Deep Ocean cabled Observatories and synergies with Astroparticle Physics

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Amsterdam

24 May 2011

www.aspera-eu.org

ASPERA

What is Astroparticle Physics ?
Main themes

What is the role of high energy phenomena in the Universe ?

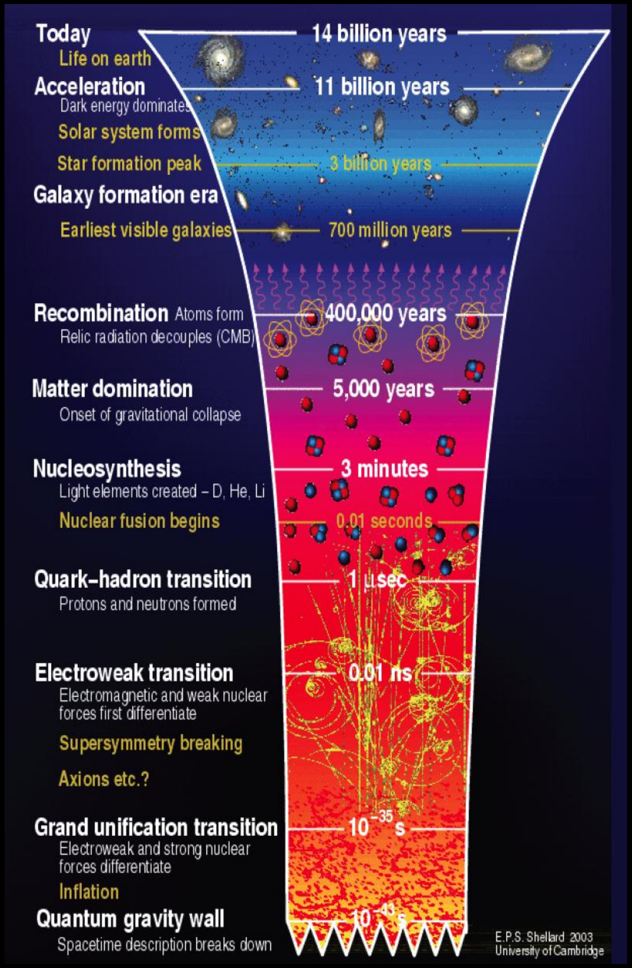
- High Energy messengers (γ, ν , p/N)
- Gravitational waves

What is the Universe made of ?

- Dark Matter
- Dark Energy

What is the nature of matter and interaction at the highest energies ?

- Neutrino Mass
- Proton decay and neutrino properties

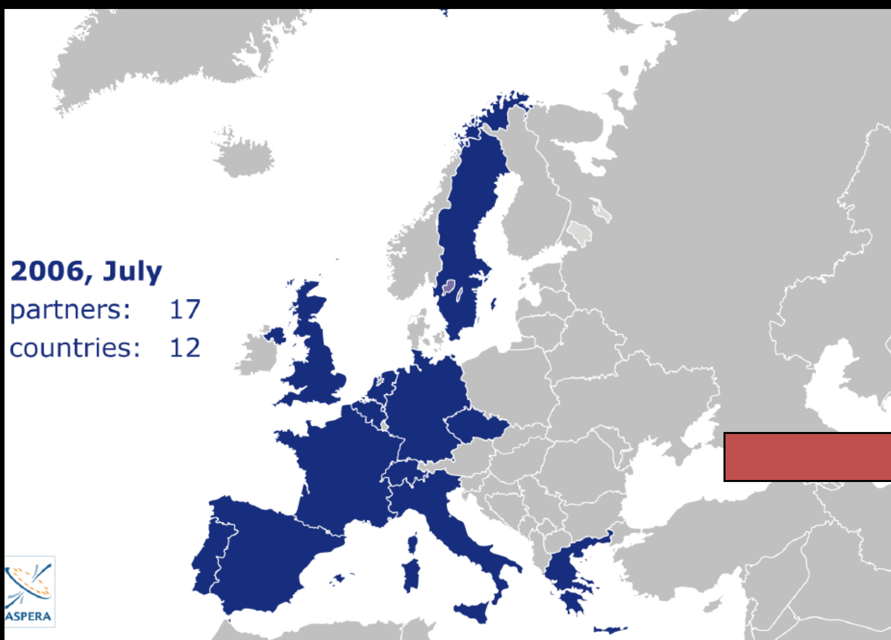


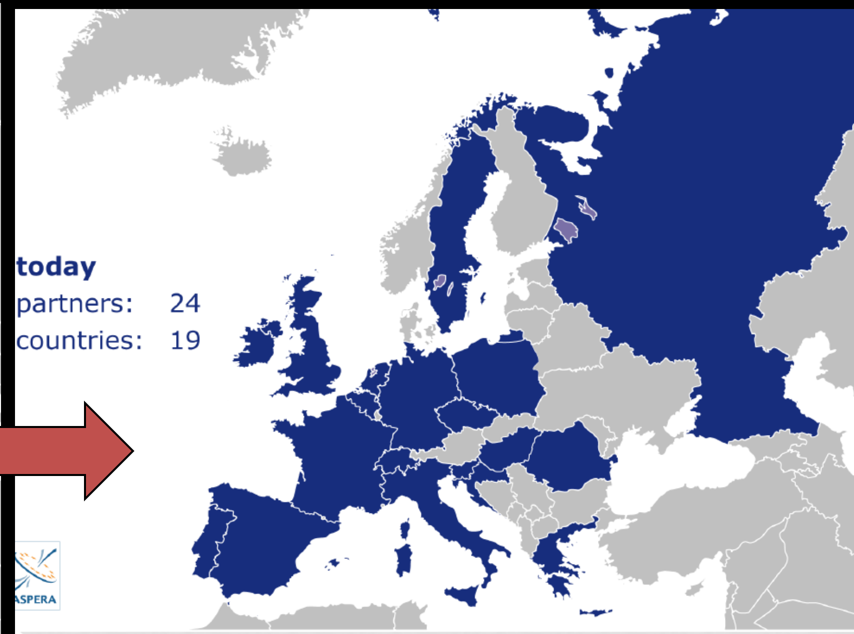
Organising the Astroparticle
From ApPEC to ASPERA and back

