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10 years of GTC - GTC Science Operations Status.

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Abstract

10 years after Gran Telescopio Canarias' First Light, GTC is producing science in a routinely manner but at the same time enhancing its capabilities with the continuous advent of new instruments at the facility. This contribution summarizes the current status of the night operation of the 10.4 m Gran Telescopio CANARIAS (GTC) and describe GTC short- and medium- term instrumentation plan, that will make possible to provide access up to six different instruments to the GTC-users community from middle 2018, 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 with a wide instruments suite. 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 the two Folded Cassegrain foci 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 from Spain, Mexico and University of Florida, matching their requirements to the prevailing observing conditions. This produces that GTC 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 others. Despite of the overall oversubscription factor has peaked at 6, in the last six 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).

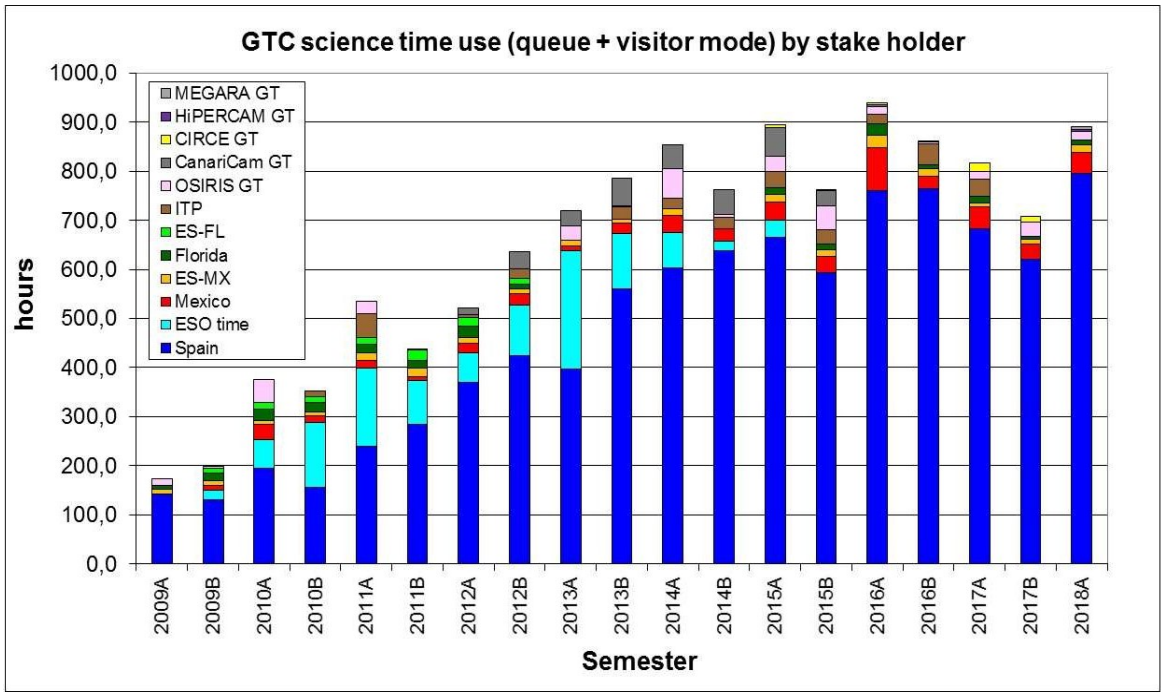

Figure 1: Evolution in the number of hours of scientific data provided by GTC with time.

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. These numbers translate in more than 630 observing programs completed to date and more than 12000 hours worth of data delivered to the GTC community.

Note also 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 (mostly raw data, but also some reduced datasets) are freely available once the proprietary (1 year) is over via the GTC public archive at http://gtc.sdc.cab.inta-csic.es/gtc/.

