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Title: Exploring Gamma-Ray and Neutron Spectroscopy Missions to Mars Caves

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# Exploring Gamma-Ray and Neutron Spectroscopy Missions to Mars Caves

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# Agenda

01

## Background

- Review of project conception, GRNS, and Mars caves

02

## Project Overview

- Big-picture look at the project and relevant questions

03

## Results

- Description of simulation setup and configuration
- Overview of results

04

## Conclusions + Future Work

- Summary of conclusions and next steps
- Description of future work

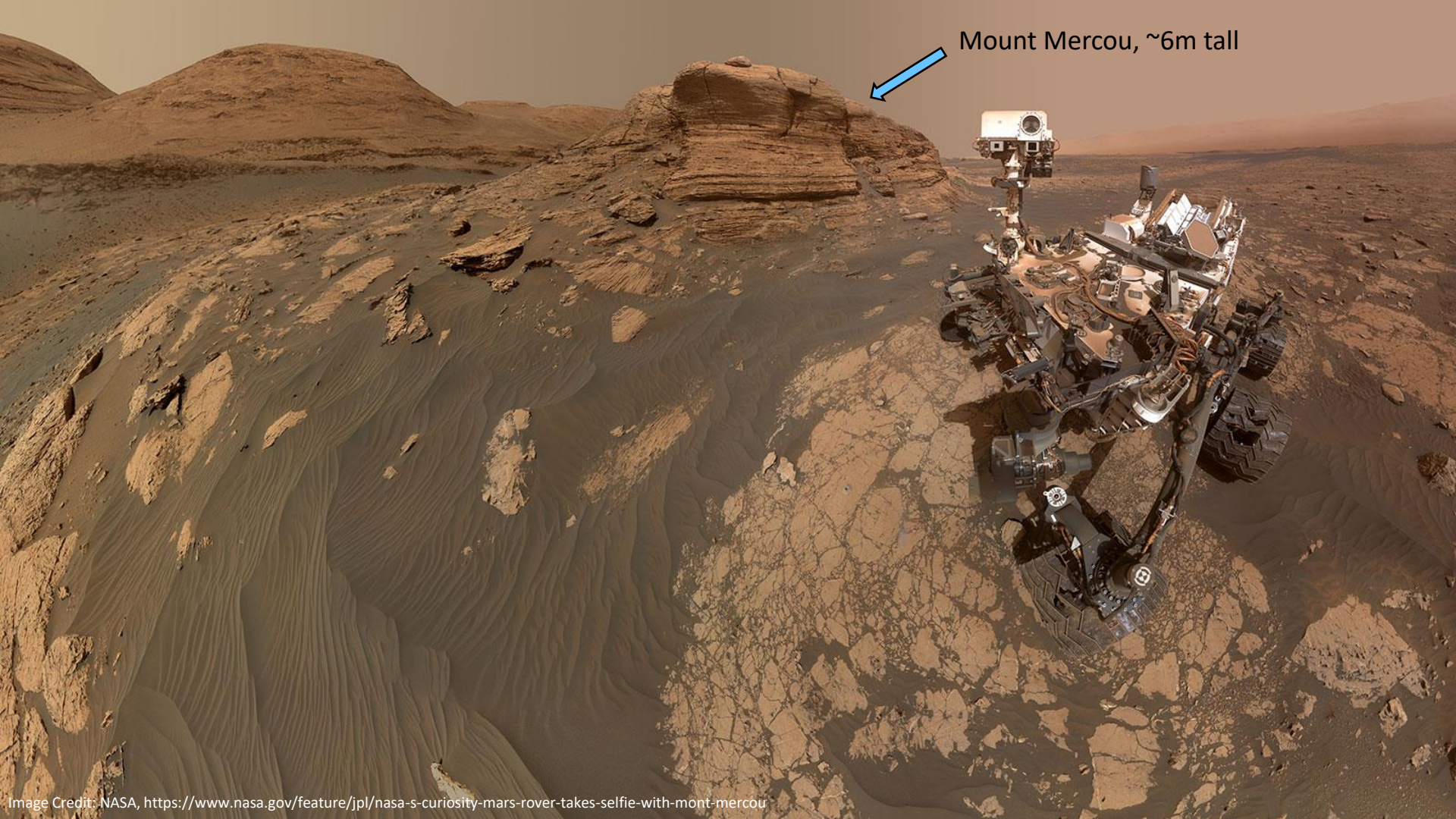



Image Credit: NASA, https://www.nasa.gov/feature/jpl/nasa-s-curiosity-mars-rover-takes-selfie-with-mont-mercou

