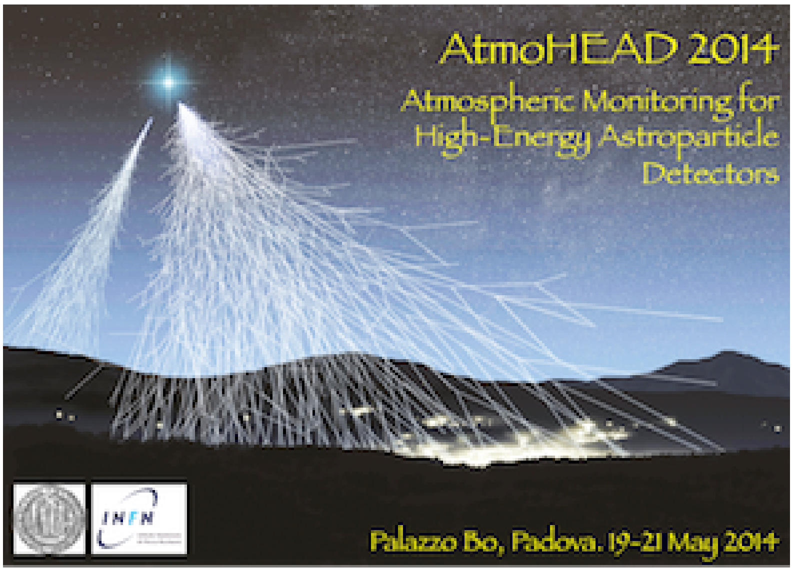
AtmoHEAD 2014:
 Atmospheric Monitoring for High Energy AstroParticle Detectors

Monday, 19 May 2014 - Wednesday, 21 May 2014

Palazzo del Bo



Book of Abstracts

Contents

Highlights / 0

Welcome

Author: Michele Doro[1]

[1] *PD*

Corresponding Author: michele.doro@pd.infn.it

Highlights / 1

Atmospheric Characterization of Sites

Author: Sergio Ortolani[1]

[1] *Dipartimento di Fisica e Astronomia, Università di Padova*

Corresponding Author: sergio.ortolani@unipd.it

Highlights / 19

Climate Changes

Author: Alessio Bellucci[1]

[1] *CMCC*

Corresponding Author: alessio.bellucci@cmcc.it

Highlights / 16

The Innsbruck / ESO Sky Models and Telluric Correction Tools

Author: Stefan Kimeswenger[1]

Co-authors: Amy M. Jones [2]; Stefan Noll [2]; Stefanie Unterguggenberger [2]; Wolfgang Kausch [3]

[1] *Universidad Catolica del Norte, Antofagasta, Chile / University Innsbruck, Austria*

[2] *Institute of Astro and Particle Physics, Innsbruck*

[3] *Institute of Astro and Particle Physics, Innsbruck & Institute of Astrophysics, Vienna*

Corresponding Author: stefan.kimeswenger@uibk.ac.at

A large fraction of uncertainty for the interpretation of data from imaging Cerenkov telescopes originates from the use of static average atmosphere models. We present an alternative approach to this issue.

As part of the entrance fee to the European Southern Observatory (ESO) Austrian universities developed software modules for various projects, called in-kind projects, dealing with the effect of the Earth's atmosphere on ground-based astronomical observations. The Innsbruck team (http://www.uibk.ac.at/eso)

has provided tools to calculate this influence of the atmosphere for the astronomical community (https://www.eso.org/observing/etc/skycalc/skycalc.htm; Noll et al. 2012, A&A, 543, A92, Kausch et al. 2014, arXiv, 1401.7768). In the framework of the follow up programs, the team now extends the applications to geoscience (Jones et al. 2013, EGUGA, 15, 8478; Kausch et al. 2013, EGUGA, 15, 7425), and other astronomical fields. In particular, the adaption of these tools to air shower experiments looks promising.

The software is based on the radiative transfer code LBLRTM (http://rtweb.aer.com/lblrtm.html) for molecular absorption and our own elaborate code aimed for calculating the scattering of the continuum (including local sources e.g. ground reflection). For information on the molecular line parameters, the HITRAN data base (http://www.cfa.harvard.edu/hitran) is used. In addition, atmospheric profiles based on a standard atmosphere and the Global Data Assimilation System (GDAS) weather models obtained from the National Climatic Data Center (NOAA; http://www.ncdc.noaa.gov/) are incorporated. We also compared our results with data obtained with the Low Humidity and Temperature Profiling microwave radiometer (LHATPRO; for details see Kerber et al. 2014, doi:10.1093/mnras/stt2404) profiles.

Recently, dedicated observations of scattered moonlight with the ESO VLT have been taken to study aerosol scattering in more detail (Jones et al. 2013, A&A, 560, A91; 2014, in prep). The ESO site at Cerro Paranal was perfect for the study, as it provides many different sources of information to improve the model, e.g. local meteorological information, as well as radiometer data, and high resolution astronomical spectra containing the finger print of the state of the Earth's atmosphere. Although these investigations are based on Cerro Paranal data, the deep understanding of the connection between the GDAS models and local calibrators can also be applied everywhere.

