



<http://www.appec.org>

AstroParticle Physics European Consortium



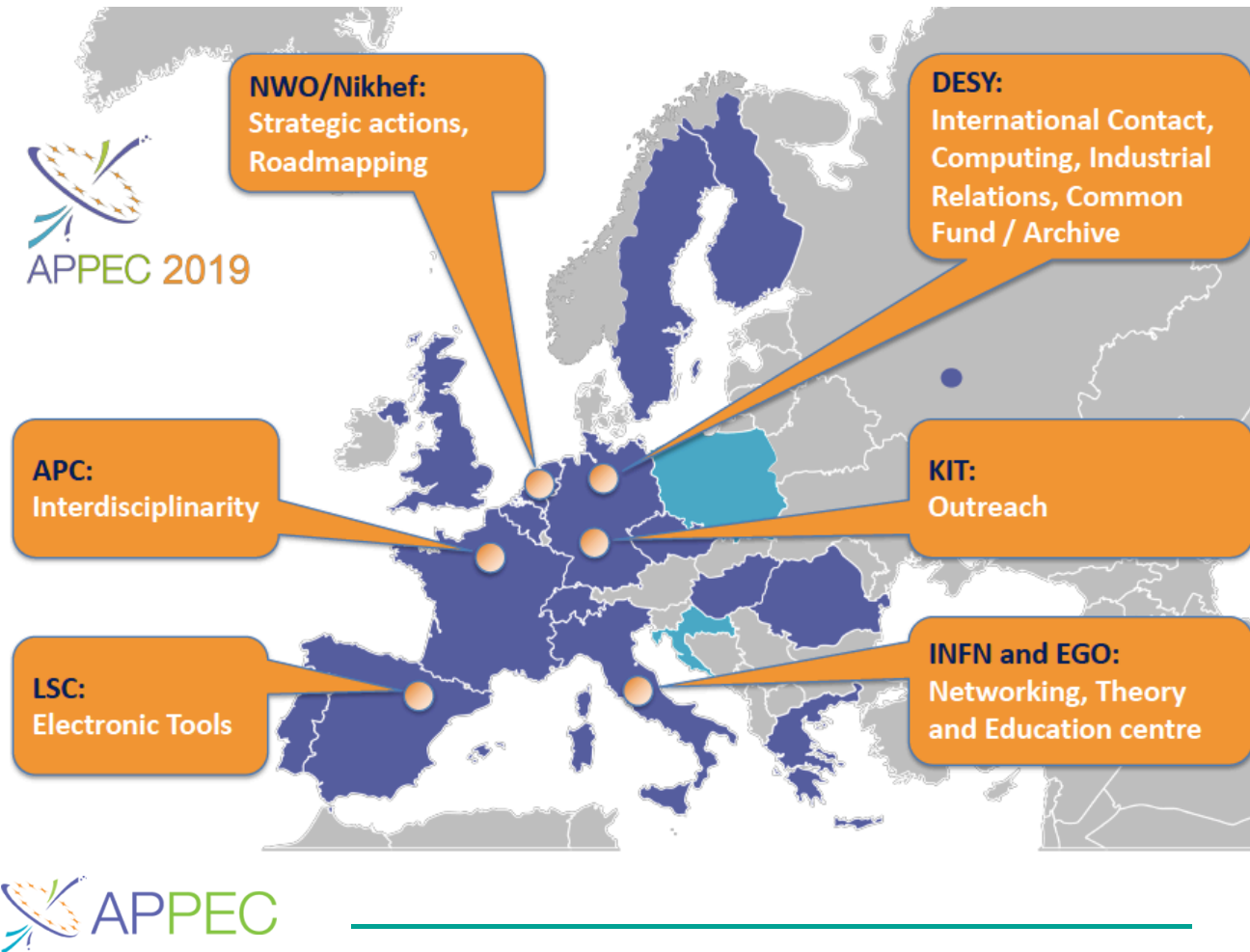
A meeting for framing cooperation on Science, Technology & Innovation, Data & Computing, Education, Outreach, Code of Conduct and Policies between 3 communities which share many scientific scopes. Inputs from your side (early career scientists!) are fundamental for its success.

14 Oct 2019

The APPEC Consortium

- Present APPEC MoU approved in 2012
- APPEC current organisation:
 - **The General Assembly (GA)** : strategic, decision making and supervisory body
 - Chair: TM (UniGeneva),
Deputy Chair C. Stegmann (DESY),
General Secretary: Job De Kleuver (NWO)
 - **The Scientific Advisory Committee (SAC)**
Chair: L. Baudis (UniZurich)
vice-Chair: J. Monroe (UniLondon)
 - **The Joint Secretariat** running the functional centres.

<https://www.appec.org>



Why APPEC is needed?

- APPEC **mandate**:
- Guarantee **Coordination** of European Astroparticle Physics in Europe between funding agencies and visibility at Ministry level through
- Structured **scientific advising** (SAC, dedicated panels to specific challenges)
- Development and update of **roadmaps** based on **scientific** strategies and **financial** considerations
- Establish relations with other bodies in companion fields
- Express collective views on APP in **international fora**
- Organise **Town meetings** (last one in April 2016, Paris)
- Support relevant meetings/schools of the community
- TechFora and Open Calls
- Engagement with society (Outreach, Education,...)
- Working Groups (R&D panel, Individual Recognition, Early Scientist career, Science WGs) and Organisations (EuCAPT...) to support the community



...and what does APPEC need?

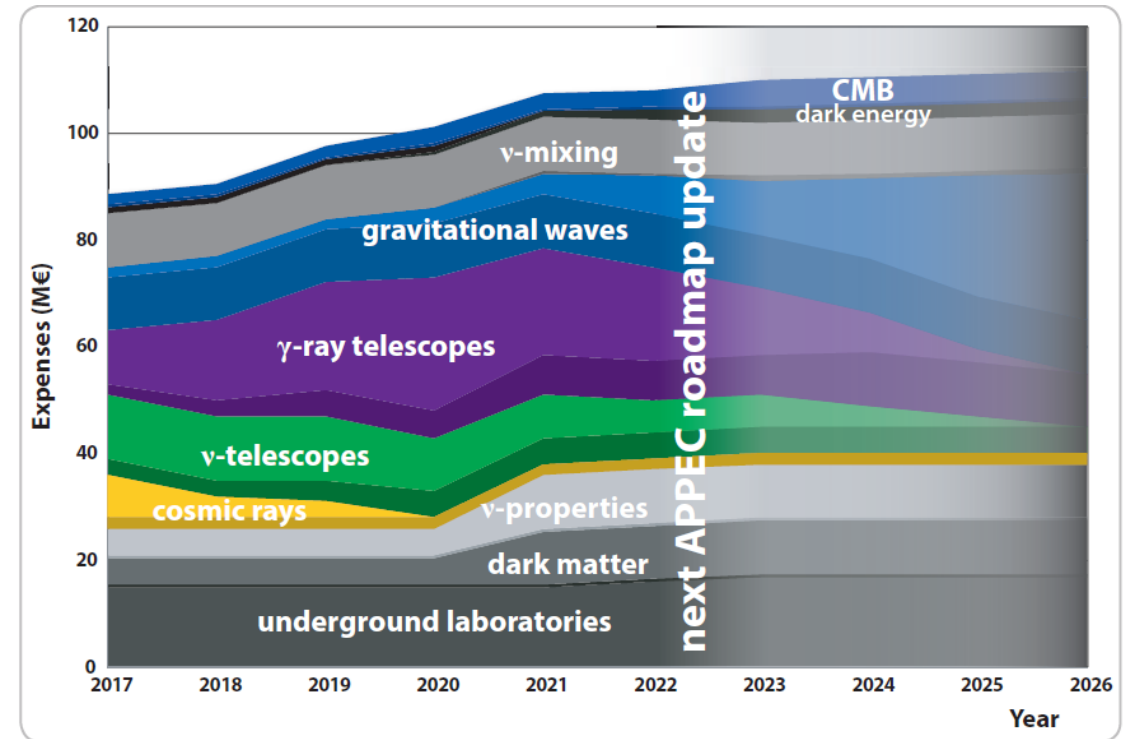
- On the long term **sustainability** of APPEC requires >> 2 FTE (already the 2012 MoU foresaw 6-8 FTE)
- **Sustainable APPEC** : set up a call for a **central office hosting & legally representing APPEC** is being proposed to the GA.
- 4-7 FTE would guarantee that the tasks of the **mandate** are executed with appropriate resources and **additionally**
- **Support the Community Research:**
 - advice and support applications to International and EC calls,
 - individuate programs to apply useful to specific APP communities, advise on proposal preparation
 - support for ESFRI applications
- **Network and Strategic Actions:**
 - Establish regular contact with the EU commission
 - Consult large collaboration about legal entities and governance, support operation of large experiments
 - Advice on their program implementation
 - Contact point for industry and for innovation (survey patents and spin-offs), organise more regular Tech Fora
 - Sustain further collaboration with ECFA and NuPECC: ECFA Detectors Panel, Individual Recognition panel...
- **Roadmapping:**
 - Roadmap preparation
 - Regular bi-annual Town meeting organisation
- **Governance & Policies:** Diversity & Gender, Early Career issues.