# Background

- Mars Caves
  - Collapse chains → subsurface caves[1]
  - Good candidates for habitability?
    - Potential to host water resources
    - Shielded from radiation

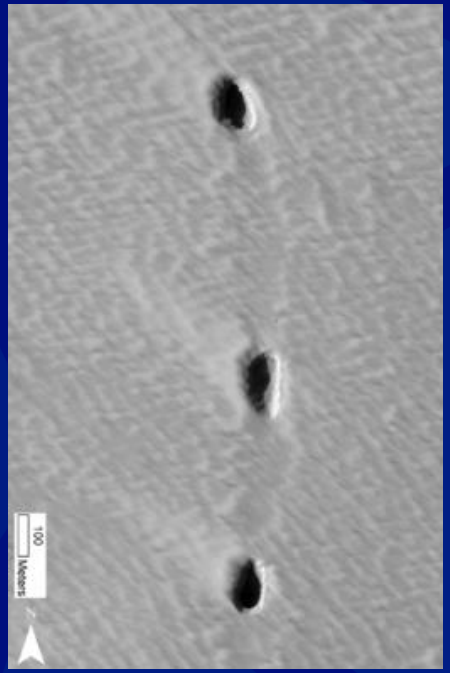



Image credit: Sauro, F., et al. (2020) Supplement

[1]Sauro, F., et al. (2020). Lava tubes on Earth, Moon and Mars: A review on their size and morphology revealed by comparative planetology. *Earth-Science Reviews.* https://doi.org/10.1016/j.earscirev.2020.103288

# Project Overview

- **What:** Investigating the sensitivity of active neutron detector systems in Mars caves

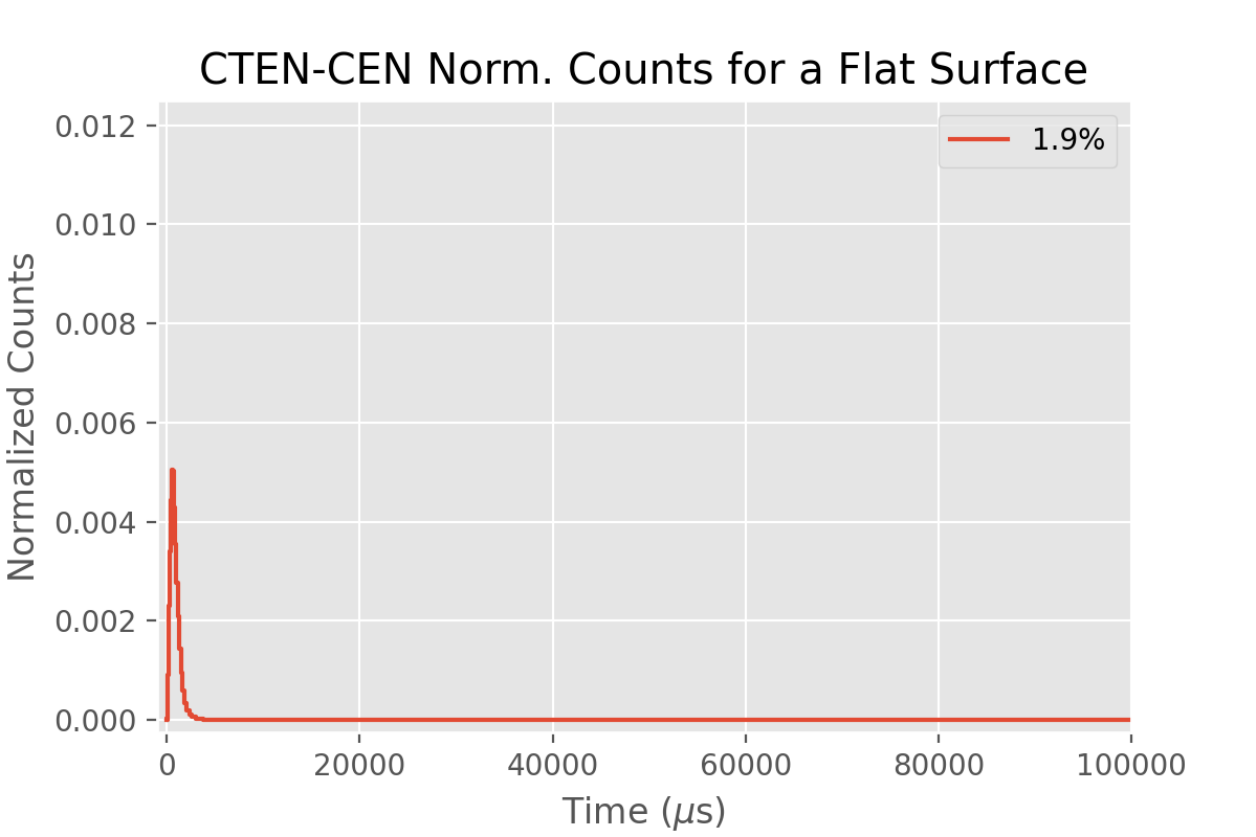
- **How:** Using MCNP6 to model neutron transport in different cave geometries, compositions, and detectors

