STFC Astronomy Advisory Panel Summary of 2021 Community Consultation

6 June 2022 (Amended 13 Oct 2022)

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1. Overview

This report provides the results of the AAP consultation exercise in late 2021. This consultation, plus the white papers that were solicited in parallel, inform the roadmaps that will be released to the community for comment shortly, but AAP have some concerns about

potential mis-uses of the roadmaps. These roadmaps only describe the community's present strengths and aspirations, and an overview of the community's near-term and mid-term priorities for science and technology opportunities. The roadmaps are not suitable for drawing a funding threshold line if the core programme funding is reduced, because that would need an Astronomy Evaluation panel in a Balance of Programmes exercise. Nor should the roadmaps be used to award funding to something that appears to be a priority, without any discussion with AAP about the consequences for other parts of the programme and any developments since the roadmaps were drafted.

The AAP science roadmap last had a major update in 2012, and the technology roadmap is even further outdated. In the meantime, there have been minor updates following AAP's 2016 roadmap consultation, and its 2018 consultation to feed into the second STFC Balance of Programmes review. The non-confidential parts of AAP's 2018 consultation report were published in Astronomy and Geophysics.

AAP nevertheless opted to delay its most recent consultation and report for several reasons. Firstly, the global health crisis meant that the capacities of both the panel and the wider community were limited. Secondly, the outcomes of the European ASTRONET review could affect the policy decisions for AAP. Finally, the US Decadal Review outcomes would also be likely to affect the AAP roadmap. Both the ASTRONET and US Decadal reviews were also delayed partly due to the global health crisis.

This document summarises the outcome of the community consultation. Our results include the following headline outcomes:

- Exploitation, i.e. grants, remain the top community priority and are chronically underfunded. This funding for human capacity is now the main limiting factor for our national science capability in astronomy, but it is a UKRI-wide problem. As John Womersley put it six years ago, we are still *"paying for gym membership and being unable to afford the bus fare to get there"*. Astronomy's UKRI exploitation funding gap has been partly counterbalanced by EU funding, reflecting also our strong relationships with continental communities and beyond, so our association to the Horizon programmes is critical. Since the community consultation closed, the UK has become dangerously close to losing associated country status in the Horizon programmes.
- SKA (together with its pathfinders/precursors) and ESO (including ELT) remain highest rated in both the science and technology roadmaps.
- High performance and high throughput computing provision also remain a community priority. This has received a welcome boost in 2020 in the form of £20m of capital funding from the UKRI World Class Laboratories funding line, enabling the long-awaited deployment of the DiRAC-3 phase 1 upgrade in 2021. The establishment of the IRIS project, following capital grant funding from BEIS in 2018, has also provided a framework for linking the range of digital research infrastructure that falls under the STFC remit. However, large oversubscription factors and the ever increasing data requirements of state-of-the-art simulation codes and large-scale surveys mean that continued support remains vital.

Since the consultation closed, UKRI postgraduates have recently written an open letter to UKRI on the impact of the cost of living crisis combined with stipends being calculated on the

previous year's inflation, and requesting that stipends are uplifted to match the current inflation rate.

Also since the AAP consultation concluded, STFC have launched a further consultation on the changes to the consolidated grant system. This new consultation is still ongoing. Section 3.7 of our consultation touches on the consolidated grant system.

The following sections describe our consultation process and the responses to individual questions.

2. Consultation process

We conducted a consultation exercise with the UK astronomy community via an online survey in November 2021. This was advertised via astrocommunity and other routes. We greatly appreciate the help of our STFC colleagues in assembling the survey, providing us with the results promptly in a digestible format and in providing other contextual information.

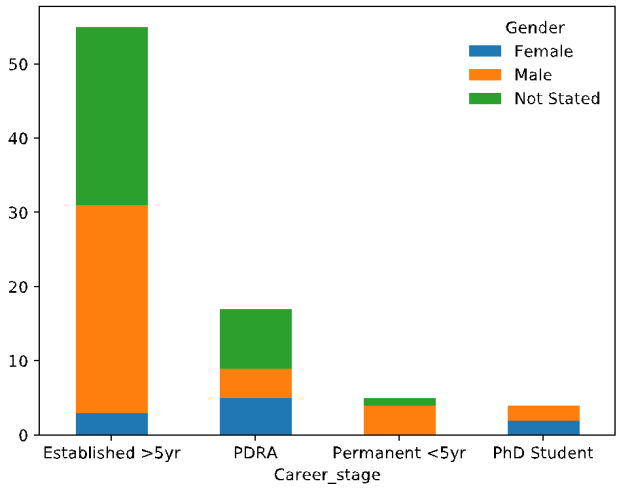


Figure 1: Histogram of respondents by employment status and gender.

