# Sealing Ring Testing and Characterization

## Interim Design Review


**Team 1:**

Tawakalt Akintola
Richard Edgerton
Erin Flagler
Emilio Kenny
Kenneth McCloud


**Sponsored by:** Cummins, Inc.
**Advised by:** Dr. Oates and Dr. Alvi

# Outline

- Motivation
- Objectives
- Project Status Update
- Procedure/Test Fixture
- Data Analysis
- Setbacks and Challenges

# Introduction

- Sealing elements
  - Mating engine components
  - Resistant to harsh conditions
  - Various size and shapes
  - Wide variety of applications

- Various Cross-Sections
  - Circular sealing rings (O-rings)
  - Rectangular sealing rings
  - Irregular cross-sections
    - Shown on the right in Figure 1

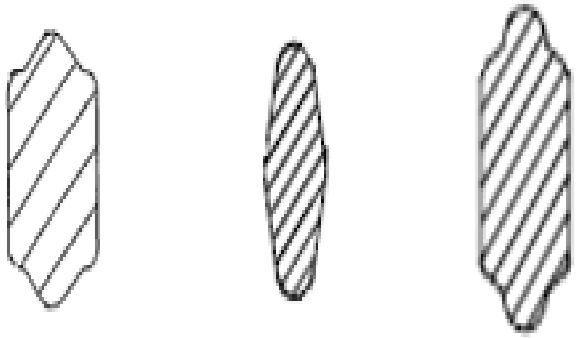
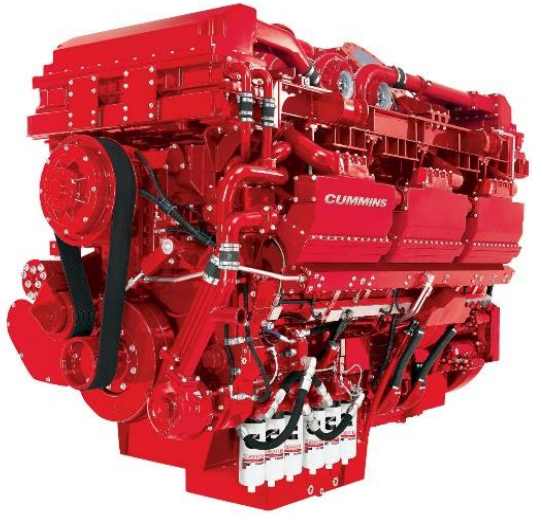


Figure 1: Irregular Cross-Sections

# Motivation

- Current sealing ring selection process:
  - Extensive Finite Element Analysis
  - Time Consuming
  - Costly

- We aim to *reduce time and effort* by providing an approximate starting point sealing ring selection



# Objectives

- Test sealing rings in static face-seal compression
  - Measuring load, displacement, and sealing pressure
- Determine a relationship between the following variables allowing for the creation of a 3-D contour
  - Cross section geometry
  - Sealing pressure
  - Percent crush
- Create a user interface to access data
  - the user will enter 2 known parameters and the interface will provide a suitable value for the unknown variable

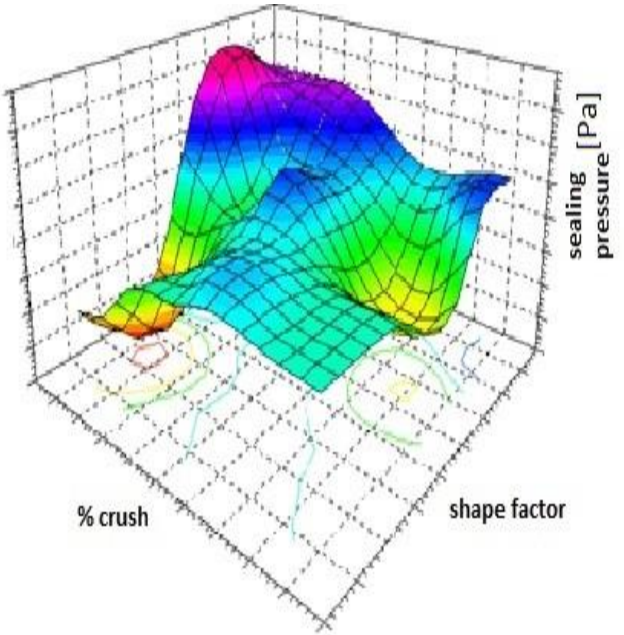



Figure 2: End Product Example

# Completed Milestones

- Research of ASTM and Cummins standards for test methods and groove design
- Designed grooves for each seal
- Developed test procedure
- Test fixture designed and built
- Tests completed

