
Beaver Works Summer Institute: Build A CubeSat

Rebecca Keenan

CubeSat Developer's Workshop 2021



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- **BWSI was started in 2016 to fill a need :**
 - Project-based STEM curriculum with focus on AI and CS skills**
- **BWSI Core :**
 - No cost to students, any talented and passionate students able to attend**
 - Project-based with teamwork**
 - Scientists and engineers actively working in research as instructors**
 - Teams are motivated by competitions and capstones projects**
 - Participation is based on independent (online) program prior to 4 week program**

BWSI is a transformational STEM experience for students through project-based learning

– “It was an incredible and life-changing experience for everyone that has the privilege to attend”(Class of 2016 student)



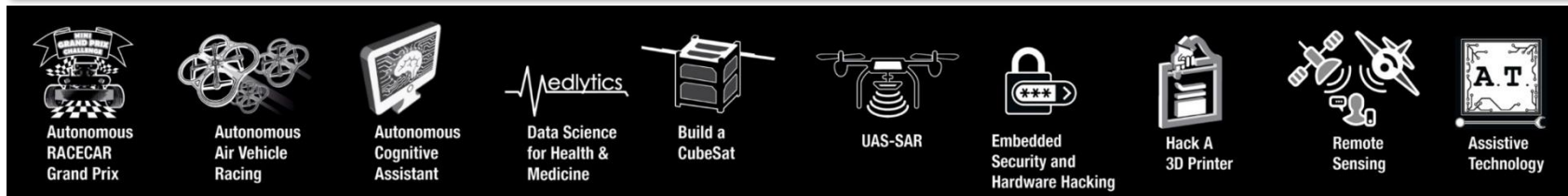


- **The Build A CubeSat course invites students to design and build their own prototype CubeSat**
 - **Prospective students start with an online course in satellite basics and Python programming**
 - **4 week full time summer program focuses on hands-on project based learning mixed with lectures on satellite systems from subject matter experts**
- **Partnership with Woods Hole Oceanographic Institution (WHOI)**
 - **Support hardware kit develop and provide yearly science mission**
- **CubeSats are a tool to motivate learning:**
 - **Fundamental engineering skills (intro to EE, ME, CompSci, and Aerospace)**
 - **Teaming, peer leadership, and project management**
 - **Communication (documentation, presentations, and daily coordination)**



