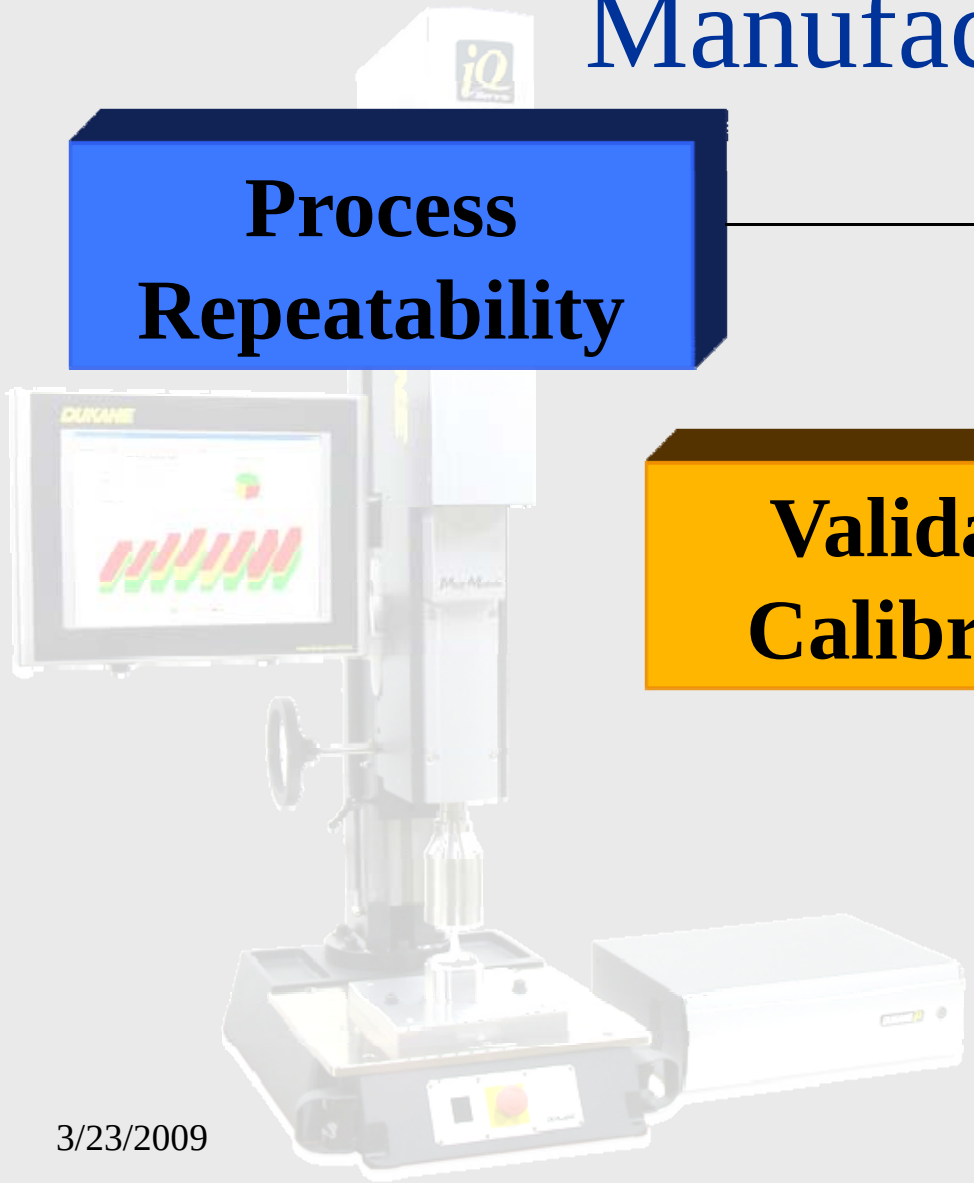
# Latest Advances in *iQ* Series Ultrasonic Systems

*iQ Series*

Leo Klinstein
Dukane Corporation
Intelligent Assembly Solutions
St. Charles, IL 60174
630-797-4950
lklinstein@dukcorp.com

DUKANE

# Challenges facing Medical Device Manufacturing

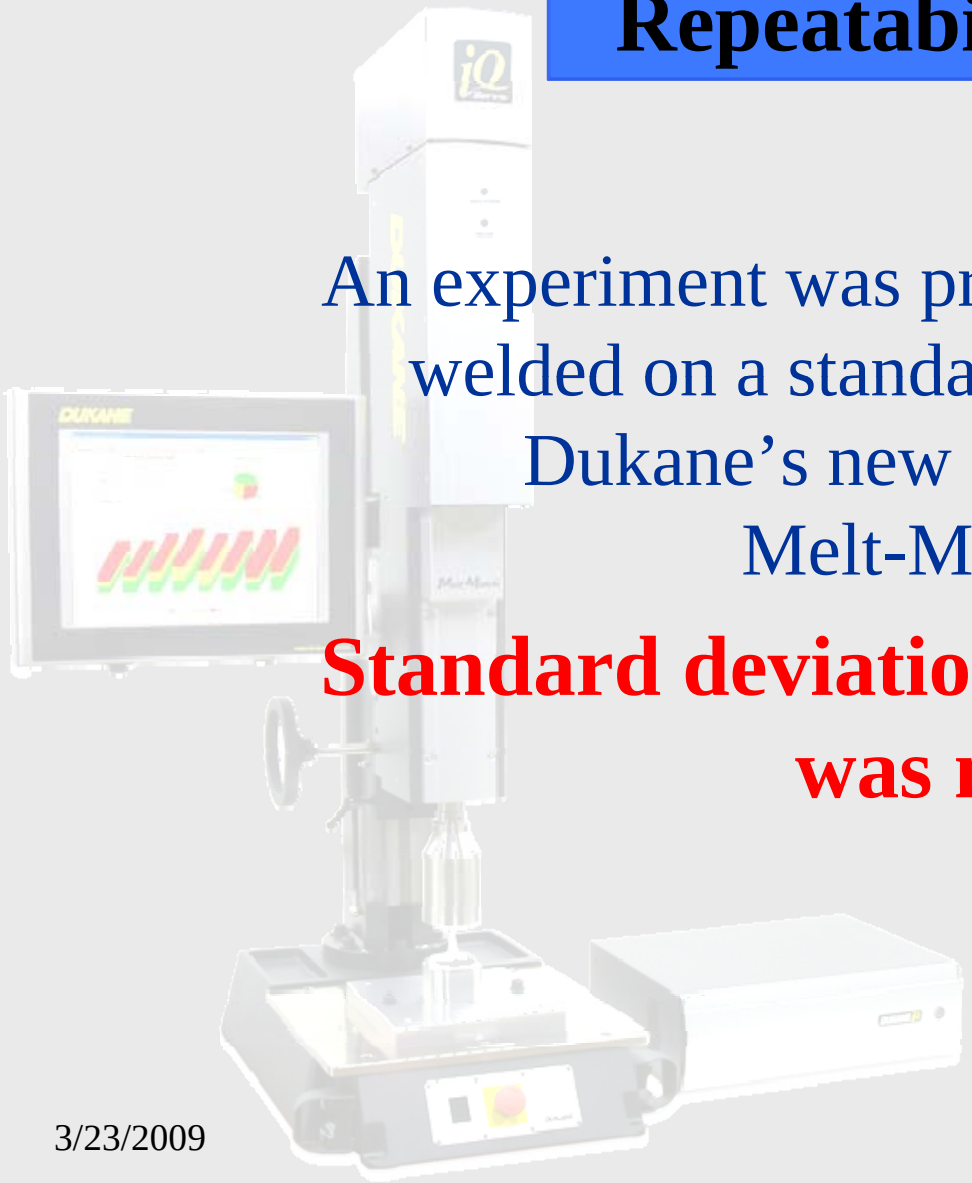


**Process Repeatability**

**Validation Calibration**

**Manufacturing Costs**

# Process Repeatability



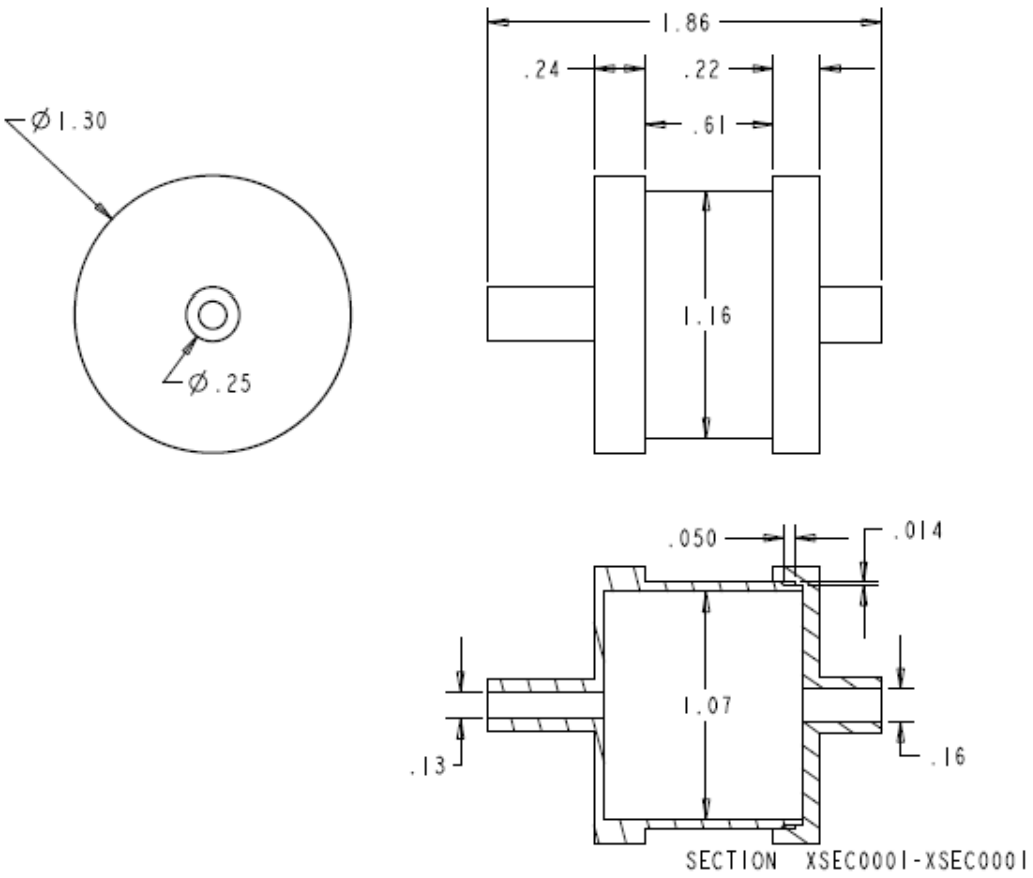
An experiment was preformed comparing parts welded on a standard pneumatic welder and Dukane's new Servo welder with Melt-Match® technology

**Standard deviation of the pull strength was measured.**

# Experiment

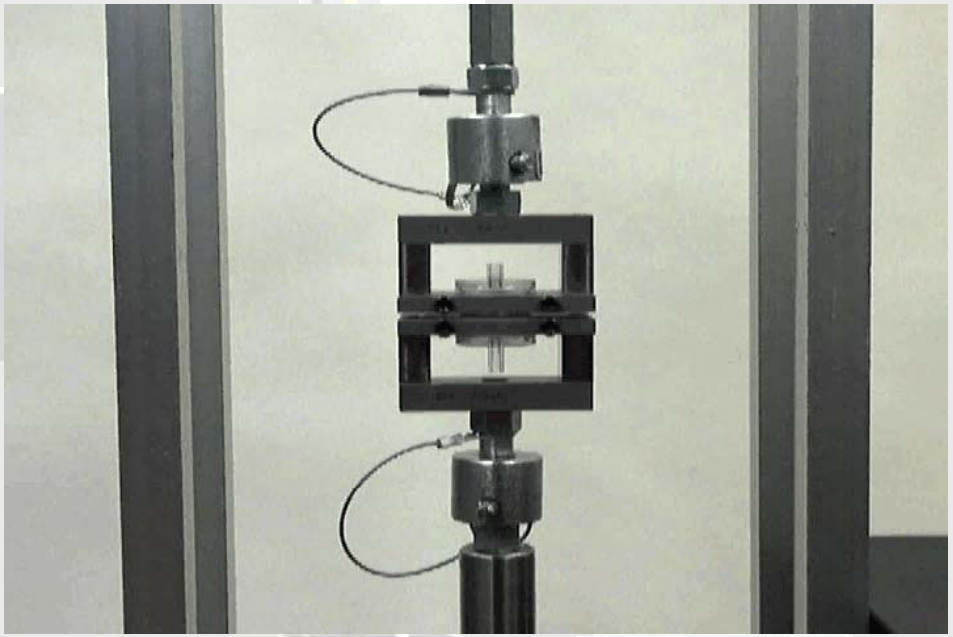
- Typical Poly-carbonate filter housing.
- Provided to Dukane by a major medical device manufacturer.

# Experiment




Common ultrasonic shear joint design.

