



Federal Aviation  
Administration

# International Aircraft Materials Fire Test Working Group Meeting

## Development of a New Flammability Test for Magnesium-Alloy Seat Structure

Presented to: International Aircraft Materials Fire Test  
Working Group, Atlantic City, NJ

By: Tim Marker, FAA Technical Center

Date: October 27, 2014



# Magnesium Alloy Flammability Highlights

**733** tests completed to date

Experimentation with Various Sample Holders

Calibration Using Igniterless Stator/Turb w/various ignition techniques

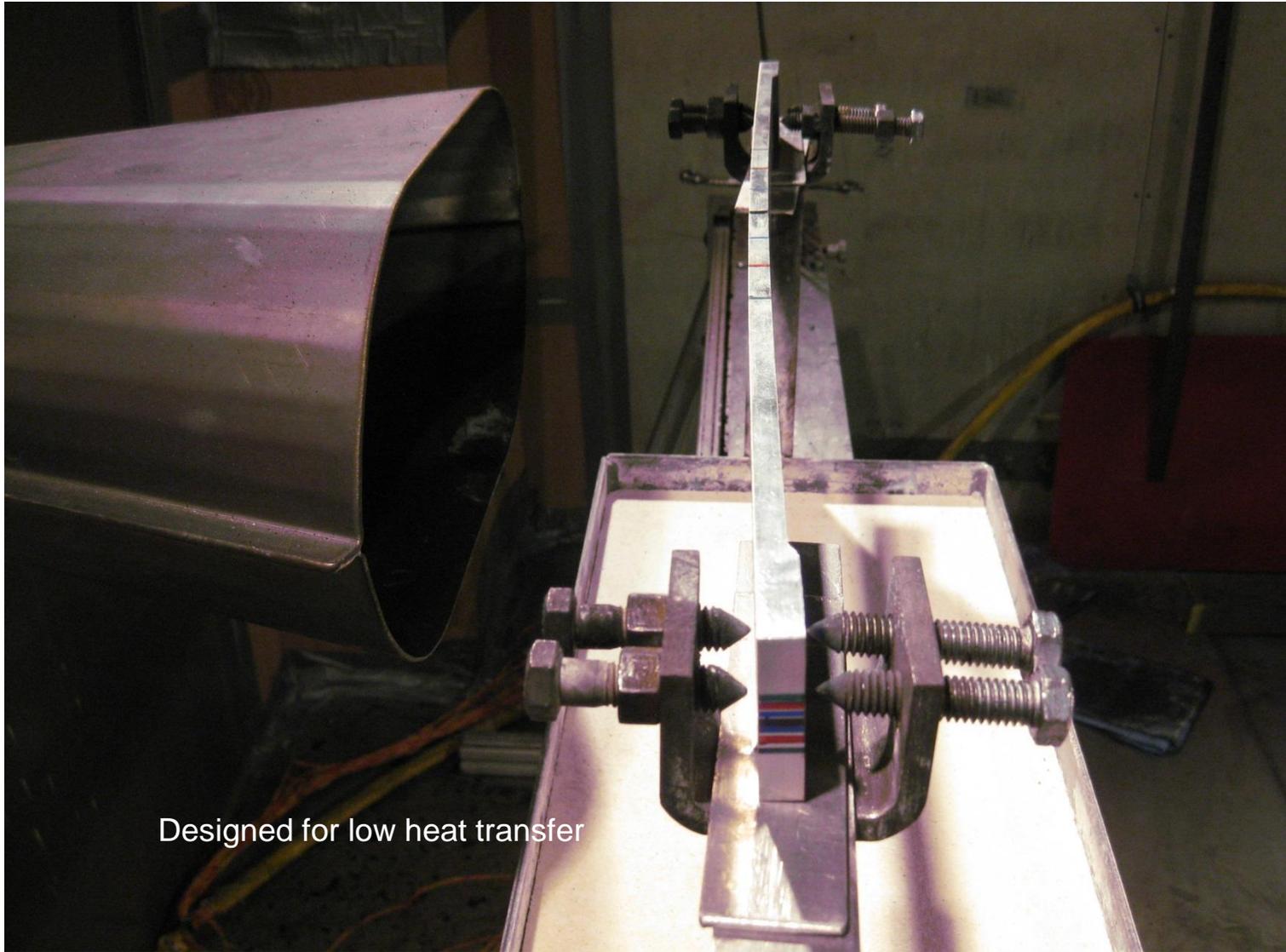
Wildcard?

Future Work

# How Can Test Repeatability Be Improved?

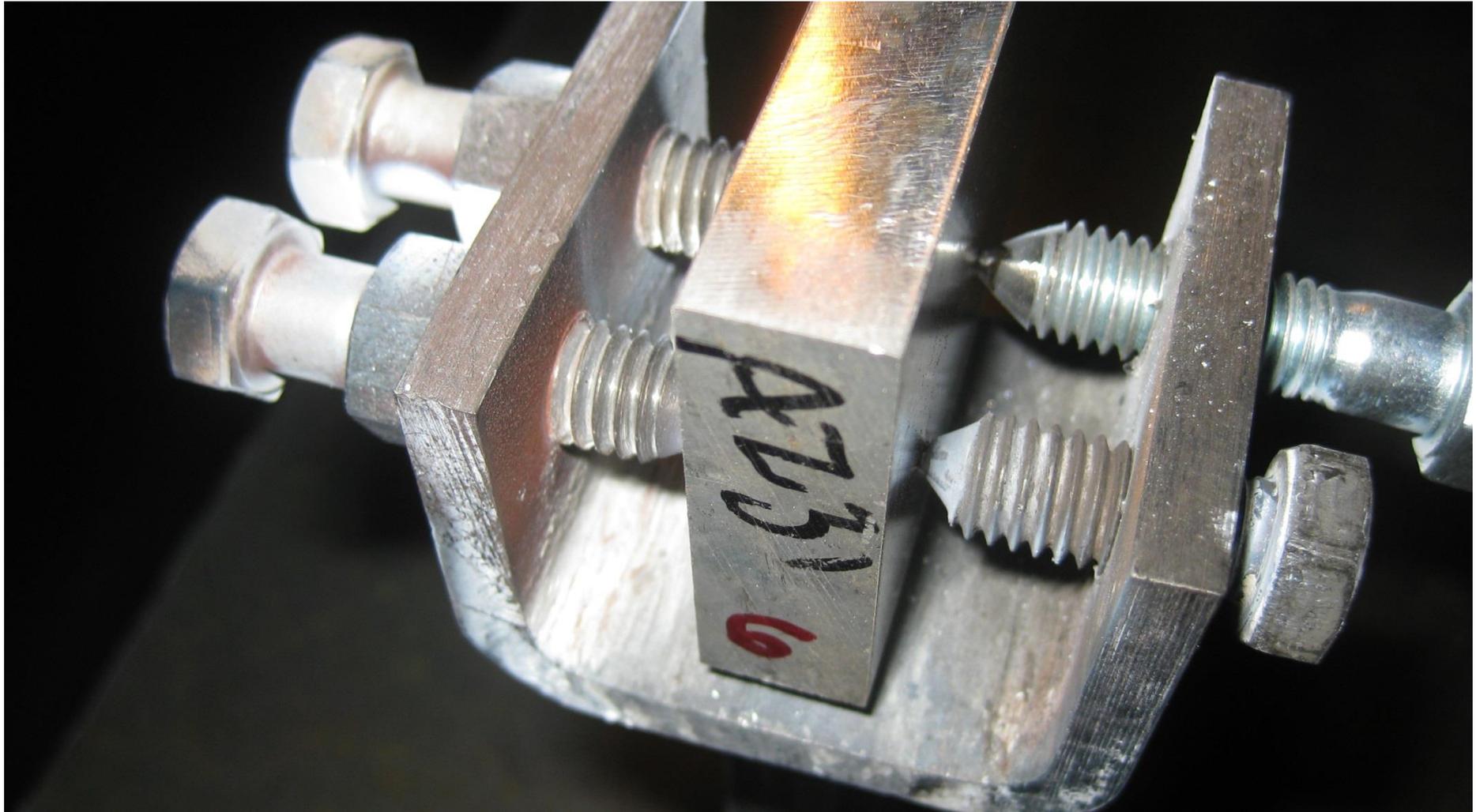
1. Reduce data scatter on “time to burn” measurement
  - Better definition of what burning is (i.e., 10-second sustained ignition = burn)
  - What is impact of sample holder?
2. Reduce data scatter on “time to self extinguishment” measurement
  - Elimination of residue self-extinguishment measurement
  - Better definition of what constitutes sample extinguishment
  - Produced & circulated video of what constitutes sample extinguishment
3. Reduce data scatter on “weight loss” measurement
  - Conducted testing to determine impact of time, brushing, hammering, etc

