



COSMOS Educational Toolkit

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<https://cosmos-lab.org/outreach>

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*The **COSMOS testbed design and deployment** is joint work with the COSMOS team (www.cosmos-lab.org).



COSMOS

RUTGERS



COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK



NYC



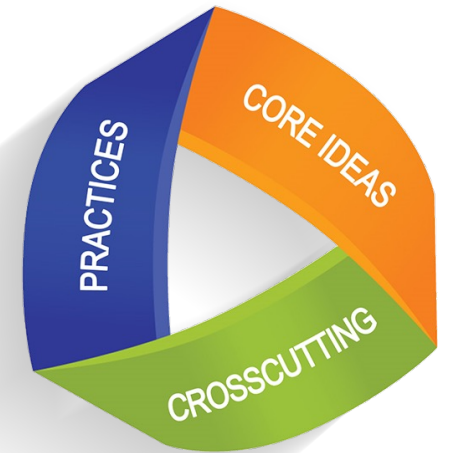
The City College
of New York



IBM

COSMOS Outreach

- Global economy changing via technological advances
- **All students** should have quality access to science, technology, engineering, and math (STEM) precollege coursework
- Higher education is **critical** in preparing the next generation of STEM professionals
- **This work** → Develop a teacher's professional development (PD) program and an educational toolkit, using wireless communications and Next Generation Science Standards (NGSS)



How could engineers and educators collaborate to create a wireless communications teacher PD program in order to develop NGSS lessons with STEM teachers?

Program Overview (1/3)

- a. **Lecture and lab phase:** The participants are introduced in fundamental and some advanced concepts in wireless communications and networking
 - \$8K stipend for summer
- b. **Design phase:** The participants conduct research on potential educational NGSS STEM lessons with a hands-on wireless labs using the 'COSMOS Educational Toolkit'

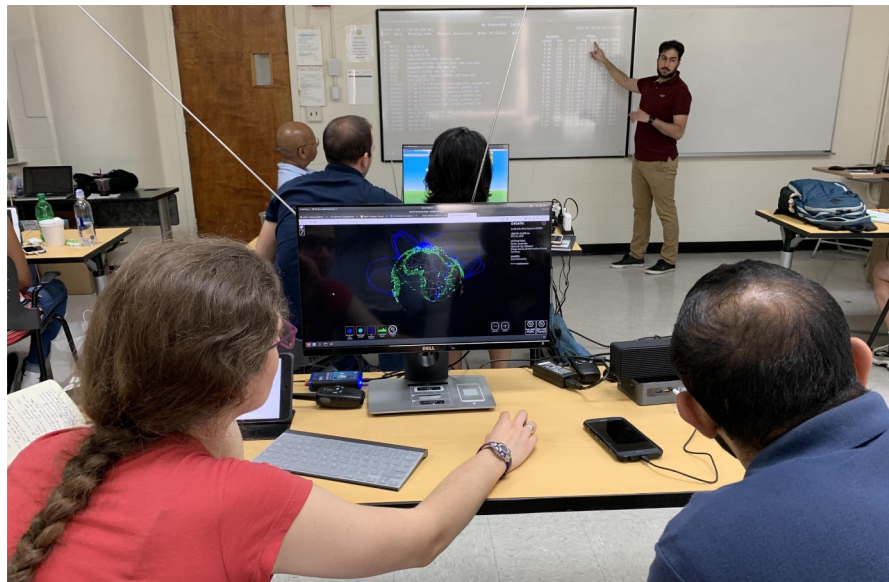


Fig: Participants attend an instructor-led lesson using the 'COSMOS Educational Toolkit'



Fig: Participants conduct research using sensors

Program Overview (2/3)

- c. **Development phase:** teachers co-develop with the researchers their best ideas on how to use the wireless labs for NGSS-aligned STEM lessons
- d. **Implementation phase:** teachers and students use the developed lessons in the class during the school year