Imaging atmospheric Cherenkov telescopes like MAGIC and HESS are dominated by the effects of the lower 10km of the atmosphere and are working at the very blue end of the spectrum until the ozone absorption. Recently, the molecular data base HITRAN was extended into this blue domain.

The talk shows the status of the current research and the existing tools and discusses how information from various other calibrators (stars, radiometers, ⋯) can be included into the model optimisation. Furthermore, we discuss how radiation generated in the lower atmosphere can be handled. This opens the discussion about which adaption of such models, originally designed for optical/IR light sources from outer space, can be applied in the case of the atmospheric Cherenkov telescopes and which kind of calibrators are useful to obtain better results than general static profiles mostly used up to now in the astro-particle community.

Highlights / **40**

Science and More with Lasers and Astroparticle Observatories

Author: Lawrence Wiencke[1]

[1] *Colorado School of Mines*

Corresponding Author: lwiencke@mines.edu

Between the experiments in operation, including Auger and Telescope array, planned upgrades to Auger and TA, and activities in progress to realize JEM-EUSO and CTA, there is a growing interest in the design and applications of laser systems for optical astroparticle observatories. There are no particle test beams at EeV energies. Laser systems placed in the field have a history of providing a cost-effective and practical alternative. The bistatic lidar arrangement in which the astroparticle detector is the receiver, offers the opportunity to explore a variety of techniques and measurements. Some of these, various practical and design considerations will be the topic of this presentation.

Highlights / **43**

Multi-wavelength polarization Lidar characterization of mineral dust at Dunhuang (China)

Author: Xuan WANG[1]

[1] *CNISM - University of Naples "Federico II"; CNR-SPIN, Napoli*

Corresponding Author: wang@na.infn.it

Xuan Wang1, Antonella Boselli2 , Alessia Sannino3 , Nicola Spinelli3 , Yiming Zhao4,, Song Changbo4
CNISM& BRIT - China-Italy Laser Remote Sensing Joint Research Center
and
1CNR-SPIN, Napoli, Italy
2CNR-IMAA, Napoli, Italy
3Dipartimento di Fisica, Università di Napoli "Federico II", Napoli, Italy
4Beijing Research Institute for Telemetry, Beijing, P.R. China

The Gobi desert is the major source of mineral dust in China, that is one of the most interesting regions for aerosol study being surrounded by the main sources of anthropogenic and natural aerosol. In order to characterize the chemical and physical properties of atmospheric aerosols, their spatial and temporal distribution and the main transport mechanisms a new, versatile and portable Raman scanning lidar system has been designed and developed at Physics Department of University of Napoli "Federico II"in the frame of the AMPLE project, the first action of the recently founded China-Italy Laser Remote Sensing Joint Research Center between the National Consortium of Italian Universities for the Physical Science of the Matter (CNISM) and the Beijing Research Institute for Telemetry (BRIT). A first demonstrative measurement campaign has been performed on May 2013 in Beijing, while on August 2013 AMPLE has been carried in Dunhuang close to the Gobi desert and far away from the urban area, in order to study sand dust directly at source. Results of those measurements will be described.

Highlights / **37**

GDAS/HYSPLIT models

Author: Martin Will[1]

Co-author: Karim Louedec [2]

[1] *IFAE*

[2] *LPSC, CNRS/IN2P3, UJF-INPG, Grenoble*

Corresponding Author: karim.louedec@lpsc.in2p3.fr

Astroparticle experiments depend on a good knowledge of scattering and absorption of photons in the atmosphere. Typically two kinds of scattering can be distinguished, Mie scattering on large scale dust particles and Rayleigh scattering due to the molecular atmosphere. Both can be characterized quite well by measurements, but through advances in the modeling of the atmosphere in recent years, a very powerful alternative is provided. GDAS is a 3-hourly global model of the atmospheric state parameters on a 1 degree grid, based on real-time measurements and numeric weather prediction. HYSPLIT is a powerful tool to track the movement of air masses at various heights, and with it the aerosols. Typically the GDAS model is used in HYSPLIT to model the molecular atmosphere, and while the aerosol scattering itself can not be estimated using this tool, it is possible to track the path of air masses and make estimations of the clarity or the atmosphere depending on the origin of the aerosols (sea, desert, vegetation). Both GDAS and HYSPLIT were developed by the US weather department NOAA and the data are available through the internet without cost. In this talk we will present shortly the two models and some case studies for several astroparticle experiments.

