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Characteristics of a High-Pressure Pulsed Arc Discharge Environment for Model Verification

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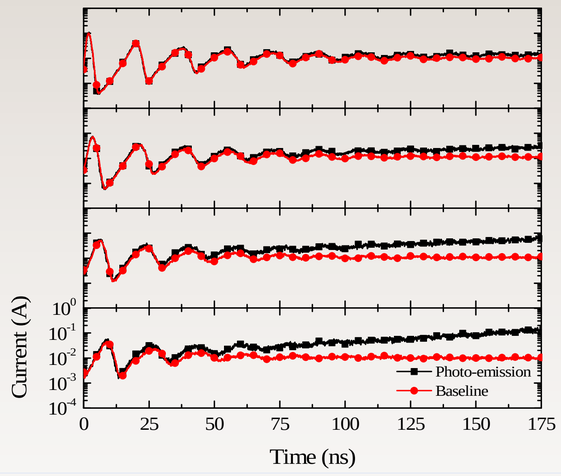
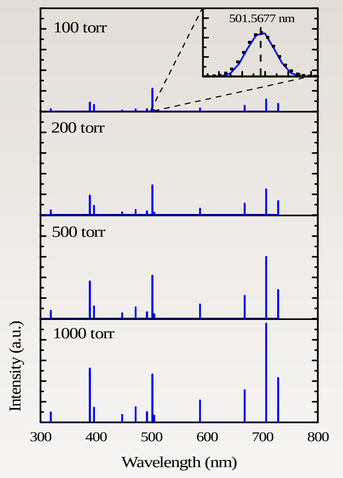
1. Motivation

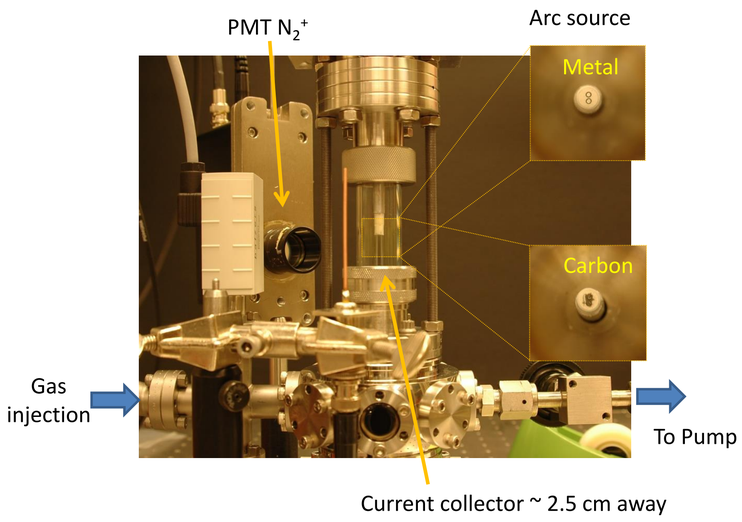
- In a discharge, various processes contribute to overall discharge characteristics.
  - Electron chemistry (ionization, excitation, elastic collisions, recombination).
  - Photonic processes (photoionization, photoexcitation, spontaneous emission).
  - Surface interaction (ion impact, photoelectric current, field and thermionic emission).
- Pressure also plays a role in determining which processes are dominant.
  - Three-body collisions (attachment, recombination) dominant electron loss mechanism in high pressures.
  - Photonic processes operate on inherently different timescale than electronic processes.
- Mechanism of charged species interaction can be inferred from photo-emission spectra and dI/dt induced by local electric field.





