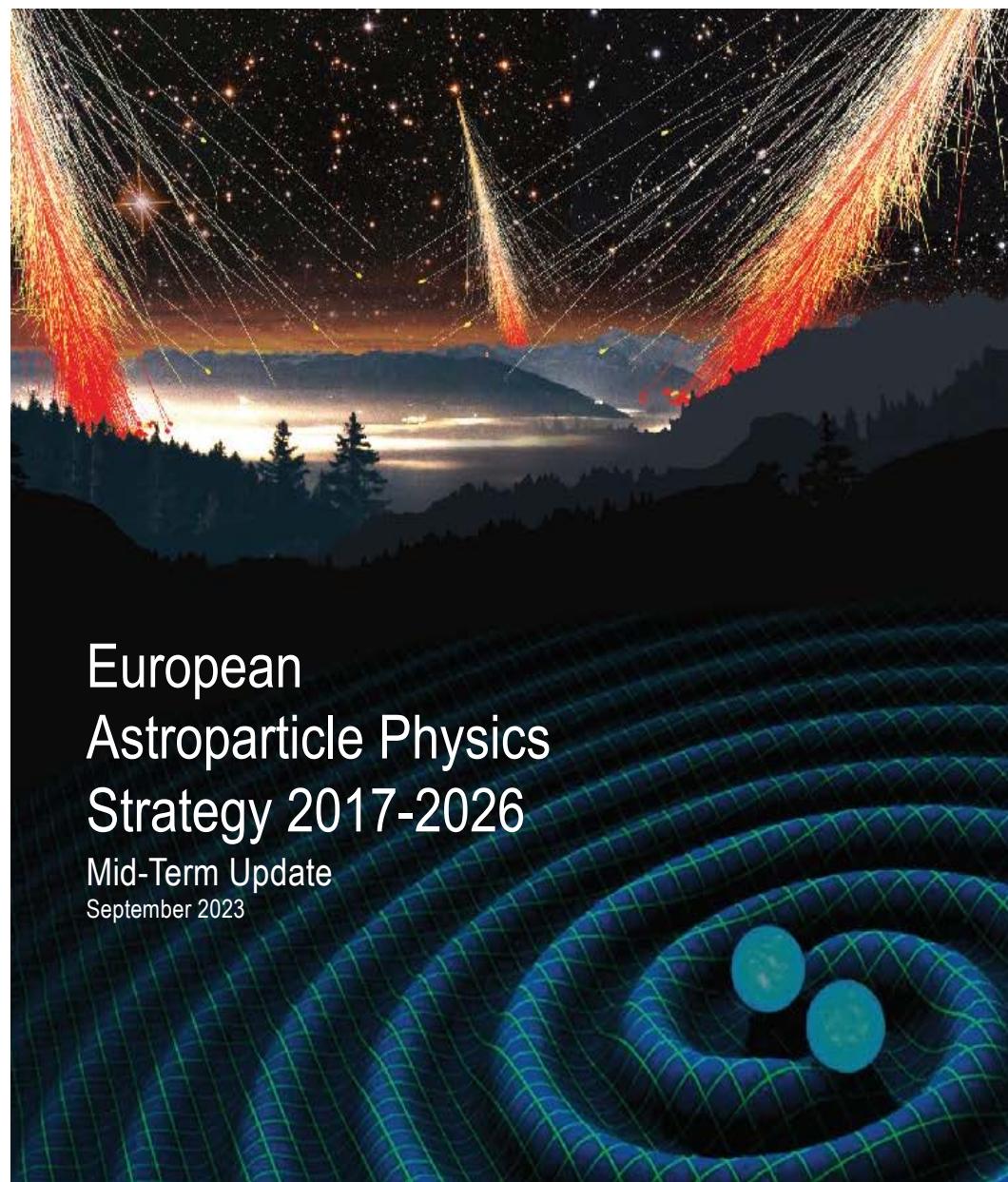




Astroparticle Physics European Consortium

Coordination of Astroparticle Physics in Europe

Aldo Ianni (INFN-LNGS), for the APPEC GA
Neutrino 2024 Milano, 17-22 June 2024



European Astroparticle Physics Strategy 2017-2026

Mid-Term Update
September 2023

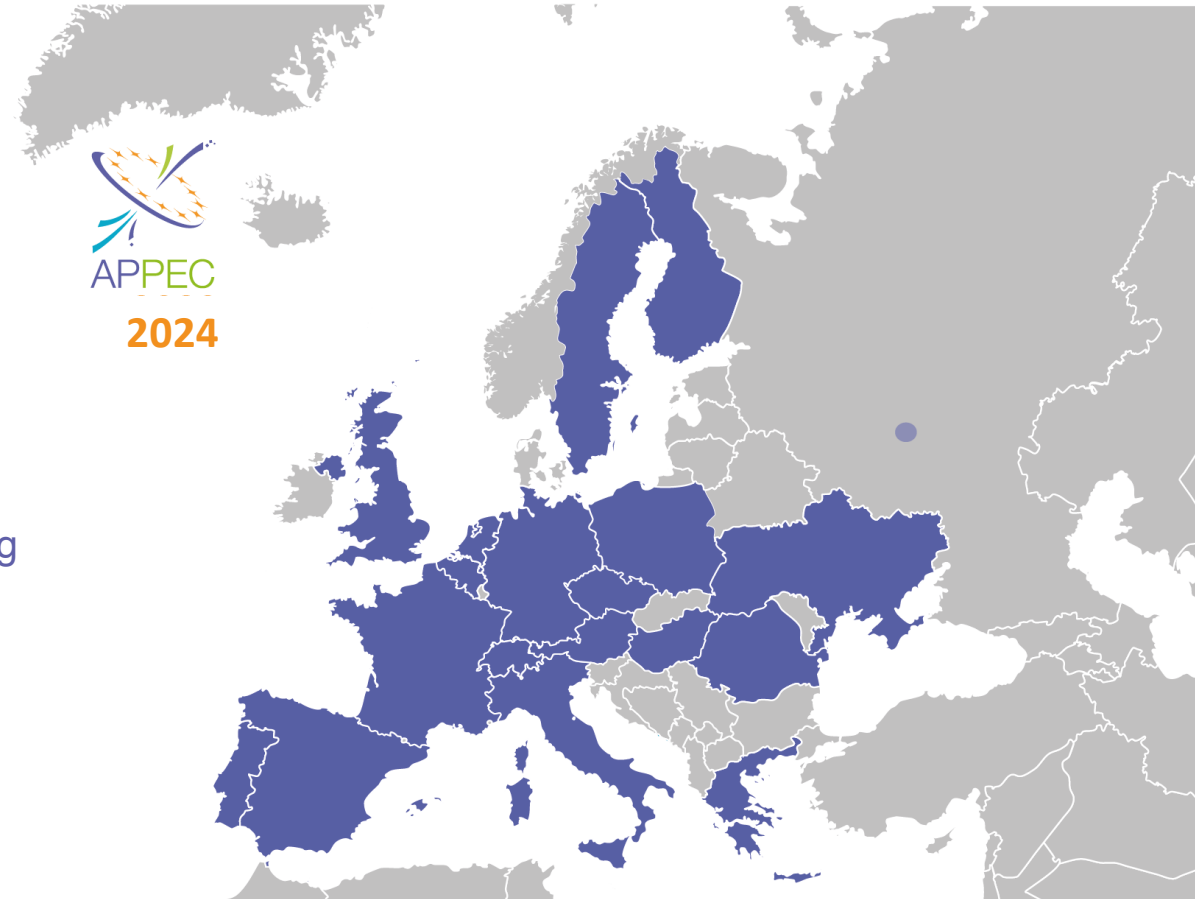
APPEC: what is it?



www.appec.org

AstroParticle Physics European Consortium

- An international coordinating structure, founded in 2001
 - ✓ European Strategy for Astroparticle Physics published in 2008
 - ✓ First roadmap with priorities in 2011
- Based on MoU by all partners and an APPEC Common Fund of order 70k€/year
- 18 (+1 suspended) member countries with 22 funding agencies
 - In discussion with Denmark and Norway
