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Title:	Summer 2023 Student Internship
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Summer 2023 Student Internship

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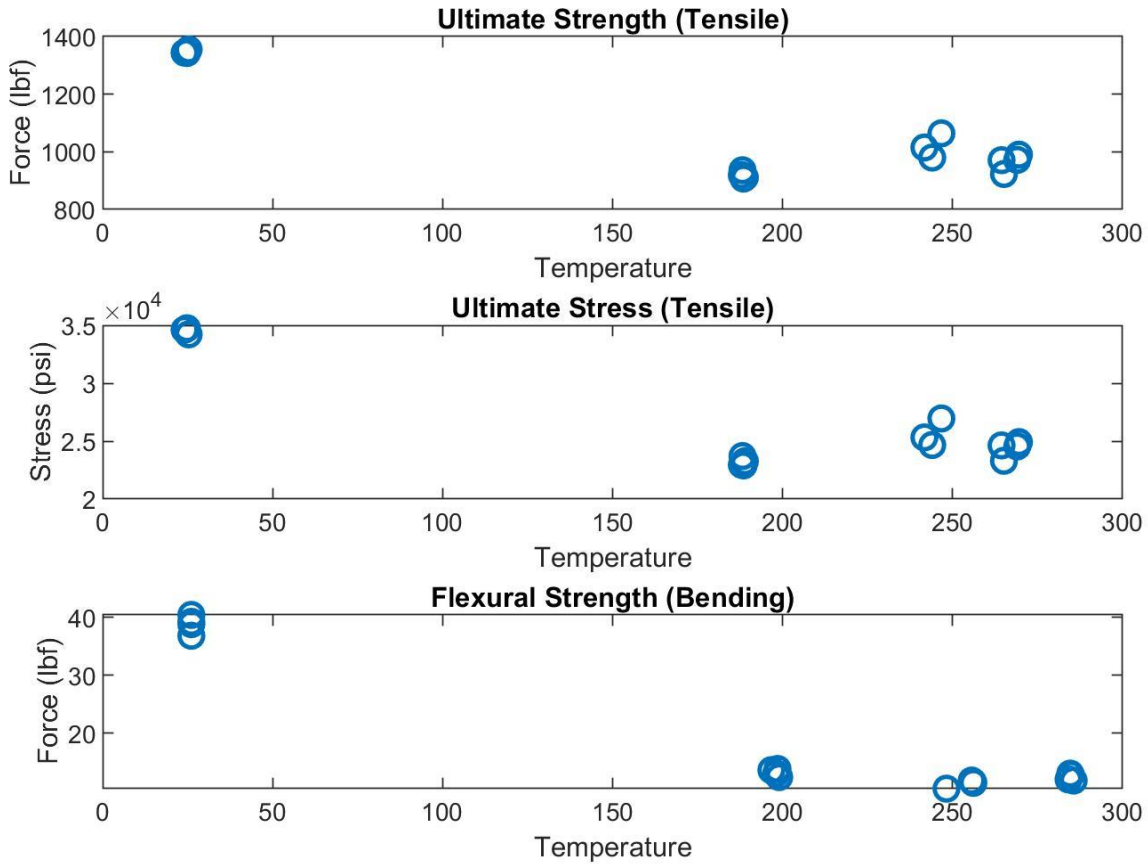
G7 Tests

Background

- The material of the nosecone of a reentry body needs to fulfill three criteria:
  - Can withstand temperatures of 300°C
  - Is readily and cheaply manufacturable
  - Is transparent to RF so that an antenna can go behind the nose
- G7 was chosen because it meets the last two parameters. However, the material lists its continuous temperature limit at 220°C, but a few sources say its intermittently fine to 600 °C

