2011 HASP payload proposal
Maple Leaf Cosmic Ray Detector

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HASP Student Payload Application for 2011

Payload Title: Maple Leaf Cosmic Ray Detector

Payload Class: (check one)	Institution:	Submit Date:
Small ■ Large	University of Alberta	December 17th, 2010

Project Abstract

The Maple Leaf Cosmic Ray Detector is the effort of the University of Alberta High Altitude Balloon Program team (UA-HAB), as the first Canadian Institution participating in HASP following the mandate of the Canadian Space Agency to 'build capacity in the science and technology space sector, in particular through promoting the use of accessible and cost effective suborbital platforms'. The Maple Leaf Cosmic Ray Detector is a simple low mass cosmic ray detector that aims to measure particles with energies greater than 200MeV, following the design made by University of Louisiana Lafayette in 2006. The detector will be constructed from sheets of metal and photo-emulsion paper with HR Fast Screens layered and bolted together. Emphasis of this project will be to explore film resolution to increase the particle detection, and improve the data analysis techniques used by the previous team.

Team Name: Cosmic Canucks	Team or Project Website: http://www.isset.ualberta.ca/students/HASP

	Student Team Leader Contact Information:	Faculty Advisor Contact Information:
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City, State, Zip code:	Edmonton Alberta T6G 2G7 CANADA	Edmonton Alberta T6G 2G7 CANADA
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1 Introduction

The Maple Leaf Cosmic Ray Detector is a University of Alberta (UofA) project, under the sponsorship of the Canadian Space Agency (CSA), to participate in HASP 2011. One of the CSA's priorities is to "build capacity in the science and technology space sector, in particular through promoting the use of accessible and cost effective suborbital platforms" to "contribute to training the next generation of the space workforce in Canada" [1].

In order to present a proposal forward for UofA to participate in HASP, leaders of the University of Alberta High Altitude Program (UA-HAB) met within 2010, during the CSA 2010 Workshop on Suborbital Platform and Nanosatellite, held CSA Headquarters (Montreal). CSA Space Awareness and Learning saw great potential the project and received a formal proposal [2] from the UA-HAB September 2010, requesting sponsorship to participate in HASP 2011. As a result, the confirmation from CSA was received at the end of November. A contribution agreement was prepared by CSA and sent to UofA for its review. The contribution agreement is in the process of being signed.

The detector will be constructed from sheets of metal, and photo-emulsion paper layered and bolted together. The metal will be selected during the planning phase of the project to optimize the weight of the payload and effectiveness in detecting. This optimization will be simulated with the computer programs Geant4 and SRIM. The photo emulsion paper will be decided on after consulting with engineers from companies such as fuji and kodak.

2 Theory

Cosmic rays are "particles that bombard the Earth from anywhere beyond its atmosphere" Anderson (2010). These particles fall under three categories: Galactic Cosmic Rays, Solar Cosmic Rays, and Anomalous Cosmic Rays, originating from outside our solar system, solar activity such as solar flares, and the edge of the heliopause in interstellar space respectively Anderson (2010). Galactic Cosmic Rays have the highest energies, which typically range from 100MeVto 10GeV, corresponding to protons traveling 43% to 99.6% the speed of light n.d. (n.d.). Galactic cosmic rays are composed of "atomic nuclei from which all of the surrounding electrons have been stripped away during their high-speed passage through the galaxy" von Rosenvingen (2010). Of these nuclei, approximately 90% are hydrogen, 9% are helium, and the rest of the particles in the universe constitute the remaining 1% Lochner (2010). While this composition is similar to our solar system's, studies may indicate that the seed population for galactic cosmic rays is neither interstellar gas nor remnants of supernovas von Rosenvingen (2010). Such studies fuel current research, making the measurement and observation of galactic cosmic rays of considerable importance.

This experiment will measure the energy of galactic cosmic rays using the historic method of photo-emulsion paper layered with metal plates. We will need to adjust our experiment to filter out lower-energy solar cosmic rays (3MeV-100MeV). This will be done by selecting the appropriate paper. When cosmic rays collide with the detector, dark spots will be produced on the paper. These dark spots will be used to measure the total energy of our observed cosmic rays. Since the flux of cosmic rays vs. their energy follows a "knee" shape (see Figure 2), we expect higher-energy cosmic rays should leave smaller "dots" on the photo-emulsion paper, while lower energy cosmic

[1] CSA 2010 Workshop on Suborbital Platform and Nanosatellites - Report April 14-16, 2010
[2] Contributions Form 2010 UAHAB *see Appendix*

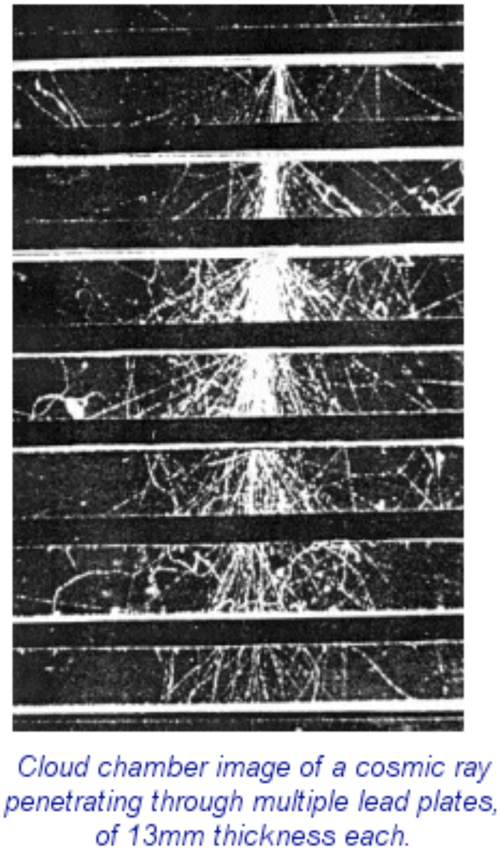

Figure 1: Cloudchamber Borg (2010)

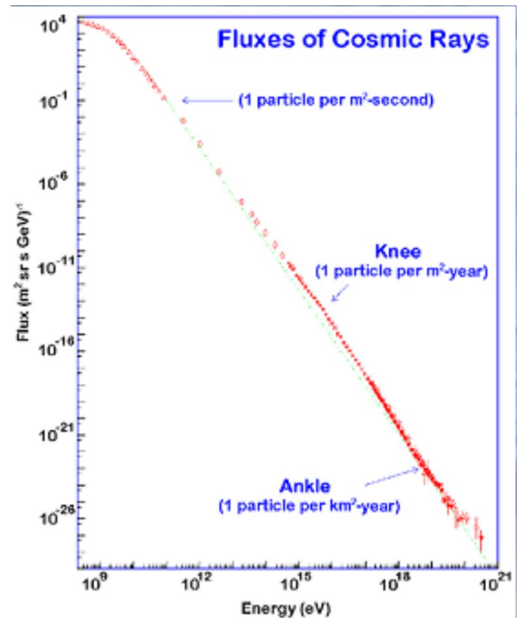

Figure 2: Flux of cosmic rays graphed against their total energies follow a downward "knee" shape, showing flux decreases as energy decreases. Borg (2010)

rays with higher flux should leave wider dots. With our data, we will plot a graph of count fluence, "a particle that is being slowed down by the interaction of the film stack and is depositing most of its energy into the stack" Fontenot et al. (2007) vs. depth . This will show us the relationship between the fluence and stack layer and compare our results with previous experiments. We expect to see count fluence decrease as the stack layer increases, as illustrated in Figure 1, wherein the cosmic ray loses energy passing through consecutive layers of lead plates.