# Experiment

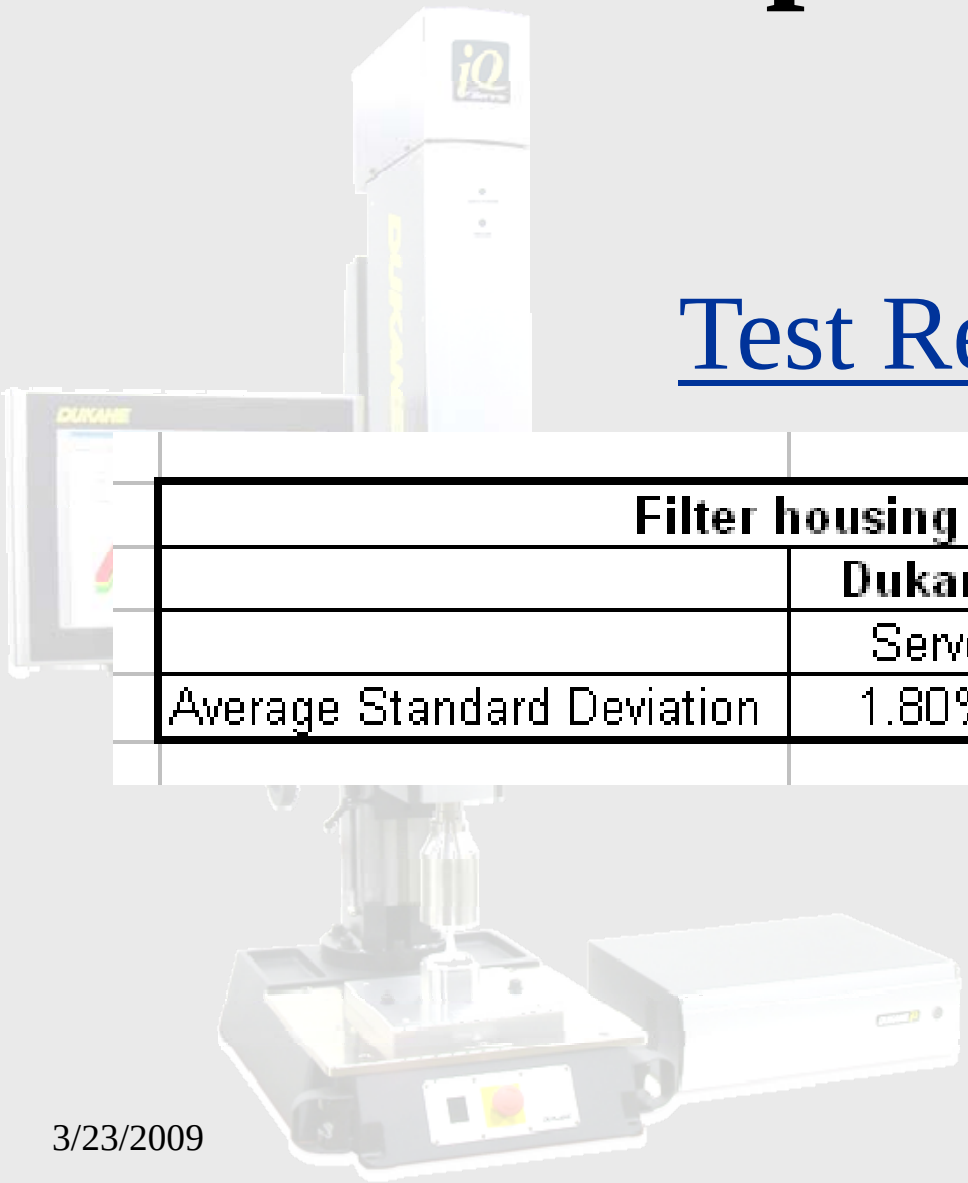


High quality pull test fixture was developed

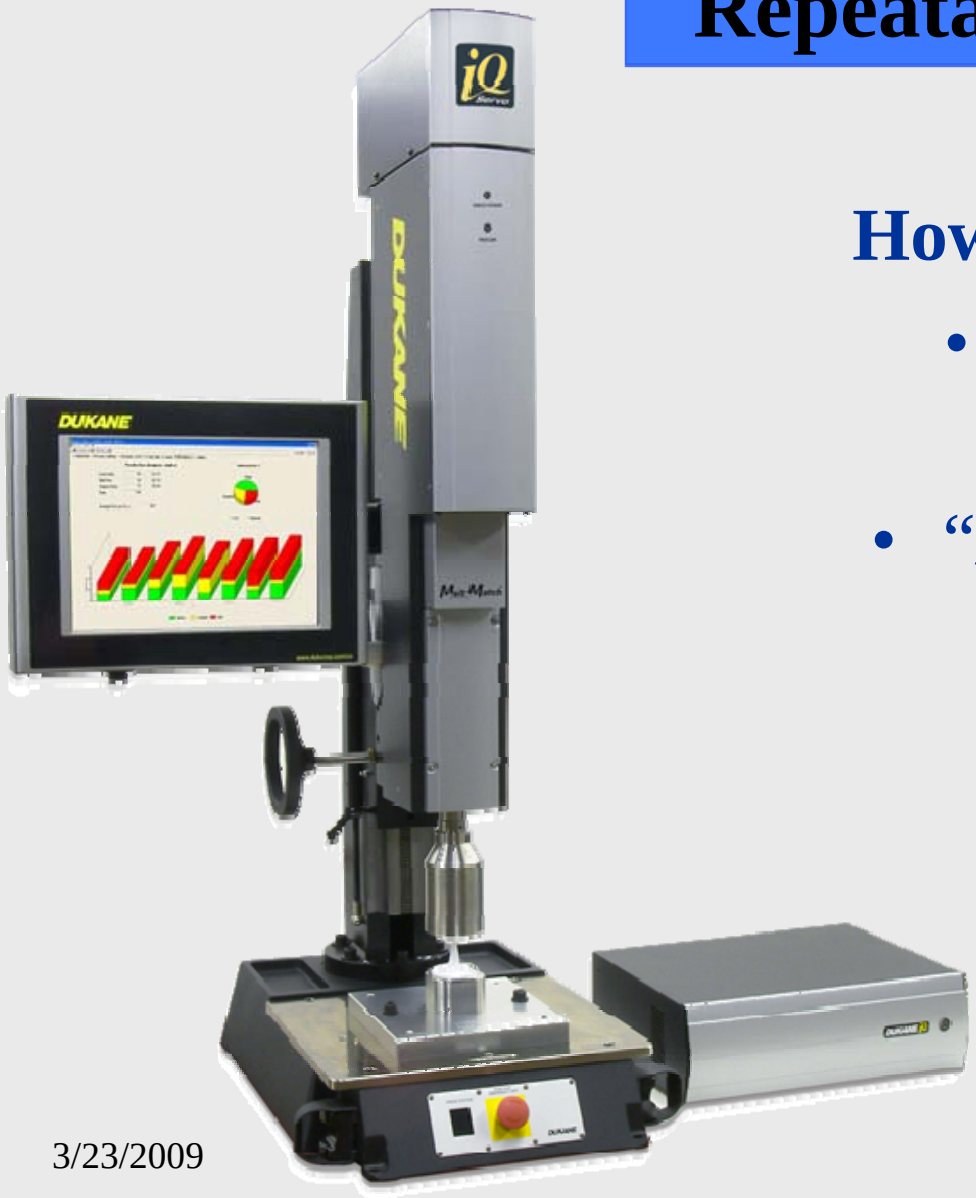
# Experiment

## Test Results

| Filter housing test results | | | |
|---|---|---|---|
| | Dukane | Customer | Customer |
| | Servo | Servo | Pneumatic |
| Average Standard Deviation | 1.80% | 1.90% | 6.60% |

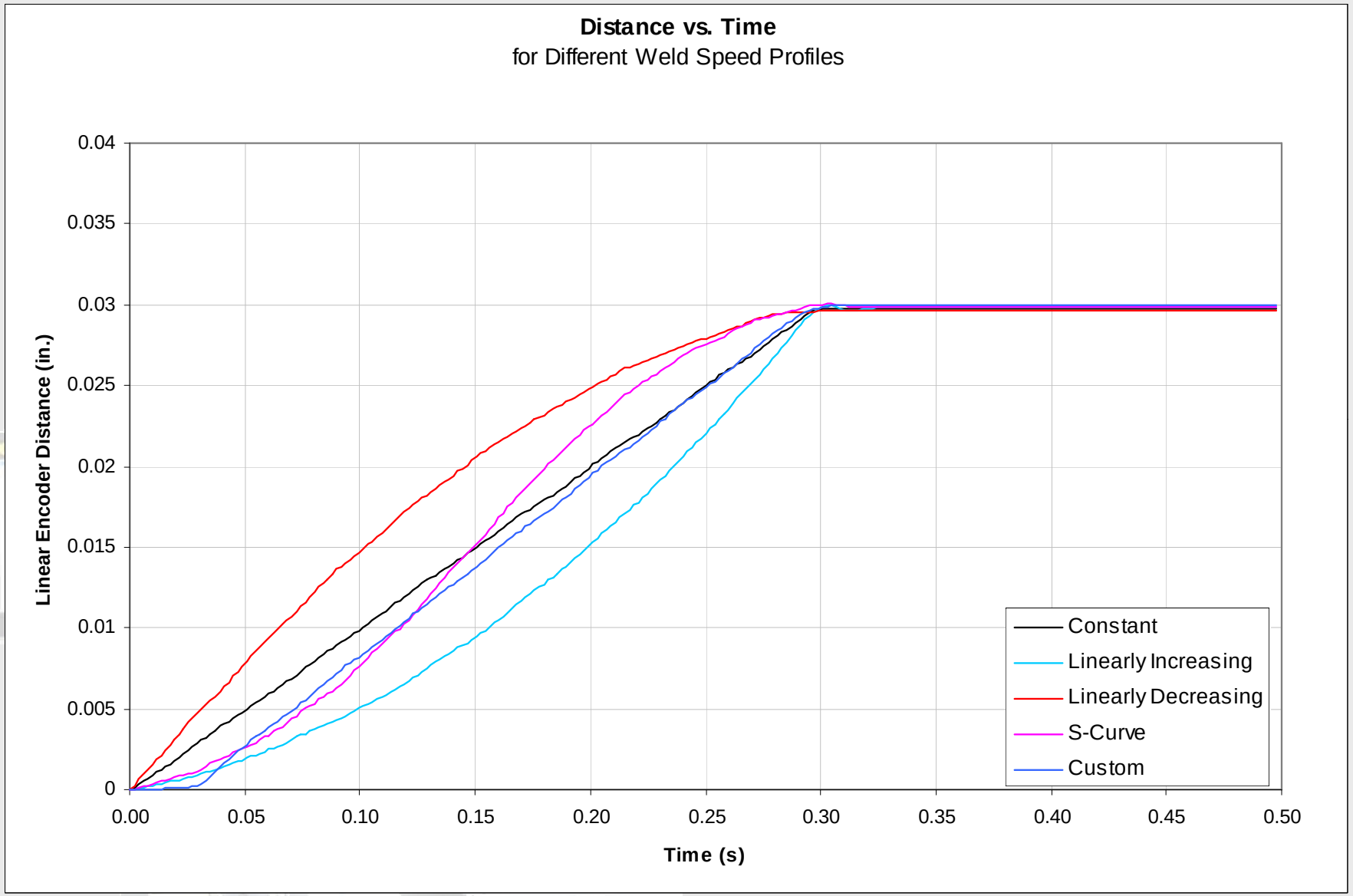


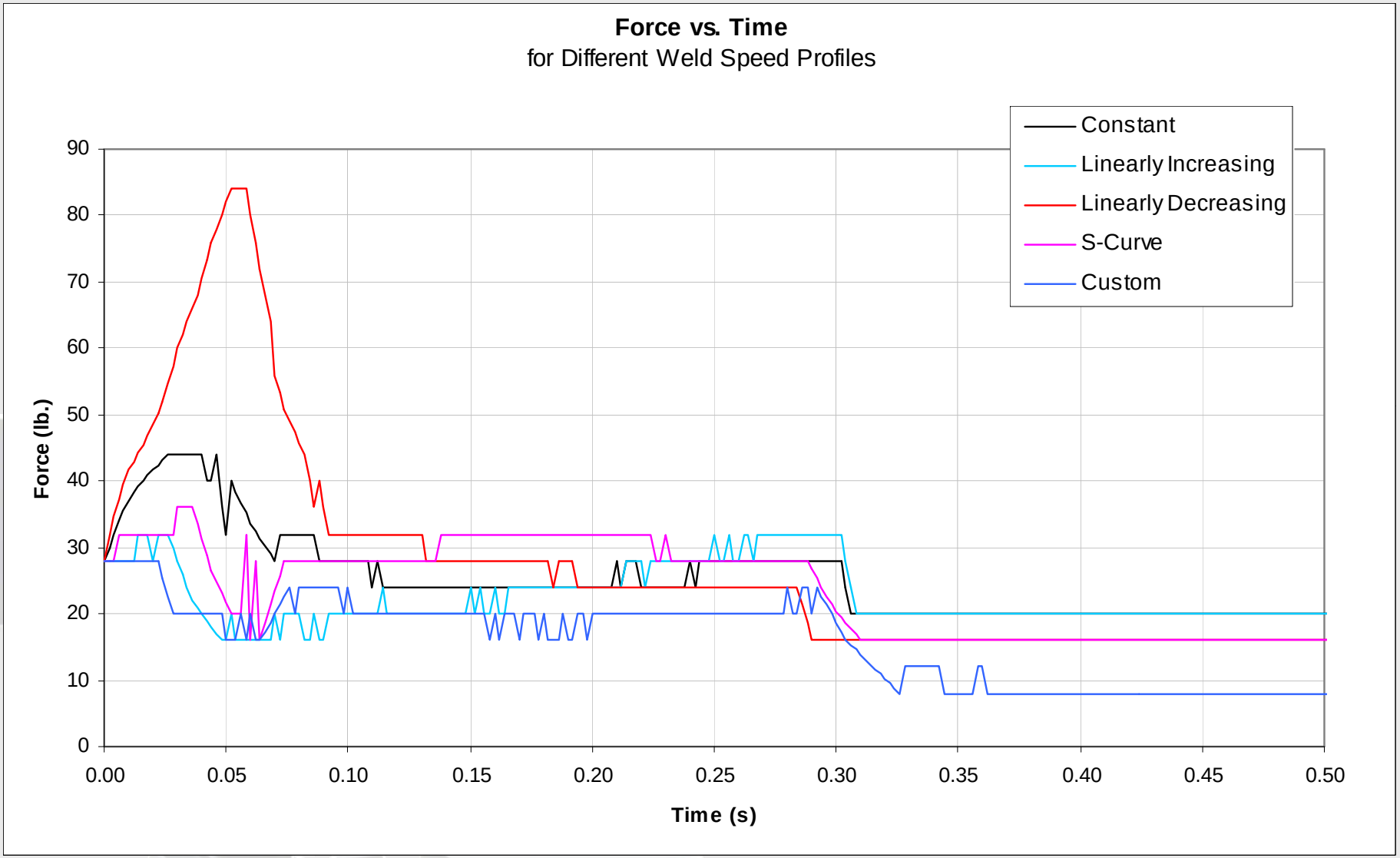
# Process Repeatability

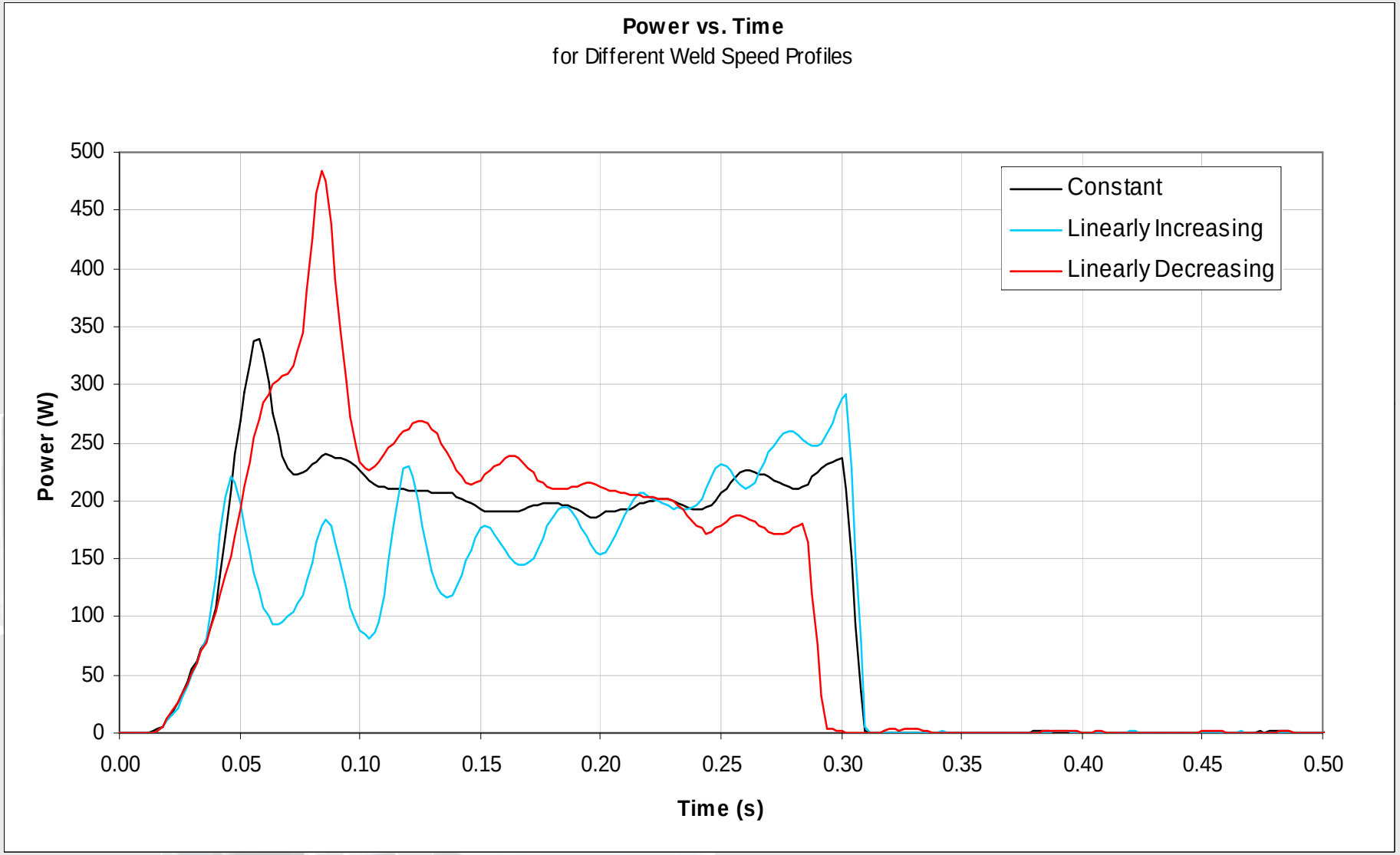



## How does it work?

- Precision control of the collapse speed.
- *"Melt Match® Technology"*


Distance vs. Time
for Different Weld Speed Profiles
Linear Encoder Distance (in.)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Time (s)
Constant
Linearly Increasing
Linearly Decreasing
S-Curve
Custom


