Objective
As the weather patterns change around the world it becomes increasingly important to gather more accurate data on it. This is what PolarCube aims to do with 118 GHz O2 resonance. The mission of the MiniCam project is to take images during radiometer data collection to verify/correlate data post flight. It is important to do this so that one can identify the source of any anomalous readings off of the radiometer. Development of the MiniCam system of the system is being used to examine the feasibility of implementation on the PolarCube mission.

Requirements
• Fit within a 3x4x5 cm volume
• Consume no more than 1 Watt of power while taking a picture and 50mW in standby mode
• Be no more than 200g in mass
• Take Pictures at resolution above 640x480 pixels
• Angular field of view of at least 60 degrees
• Retrieve meta data on exposure, white balance, and artificial shutter speed

Design Evolution
• initial design used AVR microcontroller, SD card storage, and Aptina camera module
• Full camera datasheet was difficult to acquire resulting in incorrect selection of microcontroller
• Microcontroller had insufficient speed and memory
• Camera operation was vague in datasheet, particularly with nominal camera operation settings
• Communication between camera and microcontroller was complicated by varying voltages
• the second design utilized BeagleBone and preexisting camera cape
• Linux operating system frequently froze while running extended image processing
• Image capture software suffered from significant memory leaks filling up the OS partition
• Image capture software was unreliable at higher resolutions above 1.3MP

Development from concept to flight

Flight Results
• flew on the August 3, 2013 DemoSat flight
• 90 minute flight up 45 minute down
• Out of Deer Trail, Co
• 18 pictures fairly evenly spaced throughout the flight
• Resolution: 1024x 768 pixels
• Proved feasibility of CubeSat camera system
• Met volumetric, power, mass, and resolution requirements
• Did not meet meta data requirement due to time and configuration constraints but this can be met in future attempts

Post Flight Image Processing
• Gimp/X.11 image processing
• Adjustments made on the color balance and contrast
• EOSS flight path for post flight georegistration

Future Implementation
After the Beaglebone flight setup there are several recommendations to consider for possible future work on the system.
• Future designs
  • FPGA or similar hardware accelerators	o handle images
  • not require many I/O pins or excessive amounts of gates (>3000)
  • speed of 8MHz needed so that the parallel bus can be utilized at 1MHz
  • 3x3cm footprint can be found to fit space allotted
• External flash memory
  • faster
  • Less overhead
  • 1GB Flash memory can be found in small form factor
• Initialization can be reversed from BeagleBone
• The stacking of an small FPGA, flash memory, camera and connectors
• push the volume constraints to the limit
• may not allow some support circuitry such as voltage regulators to be incorporated in the package.
• Effort to be continued Spring 2014

Team
From Left to Right (MiniCam Team): Dave Gallagher(Advisor), Rocky Marcus(Power System), Alexandra Hickey(Structures, Team Lead), João Cavalcanti Costa(Software), Felipe Regis e Silva(Software), Evan Schomer(Command and Data Handling)
Not Pictured: Frank Erdesz(Power System), ALL-STAR Team (mentoring and debugging)