Cosmic rays and dark matter

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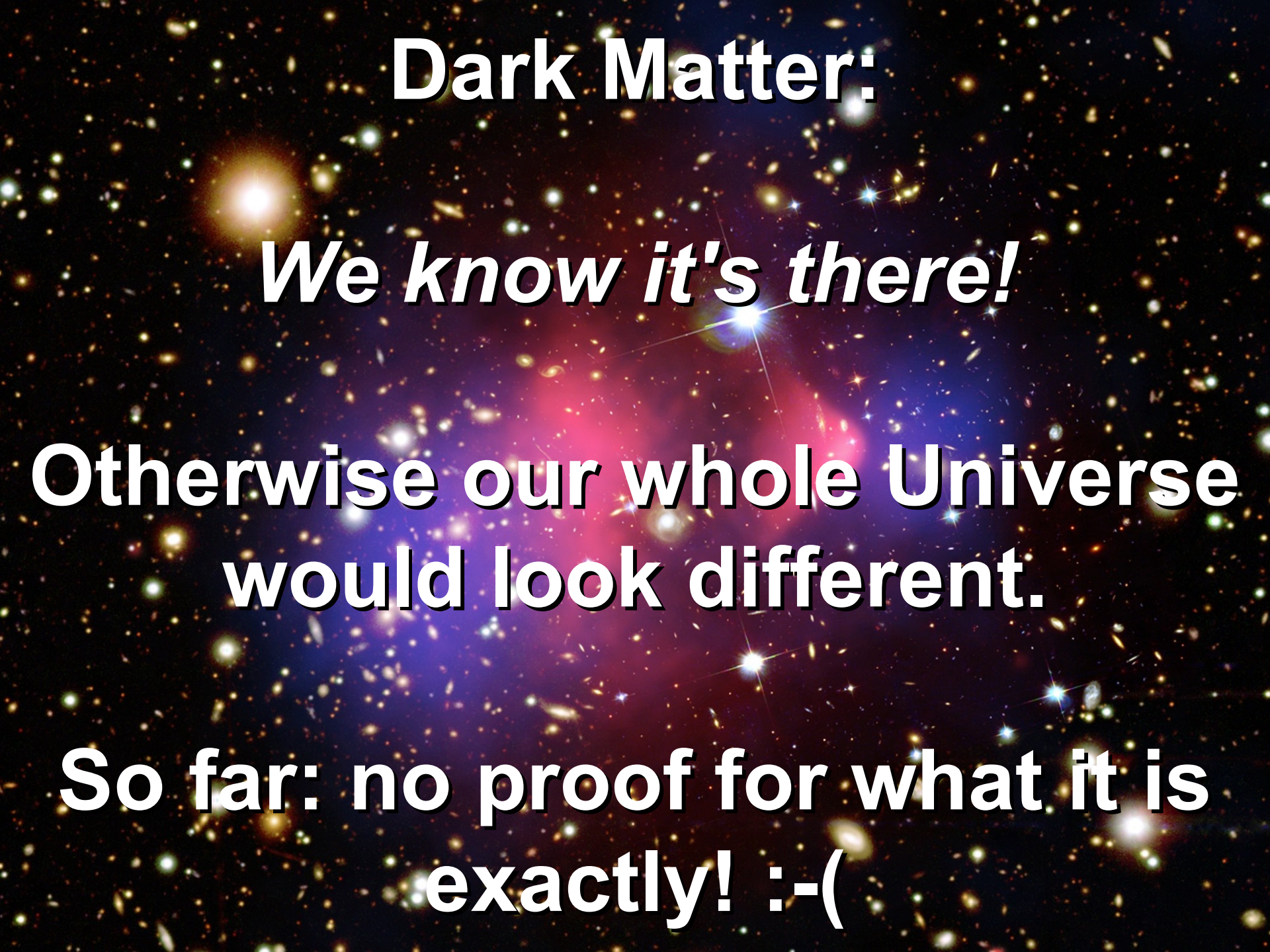
Philip von Doetinchem & Travis Nelson
Department of Physics & Astronomy, University of Hawai'i
philipvd@hawaii.edu
http://www.phys.hawaii.edu/~philipvd


Dark Matter:
We know it's there!
Otherwise our whole Universe would look different.
So far: no proof for what it is exactly! :-(

stuff we know

stuff we don't know:
dark matter

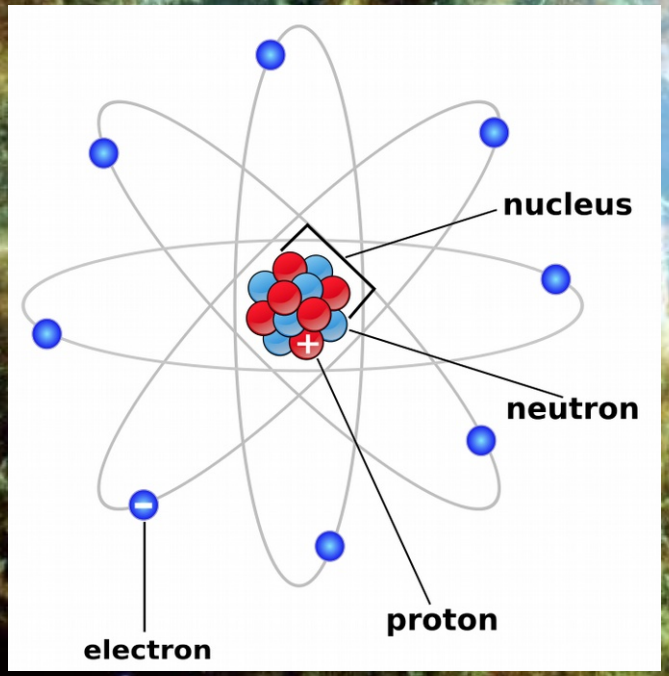
Now what?

Dark Matter

These guys could be *cosmic rays*

Why not ask somebody who has been there and is fast?

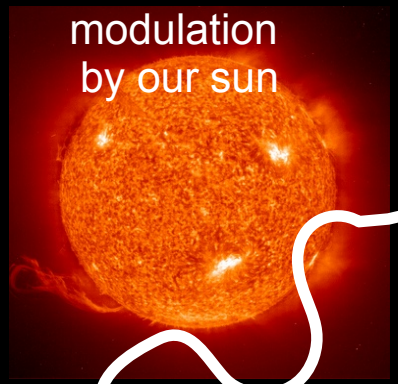
Cosmic rays - What is that?

