

A cosmic ray detection experiment based on the CosmicWatch project, coupled with CMOS sensor detection.

Departure: 6/20: 7:49 am leaving and 9:57 arriving

Return: 6/23: 9:45 am leaving and 12:10 arriving



apex presentation 2

<https://docs.google.com/document/d/19dGgUTYC9sqgvP1axl323m2rqg4qyNU1QqBJS5Jl180/edit?usp=sharing>

Hotel:

[https://www.expedia.com/Boston-Hotels-Comfort-Inn-Suites-Logan-International-Airport.h543784.Hotel-Information?chkin=2025-06-22&chkout=2025-06-23&x_pwa=1&rfr=HSR&pwa_ts=1748305028949&referrerUrl=aHR0cHM6Ly93d3cuZXhwZWRpYS5jb20vSG90ZWwtU2VhcmNo&useRewards=false&rm1=a1%3Ac17%3Ac17®ionId=178239&destination=Boston%20\(and%20vicinity\)%2C%20Massachusetts%2C%20United%20States%20of%20America&destType=MARK](https://www.expedia.com/Boston-Hotels-Comfort-Inn-Suites-Logan-International-Airport.h543784.Hotel-Information?chkin=2025-06-22&chkout=2025-06-23&x_pwa=1&rfr=HSR&pwa_ts=1748305028949&referrerUrl=aHR0cHM6Ly93d3cuZXhwZWRpYS5jb20vSG90ZWwtU2VhcmNo&useRewards=false&rm1=a1%3Ac17%3Ac17®ionId=178239&destination=Boston%20(and%20vicinity)%2C%20Massachusetts%2C%20United%20States%20of%20America&destType=MARK)

[## DATA ANALYSIS . . .](http://ET&latLong=42.359355%2C-71.059785&trackingData=AAAAAQAAAAEAAAAQ_LYiab3HaW07jtEQjglYKMGxRr_2z_Lpo7U3GyVj1-w7X7hF0dptfxvKiozTb0_aj_urCHK8zS-OihlSRlhbB9hShjr wToVPpQTwuYoPq6n6OaP Jot04wTjBnDtJFZssJVii2bQU3GOaR24TMZKus4NkXPYD2wI5KzCr youp4cZ3iRhEjPo-0JwypUJh9ff92gljlpEp8CL7BdF81hcSRV4YZIXtnTn9JW7TMJ3wp-QgW4DN ScdlwSYGVXImw7u3IFc9TU2I-6OuWXjlij8yX9mUCHyYuRETE7yPdKpDLbjFiusU65EELvKbEJx WEnlAbcmJoGiHS ILynrD4LhP2qnyQK ij3NBjIem TJbJDGWeZAUDZIO THqfzN8qNCXvKpN yjHs9i7jYn5RB8Xst1nOw2GBUIx5WE_8rt0Xsr_y_aA8Zj9-8IXv5ERhudAnkgzgcUO8zKZeQY9c TOf2 SOBCTRTmZQHaW8dLht2hiZ-YT4M7hbHlOB3i6LJ6ktBWHxXdpxl7vddoGg_tL5zZJ-Ys2 KTco6GfOIF-5kjwRteo4nkZs9WypsiHbBggqSK_4u-qkprEOkBmaUSyRCTt_UWNL-xgGDsTX9 Kyot4FDQwPG9gj2OecEpRZGDEB8Q-ChLQPTtnEo15or_S4XP2a8AqI5coiV7x_-_Mtuc2Sg3q KYZFtdyA-3tP-r_DxYOJpvnQ1tYQfMVJ2xcYVJh7YGAQsU5O11uDddgiavmCdpKw5VUOTUPZ XKwOI7K-dSvN0WhHD1hTmYuV3Bgc2sbLinSWTs8HTGA5FFXNyL1rPU9bTGEophhIVs12GF5 tZLmnGc1927qFQVYN1CCKZa-CWC_MZa08vGDG6lRQFhLvNtmDCHRV9nlQeQF5aOhA10tb6 BH98mOmJ1la-eb53d6FWaujbDuuwMp8HFSKjzv-cnMV2FTJvHrUJqTZQ7EIhldvJHUWZVwY YsSTOxp0yZhYO7x_zkddvnrOU9d_464MdXk_nz7tY_Cxc_xhyH7nJ3PztZbGVPdMqTP_bnIRX 405WKyp2B_fBfOJhb8o8hpRxR-CHPhDN8PSglKeAVOCMDwP9Eoc2HwaWU8EfCC60tASmb2 Q62OqJ9at9O6yUQYqj3tbKXE-pLICiZlOLRM_ali7slrptz0Lbc-0hdT_syxbmlGbaicREvDj6yTiw1n 95t92MDGcfaH9coUUjnvQgegA3iZ4V_twLvFnpKoCo74acGh43jnzAYqjYkyNrP_vcoDhF2_izoo Dqr4CTHi0ODIx-4skAsG4SuCpsKMkD7xidanRN40a1ZCnaKo8SQd0ziCouZYuOaZ1P6qMMc3 7vGfGiQTWCd6C3dh6XTt0DDmA%3D%3D&rank=2&testVersionOverride=Buttercup%2C3948 3.0.0.%2C50028.0.0.%2C50813.0.0.%2C51642.169494.0.%2C51690.201908.0.%2C52131.18785 2.1.%2C54709.194717.1.%2C59134.0.0.%2C50988.158353.0.%2C60140.211636.0.%2C54072.0. 0.%2C57292.224265.0&slots=&position=7&beaconIssued=&price=0&price=199&token=BEST&s ort=RECOMMENDED&top_dp=199&top_cur=USD&gclid=Cj0KCQjwotDBBhCQARIsAG5pinNk TjOgZt1_3VvFTxl_wWSg2EchspK4jMCmjEPbqijVbd6nyuocWyUaAjaWEALw_wcB&semcid=US .UB.GOOGLE.DT-c-EN.HOTEL&semdtl=a111798314238.b1120386114371.g1kwd-325302710.e 1c.m1Cj0KCQjwotDBBhCQARIsAG5pinNkTjOgZt1_3VvFTxl_wWSg2EchspK4jMCmjEPbqijVbd 6nyuocWyUaAjaWEALw_wcB.r136a97f4ba52fb5055141ea7b1e76384c0fabfa52a4365522f0e3c 7e386b21945.c1.j19010676.k1.d1618767995590.h1p.i1.l1.n1.o1.p1.q1.s1.t1.x1.f1.u1.v1.w1&us erIntent=&selectedRoomType=85747&selectedRatePlan=383294440&searchId=173866a0-808 d-4495-a039-cb05750c2d47</p></div><div data-bbox=)