Outreach, Education, Society



Astroparticle Roadmap 2017-2026

Science Focus: Multi-messenger astrophysics and gravitational waves, neutrino nature and properties and the cosmological exploration (dark matter and dark energy).



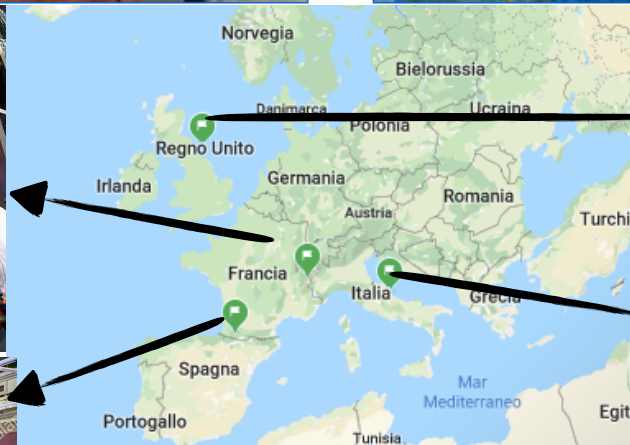
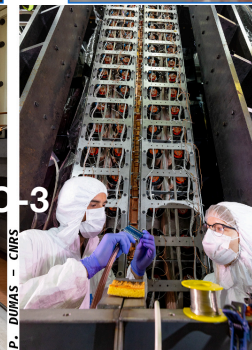
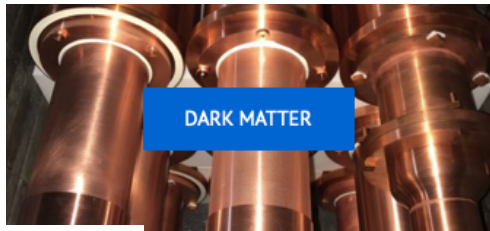
- A resource aware roadmap (darker colors mark M&O of RI)
- Awareness on long-term operation of large RI

2017 Thanks F. Linde, A. Masiero!

Underground laboratories

APPEC recognises the uniqueness of the infrastructures provided by Europe's deep-underground laboratories. Without these, key APPEC research objectives would become impossible to achieve.

*Important multi-disciplinary connections with geosciences - **nuclear and particle physics** - biology*



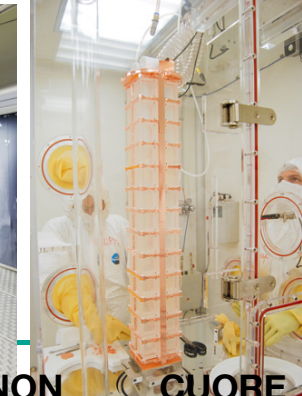
LABORATORI NAZIONALI DEL GRAN SASSO



New RITA facility for ^{226}Ra Ba tagging from Xe decay R&D
arXiv:1909.02782

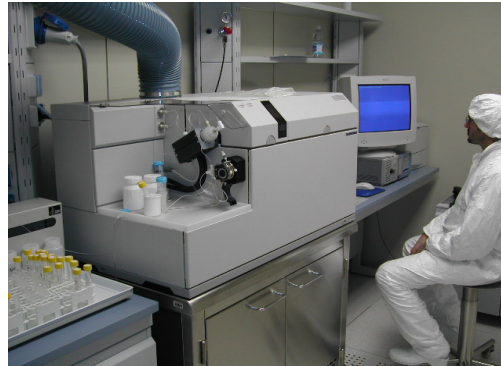


Thanks to directors being here!

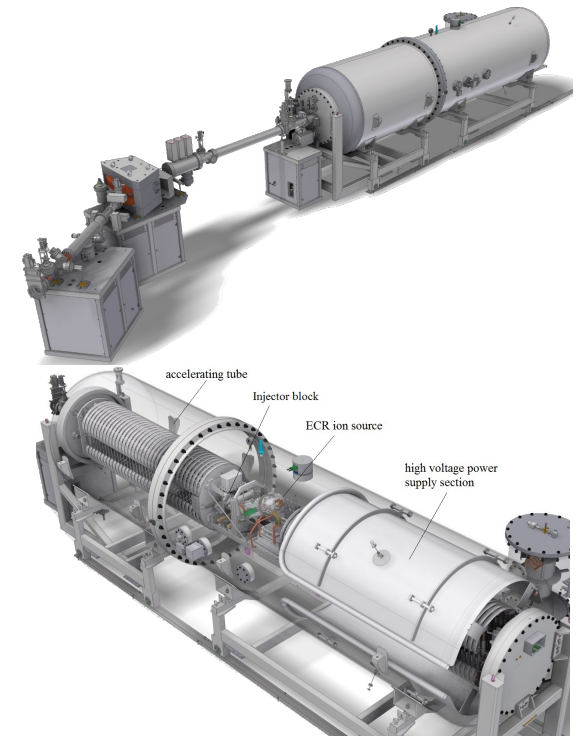


Nuclear Physics and Detector Facilities @ LNGS

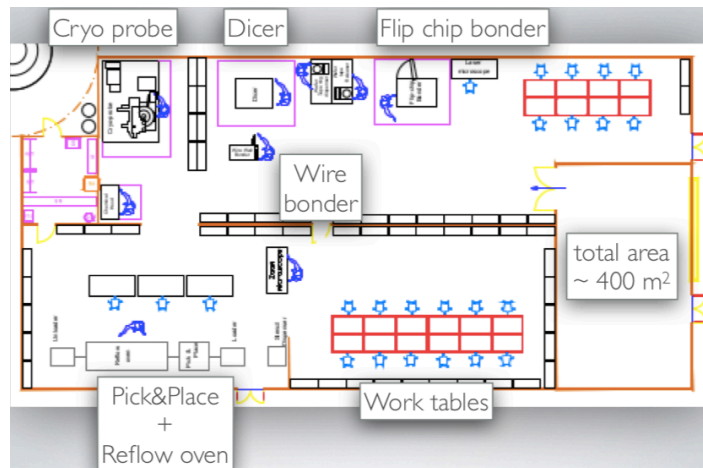
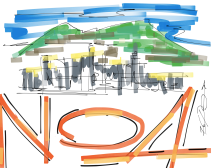
Material screening to improve detection limit Ultra Low-level Gamma-ray Spectrometry and ICPMS inductively coupled plasma mass spectrometry radiopurity assay to meet low background experiment demanding requirements



