

PAAP Activities

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PAAP Activities

- ⦿ **PAAP reboot in June 2012**
 - ▷ Members: Anne Green (Nottingham), Jim Hinton (Leicester), Silvia Pascoli (Durham), Patrick Sutton (Cardiff), Lee Thompson (Sheffield)
- ⦿ **Web-based consultation 17/08/12 – 14/09/12**
- ⦿ **Community meeting 12/10/12**
- ⦿ **Roadmap draft 10/10/12, submission 31/10/12**
- ⦿ **Presentation to PPAN 20/11/12**
- ⦿ **Input to Triennial Review of Research Councils**
 - ▷ via Science Board

PA Scope?

① 1) Multi-messenger Astronomy

- ▷ Astrophysical measurements using unconventional messengers, including ultra-high-energy protons, very-high-energy γ -rays and neutrinos, and gravitational waves
 - ◆ the exploration of extreme and/or otherwise inaccessible environments and phenomena and the origin and role of accelerated particles in astrophysical systems.

② 2) Fundamental Physics with Cosmic Messengers

- ▷ Use messengers to test fundamental physics under extreme conditions and/or at energies beyond the reach of terrestrial experiments
 - ◆ includes tests of Special and General Relativity and the Standard Model of Particle Physics, and the search for the nature of Dark Matter.

Consultation

⦿ Inputs from 96 individuals, 84 web submissions

- ▷ +Pro-formas and other project input
 - ◆ DIRAC, CTA, AdvLIGO, GWs, DMUK, Inverse Square Law, STE-QUEST, LISA-PF, GOTO

⦿ Are these the right questions? Yes (~74/84)

- ▷ all questions considered important

⦿ Facilities and Areas

- ▷ 57 different facilities mentioned! Strong support for multi-wavelength and multi-messenger approach
- ▷ 90% of responses very positive about one of these areas:
 - ◆ Gravitational-wave astronomy
 - ◆ Gamma-ray astronomy
 - ◆ Direct dark matter detection

