

Auger North:

The science behind why this proposed
cosmic ray observatory is right for Kansas



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Telescope:

Galileo was the first to use a telescope to study the moon, Jupiter and the stars.

Galileo's telescope is what is considered the traditional concept of the telescope.



Telescope

Some famous telescopes and Observatories are:

- Hubble
- Hawaii Observatory

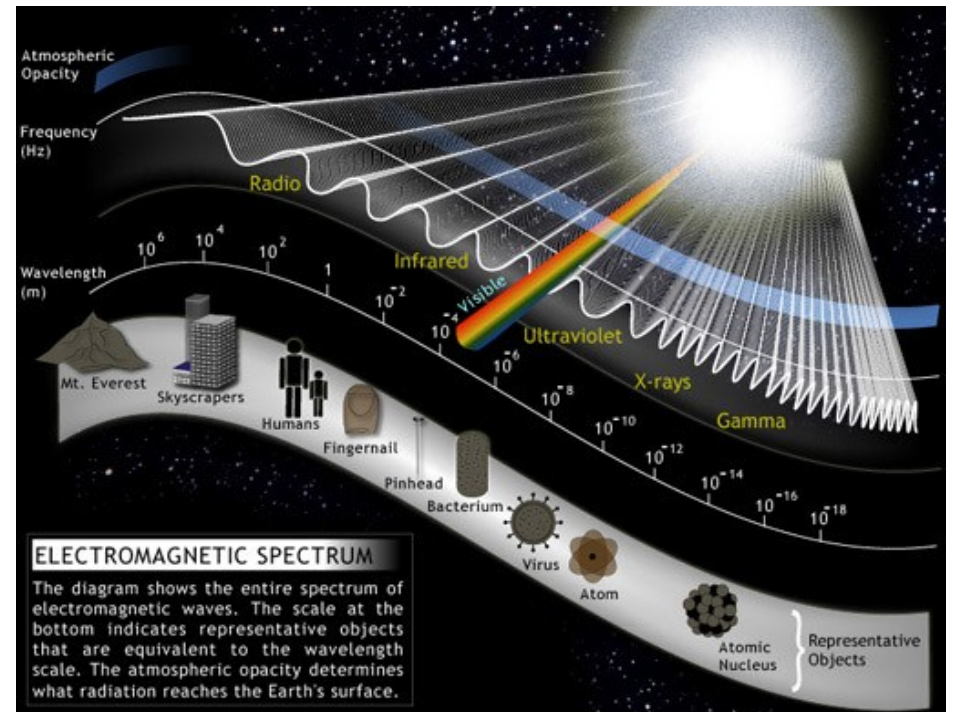


Telescope

Visible light is a very small part of what can be observed.

More information is contained outside of the visible range, and is of great scientific value.

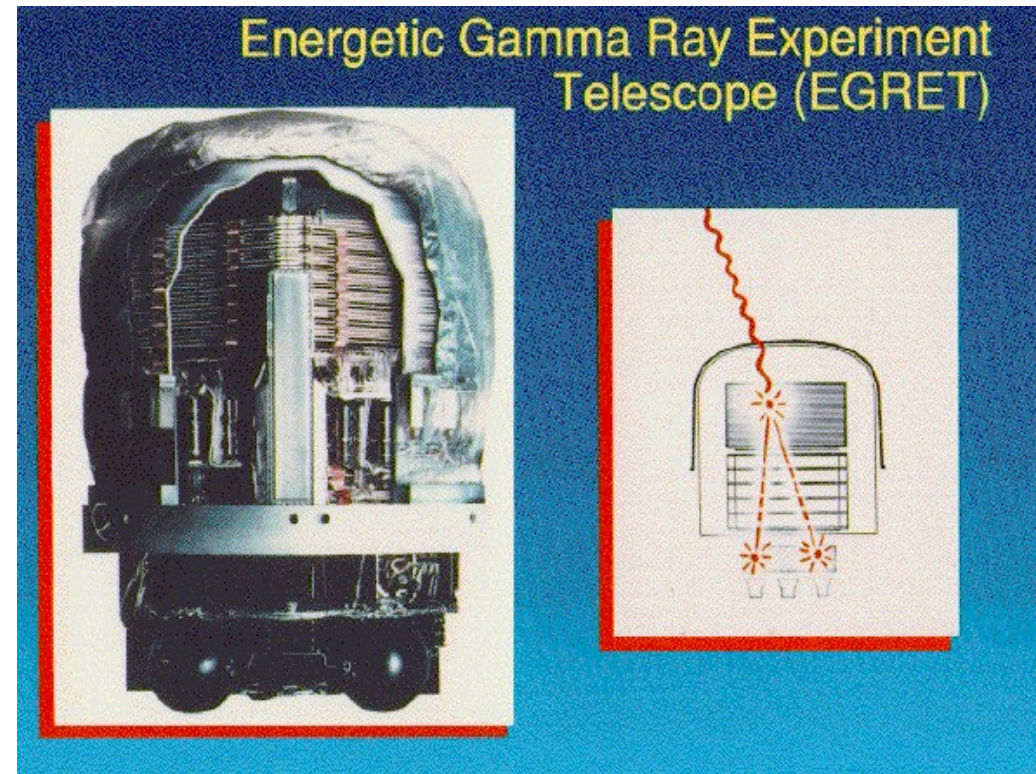
Optical telescopes cannot be used to study all of this.