Nuclear Astrophysics LNGS 3.5 MV Accelerator Facility



Sen, A., NIM B <https://doi.org/10.1016/j.nimb.2018.09.016>



A new infrastructure for testing and packaging silicon photo-detectors started from DarkSide activities

Interdisciplinarity...



XIA alpha particle counter



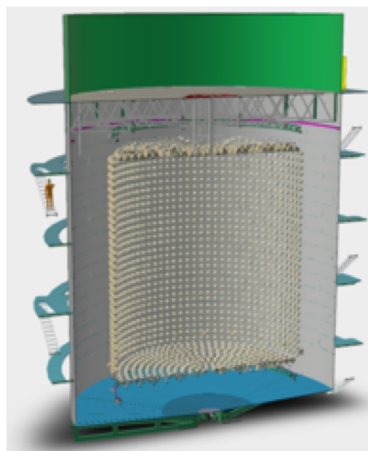
Ultra-Low-Background germanium detectors for rare-event detector material screening...



BUGS: Boulby Underground Germanium Suite

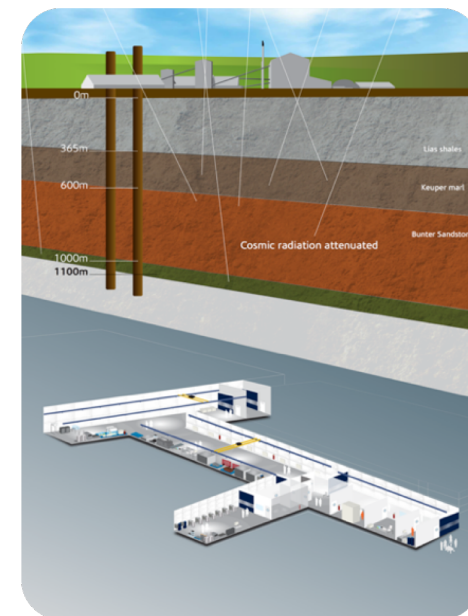
Deep Underground Multidisciplinary Science: Rare-event and low background studies (Dark Matter, neutrinos, etc), studies of geology geophysics, climate, the environment, astrobiology, life in extreme environs and technology development for planetary exploration

AIT- Advanced Instrumentation Testbed



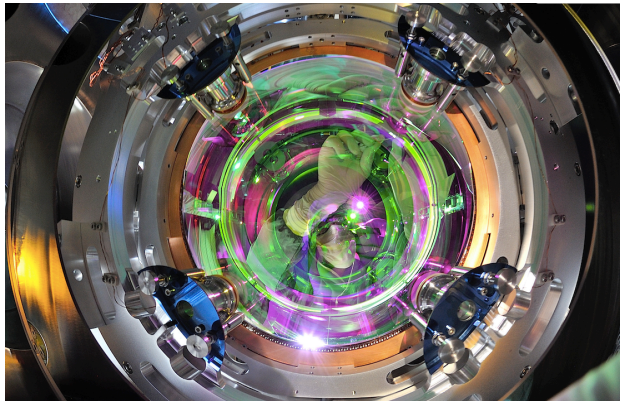
WATCHMAN: A 6kT Gd-loaded water detector looking at reactor anti-neutrinos for nuclear security, non-proliferation and technology R&D

STFC Boulby Underground Laboratory, UK

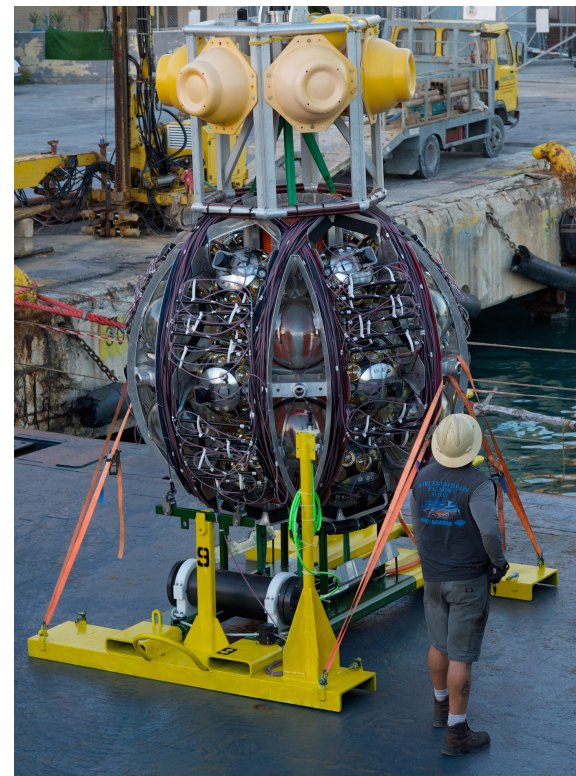


Science and Technology Facilities Council

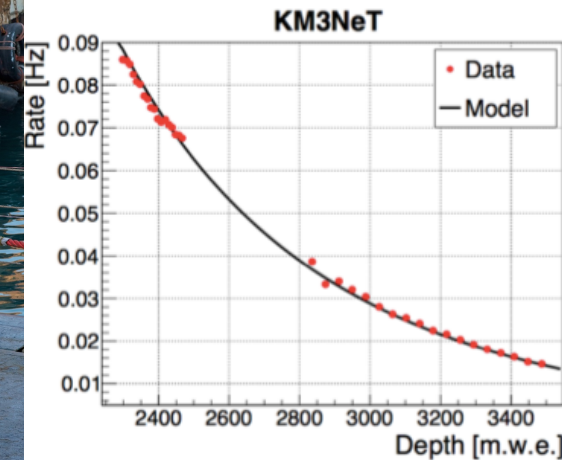
...and Research Infrastructures (RI) and facilities