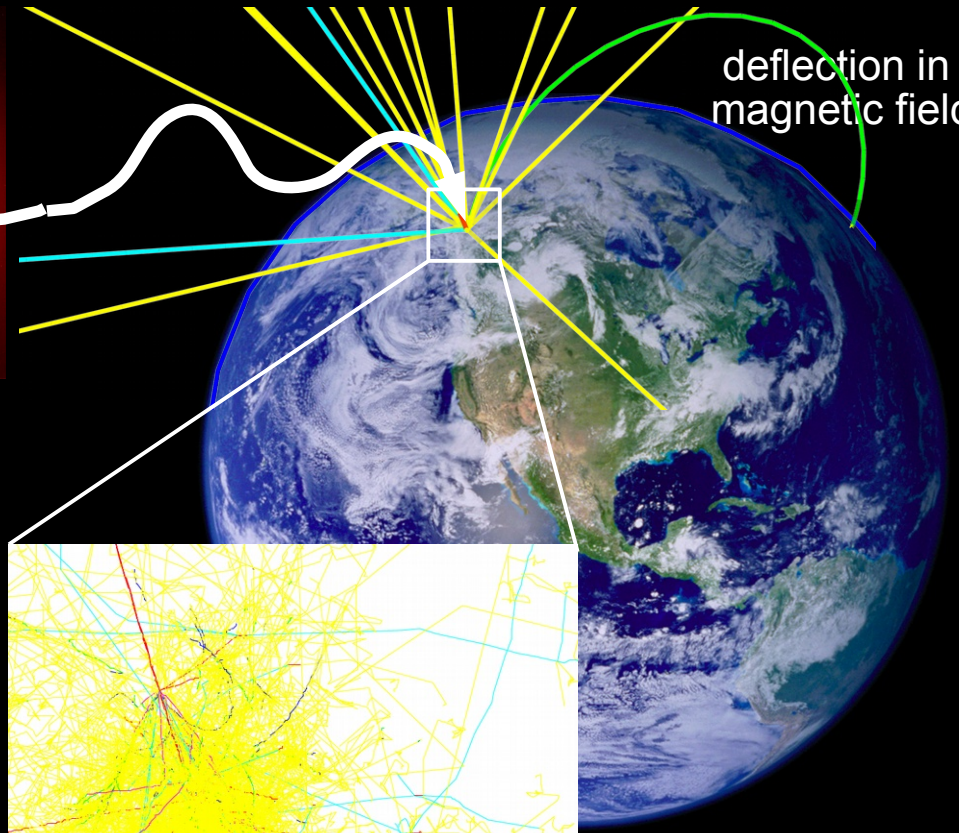


Products of star explosions

→ mostly composed of the same components that we are made of

Cosmic rays on the journey to us





scattering in
magnetic fields,
interaction with
interstellar medium

interactions with
atmosphere

Let's be honest: the details *do* require to study Physics in more depth...however:

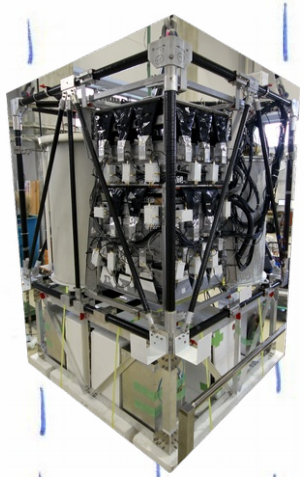
We can build machines that measure these runners (cosmic rays) and tell us more

We are looking for special types of cosmic rays that hopefully know more about dark matter.

Where to install a cosmic-ray experiment?

Imagine you wanted to collect rain...

too dry



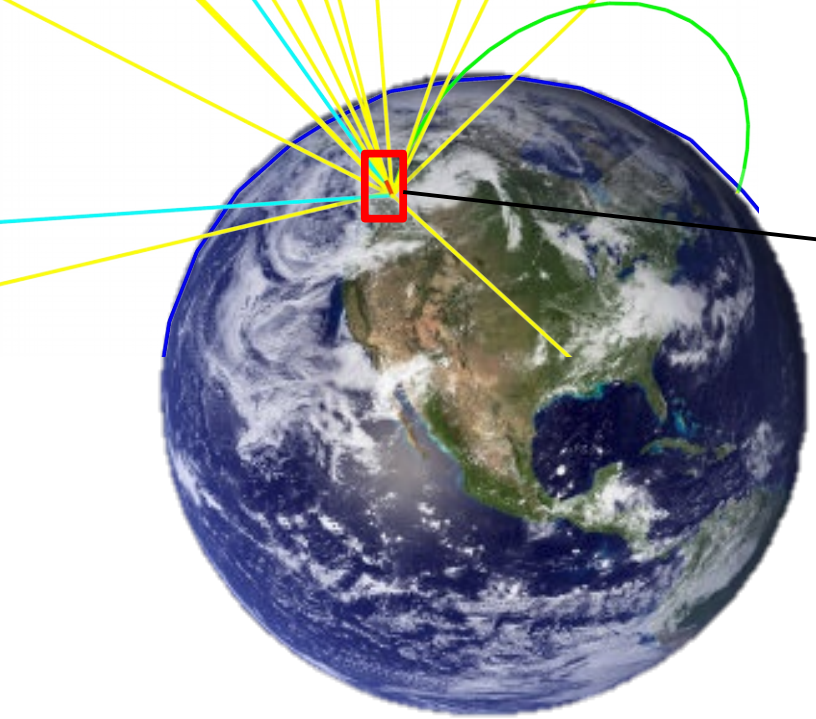

The atmosphere acts as a roof for cosmic rays
atmosphere
Which is good to stay healthy, but bad to measure cosmic rays

