NANOSECOND PULSED POWER AND ITS APPLICATIONS

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Pulsed Power

- It is the science of releasing stored energy in a short duration leading to very high instantaneous power.
- Here at USC, we design application specific pulse generators to deliver high voltage pulses that are < 100 ns wide and have very short rise times (~10ns) .

Our Pulse Generators

The ability to deliver short pulses depends greatly on the types of switches used. At the Pulsed Power Research Group and in collaboration with Transient Plasma Systems Ltd, we've designed as well as built pulse generators for various applications:

- Thyratron based Pulse Generator: This pulser uses a thyratron switch to deliver 30 kV pulses into a 50 Ohm load.
  - ➢ Pulse Rise Time: 50 ns
  - ➢ Peak Instantaneous Power: 500 kW
- Magnetic Pulse Compression based Pulse Generator: These pulsers (Fig. 1) are based on a technology that makes use of stages of saturable inductors followed by a junction recovery diode to achieve very short rise times.
- Low Energy Compact Pulsers: Designed and built for use in Transient Plasma Ignition research, these pulsers (Fig. 2) use Pseudospark and solid state switches to deliver 365 mJ and 75 mJ respectively into a 200 Ohm load.
- Nanosecond Pulse Generator for Biological Loads: This is a highly stable, low jitter pulser (Fig 3) developed for delivering 5 kV pulses with 2.5 ns FWHM to biological samples for studying behavior of cells.

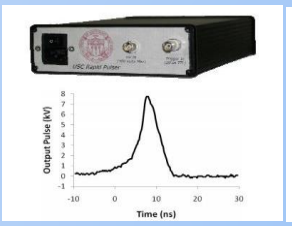


Figure 1
Voltage vs Time of MPC Pulser

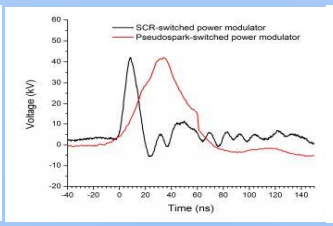


Figure 2
Voltage vs Time of SCR based & Pseudospark Pulser

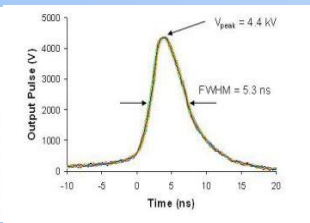


Figure 3
Voltage vs Time of Pulser for biological Loads

Applications

- **Emissions Treatment from Diesel Engines:**
  - ➢ Short nanosecond pulses are being used in an ongoing effort to study the effect of non thermal plasma on diesel exhaust.
  - ➢ Non thermal plasma is known to effectively remediate NOx, SOx and PM from engine exhaust.

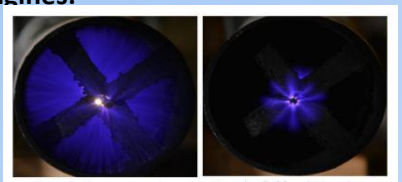
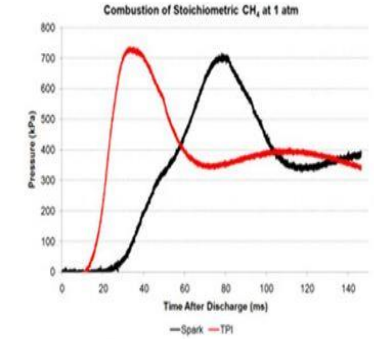


Figure 4
The variation in Plasma distribution on application of different voltage and rise times

- **Biological Applications:**
  - ➢ Application of nanosecond pulses induces apoptosis or programmed cell death showing great potential for cancer therapy and application of even shorter pulses was shown to be useful for targeted drug delivery.
- **Plasma Accelerator Research**
  - ➢ The principal application for the work at USC, however, is plasma-based wakefield accelerators (PWFA), demonstrating potential as a novel method for charged particle acceleration that could boost incoming beam energy over short distances.
- **Transient Plasma Ignition**
  - ➢ Transient plasma generated by nanosecond pulses was used to initiate combustion of air- CH4 mix.
  - ➢ It demonstrated significant advantages over conventional ignition: shorter ignition delay, lean burn capability and better efficiency and reduced emissions.



Comparison of pressure traces between transient plasma ignition and traditional spark ignition in quiescent CH4-air mixture.

Acknowledgements

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