

Astroparticle physics in Poland

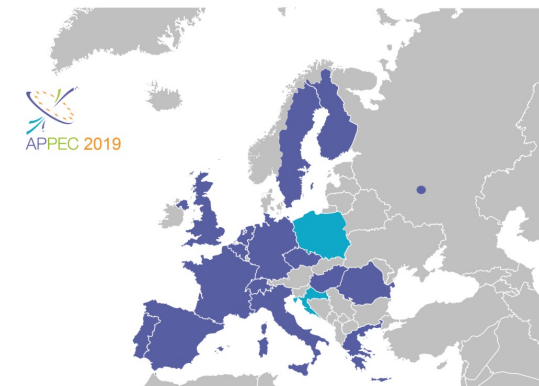
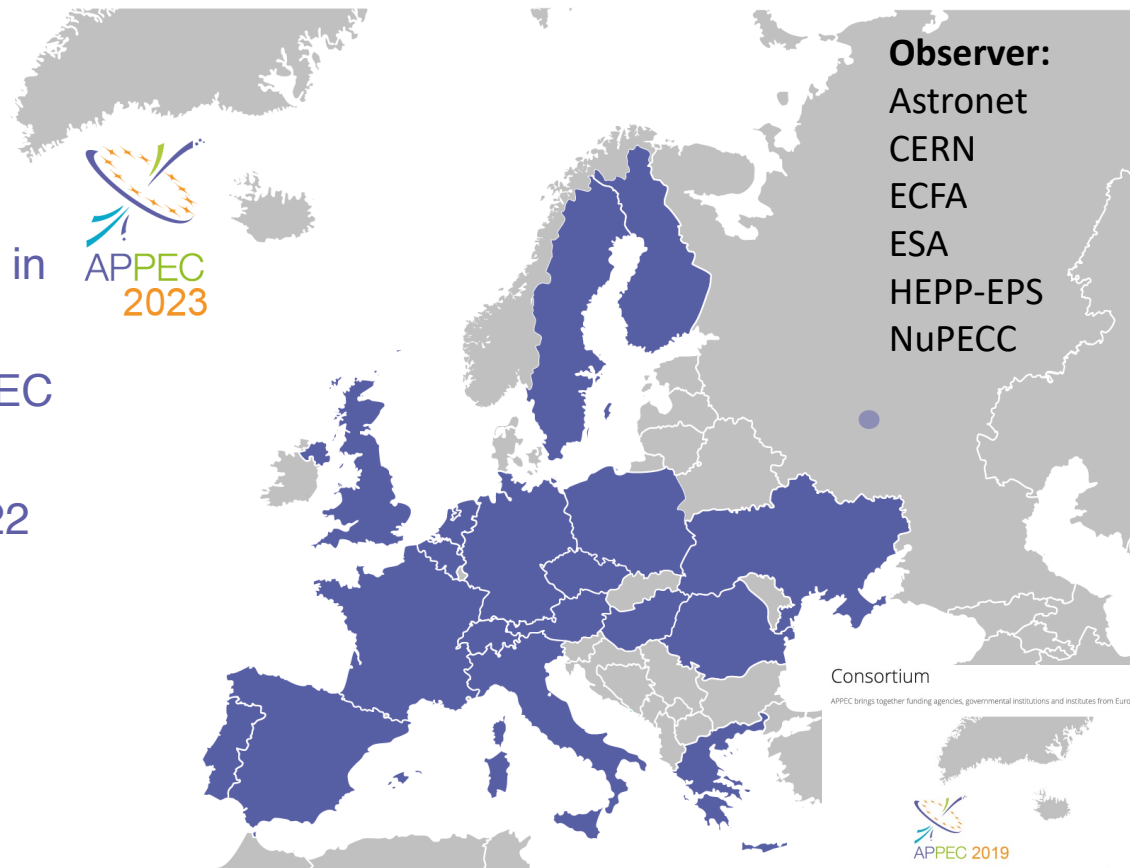
Leszek Roszkowski

