Consultation on possible topics for future activities for integrating and opening existing national research infrastructures

Title	
Title of the proposal -open reply-(compulsory)	OPTICON: Optical-Infrared Coordination Network for Astronomy
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Is your proposal representing your own personal view or are you responding on behalf of your organisation as a whole? -single choice reply-(compulsory)	Organisation view
Description of the research infrastructures covered and the trans-national access and /or services provided	
Indicate the type of research infrastructures to be covered by the proposed topic, and list the research infrastructures in Member States, Associated Countries and Third Countries, that would provide transnational access and/or services to researchers, with brief descriptions of the state-of-the-art equipment and services offered to users that make them rare or unique in Europe. Outline the specific areas of research and scientific communities normally served by the infrastructures, as well as new areas opening to users, if any. Indicate what would be the overall access modalities necessary to be developed. Text of maximum 4000 characters including spaces. -open reply-(compulsory)	
Optical-infrared astronomy in Europe is in a state of transition and opportunity, with the goal of a world-leading European-scale community in sight. A strong astronomical community requires access to state of the art infrastructures (telescopes, data archives, instrument technology R&D labs, critical industrial-scale process capabilities, information systems, networking opportunities,…), equipped with the best possible instrumentation, and with that access being open to all on a basis of competitive excellence. The community needs training in optimal use of those facilities to be available on need. A viable operational model, with long-term support from the national agencies, is essential to operate those infrastructures. Individual astronomers need open access to a viable set of telescopes, with a range of apertures relevant to the range of cutting-edge research appropriate in modern astronomy, with these excellent facilities complemented by superb instrumentation on the extant large telescopes. In addition, ensuring future continuing global	

leadership, requires that distributed teams can be involving in coordinated technology development, community structuring, and preparatory scientific research, working towards next generation instrumentation on the future flagship, the European Extremely Large Telescope, and complementary multi-wavelength capabilities. OPTICON has made, and makes, a substantial contribution to preparing the realisation of that ambition. OPTICON supported R&D has, and is developing critical next- generation technology, to enhance future instrumentation on all telescopes. An immediate challenge is to retain a viable set of well- equipped medium aperture telescopes. The H2020-scale challenge is to build on the proof of principle that European-wide coordinated R&D and research is possible - a situation developed by OPTICON under its present and previous contracts, in collaboration with the EC supported strategy network ASTRONET - and take the step to full implementation of an access, networking and technology R&D opportunity which retains and strengthens European community-wide leadership in this cutting-edge STEM subject. The relevant communities include all EC member and associated states, with of course specific challenges involved in ensuring excellent scientists from communities which lack a tradition of access to global-scale facilities are fully integrated. This requires both information and dedicated training school activities. The infrastructures are a pyramidal mix, starting with many small but valuable special-purpose facilities in many locations. These include the small robotic-controlled telescopes which are well known for extra-solar planet discovery, and which especially involve leadership by communities from central Europe. The next step is intermediate-scale observatories, on the few high, clear mountain sites optimal for astronomy, followed by the current largest facilities, on the few very best sites worldwide. The next generation extremely large facilities (ALMA, EELT) are unique multinational facilities located in the high Andes. All medium-scale observatories make up the present Opticon I3 access project. There are no comparable capabilities with European participation outside Opticon. Complementary labs, technology developments, etc are distributed across Europe's research community, high-tech industry, and several spin-off SMEs resulting from astronomy R&D.

