SLAC National Accelerator Laboratory
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slac.stanford.edu

Bold People. Visionary Science. Real Impact.

The 426-acre campus of SLAC National Accelerator Laboratory is located in Silicon Valley, 30 miles southeast of San Francisco, Calif., on the Stanford University campus.

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SLAC NATIONAL ACCELERATOR LABORATORY

Stanford University

U.S. DEPARTMENT OF ENERGY

BOLD PEOPLE VISIONARY SCIENCE REAL IMPACT

SLAC NATIONAL ACCELERATOR LABORATORY

OUR MISSION

We explore how the universe works at the biggest, smallest and fastest scales and invent powerful tools used by scientists around the globe. Our research helps solve real-world problems and advances the interests of the nation.

OUR VISION

We open new windows to the natural world and build a brighter future through scientific discovery.

OUR VALUES

EXCELLENCE

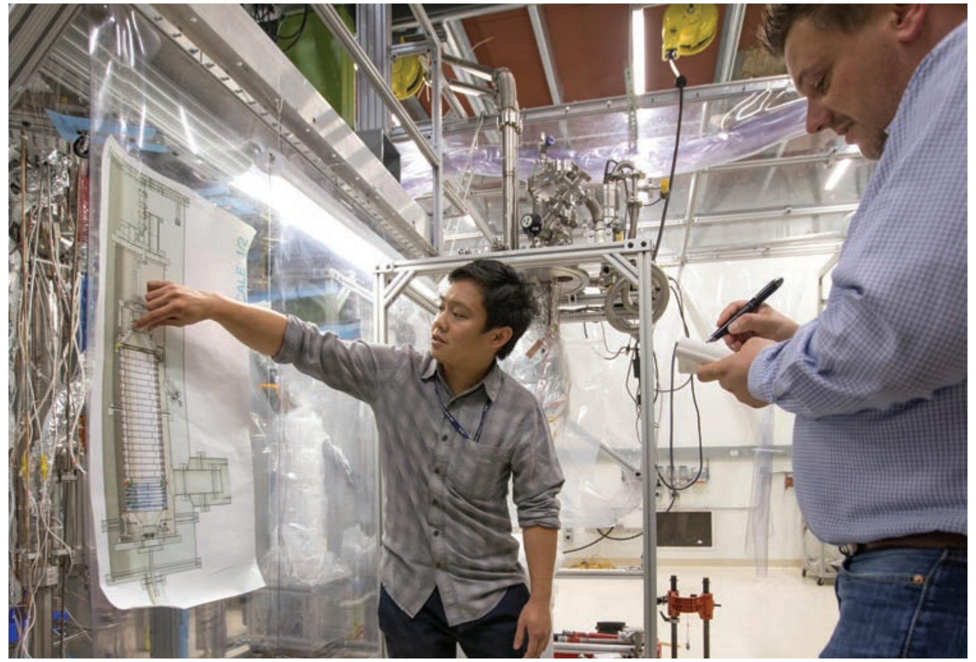
We hold ourselves to the highest standards, continually looking for ways to improve our work, advance our skills and make the best use of our experience and talent.

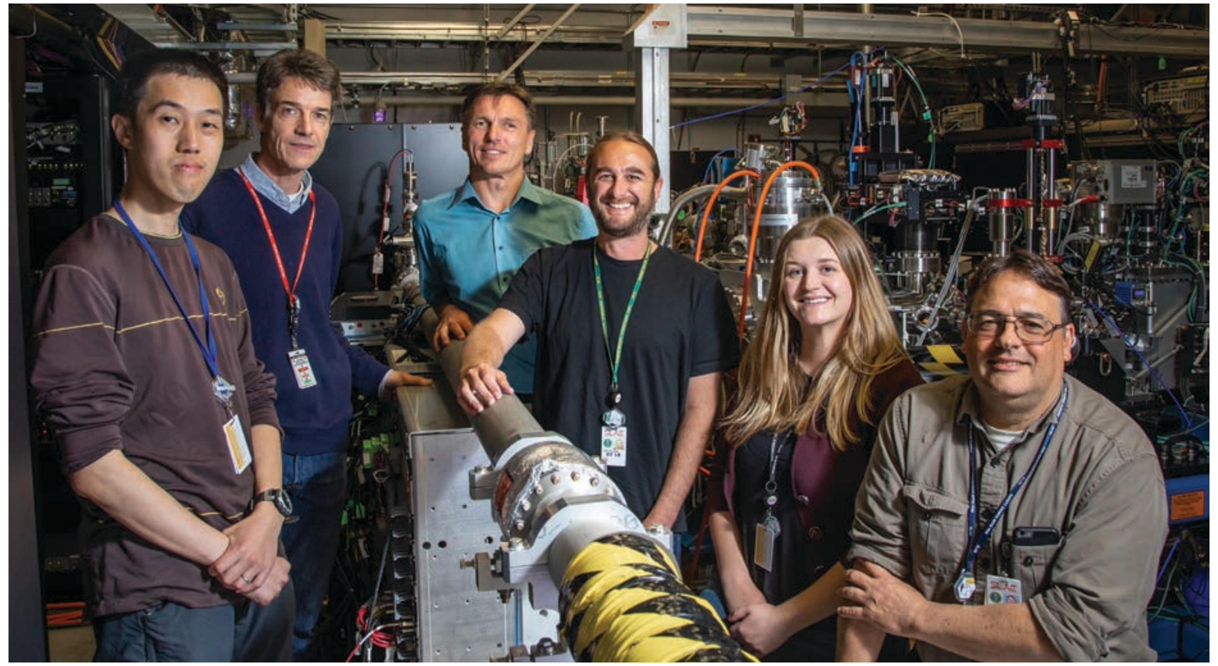
We achieve outstanding results without compromising safety, security or the environment.

INTEGRITY

We are accountable for our actions and for the culture of the lab.

We are honest and transparent in our conduct, communication and research practices.





CREATIVITY

We explore radically new ideas with courage and confidence.

We bring an optimistic and entrepreneurial spirit to our work.

COLLABORATION

We are committed to the collective success of SLAC and its user community.

