COSMIC RAY PROJECT

STEMposium | Napa Valley Vollege

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PROJECT OVERVIEW

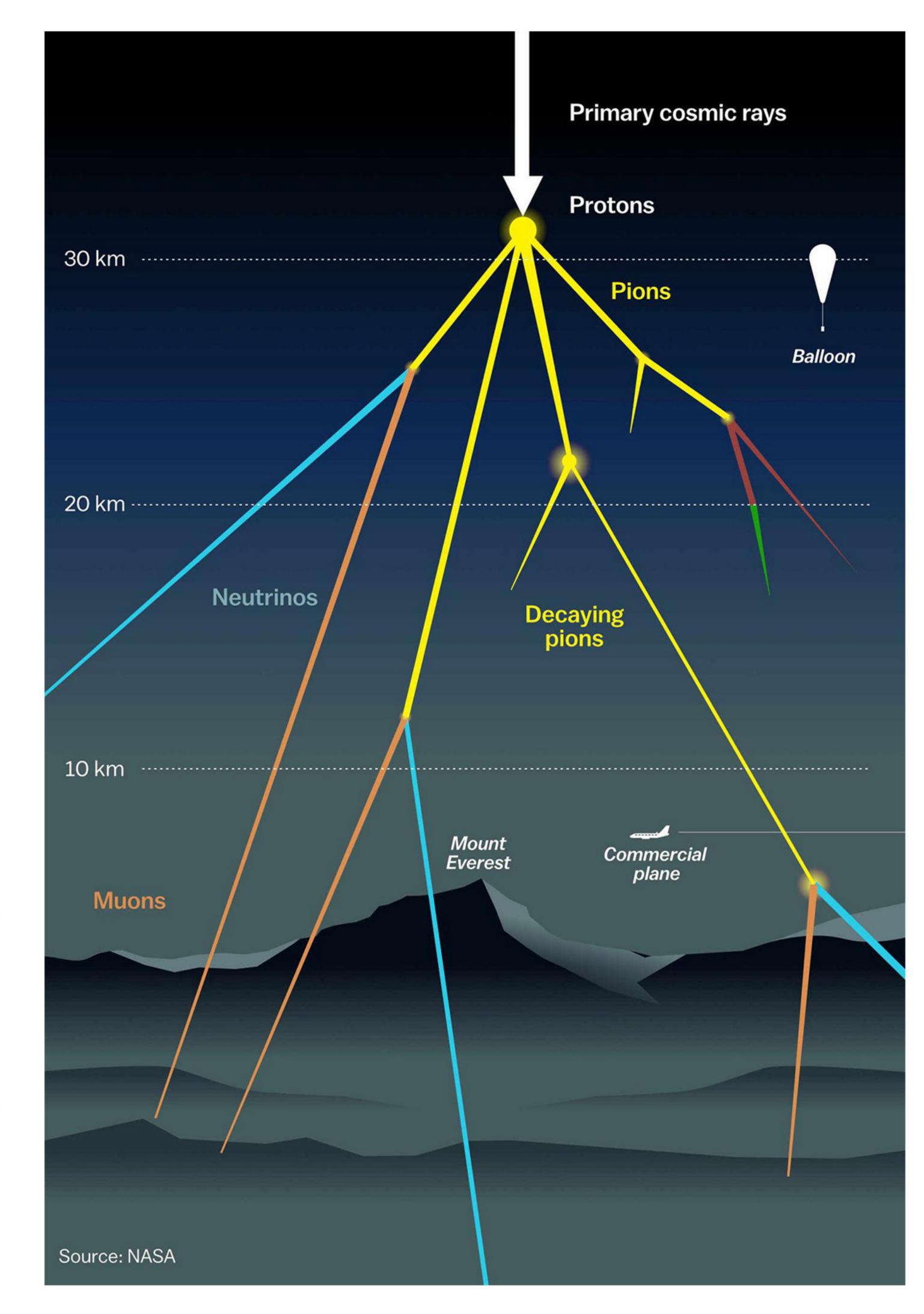
GOALS

- Understand cosmic rays
- Observe cosmic rays
- Measure muon lifetime

Particle physics is a branch of physics that studies the nature of the particles that constitute matter and radiation.

