


# COSMIC MAXIMUS!

## Using a Scintillator Counter to Evaluate the Sun's Contribution to Cosmic Radiation

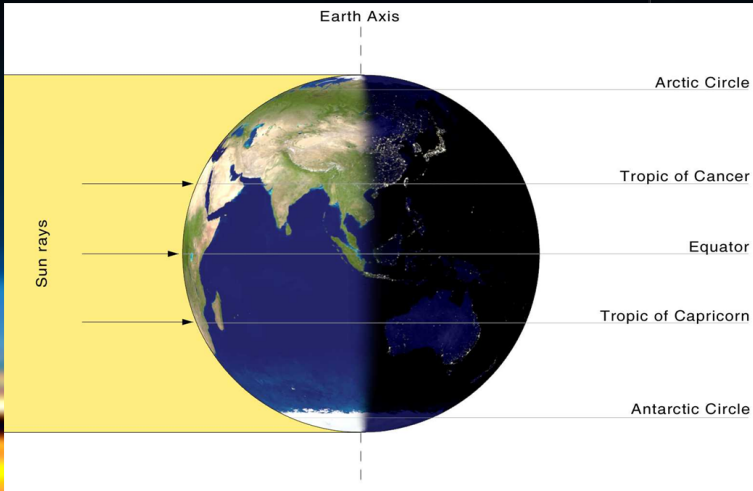
A Simple Study Conducted as Part of the PAN Project held at the NSCL of the Michigan State University July 30 - August 3, 2012  
William Heeren

Partners... James Harvey and Manju Prakash



Aug 7-1:13 PM

**To Be Tested...** If the Sun contributes a large fraction of the cosmic radiation, then cosmic radiation levels should be higher during the day than at night.

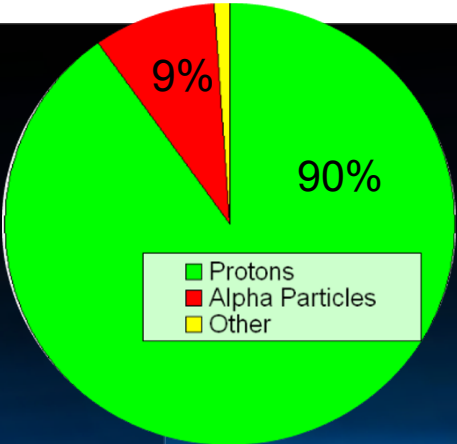


<http://scienceblogs.com/startswithabang/2010/03/21/weekend-diversion-a-little-sun/>

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Background

- Particles from
  - the Sun
  - Various Supernova
  - Other Extraterrestrial Sources
- Traveling at very high speeds
- Constantly raining down on Earth's surface



