

# Princeton Collaborative Low Temperature Plasma Research Facility (PCRf): First Year, First Results

**Yevgeny Raitses**  
on behalf of PCRf team

**US DOE Princeton Plasma Physics Laboratory**  
**Princeton University**

<http://pcrf.pppl.gov>



- Formed in 2019 from the existing Low Temperature Plasma (LTP) laboratories at the PPPL and the MAE Department of the Princeton University
- Supported by the Department of Energy, Fusion Energy Science
- Mission: to provide state-of-the-art research capabilities and expertise to advance understanding and predictive control of LTPs with focus on:
  - Plasma-liquid interactions
  - Plasma-solid interactions
  - Plasma-nanoparticle interactions
  - Transport and collective phenomena in LTPs
  - LTP in modern applications: materials, health, environments, aerospace etc.

# PCRF Team

PCRF



Theory and simulations

Experiments and diagnostics



Mikhail Shneider  
(co-PI) Princeton



Igor Kaganovich  
(co-PI) PPPL



Sophia Gershman  
PPPL



Shurik Yatom  
PPPL



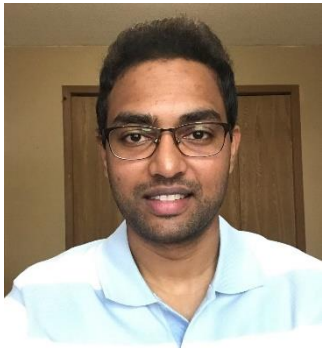
Arthur Dogariu  
PPPL



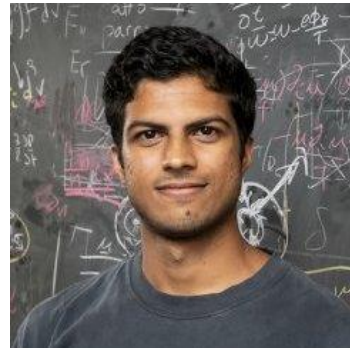
Yevgeny Raitsev  
(PCRF Director)  
PPPL

