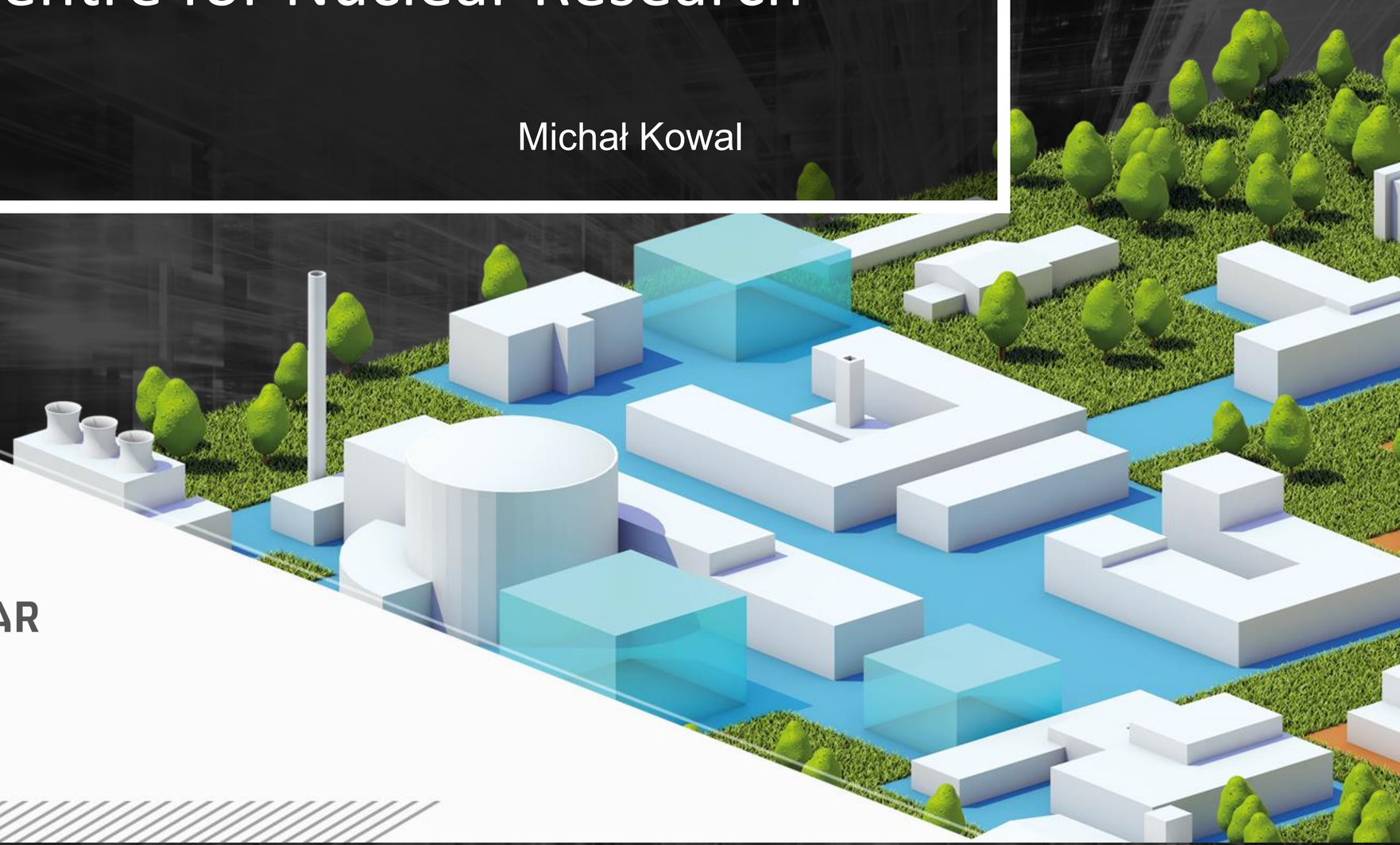
Nuclear Science and Technology in National Centre for Nuclear Research

Michał Kowal



NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

Research sector in NCBJ

A+ category scientific unit

HR EXCELLENCE IN RESEARCH

One of the largest research institute in Poland

1031 employees, inc. 76 prof. & 150 PhD

PhD Study: ~80 students

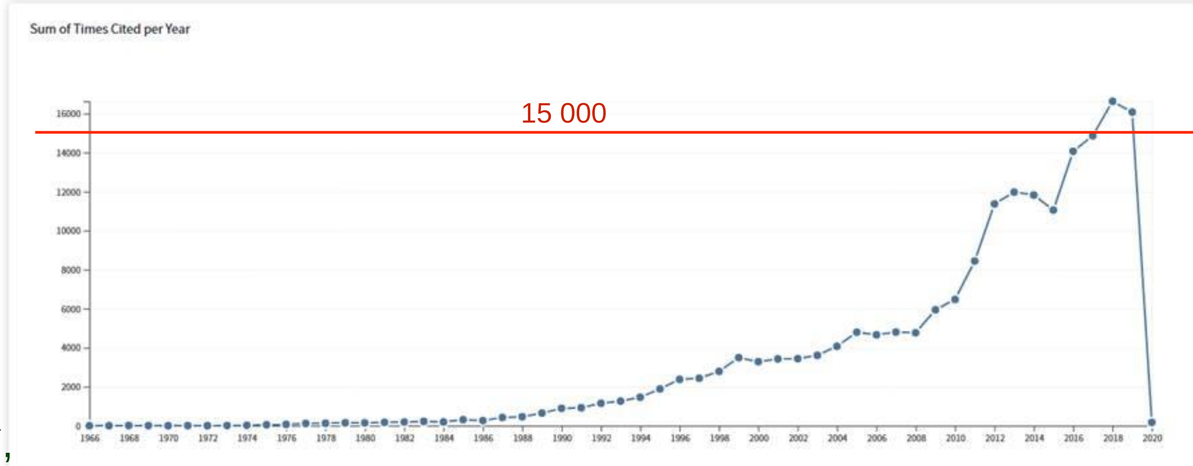
Scientific achievements:

~500 reviewed papers,

~15000 quotations each year,

5/4th position in Poland,

EU projects: success rate: 35%



117 different types projects

International collaborations with largest laboratories in the world (CERN, DESY, Grenoble, JParc, FAIR, Julich, ESS, JINR, T2K), cooperation in many universities around the world

Nuclear Facilities Operations Department

Reaktor MARIA

Material Physics Department

LBM

Department of Fundamental Research

Department of Nuclear Techniques and Equipment

Complexity Center

Centrum Informatyczne Świerk

Radioisotope Centre

POLATOM

Division of Nuclear Equipment HITEC

Science and Technology Park

Scientific-and-Industry Centers

FUNDAMENTAL RESEARCH
(NUCLEAR + THEORETICAL PHYSICS DIVISION)

Department of Fundamental Research

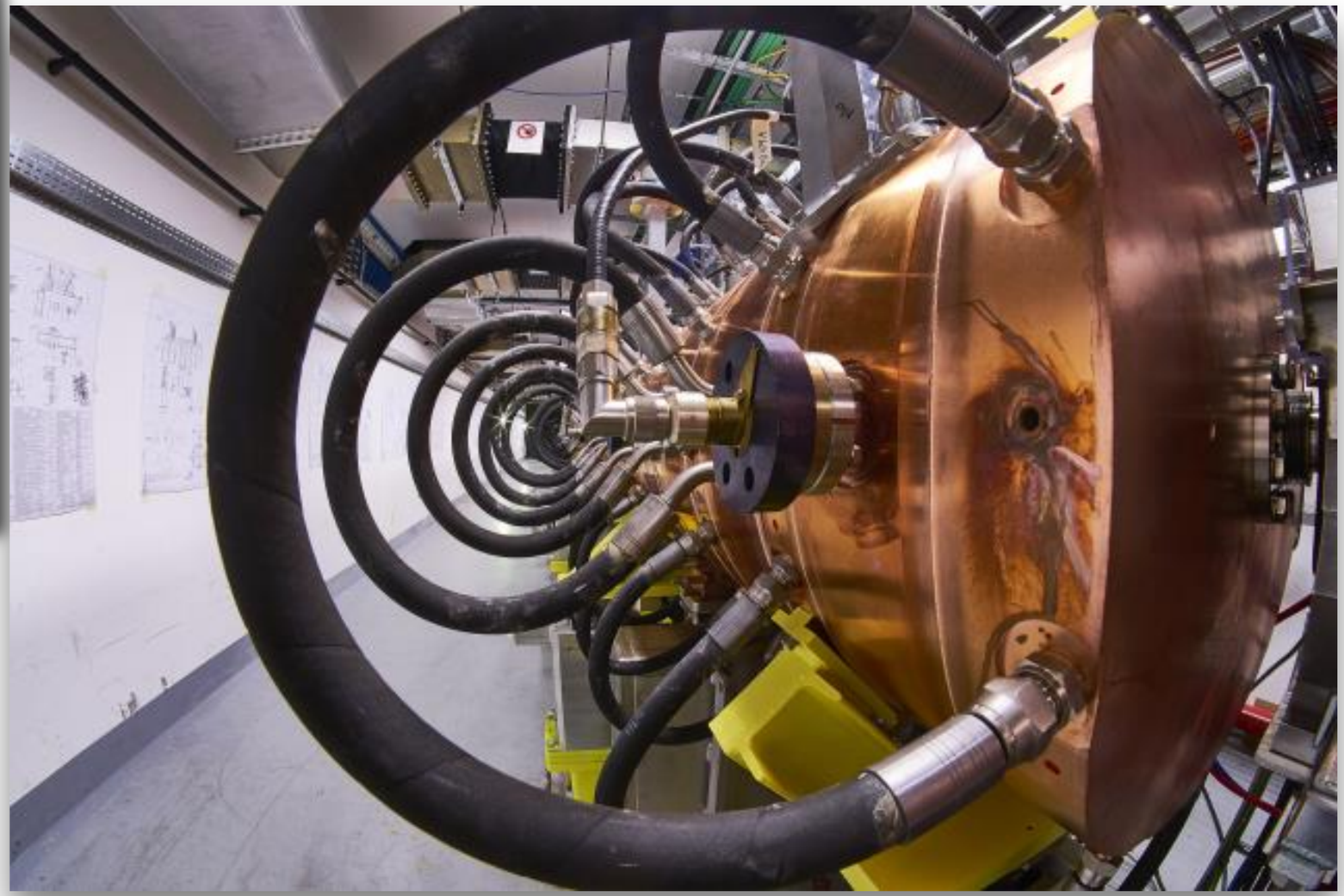
- Research on mechanisms of nuclear reactions.
- Properties of light nuclei.
- Possibility of existence/stability/structure of super-heavy nuclei.
- Synthesis of SHN - cross-sections calculations & predictions.
- Properties of nuclei far from stability.
- Nuclear exotic states (third minima, K-isomers, super-deformation).
- Evaluation and analysis of nuclear masses.
- Hadrons and nuclei.
- Nucleon structure spin functions and spin-dependent effects in collisions of hadrons/lepton.
- Participation in the construction of the PANDA detector.
- Analysis of multi-particle production processes in high-energy collisions of hadrons and nuclei.
- Hyper-nuclei, antiprotons, Gamow resonance states, "strange" - particles, - nuclei & - -atoms.