3 Team Management

3.1 Project Organization

There are two levels of participation within the project. Participants will participate in all stages of the project. This includes writing the proposal, designing, manufacturing, testing, launching, recovering, analyzing and publishing. They will receive a compensating salary during the spring/summer and during the manufacturing and they will be authors of all publications related to the project. Travelling to testing/launching/conferences will be determined upon availability of funds.

The second level of participants are the volunteer participants. Volunteer participants are participants that want to participate in the project, but for reasons cannot participate in all stages.

However, they will participate in some stages of the project on a volunteer basis (ie. will not receive any compensation).

The team is coordinator by Laura Mazzino with assistance from the Project Advisors Dr. Jonathan Rae and Dr. Jeffrey Kavanaugh. The project is overseen by Dr. Ian Mann. The chart below illustrates the Maple Leaf Cosmic Ray Detector 's team organization.

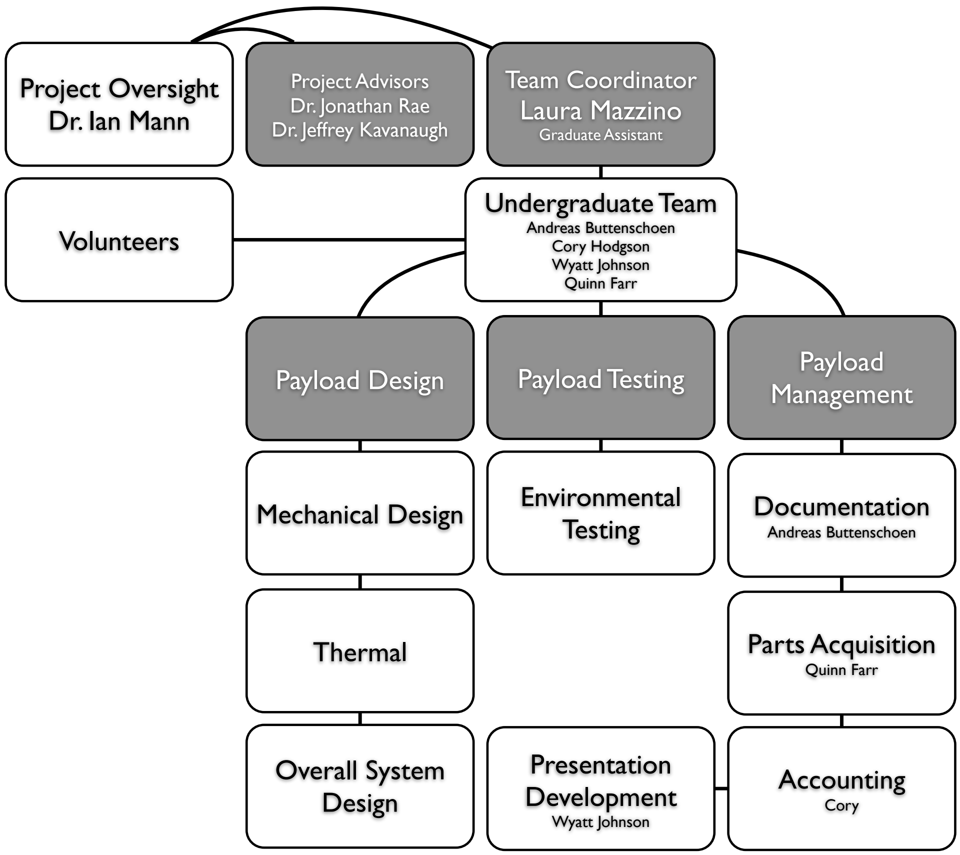

Figure 3: Team structure

3.2 Contact Information

The following chart gives phone and email contact for the commited participants.

Name	*Phone*	`Email`
Laura Mazzino	*(780) 492-8179*	mazzino@ualberta.ca
Andreas Buttenschoen	*(780) 709-0091*	andreas.buttenschoen@ualberta.ca
Cory Hodgson	*(780) 668-6120*	crhodgson@ualberta.ca
Wyatt Johnson	*(780) 965-3962*	wyatt.johnson@ualberta.ca
Quinn Farr	*(780) 434 9565*	qfarr@ualberta.ca

Table 1: Contact Information for commited participants

Name	*Phone*	`Email`
Alistair Kirk	*(780)*	kirk1@ualberta.ca
Abouzar S. Shahrbabak	*(780)*	shamsadd@ualberta.ca
Tania Wood	*(780) 719 0629*	trwood@ualberta.ca
Sonia Budak	*(780) 965-3962*	budak@ualberta.com
Matt Nagy	*(780) 218-6288*	mjnagy@ualberta.ca
Tyler Naffin	*(780)*	naffin@ualberta.ca

Table 2: Contact Information for volunteers

3.3 Timeline

Date	**Item**
2010	
October 13	Contribution Form send to CSA
November 26	CSA confirmation of acceptance of Contribution agreement
November 29	Team Recruitment
December 6-10	First team meetings
December, 17	HASP Proposal deadline
2011	
January	Begin Design
February	Monthly status report to HASP/teleconference with HASP
February	Completion Course
February	Completion Design

Continued on next page

Date	Item
March	Begin Manufacturing
March	Monthly status report to HASP/teleconference with HASP
April	Manufacturing continous
April	Final PSIP document due (Payload Specification & Integration Plan)
May	Completion of Manufacturing
May	Monthly status report to HASP/teleconference with HASP
June	High School Balloon launches
June	Final FLOP document due (Flight Operation Plan)
June	Second Report to CSA
July	Testing, Calibration (David Florida Labs)
July	ISSET Space Academy Balloon launches
August	Student payload integration at CSBF (USA) Payload Integration Certification
September	Presentation at ISSET Sympoisum
September	Launch (Fort Summer, NM USA)
September	Monthly status report to HASP/teleconference with HASP
October	Data Analysis
October	Third report to CSA
October	Presentation at UA Open House
November	Completion of Data Analysis
November	Publication (AGU, Phys Teacher)
December	Final report to HASP
December	Presentation at AGU (USA)
2012	
February	Final Report to CSA

Table 3: Timeline

3.4 Launch Personnel

The number of participants attending the launch will be determined on the availability of funds.

4 Payload Specifications

4.1 Payload Size

The payload will have maximum dimensions of 30cm $\times$ 38cm $\times$ 30cm and a minimum dimension of 25cm $\times$ 33cm $\times$ 28cm.

4.2 Weight Budget

20 kgmaximum
80 – 90% absorber material
8% rods
1 – 2% photo paper
1 – 2% housing

4.3 Structure of the Experiment

The experiment will consist of layers of photo paper, in between layers of metal plates. The photo paper will be sealed inside of light proof bags so as not to expose them to light and ruin the film. The entire apparatus will be bolted together by metal rods, one in each corner of the metal plates. This will all be incased inside a housing, which will further reduce the risk of the experiment being exposed to sunlight. The housing shall be made of foam board, or another suitable material that shall be determined after experimentation. We also should investigate the possibility of having a mechanism that would allow our detector to function only beyond a certain altitude, such as a lid with a balloon that inflates and lifts the lid as pressure decrease, or electronic system. If we chose to this shielding would be need around the entire experiment until the designated altitude.