Beaver Works Summer Institute Class of 2019

4-week summer program for high school and middle school students



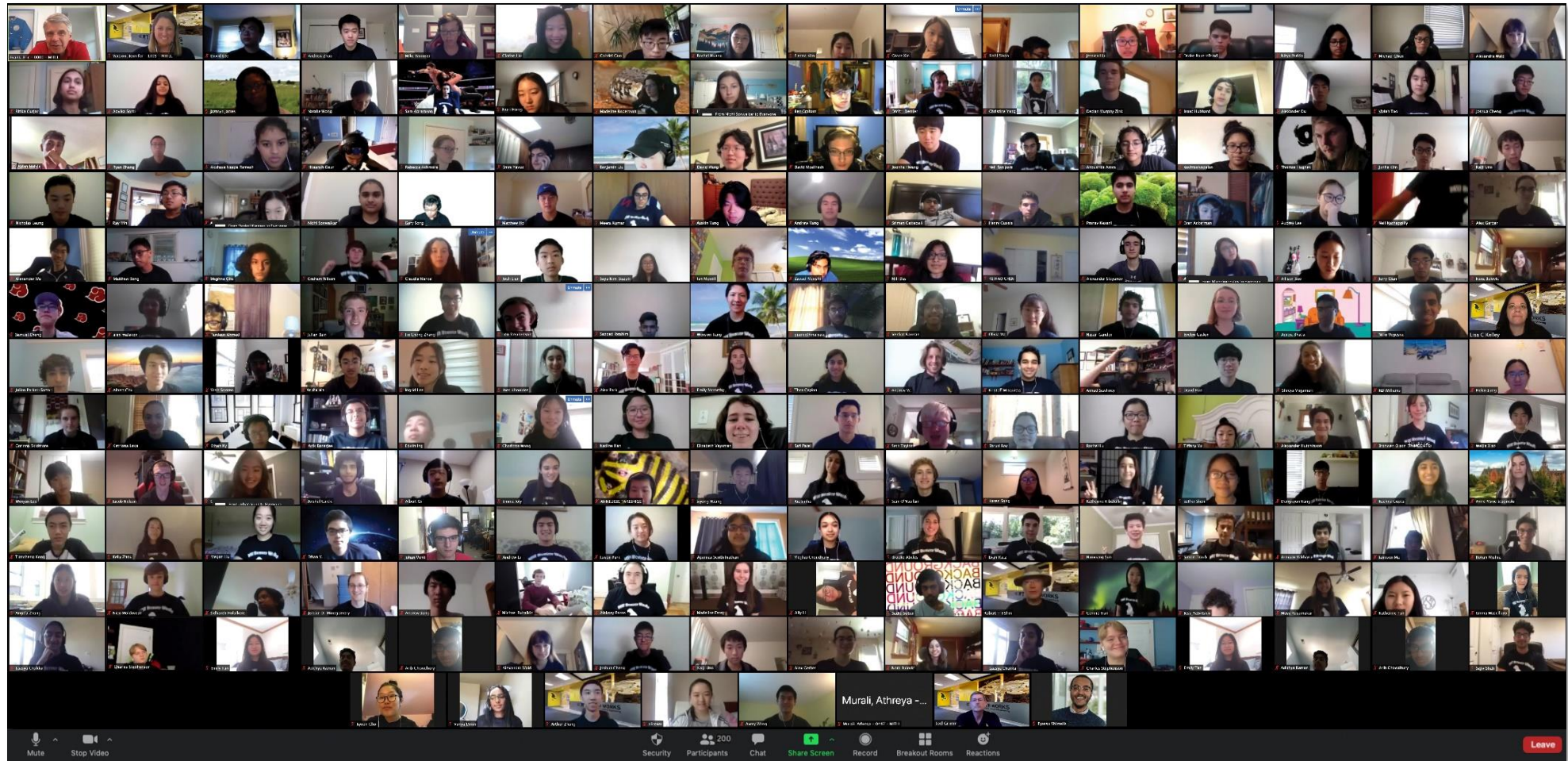
- **Transformational STEM experience for talented high school and middle school students through project-based learning**
 - “It was an incredible and life-changing experience for everyone that had the privilege to attend”
 - 2019 program expanded to 11 courses*, 263 students from 142 schools across the United States (7 students from Puerto Rico)



