OPPORTUNITIES FOR PARIS IN POLISH NLC LABORATORIES IN WARSAW AND KRAKOW

ADAM MAJ, KRZYSZTOF RUSEK,
BOGDAN FORNAL, PAWEŁ NAPIORKOWSKI

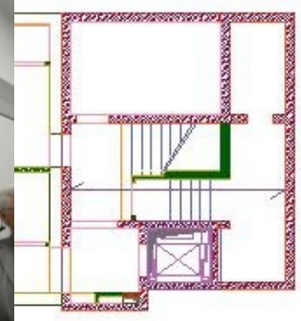
SCIENTIFIC CAMPUS OCHOTA
UNIVERSITY OF WARSAW

ce

nd

tical

Production

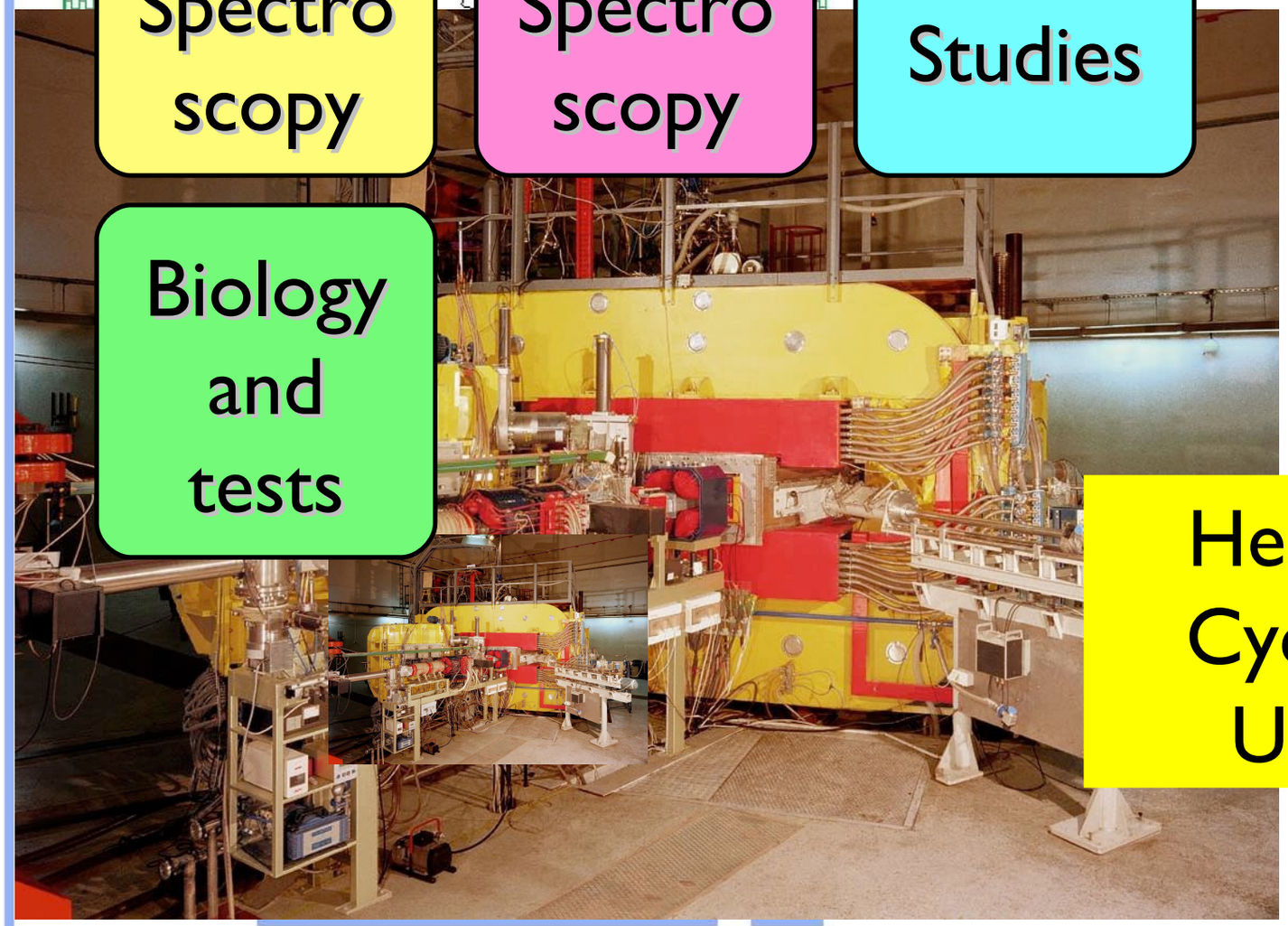


Offline Spectro scopy

Gamma Spectro scopy

Reaction Studies

Biology and tests



Heavy Ion Cyclotron U-200P

The Henryk Niewodniczański

Institute of Nuclear Physics

Polish Academy of Sciences

IFJ PAN

- established 1955
- 500 employees
- (190 with Ph.D. degree)
- Ca. 80 Ph.D. students
- Cathegory: A+

- main interests:
  Particle physics (CERN)
  Nuclear physics
  Applications
  Solid state physics

