CPS Plasma Page

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Better Fusion through Computer Modeling takes CPS Prize at INTEL ISEF

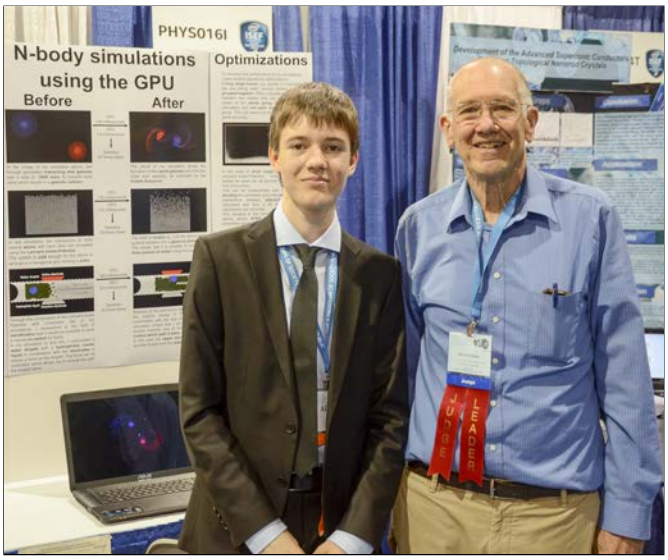
Pittsburgh, PA – When CPS Chair Lee Berry and Princeton Plasma Physics Laboratory Senior Program Leader in education Arturo Dominguez arrived at the INTEL International Science & Engineering Fair (ISEF) this year, they faced the daunting task of reviewing over 1000 projects and selecting the plasma 'finalists' on the first afternoon of judging, and then selecting the recipient of the CPS plasma award the next morning.

Despite this tight schedule, Lee and Arturo agreed to award this year's CPS Plasma Excellence prize of $1500 to Antonio Perez and Che Olavarria, two sophomores from the Albuquerque Academy in New Mexico. Their project, titled "**Developing a More Efficient Fusion Reactor through Computer Modeling**," focused on how to select parameters for a fusion reactor that would result in a design with the best performance.

The goal of the project, as their abstract stated, was to "develop and use software capable of accurately simulating the motion of charged particles under electromagnetic fields to test new and existing designs for fusion reactors and then improve those designs using a genetic algorithm." The students hoped to "provide a guide for future research into fusion power and prototyped designs for efficient fusion reactors."

Antonio Perez (left) and Che Olavarria impresed CPS judge Arturo Dominguez with their winning project, ***Developing a More Efficient Fusion Reactor through Computer Modeling.*** *Photo/Lee Berry*

The approach Che and Antonio used is a variation on the so-called 'genetic' algorithm: they chose design parameters for a number of trials, and then used the fittest of these choices to select a new set. The students were able to show that this algorithm was much more efficient than randomly searching for an optimum, if new generations of designs were chosen properly.



Adrian Lenkeit, Sophomore, St. Michael-Gymnasium in Germany, here with CPS judge Lee Berry, received a Physics and Astronomy Fourth Award of $500 for his project, ***N-body Simulations Using the GPU.*** *Photo/Arturo Dominguez*

Antonio and Che used a mirror-like configuration of magnetic coils to test their algorithm. They wanted to find design parameters for the coils (which include their size, current and spacing) that would maximize the resulting ion density. They chose a first generation of designs randomly, and found the ion densities by following the trajectories of a large number of particles. From this first generation they selected a small number of designs, which promoted the highest ion density, to seed the next generation. Typically a generation contained thousands of designs, from which the students selected ten. The algorithm next produced a new generation of designs, which hopefully 'inherited' the high-performing properties of the first. The students identified the best performing designs, and iterated the sequence until they discovered an optimum.

Dominguez praised the student researchers: "They tackled so many computational fields that are relevant for plasma physics and fusion reactor development, and they've done so much work in the little amount of time that they've worked on it, that they truly deserved the CPS prize." The program, including graphics, was written by Antonio and Che using both "C" and Java within the Eclipse development environment.