Postdoc, graduate and undergrad students

Technical and engineering support



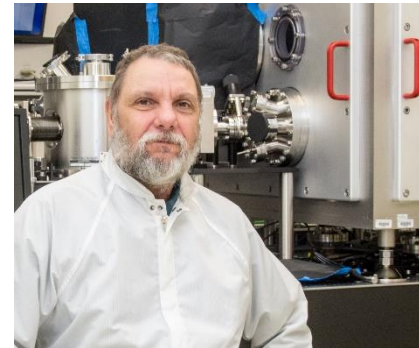
Santosh Kondeti  
PPPL



Nirbhav Chopra  
Princeton, Astro



Benjamin Benjadol  
Princeton, MAE



Tim Bennett  
PPPL/Princeton

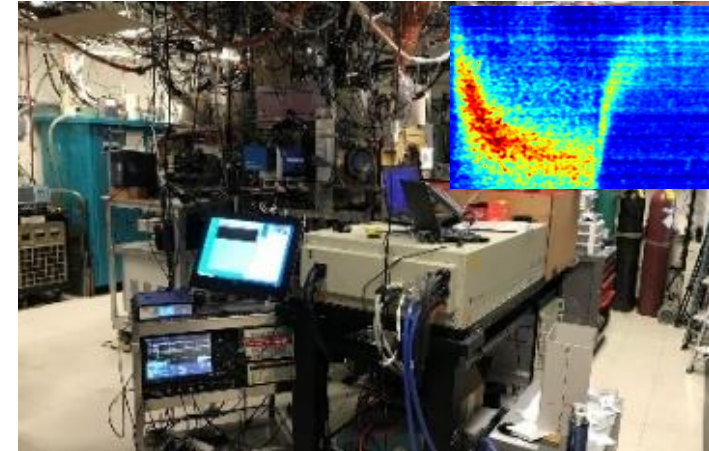


Alex Merzhevskiy  
PPPL

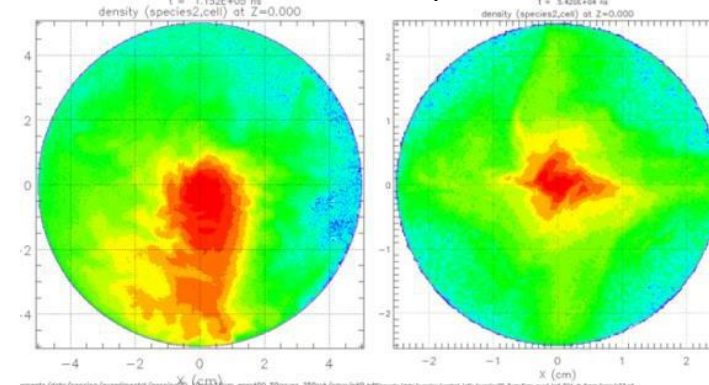


- Spatially and temporally resolved diagnostics and modeling of low temperature plasmas in a broad range of conditions:
  - low pressure collisionless to high pressure collisional
  - non-equilibrium and thermal
  - magnetized and non-magnetized
  - DC, RF, pulsed, laser-generated
- Advanced fs-ns-cw laser diagnostics of plasmas, gas phase, nanoparticles, plasma-surface interactions
- Fluid, kinetic (PIC, Vlasov) and atomistic simulations
- Machine Learning, Control

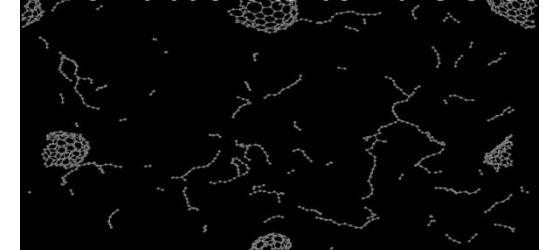
fs-TALIF of H in magnetized LTP



2-D PIC simulations of ExB plasma structures



MD simulations carbon fullerenes





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A background image showing a laboratory setting with a glowing green plasma source and a blue laser beam. The text "Apply to do research at PCRF!" is overlaid in white, bold font. Navigation arrows are visible on the left and right sides of the image.

# Apply to do research at PCRF!

The Princeton Collaborative Low Temperature Plasma Research Facility (PCRF) provides the entire scientific community access to specialized, world-class diagnostics, computational tools, and expertise in plasma physics.

[Learn how to submit a research proposal here.](#)



- Successful first, 2020 solicitation of collaborative research proposals with **46 submissions** from US and international academia, national labs and industry
- All submitted proposals were evaluated by 2-3 external reviewers + one internal reviewer and selected by External (non-PPPL/Princeton) Review Panel:
  - 1) Scientific and Technical Merit of the Project
  - 2) Appropriateness of the Proposed Method or Approach
  - 3) Availability of Appropriate Research Capabilities at the Facility
- Granted and scheduled **19 collaborative research projects** for runtime at PCRF
  - Schedule adjusted for COVID-related delays, September 2020-February 2021
- DOE FES Opportunities in Frontier Plasma Science supports 13 collaborative projects at PCRF



- Completed **5** fast-track ( $\leq 2$  weeks) collaborative proposals
- Conducting **8** standard (up to 2 months) collaborative proposals
  - 3 experimental projects (on sites): PI- E. Thimsen (Washington Univ. St Louis), PI- L. Maddalena (UT Arlington), and PI- A. Starikovskiy (Princeton)
  - 5 modeling projects (remote): PI- S. Macheret (Purdue), PI- A. Gerakis (Texas A&M at College Station), PI- X. Zhang (Texas A&M at Kingsville), PI- D. Levin, (Illinois Urbana Champaign), PI- T. Casey (Sandia)
- Because of COVID, 6 proposals rescheduled for November-February 2021
- PCRF outreach: SULI 2020 and PPPL Graduate Summer School 2020 at PPPL

