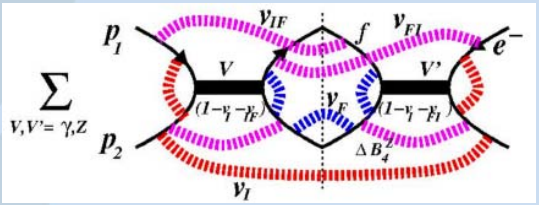
Theory of structure of matter

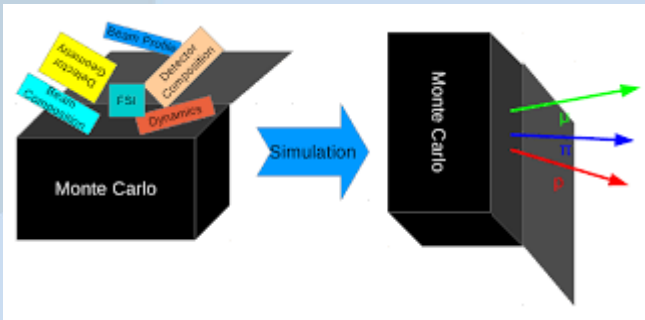
- Studies of q-g plasma created in heavy ion collisions: hydrodynamical description, early thermalization, plasma polarisation
- Studies of parton distribution functions of nucleon and their QCD evolution: GPDs, quasi PDFs, double PDFs, TMDs
- Phenomenological analyses of high precision rare and semi-leptonic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



Particle Theory

- 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



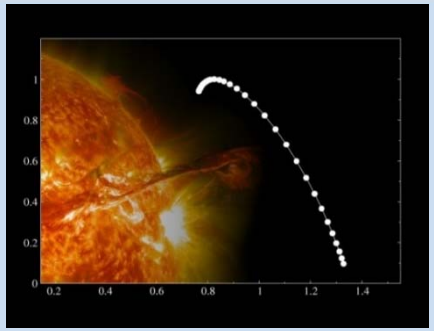


Division of Theoretical Physics (NO4)

Theory of complex systems

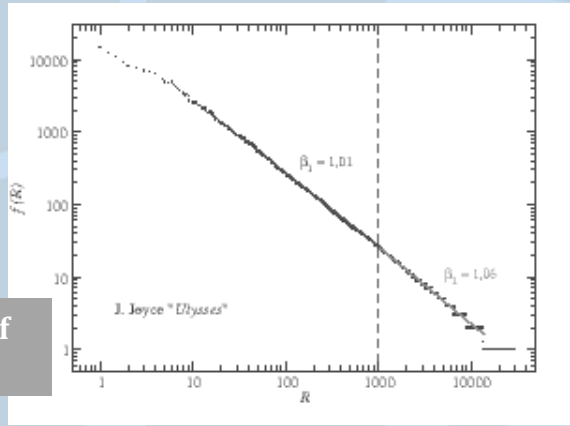
- Identification of the general characteristics of complexity and development of related methodology
- Quantification of long-range temporal correlations in time series in terms of multifractals
- Study of the dynamics of fluctuations and correlations in the financial markets
- Analysis of the brain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

Multifractal analysis of sun spots



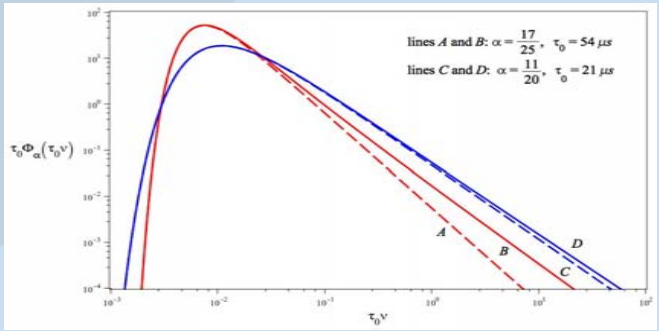
Short term change of bitcoin's price

Language study of Joyce's „Ulysses"



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



Division of Condensed Matter Physics (NO3)

Staff: about 60 people

Results: about 100 publications/yr

➢ Major studies

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

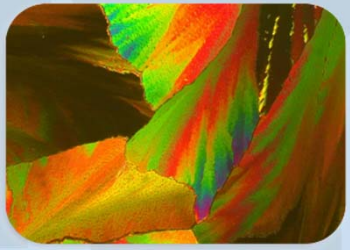
➢ International cooperation:

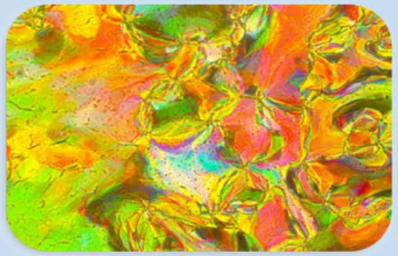
- DESY, EuXFEL, PSI, PSI, ESRF, EPFL, UAugsburg, HZDR Dresden, ILL,…

Liquid Crystals Thermography applied for skin tumours detection

- Mixture of a few LC materials and black base is put on the skin (thermovision matrix)
- This allows for the measurement of UV radiation from the skin region affected by the potential tumour
- High spatial resolution (0,01 x 0,01 mm^2),
- Low time of check in (10-15 min)
- Non invasive method

LC textures:

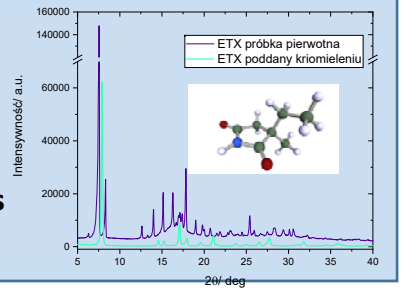




Cocrystals as new forms of pharmaceuticals with better therapeutical properties

Example:

