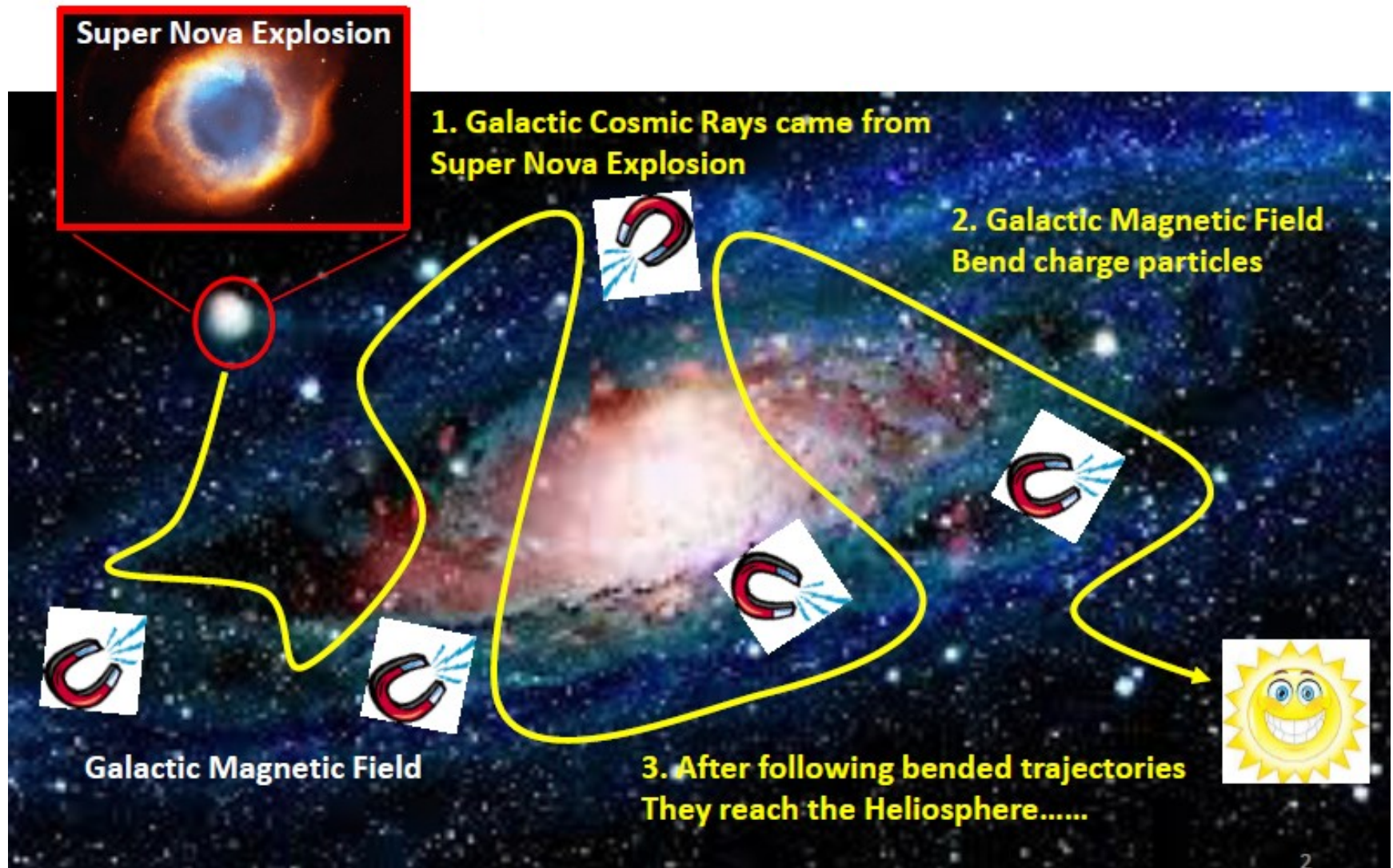




Solar Modulation Effect On Galactic Cosmic Rays

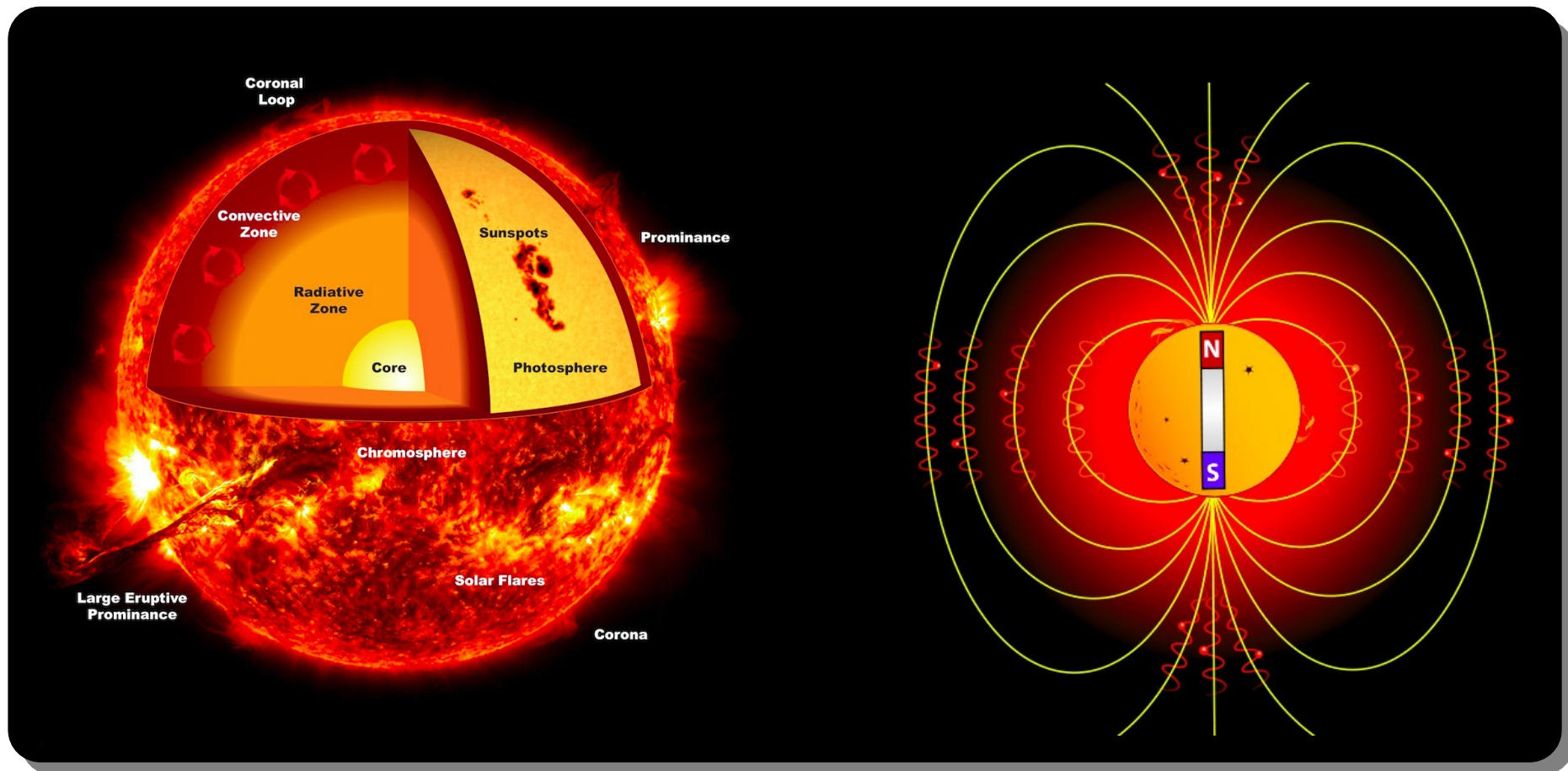


Galactic Cosmic Rays Voyager in The Galaxy



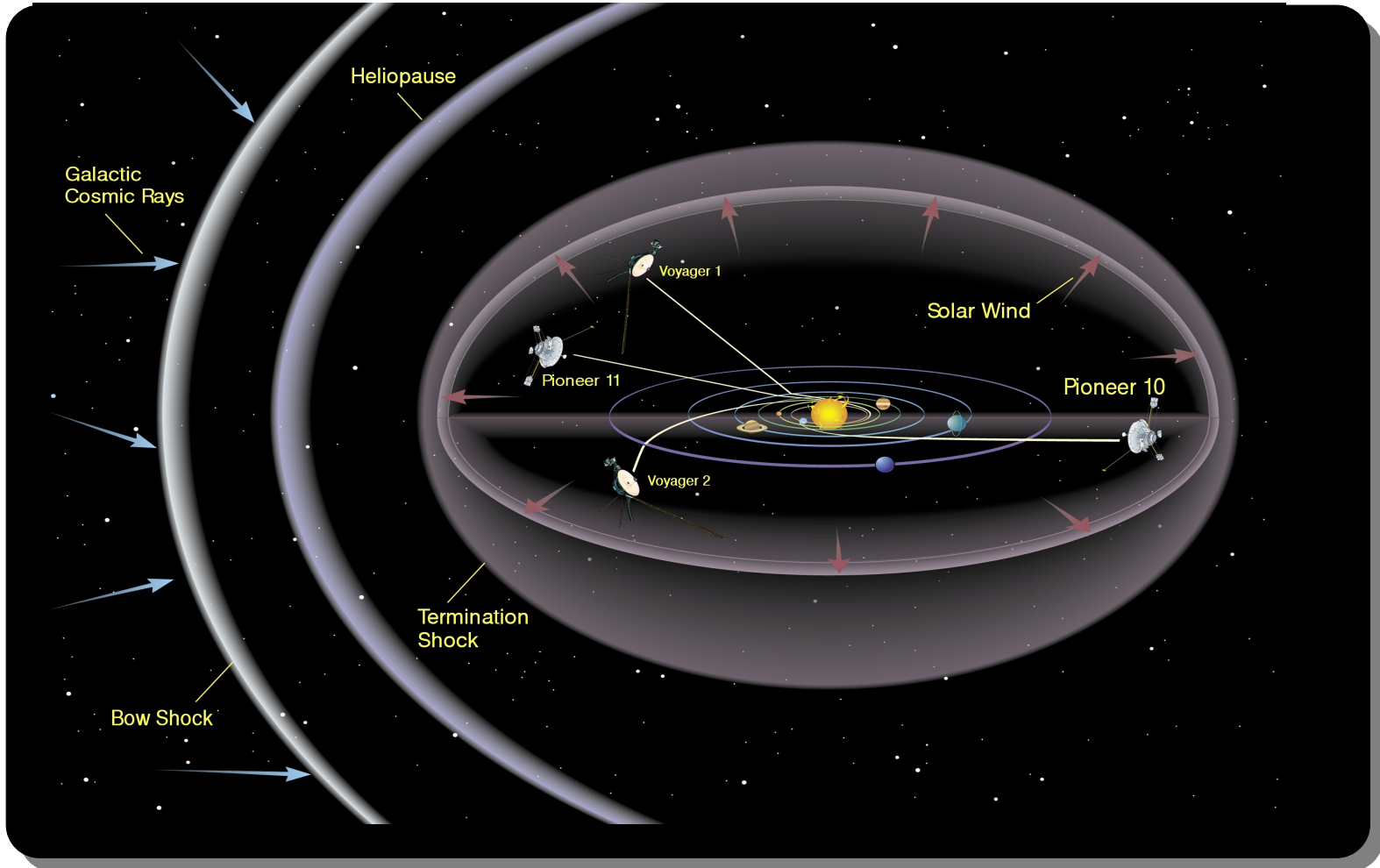
The Sun

The Sun is a **Star**. It is a nearly perfect spherical ball of hot plasma, with internal convective motion that generates a **magnetic field** via a dynamo process.



The Sun & The Heliosphere

The heliosphere contains the **solar system**



GCR may **penetrate** the Heliosphere and **propagate** through it by following the Sun's magnetic field lines.

