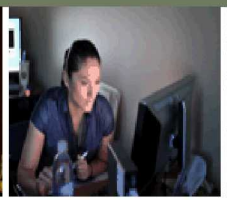
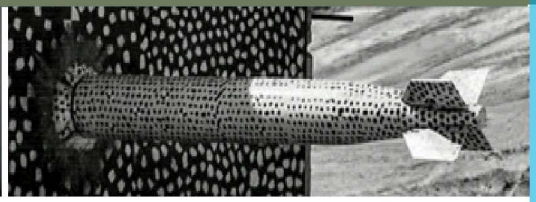
SAND2018-13968PE

High Throughput Tribometry for KCNSC





PRESENTED BY

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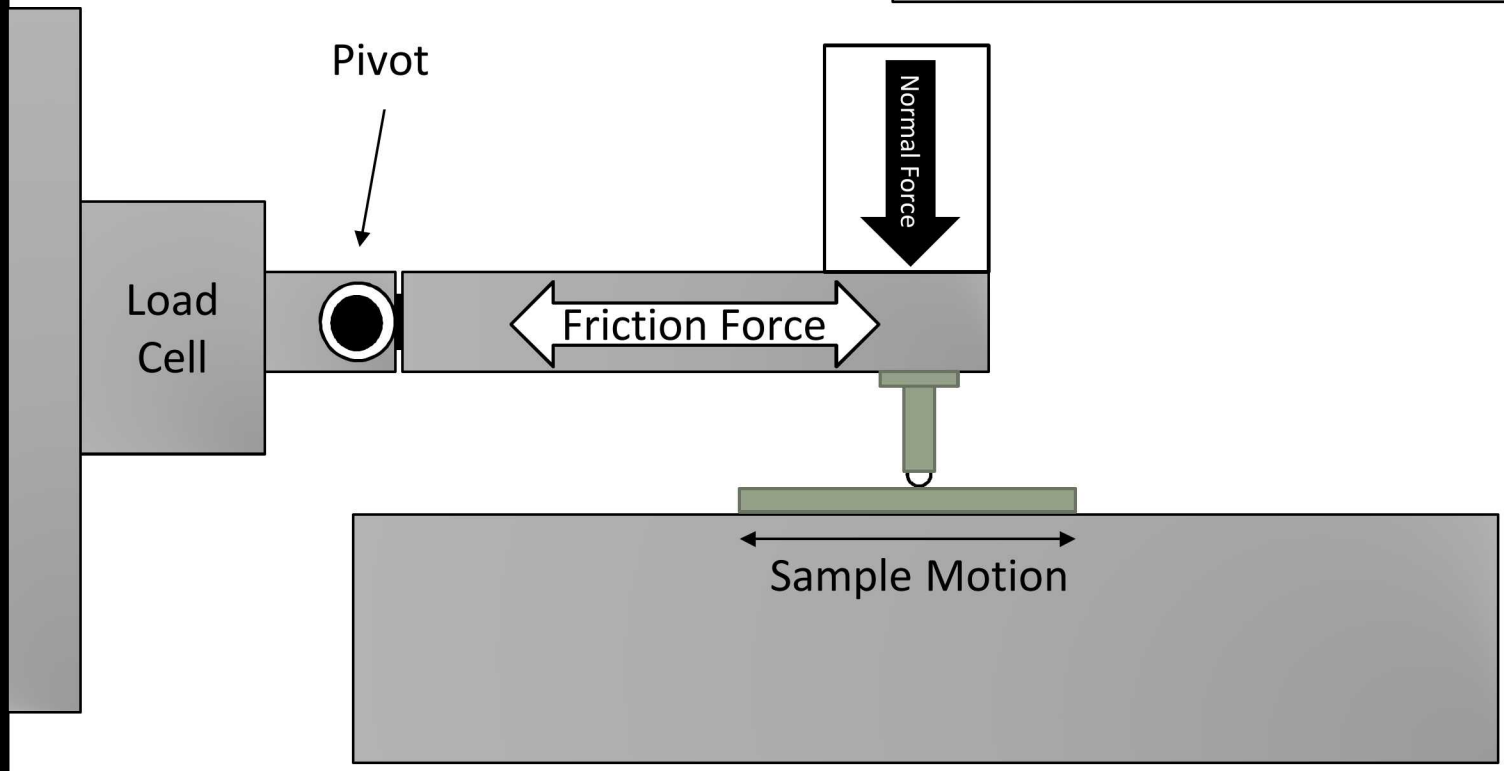
Friction Measurement Concept