Scientific domains served by the research infrastructures

Select the scientific domain(s) served by the research infrastructures -multiple choices reply-(compulsory)	Engineering, Material Sciences and Analytical Facilities - Physical Sciences - Mathematics and ICT
Indicate the main scientific domain served -multiple choices reply-(compulsory)	Physical Sciences

Key potential partners

Indicate a list of key potential partners. Text of maximum 3000 characters including spaces, with 1 line per potential partner (participant organisation name, country and contact person)
-open reply-(compulsory)

The current Opticon partners would form the core of future activity, as these organisations own, operate, and develop new capabilities for the entire set of European astronomical mid-large observatories, hi-tech instrumentation and software labs, and database infrastructures. New industrial partners continue to request partnership, so H2020 would include more SMEs. A key strength is that the European national funding agencies are Opticon partners, linking strategy, policy, funding and the wider community. Contact persons change frequently in large organisations, but the names and details are available in the updated Opticon contract data. Participant no. Participant organisation name Country 1 The Chancellor, Masters and Scholars of the University of Cambridge United Kingdom 2 Centre National de la Recherche Scientifique France 3 Istituto Nazionale di Astrofisica Italy 4 Max Planck Gesellschaft Germany 5 The Science and Technology Facilities Council United Kingdom 6 European Southern Observatory International 7 Consejo Superior de Investigaciones Cientificas Spain 8 Office National d'Etudes et de Recherches Aerospatiales France 9 Stichting Astronomisch Onderzoek in Nederland The Netherlands 10 Instituto de Astrofisica de Canarias Spain 11 Department of Innovation Industry Science and Research Australia 12 Nordic Optical Telescope Scientific Association Sweden 13 National Observatory of Athens Greece 14 Liverpool John Moores University United Kingdom 15 Universidade do Porto Portugal 16 Politecnico di Milano Italy 17 University of Durham United Kingdom 18 National University of Ireland, Galway Ireland 19 Astrophysikalisches Institut Potsdam Germany 20 Uniwersytet Warszawski Poland 21 Universiteit Leiden on behalf of Nederlandse Onderzoekschool Voor Astronomie (NOVA) The Netherlands 22 e2v United Kingdom 23 Heriot-Watt University United Kingdom 24 University of Bath United Kingdom 25 Alpao France

Scope and activities

Describe the overall objectives of the activity. Describe the benefit that the proposal would bring about in terms of integrated provision of infrastructure related services. When appropriate, describe how the network would integrate with the relevant e-Infrastructures. Text of maximum 2000 characters including spaces.

-open reply-(compulsory)

The Opticon consortium exists to deliver a simple yet challenging set of strategic objectives. - Structuring the whole European astronomical community, by ensuring all astronomers are able to carry out state of the art research on state of the art facilities. - Developing European astronomy, by allowing astronomical communities to develop scientific plans for their own future facilities, and agencies to plan for a viable future set of facilities. - Strengthening European astronomy, by delivering cutting edge technology research and development, helping ensure extant and future astronomical research facilities are state of the art, and internationally leading in performance. Opticon has consistently defined and implemented radically new sets of actions to improve the effectiveness of the Access programme. A special success is development of a common `Opticon' telescope time "pool" allocated by a single peer-review process. Feedback from this peer-review informs users, and defines the training programme. The joint goal is to increase new users, and to migrate users onto the best modern facilities. Opticon provided a common proposal system for use by all Europe's telescopes, to minimise interface complexity for inexperienced users. Together with AstroNet, Opticon devised a strategic plan for future optimisation of Europe's telescope, aiming to deliver a high quality subset of optimally-instrumented and specialised facilities, which will be used by all Europe's astronomers. Implementation of these ambitions leading to the ESFRI-listed European Extremely Large Telescope requires consistent coordinated innovative actions and developments through the ELT development phase, into the mid-2020s. It takes a generation to evolve into a stable new community. That community is becoming world-leading. We have the opportunity, through consistent investment, to ensure that pan-European global leadership.

Indicate the Networking Activities that could be foreseen to foster a culture of co-operation between the research infrastructures and scientific communities. Indicate the Joint Research Activities that could be foreseen to improve, in quality and/or quantity, the services provided by the infrastructures. Text of maximum 4000 characters including spaces.