Beaver Works Summer Institute

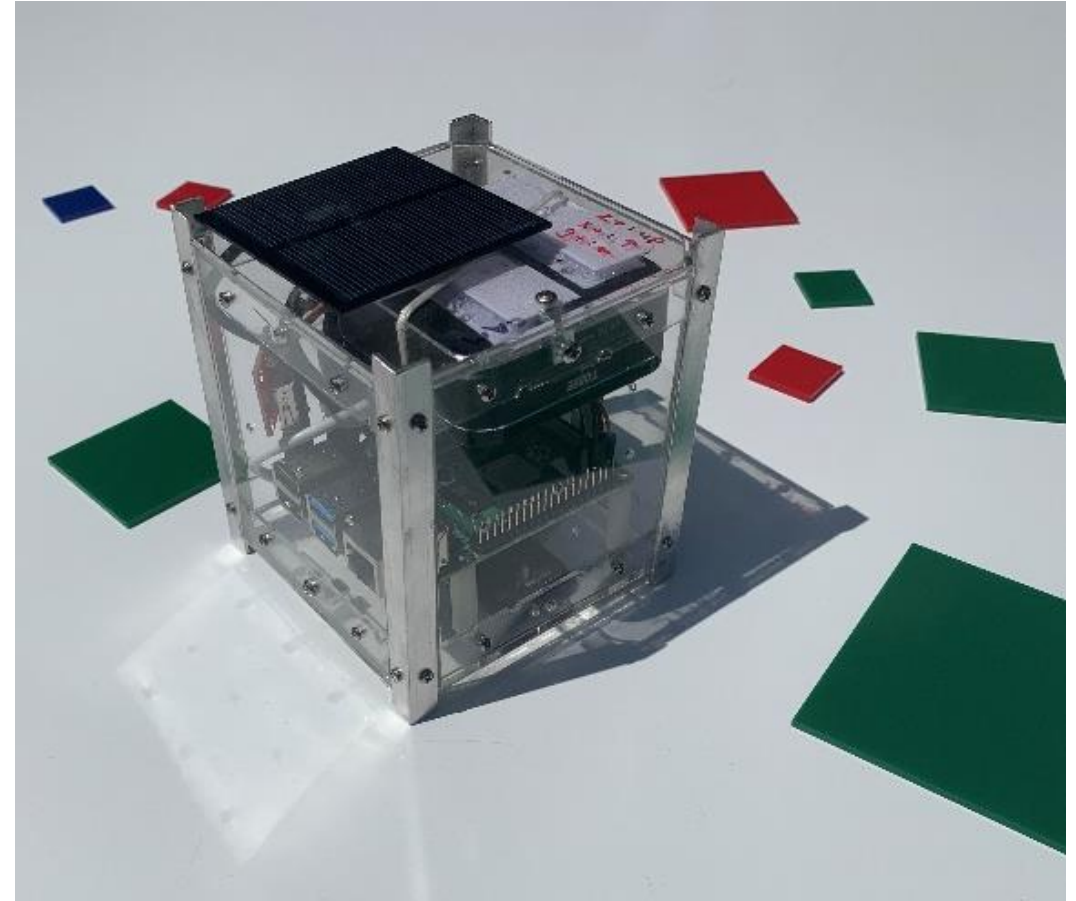


BWSI Class of 2020





- **Raspberry Pi**
- **Raspberry Pi camera**
- **9 DoF IMU**
- **Battery**
- **Solar panel**
- **1U acrylic and aluminum structure**
- **Tools for building and testing**
- **Additional in-person components**
 - **GPS**
 - **XBee radios**





CubeSat Course Outline



	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Intro	Systems Engineering	WHOI Tour	Ocean Science	Spacecraft electronics
	Flat Sat Challenge		Meet the Hardware Project		
Week 2	Communications	Power	Structures/ Environmental	Imaging	Software & CONOPs
	Subsystem Labs				
Week 3	Guest Lecture	ADCS/Propulsion	Risk	Upcoming Missions	Thermal
	Final Project				
Week 4	Deployables	Testing	Flight Day	Dry Runs	Final Event
	Final Project				







CubeSat 2020 – Detecting Colored Plastic in the Ocean





In-Person Course (2019)

- 16 Students on MIT campus
- 3 Teams of 5-6 students
- Utilized zip line orbit at WHOI
- Single “ZipCube” per team
 - Allowed for more advanced/expensive hardware (kit included GPS and XBee radios)
 - Students encouraged to customize structure with machining assistance from instructors

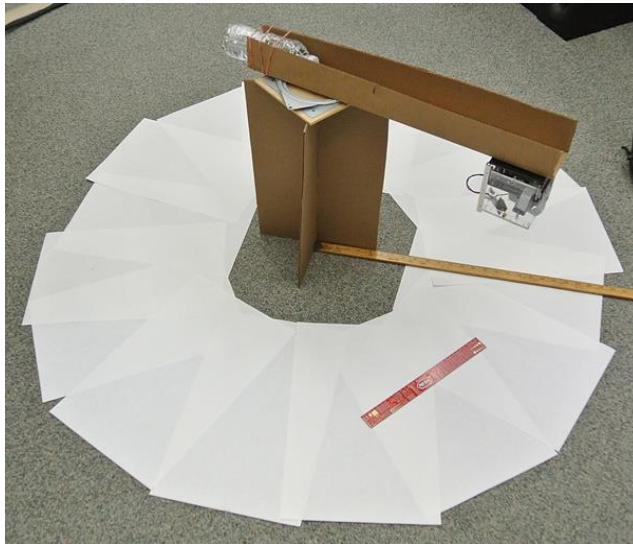
Virtual Course (2020 & 2021)

- 25 Students around the country
- 5 teams of 5 students
- Each student builds a full prototype in their home
 - Total hardware kit < \$250
 - Projects/labs adapted to work in home environment
 - Hardware customization is minimal to avoid disadvantaging students with fewer resources