Friction Coefficient:

$$\mu = \frac{Friction\ Force}{Normal\ Force}$$

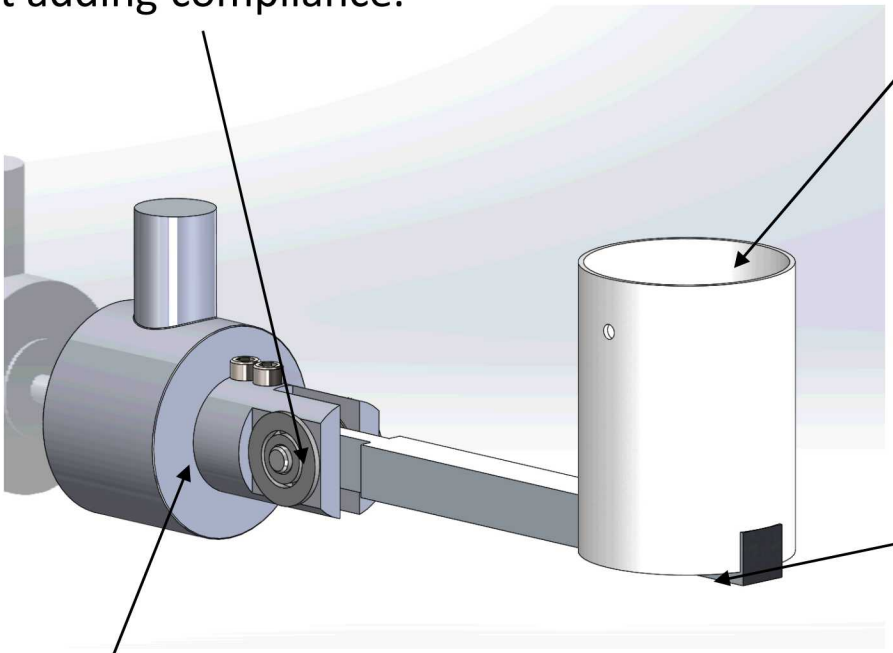


When sample moves underneath ball holder, friction force is resolved in rigidly mounted load cell. Bearing joint reduces the effects of misalignment and sample tilt.

Details of Design

High quality (ABEC-7) ball bearings allow for easy loading (arm swings away from contact during setup) without adding compliance.

Known mass (+ weight of ball holder, to achieve desired test load) is added to weight cup. This can be in the form of balls (high density materials, WC or Pb… etc) or brass weights.

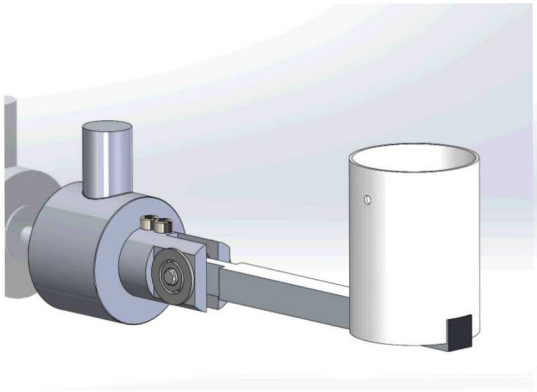


Weight of arm at contact point is measured during construction. (unless configuration changes)

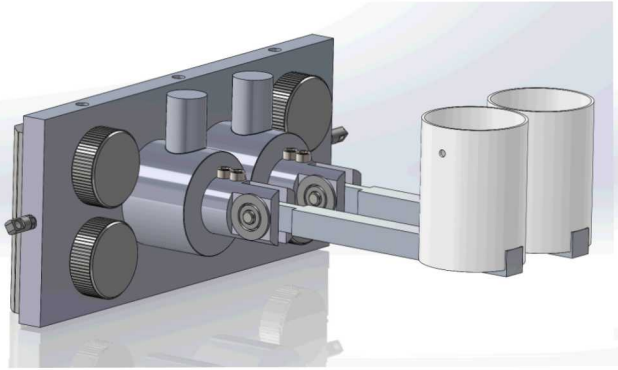
Load Cell is calibrated for tension/compression. When sample slides underneath contact, tension/compression is exerted on load cell.

