HASP Student Payload Application for 2010

Payload Title: SKC Wide Field Camera		
Payload Class: (check one) ☒ Small ☐ Large	Institution: Salish Kootenai College	Submit Date: 12/18/09

Project Abstract

Salish Kootenai College proposes the SKC Wide Field Camera, a student designed, built, tested, and operated prototype general purpose astronomical visible light camera for the 2010 High Altitude Student Platform flight opportunity. The preliminary baseline electronic design includes a CMOS image detector, FPGA control of image acquisition and storage, and Flash memory storage of images for post-flight retrieval and analysis. The preliminary optical design is a fixed focus camera with a 14 mm focal length, f/1.2 aperture lens. The camera will have a fixed mount pointing the optical axis towards Earth's horizon, with balloon rotation providing passive pointing. The primary goal of this project is to provide SKC computer engineering students with systems engineering experience for scientific payloads carried on balloon or spacecraft platforms, with a secondary goal of testing the system design in near space conditions to enable refinement of the design for possible future flight opportunities.

Team Name: SKC Wide Field Camera		Team or Project Website:
Student Team Leader Contact Information:		Faculty Advisor Contact Information:
Name:	Kody Ensley	Tim Olson
Department:	Computer Engineering	Computer Engineering
Mailing Address:	Salish Kootenai College PO Box 70	Salish Kootenai College PO Box 70
City, State, Zip code:	Pablo, MT 59855	Pablo, MT 59855
e-mail:	kody_ensley@student,skc,edu	tim_olson@skc.edu
Office telephone:		406-275-4898
Cell:		406-546-0008
FAX:		406-275-4801

Salish Kootenai College Wide Field Camera

Introduction

The Wide Field Camera is a prototype astronomical visible light camera designed for observation of a variety of astronomical objects. In order to reduce design complexity for the first HASP payload from SKC, the payload will not include an active pointing system to enable stable pointing of sufficient duration to image astronomical objects from the HASP platform. The camera will be mounted with the optical axis oriented horizontally, and images of Earth's horizon will be acquired to test the camera system. The subsequent science analysis will be modest, consisting of identification of upper atmosphere features.

The primary goal of this project is to provide SKC computer engineering students with systems engineering experience for scientific payloads carried on balloon or spacecraft platforms, with a secondary goal of testing the system design in near space conditions to enable refinement of the design for possible future flight opportunities. An example possible future flight opportunity is the student designed, built, and operated Gegenschein Imager instrument proposed to fly on the recently selected NASA Small Explorer solar observing IRIS mission. The Gegenschein Imager would be mounted on the anti-Sun side of the IRIS spacecraft, and so would point continuously toward the gegenschein, the brightest region of heliospheric interplanetary dust. The Gegenschein Imager would study spatial inhomogeneities and temporal changes in the gegenschein. The Gegenschein Imager project is led by Montana State University with Salish Kootenai College as a collaborating institution.

Payload Description

The SKC Wide Field Camera has optical properties similar to the commercial MicroVista-UV camera proposed for the Gegenschein Imager: the preliminary optical design for the Wide Field Camera is a fixed focus camera with a 14 mm focal length, f/1.2 aperture lens, yielding a field of view of approximately 52° x 43°. The preliminary baseline electronic design for the Wide Field Camera includes a 1280 x 1024 pixel CMOS image detector (such as the Aptina MT9M131C12STC), a rad-tolerant FPGA for control of image acquisition, and Flash memory storage of images for post-flight retrieval and analysis.

The preliminary operations plan includes acquiring images at one minute intervals in flight. A lens baffle and a photodetector circuit will be used to protect the camera from direct imaging of the Sun. The photo detector circuit will also be used as a light meter to set image exposure time. The lens baffle will also be used as a radiator for dissipation of heat from the FPGA. The only required telemetry via the serial downlink is the return of occasional JPEG compressed thumbnail images for verification of continued system operation. Two-byte serial uplink commands will be used for in flight changes of image exposure time and image acquisition frequency, system reset, and system shutdown if needed.

