Experience

California Institute of Technology
2012 Annual Report

California Institute of Technology
1200 East California Boulevard
Pasadena, California 91125

Read additional 2012 highlights online at
www.caltech.edu/annualreport2012

Design by DISTINC

Caltech

Letter from the Chair and the President.

David Lee (left), chair, Caltech Board of Trustees, and Jean-Lou Chameau (right), president, Caltech.

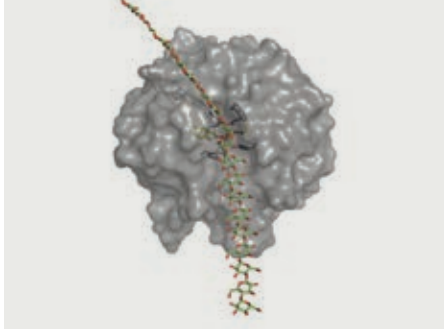
The Caltech Advantage—what distinguishes us from other education and research institutions in the world—is that we seek answers to "impossible" questions, discover new knowledge, and lead the way into the future. We do this by recruiting top-caliber scientists and scholars—intellectual pioneers who are also risk takers, problem solvers, and some of the world's greatest humanitarians. Once here, they thrive in an environment that values collaboration over competition and allows risky ideas to take flight. Whether they are developing alternative energy sources, engineering novel advanced materials, or exploring the universe, Caltech's researchers and their discoveries invigorate the economy, advance industry, and influence the international scientific agenda to expand the reach of science and engineering. In this, our 2012 Annual Report, we celebrate the achievements of the extraordinary faculty and students who drive the exploration, discovery, innovation, and impact for which Caltech is known. Our people fuel the Caltech Advantage, and through their stories, we invite you to experience Caltech.

David K. Lee
Chair, Caltech Board of Trustees

Jean-Lou Chameau
President, Caltech

Lead

Fostering education through giving.



Above: An illustration of the structure of the catalytic domain of a cellulase enzyme. **Front:** Stephen Mayo is the Caltech Bren Professor of Biology and Chemistry and the first Bowes Foundation Chair.

"Bill Bowes's important gift will give Caltech's biology division critical unrestricted funding to foster valuable research, teaching, and outreach programs."

Stephen L. Mayo, William K. Bowes Jr. Foundation Chair, Division of Biology

Stephen Mayo, a pioneer in protein engineering, is once again charting new territory. Mayo, the chair of the Division of Biology and the Bren Professor of Biology and Chemistry, now holds the inaugural William K. Bowes Jr. Foundation Chair, the very first endowed division chair at Caltech. This new chair is named after the philanthropic foundation created by William K. Bowes Jr., founding partner of U.S. Venture Partners in Silicon Valley. Unlike a named professorship, which funds salaries, the Bowes Foundation Chair is a permanent endowment that will provide funds that Mayo and all future biology division chairs will use to support innovative research, teaching, and outreach programs. "I have known firsthand for years that Caltech faculty have the unique intellectual skills, imagination, and track record to propel promising entrepreneurial adventures," Bowes says. Mayo was the first to design a protein on a computer and then build it in a lab. His research focuses on developing these quantitative approaches and understanding protein structure, stability, and function.

Explore

Blazing a trail through the universe.

Above: A self-portrait of Curiosity taken using the rover's Mars Hand Lens Imager (MAHLI). **Front:** Mars Science Laboratory team members celebrate the successful landing of the Curiosity rover on Mars.

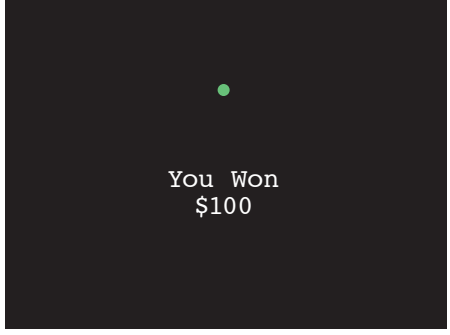
"Their bold vision defied the odds, captured the imagination of the world, and reached a new level for space exploration."

