Science Communication in the BEOBAL Framework

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High Mountain Research Stations: Windows on the Universe

In the Framework of BEOBAL FP6 Project a successful exhibition has been organized:

- Presentation to the public of research activities performed at HMO
- HMO Historical description
- HMO Geographical location
- Contribution of HMO to the modern science

High Mountain Research Stations: Windows on the Universe

- Which kind of scientific research is carried out today
- Integration of HMO in the Earth Observation system
- Integration of HMO in the space and atmosphere studies
- Integration of HMO in the environment monitoring
- HMO Network as an important tool for global change studies

XX Olympic Winter Games Torino 2006

Le stazioni di ricerca diAlta Montagna : Finestre sull'Universo"

– 9th of Februry 2006 – 20th of March 2006

Sponsored by the Organizing Committee for the XX Winter Olympic Games.

Mountains are related to sport, to art, to travel, but their contribution to modern science is almost unknown.

The exhibition on High Mountain Research Stations is addressed to highlight the vast contribution of the mountain site to scientific knowledge from 1800 until today.

The Participant Institutions

- INFN Torino
- INAF-IFSI
- UNITO
- EV - K2 - CNR
- Observatoire de Paris
- Ecole Chalonge
- Comune Chieri
- FIDAPA
- CAI Bergamo
- OTTO Comunicazione

The Participant Institutions

- Institut for Nuclear Research and Nuclear Energy,
- FP6 BEOBAL Project INCO-CT-2005-016663
- Bulgarian Academy of Sciences
- Bulgarian Academy of Sciences Central Library
- Bulgarian Union of Scientists
- Union of Bulgarian Cultural Organization- so called “citalishta”- specific Bulgarian national tradition

“High Mountain Research Stations: Windows on the Universe”

The Exhibition

- Introduction
- Historical topics
- The observatories on the Alps
- The Observatories in Central Europe
- The Observatories in the World

The epic of the mountain: a sportive and scientific challenge
L'epopea della montagna: un'avventura sportiva e scientifica

In 1800, the mountain adventure was at the beginning: the conquest of the first Alpine Peaks (Mont Blanc on 1786, Jungfrau on 1811, Monte Rosa on 1855, Eiger on 1858, Matterhorn on 1865) opened the off-limits adventure, the extreme challenge. But how could man survive in these dramatic physical and psychological stress conditions?

Nel 1800 ha inizio l'epopea della montagna: la conquista delle prime vette alpine (il Monte Bianco nel 1786, la Jungfrau nel 1811, il Monte Rosa nel 1855, l'Eiger nel 1858, il Cervino nel 1865) spalanca la dimensione dell'avventura estrema, dell'ultima sfida. Ma come possono gli esseri umani sopravvivere alle drammatiche condizioni di stress fisico e psicologico che si incontrano lassù?

Angelo Mosso

The first scientific interest was aimed at man, to his capability of endurance: physicians, biologists, **physiologists like Angelo Mosso (1846-1910)** were the first researchers climbing the mountains with a scientific interest.

Il primo interesse scientifico è rivolto all'uomo, alla sua capacità di adattamento e di resistenza: I primi scienziati a scalare la montagna con scopi di ricerca sono stati medici, biologi, ***fisiologi come Angelo Mosso (1846-1910).***

Angelo Mosso in front of Mosso Institute (1907)
Angelo Mosso davanti all'Istituto Mosso (1907)

Daniel Chalonge

Later, people glanced at the sky, at night, at stars, to the unknown universe: the adventure of the **astrophysicists like Daniel Chalonge (1895-1977)** began.

Successivamente, lo sguardo si è rivolto in su, verso la notte, verso le stelle, si è affacciato sull'universo sconosciuto: comincia l'avventura ***degli astrofisici come Daniel Chalonge (1895-1977).***

Daniel Chalonge at Junfraujoch (1932)

G. Occhialini, C. Powell (Nobel Prize, 1950)

After the discovery of cosmic rays (Hess, 1912) the study of galactic radiation began, to investigate the mystery of the origin of the Universe: **Cosmic Ray Physics** is the new fronteer for high altitude science: at Chacaltaya laboratory (5230 m, Bolivia) **G.Occhialini, C.Powell and C. Lattes** discover a new particle, the **pion (1947)**.

Dopo la scoperta dei raggi cosmici da parte di Hess nel 1912, comincia lo studio della radiazione che proviene dalle stelle e che permette di penetrare il mistero dell'origine dell'Universo: è ***la Fisica dei raggi Cosmici*** *la nuova frontiera della ricerca in alta quota: nel laboratorio di Chacaltaya, a 5230 m in Bolivia,* ***G. Occhialini, C. Powell e C. Lattes*** *scoprono una nuova particella,il* ***pione (1947)****.*

Cesare Lattes at Chacaltaya

The high mountain researchers are at the same time scientists, climbers, explorers, like **Ardito Desio**, **the geologist that reached the summit of K2 in 1954.**

I ricercatori di alta montagna sono allo stesso tempo scienziati, alpinisti, esploratori, come ***Ardito Desio, il geologo che conquista il K2 nel 1954.***

Ardito Desio at base camp after the conquest of K2
Ardito Desio al campo base dopo la conquista del K2

The High Altitude Research Stations allowed a fast improvement in the knowledge of man and Universe. They represented the outstations of science, such as the spacecraft in space exploration today.

