EST NEWS 7

THE EUROPEAN SOLAR TELESCOPE NEWSLETTER

DECEMBER 2020

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COORDINATOR'S CORNER

EST is making good progress in all the activities the project is addressing and here is again our Newsletter with the latest news.

As a project included in the ESFRI Roadmap, EST volunteered to be monitored in an exercise to follow up its current status. Various aspects were evaluated such as the relevance in a world-wide context, the scientific impact, the use of the most modern technologies, the socio-economic impact in Europe, as well as the perspectives for funding. The evaluation report acknowledged the importance of the project and emphasised that a major bottleneck exists due to the lack of involvement of the funding agencies. The project is working hard to overcome these difficulties so that construction can be started in the shortest possible time. As an intermediate step before an ERIC can be created, different possibilities for an interim legal figure have been analysed. In the coming months, steps will be given towards its creation as a bridge between the present Preparatory Phase and construction.

The EST optical design has been completely revamped after deciding to pursue the option of an adaptive secondary mirror. The optical path has been simplified, leading to a much more efficient telescope. The new concept for the Pier Optical Path, which generates the input focal plane for the instruments, is presented in this issue together with progress made in other relevant areas.

An exciting videogame "Solar Mission EST" is on the way and almost ready to be released. We all are looking forward to playing with it and saving the Earth! This and other outreach activities are described in this issue and on our new website.

All members of the EST consortium hope you are safe in these difficult times and wish you all the best for the coming year 2021, in which we expect normality will come back to our lives.

M. Collados, EST project coordinator

EST MONITORING AND UPDATE TOWARDS THE ESFRI ROADMAP 2021

In preparation for the Roadmap 2021 Update, the European Strategy Forum on Research Infrastructures (ESFRI) has carried out the monitoring of the research infrastructures (RIs) listed as Projects which entered the Roadmap in 2016, as is the case of EST. This monitoring had the goals of (1) checking the overall progress towards implementation; (2) assessing the degree to which the project fulfils the minimal key requirements for the implementation phases of the life cycle and the plans for reaching full implementation; and (3) updating all public information of EST for the upcoming ESFRI Roadmap 2021.

The documents submitted by the EST Project were analysed by the ESFRI Working Group on Implementation and the ESFRI Strategy Working Group relevant to the EST domain (Physical Sciences and Engineering). The monitoring report approved by ESFRI evaluated different key aspects of the project and included recommendations to draw attention to the most important requirements that need to be fulfilled in order for the project to be considered implemented by the time the 10-year permanence of EST on the ESFRI Roadmap expires.

The evaluators agreed that "EST will be a unique facility for high-resolution solar observations. By the time of its commissioning, EST will supersede most European high-resolution telescopes and will gather in its facility all the best of these telescopes. Hence, its pan-European relevance for solar physics is unquestionable".

The report points out that "the only solar observatory competitive to EST is the American DKIST, and that in some aspects they are complementary: DKIST better suited for studying the solar corona, while EST more appropriate for studying the chromosphere. Moreover, the 12 hours-time difference between DKIST and EST makes it possible to perform continuous observations of a given solar target with a full day coverage. Therefore, EST is of worldwide relevance".

Socio-economic impact. ESFRI also assessed the socio-economic impact of EST, finding that "during the construction and operation phases, EST will cause socio-economic effects not just on the surrounding area, but it will also generate incentives for industrial growth elsewhere, by means of the participation of private companies in the civil works, the provision of components, systems and instrumentation, technological developments, etc. [...]

In social dimension, being a world-wide RI, EST fosters international collaboration and mobility requiring people from different cultures work together. It also creates a unique network of researchers in academia and in industry giving a new dimension to the publicly funded basic science. Education and training of students in problem-solving mode as well as their involvement to data analysis and management issues will make them attractive to the industry.

The EST RI scientific results are potentially of great relevance to tackle some of the present societal challenges. For instance, the detailed information that EST will be able to provide on the solar activity will certainly help in better understanding the dynamics of strong solar phenomena like solar storms [...]".

Scientific case. The evaluation report confirms that "a significant technological progress has been made since 2016 to improve spatial and temporal resolution, which are critical parameters to achieve the scientific objectives, concluding that the project has properly reacted to the most current advances in technology and science, in order to ensure the leading role of the EST".

Finances. The major bottlenecks encountered by the evaluators is the lack of involvement of potential funders in the EST implementation: "While the response of the scientific community was very positive, yet the response of the corresponding national funding agencies was not equally enthusiastic.

In particular, given the reported broad consensus of the European scientific community working on solar physics on the EST project, the national components of such community should emphasize to their funding agencies and institutions the relevant impact of the EST project on their future research activities in the field".

In view of this situation, ESFRI urges EST "to seek for firm financial commitments for construction from the partners, but also to consolidate commitments for operational costs for at least five years. Investment decisions for ESFRI goes on to remind that the most urgent risk is the lack of sufficient funding commitment for construction and operation phases".

THE EUROPEAN SOLAR TELESCOPE ENGAGES WITH STAKEHOLDERS

Spanish Minister of Science and Technology visited the EST headquarters in La Laguna. It is one of the very few on-site meetings that we had this semester, since most gatherings went online

Spanish Minister of Science and Technology, Pedro Duque (grey suit, front right), stands at the EST booth during a visit to IACTEC, where the EST headquarters are located. He was greeted by the EST Project Manager, Systems Engineer and Support Scientist.

With a few exceptions, the COVID-19 pandemic has transformed many scientific and stakeholder meetings into online editions.

One of those few rarities was the visit, in July this year, of the Spanish Ministry of Science and Technology, Pedro Duque. A former ESA astronaut, Duque visited the IACTEC building in La Laguna (Tenerife, Spain), where the EST headquarters are located.

SPANISH SCIENCE MINISTER WAS BRIEFED ABOUT EST BY THE PROJECT OFFICE STAFF

During his visit, he met some of the EST staff, who briefed him about the science goals and technological challenges of the telescope, as well as the current state of the project. Alejandra Martín, EST Project Manager, Carlos Quintero, EST Support Scientist, and Miguel Núñez, EST Systems Engineer, were the ones in charge of guiding him through the telescope specifics.

National science meetings go online

It was the only face-to-face meeting in a semester otherwise dominated by online events. Two of those were national gatherings: the XIV.0 Meeting of the Spanish Astronomical Society and the 106 National Congress of the Italian Physical Society (SIF).

The Spanish Astronomical Society transformed its XIV annual meeting in an online one. This society brings together more than 800 astronomy professionals and intends to be an independent forum for discussing all sort of topics related to Astronomy and Astrophysics in Spain. The online edition was held in July this year, with a special focus on the current and future scientific projects that will concentrate the efforts of the community for the next decade.

EST Support Scientist Carlos Quintero gave an overview of the most recent developments of the European Solar Telescope during the solar physics session coordinated by another EST scientist, Luis Bellot. Both the PDF and the recording of the session are available online (his intervention starts at 03:10).