STAFF

prof. dr hab. Zygmunt Patyk
prof. dr hab. Lech Szymanowski
dr hab. Nicholas Keeley, prof. NCBJ
dr hab Janusz Skalski, prof. NCBJ
dr hab Michal Kowal, prof. NCBJ
dr hab Ernest Grodner
dr hab. Janub Wagner
dr hab. Tolga Altinoluk
dr Tomasz Cap
dr Volha Charviakova
dr Pawel Sznajder
dr Guillaume Beuf

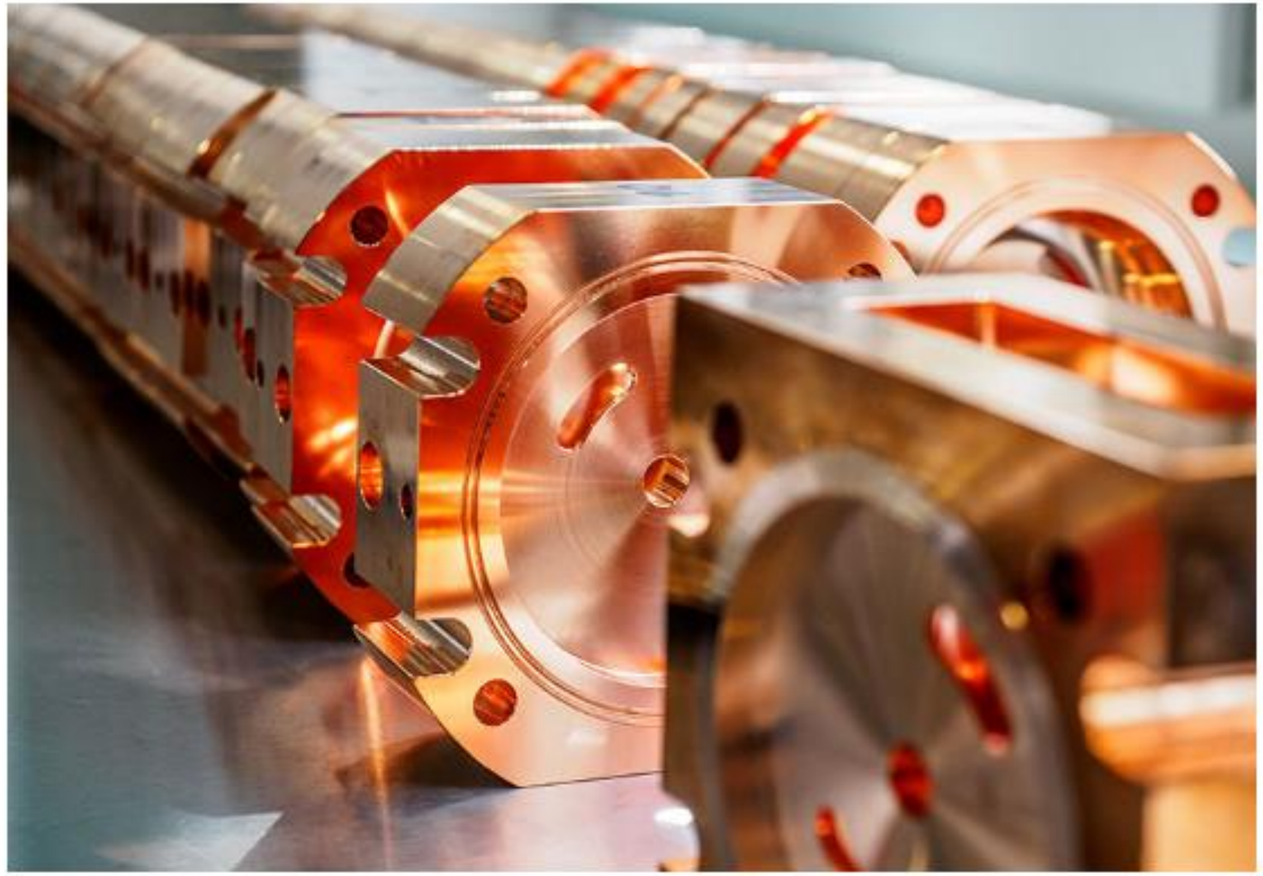
Prof. Grzegorz Wilk*
Prof. Bogusław Zwęgliński*
Prof. Sławomir Wycech *

CERN (CMS, LHCb, ALICE, COMPASS, NA61/Shine, GBAR)



NCBJ contribution:

- CMS muon trigger system
- LHCb „straw tube”
- Linac4 - accelerating structures
- GBAR - e accelerator



About us

Department of Nuclear Equipment HITEC (ZdAJ) is a facility of the National Centre Nuclear Research (NCBJ) dealing with the construction, production, sales maintenance services of equipment applied in the industrial and medical sectors.

Over 100 highly qualified employees of the Department of Nuclear Equipment clo cooperate with the research part of the National Centre for Nuclear Research, streamli existing and developing new products.

We have technological facilities and, above all, our own modern production hall bunkers necessary to work with devices generating ionizing radiation. Thanks to this can offer a wide range of services using modern infrastructure.

We work with leading scientific and research Centres in Europe and in the world.

The Department of Nuclear Equipment has implemented an integrated qu management system certified in accordance with the ISO 9001 and ISO 13485 standa The Director of NCBJ HITEC has established the Quality Policy as an expression of str for continuous improvement of the organization as well as its products and services.

Nuclear technology

Division of Nuclear
Equipment HITEC

ogy

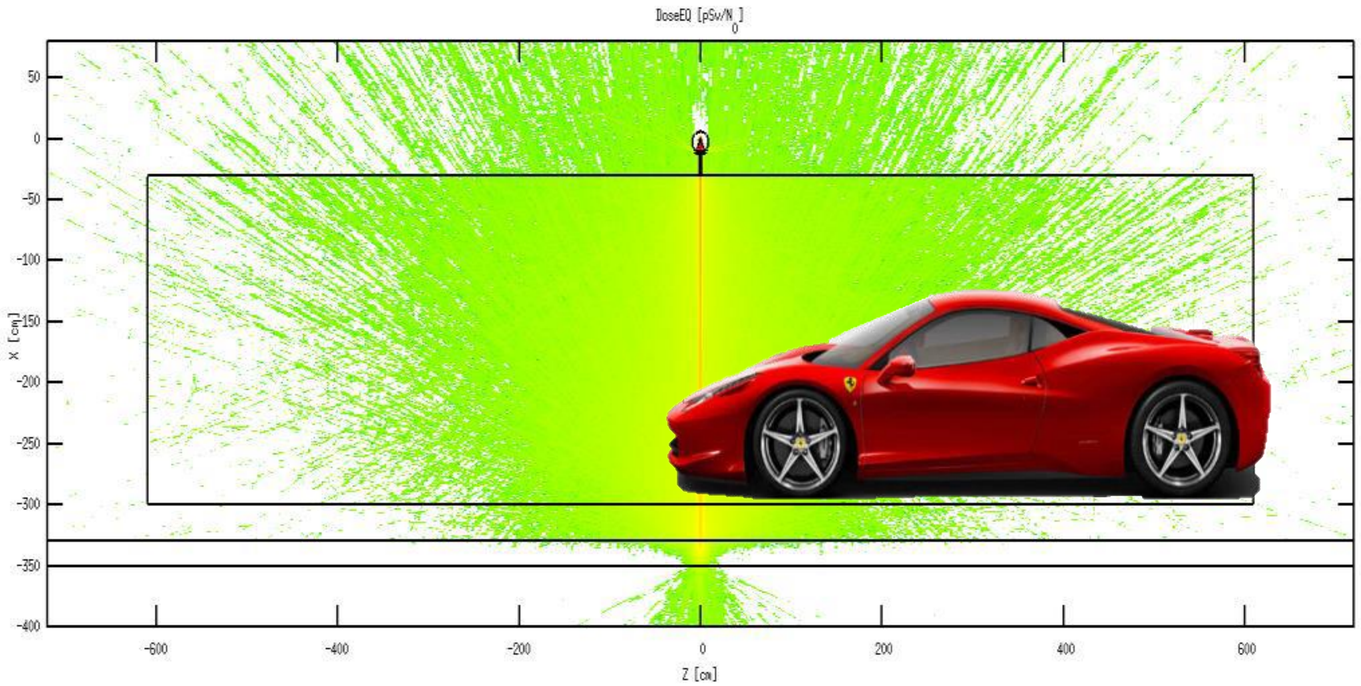
edical electron
tor for intraoperative
n Therapy

