Optics Payload System for 12U Sun Monitoring CubeSat
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Abstract
- Overall objective: Real-time monitoring of solar activity
- Science Payload:
  - White light coronagraph to monitor coronal behavior
  - Extreme ultraviolet (EUV) imager to analyze solar disk for increased activity
  - Rotating gear wheel system to transition between EUV filters and coronagraph
  - Telescope aligned with active filter and CMOS camera
  - CubeSat design intended for constellation in heliocentric orbit

Methodology
To accomplish SCORCH’s science goals, observation time must be split between EUV imaging and the coronagraph. This is accomplished using a filter wheel containing the three EUV filters and the occulter. Light enters the sun-pointing satellite, flowing through the system described in Figure 1.

Several components are used to accomplish the goals of SCORCH’s mission, as detailed in Table 1. Table 2 specifies the size and specs of the gears made in house. Assemblies are pictured in Figures 2 and 3.

<table>
<thead>
<tr>
<th>Component</th>
<th>Supplier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera</td>
<td>Imperx</td>
<td>25 MP C5180 CMOS Camera</td>
</tr>
<tr>
<td>Filter Wheel</td>
<td>In-house</td>
<td>80 mm diameter gear wheel housing EUV filters and occulter; aluminum 7075</td>
</tr>
<tr>
<td>Motor Gears</td>
<td>In-house</td>
<td>32 mm diameter gears connecting filter wheel to motors; aluminum 7075</td>
</tr>
<tr>
<td>Motors</td>
<td>Empire Magnetics</td>
<td>RH-U17-1 Radiation Hardened Stepper Motor</td>
</tr>
<tr>
<td>EUV Filters</td>
<td>NTT AT</td>
<td>30.4, 28.4, and 17.1 nm wavelengths</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Filter Wheel</th>
<th>Motor Gear</th>
</tr>
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<tbody>
<tr>
<td>z</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>dRF</td>
<td>80.0 mm</td>
<td>32.0 mm</td>
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<tr>
<td>dTP</td>
<td>86.4 mm</td>
<td>38.4 mm</td>
</tr>
<tr>
<td>dRF</td>
<td>72.0 mm</td>
<td>24.0 mm</td>
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</tbody>
</table>

Figure 1: How the light flows through the payload subsystem.

Figure 2: Full payload assembly, including the telescope, three motors and gears, the filter wheel, four lenses, and camera. Note that the camera, telescope and lenses are in-line features.

Conclusion
In summary, the science payload is equipped with:
- Ritchey Chretien Telescope
- Filter Wheel
- Three EUV filters
- Occulter
- Three motorized gears
- C5180 CMOS Camera

The entire data cycle is 15 seconds with 1.5s exposure for each EUV filter, 5s exposure for the coronagraph, and 1s rotation of the filter wheel between experiments.

Based on the capability of the system design and experience from heritage vehicles, this payload is fully functional and capable of capturing solar images for real-time monitoring of solar activity.

Further areas of research include:
- Pointing accuracy required for level of data quality and monitoring capability
- Error associated with aberration and alignment
- Integration with data handling for activity recognition and reporting system

References