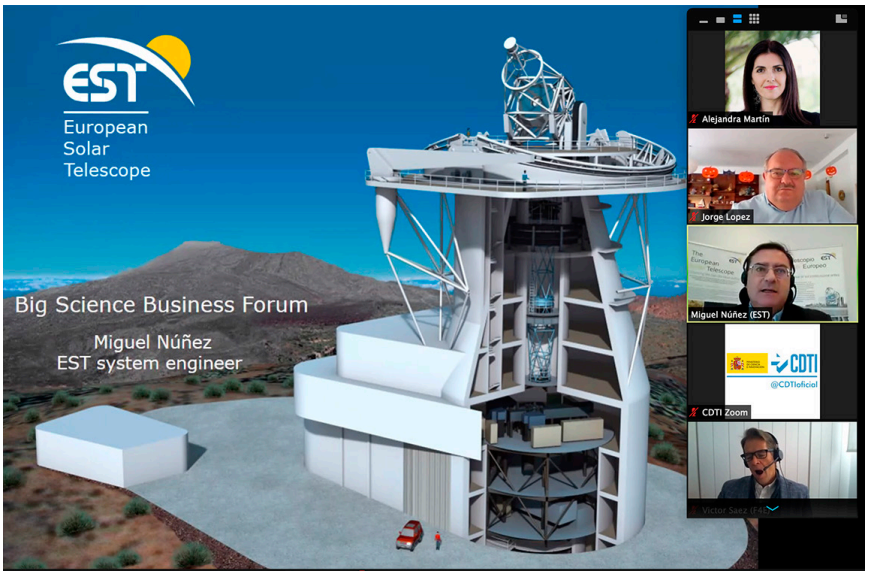
THE SPANISH ASTRONOMICAL SOCIETY WENT ONLINE FOR ITS ANNUAL MEETING

Also online was the 106th National Congress of the Italian Physical Society (SIF), held in September. The event gathered about 600 Italian physicists from different research areas (Nuclear Physics, Astrophysics, Geophysics,

Biophysics, Applied Physics), who shared their projects towards finding common ground and synergies.

ITALIAN CONTRIBUTIONS TO EST WERE HIGHLIGHTED AT THE NATIONAL CONGRESS OF THE ITALIAN PHYSICAL SOCIETY

For the Astrophysics track, Francesco Berrilli was invited to introduce the European Solar Telescope to the Italian community. The video of the presentation, which highlights the Italian scientific and technological contribution to the project, is available online (he appears from minute 33 onwards). The PDF is also available.



In October, EST Systems Engineer Miguel Núñez participated in the second BSBF21 webinar

BSBF seminars

The European Solar Telescope is one of the Affiliated Big Science Organisation of the Big Science Business Forum 2021. This biennial event, initially scheduled for September this year in Granada (Spain), had to be postponed to 2021 due to the health crisis.

In the meantime, the organisation is setting up several webinars to keep the momentum and foster business opportunities and collaborations between science organisations and the European industry.

EST Systems Engineer Miguel Núñez participated in the second of those webinars, held on October 8-9, 2020, together with organisations like CERN, EMBL, ESA, ESO, and ESRF, and representatives of several European technology companies.

Núñez gave an overview of the current situation of the European Solar Telescope, highlighting the upcoming procurements and business opportunities for the next years. The webinar was recorded, and Núñez's presentation is available here.

Francesco Berrilli highlighted the Italian contrbution to EST at the 106th National Congress of the Italian Physical Society (SIF)

EST PREPARATORY PHASE

A report of activies carried out by the project during the last 6 months is provided, with emphasis on the efforts to set up a legal figure for EST and the impact of the COVID-19 pandemic

The aim of the Preparatory Phase (PP) of the European Solar Telescope (EST) is to provide a detailed plan regarding the implementation of EST, aiming at delivering the necessary information to make decisions, addressing both technical and organisational issues as well as costs and risks analysis. The PP is leading the detailed design of EST key elements to the required level of definition and validation for their final implementation.

To achieve its goals, the PP of EST is supported by: (1) the PRE-EST H2020 project, (2) funds from the Regional Government of the Canary Islands to install, equip and recruit the EST Project Office personnel, (3) funds from the Spanish Ministry of Science and Innovation to test the EST MCAO and to develop the EST design and (4) the annual contributions provided by the EAST partners from Switzerland, the Czech Republic, Spain, Hungary, Norway, Sweden, and the UK. The progress made so far was satisfactorily assessed by the European Commission, which declared that the consortium is demonstrating its relevant role towards the realization of EST.

The EST Board has chosen a European Research Infrastructure Consortium (ERIC) as the most appropriate legal vehicle for EST. The Spanish Ministry of Science and Innovation shall initiate the negotiations with the corresponding EST partner authorities. The EST ERIC statutes and governance structure have been defined.

Actions to set up a EST Board of Governmental Representatives have been carried out but is not established yet. The lack of a direct involvement of the potential funders in the governance scheme of EST has been identified as an issue and a larger and permanent involvement of potential funders will be pursued. In the meantime, a Board of Directors has been established. Its second meeting took place on December 10, 2020.

In parallel, the project has decided to also explore the viability of an interim legal figure formed by individual institutions, as a way to continue the works leading to the EST construction.

The Czech 2019 Roadmap update prioritised the project EST-CZ to ensure the participation of CZ in the construction and operation of EST. The UK Roadmap includes EST in its recent 2019 update as a priority project for understanding the universe with ground-based observational astronomy. The Swiss Roadmap 2019 update set EST in the category of infrastructures in which Swiss institutions have shown an interest.

The EST Project Office is currently set up with a team of 29 people and is working, jointly with the EST Science and Technical Advisory Groups, to: (1) update the scientific and technical requirements; (2) consolidate the conceptual design or modify it where necessary; (3) define subsystem specifications for the preliminary design; (4) set the EST preliminary design and (5) define the specifications for detailed design and fabrication, updating the cost estimates and construction schedule.

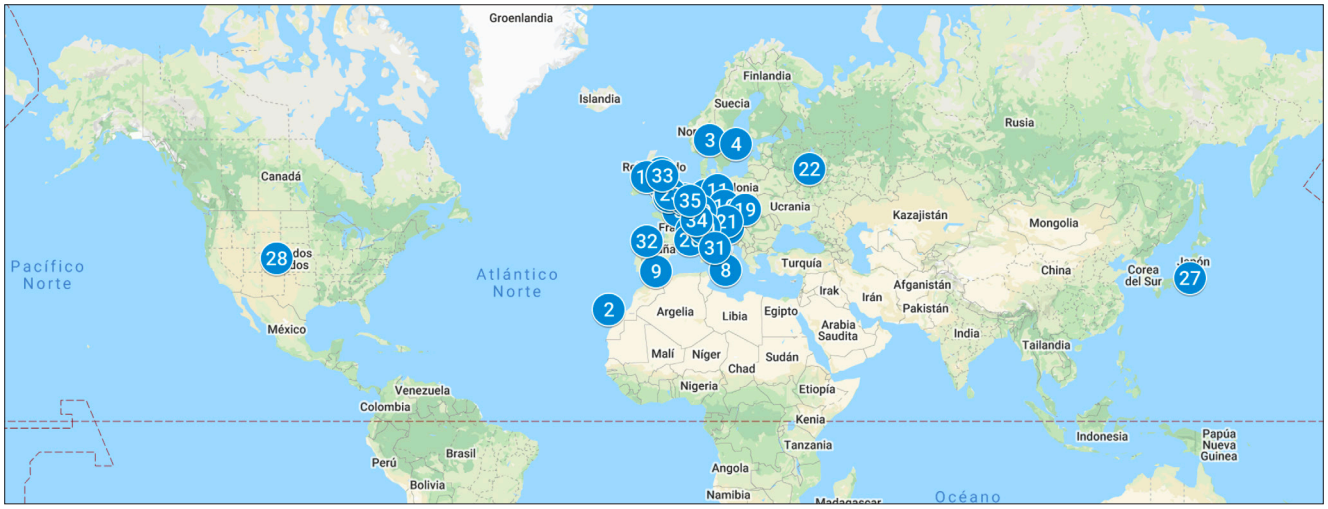
The EST Science Requirement Document is consolidated by now and a proposal to the International Scientific Committee of the Observatorios de Canarias (CCI) to consider a location near the Swedish 1-m Solar Telescope at the Observatorio del Roque de Los Muchachos on La Palma has been presented. An intensive communication activity at societal, scientific, industrial and political level has been carried out. The EST communication strategy has been evaluated by the EU as remarkable.

COVID-19. On 14th March 2020, the Spanish government approved the declaration of state of emergency throughout Spain to deal with the health emergency caused by the COVID-19 pandemic. This state was extended until June 21st. The Royal Decree 463/2020 declaring the state of emergency included the suspension of conditions and interruption of deadlines for administrative proceedings under way. Moreover, it set a number of limitations on the freedom of movement of citizens which also affected the working conditions. Similar measures were adopted by the governments of other EST partners at regional as well as national level.