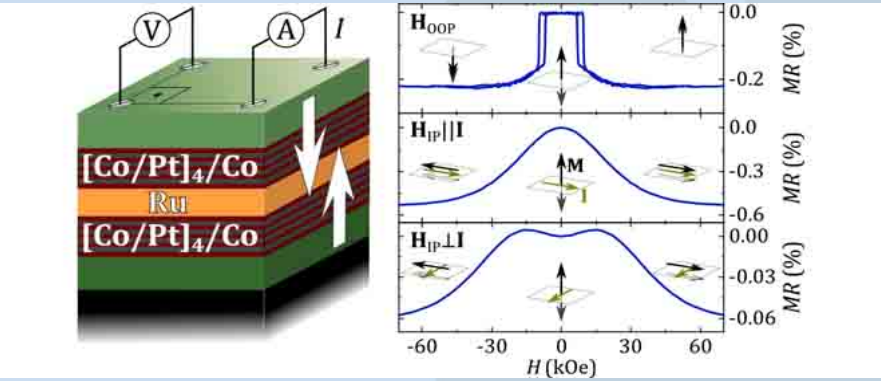
- **the anti-epilepsy drug etosuksyimid (ETX) can be improved in the process of mechanical milling**
- **During this process ETX is transferred to the phase of lower symmetry with the creation of hydrogen bonds which stabilise the crystal's structure**



Division of Condensed Matter Physics (NO3)

Modern magneto-resistive sensors

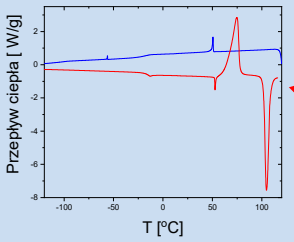
Studies of the influence of gigantic and anisotropic magneto resistance on the properties of syntetic layers of antiferromagnetics
Aim: more precise design of magneto resistive sensors built on these structures

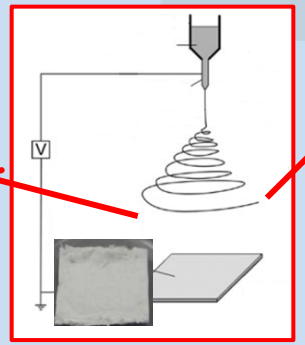


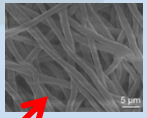
New electrostatic technique of electrospinning fibers production

The fibers are electrospinned from the polimer solution
They can be used as drug carriers with the controlled release rate

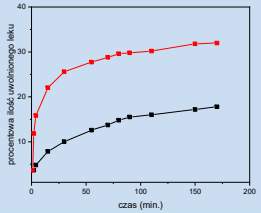
Physical properties





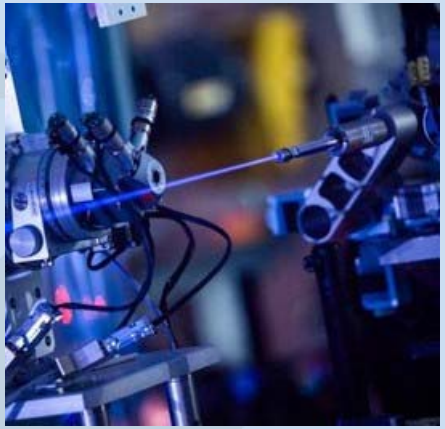


Drug's release rate

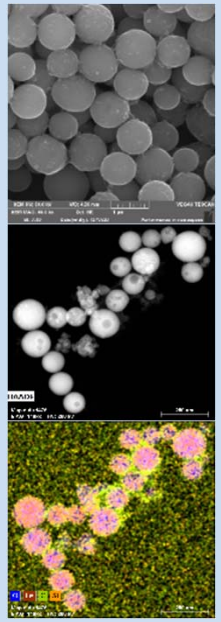


Studies at EuXFEL

Development of the simulation tool XSPIN to control the demagnetization of materials caused by X rays



- Determination of the impact of fluid's chemical structure on the size and composition of composite particles produced during impulse laser irradiation of nanoparticles.
- Evaluation of phase diagrams, describing processes occuring during interaction of laser light with nanoparticles, thus allowing for the design of phase composition of materials



Division of Interdisciplinary Research (NO5)

Staff: about 40 people | **Results: about 80 publications/yr**

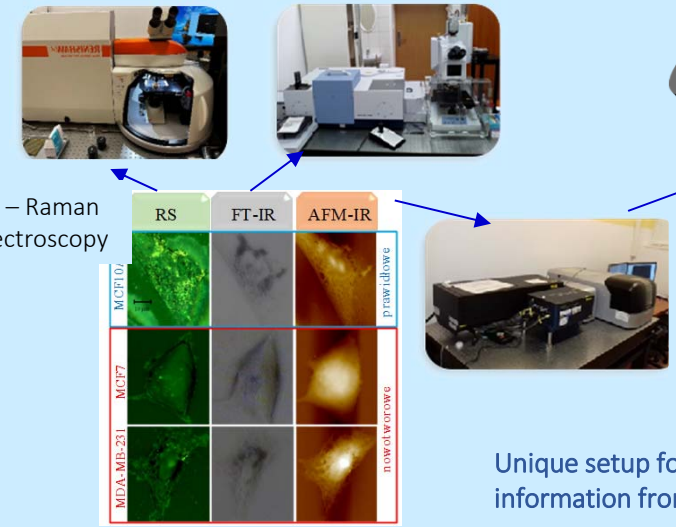
➢ Major studies

- 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:

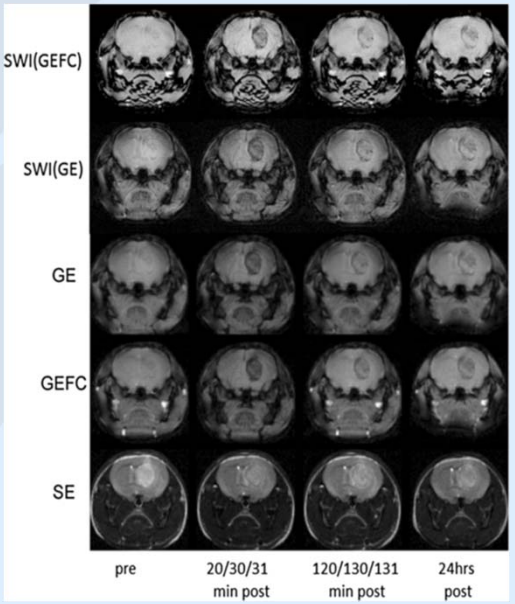
- **DESY, EuXFEL, PSI, SwisFEL, ELI, INFN LNF, Eletra, ESRF, Diamond, Soleil, EPFL, NUS, PennUni, UMalaga, UTromso, UMilano, UCalgary, UVictoria**

Studies of ionizing radiation influence to chemical composition imaging (brest cancer cells)



Unique setup for correlative imaging allows to collect information from exactly the same cell using various systems!

