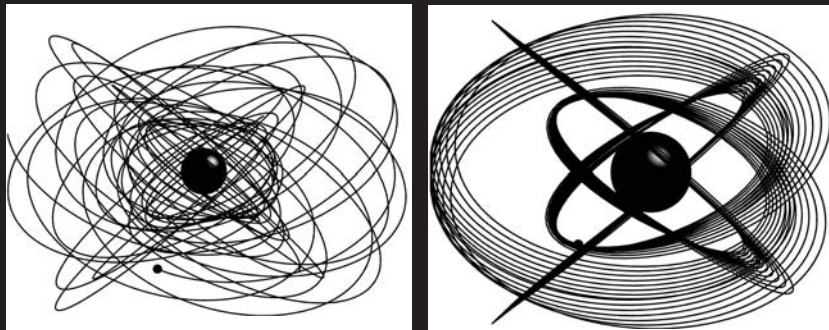




A small black hole spirals into a massive black hole in this simulation. At left, the frequencies in each of the three degrees of freedom are independent. At right two of the frequencies have transiently become harmonics of each other. Such resonances are also obvious in the sonification of the gravitational waves created by the inspiraling; a movie simulation including sonification is available at <http://www.tapir.caltech.edu/~sdrasco/animations>.

better way to represent data for exploration of large amounts of data when you don't know exactly what you are looking for—comparing things, noticing patterns, making correlations." Sifting through large data sets—for example, from planets and stars, particle physics events, ocean samples, DNA—requires making sense of a "huge amount of information all at once," she says. "With Mars data, time of day, place in orbit, height in the atmosphere, aerosol loading of the atmosphere, how cloudy or dusty it is are just a few of the changing variables that come into play," says Snook, who recently became studio manager and engineer for singer-songwriter Imogen Heap in London. "I think you can saturate your visual space."

For centuries of science publications, "all we had was print," notes Snook. "We should take advantage of what has opened up to us through the internet and our ability to compute things quickly." A step in that direction is the use of Scalable Vector Graphics (SVG) in online publishing. The American Physical Society, for example, is exploring SVG thanks largely to John Gardner, a physicist who retired from Oregon State University after becoming blind. Physicists want SVG "because it makes the original data accessible," says Gardner. The format also means that data would be available for sonification. Gardner says he became frustrated when he couldn't see the graphs his students made. He went on to found ViewPlus, a company that makes technologies to aid the visually impaired (see *PHYSICS TODAY*, February 2012, page 24).

"We are just beginning to develop sonic paradigms equivalent to the visual ones that we have developed for hun-

dreds of years. The sonic representations have not yet been exploited even at the basic level," says Snook. "If you hit on the right manipulations to take advantage of the different senses, you have a broader space for optimization of data analysis. In real life we use both our eyes and ears. It's not one versus the other."

Sound does have pitfalls. Among them, says Snook, is that sound can be "annoying. People are forced to impose their own musical taste and ideas subjectively on data." Sound is also fleeting, it can be hard to describe, and with no printout, it can be difficult to show results to others. Listening can require training, and it can take longer than looking, although that depends on the data. The type of data also needs to be taken into account. Says Walker, "It is hard to represent a spatial arrangement with sound. You need to use the appropriate display."

"Wobble like a drum"

In a TED talk in March 2011, Columbia University theoretical astrophysicist Janna Levin said, "I'd like to convince you that the universe has a soundtrack and that soundtrack is played on space itself, because space can wobble like a drum. . . . And while we've never heard the sounds from space, we really should." In an interview, Levin pointed out that those sounds, like images from the *Hubble Space Telescope*, are "communications tools."

As a communications tool, sound is already proving itself. Ballora, for example, is working with physics Nobel laureate George Smoot and former Grateful Dead drummer Mickey Hart on *Rhythms of the Universe*, a multimedia presentation that opens later this year in science museums. The idea, says

Ballora, "is to get kids tapping their feet to the cosmic microwave background, helioseismology, the spectra of supernovae, solar winds. . . . I have been making sounds out of astronomical data sets and it's been a blast." An audience's eyes "will glaze over if you talk about Fourier transforms," says Cornish. "Rather than explain what a spectrogram is, if you play sound, they get a sense of the information encoded in the signals. Our brains have evolved to understand. It's very powerful to explain things to the public, and even to other scientists."

While working on her PhD in experimental particle physics at University College London, Lily Asquith was inspired by conversations with musician friends to sonify data from the Large Hadron Collider. The result, LHCsound (<http://lhcsound.hep.ucl.ac.uk>), launched in 2010, represents real and simulated data using synthesizers and compositional software. "Nothing we have done so far could be used in analysis," says Asquith, now a postdoc at Argonne National Laboratory. "I do think it could bring insight, but that's a long way off."

