71 institutions spent a total of $23 million in the year after the reforms took effect, although their costs going forward may be lower.

Paul Thacker, who led the 2008 Senate investigation as a member of Grassley's staff, admits that it is difficult to know how well the reforms are working. That is largely because the potential benefits of greater disclosure of financial ties, such as peer reviewers giving closer scrutiny to studies by researchers with conflicts, are tough to measure.

Still, Thacker says, there is a clear need for closer scrutiny. This is backed up by evidence showing that studies funded by private sources, such as drug firms, more often produce results that benefit the funder than do publicly funded studies (A. Lundh *et al. Cochrane Database Syst. Rev.* **12,** MR000033; 2012). And Thacker has little sympathy for universities' complaints. "It just shows that they still don't get what the problem is," he says. "They're in this place today because they've failed to create confidence for the public in the past."

Others worry that the HHS policy is still not strict enough. Krimsky says that the current rules may give institutions too much power to assess conflicts, without accounting for ways that universities themselves can be compromised by ties to government or industry. This could be one reason why the HHS reforms did not significantly increase the number of reported conflicts, Krimsky adds.

Those pushing for greater transparency are also frustrated that the NIH does not require institutions to publish information about researchers' conflicts and management plans online. Instead, members of the public must ask a university for information on a researcher's conflicts; the institution has five days to disclose dollar amounts and sources. Nonetheless, the NIH Office of Extramural Research says that about 50% of institutions that submit conflict-of-interest reports have voluntarily created online databases, although these vary in usability and completeness.

Requesting such information from universities directly also produces mixed results. *Nature* contacted 20 public and private institutions that had reported individual researchers with conflicts of interest involving more than $1 million, seeking details on these relationships. The majority of these institutions responded immediately, but some took as long as two weeks to respond, directed *Nature*'s reporter to the media office, or instructed her to submit a freedom-of-information request. Most declined to share information about conflicts that occurred before the current calendar year, which is not required by the HHS.

"We are still at the mercy of what's disclosed to us."

Nor does the department require the release of management plans, which troubles Tobin Smith, vice-president for policy at the Association of American Universities in Washington DC. "If you disclose that there is a conflict but don't disclose how the university is managing it — which is not part of the regulations — the public doesn't understand the relationship," he says.

The NIH also struggles to defend its own regulations. "One could debate whether or not we needed to promulgate a new rule," says Sally Rockey, director of the NIH Office of Extramural Research. "At the time, there was a lot of scrutiny in the press and Congress got involved." She concedes that the reforms were mostly in response to this outside pressure. (Grassley declined to comment on the regulations.)

And it is unclear whether the revised regulations would have identified Nemeroff, who did not tell Emory about his industry relationships. "Science and research are built on trust, and we are still at the mercy of what's disclosed to us," says Eric Mah, senior director of research compliance at the University of California, San Francisco.

The NIH plans to review the conflict-of-interest reforms later this year, to develop best practices for compliance. The agency will examine data on the type and number of reported conflicts, as well as institutions' experiences of complying with the requirements. But Rockey says that the HHS is unlikely to make significant changes to the rules, given that they took four years to develop.

In the meantime, research institutions are caught in a bind. The 1980 law that allows US universities to patent inventions encourages relationships with industry, and tight federal research budgets are driving more scientists to seek support from private funders. "There are no easy answers," Thacker says. "Universities are being pushed into greater reliance on industry funding and until that reverses, these problems just become more and more complicated." ■

PHYSICS

Hunt for cosmic waves to resume

Upgraded LIGO detectors will improve chances of finding ripples in space-time.

BY DAVIDE CASTELVECCHI

Almost 100 years after Einstein presented the general theory of relativity in a Berlin lecture theatre, the quest to spot the gravitational waves he predicted may be entering its final stages.

This week, the world's largest gravitational-wave facility is expected to start collecting data again after a 5-year US$200-million overhaul. The Laser Interferometer Gravitational-Wave Observatory (LIGO) searched fruitlessly for these cosmic ripples for almost a decade in the 2000s. But the odds that its improved version — known as Advanced LIGO — will detect any waves in the next three months may be as high as one in three, according to some of the physicists involved in the experiments.