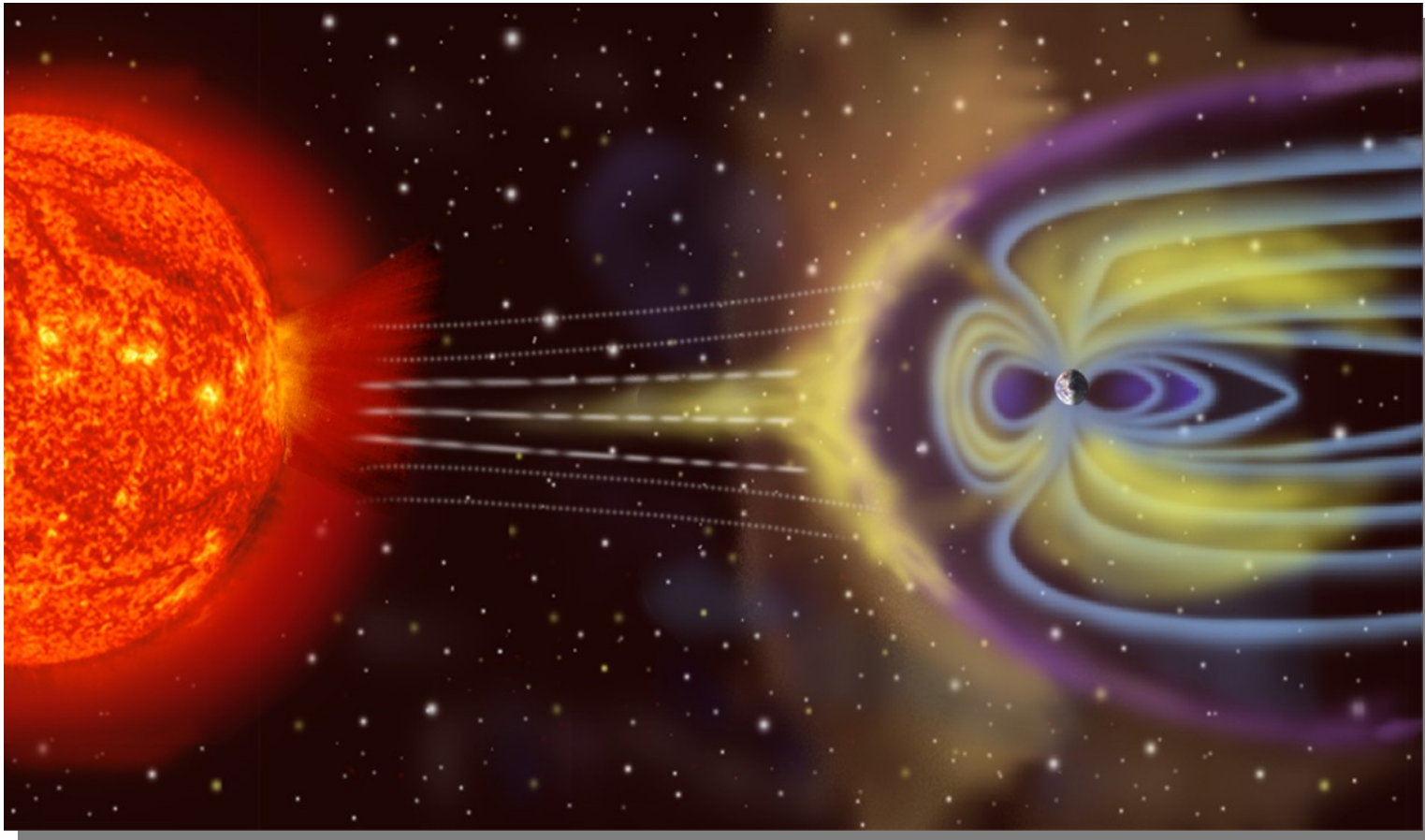
The Heliosphere Boundaries

The **Heliosphere** is the region around the Sun over which the effect of the **solar wind** is extended.

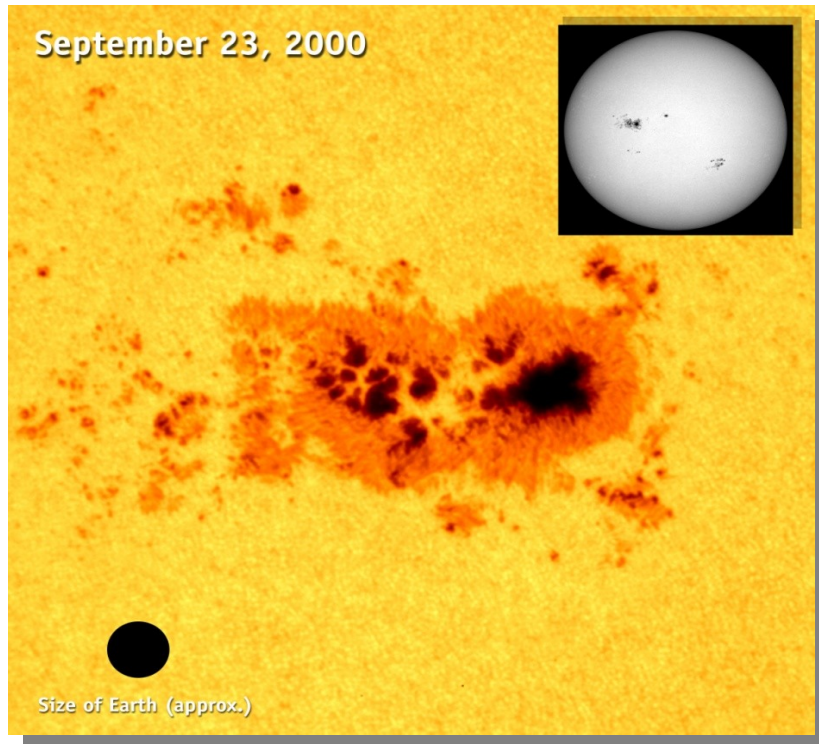


The Solar Wind

The Solar Wind is the **constant stream of charged particles**, protons and electrons, emitted by the Sun **together with its magnetic field**.



Solar Wind & Sunspots



Sunspots appear as dark spots on the Sun's surface.

