Institut national de physique nucléaire et de physique des particules

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French contributions and challenges in large astroparticle physics projects @*FCC Week*

IN2P3

Berrie Giebels IN2P3-CNRS

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Astroparticle & Cosmological Physics

Challenge #1 – Define Astroparticle Physics..

HELMHOLTZ ASSOCIATION
Alliance for Astroparticle Physics

Helmholtz Alliance for Astroparticle Physics

CONNECTING SMALLEST PARTICLES AND LARGEST STRUCTURES IN THE UNIVERSE

Commissione Scientifica Nazionale 2 (CSN2)

CSN2
Fisica delle Astroparticelle

Particle astrophysics

The Science and Technology Facilities Council particle astrophysics programme is helping to answer some of the fundamental questions of the Universe. It focuses on gravitational waves, gamma ray astronomy, neutrinos and the search for dark matter.

Partners involved: Science and Technology Facilities Council (STFC)

Show related funding opportunities

Open all

The scope and what we're doing

Programmes funded by STFC in particle astrophysics foc
gravitational waves, gamma ray astronomy, neutrinos an
These programmes aim to achieve STFC's science challe

Gravitational wave detectors offer an opportunity to see
perspective, opening up a new field of astrophysics. Dete
come from huge astronomical events, such as colliding black holes or supernovae. Investigating these events will provide information on pulsars, compact binaries, the origins of our Universe and provide an insight into the secrets of our Universe.

The Cherenkov Telescope Array will be a major step forward in sensitivity and precision for high energy gamma ray astronomy and will address key questions in astrophysics and fundamental physics.

Direct detection of dark matter is the subject of competing projects worldwide based on liquid-xenon and argon technologies. UK groups are positioned to participate in collaborations using either of these technologies. LUX ZEPLIN is a next-generation experiment to detect and study dark matter in the US.

APPEC

WG10: ASTROPARTICLE PHYSICS INTERNATIONAL COMMITTEE (APPIC)

WG10: Members | WG10: Reports | WG10: Conferences and Meetings

Working Group 10 (WG10), the Astroparticle Physics International Committee (ApPIC) was created by the International Union of Pure and Applied Physics in 2011 at the London, England General Assembly to review the scientific status of the field of Astroparticle Physics.

The Astroparticle Physics International Forum (APIF)

The Astroparticle Physics International Forum of the OECD Global Science Forum

The OECD Astroparticle Physics International Forum (APIF) brings together officials and representatives of funding agencies of countries that make significant investments in astroparticle physics research. It is a venue for information exchange, analysis, and coordination, with special emphasis on strengthening international cooperation, especially for large programmes and infrastructures. APIF members can address issues that are the special responsibility of funding agencies, for example, legal, administrative and managerial arrangements for international projects. They may also consider matters such as access to experimental facilities and data, procurement of essential materials, and optimal use of resources on a global scale. APIF is not a venue for discussing purely scientific matters, and it does not duplicate or replace established national and international processes for planning, prioritisation, funding, assessment or implementation of specific projects or programmes.

THE OECD GLOBAL SCIENCE FORUM

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Particle Physics Project Prioritization Panel (P5)

P5 Science Drivers in 2014:

- Use of the Higgs boson as a tool for further inquiry
- Investigation of the physics of neutrino mass
- Investigation of the physics of dark matter
- Investigation of the physics of dark energy and cosmic inflation
- Exploration of new particles, interactions, and physics principles

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Particle Physics Project Prioritization Panel (P5)

P5 Science Drivers in 2014:

- Use of the Higgs boson as a tool for further inquiry
- Investigation of the physics of neutrino mass
  → neutrino *nature (*through NDBD) in nuclear physics
  → includes measurement of Sigma mv with CMB (S4)
- Investigation of the physics of dark matter
  → direct, indirect & colliders
- Investigation of the physics of dark energy and cosmic inflation
  → DESI, LSST, S4,..
- Exploration of new particles, interactions, and physics principles

→ No GW physics..

