

DESIGNING LASTING PERFORMANCE IN FLEXIBLE ELECTRONICS

ENDURANCE TESTING SYSTEMS, LLC

An independent affiliate of YUASA SYSTEM CO LTD.

FLEX Webinar

February 6, 2019

Abstract (as advertised)

- New form factors in components and products are continuously being introduced today. Some examples of products for personal use are foldable smartphones, wearable sensors, and smart IoT speakers with AI. Examples of components are curved screens, metal ink compounds, bendable batteries, and bendable antennas. New material components will be needed for electric and autonomous vehicles, and elsewhere.
- ***As the design of our future electronics systems shifts from their past rigid state to being made from flexible hybrid materials and components, innovators will require new methods to design continuous and lasting mechanical performance into their product designs, as well as new methods for testing those new products.***
- What will be needed is a series of unique, scalable, and modular mechanical endurance testing solutions for ambient and hostile conditions, with the added ability of measuring the performance of the flexible components throughout the enhanced testing cycle.
- Those testing solutions may include, as examples, flexing, stretching, rolling, twisting, and bending machines. You may wish to increase the stress during testing to the breaking point, to determine the limits of the components. And you may wish to use equipment that allows you to test twisting, for example, without tension to better understand how the component reacts to different types of stress.
- The machines should provide the capability of simultaneously making measurements of resistance, temperature, tension, capacitance, etc., of the components as they are undergoing testing in order to provide information that can be used for worst-case design.
- YUASA SYSTEMS is marking its twenty-fifth anniversary by reaffirming its US tailored support programs available to all innovators from academia, government, corporations, and start-ups by making available, on a permanent basis, its cutting-edge flexible hybrid electronics solutions at NextFlex in San Jose, California.

Speakers (as advertised)

Eisuke Tsuyuzaki

- San Francisco Bay Area, California
- BSc: Sophia, UCLA, Stanford
- GM, Yuasa Americas
- Founder, Nikkei Ventures
- Ex-CTO, Panasonic
- Ex-SVP, Sony



Dr. Robert Hopkins

- North Palm Beach, Florida
- BSEE: Purdue; PhD: Rutgers
- Senior Advisor, Yuasa Systems Co. Ltd
- EX-SVP & GM, Sony Pictures
- Ex-Executive Director, ATSC
- EX-GM, RCA



Overview

- Opportunity (what) (Tsuyuzaki)
- Generic Testing Methods (why & how) (Hopkins)
- Execution & Support (who) (Tsuyuzaki)
- Q&A (Both)

Just recently...

- Record attendance
- Record exhibit space
- Record # companies
- Record # start-ups



CES 2019

Consumer
Technology
Association™

LAS VEGAS

JANUARY 08 - 11, 2019





Opportunities

FLEXIBLE HYBRID ELECTRONICS

- OLED Displays in Smartphones, Tablets, Automobiles
- Multiple Sensors and Wearable devices (with AI)
- IoT Components & Devices (SmartHome devices & systems)
- Flexible Batteries (Consumer & Industrial applications)
- RFID and Smart Retail
- New & EV Automobile Components

A New World

Experiences from three separate but intertwined industries
Working towards New applications and New approaches

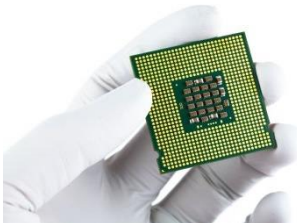
Semis

Nano scale

Probe

Conductivity

Clean room



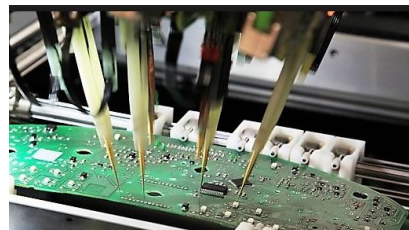
PCB

Rigid board

Conductivity

Visual Inspection

Probe



Display

Large

Mass production

Long-lasting

Materials



We Can Do It!





FOLD / FLEX



STRETCH



BEND



TWIST



ROLL

New Testing Functions

Technical portion of presentation

Dr. Robert Hopkins

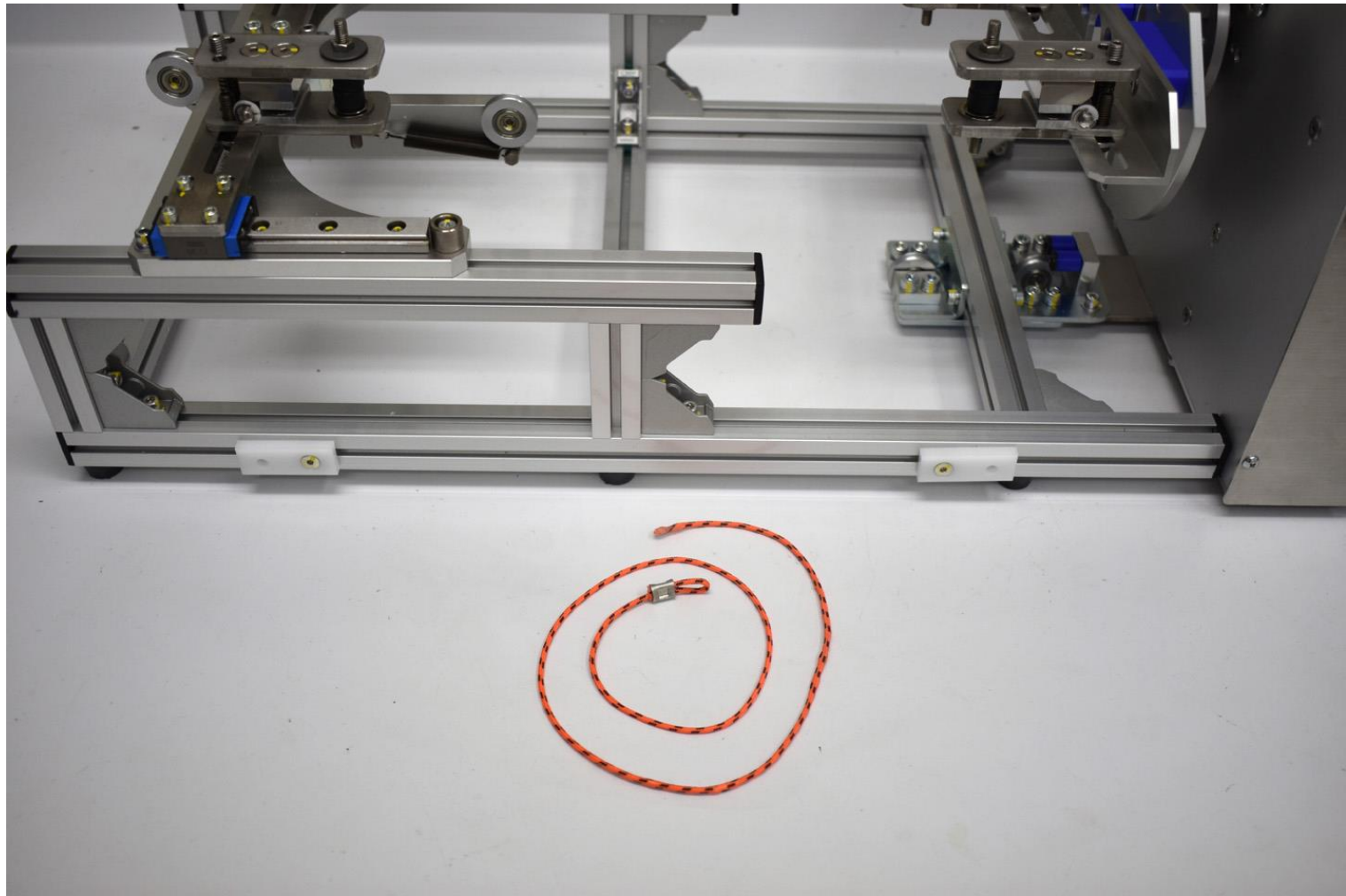
Senior Advisor, YUASA SYSTEMS

New Testing Functions

- **Flexing** (Folding)
- **Stretching**
- **Twisting** (Washability)
- **Rolling**
- **Bending**