Telescope

Not all telescopes look like the traditional optical telescope.

The first gamma-ray telescope looked more like a nuclear-physics experiment with a spark chamber.



Telescope

Today there are many different specialized telescopes doing different types of research:

- Hubble, visible light
- Chandra, X-ray
- James Webb, Infra-red
- Fermi Gamma ray

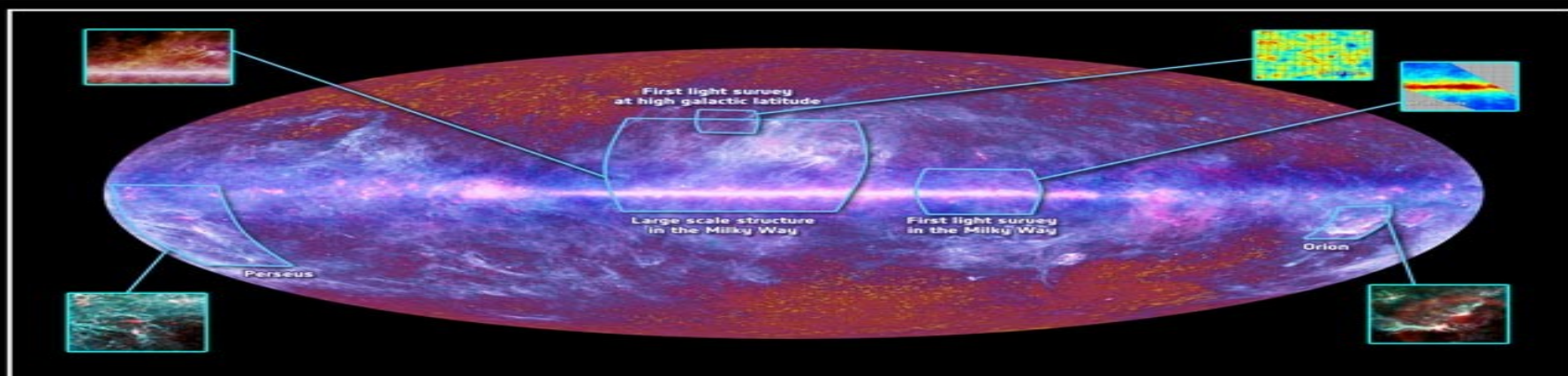
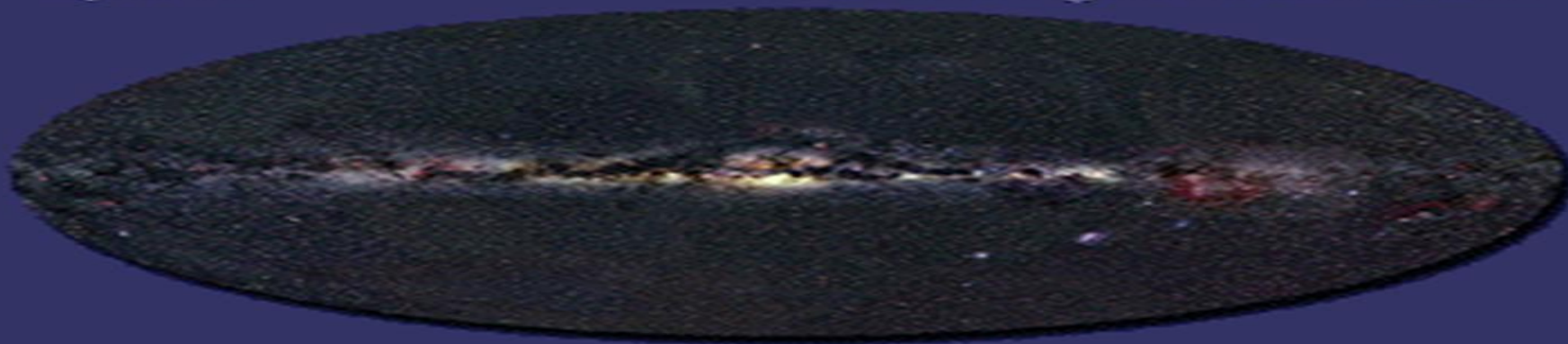
All of these study the Universe with photons.



