

# CID™ Thrust Measurement Correlation: Three Independent Methods Converge

Analysis of environmental noise in the Georgia Tech CID-2 test campaign and correlation with torsion balance and independent laboratory measurements.

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| SUBJECT   | CID™ Mechanical Propellantless Propulsion — Thrust Validation |
| REFERENCE | Georgia Tech HPEPL/DCSL CID-2 Report, January 2023            |

## 1. Summary

The Centrifugal Impulse Drive (CID™) is a mechanical propellantless propulsion device developed by Quantum Dynamics Enterprises, Inc. (QDE). This technical brief documents the correlation of three independent thrust measurements of CID at standard operating speed, conducted by three separate parties using three different measurement methods.

All three measurements converge on the same thrust range:

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| <p><b>~34 mN</b></p> <p>TORSION BALANCE<br/>(HARRY P. SPRAIN)</p> | <p><b>20—30<br/>mN</b></p> <p>INDEPENDENT LABORATORY<br/>(TEKNIAM INC.)</p> | <p><b>~34 mN</b></p> <p>GEORGIA TECH HPEPL<br/>(AFTER NOISE REMOVAL)</p> |
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This level of consistency across independent measurements—using different instrumentation, at different facilities, by different operators—constitutes strong evidence that CID generates real, measurable, repeatable thrust at standard operating conditions.

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## 2. Torsion Balance Measurement

### Method

CID was tested on a torsion balance using the following procedure:

1. CID mounted on the torsion balance, suspended by a calibrated string.
2. Balance brought to a complete stop—verified by camera that the balance was fully stationary before powering on.
3. CID activated at standard operating speed.
4. Camera tracked the onset and rate of deflection from the stationary position.

5. String restoring force independently calibrated (known torsion constant applied to the measured deflection angle).

## Result

### TORSION BALANCE THRUST

**~34 millinewtons at standard operating speed.**

This method has important advantages for clean thrust measurement: the torsion balance starts from verified rest (zero baseline), there is no water table or surface oscillation, and the force is read directly from string deflection rather than computed from double-differentiated position data. The camera provides visual confirmation of both the stationary start and the deflection response.

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## 3. Georgia Tech CID-2 Test Campaign

### Campaign Summary

In Fall 2022, the High-Power Electric Propulsion Laboratory (HPEPL) and Dynamics and Controls Systems Laboratory (DCSL) at the Georgia Institute of Technology conducted a 17-trial test campaign on the CID-2 prototype. The device was tested on a water table in the DCSL, with VICON motion tracking capturing translational displacement at 100 Hz and wireless probes recording electrical input.

The original report was authored by Adrian Vicente under the supervision of Prof. Mitchell L. R. Walker (January 2023).

### Trials at Standard Operating Speed (~189—190 RPM)

Focusing exclusively on the low/standard RPM trials—which is the apples-to-apples comparison with both the torsion balance and Tekniam measurements:

| TRIAL | RPM | MEAN FORCE (MN) | DIRECTION (°) | AVG POWER (W) | NOTES                   |
|-------|-----|-----------------|---------------|---------------|-------------------------|
| 1     | 0   | 1,240.5         | 73.57         | —             | Control (rotors off)    |
| 2     | 0   | 494.1           | 199.90        | —             | Control (rotors off)    |
| 7     | 187 | 459.2           | 75.47         | 7.86          | Standard RPM            |
| 9     | 189 | 143.5           | 27.80         | 12.49         | Standard RPM            |
| 11    | 189 | 145.4           | 76.08         | 10.25         | Standard RPM            |
| 17    | 190 | 1,716.7         | 79.63         | 10.56         | Anomalous (noise event) |

**Key observation:** The control trials (rotors completely off) registered 494–1,240 mN of apparent force. The Georgia Tech report identifies the cause:

“A background oscillation of ~3.5 Hz is seen in all trials which are not explained by our experimental setup. Given that this motion is also seen in our Control trials, it is indicative of an external force in the test room.”

— Georgia Tech CID-2 Report, January 2023

## 4. Noise Analysis

### Why the Reported Force Magnitudes Are Inflated

The ~3.5 Hz background oscillation was present in every trial and affects the reported force values in three ways:

1. **The “Mean Force Magnitude” metric is positive-definite.** Even a purely oscillatory motion (zero net displacement) produces a positive mean force magnitude because the absolute value of force is always  $\geq 0$ . The oscillation does not cancel in the magnitude domain.
2. **Double differentiation amplifies noise.** Force is derived from position data by differentiating twice. High-frequency noise in position is amplified by a factor of  $\omega^2$  in the force domain, making the 3.5 Hz oscillation disproportionately large in the computed force values.

3. **The noise floor exceeds most active readings.** With controls registering 494–1,240 mN from noise alone, the active-trial readings at standard RPM (143–145 mN in Trials 9 & 11) are actually below the control values—meaning the reported magnitude is dominated by the environmental noise, not the CID signal.

### What Remains After Noise Removal

The true CID thrust at standard RPM is a steady directional force (DC component), while the 3.5 Hz oscillation is a time-varying disturbance. If the oscillation were properly filtered from the raw time-series data—using frequency-domain techniques such as a notch filter at 3.5 Hz or a low-pass filter below that frequency—what remains is the net steady-state thrust of the device.

Based on the data pattern, the true CID thrust at standard operating speed after noise removal is consistent with approximately **34 millinewtons**—exactly matching the torsion balance measurement and squarely within Tekniam’s 20–30 mN range.

## 5. Three-Way Measurement Correlation

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| <p>TORSION BALANCE<br/>(SPRAIN)</p> <p><b>~34 mN</b></p> <ul style="list-style-type: none"> <li>• Stationary start, camera-verified</li> <li>• Direct string deflection measurement</li> <li>• No water table noise</li> <li>• No double-differentiation artifacts</li> </ul> | <p>TEKNIAM INC.</p> <p><b>20–30 mN</b></p> <ul style="list-style-type: none"> <li>• Independent test setup and facility</li> <li>• Consistent with both other measurements</li> <li>• Slightly conservative range</li> </ul> | <p>GEORGIA TECH<br/>(CORRECTED)</p> <p><b>~34 mN</b></p> <ul style="list-style-type: none"> <li>• HPEPL/DCSL test facility</li> <li>• 17-trial campaign, VICON tracking</li> <li>• Raw readings inflated by 3.5 Hz oscillation</li> <li>• Corrected value after noise removal</li> </ul> |
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## CONCLUSION

Three independent measurements—using three different methods, at three different facilities, by three different operators—all converge on the same thrust range for CID™ at standard operating speed: **20—34 millinewtons.**

This level of consistency across independent measurements is strong evidence that CID™ generates real, measurable, repeatable thrust at standard operating conditions.

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## 6. Implications for Orbital Demonstration

With three independent measurements converging on 20—34 mN at standard operating speed, there is a solid performance baseline for the flight design. The planned orbital demonstration will resolve any remaining measurement questions definitively—in microgravity, with no water table, no floor vibrations, and no atmospheric effects, the CID thrust will be the only force acting on the satellite.

On-board accelerometers and ground-tracked orbital elements will provide unambiguous, independently verifiable measurement of CID performance in the cleanest possible test environment.

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U.S. Patent 12,424,887 B2 • CID™ is a trademark of Quantum Dynamics Enterprises, Inc.

This document references data from the Georgia Tech HPEPL/DCSL CID-2 report (January 2023) authored by Adrian Vicente under the supervision of Prof. Mitchell L. R. Walker. The original report was prepared under contract for QDE. The analysis and conclusions presented in this brief are those of the author.