- **Why:** To determine if active neutron measurements can be used to identify the hydration of cave walls vs floor vs ceilings, and to perform a concept study for potential future Mars cave missions in search of hydration and habitable regions

# Results: Detectors on the Surface

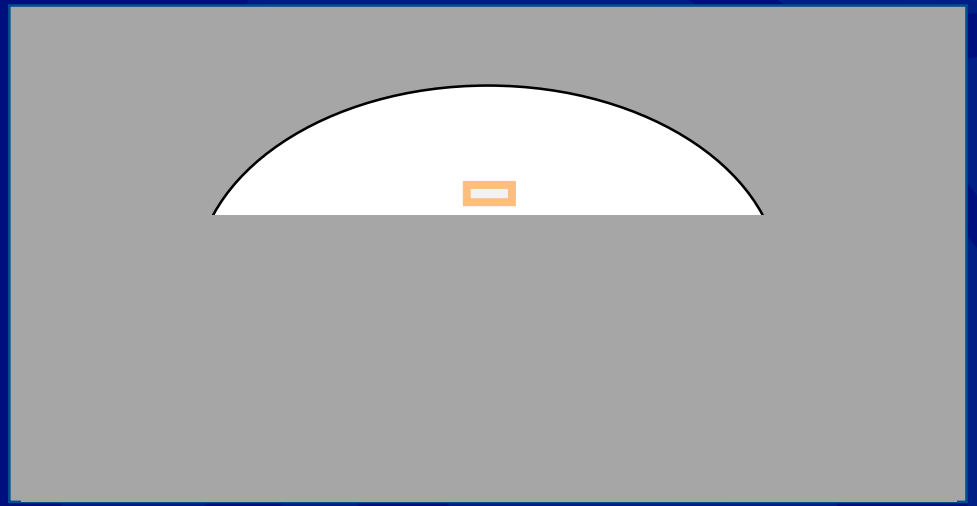
- Box of air
  - Basic Mars atmosphere composition
- Box of planetary material
  - Crust+Mantle Mixture (Taylor, 2013)
- Detectors
  - Maintain same position from Curiosity model
  - Center of surface box

# Results: Detectors on the Surface



# Results: Simple Cave Model

- Geometry:
  - Hemisphere
- Composition:
  - Crust+Mantle mixture (Taylor, 2013)
  - Surrounding material is uniform
- Detectors:
  - Location varies (approaches wall)