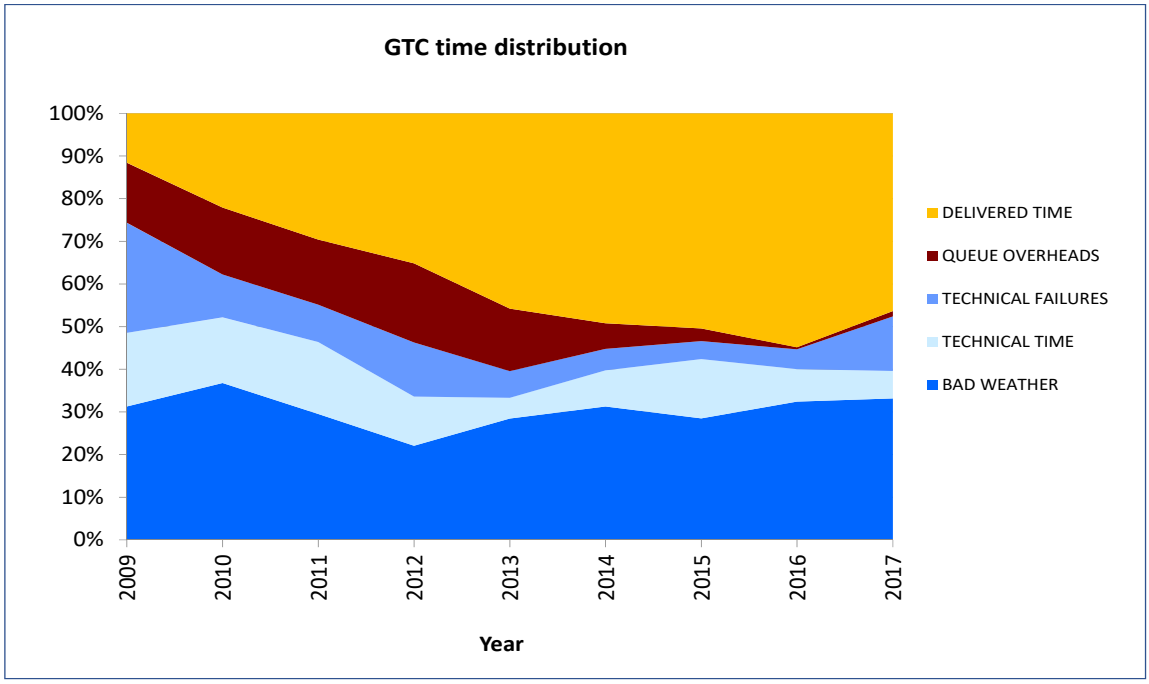

Figure 2: Evolution in the GTC time distribution with time.

3 GTC telescope instrumentation plan

Regarding telescope instrumentation, GTC currently operates with three major facility instruments: **OSIRIS** ([1]), an optical imager - intermediate resolution spectrograph with narrow band imaging (via Tunable Filters), fast imaging and Multi-object spectroscopy capabilites, **EMIR** ([4]), a near-infrared (0.9 - 2.5 μm) wide-field imager and medium-resolution multi-object spectrograph and **MEGARA** ([5]), an optical integral-field Unit (IFU) and

multi-object spectrograph (MOS); as well as with **HiPERCAM** ([2]), a visitor intrument able to image simultaneously in 5 channels (ugriz), at (windowed) rates of over 1 kHz. An additional fourth facility instrument, **Canaricam** ([8]), the Mid-Infrared imager, spectrograph and polarimeter provided by the University of Florida (that 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) will be available again by the end of 2018, but now located in a new focal station (Fig. 3). Finally, at early 2019 GTC will incorporate **HORS** ([7]), a visitor instrument that provide point source fiber spectroscopy at R 23000 in the blue optical band (377-691 nm).

