

**Round Table at the XVII Int. Workshop on  
Neutrino Telescopes, Venice, 13-17 March 2017**

**Multi-messenger and neutrino physics in  
the new APPEC roadmap**

**Antonio Masiero**

**Chair of APPEC**

# Astroparticle Physics in Europe

Many of the next-generation astroparticle physics research infrastructures require **substantial capital investment** and for Europe to remain competitive in this rapidly evolving global research field – on the ground as well as in space – a clear, collective and ***resource aware strategy is essential.***

As opposed to its progenitors, as a relatively new field European astroparticle physics does **not** profit from a natural and strong inter-governmental organisation like CERN, ESO and ESA to drive the field

# APPEC

This is why in 2001 European scientific agencies founded APPEC (Astroparticle Physics European **COORDINATION**). Since 2012, **APPEC – Astroparticle Physics European Consortium** – operates on the basis of a Memorandum of Understanding with as overarching aim to strengthen European astroparticle physics.

Apart from the promotion of cooperation and coordination, a crucial APPEC activity is to formulate, update and realize the **European astroparticle physics strategy**.

# APPEC: *organisation*

S. KATSANEVAS at the  
IN2P3 CS, Feb. 2-3, 2017

*AstroParticle Physics European Consortium*

## GENERAL ASSEMBLY

*Chair: A. Masiero (INFN)*

*General Secretary: Job De Kleuver (FOM)*

## APPEC *functional centers*



**APC - Paris/F**

Roadmapping, Common Calls, Interdisciplinary



**DESY - Hamburg/D**

Management, Computing & Industry



**LNGS - L'Aquila/I**

Networking, Theory, Graduate Schools

Coordination 2001-2006

ASPERA 2006-2012

Consortium 2012-....



Outreach, Web pages

**STFC – Swindon/UK**

**Scientific**

**Advisory** + CERN

**Committee** ESO

# APPEC: *roadmapping*



From the  
Nature article

2008



2011



## **Magnificent 7**

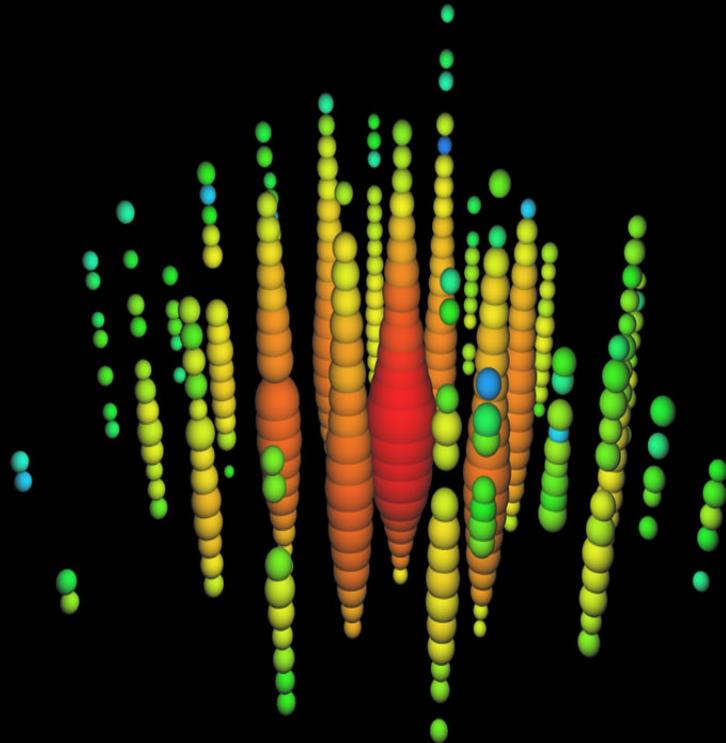
1. **HE gammas**
  2. **HE neutrinos**
  3. **HE cosmic rays**
  4. **Gravitational waves**
  5. **Dark matter**
  6.  **$\nu$ -mass**
  7.  **$\nu$ -mixing &  $p$ -decay**
- CMB**  
**Dark Energy**