Overview of Experiments / 7

Atmospheric Monitoring in the Pierre Auger Observatory

Author: Bianca Keilhauer[1]

[1] *Karlsruhe Institute of Technology KIT*

Corresponding Author: bianca.keilhauer@kit.edu

The Pierre Auger Observatory detects high-energy cosmic rays with energies above some 10^17 eV. It is built as a multi-hybrid detector measuring extensive air shower with different techniques.
For the reconstruction of extensive air showers, the atmospheric conditions at the site of the observatory have to be known quite well. This is particularly true for reconstructions based on data obtained by the fluorescence technique. For these data, not only the weather conditions near ground are relevant, most important are altitude-dependent atmospheric profiles. Thus, the Pierre Auger Observatory has set up a dedicated atmospheric monitoring programme at the site of the observatory in the province Mendoza, Argentina.

Most atmospheric monitoring activities aim primarily for a high-quality reconstruction of air showers. Further interests are beyond the scope of cosmic ray investigations, in the field of atmospheric science. Local measurements can be used for determining the accuracy of global model data at the site of the Observatory or can serve for dedicated studies of local conditions in the Pampa Amarilla, Argentina.

Overview of Experiments / 51

Atmospheric monitoring in H.E.S.S.

Author: Joachim Hahn[1]

[1] *MPIK*

Corresponding Author: joachim.hahn@mpi-hd.mpg.de

Instruments applying the IACT method, such as H.E.S.S. (High Energy Stereoscopic System), observe VHE (very high energy, E>100GeV) photons indirectly, using the Earth's atmosphere as a calorimeter. In the H.E.S.S. data reconstruction, the properties of this component are estimated by Monte Carlo simulations of a yearly averaged atmosphere density profile. Deviations of the real atmospheric conditions from this assumed atmospheric model will result in a biased reconstruction of the primary gamma-ray energy and thus the resulting source spectrum. In order to keep the corresponding systematic effects to a minimum, H.E.S.S. operates a set of atmosphering monitoring devices that allows it to characterise the atmospheric conditions during data taking. This information in turn is then used in data selection. Here, a short overview with respect to their usage during source observation and a posteriori analysis data selection will be presented.

Overview of Experiments / 4

Atmospheric Monitoring in MAGIC and Data Corrections

Author: Christian Fruck[1]

[1] *MPI Munich*

Corresponding Author: christian.fruck@gmail.com

A method for analyzing returns of the custom-made 'micro'-LIDAR system, which is operated along side with the two MAGIC telescopes is presented. This method allows to calculate the transmission through the atmosperic boundary layer as well as thin cloud layers by applying exponential fits to regions in the signal that are dominated by Rayleigh scattering. Writing this real time transmission information into the data stream allows to apply atmospheric corrections in the MAGIC data analysis chain later on. Such corrections make it possible to extend the effective observation time of MAGIC under adverse atmospheric conditions and reduce the systematic errors of energy and flux in the data analysis. Further more it is possible to perform long-term studies of the observational conditions based on the LIDAR data.

Overview of Experiments / 53

FACT - Measuring atmospheric condition with an Imaging Air Cherenkov Telescope

Author: Dorothee Hildebrand[1]

[1] *ETH Zurich*

Corresponding Author: dorothee.hildebrand@phys.ethz.ch

For Imaging Air Cherenkov Telescopes, knowledge about the condition of the atmosphere is very important. Usually, this information is gathered by external devices like lidars and pyrometers. While pyrometers only give integral information, lidars have the problem that their lasers can affect data-taking.

Based on experience from the First G-APD Cherenkov Telescope (FACT), we present possibilities to extract information about quality of the atmosphere as well as ambient light conditons directly with the Cherenkov telescope itself during data-taking.

Overview of Experiments / 52

Atmospheric monitoring at the TNG site

Author: Adriano Ghedina[1]

Co-authors: Albar Garcia de Gurtubai Escudero [1]; Marco Pedani [1]

[1] *TNG*

Corresponding Author: ghedina@tng.iac.es

For more than 20 years the TNG and its surroundings at the ORM have been the site for monitoring the atmosphere under several of its parameters.
From the first instruments installed in the early '90s to characterize and show the quality of the sky at the chosen site
(particularly the Automatic Weather Station and the DIMM) we evolved into the actual set up of remote sensing devices
to be considered as a fundamental aid for the telescope, in particular for its safety and to optimize the scientific throughput.
We will resume here the lessons learned, some results and the new choices for monitoring the atmosphere at the TNG.

Overview of Experiments / 6

Atmospheric Monitoring and Calibration for CTA

Author: Michele Doro[1]

[1] *PD*

Corresponding Author: michele.doro@pd.infn.it

Overview of Experiments / 41

All sky camera, Lidar, and Electric Field Meter for the ASTRI SST-2M prototype for CTA

Author: Giuseppe Leto[1]

Co-authors: Eugenio Martinetti [1]; Giancarlo Bellassai [1]; Maria Concetta Maccarone [2]; Pietro Bruno [1]; Ricardo Zanmar Sanchez [1]

[1] *INAF-Osservatorio Astrofisico di Catania*

[2] *INAF-IASF Palermo*

Corresponding Author: gle@oact.inaf.it

ASTRI, Astrofisica con Specchi a Tecnologia Replicante Italiana, is a flagship project of the Italian Ministry of Education, University and Research, entirely supported and led by the Italian National Institute of Astrophysics, INAF. The project is developed in the framework of the International Cherenkov Telescope Array, CTA. The primary goal of the ASTRI project is the realization of a wide field of view end-to-end prototype of a Small Size Telescope (SST-2M) for the CTA devoted to the investigation of the energy range from a few TeV up to hundreds of TeV.