when you are hiking at high altitudes

→ you are exhausted much faster

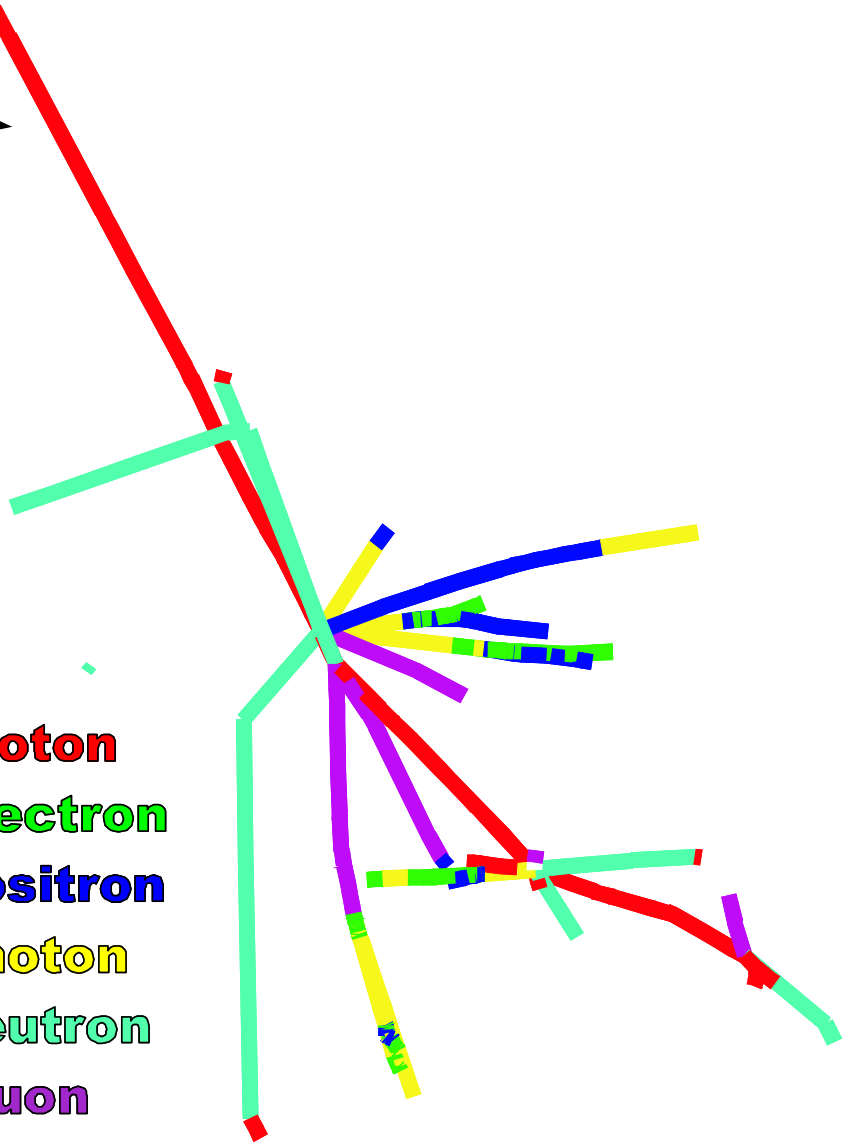
→ because there is less air to breathe

→ *roof for cosmic rays is getting weaker*



zoom

computer simulation of interaction of a proton with the atmosphere



Cosmic ray interacts with atmosphere

→ slows down

→ composition changes a lot with altitude

→ we are exposed to hundreds of cosmic rays this very moment

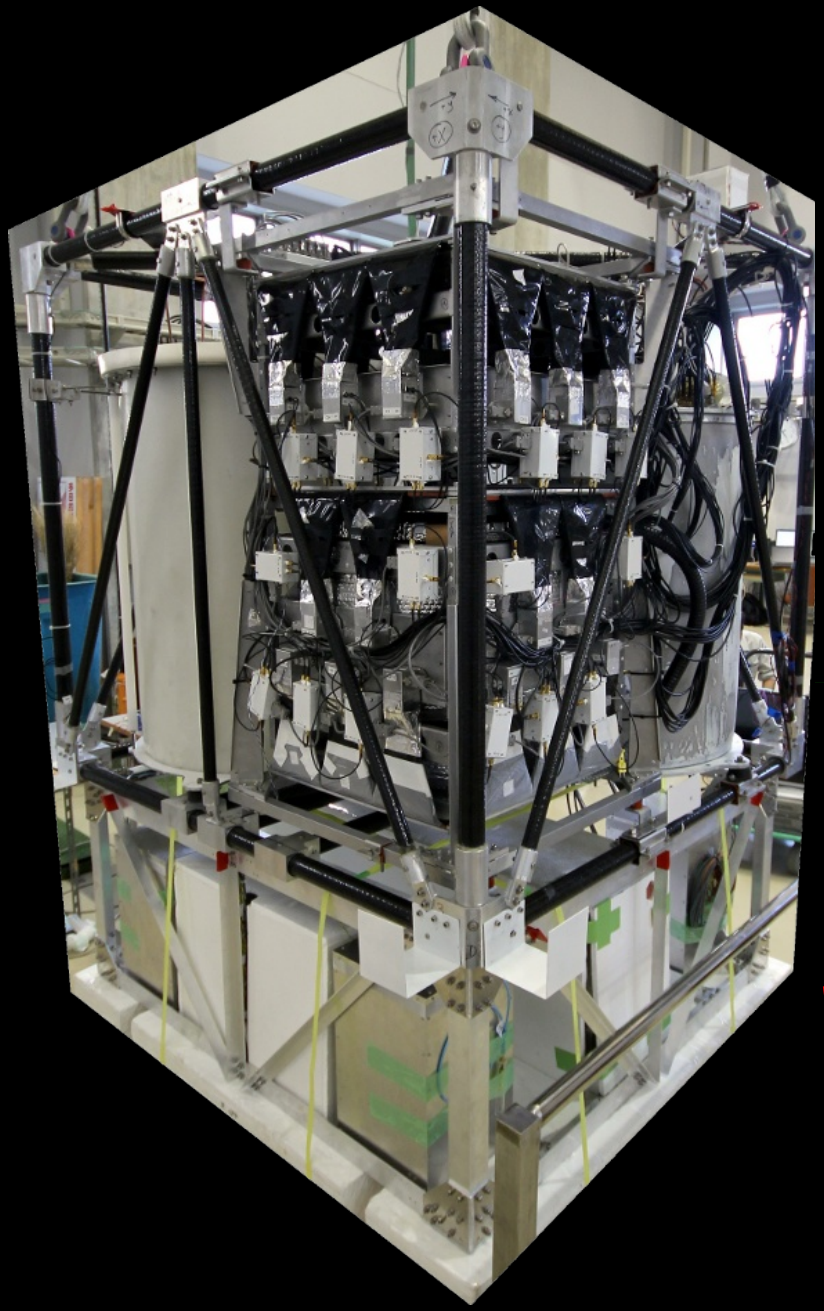
- proton
- electron
- positron
- photon
- neutron
- muon

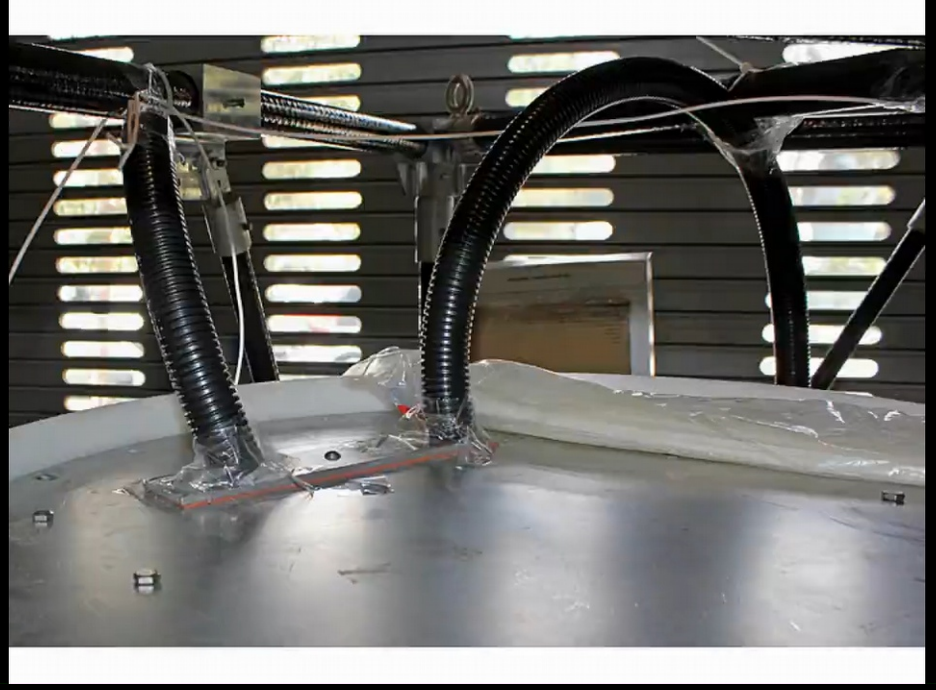
Therefore put the experiment as high as possible!