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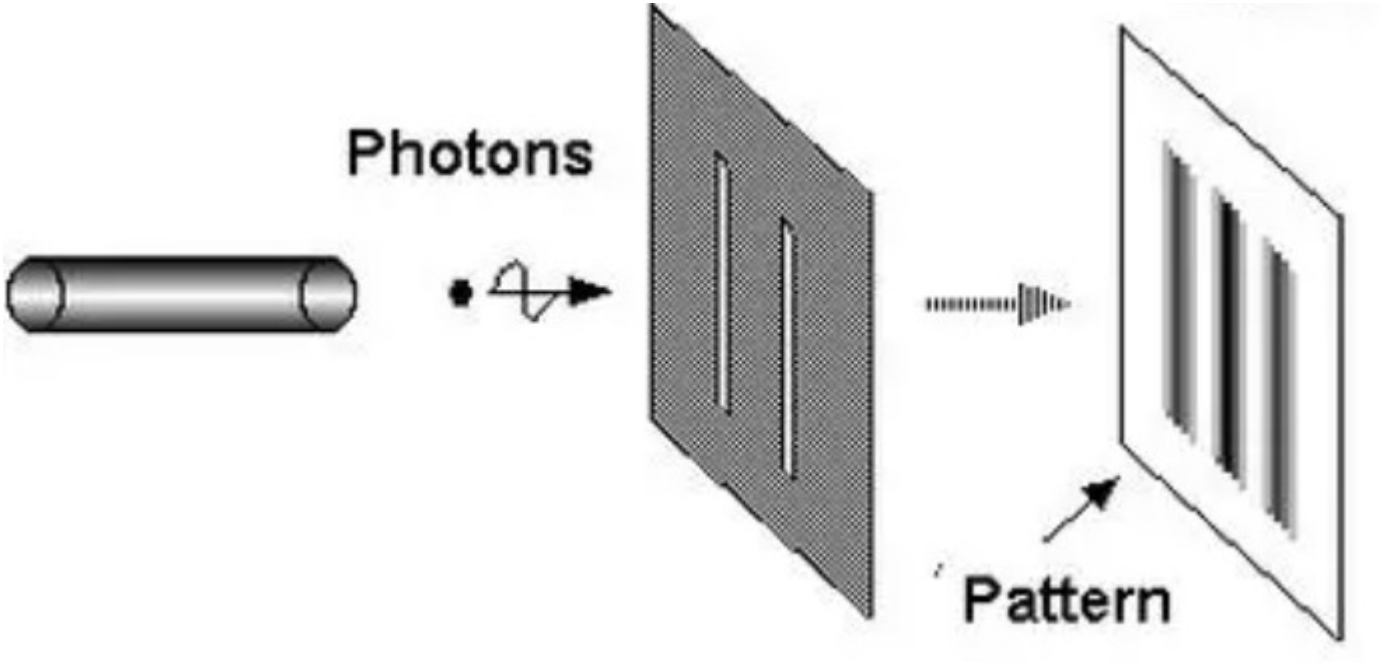
Is it particle physics?
Is it nuclear physics?
Is it (nuclear) astrophysics?
Cosmology ?...



Challenge #2 – Get On a RI Roadmap

(and stay there..)

- Fifth French national IR roadmap since 2008 organized by the ministry of research (and..)

  → *complimentarity* with 2021 ESFRI roadmap (used to be required)
  → *no space-based science*

- Provides a *quality* label for the 108 selected research infrastructures and the *recognition* of its national strategic importance

  → not *directly* related to funding

- Serves as *reference* document to

  - explicit the state's RI strategy

  - select and/or prioritize RI in arbitrations

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1. Astronomie et astrophysique
2. Biologie et santé
3. Énergie
4. Physique nucléaire et des hautes énergies
5. Les infrastructures de recherche en sciences humaines et sociales
6. Sciences de la matière et ingénierie
7. Sciences du numérique et mathématiques
8. Sciences du système Terre et de l'environnement
9. Services et infrastructures numériques

Astronomie et astrophysique		ESO	European Southern Observatory	OSI	ELT : ESFRI landmark
		ESO/ALMA	Atacama Large Millimeter/Submillimiter Array		
		SKAO	SKA Observatory	OSI	SKAO : ESFRI landmark
		CFHT	Canada-France-Hawaii Telescope	IR*	
	Physique nucléaire et des hautes énergies	CTA	Cherenkov Telescope Array	IR*	CTA : ESFRI landmark
		IRAM	Institut de RadioAstronomie Millimétrique	IR*	
		CDS	Centre de Données astronomiques de Strasbourg	IR	
	Physique nucléaire et des hautes énergies	HESS	High Energy Stereoscopic System	IR	
		Instrum-ESO	Instrumentation pour les grands télescopes de l'ESO	IR	
		LOFAR/NenuFar	International Low Frequency Radio Array Telescope – LOFAR FR	IR	
		PARADISE	Plateforme pour les Activités de Recherche Appliquée et de Développement en Instrumentation au Sol et Embarquée	IR	

