Alex Martinez

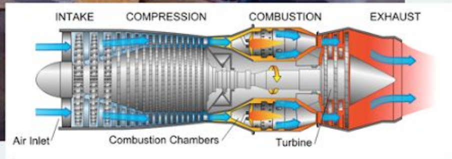
BSME ‘09

MSME ‘12

Research Eng ‘14-’17

Self-Employed Freelance Consulting, NewSpark Labs 2015-

Sikorsky CH-53K Super Stallion, 2x GE38 Turboshaft Engine

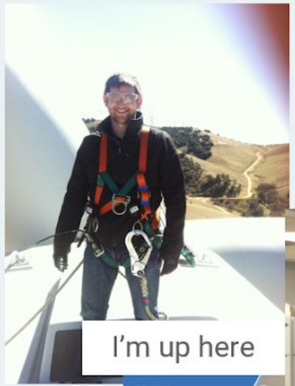


GE Gas Turbine Rotor

AQUARIUM

MONTANA SKIING

EEDP VACATION TRIP

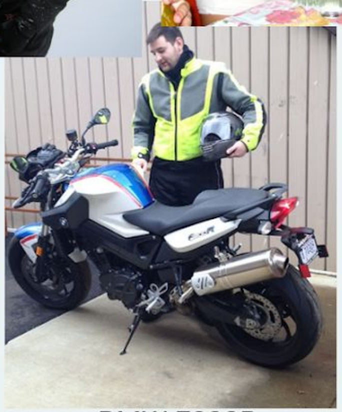


I’m up here

WINTER AT CLEAN COAL PLANT

SI CRYSTAL GROWTH

ALEX AND ROCKO



BMW F800R

FIRE HINGE DEVICE TESTING

United States Patent
Teta et al.
Patent No.: US 11,053,722 B2
Date of Patent: Jul. 6, 2021
SELECTIVELY CLOSABLE HINGE

8 Patents / Applications

MIT PHARMA MACHINE

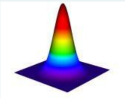
https://www.linkedin.com/in/martinezalexander/

Alex Martinez
Associate Director of Engineering
“L” Therapeutics

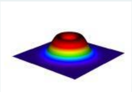
Thermal Model – Full Weld Recipe Modeling

red act ed	redacted			
Pas	400	300	230	260
Pov	25	40	65	50
Spe)	2000	3500	3000	2800
Wo	3000Hz, 3x3mm			
Hol	20			

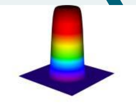
- Calculates Energy [J], Energy Density [J/mm^2], Average Power [W]
- Helpful for comparing laser types, ie. 1-up to Dual laser, diagnosing hot spots, etc.



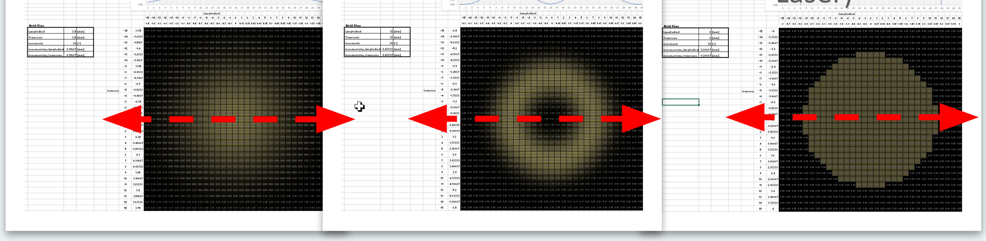
Gaussian Spot



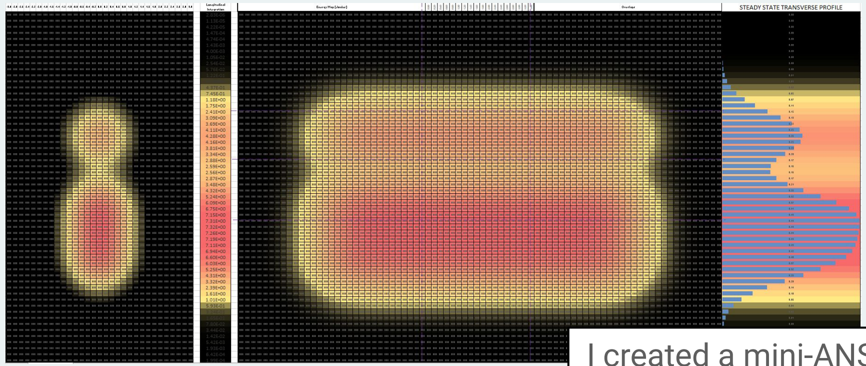
Wobbled Gaussian Spot



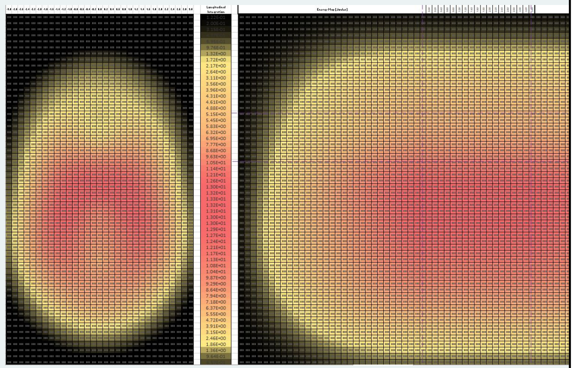
Flat Top Spot (Our New Sakar Laser)



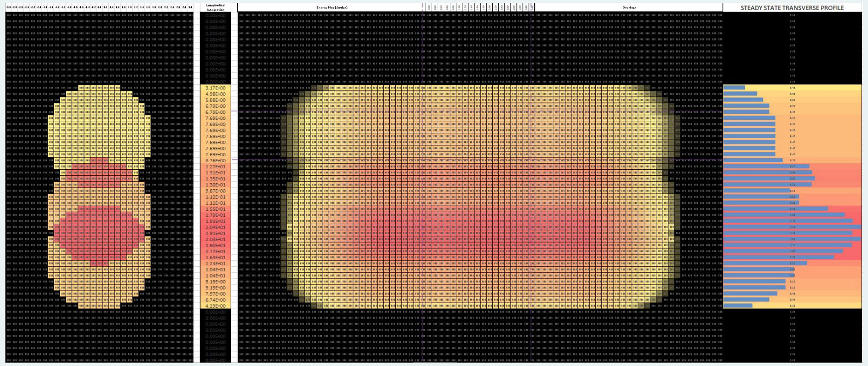
3x Gaussian Traces



3x Wobbled Gaussian Traces



3x Flat Top Traces

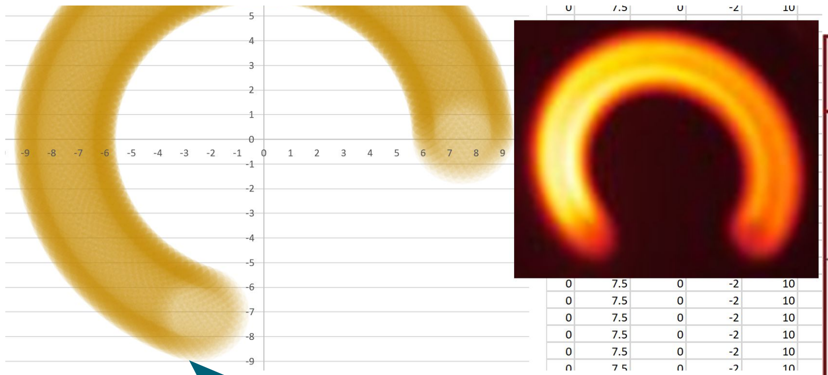


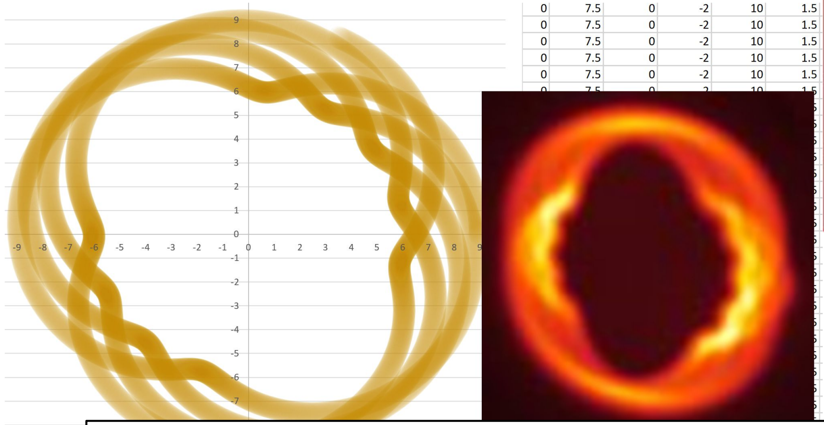
I created a mini-ANSYS physics engine inside Microsoft Excel to evaluate the spatial thermal energy input from a polymer welding laser beam. Before my modeling technique the teams relied solely on machine parameter DoE experiments and subsequent testing that took weeks to complete.

The Physics Engine was very complex under the hood but easy for a user to select the laser beam energy profile, power, scanning speed, etc.

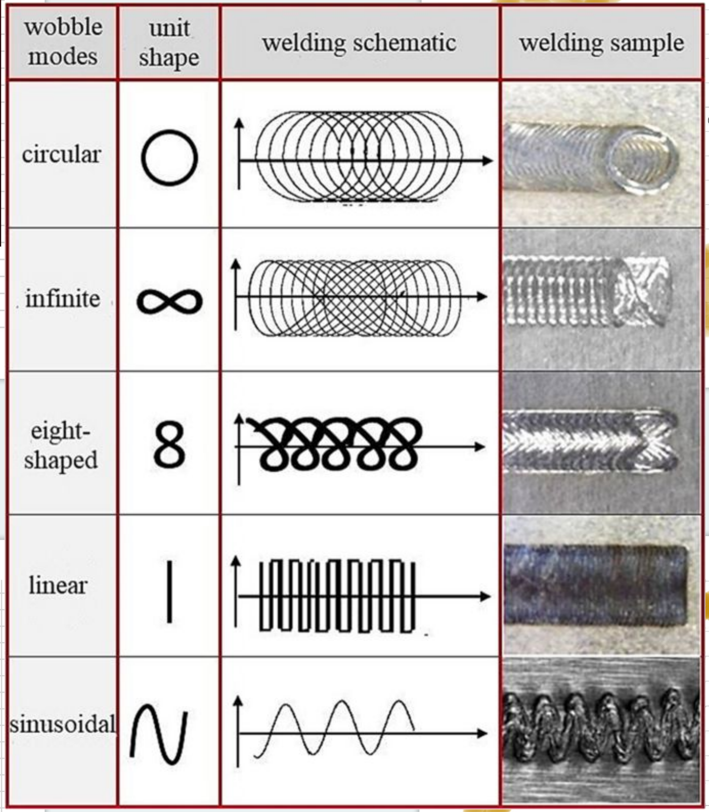
Alex Martinez

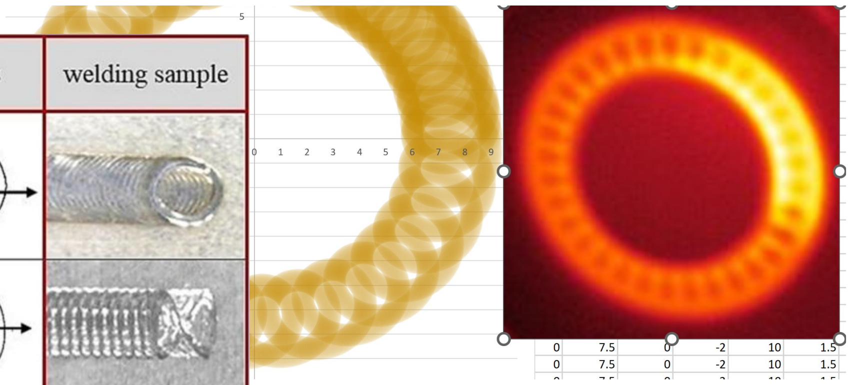
ENGINEERING LASER MODEL

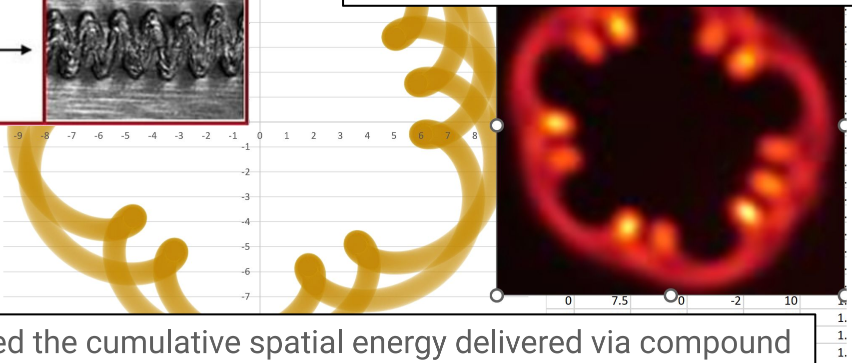




4X MATHEMATICAL TRACE MODEL PREDICTION







Gold Traces: Excel Model predictions based on scan and wobble settings

Red/Orange Traces:
Photos of Corresponding laser settings run on special black laser paper, photographed with high speed IR camera showing perfect agreement and validation of my model and technique.

In addition to the thermal model I created a separate geometric model that predicted the cumulative spatial energy delivered via compound rotational movements of the laser dot.

The laser dot was programmed for circular wobble, and was programmed to scan along a circle. These compound movements created harmonic superpositions and hot spots. My model allowed users to preview any harmful harmonics before running any experiment that could result in scorched polymer areas.

Pharma Mfg. Lab Dehumidification

30,000 lbs. of high-tech equipment
added to dehumidify suite 1 & 2

Alex Martinez

Pharmaceutical Manufacturing Site-Wide Environmental Monitoring and Data Logging System

Room Temp & %RH Logging

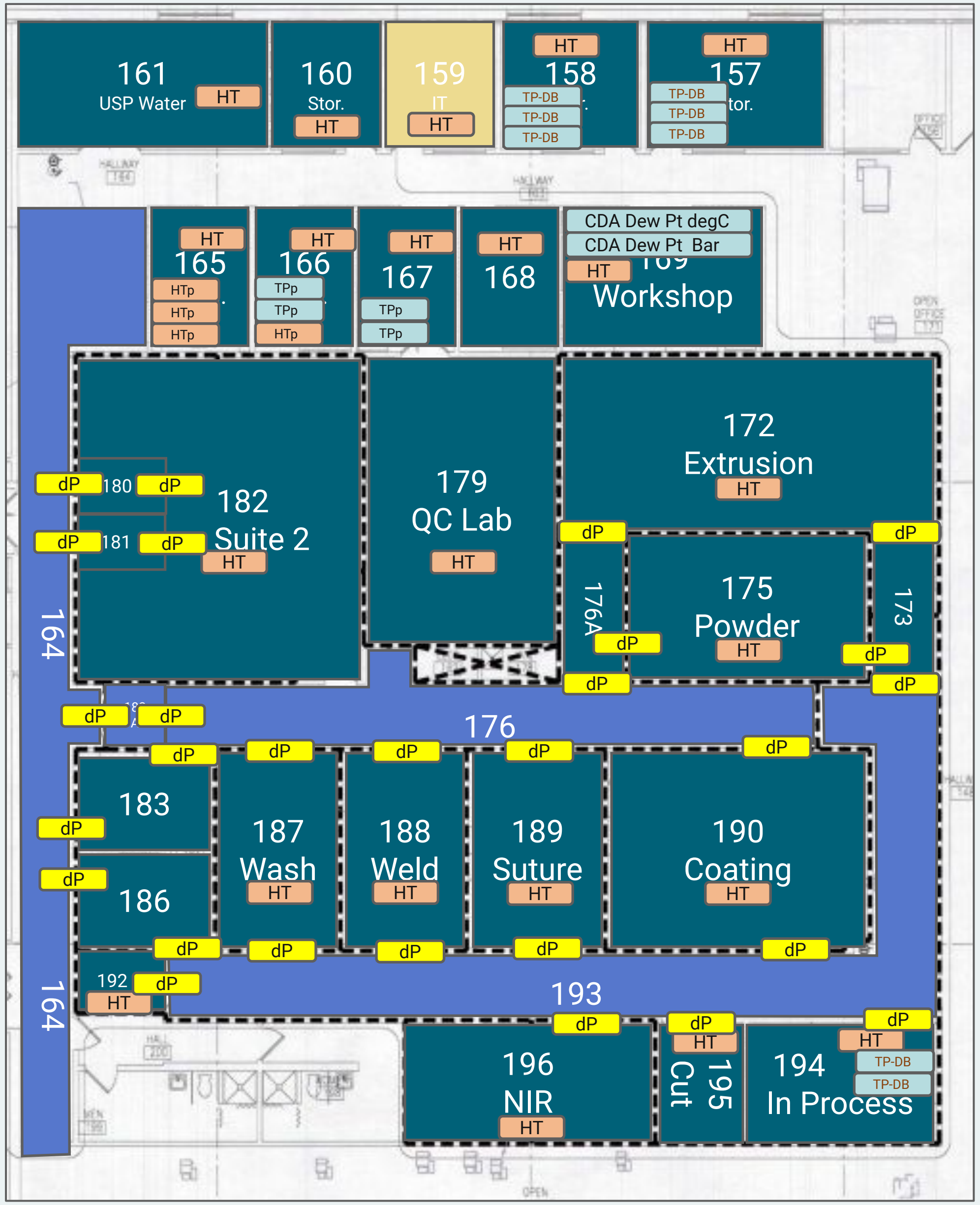
Fridge, Freezer, and Stability Chamber Logging

Compressed Air Dew Point Logging


VAISALA
DPT146 Dew Point and Pressure Transmitter
For compressed air

GMP Suite Differential Pressure Logging

QTY 22 – Humidity/Temp HT
QTY 4 – Humidity/Temp Remote Probe HTp
QTY 8 – Temp Probe with Dampening Block TP-DB
QTY 6 – Temp Probe – Remote Probe TPp
QTY 1 – Compressed Air Dew Point Comp. Air Dew Pt
QTY 28 Differential Pressure Nodes dP