# Future Work

- Complete data analysis
  - Define correlation between cross section geometry and other variables
  - 3-D Contour plot

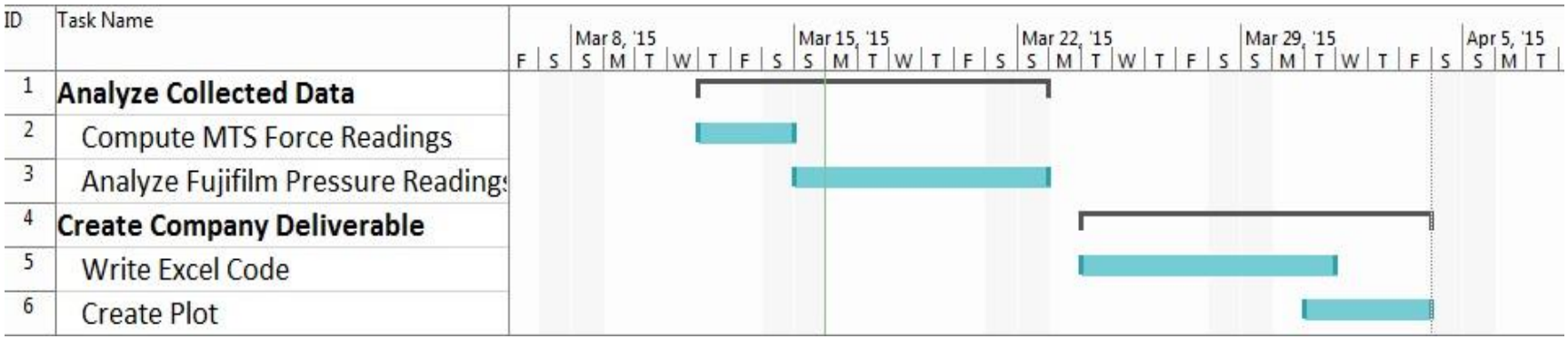
- Develop user interface and user manual

# Procurement & Gantt Chart

Table 1: Procurement

| Item | Cost ($) | Remaining ($) |
|---|---|---|
| Fixture Material | 130.71 | |
| Fujifilm | 427.99 | |
| Shipping | 35.17 | |
| Total | 593.87 | 1406.13 |

Figure 3: Gantt Chart



# Test Fixture

- Design Considerations
  - Rigidity
  - Groove plate interchangeability
  - Simplicity
  - Ease of use with existing equipment
- Material: Aluminum 6061
  - Surface hardness
  - Machinability
  - Low cost

Figure 4: Mounted Test Fixture

# Test Procedure

- Mount sample and place film
- Input displacement corresponding to percent crush
  - %5, %10…%40
- Reset crosshead and exchange film

- Data Collection
  - Load measured by load cell and organized in Excel
  - Sealing pressure measured with Fujifilm Prescale

