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GTC science operations and instrumentation plan

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Abstract

The 10.4 m Gran Telescopio CANARIAS came into operation in 2009, and now we can clearly state without any doubt that we have in our hands an extraordinary tool to produce science with all its capabilities and functionalities operating under specs. This contribution summarizes the current status of the night operation of the telescope and describe GTC short- and medium- term instrumentation plan, that will make possible to provide access up to five different instruments to the users community from middle 2017, largely enhancing the scientific return from the telescope.

1 GTC telescope operation

The GTC was conceived as a general-purpose facility with a capability to host several instruments simultaneously. In this sense, the GTC can work from the UV atmospheric cutoff to the mid-IR and host several instruments simultaneously. In its original design, GTC allows the possibility to use two Nasmyth, a main Cassegrain, a Prime, a Coudé, and four Folded Cassegrain (these latter ones for lighter instruments) focal stations. Presently, the two Nasmyth and one Folded Cassegrain focus are in use, but additional focal stations are being equipped at the same time as new instruments are developed. During night operations, it is possible to switch from one instrument to any other in the order of few minutes.

GTC is operated mainly in queue-scheduled mode (>90% of the time is used in this mode), where programs are selected in a dynamic fashion based on their ranking by the time allocation committees, matching their requirements to the prevailing observing conditions. This produces that support astronomers (SA) staff might play an extraordinary role in exploiting the full capabilities of the telescope and its instruments, as the night operation rely completely on their shoulders: they have to operate the full system with all its complexity, and resolve faults that might occur; there is no night-time engineering support. Data handling activities such as quality control, data packaging and time accounting take place during normal week days, as is the overall planning of observing priorities. GRANTECAN has opted for a relatively low-cost support model, and hence the service that can be offered to the community is rather restricted.

2 GTC observing time distribution

The overall demand for the telescope from the user community has seen large fluctuations from one semester to the next. The overall oversubscription factor has peaked at 6, but in the last four years has reduced to a constant value of about 3. Of the science time, in round figures about 5% of the available time has been lost due to technical problems, while some 30% of the time the weather was too poor to observe (in agreement with the predictions for the observing site at ORM).

