European Astroparticle Physics Strategy 2017-2026

Presented by Sijbrand de Jong (APPEC SAC chair)

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Overview

- Key Questions
- Observatories and Experiments
- Theory, Detector R&D, Computing
- Astroparticle Physics and Society: Ecology, Society, Open Science
- Organising the Community: Talent, Deep Underground Laboratories, connecting to adjacent fields
- Resource Planning and the Need for European Cooperation
- Towards the APPEC 2027-2036 Road Map

AstroParticle Physics

Key Research Areas

- The Extreme Universe
- The Dark Universe
- Mysterious Neutrinos
- The Early Universe

Spectacular to Steady Progress
But no definitive answers yet !

Key Questions

- What is Dark Matter?
- What is Dark Energy?
- What caused our Universe to become dominated by matter and not anti-matter?
- Can we probe deeper into the earliest phases of our Universe's existence?
- What are the properties of neutrinos?
- Can we identify the sources of high-energy neutrinos?
- What is the origin of cosmic rays?
- Do protons decay?
- What do gravitational waves tell us about General Relativity and cosmology?
- What will multi-messenger astronomy teach us?

High Energy Gamma Rays

APPEC fully endorses the construction and subsequent long-term operation of CTA in both the northern and southern hemispheres. APPEC supports work towards the selection of the mission concept THESEUS and the construction of SWGO. It urges the community to consider a replacement for the Fermi telescope.

High Energy Neutrinos

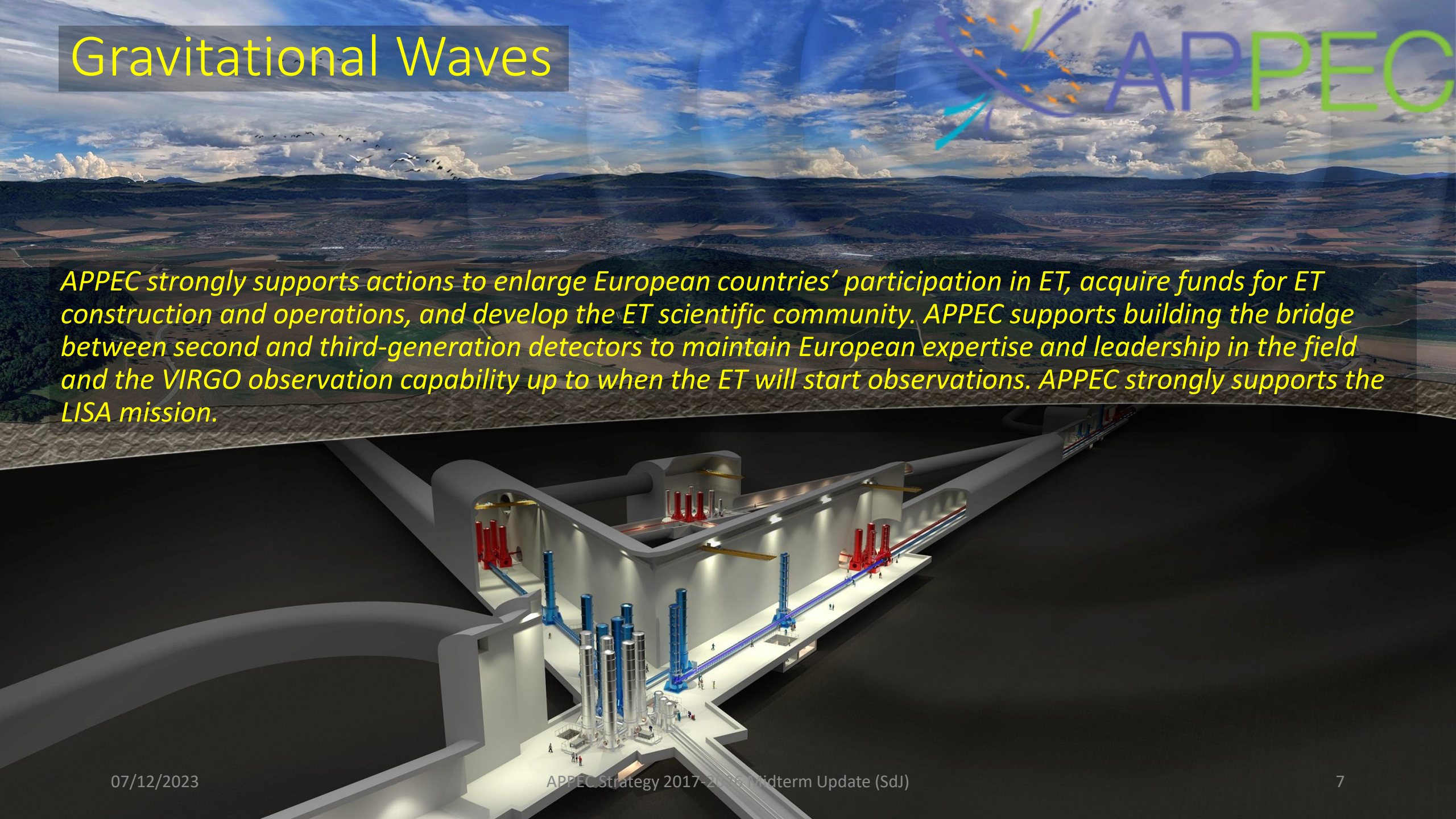
APPEC fully endorses the goal of the KM3NeT collaboration to complete the construction of the large-volume telescope optimised for high-energy neutrino astronomy ARCA, and the dedicated detector to resolve the neutrino mass hierarchy ORCA. APPEC strongly supports the construction of the IceCube Upgrade, and the ambition to build IceCube-Gen2 in the following decade.

High Energy Cosmic Rays

APPEC fully endorses the completion of AugerPrime and strongly supports the exploitation of the combined Auger and TA full sky coverage by joint working groups. APPEC encourages continued R&D on new cost-effective detector technologies for a next-generation observatory. APPEC encourages theory efforts to understand air shower physics, physics at cosmic-ray sources and cosmic-ray propagation.