60 MeV proton cyclotron
2 MeV proton V-d-Graaff
230 MeV Proteus IBA

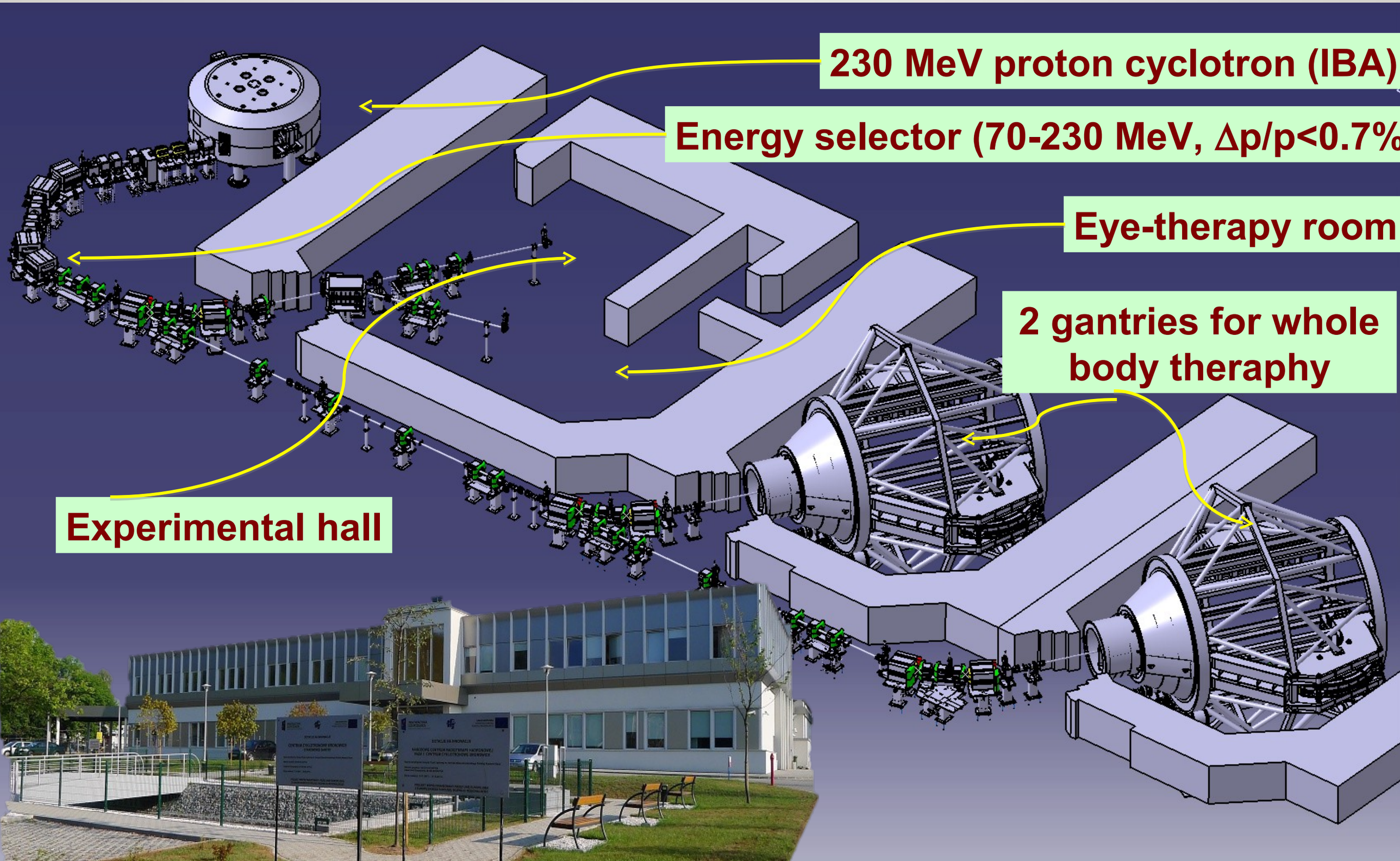
Cyclotron Center Bronowice
Institute of Nuclear Physics Polish Academy of Sciences
Krakow, Poland

Since 2012 eye cancer (melanoma) protontherapy is conducted in IFJ PAN using home made 60 MeV proton cyclotron AIC-144.

In December 2012, a new proton cyclotron became operational at the Institute of Nuclear Physics PAN in Kraków. Together with the existing cyclotron AIC-144, it is a part of the Cyclotron Center of Bronowice (CCB).

Although the primary objective of the facility is proton cancer therapy, an extensive research program at this cyclotron is conducted in the field of nuclear physics, radiobiology, dosimetry and medical physics.

.


230 MeV proton cyclotron (IBA)
Energy selector (70-230 MeV, Δp/p<0.7%
Eye-therapy room
2 gantries for whole body theraphy
Experimental hall

In 2011 the Heavy Ion Laboratory in Warsaw and the IFJ PAN in Krakow decided to form a Consortium, called

NLC (National Laboratory of Cyclotrons)

with the aim to support each other in conducting the research on basic nuclear physics and applications with the use of cyclotrons in both institutions