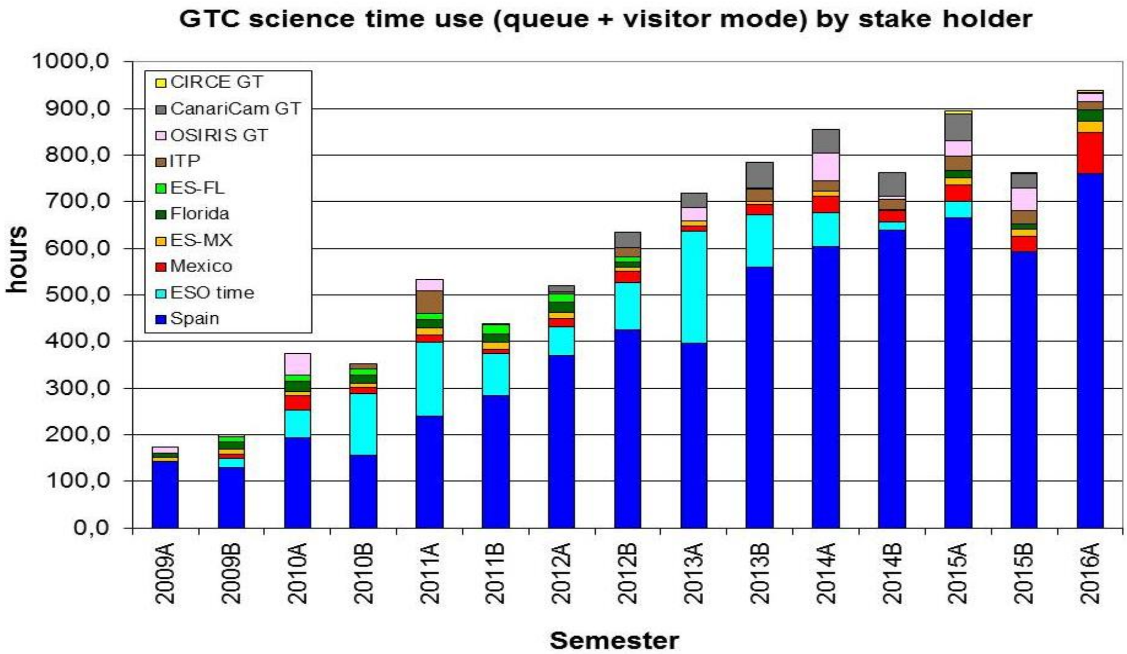

Figure 1: Evolution in the number of hours of scientific data provided by GTC with time.

Despite every semester a certain fraction of time is reserved for commissioning of new functionalities and forthcoming instruments (about a 20% of the total available time), the amount of scientific data provided by GTC has been progressively increasing with time (Fig. 1) simultaneously with a notable progress on the nightly queue efficiency with a value as high as 95%. This means that every night assigned for scientific observations, from the total amount of available time (once discounted technical and weather losses) we are able to produce useful science 95% of the time, that gives an idea of the current high-efficiently exploitation of the telescope time.

In this regard, S16A has been the most productive semester in the telescope's life, with more than 900 hours of scientific data delivered to users and more than 60 observing programs completed along this period. These numbers translate in more than 400 observing programs completed to date and more than 8600 hours worth of data delivered to the community.

Note that in queue mode all the time delivered must fulfill the observing conditions initially required by the user (following the aim of this operational mode), hence each observing hour delivered to the user might be useful for retrieving the expected scientific return. All those data are also available once the proprietary (1 year) is over via the GTC public archive at http://gtc.sdc.cab.inta-csic.es/gtc/.

3 GTC science productivity

Data from GTC have produced nearly 200 publications by January 2016, including some high-impact results presented in Nature/Science journals, covering a wide range of scientific topics: exoplanets, GRBs, solar system bodies, high redshift objects, etc... GTC scientific community is well represented in those numbers, with a strong participation of the Spanish, Mexican and Florida University researchers in the papers. The evolution in the number of publications with time follows the expected trend (Fig. 2), and places undoubtedly GTC among the group of largest telescopes in the world.

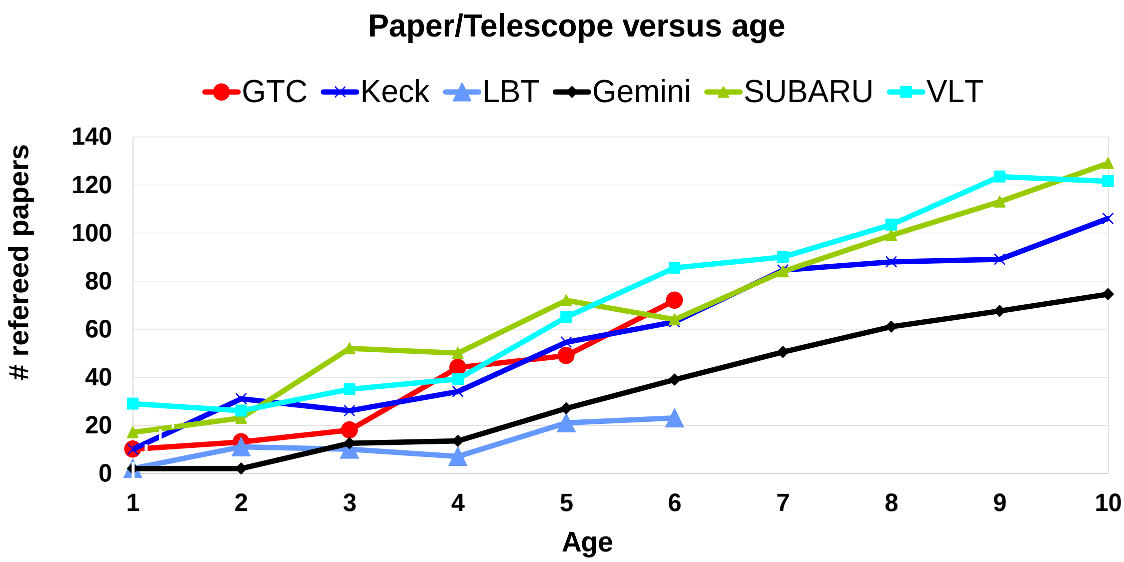

Figure 2: Evolution in the number of refereed papers produced during the first years of operation of the largest telescopes in the world (Keck, VLT and Gemini numbers are averaged for a single telescope).