The negative impact of this situation motivated the request by the EST coordinator to activate article 51 (Force Majeure) of the Grant Agreement. As a consequence, the project may seek an amendment for an extension due to the COVID-19 situation. Such requests will be handled favorably and in a speedy manner by the EC. However, the maximum grant amount cannot be increased.

The lockdown mainly affected the call for tenders for the preliminary design of three subsystems of the European Solar Telescope. The tender process was reactivated in June 2020 and it is currently in the contract award phase.

SOLARNET MID-TERM REVIEW



Map showing the 35 partners of the SOLARNET consortium in Europe, Japan, and the USA

The SOLARNET consortium successfully defended the mid-term review of the project by the EU Commission on November 9th, 2020. The evaluation committee was presided by EU Project Officer Dr. Mina Koleva and Prof. Dr. Kristof Petrovay from Eötvös Loránd University, Budapest, Hungary, acting as the external reviewer. The meeting was organized via zoom and attended by 33 members from the consortium.

The SOLARNET H2020 project started on January 1, 2019, with one of the primary objectives to integrate the major European research infrastructures in the field of high-resolution solar physics, to promote their coordinated use and instrumentation development. Despite the initial setback in the year 2020 with the sudden outbreak of the COVID 19 pandemic and lockdown imposed by the governments, the commitment, untiring coordinated efforts, and huge motivation from all its 35 consortium members enabled SOLARNET to accomplish its deliverables and milestones at a success rate of 93.5% and 60% respectively within its originally planned timeframe. The commendable efforts did not go unnoticed by the evaluation committee who did not hesitate to congratulate the consortium.

A particular highlight was the on-track Trans-National Access Programme which provided easy access to telescope infrastructures in the Canary Islands in addition to the Piz-Daint supercomputer owned by the Swiss National Computing Center. A total of 90 researchers, primarily across EU organizations and a few from non-EU institutions, have benefitted from the access to the installations. This not only facilitated collaboration and networking but also provided an opportunity to link theory with observations. The services at these infrastructures were also improved. Particular highlights are the capacity development to provide service-mode observations for SST and remote-based observations for GREGOR. Virtual access activities have progressed as planned: new data have been added to the archives and steps have been taken towards the addition of higher-level data products.

Another highlight of the SOLARNET project is the industry-academy partnership which forms an integral association of the project as part of the joint research activities. It is playing a critical role towards the development of advanced cutting-edge European solar instrumentation. In the words of Prof. Dr. Kristof Petrovay, "The participation of SMEs in the consortium goes far beyond a formal association. Highly intense collaborative links have been maintained between the SMEs and academic institutions, with strong networking focused on the development of innovative, state-of-the-art technologies and solutions. In this respect, the project might even potentially serve as a showcase for the successful promotion and support of industry-academia partnerships leading to world-leading new technological developments with EU support."

Due to COVID 19, several of the SOLARNET's workshops and schools had to be postponed. After an initial success where 8 early-stage and 4 senior researchers could execute their research stays outside their home institutions, the mobility programme suffered a major impact due to lockdown restrictions. This programme is currently suspended but can be expected to resume once international travel is unrestrained.

With the on-going restrictions on travel, the 2nd General Assembly Meeting is planned for February 4, 2021 when the whole consortium will meet online and discuss the next strategies towards achieving the project objectives.

CONCEPTUAL DESIGN OF THE EST PIER OPTICAL PATH SYSTEM

During the last 6 months, work has been done on the design of a lens-based Pier Optical Path System. It will relay the light beam from the focal plane to the instrument room, 30 metres below.

Introduction. The European Solar Telescope (EST) will have an on-axis Gregorian configuration with an entrance pupil diameter of 4.2 metres. The telescope aims to observe the Sun with unprecedented spatial and spectral resolution. Following standard practice, the main telescope will be placed on top of a high building, to keep the telescope aperture away from image distortions generated by the ground heat. At the same time, the scientific instruments will be installed at the base of the building where there is more room to accommodate them. The base of the telescope has more stability, so vibrations and local seeing degradation are smaller there. In the case of EST, the vertical distance between the telescope mount and the Coudé room containing the scientific instruments is around 30 metres. This long distance requires a complementary optical system to transfer the focal plane from the top of the building to the scientific laboratory at the bottom of the structure.

The current version of this EST Pier Optical Path (POP) system uses a lens-based relay consisting of a collimator-camera set up transferring the F2 Gregorian focus to a new F3 science focus at the instrument location (see the conceptual design in Figure 1). The option of a mirror-based system was evaluated but discarded due to mechanical and space limitations; the required off-axis configuration and apertures of the mirrors are not feasible.

The main challenge of a lens-based POP system is to overcome the chromatic aberration introduced by the optical glass. This phenomenon implies that lenses produce an image plane whose spatial location varies with wavelength. In order words, a given instrument can be focused for a certain wavelength range but defocused for other spectral ranges. Thus, the EST POP system is being designed to deliver diffraction-limit performance over the entire wavelength range to be observed with the telescope.

System requirements. The design of the optical system should fulfill the requirements presented in the EST Science Requirement Document (SRD). The most relevant related to the POP system are: i) the working spectral range goes from 380 nm to 2200 nm, ii) the image quality shall be limited by diffraction over a field of view (FoV) of 90" x 90", and iii) the POP system shall be optimised to deliver the highest possible throughput (in order to reach outstanding polarimetric accuracy at the highest spatial resolution and be able to follow the fast evolution of solar phenomena), which calls for a minimum number of optical surfaces in the system.

Pier Optical Path design. The original concept of the POP design was an optical system composed of a set of two achromatic doublets, as shown in Figure 1. Several glass combinations were examined and analysed by means of simulations and analytical methods. Their performance over the working spectral range was compared and studied. Nevertheless, owing to the great extension of the spectral range, none of the examined glass combinations was able to produce a residual chromatic aberration that guaranteed the required diffraction-limited performance.

Those results prompted us to think of an alternative design to compensate the strong chromatic aberration. Having in mind that the current light

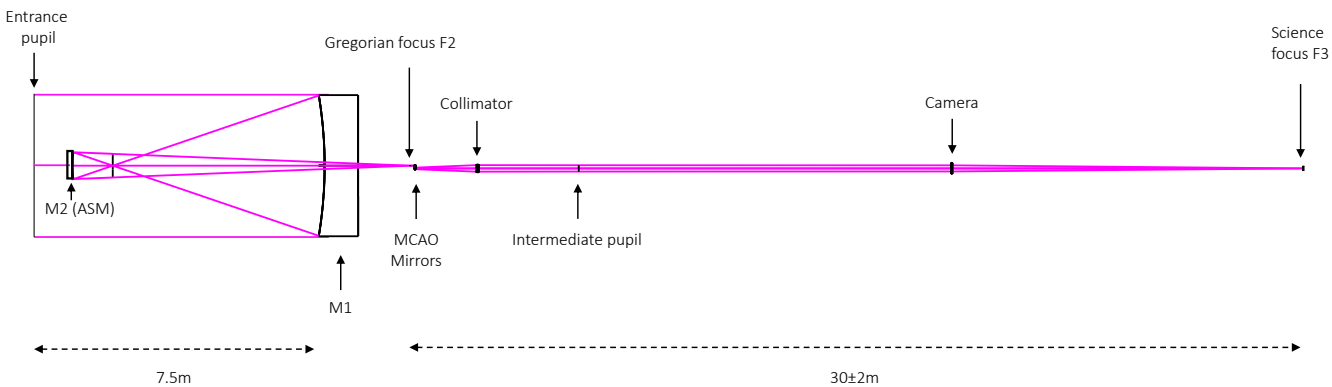


Figure 1. EST optical layout including the current version of the POP system. Distances between optical elements as well as their sizes are not to scale. For clarity purposes, only rays coming from an object point on the optical axis are represented.

