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L IMPF & XV CPAN days

Progress report on the Astroparticle Physics European Consortium



AstroParticle Physics European Consortium - APPEC

APPEC was created in 2012. It emanated from the [Astroparticle Physics European Coordination](#) committee founded in 2001 and operates under the same acronym. APPEC is the outcome of a decade of preparatory work by a consortium of representatives from ministries and agencies, and of intense preparatory work provided by the EU-funded ERANETs, ASPERA and ASPERA-2 (2006-2012).

Strategic Objectives

Provide a [discussion forum](#) for the coordination of European Astroparticle Physics and express [collective views](#) on astroparticle physics in international fora.

Develop and update [long term strategies](#) and participate in European scientific strategy such as the European Strategy Session of CERN Council and ESFRI.

Develop [closer relationships](#) with organizations involved in Astroparticle Physics research such as CERN, ESA, ESO.



APPEC Structure

General Assembly

Strategic, decision-making and supervisory body

Representatives: directors of major institutes or agencies or managers of AP programs (18 countries)

AEI, Pilar Hernández Gamazo **LSC**, Carlos Peña Garay

Joint Secretariat

Executive body

Representatives: heads of functional centers (10 institutions)

LSC, Carlos Peña Garay

Scientific Advisory Committee

Examines and reports on strategic scientific programs

Topics: CRs, DM, HE photons, Neutrinos (Properties, Mass, UHE), GWs, Theory, DE, CMB,



European Astroparticle Physics Strategy 2017-2026

APPEC strategy report (20 agencies in 16 countries) made **21 recommendations** spanning scientific issues, organizational aspects and societal factors.

APPEC has recently approved the **Mid-Term Update** of the current Strategy, to be widely publicized in the next APPEC General Assembly meeting (December 7-8) in Brussels.

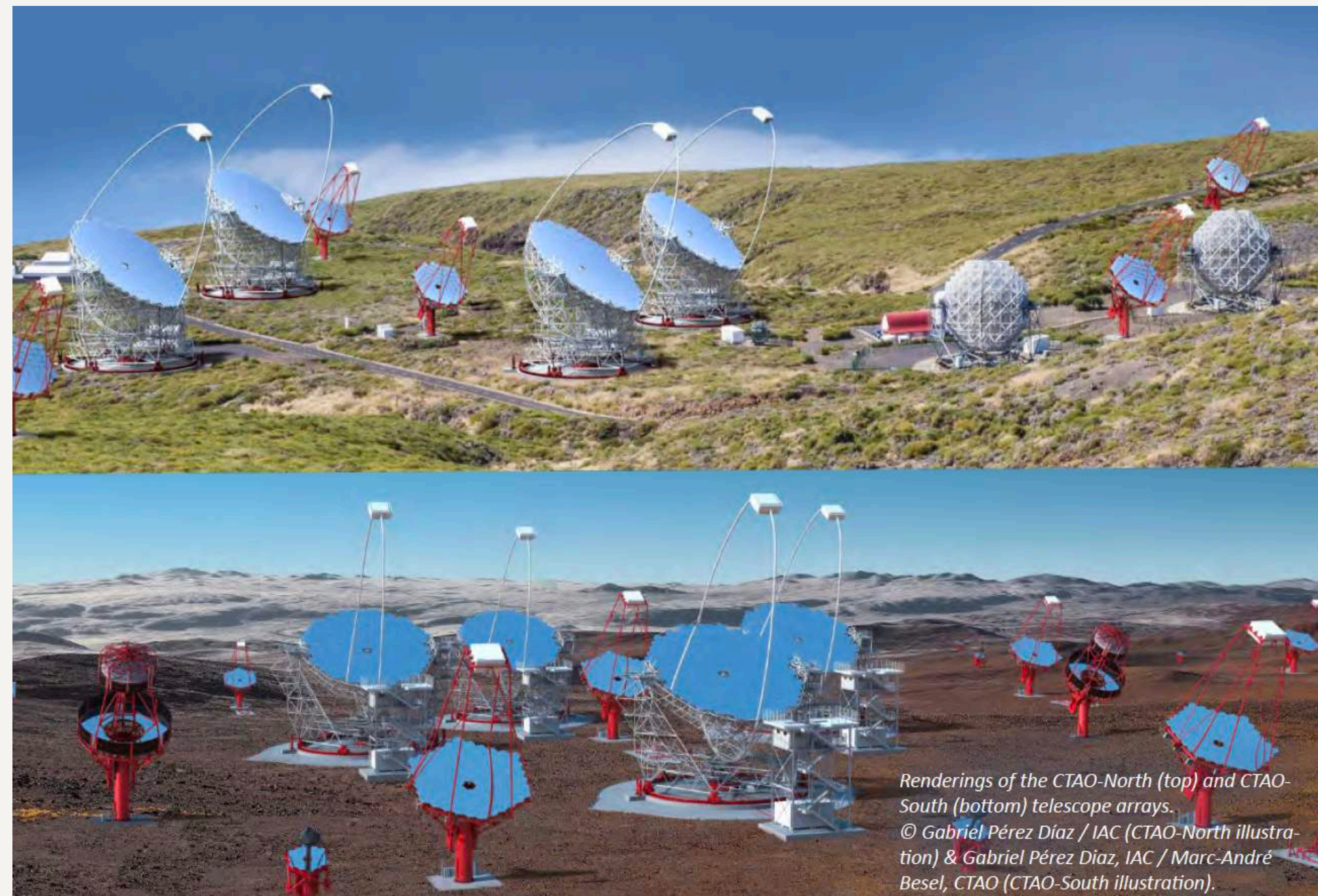
Written by SAC with community feedback and revised in town meeting (Berlin '22). Approved by GA in Warsaw (June '23)