Fig: Teachers present their developed NGSS lesson plans at Silicon Harlem

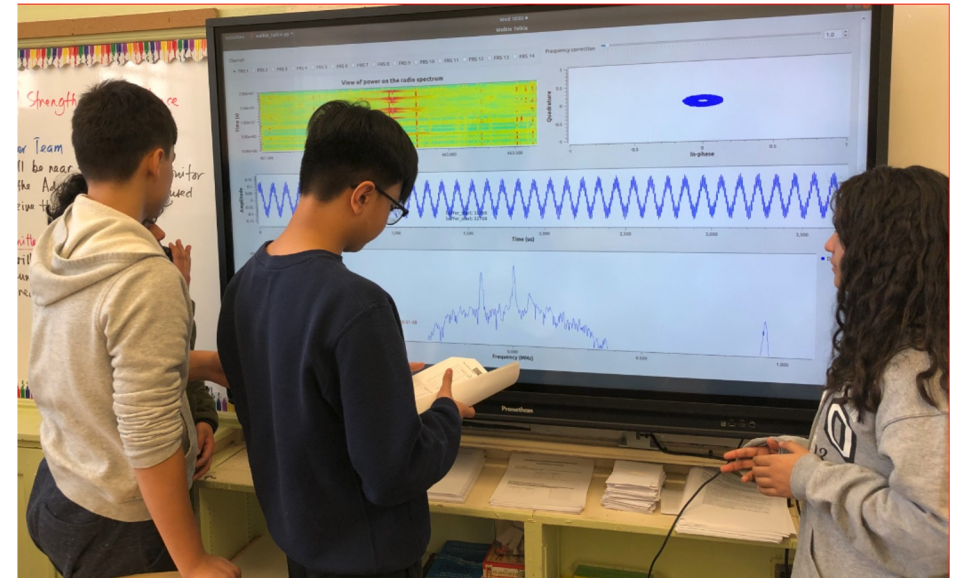


Fig: Middle school students using the 'COSMOS Educational Toolkit' in a Mathematics Class

Program Overview (3/3)

- e. **Feedback phase:** teachers provide feedback in order to improve the NGSS STEM lessons and develop new ones

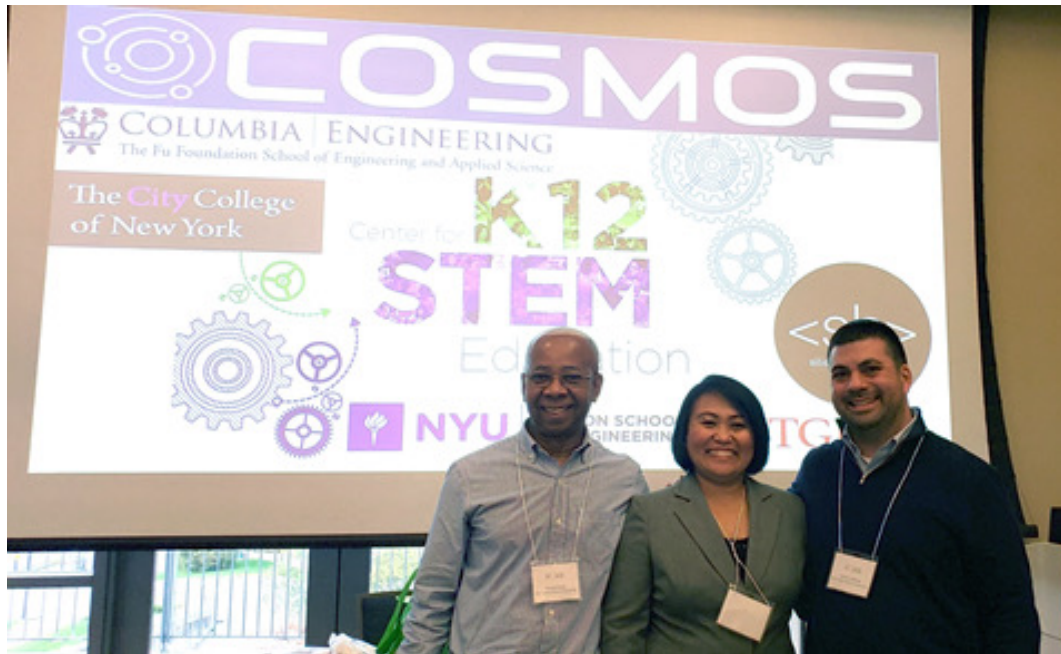


Fig: Teachers present the PD Program and the developed NGSS Lesson Plans at the NE-ASTE Conference 2018