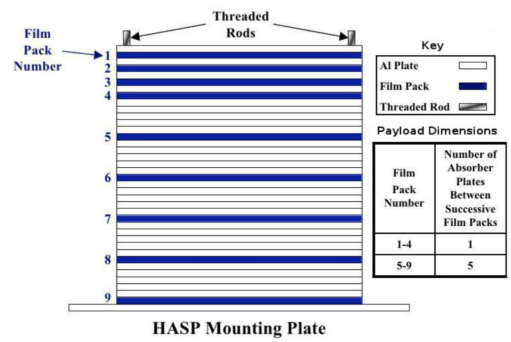

Figure 4: Block diagram of the UL Lafayette HASP cosmic ray payload design (Fontenot et al. 2007, Fig. 4)

4.4 Photo Emulsion Paper and developing process

The paper for the experiment shall be selected after an appropriate amount of research and testing. Kodak T-Mat H600 Film is a possible choice. The photo paper will be sealed in light proof bags, so as to not let them be exposed to light during the course of the experiment. These bags will not be vacuum sealed, but instead will have a light trapping tube to regulate pressure in the bag. One important consideration is to uniformly develop the film. In order to compare images in different pieces of film, they need to be developed, stopped, and fixed with the same chemicals for a consistent amount of time. We shall build a simple film holder apparatus similar to the one shown in Figure 4.4 to simultaneously expose the film pieces to the processing chemicals. Each piece of film will be identified by a number marked with a pencil. Moreover, each light tight bag will be given the same label, corresponding to their individual position and depth on the payload. As a preparation for the developing process, each sheet of x-ray film will be opened in the complete darkness, separated from the screens, and attached to the holder by individual hangers. The film is processed by sequential immersion in four chemical

Figure 5: Picture of a student constructed tank and holders used to develop the film (Fontenot et al. 2007, Fig. 5)

baths: developer, stop, fixer, and final rinse. We will select the chemicals we use and the appropriate amount of time to submerge the photos in the chemical baths based on the photo paper chosen.

4.5 Possible Energy Range

The maximum energy our experiment will be able to detect will vary with the size of the experiment and the material we chose to use as an absorber. From previous experiments we know we can at least have a maximum energy of 250 MeV, but with the weight budget doubled, we could reach energies of 500 MeV. If cost allows, one of the ideal materials to choose would be tungsten, which could possibly lead to maximum energies of up to 1 GeV.

Here are some sample material and energies: The material will be selected only after running

Material	Energy (MeV)	Length (cm)	Width (cm)	Thickness (cm)	Density (g/cm^3)
Pb	500	5	6.5	22	11.334
Pb	400	6	7.2	16.5	11.334
Pb	300	8	9.3	9.5	11.334
Pb	200	12	12	5	11.334
Pb	100	18	19.6	2	11.334
Al	500	7	7.1	60	2.702
Al	400	8	9.1	41	2.702
Al	300	11	10.4	26	2.702
Al	200	15	14	14	2.702
Al	100	27	27.5	4	2.702
Fe	500	7	6.3	23	7.866
Fe	400	8	8	16	7.866
Fe	300	9	10.3	11	7.866
Fe	200	14	14.5	5	7.866
Fe	100	22	23.2	2	7.866

Table 4: Sample maximum energy ranges

simulations with programs such as Geant4 and SRIM. We shall select the configuration that gives us the highest maximum energy within out budget.

5 Integration and Testing

The payload will conform the the dimensions of a large class payload (30cm × 38cm × 30cm). The payload will also conform to the interface restrictions on weight of a maximum of 20kg. Our Payload will also not be using any power source nor any data/serial connection to the HASP system. The payload also does not contain any electronics equipment. The payload will be oriented upwards for the duration of the flight as well.

Trial runs will be conducted prior to the analysis of the final data collected during the flight. We will practice our ability to process and develop the photo emulsion paper to ensure that we are confident in our skills at developing before applying our knowledge on the data collected during the flight.

To eliminate additional costs, the testing and launching of the payload will occur on the same trip and will consist of a team of 2-4. The integration component will consist of mounting the payload, verification that the payload satisfies the standards set out by the HASP Payload Integration Certification requirements.

5.1 Environmental and Physical Testing

The materials that will be used in the construction of the payload will be chosen for their ability to withstand temperature, durability, and vacuum tests as set out by the standards of the HASP Payload Integration Certification requirements. The payload will be secured as well as so that it remains intact and attached to the mounting plate under a 10g vertical and 5g horizontal shock.

5.1.1 Vacuum Testing

The first test that will be conducted will be a vacuum test. This test would be able to model the conditions that will be experienced by the payload during the ascent of the balloon. The test will be conducted using a reduced sized film bag. This is then placed into a small vacuum chamber where the pressure will reach 3 Torr after an hour of exposure to the vacuum pressure. Once the hour is up, the vacuum chamber would be pumped up, we would then look for any leaks in the bag.

5.1.2 Light Leakage Prevention

Testing will also be completed on the film pack to ensure its ability to block light from exposing the film to visible light. A sensitive digital light probe will be placed into the pack, which was then attached to a computer to measure the light intensity. The light pack and probe where then sealed in two bags. Once the light probe was operational, a variety o light sources will be shined on all parts of the surface of the film pack. As long as the light sensor does not detect any intensity changes during these testing, the pack will be considered to have passed the test.

5.1.3 Stress and Rough Handling

To test for the payload's ability to resist the impact when the payload lands, the payload will undergo a series of "drop tests", where a simulated fall at terminal velocity will occur followed by a verification of integrity of the components of the payload.

5.1.4 Temperature Testing

The payload will also be tested for temperature tolerance at low temperatures. For this test, the payload will be placed in a cold chamber for around 24 hours at a minimum temperature of $-74°$C. After this temperature has been reached, we will retest the stress tests in an additional effort to verify structural integrity at these temperatures.

6 Summary

Participating in the HASP program will be an amazing opportunity for us. As undergraduates, we don't often get a chance to do an experiment where we're doing real science. We hope to gain better understanding of what a team project of this magnitude entails, so that in the future we can participate on other projects as experienced and competent team members. Working together on this payload will also show us the importance of teamwork when collaborating on scientific projects. Overall HASP will be an amazing experience for us, and we are glad we have the opportunity to apply for it.'

References

Anderson, P. W. (2010), 'Cosmic rays', `http://helios.gsfc.nasa.gov/cosmic.html`.

Borg, X. (2010), 'The emrp gravity theory', `http://www.blazelabs.com/f-g-rpress.asp`.

Fontenot, R. S., Fountain, W., Christl, M. & Hollerman, W. A. (2007), Results from the low mass cosmic ray experiment on the HASP balloon, *in* '2007 IEEE NUCLEAR SCIENCE SYMPOSIUM CONFERENCE RECORD, VOLS 1-11', IEEE NUCLEAR SCIENCE SYMPOSIUM - CONFERENCE RECORD, IEEE, IEEE, 345 E 47TH ST, NEW YORK, NY 10017 USA, pp. 385–391. IEEE Nuclear Science Symposium/Medical Imaging Conference, Honolulu, HI, OCT 26-NOV 03, 2007.

Lochner, D. J. (2010), 'Cosmic rays - introduction', `http://imagine.gsfc.nasa.gov/docs/science/know_l1/cosmic_rays.html`.

n.d. (n.d.), 'An introduction to cosmic rays', `http://www.macalester.edu/astronomy/people/mattc/CRIntro.htm`.

von Rosenvingen, D. T. (2010), 'Galactic cosmic rays', `http://helios.gsfc.nasa.gov/gcr.html`.

UA-HAB Supporting documents

CSA Contribution form and supporting documents

CSA Class Grant and Contribution Program to support Awareness

CONTRIBUTIONS APPLICATION FORM

Canadian Space Agency, Space Learning Program, 6767 Route de l'Aéroport, Saint-Hubert, Québec, J3Y 8Y9 Canada

Instructions for completing this form:

You must answer all fields as indicated. Your application will not be considered if there is missing or incomplete information.

Submit this application form along with the constitution of the organization.

It is the applicant's responsibility to ensure that the application complies with all relevant federal, provincial/territorial and municipal laws.