Labelled RI must have:

- Identified governance, scientific steering
- Pluriannual budgeting
- Open science dynamic, data preservation

Physique nucléaire et des hautes énergies		CERN	Organisation Européenne pour la Recherche Nucléaire	OSI	
		CERN LHC	Large Hadron Collider	IR*	HL-LHC : ESFRI landmark
		DUNE / PIP-II	Deep Underground Neutrino Experiment / Proton Improvement Plan II	IR*	
	Astronomie et astrophysique	EGO-Virgo	European Gravitational Observatory - Virgo	IR*	
		FAIR	Facility for Antiproton and Ion Research	IR*	FAIR : ESFRI landmark
		GANIL-SPIRAL2	Grand Accélérateur National d'Ions Lourds – Système de Production d'Ions Radioactifs en Ligne de 2e génération	IR*	SPIRAL2 : ESFRI landmark
		AGATA	Advanced GAmma Tracking Array	IR	
		JUNO	Jiangmen Underground Neutrino Observatory	IR	
	Astronomie et astrophysique	KM3NeT	Kilometre Cube Neutrino Telescope	IR	KM3NeT : ESFRI project
		LSM	Laboratoire Souterrain de Modane	IR	
	Astronomie et astrophysique	LSST	Legacy Survey of Space and Time	IR	
	Astronomie et astrophysique	PAO	Pierre Auger Observatory	IR	
Services numériques (calcul et réseau)		GENCI	Grand Équipement National de Calcul Intensif	IR*	PRACE : ESFRI landmark
		RENATER	Groupement d'intérêt public pour le réseau national de communications électroniques pourla technologie, l'enseignement et la recherche	IR*	
	Physique Nucléaire et des Hautes Énergies	CC-IN2P3	Centre de Calcul de l'IN2P3	IR	
		CINES	Centre informatique national de l'enseignement supérieur	IR	
		France Grilles		IR	

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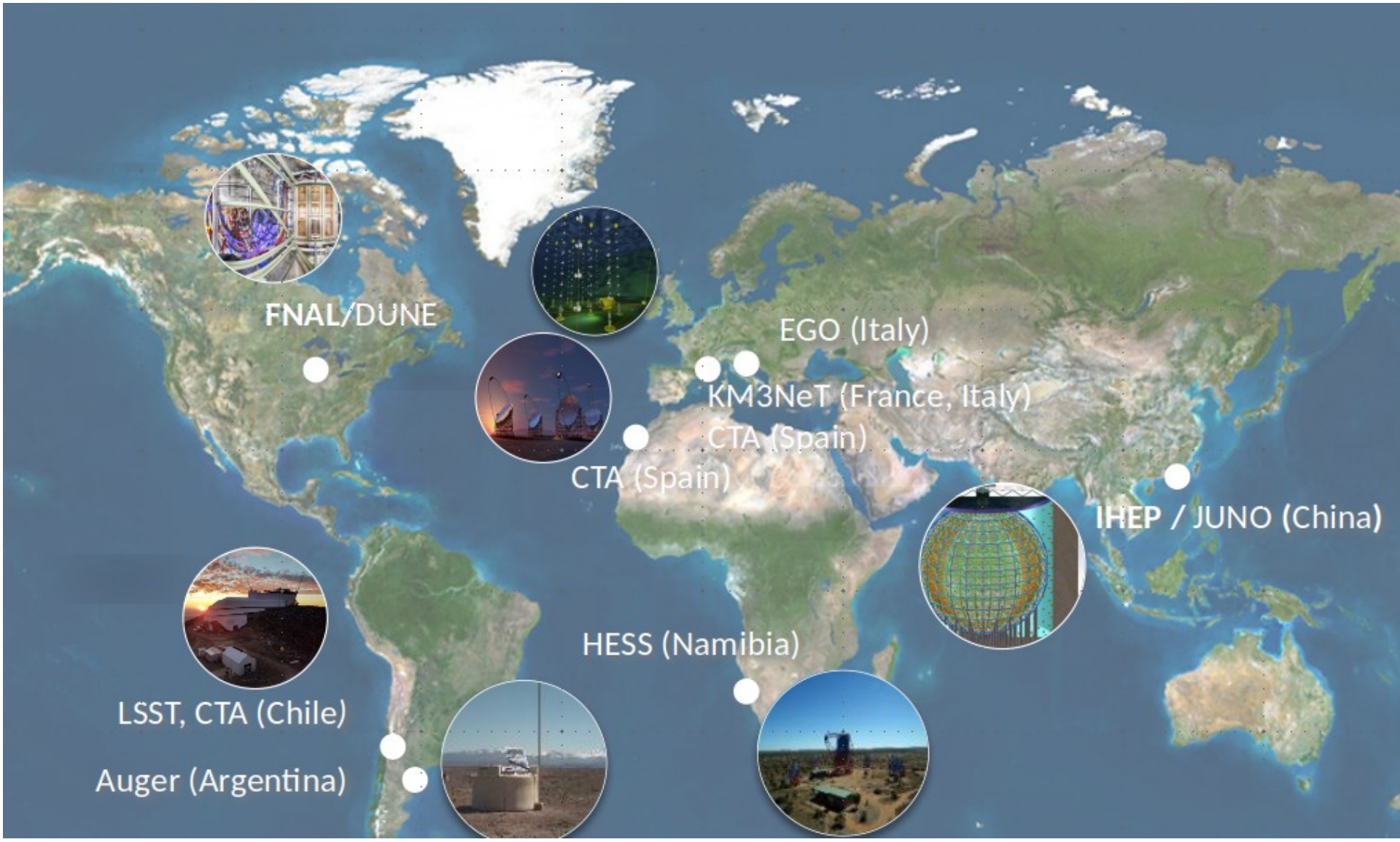