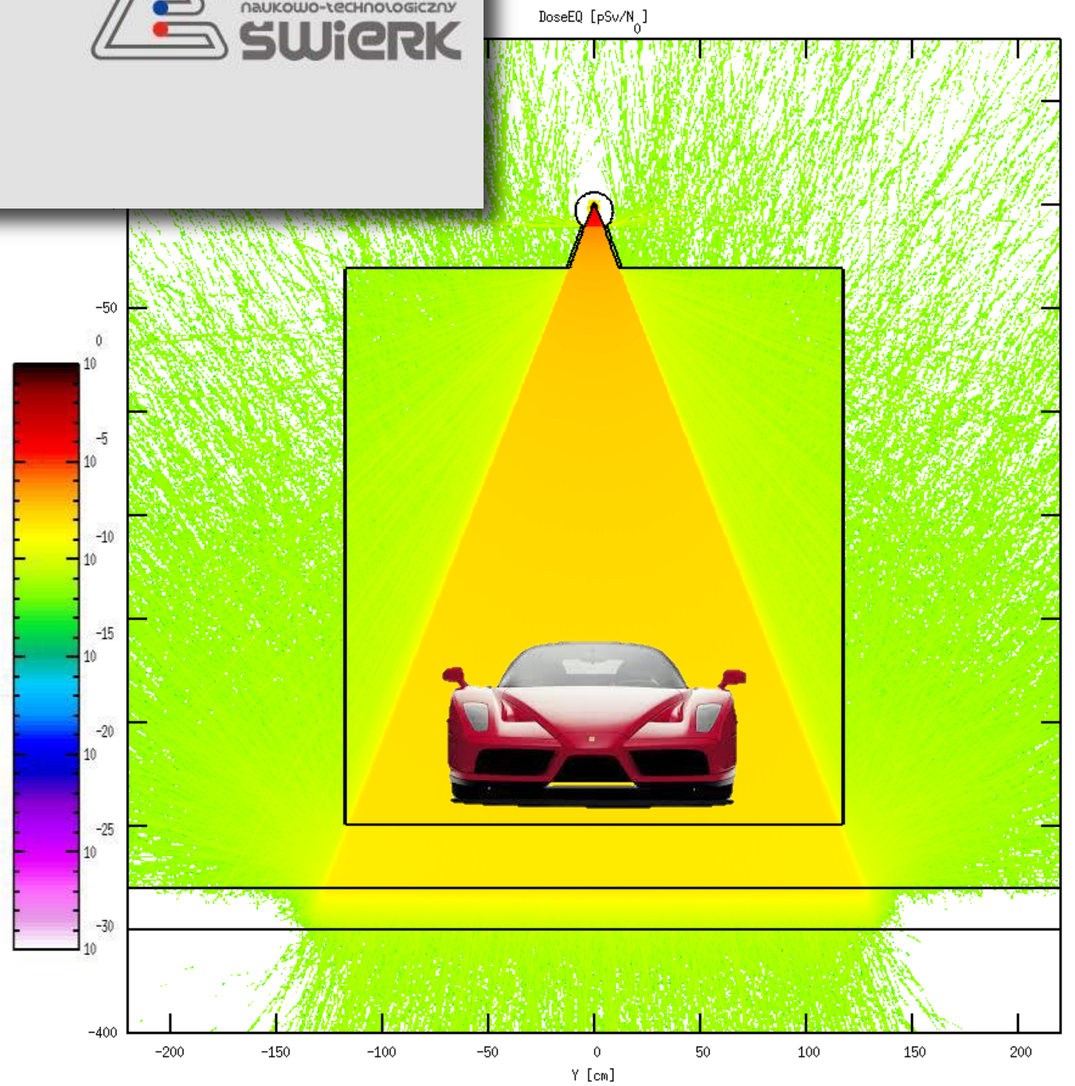
Polski Produkt Przyszłości ®

NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

SOWA

PARK naukowo-technologiczny ŚWIERK





ELEKTRONIKA I DETEKTORY

Nowe techniki detekcyjne oraz ich zastosowanie w medycynie nuklearnej, monitoringu przejść granicznych oraz eksperymentach

1. Szczegółowe badania odpowiedzi materiałów scyntylacyjnych (impulsy świetlne, nieproporcjonalność, zdolność rozdzielcza, etc.) w zależności od typu padającego promieniowania, jego energii, domieszkowania scyntylatora i temperatury.
2. Badania podstawowych własności fotopowielaczy krzemowych i materiałów scyntylacyjnych w celu ich zastosowania w eksperymentach fizycznych, przemyśle i medycynie.
3. Badanie zniszczeń radiacyjnych w materiałach scyntylacyjnych i fotodetektorach krzemowych na potrzeby przyszłych eksperymentów fizycznych
4. Adaptacja gazowego detektora neutronów opartego o nanocząstki B-10 do monitoringu granic.

Elektronika dla fizyki eksperymentalnej i systemy Rozwój systemów akwizycji danych do zastosowań przemysłowych i laboratoryjnych. • Wsparcie dla istniejących systemów elektroniki rozwijanej w TJ2 (tukanUSB, tukanDSP). TJ2 20 spektrometryczne promieniowania jądrowego.

Employee List

(TJ3) Radiation Detectors and Plasma Diagnostics Division

dr Sławomir Mianowski
dr Kamil Brylew
dr Wiesław Czarnacki
dr inż. Martyna Grodzicka-Kobyłka
dr Joanna Iwanowska-Hanke
dr Łukasz Janiak
dr Karol Kozioł
dr Roch Kwiatkowski
dr hab. Aneta Malinowska, prof. NCBJ
mgr Zuzanna Mianowska
prof. dr hab. Marek Moszyński
dr Cezary Pochrybniak
dr hab. inż. Marek Rabiński
prof. dr hab. Marek Sadowski
dr Agnieszka Syntfeld-Każuch
dr Karolina Szamota-Leandersson
dr Tomasz Szczęśniak
dr hab. Łukasz Świderski, prof. NCBJ
dr hab. Roman Zagórski, prof. NCBJ
dr Jarosław Żebrowski

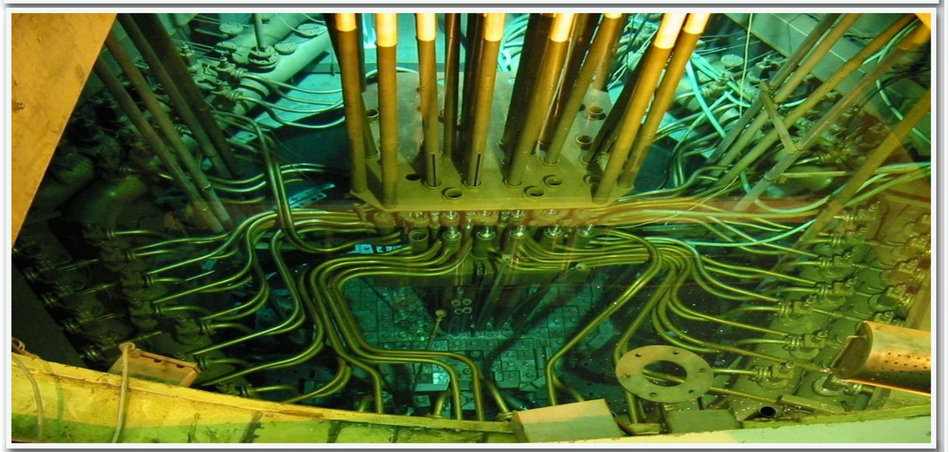
Research reactor MARIA

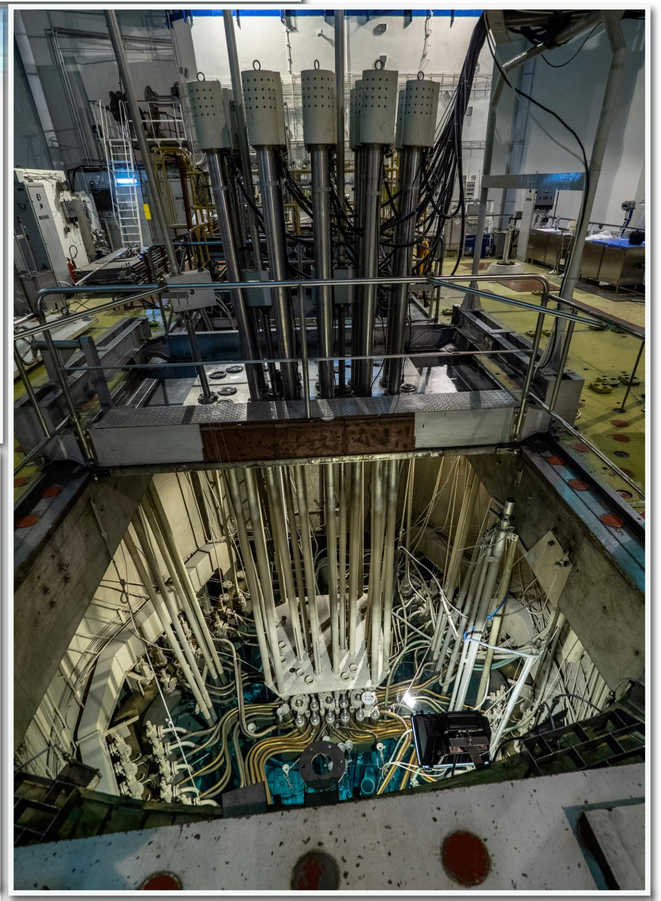
as scientific tool for medicine,
material testing,
nuclear research…