Section 1 – Information on the Applicant

Applicant Designation:

- Canadian primary school ________
- Canadian secondary school ________
- Canadian post-secondary school __X__
  University of Alberta
  Institute for Space Science Exploration and Technology (ISSET) Students
- Canadian science centre or planetarium ____
- Other not-for-profit organization (please specify) ____

Name of individual submitting the proposal on the applicant's behalf: Laura Mazzino
Title and/or position of individual within the organization
Graduate Student
Co-founder of the ISSET-Students group
ISSET-Students Balloon Project Leader

Address (including postal code):
Department of Physics
11322 - 89 Avenue,
Edmonton, AB
T6G 2G7
Telephone number: (780) 492-8179
E-mail address: mazzino@ualberta.ca

Annual reach of organization: 620 people

Describe major space-relevant activities, projects or initiatives undertaken by the applying organization:

ISSET Students (ISSET-S) is an independently operated student group at the University of Alberta (U of A) that is associated with the Institute for Space Science, Exploration and Technology. ISSET is a newly-formed institute that brings together faculty from science and engineering disciplines in order to solidify the heritage of institutional excellence in the pursuit of space-related goals. ISSET-S was founded by two graduate students, Laura Mazzino and David Miles, in September 2009. The mandate of the ISSET-S is to increase awareness in the community, and at the university, of Canadian space science and technology as well as provide opportunities for U of A students to become involved in space-related activities. Founded a year ago, ISSET-S is a vibrant, dynamic student group with realistic and ambitious goals that mirror their mandate and the goals of the Canadian Space Agency Space Learning and Awareness Program.

ISSET-S is an organization of 36 members, comprised primarily of undergraduate and graduate students from several departments mirroring the cross-disciplinary appeal of ISSET, but also with Post-Doctoral Fellows, Academic Trust Professionals and Research Associates members. ISSET-S has run information booths during the Canadian Undergraduate Physics Conference and the University Open House. ISSET-S also runs member recruiting drives during the first week of term at the University of Alberta Club Week, to provide support for ISSET educational outreach programs such as the ISSET Space Academy, Art Contests, and ISSET Space Exploration Symposium, and to provide an excellent education to its members in space-related research and on the possibilities of being involved in space-related activities.

ISSET-S members assist in a broad range of ISSET outreach activities. ISSET-S volunteered at the annual Symposium and the ISSET Art Contest Ceremony. Recently, one member of the ISSET-S was responsible to organize the participation of a high profile keynote speaker in the ISSET Space Exploration Symposium, for which the participation for the symposium reached more than 1000 people this year.

ISSET-S actively participates in the organization of the ISSET Space Academy (Grades 7-9), which comprised 30 Junior High Students in 2010, and a similar number in 2011. During the Space Academy, ISSET-S members acted as both camp leaders and supervised the organization of the model rocket and balloon missions (including the design, manufacture, launch, and recovery), building of telescopes, the visit to the campus observatory, and other space related activities. Moreover, the rocket and balloon programs received major exposure in the local media (see attached documentation).

Finally, ISSET-S also facilitates the CANoRock Project, a collaboration between the University of Alberta, University of Calgary, University of Saskatchewan, and University of Oslo to fly a series of Student Sounding Rockets.

Future ISSET-S activities include, but are not limited to, model rocket competitions (October 2010; 10-30 participants), meteorite museum visit (December 2010; 10-30 participants), and the Canadian Satellite Design Challenge (Sept 2010- Dec 2011; 40-70 participants)

I understand that I will be contacted to participate in pre-funding, post-funding, and follow-up (if applicable) evaluation surveys, regardless of the outcome of my application for funding.

I certify that any former public office holder or public servant employed by our organization complies with the provisions of the relevant Conflict of Interest and Post-Employment Code for Former Public Office Holders and the Value and Ethics Code for Public Servants respectively.

FOR QUEBEC INSTITUTIONS
The applicant is subject to chapter M-30, An Act respecting the Ministère du Conseil Exécutif
____Yes ____No

If Yes, please include the M-30 Supporting Documentation Form

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Section 2 – Information on the Proposal

1.1 Executive Summary – Please provide a high-level resume of what the proposed project entails, i.e. a description of the project, its scope, the expected target audience level (from a youth/student perspective) and quantitative reach, whether the initiative will be offered in one or both official languages, and the benefits to Canada or to Canadian youth, and/or students anticipated through the execution of the proposed initiative.

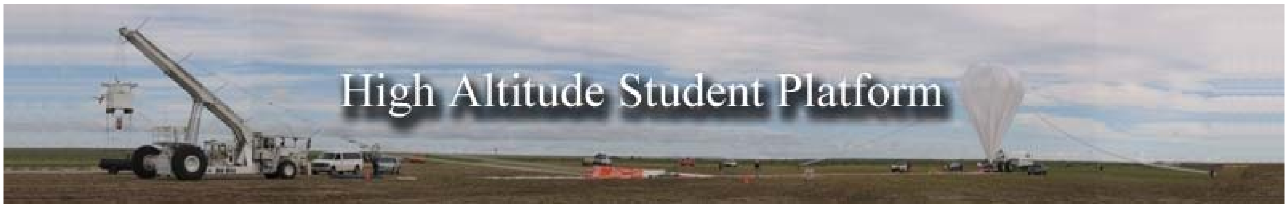
UA-HAB: University of Alberta High Altitude Balloons

The University of Alberta High Altitude Balloons (UA-HAB) is a unique opportunity for University of Alberta students (undergraduate and graduate) to learn the different steps on the development of a complete space mission, by working on a high altitude balloon project: The project consists of forming a Canadian institution team to participate in the American program HASP (High Altitude Student Payload). Balloons offer a low-cost alternative to other suborbital payloads.

UA-HAB's primary goal is to build knowledge and skill among Canadian undergraduate and graduate students through hands-on project experience using a high-altitude balloon platform. By including both undergraduate and graduate students, the younger participants of this project will receive an early education that will allow them to acquire the necessary skills to join more complex space-related projects.

UA-HAB aims to involve University of Alberta undergraduate and graduate students in an end-to-end training that lasts less than two years and will incorporate the following items related to a space project: grant proposal writing, planning, design, manufacture, calibration, integration testing, launch, recovery of the data, data analysis, publication and dissemination of results.

UA-HAB will be a collaboration with HASP, organized by LaSpace (Louisiana Space Consortium): A small group of undergraduate students from University of Alberta, lead by a graduate student and supervised by three advisers (two professors and one research associate) will participate in the High Altitude Student Platform (HASP) project, a program that “is designed to carry up to twelve student payloads to an altitude of about 36 kilometers with flight durations of 15 to 20 hours using a small volume, zero pressure balloon. It is anticipated that the payloads carried by HASP will be designed and built by students and will be used to flight-test compact satellites or prototypes and to fly other small experiments. HASP includes a standard mechanical, power and communication interface for the student payload, based upon a flight tested design. This simplifies integration, allows the student payloads to be fully exercised, and minimizes platform development / operation costs. In addition, HASP is lightweight and has simple mission requirements, thus providing maximum flexibility in the launch schedule. The major goals of the HASP Program are to foster student excitement in an aerospace career path and to help address workforce development issues in this area. HASP plans to provide a "space test platform" to encourage student research and stimulate the development of student satellite payloads and other space-engineering products. By getting the students involved with every aspect of the program, HASP will enhance the technical skills and research abilities of the students."[1]



The HASP[2] program has been successfully implemented by LaSpace for several years in the United States[3], and the University of Alberta group will follow the regulations of the HASP project[4] as any other American university group. A member of ISSET-S, Laura Mazzino, has participated as a balloon project leader[5] in 2006 while studying at one of the institutions in the USA participating in the HASP program. This served her both as a personal enriching experience as well as opened professional opportunities after she finished her degree. Therefore, she would like that undergraduates at her current Canadian university have the same wonderful opportunity that she had. By participating in HASP, the University of Alberta balloon team is opening the prospect to other Canadian institutions to participate in the future as well.