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 **SWGGO**. It urges the community to consider a replacement for the Fermi telescope.

APPEC fully **endorses** the goal of the **KM3NeT** collaboration to complete the construction of the large-volume telescope optimized 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.



Renderings of the CTAO-North (top) and CTAO-South (bottom) telescope arrays.
© Gabriel Pérez Díaz / IAC (CTAO-North illustration) & Gabriel Pérez Díaz, IAC / Marc-André Besel, CTAO (CTAO-South illustration).

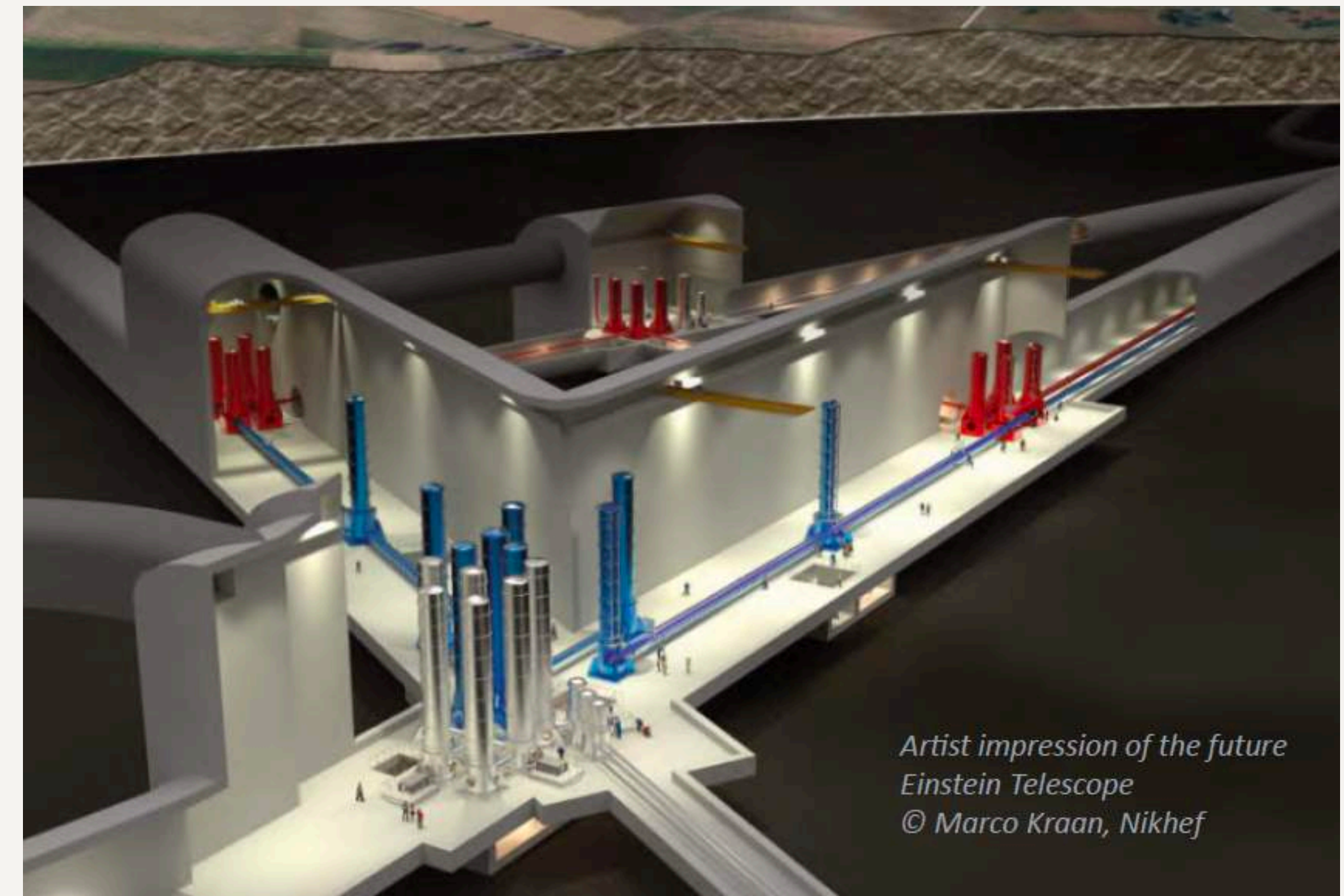


View from inside a detector building block of KM3NeT detection units. Clearly visible the yellow buoy of a near by detection unit.
© Edward Berbee / Nikhef / Courtesy of KM3NeT



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.

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**.





APPEC **strongly supports** the European leadership role in Dark Matter direct detection, underpinned by the pioneering LNGS program, to realize 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 time scale for WIMP searches for the widest possible mass range.

