AHEAD bkg Workshop abstract

Name:	**Jonathan Keelan**
Institute / Company	The Open University
Abstract Title:	Validation of Geant4 simulations for instrument background modelling towards the Athena WFI.
Abstract 250 word max	The in-orbit instrument background for the XMM-Newton mission was found to exceed that predicted pre-launch, demonstrating the vital importance of accurate predictive tools for in-orbit instrument background. Post-launch simulations for XMM-Newton, consistent with in-orbit data, have found the particle induced X-ray-like background to be dominated by secondary electrons generated in materials surrounding the detector. GEANT4 allows a detector scientist to perform instrument background simulations, as were implemented for XMM-Newton post-launch, however it is only in recent years that its validity in the energy range of interest has been examined to such levels of detail. Simulations attempting to predict instrument background require accurate hadronic and electromagnetic physics, over a wide range of energies. Recent papers have demonstrated that low energy electromagnetic processes in GEANT4, such as electron backscattering, show large deviations from experiment at energies around 1keV and below, particularly in lower-Z materials. Building upon previous studies in the literature, we have investigated the validity of various physical processes in the latest GEANT4 builds. Alongside these studies, we are developing independent experimental tests, aimed at identifying critical physical processes involved in the production of instrument background. The results of these studies will be used to improve the accuracy of our instrument background simulations.

Name:	**Emanuele Perinati**
Institute / Company	IAAT
Abstract Title:	Effects of hyper-velocity impacts
Abstract 250 word max	Impacts by hyper-velocity dust particles pose a hazard to the safety of spacecrafts and instruments in space. The resulting damage is highly variable with the characteristics of the projectiles and of the target. Commonly adopted mitigation techniques rely on the application of bumper layers. We review a few case studies and make an estimate of the risk for ATHENA.

Name:	**Emanuele Perinati**
Institute / Company	IAAT
Abstract Title:	Background studies at IAAT
Abstract 250 word max	We give an overview of the activities related to the instrumental background ongoing at our institute in the context of future space missions and AHEAD project, and briefly illustrate some results achieved so far.

Name:	Francesco Piacentini
Institute / Company	Sapienza - Universita' di Roma
Abstract Title:	Characterization and physical origin of energetic particles on Planck HFI.
Abstract 250 word max	The Planck High Frequency Instrument (HFI) has been surveying the sky continuously from the second Lagrangian point (L2) between August 2009 and January 2012. It has been operating with 52 high impedance bolometers cooled at 100 mK in a range of frequency between 100 GHz and 1THz with unprecedented sensivity, but strong coupling with cosmic radiation. At L2, the particle flux is about 5 $cm^{−2} s^{−1}$ and is dominated by protons incident on the spacecraft. Protons with an energy above 30MeV can penetrate the focal plane unit box causing two different effects: glitches in the raw data from direct interaction of cosmic rays with detectors (producing a data loss of about 15% at the end of the mission) and thermal drifts in the bolometer plate at 100mK adding non-gaussian noise at frequencies below 0.1Hz. The HFI consortium has made strong efforts in order to correct for this effect on the time ordered data and final Planck maps. This contribution intends to give a view of the physical origin of the glitches observed in the HFI instrument in-flight. We have shown that the dominant part of glitches observed in the data comes from the impact of cosmic rays in the Si die frame supporting the micromachinced bolometric detectors.

Name:	Norbert Meidinger
Institute / Company	Max-Planck-Institut MPE
Abstract Title:	XMM EPIC-PN, eROSITA, ATHENA-WFI cameras
Abstract 250 word max	Three different types of cameras, developed for X-ray astronomy, will be presented: The EPIC-PN camera of XMM-Newton, the eROSITA camera array on SRG and the Wide Field Imager if ATHENA. Apart from the concept, their characteristics are explained including radiation damage and instrument background.

Name:	Michael Freyberg
Institute / Company	MPE Garching, Germany
Abstract Title:	Background: from XMM-Newton to eROSITA
Abstract 250 word max	XMM-Newton is now operational in a highly eccentric orbit for almost 17 years, passing through various parts of Earth's magnetosphere. We will give a summary (with emphasis on EPIC-pn) about the background expectations, actual experiences (on short and long time scales) and effects, and lessons learned. eROSITA/SRG is expected to be the first X-ray mission being operational in a halo orbit around L2 (also Athena's proposed location). We will describe the differences and similarities in the backgrounds to be expected, and what could be learned for Athena - and what can not (e.g., due to absence of radiation monitors sensitive in the proper energy range of soft protons).