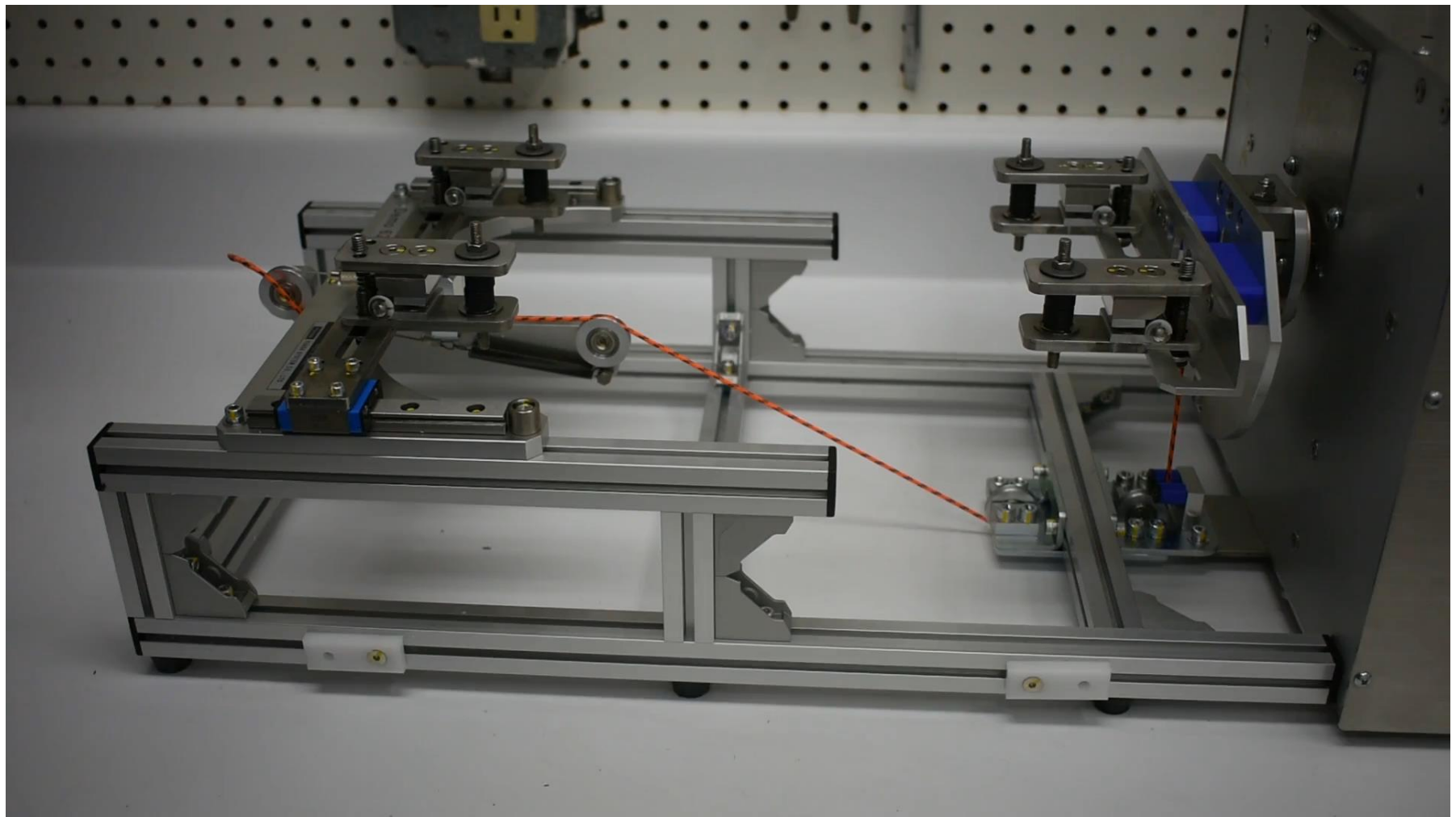
Topics

- **Types of Flexing Machines**
- **Tension-Free Machines**
- **Measurements**
- **Environmental Chambers**
- **FHE Failure Modes**



You can't push with a string

But you can pull

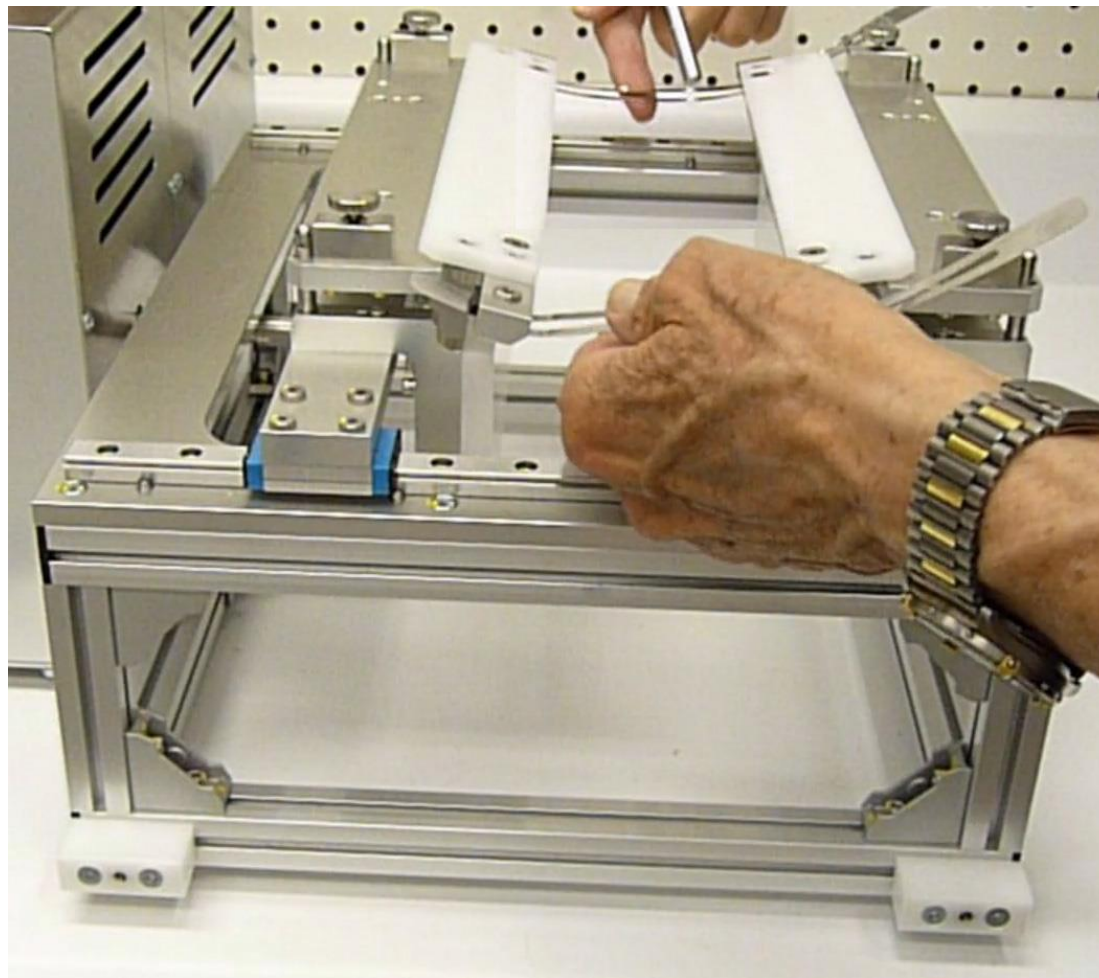


Tension-Free Twisting

As the twisting clamp rotates the String pulls the fixed clamp closer to the twisting clamp

