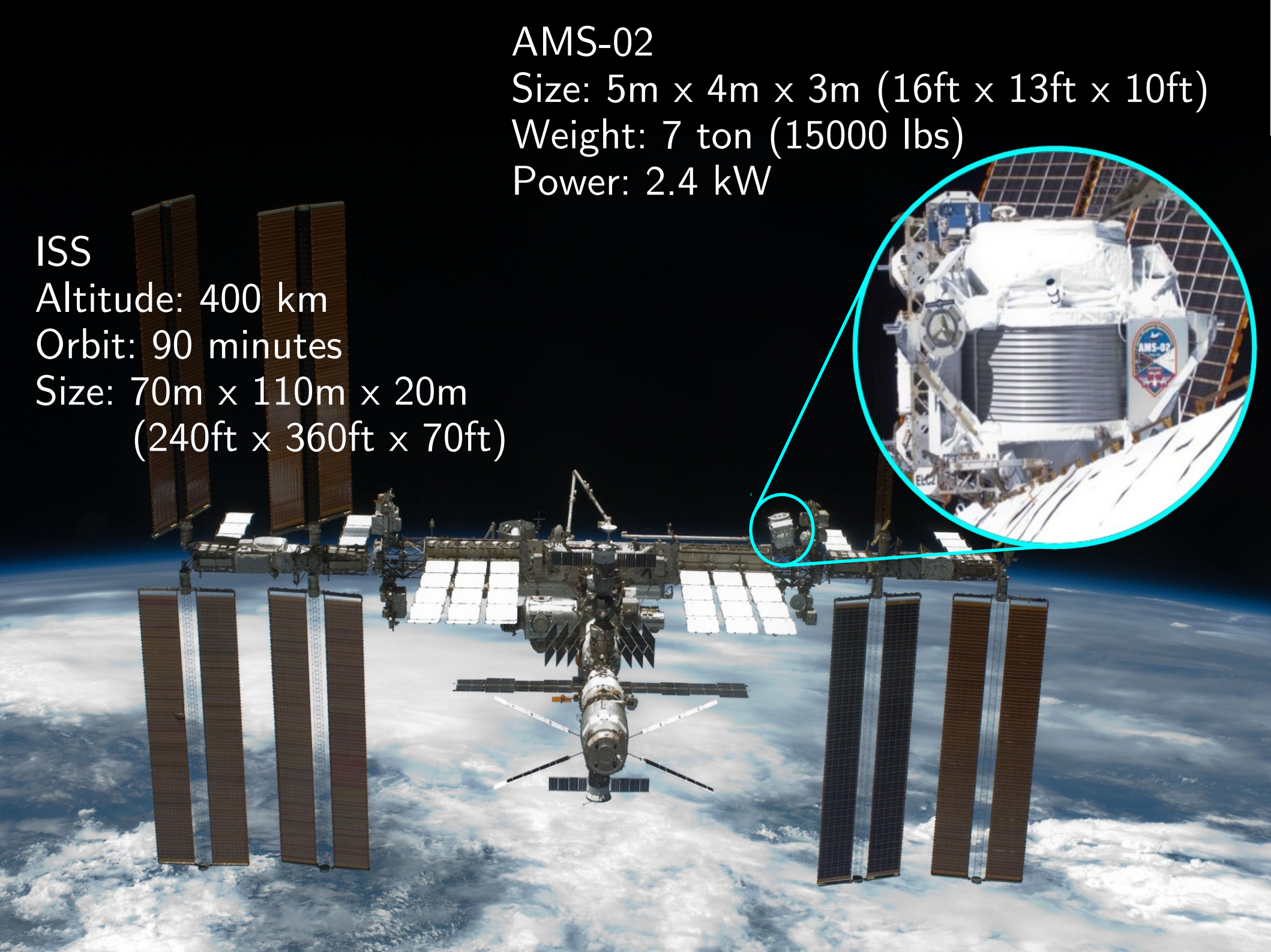
Activity:
Solar modulation with AMS-02

AMS-02
Size: 5m x 4m x 3m (16ft x 13ft x 10ft)
Weight: 7 ton (15000 lbs)
Power: 2.4 kW