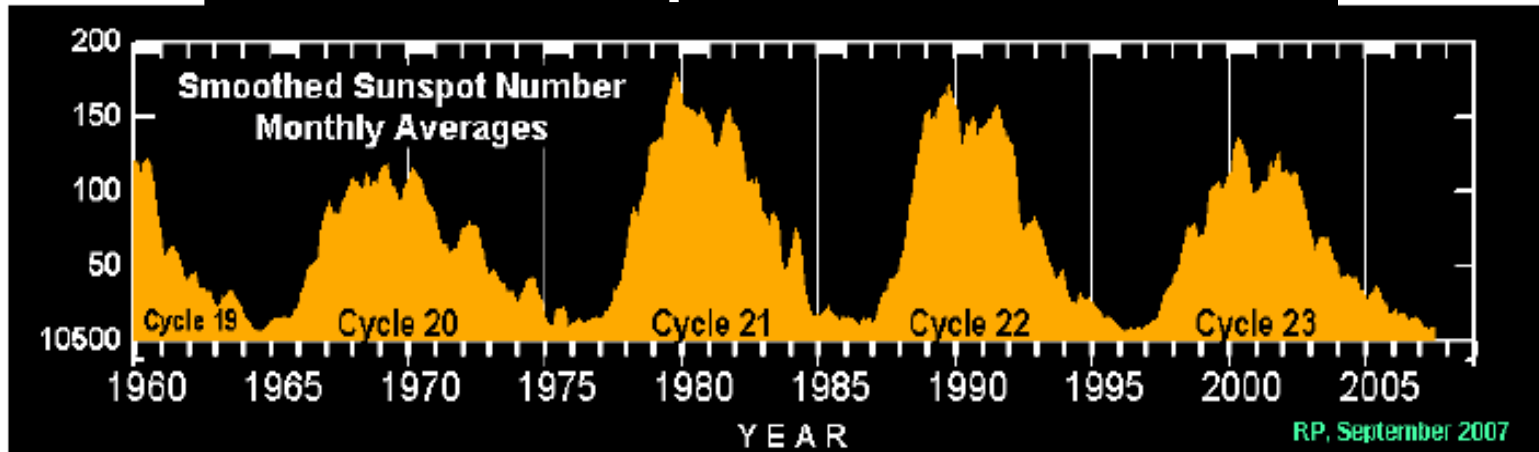
Sunspots are regions of strong magnetic fields. The Sun's surface at the spot is cooler, making it look darker.

It was found that the stronger the solar wind, the higher the sunspot number.

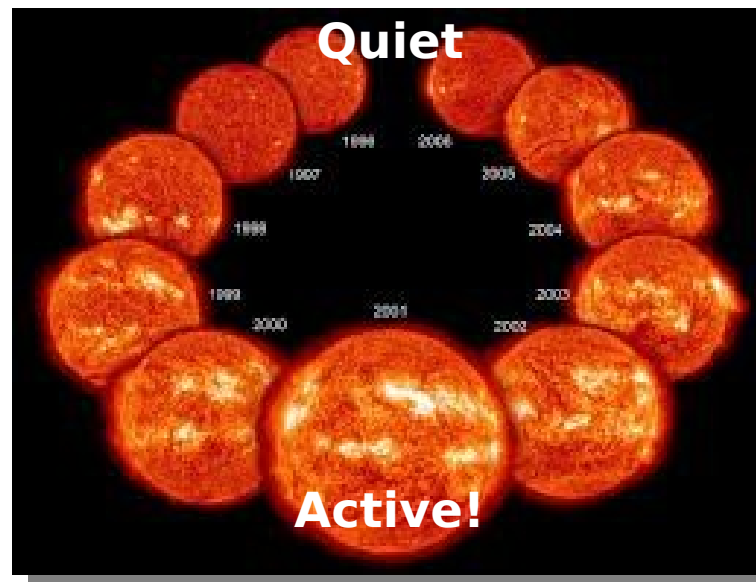
The sunspot number gives information about the Sun activity.