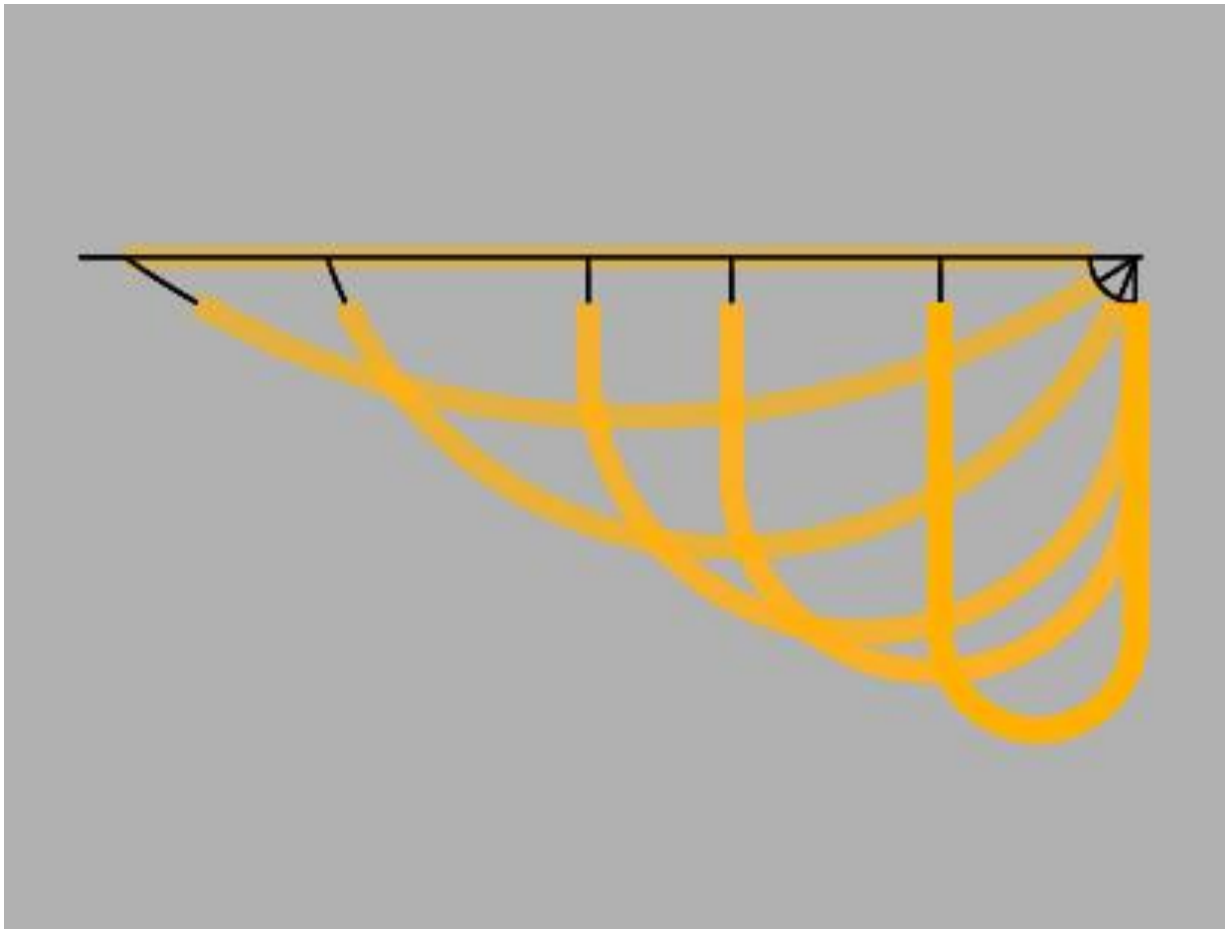


Twisting in action

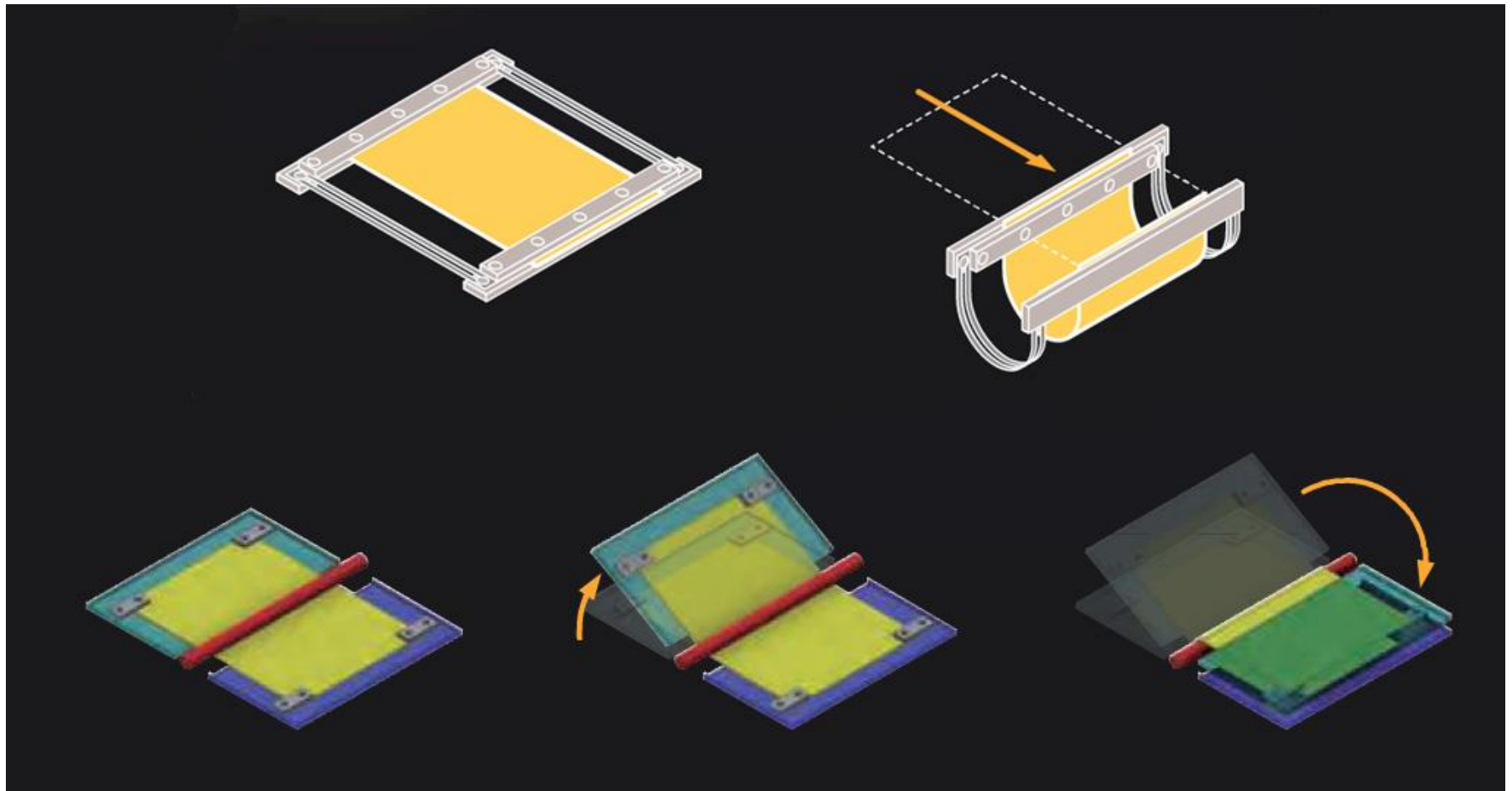


Tension-Free Flexing

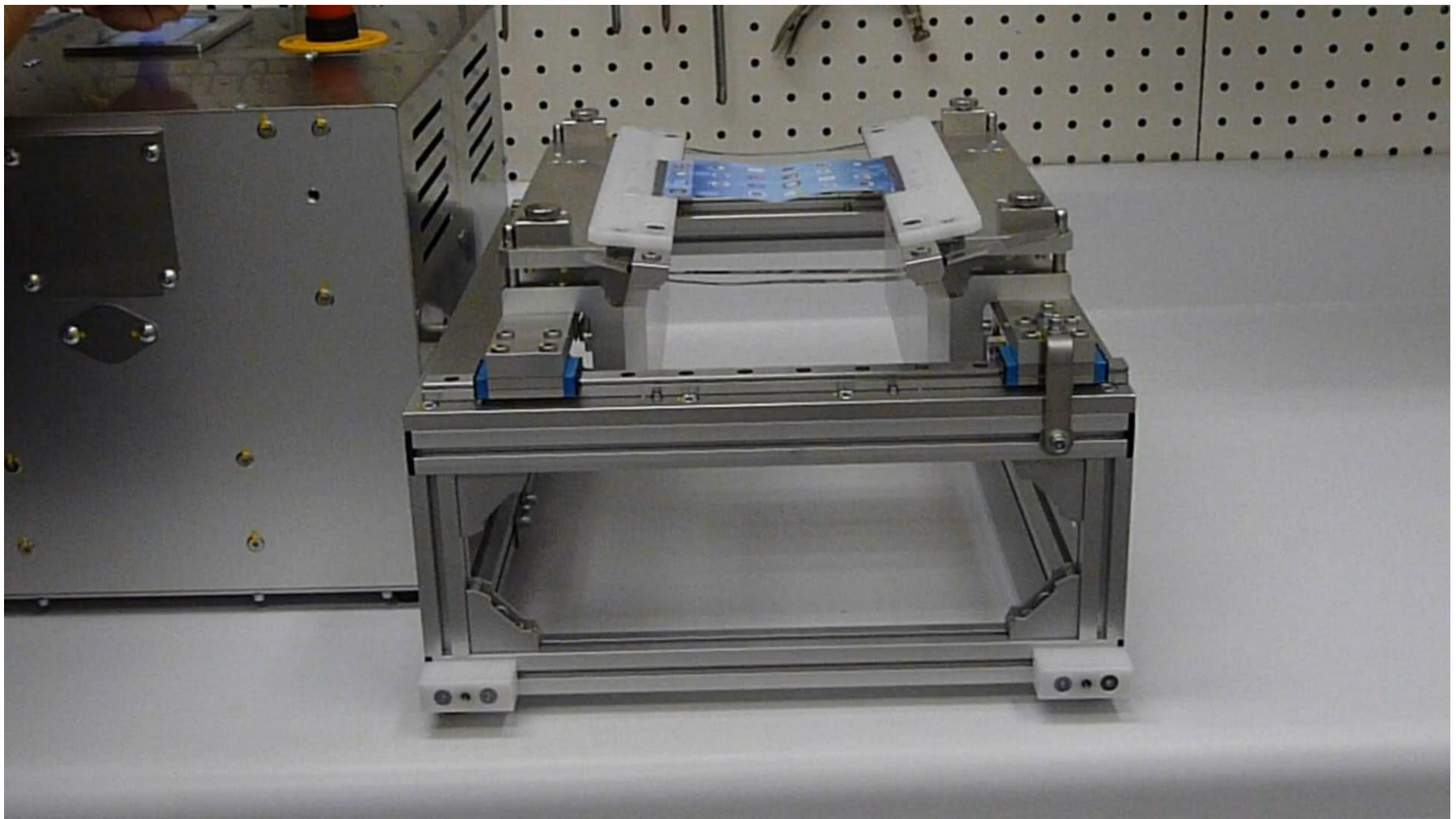
**Tilt Controllers absorb the tension so the flexing can proceed
Tension-Free**