# Impact of Sample Holder on Test Outcome

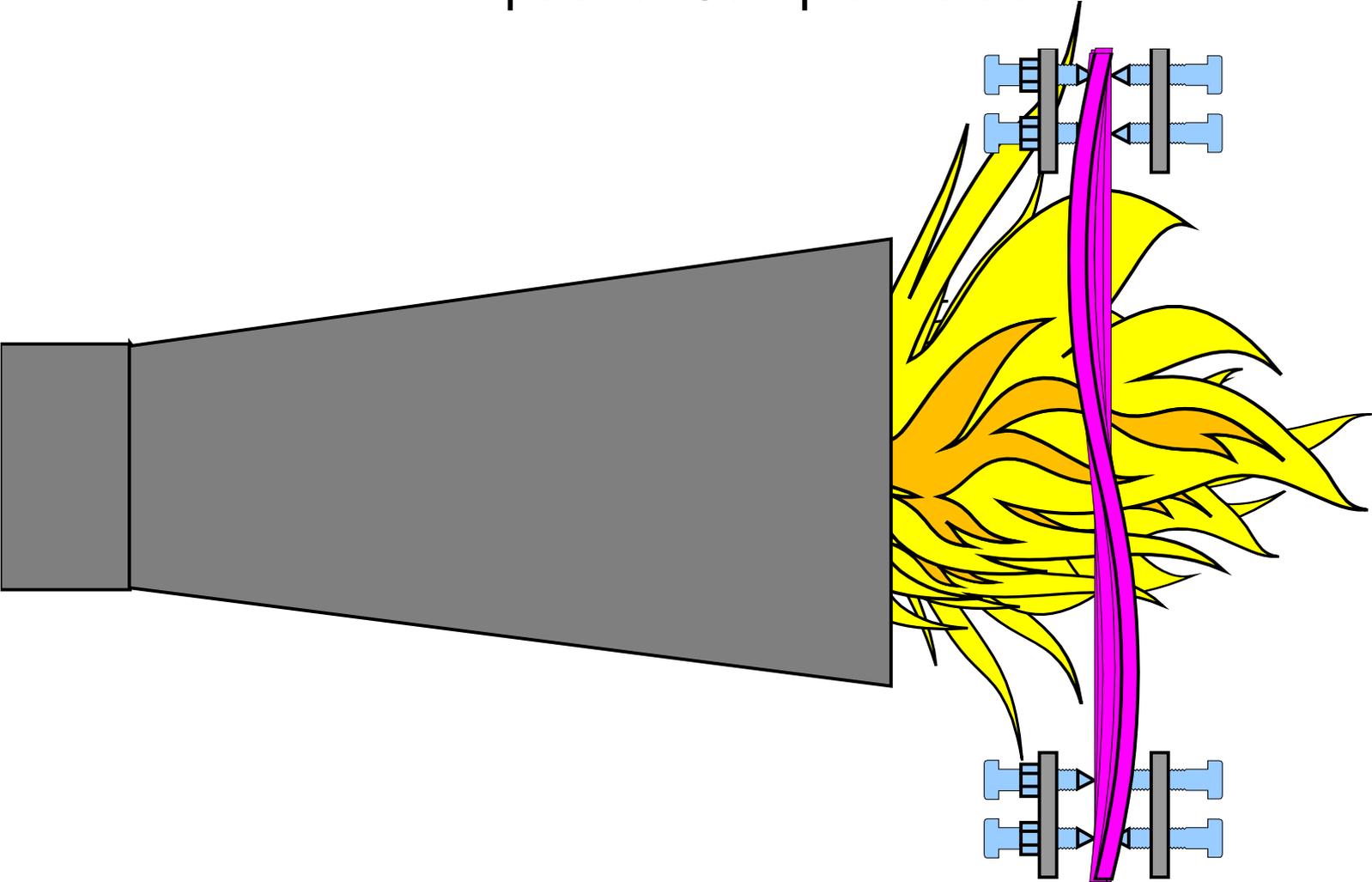


Designed for low heat transfer

# Sample Restrained in Fixture - Locked



# Impact of Sample Holder



# Elongation of Restrained Sample

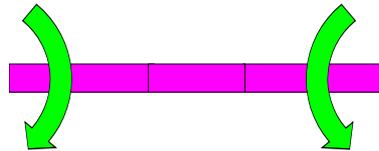


# 3 Main Functions of Sample Holder

1. Must allow for sample to elongate



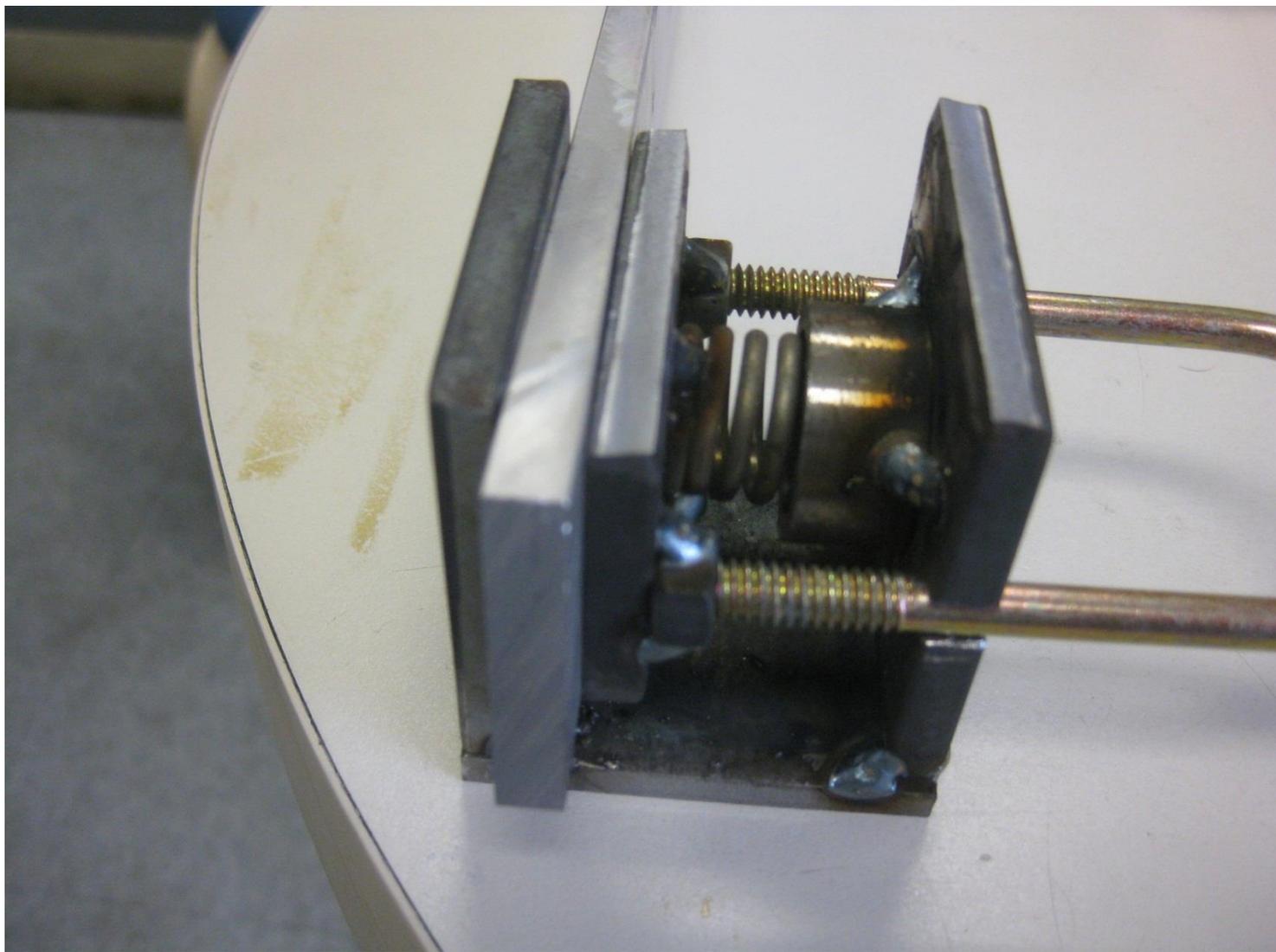
2. Must prevent sample from rotating after melting



3. Must accommodate slight variations in sample thickness



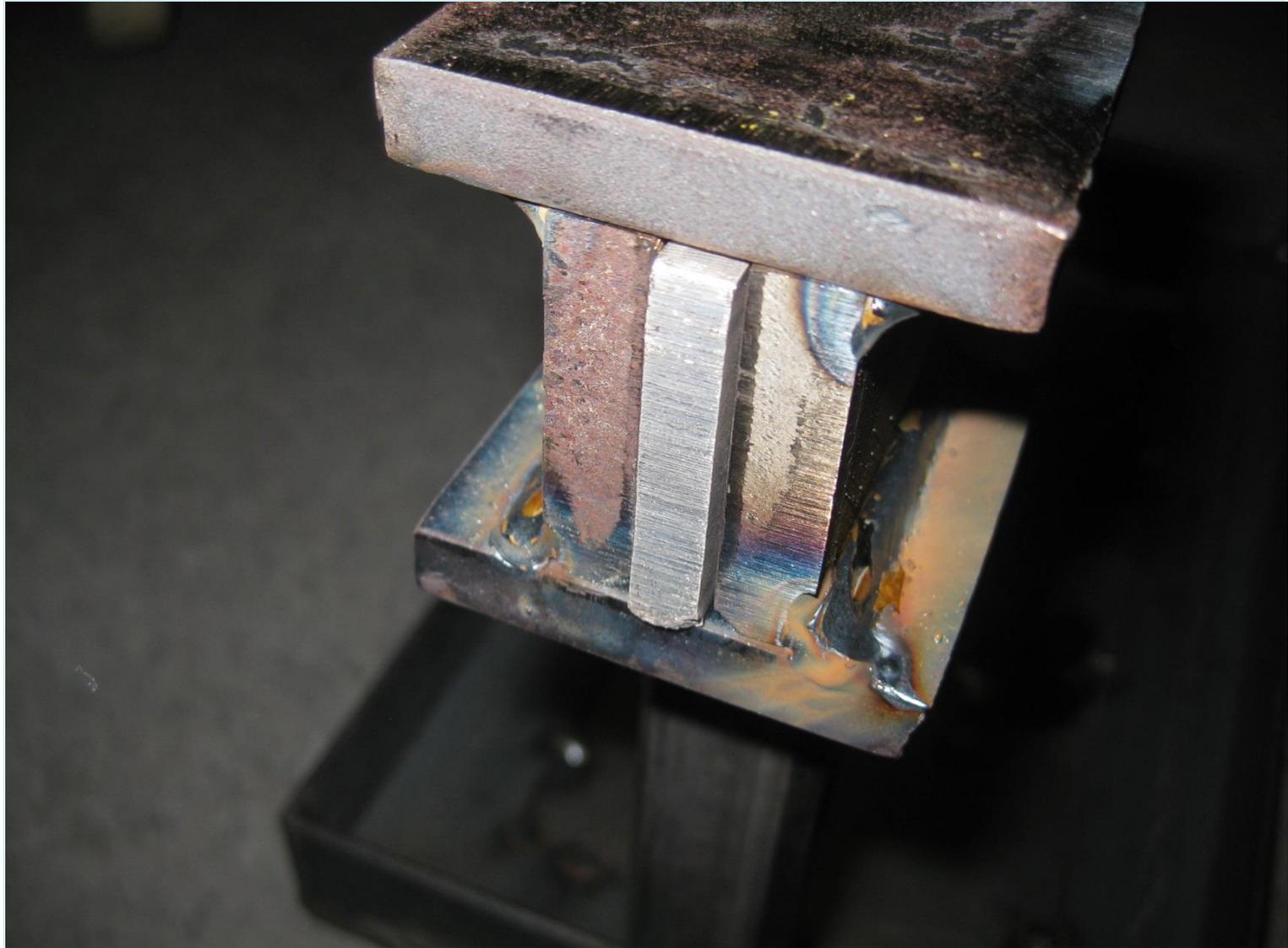
# Experimentation with Various Sample Holders