Sky at night

Optical

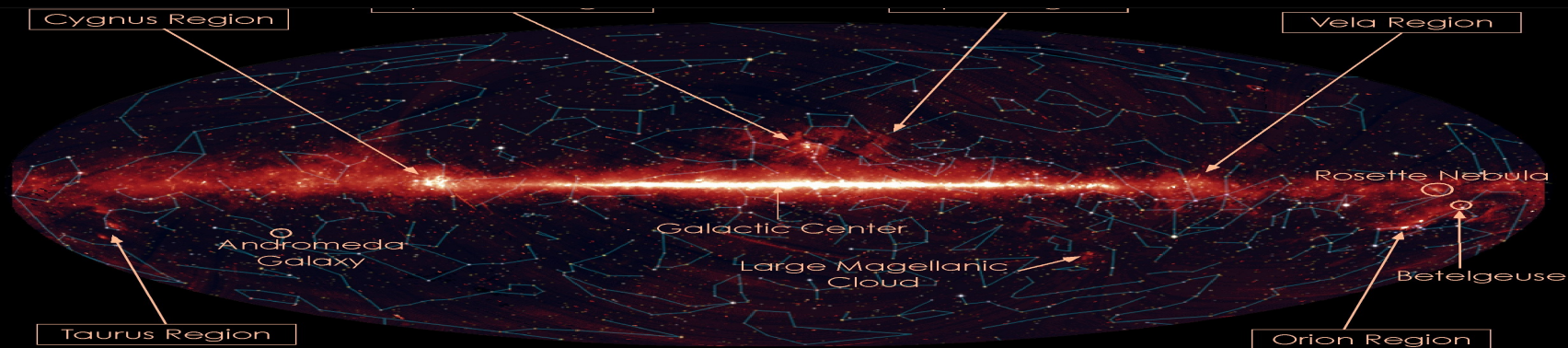
A. Mellinger Photomosaic



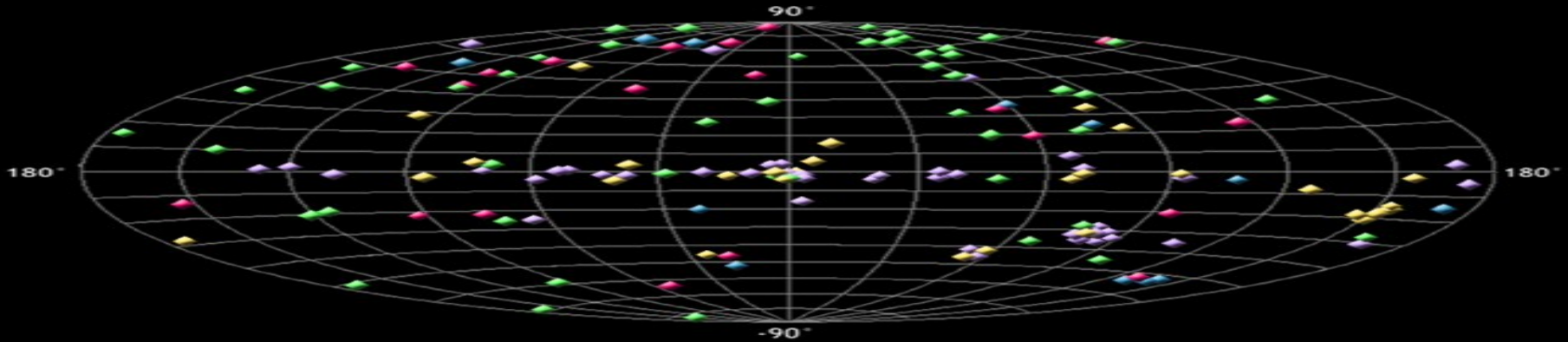
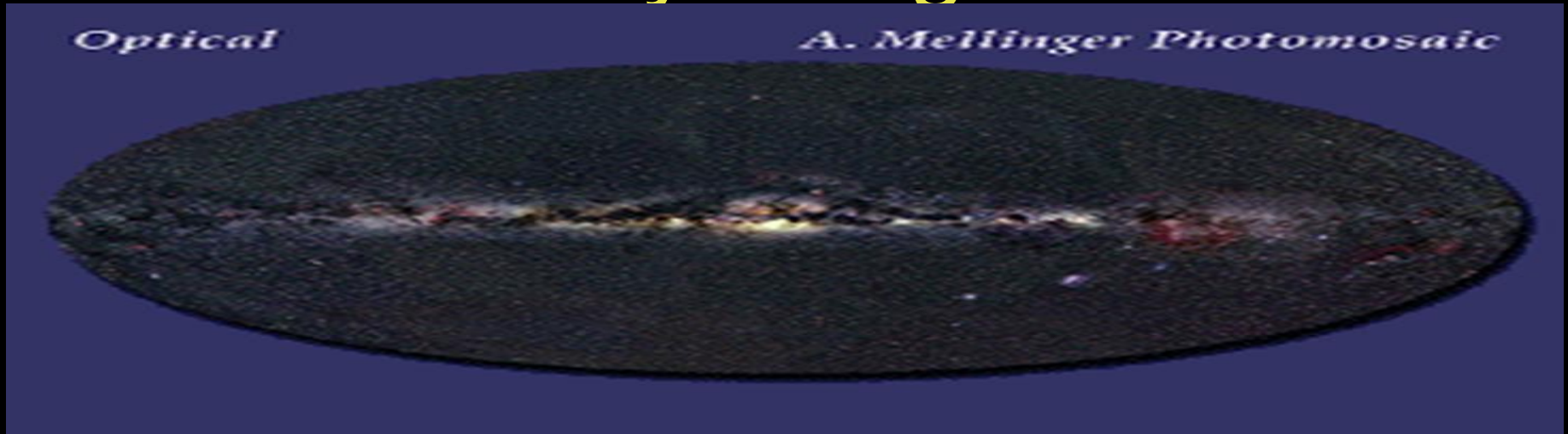
The Planck one-year all-sky survey