The 11-year Solar Cycle

**The solar Wind depends on the
Sunspot Number**

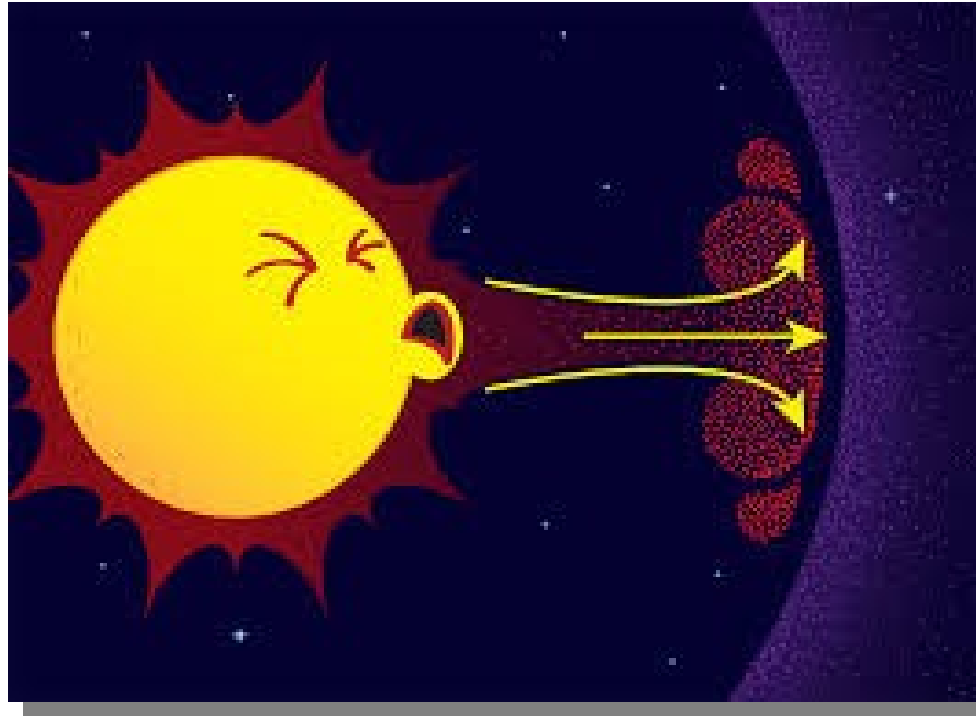


**At maximum
of Sun Spot
Number the
sun is Active**



**At minimum
of Sun Spot
Number the
sun is Quiet**

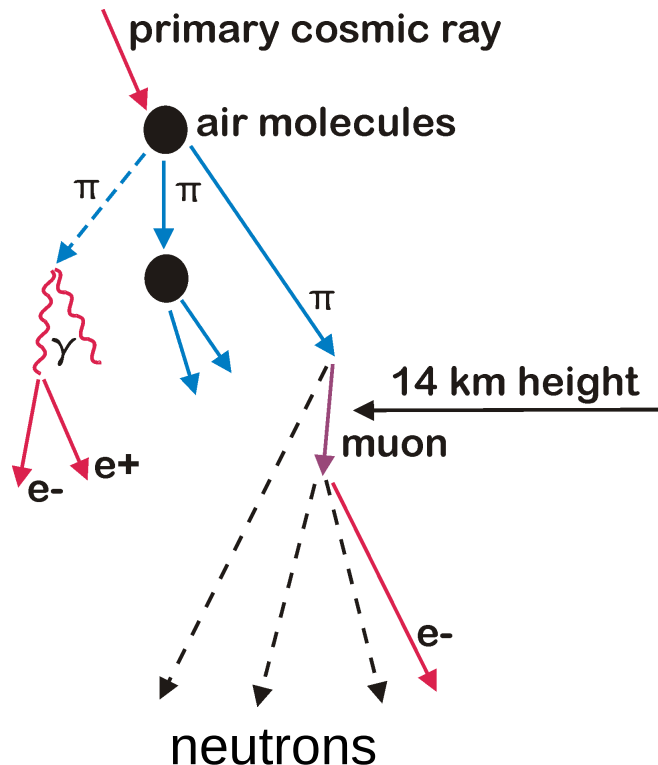
The Solar Wind & GCR



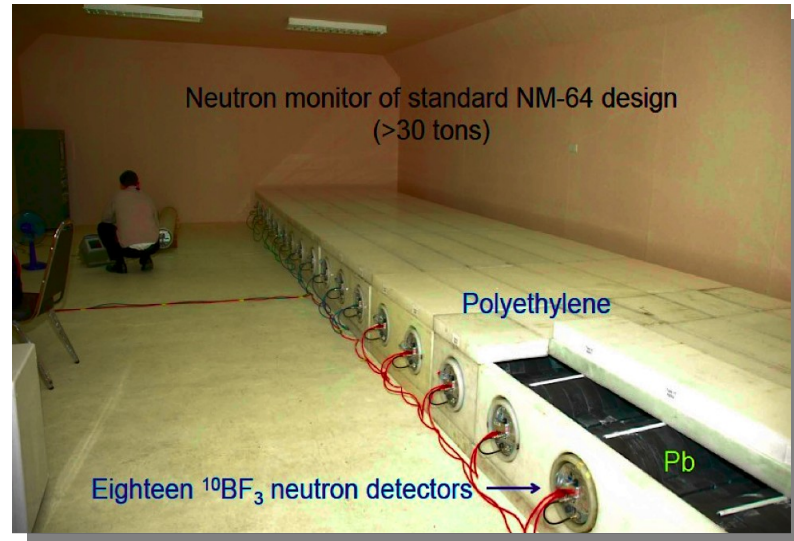
The number of Galactic Cosmic Rays entering the Heliosphere depends on the Solar Wind Strength:
the stronger is the Solar wind the less probable would be for less energetic Galactic Cosmic Rays to overcome the solar wind!

How do we measure low energy GCR on ground? With Neutron Monitors!

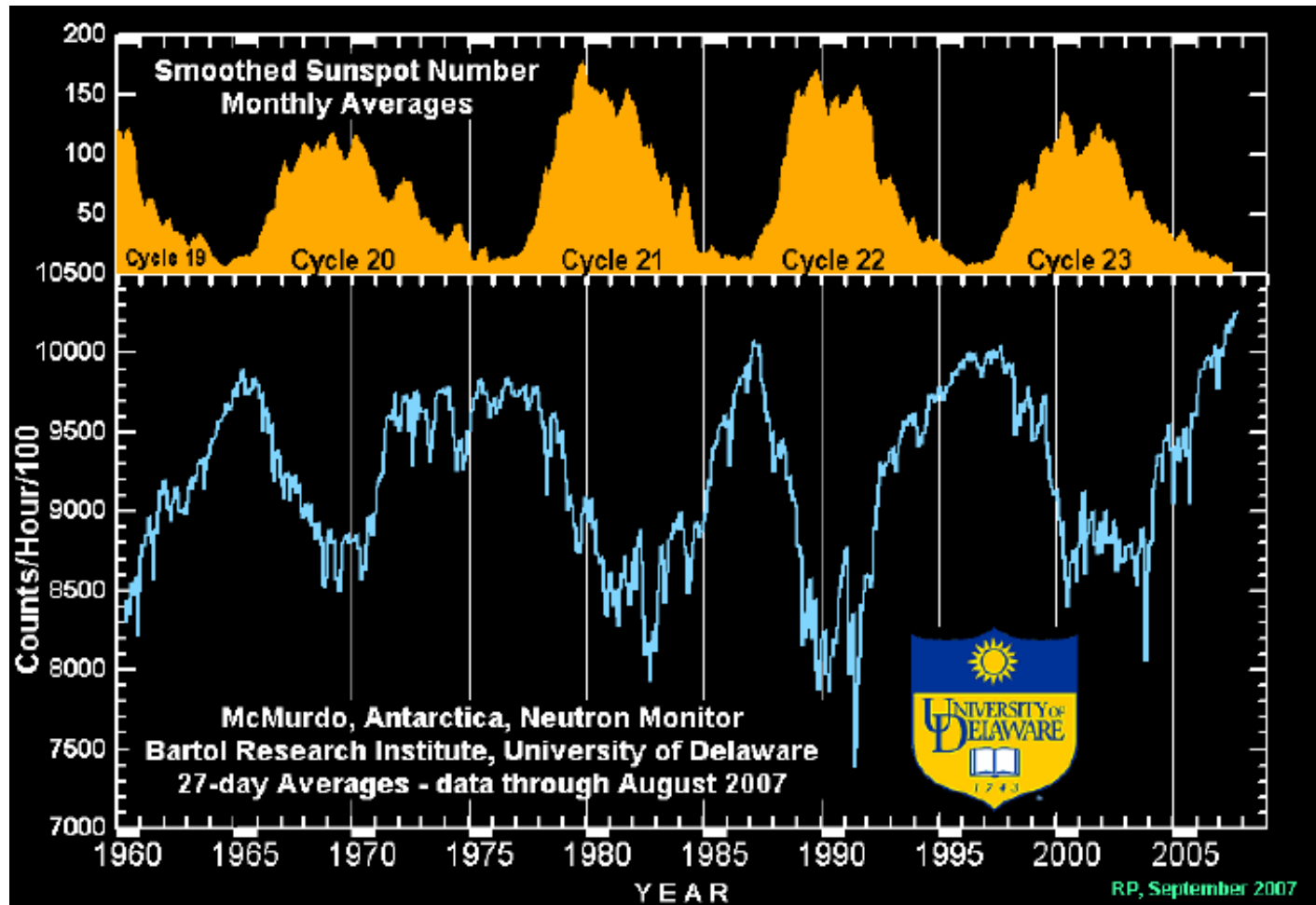
The **primary cosmic ray** has enough energy to start a cascade and produce secondary particles. Some of its **secondary products are neutrons** that will reach ground where they can be detected.



