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.
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

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

arXiv:1909.02782

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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.

A new infrastructure for testing and packaging silicon photodetectors started from DarkSide activities.

Nuclear Astrophysics
LNGS 3.5 MV Accelerator Facility

Interdisciplinarity...

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

BUGS: Boulby Underground Germanium Suite

XIA alpha particle counter

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

STFC Boulby Underground Laboratory, UK

Life in Boulby Salt...

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
...and Research Infrastructures (RI) and facilities

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

ARCA 2 and ORCA 1 data
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 Eiroforum member and at least 2 additional MS/AC or Eiroforum member;

• the expression of funding commitment by the lead Member State or Associated Country or a resolution of the Council for Eiroforum 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

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 \( \times \rho_0 \approx 2.5 \times 10^{14} \text{ g cm}^{-3} = \text{terrestrial nuclear density} \), 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.

- 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 DM searches, 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.
Neutrinoless double-beta decay

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

Synergy between PP and NP: nuclear matrix elements

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

Weinberg, 1979

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

Phase factor well understood

NME must be evaluated using tools of nuclear theory

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.
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 Vercnocke, 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,…).


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

Briefing Book at: http://cds.cern.ch/record/2691414
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

______________________________  APPEC  ________________________________
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!

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

Current Members

<table>
<thead>
<tr>
<th>Name</th>
<th>Advisory role in area of</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
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</tr>
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**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
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/](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](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

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: applis to Institutes, experiments and Conferences

See Tomas Brage Diversity Panel
Outreach or Public Engagement

• 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

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

- **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.

- Relaunched Science Gateway **could extend its scope as a platform to raise funds presenting from its portal projects in science/art?**

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,...)