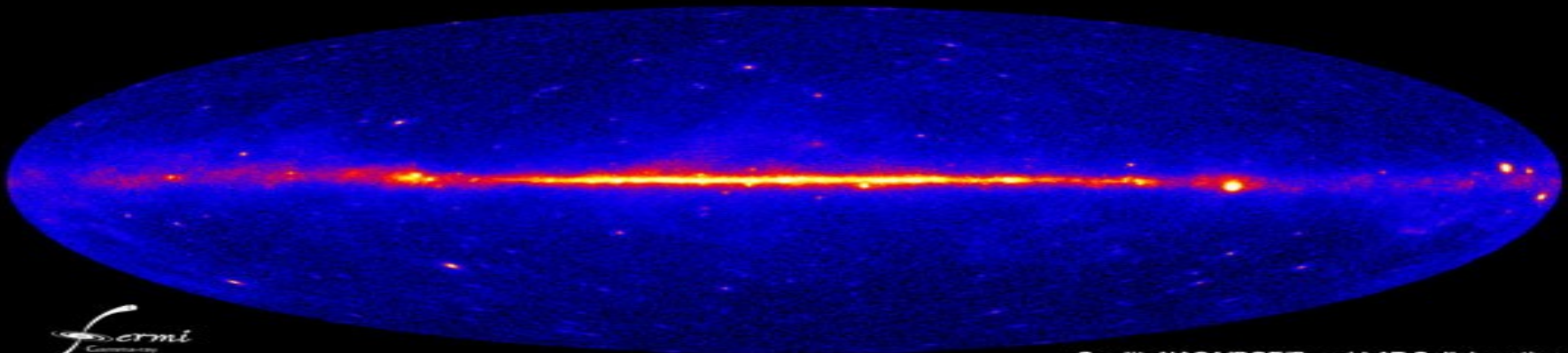
(c) ESA, HFI and LFI consortia, July 2010



Sky at night



NASA's Fermi telescope reveals best-ever view of the gamma-ray sky



Cosmic Rays

Cosmic rays from space are hitting the earth at all times. They are composed of different types of energetic particles:

- Photons and neutrons, which are neutral
- Charged particles: protons, nuclei and muons
- Neutrinos, ghostly elusive particles with no charge and almost no mass.



Cosmic Rays

Cosmic rays were discovered in the 1930s.

The mystery of cosmic rays is we still do not know the origin of these particles:

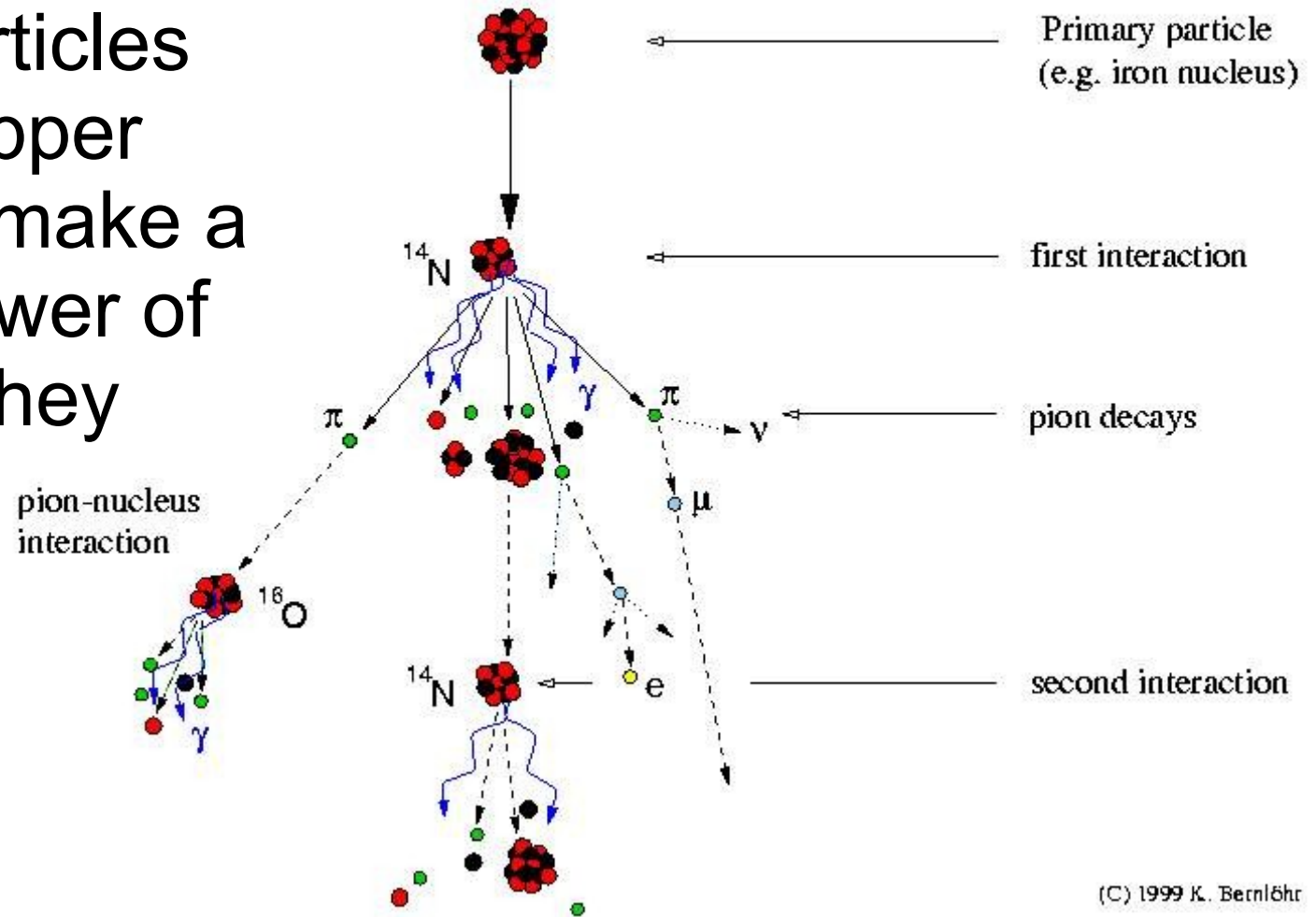
- Big bang creation of the Universe
- Exploding stars, black holes
- Anti-matter matter collision.



