



# Reactor Software Upgrades and Test Stand Behavior

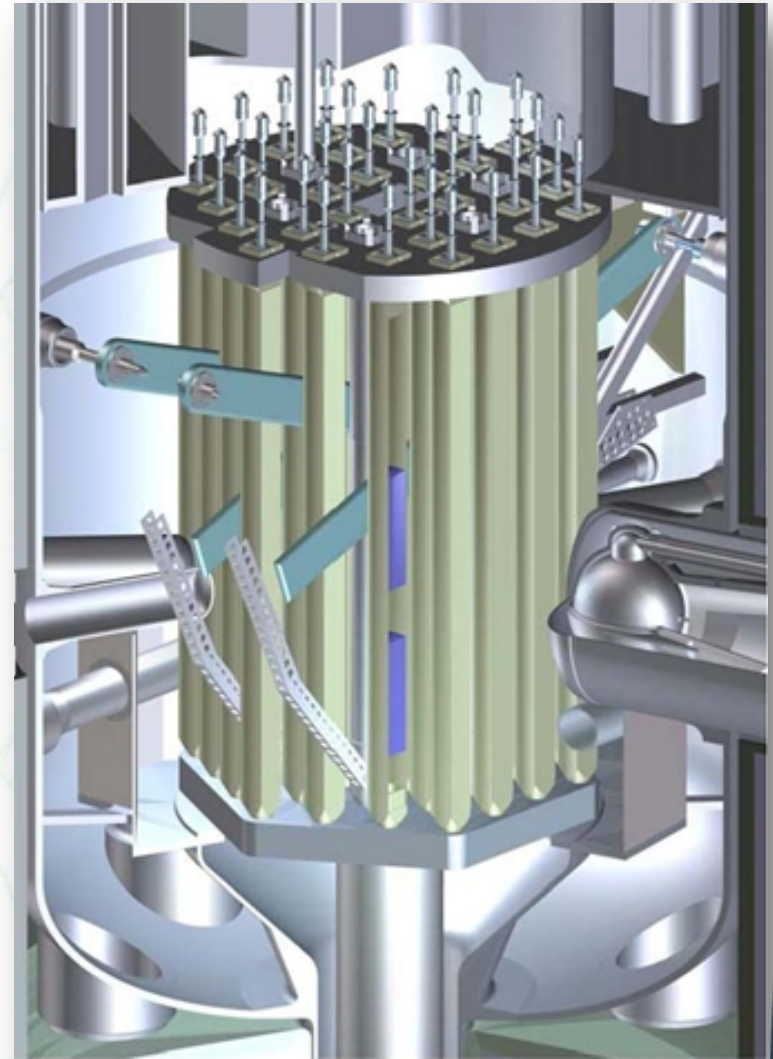
Josh Johnson  
Joe Reyenga



**NIST**  
National Institute of  
Standards and Technology  
U.S. Department of Commerce

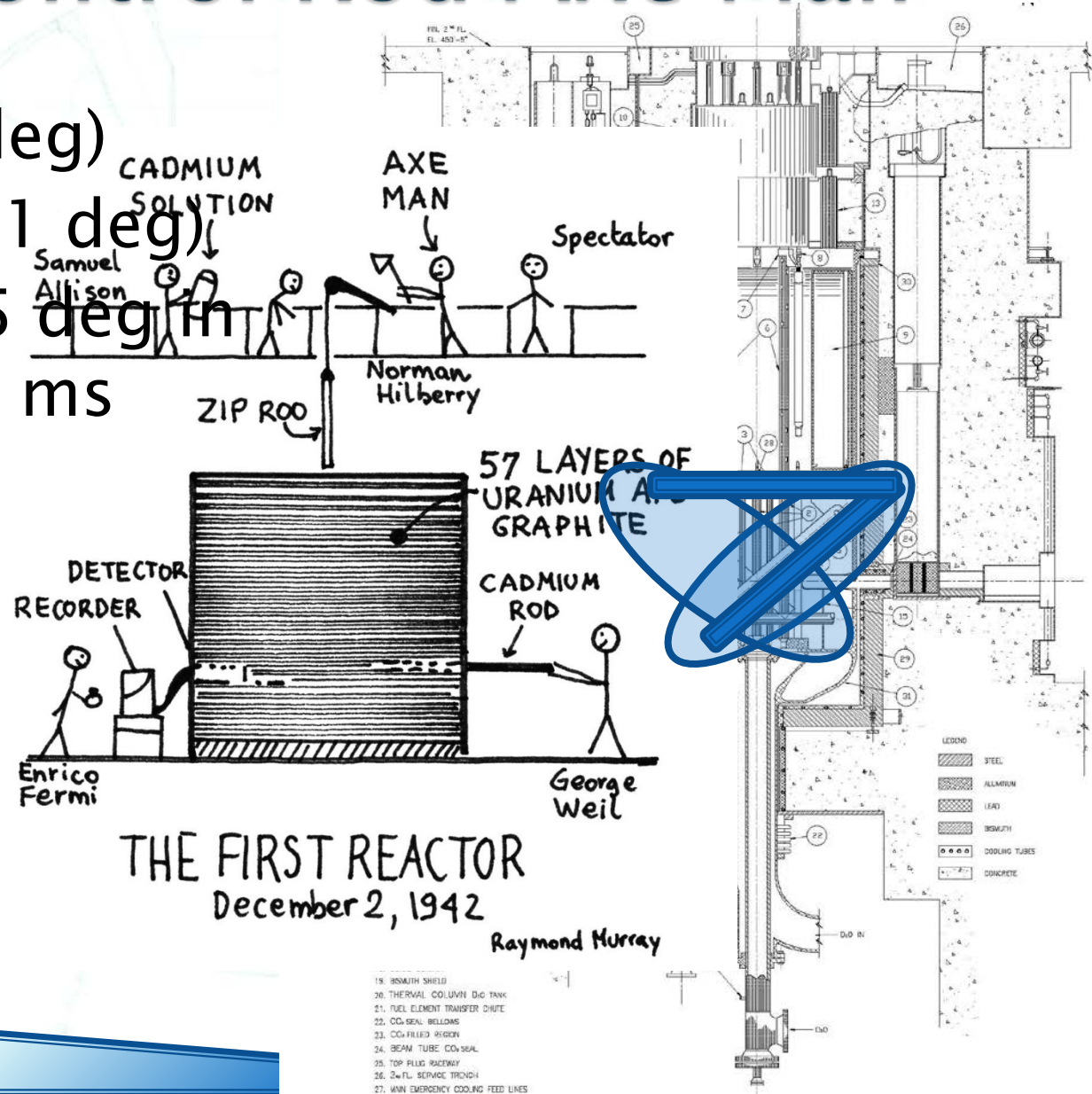
# Background

- ▶ 20 MW Reactor
- ▶ Source of neutrons
- ▶ Control Needs upgrades
- ▶ New hardware requires new software
- ▶ Must still meet operating license requirements
  - SCRAM Test
  - Withdrawal & Insertion Test