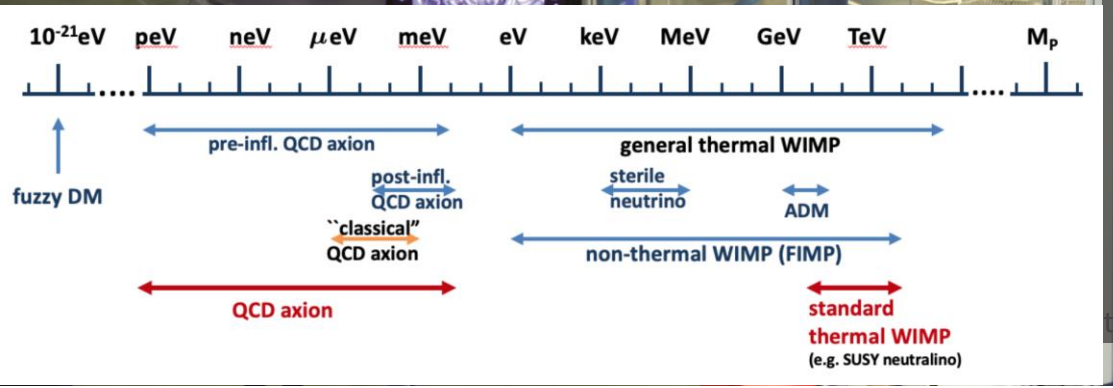
Gravitational Waves

APPEC strongly supports actions to enlarge European countries' participation in ET, acquire funds for ET construction and operations, and develop the ET scientific community. APPEC supports building the bridge between second and third-generation detectors to maintain European expertise and leadership in the field and the VIRGO observation capability up to when the ET will start observations. APPEC strongly supports the LISA mission.

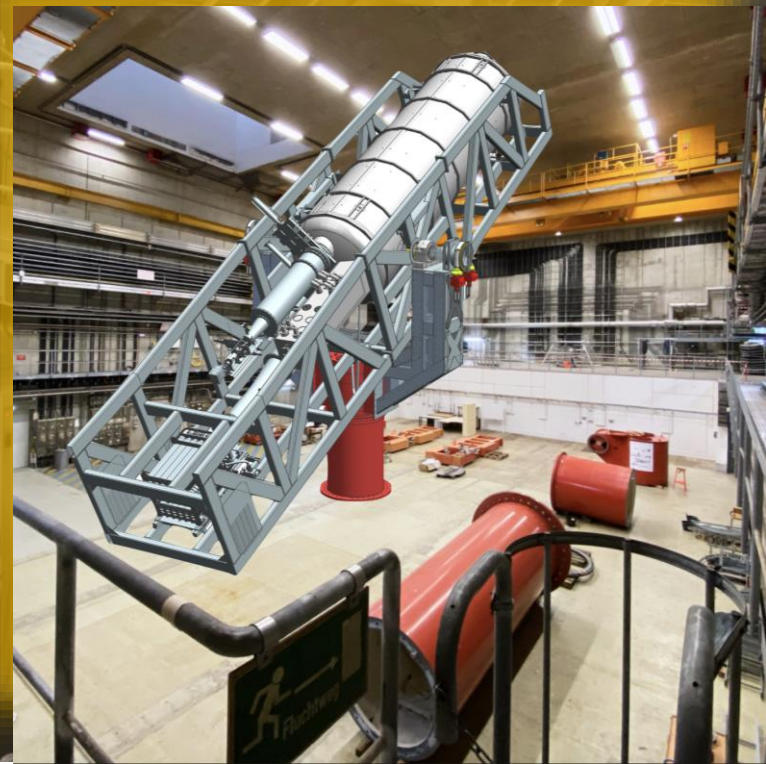


Dark Matter

WIMPS: *APPEC strongly supports the European leadership role in Dark Matter direct detection, underpinned by the pioneering LNGS programme, to realise at least one next-generation xenon (order 50 tons) and one argon (order 300 tons) detector, respectively, of which at least one should be situated in Europe. APPEC strongly encourages detector R&D to reach down to the neutrino floor on the shortest possible ?me scale for WIMP searches for the widest possible mass range.*

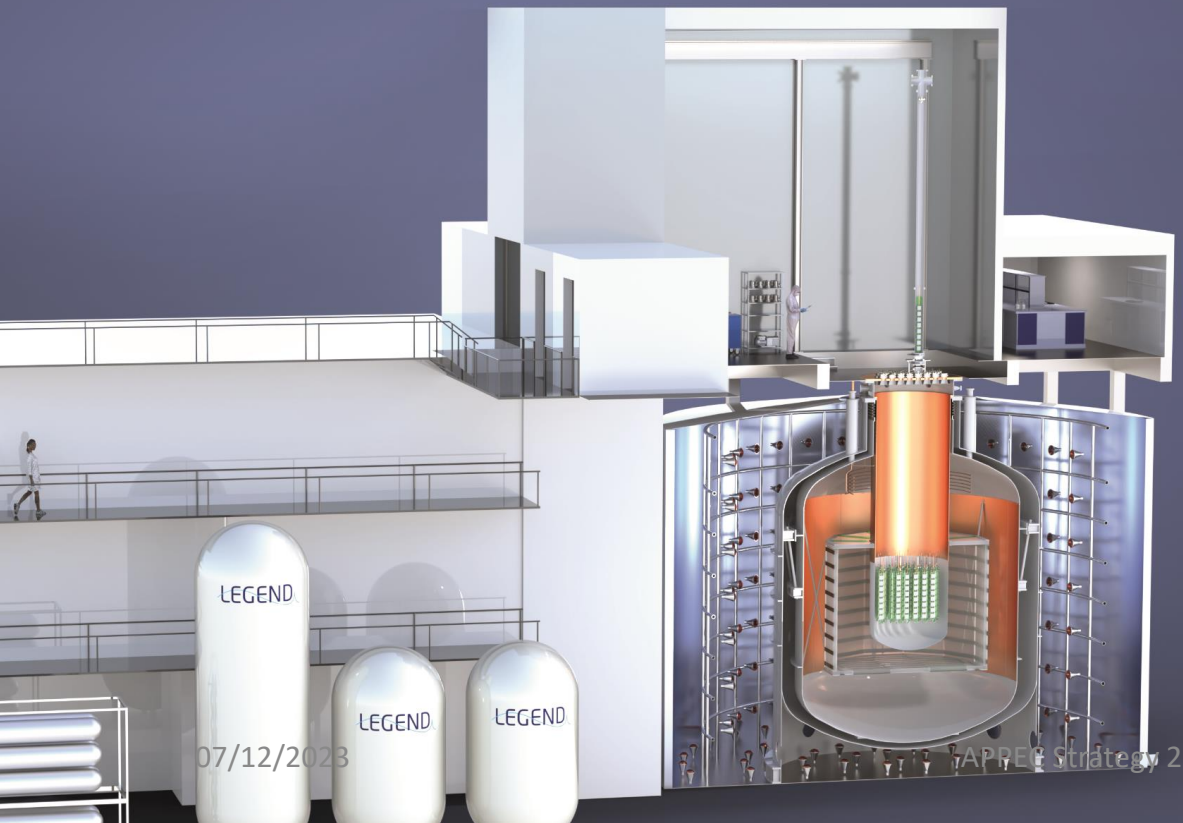


Axions, ALPs and other non-WIMP: *APPEC supports the unique European-led efforts for axions and ALPs detection in mass ranges complementary to the established cavity approach. APPEC encourages R&D efforts to improve experimental sensitivity and extend the accessible mass range.*