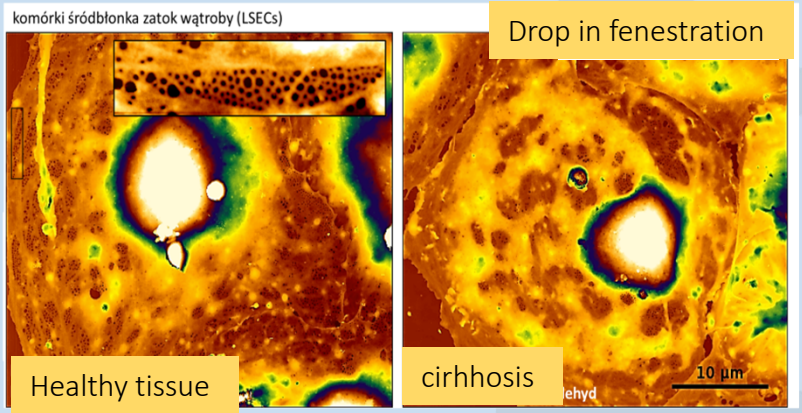
Application of NMR imaging and spectroscopy to study the properties of drug carriers, modern contrast agents and porous materials



Division of Interdisciplinary Research (NO5)

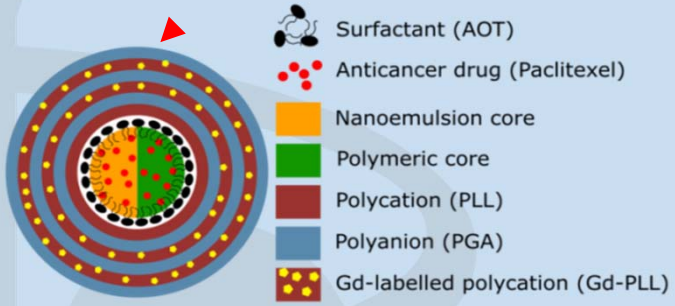
AFM: biomechanics in search for diseases

Imaging of liver fenestration (of pore membranes) as a diagnostic tool in cirrhosis



Theranostics – nanostructural drug carriers

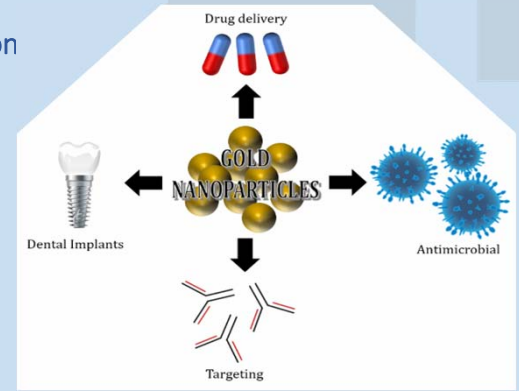
Theranostics are structures applicable to combined MRI diagnostics and to the targeted theraphy of tumors, neurological, pulmonological and cardiac diseases



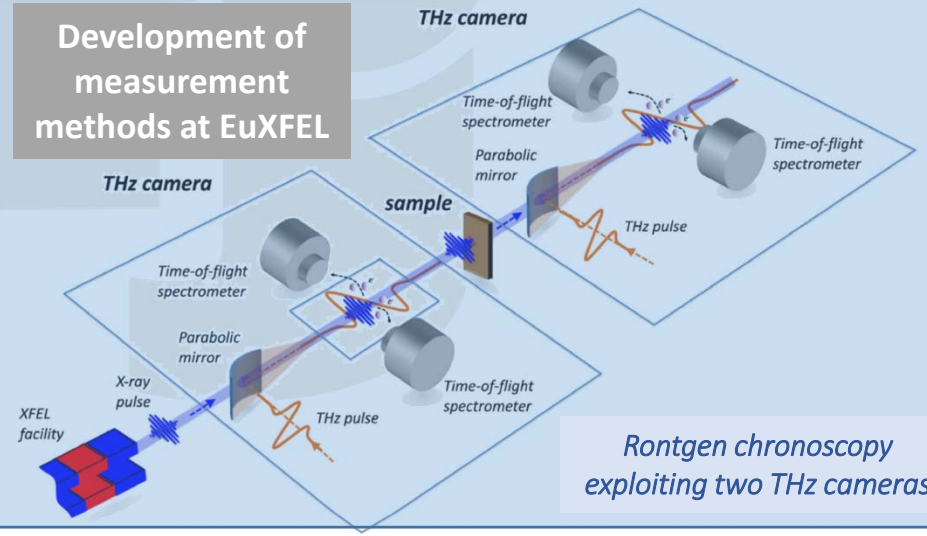
Nanocapsules (100nm) as drug and MRI contrast carriers (Gd) to be delivered in the respective diseased tissue

Modelling of the systems drug-nanoparticle in order to improve their effectiveness

- Controlled functionalization of the drug-nanoparticle system to improve their transportation to the cells
- Biocompatibility of nanoparticles possessing potential for medical applications