We celebrate our individual strengths and talents while acknowledging that we achieve more by working with others.

RESPECT

We make everyone feel welcome and respected and encourage all to contribute.

We embrace individual differences and welcome the richness and value they bring to SLAC.

OUR STORY

In 1956, Stanford University physicists hatched a bold plan to build a 2-mile-long electron accelerator in the hills above the main campus. They called it "M" for monster, because it would be the biggest government-funded science project built to date. It would take particle physics to an exciting new level and lead to three Nobel prizes.

That linear accelerator is still the backbone of SLAC, feeding speedy electrons into the world's first-ever hard X-ray free-electron laser and into experiments that are developing smaller, cheaper particle accelerators for science, medicine and industry.

While SLAC's research has expanded in many directions since our founding in 1962, our guiding principle remains the same: We dream big, and our visionary ideas accelerate discovery not just here but around the world. We're known for leading large-scale science projects, and we welcome scientists to come use our X-rays, lasers and electron beams for groundbreaking experiments.

"we **dream big**, and our **visionary ideas** **accelerate** **discovery**"

OUR PEOPLE

To achieve our ambitious goals and keep SLAC a great place to work, the lab needs a creative, diverse and united workforce – people with a wide variety of experiences and ideas, skills and backgrounds. SLAC people are scientists, engineers and technicians; they are IT, finance, facilities and infrastructure experts; project managers and safety and security professionals; administrative, human relations and public relations specialists; and many others, all working together.

Our people give back to the local community through public outreach, events and service projects. SLAC employees volunteer as lab tour guides, give public lectures, talk to school kids about science, donate warm coats and school supplies, host professional workshops and mentor students and interns, inspiring and training the next generation.

> “a **creative, diverse** and **united** workforce”

“inspiring and training the **next generation**”

(Credit: Nathan Yan)

SLAC AT A GLANCE

Founded: **1962** with **200** employees

Site: **426** acres leased from Stanford

Staff: **1,500** employees
430 postdocs and grad students
and **66** faculty

2,700 scientists use our cutting-edge facilities each year

4 Nobel prizes awarded to **6** laureates for research conducted at SLAC

SLAC+DOE

SLAC is one of 17 Department of Energy (DOE) national laboratories that tackle the critical scientific challenges of our time. The most comprehensive research system of its kind in the world, DOE labs take a multidisciplinary approach to translating basic science into innovation.

Within DOE we are part of the Office of Science – the nation's biggest supporter of basic research in the physical sciences. A major part of the office's mission is supporting the development, construction and operation of unique, open-access scientific user facilities.

SLAC is home to three of those user facilities: the LCLS X-ray free-electron laser, SSRL synchrotron and FACET test facility for next-gen accelerator technologies.

SLAC is a multipurpose lab, and we are expanding our programs to address a wide range of scientific challenges within the DOE mission.

"translating **basic science** into **innovation**"

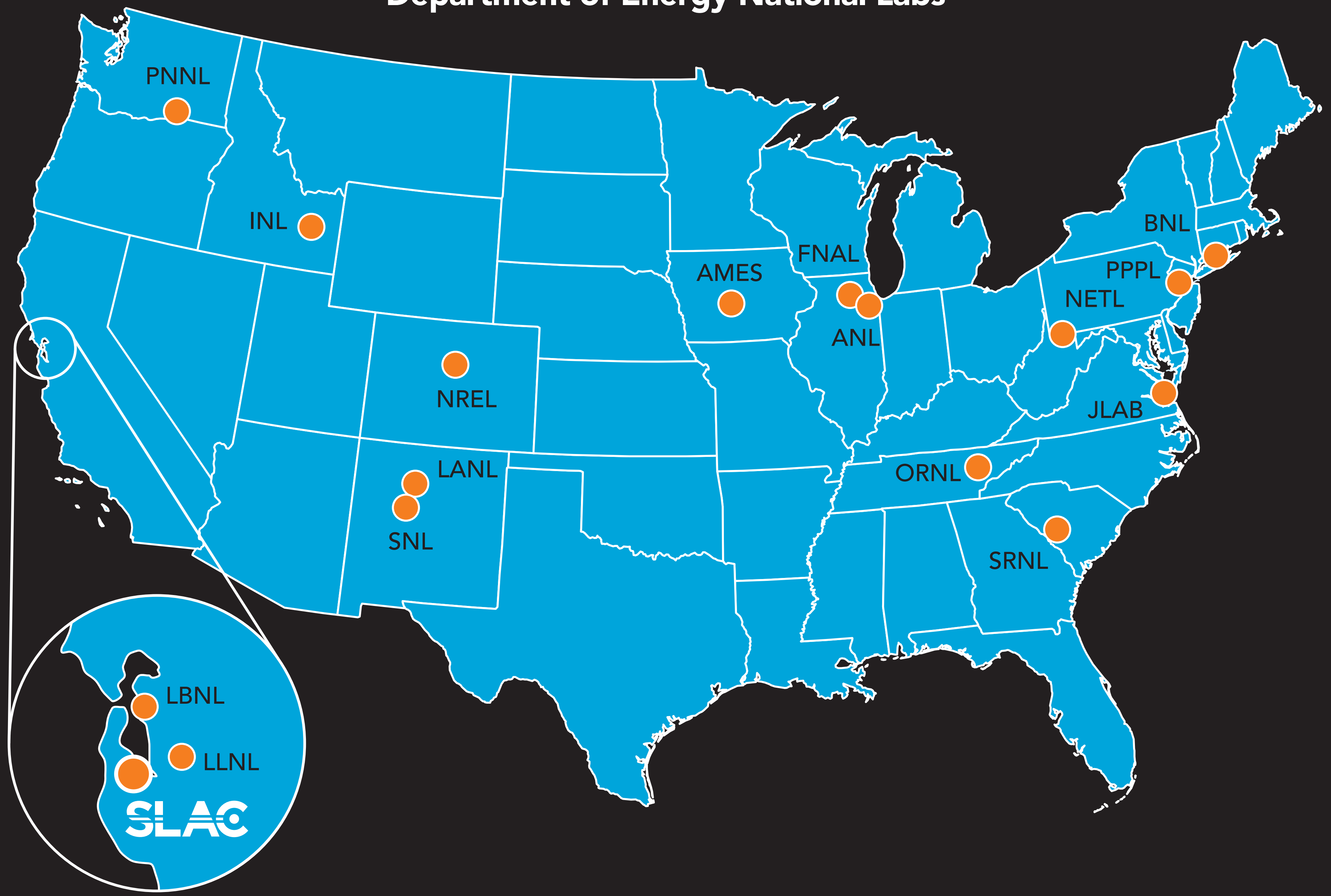
DOE mission:

Ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.

