



Reactor Software Upgrades and Test Stand Behavior

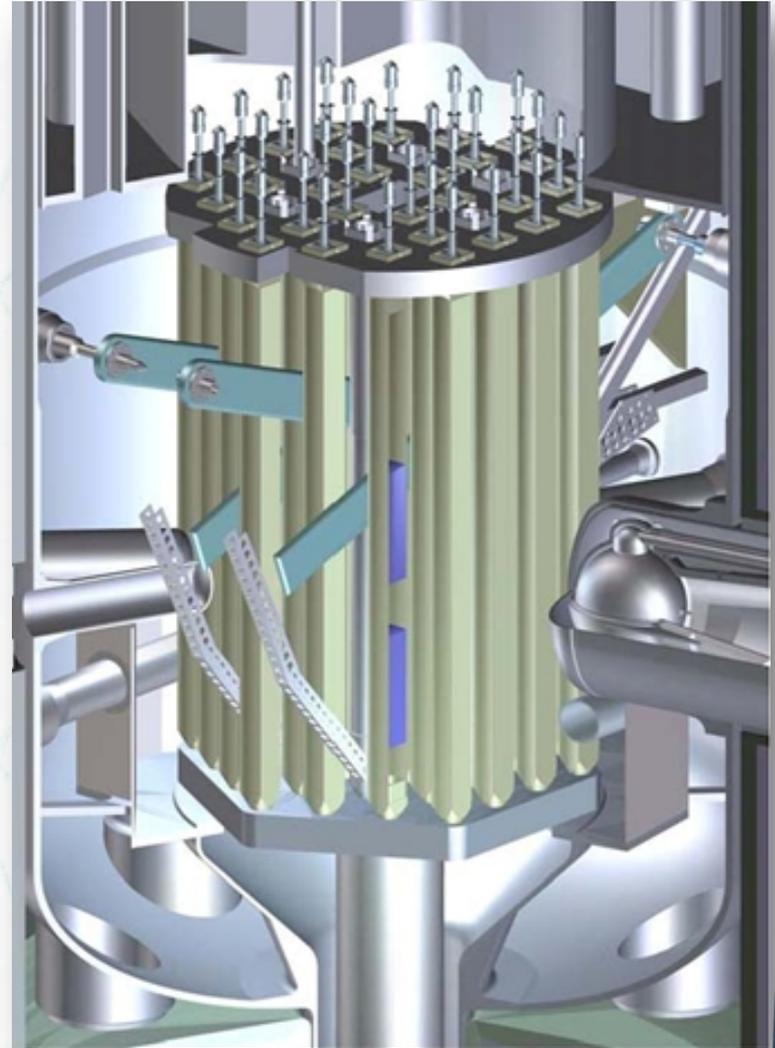
Josh Johnson
Joe Reyenga



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

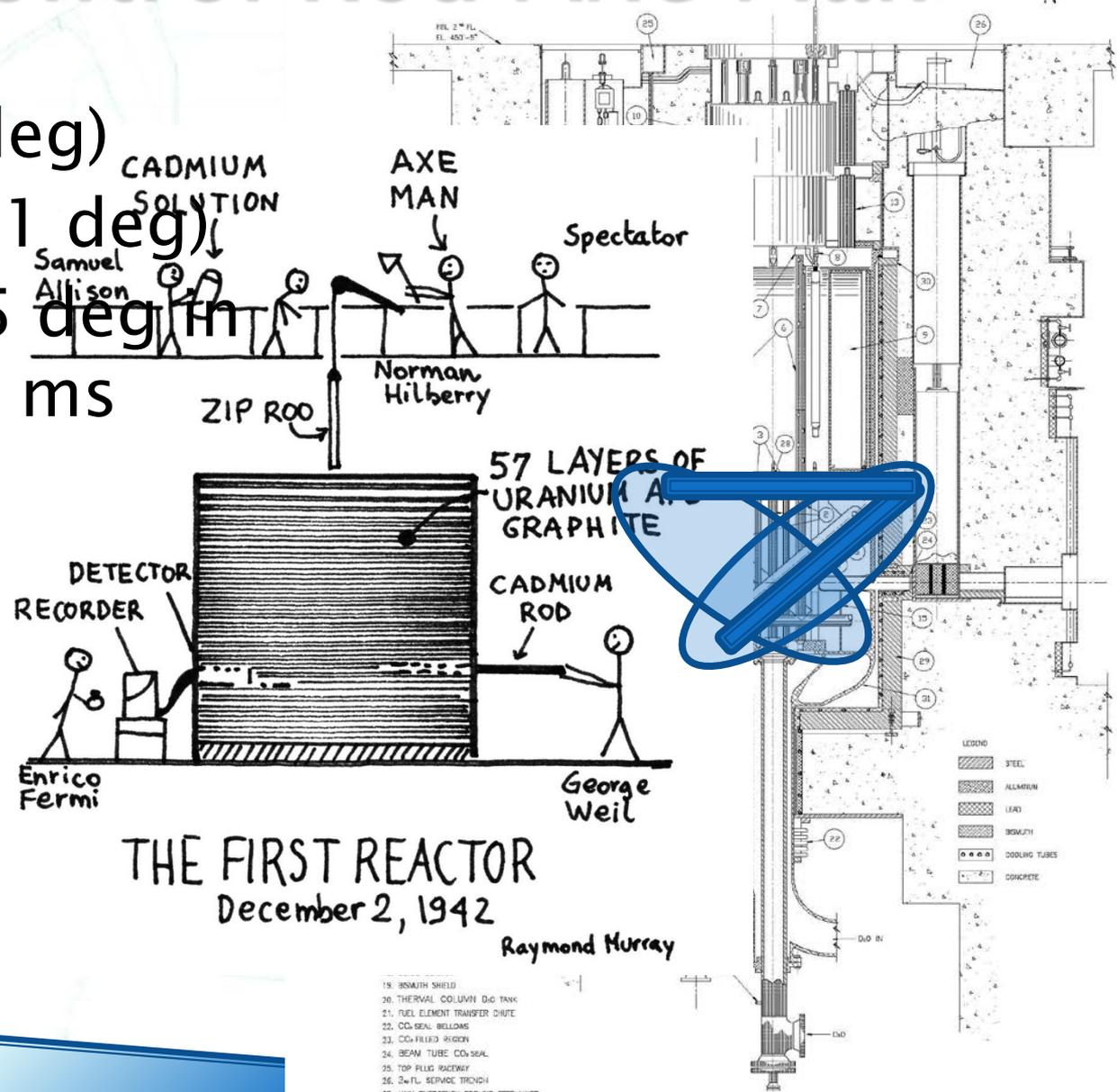
Background

- ▶ 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



SAFEAM Control Rod Axe Man

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



THE FIRST REACTOR
December 2, 1942

Raymond Murray

- 19. BISMUTH SHIELD
- 20. THERMAL COLUMN DIG TANK
- 21. FUEL ELEMENT TRANSFER CHUTE
- 22. CO. SEAL. BELLOMS
- 23. CO. FILLER REGION
- 24. BEAM TUBE CO. SEAL.
- 25. TOP FILLER REGION
- 26. 2'-6" FL. SERVICE TRENCH
- 27. MAIN EMERGENCY COOLING FEED LINES

