DOI: 10.18727/0722-6691/5238

Report on the Scientific Prioritisation Community Poll (2020)

Antoine Mérand[1]
Paola Andreani[1]
Michele Cirasuolo[1]
Fernando Comerón[1]
Itziar De Gregorio Monsalvo[1]
Miroslava Dessauges-Zavadsky[2]
Éric Emsellem[1,3]
Rob Ivison[1]
Francisca Kemper[1]
Franz Kerschbaum[4]
Bruno Leibundgut[1]
Jochen Liske[5]
Ross McLure[6]
Tony Mroczkowski[1]
Livia Origlia[7]
Neil Philips[1]
Hugues Sana[8]

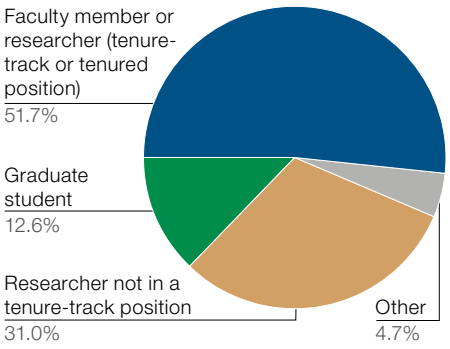
[1] ESO
[2] Department of Astronomy, University of Geneva, Switzerland
[3] CRAL, University Claude Bernard Lyon 1, ENS of Lyon, France
[4] Department of Astrophysics, University of Vienna, Austria
[5] Hamburg Observatory, Germany
[6] Institute for Astronomy, University of Edinburgh, Royal Observatory Edinburgh, UK
[7] INAF – Astrophysics and Space Science Observatory of Bologna, Italy
[8] Institute of Astrophysics, KU Leuven, Belgium

ESO regularly updates its science-driven perspective in order to provide the best facilities and services for its community. As part of this exercise, ESO polled its users between January and February 2020. Questions were inspired by the previous poll, conducted in 2015, to probe any evolution of community opinions and profile, with an emphasis on the future of the Very Large Telescope (VLT) and the VLT Interferometer (VLTI). Of the approximately 17 700 registered users targeted, 10% had accounts in both the ESO and European ALMA portals, another 14% were registered in the ALMA portal only, and the remaining 76% were registered in the ESO portal only. Some 3700 email addresses, predominantly associated with the ESO portal, were invalid. From the remaining approximately 14 000 user accounts, 1673 complete responses were received, a response rate comparable to that of the 2015 poll. The present poll was split into three parts: 1) profile of respondent; 2) current and future observing facilities; 3) ESO in the coming decade. Here we summarise the results and provide some highlights from the poll.

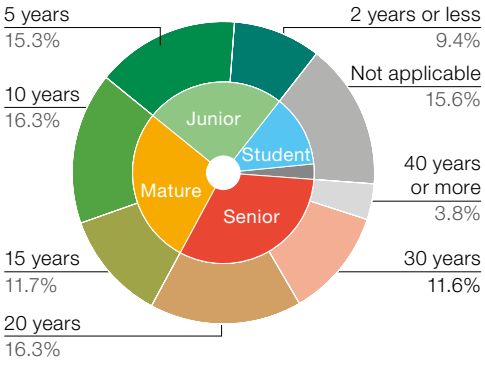
Respondents' profiles

The poll started with questions designed to assess the profile of each respondent, including their academic and professional

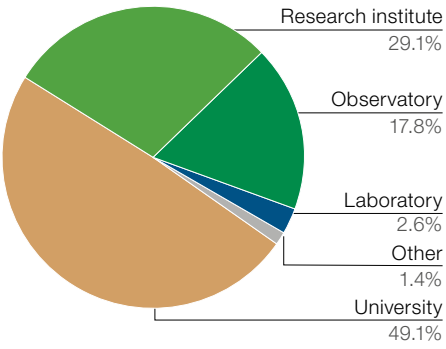
What best describes your current position?



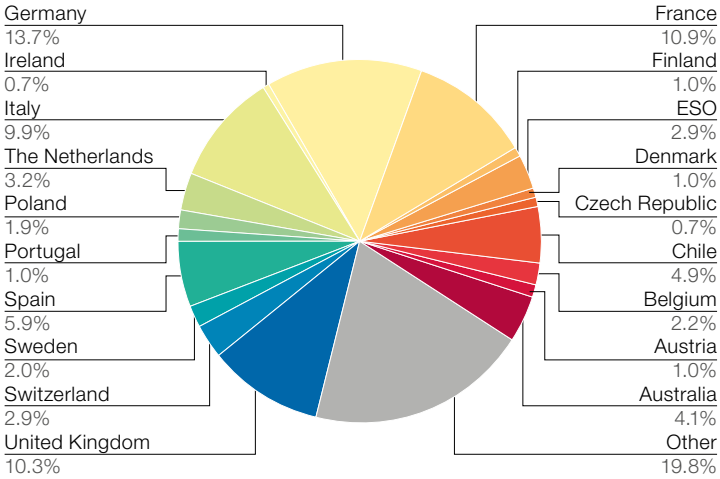
If you have a PhD, for how many years have you had it (choose the closest number of years)?