Office of Science mission:

Deliver discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic and national security of the U.S.

Department of Energy National Labs



SLAC+STANFORD

Stanford University operates SLAC for the DOE Office of Science. Our strong ties with Stanford go all the way back to the lab's founding. We sit on Stanford land, our people are Stanford employees and our faculty teach and mentor Stanford graduate students, helping to train the next generation. Our growing partnership with Stanford is crucial to carrying out our scientific vision.

SLAC and Stanford work together in joint research institutes and facilities that focus on cosmology and astrophysics, materials and energy sciences, catalysis, ultrafast science and cryogenic electron microscopy. **Our combined intellectual power fuels exciting collaborations** between scientists and engineers from a wide range of fields.

SLAC also plays a unique role for Stanford, which benefits from our deep expertise in key areas and from our ability to develop and run large-scale research facilities.

Stanford has made numerous investments in the lab and provides key services such as the SLACafé and the Stanford Guest House. This makes our operations more efficient and lowers the cost of running SLAC.

(Photo courtesy of HDR © 2017 Blake Marvin)

Stanford contributions:

- Arrillaga Science Center Building
- Kavli Building
- Stanford-SLAC Cryo-EM Facility*
- Stanford Research Computing Facility
- Stanford Guest House
- Arrillaga Recreation Center at SLAC
- Arrillaga Family Main Quad Renewal

** Partial Stanford funding*

SCIENCE AT SCALE

SLAC has always been known for building big, sophisticated machines for teasing out the secrets of the universe. Every new instrument and facility gives scientists new eyes on the world, spurring discoveries that spark new inventions in an endless cycle.

Today, SLAC's Stanford Synchrotron Radiation Lightsource (SSRL) welcomes more than 1,600 visiting scientists each year to use its X-ray beams for a wide variety of experiments.

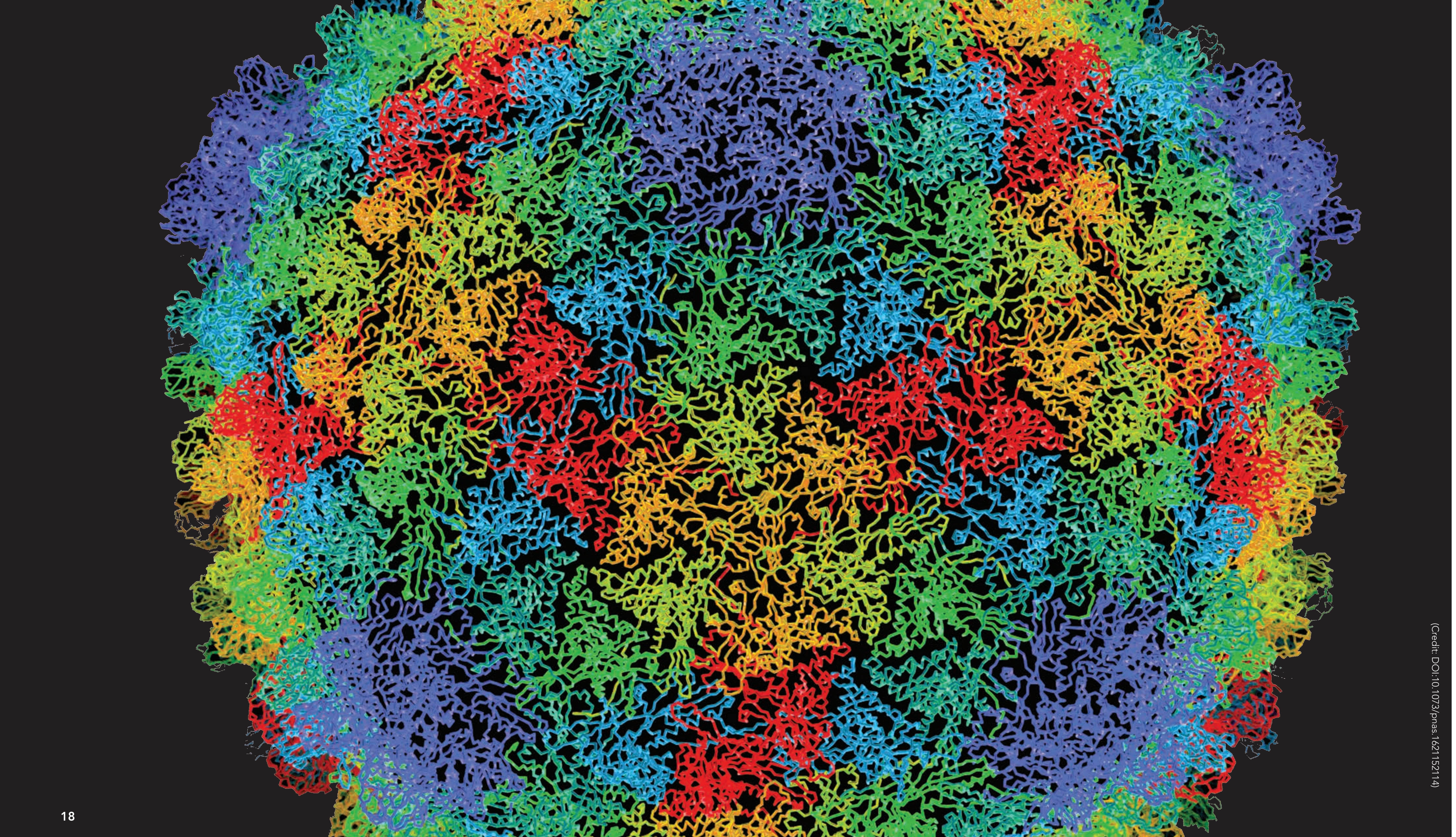
The Linac Coherent Light Source (LCLS), the first-ever hard X-ray free-electron laser, provides the brightest and shortest X-ray pulses ever made for studies that reveal the atomic world in unprecedented detail.

