

AMS Roma Group Research Activities 2018-2019

AMS Roma SPRB Project

«SPace RadioBiology investigations using AMS-02 experiment on the ISS»

June 2017 – A proposal for a research collaboration with IRE-IFO institute to use of AMS Data for Space Radiobiology research activities.

Proposers

Dr. A. Bartoloni (INFN ROMA)
Drs. L. Strigari (IRE-IFO)
Prof. B. Borgia (INFN Roma and Sapienza)
Dr. G. Bossi (IRE-IFO)

Target

“Production of new models of the expected damage of ionizing radiation exposure in space to be used for Space dose characterization and new dosimetry instrumentation design”

September 2017 – Project Approved by INFN Roma and INFN National Scientific committee II.

October 2017 – Grant of about 20K euro from Italian Space Agency for support to the SPRB project

07.10.2017

Research Project Proposal

Space Radiobiology investigations using AMS-02 experiment on the International Space Station (ISS)

Project Name
Space Radiobiology studies using AMS-02 experiment on the International Space Station (ISS)

Research Institutions
INFN
IRE - IFO

Research Leaders
Ing. Alessandro Bartoloni
Drs Lidia Strigari

Research Collaborators
Prof. Bruno Borgia
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Prepared By
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Scope Summary

On May 2011, the Alpha Magnetic Spectrometer (AMS-02), has been installed on the International Space Station, to measure with high accuracy the Cosmic Rays (CR) properties.

AMS-02 is the result of nearly two decades of effort of an international collaboration, to design and build a state of the art detector capable to perform high precision Cosmic Rays measurement.

By the day, more than 102 billion CR events have been collected and the duration of the AMS mission on the ISS has been approved until the end of 2024.

The scope of this research is use the capability of charged particle measurement of AMS to investigate and modelling the ionizing radiation damage on living things in the space environment (ISS, manned solar system exploration, ...).

Living things in the solar system are continuously exposed to Galactic Cosmic Ray (GCR) particles and rarely to more energetic particle emitted by the Sun named Solar Energetic Particles (SEP)

The research will produce new models of the expected damage of ionizing radiation exposure in space using the information on doses and spectra calculated using the AMS data by comparison with the data collected in the “ground environment”.

The produced models will be useful for characterization of expected doses and used to design R&D activities for new dosimetry instrumentation for space.

The research will be conducted in collaboration with the IRE IFO research institute (www.ifo.it) using the following knowledge and skill:

- AMS detectors, Solar Physics Data Analysis (INFN)
- Radiobiology, Modelling of Ionizing Radiation Damage (IRE-IFO)

INFN-ROMA AMS2 Group

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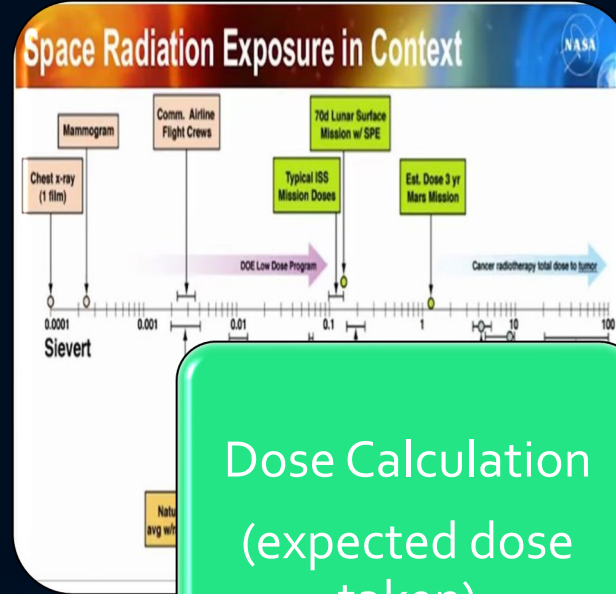
www.ams02.org
www.infn.it



Why this collaboration between INFN & IFO on SpaceRadiobiology



ISS-AMS-Data
(spectrum of
ionizing particles
in space since
2011)



Dose Calculation
(expected dose
taken)