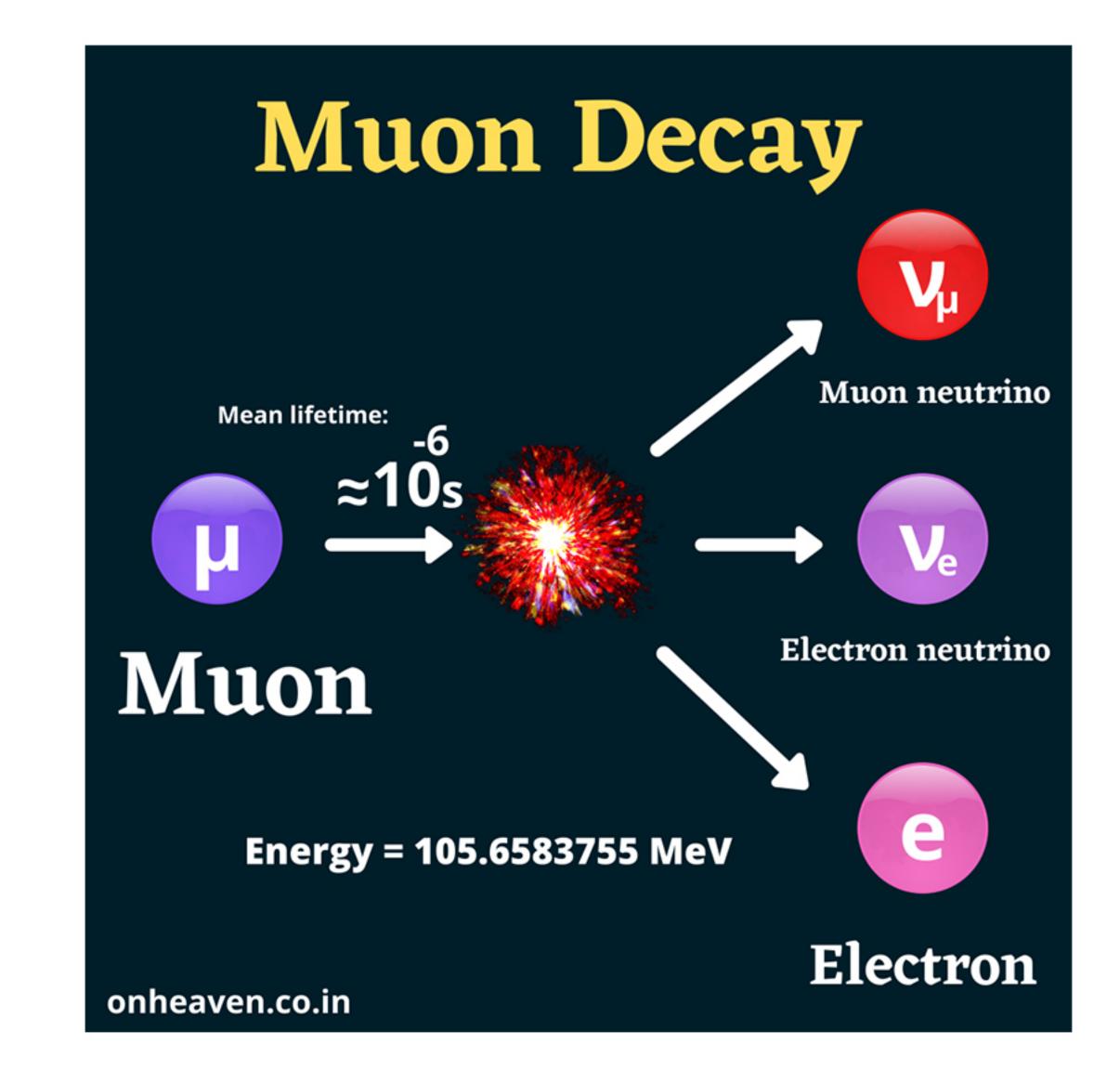
The standard model of particle physics tells us what kinds of particles exist, and how they interact.

