



August 21–27, 2017

**Congratulations
to Dr. Eric Shi
for successfully
defending his
thesis!**



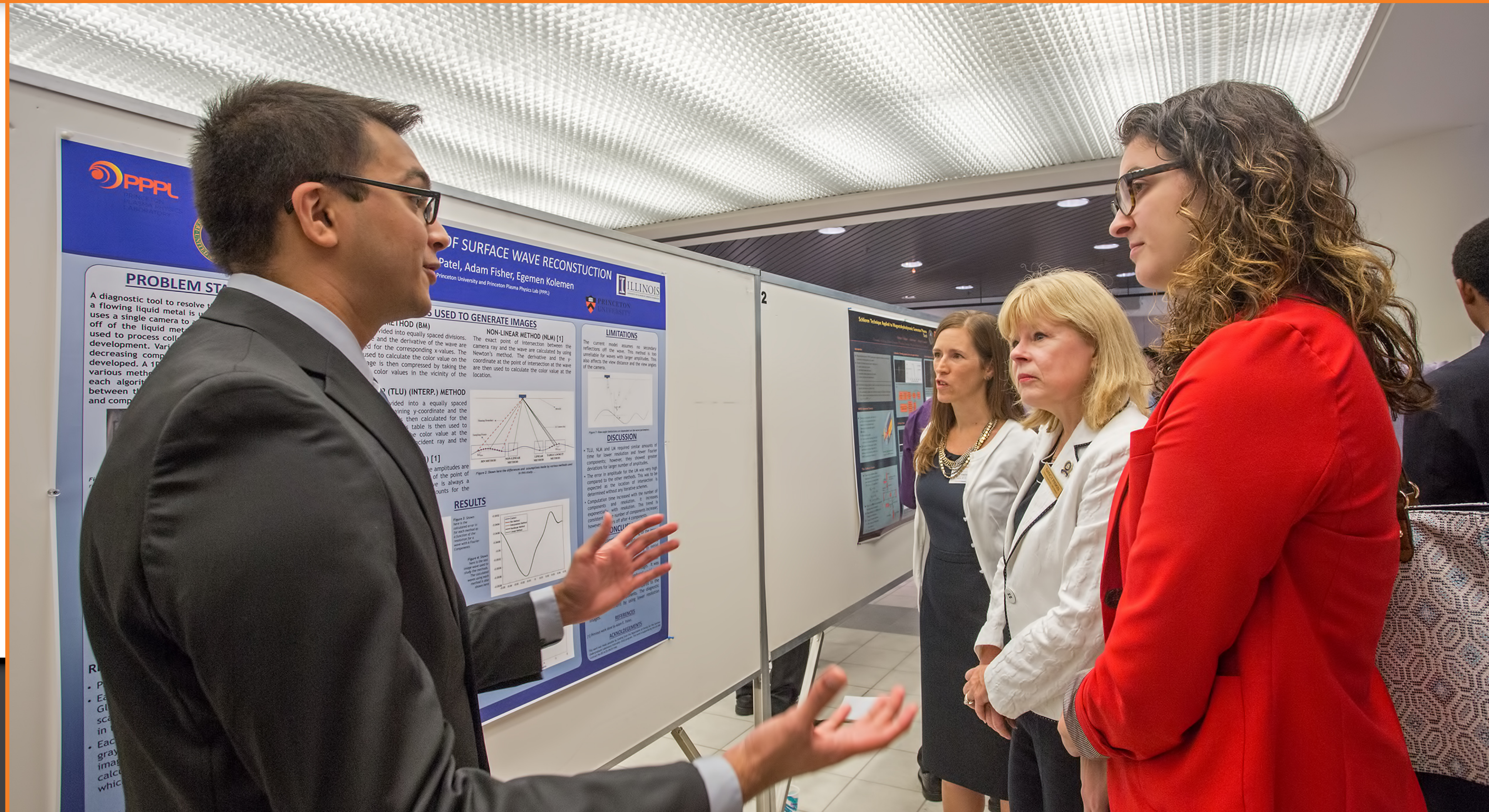
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Student interns show off their summer research projects at Aug. 16 poster session.



