OAK RIDGE National Laboratory

June 1st, 2026

Introduction to the Introduction to Plasmas and Fusion Course

Presented by:

Arturo Dominguez

Fusion Partnerships Scientist, ORNL

U.S. DEPARTMENT of ENERGY

ORNL IS MANAGED BY UT-BATTELLE LLC
FOR THE US DEPARTMENT OF ENERGY

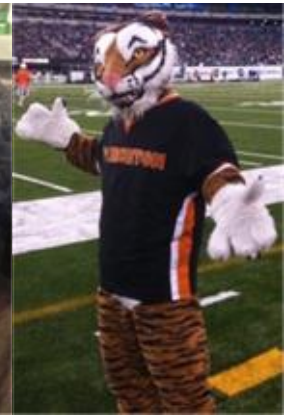
First, a bit about myself

- From Bogotá, Colombia
- Started studying physics at the National University of Colombia at Bogota.

- Did my graduate work at MIT, in Boston on fusion plasmas (GO BEAVERS!)

- Transferred to University of Texas at Austin where I finished undergrad (HOOK'EM HORNS!)

- In 2012, I started at the Princeton Plasma Physics Lab (GO TIGERS!)
- I led the Science Education Department from 2022-2025



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PPPL PRINCETON PLASMA PHYSICS LABORATORY

Lots of changes since last year!

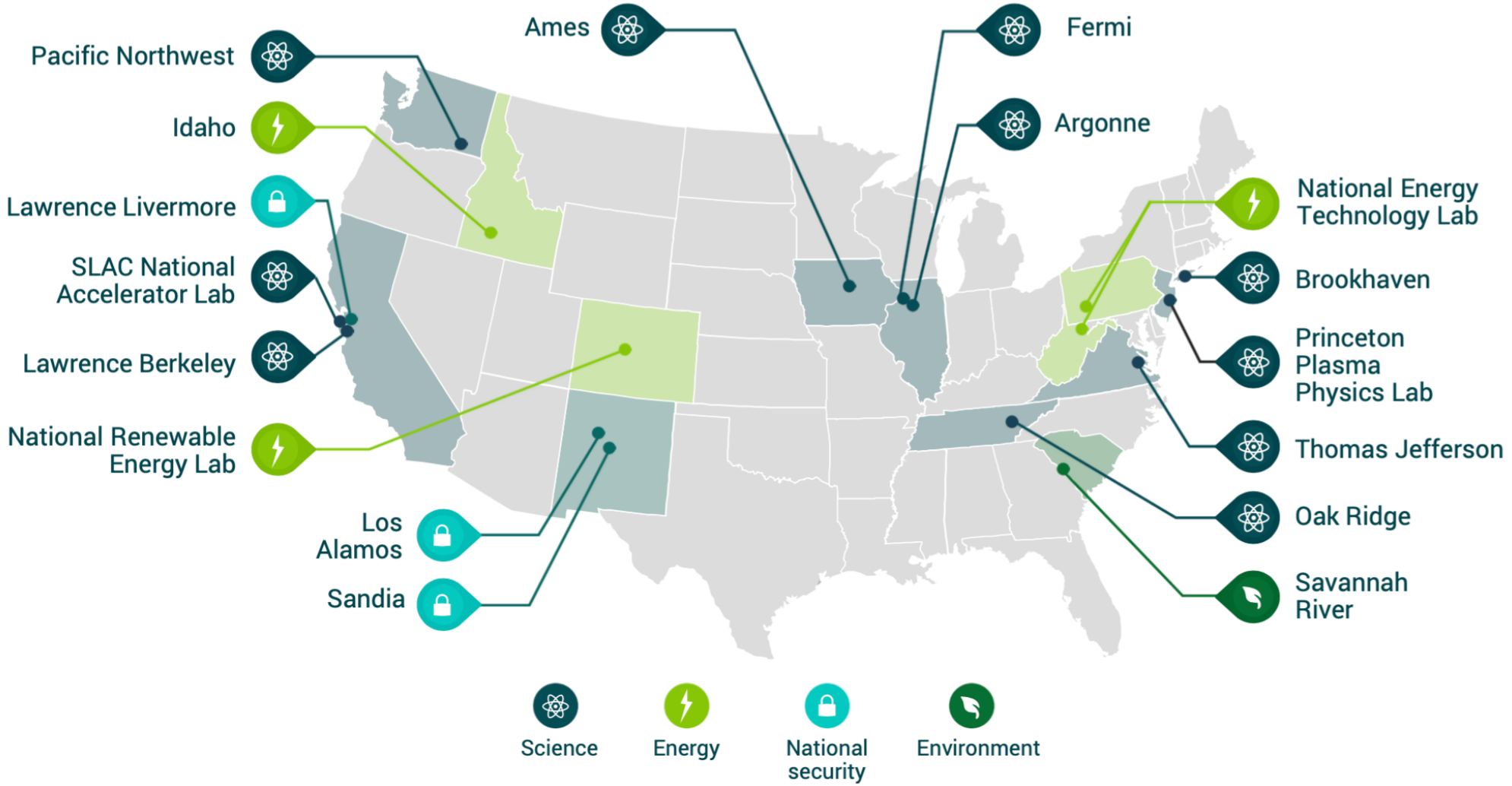
- In October/25 I switched roles within PPPL to support the growing public-private partnerships at PPPL

- Starting in March/26 I joined the Oak Ridge National Laboratory! (GO…ISOTOPES?)

- As **Fusion Partnerships Scientist**, I continue to support the growing public-private landscape in fusion

This is the first year of a PPPL+ORNL Intro to Plasma and Fusion Course!

PPPL and ORNL are 2 of 17 Department of Energy national laboratories



PPPL

Managed by PRINCETON UNIVERSITY

700+
Lab employees

$150 million+
government funding

90 acres
Princeton, NJ campus

300+
annual research publications

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PPPL PRINCETON PLASMA PHYSICS LABORATORY

Lyman Spitzer started PPPL (originally Project Matterhorn) in 1951…Birthplace of US fusion

