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The Atacama Large Aperture Submillimeter Telescope (AtLAST): enabling large-scale sub-mm science beyond 2030

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The Atacama Large Aperture Submillimeter Telescope (AtLAST) is a next-generation, environmentally sustainable (sub-)millimeter astronomical single-dish facility, currently continuing in a second EU-funded development study that will bring the telescope design to PDR level by the end of 2028 (atlast.uio.no). INAF is a Beneficiary Partner of this EU project and the Sardinia Radio Telescope will be used as a pathfinder to test key technologies. With its 50m-diameter primary mirror and the possibility to host multiple instruments accessing a 1 to 2 degree diameter field of view, the strength of AtLAST is in science where a wide field of view, highly multiplexed instrumentation, and sensitivity to faint extended structures is important. As an indication, AtLAST would provide continuum sensitivity comparable to ALMA/WSU but with up to 10^5 faster mapping speed once its focal plane is fully populated.

AtLAST will perform transformational science in most fields of Astrophysics. Among other things, AtLAST will detect the elusive low surface brightness gas that fills and surrounds galaxies in both its cold (T<100K, through molecular/atomic line emission and dust emission) and hot phases (through the Sunyaev-Zeldovich effect), it will resolve 80% of the Cosmic Infrared Background into >50 million galaxies from z=0 to z=8, it will observe the HDO lines in several comets and provide new insights into the origin of water on Earth, and it will be able to map the whole disk of the Sun at very high temporal cadence for the first time in the sub-mm. As a single-dish telescope, AtLAST will also be ideal for time-domain astronomy and sub-mm VLBI observations. As such, AtLAST will be the ultimate complement to ALMA, ELT, Vera Rubin, and SKA in the 2035+, with an expected lifetime of 50+ years.

The requirements of fast scanning speed (3 deg/s), large aperture (50m), large FoV (>1 deg), and high surface accuracy (20μm over the full 50m dish to observe wavelengths from 10mm down to 350μm) make AtLAST's design unique for a radio facility and closer to that of 30m class optical telescopes. The design features a rocking chair mount with an active main reflector surface, a high precision closed-loop metrology system, and the space to house six major instruments. Instruments will be periodically upgraded as spectroscopic focal plane array technologies are expected to significantly advance in the next decades. AtLAST will also feature a cutting-edge energy recovery system that enables the reuse of braking energy. This innovative approach significantly reduces the motion power demand and takes an additional step towards realising a sustainable observatory. From the start of the design phase, AtLAST has placed a renewable and efficient energy generation as a core requirement, by investing resources into the development of a tailored renewable energy system with a hybrid energy storage that can team up with other observatories and/or civil users.

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