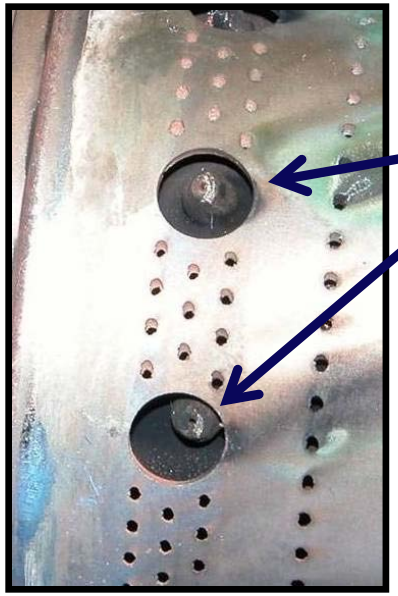
Alternative Fuels Thermal Stability and Fuel Fouling

❖ **Purpose of Research :** In order to meet NASA's Fundamental Aeronautics performance and emissions goals, the future jet engine will require a high pressure, high bypass ratio cycle. At this high pressure cycle the inlet air temperature will be extremely high which will cause fuel coking problems with current aviation fuels. To protect both NASA and industries engine hardware, a well defined fuel fouling investigation is required.

❖ **Goal:** To enhance thermal stability research on alternative type fuels by using a Ellipsometer to determine fuel fouling profiles at elevated temperatures. A well quantified fuel fouling knowledge is critical in developing a suitable engine model and simulating combustion behaviors for alternative fuels and future highly efficient engine applications.



Fuel Fouling on fuel injector tips with conventional jet fuel.

Fuel injector damage due to fuel fouling.

Research Plan

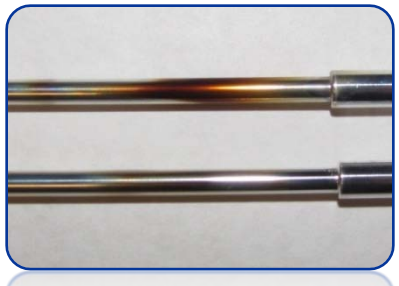
❖ An Ellipsometer will be used to analyze the fuel fouling profiles formed on Jet Fuel Thermal Oxidation Test (JFTOT) tubes to determine if the current Thermal Stability test method is valid for alternative type fuels containing minimal to no sulfur content.

❖ The Ellipsometer will also be able to decipher between actual hydrocarbon deposits versus material property changes that occur with steel tubes.

❖ Alternative fuels have a much higher thermal stability temperatures due to minimal to no sulfur content. Temperatures above 370 C require the use of steel tubes which are rated in excess of 650 C .

❖ The discoloration of steel tubes may not reflect a true fuel failure due to the material properties of the tubes at elevated temperatures.

- ➢ Hydrocarbons in conventional jet fuels cause carbon coatings to form on the tubes when the fuel has reached its thermal stability breakpoint.
- ➢ Steel tubes have shown to discolor at elevated temperatures without fuel being present.



Aluminum test tubes- can test up to 270 C
Failed test tube (top)
Passed test tube (bottom)

Stainless Steel tubes tested at temperatures ranging from 270-600C. Tube colors vary with no fuel present.

Project Status

- Cost: $134K ($50 K –IPP , $84K from ERA)
- Delivery/ Installation - Oct 2010
- Baseline test tubes have been sent to Horiba to pre-load heat treated surface test results
- Thermal Stability Lab preparing for Ellipsometer arrival
- Setup and training to be conducted in Oct/Nov 2010
- Film thickness testing to begin Dec 2010
- Initial results expected by Jan 2011

Horiba Ellipsometer