COSMOS Educational Toolkit

- Hardware components:
 - **Processing Units:** Intel NUC, Raspberry PI
 - **Software Defined Radio:** ADALM Pluto SDR, RTL-SDR
 - **IoT Nodes:** Arduino/Micro:bit, XBEE/BLE, sensors
- Software components:
 - **Web front-end interface:** HTML, CSS and Javascript
 - **Web back-end server:** Python
 - **SDR Software:** GNU Radio
 - **IoT management:** influxdB and Chronograf



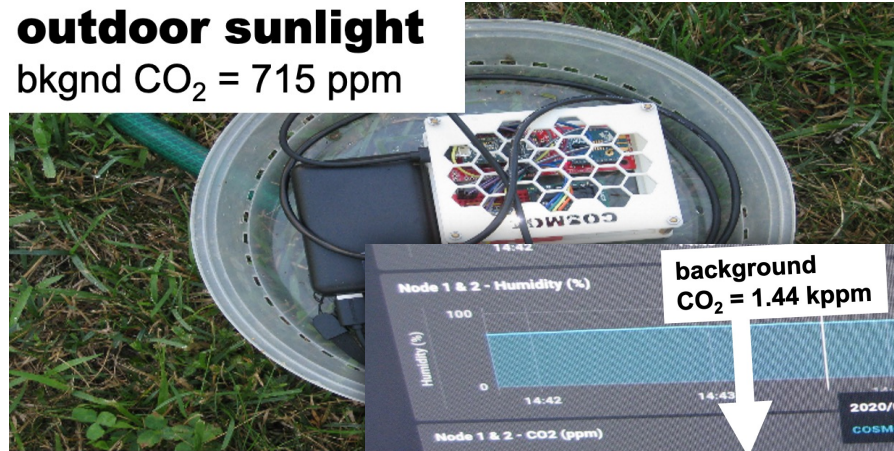
Fig: Hardware components of the 'COSMOS Educational Toolkit'

Example Lab: Destructive Interference

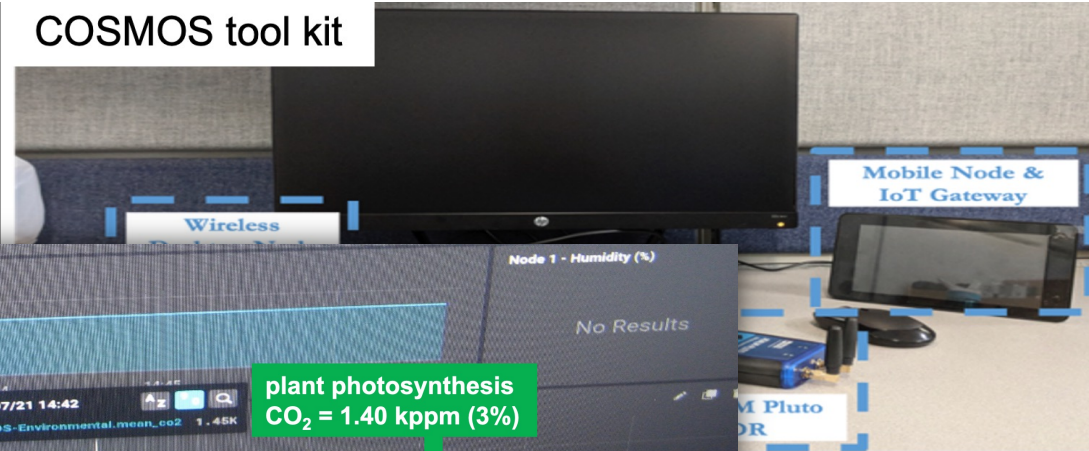
The screenshot shows a web browser window with several tabs open: '- mchoi1201@', 'Launch Meeting - Zoom', 'Post Attendee - Zoom', 'Math Labs - COSMO', and 'COSMOS RET'. The address bar displays 'cosmos.toolkit.edu' with a 110% zoom level. The main content area features the 'COSMOS Project' logo and the text 'Educational Activities' above a blue 'GET STARTED TODAY' button. The background is a panoramic night view of a city skyline. At the bottom, three blue circular icons represent 'MATH' (calculator), 'SCIENCE' (flask), and 'COMPUTER SCIENCE' (keyboard). A small video feed of a woman is visible in the top right corner of the browser window.