- 3 bodies:
 - **General Assembly** with Observers
 - **Scientific Advisory Committee**
 - **Joint Secretariat**



APPEC Bodies



- **General Assembly**

- Strategic, decision making and supervisory body
- Representatives of funding agencies
- Chair: **Andreas Haungs** (KIT)
 - ✓ new elected chair: **Carlos Peña-Garay** (LSC) 2025-2026
- Vice-Chair: **Antoine Kouchner** (APC) – new election in 2024

- **Scientific Advisory Committee**

- Advisory body
- Chair: **Aldo Ianni** (INFN-LNGS) since May 2024;
- Vice-Chair: **Mathieu de Naurois** (CNRS) since 2024

- **Joint Secretariat (distributed office)**

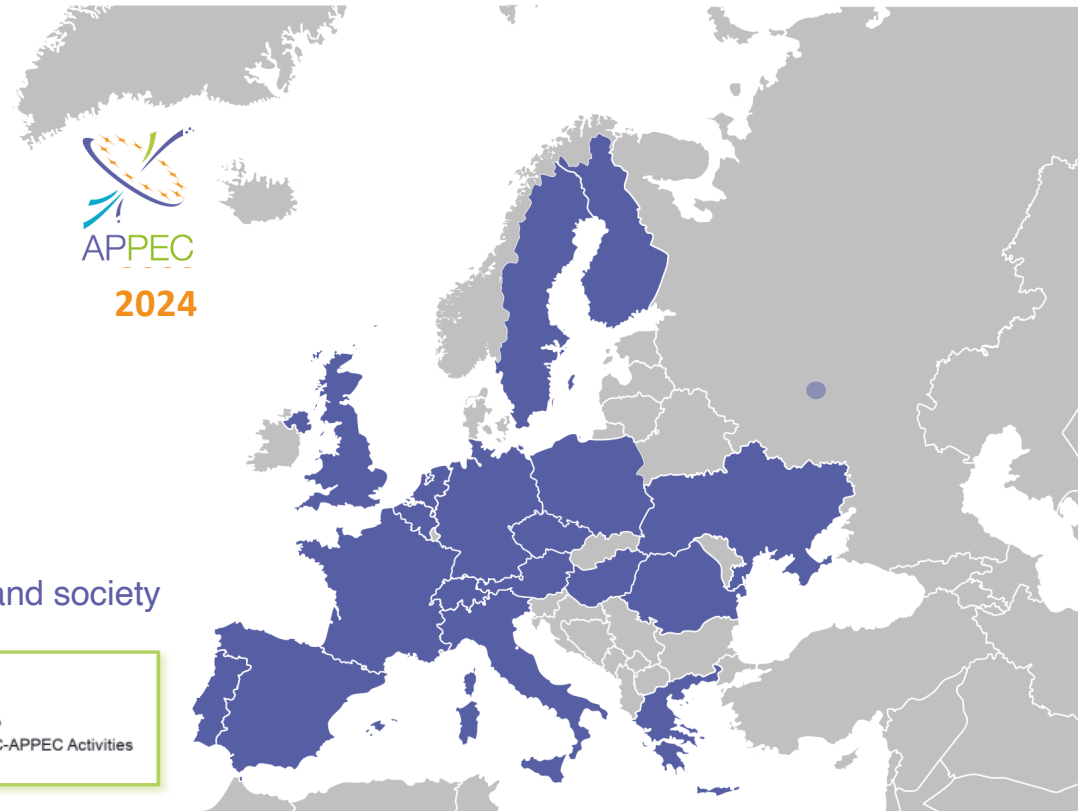
- Executive body chaired by the General Secretary
- General Secretary: **Julie Epas** (APC) since June 2024