use balloons

that go up very very high

→ 25 miles above ground

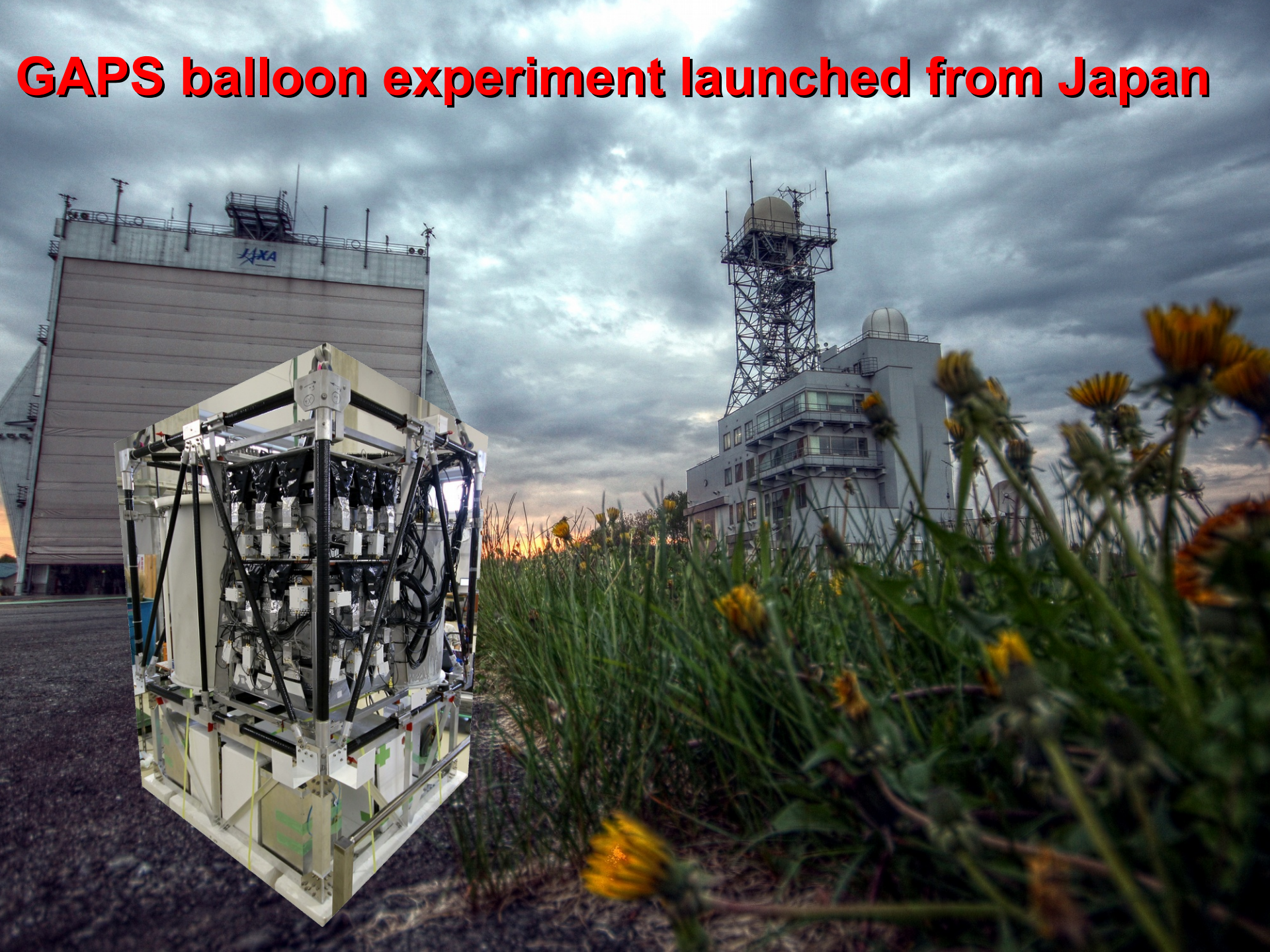




A lot of hands on work with all sorts of different tasks!

