



# ALMA Wideband Sensitivity Upgrade (WSU)

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# ALMA: Atacama Large Millimeter/submillimeter Array

- ALMA is an interferometer for millimetre and submillimetre astronomy
- ALMA is built and operated by Europe (ESO), North-America (NRAO) and East-Asia (NAOJ)
- Baseline construction completed 2014
- Construction cost: \$1500 million
- A very oversubscribed facility





## A large collage of various astronomical images from the ALMA observatory. The images include: a ring-shaped protoplanet (proplyd), spiral galaxies, molecular clouds, protoplanets with rings, and various other celestial structures. The text "10+ Years of Amazing ALMA Science" is overlaid in the center. In the top right, there are four small panels labeled "Dust", "Sulfur Dioxide", "Nitric Oxide", and "Formaldehyde", each showing a different chemical map of a protoplanet. A scale bar indicates "1 light-year". In the bottom right, the text "Cycle 1 started in January 2013" is displayed.

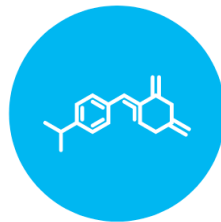
**Cycle 1 started in January 2013**

# What is ALMA Wideband Sensitivity Upgrade (WSU)?

- Keep ALMA at the forefront! Technology now 20 years old. Upgrade will guarantee ALMA's long-term health
- Upgrade of the bandwidth (initially x2, eventually x4) and throughput of the ALMA system
  - Improved **sensitivity** (imaging speed: factor 3-6 in continuum, factor 2-3 for spectral line)
  - Improved **high-spectral resolution capabilities** (1-2 orders of magnitude)
- Major upgrade of the complete signal chain and related software
- Impact will span all astronomical topics that embodies ALMA's motto *"In Search of our Cosmic Origins"*



ORIGINS OF GALAXIES



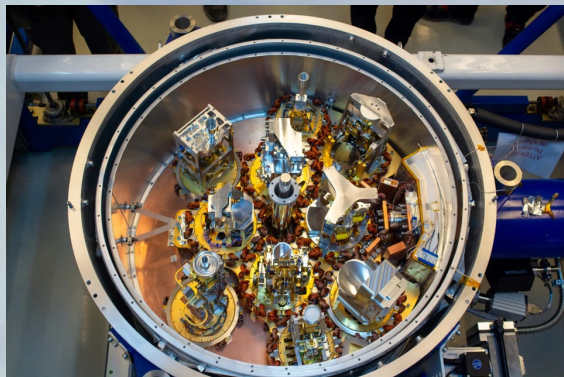
ORIGINS OF CHEMICAL COMPLEXITY



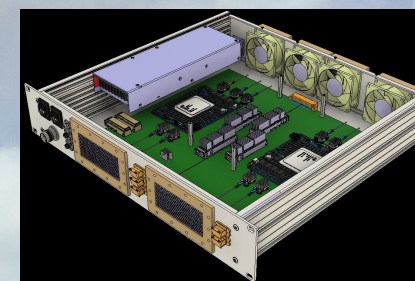
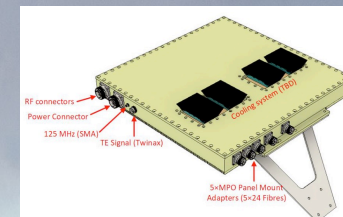
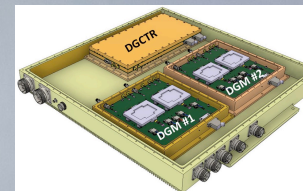
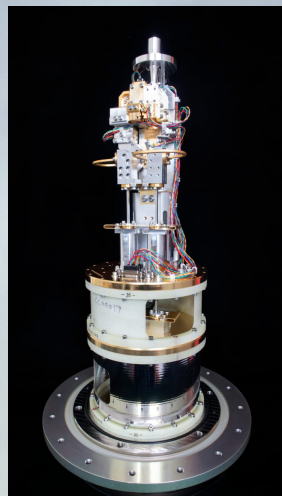
ORIGINS OF PLANETS



# Array Operations Site in Chajnantor (5050 m)



Upgrade of receivers



Upgrade of electronics  
(including digitizers, IF  
processors)