Example Lab: Photosynthesis

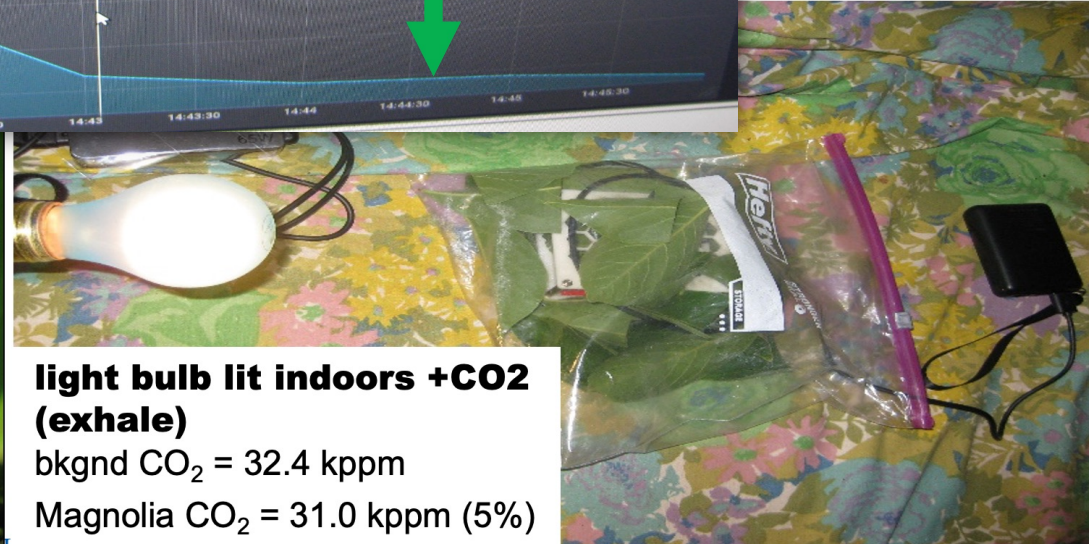
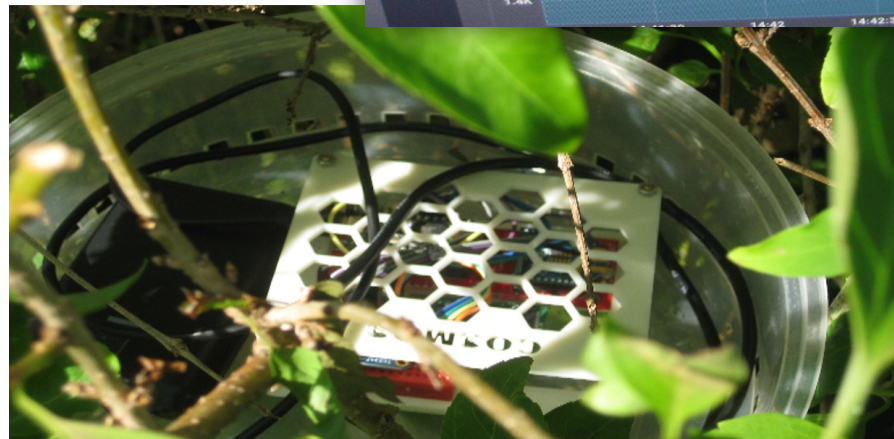
outdoor sunlight
bkgnd CO₂ = 715 ppm



