



# The Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences

[www.ifj.edu.pl](http://www.ifj.edu.pl)



**World University Rankings 2024**

Discover the world's top 2000 universities



**Place 753 (3.6%)**

Prof. Tadeusz Lesiak  
Director General

# General Information about IFJ PAN

- Personnel: **567**; Prof. **31**, Assoc. Prof. **58**, Ph.D. **93**, engineers **120**

- 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

- Research Departments:

- Cyclotron Centre Bronowice
- Division of Scientific Equipment and Infrastructure Construction
- Four accredited laboratories

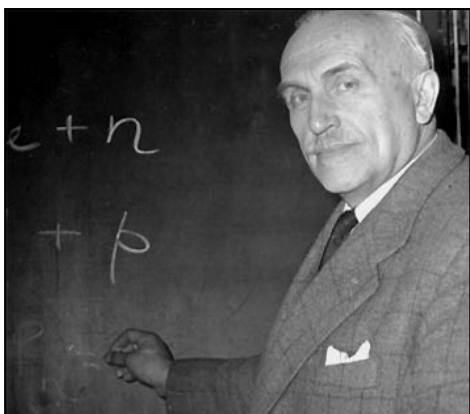
- Education:

- International Ph.D. Studies
- Interdisciplinary Doctoral Studies
- Kraków Interdisciplinary Doctoral School

- Scientific output: **> 650** publications annually



# Genesis and History



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



(Fot. Archiwum of the IFJ PAN)

- **1960** – IFJ as a standalone unit
- **1970** – Particle physics enters – Prof. Marian Mięśowicz (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





## Projects coordinated by the IFJ PAN

1. CCB – Cyclotron Center Bronowice (development, next phase)
2. Centre of Engineering of Cryogenic Materials and Research Equipment
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 – Free Electron Laser
2. ELI – Extreme Light Infrastructure
3. CTA – Cherenkov Telescope Array
4. FAIR – Facility for Antiproton and Ion Research
5. ESRF – European Synchrotron Radiation Facility



## Participation of IFJ PAN in projects aimed at the Development of Innovation and Cooperation of European Technological Infrastructures for Accelerators and Magnets



### **TIARA** – Test Infrastructure and Accelerator Research Area (2 years, 2011-2013)

In Poland, the project was carried out by a consortium of 7 scientific institutions: the Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences, the AGH University of Science and Technology, the Cracow University of Technology, the Andrzej Sołtan Institute of Nuclear Problems, the Warsaw University of Technology, the Lodz University of Technology, the Wrocław University of Technology.



### **AMICI** – Accelerator and Magnet Infrastructure for Cooperation and Innovation (2017-2019)

In Poland, the project was carried out by the Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences



### **i.FAST** – Innovation Fostering in Accelerator Science and Technology (2021-2025)

WP13 activities are carried out by the Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences



### **FuSuMaTech** - Future Superconducting Magnet Technology (2017-2019, 2021-2025)

In Poland, the project is carried out by the Henryk Niewodniczański Institute of Nuclear Physics Polish Academy of Sciences

# Division of Particle and Astroparticle Physics (NO1)



Staff: about **55** people

Results: about **200** publications/yr

## 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 ( $b \rightarrow s$ , CKM  $\gamma$ , 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 **MUonE** experiment at CERN
- Preparation of **ATHENA** experiment at future Elektron Ion Collider (EIC)
- Physics feasibility studies for future accelerators (mainly **FCC**)
- development of “Cloud Computing” and GRID computing infrastructures





➤ Major expts:

- AGATA
- PARIS
- ALICE
- NA61/SHINE
- neutron EDM
- ...

