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# Assessing Shape Repeatability in Variable Geometry Polymer Extrusion Dies

Alex Watt

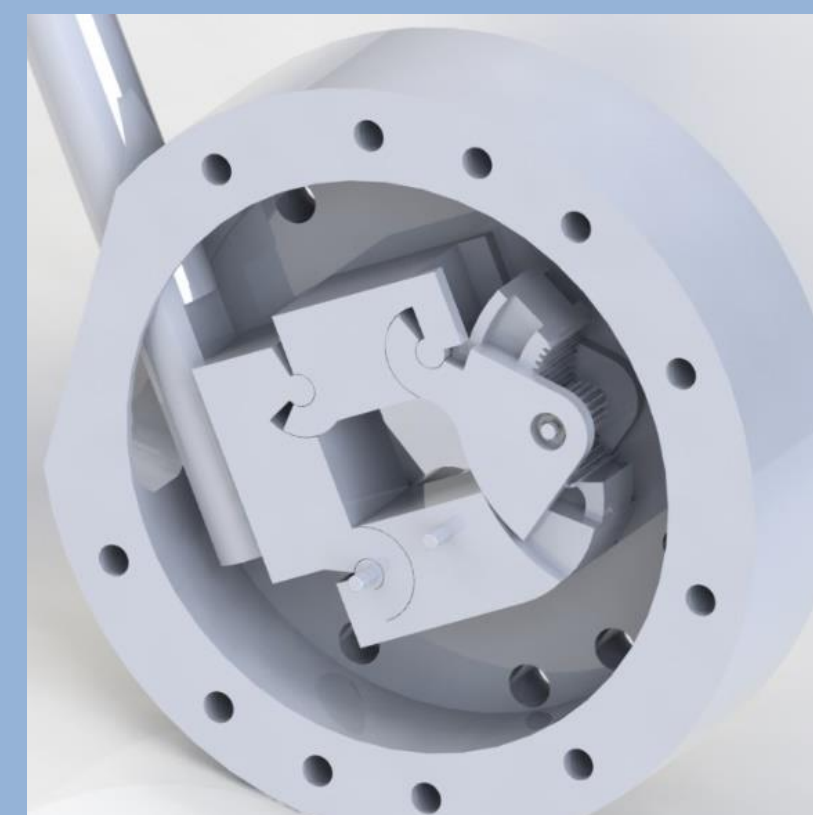
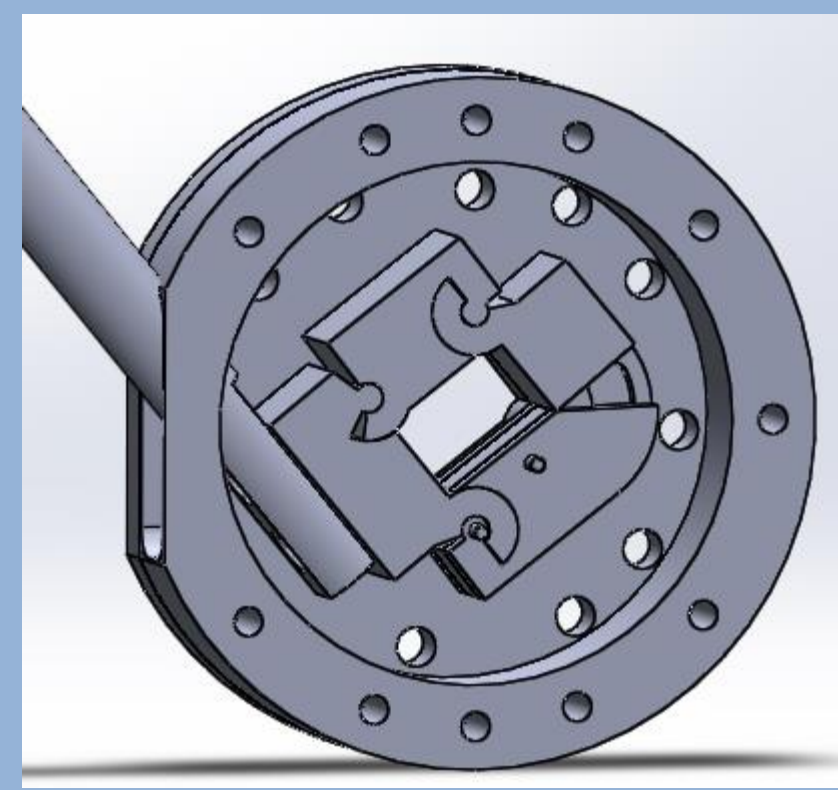
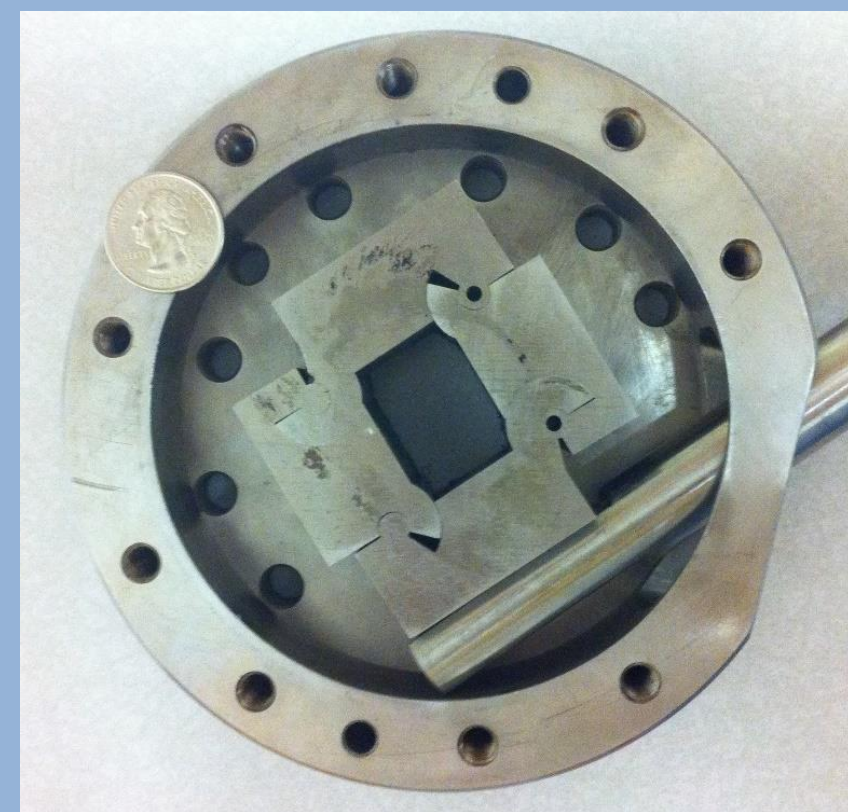
Advisors: David Myszka, Ph.D., Andrew Murray, Ph.D.



