

Sandia High Temperature Split Hopkinson Pressure Bar

Megan Boston

8246 Mechanics of Materials

August 4, 2011



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Introduction

- Split Hopkinson Pressure Bar

External Impact

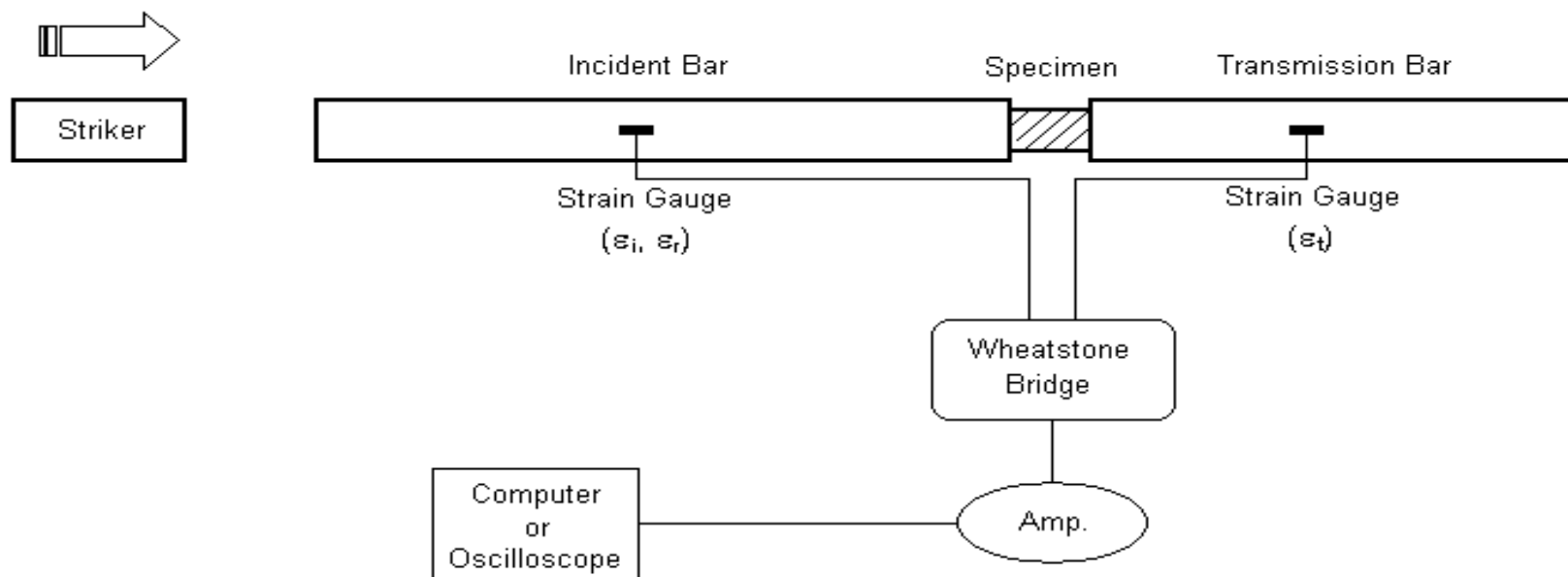


- Uses and Benefits

- Stress and strain in material under dynamic loading
- Performance of materials under impact loads
- Can get data from Hammer like impact loads

Conventional Split Hopkinson Pressure Bar (SHPB)