My home institute is best described as:



My home institution is located in:



Details for "Other":

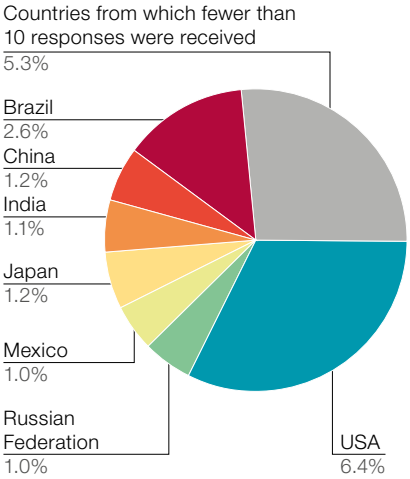


Figure 1. (Above) Respondents' academic profiles. Position (left), years post-PhD (centre) and institution (right).

Figure 2. Respondents' country of home institute.

background. As can be seen in Figure 1, the distribution shows a slight majority of tenured or tenure-track researchers (51.7%), the rest consisting of non-tenured researchers (31.0%) and graduate students (12.6%). Regarding the number of years post-PhD (relevant for 84.4% of respondents), we have a relatively even spread between 2, 5, 10, 15, 20, 30 and 40 years. The respondents are predominantly from universities (49%), with the remainder from research institutes (29%), observatories (18%) and laboratories (3%).

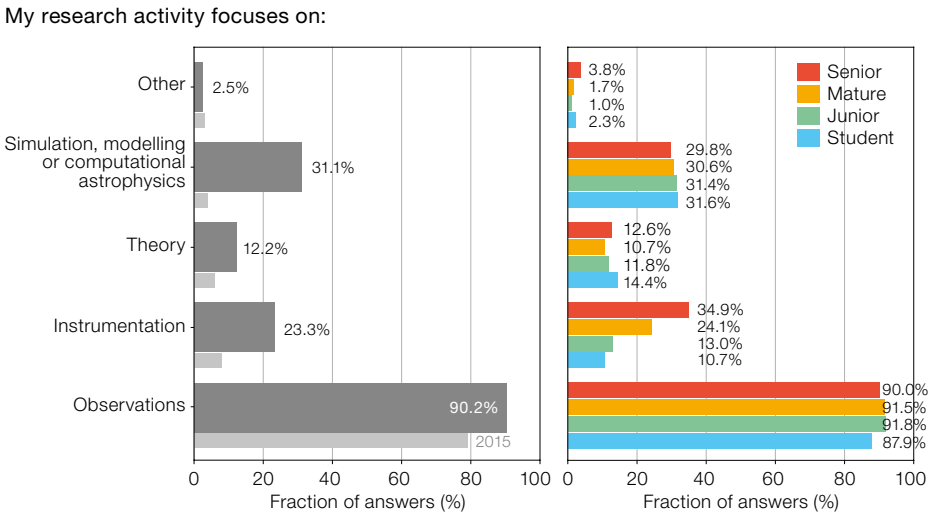
For later analysis, we define career stages (i.e., seniority) as:
- Respondent without PhD degree (15.6%), of which 4/5 were students.
- Junior: up to 5 years post-PhD (24.7%) (an average density of 4.9% per year post-PhD).
- Mature: 5 to 20 years post-PhD (28.0%) (an average density of 1.9% per year post-PhD).
- Senior: more than 20 years post-PhD (31.7%) (an average density of 1.5% per year post-PhD).

Our choices of the ranges of years after a PhD do not have equal spread: if we consider the average density per year post-PhD, we seem to have obtained better response rates from junior people.

The poll collected information about home institutions. Only ESO Member States, Australia as a Strategic Partner, the Host State Chile, and ESO were listed individually. Other countries could be entered manually. Figure 2 shows the relative numbers of answers per country. More than 80% of the respondents are from ESO Member States, associated countries and ESO.

A multiple-choice question probed research categories: Observations; Instrumentation; Theory; Simulations; Other (Figure 3). The vast majority of respondents (90.2%) are involved in observational astronomy, with 10–30% pursuing other types of research. Interestingly, a breakdown by seniority reveals that the Instrumentation category is more strongly represented amongst senior respondents (38%) than amongst students (10.7%): comparatively fewer students participate actively in instrumentation development. Precise comparison with the previous poll (Primas et al., 2015) is difficult, since then only a single answer was allowed to this question. However, the respondents then were also dominated by observational astronomers.

Regarding the part of the electromagnetic spectrum used (Figure 4), the majority of the respondents primarily focus on the



