Keeping chilly in Chile — the challenges of high high-performance computing

The ALMA space observatory promises new insights into our cosmic origins. But the supercomputer at the heart of the telescope array faces some serious challenges, due to the extreme high altitude of the site.

At

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The Atacama Desert is one of the driest places on Earth. This photomontage shows all four types of antennas that will be installed at the ALMA site: European, North American and Japanese 12-meter antennas, along with a 7-meter diameter one. Image coutesy ALMA (ESO/NAOJ/NRAO), W. Garnier (ALMA).

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5,000 meters altitude, the Chajnantor plateau in Chile's Atacama desert is a perfect location for one of the world's most ambitious astronomical observatories. With the air thin and exceptionally dry at this extreme height, absorption and distortion of electromagnetic radiation is kept to a bare minimum.

Yet, despite these advantages, the thin air hasn't just made life difficult for the construction workers racing to complete the $1.5-billion Atacama Large Millimeter/submillimeter Array (ALMA) by March. The altitude also poses major challenges for 'The Correlator', the supercomputer at the heart of this ambitious project. The Correlator takes the signals coming from ALMA's manifold antennas and combines them, in order to generate astronomic data for subsequent analysis. Thanks to The

Correlator, up to 64 of the 66 individual antennas at the ALMA site are able to function in unison as one giant telescope, providing unprecedented insight into star birth during the early universe, as well as detailed imaging of local star and planet formation.

Capable of 17 quadrillion operations per second and equipped with 134 million processors, allowing it to continually combine and compare faint celestial signals received by the antennas in the ALMA array, The Correlator is a very impressive piece of kit, on par with some of the world's very finest general-purpose supercomputers.

Like any supercomputer, The Correlator requires some serious cooling. Normally, this wouldn't be a problem. But the thin air at this extreme altitude poses some very unique problems for the machine. Thanks to careful optimization of the design and placement of resistors, capacitors, and other components, power consumption is held at around 140 kilowatts. Despite these power-saving measures being put in place, twice the normal airflow is necessary to cool the supercomputer. And that isn't even the end of the problems: spinning disk drives couldn't be used for The Correlator, since a cushion of air is necessary to stop their read/write heads from crashing into their platters. Consequently, The Correlator is diskless, with data being transferred to an ALMA support facility located at 2,900 meters above sea level. Finally - if that isn't enough - ALMA is located in an area

prone to seismic activity. So, the Correlator has to be tough enough to withstand this too!

- Andrew Purcell

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