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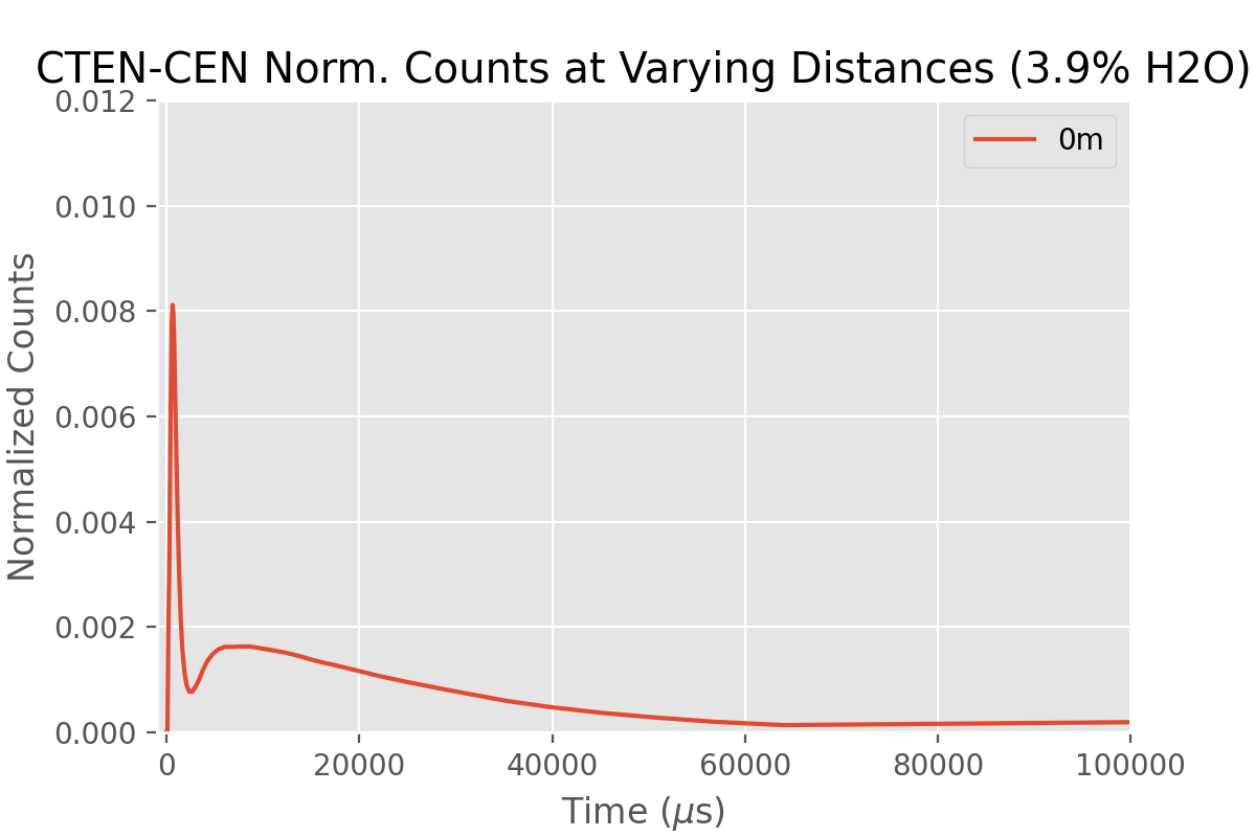
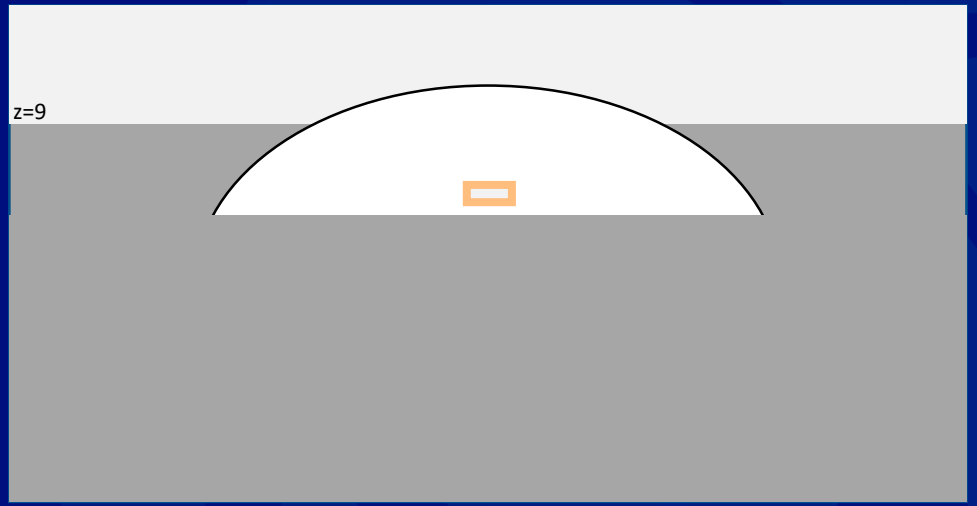


# Results: Ceiling H2O Content Varies (z=9)

- How does detector response change when only the top few meters of the cave ceiling change in composition?