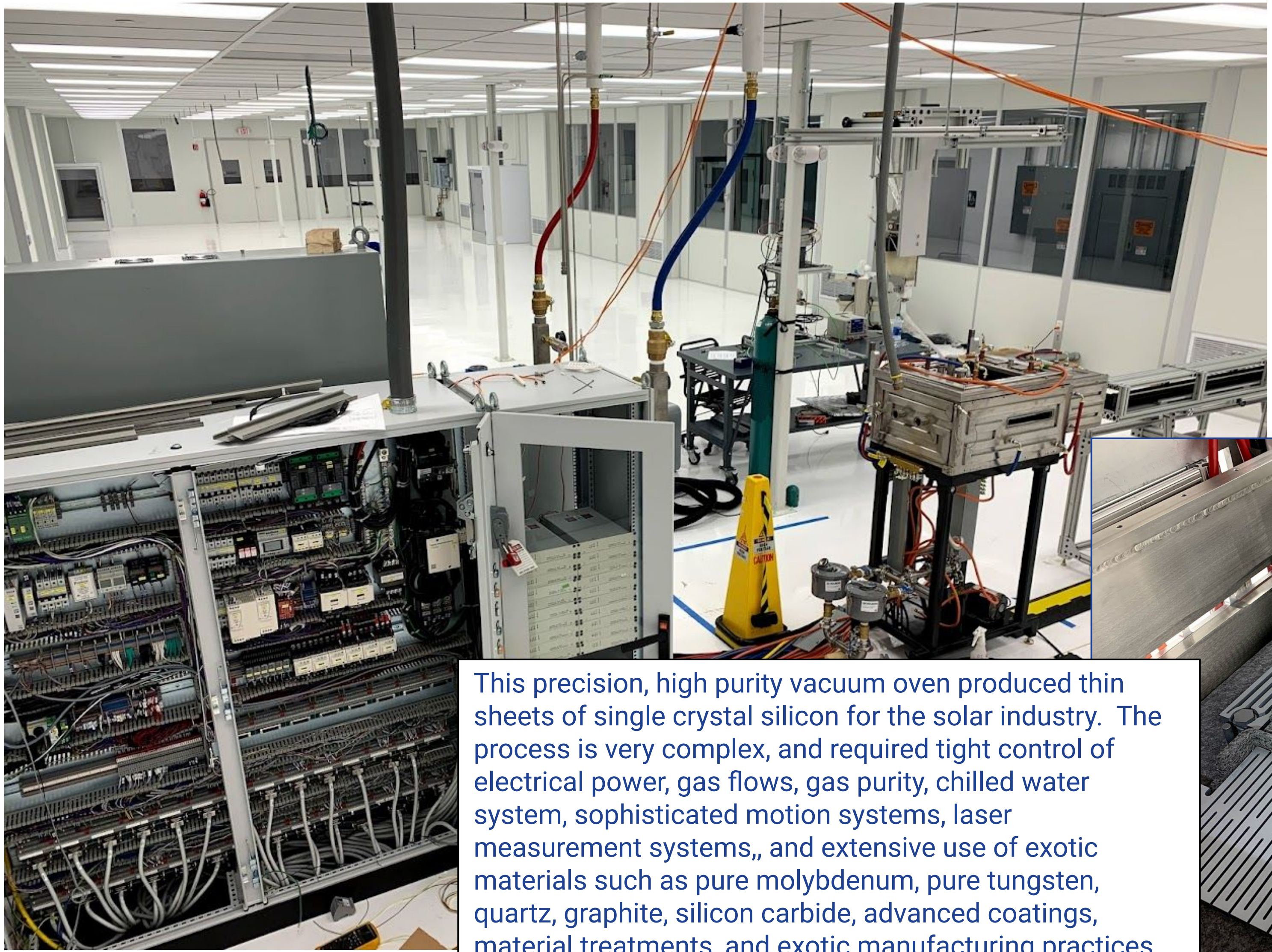
SPARE
TPp
TPp

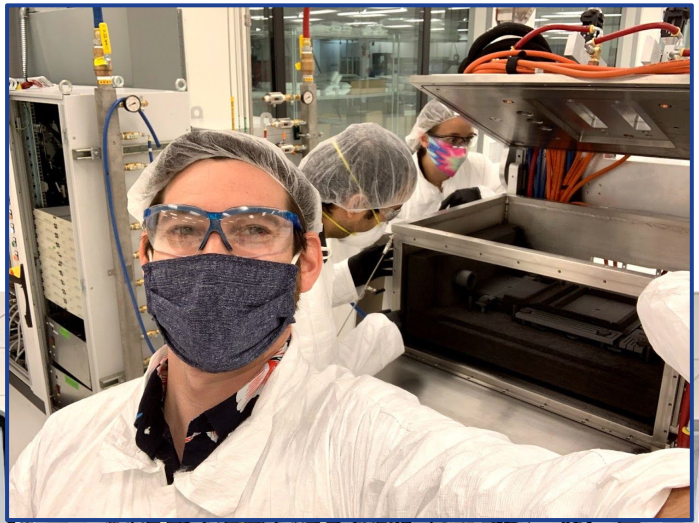
Alex Martinez

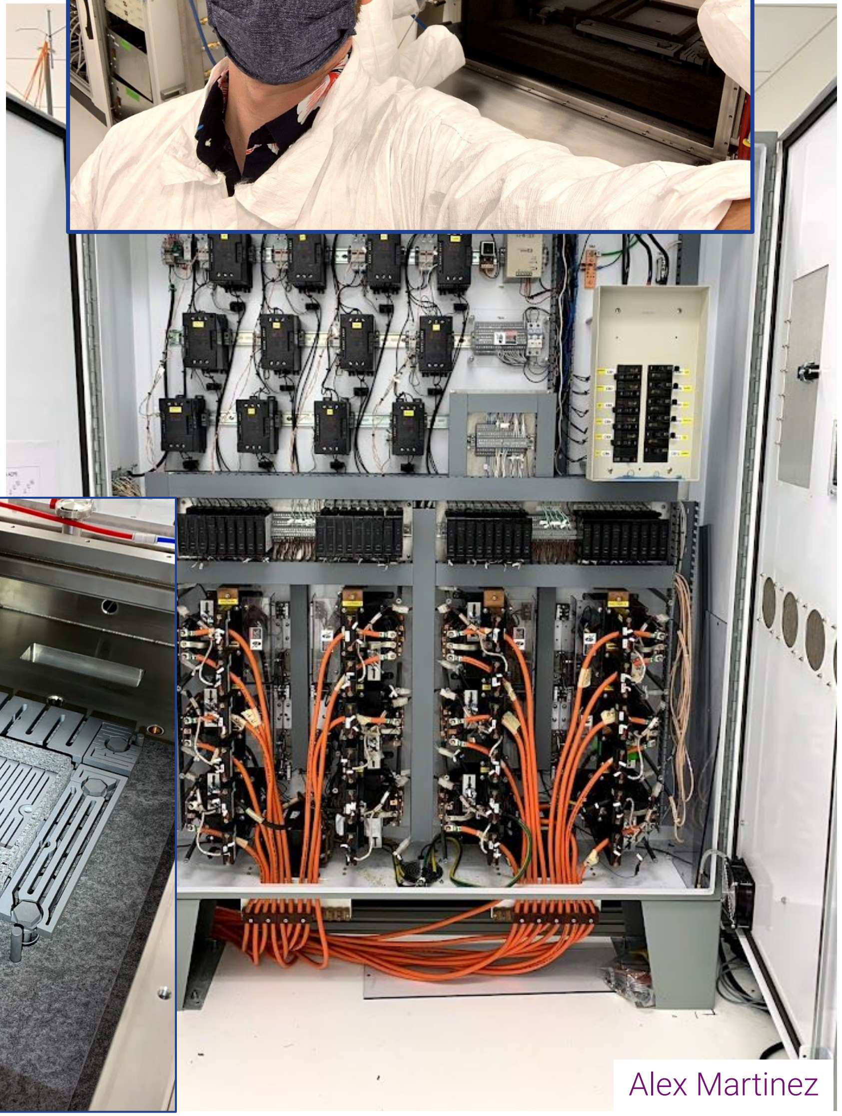
Alex Martinez
Lead Mechanical Engineer
Leading Edge Crystal

1414°C Molten Silicon Casting Furnace

I designed virtually everything shown







This precision, high purity vacuum oven produced thin sheets of single crystal silicon for the solar industry. The process is very complex, and required tight control of electrical power, gas flows, gas purity, chilled water system, sophisticated motion systems, laser measurement systems,, and extensive use of exotic materials such as pure molybdenum, pure tungsten, quartz, graphite, silicon carbide, advanced coatings, material treatments, and exotic manufacturing practices.

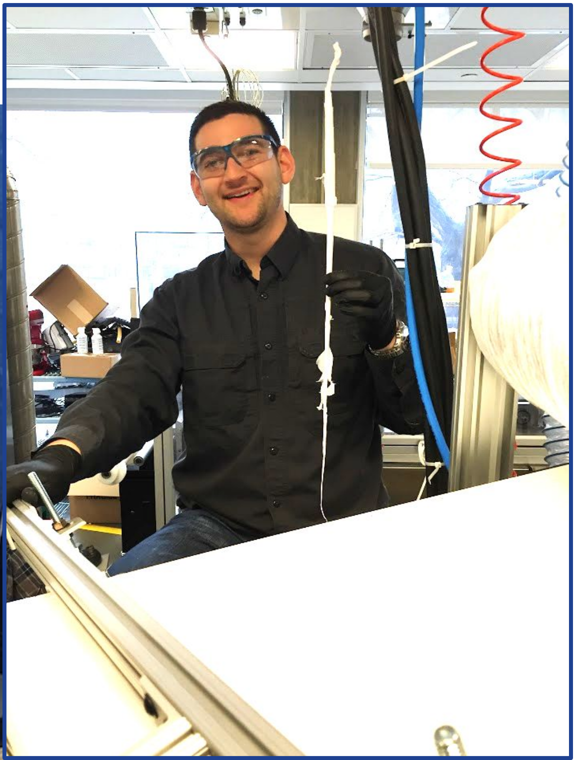
Alex Martinez

Alex Martinez
Lead Research Engineer
MIT

Novartis-MIT Center for Continuous Manufacturing

Continuous Pharmaceutical Electrospinning @ MIT

I designed virtually everything shown

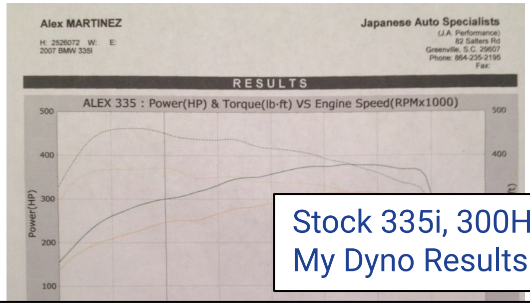


I designed and built a machine that charges a liquid solution of drug product and polymer to 80,000 - 100,000 volts, causing it to spontaneously fling to a grounding plate in a process known as electrospinning. In flight, the liquid strands pull thin, and dry, forming nanofibers. I generated sheets of nanofibers, and designed mechanisms to convey and roll them into a long spiral (I'm holding it in the photo above). That long roll would then be chopped to about 0.3 inch long, and compressed into a tablet shape (other photo). This multi-year effort served as a valid proof of concept to continually produce pharmaceutical tables based on electrospinning.

Alex Martinez
Freelance Engineering Consultant
and
Personal Projects

Car Hobby ~2012

Upgraded Intercooler



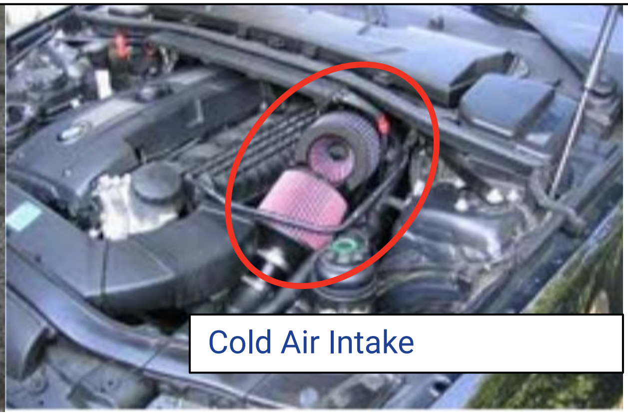
Stock 335i, 300HP, ~300ft-lb Torque
My Dyno Results **379**HP, **462**ft-lb Torque.

All modifications were done myself in my garage.
Dyno performance testing was done at 3rd party lab.

Alex's 2007 BMW 335i Twin Turbo Modifications

- *Vishnu Procede* Aftermarket Engine Computer **+55HP**
  - Intercepts and falsifies altitude and air density values to trick the OEM BMW engine computer to make the turbos work harder and produce more power.
- K&N Cold Air Intake **+5HP?**
  - Decreases incoming air temperature, increases density, reduces likelihood of fuel pre-detonation (engine knock), and decreases air flow resistance through the filter element.
- ETS Intercooler Upgrade **+10HP?**
  - Decreases intake air temperature post-turbo-compressor, increasing density, decreasing likelihood of knock, decreasing flow resistance.
- Methanol Injection System **+10HP?**
  - Methanol mist injected directly into the post-compressor air intake evaporates and further cools the air, increases the effective octane rating of the fuel/air mix, stabilizing it against pre-detonation or knock. Higher octane fuel is ***more stable,*** not higher energy density.

Methanol Injection System



Cold Air Intake

- **More Oxygen**
- **More Fuel**
- **More Power**
- **Avoid Knocking and Misfiring**

Home Project 2024- RO/DI Ultrapure Laboratory Water System

I need ultrapure water for my home laboratory for a variety of applications and it was not feasible to buy distilled water gallon by gallon.

- Drug dissolution media preparation
- Probe calibration solution preparation
- Simulated Gastric Fluid media preparation for ingestible med device client work.

- I also have a planted fish tank that requires water with lower hardness than my municipal supply, so I prepare water from scratch using RO/DI water and precise levels of added minerals.

Alex Martinez

Home Project: Commercial Seltzer System & Chiller ~2017

Finished Seltzer draft arm with equipment hidden in adjacent closet.

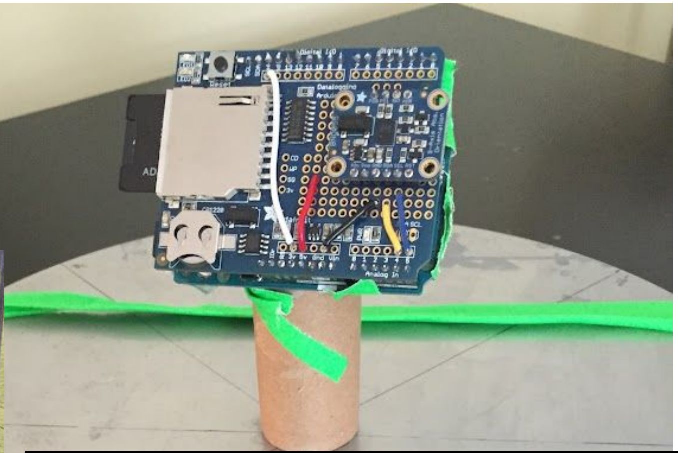

Drill out/modify Bar Cabinet


Installed shelves, mounting panels, and I ran new plumbing and electrical supplies.

Arrived on Pallet


Install carbonator, CO_2 tank, and ice chiller on vibration isolation pads

Vehicle Action Camera - Consulting Client ~2015

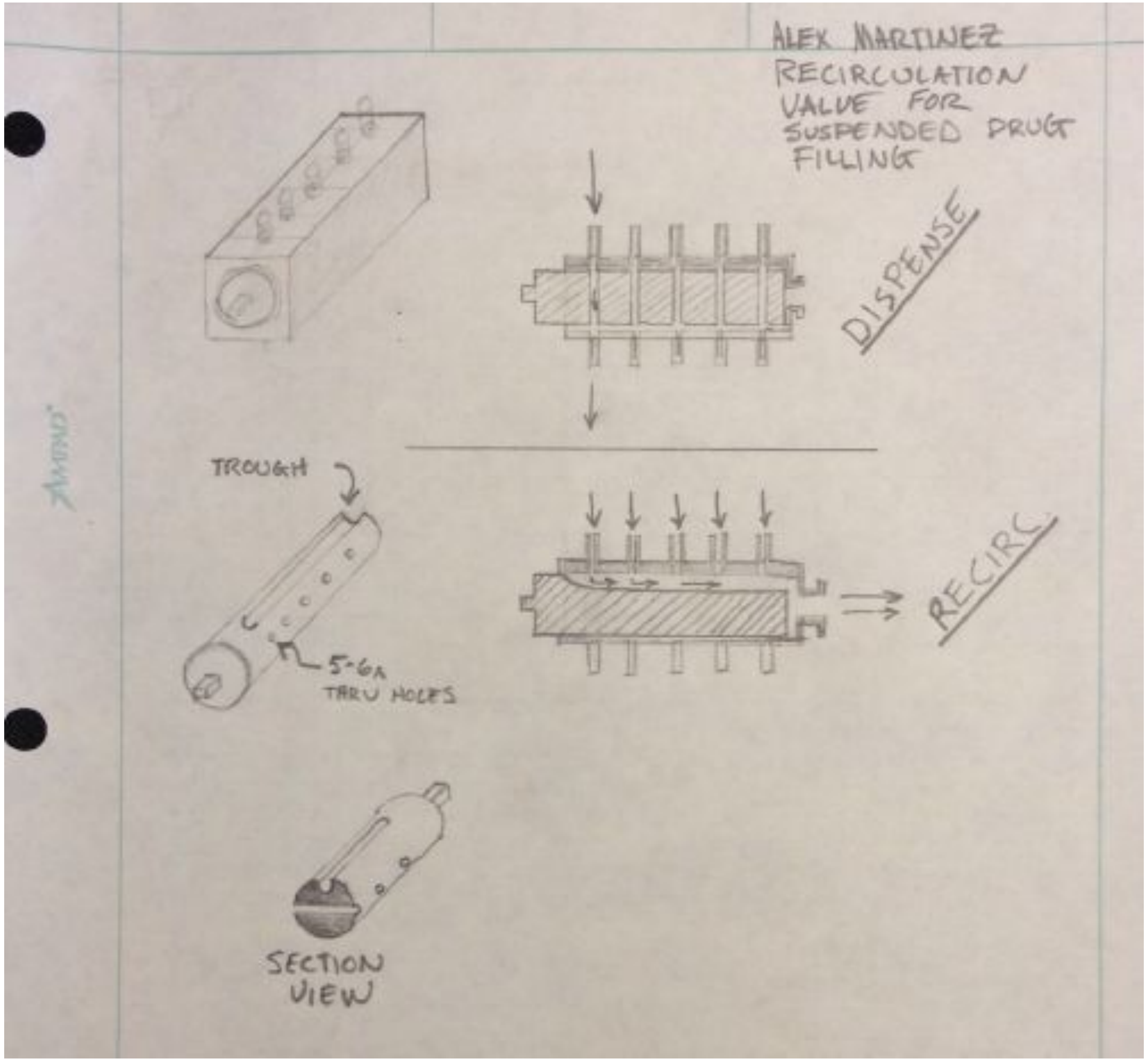


The device detects lateral acceleration (G forces) and adjusts the yaw angle of the action camera via servo to capture the vehicle turning, such as in a race track.

Additionally I had a OBDII connector in the vehicle diagnostic port to capture dozens of real time vehicle performance data streams including engine RPM and road speed, from which I calculated the transmission gear.

The camera being developed would compile all this data and co-record it and superimpose it on the driving footage

Pharmaceutical Recirculating Valve ~2006



High Value Drug Suspension ($1000’s/mL) wasted due to purging requirement between manufacturing runs (automated vial filling). Drug suspension would settle during off-time.

My invention allowed for the liquid suspension to remain moving during machine downtime, eliminating need for purge.

Sensitive pharma application forbade the addition of new wetted materials, so no elastomer seals were permitted. Instead I deployed a full 316L stainless steel design that was piston/cylinder matched to some millionths of an inch tolerance via precision grinding and honing, providing an adequate seal.

Alex Martinez
Mechanical Engineer
General Electric Fleet and Prototype Test

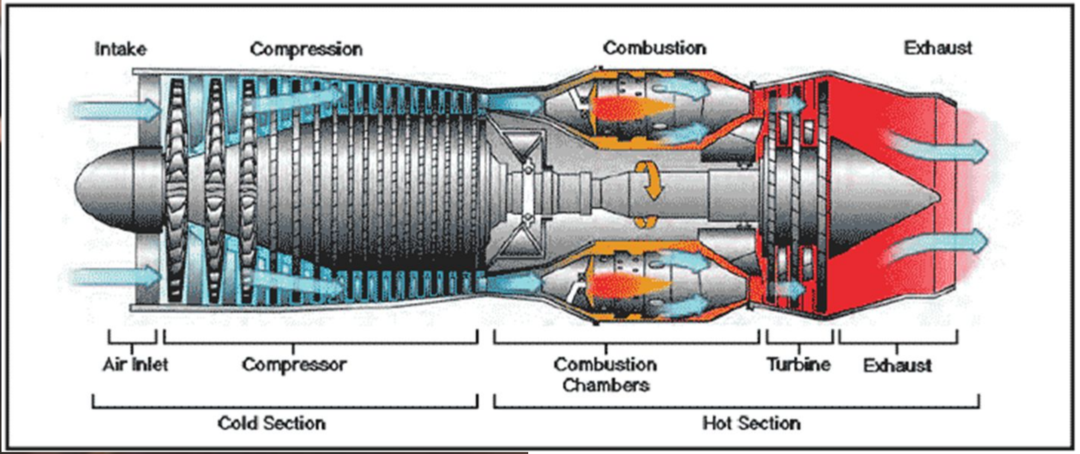
Alex Martinez

Alex Martinez

GE Gas Turbine, Greenville, SC

Natural Gas powered “Land-Based Jet Engine” for generating electricity.

The “FA” machine operated at higher temperatures than previous machines to improve thermal efficiency, however the increased temperatures required new materials, coatings, and manufacturing methods which needed to be tested and validated.



Alex Martinez


I pulled this photo from Google Images solely to demonstrate the general size and scale and complexity of a Gas Turbine.
SIEMENS

I pulled this photo from Google Images solely to demonstrate the general size and scale and complexity of a Gas Turbine.

GE Gas Turbine “Buckets” or power turbine airfoils. These airfoils experience the hot, high speed combustion gases and convert them into rotational power.

At the leading edge of each airfoil, a small divot was excavated, and an irradiated crystal with atomic dislocations (crystallographic imperfections) was buried and covered with a small nickel chrome cover plate.

After operation at high temperature, the crystals are excavated and analyzed by a 3rd party laboratory to determine the level of stress relaxation (dislocation reduction), and thus can be used as an indicator of the temperature experienced at that location during engine operation.

