Astronomical research, in what is still a discovery-led subject, is limited largely by technology. OPTICON’s JRA activities push the boundaries of potentially disruptive technologies in photosensitive materials and in novel manufacturing processes. OPTICON aspires to deliver the fastest high-efficiency CMOS camera, for scientific real-time control systems, and with knowledge transfer to an SME to ensure wider applications. OPTICON plans to advance the TRL of critical path technologies identified from our earlier technology planning, as crucial for next generational capabilities, particularly in photosensitive materials and in innovative manufacturing processes. In all cases we emphasise knowledge transfer and training of a new generation of technologists. Summer
schools, more specialist subject schools organised through the JRA activities, and expert visiting/transfer programmes ensure diffusion of knowledge. One major challenge is to ensure the breadth, the depth and the viability of the broader communities outside one-off project-specific partnerships. Ambitious scientific objectives clearly increase the complexity of future instruments, which in turn will require further development of critical technologies, and also elaboration of new system concepts, new control strategies and new data reconstruction methods.

OPTICON’s Trans National Access (TNA) ambitions are twofold. The first is to deliver open access to the most appropriate facilities for cutting edge research on Europe’s medium sized telescopes, through the highly-regarded CTAC Calls for Observing proposals. The second TNA ambition is completely new, and visionary. Time Domain astronomy (TDA), the study of variable sources, is the fastest growing branch of astronomy. The community ranges from enthusiastic amateur astronomers to major collaborations. We coordinate and where necessary train these communities, providing the crucial common software and prototype hardware systems needed to deliver characterised science quality data, and to implement effective facility integration. We work to provide a central data resource with global open access ensuring added value, data preservation and maximal utility.

To achieve these ambitions OPTICON includes 16 Work Packages, with 8 focussed on technology development, 4 networking, 2 on future strategy (technical and managerial) and two on project delivery (management and TNA). All 16 are active and productive.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

The CMOS camera completed its Final Design review, and detailed market review for the SME partner. Several Schools and Workshops have already been held, disseminating knowledge. As an interesting example, the June 2018 ESO Messenger, very widely distributed across Europe and globally, had two articles on OPTICON activity. One on a large Workshop on photosensitive materials held in Italy, the other on one of our Training Schools held in Chile. General information about the TNA process, including a map of the facilities available can be found on the OPTICON website here. http://www.astro-opticon.org/h2020/tna/index.html. All the TNA is allocated via our OPTICON Common Time Allocation Committee. There are two calls per year, roughly aligned with the semesters used by the participating observatories. For each of these semesters every telescope in the TNA programme is invited to offer a number of nights to the OPTICON pool. The details of the number of nights available on each facility are then promulgated in the call for proposals on the OPTICON website which is normally open during February (for the B semester) and August (for the A semester). The most recent call can be found here http://www.astro-opticon.org/h2020/tna/call/call-2018b.html Proposals are entered via the Northstar system and are reviewed by an international panel. This panel (the CTAC) comprises 7 independent scientists drawn from 7 different national communities and often linked to their own national time allocation process as either current or recent members of national panels. This ensures both a valuable mix of skills and provides essential feedback between the OPTICON and the various national processes. The over-subscription level remains high and constant - the community value the opportunities.

The study of new functional materials includes work related to Volume Phase Holographic Gratings (VPHGs). One challenge for VPHGs is understanding the actual status and the outlook of the astronomical instrumentation in terms of dispersing elements and the role covered by the VPHG
technology in this field. For this reason, a dedicated workshop was organized in Milan (October 9-11, 2017) with the title: “Dispersing elements for astronomy: new trends and possibilities”. This workshop, supported by EU through this project and ESO (European Southern Observatory), was led by INAF with the collaboration of IAC and experts from different institutions in Europe and USA in the scientific committee. More than 70 researchers, companies, engineers from about 20 countries attended this event providing talks, posters and active informal discussions.

Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

The Schools group has carried out a detailed impact analysis of the value of the NEON training schools OPTICON has supported since 2000. In total 181 students participated in the first 10 NEON Observing Schools. From these students 93 are women (51%). In August 2018, 115 of these students are still in astronomy, meaning that 64% of our alumni from the first 10 schools are still in astronomy. For women the fraction is slightly higher than for men (68% vs 59%). The figure shows this success - Green - all students, blue- men, red - women.

Coordination of operation of a network of observatories collecting time-domain data over days-to-years is the main goal of the OPTICON Time-Domain Astronomy WP. This includes technical support, training, help with the data processing, workshops. Our main deliverable is an automatic software system processing the data from telescopes operated manually and robotically – this is operational, in wide use, and being enhanced. Automation of the data analysis process is particularly necessary for the time-domain astronomy, where the data volume and time pressure are significant. One major activity aims at enhancing the existing European Very Large Telescope Interferometer (VLTI) facility by providing concrete concepts and feasibility studies for future interferometric instrumentation. The main objective is to pave the way for a near-future instrument plan beyond the 2nd generation of interferometric instruments currently being implemented at the observatory. As such this JRA is highly complementary to efforts at ESO which concentrate of commissioning the 2nd generation instruments. We intend to demonstrate with this JRA that the VLTI deserves future developments, and to inspire ESO to prepare a call for 3rd generation instrumentation to maximize the exploitation of the given VLTI research infrastructure.

The VLTI is a globally unique infrastructure, which provides European astronomers with access to the highest angular resolutions at infrared wavelengths. One JRA is developing three concrete instrument proposals to serve the scientific needs of the astronomy community.
Fraction of the NEON Observing School alumni who are still in astronomy.

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