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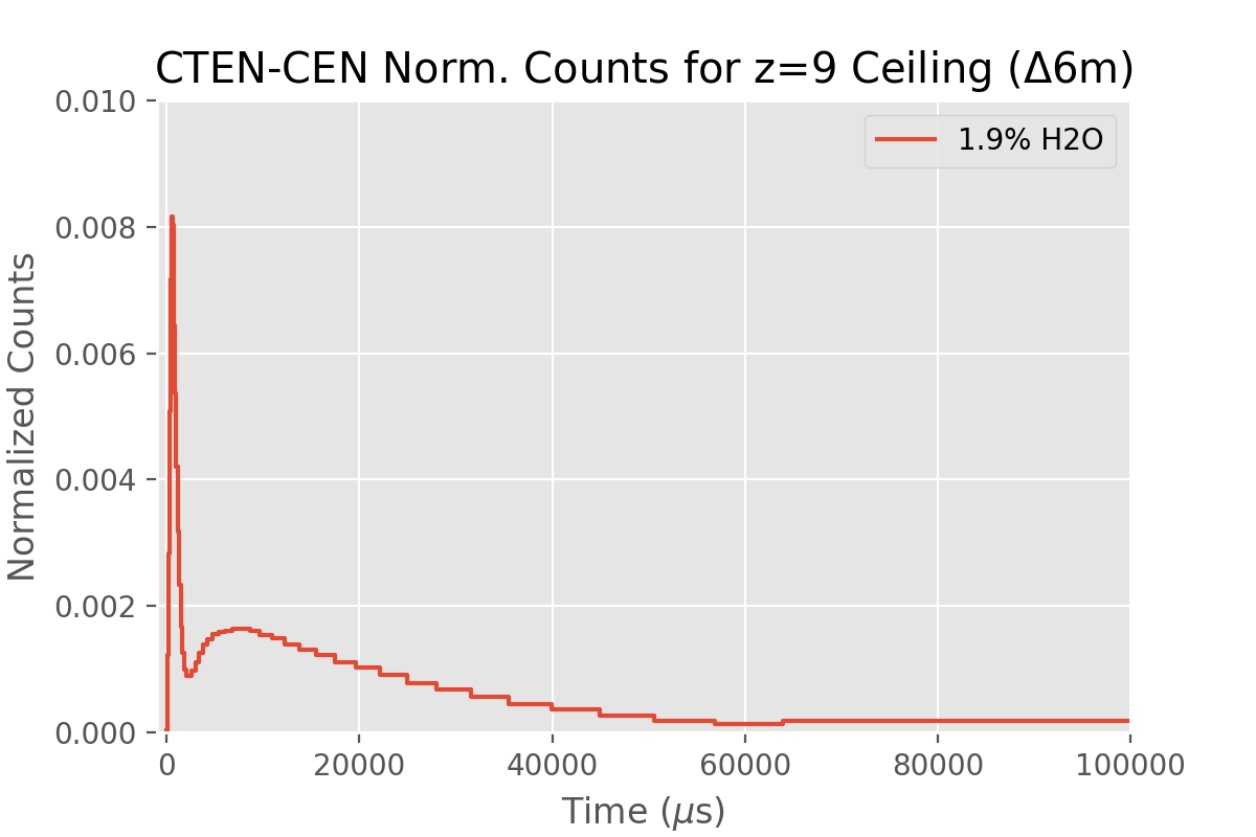
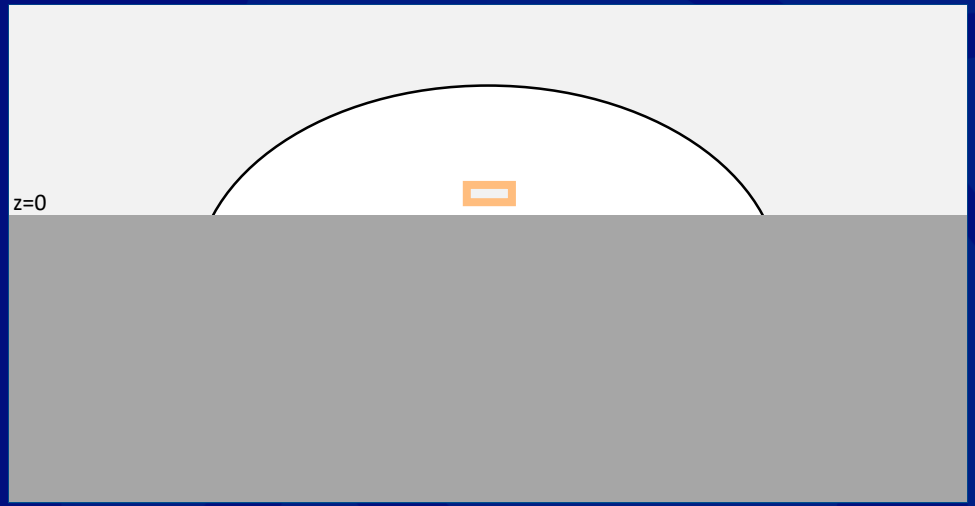


# Results: Ceiling H2O Content Varies (z=0)

- How does detector response change when the ceiling is defined as everything above z=0?