- ✓ **Astroparticle Physics European Coordination (ApPEC) since 2001**
- ✓ **AStroparticle Physics ERAnet ASPERA (2006- 2012)**
  - ✓ ASPERA -1 (FP6, 2006-2009)
  - ✓ Definition of the field ➔ the Seven Magnificent Roadmap
  - ✓ Many other actions: census, common calls, national days, linking
  - ✓ ASPERA-2 (FP7, 2009-2012)
  - ✓ Update of the roadmap ➔ action plan
- ✓ **Astroparticle Physics European Consortium (ApPEC) (2012-…)**
  - ✓ ➔ Under construction (MoU)

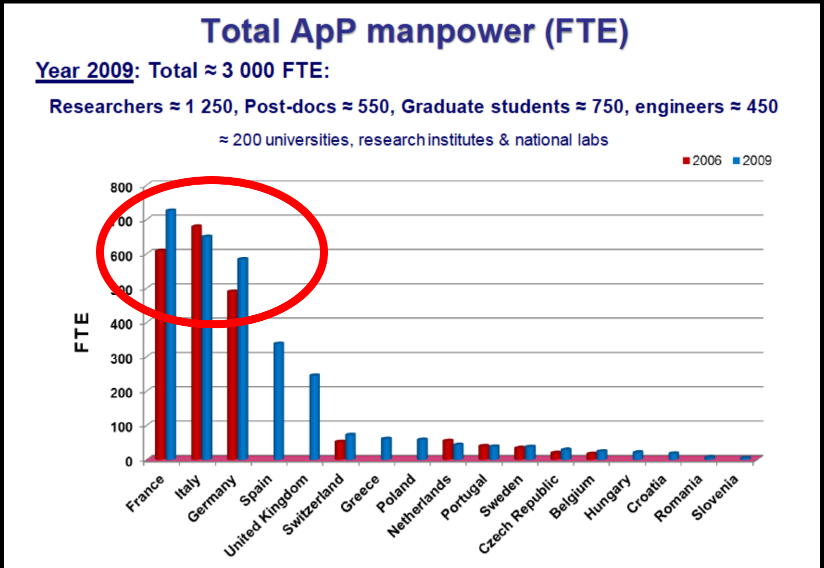
ASPERA

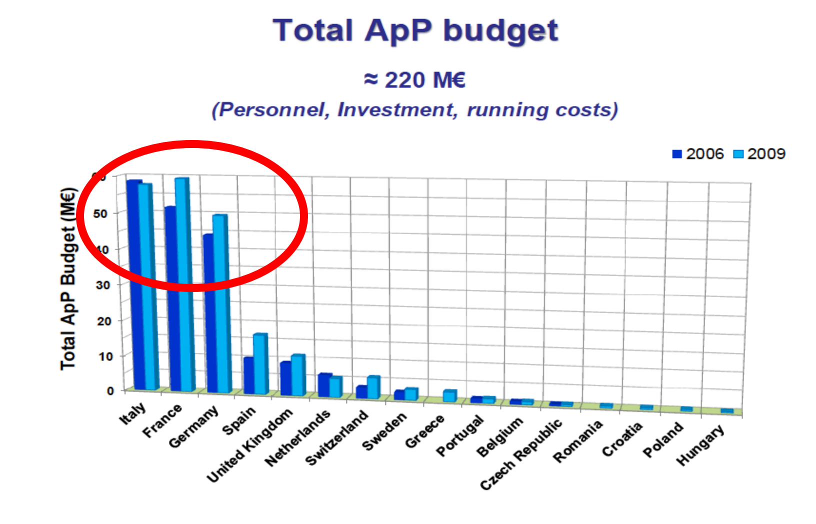
Extending the network