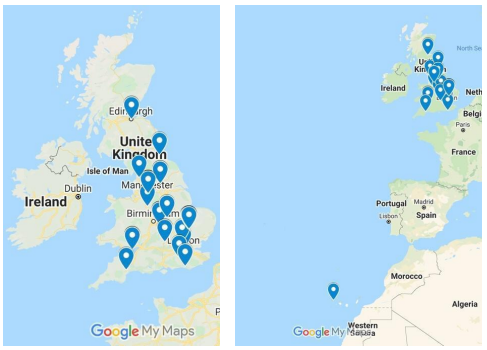


Figure 2: Geographical distribution of respondents in the UK and beyond. Images generated using Google MyMaps.

Only 81 responses compared to 293 in 2018. AAP suspects time pressures related to working from home and the pandemic. There was particularly low representation among early career researchers. Several large astronomy groups are unrepresented (see figures). We will attempt to rectify this incompleteness with town hall meetings in 2022. The geographical locations of respondents in the UK and Republic of Ireland, where available, is shown in Fig. 2 below. The coverage of UK astronomy groups is neither comprehensive nor fully representative.

3. Community responses to consultation questions

3.1 Funding balance

The majority of respondents were supported by STFC, but note small number statistics in each category.

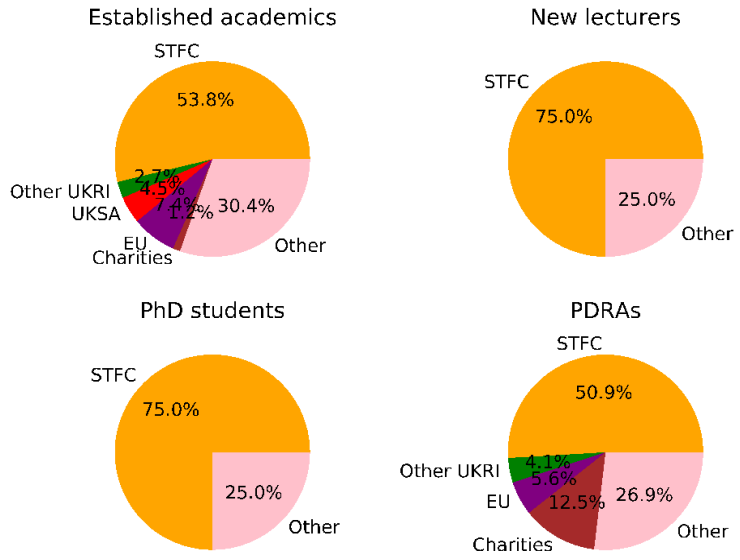


Figure 3: Total funding reported by respondents in the four employment categories, summing fractional contributions from each respondent in each category. The apparent decline in EU funding from our 2018 consultation is plausibly an artefact of the low response rate to our consultation.

3.2 STFC Key Science Challenges

10 respondents (12.7%) felt some STFC challenges need removing, particularly merging *"B:2. What effects do the Sun and other stars have on their local environment?"* with *"B:6. What are the processes that drive space weather?"*

27 respondents (35.1%) felt some STFC challenges need revising, including a variety of representations on solar system and exoplanet biosignatures, exomoons, constraining theories of gravity from pulsars, star/galaxy/ISM/CGM interaction. Several challenges need updating in the light of new technology and surveys, e.g. DESI, 4MOST, WEAVE, VRO-LSST, SKA and Gaia for the galaxy evolution challenge.

24 respondents (30.8%) felt there is a need for new STFC science challenges, again including the interactions between stars/galaxy/ISM/CGM; a lack of emphasis of gravity and compact object physics; FRBs; promoting gravitational wave astronomy to its own challenge; space plasmas; proplyds; accretion physics (several comments noting how this is currently dispersed among the challenges).