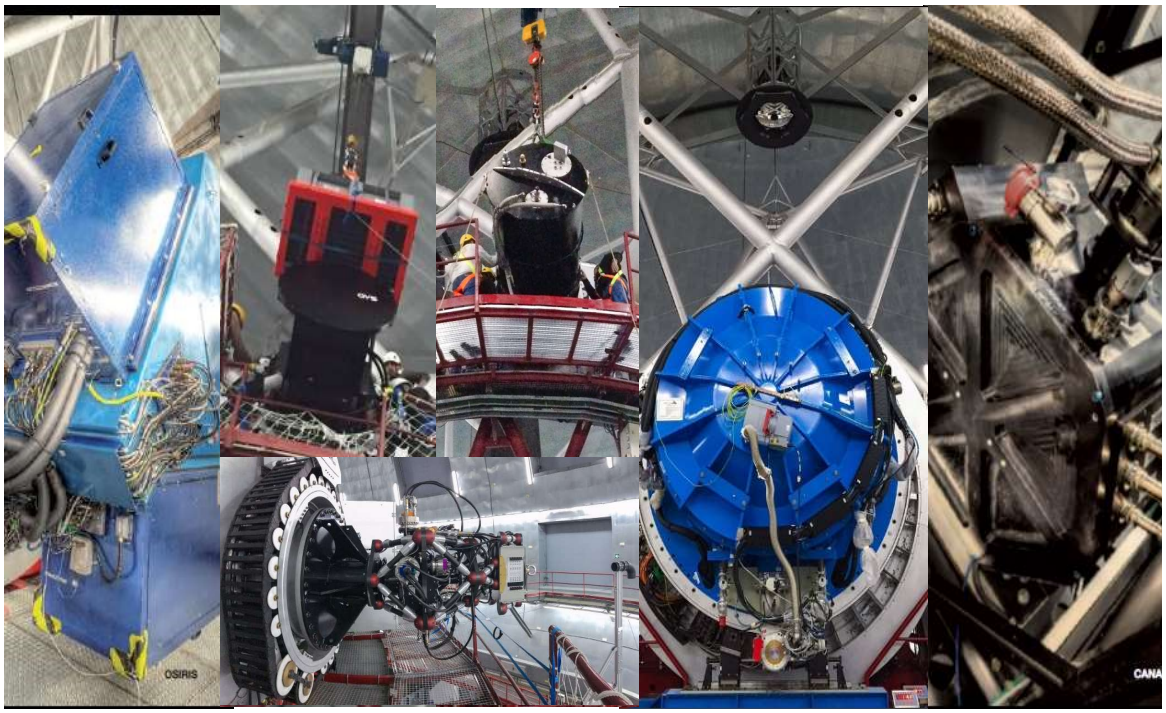

Figure 3: Detailed view of OSIRIS, MEGARA, HiPERCAM, CIRCE, EMIR and Canaricam (from left to right), the different instruments available at the currently operational foci of GTC.

In a short-term, period 2019-2020, 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 bandpass. 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. 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]). This 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 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.

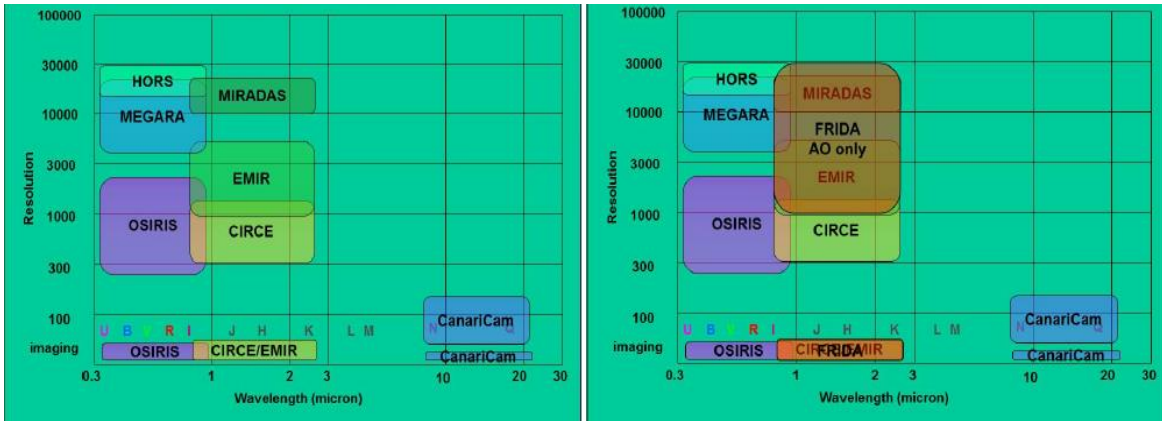

Figure 4: Global scheme of the GTC instrumentation available by 2019-2020.