Neutrino Properties

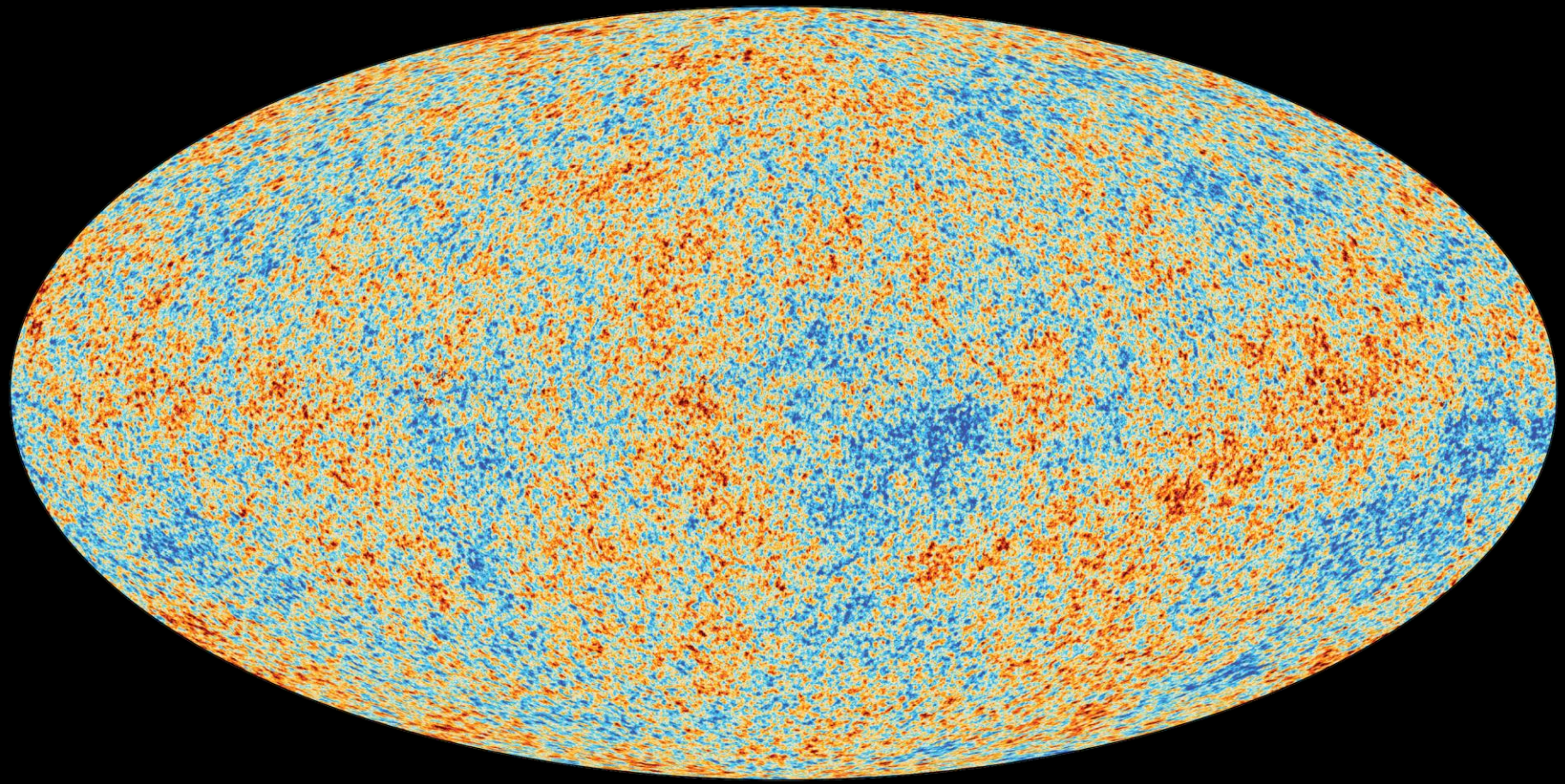
Mass & Nature: *APPEC strongly supports the CUPID and LEGEND 1000 double-beta decay experiments selected in the US-European process and endorses the development of NEXT. APPEC strongly supports fully exploiting the potential of the KATRIN direct neutrino mass measurement and the development of a new generation of experiments beyond KATRIN.*



Mixing & Mass Ordering: *APPEC repeats its strong endorsement of the KM3NeT neutrino telescope, with ORCA as an important neutrino mass ordering detector. APPEC strongly supports European participation in the long baseline neutrino oscillation experiments DUNE and Hyper-Kamiokande, as well as in the JUNO reactor experiment.*