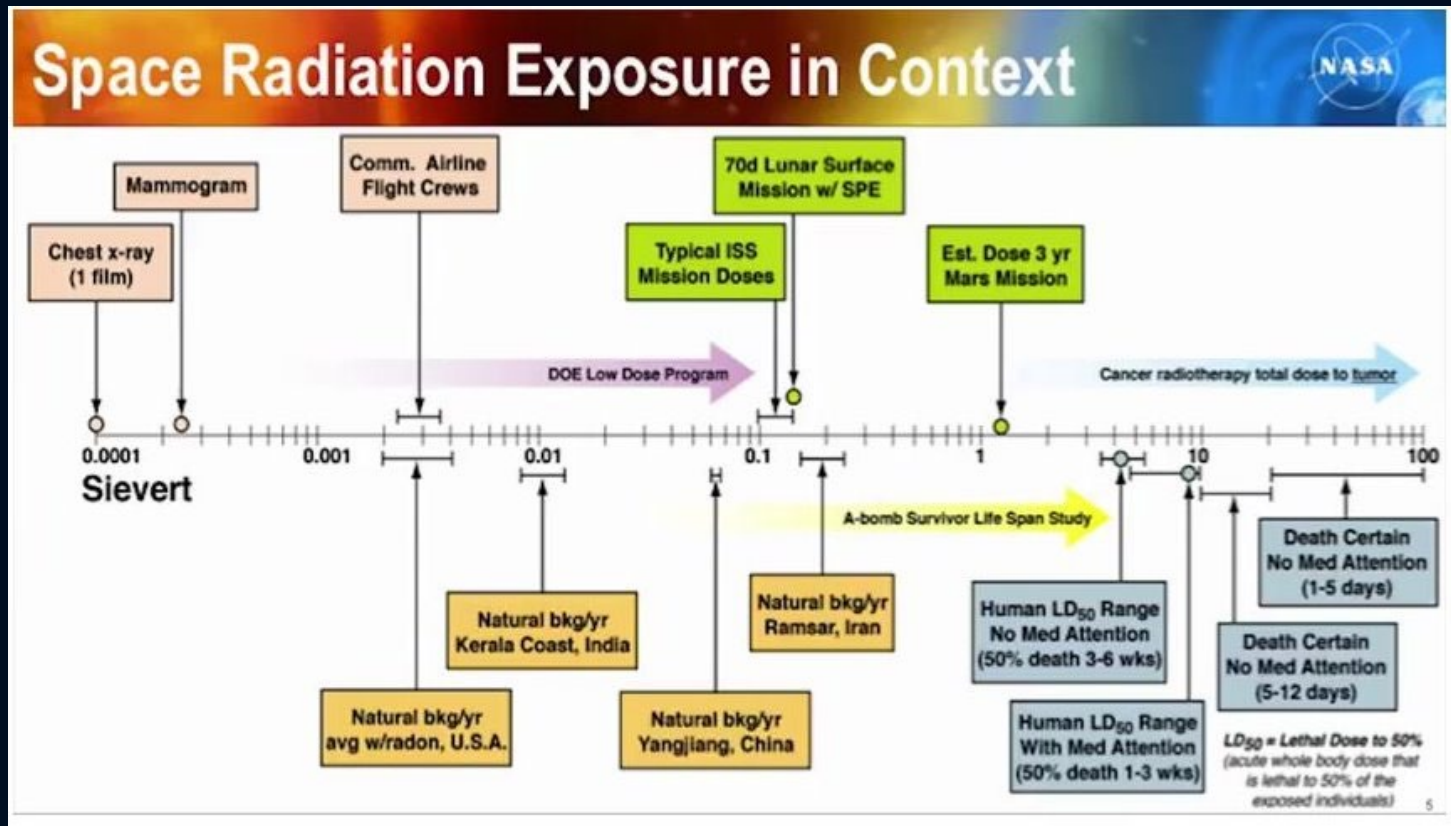


Biological Damage
(effects on living things)

Exposure in Space

- Typical mission doses on International Space Station (ISS) **100-150 mSv**
- Interplanetary Space natural Background/year **400-600 mSv**
- Charged Particle event (Solar Flare) dose on moon with no shielding **0.5-2 Sv**
- Estimated dose for 3-years Mars mission with shielding **1.5 Sv**

Nasa Human Research Program point of view

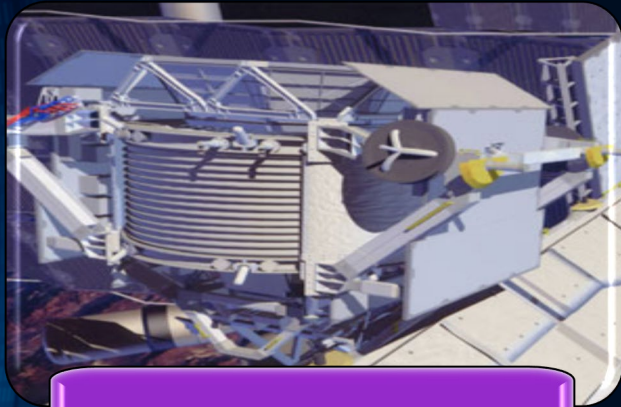


WHAT IS ONE OF THE GREATEST CHALLENGES FOR AN ASTRONAUT ON THE JOURNEY TO MARS?

