

ASPERA (& ApPEC) Roadmap

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Aspera-Spain Coordinator Benasque IMFP 1 June 2012

Cosmology

Origin

of cosmic rays

Violent phenomena Galaxy formation and evolution Gravitation

Unification Proton decay Neutrino

Astrophysics

Particle Physics

> What is ApPEC ?

> ApPEC is an
 European Consortium
 of funding agencies
 for Astroparticle Physics
 Coordination.

ASPERA





- > ApPEC created in 2001 by the national funding agencies of France, Germany, Italy, the Netherlands and UK.
 - Since then Spain, Belgium, Portugal, Greece, Switzerland and Poland have joined

> ApPEC aims to

- Promote and facilitate co-operation within the European Particle Astrophysics (PA) community
- Develop and promulgate long term strategies for European PA, offering advice to national funding agencies and EU
- Assist in improving links and co-ordination between European PA and the scientific programmes of organisations such as CERN, ESA, and ESO
- Express their collective views on AP in appropriate international forums, such as OECD, UNESCO etc.

> What is ASPERA ?

> ASPERA is an ERANET, a European network of national government agencies responsible for coordinating and funding research in astroparticle physics.

ASPERA

> ASPERA is funded by the European Commission (FP 6) at the level of 2.5 Million € over a three years period. It started in July 2006.

> ASPERA arises from the existence of ApPEC
 (Astroparticle Physics European Coordination).



What is ASPERA?

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Astroparticle Physics for Europe

'per aspera ad astra'

www.aspera-eu.org

ASPERA-I FP6 ERANET (July2006-July2009, 2.5 M€)

 Study APP personnel and funding in Europe
 >2500 researchers and 70 M€/year
 >Priority Roadmap for Infrastructures ≻and R&D >Linking of existing infrastructures Underground laboratories
 Issue a common call for R&D/Design studies
 2nd April 2009

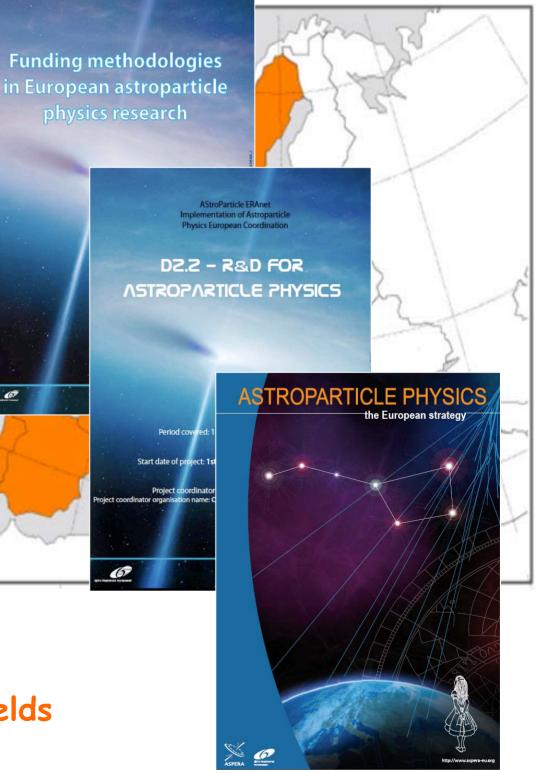
>Common outreach, databases, portal, ...

>ASPERA-II FP7 ERANET (July 2009-July2012, 2.5 M€)

Goals:

ASPERA

 Accompany the realization of the roadmap
 Strengthen joint programming
 Move to a sustainable coordination >Coordinate with other continents >Knowledge transfer : industry/neighboring fields >Include the remaining European countries





> The participants

 > 19 member states:
 Belgium, Croatia, Czech Republic, France, Germany, Greece, Hungary, Italy, Ireland, Netherlands, Poland, Portugal,
 Spain, Sweden, Switzerland, United Kingdom, Romania and Russia.

> 24 national funding agencies: CNRS (FR) - BMBF(DE) - CEA(FR) -FCT(PT) - FRS-FNRS(BE) - FOM(NL) -FWO(BE) - INFN(IT) - MINECO (ES) -MEYS(CZ) - NIH (HU)- NCBIR (PL) -NZZ (CR) - SNF(CH) -IFIN.HH(RO) DEMOKRITOS(GR) - STFC(GB) -PT-DESY(DE) - VR(SE) - CERN.