- **Connections**

- Nuclear, particle, and astroparticle physics communities (NuPECC, ECFA, APPEC, ESFRI) joining efforts for science and society
- ESO (Andy Williams)
- EPS-HEPP (Ramon Miquel)
- EU Consortium for Astroparticle Physics Theory (EuCAPT, Silvia Pascoli)



www.appec.org



APPEC science and mission



Understanding

the Extreme Universe

- Multi-Messenger observations of cataclysmic events
 - ✓ HE γ rays, neutrinos, cosmic rays, GW

the Dark Universe

- Exploring the nature of **Dark Matter and Dark Energy**

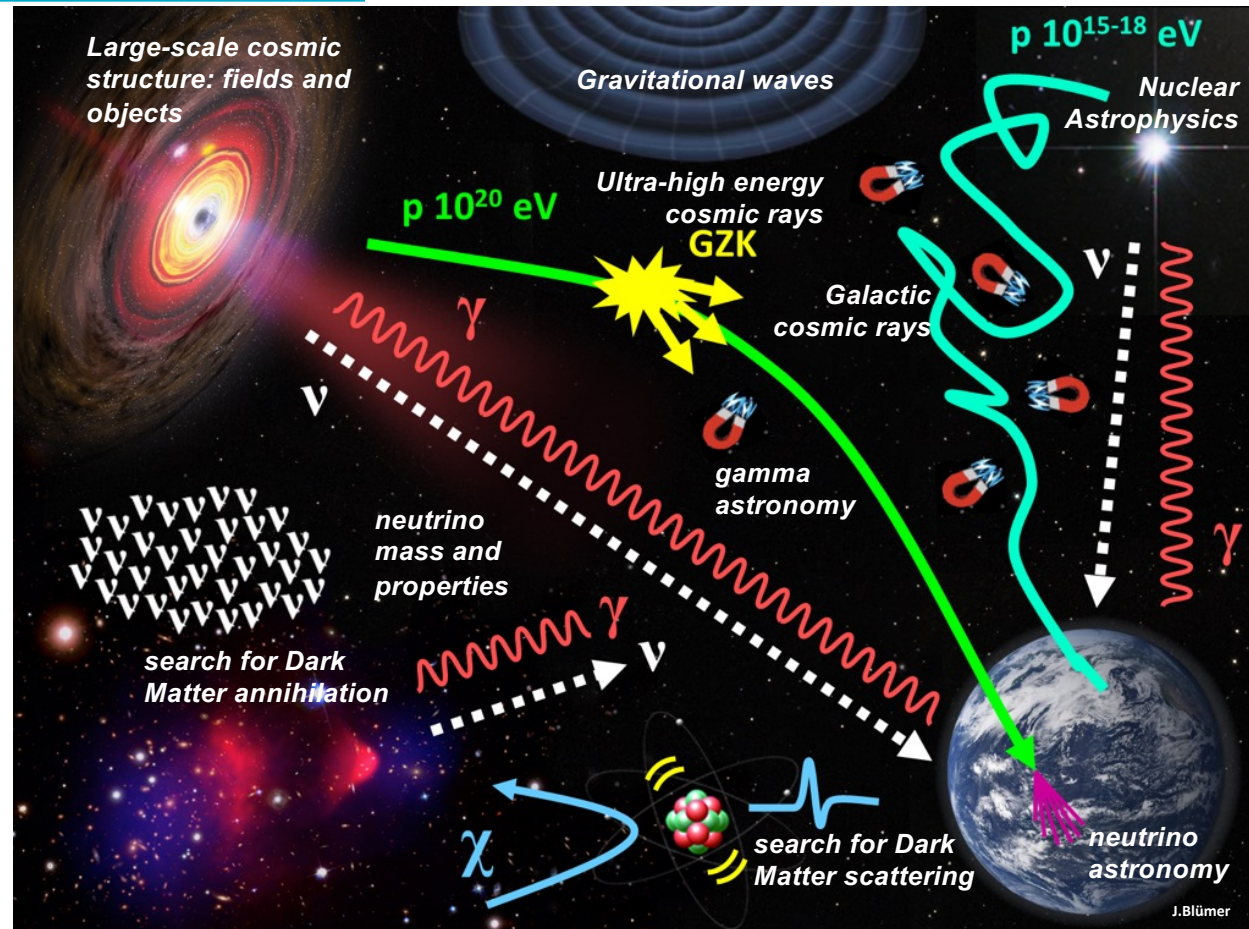
the Neutrinos

- Measuring **neutrino properties** und unveil their role in the universe
 - ✓ $0\nu\beta\beta$, reactor, solar, SN, and atmospheric ν

the Early Universe

- Learning about the Big Bang from **CMB**

- Large-scale research facilities
- Interplay of theory with experiment
- Synergies with neighboring fields
- Connecting with society