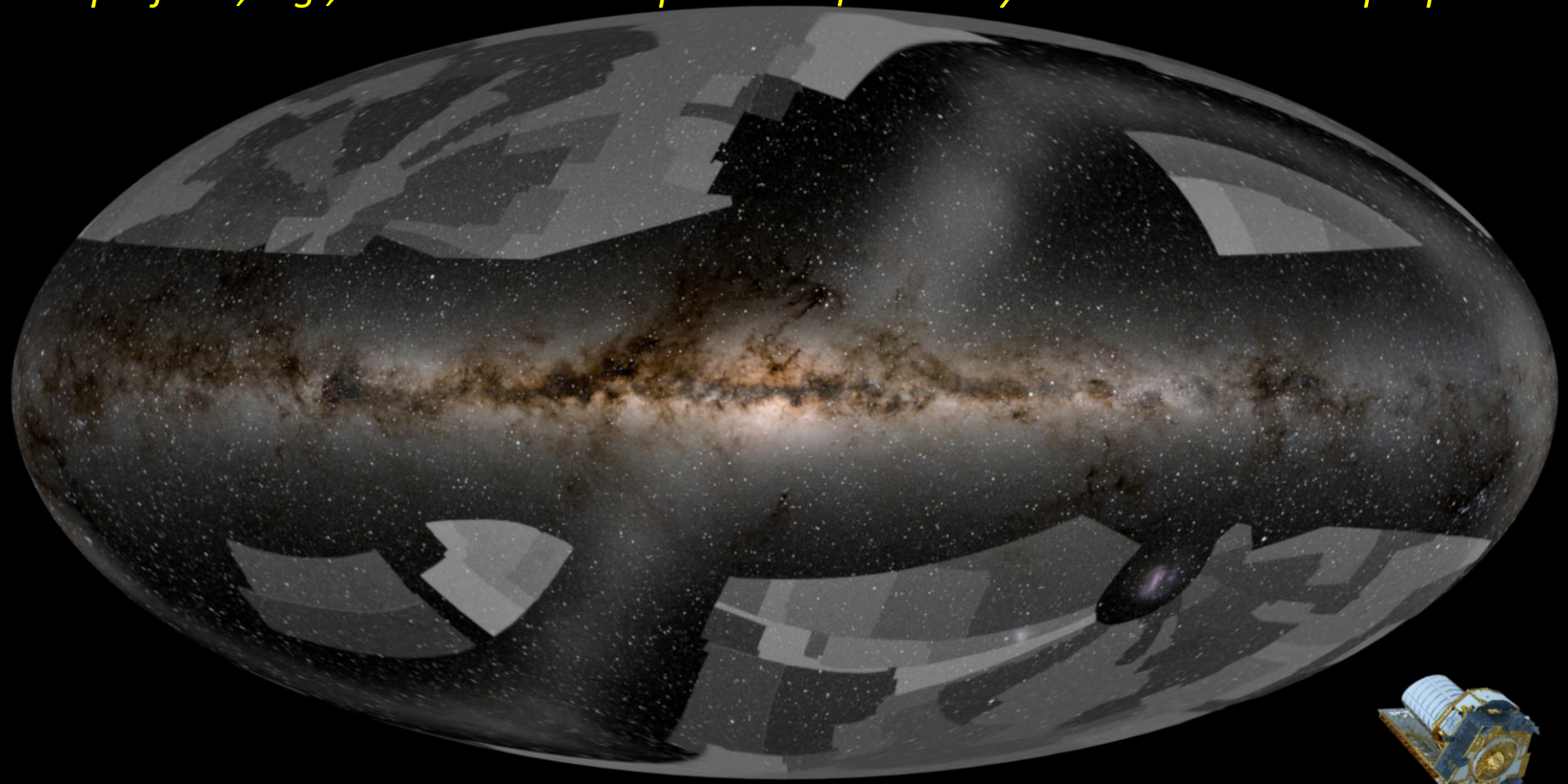
Cosmic Microwave Background

APPEC encourages European contributions to the Japanese LiteBIRD mission as well as R&D for further space-based CMB studies, such as a possible successor to COBE/FIRAS. APPEC encourages contributions to CMB Stage 4 and R&D towards other, next-generation, ground-based experiments.