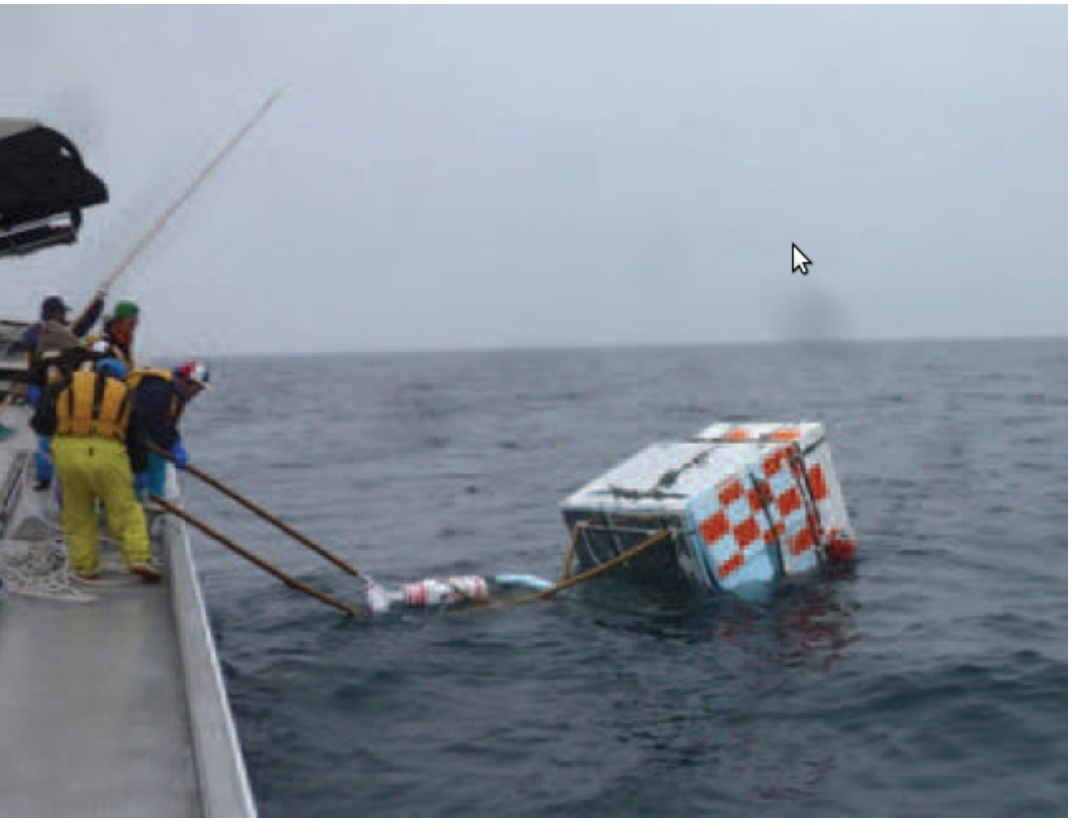
Playground for big kids

GAPS balloon experiment launched from Japan



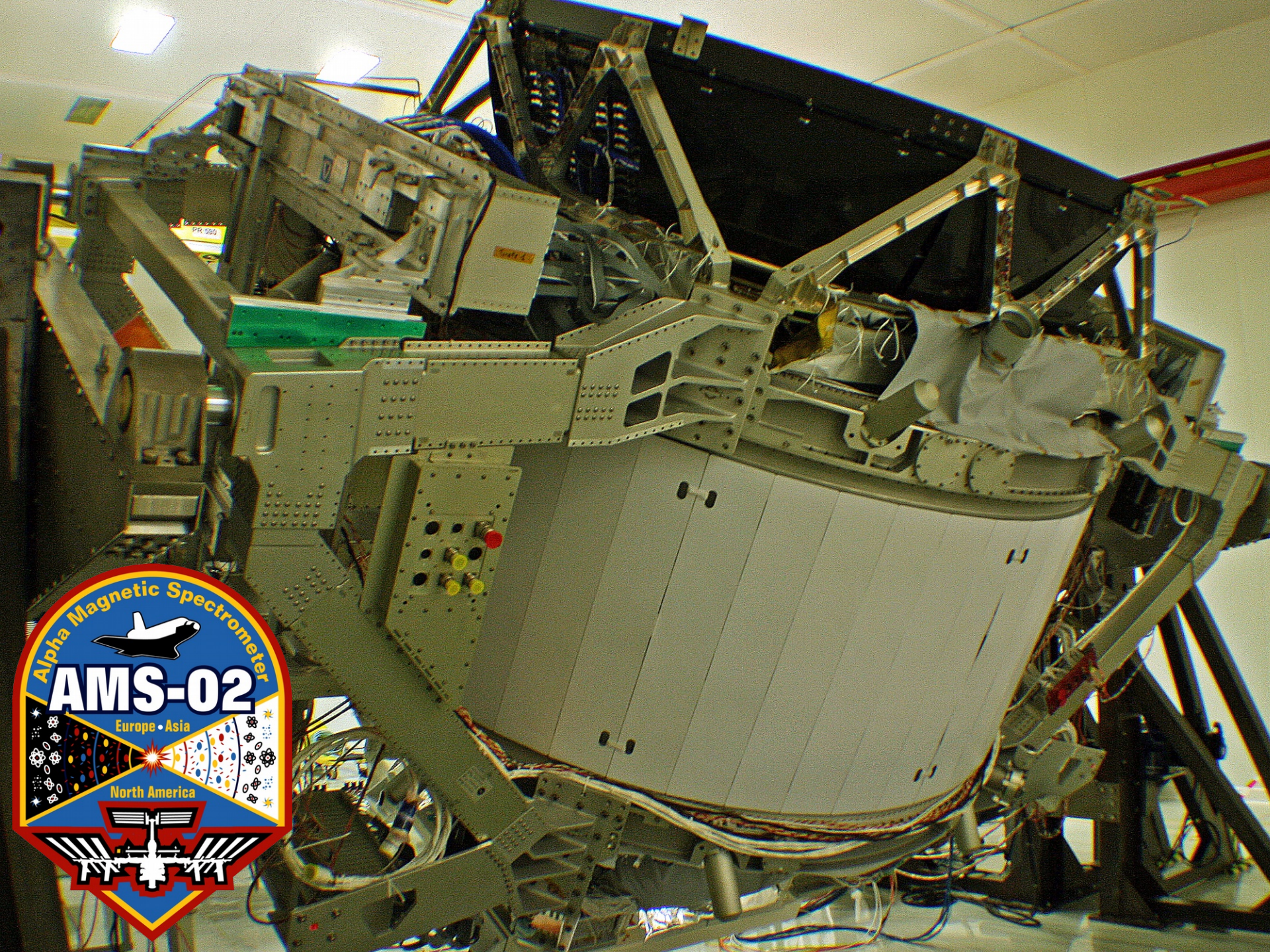

GAPS
GENERAL ANTIPARTICLE SPECTROMETER
NASA • JAXA
2012:06:03 02:29:14

Experiment landed in the Pacific ocean!



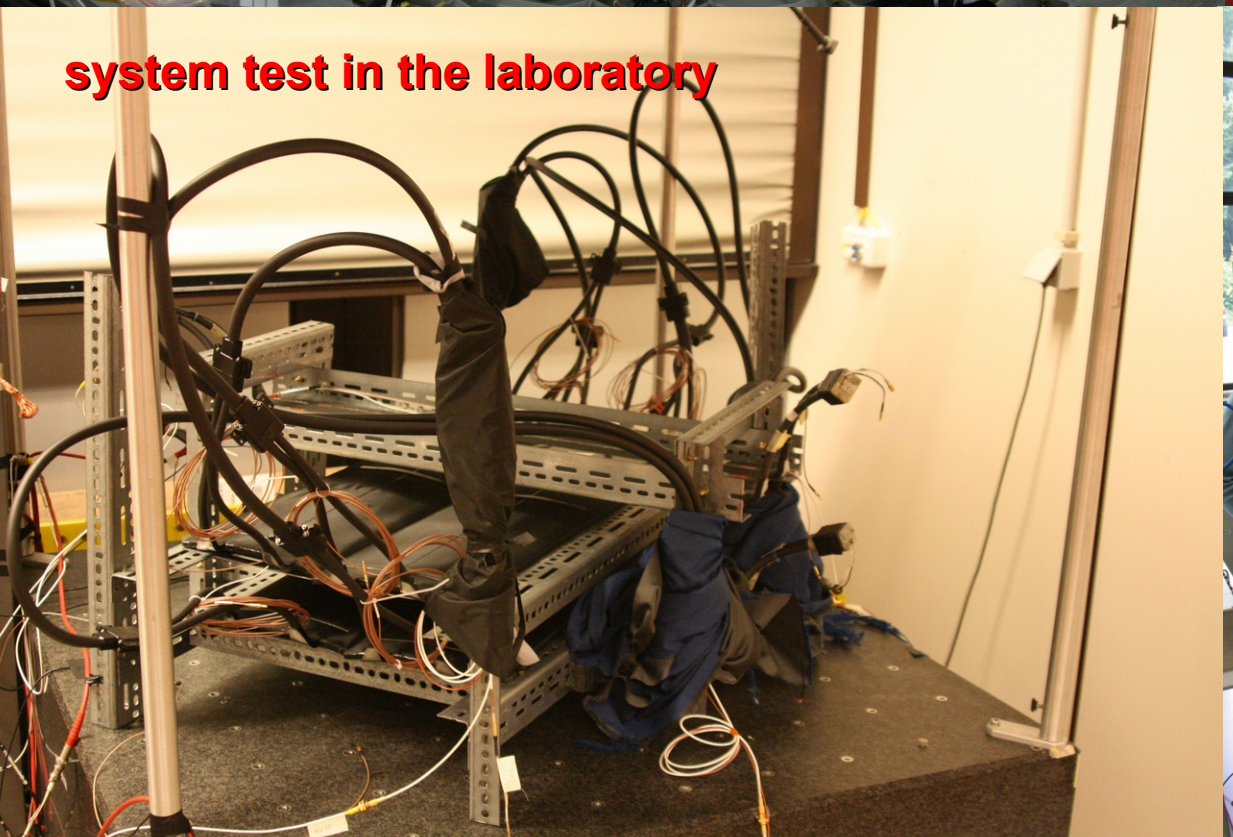
Want something better than high altitude balloon → go to space (expensive about $1,000,000 for 2lbs)

