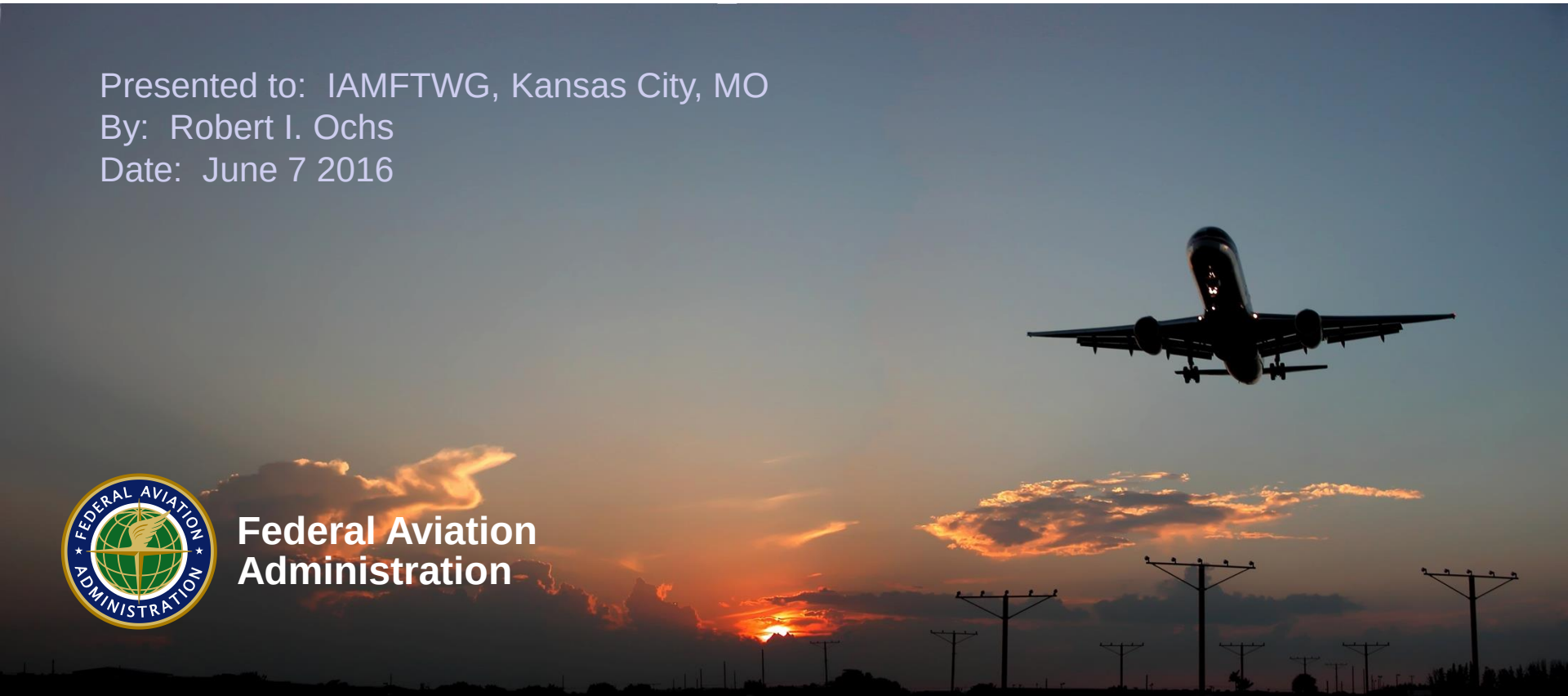
Vertical Flame Propagation (VFP) Test Method Update



