SEVENTH FRAMEWORK PROGRAMME

FP7 – INFRASTRUCTURES – 2010 - 1

ASTRONET Final report

Project acronym: ***ASTRONET***

Project full title: ***Coordinating strategic planning for European Astronomy***

Grant agreement no.: ***262162***

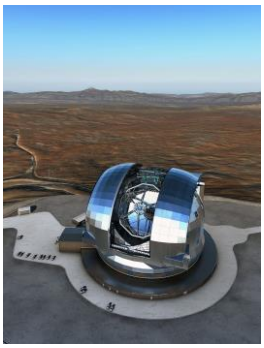
EXECUTIVE SUMMARY

ASTRONET was first formed in 2005 as a consortium of the major European agencies funding European astronomy, supported by the EC through two ERA-NET grants. Its goal was to launch and implement a joint strategic planning mechanism for all of astronomy for the next 5-25 years, enabling the partners to take *science-based*, coordinated and rational decisions for a productive future for this front-line science. Plans should cover all scientific topics from the Sun and Solar System to the limits of the Universe, research infrastructures from the radio domain to gamma-rays and particles, on the ground and in space, but also theory and computing, outreach, training, and capacity buikding. Importantly, ASTRONET also aimed to include all significant scientific communities and funding agencies in Europe. At the end of its second five-year period, the ASTRONET partners note with pride that all of its main objectives have been achieved, and a permanent, self-sustained, coordinating activity is ready to take over.

ASTRONET-1: NETWORKING AND PREPARING DECISIONS ON MAJOR INFRASTRUCTURES

At the outset, the ASTRONET partners faced a bewildering array of proposals for constructing major infrastructures at all wavelengths and particles. They agreed that comprehensive, science-based, coordinated planning was the most cost-effective basis on which to address this challenge, both in the construction and operational phases. Despite the formidable challenges of establishing such a comprehensive plan across diverse scientific disciplines and communities, ASTRONET-1 reached that key goal with the publication of its *Science Vision* and *Infrastructure Roadmap* reports in November 2007 and 2008, after extensive community consultation. A number of concomitant surveys and topical strategy plans were also prepared, and the value of close contact between European astronomy and its funders was proven at the same time. These were very significant new steps towards the coordination of all European resources in the field.

ASTRONET-2: IMPLEMENTING THE ROADMAP AND PREPARING THE FUTURE

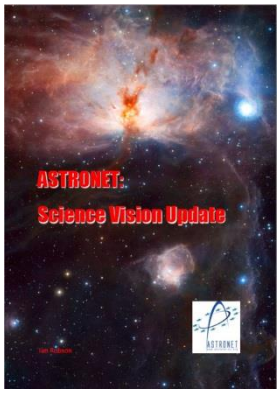


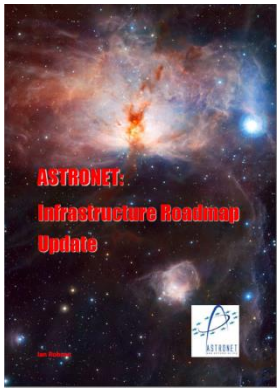
Building on these initial achievements, ASTRONET-2 has addressed the – no less challenging – stage of implementing the Roadmap. On the backdrop of the *Science Vision* and *Infrastructure Roadmap* (of course developed in concert with ESO and ESA's own long-term plans), their main recommendations were followed by decision makers: The ESO Council has launched the *European Extremely Large Telescope* (E-ELT) project; the next major ESA missions have been selected; the SKA and CTA projects are off to a firm start. Thus, the future main facilities for European astronomy have been approved as

foreseen – the more remarkable since the economic downturn has put budgets, recurrent costs and staffing under stress in the same period.

