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Press Release
Cairo, April 27th 2016

#ScanPyramids – Results from the first measurements campaign in the Bent Pyramid

Tuesday April 26th, The #ScanPyramids team presented to The Minister of Antiquities, Dr. Khaled El-Enany, to the former minister of Antiquities Dr. Mamdouh El Damaty and to the members of the permanent Committee of Egyptian Antiquities the results of its first muography mission done on the Bent Pyramid.
The principle of this new innovative technology: Get an inside radiography of the monument thanks to muons, cosmic particles that are permanently and naturally raining on earth and are able to penetrate any material very deeply.

In December 2015 a team from Nagoya University (Japan) installed in the lower chamber of the pyramid a setup consisting in 40 plates covering a total area of 3.5 m². Each plate contained 2 muon sensitive films. This setup was retrieved in January 2016 after 40 days of exposure – corresponding to the maximal lifetime of chemical emulsions within the temperature and humidity conditions inside the pyramid. These films were then developed in a dedicated lab installed at the Grand Egyptian Museum (GEM), and shipped to Nagoya University for analysis.

From these plates, more than 10 Millions of muon tracks were reconstructed, with a spectacular result: for the first time ever, the internal structure of a pyramid was revealed with muon particles. The images obtained indeed show the second chamber of the pyramid,

located roughly 18 meters above the lower one in which emulsions plates were installed. The available statistics from the 40 days of exposure is not yet sufficient to precisely reveal the known corridors. However, various simulations were performed by randomly placing, within the field of view, a hypothetic chamber of size similar or larger than the upper one. Compared with the results obtained by the Japanese team, these simulations could validate the fact there is no additional chamber of this size in the surroundings.

This scientific breakthrough validates the muography principle applied to Egyptian pyramids. The technique validated at Bent Pyramid is now planned to be used on other old kingdom pyramids. Besides the chemical emulsion films from Nagoya University, two other types of electronic instruments will be deployed. On the contrary to the emulsions, they have no limit in exposure time, and further allows for real time analysis.

More information on muography

Muon particles permanently reach the Earth with a speed close to the speed of light and a flux around 10,000 per m^2 per minute. They originate from the interactions of cosmic rays created in the Universe with the atoms of the upper atmosphere. Similarly to X-rays which can penetrate our body and give access to bone imaging these elementary particles, also called "heavy electrons", can go through hundreds of meters of stones before being absorbed. Judiciously placed detectors (for example inside a pyramid, below a potential, unknown chamber) can then record particle tracks and discern cavities (which muons cross with practically no interactions) from more dense regions in which some muons are absorbed or deflected. The challenge of such measurements consists in building extremely precise detectors and in accumulating enough of data (during several days or months) to increase the contrast.

The muography technique is nowadays frequently used in volcanology, in particular by the research teams of Nagoya University. Within the ScanPyramid mission, 3 types of detectors have been developed. Nagoya University uses chemical detectors based on silver emulsion films. The KEK has built an electronic device working with muon sensitive, scintillating plastics. Such instruments allowed in particular the imaging of the inside of nuclear reactors in Fukushima. Concerning the muon telescopes of CEA which joined the mission on April 15th, they are made of gaseous detectors based on an argon mixture. On the contrary to chemical emulsions, electronics instruments (plastic or gas) allow for a real time imaging.

About #ScanPyramids

#ScanPyramids mission (www.scanpyramids.org) was launched on 25 October 2015 under the authority of the Egyptian Ministry of Antiquities and is led by Faculty of Engineering, Cairo University, and HIP.Institute (www.hip.institute) , Paris (Heritage, Innovation and Preservation Institute). This project aims at scanning, over a year, some of the Egyptian Pyramids: Khufu, Khafre, the Bent and the Red Pyramids. #ScanPyramids combines several non-invasive and non-destructive scanning techniques in order to try to detect the presence

of any unknown internal structures and cavities in ancient monuments, which may lead to a better understanding of their structure and their construction processes / techniques. This mission is using, today, Infrared thermography, muon tomography and 3D reconstruction techniques.

Several international scientific institutions are part of #ScanPyramids: Nagoya University (Japan), KEK (High Energy Accelerator Research Organization – Tsukuba – Japan) and CEA (French Alternative Energies and Atomic Energy Commission – Saclay - France) for muon techniques and Laval University (Quebec – Canada) for infrared thermography.