Our approach

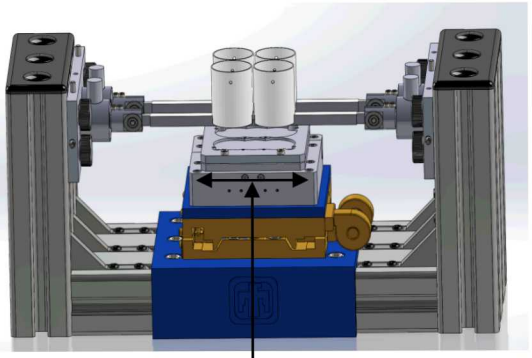
Load Cell Assembly → Load Cells Module → Module Assembly



This method of friction measurement is reliable and repeatable. Has been used by industry in various configurations for decades.



The tester is made of simple, dual load cell assemblies. Which are adjustable to accommodate different sample geometries and sizes.

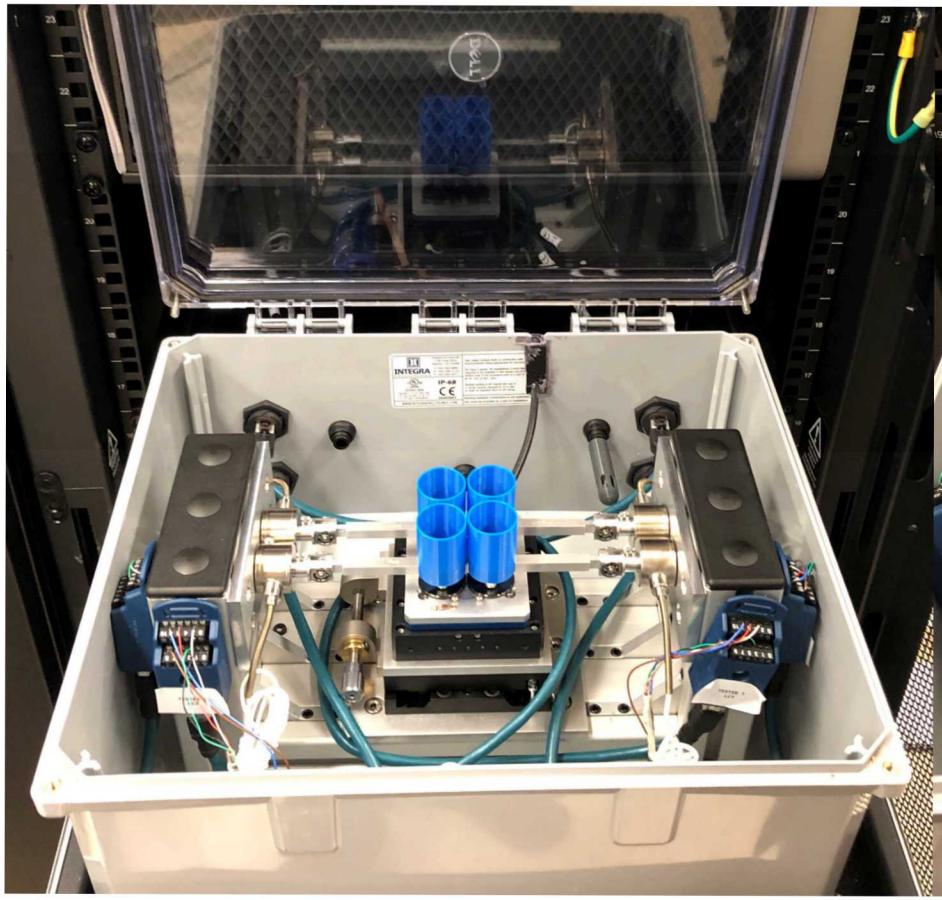