Particle Type	Percentage
Protons	90%
Alpha Particles	9%
Other	1%

- Rarely does primary cosmic radiation reach the Earth's surface

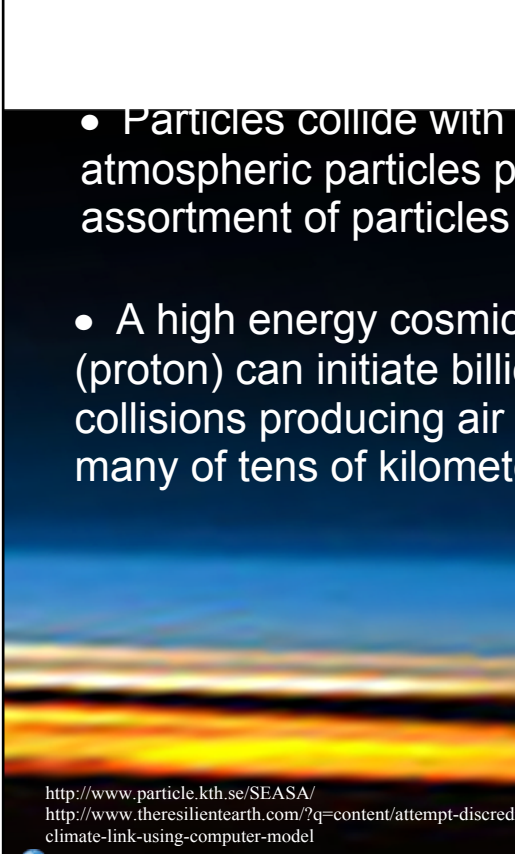
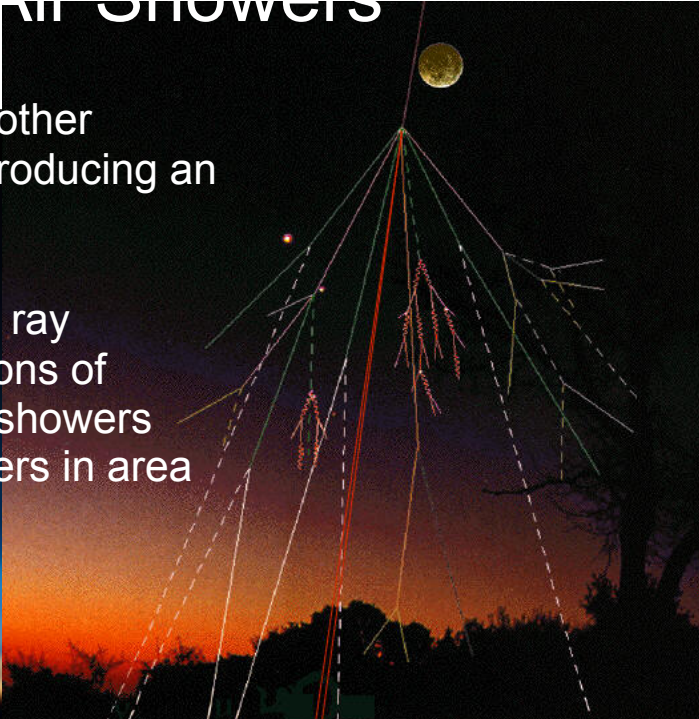


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Background

### AIR SHOWERS

- Particles collide with other atmospheric particles producing an assortment of particles