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Barbara Israelson (Edinboro University) advised by Dr. Johan Carlsson (Princeton University) and by Larry Guttadora (Princeton Plasma Physics Laboratory)

Objectives

- Examine the discharge curves of various neon glow lamps and develop an electronic oscillator
- Understand negative differential resistance and design an incandescent bulb blinker with a glow discharge and oscillator circuit
- Obtain proof of principle for a plasma microphone by designing equipment to transduce audio to electronic signals via brush discharge plasma speaker

Plasma Speaker

The proof of principle for a plasma microphone was obtained using the existing plasma speaker, which modulates a 4 MHz AC brush discharge with an electronic signal that generates the audio. For the plasma microphone experiment, the audio modulation was disabled, and a sinusoidal sound wave propagated through the brush discharge. Theoretically the pressure perturbation of the sound wave modifies the discharge's resistivity. A short monopole antenna was used to receive EM emission from the discharge.

Due to the high frequencies, several filters were necessary, including a custom LC filter. After significant effort to suppress high-frequency noise, the transduced sound wave became visible on a digital oscilloscope connected to the antenna.

Science Education Lab Plasma Speaker in operation

Resonant LC notch filter: $L = 15 \mu\text{H}$, $C = 55\text{pF}$, $L_2 = 30 \mu\text{H}$, $C_2 = 67\text{pF}$

Characterizations of Various Neon Glow Lamps

A glow discharge plasma could potentially be a good transducer for a plasma microphone. Several types of neon glow lamps, a common type of glow discharge that have many advantages, were therefore considered for this application.

The graph above shows the data for a standard NE-2 glow lamp. Voltage is taken as a function of current. Data was taken both for when current was increased and decreased. The difference in breakdown voltage and extinction voltage is noted. The value of the resistor was changed in order to gain resolution for different areas of the discharge curve. For the breakdown and subnormal glow regions, high resistances were chosen to limit current through the circuit. To show the beginning of the abnormal regime, a small resistor was chosen. The data is highly consistent, indicating good conformity in performance for NE-2 bulbs and smaller.