Cosmic Rays

Any of these energetic particles that hit the upper atmosphere make a cascade shower of particles as they interact with the Nitrogen in the atmosphere.

Development of cosmic-ray air showers



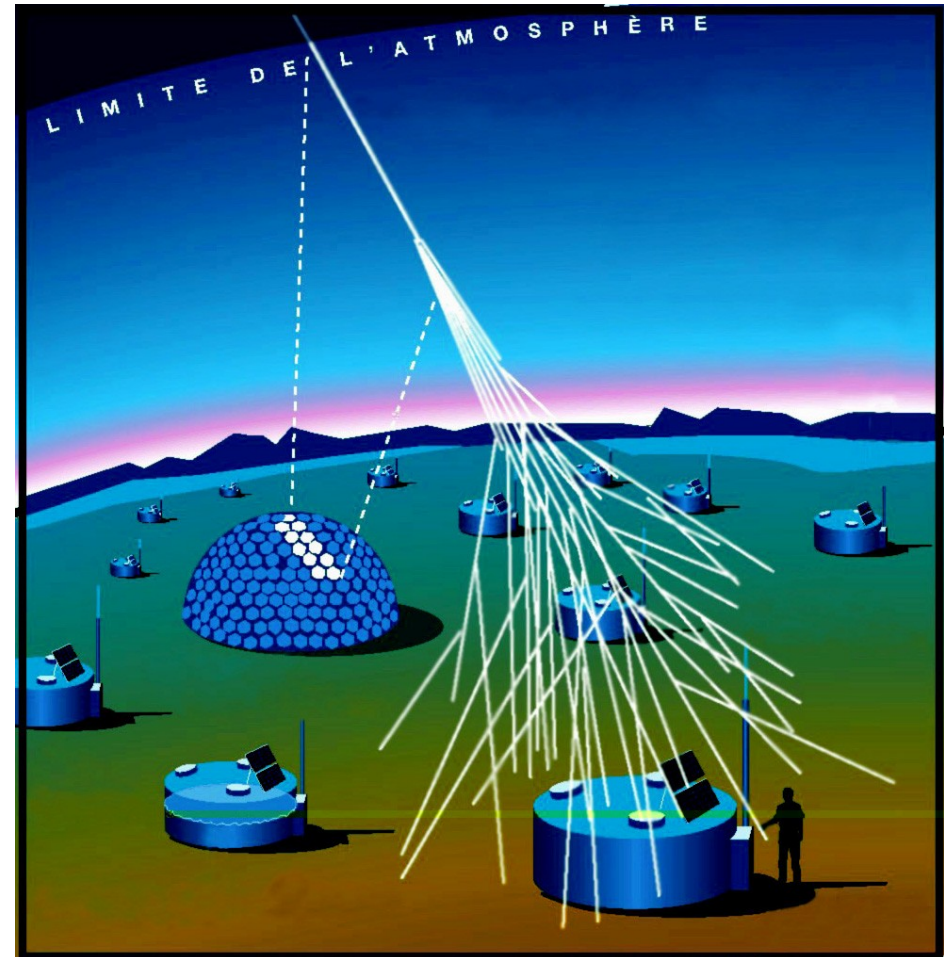
Cosmic Rays

The Pierre Auger Cosmic-ray Observatory is proposed as a major facility. It needs

- Dark skies at night
- Large area on a flat plane
- High altitude
- South and North array

Two different measurements made:

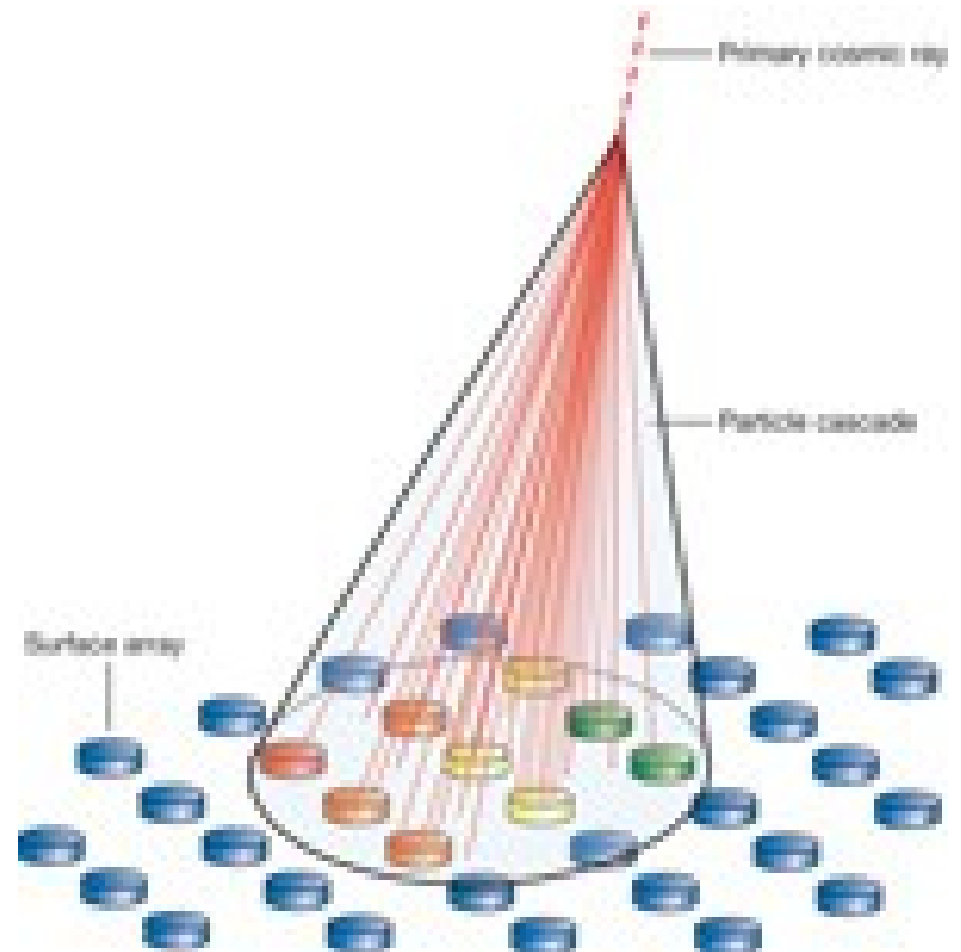
- Water tank array
- Night time fluorescence