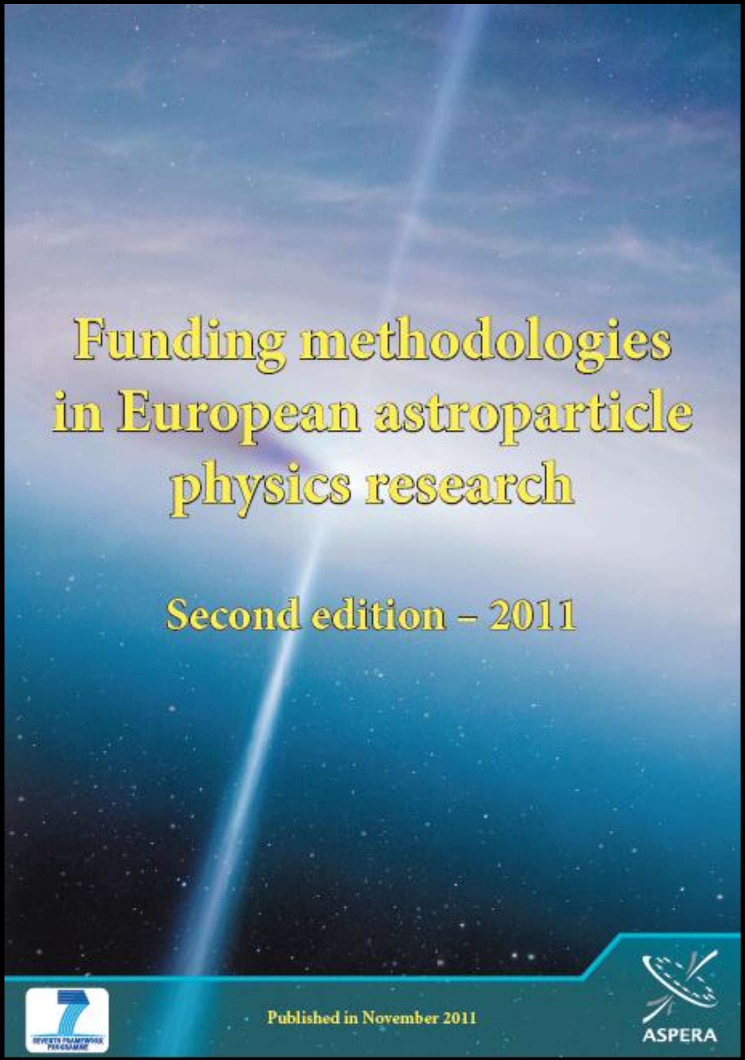




Census of funding and personnel

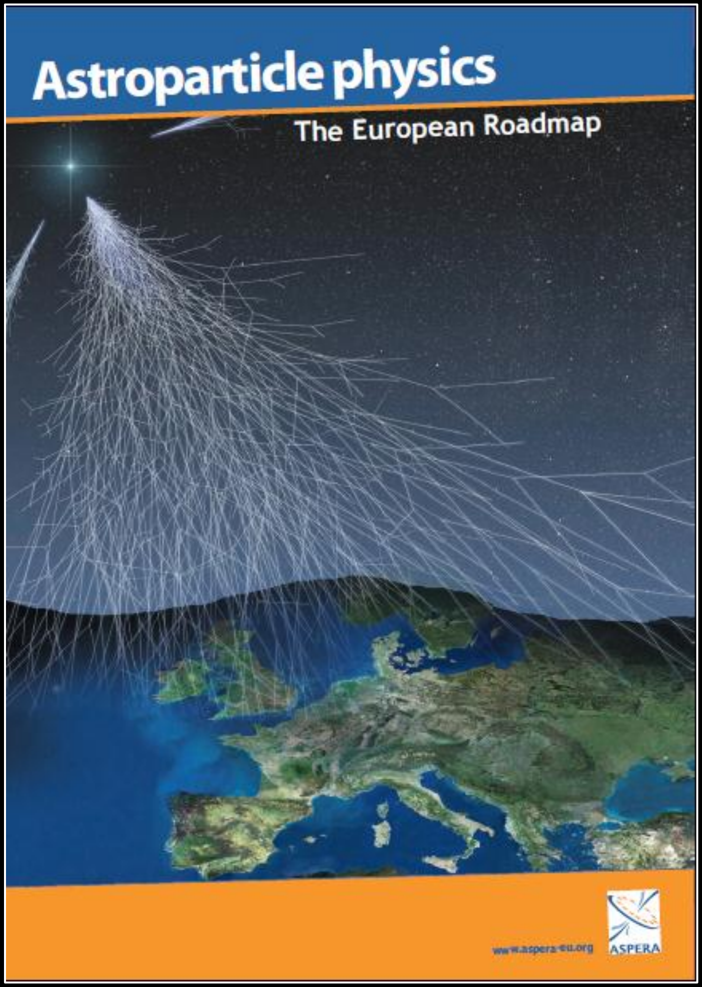






The Roadmap priorities

preserve MEDIUM scale



1. Gravitational wave advanced detectors,
2. Dark matter searches,
3. Neutrino property measurements,

initiate LARGE scale

1. Cherenkov Telescope Array (CTA)
2. High-energy neutrino telescope (KM3NeT)
3. Large ground-based UHECR observatory

interface for VERY LARGE

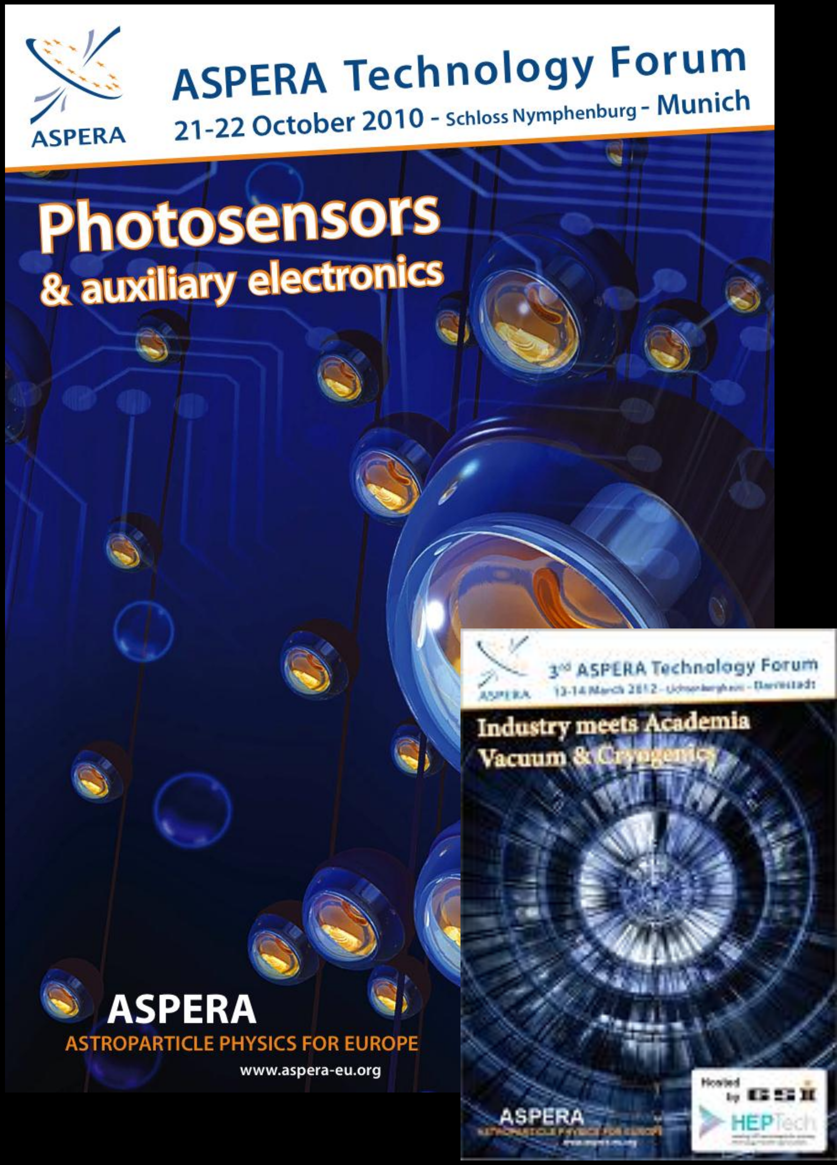
- LAGUNA (CERN, large scale neutrino detector)
- EUCLID(ESA)/LSST(US)
- eLISA-NGO(ESA)/E.T