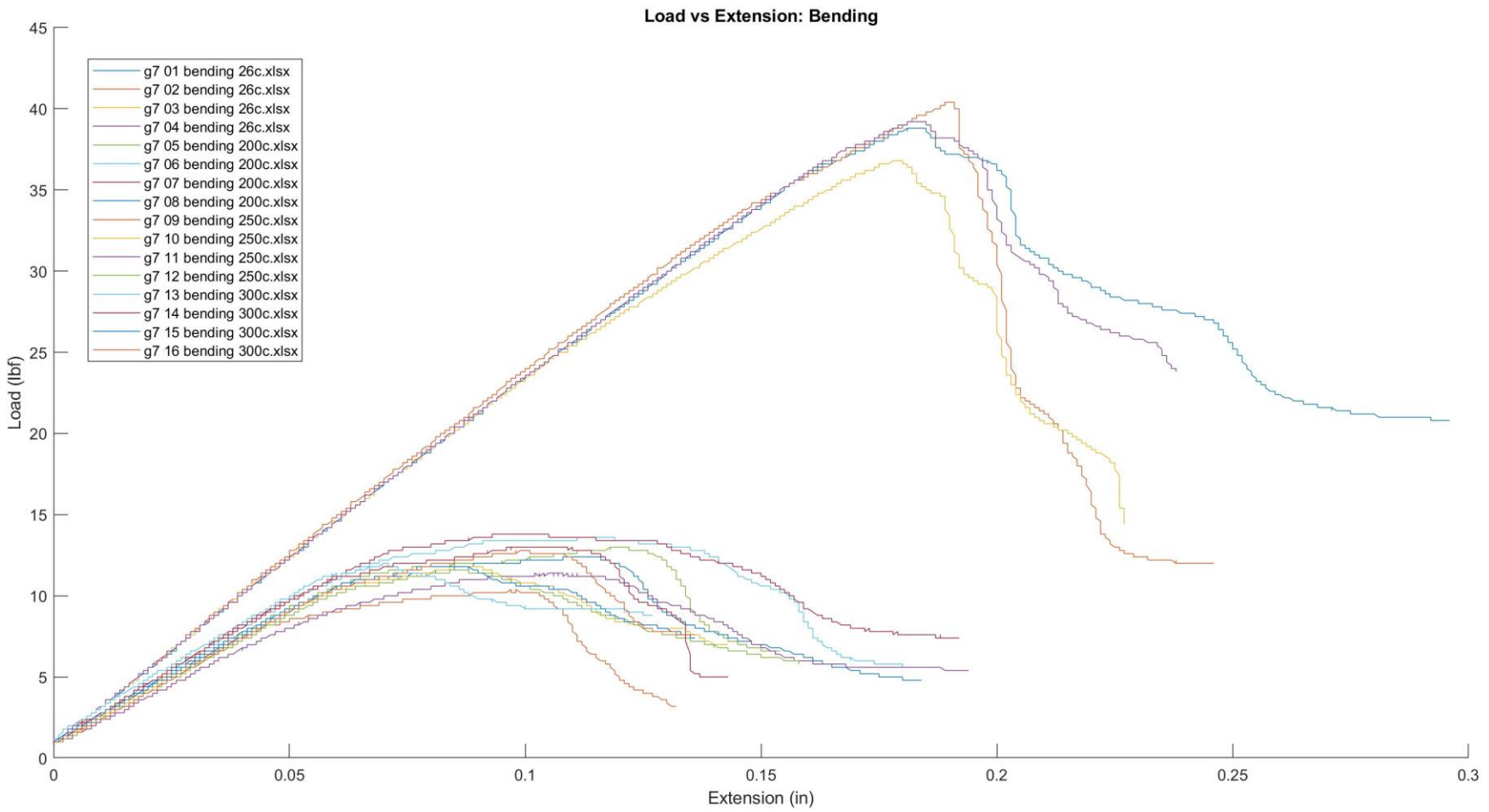
Testing

- Because of this discrepancy, tensile and 3-point bending tests were performed at high temperatures.
- Using a custom MATLAB script, graphs of each of the were found and graphs were produced.
- It can be seen there is a significant decrease in each of the strength of the material between room temperature and 200°C.
- However, there is no significant effect between 200°C and 300°C.