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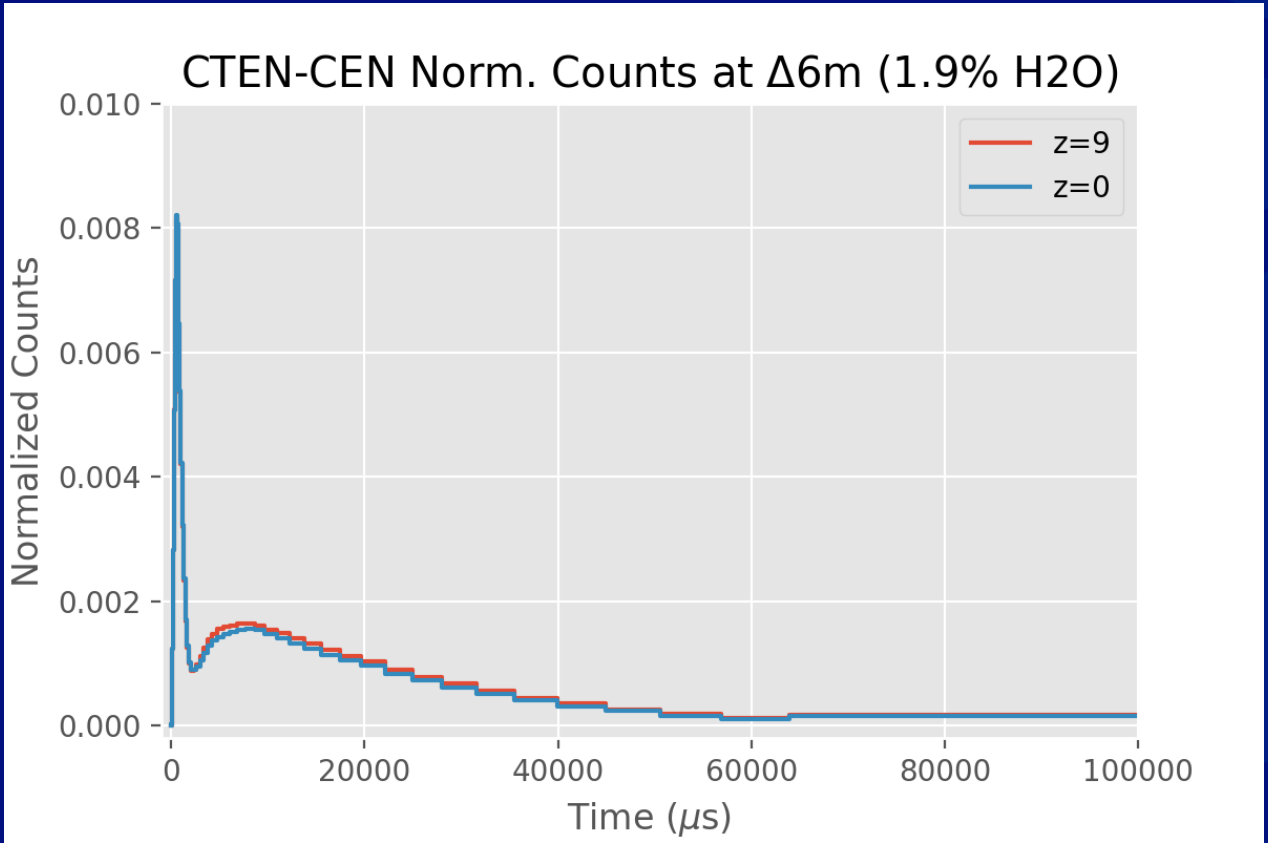

