Dose and Radiation Effects Assessment During Future Missions to the Moon and Mars

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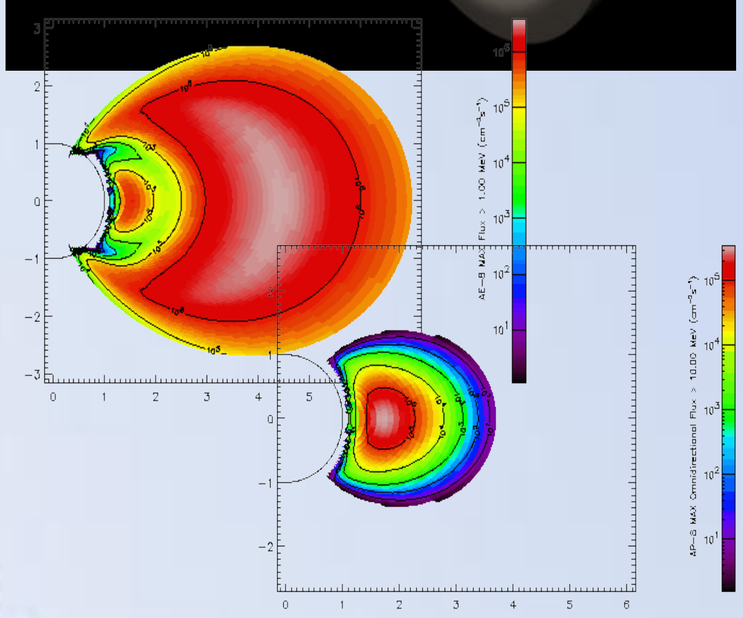
SEVENTH FRAMEWORK PROGRAMME

Main Radiation Sources

Van Allen Belts

- Protons
- Electrons

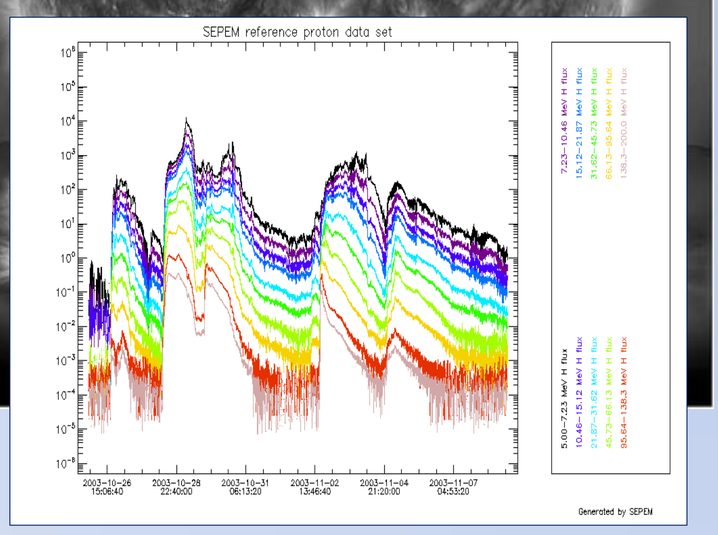
negligible for interplanetary travels - short time exposure



