



# CATCHING COSMIC-RAY MUONS

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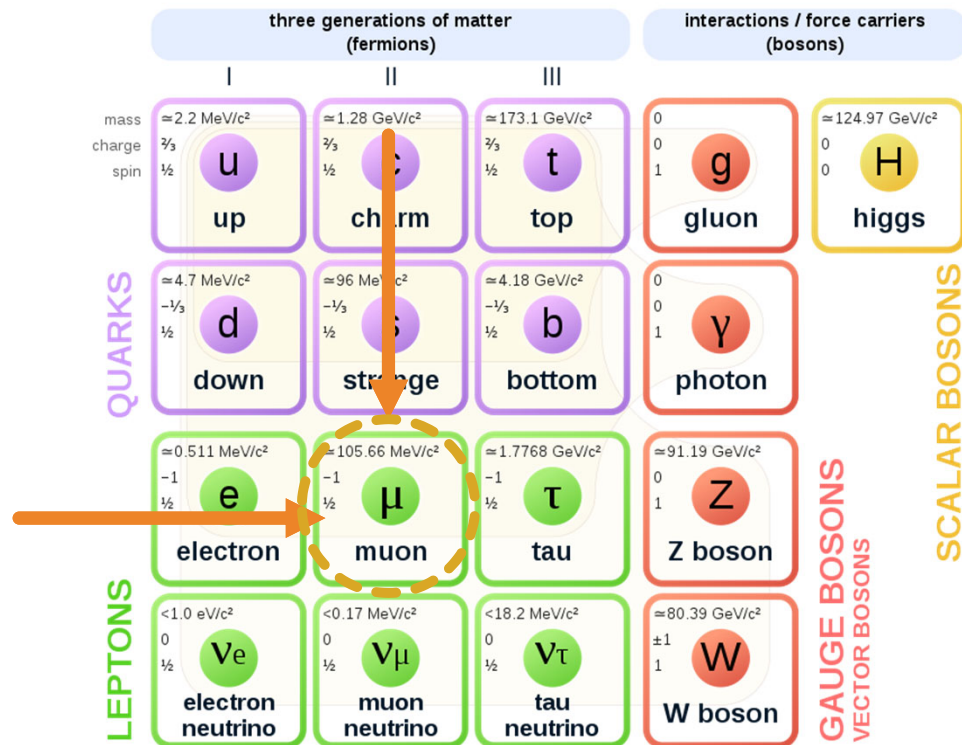
STEINMETZ SYMPOSIUM 2020

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# WHAT ARE MUONS?

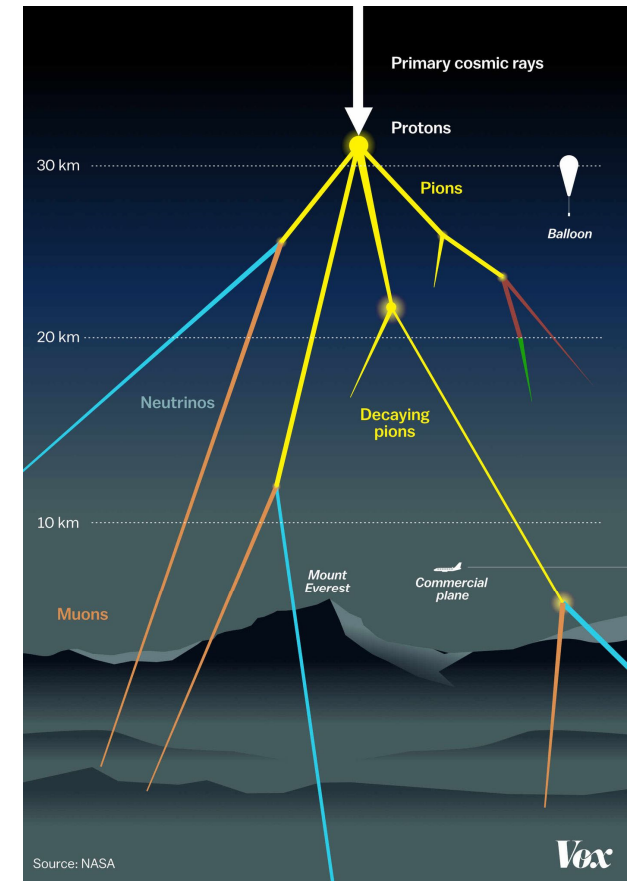
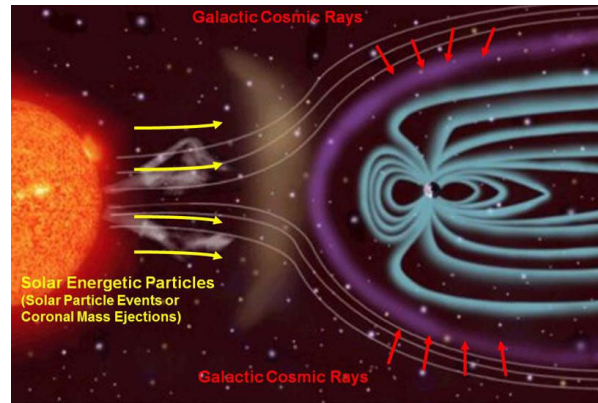
- Fundamental particles
- Lepton; same family as electron
- Same charge as electron
- 207 times more mass than electron