Cosmic rays are high energy particles that rain down on Earth from outerspace at the speed of light.

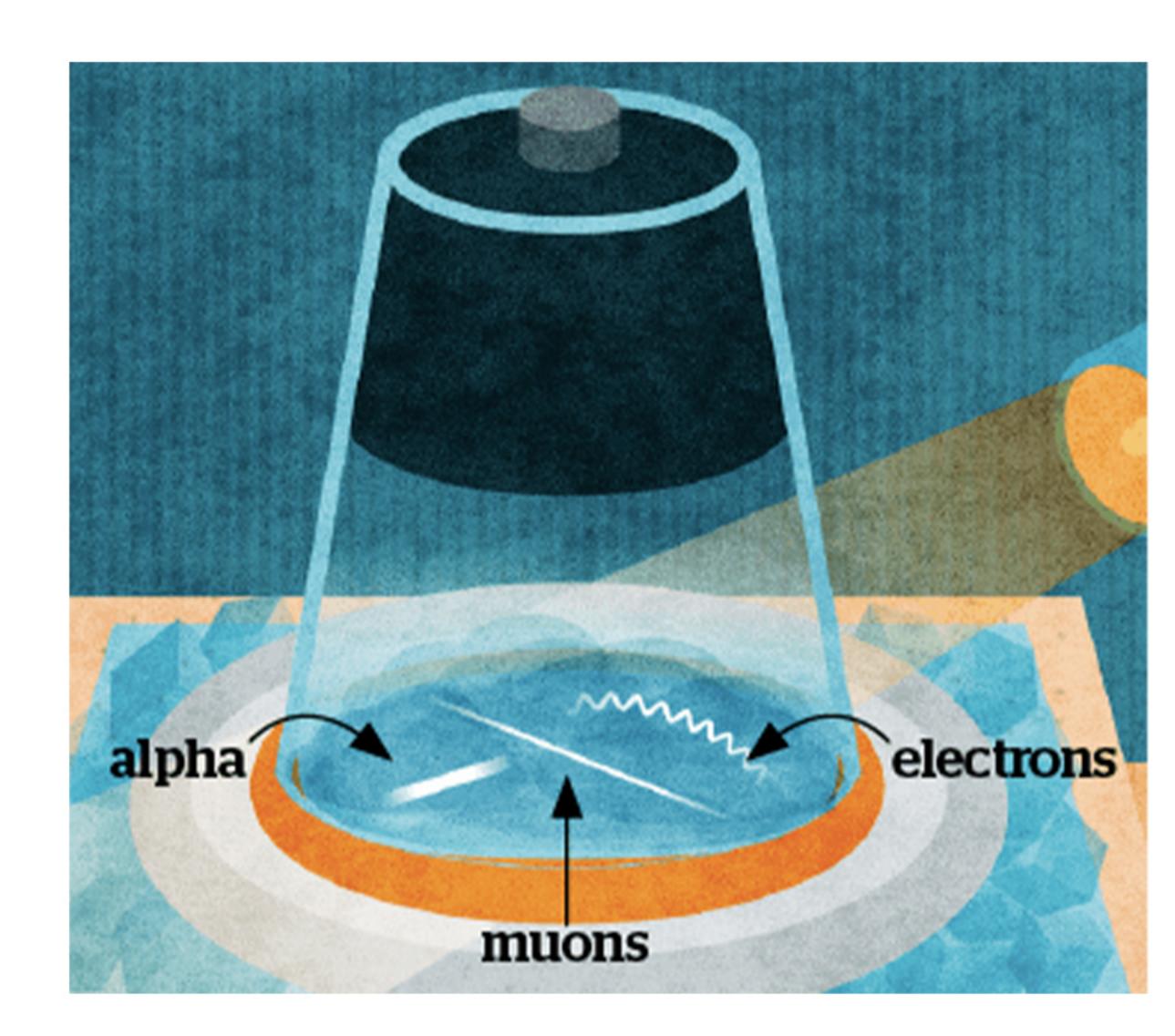


WHAT IS A MUON?