The ASTRI SST-2M end-to-end prototype, currently under construction, will be installed and operated in Italy at the INAF observing station located at Serra La Nave on Mount Etna during next autumn 2014. In the framework of the environmental monitoring studies, a set of auxiliary instrumentation has been configured on site and in particular an all-sky camera, an Electric Field Meter and a Raman Lidar.

In this contribution we present our progress in detecting clouds in color all-sky images taken during the day and the night, the results in monitoring the volcanic ash with our Lidar system, and the first results coming from the Electric Field Meter, mainly acting as lightning detector.

Summary:

The talk will focus on the progress on data taking and analysis of three instruments, all-sky camera, an Electric Field Meter and a Raman Lidar, that are being set for the monitoring of the sky conditions at the INAF ASTRI SST-2M test site of Serra La Nave.

Highlights / 17

Raman LIDARs for Pierre Auger Observatory: field experiences and results.

Author: Vincenzo Rizi[1]

[1] *CETEMPS-DSFC and INFN, Università Degli Studi dell'Aquila*

Corresponding Author: vincenzo.rizi@aquila.infn.it

The optical properties of the troposphere are quite important for ultra-high energy cosmic ray observatories that use the atmosphere as a giant calorimeter. To estimate the energy of a cosmic ray extensive air shower (EAS), the amount of UV scintillation light generated by an EAS (air fluorescence) can be measured, and, the optical transparency of the atmosphere affects the amount of UV light that reaches the ground-based air fluorescence detector. The most variable component of atmospheric optical transmission is the vertical aerosol optical depth (VAOD).
The Raman LIDAR is the technique to be preferred for the measurements of the VAOD in the UV wavelength range [1].
We present the design and the technical details, and the performances and the limitations of the Raman LIDAR systems used at the Pierre Auger Observatory [2] and in the Auger R&D in South-Eastern Colorado [3]. The latter field experiment combined a UV backscattered Raman LIDAR and a side-scattering detector, i.e., a LIDAR detector in bi-static configuration; this was a model of the new setup of part of the atmospheric instrumentation [4], now in use at the Pierre Auger Observatory, and it was designed to improve the methods to measure the VAOD profiles.

[1] G. Pappalardo, et al., Aerosol lidar intercomparison in the framework of the EARLINET project. 3. Raman LIDAR algorithm for aerosol extinction, backscatter, and LIDAR ratio, Appl. Optics 43 (2004) 5370{538.
[2] Pierre Auger Collaboration, Iarlori M., Visconti G. (2012), Atmospheric monitoring with LIDARs at the Pierre Auger Observatory. THE EUROPEAN PHYSICAL JOURNAL PLUS, vol. 127, ISSN: 2190-5444, doi: 10.1140/epjp/i2012-12092-0
[3] Pierre Auger Collaboration et al., (2012), UV Raman lidar and side scattering detector for the monitoring of aerosol optical transmission at the Pierre Auger Observatory, PROCEEDINGS FOR THE ILRC 2012, Greece, June 2012.
[4] Pierre Auger Collaboration (2013), Techniques for measuring aerosol attenuation using the Central Laser Facility at the Pierre Auger Observatory, JOURNAL OF INSTRUMENTATION, 8, P04009, 10.1088/1748-0221/8/04/P04009, 1748-0221, 2013.

Highlights / 46

Monte Carlo simulations of atmospheric showers in the future

Author: Tanguy Pierog[1]

[1] *KIT, IKP*

Corresponding Author: tanguy.pierog@kit.edu

Last year, the air shower simulation model CORSIKA had a major release opening new windows in term of uncertainty due to hadronic interaction models and of simulation time. On the one hand, the two hadronic models EPOS and QGSJETII were updated taking into account new LHC data. As a consequence the uncertainties in air shower observables were reduced by about a factor of 2 at the highest energies. On the second hand, two new possibilites of running CORSIKA was introduce: either in a parallel mode on big CPU clusters allowing the simulation of unthinned showers in a reasonable time, or using cascade equations to reduce the simulation time by about of factor of 10 on a single CPU. All these improvements togehter with future developments will be presented.