Le Stazioni di Ricerca di Alta Montagna *hanno consentito di avanzare rapidamente nella conoscenza dell'uomo e dell'universo, sono state gli avamposti della scienza, come oggi le astronavi nell'esplorazione dello spazio.*

All the high mountain scientists, in the past as well as today, have in common the passion for alpinism and nature, the solidarity, the sacrificial attitude and a crazy determination.

Tutti gli scienziati di alta montagna,dal passato fino ad oggi, hanno condiviso l'amore per l'alpinismo, la sintonia con la natura, la solidarietà, lo spirito di sacrificio, la determinazione che rasenta la follia.

The incredible stories concerning the Vallot Hut and Jannsen Observatory are the witnesses.

Le incredibili storie legate all'Osservatorio Vallot e all'Osservatorio Janssen lo testimoniano.

La Capanna Vallot e l'Osservatorio Janssen sul Monte Bianco

The Vallot Observatory
L'Osservatorio Vallot

Joseph Vallot (1892)

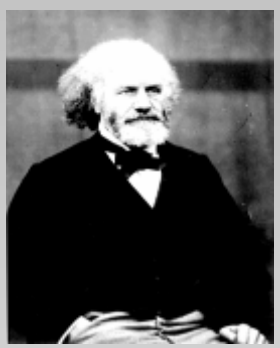
Joseph Vallot (1854-1925), a rich Parisian gentleman fond of science and self-taught in botany, biology, meteorology, built in 1890 the Vallot Observatory at 4350 m asl on the Mont Blanc.
Later he established a more comfortable mountain hut, with also a "salon chinois", following the exotic taste at the end of 1800!
Here he carried out studies on high altitude adaptation.
In 1913, with experiments on squirrels, he established for the first time the reduction of physical capacity caused by high altitude.

Joseph Vallot (1854-1925), un ricco signore parigino appassionato di scienza, botanico, biologo, metereologo autodidatta, costruisce nel 1890 l'Osservatorio Vallot a 4350 m sul Monte Bianco.
Successivamente realizza una struttura più confortevole, dotata anche di un "salon chinois" secondo il gusto esotico di fine ottocento!
Qui svolge studi sull'adattamento all'alta quota.
Nel 1913, con un esperimento sugli scoiattoli, conferma per la prima volta la riduzione delle capacità fisiche per effetto dell'altura.

The Vallot Hut.
La Capanna Vallot in un disegno dell'epoca.

Transport of instrumentation at Vallot Hut.
Trasporto della strumentazione alla Capanna Vallot in un disegno dell'epoca.

The Janssen Observatory*
*L'Osservatorio Janssen**



Pierre Janssen

Pierre Janssen (1824-1907), astronomer at the Paris Observatory, during his studies of spectroscopy, discovered that several lines of absorption due to Earth atmosphere disturb the solar spectrum.
What's the solution? To perform his research at very high altitude … on top of the Mont Blanc, at 4807 m asl!
In 1893 , after two years of work under incredible conditions, the new Observatory was installed on top of the highest mountain in Europe, using a system of pylons fixed into the glacier ice.
Finally Janssen (69 years old at that time) could carry out his research in the best conditions!
The Observatory however fell in a crevasse in 1909, two years following Janssen death. Conserved in the museum of Chamonix, the meteorological tower is the last witness to this incredible adventure.

P. Janssen transported on the Mont Blanc
P. Janssen trasportato sul Monte Bianco

The meteorological tower is falling in the glacier (1909)
La torre metereologica dell'Osservatorio Janssen sta sprofondando nel ghiacciaio (1909)

Pierre Janssen (1824-1907), astronomo a l'Osservatoire de Paris, nei suoi studi di spettroscopia scopre che alcune righe di assorbimento dovute all'atmosfera terrestre disturbano lo spettro solare.
Qual è la soluzione? Svolgere la ricerca ad altissima quota…in cima al Monte Bianco a 4807 metri!
Nel 1893, dopo due anni di lavoro in condizioni incredibili, il nuovo osservatorio viene installato sulla cima della montagna più alta d'Europa, montato su una struttura a traliccio ancorata nel ghiaccio.
Finalmente Janssen (che all'epoca aveva 69 anni!) può svolgere le sue ricerche in condizioni ottimali.
L'Osservatorio viene inghiottito da un crepaccio nel 1909, due anni dopo la morte dello scienziato.
Rimane come testimonianza, presso il museo di Chamonix, la torre metereologica.

* The information about P. Janssen comes from news item of Piero Bianucci (TuttoScienze 4 Gennaio 2006)
* *Le notizie su P. Janssen provengono dall'articolo di Piero Bianucci su TuttoScienze 4 Gennaio 2006*

Vallot and Janssen represent the extreme example of heroism and madness in the name of science: living conditions at altitudes of about 5000 m were prohibitive in that time. Vallot suffered from rheumatic fever, Janssen limped and had to be taken to the top of mountain in a sedan-chair or in a sledge. It was impossible to stay for a long time in the observatories, due to altitude related damages. However, both these scientists (Janssen was almost 70 years old!) climb tirelessly up and down the mountain, in absolute, visionary and grand dedication to science.

Vallot e Janssen rappresentano l'esempio estremo di eroismo-follia in nome della scienza: le condizioni di vita a quasi 5000 m di altezza erano proibitive all'epoca. Vallot soffriva di reumatismi, Janssen zoppicava e veniva trasportato sulla montagna in portantina o in slitta. Non era possibile soggiornare a lungo negli osservatori (non più di una decina di giorni) per i danni provocati dall'altezza. Ma i due scienziati, (Janssen a quasi 70 anni!) salgono e scendono instancabili dalla montagna, in una dedizione totale, visionaria e grandiosa, alla scienza.