Ultrafast Electron Diffraction (UED), an ultrahigh-speed "electron camera," probes the interiors of sample materials and makes molecular movies of chemical reactions.

And a Stanford-SLAC facility for cryogenic electron microscopy, or cryo-EM, features a technique for imaging flash-frozen cells and the molecular machinery of life that earned three of its developers a 2017 Nobel Prize.

"every **new instrument** gives **scientists** new **eyes** on the **world**"

(Credit: Borin Taing)



(Credit: DOI:10.1073/pnas.1621152114)

SCIENCE WITH IMPACT

SLAC focuses on understanding the way nature and technology work at the largest, smallest and most fundamental levels and learning how to manipulate and control matter at the scale of atoms and electrons. Like all basic research, this lays the foundation for scientific advances and practical innovations.

Describing every single step of a chemical reaction helps make **industrial processes** greener and more efficient.

Revealing a protein's structure and function helps researchers develop vaccines and medications, promoting **human health**.

Tracking lithium ions through a battery is a step toward creating smaller, more capable batteries for a cleaner and more **sustainable energy** future.

Studying how a material's electrons behave is a critical step in advancing **electronics and computing**.

And probing the origins and nature of the universe, from subatomic particles to what happened after the Big Bang, expands **human knowledge**.

In addition to our own research, thousands of scientists come to SLAC each year to do experiments ranging from fundamental science to improving medications, computer chips, jet planes and refinery operations, to name just a few, and this increases our impact on society.

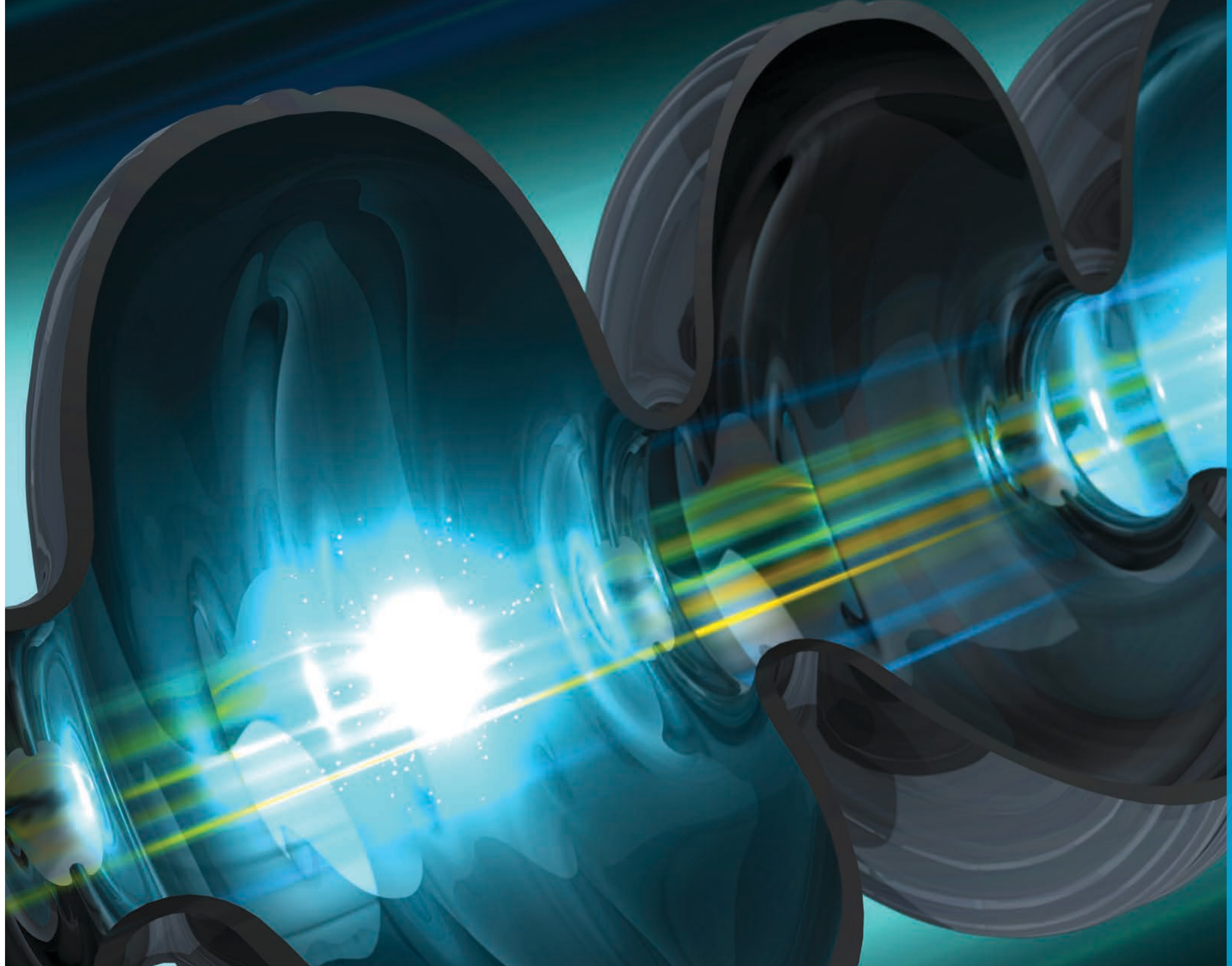
ULTRAFAST SCIENCE

SLAC is the world's leading center for developing "ultrafast" X-ray, laser and electron beams that allow us to see atoms and molecules moving in just millionths of a billionth of a second. We can even create stop-action movies of these tiny events.