Credits EGO



Credits KM3NeT



ARCA 2 and ORCA 1 data

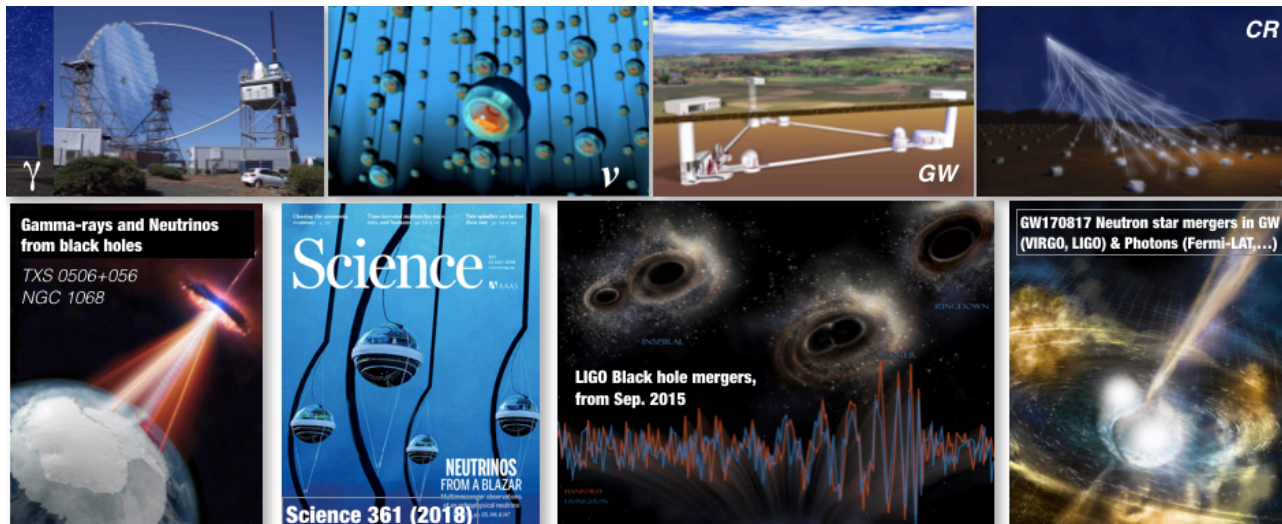
Town Hall KM3NeT multimessenger meeting 17-19 Dec.
<https://indico.cern.ch/event/848390/overview>

Muti-Messenger and Research Infrastructures

Last September **ESFRI** announced the **launch of the Roadmap 2021 Update**, a 2-yr-long process that will lead to the creation of a new **ESFRI Roadmap**. Deadline for Submission: **5th May 2020 at 18:00 CET**

- **Requirements:**

- proof of **political support** by the lead Member State (leads the preparatory phase) or Associated Country or Euroforum member and at least 2 additional MS/AC or Euroforum member;
- the expression of **funding commitment** by the lead Member State or Associated Country or a resolution of the Council for Euroforum Member;
- **inter-institutional and multi-lateral agreement** signed by the core partners formally involved in the consortium.
- have a **legal status and a governance structure** with clear responsibilities and reporting lines, including international supervisory and relevant external advisory bodies;

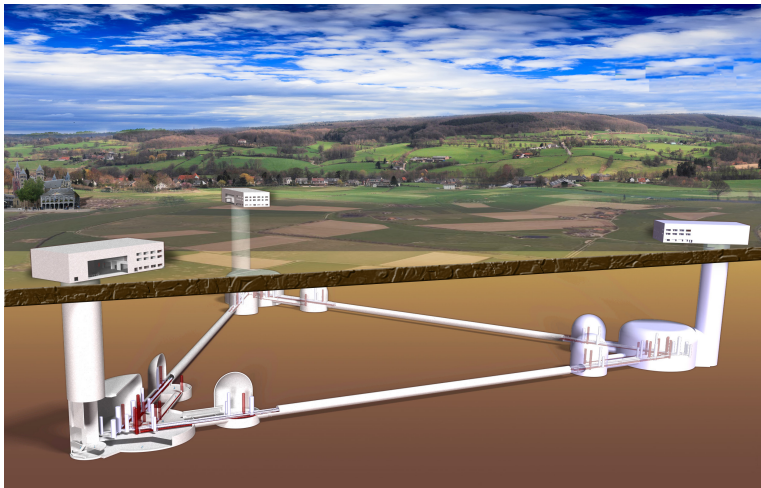


APPEC community major challenges:

- **ET ESFRI proposal in preparation**
- **KM3NET midterm review**

<https://www.esfri.eu/esfri-roadmap-2021>

Future larger scale RI: Einstein Telescope



GW Science: tests of gravity in regions of greatest space-time curvature, graviton mass constraints, Hubble constant, black holes existence, their horizon and their connection to dark matter, matter in extreme environment, origin of heavy elements, equation of state of ultra-dense matter elements, exotic objects (assessment of the science case report for 3G Gravitational Waves detection ongoing in SAC)

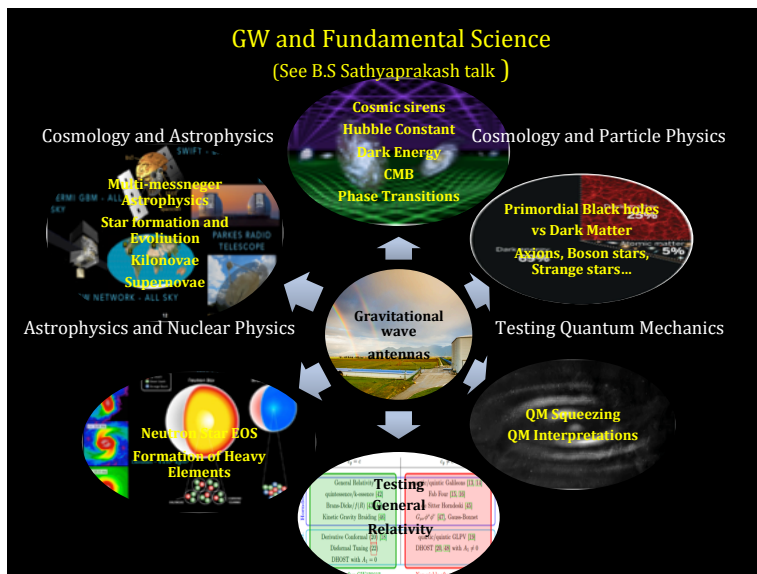
3G Governance possible models:

GWIC should found an international Umbrella Organization by the Dawn V meeting in Spring 2019 to coordinate international research and development for 3G and detector upgrade plans (relevant also for ESFRI)

Possible scenarios:

- 1) International non-profit company : privileges and immunities are based on voluntary agreements
- 2) An international RI consortium e.g. ERIC or International Research Infrastructure Consortium (IRIC) where each partner deposits a letter of commitment on agreed work in the consortium
- 3) An Intergovernmental Organization (IGO) based upon a treaty-strength international Convention as CERN or emerging SKA IGO

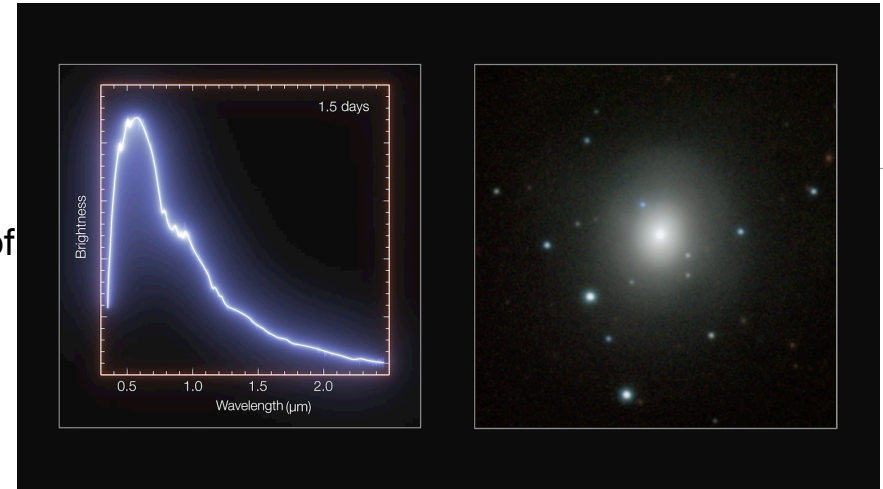
GWIC details a program of ~6 year to achieve an international legal entity