November 2011

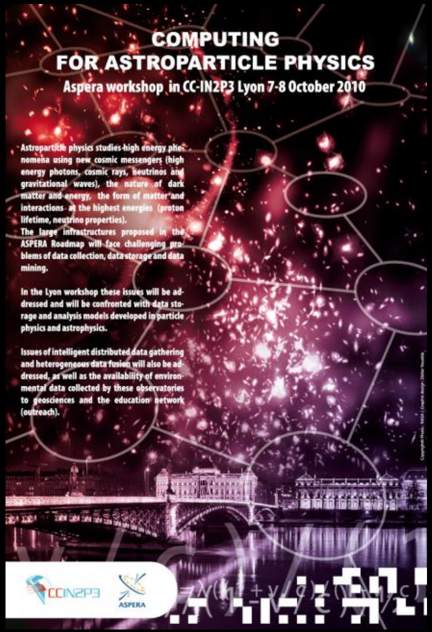
Industrial contacts and innovation

- Photosensors and Electronics
  - Munich 21-22 October 2010
- Mirros and Lasers
  - Pisa 20-21 October 2011
- Cryogenics and Vacuum
  - Darmstadt March 2012

- Cartography of industrial landscape
- Organisation of procurement
- Encourage industrial developments
- Encourage European Innovation



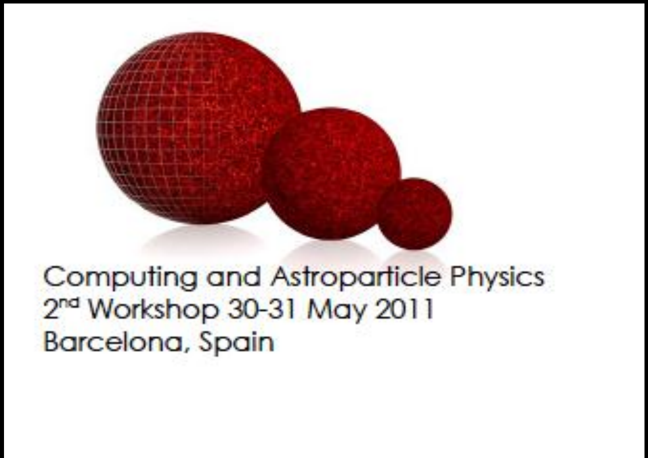
Define the computing model for Astroparticle Physics



- 3 workshops

  1. Lyon October 2010
  2. Barcelona May 2011
  3. Hannover May 2012

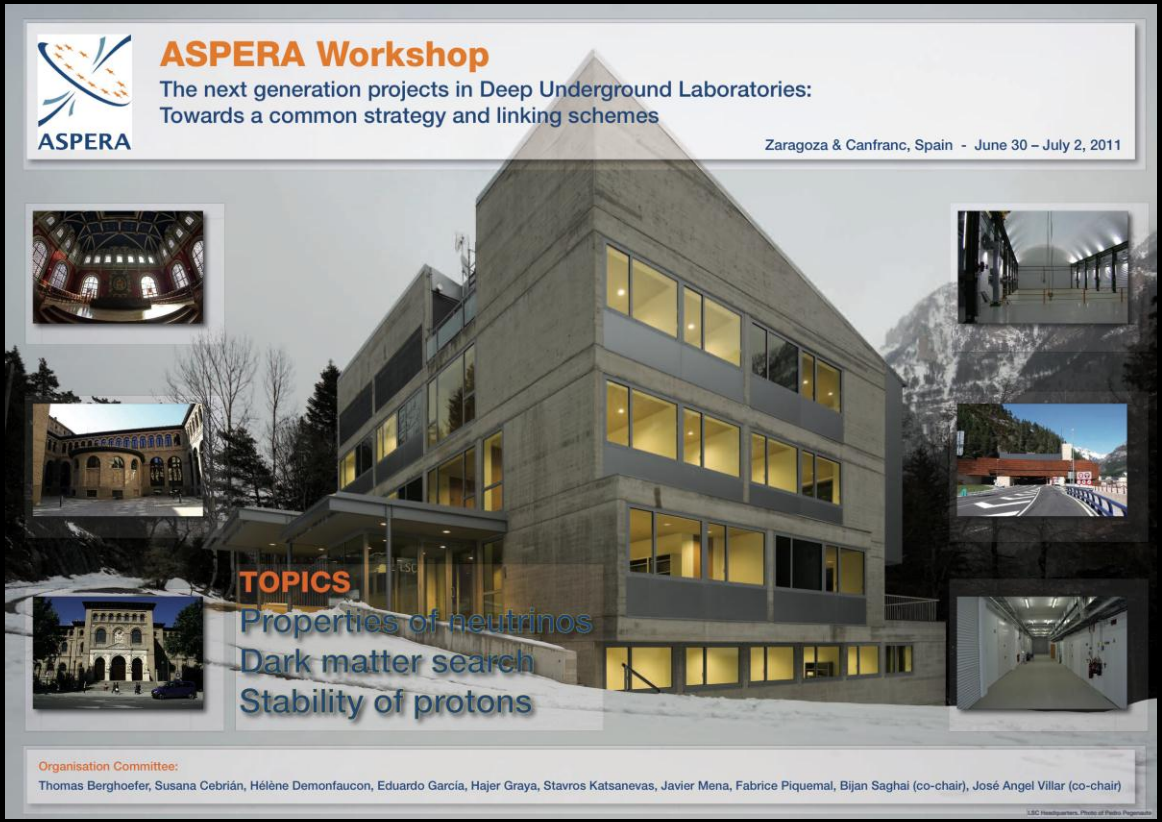
- Deliverable: a white paper by December 2012