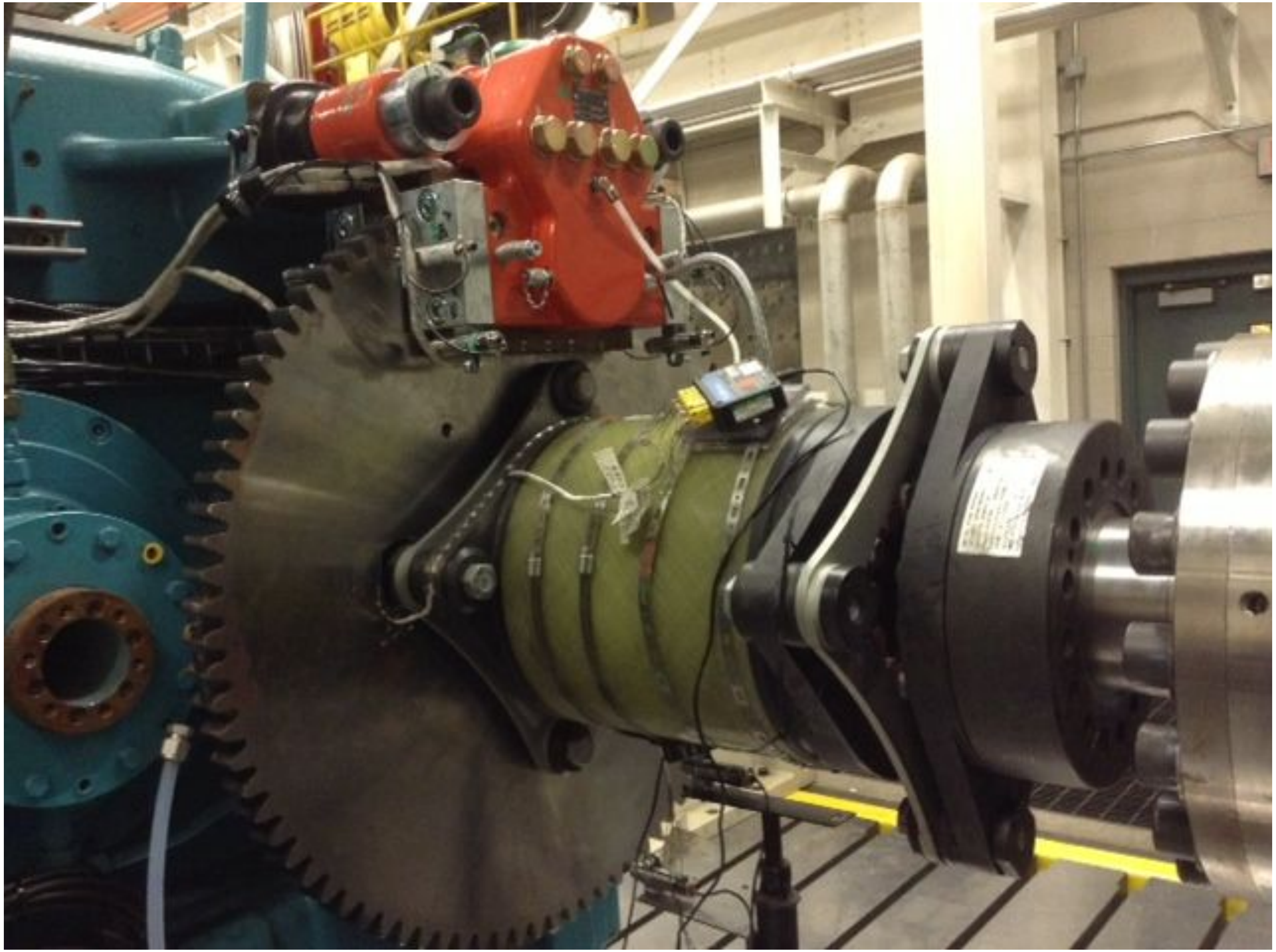
These crystals are used when there is no other feasible option to measure and record temperature due to a variety of engineering challenges (oxidation stress, absolute temperature, effect on flow path, etc.)

Alex Martinez

GE Wind Turbine Machine Head

I designed test and instrumentation schemes for these units, including strain gages, load cells, accelerometers, temperatures, etc.

Designed HALT (Highly Accelerated Life Test) protocols for structures and gearbox evaluations



GE Wind Turbine Gearbox Disc Brake Thermal Performance Test

-Some sensors on rotating equipment (wireless comm.)
-Some sensors static (wired comm)

Alex Martinez

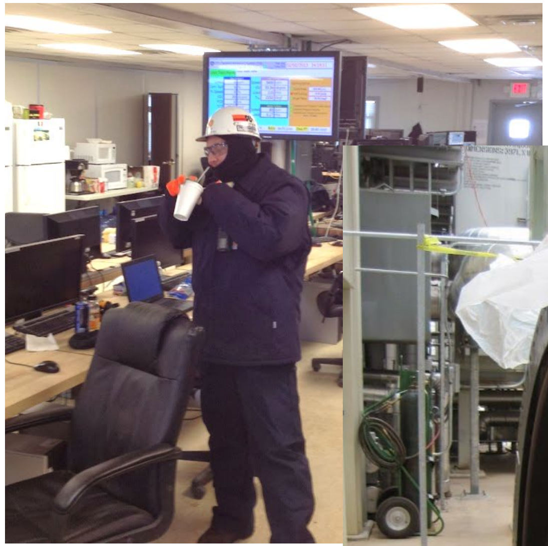
GE Wind Turbine Gearbox Disc Brake Thermal Performance Test

-Brake Pad after Test
-Note the metallic thermocouple lines installed throughout, measuring various brake pad temps, and brake shoe temps.
-Type K, Special Limits, MgO insulation, ungrounded junction.

GE Wind Turbine Gearbox Disc Brake Thermal Performance Test

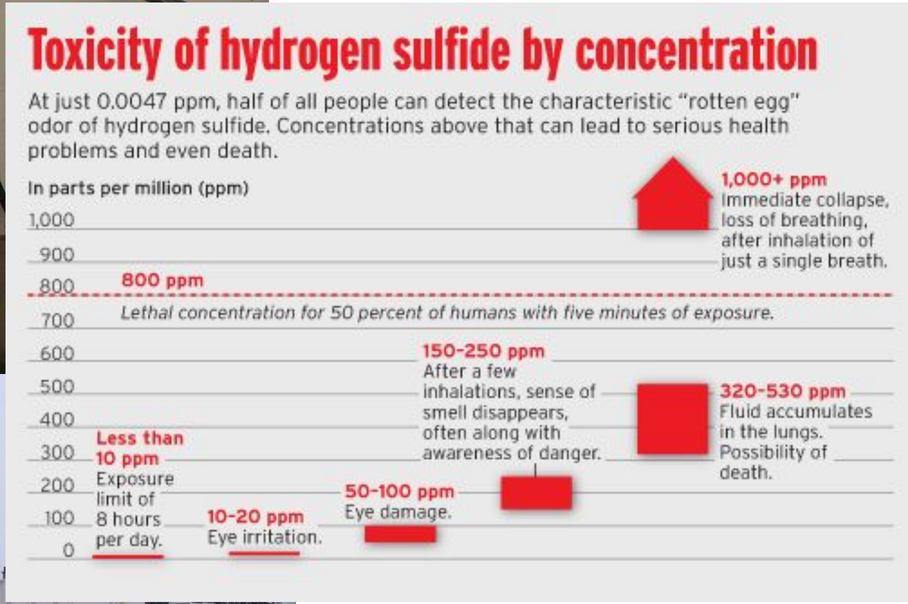
-Brake Disc after Test
-Note the metallic thermocouple lines installed throughout, measuring various brake disc temps
-Type K, Special Limits, MgO insulation, ungrounded junction.

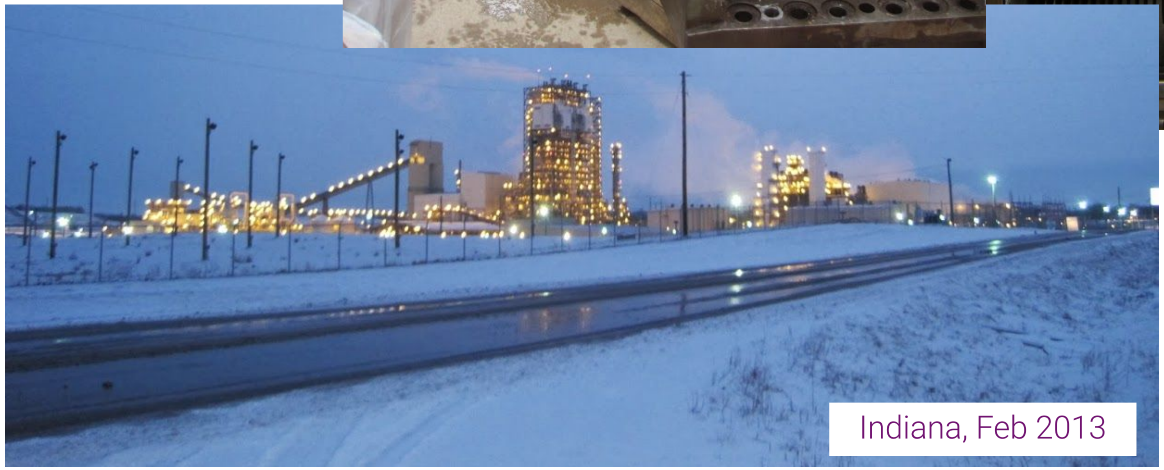
More GE Powerplant work, this time I was stationed in Incheon, South Korea for 1 month to test an upgrade package.



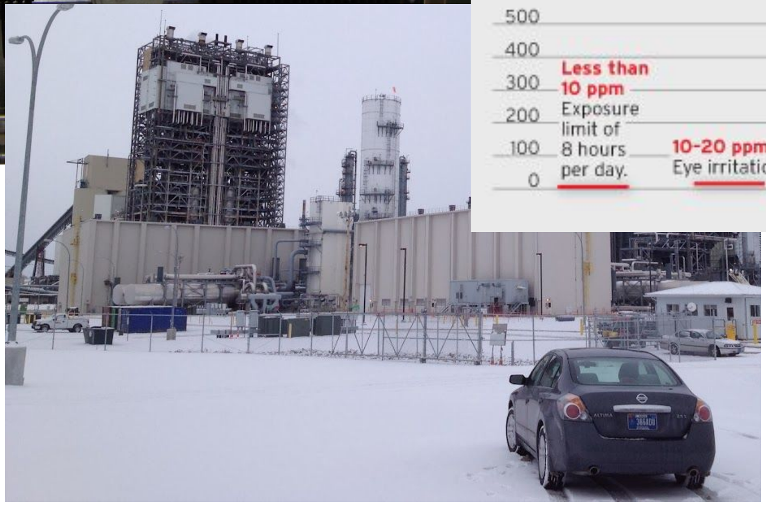
20%, (**200,000 ppm**) Hydrogen Sulfide gas analysis cabinet at IGCC (Integrated Gas Combined Cycle) Power Plant.

“Clean Coal Power Plant” technology that converted powdered coal to a combustible gas that fueled Gas Turbines.

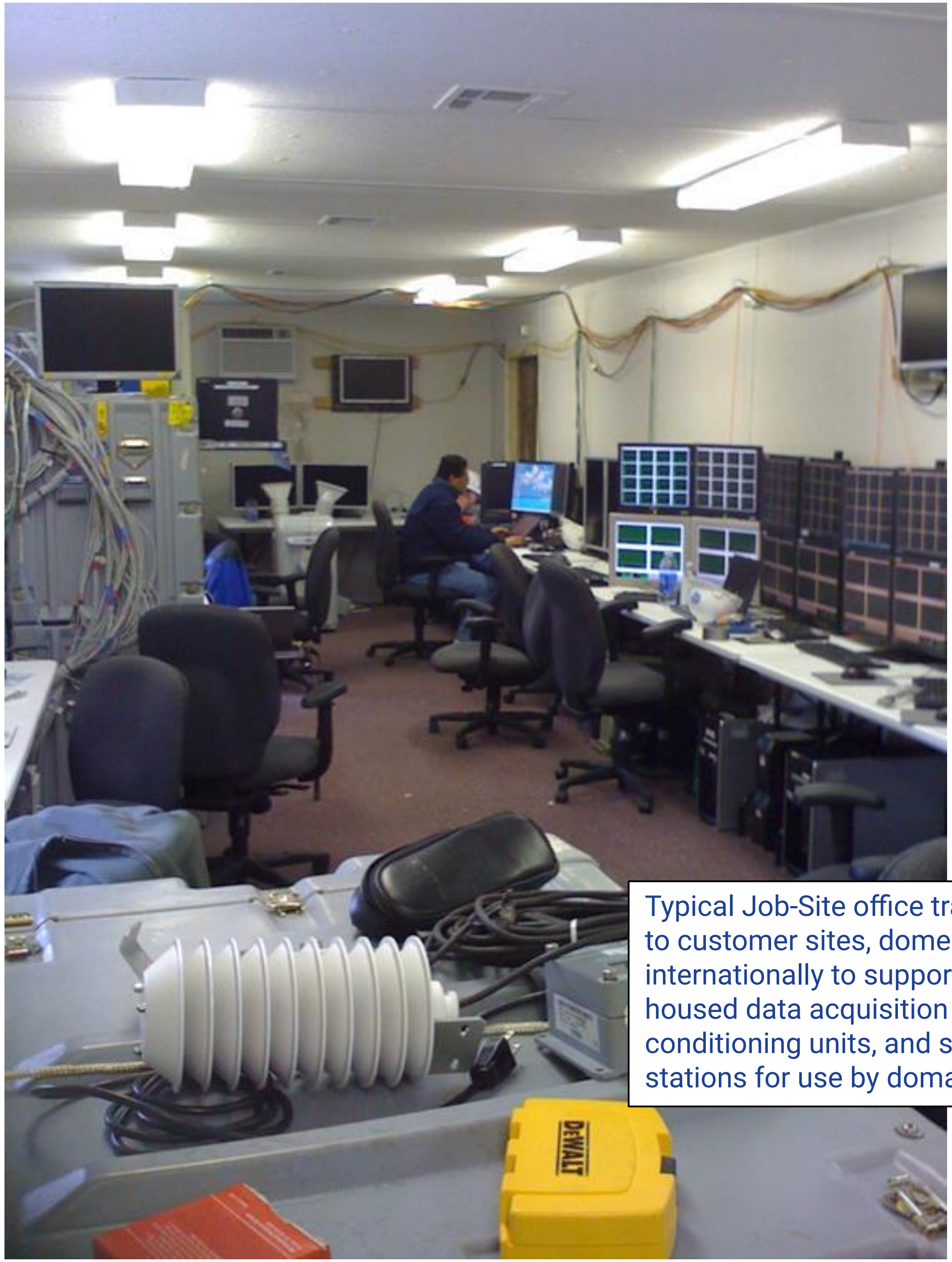




Indiana, Feb 2013

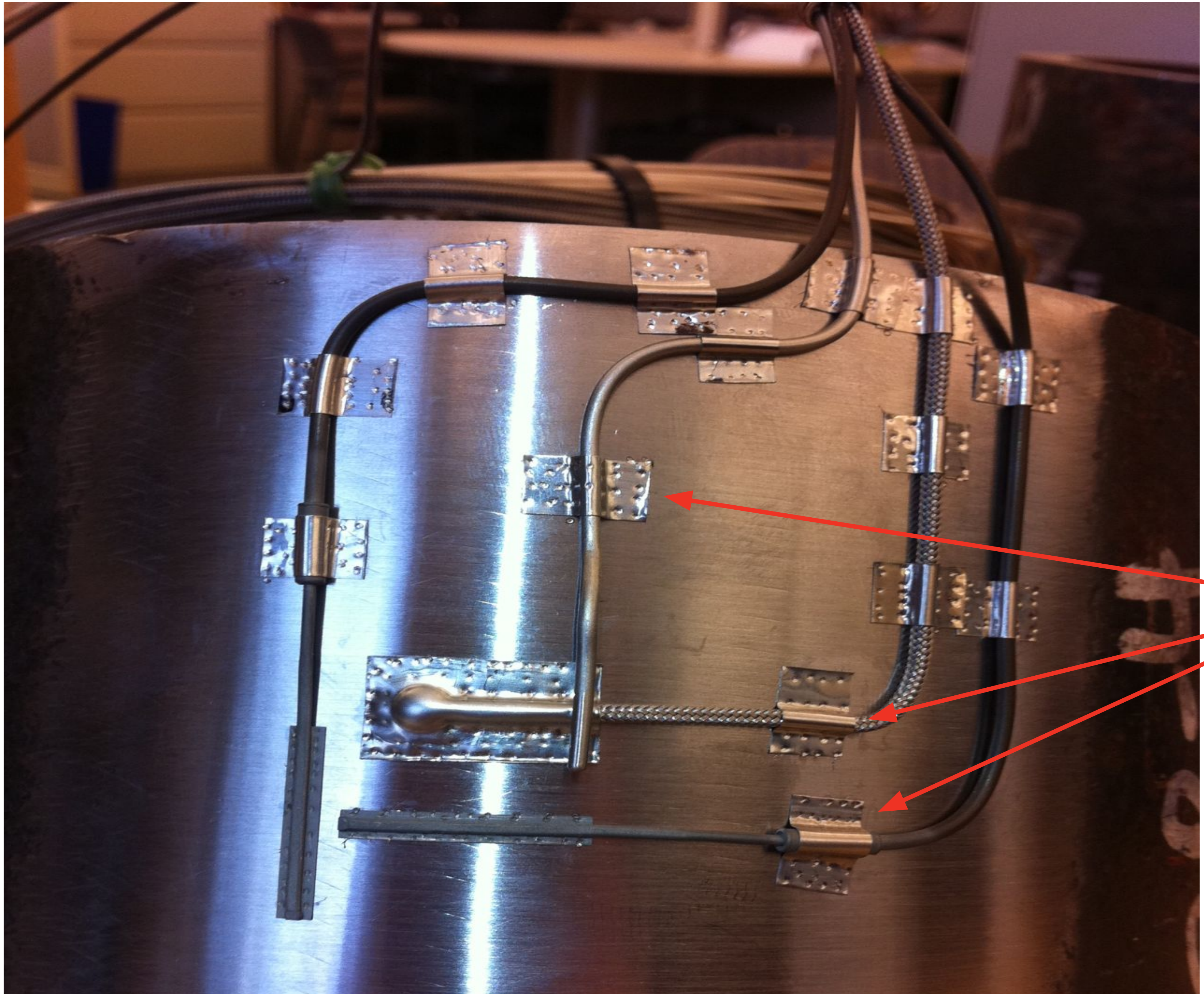


Alex Martinez



Typical Job-Site office trailer that I would deploy to customer sites, domestically and internationally to support test activities. Trailers housed data acquisition equipment, signal conditioning units, and signal monitoring stations for use by domain experts on test days.

Alex Martinez



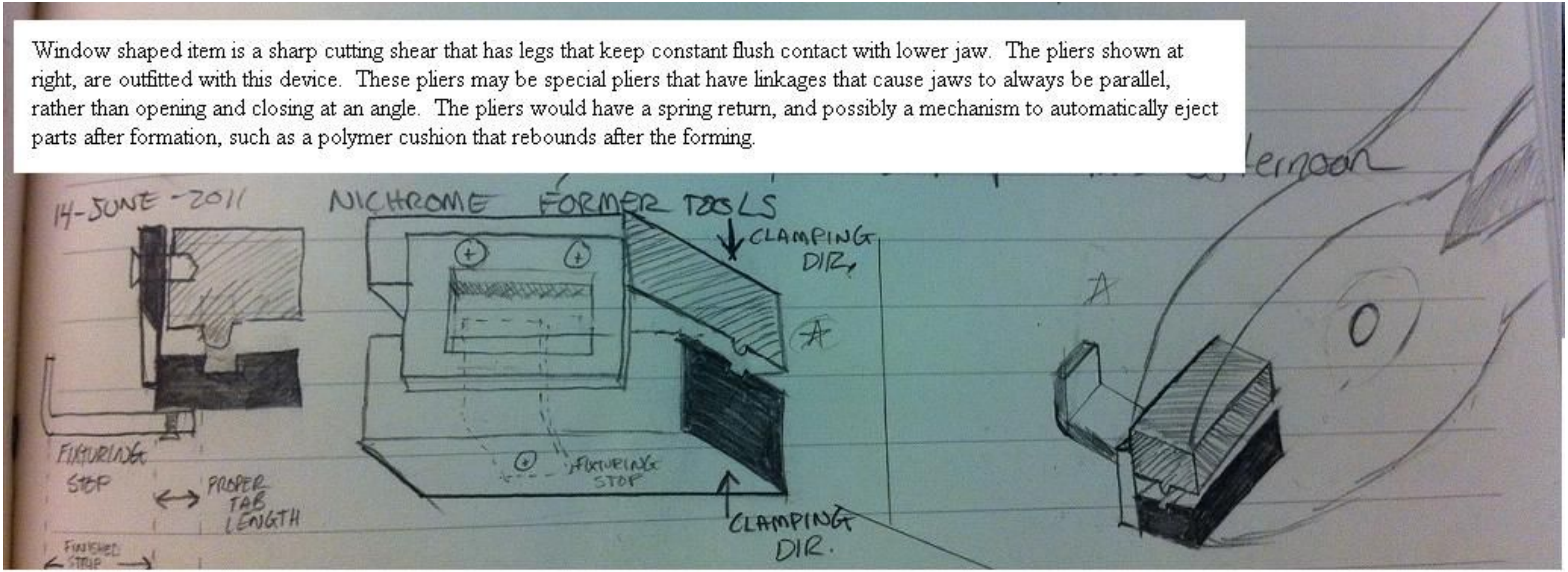
HRSG (Heat Recovery Steam Generator) Piping Mockup.

Through the use of 1x thermocouple and 2x strain gages, and an oven, I was able to determine Poisson Ratio and Coefficient of Thermal Expansion. In the field, the piping was subjected to significant fluid pressure as well as thermal stress. Bench testing beforehand allowed for the various field stresses to be differentiated.