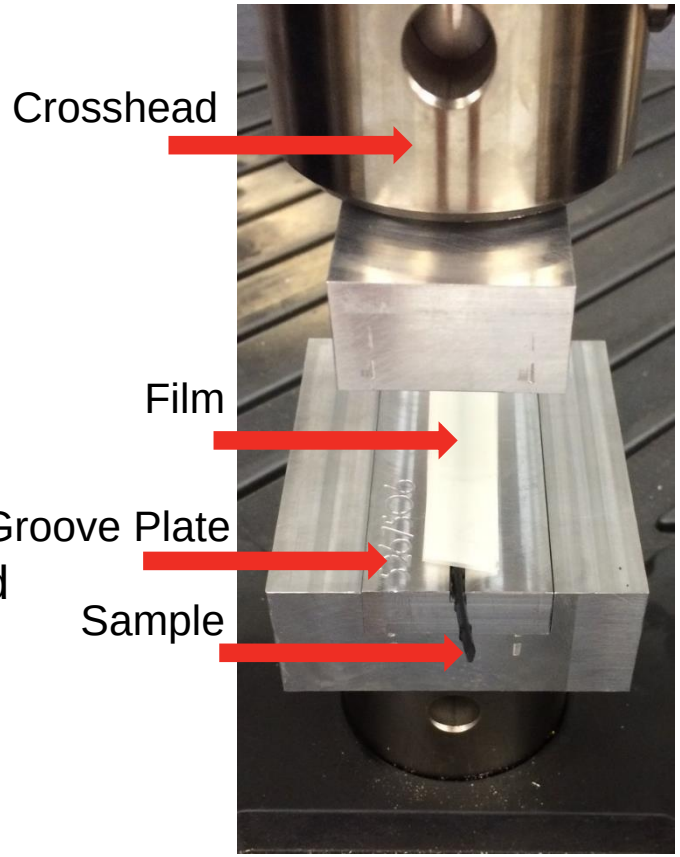



Figure 5: MTS machine

# Testing Results: Force

- Compression creates an opposing force on the contact surfaces.

- Found Trends:
  - The larger the contact width, the larger the force exerted
    - Rectangular cross sections can produce the highest forces.
  - The larger the change in contact width, the larger the change in force