> Associated
 RIA (Ireland)
 RFBR (Russia)
 VRRS (Slovenia)

ASPERA IN EUROPE



ASPERA members

Associates

Astroparticle Physics for Europic le Physics: field defining question

> What is the Universe made of?
> Do protons have a finite lifetime?

ASPERA

> What are the properties of neutrinos?
> What is their role in cosmic evolution?
> What do neutrinos tell us about the interior of Sun, Earth and Supernova explosions?

> What is the origin of cosmic rays?

> What is the view of the sky at extreme energies?

> What is the nature of gravity?
> Can we detect gravitational waves?



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Astroparticle Physics for Europe

> Astroparticle physics in Europe

> Over 2000 Astroparticle Physicists

> About 50 laboratories managing:

- underground laboratories shielding the experiments from the cosmic ray background.
- observatories, telescopes or antennas

• satellite observatories of high energy gamma rays, cosmic rays or gravitational waves.

> A total funding around
 200 Million €/year for all the
 programs running in Europe today.

ASPERA

Astroparticle Physics for Europe

> ASPERA objectives

> Study funding and evaluation of Astroparticle Physics in Europe and identify formal and legal barriers to international coordination.

> Install a common information (Web) and outreach system.

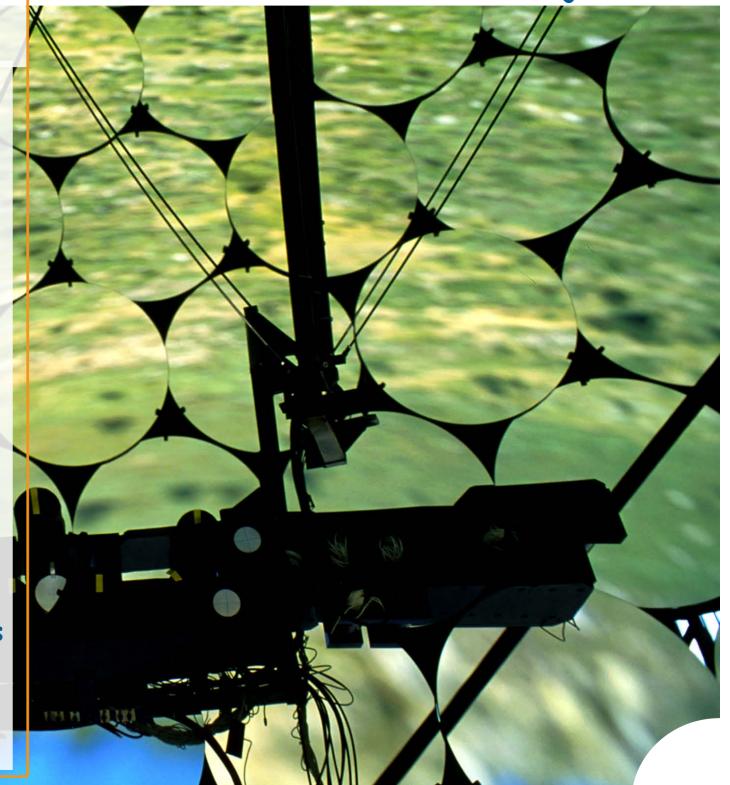
> Define a roadmap on infrastructures and R&D.

> Explore further linking of existing astroparticle infrastructures

> Launch common R&D calls

>Implement new European-wide procedures of common funding of large infrastructures.

> Synchronize national funding systems



ASPERA

Astroparticle Physics for Europe

> ASPERA activities

> Six Work Packages:

- WP1: management
- WP2 Extension of the network and update of status of Astroparticle Physics.
- WP3: Knowledge and Technology Transfer.
- WP4 Positioning European Astroparticle Physics in the world-wide context
- WP5: European-wide common calls and other common actions .
- WP6: development of common electronic infrastructures, outreach.

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> ASPERA organization

> The Governing Board (GB) responsible for all management decisions of the network and for approval of all documents.

