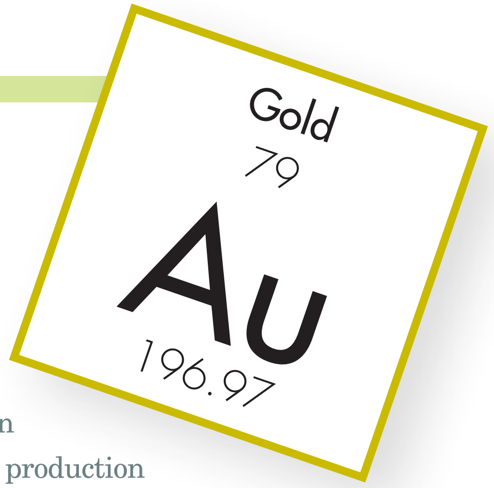
10 Insights from LIGO Insiders

LIGO (the Laser Interferometer Gravitational-wave Observatory) had quite a year in 2017. On August 17, scientists for the first time detected both the ripples in space and time known as gravitational waves as well as the light produced and emitted during the same cosmic event: the collision of two neutron stars. They did so using LIGO, the Europe-based Virgo detector, and approximately 70 ground- and space-based observatories.

But there was more. Over the year, LIGO made a total of four gravitational-wave detections and garnered a Nobel Prize for Caltech's Kip Thorne (BS '62) and Barry Barish, along with MIT's Rainer Weiss, for their "decisive contributions to the LIGO detector and the observation of gravitational waves."

Caltech magazine asked the scientists, engineers, and staffers on the LIGO front lines—at Caltech and at the observatories in Hanford, Washington, and Livingston, Louisiana—to look back at the year and at what the project has taught them. Here is what they had to say.



1 The birth of heavy metals

We learned that binary neutron star mergers are an important source of matter production in the galaxy. If you ask where the gold in your jewelry was made, the most likely answer seems to be a binary neutron star merger in the distant past. LIGO helped us observe this process in detail for the first time.

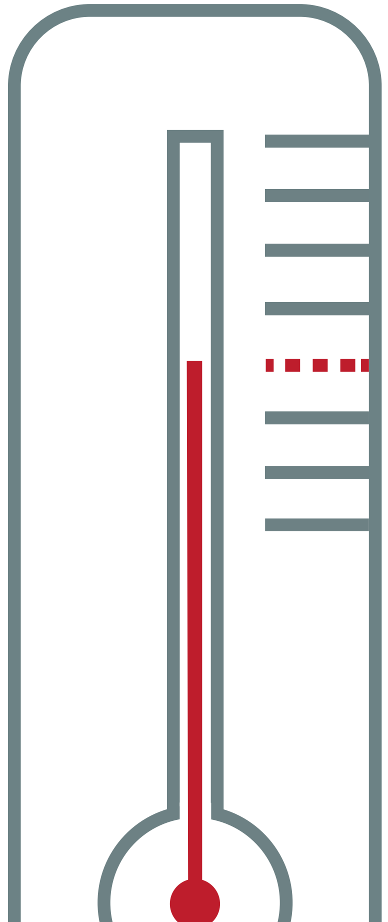
Jonah Kanner
Scientific Data Application Developer,
LIGO Caltech

2 It bends!

I was surprised that a mirror coating could bend a 40-kilogram piece of glass. The way LIGO mirror coatings are deposited means that this 6-micrometer-thick layer produces enough force to bend our 200-millimeter-thick optic! The mirror deforms by less than 10 nanometers, but the fact that it changed at all was a surprise.

Garilynn Billingsley
Senior Optical Engineer,
Advanced LIGO

3 One degree can throw everything off



The LIGO facilities and the maintenance performed there are critical to the quality of the scientific observations. This is especially true regarding temperature control. We are tasked with maintaining a 68°F temperature throughout the space year-round and, in south Louisiana, this is quite a challenge. Still, we are able to stay within half a degree of that target 24/7. Maintenance and temperature control were important in my previous job, but here at LIGO, a one-degree rise in temperature can mean hours of lost observation.