# SCRAM Control Rod Axe Man

- ▶ Full in (0 deg)
- ▶ Full Out (41 deg)
- ▶ Must Fall 5 deg in under 240 ms





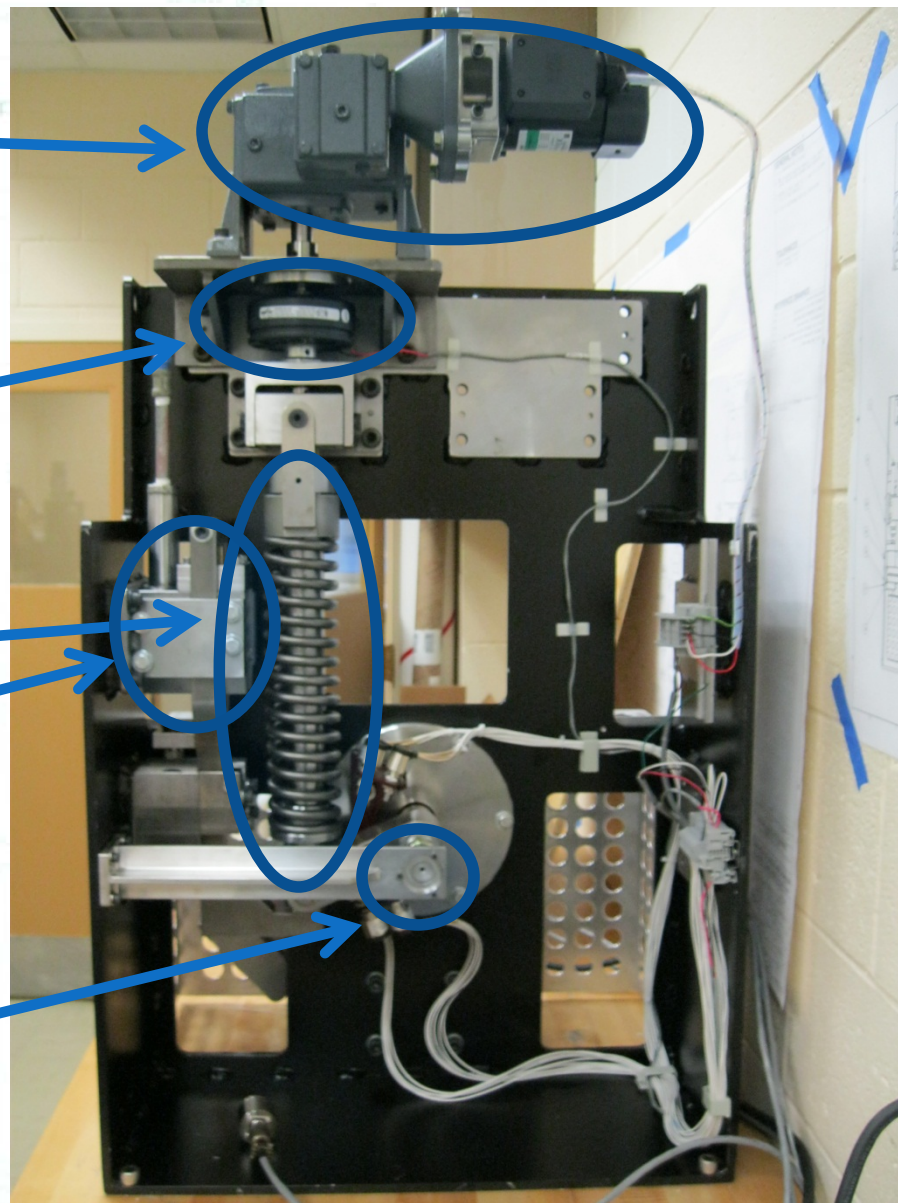
Shim Drive  
Motor

Electromagnetic  
clutch

Spring Assist

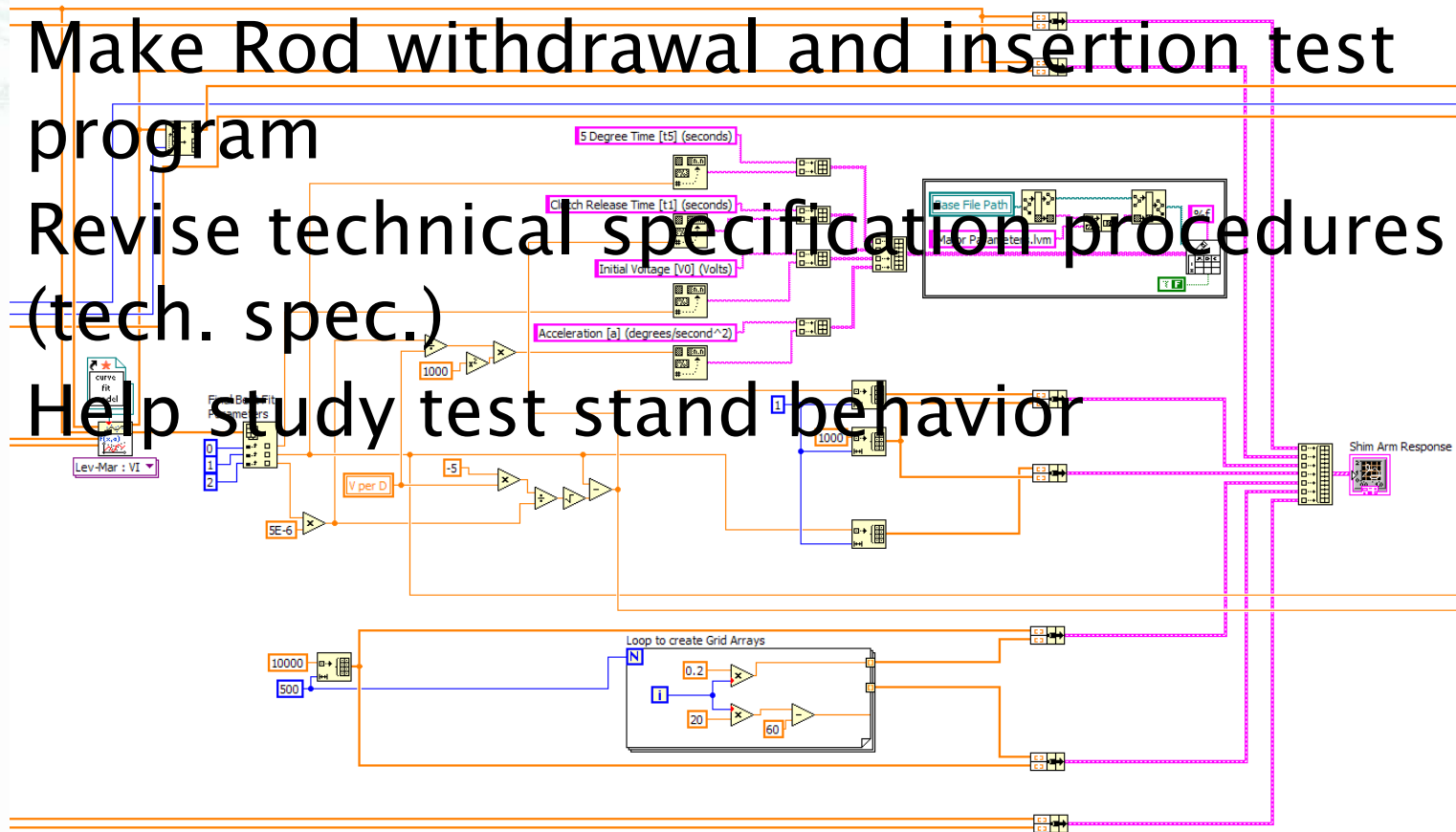
Damper

Position Sensor



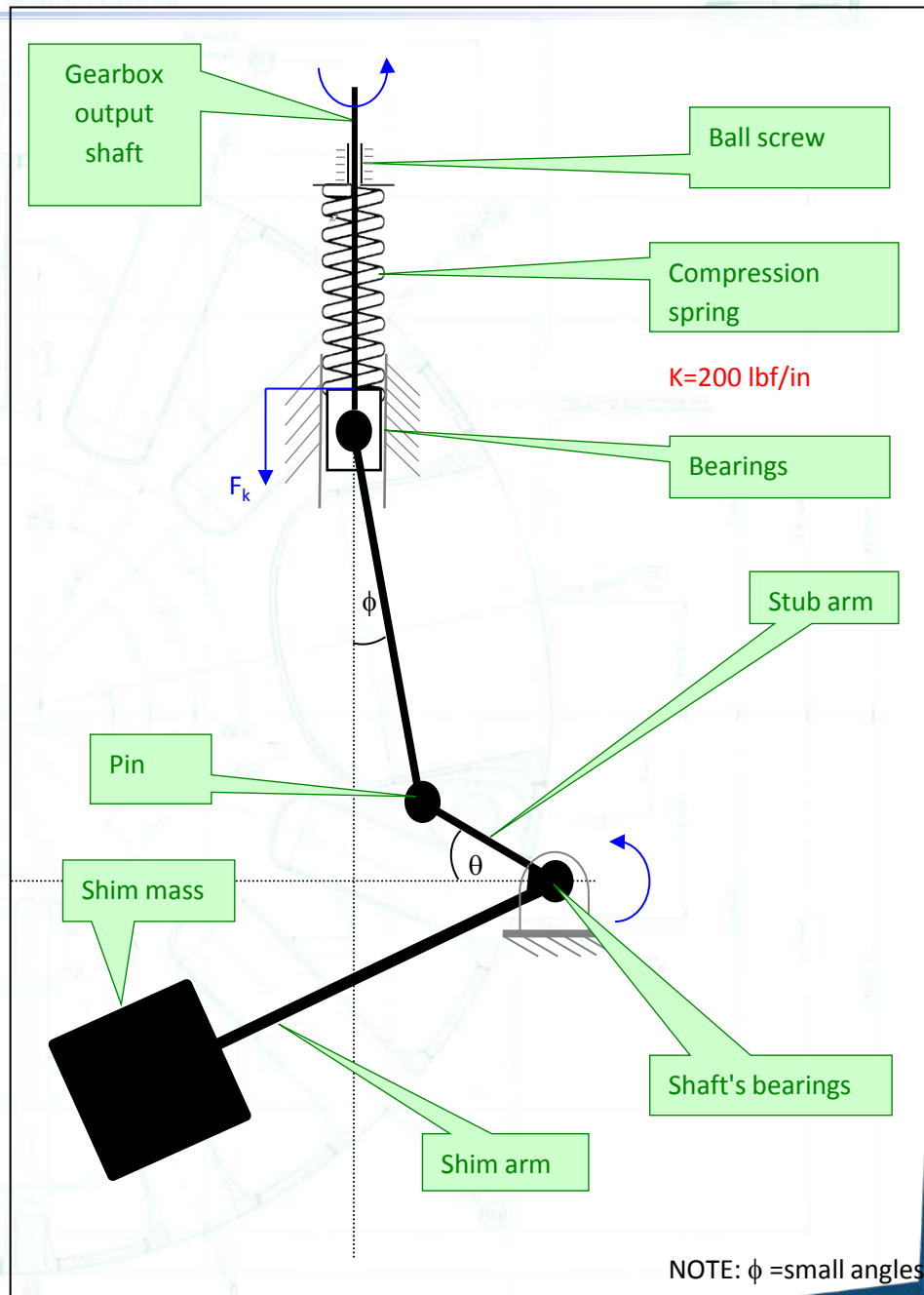