**Project Objective:** To successfully produce shape changing extrusion dies for practical application in the real world. Examining shape repeatability of prototyped dies is a large factor to determine whether or not the design performs effectively.

## Introduction/Motivation

- **Extrusion:** Manufacturing process that uses pressure to force melted plastic through a die
- Current dies define parts with uniform cross section
- Varying cross section allows for innovative parts
- Two batches of prototypes have been produced and tested to examine profile comparison



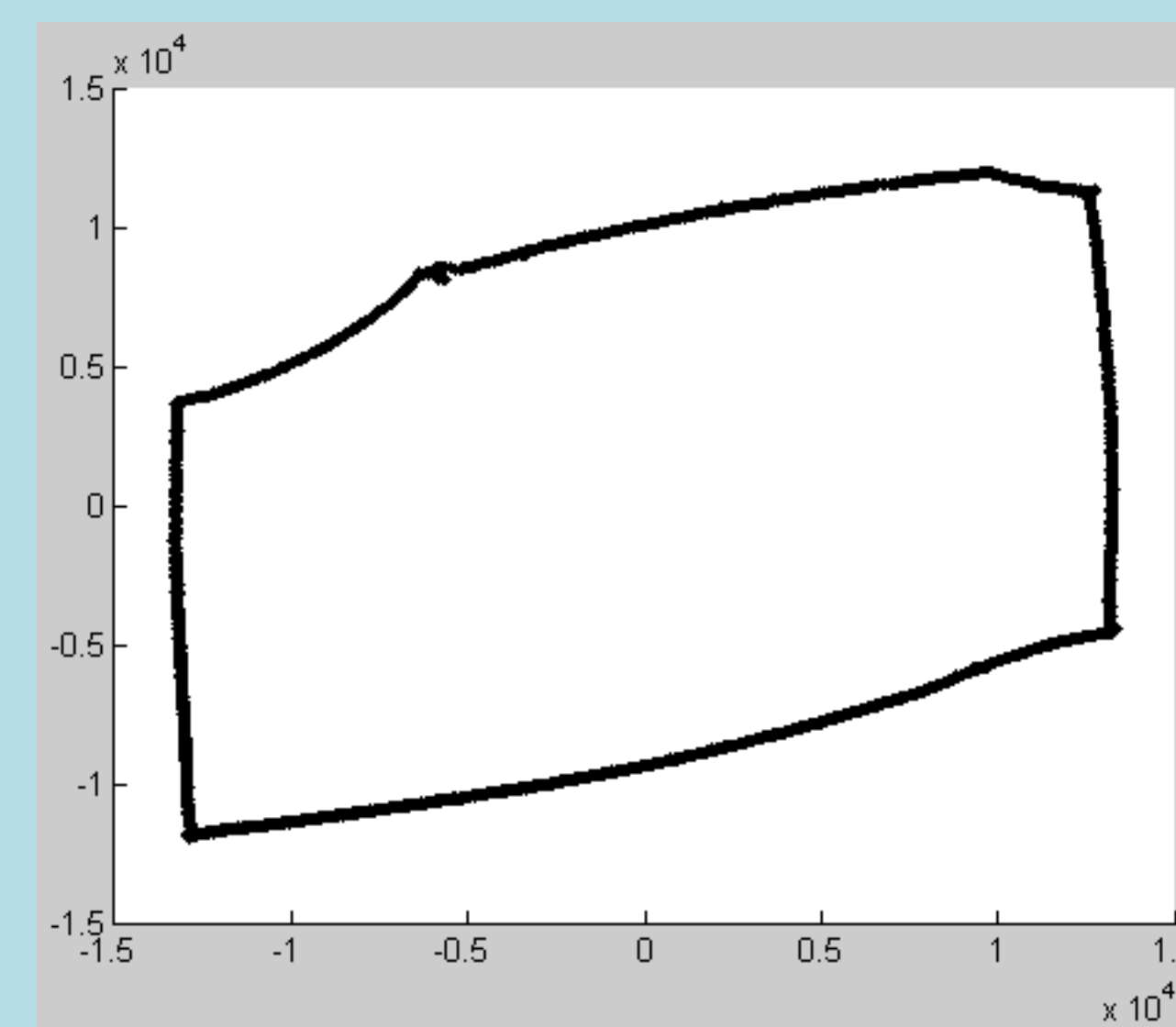
4 Bar Crescent Joint

Corner Die

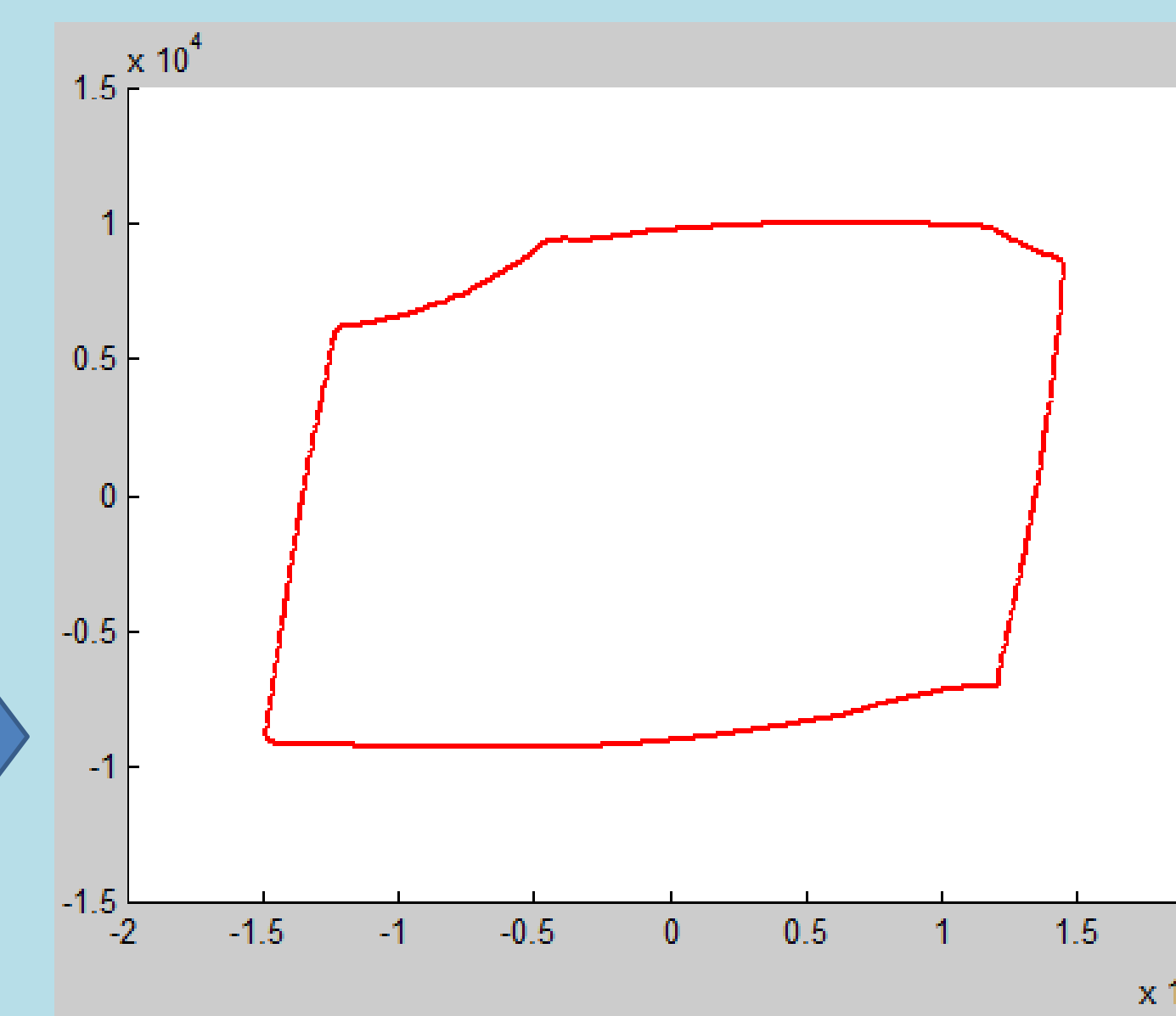
4 Bar Prismatic

## Computational Analysis Method

- Starrett Profile360 In-Line Profile Measurement System used laser to scan 6 profiles
- Matlab used to examine profiles and compare one another
- Outliers removed, profiles linearized, rotated, and centered before stacked and compared