Cosmic Rays

The angle of the primary cosmic ray comes from measuring which water tank is first hit.

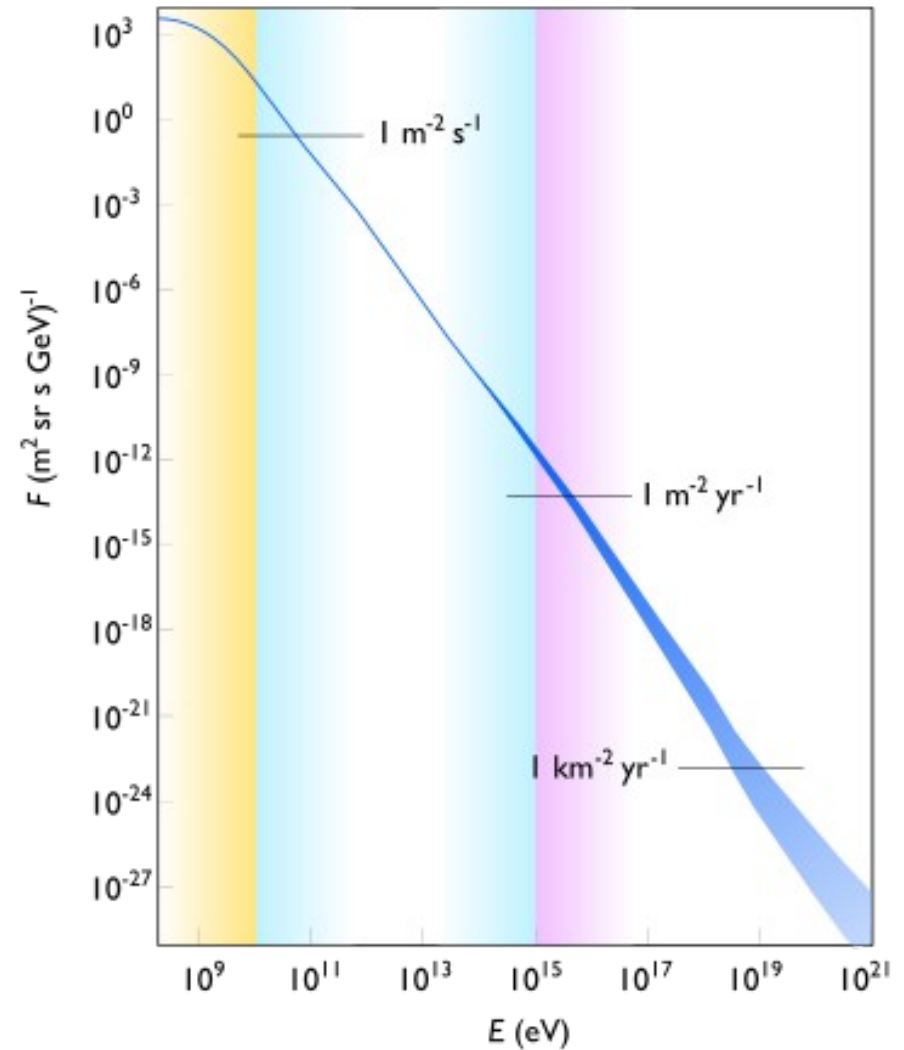
This along with the time and location of the Earth in space allows them to know the initial direction.



Cosmic Rays

Cosmic rays of charged particles at the highest energy are rare.

Cosmic rays are charged and magnetic fields bend them, so low energy cosmic rays are not good for imaging a source.