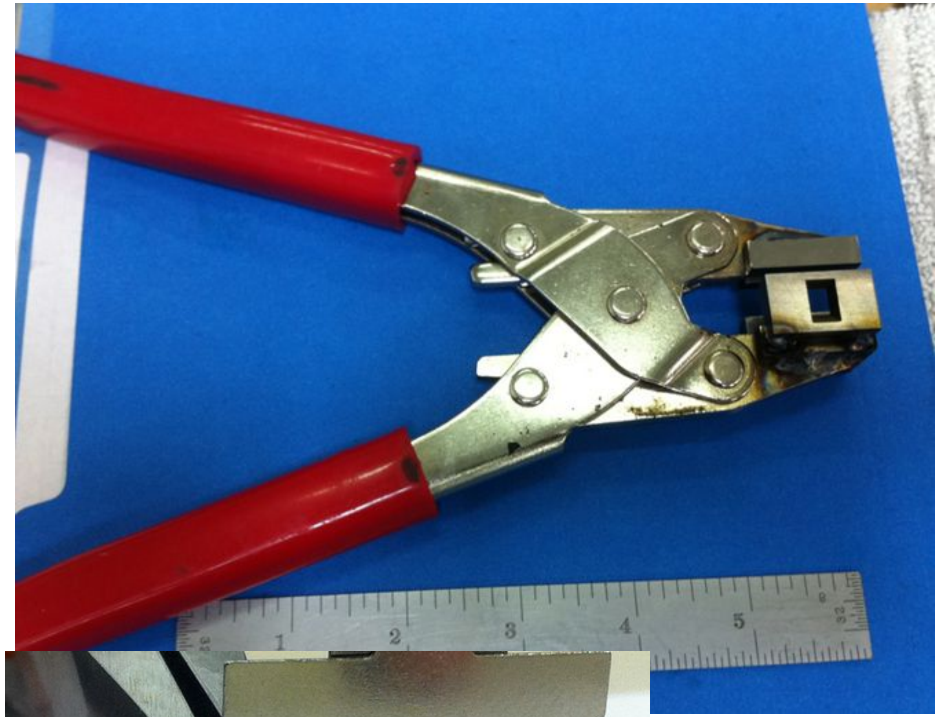
Nickel-Chrome (Nichrome) strips with resistance welds, hold down instrumentation lines on high temperature components. We used thousands of these handmade strips which were time consuming to make, and shape. A prototype automated forming machine is described in the next slides.

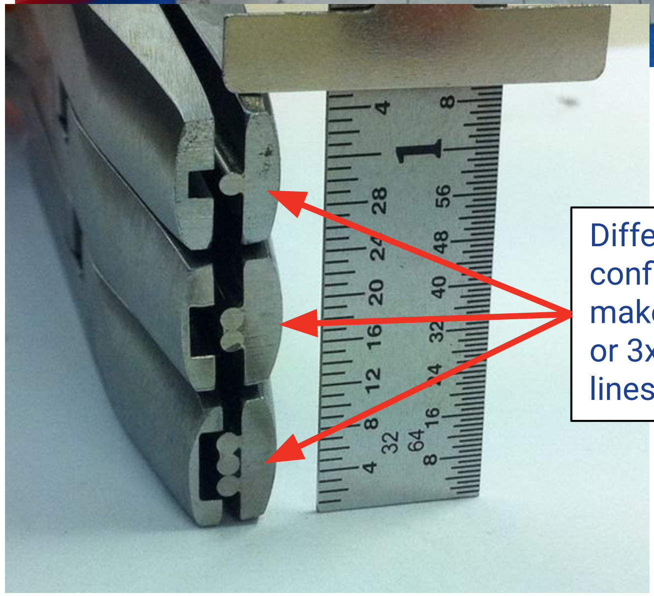
Nichrome Forming Hand Tool Concept ~2011

Window shaped item is a sharp cutting shear that has legs that keep constant flush contact with lower jaw. The pliers shown at right, are outfitted with this device. These pliers may be special pliers that have linkages that cause jaws to always be parallel, rather than opening and closing at an angle. The pliers would have a spring return, and possibly a mechanism to automatically eject parts after formation, such as a polymer cushion that rebounds after the forming.

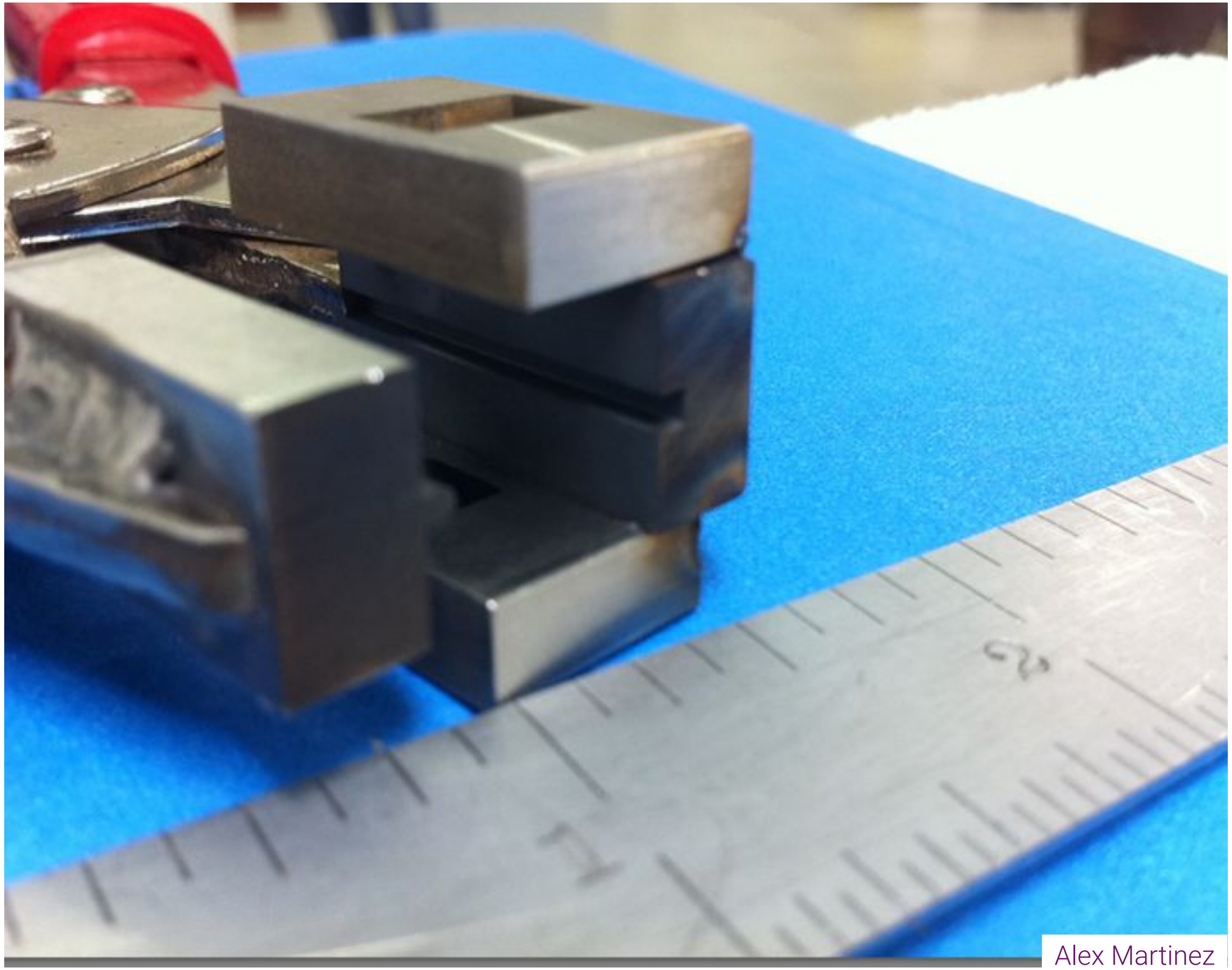


Nichrome Forming Hand Tool Prototype



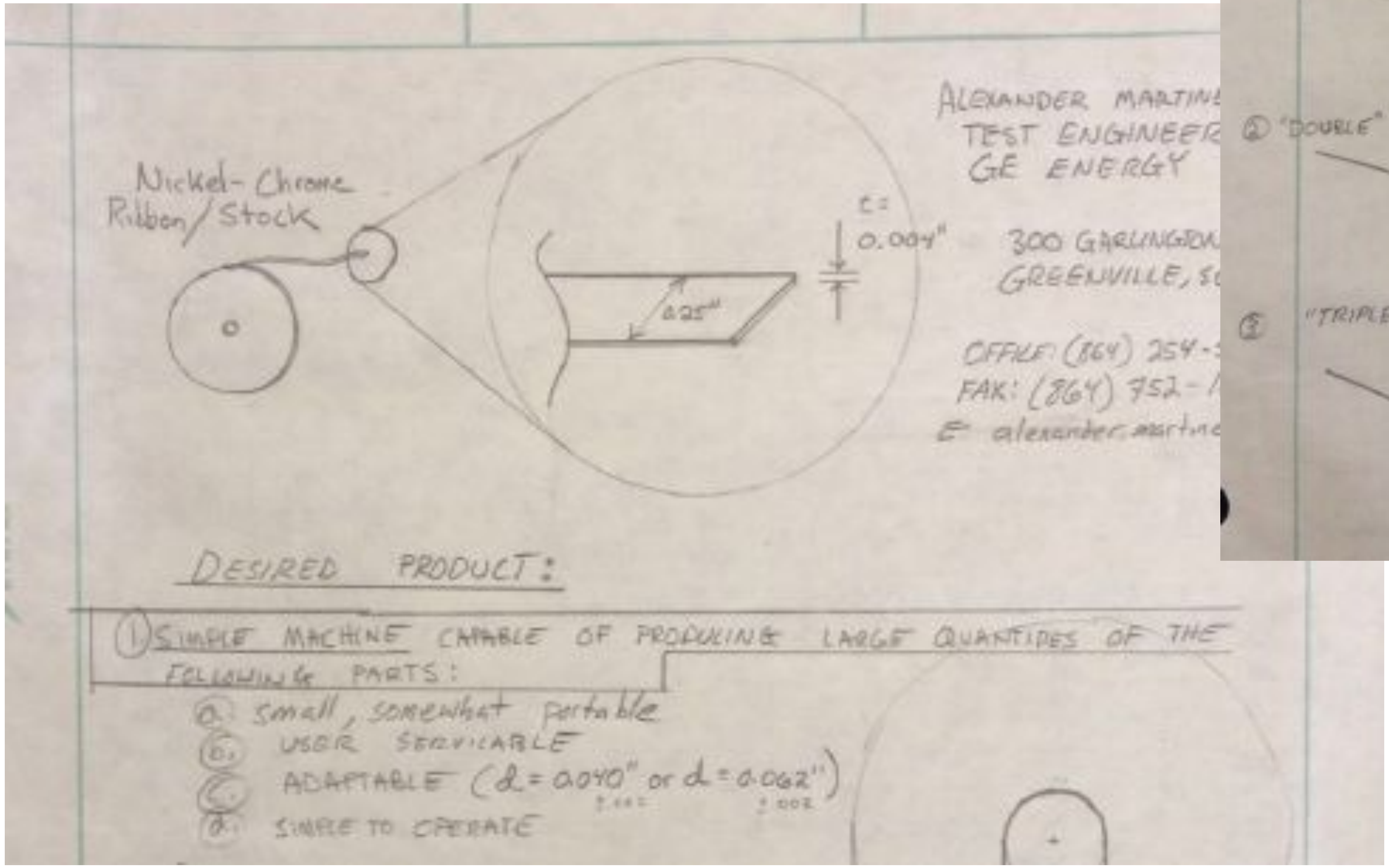


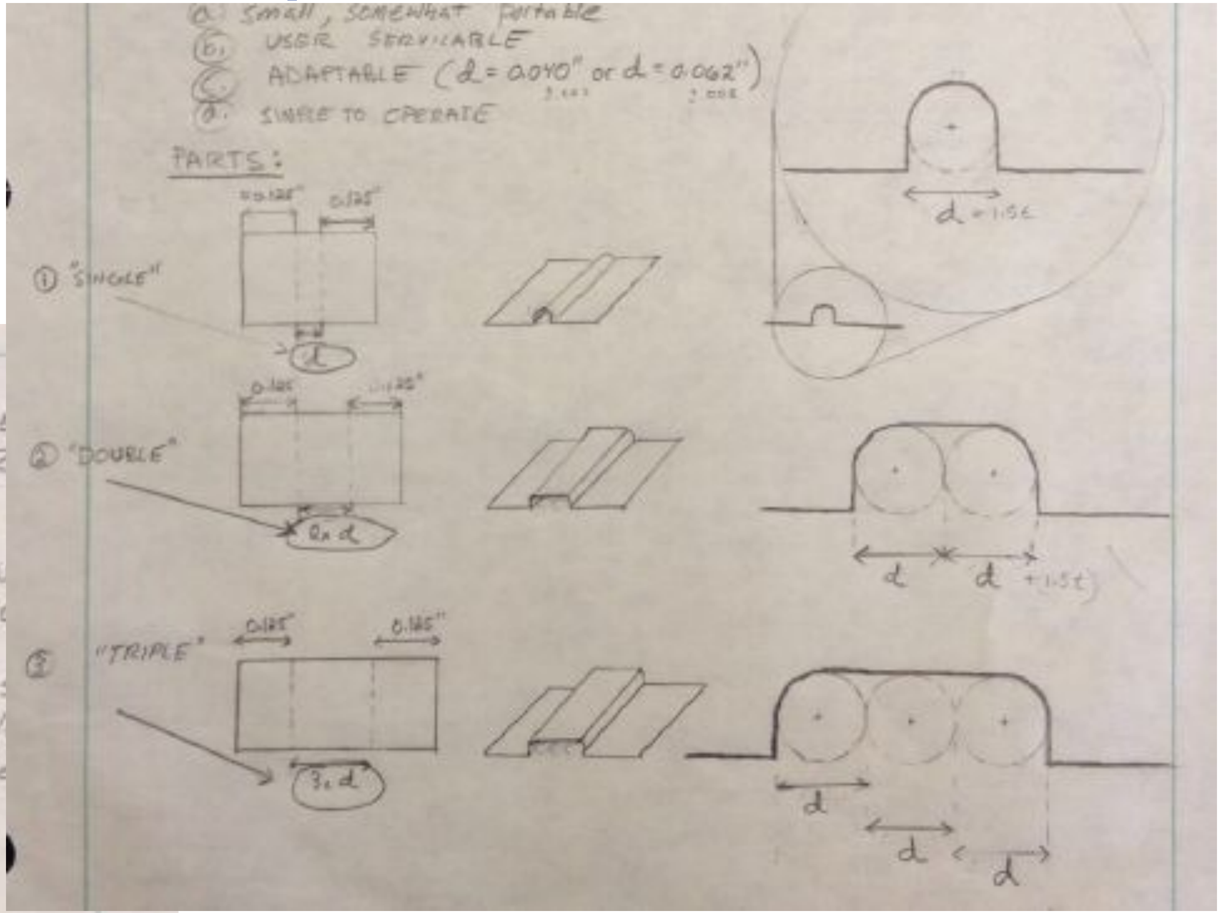
Different configurations to make strips for 1x 2x, or 3x parallel signal lines.



