

# SPETTRA 2025

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The first SPETTRA summer school, SPETTRA being the acronym of *SPECIALIZED Training in Technologies for Radio Astronomy*, took place at the INAF Radioastronomical Station of Medicina (Bologna) from the 15<sup>th</sup> to the 19<sup>th</sup> of September 2025.

The school was organized by the Italian National Institute for Astrophysics (INAF) as part of a collaboration between the Astrophysical Observatory of Arcetri, the Astronomical Observatory of Cagliari and the Institute of Radio Astronomy of Bologna. The event was also supported by Commission J (Radio Astronomy) of the Italian National Committee of the International Union of Radio Sciences (URSI).

SPETTRA was dedicated to the memory of Gianni Tofani (1938-2015), a leading figure at Arcetri Astrophysical Observatory with his fundamental contribution to the development of Italian radio astronomy. Gianni Tofani's technological and scientific production ranges from the development of radio telescopes for the observation of solar activity, in the 1960s, to the creation of the reflector antennas in Medicina, Noto and the Sardinia Radio Telescope (SRT).

The school was made possible by the generous financial support of a group of friends of G. Tofani, coordinated by Alberto Pecci, and it continued the 'Gianni Tofani' Award series (2022 and 2023 editions), maintaining the original spirit but proposing a new format.

The aim of the school was to train and attract brilliant young astronomers and technologists into cutting-edge radio astronomy technologies, offering them hands-on experience in a dynamic research environment. The program offered a unique blend of theoretical learning and practical laboratory applications.



The lectures were given by more than twenty researchers and technologists, mostly affiliated with INAF. The program started with a more science-oriented introduction to the fundamentals of radio astronomy and then followed the entire receiving chain of a radio telescope, from the antenna to the cryogenic front-end receivers and finally to the digital acquisition and data reduction systems. Besides the hardware, the software used to control and monitor the operation of the radio telescope was presented, as along with all the activities necessary to the success of scientific observation (calibration, pointing, focusing etc). Along with the single-dish method, participants were trained in the interferometer technique, which allows a significant increase in angular resolution. The program ended with a description of project management and system engineering, both of which are key disciplines in complex projects today, and with a perspective on future technologies for radio astronomy. Students were also made aware of the protection of radio astronomy frequency bands against man-made radio frequency signals.

Besides theoretical lectures, the characteristics of several national and international radio telescopes (Sardinia Radio Telescope, Atacama Large Millimeter/submillimeter Array, Square Kilometer Array, Low Frequency Aperture Array, Meerkat) were presented, providing insights into real observing radio facilities. The choice of these radio telescopes also made it possible to cover different technologies implemented in radio astronomy, from low (tens of MHz, LOFAR and SKA-Low) to high frequencies (hundreds of GHz, ALMA).

Lastly, INAF tutors organized laboratory sessions on topics that are common experimental activities conducted for developing radio astronomical instrumentations: *i)* RF characterization of microwave components; *ii)* introduction to electromagnetic numerical simulations using commercial software applications; *iii)* Radio Frequency over Fiber technology; *iv)* Radio Frequency Interference monitoring; *v)* setup strategies for computational analysis of monitoring data.

The school was attended by 30 students from various Italian universities, along with a representative group of international students. The gender balance of the students was good: 44% female / 56% male. Despite the wide diversity in student backgrounds (from astrophysics to engineering) and age (from bachelor's students to post-doc), a survey conducted at the end of the week showed a very high level of satisfaction with the effectiveness of the school. Another positive aspect was that students and lecturers stayed in the same hotel, allowing pleasant and ongoing exchanges that transcended the formality of lectures alone.

One of the most touching moments of SPETTRA was the memorial ceremony for Gianni Tofani. In the presence of Annamaria Petrioli Tofani and Paola and Alberto Pecci, several of Tofani's former collaborators shared heartfelt memories of his many contributions to radio astronomy.

In conclusion, SPETTRA was a new initiative proposed by INAF aimed at training excellence in the Italian scientific landscape. Its main aim was to provide a select group of young researchers and students with theoretical insights

and practical experience in radio astronomy technologies. The aim was to advance their expertise in the field, representing a strategic investment in the next generation of researchers and technologists. Positioning itself as a link between basic research and practical application, the SPETTRA school was a key event in the context of INAF's educational mission, embracing both Italian observational infrastructures and major international collaborations.



Figure 1. SPETTRA group photo with donors, organizers, lecturers and students during the memorial ceremony for Gianni Tofani at the “Marcello Ceccarelli” Medicina Radio Telescope Visitor Center. Credits: S. Righini (INAF-IRA).