VIDEO

www.vimeo.com/hipinstitute/muons

PICTURES

Password for following HD pictures on request

http://www.hip.institute/press/pictures/Pictures_HIP.Institute_Bent_Pyramid_Muography.zip

CONTACTS

Site officiel : http://www.hip.institute

#ScanPyramids: http://www.scanpyramids.org

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PASSWORD FOLLOWING HD PICTURES ON REQUEST

Bent Pyramid

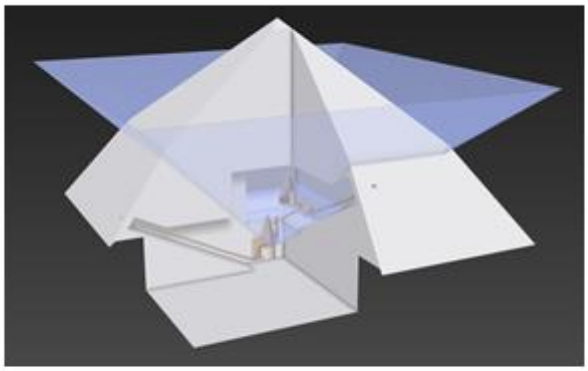
3D Cutaway view of Bent Pyramid
with lower and upper chamber

Muons Emulsion films setup in lower chamber

Muons Emulsion films development

Muons Emulsion films analysis

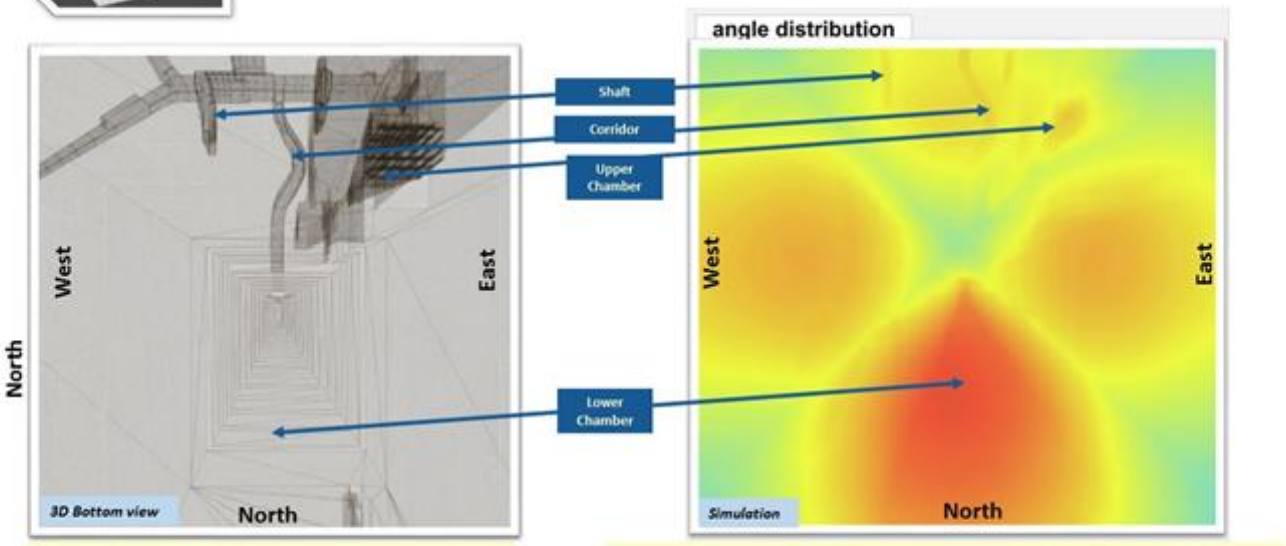
ScanPyramids team presenting Bent Muography
Results at Ministry of Antiquities



Muons Setup Field of view from lower chamber Inside Bent Pyramid

Bent 3D View from Muons Emulsion Films Perspective

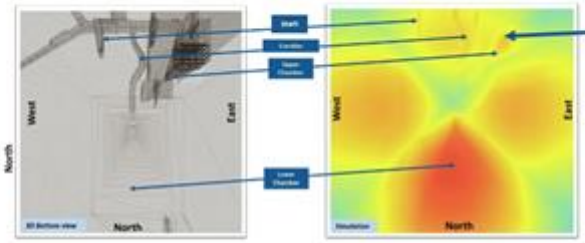
From 3D View to Simulation

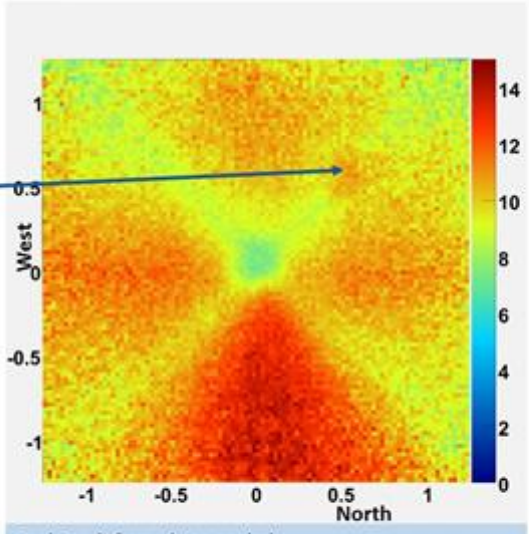


If I'm one of the plate, looking up what should I see through wall and detect.

Scientific simulation of what we should get with Muons. Here we remove the constraint of 40 days and we suppose that the emulsion can be set for a very long time

From Simulation to Results





Real Result from plates analysis after 40 days of Exposure