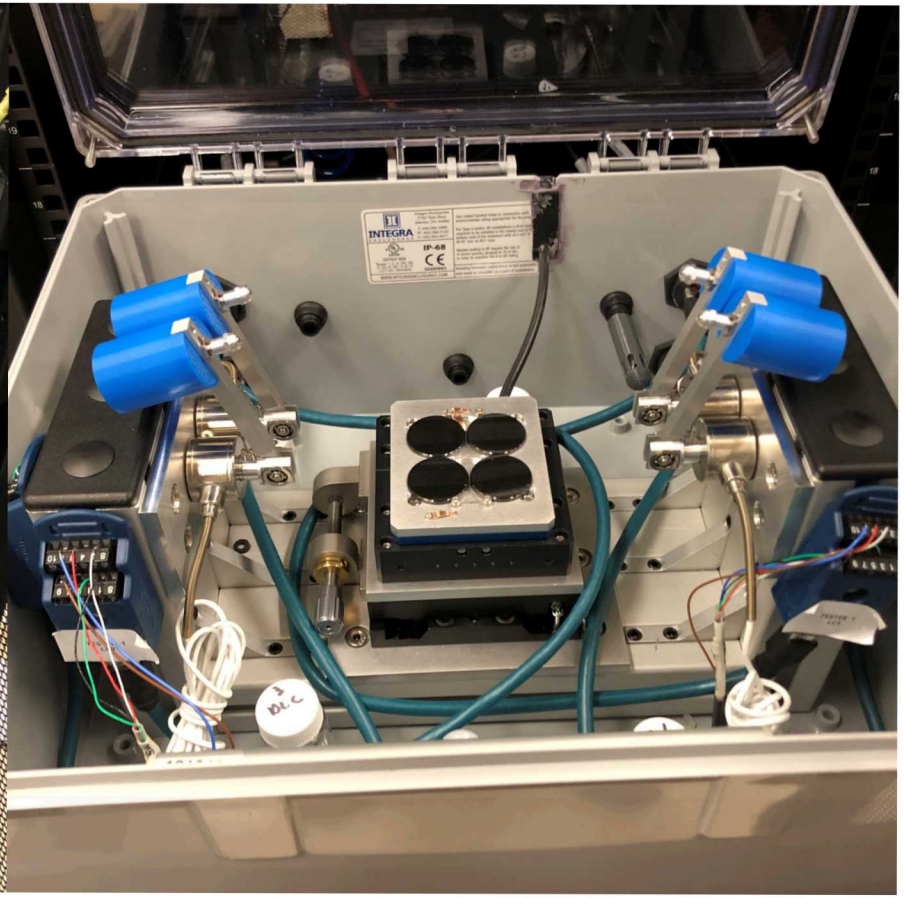
A single linear motion stage is paired with two load cell modules to create a “parallel” friction tester with the ability to test four samples simultaneously.

Setting up a new test

1.) Open Lid
(four screws at corners or two front latches)

2.) Remove weights
3.) Retract Arms

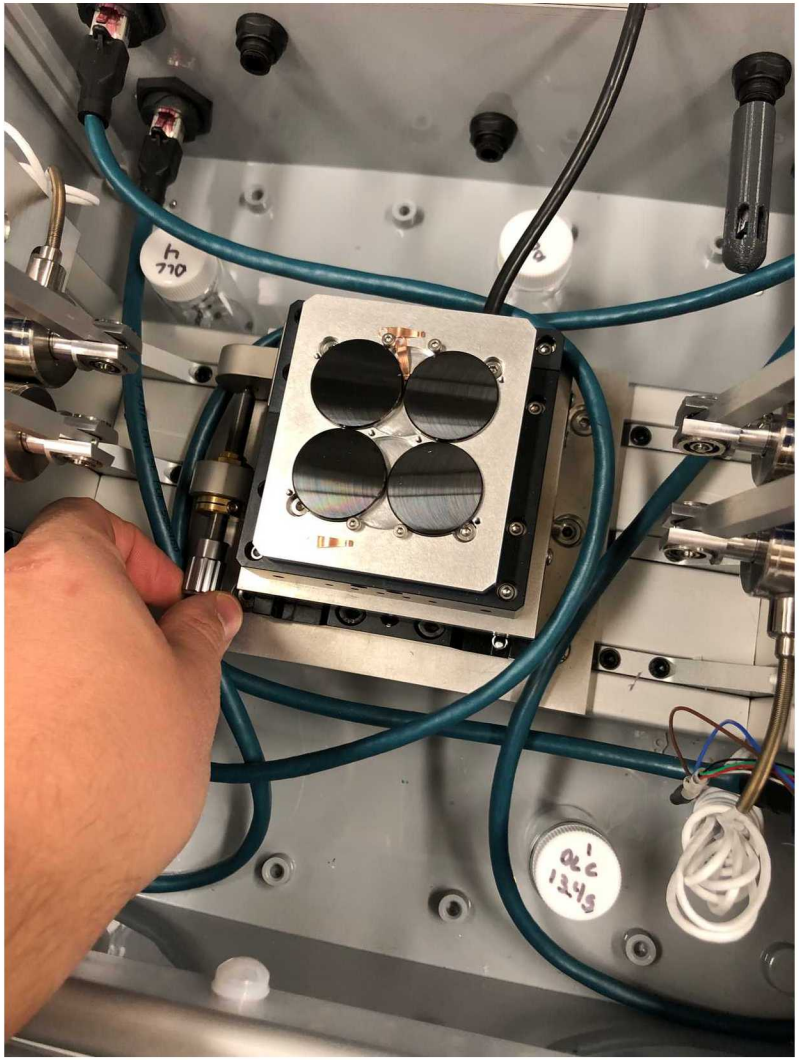




Setting up a new test (continued)