Jean-Lou Chameau, Caltech president, Sonja and William Davidow Presidential Professor, and professor of civil engineering, environmental science and engineering, and mechanical engineering

Two simple words—*touchdown confirmed*—punctured a nervous silence and ended the so-called "seven minutes of terror," sending the control room at JPL into celebration mode as the Mars Science Laboratory (MSL) rover, Curiosity, landed successfully on the Red Planet in August 2012. Within days, the rover had familiarized itself with its new surroundings and begun scouring Mars for evidence that the planet was once habitable. The MSL science team, led by John Grotzinger, the Fletcher Jones Professor of Geology, includes Caltech provost Edward Stolper, the William E. Leonhard Professor of Geology; geological and planetary sciences division chair Kenneth Farley, the W. M. Keck Foundation Professor of Geochemistry; and Assistant Professor of Planetary Science Bethany Ehlmann. In addition, Caltech graduate students are among the almost 500 scientists and numerous engineers on the mission, programming Curiosity's daily tasks and communicating the team's work with the public.

Question

Advancing society through self-discovery.



Above: A screen from the virtual task challenge indicating a successful challenge completion. **Front:** Caltech professor of psychology John O'Doherty (R) explains the virtual task challenge to a participant.

"This isn't just about playing games; it's relevant to any sort of decision making that contains high stakes and uncertainties."

Shinsuke Shimojo, Gertrude Baltimore Professor of Experimental Psychology

Sweaty palms in the bottom of the ninth. Drawing a blank during the bonus round of a quiz show. Writer's block as a big deadline nears. What causes performance to suffer when the stakes are high? Caltech researchers Shinsuke Shimojo, the Gertrude Baltimore Professor of Experimental Psychology; John O'Doherty, professor of psychology; and postdoctoral scholar Vikram Chib recently identified neural correlates in the ventral striatum and found that what makes people choke is the risk of losing out on large amounts of money. In a 2012 study funded by the National Science Foundation, the Gordon and Betty Moore Foundation, and programs through the Japan Science and Technology Agency and the Caltech/Tamagawa University Global Center of Excellence, Shimojo and O'Doherty offered volunteers different monetary rewards for completing a series of virtual tasks. The team found that as the dollar amounts increased, so too did the volunteers' performance—up to a point. When the money offered became serious, people became more likely to fall short than to succeed. These findings could help employers to create more effective incentive programs for employees—and to think about the effects of dangling that proverbial carrot.

Innovate

Breaking new ground in forecasting natural disasters.

"The Moore Foundation's grant is a huge contribution to moving forward the science of earthquake early-warning systems."

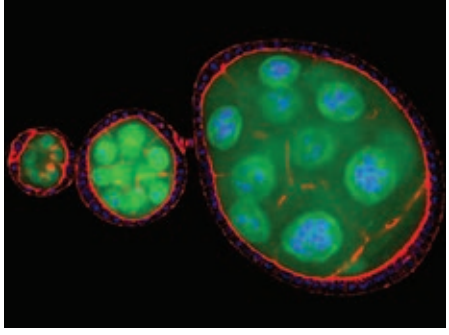
Thomas Heaton, professor of engineering seismology

Above: A screenshot from the ShakeAlert early-warning system for a simulated earthquake. **Front:** Caltech professor Jim Beck and senior research fellow Maren Boese view the ShakeAlert early-warning system display.

When a major earthquake strikes, just a few seconds' warning can save lives, allowing people in harm's way to prepare themselves before the shaking starts. This is why some of Caltech's seismologists are working to create systems that can alert the public when some serious shaking is imminent. Along with initial seed funding from the Chair's Council of the Division of Geological and Planetary Sciences, the Institute was one of three schools awarded a $2 million grant from the Gordon and Betty Moore Foundation in 2012 to create a prototype earthquake early-warning system for the Pacific Coast. The result is a prototype system called ShakeAlert, spearheaded at Caltech by Thomas Heaton, director of the Earthquake Engineering Research Lab and professor of engineering seismology; Jim Beck, George W. Housner Professor of Engineering and Applied Science; and Maren Boese and Egill Hauksson, senior researchers. Early results on the Shake Alert system have shown that it can give up to 60 seconds warning, and perhaps more, before the waves from a powerful quake hit.

Educate

Awarding opportunity to students of all backgrounds.