# Project Goals

- ▶ Study code and revise Scram test program
- ▶ Make Rod withdrawal and insertion test program
- ▶ Revise technical specification procedures (tech. spec.)
- ▶ Help study test stand behavior



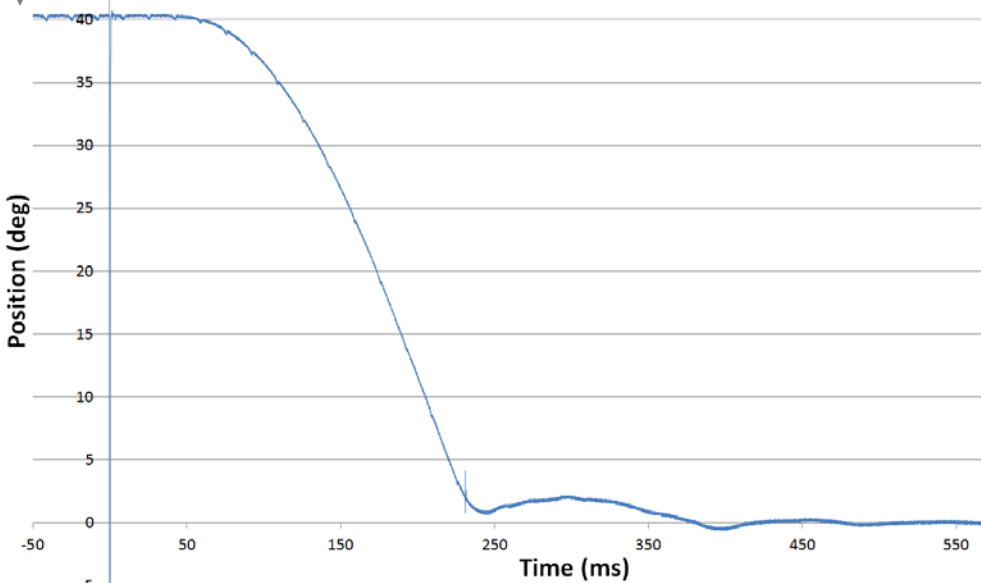
# Model

- ▶ Represented with ideal elements
- ▶ Classic mass spring damper system
  - Two stage damper
  - Unknown friction forces