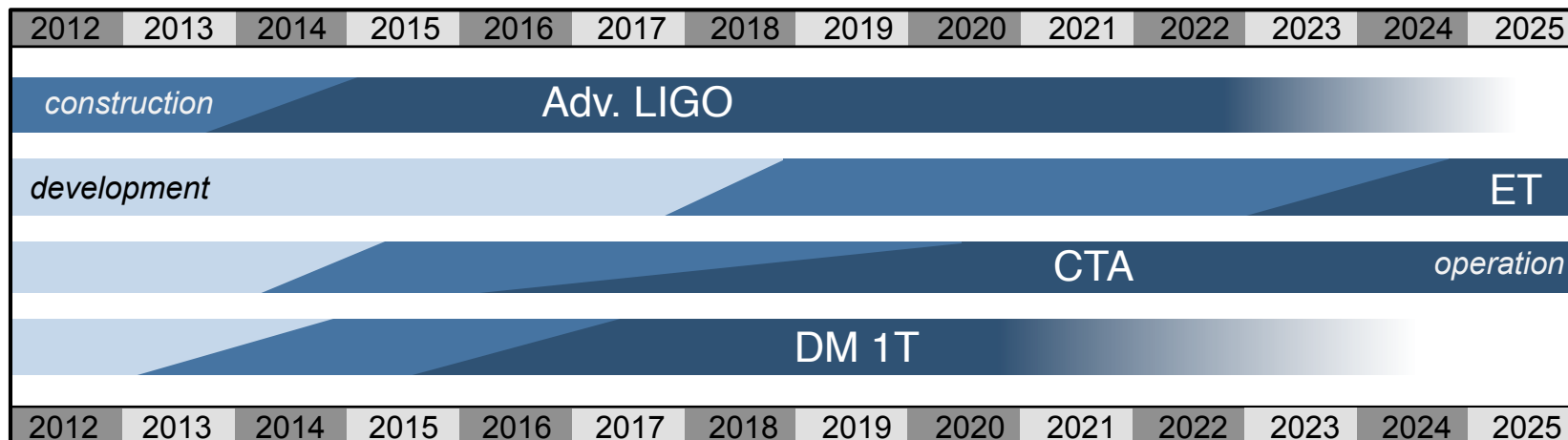


Science / Techniques Mapping

Type	Instrument	e.g.	Compact Objects				CR Impact	Dark Matter	Dark Energy	Relativity	Neutrino Prop.	New Particles
			1a	1b	1c	1d						
			2a	2b	2c	2d						
PA	GW Observatory	Adv. LIGO	3	3				2	3		1	
PA	γ-ray Observatory	CTA	1	2	3	3	2		2		1	
PA	VHE Neutrino	Km3Net	1	2	2	1	2		1	2		
PA	UHE Cosmic Ray	Auger	1	1	3	1			1	2	1	
PA	UHE Neutrino	ARA			2					2	1	
PA	Direct DM	DM-1T					3				1	
PA/PP	MT multi-purpose	LAGUNA	1	3			1		1	3	2	
PP	Non-collider PP											
PP	Collider PP											
AP	Optical-IR Obs.											
AP	Radio Observatory											
AP	X-ray Observatory											

Roadmap / Priorities

- | | | | |
|----------|---|---|---|
| 1 | <ul style="list-style-type: none"> ● Advanced LIGO | ← | Capitalise on major investment |
| 2 | <ul style="list-style-type: none"> ● CTA ● 1T-scale DM detector ● Einstein Telescope | ← | New opportunities with exciting science and UK leadership |
| 3 | <ul style="list-style-type: none"> ● GEO-HF, GW space R&D ● LAGUNA, ISL | ← | Excellent additional PA science |



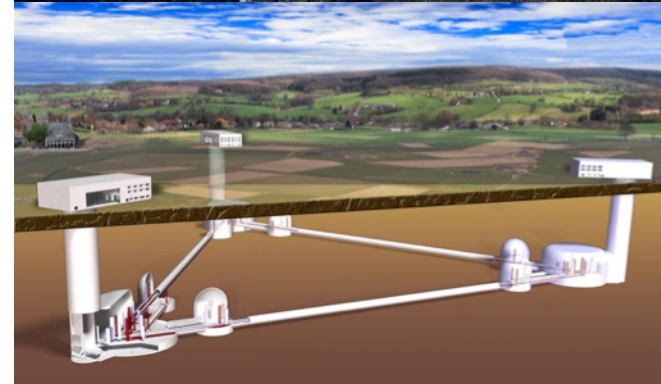
Gravitational Waves

⊙ Advanced LIGO

- ▶ Under construction in US, first science operations 2015, expect first direct detection of gravity waves by ~2017
 - ◆ rate of detected compact binary coalescences $0.4-400 \text{ yr}^{-1}$
- ▶ Strong UK involvement
- ▶ Recommendation: *Strong support for exploitation & upgrades to profit from UK investment*

⊙ Einstein Telescope

- ▶ Design phase 3rd Generation detector
 - ◆ 10^5 binary coalescences / year, cosmological parameters, precision studies of compact objects +++
- ▶ Recommendation: *Support R&D for future GW detectors, working towards participation in ET*



Very High Energy Gamma Rays

◎ CTA

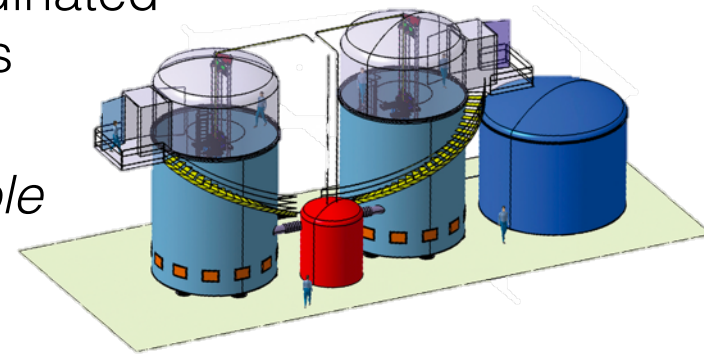
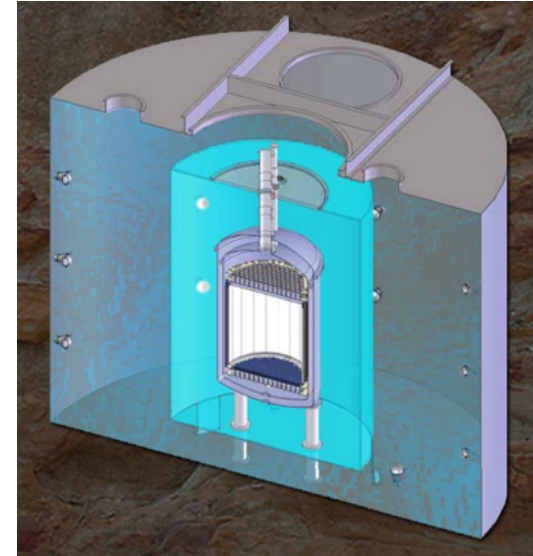
- ▷ £150M global (27 nation) project (~100 telescopes)
- ▷ Preparatory phase, Construction 2015-2020, Science from 2016. STFC funded camera prototyping+ 2012-15
- ▷ The major γ -ray observatory of the next decade(s)
- ▷ Broad science case: DM, LIV, axions, particle acceleration and impact, ...
- ▷ Strong UK involvement and leadership roles
- ▷ Recommendation: *Support major UK role in CTA*