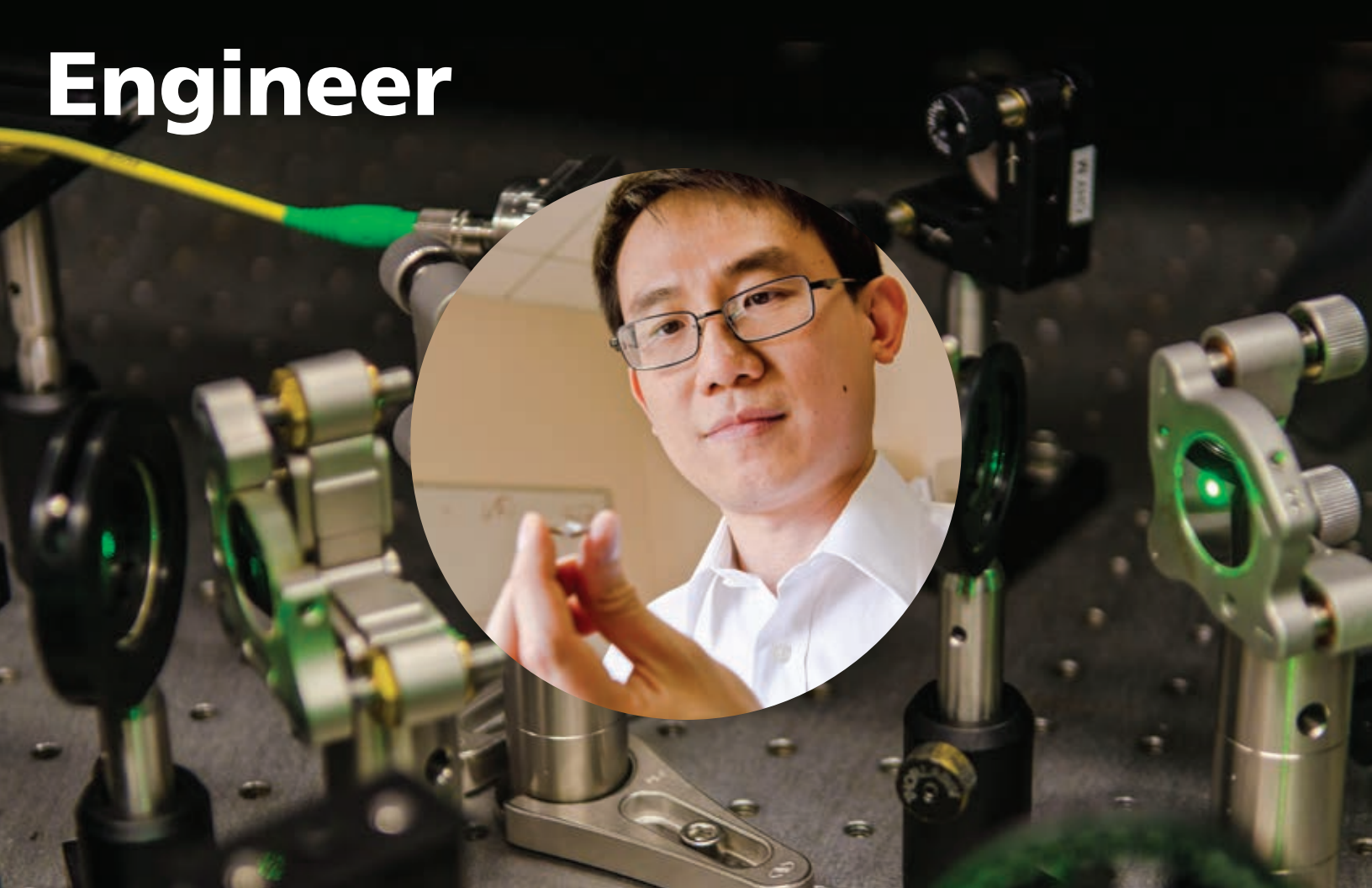
Above: A representation of genetic expression in differing stages of developing *Drosophila* oocytes.
Front: Caltech undergrad Mario Zubia shares a laugh with a fellow student.

"The best part about being a student at Caltech is being able to interact with world-class faculty and perform top-notch research."