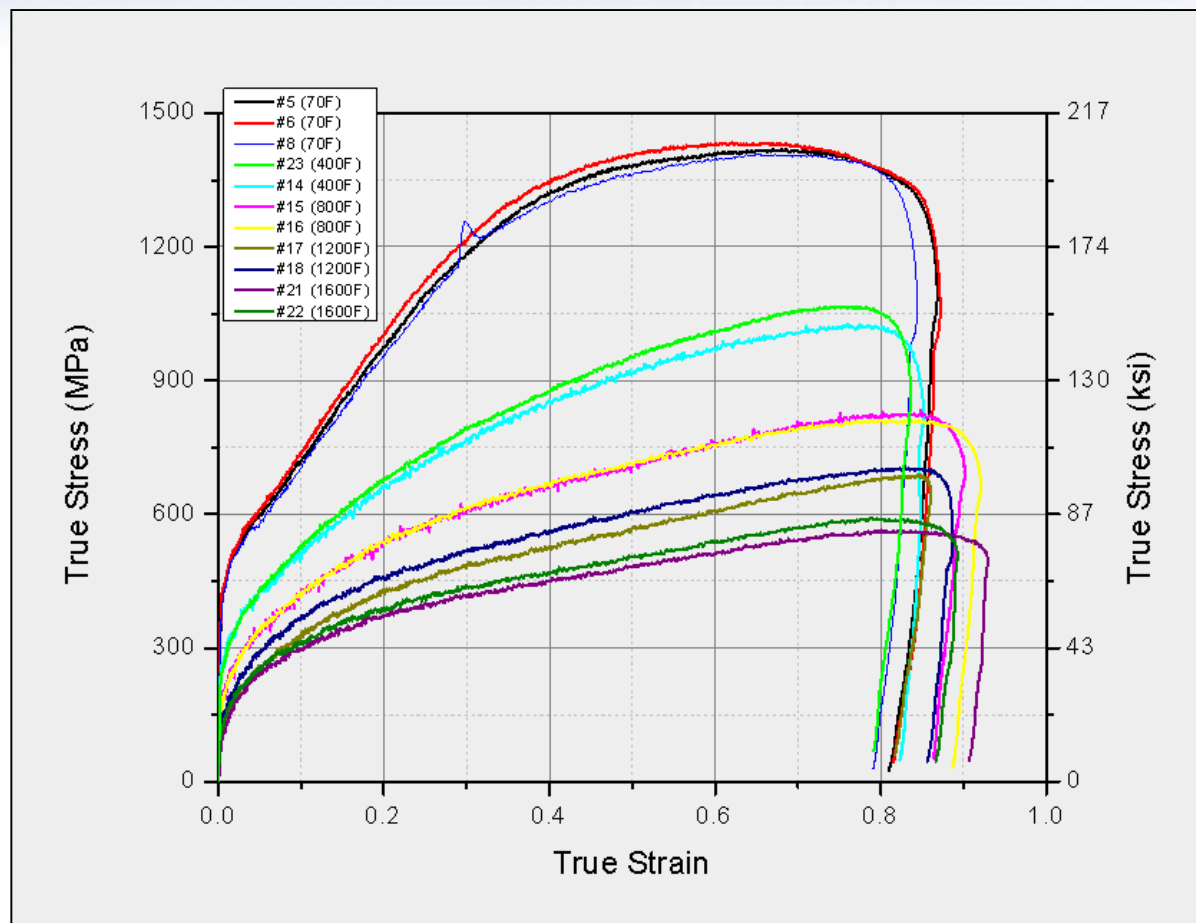
Strain rate range from 10^2 to 10^4 s⁻¹.



High Temperature Testing

- Why High Temperature Testing
 - See how materials perform under high strain rates at elevated temperatures for GTS fabrication processes
 - Welding
 - Machining
 - Forging
- Can examine how the substructure of a material changes when subjected to dynamic loads at high temperatures

High Temperature Testing



Heating Methods

- Heat the specimen and the bars
 - Temperature gradients in the bars
 - Properties of the bars change
- Heat the specimen separately and then bring the bars into contact with the bars
 - Furnace, radiant heating system, electric pulse heating
 - Cold Contact Time

Kuokkola HT-SHPB

- Computer controlled testing
 - Automated control of removing the specimen from the furnace
 - Controls when the bars are moved into contact with the specimen
 - Controls when the Fire Valve is opened
- Eliminates the amount of time the specimen is in contact with the cooler bars

Video of existing setup

Specimen Preservation and Quenching

- Specimen Preservation
 - Single loading of the specimen
 - Momentum Trap
- Quenching
 - Preserve the microstructure of the loaded specimen
 - Way to observe the recrystallization of the specimen after high temperature high strain loading conditions

Sandia HT SHPB

- Modifications to the Kuokkola setup
 - Added controls that provide ways to preserve the sample for help in modeling and simulation
 - Momentum Trap
 - In typical Kolsky bar experiments, specimen is loaded by multiple incident waves.
 - Momentum trap should stop the incident bar from hitting the sample again.
 - Able to have a force history
 - Stress Strain rate

Sandia HT SHPB

- Reheating the specimen
 - Can control how long specimen is reheated
 - Reheating helps with controlling the quenching conditions
 - Reheat sample to previous temperature
 - Helps with modeling and simulations

- Specimen Quenching
 - User can adjust the time for quenching the specimen
 - Quenching to lockup microstructure to help with modeling

Control Panel

Sandia High Temperature Kolsky Bar System

Testing Before Firing

Specimen Position: **Retracted**
Retract Time (ms): 0
To Furnace **From Furnace**

Back Bar Position: **Back**
Close Time (ms): 0
Bar Back **Close Bars**

Fire Valve Status: **CLOSED**
Fire Time (ms): 0
FIRE!