4 Next Generation of Instruments for the GTC

Current GTC instrumentation plan will be completed around 2022. At that time, six or seven science instruments will fill the large suite of focal stations of the GTC. They should guarantee the scientific competitiveness of the telescope for several years to come, also considering that the GTC will continue to be the largest optical telescope in operation. Even so, it is time to think about the future. Defining and building new instruments is a complex process that takes a minimum of five years. This puts us to around 2025, when the new generation of extremely large telescopes will presumably start operation.

For this reason, GRANTECAN has opened a process to define the next generation of GTC instruments, with science as the main driver in this process. In this sense, the input of the whole GTC community is vital to address the process from a wide perspective, taking advantage of the expertise that our community has gained with its participation in many

front-end astronomical projects and facilities. Young and mid-career astronomers should have a pivot role in the process, not only because of its timescale, but also to provide innovative and visionary ideas anticipating the future trends of observational astrophysics.

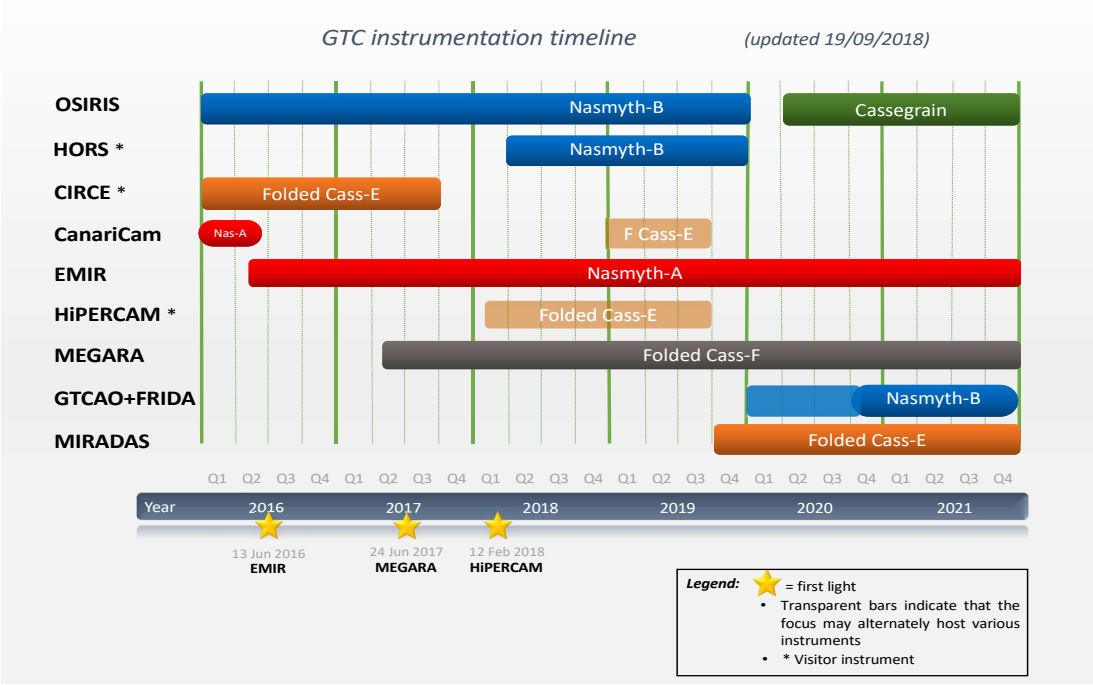

Figure 5: Current timeline for GTC instruments in the period 2016-2021.

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