Linking Infrastructures

Network of Underground Laboratories

Workshop on Underground science June 3 2011 in Zaragoza



Other common Actions

- Common calls
  - 1st common call (CTA, Dark Matter)
  - 2nd common call completed (UHECR and neutrino mass R&D)
  - 3rd common call in preparation (Low energy neutrino, grav waves)

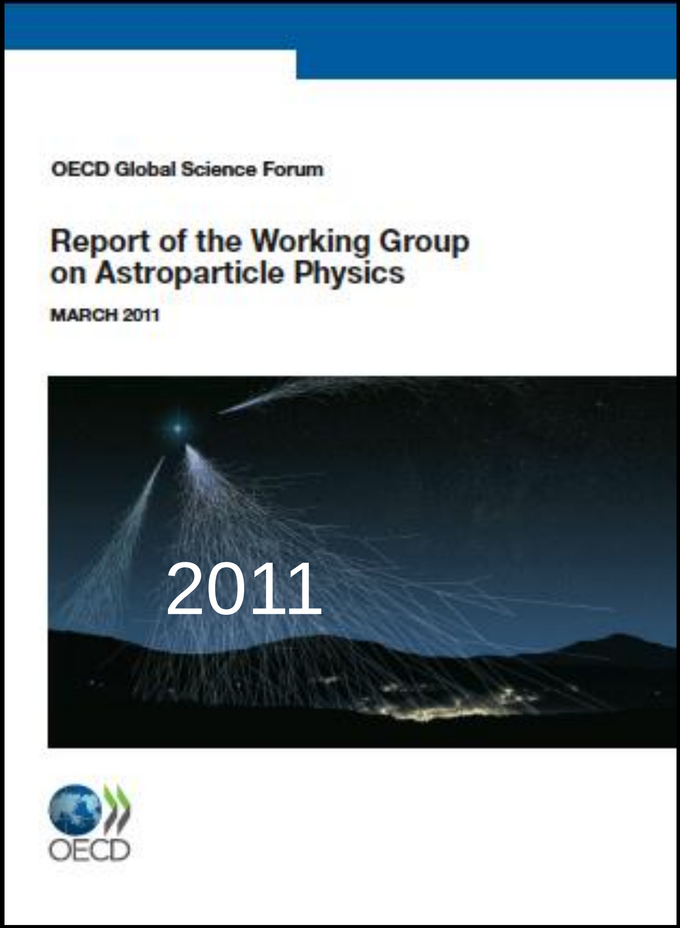
- Create standards for project management for future large infrastructures of the astroparticle
  - A report in preparation for
    - Phases (from conceptualisation/preconstruction to decomissioning)
    - Management deliverables (WBS, PBS, OBS)
    - Oversight structures (Collaboration, Resource Boards, etc)
  - A report on relationships with international organisms
    - CERN, ESA, ESO

Extending coordination to global scale

A Worldwide Vision
Creation of APIF

- **Astroparticle International Forum (APIF)** subsidiary body of the OECD Global Science Forum composed of funding agency officials

- APIF goals:
  - **Exchange information**
  - **Prepare joint actions**
  - **Propose solutions for governance structures**
  - **Propose solutions to science policy issues**
    - **facility access, operation costs etc**
  - **Engage collective dialogue with governmental and non-governmental entities**
  - **...**


OECD Global Science Forum

Report of the Working Group on Astroparticle Physics

MARCH 2011

2011

OECD

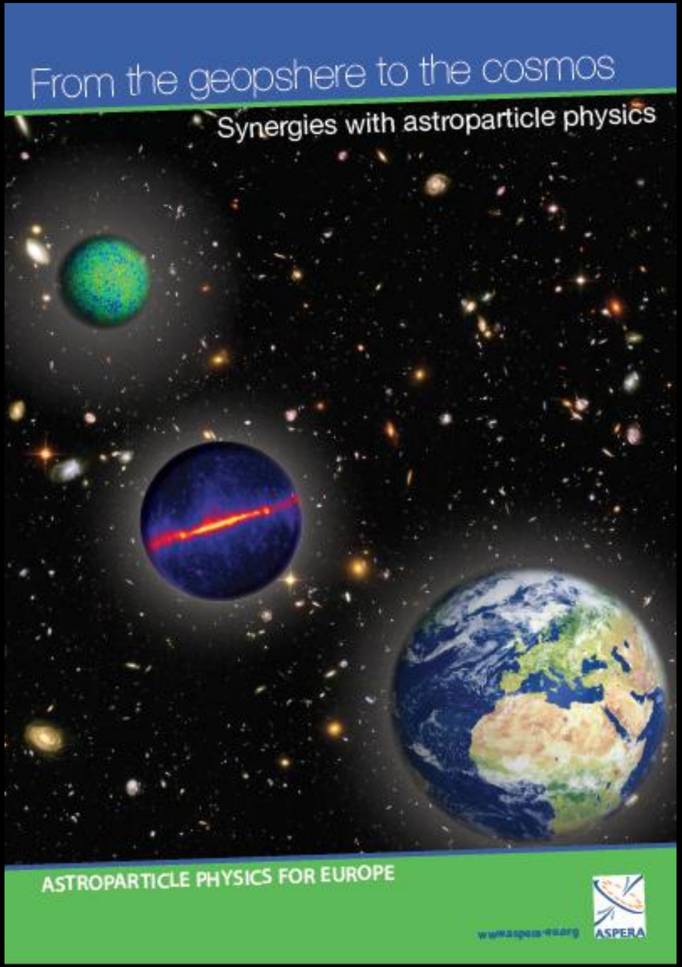
ASPERA

Synergies with other fields

- From the Geosphere to the Cosmos
  - Paris 1-2 December 2010
  - ➔ Underwater Science
  - Amsterdam 24-25 May 2012

A new frontier:

- Continuous time series data to other sciences by deploying large networks in hostile environments (sea, desert, underground)
- Radioctivity-free platforms (underground laboratories) for dating and other high sensitivity searches for environment and applications
- High sensitivity instruments for probing very low intensity geological effects, metrology
- Large data manipulation and worldwide networking