Inventor of the Stellarator

Founder of the lab

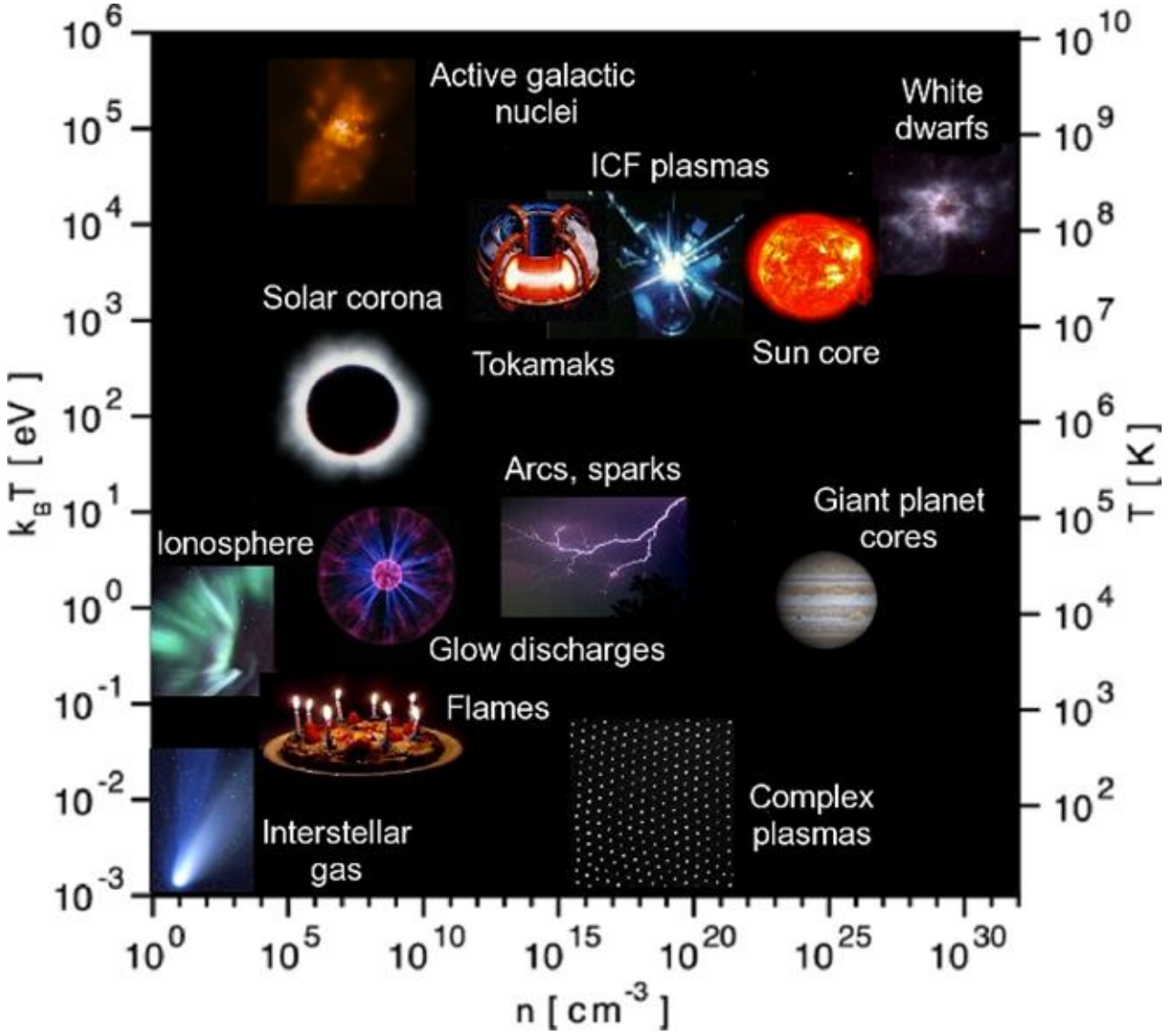
Made countless advances in plasma physics (his name is everywhere)

Proposed telescopes in outer space (hence the Spitzer Space Telescope)

Plasma physics is a rich and varied field of study

Plasma is the 4th state of matter: It is qualitatively different than gas due to its collective behavior, particularly its interactions with E&M fields.

Plasmas cover a **wide range of densities and temperatures** This makes the field rich in scope

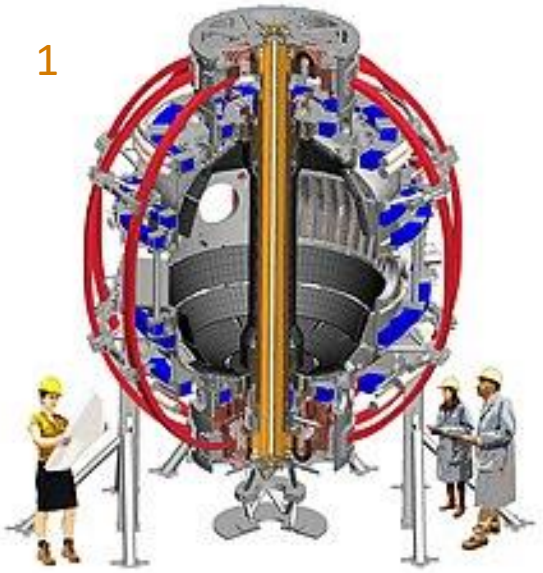


PPPL: From National Priorities to Laboratory Mission

PPPL has three major missions:

1. to develop the scientific knowledge and advanced engineering to enable fusion to power the U.S. and the world
2. to advance the science of nanoscale fabrication for industries of the future
3. to further the scientific understanding of plasmas from nano- to astrophysical-scales

1



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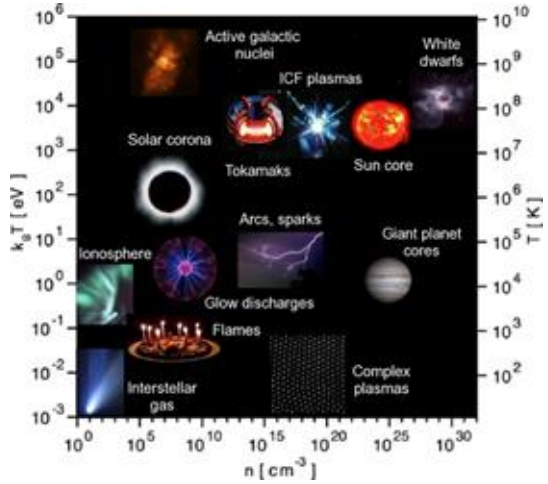

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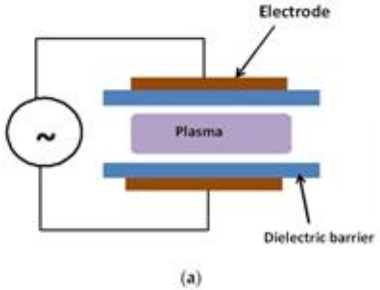