- AMS is a multi-purpose particle physics detector installed on the International Space Station
- large international collaboration (~600 people from 60 countries involved)
- AMS collected 10^{th} of billions of events


Alpha Magnetic Spectrometer
AMS-02
Europe • Asia
North America


payload integration


vibration testing


system test in the laboratory


vacuum testing

Integration of AMS-02 at CERN with STS-134 astronauts

Launch STS-134

on the launc
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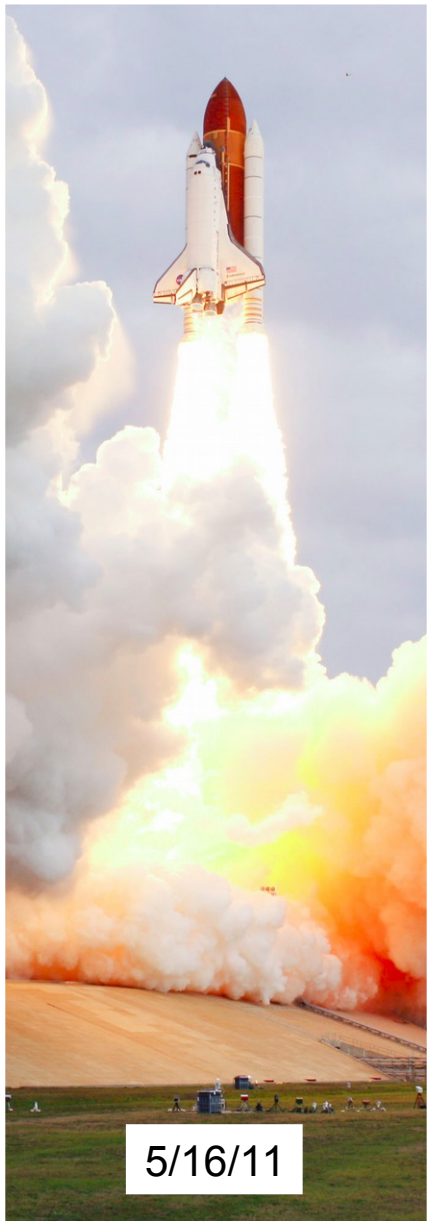

