NUCLEAR PHYSICS AT CCB

ADAM MAJ

IFJ PAN KRAKÓW

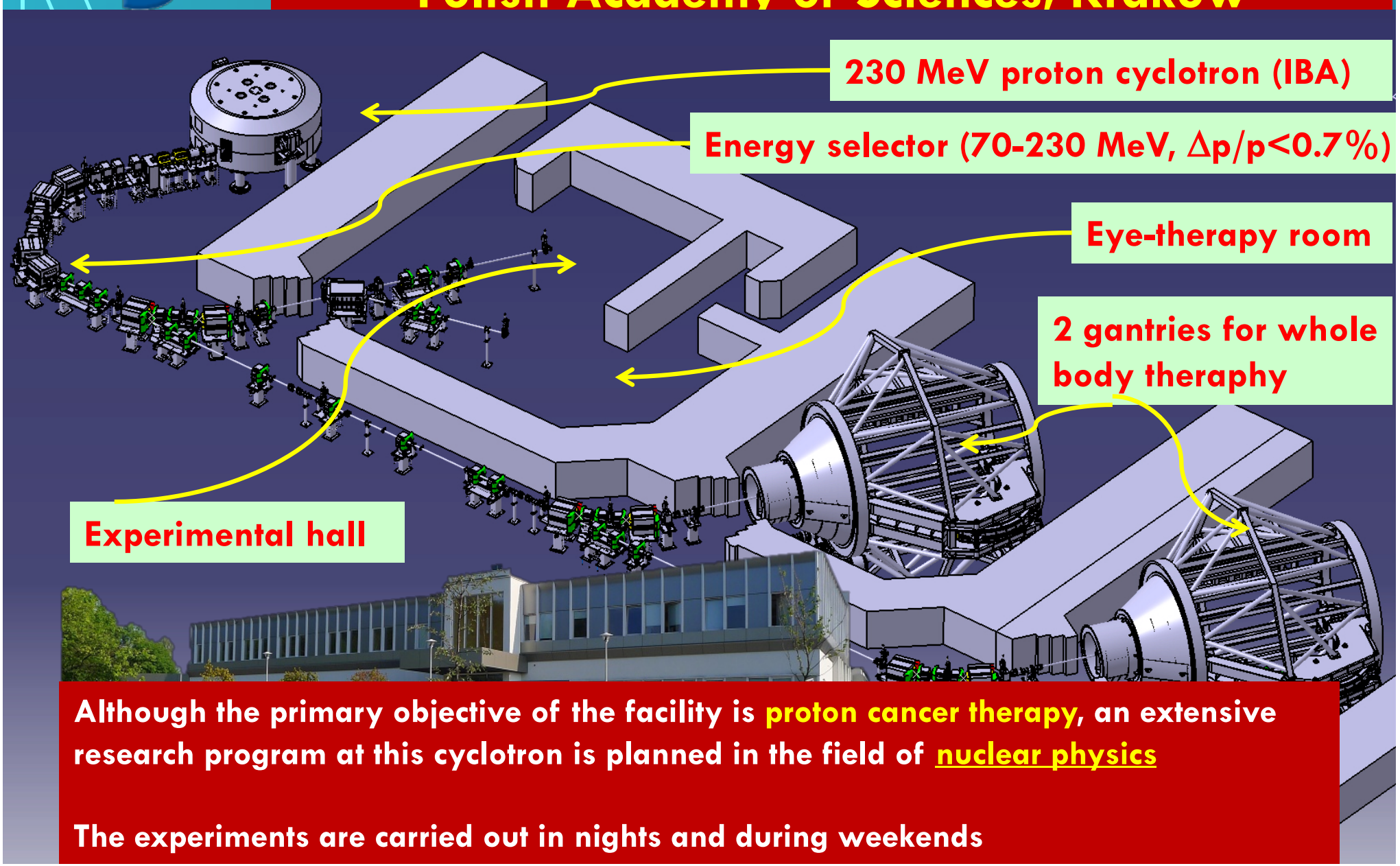
PRZYSZŁOŚĆ FIZYKI JĄDROWEJ NISKICH ENERGII W POLSCE

A ROZWÓJ KRAJOWEJ INFRASTRUKTURY BADAWCZEJ

14-15 stycznia 2019

Środowiskowe Laboratorium Ciężkich Jonów UW

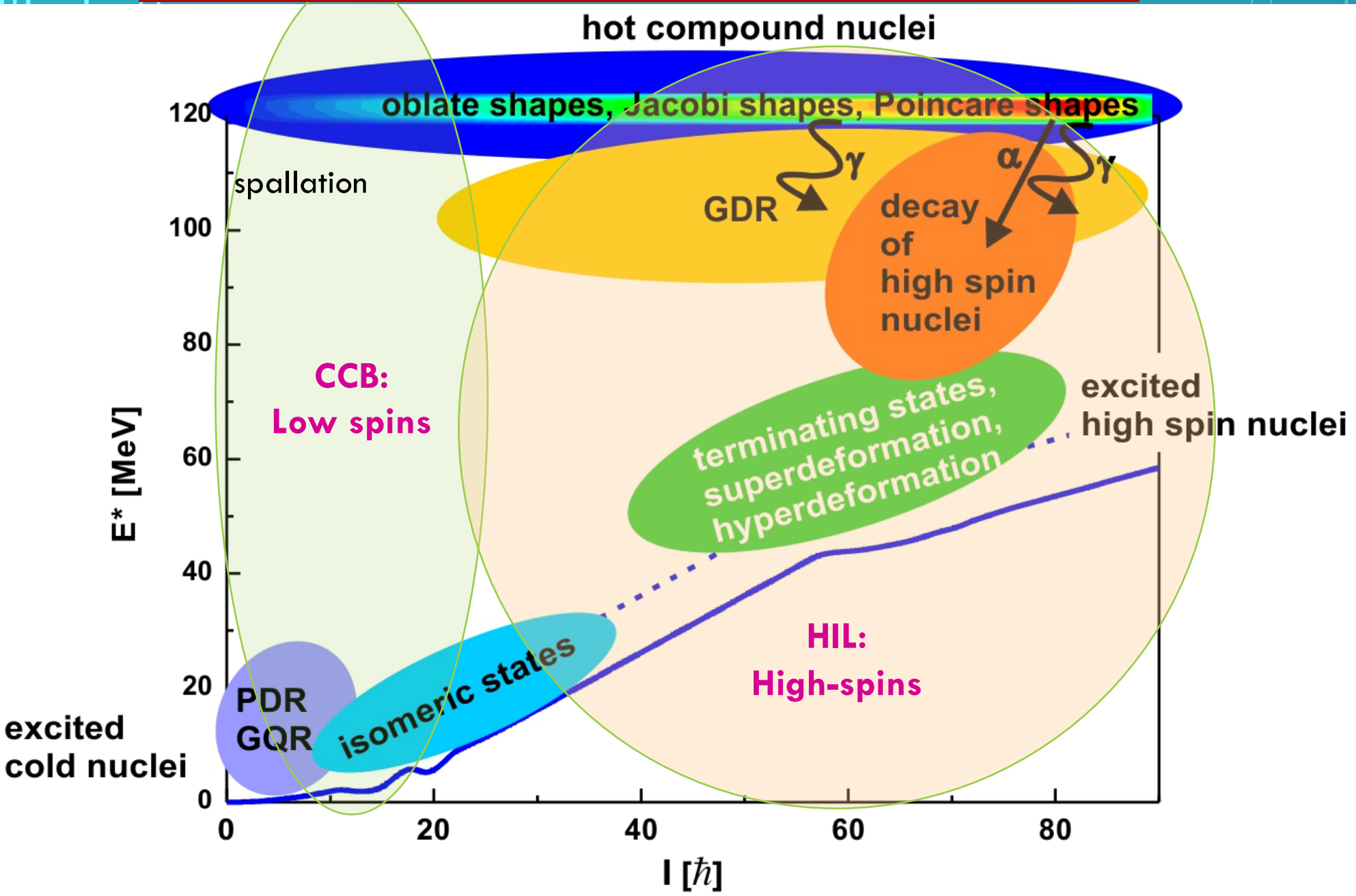
CCB - Cyclotron Center Bronowice at Institute of Nuclear Physics Polish Academy of Sciences, Kraków



Although the primary objective of the facility is proton cancer therapy, an extensive research program at this cyclotron is planned in the field of nuclear physics

The experiments are carried out in nights and during weekends

Research at HIL and CCB is complementary



CCB - International Advisory Committee

- Faical Azaiez (IPN, Orsay, France)
- Angela Bracco (University of Milano and INFN, Italy)
- Bogdan Fornal (IFJ PAN, Kraków, Poland) - co-chair
- Zsolt Fulop (ATOMKI, Debrecen, Hungary)
- Muhsin Harakeh (KVI, Groningen, Netherlands) - 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)
- Nicolae Victor Zamfir (IFIN-HH, Bucharest, Romania)
- Wiktor Zipper (University of Silesia, Katowice, Poland)