Data transmission system

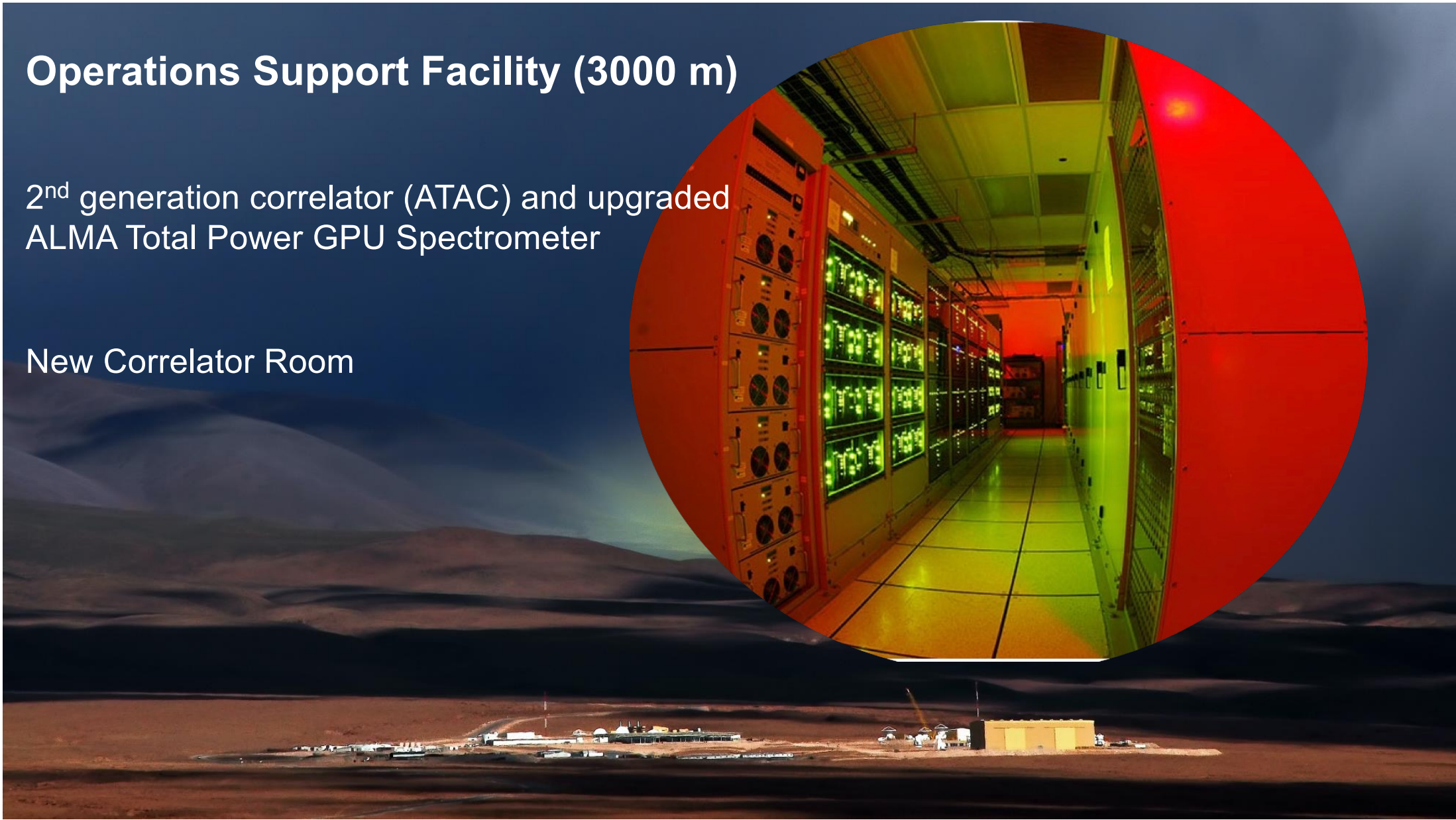
Upgraded fibre optics connection to Operations Support Facility (3000m)



## Operations Support Facility (3000 m)

2<sup>nd</sup> generation correlator (ATAC) and upgraded  
ALMA Total Power GPU Spectrometer

New Correlator Room





# ESO's main WSU projects

## Wideband IF Processor (WIFP) (with Bordeaux Uni)

New antenna-based high-speed system to digitize analogue receiver outputs, and to process and format the resulting data stream

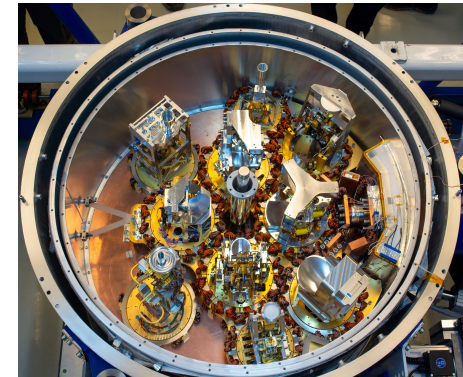
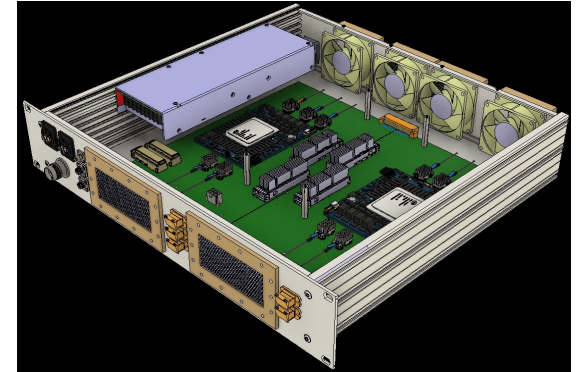
## Band 2 receivers (with NOVA and partners)

RF bandwidth: 67-116 GHz, first wideband receiver (16 GHz per sideband)

Manufacturing and integration are ongoing

## Fibre Optic Connection

New trenches and fibre optics cable between high and low site





## ESO's *future* WSU projects

Most activity is directed to wideband receiver technology - 32 GHz IF bandwidth

Technologies investigated: SIS junctions, MMIC-based cryogenic low noise amplifiers (LNAs), integrated and scalable approaches to building the LNAs and mixers

ESO's priority bands: **Band 7 (~275-373 GHz) and Band 9 (~602-720 GHz)**

Timeline to start new project: ~2026 onward. **Band 7 is highest priority.**

Industrial and institutional collaboration with ESO member states welcomed





# Thank you!

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