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GTC Science Operation Status

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Abstract

The 10.4 m Gran Telescopio CANARIAS came into operation in 2009. During the five years since that date the facility has seen important changes and improvements that have helped its scientific exploitation 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 highlights some of the results of these first years of science operation and briefly sets out aspects of our operational methodology.

1 GTC telescope operation

The GTC was conceived as a general-purpose facility with a capability to host several instruments simultaneously. The development of not only the instrumentation suite, but also of the telescope itself is ongoing. In spite of this, the facility is well capable of delivering high-quality data in an efficient manner. With s RMS pointing error of about 2 arcsec, an open-loop tracking stability of 2 arcsec/hour, rou- tine guiding stability of 0.1 arcsec for essentially indefinite periods of time, and blind offset accuracy of 0.2 arcsec over relatively short distances, one can conclude that the telescope is in good working order. Moreover, during the years a gradual, laborious program of mirror re-aluminization has been started, now leading the on overall reflectivity of M1 of about 85%. Image quality is normally limited by natural seeing, in spite of the fact that detailed characterization of the optics is still underway and that the level of automation of the active optics is still limited. More work remains to be done, a task that will never end during the working life of the telescope, to ensure that its 73 square meters of effective light collecting area is maximally exploited.

GTC is operated mainly in queue-scheduled mode (>95% 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 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 10% of the available time has been lost due to technical problems (a value that has been progessively decreasing to less than 5% in the last year), while some 30% of the time the weather was too poor to observe (in agreement with the predictions for the observing site at ORM).

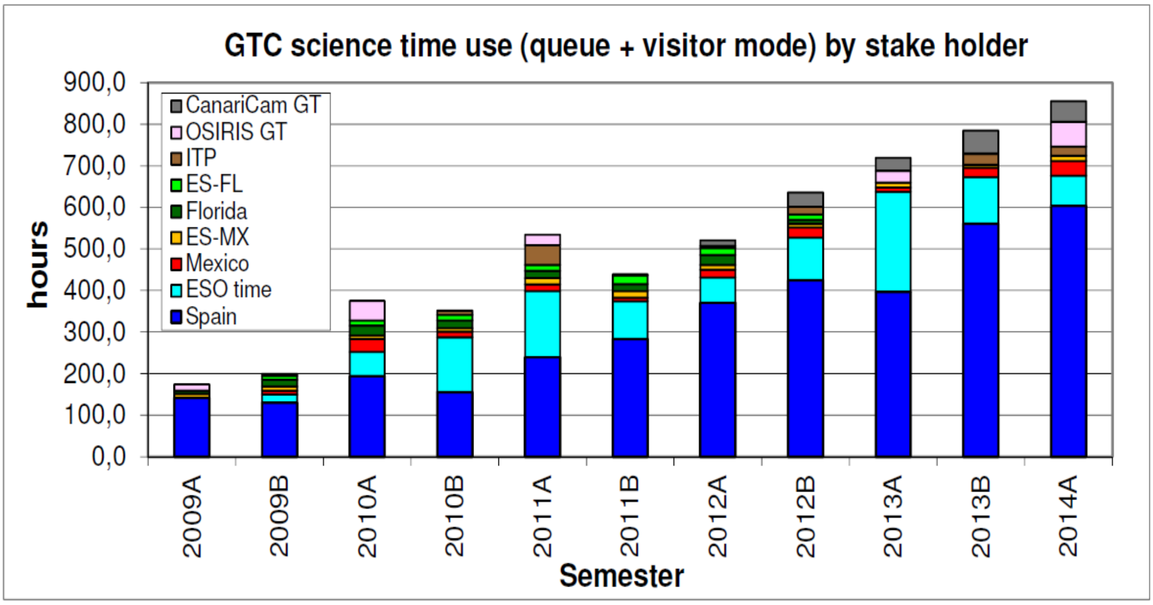

Figure 1: Evolution in the number of hours of scientific data provided by GTC with time.

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 90%. 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 90% of the time, that gives an idea of the current high-efficiently exploitation of the telescope time.