-open reply-(compulsory)

Networking activities link people and communities and motivate future developments. To appreciate this context, it is perhaps helpful to imagine an (oversimplified!) story of how people are trained and motivated and how this maps onto the current Opticon programme. It begins with training and motivation (via schools, exchange visits, outreach), and progresses via experience, often on existing medium sized facilities (TNA activity) whose operations are being rationalised to ensure viability and efficiency (Telescope Directors Forum, ASTRONET implementation activities, common time application system) and whose individual capabilities are being enhanced by new software and hardware (JRAs + exchange visits). These users may require experience of specialist skills (High Time Resolution astronomy, Time Domain astronomy, Interferometry). All this leads toward the E-ELT, for which the science case is being developed, evangelised and co-ordinated with other projects (ELT network and workshops) and for which the community is developing new hardware (JRAs, including photonics, new materials, new detectors, fast optic-mechanical control systems for adaptive optics, interferometric wavefront recontructiontion systems, etc). Some of this is being prototyped (JRAs), while a watching brief is maintained on far future technology (Innovation Network), some of which is already being considered now and for future JRA effort, in the light of science-industry developments in the next decade or more. Several Opticon-sponsored developments have led to new spin-out SMEs (eg FirstLight, marketing OCAM, the Opticon camera). The technology challenges are identified, through roadmaps, and need effort. As a specific example of the success of Opticon networks, we note that the ground-based Solar astrophysics community, initially included inside Opticon, have their own I3, having "matured" into a viable independent community under Opticon support, and having benefited from seeing how a community develops and plans inside an EC-supported context. The Virtual Observatory community also started inside Opticon. As a second specific example of success and the current state of the art, we note the Opticon training and exchange Schools, for both scientists and technical support staff. These are so successful they are now a model for others. There are currently requests for help in setting up similar activities from China, Ukraine, the International Astronomical Union in Africa and from South America. Opticon networking activities are a model which others consider worth following.

Need for European integration

Explain why this proposed topic would require a European (rather than a national or local) approach. Describe how resources provided by EU would be mobilised. Indicate how account is taken of other national or international activities, and any resources that would complement an EU contribution. Text of maximum 3000 characters including spaces.

-open reply-(compulsory)

The next decades will start to deliver the much-promised integration of astronomy across wavelengths, joining optical (VLT, ELT), radio (SKA), sub-mm (ALMA), and high energy (CTA, HESS, Auger), developing distributed data sets and virtual observatory methodologies. As dark matter studies develop, astroparticle physics will become the mainstream, connecting both the specialist physics labs, and CERN. These are all inherently European (or global) projects, with no room for national-scale leadership. Of course, projects on this scale are multi-decadal challenges, which demand long-term support for their success. Providing the opportunities for national

communities to work together jointly on multi-national scale challenges is the only way to build this ERA-scale community. These challenges include the whole spectrum of activity, starting with development of plans and ambitions (networks), through technology R&D (JRAs) to ensure state of the art viability [a demand which continues throughout the operational life of an infrastructure, and includes both hardware and data processing/analysis software], through to proposal, management, development, construction and operation of major facilities. In fact, astronomy and particle physics are the most advanced communities along this path, and will be those proving the viability of concept – given support on an appropriate timescale.

Expected impact

Describe the expected impact of the proposed activities on the scientific communities, on the functioning of the research infrastructures, and on the development of the European Research Area (including balanced territorial development). Highlight the contribution to socio-economic impacts, including for promoting innovation and developing appropriate skills in Europe. Text of maximum 3000 characters including spaces.

-open reply-(compulsory)