<https://gwic.ligo.org/3Gsubcomm/documents.shtml>

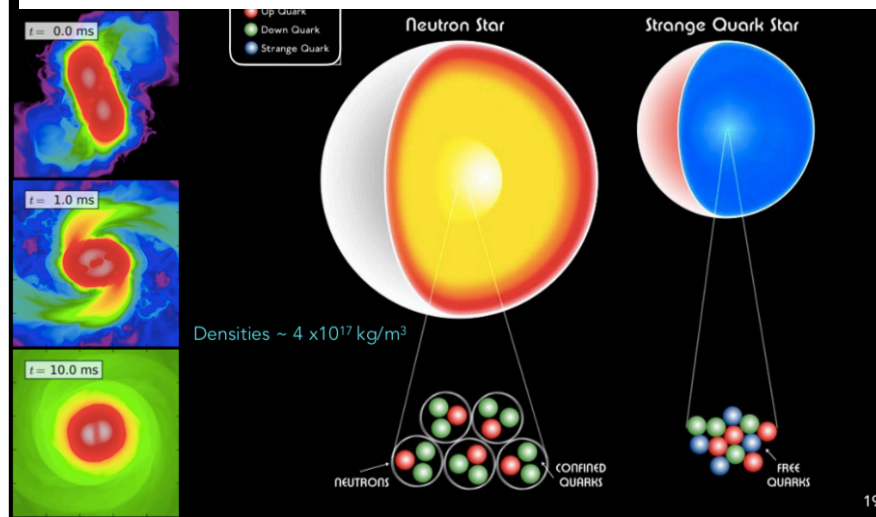
GW & Nuclear Physics

Neutron stars are precious laboratories for the subatomic physics of matter under unique conditions, and the multitude of phenomena connected with multi-messenger emission from NS binary mergers is of broad interest to NP and PP. At density $> 2-3 \times \rho_0 \approx 2.5 \times 10^{14} \text{ gcm}^{-3} =$ terrestrial nuclear density, phase transition to new states of matter containing deconfined quark-gluon plasma



The collision of two NS in GW170817 is a complex nuclear physics experiment, where it has been possible

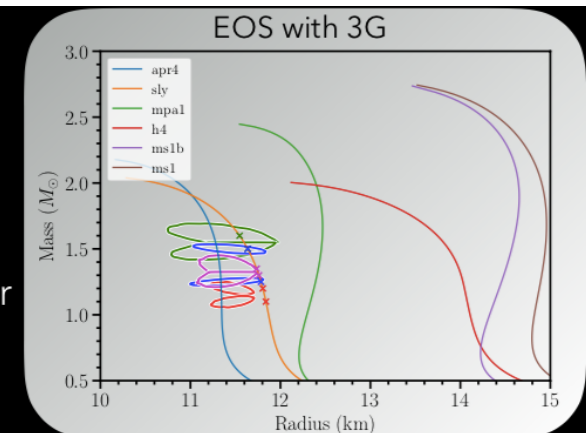
- 1) To accurately measure the mass and radius of the NS through the tidal deformation of the star \rightarrow and constrain the EOS
- 2) The brightness and color of the kilonovae are diagnostic of both the total mass of r-process elements and the relative abundance of lighter to heavier elements.



Sathyapakash's talk Granada

- ❖ constraints on NS radius : $9.1 \text{ km} < R_1$, $R_2 < 13.3 \text{ km}$
- ❖ softer EoS preferred (e.g. APR4) over stiffer ones (e.g. H4)

Abbott+, arXiv 1805.11581



Synergy with CERN towards 3G GW detectors

An accelerator beam pipe without a beam, many shared challenges with CERN

I) **Vacuum** and **cryogenics** R&D is an enabling factor for new accelerators and GW interferometers

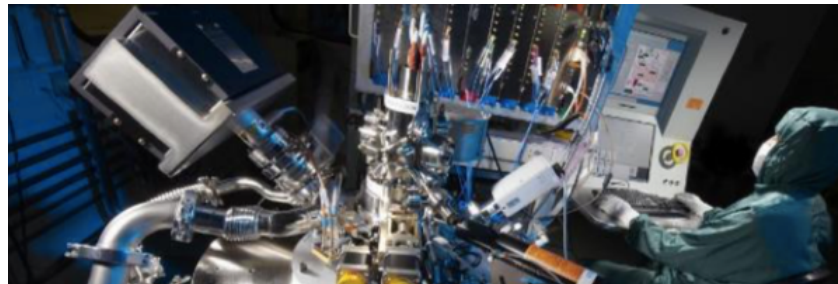
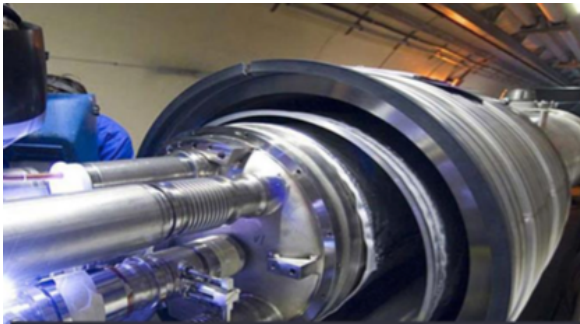
II) **Extreme photonics** and **Control** are necessary both in HEP & GW detectors for stray light control and mitigation

III) The **civil engineering infrastructure** is main cost is a large part of the next generation projects (PP including neutrino and GW interferometer arms on ground or underground), and therefore, “smart” and resilient solutions have to be found

IV) Innovative solutions will have to be found for the **computing and data analysis infrastructure**, including the distribution of low latency alerts among continents as well as new data harvesting methods (big data analytics, machine learning,..)

V) Last but not least the consortia building GW large infrastructures will profit enormously from the previous experience of the PP community on **building and sustaining large communities and infrastructures**.

An MoU will detailed Working Packages for common work with CERN

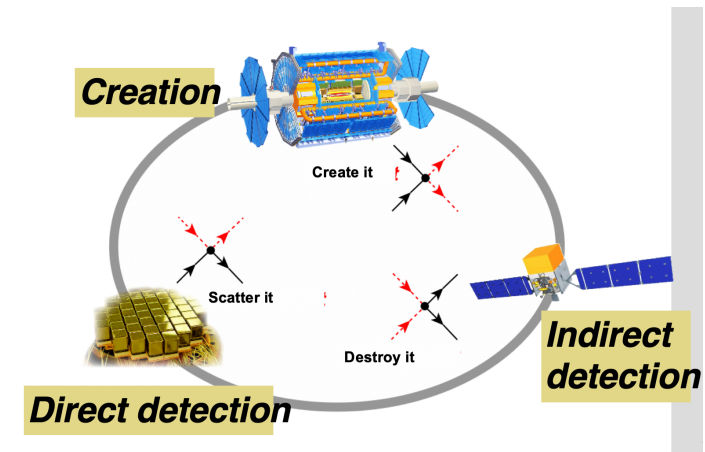
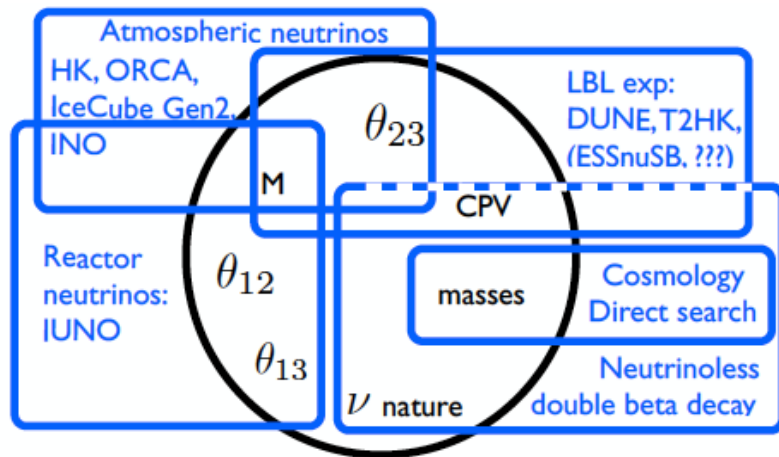