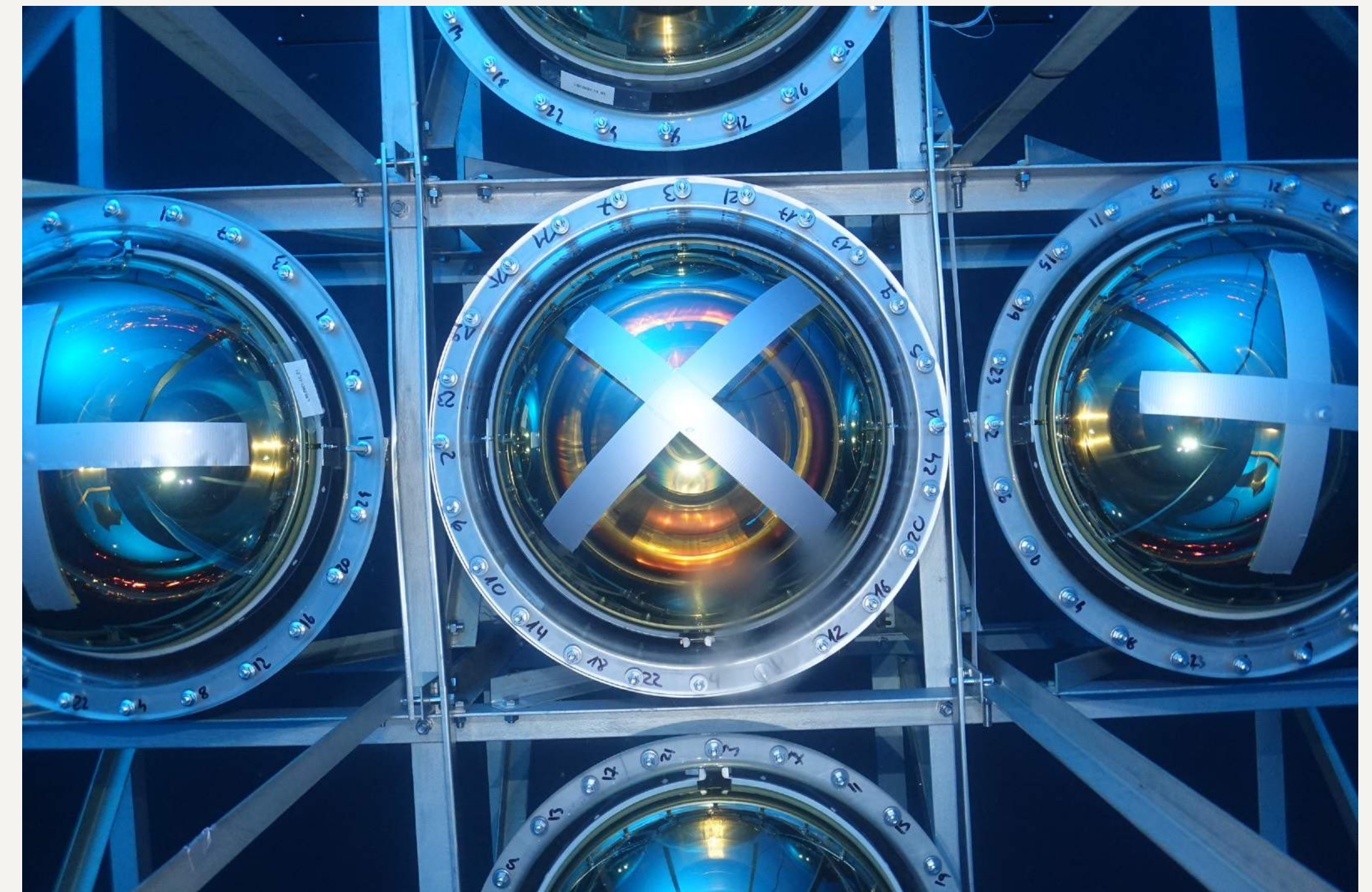
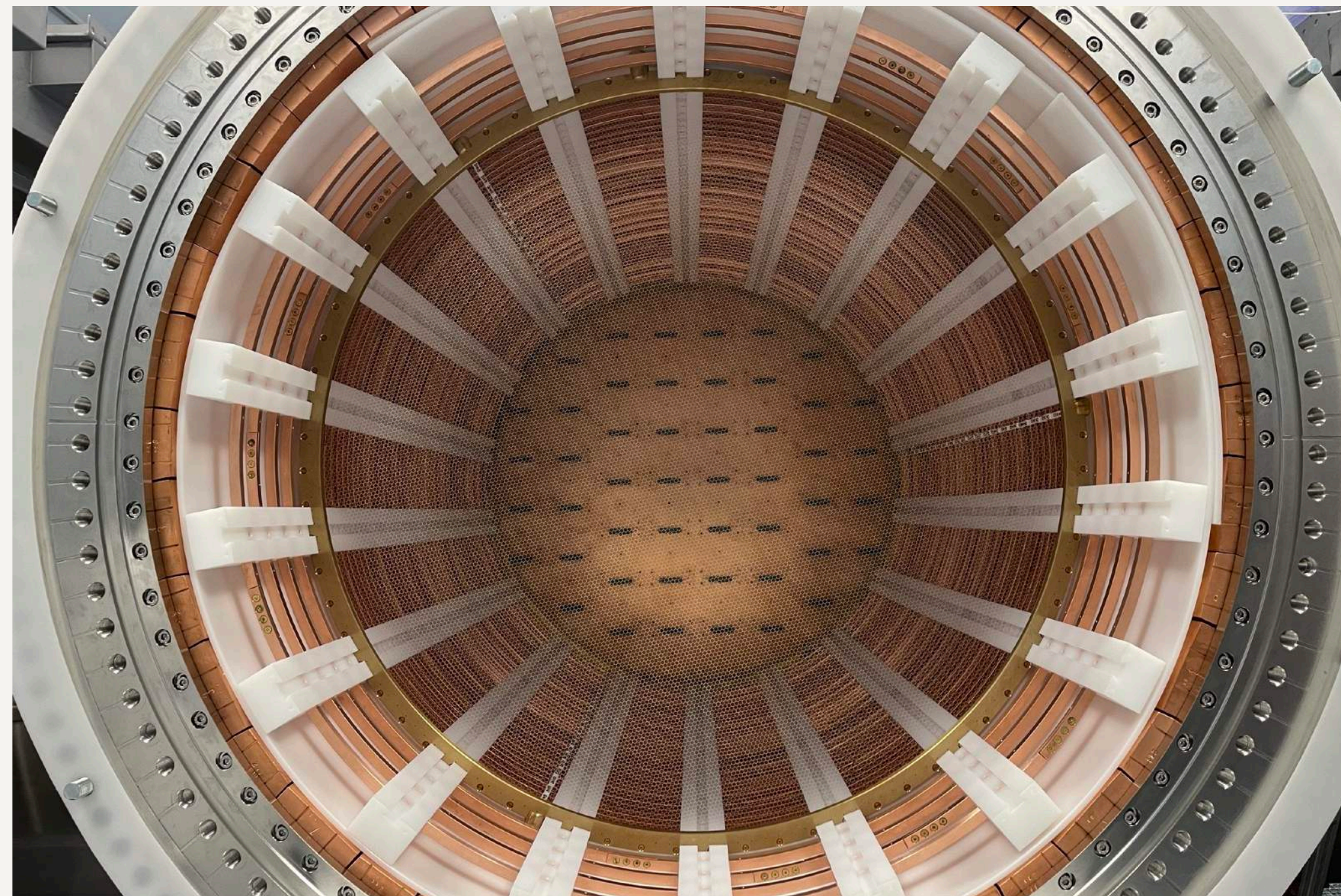
APPEC **supports** the unique European-led **efforts for axions** and ALPs detection in mass ranges complementary to the established cavity approach. APPEC **encourages R&D** efforts to improve experimental sensitivity and extend the accessible mass range.