APPEC tasks



Coordination link of European Astroparticle Physics in Europe between funding agencies and the community needs through:

- Structured scientific advising (SAC, dedicated panels to specific challenges)
- Development and update of roadmaps based on scientific strategies and financial considerations
- Establish relations with other bodies in companion fields
- Initiate activities within Horizon Europe
 - ✓ to encourage/support applications for grants:
 - ACME (Astrophysics Center for Multi-messenger studies in Europe) recently approved (better access to RI services)
 - DEEPEN-STUDI (coordination of EU DULs) recently submitted
- Organise Town meetings
 - ✓ to engage the community
- Support relevant meetings/schools of the community
- Organize TechFora and Open Calls
 - ✓ to support R&D and engagement with industry
- Engagement with society (Outreach, Education,...)

APPEC is

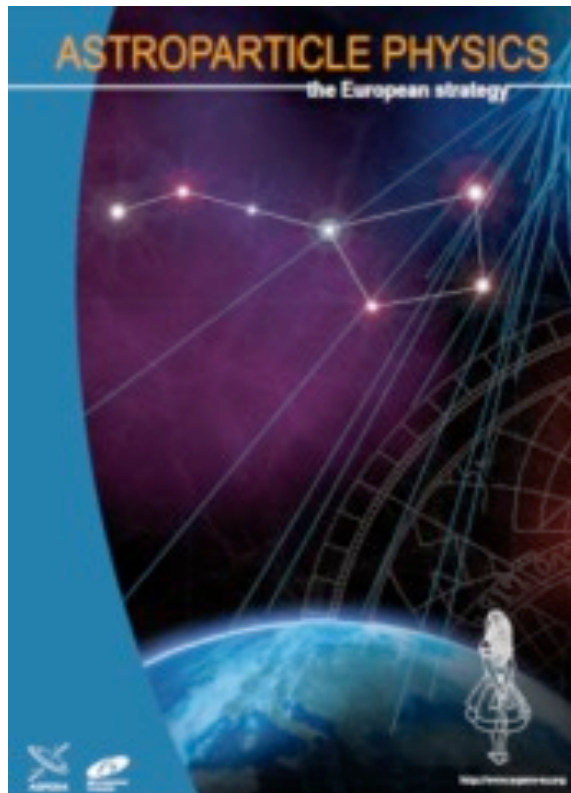
- Helping in coordination of large-scale RI
- Helping in transition of mid-scale experiments to large-scale RI
- Helping in support of small-scale experiments and R&D projects

APPEC Roadmaps

<https://www.appec.org/roadmap>



2008



2011



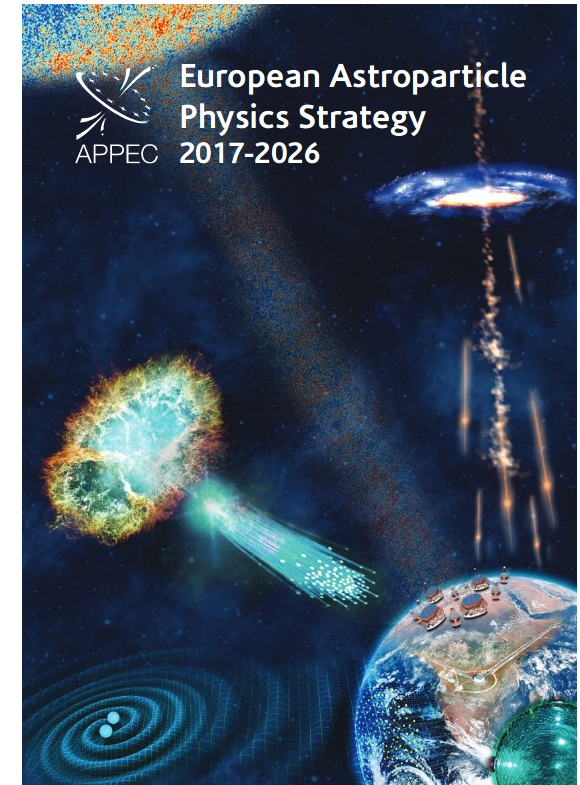
2017



Highlights since 2017

Mid-term update to account for relevant developments since 2017

- Multi-messenger observations: a new window to the universe
 - ✓ Multi-messenger event of a neutron star merger GW170817
 - ✓ Multi-messenger event by a neutrino alert from a blazar TX0506+056
- High Energy Gamma Rays: PeV sources in Milky Way
- Neutrinos from the Milky Way
- Instep structure in spectrum of UHECR and anisotropy
- Neutrino mass limit by direct measurements
- Improved neutrino oscillation matrix determination
- Direct dark matter search increased sensitivities
-
- **Methodically we improved by:**
 - Structured theory connection (EuCAPT, established in 2020)
 - Machine learning applications
 - Cooperation of underground laboratories
 - Closer cooperation with neighbouring fields and European Commission