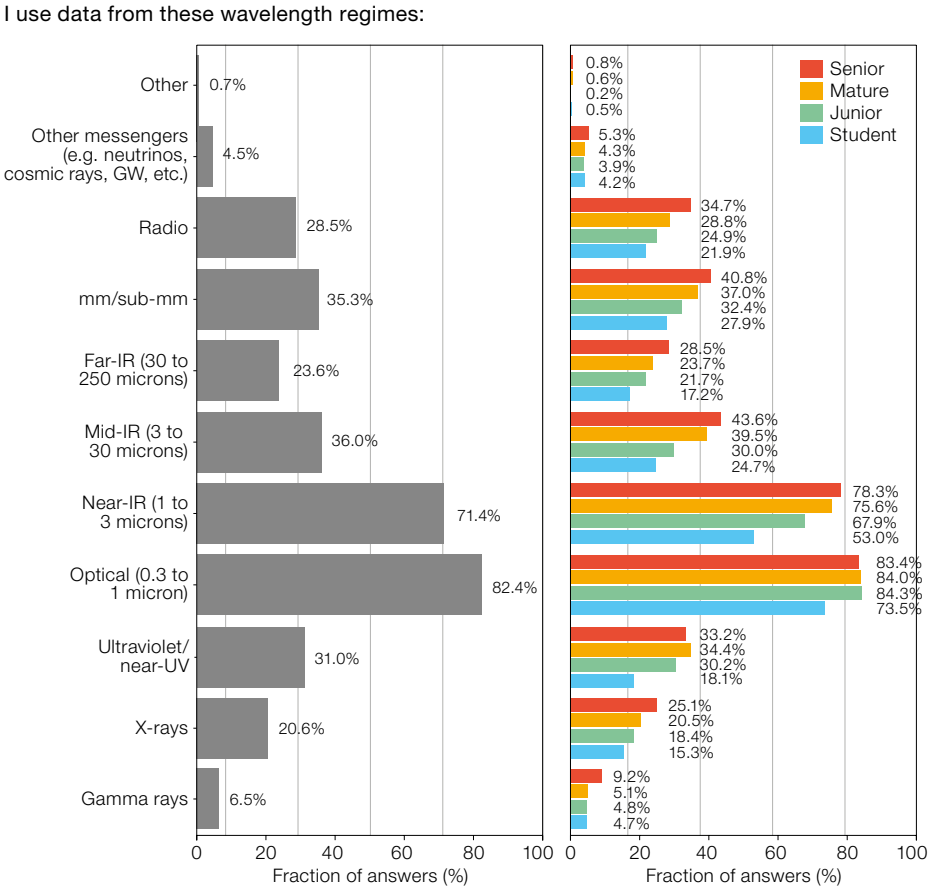


Figure 3. (Upper) Type(s) of research activities (left), with a breakdown by career stage (right). In the left panel, numbers for the 2015 poll are shown as the thinner and lighter grey bar. Note that, in 2015, only one answer was possible.

Figure 4. (Lower) Wavelength domain(s) of research activities (left) and broken down by career stage (right).

optical and near-infrared, with a significant number of respondents working in the submillimetre and radio domains. Only a small fraction of respondents use domains not covered by ESO telescopes (gamma rays, X-rays, far-infrared, radio and other messengers). A breakdown by career stage shows that the more senior researchers tend to use more multi-wavelength/multi-messenger facilities: students, junior, mature and senior scientists use, on average, 2.6, 3.2, 3.5 and 3.8 different spectral ranges and non-electromagnetic messengers, respectively.

Finally, we asked respondents in which domain they currently work, and how important they feel different fields will be in the 2030s (Figure 5). One can compare how popular a field is currently with its perceived importance in the coming decade: the most popular fields, "Structure and evolution of galaxies (including AGNs)" (43.8%) and "Life cycle of stars" (40.6%), are predicted to be very important one decade from now by only 24.7% and 16.9% of the respondents, respectively. This difference between current and future importance was also observed five years ago, but only for stellar physics: five years ago the number of people who worked in Galaxy Evolution was equal to the number who thought it would be an important field in the future. The research domains which have the largest difference between the number of respondents engaged in research in that domain and the number who think it will be very important in future are "Search for life outside Earth", "Planetary system formation and evolution" and "Cosmology and/or fundamental physics". This is very similar to the 2015 results, again except for "Structure and evolution of galaxies (including AGNs)".

Present and future facilities

The second part of the poll focused on observing facilities. The first question aimed at gauging what kind of ground-based capabilities respondents will need in the 2030+ timeframe, with a maximum of three possible choices. The question was split between observing technique, spectral resolution and spectral domain. The results are presented in Figure 6. Polarimetry and high-contrast imaging are the least selected (13% and 16%), whereas integral-field, multi-object and single-object spectroscopy and high-angular-resolution imaging (40%, 39%, 37% and 35%) are the most popular techniques. Interferometry and wide-field and/or low-angular-resolution imaging have intermediate results (26% and 25%).

Comparing with the facilities offered by ESO (present and planned), we can identify the following missing capabilities:

- High-resolution (R ~ 100 000 k) spectropolarimetry in the visible: this is a capability offered outside of ESO, though not on 8-metre telescopes.
- High-resolution (R > 10 000 k) interferometry in the visible and near-infrared; high resolution (R > 10 000 k), high-contrast imaging in the near-infrared. These two capabilities do not yet exist and would offer a unique parameter space.

The second question concerned which current ESO facilities are required for future research (Figure 7). The respondents, of which 24% are registered at the ALMA portal, and 86% at the ESO portal, indicated that they would most likely require the VLT and the Extremely Large Telescope for their research (81.4% and 71.9% respectively), followed by the data archive and the Atacama Large Millimeter/submillimeter Array (ALMA) (58.9% and 49.5%, respectively). In 2015, the data archive was not a possible choice. All facilities grew in community interest. Amongst the facilities which grew in perceived importance, the Atacama Pathfinder EXperiment (APEX) jumped by a large factor; ALMA and the VLTI roughly doubled in fractional answers. The large fraction of respondents (49.5%) indicating that they intend to use ALMA in

What are your main areas of astrophysical research?
How important do you think these domains will be in the 2030s?

