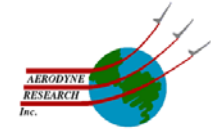


# Single-Cylinder Two-Stroke Free-Piston Internal Combustion Generator

**Aerodyne Research, Inc. (Prime Contractor)**



Free Piston MICE (Miniature IC Engine) Generator Developer

**Stony Brook University**



Internal Combustion Engine R&D

**Precision Combustion, Inc.**



Catalytic Combustion R&D and Products

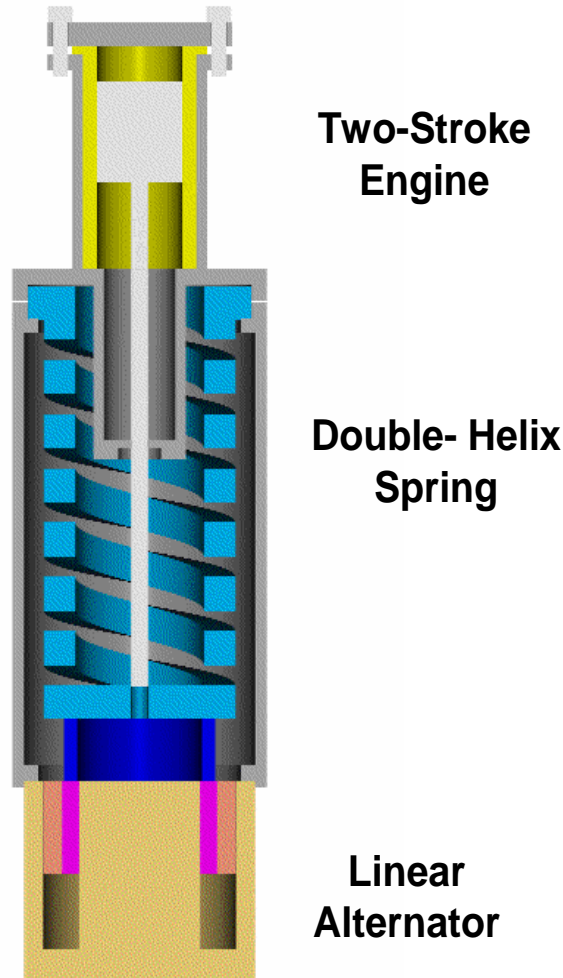
**C-K Engineering**



IC Engine Sealing and Lubrication R&D and Products



# Free-Piston MICE Generator



## Unique Features

- HCCI combustion for high efficiency and low emissions
- Resonant multiple helix spring for high cycle frequency, energy storage, and easy startup
- Moving coil linear permanent magnet alternator for low active mass and high efficiency
- GENSETS MICE generator basic unit weight ~ 8 lb, size ~ 11" L x 3.5" Dia