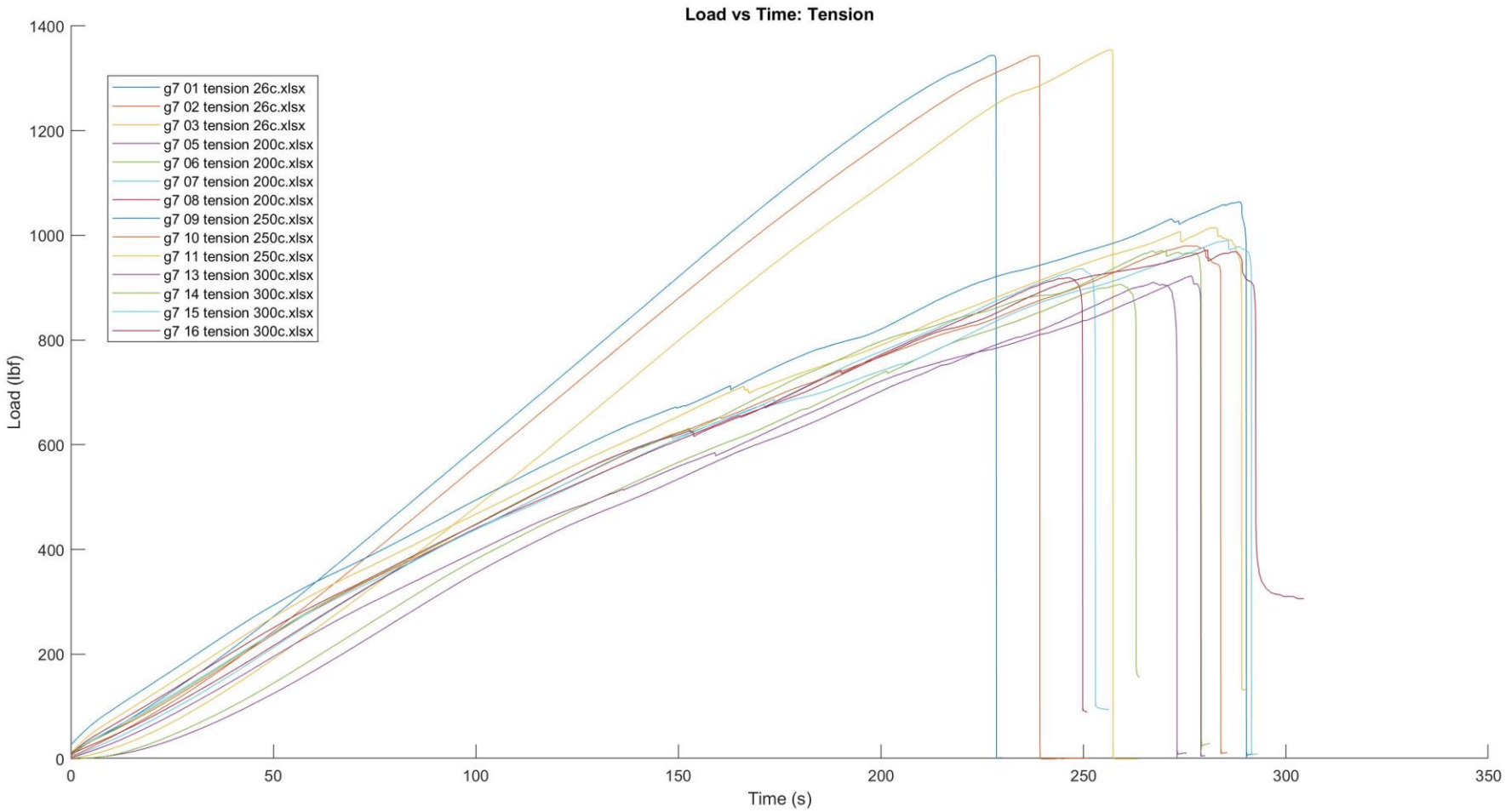


G7 Test Results

Bending Graph



Tensile Graph



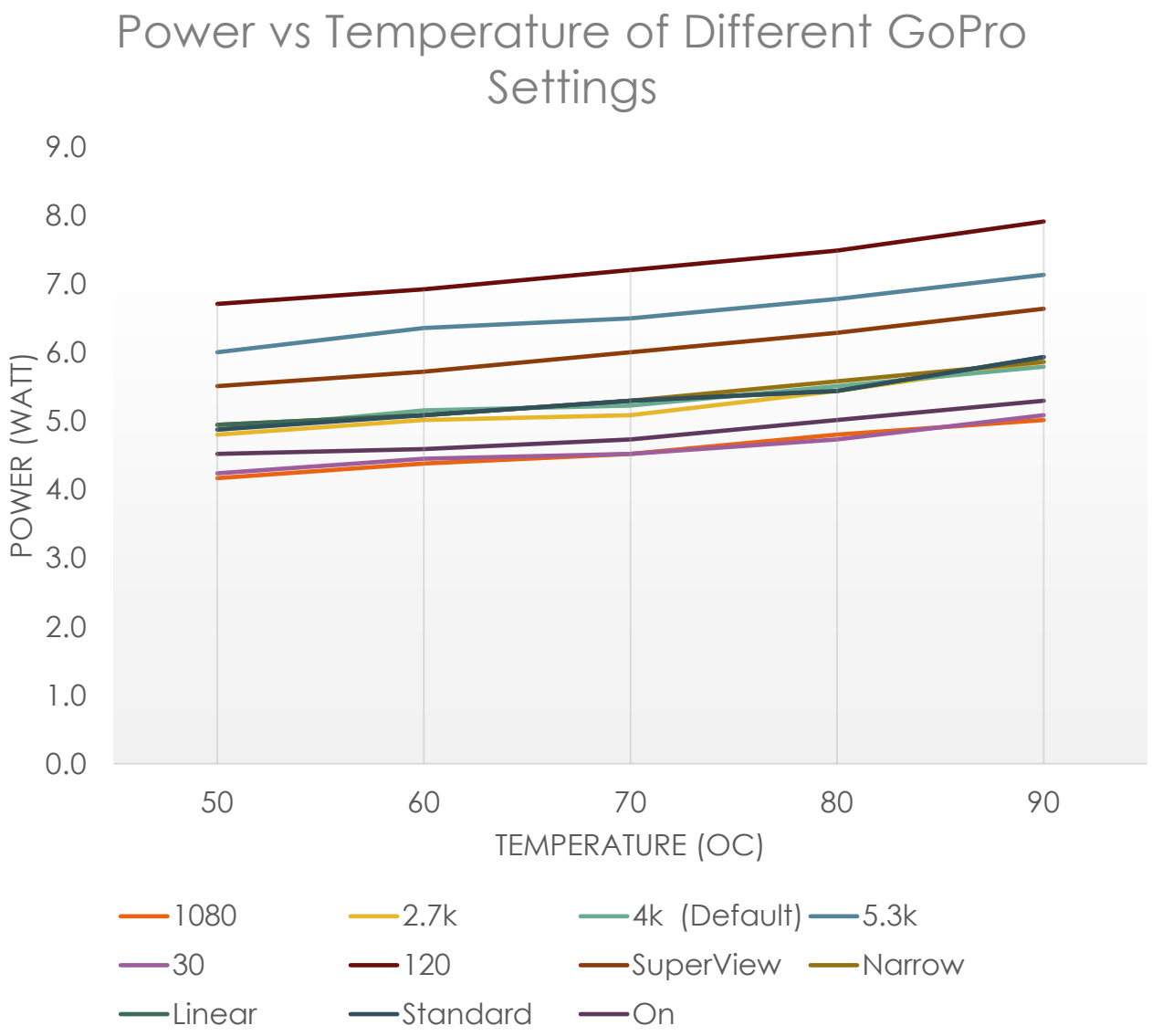
GoPro Testing

- A GoPro (Hero 10 Black Bones) was stripped down, so that the electronic circuit board could be seen.
- Using a thermal camera, the temperature of the hottest part of the GoPro could be seen and recorded.
- Once the GoPro started recording, the power consumption was recorded every 10°, starting at 50°C and ending at 90°C. The time this took was also recorded
- This was done for several settings. Resolution (1080, 2.7k, 4k, 5.3k)
  - Frame Rate (30 60 120)
  - Lens (Wide, SuperView, Narrow, Linear)
  - Hypersmooth (on, off)
  - Tripod (on, off)
- One setting changed at a time while the rest were kept at 4k resolution, 60 fps, wide lens, hypersmooth off, and tripod mode off