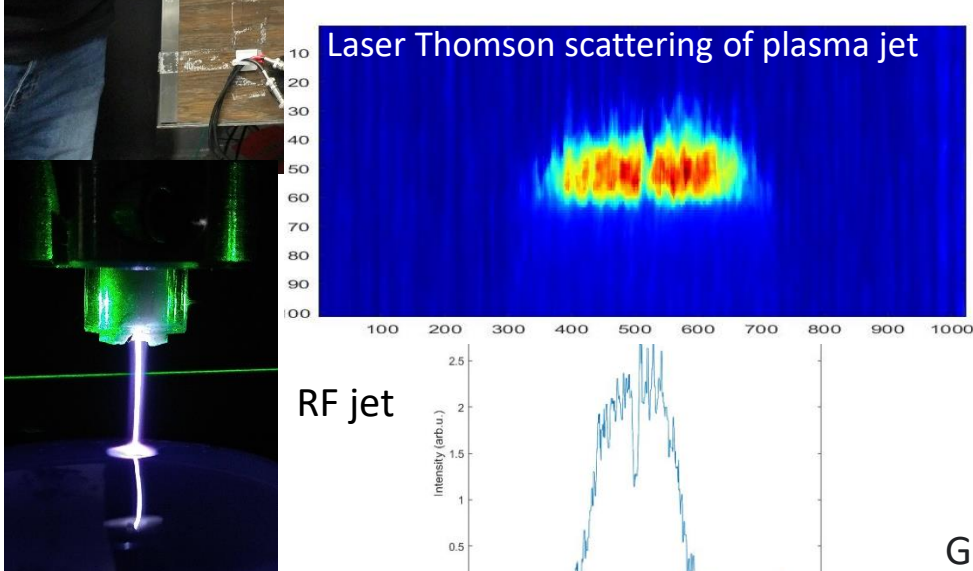
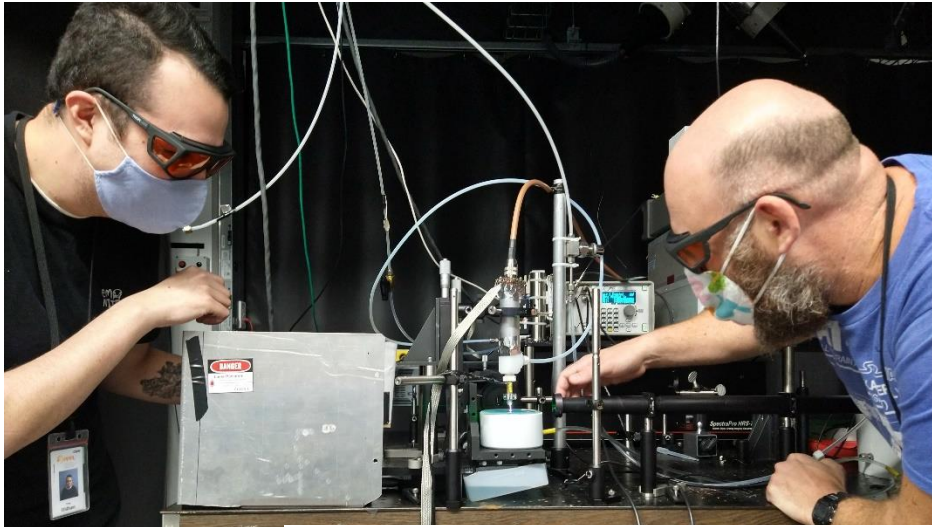


# On-going Collaborative Research Projects

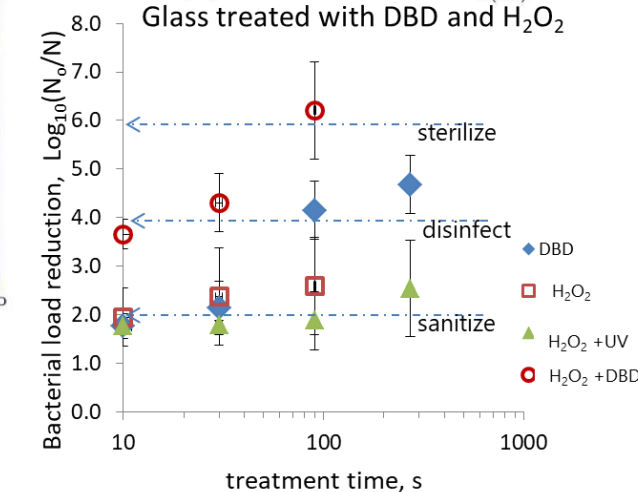
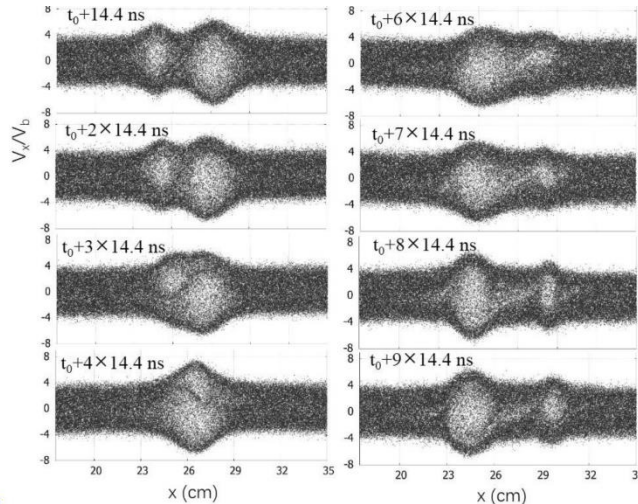
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E. Thimsen/T. Oldham (WUSTL) project on RF plasma jet-liquid interaction (S. Yatom, PCRF) at PPPL



