2017 NSF CYBER-PHYSICAL SYSTEMS PRINCIPAL INVESTIGATORS' MEETING

Plasmas for Low Noise Reconfigurable RF Systems

ECCS-1619547, Award Date: September 1, 2016, Purdue University

PIs: Dimitrios Peroulis, Sergey Macheret, and Abbas Semnani

Challenge:

- Plasma antennas benefit:
  - easy reconfigurability
  - lower radar cross section
  - very fast on/off and tuning
  - lower mutual coupling
- However, they are **Bulky** and **Noisy**
- Microplasma technology to implement miniaturized plasma antennas
- This work: **Low-noise plasma antenna**

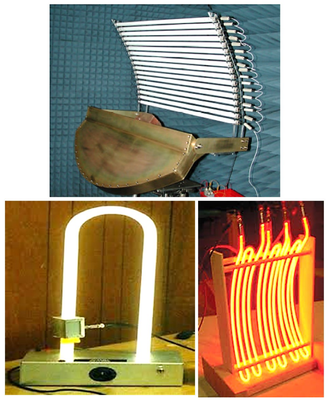
Solution:

- Using *a train of high-voltage nanosecond pulses for plasma excitation* to
  - keep the electron density high
  - but, reducing the electron energy
  - and decreasing power consumption

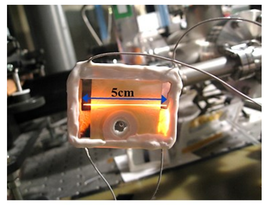
$$P_{noise}/\Delta f = \frac{4kT_e}{1+\frac{\omega^2}{\nu^2}}$$

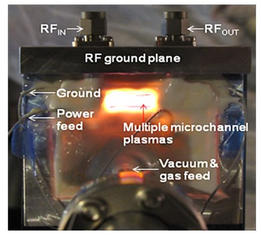
{dperouli; macheret; asemnani}@purdue.edu
Purdue University, 1205 W. State St., West Lafayette, IN 47907
https://engineering.purdue.edu/plasma/

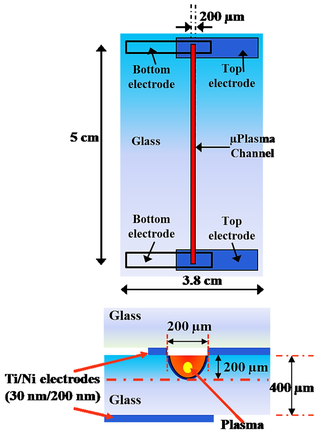
University of Tennessee/ Haleakala Inc.



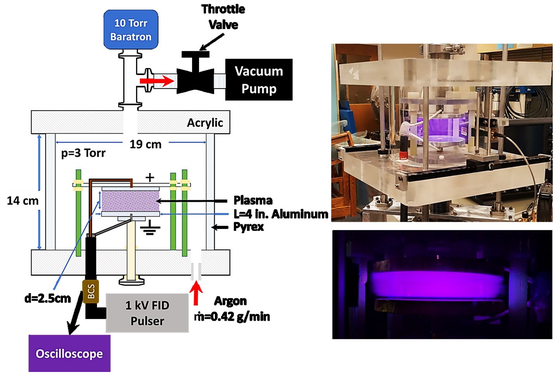
Lockheed Martin & UIUC



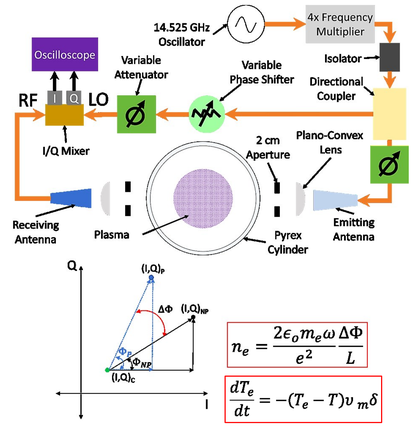




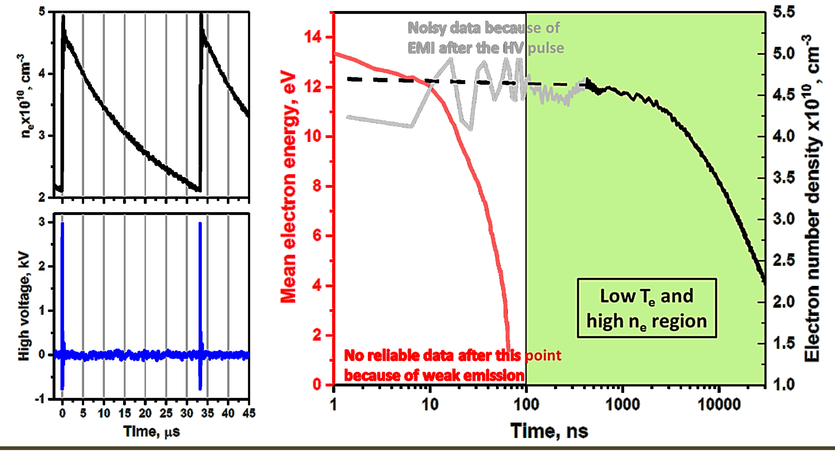
Plasma Chamber Setup



Microwave Interferometry Setup



Measured Results for Pure Nitrogen at 3 Torr. PRF = 30 kHz. P.W. = 2 ns



Scientific Impact:

- Transformative impact to introduce plasma antennas that can have thermal noise even less than those in metallic antennas
- The involved physics has been successfully examined.
- Cold plasma has been successfully employed for high-power tunable limiter, attenuator and switch.
- A low-noise loop antenna is being to be designed and fabricated.

Broader Impact:

- Foundation for next-generation reconfigurable RF electronics, from space communications to mobile consumer devices
- High-power tuning suitable for transmitters of communication and radar systems from the MHz to the 100 GHz regime
- will be incorporated into the Purdue curriculum and will also be used to create new exhibits for focused middle-school outreach activities such as the Purdue Nanodays