National Laboratory of Cyclotrons

Warsaw / Kraków

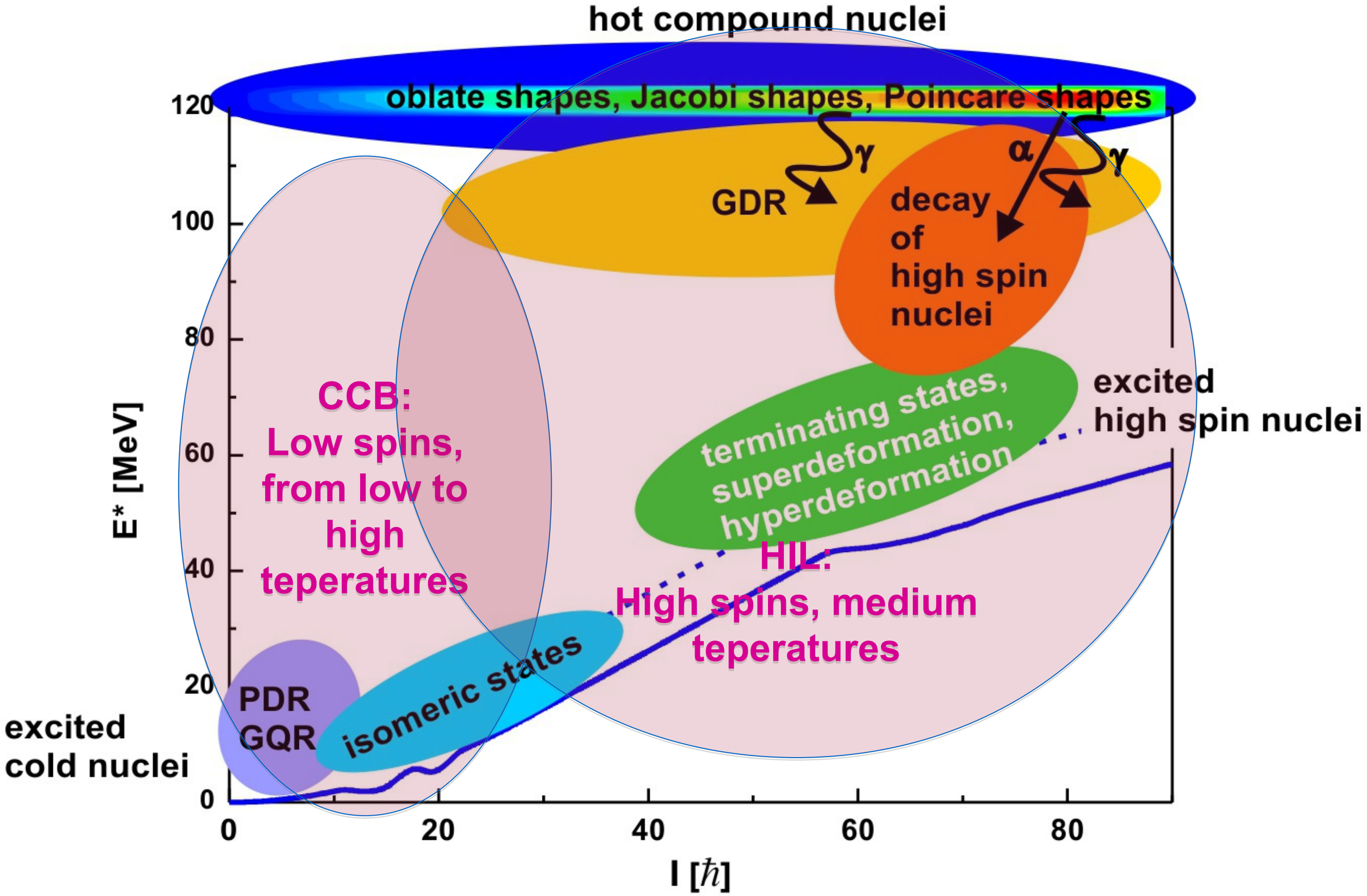
A consortium between HIL UW and IFJ PAN

The nuclear physics research programme of NLC aims at obtaining high quality data on nuclear properties at and around the valley of stability. Therefore, it is complementary to the programmes of large-scale European RIs, which are concentrated on the physics of nuclei very far from the stability line, often at the limits of detection.

The investigations carried out in Warsaw and Kraków are also in many aspects complementary - at CCB high-energy proton beam is available while at SLCJ beams of heavier nuclei from boron to argon can be accelerated.

From 2016 NLC (CCB at IFJ PAN and HIL at Warsaw University) is a part of the HORIZON2020 ENSAR2 project as Transnational Access Facility

Research at NLC: complementarity of HIL and CCB



CYCLOTRONS

U-200P in Warsaw

Dubna type (first beam 1993)

diameter 200 cm; K_{max}=160

beams: from He (internal) to Ar;
new: Mg, Ni

energy range: 2 – 10 MeV/nucl.

2 ECR ion sources:

10 GHz

14 GHz from Pantechnic

Proteus C-235 in Krakow

- produced by IBA (first beam 2012)
- beam: protons
- energy range: 70 – 230 MeV,
- energy definition: ΔE/E < 0.7%
- beam current: 0.1 nA - 500 nA
- quick alternation between different beam energies (seconds);
- quick changes of beam intensity (seconds)

