PROCEEDINGS OF SCIENCE

"So Far, So Close": Communicating Science through a Replica of the Alpha Magnetic Spectrometer Payload Operation Control Room

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Abstract: This paper outlines an outreach exposition named “So far , So close” featuring a replica of the Alpha Magnetic Spectrometer Payload Operation Control Room to elucidate the continuous supervision and regulation of space mission payloads by Earth's various control rooms. The exposition's value is magnified by cutting-edge AMS collaboration software, granting access to AMS telemetry data. This innovation, born during the pandemic, allowed remote engagement in the experiment's daily operations due to physical access limitations to the CERN site, housing the AMS POCC. The replica POCC, complemented by posters and videos, serves as an effective tool for conveying the importance of fundamental research in space radiation and cosmic rays.

The paper further encapsulates the inaugural exposition held in May 2023 in Bologna, in collaboration with the Moon Village Association Italian branch and the Marco Peroni studio. The event featured "Far yet so close: Cosmic Ray Measurements in Space with the Alpha Magnetic Spectrometer (ams02.space)" and "Ground Control Operations of Space Missions" exhibitions, shedding light on cosmic ray shielding in lunar exploration. The collaboration activities involved the AMS INFN Roma Sapienza research group and Marco Peroni Ingegneria studio.

Held at the "Living in Space" Permanent Exhibition within the Marco Peroni Ingegneria Studio, the event effectively bridges the knowledge gap, making science comprehensible and visually engaging. It enriches diverse audiences with insights into space exploration and radiation protection, promoting scientific literacy and fostering curiosity and participation among non-scientific audiences.

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1. Introduction

We propose an engaging and informative outreach exposition named “So Far , So Close” (SFSC) centered around a replica of the Alpha Magnetic Spectrometer (AMS) Payload Operation Control Room (AMS POCC) [1]. This initiative aims to enhance public understanding of the continuous monitoring and control of space mission payloads conducted in various control rooms on Earth. The exposition's unique value lies in showcasing AMS collaboration's cutting-edge monitoring software, enabling access to AMS telemetry data. This software, a pandemic-driven innovation, allowed remote participation in day-to-day operations when physical access to the CERN site was restricted. The replica of the POCC, complemented by informative posters and videos, serves as an effective tool for conveying the importance of fundamental research in space radiation and cosmic rays.

In this exposition, we will delve into the intricate workings of the AMS, a state-of-the-art particle physics detector mounted on the International Space Station (ISS). By replicating the AMS POCC, visitors will gain a deeper understanding of how scientists and engineers monitor and manage the AMS in real-time, providing critical insights into the behaviour of cosmic rays and space radiation. Through interactive demonstrations and immersive exhibits, we aim to demonstrate how this powerful tool contributes to our understanding of the cosmos, shedding light on the mysteries of the universe. We will explore the significance of space-based research in unravelling fundamental questions about the origins, composition, and behaviour of cosmic particles, with implications for astrophysics, cosmology, and our understanding of the universe's evolution. Moreover, we will highlight the collaborative nature of scientific endeavours, emphasizing the partnerships and cooperation that make space exploration and research possible. By showcasing the cutting-edge monitoring software and its adaptation during the COVID-19 pandemic[2], we underscore the resilience and adaptability of the scientific community in challenging times.

This exposition seeks to inspire curiosity, foster scientific literacy, and promote appreciation for the remarkable advancements in space research that have the potential to transform our understanding of the universe and, ultimately, our place within it. Through an engaging and educational experience, we aim to ignite a passion for exploration and discovery, encouraging the next generation of scientists, engineers, and space enthusiasts to reach for the stars.

1.1 Educational Engagement

The exposition aims to educate the public about the critical importance of space research, with a specific focus on space radiation and cosmic rays. Space is an environment filled with radiation and cosmic particles, which have profound effects on both humans and the technological instruments we use in space. By imparting knowledge about these phenomena, the exposition seeks to raise awareness of the challenges and opportunities inherent in space exploration and research. The objective is to ensure the public gains a comprehensive understanding of space radiation and cosmic rays, their impact, and the significance of studying them for advancements in space science and technology.