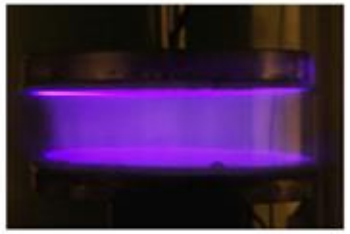

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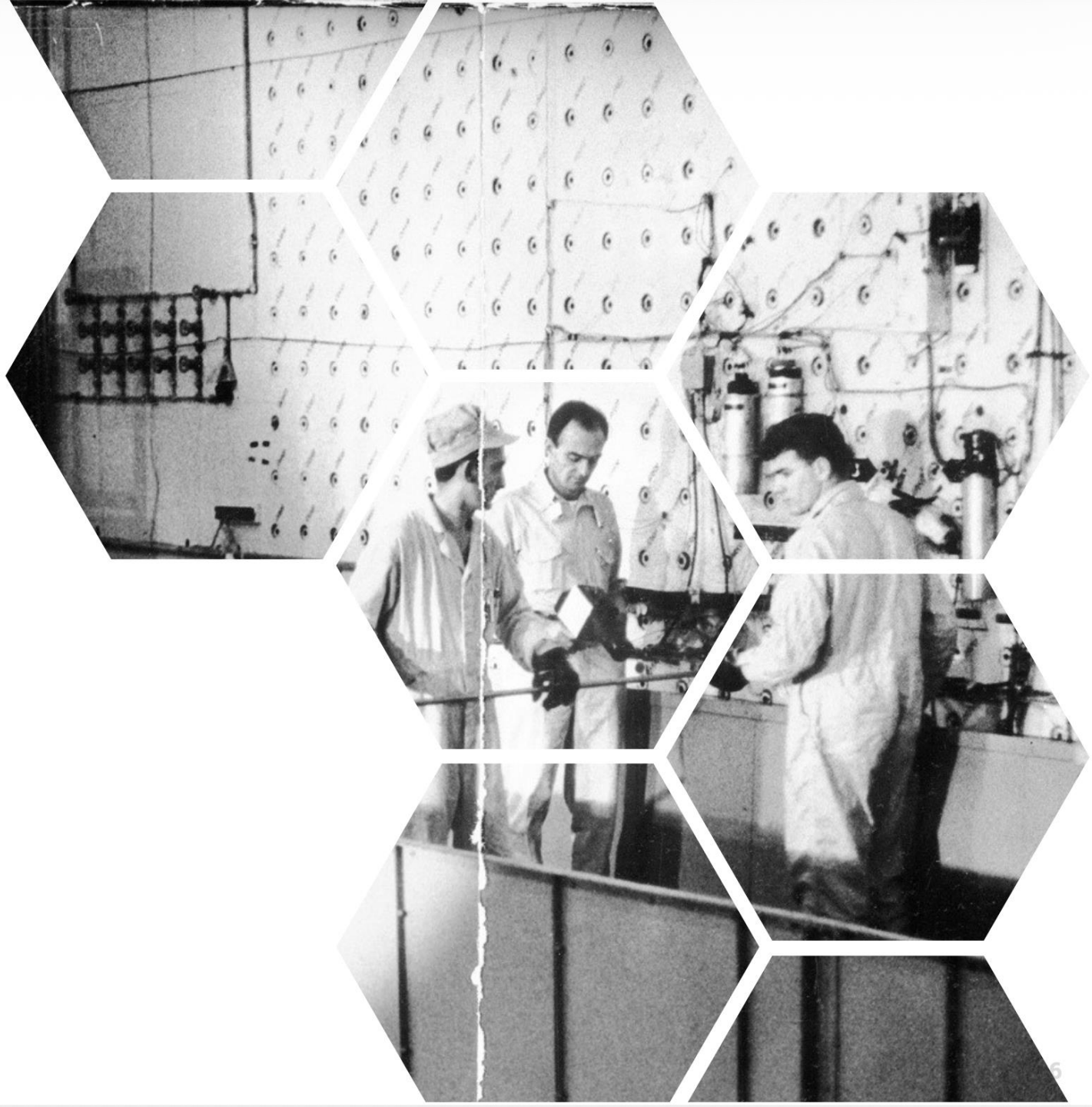
ORNL began in 1943 with the world's first continuously operating nuclear reactor

MISSION

Demonstrate that gram quantities of plutonium could be chemically separated from irradiated uranium



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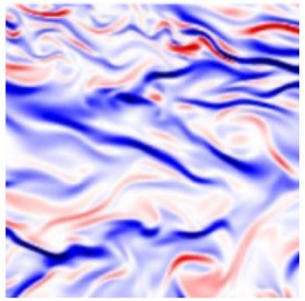
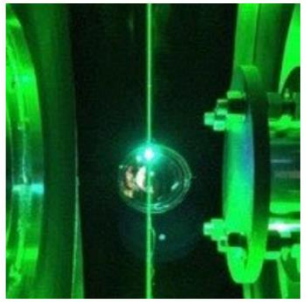
ORNL is the oldest and largest Office of Science Lab. Its research spans many national and global priorities