S. Katsanevas

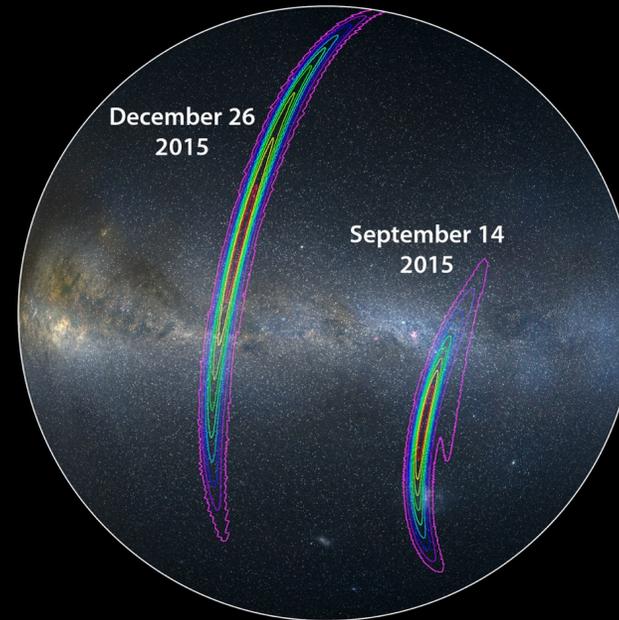
**nasty comment:** *But... at least 4 -5 domains have not seen a signal yet*

Well 2 of the domains have detected a signal in the first 3 years

## PeV neutrinos 2013



## GW1509-2014



The search of point sources for HE cosmic-rays, neutrinos and GW (better pointing) ongoing



# APPEC Roadmap: the priorities of the first European “decadal survey” and its mid-decadal update

S. Katsanevas

- **2011 The first APPEC priority roadmap:**
  - I. Complete the upgrades:
    - ✓ Adv. Gravitational Wave antennas
    - ✓ Underground Science a (1 ton Dark Matter)
    - Underground Science b (1 ton  $\nu$ less $2\beta$  decay )
  - II. Prepare construction of large CR programs:
    - ✓ CTA (TGIR)
    - KM3Net/IceCube (→ ESFRI, IR FdR France)
    - AUGER upgrade (→ upgrade TDR 2014)
  - III. Global coordination for very large projects:
    - Dark Energy (LSST-EUCLID → data sharing?)
    - Large neutrino detectors (APPEC global workshop → DUNE)
    - CMB (APPEC global workshop → DS CMB-S4 )
- **→ 2016 Roadmap “mid-decadal” “resource aware update**

First input  
asked to the  
SAC of  
APPEC:

\*A. Masiero (chair), Michal Ostrowski, Mauro Mezzetto, Gisela Anton, Laura Baudis, Jocelyn Monroe, Petr Tiniakov, Jo van den Brand, Patrick Sutton, Ramon Miquel, Zito Marco, Andrea Giuliani, Felix Aharonian, Pierre Binétruy, Ignatios Antoniadis, Yifang Wang, Francis Halzen, Hank Sobel, A. Haungs, S.Katsanevas (APPEC)