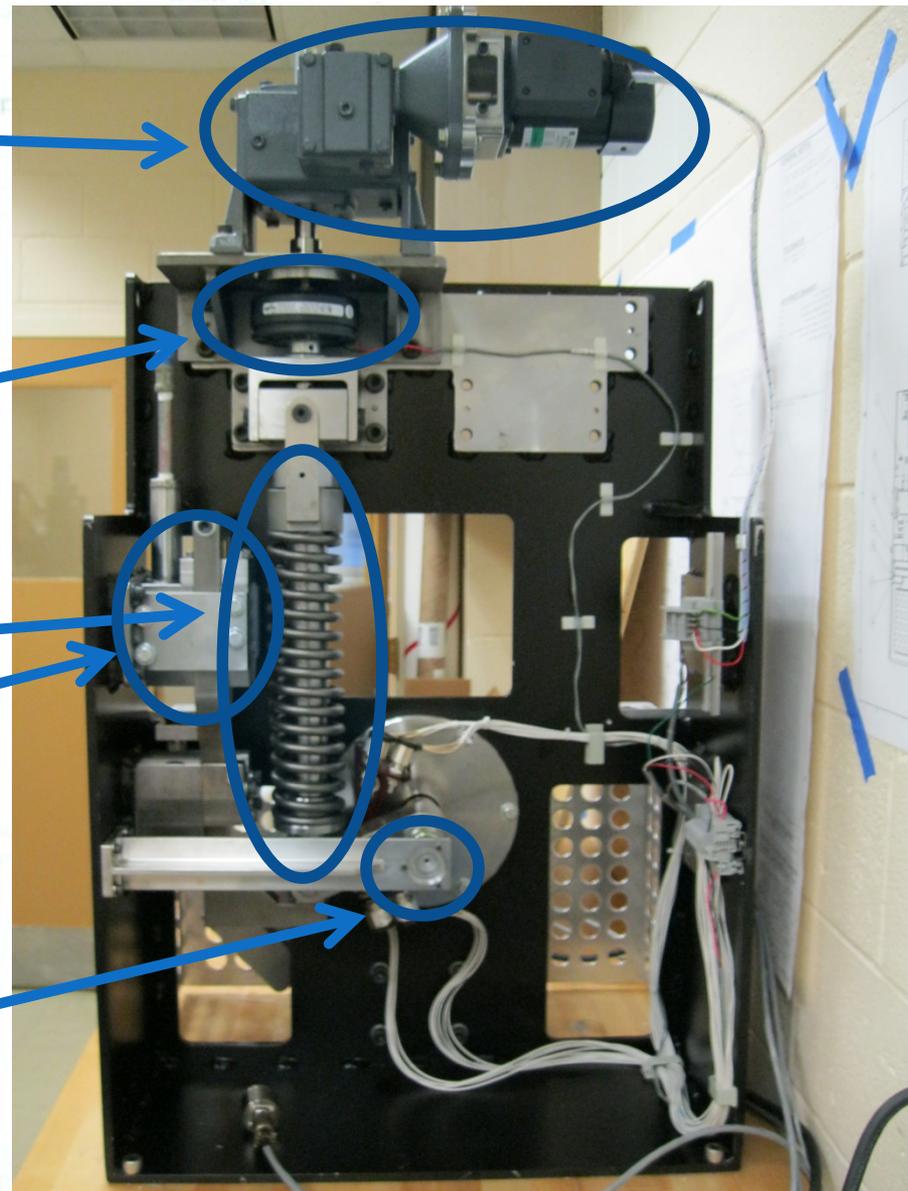
Shim Drive
Motor

Electromagnetic
clutch

Spring Assist

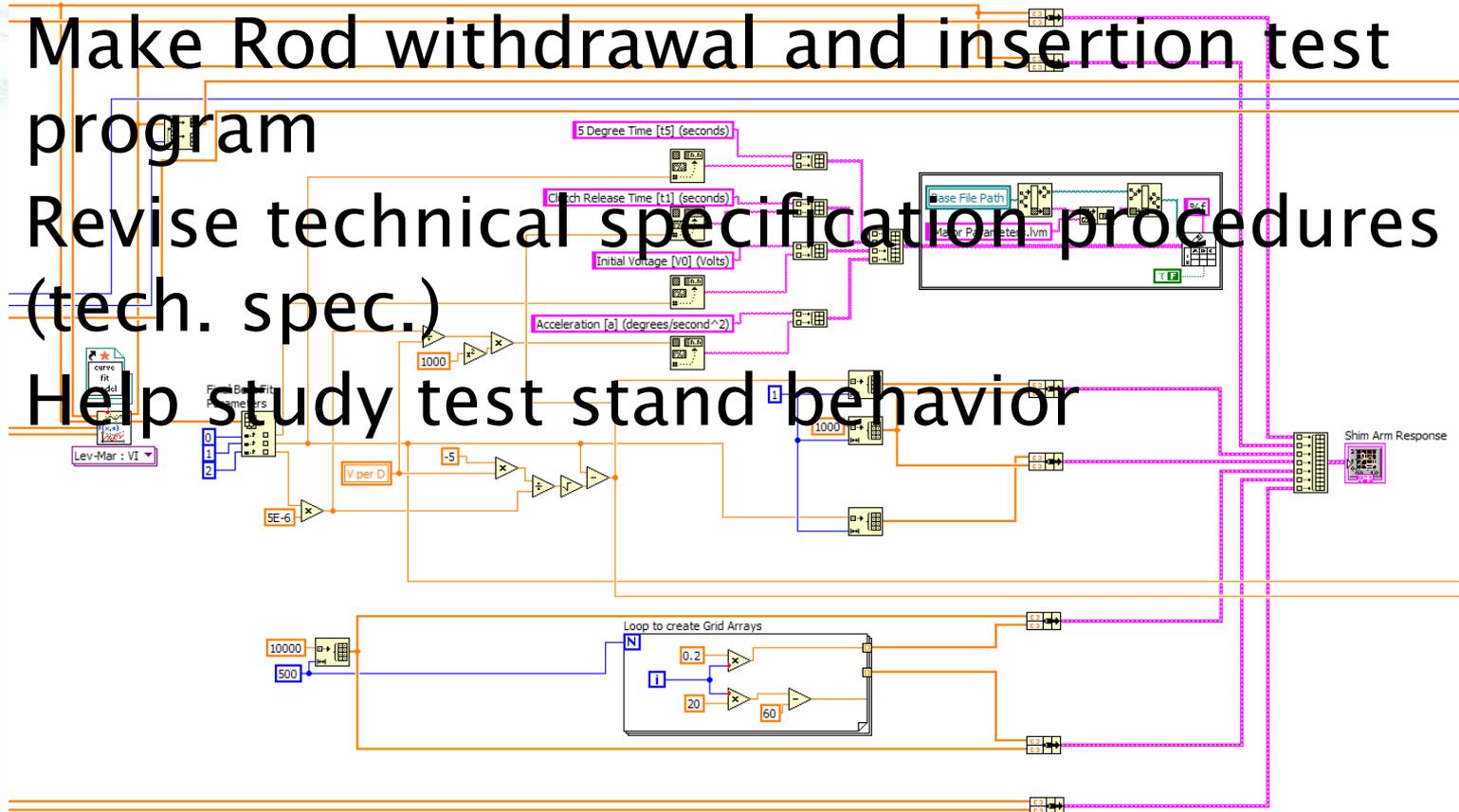
Damper

Position Sensor



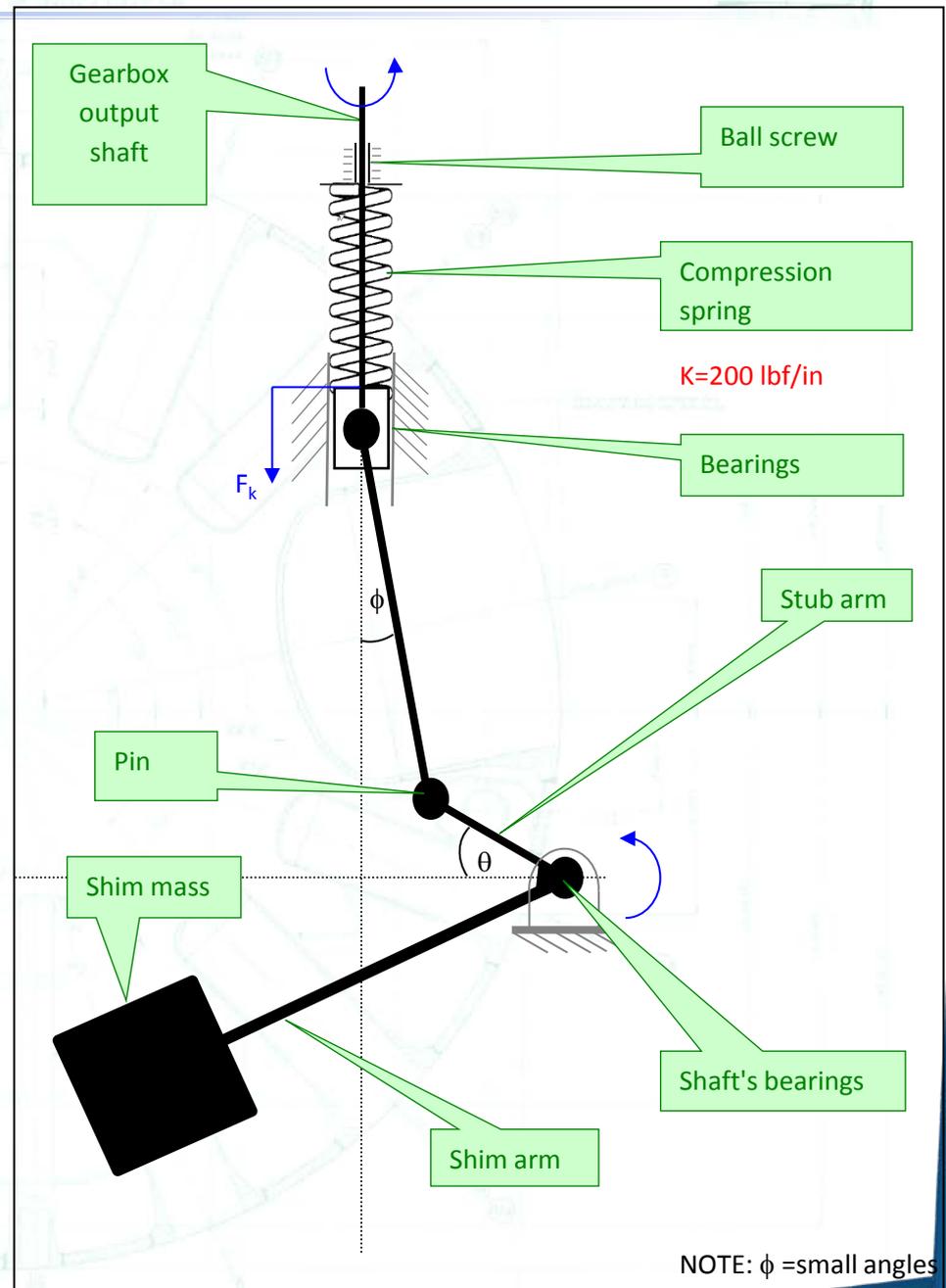
Project Goals