Force vs. Time
for Different Weld Speed Profiles
Constant
Linearly Increasing
Linearly Decreasing
S-Curve
Custom
Force (lb.)
Time (s)
0
10
20
30
40
50
60
70
80
90
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50


Power vs. Time
for Different Weld Speed Profiles
Power (W)
Time (s)
Constant
Linearly Increasing
Linearly Decreasing
0
50
100
150
200
250
300
350
400
450
500
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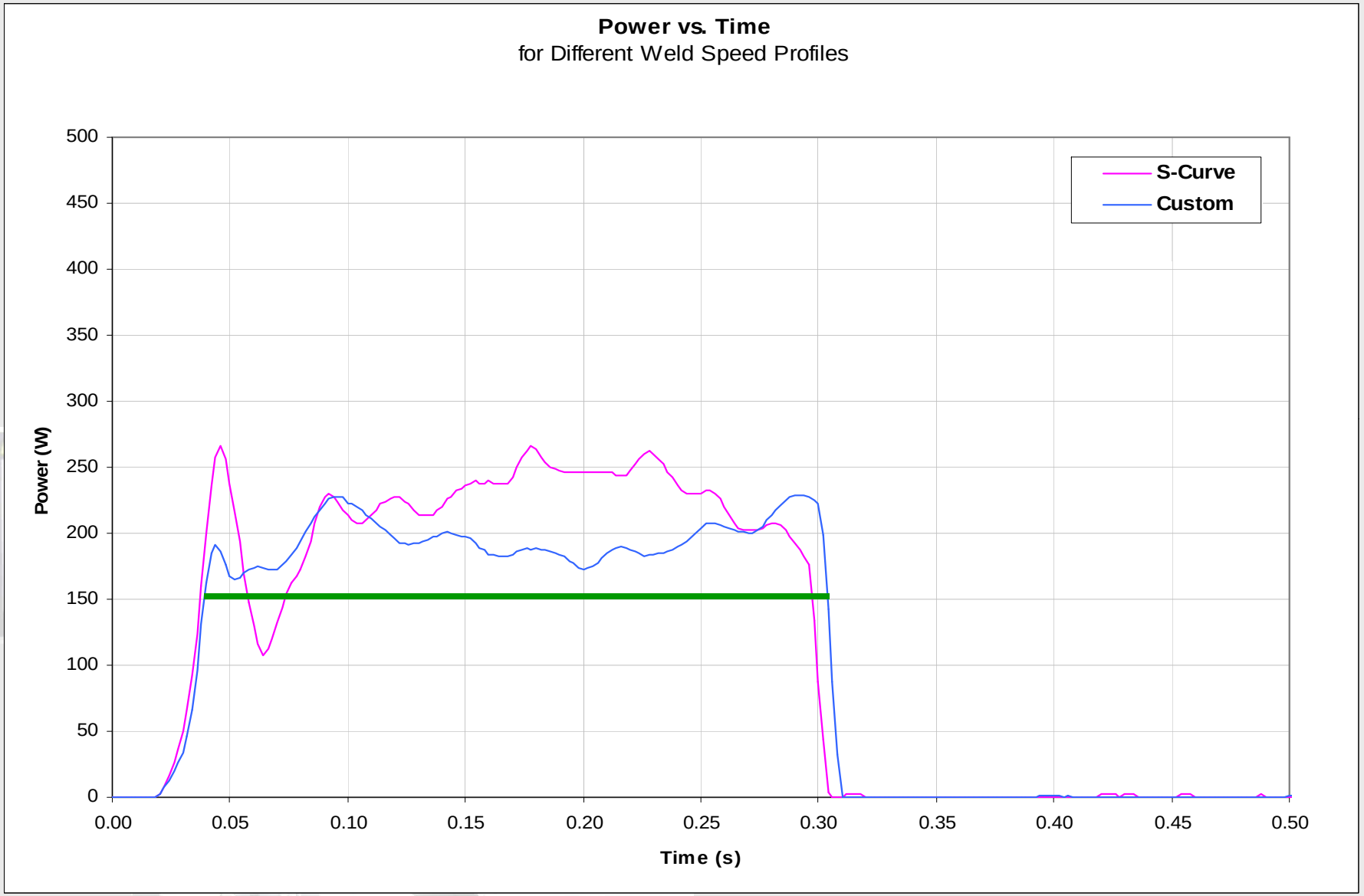
0.45
0.50


Power vs. Time
for Different Weld Speed Profiles
Power (W)
Time (s)
S-Curve
Custom
500
450
400
350
300
250
200
150
100
50
0
0.00
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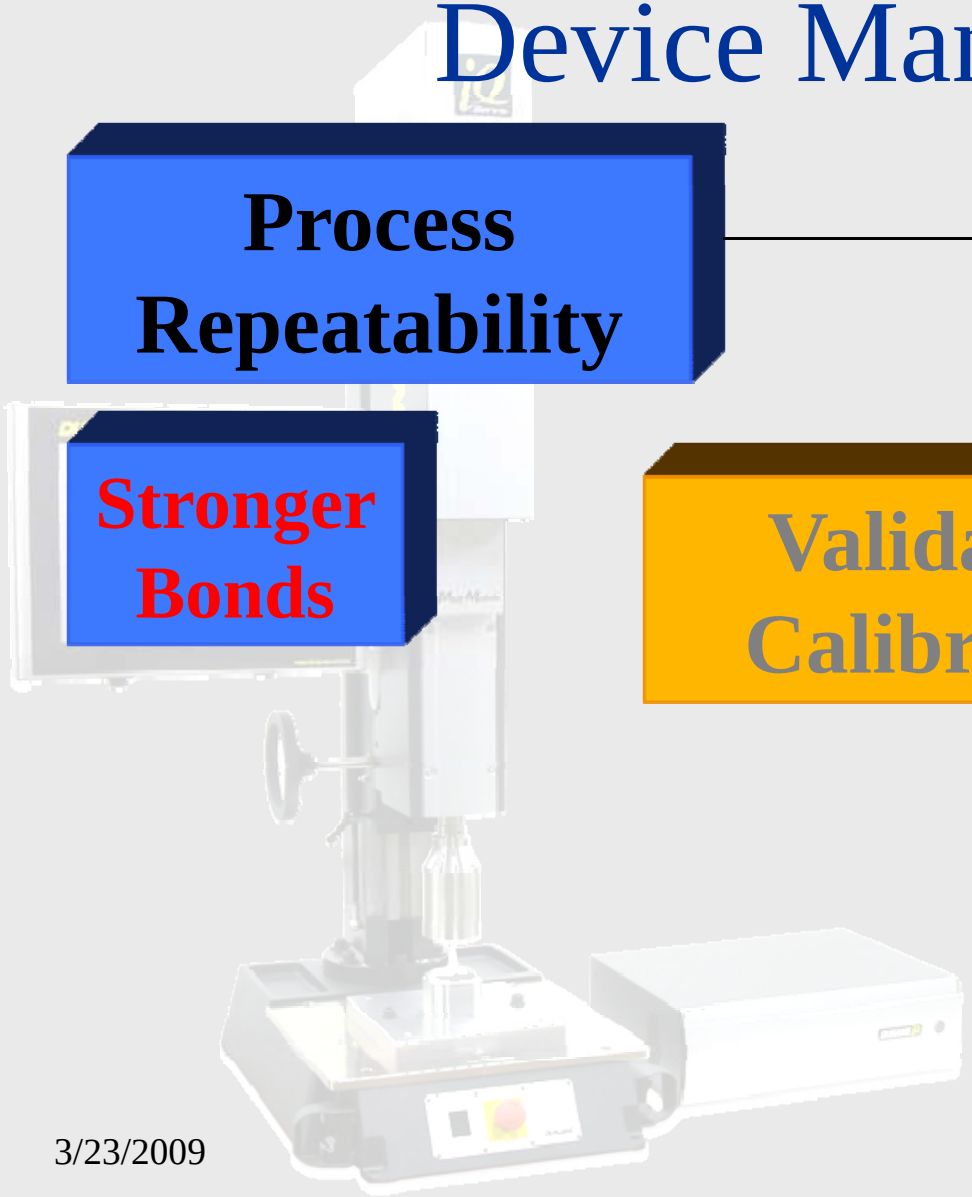
0.40
0.45
0.50

# Challenges facing Medical Device Manufacturing



**Process Repeatability**

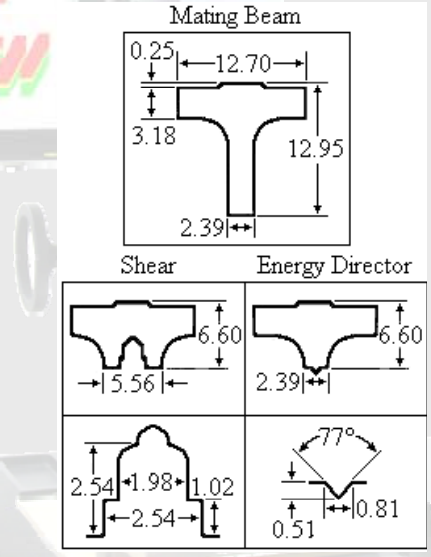
**Stronger Bonds**

**Validation Calibration**

**Manufacturing Costs**

# Stronger Bonds

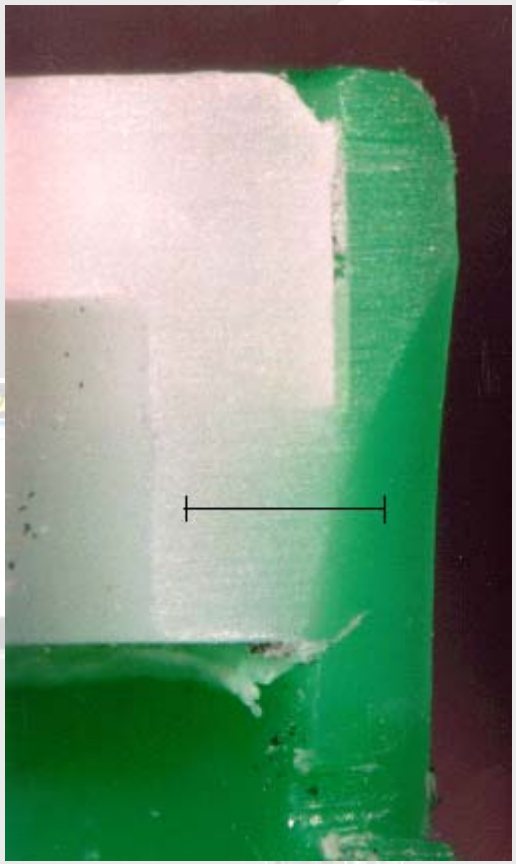
| Speed Variation Weld Strength Results (N) | | | | | | |
|---|---|---|---|---|---|---|
| # | Shear Joint | | | Energy Director | | |
| | 1.27 mm/s | 2.54 mm/s | 3.81 mm/s | 1.27 mm/s | 2.54 mm/s | 3.81 mm/s |
| 1 | 3323 | 2665 | 2411 | 2758 | 1775 | 552 |
| 2 | 3203 | 3212 | 2113 | 3198 | 2998 | 672 |
| 3 | 2184 | 2607 | 3172 | 2589 | 2731 | 334 |
| Ave. | **2903** | 2828 | 2565 | **2848** | 2501 | 519 |




AWS I-Beam Welding Test Specimen (mm)

- Early experimentation was done using AWS standard I-beam test bars.
- We discovered that optimizing the collapse speed during the weld and the hold phase, created stronger pull test results.

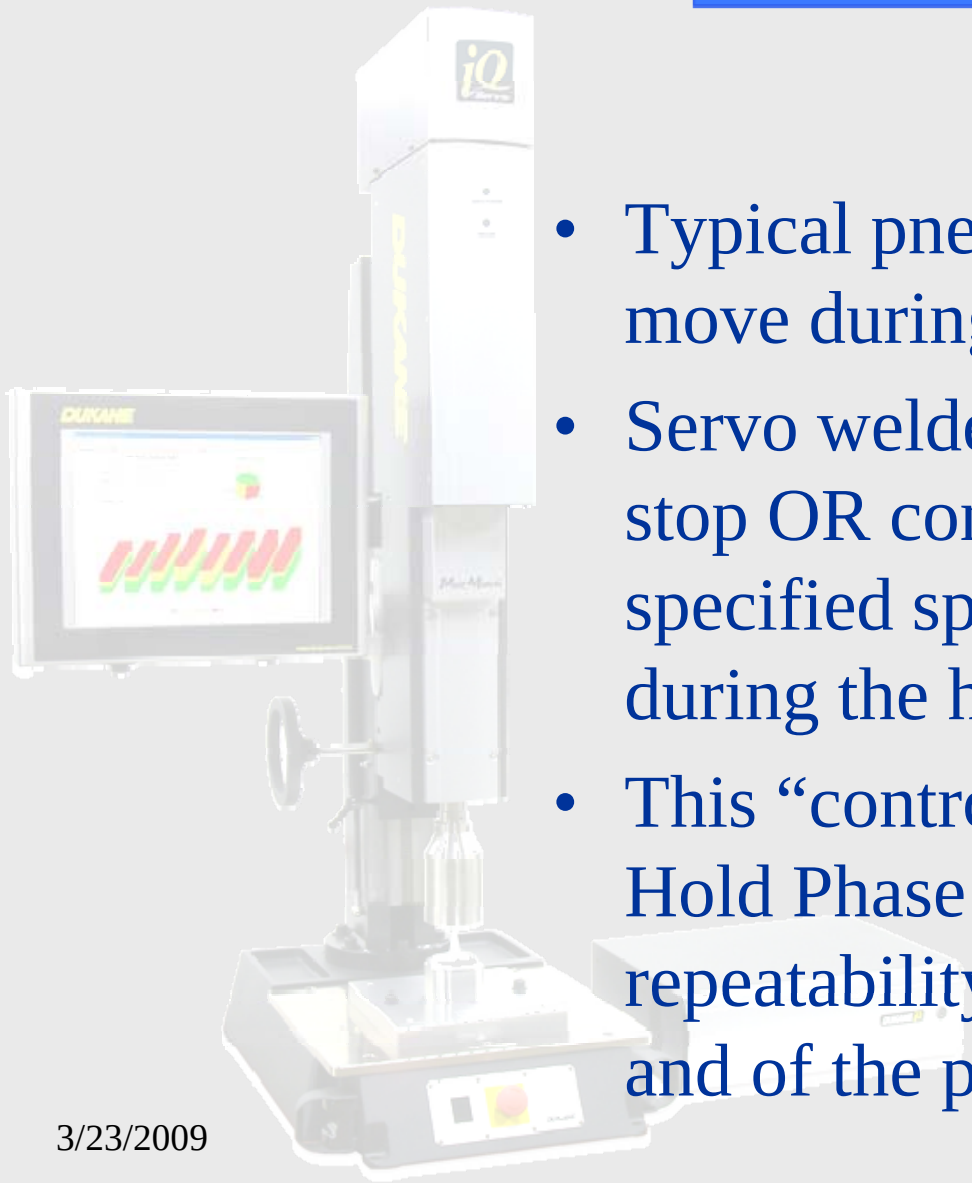
# Stronger Bonds



## Melt Phase

- Collapsing too slow allows for material degradation
- Collapsing too fast may cause cold forming.
- Matching the collapse speed during the melt phase of the process is critical to producing superior bond strength. MeltMatch™
- The ultrasonic propagation is allowed to penetrate deeper into the bond area.