The expected outcome is to motivate students from a very early stage on their university degree program to consider a career in the space research and/or the space program. The balloon program is an excellent opportunity for students to participate in an end-to-end process before they get involved in more sophisticated projects (such as sounding rockets, nanosatellite projects, etc). The UA-HAB program will involve the selected and trained students from the University of Alberta Weather Balloon program applying to the UA-HAB program and will involve the designing, building, testing and flying of their chosen instrumentation.

Most Space Environment projects extend for a period longer that universities degree programs. Therefore, most students are never exposed to the opportunity of obtaining practical experience in each of the steps. This project will be of great benefit to the Canadian students participating, since it will provide the opportunity of hands-on participation in a comprehensive project to explore the different areas of the space program and to establish invaluable network connections that might benefit them in the future.

The target audience of UA-HAB is (but not limited to) undergraduate students from different disciplines (in the Faculties of Science and Engineering), preferably in the second year or third year of their degrees. The 'balloon team' will be composed by approximately 5 committed students that will work from September 2010 until December 2011 in the project. The project will be advertised in both official languages (French and English) in all University of Alberta campuses, including the "Universite de L'Alberta Campus Saint Jean" which offers Baccalauréat ès sciences (B.Sc.) and Baccalauréat ès science engénie (B.Sc. Eng.)

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[1] From HASP website: http://laspace.lsu.edu/HASP/

[2] T. Gregory Guzik and John P. Wefel, ***The High Altitude Student Platform (HASP) for Student-Built Payloads***. Advances in Space Research, Volume 37, Issue 11, 2006, Pages 2125-2131. The Next Generation of Scientific Balloon Missions. (Attached to this proposal)

[3] Guzik et al, ***Development of the High Altitude Student Platform***. Advances in Space Research Volume 42, Issue 10, 17 November 2008, Pages 1704-1714 (Attached to this proposal)

[4] HASP1_project (attached to this proposal)

[5] HASP16_Mazzino (attached to this proposal); http://laspace.lsu.edu/hasp/groups/Payload.php?py=2006&pn=10

There are short terms benefits to Canada in the implementation of UA-HAB: As stated before, the program will open the doors for other Canadian institutions to participate in HASP in the near future. Also, University of Alberta will partner with LaSpace and NASA in an outreach program that will allow Canadian universities access to facilities not available in Canada, such as the Columbia Balloon Facility in Texas, the launching facility for the HASP platform.

In the long term, UA-HAB would recruit bright students to consider a career in the space program, and it would train students in specific tasks and skills before they graduate, building capacity for Canada by training students in low cost missions before they have the opportunity to participate in larger and more costly missions.

2.1 Purpose of the Initiative – Please describe the rationale/need for the development of the proposed initiative and indicate any linkages to the objectives of the Space Awareness Contributions Program (outlined below).

Program Objectives:

i. To increase awareness of Canadian space science and technology among Canadian youth and educators, and to foster their participation in related activities;

ii. To provide learning opportunities to Canadian students and physicists in various space-related disciplines; and

iii. To support the operation of organizations dedicated to space research and education.

Objectives: CSA	Objectives delivered by HASP
i. To increase awareness	Exposure of undergraduate and graduate students to space related activities at UofA, CSA, and NASA Attract bright individuals to space carriers Raise awareness of CSA Facilities Raise awareness of NASA Facilities Raise awareness of CSA - NASA Partnerships
ii. To provide learning opportunities	Short (one year) end to end space mission Grant writing Launch Design Recovery of data Manufacture Data analysis Testing Publication of results Integration Dissemination Holistic approach: apply knowledge learned in physics courses to a real-life, hands-on experi-ence
iii. To Support the operations of organizations	Support the ISSET-Students mandate Support the ISSET mandate

1.1 Deliverables – indicate what the deliverables of the proposed initiative are (i.e. space-related pedagogical content, extra-curricular hands-on activities, etc.)

Date	HASP
2010	
November 15	Deliverable 1: First report to CSA which will include payload design idea
December	Deliverable 2: Proposal[6] submission to HASP
2011	
February	Deliverable 3: Monthly status report to HASP
February	Deliverable 4: Completion of Course
February	Deliverable 5: Completion of Design
March	Deliverable 6: Monthly status report to HASP
April	Deliverable 7: Final PSIP[7] document due (Payload Specification & Integration Plan)
May	Deliverable 8: Monthly status report to HASP
May	Deliverable 9: Completion Manufacture
June	Deliverable 10: High School Balloon launches
June	Deliverable 11: Final FLOP[8] document due (FLight Operation Plan)
June	Deliverable 12: Second report to CSA
July	Deliverable 13: Testing, Calibration (David Florida Labs)

[6] HASP7_CFPCover 2010 (attached to this proposal)
[7] HASP9_PayloadSpecificationandIntegrationPlan (attached to this proposal)
[8] HASP10_FlightOperationPlan (attached to this proposal)

July	Deliverable 14: ISSET Space Academy Balloon launches
August	Deliverable 15: Student payload integration at CSBF (USA) Payload Integration Certification
September	Deliverable 16: Launch (Fort Sumner, NM USA)
September	Deliverable 17: Presentation at ISSET Symposium and at the GPSA Symposium
October	Deliverable 18: Third report to CSA
October	Deliverable 19: Presentation at UA Open House
November	Deliverable 20: Completion Data Analysis
November	Deliverable 21: Publication (AGU, Phys Teacher)
December	Deliverable 22: Final report to HASP
December	Deliverable 23: Presentation at AGU (USA)
2012	
February	Deliverable 24: Final report to CSA

4. Implementation Approach – Please provide a description of how the development and delivery of the proposed initiative will be undertaken.

4.1 Participating in HASP

One of the most interesting and enriching aspects of the HASP project is that it gives the opportunity to students, faculty and other advisers to work on all the steps of a space mission. Therefore teams have great flexibility to work on the design of a payload, which could be a reproduction of something done in the past or a completely new idea. For this, the team has to go through the following steps[9]:

1) Teams prepare a HASP proposal/payload[10]
2) HASP officers approves the team to start working on their payloads (Design, Manufacture)
3) Teams provide documentation describing their payloads as well as plans for integration and flight (after working on the design). Several deliverables occur in this step, such as the ***"HASP Payload Specification and Integration Plan[11]", "HASP Payload Integration Certification[12]", "HASP Flight Operation Plan[13]"***
4) Payloads are integrated, launched and recovered
5) Data analysis is performed by teams
6) Final Flight/Science Report is presented

4.2 The UA-HAB Payload: Deciding what the UA-HAB project will be

The U of A balloon team has great flexibility to decide on the idea for a design of a payload for the UA-HAB Project, as any other team in an American Institution participating in HASP. Past missions included a different variety of student payloads, such as a particle astrophysics project or testing of components for rockets or CubeSats.[14]

The UA-HAB team, once formed, will decide on the project that they want to pursue for the payload. Prospective projects are a cosmic ray detector or an x-ray detector to detect the Bremsstrahlung created by highly relativistic electrons in the upper atmosphere. The first prospective project, a cosmic ray detector,

[9] HASP2_Manual, HASP3_shortdescription, HASP4_TimeandPositionData, HASP5_specifications (attached to this proposal)
[10] HASP7_CFPCover 2010 (attached to this proposal)
[11] HASP9_PayloadSpecificationandIntegrationPlan (attached to this proposal)
[12] HASP8_PayloadIntegrationCertification (attached to this proposal)
[13] HASP10_FlightOperationPlan (attached to this proposal)
[14] HASP14_Studentpayloads2006 and HASP15_Studentpayloads2007 (attached to this proposal)

would complement the efforts of another project at the U of A's Department of Physics, the Alberta Large-area Time-coincidence Array (ALTA)[15]. This project is a partnership with the local high schools to study cosmic rays with energies >10^{14} eV, probed only by ground based experiments. ALTA uses a sparse array of cosmic ray detection stations located in high schools across a large geographical area to search for non-random high-energy cosmic ray phenomena. The second prospective project, an x-ray detector which would detect the Bremsstrahlung radiation created by highly relativistic electrons in the upper atmosphere, would be the continuation of a project started by an undergraduate 2010 summer student in the ISSET balloon group. This particular undergraduate was successful in constructing a 1kg detector composed of a scintillator-PMT apparatus connected to a micro-controller, and transmitter or data storage device. For that she used a plastic scintillator and a light and compact photomultiplier tube from Hamamatsu.

