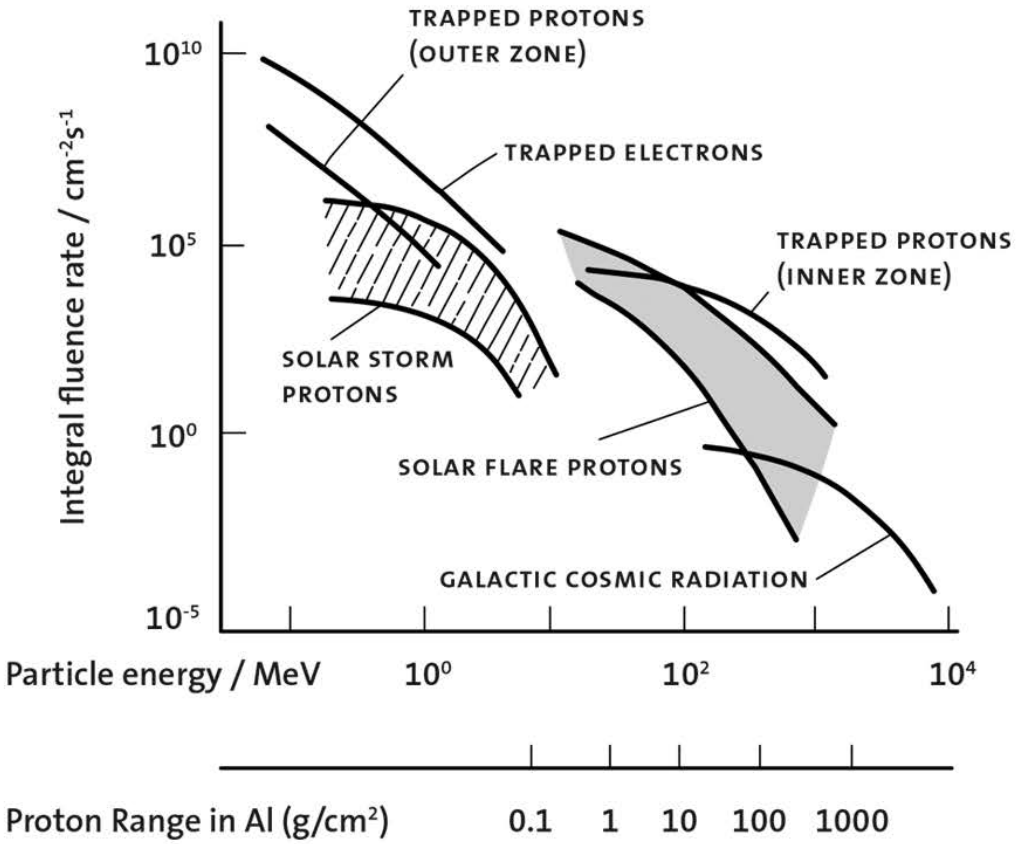
# Raditation sources - 3 main components