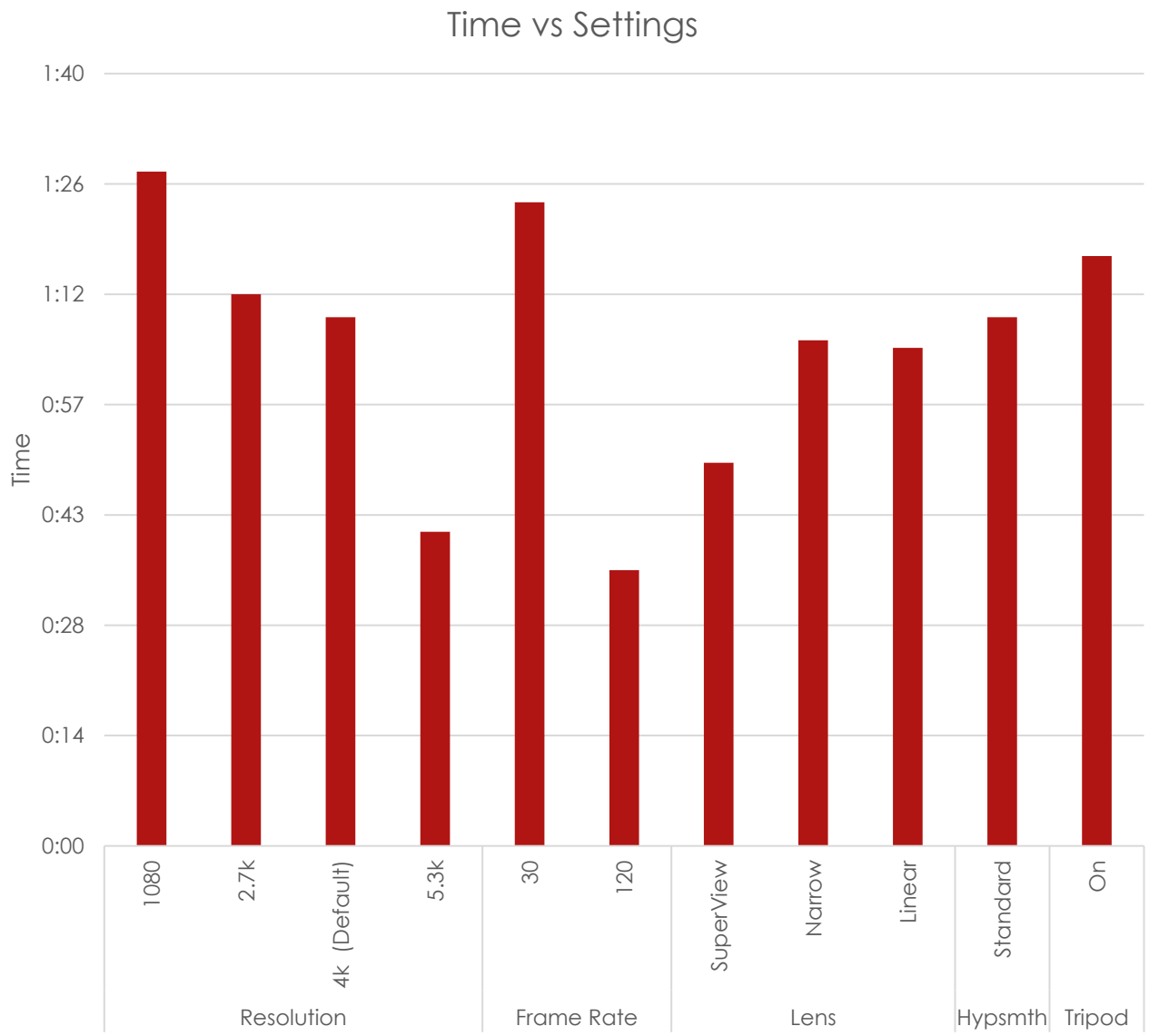
GoPro Results

Power (Watts)											
	Resolution				Frame Rate		Lens			Hypersmooth	Tripod
Temp (°C)	1080	2.7k	4k (Default)	5.3k	30	120	SuperView	Narrow	Linear	Standard	On
50	4.2	4.8	4.9	6.0	4.2	6.7	5.5	4.9	4.9	4.9	4.5
60	4.4	5.0	5.2	6.4	4.4	6.9	5.7	5.1	5.1	5.1	4.6
70	4.5	5.1	5.2	6.5	4.5	7.2	6.0	5.3	5.3	5.3	4.7
80	4.8	5.4	5.5	6.8	4.7	7.5	6.3	5.6	5.4	5.4	5.0
90	5.0	5.9	5.8	7.1	5.1	7.9	6.6	5.9	5.9	5.9	5.3
Time	1:28	1:12	1:09	0:41	1:24	0:36	0:50	1:06	1:05	1:09	1:17

As expected, higher frame rates and resolution use more power and take less time for temperatures to rise from 50°C to 90°C. The SuperView lens setting also has a significant impact on power consumption and time.



GoPro Power Results



GoPro Time Results

Thermal Picture

Light Guide Background

- When light passes from one medium to another, it will refract or reflect. This is dependent on two things:
  - The angle at which the light hits the surface of the medium. This is also known as the angle of incidence and is measured from normal to the surface
  - The critical angle of the material
- When light hits a medium at the critical angle, it refracts along the surface of the material.
- This means that any light that comes in at an angle less than the critical angle will refract and pass through the medium. However, any angle greater than the critical angle will instead reflect. This is known as total internal reflection.
- Light guides are used to funnel light from one place to another with minimal loss. It does this by taking advantage of total internal reflection.
- One way to measure the effectiveness of light guides is through transmittance or absorbance
  - Transmittance is what percentage of light gets through.
  - Absorbance is how much light gets absorbed, and is the –log of transmittance