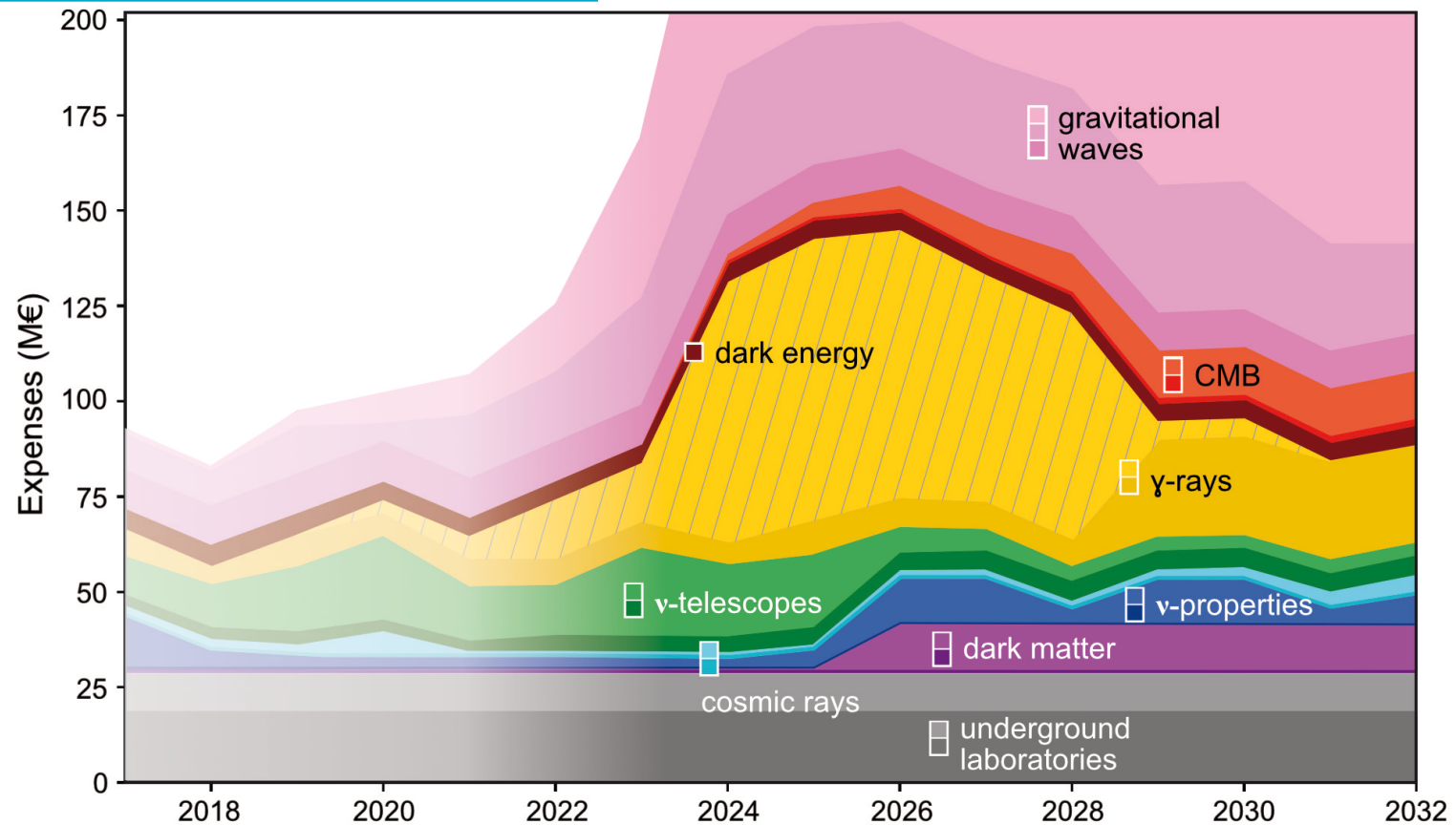


Resources update: survey from major experiments/projects

A resource aware roadmap (darker colors show M&O of RI)

Observations:

- Predictions from 2017 (until 2022) were okay
- CTA-peak shifted to later years compared to 2017 roadmap
- CTA-investments funded
- HE Neutrinos: stretched
- ET peak has 3 colors: operation, instrument, infrastructure