- Muons are sub-atomic particles with negative charge they are similar to electrons but have a lot more mass.
- Muons are unstable particles and they randomly decay into smaller particles.
- Since decay is random, it is impossible to predict when a muon will decay.



BUBBLE CHAMBER EXPERIMENT



Bubble chambers (also called cloud chambers) have a supersaturated vapor cloud inside them that is just on the verge of condensing.

When a cosmic ray flies through the chamber, it causes a small disturbance in the vapor cloud which can be seen with the naked eye.

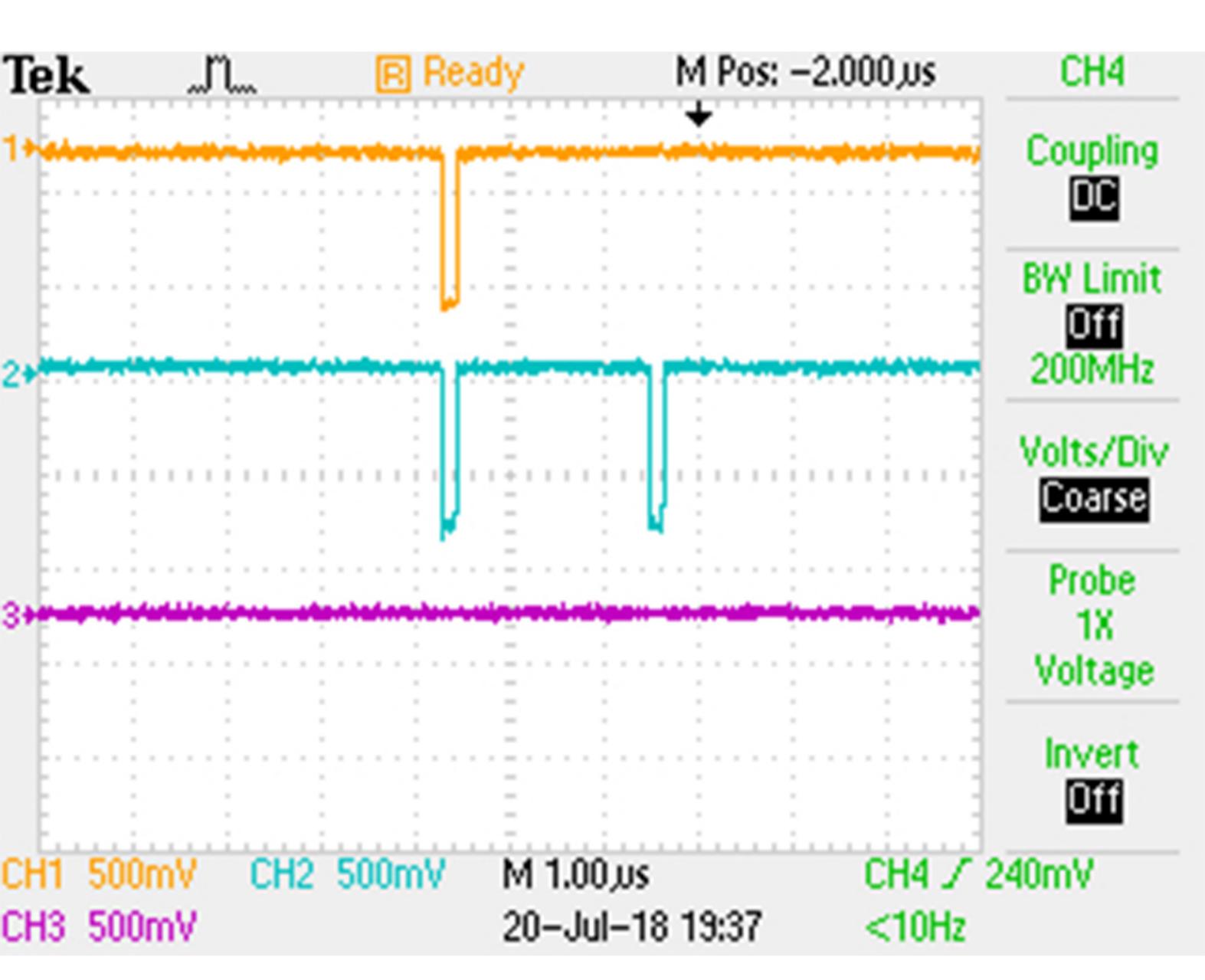
MEASURING MUON LIFETIME

MUON LIFETIME EXPERIMENT

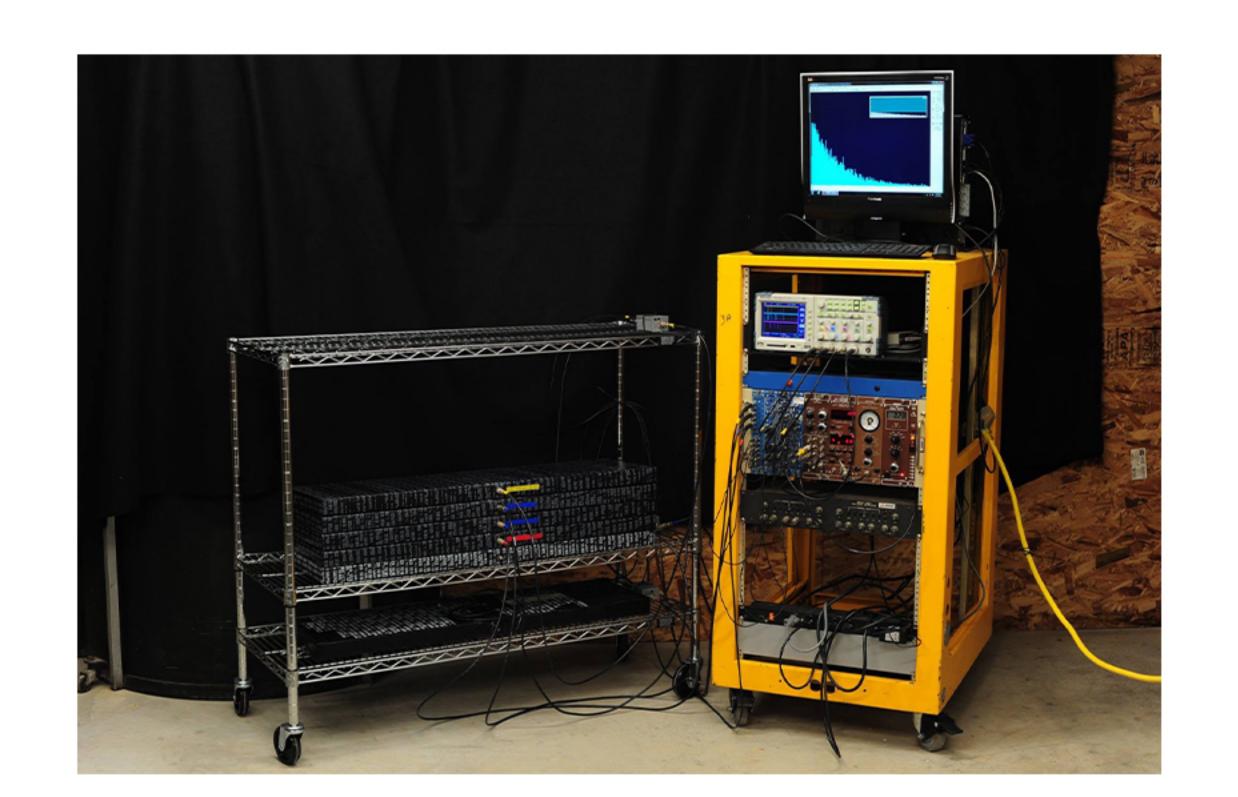
A scintillator is a device that detects when charged particles move through them.

