## ASCENT Project 070

# Reduction of nvPM Emissions from Aero-Engine Fuel Injectors

**Georgia Institute of Technology & Honeywell International, Inc.**

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Cost Share Partner: Honeywell International, Inc.

## Objective:

- Characterize the formation and oxidation of non-volatile particulate matter (nvPM)
- Optimize the design of an aeronautical gas turbine fuel injector to reduce nvPM

## Project Benefits:

- Improve the understanding of nvPM formation/oxidation at engine relevant conditions
- Develop numerical models to predict nvPM emissions from aero-engines, and guide new fuel injector designs.
- Enable cleaner aircraft engines compliant with the ICAO CAEP/11 nvPM LTO standard.

## Research Approach:

- Experimental system development
  - A combustor sector with three fuel injectors is designed and will be fabricated.
- Experiments at practical conditions and numerical simulations.
  - PAH/OH PLIF, LII for soot volume fraction and primary particle size, and PIV for flow field.

## Major Accomplishments (to date):

- Design of high pressure system with fabrication in progress
- Combustor design and analysis is underway
- Shakedown of optical diagnostics is also being completing

## Future Work / Schedule:

- High pressure combustor commissioning (Y1Q3&Y14)
- Preliminary optical diagnostics (Y1Q4)
- Measurement of nascent soot to cover the entire process of nvPM formation (Y2Q3&Y2Q4)
- Numerical simulation to optimize fuel injector design (Y2Q3&Y2Q4)