Roadmap Update 2023: Projected annual capital investment

The path to the roadmap: Town Meeting

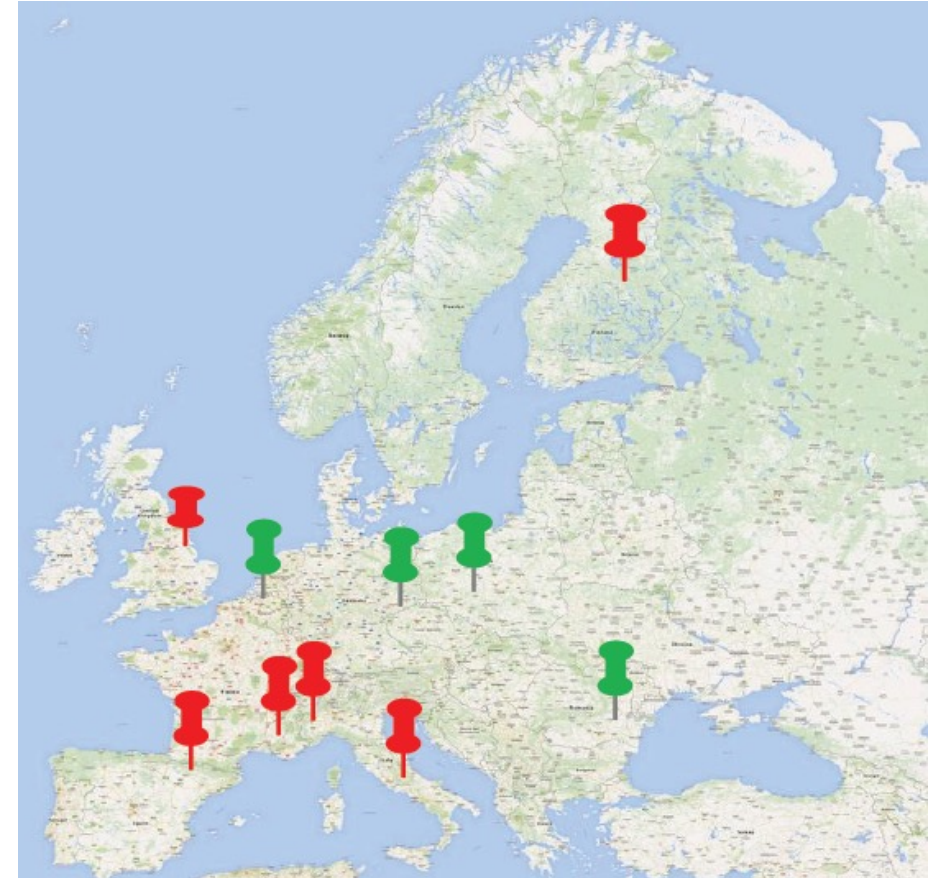
<https://indico.desy.de/event/25372/>



- ➔ An inspiring, lively and colourful event with a lot of debates and exchange!
- ➔ Active work tables on specific topics with summary reports in plenary session
- ➔ Important input to the Roadmap update

Enhance European Research Infrastructures

- A required path towards next-generation experiments
 - ✓ Support and development of EU RI
- Underground Laboratories offer a clear example
 - ✓ Enhance a **trans-national access policy** and training programs for young scientists
 - ✓ Support structured coordination
 - optimise use of facilities
 - ✓ Reinforce connections between DULs and associated research institutes

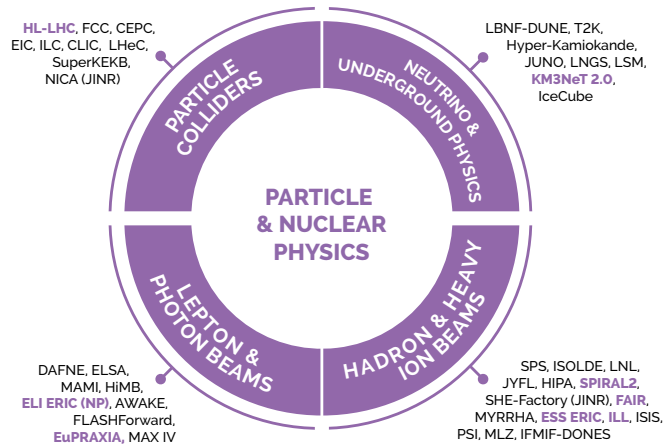
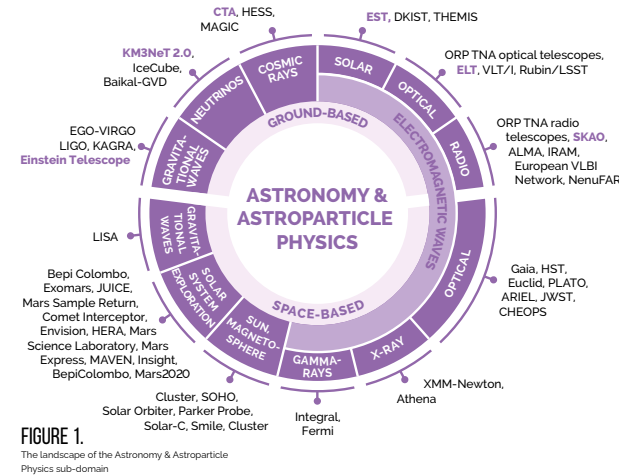


ESFRI and APPEC RIs (landscape analysis 2024)

- APPEC RIs included in ESFRI roadmap

- ✓ KM3NeT
- ✓ CTA
- ✓ ET

- DULs considered essential key RIs to Astroparticle Physics projects
- Underlined APPEC role and recommendations to support Astroparticle Physics advancement



The path to the new roadmap

Strategy:

- science driven process
- community driven process: inputs from community and kick-off meeting
- crucial interaction with GA to properly benefit of European and national programs
- take into account the international landscape to develop synergy and optimise outcome of fundamental research
- acknowledge international cooperation, viability, and sustainability in projects planning
- benefit of SAC members international and national connections