With projects now underway, we'll soon be able to drill down even further, taking snapshots of electrons forming and breaking chemical bonds and transferring energy from one place to another – processes that underlie all of human technology and, in fact, all of life.

Understanding and controlling these ultrafast processes will help speed the discovery of new materials – including quantum materials with quirky traits that could have a profound impact on society – and the creation of new chemical processes for energy, manufacturing and other areas.

> "**processes** that **underlie all** of **human technology** and, in **fact**, **all** of **life**"



LINAC COHERENT LIGHT SOURCE-II

SLAC's Linac Coherent Light Source X-ray laser has been used by thousands of scientists since it opened in 2009. Its success created an international competition to open more facilities like it and continually improve the technology.

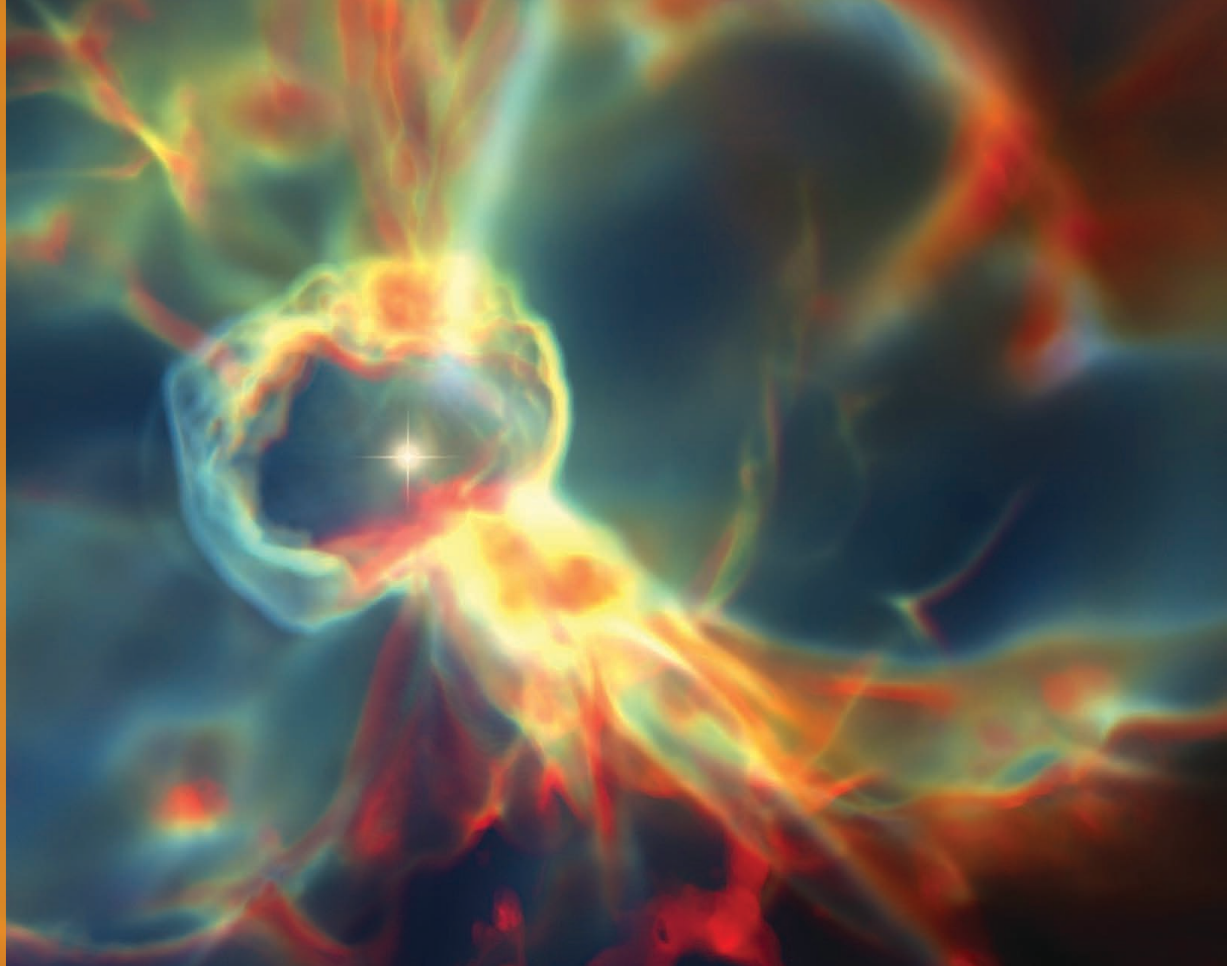
An upgrade called LCLS-II will add a second X-ray laser beam that's 10,000 times brighter, on average, than the first one and fires 8,000 times faster, up to a million pulses per second. This new beam will operate at temperatures nearly as cold as outer space.

Even before it opens for experiments, we're developing a second upgrade that's a leap far beyond any existing X-ray source. It will deliver brighter pulses at much higher energies and at the same high pulse rate, allowing scientists to see rapidly changing atomic-scale processes in unprecedented detail. It will keep the U.S. at the forefront of this important technology and the science it can deliver.

LARGE SYNOPTIC SURVEY TELESCOPE

SLAC is in charge of building a 3-ton, 3.2-gigapixel camera the size of a small car for the Large Synoptic Survey Telescope (LSST), which will survey the entire visible southern sky every few days for a decade from a mountaintop in Chile. It will be the widest, fastest and deepest view of the night sky ever observed.

LSST is the top-ranked national priority for ground-based astronomy. Its vast public archive of data will dramatically advance our knowledge of the dark energy and dark matter that make up 95 percent of the universe, as well as galaxy formation and potentially hazardous asteroids.