3.3 Emerging Technologies or Capabilities to be included in the Roadmap

There were 59 responses to this question. Excluding blank, duplicate and uncertain replies leaves 54 replies.

Many replies highlight the importance of existing or upcoming projects. ALMA, LOFAR, SKA, JWST, LSST, GRST are mentioned several times (3 to 5), while Euclid, CTA, new instruments on the VLTs (in particular optical/NIR interferometry), gravitational wave research, exoplanet science, high-energy instruments and improved radio telescopes were mentioned a couple of times. Some respondents highlight a single mission, others just listed a few, so it is difficult to extract a real weighting of the preferences of what is still a small section of the community.

The use of Big Data and Machine learning techniques was also mentioned as an opportunity in 5 responses, and one response mentioned computational infrastructure.

The single area that attracted the most responses (11) is the development of improved detectors, in particular energy-sensitive detectors (KIDS, MKIDS).

3.4 Science challenges requiring major investment

There were 47 responses to this question. After removing blank, duplicate and uncertain replies 43 answers are left. A total of 30 different topics/techniques/instruments are mentioned, reflecting on the one hand the wide range of interests of the community and on the other the desire to "have it all".

Topics mentioned range from gravitational waves from space to Gamma-ray detectors, a new all-purpose space observatory, supporting ESO, various space missions, studying planets, discovering life, and strengthening person-power for research.

A couple of topics attracted more than a single mention: high performance computing (5 mentions and a sub-mm telescope (4 mentions).

As such, it would be difficult to choose a particular area or even a specific instrument.

This reflects what is seen in later questions, which highlight the need for increased funding.

3.5 Key opportunities for UK researchers to play leading roles in large international Astronomy projects

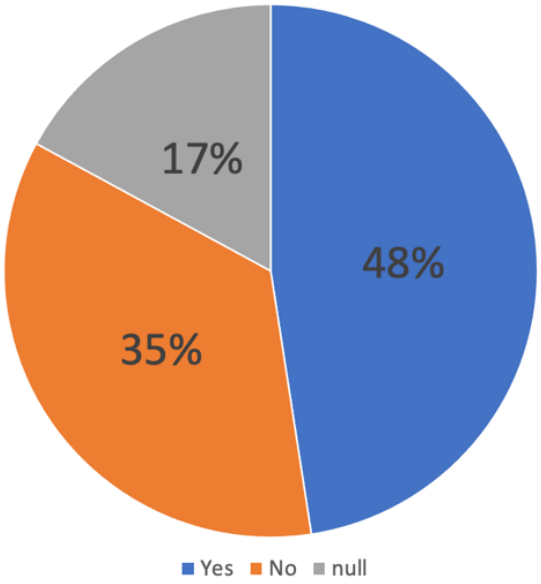
There were 66 non-blank responses (80% of all survey responders). For observational astronomy, almost every wavelength was mentioned here from radio to gamma-rays, in addition to gravitational waves. Specifically, the missions/telescopes that achieved the most mentions include VRO, SKA, Euclid, LISA, ELT. ‘Theory’ also had several mentions, reminding us that the UK has traditionally been strong on the theoretical front. Finally, bi/multi-lateral opportunities were repeatedly brought up (NASA/China/Japan). Alignment with the Decadal2020 outcome was mentioned.

3.6 Is the current UKSA/STFC dual key arrangement fit for purpose?

There were 68 responses (83%) split into:

- Yes: 39 responses (48±10%)[1]
- No: 29 responses (35±8%).

Several amongst the 'No' crowd brought up the 'ambiguity' between the two agencies, and 'falling between the cracks'. e.g.: "*The overlap between the two agencies creates ambiguities in the respective responsibilities and an imbalance between infrastructure and technology on the one hand, and scientific exploitation on the other. It would be preferable to have UKSA taken on a larger role, including the scientific exploitation (as e.g. NASA does).*"



There appears to be substantial confusion amongst the community regarding the roles, responsibilities, and funding remit of the two agencies. We should work to clarify this, and consider how they can be better aligned.

A lack of exploitation funding was repeated (in the context of both agencies).

In retrospect, we felt like we could have learnt more by asking the "Yes" crowd to also state the reasons why they believe the arrangement works well.