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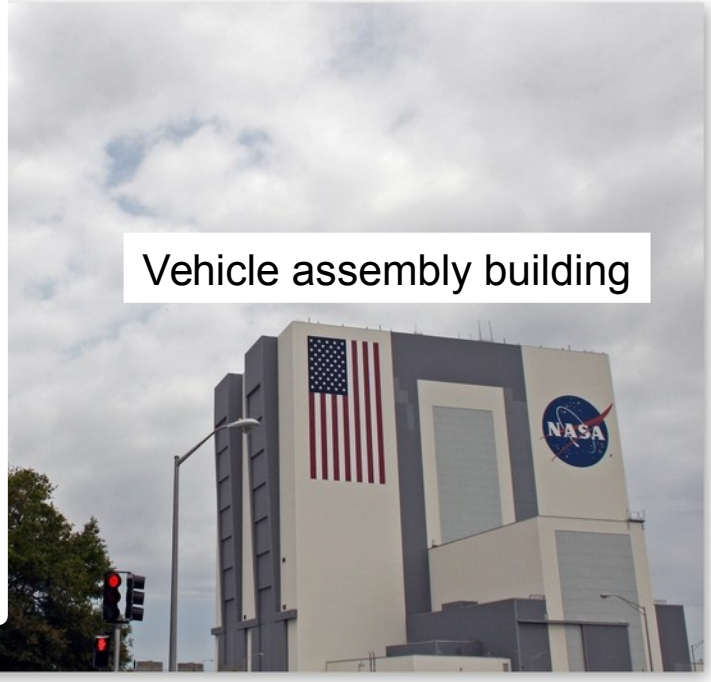
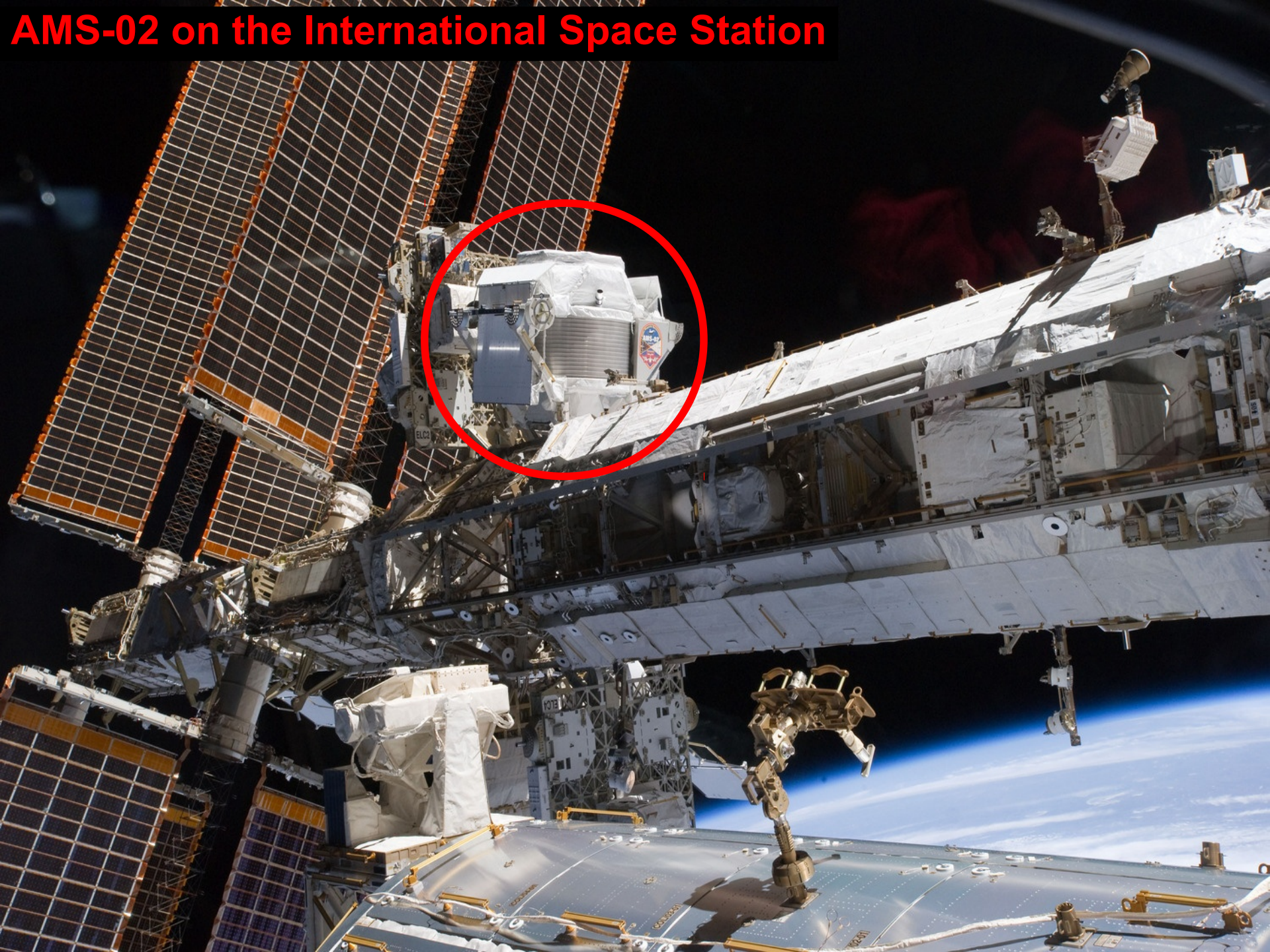
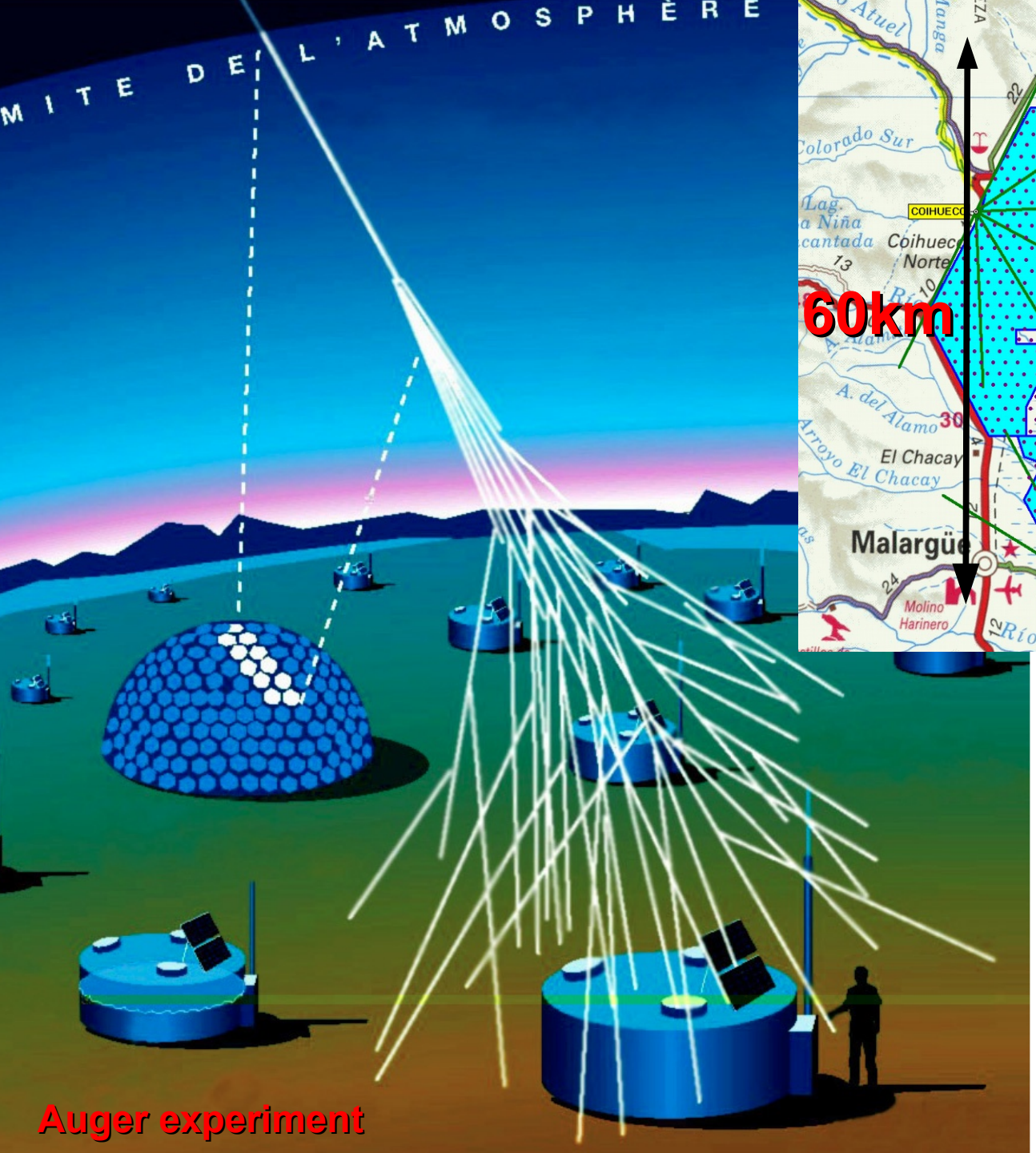
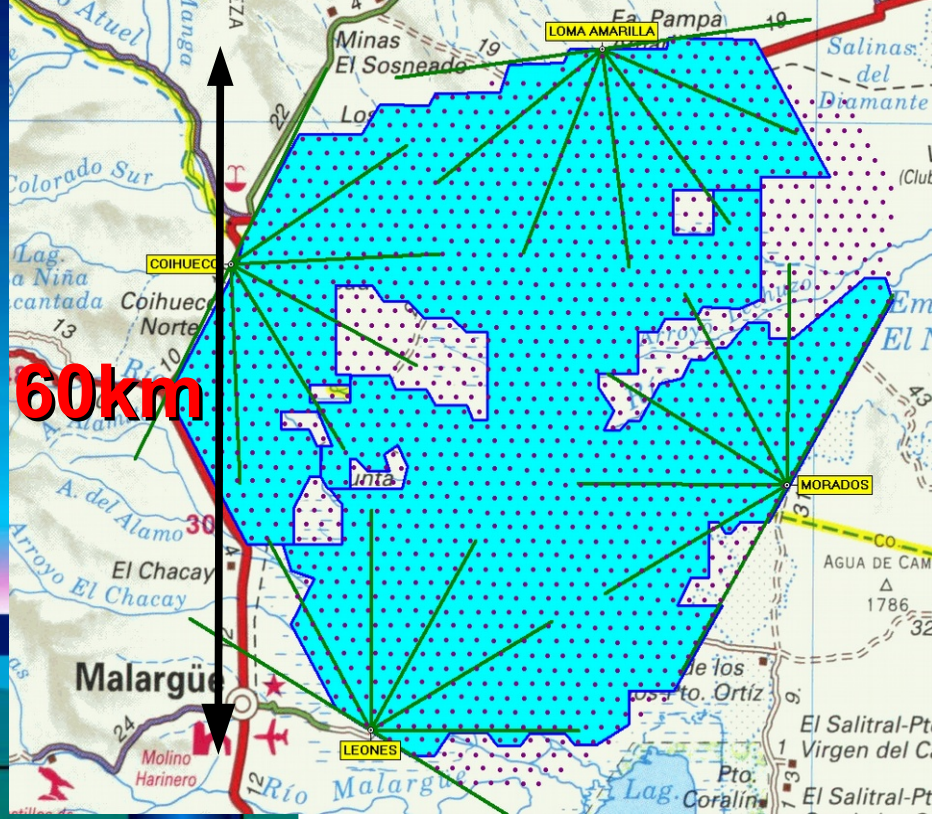


