For immediate release

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With art: images of JWST mirror machining

Mitsui Seiki Machines Tackle James Webb Space Telescope Mirror Machining. Overseeing Project: Nobel Physics Prize Winner John Mather

[FRANKLIN LAKES, NJ – MARCH 2007] John Mather, winner of the 2006 Nobel Prize in Physics and project scientist for the James Webb Space Telescope, is one of many overseeing the project at NASA's Goddard Space Flight Center. The JWST is scheduled for launch in June 2013. JWST is designed to study the earliest galaxies and some of the first stars formed after the Big Bang.

The 6.5 meter mirror, one of the most important aspects of the JWST, is comprised of 18 beryllium segments which were just completed by Axsys Technologies Inc. in its climate-controlled factory in Cullman, Alabama. Each segment is about 1.5 meters across. It's the largest lightweight beryllium optic that has ever been made. After a thorough selection process, Axsys chose Mitsui Seiki USA Inc. (Franklin Lakes, NJ) to supply the technology to machine the segments. Northrop Grumman Corp. is the prime contractor for JWST.

The horizontal machining centers Mitsui custom-built to produce the JWST mirror segments combine a massive structure – the column weighs 11 tons, the bed is 20 tons -- with the ability to position to within a few microns anywhere in the machining envelope.

“These are very large, heavy machines; the components are substantial,” says Scott Walker, president, Mitsui Seiki USA Inc. “However, they are also elegant in that they have to position and travel in a very specific, ultra precise manner.”

Machining begins when a 540 lb beryllium billet is fixtured vertically onto an angle plate on one of the eight Mitsui machines. The six-sided billet is 4” thick, 54” across, and 62” from point to point. The reverse side of each mirror segment has 600 pockets – about 2.5” square each. There are also 22 mounting pads and 249 light-weighting holes. Producing the pockets, pads and holes takes about two months to complete.

After pocket milling on the reverse side, the billet weighs about 275 lbs at this point. The segment is heat treated to relieve machining stresses, and then the mirror side is roughed before another stress-relief treatment. Roughing is a circular cut that starts in the center and works its way out, and removes another 50 to 60 lbs of material. The next operation is finish milling of the pocket side, which is another 10 weeks of machining time.

“Consistent cutting is paramount in this application,” says Walker. “Machining generates stress and a lot of material is being removed on these mirror segments. The cutting conditions, the toolpath, and how the servo motors control the toolpath to provide consistency of machine load are the keys to successful cutting of the mirror.”

After finish machining and chemical milling, the final dimensions on the pocket wall thicknesses range from 0.020” to .299”. Finish milling of the mirror side, pocket side, and locator hubs is next. Tolerances for many of the finished elements of the mirror structure are +0.0002/-0.00”, and true position is 0.001” from the inside to the outside of the hubs and 0.005” all the way around a 48” bolt circle. The mirror surface itself has a specified thickness of 0.098” with a profile tolerance of +/- .002”. The final machining

operation is for 30, 0.250” diameter holes and slots on the edge and tolerances for those are +0.0002/-0.00”. These holes are for tooling balls used to maintain a profile of the mirror surface during polishing.

At Axsys, each segment requires almost one year of processing which includes machine time, heat treatment, and inspection. Parts are inspected at each step of the process for dimensional accuracy and for residual stresses.

“Obviously the goal here was not speed, but accuracy,” says Walker. “Contributing to machine precision is the foundation we recommended built under each machine. When Axsys designed the new building to house mirror production, they included a concrete pad under every machine at 39” thick. Each pad is surrounded by a bed of sand to isolate the machine from any vibration generated by neighboring equipment. Each machine is anchored to its pad using 27 anchor plates with four anchor bolts per plate for a total of 108 bolts.”

For more information, contact Mitsui Seiki, Franklin Lakes, New Jersey, 201-337-1300.

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Photo captions:

Reverse side machining: Machining begins when a 540 lb beryllium billet is fixtured vertically onto an angle plate on one of the eight Mitsui machines. The six-sided billet is 4” thick, 54” across, and 62” from point to point. The backside of each mirror segment has 600 pockets, about 2.5” square each. There are also 22 mounting pads and 249 light-weighting holes. Producing the pockets, pads and holes takes about two months to complete.

Mirror side machining: The 6.5 m mirror, one of the most important aspects of the JWST, is comprised of 18 beryllium segments. Each one is about 1.5 m across. It’s the largest lightweight beryllium optic that has ever been made. After a thorough selection process, the company chose Mitsui Seiki USA Inc. (Franklin Lakes, NJ) to supply the manufacturing technology to machine the segments. The horizontal machining centers Mitsui custom-built to produce the JWST mirror segments combine a massive structure – the column weighs 11 tons, the bed is 20 tons -- with the ability to position to within a few microns anywhere in the machining envelope.