COSMOS tool kit



Japanese boxwood
CO₂ = 700 ppm (4%)



Example Lab: Bandwidth

Student Worksheet

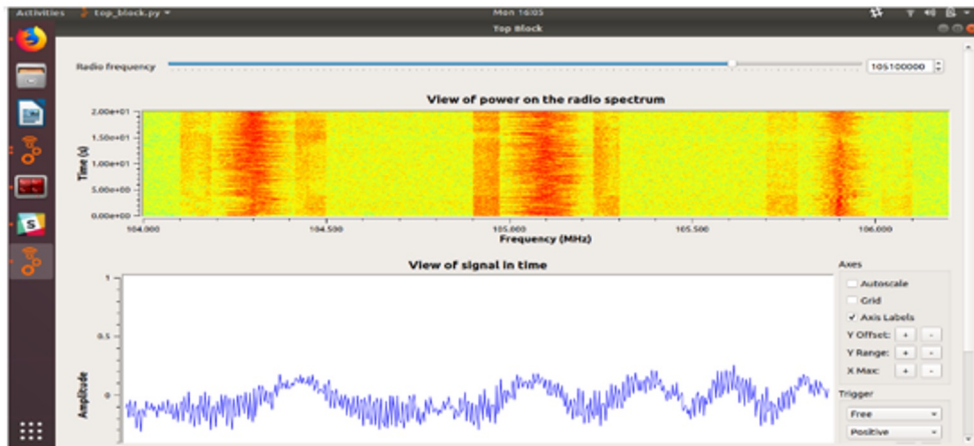


Student Name _____ Class _____

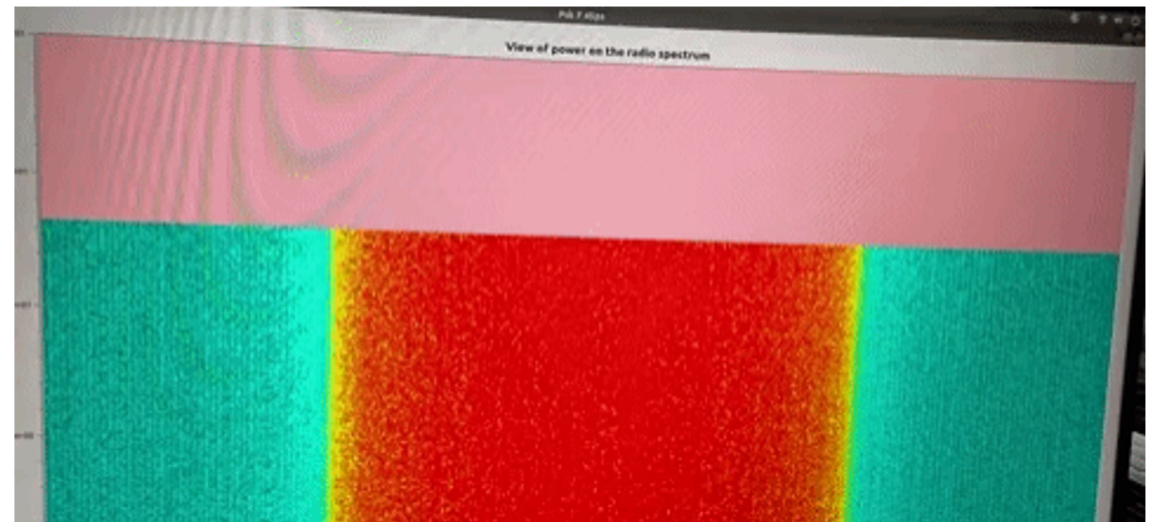
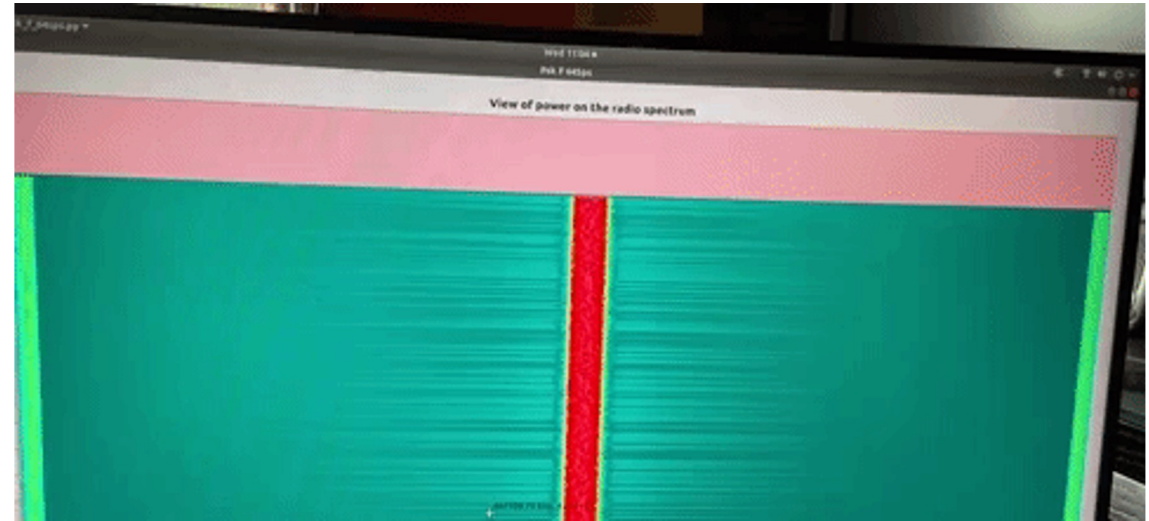
Bandwidth