Pic du Midi (Pirenei - France)

The mountains: not only for sport activities but a special environment for scientific research

Researchers on their way to the Ottavio Vittori laboratory (Monte Cimone, Italy) in winter.

I ricercatori in viaggio verso il laboratorio Ottavio Vittori (Monte Cimone, Italia) in inverno.

In the framework of the XX Olympic Winter Games held in Turin in February 2006, the exhibition on high mountain observatories is addressed to highlight that the mountains are not only exploited for sports and free time activities, but they are also a special location for scientific research.

Schneefernerhaus Zugspitze (Germany)

The High Mountain Observatories (HMOs) are widely distributed in the mountain regions of Europe, in the Alps, in the Caucasus, in the Carpathians, in Anatolia, in Armenia, always placed in spectacular, breathtaking places.

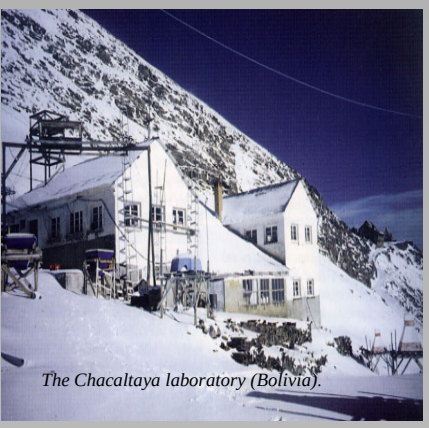
The Testa Grigia laboratory (Plateau Rosa - Cervinia)

Scientific and interdisciplinary exchanges are active with other high altitude laboratories in the world, from Tibet to the Antarctic, from the Andes to the Rocky Mountains, to Hawaii.

Pyramid (Everest - Nepal)

The HMOs represent privileged windows on the Universe for scientific investigation and human knowledge.

The High Mountain Observatories: an European Scientific Heritage



The Chacaltaya laboratory (Bolivia).

Snow storm at Schneefernerhaus laboratory Zugspitze (Germany).

Tempesta di neve al laboratorio Schneefernerhaus Zugspitze (Germania).

Jungfraujoch (Jungfrau – Switzerland)

Sonnblick laboratory (Sonnblick - Austria)

The High Mountain Observatories were established in Europe at the beginning of modern science (end of 1800) in order to provide the European community of scientists with suitable and unique places to carry out research in various fields from astronomy, to solar physics, to physiology.

In the course of time, HMOs have become important laboratories for the European Scientific Community, witnesses of the science development and site of historical data collections.

The strategic role of the High Mountain Observatories is still today crucial in Earth observation systems, for long term observation and data collection in many scientific fields.

The activities performed at HMO concern fundamental science as well as studies related to human life and environmental change.

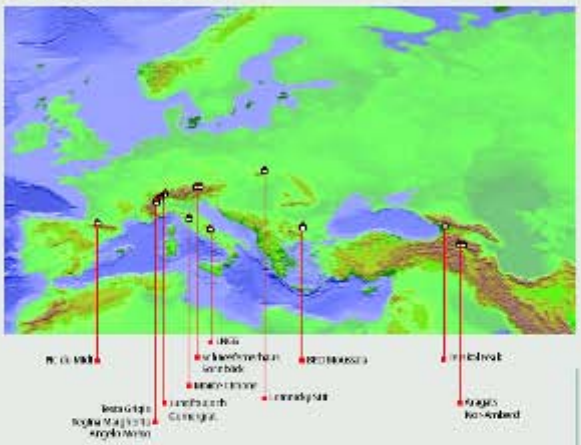
National Governments invest resources in terms of manpower, financial support, equipment, energy supply, to maintain these important and flexible structures in activity.

Where?
Dove?

The High Mountain Research Stations are widely distributed in the mountain regions of Europe, in the Alps, in the Caucasus, in the Carpathians, in Anatolia, in Armenia, always placed in spectacular, breathtaking places.

Le Stazioni di Ricerca di Alta Montagna sono situati nelle regioni montuose dell'Europa, sulle Alpi, nel Caucaso, nei Carpazi, in Anatolia, in Armenia, fra paesaggi spettacolari e panorami mozzafiato.

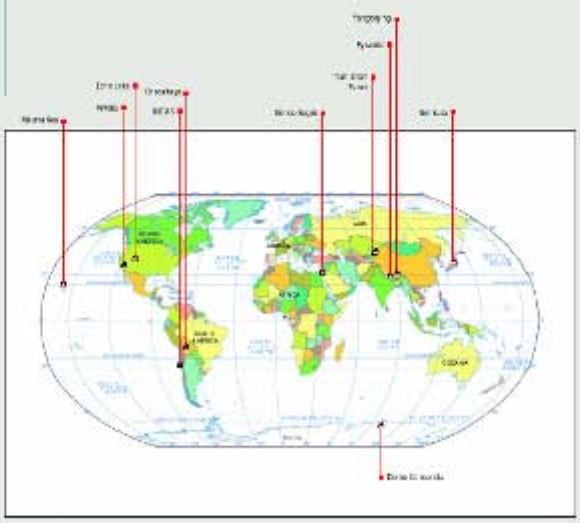
European Laboratories
Laboratori Europei