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APPEC projects in FRA roadmap:

HEP perimeter

- DUNE
- JUNO
- **EGO-Virgo**
- **KM3NeT**
- LSM
- LSST
- PAO

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A&A perimeter

- HESS
- **CTA**

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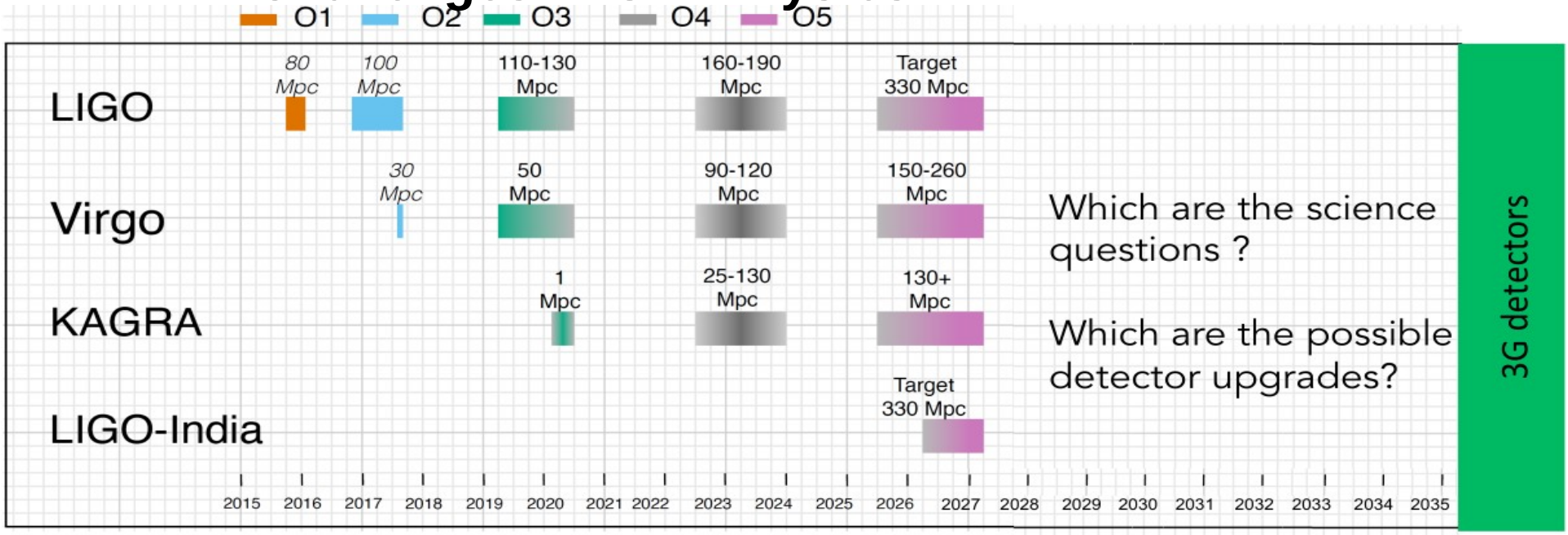
		France Grilles		IR	