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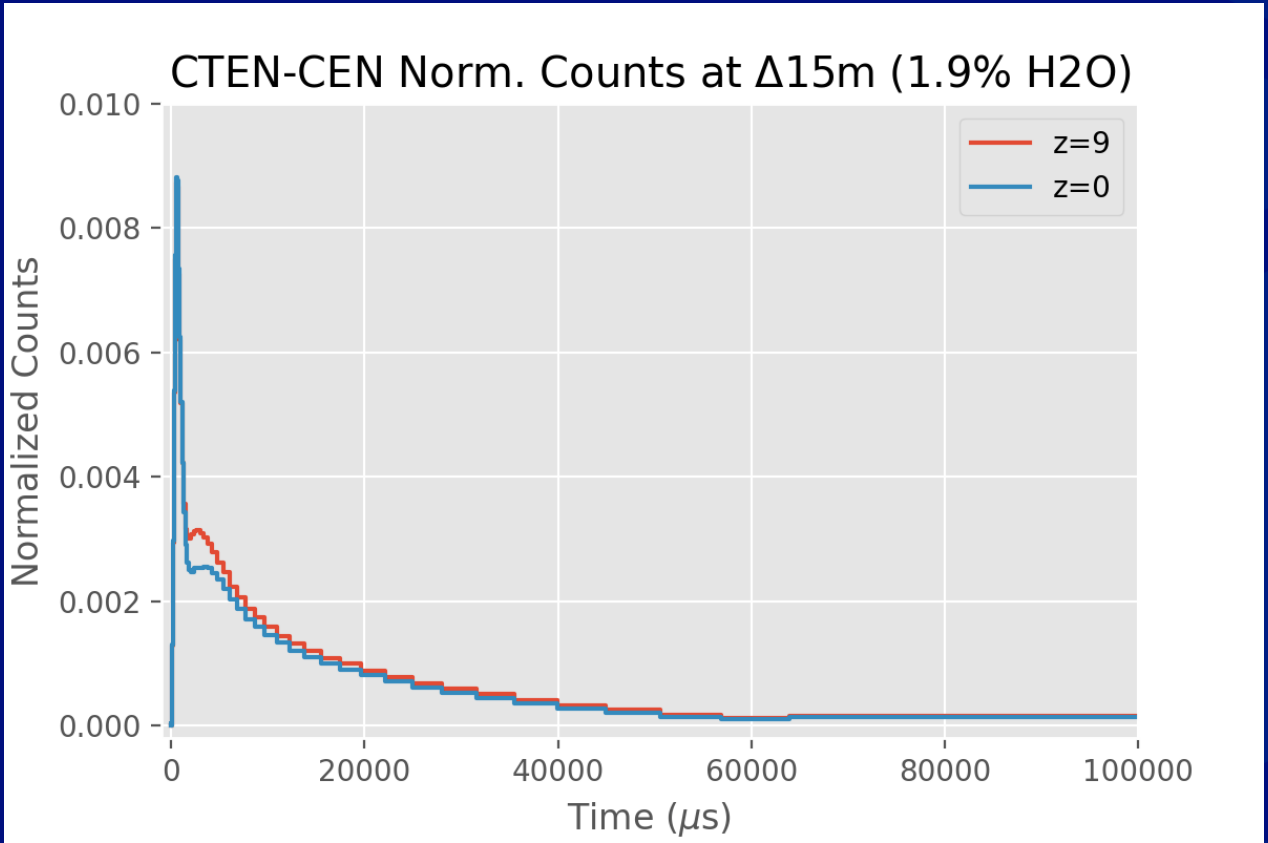
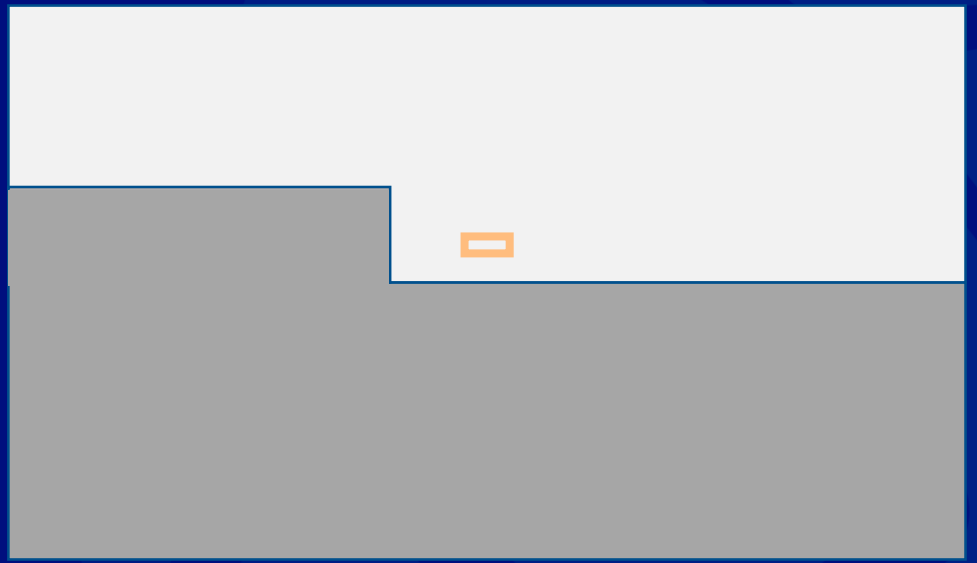