These detectors are commonly called **Neutron Monitors**



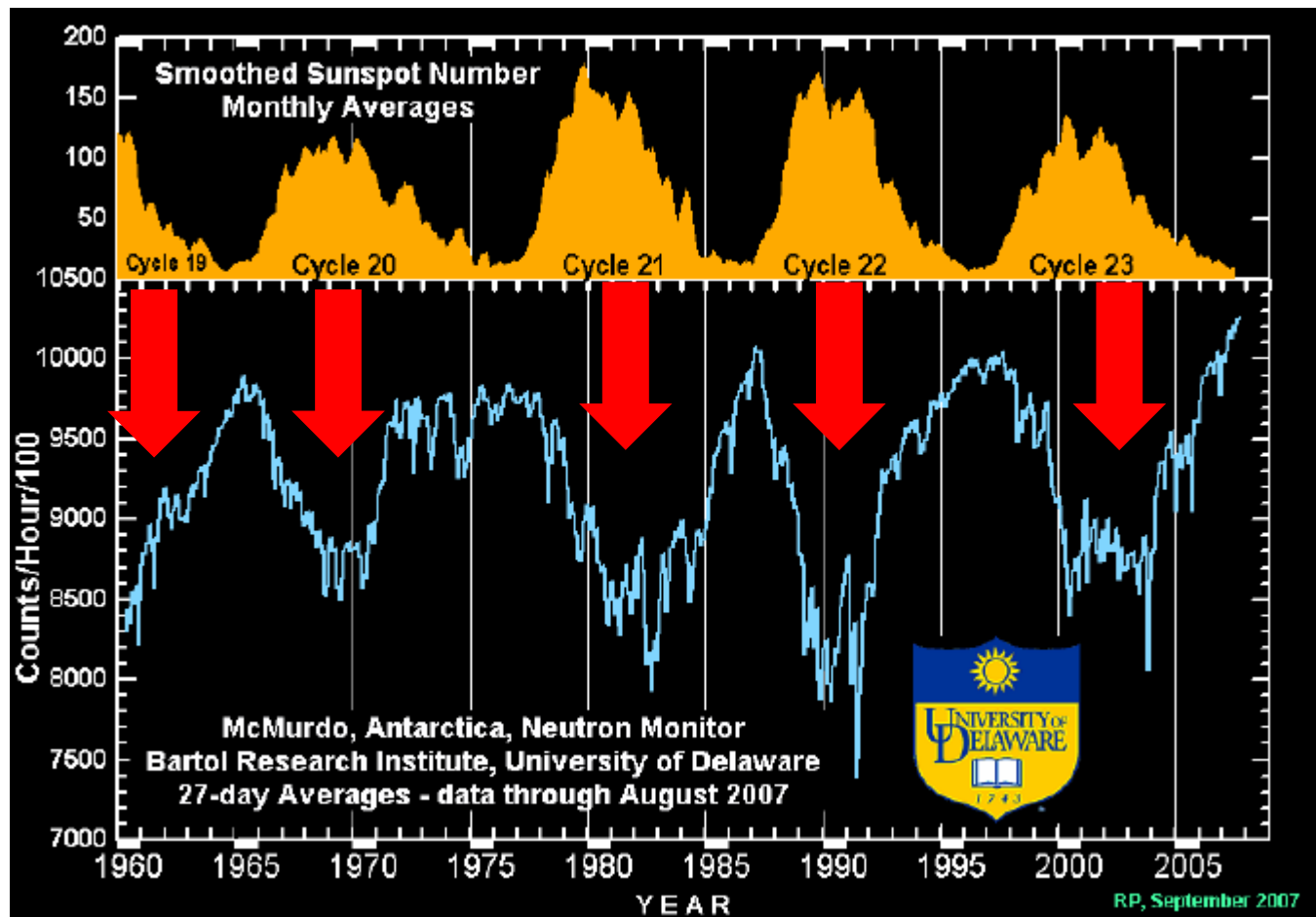
Sunspot Number and Galactic Cosmic Rays



Solar Modulation Effect

When the Sun is **Active** the Sunspot number increases and the solar Wind is stronger: we will have **less GCR!**

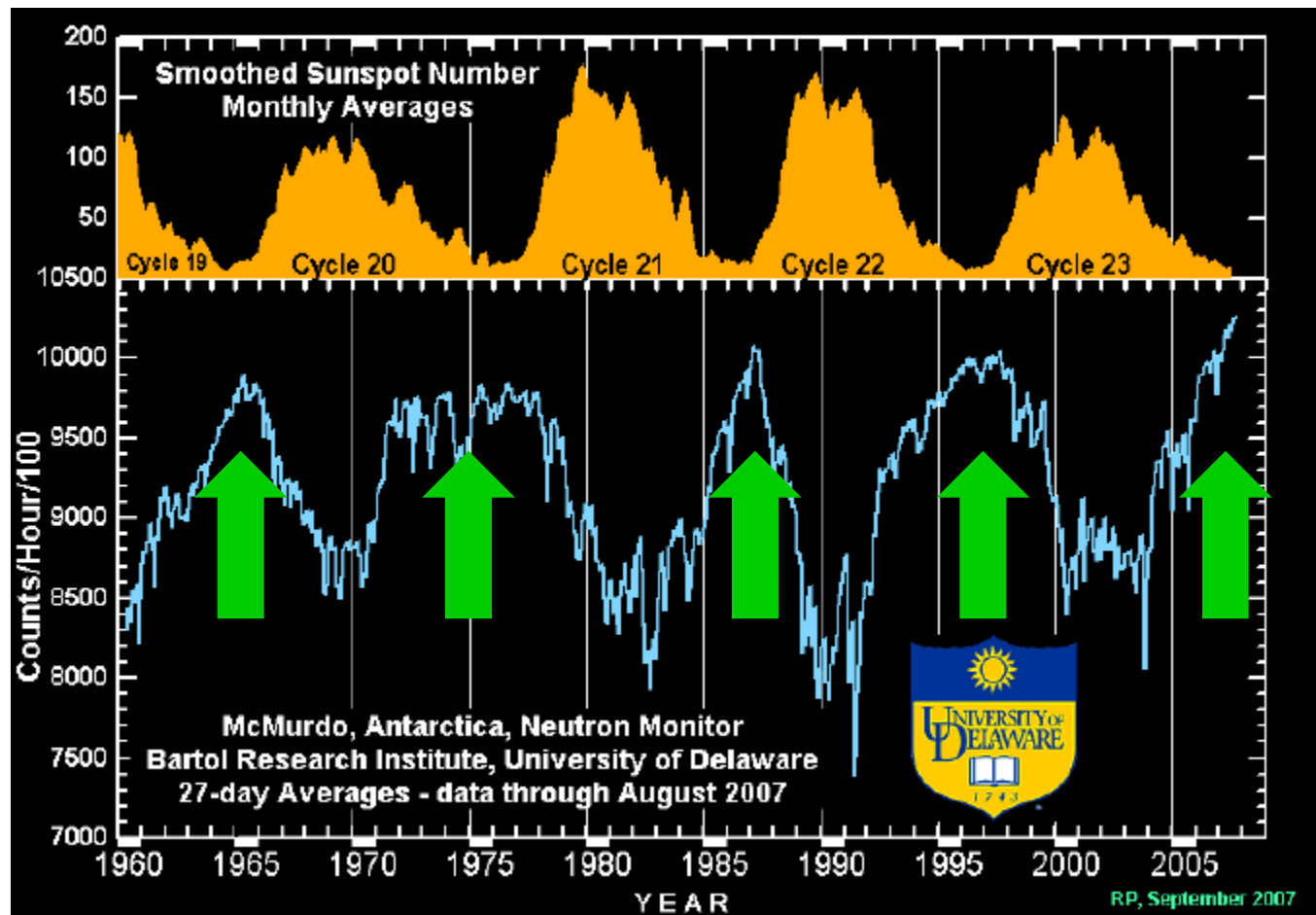
During Solar Maximum The GCR flux goes down!