Development of measurement methods at EuXFEL

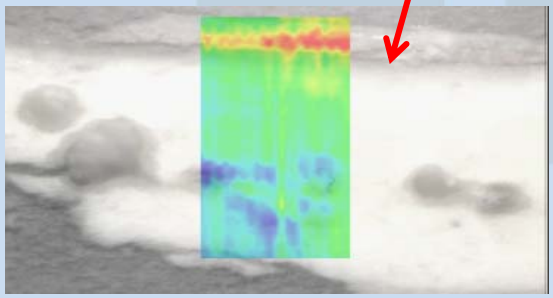


Rontgen chronoscopy exploiting two THz cameras

Division of Interdisciplinary Research (NO5): in Service for National Heritage

Viet Stoss Altarpiece: analysis of sculptures

The scene: *Christ descends to the abyss*



Map of distribution of proteins (amid I)

FT-IR analysis of chemical composition of dyes

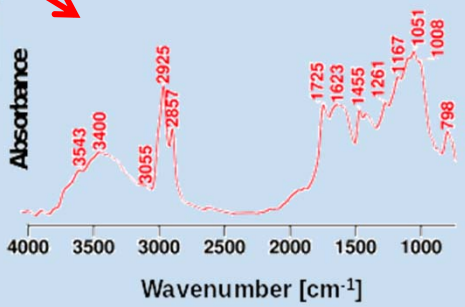
Studies of medieval Polish coins „Piast denars"

Trace elements in the alloy Ag-Cu as markers of the ore origin

X-ray Fluuorescence Spectroscopy

- Triad Au, Zn, Bi: mines in Harz Mountains
- Hg: central Asia – remelting of Arabic coins

measurements of surface pollution: FT-IR method



Division of Applications of Physics (NO6)

➢ **Major studies**

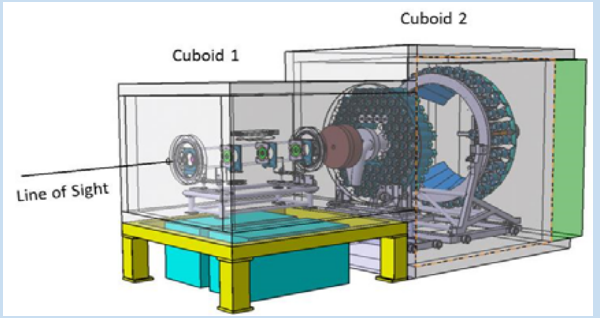
Staff: about 45 people

Results: about 100 publications/yr

- neutron transport,
- neutron and ion diagnostics for tokamaks and stellarators,
- 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.)

HRNS (High Resolution Neutron Spectrometer) for ITER

to determine the ratio of T/D ions in plasma

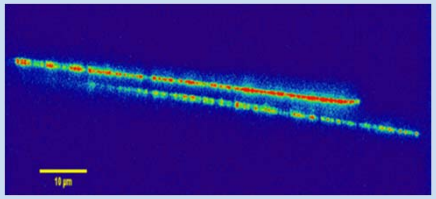


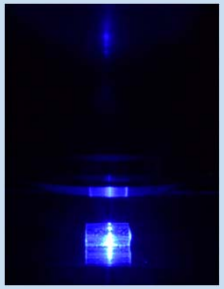
➢ **International cooperation and projects:**

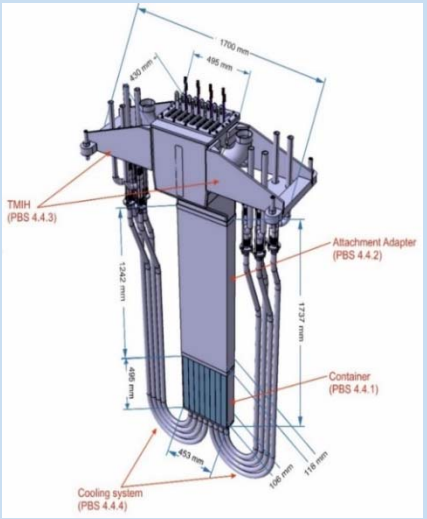
- **ITER, JET (EUROFUSION), EURADOS, ARTEMIS**
- **Transnational Access: EURO-LABS, INSPIRE, PIANOFORTE**

➢ **Local research program at AIC-144** ➔ **see below**

Novel detection method: LiF crystals as tracking detectors – fluorescence tracks of carbon ions in LiF crystals







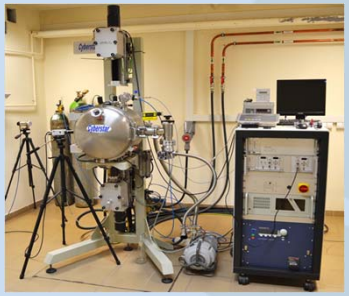
Start-up Monitoring Module for IFMIF-DONES

to monitor radiation and thermal conditions during the commissioning phase of IFMIF-DONES

Division of Applications of Physics (NO6)

New materials and detectors for thermoluminescence (TLD) and optically stimulated luminescence (OSL)

Crystal grow for dosimetry (Czochralski and micro-pulling down methods)



3-D printed compensators for kids' treatment

Banknotes and medicines as markers of radioactive pollution:

Geochemistry and radioecology: studies of Arctic cryoconites as markers of radioactive pollusion

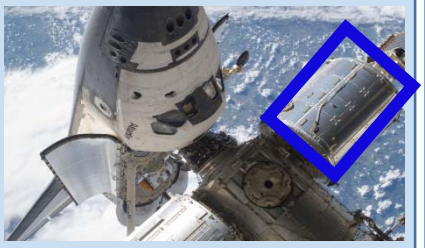
High concentrations:
up to 5 kBq/kg of Cs-137 and 12 kBq/kg Pb-210.