Figure 4: responses to the community question on whether the STFC/UKSA dual key is fit for purpose.

3.7 Satisfaction with the current balance of STFC support between development, operations and exploitation

The AAP asked two questions about the current balance of STFC funding between development, operations and exploitation (see Figures 5 and 6). The questions were "Q15: *Are you satisfied with the current balance of support provided by STFC for different aspects of astronomy research?*" and "Q16: *Within the exploitation funding line, are you satisfied with the balance between PI, PDRA and PhD funding?*".

A majority (60%) of respondents were dissatisfied with the balance between exploitation, operations, and development (Q15). By far the most common response was that there is too little funding for exploitation. Several respondents also noted the lack of any explicit mention of theoretical astrophysics within the funding balance profile (this referred to both analytical

[1] 1-sigma confidence sampling uncertainties, according to Gehrels (1986, ApJ 303, 336).

"pen and paper" research as well as numerical work using high performance computing facilities). It was noted this is often a low cost yet high impact area, and that (for comparison) theory funding in the US is ring-fenced.

There were a variety of views expressed on the issue of funding balance for exploitation (Q16), where a larger fraction (47%) of respondents were satisfied or very satisfied with the current funding balance. The overwhelming message was consistent with the response to Q15, however. It is not so much that there is dissatisfaction with the balance of exploitation funding, but rather the *overall exploitation budget is far too small*. This picture is very much in line with the (much larger) response received from the community to the AAP's questionnaire in 2018.

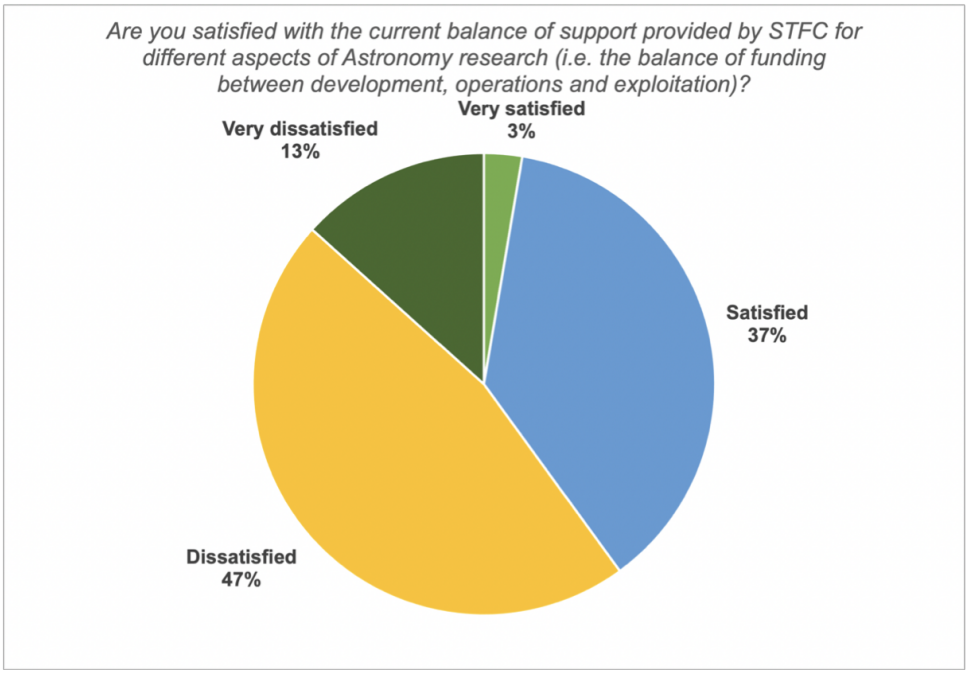


Figure 5: Responses to the community question (Q15) on the overall balance of spending. The response fraction was 91.5% (75/82), with a free text response fraction of 63.4% (52/82).