So far 6 meetings of IAC took place

Each time status of the CCB project was reviewed,

Proposals and LoIs were discussed and recommendations given

Call for proposals: every year in summer

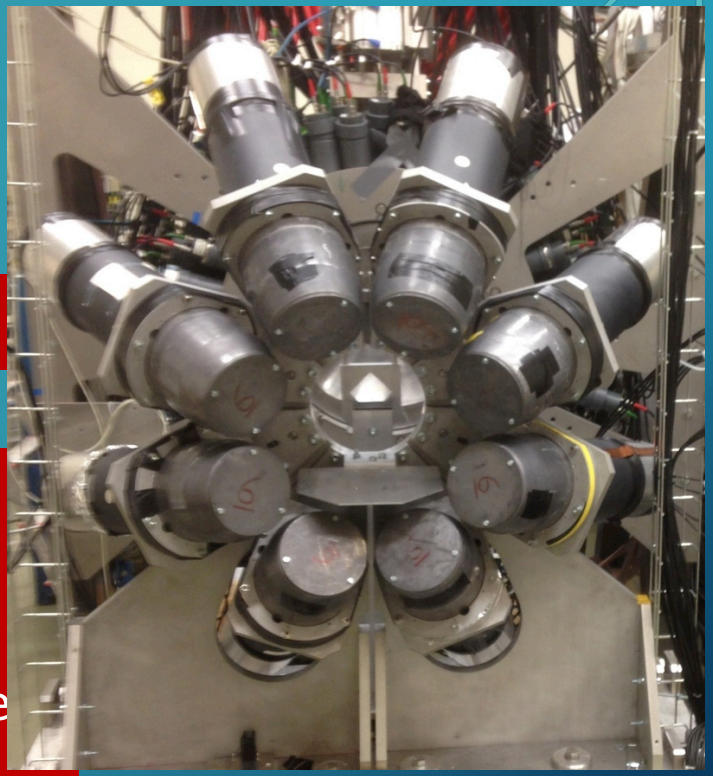
Physics program recommended by IAC

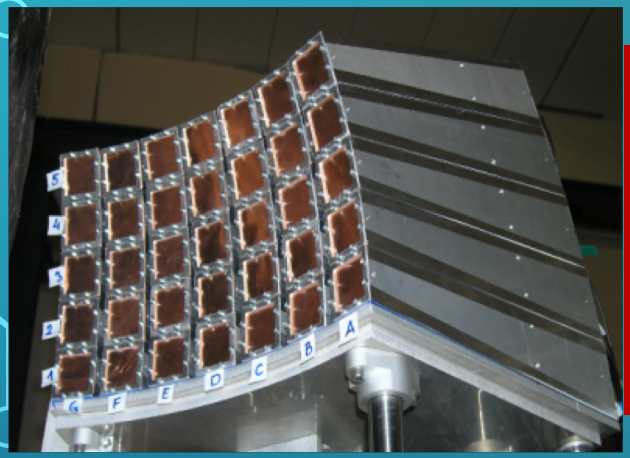
- Gamma decay from high-lying states and giant resonances excited via (p,p'γ)
- Dynamics of few-nucleon systems
- Study of high-lying single-particle states
- Investigation of the mechanism of proton-induced fission and spallation
- In-beam testing of detectors constructed for large infrastructures
- Investigation of gamma emission in experimental modelling of hadron therapy