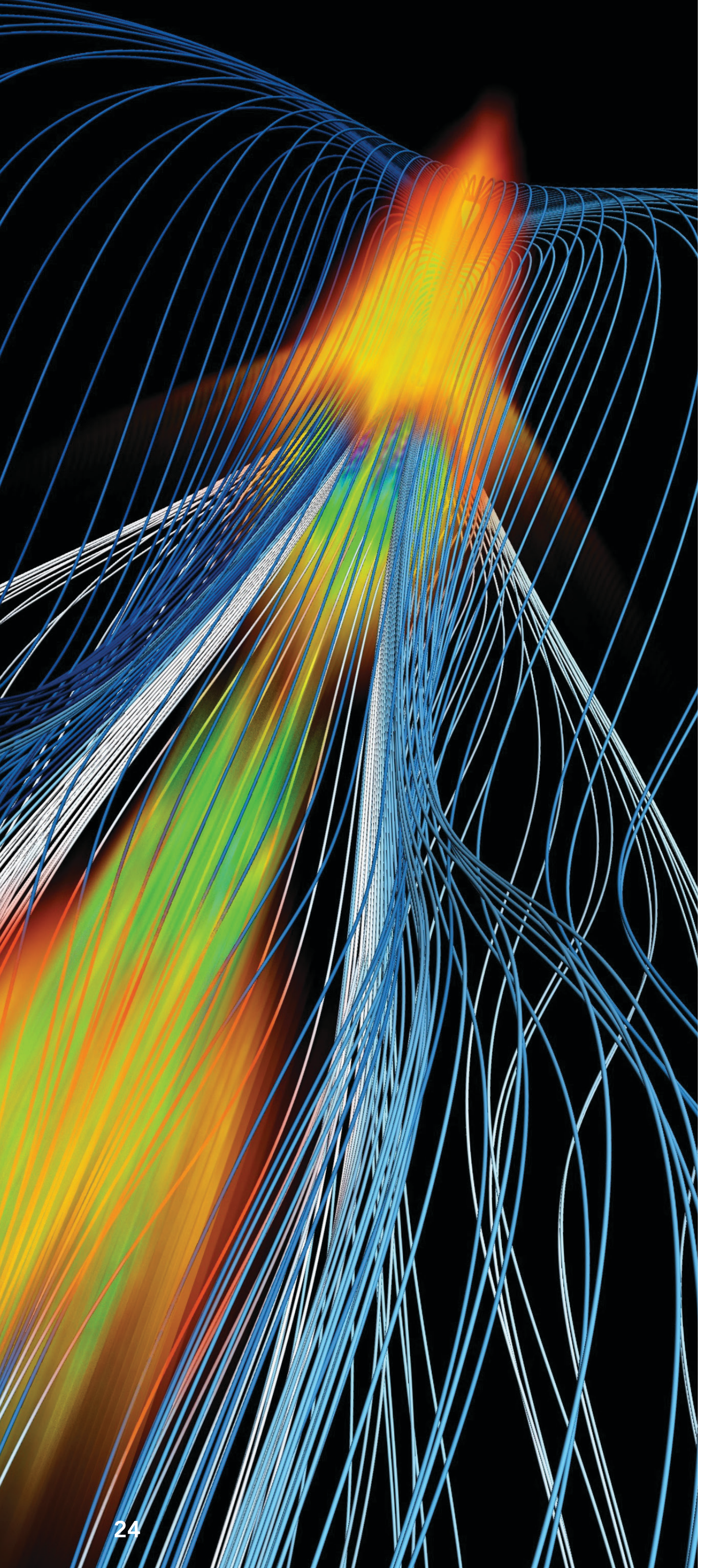
PHYSICS OF THE UNIVERSE

We deploy our scientific talent and technology from mile-deep caverns to an orbiting satellite, from a giant particle collider in Europe to the icy South Pole, to learn more about the basic particles and forces that knit the cosmos together and how the universe evolved over the 13.8 billon years since the Big Bang.

Only 5 percent of the universe is made of the normal matter we can see. The rest is dark matter, known mainly from its effects on the rotation of galaxies, and dark energy, a force that's accelerating the expansion of the universe. SLAC plays a leading role in the quest to discover the nature of these mysterious phenomena and to probe the nature of the neutrino, a ghostly particle that sweeps through our bodies by the trillions every second with no harm done.

We're at the leading edge of using theory and computer simulation to visualize things we can't see directly, from webs of dark matter to the first stars.

"to **learn more** about the **basic particles** and **forces** that **knit** the **cosmos** **together**"



ADVANCED ACCELERATORS

Particle accelerators aren't just for science. Of the 30,000 accelerators in use today, most are doing other work, from shrinking tumors to strengthening materials and sterilizing medical supplies.