**Stronger Bonds**

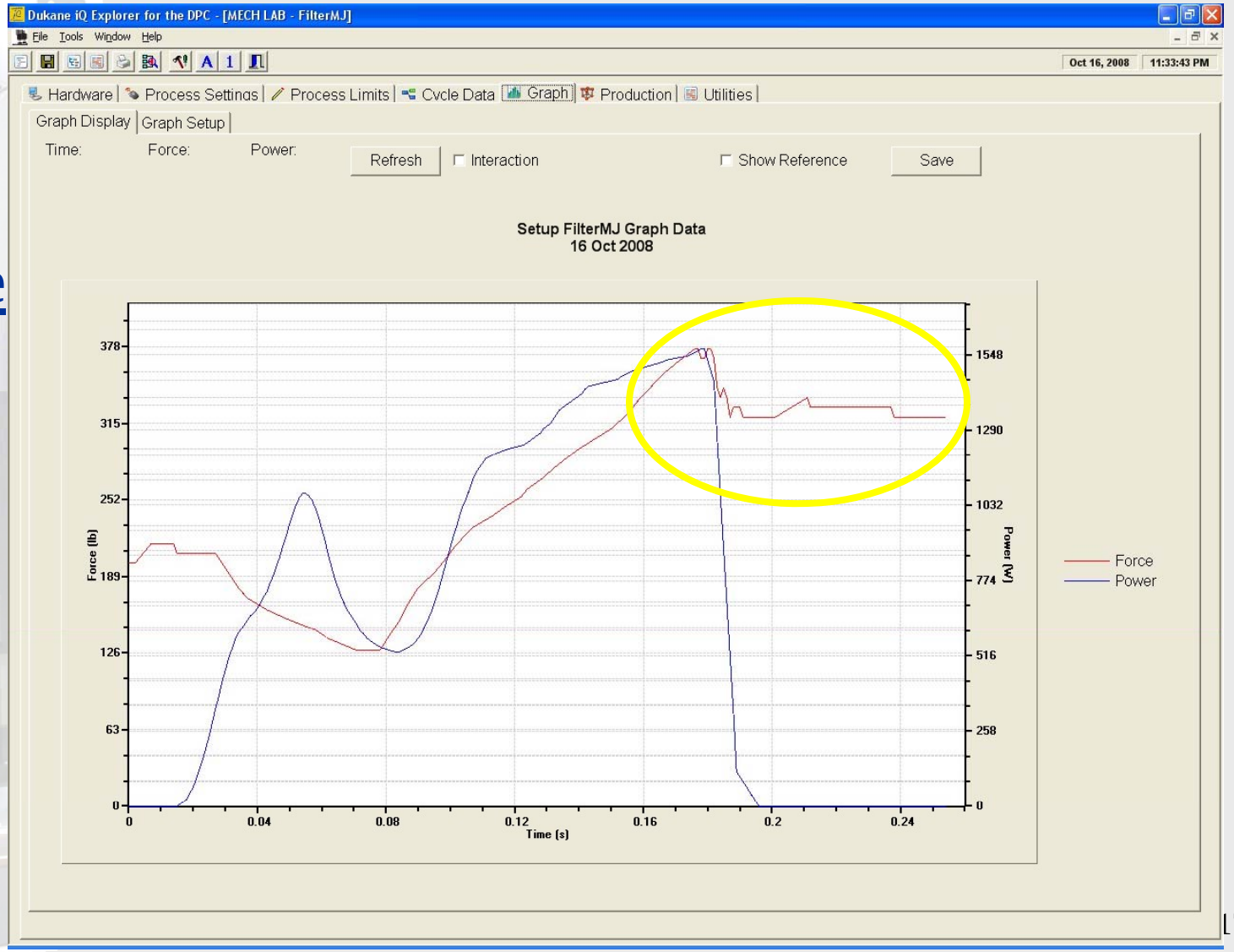


## Hold Phase

- Typical pneumatic welders continue to move during hold phase
- Servo welder has the ability to either stop OR continue collapse at a specified speed for a specified distance during the hold phase
- This “controlled” collapse during the Hold Phase significantly improves repeatability of the collapse distance and of the pull strength

# Stronger Bonds

## Hold Phase



# Stronger Bonds

3-28-08

This spreadsheet contains results for welding machined Polycarbonate pieces on a pneumatic DPC system and a servo system. Both systems used the same stack and generator. The results are contained in tabs in this file.

**Key results:**

| Parameter | Servo | Pneumatic |
|---|---|---|
| Collapse standard deviation (in.) | 0.0004 | 0.0013 |

AWS I-Beams were welded

**Process Repeatability** — **Stronger Bonds**


US Patent #7,475,801

## How does it work?

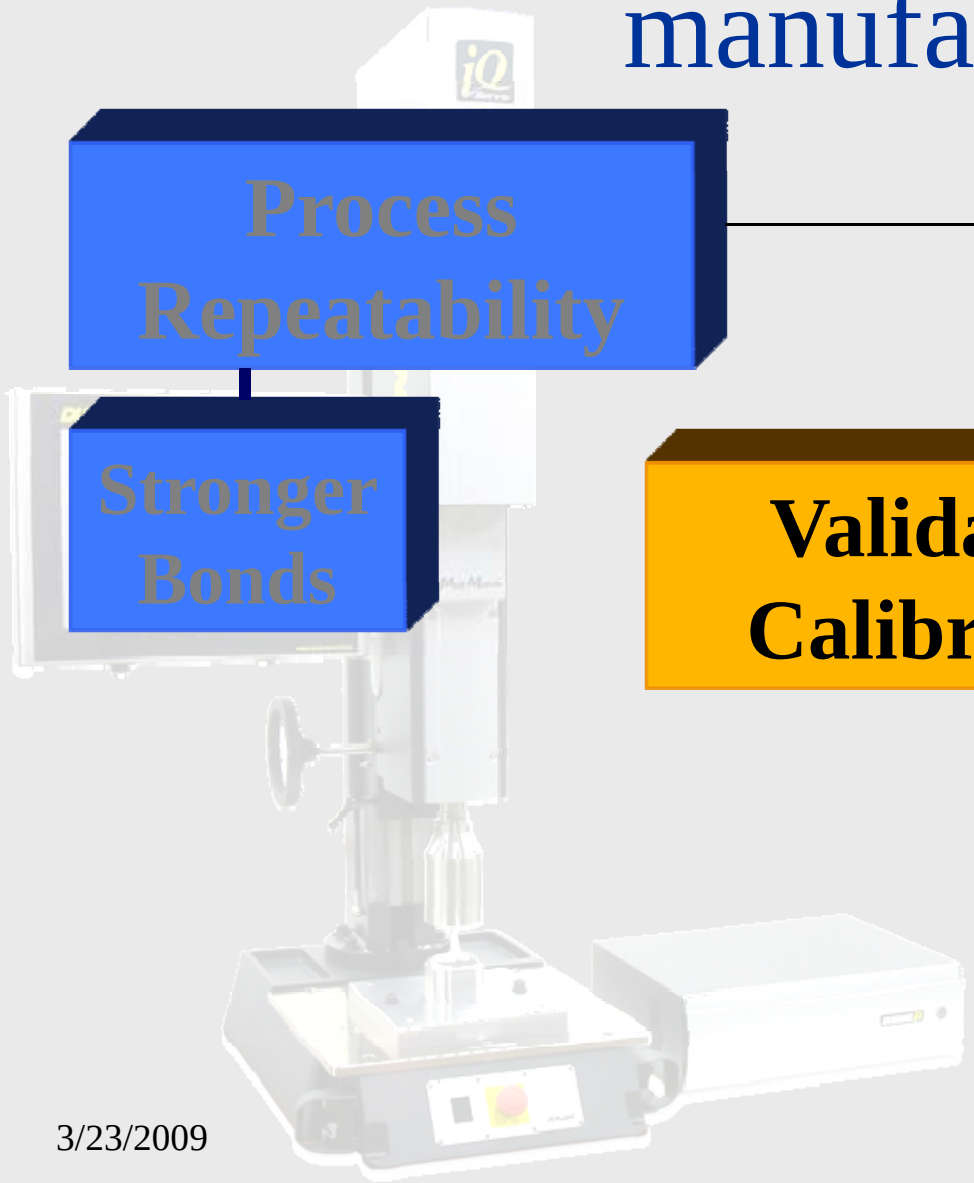
- Precise control of the collapse speed.
  *"Melt Match Technology"*
- iQ Series patented digital power supply
  - ***0.5 msec sample rate, fastest in the industry***

**Process Repeatability** — **Stronger Bonds**


## How does it work?

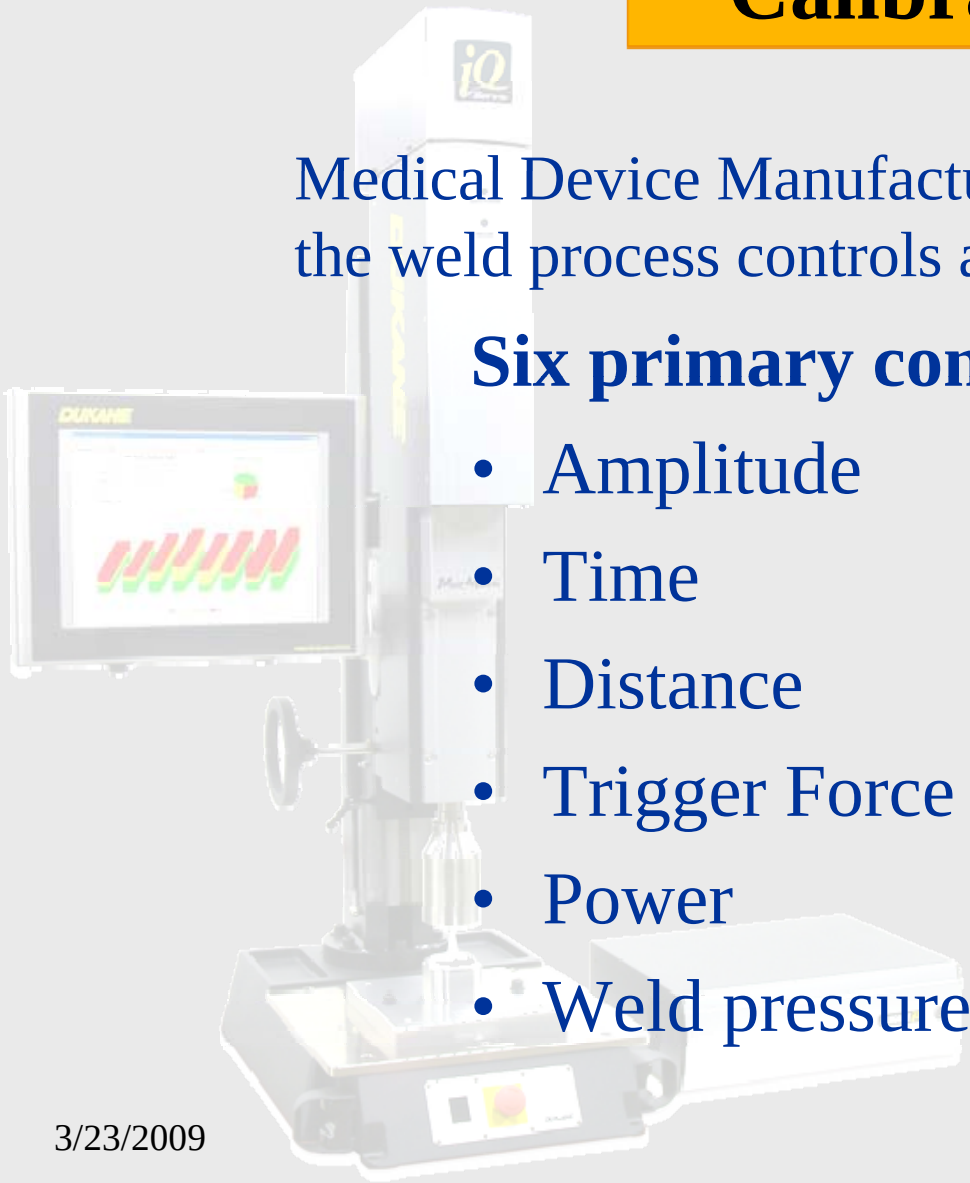
- Precise control of the collapse speed.
  *"Melt Match Technology"*
- iQ Series patented digital power supply
  - ***.5 m/sec sample rate, fastest in the industry***
- Robust Mechanical design
  *ultra rigid support*

# Challenges facing Medical device manufacturing



- Process Repeatability
- Stronger Bonds
- **Validation Calibration**
- Manufacturing Costs