4 GTC telescope instrumentation plan

GTC currently operates with two major instruments: OSIRIS ([1]), an optical imager - intermediate resolution spectrograph with narrow band imaging (via Tunable Filters), fast imaging and Multi-object spectroscopy capabilites (Fig. 3), as well as CIRCE ([2]), a visitor NIR instrument that offers imaging and polatrimetry in the JHK bands in a 3.4 x 3.4 arcmin FOV with a plate scale of 0.1 arcsec pix^{-1} (Fig. 4). A third common-use instrument, Canaricam ([7]), the Mid-Infrared imager, spectrograph and polarimeter provided by the University of Florida, has been in use from 2012 to 2016, when it was decommissioned to let its place to EMIR in the Nasmyth-A focus of the telescope (Fig. 3).

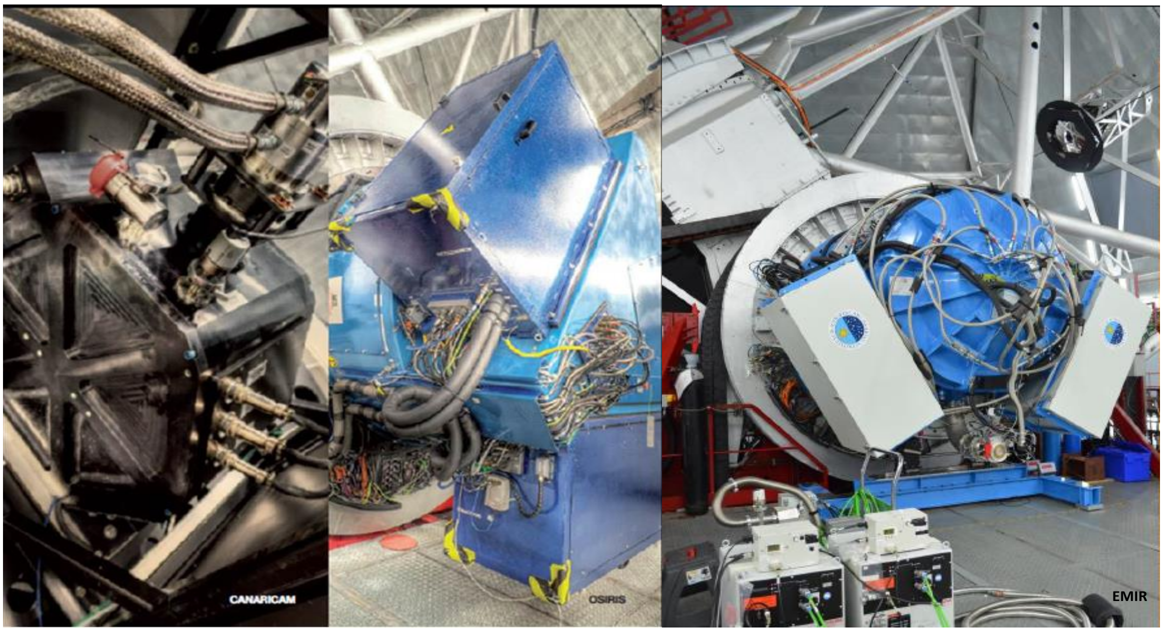

Figure 3: Detailed view of Canaricam (left), OSIRIS (center), and EMIR (right), the facility instruments that operate at the two Nasmyth foci of GTC.