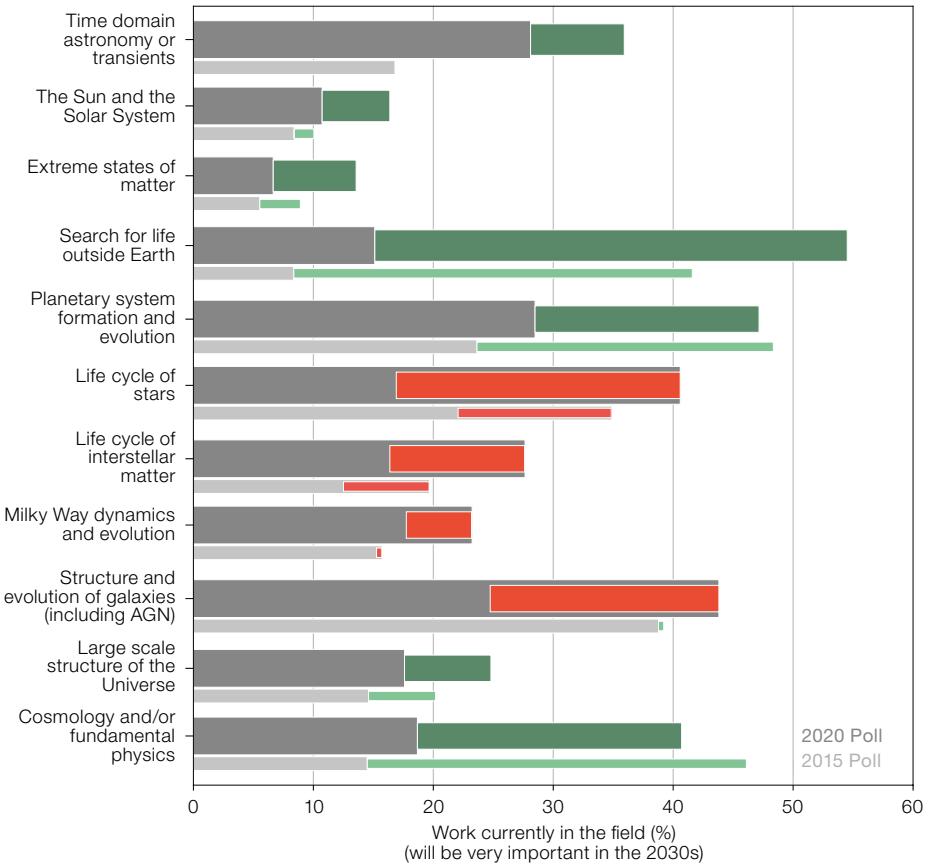


Figure 5. Current field of research (grey bars), and fraction of respondents thinking it will be very important in the future (green bar for increase and red bar for decrease). The thinner and lighter colour bars show the results of the 2015 poll. Note that in 2015, it was not asked whether "Time domain…" will be of importance in the coming decade.