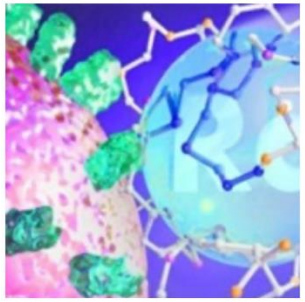
Biology and environment



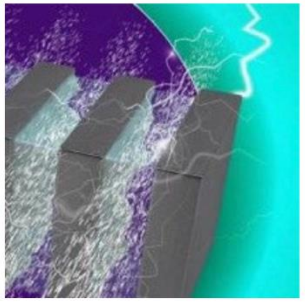
Fusion and fission



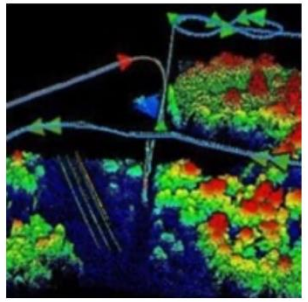
Isotopes

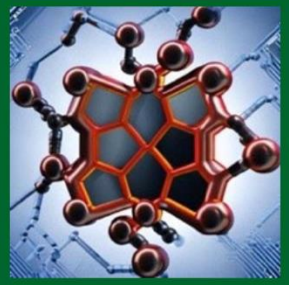


Energy science and technology



National security





Computing, AI, and quantum

Neutrons

Materials, chemistry, and nuclear physics

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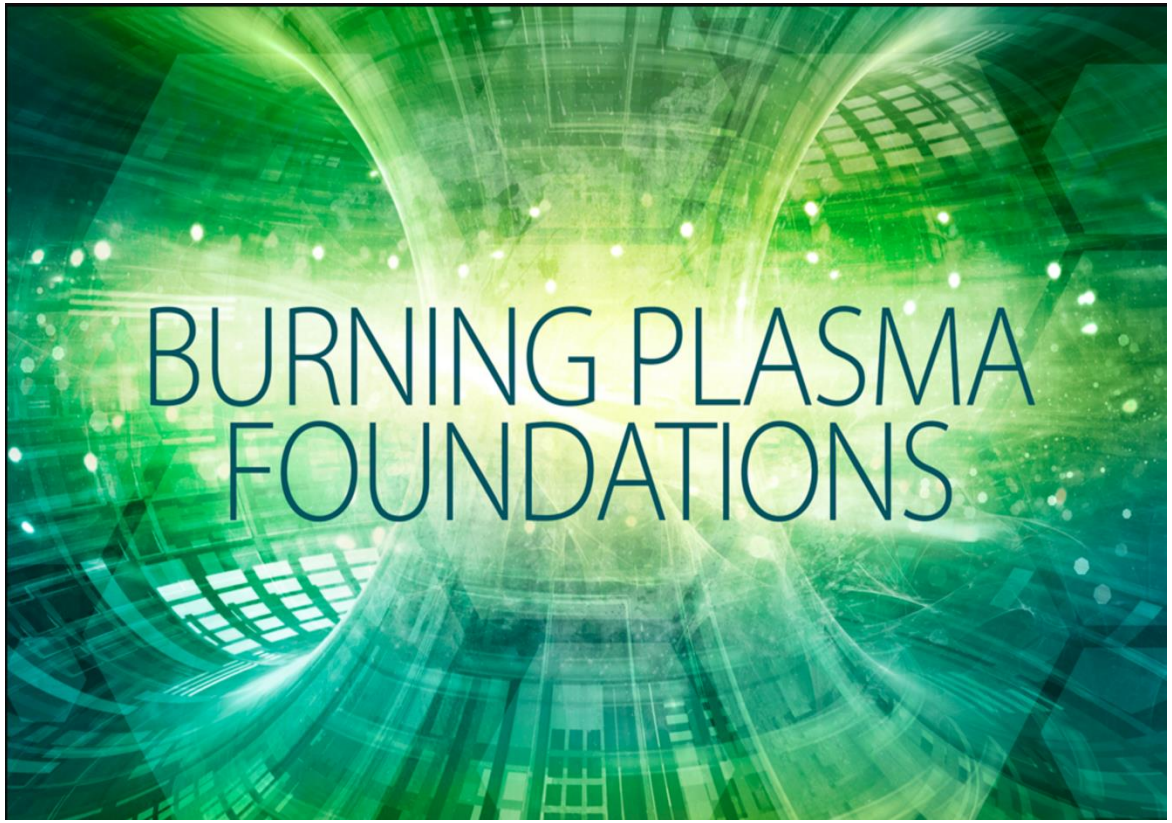
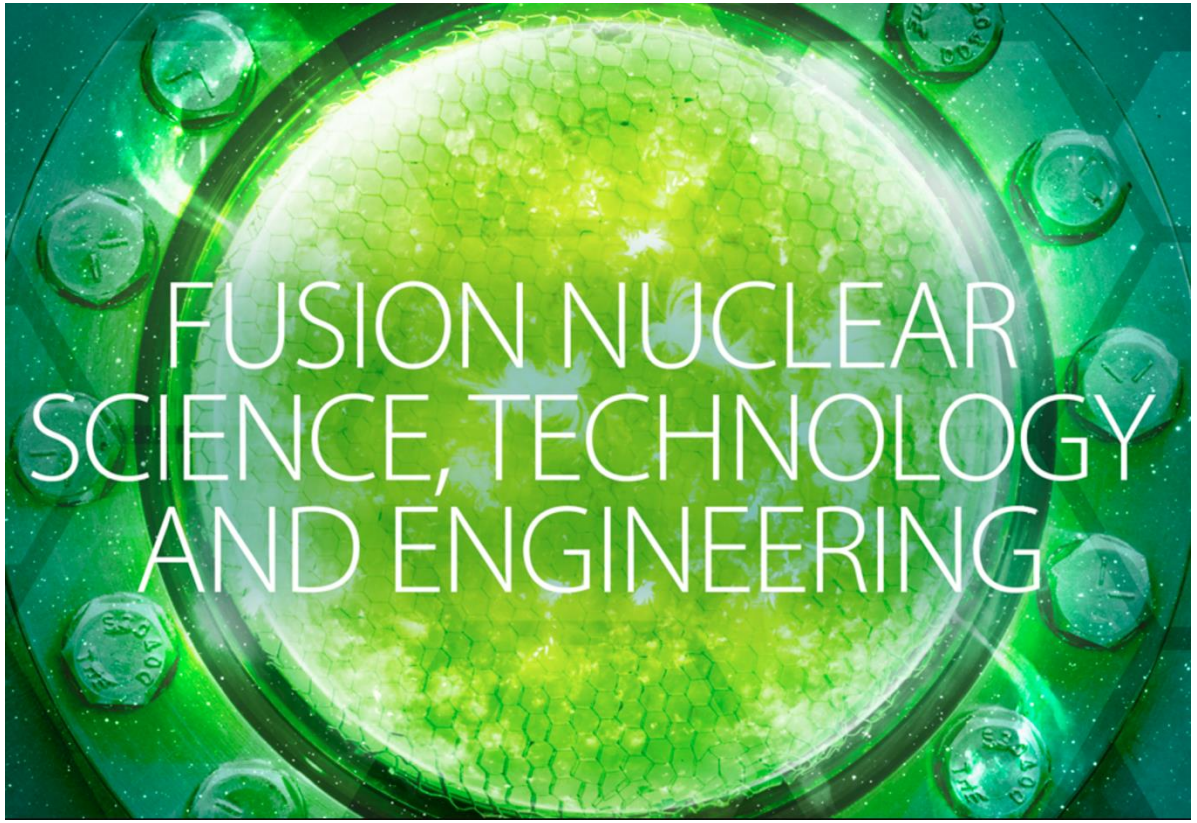
ORNL's Fusion Energy Division leads the fusion research at the lab





History of the Intro to Fusion/Plasma Course

Originally started in 1992 by Prof. Nat Fisch and former assistant director (and former congressman) Rush Holt, as part of the National Undergraduate Fellowship (NUF).

1994 NUF Class

Rush Holt

Nat Fisch

History of the Intro to Fusion/Plasma Course

Originally started in 1992 by Prof. Nat Fisch and former assistant director (and former congressman) Rush Holt, as part of the National Undergraduate Fellowship (NUF).