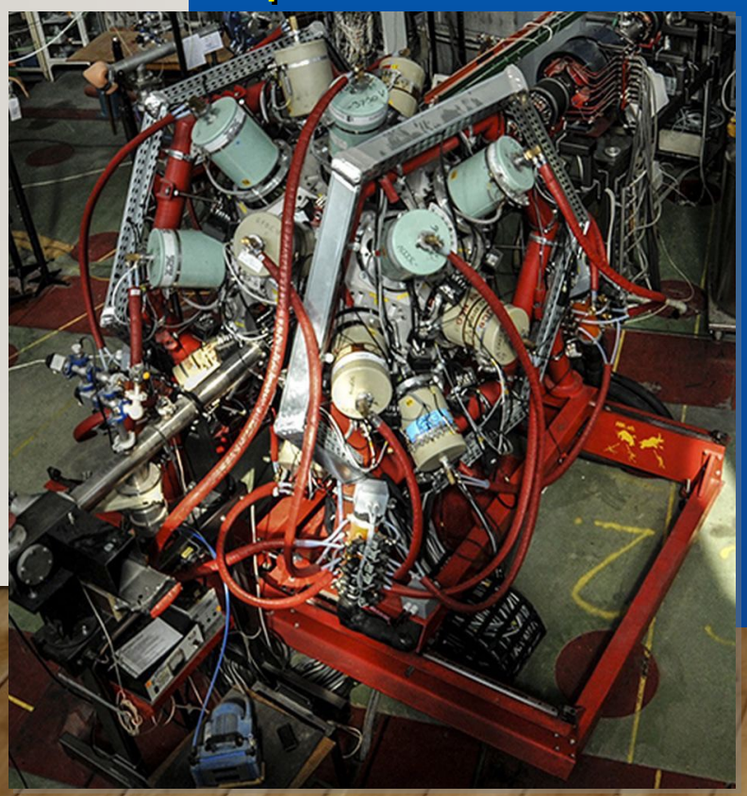
GAMMA SPECTROSCOPY

EAGLE

Central European Array

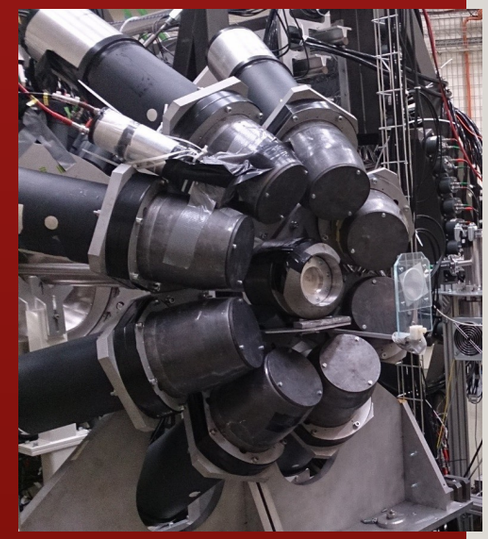
for Gamma Levels Evaluations

- up to 30 HP Ge detector
- for 2017 EAGLE will be equipped with up to 20 GAMMAPOOL *Phase I*