## Standard Model of Elementary Particles



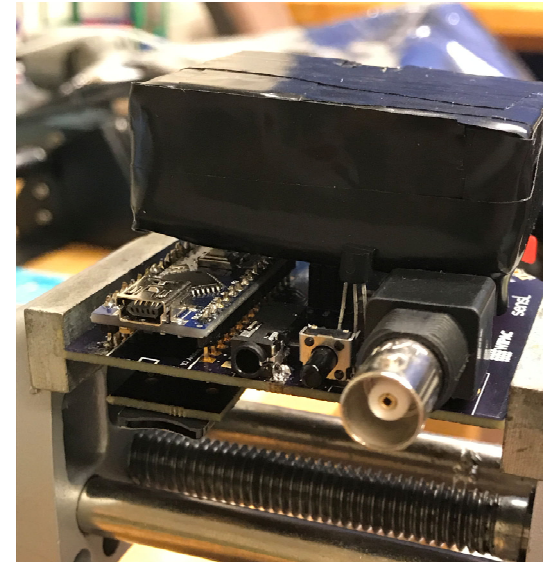
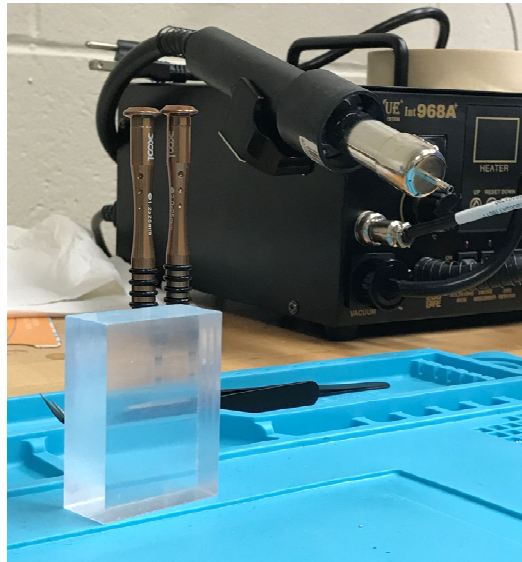
# WHAT ARE COSMIC RAYS?