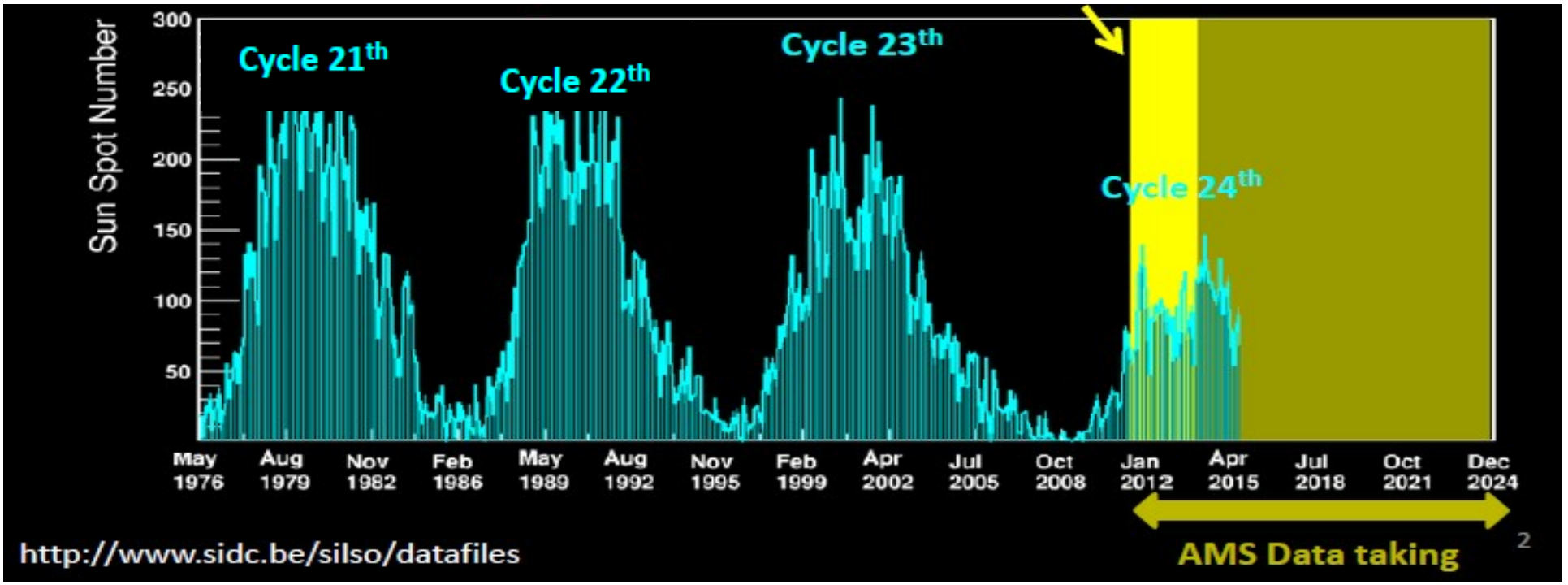
ISS
Altitude: 400 km
Orbit: 90 minutes
Size: 70m x 110m x 20m
(240ft x 360ft x 70ft)



When is AMS-02 taking data?

AMS-02 is taking data during the solar cycle 24.