# APPEC: *roadmapping*

2008



2011



***HE universe***

***gammas***

***neutrinos***

***cosmic rays***

***gravitational waves***

***Dark universe***

***dark matter***

***dark energy***

***Early universe***

***CMB***

***$\nu$ -properties***

***mass, mixing, ...***

S. Katsanevas

# APPEC: *roadmapping*

S. Katsanevas

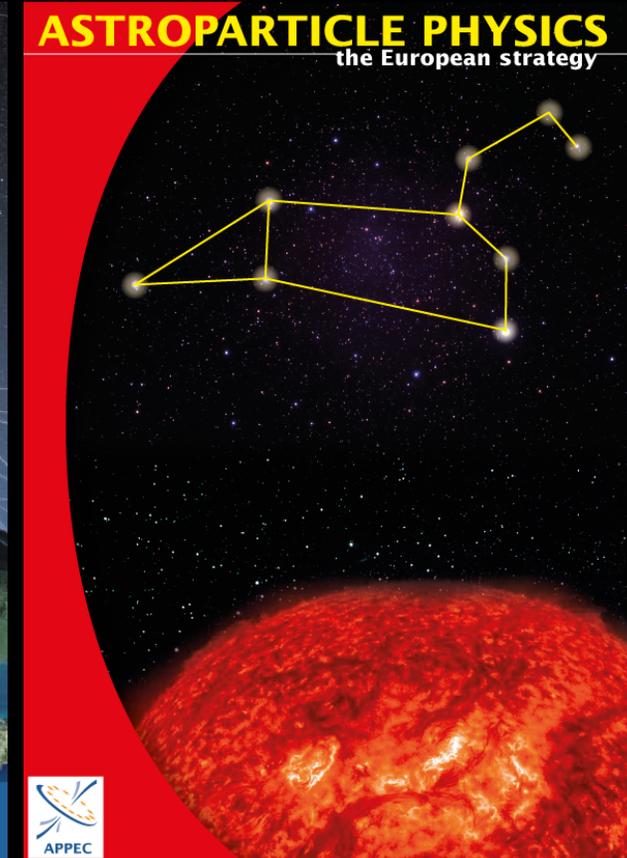
2008



2011



2017



*resource aware*

***HIGH ENERGY UNIVERSE SCIENCE***

**APPEC**

**RECOMMENDATIONS**

*APPEC fully supports the **CTA** collaboration in order to secure the funding for its timely, cost-effective **realisation** and the subsequent **long-term operation** of this observatory covering both **northern and southern hemispheres.***

*For the northern hemisphere (including Baikal GVD), APPEC strongly endorses the **KM3NeT** collaboration's ambitions to realise, by 2020: (i) a large-volume telescope with optimal angular resolution for **high-energy neutrino astronomy**; and (ii) a dedicated detector optimised for **low-energy neutrinos**, primarily aiming to resolve the neutrino mass hierarchy. For the southern hemisphere, APPEC looks forward to a positive decision in the US regarding **IceCube-Gen2**.*

*APPEC strongly supports the **Auger** collaboration's installation of AugerPrime by 2019. At the same time, APPEC urges community to continue **R&D on alternative technologies** that are cost-effective and provide a 100% (day and night) duty cycle so that, ultimately, the full sky can be observed using very large observatories.*

*With its global partners and in consultation with the ‘Gravitational Wave International Committee’ (**GWIC**), APPEC will define timelines for upgrades of existing as well as next-generation ground-based interferometers. APPEC strongly supports **further actions strengthening the collaboration between gravitational-wave laboratories**. It also strongly supports Europe’s next-generation ground-based interferometer, the ‘**Einstein Telescope**’ (ET) project, in developing the required technology and acquiring ESFRI status. In the field of space-based interferometry, APPEC strongly supports the European **LISA** proposal.*

# *NEUTRINO PHYSICS*

## **APPEC RECOMMENDATIONS**

*APPEC strongly supports the present range of **direct neutrino-mass measurements** and **searches for neutrinoless double-beta decay**. Guided by the results of running experiments and in consultation with its global partners, APPEC intends to converge on a **roadmap for the next generation of experiments into neutrino mass and nature by 2020***