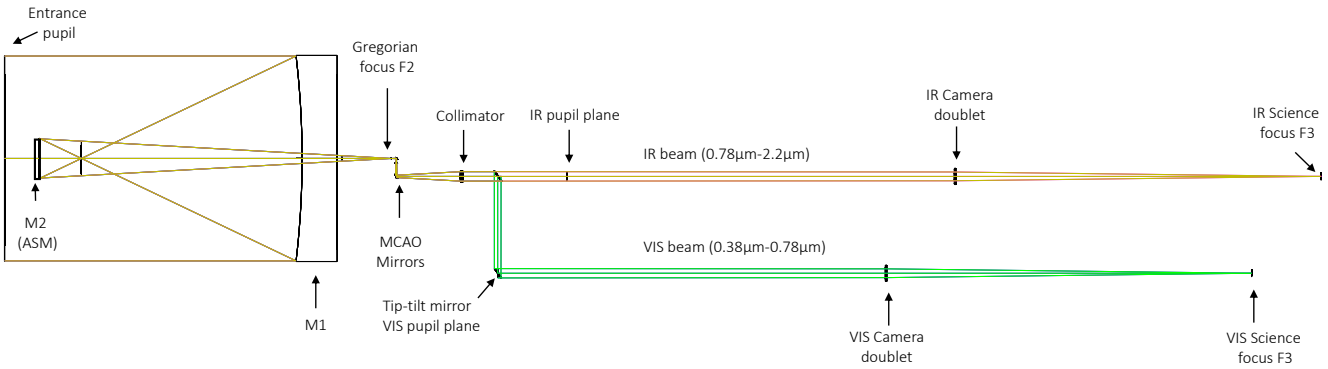


Figure 2. EST optical layout including the new design of the POP system.

distribution system divides the light coming from the telescope into four different optical instrument arms (as described in the the previous issue of the newsletter), we wondered whether one of those spectral divisions could be done inside the POP system. By splitting the beam after the collimation stage with a dichroic beamsplitter, we would introduce an extra camera doublet, but each doublet would deal with a significantly reduced spectrum. The division was made at 780 nm so that one camera doublet operates in the red and near-infrared range and the other in the blue and visible range. Further analyses were carried out seeking the best glass combinations for both lenses, and a noticeable improvement in the performance was achieved. Nonetheless, the capability of this design was still slightly out of the SRD image resolution requirements and we considered substituting the collimator doublet by a triplet. The results obtained with this triplet-based collimator coupled with two doublet camera lenses via a beamsplitter are highly satisfactory and predict that the POP system shown in Figure 2 should achieve the required diffraction-limited performance for the entire EST FoV and the entire spectral range.

We will now conduct an analysis of optical glasses and their combination in chromatically-corrected optical systems, taking into account material hardness, thermal properties, and birefringence. Detailed ray-tracing simulations will also be carried out with Zeemax to verify the performance of the design.

TUNABLE-BAND IMAGERS FOR EST

Work is underway to complete the preliminary design of the Tunable-Band Imagers of EST by December 2022. An international group has been formed to that end.

Tunable-Band Imagers (TBIs) are used in solar physics to capture phenomena that cannot be studied otherwise. Their ability to image the Sun (small resolved regions of it) in very narrow wavelength bands, scanning a spectral line in short periods of time, enables the identification of (magnetic) features and their time evolution in a way that no other instrument can achieve. As part of the instrument suite of EST, TBIs complement the information provided by spectrographs based on Integral Field Units (IFUs), which aim at diagnosing similar features but with a different approach. TBIs are also complemented by Broad-Band Imagers (BBIs). These instruments deliver excellent morphological context of the solar scene.

TBIs provide full spectropolarimetric diagnostics of the portion of the Sun they observe. Spectropolarimetry embraces all the properties we can measure to characterize the light emitted by the Sun: intensity (basically energy), wavelength (color), and polarization (a way to understand the plane where light as a wave is oscillating). It is only by measuring light that we can understand the physical state of our star.

TBI is indeed a bad name for Tunable Imaging Spectropolarimeter (TIS), that is, a device that makes images of the polarization state of light in narrow band wavelength regions of the spectrum that can be selected at will. It is a bad name because they measure polarization, as opposed to BBIs which are real imagers.

Recently, a group of European solar physicists from the Leibniz-Institut für Sonnenphysik (KIS; Germany), Università di Roma Tor Vergata (UTOV; Italy), Instituto de Astrofísica de Andalucía (IAA-CSIC; Spain), and the Institute for Solar Physics of Stockholm University (SU; Sweden), led by the IAA-CSIC Solar Physics Group, has been formed to carry out the tasks

of a conceptual design of the TBI instruments for EST. A number of such TBI devices have been constructed in different solar telescopes with different technologies. We shall concentrate here on those based on Fabry-Pérot interferometers (also called etalons; see Figure 1) as the means to select a narrow band of the spectrum, typically across a photospheric or chromospheric spectral line. A (our) TIS needs, thus, an etalon system to carry out the spectral analysis, a polarimeter to measure the four Stokes profiles of light, and an optical system that images the Sun on the detector(s). The conceptual design includes choices for the type and number of etalons, the type of polarimeter, the spectral resolution, the number of wavelength samples, and many other requirements that flow down from the scientific requirements elaborated by the EST Scientific Advisory Group. Three TIS are envisaged for EST to cover the spectrum from 380 to 500 nm, 500 to 780 nm, and 780 to 1000 nm.

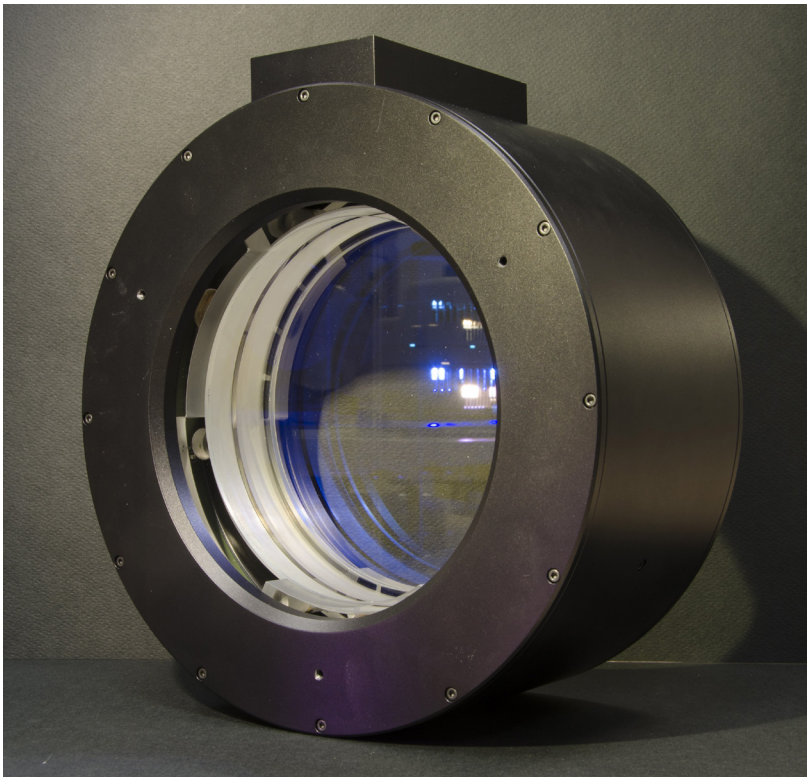


Figure 1. Prototype of a 150 mm clear-aperture etalon for EST developed by ICOS in collaboration with UTOV, INO, INAF and ADS. Credit: V. Greco / INO.

Problems like the size of the etalons (they cannot be manufactured with current tools and procedures), the optical configuration of the etalons within the instrument (a really important matter), the kind of materials they are made of, the field of view (the size of the imaged area) they should cover, the way we are measuring the polarization of light, the type and quality of the light detectors, or the possible degradation induced by the image rotation of a telescope without compensation are topics that have been addressed by sub-groups of the whole working group, which formed in its first meeting in early July 2020. The work of the sub-groups has been independent of the others and, after a co-location meeting held on 30 October, we are putting everything together in a report that will be submitted to the EST Project Office.

