



ESO & Brazil

Frequently Asked Questions

1. Brazil and the ELT

The Extremely Large Telescope (ELT) will be the world's largest and most advanced telescope for ground-based, optical/near-infrared astronomy. It will set the research agenda for the coming decades. The first industrial contract was awarded in 2012 and the groundbreaking on the Armazones site took place on 19 June 2014.

The ELT is an ESO core programme and the ESO Council gave green light for the construction of this gigantic telescope in December 2014.

At the technical level, the ELT project is progressing as planned. The contract for the Dome and the Main Structure was awarded on 3 February 2016.

Brazil will miss significant opportunities if its industry cannot be awarded with contracts because the ratification procedure is pending.

Special policies have been put in place to ensure that all ESO Member States can participate in the ELT Contracts — which will be among the biggest ever placed by ESO — and to safeguard in particular the Member States with a low industrial return coefficient. Brazil will be able to benefit from these policies.

2

Q: When did the negotiations start? What is the history of Brazil joining ESO?

A: The first informal discussions with Brazil started in early 2009, and included a colloquium about ESO in São Paulo given by the ESO Council President as part of the development of a strategic plan for Brazilian astronomy. Further discussions took place during the International Astronomical Union General Assembly in August 2009 in Rio de Janeiro and when the Brazilian Minister of State for Science and Technology, Sergio Machado Rezende, visited ALMA and ESO's Paranal Observatory in February 2010.

At the invitation of the Brazilian Ministry of Science and Technology, a special committee for astronomy elaborated a National Plan for Brazilian Astronomy, including an assessment of the options for joining one of the extremely large telescope projects currently under way. The ELT option appeared as the most appealing, greatly reinforced by the option of joining ESO with immediate access to all its facilities, with a large diversity of instruments and possibilities to participate in instrumentation development. Brazilian astronomers therefore agreed that they should apply for ESO Membership in May 2010, and accordingly made a recommendation to Minister Rezende. A formal expression by Brazil of interest in accession was submitted to ESO just before the June 2010 ESO Council meeting. As a result, informal negotiations with the government took place throughout June, July and August 2010.

An extraordinary ESO Council meeting on 5 October 2010 unanimously decided to formally invite Brazil to apply for Membership. The decision was followed by formal negotiations in Brasilia on 2 and 3 December 2010 and a formal application from Brazil, which was received on 14 December 2010. On 21 December 2010 another extraordinary ESO Council meeting unanimously approved the signing of an agreement between ESO and Brazil.



On 29 December 2010, at a ceremony in Brasilia, the Brazilian Minister of State for Science and Technology, Sergio Machado Rezende, and the ESO Director General, Tim de Zeeuw, signed the formal accession agreement aiming to make Brazil a Member State of ESO. Brazil will become the sixteenth Member State and the first from outside Europe. Since the agreement means acceding to an international convention, the accession agreement was submitted to the National Congress of Brazil for ratification in early 2013.

The ratification process was completed by the Congress on 14 May 2015. However, the final signature by the President of the Republic is still pending.

3

Q: Why Brazil? What are the criteria that the ESO Council uses to decide whether a country can join ESO?

A: ESO has a long history of successful involvement with South America, beginning with the selection of Chile as the best site for its observatories in 1963 and continued more recently when the same location was chosen for the ELT. Brazil early on negotiated an agreement with ESO for the use of two telescopes at La Silla. This long-term collaboration with South America has brought ESO closer to countries such as Brazil, which could easily see the scientific and technological advances resulting from ESO's Observatories and the positive impact on the local economy. At the same time, ESO has witnessed the impressive rapid development of the Brazilian astronomical community and the efforts made to advance science and technology in the country. Relations between ESO and Brazil took shape after a major exhibition at the planetarium of Rio de Janeiro in the summer of 1991 and agreements were made enabling Brazilian astronomers to use two ESO telescopes at La Silla in the following years (see also below). For a country to become a Member State of ESO it has to have a strong, motivated and well-prepared astronomical community. As a country, it should be ready to invest in science and technology and should have both a stable economy and a stable political situation.