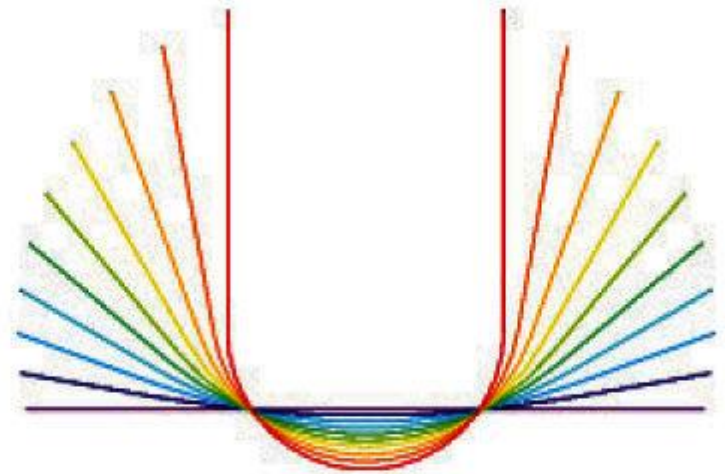
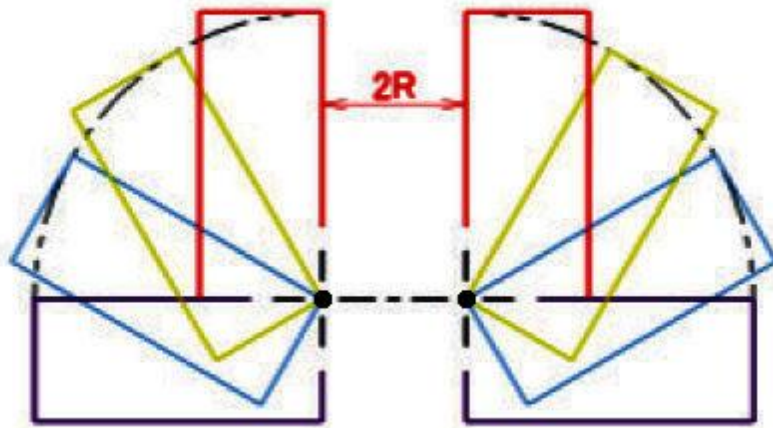
Movement of sample during Butterfly flexing



Butterfly Tension-Free Flexing
VS
Folding around a Rod

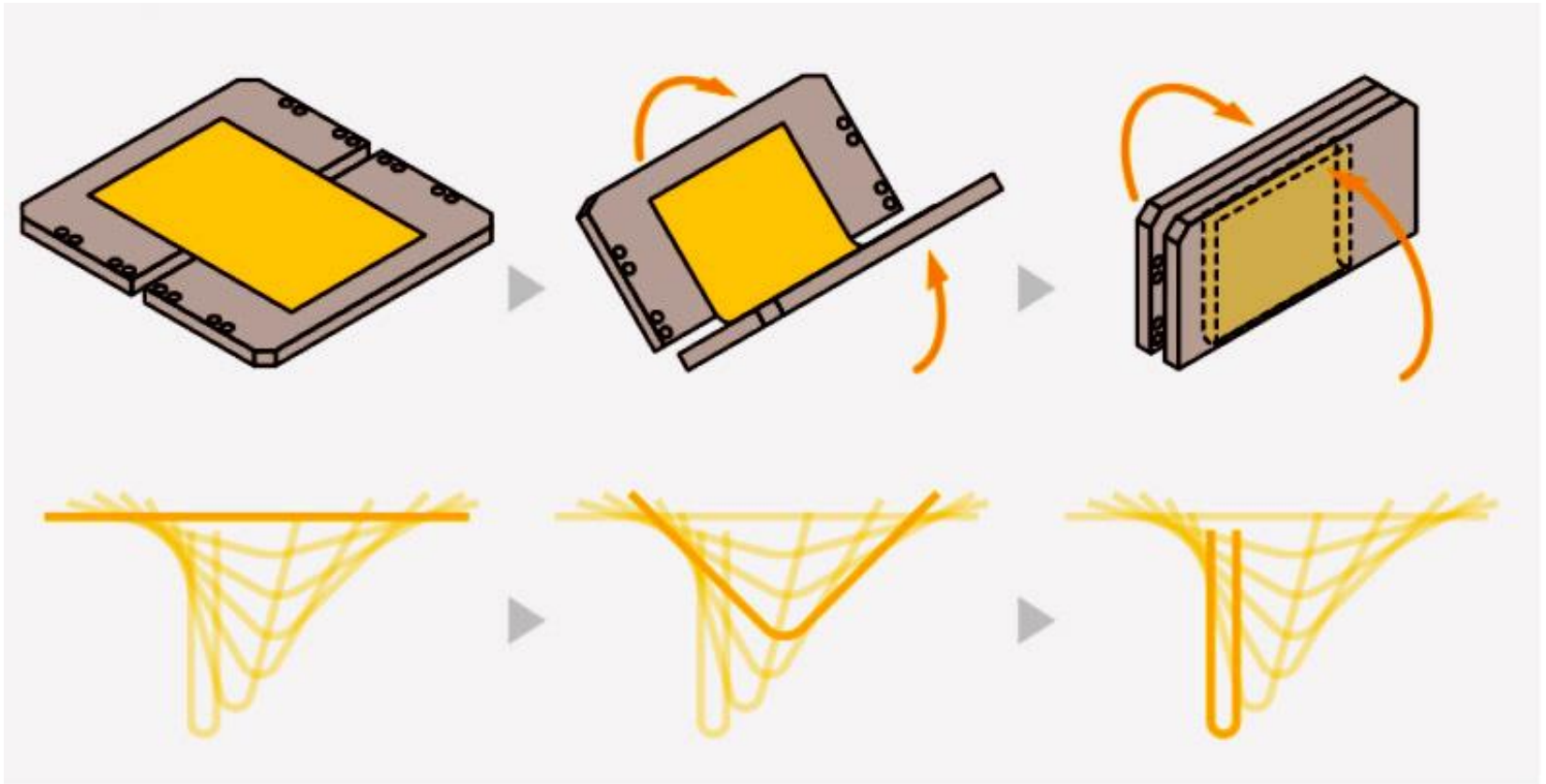


Butterfly flexing in action



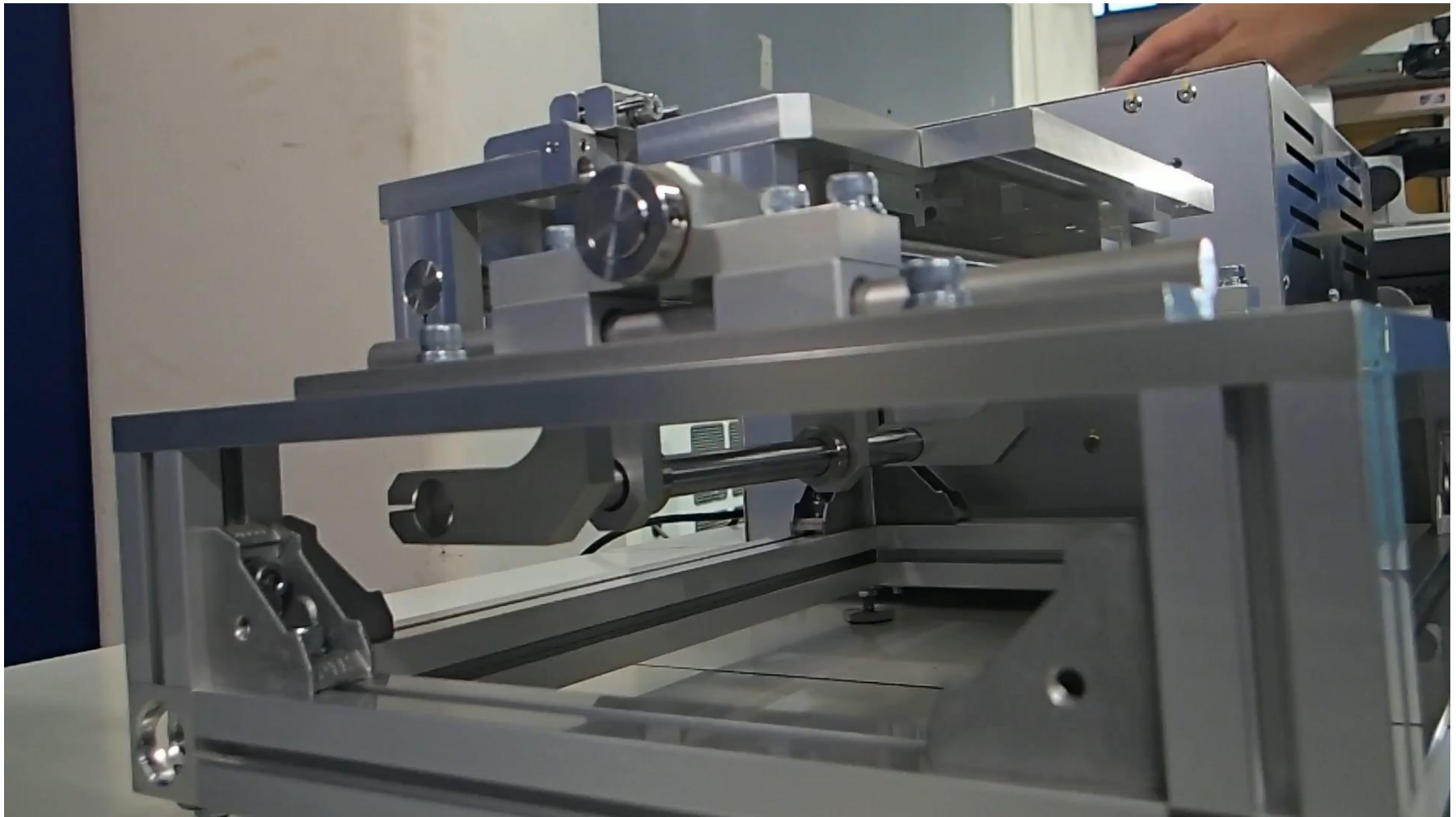
Clamshell Tension-Free Double Hinge

The holding plates rotate centered on the edges of the holding plates so the sample maintains a constant radius