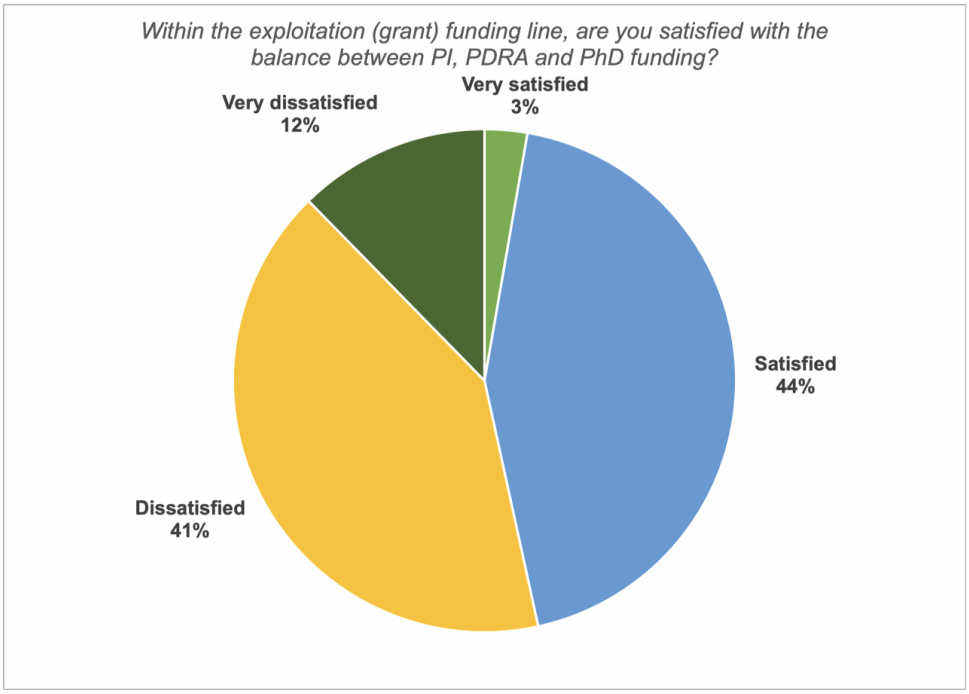


Figure 6: Responses to the community question (Q16) on the balance of exploitation funding. The response fraction was 89.0% (73/82), with a free text response fraction of 57.3% (47/82).

The most common theme raised was the lack of sufficient PDRA funding, where (on average) an established researcher can expect to work with a PDRA once in a decade. The lack of flexibility within the consolidated grant process, where applicants can submit one proposal every three years, was also a concern. It was noted that this impacts on the viability of coherent, long term research programmes, makes the UK a less reliable partner within international collaborations, and has a detrimental impact on the retention of talented researchers within the field. Several respondents felt that cancelling the STFC postdoctoral fellowship programme was a mistake, and this (or an equivalent early career scheme) should be reintroduced.

Regarding PI funding, some respondents noted that FEC has been cut rather hard by AGP to preserve PDRA funding. However, this can hamper the career prospects for PIs and Co-Is who are then unable to demonstrate grant income to their employers (with the associated implications for workload balance and promotion cases). A few respondents noted that a mid-career fellowship scheme might address this. The response on the balance of funding for PhD students was far more mixed, with no clear consensus view. It was also noted that the standard STFC PhD stipend is insufficient for high-cost regions in the South of England.

The key points raised by the community were therefore as follows:

- Exploitation funding remains the top community priority. The overall budget is too small and must increase, particularly so for PDRA support.
- The lack of PDRA support, and an early career postdoctoral fellowship scheme, has had a detrimental impact on the retention of early career researchers within the field.

- The current consolidated grant framework is inflexible, and locks applicants out of the funding stream for three years. This, coupled with an insufficient exploitation budget, impacts on the viability of coherent, long term research programmes and has implications for the career progression and (non-research) workload of PIs and Co-Is.

In summary, the overall picture with regard to STFC funding balance remains very consistent with the community response to the AAP questionnaire in 2018. The only notable difference in the response to this survey was the comparative lack of feedback regarding post-Brexit research funding. The AAP notes, however, during the period this survey was open (autumn 2021) it seemed quite likely the UK would have associated country status within Horizon Europe. At the time of writing, however (summer 2022), that status appears to still be very much in doubt. Given the historical success that the UK-based astronomers have had in winning prestigious ERC grants, the AAP believes it is still very much the case that there is serious concern within the community regarding the post-Brexit funding landscape.

3.8 Key technologies in Astronomy research where the UK is world leading

62% of respondents answered this question, representing a total of 51 out of 82 participants.