Team Management and Structure

Salish Kootenai College is a four-year college on the Flathead Indian Reservation in western Montana that serves predominantly Native American students. The Wide Field Camera team will consist mainly of students in the SKC B.S. in Computer Engineering degree program.

The computer engineering program is the only baccalaureate engineering degree offered by SKC. In addition SKC offers a transfer preparation A.S. program for students interested in other engineering specialities, and an engineering technology degree in engineering graphics. SKC does not offer majors in astronomy or physics.

The eleven student team members are listed in Table 1 below. Nine of these students are computer engineering majors, one is a mechanical engineering major, and one is an engineering graphics major. Overall leadership of the team will be the responsibility of the Project Management Lead Kody Ensley. The Project Management Lead will have overall responsibility for assuring the team meets project scope requirements and schedule milestones within budget. The Project Management Lead will be the primary interface between the Wide Field Camera team and HASP staff. The Project Management Lead will coordinate the preparation of the required monthly status reports, lead the Wide Field Camera team participation in the monthly teleconferences with HASP staff, and coordinate the preparation of the Final Flight/Science Report. The Design Lead Sean Shriner will organize the design efforts of the team including coordination of design subteams, and will organize the preparation of the Payload Specification and Integration Plan. The Assembly Lead Joseph Sorrell will lead the assembly of system components. The Test and Operations Lead Mathew Friedlander will lead system testing both in house and during thermal/vac testing at the Columbia Scientific Balloon Facility in May. The Test and Operations Lead will also have primary responsibility for preparation of the preliminary and final versions of the Payload Specification and Integration Plan, will lead team integration efforts at CSBF in August, and flight preparation and operations.

Marianne Addison, 2nd yr Mechanical Engineering	Gladys Redhorn, 2nd yr Computer Eng.
Joni Buckman, 1st yr Computer Eng.	Sean Shriner, 4th yr Computer Eng. Design Lead
Conan Christy, 1st yr Computer Eng.	Joseph Sorrell , 2nd yr Engineering Graphics Assembly Lead
Kody Ensley, 3rd yr Computer Engineering Project Management Lead	Ian Williams, 1st yr Computer Eng.
Mathew Friedlander, 3rd yr Computer Eng. Test and Operations Lead	Ryan Young, 1st yr Computer Eng.
Bradley Lehuta, 1st yr Computer Eng.	

Table 1: SKC Wide Field Camera student team members.

Four SKC faculty advisors from the computer engineering degree program will assist the Wide Field Camera team. Tim Olson, Chairman of the Division of Sciences, will be the lead faculty advisor. Olson has advised one past high altitude balloon flight student payload team from SKC in 2003 through the NASA Montana Space Grant BOREALIS program at Montana State University. Olson is a co-investigator on the MAHLI/MARDI/MastCAM Science Team for the NASA 2011 Mars Science Laboratory mission. Other faculty advisors are Al Anderson (computer engineer), Frank Stomp (computer science), and Thomas Trickel (electrical engineer).

Olson will assure the Wide Field Camera team has the needed financial resources to complete the project successfully. SKC has NSF funding in hand to fully support payload development, testing, integration, operation, and data analysis, including needed travel.

Payload Specifications

Mass: 2 kg (1.5 kg for the lens baffle/radiator, 0.5 kg for the rest of the camera system)

Footprint: 50 mm x 75 mm (the camera baffle/radiator will extend an additional 75 mm beyond the mounting plate in the outward horizontal direction)

Height: 50 mm on the mounting plate with the top of the baffle extending 80 mm above the mounting plate

Power: 80 mA

Downlink rate: maximum of 1000 bps (adequate for the downlink of 37500-byte thumbnail image every five minutes)