1994 NUF Class

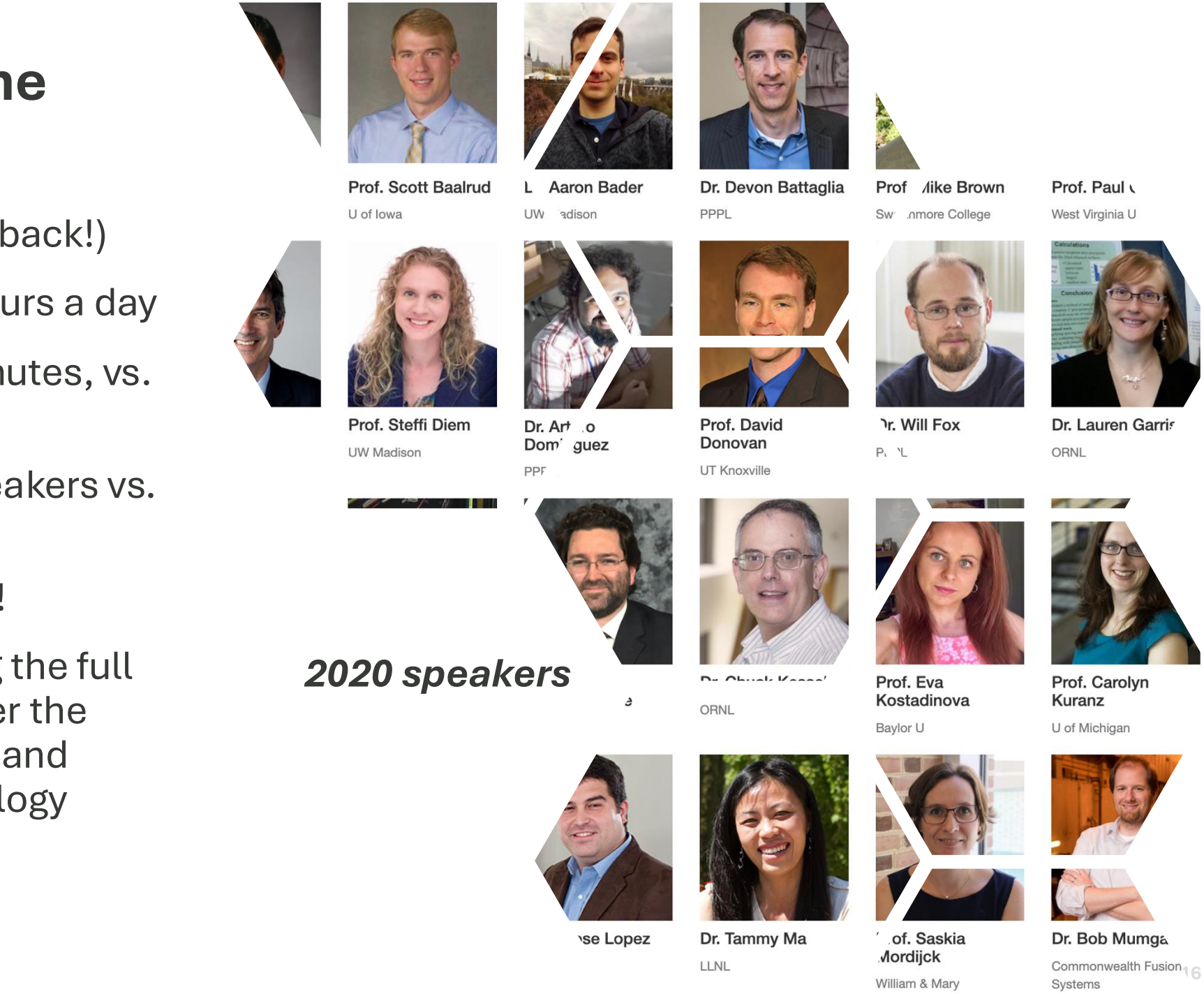
Troy Carter: Director of the ORNL Fusion Energy Division

Rush Holt

Nat Fisch

Changes during the pandemic

- Fully Remote (not going back!)
- 2 weeks long, but 4.5 hours a day
- Shorter talks (50+10 minutes, vs. 90 minutes)
- Many more talks (25 speakers vs. 15 in the past)!
- Many more participants!
- Broader scope, covering the full spectrum of topics under the Fusion Energy Sciences and Plasma Physics/Technology umbrella

