



The Upgrade of the IRAM 30-meter Millimeter Radio Telescope

Miguel Sánchez-Portal⁽¹⁾, Manuel Castillo⁽¹⁾, Salvador Sánchez⁽¹⁾, Ignacio Ruiz⁽¹⁾, Pablo Mellado⁽¹⁾, Jean Tedros⁽¹⁾, Antonio J. Vázquez⁽¹⁾, Albrecht Sievers⁽¹⁾, Gabriel Paubert⁽¹⁾, Pablo Torné⁽¹⁾, Joaquín Santiago-García⁽¹⁾, Santiago Navarro⁽¹⁾, Carlos Durán⁽¹⁾, Ángel M. Bongiovanni⁽¹⁾, Karl F. Schuster⁽²⁾, Carsten Kramer⁽²⁾, Stefano Berta⁽²⁾, J. Antonio López-Fernández⁽³⁾, Rafael Bachiller⁽⁴⁾

(1) Institut de Radioastronomie Millimétrique (IRAM), Granada, Spain, e-mail: msanchez@iram.es

(2) Institut de Radioastronomie Millimétrique (IRAM), St. Martin d'Hères, France

(3) Instituto Geográfico Nacional (IGN), Madrid, Spain

(4) Observatorio Astronómico Nacional (OAN/IGN), Madrid, Spain.

The IRAM 30-meter millimeter radio telescope is placed at 2850 m above the sea level in the Loma de Dílar, a slope of Pico Veleta in Sierra Nevada, Granada, Southern Spain. The telescope has been operating almost flawlessly for nearly forty years since its inauguration. It is still one of the most sensitive and powerful telescopes worldwide in its frequency range. In 2017 the facility got the recognition as one of the facilities within the Spanish Map of Singular Scientific and Technical Infrastructures (ICTS).

The telescope has undergone along the years multiple upgrades, including new instruments (the observatory is currently running the fifth generation), the thermal control, as well as telescope hardware and software. However, the main electromechanical systems remained unchanged since its installation and some of them, in particular the sub-reflector wobbling mechanism (a unique capability of this telescope that allows an exquisite cancellation of the atmosphere and background effects) started to show ageing symptoms.

In order to keep the 30-meter telescope in the forefront of science in the coming years, IRAM has undertaken the most profound and ambitious renewal project to date (as detailed in 1, 2). The first set of improvement actions has included a completely new servo control system for the mount and sub-reflector, comprising state-of-the-art hardware (antenna control unit, motors, amplifiers, sensors, etc.) and low-level software components. In addition, a middleware component has been developed in-house to interface the new software with the existing high-level control system. After a shutdown that extended for several months and a period of several weeks of testing and commissioning, the telescope is resuming science routine operations early February 2024. This work has been supported by the Spanish Instituto Geográfico Nacional (IGN) and is co-financed by the European Regional Development Fund (ERDF) programme.

The second upgrade activity is related to the main reflector surface; the goal is to improve the thermal behaviour, surface accuracy and gain-elevation curve. Along the years of telescope operation, the original paint slowly but steadily degraded. Now, in some areas the paint layer is as thin as some 10 μm and differences between panels can be clearly observed. This translates into a degraded thermal performance and degraded surface r.m.s. due to uneven paint layer and panel buckling. Therefore, the main action to be accomplished includes in-situ laser-cleaning and re-painting of the surface with a high accuracy, namely a 50 μm TiO_2 paint layer with a tolerance of $\pm 5 \mu\text{m}$ peak-to-peak. The new paint layer will improve the thermal stability of the telescope in day time and reduce surface shape distortions due to uneven heating of the surface. This activity will be likely performed in early Summer 2024, taking advantage of the stable weather conditions. In addition, and as a conclusion of the finite element modelling analysis performed on the telescope structure, it is also being considered to reinforce some of the frames supporting the panels, as this would improve the gravitational behavior of the surface at a range of elevations.

1. M. Sánchez-Portal, et al, "Improving the Good: The Upgrade of the IRAM 30 Meter Millimetre Telescope", *Astronomical Data Analysis Software and Systems XXX*, ASP Conference Series, Vol. 532, 2021.
2. M. Sánchez-Portal, "Present and future of the IRAM 30-meter millimeter telescope", *Highlights of Spanish Astrophysics XI*, Proceedings of the XV Scientific Meeting of the Spanish Astronomical Society, 2023.