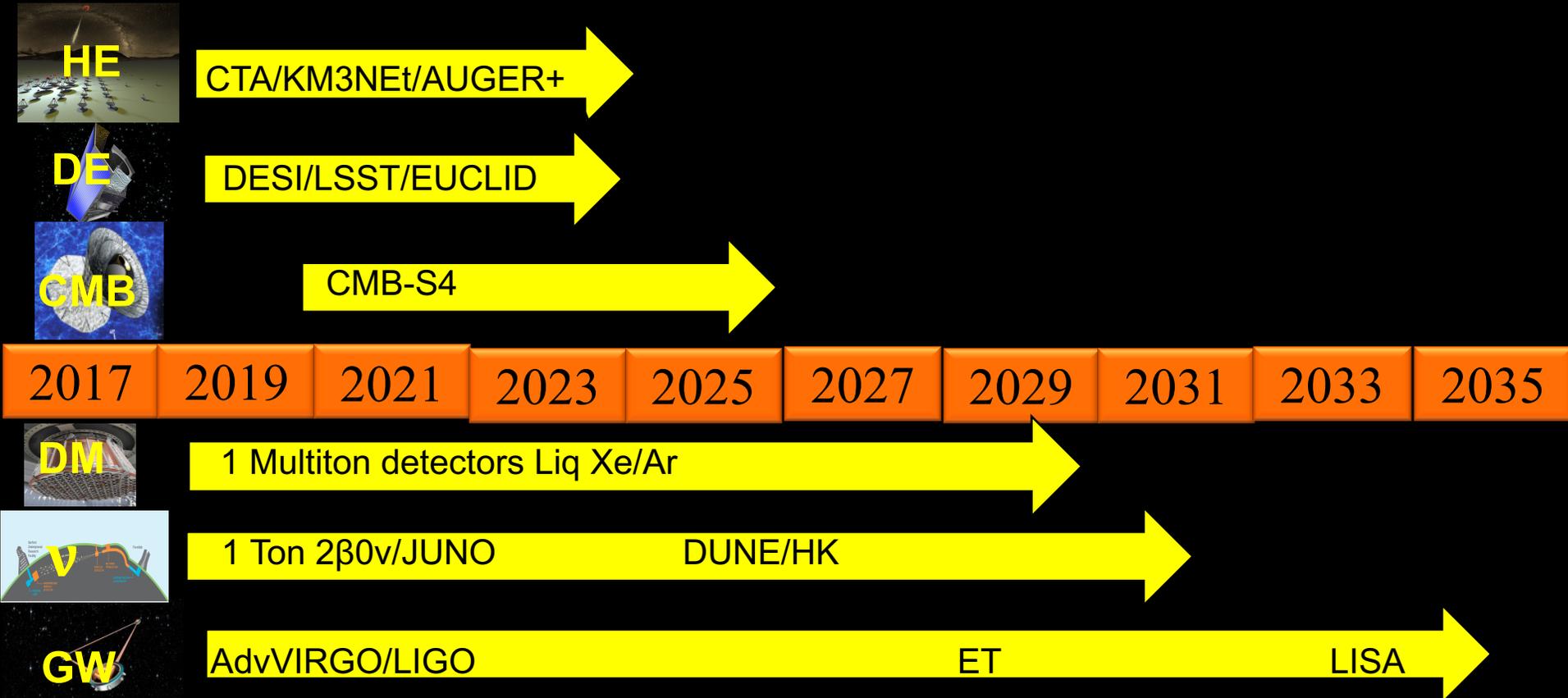
*From a scientific perspective and as part of a global strategy, APPEC strongly endorses European participation in **DUNE** and **Hyper-Kamiokande** experiments - exploiting long baseline neutrino beam facilities - as well as in the **JUNO** nuclear reactor neutrino experiment.*