Direct Dark Matter Detection

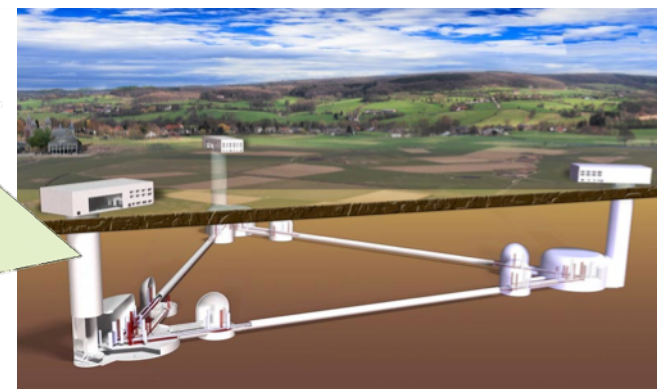
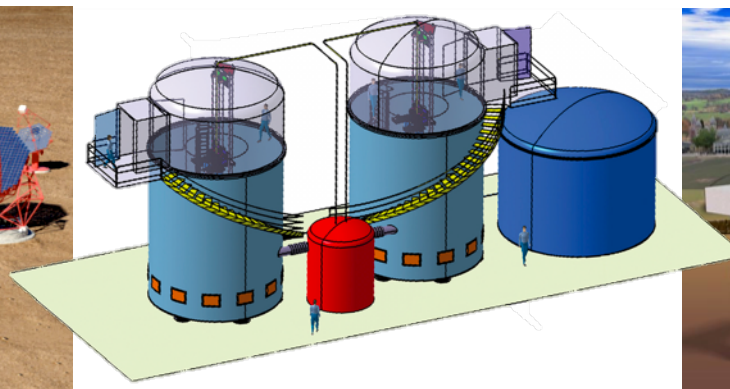
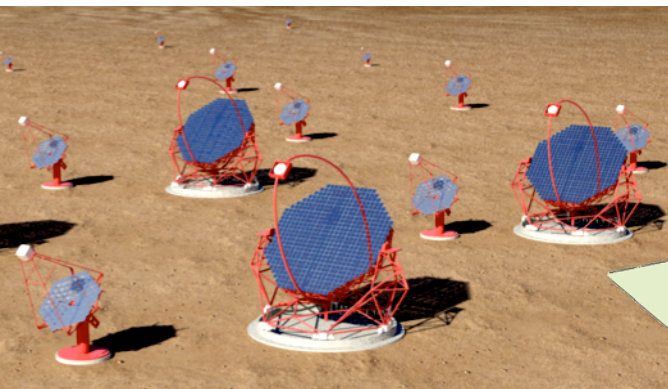
◎ Tonne-scale instruments

- ▷ Strong prospect of WIMP detection – two order of magnitude improvement in limits
- ▷ Three major planned instruments with UK involvement:
 - ◆ **LZ, CLEAN-100, and EURECA**
- ▷ External factors may influence choice of UK focus, e.g. US down-selection process
- ▷ DMUK consortium formed 2012 – coordinated effort to converge on common UK focus
- ▷ UK leadership roles in all projects
Recommendation: *Support major UK role in a tonne-scale DM detector*



PPAN Presentation Conclusions

- ◎ Broad community consensus on the right direction for UK Particle Astrophysics
 - ▷ *Breadth* in the programme: GW, γ , DM as core
 - ▷ Strong support needed for world-leading UK PA *theory*
- ◎ Ambitious and exciting projects that can be used to help make the case for increased investment into STFC: **Adv. LIGO, CTA, DM-1T, ET**



Feedback from PPAN (4/4/13)

We would like to take this opportunity to formally thank you for the hard work of you and your panel in consulting the Particle Astrophysics community. The PPAN Sub-Group appreciates the time and effort invested into writing your report, which we have considered and used to inform our discussions. We were also grateful to have you present your Advisory Panel's report and respond to queries at the November 2012 PPAN Sub-Group meeting. The Sub-Group has respected the Advisory Panels' recommendations and implemented them accordingly so that the Sub-Group's priorities are broadly consistent with the Advisory Panels'. As you will already be aware, the Programmatic Review is very important to STFC as it sets the strategic direction for the next four years and, therefore, it is imperative to have your input to get it right.