"I do physics because I want to know what the universe is made of," says Asquith. The LHCsound project "is putting me in touch with people who share this enthusiasm. Anything that shows what is happening at the LHC and is enjoyable and feeds back into art is also good for science. And everyone enjoys hearing and looking at beautiful things."

Toni Feder

Fostering a research "ecosystem"

Universities and DOE labs are in solidarity about support for research.

Facing a bleak budget picture, US research universities and national laboratories are for the first time forming joint delegations to lobby key lawmakers as they consider funding bills for fiscal year 2013. The teaming strategy emerged from a mid-March meeting between senior research officials from 45 of the 61 members of the Association of American Universities and the directors or deputy directors of four national labs.

"All of us share the concern for federal funding for science, for maintaining this ecosystem for basic research across

the mission-driven research of the labs and into partnering with industry," says Ann Arvin, vice provost and dean of research at Stanford University. Although Stanford has a close relationship with SLAC, which it operates for the Department of Energy, researchers from many institutions experiment at SLAC's two x-ray sources. The circumstances are similar for the other universities that manage DOE labs, including the University of Chicago, which runs Argonne National Laboratory, and the University of California, which operates Lawrence Berkeley National Laboratory. Both ANL and LBNL offer light sources and nanoscience centers to university researchers. Universities have partnered with DOE labs in the formation of dozens of energy frontier research centers and energy innovation hubs.

"Both the universities and laboratories have essential parts to play, and each one needs the other," notes Michael Witherell, vice chancellor of research at the University of California, Santa Barbara. "The labs provide the large facilities that thousands of university researchers use; the universities provide graduate students, undergraduate students, and a lot of scientific manpower that cannot be [found] just in the laboratories." Witherell, a former director of Fermilab, says many members of Congress don't know that DOE's Office of Science funds and administers DOE's basic science labs. Lawmakers on key committees who do become familiar with the office's role are routinely replaced by a new crop of members who need to be brought up to speed.

Persis Drell, director of SLAC, recounts that when she and three other DOE lab directors visited congressional offices last spring, "we were having to educate them from ground zero that, for example, the DOE supported basic research. They weren't even aware of that." Such visits, notes Witherell, also help "dispel the notion that somehow what's going on [in the Office of Science] is duplicating something somewhere else in government."

Eric Isaacs, ANL director, describes the "prisoners' dilemma" that the labs and universities face. "Either side could go off alone and compete with each other and end up losing everything, or we could go in together, maybe get a little less for the total, but in the end do a better job for US science." With the exception of the universities that run labs, Isaacs notes, historically "there hasn't been tremendous support by universities for the labs." But now, he says, "It's a zero-sum game at some level for all of

Professional Tools for Motion



Kurt J. Lesker
Company

www.lesker.com

Kurt J. Lesker Company
United States
412.387.9200
800.245.1656
salesus@lesker.com

Kurt J. Lesker Canada Inc.
Canada
416.588.2610
800.465.2476
salescan@lesker.com

Kurt J. Lesker Company Ltd.
Europe
+44 (0) 1424 458100
saleseu@lesker.com

Kurt Lesker (Shanghai) Trading Company
科特·莱斯科(上海)商贸有限公司
Asia
+86 21 50115900
saleschina@lesker.com

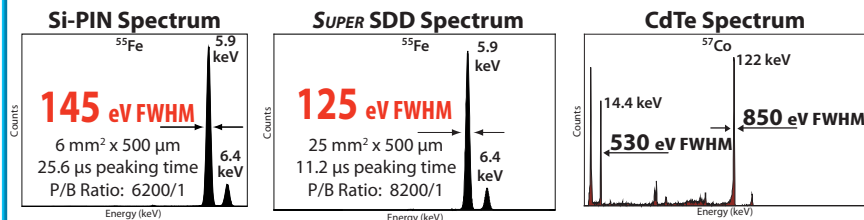


12-004

X-Ray and Gamma Ray Detectors

- Solid State Design
- Easy to Use
- USB Controlled
- Low Cost

Your choice of detector



Your choice of configuration

X-Ray Spectrometer



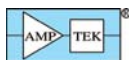
OEM Components



Experimenter's Kit



OEM's #1 Choice for XRF



AMPTEK Inc. sales@amptek.com

APPLICATIONS

- Fluorescence
- OEM
- Process Control
- Lead Detectors
- RoHS/WEEE Compliance
- Environmental Monitors
- Nuclear Medicine
- Teaching and R&D
- Art & Archaeology
- Portable Instruments
- X-Ray Tube Beam Monitor
- Semiconductor Processing
- Nuclear Plant Monitors
- Vacuum Applications
- Plastic & Metal Separation
- Sulfur in Oil & Coal Detection
- Nuclear Safeguards Verification
- Space & Astronomy

www.amptek.com

us. As the budgets get tight, flat, or worse, we feel there's a much better chance of the two of us going through this together, promoting science for the nation in general."