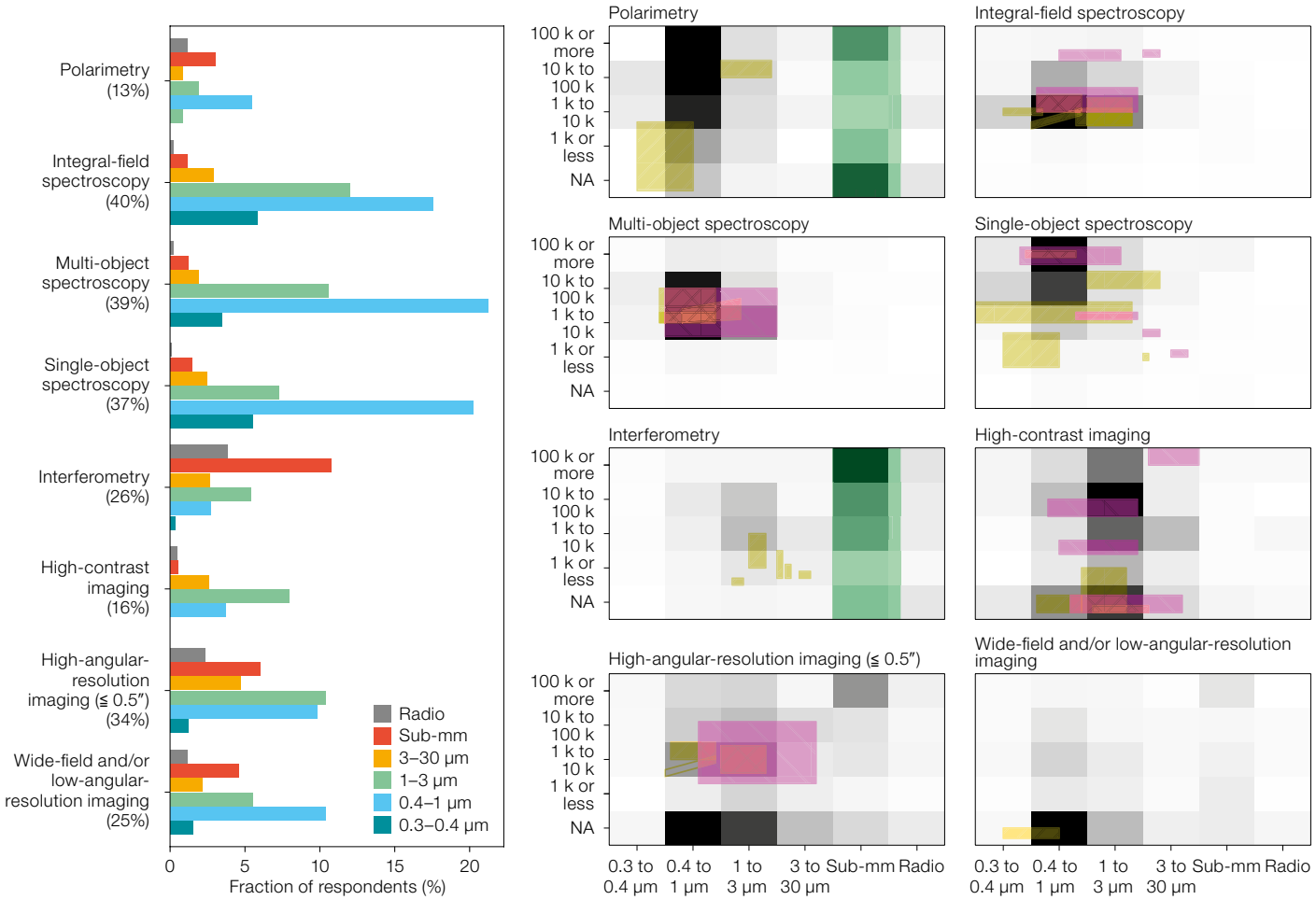


Figure 6. On the left, the fraction of respondents choosing each technique is shown (in percent, broken down into wavelength domains). The right panels show the density maps of the answers, in the "spectral resolution-spectral domain" plane (darker means more answers). Areas covered by VLT and ELT instruments are shown in yellow and purple respectively. Green areas cover ALMA (only for polarimetry and interferometry, even though ALMA covers other aspects).

the future is remarkable, given that only 24% of the users polled are currently registered at the European ALMA portal. Only 4-metre-class telescopes seem to have remained stable since 2015. There do not seem to be any strong generational trends in these answers.

Regarding possible future ground-based facilities (Figure 7, lower left), a large majority (75%) expressed the need for a dedicated spectroscopic telescope. It should be noted that the poll did not define what "dedicated" meant: it could either be a highly multiplexed telescope, or a telescope dedicated to transient follow up. The other options each attracted about 25% of the respondents. All numbers have at least doubled since 2015, though only a single answer was allowed in the previous poll.

We also polled the community regarding planned facilities, ground- or space-based (Figure 7, right panel). The answers are very similar to those in 2015, with the James Webb Space Telescope (JWST), Vera C. Rubin Observatory (formerly the LSST), Nancy Grace Roman Space Telescope (formerly WFIRST) and the Square Kilometre Array (SKA) (in that order) included as a choice in the 2015 poll.

ESO in the coming decade

We began by asking a question that referred back to the "VLT in 2030" workshop held in 2019 (Mérand & Leibundgut, 2019), the purpose of which was to discuss future developments for the VLT and VLTI, in the 2030+ timeframe. Several projects were discussed, and four projects were selected by the Science and Technical Committee (STC) for further review: BlueMUSE, GRAVITY+, HR-MOS, and SPHERE+ (in alphabetical order). Respondents were asked how relevant those projects were for their research. The breakdown of answers by instrument is given in Figure 8.

Something the Figure does not show is that 67% (26%) of the respondents find at least one (two) of the four projects "very relevant". This percentage climbs to 89% (69%) when "relevant" is also included. This means that at least one VLT2030 instrument captured the interest of the vast majority of respondents. The next question attempted to identify capabilities