4

Q: What are the benefits for Brazil?

A: ESO Membership brings a wide range of unique advantages for Brazil. Many of these advantages have already been implemented during the interim (pre-ratification) period.

As a member of ESO, Brazil will enjoy all the benefits and be able to exploit all the opportunities of the membership on a par with the current Member States. It includes:

- Brazilian astronomers will have full and immediate access to all ESO facilities (La Silla and Paranal) and ESO partnership facilities (ALMA, APEX) – i.e. access to the leading ground-based facilities in the world, covering both optical and non-optical astronomy.



- Brazilian scientists and government representatives will be fully represented in all ESO advisory and governing bodies that are composed of national representatives, including strategy discussion and planning for future activities and facilities – i.e. the opportunity to influence the future research agenda in astrophysics.
- Full eligibility of Brazilian companies to receive contracts from ESO, covering all business areas from provision of services to technical studies and delivery of advanced equipment – i.e. boosting the Brazilian industrial sector in selected areas, enabling industrial spin-off and innovation, especially in areas of high technology.
- Since 1990, ESO has been running a highly successful Student Programme, which allows PhD students to spend extended periods of time at ESO and thus to gather hands-on research experience at one of the world's leading science facilities. So far more than 200 doctoral students have participated in the programme, which complements ESO's equally successful Fellowship scheme.
- As a part of ESO's mission of promoting collaboration in astronomy, the ESO Directorate of Science maintains various channels to promote and fund scientific exchanges among scientists of its Members States, including visitorships and joint organisation of scientific conferences. Access to these programmes will promote scientific collaboration of Brazilian scientists at all levels with Europe-based colleagues.
- Most of the world-leading astronomical instruments in operation or construction at ESO telescopes are built by international consortia composed of institutes in several ESO Member States, a model to be continued with the construction of future ELT instrumentation. Membership will provide Brazilian institutes access to cutting edge know-how in areas such as opto-mechanics, control software, and detector technology, etc.

5

Q: What is the situation before ratification is completed?

A: Until the ratification process has been completed by Brazil, the following interim regulations have been agreed between the Federal Government and ESO:

- Brazilian astronomers have the same access to ESO's facilities as those of the current 15 Member States. This means the application of the same scientific criteria and selection process, i.e. for allocation of telescope time.
- Brazil is invited to send observers (without voting rights) to attend the meetings of the ESO Council, the Finance Committee, the Scientific and Technical Committee and the Users' Committee.
- Brazilian companies are placed on the same footing as companies and institutions of the current Member States with regard to the participation in ESO Calls for Tender (but contracts can only be granted to Brazilian companies and institutions after the ratification procedure has been concluded, except where otherwise decided by ESO).



6

Q: What is Brazil's contribution?

A: Brazil's accession fee is 130 million euros and this will be paid over the course of ten years. The annual contribution is proportional to net national income, but will ramp up in the early years, taking into account the relatively modest GDP/capita of Brazil. Brazil's cumulative contribution over the coming decade will help with the planned expansion of ESO's programme, including the construction of the ELT.

7

Q: When is the Brazilian Government expected to ratify the Membership?

A: As soon as possible.

8

Q: Is Brazil ready to exploit these benefits?

A: The Brazilian science community is mature, competent and ready to exploit the benefits from an ESO membership. Brazilian industry presents interesting options and will be able to compete for ESO industrial contracts.

1. Science

According to the last census by the SAB in 2011 the astronomical community had 660 members, including students, working in more than 60 institutes. The present number is estimated to exceed 700. Generally, in terms of winning observing time in international peer-reviewed allocation processes, the success rate of Brazilian astronomers is very good. This is confirmed by the early experience with ESO.