- A high energy cosmic ray (proton) can initiate billions of collisions producing air showers many of tens of kilometers in area



<http://www.particle.kth.se/SEASA/>  
<http://www.theresilientearth.com/?q=content/attempt-discredit-cosmic-ray-climate-link-using-computer-model>

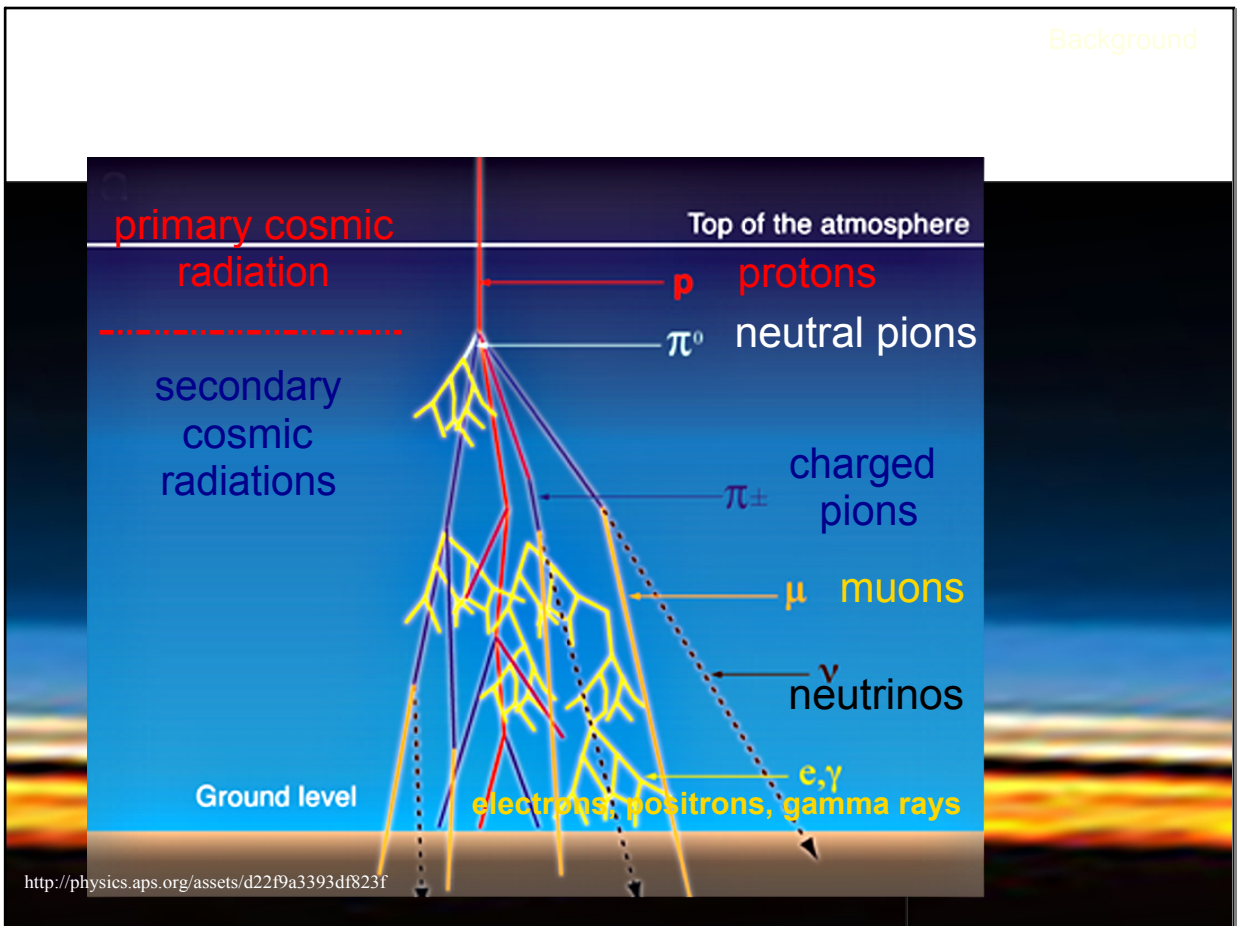
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Background