# Alternate Sample Holder Allows Elongation



# Alternate Sample Holder Allows Elongation



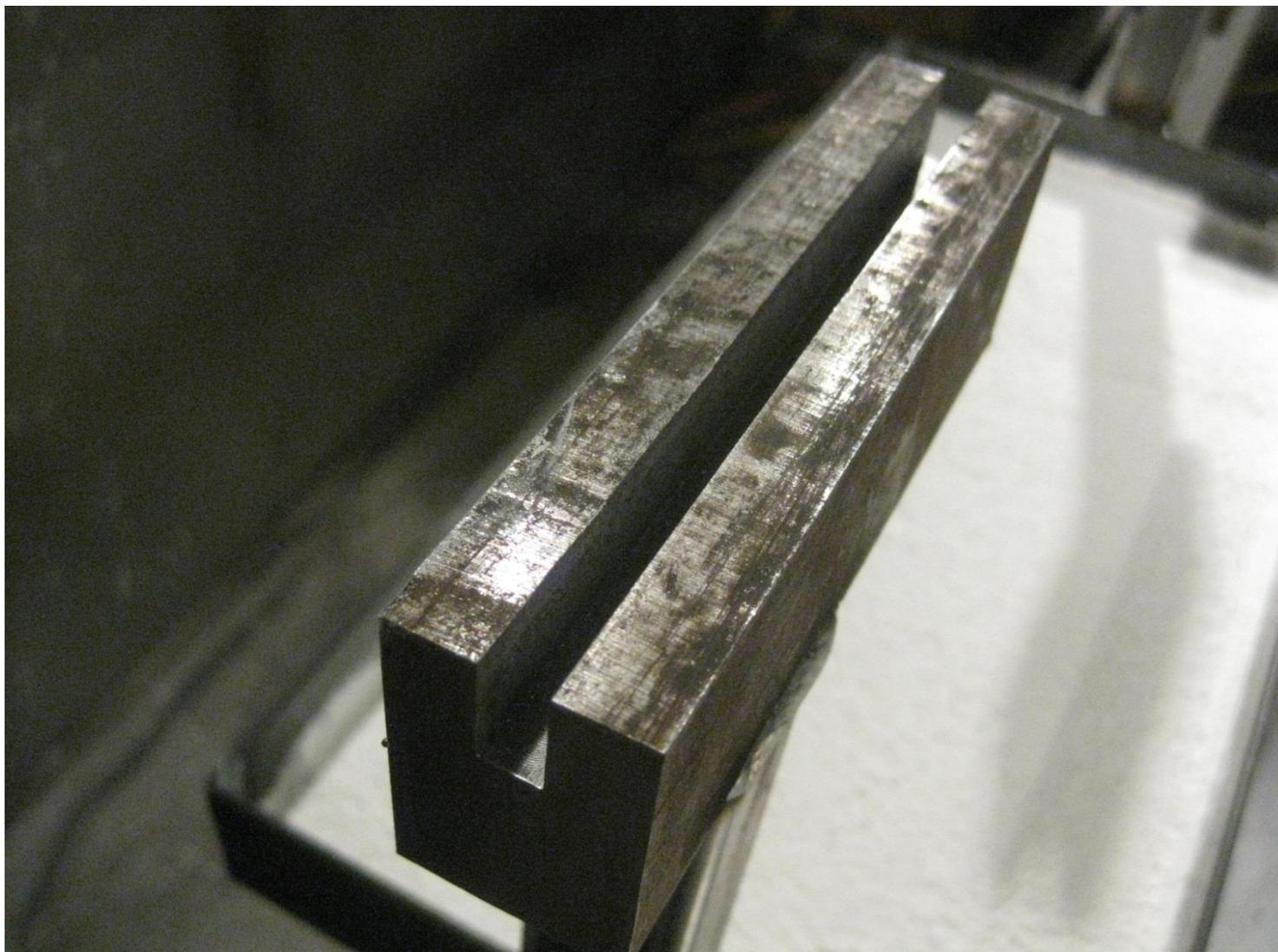
# Slotted Sample Holder Allows Elongation