➤ International cooperation:

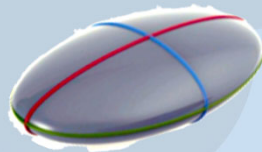
- IJCLAB Orsay
- GANIL Caen
- LNL INFN Legnaro
- Milano University,
- GSI Darmstadt
- FZ Julich
- RIKEN Japan

➤ Local research program at Cyclotron Center Bronowice IFJ PAN

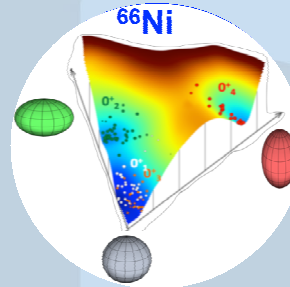
Staff: about 45 people

Results: about 140 publications/yr

Superdeformed and triaxial states in Ca-42

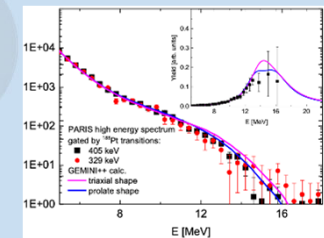
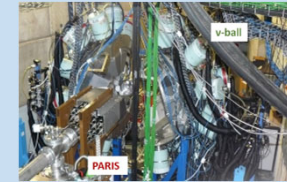


Identification of shape isomers in Ni-66 and Ni-64

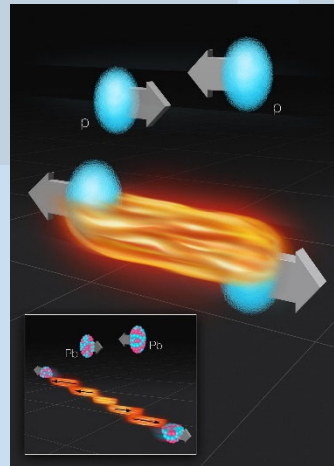


PARIS

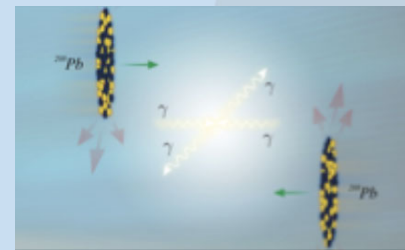
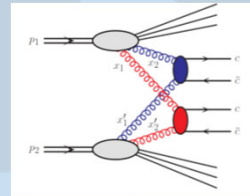
– coordinated by the IFJ PAN



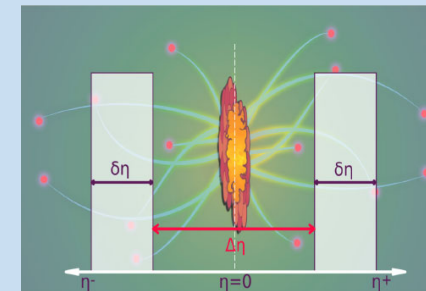
Fire streaks model of nuclei and proton collisions



„Light-on-light” scattering in HE ultraperipheral nucleus-nucleus collisions



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



# Division of Applications of Physics (NO6)

## ➤ Major studies

Staff: about **45** people

Results: about **100** publications/yr

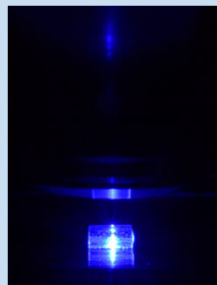
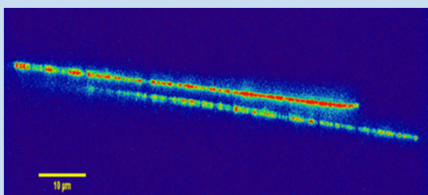
- neutron transport,
- neutron and ion diagnostics for tokamaks and stellarators,
- medical physics for proton therapy, space dosimetry, thermo- and optically stimulated luminescence, retrospective dosimetry,
- low-level radioactivity measurements in environment:  $\alpha$ ,  $\beta$ ,  $\gamma$  spectroscopy,
- mass spectrometry (Arctic, glaciers, etc.)