Observatory	Location	Country
Pic du Midi	43° 04' N,0° 09' E Altitude, m 2887 asl	France
Testa Grigia	45° 56' N,7° 42' E Altitude, m 3480 asl	Italy
Capanna Regina Margherita	45° 56' N,7° 42' E Altitude, m 4559 asl	Italy
Istituto Angelo Mosso	45° 56' N,7° 42' E Altitude, m 2901 asl	Italy
Ottavio Vittori Mt. Cimone	44° 11' N,10° 42' E Altitude, m 2165 asl	Italy
Laboratori Nazionali Gran Sasso	42° 28' N,13° 33' E Altitude, m 2150 asl	Italy
Jungfraujoch Sphinx	46° 33' N,7° 59' E Altitude, m 3454 asl	Switzerland
Cornergrat	45° 58' N,7° 47' E Altitude, m 3131 asl	Switzerland
Schneefernerhaus	47° 25' N,10° 59' E Altitude, m 2650 asl	Germany
Sonnblick	47° 25' N,12° 57' E Altitude, m 3106 asl	Austria
Lomnicky Stit	49° 12' N,20° 13' E Altitude, m 2634 asl	Slovakia
BEO Moussala	42° 11' N,25° 35' E Altitude, m 2925 asl	Bulgaria
ASEC Aragats	40° 10' N,40° 30' E Altitude, m 3200 asl	Armenia
Nor Amberd	40° 10' N,40° 30' E Altitude, m 2000 asl	Armenia
Terskol Peak	42° 18' N,42° 40' E Altitude, m 3100 asl	North Caucasus Russia

Laboratories in the World
Laboratori nel Mondo

Observatory	Location	Country
WMRS	N37° 35' N. 118° 14' W Altitude, m 4340 asl	California USA
Echo Lake	39° 59' N. 105° 38' W Altitude, m 4312 asl	Colorado USA
Mauna Kea	19°49' N. 155° 28' W Altitude, m 4200 asl	Hawaii USA
Chacaltaya	16°29' S. 68° 8' W Altitude, m 5230 asl	Bolivia
INCAS Putre	18°12' S, 69° 33' W Altitude, m 3600 asl	Chile
Dome Concordia Station	75°06' S, 123° 23' E Altitude, m 3280 asl	Antarctica
Enrico Segrè	31° 10' N. 35° 29' E Altitude, m 2025 asl	Israel
Tien-shan	42° 39' N. 82° 10' E Altitude, m 3340 asl	Kazakhstan
Pamir	43° N. 77° E Altitude, m 4380 asl	Kyrgyzstan
Pyramid	27° 59' N. 86° 57' E Altitude, m 5050 asl	Nepal
Yangbajing	30° 7' N. 90° 32' E Altitude, m 4100 asl	Tibet PR. China
Norikura	36° 6' N. 137° 19' E Altitude, m 2770 asl	Japan



Scientific and interdisciplinary exchanges are active with other high altitude laboratories in the world, from Tibet to the Antarctic, from the Andes to the Rocky Mountains, to Hawaii.

Sono in corso scambi scientifici interdisciplinari con i laboratori di alta montagna nel mondo, dal Tibet all'Antartide, dalle Ande alle Rocky Mountain fino alle Hawaii.

When?
Quando?

Pic du Midi
2887m asl
France
1873

Sonnblick
Laboratory
3106 m asl
Austria
1886

Capanna
Regina Margherita
4559 m asl
Italy
1894

Istituto
Angelo Mosso
2901 m asl
Italy
1907

Thien-Shan
Laboratory
3340 m asl
Kazakhistan
1912

Jungfraujoch
Laboratory
3454 m asl
Switzerland
1926

Echo Lake
Laboratory
3200 m asl
USA
1930

Lomnick Stit
2634 m asl
Slovakia
1940

Chacaltaya
Laboratory
5230 m asl
Bolivia
1942

ASEC, Aragats
3200 m asl
Armenia
1943

Terskol Peak
Laboratory
3100 m asl
North Caucasus
Russia
1944

Pamir
Laboratory
4380 m asl
Kyrgyzstan
1946

Osservatorio
astronomico
Campo Imperatore
2150 m asl
Italy
1947

Testa Grigia
Research Station
3480 m asl
Italy
1947

White Mountain
Research Stations
USA
1951

Norikura
Observatory
2770 m asl
Japan
1953

BEO Moussala
2925 m asl
Bulgaria
1959

Gornergrat
Laboratory
3012 m asl
Switzerland
1960

Mauna Kea
Observatories
4200 m asl
USA
1961

LNGS (INFN)
Italy
1988

Yangbajing
Laboratory
4300 m asl
Tibet
P.R. China
1990

Pyramid
Laboratory
5050 m asl
Nepal
1990

Dome Concordia
Station
(summer station)
3233 m asl
Antarctica
1995

Ottavio Vittori
Laboratory
2165 m asl
Italy
1996

Mount Hermon
2020 m asl
Israel
1997

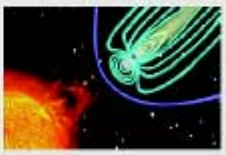
Schneefernerhaus
Laboratory
2650 m asl
Germany
1998

Which science?
Quale scienza?

Space Science
Scienza dello spazio

Astronomy
Astronomia

Solar Physics
Fisica Solare



Space weather forecast
Previsioni del tempo spaziale

Astrophysics
Astrofisica

Cosmic Rays Physics
Fisica dei raggi cosmici

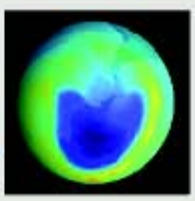
Atmosphere Science
Scienza dell'atmosfera

Atmospheric Chemistry
Chimica dell'atmosfera

Atmospheric Physics
Fisica dell'atmosfera

Clouds formation
Formazione di nubi

Lightning & thunderstorm
Fulmini e temporali



Ozone depletion
Buco dell'ozono

Earth Science
Scienza della Terra

Paleoclimatology
Paleoclimatologia

Seismology
Sismologia

Geology
Geologia

Glaciology
Studio dei ghiacci

Which science?
Quale scienza?