Allows for elongation

Prevents rotation

# Slotted Sample Holder



# Slotted Sample Holder



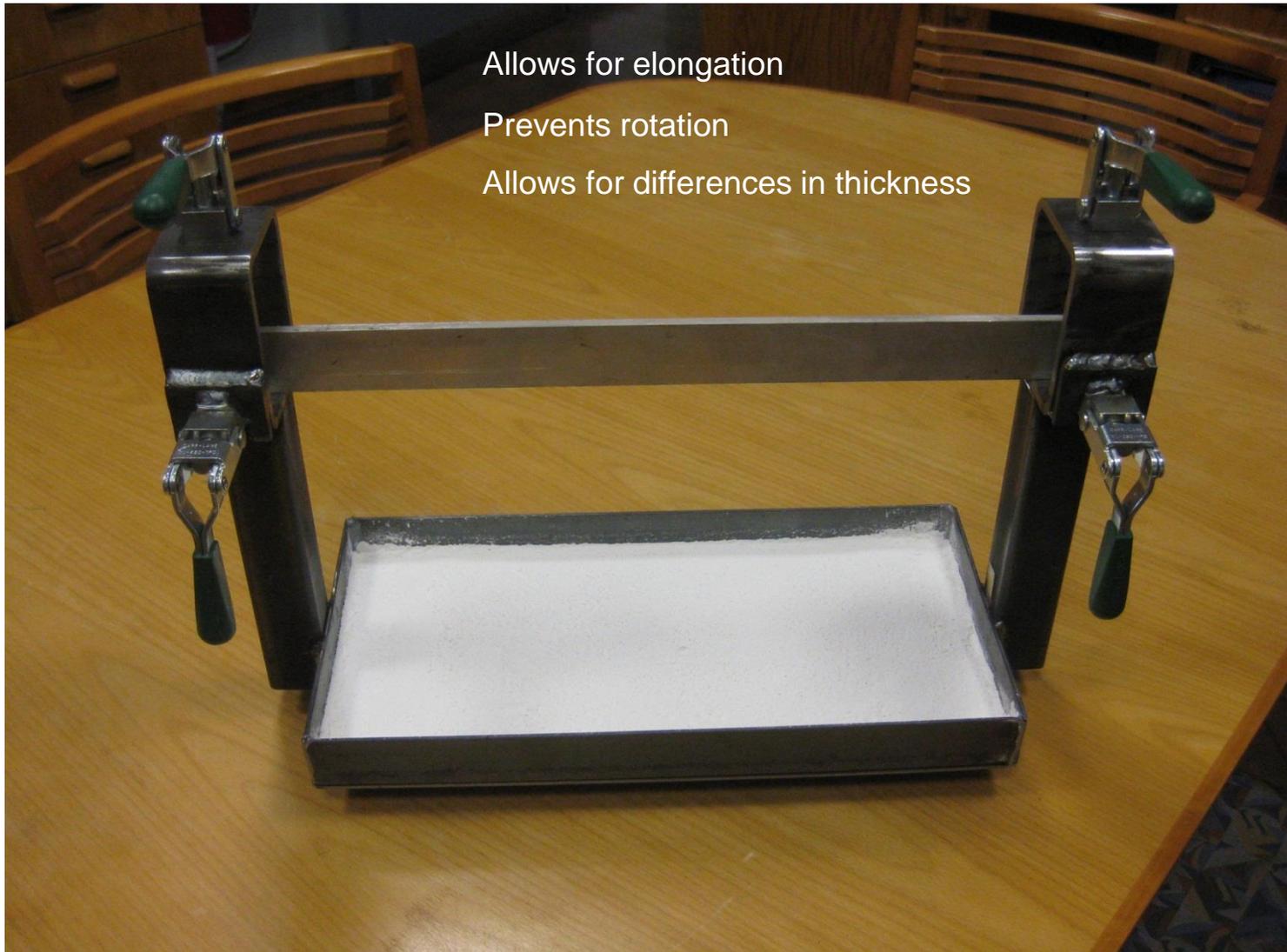
# Slotted Sample Holder



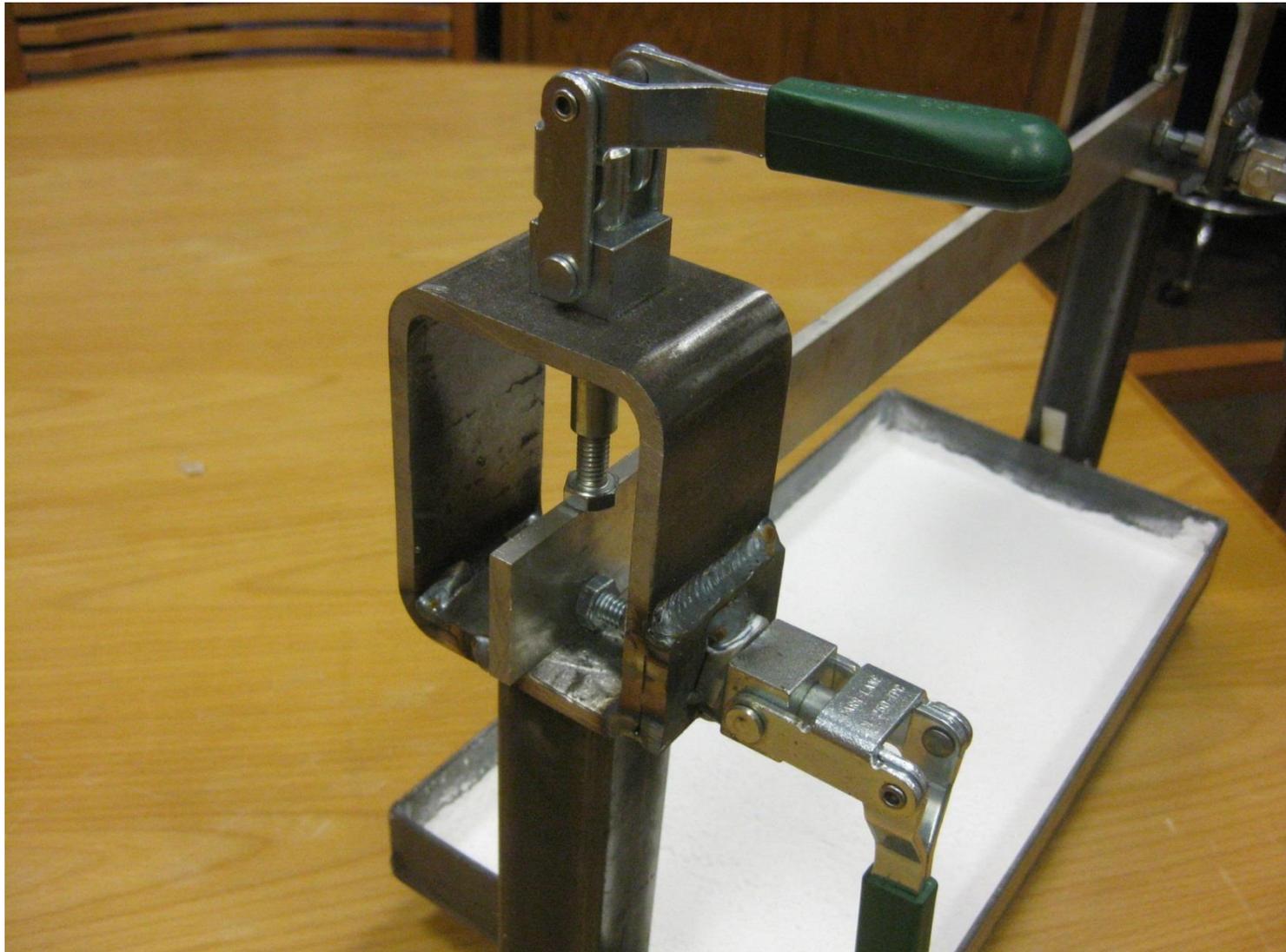
Allows for elongation

Prevents rotation

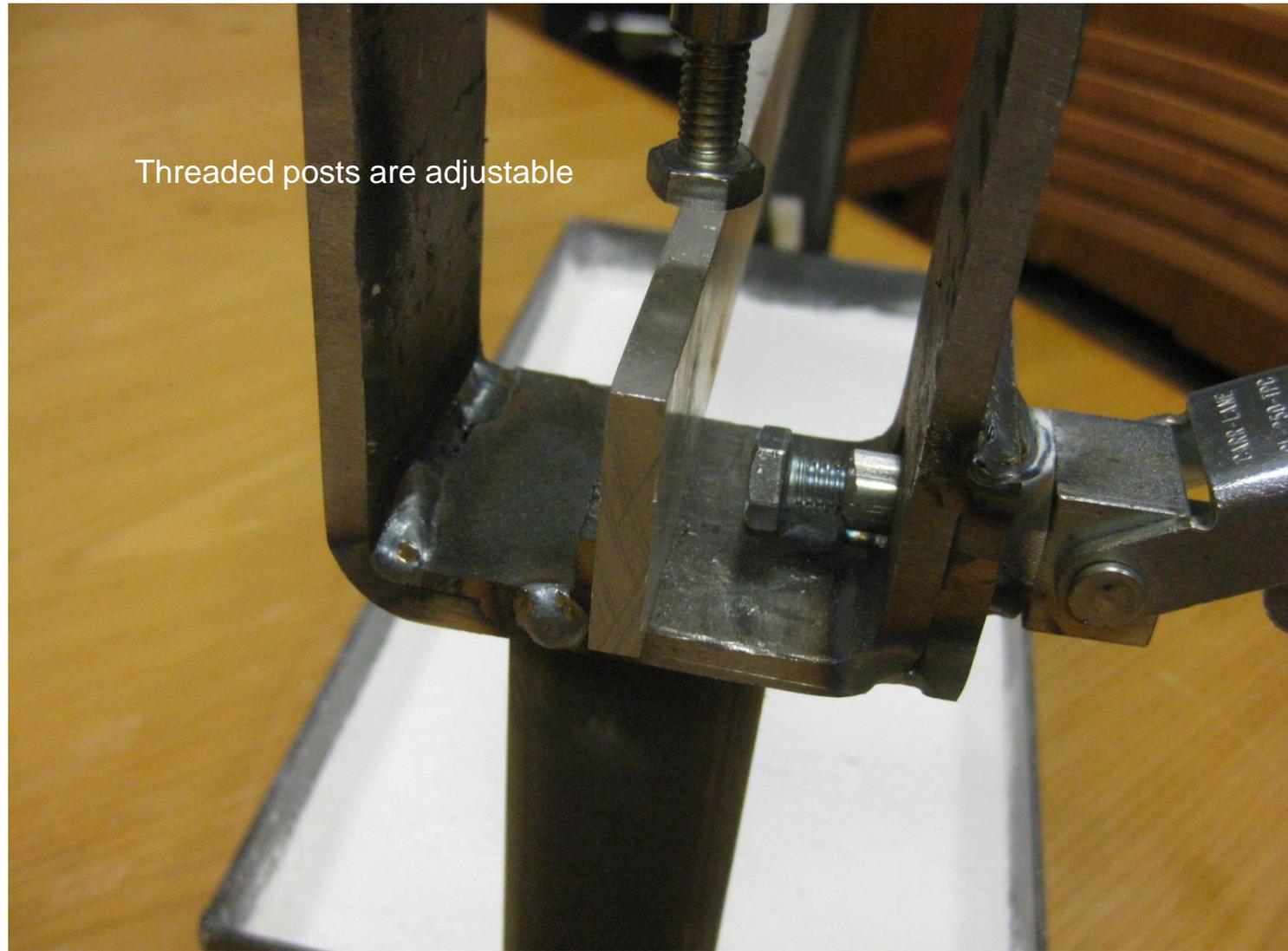
