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LIGO gives makeover to Livingston landscape, image

By ALICE DOWTY

LIVINGSTON — Fabrication of 5 miles of steel tube to hold laser beams in a vacuum may begin north of Denham Springs this summer, said Fred Asiri, construction manager for the Laser Interferometer Gravitational Wave Observatory, LIGO.

The 80,000 square foot metal building now going up near the intersection of La. 1019 and La. 64 will house a unique $1 million steel mill. The steel will arrive in giant rolls and leave as spiral tube 4 feet in diameter.

The building will be 800 feet long to accommodate the mill and the 65 foot sections of tube produced through the mill. A total of 5 miles of pipe will be fabricated and sent to the LIGO site in the woods north of U.S. 190 between La. 449 and La. 63. The site is remote and quiet, undisturbed by vibrations that could ruin the record breaking measurements the facility is designed to make, said Caltech site manager Gerry Stapfer.

The first objective at the LIGO facilities, the one here and the other 2,000 miles away in Washington State, will be to demonstrate the existence of gravitational waves, infinitesimal ripples resulting from the asymmetrical warping of space and time. Having two facilities allows physicists to verify that findings are not the result of local disturbances.

The basic facility consists of a three story building between "L" shaped arms, each arm being a 2.5 mile vacuum tube made of the special steel.

The two installations will cost the federal government about $300 million, but LIGO physicists say information about gravity waves is beyond price. LIGO will give physicists new information about the universe, about black holes, regions of gravity so strong that even light cannot escape. LIGO is a new eye on the universe, an eye that is able to view phenomena based on bulk motions of matter, said LIGO physicist Frederick J. Raab.

Information carried by light can be distorted by stars and cosmic debris, but gravity waves are distortions of time and space and they pass through matter.

Physicists say that when a gravity wave (sufficiently large) passes through the installation, the distance between LIGO's suspended masses (two and a half miles apart) will change, but the distance between two pairs of perpendicular test weights will only change about one-thousandth of the diameter of an atomic nucleus.

It is this infinitesimal compressing and stretching of matter as gravity waves pass through it that LIGO will attempt to measure. Raab said it helps to visualize the test weights as glued to a rubber sheet. If the sheet stretches in one direction, moving the weights apart, it will shrink in the other. The movement will be measured by a laser beam. Half the laser beam

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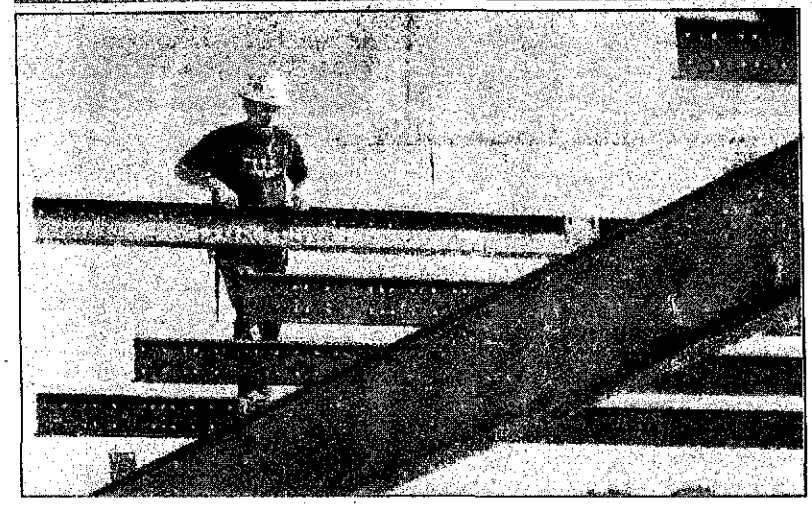