**AstroCeNT, Nicolaus Copernicus Astronomical Centre PAS
and
National Centre for Nuclear Research**

AstroParticle Physics European Consortium

- an international coordinating structure, founded in 2012
- Based on MoUs by all partners and an APPEC Common Fund with c. 70k€/year
- 18 (+1 suspended) member countries with 22 funding agencies
- 3 bodies:
 - General Assembly with Observers
 - Scientific Advisory Committee;
 - Joint Secretary

- **Fall 2019: Poland re-joined APPEC**
- **Represented by CAMK PAN**



Astroparticle physics in Poland



List of institutions involved in Astro/cosmo

- Jagiellonian University, Kraków (UJ)
- Institute of Nuclear Physics Polish Academy of Sciences, Kraków (IFJ PAN)
- Nicolaus Copernicus Astronomical Center Polish Academy of Sciences, Warszawa (CAMK PAN)
- AstroCeNT - Particle Astrophysics Science and Technology Centre (AC) (autonomous centre at CAMK PAN)
- National Centre for Nuclear Research, Otwock (NCBJ)
- Space Research Centre Polish Academy of Sciences, Warszawa (CBK PAN)
- University of Warsaw, Warszawa (UW)
- Warsaw University of Technology, Warszawa (PW)
- AGH University of Science and Technology, Kraków (AGH)
- Academic Computer Centre Cyfronet AGH, Kraków (Cyfronet)
- University of Silesia, Katowice (US)
- University of Lodz, Łódź (UŁ)
- Nicolaus Copernicus University, Toruń (UMK)
- University of Białystok, Białystok (UwB)
- University of Zielona Góra, Zielona Góra (UZ)
- Jan Kochanowski University, Kielce (JKU)

APP in Poland – main activities

“Core” and related to APP:

- **Gravitational waves**
- **Dark matter**
- **Neutrinos**
- **Cosmic rays**
- **Gamma ray astronomy**
- **X-rays**
- **CMB**
- **Dark energy**
- **Observational cosmology**
- **$0\nu 2\beta$**
- **theory**

Plus other related:

- **Astronomy**
- **Astrophysics**
- **Collider and non-collider physics**
- **...**

APP in Poland – main activities

Core APP:

➤ Gravitational waves

- **LIGO-Virgo-Kagra: large consortium: AO UW, NCBJ, IM PAN, CAMK, AC** Polgraw Consortium
- **Einstein Telescope: AO UW, CAMK, AC**
- LISA: AO UW
- TORES: NCBJ
- WERA: UJ

➤ Dark matter

- **DarkSide: AC, UJ**
 - **DEAP-3600: AC**
- Major growth since 2019, when Astrocent started.

➤ Neutrinos

- **HyperKamiokande: large consortium of 9 institutions:
NCBJ, U Silesia, IFJ, WUT, UW, Uwr, AGH, UJ, CAMK, AC
(SuperKamiokande)**
- **KM3Net: NCBJ, UJ, AC (observer), since 2020**
- GRAND: UW
- ~~Lake Baikal: IFJ PAN – terminated 2022~~
- PONE: IFJ PAN
- **T2K: NCBJ**
- Borexino
- DUNE
- Neutrino Platform@CERN

➤ Cosmic rays

- Pierre Auger: IFJ
- CREDO: IFJ
- JEM-EUSO: NCBJ
- GRAND: UW

➤ Gamma ray astronomy

- CTA: Polish CTA Consortium of 13: UJ, NCBJ, ...
- SST-1M: Polish CTA Consortium (currently active: UJ, IFJ, CAMK, AGH, UW, UwB, CBK)
- H.E.S.S: 5 institutions: CAMK, UJ, IFJ, UW, UMK
- POLAR-2: NCBJ, IFJ
- MAGIC: UŁ
- HAWC: IFJ

POLAR-2 - gamma-ray spectrometer to be launched on the Chinese space station (Tiangong-2 Space Lab)

➤ X-rays

- Athena: CAMK

➤ CMB

- PLANCK: NCBJ
- (LiteBird: AO UW?)