Radiation doses in space

Project DOSIS 3D

Measurements of dose distribution in the Columbus ISS

astronauts: 300-400 mGy
i.e 300x Earth's dose



Mission Artemis-1

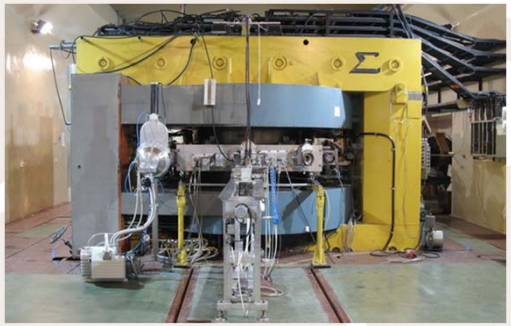
Studies of cosmic rays exposition of astronauts (on the Moon's orbit)

Two phantoms with our TLD and tracking detectos on board

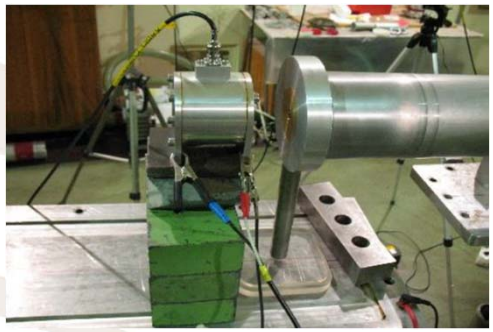
Applied research at the AIC-144 60 MeV proton cyclotron

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

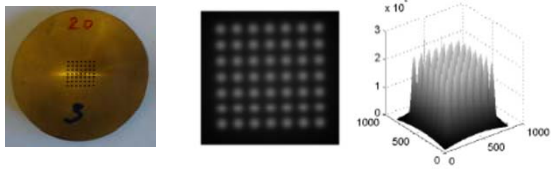
Line for isotope production
- proton current: < 100nA;



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

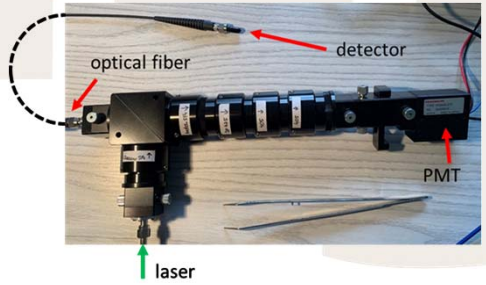


Experimental room: high beam intensity
- proton current: 2nA – 100nA;
- Dose rate up to 50 Gy/s
- irradiation field d < 12 cm;

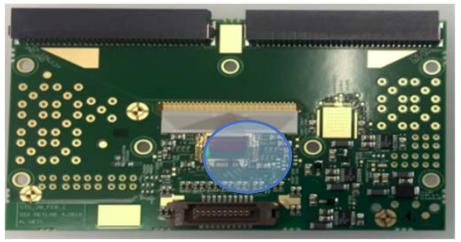


Proton grid therapy – to reduce side effect sof treatment

Staff: 10 people



Testing of detectors and dosimeters



Testing of electronics for space flights

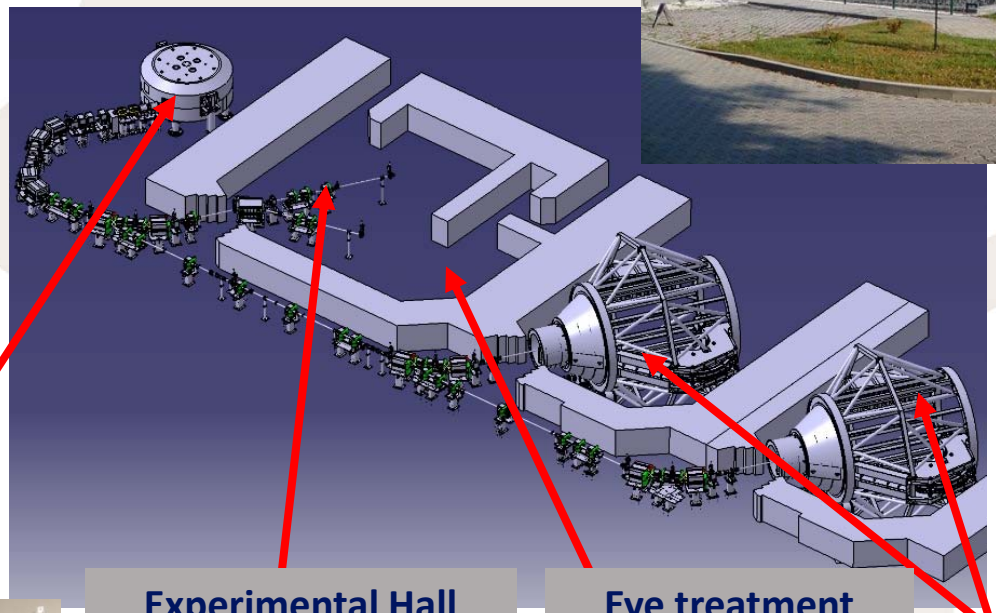
Cyclotron Centre Bronowice (CCB)

Construction 2010-2015;
the 1st patient: Oct. 2016

- **918** patients finished irradiation in gantries
- **348** occular patients with eye melanoma

(by August 2023)

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



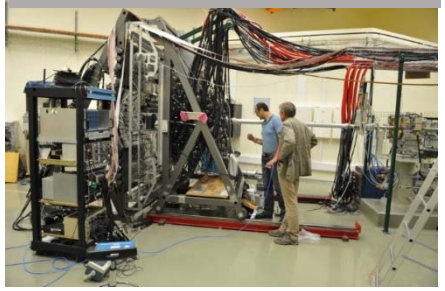
Staff: about 50 people

Proteus-235 cyclotron IBA

Two dedicated scanning gantries

70-230 MeV, I_{beam} = 1-500 nA

Experimental Hall

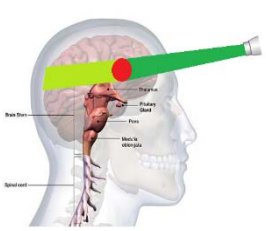


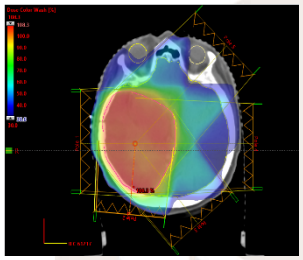
Eye treatment

Cyclotron Centre Bronowice (CCB)

