

# DECO: The Distributed Electronic Cosmic-ray Observatory

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## Introduction

Cosmic rays are energetic subatomic particles produced by astrophysical particle accelerators (such as black holes and exploding stars) in space. When they hit the top of the atmosphere, they produce showers of secondary particles including muons (a muon is a heavy version of an electron). The atmosphere absorbs some muons, but many travel all the way through the atmosphere to reach the ground. At high elevation, such as in mountains or on an airplane, the rate of these cosmic-ray muons is greater than at sea level.

Digital camera sensors (both CCD and CMOS technology) work through the photoelectric effect: when photons hit the semiconductor, electrons (charge) are liberated. Similar to photons, when cosmic-ray muons hit a camera image sensor, they also liberate charge. In this way, digital cameras can be used to detect cosmic-ray muons. In particular, camera sensors in cell phones can be used as radiation detectors, both for cosmic-ray muons and for other types of particles such as electrons and alpha particles (helium nuclei) produced by the decay of radioactive elements that occur naturally in the environment.

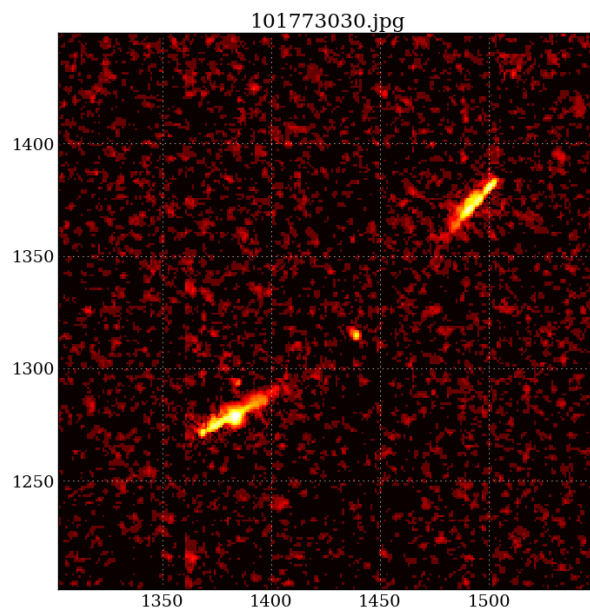
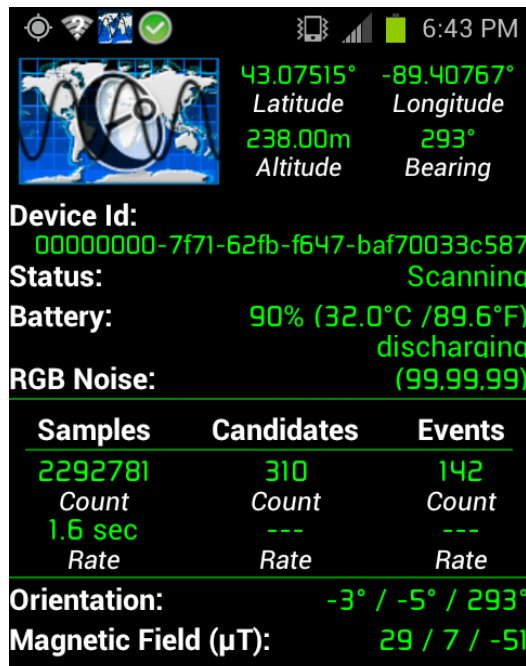


Figure 1. Left: screen shot of the DECO app. Right: Example event recorded by the DECO app. This particular event has an interesting and so far unexplained topology. The axes are in units of pixels. A high school student in the UW Madison internship program found this event in the database.

## The DECO app

DECO is a cosmic-ray detector app that runs on Android OS (an iOS version is in development). Figure 1 shows a screen shot of the DECO app, as well as an example DECO event.

DECO works by recording a camera image once every 1-2 seconds (the average rate is displayed by the app). Each image is called a *sample*. The app analyzes a low-resolution version of the image to determine if there are several bright pixels. If there are, the sample is considered a *candidate*. With candidate images, the app repeats the analysis on a higher-resolution version of the image. If there are sufficiently many hit pixels found in the higher resolution image, the candidate is considered an *event*. The app displays the total number of samples, candidates, and events it has recorded.

DECO is part of the Global Sensor Web, a framework for collecting data from distributed sensors. The DECO data are automatically synchronized to a central database by the data logger app.

DECO data can be downloaded in this data repository  
<http://wipac.wisc.edu/deco/data>.

## Installation

You need two apps to run DECO (one for detecting particles in camera images and one for logging the data). You can download them both at  
<http://wipac.wisc.edu/deco>

## Usage

It is important to keep the camera lens covered, in order to minimize background light. A good way to do this is with dark tape such as electrical tape. The phone can be in any orientation, however it is easiest to keep it dark if the screen faces up (with the main camera facing down) on a flat surface.

Muons can penetrate through roofs and walls, so it does not matter if the phone is inside or outside, near a window or not, or on the top floor or bottom floor.

Because cell phone camera image sensors are small (only a dozen or so square millimeters), the rate of detected events is low. The exact rate depends on the model of phone, camera image sensor, and camera configuration, but is typically several events per 24 hours of running. Because of this, it is best to run the app for many hours. This is easiest overnight or if you have an old phone you can leave running for a long time.

## E-mail list (google group)

Please join for news (including future Android and iOS releases and curriculum for teachers), announcements, and discussion:

<https://groups.google.com/forum/#!forum/deco-users>

## Beta development and feedback

The app is still in development. If you have any bug reports or questions/comments/suggestions about the app, please let us know!