Name:	**Simone Lotti**
Institute / Company	INAF/IAPS Roma
Abstract Title:	The particle background expected for the X-IFU instrument onboard of ATHENA
Abstract 250 word max	ATHENA is the second large mission in ESA Cosmic Vision 2015-2025, with a launch foreseen in 2028 towards the L2 orbit. The mission addresses the science theme “The Hot and Energetic Universe”, by coupling a high-performance X-ray Telescope with two complementary focal-plane instruments. One of these, the X-ray Integral Field Unit (X-IFU) is a TES based kilo-pixel array, providing spatially resolved high-resolution spectroscopy (2.5 eV at 6 keV) over a 5 arcmin FoV. The particle background for X-ray detectors accounts for two components: the low energy particles (< ~100 keV) focalized by the mirrors and reaching the detector from inside the field of view, and the high energy particles (> ~100 MeV) crossing the spacecraft and reaching the focal plane from every direction. In particular, these high energy particles lose energy in the materials they cross, creating secondaries along their path that can induce an additional background component. The relative contribution of each component depends on the mission and instrument features. Given the lack of data on the background of X-ray detectors in L2, each one of the variables influencing the background estimates is under study of the AREMBES (Athena Radiation Environment Models and Background Effects Simulator) team, from the reanalysis of the data of previous missions like XMM-Newton, to the characterization of the L2 environment by data analysis of the particle monitors onboard of satellites present in the Earth magnetotail, to the characterization of solar events and their occurrence, and to the validation of the physical models involved in the Monte Carlo simulations. All these activities will allow to develop a set of reliable simulations to predict, analyze and find effective solutions to reduce the particle background experienced by the X-IFU, ultimately satisfying the scientific requirement that enables the science of ATHENA. While the activities are still ongoing, we present here some preliminary results already obtained by the group.

Name:	**Ignacio de la Calle**
Institute / Company	European Space Astronomy Centre, Madrid, Spain
Abstract Title:	The XMM-Newton Background
Abstract 250 word max	The XMM-Newton observatory provides unrivaled capabilities for detecting low surface brightness emission features from extended and diffuse galactic and extragalactic sources. In order to exploit these capabilities the background that affects the detectors needs to be understood thoroughly, including its nature and its spectral and temporal properties. In this contribution we will discuss the different background components that affect the spacecraft, the impact on the different instruments and the measures that are put in place by the XMM-Newton SOC to alleviate the impact on the scientific output.

Name:	Iacopo Bartalucci
Institute / Company	CEA Saclay - DSM - IRFU – Service d'Astrophysique
Abstract Title:	Particle background impact on current X-ray missions and future prospects
Abstract 250 word max	One of the major problems affecting current X-ray observatories is the instrumental background. Spatial and temporal variations represent an issue for a precise and correct measure, which may put an intrinsic limit on the instrument capability. These are particularly important in the case of low surface brightness, extended sources. Using the experience we developed from the production of an analytic model of the Chandra ACIS-I particle background, we present the problems associated with this instrumental background and how they affect, as a test-case, the study of a class of X-ray extended objects: the galaxy clusters. We discuss the methods currently used to handle this component and, in the context of future missions, what new strategies we can consider implementing.

Name:	Monica Laurenza
Institute / Company	INAF/IAPS Roma
Abstract Title:	The energetic particle environment in the interplanetary space
Abstract 250 word max	The energetic particle environment in the interplanetary space is composed by several populations of different origin and characteristics (composition, energy spectrum, timing), such as galactic cosmic rays, solar energetic particles (SEPs), sporadically emitted at the Sun, particle enhancements related to transient and corotating interplanetary shock waves. The estimation of the energetic particles radiation environment in the interplanetary space is essential to perform an assessment study related to any scientific mission profile, as they produce a background that can interact with spacecraft and instruments. For instance, the proton component with energy in the range 50 keV < E < 10 MeV could have an important impact on the ATHENA mission, since it can be focused by the X-ray optics towards the Focal Plane Assembly, so decreasing the instrumental sensitivity. This talk is dedicated to the characterization of the energetic particle environment at L1 and L2 in the high (0.1 MeV – 10s MeV) and the very high (>100 MeV) energy ranges. An extended statistical analysis of the energetic proton fluxes recorded by several spacecraft is performed to provide reliable estimates of the energetic proton flux levels and occurrence frequency along the solar cycle. Moreover, the energetic proton spectrum is derived and parametrized during SEP events to accurately evaluate the background variability and worst case scenarios.