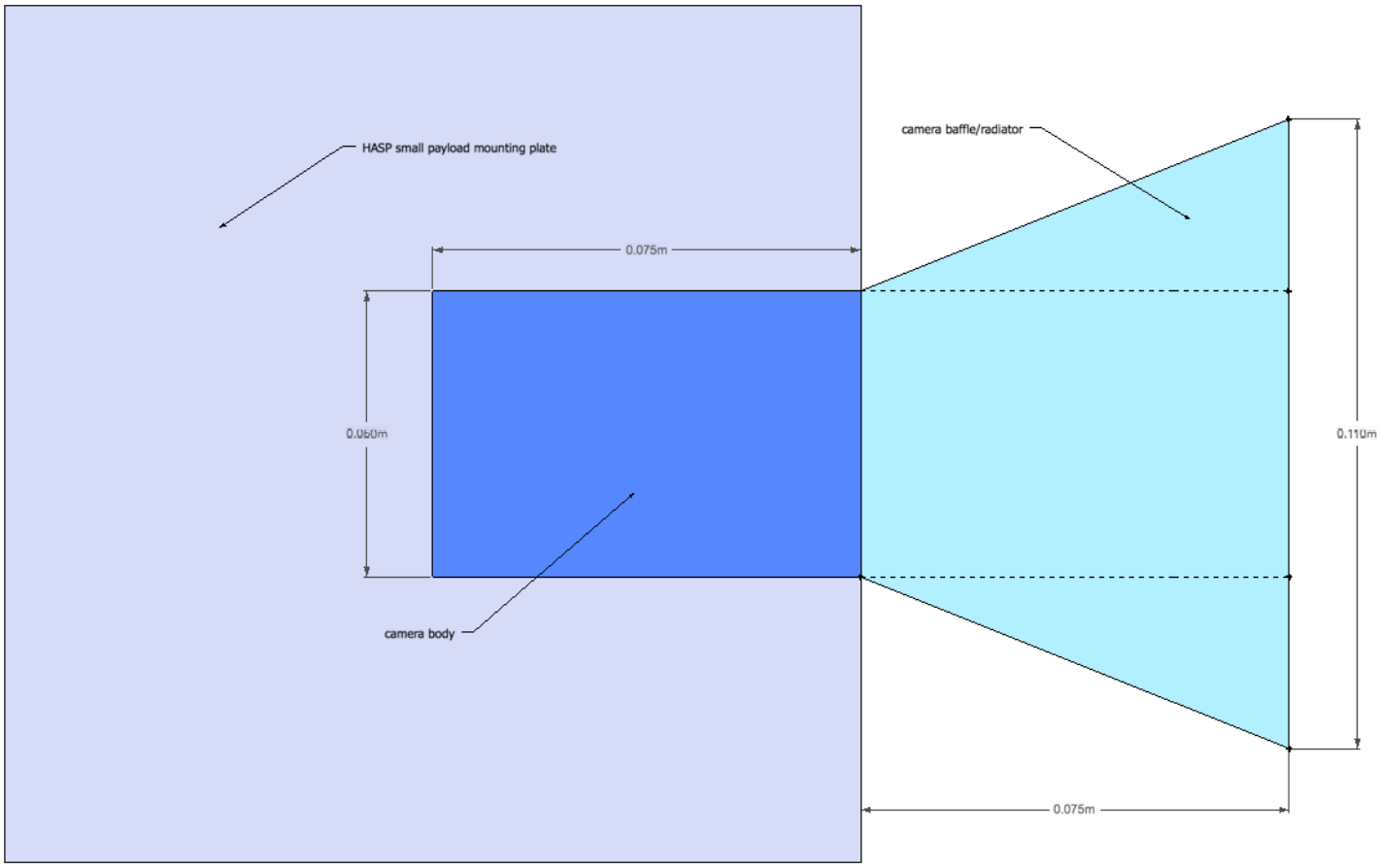
Uplink rate: 8 bytes per minute maximum