$$n + {}^{14}\text{N} \rightarrow p + {}^{14}\text{C} \quad \text{Formation of C-14}$$
$${}^{14}\text{N} + n \rightarrow {}^{12}\text{C} + 3\text{T} \quad \text{Formation of tritium (H-3)}$$
$${}^{16}\text{O} + n \rightarrow {}^{10}\text{Be} + {}^4\alpha + 2{}^1\text{p} + n \quad \text{Formation of Be-10}$$

<http://www.particle.kth.se/SEASA/>  
<http://www.theresilientearth.com/?q=content/attempt-discredit-cosmic-ray-climate-link-using-computer-m>  
[http://en.wikipedia.org/wiki/Cosmic\\_rayodel](http://en.wikipedia.org/wiki/Cosmic_rayodel)

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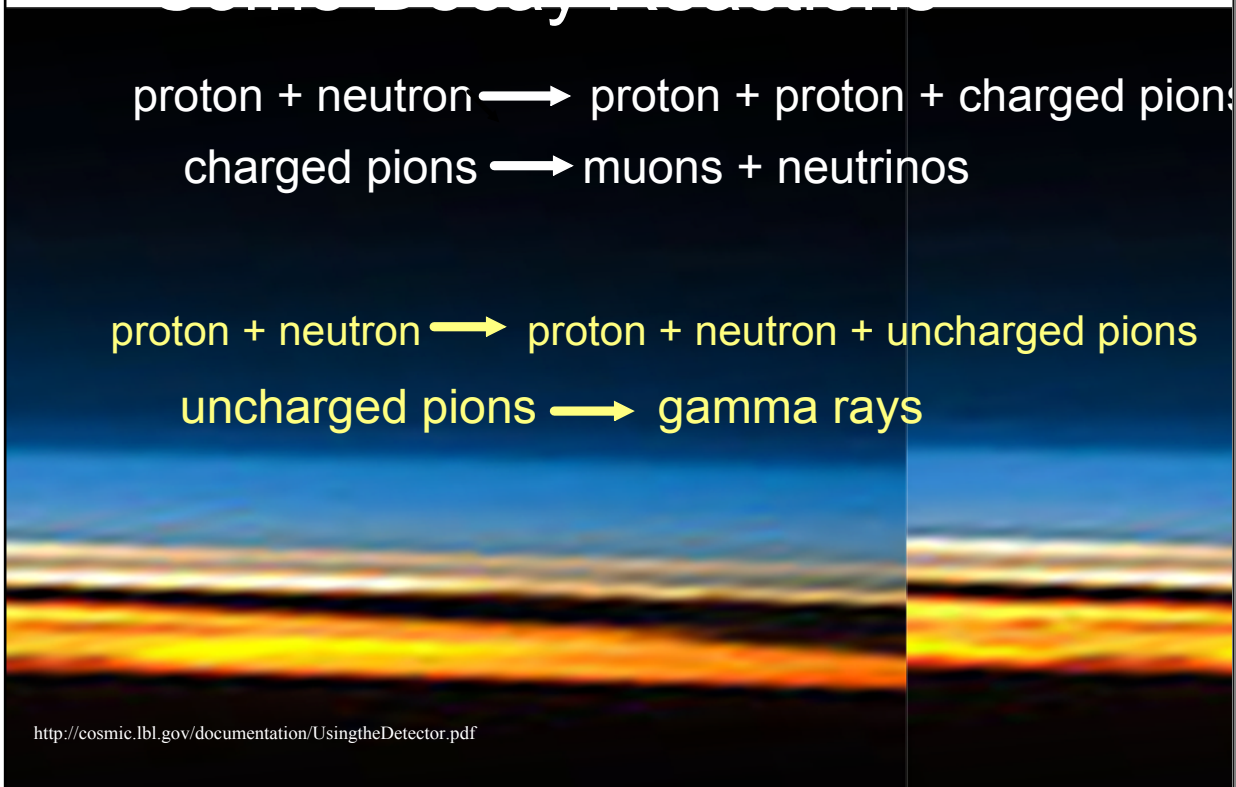
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Background

proton + neutron  $\longrightarrow$  proton + proton + charged pions  
 charged pions  $\longrightarrow$  muons + neutrinos

proton + neutron  $\longrightarrow$  proton + neutron + uncharged pions  
 uncharged pions  $\longrightarrow$  gamma rays

<http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf>



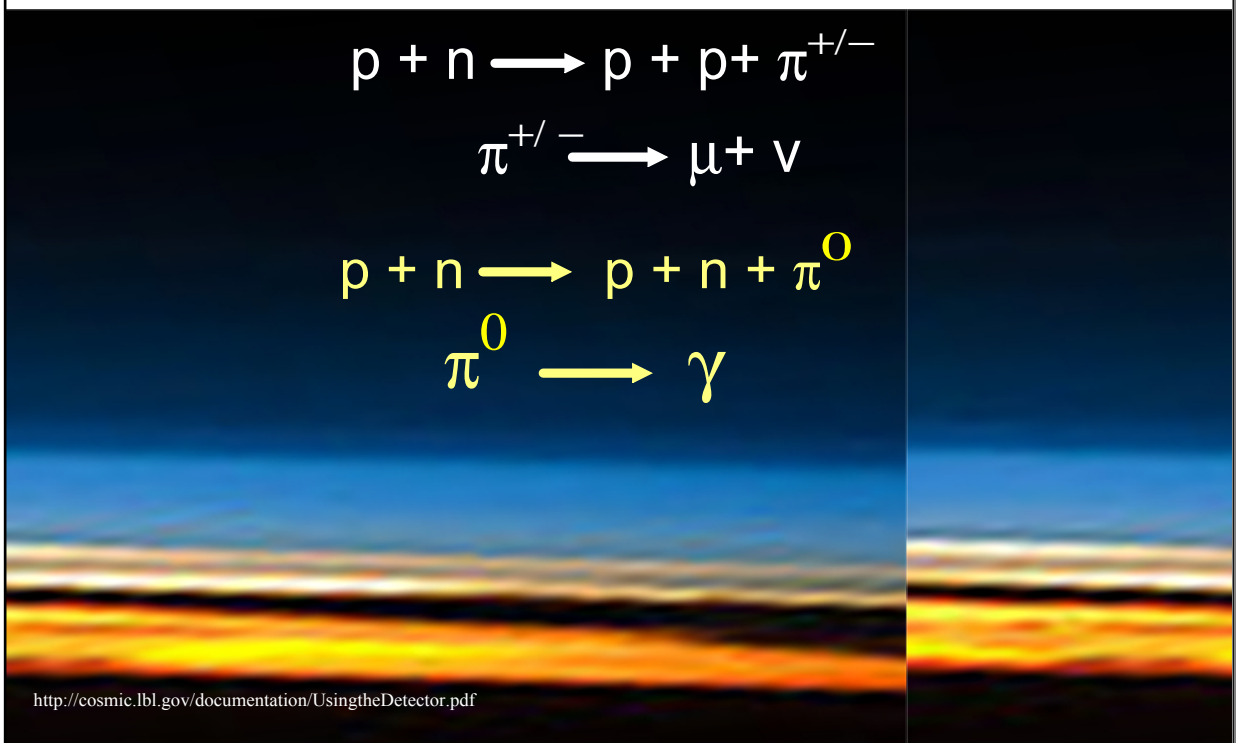
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Background