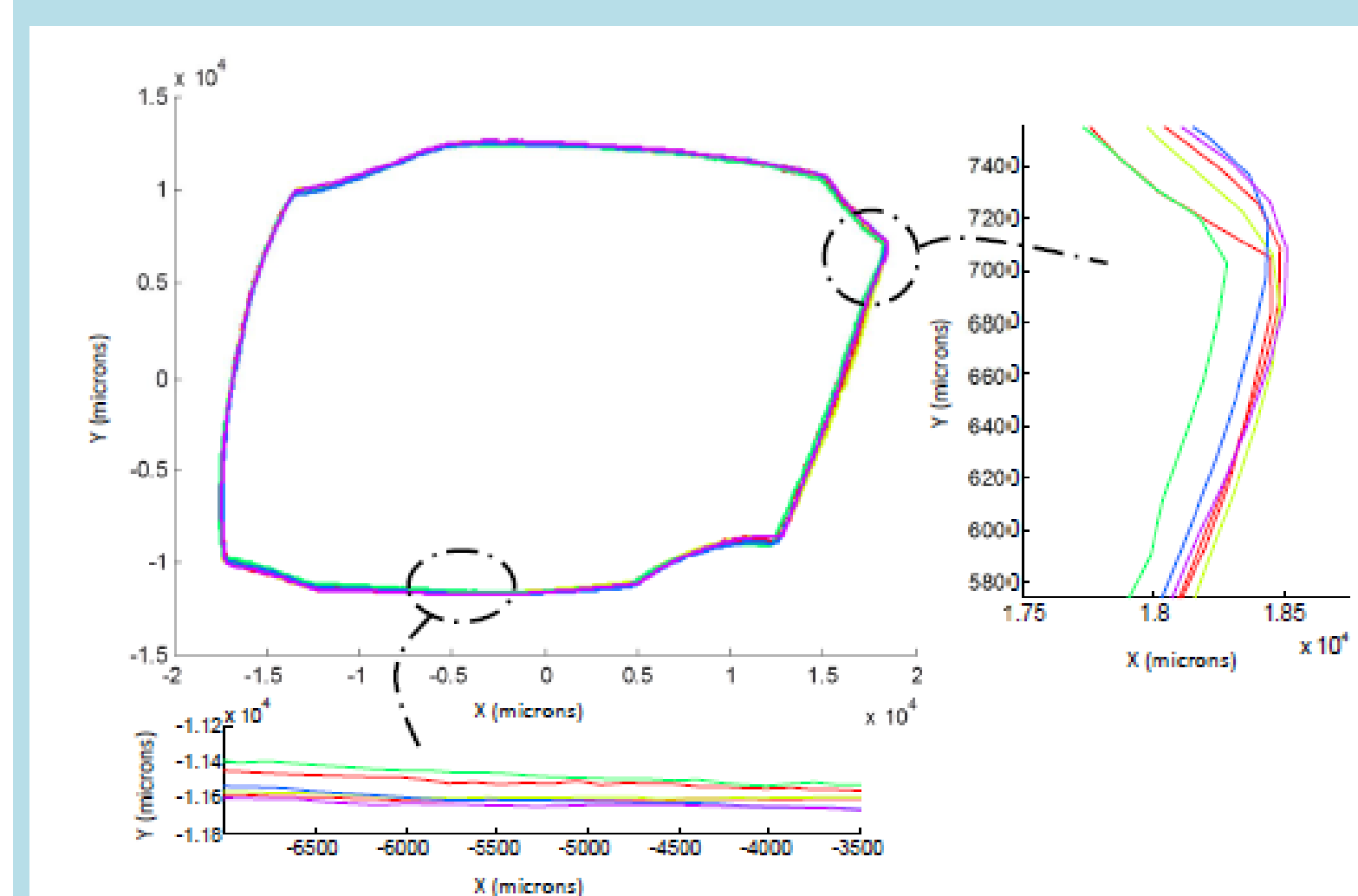


Prior to being linearized, rotated, and centered