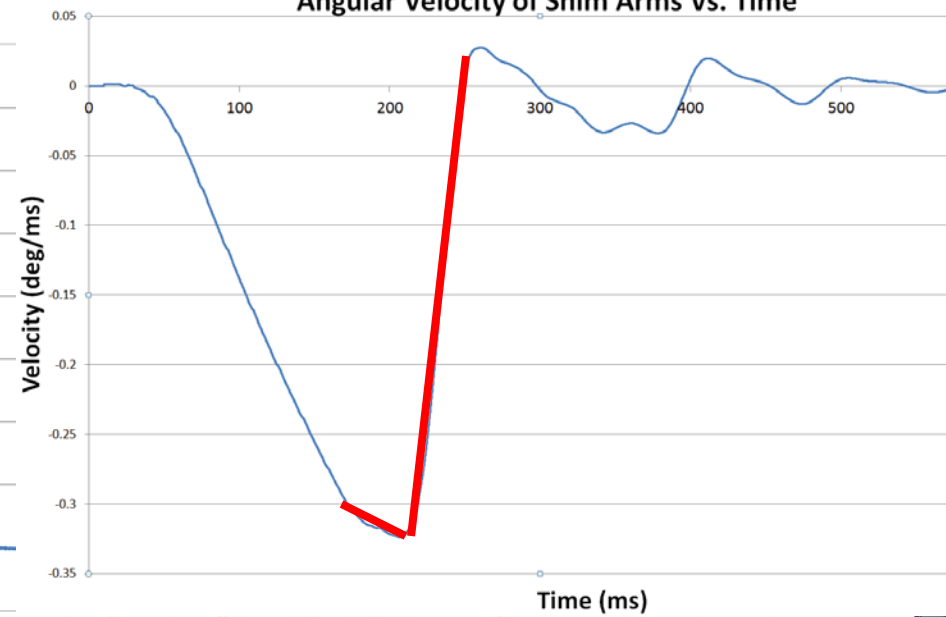




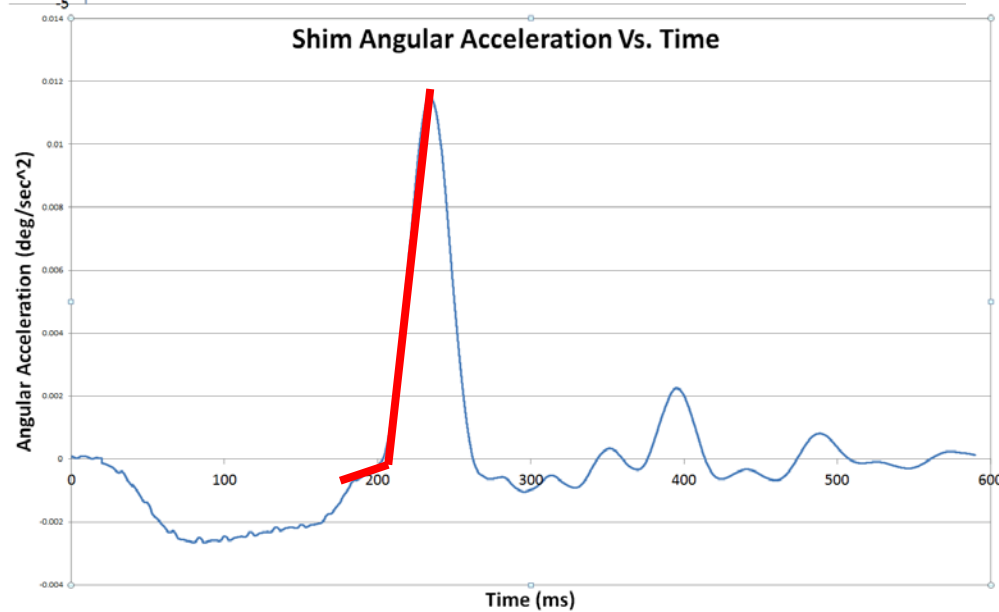
### Shim Angular Position Vs. Time



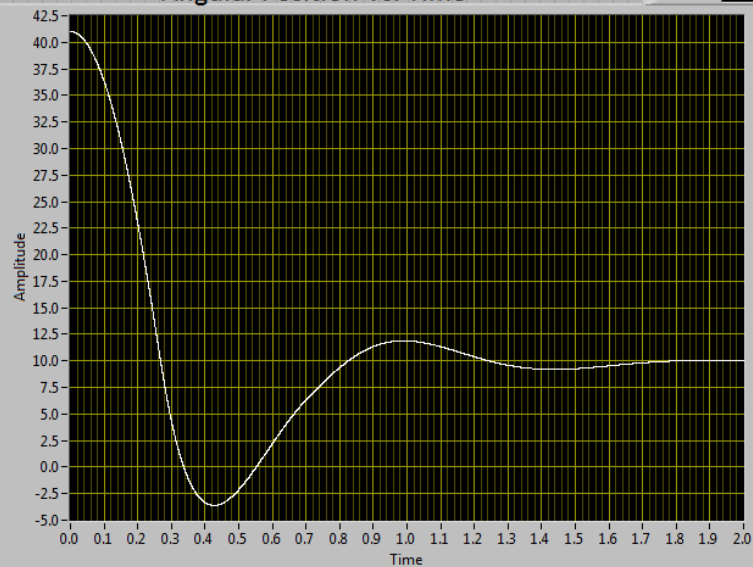
### Angular Velocity of Shim Arms Vs. Time