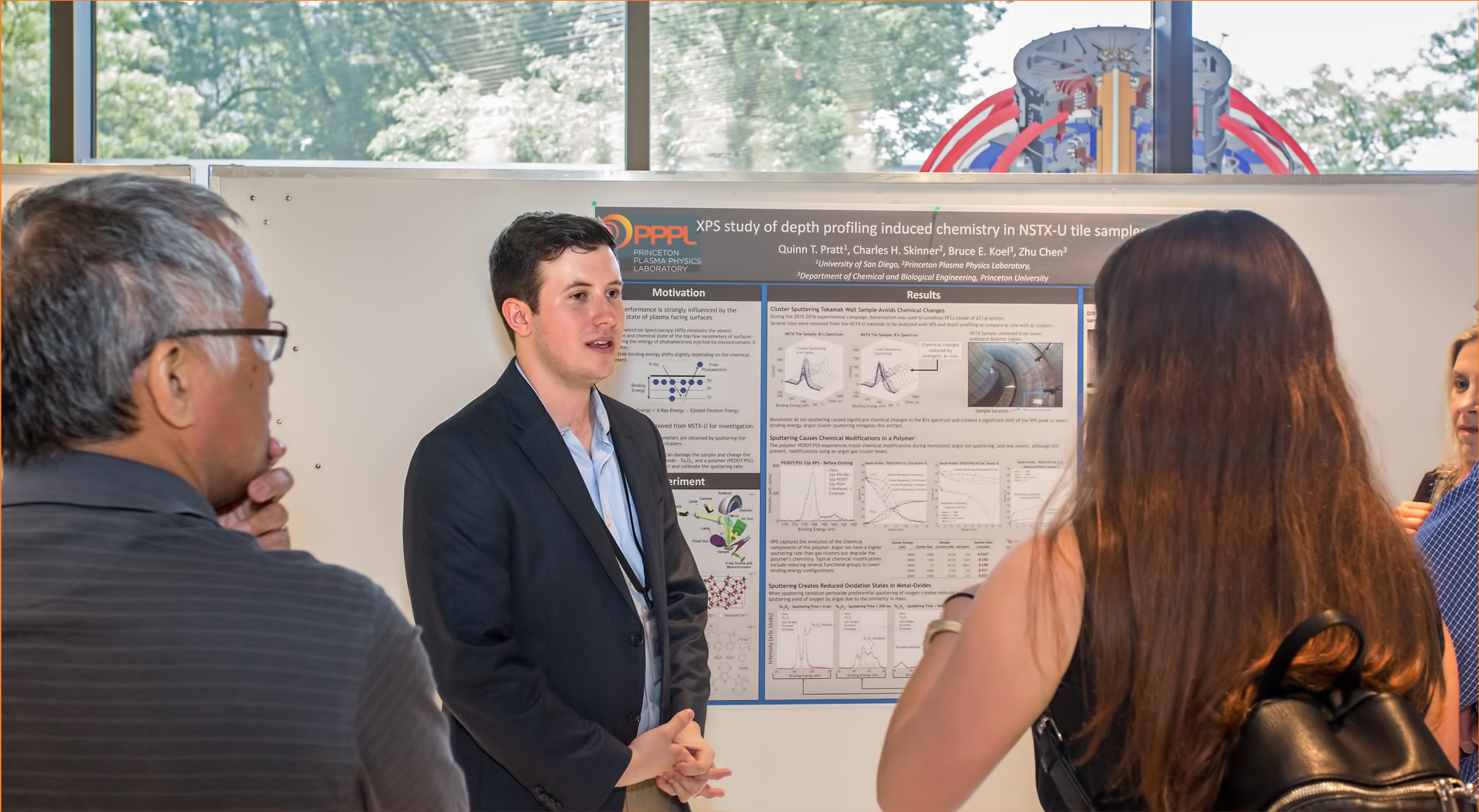
The graph above shows the data for a smaller NE-1 glow lamp. Data was taken for current and voltage after the lamp had time to warm up, then the circuit was allowed to cool, then data was taken in order to determine any dependence on temperature. The percent difference between the cold and warm extinction voltages is 4.1%, enough to note that in a cold circuit, the extinction voltage may be slightly higher, but not by a statistically significant amount.

The graph above shows the data for the same small lamp. Data was taken in the same manner, with the bulb uncovered and with the bulb covered with black electrical tape. Since breakdown can be triggered by a number of sources, blocking light is an effective way to assess the lamp's dependence on environment. The percent difference for the breakdown voltage with light and with no light is 19% which indicates a dependence on light to trigger breakdown. The percent difference for the extinction voltage with and without light is 1.1%, indicating no statistically significant dependence on light for the extinction voltage, which is expected.

Top graph: Data was taken using two different NE-2 lamps and two different resistors, a low value of $500 \text{ k}\Omega$ and a high value of $3 \text{ M}\Omega$. The low value resistor was chosen so that the beginning of the abnormal regime could be observed, which occurs as the current approaches 1 mA . The high value resistor was used to limit current so that high resolution data could be obtained for the breakdown regime. It should be noted that the two different lamps perform very similarly. There is little deviation in the data. Some deviation may be attributed to small manufacturing defects, exacerbated by higher currents.

Bottom graph: Data was taken using two IN-3 lamps with the same two resistors as were used to test the NE-2 lamps. There is clear disparity between the performances of the two Russian neon glow lamps, which is most probably attributed to manufacturing irregularities and poor quality control. It could also be a result of the internal structure; there is a square metal cathode and a wire rectangle anode in the IN-3, which may result in performance differences if polarized incorrectly or if they are not identically separated across bulbs. The NE-2 lamps have two metal rods. There is a wide spread in data and a hysteresis should be noted. It is also clear that the IN-3 lamp is capable of operating at higher currents.

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Modifications to the Hall Probes in the Magneto-Rotational Instability Machine

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Introduction

Accretion disks form when gas, plasma, and dust rotate and fall into a central object. This high angular momentum is then transported outwards because of the gradual loss of the angular momentum, matter moves inwards which causes the energy to dissipate. There are also magnetic fields in the disk.