Since the signing of the Accession Agreement in 2010, Brazilian astronomers have provisionally been granted access to ESO facilities under the same competitive conditions as astronomers in the ESO Member States. The statistics of success rates of proposals led by Brazilian astronomers are on a par with those of the current ESO Member States, including the largest ones with the longest membership, showing that there are no significant differences in the average quality of scientific proposals. Therefore, Brazilian astronomers have demonstrated their ability to exploit the scientific benefits of membership in ESO to the same level as their colleagues in the other ESO Member States. The more proposals they submit, the more observing time they will get.

Thanks in part to Brazil's past involvement in the ESO 1.5-metre telescope and the MPG/ESO 2.2-metre telescope at La Silla (these agreements have now ended), Brazilian astronomers have gained experience in working with ESO. Over the years they have published a number of scientific papers based on data obtained with ESO telescopes.

Brazilian astronomy is recognised to be particularly strong in certain areas, with Brazil-based world-class groups in the topics of chemical evolution of galaxies and stellar atmospheres, among others. Access to specific ESO instrumentation that is particularly suited for observational studies in these fields will be an obvious direct benefit enabling these groups to consolidate their leadership.



Brazilian astronomers produce around 230 scientific papers/year, not counting papers from physicists working on theoretical cosmology, particle physics, and the Auger project (if these were included this number would double). Nearly 40 Brazilian astronomers have more than 1000 citations, and ten of them have between 2500 and 7700 citations in NASA/ADS, attesting to the quality of astronomy done in Brazil. Most of the astronomers work in optical/infrared astronomy, and a small fraction in radio astronomy.

Interestingly, the productivity and use (measured by the number of papers by Brazilian astronomers) of international facilities to which Brazil is currently a member, such as Gemini and the Southern Astrophysical Research (SOAR) telescope, is much lower than that obtained with ESO telescopes. This is also true for the Observatorio do Pico dos Dias (OPD), the national facility managed by the Laboratório Nacional de Astrofísica (LNA/BR).

In the period 2006-2010, the number of papers based on data from Gemini was 58 (see <http://www.lna.br/lna/public/gemini/public.html>), 24 from SOAR (<http://www.lna.br/lna/public/soar/public.html>), and 77 from OPD (<http://www.lna.br/lna/public/opd/public.html>) (see below), whereas 189 papers were produced with ESO data (ftp://www.astro.iag.usp.br/pub/barbuy/CEA/Brazilian_authors_2006-Mar2011.xlsx), 94 of these with a Brazilian first author, even before the country has become a member of ESO.

2. Industry

The industrial return is measured at ESO through each Member State's return coefficient (the ratio between the percentage of expenditures in an individual Member State and their percentage contribution to the budget). ESO aims for a reasonable balance between its Member States and monitors it very closely. ESO Council and Finance Committee receive yearly reports on industrial return (and observing time). ESO works pro-actively with 'under-returned' Member States. This approach helps ESO to keep costs down and it helps to develop competitive high-tech industries within the Member States.

In the Accession Agreement with Brazil it is explicitly stated that ESO shall make all efforts to distribute the contracts as fairly as possible among the Member States. ESO will use its best endeavours to provide Brazilian companies and institutions with all manner of assistance and facilities to participate in ESO Calls for Tender.

So far, industry awareness events carried out by ESO in the context of the accession process have taken place in São Paulo and in São José dos Campos on 23–24 August 2011 and in São Paulo on 16 November 2015 with participation also of representatives of the Federal Ministry of Science and Innovation. Also this time, the event was followed by dedicated visits to specific Brazilian companies.

The briefings were attended by many members of Brazilian industry – from large construction companies, medium-sized engineering companies and smaller software and precision engineering houses and consultants. The briefings covered the technology used by ESO along with developments in instrumentation and the core subject of the ELT development and opportunities. Some 30 companies attended the São Paulo meeting and 25 were in attendance at the São José dos Campos briefing.



In addition to discussing opportunities and registering companies who would be interested in receiving Calls for Tender from ESO, several individual company visits took place in São Carlos, São Paulo and in São José de Campos.

All of these visits demonstrated the wide and sophisticated skills of Brazilian industry and showed that they possess capabilities in the majority of technology areas to participate strongly in the ELT and in normal ESO procurement.