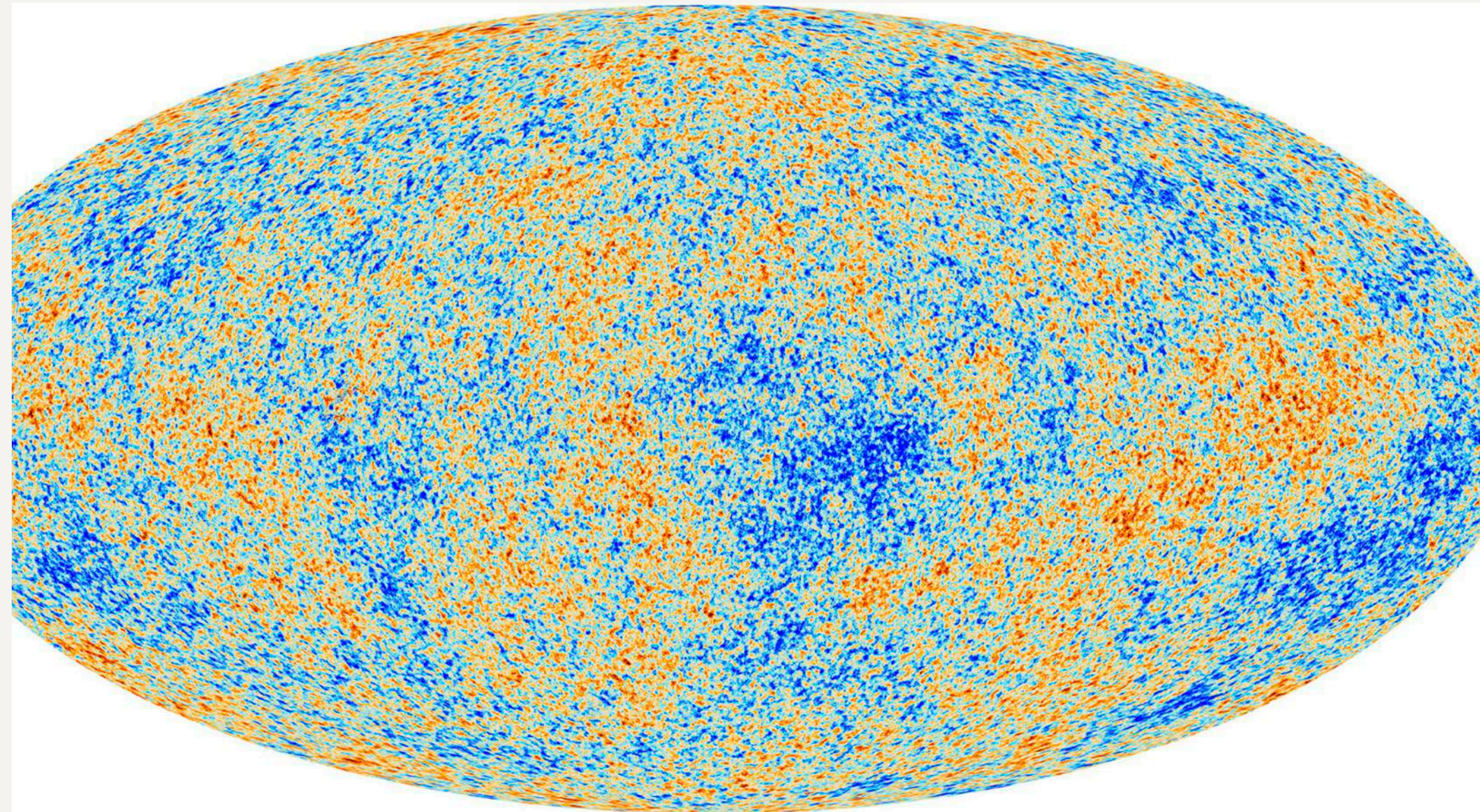
APPEC **strongly supports** the **CUPID** and **LEGEND 1000** double-beta decay experiments selected in the US-European process and **endorses** the development of **NEXT**. APPEC **strongly supports** fully exploiting the potential of the **KATRIN** direct neutrino mass measurement and the development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