> The Joint Secretariat (JS) assures the day-to-day follow up of the program.

> The Scientific Advisory Committee (SAC) responsible for the evaluation of the network's activities.



The Coordinator and the Deputy Coordinator

Coordinator: Thomas Berghöfer Deputy Coordinator: Stavros Katsanevas

The Governing Board (GB)

Chairman: H.-F. Wagner Deputy Chairman: F. del Águila

Members: L. Bergström, S. Bertolucci, U. Bassler, J. Bonfim, M. Bourquin, I.M. Brancus, C. De Clercq, H.-J. Donath, B. D'Ettorre, D. Fegan, F. Linde, J. Martino, V. Németh, A. Ostapczuk, J. Ridky, I. Siotis, J. Seed, S. Stanic, T. Suric, F. van Hee Observers: J.M. Hameury (ASTRONET), B. Leibundgut (ESO)

The Joint Secretariat (JS)

T. Berghöfer, S. Bertolucci, D. Bertrand, M. Bojanowska, J. Bonfim, I. Brancus, D. Carrilho, C. de Clercq, H. Demonfaucon, D. Fegan, A. Ferrer, Z. Frei, H. Graya, S. Hesping, S. Katsanevas, A. Marini, A. Marsollier, R. Martínez, E. Olsson, L. Perinic, E. Pistoia, P. Rapidis, B. Revaz, R. Reynolds, J. Ridky, B. Saghai, S. Stanic, T. Suric, R. Szabó, F. van Hee

The Science Advisory Committee (SAC)

Chairman: C. Spiering

R. Battiston, L.Baudis, J. Bernabéu, P. Binetruy, J. Carr, E. Fernández, F. Fidecaro, G. Gerbier, A. Giuliani, A. Haungs, W. Hofmann, S. Kahn, U. Katz, P. Kooijman, H. Kraus, A. Lester-Selvon, M. Martínez, B. Mours, L. Oberauer, R. Ong, M. Ostrowski, W. Roland, S. Rowan, S. Sarkar, S. Schoenert, G. Sigl, R. Svoboda, M. van den Berg, F. Vissani, L. Votano

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> ApPEC organization

The Steering Committee (SC) responsible for all decisions for approval of all documents.

The chairman of the SC Stavros Katsanevas

The Scientific Advisory Committee (SAC) responsible for the scientific evaluation.

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Study of funding mechanisms (update)

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Astroparticle Physics for Europe

2300 FTF

Investment 70 M€year

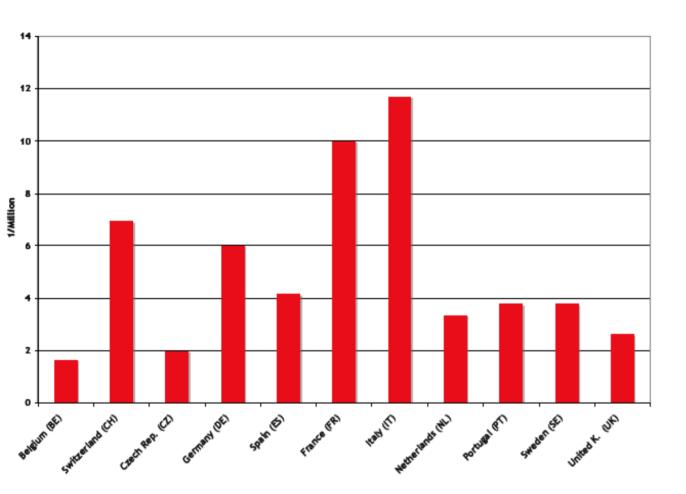


Figure 9: ratio of number of active ApP researchers to the total population of each country

Overall budget 175 M€/year

Funding methodologies in European astroparticle physics research

Astroparticle Physics for	Annual Funding*	Lab Operation	Investment	Salaries	Other	Total
	Europe	26	50.6	90.35	10	176.95
	US	9.9	34.9	56.3	2.1	119.2
	Canada	5	6	3	1.0	15
	South America	0,95	1,42		0,2	2,57
	Russia	3.5	2.5	6.0	0.5	12.5
	India	1.5	2.0	1.0	0.5	5
	China	3.5	5.6	4.6	0.5	14.2
	Japan	14.0	13.2	24.4	0.4	52.0
	Australia	0.3	0.3	1.4	0	2.0
	TOTAL	64,35	116,2	187,05	15.2	399,42