As a Member State of ESO, Brazil will be able to compete for contracts in all areas of ESO's technology activities. For the ELT in particular, ESO sees potential for Brazilian industry in the areas of Control Software, General Handling Equipment, Washing & Coating Units, Cryogenic facilities, and consultancies, in addition to the large field of advanced scientific instrumentation.

Today ESO is the undisputed leader in ground-based optical/IR astronomy. This leadership is due to the VLT observatory. However the success is due not only to the four 8-metre telescopes, but also to the state of the art instrumentation on the telescopes. ESO has been uniquely placed to be able to have an on-going instrumentation programme, which keeps the telescopes at the forefront of astronomical research.

Brazil has already started to engage in this programme with the start of the CUBES project (led by Brazil) and with the involvement of the Universidade Federal do Rio Grande de Norte in the HARPS laser frequency comb project and the development of the near infrared spectrograph – NIRPS.

9

Q: What is the position of the scientific community in Brazil?

A: There is strong support among Brazilian astronomers for ESO membership, which offers access to the world's leading ground-based observatories, both today and in the future. But ESO membership will also bring interesting perspectives for the associated areas of science and technology.

The scientific interests of the majority of the Brazilian astronomical community are closely related to observational astronomy and will thus directly benefit from the access to world-leading instrumentation, both current and future, available at ESO facilities. This has naturally translated

into a strong support from most of the Brazilian astronomical community for ESO membership, which ultimately led to the signature of the Accession Agreement in 2010.

From a survey carried out by CEA (Comissão Especial de Astronomia, created in June 2009 with the goal of writing a plan for the Brazilian astronomy for the next 5 years) in 2010, including only Brazilian astronomers with a permanent job, the result has been that 75% are in favour of joining ESO, 17% being theoreticians had no opinion, and 8% were against it. As can be expected from a mature scientific community with a very diverse portfolio of interests, activities, and international collaborations, the support for ESO membership, while very strong, is not unanimous. It is therefore important to take the following considerations into account:

Unlike other international collaborations in which Brazil already participates, ESO does not provide access to a single facility designed for a narrow set of scientific goals, however important these may be. On the



contrary, through membership in a single organisation like ESO, Brazilian astronomers will have access to a wide range of state-of-the-art facilities and instruments covering virtually the entire spectrum of ground-based observational astronomy. Indeed, ESO provides unique instrumentation in several aspects, e.g:

multi-object high resolution spectroscopy: more than a hundred spectra are observed at the same time — giving up to a hundred times higher efficiency.

spectrography covering wavelengths from ultraviolet to infrared — giving at least 3 times more efficiency for the time spent.

multi-object integral field unit spectrography — providing 24 times more spectra than any other such spectrographs in any other observatory in a given time.

Considering also ESO's participation in ALMA, no other organisation or international collaboration in astronomy existing at present can serve the needs of as many Brazilian astronomers as ESO.

Contrary to other observational astronomy facilities in which Brazil is currently a member, ESO does not have a fixed, semester-by-semester allocation of observing time per country, which would limit the duration of scientific programmes that can be executed with the facility. This means that projects by Brazilian astronomers recognized as outstanding on the basis of their scientific merit can obtain as much observing time as required to fulfil their goals, even if this exceeds the fraction of observing time that would correspond to Brazil's share if it were computed as the corresponding fraction of its financial contribution.

ESO's mission of promoting collaboration in astronomy means in practice that important efforts are made to ensure that the entire ESO community is able to exploit new facilities as they become a reality. This takes place in multiple ways, such as conferences, dedicated training workshops, exchange of scientists, or seminars at institutes of member states. Thus, in the long run the benefit of ESO membership not only goes to existing groups able to make use of the facilities: it also fosters a generation of new local expertise that could be otherwise very difficult to obtain.

Numerous examples of these advantages can be found among national communities that have entered ESO in the past.