Climatology
Climatologia

Climate changes

Cambiamenti climatici

Meteorology

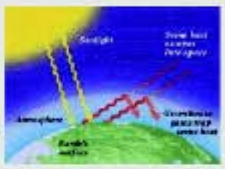
Meteorologia

Pollution monitoring

Monitoraggio dell'inquinamento

Weather forecast

Previsioni del tempo



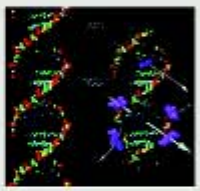
Greenhouse effect

Effetto serra

Medicine and Biology
Medicina e Biologia

UV exposure

Esposizione ai raggi UV



Radiobiology

Radiobiologia

Human life in extreme conditions & Sport Medicine

Vita umana in condizioni estreme e medicina sportiva

Pollutants effect on life and food chain

Effetto di inquinanti sulla vita e sulla catena alimentare

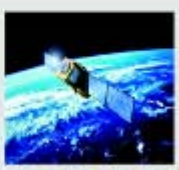
Physiology and Biophysics

Fisiologia e Biofisica

and more...
e inoltre...

Telecommunication

Telecomunicazioni



Satellite data validation

Validazione dei dati da satellite

Ecological tourism

Turismo ecologico

Instruments calibration

Calibrazione di strumenti

Science divulgation & Education

Divulgazione scientifica & Educazione

Environmental protection

Protezione ambientale

On High Altitude Research Stations there are optimal conditions for scientific research

No light pollution

No anthropogenic pollution

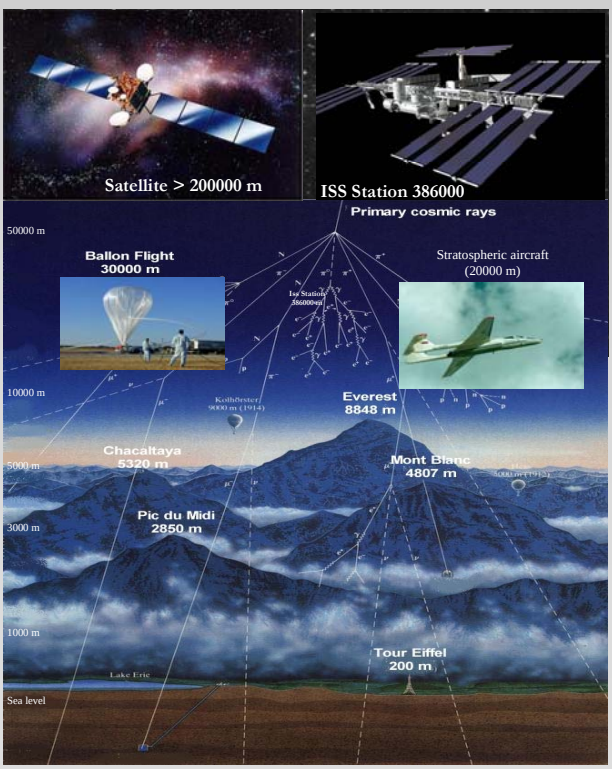
High UV intesity

High cosmic ray flux

Millenarian glaciers

Extreme conditions for human life

Integration in Earth Observation



➢The High Mountain Research Stations, worldwide distributed, allow to perform contemporary investigation on the "Earth System" at various altitudes and latitudes, in different conditions of atmospheric shielding and geomagnetic field.

➢The Laboratories represent essential ground–based facilities, integrated in the system of Earth observation:

- high altitude aircraft for scientific flights ~ 20 Km
- stratospheric ballons ~ 30 km
- Low Earth Orbit (LEO) satellites ~ 200Km
- International Space Station (ISS) - 386 Km

Integration in Earth Observation

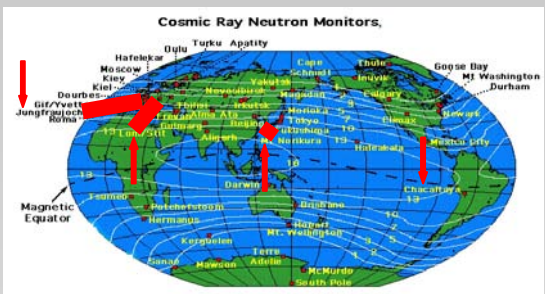
Global Atmosphere Watch GAW

(http://gaw.web.psi.ch/)

GAW global atmospheric monitoring stations
Stazioni mondiali GAW di monitoraggio atmosferico

Some GAW regional atmosphere monitoring stations
Alcune stazioni locali GAW di monitoraggio atmosferico

Cosmic Ray Neutron Monitors

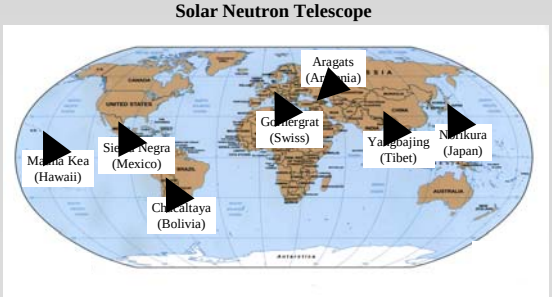


(http://ulysses.sr.unh.edu/NeutronMonitor/images/O_WorldNeutronMonitors.gif)

Cosmic Rays Neutron Monitors map

Mappa della rete di monitoraggio dei raggi cosmici

Solar Neutron Telescope



Solar Neutron Telescope network map

Mappa della rete Solar Neutron Telescope

Atmosphere monitoring
Monitoraggio atmosferico

WMO

The World Meteorological Organization (WMO), an intergovernmental organization with a membership of 187 Member States and Territories, is the specialized agency of the United Nations for meteorology (weather and climate), operational hydrology and related geophysical sciences..