Clamshell Tension-Free Double Hinge

As the holding plates rotate the sample is flexed with a constant radius



▶ **Clamshell Tension-Free Double Hinge**

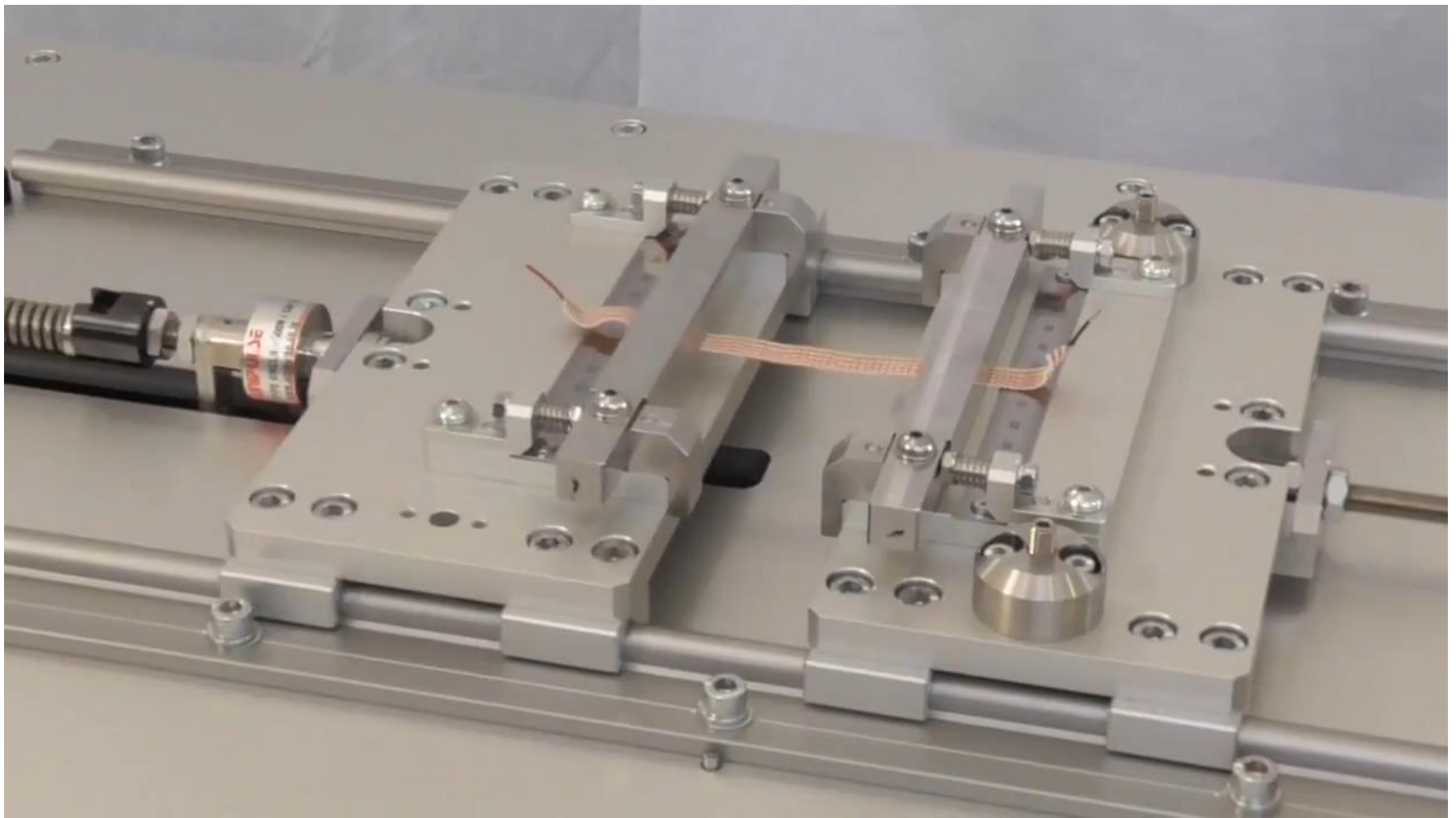
Hinges are kept the same distance apart as the holding plates rotate