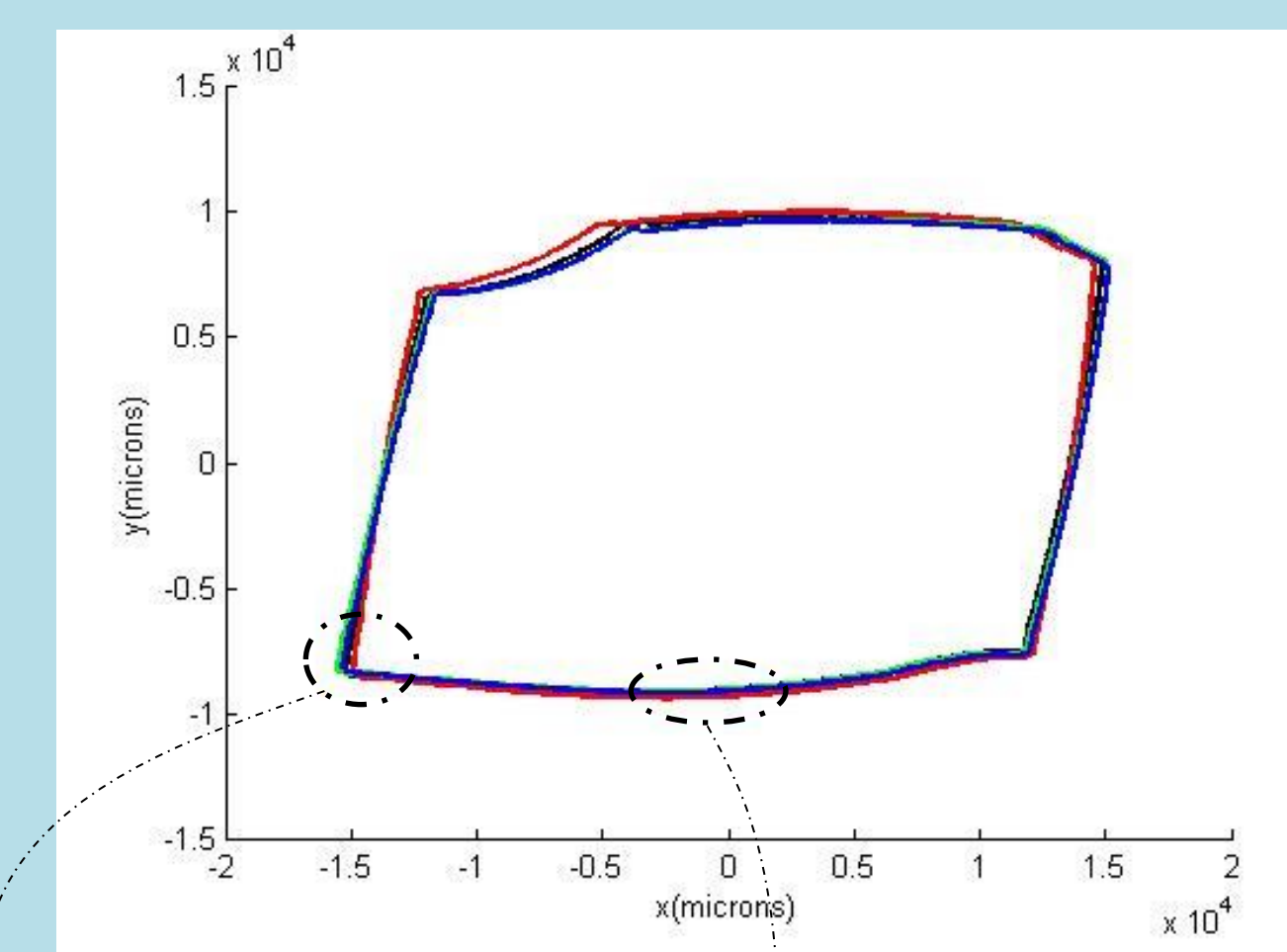


After being linearized, rotated, and centered

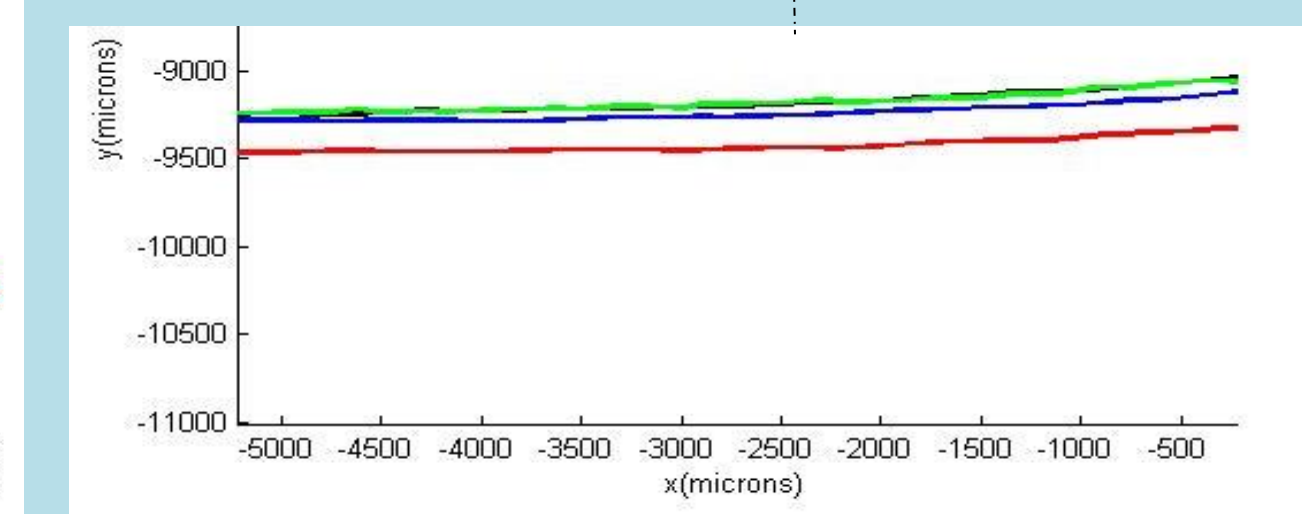