- Powerful events in the space produce mainly energetic protons moving close to the speed of light
- Protons collide with molecules of the upper atmosphere of the Earth and produce muons
- Muons travel very close to the speed of light and reach the surface of the Earth



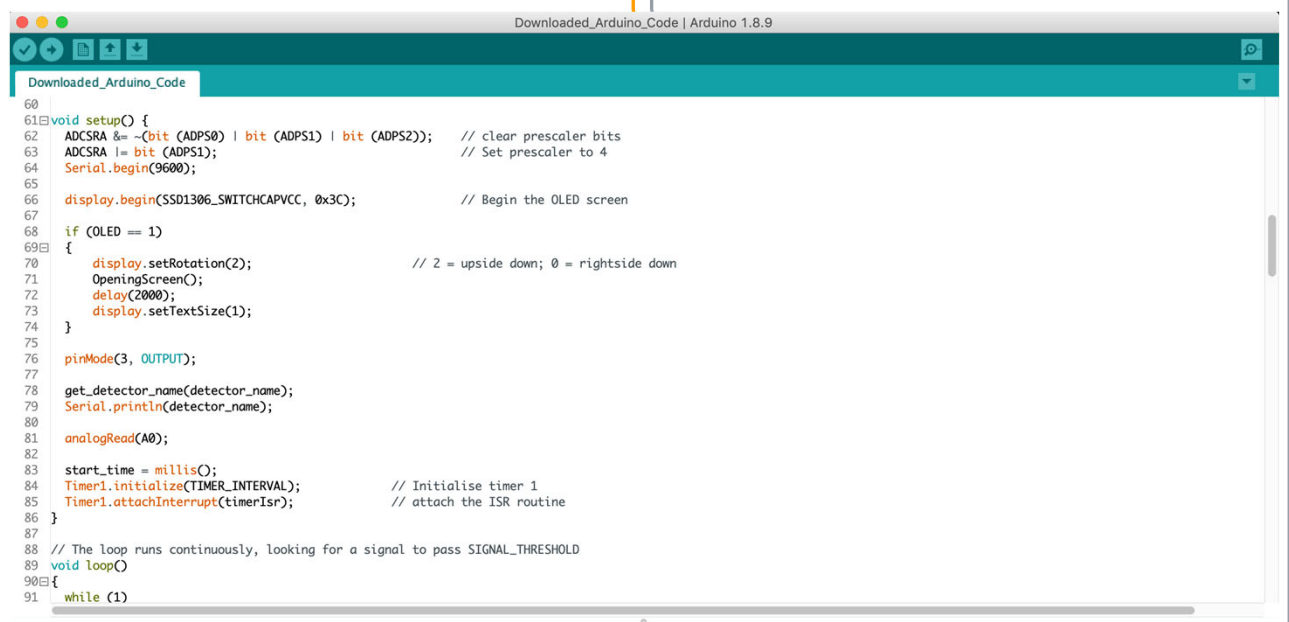
# APPARATUS

- Muons pass through the scintillator that give off light at a particular frequency
- This light is detected by a Silicon Photomultiplier
- The Photomultiplier converts light to voltage and transmits the signal to the Main Board



# SIGNAL ANALYSIS

- Signal gets amplified and delayed in time
- It is now detectable by the microcontroller, an Arduino Nano
- Arduino IDE used to communicate with microcontroller