*In Million Euros, Dollars or Okuyen, where an exchange rate of 1:1 was applied

			Graduate		
PERSONNEL (FTE)	Permanent*	Postdocs	Students	Other	TOTAL
Europe	1021	269	439	197	1926
U.S.	269	135	220	68	692
Canada	46	35	63	55	199
South America	61	22	40	23	146
Russia	500	60	50	100	710
India	45	5	20	0	70
China	100	20	90	35	245
Japan	150	48	98	29	325
Australia	6	4	20	0	50
TOTAL	2192	598	1040	595	4343

* Scientists and Engineers

Budget and Personnel for Astroparticle Physics in Participating Countries

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OECD GSF

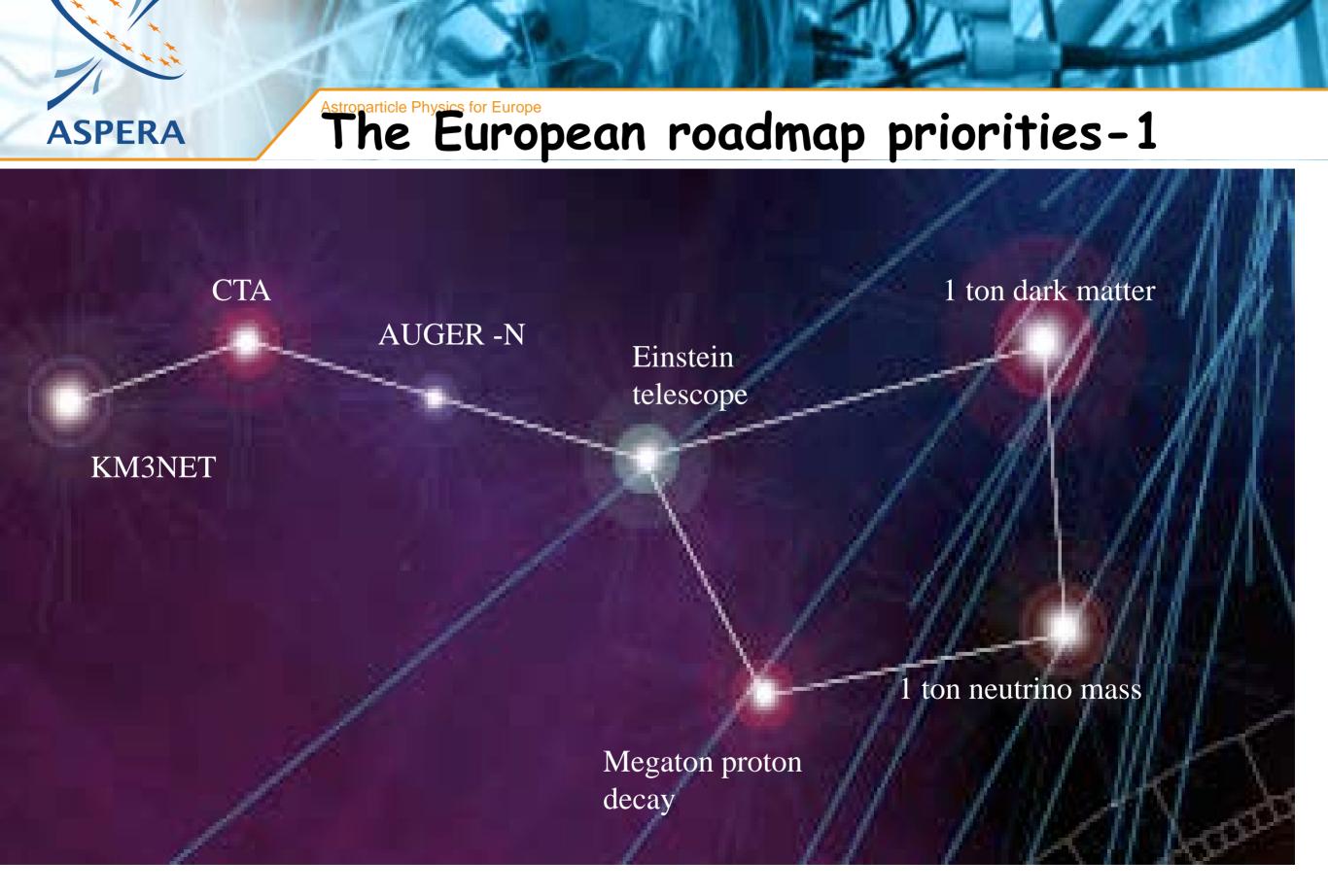
Worldwide

4300

researchers

400 M\$

annual investment



The magnificent seven

Timeline and budget

Astroparticle Physics for Europe

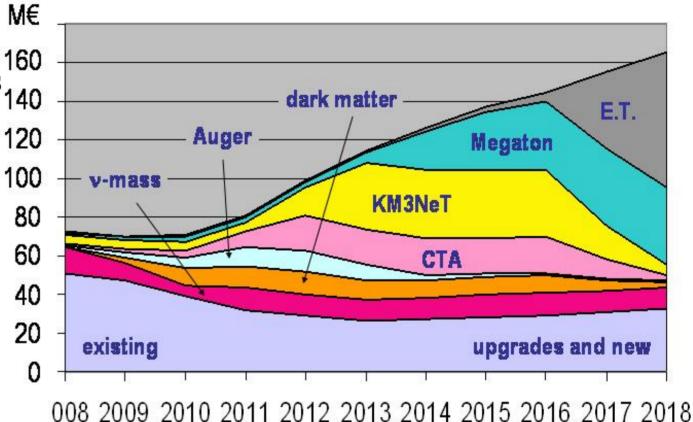
>By 2012 start the construction of : M€
 >KM3net and CTA (200 M€scale) 160
 *>*Also in ASTRONET and ESFRI roadmaps 140

> 2012 milestone for technology decision of:
 > One ton dark matter and neutrino mass detectors (50-100 M€scale)

ASPERA

>Discuss with international partners the realisation of

Auger North in US (50-100 M€, 2012?)
 Megaton detector for proton decay and neutrino astrophysics (500 M€, >2015)
 Einstein Telescope, 3rd generation gravitational wave antenna (300 M€, after first results of adv VIRGO and advLIGO by years) 2015)



✓ Budget 50% increase over available European budget for astroparticle (700 M€10 years)

✓ Share with other continents

- ✓ Regional funding? (e.g. KM3Net)