# Sample Holder Using Lever Clamps



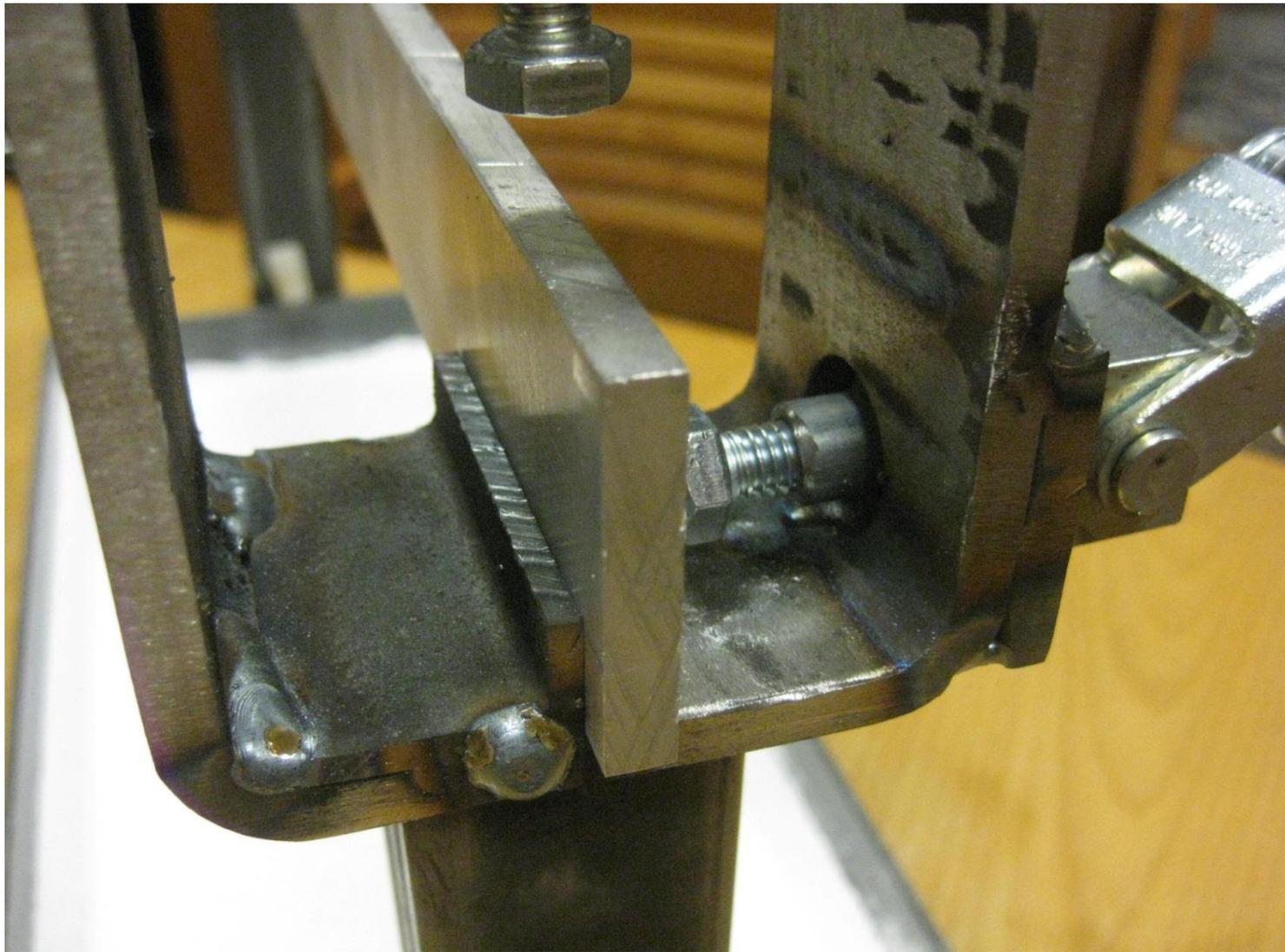
# Sample Holder Using Lever Clamps



# Sample Holder Using Lever Clamps

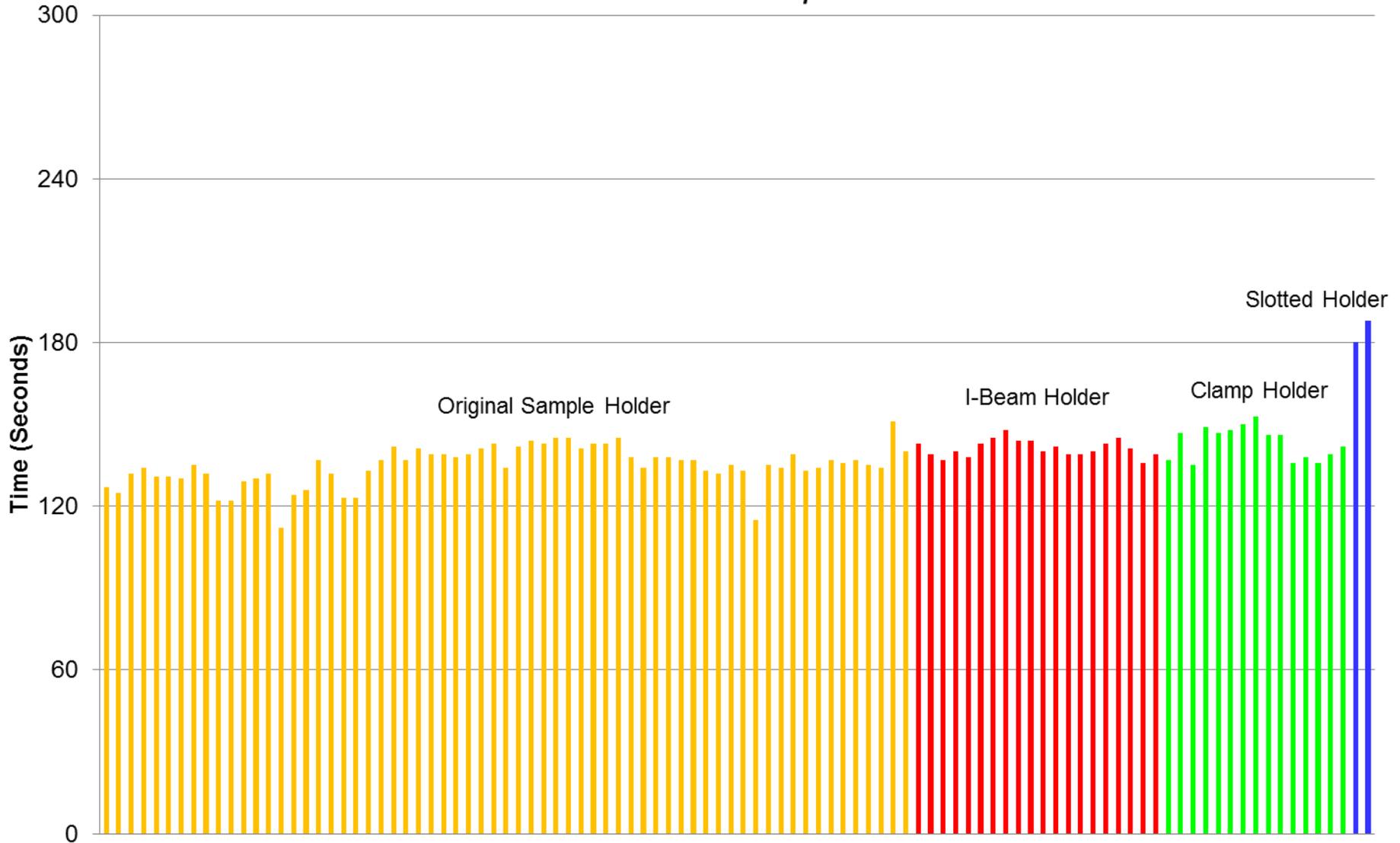


# Sample Holder Using Lever Clamps



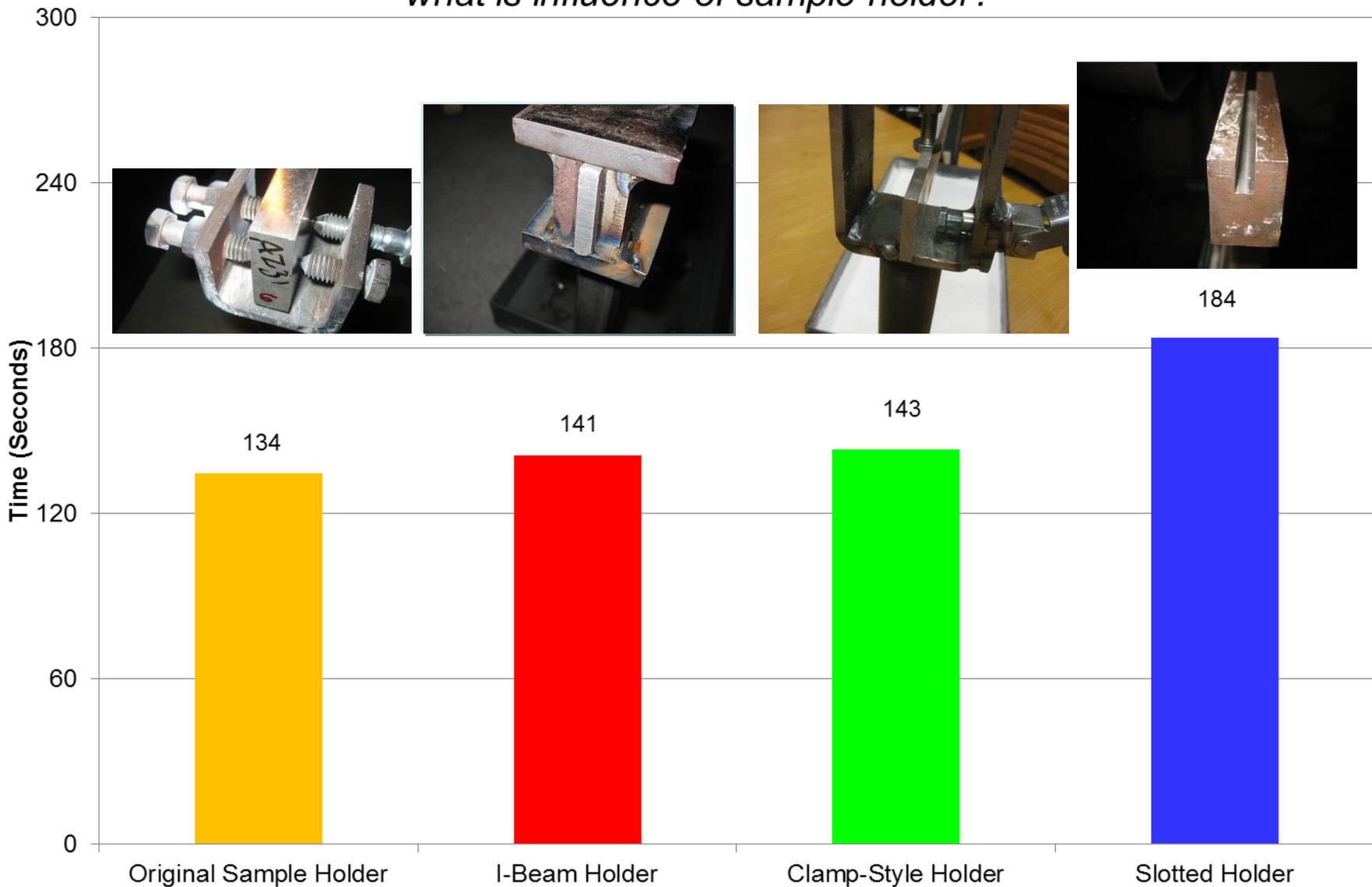
# Melt Times Using Igniterless Stator

*what is influence of sample holder?*