Testing After Firing

Front Bar Position: **Back**
Open Time (ms): 0
Bar Back

Release Bar Position: **UP**
Release Time (ms): 0
Down **Up**

Time Back in Furnace (ms): 0
Time Out of Furnace (ms): 0
Time left in Furnace (s): 0

Run Entire Test

Bar Close Delay (ms): 300
Fire Valve Delay (ms): 1

☐ Move Front Bar Back
Front Bar Delay (ms): 500

☐ Specimen Back To Furnace
Time in furnace (s): 60

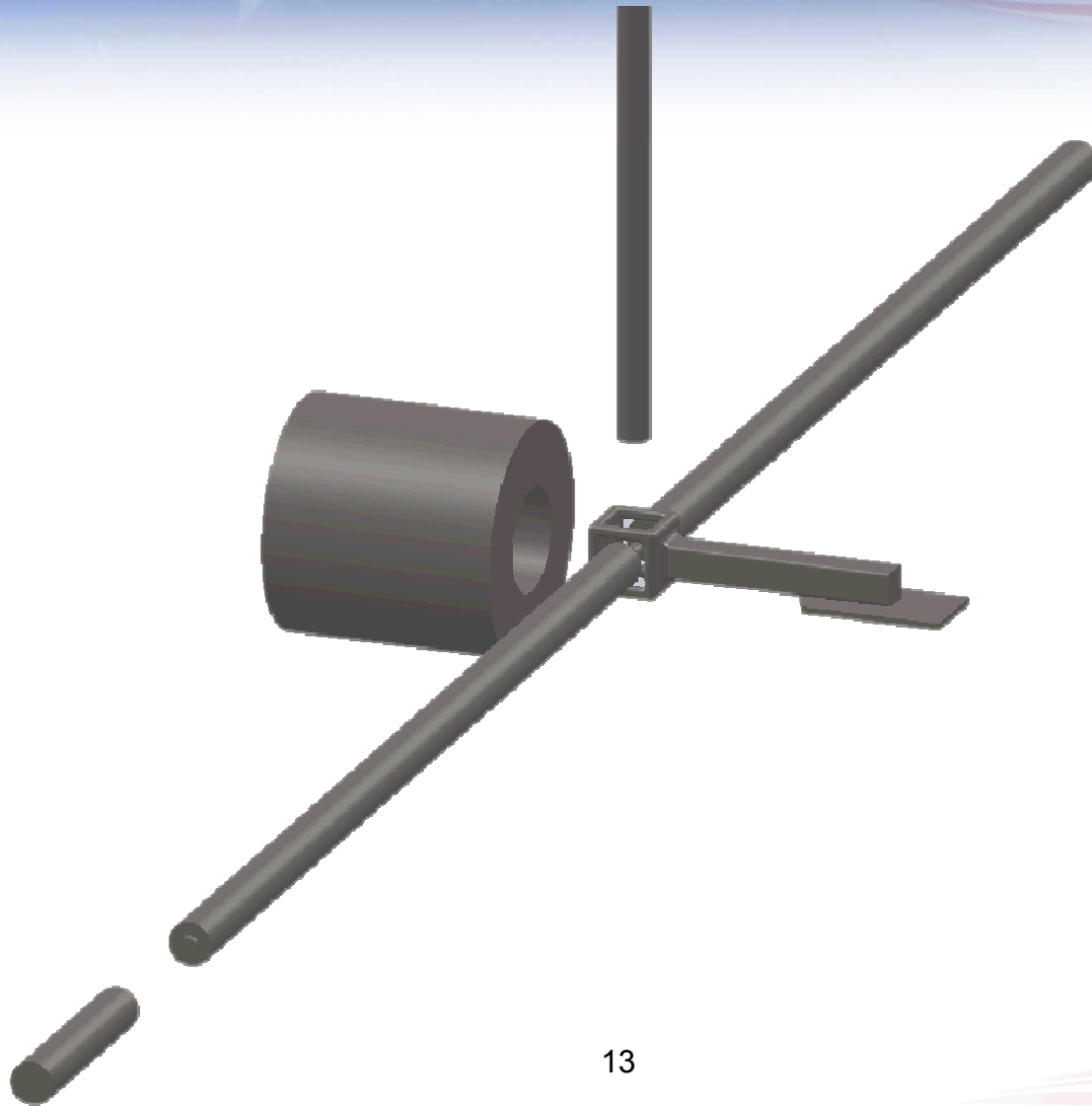
☐ Release Specimen
Release Delay (s): 10

SHOOT!