Presented to: IAMFTWG, Kansas City, MO
By: Robert I. Ochs
Date: June 7 2016

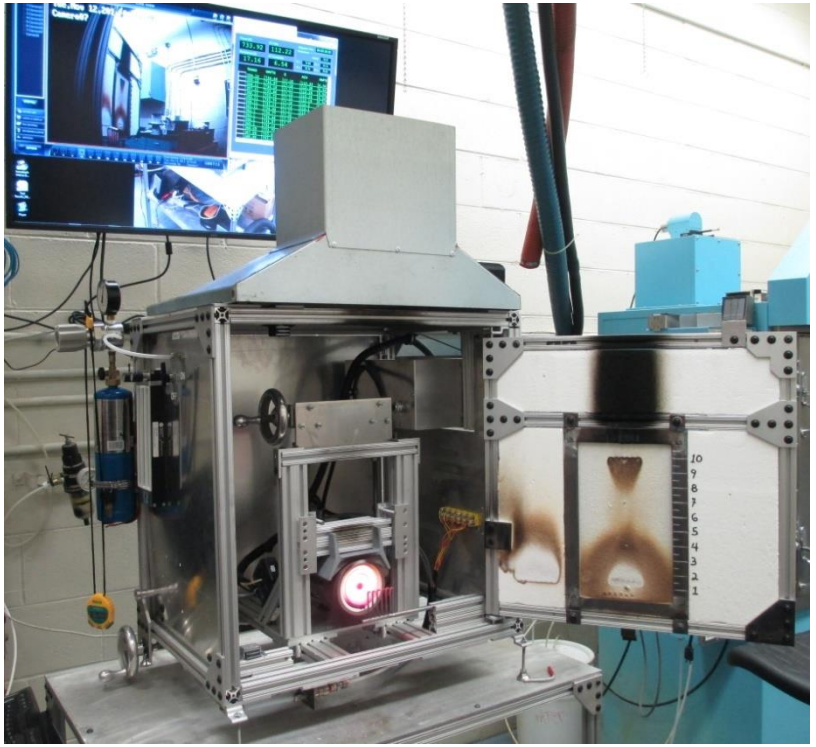
Federal Aviation Administration

Introduction

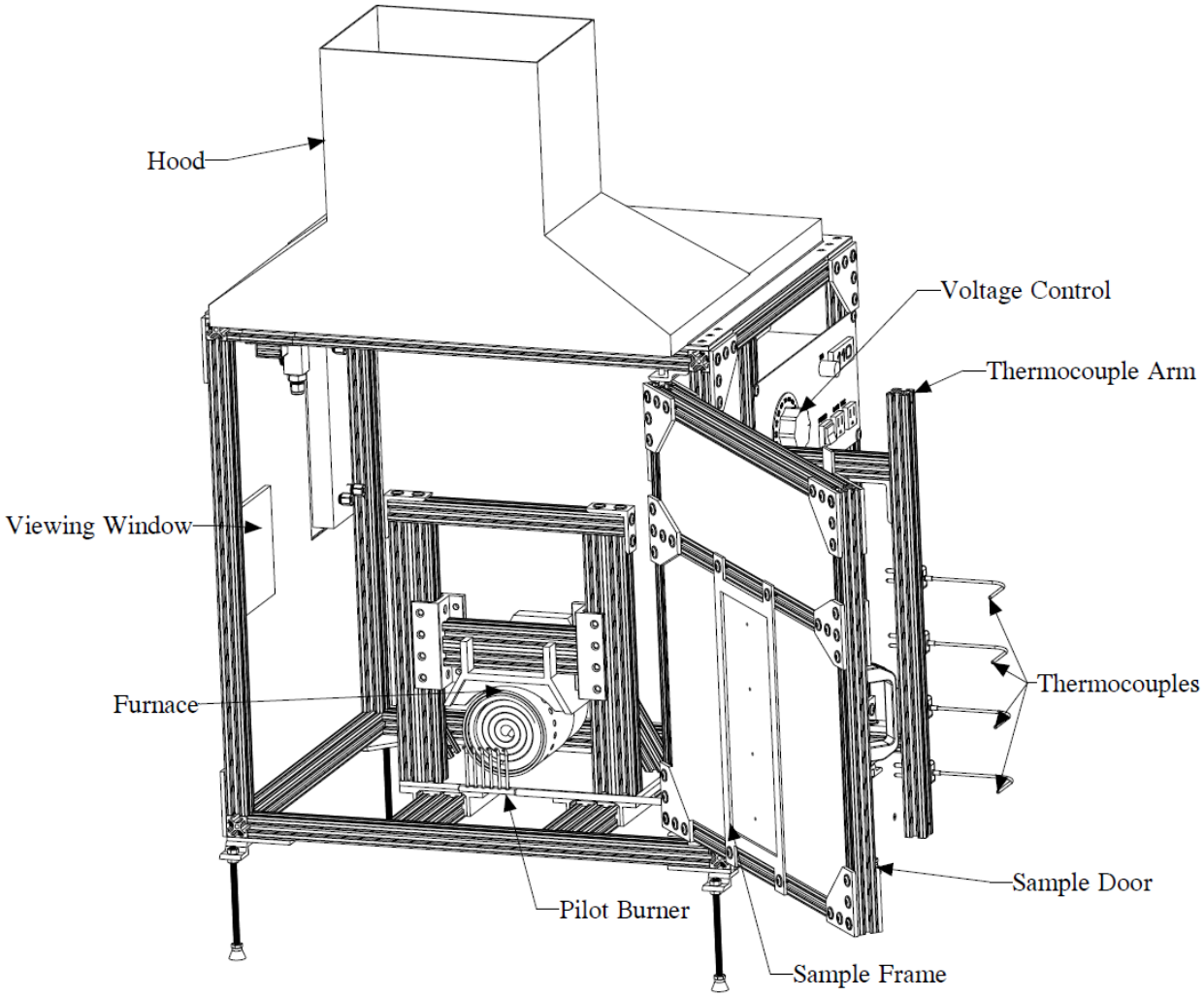
- **Carbon fiber composites are being used more frequently in aerospace applications**
  - Increased strength
  - Lower density
  - Better corrosion resistance
- **New designs of commercial transport airplanes include primary and secondary structure constructed from carbon fiber composites**
- **Current FAR's do not require flammability testing for fuselage skins or structures, as traditional designs are inherently non-flammable**
  - Special Conditions for certification of fire resistance of composite fuselage
  - Must demonstrate level of safety equivalent to or better than traditional constructions
- **To continue with the FAA's efforts to enhance in-flight fire safety, materials in inaccessible areas of the cabin should meet a flammability test based on the "block of foam" fire source**

Objective

- **Design, construct, and evaluate a new flame propagation test method**
  - Determine effectiveness of evaluating flame propagation
  - Determine level of repeatability and reproducibility
- **Deliver new test method to FAA Transport Directorate for use in certification of novel design airplanes**
  - Inclusion in next-generation fire test requirements
  - Possibly replace current Special Conditions requirements
- **Attempt to test other inaccessible area materials on same apparatus**
  - Wire insulation
  - Ducts, hoses