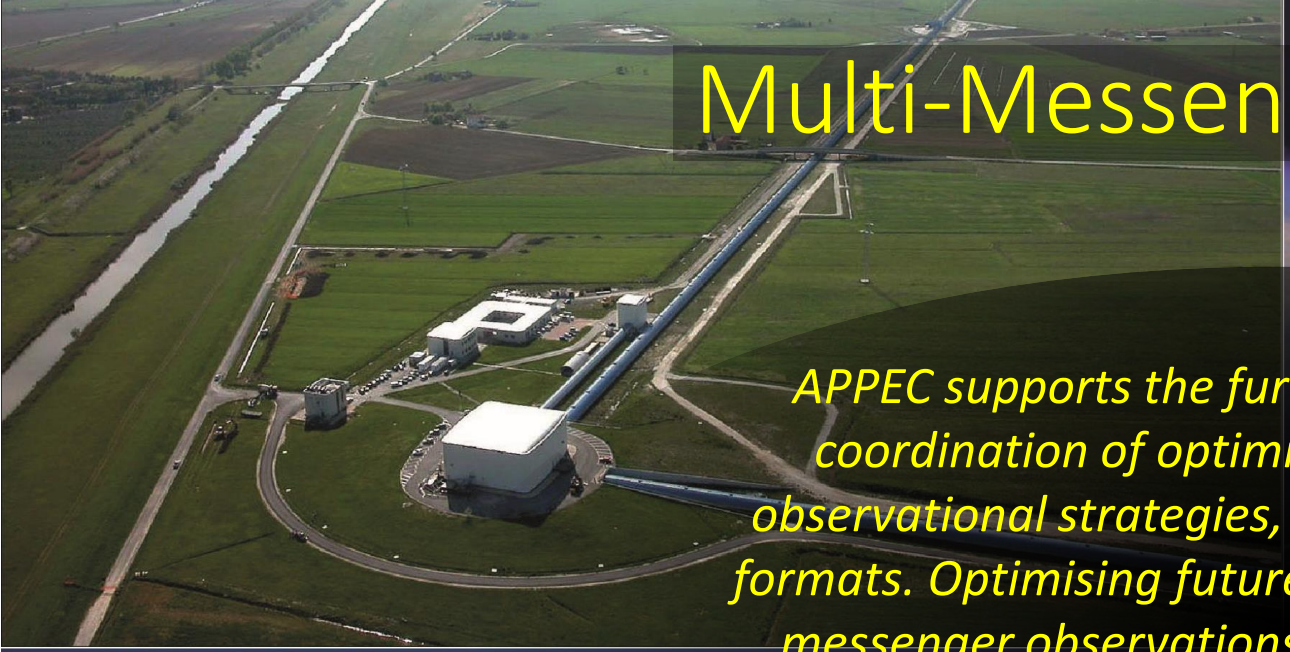


Dark Energy

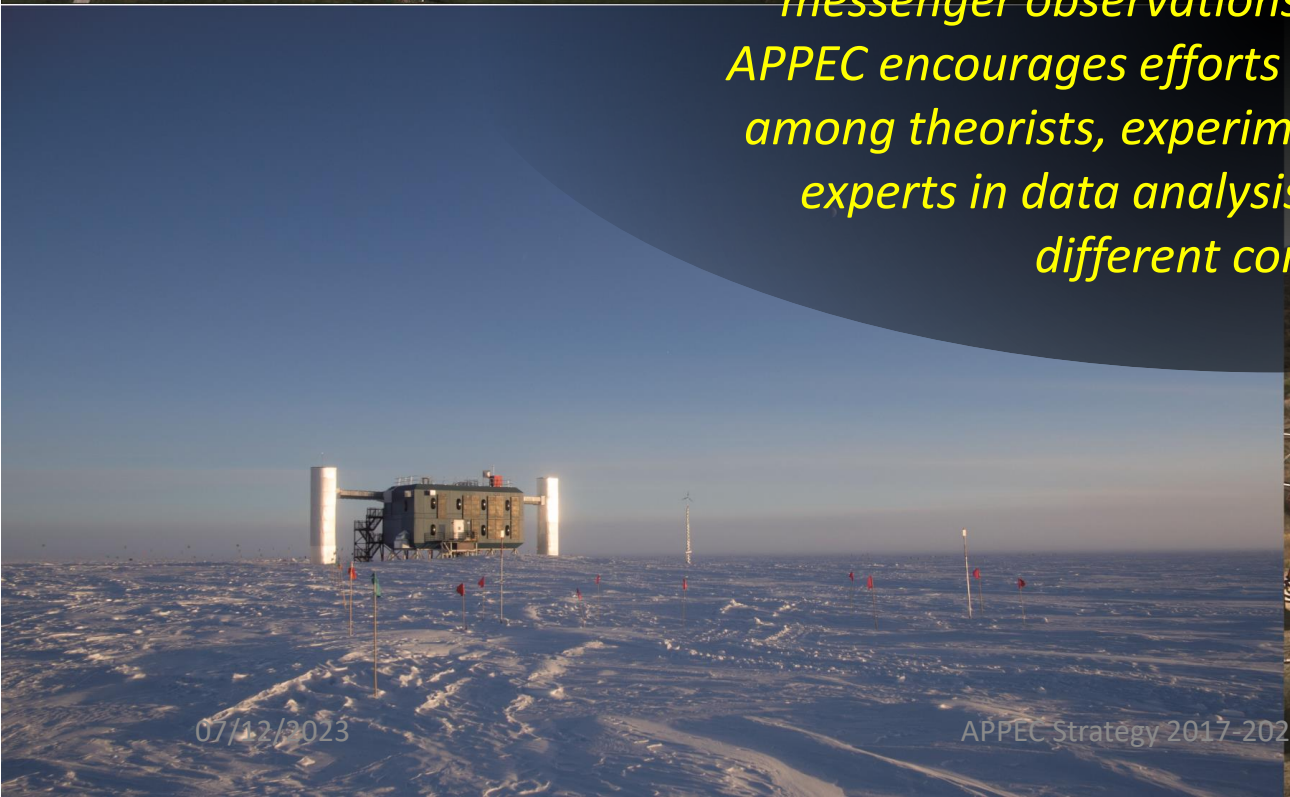
APPEC supports the forthcoming ESA Euclid satellite mission, which will establish European leadership in space-based Dark Energy research. APPEC encourages continued participation in next-generation ground-based research projects, e.g., Rubin-LSST and spectroscopic surveys such as DESI and proposed successors.



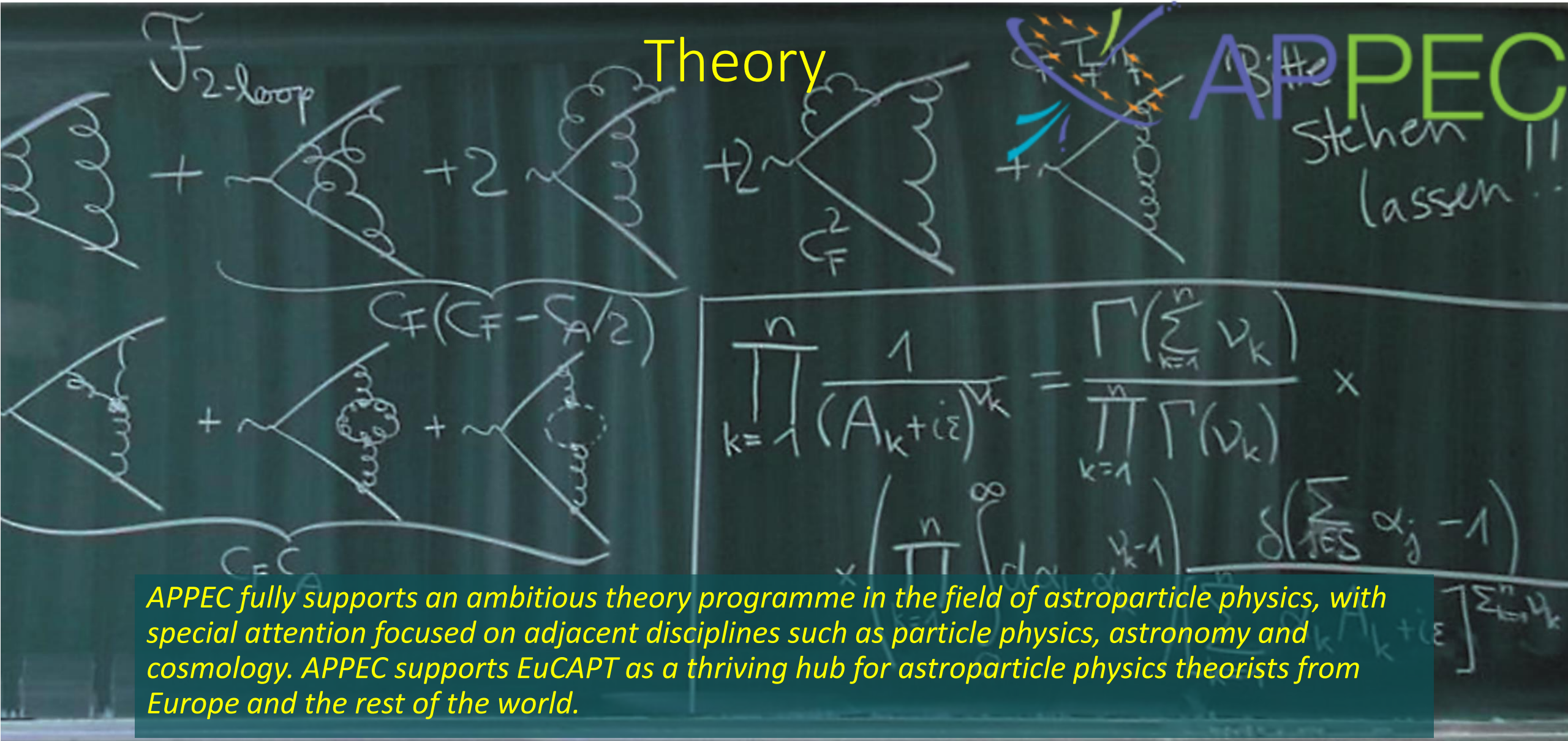
Multi-Messenger APP



APPEC supports the further development and coordination of optimised multi-messenger observational strategies, common tools and data formats. Optimising future observatories for multi-messenger observations is strongly supported. APPEC encourages efforts to enhance collaboration among theorists, experimentalists, observers, and experts in data analysis and computing from different communities.