Out of growing concern about climate change and air quality issues due to human activities, the World Meteorological Organization (WMO) has initiated the Global Atmosphere Watch (GAW) programme.

GAW

The Global Atmosphere Watch (GAW) programme coordinates the effort of 22 global and some 300 regional atmospheric monitoring stations to produce data that are relevant to climate change.

Cosmic Rays monitoring
Monitoraggio della radiazione cosmica

Neutron Monitors
Rivelatori di neutroni

Primary cosmic rays consist of electromegnetic radiation and energetic charged particles of galactic (GCR),solar (SCR) extragalactic origin (ACR). The primary radiation is constituded by protons (87%), Helium nuclei (12%) heavy ions (1%).

When primary cosmic rays interact with the Earth atmosphere nuclei (Nitrogen and Oxigen). a secondary radiation is produced (atmospheric shower) costituted by many particles (protons, electrons, neutrons, muons), whose detection allows to set the value of the primary flux.

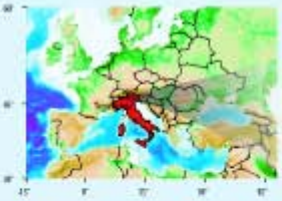
The world's neutron monitor network is constituted by almost 50 stations worldwide distributed. Most of them are located at High Mountain Research Stations, were the Neutrons flux is higher, due to the reduced atmospheric layer.

SALA 1

Observatories in Italy and France

LABORATORY	LOCATION	COUNTRY
Testa Grigia	Altitude, m 3480 asl	Italy
Regina Margherita	Altitude, m 4559 asl	Italy
Angelo Mosso	Altitude, m 2901 asl	Italy
Ottavio Vittori	Altitude, m 2165 asl	Italy
LNGS Gran Sasso	Altitude, m 2150 asl	Italy

Testa Grigia Research Station



Altitude 3.480 m asl
Latitude N 45° 56'
Longitude E 7° 42'

situated at Plateau Rosa, Matterhorn, Italy

Activities
astrophysics
cosmic ray physics
atmosphere physics
meteorology

IN THE HEART OF ALPS

The Testa Grigia Laboratory is located in a wide upland, surrounded by glaciers of some of the highest peaks of Europe, on the Italian side of Matterhorn. The laboratory is near the Testa Grigia Peak on the borderline between Italy and Switzerland.

Testa Grigia Laboratory

Lago Blu and Matterhorn

RESEARCH IN THE MOUNTAINS

Still now the life in the laboratory is an adventure for the researchers: complete isolation during stormy days and water production from snow just like 50 years ago!

Landscape from Matterhorn

SCIENTIFIC EXPERIMENTS

Scintillator counters

Cosmic ray observation

INAF-IFSI, Università di Torino

Investigation of high energy component (10 – 100 GeV) of cosmic Gamma Ray Burst (GRB) observed by satellite experiments

Greenhouse monitoring

CESI e Università di Torino

Because of its elevation and position, far from urban and polluted zones, the Testa Grigia Station has been considered suitable for being included in the world wide network (WMO World Meteorological Organization) devoted to the monitoring of green house gases concentration.

Weather station to monitor some parameter related to Greenhouse Gases

Ground-Based Telescope for mm-Infrared Observations

Università di Roma "La Sapienza"

MITO telescope (2.6 m in diameter) at Testa Grigia laboratory

The still carbon fibre spider support of MITO telescope

The scientific goal of MITO (Millimetre & Infrared Testagrigia Observatory) project is the intensity and polarization observation of the anisotropies of Cosmic Microwave Background Radiation (CMB) at millimeter wavelengths.

Spectrometry and Dosimetry of Neutrons from Cosmic Rays

INFN-Sezione di Torino, APAT – Roma

The measurement of neutron spectra at various altitudes in atmosphere is important for many dosimetric applications, the radioprotection of the aircrew on intercontinental flights, astronauts dosimetry in space mission, evaluation of human exposure in high altitude countries.

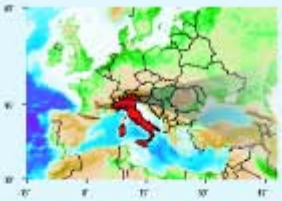
Bubble detectors for neutron dosimetry

Testa Grigia Laboratory

Radio-acoustic measurement of the temperature profile in the Troposphere

Dipartimento di Fisica Generale, Università di Torino, Istituto di Cosmogeofisica, CNR, Torino

The Radio-acoustic Sounding System allows to measure the thermal vertical profile of the low atmosphere.
The technique exploits a Doppler tracking of an acoustic pulse by a continuous wave radar



The history

Testa Grigia Research Station

Altitude 3.480 m asl
Latitude N 45° 56'
Longitude E 7° 42'

situated at Plateau Rosa, Matterhorn, Italy

Built in 1947

The Testa Grigia Laboratory was built in 1947 by the Study Centre for Nuclear Physics of CNR (National Council of Research) on behalf of the Institute of Physics in Rome, headed by Edoardo Amaldi. The project and the realization were executed by Gilberto Bernardini, Claudio Longo and Ettore Pancini.