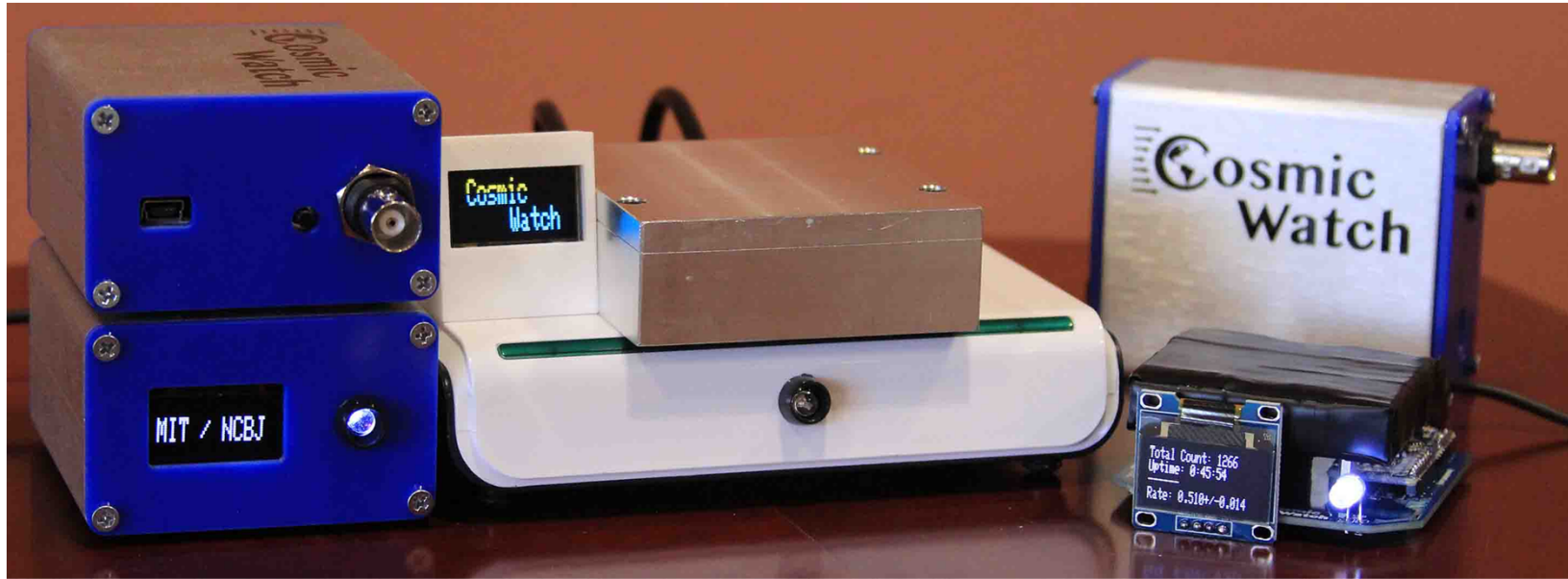
```
Downloaded_Arduino_Code | Arduino 1.8.9
Downloaded_Arduino_Code
60
61 void setup() {
62   ADCSRA &= ~(bit(ADPS0) | bit(ADPS1) | bit(ADPS2)); // clear prescaler bits
63   ADCSRA |= bit(ADPS1); // Set prescaler to 4
64   Serial.begin(9600);
65
66   display.begin(SSD1306_SWITCHCAPVCC, 0x3C); // Begin the OLED screen
67
68   if (OLED == 1)
69   {
70     display.setRotation(2); // 2 = upside down; 0 = rightside down
71     OpeningScreen();
72     delay(2000);
73     display.setTextSize(1);
74   }
75
76   pinMode(3, OUTPUT);
77
78   get_detector_name(detector_name);
79   Serial.println(detector_name);
80
81   analogRead(A0);
82
83   start_time = millis();
84   Timer1.initialize(TIMER_INTERVAL); // Initialise timer 1
85   Timer1.attachInterrupt(timerIsr); // attach the ISR routine
86 }
87
88 // The loop runs continuously, looking for a signal to pass SIGNAL_THRESHOLD
89 void loop()
90 {
91   while (1)
```



## METHODS & RESULTS

- Used **surface mount soldering** and **through-hole soldering** and a heat gun to construct the circuits on the board
- The circuits consisted of resistors, capacitors, inductors, diodes, and LEDs
- Had a working detector that registered events, but soon later the Photomultiplier broke





## ORIGINAL PROJECT

- Cosmic Watch: Catch yourself a Muon
- Designed by MIT

## REFERENCES

- [1] S.N. Axani, K. Frankiewicz, J.M. Conrad, *The CosmicWatch Desktop Muon Detector: a self-contained, pocket sized particle detector*, Journal of Instrumentation, vol. 13, March 2018.
- [2] D. Griffiths, *Introduction to Elementary Particles*, John Wiley & Sons, Inc., 1987.
- [3] <http://www.cosmicwatch.lns.mit.edu/about>
- [4] <https://hardhack.org.au>.
- [5] <https://eljentechnology.com>
- [6] <https://crystals.saint-gobain.com>



THANK YOU  
FOR YOUR  
ATTENTION!

QUESTIONS?

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