1.2 Interactive Learning

The exposition is designed to provide an interactive and immersive learning experience. Visitors will have the opportunity to engage with a replica of the AMS POCC and explore the telemetry data coming from space in real time. By actively involving visitors in the process of understanding how the AMS is monitored and controlled, they can appreciate the complexity of space missions and the role of technology in managing these missions. This is to enable visitors to interact with AMS telemetry data, replicate control room activities, and enhance their comprehension of the intricate workings of space research instruments and operations.

1.3 Inspire Future Scientists

An essential objective of this exposition is to inspire general public with a special focus in motivating young individuals to consider careers in STEM (Science, Technology, Engineering, and Mathematics) fields. By providing an insightful and captivating display, the exposition aims to ignite curiosity and enthusiasm for space exploration and research, encouraging aspiring scientists and engineers to pursue educational and professional

paths related to space science and technology. The objective is to encourage young minds to envision themselves as future scientists, engineers, or researchers by showcasing the exciting possibilities and contributions that can be made in the field of space science and technology. By aligning the exposition with these objectives, the initiative endeavours to bridge the gap between scientific endeavours and the general public, nurturing a society that is well-informed, engaged, and enthusiastic about the advancements and potential of space research. This, in turn, contributes to fostering a scientifically literate populace and nurturing a new generation of innovators and leaders in the STEM fields.

2. Remote Monitoring of the AMS Telemetry

A highlight of the exposition was the demonstration of remote monitoring of AMS telemetry, see Fig.1. Visitors had the opportunity to access and interact with AMS telemetry data through the collaboration's monitoring software. This hands-on experience allowed attendees to engage with real-time and historical telemetry data, deepening their understanding of space mission operations.

Figure. 1. A typical panel of the remote monitoring software. In this example it is showed the one that allows the control by remote of the main elements of one the detection instrument that compose the AMS, the Transition Radiation Detector[3]. The INFN AMS Roma Sapienza research group took part to the instrument's developments, test and integration.

2.1 Replica AMS POCC Display

Description: The Replica Alpha Magnetic Spectrometer Payload Operation Control Center (AMS POCC) Display is a meticulously recreated representation of the actual control room that oversees the operation and control of the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS). This replication aims to provide visitors with a tangible and visually accurate experience of what a genuine space mission control center looks like. Every detail, from the layout of the room to the instrumentation and technology present, has been carefully crafted to mimic the authentic control room environment.

2.1.1 Interactive Elements: Simulated Control Room Environment

The AMS POCC operates as a central hub responsible for monitoring and controlling the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS). In some instances, AMS POCC operations can

be conducted remotely, allowing for management and oversight of the AMS mission without requiring physical presence at the control center's location.

Remote control of the AMS POCC involves leveraging advanced telemetry, telecommunication, and computing technologies. Visitors stepping into the replica AMS POCC will enter a simulated control room environment that closely mirrors the actual setup of the remote control of the AMS POCC. The design and layout will emulate the real control room to create an immersive experience. The arrangement of desks, monitors, control panels, and communication systems will replicate the authentic operational setup, allowing visitors to understand the advancement of technology and the ability to manage complex space missions remotely, contributing to the success and productivity of scientific endeavours conducted aboard the ISS. Visitors can explore the functions of different instruments, understand how telemetry data is monitored, and simulate the decision-making processes involved in managing a space mission.

By immersing visitors in this simulated control room environment, the replica AMS POCC display serves as a powerful educational tool, providing a glimpse into the sophisticated operations and technological advancements required for successful space missions. It encourages a deeper appreciation for the expertise and dedication of scientists, engineers, and mission controllers involved in the intricate world of space exploration. Additionally, it stimulates curiosity and fosters interest in the field of space science and technology, inspiring future generations to aspire towards careers in space-related disciplines.

2.2 Relating Informational Posters and Videos to the concept

Description: The informational posters, see Fig 2, videos complement the Replica AMS POCC Display by providing detailed and comprehensive information about the AMS project. These resources are designed to educate visitors about the objectives of the AMS project, its significance in space research, and the specific role that the AMS POCC plays in achieving those objectives. They serve as educational aids that enrich the visitors' understanding of the intricacies of space missions and the valuable data collected by the AMS.

Figure. 2. Three examples of the Informational Posters prepared and used for the"So Far , So Close" exposition. Left: "AMS Collaboration and Space Mission". Middle : "AMS Flight and Ground Operations" . Right: "Space Radiobiology, AMS and the Human Space Exploration".