4.3 Implementing UA-HAB as part of HASP

The UA-HAB team, after deciding upon the idea for the design of the scientific payload, will write and send a proposal to be approved by LaSpace[16], in order to participate in HASP. Since the scientific payload needs to be electronically integrated to the large platform using a hardware piece called *SkeeterSat*[17] (a simple data collection system), HASP requires members of the balloon team to participate in a 14 week electronic lecture course. For this purpose, HASP has already sent to the UofA the *SkeeterSat* and the CD containing the lectures [18] to be delivered to students participating in the program. Topics on these lectures included, but are not limited to, knowledge in circuit boards, designs for payloads (interfaces payload-platform), integration tests, etc. [19]

A preview of the lectures can be found at: http://laspace.lsu.edu/aces/BalloonCourse/index.php

At the moment, there are no electronics courses being offered by the U of A Department of Physics. Physics undergraduates interested in learning this material have the option of taking an introductory electronics course in the U of A's Electrical Engineering Department, although many cannot due to the constraints of their degree program. These lectures provided by HASP will fill an existing gap by providing applicable electronic topics to a population of undergraduate physics students interested in working on experimental physics in the future. Lectures will be available not only to the balloon team participants also to any other undergraduate and graduate students interested in learning the topics. The lectures in the CD are self-thoughts and are reinforced by the teleconferences with the HASP team. Moreover, the U of A will invite Dr. Gusik, The Director of HASP, to visit for one week to deliver a workshop on some of these lectures, more specifically on the interfaces between payload and the platform.

The balloon team will then start working on the design of the payload. A written report of the design will be sent for approval to LaSpace before start the manufacturing of the payload. Following months will be devoted to manufacture, testing, launch, recovery of the payload. Data analysis and dissemination of results will finalize the project.

4.4 Other UA-HAB outreach contributions

UA-HAB is an excellent opportunity to develop further outreach programs that would highly enrich the local community: UA-HAB team members will utilize their newly-acquired knowledge by organizing the balloon activities during the ISSET Space Academy 2010. Furthermore, the UA-HAB team members will facilitate weather balloon launches for High Schools interested in learning about ballooning and scientific space missions.

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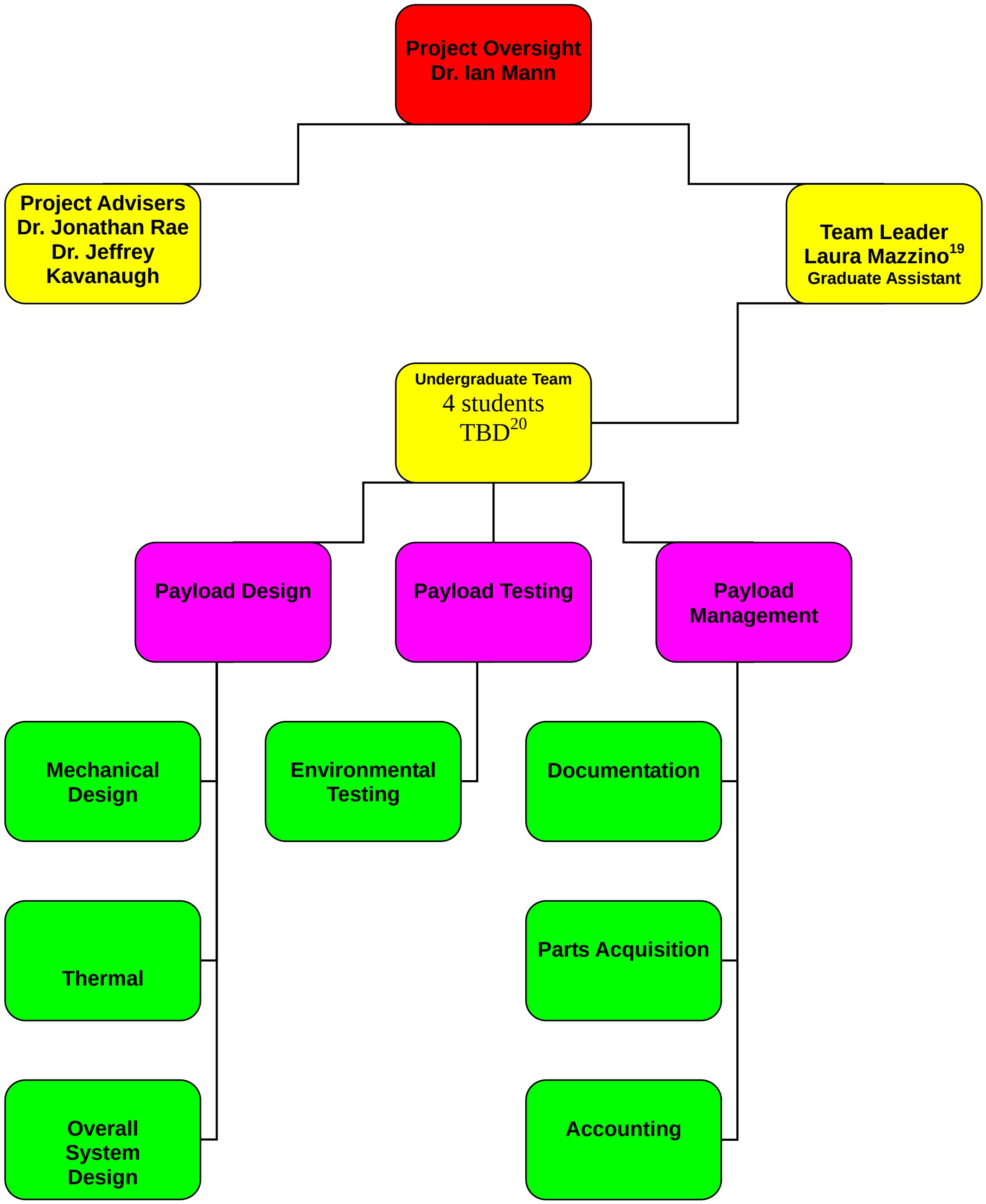
[15] Brouwer et al, ***The ALTA cosmic ray experiment electronics system.*** Nuclear Instruments and Methods in Physics Research A 539 (2005) 595–605
[16] HASP2_Manual (attached to this proposal)
[17] HASP11_SkeeterSat Assembly and Operations Manual (attached to this proposal)
[18] HASP12_Curse (attached to this proposal)
[19] HASP13_LetterGuzik (attached to this proposal)

5. **Team Members** – Please provide the names and relevant qualifications of team members proposed to develop and/or implement the proposed initiative indicating the role of each in the project.[20, 21]



[20] CVs of Dr. Rae and Laura Mazzino attached to this proposal (Mazzino_CV; Rae_CV)
[21] Interested students: Cory Hodgson, Matt Nagy, Wyatt Johnson, Tyler Naffin, Tania Wood, Sonia Budac