$p + n \longrightarrow p + p + \pi^{+/-}$   
 $\pi^{+/-} \longrightarrow \mu + \nu$

$p + n \longrightarrow p + n + \pi^0$   
 $\pi^0 \longrightarrow \gamma$

<http://cosmic.lbl.gov/documentation/UsingtheDetector.pdf>



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Background

## Some Decay Reactions

muons<sup>-</sup> → electrons + antielectron neutrinos + muon neutrinos

$$\mu^{-} \longrightarrow e^{-} + \bar{\nu}_e + \nu_{\mu}$$

Muons are the usual form of cosmic radiation that reaches the Earth

[http://en.wikipedia.org/wiki/Muon#Muon\\_decay](http://en.wikipedia.org/wiki/Muon#Muon_decay)

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Background

Particle	Lifetime(seconds)	Composition
neutron	881.5	3 quarks (1 up and two down quarks)
pion	$2.6 \times 10^{-8}$	2 quarks (up or down quark and an anti up or down quark)
muons	$2.2 \times 10^{-6}$	Elementary particle

Muons are the usual form of cosmic radiation that reaches the Earth

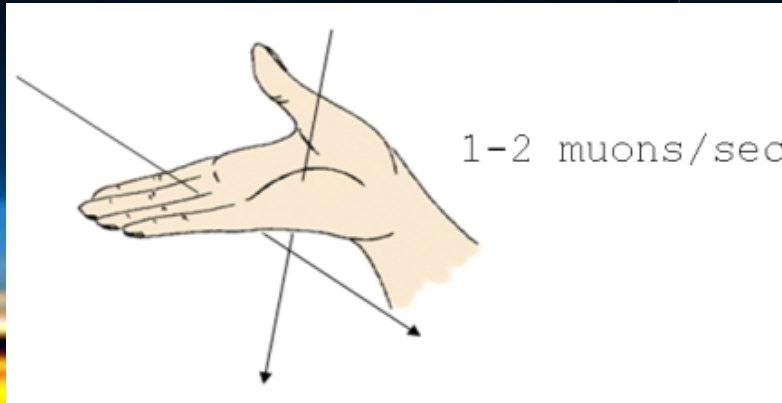
[http://en.wikipedia.org/wiki/Muon#Muon\\_decay](http://en.wikipedia.org/wiki/Muon#Muon_decay)

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Background

# INCIDENCE

At the Earth's surface, a rough estimate is that in one second there are 1-2 muons passing through your hand



[http://www18.i2u2.org/cosmic/library/upload/3/3f/6000CRMD\\_How\\_to\\_Plateau.ppt](http://www18.i2u2.org/cosmic/library/upload/3/3f/6000CRMD_How_to_Plateau.ppt)

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Background

# DETECTION

On a large scale, cosmic air showers can be measured by arrays of detectors placed strategically at different parts of the Earth's surface



<http://www.particle.kth.se/SEASA/rain>

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Background

# Detection

On a small scale, the rate, direction and energy of cosmic radiation can be measured by using a cosmic ray detector such as this...