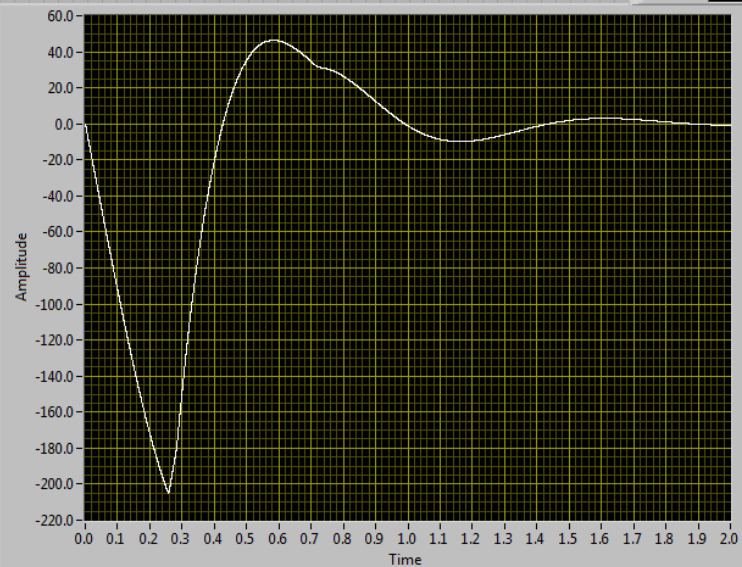
### Shim Angular Acceleration Vs. Time



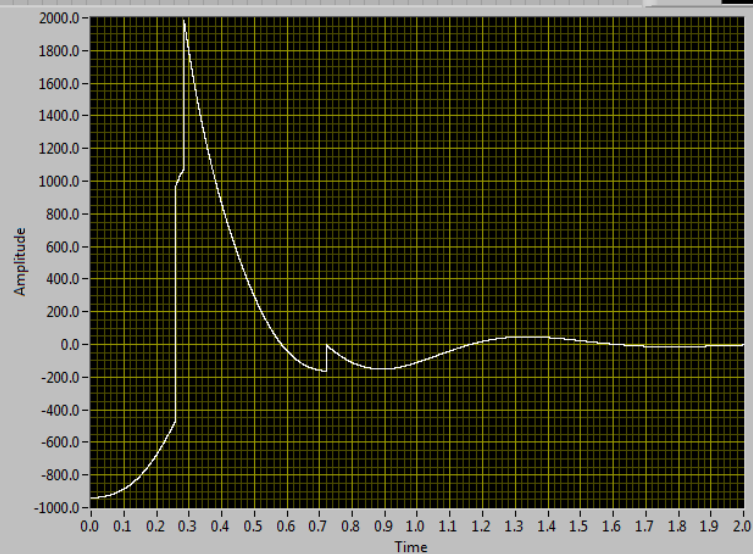
Angular Position Vs. Time



Angular Velocity Vs. Time

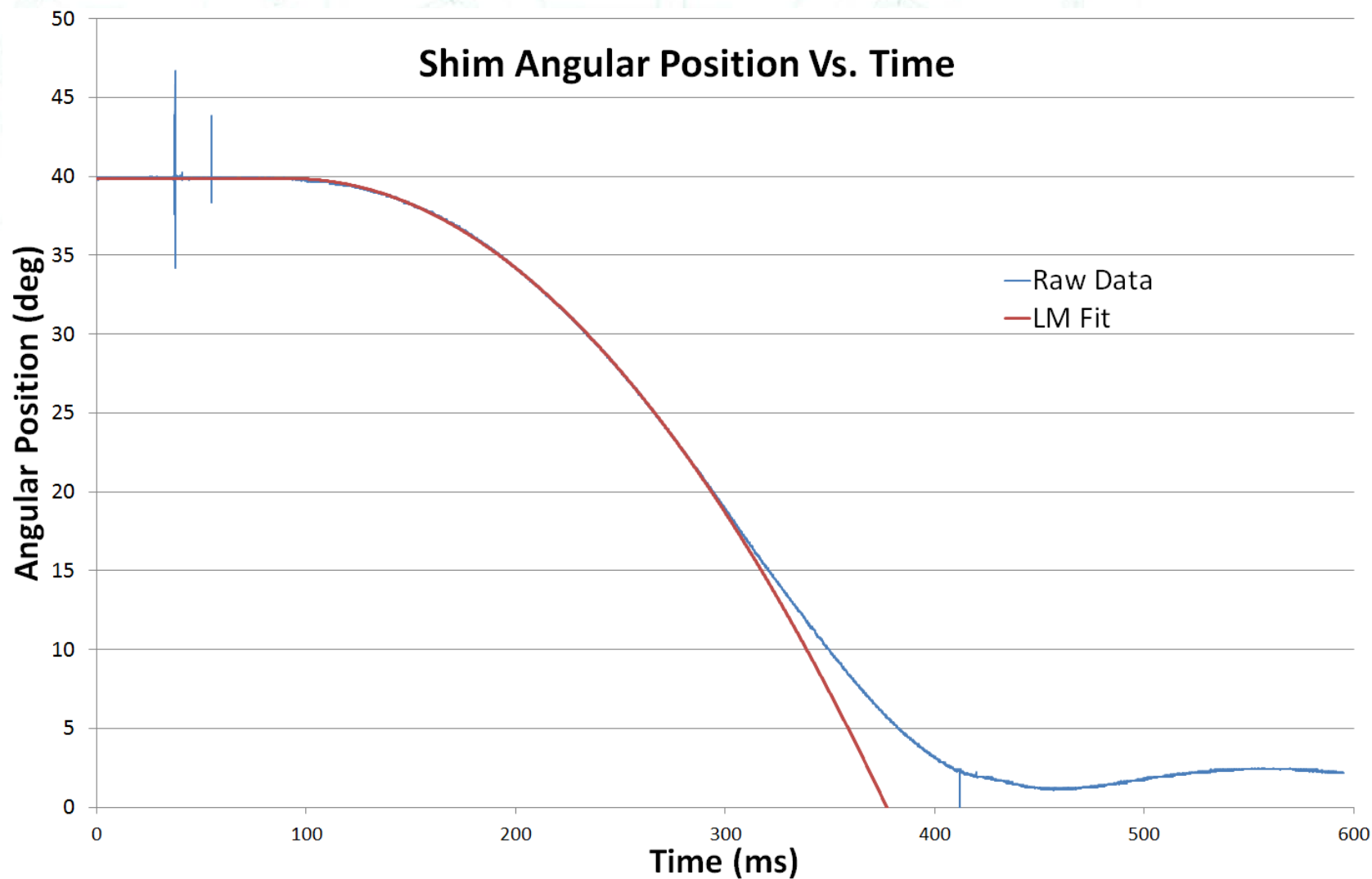


Angular Acceleration Vs. Time





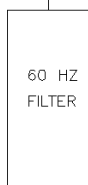
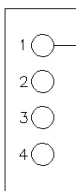
# Typical Scram Response Curve



# Old Setup

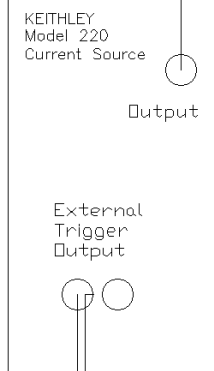
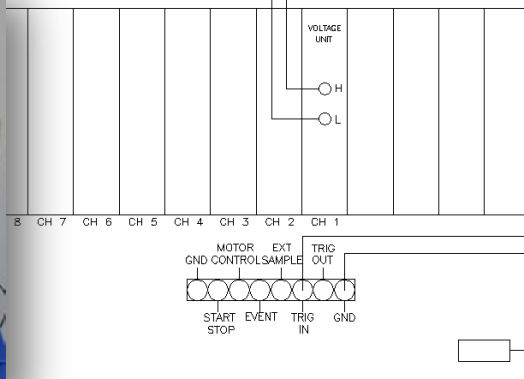


ROD DROP  
TEST BOX



NOTE: SHIELD SIDE  
OF  
CONNECTOR IS L  
(LOW)