- ▶ 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



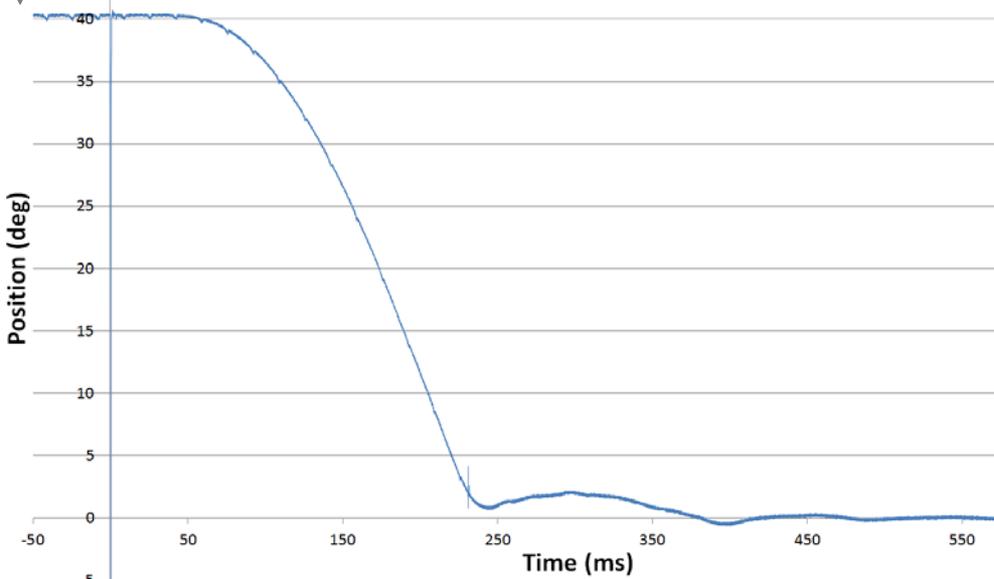
Model

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

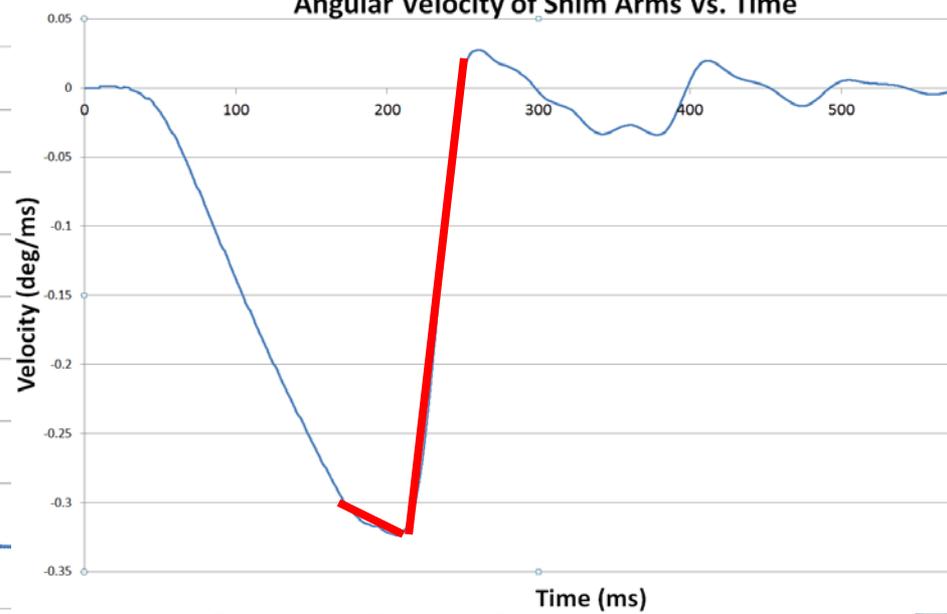




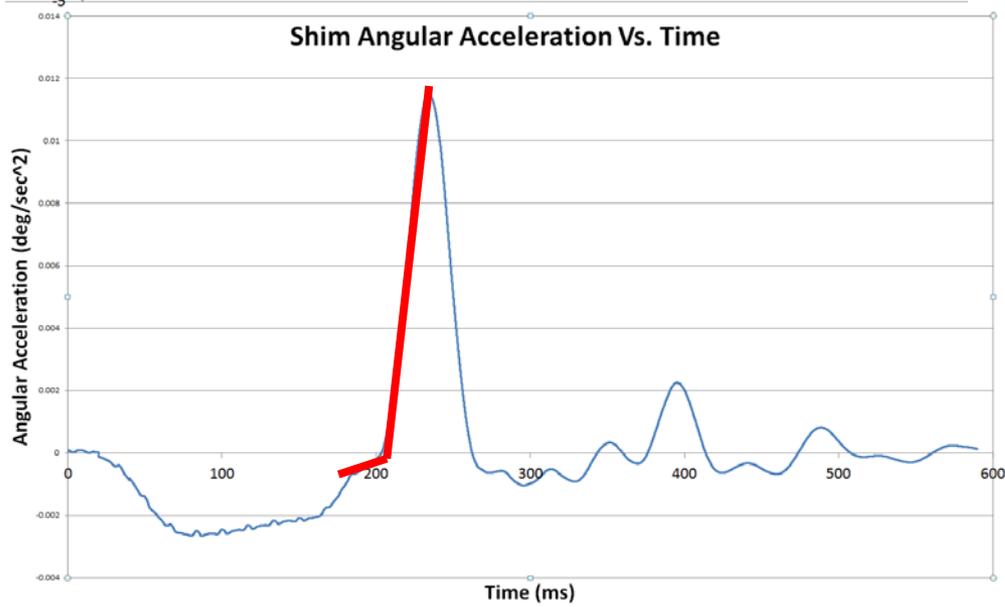
Shim Angular Position Vs. Time