A Large GW Physics project: EGO-Virgo

- A *competitive and successful* GW antenna in Europe

→ tremendous growth of the scientific Virgo int'l collaboration
→ strong cooperation with LIGO and KAGRA (VLKC)
→ 10 CNRS teams in FRA, 109 scientists, ~60 FTE tech+eng
→ ~10M€/yr opex, ~300M€ capex (50% ITA/FRA + NED)
→ FRA strenghts: Mirror coatings, electronics, vacuum, ..

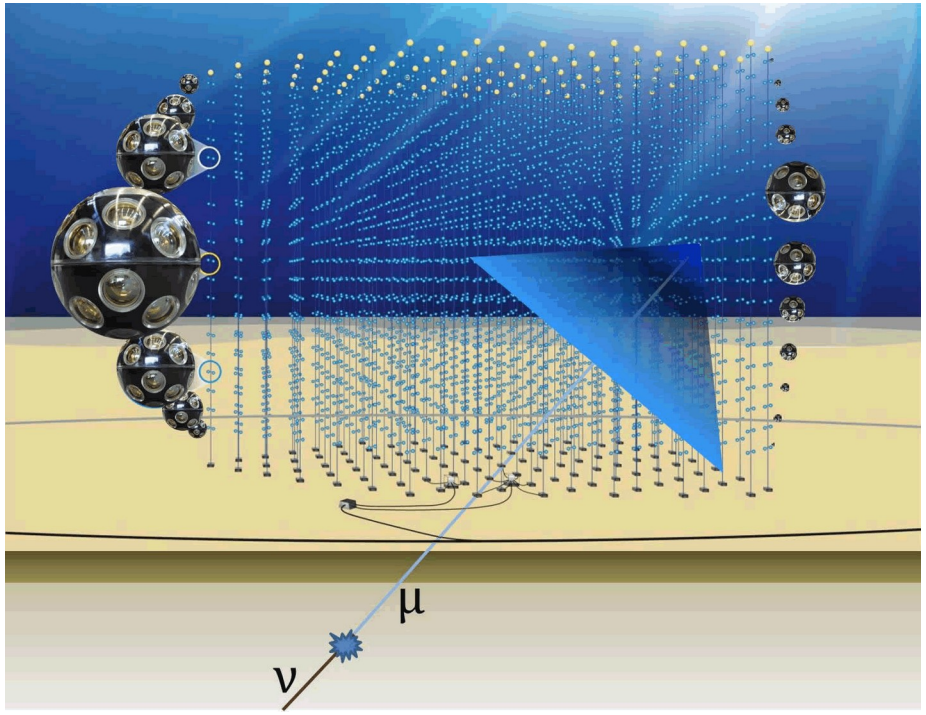
Challenges in GW Physics



- A *competitive and successful* GW antenna in Europe *until 3G*
  - → tremendous growth of the scientific Virgo (LVC) collaboration
  - → coordinated push to bring infrastructures to their boundaries
  - → right balance in international data openness..