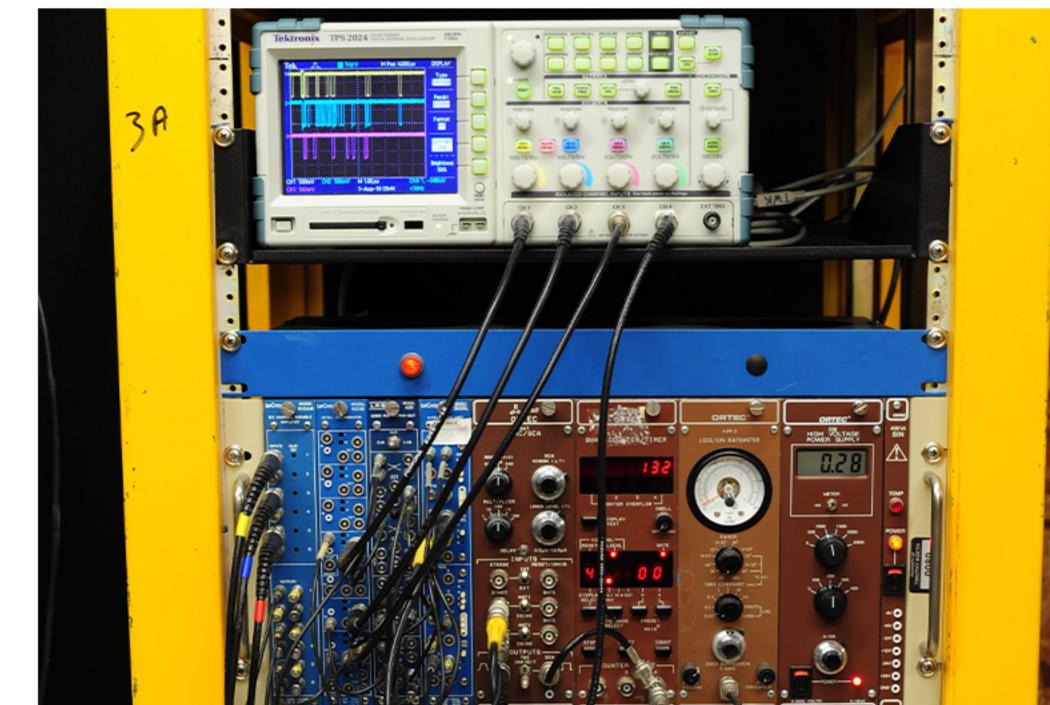
Using an array of scintillators and some electronics, we are able to measure how long a muon takes to decay into smaller particles.

Since muons decay randomly, a statistically meaningful number of muon decay events must be recorded in order to produce a reliable muon lifetime value.