The discussion has built upon the previous TBI conceptual designs achieved in 2011 with their pros and cons, plus new calculations that enlighten the expected results. As in any other scientific design, we started with a number of assumptions that drive further decisions. Specifically, the EST TBIs will have a tandem of two air-gapped etalons, each with cavity (roughness) errors of less than 2 nm (they are virtually the flattest, smoothest surfaces on Earth), one of them with a high reflectivity coating and the other with a low reflectivity coating. This combination has proved very successful for the Crisp Imaging Spectropolarimeter (CRISP) and the Chromospheric Imaging Spectrometer (CHROMIS), two TBI instruments currently in operation at the Swedish 1m Solar Telescope on La Palma.

We started by collecting a number of requirements TBIs should comply with. The number of requirements has grown since and is still expected to grow. We aim at having a robust TBI General Requirements Document by early 2021. This will be the basis for the conceptual design of the instrument, which is expected by December 2022, when a preliminary design review will be held. All these developments will of course depend on the available funding.

MEMBERS OF THE GROUP

Francisco J. Bailén, IAA-CSIC
Nazaret Bello González, KIS
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Dario del Moro, UTOV
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Göran Scharmer, SU
Rolf Schlichenmaier, KIS
Jose Carlos del Toro Iniesta, IAA-CSIC

MCAO TESTBENCH UPDATE

The three deformable mirrors of the EST Multi-Conjugated Optics testbench have been characterized in the lab, in preparation for the integration of all the optical elements

The European Solar Telescope (EST) will include Multi-Conjugated Adaptive Optics (MCAO) to correct the blurring in the images introduced by the Earth's atmosphere. The difference between classical Adaptive Optics and a MCAO system is that the later uses several deformable mirrors (DM) to achieve image correction in a wider field of view (FoV). To provide maximum spatial resolution over a square FoV of 40"x40", the EST design includes 5 DMs..

There is no MCAO system working regularly in visible wavelengths, nor in solar neither in nighttime telescopes. To study and evaluate in a controlled environment the novel solutions developed for EST, an MCAO bench demonstrator with three DMs is being developed at IAC within SOLARNET WP7. During 2020 most of the testbench hardware has been received, including 3 ALPAO DMs: one with 820 actuators and two with 468 actuators. These DMs are based on a thin silver-coated optical surface with magnetic actuators attached to it. The actuators deform the optical membrane and compensate for the atmospheric aberration, providing a nearly flat wavefront in the science instruments.

The characterization of the DMs was done last November by EST engineers. These tests were performed in the IAC optical laboratory using a Zygo Fizeau interferometer. The functioning and the specifications of the mirrors have been verified including the validation of parameters such as best flat figures (with surface flatness better than 10nm rms), tip-tilt stroke after flattening (larger than 10 µm peak-to-valley), defocus stroke (larger than 8 µm peak-to-valley) or linearity (better than 96%). The next step will be integrating all the optical elements in the bench.

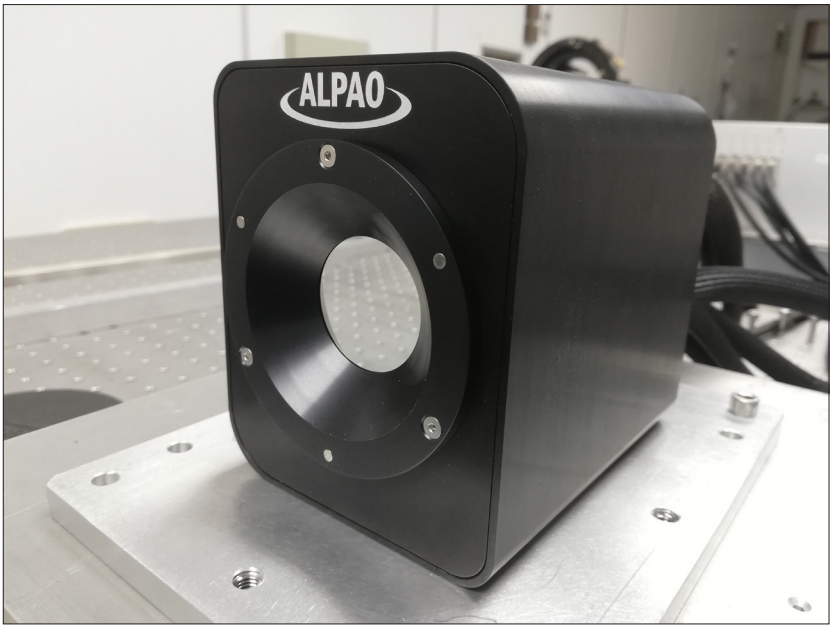


Figure 1. One of the three deformable mirrors of the EST MCAO testbench, manufactured by ALPAO.

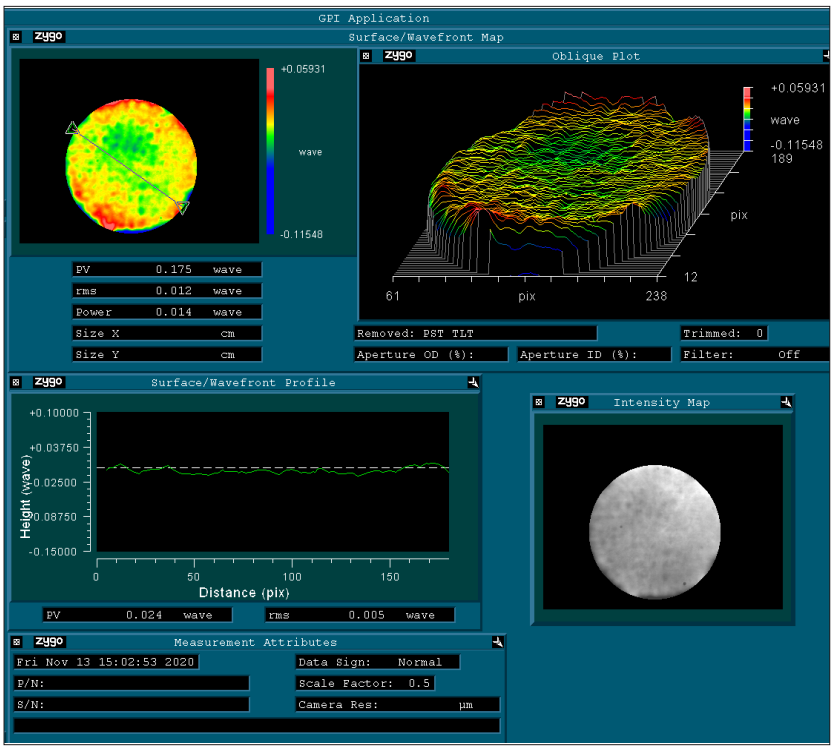


Figure 2. Results of flattening measurements with the Zygo interferometer.

RESULTS OF THE FIRST CALL FOR TENDERS

The primary mirror assembly (M1), the telescope structure (TS) and the adaptive secondary mirror (M2) were the systems included in the first call for tenders for the preliminary design.

The EST Project Office is currently working on the update of the telescope design, starting from the conceptual design developed in 2011 and taking into account the science requirements set by the EST Science Advisory Group in December 2019. The goal is to achieve the preliminary design of the telescope, which implies comparing different options, manufacturing prototypes to test some critical requirements and writing the specifications for the detailed design and construction. For this preliminary design, the EST project will contract external companies with expertise on specific technologies to help us make progress at a faster pace and in a reliable way.

In 2020, a first call for tenders was published for the preliminary design of the primary mirror, the secondary mirror and the set composed by the telescope structure, the pier and the enclosure. Due to the COVID-19 crisis, the call was stopped for more than three months and later reactivated to receive bids from the companies. The closing date for the submission of bids was 7 August 2020. On the 10th of August, the bids were initially reviewed.