APPEC Science challenges in the EPPSU 2019

- APPEC EPPSU input # 84:
 - i) the **dark matter searches** (Ch. 9 of Briefing Book);
 - ii) the **multi-messenger astronomy**, in particular the **3G GW** experiments (ET) (Ch. 7 of Briefing Book);
 - iii) **the neutrino physics** (Ch. 6 of Briefing Book);
 - iv) the creation of a **European Center for AstroParticle Theory (EuCAPT)**
- Many EPPSU Inputs on ApP from national labs & organisations (INFN, Nikhef, KAT, SFP, JINR & RA,...)

In The vigorous continuation and full development of the CERN neutrino platform as well as an active role of particle physicists and engineers for global collaboration on neutrino projects aiming at clarifying the crucial puzzle of the origin, **nature** and features of **neutrino masses and mixings** and the possible existence of **sterile neutrino** states.

Particle Physics Cooperation with respect to DMsearches, including R&D and enabling technologies leading towards a global program on DM searches, similar in breadth to the neutrino physics program. The objective of DD experiments is to reach the neutrino floor beyond which new strategies/R&D need to be prepared as well to address other DM candidates than WIMPs



APPEC Direct Detection DM panel mandate composition approved

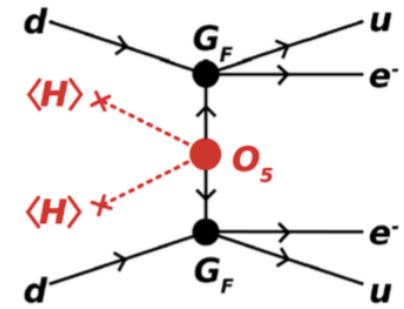
Neutrinoless double-beta decay

APPEC $0\nu\beta\beta$ (Chair. S. Pascoli): Launch of Roadmap Document

Synergy between PP and NP:
nuclear matrix elements

$$(A, Z) \rightarrow (A, Z+2) + e^- + e^-$$

$0\nu\beta\beta$ decay:



Weinberg, 1979

APPEC Community Meeting on Neutrinoless Double Beta Decay

Hallam Conference Centre, 44 Hallam Street,
W1W 6JJ London
31 Oct 2019

<https://indico.cern.ch/event/832454/>



$$\left(T_{1/2}^{0\nu}\right)^{-1} = \left|\frac{m_{\beta\beta}}{m_e}\right|^2 g_A^4 \left|M_\nu^{0\nu}\right|^2 G^{0\nu}$$

Phase factor well understood

?

NME must be evaluated using tools of nuclear theory

$$m_{\beta\beta} = \left| c_{13}^2 c_{12}^2 e^{i\alpha_1} m_1 + c_{13}^2 s_{12}^2 e^{i\alpha_2} m_2 + s_{13}^2 m_3 \right|$$

Double Beta Decay APPEC Committee

Silvia Pascoli (Chair, Durham U.)
Andrea Giuliani (CNRS/IN2P3)
J.J. Gomez Cadenas (DIPC)
Ezio Previtali (Milano-Bicocca),
RubenSaakyan (UCL)
Karoline Schaner (GSSI)
Stefan Schonert (TUM)



Activities of EuCAPT European Centre for Astroparticle Theory

Central Hub established at CERN (thanks to INFN and NIKHEF, since APPEC has no legal basis to sign)

Director nominated on consensus: Gianfranco Bertone. Portal in ~2 weeks

Steering Committee of supporting Institutes:

- **APC Paris**, Fr [David Langlois]
- **CERN Theory Department** [Gian Giudice]
- **DESY (Hamburg+Zeuthen)**, G [A. Taylor]
- **GRAPPA/Nikhef Amsterdam**, NL [G. Bertone]
- **ICC Barcelona**, ES [Licia Verde]
- **IFPU (SISSA+ICTP+INFN+INAF)** Trieste, I [P. Ullio]
- **IPPP, Durham**, UK [Silvia Pascoli]
- **IST Lisbon**, Portugal [Vitor Cardoso]
- **OKC Stockholm**, Sweden [David Marsh]
- **Paris-Saclay**, FR [Philippe Brax]
- **Université de Genève**, CH [Antonio Riotto]
- **University of Oxford**, UK [Subir Sarkar]



Proposal of a **WhitePaper Theoretical Cosmology and Astroparticle physics** in the next decade to be examined by the SAC before submission to GA.

1st EuCAPT Workshop: Gravitational Wave Probes for Fundamental Physics

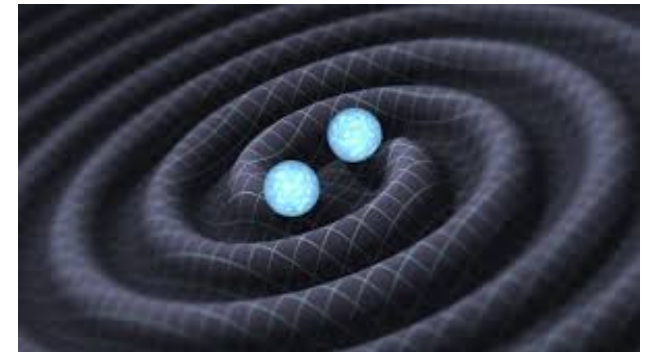
11-13 Nov. <https://indico.cern.ch/event/843270/>

It aims at bring together the Gravitational Wave and Fundamental Physics communities to discuss topics in Dark Matter, exotic objects, tests of GR and early Universe physics, as well as tests of Standard Model physics in unexplored regimes.

Confirmed speakers: Tessa Baker, Andrea Bertoldi, Vitor Cardoso, Siyuan Chen, Djuna Croon, Neal Dalal, Thomas Edwards, Stephen Feeney, Alex Jenkins, Peter Johansson, Bradley Kavanagh, Eugene Lim, Masha Okounkova, Paolo Pani, Pedro Schwaller, Ulrich Sperhake, Yevgeny Stadnik, Bert Vercknocke, Marta Volonteri, Anna Watts, Helvi Witek

Future happenings:

- Identified possible international programs for joint proposals
- set up monthly EuCAPT colloquia
- 1 community-building annual general meeting at CERN (7-9 Sep. 2020);
- another thematic workshops at other participating institutions.
- possibly 1-week “micro workshops” at CERN.



