



Istituto Nazionale di Fisica Nucleare



SAPIENZA  
UNIVERSITÀ DI ROMA

Pomeriggio Tematico:

*Space Radiobiology  
and  
Precision Galactic Cosmic Ray Measurements*

*on how the AMS02 experiment on the International Space Station can help the radiation health hazard assessment in exploratory space missions*

*A. Bartoloni, G. Cavoto*

In the last two decades many experiment was built and deployed in space to produce a complete inventory of charged particles and nuclei in cosmic-ray (CR). The physics goals are the study of CR properties, indirect search of Dark Matter and direct search of primordial antimatter. By now precise measurements of CR components exist in the energy region from few KeV to hundreds of TeV.

Such precision measurements can be used also to evaluate the health hazard of astronauts due to the exposure to ionizing radiation in exploratory space missions and are of interest for the space scientist (physicists, biologist, engineers, ...) working on space radiation and health.

These seminars are addressed to a broad audience of researchers and students of different discipline.

- We shall start with a detailed description of the AMS02 experiment installed since 2011 on the International Space Station, to which construction took part also a group of INFN Roma and Sapienza University people. AMS02 has collected up to now more than 146 billion CR events and its measurements has changed the current understanding of CR components.
- We shall then discuss the present and future research activities done by European Space Agency (ESA) for the radiation health hazard assessment in exploratory space missions.
- Finally, the problem related to space ionizing radiation in design and build a space infrastructure will be presented, with particular attention to shielding solutions for manned lunar/mars missions.

# Agenda

- 14:30-14:45

## **Introduzione**

*A.Bartoloni – INFN Roma (15 min.)*

- 14:45-15:35

**«High precision measurements of charged cosmic rays in space with the Alpha Magnetic Spectrometer.»**

*M.Paniccia – Università di Ginevra (40+10)*

- 15:35-16:20

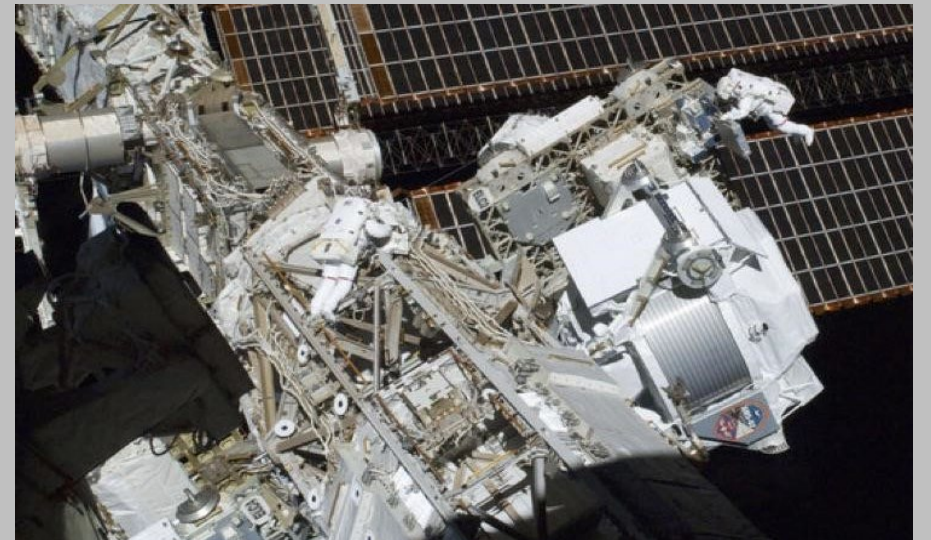
**«ESA Human Spaceflight Radiation Research Programme activities»**

*L.Surdo – European Space Agency (35+10)*

- 16:20-17:05

**«Shielding design for long duration human exploratory space missions : issues and future perspective »**

*M.Giraud – Thales Alenia Space (35+10)*



# High precision measurements of charged cosmic rays in space with the Alpha Magnetic Spectrometer

Dr. Mercedes Paniccia – Università di Ginevra



The Alpha Magnetic Spectrometer (AMS) is the most powerful and sensitive cosmic-ray detector ever deployed in space to produce a complete inventory of charged particles and nuclei in cosmic rays near Earth in the rigidity (momentum/charge) range from GV to few TVs. Its physics goals are the study of cosmic-ray properties, indirect search for Dark Matter and direct searches for primordial antimatter and exotic form of matter. The improvement in accuracy over previous measurements is made possible through its long duration time in space, large acceptance, built-in redundant systems and its thorough pre-flight calibration in the CERN test beam. These features enable AMS to analyse the data to an accuracy of  $\sim 1\%$ . Since its installation on the International Space Station in May 2011, AMS has collected more than 146 billion cosmic-ray events and has produced precision measurements of electron, positron, proton, antiproton, and helium to oxygen nuclei fluxes in cosmic rays of rigidity ranging from GV to few TVs, as well as the helium isotopic composition in the 2.1 GV to 21 GV rigidity range. The percent precision of the AMS results challenges the current understanding of the origin and of the acceleration and propagation mechanisms of cosmic rays in the galaxy and thereby requires new theories to be developed by the physics and astrophysics community. In this talk, after a brief introduction to cosmic-ray physics, I will present the latest AMS results, pointing out their implication for cosmic-ray modelling and for Dark Matter searches.