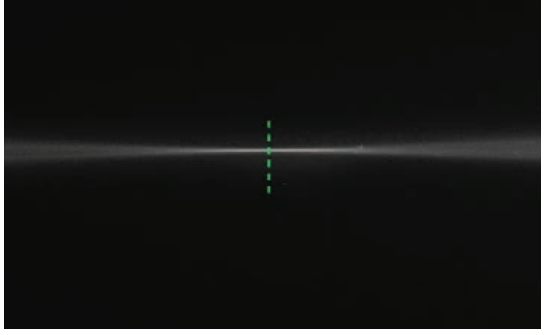
Mario Zubia, Caltech undergraduate student

Inspired to find a cure for Alzheimer's after his grandmother was diagnosed with the disease, Mario Zubia decided while in high school to pursue biology as a career path. Initially unsure he could afford Caltech for his undergraduate degree, Zubia was able to come here thanks to a competitive financial-aid package. His is one of many student stories made possible because of support from Caltech donors. Since completing his first year, Zubia has been a recipient of the Carnation Scholarship, an annual award funded by donors and given to the most academically talented students returning to Caltech. For the past three summers, he has participated in the Summer Undergraduate Research Fellowships (SURF) program—made possible, again, through donor support—conducting research in the lab of Paul Patterson, the Anne P. and Benjamin F. Biaggini Professor of Biological Sciences, investigating the role of a particular protein in Huntington's disease. This fall, Zubia plans to go to graduate school to continue his quest to find a cure for Alzheimer's.

Engineer



Revolutionizing surgery with a light scalpel.



Above: An illustration of a laser focusing through a scattering medium.
Front: Professor Changhuei Yang inspects a cell sample on a slide.

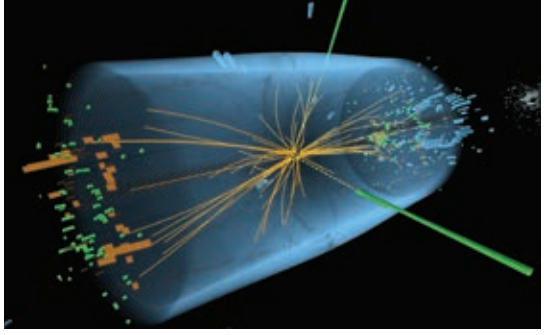
"This development has the possibility of revolutionizing surgery as we know it."

Changhuei Yang, Caltech professor of electrical engineering, bioengineering, and medical engineering

It sounds like something straight out of a science-fiction novel: doctors using concentrated light to perform surgery on organs deep within the body without making a single incision in the skin. Thanks to Changhuei Yang, a professor of electrical engineering, bioengineering, and medical engineering at Caltech, that fiction is closer to becoming a reality. Yang has developed—with the support of the National Institutes of Health, the Defense Advanced Research Projects Agency, the Sir Henry Wellcome Postdoctoral Fellowship, and the Singapore Agency for Science, Technology and Research—a new way to focus light efficiently deep inside biological tissue by using time-reversal. Yang says this focused light array has the potential to reach nearly four inches beneath the body's surface, possibly making the scalpel an instrument of the past and getting patients back up on their feet after surgery in less time and with less pain—lightening the mood around surgical procedures, which traditionally have been something to dread.

Discover

Exploring information and communication systems.



Above: Visualization of the data produced by a Higgs boson decaying into two photons in the CMS detector. **Front:** Professors of physics Maria Spiropulu (L) and Harvey Newman (R)