Auger Observatory

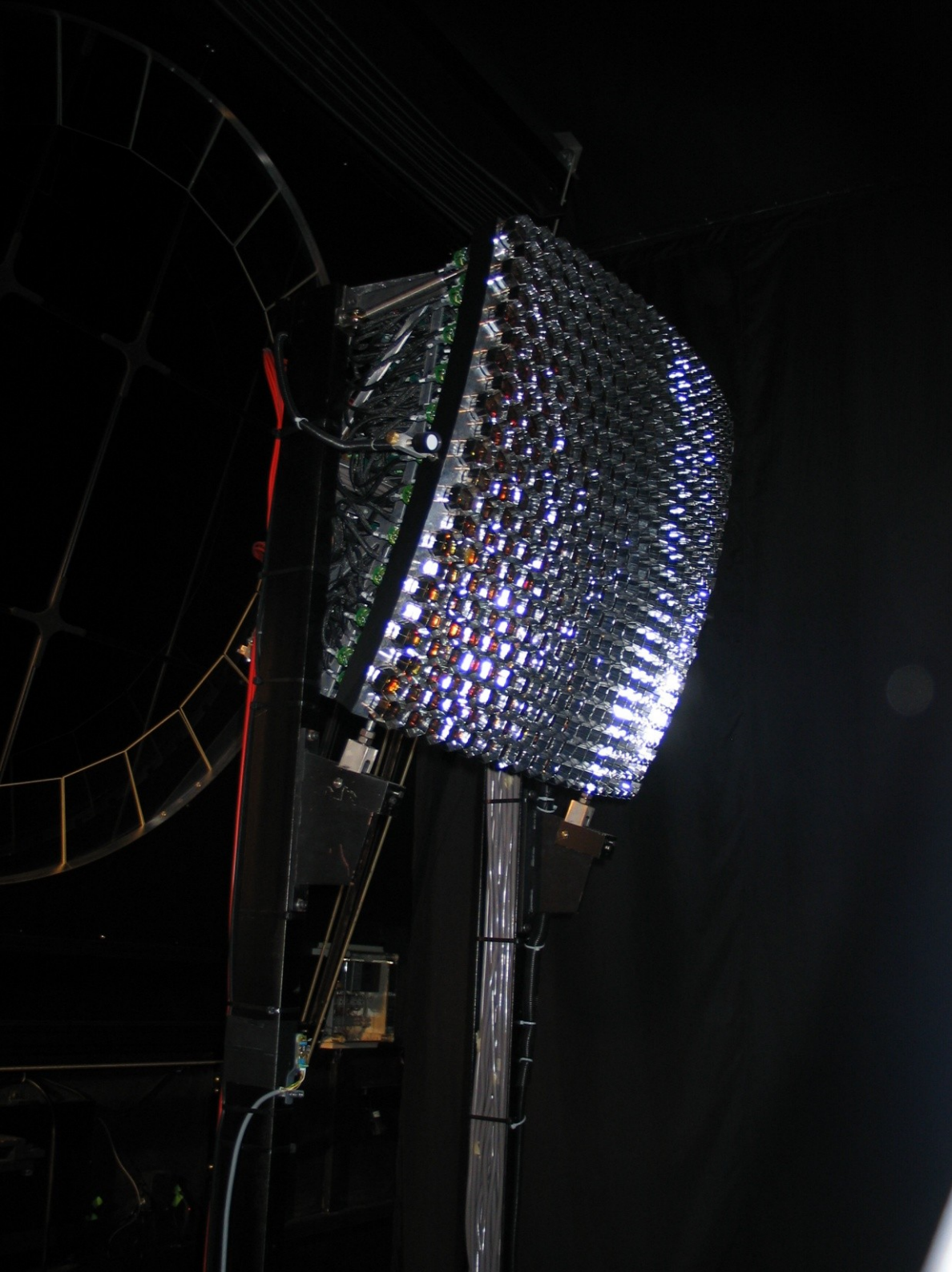
The Auger Observatory is already constructed and operating in the southern hemisphere in Argentina.

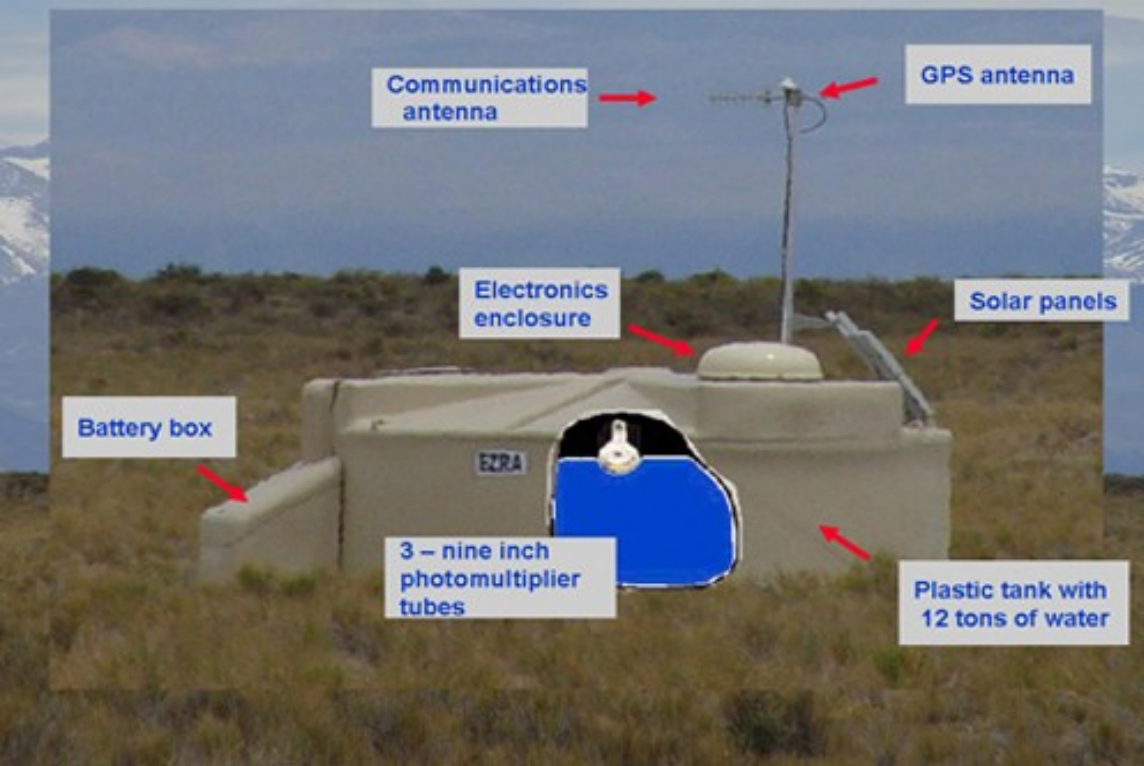
The Auger Northern Array will be much larger and currently set for Eastern Colorado high plateau.