# Validation Calibration

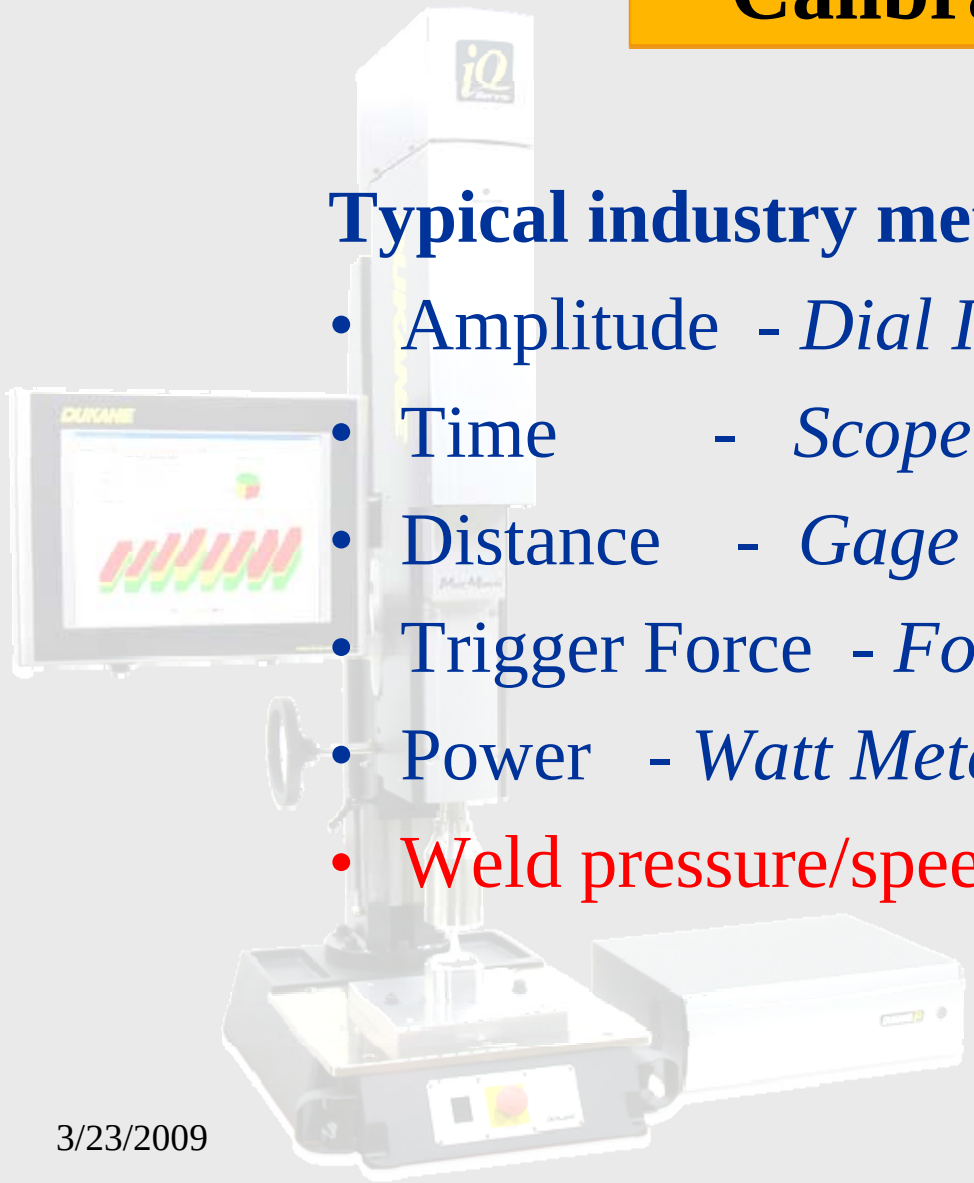


Medical Device Manufactures need to verify that the weld process controls are in tolerance.

**Six primary controls**

- Amplitude
- Time
- Distance
- Trigger Force
- Power
- Weld pressure/speed

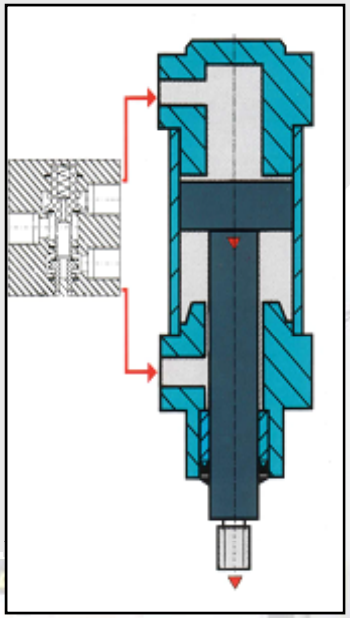
# Validation Calibration

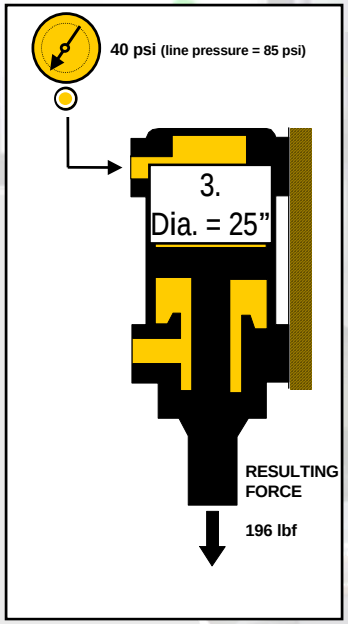


## Typical industry methods for Validation

- Amplitude - *Dial Indicator*
- Time - *Scope*
- Distance - *Gage Blocks*
- Trigger Force - *Force Gage*
- Power - *Watt Meter*
- Weld pressure/speed - *Pneumatic gage?*

# Validation Calibration






- Weld pressure/speed - *Pneumatic gage?*

***Current pneumatic devices attempt to control the weld speed via air pressure or a proportional valve device. However, actual collapse speed during the weld is a variable (out of control)***

***Therefore, validating the air pressure does not ensure the collapse speed is accurate and consistent.***

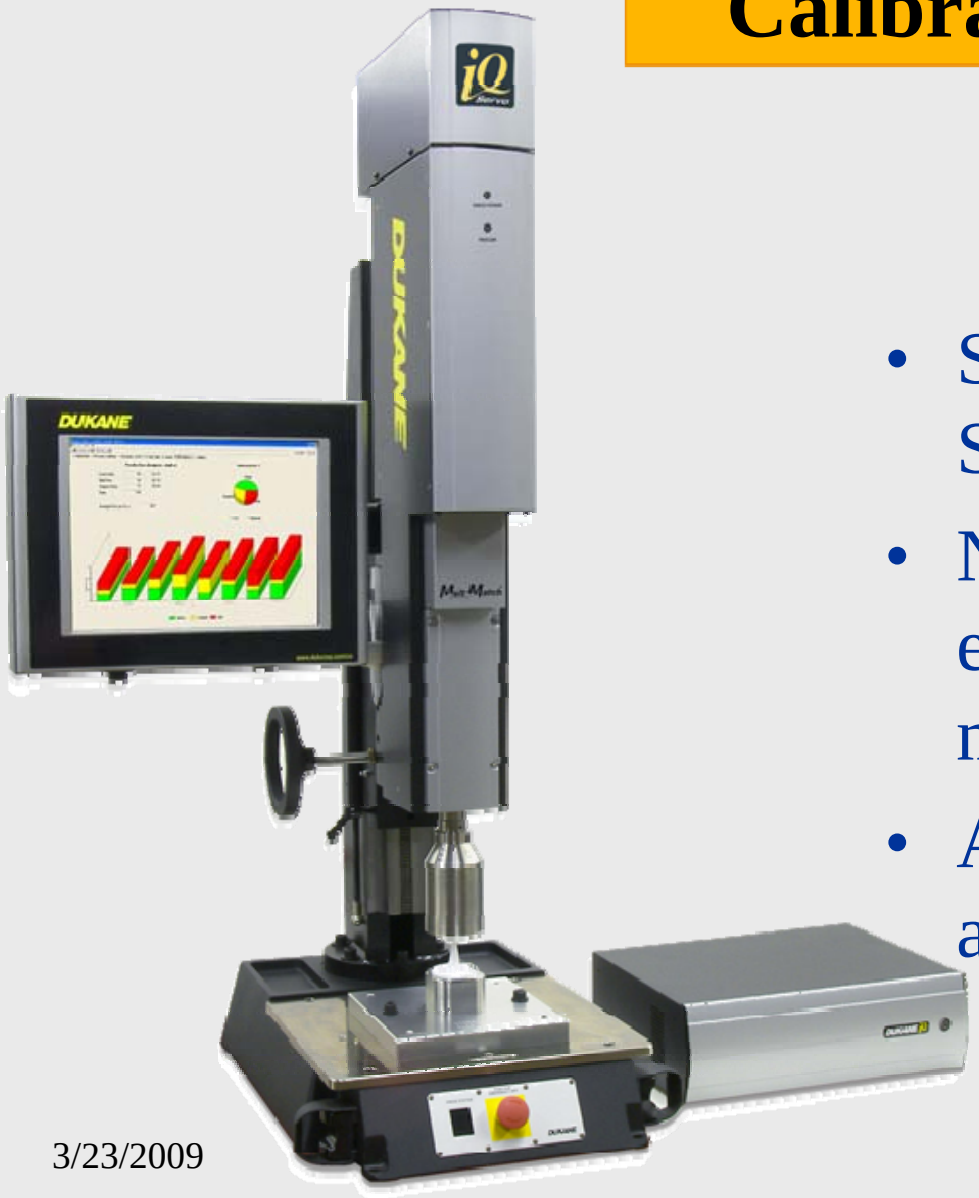
# Validation Calibration

## Servo Press w/ Melt-Match technology

- Amplitude - *Indicator*
- Time - *Scope*
- Distance - *Gage Blocks*
- Trigger Force - *Force Gage*
- Power - *Watt Meter*
- Weld Speed - ***Simple gage blocks can be used to verify speed.***

  ***Distance / Time = Speed (mm/seconds)***

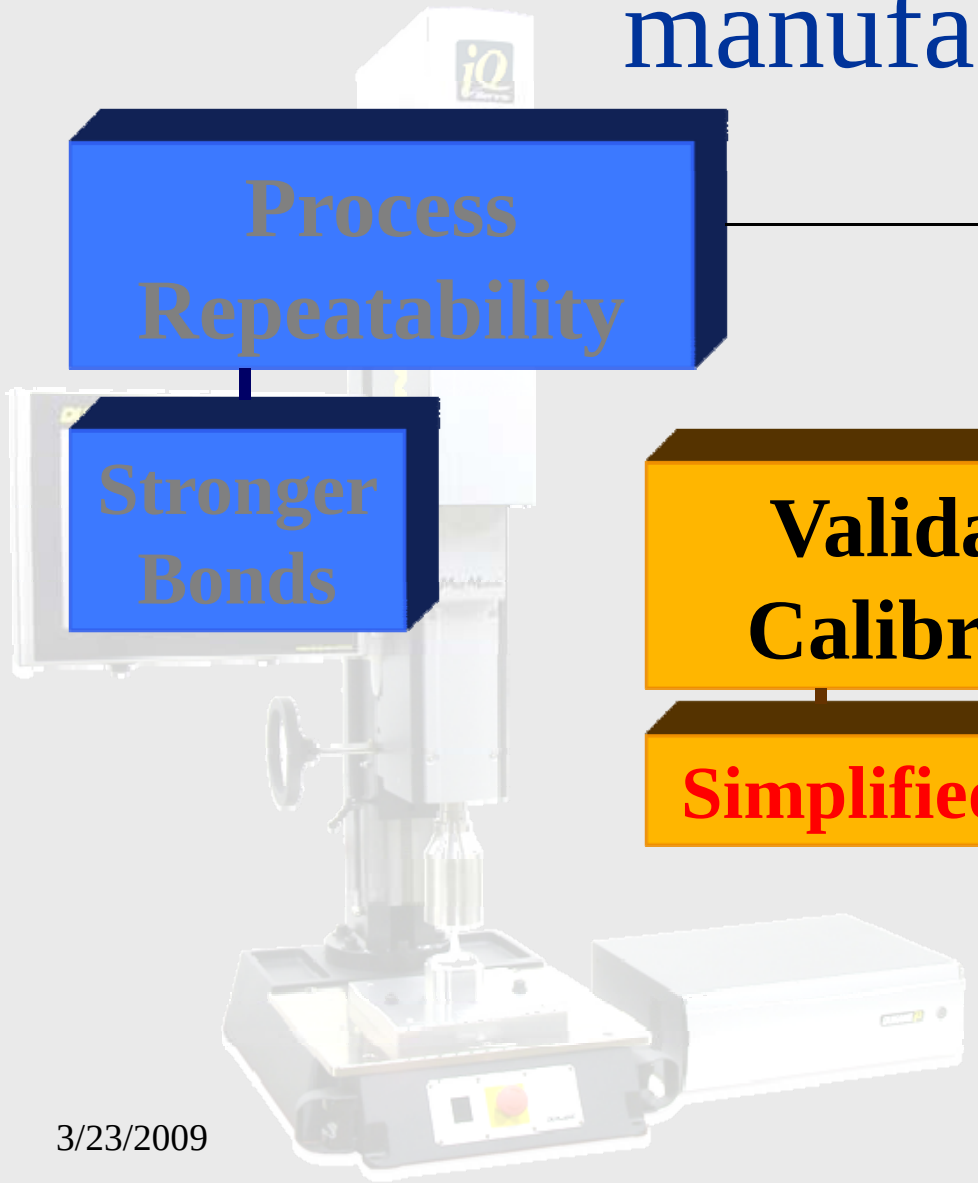
# Validation
# Calibration




***FDA compliant***

- Simplified Validation
  Servo vs pneumatic
- No operator controls - eliminates unauthorized machine adjustments
- All mechanical adjustments require tool.