# Melt Times Using Igniterless Stator

*what is influence of sample holder?*



# Advantages of Igniterless Stator



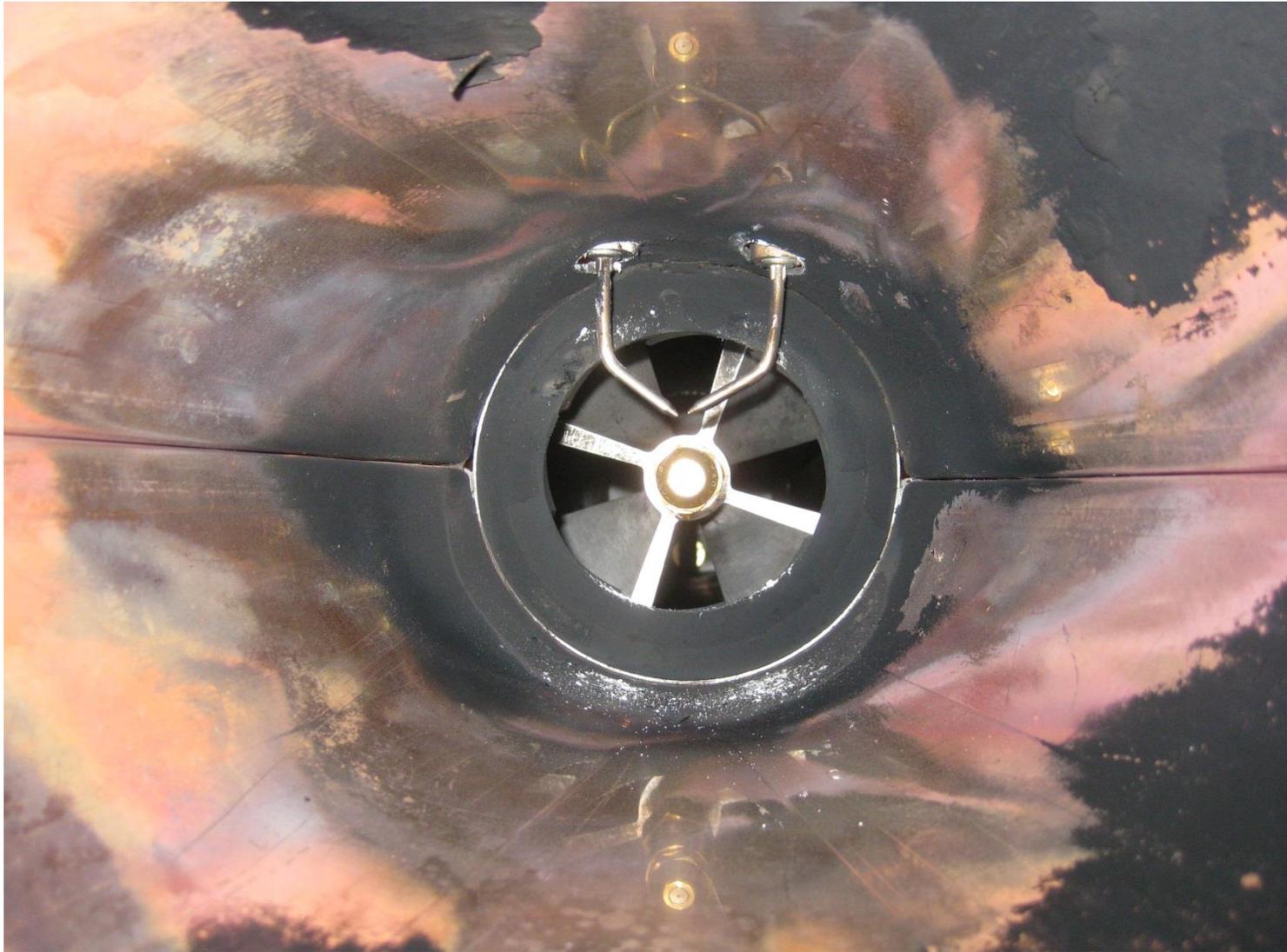
# Igniterless Stator/Turb w/Protruding Electrodes



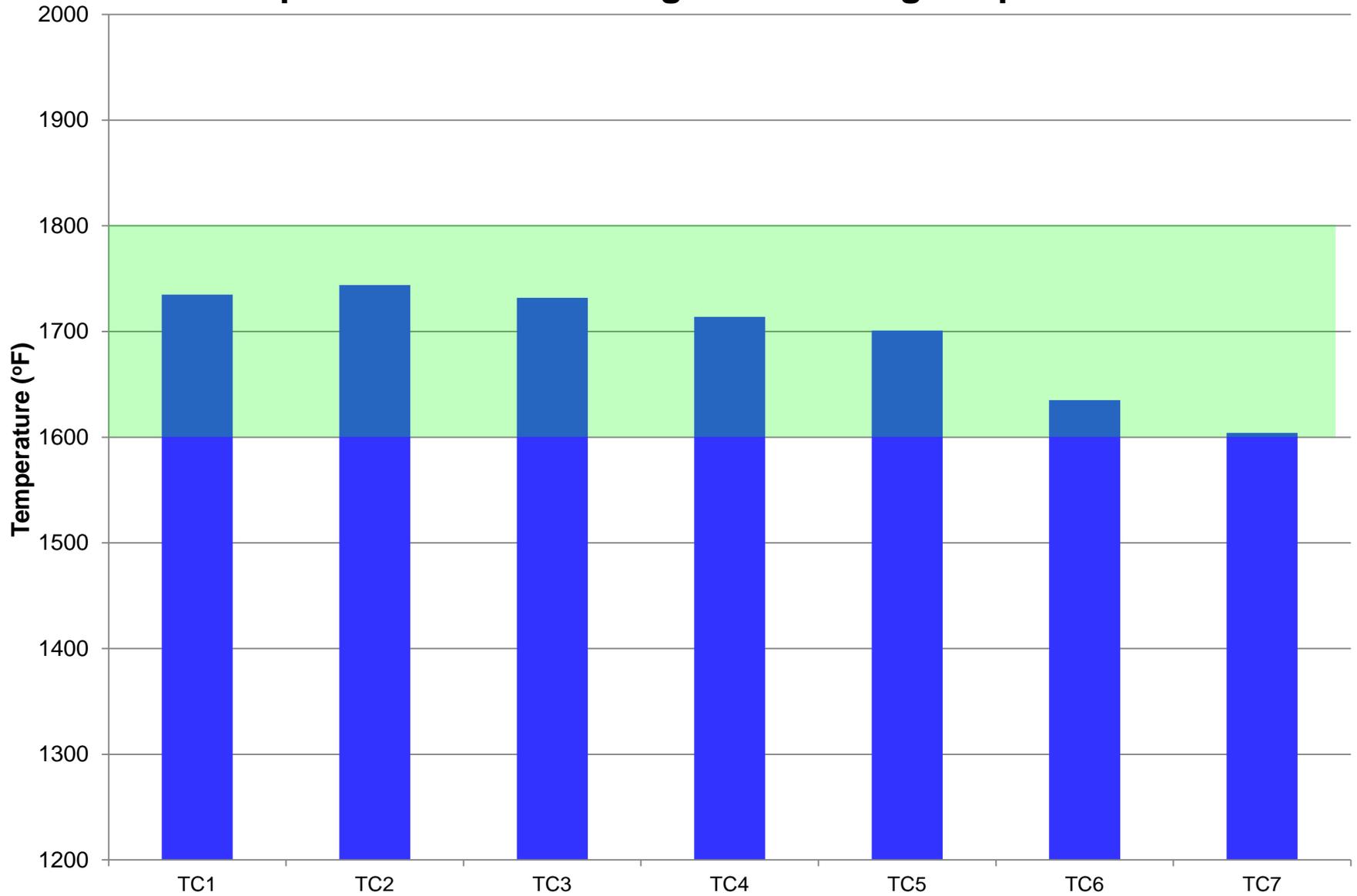
# Igniterless Stator/Turb w/Protruding Electrodes