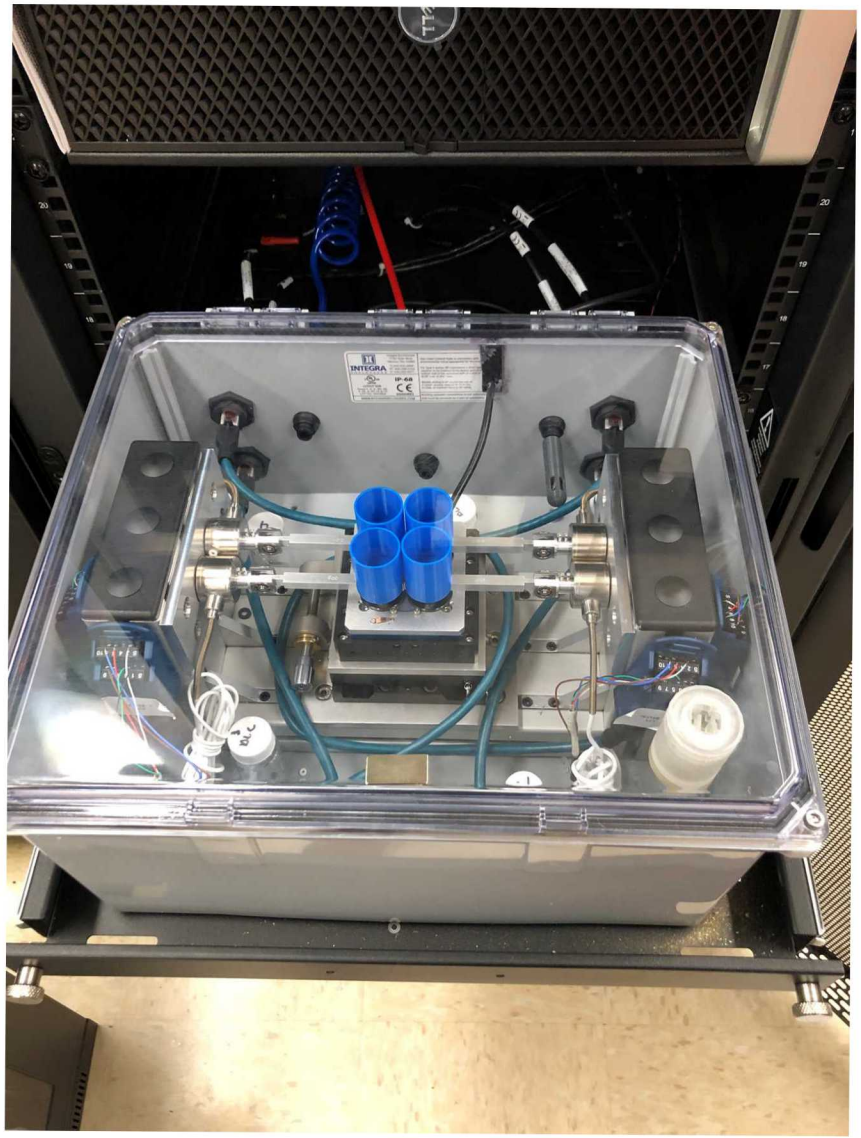
4.) Replace used ball:
- Remove ball holder
- Dump out old ball
- Drop in new ball
- Replace ball holder

Setting up a new test (continued)



5.) Adjust sample position to new test location

Setting up a new test (continued)



6.) Lower arms, add weights and secure lid

Setting up a new test (continued)

7.) Start Gas Purge

Setting up a new test (continued)