A recorded muon decay

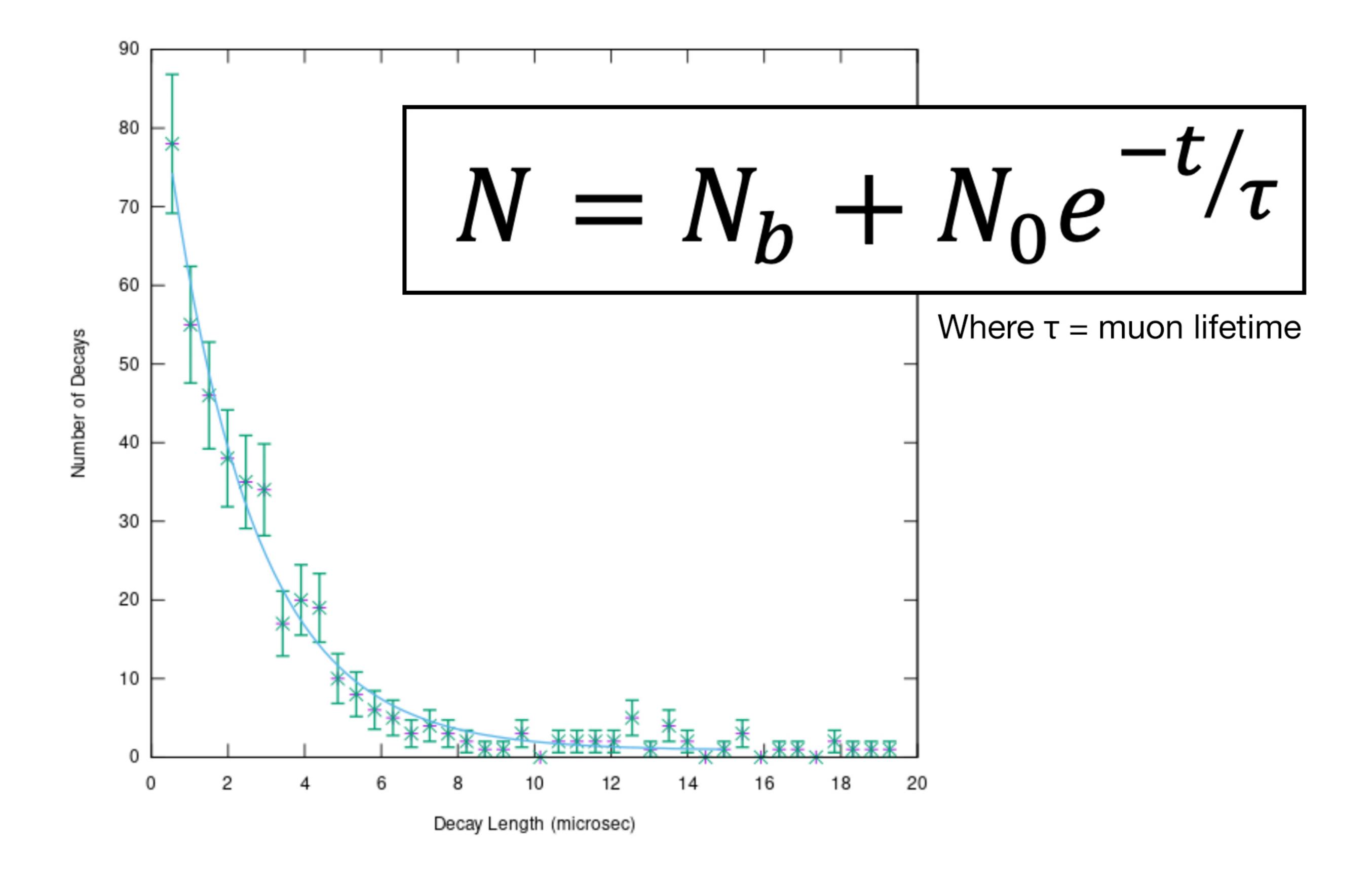




CALCULATING MEAN LIFETIME

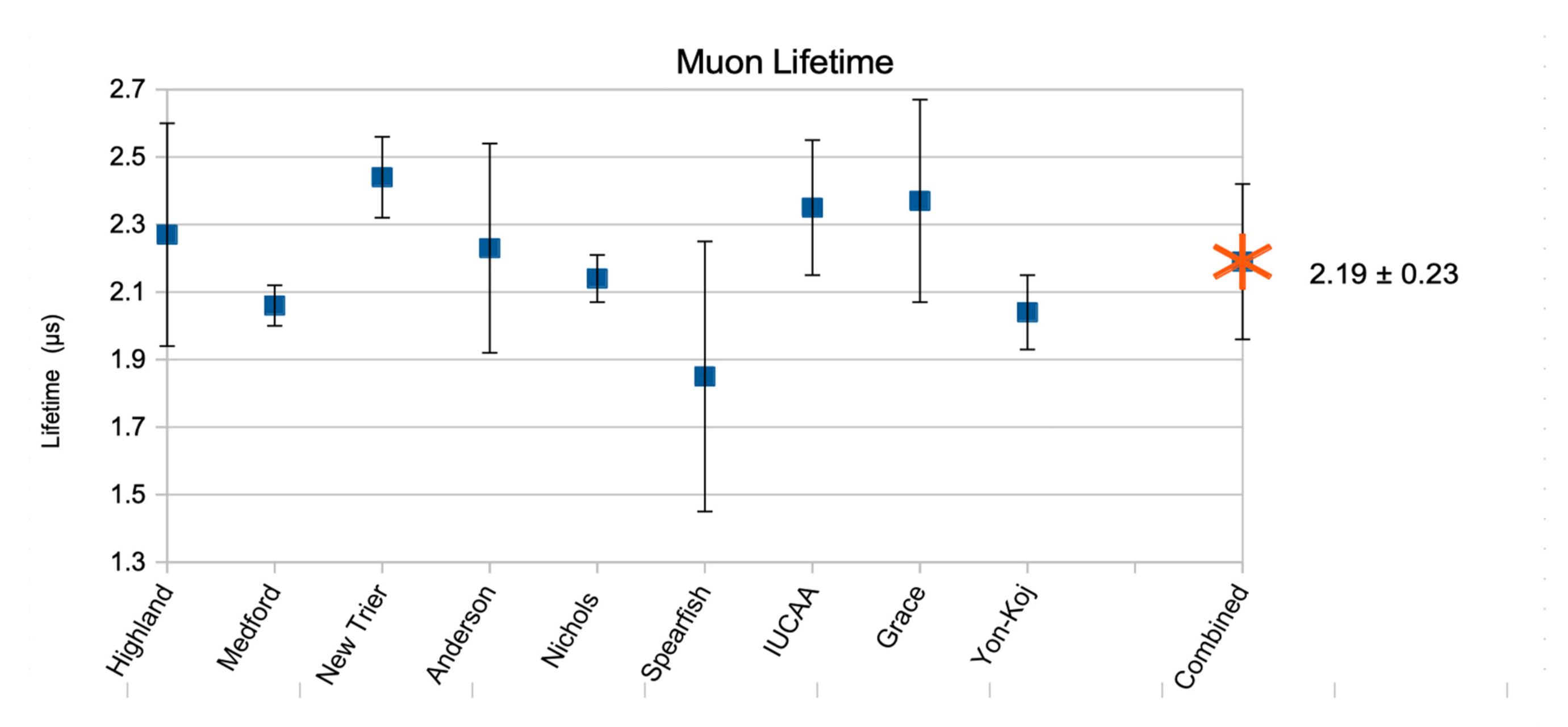
In order for us to calculate the mean lifetime of a muon as accurately as possible, we collected data sets from 9 different muon lifetime experiments from QuarkNet.org.

We analyzed each one mathematically and calculated an average mean lifetime.



DATA ANALYSIS

- We calculated a mean muon lifetime of 2.1943 μs with a standard error of \pm 0.23 μs .
- The accepted average lifetime for a muon is 2.1969 μs.
- This is within our standard error range, and our mean value is within a hundredth of a microsecond.



CONCLUSION

- Understanding cosmic rays is important because they can tell us about the cosmos; from our own stellar neighborhood to the edges of the visible universe.
- Using a bubble chamber, we are able to indirectly see cosmic rays with the naked eye.
- Using experimentation and mathematical analysis, we are able to reveal properties of cosmic rays, such as their mean lifetimes.

REFERENCES

- Data from QuarkNet made possible by the National Science Foundation https://quarknet.org/
- Nuclear Physics Lab http://www.nuclearphysicslab.com/npl/npl-home/experiments/muons/muon-lifeti me-measurment/
- NASA https://www.nasa.gov
- On Heaven https://onheaven.co.in
- Make: Magazine https://makezine.com/projects/123-cosmic-ray-detector/

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