# Igniterless Stator/Turb w/Protruding Electrodes



# Temperature Profile with Igniters Through Top of Cone



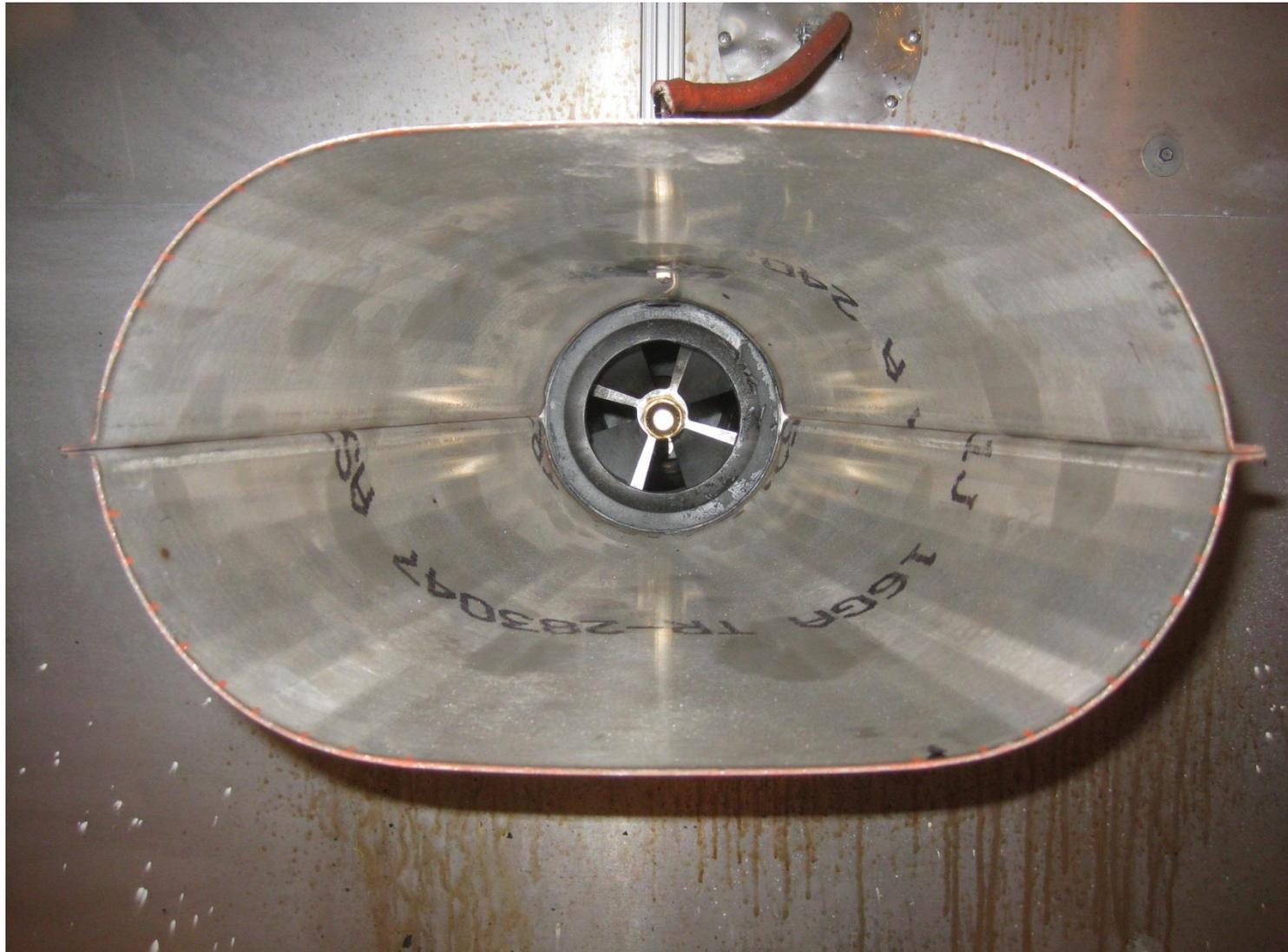
# Igniterless Stator/Turb + Spark Plug



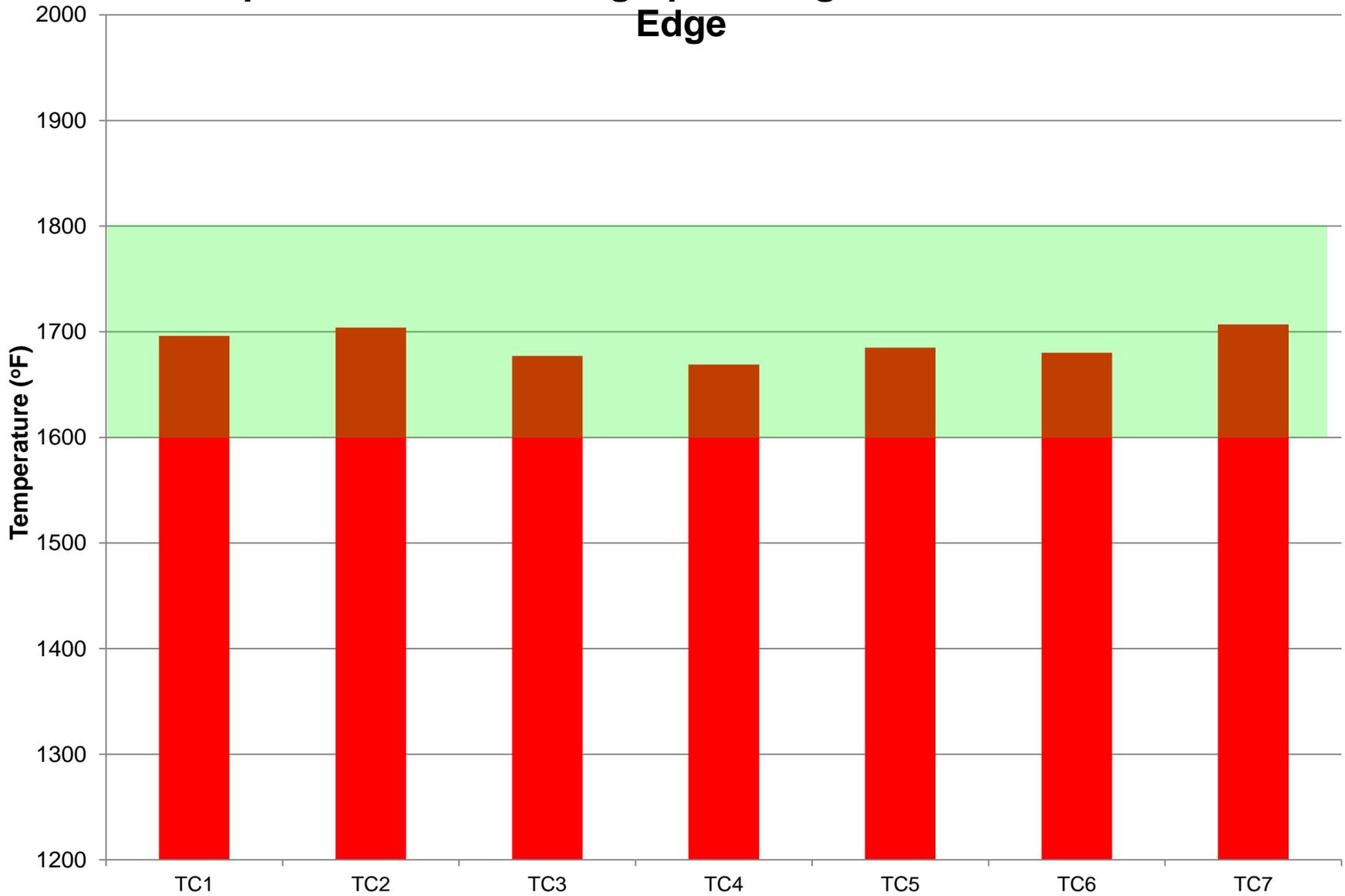
# Igniterless Stator/Turb + Spark Plug



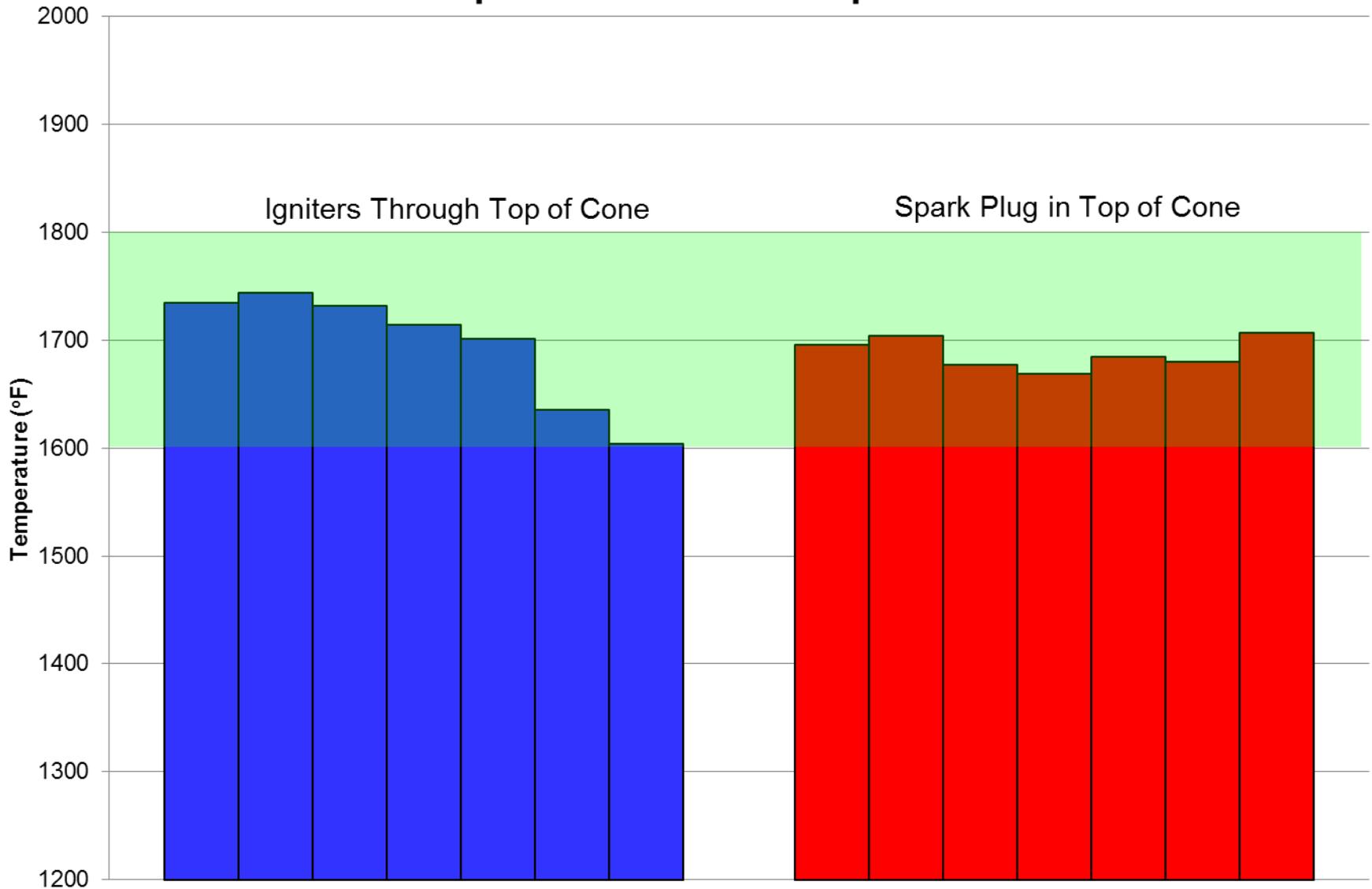
# Igniterless Stator/Turb + Spark Plug



# Temperature Profile Using Spark Plug 4 Inches from Cone Edge



# Temperature Profile Comparison



# Wildcard

**Magnesium Alloy Flammability Test Method is  
now in the Aircraft Materials Fire Test Handbook!**





**Federal Aviation  
 Administration  
 Fire Safety**

 Search

**What's New**

Date	Section	Description
10/15/14	Handbook	Added Chapter 25 - Oil Burner Flammability Test for Magnesium Alloy Seat Structure
10/10/14	Handbook	Updated <a href="#">Appendix F</a> and <a href="#">Appendix G</a>
10/01/14	Reports	Posted report <a href="#">DOT/FAA/TC-14/24</a>
09/19/14	Systems	Oct. meeting info posted and registration opened.
09/16/14	Materials	Oct. meeting info posted and registration opened.
07/21/14	Handbook	Posted the <a href="#">Federal Register for Use of the Aircraft Materials Fire Test Handbook</a>
07/16/14	Materials	Minutes, and attendee list posted from June meeting.
07/09/14	Materials	Posted presentations from June meeting.
06/11/14	Reports	Posted report <a href="#">DOT/FAA/TC-14/6</a>
05/28/14	Systems	Presentations, minutes, and attendee list posted from May meeting.
05/07/14	Handbook	Updated <a href="#">Appendix F</a> and <a href="#">Appendix G</a>
04/15/14	Materials	June meeting info posted and registration opened.
04/15/14	Systems	<a href="#">Agenda</a> posted for May meeting.
03/12/14	Systems	<a href="#">Registration</a> open for May meeting.
03/12/14	Materials	Presentations, minutes, and attendee list posted from March meeting.
03/05/14	Reports	Added report <a href="#">DOT/FAA/TC-13/52</a>
02/13/14	Materials	March meeting info and <a href="#">agenda</a> posted.
02/03/14	Conference	Posted attendance list.
01/30/14	Conference	Posted <a href="#">proceedings</a> .
01/30/14	Reports	Added Report <a href="#">DOT/FAA/TC-13/53</a>
01/10/14	Front Page	<a href="#">2013 Highlights</a> posted
11/22/13	Conference	Added meeting room information.
11/21/13	Conference	Updated schedule, abstracts and bios.
10/22/13	Reports	Added report <a href="#">DOT/FAA/TC-13/46</a>
10/21/13	Reports	Added report <a href="#">DOT/FAA/TC-12/13</a>
10/04/13	Materials	Added <a href="#">September 2013 HR2 Task Group Meeting files</a> .
08/22/13	Conference	Added abstracts and author biographies.
07/22/13	Materials	Minutes and attendee list posted from June meeting.
07/02/13	Materials	Presentations posted from June meeting.
06/07/13	Systems	Presentations, minutes, and attendee list posted from May meeting.
05/17/13	Handbook	Updated <a href="#">Appendix F</a> and <a href="#">Chapter 6</a>
05/14/13	Materials	June meeting agenda posted.
05/14/13	Systems	Update the May meeting <a href="#">agenda</a> .
05/09/13	Systems: Lavex: Lavex MPS	Updated Lavex Minimum Performance Standard
04/12/13	Reports	Added Report <a href="#">DOT/FAA/TC-13/5</a>

**Announcements**

- Update:** Heat Release Rate Apparatus
- SAFO:** Risks in Transporting Lithium Batteries in Cargo by Aircraft
- Final Policy:** Policy Statement on Flammability Testing of Interior Materials Issued (link opens small window)
- UPDATED 08/12:** Statement on the Use of Magnesium in Airplane Cabins
- Released:** AC 20-42D - Hand Fire Extinguishers for Use in Aircraft
- Cabin Safety Research Technical Group:** Accident Database now available online.
- Info:** Availability of a Federal Aviation Administration (FAA) In-flight Firefighting Training Video (see VIDEOS below)
- SAFO:** Fighting Fires Caused By Lithium Type Batteries in Portable Electronic Devices (see VIDEOS below)
- VIDEOS:** View videos on Cabin Crew Fire Fighting Training (updated 03/09/09) & Laptop Battery Fires.

**Highlights**

- 2013 Highlights
- 2012 Highlights
- 2011 Highlights
- 2010 Highlights
- 2009 Highlights

Chapter	Title
Chapter 1	Vertical Bunsen Burner Test for Cabin & Cargo Compartment Materials <a href="#">Burn Length Determination</a> <a href="#">Lab Test Form - Bunsen Burner Test</a>
Chapter 2	45-Degree Bunsen Burner Test for Cargo Compartment Liners and Waste Stowage Compartment Material <a href="#">Lab Test Form - Bunsen Burner Test</a>
Chapter 3	Horizontal Bunsen Burner Test for Cabin, Cargo Compartment, and Miscellaneous Materials <a href="#">Lab Test Form - Bunsen Burner Test</a>
Chapter 4	60-Degree Bunsen Burner Test for Electric Wire <a href="#">Lab Test Form - Bunsen Burner Test</a>
Chapter 5	Heat Release Rate Test for Cabin Materials <a href="#">Lab Test Form - OSU Heat Release Test</a> <a href="#">Heat Release Rate Calibration Factor</a>
Chapter 6	Smoke Test for Cabin Materials <a href="#">Lab Test Form - NBS Smoke Burner Test</a> <a href="#">Report on the Smoke Chamber Furnace</a> <a href="#">New Furnace</a>