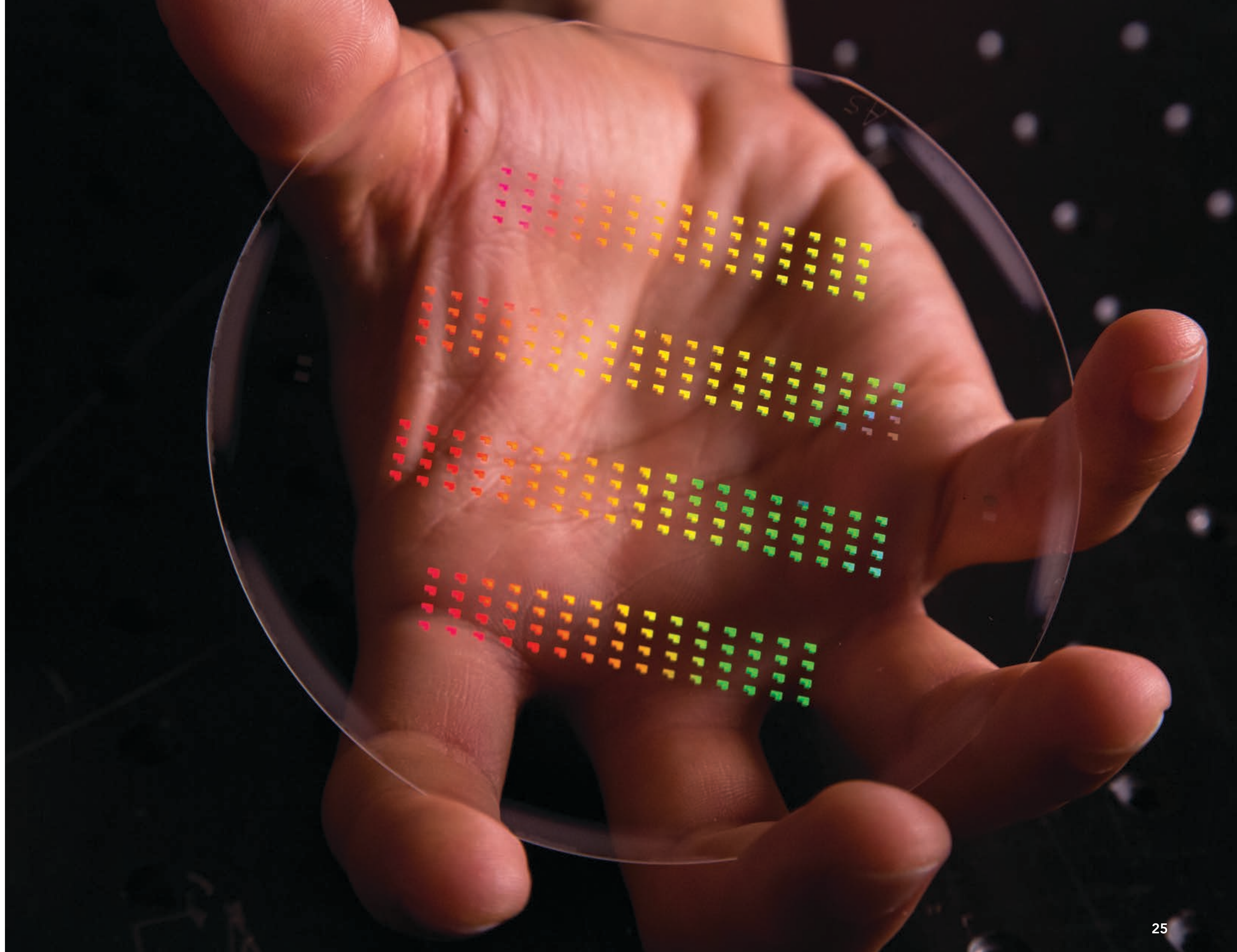
SLAC is a leader in the quest to make future particle accelerators 100 to 1,000 times smaller.

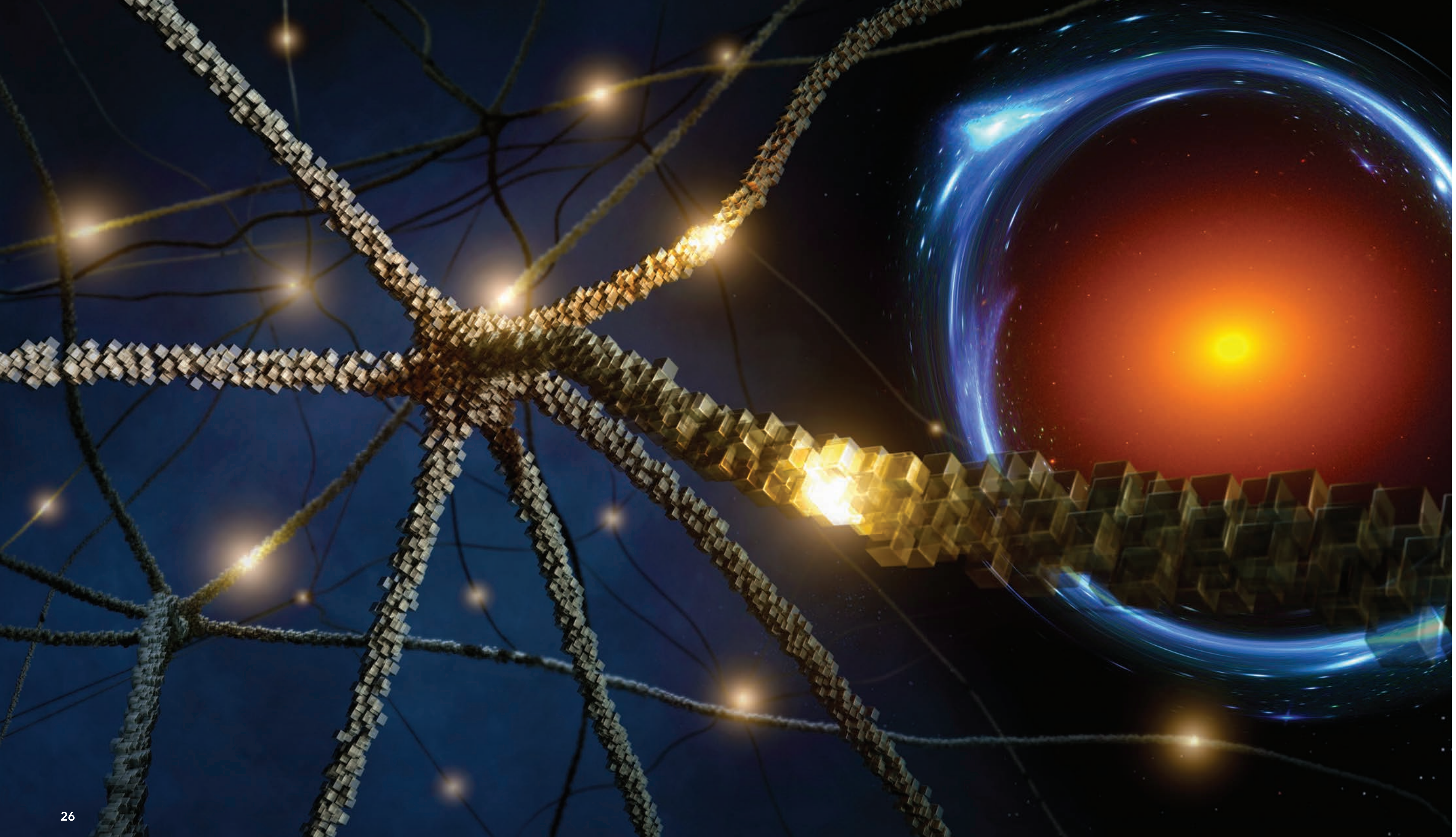
Experiments at the lab's FACET accelerator test facility have already shown that electrons and their antimatter counterparts, positrons, can accelerate to much higher energies over a given distance by "surfing" on waves of plasma – a hot gas of charged particles.