# Challenges facing Medical device manufacturing



Process Repeatability

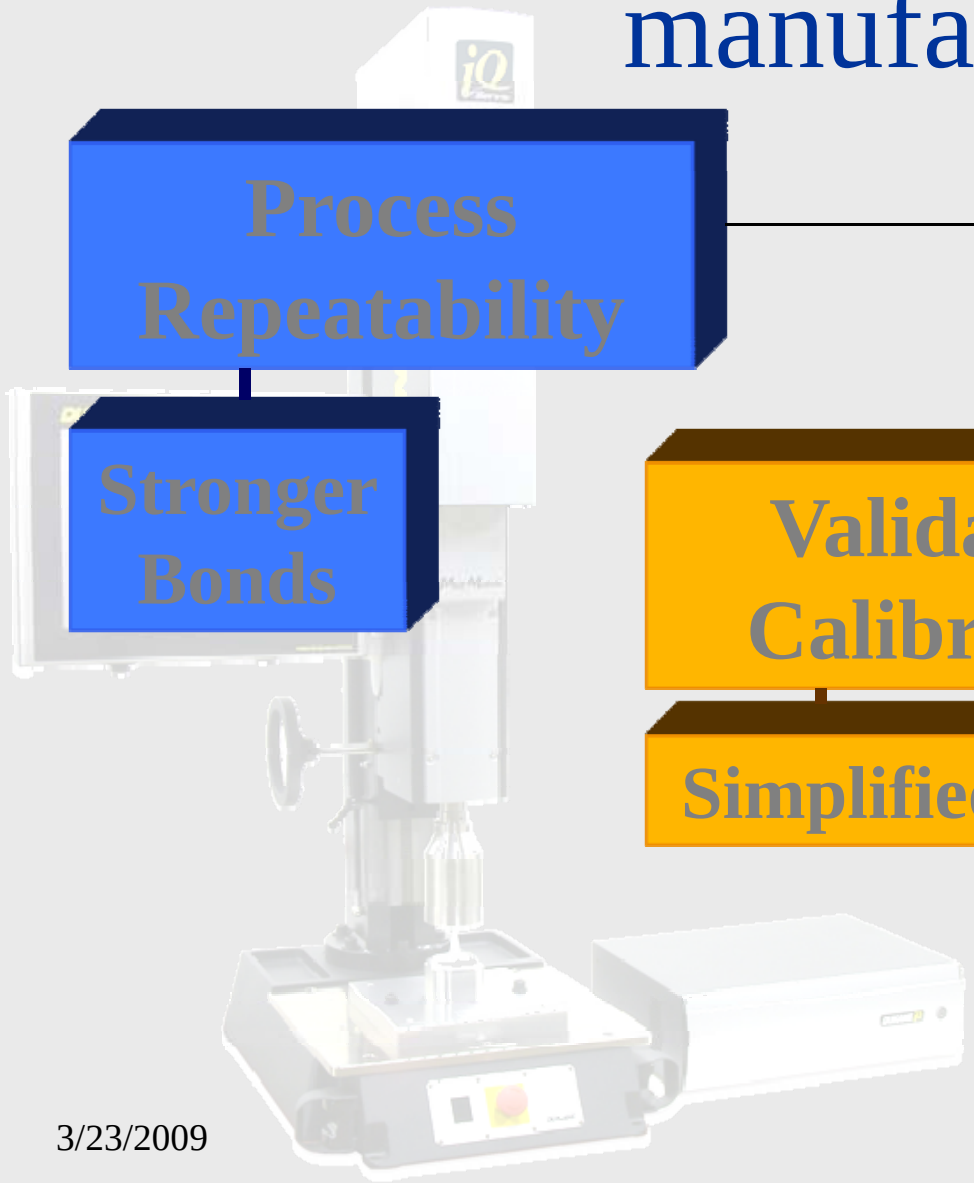
Stronger Bonds

Validation Calibration

Simplified

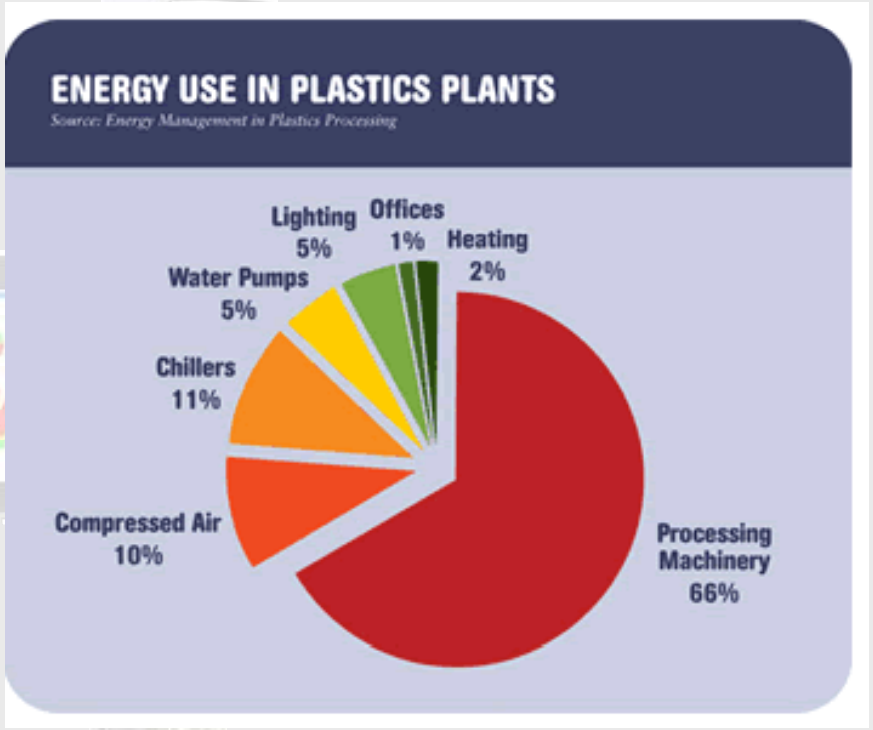
Manufacturing Costs

# Challenges facing Medical device manufacturing



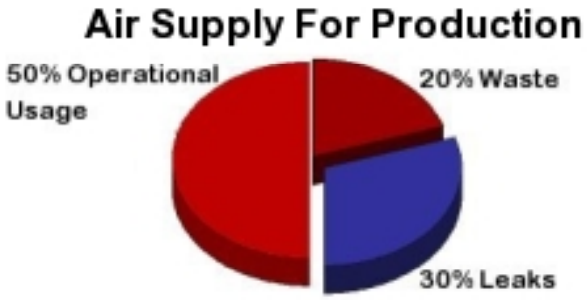
- Process Repeatability
  - Stronger Bonds
- Validation Calibration
  - Simplified
- Manufacturing Costs

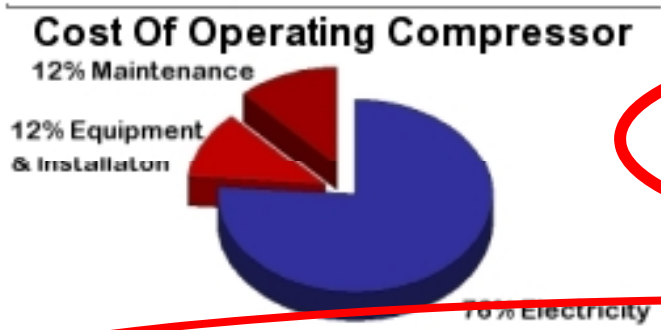
# Manufacturing Costs




Dr Robin Kent. Plastics Technology, Introduction to Energy Management For Plastics Processors, **37**,p. (Jan, 2009)

# Manufacturing Costs




## Cost of Compressed Air

Compressed air is used in almost every facility and manufacturing plant. The cost of generation, however, is often overlooked by plant managers, maintenance, and production. Air is not free. Ultrasound can be used to save $10,000's, even $100,000's annually in energy savings.

According to a U.S. Department of Energy survey, between 10% and 30% of electricity consumed is for compressed air. Most manufacturing facilities use compressed air. A significant amount of energy is lost due to waste and air leaks.

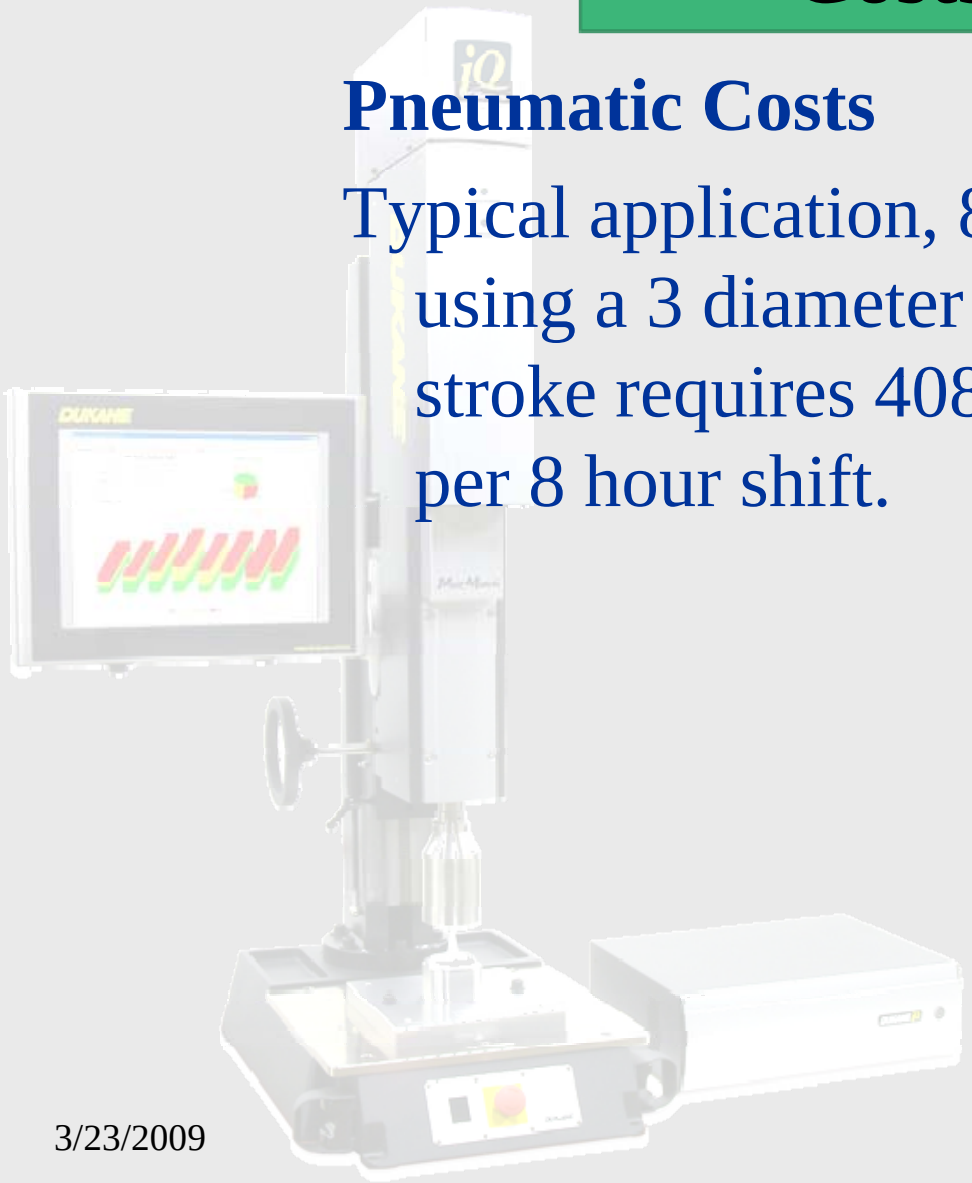
The typical compressed air system uses only 50% of its air supply for production. The rest is wasted or lost to air leaks.

CRTL Systems Inc.
http://www.ctrlsys.com/library/articles/compressed-air.php

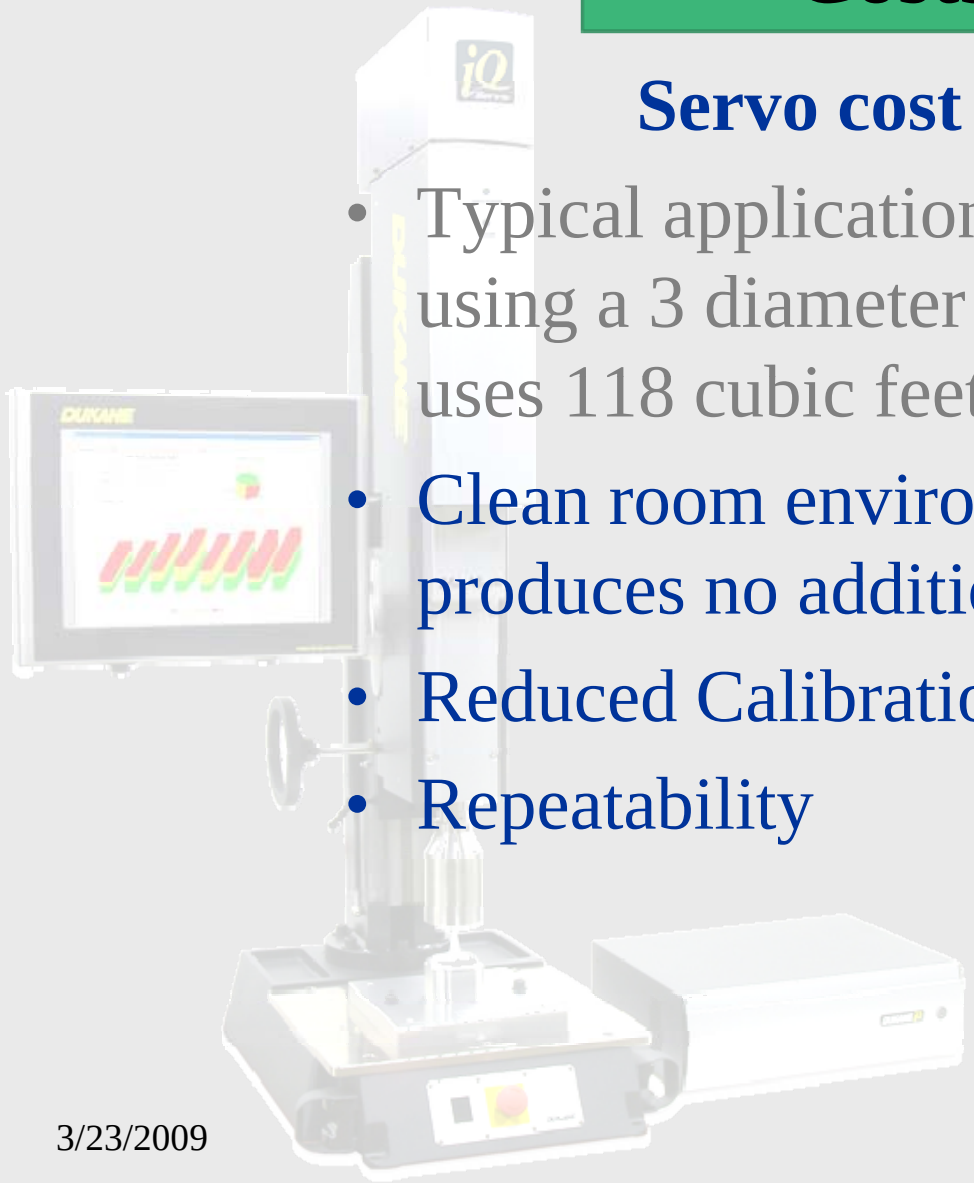
# Manufacturing Costs

## Pneumatic Costs

Typical application, 8 cycles per minute, using a 3 diameter air cylinder at 5” stroke requires 4080 cubic feet of air per 8 hour shift.