MUON Detector

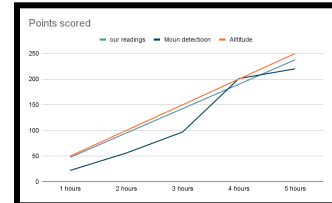
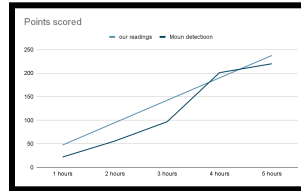
- The place where we record: <http://cosmicwatch.lns.mit.edu/measure>
 - We can upload from the SD card to a computer, and then insert that file into this
- The code for the data collection from the SD card of the detector: [http://cosmicwatch.lns.mit.edu/measure](#)
- We can compare the moun detector (when each detection occurred), with an altitude graph = look something a little like this. --->



CAMERA

- The live time increases if we switch to video mode, instead of photo capture of each particles
- The photo captures 1/20, while the video captures 19/20
- We could also amplify by the 5% to make it so that it is accurate with the theoretical measurements.

-we can have a graph with our data, compared with an amplified one. And we can have a graph with both the Moun and Camera data



We will upload the footage to our computers, and manually dissect and record the readings

https://www.ebay.com/itm/145744389903?_skw=plastic+scintillator&itmmeta=01JW57WY9M5QSBS34TC0SJSKAW&hash=item21ef0ae70f:g:cxMAAMXQbXtRB0vh&itmprp=enc%3AAQAKAA%3AA0FkggFvd1GGDu0w3yXCmi1ee5JNufwSA67KeWO2Gs3ScXvGPAY8mMtH5Url%2B3X5v%2F5OWnpbjZIRYjo8dg12IK0SyApcalbfBowS0D87ZLgb0AwvbpVMbmGXhtFLB0ZF%2BL7QNifJYXXCu6wVN%2BoZnofvDLiHlwth22O7wpQBmgfNFP3qazto9lQQ81hfXxR7M4q2%2BPORB2S0U40ARxv%2BFRI6uv9JvdVEI9df%2FSzg%2BkiaQjulvyfZAvuCiEuR8SM9fWZM4gtO77goriUVI%3D%7Ctkp%3ABk9SR_zk86fhZQ