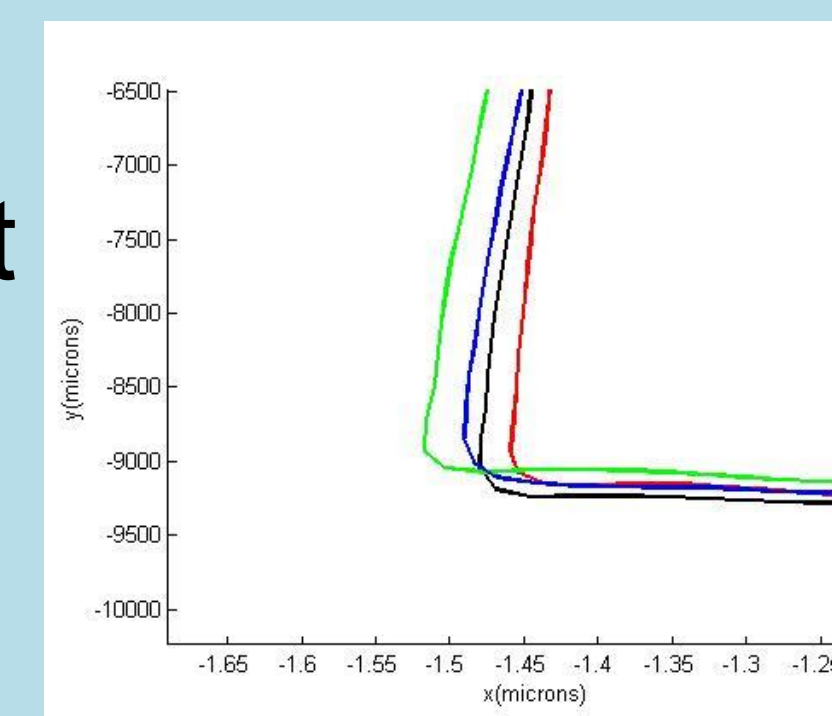
- Profiles were then stacked and compared