Name:	Fabio Gastaldello
Institute / Company	INAF/IASF Milano
Abstract Title:	The origin of XMM unfocused and focused particle backgrounds
Abstract 250 word max	We will show the results obtained in the FP7 European program EXTraS and in the ESA R&D ATHENA activity AREMBES aimed at a deeper understanding of the XMMbackground. Thanks to an analysis of the full EPIC archive coupled to theinformation obtained by the Radiation Monitor we will show the cosmic ray origin of the unfocused particle background and its anti-correlation with thesolar activity. We will show the first results of the effort to obtain

	informations about the particle component and a flux calibration of the soft proton focused background.

Name:	**Christian Kirsch**
Institute / Company	University of Erlangen-Nuremberg - Astronomical Institute
Abstract Title:	The Athena end-to-end simulator
Abstract 250 word max	We present the end-to-end simulator for the WFI and X-IFU instruments of the Athena mission, which allows us to calculate realistic event lists for astronomical sources observed with Athena and other missions. The simulator takes the proper detector physics into account. Particle background generated by Geant4 has already been implemented in the WFI-simulator, while an implementation in the X-IFU simulator will follow shortly. As such, particle simulations can be seamlessly integrated into the detector physics simulations. We demonstrate simulation results for the particle background in the WFI detector for several scenarios.

Name:	**Ricardo Perez-Martinez**
Institute / Company	XMM-Newton SOC / ISDEFE
Abstract Title:	Modelling the radiation environment of XMM-Newton
Abstract 250 word max	Modelling the radiation environment in the surroundings of XMM-Newton orbit is key to keep the health and safety of its payload as well as to optimize its observing time. In this talk the radiation model adopted by XMM-Newton is described together with the accuracy of this semi empirical approach.

Name:	**Caroline Kilbourne**
Institute / Company	NASA Goddard Space Flight Center
Abstract Title:	The In-orbit Background of the Hitomi SXS
Abstract 250 word max	The XRS instrument of Suzaku provided the first indication of the instrumental background of an x-ray calorimeter spectrometer, but the data set was limited. The SXS instrument of Hitomi has provided a more detailed picture of x-ray calorimeter background, with more than 150 ks of data while pointed at the night-earth, more than 100 ks while pointed at the bright earth, and more that 360 ks of blank-sky data. We will present the contributions to the SXS NXB (and broad-band redistribution), the types and effectiveness of the screening, and the residual background spectrum as a function of orbital position (magnetic cut-off rigidity). We will also discuss the implications for future space-borne x-ray calorimeter spectrometers.

Name:	**Simona Ghizzardi**
Institute / Company	INAF/IASF Milano
Abstract	Impact of the magnetospheric environment on the XMM-Newton background.

Title:	
Abstract 250 word max	A detailed characterization of the particle induced background is fundamental for many of the scientific objectives of Athena. One of the most important contribution to the background omponent comes from soft-protons, so an adequate knowledge of the soft proton environment that will be encountered by the Athena X-ray telescope is desirable. The soft proton component is highly variable: different regions of the magnetosphere can have very different environmental conditions, depending on the strength and the orientation of the magnetic field, the speed and the density of the particles etc. The different conditions can, in principle, differently affect the particle induced background detected by the instruments. We present results concerning the influence of the magnetospheric environment on the background level detected by EPIC instrument onboard XMM-Newton, through the estimate of the variation of soft proton flux along XMM-Newton orbit.

Name:	**Pere Blay**
Institute / Company	Instituto de Astrofisica de Canarias
Abstract Title:	Geant4 Simulations of the two detector layers in ASIM/MXGS
Abstract 250 word max	The Atmosphere-Space Interactions Monitor will be installed in the International Space Station, by the Columbus Module, and will contain the Modular X-ray and Gamma-ray sensor, a coded-mask telescope aimed to explore the nature of the Terrestrial Gamma-ray Flashes. We have developed a simulation of MXGS installed by Columbus, including the shielding structure, the two high energy detector layers and the coded mask. We have studied the transparency of the coded-mask, the effectiveness of the shielding and the background produced by backscattered photons from the nearby Columbus module. Geant4 in combination with GDML have been used. We have also used the Geant4 setup to simulate X-ray images and test the scientific analysis software.