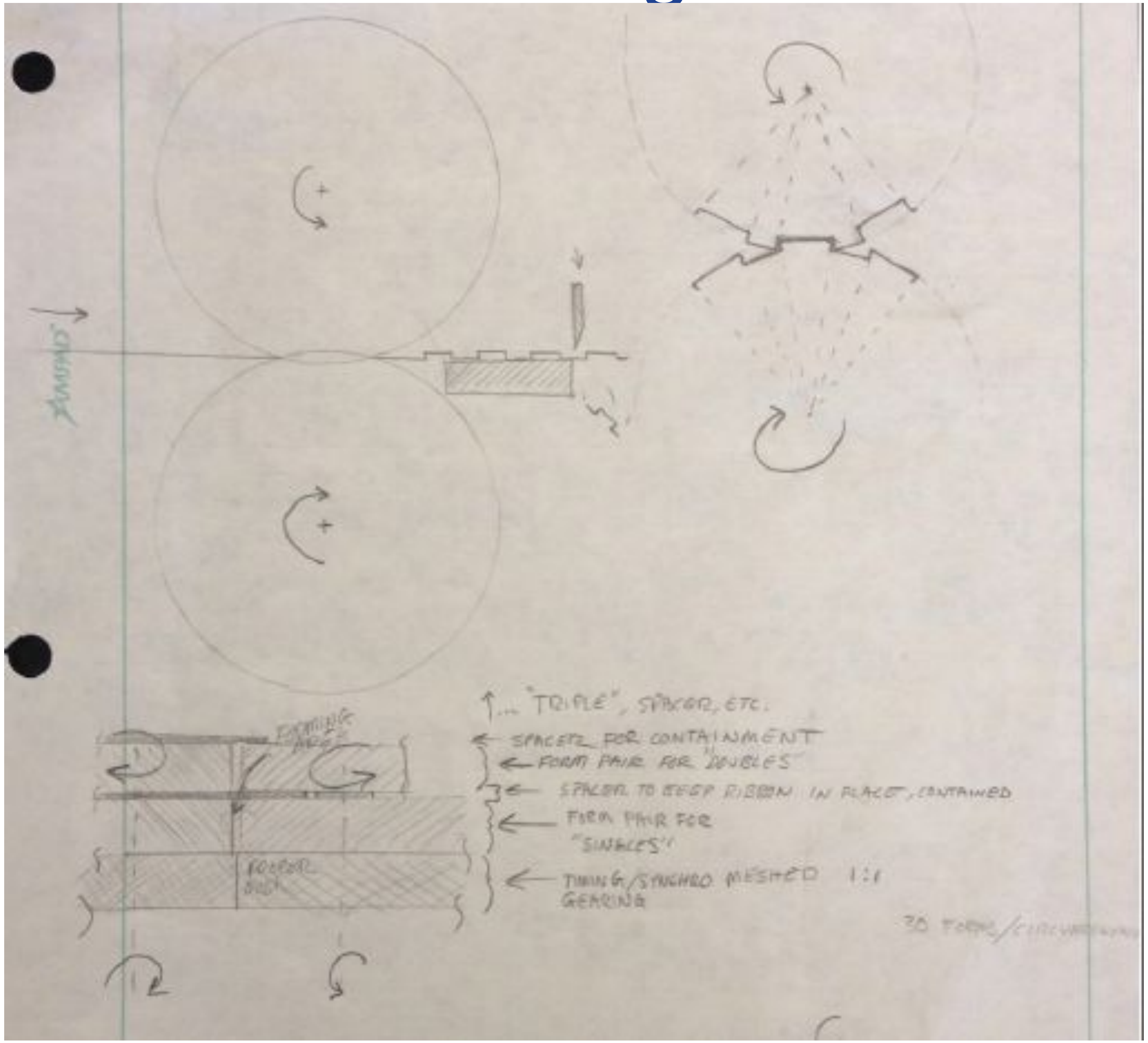
Alex Martinez

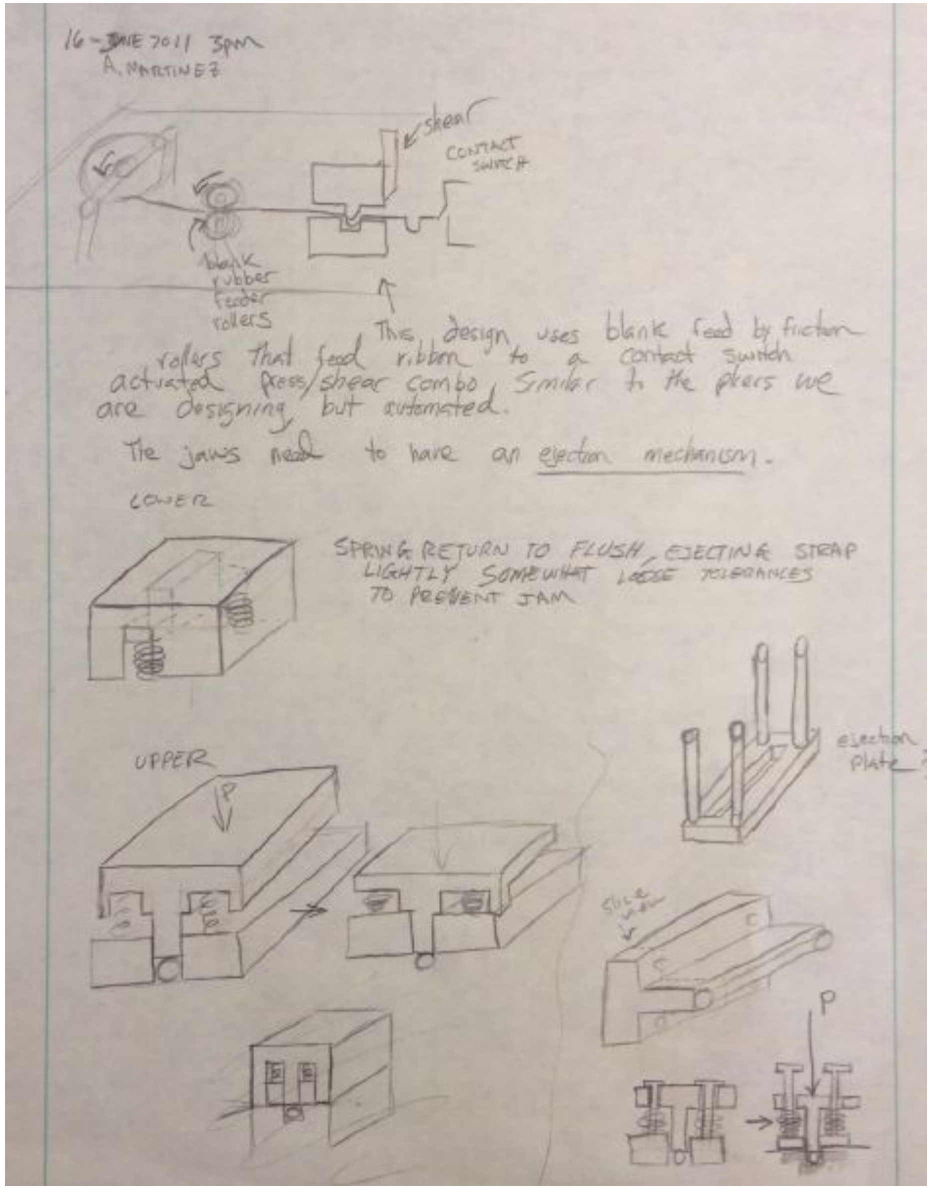
Automated Forming Tool Concept ~2011





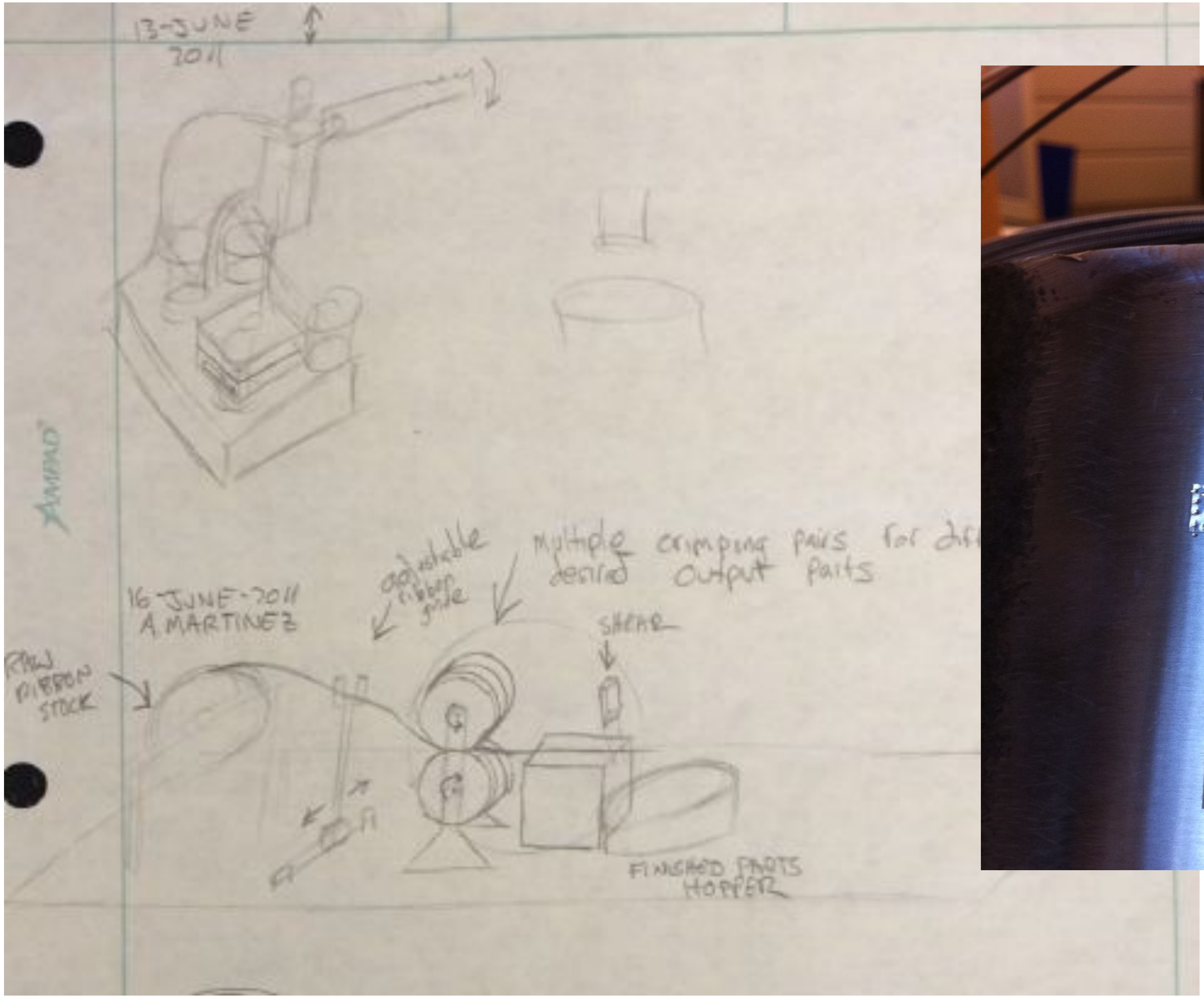
Automated Forming Tool Concept ~2011





Alex Martinez

Automated Forming Tool Concept ~2011

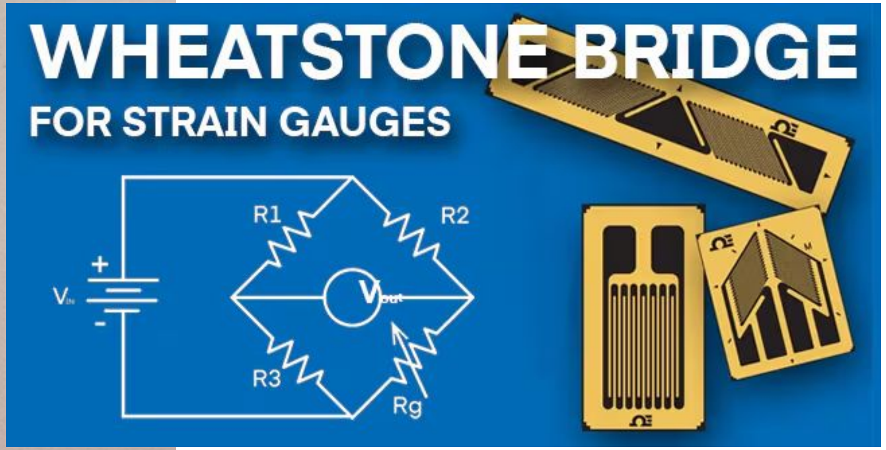


Handmade Simulated Strain Gage Circuit

There were many individual pieces of equipment in the signal path from the sensor itself to digital data recording, including various software filters and amplifiers and equipment settings.

I designed a proof of concept device with laser trimmed precision resistors that simulated a wheatstone bridge strain gage undergoing a known deformation.

A given strain gage could be temporarily disconnected and replaced with this device to confirm that all recording and filtering system settings are correct, and the correct strain values are recorded.



Alex Martinez

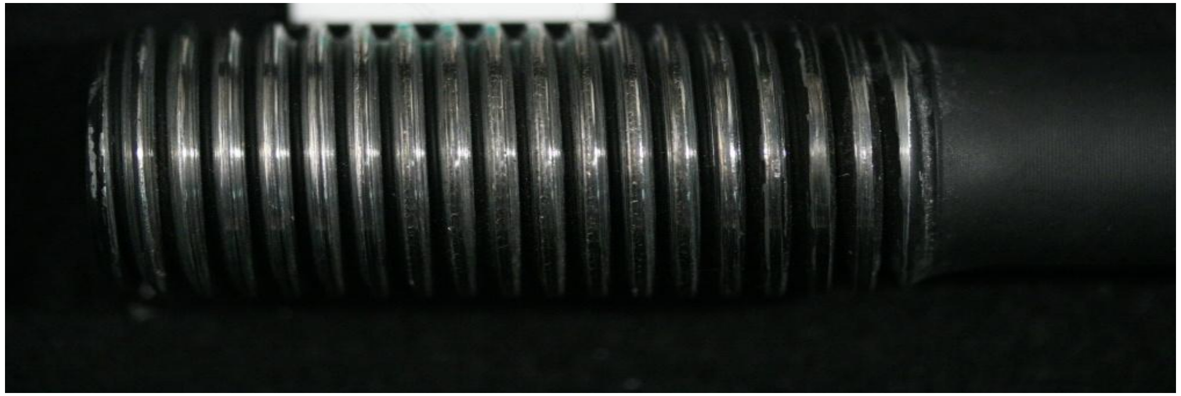
Materials and Processes Engineering Rotation Presentation

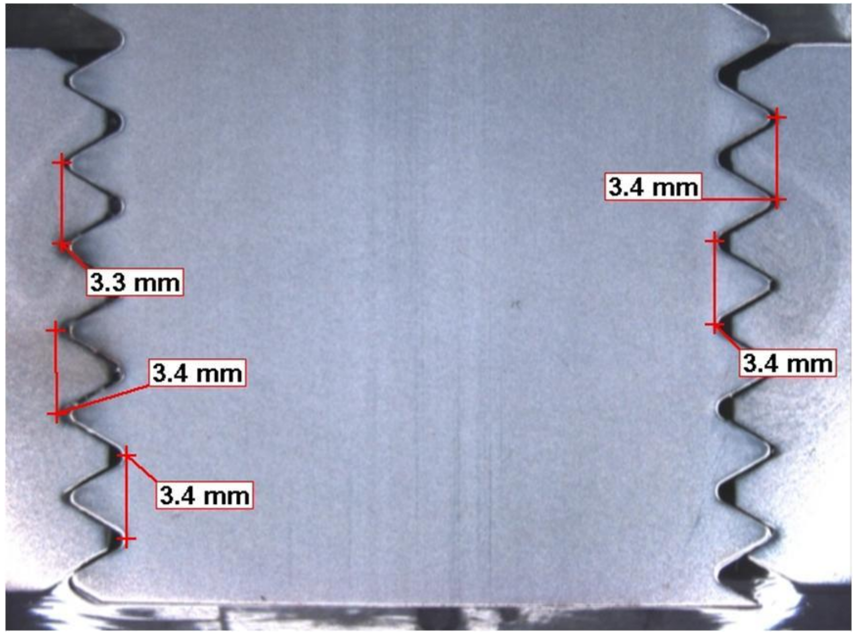
Alexander R. Martinez
GE Energy
EEDP Engineer

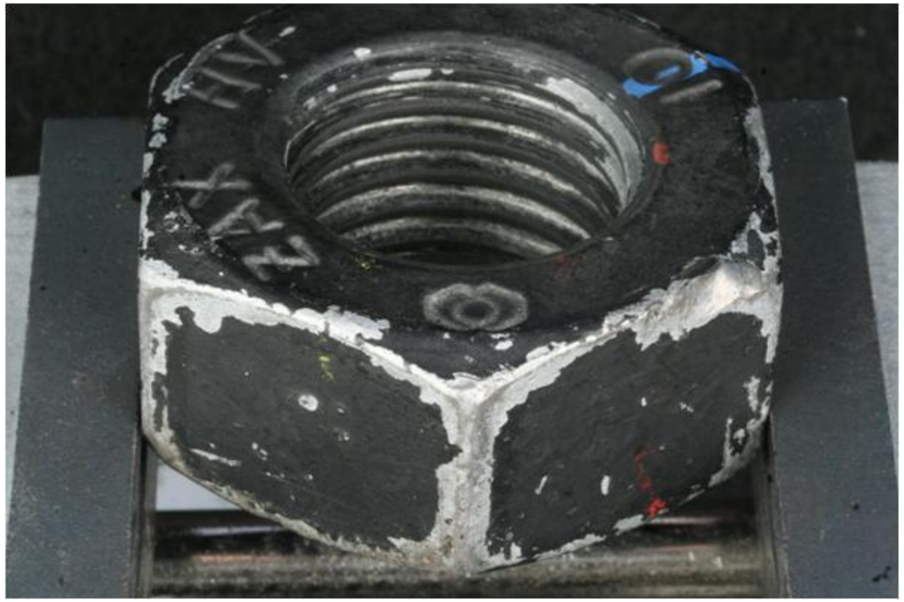
imagination at work

Wind – 1.5XLE Blade Stud

Field Issues arose during blade installation and nut tightening

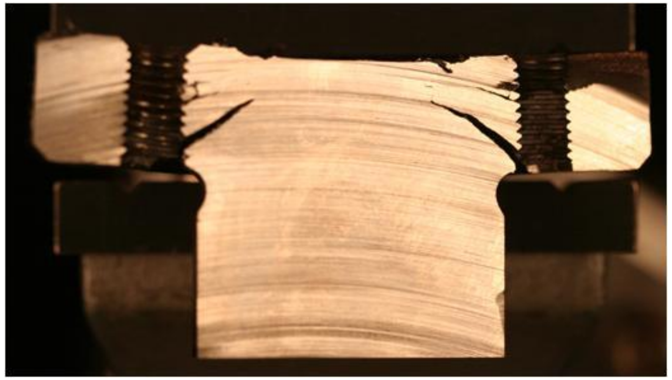


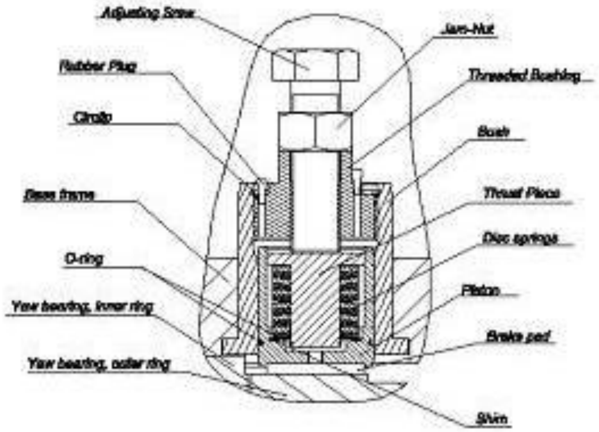


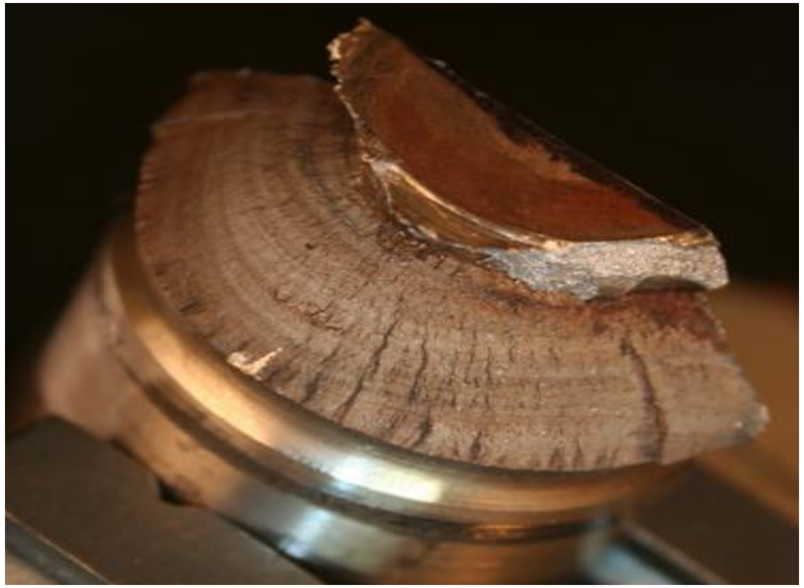


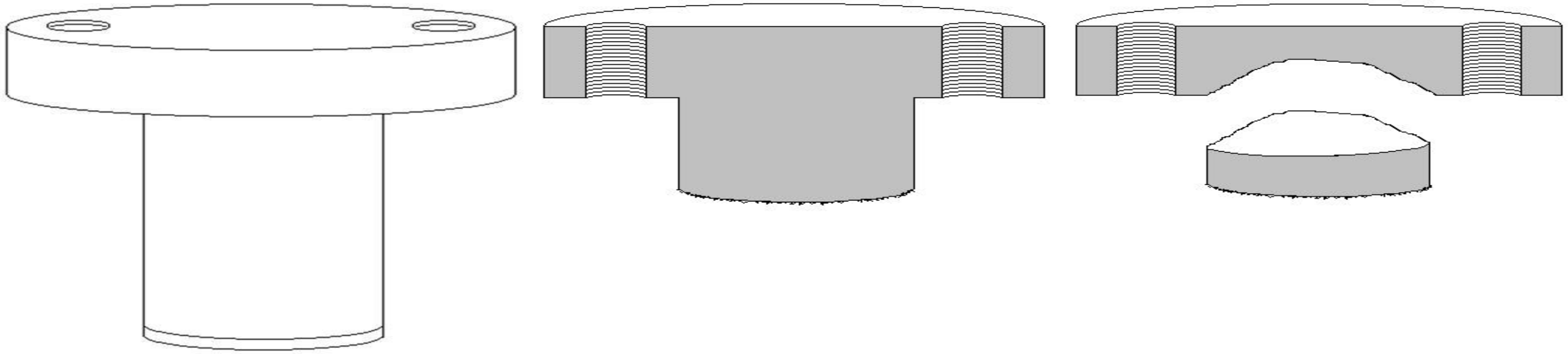
Wind Static Yaw Brake

Is “Foghorning” Related?









imagination at work

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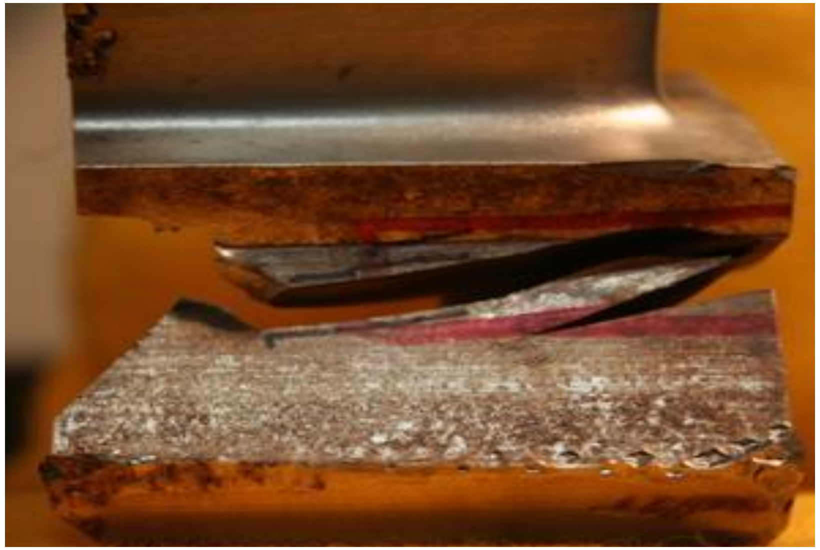
Dabhol R3

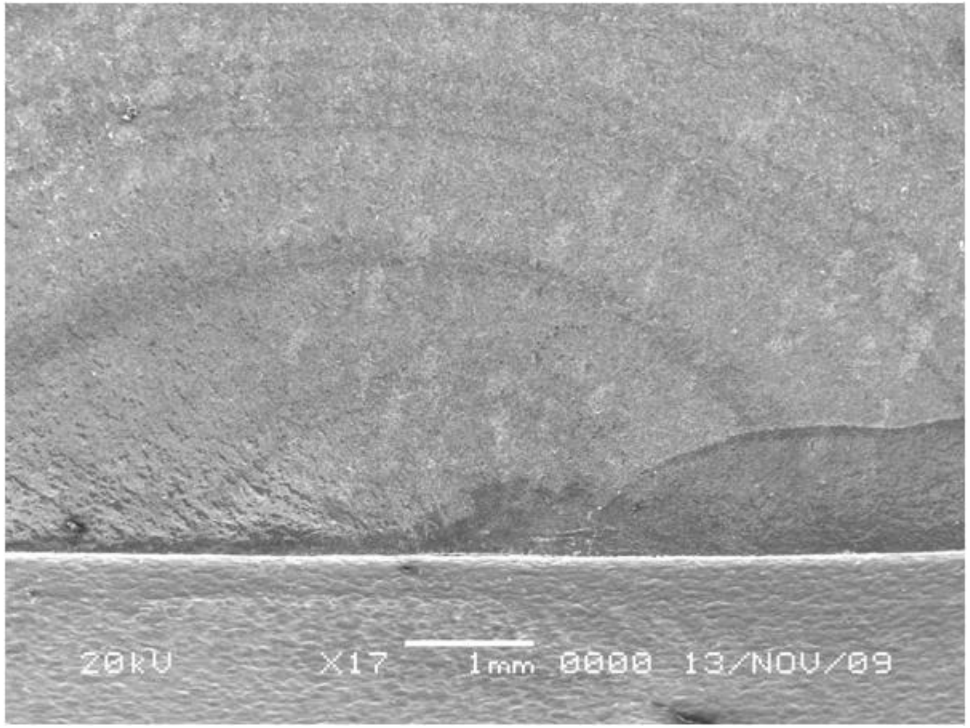
Field UT indication prompted inspection of whole rotor.