**UNIVERSITÉ  
DE GENÈVE**

**FACULTÉ DES SCIENCES**

Département de physique  
nucléaire et corpusculaire

## “ESA Human Spaceflight Radiation Research Programme activities”

Dr. Leonardo Surdo – European Space Agency



Space radiation has long been recognized as a potential showstopper for long duration human exploration missions: crewmembers will be exposed to different doses and qualities of radiation, threatening life quality and individual survivability, thereby disrupting mission success. When assessing the risks related to radiation in human exploration scenarios, high uncertainty remains about the biological effects of this space radiation. To support research enabling safe and stable human space exploration with acceptable risk from exposure to space radiation, the European Space Agency has intensified its efforts to advance knowledge on quantifying the risks and actual exposures to radiation in space to allow developing effective countermeasure strategies to protect crewmembers from the damaging effects of space radiation.



European Space Agency  
Agence spatiale européenne



# *“Shielding design for long duration human exploratory space missions : issues and future perspective”*

Dr. Martina Giraudo - Thales Alenia Space



“As manned spaceflights Beyond Low Earth Orbits (BLEO) are in the agenda of space agencies, concerns related to the astronaut space radiation exposure are still under discussion and without conclusive solutions.

In BLEO missions, outside the protection provided by Earth’s atmosphere and magnetic field, the astronauts will be exposed to the full spectrum of space radiation.

Many uncertainties characterize indeed the radiobiological effects and the nuclear interactions with the spacecraft materials of this high energy radiation found in space, in particular when the Galactic Cosmic Rays (GCR) are concerned, and no definitive shielding solution has been found. For this reason risk assessment of long-term detrimental health effects for a deep-space mission is a difficult task.

A long term space exploration mission requires to mitigate the effects of GCR and, at the same time, emergency countermeasures must be planned to avoid the short-term consequences of exposure to Solar Particle Events (SPE), able to impair mission success and to endanger astronauts’ life.

The various themes related to the design of shielding for deep space human missions will be presented and discussed, focusing on the work done in Thales Alenia Space and discussing possible developments. “



# Locandina pomeriggio tematico 4/11/2019

## SPACE RADIOBIOLOGY AND PRECISION GALACTIC COSMIC RAY MEASUREMENTS

ON HOW THE AMS02 EXPERIMENT ON THE INTERNATIONAL SPACE STATION CAN HELP THE  
RADIATION HEALTH HAZARD ASSESSMENT IN EXPLORATORY SPACE MISSIONS

LUNEDÌ 4 NOVEMBRE 2019

DIPARTIMENTO DI FISICA – AULA CONVERSI



14:30-14:45  
Introduzione  
*A. Bartoloni – INFN Roma*



14:45-15:35  
High precision measurements of charged cosmic rays in space with the Alpha Magnetic Spectrometer.  
*M. Paniccia, Università di Ginevra*



15:35-16:20  
ESA Human Spaceflight Radiation Research Programme activities.  
*L. Surdo, European Space Agency*



16:20-17:05  
Shielding design for long duration human exploratory space missions : issues and future perspective.  
*M. Girauda, Thales Alenia Space*



Versione abstract per bollettino (150 paro



Istituto Nazionale di Fisica Nucleare

Pomeriggio Tematico:

*Space Radiobiology  
and*

*precision Galactic Cosmic Ray Measurements*

*on how the AMS02 experiment on the International Space Station can help the radiation health hazard  
assessment in exploratory space missions*

*A. Bartoloni, G. Cavoto*



SAPIENZA  
UNIVERSITÀ DI ROMA

In the last two decades many experiment was built and deployed in space to produce a complete inventory of charged particles and nuclei in cosmic-ray (CR). The goals are the study of CR properties, search of Dark Matter and antimatter, but potentially can be used to evaluate the health hazard of astronauts due to the exposure to ionizing radiation in space missions.

We shall start with a detailed description of the AMS02 experiment, to which construction took part also INFN Roma and Sapienza University. AMS02 has collected up to now more than 146 billion CR events.

We shall then discuss the present and future research activities done by European Space Agency (ESA) for the radiation health hazard assessment in exploratory space missions.

Finally, the problem related to space ionizing radiation in design and build a space infrastructure will be presented, with particular attention to shielding solutions for manned lunar/mars missions.