- ✓ Links to CERN and ESO

Launch common actions

Astroparticle Physics for Europe

- Decision February 13 2009: ApPEC/ASPERA will launch 3 common calls on targeted R&D towards the realisation of large infrastructures
 - First call in ASPERA-1 themes:
 - CTA, Dark Matter

ASPERA

- 2 more calls in the context of ASPERA2 (one in 2010 and one in 2012) for the rest of the 7 magificent
- Virtual pot of 3,5 M€(9 agencies)
- Call published in march 2009 open till May 2009
- At least 3 different countries
- Proposals will be evaluated by a unique evaluation committee
- Resources to successful programs will be granted by a program committee
- Programs start by October 2009

The process is an experimentation of common European procedures

The European roadmap priorities-2

Status and Perspective of Astroparticle Physics in Europe

2007

2008

ASTROPARTICLE PHYSICS

the European strategy

Astroparticle physics

The European Roadmap

2011

Astroparticle Physics Roadmap Phase I

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http://www.aspera-eu.org

www.aspera.eu.org

- Medium scale, ongoing/extension
- Large scale (few hundred M€),
 mid of decade
- Very large scale (several hundred M€ to G€), end of decade

Medium scale

- Advanced detectors for gravitational waves
 - Dark Matter
- Neutrino properties

Extension of the Modane Underground Laboratory (LSM)

"We prioritize these projects for immediate funding, and urge agencies to join their forces for an effective, substantial support"