LOT 1. M1 preliminary design

Advanced Mechanical & Optical Systems SA

SENER AEROESPACIAL, S.A.

LOT 2 .Telescope structure, pier and enclosure design

EIE GROUP Srl

Empresarios Agrupados Internacional SA

ESTEYCO SA

IDOM CONSULTING, ENGINEERING, ARCHITECTURE, SAU

MT Mechatronics GmbH

LOT 3. M2 preliminary design

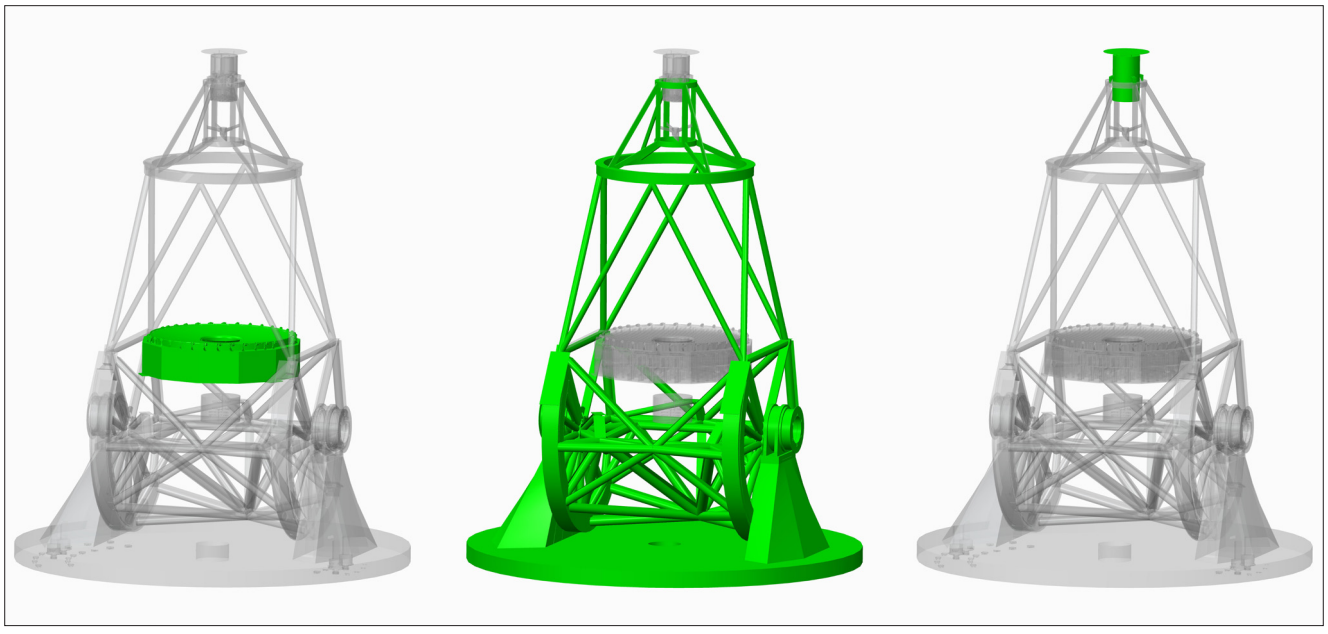
A.D.S. INTERNATIONAL

TNO

The EST project is pleased to have received proposals from a large number of important companies from several European countries. These companies invested valuable time to prepare their bids and the contracting authority has evaluated them in detail to make sure the process complies with the tender conditions.

The evaluation has already been completed and the results are in process of publication. On 16 October 2020, the evaluation board proposed to award LOT 2 to IDOM CONSULTING, ENGINEERING, ARCHITECTURE, SAU. The next steps in the process are the award of LOTS 1 and 3 to the selected companies, which is expected to happen in the coming weeks, the period of time for claim, and finally the signing of the contracts.

The next call for tenders will be issued soon for the preliminary design of the EST heat rejecter.



Main EST subsystems making up lots 1, 2 and 3 in the call for tenders issued in 2020.

OUTREACH ACTIVITIES: EST GOES ONLINE

In the face of the COVID-19 pandemic, EST scientists and engineers could not take the streets, but they nevertheless found ways to share their passion online.

The COVID-19 pandemic has undoubtedly conditioned all cultural activities in the continent. With museums, conference centres, and even bars closed (no Pint of Science this year), EST researchers and engineers had to turn to the Internet to keep sharing their investigations and results.

The European Researcher's Night 2020 is a case in point. Celebrated on Friday, November 27, all activities were online. In Granada (Spain), Dr. Luis Bellot explained the role of magnetic fields in the Sun and the importance of EST to understand them in a short talk released on YouTube and organised by the Instituto de Astrofísica de Andalucía-CSIC and Fundación Descubre.

Dr. Luis Bellot (IAA-CSIC) explained the role of solar magnetic fields in a video.

In Portugal, researchers from the Geophysical and Astronomical Observatory of the University of Coimbra organised an online live round table about the mysteries of the Sun. Drs. Teresa Barata, Nuno Peixinho, Ricardo Gafeira and João Fernandes explained how scientists try to unveil them with the help of advanced instruments like the future European Solar Telescope. They answered questions from the public.

Online round table by scientists from Universidade de Coimbra (Portugal).

Also live was the event organised by the Trinity College Dublin (Ireland) in which scientists shared their research with the public. Our colleague Dr. Sophie Murray was there to talk about the study of the Sun and the astrophysics research done by Irish institutions.

Italy loves the Internet

But it was Italy who turned to Internet the most: not less than seven online activities, including a virtual tour to the laboratories at the Physics Department of Università di Roma Tor Vergata (that can still be viewed online).

Prof. Francesco Berrilli, from Università di Roma Tor Vergata, debunked myths linking the Sun and global warming and gave an overview on its actual role in Earth's climate in a live talk that can still be watched online. In turn, Prof. Francesca Zuccarello from Università di Catania participated in a round table about the Sun and its role as a source of renewable energy organised by the Osservatorio Astrofisico di Catania, available on the OACT YouTube channel.

Two other online seminars were held

Dr. Luca Giovannelli (Università di Roma Tor Vergata), talking about EST in the ERN 2020.

by INAF institutions: a 45-minute conference on Sun-Earth relations, 24/7 observations, and solar instruments (including IBIS 2.0), by Osservatorio Astronomico di Roma (INAF-OAR), and a two-hour overview on current research in Astrophysics, by INAF-OACT.

Other researchers chose to share not only their investigations but their experience as scientists. For example, Dr. Luca Giovannelli participated in #ScienzaInsieme with a video summarising his research journey and his role in EST. Drs. Ilaria Ermolli and Mariarita Murabito (from INAF-OAR) participated in a live event in which female astronomers shared their research topics and experiences with the public.

Activities in the real world

However, not all activities were online. Some lucky ones in Gyula (Hungary) coud participate in the Astronomical Days at Almásy Castle. About 300 visitors had the opportunity to observe the sky with binoculars and participate in lectures about space weather, solar energy and how scientists study the Sun (including a presentation of the EST project). Drs. Robertus Erdelyi, Bernadett Belucz, and Marianna Korsós actively engaged with participants and answered their questions.

Finally, the lockdown has allowed EST scientists and other researchers to write articles for popular magazines. This is the case of Dr. Gianni Mainella (Telescopio Nazionale Galileo), who prepared an article for *Il Carabiniere* about the facilities at Observatorio del Roque de los Muchachos, including EST.

Dr. Marianna Korsós (ELTE) giving a presentation at the Gyulia Astronomical Days.