Vertical Flame Propagation Test Apparatus



Ribbon Burner

$D_{primary}$= 0.04 in; $A_{primary}$ = 0.00125 in^2

D_{pilot}= 0.0175 in; A_{pilot} = .0002405 in^2

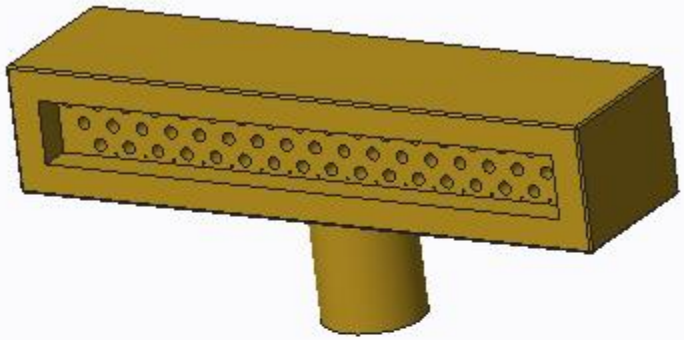
A_{total}=51×0.00125 in^2 + 32×0.0002405 in^2

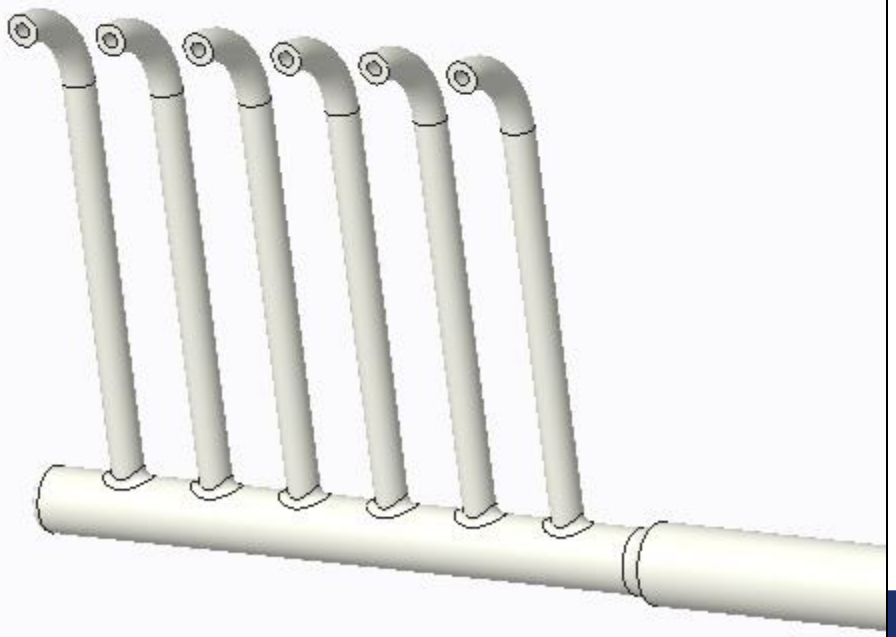
= 0.07145 in^2

Original Pilot Burner

D=0.050 in; A=0.001963 in^2

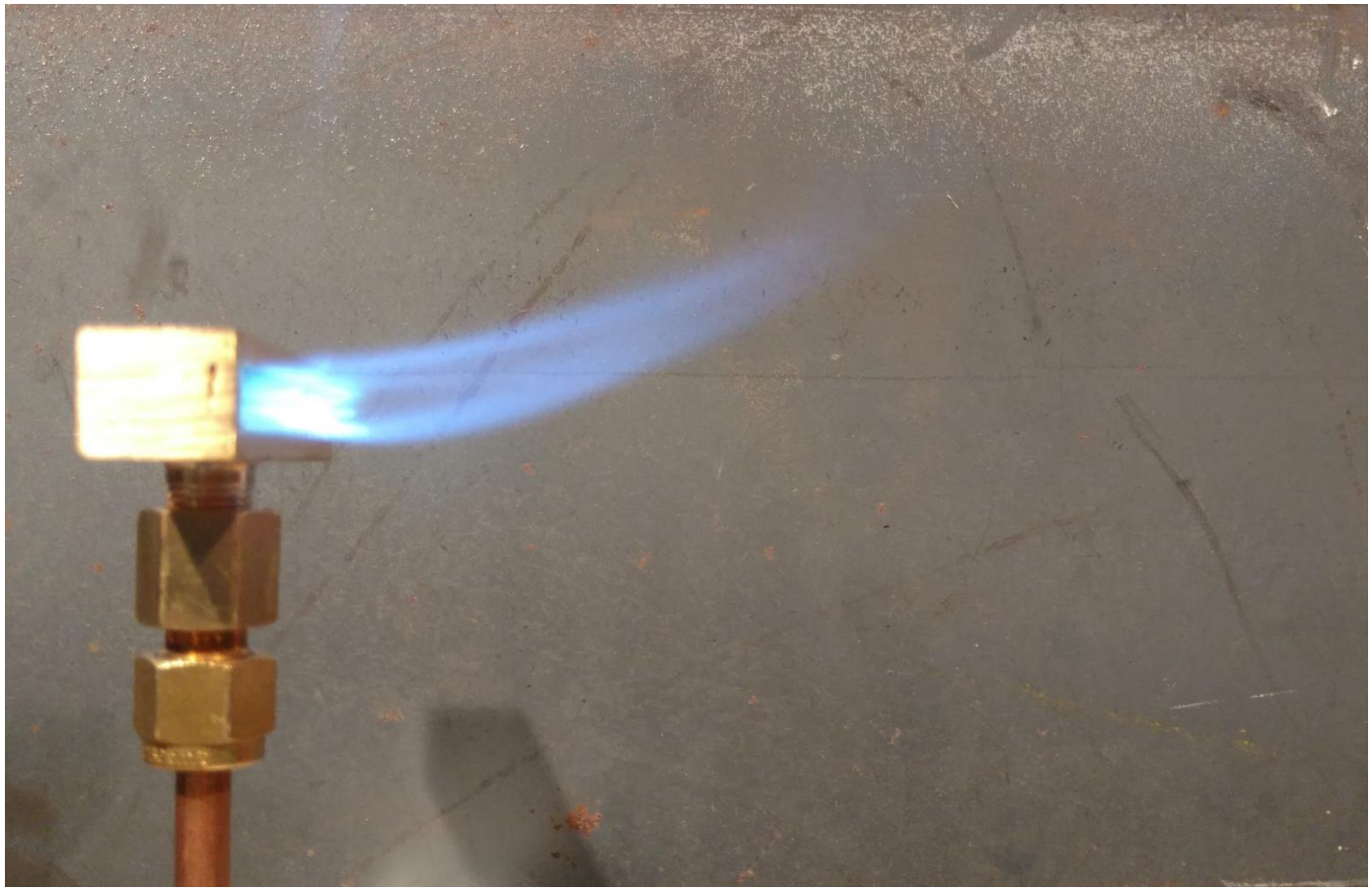
A_{total}=0.01178 in^2