m.gryzinski@ncbj.gov.pl

Ingore experiments examples

Nuclear research reactor MARIA





Reaktor MARIA

- built in 1974
- upgrade 1992, 2011, 2017-…
- pool type
- H_2O, Be moderated
- 30 MW thermal power
- neutron flux:
  - thermal $4 \cdot 10^{14}$ n/cm^{2}s
  - fast $2 \cdot 10^{14}$ n/cm^{2}s

One of the best neutron sources!

- Curium
- POLATOM-NCBJ

Radioisotopes
for 400k patients a week!

NUCLER ENERGY & ENVIROMENTAL STUDIES (UZ3)

- Neutron physics analysis of reactor cores with particular stress on research reactors: fuel conversion studies, feasibility and safety of test and irradiation rigs.
- Calculation of reactor core operational history, operational transients and core composition for various types of reactors, including GEN IV.
- Activities related to development Gas Cooled Reactor Technology.
- Activities related to nuclear cogeneration.
- Development of models of phenomena, development and validation of computational tools.
- Analyses of failures within extended design conditions and severe accidents: phenomena occurring in the core and the reactor vessel& in containment; assessment of radioactive substances from power reactors, storages – source term quantification.
- Nuclear fuel cycle analyses: Spent fuel recycling, transmutation Fuel properties studies.
- Probabilistic safety analyses of nuclear reactors.
- Advanced computer modelling of physical processes, in particular computational fluid dynamics and, transport and dispersion of dangerous substances in environment.

STAFF

prof. dr hab. Mariusz Dąbrowski
dr hab. Tomasz Kozłowski, prof. NCBJ
dr hab. inż. Marcin Szuta, prof. NCBJ
dr Marcin Bielewicz
dr Agnieszka Boettcher
dr Orest Dorosh
dr Piotr Kopka
dr inż. Karol Kowal
dr Sławomir Potempski
dr Elżbieta Strugalska-Gola
dr inż. Jan Szczurek
dr Anna Wawrzyńczak-Szaban
dr Andrzej Wojciechowski
mgr Henryk Wojciechowicz
mgr Mina Torabi
mgr inż. Piotr Prusiński

Computing Centre Świerk

Centrum Informatyczne Świerk

RADIONUCLIDES & MEDICAL APPLICATIONS

- Radionuclides for therapeutic applications with high specific activity, generated by irradiation with neutrons.
- Development of methods for obtaining new tracers for diagnostics and isotope therapy.
- Technologies of obtaining radionuclides in cyclotrons.
- Novel Methods of Producing Tc-99m and Tc-99m Generators in Poland (IAEA Research Contract No: 22652).

- **The CERAD project** - Centre for Design and Synthesis of Molecularly Targeted Radiopharmaceuticals.
- **The NOMATEN module** : Novel radiopharmaceutical materials for medical applications

.

The most common therapeutic isotopes include: ^{131}I, ^{89}Sr, ^{90}Y, ^{153}Sm, ^{177}Lu, ^{99m}Tc, 123I, ^{131}I-131, ^{18}F and ^{68}Ga.

History of the POLATOM's activity begun in the 1950s and was connected with the Institute of Nuclear Research. In 1990 the Radioisotope Centre POLATOM was create as a part of Institute of Atomic Energy. In February, 2005 the limited liability company Radioisotope Centre POLATOM was separated to deal with manufacturing and commercial activity. As the next step Institute of Atomic Energy and Institute of Nuclear Studies was merged to National Centre for Nuclear Research.

people working at the interface with nuclear physics

dr hab. R. Mikołajczak, prof. NCBJ
dr hab. Ryszard Broda, prof, NCBJ
mgr inż. Tomasz Dziel
mgr inż. Anna Listkowska
mgr Zbigniew Tymiński
mgr Tomasz Ziemek

^{131}I hot cells

^{90}Y & ^{177}Lu hot cells

POLATOM

Radiopharmaceuticals with marketing authorisation

Quality Assurance System certified:

ISO: PN-EN ISO 9001:2015-10
cGMP and GLP

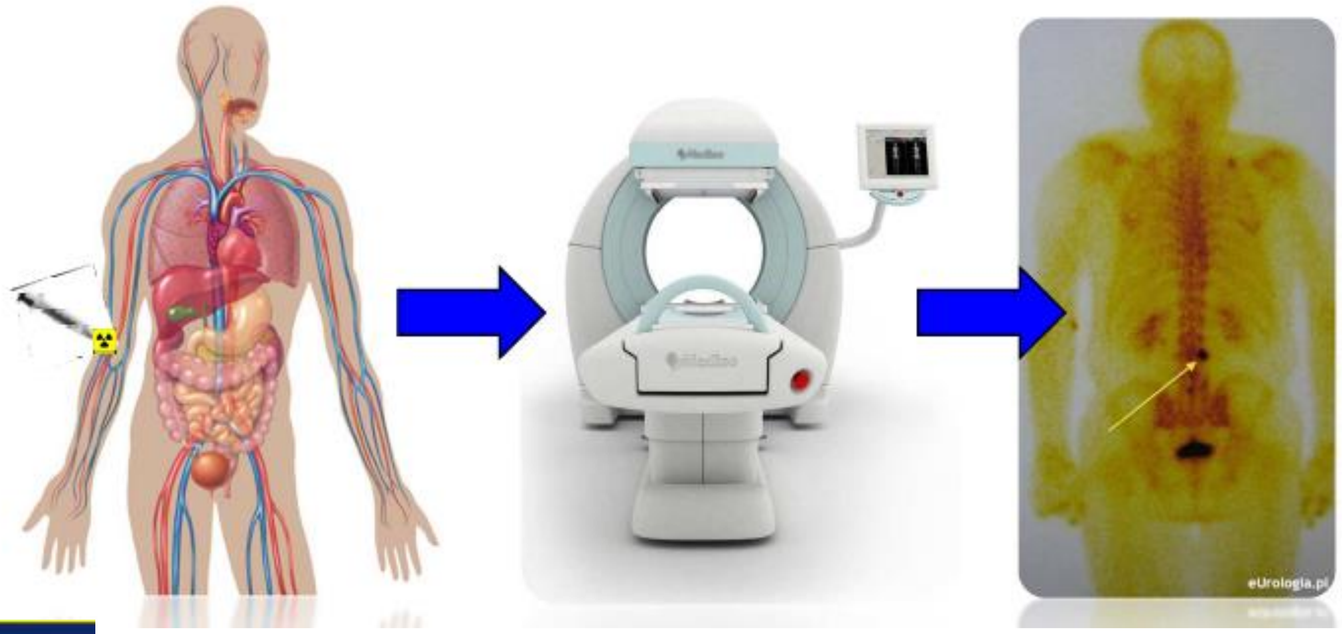
^{99}Mo/^{99m}Tc generator line

^{131}I-Hipuran,
^{131}I-MIBG
injection
solutions line

NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

Krzysztof Kurek

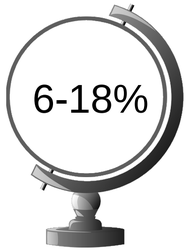
Radioisotope Centre POLATOM-NCBJ



Export to 80 countries
100% polish market
(except PET)

Medicines for 17 million
patients a year

I-131



Mo-99

CERAD

Center of Design and Synthesis of Radiopharmaceuticals for Molecular Targeting

Objective: to improve and expand the research infrastructure located at the NCBJ for research programs oriented at the design and pre-clinical evaluation of new drugs carrying the radioactive probe (**radiopharmaceuticals**) and other multimodality probes, suitable for diagnostic and therapeutic application using biologically active molecules traced at the cellular and molecular level

Widdening the range of available radionuclides:
^{11}C, ^{13}N, ^{15}O, ^{18}F, ^{22}Na, ^{44}Sc, ^{47}Sc, ^{74}As, ^{64}Cu, ^{67}Cu, ^{67}Ga, ^{68}Ge, ^{81}Rb, ^{82}Sr, ^{86}Y, ^{89}Zr, ^{94m}Tc, ^{99m}Tc, ^{109}Cd, ^{111}In, ^{123}I, ^{124}I, ^{201}Tl,^{211}At, ^{225}Ac,