APEX graphic 1=

<https://docs.google.com/drawings/d/1NoOtkFoXHn9fdJ8wPIAWGbppEPnYxSkgTSfW5Ylbor4/e/dit>

- 2

<https://docs.google.com/drawings/d/1ISyozY3DBpc81McvTCCbq8LeoRPefE6tRbXwvRbK15E/edit>

<https://github.com/Acoltvet/ATAL>

https://www.amazon.com/Polar-Tech-205C-Insulated-Shipper/dp/B007PB0ZK2/ref=sr_1_28?crid=22WLCDETQ5CE5&dib=eyJ2ljoimSJ9.UQlXJ7Q6nD4K7r0MF2o4YUsZ5hP2cq5rTLrm131YvNTNkBhS7DvY6kwb_5whiyFWAdg-fsutw340FtCQQyzUySt4z7AAEZfIISPETMOzEYPYthI4Yk8n9BAte1imGboeq9oj9n1tvXNRa5bC_uNyJMDOTdJlr_hvueXCRfmGJGTkounVS35l7mvAPT_I1nRRzm-vo5vVConljxw0UuiK6H_3aCUAfmK30bPGrE0teumkYMceHmKFevWCNKxFcy78NyFL8igVcghFw2D7h4RyxHOJRso14mDVwscvitOfc.u0CK6Nm79JMz8FzNNFI7DFwvxaDmRuFGtbRAjul_nCA&dib_tag=se&keywords=4x4x6%2Bstyrofoam%2Bbox&qid=1746391756&refine

[nts=p_36%3A-4500&rnid=2661611011&s=industrial&sprefix=4x4x6%2Bstyrofoam%2Bbox%2Cindustrial%2C61&sr=1-28&th=1](https://www.mrboxonline.com/8x6x7-quarts-lil-styrofoam-coolers-p-6787.html)
<https://www.mrboxonline.com/8x6x7-quarts-lil-styrofoam-coolers-p-6787.html>

Apex Link: <https://apex.hackclub.com/>

Slack Link: <https://hackclub.com/slack/?event=Apex>

Time Link: <https://apex.hackclub.com/time>

REGISTER!!!: <https://forms.hackclub.com/apex-event-registration>

Screen recorder <https://screen-recorder.com/>

https://github.com/spenceraxani/CosmicWatch-Desktop-Muon-Detector-v2/blob/master/PB_Files/SMT_reference.pdf stuffs for pcb

<https://docs.google.com/spreadsheets/d/1COggnIU95VSvbioz9-bSUiMewqK-UZ0-jFnCBzSJOIk/edit?gid=0#gid=0>

<https://www.adafruit.com/product/5657?src=raspberrypi> pi camera

<https://www.adafruit.com/product/4561?gQT=2> I think better pi camera

<https://www.youtube.com/watch?v=Js-IOOS7sVE> - IMPORTANT

<https://www.instructables.com/Real-time-Radiation-Detector-Scintillino-test/> scintillino detector

<https://data.energizer.com/pdfs/l91.pdf> battery datasheet

Tracker thing <https://github.com/New-England-Weather-Balloon-Society/Tiny4FSK>

HOW TO MAKE AN AI - <https://www.youtube.com/watch?v=-mDcL314IFI>

<https://via.library.depaul.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1021&context=ahac> cmos detecting paper

<https://github.com/spenceraxani/CosmicWatch-Desktop-Muon-Detector-v2/blob/master/ThePhysicsPaper.pdf> giant paper about CosmicWatch

Proposal document:

https://docs.google.com/document/d/1cPGaUw7b5IzSHCMd7bN_-LYU8be83jfn6p3k_aTtpM4/edit?tab=t.0

<https://news.mit.edu/2017/handheld-muon-detector-1121> Epic muon detector

- Moun detector instructions

<https://github.com/spenceraxani/CosmicWatch-Desktop-Muon-Detector-v2>

<https://github.com/crnicholson/StratoSoar-MK3> look at this

- https://www.amazon.com/Estes-2246-Altimeter/dp/B00EZBH896?source=ps-sl-shopping-ads-lpcontext&ref_=fplfs&psc=1&smid=ATVPDKIKX0DER&gQT=1#averageCustomerReviewsAnchor altitude meter

Due Dates:

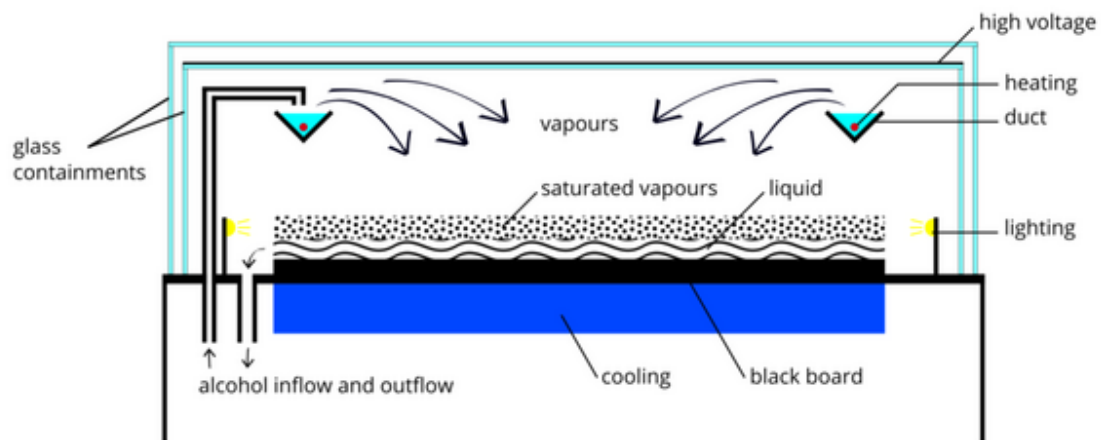
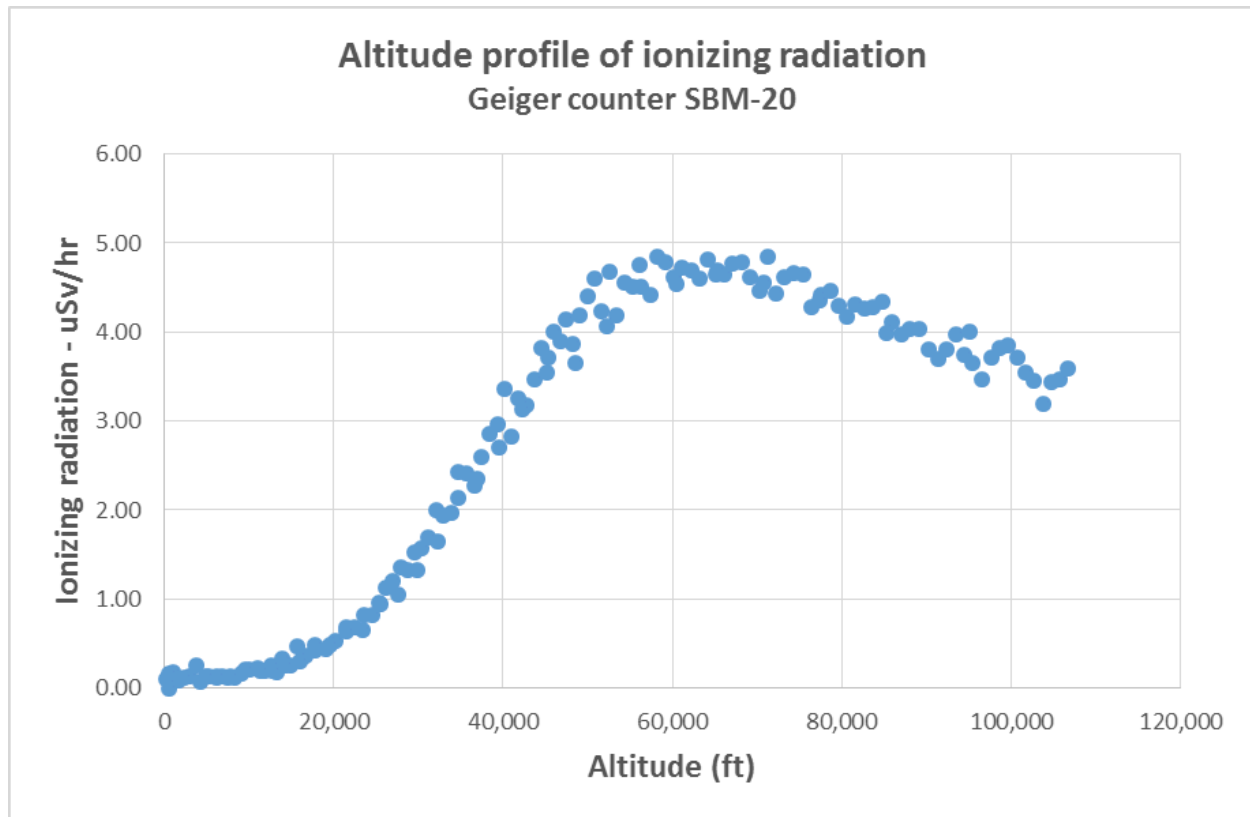
- Proposals due April 1
- Project due by June 10