Scienze

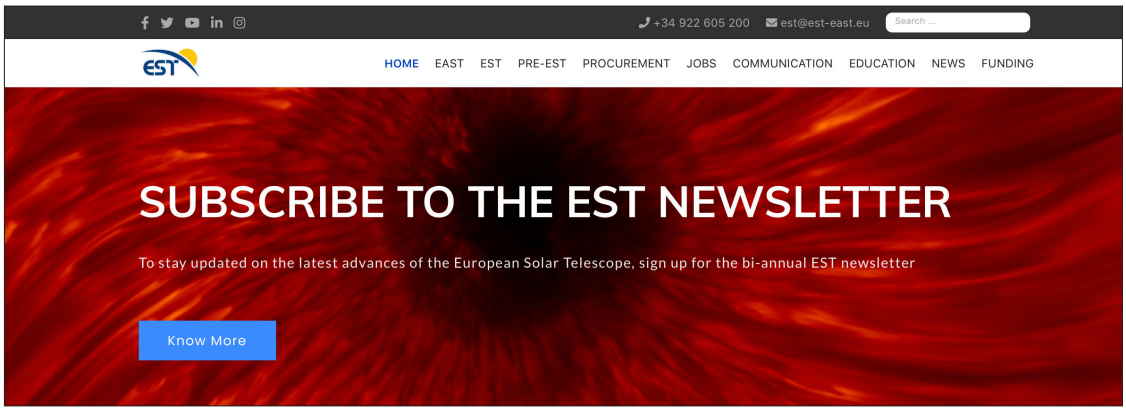
OCCHI AL CIELO

Non sono solo ambite mete turistiche, le isole Canarie: è nell'arcipelago spagnolo, tra Tenerife e La Palma, che si concentra infatti il meglio della ricerca astrofisica internazionale. Con un decisivo contributo italiano

"Occhi al Cielo" by Dr. Gianni Mainella (TNG) for the Il Carabiniere magazine.

NEW EUROPEAN SOLAR TELESCOPE WEBSITE

Towards an informative, responsive and maintainable website



Home page of the EST website at www.est-east.eu

The EST website is the main entry point of information about the project. All the material generated by the project is made publicly available through the EST website. This includes news, articles, scientific information, image galleries, and private documents for the collaborators, among other resources.

Starting in March 2020, a significant effort was made to keep the EST website updated. A major overhaul was carried out by the Project Office, with a complete redesign resulting in a modern look and feel. The new interface supports multiple devices by means of a Responsive Web Design (RWD) approach. At the same time, the website remains graphically attractive, simple and informative due to the use of a template supporting Joomla 3.9 and bootstrap 4.0.

RWD is an approach that makes web pages render properly on a variety of devices and screen sizes. It also reacts to common user behavior such as screen orientation changes (vertical/horizontal). That approach offers various advantages such as an optimized user experience for different devices (desktop, mobiles and tablets) and proper SEO (Search Engine Optimization) results, as the Google search engine rewards responsive websites. Moreover, multiple-device support is an important objective due to the increase in internet traffic using mobile devices. Indeed, in May 2020, mobile devices accounted for up to 50.4 percent of the total web page views worldwide.

In order to follow a RWD approach, new tools were added to the EST website to facilitate the generation of responsive and eye-catching content. The most relevant is the page editor used to rebuild the Homepage that can generate responsive content with a modern look and feel based on a variety of layouts and building blocks.

Not only the general appearance has been improved, but also the contents and maintainability. The EST Communication Office helped to migrate all the contents to the new website, adding and deleting material as necessary. Also a Funding section was created. Another area that experienced deep changes is the News section. Apart from a revamped design, a significant improvement was achieved with the addition of a tool to build news listings automatically. This tool gather data and meta-data from the news articles and generate well organized listings, reducing the maintainability cost of the section.

Since the Joomla article editor is still an important tool for content generation, the Project Office has set new building blocks and sample codes to simplify and to improve the content generated through this editor. These elements positively affect site maintenance by providing a common solution to recurrent problems of web content generation such as positioning and responsiveness of the graphic material.

As an extra tool, a global search facility has been implemented. The EST website now contains a text search field on the top of the site that eases the process of finding relevant articles and content related to the criteria set by the user.

From July 2019 we are employing Google Analytics to generate statistics on the use of the website. According to this service, in the period June-November 2020 we had 2,955 unique users, who started 4,872 sessions and visited 18,767 pages (an average of 3.85 pages per session). The mean session duration was 3.5 minutes. The top ten visitor countries were Spain, USA, Germany, Italy, UK, Japan, China, India, France, and Argentina, in that order. These numbers clearly show the importace of the website to promote the EST project as a whole.

THE SOLAR TELESCOPE GALLERY – A NEW EDUCATIONAL RESOURCE

The EST Communication Office has just released a solar telescope gallery, which contains high-quality images of 21 telescopes and observatories currently in operation all over Europe.

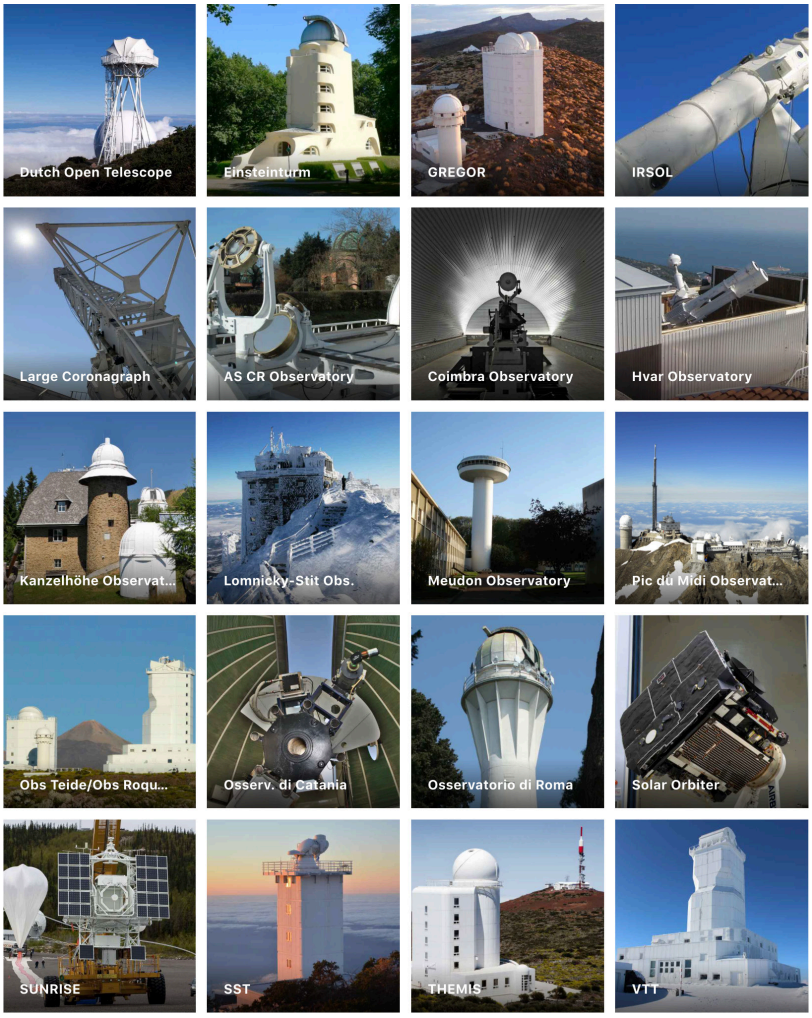
Through 354 selected images, the new EST telescope gallery showcases solar telescopes and observatories across Europe, along with some of their instruments and laboratories. Represented in the gallery are the Dutch Open Telescope, the Einstein Tower, the Observatory of the University of Coimbra, GREGOR, Hvar Observatory, the IRSOL Gregory Coudé Telescope, Kanzelhöhe Solar Observatory, the Large Coronograph at the Astronomical Observatory of the University of Wrocklaw, Lomnický Štít Observatory, Observatoire de Paris-Meudon, Observatoire du Pic du Midi, Observatorio del Roque de los Muchachos, Observatorio del Teide, Ondřejov Observatory, Osservatorio Astrofisico di Catania, Osservatorio Astronomico di Roma, Solar Orbiter, SUNRISE, the Swedish 1-m Solar Telescope, THÉMIS, and the German Vacuum Tower Telescope.