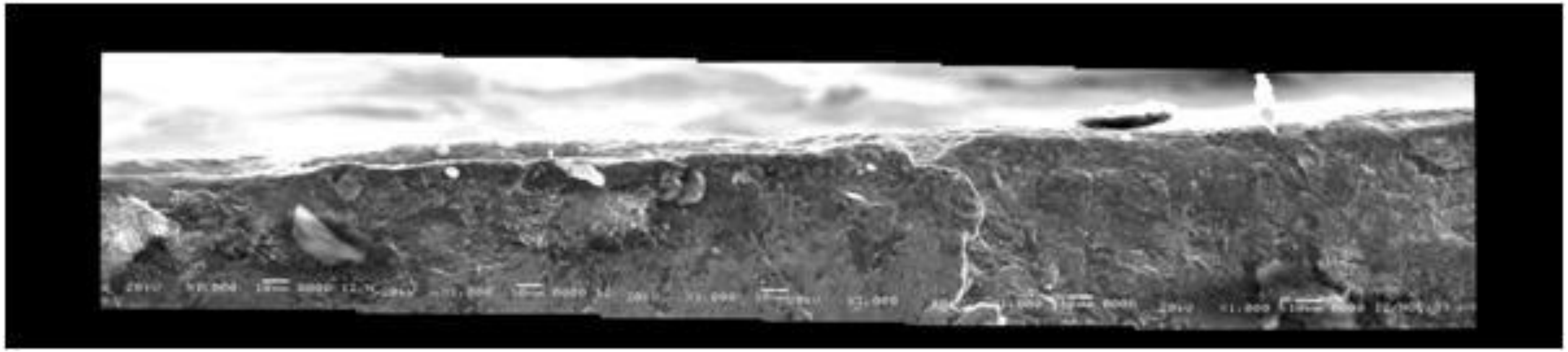


Dabhol R3

Determine Failure Mode, initiation sites, etc.

Perform a Complete Characterization.

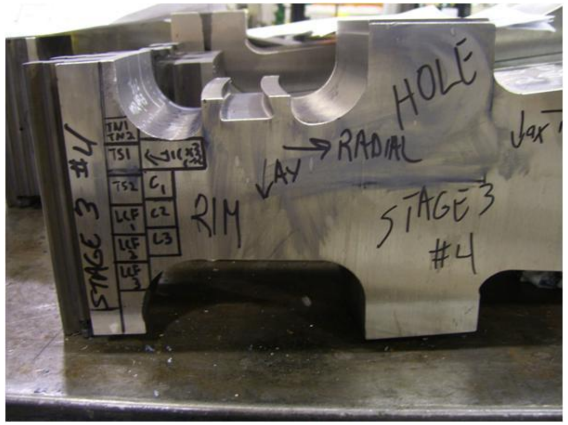




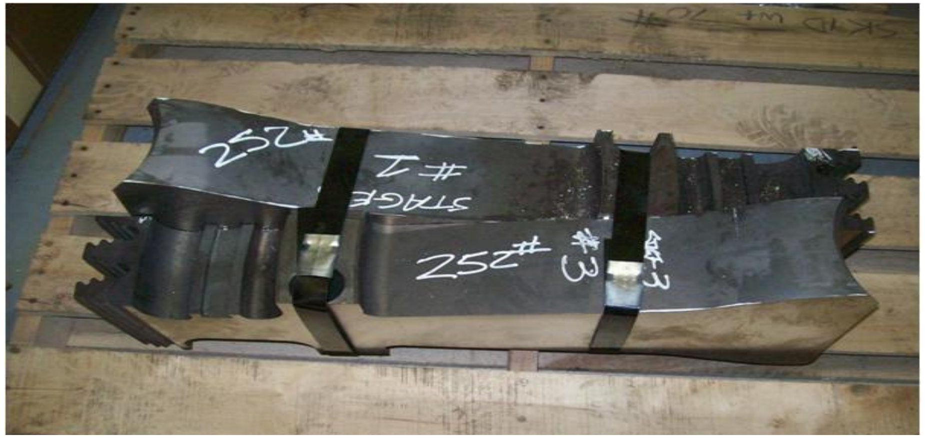
Three Step Age - Rejuvenation

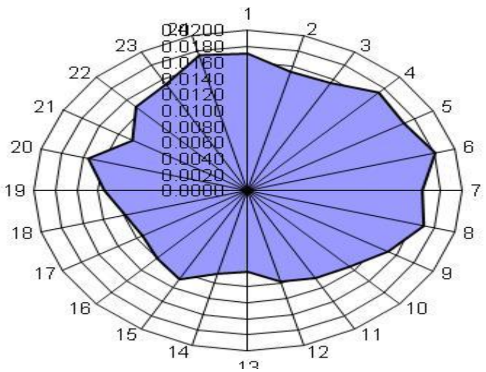
Instrumented Wheel
for Treatment

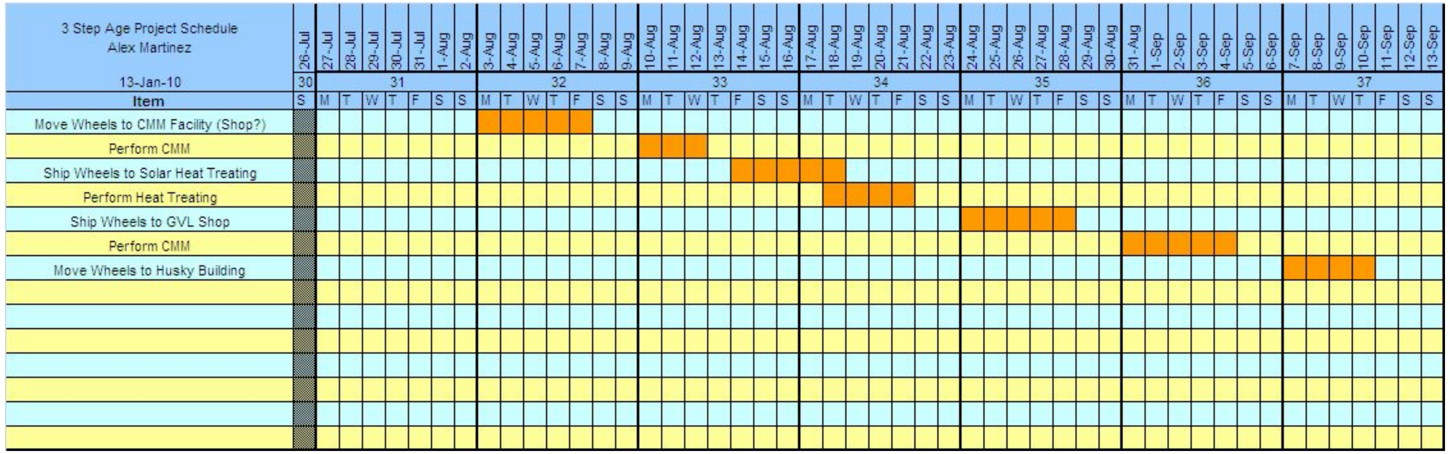
Specimen Layup



Cut Material





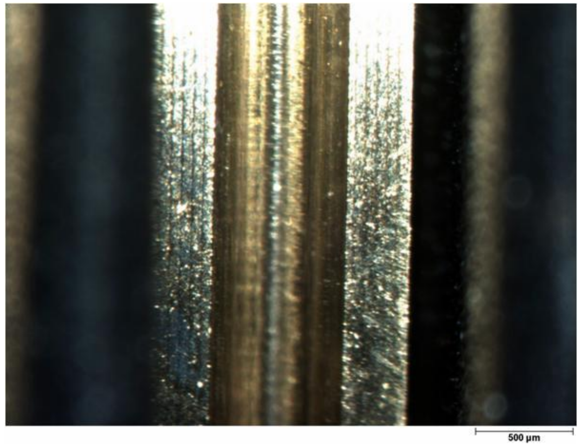


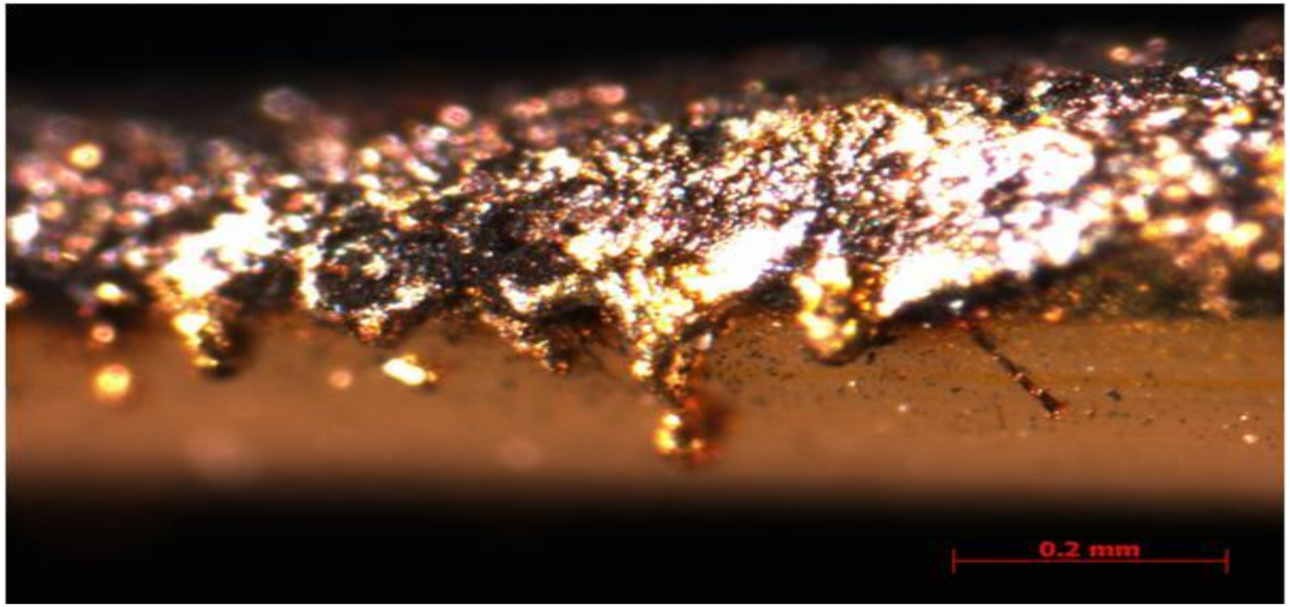
CMM Data and Schedule

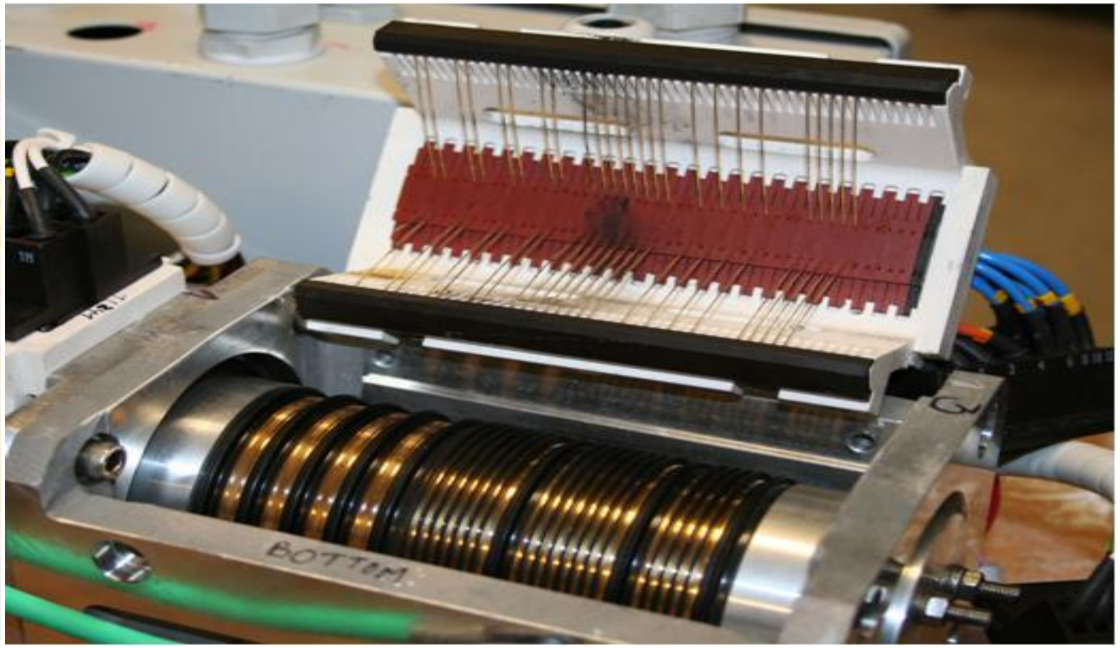
Wind Slip Ring

Determine the cause of accelerated wear.

Worn and Unworn Grooves

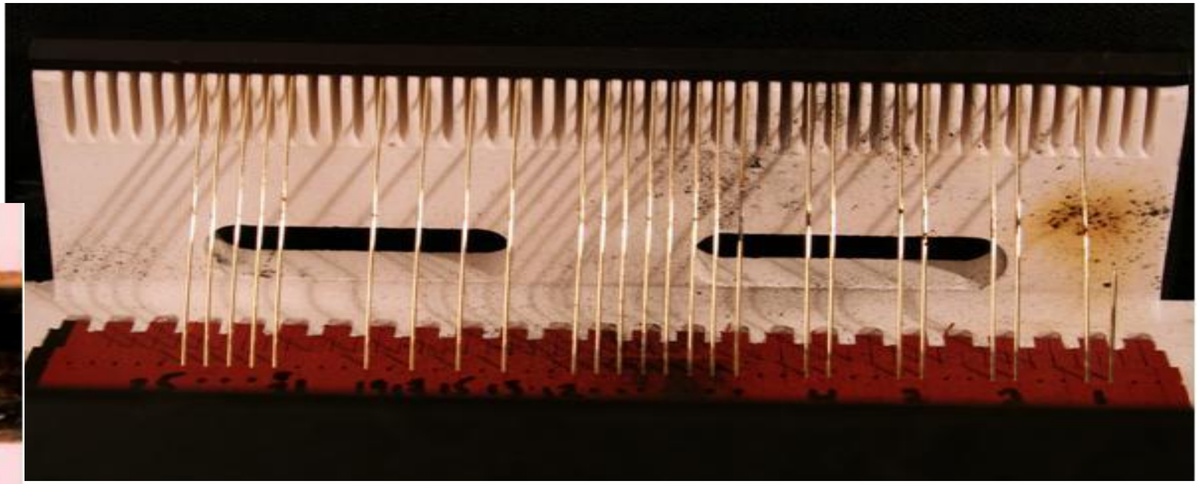




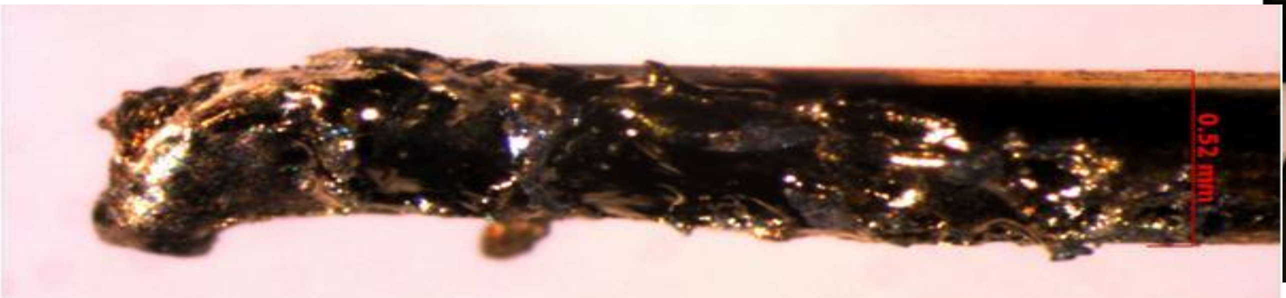


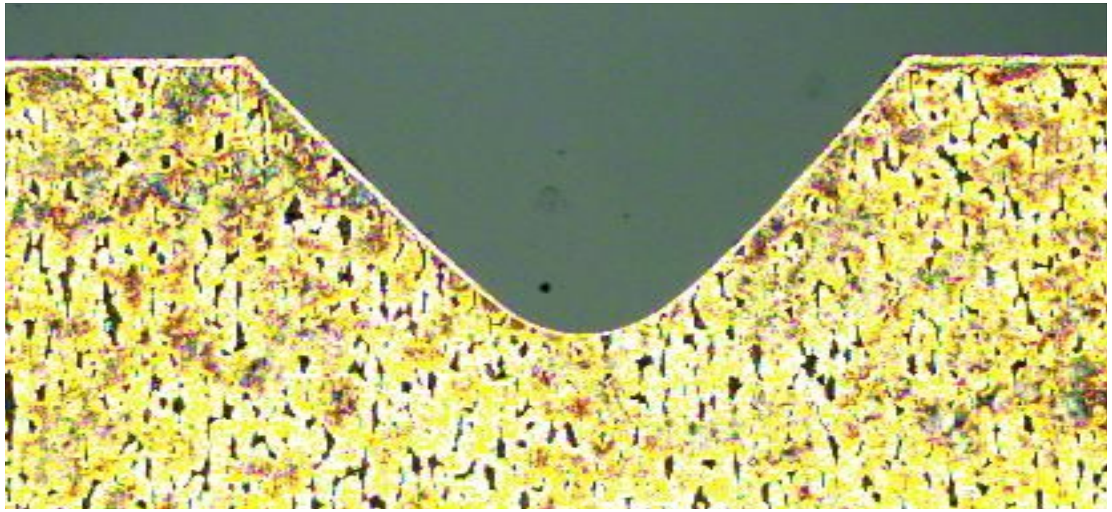
Slip Ring Brush and Assembly

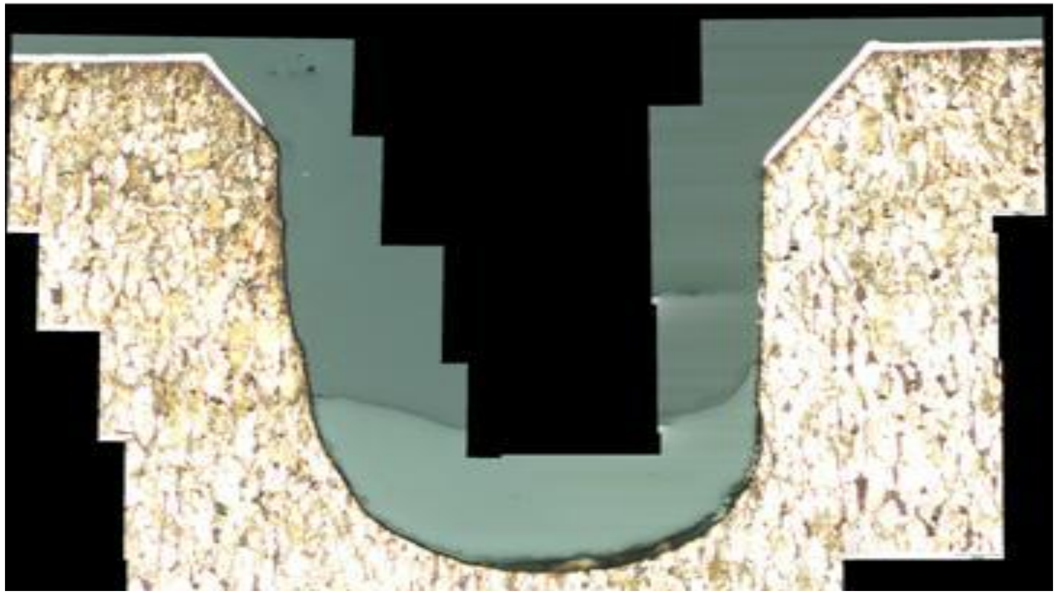
Wind Slip Ring



Melted Brush and Arc Location







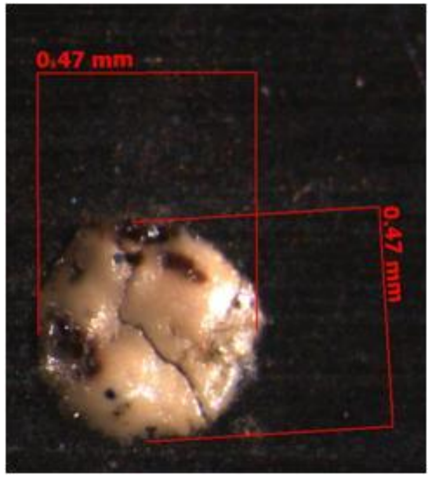
Groove Comparison (Unworn, Worn)