In another approach, SLAC is working with scientists from Stanford, Germany, Switzerland and elsewhere to build a particle accelerator the size of a shoebox. It's based on an innovative technology known as "accelerator on a chip" that uses laser light to propel electrons through a series of artfully crafted chips. Scientists hope it will do for accelerators what the microchip did for computers, potentially making them available to millions of people.

SLAC is also working with Stanford on a new type of compact accelerator that could shrink the length of a cancer radiation treatment from minutes to seconds.

"future **particle accelerators 100** to **1,000** times **smaller**"





EXPANDING OUR RESEARCH

SLAC continues to expand into areas of research and expertise needed to push our science forward.

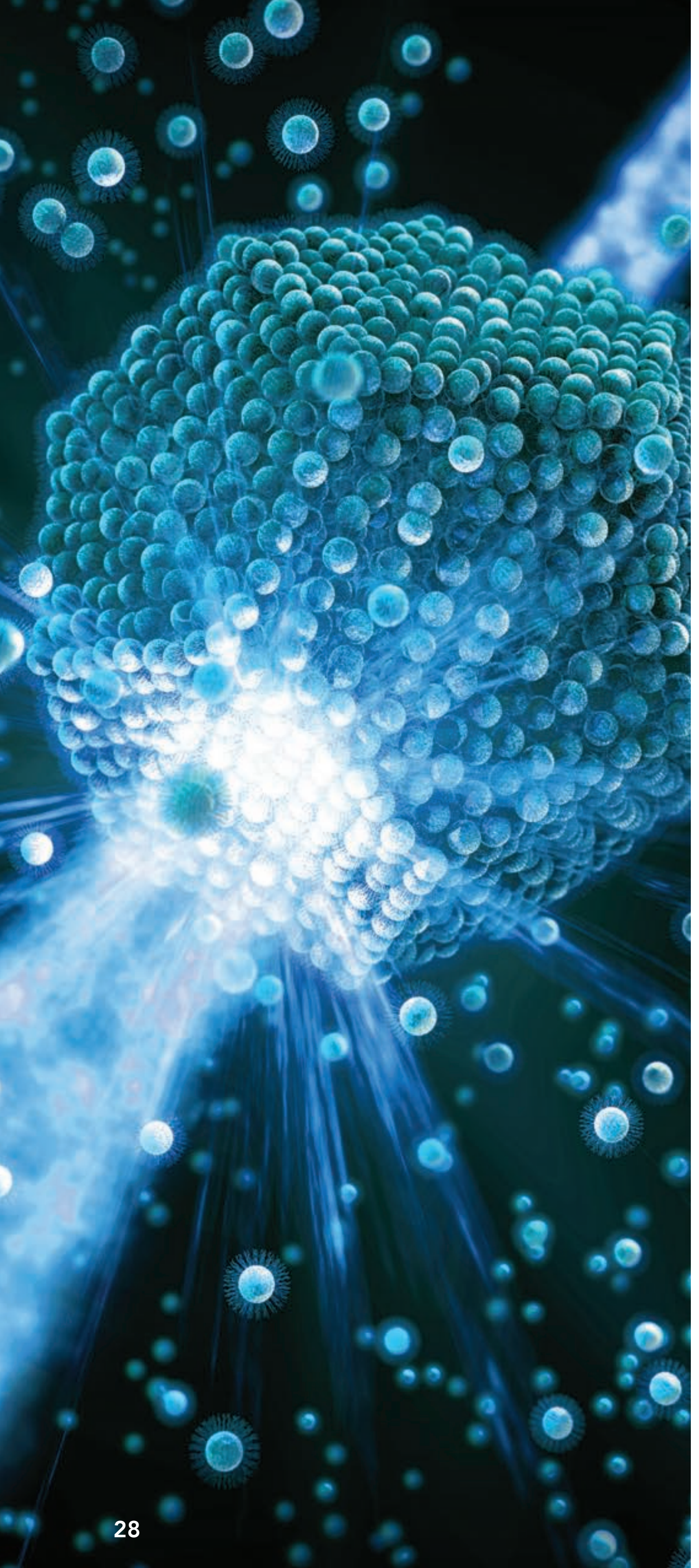
In fusion energy science, powerful lasers zap materials to create the extremely hot, dense conditions found in the hearts of stars and planets and in fusion reactors that could theoretically provide unlimited clean energy. This line of research takes advantage of our existing expertise in ultrafast science.

Our computing initiative is driven by the need to collect and analyze vast torrents of data that will come from LCLS-II and LSST. SLAC is developing the technology to do this, working with computer science colleagues at Stanford to explore exascale computing and quantum information systems and to take full advantage of machine learning.

SLAC is also taking steps to create a world-class bioimaging center, where we work to advance cryo-EM technology and use it in combination with X-ray imaging to answer key questions in bioenergy, environmental science and human health.

We'll continue to look for important national challenges we are uniquely qualified to solve and strategically invest in science with a high potential for breakthroughs.

"look for **important national challenges** we are **uniquely qualified to solve**"



TECHNOLOGY INNOVATION

Developing new technologies is a central focus at SLAC. It helps keep our science at the cutting edge and allows us to broaden our mission into new areas like national security and nuclear nonproliferation, cancer treatment, neuroscience, telecommunications and advanced electronics for autonomous vehicles.

We're also expanding our applied energy research – developing new materials for batteries, fuel cells and solar cells, studying how plants get energy from photosynthesis and finding ways to make the electrical grid smarter and more resilient.

We amplify our impact by working with companies to help spread the benefits of basic research out into society. Partnering with SLAC gives companies access to our world-class experimental facilities, expert scientists and patented technologies.

We continue to strengthen our ties with our industrial partners, Stanford, Silicon Valley and other government agencies that come to us with problems requiring the unique combination of facilities and expertise only SLAC can provide.

"**unique combination** of **facilities** and **expertise** **only SLAC** can **provide**"