Angular Velocity of Shim Arms Vs. Time

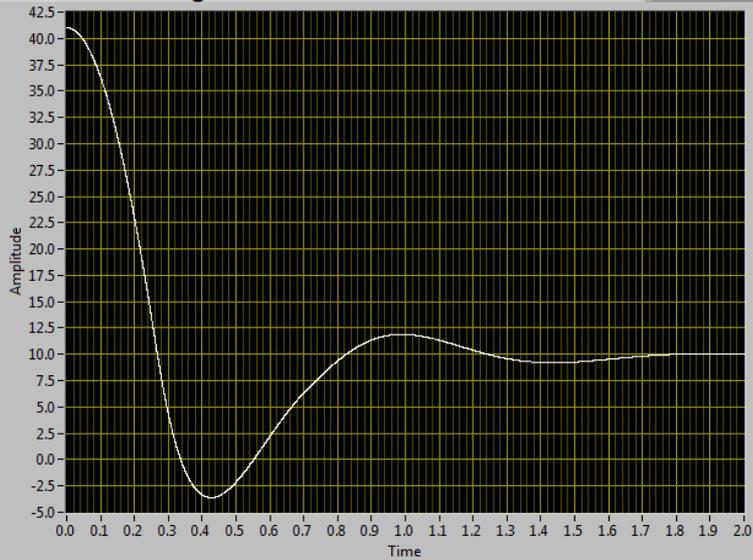


Shim Angular Acceleration Vs. Time



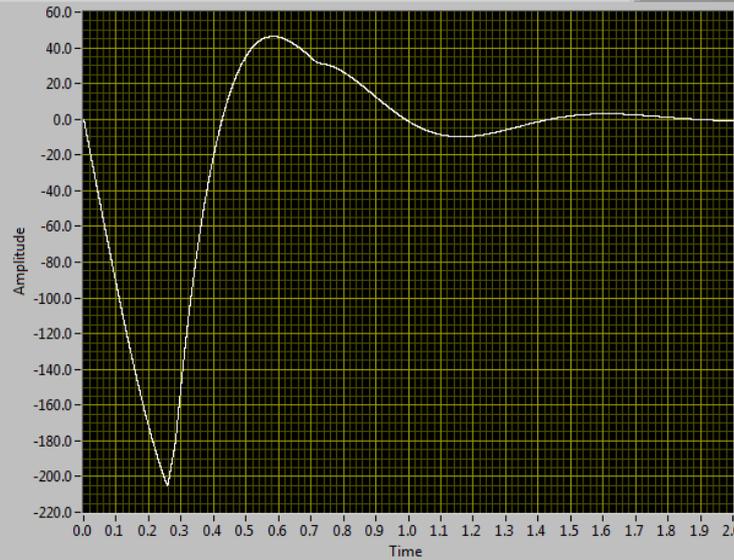
Angular Position Vs. Time

Plot 0



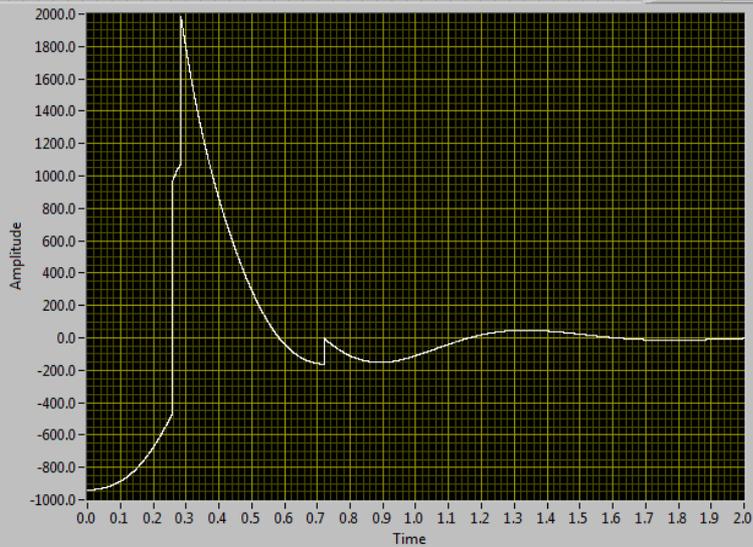