Along 2017, at least two more instruments will be available for the GTC community: EMIR ([4]), a very complex NIR imager and spectrograph in a wide FOV of 6 x 6 arcmin with a plate scale 0.2 arcsec pix^{-1} that incoporates Multi-Object spectroscopy via reconfigurable slits (up to 55) in a cryogenic environment (Fig. 3), and MEGARA ([5]), a facility instrument that will offer two new observing spectroscopic modes to the GTC community, using either an Integral Field Unit (IFU) covering 12.5" x 11.3" on the sky with a spaxel size of 0.62" (Large Compact Bundle, LCB), or a MOS mode that uses 100 fibre-bundle positioners within a field of view of 3.5 x 3.5 arcmima. A unique characteristic of MEGARA, which makes it a competitive instrument among large telescopes, is the combination of the multiplexing (IFU and MOS) capabilities with intermediate-to-high spectral resolution (R 6000, 11000 and 18700), and a high efficiency.

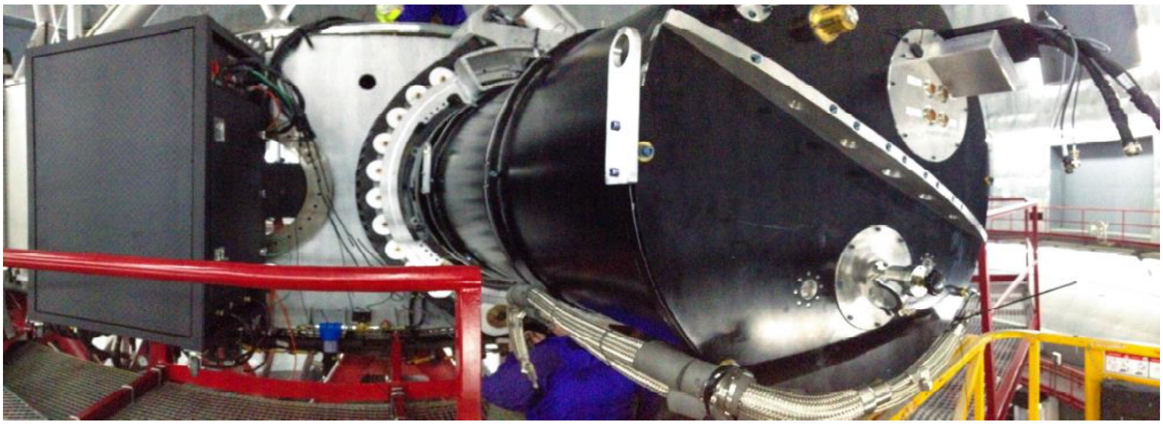

Figure 4: The CIRCE NIR instrument attached to the elevation ring in one of the GTC Folded Cassegrain stations.

In a medium-term (2018-2020), the instrument suite for GTC will be enhanced with MIRADAS ([3]), a near-infrared multi-object echelle spectrograph under development at the University of Florida, operating at spectral resolution R 20000 over the 1-2.5 micron band-pass. MIRADAS selects targets from a 5 arcmin field using up to 12 deployable probe arms with pickoff mirror optics, each feeding a 3.7 arcsec x 1.2 arcsec field of view to the spectrograph.

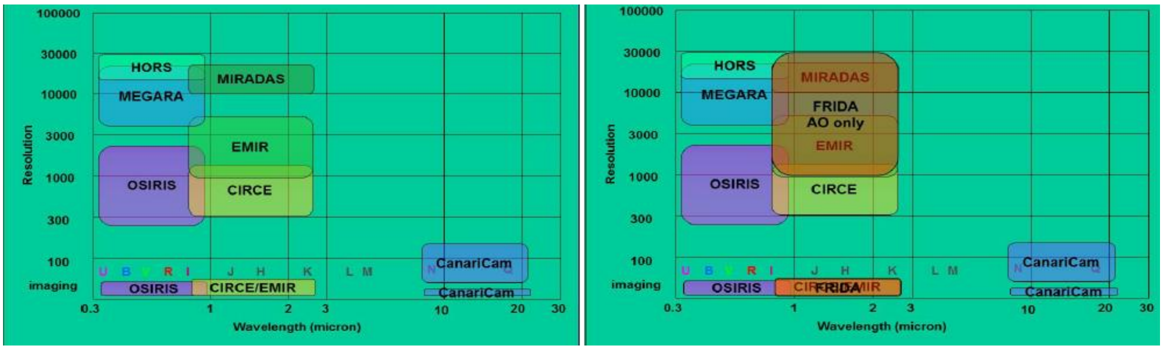

Figure 5: Global scheme of the GTC instrumentation available by 2020.