The Big Science quests emerging from EPPSU2019

PP and APP share many of the science open questions (Theory overview Ch. 2):

- 1) Higgs sector: role of Higgs naturalness in SM still requires precision measurements
- 2) Strong Interactions (**heavy ions to proton collisions, neutron stars to early-Universe cosmology**)
- 3) Strong CP (**axions** which is also DM, or influences stellar evolutions, dynamics of early cosmology)
- 4) Flavour physics: why pattern of masses and mixing of quarks and leptons is different
- 5) **Neutrinos** : special **nature** of its mass, **penetrating probe into the far structure of the Universe** and to peek into the **dark sectors of the cosmos**, requiring increasing precision on overall mass scale and mixing parameters, CP violation connection to leptogenesis and search for new light particles
- 6) **Dark matter**: overwhelming evidence from cosmology and astronomy on its gravitational imprint, but nature and location remain mysterious.

Both 5) and 6) are **exciting** because they **bring together different fields** (PP & APP, cosmology, astrophysics) + **different technologies** (accelerators and beam dump, underground detectors, cosmic particles, reactors,...).

- 7) The **cosmos**: Inflation and Dark Energy. Cosmic Multi-Messengers.
- 8) **Gravity** is the most familiar of all forces in nature and yet it hides some of the most perplexing open questions in PP today: the ultimate theory bringing together **quantum gravity** and the **SM**

Towards Final recommendations

- EPPSU 2013 Recognition of complementarity and synergy : *The question can be asked whether this support should be enlarged and also whether CERN should directly engage in Astroparticle Physics experiments.*
 - ...strong scientific case for a **long-baseline neutrino programme** exploring **CP violation** and the **mass hierarchy....** CERN should develop a neutrino programme to pave the way for a substantial European role in future long-baseline experiments => **CERN Platform indisputably important!**
 - In the coming years, CERN should seek a **closer collaboration with APPEC on detector R&D** with a view to maintaining the community's capability for **unique projects** in this field. **REC is not enough!**
- **EPPSU 2019 should be a step ahead!**
 - **recognition of APP scientific impact:** Recent particle physics discoveries in astroparticle physics experiments and observatories and their promising future potential for more key discoveries in particle physics, demand mechanisms for concrete co-operation between both accelerator laboratories (such as CERN) and astroparticle physics facilities
 - Under discussion in WG3:
 - For technology **dedicated MoUs** with some common guidelines
 - Future cooperation on **governance** of large RI

Facing a new European Community : Research & Innovation days

The eve of a **new European Commission leadership** and framework cycle : set directions for a more **sustainable** (for society and economy!) and **competitive** innovation in the future. Get innovation to the market!

<https://ec.europa.eu/digital-single-market/events/cf/european-research-and-innovation-days/programme.cfm?id=452>

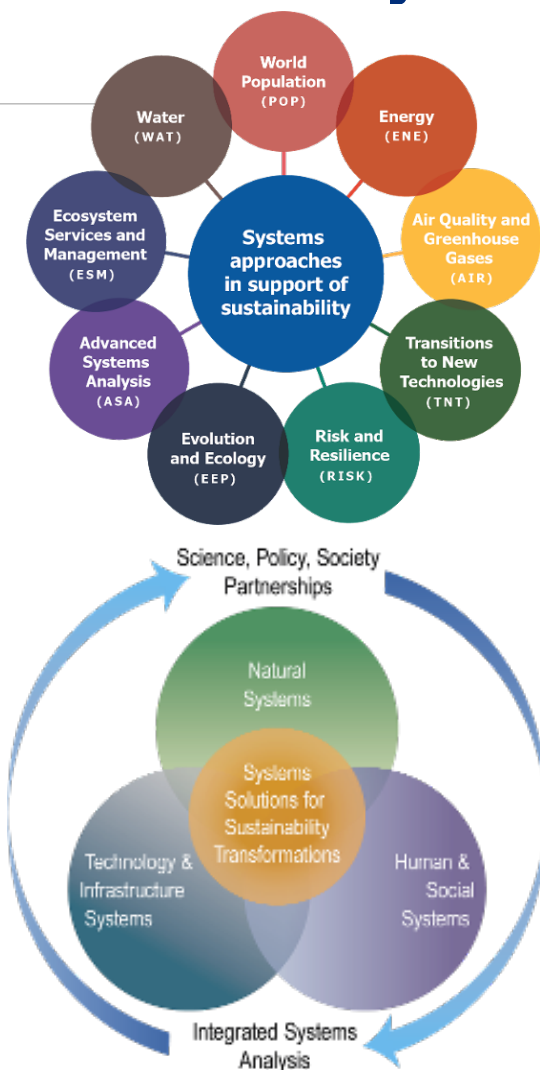
NATURE SUSTAINABILITY

PERSPECTIVE



<https://www.nature.com/articles/s41893-019-0352-9.epdf?>

author_access_token=PYxHlTzicPDZ1f8Mpi4ddRgN0jAjWl9jnR3ZoTv0OUvCcY5pZ8AaTx0MkoopkKOS7OzdwrSBL-nqy90SNoGgHmldD2otpkpRagcTqK2IJMLpfAw86QRMHl3QEjytXGWz5FGotx9W9u1jWK0QbJVw%3D%3D



<https://www.iiasa.ac.at>

What APPEC-ECFA-NuPPEC could do for R&D and technology?

Current Members

Name	Advisory role in area of	Contact
Federica Petricca (MPI für Physik)	Astroparticle	petricca_at_mpp.mpg.de
Laurent Serin (FR)	Calorimetry	Laurent.Serin_at_cern.ch
Silvia Dalla Torre (IT)	Gaseous Detectors	Silvia.Dallatorre_at_cern.ch
Phil Allport (UK)	Chair, Silicon	philip.patrick.allport_at_cern.ch
Arno Straessner (DE)	Electronics/DAQ	Arno.Straessner_at_cern.ch
Lucie Linssen (CERN)	General	Lucie.Linssen_at_cern.ch
Ariella Cattai (ICFA, CERN)	Ex-officio	Ariella.Cattai_at_cern.ch
Doris Eckstein (DESY)	Silicon, Scientific Secretary	doris.eckstein_at_desy.de
Ian Shipsey (Oxford)	Ex-officio	ian.shipsey_at_physics.ox.ac.uk

ECFA (APPEC-NuPPEC detector panel: A real platform for cooperation:

The ECFA Detector Panel is aimed at providing advice on detector development efforts for projects in their preliminary and preparatory phases. It receives R&D proposals on request by research communities, laboratories, institutions, individual authors and bodies such as science funding agencies. It appoints experts charged to evaluate them and make recommendations. It helps to create coherence of global detector R&D efforts by encouraging synergies between different activities and advising funding agencies on request. It is primarily concerned with large projects, related to accelerator and non-accelerator experiments in the fields of particle and astroparticle physics, involving several institutions and requiring significant resources. It is in particular intended for the review of projects that do not undergo an existing review process elsewhere.