Image obtained from NASA [3].

Magneto-rotational instability (MRI) is believed to be responsible for the transport of angular momentum in accretion disks. MRI takes the vertical magnetic field (B_z) and turns it into creating the B_r and B_θ magnetic fields.

Image obtained from PPPL [2].

- A Hall Probe was made by attaching a sensor chip. Then the probe was inserted into the machine in the azimuthal direction.
- The sensor chip measures the voltage to the right of the probe, which is proportional to the magnetic field.
- The sensor chip measures the voltage below) of the probe, which is proportional to the magnetic field.

Data Analysis and Conclusion

- The distance is indirectly proportional to the voltage. These results are important because they tell us roughly how the hall probe will act in the MRI experiment azimuthally.
- The sensor chip measures 1.3 mV per gauss and the amplifier has a gain of 6.
- Because of the gain, the output ends up to be 7.8 mV per Gauss.

Future Directions

- Map and obtain data when the hall probe is inserted in the MRI machine azimuthally
- Measure simultaneously with the B_r hall probes to obtain the Maxwell Stress
- Create a hall probe that is able to change its angle

Figure 3 (left): Predicted simulation of MRI threshold.

Figure 4 (right): Predicted simulation of B_z near the MRI threshold.

Acknowledgments

We would like to thank Erik Gilson and Kyle Caspary for their assistance in this project. This work was made possible by funding from the Department of Energy for the Princeton Plasma Physics Laboratory Summer Internship.

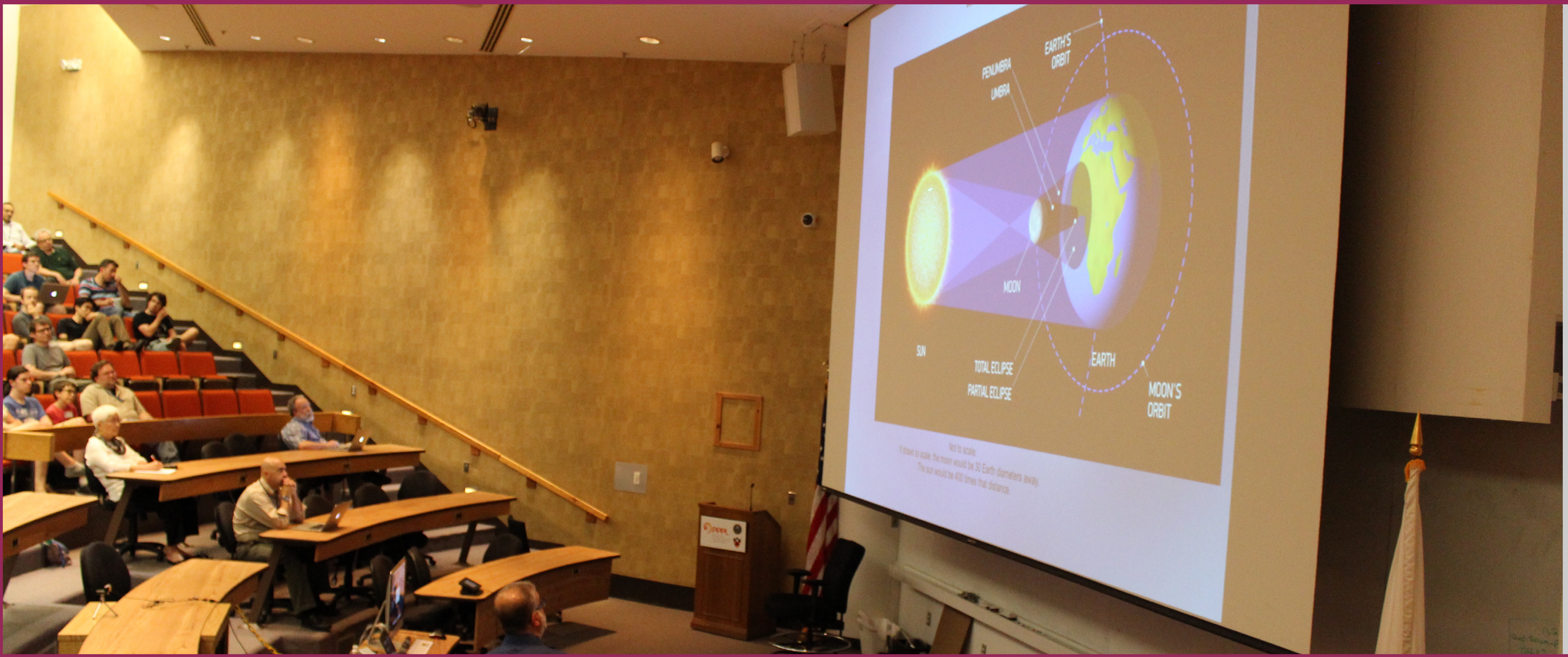
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PPPL staff learn about the Aug. 21 eclipse at Amitava Bhattacharjee lecture