## ➤ International cooperation and projects:

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

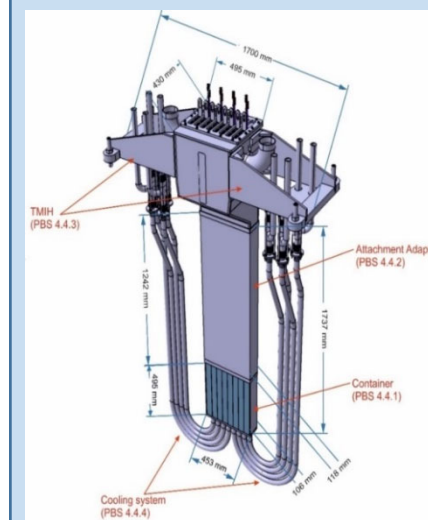
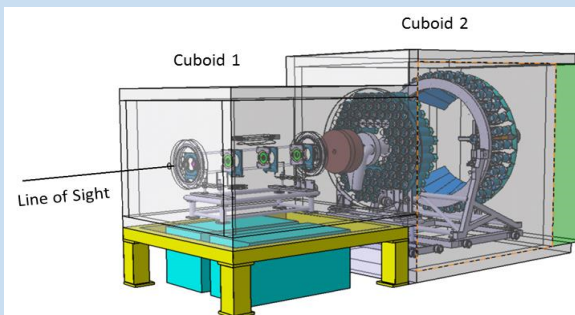
## ➤ Local research program at AIC-144 → see next slide

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



HRNS (High Resolution Neutron Spectrometer) for ITER

to determine the ratio of T/D ions in plasma



Start-up Monitoring Module for IFMIF-DONES

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



# Applied research at the AIC-144 60 MeV proton cyclotron

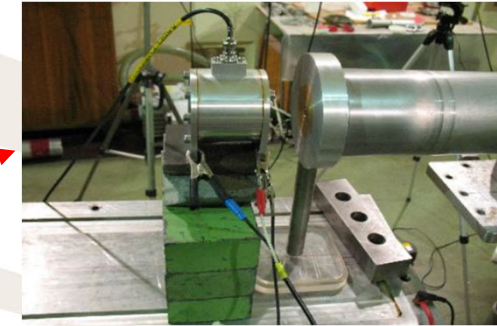


## Eye line for precise irradiation

- dose rate: 0.001 – 1 Gy/min
- beam field size:  $\leq 40$  mm;
- Typical flux:  $10e8 - 10e9$  p/cm<sup>2</sup>·s;

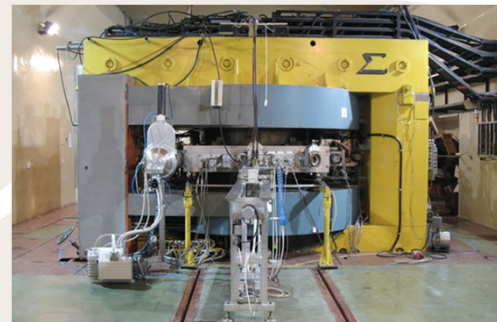
## Line for isotope production

- proton current:  $< 100$ nA;



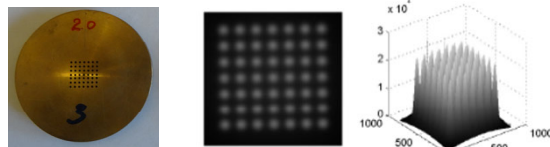
## Experimental room: high beam intensity

- proton current: 2nA – 100nA;
- Dose rate up to 50 Gy/s
- irradiation field  $d < 12$  cm;



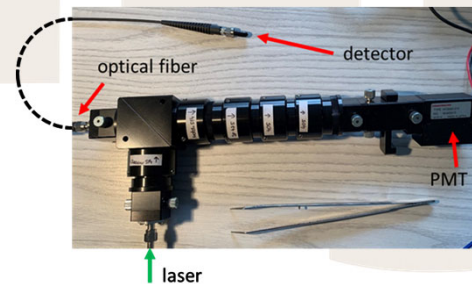
## AIC-144 Cyclotron

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

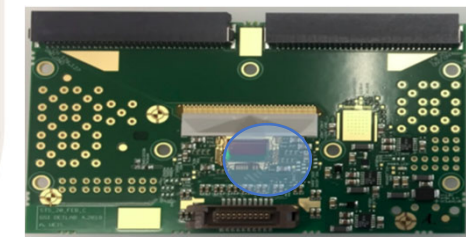


Proton grid therapy – to reduce side effect sof treatment

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

- **1214** patients finished irradiation in gantries
- **371** ocular patients with eye melanoma

(by June 2024)