YOKOGAWA RECORDER



Manually Program  
Current Source  
and Recorder

NC-3,4,6, or 7 INPUT

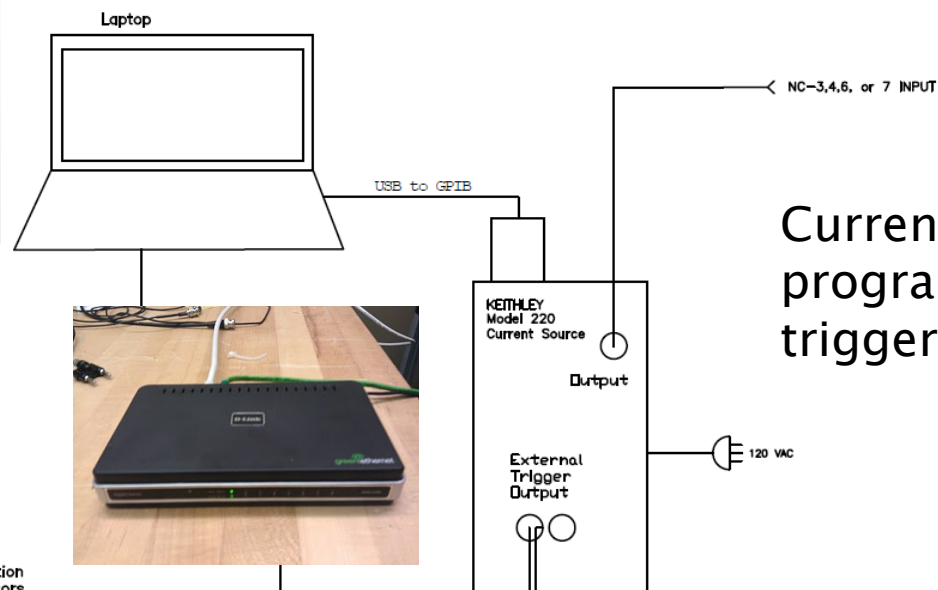
120 VAC



# Eventual Setup



All shim arm data  
streamed to laptop



Current source  
programmed and  
triggered by laptop

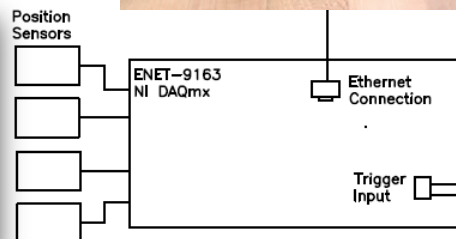
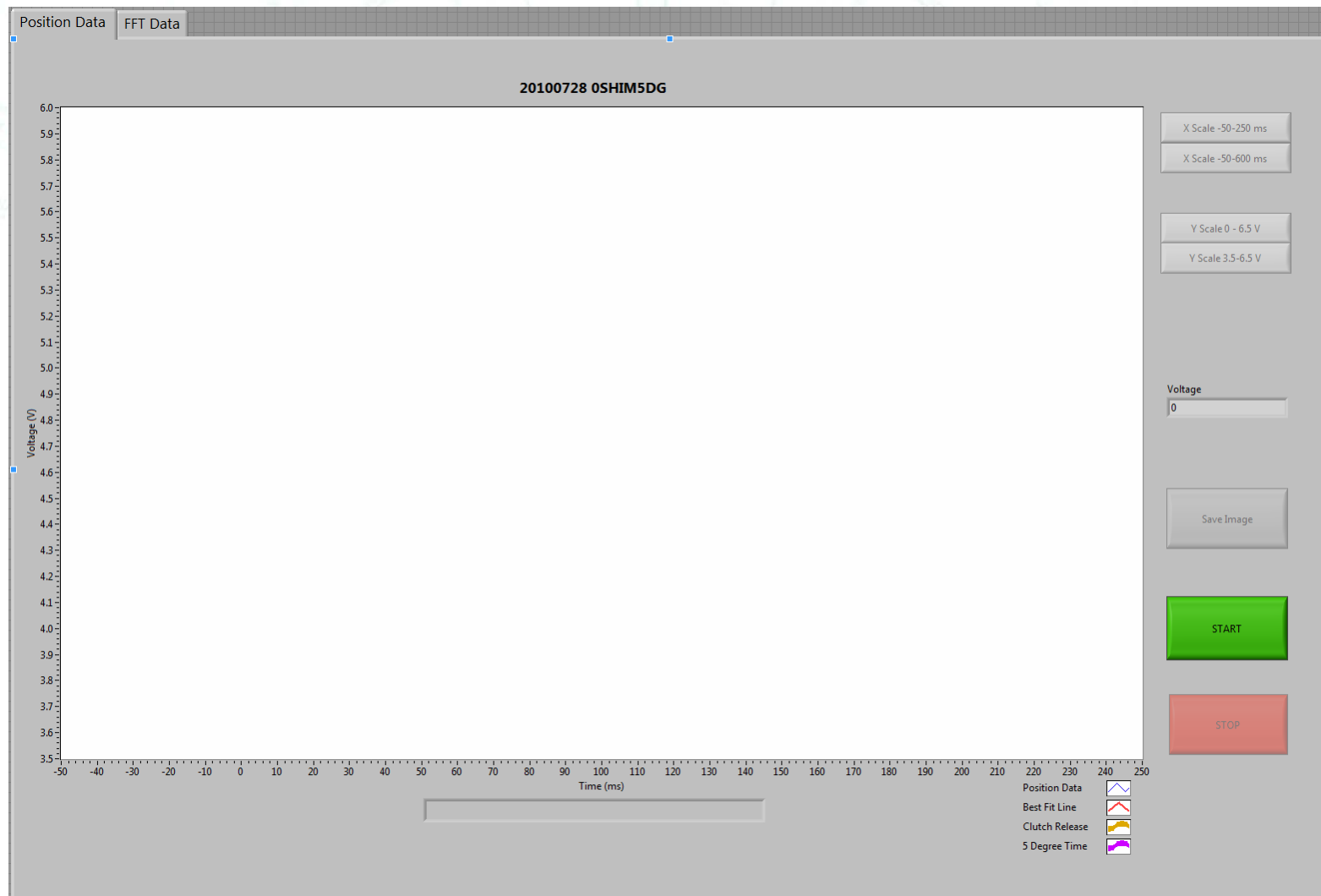