Updating the Initial Planning Documents

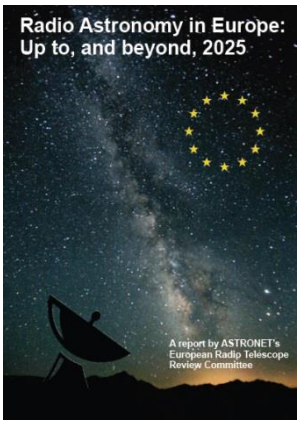
After seven years, it was time to update the initial *Science Vision* and *Infrastructure Roadmap*, again in close consultation with the scientific community. This exercise showed the impressive progress made across the globe and highlighted the many significant new discoveries and advances, e.g. in the fields of co-evolution of galaxies and black holes, formation and evolution of our Milky Way, exoplanets and astrobiology, or solar weather. Remarkably, most original questions remain valid, even if changes can be foreseen in another decade. Equally notable was the way these discoveries are driven by new facilities on the ground and space. The update of the roadmap itself showed excellent progress on both fronts, from the ground and in space. Most recommendations of the original Roadmap (41 in total) have been executed or being actively planned, and the coherent European planning for astronomy is internationally recognised as a model.





Initiatives to Optimise the Scientific Returns of European Infrastructures

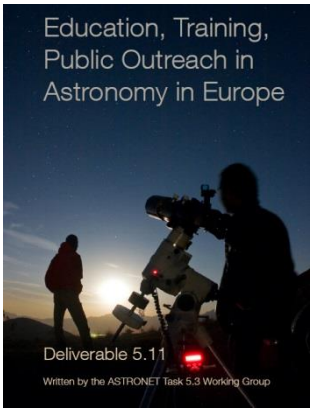
An important part of rational forward planning is to coordinate and prioritise the role of existing infrastructures. In coordination with RADIONET, ASTRONET's *European Radio Telescope Review Committee* has prepared a comprehensive report with important recommendations for radio astronomy in the context of the SKA, strengthening the Pan-European positioning of radio Astronomy in support of the *Science Vision*. In coordination with OPTICON, we have also developed a continuous vision of the European (2-4m and 8-10m class) *optical/IR telescopes* to optimise their use by the astronomical community. An important initiative is the support for the development of *WEAVE*, a wide-field multi-object spectrograph for the William Herschel Telescope, to support the ESA/Gaia mission and further ground-space synergy in Europe.



In coordination with CoSADIE, ASTRONET also plays an important role as a catalyst in developing a sustainable *Virtual Observatory* (VO) scheme in Europe. The VO is now well placed to turn this vision into reality within the ASTERICS project (Cluster of Infrastructures in Astronomy/Astroparticles). The *Astrophysical Software Laboratory* initiative, aiming to establish a common vision of code sharing and development in Europe, has not completely converged, but relevant actions have found a place in the High Performance Computing activities of ASTERICS, enabling this initiative to mature. Finally, ASTRONET has founded a *European Task Force for Laboratory Astrophysics* (ETFLA), which is undertaking a wide range of important cross-wavelength actions. All these initiatives are pushing the implementation of the *Science Vision* and *Infrastructure Roadmap* recommendations forward across a broad front.

THE CRUCIAL HUMAN FACTOR

To complement these, more technical, initiatives, we have supported the development of an extensive report on Education, Training and Public Outreach for astronomy in Europe. Coordinated by ESO, one of the key partners in ASTRONET, it includes recommendations on the relationships with industry and technology transfer. It has been designed to show how Europe can overcome the fragmentation in these fields and take a significant step towards the coordination and integration of European resources. It seems clear that the need for a Europe-wide coordination and consolidation of efforts in education and public outreach is stronger than ever; opportunities and sufficient funding for the recommended actions are urgently needed.



MAINTAINING CONTACT WITH THE SCIENTIFIC COMMUNITY AND OTHER STAKEHOLDERS

Successful long-term planning is impossible without an effective ‘buy-in’ by the scientific community. Close contacts to the coordinating bodies for European and global science in general are also vitally important. Throughout, ASTRONET has maintained close contacts with both groups of external stakeholders, especially in preparing and presenting the updates to the initial *Science Vision* and *Infrastructure Roadmap*. To this end, ASTRONET initiated cooperation with the *European Astronomical Society* (EAS) and its EWASS (*European Week of Astronomy and Space Science*) conferences, which gather a broad cross-section of European astronomers.

