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Design and Engineering of a Millimeter-Wavelength Spectrometer

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DESIGN AND ENGINEERING OF A MILLIMETER-WAVELENGTH SPECTROMETER

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This project encompasses the design and fabrication of a Fourier Transform Spectrometer (FTS) that will be used to study the millimeter-wavelength optical properties of cosmic analog dusts at astronomically relevant temperatures (close to absolute zero). Autodesk Inventor was used to digitally design parts of the FTS and Inventor's Computer Aided Machining (CAM) feature was used to generate an instruction set for our recently acquired Computer Numerical Control (CNC) milling machine. The CNC mill was used to precisely machine FTS parts to within 0.002".

The FTS consists of two flat aluminum mirrors that reflect millimeter wavelength light at a 45-degree angle, two sets of five side mirrors, a center aligner, a vacuum enclosure, and a centerpiece that holds four polarizers. With the exception of a few parts whose optical accuracy is critical, students in Illinois Wesleyan's physics department machined every component of the FTS.

A large element of this project involved learning how to use the new CNC milling machine starting from a shallow pool of expertise. In addition to the research and self-education that went toward properly operating the CNC mill, certain parameters such as feed rates and spindle speeds used for producing accurately machined parts were found empirically through trial and error.

On the engineering front we have designed a system for moving a translational stage within the FTS that moves by increments of 0.001". This presentation describes the current status of the construction of the FTS and immediate plans for completion and testing by summer 2016.