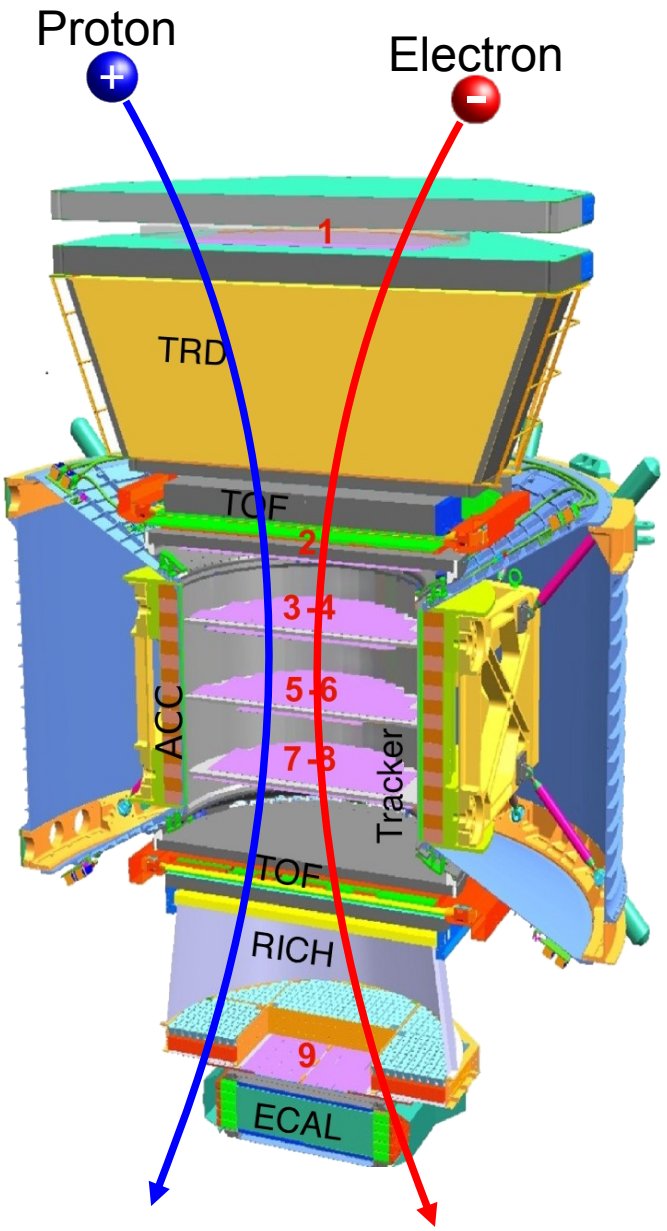
Up to now, it measured cosmic rays during the ascending phase and the maximum of the solar cycle.



How do we measure cosmic rays?

AMS-02 has many different sub-detectors that measure different properties of each particle: velocity, charge, energy, mass.

AMS-02 is surrounded by a permanent magnet, so charged particles curve while passing through it.
Measuring the bending of the trajectory, we can know the energy and the sign of the charge.