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.



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.

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.





APPEC **supports** the further development and coordination of optimized **multi-messenger** observational strategies, common tools and data formats. **Optimizing** 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.

APPEC fully **supports** an ambitious **theory program** 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.



APPEC exclusively **supported** the Astrophysics Center for Multimessenger studies in Europe (ACME) proposal in HORIZON-INFRA-2023-SERV-01-02 call (12-14.5 M€)

“Better access to RI services to advance frontier knowledge”



The European Consortium for Astroparticle Theory

126 European Institutions



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 programs**. 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.

APPEC **requests** all relevant experiments to continue to have their **computing requirements scrutinized**. 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.

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 minimize 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.

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.



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.

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 transnational access policy.

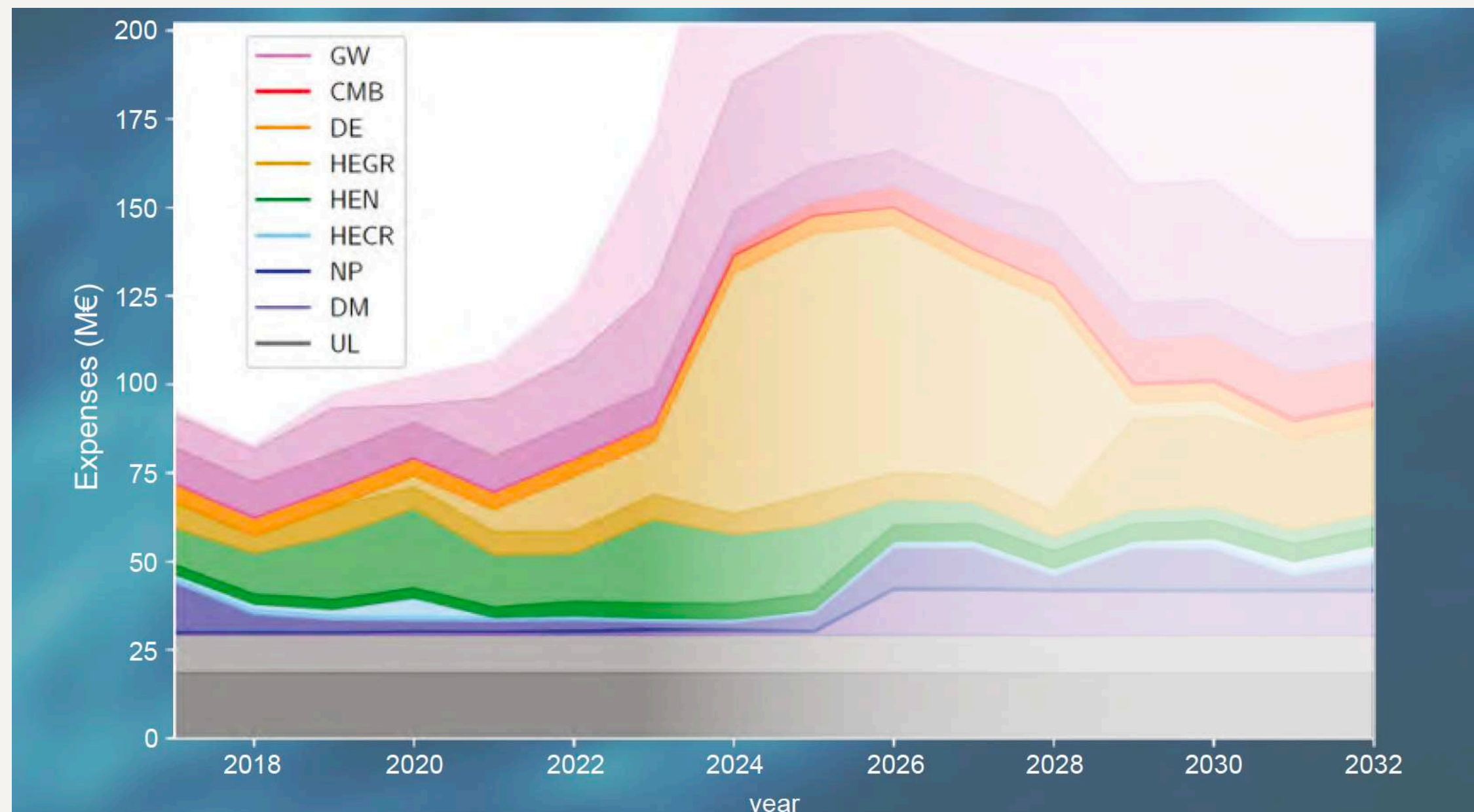
APPEC will **continue** to seek **collaboration** and **coordination** with its global partners —scientists, funding agencies and society— to advance the design, construction, sustainable use and governance of the next generation of large-scale, world-class research infrastructures to make the scientific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

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



The major astroparticle physics experiments and labs have been asked to provide information through a questionnaire to update the expected annual investment and exploitation costs. For the coming years, a major increment can be observed. This is mainly due to two facts:

- The investment in CTA (mostly secured) has been delayed and is foreseen to catching up in the coming years, resulting in a bulge in the investment for the years 2023 to 2029. The exploitation budget for CTA has now also been carefully estimated and is a major expense from 2029 onwards.
- The second new fact is the Einstein Telescope (not secured), for which major work has been done on costing. With a total planned investment budget of 1.8 B€, a large fraction of the investments will have to come from exceptional resources, such as European, regional, and national investment funds, not primarily targeted to fundamental science.



Estimate of realised and planned investment and exploitation expenditures in Astroparticle Physics.
 The division of the APP sub-fields is
 UL: underground laboratories
 DM: Dark Matter experiments
 NP: Neutrino Properties experiments
 HEGR: High-Energy Cosmic Ray Observatories
 HEN: High-Energy Neutrino observatories
 HEGR: High-Energy Gamma Ray observatories and satellite missions
 DE: Dark-Energy observatories and satellite missions
 CMB: Cosmic Microwave Background observatories and satellite missions
 GW: Gravitational Wave observatories and satellite missions.