I. GAMMA-RAY & CHARGED PARTICLE SETUP

Coord.: M. Kmiecik

1. **HECTOR** array to measure high energy gamma-rays



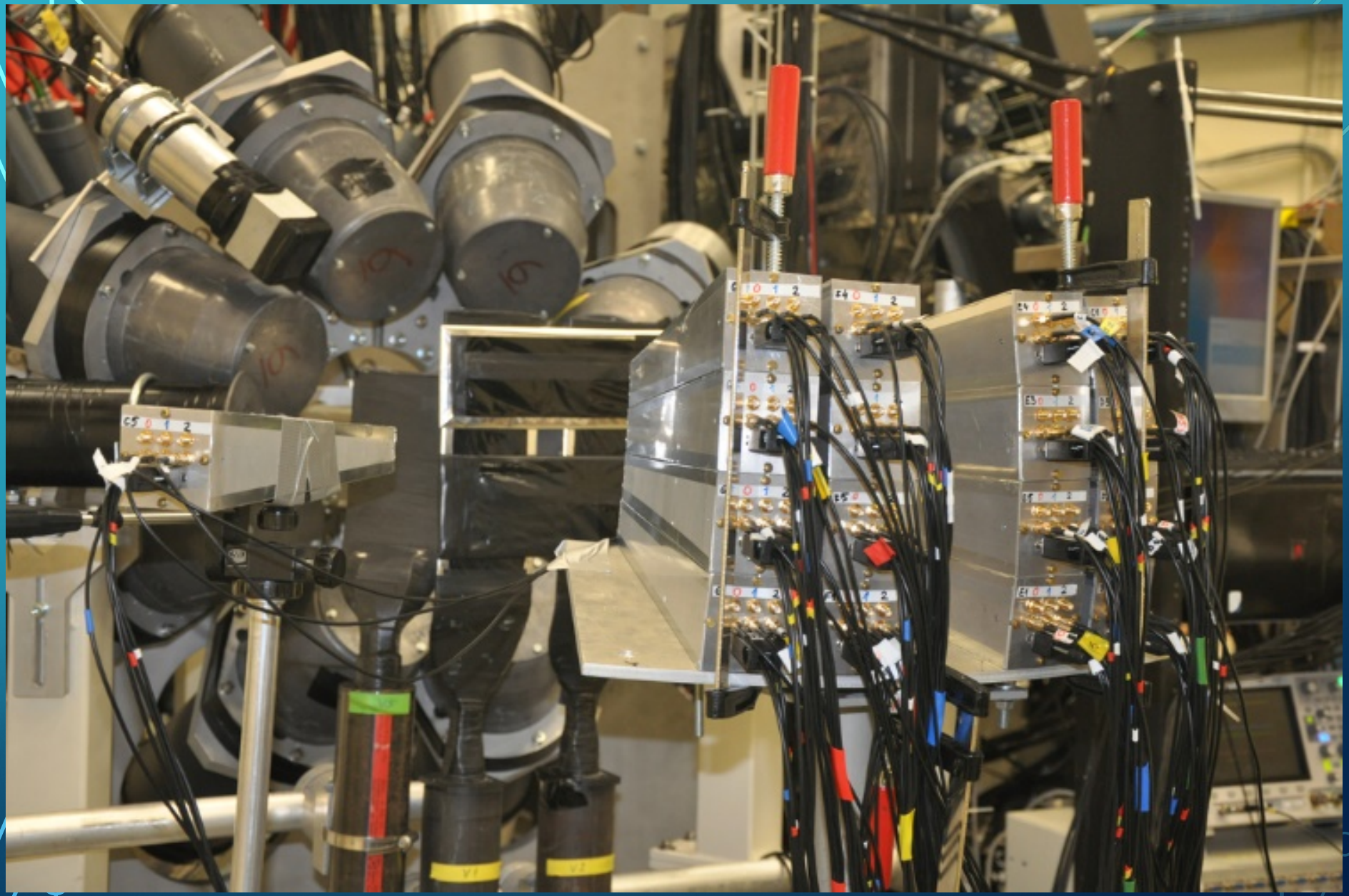


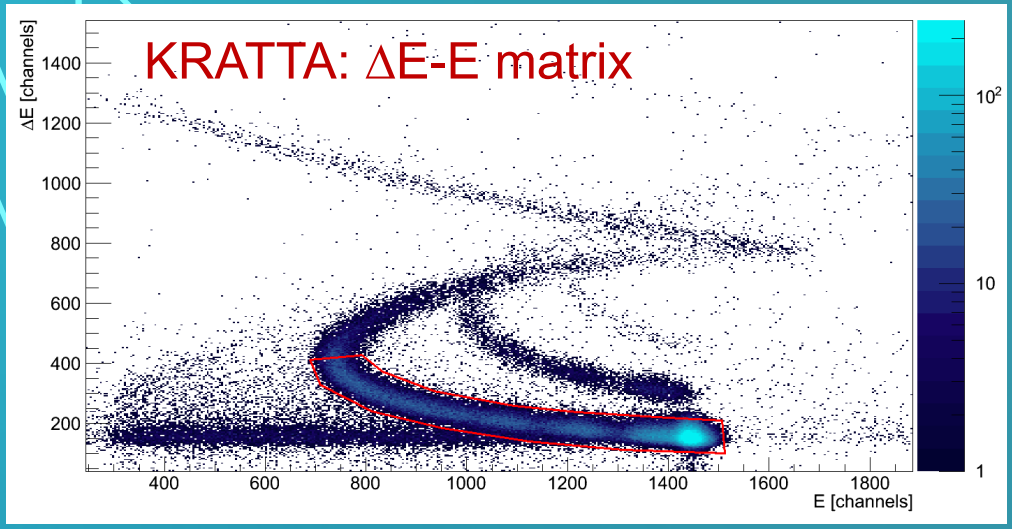
2. **KRATTA** array (triple CsI telescopes) at forward direction to measure the energy of inelastically scatte protons

3*. **LaBr3 and PARIS clusters** for measurements with high-resolution, in coincidence with KRATTA