Alex Martinez

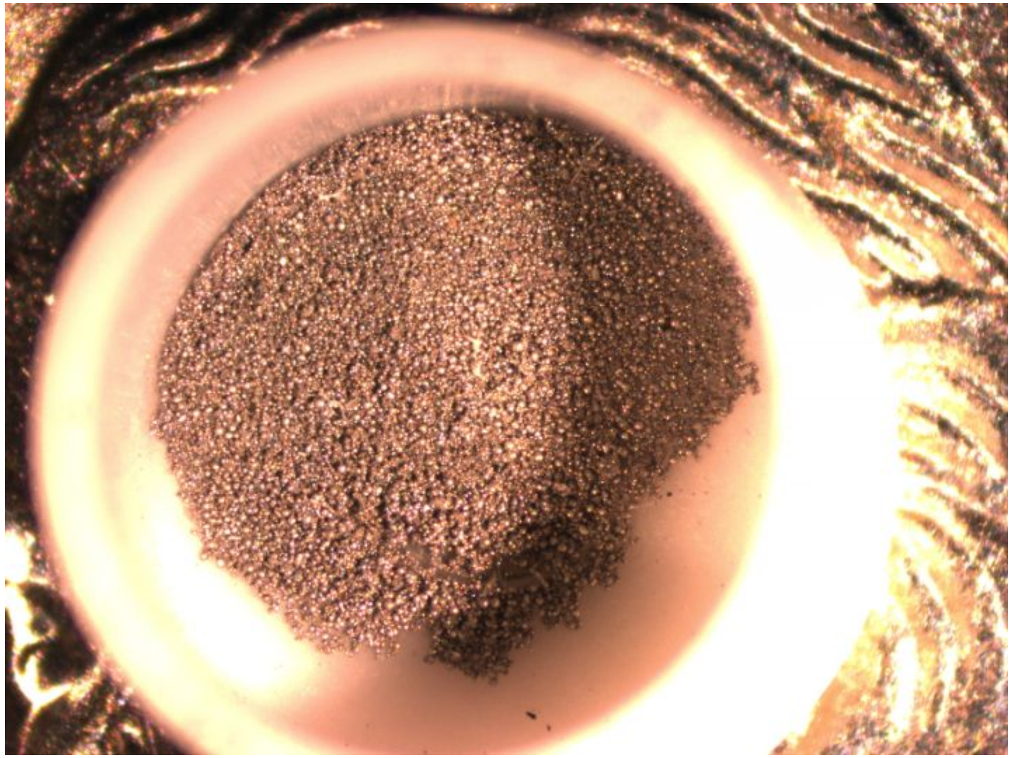
ARA725 Powder Metal

Determine Potential Contamination Sources

Unknown Hopper Surface Deposit



Representative Astraloy Mass



Infamous PM Hopper

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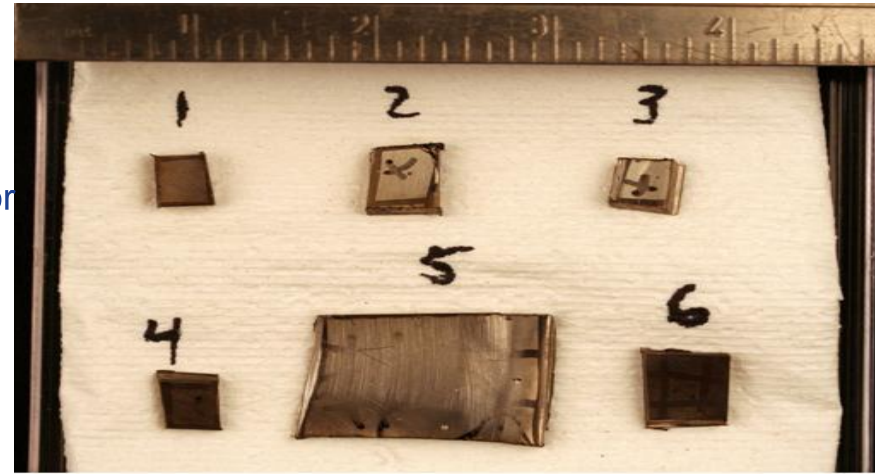
Alex Martinez

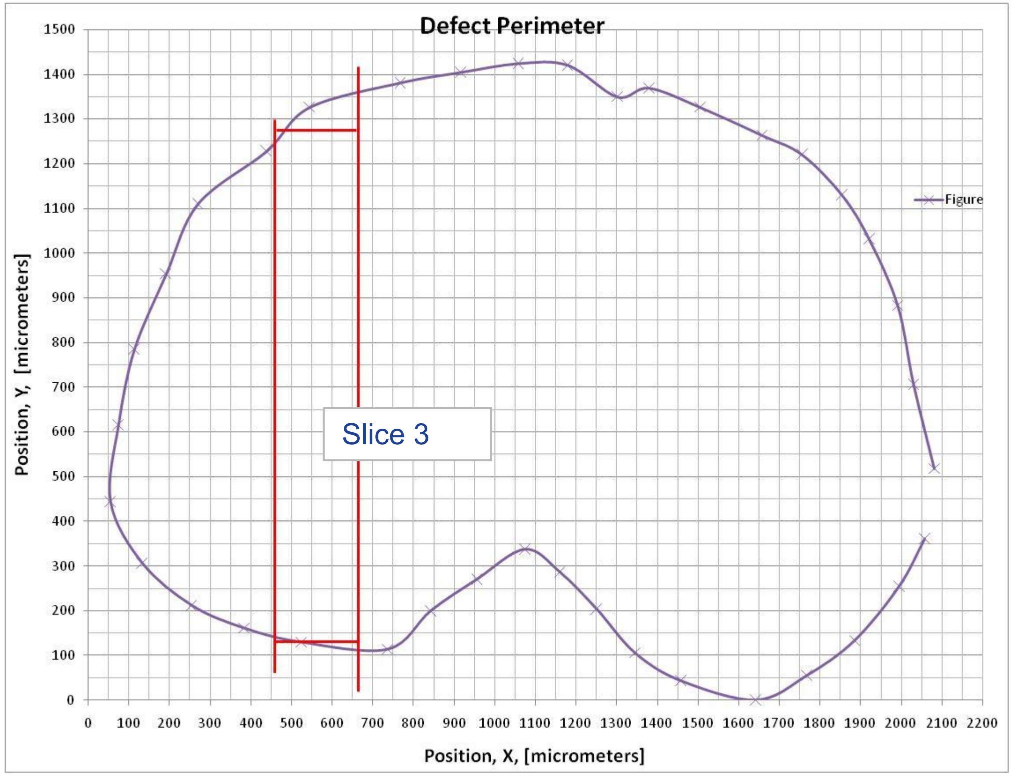
ARA725 Powder Metal

Inclusion Characterization: Volume, Mass, Chemistry

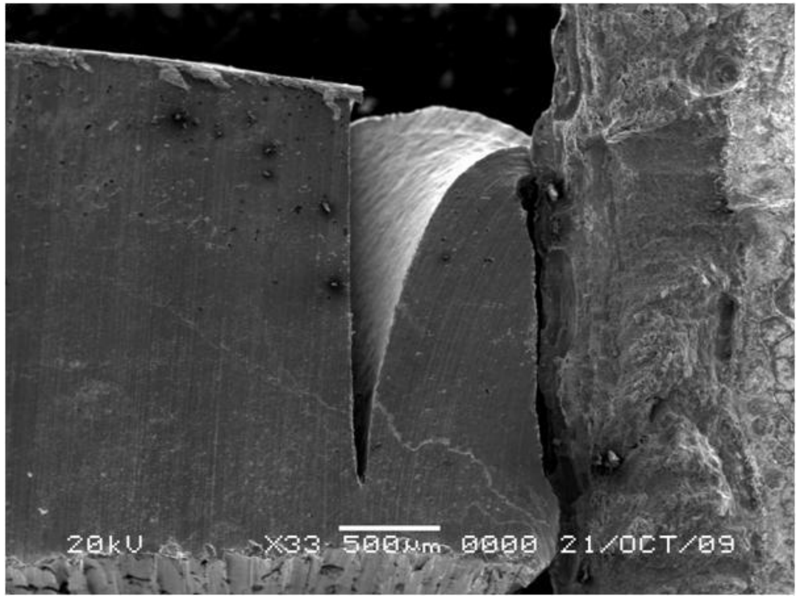
Hopper Fragments for Analysis



Integral Estimation of Inclusion Volume



Incomplete Weld – Opened to Inspect for Astraloy



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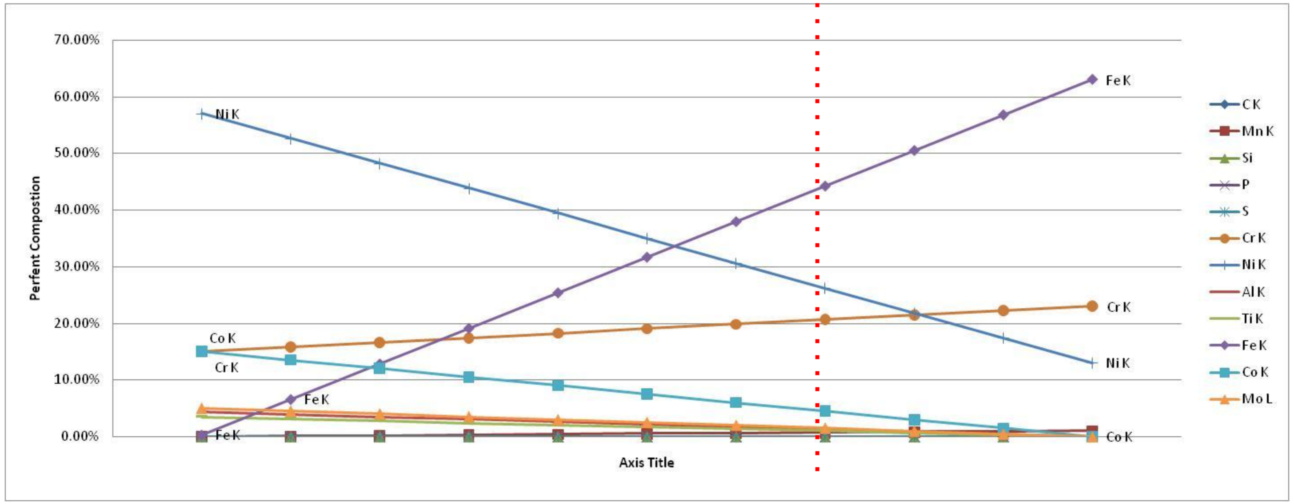
ARA725 - Inclusion Chemistry

53.9% Astroloy, 46.1% ARA725 **10.4% Total Error**

Inclusion: Binary Mixture? Tertiary? Other?



39.9% Astroloy, 15.0% ARA725, 44.9% 309 Weld, **6.12% Total Error**

309 Alloy										
Element	Defect Compositio	725	Astroloy	309 Alloy	309 Alloy M	309 Alloy MA	Ratio 725	Ratio Astr	Calculated Combined Composition	Error
C K	0.000		0.000	0.000	0.000	0.200	0.150	0.400	0.000	0.0000
Mn K	0.700		0.000	1.350	0.000	2.000	0.150	0.400	0.607	0.0930
Si	0.000		0.000	0.000	0.000	1.000	0.150	0.400	0.000	0.0000
P	0.000		0.000	0.000	0.000	0.045	0.150	0.400	0.000	0.0000
S	0.000		0.000	0.000	0.000	0.030	0.150	0.400	0.000	0.0000
Cr K	20.800	20.500	15.000	23.350	22.000	24.000	0.150	0.400	19.582	1.2183
Ni K	37.000	61.500	57.000	12.000	12.000	15.000	0.150	0.400	37.442	0.4423
Al K	0.500	0.400	4.400	0.000			0.150	0.400	1.820	1.3200
Ti K	0.300	1.400	3.500	0.000			0.150	0.400	1.610	1.3104
Fe K	29.200	5.000	0.300	63.000			0.150	0.400	29.200	0.0000
Co K	6.000		15.000	0.000			0.150	0.400	6.000	0.0005
Mo L	5.000	7.500	5.000	0.300			0.150	0.400	3.263	1.7374
Total	99.500	96.300	100.2	99.999999					error	6.122

7FA.05 Normal vs. Fast Start - Circumferential Rotor Gaps

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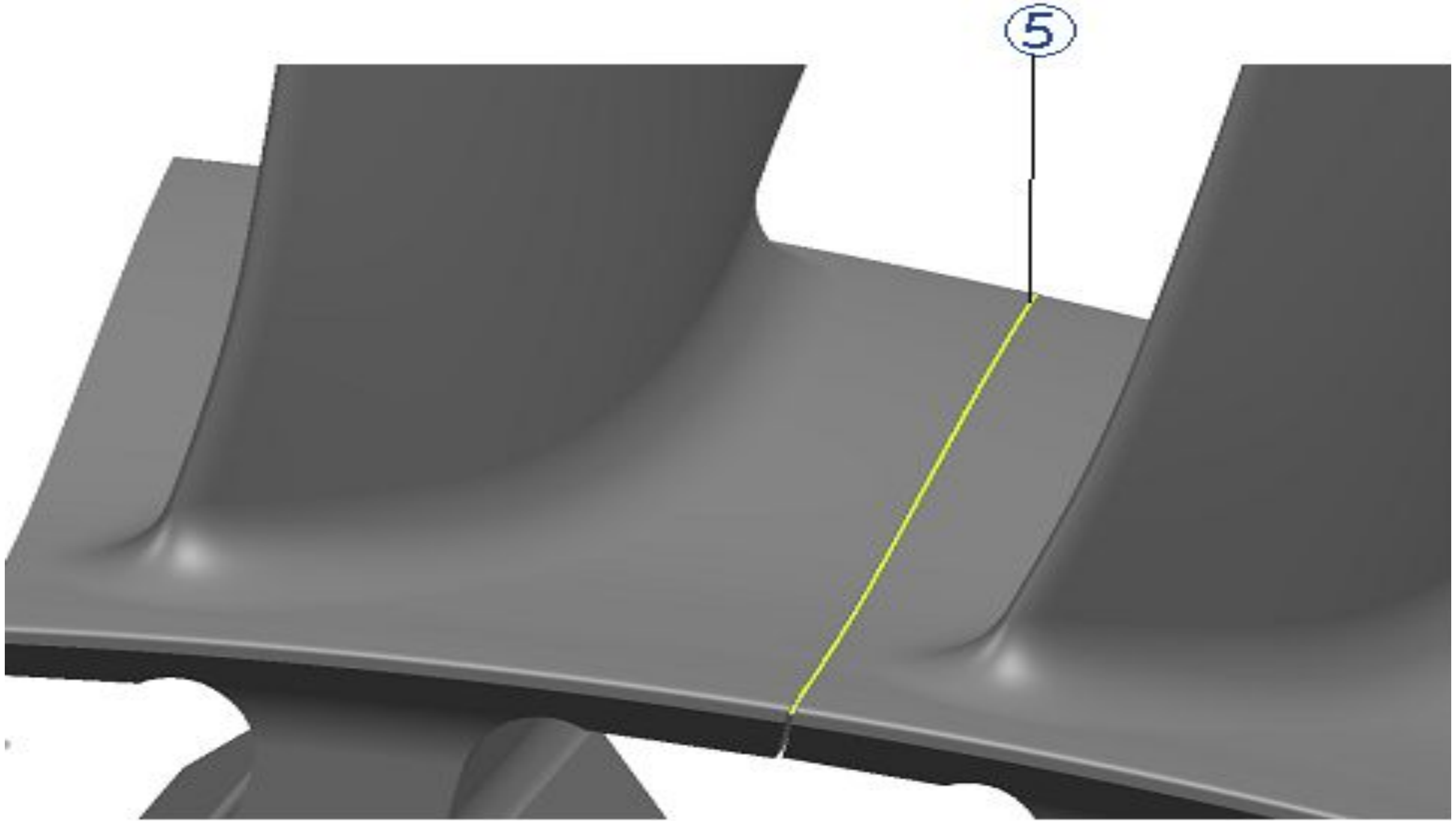

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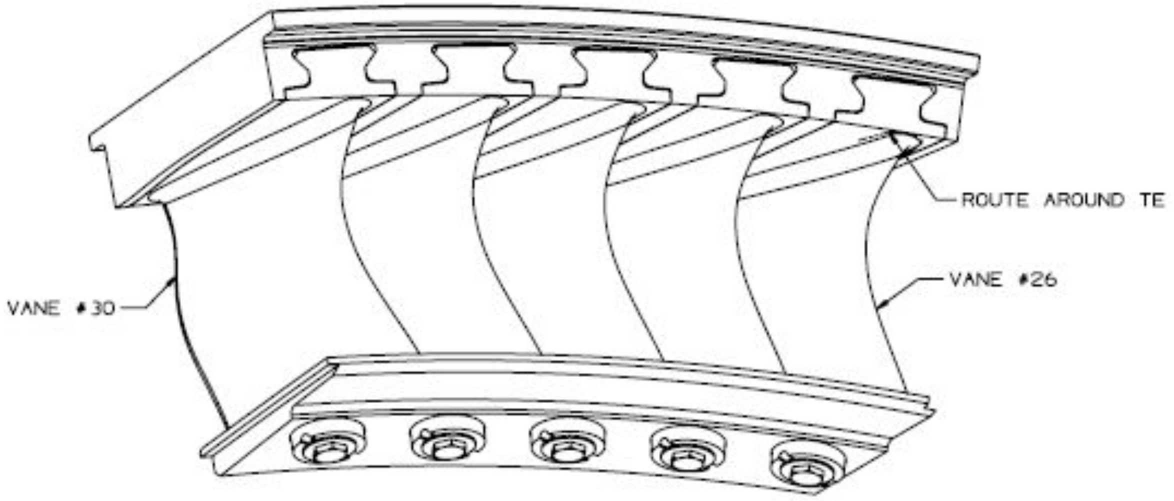
7FA.05 Stator 14 Ring/Vane/Shroud Stack-up



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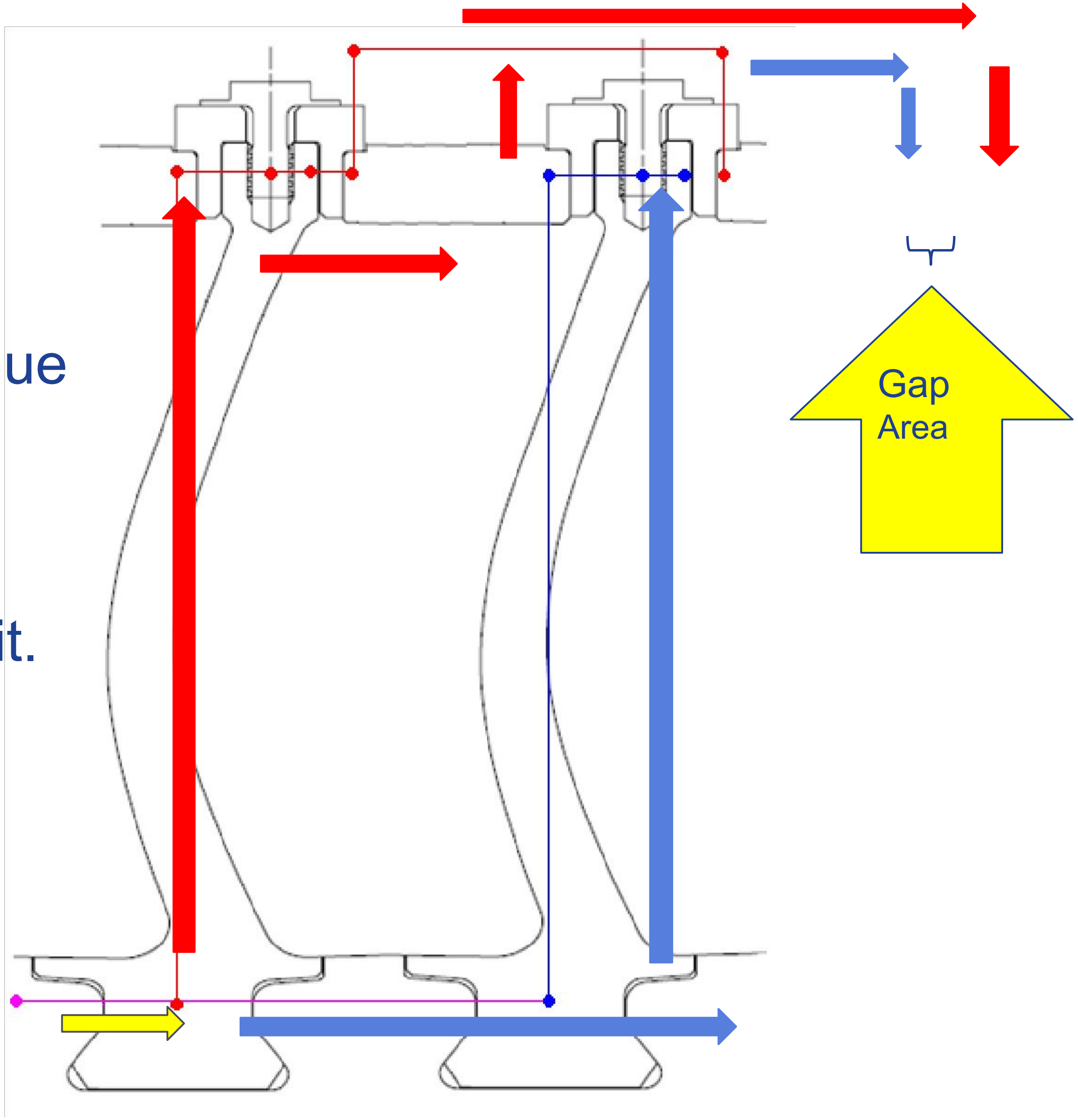
Overview

- Stack-up begins at the edge of the stator ring(pink), and propagates to (Tenon/Bushing/Shroud) interface
- Gap is *clearance* sum, between last Red/Blue dots
- Bushing thickness is incorporated
- Gap acceptance level: G >0.0”
- Each vane has identical probability (P) of fit.
- *Assembly* success rate is:

  =P(vane fit)^(#vanes)



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Alex Martinez

S14 Assembly Performance - RSS/Statistical Method

New Dimensioning Scheme

Tenon Centerline Tolerance	0.0050 in
Tenon "+/-"Tolerance (half of profile tolerance)	0.0030 in
Sigma Level	3.0