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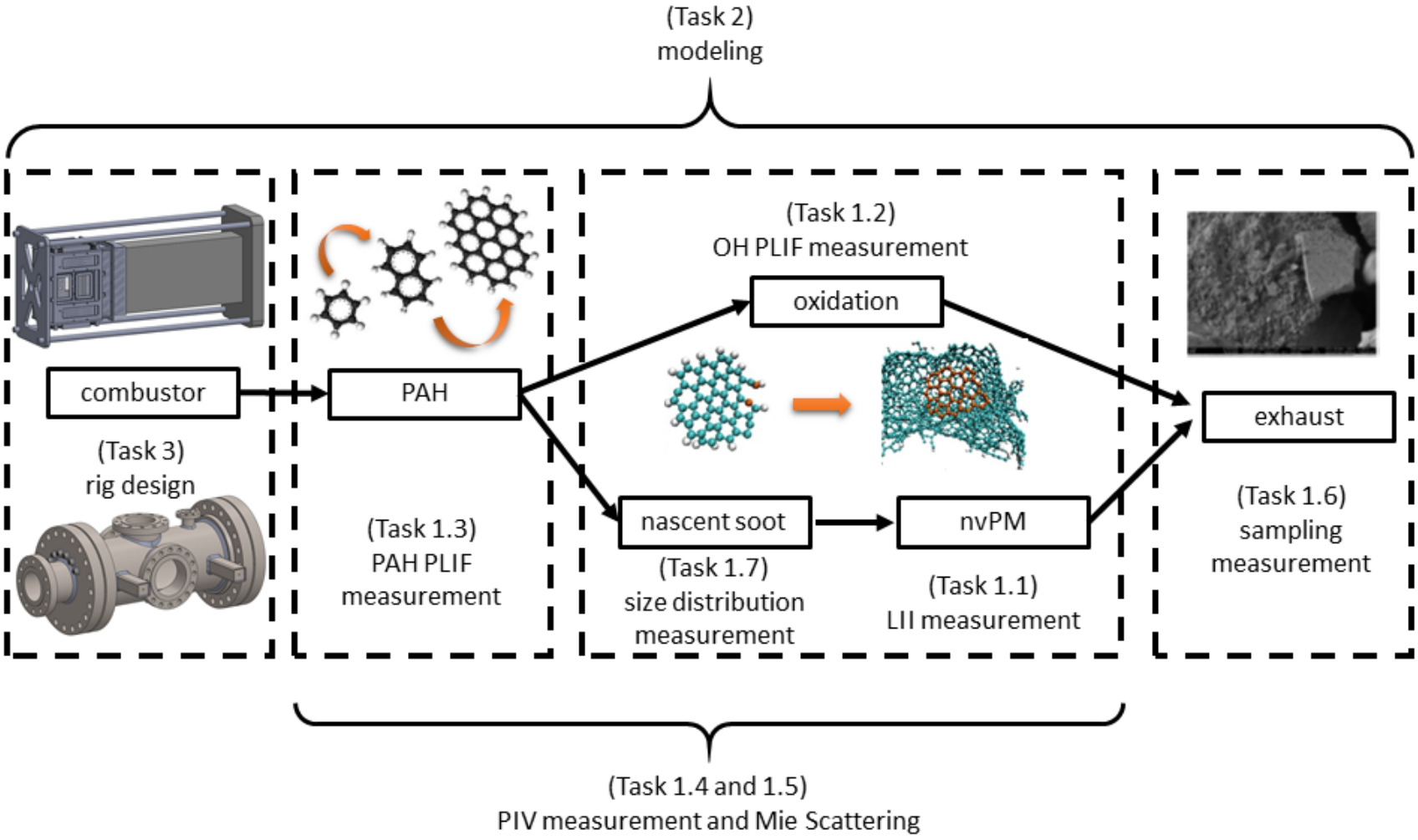
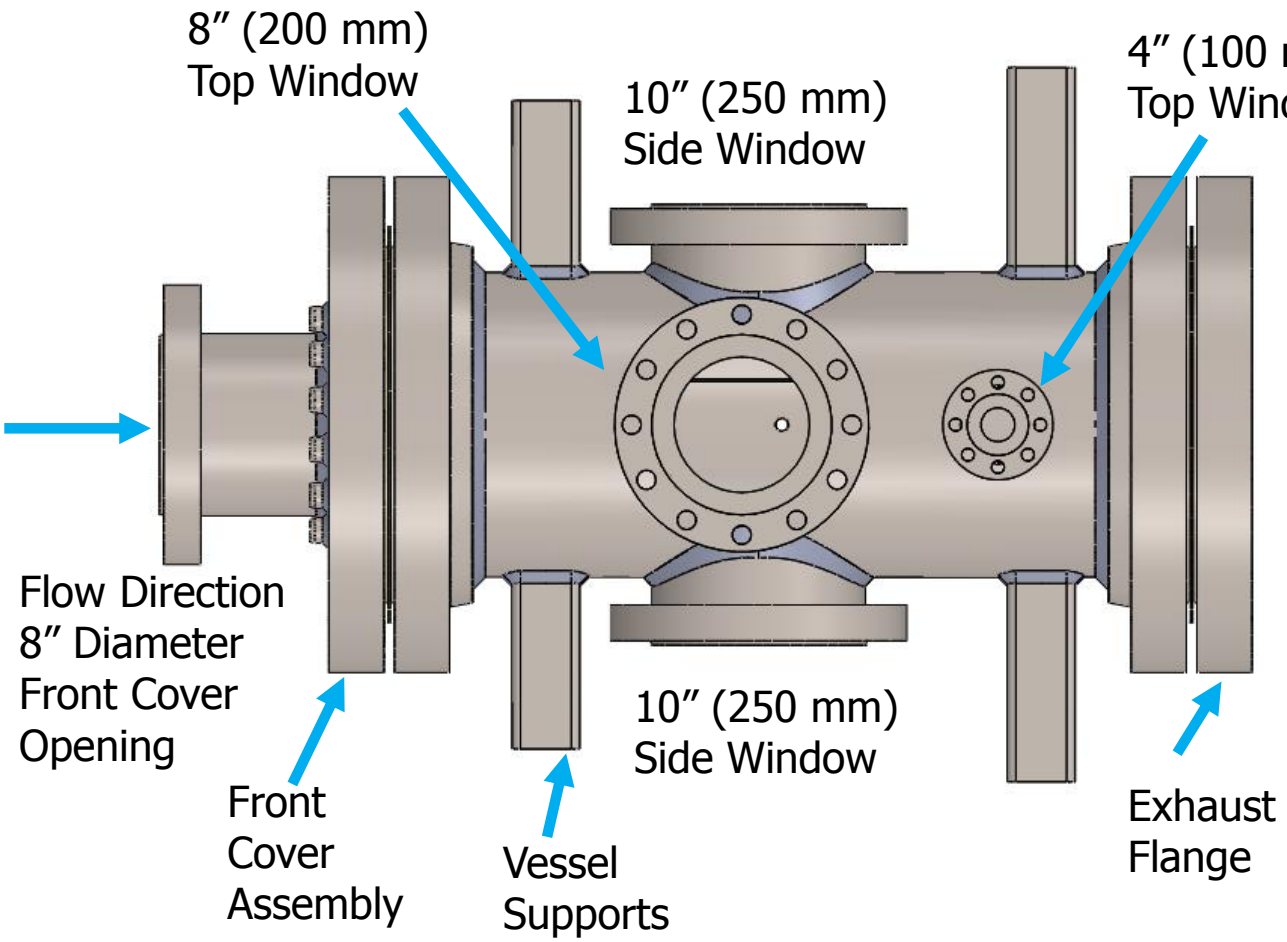
# Project Overview