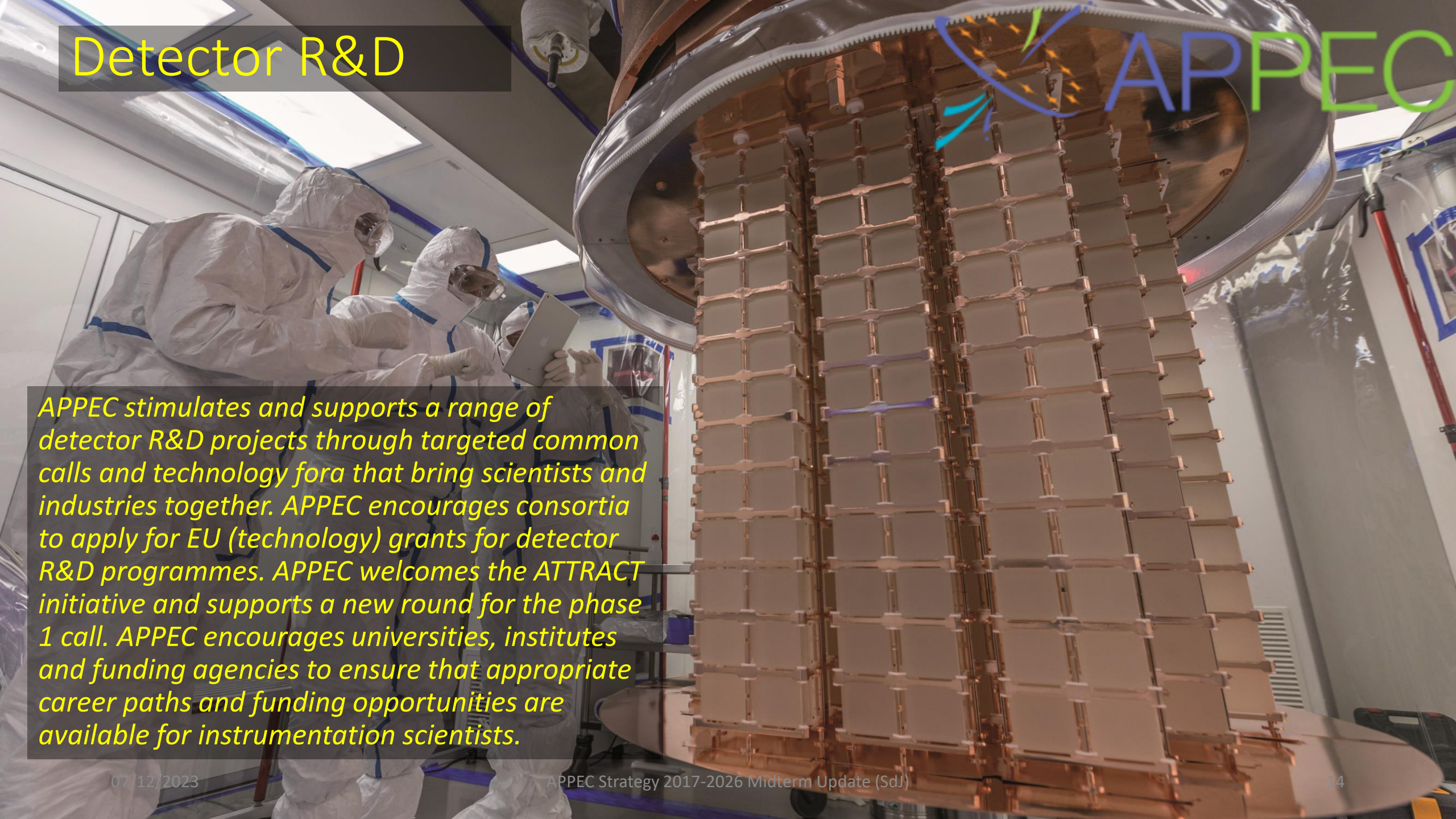


Theory



APPEC fully supports an ambitious theory programme in the field of astroparticle physics, with special attention focused on adjacent disciplines such as particle physics, astronomy and cosmology. APPEC supports EuCAPT as a thriving hub for astroparticle physics theorists from Europe and the rest of the world.

Detector R&D



APPEC stimulates and supports a range of detector R&D projects through targeted common calls and technology fora that bring scientists and industries together. APPEC encourages consortia to apply for EU (technology) grants for detector R&D programmes. APPEC welcomes the ATTRACT initiative and supports a new round for the phase 1 call. APPEC encourages universities, institutes and funding agencies to ensure that appropriate career paths and funding opportunities are available for instrumentation scientists.

Computing and Data Policies

APPEC requests all relevant experiments to continue to have their computing requirements scrutinised. APPEC will engage with the particle physics and astronomy communities to secure a balance between available European computing resources and needs for now and into the future. Appropriate training in data science should be provided for astroparticle physicists.