All the pictures can be downloaded from the EST website at https://est-east.eu/telescopes-gallery. They are accompanied by a short description and appropiate credits. The Solar Telescope Gallery has been possible thanks to the collaboration of the institutions running the facilities, who have selected the best images and provided detailed descriptions. The collection testifies to the strength of the European solar community and the diversity of facilites that support it. From the Einstein Tower to Solar Orbiter, the gallery goes through a century of state-of-the-art infrastructures devoted to solar physics research in Europe.

The Solar Telescope Gallery is conceived as a tool for education, dissemination, and outreach. The images can be used for presentations, documents and printed publications. It provides a convenient resource to illustrate the main infrastructures used to study the Sun in Europe.

Similarly to the EST Solar Gallery, the images can be downloaded freely under a Creative Commons Attribution Non Commercial NoDerivatives 4.0 International License. We encourage people to make use of them as much as possible, giving proper credits to the authors and institutions that kindly contributed their photographs. The gallery is open to improvements, so the EST Communication Office will be happy to consider adding new pictures. All the images, plus many additional ones, are available for download through the EST Cloud Repository.

The gallery has received more than 630 visits since its release in October 2020. To promote this new resource, we have prepared a series of short videos showing drone recordings of some of the telescopes. They offer astonishing aerial views of the buildings. The videos will appear on the EST social media over the course of the next weeks. We invite you to watch them and share them as much as possible.



STATUS OF "SOLAR MISSION EST" – THE VIDEOGAME

The EST videogame is making good progress. All characters and scenarios have already been implemented. Now the solar puzzles are being programmed, for a release in the first half of 2021

Spot getting ready to perform observations in his telescope, as part of Solar Mission EST.

The EST videogame is making good progress. The development has reached a point where the first tests of the gameplay will begin soon. The tasks to be accomplished by the players in the different scenarios have been defined, along with the general script and structure of the whole story.

Now is the time to turn the words into an adventure. All the programming elements have been compiled for one of the scenarios to check different aspects: menus, movements, dynamics, dialogue systems, combats, puzzles... This phase will allow us to detect errors, helping us improve the gameplay through the user experience. The results of these tests will be applied to the other scenarios.

"Solar Mission EST" is based on a fantasy story where solar magnetic fields go crazy and affect all electronic systems on Earth (such that the machines rise against humans). A team of solar astronomers will be in charge of completing the construction of the European Solar Telescope. EST is the last hope of finding out what is happening on the Sun. The team will have to build or test devices and pieces for EST in different observatories. The scenarios are inspired by real locations. In that way we want to make solar telescopes known among a broad audience, to the highest degree of realism possible. However, for the sake of a funny and entertaining dynamics, players will come across situations that would never happen in any real telescope (or any other place on Earth, for that matter!).

But beyond the fantasy licenses, science is also present all over the game, especially in the puzzles that players will have to solve. They cover a wide range of concepts of solar research and observations: the features that can be observed in the Sun, the importance of multi-wavelength measurements, the use of adaptive optics systems, the need to control local seeing, etc.

Following the current test phase, several beta versions will be produced over the next few months. The idea is to release the final version of the videogame in the first half of 2021 and distribute it through the App Store and Google Play. The videogame will be offered in English and Spanish, with the possibility of adding other languages depending on the availability of resources.

The EST videogame has a dedicated section on the EST website at https://est-east.eu/solar-mission-est.

Between July and August 2020, the characters of "Solar Mission EST" have been introduced to the public through a series of 7 short posts on the EST social media channels, to raise interest on the videogame. They have been very well received, reaching a total audience of 31,883 people so far.

EST NEWCOMERS

NOELIA FEIJÓO AMOEDO

OPTICAL ENGINEER

Noelia has a degree in Optics and Optometry from the University of Santiago de Compostela, and a Master degree in Optical and Image Technologies from Complutense University of Madrid, with which she gained skills in optical design and optical laboratory testing. After her Master, she carried out research at the same university on multi-angle light scattering. She has also worked as an optical designer in a lighting company. Noelia joined the EST team this year to work in the assembling and testing of the Multi-Conjugated Adaptive Optic system.

NOÉ RODRÍGUEZ GONZÁLEZ

SOFTWARE ENGINEER

Noé is a software engineer with more than 12 years of experience. He has been involved in a wide variety of software projects like, for instance, interoperability solutions for complex software systems and high-performance scalable software for architecture discovery of large software systems. He has been involved in R&D projects focused on the development of tools to automate software development and to improve the quality of software systems using Model Driven Engineering techniques. Currently, he is part of the EST Project Office, working in the software team.

SILVIA REGALADO OLIVARES

SOLARNET OPTICAL ENGINEER

Silvia has a degree in Optics and Optometry. She specialized in Colour Technology at the Alicante University and in Optical and Imaging Technologies at the Complutense University of Madrid. During her professional career she acquired experience as a colourist in the automotive and in the industry sector as well as in the optical engineering field. In 2019, she did her final Master Thesis at the IAC about an anamorphic scale simulator of the HARMONI instrument for the E-ELT telescope. Currently she is in charge of the optical design of IFUs for the SOLARNET Project.

FRANCISCO GONZÁLEZ PÉREZ

MECHANICAL ENGINEER

Francisco obtained his PhD in Computational Engineering at SIANI, Universidad de Las Palmas de Gran Canaria. At this university he previously obtained the Industrial Engineering degree in Mechanics. His research has focused on developing models for dynamic soil-structure interaction analysis. He carried out two research stays at Università Politecnica delle Marche (Italy), where he taught finite element and finite volume methods in the Naval Engineering degree. He joined the EST team in February 2020, and currently works on the MCAO test bench as a mechanical engineer.

EVENTS

EST INVITED TALKS

Due to the COVID-19 pandemic, most meetings have been postponed. Until normal activity resumes, a list of EST invited talks in past international meetings will be given here. An updated list is available on the EST website at http://www.est-east.eu/est-invited-talks

EST: UN TELESCOPIO DI PROSSIMA GENERAZIONE PER STUDIARE IL SOLE
Francesco Berrilli, in *106th National Congress of the Italian Physical Society*, online, 18 September 2020

THE EUROPEAN SOLAR TELESCOPE
Francesca Zucallero, in *XIV Scientific Meeting of the Spanish Astronomical Society*, La Laguna (Spain), 13-17 July 2020 (cancelled)

EST UNIQUENESS
Rolf Schlichenmaier, in *Solar Polarization Workshop 9,* Göttingen (Germany), 26-30 August 2019

SCIENCE REQUIREMENT DOCUMENT FOR THE EUROPEAN SOLAR TELESCOPE
Elena Khomenko, in *Preparing for the next generation of ground-based solar physics observations*, Guilford (UK), 23-25 July 2019

OTHER EVENTS

SOLARNET SCHOOL: A HOLISTIC VIEW OF THE SOLAR ATMOSPHERE
Online, January 25-29, 2021

43RD COSPAR SCIENTIFIC ASSEMBLY
Sydney (Australia), January 28-February 4, 2021

PRE-EST BOARD MEETING
Online, February 2, 2021

EAST GENERAL ASSEMBLY
Online, February 3, 2021

COOL STARS 20.5 MEETING
Online, March 2-4, 2021

SOLAR ORBITER SCHOOL ÉCOLE DE PHYSIQUE DES HOUCHES
Les Houches (France), April 6-9, 2021

HINODE-14/IRIS-11 JOINT SCIENCE MEETING
Washington DC (USA), May 24-27, 2021

NASA HELIOPHYSICS SUMMER SCHOOL
Boulder (USA), June 15-22, 2021

IAUS 365: DYNAMICS OF SOLAR AND STELLAR CONVECTION ZONES AND ATMOSPHERES
Moscow (Russia), August 9-13, 2021

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