Angular Velocity Vs. Time

Plot 0

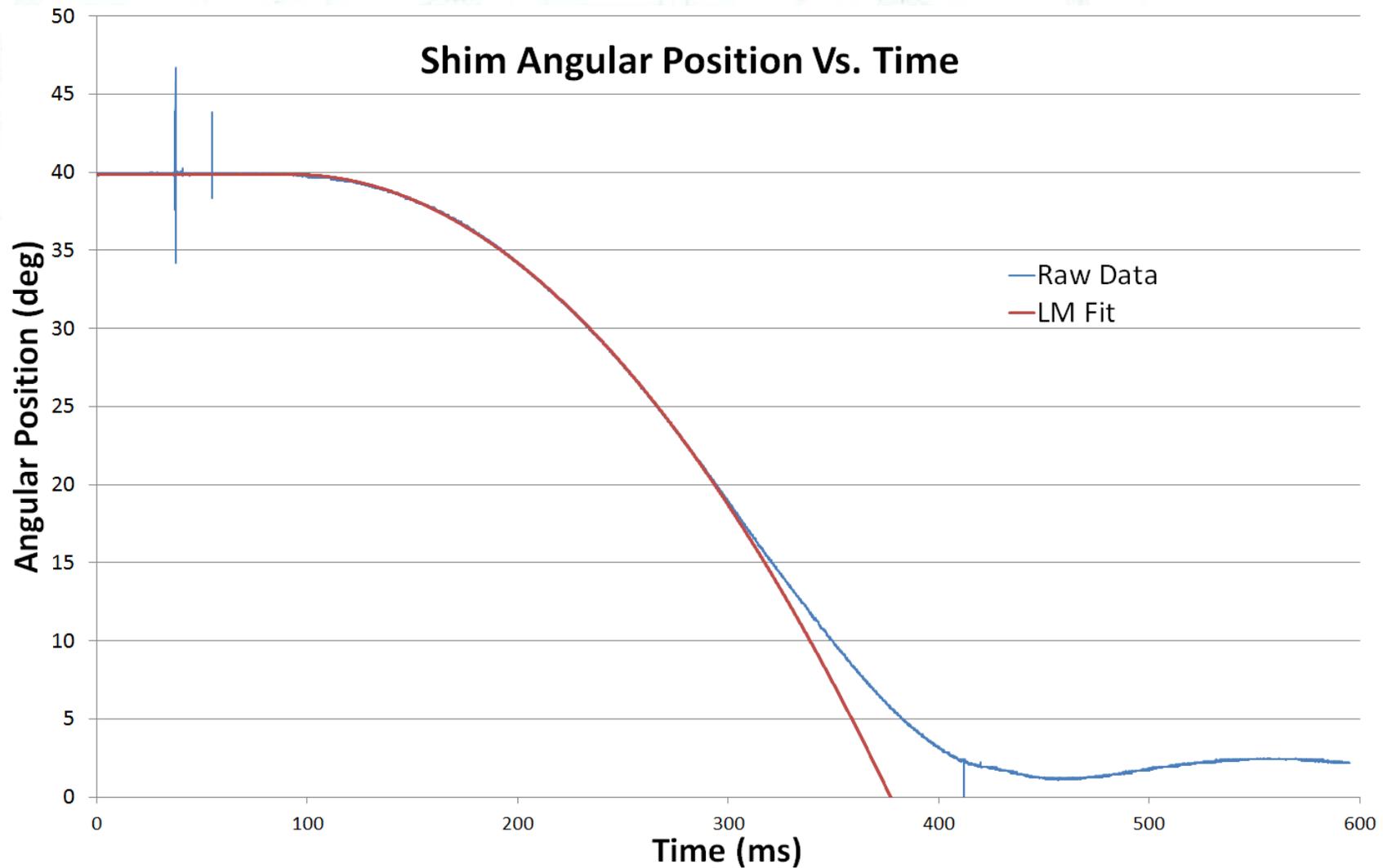


Angular Acceleration Vs. Time

Plot 0



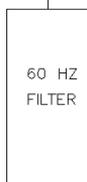
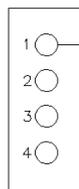
Typical Scram Response Curve