Initial tests have shown that the observatory's twin detectors, in Washington state and Louisiana, are performing as expected, says Gabriela González, spokesperson for the 900-strong LIGO Scientific Collaboration. And that is no mean feat for an instrument that has cost $620 million so far. "It's the first time that anything in this field is on budget and on schedule," says Karsten Danzmann, director of the Max Planck Institute for Gravitational Physics, in Hannover, Germany, who is not part of the LIGO management team.

According to general relativity, gravitation originates from the interplay between massive objects and the malleable fabric of space-time. Einstein predicted that accelerating masses such as colliding neutron stars or black holes would disturb that fabric and produce gravitational ripples that propagate through the Universe.

Each of LIGO's detectors is designed to measure the deformation of space-time by comparing changes in the paths of laser beams that race down its two perpendicular 4-kilometre-long arms, bounce between mirrors and interfere with each other back at their source. When a gravitational wave passes through, it slightly alters the lengths of the arms, and the observatory can spot such changes with a sensitivity of one part in 10^{22}. That is comparable to a hair's-width change in the distance from the Sun to Alpha Centauri, its nearest star, says Laura Cadonati, a physicist at the Georgia Institute of Technology in Atlanta who will be coordinating the experiment's data analysis.

A crucial part of the improvement is better damping of the vibrations caused by ▶

less-than-heavenly sources. The problem was especially acute at the site in Livingston, Louisiana, which is in the middle of a timber plantation. Any felling of trees would disturb the detector, so it could keep its laser beams 'in lock' — vibrating at precise frequencies — only at night or on weekends. A passing train would knock the site out for an hour, says physicist Brian O'Reilly, who will coordinate the follow-up of detections at the Livingston site. But now, he says, the detector should be able to take data over several days at a time without interruption.

Advanced LIGO is already three times more sensitive than its predecessor, but in three months' time it will shut down for more improvements that will make it ten times more sensitive. When it reopens around 9 months later, it should be able to spot cosmic ripples from cataclysmic events — such as the collisions of black holes — up to 120 megaparsecs (326 million light years) away on a regular basis and sample a volume of space 1,000 times greater than the original observatory.

Next year, LIGO will be joined by a slightly smaller €200-million (US$226-million) Franco-Italian detector near Pisa, Italy, called Advanced Virgo, which is undergoing its own upgrade. The LIGO and Virgo teams will pool their data to check each other's detections. They expect to see waves from mergers of binary neutron stars — events that should generate strong, predictable signals — but do not know precisely how many to anticipate. "It could be, depending on the models, ten binary neutron star detections a year or so," González says. "But it could be 10 times higher or 100 times lower."

"The first detections will be quite dramatic for us," says Rainer Weiss, a theoretical physicist at the Massachusetts Institute of Technology in Cambridge who was one of LIGO's founders. "The first thing we will need to sort out is whether we truly believe what we are seeing."

Having detectors on different continents is crucial for providing a rough estimate of the origin of the waves, says Fulvio Ricci, a physicist at the Sapienza University of Rome and the spokesperson for Virgo. Once they know that, astronomers will be able to look for other signs of that event using electromagnetic radiation, such as X-rays or visible light.

Einstein published his first papers on gravitational waves in 1916. Detecting these ripples a century later, Weiss says, would be of "enormous symbolic importance". ■

A meteor (upper left) streaks through the Orion constellation during the Perseid shower.

BABAK TAFRESHI/NATIONAL GEOGRAPHIC CREATIVE

ASTRONOMY

Dates added to meteor calendar

Skywatching cameras spot 86 previously unknown events.

BY ALEXANDRA WITZE

The list of meteor showers that occur every year has just grown longer. Eighty-six previously unknown showers have now joined the regular spectaculars, which include the Perseids, Leonids and Geminids. Astronomers spotted the shooting-star shows using a network of video cameras designed to watch for burglars, but repurposed to spy cosmic debris burning up in Earth's atmosphere.

The newfound showers are faint but important: each is fuelled by Earth's passage through a trail of particles left behind by a comet or asteroid, so mapping them reveals previously unknown sources of dust.

"The cool thing is, we are not just doing surveillance of meteors in the night sky," says Peter Jenniskens, an astronomer at the

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