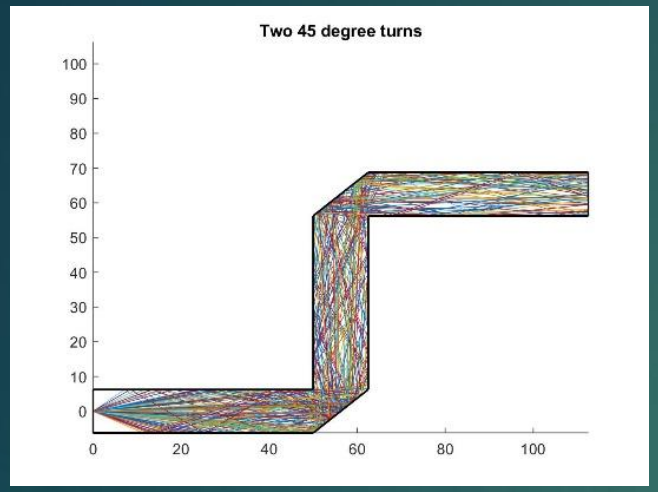
Ray Tracing For Light Guides

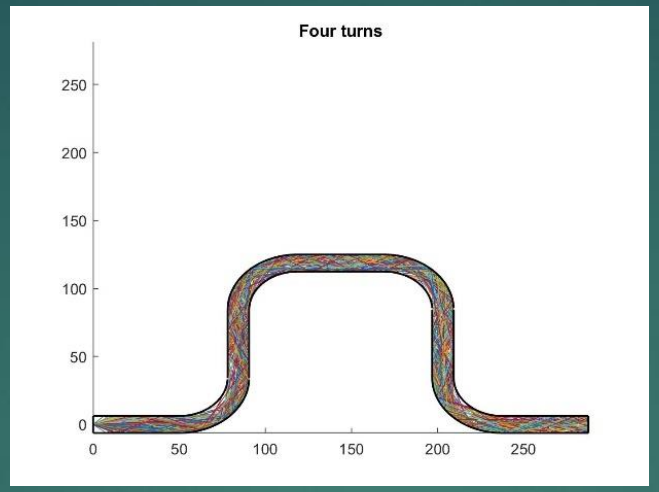
- Using principles described previously, a MATLAB code was made to predict the effectiveness of light guides with different geometries.
- The geometries created were 2D projections of 3D circular geometry.
- The code uses a Monte Carlo simulation to randomly shoot out photons according to a Normalized Intensity vs Beam Angle graph.
- As with most plastics, the critical angle was set to 42.2 degrees
- 100,000 photons were shot out per geometry and the transmittance and absorbance were calculated and graphs were produced

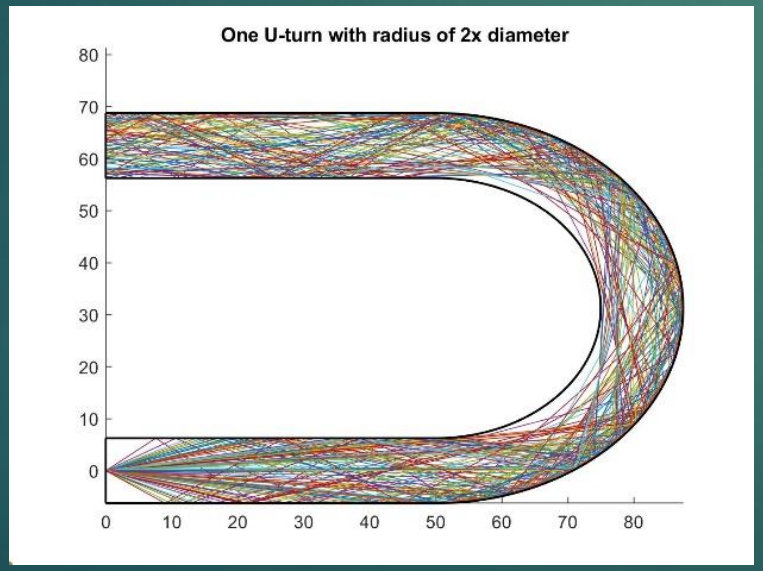
Ray Tracing Results

Geometry	Transmittance (%)	Absorbance
One turn with 45 degrees corner*	76.90544576	0.114042906
Two turns with 45 degree corners*	60.8330121	0.215860679
One 90 degree curve	95.374	0.020570003
Two curves, U-shaped	90.284	0.044389208
Two Turns, S-Shape	87.62	0.057396751
Three turns	81.603	0.088293875
Four turns	73.847	0.131667143
One U-turn with radius of 1x diameter	60.899	0.215389839
One U-turn with radius of 1.75x diameter	83.799	0.076761164
One U-turn with radius of 2x diameter	91.202	0.039995638
One U-turn with radius of 2.25x diameter	95.462	0.020169471
One U-turn with radius of 3x diameter	98.503	0.006550542
One U-turn with radius of 10x diameter	99.998	8.69E-06
Straight with length 0.5 in	100	0
Straight with length 1 in	100	0
Straight with length 2 in	100	0
Straight with length 3 in	100	0

*45 degree turns are 98% reflective
**Diameter refers to the diameter of the light guide. In the graphs this will be the width







Sample Graphs