4*. Germanium detectors

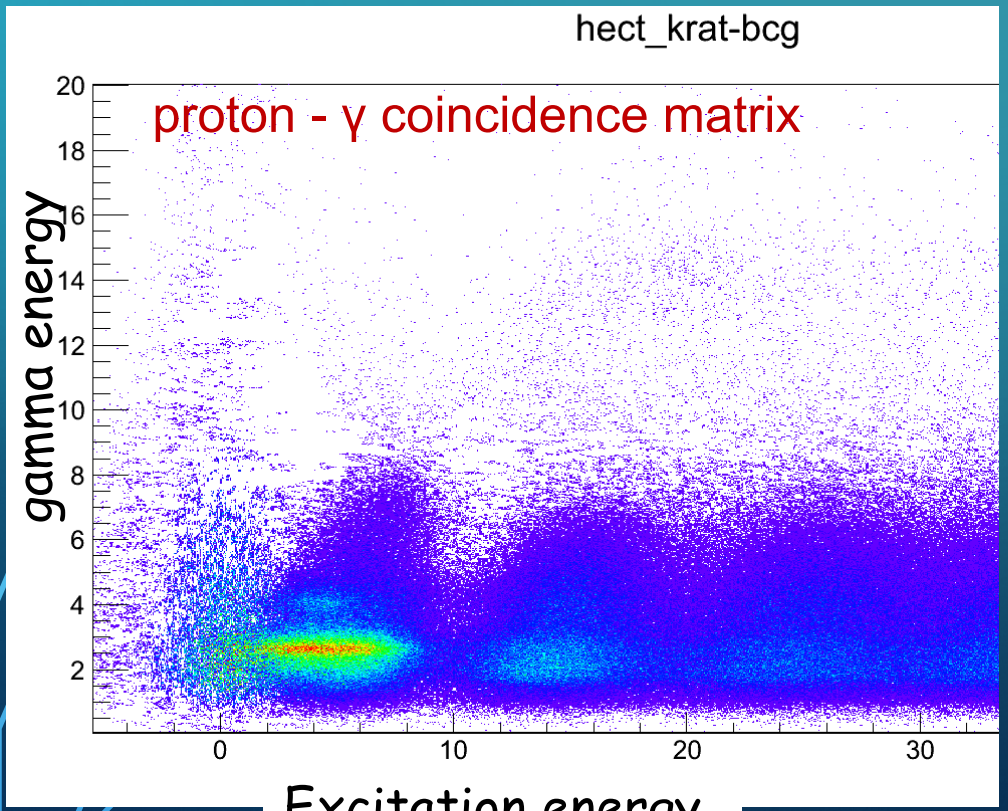
** - in dedicated campaigns*



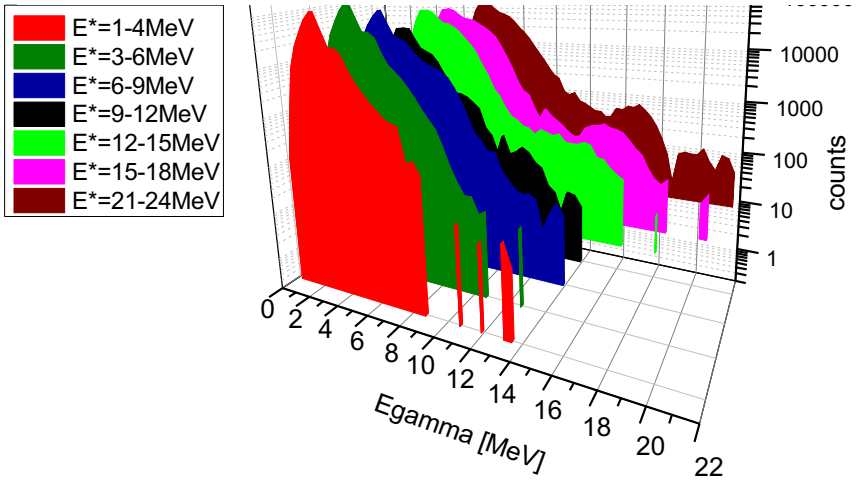


Conditions:

- Proton identification (KRATTA)
- Proton-gamma coincidence time (Plastic-HECTOR)