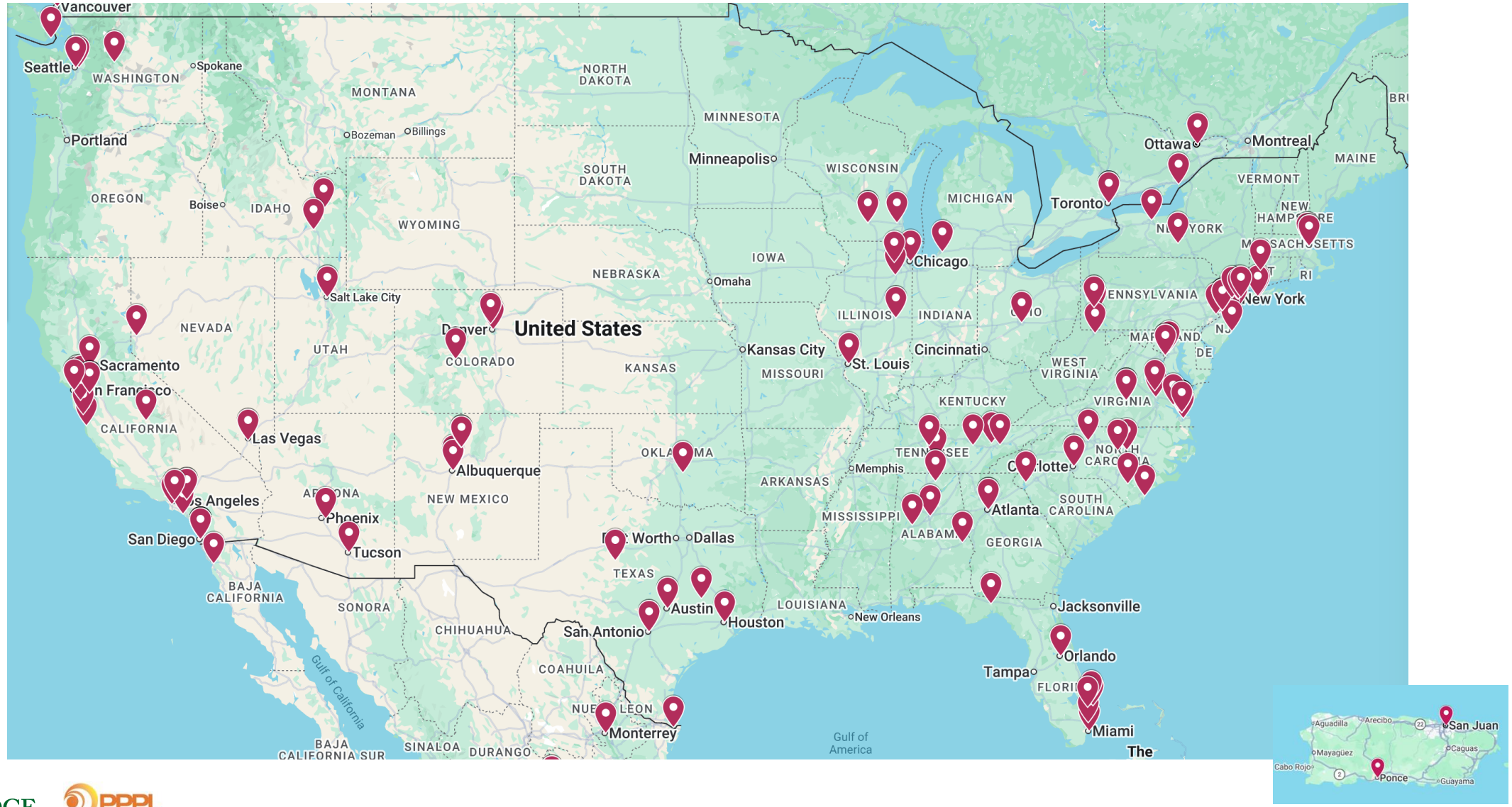


All lectures are free to watch and will be posted

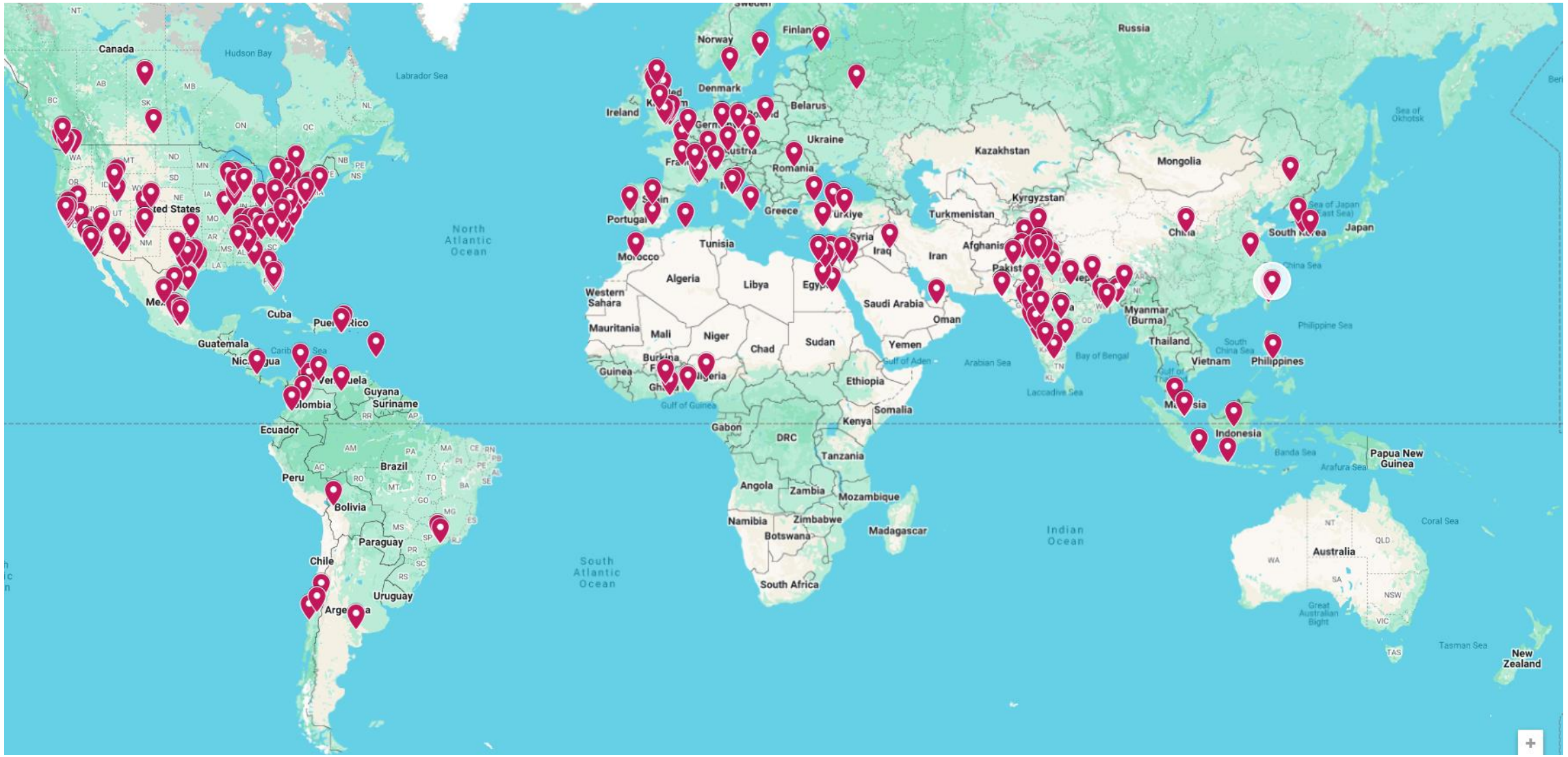
- All lectures will be streamed via Zoom.
- Participants will have a Zoom-Brady-Bunch-Square. **Turn your video on whenever possible! It feels empty when speaking to a bunch of names!**

- Please hold questions until the end unless they're clarifying questions or the speaker has asked for live quesitons
- As has been done since 2015, the course lectures and the speaker videos will be posted on the site.

Y’all are all over the US!



Y’all are all over the WORLD!



What to expect during the next couple of weeks

Today (6/1) we'll frame the Science & Technology challenges of fusion as well as giving it context in the energy market

Eastern Time	Day 1 (6/1/26)
12:00 PM	
1:00 PM	**Intro to the Course** *Dominguez*
1:30 PM	**Intro to Fusion** *Srinivasan*
2:30 PM	Break/Hallway Discussion
3:00 PM	**The role of clean firm resources and why fusion needs to compete** *Jenkins*
4:00 PM	**Hallway discussion/Adjourn**

- After this intro, **Prof. Bhuvana Srinivasan** (U Washington) will present an overview of Fusion Energy S&T
- **Prof. Jesse Jenkins** (Princeton U), will give an overview of clean energy challenges and where fusion plays a role

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Tomorrow (6/2) we introduce plasmas

Eastern Time	Day 2 (6/2/26)
12:00 PM	**Intro to Plasmas** *Schaffner*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Single Particle Motion** *Capece/Williams*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Plasmas as a Fluid** *Cerfon*
4:00 PM	**Hallway discussion/Adjourn**

- **Prof. David Schaffner** (Bryn Mawr College) will introduce plasmas and describe their characteristics
- **Prof. Jeremiah Williams** (Wittenberg U) and **Prof. Angie Capece** (TCNJ) will describe the motion of charged particles in space in the presence of EM fields
- **Dr. Antoine Cerfon** (Type One Energy) will close the day by presenting plasmas as a fluid

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On Day 3 we complete the introduction to plasmas

Eastern Time	Day 3 (6/3/26)
12:00 PM	**Plasma Waves** *Barnett/James*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Plasma Turbulence** *Parisi*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Magnetic Reconnection (Nuno's 2018 prerecorded SULI lecture)** *Loureiro/Zhou/Jin*
4:00 PM	**4:30PM: Adjourn**