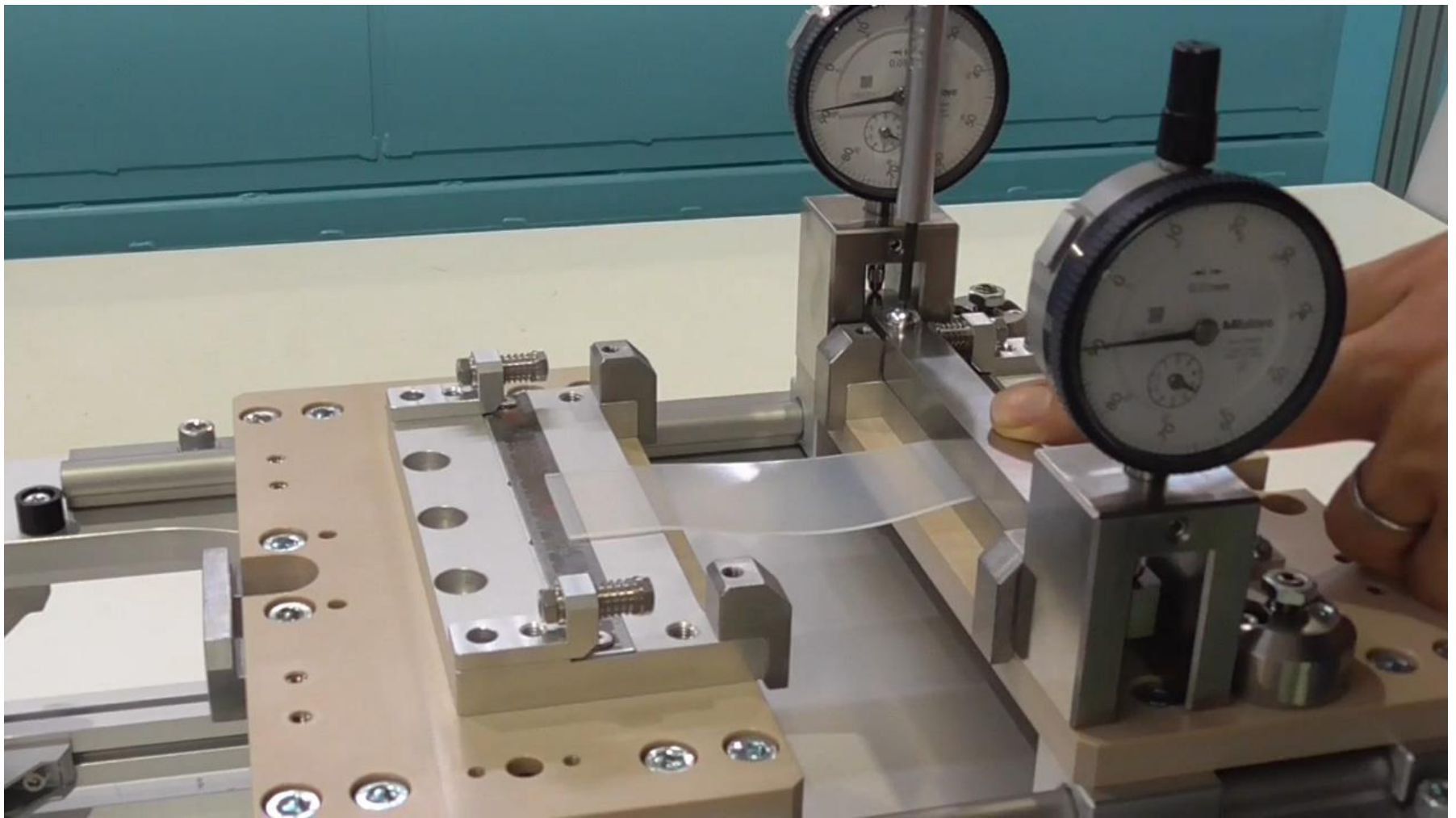
Clamshell in action

Comparison of Butterfly and Clamshell

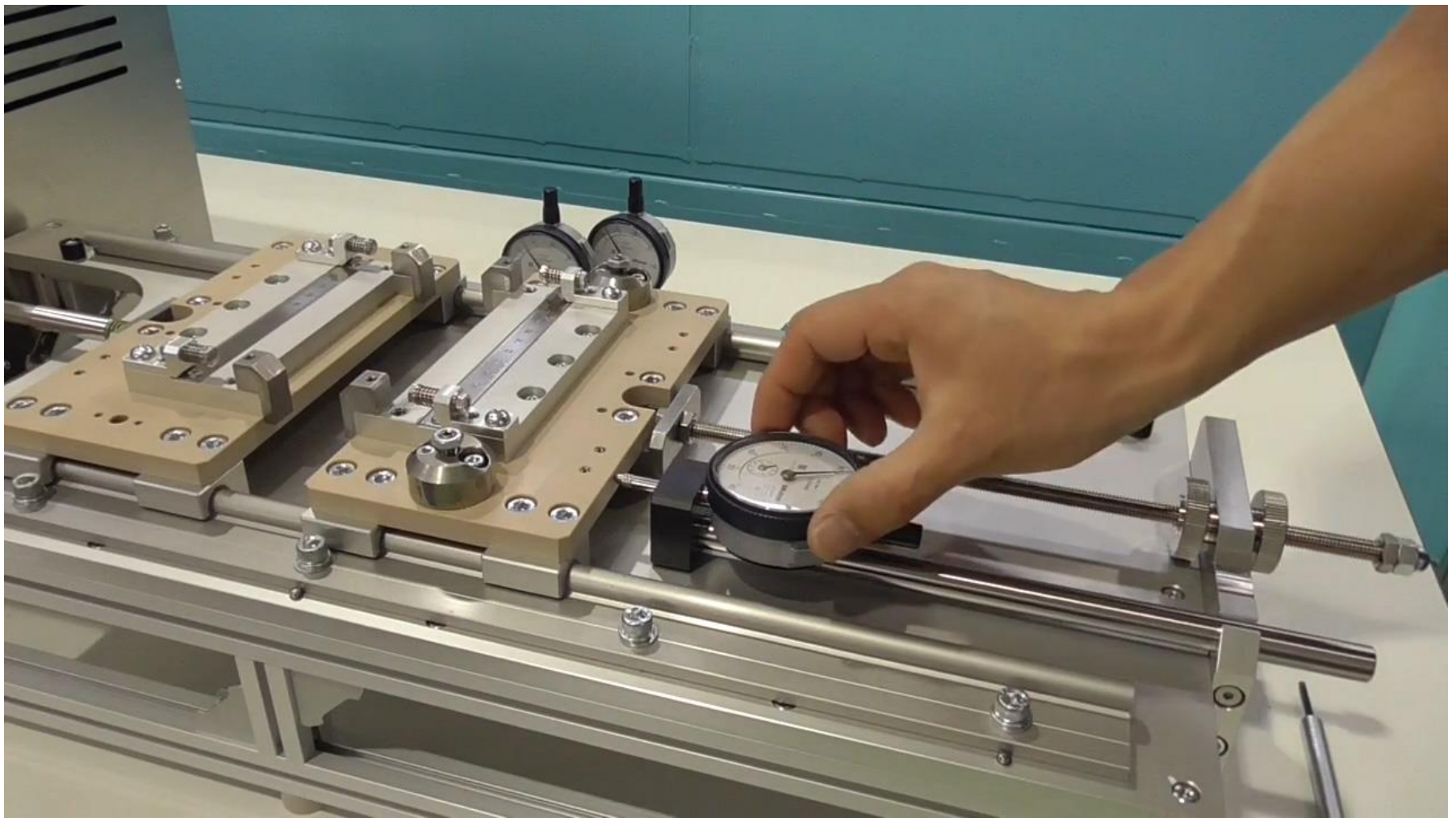
- Clamshell flexes only the center $\pi \cdot R$ portion of sample
- Butterfly flexes entire length of sample
- Clamshell flexes at any angle up to 180°
- Butterfly flexes only at to 180°
- Some Butterfly Machines also can be Stretch Machine
- Clamshell accepts shorter samples