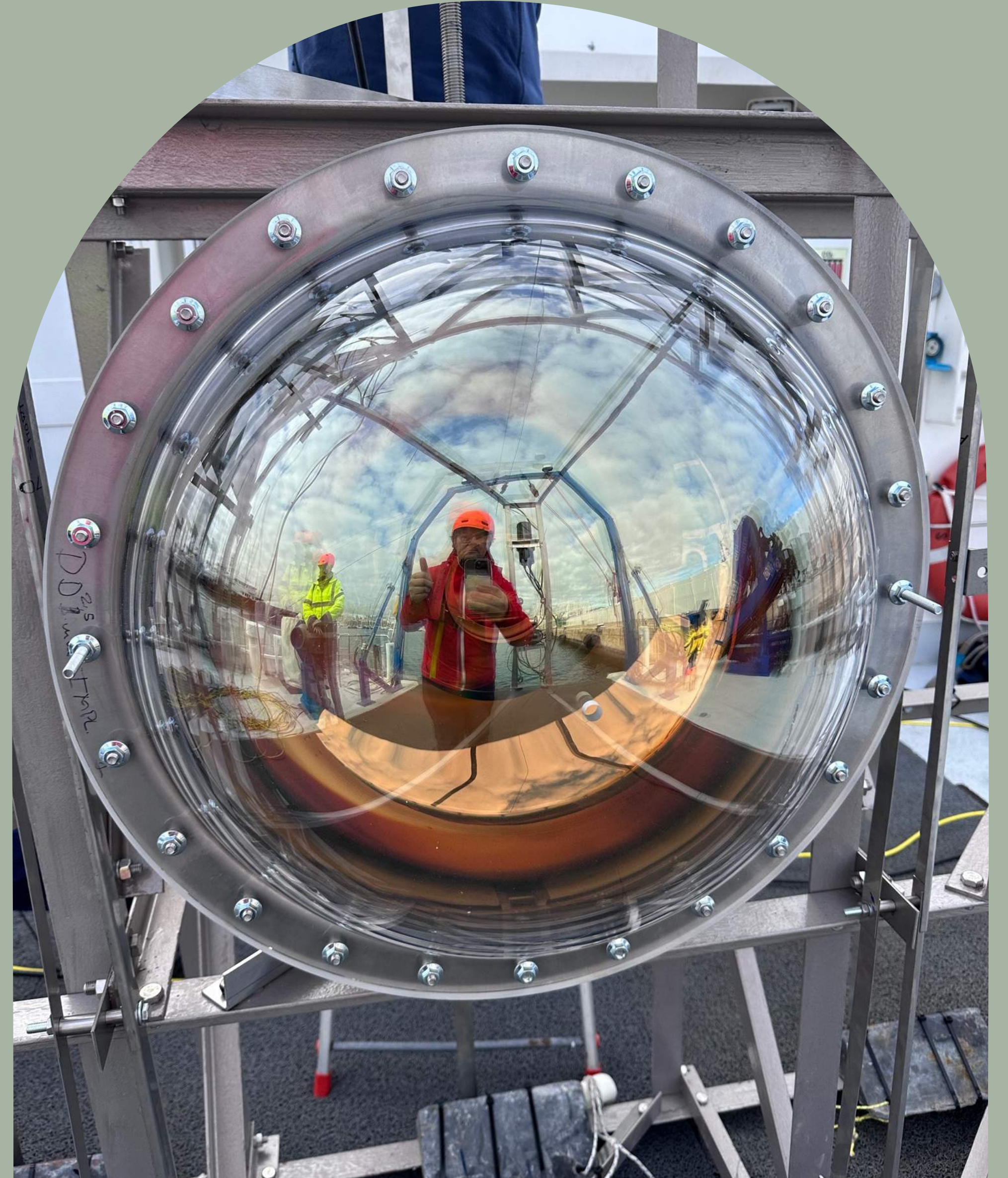


Mid-term update shows some [significant updates](#) of the strategy for a good number of topics. And the [pace](#) at which Astroparticle Physics research is moving [will likely accelerate](#) in the next few years.

In addition to the scientific progress that will change our perspective, [society](#) at large, of which the Astroparticle Physics community is part, [is changing](#).

For all these reasons, a [new APPEC Astroparticle Physics Strategy](#) from 2027 onwards will likely not be business as usual. It will require yet another thorough discussion in our community, which should be held in the years [2025 and 2026](#) and be prepared before that time, [starting in 2024](#).

Laboratorio Subterráneo Canfranc



Stay tuned to contribute to the next

APPEC Strategy Plan 2027-2036