Staff: about **60** people

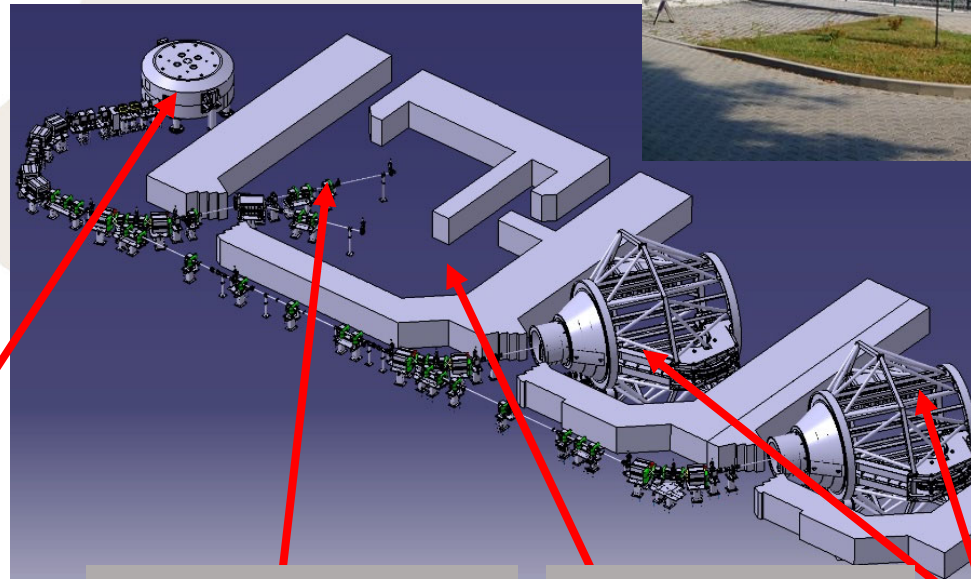
Two dedicated scanning gantries



**AIC-144 cyclotron**

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

**Proteus-235  
cyclotron IBA**

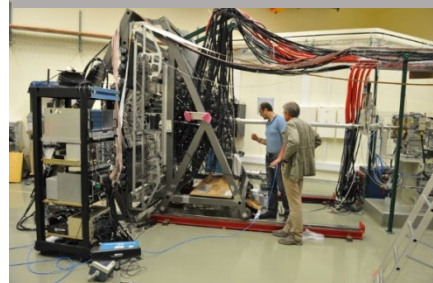


**Experimental Hall**

**Eye treatment**



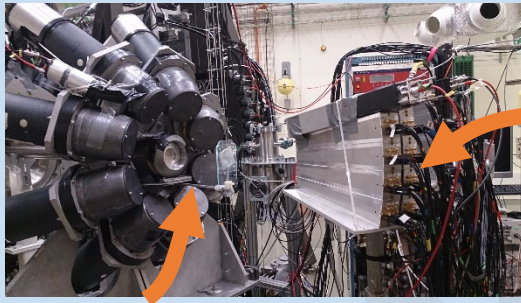
70-230 MeV,  $I_{\text{beam}} = 1-500$  nA



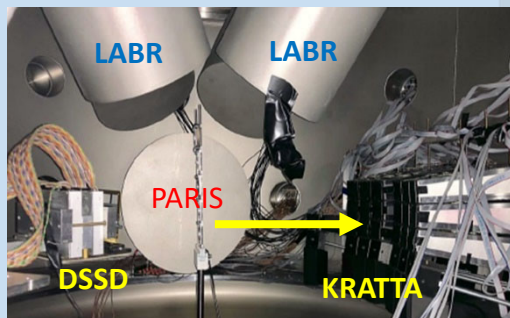


## Proton beam (230 MeV) from the Proteus-235 Cyclotron at the Cyclotron Centre Bronowice

### Studies of resonance excitations of nuclei

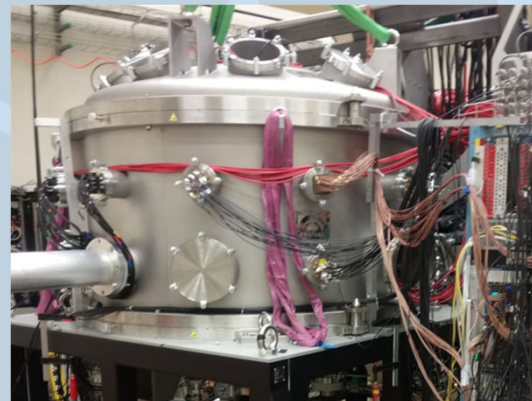


detector **HECTOR**  
Measurements of gammas)