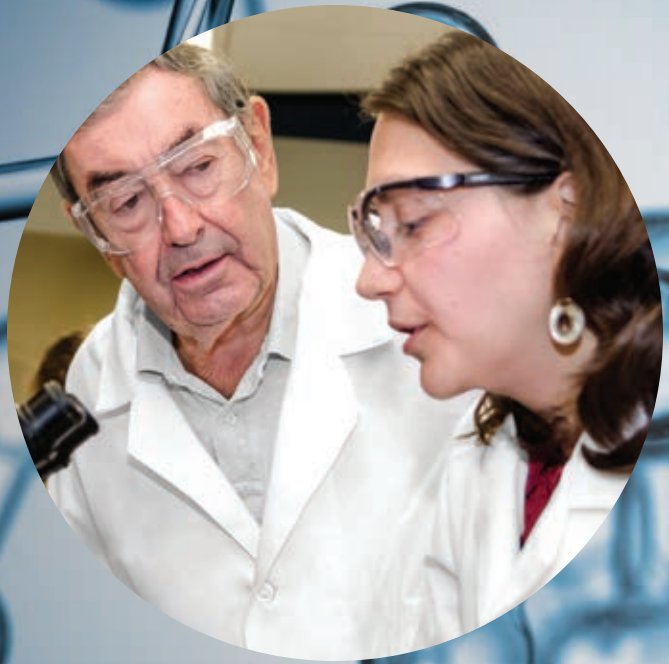
"This is a momentous time in the history of particle physics and in scientific exploration—the implications are profound."

Harvey Newman, Caltech professor of physics

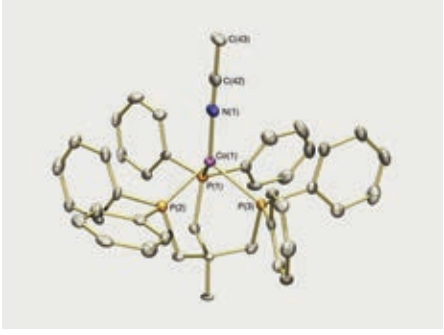
Physicists at the Large Hadron Collider (LHC) in Geneva, Switzerland, marked a milestone last summer by announcing the discovery of a new particle that may be the long-sought Higgs boson, which is thought to endow elementary particles with mass. At the center of the action was a large Caltech team, led by physics professors Harvey Newman and Maria Spiropulu. Together, Caltech faculty, postdocs, and graduate and undergraduate students developed multiple generations of experiments, designing and building detectors to precisely measure photons, electrons, muons, and jets, which were key to last year's discovery. They also invented large-scale computing and communications systems that enabled physicists around the world to rapidly—and collaboratively—collect, share, and analyze the immense amounts of data generated in each experiment.

"It has been an incredible learning experience for every team member," said Spiropulu. "Because we were trying to find and understand something for the first time, we had to keep inventing new ways to search for it, and to analyze the results."

Sustain



Developing solutions for a greener future.



Above: A rendering of the structure of one of the hydrogen-evolving cobalt complexes. **Front:** Beckman Professor of Chemistry Harry Gray discusses research findings with postdoctoral scholar Smaranda Marinescu.

"This work has completely changed our thinking about which catalyst designs to pursue."

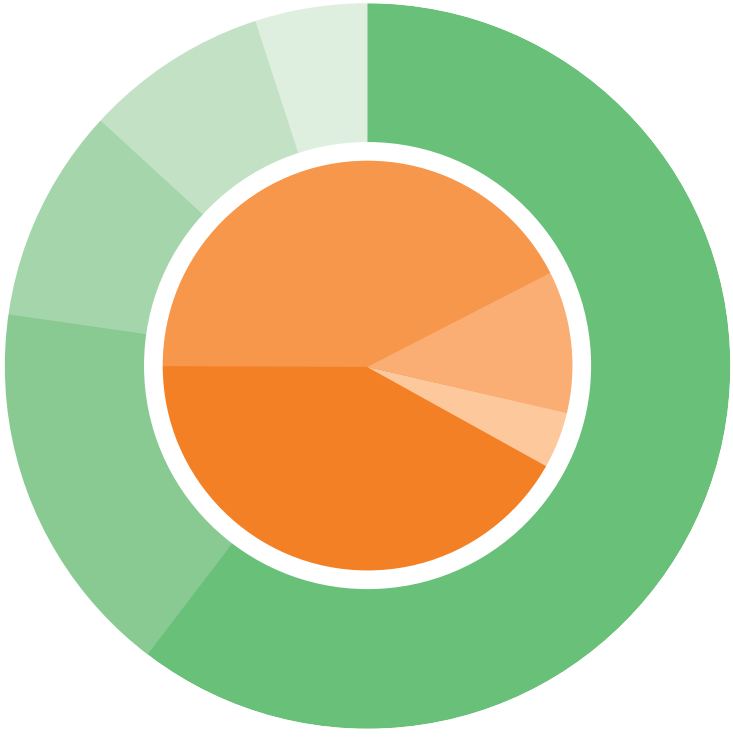
Harry Gray, Arnold O. Beckman Professor of Chemistry