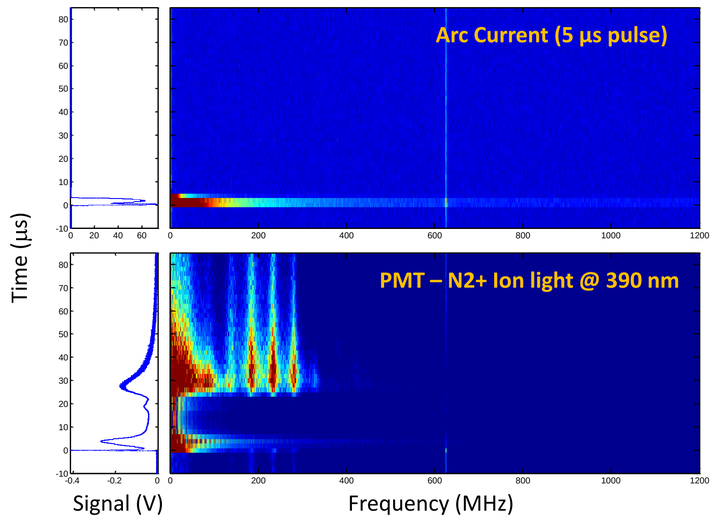
2. Arc Discharge Experiment

- Aim to understand what happens in discharge environment via modeling and experiments.
  - Study discharge and emission characteristics for pure and dusty plasmas.
- Quartz tube contains electrodes for arc source and collector plate to measure collected current due to discharge.
  - Open to laboratory air, gas/vacuum system incorporated for different gas/pressure study.
- Electrodes for arc source separated by mm-distance.
  - Nanosecond pulser supply high voltage for arc generation across electrodes.
  - Surrounding gas ionized by arc.
  - Study charged species interaction in the arc environment.



3. Preliminary Optical Data

- Demonstrated ability to collect optical emission from discharge.
- 5-µs arc source generated with pulser in laboratory air at atmospheric pressure.
  - Grounded current-collecting plate measure the current pick-up due to charged species created by the arc.
- PMT with 390-nm filter collects $N2^+$ emission from the resulting post-arc discharge.
  - Different wavelength filter can collect different emissions to compare with model results, along with pressure dependence.
- Data show emission during arc, as well as post-arc peak and subsequent decay.
  - FFT shows higher-order frequency components in the post-arc discharge due to charged species interaction.

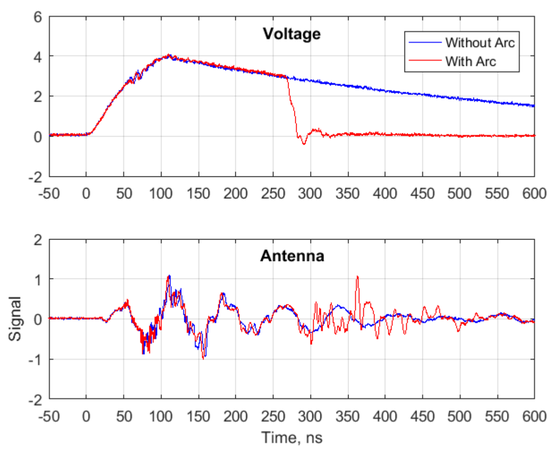


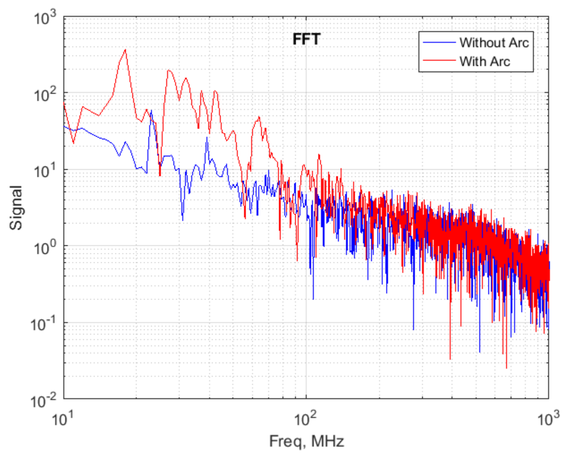
4. Discharge Behavior Inferred from dI/dt due to Localized Electric Field

- Charged species created by the arc set up local electric field.
  - Results in current flow between these differentially-charged regions.
  - Sources of electrons can be due to electronic and photonic processes.
  - Model simulates/isolates these processes, weighs their significance for various conditions, provides observables (emission spectra, dI/dt) that can be measured.
  - Comparison of experimental and model results help validate/verify the processes involved.
- Antenna used to measure time rate of change of this localized current flow between charged species.
  - FFT shows frequency components associated with this current flow.

Varied Gas/Pressure Conditions

- Preliminary data showed (lab) air discharge; helium will be used to validate model.
  - Air discharge chemistry and process cross sections less characterized than helium → more challenging to model, experiments serve to inform model development.





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