Edoardo Arnaldi, Gilberto Bernardini and Ettore Pancini at the Testa Grigia Laboratory (1947)

The Testa Grigia Laboratory at the beginning

1957 - 1958 G. Wataghin and G. Pinagino

Measurement of absorption curve of penetrating component of cosmic rays

Fast electronics in detectors with 6SM7 valves of Gleb Wataghin

After the Second World War, the research in the cosmic rays field was mainly developed in high mountain laboratories.

In fact an intense cosmic ray flux is detectable due the reduced atmospheric absorption at high altitudes.

In these conditions it was possible to investigate the properties of the basic constituents of the matter at high energy, that would be available at the particle accelerators some years later.

Enrico Persico.
The other physicists used to say that he invented the "adiabatic ski", because of his slowness climbing down any slope

Physics and mountains

The profound attraction for the mountains was a distinctive feature of almost all the protagonists of the physical and mathematical community in the early 1900s. This is clear in many biographies of some exponents of "via Panisperna group": Fermi, Amaldi, Rasetti, Segrè...

Edoardo Arnaldi on the top of Lyskamm. Monte Rosa range (August 1932)

Without doubts during the stay in the Testa Grigia Laboratory, many physicists found the way to conjugate a total devotion to the research activity with passion for the mountains and the climbing.

Many important experiments were carried out until mid '50s, when research was interrupted for almost ten years due to financial problems.

Enrico Fermi, Franco Rasetti, Nello Carrara

Prof. C. Castagnoli visiting the Laboratory

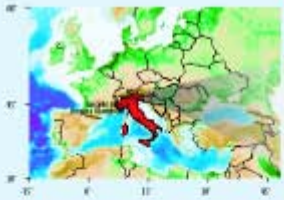
Physicists on holiday in the mountains. from the left: Antonio Rostagni, Gleb Wataghin, E. Persico, E. Fermi and M. Rostagni (1932)

Since 1965, the Laboratory has been run again by the Istituto di Cosmo Geofisica headed by Prof. C. Castagnoli.

Since 2002 the Station belongs to the Istituto di Fisica dello Spazio Interplanetario - Torino and it is still fully operational.

1955
The Plateau Rose cableway

The Testa Grigia laboratory. On the background Matterhorn; to the foreground the dog Ali, the mascotte



"Angelo Mosso" Institute, Col D'olen, Alagna Valsesia
Capanna Margherita Laboratory, Punta Gnifetti

Altitude	2.901 m asl and 4.559 m asl
Latitude	N 45° 56'
Longitude	E 7° 42'

situated in the Monte Rosa range, Italy

Activities
biomedical research
historical museum
meteorology


Capanna Margherita Laboratory


Gnifetti Peak – Punta Gnifetti

MONTE ROSA RANGE

"Angelo Mosso" Institute is located in the valley between Corno del Camoscio and Stoldenberg, at 2901 meters, near Col d'Olen, in Monte Rosa group.

Monte Rosa range links Piemonte, Valle d'Aosta and Switzerland. It is one of the most overshadowing mountain in the Alps, it ranges for dozen kilometres and it owns peacks that pass the 4000 meters. Dufour Peak is lower than the Monte Bianco just for 150 meters.

The Capanna Margherita laboratory is on the top of Gnifetti Peak in Monte Rosa range, at 4559 meters.


View of "Angelo Mosso " Institute during the reconstruction (2005)

An INTERREG project (Interreg III Italia-Svizzera "A Network of historic-scientific Museums in the Monte Rosa group") supported by Regione Piemonte, Regione autonoma Valle d'Aosta and Musées Cantonaux du Valais was the basis for a three year reconstruction campaign, under the technical survey of the University of Turin.

In September 2005, the new building of Istituto Scientifico " Angelo Mosso" was presented in his original external shape and structure.
The completion of the internal structures will be the final step in year 2006.


View of Monte Rosa range from Capanna Margherita

RESEARCH ACTIVITIES


Capanna Margherita Laboratory

In the reconstructed Angelo Mosso Institute, part of the damaged interior frame was replaced in order to provide in the first floor adequate spaces for new laboratories and modern equipments in biomedical research.

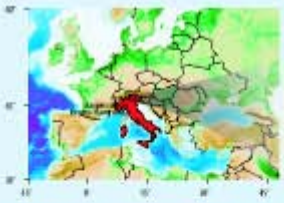
In addition, permanent historic-musical structures depicting the development of studies in Human Physiology in the past century will be hosted in the basement. Spaces for temporary exhibitions on different themes of the scientific research in the alpine territory will be arranged in order to provide a multiple interactive approach to the mountain.

Facilities for the Laboratory on the study of snow and the alpine soil (LNSA) will be located in the upper part of the building.


"Angelo Mosso" Institute and Bowditch lake

As an important improvement supported by the Italian Army, new facilities for meteorological survey in the area were installed by the Comando Truppe Alpine through the Servizio METEOMONT in the former Osservatorio Meteorologico, located beside the Istituto Scientifico "Angelo Mosso".