γ spectra gated by excitation energy



II. BINA array

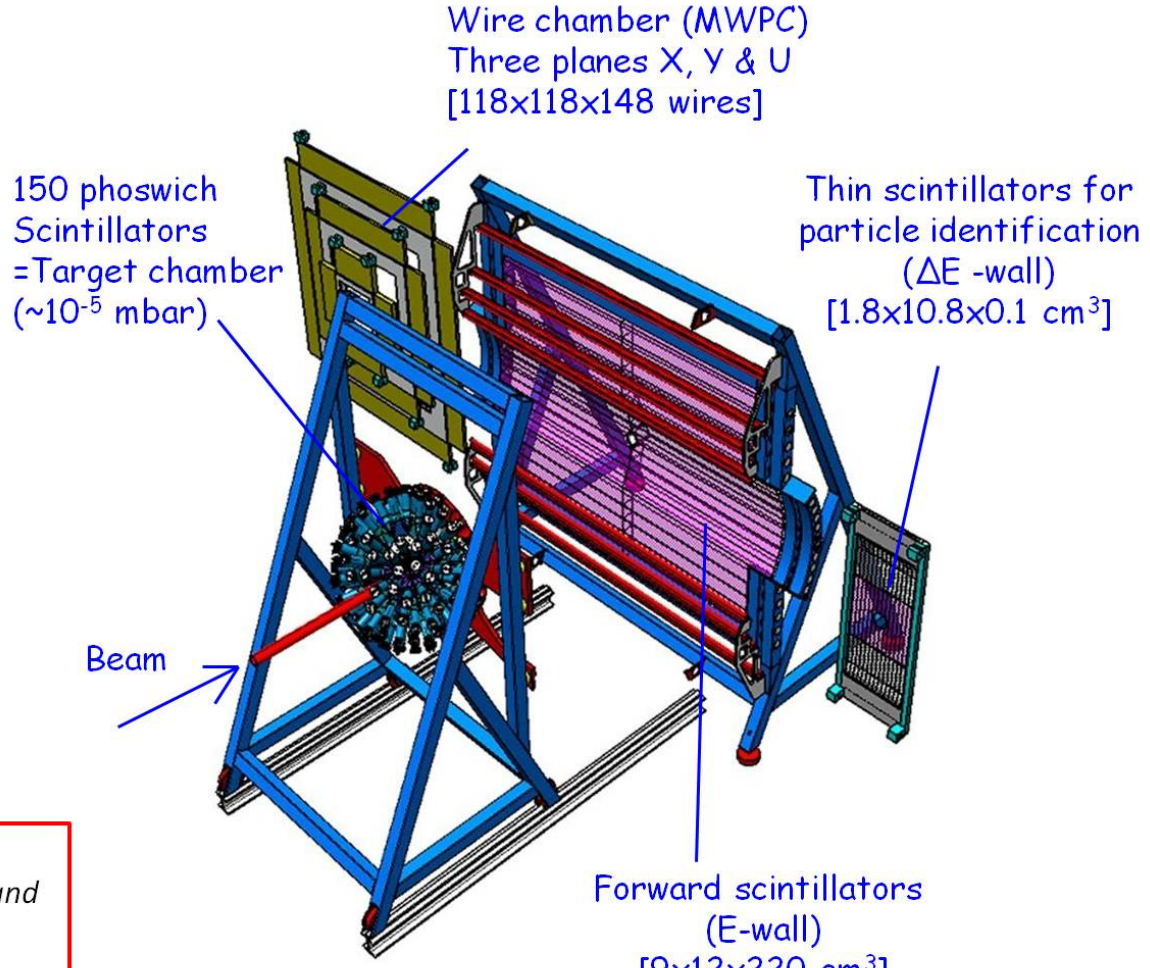
Coord.: A. Kozela

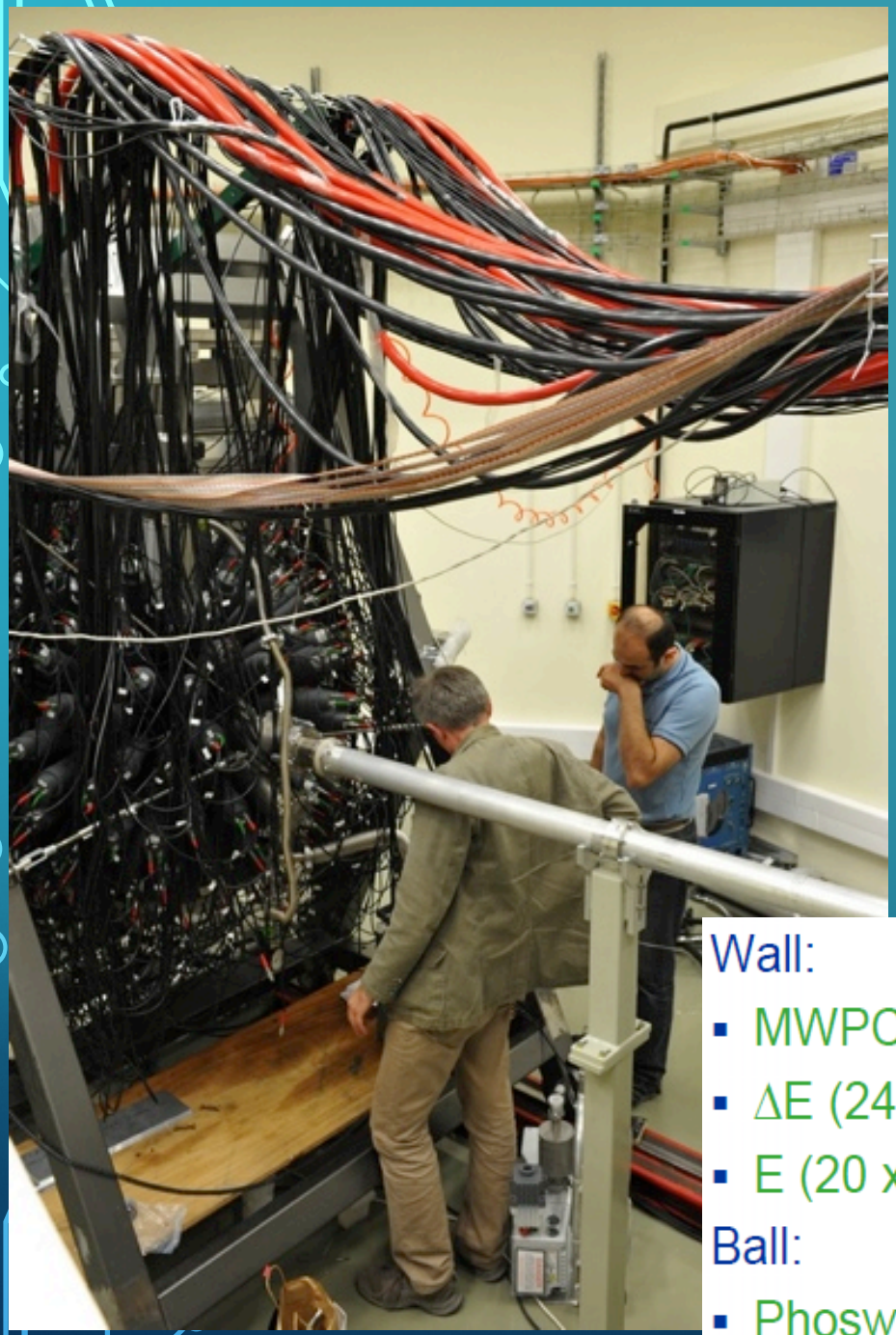
Detector BINA (moved from KVI Groningen) for light nuclei reactions studies - especially for 3-body forces studies