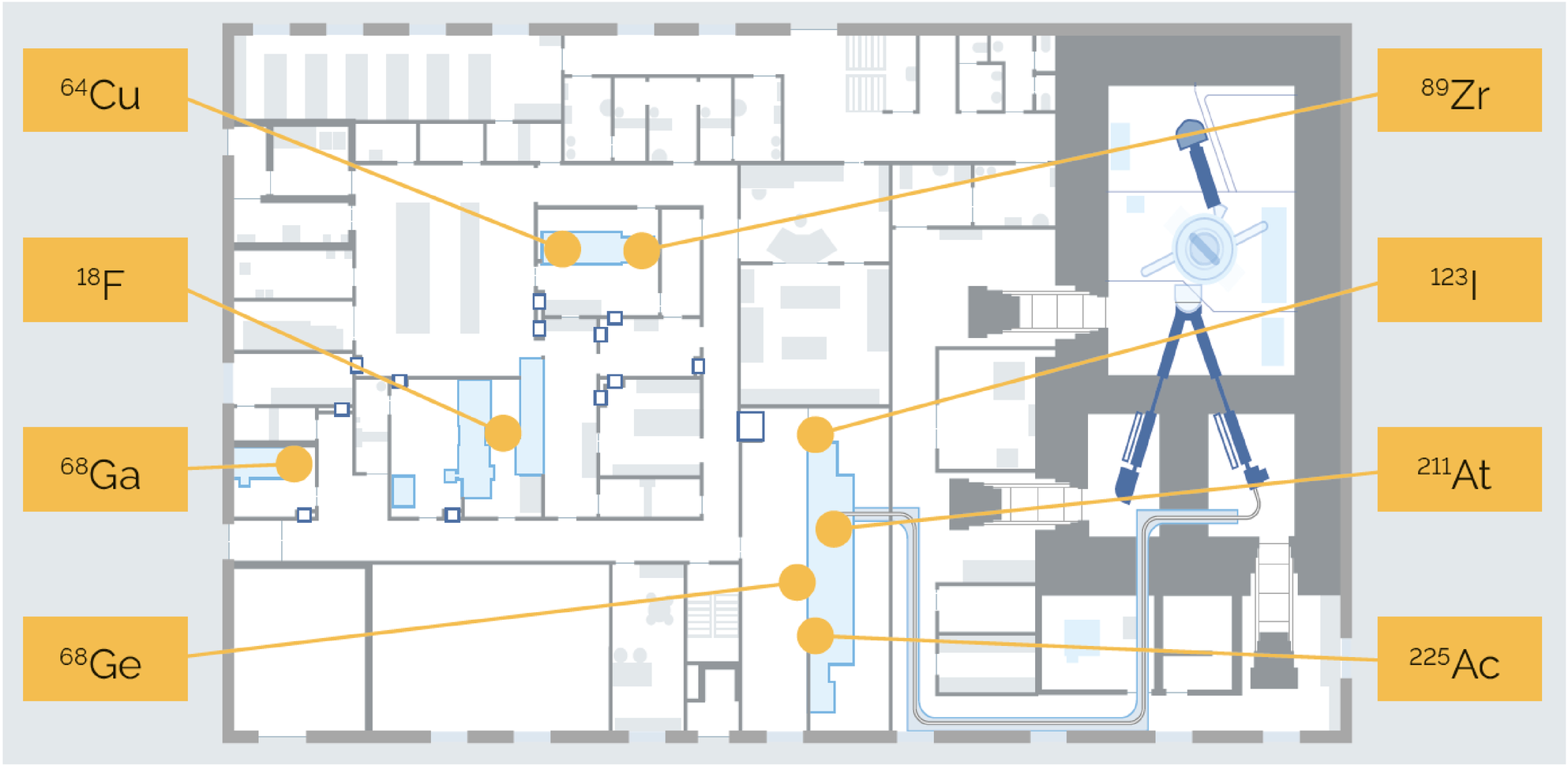
Novel imaging techniques:
Multimodality scanners,
Chemical synthesis and Biochemical laboratories,

30 MeV cyclotron

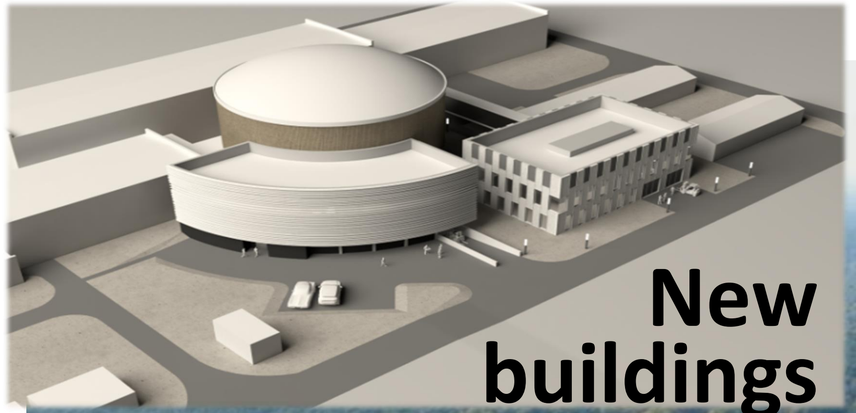
accelerating protons and alpha particles to 30 MeV and deuterons 15 MeV

Cost: ~ 30 M€

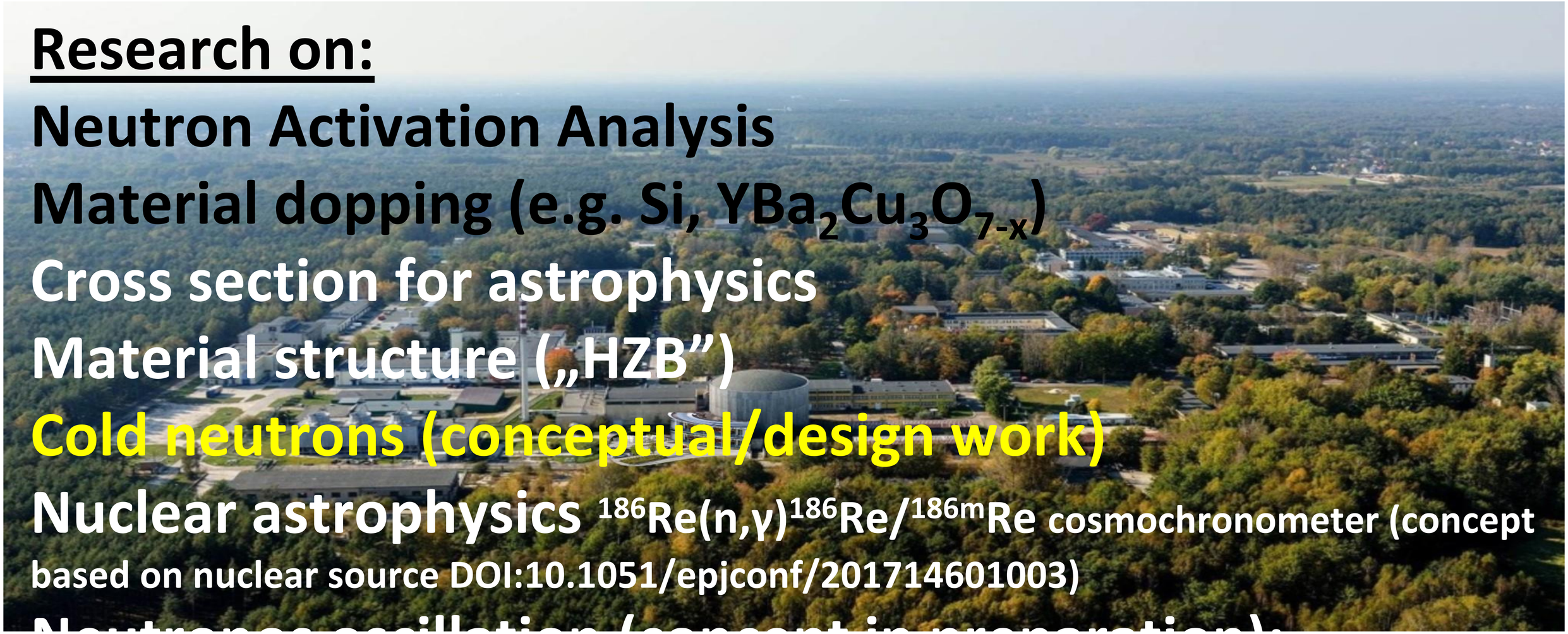
CERAD infrastructure



MARIA – renovation and new buildings



Reactor MARIA in basic science



Research on:

Neutron Activation Analysis

Material dopping (e.g. Si, $YBa_2Cu_3O_{7-x}$)