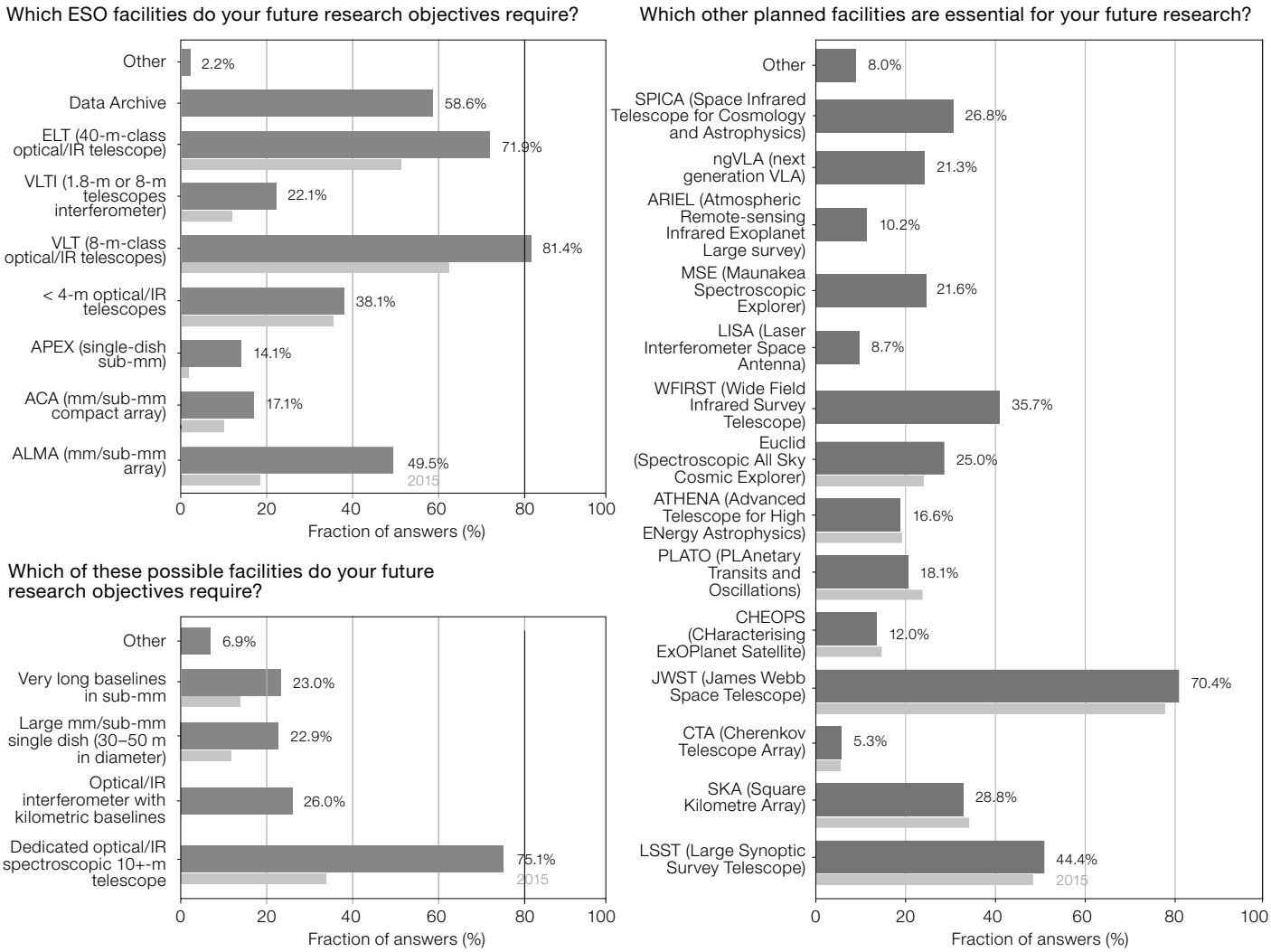


Figure 7. Importance of present and future (planned or not) facilities. The thinner and lighter grey bars show the numbers from the 2015 survey (where available).

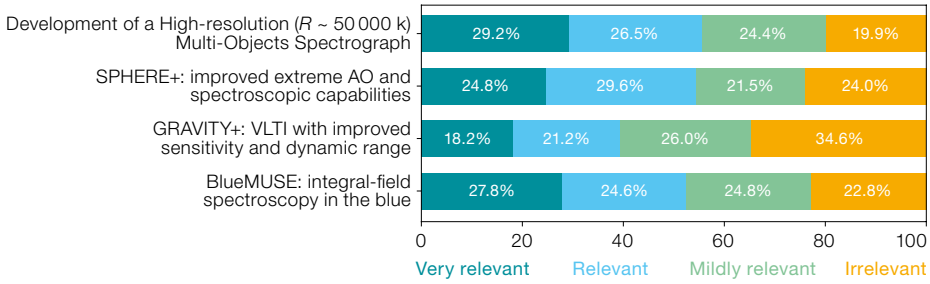
missing from the current and planned offerings at ESO's VLT/I. Nearly a quarter of the respondents (399 or 24%) commented, most of them providing details of missing capabilities. Most answers suggest different telescopes (for example, smaller telescopes or 10-metre spectroscopic telescopes). In broad terms, the missing capabilities for the VLT are in the areas of multi-object spectrographs and integral-field units (99 answers), in the near-infrared, or concern adaptive optics at bluer wavelengths. Other popular requests are for VLTI extended capabilities (48 answers), and polarimetric modes, either for spectroscopy or imaging (34 answers).

The next question concerned current observing modes and scheduling capabilities and which of those will be important for research objectives in the coming decade. The question is similar to one asked in 2015, but the numbers cannot be compared directly as the methodology was slightly different. However, we can make some interesting observations (see Figure 9):

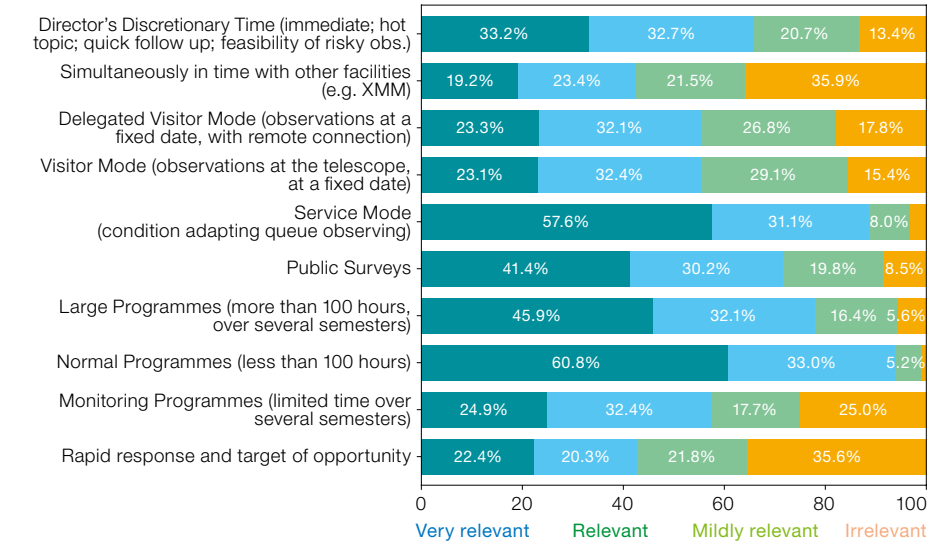
– Normal Programmes and Service Mode have the most support (~ 90% find it very relevant or relevant). Public Surveys and Large Programmes also have significant support (~ 70%). Around half (40–60%) of the community found the other modes relevant.
– Visitor Mode is less favoured (55.5%) compared to service mode (88.9%). There is a generational trend: the youngest and most senior scientists tend to be more in favour of Visitor Mode than their mid-career peers.
– Visitor Mode and Delegated Visitor Mode[a] have exactly the same level of support.
– Director's Discretionary Time (DDT) is found to be less relevant to students than to more senior researchers.