APPEC representative:

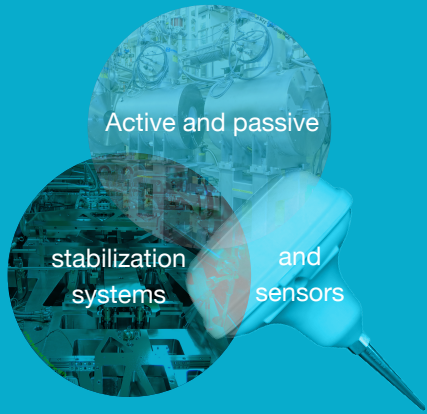
Federica Petricca
MPP, Munich



- Renew the mandate of the panel : survey of efforts with return on society, sustainable ?
energy (High Temperature Superconducting, Nuclear Magnetic Resonance, Nuclear Fission with lower waste)
medical applications (accelerators, photosensors, ultra-fast electronics, scintillators,...)
Climate change, geo-physics (atmosphere monitoring, LIDAR, tomographies for volcanoes, glaciers, ...)
Digital revolution: computing, analysis methods....
- APPEC TechFora can be open to ECFA and NuPPEC: advice in TechFora scientific programs.

See Jo van den Brand's talk

APPEC Technology Forum 2018



More APPEC-ECFA-NuPPEC Common Activities

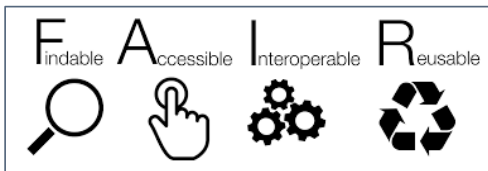
- APPEC **transversal** contacts with other communities are very important. Bi-annual JENAS APPEC-ECFA-NuPECC meetings
- Chairs observers in the 3 assemblies
 - Oct 17: NuPPEC Meeting now includes a discussion on possible synergy with APPEC

- **HEP Software Foundation meeting** (LAL, 16/10 at 16:00 also by Vydio to discuss common ground on software challenges: <https://indico.cern.ch/event/852242/>)

Use this meeting to start areas of cooperation on **data analysis in cooperation (establish a real WG should be an objective!)**: address advanced analysis methods, frameworks that able to treat data of different experiments, computing, processing, storage/data policies.

New WG or already existing frameworks? E.g. HEP Science Foundation, ESCAPE, Physics Beyond Colliders WG, Rucio... advanced training!

- Theory support: **EuCAPT**. Notice also the meeting in these days The Paris-Saclay AstroParticle Symposium at Institut Pascal (<https://ipa-user.universite-paris-saclay.fr/AstroParticles>)



See G. Lamanna's presentation

Diversity, Code of conduct, Early Career, Individual contributions

- APP large projects need fair regulation which are normally hard coded in large organisations of Euroforum
 - After the successful ECFA Survey, Working Group on Recognition of Individual contribution in large experiments, APPEC nominated 2 members from APPEC: K-H. Kampert (Wuppertal U.) and E. Gangler (Clermont-Ferrand) in the WG
 - Future actions of the WG:
 - discuss the eligibility criteria for the collaborations joining the WG
 - Next steps: assemble list of collaborations, contact them, set up modus operandi of the WG setup mailing lists for the WG and organise their minuting and reporting structures, organise meetings
 - For Social and Career Aspects for the Next Generation ESG - WG1 launched a mini-survey (400 answers).
- ECFA Meeting of Early Career researchers on the EPPSU2019 Nov 15 will hopefully cover APP and NuPPEC areas.



See J. d'Hont talk

Launch of the Diversity Charter @ JENAS 2019

PLENARY ECFA
[Composition](#)
[Meetings](#)
[Documents](#)

RESTRICTED ECFA
[Composition](#)
[Meetings](#)
[Documents](#)

Diversity Charter



Diversity Charter
APPEC-ECFA-NuPECC

<http://ecfa.web.cern.ch/content/diversity-charter>

Adhering to the Diversity Charter allows to be part of a long term monitoring process

Monitoring through an initially very simple survey: applies to Institutes, experiments and Conferences

See Tomas Brage Diversity Panel

Outreach or Public Engagement

(see Steven Goldfarb's talk)

- APPEC current activities: website & ~monthly Newsletter: describe APPEC activities, informing, contact with scientists (interviews, news to foster their science), advertise meetings and successful measurements /theory
- In the frame of ESG-WG5 (led by Sijbrand de Jong) decision to strengthen the liaison with European Particle Physics Communication Network (**EPPCN**) (of which APPEC is a member) + APPEC will attend the International Particle Physics Outreach Group (**IPPOG**) meetings. IPPOG a suitable frame for APP activities (e.g. for GW?)

Possible IPPOG/APPEC cooperation on

- Inventory of activities some of which are still poorly connected International Cosmic Day (<https://icd.desy.de>) and Dark Matter Day (<https://www.darkmatterday.com>), PP and APP experiments' master classes
- City Science projects of experiments
- Announcements of dedicated sites for outreach in institutes eg. EUTOPIA, LAPP: an excellent example of outreach in synergy between PP-APP, exhibitions, or arts/science installations



First results of KATRIN – limit on the neutrino mass

26TH SEPTEMBER 2019

Interview with Christian Weinheimer on the recent publication of the first KATRIN results The long awaited science run at KATRIN...

[Read More](#)

Congratulations to KATRIN!



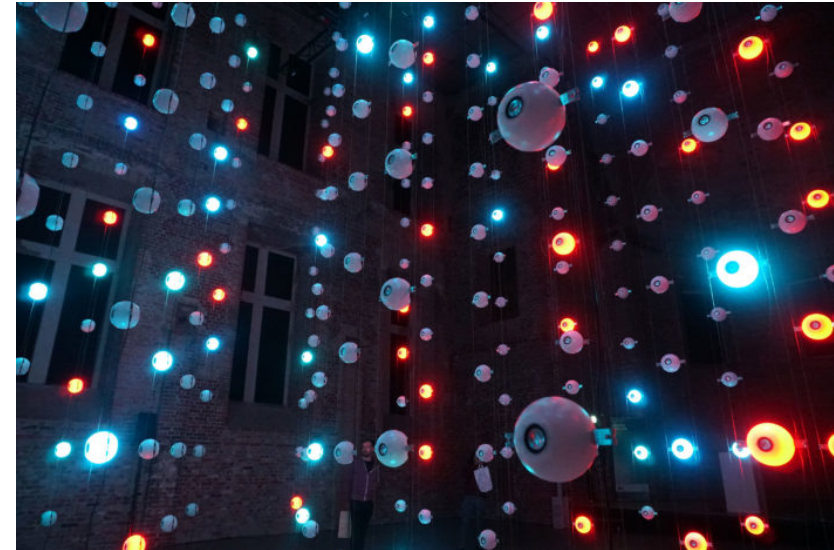
Art & Science

IL RITMO DELLO SPAZIO LE RYTHME DE L'ESPACE THE RHYTHM OF SPACE

Oct. 12 - Dec 8, Museo della Grafica, Pisa



Tim Otto Roth



- **Science Gateway** activities at Globe of Science, Education & Outreach, Innovation & Knowledge exchange, Culture & Creativity should be more inclusive of Astroparticle to enrich the current portfolio.
- Relaunch Science Gateway **could extend its scope as a platform to raise funds presenting from its portal projects in science/art?**



SFB 1258



HAMAMATSU



<http://ludwigforum.de/event/tim-otto-roth-ais3-a-sound-laboratory/>

Conclusions

- Our roadmaps require more coordination
- Joint meetings & panels on innovation and technology
- Organisations should foster multi-disciplinarity and bottom up approaches on formation of dedicated WGs
- JENAS offers an opportunity and can become a regular meeting point for discussing science and much more (technology & innovation, data share and analysis, diversity, gender, education, policies, governance of infrastructures,...)