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The PPPL Big Bang Bash 2017

**Friday
Sept. 15
11 a.m.**

Volunteers needed!

Enjoy great food, fun games and team-building activities, and the opportunity to network and socialize with friends and colleagues and meet new ones!

The Big Bang Bash includes:

- **An Antique & Specialty Vehicle Show**
- **Diversity Fair**
- **A United Way community service project**
- **Dunk Tank and other activities**

Many Voices. One Mission.

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Antique & Specialty Vehicle Show



11 a.m., Sept. 15
D-Site Parking Lot

Sign up through your email invitation!

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Celebrate PPPL's Cultural Diversity



11 a.m., Sept. 15

If you have a country of origin other than the USA and would like to showcase your cultural heritage with costumes, artifacts, and food, sign up through your email invitation.

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**Join the PPPL team
helping disadvantaged
schoolkids!**

**Help assemble snack bags for after-school programs in our community.
Or donate snacks!**

We need:

- **Juice boxes/pouches**
- **Mini water bottles**
- **Nut-free snacks (i.e. Goldfish, Teddy Grahams, fruit snacks, granola bars, chips, etc.).**

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BROCK

NICK PETTI

Chef Manager

Premier

Café

at PPPL

BREAKFAST 7 a.m. • 10 a.m.

CONTINENTAL BREAKFAST 10 a.m. • 11:30 a.m.

LUNCH 11:30 a.m. • 1:30 p.m.

SNACK SERVICE until 2:30 p.m.

	Monday August 21	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25
COMMAND PERFORMANCE Chef's Feature	Roast Pork with Barley Wild Rice Pilaf and Vegetable	Power Bowl	Caprese Chicken with Orzo Pilaf	Wild Mushroom Turkey Meatloaf with Mashed Potatoes and Vegetable	Fish and Chips
Early Riser	Bacon, Egg and Cheese English Muffin	Mexican Breakfast Burrito	Potato, Roasted Pepper & Sundried Tomato Casserole with 2 Eggs any Style	Cinnamon-Raisin Pancakes with Homemade Apple Compote	French Toast Sticks
Country Kettle	Manhattan Clam Chowder	Vegetable	Chicken Noodle	Tomato Soup	Chili Bean
Deli Special	Spring Chicken Salad Wrap	Asiago Roast Beef with Grilled Onion, Tomato & Horseradish on Pumpernickel	California BLT with Avocado	Turkey Sloppy Joe	Spicy Crab Sushi Wrap
Grille Special	Grilled Vegetable Quesadilla	Chipotle BBQ Pulled Pork Sandwich with Fries and Slaw	Burgerlicious Buffalo Turkey Burger	Jalapeño Popper Bacon-Wrapped Hot Dog	Teriyaki Chicken Cheesesteak
Panini	TBD	Baja Fried Flounder Hero with Crunchy Slaw and Pico de Gallo	Pastrami and Swiss on Marble Rye	Chipotle Roast Beef Melt on Foccacia	Breaded Chicken Cutlet with Ham, Swiss Cheese, Lettuce & Honey Mustard on Ciabatta

MENU SUBJECT TO CHANGE WITHOUT NOTICE

HEART HEALTHY

VEGETARIAN OPTION