Overview of Experiments / 58

The Atmospheric Monitoring System of the JEM-EUSO Space Mission

Author: Maria Rodriguez Frias[1]

[1] *Space and Astroparticle Group. UAH Madrid*

Corresponding Author: dolores3.frias@gmail.com

An Atmospheric Monitoring System (AMS) is a mandatory and key device of a space-based mission which aims to detect Ultra-High Energy Cosmic Rays (UHECR) and Extremely-High Energy Cosmic Rays (EHECR) from Space. JEM-EUSO has a dedicated atmospheric monitoring system that plays a fundamental role in our understanding of the atmospheric conditions in the Field of View (FoV) of the telescope. Our AMS consists of a very challenging space infrared camera and a LIDAR device, that are being fully designed with space qualification to fullfil the scientific requirements of this space mission. This AMS will provide information of the cloud cover in the FoV of JEM-EUSO, as well as measurements of the cloud top altitudes with an accuracy of 500 m and the optical depth profile of the atmosphere transmittance in the direction of each air shower with an accuracy of 0.15 degree and a resolution of 500 m. This will ensure that the energy of the primary UHECR and the depth of maximum development of the EAS (Extensive Air Shower) are measured with an accuracy better than 30% primary energy and 120 g/cm2 depth of maximum development for EAS occurring either in clear sky or with the EAS depth of maximum development above optically thick cloud layers. Moreover a stereoscopic retrieval technique and a very novel that seems to be the most promising radiometric retrieval technique considering the LIDAR shots as calibration points are under development to infer the Cloud Top Height (CTH) of all kind of clouds, thick and thin clouds in the FoV of the JEM-EUSO space telescope.

Instruments and Tecniques Developments / 59

Thick & Thin Cloud Top Height Retrieval Algorithm with the Infrared Camera & LIDAR of the JEM-EUSO Space Mission.

Author: Guadalupe Saez Cano[1]

Co-author: Maria Rodriguez Frias [2]

[1] *Space and Astroparticle Group, UAH, Madrid*

[2] *Space and Astroparticle Group. UAH Madrid*

Corresponding Author: dolores3.frias@gmail.com

JEM-EUSO is a space-based telescope which will detect Ultra High Energy Cosmic Rays (UHECR) and Extremely High Energy Cosmic Rays (EHECR) using the atmosphere as a calorimeter. It will be located at the International Space Station (ISS), and will look down to the atmosphere. To estimate the energy and arrival direction of the UHECR & EHECR as well as its primary composition, the UV light profile from EAS is needed to be measured. The observed profile depends on atmospheric conditions such as the clouds top height. Unlike stationary observatories on the ground, the JEM-EUSO space telescope traverses above various atmospheric situations within its large observation area. To characterize the properties of the atmosphere, the JEM-EUSO space mission comprises an Atmospheric Monitoring System (AMS) with an infrared camera and a LIDAR. As the scientific requirement of this project is to retrieve the clouds height and not the brightness temperature of the clouds it is mandatory to develop an effective radiative retrieval algorith that retrieves directly the height of the cloud avoiding any indirect approach that do not retrieve the cloud height and therefore increasing the contribution to the NETD Budget of the Infrared camera. Therefore, a novel radiative retrieval algorith that seems to be the most promising to achieve the Infrared camera scientific requirement, i.e., to retrieve directly the cloud top height is presently under development, taking into account the LIDAR shots as calibration points in the FoV of the infrared camera image.

Instruments and Tecniques Developments / 56

Clouds phase identification based on brightness temperatures provided by the bi-spectral IR Camera of JEM-EUSO Mission

Author: Irene Rodríguez[1]

Co-authors: Antonio J. de Castro [1]; Fernando López [1]; Isabel Fernández-Gómez [1]; Pacheco Briz [1]

[1] *Universidad Carlos III de Madrid*

Corresponding Author: sbriz@fis.uc3m.es

Cloud information is extremely important to correctly interpret the JEM-EUSO telescope data since UV radiation coming from the Extensive Air Shower can be partially absorbed or reflected by clouds. In order to observe the atmosphere and clouds in the field of view of the UV telescope the JEM-EUSO system will include an atmospheric monitoring system, which consist of a LIDAR and an IR Camera. Different methods can be applied to retrieve the cloud top height from IR images: stereovision and techniques based on radiative measurements. Until now several radiative algorithms have been developed to retrieve the cloud top temperature from the brightness temperatures (BT) that the IR Camera will provide in two IR spectral bands (10.8 and 12 μm). In some cases the performance of the algorithms depends on cloud phase: water, ice or mixed. For this reason the identification of the cloud phase is valuable information for the correct interpretation of the cloud temperatures retrieved by radiative algorithms.
Cloud classification from bands in the 10-12 (micrometers) spectral region is not an easy task. Some previous proposals based on BT and brightness temperature difference (BTD) in 11 and 12 (micrometers) bands have revealed that there are not clear limits to determine unambiguously the phase. In this work we present criteria for BTD and BT(10.8μm) to retrieve the cloud phase. These criteria has been checked with MODIS images to evaluate the possibilities to identify cloud phase with the JEM-EUSO IR Camera, although these results can be also applied to other sensors measuring in the same spectral bands.

