GRAN TELESCOPIO CANARIAS: A KEY ASSET FOR SPANISH ASTRONOMY

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First of all I would like to thank the organisers of this Astrophysics Symposium (Ana Ulla and Minia Manteiga) for inviting me to take part, and congratulate them on a very successful event.

I would like to begin by stating the obvious: the history of Astronomy is the history of astronomical observation. We should remember that the reasons for which it has been practiced have changed throughout human evolution. In early times it was used to predict the future (astrology) and for mythic and ritual purposes (primitive religion). Practical applications, such as agriculture, navigation and new technologies, have always been sought for it and in very recent times it has been used in mathematics (celestial mechanics) and physics (Astrophysics). With these latest steps, Astronomy has completed its evolution: Understanding the Universe (including LIFE) both as a whole and in all its detail is now the sole aim of our research into space.

Observation will continue to be the key to astronomical knowledge. All recent studies into the future of Astronomy have confirmed this, and they have also pointed to the need for giant telescopes to be installed at the world's best sites. Spain is lucky in this respect as the Canaries are one such location.

All of this is relevant to understanding why the Gran Telescopio CANARIAS (GTC) was built and the impact it will have in the future. This is my subject today.

Three things inspired Spain to embark on this daring project to build what is the largest and most advanced optical infrared telescope of its time: the flourishing Astrophysics community in Spain; the level of technical ability achieved by the country's industry; and the excellent observatories in the Canaries.

Anyone involved in characterising observation sites around the world will know that the astronomical quality of the observatories in the Canaries has been more thoroughly researched than any other, and that the reams of data generated by that research testify to the permanent nature of their extraordinary quality. In excess of seventy institutions from nineteen different countries have installed instruments at these observatories, which belong to the Instituto de Astrofísica de Canarias (IAC), and together they make up the European Northern Observatory.

From the beginning of the project, the Gran Telescopio CANARIAS has had the following guiding aims:

1. To provide the Spanish Astronomy community with its own cutting-edge instrument:
   - to involve the community from the start (feasibility study, design, construction);
   - focal instruments specifically designed to meet the needs of the Astrophysics community;
   - to prepare observation programmes very early (this is why the three international symposiums on *Science with the GTC* have been held);
   - to encourage our research centres to participate in developing the instruments.
2. To ensure that the observatories in the Canaries continue to be amongst the world's leading observatories:
   - to lead (Spain) the design and construction of the GTC;
   - to site the telescope at the Observatorio del Roque de los Muchachos;
   - to continue ongoing characterisation of the skies over the Canaries;
   - to strengthen enforcement of what is known as the "Law of the Sky".
3. To stimulate the development of Spanish industry in the field of advanced technology:
   - to build up the capacity of companies;
   - research centres and industry should tender for work jointly;
   - an open and interactive tender process;
   - to provide information flexibly and on an ongoing basis from the "Project Office".

Two of these aims have already been met: the observatories in the Canaries are front runners in the contest to host the super giant telescopes of the immediate future, and Spanish companies involved in building the GTC have amassed the knowledge and reputation they will need to secure the most rewarding international contracts. The first objective will not truly be achieved, however, until results produced by our Astrophysics community once the telescope has entered service have propelled some of its members into leading positions in important fields of knowledge.

1 Principal features of the GTC

- A large collecting surface: it will have a segmented primary mirror 11.4 meters in diameter (equivalent to a monolithic mirror of 10.4 meters).
- Excellent image quality: the mirrors will be as highly polished and the adaptive optics system will be as accurate as current technology allows.
- From its inception, the telescope has been designed to use adaptive optics.
- High levels of reliability: 2% reductions in time lost to maintenance and breakdowns.
- High levels of operating efficiency.
- Advanced control system.
- Only one secondary mirror (it can work in both the visable and infrared ranges).
- Collapsible tertiary mirror.
- Classical and queued observation.

2 "Day One" focal instruments

- OSIRIS (optical), for spectroscopy and imaging.
- CANARICAM (infrared), for spectroscopy and imaging.
- ELMER (optical), substitute instrument for OSIRIS.

3 Second generation focal instruments

- EMIR: near-infrared (0.9 to 5 microns) imager and spectrograph.
- FRIDA: spectroscopy and imaging with adaptive optics.

