**Background**

* Introduction
  + A spectrograph in the mid-infrared spectral region, which is difficult but provides significant and unique information
  + Spectral features of the mid-infrared fall into three broad categories:
    - Emission and absorption by grains and large molecules
    - Fine-structure and recombination line emission by ions
    - Emission and absorption by other molecules
  + These lines have been studied by many other ground-based telescopes such as ISO (Infrared Space Observatory) and the SIRTF (Space Infrared Telescope Facility), but they aren’t studied in the mid-infrared as often
  + It’s been determined after failures to fully study the lines that a higher spectral (not spatial) resolution and high-sensitivity spectrograph was needed for a more in-depth study in the mid-infrared
* Instrument Design Choices
  + The mid-infrared mainly defers from visible spectral regions because it has so much more thermal background radiation, and must be cooled
  + Heterodyne spectrometers can have a higher resolution but have more quantum noise than in the mid-infrared and also have a diffraction-limited view of the sky
  + Another alternative are Fabry-Pérot spectrometers: monochromators that have to sequentially observe different wavelengths, but that also require several interferometers (these must be cooled) to isolate a single transmission
  + Grating spectrographs are another option because they can see many spectral elements at the same time through a narrow slit
  + We chose the grating spectrograph over the Fabry Pérot because the grating had simultaneous spectral capabilities as well as one-dimensional spatial capabilities and have the higher resolution deemed necessary
  + The difficulty of using the grating spectrograph is because using a high resolution in the mid-infrared requires large grating, which is diffraction-limited and isn’t achieved without a large loss of light
  + Another problem with this spectrograph is that it would require cryogenic-cooling in a 1.5 meter-long, 0.4 meter diameter liquid-helium (LHe) Dewar