There is a wealth and depth of key technologies mentioned here where the UK is a leading force:

- Kinetic inductance detectors used for a range of aspects such as spectroscopy, imagine, time-domain, CMB, galaxy formation studies, etc.
- Software, computing, receivers, and development for radio astronomy (Jodrell Bank Observatory, E-Merlin, Lovell telescope, Square Kilometer Array).
- Infrared detectors, in particular LEONARDO
- High performance computing

3.9 Capabilities or technologies which are cross cutting or multidisciplinary and the other areas to which they relate

45% of respondents answered this question, representing a total of 37 out of 82 participants.

There is a concordance among responses agreeing that many tools developed in astronomy have the strong potential of being useful for a wealth of disciplines and this should be explored further (with an emphasis on cancer/medical research). Some examples are to branch out to have more synergies with areas that require mathematics and quantum devices development, time-domain astronomy, machine learning, high performing computing, artificial intelligence, data science/big data, and communications.

There was support for further development of submillimetre astronomy for a wide range of research from planet/star formation to ISM/dust, galaxies, and cosmology as well as more investment on fluid dynamics.

3.10 Scientific challenges in Astronomy Research to be solved in the next 20-30 years

67% of respondents answered this question, representing a total of 55 out of 82 participants.

There seems to be a broad agreement regarding the challenges we face in the next two decades. A significant number (42%) of the respondents identified “life elsewhere” and “exoplanet formation and characterisation” studies as a priority. This is followed by understanding the nature and composition of Dark Matter (29%) and Dark Energy (26%) in order to disentangle the processes involved in galaxy formation and evolution. This is closely followed by the studies of high precision gravitational tests of GR, gravitational waves, including different sources as well as waveform models ahead of LISA, (29%).

3.11 Barriers for creating a healthy career pathway for academic staff, technicians, engineers, software engineers, PDRAs and PhD students

67 responders out of 82 to this question. The results were as follows.

- There was significant number of the respondents that identified that one of the fundamental issues is the lack of funding for early career researchers in general and this has many spin off effects including:
    - The need to move overseas which significantly disadvantages those for whom that isn’t possible or who don’t wish to do so.
    - It generates too much competition which is unhealthy, stressful and can result in affecting diversity.
    - Very few intermediate PDRA positions between PhD and URF/ERFs.
- This lack of funding was also highlighted to affect:
    - Ability to stay competitive, less than 30% of CGs funded
    - 3 year timeline for CGs gives a very short horizon time especially given grant announcements are made so late, so hiring is not possible until well into the grant.
    - Grant funding is too infrequent, which affects ECRs who are just starting.
    - Over reliance on reputations affects ECRs in the CG.
    - Removal of funding for Co-Is on CGs affects reputation and workload models. Becomes a spiral.
    - Short term contracts affect type and style of project and retention of staff.
- There is little recognition of the software engineer / blended (software and astronomy) as a career path in an environment where this is crucially important.
- There is a culture of overwork and generally poor work-life balance.
- Differences in leave (including maternity) for professional staff, no maternity leave funding on grants.
- Insufficiently diverse set of role models at all levels.
- Unsafe/unhealthy work environments -- i.e. not free of prejudice/abuse

3.12 Suggestions to address these barriers

56 said they had suggestions for addressing the barriers, while 13 said No. The suggestions were as follows.

- Increase funding in general, but some specific ideas:
    - Introduce Longer grants (>=5yr)
    - More and smaller pots of money
    - More early career fellowships (not too short).
    - Increase length of CGs -- but also not too infrequent.
- Reduce grant award focus on publication metrics and previous grant success.
- Enable more technical and blended career opportunities (instruments/software/science/project managers/etc…) -- improve recognition of these roles within University too.
- Increase role model diversity at all levels.
- Improve the leave systems at Universities / provide ways for families to attend conferences. General greater support for families.
- More career advice for PhD students.
- Be more honest about the number of jobs available.

3.13 Changes or activities could STFC promote within the field of Astronomy research to support increasing diversity, equality and inclusion

Due to an error in the form, this question was repeated twice (Q22 and Q23). Answers to both questions are summarised here.