Instruments and Tecniques Developments / 18

The EUSO-TurLab project

Author: Mario Edoardo Bertaina[1]

Co-authors: Anike BOWAIRE [2]; Giorgio COTTO [2]; Giovanni CONTINO [3]; Massimiliano MANFRIN [4]; Nunzio GUARDONE [3]; Pier Silvio TIBALDI [2]; Renato FORZA [2]; Roberta MULAS [2]; Rossella Caruso [5]

[1] *TO*

[2] *Univ. Torino*

[3] *INFN Catania*

[4] *INFN Torino*

[5] *CT*

Corresponding Author: mario.bertaina@to.infn.it

The TurLab facility is a laboratory, equipped with a rotating tank, located at the Physics Department of the University of Torino.
It consists of a 5 m diameter tank, which is used for fluido-dynamics studies. The system has been thought mainly for studying problems where system rotation plays a key role in the fluid behaviour, for example in atmospheric and oceanic flows at different scales.
The tank can be filled with different fluids of variable density allowing studies in stratified conditions too; sea waves (infinite fetch) can be reproduced and analysed. The tank can be also used to simulate parts of the terrestrial surface with optical characteristics of different environments (snow, grass, ocean, land,….. fogs and clouds can be simulated as well).
The tank is located in an extremely dark place, therefore the light intensity can be controlled artificially.
The EUSO-TurLab project is an on-going activity to reproduce artificially atmospheric and luminous situations that JEM-EUSO will encounter on its orbits around the Earth. This is suitable to test the

detector performance as well as the trigger system.
In this talk, a review of the on-going tests related to the JEM-EUSO mission will be presented.

Companies / 22

LICEL

Companies / 23

CAEN

Corresponding Author: g.mini@caen.it

Companies / 39

Raymetrics

Author: George Avdikos[1]

[1] *Raymetrics*

Corresponding Author: gavdikos@raymetrics.gr

Companies / 38

Bright Solutions

Author: Luca Carra'[1]

[1] *Bright Solutions*

Instruments and Tecniques Developments / 27

ARCADE : description of the project and setup of the LIDAR/AMT system

Author: Laura Valore[1]

[1] *NA*

Corresponding Author: laura.valore@na.infn.it

The Atmospheric Research for Climate and Astroparticle DEtection (ARCADE) project is a 3 years project funded by MIUR, that aims to study the aerosol attenuation of UV light in atmosphere using multiple instruments and techniques, as those commonly used in the cosmic rays community: elastic

Lidar, Raman Lidar, side-scattering measurements using a distant laser source. All measurements will be acquired on the same air mass at the same time, in semi-desertic site near Lamar, Colorado. For each instrument, multiple analysis techniques will be tested: the target is a better comprehension of the systematics and limits of applicability of each method. The system is composed by a Lidar (elastic+Raman), fully designed and built within this project, and by the Atmospheric Monitoring Telescope (AMT), a telescope for the detection of UV light owned by the Colorado School of Mines. The setup of the two instruments is described in detail here. The project is presently entering its third year : the Lidar system has been tested at the University of L'Aquila last February before shipment to the U.S., and the AMT has been recently reinstalled and tested in Lamar. During the next month the ARCADE group will work out the final setup of the Lidar+AMT system in Lamar and begin data acquisition.

Instruments and Tecniques Developments / **57**

Retrieval of optically thin cloud emissivity from brightness temperatures provided by IR Camera of JEM-EUSO Mission

Author: Isabel Fernández-Gómez[1]

Co-authors: Antonio J. de Castro [1]; Fernando López [1]; Irene Rodríguez [1]; Pacheco Briz [1]

[1] *Universidad Carlos III de Madrid*

Corresponding Author: sbriz@fis.uc3m.es

Clouds interact with the radiation propagating through the atmosphere absorbing, reflecting and transmitting part of the energy. This interaction may lead to misinterpretation of data retrieved from the radiation observed by JEM-EUSO UV telescope. At the same time the interaction cloud-ratiation can be used to retrieve cloud properties. JEM-EUSO Mission includes an Atmospheric Monitoring System (AMS), consisting of a LIDAR and an IR Camera, devoted to provide the cloud coverage and the cloud height in the FOV of the main UV Telescope.
Different methods can be applied to retrieve the cloud top height from IR images: stereoscopic and radiative techniques. Radiative algorithms are based on the Radiative Transfer Equation which changes significantly depending on the cloud optical depth (thick or thin clouds). The cloud temperature retrieval becomes much more difficult for thin clouds (emissivity lower than 1).
In this work we present a methodology based on brightness temperatures in 10.8 and 12 micrometers bands measured by the JEM-EUSO IR camera. The method uses Look Up Tables (LUTs) which involve values of emissivity and brightness temperature differences in both bands. This LUT method has been validated with data obtained by simulation but also in real scenarios (MODIS images). The results are very promising for emissivities higher than 0.5. For lower emissivities, the retrievals become much more difficult since the IR radiation impinging the IR Camera also comes from other emitters such as Earth surface and atmosphere beneath the cloud.