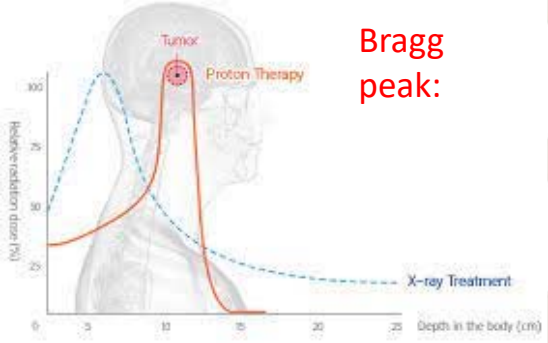
Physics properties of protons allow for uniform dose distribution inside the tumour; at the same time the surrounded tissues and organs are not irradiated

Photon beam

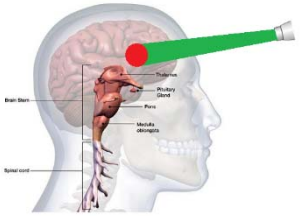


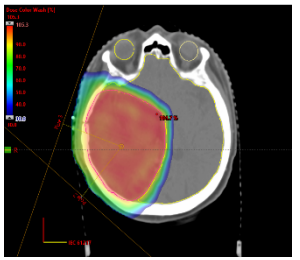


Bragg peak:

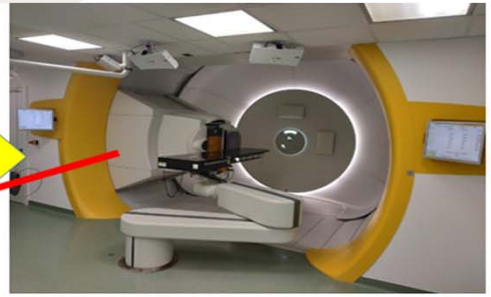


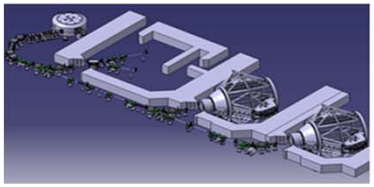
Proton beam:

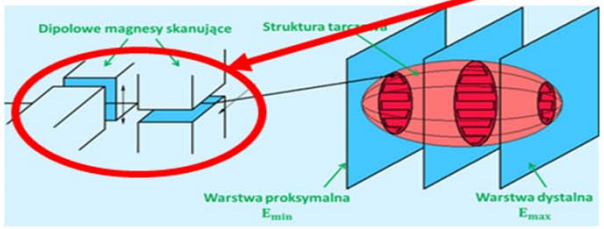


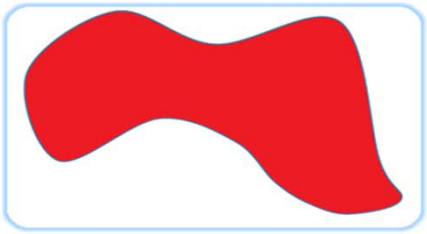


These advantages strenghtens exploitation of the Pencil Beam Scanning:









Division of Scientific Equipment and Infrastructure Construction (DAI)

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

- **Cooperation with:**

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

Klystrons used at ESS

XFEL cryomodules

Last decade engagements: 536 FTE
Income ~30 M EUR

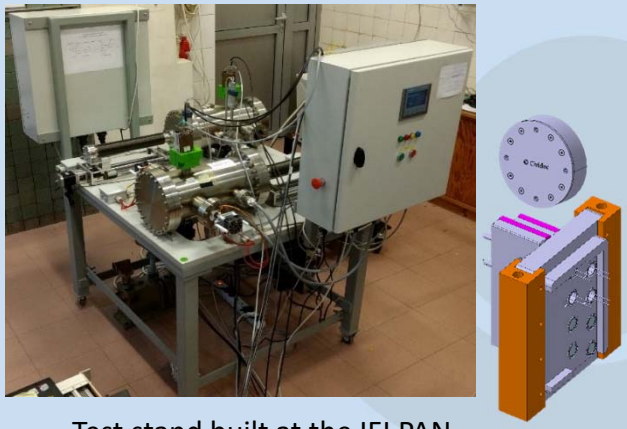
Scientific Results:
about 10 publications/yr

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

Division of Scientific Equipment and Infrastructure Construction (DAI)

Tests for ITER

(feedthrough, diamod detectors)



Test stand built at the IFJ PAN

Surface Scintillator Detector (SSD) for Pierre Auger

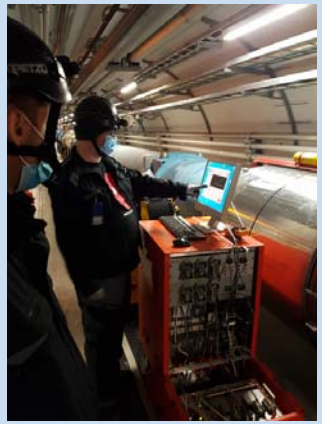
225 pieces

Batch of 15 SSDs ready to move to Argentina

Installation of SIS100 (GSI)

Contribution to LHC

QC for interconnections of LHC magnets



Dedicated measuring apparatus built at the IFJ PAN

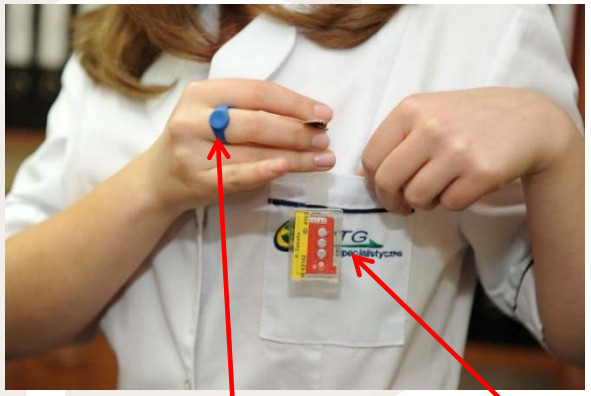
Local infrastructure: test stand for S.C. wires and magnets