	2024				2025				2026				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
SAC activity		prepare kick-off meeting				prepare roadmap							finalize roadmap
EU community			launch community inputs request			kick-off meeting					Town meeting		

Take away message

Astroparticle physics is a reach field in science with multi-disciplinary opportunities

APPEC role:

- ✓ provide a coordinated EU effort to enhance Astroparticle Physics
- ✓ stimulate funding agencies to improve synergy
- ✓ engage community in the roadmap development
- ✓ support RIs connections
- ✓ enhance new ideas
- ✓ enhance connection with society



**Thank You
for your attention**

Back up

Enhance the future of Astroparticle Physics in Europe

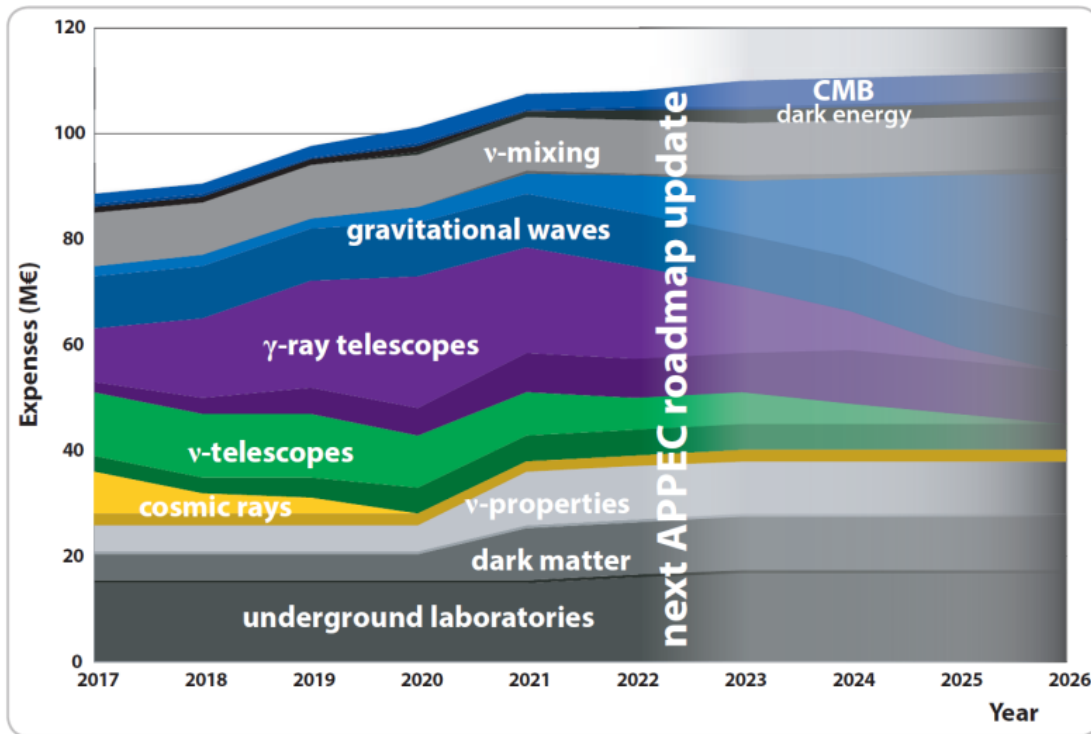


Presentation of the European Astroparticle Physics Strategy Mid-Term Update

7/12/2023 14-18:00
<https://indico.cern.ch/event/1339060/>



Resources



From Roadmap 2017: Projected annual capital investment

- A resource aware roadmap
(darker colors also show M&O of RI)
- Midterm Evaluation: Preparation of roadmap update <https://www.appec.org/mid-term-review>
 - Direct Dark Matter working group
 - Double Beta Decay APPEC sub-Committee
 - Multi-messenger Discussion Workshops
 - Coordination workshop of Underground Labs
 - Town Meeting June 2022
<https://indico.desy.de/event/25372/>
 - Census / Survey of time and cost lines
- Goals
 - Identify new developments and new topics
 - Update recommendations
 - Update of time and cost line

APPEC roadmap - scientific topics

- Cosmic rays
- High-energy neutrinos
- High-energy photons
- Gravitational waves
- WIMP Dark Matter
- Non-WIMP Dark Matter
- Neutrino properties
- Cosmic Microwave Background
- Dark Energy
- Multi-messenger astroparticle physics
- Astroparticle theory
- Detector R&D
- Computing and data policies



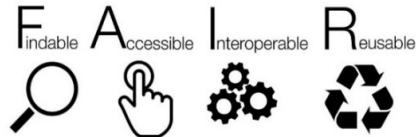
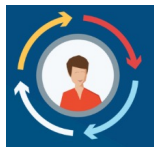
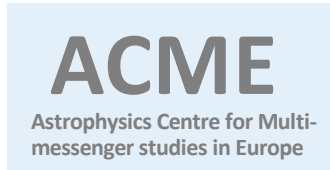
Recommendations are given for each topic

Roadmap - Connecting to Society and Organisation

- Ecological Impact
- Societal Impact
- Open Science and Citizen Science
- Human Talent Management
- Central Infrastructures
- European and Global Cooperation
- Interdisciplinary Opportunities

Recommendations are given for each topic

[RoadmapUpdate.pdf](#)