4 Third generation focal instruments

- SIDE: multiple spectrometer with variable resolution.
- Many other instruments yet to be developed.

Obtaining this powerful tool for what is known as "big science" has been very laborious. For an understanding of the work involved, the following chronology is instructive. Even this, though, cannot truly portray the problems we had with the most serious obstacle of all: the culture of mistrust and jealousy that had to be overcome both in Spain and abroad.

1987. The William Herschel Telescope (4.2 m) enters service at the ORM:

- British (RGO) and Spanish (IAC) scientists start work to design an 8 meter class telescope.

1989. Preparations for an 8 metre monolithic telescope are completed:

- a presentation is made to the Governing Council of the IAC and the CCI (International Scientific Committee) of the Canarian observatories, and is received very positively
- formal negotiations begin between Spain and the UK to jointly build the telescope.

1990. In Britain, the SERC decides to abandon the project, opting instead for the American Gemini project:

- the IAC decides to continue with the project alone.

1993. Funds are secured from FEDER to undertake studies into the possibility of building a large telescope in the Canaries:

- consultation with the Spanish astronomical community confirms that it is in favour of the project.

1994. The Government of the Canaries (through the express wish of President M. Hermoso) sets up GRANTECAN S.A. to build the GTC, a turning point in the project:

- the feasibility study and pilot project for a monolithic 8 m telescope begins.

1995. Meeting of experts on large telescopes is held at the IAC to scrutinise the proposal:

- at the last minute the experts are consulted on the potential for building a segmented 10 metre class telescope. They are of the opinion that this is the future
- the existing feasibility study is considered fit for the new concept.

1996. The Governing Council of the IAC (under the Chairmanship of Minister J. Saavedra) approves the viability study and gives the project the "green light":

- the Spanish Government makes its involvement conditional on the necessary funds being available in advance, on three other countries participating, and on the project being overseen by a foreign expert in large telescopes (following the recommendations of the Evaluation Committee for Large Science Installations)
- the "demonstration contracts" designed to build capacity for the project in Spanish Industry are in place (with funding from the national Ministry of Industry and the Department of Industry of the Canarian Government)
- Spain's membership of ESO 'to extend into the Northern Hemisphere from the Canaries,' is about to be signed. The discussions break off as a result of the change of Government in Spain, just as the possibility of installing a 5th VLT at La Palma, and the participation of the ESO in building the GTC as a means of payment for Spain's membership of that organisation, are being investigated.

1997. The conceptual design of the GTC is completed, and work is underway to secure the funds needed to build it.

1998. The Office for Science and Technology (on the instruction of its Director F. Aldana) succeeds in unblocking the project:

- the Spanish Government, from this time onwards, becomes a full participant in the project and leads the GRANTECAN S.A. public company.

1999. The GTC is mentioned explicitly in the State Budgets, and in the FEDER2000.

2000. His Royal Highness the Prince of Asturias lays the "foundation stone" at the Observatorio del Roque de los Muchachos.

2001. Mexico (Universidad Nacional Autónoma de México, and the Instituto Nacional de Astrofósica Óptica y Electrónica) and the United States (University of Florida) become partners.

2001. The "National Programme of Astronomy and Astrophysics" begins (as part of the national Research and Development Plan), as a result of the GTC project.

2002. The "civil engineering works" are completed and the handover of the dome takes place.

2003. Assembly of the telescope structure begins at the Observatory.

2004. The first segments of the primary mirror are received.

2005. The framework for the telescope is completed and delivery is taken of the tertiary mirror and Acquisition and Guidance camera.

2007. "First Light" at the GTC.

The GTC is currently on the way to being completed (its "First Light" on the 13th July 2007 was a notable success), although many details remain to be finalised before it is fully operational. *Within a year it will be open for use by the astronomical community*, with "day one" instruments (OSIRIS + CANARICAM), and substitute instrument (ELMER). Observing time will be available in the "008 B" semester (October 2008 - March 2009). "ESO time" (time given over to the European Southern Obeservatory as part payment for Spain's membership of that organisation) will be available from January 2009.

I will never tire of congratulating all of the people responsible for bringing the project to fruition, headed by Pedro Álvarez (Project Director) and José Miguel Rodríguez Espinosa (Scientific Manager). Over time their tremendous contribution will come to be valued even more.