# Results: Detectors on the Surface Near a Wall

- Wall added to surface model
  - 5m away, 6m tall



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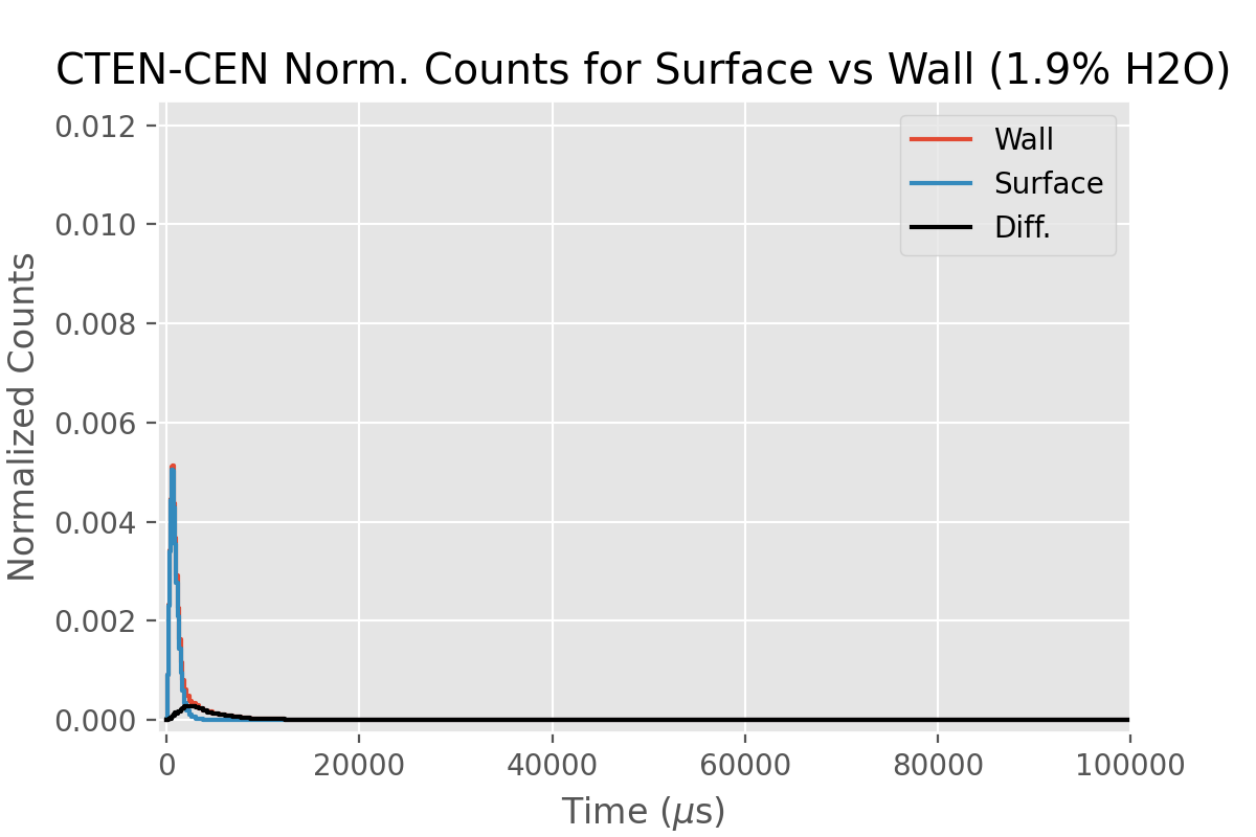

# Conclusions

- Initial results show that later time bins hold valuable information that allows us to discriminate between the ceiling and the wall of the cave
  - Particularly sensitive to composition and distance

- Immediate next steps:
  - Finish varying ceiling height runs
  - Explore and quantify the contribution of the wall to the cave response by varying detector distance on the surface
  - Look for possible second peak in real DAN data

# Future Work

- Change the model geometry (steeper walls?)
- Change the detectors
- Acquire real data
  - BRAILLE team but with GRNS!

Image Credit: NASA, https://www.nasa.gov/feature/ames/braille