Community feedback was especially vital in updating our basic planning documents. Accordingly, ASTRONET organised discussion sessions at the EWASS 2013 conferences in Turku and 2014 in Geneva before the final updates were prepared and published. The final session at EWASS 2015 on June 24 had a different, forward-looking purpose: A discussion of the planned ASTRONET activities in the decade 2015-2025, when the major new infrastructures will be built and start operating.

At this meeting, future developments in synergy between astrophysics and astroparticles in the era of Big Data and multi-messenger facilities within the EU-funded ASTERICS project were reviewed by Michael Garrett (ASTRON). The new Roadmap for European radio astronomy was presented by Jason Hessels (Univ. of Amsterdam), and a future strategy for European OIR astronomy, including a more integrated synergy with ESA missions as just agreed, was outlined by Bruno Leibundgut (ESO). This served as a prelude to a review by Xavier Barcons (Univ. de Cantabria) of scientific areas where such ground-space and multi-messenger synergy will be particularly beneficial. Preparations for a permanent successor to ASTRONET were reviewed by Colin Vincent (STFC), outlining the challenges and balances facing ASTRONET for the mid-term future and leading into a lively discussion that helped to define priorities for our future programme.

Finally, the update of the *Science Vision* and *Infrastructure Roadmap* and our plans for the next decade(s) were presented at a high-level event in Paris on June 17 with representatives from ESFRI, the OECD Global Science Forum, ESA, ESO, and other major external stakeholders.

COMPLETING THE NEW ASTRONOMICAL MAP OF EUROPE

Last, but not least, an important activity of ASTRONET-2 has been to promote the integration of the New Member States in the European coordination. Starting from an analysis of the status of astronomy in these states, targeted visits were conducted, followed by a concluding workshop in Prague in June 2015. ASTRONET will thus offer a new platform for coordination; it also plans to establish a network of regional infrastructures and promote the education and training of future astronomers and engineers with versatile skills which will be useful in society at large. Improved access to data through the VO and to large facilities will also be actively explored.

PREPARING THE FUTURE

A key long-term objective of ASTRONET-2 was to prepare a self-sustainable coordination for European astronomy. After a survey of potential governance models, a draft Memorandum of Understanding (MoU) to create a new consortium of funding agencies, infrastructure operators, and user organisations was prepared. Iterating a final version will take time, so the ASTRONET Executive Committee suggested a Letter of Intent to commit the present partners to this phase, the aim being to have a final MoU signed by June 30, 2016; all present Contractors and over 10 Associates signed the LoI already in June 2015. Negotiations will continue for a target date of January 1st, 2016, with CNRS, NWO and STFC in the lead and taking into account the important recommendations received at the June 2015 Launch Event and the EWASS meeting.

All partners agree that the future ASTRONET should evolve from the world of roadmapping and recommendations to that of actually realising its plans. The key goals are to maintain an updated *Infrastructure Roadmap* and implement its main recommendations, viz. to: 1): liaise closely with the major national and international infrastructure projects: E-ELT, TMT, SKA, CTA, EST, KM3NeT, LIGO/VIRGO, etc.; 2) rationalise the network of European 2-4m OIR telescopes and expand trans-national access in the longer term; 3) similarly rationalise the network of European radio telescopes; 4) develop the VO, ASL, and Laboratory Astrophysics as indispensable for the scientific returns from the large infrastructure investments; and 5) strengthen the links to industry and promote innovation and spinoffs from these large projects.

EPILOGUE

In short, ASTRONET has established permanent contacts among the main actors of European and international astronomy; has updated the *Science Vision* and *Infrastructure Roadmap*, and is vigorously pursuing their implementation; initiated coordination in wide variety of fields, and has finally set the stage for a self-sustainable *Astronomy Coordination in Europe*. These results were much applauded by the participants in the Launch Event in Paris on June 17th, 2015.

ASTRONET has made a permanent impact on European astronomy, with the *Science Vision* and *Infrastructure Roadmap* as the basis for the coordination. It has proven a successful combination of bottom-up and top-down approach, with very good interaction with all key stakeholders – also globally seen as a model of coordination. What the community now expects is implementation of the Roadmap recommendations. This implies long-term commitment to action at different levels and a flexible, tailor-made, pragmatic approach – which is the spirit of the future ASTRONET.