There were clear concerns regarding the EDI and a recognition that funding is required to support and increase diversity, equality and inclusion activities and objectives. Existing barriers were discussed and suggestions for affirmative actions for improvements.

Better data: Collect institutional evidence for EDI practice, as well as for individuals. Several expressed concerns that actions must be meaningful, to avoid tick box practices and empty practices with no demonstrable outcomes

- better understanding the causes of anti-diversity are required before action is taken - address the causes, not the symptoms
- collect evidence for ‘perceptions’ of intellectual capabilities and` science productivity with race, gender, economic class, parental status, and ableness from individuals to establish if any anti-diversity issues exist for potential grant holders
- call out bullying, prejudice, and bias and take action against staff who disregard diversity, equality and inclusion
- acquire school/host institute confirmation that any potential grant holders do not have any bullying/harassment complaints and/or pending investigations.
- take account commitment of the School to EDI in grant applications, together with the

data (i.e. percentage of staff diversity across all levels) and what are the positive actions taken summarised and share aggregated data and **publish statements** along with grant awards
- Set-out expectations by STFC/UKRI that grant holders /PIs should have completed EDI, unconscious bias, active bystander training (could be a mandatory requirement).

Increase dedicated funding towards EDI: Lack of funding was identified as a key area that RCs can make headway on. Grants awarded should have a fraction that can be set aside to support EDI initiatives in a similar way to PE activities. This funding can e.g.
- Provide training for researchers and staff
- Enable hire a dedicated EDI coordinators, facilitators and speakers

Grant & fellowship awards: review the current grant & fellowship allocation processes in terms of EDI and improve tracking
- grants are awarded in an equitable and unbiased way
    - Double-blind process
    - Composition of awarding panels & reviewers
- link future funding to improvement in key inclusion metrics. Groups receiving funding should be able to show that they have certain processes in place (e.g. Gender Equality Plans are becoming a requirement for EU grant funding).UK equivalents, Athena SWAN and/or others should be considered.
- expect research consortia implement and adhere to codes of conduct
- Review the ERF process that may have small but significant biases owing to the pre-selection by individual universities. Much harder to ensure fair practice is being employed.
- Allow joint PI-ship of grants and specifically consider yearly grants to fund individual PDRAs or early/mid-career staff with no PDRA staff to allow them to be responsive to new projects. Could be targeted at underrepresented groups.

Low income backgrounds: Several respondents noted that the precarity of academic careers (or the leaky pipeline) is a barrier for those from low-income backgrounds as the risk of failure is simply too high. I.e. Other professional STEM career options would be far more attractive (e.g. medicine or engineering) for STEM minded school leavers and Physics and Astronomy graduates.
- improving academic career paths including the security of them with longer term contracts will automatically make the field more inclusive and increase diversity

Recruitment Practices: Affirmative action to increase recruitment in hiring students from low-income, social economic and diverse backgrounds to provide through increased access and engagement activities. E.g.
- Provide fellowships or funding for underrepresented communities
- More work within schools to promote STEM careers
- young-scientist type award schemes for secondary school students that incentivise diverse students to consider physics etc at GCSE and A-level. Could be teamed with a university research group
- Share positive success stories and role models
- Increased support for activities that help provide training opportunities to traditionally under-represented groups (some Newton-funded projects are great examples - e.g.

DARA/DARA-big data).

Engage with diverse international communities: Affirmative action to counter the hostile environment caused by Brexit particularly for EU and international students.

- Research councils could work alongside Universities to provide affordable PhD positions for international students and to cover the loss of those who would have taken up UK PhD places from the EU
- Make clear statements higher-up to UKRI & BEIS how the current environment is unwelcoming and preventing international/diverse hires

Reward: Recognition and rewards for those who practice and promote good EDI behaviours considered as strongly as publication metrics and/or grant success. This would benefit scientific quality and cultural change

- This may take the form of EDI prizes or awards, pay-uplifts
- EDI practice statement or sections in applications weighted as strongly as science
- Reward departments/schools/institutes that have demonstrably improved against appropriate metrics, without sacrificing performance quality.

Staff Retention: STFC could make efforts to ensure that diverse staff are retained within the system they fund, those from diverse backgrounds are often the ones on short term contracts, face challenges with pay rises and promotions and suffer from the leaky pipeline.