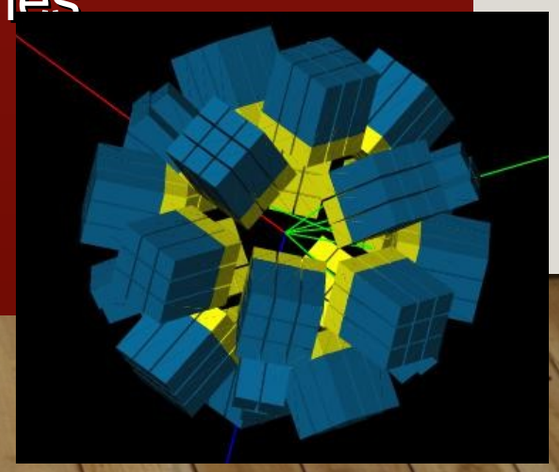
HECTOR

- 8 large volume BaF_2
- 2 large volume $LaBr_3$



PARIS

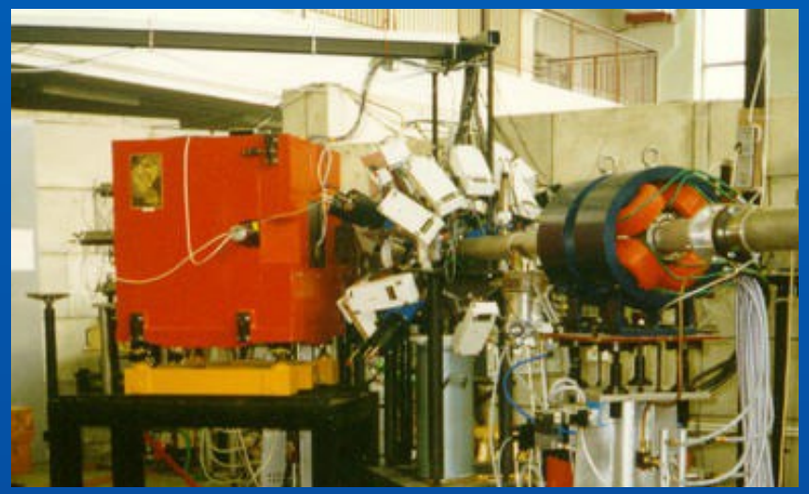
- LaBr3+NaI phoswiches



GAMMA SPECTROSCOPY

JANOSIK

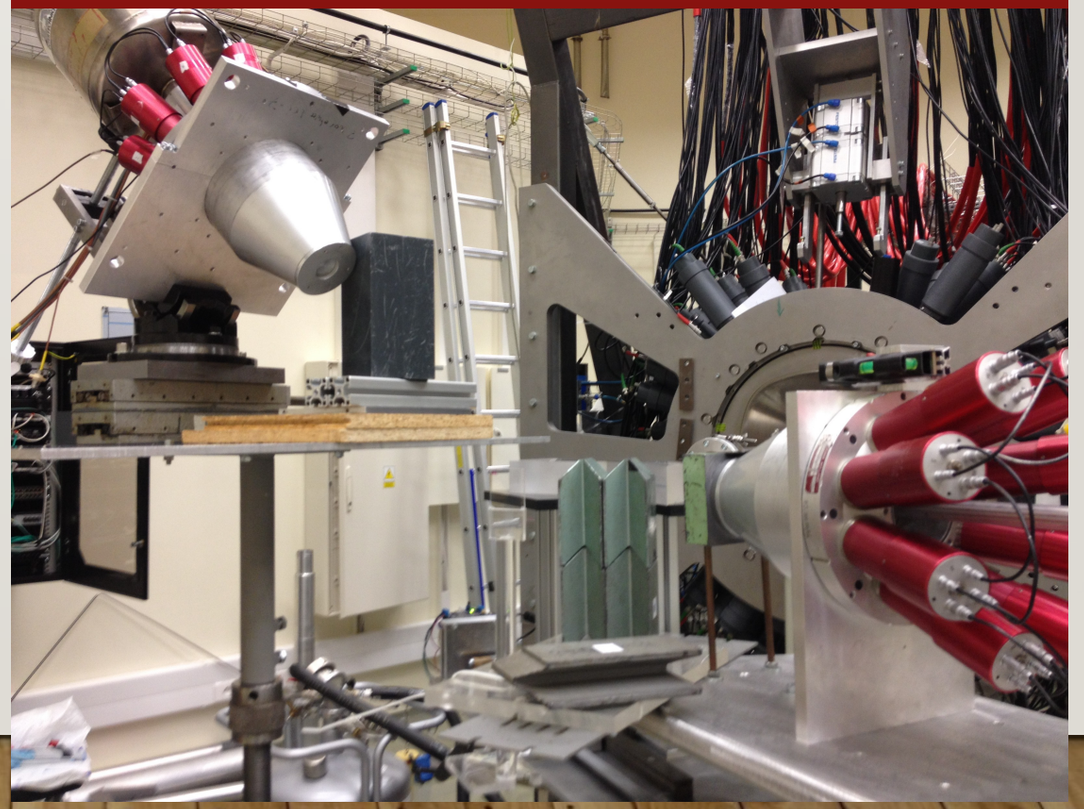
- large NaI(Tl) crystal
- 32-element multiplicity filter



EAGLE + PARIS

High resolution gamma spectroscopy @CBB

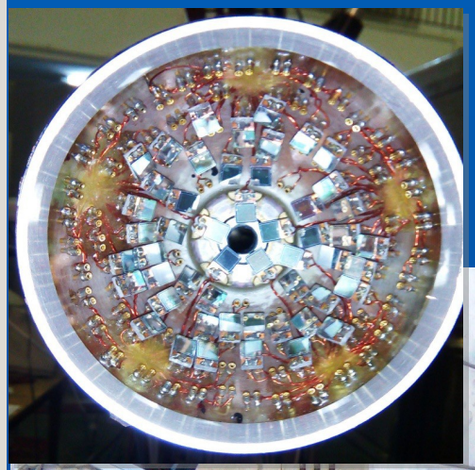
- Investigation of gamma emission in experimental modelling of hadron therapy

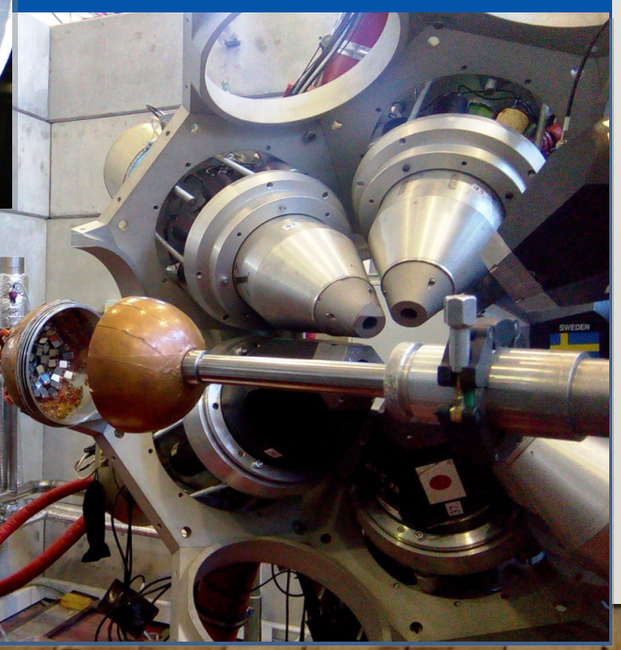


PARTICLE & GAMMA

EAGLE & PiN-diode array

for Coulex

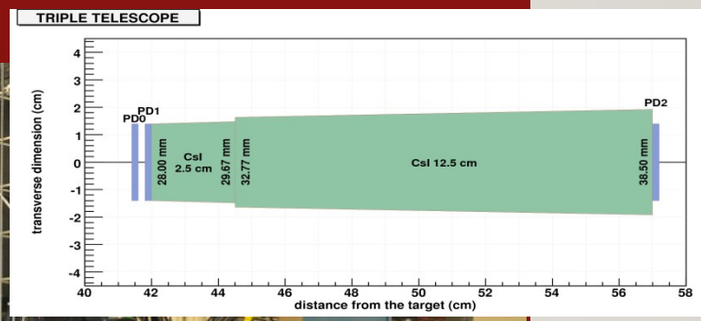




HECTOR & KRATTA
(Kraków Triple Telescope Array)