- impressing momentum which needs to be maintained;
- enter a region with high discovery potential;
- hand in hand with LHC physics;
- technologically ready and worldwide community

http://www.aspera-eu.org

Medium scale

Advanced detectors for gravitational waves

Dark Matter

Neutrino properties

Extension of the Modane Underground Laboratory (LSM)



- With the advent of the LHC and thanks to a new generation of astroparticle experiments using direct and indirect detection methods, the well-motivated <u>SUSY -</u> <u>WIMP dark matter hypothesis will be proven or disproven within the next 5-10 years.</u>
- The highly significant annual modulation signal observed by DAMA/LIBRA, and its interpretation in terms of dark matter interactions, will also be scrutinized in the next years.
- The dramatic progress of the liquid-xenon technology over the past 2-3 years demonstrates a high momentum, which must be maintained. The recently approved XENON1T at Gran Sasso laboratory is expected to start operation in 2014/15.
- The bolometric experiments CDMS and Edelweiss have recently provided upper limits close to those of XENON100 and move towards a closer US-Europe coordination. We recommend supporting the development of EURECA, which envisages one ton of sensitive mass, eventually in a common US-Europe framework.
- Looking beyond the scale of one ton, we strongly recommend that DARWIN, a program to extend the target mass of noble liquids to several tons, is pursued and supported.

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Medium scale

Advanced detectors for gravitational waves

Dark Matter

Neutrino properties

Extension of the Modane Underground Laboratory (LSM)



ASPERA Astroparticle Physics Recommendations Neutrino Properties

- Several highly important experiments in Europe are either in the commissioning phase or in the final years of construction: GERDA, CUORE and the demonstrator for SuperNEMO will search for neutrino-less double beta decay, KATRIN for neutrino mass via single beta decay. Double CHOOZ, a nuclear reactor experiment, is studying neutrino oscillations. The mentioned experiments build on a long experience and validation with precursors. They have recently joined by NEXT, a new approach to the search for double beta decay.
- We renew our strong support for these experiments and look forward to first results.
- Beyond this, we recommend phased experimental approach in neutrino-less double beta decay with a sensitivity (ton scale masses) exploring fully the mass range predicted by oscillation experiments for the inverted mass hierarchy.

Large scale, mid of decade:

TeV gamma-ray astrophysics: CTA

- High energy neutrinos: <u>KM3NeT</u>
- High energy cosmic rays: 30,000 km² ground based array

Low energy neutrinos & p-decay: LAGUNA

Large scale, mid of decade:

TeV gamma-ray astrophysics

- High energy neutrinos: <u>KM3NeT</u>
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- Low energy neutrinos & p-decay: <u>LAGUNA</u>

ASPERA Astroparticle Physics for Europe TeV gamma-ray astrophysics:

- The Cherenkov Telescope Array (CTA) is the worldwide priority project of this field. It combines proven technological feasibility with a high speed towards prototyping, with a guaranteed scientific perspective and a mode of operation and wealth of data similar to mainstream astronomy.
- The cost scale of CTA is 200 M€.

We recommend to design and to prototype CTA, to select the site(s), and to proceed vigorously towards start of construction in 2014.

Large scale, mid of decade:

TeV gamma-ray astrophysics: <u>CTA</u>

High energy neutrinos

High energy cosmic rays: 30,000 km² ground based array

Low energy neutrinos & p-decay: LAGUNA

http://www.aspera-eu.org

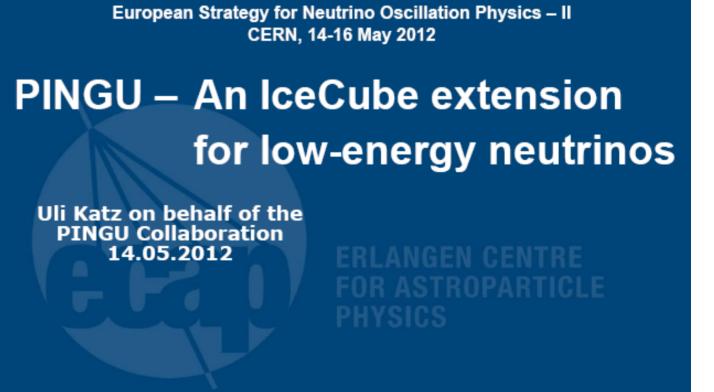
High-energy neutrinos

- IceCube is now providing data with unprecedented quality and statistics. The European partners should be supported in order to ensure the appropriate scientific return.
- There is a strong scientific case for a neutrino detector in the Northern hemisphere, with a substantially larger sensitivity than IceCube.
 Resources for a Mediterranean detector should be pooled in a single optimized design for a large research infrastructure. The KM3NeT collaboration is encouraged to present a technical proposal matching these requirements and in particular take final site and design decisions that would enable start of construction in 2014.
- The IceCube, ANTARES and KM3NeT collaborations are encouraged to strengthen cooperation, with the vision to form a **future Global** Neutrino Observatory, including also other projects like GVD-Baikal.



ASPERA Roadmap: A moderate infill of 15-20 strings would results in a threshold of ~1 GeV and might allow to measure matter oscillation effects which are sensitive to the neutrino mass hierarchy. A massive infill of 50-100 strings might lead to a 20 Megaton detector sensitive to supernova bursts from much beyond our own galaxy and possibly even to proton decay. **The committee**

encourages the on-going Monte-Carlo studies and related photo-sensor developments.





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Large scale, mid of decade:

TeV gamma-ray astrophysics: <u>CTA</u>

High energy neutrinos: KM3NeT

Cosmic rays

Low energy neutrinos & p-decay: LAGUNA

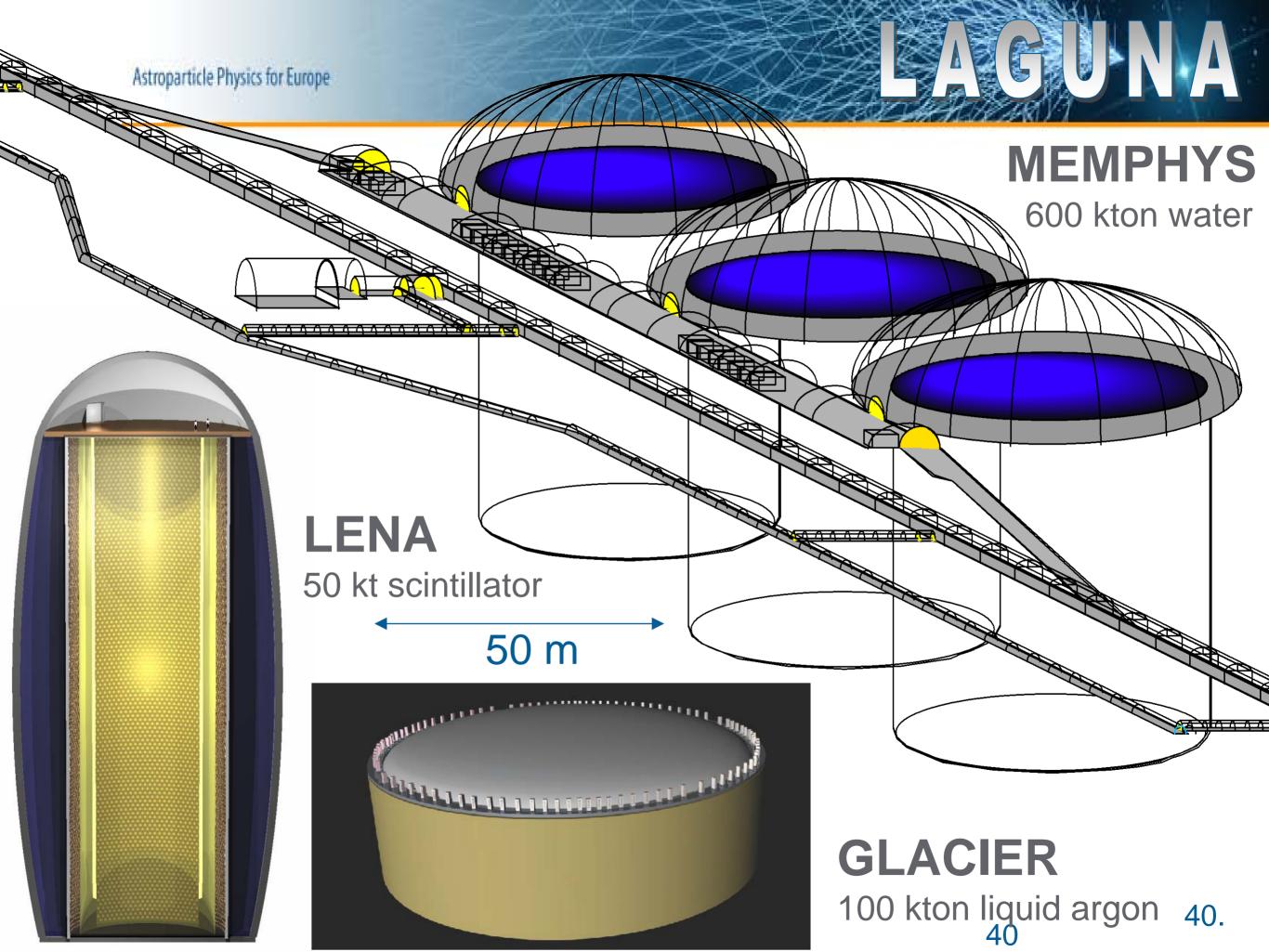


- We reiterate the definition of a substantially enlarged groundbased cosmic-ray observatory as the priority project of high energy cosmic-ray physics – wherever it will be deployed.
- Cost scale 100-150 M€
- We encourage the community to work towards a global common path for such a substantially enlarged observatory including the development of new detection technologies. We recommend that European groups play a significant role in preparing a proposal for the next generation experiment, and, after its approval, make a significant contribution to construction and operation.
- We also support European participation in JEM-EUSO with its novel technology. We encourage cross coordination between these two approaches.

Large scale, mid of decade:

- TeV gamma-ray astrophysics: <u>CTA</u>
- High energy neutrinos: <u>KM3NeT</u>
- High energy cosmic rays: 30,000 km² ground based array

Low energy neutrinos & p-decay



- The scientific goals combine high-risk research addressing several fundamental questions of physics (proton decay, CP violation) with exciting neutrino astrophysics (e.g. supernova, solar, geo- and atmospheric neutrinos).
- We recommend the LAGUNA-LBNO program, including options with and without a new neutrino beam.
- Due to the high cost (350-700 M€, depending on site and type of detector) and the long development time, we recommends that this program is pursued in a global context.
- If the current indications for a large mixing angle θ₁₃ were to be confirmed within one or two years, attractive scenarios for the mediumterm CERN strategy open up.
- As such the LAGUNA project constitutes a high astroparticle physics priority to be discussed within the CERN strategy update process.

Large scale, mid of decade: All Four ?

- The presently conceived start of construction of KM3NeT, "AugerNEXT" and LAGUNA is between 2014 and 2016.
- It seems likely that this does not fit into a realistic funding scheme!

We would support a strategy to search for funding opportunities for these projects – both in Europe and worldwide – and promote any one of these projects as soon as a corresponding window appears.



Extracts from CERN Convention

- 1. The Organization shall provide for collaboration among European States in **nuclear research** of a pure scientific and fundamental character, and in research essentially related thereto
- 2. ... the construction and operation of **one or more international laboratories** ... for research on high-energy particles, **including work in the field of cosmic rays**
- 7. ... co-operate to the fullest possible extent with laboratories and institutes in the territories of Member States within the scope of their programmes of activities. ... the Laboratories shall seek to avoid duplicating research work which is being carried out the said laboratories or institutes

European Strategy for Particle Physics

- Agreed by the CERN Council on July 14th,
 - 7. A range of very important non-accelerator experiments take place at the overlap between particle and astroparticle physics exploring otherwise inaccessible phenomena; *Council will seek to work with ApPEC to develop a coordinated strategy in these areas of mutual interest.*
- From accompanying discussion document
 - "The areas of more direct interest to astrophysics and cosmology include
 - -very-high-energy particles from the Universe
 - -low-energy neutrinos from supernovae, sun and earth
 - gravitational waves
 - axions from the Sun or the early Universe ...



> Per aspera ad astra

Positioning Europe as a leader actor in Astroparticle Physics

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