Solar Energetic Particles SEP

- Protons
- Helium nuclei

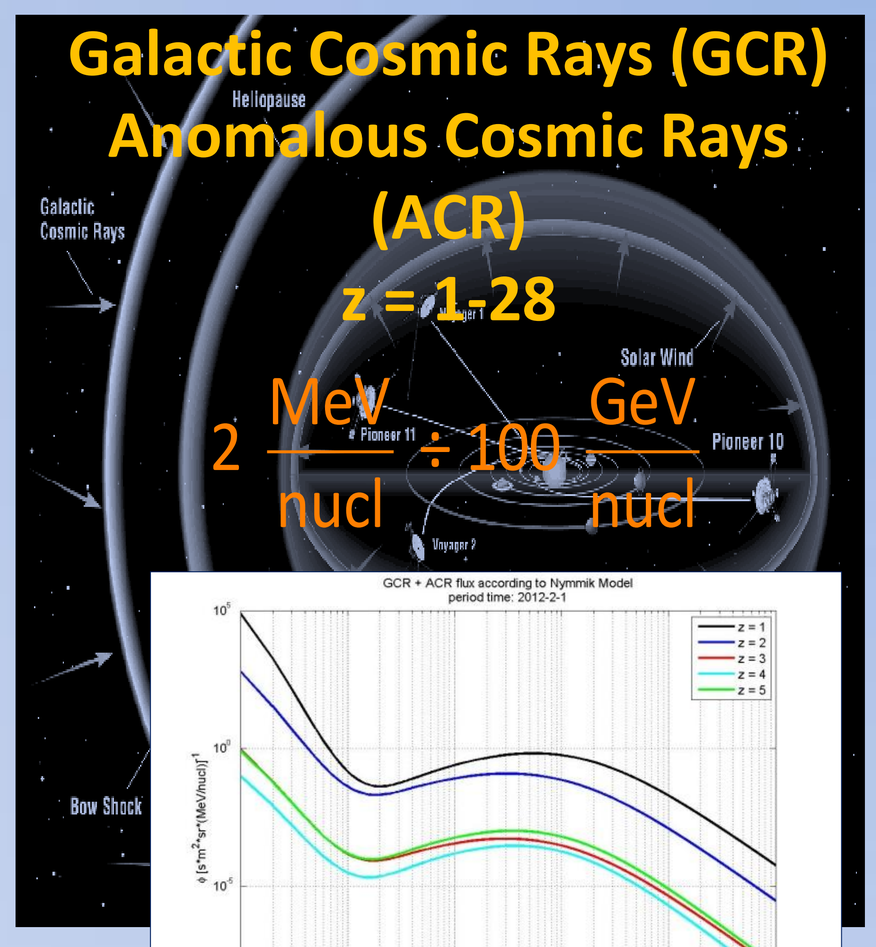
$5 \div 5 \cdot 10^2$ MeV



Galactic Cosmic Rays (GCR) Anomalous Cosmic Rays (ACR)

$z = 1 \div 28$

$2 \frac{MeV}{nucl} \div 100 \frac{GeV}{nucl}$

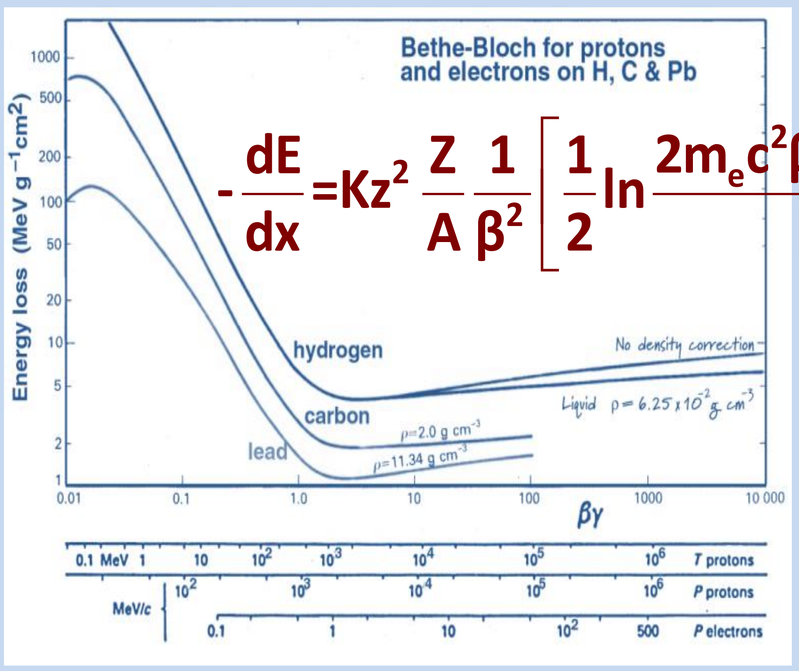


Purpose

The main purpose is to construct a code for the Dose Assessment, whose principal user inputs are:

- Time period to consider
- Data recorded by satellites or calculated through specific models (Nymmik Model for GCR+ACR)
- Info concerning shielding material and thicknesses
- Type of exposure

Core Equation



$$-\frac{dE}{dx} = Kz^2 \frac{Z}{A} \frac{1}{\beta^2} \left[\frac{1}{2} \ln \frac{2m_e c^2 \beta^2 \gamma^2 T_{max}}{I^2} - \beta^2 - \frac{C}{Z} - \frac{\delta}{2} \right]$$

Since the radiation sources are charged particles, the core of the code is the *Bethe-Bloch* formula used to calculate the energy released within matter, as a function of incoming particle energy and atomic number, as well as of the *target* physical properties

Output and Results

As output, the Code provides the *Effective Dose* and the *Ambient Dose Equivalent* assessment, according to the classical dose definitions and the radiation protection practices

$$D = \frac{energy}{mass} \left[Gy \right]$$

Considering the artificial or natural shielding, the Code obtains results by using specific *fluence-to-effective-dose* and *fluence-to-ambient-dose-equivalent* coefficients, which have been pre-calculated through experimental campaign or *Monte Carlo* simulations, and available in the literature (such as ICRP publications)

$$H = \sum_R w_R \cdot D \left[Sv \right]$$

$$E = \sum_T w_T \cdot H \left[Sv \right]$$

Feb 1st 2012 to Feb 8th 2012 – no recorded event				
	ACE	GOES-13	GOES-15	Nymmik Model (z = 1:28)
E [mSv]	0.45931	8.7935	7.9255	5.0563
H [mSv]	0.6494	7.8565	7.3445	0.94389

Mar 6th 2012 to Mar 13th 2012 – solar event recorded				
	ACE	GOES-13	GOES-15	Nymmik Model (z = 1:28)
E [mSv]	$4.0685 \cdot 10^{-2}$	70.092	63.733	5.04
H [mSv]	0.38549	166.87	153.68	0.94061

http://www.spaceweather.eu/biological_effects