Regarding possible future operational capabilities, most ideas attracted a positive response (see Figure 10). The most favoured options are those bringing operations towards more virtual access: archival proposals, remote observations, cloud-based access to data and reduction tools. Many new features have generational trends. The ideas that are clearly preferred by younger researchers include distributed peer review, dual-anonymous proposals, the possibility of applying for several facil-

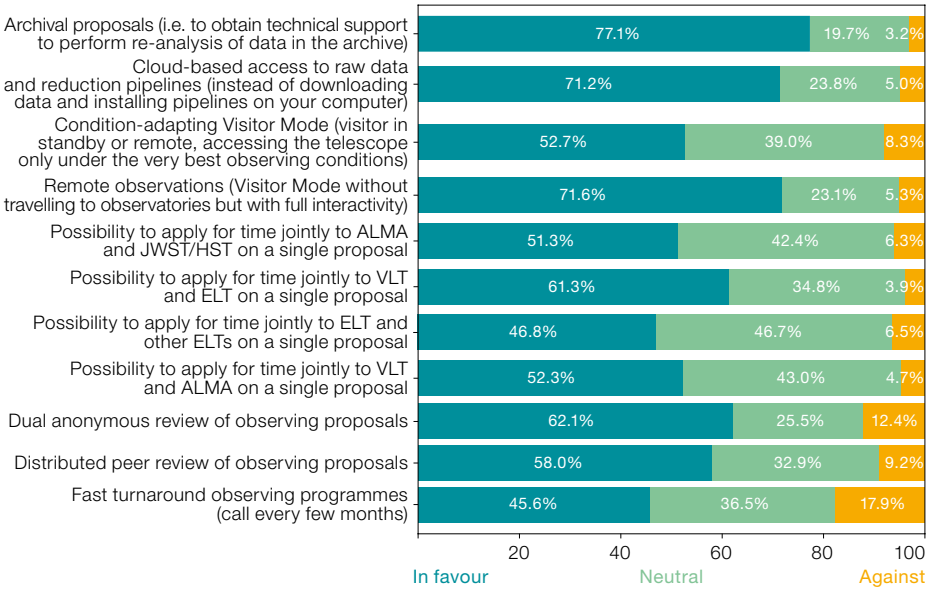
In June 2019 ESO organised a workshop to discuss future developments for VLT and VLTI in the 2030+ timeframe. Several projects were discussed and four projects were selected by the Science and Technical Committee (STC) for further review. Three of these projects have advanced design, whereas the fourth is only a concept, currently lacking a consortium. How relevant are the following projects for your research?



Which of the current observing modes and scheduling capabilities will be important for your research objectives in the coming decade?



How favourably do you consider the following possible capabilities?



ities at once, and cloud-based access to data and pipelines. Only the capability for remote observations is less favoured by younger scientists; this trend was also seen in the level of enthusiasm for the Visitor Mode amongst more junior researchers.

Cross analysis: facilities versus research fields

Although the poll was fully anonymous we can match answers to one question with those to another, as we already did to analyse answers by career stage. For example, we can examine the desire for current and future facilities as a function of the research field the respondent works in.

Figure 11 displays both coloured and tabulated values for the people finding current, planned or future projects "relevant" or "very relevant" for their research, broken down by community. The data are very rich, but a few broad conclusions can be drawn: the VLT, the ELT, the data archive and a future 10-metre spectroscopic telescope are considered to be true multi-purpose machines, since they are embraced by a large fraction of all communities. Other facilities are specialised in terms of the communities they serve, because of their excellence in spectral coverage, angular resolution, sensitivity, operational modes, etc. The most popular research area is "Structure and Evolution of Galaxies (including AGN)" with 733 respondents indicating that they work in this area. The facilities that these respondents would like to use for their future research closely match the overall outcome of the poll. The second-most popular research area is "Life Cycle of Stars", where the optical telescopes (VLT and ELT) and the archive are mentioned as important facilities for future research, while the third-most popular research area "Life Cycle of Interstellar Matter" clearly benefits from having access to ALMA, which for these respondents is as important as the VLT to achieve their research goals.

Figure 8. (Upper) Relevance of the VLT 2030+ instruments according to the poll respondents.

Figure 9. (Middle) The relevance to respondents' research of current observing modes and scheduling capabilities.

Figure 10. (Lower) Possible future capabilities.