Interactive Elements: Multimedia presentations, including informative videos and well-designed posters, are utilized to enhance engagement and comprehension. These multimedia elements are carefully curated to present complex scientific concepts in a visually appealing and accessible manner, making it easier for a

broader audience to grasp the scientific advancements and research conducted with AMS. Through the integration of interactive multimedia, visitors can engage with the content actively. They can watch videos explaining the AMS project's mission, fly alongside NASA satellites, and view real-time datasets, its technology, and the role of the AMS POCC in managing the instrument's operations.

3. The Collaborations with Moon Village Association and Marco Peroni Studio Ingegneria

The collaboration with the Moon Village Association (MVA) and Marco Peroni Studio (MPS) was crucial in ensuring the accuracy, depth, and effectiveness of the educational outreach. The AMS Roma Sapienza Research Group provides expertise and guidance on AMS projects and data interpretation, while the MVA and MPS plays a crucial role in developing and organizing the overall event. Our outreach exposition is the result of fruitful collaborations with the Moon Village Association (MVA) and Marco Peroni Studio Ingegneria. These partnerships have been instrumental in realizing the vision and objectives of the exposition and facilitated a platform to engage with a broader audience and promote awareness of space exploration and its importance.

First Implementation: In the initial successful implementation of SCSF was during an event organized in Bologna by the MVA to present the organization and the planned activities for the 2023, see Fig.3.

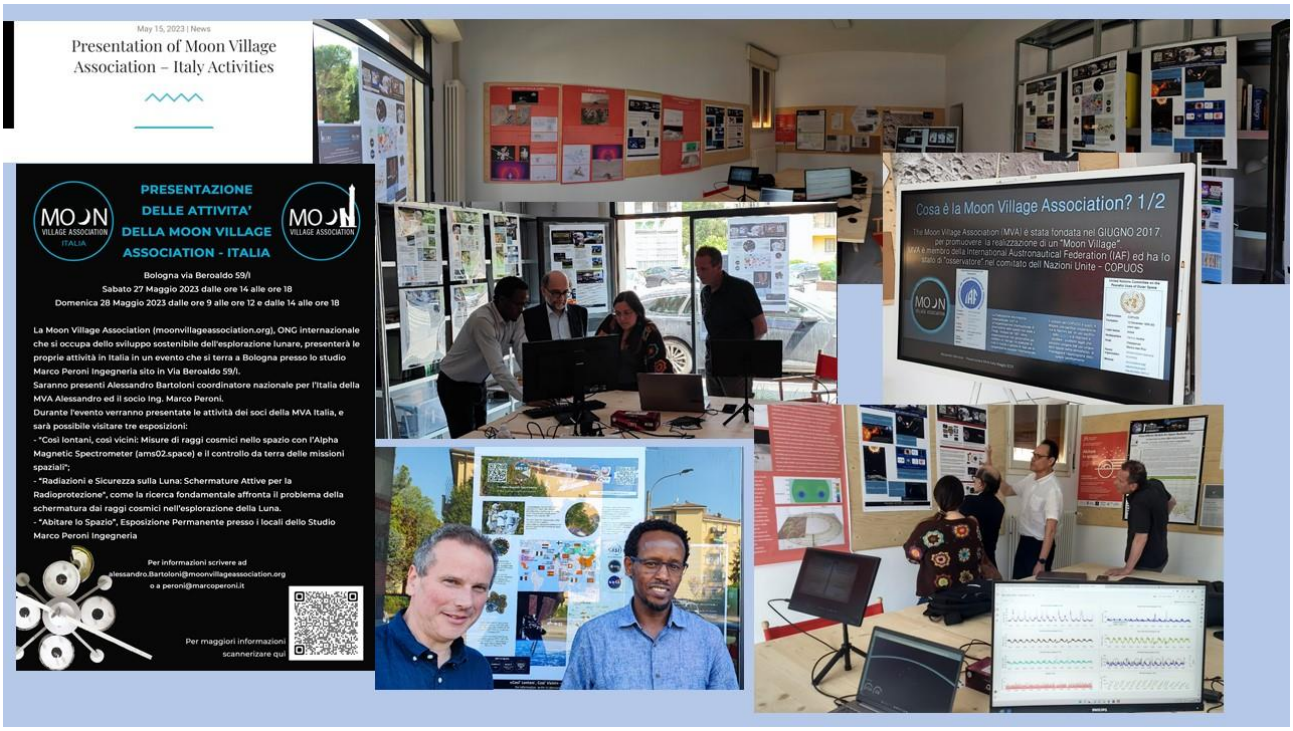

Figure. 3. Some highligts from the first implementation of the exposition. On the Left the flyer of the event hosting the “So far , So Close” exposition. Center and Right picture shows the authors and organizers of the event (A. Bartoloni, A.N. Guracho, M.Peroni) during some key moments of the two days event in May 2023.