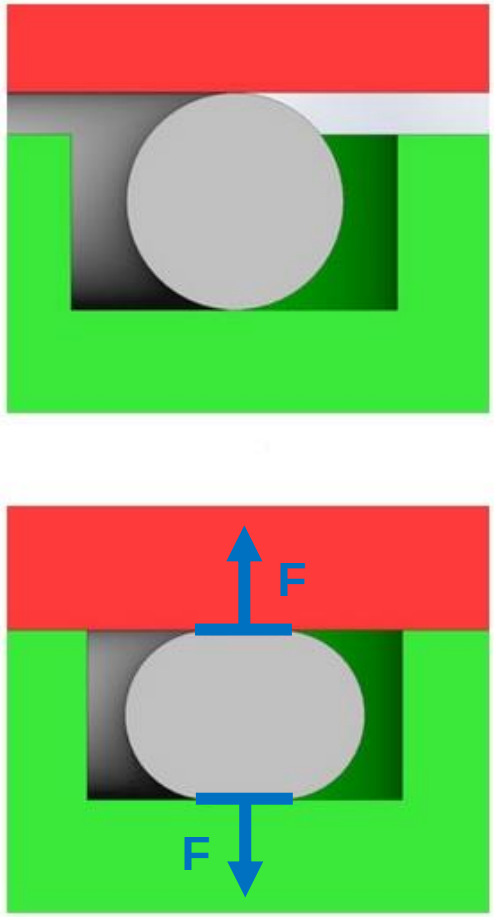



Figure 6: O-ring in compression

# Testing Results: Force contd.

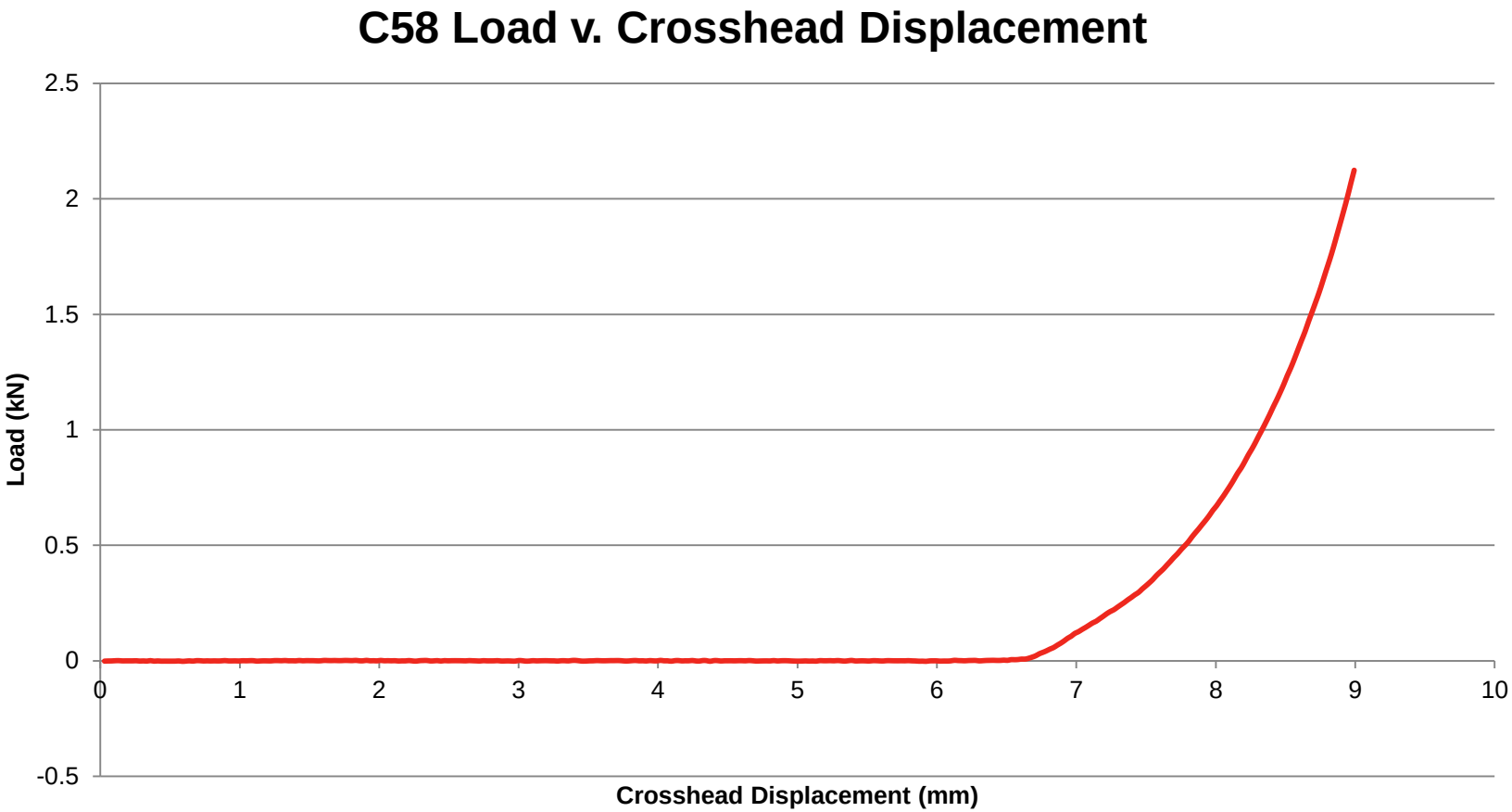



Figure 7: Sample plot of Force versus Crosshead displacement

# Testing Results: Force contd.

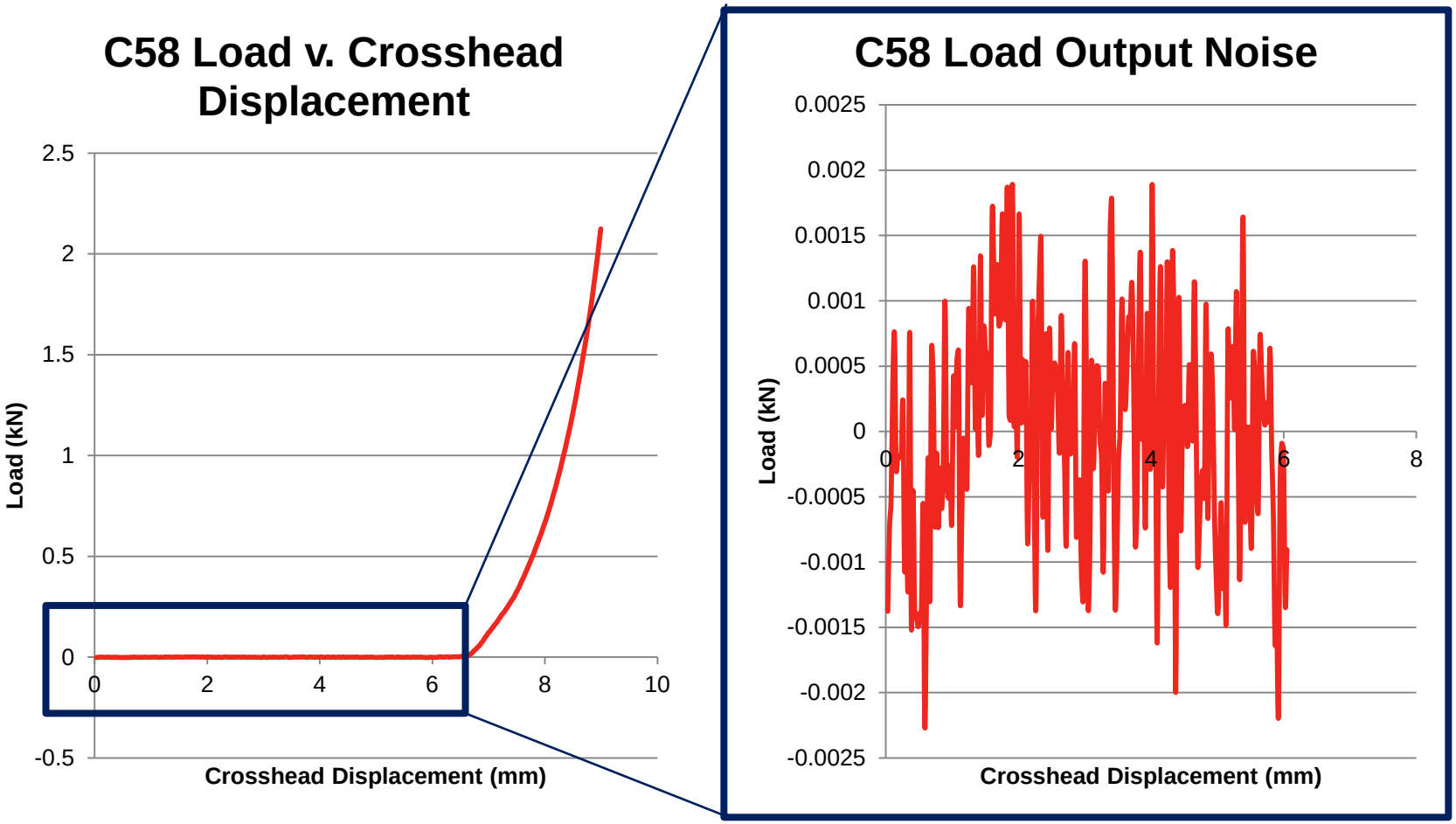



Figure 8: Sample plot showing accuracy of MTS Force Readings

# Testing Results: Force contd.

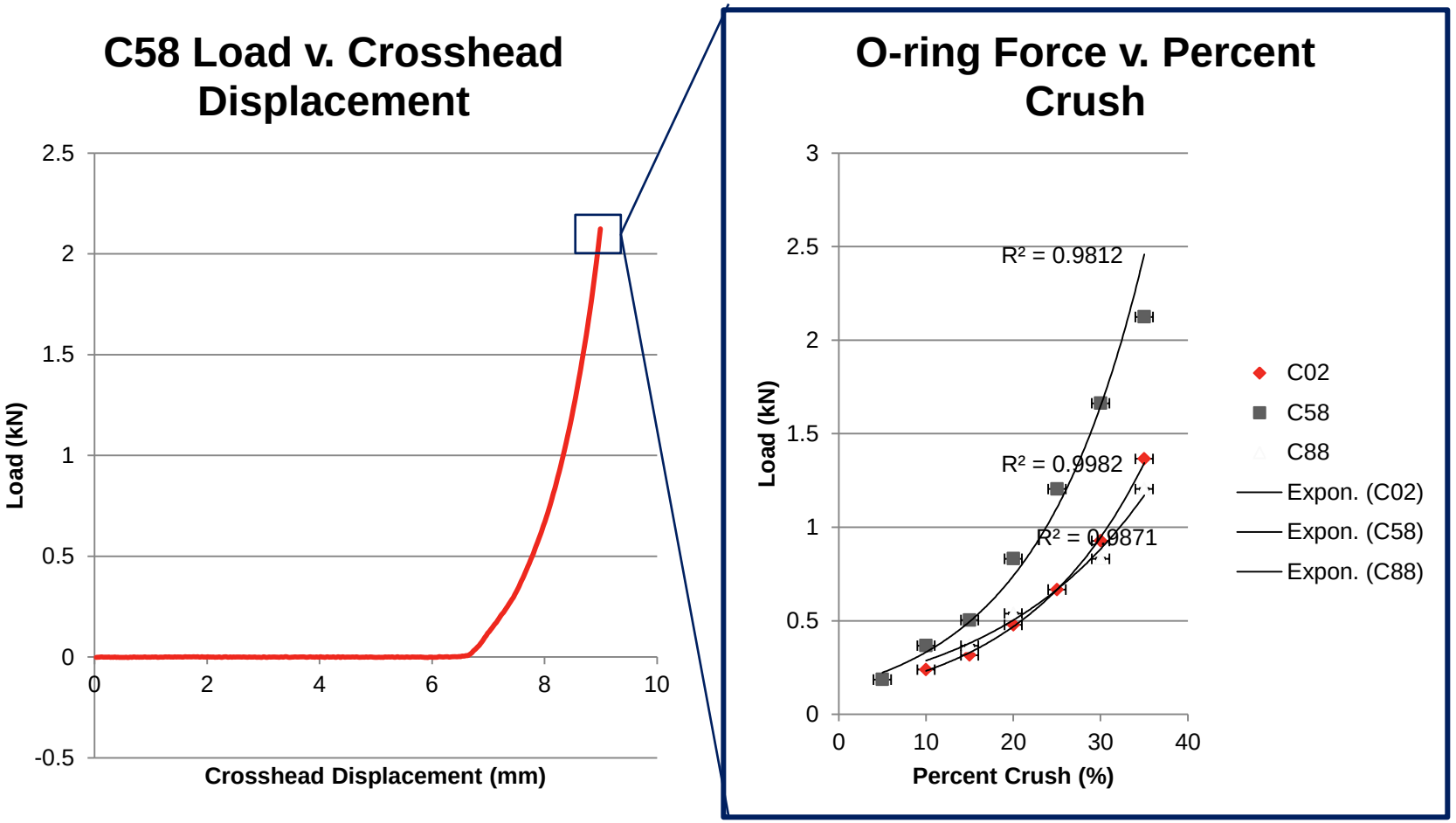



Figure 9: Sample plot showing retrieval of force points