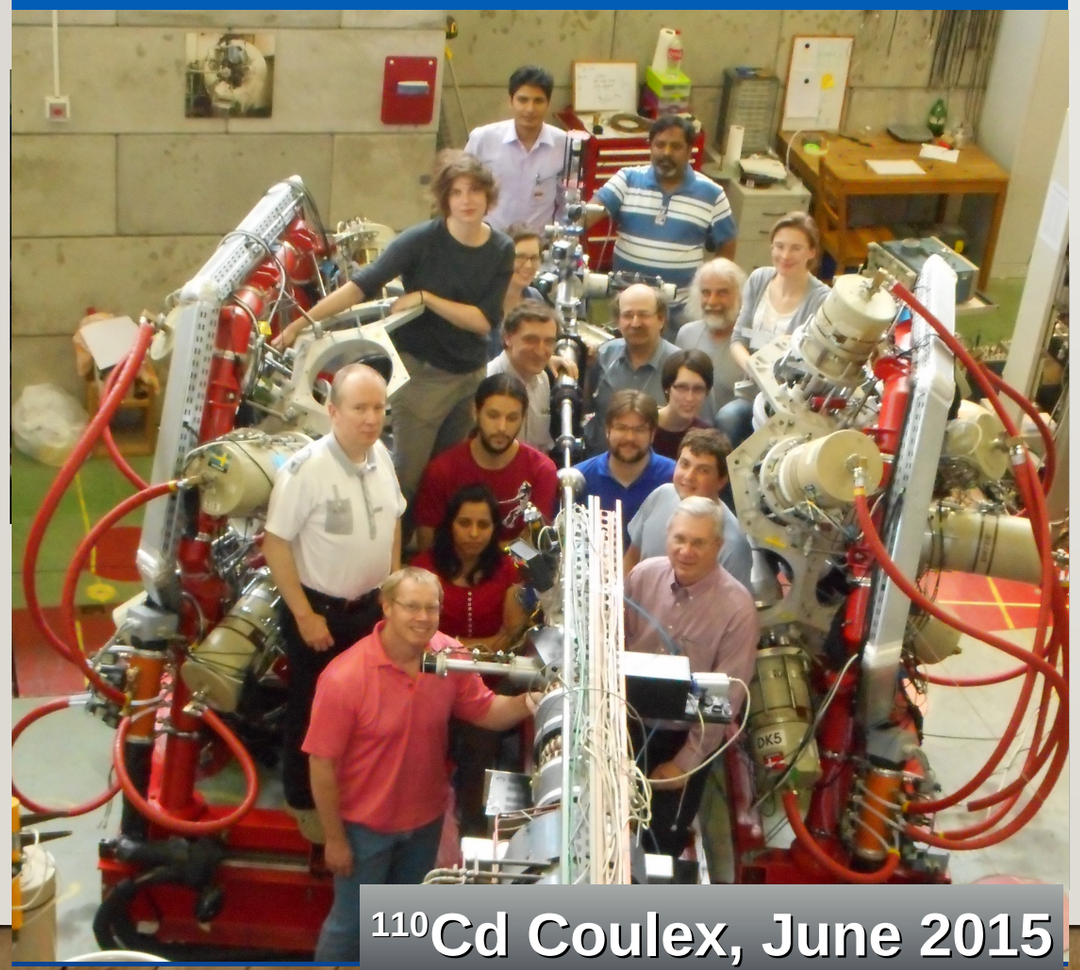
multi-module array for charged particle detection

for inelastic proton scattering



USERS

EAGLE & PiN-diode array



^{110}Cd Coulex, June 2015

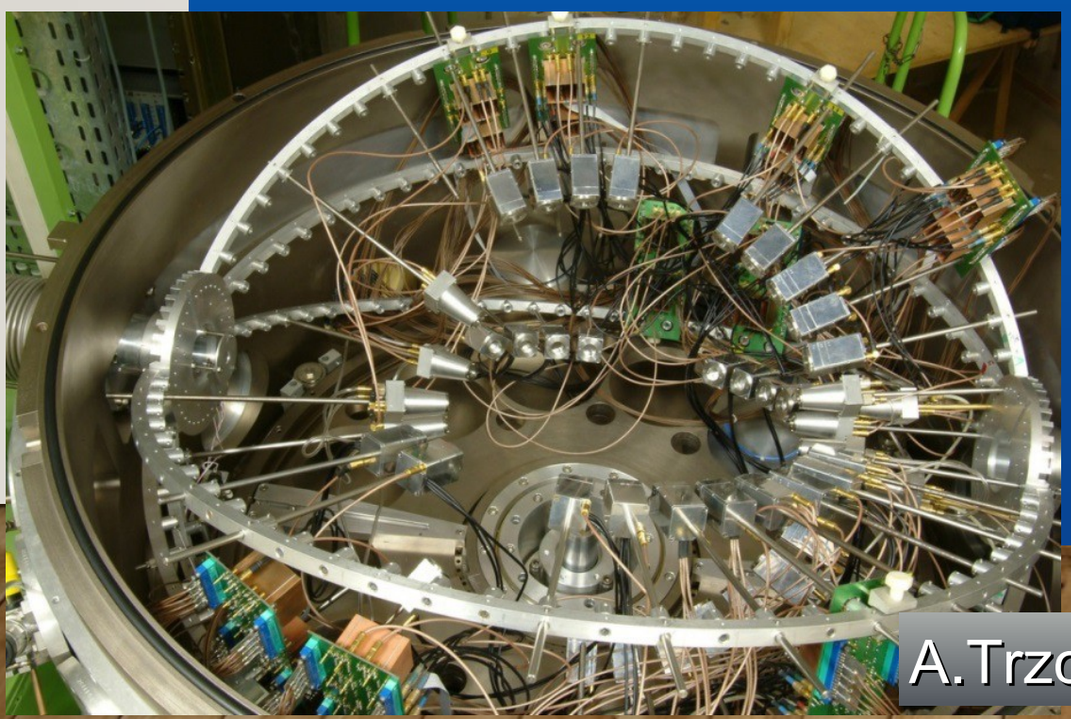
HECTOR & PARIS

HECTOR arrived to CBB, May 2014

REACTION STUDIES

ICARE

- 8 telescopes ΔE(gas) + E(Si)
- 24 telescopes ΔE(Si) + E(CsI)
- 16 telescopes ΔE(Si)+ΔE(Si)+E(CsI)