Chapter 7	Oil Burner Test for Seat Cushions <a href="#">Advisory Circular on Flammability Requirements for Aircraft Seat Cushions.</a> <a href="#">Lab Test Form - Oil Burner Seat Cushion Test</a>
Chapter 8	Oil Burner Test for Cargo Liners <a href="#">Lab Test Form - Oil Burner Cargo Liner Test</a>
Chapter 9	Radiant Heat Testing of Evacuation Slider, Ramps, and Rafts
Chapter 10	Fire Containment Test of Waste Stowage Compartments
Chapter 11	Powerplant Hose Assemblies Test
Chapter 12	Powerplant Fire Penetration Test
Chapter 13	Test for Electrical Connectors used in Firewalls
Chapter 14	Test for Electrical Wire used in Designated Fire Zones
Chapter 15	Two Gallon per hour Oil Burner Certification Testing for Repaired Cargo Compartment Liners
Chapter 18	Recommended Procedure for the 4-Ply Horizontal Flammability Test for Aircraft Blankets <a href="#">Lab Test Form - Bunsen Burner Test</a>
Chapter 19	Smoke test for Insulated Aircraft Wire
Chapter 20	Dry Arc Tracking Test Procedure
Chapter 21	Dry Arc-Propagation Resistance
Chapter 22	Cotton Swab Test for Thermal Acoustic Insulation Blankets
Chapter 23	Test Method To Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustic Insulation Materials
Chapter 24	Test Method To Determine the Burnthrough Resistance of Thermal/Acoustic Insulation Materials
Chapter 25 (new)	Oil Burner Flammability Test for Magnesium Alloy Seat Structure
Appendix A	FAA Regulations
Appendix B	The Approval Process
Appendix C	Materials Used in Aircraft
Appendix D	Regulatory Methodology Used By Other Countries
Appendix E	Aircraft Industries Internal Test Methods and Guidelines
Appendix F *	Laboratories Actively Using Fire Test Procedures
Appendix G *	Commercial Manufacturers of Fire Test Equipment

\* Updated 10/10/2014

## Chapter 25

### Oil Burner Flammability Test for Magnesium Alloy Seat Structure

#### 25.1 Scope

##### 25.1.1 Applicability

This test method evaluates the ignition resistance and flammability of magnesium alloy when used in the construction of aircraft seat primary structural components by using a high-intensity open flame to show the material adequately resists involvement in a postcrash fire.

#### 25.2 Definitions

##### 25.2.1 Magnesium Alloy

A magnesium alloy is defined as any solid form of magnesium containing a variety of alloying materials (e.g., zinc) or rare-earth elements (e.g. yttrium). Any component or material containing more than 10% elemental magnesium by weight shall be considered a magnesium alloy.

##### 25.2.2 Sample Set

A sample set consists of three or more replicate test samples of a particular magnesium alloy used in the construction of an aircraft seat primary-load-path structural component.

##### 25.2.3 Burning

Burning (sustained ignition) is defined as an ignition lasting for 10 consecutive seconds (i.e., the start time of an ignition lasting for more than 10 seconds shall be considered the beginning of the burning period, in the event that ignition stops and then re-starts).

# Important Changes to Test in Handbook

## Removal of temperature calibration (temp check):

Although not a requirement for testing, the recommended average temperature of each of the seven thermocouples should be  $1700^{\circ}\text{F} \pm 100^{\circ}\text{F}$  ( $927^{\circ}\text{C} \pm 38^{\circ}\text{C}$ ). The burner should be rechecked to ensure it is configured properly if temperatures are measured outside of this recommended range. A fine adjustment of the internal stator orientation and/or distance from the end of the draft tube may be necessary to achieve the required temperatures, provided the adjustments are within allowable tolerances. If no problems are found with the burner, any thermocouple reading outside of this range may require replacement. It is recommended that burner flame temperature be validated prior to running a series of tests to ensure test result consistency.

Additional language in the Supplemental section...

# Important Changes to Test in Handbook

## Removal of time for sample to self-extinguish:

Measuring the exact time of flame extinguishment of the test sample is difficult and subjective, given the nature of a burning magnesium alloy. The transition of the alloy from burning to self-extinguishment typically happens gradually rather than instantaneously, as is the case with most traditional cellulosic materials. For this reason, a maximum allowable time until self-extinguishment of the test sample is not required, per se. However, if new magnesium alloys become available that exhibit extended burn periods prior to self-extinguishment, but still pass the weight loss criteria, it may be necessary to incorporate a maximum time requirement for the alloy to self-extinguish.

# Future Work

What is impact of spark plug on flame profile & test results?

Update Handbook to include new ignition methodology?

Testing of Altered Magnesium Samples (Anodized, Powder-coated, etc)

Testing of Thin Magnesium Alloy sheet