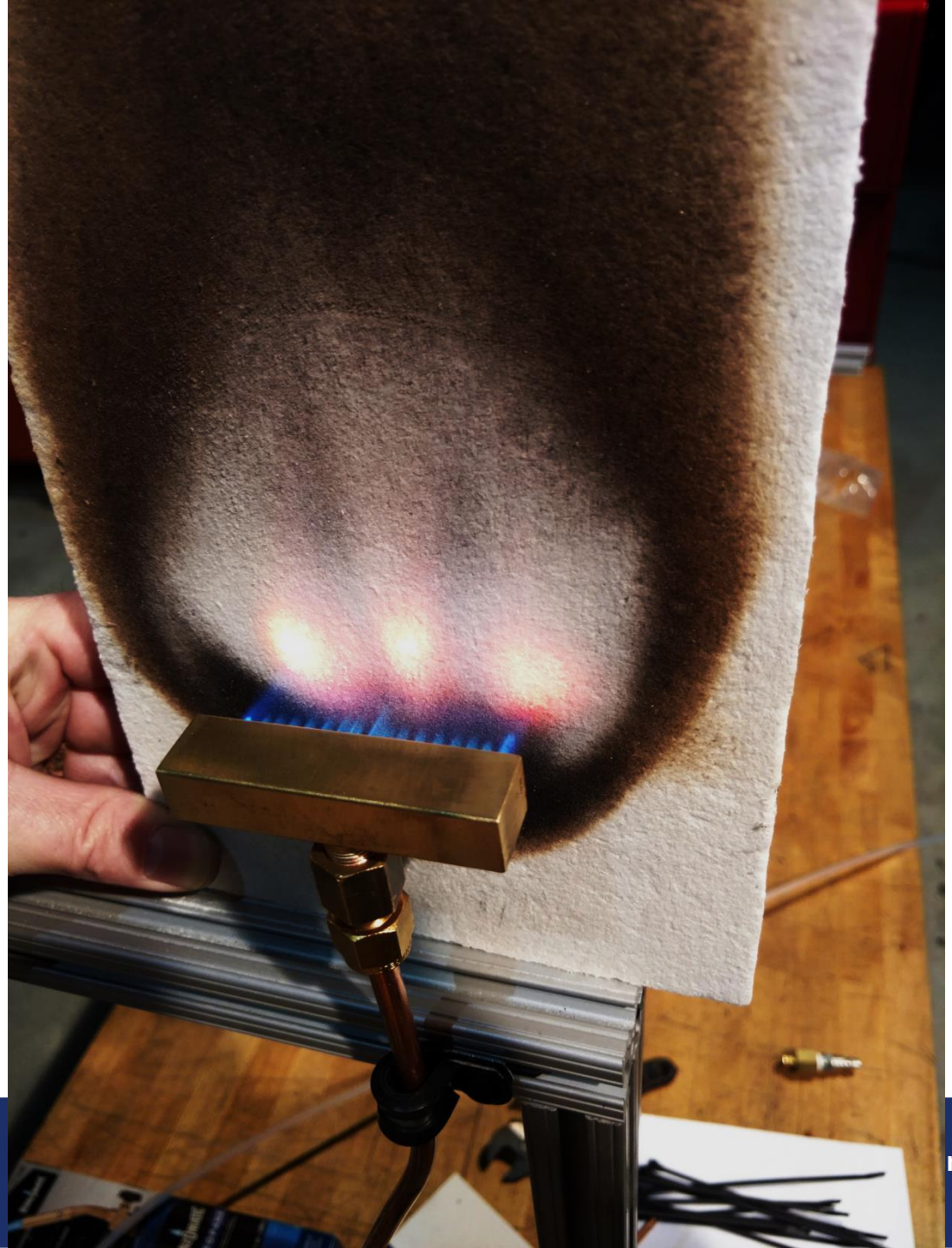


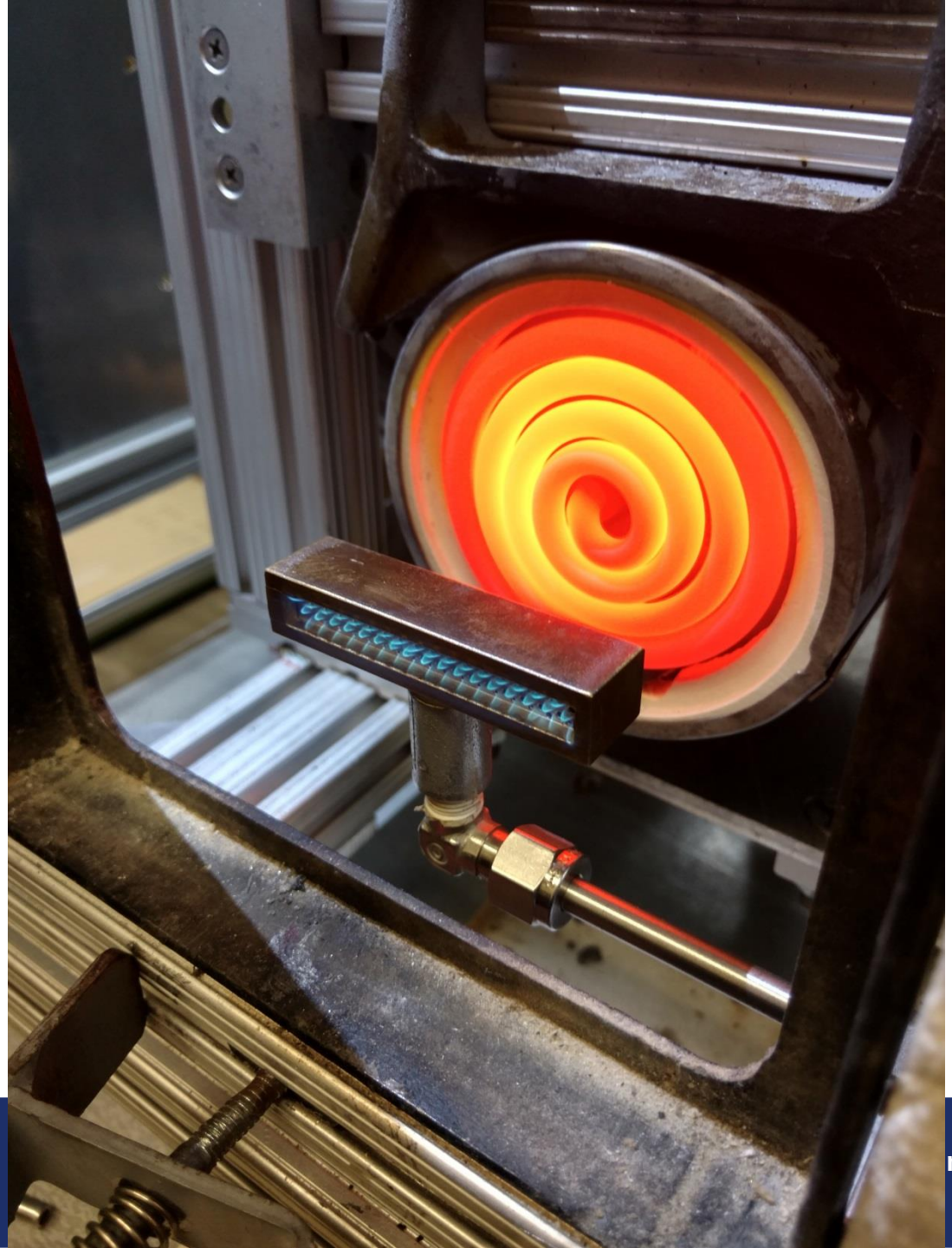


Area Ratio

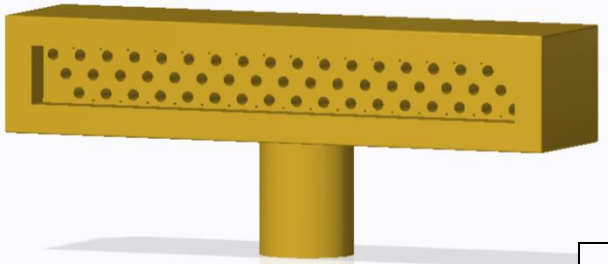
$$A_{ratio}=\frac{A_{ribbon}}{A_{original}}=\frac{0.07145}{0.01178}=6.06$$