Name:	**Alfonso Mantero**
Institute / Company	SWHARD srl
Abstract Title:	The Geant4 LowEnergy Electromagnetic Physics.
Abstract 250 word max	Geant4 is a software toolkit for the simulation of the passage of particles through matter. It is used by a large number of experiments and projects in a variety of application domains, including high energy physics, astrophysics and space science, medical physics and radiation protection. The “Low Energy” Geant4 Category includes a set of physics models to describe the electromagnetic interactions of photons, electrons, positrons, hadrons and ions with matter down to very low energies (eV scale), thanks to the Geant4-DNA sub-category, initiated and partly funded by ESA. Applications of such models range from high energy physics experiments to space science and astrophysics to the medical and biological fields. A common interface to the “Standard” electromagnetic physics models is provided, allowing a natural combination of ultra-relativistic, relativistic and low-energy models for the same run providing both precision and CPU performance. A set of recommended physics constructors are available with the Geant4 release. Each

	constructor includes a full list of particles and their interactions, tuned for specific use cases, that can be added to build up modular Physics Lists to be used in the user simulations. Recommended physics constructors are intensively and continuously validated, so these components of Physics Lists are more reliable and the accuracy of results are better predicted. A quick tour of the models and the physics lists will be presented, with the focus on the space-related use cases.

Name:	**Martino Marelli**
Institute / Company	INAF/IASF Milano
Abstract Title:	Extraction and analysis of the XMM-Newton Soft Proton Background
Abstract 250 word max	Fifteen years of XMM-Newton data have been collected so far, allowing for detailed analysis of the on-flight XMM-Newton characteristics and its response to photons and particle environment. We made use of preliminary EXTraS results to produce the most complete and clean data set ever used to characterize XMM-Newton particle-induced background. Within the AREMBES collaboration, we built new scripts to extract and study different aspects of its background: this covers time behavior as well as spectral and spatial characteristics. Our results are far beyond the results from literature, covering a factor 10 more data and making use of new techniques.

Name:	**Fan Lei**
Institute / Company	RadMod Research
Abstract Title:	Collaborative Iterative Radiation Shielding Optimisation System – CIRSOS
Abstract 250 word max	CIRSOS is an integrated modelling environment (IME) for radiation effects analysis in space mission developments. It was developed in support of the ESA Cosmic Vision programme, the JUICE mission in particular. It provides a complete set of models and tools required for a mission radiation effects analysis at different phases of its developments from conception to operation. This talk will introduce the top level design of CIRSOS, its main components and features. Its application in the ATHENA mission will also be discussed.

Name:	**Fan Lei**
Institute / Company	RadMod Research
Abstract Title:	Is Ion LET Still Suitable for Parameterising SEE Cross-Sections of Nano-Scale Devices
Abstract 250 word max	Geant4 simulations are used to explore whether ion LET remains the best metric for parameterising energy-deposition spectra in 14nm and 28nm devices, and show alternative metrics (such as restricted dE/dx) to provide more consistent performance.

Name:	Teresa Mineo
Institute / Company	INAF/IASF Palermo
Abstract Title:	A proton response matrix for XMM-Newton
Abstract 250 word max	Soft protons constitute an important source of background in focusing X-ray telescopes, as Chandra and XMM-Newton experienced. The optics in fact transmit them to the focal plane with the same efficiency of photons. This effect is a good opportunity to study the environment of the hearth magnetosphere crossed by the X-ray satellite orbits, provided that we can link the spectra impacting on the detectors with the ones impacting on the optics. For X-ray photons this link has the form of the so-called response matrix that includes the optics effective area and the energy redistribution in the detectors. Here we present a first attempt to produce a proton response matrix exploiting ray-tracing and GEANT4 simulations with the final aim to be able to analyze XMM-Newton soft protons data and link them to the external environment. If the procedure is found to be reliable, it can be applied to any future X-ray missions to predict the soft particles spectra impacting on the focal plane instruments.