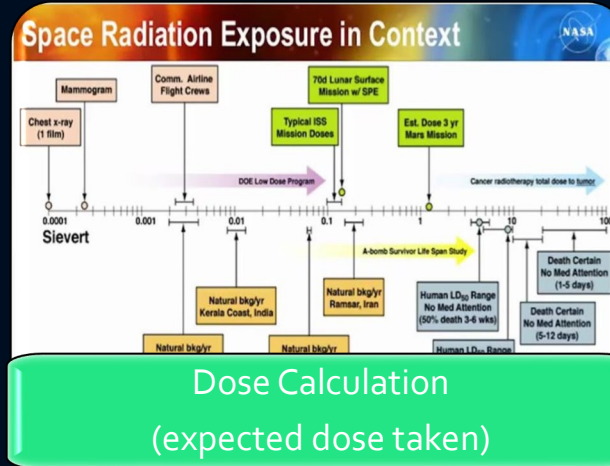
- Radiation exposure, both in-flight and long-term consequences



Why this collaboration between INFN & IFO on SpaceRadiobiology



ISS-AMS-Data

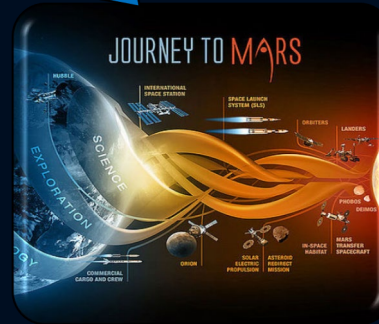
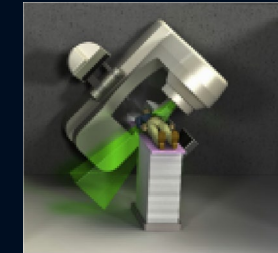
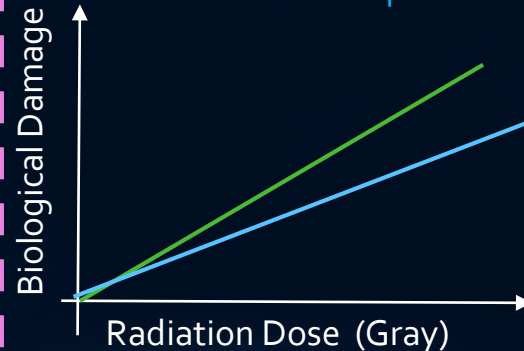


Experimental setup and measurements to assess the Biological Damage (effects on living things)

Development/validation of RB models Using Proton/Nuclei Accelerator Test Facilities/ experiment from space (i.e. ISS,...)

(Spectrum of ionizing particles in space since 2011) -> Dose (Gray)

Review of Radiobiological Models comparing results from clinical and Space RB



SPRB Research Target

2018 – a year of thinking and understanding, an outline... (1/2)

- **People**

AMS ROMA group grew up, 2 new persons join AMS and SPRB project

- Elena Solfaroli Camillocci
- Emiliano Loi
- **Topics of interest for AMS SPRB project studies**
 - Human Space Exploration
 - Radiobiology & Radiotherapy
 - Space Radiation
- **Contacts**
 - Stefano Della Torre INFN-MIB
 - Matteo Duranti INFN-PG
 - Alberto Oliva CIEMAT
 - Valeria De Felice ASDC

Thanks to all for collaboration, support and patience !!

- **AMS Data**

- AMS data analysis flux tools and knowledge acquisition
- AMS data of interest for Radiobiology research definition

2018 – a year of thinking and understanding, an outline... (2/2)

- **Master degree thesis available at Sapienza University**

- «Data Analysis of satellite experiment aiming at developing a low orbit radiation monitor at the Italian Space Agency» (V. De Felice - A.Bartoloni)
- «Study of the synergistic effects between the measures of AMS02 and the dosimetry data of radiotherapy as a tool to improve the prediction of dose-effect relationships» (L.Strigari - A.Bartoloni)