Old Setup

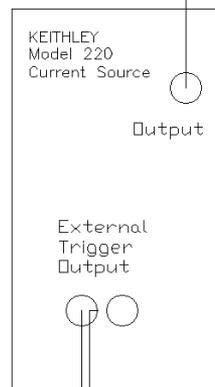
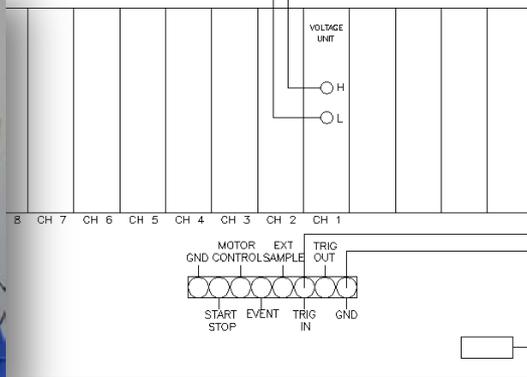


ROD DROP TEST BOX



NOTE: SHIELD SIDE OF CONNECTOR IS L (LOW)

YOKOGAWA RECORDER



Manually Program Current Source and Recorder

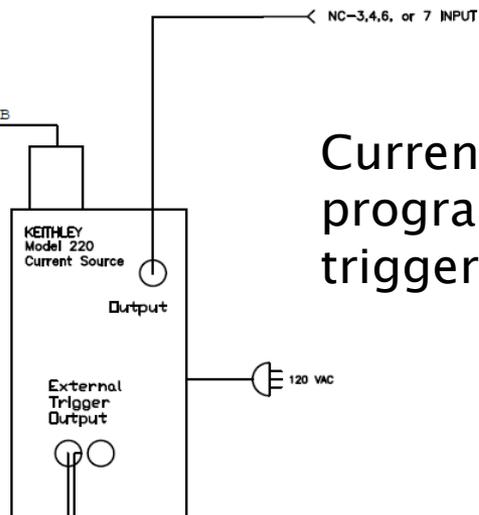
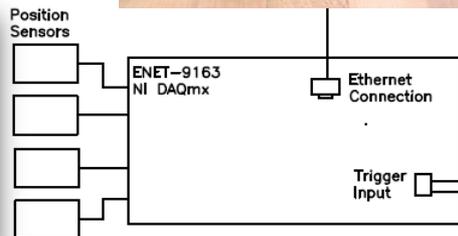
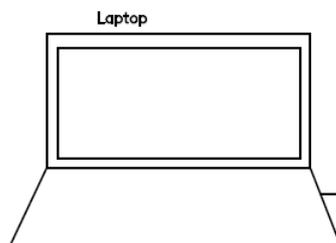
NC-3,4,6, or 7 INPUT