7.) Setup software

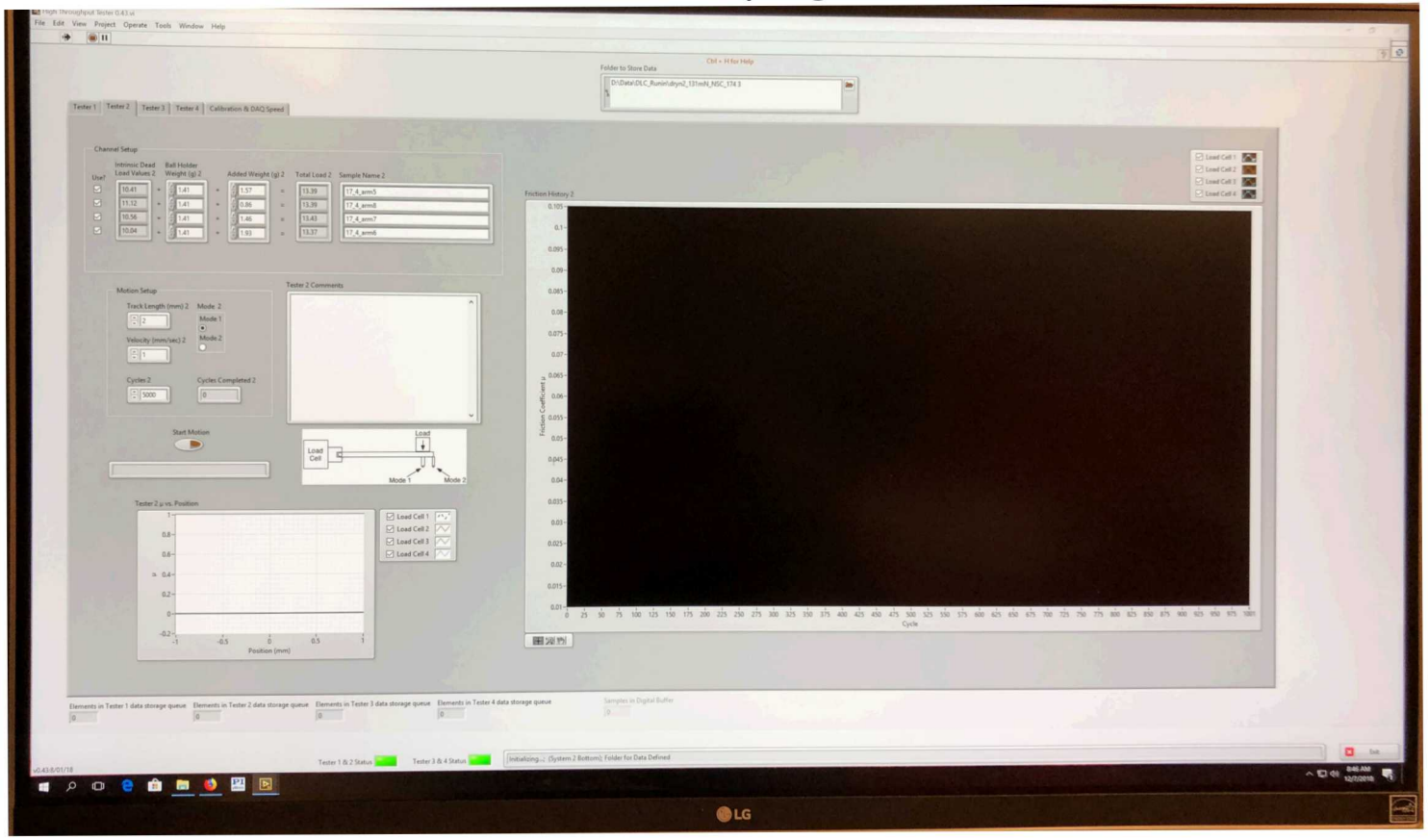
Enter weight of ball holder

Enter added weight

Add sample ID details

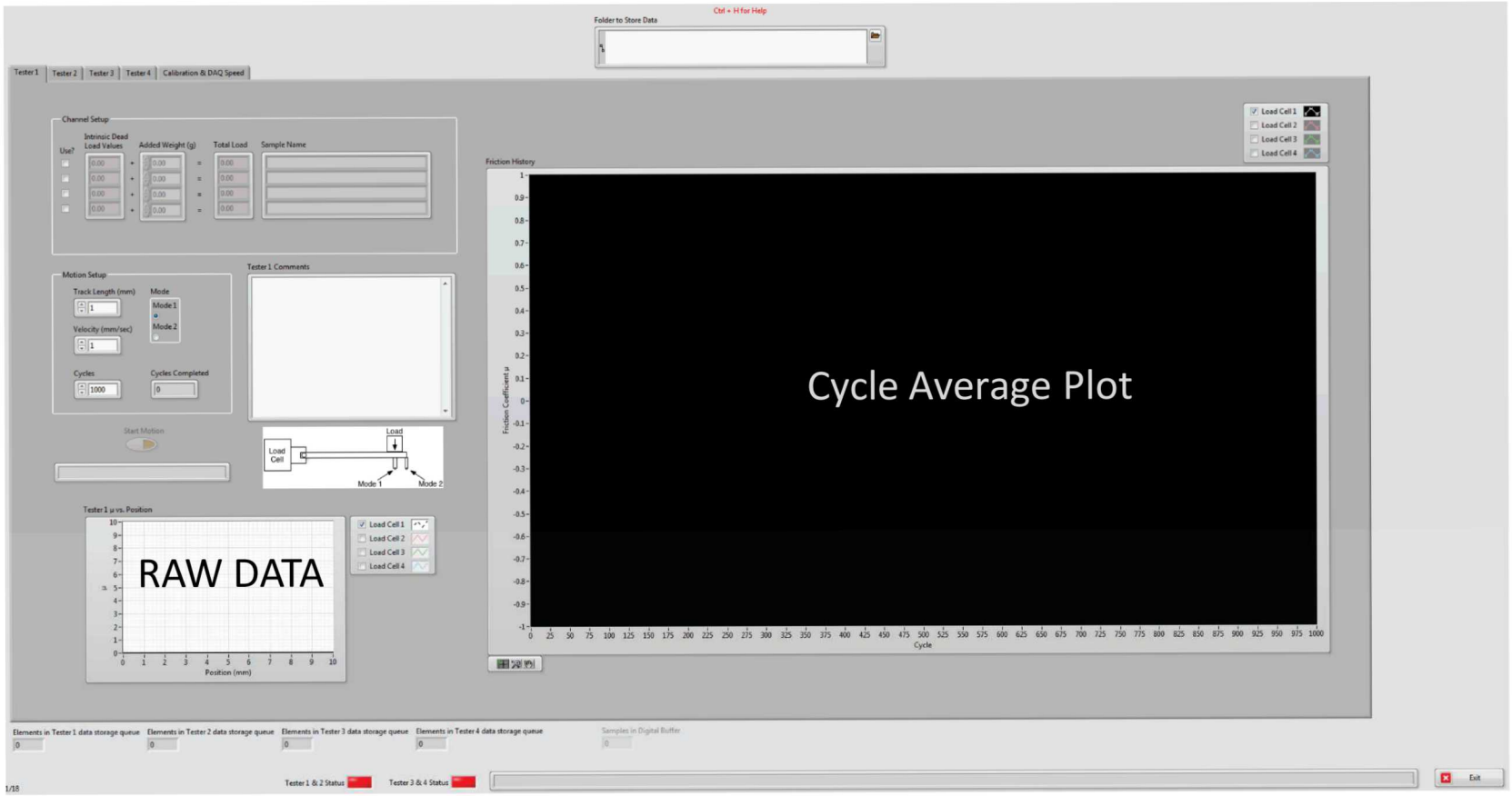
Enter test parameters (length, speed, cycles etc)

Start test when purge is complete



Software Features

Software automatically analyzes data and plots “cycle averaged” friction coefficient.
A hierarchical folder structure is used to organize “analyzed data” and raw data so the user can plot later using Excel or other plotting software very easily. All sample IDs/calibrations/test parameters are stored with the summary data to ensure ease of reporting.



Software makes test monitoring easy. Plots last cycle’s raw data to enable user to see whether tester is operating normally and as expected. User can be informed of “red flags” in raw data during training.