Lesson 6a – for Toolkit

Bandwidth is the range of frequencies “occupied” by a signal – in particular, the width of the range of frequencies. Recall, that when looking at a signal in the frequency domain, we saw that the signal may not be only confined in a narrow range of frequencies but may have energy on a wider set of frequencies. See below:



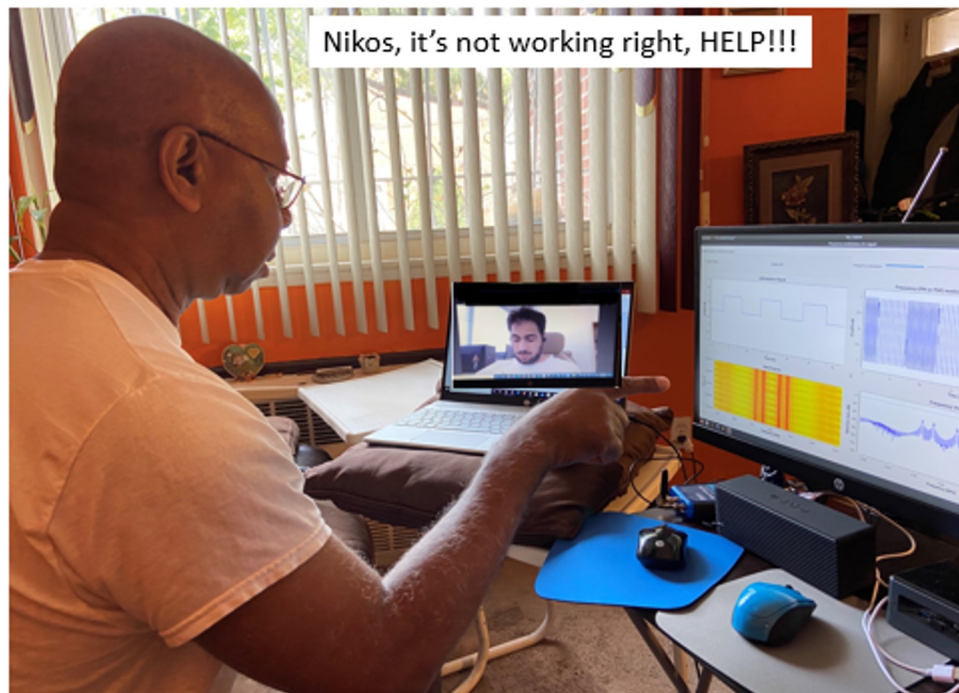
Let us take a closer look at the top graph showing the “Power of the radio