Instruments and Tecniques Developments / **44**

Recent development of the H.E.S.S. Lidar

Author: George Vasileiadis[1]

Co-authors: Johan Bregeon [1]; Ryan Chaves [1]

[1] *LUPM*

Corresponding Author: george.vasileiadis@lupm.in2p3.fr

We present recent results obtained with the H.E.S.S. Lidar installed and operating for the last four years at the Namibian desert. Results obtained, using a recent Klett type analysis, permit a better cor-

relation with relevant H.E.S.S. type related run parameters. Future plans as scenarios to implement these results on the main physics analysis chain will also be discussed.

Instruments and Tecniques Developments / 49

Atmospheric Monitoring With An Infrared Radiometer

Author: Michael Daniel[1]

Co-author: Paula Chadwick [2]

[1] *University of Liverpool*

[2] *University of Durham*

Corresponding Author: michael.daniel@liverpool.ac.uk

The molecular atmosphere has a number of windows where it is effectively transparent to electromagnetic radiation, one of these being in the infrared 8-14 micron region. The presence of clouds and aerosols, which are more effective emitters of infrared radiation, in the atmosphere show up as an increase in the effective brightness temperature compared to the clear sky. This talk will cover the results from operating a scanning radiometer at the H.E.S.S. site in Namibia in determining atmospheric conditions.

Instruments and Tecniques Developments / 42

FRAM for CTA

Corresponding Author: janecekp@fzu.cz

The Cherenkov Telescope Array (CTA) is a project to build a new generation ground-based gamma-ray observatory. Among other goals, the project aims to achieve high precision measurements of gamma-ray properties while maximizing the use of observation time. These objectives require detailed and fast information about atmospheric conditions, particularly the transparency (varying mostly with aerosol content) and cloud cover (including thin high-altitude clouds). This knowledge is required not only to select and calibrate data after observation, but also to make on-the-fly scheduling decisions. To provide such data without interfering with the observation (as would be the case when using laser-based methods), we propose to use the FRAM (F(/Ph)otometric Robotic Atmospheric Monitor) device, which is a small robotic astronomical telescope with a large field of view and a sensitive CCD camera. FRAM will use stellar photometry to measure atmospheric extinction across the field of view of the CTA. The fast robotic mount of the telescope allows quick observation of multiple fields, when the array is split, and even a check of the conditions in the directions of upcoming observations. The FRAM concept is built upon an experience gained with a similar device operated at the Pierre Auger Observatory.

Instruments and Tecniques Developments / 50

All Sky Camera for the CTA CCF Atmospheric Calibration work package

Author: Dusan Mandat[1]

Co-authors: Jan Ebr [1]; Michael Prouza [1]; Miroslav Hrabovsky [1]; Miroslav Palatka [1]; Miroslav Pech [1]; Petr Janecek [2]; Petr Schovanek [1]; Petr Travnicek [1]

[1] *Institute of Physics Academy of Sciences of the Czech Republic*

[2] *Institute of Physics AS CR*

Corresponding Author: mandat@fzu.cz

The All-Sky-Camera (ASC) is a passive non-invasive imaging system for rapid night sky atmosphere monitoring.
The operation of the ASC will hence not disturb standard operation of the CTA telescopes, however results from the measurements will help to improve the accuracy and effective duty-cycle of the CTA observatory.
The goal of ASC, and recently developed intelligent image analysis algorithms, is to identify the position of clouds, atmospheric attenuation and time evolution of the local sky conditions.
The monitoring will be able to predict the night-sky quality on a short term basis.
In case of partly cloudy night-sky, the cameras will identify uncovered regions of the sky during the CTA operation time, and pinpoint those regions where observation targets can be viewed without atmospheric disturbance.

Instruments and Tecniques Developments / 54

Weather and atmosphere observation with the ATOM all-sky camera

Author: Felix Jankowsky[1]

[1] *LSW*

Corresponding Author: f.jankowsky@lsw.uni-heidelberg.de

The Automated Telescope for Optical Monitoring for H.E.S.S. (ATOM) is an optical 75cm telescope which operates fully automated. As there is no observer present during observation, an auxiliary all-sky camera serves as weather monitoring system. This device takes an 180° image of the whole sky every three minutes. The gathered data then undergoes live-analysis by performing astrometric comparison with a theoretical night sky model, interpreting the absence of stars as cloud coverage. It also serves as tool for a meteorological analysis of the observation site of the the upcoming Cherenkov Telescope Array (CTA). This presentation covers design and benefits of the all-sky camera and additionally gives an introduction into current efforts to integrate the device into the atmosphere analysis programme of H.E.S.S.

Instruments and Tecniques Developments / 36

Remote sensing of clouds with Cherenkov telescopes

Author: Denys Malyshev[1]

[1] *ISDC*

Corresponding Author: denys.malyshev@unige.ch

Remote sensing of atmosphere is conventionally done via a study of extinction/scattering of light from natural (Sun, Moon) or artificial (laser) sources. Cherenkov emission from extensive air showers generated by cosmic rays provides one more natural light source distributed throughout the atmosphere. We show that Cherenkov light carries information on three-dimensional distribution of clouds and aerosols in the atmosphere and on the size distribution and scattering phase function of cloud/aerosol particles. Therefore, it could be used for the atmospheric sounding. The new atmospheric sounding method could be implemented via an adjustment of technique of imaging Cherenkov telescopes. The atmospheric sounding data collected in this way could be used both for atmospheric science and for the improvement of the quality of astronomical gamma-ray observations.