Following PPAN Sub-Group meetings in March and April, the Sub-Group will begin finalising their recommendations for the programme ready to submit to Science Board in May 2013. It is expected that the Programmatic Review outcome will be announced by October 2013. If there are any changes to the timescales, we will keep you informed.

Again, we would like to thank you, the Advisory Panel members and your communities for your help and support in the Programmatic Review process.

Best wishes,

A handwritten signature in purple ink, appearing to read 'J. Hinton', is positioned below the text 'Best wishes,'.

Finally...

- Upcoming IoP-sponsored meeting on Astroparticle Physics:



An IoP Topical Discussion Meeting, organised by the Astroparticle Physics Group

The Violent Universe

31 Oct & 1st November 2013
76 Portland Place, London

Roger Blandford Henrique Araujo

Christian Spiering Werner Hofmann Gus Sinnis

Dan Hooper Angela Olinto

Tim Greenshaw John Ellis Bernard Schutz

Tony Bell David Shoemaker Sheila Rowan

Science Questions 1 [MMA]

- ⦿ **1a) What is the nature of compact objects?**
 - ▷ Nature, mass-function, evolution of black holes and neutron stars
- ⦿ **1b) What is the physics behind SNe and GRBs?**
 - ▷ Physical mechanism for core-collapse supernovae, what happens when compact objects merge?
- ⦿ **1c) What are the origins of ultra-relativistic cosmic particles, and how are they accelerated?**
 - ▷ Dominant sources in star-forming regions/galaxies? Of the 10^{20} eV particles? Acceleration processes in SNR, PWN, AGN jets?
- ⦿ **1d) What role do ultra-relativistic particles play in astrophysical environments?**
 - ▷ Role in B-field evolution? In ISM feedback? Galaxy evolution? AGN/cluster feedback?

Science Questions 2 [Fundamental Physics]

- ⊙ **2a) What is the nature of Dark Matter?**
 - ▷ Properties of the DM particles as well as distribution
- ⊙ **2b) What is the nature of Dark Energy?**
 - ▷ Equation of state of dark energy versus redshift
- ⊙ **2c) Does relativity break down under extreme conditions?**
 - ▷ Deviations from special and general relativity
 - ▷ Probes of quantum and or modified gravity
- ⊙ **2d) What are the properties of neutrinos?**
 - ▷ Masses, CP violation, mixing, ... (+role in astrophysics)
- ⊙ **2e) Are there particles present in the universe which have not yet been detected either directly or indirectly?**

Current UK PA Programme

Core PA activity with
current STFC support

⊙ Gravitational Wave Astronomy

- ▶ **Adv LIGO, GEO 600**, Lisa Pathfinder, ET

⊙ Direct Dark Matter Detection

- ▶ Directional detection, **R&D for tonne-scale detectors**

⊙ Neutrino Astronomy

- ▶ (*SN neutrino: SNO+, SuperNEMO, LAGUNA (R&D)*)
- ▶ VHE, UHE: ANITA, KM3Net, IceCube

⊙ Gamma-ray Astronomy

- ▶ HESS (+Fermi exploitation), **CTA Prototyping**

⊙ Non-GW probes of Gravity

- ▶ **Inverse Square Law**, STE-QUEST (ESA M3 candidate)

Space-Based Instruments

⊙ eLISA (and LISA Pathfinder)

- ▷ Massive black hole coalescence, galactic binaries, ...
- ▷ LISA Pathfinder launch 2014
- ▷ eLISA proposal to ESA as L2 mission 2013 – launch 2028

⊙ STE-QUEST

- ▷ Equivalence principle tests
 - ◆ Predicted violations from string theory, quantum gravity, ...
- ▷ ESA M3 mission candidate – selection 2013 – launch 2024

⊙ Recommendation:

- ▷ *UKSA should strongly support either/both of these missions if selected*