Protons in cosmic rays

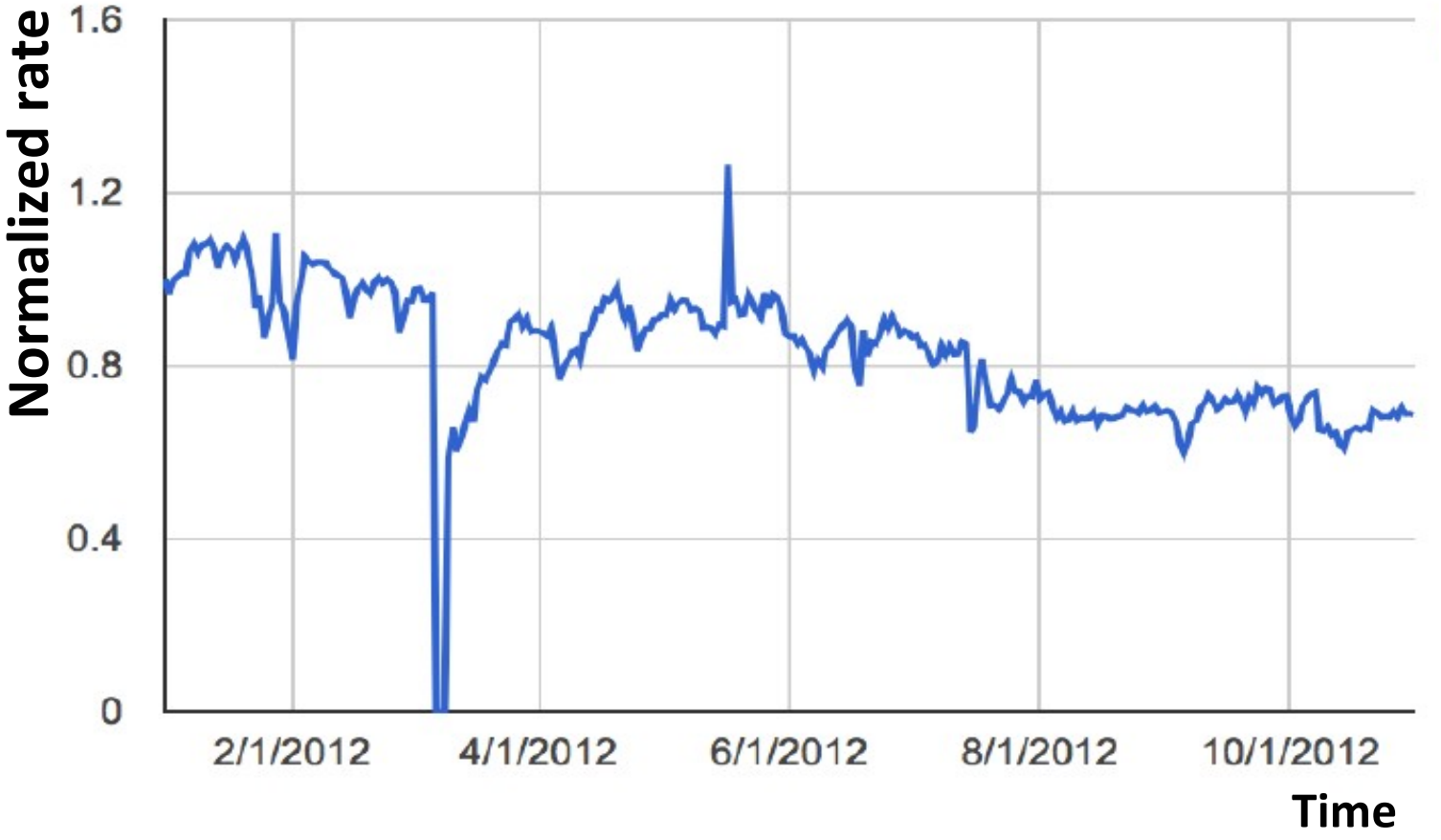
79% of cosmic rays are protons, 14% is Helium nuclei, the rest are electrons and other nuclei (carbon, oxygen, iron, etc)

We can ***count the number of protons*** that pass trough our detector ***for each second*** to get the rate of particles for each energy.

Rate = particles / sec = Hertz
Energy = GeV = 1 billion eV (electronvolt)
eV = energy gained by an ***electron*** that freely moves across a ***potential difference*** of ***1 Volt***
200 billion protons @ 1 GeV = 1 Pepsi can
1000 protons @ 1 GeV = 1 flying mosquito

AMS-02 proton rate vs time

We can select a specific energy and see how it varies with time. For this, we use the ***normalized proton rate***: we divided the proton rate by the value of the first day, so we can easily compare the rate at different times.



Normalized proton rate slope

We can fit the normalized proton rate with a straight line, to understand better the general trend.