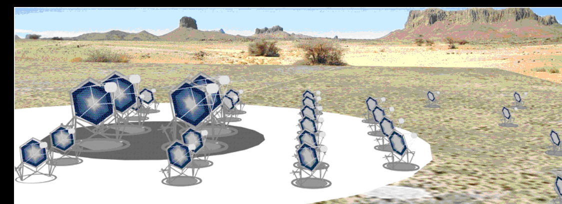


NEW Brochure
37 published studies

An old synergy: you need to understand the geosphere in order to understand the properties of cosmic messengers

ABOVE GROUND

H.E.S.S

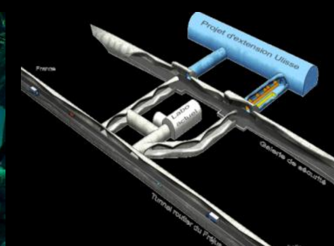


CTA

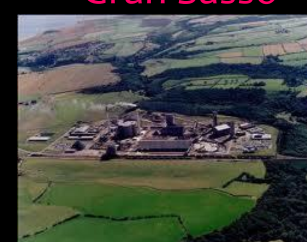
Pierre Auger Observatory

UNDERGROUND

Gran Sasso



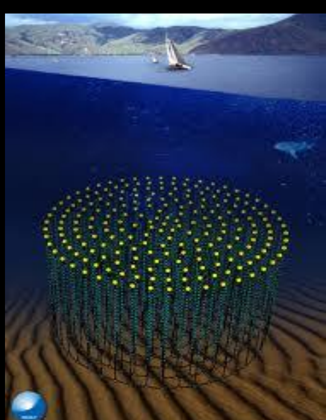
Modane



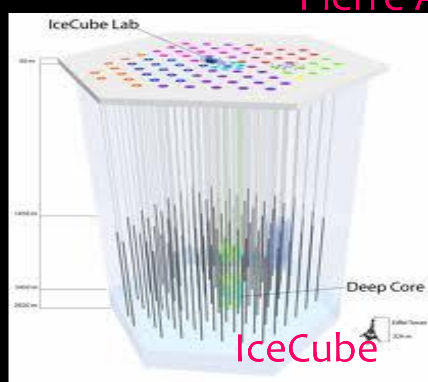
Boulby

Canfranc

UNDERWATER



KM3NeT



IceCube

UNDER-ICE

Currently close to 40 points of synergy

	ATMOSPHERIC AND TERRESTRIAL	UNDERGROUND	UNDERWATER
UNDERSTANDING THE ATMOSPHERE	1. SPACE WEATHER (Section 3.1.1) 2. ATMOSPHERIC MONITORING (Section 3.1.2) 3. COSMOCLIMATOLOGY (Section 3.1.3) 4. THUNDERSTORMS and LIGHTNINGS (Section 3.1.5)	1. COSMOCLIMATOLOGY (Section 3.1.3)	1. ATMOSPHERIC TEMPERATURE VARIATION (Section 3.1.4)
UNDERSTANDING THE EARTH	1. EROSION RATE CALCULATION (Section 3.2.1) 2. VOLCANO TOMOGRAPHY (Section 3.2.5)	1. COASTAL ROCK CLIFF EROSION (Section 3.2.2) 2.CHRONOLOGY for THE PALEOENVIRONMENT (Section 3.2.3) 3. EARTH's INTERIOR - GEONEUTRINOS (Section 3.2.6)	1. PALEOCLIMATE (Section 3.2.4) 2. EARTH RADIOGRAPHY (Section 3.2.7)
UNDERSTANDING THE OCEANS	**New: Gravitational antennnas for probing earth interior**	1. CORAL CHRONOLOGY (Section 3.3.6)	1. CONTINUOUS OCEANOGRAPHIC DATA (Section 3.3.1) 2. SEDIMENT TRANSPORT (Section 3.3.2) 3. OXYGEN DYNAMICS (Section 3.3.3) 4. RADIOACTIVITY (Section 3.3.4) 5. INTERNAL WAVES (Section 3.3.5)
UNDERSTANDING EARTHQUAKES	1. EARTHQUAKE MONITORING GRID (Section 3.4.1)	1. SEISMO-ELECTROMAGNETIC COUPLINGS (Section 3.4.4) 2. EARTHQUAKE PRECURSORS (Section 3.4.5) 3. SLOW EARTHQUAKE MONITORING (Section 3.4.6)	1. EARTHQUAKE AND TSUNAMI MONITORING (Section 3.4.2) 2. STUDYING THE LAKE ENVIRONMENT (Section 3.4.3)
UNDERSTANDING BIODIVERSITY		1. IMPACT OF RADIATION (Section 3.5.7) 2. EXTREMOPHILES (Section 3.5.8)	1. UNDERWATER SOUND MONITORING (Section 3.5.1) 2. DEEP SEA BIOLUMINESCENCE (Section 3.5.2) 3. BIODIVERSITY UNDER ICE (Section 3.5.3) 4. BIODEGRADATION (Section 3.5.4) 5. MICROBIOLOGY (Section 3.5.5) 6. BIOFOULING (Section 3.5.6)
APPLICATIONS		1. WINE DATATION (Section 3.6.1) 2. SALT CHARACTERISATION AOC (Section 3.6.2) 3. SOFT ERROR RATE IN ELECTRONICS (Section 3.6.3) 4. ROCK DEFORMATION (Section 3.6.4)	

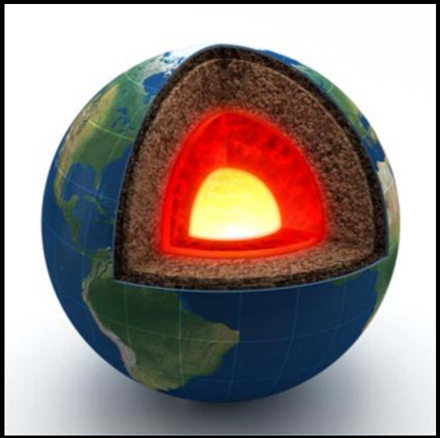
In the following: non-ocean examples

Understanding the Earth

ATMOSPHERIC AND TERRESTRIAL	1. EARTHQUAKE MONITORING 2. VOLCANO TOMOGRAPHY
UNDERGROUND	1. EARTH's INTERIOR 2. EARTHQUAKE PREDICTION (1) 3. EARTHQUAKE PREDICTION (2) 4. SLOW EARTHQUAKE PREDICTION
UNDERWATER	1. EARTHQUAKE PREDICTION 2. EARTH RADIOGRAPHY

Understanding the Earth

Earth Radiography



UNDERGROUND: **BOREXINO** collaboration confirmed that radioactive decays contribute to more than 50% of the Earth's heat.