GTC will also incorporate Adaptive Optics (GTCAO) by 2019. Currently, the integration is being done at the Instituto de Astrofísica de Canarias (IAC) in collaboration with the GTC. GTCAO is planned to work in the NIR (0.9-2.5 micron) with the corrections made in visible light with a Shack-Hartmann wavefront sensor. The system will operate initially with a Natural Guide Star (NGSAO), and with a Laser Guide Star (LGSAO) probably one or two years later. The GTCAO will be placed at the Nasmyth-B platform, displacing OSIRIS instrument to the Main Cassegrain Station whose equipment is under development. The

GTCAO system will feed FRIDA ([6]). It is a near infrared, diffraction limited imager and integral field spectrograph that has been designed and is being built as a collaborative project between GTC partner institutions from Mexico, Spain and the USA. FRIDA will operate with GTCAO in imaging mode at three different scales, namely 0.010, 0.020 and 0.040 arcsec/pix. The integral field unit is based on a monolithic image slicer that will slice the field of view into 30 slices. Spaxels have a 2:1 pixel aspect ratio (2 pixels along the spectral axis and 1 along the spatial axis) and it will offer three different spectral resolutions, R=1000, 5000 and 30000, the latter over selectable regions in the HK bands.

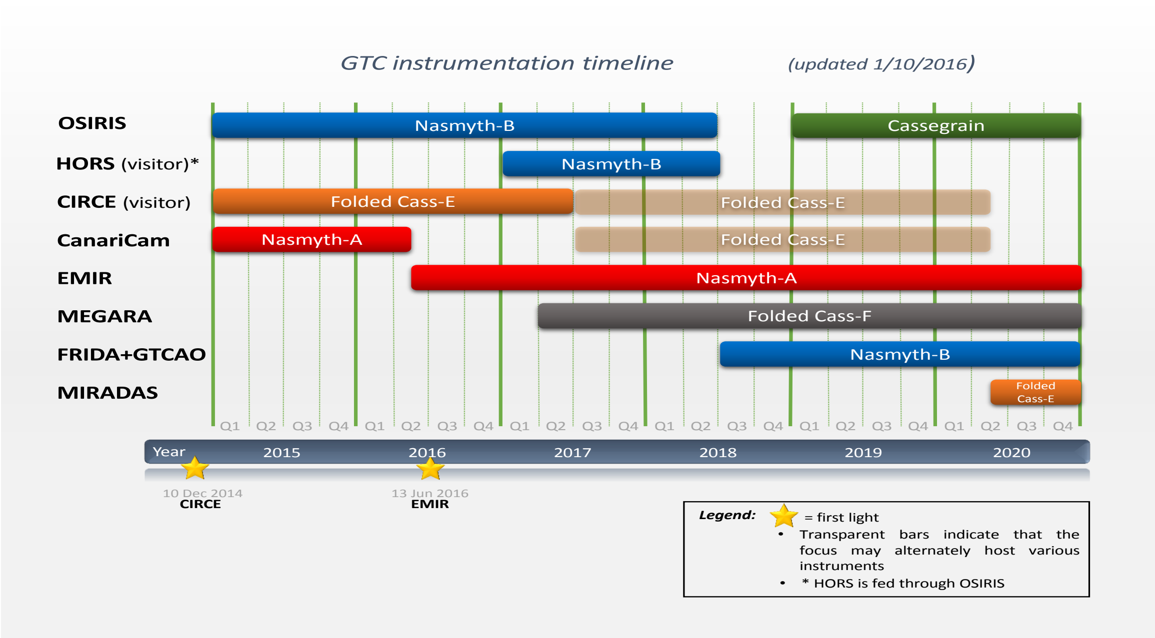

Figure 6: Current timeline for GTC instruments in the period 2015-2020.

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