Tim Nelson
Facilities Team Lead,
LIGO Livingston

4 It takes a village

One person can make a difference and every role is important no matter how small. Whether you are a physicist, engineer, accountant, or custodian, your role within LIGO is just as important as the next guy's. We climbed to Nobel status as a team, and there is nothing that any and all team members wouldn't do to ensure that LIGO is successful in its mission to measure gravitational waves.

Nichole Washington
Property and Logistics Manager,
LIGO Caltech

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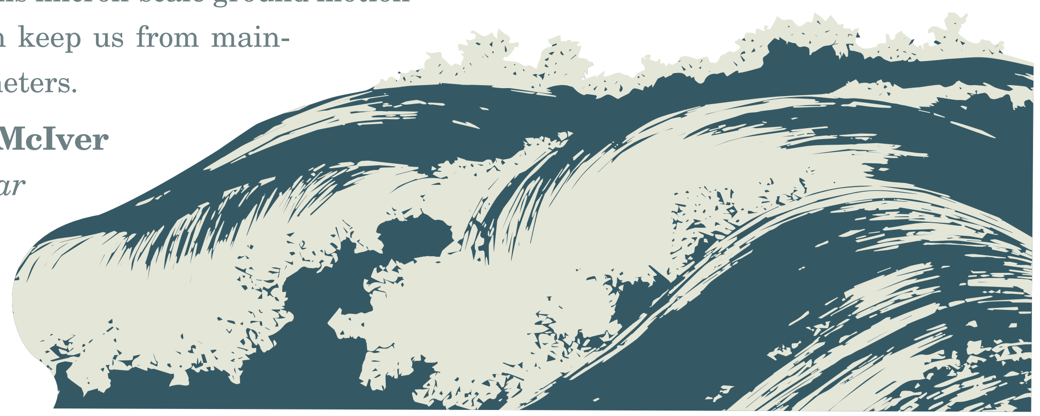
Coastal weather shakes things up

I learned from working on the LIGO experiment that ocean waves beating on the shore induce ground motion with different characteristic frequencies depending on the body of water. We can see these "microseismic" ground motions with seismometers at the LIGO sites. For example, when the waves are high, it's easy to tell from the frequency peaks in the LIGO-Livingston detector's seismometers whether the sea winds are driving inland toward the site from the Gulf of Mexico, or the Atlantic Ocean, or both. In bad coastal weather, this micron-scale ground motion shakes the instruments around and can keep us from maintaining light resonance in the interferometers.

Jess McIver
Postdoctoral Scholar in Experimental Physics, LIGO Caltech



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It's personal

I worked on the output optical system of the Advanced LIGO detectors. When I heard about the first detection, I realized that the gravitational wave, imprinted on the laser beam, had passed through my equipment as it was converted into an electrical signal. I felt a strong sensation of accomplishment when I thought about it.

Koji Arai
Senior Scientist, LIGO Caltech

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LIGO and Virgo are *super* accurate

The biggest surprise for me was LIGO's detection, with Virgo, of gravitational waves from a binary neutron star merger. It is astounding to me that LIGO and Virgo could so accurately give the sky position and distance to the first-ever detection of gravitational waves from colliding neutron stars, and when the telescopes looked, they found the optical counterpart in the region we told them to search!

Greg Mendell
Senior Scientist, LIGO Hanford

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Orders of magnitude

I enjoy seeing an experimental technique I am using being exploited for precision measurements in another field. That wouldn't have been possible without LIGO. When I heard that the suspension team had reduced the effects of Earth's vibration by 10 orders of magnitude, that was another "wow" moment.

Brittany Kamai
Postdoctoral Scholar in Physics, LIGO Caltech

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It works!

LIGO is made up of many, many thousands of pieces. When you start to think about how many of these can and do go wrong, it is testimony to the team that not only does it work but that it can also detect!

Calum Torrie
Senior Systems Engineer, LIGO Caltech

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Waves of wonders

The universe is full of nice surprises. I'm sure that no one would have predicted that the first gravitational-wave detection would happen the day we turned on the Advanced LIGO detectors, or that the signal from the first black hole merger would be large enough to see in the raw data. Not to mention that the first detection of two neutron stars colliding with each other would also be captured by astronomers here at Caltech and around the world. The universe, it seems, wants to tell its story in gravitational waves. I can't wait for the next chapter!

Dave Reitze
Executive Director, LIGO Project