- **Dr. Rhea Barnett** (ORNL) and **Prof. Royce James** (Howard U) will discuss the zoology of waves that exist in plasmas

- **Dr. Jason Parisi** (Marathon Fusion) will be presenting the ubiquitous phenomenon of plasma turbulence

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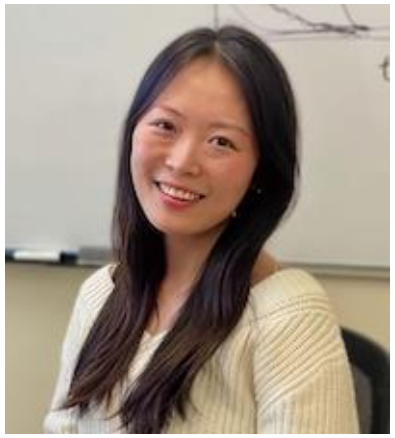
We close Day 3 with a special tribute to Nuno Loureiro

Eastern Time	Day 3 (6/3/26)
12:00 PM	**Plasma Waves** *Barnett/James*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Plasma Turbulence** *Parisi*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Magnetic Reconnection (Nuno's 2018 prerecorded SULI lecture)** *Loureiro/Zhou/Jin*
4:00 PM	**4:30PM: Adjourn**



- This year we lost our colleague and friend **Prof. Nuno Loureiro** (MIT PSFC). Prof. Loureiro set the standard when he presented the Intro Course Magnetic Reconnection talks from 2016-2018.
- This year we will replay his 2018 talk and his colleagues/former students **Dr. Suying Jin** (MIT PSFC), and **Prof. Muni Zhou** (Dartmouth) will introduce him and lead the Q&A and.

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Day 4 we explore the intersection between AI and Fusion, begin magnetic confinement, and do some networking

Eastern Time	Day 4 (6/4/26)
12:00 PM	**AI for Fusion** *Rea*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Tokamaks** *Thome*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Networking Session I** *Grads and early careers*
4:00 PM	**Adjourn**

- **Dr. Cristina Rea** (MIT PSFC) will discuss the intersection between AI and fusion
- **Dr. Kathreen Thome** (GA) will begin the topic of magnetic confinement by introducing Tokamaks
- The day will finish with the first networking session with graduate students and early career scientists/engineers.

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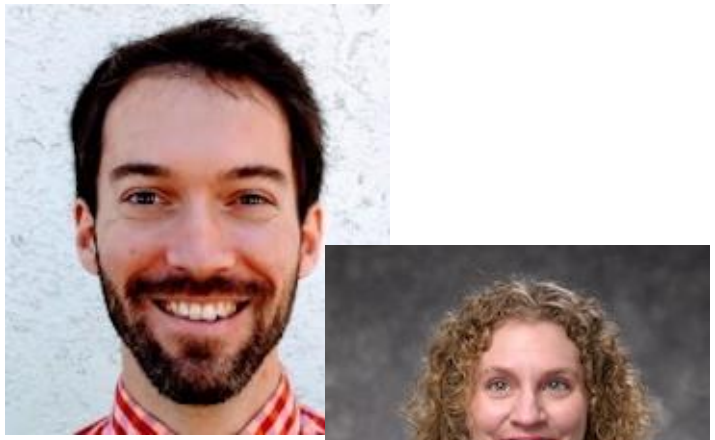
We close the first week with a discussion of alternate fusion concepts, plasma heating and inertial fusion energy

Eastern Time	Day 5 (6/5/26)
12:00 PM	**Alternate Fusion Concepts** *Parke*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Heating and Current Drive in Magnetized Plasmas** *Diem*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Inertial Fusion Energy** *Grace*
4:00 PM	**Hallway discussion/Adjourn**



- **Dr. Eli Parke** (Novatron) will begin the day by presenting on innovative alternative fusion approaches.
- **Prof. Steffi Diem** (U Wisconsin) will present on using RF waves to heat and drive current in magnetized plasmas
- **Dr. Liz Grace** (LLNL) will finish the week by introducing the only fusion concept which has reached ignition in a lab, Inertial Fusion

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Sunday and Saturday we rest

We start week 2 with a dive deep into Fusion Materials and Technology (FM&T)

Eastern Time	Day 6 (6/8/26)
12:00 PM	**Fusion Blankets** *Gehrig*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Fusion Materials and Corrosion** *Romedenne*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Fuel Cycle** *Gacia-Diaz*
4:00 PM	**Adjourn**

- **Dr. Monica Gehrig** (ORNL) will introduce the fusion blanket, its importance and its challenges.
- **Dr. Marie Romedenne** (ORNL) will discuss the challenges of material compatibility and corrosion in fusion systems.
- **Dr. Brenda Garcia-Diaz** (SRNL) will close the day discussing how a fusion plant will ensure it has the necessary fuel to run.

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Day 7 we go to the other extreme (temperature-wise) and discuss low temperature plasmas, dusty plasmas, and plasma-material interactions

Eastern Time	Day 7 (6/9/26)
12:00 PM	**Low Temperature Plasmas** *Lopez*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Dusty Plasmas** *Kostadinova*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Plasma-Material Interaction** *Schamis/Capece*
4:00 PM	**Adjourn**

- **Prof. Jose Lopez** (Seton Hall) will present the vast and fruitful world of Low-Temperature Plasmas.
- **Prof. Eva Kostadinova** (Auburn) will introduce the complex physics of dusty plasmas.
- To close the day, **Dr. Hanna Schamis** (PPPL) and **Prof. Angie Capece** (TCNJ) will discuss the importance of the plasma-facing materials in fusion reactors

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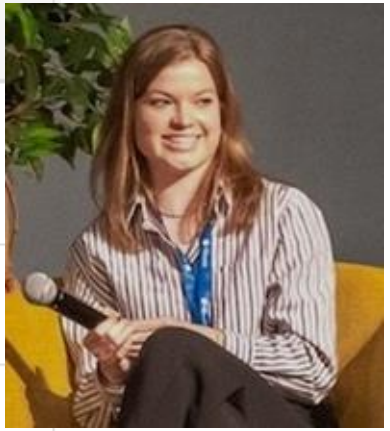
Day 8 we finish fusion configurations and a have panel about undergrad/grad/career opportunities

Eastern Time	Day 8 (6/10/26)
12:00 PM	**Pulsed Power** *Rocco/Hare*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Stellarators** *Hammond*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Opportunities for undergraduate and graduate students** *Anderson/Slowing/Williams*
4:00 PM	**Adjourn**

- **Prof. Jack Hare** (Cornell) and **Dr. Sophia Rocco** (LLNL) will introduce pulsed power configurations.
- **Dr. Ken Hammond** (PPPL) will close out fusion configurations with a talk about Stellarators.