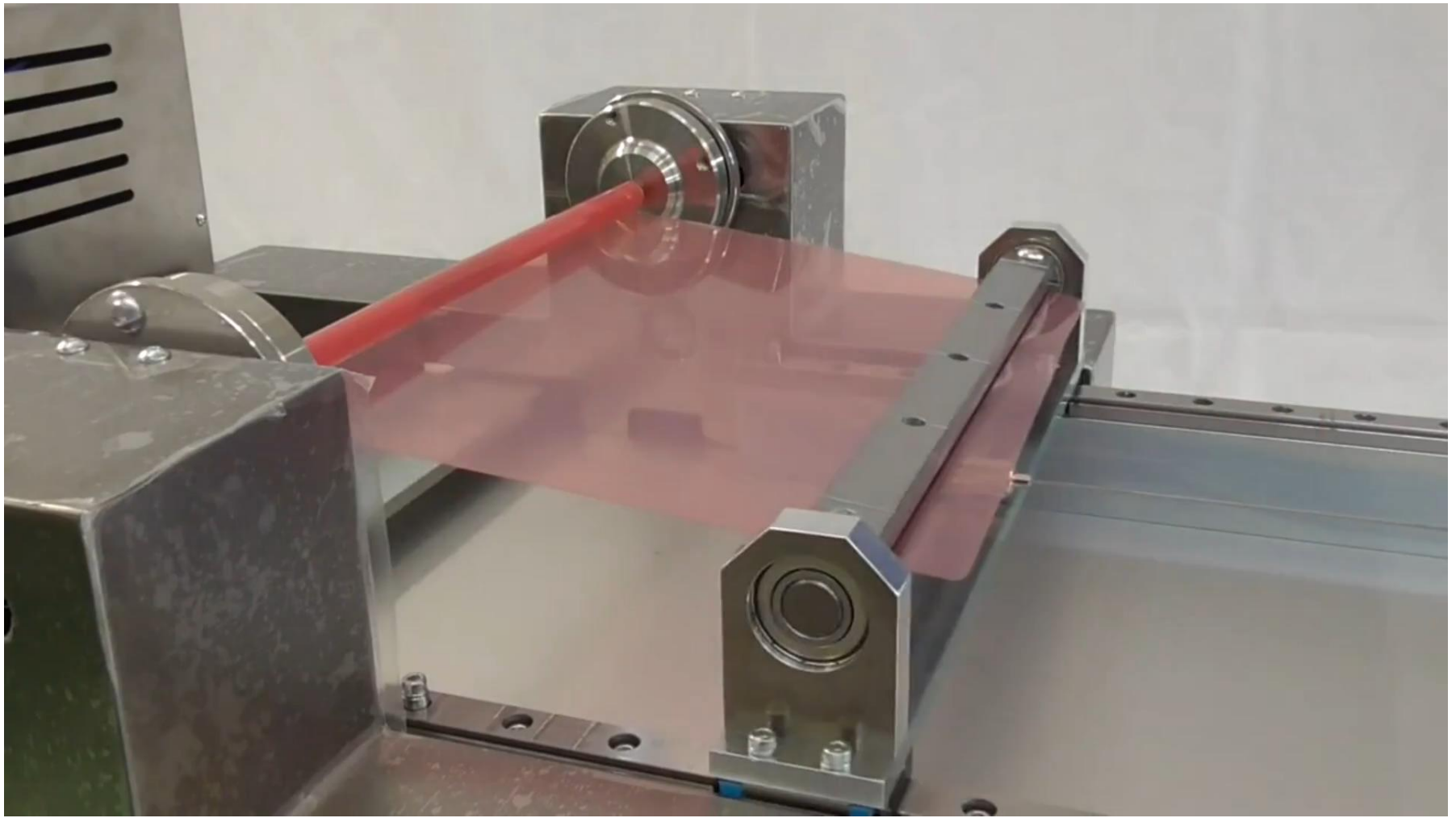
Stretching in action



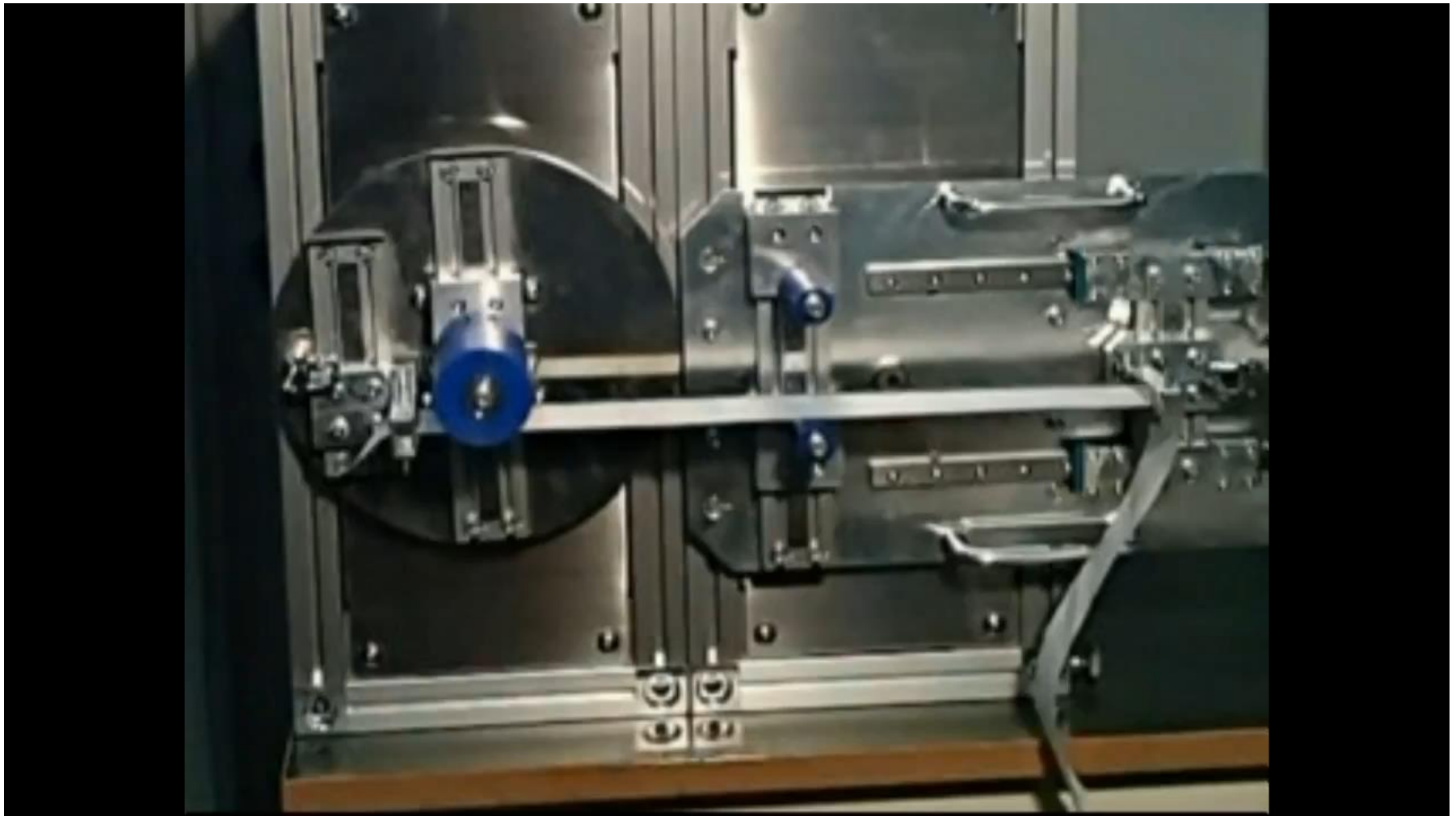
Squashing Gauges



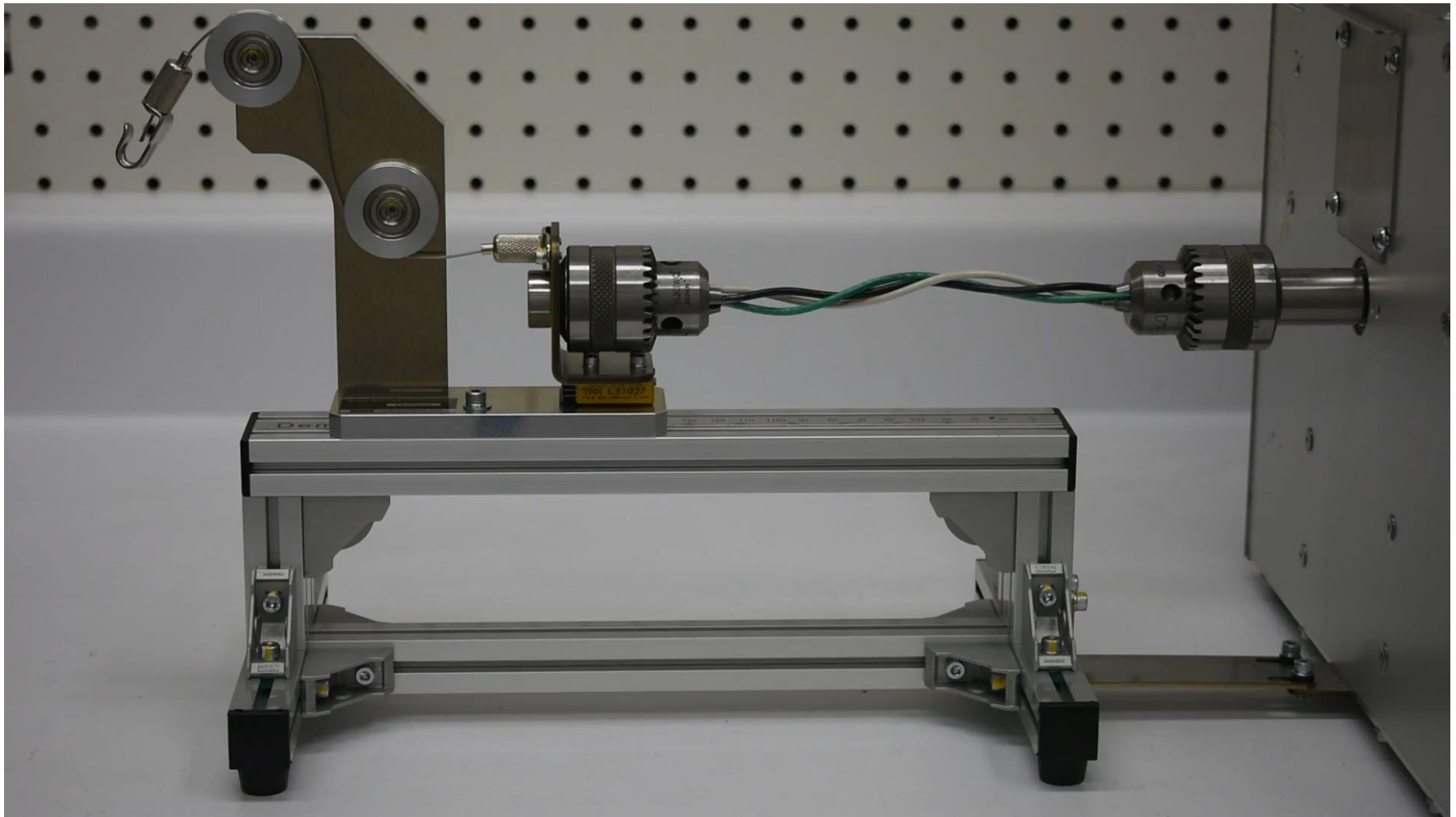
Position Adjuster



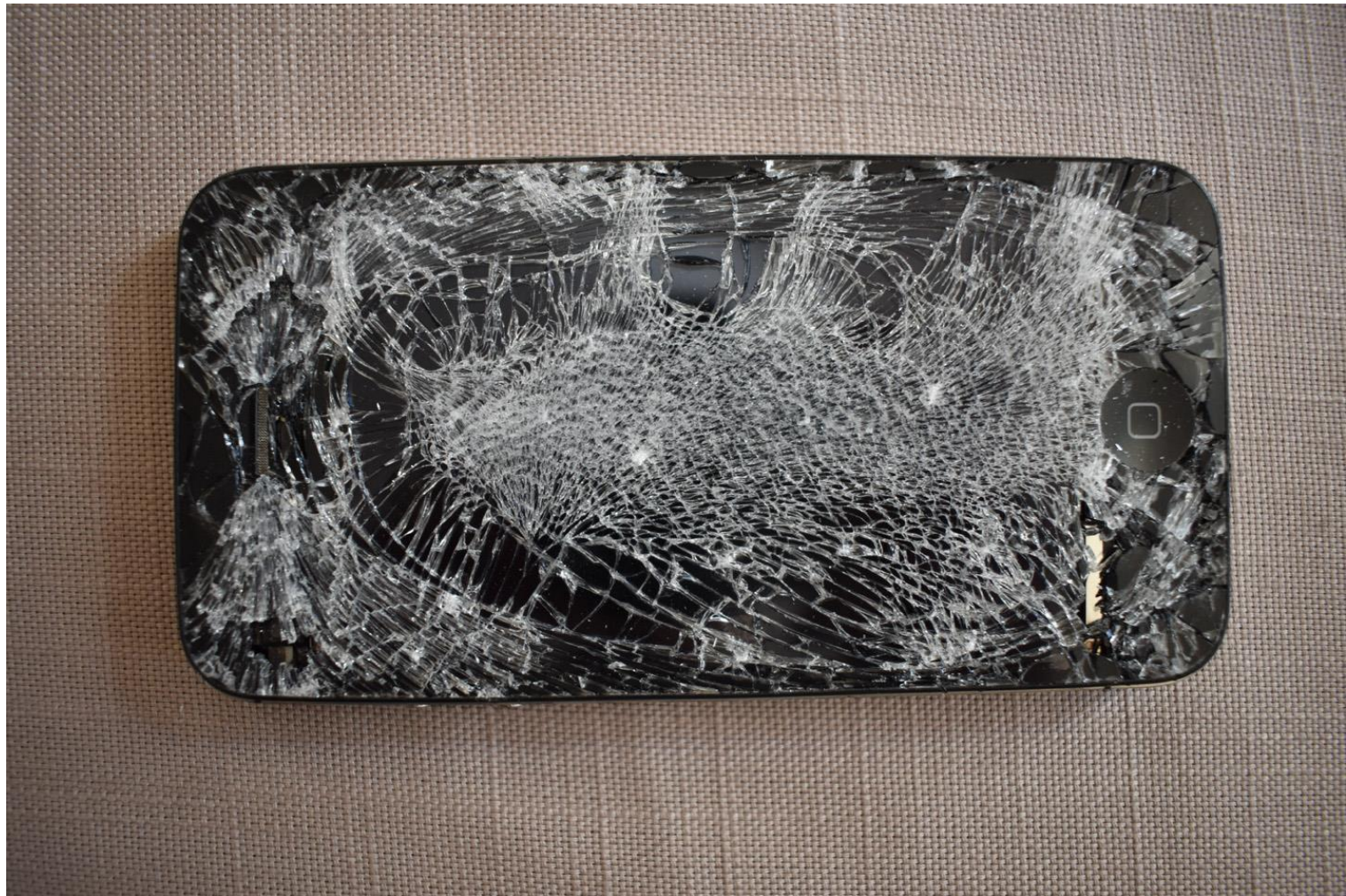
Rolling in action



Tension-Free Bending in action



Linear Sample Twisting in action



Breaking Test – My Smartphone

After it was run over by a truck!

How to Make Measurements

- **Examine sample with a microscope**
- **Removable cartridge made it easier**

- **Measure resistance while testing**
- **Add wires from sample to resistance meter**

- **Measure tension while stretching**
- **Add stress sensor with meter**

- **Measure temperature while testing**
- **Add thermal sensor with meter**



Testing in Environmental Chamber

Test at different temperatures and different humidity

Which Test Machine for FHE Failure Modes

	Butterfly Flex	Clamshell Flex	Twist	Roll	Stretch	Bend
Cracked	XX	XX	XXX	X	XXX	X
Delaminated	XXX	XXX	XXX	X	XX	X
Bent Permanently	XXX	XXX		XXX		X
Stretched Permanently	X*		X		XXX	XX
Torn			XXX		X	

** Some Butterfly test machines also can be configured as a stretch machine*

Summary of Technical Portion

- **We have looked at Tension-Free Twisting Machines**
- **And Tension-Free Flexing Machines**
- **Two different styles of Flexing Test Machines**
 - **Butterfly Flexing (U-shape)**
 - **Clamshell Flexing (two axes)**
- **Machines that can:**
 - **Stretch**
 - **Rollup**
 - **Bend**
- **Measuring the effects of the stress during testing**
- **Environmental chambers to enhance testing**
- **Test Machines most likely to show different failure modes**

Problems

Solution: NextFlex



Engineers make their own custom rigs for testing



Not based upon emerging or defacto standards



Consistency at scale; Global R&D collaboration



Efficiencies at scale; Vendors and Mass Manufacturing



Need to build-in lasting quality

About Yuasa System

- **Established 1941**
- **25 Years in Endurance Testing Systems**
- **Office in San Francisco Bay Area**
- **US technical support**

- **Field proven technology with established reliability in high demand Consumer Electronics and Auto Industry working with leading manufacturers**



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YUASA YUASA SYSTEM CO., LTD.

Step 1
PICK MOTOR DRIVE



5 types

Step 2
SELECT JIG



30 types



**Option
Chamber ?**

Step 3
ELECT MEASURE



2 types

Modular Configuration

SOLUTIONS FOR MATERIALS

- **[FOLD] Tension Free U-shape folding test (DLDMLH-FS)(FS-C)**

**YUASA DLDMLH-FS Test Jig + YUASA Small Drive Unit
for planar test pieces**

<https://www.yuasa-system.jp/en/test/fold03>

DLDMLH-FS

Tension Free
U-shape Folding Test



- **[BEND] Bending Test (with 150mm radius faceplate)**