Under commissioning

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



For measurements on 3 mm depth in tissue (for eye-lens) Hp(3) w mSv

0,07mm skin dosimetry Hp(0,07) w mSv

10 mm depth for the whole body dosimetry of deep organs Hp(10) w mSv

Laboratory of Calibration of Radiation Protection Instruments

- Calibration of up to 2300/yr survey meters (g-rays)
- Calibration of 240/yr survey meters (a, b surface emission)
- 150/yr calibrations of passive dosimeters

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)

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

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

application for funds

Krakow School of Interdisciplinary PhD Studies (KISD)

Krakow School of Interdisciplinary PhD Studies (established in 2019)

I. **The Henryk Niewodniczański Institute of Nuclear Physics PAN - coordinator**
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**

KISD
KRAKOWSKA INTERDYSCYPLINARNA SZKOŁA DOKTORSKA

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.

~~130 PhD students (20% of non-Poles)

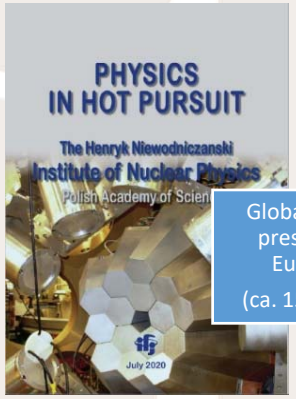
Outreach Activities – Promotion and Education in Science

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

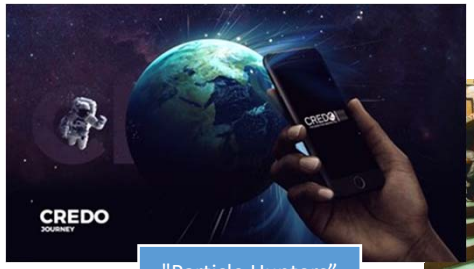
Silesian Science Festival in Katowice

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

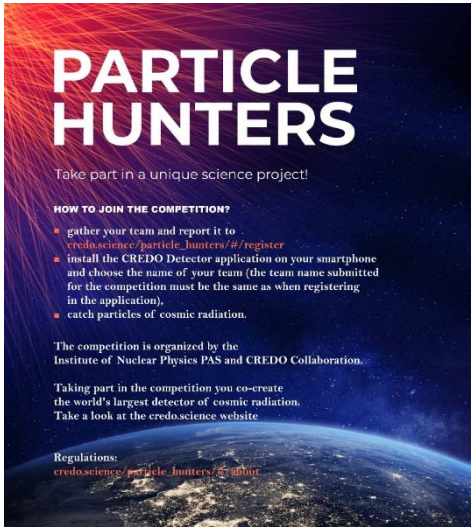
Thanks for your attention

CREDO Collaboration

Cosmic Ray Extremely Distributed Observatory:

CREDO
THE QUEST FOR THE UNEXPECTED

- Studies of correlations of cosmic rays in the global scale and in the full energy spectrum



- **Citizen Science – Open laboratory:** research encompassing and connecting data from technologically diversed apparatus
- Detectors: big observatories & smartphones
- **International collaboration**: 50 institutions; 20 countries; 5 continents
- **IFJ PAN: founder and leader of CREDO**
- Big activity in schools, social media etc

Układ detekcyjny wysokoenergetycznych kwantów gamma

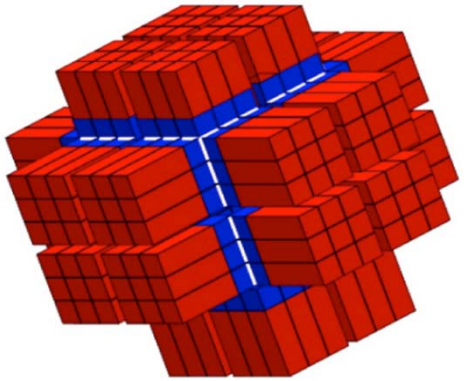
Photon Array for Studies with Radioactive Ion and Stable Beams

PARIS

Pomysł projektu i koordynacja projektu: **IFJ PAN**

element układu – detektor phoswich: scyntylatory LaBr3/CeBr3 + NaI

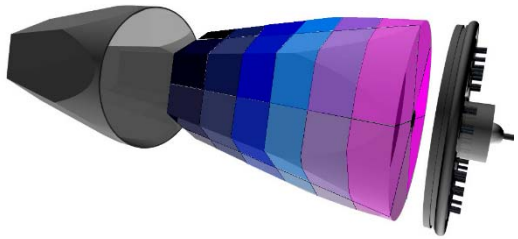
klaster:
9 detektorów phoswich



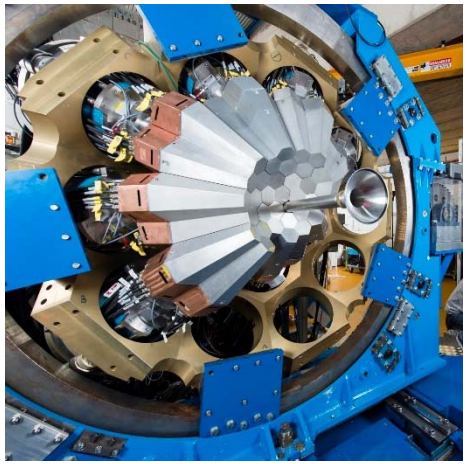
układ docelowy:
24 klastry

Projekt skupia fizyków, inżynierów i techników z 9 krajów, w tym z 19 instytucji naukowych.