# Program Challenges

- **Fuel-to-Electricity Efficiency of 40% or Greater**

- **Indicated thermal efficiency greater than 51%**

- $\Phi < 0.5$
- Compr. Ratio  $> 12$

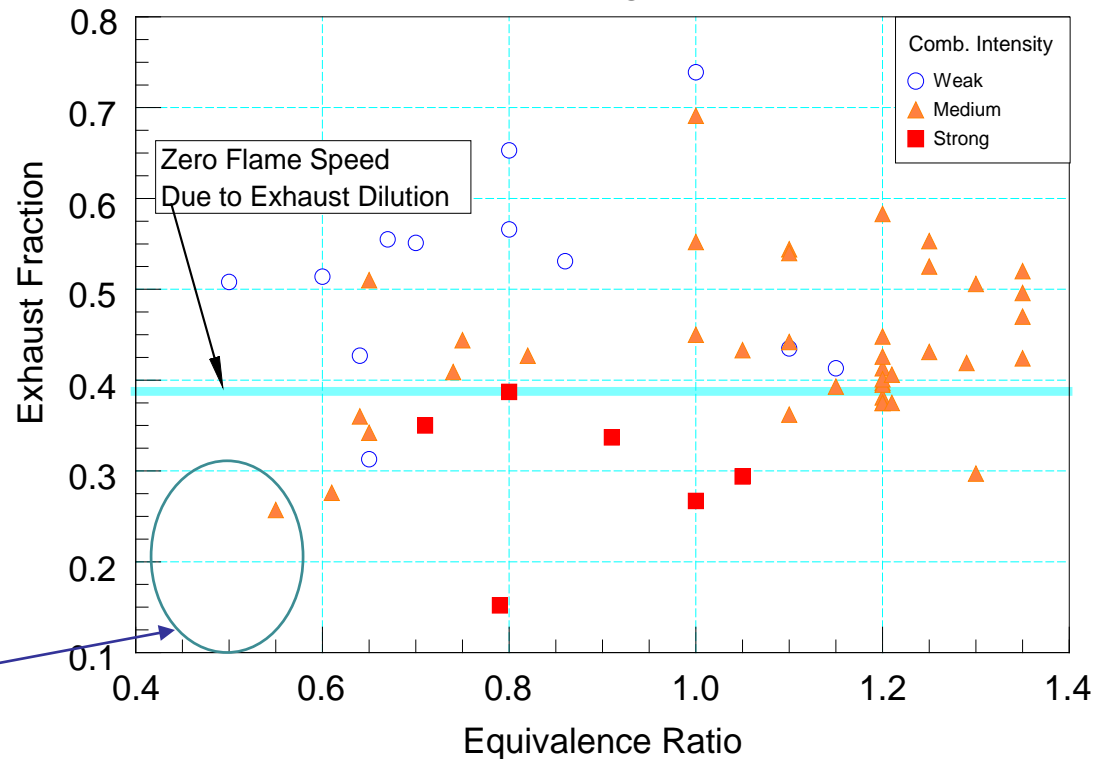
- **Comb. efficiency  $> 94\%$**

- Use catalytic glow plug

- **Mechanical efficiency  $> 92\%$**

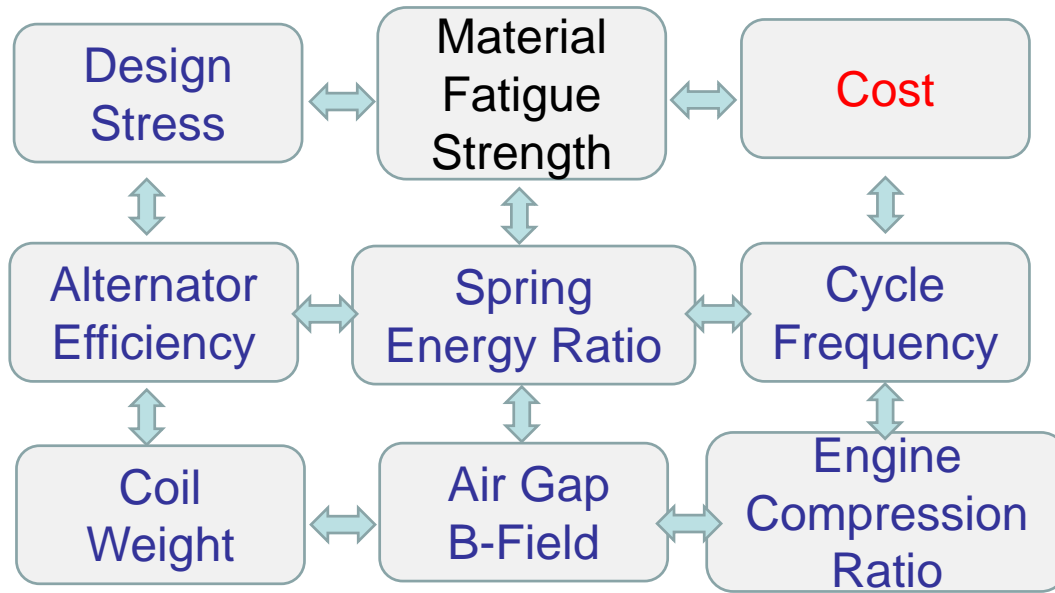
- Optimize ring and lubrication design

MICE Generator Operating Condition Experience



# Program Challenges

- **Spring Life of 10 years ( $5 \times 10^{10}$  cycles)**
- **Optimize Design Stress Relative to High Cycle Fatigue Strength**
  - Use best suitable high fatigue strength material
  - Minimize “dead” or low stress active mass

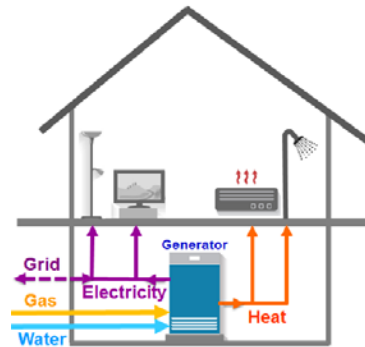


# Impact

## Per J-C Zhao presentation:

- Widespread distributed electrical power generation at high efficiency and utilization of waste heat
- Application to lightweight electric power generation for transportation sector using renewable fuel sources

### GENSETS: GENerators for Small Electrical and Thermal Systems



- 1 kW electricity system
- 40% electrical efficiency
- 10 year durability/life
- \$3,000 system cost

- Save energy (~ 5 quads)
- Save \$ (~ 4-5 year payback)
- Reduce CO<sub>2</sub> by 200 million tons
- Reduce fresh H<sub>2</sub>O withdrawal (8% of US total)
- Increase power resiliency
- \$240 billion business opportunity

Technologies to enable widespread deployment of CHP systems for residential & commercial sectors

arpa·e CHARGE WHAT'S POSSIBLE Improve Efficiency ✓ > +25% ↑ Reduce Emissions ✓ - 200 million tons ↓ Reduce Imports □ 18

- Many GENSETS derivatives, as well as other large portable-power applications at fractional-to-several kW

## Needed resources:

- Market / industry and mass-production contacts
- Partners for ultimate product