D. Levin (UIUC) project on 3-D PIC simulations of beam interactions and solitons (I. Kaganovich, PCRF)

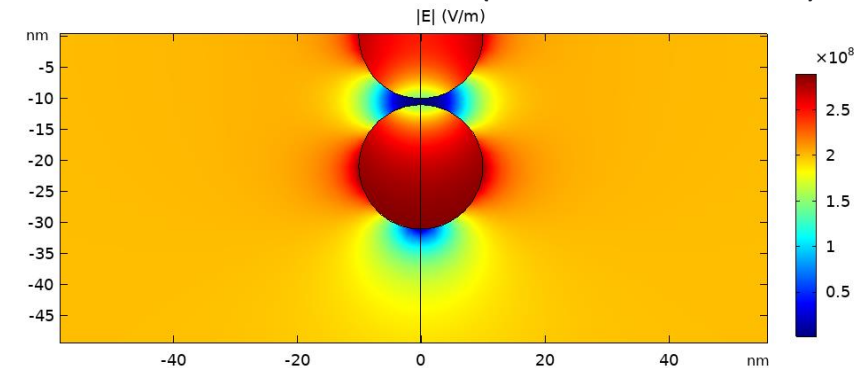


G. Haspel (NJIT) project on plasma disinfection (S. Gershman, PCRF) at NJIT

L. Maddalena (UT Arlington) project on fs TALIF and FLEET on arcjet tunnel (A. Dogariu, PCRF) at Arlington, TX



X. Zhang (UT Kingsville) project on modeling of ns-breakdown in water (M. Shneider, PCRF)





XF4.00007 : Igor Kaganovich (invited), “Integrated Modeling of Carbon and Boron Nitride Nanotubes Synthesis in Plasma of High-Pressure Arc”

JT2.00005: Arthur Dogariu et al., “Neutral Atomic-Hydrogen Measurements in a Mirror/FRC Plasma Device using fs-TALIF”

KT3.00003: Xuewei Zhang et al., “Electron generation and multiplication at the initial stage of nanosecond breakdown in water”

LT2.00039: Sophia Gershman et al., “Low Power Flex Dielectric Barrier Plasma Source for Surface Decontamination”

PW2.00004: Michael May et al., “Simulation of a capacitively coupled plasma micro-thruster using the particle-in-cell method”

LT2.00019: Jian Chen et al., “Particle-in-cell simulations of ion acoustic turbulence and energy exchange between ions and electrons in collisionless plasmas”

TR1.00003: O. D. Dwivedi et al., “DFTB+ simulation of BxNy species formation for boron nitride nanotubes synthesis”

YF1.00004: Y. Raites (invited), Princeton Collaborative Low Temperature Plasma Research Facility: First Results



- **Coordinated with Plasma Research Facility at Sandia National Laboratory (PI, Ed Barnat)**

Call for proposals open: November 2

**Close call: December 11**

External Review: ~ 1 month

Downselect: January 22

Decision: January 29

Notify Collaborative PIs: by February 8

**<http://pcrf.pppl.gov>**

## Information for Users

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### Proposal Information

Thank you for your interest in doing research with the PCRF. This section will guide you through the submission process.

First, please read about the call, submission, review, and decision process by clicking the below button and downloading the information document.

[Call, Submission, Review, and Decision Process](#)

Second, please click the below button to download the research template. The template contains all of the instructions, requirements, and necessary information needed from you to submit a complete proposal.

[Collaborative Proposal Template](#)

Once you have completed your proposal, please fill in the short form below and upload your document. Your proposal will be sent to PCRF principal investigator Yevgeny Raitses ([yraitses@pppl.gov](mailto:yraitses@pppl.gov)), and will be reviewed as soon as possible.

### Proposal Upload Form

Email \*

Enter Email

Confirm Email

Your email associated with your university/research institution

Completed Proposal \*

Drop files here or

[Select files](#)

# Acknowledgment

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PCRF



- PCRF External Review Panel (4) and External Reviewers (60)
- PCRF Advisory Board: Stewart Prager, Amy Wendt, Uwe Kortshagen, and Michael Keidar
- PPPL: Jonathan E. Menard (CRO), Philip C. Efthimion (PS&T), David B. Graves (ALD)
- Princeton University: Howard A. Stone (MAE)
- PCRF is sponsored by the US Department of Energy, Office of Science, Office of Fusion Energy Sciences
- DOE FES Program Manager: Dr. Nirmol Podder

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