**YUASA TCDMLH-P150 Test Jig + YUASA Small Drive Unit
JIS C3005, C6851, C9335, C5016 standards for linear &
planar pieces**

<https://www.yuasa-system.jp/en/test/bend01>

TCDMLH-P150

Bending Test
(ϕ 150 Faceplate)



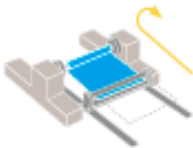
- **[ROLL-UP] Rolling Test**

**YUASA DLDMLH-FR + YUASA Small Drive Unit
IEC-62715 and JEITA ET-4501 standards for planar test**

<https://www.yuasa-system.jp/en/test/rollup01>

DLDMLH-FR

Rolling Test
for Planar Object



SOLUTIONS FOR DEVICES

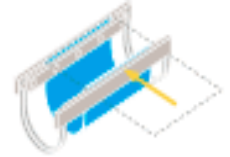
- **[FOLD] Tension Free U-shape folding test (DLDMLH-FS)**

**YUASA DLDMLH-FS Test Jig + YUASA Small Drive Unit
for planar test pieces**

<https://www.yuasa-system.jp/en/test/fold03>

DLDMLH-FS

Tension Free
U-shape Folding Test



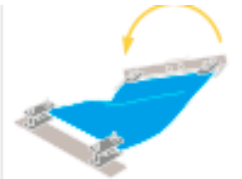
- **[TWIST] Torsion test for Planar objects (TCDMLH-FT)**

**YUASA TCDMLH Test Jig + YUASA Small Drive Unit
IEC-62715 & JEITA ET-4501 standards for planar test pieces**

<https://www.yuasa-system.jp/en/test/twist02>

TCDMLH-FT

Torsion Test
for Planar Object



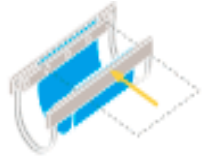
SOLUTIONS FOR MANUFACTURING

- **[FOLD] Tension Free U-shape folding test (DLDMFH-FS)**
YUASA DLDMFH-FS Test Jig + YUASA Small Drive Unit
for planar test pieces

<https://www.yuasa-system.jp/en/test/fold03>

DLDMFH-FS

Tension Free
U-shape Folding Test

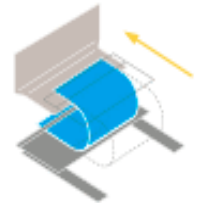


- **[FOLD] U-shape sliding plate test**
YUASA DLDMFH-FU Test Jig + YUASA Small Drive Unit
IEC-62715 & JIS C3663, 6851, 5016 standards for planar
tests

<https://www.yuasa-system.jp/en/test/fold01>

DLDMFH-FU

U-shape Sliding
Plate Test



- **[PUSH] Pushing & Pulling Test**
YUASA DLDMFH-PP + YUASA Small Drive Unit
JIS C4526, C5401, C6065, X6301 standards for switches,
flash memory

<https://www.yuasa-system.jp/en/test/push01>

DLDMFH-PP

Pushing /
Pulling Test



FS

FOLD "Butterfly"



Bending radius: 0 – 180'
Sample size: 224 x 56mm

ST-L

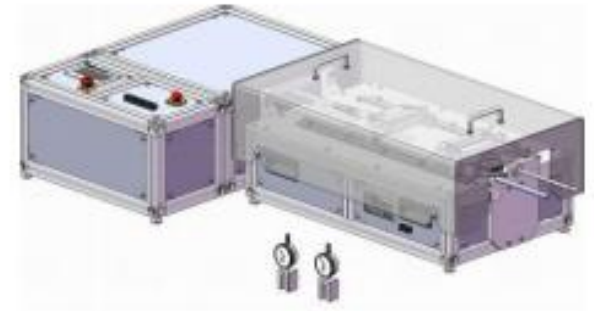
STRETCH



Strength: 1,500N
Sample size: 100mm x 400mm
Stretching: 100mm

ST-N

STRETCH



Strength: 100N
Sample size: 100mm x 240mm
Stretching: 240mm

Showcased Products

NEXT FLEX[®]

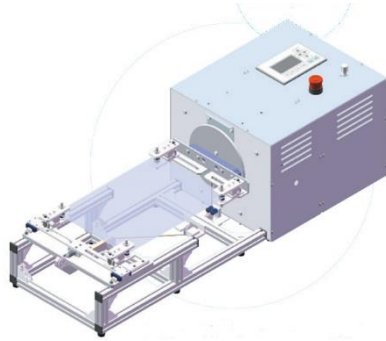
CS

FOLD "Clamshell"



FT

TWIST



P150

BEND



ECP

MEASURE



Academic & Start-Up
Loaner Program

Free Basic
Software

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YUASA YUASA SYSTEM CO., LTD.

YUASA SYSTEMS

GLOBAL LEADER IN
ENDURANCE
TESTING SOLUTIONS

Tension-free
Worry-free
Modular systems

info@yuasa-system.jp

Overview

- Opportunity (what) (Tsuyuzaki)
- Generic Testing Methods (why & how) (Hopkins)
- Execution & Support (who) (Tsuyuzaki)
- **Q&A** (**Both**)

[YUASA 2018 Demo Reel](#)

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