The System

4 Modules in a single self-contained rack

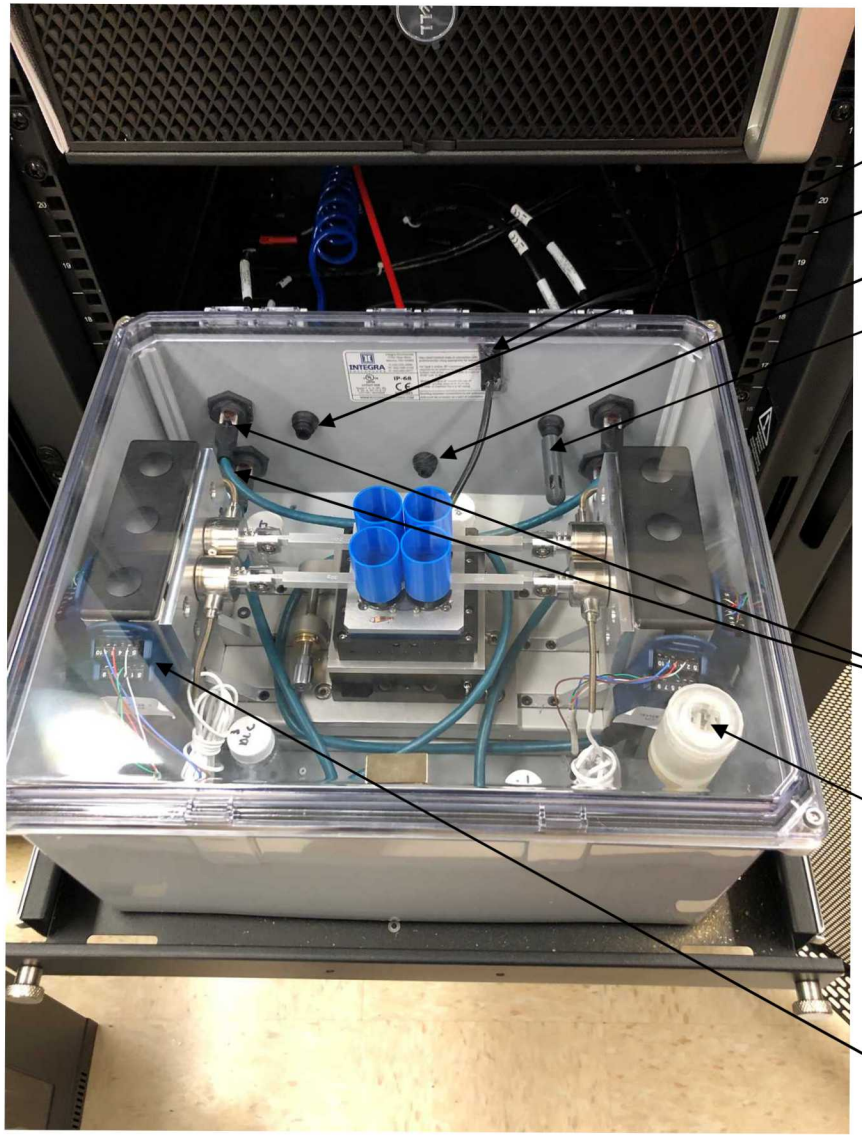
Also includes:

- Data Acquisition System
- Motion Controller
- Control Computer

Capabilities/Specifications:

- ± 2.5 mm Track Length
- 0.1 - 250 mm/s stage speed
- 1 N Max Normal Force
- 1 N Max Friction Force
- 16 sample simultaneous measurement
- 4 Independent Atmospheres
- (1 per module, 0-60% RH, within 0.5%)
- 50 kHz DAQ per load cell (Before averaging)
- 2 Testing Modes:
  - 4 Tracks on 4 coupons
  - 4 Tracks on 2 Coupons

Other Tester Features



Linear Stage Feedthrough (improved for your version)

Gas Inlet

Oxygen Sampling Port

Solid-state analog humidity sensor

Load Cell Feedthroughs (four total) will be LEMO in your version

Pressure relief valve (floating ball style)

Load Cell Terminal Blocks (as well as blue/green cables will be eliminated in your version)

Gas Handling System

Each set of two flow meters (dry and humid) mixes to form one gas stream for each module (with a prescribed humidity). User can vary humidity by changing respective flow rates of dry and humid gas. Humid gas is created by flowing dry gas through bubblers which must be manually refilled.

We've created a very simple method for refilling that requires very little interruption to testing:

1.) A "filling" bubbler is filled with DI water.

2.) The "filling bubbler" is plugged into the back of the gas handling system.

3.) An illuminated, momentary flush mounted button switch labeled "refill bubblers" is depressed.

4.) User observes water levels in bubblers to determine when to stop refill process.

5.) "filling" bubbler is detached from back of gas handling system

6.) tests can resume

Calibration Methods:

1.) Remove arms and set weights on load cells

2.) Use calibrated shunt resistors to check nominal load cell resistance/bridge balance.

3.) Check stage calibration by verifying track length under microscope

4.) Check humidity sensors using a chilled mirror (humidity sensors are +/-1% RH, used for indication purposes)

5.) Check oxygen sensors using an oxygen analyzer