Straight line: $y = mx + q$

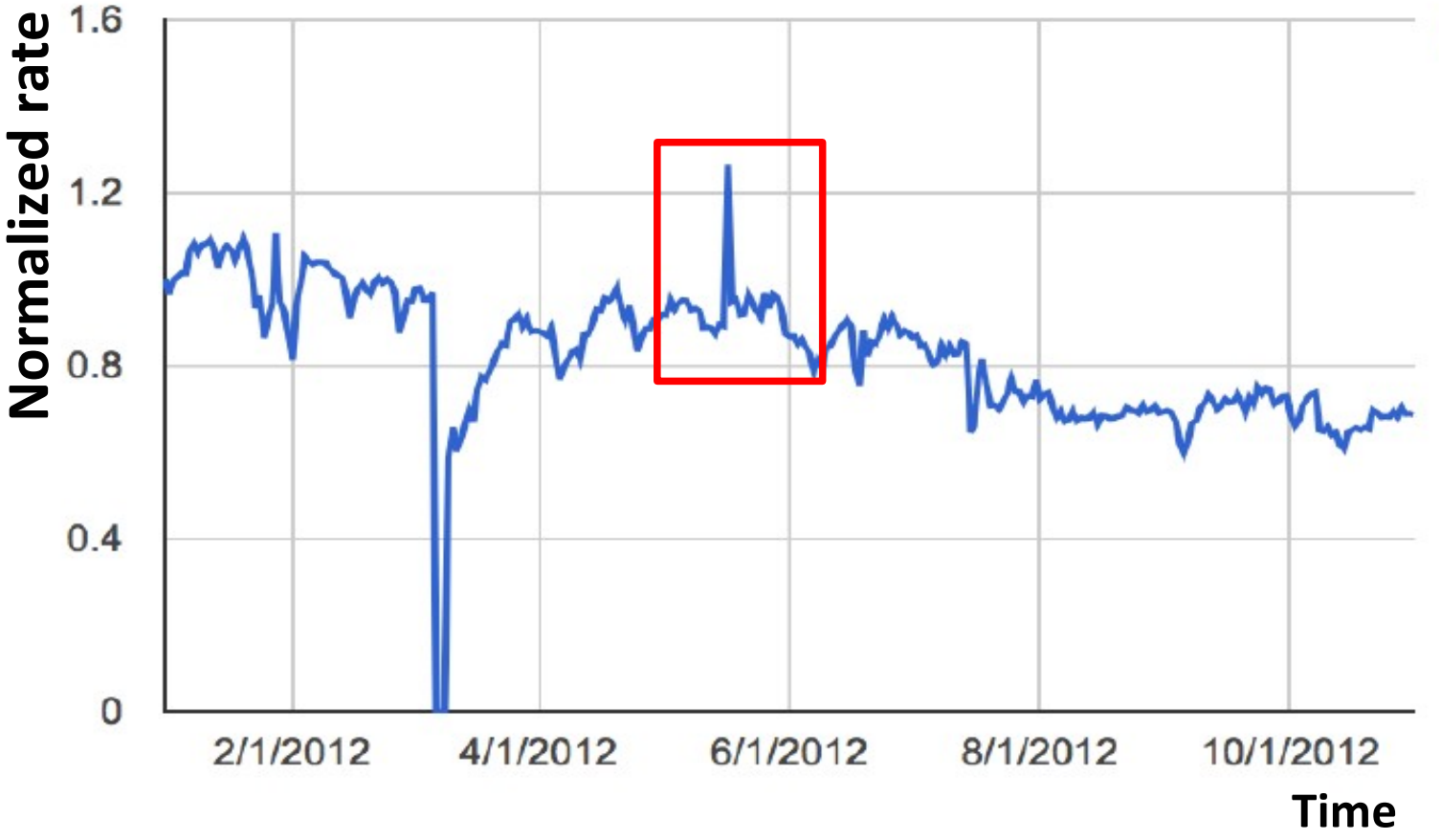
m = Slope: how much the rate change in time

Short timescale solar activity
Forbush decrease

When the Sun emit a Coronal Mass Ejections (CME), the solar wind is stronger and the GCRs may suddenly decrease for a short period of time.

Short timescale solar activity
Solar energetic particles

During intense activity, the Sun may accelerate particles: they become Solar Energetic Particles (SEP). SEPs can be observed as an excess of particles over the GCRs.



Activity goals

- You will use the normalized proton rate measured by AMS-02 between January and October 2012 to explore how cosmic rays are influenced by the Sun.
- You will use measurements at different energies to investigate whether solar modulation affects particles of all energies in the same way or not.