In this regard, S14A has been the most productive semester in the telescope's life, with more than 850 hours of scientific data delivered to users and more than 50 observing programs completed along this period. These numbers translate in nearly 300 observing programs completed to date and more than 5600 hours worth of data delivered to the community, of which some 1050 hours were produced for a small number of large ESO-GTC programs up to complete 95% of the time reserved to these.

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 telescope short-term instrumentation

Regarding telescope instrumentation, 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, as well as Canaricam ([4]), the Mid-Infrared imager, spectrograph and polarimeter provided by the University of Florida.

During 2014, new functionalities of these instruments have been incorporated: Multi-object spectroscopic observations with OSIRIS instrument were initiated on March 1^{st} 2014 with an extraordinary success both in the users' demand as well as in the data quality obtained, and Canaricam now offers dual-beam spectropolarimetry in the 10 micron window for its exploitation from S15A onwards.

Next year, at least two more instruments will be available for the GTC community: 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}, and EMIR ([3]), -the workhorse instrument for GTC-, 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 in a cryogenic environment.

4 GTC science productivity

Data from GTC have produced nearly 130 publications to date, 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.

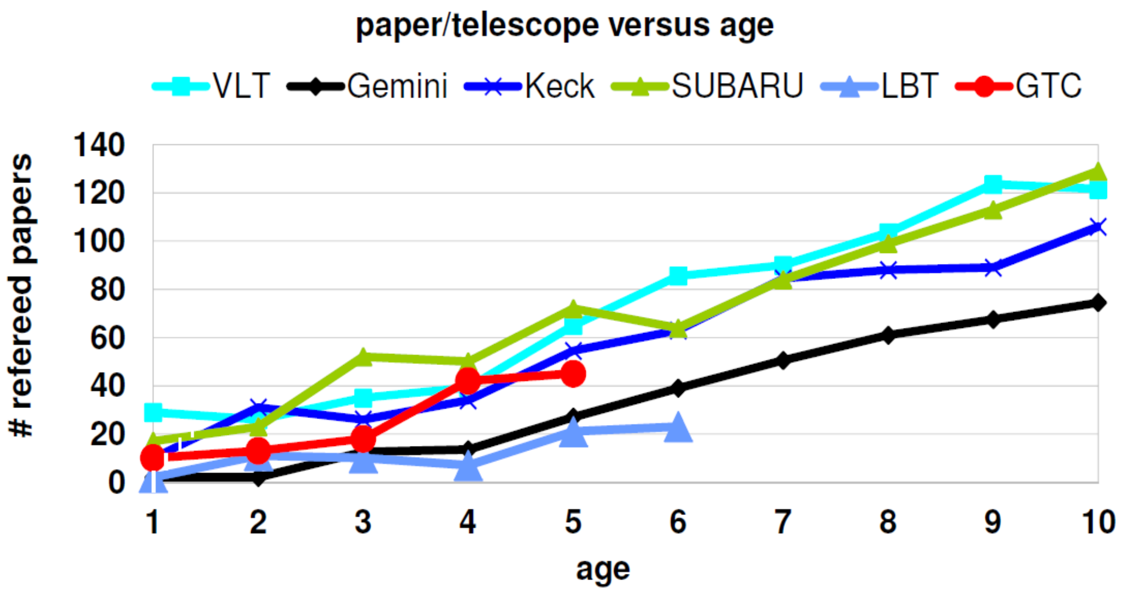

Figure 2: Evolution in the number of refereed papers produced during the first years of operation of the largest telescopes in the world (Keck, VLT and Gemini numbers are averaged for a single telescope). GTC number for 2014 only accounts for the papers produced at the time of writing this contribution, so it's uncomplete.

The evolution in the number of publications with time follows the expected trend (Fig. 2), and places undoubtedly GTC within the group of largest telescopes in the world.

References

[1] Cepa, J., Aguiar, M., Escalera, V. G., et al., 2000, SPIE, 4008, 623

[2] Eikenberry, S. S., Lasso, N., Raines, S. N., et al., 2013, RMxAC, 42, 119

[3] Garzón, F., Abreu, D., Barrera, S., et al., 2006, SPIE, 6269, 18

[4] Telesco, C. M., Ciardi, D., French, J., et al., 2003, SPIE, 4841, 913