UNDERICE: **IceCube**, already in its data-taking phase, is expected to construct the first independent global survey of the core, mantle and their boundary (CMB)

NEW: **VIRGO sensing of core movements ?**

Understanding the Earth

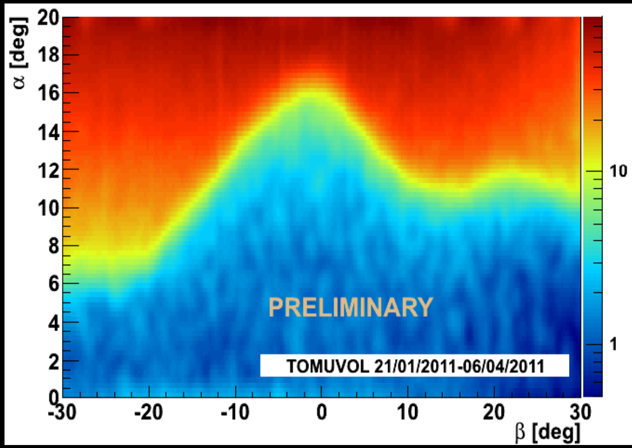
Muon volcano tomography

DIAPHANE Lesser Antilles

MU-RAY Vesuvius, Italy

TOMUVOL Puy de Dôme, France

portable telescopes are able to detect the muon flux, then compared to models using data on rock thickness, to produce a muon tomography



Understanding the Earth

monitoring earthquakes

Also accurate and timely earthquake prediction is still an elusive goal: could solutions coming from the field of ApP help ?

TERRESTRIAL

80 seismic stations will be installed in 2012

Pierre Auger Observatory

UNDERGROUND

electromagnetic signals and U groundwater anomalies

LSBB/LNGS

UNDERGROUND

real-time picture of seismic activity

LNGS

UNDERWATER

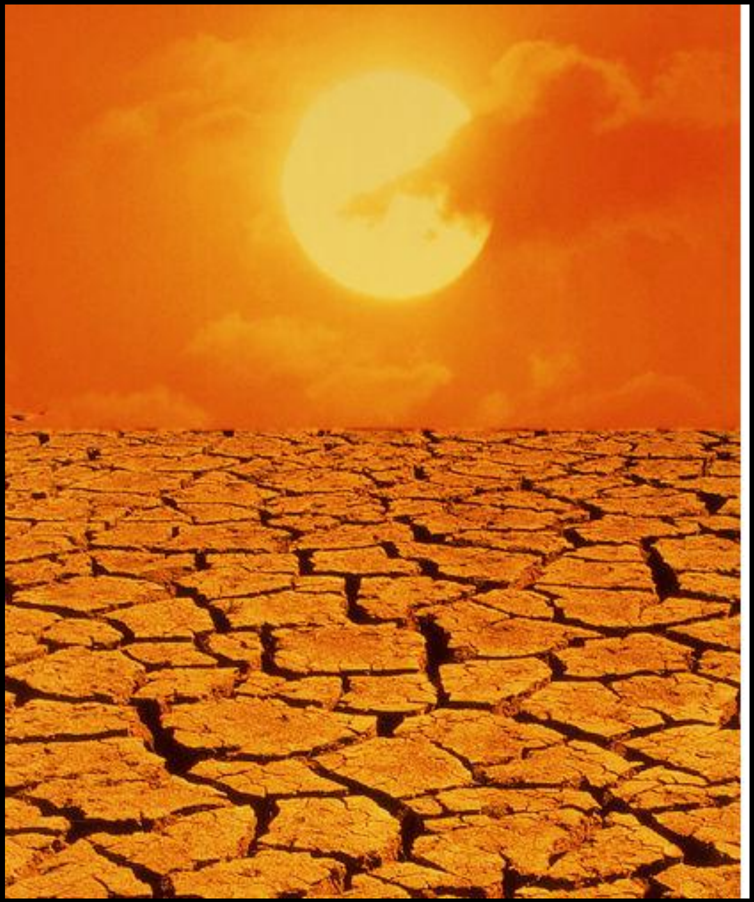
seismometers 2400m deep tsunami warning systems

ANTARES/NEMO

LSBB = Low Noise Underground Laboratory

LNGS = Underground Laboratory of Gran Sasso

CLIMATE CHANGE



ATMOSPHERIC AND TERRESTRIAL

1. SPACE WEATHER
2. ATMOSPHERIC MONITORING
3. COSMOCLIMATOLOGY
4. EROSION RATE CALCULATION
5. THUNDERSTORMS AND LIGHTNINGS

UNDERGROUND

1. CHRONOLOGY for PALEOCLIMATE RESEARCH
2. COASTAL ROCK CLIFF EROSION

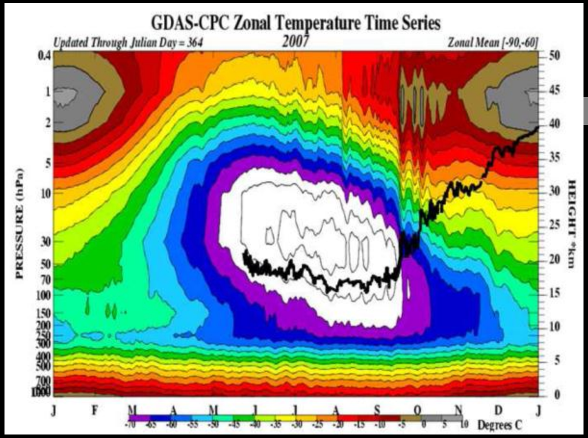
UNDERWATER

1. CONTINUOUS OCEANOGRAPHIC DATA
2. PALEOCLIMATE
3. RADIOACTIVITY
4. SEDIMENT TRANSPORT
5. ATMOSPHERIC TEMPERATURE VARIATION
6. OXYGEN DYNAMICS