Once you reach your 100 hours of work, we'll cover the cost of your airfare or transport to Boston up to \$400! (If the price of your transportation to Boston is over \$400, don't worry! You'll receive an additional \$5 towards your travel stipend for every hour you spend working past your initial 100 hours of work.) We'll also cover up to \$40 worth of transport to and from the airport

LIMITATIONS

<https://apex.hackclub.com/resources/limitations>

- Fit inside 12 x 12 x 12 box
- $\frac{3}{4}$ lbs weight limit (would hit 103,000 ft)
- Any radio transmissions must not interfere with onboard radio communications used for tracking the balloon (432.XXX MHz)
- Nothing hazardous or flammable
- powered off Energizer Ultimate Lithium batteries, which are rated to work in -40 deg C temperatures.
- Use of red duct tape around corners.
- Enough space for a $\frac{3}{8}$ " vinyl tube to pass all the way through the payload box
- Please attach 4 small placards around the sides of the payload box, and one large one on the top.



Cloud chamber for sale:

https://www.arborsci.com/products/cloud-chamber?currency=USD&variant=18700742131785&utm_source=google&utm_medium=cpc&utm_campaign=Google+Shopping&stkn=76ed39d3225f&com_cvv=8fb3d522dc163aeadb66e08cd7450cbbdddc64c6cf2e8891f6d48747c6d56d2c

Notes:

When cosmic rays (high-energy particles from space) hit the **Earth's atmosphere**, they create **secondary particles**:

- **Muons** (what the muon detector will measure)
- **Alpha particles, beta particles, and other charged radiation** (what the cloud chamber will visualize)

Muon Detector gives you precise data on muons per second at different altitudes.

Cloud Chamber gives you visual confirmation of different types of radiation present.

Step 1: Build and Test the Muon Detector

- Uses plastic scintillator and photomultiplier tubes (PMTs).
- When a muon passes through, the scintillator lights up so the PMT detects the light and the microcontroller records it.
- Stack two or more layers so that only real muons get detected.

Step 2: Build and Test the Cloud Chamber

- Uses dry ice + alcohol vapor.
- When radiation passes through, it ionizes the vapor, forming visible tracks.
- You'll see thick, short tracks for alpha particles, thin long tracks for beta particles, and straight tracks for muons.

Step 3: Launch the Muon Detector on a Balloon (100,000 ft)

- The muon detector will record the number of muons at different altitudes.
- Expect more muons at high altitude, then fewer as you go higher

Step 4: Compare Data

- Compare muon counts at different altitudes to confirm how cosmic ray interactions change.
- Use the cloud chamber at ground level to identify different types of radiation and confirm that muons exist in the mix.

CONSTRAINTS

- **Weight < 3/4 lbs**
 - Muon detector = 0.149914
 - Cloud chamber = unknown for now
 - Or geiger counter
 - Camera =
 - GPS =
 - Wiring electronics =
 - The box =
- **Cost**
 - Muon detector = 100
 - Cloud chamber =
 - Or geiger counter
 - Camera =
 - GPS =
 - Wiring electronics =
- <https://www.instructables.com/Real-time-Radiation-Detector-Scintillino-test/>
 - a scintillator crystal (we used a 1cmx1cmx2cm LYSO ($\text{Lu}_2\text{Si}_2\text{O}_7:\text{Ce}^{3+}$) but most any scintillation material should do) =
 - a Silicon photomultiplier (we prefer that over a PMT because HV biasing is easier and they are also harder to destroy)
 - resistors, capacitors
 - two fast rail2rail op-amps
 - a simple DC-DC step-up converter off eBay
 - a piezo buzzer for added dramatic effect
 - Arduino Uno board
 - LCD Keypad Shield (or another LCD, with minor adjustments to the Arduino sketch)
 - soldering iron and tin (we use, lovingly, the old school non-ROHS stuff that will kill you etc etc yada yada)
 - cardboard (for the motherboard), nylon ties
 - a bunch of wires
 - something to hold your SiPM tight against your crystal (we drilled holes into a scrap piece of thick plastic)

Your reference number is: **17506889fv**

<https://www.youtube.com/watch?v=G19HS7-H0mI>