- Tasks include new rig design and systematic characterization of nvPM



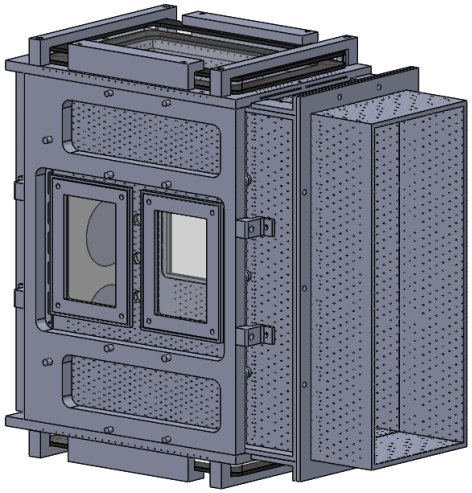
# Pressure Vessel Design

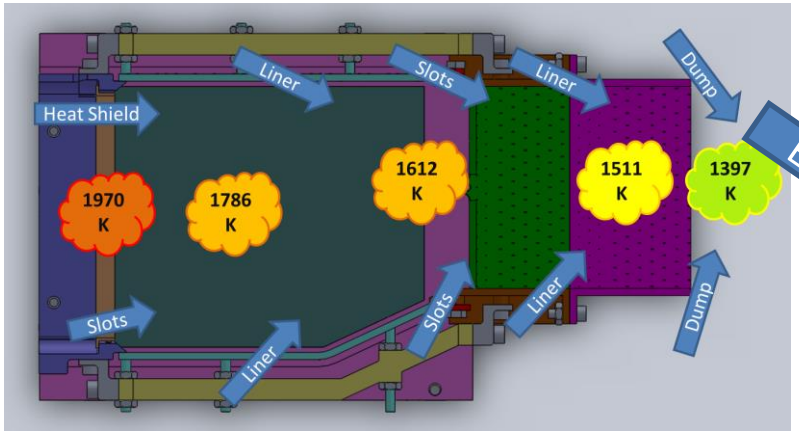


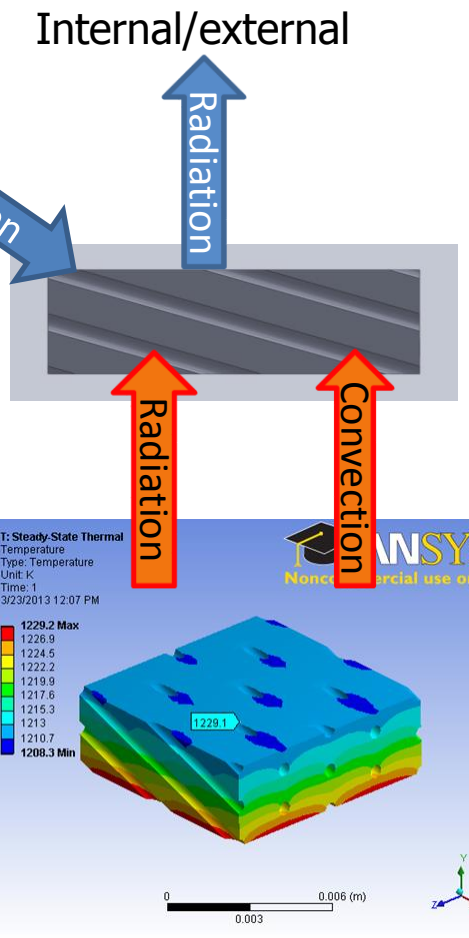

## General Specification

- 436 psig (29.6 atm) & 850 F (728 K) design basis
- Material 316 SS, designed per ASME BPVC Section VIII Div. 1
- 18 in (457 mm) Inside Diameter
- 47.25 in (1200 mm) Length
- Optical access through side and top window openings
- Total Weight: 3400 lbs (1542 kg)

# Liner Heat Transfer/Structural Analysis






- Liner structural and heat transfer analysis were carried out through ANSYS FEA.
- Cooling air budget and liner gas temperature profile calculation were based on targeted pressure drop and desired primary and post RQL equivalence ratios.
- Major assumptions:
  - Lefebvre correlations for radiation heat transfer
  - Flat plate boundary layer for internal and external surfaces
  - Fully developed pipe for cooling holes

# Summary

- Large optical windows designed, purchased, and delivered.
- Pressure vessel design completed and fabrication in progress
- Combustor design is ongoing
- Flow control system is being set up
- Optical diagnostics shakedown near completion

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|---|---|---|
| Facility design | Q1 | completed |
| Preliminary setup of LII, PLIF diagnostics | Q1 | |
| Preliminary setup of PIV and Mie scattering measurement | Q2 | |
| Fabrication of testing facility | Q2 | |
| Installation/shakedown of Georgia Tech facility | Q3 | ongoing |
| Initial LII, PLIF measurement | Q3 | |
| Initial PIV and Mie scattering measurement | Q4 | |
| Initial sampling measurement | Q4 | |