Cluster 5 hit the ground running with a safety brief on proper use of class 3B, 3R and 4 lasers followed by a lecture by Professor Charles Tu about the fundamentals and the revolutionary potential of light technologies. After lunch at Canyon Vista Restaurant in Warren College, we returned to the photonics lab in the basement of the Jacobs Engineering building to conduct an investigation using red and green lasers to develop a clearer understanding of total internal reflection, Snell's Law and dispersion of light which was led by Development Engineer Dr. Peter Ilinykh.

Tuesday morning we attended our first Discovery Lecture which was delivered by an animated and engaging Professor Boubacar Kante of UC San Diego. Dr. Kante’s recent research has focused on artificial electromagnetic composites -- metamaterials. Using the unique optical properties these metamaterials (such as, negative refractive indices), he was the first to demonstrate the first non-magnetic metamaterial invisibility cloak! We look forward to building our own (slightly less exotic) cloaking device using mirrors and lens. Each Tuesday and Thursday morning we have our Science Communications sessions with Teacher Fellow David Hurst of San Diego City Schools. During these sessions, we focus the importance of clear communication skills in science and on ethical issues in the field of optics and photonics. Each afternoon, our photonics workshops are hosted by Dr. Peter, assisted by fourth-year PhD student Mr. Rui La, and first year Masters student Mr. Sushant Kumar. We went hands-on with lasers our first day!

By the end of the second day’s lab, we had created working organic solar cells using blackberry juice and graphite with titanium dioxide as the semiconductor. Each team measured and compared the voltage, current and calculated power of their solar cells with the other team’s results. In addition to being fun, the daily Photonics lab challenges each of us to improve our lab skills, optical physics-based math knowledge, team work and communication skills. We will continue to deepen our conceptual knowledge of photonics through lecture and labs. Currently, we are close to achieving the goal of developing a understanding of the structure and function of semiconductors such as LEDs and spectrometers by the end of the first week. For each of us, COSMOS Cluster 5 has already been an unique experience and opportunity that has deepened and advanced our knowledge of the physics of light and light-based technologies. Lux Fiat!

After such a busy week we are looking forward to having fun AND winning the COSMOS OLYMICS!!! Followed by a well-earned weekend spent relaxing at the world-famous San Diego Zoo and the beaches of La Jolla Shores! Weekend Weather: Early morning clouds, followed by sun both days. Temperatures: Saturday are 74° to 64° (RealFeel® of 81° to 63°), Sunday are 75° to 66° (RealFeel® of 82° to 64°).
CLUSTER 5: FROM LASERS TO LCDS: LIGHT AT WORK

After training hard for the COSMOS Olympics, Cluster 5 acquitted themselves honorably all the while building their sense of comradeship and fun! The weekend was spent relaxing at the world-famous San Diego Zoo and on the beaches of La Jolla Shores. Rested and refreshed, they were ready to explore laser theory, diffraction optics and polarization in week two.

From learning how to polarize light to constructing Michelson Interferometers*, students have developed an understanding of the theory and technology behind the tools through both lecture and lab. To prepare for their final presentations, they gather data then share their conclusions with the class while surviving the good-natured grilling of Principal Investigator Dr. Peter Ilinyk and Lab assistants Rui La and Sushant Kumar.

Everyone found the second Discovery Lecture on Tuesday entitled "Embryos and Evolution" given by Professor Bill McGinnis, Dean of Biological Science at UC San Diego, most intriguing! The slides showing mutant fruit flies with extra wings and eyes growing from odd places were very popular. On Wednesday, we toured the Qualcomm Institute, right next door to our lecture and lab spaces in Jacob Hall, and were immersed in their 3-D visualization technology in the StarCAVE and NextCave before heading to the Nano3 Lab for our first look at a nanotechnology microfabrication lab.

Cluster 5 students have now achieved a working knowledge of photonics that most are starting to apply and use to communicate in deeper and more exciting ways. However, it is also important that these future scientists and technologists be prepared for the increasingly critical role that ethical considerations concerning science and technology will play in their social, academic and professional lives.

Our five-page Ethics in Science Essay is a unique requirement of the UC San Diego COSMOS program that asks students to consider the power of light-based technologies for potential good or ill to society and the future. After last week's orientation to the Geisel’s Library collection and online resources, they have spent hours researching the ethical issues in the general field of photonics and those touching upon their own final project areas. Cluster 5 is tackling issues as diverse as the use of nanophotonics to improve stealth technology for the military, to dealing with pollution associated with manufacturing LEDs and solar panels, to the effect of health-care high technology such as cosmetic lasers on the cost to consumers. They will find out soon who among them will claim the $200 prize for best essay!