CLIMATE CHANGE

Atmospheric monitoring

Atmospheric composition, clouds, lightning and aerosols at the **Pierre Auger Observatory**



- **IceCube** background muon rates can be used as a proxy of atmospheric temperature variation

CLIMATE CHANGE

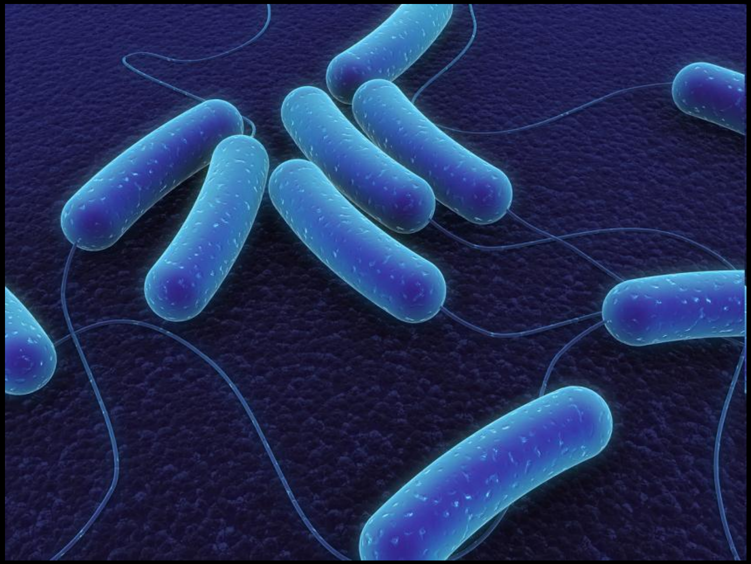
Decoding the past

At the **UNDERGROUND LABORATORY OF MODANE** radionuclide dating (^{210}Pb, ^{137}Cs and ^{241}Am) of sediments from Lake Bourget used to reconstruct evolution of trophic state and hypolimnetic anoxia during the last century

- At the **UNDERGROUND LABORATORY OF MODANE** dating methods are also used to determine the ages of corals to obtain insights into past climate and ocean circulation changes

- **IceCube** collaboration invented an optical dust-logging instrument that fits into the deep boreholes in glacial ice. They found that times of strong volcanic eruptions correlate strongly with onsets of global cooling

BIODIVERSITY



UNDERGROUND

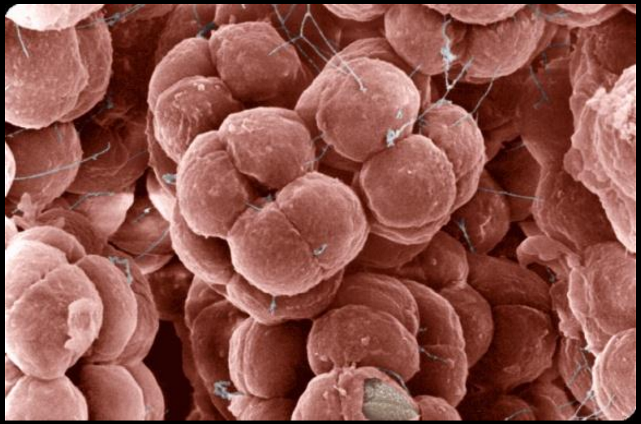
1. IMPACT OF RADIATION
2. EXTREMOPHILES

UNDERWATER

1. UNDERWATER SOUND MONITORING
2. BIODIVERSITY UNDER ICE
3. MICROBIOLOGY
4. BIODEGRADATION
5. BIOFOULING

Biodiversity

The secret life of bacteria



At **BOULBY UNDERGROUND LABORATORY** the scientists are trying to discover the origins and biology of ancient halophilic communities. Such extremophiles can help us understand how our planet's biosphere evolved

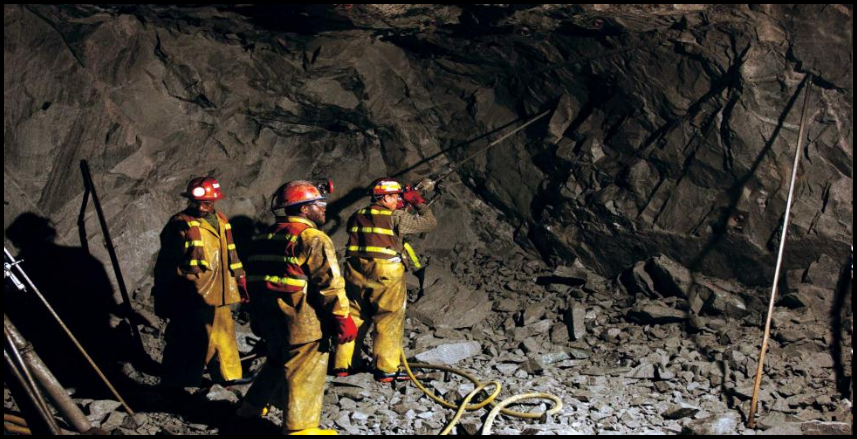
- In ice, the Biospectral Logger developed by members of the **IceCube** collaboration takes advantage of the strong autofluorescence of many biomolecules in order to detect bacteria that are capable of living in ice at temperatures tens of degrees below 0°C

APPLICATIONS

Wine dating at the **Underground Laboratory of Modane**

Studying **soft error rates in electronics** at the **Underground Laboratory of Modane**

understanding the strength and deformation behaviour of rocks in response to applied stresses at the **Boulby Underground Laboratory**



What do we expect from this workshop ?

- Survey the state of the art in the field in Europe and worldwide

- Understand from the other disciplines the main questions and eventually discover new points of synergy

- Present to the other disciplines our infrastructures and instrumentation and eventually create new opportunities for measurements

- Think together to invent new instruments of the extreme

- Foster new collaborations