➤ Dark energy/observational cosmology

- Vera Rubin Observatory (LSST): NCBJ, UW, UW_r, UJ, UMK, CAMK, CFT
- VIPERS: NCBJ, UJ, JKU

➤ 0nu2beta

- LEGEND: UJ
- GERDA: UJ

➤ theory

diverse range of activities and interests by many groups:

- dark matter: AC, NCBJ, UW, ...
- GWs: NCBJ, UW, CAMK, ...
- Neutrinos: UW, UW_r, NCBJ, ...
- Early Universe: UW, AC, NCBJ, ...
- New physics: UW, AC, NCBJ,

APP in Poland: Activities

➤ **Biennial conferences of the community**

- Since 2013, alternating between Kraków and Warsaw
- Last one: Feb 2023
- About 120 participants, some from astronomy & astrophysics
- Many young researchers
- Good fraction of females (~25%)

➤ **National Council of Particle Astrophysics (Krajowa Rada Astrofizyki Cząstek)**

- Set up in 2013
- Representatives of APP centres in Poland
- L. Roszkowski – current chair
- (no funding available for animating activities)

➤ **AstroCeNT: Particle Astrophysics Science and Technology Centre**

- Set up in July 2018
- First centre in Poland devoted entirely to APP
- Director: L. Roszkowski
- Help from Stavros Katsanevas, ...

AstroCeNT

Particle Astrophysics Science and Technology Centre

- ❖ International Research Agenda: new centre of excellence
- ❖ Funding: 38 MPLN (8.3 MEuro) for 5 years (1 July '18 – 30 June '23)
- ❖ Autonomous department of CAMK PAN

source: FNP
(EU structural
funds)

31 December '23

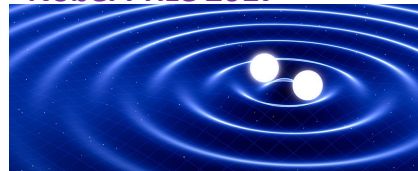
Main objectives:

- Studies of the invisible Universe (gravitational waves, dark matter,...)
- Ultra-sensitive instruments to detect extremely faint signals
 - Seismic sensors, modules of silicon photomultipliers (SiPMs), ...
- Big data collection and processing
- Applications to hi-tech industry and medicine (e.g., PET)
- ...

Big Science

Innovative
technologies

Nobel Prize 2017



Main partners: APC (Paris), Princeton, McDonald Institute (Canada), GSSI (Italy)
Locally: NCBJ, Łukasiewicz Network, Warsaw University, Warsaw University of Technology, ...

FNP: Foundation for Polish Science,
CAMK PAN: Nicolaus Copernicus Astronomical Center
of the Polish Academy of Sciences
APC: Astroparticule et Cosmologie Laboratory (Paris)

Main research directions, collaborations and partners

main roadmap directions (APPEC)

Experimental collaborations:

Dark matter:

- DarkSide, DEAP-3600
- Global Argon Dark Matter Collaboration (ARGO) -

future

Gravitational waves/seismic noise:

- Advanced VIRGO/LIGO,
- Einstein Telescope - future

Other (neutrinos, DM, techno...):

- KM3Net (observer)
- Hyper-Kamiokande (joined 2021)

Strategic partner APC

- growing collaboration in large international experiments: Virgo (GW), DarkSide (DM), KM3Net (neutrino), ...
- Joint (cotutelle) student
- plan to expand KM3Net and other collaboration involvement

Technology for science and industry:

- Silicon Photo Multiplier (SiPM) systems
- systems of seismic sensors
- data acquisition and large data set processing
- quantum computing and artificial intelligence
- Liquid Argon PET

Main scientific partners:

- APC
- European Gravitational Observatory
- Princeton University
- Gran Sasso Science Institute
- + TUM, (via DarkWave)

- National Centre for Nuclear Research
- Warsaw University of Technology
- University of Warsaw