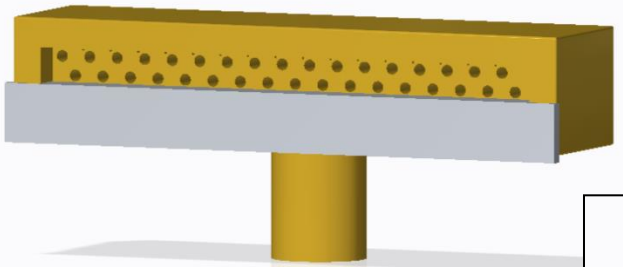
Original Burner



A_{total}=0.07145 in^2

$A_{ratio}=\frac{A_{ribbon}}{A_{original}}=\frac{0.07145}{0.01178}$ =6.06

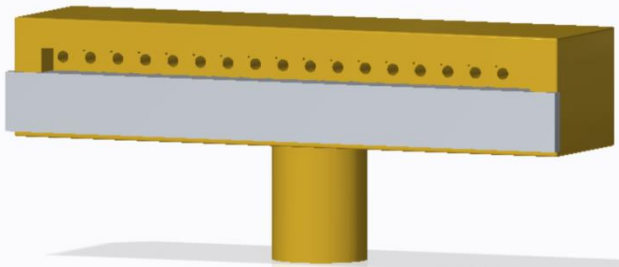
Small Burner Plug
One Row Covered



A_{total}= 0.04635 in^2

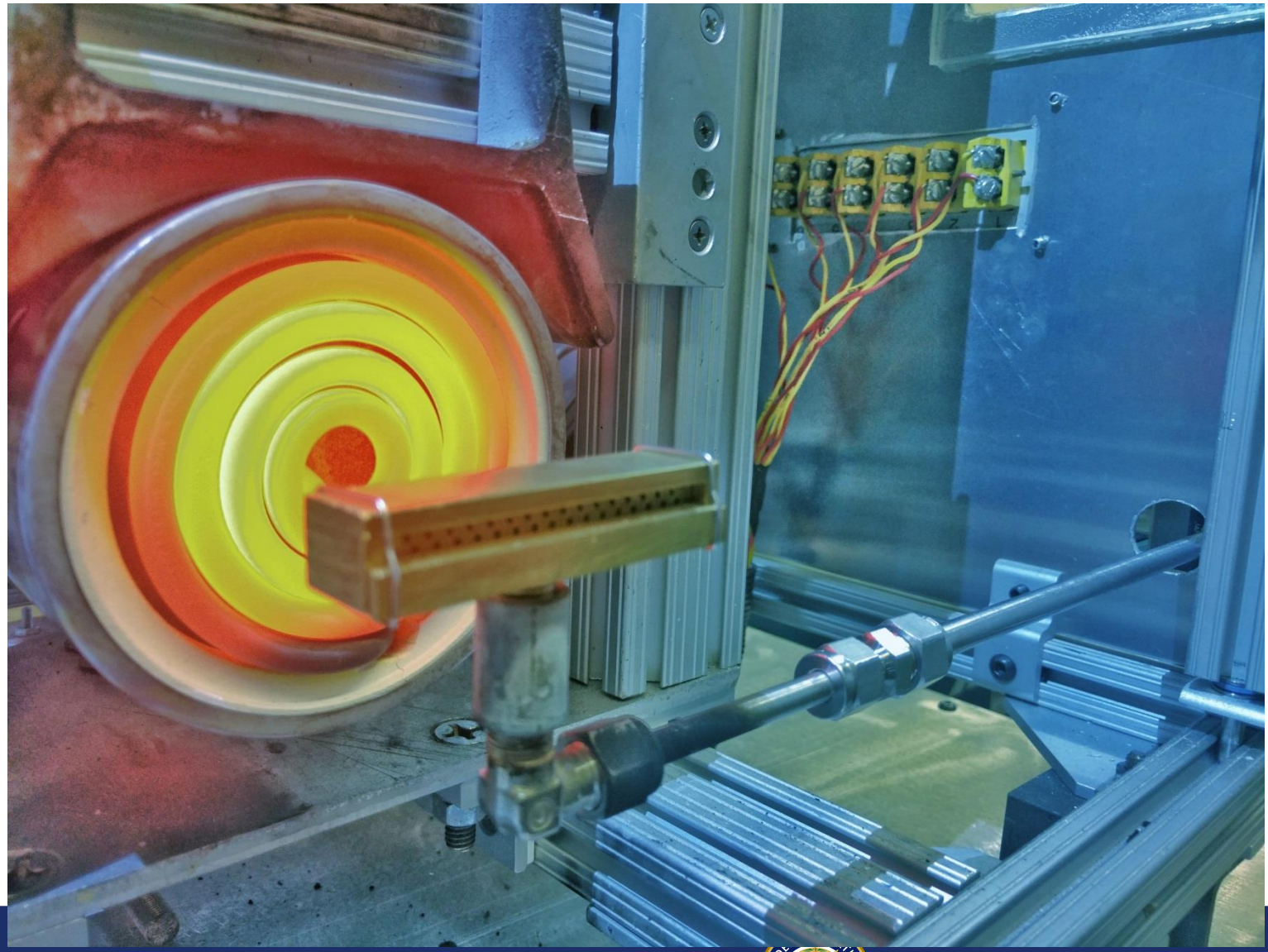
$A_{ratio}=\frac{A_{ribbon}}{A_{original}}=\frac{0.04635}{0.01178}$ =3.93