It is also important to point out that an ESO membership is not only of benefit to the astronomical community. Because of astronomy's long-standing role as a technology driver, astronomy projects on the scale of ESO's involve a wide range of other professional communities, such as engineering (from mechanical to optics to software), mathematics, etc.



10

Q: How has the investment been made compatible with Brazil?

A: The Accession Agreement between Brazil and ESO includes important concessions to Brazil to ensure that the investment by Brazil is commensurate with the overall economic capability and status of the country.

The financial contributions to ESO (annual membership fee and the special (one-off) contribution) are based on the size of the national economy and calculated in a transparent and verifiable manner using internationally recognized base figures from OECD and other sources. This notwithstanding, in the course of the 2010 negotiations, a number of unique advantages was offered to Brazil. They include:

- A reduced special contribution to take into account that Brazil's GDP per capita was significantly smaller than that of any other Member State. The special contribution was set at 130 MEUR.
- An unprecedented ramp-up of the Brazilian annual contributions due to the fact that (1) the Brazilian astronomical community was relatively small compared to its GDP (though not to the size of astronomical communities in many current ESO Member States) and (2) accepting Brazil as a Member State was of significant strategic value for the future development of ESO's programme. Brazil will only contribute with the full annual fee as of 1 January 2021.
- Brazil has been exempted from the additional contribution that the current Member States have agreed to make towards the ELT, equalling about a quarter of the total ELT cost. This, together with the discount on the special contribution mentioned above, amounts to a significant lowering of the one-off costs of joining ESO.
- ESO also agreed to spread out the payment of the special contribution over a period of ten years rather than requesting that this was made within one month after the completion of the ratification procedure although the amounts are due since January 2011. This has not been done in the past with other accessions.

It is widely considered that the long-term future of astrophysics in a country is linked to that country's access to the next generation of telescopes (the ELTs). An ESO membership not only provides for access to the largest and most powerful of the ELTs currently being planned, but also secures access to the existing ESO facilities, recognised to be world-leading today. An ESO membership therefore provides both a very attractive perspective for the future for Brazilian astronomy as well as bringing immediate and tangible benefits today.

It may be noted that many aspects of the development of instrumentation for space-based research shares important commonalities with the development of astronomical instrumentation in areas such as cryogenics, opto-mechanics, detector systems, remote sensing, metrology, and data handling. Direct exposure through collaboration in the development of state-of-the-art astronomical instrumentation and of ELT systems will thus be a direct benefit for the development of high-tech expertise in the Brazilian academia and industry applicable to the development of the Brazilian space programme.



11

Q: How will Brazil's membership of ESO relate to its international relations?

A: As stressed by the appointed rapporteur (Relator) of the Congress Commission on External Relations and National Defence, an ESO membership will have a positive impact on Brazil's relations with Chile. It is certain also to be seen very favourably by the European countries that actively pursue international cooperation in science and technology as part of their overall international relations as well as by the European Union (EU), as it dovetails with the stated EU policy of opening up the European Research Area to international participation. A Brazilian membership of ESO will furthermore strengthen the integration of the Brazilian knowledge community in the global fabric and certainly increase the visibility of Brazilian science and the standing of Brazil as a high-tech country.

12

Q: How will ESO ensure a smooth entrance of Brazil into the Organisation?

A: ESO is undertaking considerable efforts to facilitate a smooth entrance of Brazil into the Organisation and to ensure that Brazil will be able to exploit the full benefits of its membership. ESO is committed to helping new Member States in order to secure their full participation and the ensuing benefits to the country in question. Where deemed to be useful, this includes:

- Increased programme of industry days and networking events.
- The possibility for Brazil to appoint an Industrial Liaison Officer who can assist ESO in identifying potential suppliers.
- Guidance and assistance to the scientific community regarding ESO's time allocation procedures and the necessary application process. As mentioned above, ESO has already organised science days/tutorials on proposal writing and it should continue to do so. Training sessions took place in Rio de Janeiro, Porto Alègre and São Paulo between 5 – 15 August 2013.
- Visits of scientists and engineers for the engagement of Brazilian institutions in ESO's instrumental programmes are being organised.
- Installation in Brazil of a 'node' of European ALMA Regional Centre, which will support the users of the world's largest telescope array on Cerro Chajnantor in Northern Chile.
- Appointment of a Brazilian 'node' in ESO Science Outreach Network, 1 January 2011.
- Scientific meetings with the participation of ESO in Brazil:
 - Special focus of the Annual Meeting of the Brazilian Astronomical Society between 4 – 8 September 2011 with presentations by the ESO Director General and senior astronomers from the ESO community;
 - The joint ESO/IAG/USP Workshop on Circumstellar Dynamics at High Resolution, Foz do Iguaçu, 27 February – 2 March 2012;
 - ESO/Brazil co-organised workshop on 400 Years of Stellar Rotation, Natal, 21 – 26 November 2013;
 - ESO participation at the XIV IAU Latin-American Regional Meeting, Florianópolis, 25 – 30 November 2013;



- ESO/NUVA/IAG Workshop on Challenges in UV Astronomy. ESO, Garching, 7 – 11 October 2013 (with Brazilian participation).
- ALMA and the Brazilian Community Workshop, ON, Rio, 18 – 21 August 2014.
- ESO Prize 2015 for the Champion of the Brazilian Astronomy Olympics.

13

Q: What is the experience of other countries when they joined ESO?

A: Since 2001, six countries have become Member States of ESO. Several other countries have expressed interest in joining.

In all of the countries, the political considerations prior to the membership have been similar to those in Brazil. ESO's history shows that the association of a country to the Organisation has always amplified, in a significant way, the growth and scientific and technological development of all astronomy, including activities and projects not directly related to ESO. Similarly, industry has benefitted from membership, both in terms of contracts and technological know-how.

14

Q: Is Brazil a member of any other European intergovernmental institutions?

A: As far as ESO is aware Brazil is not yet a full member of any other European intergovernmental organisation. Brazilian membership of CERN is being discussed.

15

Q: Are any other non-European potential Member States currently negotiating with ESO?

A: ESO has reached a new phase in its evolution where it can become a platform for global scientific projects. There is no formal basis in the Convention (which is the ESO founding treaty), or in actual practice at ESO, for the position that Membership in ESO is restricted to European Member States. Council's interpretation of the Convention is that any country may qualify for Membership.

Currently ESO is not having formal negotiations with other countries outside Europe for potential ESO Membership. However, several countries have expressed an interest and informal discussions are taking place.

16

Q: Will the ELT be ready before other extremely large telescopes such as the Thirty Meter Telescope?

A: In December 2012 the start of the ELT programme received full approval from the ESO Council ([ann12096](#)). The greenlight for the start of construction was given by Council in December 2014 with first light expected about ten years later.

It is not possible to predict whether this will be ahead of the other extremely large telescope projects, although ESO would naturally be proud to deliver the first results from the coming generation of groundbreaking mega-telescopes. However, building these massive telescopes is not a race between competing projects, but the next step on the path that ESO is following is to discover answers to fundamental questions about our existence and the origin of the Universe.



17

Q: Will the ELT still be named the Extremely Large Telescope?

A: The Extremely Large Telescope is a temporary name that has been commonly used to refer to the project. Its official and final name has not yet been decided and will likely not remain the same.

18

Q: Could you say more about the astronomy in the Brazilian flag?

A: The Brazilian flag has an important astronomical background. There are several constellations pictured, each star representing a Brazilian state. The constellations are depicted as if seen from above (i.e. from outside the illusory celestial sphere that the night sky appears to resemble when seen from Earth), and positioned as they would have been on 15 November 1889 at 08:30 over Rio de Janeiro. The day of 15 November 1889 was when the Republic was proclaimed, and 08:30 was the moment at which the constellation of the Southern Cross was on the meridian of Rio de Janeiro and the longer arm (of the cross) was vertical. Read more about the astronomy behind the Brazilian flag on:

http://flagspot.net/flags/br_astro.html