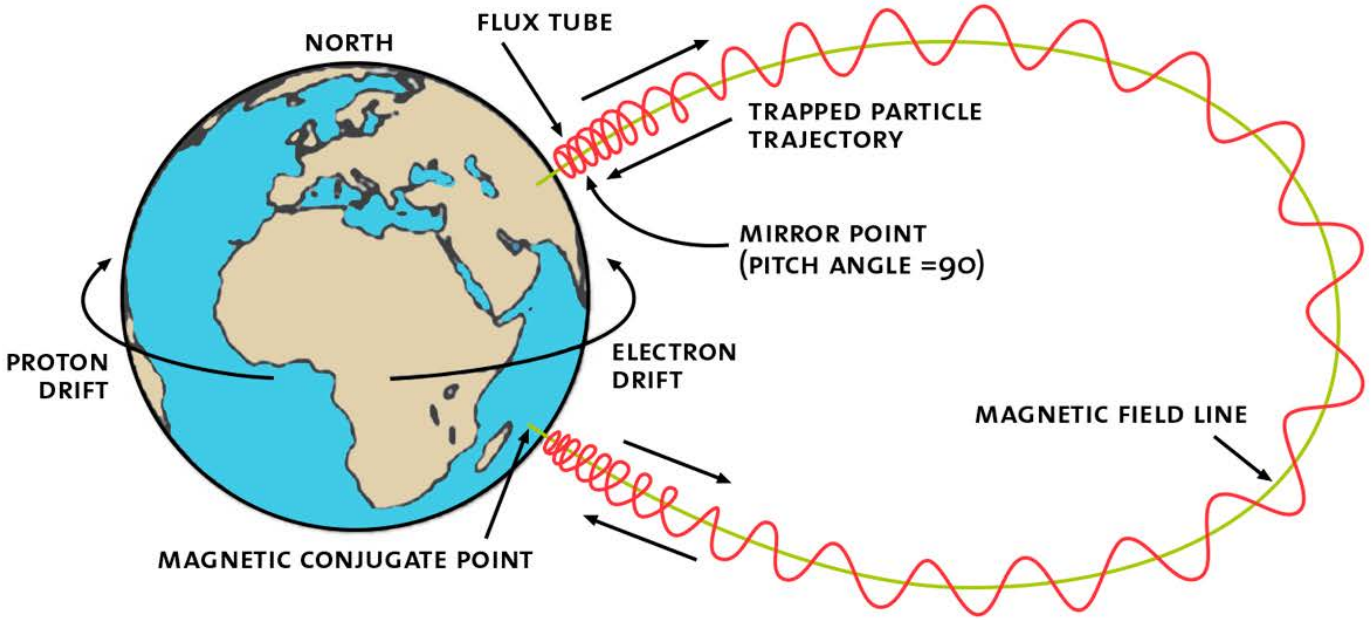
**PERSPECTIVE:**

A proton (p) has a mass with the equivalent energy ($E=mc^2$) of ca 1 GeV (938 MeV, exact).

Kinetic energy of 1 GeV for a p requires a speed of 0.88c (88% of the speed of light in vaccuum)