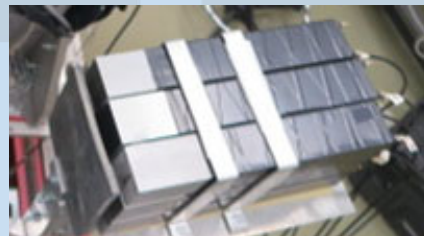


Detectors inside  
the scattering chamber

Detector **KRATTA**  
Measurement of proton's  
inelastic scattering



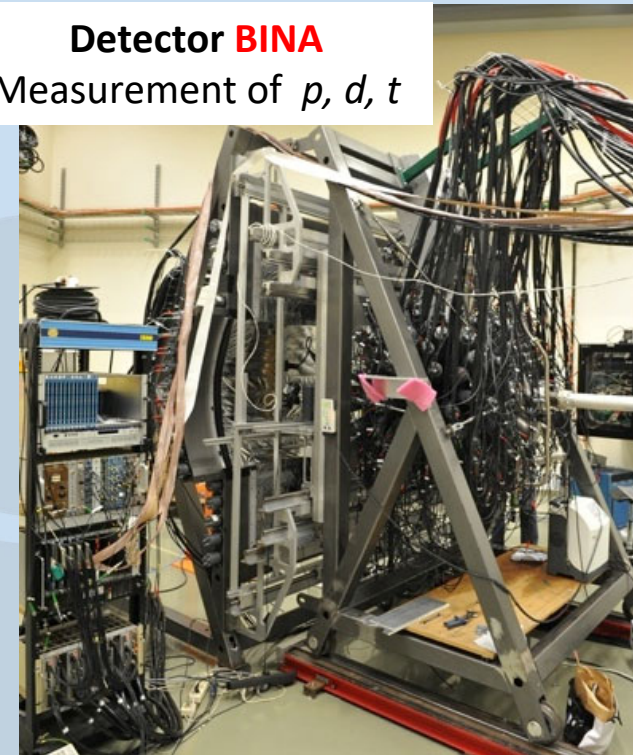
„Big” scattering chamber



**PARIS and LaBr3**  
high-energy  $\gamma$ -ray array

### Studies of triple nucleon dynamics

Detector **BINA**  
Measurement of  $p, d, t$



# Division of Scientific Equipment and Infrastructure Construction (DAI)



- Constructions of **large international research infrastructures** AND **development of local engineering R&D setup** (cryogenics, vacuum, precise mechanics, RF systems, superconductors, construction and test of detectors, quality systems, ...)

➤ Cooperation with:



Last decade engagements: 536 FTE  
Income > 30 M EUR



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

**Staff:**  
specialist/engineer/technician: **42**  
Prof./Assoc. Prof./Phd: **5**

**Scientific Results:**  
about **10** publications/yr



QC for interconnections of LHC magnets

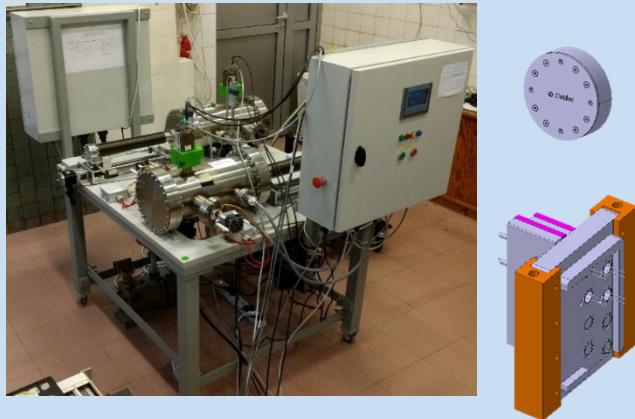


Dedicated measuring apparatus built at the IFJ PAN



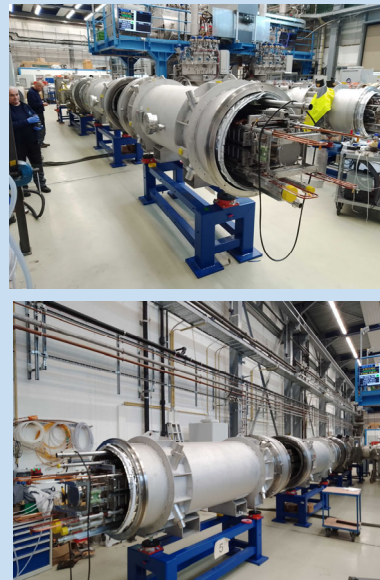
## Tests for ITER

(feedthrough, diamond detectors)



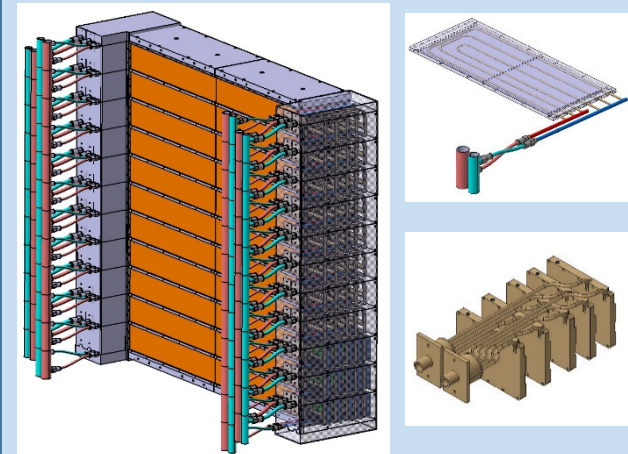
Test stand built at the IFJ PAN

## Installation of the string SIS100 (GSI)



## Contribution to ALICE (FoCal)

Custom FOCAL cooling system



- DESIGN
- PRODUCTION
- TEST DELIVERY

## Testing and installation of the Cryomodules at ESS

31 Cryomodules foreseen to the test



Incoming inspection and preparation for tunnel installation of 13 spoke cryomodules.

Poster session -> P6

Poster session -> P5

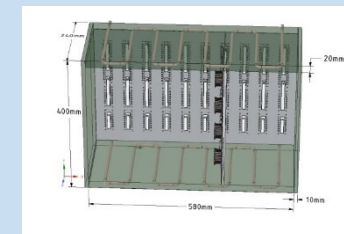
## Local infrastructure: test stand for sc. materials



Recently commissioned

## Contribution to ATLAS

Custom cooling system for electronics



45 dedicated units.

- DESIGN
- PRODUCTION
- TEST DELIVERY



Krakov 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



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



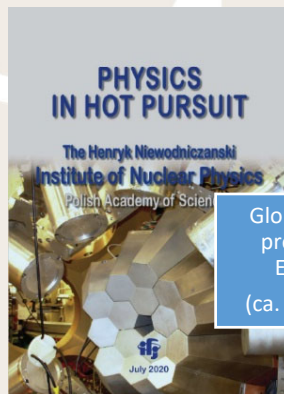
"Physics Couch" discussion series



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

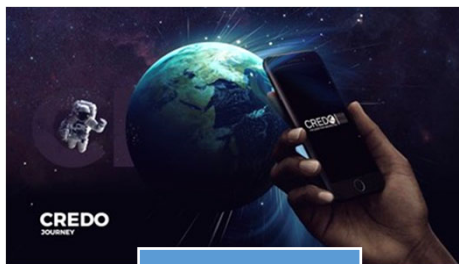
IFJ PAN Open Day for students

Małopolski Festival of Innovation

QuickPhysX and QuizFiz contests

Silesian Science Festival in Katowice

Particle Physics Summer Student Program at IFJ PAN



"Particle Hunters" contest with the CREDO Detector application



Children's Day 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



**THANK YOU FOR YOUR ATTENTION**