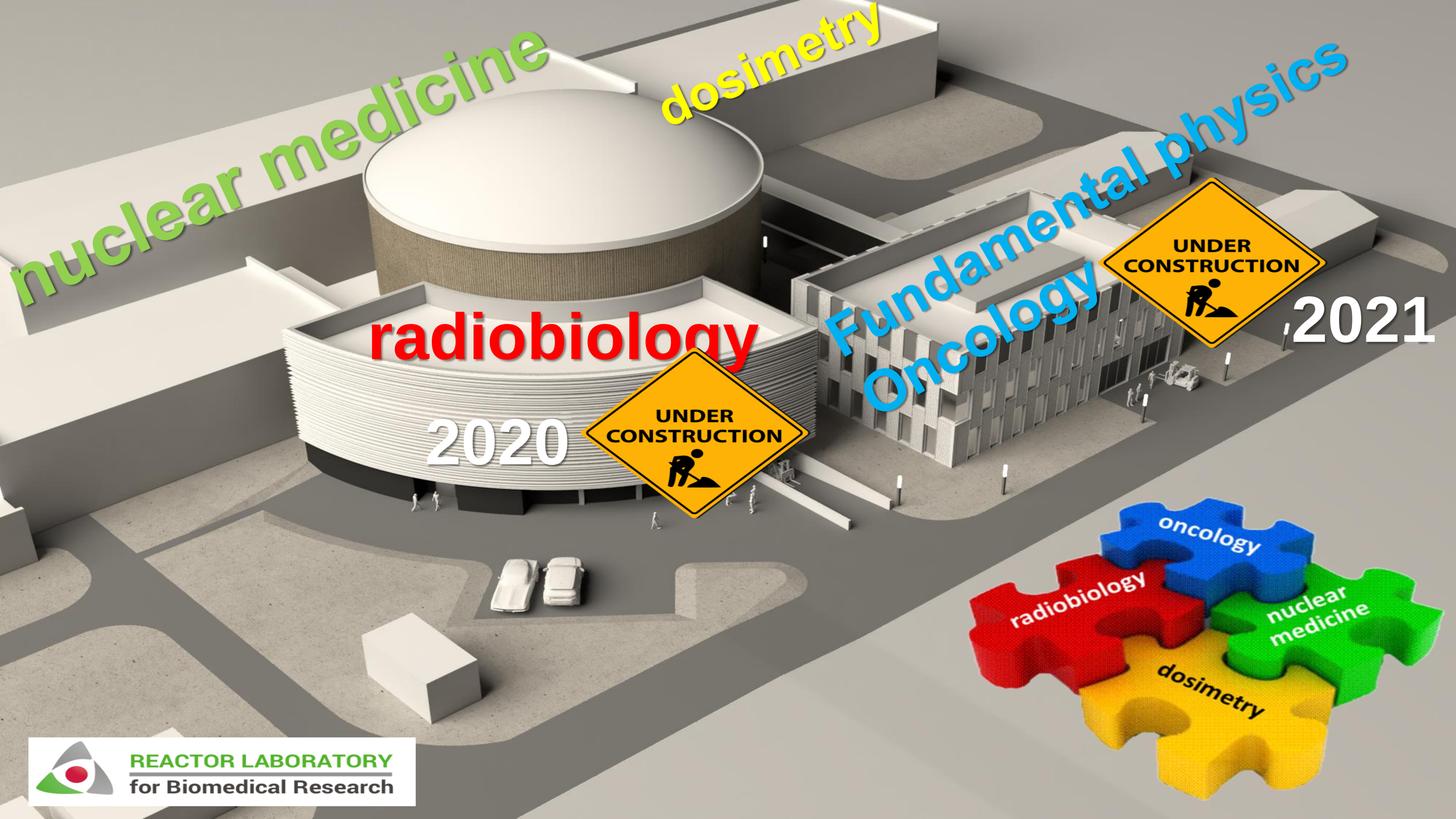
Cross section for astrophysics

Material structure („HZB”)

Cold neutrons (conceptual/design work)

Nuclear astrophysics $^{186}Re(n,\gamma)^{186}Re/^{186m}Re$ cosmochronometer (concept based on nuclear source DOI:10.1051/epjconf/201714601003)

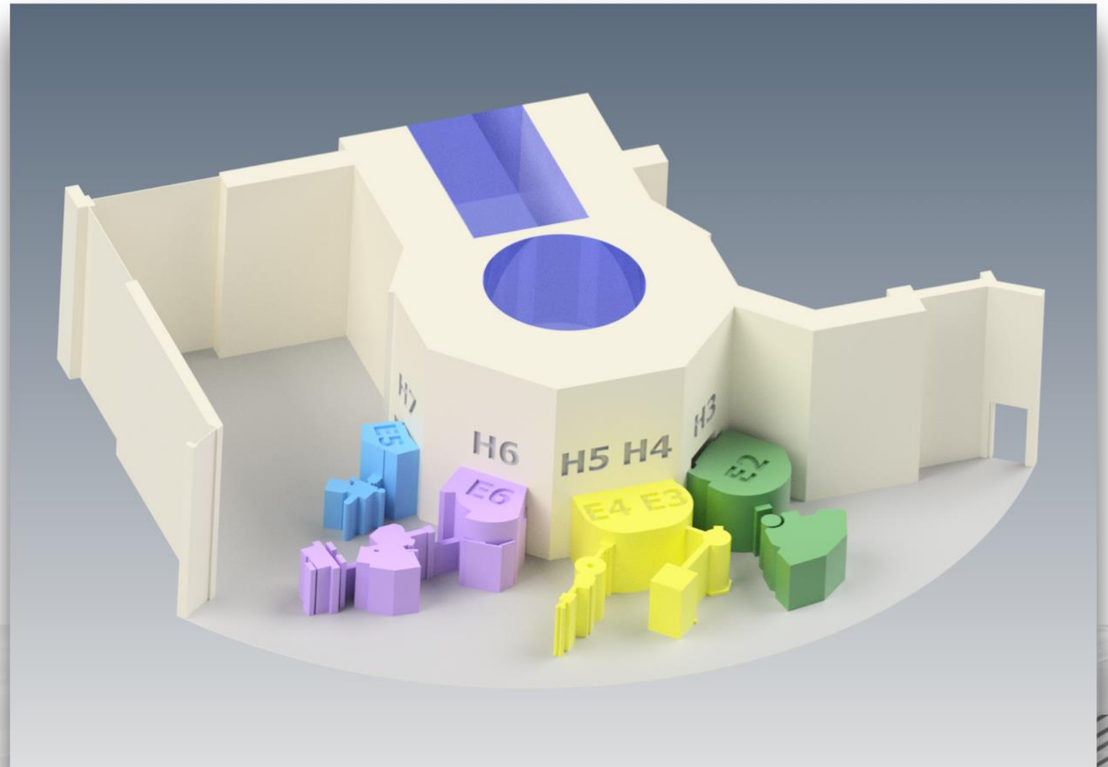
Neutrons oscillation (concept in preparation)


nuclear medicine
dosimetry
radiobiology
2020
UNDER CONSTRUCTION
Fundamental physics
Oncology
UNDER CONSTRUCTION
2021
oncology
radiobiology
nuclear medicine
dosimetry
REACTOR LABORATORY
for Biomedical Research

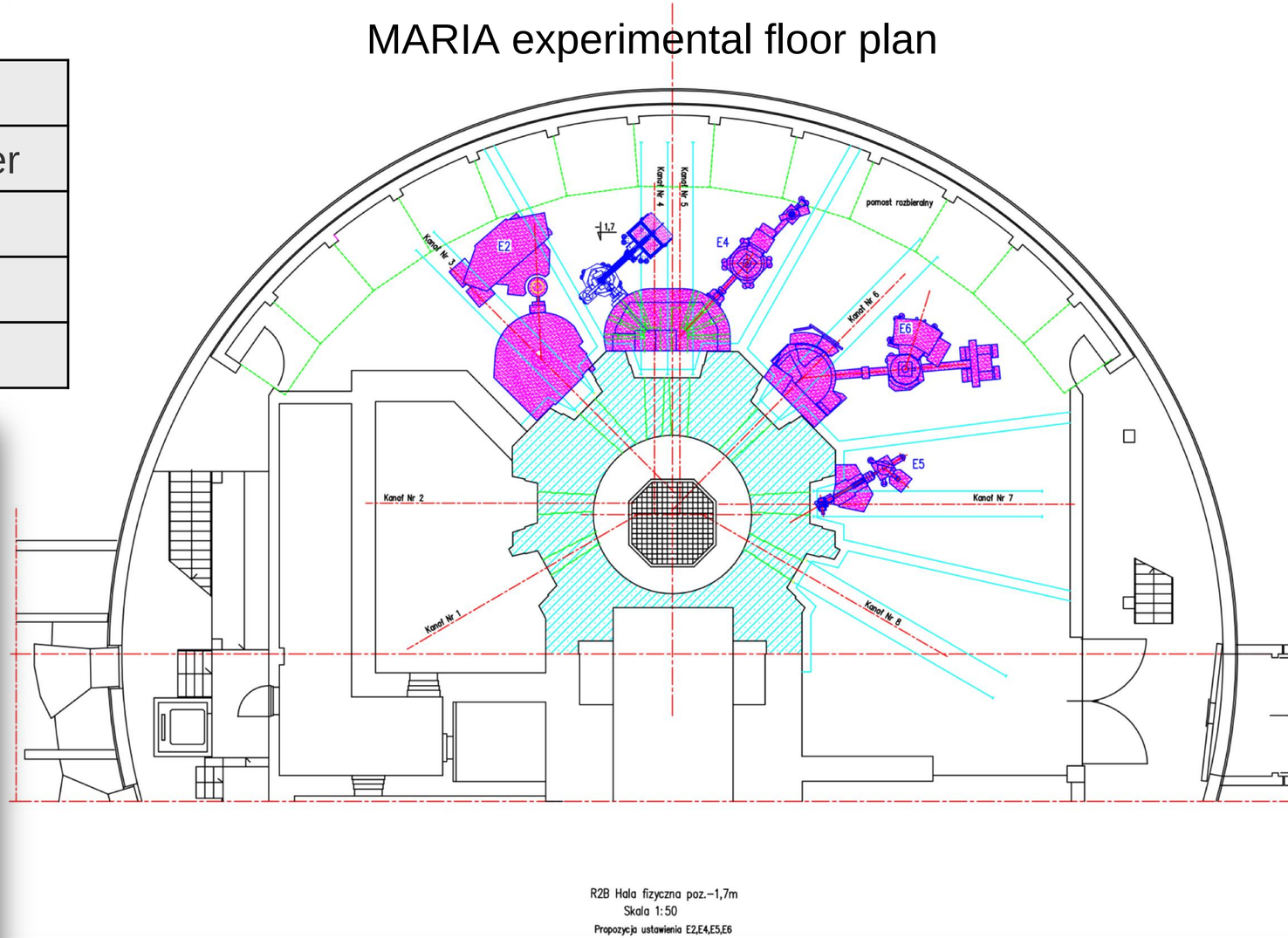
New research instruments
NCBJ-HZB Berlin cooperation