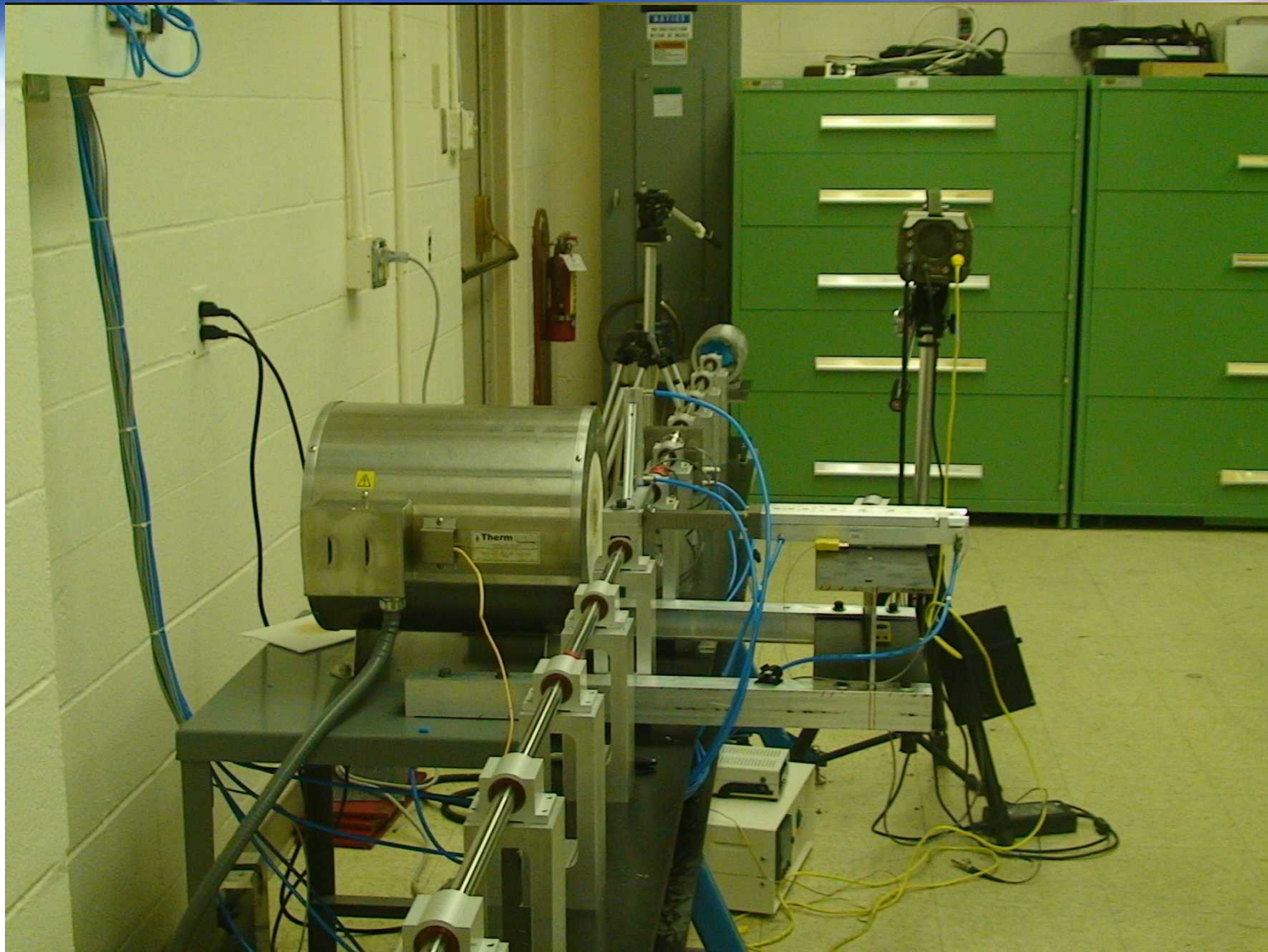
1 2 3 4 5 6 7 8

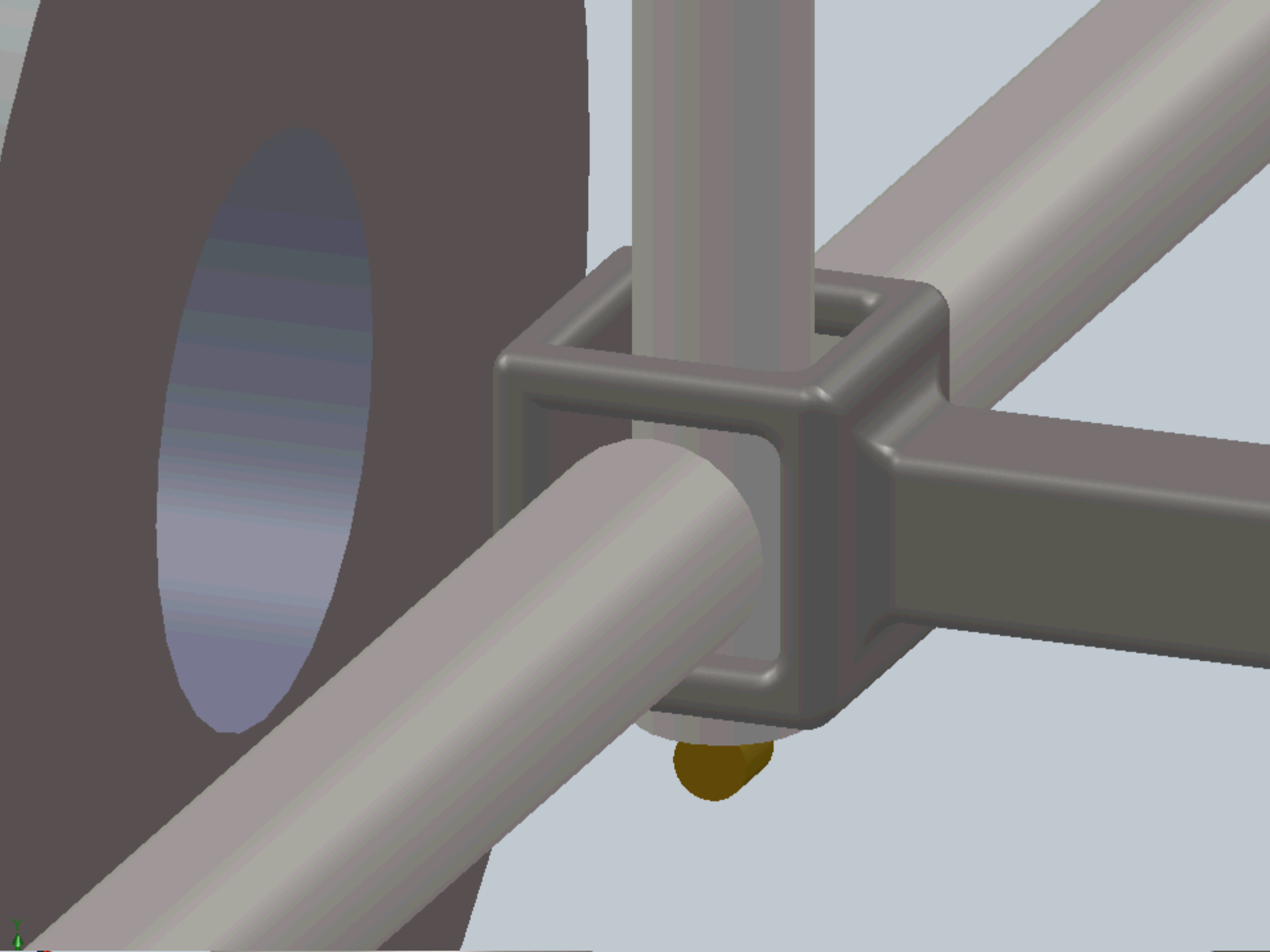
Help About Exit

System Set Up



Pictures





Acknowledgments

- EPSRI
- RTBS
- Bo Song
- Bonnie Antoun
- Kevin Connelly