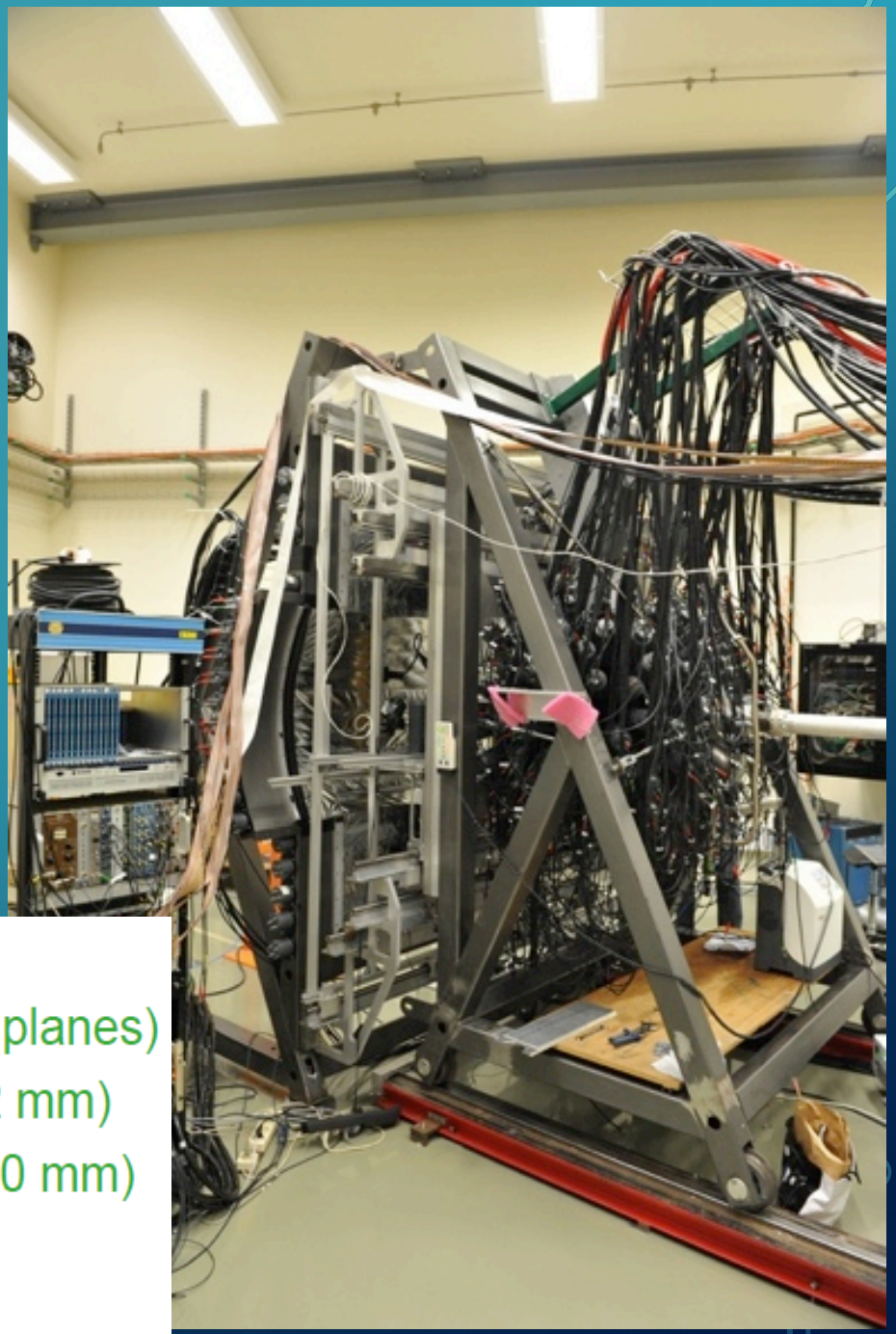
Wall covers
θ=10-35°
+
Ball covers
θ=up to 165°
≡
4π Phase-Space

MWPC:
- *CF4(80%) + Isobutene(20%) gas-mixture*
- *20μm diameter tungsten wire*

Ball:
Triangular fast scint. and slow phoswitch parts connected to PMT's through lightguide







Wall:

- MWPC (3 planes)
- ΔE (24 x 2 mm)
- E (20 x 120 mm)

Ball:

- Phoswich (149 x 90/30 mm)

III. Other smaller ad-hoc setups

1. **Germanium detectors+ LaBr3 array** (coord. P. Bednarczyk)
2. **Detector irradiation platform** (M. Zięblíński)
3. …