ACME - Astrophysics Centre for Multimessenger studies in Europe

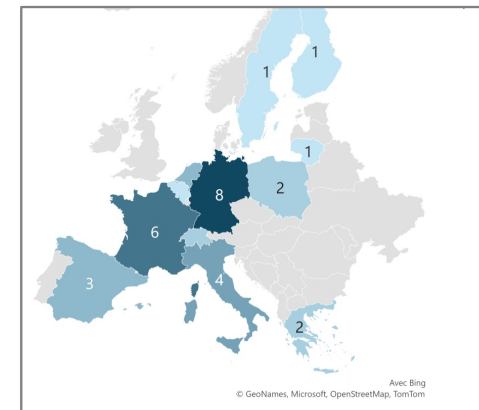


HORIZON-INFRA-2023-SERV-01-02 (domain: Astronomy & Astroparticle physics)

- Topic: **better access of users to RI services to advance frontier knowledge**
- **ACME is an ambitious coordinated European-wide optimization of the accessibility and cohesion between multiple leading RI, offering access to instruments, data and expertise.**
- Selected for funding by the European Commission: 14.5 M€ (in Feb 2024)
- Provides in 7 WP Transnational access (TA) and Virtual Access (VA) to RI and harmonize data formats and data analysis tools
- Consortium: 41 partners, 15 countries, >30 research infrastructures
- Grant Agreement Preparation phase



Astronet



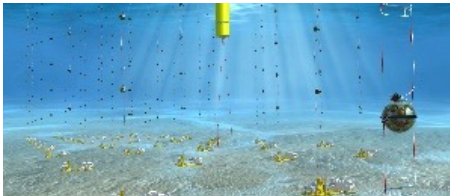
APPEC Flagship Research Infrastructures

This is not a closed, but dynamic list...

ESFRI=European Strategy Forum on Research Infrastructures

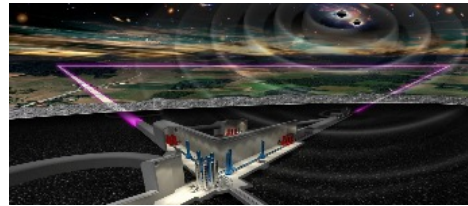


[construction KM3NeT 2020-2026; IceCube-Gen2]



ESFRI

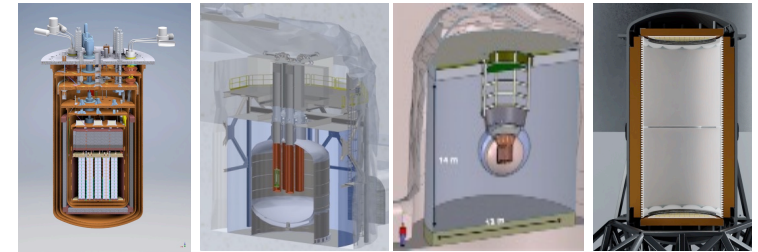
HE Neutrinos



ESFRI

[construction Einstein Telescope 2026-]

Gravitational Waves



[construction LEGEND-1000 / nEXO 2023- ; ...]

Neutrino Properties

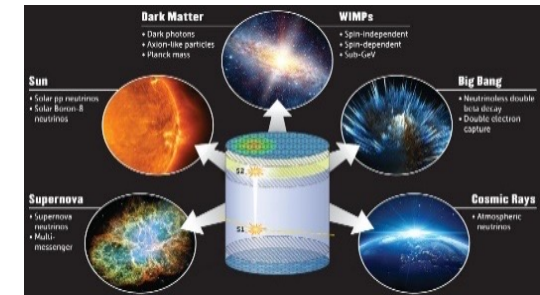
[construction AugerPrime 2019-2023]



HE Cosmic Rays

High-Energy

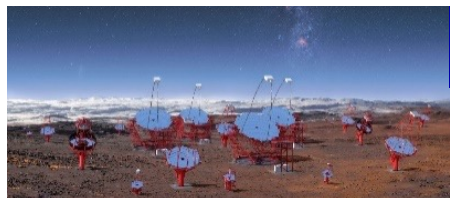
Dark



[construction DARWIN 2024- ; XLZD, ARGO, ...]

Dark Matter

[construction CTA 2021-]



ESFRI

HE Gamma Rays

Universe

APPEC SAC composition

Country	Cosmic rays	High-energy photons	High-energy neutrinos	GW	Neutrino properties	Dark Matter	Dark Energy	CMB	Theory
FR		Mathieu de Naurois		Edwige Tournefier			Stéphanie Escoffier	Sotiris Loucatos	
DE			Anna Nelles		Christian Weinheimer				Joachim Kopp
ES					Concha Gonzalez-Garcia				
IT				Marica Branchesi	Oliviero Cremonesi	Aldo Ianni			
FI									
SE			Chad Finley						
EL									
CZ									Fedor Simkovich
BE	Ioana Maris								
HU									
PL						Marcin Kuzniak			
PT									
RU									
CH									
UK		Paula Chadwick					Ofer Lahav		
AT									
NL	Sijbrand de Jong								
DK									Irene Tamborra

Chair: Aldo Ianni
Deputy chair: Mathieu de Naurois
Secretary: Nicola Rossi
 from LNGS

To be changed or re-discussed in 1yr