Vehicle assembly building

AMS-02 on the International Space Station



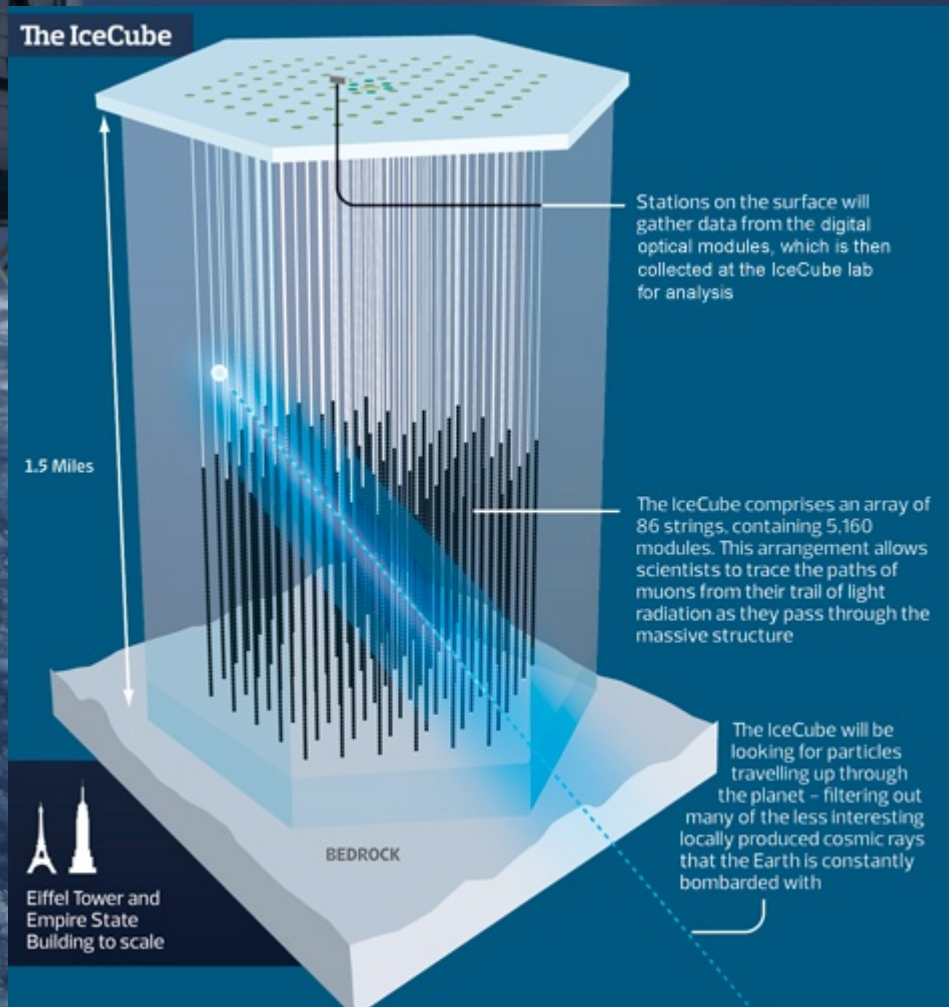


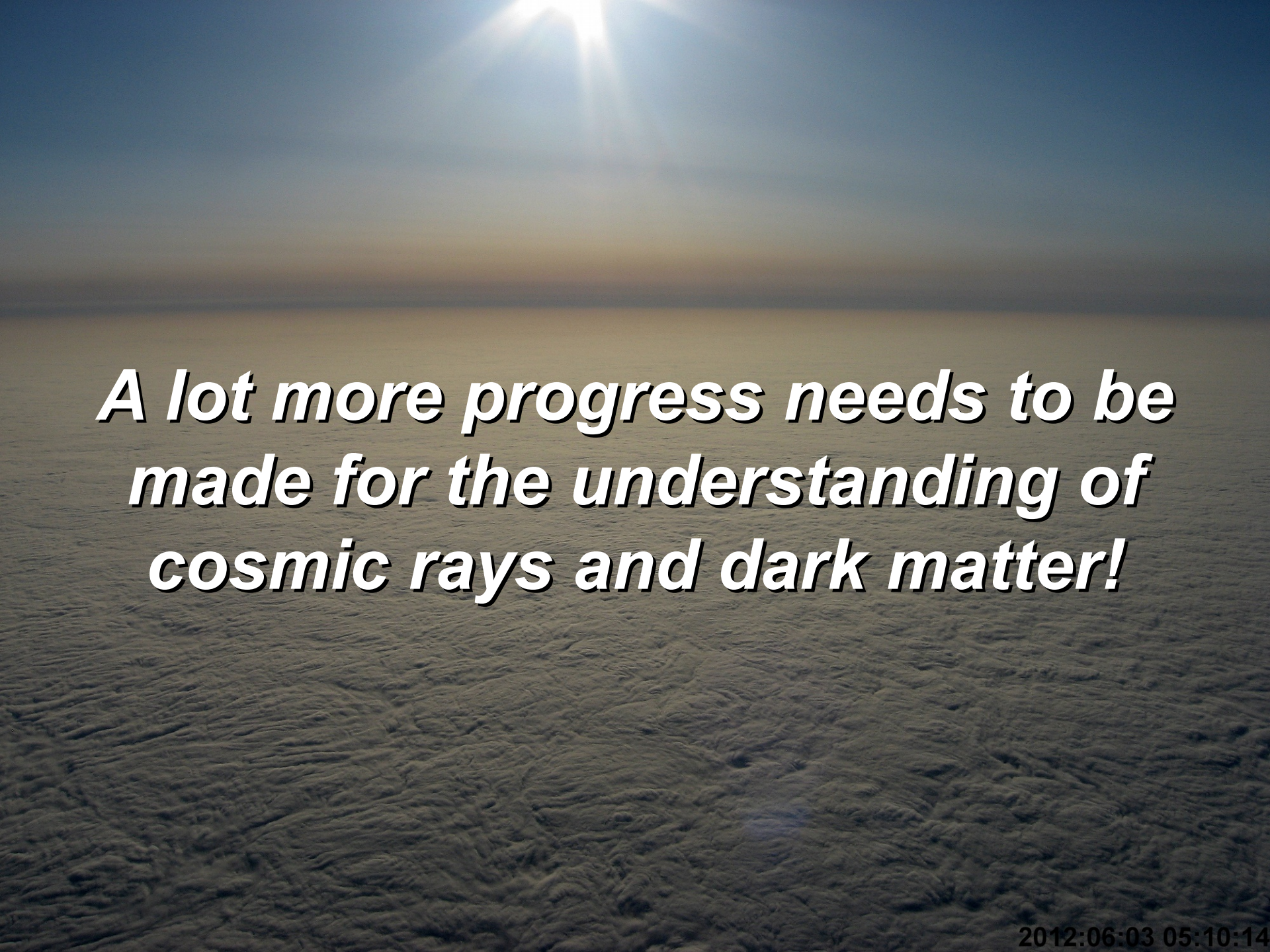


You can also use the atmosphere to measure cosmic rays

→ you can build gigantic detectors

IceCube at the Southpole




A lot more progress needs to be made for the understanding of cosmic rays and dark matter!
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