Instruments and Tecniques Developments / **48**

The impact of clouds on image parameters in IACT at very high energies

Author: Dorota Sobczynska[1]

Co-author: Wlodek Bednarek [1]

[1] *University of Lodz*

Corresponding Author: ds@kfd2.phys.uni.lodz.pl

The effective observation time with the Cherenkov telescopes arrays is limited to clear sky conditions due to considerable absorption of Cherenkov light by the possible presence of clouds. However below the cloud altitude the primary particles with high energies can still produce enough Cherenkov photons to allow detection by the large telescopes. In this paper, using the standard CORSIKA code, we investigate the changes of shower image parameters due to cloud absorption for gamma-ray and proton showers with various energies - from 2 TeV to 100 TeV and from 10 TeV to 200 TeV, respectively. We consider the clouds with different transmissions located at various altitudes above the ground level (between 8 km and 3 km). We show that, for both simulated primary particles at fixed energy, in the presence of clouds the WIDTH and the DIST distributions are shifted towards larger values. This shift decreases with the cloud altitude. The LENGTH distributions are shifted towards smaller values for the primary gamma-ray, while for primary proton this shift is not expected. We conclude that large Cherenkov telescopes with large camera FOV might be used for observation of energetic gamma-ray shower.

Instruments and Tecniques Developments / **28**

Remote Sensing of Clouds using Satellites, Lidars, CLF and IR Cameras at the Pierre Auger Observatory

Author: Johana Chirinos[1]

[1] *MTU*

Corresponding Author: jmchirin@mtu.edu

61

Pilot study of ultra-high energy COsmic rays through their Space-ATmospheric interactions - COSAT

Author: Paula Gina Isar[1]

[1] *Institute of Space Science (ISS)*

Corresponding Author: gina.isar@spacescience.ro

One hundred years after the discovery of cosmic rays, the study of charged ultra-high energy cosmic rays remains a vital activity in fundamental physics.
While primary cosmic rays could not be measured directly until it was possible to get the detectors highly in the atmosphere using balloons or spacecraft, nowadays very energetic cosmic rays are detected indirectly by ground-based experiments measuring their EAS induced Cherenkov, fluorescent light, or radio waves. Moreover, all cosmic ray measurements (performed either from space or ground) rely on accurate understandings of atmospheric phenomena.
The concept of the COSAT project is the inter-link between Astroparticle Physics, Remote Sensing and Atmospheric Environment, willing to investigate the energetic cosmic rays physical processes using the atmosphere as a detector, to identify potential scientific niches in the field of space sciences and prepare to participate to the ESA's Programs (e.g. Science, Earth Observation).
A short introduction on current status and perspectives of the national partnership COSAT project will be given in a poster presentation.

55

Comparison between stereovision and radiative methods to retrieve the cloud top height from an IR Camera on board the ISS in the frame of JEM-EUSO Mission

Author: Susana Briz[1]

Co-authors: Anna Anzalone [2]; Antonio J. de Castro [1]; Francesco Isgrò [3]; Irene Rodríguez [1]; Isabel Fernández-Gómez [1]; Mario Edoardo Bertaina [4]; Roberto Cremonini [5]; Tabone Ilaria [6]

[1] *Universidad Carlos III de Madrid*

[2] *IASF-Palermo*

[3] *Università di Napoli Federico II*

[4] *TO*

[5] *Arpa Piemonte*

[6] *Dipartimento di Fisica, Università degli Studi di Torino, Italy.*

Corresponding Author: sbriz@fis.uc3m.es

The main telescope of JEM-EUSO will determine Ultra High Energy Cosmic Rays properties by measuring the UV fluorescence light generated in the interaction between the cosmic rays and the atmosphere. Therefore, cloud information is crucial for a proper interpretation of the data. JEM-EUSO will observe the conditions of the atmosphere and clouds in the field of view of the telescope making use of an atmospheric monitoring system, which consist of a LIDAR and an IR Camera.
To retrieve the cloud top height from IR images two different methodologies will be used. The first one is based on sterovision algorithms and requires two different views of the same scene. The second one is based on the relationship between the cloud temperature and the cloud height. However the IR images just provide brightness temperatures. Therefore some algorithms have been developed to consider atmospheric effects and to retrieve the real cloud temperature from the brightness temperature.
This article presents a preliminary work in which both methodologies are compared. The stereo system is provided by the two geostationary satellites MSG-8 and MSG-9. A mono-band algorithm has been developed to correct these images in order to retrieve the real cloud temperature from which the height can be calculated. MODIS images of the same area have been used to test the radiative procedure. Although MSG bands and the algorithms are not exactly the ones used by the IR Camera, this initial work is a first step to compare a very simplified version of both methodologies.