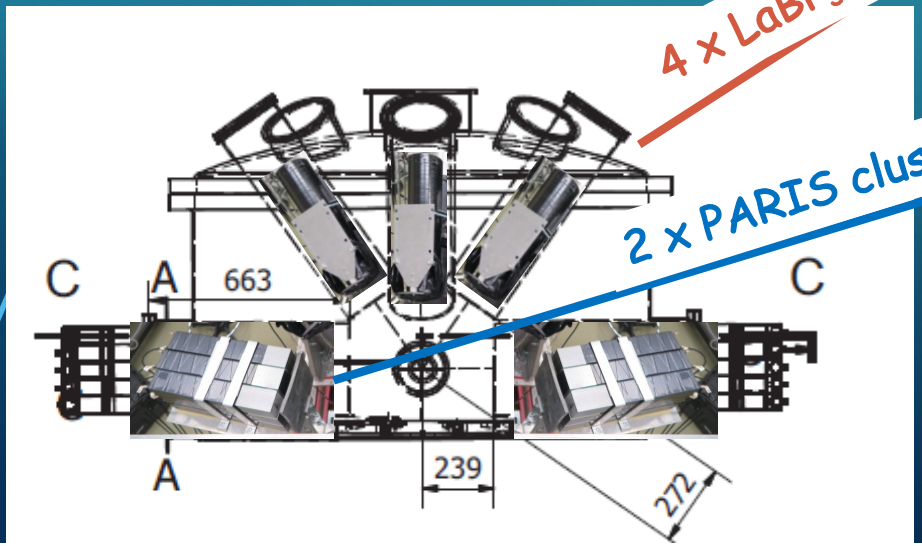
NEAR-FUTURE UPGRADE PLANS FOR CCB

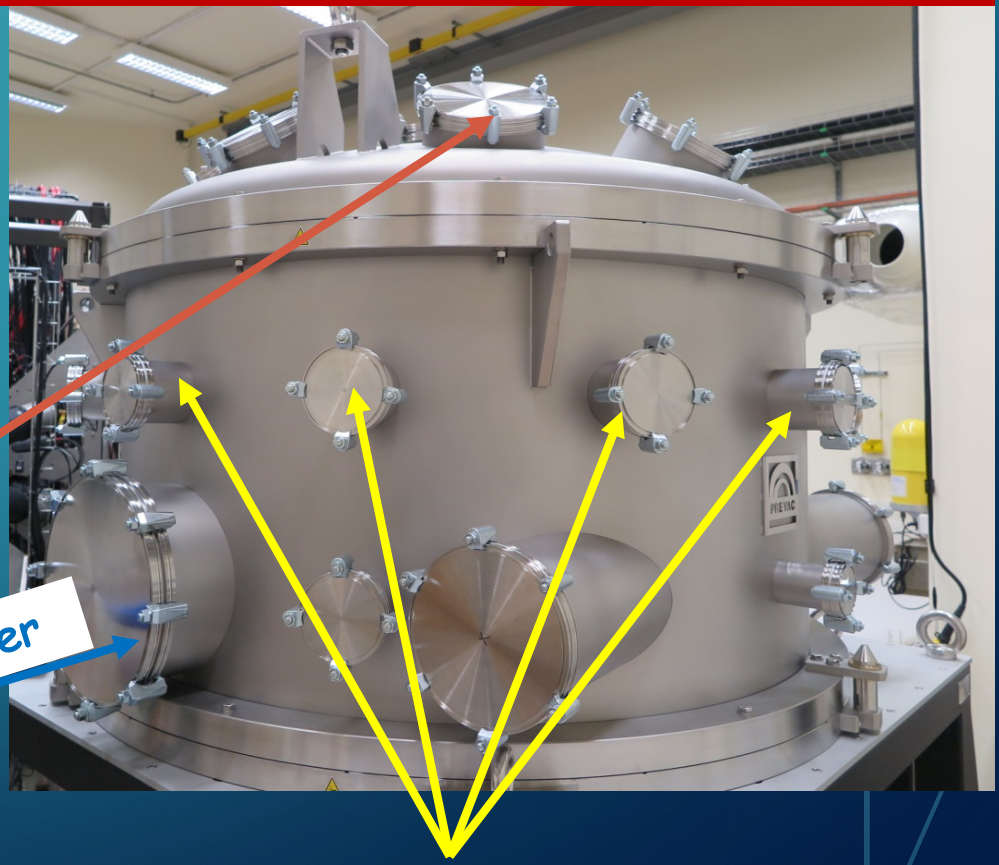
1. Large reaction chamber for particle-gamma experiment

- KRATTA inside – in vacuum
- gamma detectors outside

(4 $LaBr_3$ and 2 PARIS clusters)

- holders are designed





Use of other detectors possible,
e.g. neutron detectors

2. New ACQ system

3. Criogenic polarized target for BINA

4. Improvements of beam quality (smaller halo)

5. Reducing the neutron background

Considered:

- Array of small LaBr3 detectors for timing definition
- Tape station (for off-beam experiments)
- Small reaction-products separator

Maybe in longer term future:

- New exparimental hall with magnetic spectrometer and nToF measurements

National Laboratory of Cyclotrons

Warsaw / Kraków

NLC (CCB at IFJ PAN and HIL at Warsaw University) is the Transnational Access Facility in the ENSAR2 EU project (2016-2019)

It will be also included in the follow-up proces: ERINS (2020-2023), if ERINS is founded

CONCLUSIONS

- CBB is a complementary to HIL polish Research Infrastructure
- CCB is a medical facility, so the nuclear physics experiments have to obey many complications
- Despite that a numer of world class studies are pursued
- Some upgrades are planned to keep this position

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