# Two radiation belts with trapped p and e (p only in the inner belt)

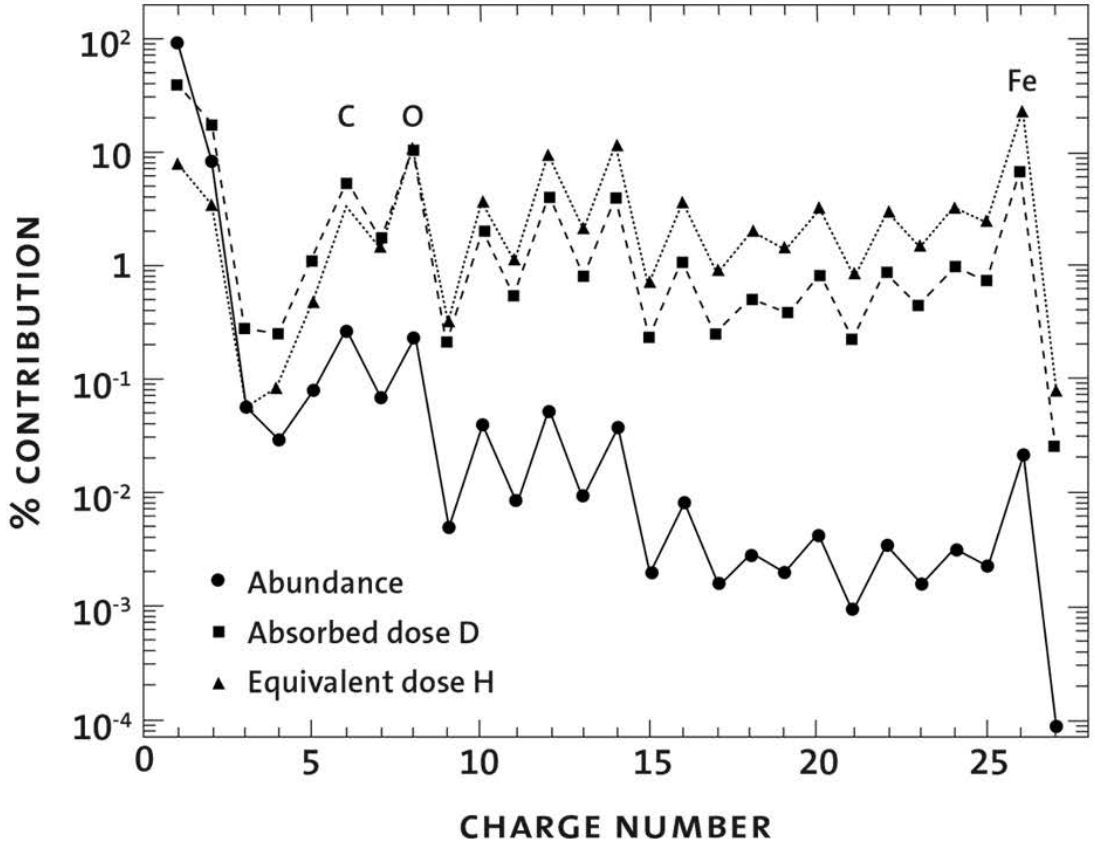




# Galactic Cosmic Rays (GCR)



Although "heavy ions" are few, due to high WR , their contribution to the biological hazards are large