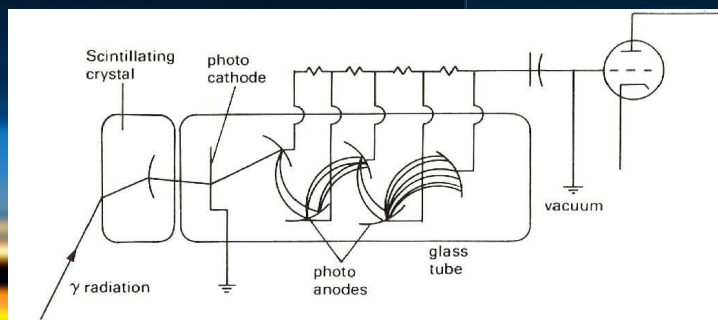
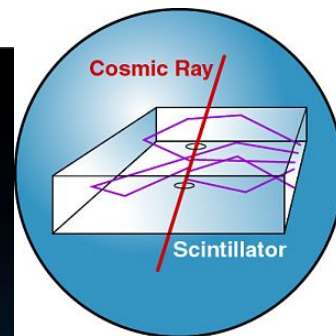


<http://cosmic.lbl.gov/documentation/CosmicDetector2-0.pdf>

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Background

Charged cosmic rays excite atoms in scintillator panels, (often Plastic Lucite panels) causing the atoms to emit light. The light is directed to photomultiplier tubes which amplify the signal.

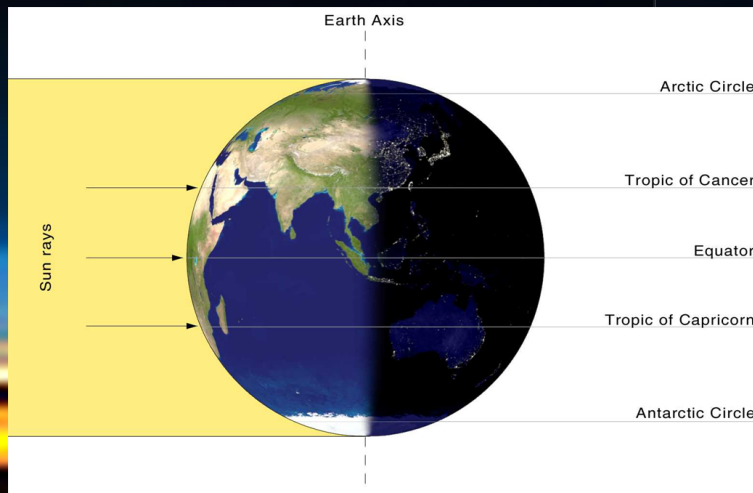


<http://durpdg.dur.ac.uk/vvc/cosmicrays/images/scintillator2.jpg>  
<http://2.bp.blogspot.com/-nLZZa77B8S7/1giiH4EK1/AAAAAAAAAAWw/14-Rxy1Ys1600/scintillation-chamber.JPG>

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The Test

**To Be Tested...** If the Sun contributes a large fraction of the cosmic radiation, then cosmic radiation levels should be higher during the day than at night.



<http://scienceblogs.com/startswithabang/2010/03/21/weekend-diversion-a-little-sun/>

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The Test

- Using a Scintillator Counter, take three different sets of cosmic radiation data: at 9:00PM, 5:00AM, 1:00PM
- Several three minute test samples will be taken during each interval.