Vane Dimensions

	Stator Ring #s	Nominal Dimension	Initial Tolerance[1]	Quality Specification[2]	Component Sigma[4]	Statistical Dimension	
R1	Stator Ring Slot1 - True Position	0.000 in	0.0040 in	1.355	0.002952 in	0.0012 in	normal
R2	Stator Ring Slot1 Width - Profile	0.844 in	0.0020 in	3.445	0.000581 in	0.8436 in	normal
R3	Stator Ring Slot Spacing (ONLY FOR ENTERING SIGMA LEVEL)	3.447 in	0.0090 in	3.000	0.003000 in		
	Vane #1	**Nominal Dimension**	**Initial Tolerance[1]**	**Quality Specification[2]**	**Component Sigma[4]**	**Statistical Dimension**	
V1	Vane Shank1 Width - Profile	0.844 in	0.0020 in	3.000	0.000667 in	0.8441 in	normal
	Tenon #1	**Nominal Dimension**	**Initial Tolerance[1]**	**Quality Specification[2]**	**Component Sigma[4]**	**Statistical Dimension**	
T1	Tenon1 Centerline	0.000 in	0.0050 in	3.000	0.001667 in	0.0008 in	normal
T2	Tenon1 Surface	0.301 in	0.0030 in	3.000	0.001000 in	0.3016 in	normal
	Bushing #1	**Nominal Dimension**	**Initial Tolerance[1]**	**Quality Specification[2]**	**Component Sigma[4]**	**Statistical Dimension**	
B1	Tenon1 Slot	0.308 in	0.0030 in	3.000	0.001000 in	0.3083 in	normal
B2	Bushing1 OD - Diameter	0.3905 in	0.0010 in	1.468	0.000681 in	0.3898 in	normal
B3	Bushing1 OD - True Position	0.000 in	0.0010 in	2.470	0.000405 in	-0.0004 in	normal
	Shroud #1	**Nominal Dimension**	**Initial Tolerance[1]**	**Quality Specification[2]**	**Component Sigma[4]**	**Statistical Dimension**	
S1	Shroud Hole1 - Radius	0.392750 in	0.0003 in	1.470	0.000170 in	0.39258 in	normal
S2	Shroud Hole Spacing (ONLY FOR ENTERING TOL&SIGMA LEVEL)	0.000 in	0.0015 in	2.469	0.000608 in	0.00000 in	normal

Statistical

Left Hand Side

Shroud / Bushing Gap				Bushin	
DIM	Sign	Mean	SD	DIM	Sign
+S1	1	0.392750 in	0.000170 in	+B1	1
-B2	-1	0.3905 in	0.000681 in	-T2	-1
-S2	-1	0.000 in	0.000608 in	+R1	1
				+R2	1
				-V1	-1
				+T1	1
		0.002250 in	0.000928 in		0
		P_a1(x>0)	99.231%		

	P(vane fit)= (P_a1) & (P_b1) & (P_c1) & (P_d1)=	92.275%
	P(5 vanes fit)= P(vane fit)^5 =	66.901%
Crystal Ball -->	P(5 vanes fit)= P(vane fit)^5 =	67.200%
Crystal Ball+Solver -->	P(5 vanes fit)= P(vane fit)^5 =	97.400%
	Max Alpha Error	30.499%
	Max Beta Error	0.000%

Statistical

Old Dimensioning Scheme

Tenon Centerline Tolerance	0.0000 in
Tenon "+/-"Tolerance (half of profile tolerance)	0.0030 in
Sigma Level	3.0

Vane Dimensions

	Stator Ring #s	Nominal Dimension	Initial Tolerance[1]	Quality Specification[2]	Component Sigma[4]	Statistical Dimension	
R1	Stator Ring Slot1 - True Position	0.000 in	0.0040 in	1.355	0.002952 in	0.0003 in	normal
R2	Stator Ring Slot1 Width - Profile	0.844 in	0.0020 in	3.445	0.000581 in	0.8443 in	normal
R3	Stator Ring Slot Spacing (ONLY FOR ENTERING SIGMA LEVEL)	3.447 in	0.0090 in	3.000	0.003000 in		
	Vane #1	**Nominal Dimension**	**Initial Tolerance[1]**	**Quality Specification[2]**	**Component Sigma[4]**	**Statistical Dimension**	
V1	Vane Shank1 Width - Profile	0.844 in	0.0020 in	3.000	0.000667 in	0.8436 in	normal
	Tenon #1	**Nominal Dimension**	**Initial Tolerance[1]**	**Quality Specification[2]**	**Component Sigma[4]**	**Statistical Dimension**	
T1	Tenon1 Centerline	0.000 in	0.0000 in	3.000	0.000000 in	0.0000 in	normal

Statistical

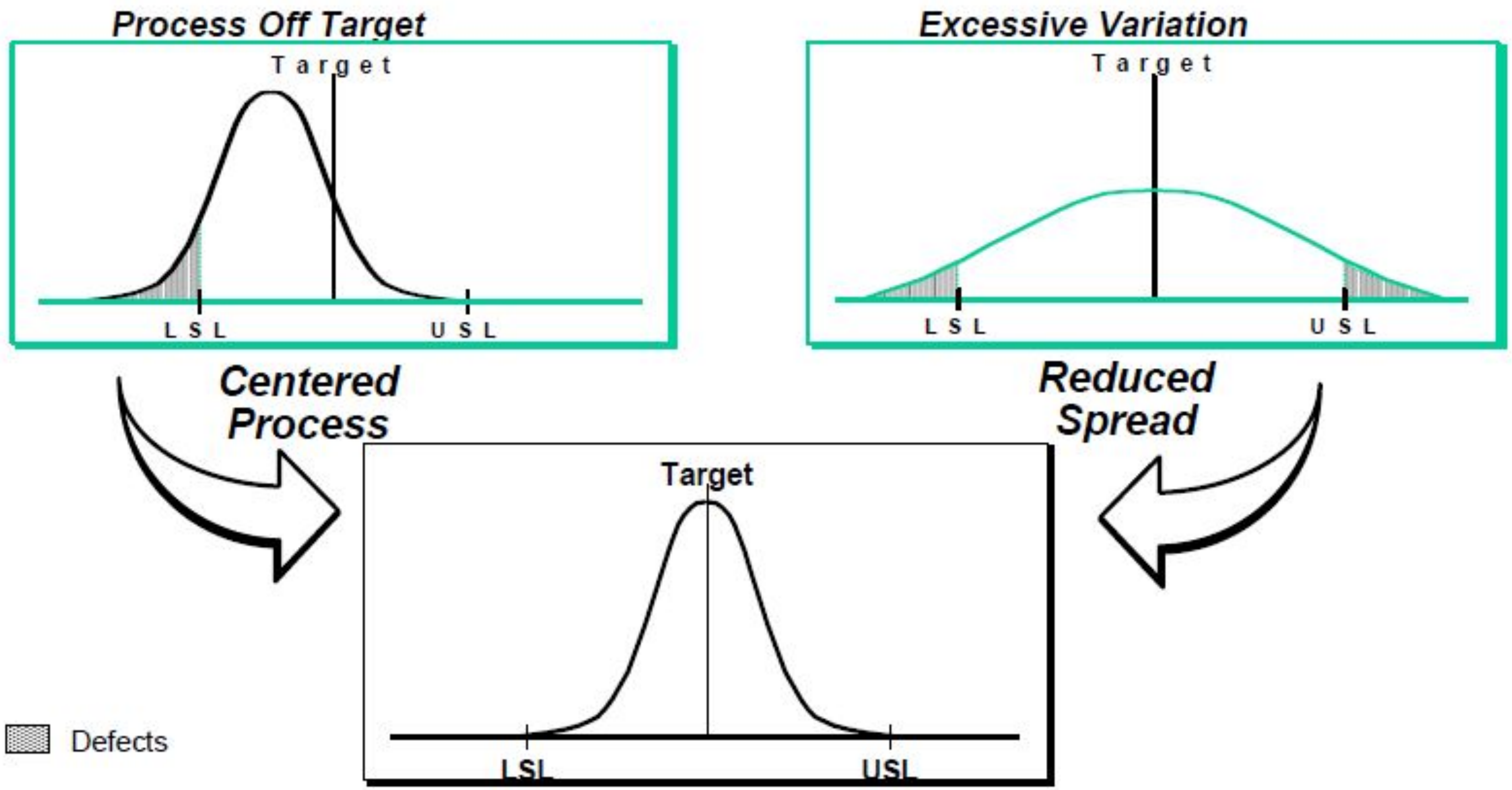
Left Hand Side

Shroud / Bushing Gap				Bushin	
DIM	Sign	Mean	SD	DIM	Sign
+S1	1	0.392750 in	0.000170 in	+B1	1
-B2	-1	0.3905 in	0.000681 in	-T2	-1
-S2	-1	0.000 in	0.000608 in	+R1	1
				+R2	1
				-V1	-1
				+T1	1
		0.002250 in	0.000928 in		0
		P_a1(x>0)	99.231%		

	P(vane fit)= (P_a1) & (P_b1) & (P_c1) & (P_d1)=	94.669%
	P(5 vanes fit)= P(vane fit)^5 =	76.038%
Crystal Ball -->	P(5 vanes fit)= P(vane fit)^5 =	77.260%
Crystal Ball+Solver -->	P(5 vanes fit)= P(vane fit)^5 =	98.950%

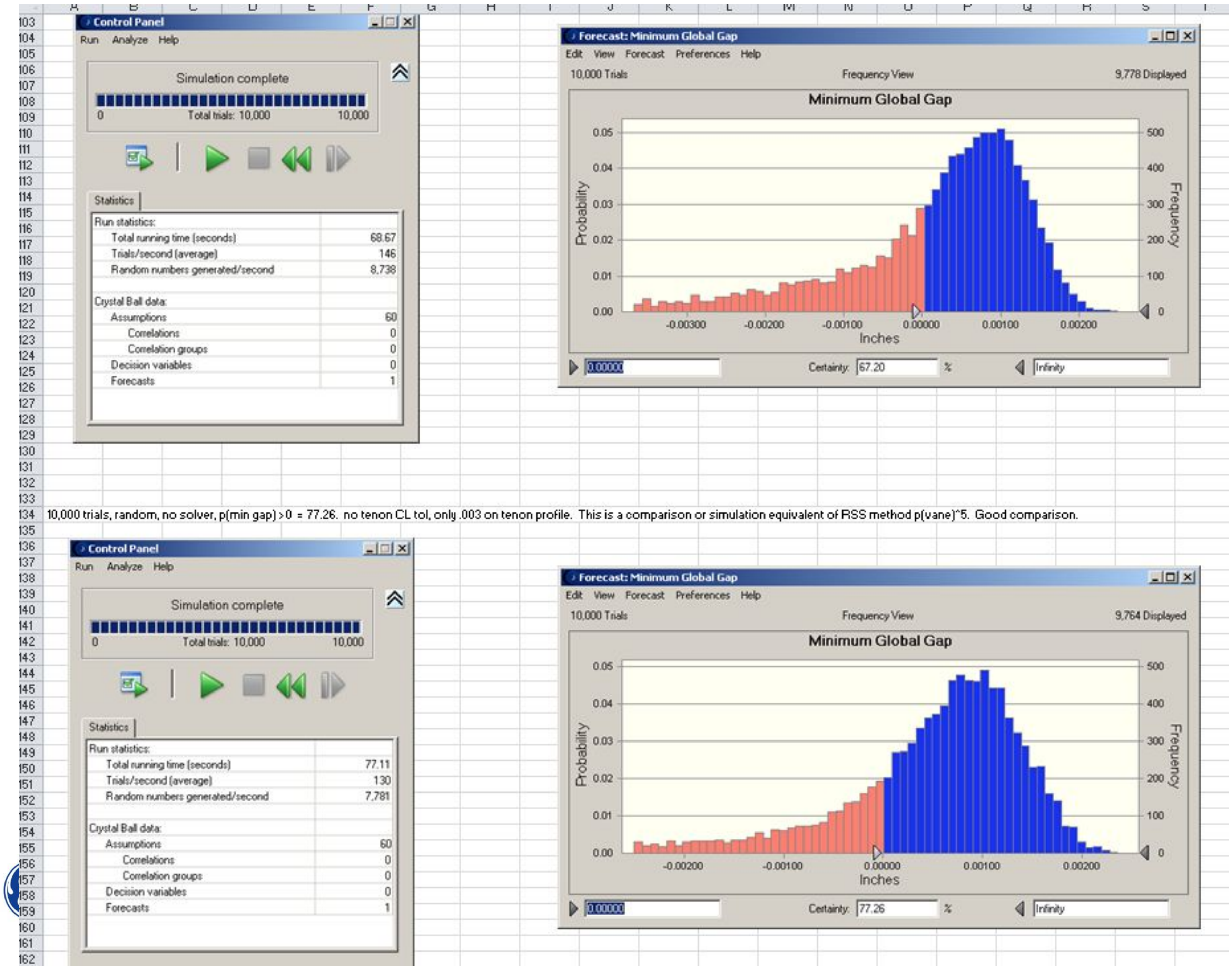
The Statistical Objective of Six Sigma

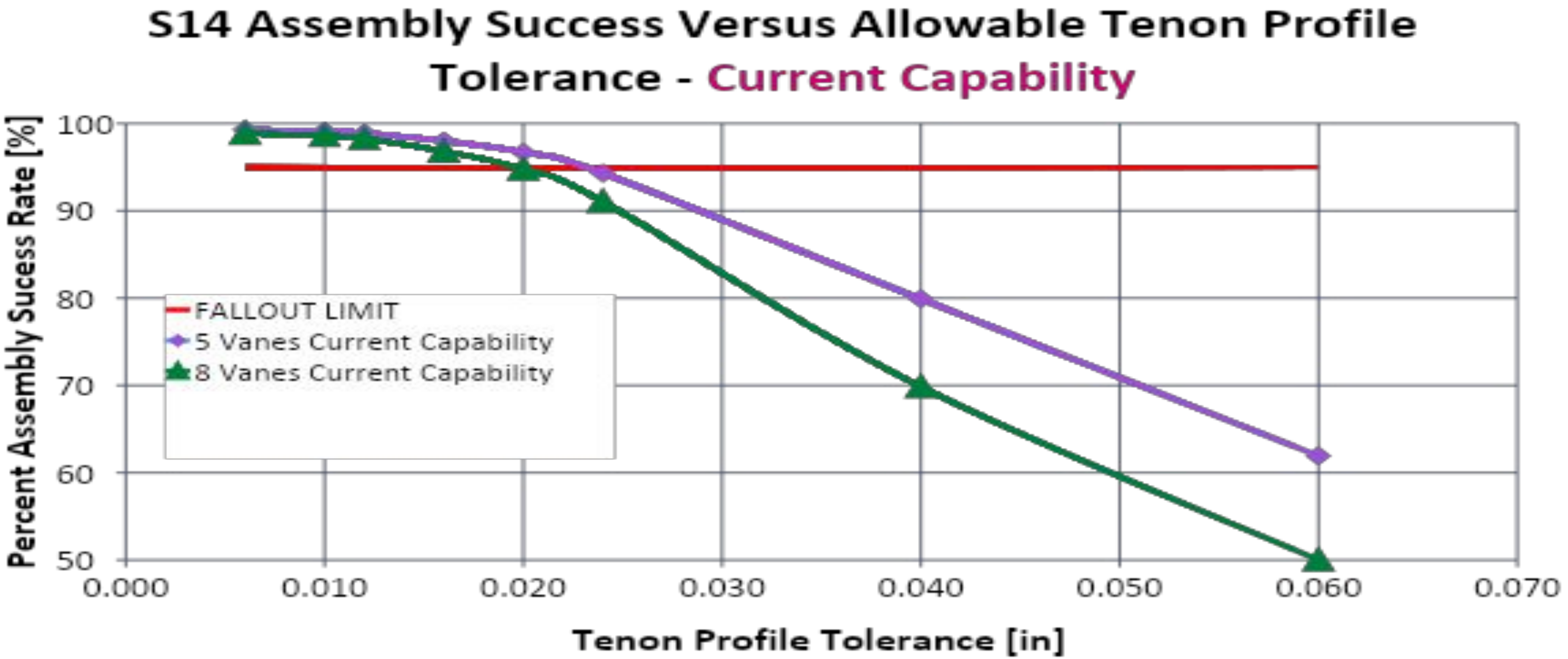
GE DFSS Course



σ	PPM
2	308,537
3	66,807
4	6,210
5	233
6	3.4
Process Capability	***Defects per Million Opportunities***

The Classical View of Quality "99% Good" (3.8σ)	The Six Sigma View of Quality "99.99966% Good" (6σ)
20,000 lost articles of mail per hour	Seven lost articles of mail per hour
Unsafe drinking water almost 15 minutes each day	One minute of unsafe drinking water every seven months
5,000 incorrect surgical operations per week	1.7 incorrect surgical operations per week
2 short or long landings at most major airports daily	One short or long landing at most major airports every five years
200,000 wrong drug prescriptions each year	68 wrong drug prescriptions each year
No electricity for almost 7 hours each month	One hour without electricity every 34 years

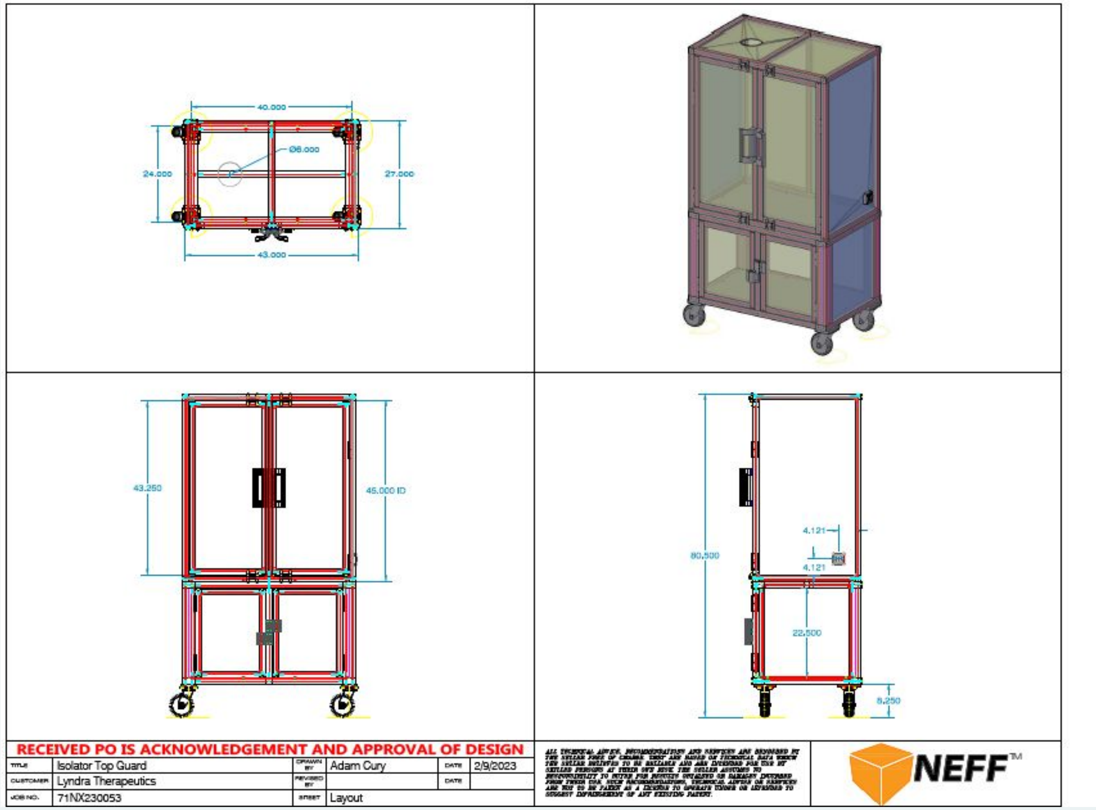

Control Panel
Run Analyze Help
Simulation complete
0 Total trials: 10,000 10,000
Statistics
Run statistics:
Total running time (seconds) 68.67
Trials/second (average) 146
Random numbers generated/second 8,738
Crystal Ball data:
Assumptions 60
Correlations 0
Correlation groups 0
Decision variables 0
Forecasts 1
Forecast: Minimum Global Gap
Edit View Forecast Preferences Help
10,000 Trials
Frequency View
9,778 Displayed
Minimum Global Gap
Probability
Frequency
Inches
0.00000
Certainty: 67.20 %
Infinity
10,000 trials, random, no solver, p(min gap) > 0 = 77.26. no tenon CL tol, only .003 on tenon profile. This is a comparison or simulation equivalent of RSS method p(vane)^5. Good comparison.
Control Panel
Run Analyze Help
Simulation complete
0 Total trials: 10,000 10,000
Statistics
Run statistics:
Total running time (seconds) 77.11
Trials/second (average) 130
Random numbers generated/second 7,781
Crystal Ball data:
Assumptions 60
Correlations 0
Correlation groups 0
Decision variables 0
Forecasts 1
Forecast: Minimum Global Gap
Edit View Forecast Preferences Help
10,000 Trials
Frequency View
9,764 Displayed
Minimum Global Gap
Probability
Frequency
Inches
0.00000
Certainty: 77.26 %
Infinity



CURRENT SIGMA LEVELS (All other dimensions assumed to be 3σ)							
RING		VANE		BUSHING		SHROUD	
True Position	**1.355**	All Features	3	Outer Diameter	**1.824**	Hole Diameter	**1.468**
						Hole True Position	**2.47**

CO-MILL Isolator Design

Very simple enclosure designed and built to contain and filter out airborne drug particles from a powder milling (grinding) operation. This design greatly improved the safety of working with that particular drug substance.



Alex Martinez