Large Burner Plug
Two Rows Covered

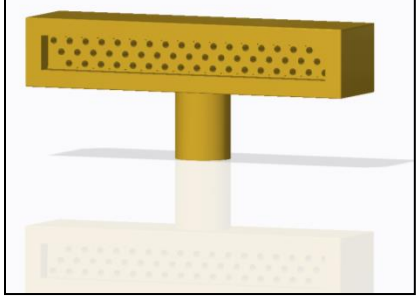


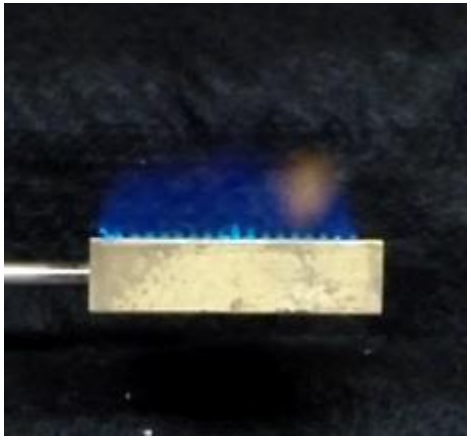
A_{total}=0.0251 in^2

$A_{ratio}=\frac{A_{ribbon}}{A_{original}}=\frac{0.0251}{0.01178}$ =2.13



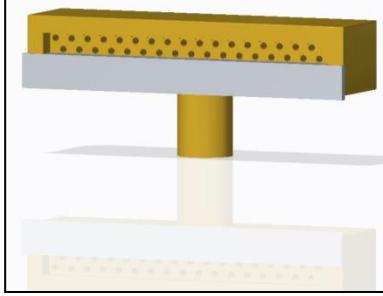
Original Burner

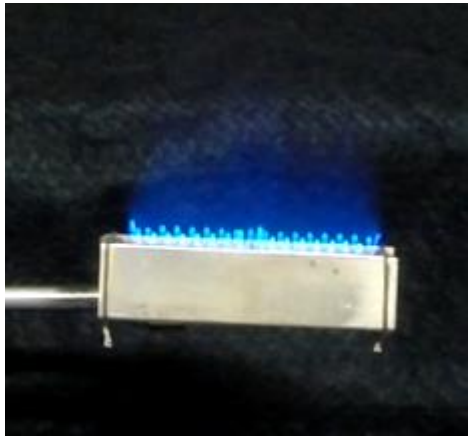


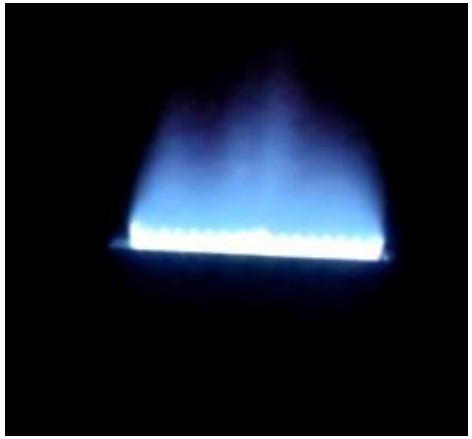


100 ccm Fuel Flow Rate

Small Burner Plug
One Row Covered

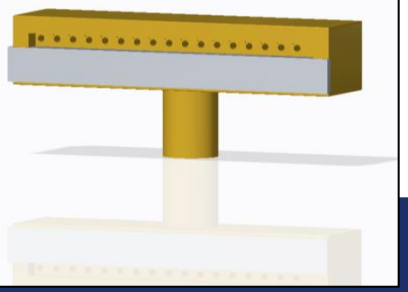






80 ccm Fuel Flow Rate

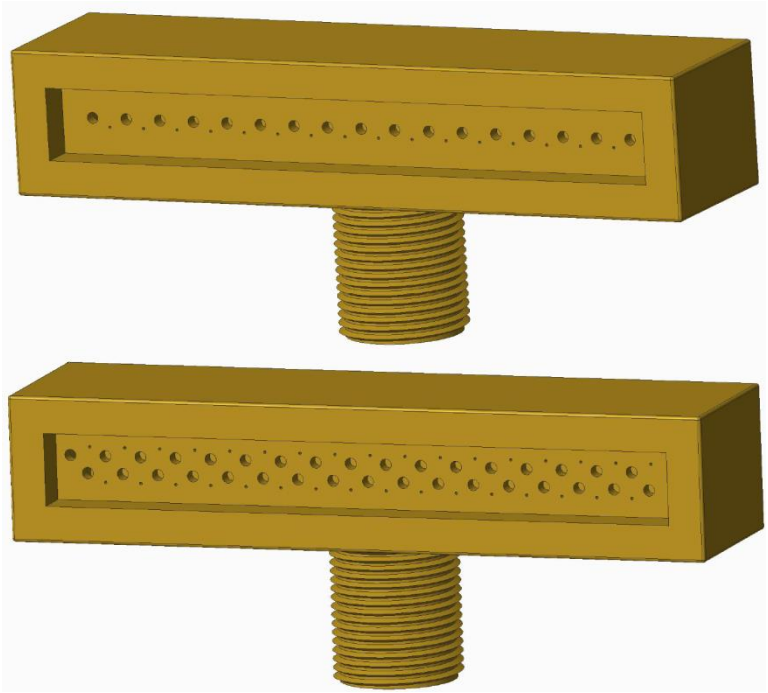
Large Burner Plug
Two Rows Covered

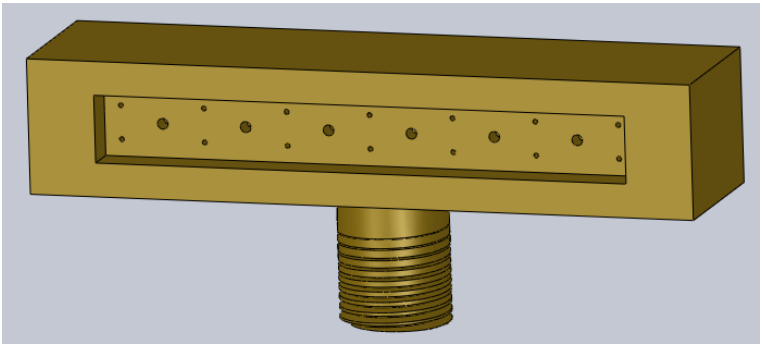


60 ccm Fuel Flow Rate

Ribbon Burner – Summary

- **Ribbon burner as received produced a flame too large and buoyant for VFP**
- **Modifications to reduce the exit area of the burner provided flames more similar to the original VFP pilot burner**
- **Test results obtained with the modified ribbon burner provided similar results to the original VFP pilot burner**
  - A flame impingement time of 30 seconds seemed to provide the most similar test results to the original VFP pilot burner
- **Advantages of using ribbon burner are clear, more work required to obtain the best possible pilot flame**
  - Produces a flat, straight mostly uniform flame across 2”
  - Alignment with wires significantly improved over original VFP burner
  - A burner-to-sample distance of 7/8” or greater provides good results, and reduces the likelihood of melting or intumescing materials clogging the pilot burner