Reaktor MARIA

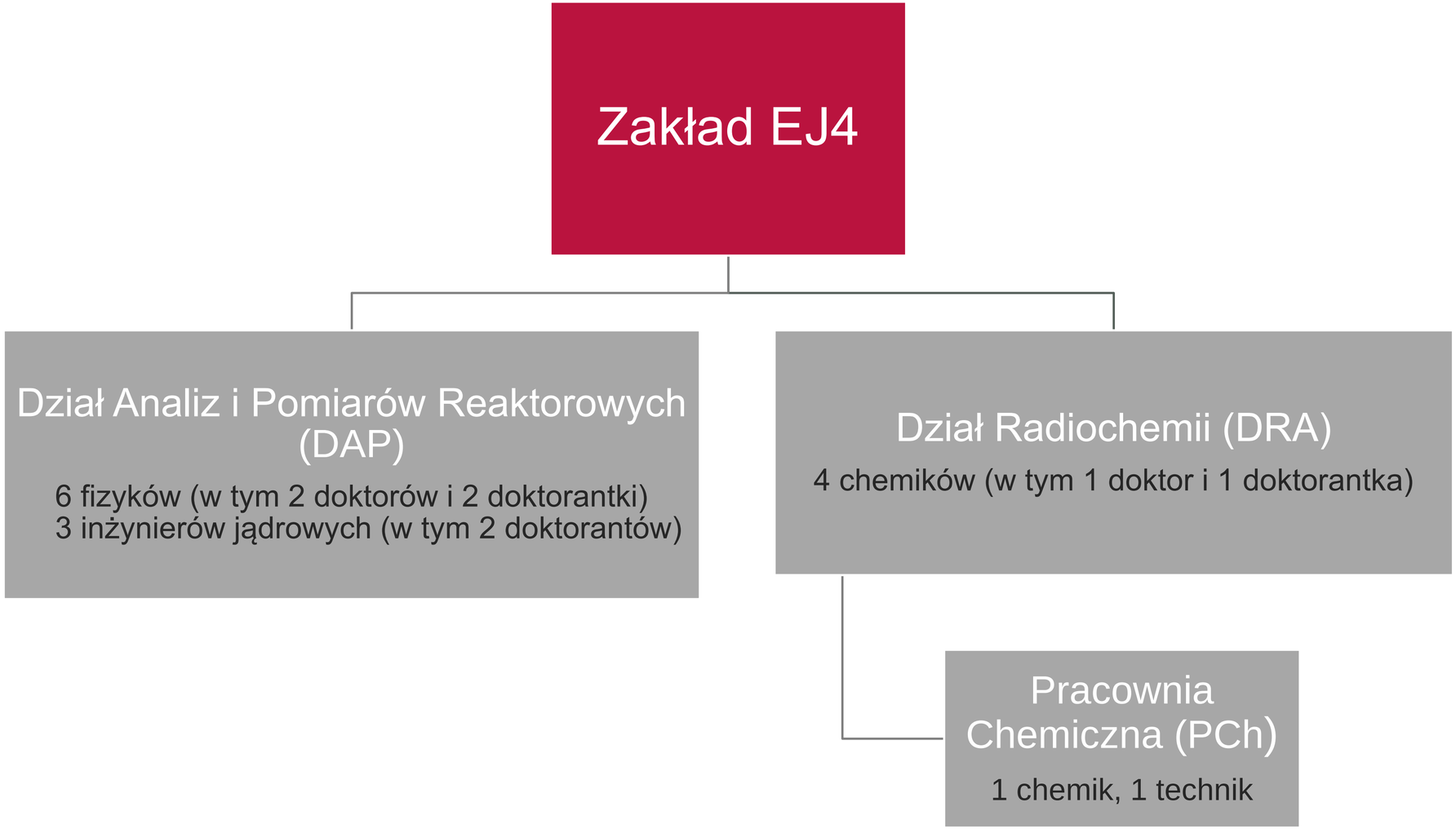
E2	Flat Cone	Diffractometer,
E3	Residual	Stress Analysis Diffractometer
E4	Two-Axis	Diffractometer,
E5	Four-Circle	Diffractometer,
E6	Focusing	Diffractometer.