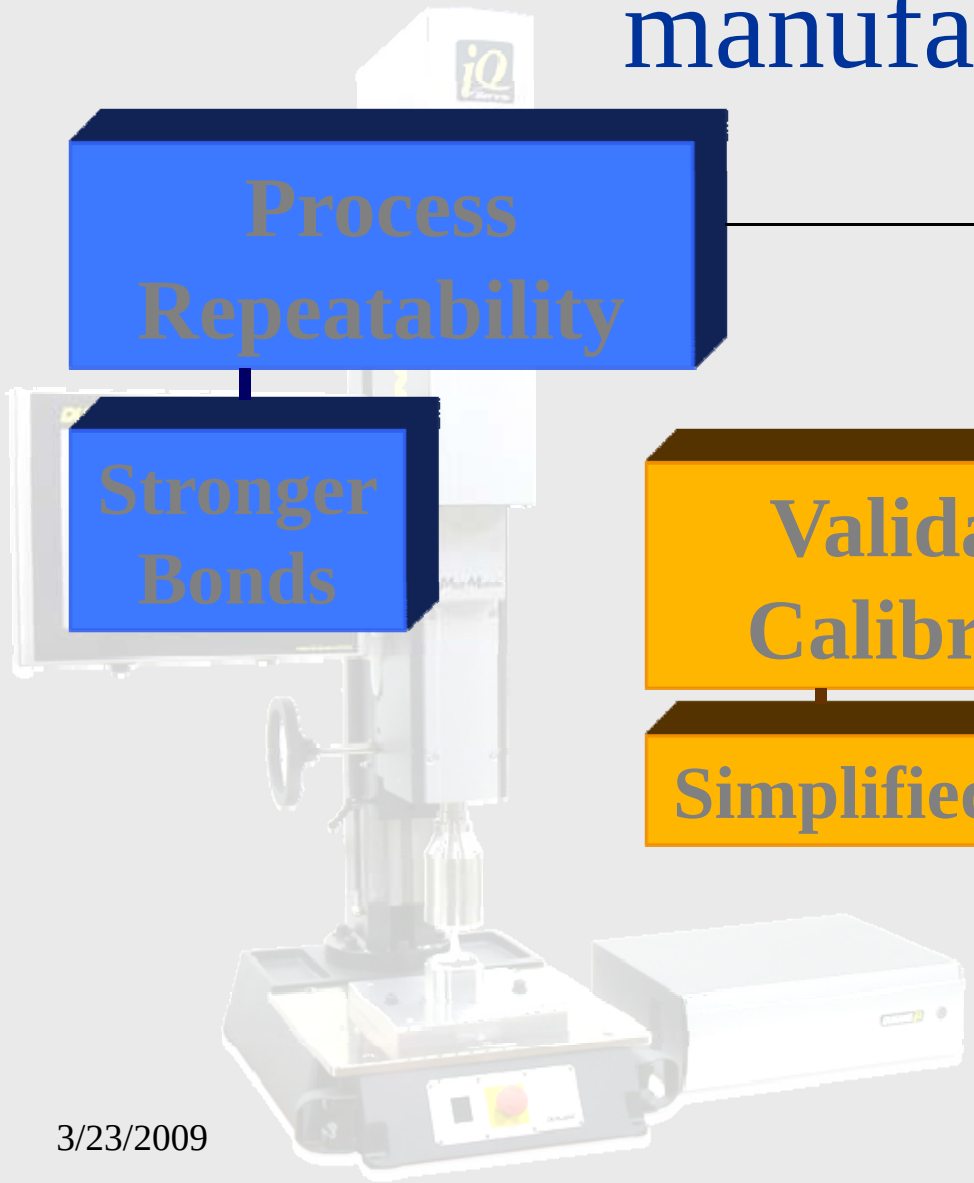
# Manufacturing Costs



## Servo cost vs Pneumatic

- Typical application 8 cycles per minute, using a 3 diameter air cylinder at 4” stroke uses 118 cubic feet of air per 8 hour shift.
- Clean room environments - Servo welder produces no additional air volume to filter.
- Reduced Calibration intervals
- Repeatability

# Challenges facing Medical device manufacturing



- Process Repeatability
  - Stronger Bonds
- Validation Calibration
  - Simplified
- Manufacturing Costs
  - Green

# Hands on demonstration

## Remote connection using ***iQ Explorer*** User Interface

VPN

Local area network

**Network configuration allows multiple local or remote iQ Systems and users**

# Why is this new technology so important to the industry?

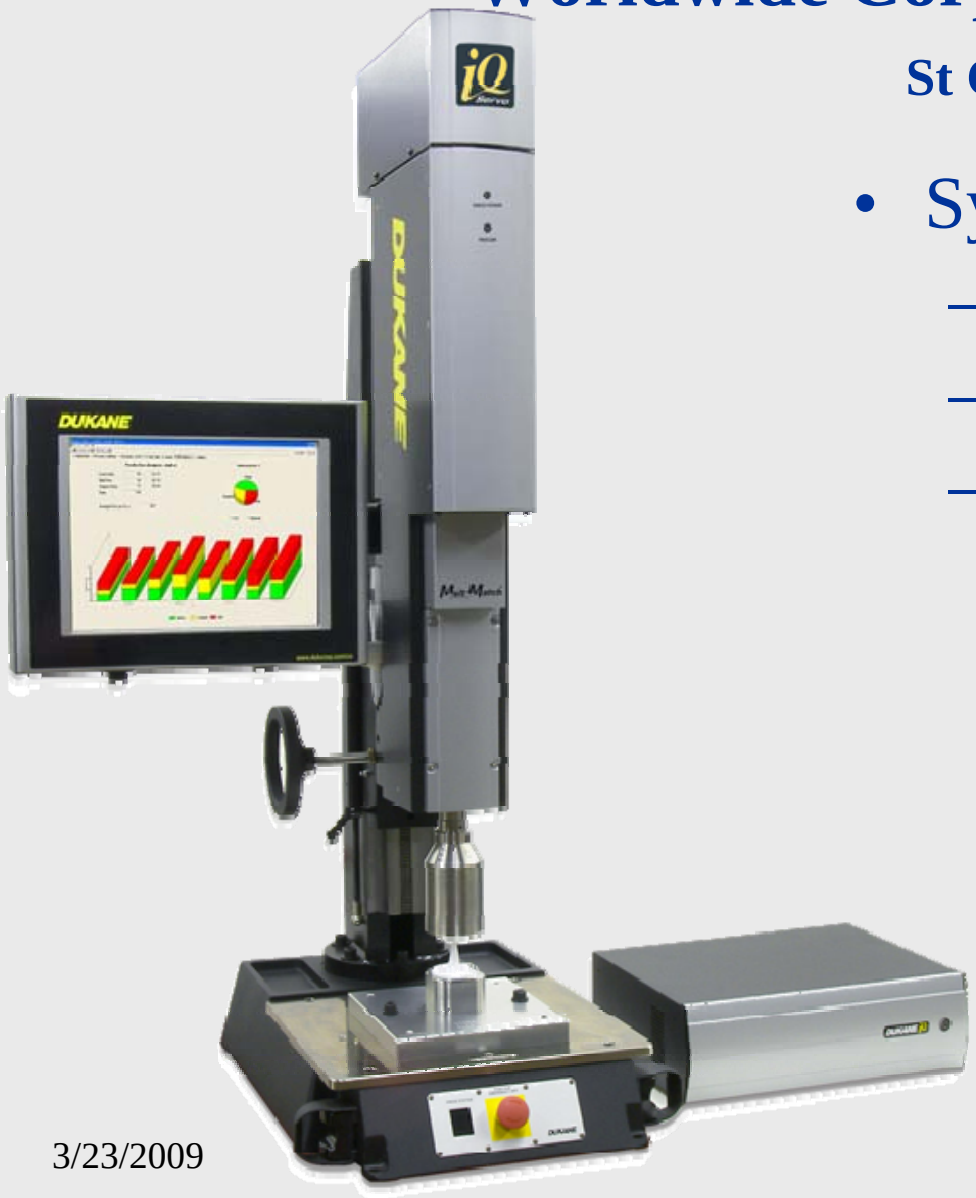

**Increased Repeatability**

**FDA Compliance**

**Green for the Environment**

# Developed and Manufactured by Dukane at Worldwide Corporate Headquarters

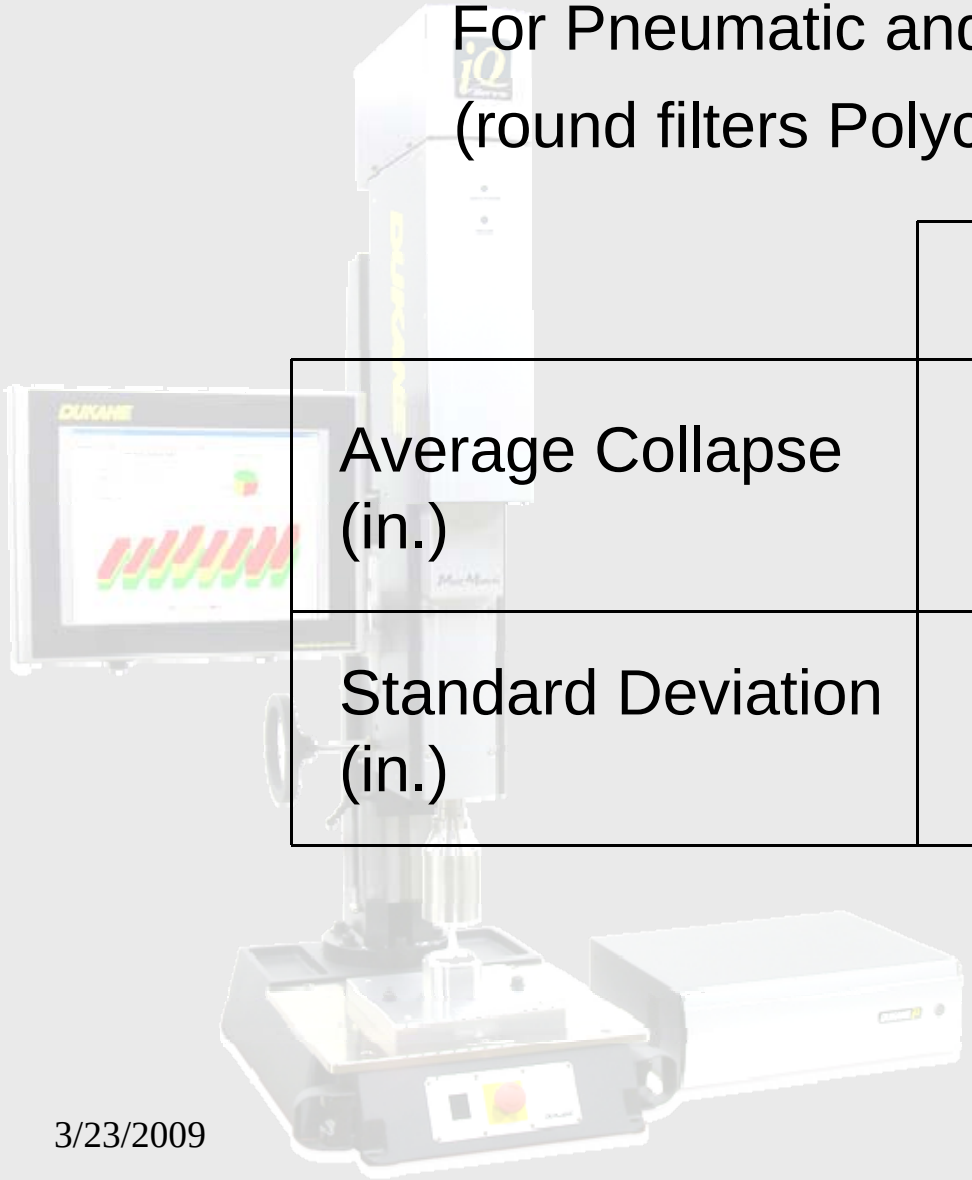
**St Charles, IL**




- System Patents
  - #7,475,801- Granted
  - 2007/0257087- Application
  - Provisional Patent - converting into Application

# Comparison of Collapse Distance Repeatability For Pneumatic and Servo Welders (round filters Polycarbonate parts)

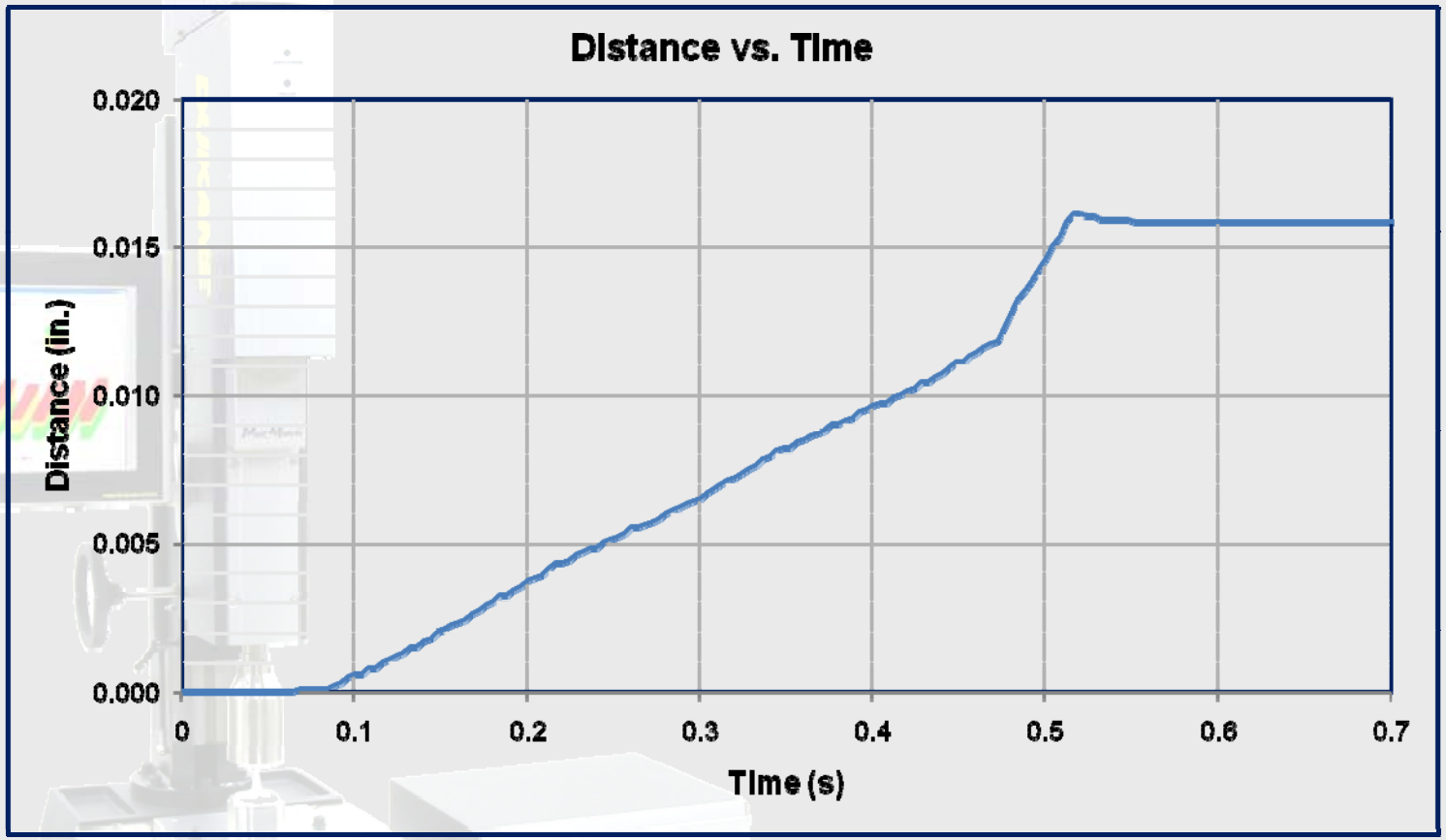
| | Pneumatic | Servo |
|---|---|---|
| Average Collapse (in.) | 0.0179 | 0.0172 |
| Standard Deviation (in.) | 0.0016 | 0.0001 |