# Testing Results: Pressure

- Leaks occur when fluid pressure exceeds contact pressure
- Retrieved maximum continuous pressure of each seal

- Found Trends:
  - Varying pressure profiles

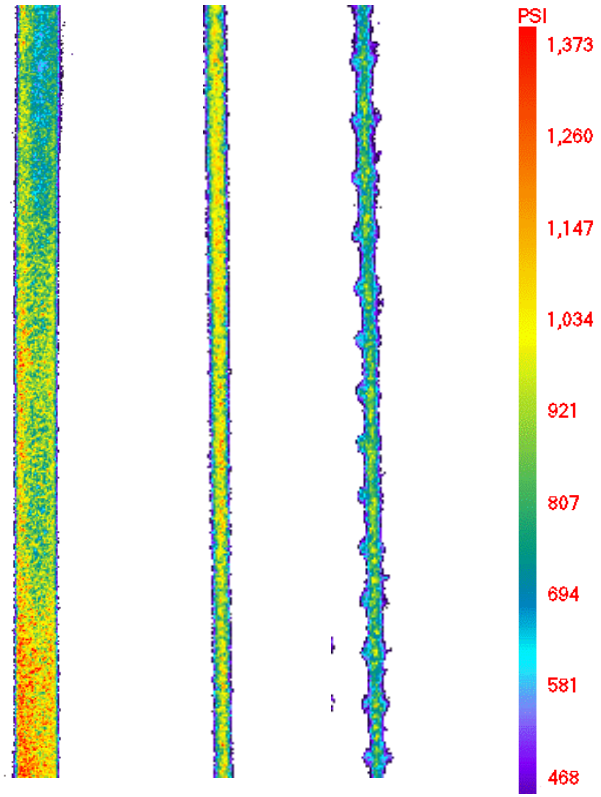



Figure 10: Sample Fujifilm

# Summary

- Goal: We aim to *reduce time and effort* by providing an approximate starting point sealing ring selection

- Completed Work:
  - Ran tests
  - Analyzed Data

- Next Steps:
  - Finding Correlation between sealing pressure, force and percent crush
  - Creating User Interface

# QUESTIONS? COMMENTS?

# REFERENCES


1. http://www.cummins.com/about-us/overview
2. http://www.nimaxseals.com/dbpics/images/article20100412_KOrings_75.jpg
3. *MTS Machine*. n.d. Webpage. 10 October 2014. <http://www.testresources.net/200-series-electromechanical-test-machines/210m1125-standalone-test-machines/>.
4. *3D Contour Plot*. n.d. Webpage. 10 October 2014. <http://www.agocg.ac.uk/reports/graphics/34/appii97/chapte_7.htm>.
5. *Fujifilm Paper*. n.d. Webpage. 10 October 2014. <http://sensorprod.ca/>.