# Challenges for next DM, $\beta\beta$ frontiers; Challenges for LNGS

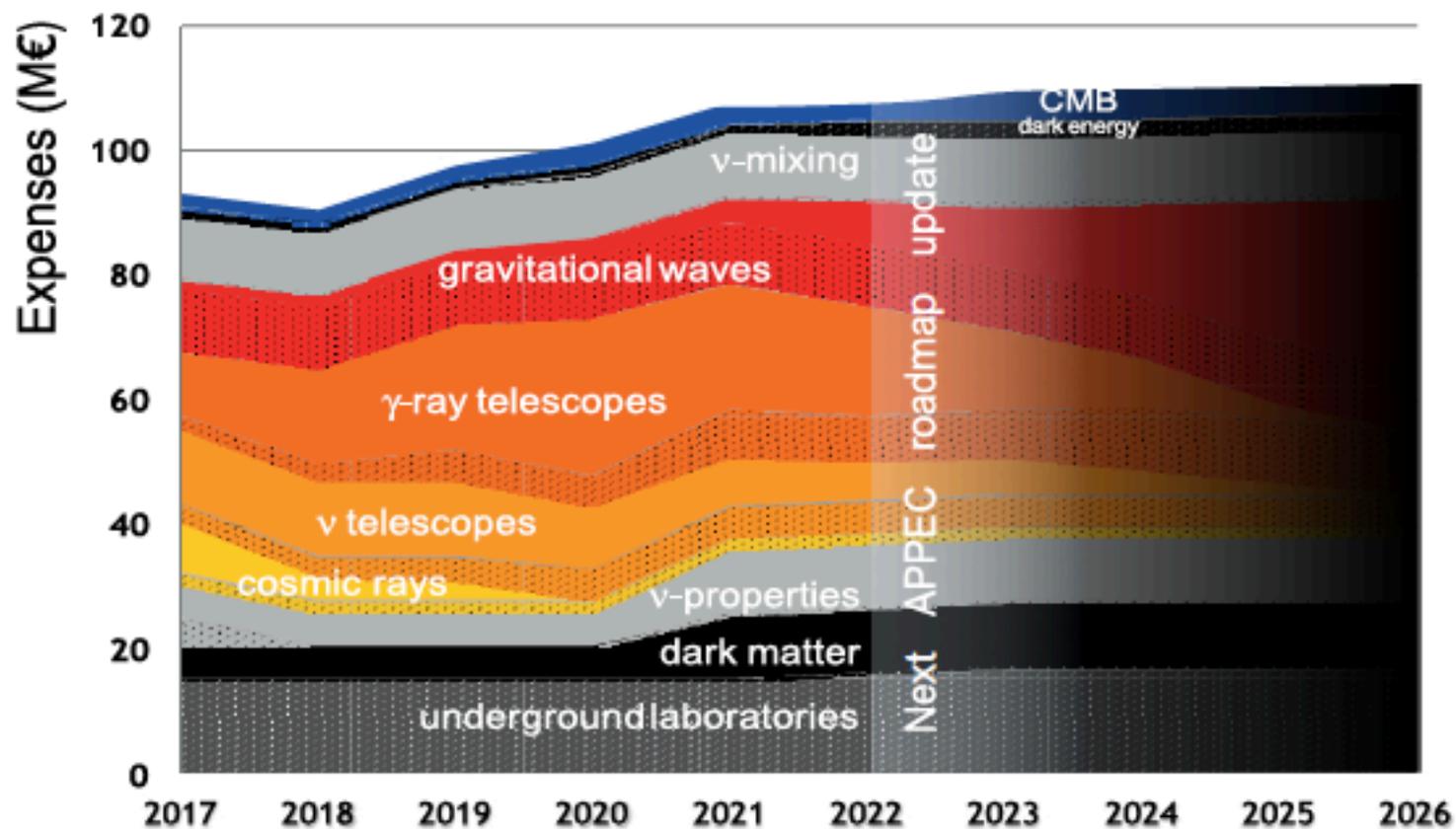
- Attack and cover the IH region  $\rightarrow$  1-ton neutrinoless  $\beta\beta$
- WIMPS DM : Reach the neutrino background  $\rightarrow$  n-ton exps. n= 20, 50 ?

**Need for GLOBAL COORDINATION**

# Astroparticle Physics and Cosmology the next 20 years



# A resource aware roadmap



*Projected annual capital investment – instrument prototyping and construction, excluding manpower – and annual running costs – consumables and shift taking expenses i.e. travel and manpower (shaded areas) – anticipated from the European astroparticle physics funding agencies required to realize the APPEC European Strategy for Astroparticle Physics. Costs related to the actual scientific exploitation are not considered in this projection. Also excluded from this projection are other, often substantial, contributions from regional and EU structural funds, from European astronomy, from European particle physics (DUNE) and contributions from our non-European partners (in particular large  $\nu$ -mixing infrastructures).*

**on the crucial synergy** **THEORY-EXPERIMENT**

*APPEC 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 encourages the establishment of a **centre for astroparticle physics theory** in one of its member countries.*

# DETECTORS 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** such as achieved by SENSE for low-level light-sensor technologies. APPEC welcomes the ATTRACT initiative, which aims to accelerate development of particle-radiation detector and imaging technologies for the science community and for the wider market*

# Computing and Data policies

*APPEC requests all relevant experiments to have their **computing requirements** scrutinised. APPEC will engage with the particle physics and astronomy communities (e.g. within the context of EU-T0) to secure for the future a balance between available European computing resources and needs. Furthermore, APPEC encourages the use of **data format standards to facilitate data access between experiments**. APPEC supports the transition to Open Access publication strategies and encourages the making of data publicly available (i.e. as 'open data') to foster 'citizen science', for example.*

# Global Collaboration and Coordination

*APPEC will continue to seek collaboration and coordination with its partners **worldwide** – scientists and funding agencies – to advance the **design, construction, sustainable exploitation** (including computing needs) and **governance** of the **next-generation world-class large research infrastructures** required to achieve the scientific discoveries of which we all dream.*