The time has come to begin producing front-line science with this great telescope. With its large collecting surface (75 square metres) the GTC is well-suited to observing very weak objects, like the distant galaxies that show us the origins of the stars which populate the Universe. It also brings advances for observing faint objects, and for investigating the birth and death of stars, quasi-stellar objects and planets. The large diameter of its primary mirror means that it will see fine detail, in near stars, other galaxies, in the structures of protostellar clouds, star clusters and more. Its capabilities in the infrared range will also allow it to penetrate dense clouds of gas and dust.

We hope, too, that new and unexpected discoveries will be made before long. Could they even be so significant that they will change our understanding of the Universe?

In addition to all this, once the GTC is in operation it will be a great ambassador for the development of technology and industry in Spain. In the future, it will help us secure the siting of the"European ELT" and the EST (European large Solar Telescope) in Spain, together with a role for our research centres and companies in their construction.

We also aim to use the GTC to train researchers and technologists and to promote science to the general public. The prospects could not be more exciting, especially for the new generations of our astrophysicists.

LNEA III, 2008.
A. Ulla & M. Manteiga (editors).

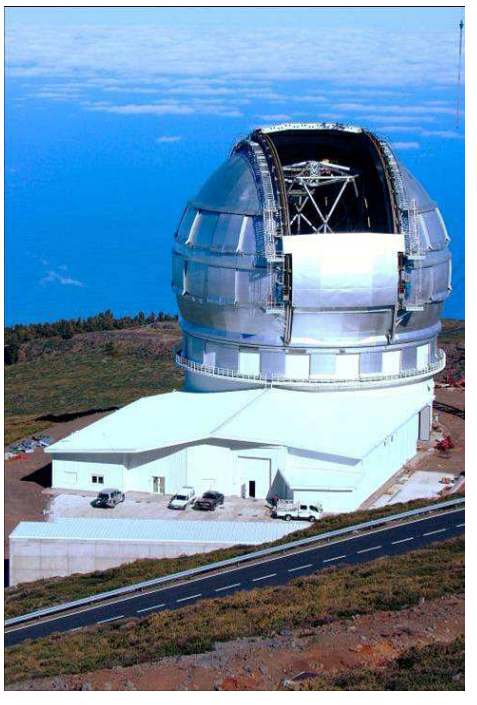

Figure 1: Exterior view of the Gran Telescopio CANARIAS (GTC), installed at the IAC's Observatorio del Roque de los Muchachos.

Figure 2: View of the GTC from inside the dome.

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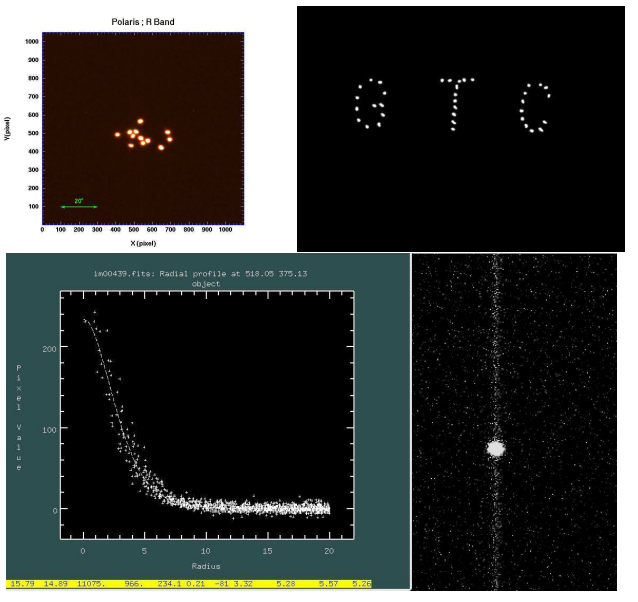

Figure 3: First light. Upper left panel: when the images of the star observed (one from each of the primary mirror segments) were still separated. Upper right panel: The images of the observed star arranged to form the letters GTC. This demonstrates the mastery over mirror adjustment that already exists. Lower panel: The star observed (the images from each primary segment are "stacked" here), showing the extraordinary resolution achieved, without optical adjustment.

Figure 4: First Light: The principal assistants drinking a Ltoast in the telescope control room immediately after achieving a very successful "first light". Happiness is written on every face.