Name:	Vladimir Ivanchenko
Institute / Company	CERN
Abstract Title:	Geant4 Standard and Low Energy EM libraries for space applications
Abstract 250 word max	The Geant4 electromagnetic (EM) physics sub-packages are key components of any simulation from a test on radiation effects for a small device to the simulation of LHC experiments. A tiny variation of EM physics may affect prediction accuracy and CPU performance of large scale Monte Carlo simulations for HEP, medicine or space science. In this work the status and evolutions of the EM sub-libraries will be presented, including unification of EM model interface and implementation of multi-threaded mode. We will report on recent improvements of the EM models for recent Geant4 versions with the focus on possible applications for space science. Validation results will be shown and limits of applicability of models will be discussed.

Name:	Silvano Molendi
Institute / Company	INAF/IASF Milano
Abstract Title:	The role of the background in past and future X-ray missions
Abstract 250 word max	Background has played an important role in X-ray missions, limiting the exploitement of science data in several and sometimes unexpected ways. In this presentation I shall review some hard lessons from past X-ray missions and discuss prospects for overcoming background related limitations in future ones.

Name:	David Salvetti
Institute / Company	INAF/IASF Milano

Abstract Title:	Characterizing the XMM-Newton/EPIC Particle Background
Abstract 250 word max	We will present an accurate characterization of the particle background behaviour on XMM-Newton based on the entire EPIC archive. This corresponds to the largest EPIC data set ever examined. Our results have been obtained thanks to the collaboration between the FP7 European program EXTraS and the ESA R&D ATHENA activity AREMBES. The analysis has mostly made use of a diagnostic slightly different from what done so far in order to describe in detail the characteristics of EPIC particle background. We will show that the focused particle background is made up of two different components, one associated to flares produced by soft protons and the other one to a low-intensity background of challenging origin.

Name:	**Guillaume Patanchon**
Institute / Company	AstroParticle and Cosmology Laboratory (APC - Paris)
Abstract Title:	Interaction of cosmic rays with Planck-HFI detectors
Abstract 250 word max	The Planck satellite allowed to measure the Cosmic Microwave Background anisotropies with unprecedented accuracy. One of the main systematic effects in Planck High Frequency Instrument was resulting from the interaction of cosmic rays, mainly galactic protons and Helium nuclei, with bolometers and the different components in their environment. I will review the different processes of interactions with the detectors, the effect on data, and how we managed to remove the associated signal to obtain a clean measurement of the cosmological signal.

Name:	**Dusan Budjas**
Institute / Company	ESA/ESTEC
Abstract Title:	Soft proton fluxes in and around Earth’s distant magnetotail
Abstract 250 word max	The second L-class (large) mission in ESA’s Cosmic Vision programme will be an X-ray telescope named Athena, planned to operate at the L2 Lagrange point of the Sun-Earth system. Current large X-ray space telescopes like XMM-Newton and Chandra have encountered periods of unexpectedly high background due to protons in energy ranges between 10 keV and 1 MeV (called “soft protons” hereafter), which also induced degradation in their detectors. This is an important issue for Athena, as no X-ray telescope has been deployed at L2 so far and the soft proton environment there is poorly known. Earth’s magnetotail, extending towards and beyond L2, contributes soft proton fluxes in addition to particles of solar origin. To compare fluxes inside and outside the magnetotail we analyse data from Artemis and ACE spacecraft.

Name:	**Petteri Nieminen**
Institute / Company	ESA/ESTEC
Abstract Title:	ESA programs and ongoing R&D

Abstract 250 word max	Radiation effects are an increasingly critical aspect to be considered for future Science missions, including Athena. Such effects are often analysed by Geant4 and related applications, and it is vital the models and tools employed are up-to-date. ESA has been a formal signatory to the Geant4 Collaboration since 1998. This presentation outlines current R&D activities for new Geant4 capabilities carried out by ESA.

Name:	**Lorenzo Natalucci**
Institute / Company	INAF/IAPS Roma
Abstract Title:	Opportunities for the high energy astrophysics community by the AHEAD European Infrastructure Project
Abstract 250 word max	AHEAD (Integrated Activities in the High Energy Astrophysics Domain) is a project approved in the framework of the European H2020 program. Its main objective is to integrate European key research infrastructures for the domain by offering free-of-cost services like transnational access to a wide choice of data analysis training, visiting program and community support through workshops and topical conferences. Moreover, AHEAD fosters important developments in the areas of technology relevant to Athena and other high energy astrophysics missions, as well as supporting studies in the area of space background and instrument cross-calibrations.