View from the test site



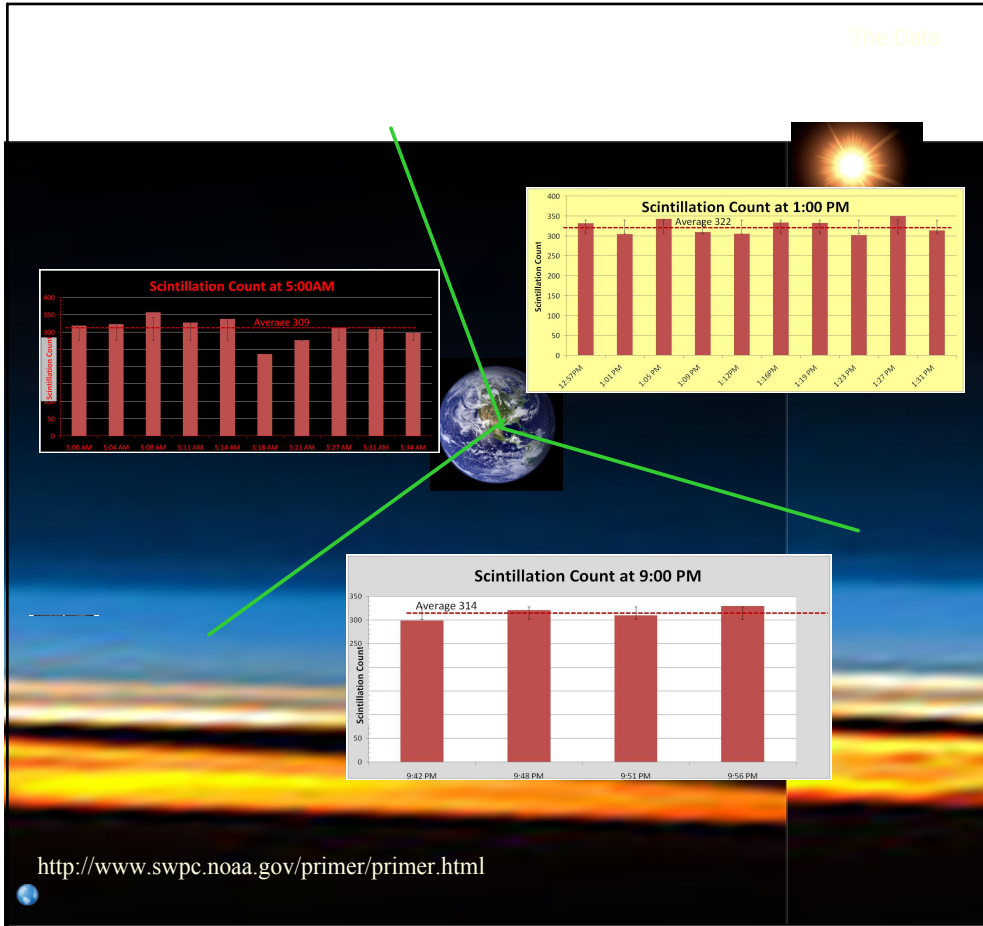
The Scintillator Counter



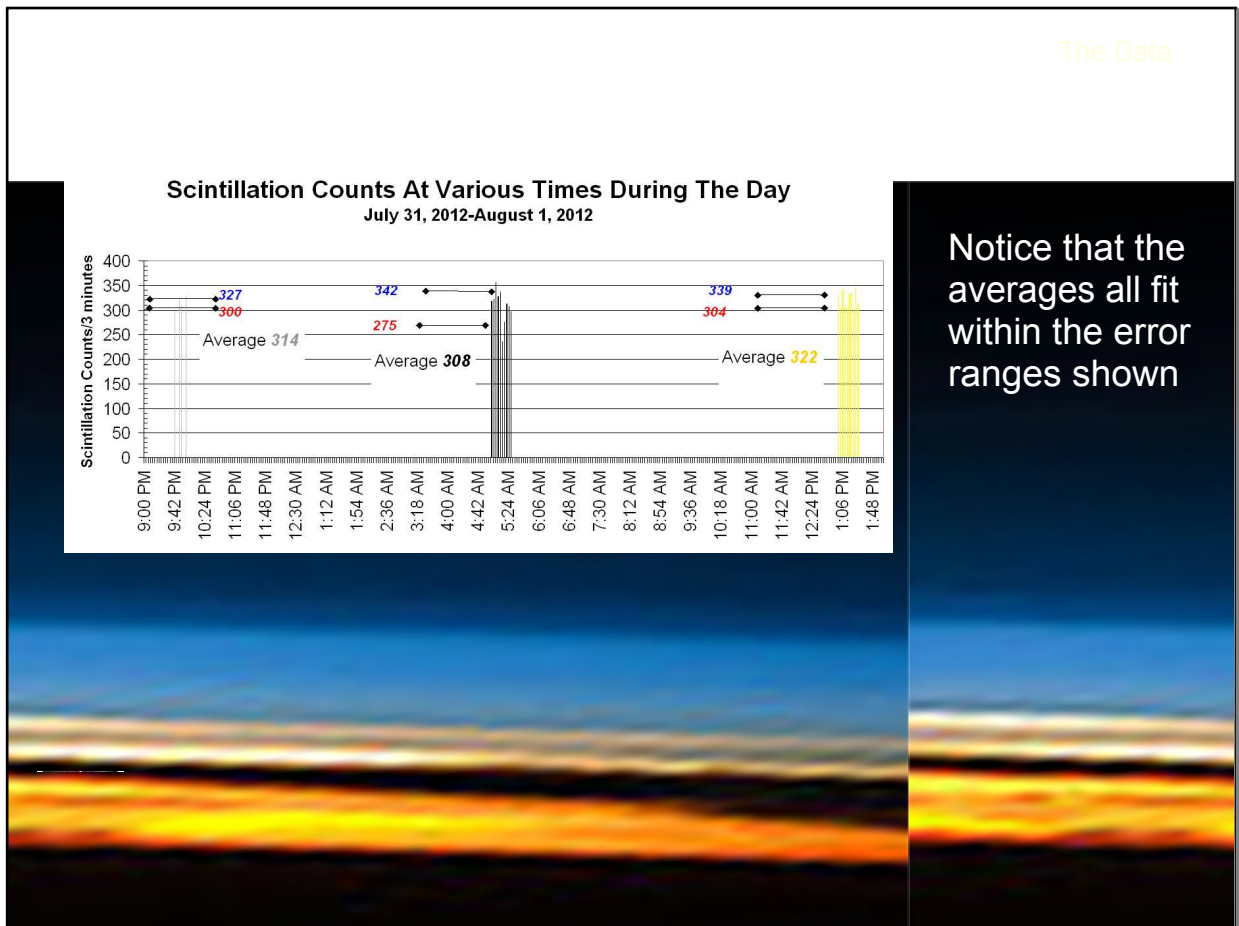
View of one of the scintillating panels wrapped in aluminum foil