6. Schedule – Please provide a detailed (monthly) schedule for the development and/or implementation of the proposed initiative

Date	HASP
2010	
October 1 or October 4	Info Session: Team recruitment
October 5-8	Applications to become part of team
October 11-29	Team meetings to determine the idea to be proposed as payload
November 15	Deliverable 1: First report to CSA which will include payload design idea
November	HASP Proposal writing (Deadline: Dec 1st)
December	Deliverable 2: Proposal[22] submission to HASP
2011	
Mid January	Announcement of acceptance into HASP
January	Begin Course/ Design[23](Taking course and designing the instrument)
February	Deliverable 3: Monthly status report to HASP
February	First teleconference with HASP
February	Deliverable 4: Completion Course
February	Deliverable 5: Completion Design
March	Begin Manufacture
March	Deliverable 6: Monthly status report to HASP
March	Teleconference with HASP
April	Manufacture continues
April	Deliverable 7: Final PSIP[24] document due (Payload Specification & Integration Plan)
May	Deliverable 8: Monthly status report to HASP
May	Teleconference with HASP
May	Deliverable 9: Completion Manufacture
June	Deliverable 10: High School Balloon launches
June	Deliverable 11: Final FLOP[25] document due (FLight Operation Plan)
June	Deliverable 12: Second report to CSA
July	Deliverable 13: Testing, Calibration (David Florida Labs)
July	Deliverable 14: ISSET Space Academy Balloon launches
August	Deliverable 15: Student payload integration at CSBF (USA) Payload Integration Certification
September	Deliverable 16: Launch (Fort Sumner, NM USA)
September	Deliverable 17: Presentation at ISSET Symposium and at the GPSA Symposium
September	Monthly status report to HASP/ Teleconference with HASP
October	Deliverable 18: Third report to CSA
October	Data analysis
October	Deliverable 19: Presentation at UA Open House
October	Monthly status report to HASP/ Teleconference with HASP
November	Deliverable 20: Completion Data Analysis
November	Deliverable 21: Publication (AGU, Phys Teacher)
November	Teleconference with HASP
December	Deliverable 22: Final report to HASP
December	Deliverable 23: Presentation at AGU (USA)
2012	
February	Deliverable 24: Final report to CSA

[22] HASP7_CFPCover 2010 (attached to this proposal)
[23] HASP12_Curse (attached to this proposal)
[24] HASP9_PayloadSpecificationandIntegrationPlan (attached to this proposal)
[25] HASP10_FlightOperationPlan (attached to this proposal)

7. Budget – Please provide a detailed and complete budget breakdown for all costs associated with the project and specify areas where funds are being requested of CSA (list of eligible expenses follows)

Assumptions:
CSA Fiscal Year 2010: April 1st 2010 – March 31st 2011
CSA Fiscal Year 2011: April 1st 2011 – March 31st 2012

Assumptions applicable to this project's budget:
CSA Fiscal Year 2010: October 1st 2010 – March 31st 2011
CSA Fiscal Year 2011: April 1st 2011 – February 28th 2012
Note: All funding in the following budget for the project is being requested to CSA.

Assumptions	
Canadian Trip	$2,000.00
International Trip	$3,000.00

	CSA Fiscal year: 2010				CSA Fiscal year: 2011				
Item	Unit Cost	Qty	Unit	Subtotal	Unit Cost	Qty	Unit	Subtotal	Comment
Instrument Design and Manufacturing									
Payload Parts, Materials, Supplies	$10,000.00	1	Estimate	$10,000.00					Estimated based on potential projects
Project Specific Equipment and Tools	$3,000.00	1	Estimate	$3,000.00					Non-standard equipment
Teleconference Fees	$50.00	1	Monthly	$50.00	$50.00	5	Monthly	$250.00	Project coordination
Vacuum and Thermal Testing Fees					$2,000.00	1	Estimate	$2,000.00	Ex. U. York Facilities (could potentially use DFL)
Payload Shipping					$500.00	6	Each	$3,000.00	Each way, off-site testing (DFL), integration (Palestine, TX), launch (Fort Sumner, NM)
Personnel Salary									
UG Summer Students Salary					$2,240.00	12	Month	$26,880.00	1.0 FTE for 3 months * 4 UG students ($14.00/h)
Graduate Student Salary	$1,284.10	6	Month	$7,704.60	$1,337.60	11	Month	$14,713.60	0.4 FTE for whole project ($19.00/h, 10% benefits)
Research Associate Salary	$800.00	6	Month	$4,800.00	$833.33	11	Month	$9,166.63	0.1 FTE for whole project ($38.74/h effective, 33% benefits)
Personnel Overhead									
UG Summer Students Overhead					$448.00	12	Month	$5,376.00	20% of total salary cost
Graduate Student Overhead	$256.82	6	Month	$1,540.92	$267.52	11	Month	$2,942.72	20% of total salary cost
Research Associate Salary Overhead	$160.00	6	Month	$960.00	$166.67	11	Month	$1,833.37	20% of total salary cost
Workshop Usage									
Departmental Shop Time (Physics)					$15.00	120	Hour	$1,800.00	Machine and Electronics shops within Physics
Dissemination									
Publications Fees					$180.00	3	Each	$540.00	Academic publication fees
Poster printing cost					$150.00	1	Each	$150.00	
Travel									
Payload Testing - Canada					$2,000.00	4	Each	$8,000.00	Travel to specialized facilities for Thermal/Vacuum Testing
HASP Integration - International					$3,000.00	2	Each	$6,000.00	Travel to support HASP integration
HASP Launch - International					$3,000.00	2	Each	$6,000.00	Travel to support HASP launch
HASP Leader Site Visit - International	$3,000.00	1	Each	$3,000.00					Bring Dr. Guzik to UofA for site visit and project review
Dissemination/Outreach - Canada					$2,000.00	2	Each	$4,000.00	Canadian Dissemination of Results (CASI/CAP?)
Dissemination/Outreach - International					$3,000.00	2	Each	$6,000.00	International Dissemination of results (IAU?)

Subtotal CSA Fiscal Year	**2010:**	**$31,055.52**		**2011:**	**$98,652.32**
Total					**$129,707.84**

Eligible costs for contributions will be direct expenses associated with the delivery of approved projects that are required to achieve the results to which they relate. Costs will include one or a combination of the following categories:

- salaries and benefits;
- consultants services;
- material and supplies;
- acquisition or rental of equipment;
- access fees;
- licenses and permits fees;
- data acquisition;
- data management;
- launcher services;
- participation fees at conferences, committees and events;
- travel;
- accommodation and meals allowances;
- training;
- translation services;
- registration fees;
- costs related to obtaining security clearance;
- acquisition, development and printing of materials;
- marketing and printing services;
- publication and communication services;
- overhead (administrative) costs (not to exceed 20% of eligible costs for universities and 15% for other eligible recipients); and
- PST, HST and GST net of any rebate to which the recipient is entitled to and the reimbursement of any taxes for goods and services acquired in a foreign country net of any rebate or reimbursement received in the foreign country.

4. Project financial support:

Outline any current and proposed future funding from other sources.

	Source (Name of institution and funding program)	Amount	Pending /Granted? [1]	For pending funds, date for announcement
1.				
2.				
3.				
4.				
5.				
6.				

[1] **Attach a copy of the notification letter.** This should clearly identify the project name, funding agency and the result(s) of the demand. For awards that are pending, please indicate the expected date for the announcement.

Privacy Notice
Necessary measures have been taken to protect the confidentiality of the personal information you provide. The information you provide is collected under the authority of the CSA Act. This information will be used to determine the eligibility of applicants for funding and may be used to subsequently provide you with information on other available opportunities.