# The 11-yr solar cycle influences all radiation sources

Sec 2.5

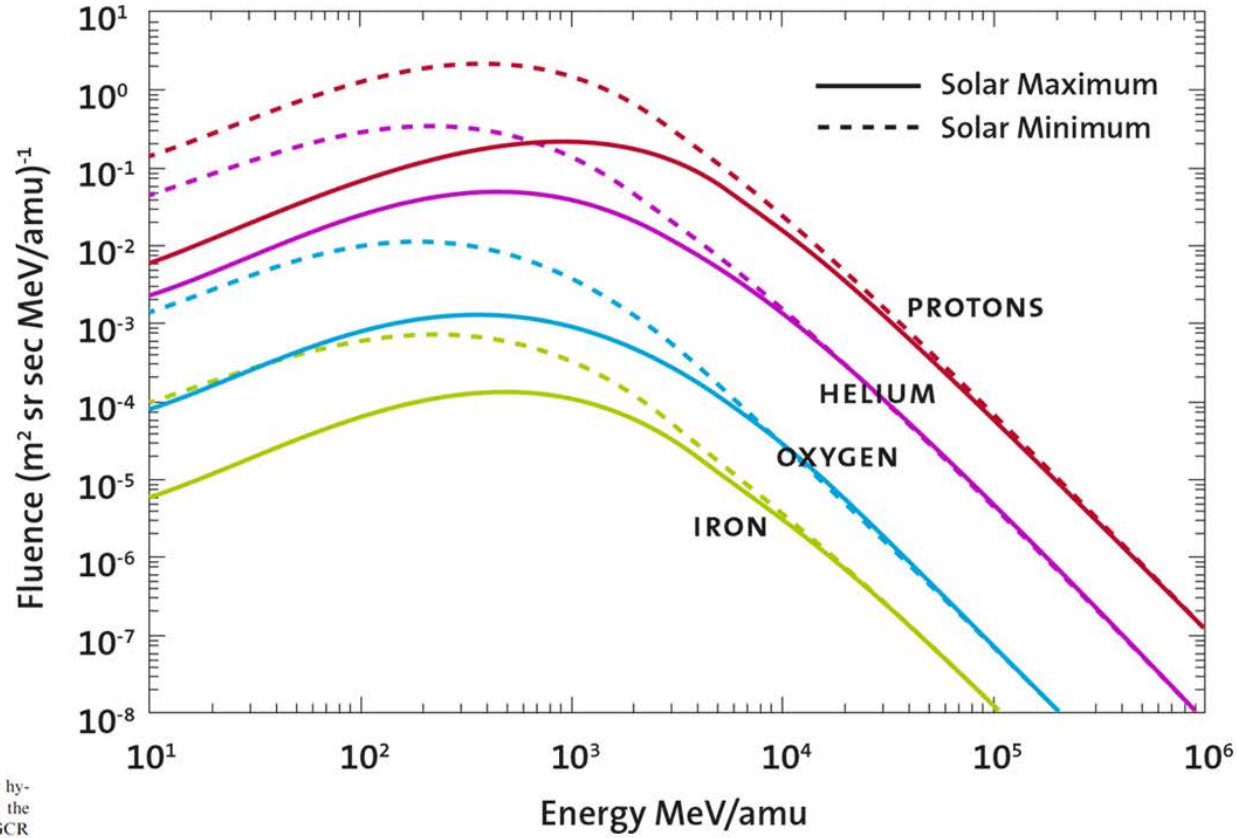
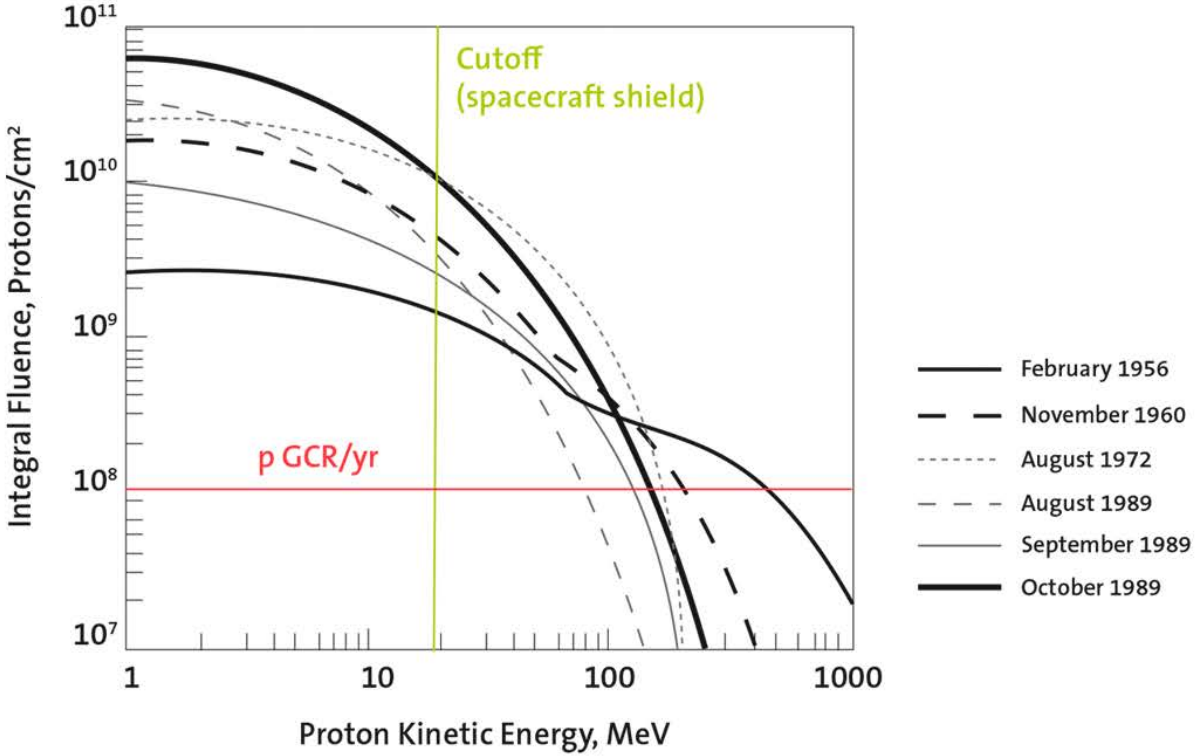



Fig. 3. Solar cycle effect on the GCR energy spectrum for hydrogen, helium, oxygen and iron. Increased intensity of the solar wind associated with solar maximum attenuates the GCR spectrum below ~1 GeV/amu [2].