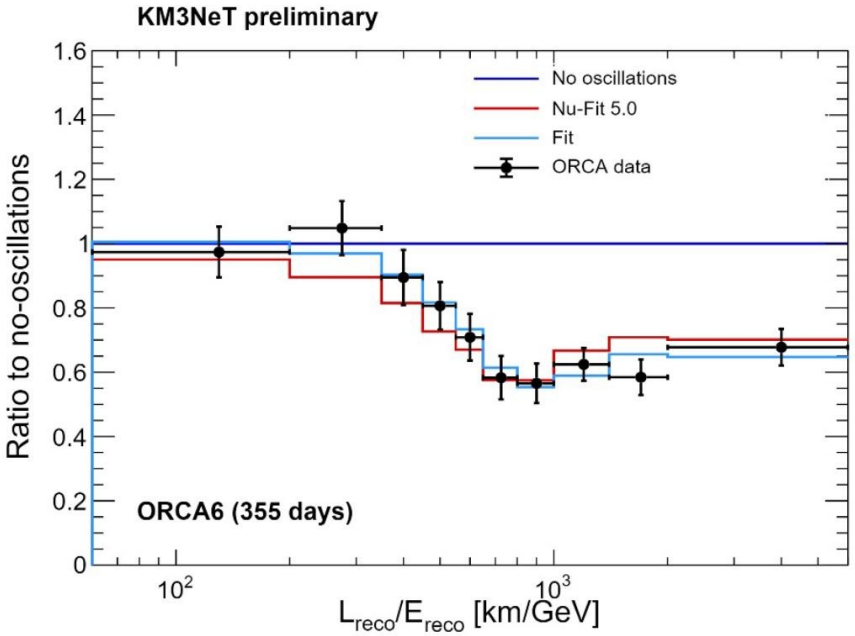
- A *smooth transition* from 2G (through 2.5G) to 3G antennas
  - → improve/upgrade *and* 3G risk reductions
  - → Horizon INFRADEV-ET-PP (Einstein Telescope)

A Large Neutrino Physics project: KM3NeT



- KM3NeT ORCA & ARCA: neutrino physics and astrophysics
  - → successful transition from successful ANTARES experiment
  - → ESFRI label,
  - → CNRS in charge of seabed infrastrucure, detectors & 115 deployments
  - → 8 CNRS laboratories, total KM3NeT capex ~196M€, opex ~3M€/yr

Challenges in Neutrino Physics



- Complete ORCA and JUNO, achieve mass hierarchy determination!
  - → Seabed infrastructure and detector technology OK!
  - → Horizon KM3NeT-INFRADEV2
  - → Critical time to **expand international participation**

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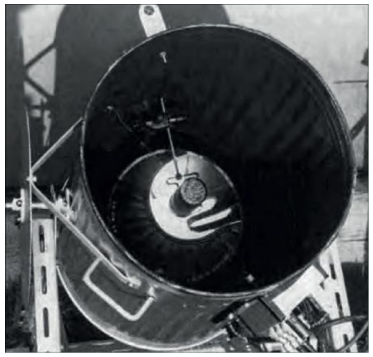
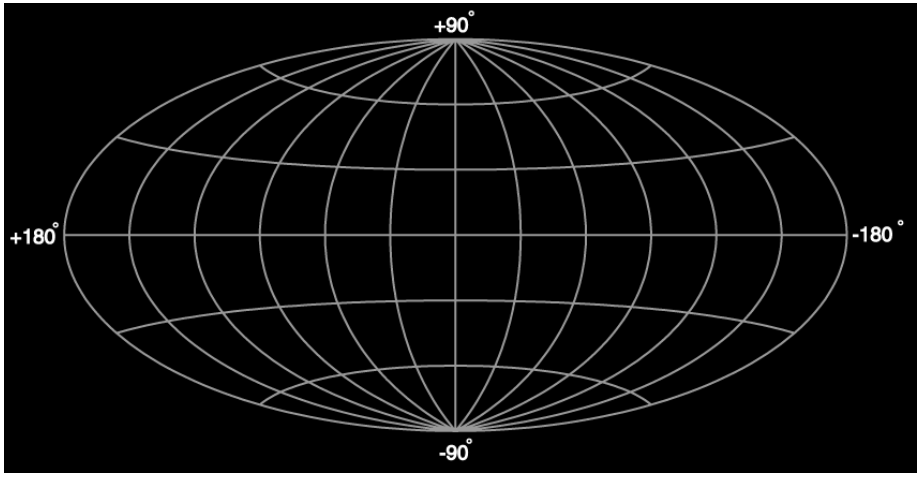
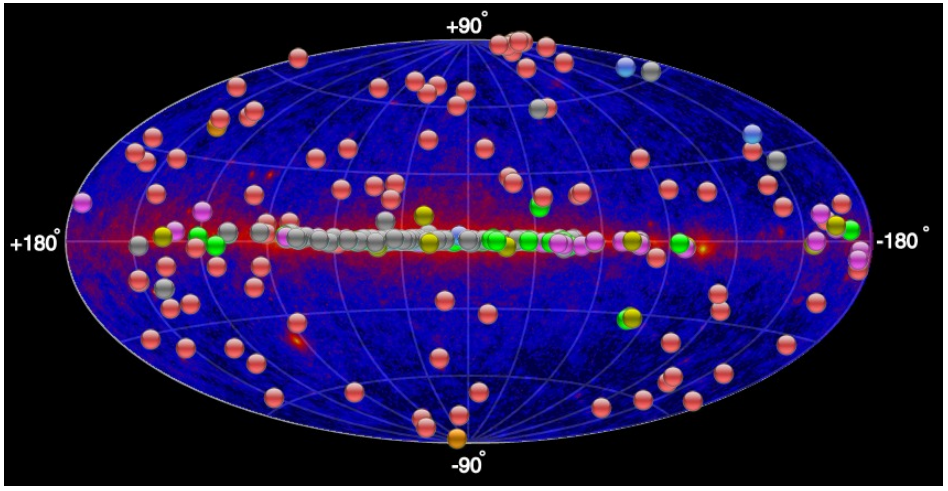
High Energy Gamma-Ray Astrophysics