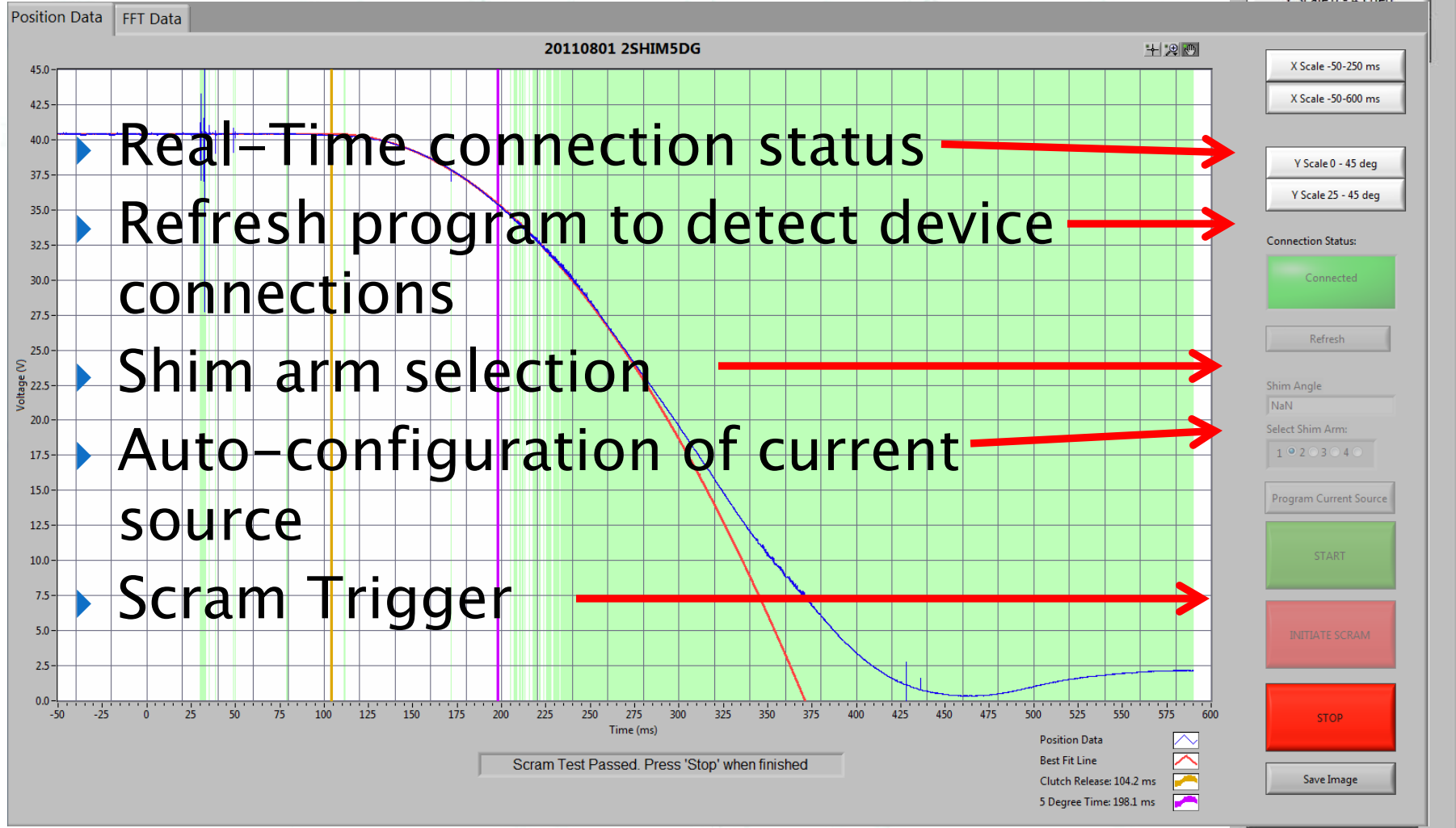
FIGURE 1

# Old Version





# Revisions



# Simplified Steps

3. Power up the Current Source and program it by the following:
  - a. "Memory" 1 "Enter"
  - b. "Source" 1 4 0 "Exponent" 6 "Enter"
  - c. "V-Limit" 1 5 "Enter"
  - d. "Memory" 2 "Enter"
  - e. "Source" 2 8 0 "Exponent" 6 "Enter"
  - f. "V-Limit" 1 5 "Enter"
  - g. "Dwell" "." 0 0 3 "Enter"
  - h. "Reset"



3. Click the "Program Current Source" button.

2. Load the 5-Degree drop program on the recorder by the following:

- a. Press "MENU", select "#5 - Load/Save".
- b. Select "Int.RAM" for Media. Select "Load" for Function.
- c. Select "Set 1" which is "5 DEG R-D". Put the cursor on "Execute" and press "Yes". Press the "Monitor" button.

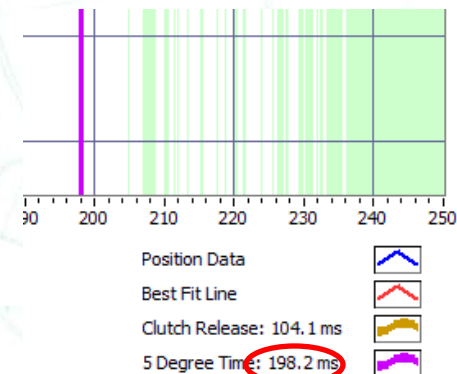
a. Run "5DegRodDrop.exe" from the desktop.

14. Save the data:

- a. Insert a formatted disk into the disk drive.
- b. Press "MENU", select "#5 - Load/Save".
- c. Media = "FD"  
Mode = "Data"  
Function = "Save(Binary)"  
Filename = Assign a unique filename for each shim (e.g. "1SHIM5DC" or "2SHIM5DC")  
Use the knob and arrow keys to select letters
- d. Put the cursor on "Execute" and press "Yes".

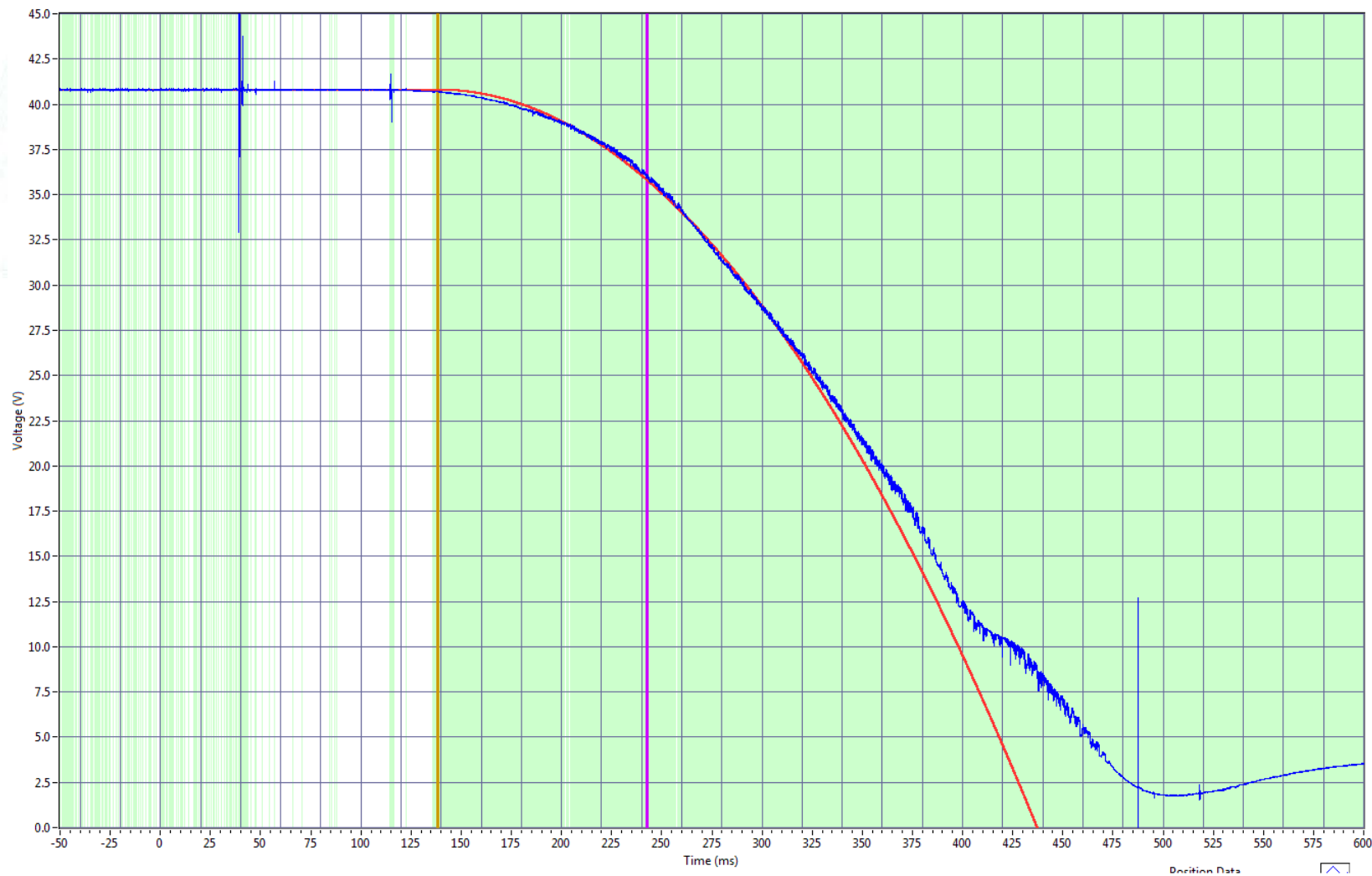
15. To calculate the drop time perform the following:

- a. Press the "SHIFT/LOCAL" key and then press the "MEMORY PRINT/DISPLAY" key.
- b. Press the "Cursor(Zoom)" key. Press the "Ref On/Off" key. This locks down one cursor at the trigger point (scram point).
- c. Use the knob to move the other cursor until the voltage value shown at the top of the screen is at least the calibrated value for a 5° delta for the shim under test (nominally -0.687 V). Use the "Zoom up" key to improve the resolution of the curve.
- d. After selecting the value for the cursor, press the "Zoom down" until the whole trace is shown on the screen. Press "SHIFT/LOCAL" and then "CHART SPEED/HARDCOPY". This will print a copy of the trace with the drop time recorded at the top.



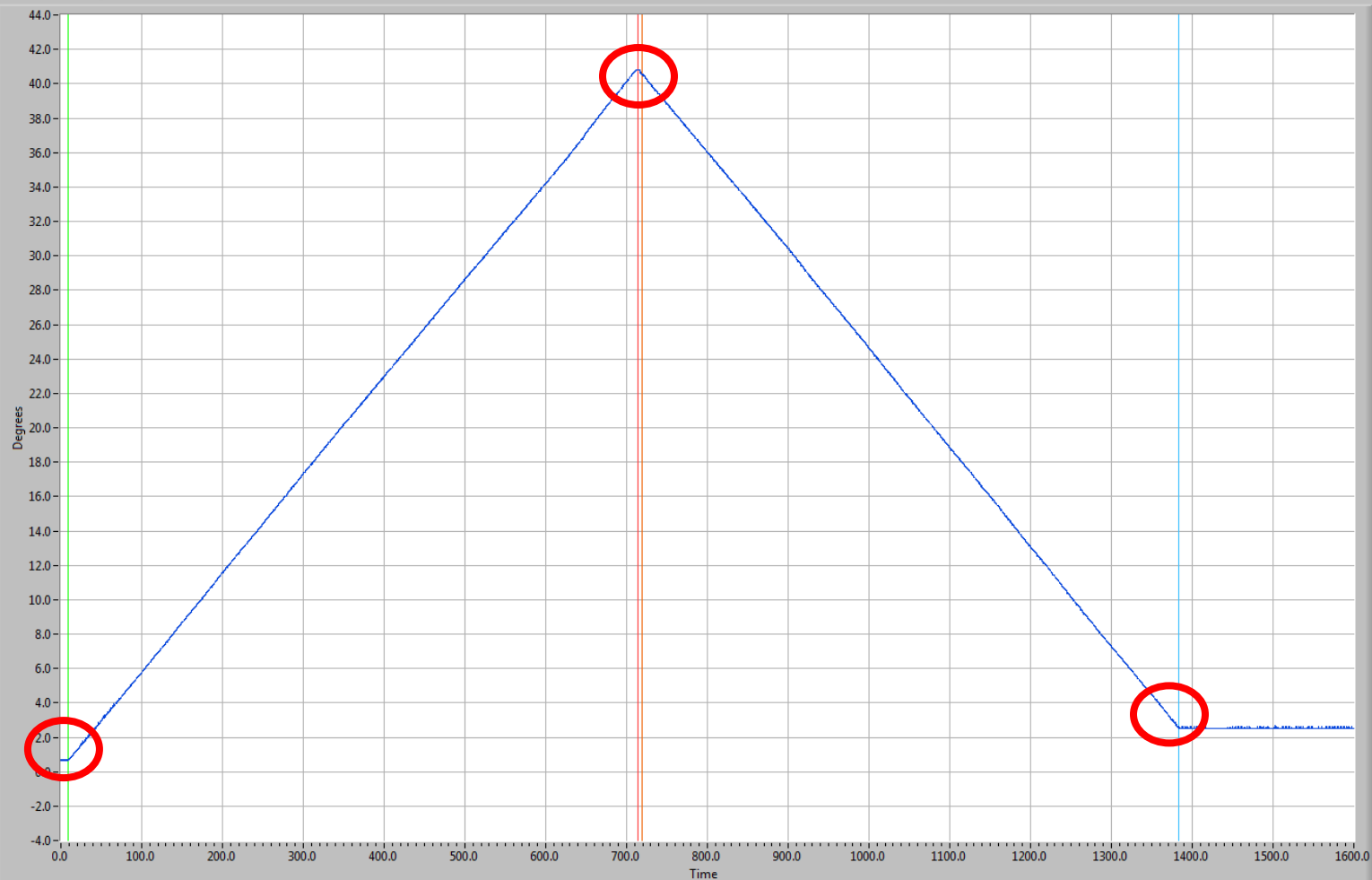
# Actual Scram Test Data

20110727 2SHIM5DG





Position Data



Data Collected. Processing...

- Position Data
- Start Rise
- End Rise
- Fall Start
- Fall End

Connected

Refresh

Voltage

0.344849

Rise Time

704.812

Fall Time

663.41

Select Shim Arm:

1 ☒ 2 ☐ 3 ☐ 4 ☐

Stopwatch

0

START

RESET

Record Data

# Project summary

- ▶ Gained LabVIEW expertise
  - Useful for research back home
- ▶ Made program to reduce user and system error
- ▶ Learned practical mechanics
  - How it's applied to engineering
- ▶ Made usable procedure updates

# Future Work

- ▶ Make more appealing to reactor operators
- ▶ Run comparison of old system to new
- ▶ Investigate scrams at different angles
- ▶ Automate analysis of Test Stand damper



# Acknowledgements

Joe Reyenga  
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