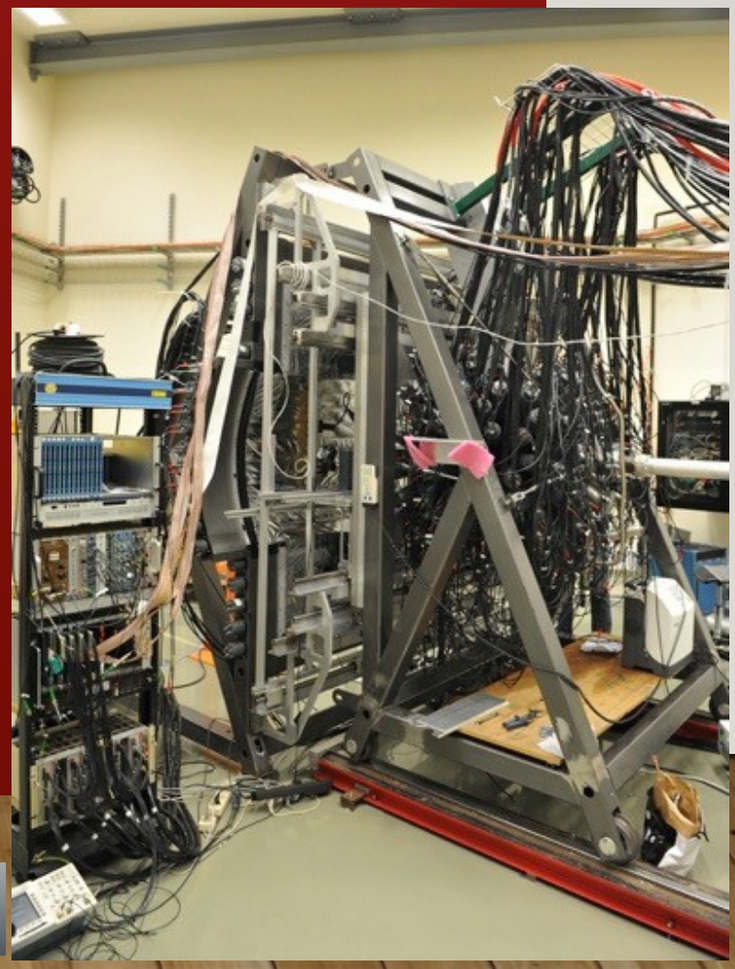
A.Trzcińska

BINA

Big Instrument for Nuclear reaction Analysis

Wall:
- MWPC (3 planes)
- ΔE(24x2 mm)
- E(20x120 mm)

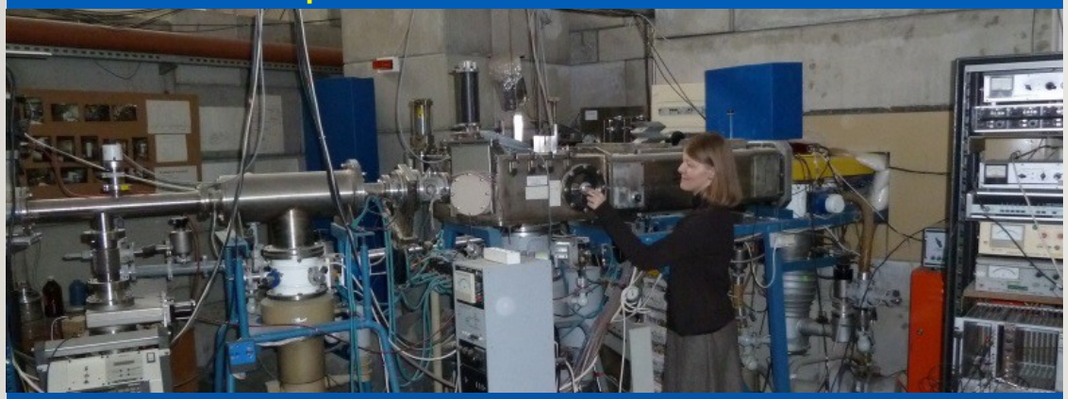
Ball:
- phoswich (149x90/30 mm)



A.Kozela

OTHER DETECTORS AND SETUPS

- **IGISOL** *Isotope Separator On-Line*
  - ion source
  - Helium jet
  - mass separators



- EAGLE ancillary detectors
  - Internal conversion electron spectrometer ULESE
  - Bucharest-Köln Plunger
  - 60-element BaF_2 gamma-ray multiplicity filter
  - 4π charged particle multiplicity filter (Si-ball)

- large reaction chamber

- large volume $LaBr_3$ detectors
- large Volume BaF_2 detector

INTERNATIONAL ADVISORS

HIL
Program Advisory Committee

- Konrad Czerski (Szczecin, Poland)
- Maria Kmiecik (IFJ PAN Krakow, Poland)
- Gilles de France (GANIL, France)
- Nicholas Keeley (NCBJ, Poland)
- Andrzej Magiera (UJ Krakow)
- Marco Mazzocco (Padova, Italy)
- Chiara Mazzocchi (UW Warsaw, Poland)
- Leszek Próchniak (HILWarsaw, Poland)
- Wladyslaw Trzaska (Jyväskylä, Finland)