Ribbon Burner Status

- **3 different burners were ordered in February**
- **Manufacturer has had significant production delays**
- **They are hoping to deliver within the next 2 weeks**

New Lab – Building 202

- **New lab acquired by Fire Safety**
  - VFP was moved in to B202
- **Modifications necessary before testing can begin**
  - Installation of exhaust hood and piping
  - Awaiting approval of design by facility safety and engineering

Introducing VFP 3.0

- **New and improved VFP**
- **Features:**
  - Smaller footprint
  - Controlled air inlet
  - Double-door system to keep backside smoke out of lab
  - Larger viewing windows
  - Improved sample frame

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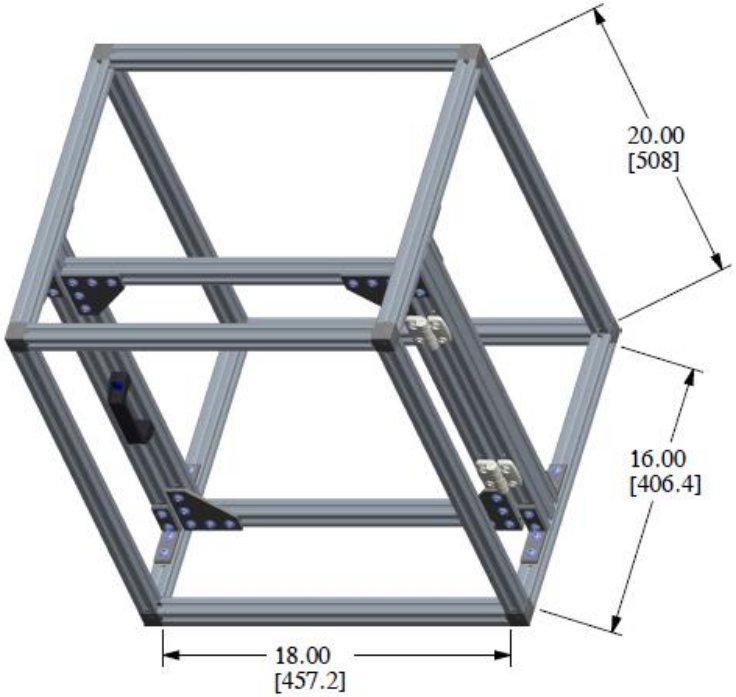
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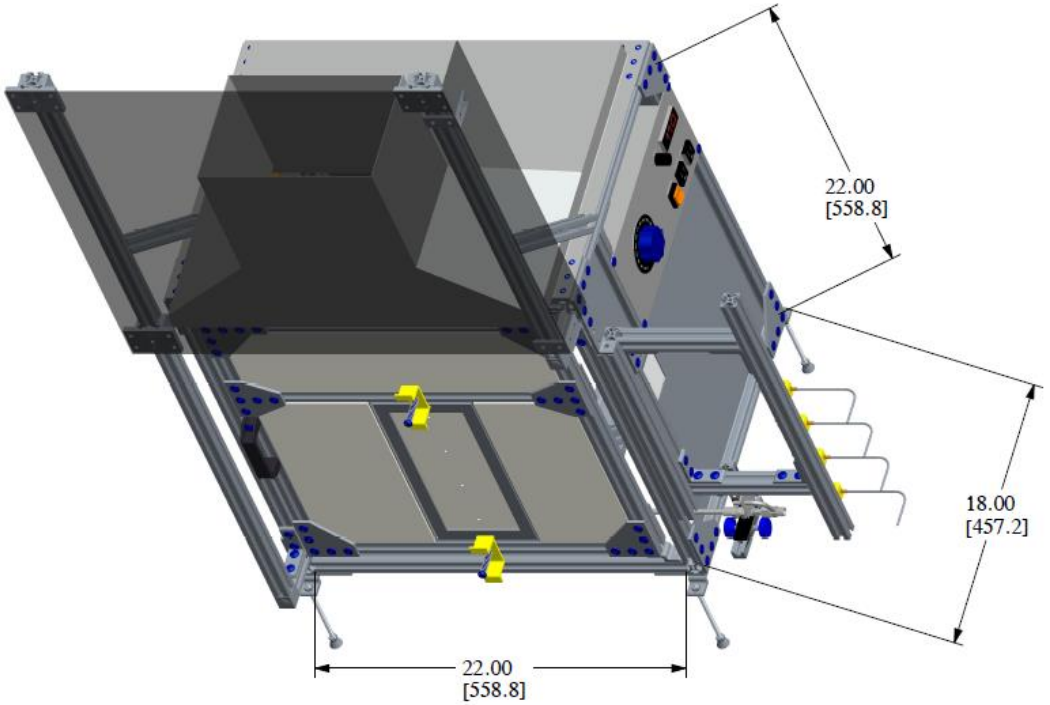
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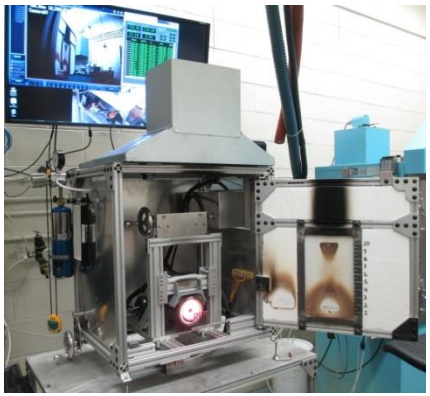

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