Solar Modulation Effect

When the Sun is **Quiet** the Sunspot number reduces and the solar Wind is weaker: we will have **more GCR!**

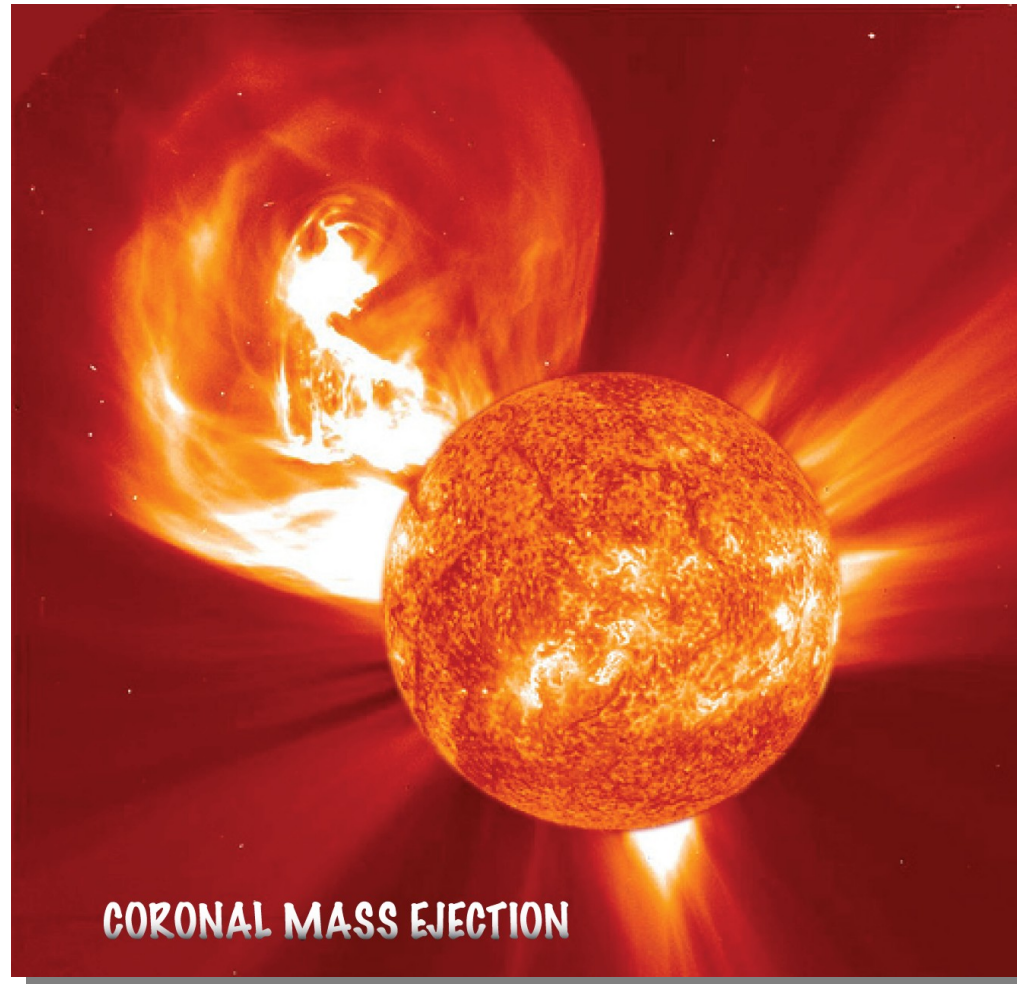
During Solar Minimum The GCR flux goes up!



Short Timescale Solar Activity

Coronal Mass Ejection

When the Sun is active it may emit Coronal Mass Ejections (**CME**):