Call for proposals: 2 times per year

CCB
International Advisory Committee

- Faical Azaiez (IPN, Orsay, France)
- Angela Bracco (University of Milano and INFN, Italy)
- Bogdan Fornal (IFJ PAN, Kraków, Poland) - Deputy Chair
- Zsolt Fulop (ATOMKI, Debrecen, Hungary)
- Muhsin Harakeh (KVI Groningen) – chair
- Robert Janssens (Argonne National Laboratory, USA)
- Stanisław Kistryn (Jagiellonian University, Kraków, Poland)
- Marek Lewitowicz (GANIL, Caen, France)
- Adam Maj (IFJ PAN, Kraków, Poland)
- Krzysztof Rusek (Warsaw University, Poland)
- Hideyuki Sakai (RIKEN, Japan)
- Christoph Scheidenberger (GSI, Germany)
- Nicolae Victor Zamfir (IFIN-HH, Bucharest, Romania)
- Wiktor Zipper (University of Silesia, Katowice, Poland)

Call for proposals: 1 time per year

RESEARCH PROGRAM

- Search for chiral symmetry breaking by DSAM and RDDS (^{132}La ^{122,124,126,128}Cs)
- Non-spherical and non-axial shapes by using COULEX (e.g., ^{42}Ca, ^{96,98,100}Mo, ^{104}Pd, ^{110}Cd)
- Violation of K-selection rules by gamma and internal conversion electron spectroscopy (^{132}Ce, ^{130}Ba, ^{134}Nd, ^{184}Pt, ^{186}Hg)
- Lifetimes of low spin levels in ^{140}Sm
- Studies of fusion barriers height distribution
- Investigations of reactions with light nuclei
- Reactions of astrophysical interest
- Radiobiology and nanodosymetry

- Gamma decay from high-lying states and giant resonances
- Dynamics of few-nucleon systems
- Study of deeply bound states in light nuclei
- Investigation of the mechanism of proton-induced reactions leading to the continuum
- Proton irradiation of CALIFA detection modules at CCB
- Investigation of gamma emission in experimental modelling of hadron therapy

MEDICAL APPLICATIONS

U-200P in Warsaw

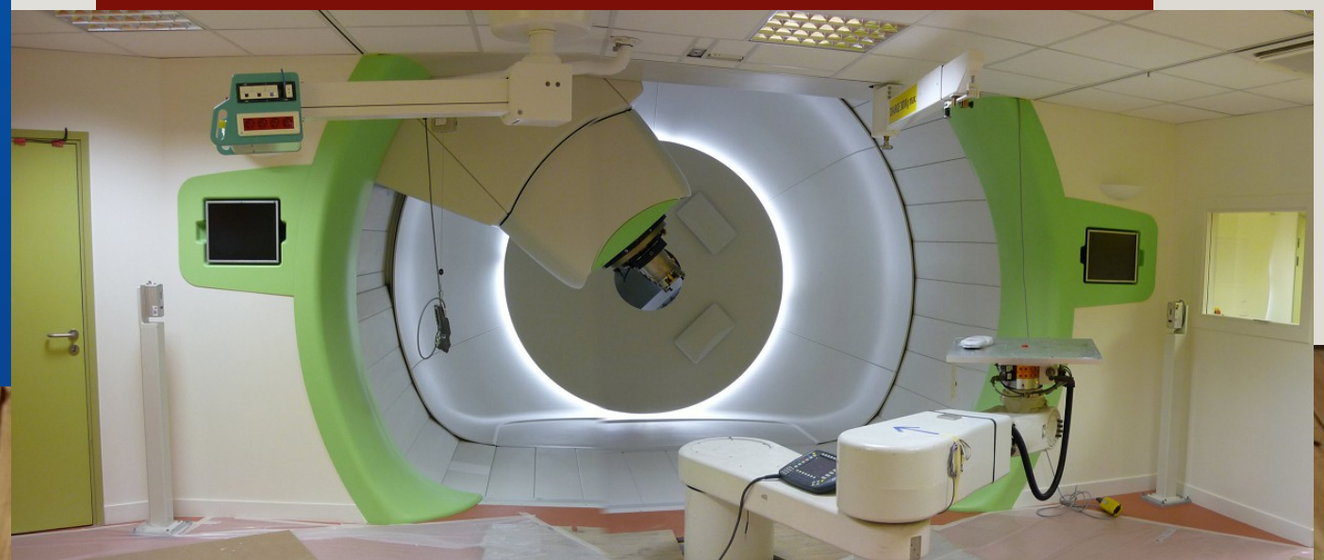
- Isotopes production for medical use at the K=160 cyclotron:
  ^{211}At, ^{43}Sc, ^{44}Sc, ^{72}Se/^{72}As, ^{99m}Tc

GE PETtrace proton/deuteron cyclotron

- Regular production of PET radiopharmaceuticals with GE PETtrace proton/deuteron cyclotron (cooperation with business partner)

Proteus C-235 in Krakow

proton cancer therapy: 2 gantries, 1 eye therapy room
- radiobiology and dosimetry
- medical physics.



NLC TNA OFFER FOR ENSAR2

- 1000 h of the beam time
- 10 TNA projects funded
- 50 users supported

- 480 h of the beam time
- 5 TNA projects funded
- 25 users supported

You are welcomed to submit a proposal, Especially with PARIS

SUMMARY

- **HIL in Warsaw is a facility which produces very valuable results concerning the nuclear structure and reaction mechanism**
- **A new facility, CCB at IFJ PAN in Krakow, starts operating. The facility is used both for cancer protontherapy and for basic research. The preliminary results look very promising.**
- **The NLC consortium is an informal 2-centre facility, in which complementary scientific programme can be conducted.**
- **NLC, being the TNA facility in the ENSAR2 programme, can provide some support for the foreign users .**
- **You are most welcome to propose an experiment, both in HIL or in CCB**

CONFERENCES

zakopane2018.ifj.edu.pl