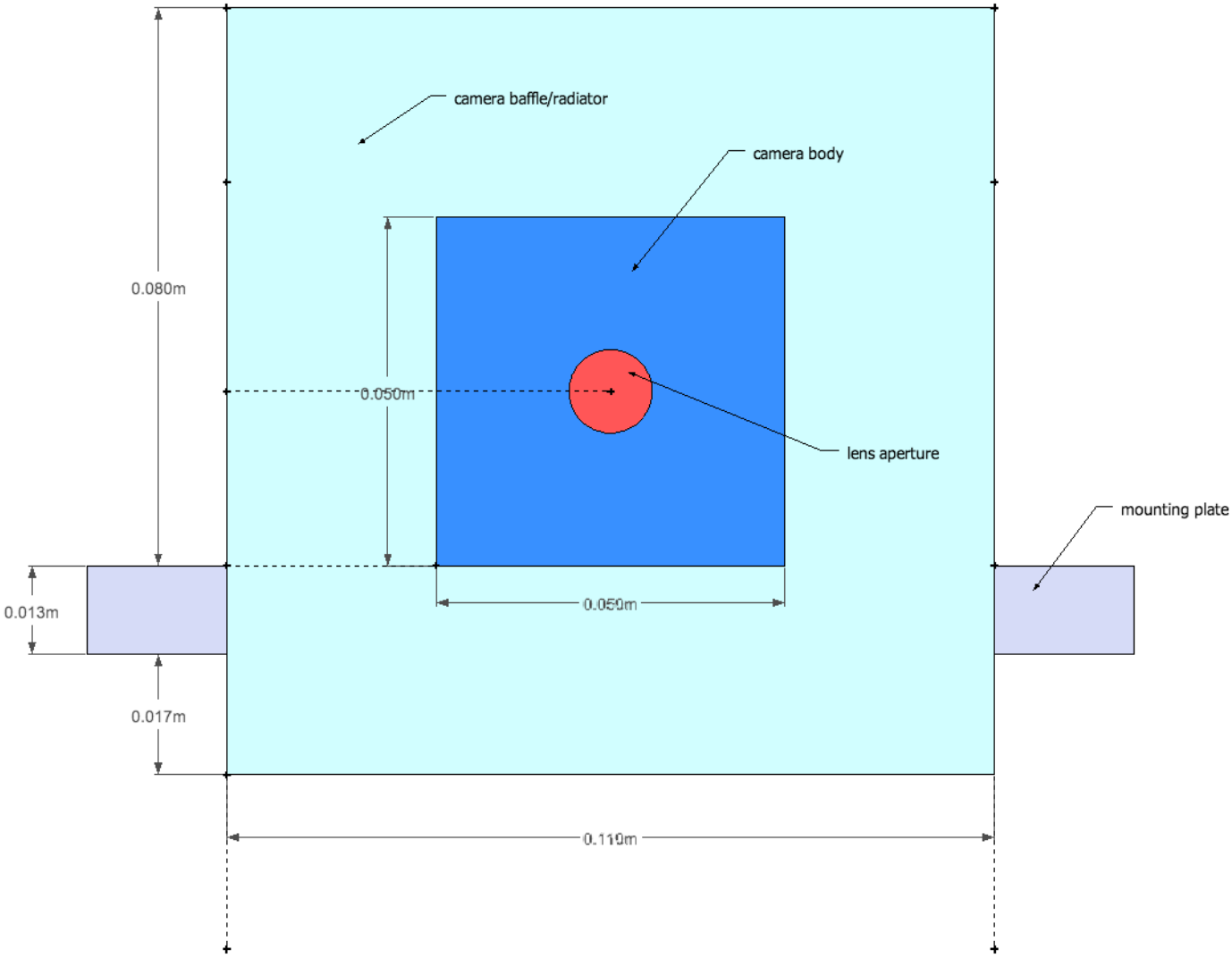
Location: On one of the small payload outrigger platforms