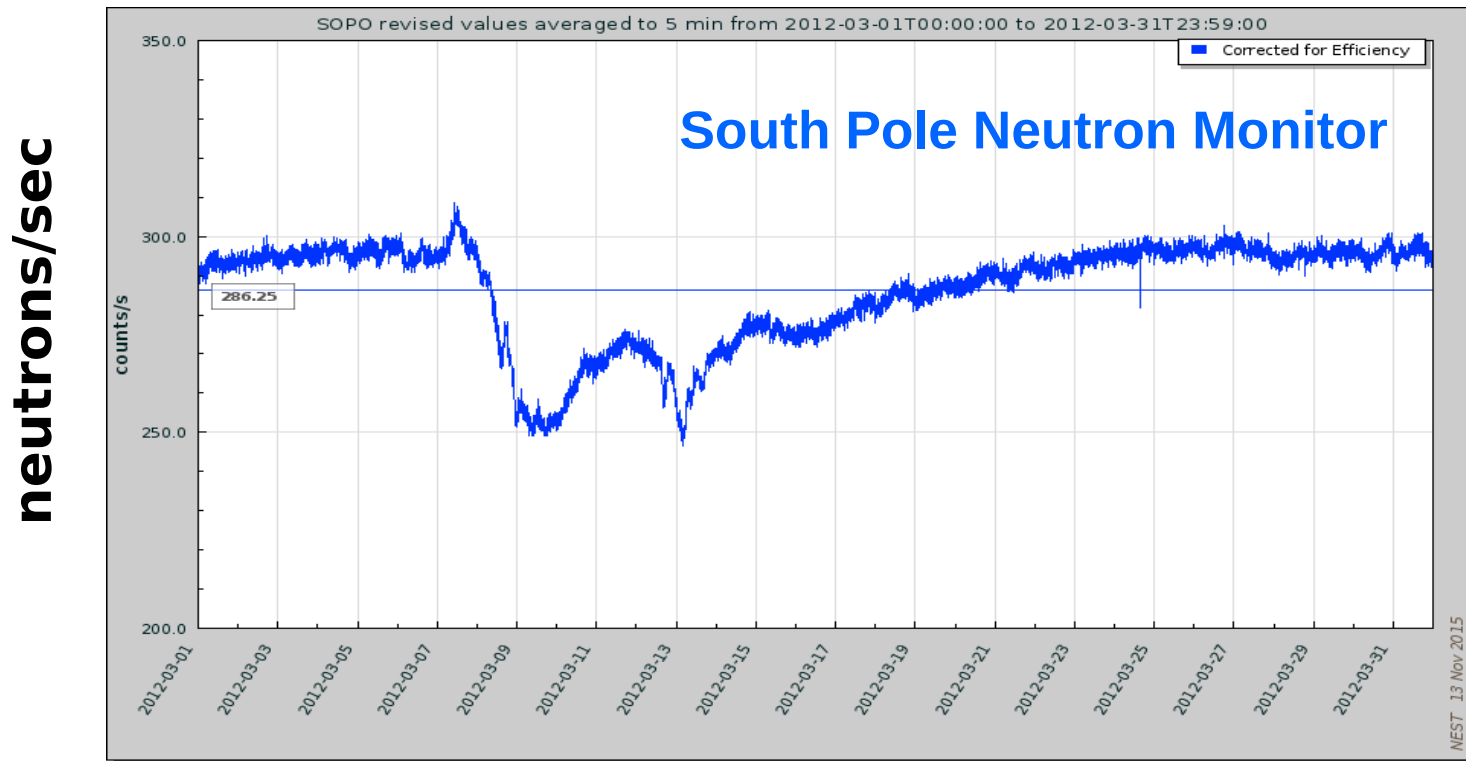


Short Timescale Solar Activity

GCR Forbush decrease

During CME the solar wind is stronger and the GCR may suddenly decrease for a short period of time:

this phenomena is called Forbush decrease

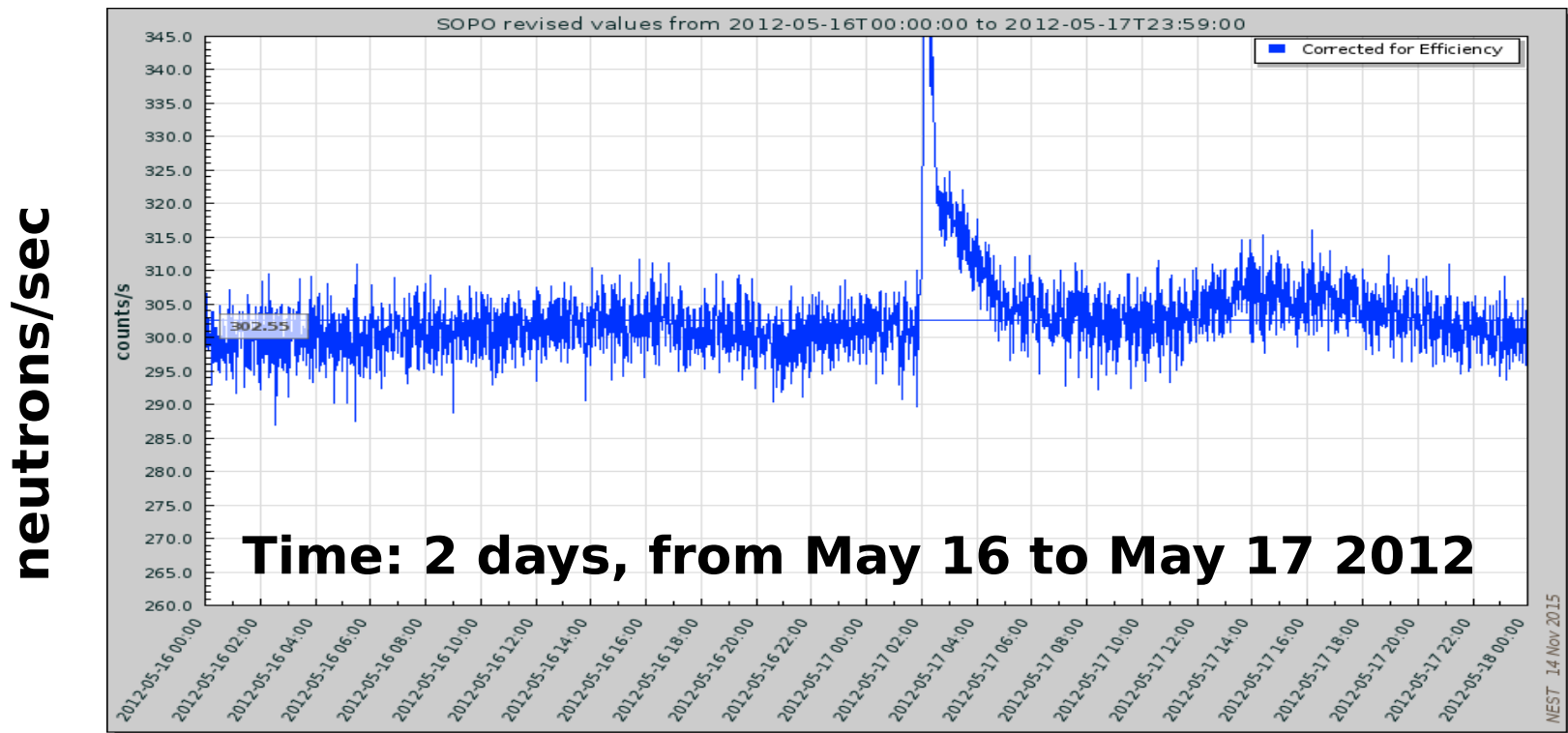


Time: 31 days, from March 1 to March 31 2012

Short Timescale Solar Activity

Solar Energetic Particles

When The Sun is active it may emit and accelerate Solar Energetic Particles (**SEP**):



The SEP number may exceed the GCR rate **and they can be observed as an excess of particles over the GCR.**

The Importance of monitoring these particles

Charged energetic particles as GCR and SEP may inflict **damage** to humans and electronic devices.

The more you go up the more you are exposed to these particles!