Ecological Impact

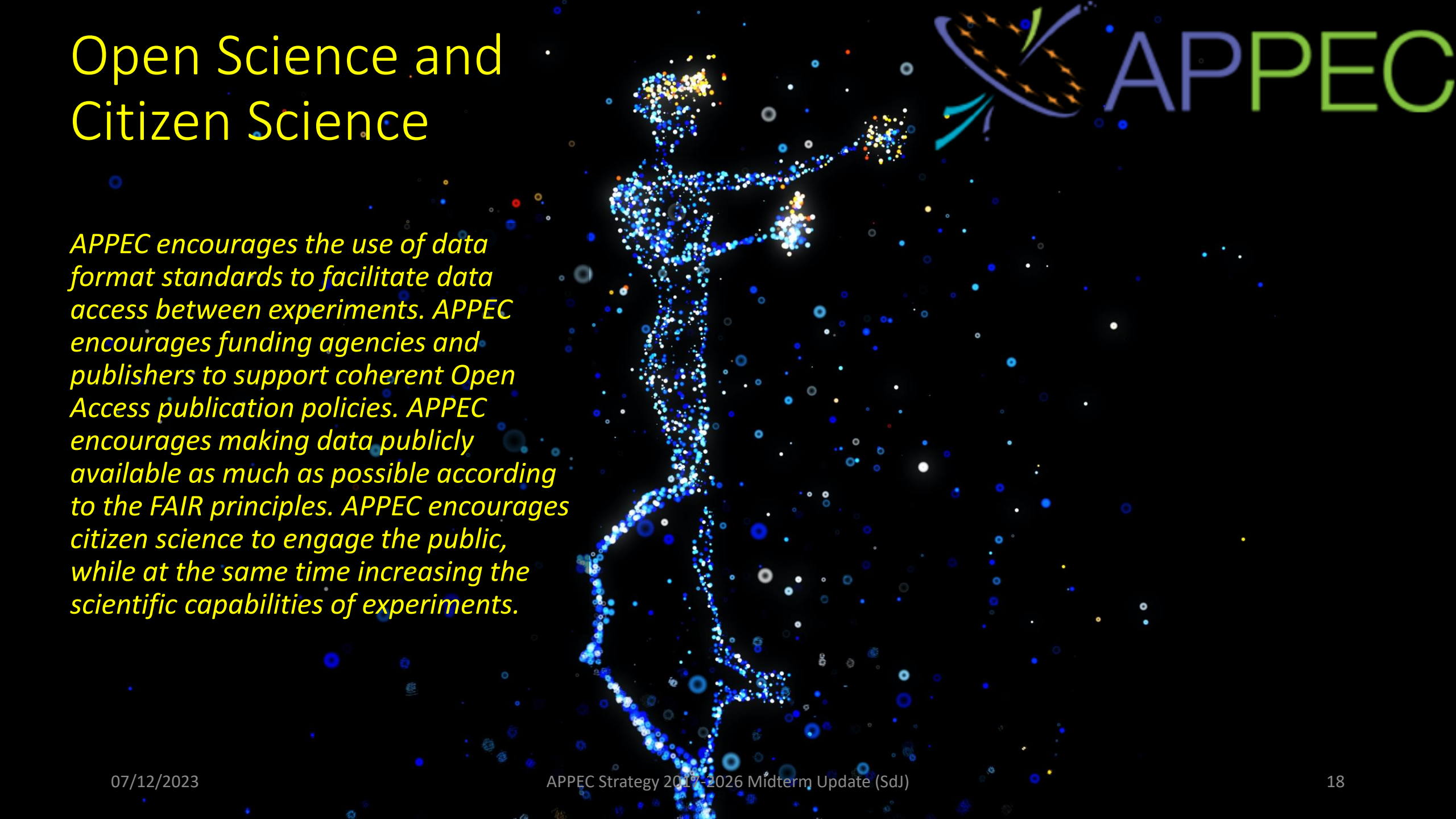
APPEC encourages experiments to assess their ecological impact and report their findings publicly and to mitigate the adverse ecological impact as much as possible. APPEC recommends keeping travel to a minimum and using smart computing strategies to minimise the use of computer resources. APPEC encourages the monitoring of environmental parameters where possible and the application of R&D results to mitigate the ecological impact in general.

Societal Impact

APPEC encourages experiments to continue to seek applications for their work which will benefit the wider society. APPEC also encourages the integration of astroparticle physics into science curricula, not only at the university but also in schools. APPEC encourages knowledge transfer to industrial partners.

Open Science and Citizen Science

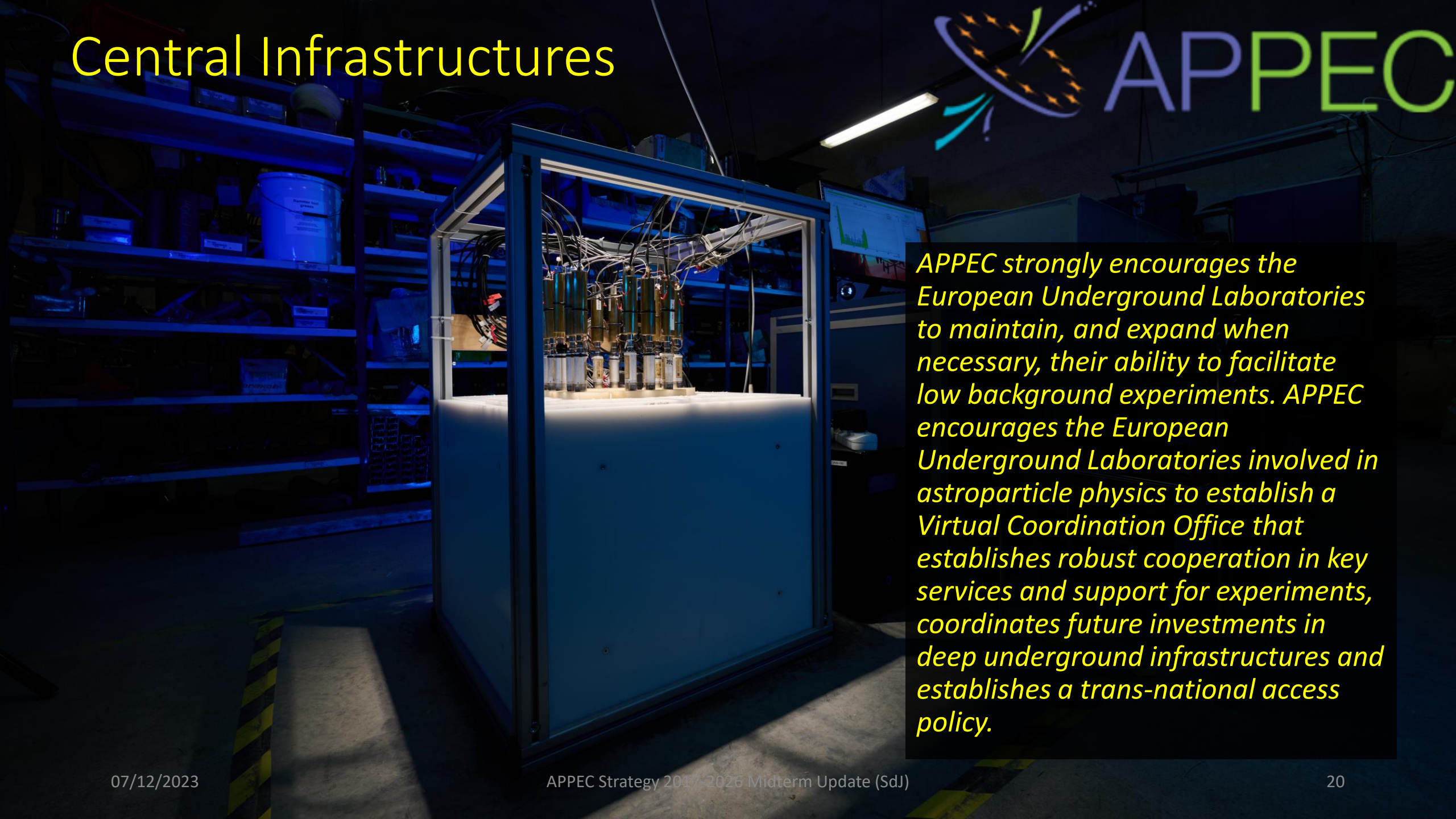
APPEC encourages the use of data format standards to facilitate data access between experiments. APPEC encourages funding agencies and publishers to support coherent Open Access publication policies. APPEC encourages making data publicly available as much as possible according to the FAIR principles. APPEC encourages citizen science to engage the public, while at the same time increasing the scientific capabilities of experiments.



