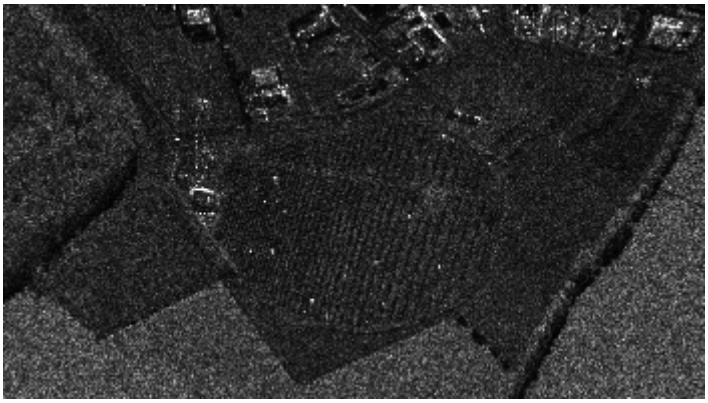
TerraSAR-X image of the month – A game of mirrors

11 March 2013

2153 mirrors twist and turn at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) Experimental Solar Thermal Power Plant in Jülich, directing sunlight onto a 22-square-metre receiver. TerraSAR-X, the German radar satellite operated by DLR, can also detect the mirrors as they follow the Sun – from more than 500 kilometres above Earth. The reflections of the radar signals make the tower and mirror array appear as bright spots of light.

Row upon row of mirrors stand in the 10-hectare field, automatically aligning themselves with the position of the Sun. The surface area of the mirrors totals 18,000 square metres, all used for converting solar radiation into power in the solar tower. But the smooth mirror surfaces also reflect most of the signals from TerraSAR-X back to the satellite. Metal components on the edges and the top of the 60-metre tower reflect the radar signals particularly well. The result is that, while many of the surfaces remain invisible to TerraSAR-X, the reflections are still sufficient for showing the contours of the tower and the majority of the mirrors in the radar image.

Light and shadows



DLR Experimental Solar Thermal Power Plant in Jülich

The houses in the nearby town of Jülich, with their reflective rooftop air conditioning units and ventilators, can also be seen as illuminated points in the radar image. “The black areas seen in the image are the industrial park. The walls face away from the satellite, meaning that none of the radar signals make it back to the receiver – so of course the satellite is not receiving any data,” explains Christian Minet, a scientist at the DLR Remote Sensing Technology Institute. "But we can combine the cast shadows with data on the orbit and orientation of the satellite to calculate the height of the buildings." The appearance of the surrounding fields depends on their surface roughness; is TerraSAR-X looking at the fields before or after the harvest? Which crop is being grown in the field? Colouring the black and white radar images in different shades of red brings out the differences.

Tractor marks and open roof windows

The German radar satellite flies over the terrain every 11 days at the same time of day. If the images are put together in a sequence, one thing above all becomes clear: "The changes in the image are almost all due to human activities," says Minet. He has generated a time-lapse sequence using 37 images, showing Jülich and the solar tower from October 2010 to November 2012. The mirrors in the Experimental Solar Thermal Power Plant turn according to the position of the Sun. Fields are harvested; agriculture changes the environment. Even the tire tracks of the tractors appear as a geometric pattern of straight lines in the fields around the facility in July

2012. Reflective roof windows on the houses are opened and closed, shutters are closed, all creating additional surfaces that reflect the radar signals. New roofs occasionally reflect signals differently than old roofs. Vehicles move on the roads. "The moment something changes, the radar satellite picks it up."

But there is one change not caused by humans, according to the geologist. For a brief moment a dark speck appears in the field to the left of the solar tower. "That is a flood, a large puddle of water, probably left by heavy rainfall," explains Minet.

The TerraSAR-X mission

TerraSAR-X is the first German satellite manufactured under what is known as a Public-Private Partnership between the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and Astrium GmbH in Friedrichshafen. The satellite travels around the Earth in a polar orbit and records unique, high-quality X-band radar data about the entire planet using its active antenna. TerraSAR-X works regardless of weather conditions, cloud cover or the absence of daylight and is able to provide radar data with a resolution down to one metre.

DLR is responsible for using TerraSAR-X data for scientific purposes. It is also responsible for planning and implementing the mission as well as controlling the satellite. Astrium built the satellite and shares the costs of developing and using it. Infoterra GmbH, a subsidiary company founded specifically for this purpose by Astrium, is responsible for marketing the data commercially.

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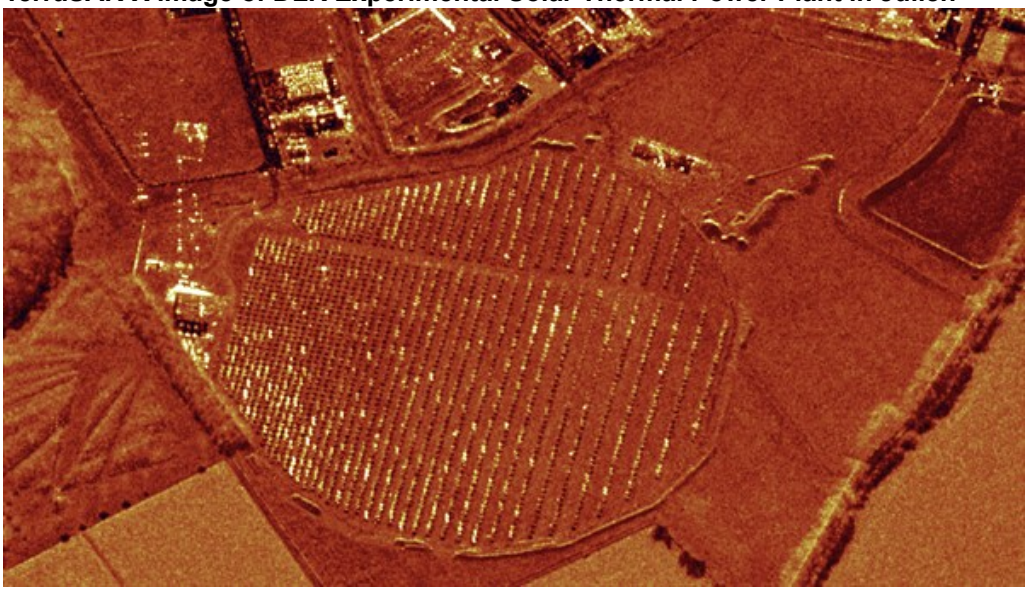
TerraSAR-X image of DLR Experimental Solar Thermal Power Plant in Jülich



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detect the mirrors as they follow the Sun – from more than 500 kilometres above Earth. The reflections of the radar signals make the tower and mirror array appear as bright spots of light.

Credit: DLR (CC-BY 3.0).

DLR solar tower in Jülich

At the Jülich site, set up on an area covering about eight hectares, are 2153 moving mirrors (heliostats). These mirrors track the path of the sun and concentrate the solar radiation on a receiver, about 22 square metres in size, installed at the top of a 60-metre-tall tower. The receiver is made of porous ceramic elements permeated by ambient air. This heats the air up to about 700 degrees Celsius and then, it releases this heat to the water-steam cycle. The steam generated here drives a turbine, which produces electrical power.

Credit: DLR/Lannert.

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