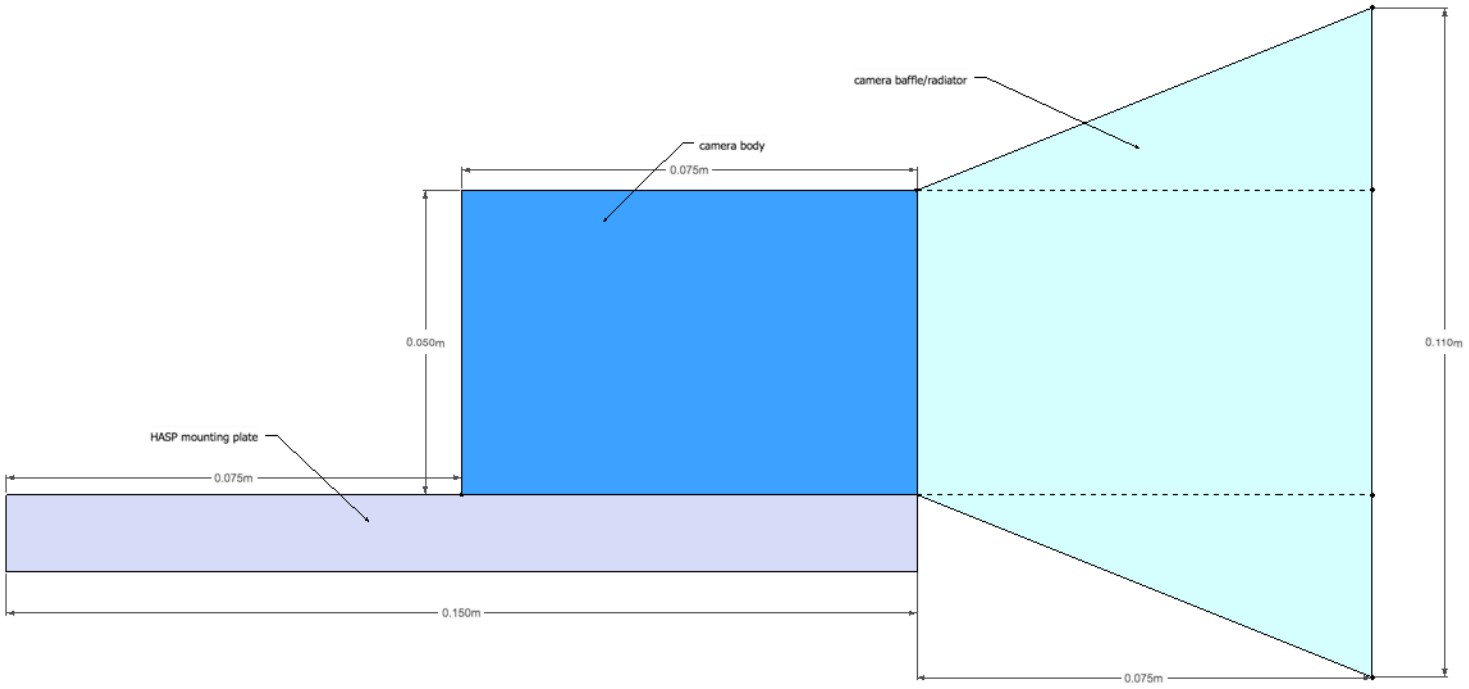
Orientation: Optical axis pointed horizontally outward from the gondola

Preliminary Drawings

The following three pages are rough preliminary drawing of the Wide Field Camera showing placement location a HASP small payload mounting plate:


HASP small payload mounting plate
camera baffle/radiator
0.075m
0.060m
0.110m
camera body
0.075m


camera baffle/radiator
camera body
lens aperture
mounting plate
0.080m
0.050m
0.059m
0.013m
0.017m
0.119m


camera baffle/radiator
camera body
0.075m
0.050m
0.110m
HASP mounting plate
0.075m
0.150m
0.075m