International Scientific Committee

1. Prof. Marek Banaszekiewicz, Space Research Center PAS
2. Prof. Barbara Erasmus, CNRS Nantes
3. Prof. Cristiano Galbiati, Princeton University and GSSI, DarkSide leader
4. Prof. Stavros Katsanevas, European Gravitational Observatory, director – ISC chairman
5. Prof. Antoine Kouchner, APC, director
6. Prof. Sotiris Loucatos, APC, deputy director
7. Dr Harald Lueck, University of Hannover
8. Prof. Michał Ostrowski, Jagiellonian University, Cracow
9. Prof. Tomasz Starecki, Warsaw University of Technology
10. Mr Marek Winkowski, MSc Eng, ex. vice-president of Wroclaw Technology Park



Stavros Katsanevas
RIP (1953-2022)
First chair of AstroCeNT's ISC
And
Strong supporter of AstroCeNT

Public talks by Nobel laureates Art McDonald and Barry Barish (22 Feb. 2023)



APPEC GA, Warsaw, 29.06.2023

Initiative to set up an underground lab in Poland

➤ Motion of several Polish institutions

Set up a small-scale lab:

- APP: supporting to main UG labs
- Industry: dosimetry

▪ Sieroszowice mine

- Lubin mine
- Salt Mine Kłodawa
- Salt Mine Bochnia
- Salt Mine Wieliczka
- other

preliminary discussions
with management and
measurements of
natural radioactivity are
underway

➤ (long history: first SunLab at Sieroszowice, 2010)

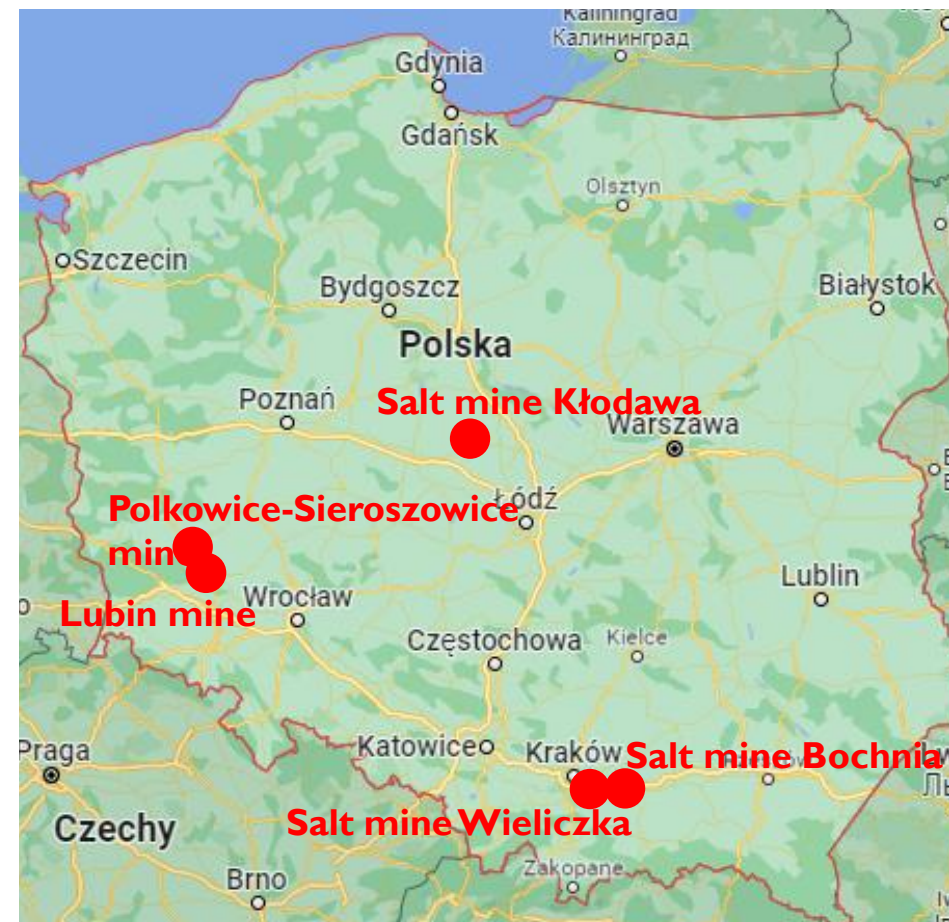
➤ **1 June 2022: visit and meeting with Vice Minister T. Rzymkowski**