Sometimes creating a chemical spark means taking things slow. That's what scientists led by Beckman Professor of Chemistry Harry Gray discovered when they sought to improve the cobalt catalyst that drives the solar-powered conversion of water into hydrogen for use in making electricity. Until now, the difficulty in designing a more efficient catalyst was that no one fully understood the chemical pathways down which such catalysts push water molecules to produce hydrogen. So, in order to speed up water splitting, Caltech postdoctoral scholar Smaranda Marinescu first had to figure out how to slow things down. She bound chemical attachments, called ligands, to the cobalt so that the splitting would happen slowly enough to be observed in real time using nuclear magnetic resonance spectroscopy. And it worked: thanks to the effort by Gray's team and to financial support from the National Science Foundation and Chevron Phillips Chemical, Caltech scientists and engineers have paved the way for developing cheaper, more efficient catalysts.

Financial Report

FY 2012
Operating Revenues
(excluding JPL)

- **59.2%** Grants and Contracts
- **16.1%** Endowment Payout
- **10%** Other
- **9.1%** Gifts
- **5.6%** Tuition and Fees



FY 2012
Operating Expenses
(excluding JPL)

- **42.9%** Organized Research
- **39.9%** Instruction and Academic Support
- **12.3%** Institutional Support
- **4.9%** Auxiliary

Caltech continues to maintain its strong financial position and to plan for its future despite a year dominated by political and economic uncertainty. Net assets increased 6.7% in FY 2012, due to diligent oversight of operating costs, generous donor support, and a 14% return on endowment investments. The outstanding investment performance, plus gifts to endowment totaling $42.5 million, increased the endowment's total market value to $1.81 billion. The endowment provided nearly $100 million in vital funding to campus programs in FY 2012, supporting 16.1% of the campus operating budget. Building upon its financial strength and with an eye toward the future, Caltech sold $350 million in taxable 100-year "century" bonds during Fiscal 2012. At issuance, the bonds' coupon of 4.7% was the lowest ever for 100-year university bonds. While uncertain times continue, particularly in the area of federal research funding, we are confident that Caltech has the core financial strength and vision to persevere through tumultuous times.

Dean Currie
Vice President for Business and Finance

FINANCIAL SUMMARY

For the fiscal years ended September 30, 2012 and 2011 (in thousands)

	2012	2011
Operating Revenues (excluding JPL)		
Tuition and fees	$34,130	$30,749
Endowment payout	97,386	93,293
Gifts	54,393	42,979
Grants and contracts	357,368	373,732
Other	60,428	66,614
Operating revenue	**$603,705**	**$607,367**
Operating Expenses (excluding JPL)		
Compensation and benefits	$338,697	$326,963
Supplies and services	155,320	171,177
Subcontracts	39,056	45,540
Graduate fellowships	17,807	16,731
Depreciation, accretion, and amortization	64,106	60,733
Utilities	17,711	17,162
Interest	21,399	13,405
Operating expenses	**$654,096**	**$651,711**
Assets, Liabilities and Net Assets Summary		
Cash, advances and deposits	$17,020	$27,319
Accounts receivable, net	221,076	206,883
Investments	2,245,694	1,798,264
Other assets	181,917	153,338
Deferred United States government billings	575,724	507,230
Property, plant and equipment, net	873,768	859,373
Total assets	**$4,115,199**	**$3,552,407**
Accounts payable and accrued expenses	452,452	403,924
Other liabilities	109,833	98,487
Bonds and notes payable	709,571	439,648
Accumulated postretirement benefit obligations	662,904	567,670
Total net assets	2,180,439	2,042,678
Total liabilities and net assets	**$4,115,199**	**$3,552,407**
Increase/(decrease) in net assets	**$137,761**	**$(113,093)**

Note: The figures that appear in the financial summary shown are derived from the financial statements for the years ended September 30, 2012 and 2011, that have been audited and have received an unqualified opinion. The complete, audited fiancial statements for the Institute can be seen at www.businessandfinance.caltech.edu.