Your personal information will be held in the CSA Personal Information Bank for the appropriate program for 2 years. It is protected under the Privacy Act. According to the Privacy Act, you have rights with respect to the information you submit. You may upon request:

- Be given access to your file
- Have incorrect information corrected or have a notation attached

For more information about your rights see Info Source. This is a Government of Canada publication available in major libraries, at government information offices and from constituency offices of federal Members of Parliament.

Space Awareness Contributions Program Committee
Request Assessment Form

Requirement	Score	Comments
Organization and Initiative meet eligibility requirements as outlined in the Terms and Conditions approved by Treasury Board		**Yes/No**
Project, if undertaken, will ultimately provide benefits to Canadians, particularly Canadian students/youth	**/15**	
The project's objectives and deliverables are well thought out and can be reasonably achieved within the proposed timeframe and budget	**/25**	
Budgetary resources requested respect eligible costs and reflect realistic costs with respect to the proposed initiative	**/15**	
The extent to which the proposed event meets Program objectives.	**/15**	
The team proposed clearly demonstrates the necessary skills and experience to complete the development and/or delivery of the propose initiative	**/15**	
The expected reach of the initiative demonstrates a sound return on requested investment	**/15**	
Total Score	**/100**	

Recommendation: ☐ **Support request** ☐ **Decline request**

Level of funding recommended: ______________________________

SIGNATURE(S) OF EVALUATORS:

UA-HAB Supporting documents

Letters of Support

UNIVERSITY OF ALBERTA
Earth and Atmospheric Sciences
Faculty of Science

1-26 Earth Sciences Building
Edmonton, Alberta, Canada T6G 2E3
www.ualberta.ca/eas
eas.enquiries@ualberta.ca
Tel: 780.492.3265
Fax: 780.492.2030

18 September, 2010

Laura Mazzino
ISSET-Students, Balloon Project Leader
Department of Physics
11322 - 89 Avenue
University of Alberta
Edmonton, AB
T6G 2G7

Dear Laura,

I am writing to offer my enthusiastic support of the ISSET-Students' participation in the High Altitude Student Platform (HASP). Participation in HASP will give students unparalleled experience in the design, development, and implementation of a scientific payload. In my eyes, this program represents the optimal mix of challenge and reward: the payload has very real weight, cost, and timeline constraints, which both limits the complexity of potential experiments and increases the design challenge; at the same time, the small size of the project encourages elegant, efficient solutions to technical problems. The result will be a challenging, rewarding, and educational experience for participating students and faculty.

As you know, I teach a third-year course in environmental instrumentation in the Department of Earth and Atmospheric Sciences (EAS 327), and have many years' experience in both instrumental and experimental design. I am pleased to offer my expertise in these areas to participating students. Given my plans to incorporate a balloon-based high-altitude experiment in EAS 327 (beginning in the Winter 2011 semester), my collaboration with ISSET-Students will also be of direct benefit to me and my students.

HASP will beautifully complement both ISSET-Students' weather balloon program, which completes relatively simple missions on shorter, several-week timescales, and the University of Alberta's participation in the Canadian Satellite Design Challenge (CSDC). The weather balloon program will, for example, introduce large numbers of motivated students to HASP and serve as a testing ground for HASP ideas; in turn, HASP will provide a crucial testing platform for CSDS systems.

For these reasons, I strongly support the participation of ISSET-Students in the High Altitude Student Platform. I look forward to a fascinating, challenging, and rewarding collaboration.

Sincerely,

Jeffrey L. Kavanaugh
Assistant Professor
Department of Earth and Atmospheric Sciences
University of Alberta
1-26 Earth Sciences Building
Edmonton, AB
T6G 2E3

BEAR

(Balloon Experiments with Amateur Radio)

Monday, August 30, 2010

Ms Laura Mazzino
ISSET-Students, Balloon Project Leader
Department of Physics
11322 - 89 Avenue
University of Alberta
Edmonton Alberta
CANADA T6G 2G7

Dear Laura,

The BEAR team would like to confirm our continuous support to ISSET-Students in their Balloon Project.

As you know, the BEAR team is a small Amateur Radio group with over 10 years of experience in launching, tracking, and recovering high altitude balloons and payloads.

We have helped ISSET students conduct three successful missions, are happy to have provided our expertise and knowledge to your group and that it served as part of your groups training. We have let you barrow our equipment for your Space Academy balloon missions, have helped members of your team get their amateur radio license to allow them to operate the balloon tracking equipment and track balloons on their own eventually and have helped you determine what hardware you will require to do this.

We will continue to support ISSET students with our knowledge and expertise and help with future missions, especially since many of the physics experiments you would like to launch are similar to things we would like to do. BEAR has already donated over 100 hours helping with past missions and look forward to continue working with you during the coming, and future, years.

Best regards,

Barry Sloan VE6SBS
BEAR team
Balloon Experiments with Amateur Radio
barry2@sbszoo.com

ISSET
UofA Students Group
Institute for Space Science Exploration and Technology Students
Department of Physics Mailstop #615
Room #238 CEB, 11322 - 89 Avenue
University of Alberta, Edmonton, AB, Canada, T6G 2G7

To: Laura Mazzino
September 16, 2010

ISST Student Support for the Balloon Project Initiative

In 2009 the Institute for Space Science Exploration and Technology Students group was founded with the mandate *"To increase the awareness of Canadian space science and technology and provide opportunities for University of Alberta students to become involved in space related activities".*

In fulfillment of this mandate, in 2009 and 2010 the ISSET students group committed volunteers and created the opportunity for ISSET members and U of A students to attend and participate in several latex sounding balloon launches as well as provided experience-founded instruction in the use of amateur radio devices, necessary for balloon tracking in our area.

Photo 1: View of University of Alberta Campus from High Altitude Sounding Balloon Launched by BEAR Radio team, in conjunction with Laura Mazzino and ISSET Student volunteers, for ISSET Space Camp.

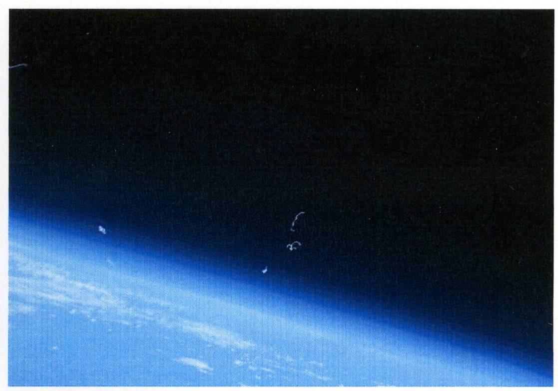


Photo 2. View of Latex Sounding balloon popping In Space, 1.5 hours after launch, approximately 27km up into the atmosphere, July 8th 2010, 2pm.

Students across many disciplines attended the launches. ISSET students provided over 80 hours of work so far for training and participation of these mission, including three members that obtained their amateur radio license in order to track balloons. Based on the success of the launches and the overwhelming positive feedback generated, ISSET Students feel balloon launches are a valuable activity for our University and Membership and would like to continue and develop this activity into an ongoing program. ISSET Students would be pleased to provide in-kind support to the Ballon Project by continuing to facilitate launches, provide a volunteer tracking team and organize advertising and outreach for Balloon project related events and payload opportunities to students at the University of Alberta and schools in the Edmonton Area. Subject to the success of this Program and support of our membership, ISSET students

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will provide 280 hours per year for the next 2 years. ISSET Students considers this time commitment to have an equivalent value to 280 hours/year * 2 years * $15/hour Undergraduate Student Wage = $ 8,400.

We look forward to an exciting and successful Balloon Project Program,

Best Regards,

T.R. Wood

Tania Wood
Vice President
ISSET Students

A. Buttenschoen

Andreas Buttenshoen
President
ISSET Students