Human Talent Management

APPEC insists that the scientific community follows the APPEC, ECFA and NuPECC diversity charter. This charter should be updated following the latest insights into diversity, equity and inclusion. APPEC encourages collaborations to establish a diversity charter and a code of conduct. APPEC calls on all astroparticle physicists to apply transparent criteria for grant applications and career advancement, valuing the various aspects of talent appropriately.

Central Infrastructures



APPEC strongly encourages the European Underground Laboratories to maintain, and expand when necessary, their ability to facilitate low background experiments. APPEC encourages the European Underground Laboratories involved in astroparticle physics to establish a Virtual Coordination Office that establishes robust cooperation in key services and support for experiments, coordinates future investments in deep underground infrastructures and establishes a trans-national access policy.

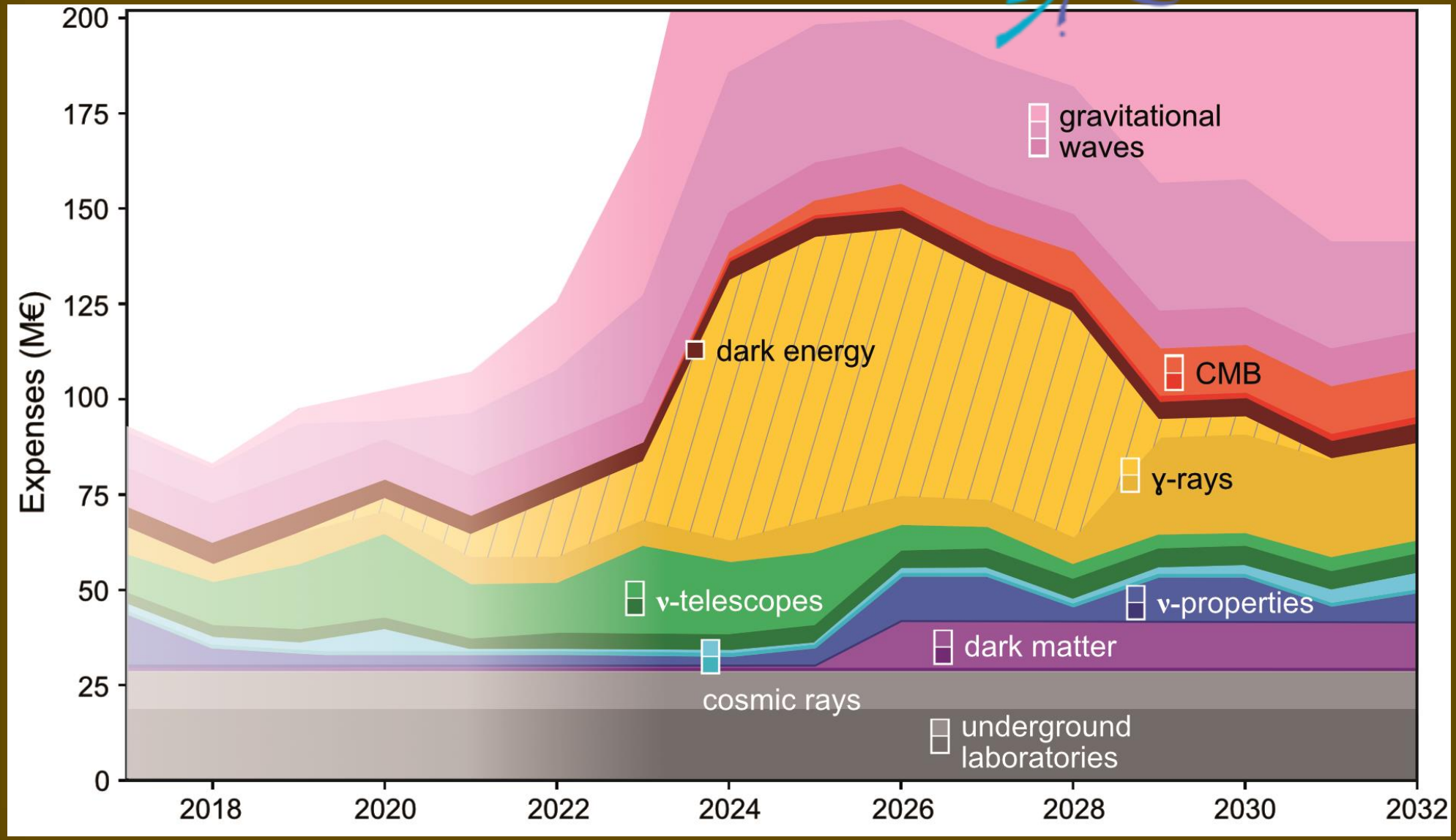
European and Global Cooperation

APPEC will continue to seek collaboration and coordination with its global partners — scientists, funding agencies and society — to advance the design, construction, sustainable use and governance of the next generation of large-scale, world-class research infrastructures to make the scientific discoveries we all dream of.

Interdisciplinary Opportunities

APPEC will continue interdisciplinary workshops and foster interdisciplinary access to its entire research infrastructure, both in academia and with industry.

Resources


Expenses (M€)
200
175
150
125
100
75
50
25
0
2018
2020
2022
2024
2026
2028
2030
2032
gravitational waves
dark energy
CMB
γ-rays
ν-telescopes
ν-properties
dark matter
cosmic rays
underground laboratories

Towards European Astroparticle Physics Strategy 2027-2036

- Living in rapidly changing times
  - Progress in AstroParticle Physics and bordering fields, particle physics, nuclear physics, astronomy
  - The AstroParticle Physics Community needs constant nurturing
  - Society is also changing rapidly AstroParticle Physics (Science) is no longer an island or ivory tower
- Process leading up to the next strategy will develop in 2025 and 2026