EDI Champions: STFC should make use of good practice already in place in the academic environment they fund

- Organise good practice workshops by those who are STFC funded and carrying out good work in their communities & collaborations
- Involve the community to drive STFC policies and actions on EDI, currently there is little engagement between STFC and the communities they support in this regard. There are many practising good EID but connection to them with STFC internal groups is limited

STFC Policy and Decision Making: Several expressed concerns about the lack of diversity in STFC

- More diverse and ECR representation inf STFC policy and decision making committees, panels and structure
- Honestly review apparent ‘cronyism’ (few individuals heaving long-term roles in strategic committee) in STFC policy and decision making committees and take positive steps to counteract it

External factors: Difficulties for those with **family and/or other caring responsibilities** are overlooked in the employment system, and those of short term contracts are particularly hard hit by not being able to be competitive with others at these vulnerable times. The work/life balance of early career scientists and non-permanent staff, who often have to make hard decisions over priorities within their lives and are disadvantaged by the system. Given that family commitments statistically affect women more than men, this is a key are of continued concern for those with short-term contracts.

- Increase support for those with family/caring responsibilities
- Include space to indicate challenges faced and take account of those in awarding

grants
- Mandate automatic (costed) extensions to PDRA contracts (grants not just fellowships, a blind eye is taken by RCs for the former) for taking maternity/parental leave
- Promote flexible working (times and location)
- Effective returner fellowships, review current scheme and make fit for purpose. If this doesn't apply to any kind of returner, this is not fit for purpose.

Ableism and availability to travel: Equal the playing field for observers at STFC associated observatories and facilities
- Improve infrastructure and availability of remote observing for those who cannot travel
- While not directly commented on in the survey, this could also apply to conference supported by STFC where remote access for those who can't travel is guaranteed

Counter position on UKRI focus on research impact:
- STFC spends far too much time on issues which are of little or no interest to their scientists. You should be concentrating on supporting their science. The two great impact successes that have come out of particle physics and astronomy in the past 50 years (wifi and WWW) - which are worth hundreds of billions of pounds - were the result purely of curiosity driven research, and nothing to do with efforts by research councils to increase impact. You only need to facilitate opportunities for impact, and it will happen of its own accord. Trying to create impact is a total waste of time and effort in astronomy and particle physics. It just doesn't work that way.

Other comments in this section not directly related to EDI (edited responses):
- STFC should stick to the Haldane principle and fund researcher-driven research rather than be stuck to particular 'agreed' challenges.
- Science challenges are outdated and others have emerged that should be added to challenges, e.g. gravitational wave astrophysics, physics of accretion, physics of protoplanetary disks, asteroseismology.
- Comments on overhaul of the entire grant funding process and structure
    - Annual cadence to improve responsivity and spontaneity in creative research
    - Increase opportunities for individuals and reduce impact of funding only going to large consortia
- Lack of funding for theoretical astrophysics
    - recognized as a separate subject of its own and a funding line to support it should be created, separate from facilities, etc. The Astrophysical Theory Program of NASA gives a good example of how this could work.
    - Address disconnect and inefficiencies with HPC/DIRAC funding
    - Bigger and smarter investment into computational astrophysics is long overdue.
    - Without this, UK lead in theoretical astrophysics will be lost in a decade
- Increase/reinstate opportunities for junior postdoctoral fellowships otherwise the UK will lose the most talented UK junior researchers elsewhere or they will leave the field.

4. Conclusions

The overall priorities of the community have not changed since AAP's 2018 consultation that fed into the Balance of Programmes Review: SKA, ESO and HPC remain key, while exploitation (i.e. research grants) remains the top community priority. However, the continued, chronic underfunding of exploitation has arguably led to the result that 53% of the community are now dissatisfied or very dissatisfied with the balance between exploitation, operations and development; in contrast, our 2018 exercise had 52% wanting the exploitation line to grow only if there were new money. The shortfall in Astronomy exploitation has been partly made up in recent years by the Horizon programmes, meaning that Astronomy is also very exposed to the loss of access to Horizon.

Our consultation did not have a high response rate this time, so AAP circulated this document for further community comment. Nevertheless, the free text narrative submissions in our consultation have yielded a very rich body of community commentary, particularly in the areas of career pathways, equality, diversity and inclusion.