* Michelson’s Interferometer is an arrangement of lens and mirrors that splits a light beam into two separate paths, creating an interference pattern when recombined that is sensitive to any changes along either path. It was used to disprove the 'ether' theory describing the propagation of electromagnetic waves (1887 Michelson-Morley), leading to the Special Theory of Relativity (1905 Einstein), and to the recent demonstration of the existence of gravity waves predicted by the General Theory of Relativity (2016 LIGO).
CLUSTER 5: FROM LASERS TO LCDS: LIGHT AT WORK

After Parents’ Weekend, students returned to the COSMOS UC San Diego campus with renewed enthusiasm for their cluster. We started off the week with a lecture from Dr. Tu about the latest developments in plasma lasers able to emit light in the deep (DUV) and extreme ultra-violet (EUV) ranges. After lecture, we returned to the lab where student teams wrote proposals for their final projects. Our Final projects this year involve in-depth investigations exploring the topics of laser seismography, comparing dye-sensitized organic solar cells, atmospheric effects affecting optical free space communication, creating improved optical polymer lens, and using lasers to create electronic music.

The laser seismography group is building a device that uses a fiber optics cable as a free-swinging pendulum coupled with a photodiode in the base to detect possible seismic activity and display the output on an oscilloscope. The solar cell team will test different organic compounds and their capacity to efficiently convert the sun’s energy into power. The optical free space communication group will test the effect of different atmospheric conditions on laser signal quality. The optical polymer lens group will be experimenting with innovative techniques to make larger inexpensive high quality plastic lens with magnifications comparable to quality direct-light microscopes. Our final group is programming computers to translate the ‘laser harp’ operator’s interaction with its multiple beams into electronic music. Cluster members are feverishly working on their respective projects to ensure that they will be ready to share their exciting findings at the end of the COSMOS summer session.

This week’s Discovery Lecture was given by Dr. Paul Jensen from Scripps Institute of Oceanography, a department of UC San Diego. Dr. Jensen spoke about “New Medicines from the Sea: Past, Present & Future” and about his work to find marine bacteria, which produce biologically active compounds that can be a resource for drug discovery. Tuesday afternoon, we toured Cymer, Inc. the industry leader in making the light-sources used in creating microchips. The highlight of the tour was being in the same room with one of Cymer’s EUV light-sources that is as big as a car! Later, a panel of three engineers shared with the students their personal experiences, insights and advice for working in the STEM fields. Students then formed five teams and attempted to program their LEGO robot to navigate a large diagram-map of the CYMER campus.

This week, we were also able to visit several optics labs in the Jacobs Engineering Building and were fortunate to hear about some of the interesting research and development that was occurring there.
CLUSTER 5: FROM LASERS TO LCDS: LIGHT AT WORK

Our final week of COSMOS has passed and what a week it was! Our last Discovery Lecturer, Professor Andrea Tao, gave all the clusters an overview of her work in the light-matter interaction field of nanotechnology and how her work found nano-scaled features on the toe-pads of gecko's that explained how geckos stick very strongly to surfaces without using mucus.

Early in the week, all five teams brought their projects to a proof-of-concept stage. The Laser Seismometer team field-tested their device with the help of Cluster 4's (Earthquake Engineering) shake-table. The Cell-Phone Microscope group utilized the Qualcomm Center: Nano3 facility's Axio Fluorescence Microscope to compare the difference in quality to their own designed elastipolymer lens. The Organic Solar Cell team tested various natural substances for their ability to boost light-to-energy conversion, including spinach to investigate chlorophyll's capacity as a photosensitizer.

The Free Space Optical Communications group was assisted in quantifying various simulated atmospheric conditions by the donation of photo-resistor's from Cluster 9: Music and Technology. The Laser Harp team brought their Photonic/Phononic musical instrument to prototype stage with the combined construction and electrical engineering skills of Dr. Peter and his staff.

On Friday, research teams from Clusters 4 and 5 met together to peer-review each other's presentations before the Research Expo on the last day.

The week culminated with the presentation of the research projects. Each team delivered their findings to an audience of family and friends. The Awards Ceremony followed with the presentation of the winners for the following categories: The Ethics in Science winners, the Gordon Center Best Project Award and the Dr. Joe Watson (former Vice Chancellor of Student Affairs, UC San Diego) Award for best team player (per cluster). At the end of our month here at COSMOS 2016, we realized that this program was one of the best experiences of our lives. We got to work with professors and made good friends and memories at the University of California at San Diego.