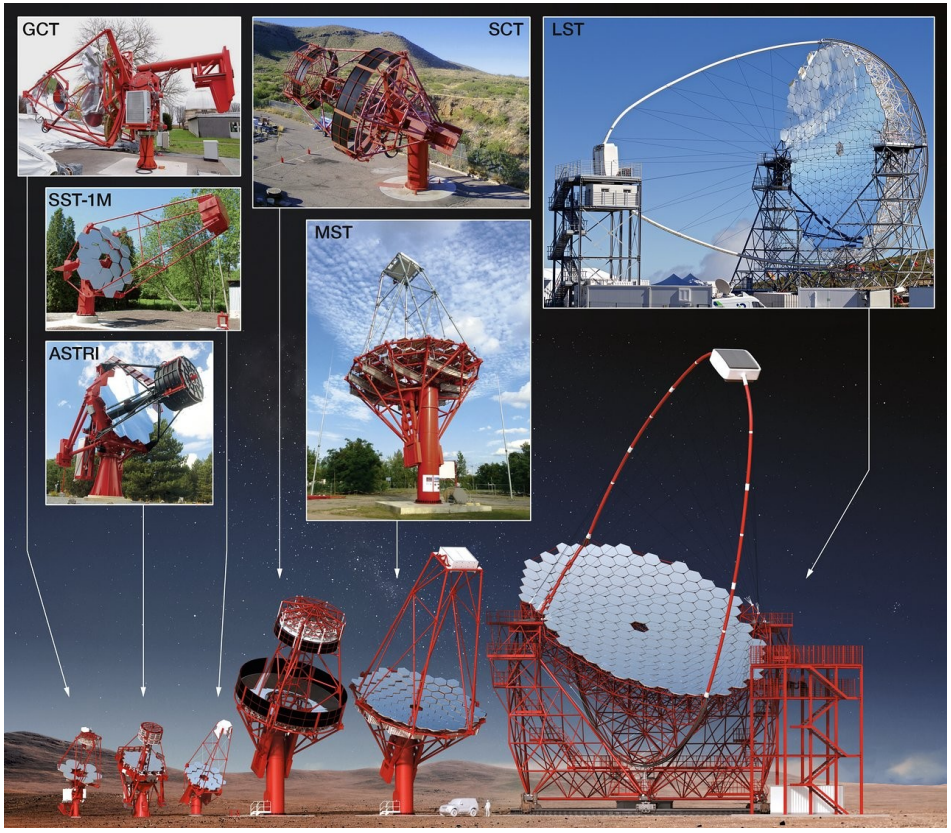
1951

1997





A HEGRA project: Cherenkov Telescope Array



- Building on the success of the HESS, MAGIC and Veritas projects
  → Well known technology & operations
- Roadmap priority **CNRS HEP, CNRS AA & CEA**
- Construction of
  - 9 Medium-Size telescope cameras
  - 4 Large-Size telescope elements
  - Small-size telescope elements
  - Data analysis package
- 160 FRA scientists, 52M€ FRA contrib
  400M€ total capex, 20M€/yr opex