Isaacs and Drell say they're hoping the new partnership with universities gets the reception they had when they, Oak Ridge National Laboratory director Thom Mason, and LBNL director Paul Alivisatos visited Capitol Hill as a

group in the spring of 2011. "We had a very crisp message of supporting the president's budget request and the president's priorities, and we just went around to any office we could get into and made the case for science," says Drell. "We were told by staffers that it was very effective, and they wanted us to do it again this year."

Still, institutions will continue to look out for their separate interests.

"Universities and laboratories will always get across the message to their local congressmen and senators about what they do, and we're not trying to suppress that," says Witherell. "What's new is a group that can talk about the whole university and lab complex together as an ecosystem for research in the physical sciences and engineering funded by the DOE."

David Kramer

Obama urges renewed efforts on arms control

Several nations are reported to have shed all their weapons-usable materials, but the president warns that the threat of nuclear terrorism remains.

Gathering with more than 50 other heads of state in Seoul, South Korea, in late March, President Obama pledged to negotiate further reductions to the US and Russian nuclear arsenals and trumpeted the progress made toward securing the world's vulnerable stocks of highly enriched uranium (HEU) and plutonium since the inaugural 2010 Nuclear Security Summit in Washington, DC.

"I firmly believe that we can ensure the security of the United States and our allies, maintain a strong deterrent against any threat, and still pursue further reductions in our nuclear arsenal," Obama said in a speech at Seoul's Hankuk University of Foreign Studies. "Going forward, we'll continue to seek discussions with Russia on a step we have never taken before—reducing not only our strategic nuclear warheads, but also tactical weapons and warheads in reserve." The New START treaty, which went into force last year, requires each of the two nuclear superpowers to reduce

its strategic stockpile to 1550 deployed weapons and 5000 warheads by 2018.

Obama touted progress made toward the goal he set at the 2010 summit: to secure all civilian inventories of HEU and plutonium by 2014. "South Korea, Japan, Pakistan, and others are building new centers to improve nuclear security and training," Obama said. "Nations like Kazakhstan have moved nuclear materials to more secure locations." Mexico and Ukraine just recently removed all the HEU from their territory, he said, noting that "all told, thousands of pounds of nuclear material have been removed from vulnerable sites around the world."

Nuclear quid pro quo

Among a slew of moves announced in March by the White House and the Department of Energy's National Nuclear Security Administration were the removal of more than 3 kg of plutonium from Sweden—a process that was four years in the making—and the shipment

to Russia of 128 kg of HEU from Ukraine, with assistance from the US. In addition, Belgium, the Netherlands, and France agreed to convert their reactors that produce the medical isotope molybdenum-99 to use low-enriched uranium by 2015 in exchange for a commitment from the US to continue supplying them with HEU until then. The European nations also agreed to "deal in a responsible manner with existing large amounts of scrap HEU resulting from past activities by recycling or disposing them, with the support of the United States and other partners," according to a statement issued jointly by the parties. And the US, Mexico, and Canada announced the removal of an unspecified quantity of HEU from a Mexican research reactor in exchange for a US supply of low-enriched material.

Obama pledged to seek Senate ratification of the Comprehensive Nuclear-Test-Ban Treaty and to propose further nuclear arms cuts when he meets with Russian president-elect Vladimir Putin this month. Obama also invited China to begin a dialog with the US on nuclear arms limits.

But despite the progress made in securing weapons materials, Obama acknowledged the continuing threat of nuclear terrorism. "We know that nuclear material, enough for many weapons, is still being stored without adequate protection. And we know that terrorists and criminal gangs are still trying to get their hands on it—as well as radioactive material for a dirty bomb. We know that just the smallest amount of plutonium—about the size of an apple—could kill hundreds of thousands and spark a global crisis," the president told the Seoul audience.

Diminished role for nukes

The US, Obama vowed, will not develop new nuclear warheads or pursue new military missions for nuclear weapons. "We've narrowed the range



A technician inspects containers of highly enriched uranium aboard a US Air Force cargo plane during an operation to transport the material from a Mexican research reactor to storage at Oak Ridge, Tennessee.