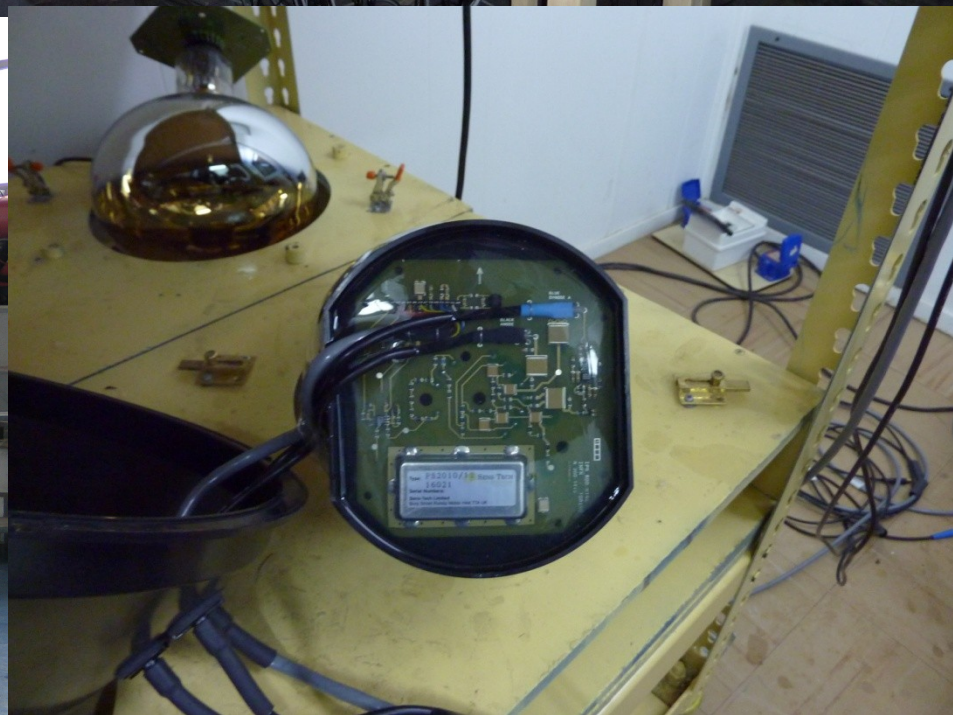
Show air shower animation movie

Courtesy of Martin Ratcliffe, Sky Skan Inc.









Auger North

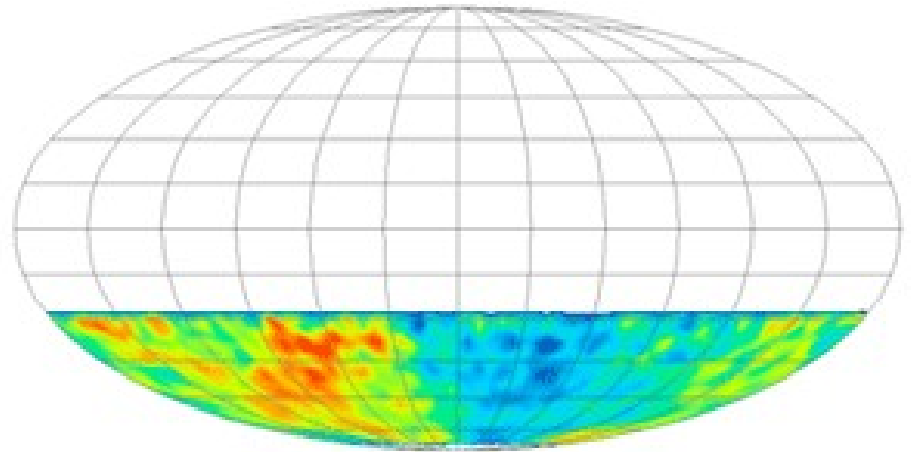
Currently planned for
Eastern Colorado

Western Kansas is just
as suitable as studied in
the summer of 2010 by
Wichita State University.



Auger North

New Science results from Ice-Cube array at the south pole show the first asymmetry of the number of charged particles from one direction of the night sky.



The northern hemisphere is blank due to a lack of a northern array.

Conclusion

A group of Kansas scientists (3.5 FTE) are interested in joining Auger Observatory and are working together:

KU (1), KSU (1)

WSU (2), PSU (1)

Baker Univ. (1),

Bethal College (1),

FHSU (1)

and ESU (interested)