Dominguez noted also being particularly impressed with a project entitled, "**Optical Ion Reflector: Investigating the**

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Hyrum Gordon Bock (left), Cameron David Beardsley and Rosemichelle Marzan field questions from CPS judge Arturo Dominguez, who felt their Fusor project deserved recognition. Photo/Lee Berry

Elastic Collision Relationship between Ions and the Chamber Walls during Nuclear Fusion in order to Enhance Plasma Density by Focusing a Plasma Beam." This project continued student research on Farnsworth electrostatic 'Fusor' systems at the Northwest Nuclear Consortium (NWNC). Research for the 2014 CPS award was also conducted at the NWC. For this year's effort, Rosemichelle Marzan, Cameron Beardsley and Hyrum Bock presented the idea that in a fusor vacuum chamber, perhaps energetic ions or neutrals could escape the central confinement region, reflect elastically from the vacuum vessel wall, and pass through the central plasma. If the walls were parabolic, then there could be a focusing effect to increase the neutron rate. Runs were made with and without a focusing curve machined in the wall, and an increased rate was observed. "They're doing great experimental work in the Fusor device," Dominguez noted. "They were a very close second, in my opinion." Although this project did not receive the CPS award, it was honored with the *Physics and Astronomy Fourth Award* of $500.

Both Berry and Dominguez had fun talking to students and trying to understand their projects on a vast range of topics. Particularly interesting was the effort by Leonard Bauersfeld (Hans Thoma Gymnasium, Lorrach, Germany) on "**Feynman's Inverse Sprinkler**." Everyone has observed that the common lawn sprinkler rotates as water is shot from the rear-pointing arms. Feynman wondered what would happen if fluid were pulled into the arms. If done carefully, the 'sprinkler' does indeed rotate in the opposite direction. The observation that a sprinkler with straight arms would rotate in either direction, only depending on the initial push, had our two judges scribbling equations on the back of programs. With this project Bauersfeld became one of the winners of the 49th Young Researchers Competition in Germany, held in Fall, 2014.

Other plasma-related projects also impressed the judges.

The Effect of Microwave Heating on Substances in Foods and Beverages: Sichen Shawn Chao, Sophomore, Oxford High School, Oxford, Mississippi.

Pressure-Assisted Microwave Sintering for Production of Transparent Poly-crystalline Spinet: Experimental Study on Non-Thermal Ponderomotive Effect and Uniaxial Pressure: Richard Joonyup Oh, Senior, Thomas Jefferson High School for Science and Technology, Alexandria, Virginia.

The Feasibility of Using an Electric Arc Flash as a Propellant: Junior, Zane Trace High School, Chillicothe, Ohio.
Received West Virginia University Scholarship: Academic Excellence or Presidential Scholarships (depending on residency) are provided to students whose research and academic aptitude align with WVU's institutional goals and research interests.

N-body Simulations Using the GPU: Adrian Lenkeit, Sophomore, St. Michael-Gymnasium, Bad Munstereifel, Germany.
Received Physics and Astronomy - Fourth Award - $500

A Low Temperature Plasma-Assisted Cataluminescence Sensor for Ethylene Discrimination: Guofu Liu, Senior, Beijing No.8 High School, Beijing, China.

Biodegradable Air Filter and Ionizer Development: Brian O'Rourke, Freshman; Allegra Paola Francesca Rollo, Sophomore, Boston Latin School, Boston, Massachusetts.
Received Environmental Engineering - Fourth Award - $500

Energetic Particles from 10B and Li Fusion Reactions: Miriam Lea Matney, Junior, Clear Lake High School, Houston, Texas.

Berry observed that the number of plasma-related projects were down this year. He noted, "The level of the projects was good with interesting results, clearly the result of a lot of work. However, in many cases, we both felt the 'plasma' content was not presented in the depth we would have liked, due to lack project mentors with a good background in plasma science. This, however, is part of the larger problem we see of teachers without the resources or time to help in getting input to the students for plasma issues."

Still, the judges were impressed. Berry applauded the hard work of the students, saying, "I continue to be amazed at the range of projects. Arturo and I spent more time than we'll admit trying to understand the 'inverse sprinkler' demonstration.

Dominguez was delighted with his first experience as a CPS judge for the Intel ISEF, and hopes to do this again. He also wants to provide further support to these hard-working students interested in plasma. He said, "I would love to have a structure in place to try to place these kids into internships with local plasma physics institutions to help foster their efforts and to nudge them into our field."