Eventual Setup



All shim arm data
streamed to laptop

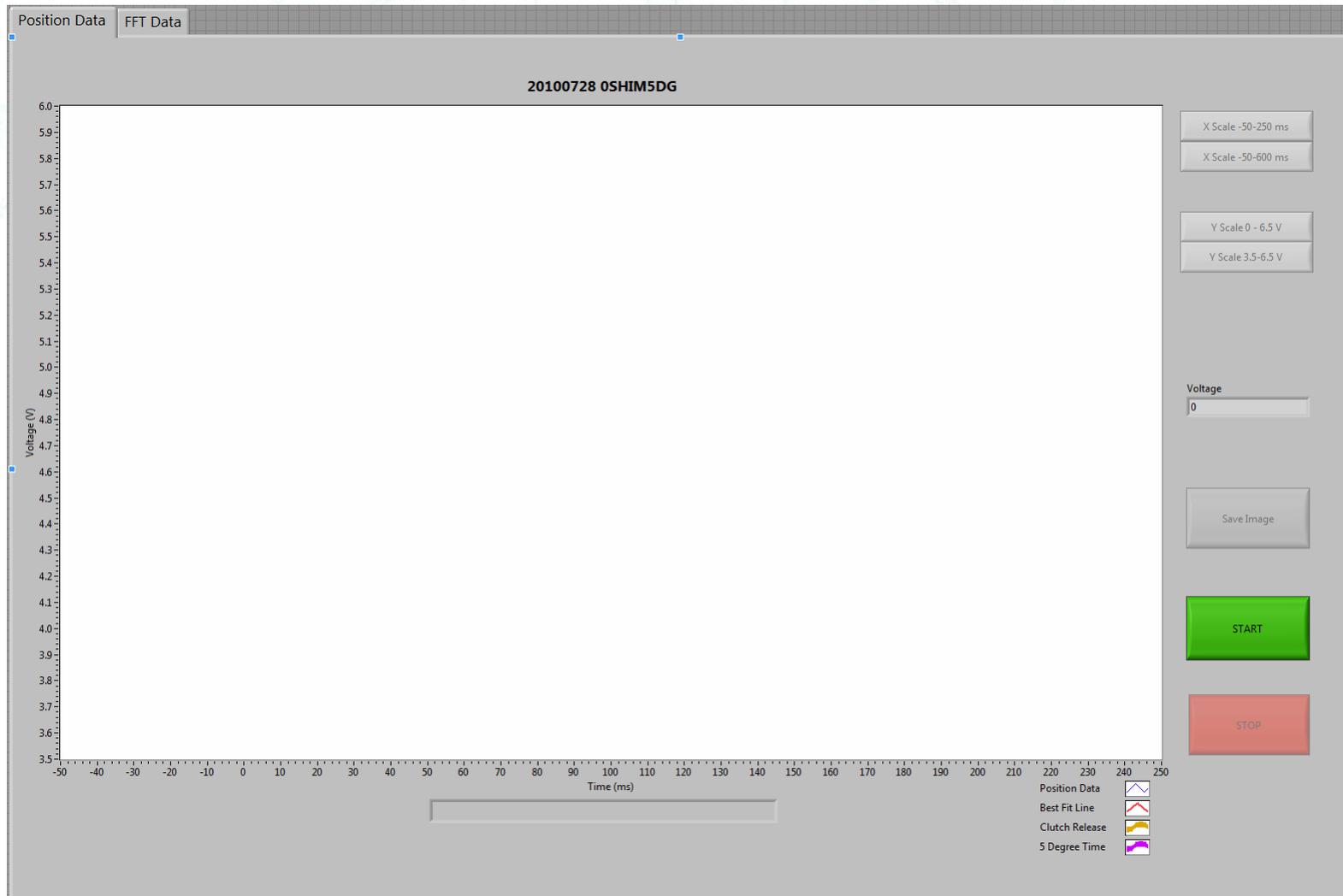


Current source
programmed and
triggered by laptop

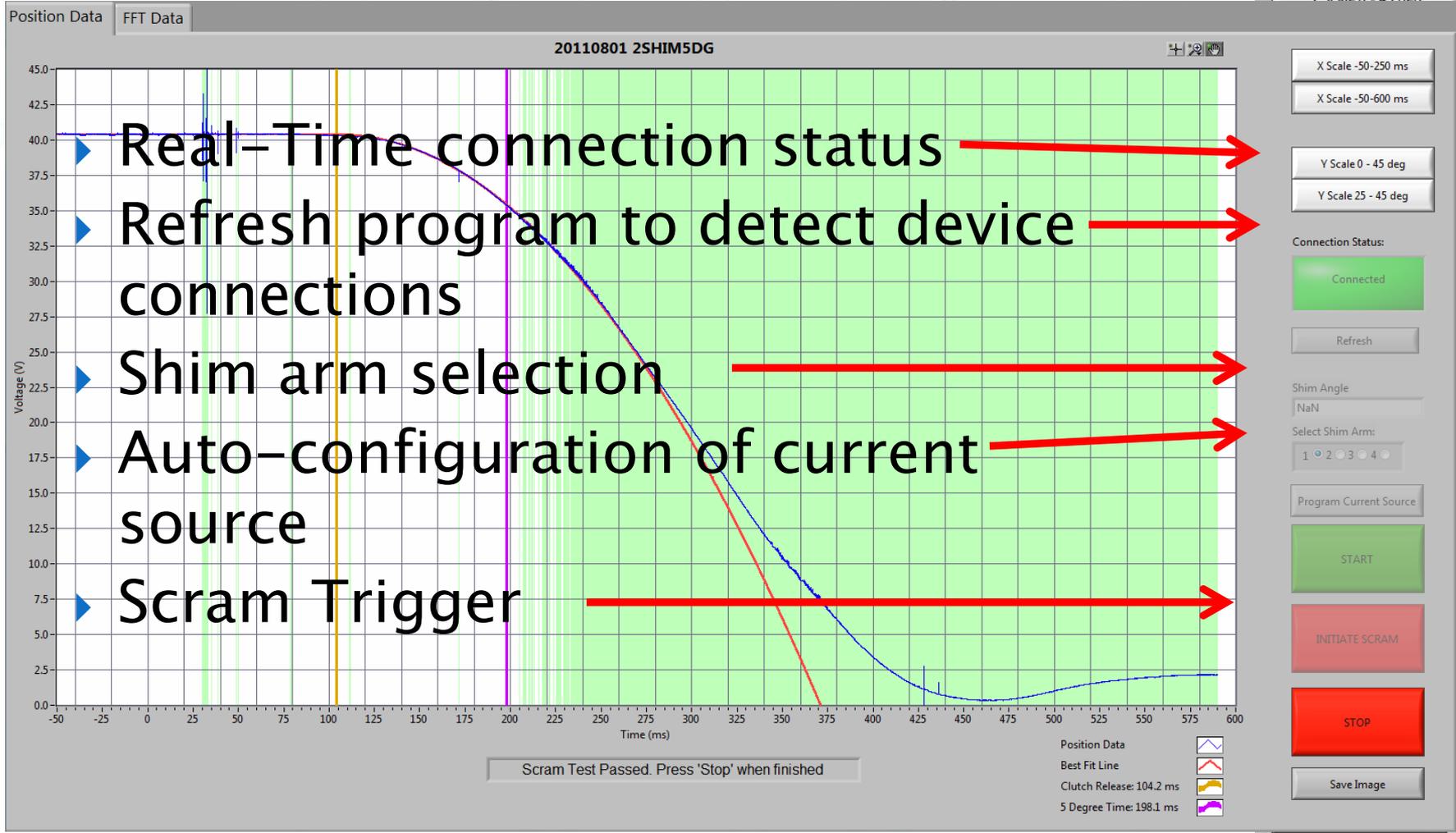


FIGURE 1

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".