This development has three fundamental roots: Science, technology, and sociology. First, the science: Astronomy is global by nature: One Universe surrounds us all, and in order to understand its origin and evolution, astronomers need to explore it all directions and at all wavelengths of the electromagnetic spectrum. Accordingly, the research infrastructures for astronomy are not simply "telescopes", but in future radio, optical, infrared, mm-wave, and high-energy observatories, extending beyond the electromagnetic to neutrinos, gravity waves, and dark matter particles. Moreover, ground-based infrastructures must be located at sites possessing the most appropriate conditions, and which have not yet been ruined by human activity (light pollution; radio noise). This by itself rules out most of Europe as a basis for purely national infrastructures in astronomy. Second, technology: The front-line technologies of tomorrow are so demanding that no single country can develop the complete panoply. This is where OPTICON and RadioNet have been so successful in driving coordinated, Europe-wide development activities of benefit for both the giga-scale infrastructures of tomorrow, like the E-ELT and SKA in the ESFRI Roadmap, but also the existing, smaller facilities. At the same time, information technology has eliminated the need for the scientist to be located geographically close to the facility. Third, sociology: Much of the thrust in pushing back the frontiers of astronomy over the next decade will be provided by international or even global teams of scientists joining forces to solve a specific large task. Already, massive imaging surveys are under way on the ground and in space, and complementing all-sky spectroscopic surveys are being planned in accordance with the ASTRONET Roadmap. The key priority for the 2020s will not be to integrate facilities, but to integrate continent-wide communities in the joint use of globally owned infrastructures - just as the LHC does, the VLT and ALMA are starting to do, and the ELT, SKA, CTA… will in future. A valuable – planned – additional benefit of scientific leadership is the training of excellent young scientists, most of whom will play a wider role in the community, working in industry and education. Technology developments lead to industrial spin-outs, providing jobs and advances in other aspects of society. Astronomy has a strong record in developing new technologies, with applications not only in high-tech industry, but in medicine, and more widely in society, from the internet to computer games.

Projects previously funded under FP7 and FP6

Only for those proposed topics that correspond to the follow-up of FP7 or FP6 funded Integrating Activities, please provide specific additional information on: the project(s) previously or currently funded and the level of funding; the main results and expected achievements of the funded project(s); the progress foreseen in the activities proposed beyond FP7. Text of maximum 4000 characters including spaces.

-open reply-(optional)

Opticon has been supported through FP6 (budget 19.8M€, 5 years) and FP7 (budget 18.5M€, 8 years). This has proven a dramatic success, with Opticon having provided a significant contribution in defining and structuring a world-leading European astronomical community. A decade ago planning assumptions for next-generation astronomical infrastructures took for granted that older facilities would become obsolete, would be closed, and their operational budgets would contribute to newer facilities. However, the number of new large expensive facilities is small – the number of extant facilities is large. This course would turn astronomy into a system which delivered research capabilities only to a small elite – inevitably the wealthier elite. In fact, this is the way astronomy was implemented earlier in the 20th century, when global domination was in the hands of a very few wealthy private institutions, all in the US. We did not wish to go down this road again, and created Opticon to help prevent it. The change from an assumption of obsolescence to an assumption of future opportunity came to be made by the development of a European-scale astronomical community. This community was able to make the case that facilities should be enhanced and shared, not closed, that technology developments were both achievable and affordable, that astronomers could deliver cutting edge science with those enhanced facilities and crucially that the talent,

expertise and financial resources to deliver all this would be available if efforts were coordinated on trans-national scales. European astronomy, largely through the excellence of the European Southern Observatory, but also through the coordination, planning, development and technical R&D work supported by the EC via ASTRONET (Strategy) and Opticon (implementation) has made that case. In consequence, Europe has become the international leader in optical-infrared astronomy. European optical-infrared astronomy will continue to undergo a dramatic transformation on two fronts, as foreseen in the ASTRONET Infrastructure Roadmap, through the next decades. The heterogeneous collection of national 2-4m telescopes is being transformed into a rational, coherent European facility, with a long-term possible future delivering scientific excellence. Second, the impending decision to construct the European Extremely Large Telescope (E-ELT), the SKA, and ESO's provision of ALMA will consolidate European global leadership in optical-infrared astronomy, and initiate the next challenge, of true multi-wavelength astro(particle)physics, using a few global macro-facilities. Opticon has been a driving force in the developments to date by: (i) maturing the astronomical community to large-scale European cooperation; (ii) preparing the factual and organisational basis for these breakthroughs; (iii) coordinating the development of the enabling technologies that will underpin this transformation. Building on that record of success to reach the next level of challenge, across astronomy, physics and particle physics, will begin under Horizon2020. It is a challenge we must meet, and can, given resources and opportunity.