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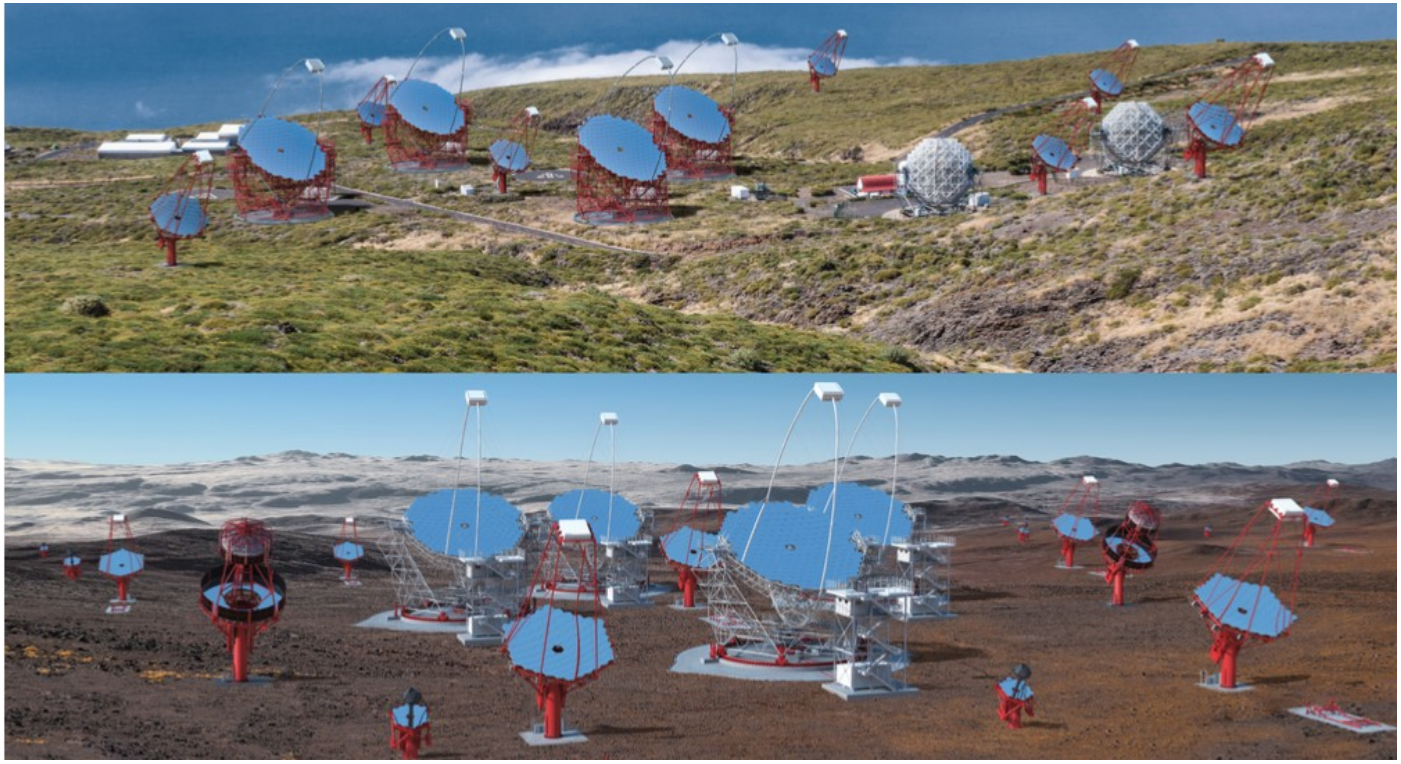

- Complete the Cherenkov Telescope Array as planned
  → CTA is the world's major step forward in HE gamma-ray astrophysics
  → broad science reach → support across institutes and organizations
  → right balance in international data openness..

- A *smooth transition* from 3G to 4G
  → maximize science return

Conclusion

- Great successes and achievements in the past decade

  → direct detection of gravitational waves
  → nextgen high-energy gamma-ray observatory funding
  → deep underwater technology for neutrino physics

- Great challenges are ahead !
  → next major DM, NDBD, CMB projects?
  → achieve construction, operate & get the science
  → keep ideas flowing between very diverse interests
  → not mentioned:
  computing & storage challenges
  environmental & energy challenges

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Thank you!