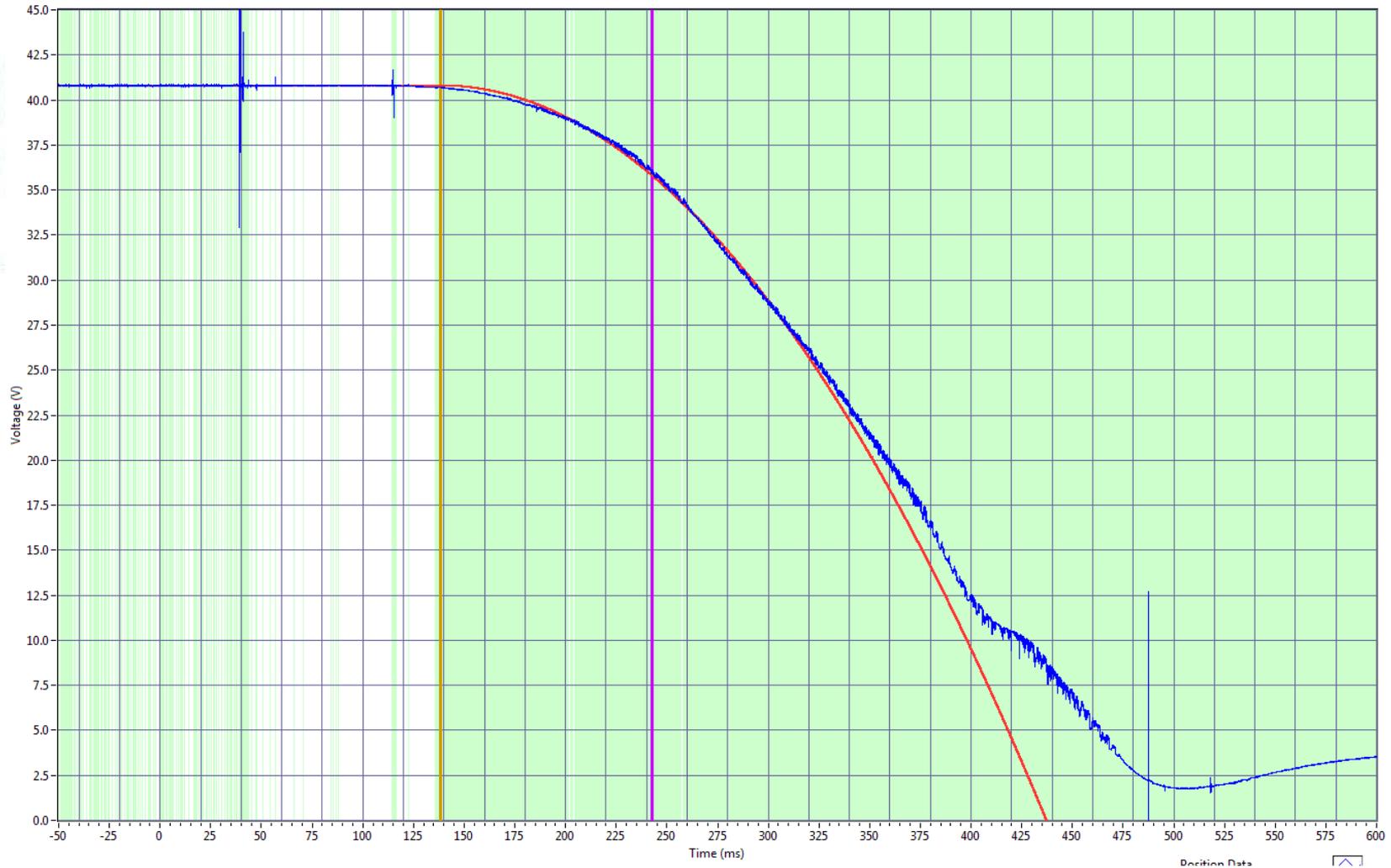
15. To calculate the drop time perform the following:

- 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.

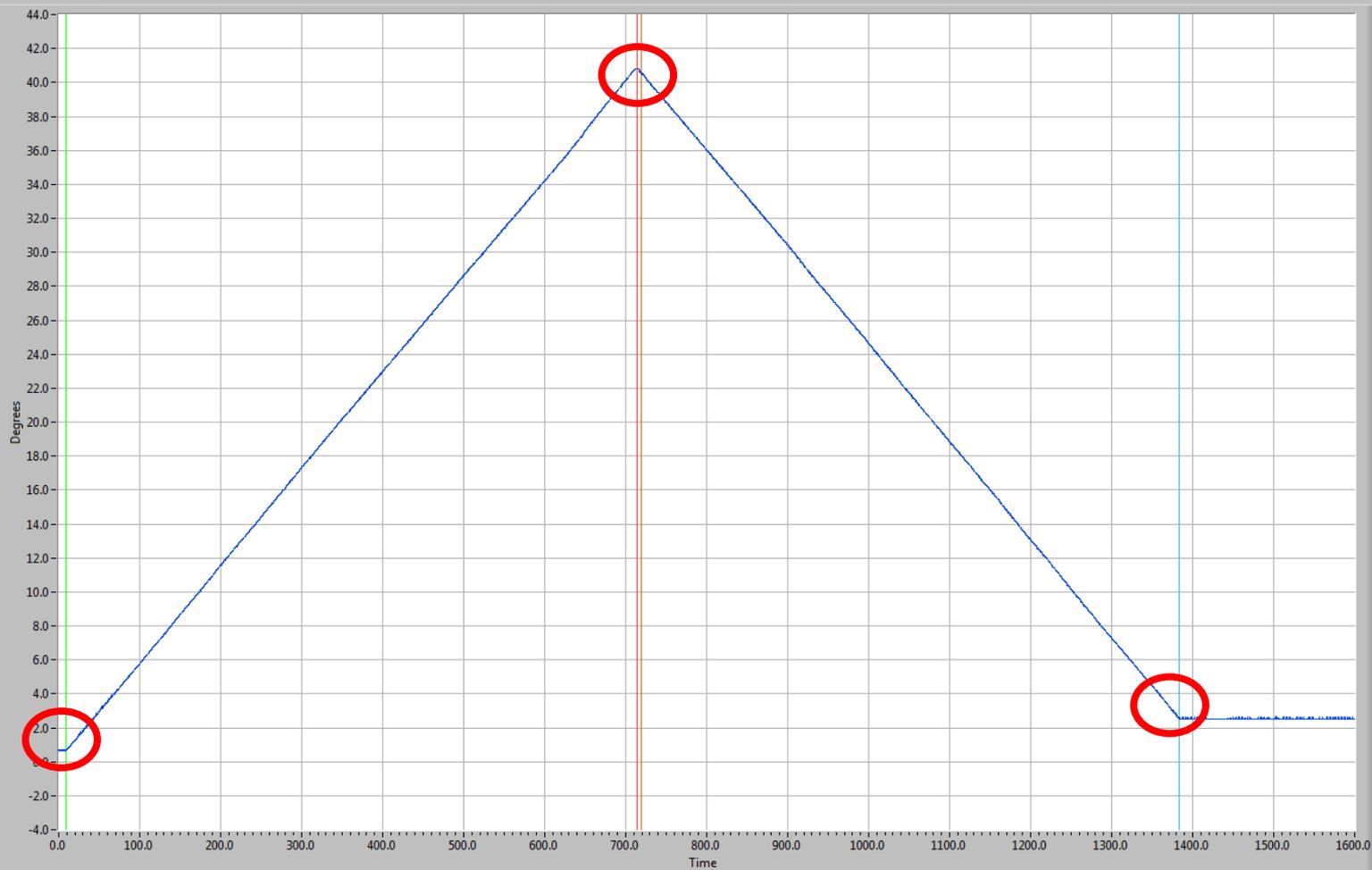


Actual Scram Test Data

20110727 2SHIM5DG



Position Data



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

Data Collected. Processing...

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

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
Alon Eyal
Lincoln Carr
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