➤ **Dec 2022: Report submitted to Ministry of Education and Science**

- Strong support from APPEC and the directors of LNGS, Canfranc, Modane, Boulby

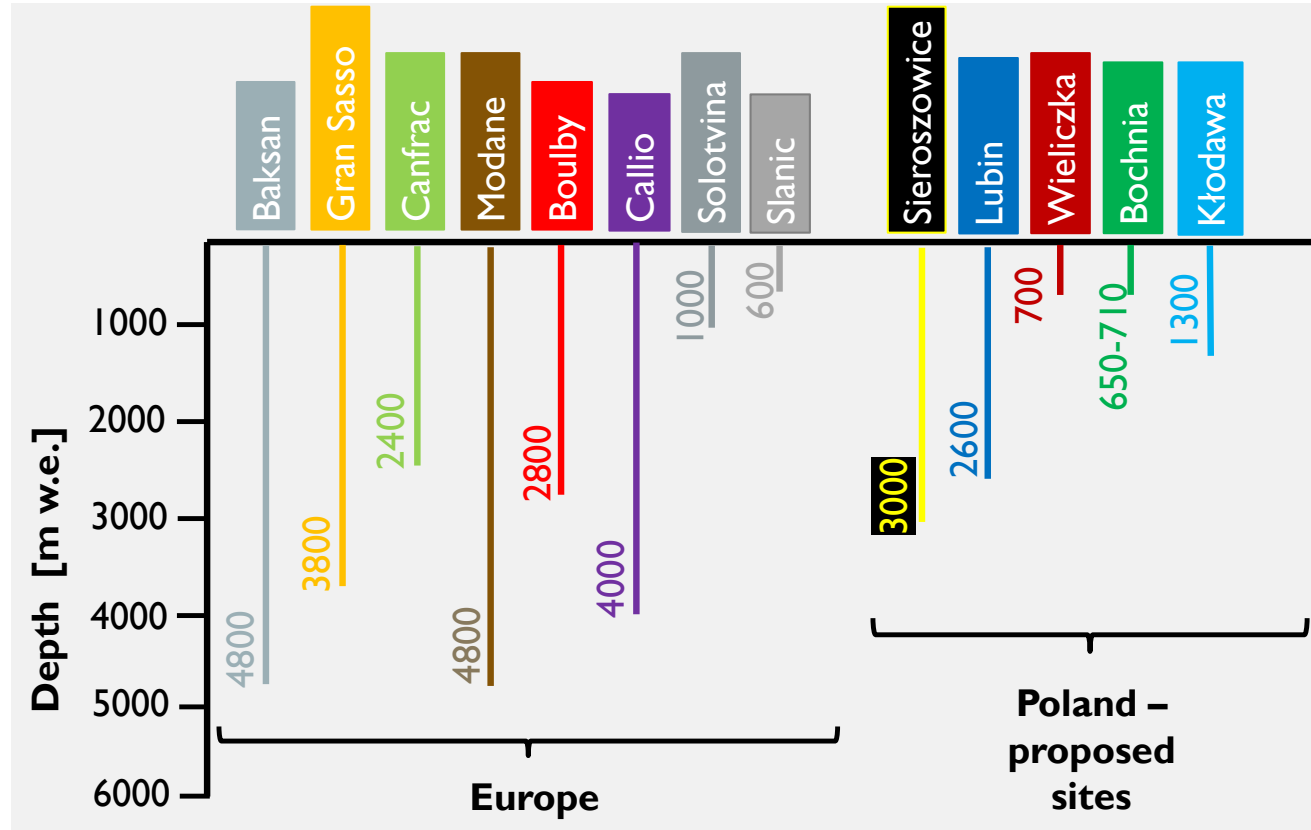
Potential sites

UGL@Poland



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Summary

- **APP@Poland: vibrant and growing activity**
- **Community still relatively small but is growing and attracting students, funding etc**
- **New centre AstroCeNT: a major investment in the field, needs to be maintained**
- **Return to full membership in APPEC in 2019: mutually beneficial**
- **Initiative to set up an UG lab in Poland**