Crescent joint



Corner joint



## Results

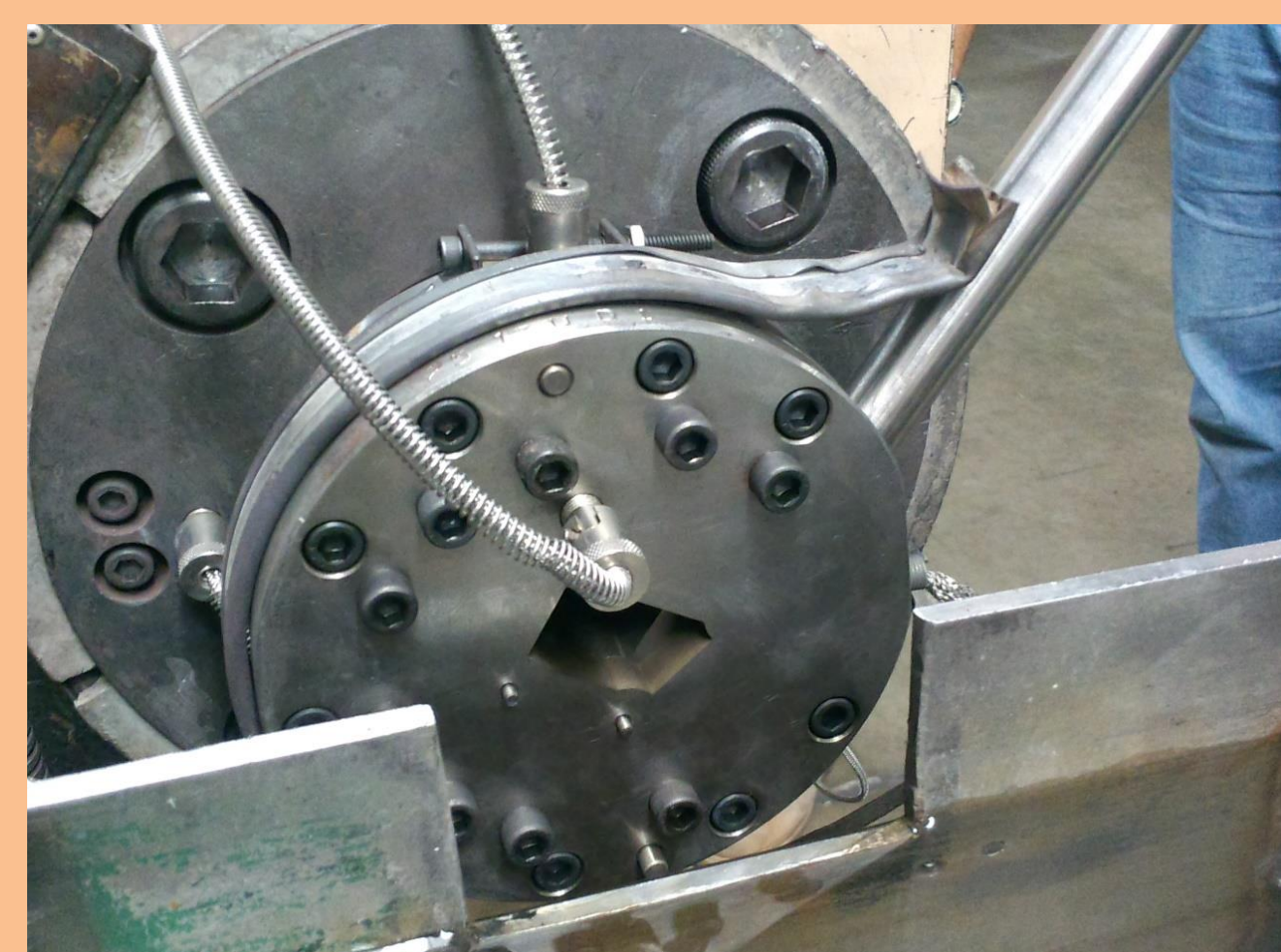
### Crescent die (in microns)

Test	Shape	$\bar{d}$	Std(d)	95% CI $\pm$	$\Delta A/A$ (%)
T-1	P	114	139	272	0.2
T-1	R	106	132	257	0.05
T-2	P	134	66	161	0.02
T-2	R	111	141	276	0.18
T-3	P	135	124	242	0.16
T-3	R	148	97	272	0.09

- Similar results for Corner Die
- Average  $d = 150$  microns
- Much larger deltas for prismatic die
- Direct result of the meshing issues and leakage

## Testing

- Dies were bolted to extruder
- Prototyped dies were tested at different line speeds with varying actuation patterns
- 4 Bar Prismatic had issues with leakage due to stacked clearances and had issues with gear meshing



Measurements	PVC	Santoprene TPV
Screw Speed (RPM)	64	64
Barrel Set Temperature (°F)	310	370
Melt temperature (°F)	296	341
Back Pressure (PSI)	530	330
Line speed (ft/min)	5.6	4.0

## Conclusions/ Future Considerations

- 4 Bar Crescent Joint Die and Corner Die exhibited good shape repeatability
- 4 Bar Prismatic Die has since been improved to eliminate issues with first prototype
- 2<sup>nd</sup> batch of prototypes have been created and tested
- Focuses on sliding prismatic with more drastic area change with a practical application (car weather stripping)

## Acknowledgements

- Creative Extruded Products
- Kevin Giaier, M.S.