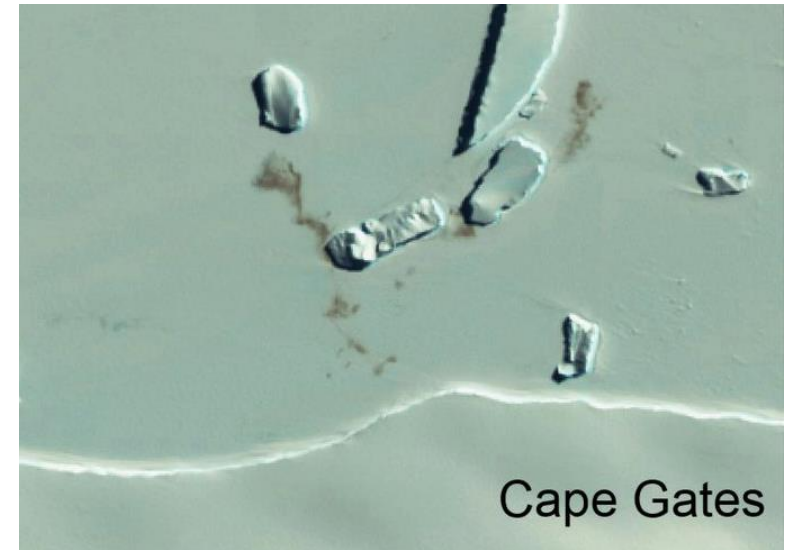


- Fully virtual
- Online application closed March 31st
- Summer program starts July 5
- Building on lessons learned from 2020 to improve virtual experience



New "Orbiter" Design

Science Mission
Estimating emperor penguin population in Antarctica



Sentinel2 satellite imagery of emperor penguin colony
 Fretwell, P.T. and Trathan, P.N. (2021), Discovery of new colonies by Sentinel2 reveals good and bad news for emperor penguins. Remote Sens Ecol Conserv.
<https://doi.org/10.1002/rse2.176>



MIT BWSI Spring 2021 Outreach Program








Lincoln Laboratory | School of Engineering

MIT Beaver Works Summer Institute

Spring 2021 Outreach Program – 7 Courses

Yes! You Can Program Autonomous Cars!

Yes! You Can Build CubeSats!

Yes! You Can Hack and Code!

Yes! You Can Do Synthetic Aperture Radar!

Yes! You Can Create Accessible Resources for Education!

Yes! You Can Design, Build and Fly Model Aircraft!

Many Interesting Things for Aspiring Engineers!




No Prior Experience Required!

WHO: High School Students (9th and 10th grade)

WHEN: Saturdays 11am-2pm (EST)-March 6, 13, 20, 27, April 3, 10, 17, 24, 2021

WHERE: Virtually, through Zoom!

REGISTER: https://mit-bwsi.formstack.com/forms/bwsi_spring_2021





Yes! You Can Program Autonomous Cars!

NO HARDWARE REQUIRED!

A BWSI Mini-Robotics Crash Course

LEARN TO CODE BY TUTOR!

No Prior Experience Required!

Yes! You Can BUILD CUBESATS!

A BWSI CubeSat Crash Course

Interested in space? Want to try to build a mission-critical satellite?

No Prior Experience Required!

Yes! You can HACK and CODE!

A BWSI Cybersecurity Recovery Course

MITRE Project CAPTURE THE FLAG CYBER COMPETITION

LEARN TO CODE BY TUTOR!

No Prior Experience Required!

Yes! You Can Do Synthetic Aperture Radar!

A BWSI Synthetic Aperture Radar Crash Course

Learn the capabilities of SAR by looking at the same area from different angles. Watch the data for the same location when illuminated from different angles. You'll have the opportunity to create an SAR image from a single SAR image.

No Prior Experience Required!

Yes! You Can Create Accessible Resources for Education!

A BWSI Designing for Accessible Technology Crash Course

Use computer-aided design (CAD) to create a simple 3D model of a device that can help teach concepts to children who are blind, hearing impaired, or otherwise have special needs.

No Prior Experience Required!

Many Interesting Things for Aspiring Engineers!

An early introduction to the technologies that shape our world.

Python • Computer Architecture • Machine Learning • Control of Vision • Linux • The Internet

No Prior Experience Required!

Yes! You Can Design, Build and Fly Model Aircraft!

Design Build Fly Crash Rebuild

A BWSI (Beaver Works Summer Institute) Course

Introduction to RC Model Aircraft Design

No Prior Experience Required!

- **8 Saturday virtual program for 9th and 10th grade high school students in USA**
 - From March 6 to April 24, 2021
 - 11am to 2pm EST over zoom*
 - Hardware kits shipped to students (for some courses)
- **185 students from 82 schools (20 states)**
 - 50% female students





Thank You For Listening!



Learn more about Beaver Works and how to apply to future BWSI programs:
<https://beaverworks.ll.mit.edu/CMS/bw/bwsi>

Or contact bwsi-admin@mit.edu