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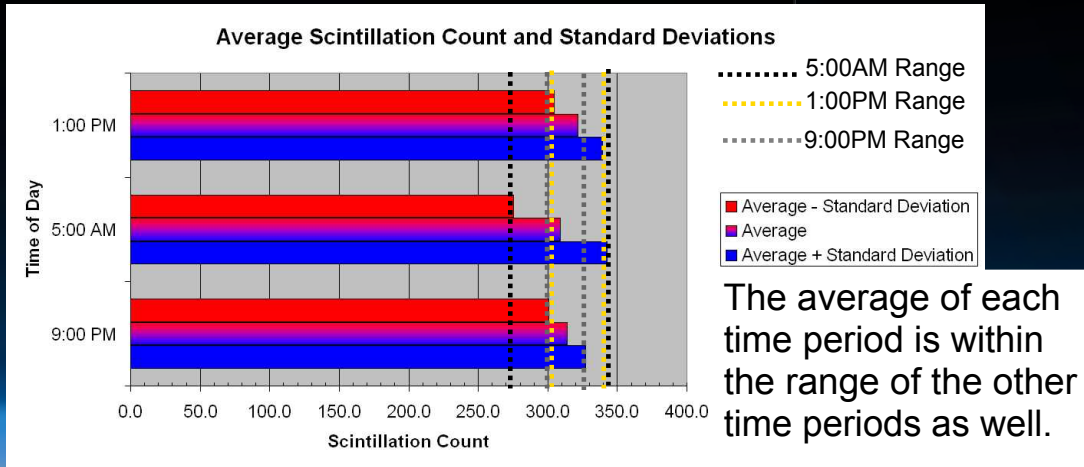


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Analysis



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Conclusion

cannot

radiation levels are higher during the day than they are during the night. This agrees with other sources that suggest very little (0.2% Blanco, et. al.) differences exist between the amounts of cosmic radiation reaching the Earth at various times of the day.



<http://www.eurekalert.org/multimedia/pub/2413.php?from=86777>  
[http://oldweb.et.infn.it/~rivel/cosmic/Documents/Publications/NOVA\\_Publisher.pdf](http://oldweb.et.infn.it/~rivel/cosmic/Documents/Publications/NOVA_Publisher.pdf)

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**The End...**  
(A Supernova has occurred.... :-)

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