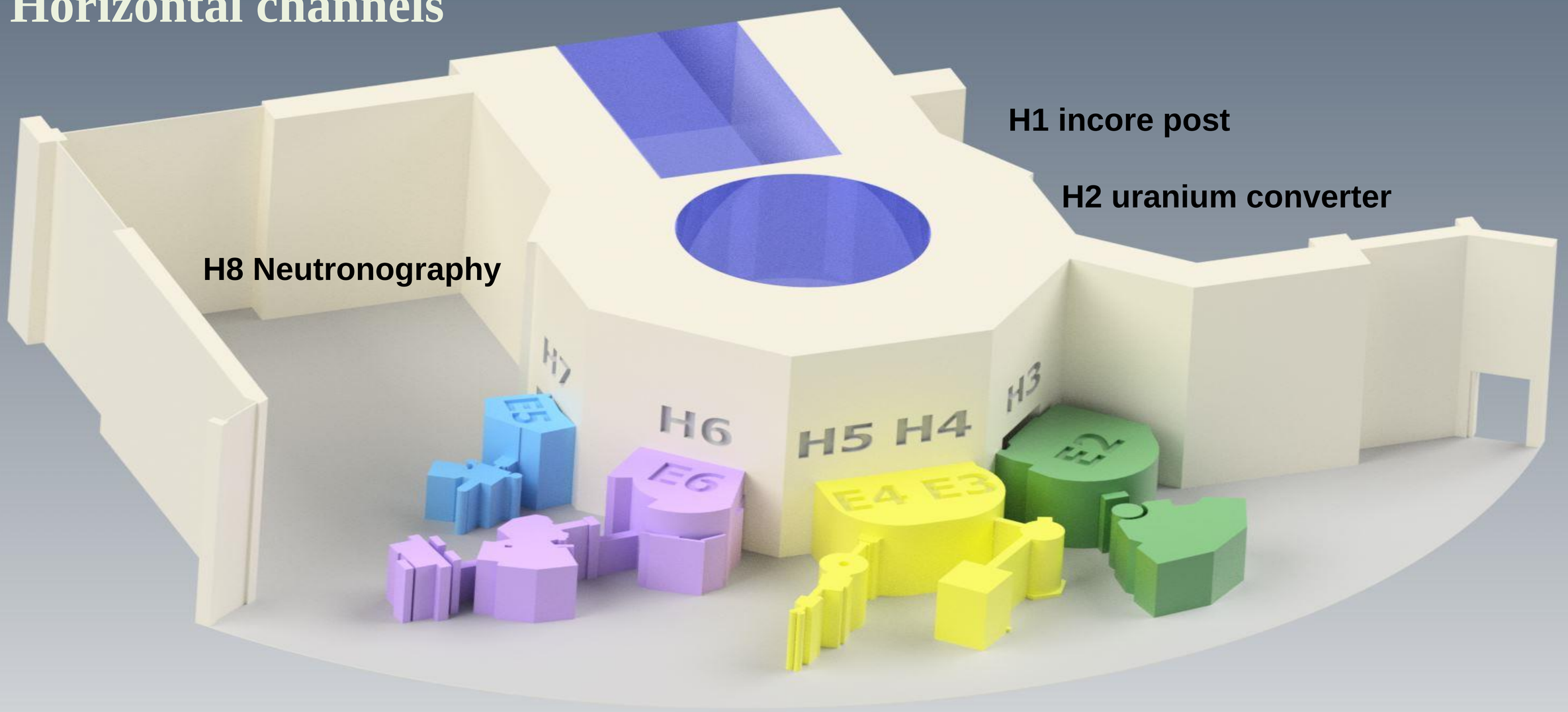
MARIA experimental floor plan



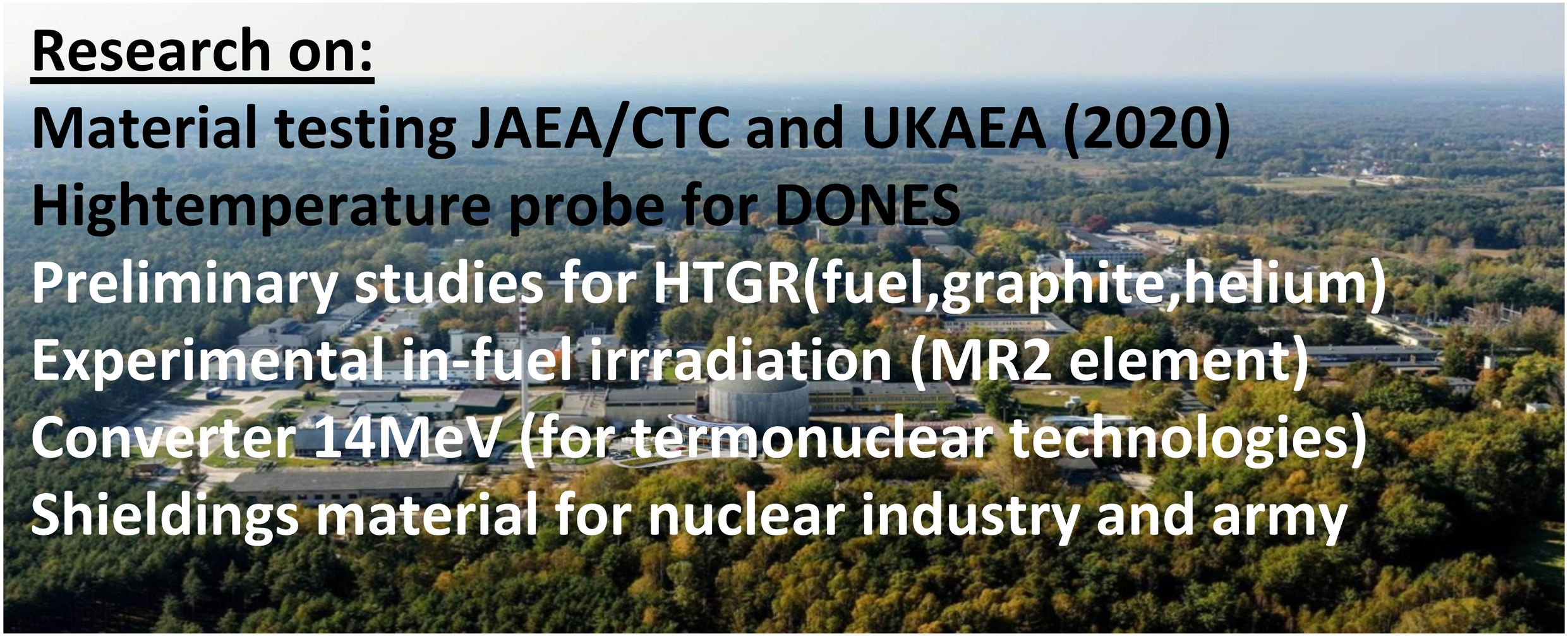
Zakład Badań Reaktorowych (EJ4) – Struktura



Horizontal channels



Reactor MARIA in nuclear technologies



Research on:

Material testing JAEA/CTC and UKAEA (2020)

Hightemperature probe for DONES

Preliminary studies for HTGR(fuel,graphite,helium)

Experimental in-fuel irrradiation (MR2 element)

Converter 14MeV (for termonuclear technologies)

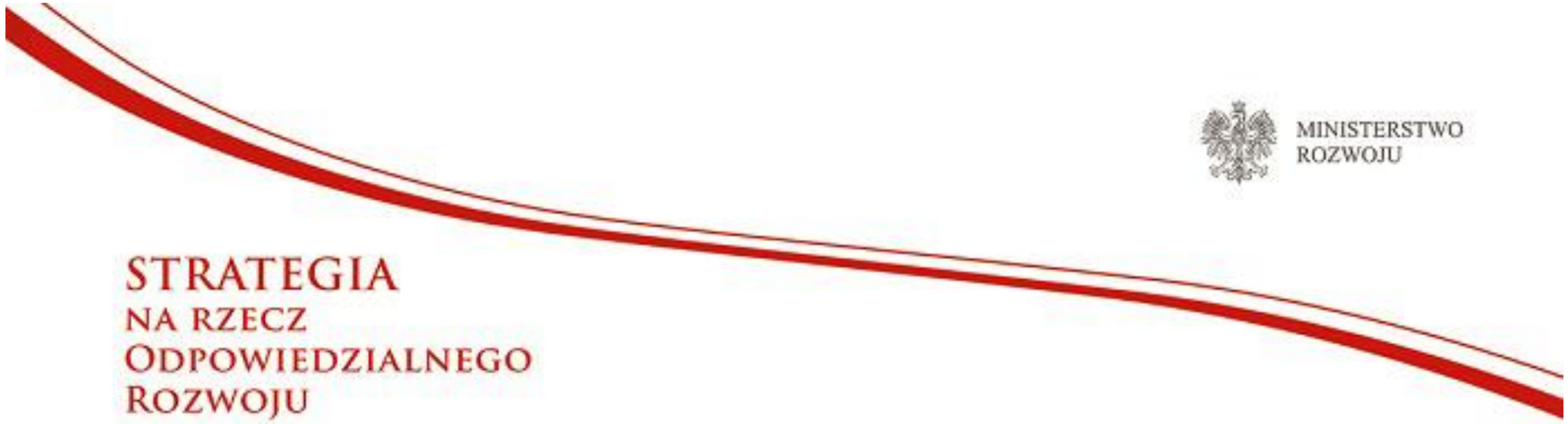
Shieldings material for nuclear industry and army

HTGR project

On 14th February 2017, the government published
„Strategy for responsible development”.
- the governmental plan for Polish economy grow

List of energy actions contains:
Preparation of HTR deployment for industrial heat production in cogeneration, using industrial & scientific potential of Poland.
Support for Polish R&D on materials for gen.IV reactors.

GoHTR - dedicated project ongoing
Preparatory phase.



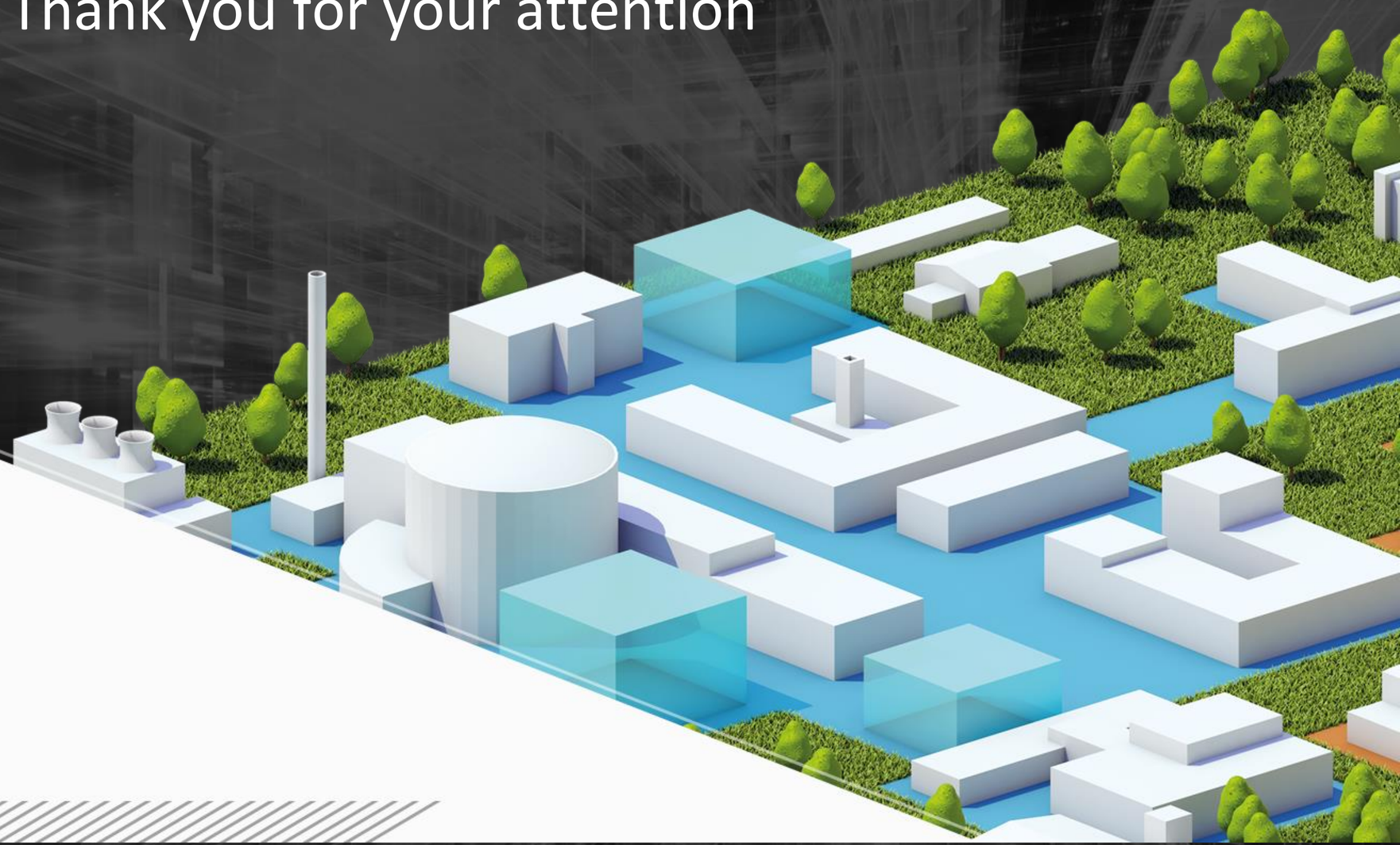
PhD Scholls @NCBJ:

The Graduate School of Physics and Chemistry http://gradschool.ncbj.gov.pl/

PhD School in Reactor Physics http://www.phd4gen.pl/

RadFarm Doctorate Studies. https://www.ncbj.gov.pl/radfarm

Thank you for your attention



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