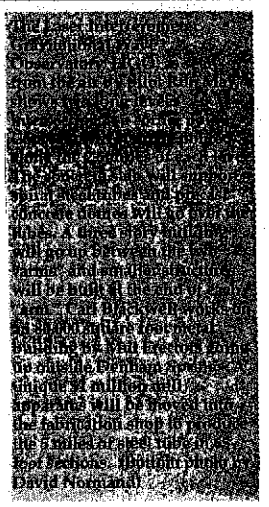

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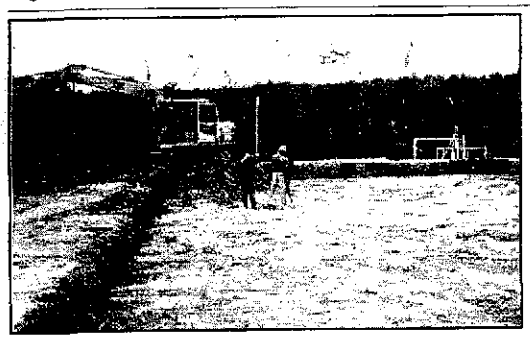

The above photos showing progress at the LIGO project's Livingston site appear on the internet page. Seen here are site preparation and road preparation work in the rural area north of Livingston.

LIGO

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travels down each 2.5 mile arm of the "L." In the absence of a gravity wave, the beam comes together perfectly and no light falls on the photodetector.

A huge gravitational wave might be 1 billionth the diameter of an atom or one-ten thousandth the size of a proton. No previous measurement has come close, said Dr. Barry Barish, who leads LIGO's team of scientists and engineers from Caltech and MIT.

Such a mind boggling measurement can be thrown off by disturbances at the molecular level, so the steel used in both the 2.5 mile "arms" has to be manufactured in a such a way as to cut down on the absorption of hydrogen gas. Typically, stainless steel absorbs hydrogen gas during the manufacturing process, but this is unacceptable for LIGO because ordinary stainless steel would leak hydrogen into the vacuum, said Asiri.

Physicists working with particle accelerators have somewhat the same problem, but compared with LIGO, every existing ultra vacuum is relatively small. The steel used for the 4 foot diameter LIGO pipes goes through a new process, involving two elaborate bake cycles prior to fabrication, to purge the steel of its hydrogen, Stapfer said.

The new mill was manufactured for Chicago Bridge and Iron in Haywood, California by the Pacific Roller Die Company. It will use huge rolls of low carbon steel 8 inches thick, manufactured by Armco in Kentucky, said Ed Jasnow, who handles LIGO's construction contracts.

Creating the huge vacuum involves several steps. One step is running an electric current through the tubes to bring the internal temperature up to 150 degrees and get rid of the water vapor. Liquid nitrogen pumps, placed every 250 meters along the pipeline, will pump for about 30 days to create the vacuum inside the 5 miles of pipe. Once the vacuum is created, it will be maintained by ion pumps located at each end and the midpoint.

The pipe produced north of Denham Springs next to Magnolia Beach truck stop by Chicago Bridge and Iron will be cut into 65 foot sections for transport to the LIGO site. The steel tubes will be installed on a 14 foot wide cement foundation, soon to be poured over a berm, or levee, above the 500 year floodplain.

The Woodrow Wilson firm in Baton Rouge won the concrete slab work with a bid of about $7 million, Jasnow said. Woodrow Wilson will pour the 5 mile long, L-shaped concrete slab over the levee. The L-shaped slab, which will support the steel vacuum tubes, will be 14 feet wide and 8 inches thick. The steel arms will be protected on top by 2,600 precast concrete enclosures, each 10 feet long and 6 inches thick.

Special welding techniques will be used on site to join the sections and expansion joints, Stapfer said.

Hensel Phelps won the $15 million contract to build the LIGO structures on 30 inch concrete slabs, Jasnow said. The three story building at the junction of the two arms will be 57,000 square feet with high bays and laboratories. The other two buildings are both 8,000 square feet, according to project officials.

Once the installation is complete, the physicists will begin the process of creating the world's largest vacuum.

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Test weights will hang inside large vacuum vessels located in the corner building and also in the buildings at the far end of each arm. The weights should be as far away from one another as possible, because the masses' motion is proportional to their separation, but practical difficulties increase as the facility expands. Even the Earth's curvature presents problems, Raab said.

Construction of the LIGO installation in Washington State near Hanford is about 9 months ahead of the installation here, principally because of Louisiana's rainy climate, Stapfer said.

The $1 million steel mill, constructed just for the LIGO project, is now at Hanford turning low carbon stainless steel into the spiral tube.

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