Day 8 we finish fusion configurations and a have panel about undergrad/grad/career opportunities

Eastern Time	Day 8 (6/10/26)
12:00 PM	**Pulsed Power** *Rocco/Hare*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Stellarators** *Hammond*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Opportunities for undergraduate and graduate students** *Anderson/Slowing/Williams*
4:00 PM	**Adjourn**



- We close Day 8 with an expert panel. **Caroline** Anderson (Fusion Industry Association), **Dr. Igor** Slowing (DOE-WDTS), and **Prof. Jeremiah Williams (NSF)** will present on opportunities available for undergraduate and graduate students, as well as opportunities in the private sector.

Day 9 we'll have an interactive workshop on computational plasma physics and the second networking session

Eastern Time	Day 9 (6/11/26)
12:00 PM	**Computational Workshop** *Murphy/Schaffner*
1:00 PM	Break/Hallway Discussion
1:30 PM	**Computational Workshop** *Murphy/Schaffner*
2:30 PM	Break/Hallway Discussion
3:00 PM	**Networking Session II** *Grads and early careers*
4:00 PM	**Adjourn**

Plasma Py

- **Dr. Nick Murphy** (Harvard Smithsonian CfA) will begin the interactive computational plasma physics workshop using tools from the PlasmaPy Python package.

  Prof. David Schaffner (Bryn Mawr College) will close by highlighting PlasmaPy examples from earlier topics.
- We close the day with our second networking session with students and early career researchers.

We close the course with the Business of Fusion

Eastern Time	Day 10 (6/12/26)
12:00 PM	**Industry Framing and Fusion Landscape** *Kniazev & Wurzel*
1:00 PM	1:15pm: Break/Hallway Discussion
1:30 PM	**Techno-Economic Analysis, Finance & Policy** *Araiinejad & Hsu*
2:30 PM	2:45pm: Break/Hallway Discussion
3:00 PM	**Constraints, regulation and international perspectives** *Sutcliffe*
4:00 PM	**Closing remarks / Adjourn**

- **Sergei Kniazev** (Module 12) will begin the day with a discussion of what makes fusion an industry.
- **Sam Wurzel** (Fusion Energy Base) will present the state of the fusion landscape.
- Continued by **Layla Araiinejad** (Module 12) who will make a techno-economic analysis of the field.
- **Dr. Scott Hsu** (Lowercarbon) will provide a practitioner's view of fusion finance and policy
- To close out the course, **Douglas Sutcliffe** (Module 12) will discuss industry constraints, regulation, and provide an international perspective.

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We've started a Discord server for the incoming fusion/plasma community!

- In the summer of 2020, we created a venue to let the undergrad and grad participants of this course, and, in general, undergrads and grads just starting out in the road of fusion and plasma physics, talk to each other and learn about summer opportunities. Conversations continued beyond the summer.

- With the help of Nigel DaSilva and Louise Ferris, we've created and maintained a Discord server for this purpose. **Click on this link to join the server.** Be sure to read the welcome page, including the code of conduct and the flair emoji info. Please treat the server as a public, professional space.

Nigel DaSilva,
2020 PPPL SULI
Current Columbia
grad student

Louise Ferris,
2020 LANL SULI
ORNL Staff (my colleague and Intro Course co-organizer)

Continue the conversations with the speakers!

- Some (most) speakers will be able to stick around after their talks to continue discussions for up to 30 mins during the main-webinar break.
- We want to ensure that the default is for people to take a break, so all “Hallway Discussions” will continue in the Hallway Discussion Zoom Room.
- We will announce if speakers will be available.

Join the Networking sessions!

- We know you have questions about academic/career pathways in plasma science and fusion energy research.
- Volunteer graduate students and early career industry researchers will be available to chat with you during our networking sessions:
  - **Thursday 6/4, 3pm-4pmET**
  - **Thursday 6/11, 3pm-4pmET**

Certificates of Completion

- Do you plan to watch all the lectures (or the vast majority of them)? If you do, we'll email you a Certificate of Completion for the course!
- Watch the lectures (live if you can, but prerecorded if necessary), and be sure to watch my closing remarks on June 12th.

APS-DPP Abstract Submission

- The American Physical Society Division of Plasma Physics (APS-DPP) meeting is scheduled for the week of **Nov. 2-6, in Chicago, IL, with Student day on Nov. 2nd (highly recommended)**.
- The conference will be held as a hybrid in-person/remote event. Visit the meeting website for up to date information.
- As with every year, undergraduates are invited to present their research at a dedicated poster session. There were **more than 100 undergraduate posters** at the 2025 APS-DPP meeting!
- While general poster abstract submissions are due July 2rnd, **the deadline for posters in the category for High school and undergraduate presentations will most likely be extended (more details on the site)!**
- Registration and APS membership is free for undergrads! Remote options available! **(AKA You have no excuse!)**

We've learned a lot from the pandemic that we shouldn't forget

- The reason the course became fully remote was because of the pandemic.
- We're still remote so that we can still reach all of the folks that can't come to PPPL or ORNL.
- Most if not all talks are recorded and will be posted, so practice self-care. Take rests, sit out when you're exhausted, stretch, stay hydrated, etc.
- **YOUR HEALTH AND WELL BEING ARE THE PRIORITY!**

Code of conduct

- Since this is a public forum we ask speakers and participants to:
- Make participation in our community a harassment-free experience for everyone
- Act in ways that contribute to an open, welcoming, diverse, inclusive, and healthy community
- We align with the Contributor Covenant Code of Conduct

Code of conduct: Unacceptable Behaviors

- The use of sexualized language or imagery, and sexual attention or advances of any kind
- Trolling, insulting or derogatory comments, and personal attacks
- Public or private harassment
- Other conduct which could reasonably be considered inappropriate in a professional setting

Code of conduct: Positive Behaviors

- Demonstrating empathy and kindness
- Being respectful of differing opinions and experiences
- Giving and gracefully accepting constructive feedback
- Accepting responsibility and apologizing to those affected by our mistakes, and learning from the experience
- Respect the pronouns of others
- Recognize that intent is not equal to impact
- Self-Care is revolutionary!

Thank you to my co-organizers!

Louise Ferris (ORNL)

Deedee Ortiz (PPPL)

Harry Tsamutalis (PPPL)

Britt Albucker (PPPL)

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PPPL PRINCETON PLASMA PHYSICS LABORATORY

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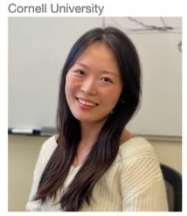

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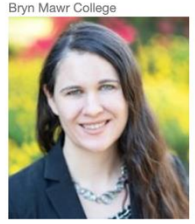

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