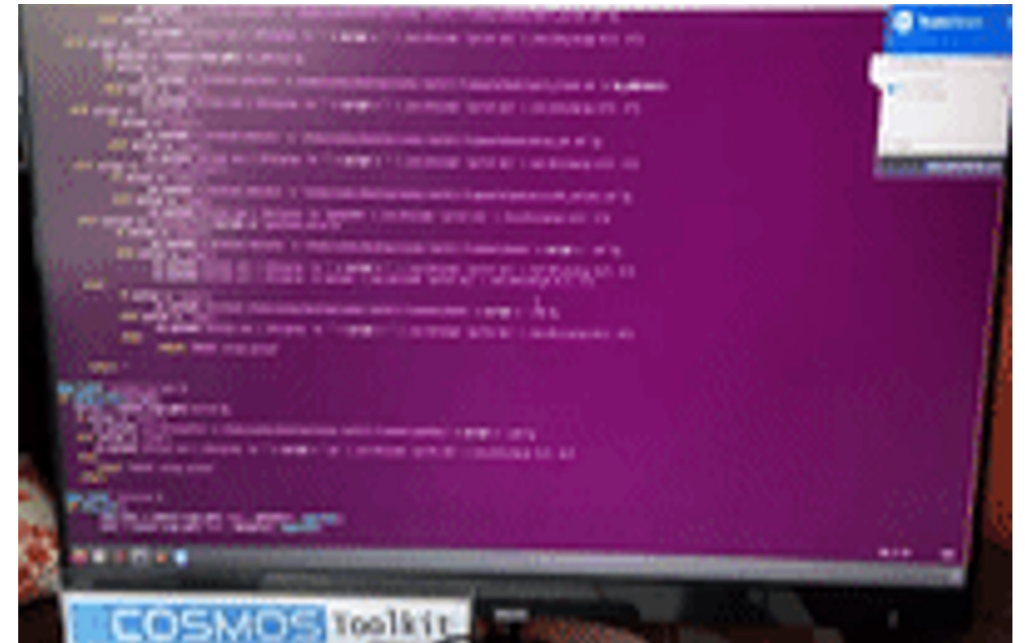
During COVID-19 Pandemic

“Everyday we would work on our labs and constantly communicate with our mentors to help us fix any problems we encountered with the toolkit. They are extremely knowledgeable and very helpful. We would be lost without them.”

- Richard Foster (Parkside Preparatory Academy MS2)



“Panagiotis is adjusting my Toolkit remotely. WOW!!!”



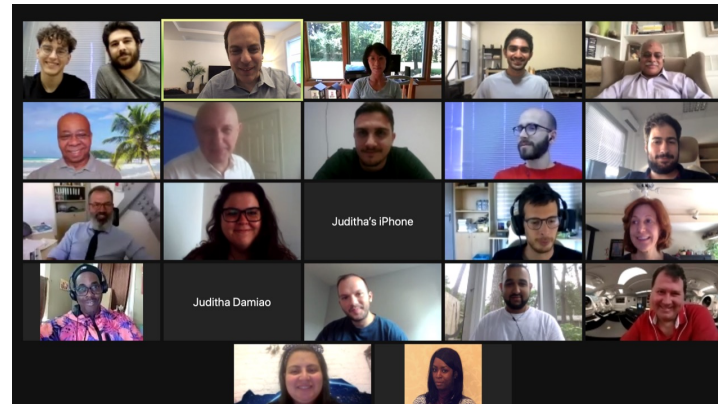
Conclusion

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2022

2021

2020



2019

2018



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