# Some large solar particle events



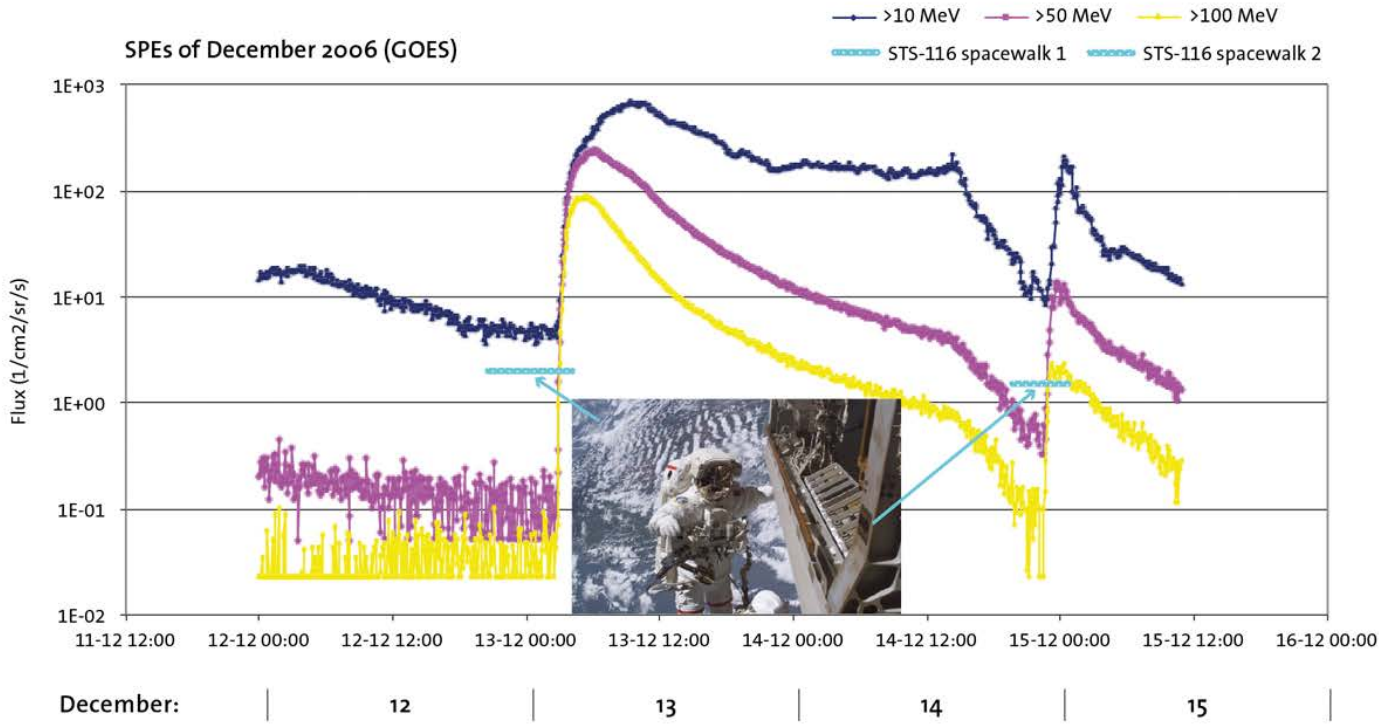
SPE:s contain mainly protons (fig.) and electrons (with E up to a few MeV). About 5-10 % α and 1 % heavy ions.




*Courtesy Marco Durante, ESTEC 2010*

# Particle flux seen by the GOES satellite from SPEs during spacewalks of STS-116





# One can ”see” the radiation in space