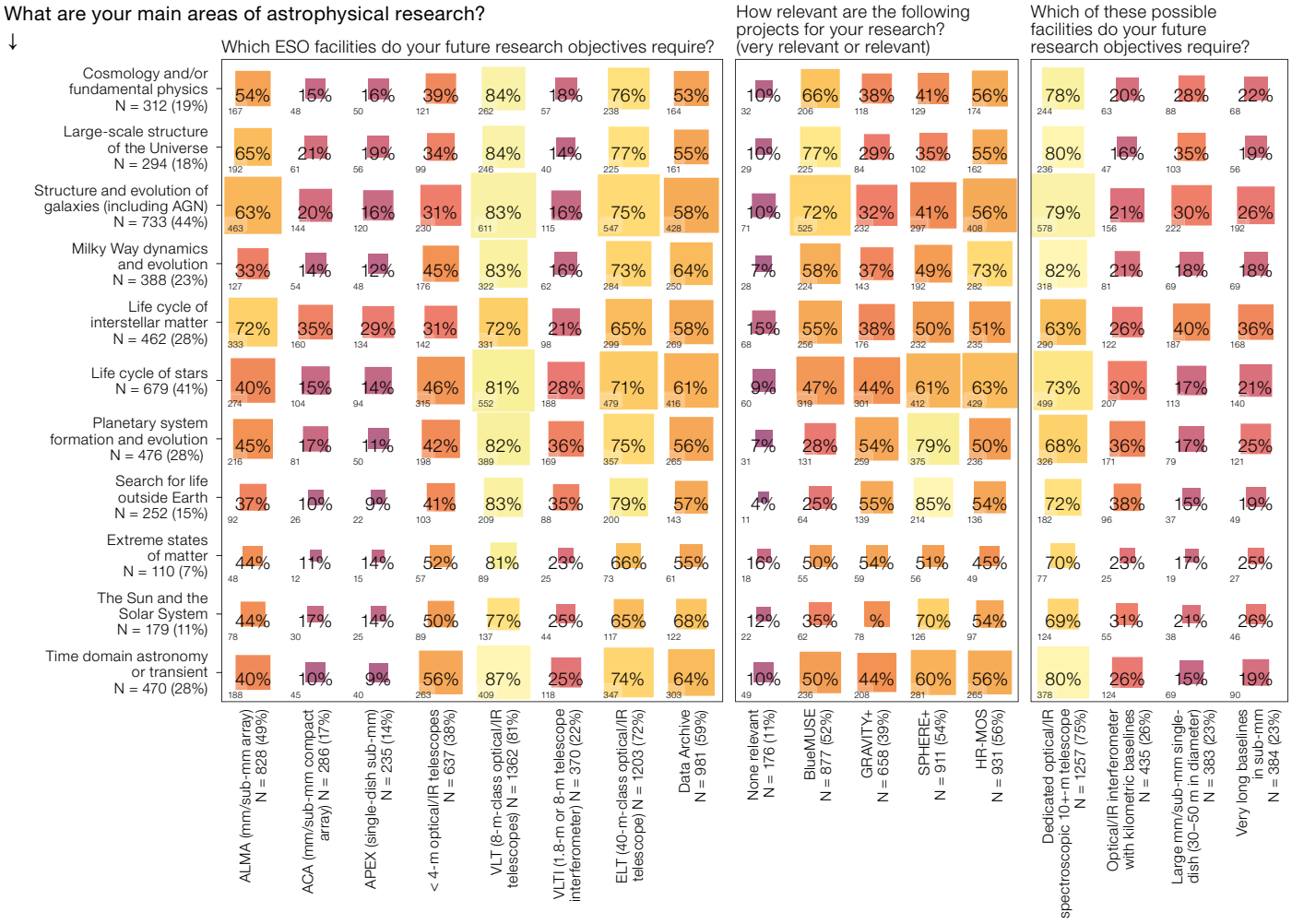


Figure 11. Interest in facilities, broken down by astrophysical fields. Facilities are in columns (current facilities to the left, VLT2030+ projects in the middle, future projects to the right). Percentages are computed by rows (research fields): for example, 72% (N = 333) of people working in "Life cycle of the interstellar matter" (N = 462) find ALMA relevant. Colours reflect the percentages, while coloured areas are proportional to the number of answers. For example, among all communities, "Life cycle of the interstellar matter" has the largest fractions interested in ALMA (333/462 = 72%), even though "Structure and evolution of Galaxies, inc. AGNs" attracts more people (463), but a smaller fraction of the community (463/733 = 63%).

Conclusion

The 2020 ESO community poll reached a diverse community spread across career stage, research field and wavelength regimes, revealing the broad use of and interest in ESO facilities. The respondents come from a pool of ESO and European ALMA portal users, with 76% coming from the former and 14% from the latter. The final 10% of users in the pool have accounts in both portals. The respondents indicate a high demand for the VLT, ALMA and the data archive, as well as the ELT and future operational modes. This is testimony to the relevance of these facilities, and an indication that users are engaged in their long-term use. Most of the observational parameter space of future interest is served by existing and planned ESO facilities (Figure 6). Yet two useful windows in this parameter space not currently covered by ESO are apparent: high-resolution spectropolarimetry and high-resolution, high-angular-resolution (interferometry and high-contrast imaging) in the optical and near-infrared. There is broad interest in the three new instruments proposed at the VLT2030 workshop, as well as in a high-resolution multi-object spectrograph. The poll shows a strong demand for the data archive (which was added in this poll but did not feature in the 2015 version), as well as for data-reduction support (Figure 10). Concerning future facilities, the broadest interest is in a dedicated spectroscopic telescope. In conclusion, the working group felt that the polled community values and demands the broad diversity of tools that ESO operates and strongly supports existing and planned ESO facilities.

References

Mérand, A. & Leibundgut, B. 2019, The Messenger, 177, 67
Primas, F. et al. 2015, The Messenger, 161, 6

Notes

[a] Designated Visitor Mode means that the astronomer connects remotely to the observatory, rather than visiting in person.