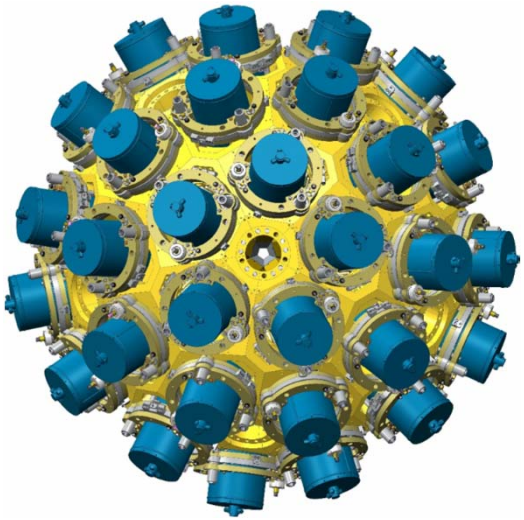
Układ detektorów germanowych najnowszej generacji
Advanced Gamma Tracking Array **AGATA:**
pozycyjnie czuły spektrometr promieniowania γ



element układu:
segmentowany (36 segmentów)
detektor germanowy



stan obecny:
39 detektorów

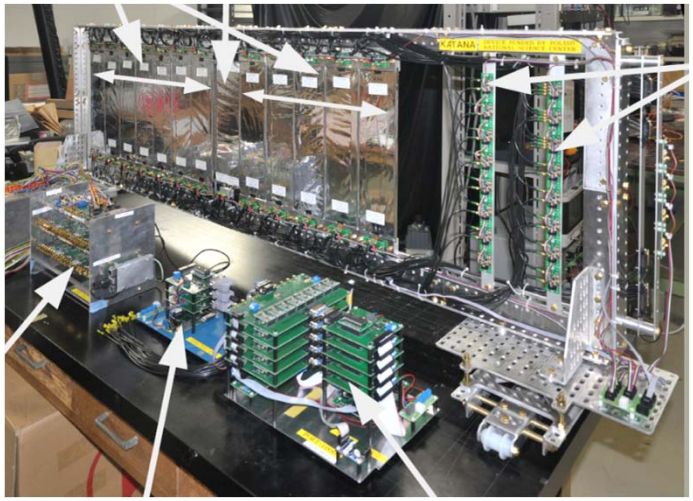


układ docelowy:
180 detektorów

Projekt europejski (13 państw) z udziałem Polski, w tym IFJ PAN.

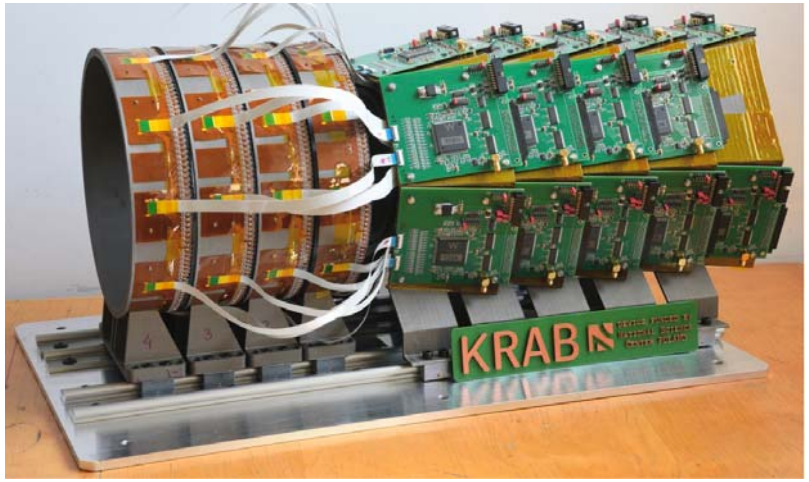
Układy detekcyjne: KATANA i KRAB

KATANA

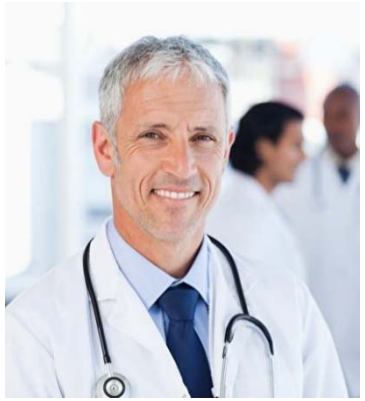


Zbudowany w IFJ PAN jako element systemu detekcyjnego dla eksperymentu SPiRIT w laboratorium RIKEN, Tokio (Japonia)

KRAB

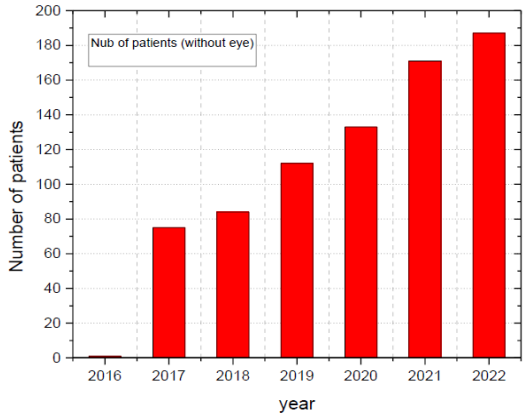


Zbudowany w IFJ PAN detektor krotności oraz rozkładu azymutalnego cząstek naładowanych dla eksperymentu ASYEOS II w GSI/FAIR, Darmstadt (Niemcy)



- Terapia w oparciu o diagnozę i leczenie wyznaczone przez lekarzy onkologów.
- Zespół Centrum Cyklotronowego Bronowice odpowiedzialny za przygotowanie naświetlań, dostarczenie wiązki protonowej, testy dozymetryczne, przygotowanie pacjentów do terapii.

Systematyczny wzrost liczby pacjentów:



Najczęściej leczone rodzaje nowotworów (wskazania):

- Nowotwory podstawy czaszki, kręgosłupa: chordoma (struniak), chondrosarcoma.
- Dzieci: nowotwory tkanki miękkiej, sarcoma (mięsak) kości.
- Gałka oczna: melanoma (czerniak).