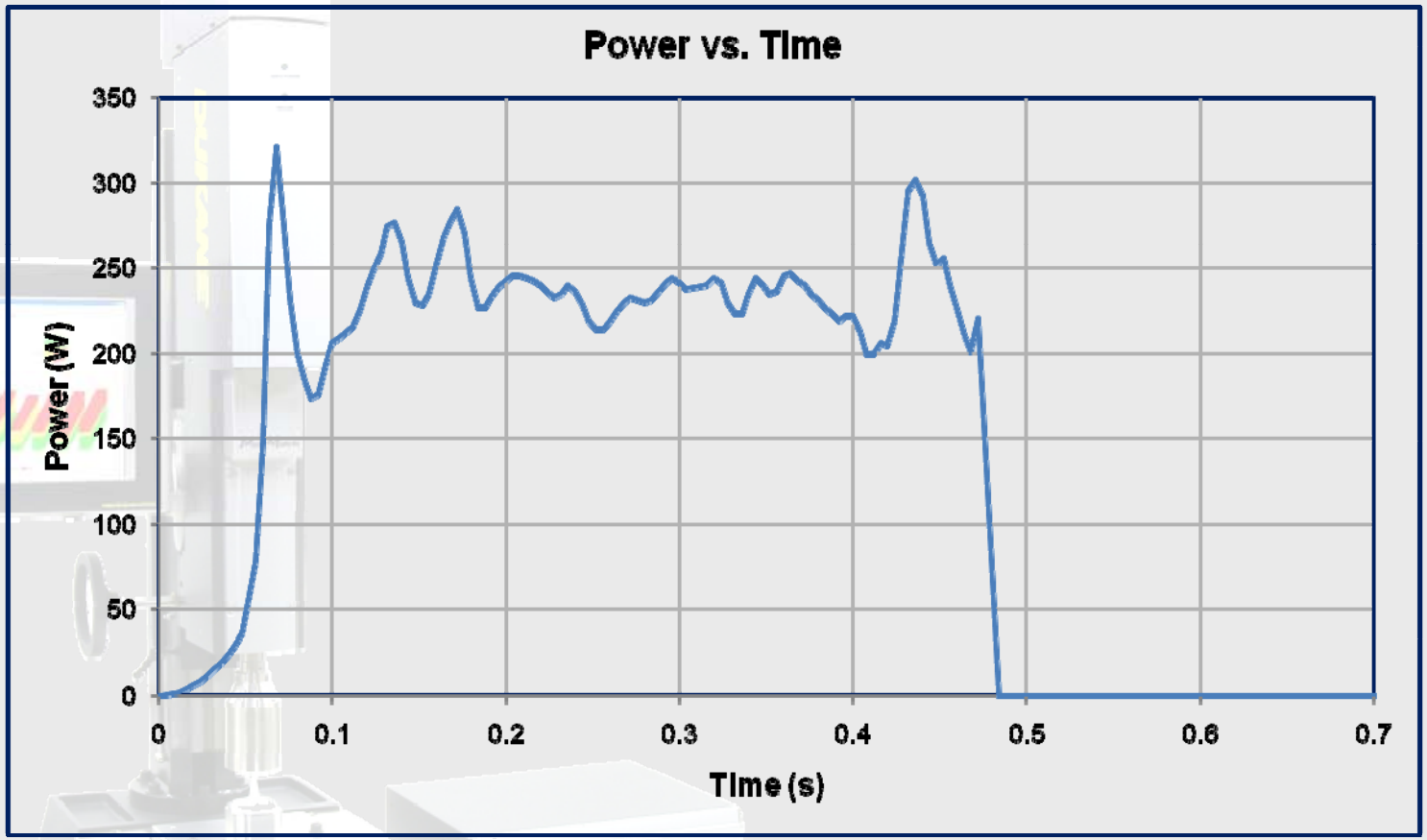
# Comparison of Pull Strength Repeatability For Pneumatic and Servo Welders (round filters Polycarbonate parts)

| Normalized Data to compensate for uneven Collapse Distance | Pneumatic | Servo |
|---|---|---|
| Average Pull Strength per Inch of Weld Depth (Collapse Distance) (lb./in.) | 56,730 | 57,610 |
| Standard Deviation (lb./in.) | 8600 (15.2%) | 1140 (2.0%) |

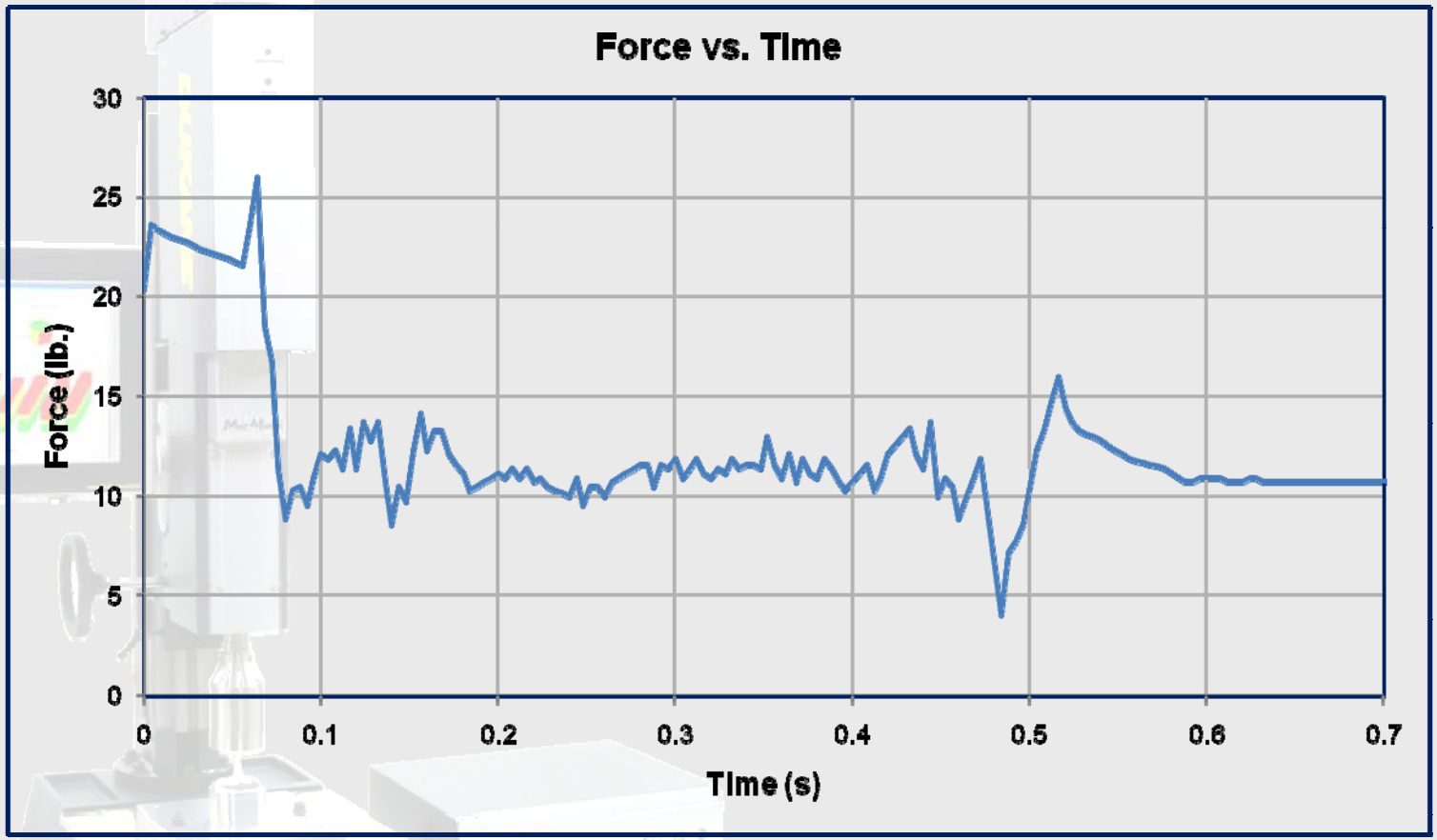
# Typical Distance vs. Time Graph for Servo Welder



# Typical Power vs. Time Graph for Servo Welder



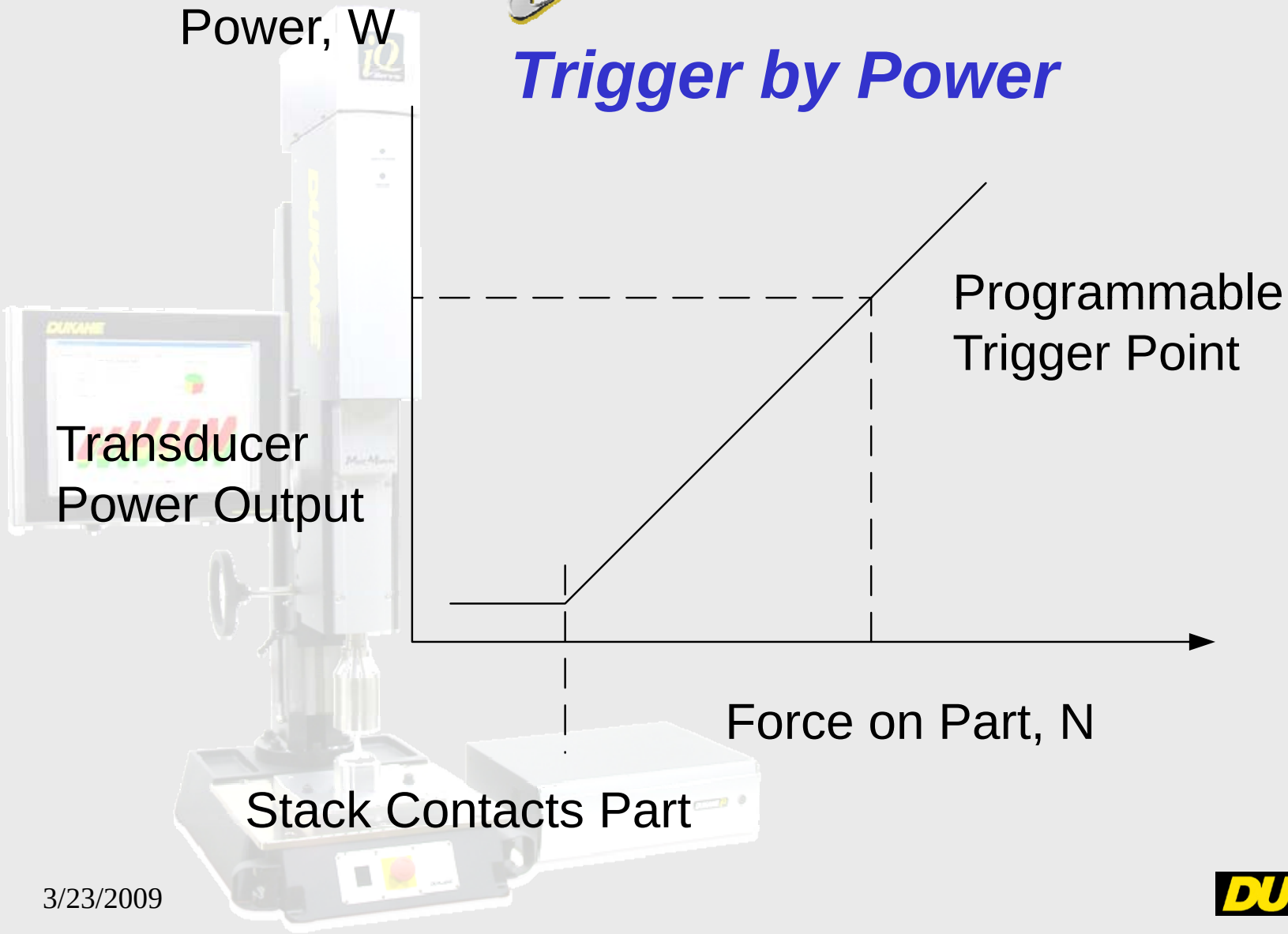
# Typical Force vs. Time Graph for Servo Welder



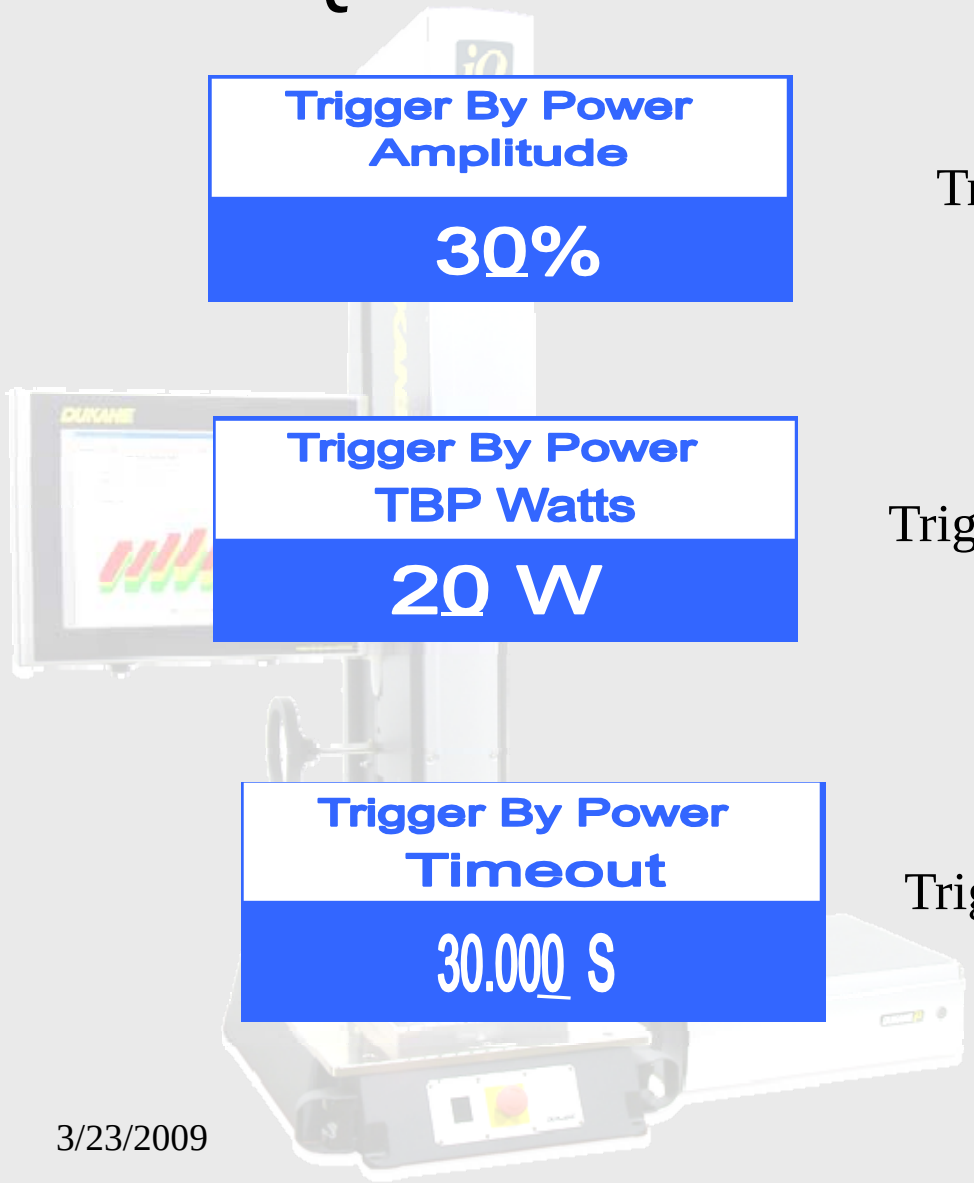
# *iQ* Hand Probe with Time & Energy

# iQ Series

## *Trigger by Power*



# *iQ* Hand Probe with Time & Energy




Trigger by Power Amplitude setting screen

Trigger by Power Power level setting screen

Trigger by Power Timeout setting screen


# iQ Series

## *Compact design*


# Acknowledgements



iQ Series of Ultrasonic Generators and Presses are the results of several years of intense R&D investment by Dukane corporation.

Many talented engineers have contributed to this effort.

MeltMatch™

DUKANE

# Questions?


Workcell


Servo

MeltMatch™

New Hand Probe

Mini Press

DUKANE