This happened in May 2023 and the location was the Bologna offices of the MPS. During such event not only the SFSC exposition was showcased but also two related topics:

"Radiation and Safety on the Moon” based on the main research activities of the INFN AMS Roma Sapeinza group on space radiobiology[4-7].

“Active Shielding for Radiation Protection." based on te research on the field of the MPS, also featuring a permanent exposition named “Abitare lo Spazio”

The collaboration with the Moon Village Association Italian branch [8] and the Marco Peroni studio [9] ensured a successful and well-coordinated event, and most of the exposition is now permanent and can be visited on request.

5. Future Implementation and Expansion

The proposal for future implementations and expansions involves taking this informative and interactive exposition to various educational institutions, science museums, and public events. By replicating and disseminating this exposition model to different locations, the initiative aims to promote scientific literacy, nurture curiosity, and inspire the public, particularly the youth, to explore and appreciate the captivating world of space exploration and research. This expansion aligns with the overarching objective of fostering an informed and enthusiastic society deeply engaged with the wonders of space science and technology.

6. Conclusion

Our ambitious outreach exposition featuring a replica AMS POCC seeks to bridge the knowledge divide by illuminating the public about space research, with a special focus on cosmic rays and radiation. By offering an interactive and immersive experience, visitors can delve into the intricacies of space mission control, fostering a deeper understanding. We're dedicated to sparking curiosity and inspiring the next generation of scientists in STEM fields, underlining the collaborative ethos that propels scientific advancements. This initiative ultimately aims to kindle a profound passion for space exploration, nurturing a scientifically enlightened society poised for the challenges and wonders of the cosmos. The SFSC exposition successfully achieved its objectives of educating and inspiring the public regarding space exploration, cosmic rays, and radiation protection. The collaborative efforts with MVA and MPS were vital in realizing this endeavour. Looking ahead, we plan to expand and replicate this exposition model, taking it to diverse locations to further promote scientific literacy and encourage active engagement with advancements in space research and exploration. Through these efforts, we aim to nurture a society that values and comprehends the exciting frontier of space science and technology.

References

[1] The Alpha Magnetic Spectrometer on the International Space Station, https://ams02.space/

[2] R.K. Hashmani, et al, (2023). New monitoring interface for the AMS experiment. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1046, 167704. https://doi.org/10.1016/j.nima.2022.167704

[3] F. Hauler et al , (2004) The AMS-02 TRD for the International Space Station, Published in: IEEE Trans.Nucl.Sci. 51 (2004), 1365-1372, DOI: 10.1109/TNS.2004.832901

[4] A. Bartoloni et al., (2023), Space Radiation Characterization for Safe Human Space Exploration and Settlements, the 17th International Conference on Space Operation, 6-10 March 2023, Dubai, UAE.

[5] Strigari L, Strolin S, Morganti AG, Bartoloni A. Dose-Effects Models for Space Radiobiology: An Overview on Dose-Effect Relationships. Front Public Health. 2021 Nov 8;9:733337. doi: 10.3389/fpubh.2021.733337.

[6] A. Bartoloni et al (2022) ,High Energy Physics Astroparticle Experiments to Improve the Radiation Health Risk Assessment in Space Missions, published in PoS EPS-HEP2021 (2022) 106, DOI: 10.22323/1.398.0106

[7] A. Bartoloni et al , (2021) Space Radiation Field Characterization Using the Astroparticle Operating Detectors, in Proceedings of the 72nd International Astronautical Conference (IAC2021) , November 2021 Dubai , UAE.

[8] Moon Village Association (MVA), https://moonvillageassociation.org/

[9] Marco Peroni Ingegneria, https://www.marcoperoni.it/