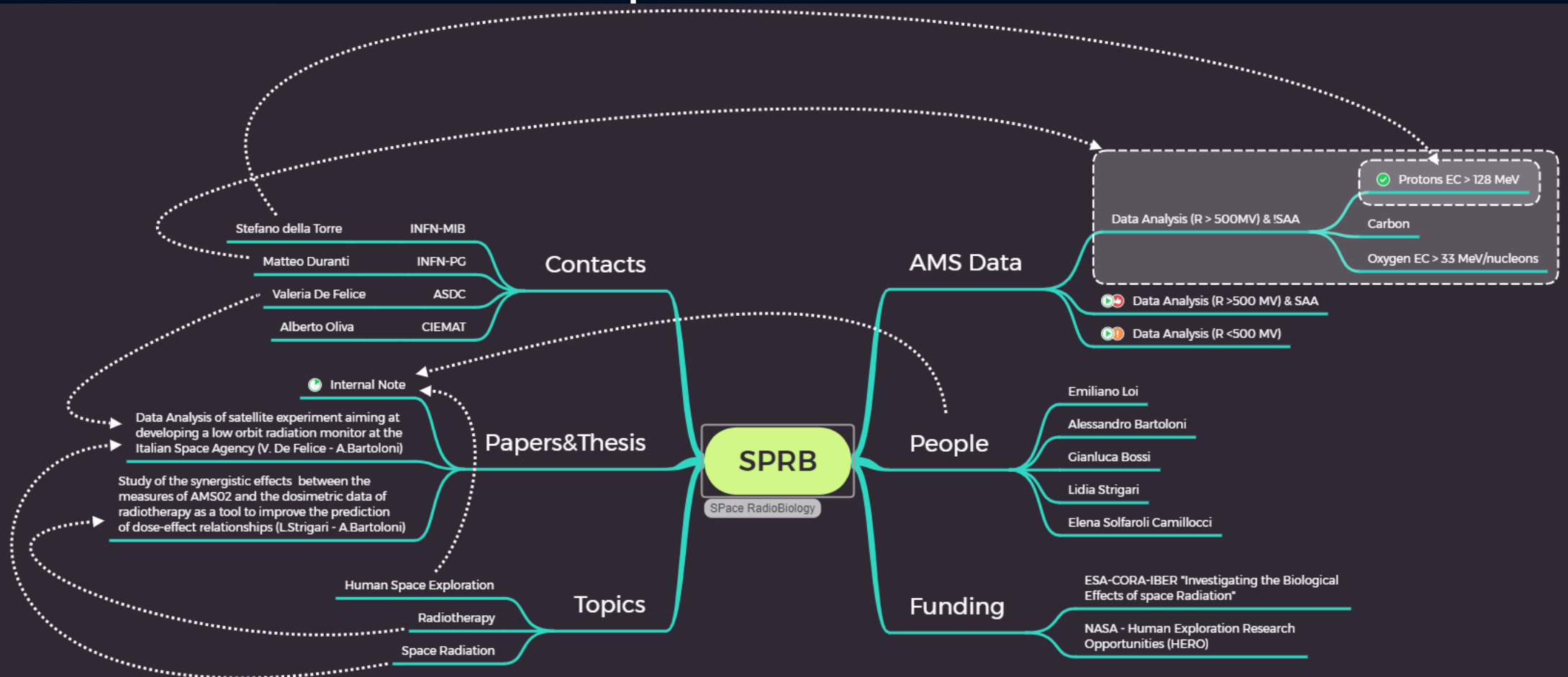
- **Funding**

since INFN AMS Roma funds priority is for AMS operations support and participation (No operations, No data, No Research!) we started to investigate possible alternative solution for funding in the fields

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- ESA-CORA-IBER "Investigating the Biological Effects of space Radiation"
- NASA-HERO Human Exploration Research Opportunities - *require a US partnership!*

...and a «mind map».



2019 – Activities and future perspectives

- 31/01/2019 AMS SPRB Group meeting
 - To study and compare the recently proposed dose-effect models for cosmic rays and clinical RT
 - To conduct the AMS data analysis focused to space dose calculation
 - i.e. to determine the Low energy (50-500 MeV) proton spectrum from the analysis of data using measures collected during 10 or more orbits
 - To propose and setup model validation using test beam at ESA accelerator facilities (ESA-CORE-IBER initiative)

2019 activities

Backup slide

Space Radiobiology @AMS

- First step - definition of the topic:
 - Identification of the cosmic ray spectrum of interest for SRB
 - kind of particles: mainly proton, helium nuclei
 - secondary due to interaction with spacecraft: mainly photons and electrons
 - their energy spectrum (order of 100MeV/u)
 - Study of the particle energy spectrum selected by AMS with potential radiation biological damage
 - Study in literature focused on dose effect model for SRB
 - Dedicated review in progress
- Results – preparation of a review related on space radiobiology on ISS

Starting Tools

- Set-up of a Geant4 workstation for AMS detector simulation and data acquisition.
- Structuring of data analysis methodology for SRB study.
- Investigation of funding calls on topic.

Data analysis

- Study of the AMS detector peculiarities
- Identification of AMS trigger menus suitable for SRB study
- Extraction from pre-processed AMS data ntuple
- Definition of the structure for SRB_ntuple (in progress)

Next steps

- Elaboration of a SRB dose-effect model based on AMS data
- Development of a SRB-dedicated Monte Carlo simulation for radio biological dose effects
- Design of a “ground experiment” with proton beam on in vitro cells and animal model
- Validation of Monte Carlo results with experimental data