Sunset on Monte Rosa range – tramonto sul Monte Rosa



The history

"Angelo Mosso" Scientific Laboratories, Monte Rosa, Italy

Altitude 2.901 m asl and 4.559 m asl
Latitude N 45°56'
Longitude E 7°42'
situated in the Monte Rosa range, Italy

Built in 1894

Capanna "Regina Margherita" on Gnifetti Peak

THE BIRTH OF CAPANNA MARGHERITA

In 1893 was founded by Club Alpino Italiano (CAI) a mountain den at Gnifetti Peak in Monte Rosa (4559m asl) named after Regina Margherita, the Queen of Italy at that time.

In the 1895 the queen Margherita di Savoja, fond in sciences and mountain climbing, proposed to Angelo Mosso (Professor in Physiology at Turin University) the establishment of a mountain observatory for meteorology physics and geophysics, close to the CAI lodge. The activities for the building, very difficult to realize for the height of the site, were realized in few years.

"Angelo Mosso" institute

Angelo Mosso

Research at Capanna Margherita

When the laboratory on Gnifetti Peak was completed, important scientific research was developed by scientists. In the 1903 the laboratory "Regina Margherita" was so operative that the Academy of Science in Washington declared that the Institute had to be considered an International Institute, important for scientific community and deserving of the economic help of the International Association of Academies.

Avant-garde research in Biology, Botany, Medicine, Physiology were carried out successfully in the following years. The new experimental measures performed at the Capanna "Regina Margherita" underlined the influence of the special environment of high mountain on living organisms.

Sculpture of Angelo Mosso (Leonardo Bistolfi)

Angelo Mosso Institute

In 1901 during the International Congress of Physiology in Turin Angelo Mosso proposed a new grand project: the construction of a building to be used as a central station for alpine studies in high altitude.

"Angelo Mosso" institute under construction

In 1907 the laboratory "Instituto Angelo Mosso" was inaugurated thanks to the approval and the economic support of the Queen Margherita di Savoia and of delegates of France, Germany, Swiss governments. The research station was dedicated to Angelo Mosso, who supported and substained it with great enthusiasm.

Studies performed by Torino University on physiology at high altitude at Col d'Olen became very important and contributed, in the '50s, in the scientific preparation of the italian expedition to K2. measures performed at the Capanna "Regina Margherita" underlined the influence of the special environment of high mountain on living organisms.

Departure from "Angelo Mosso" (18 September 1910)

Bearers on the march on the glacier towards Regina Margherita

Since its foundation, the Institute developed also studies of alpine meteorology and glaciology, supporting Capanna Margherita observatory.

In the 1927 Umberto Monterin became director of the Monte Rosa Observatories and the Angelo Mosso Institute at Col d'Olen assumed a great importance. The meteorological station was equipped with all the instrumentation available at that time and became the foremost nucleus of the meteorology observatories in Monte Rosa range.

The laboratory after the fire (June 2000)

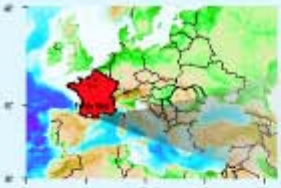
From the 1927 to the 1940 the intensive activity of Monterin made possible meteorology and glaciology observation and data collection, important still today.
In the 1940, the activity was interrupted because of Monterin death and war events, and it restart partially in the years 1950-1960 thanks to Willy Monterin, son of Umberto.
After this period, the interest for the observatory in Monte Rosa group decreases and the research activity was suspended. The enormous corpus of data, collected in many years of work, was forgotten in archives and just recently was analysed and presented to scientific community.

On the 10th June 2000, a fire caused by a lightning, destroyed almost completely the Institute Angelo Mosso. The first floor, location of the library, collapsed, and the ground floor was affected by terrible damages. Just after the accident, some works were performed to make the building safe and to protect the institute.

In 2004 started the reconstruction of the laboratory, that will be completed in 2006 thanks to an INTERREG project (Interreg III Italia-Svizzera "A Network of historic-scientific Museums in the Monte Rosa group").

The Institute "Angelo Mosso" during the reconstruction after the fire on June 2000.

Pic du Midi Laboratory



Altitude 2.887 m asl
Latitude N 43° 04'
Longitude E 0° 09'

located on the summit of Pic du Midi mountain, Pyrénées, France

Activities
astrophysics, astronomy
oceans and atmosphere
Earth sciences
medecine

The Pic Du Midi Observatory is located near Toulouse, on the Pic-du-Midi summit in the Pyrénées Mountains at 2887 metres over the sea level. It's historically famous for its planetary, lunar and solar studies.

The Pic du Midi Observatory is above the "boundary layer", a part of the atmosphere beyond which pollution become rarefied or disappear.

This is absolutely ideal for astronomers. The light is so pure that shots of the moon, planets or the sun are of enormous use to teams of scientists all over the world.

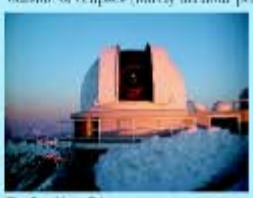
RESEARCH ACTIVITIES

The Siderostat

Observing the sun is still vitally important to scientists. Particularly because it is the only star which is close enough for us to study in detail. The Siderostat follows the sun along its daily path. Using a series of optical components, mirrors, lenses and filters, it captures the rays of the sun which are concentrated.
So, on a clear day, the dome opens up to allow the sunlight to pass through, and an image is projected onto a screen.

Baillaud Dome

Under the actual Baillaud Dome, the oldest dome, which was installed at the Pic du Midi in 1908 it's also possible to observe and understand the sun!
The Coronograph invented by Bernard Lyot in 1930 allows us to observe the sun's outer envelope, with bursts of matter and protuberances, culminating several hundred thousand Kilometres up and showing solar activity. Bernard Lyot installed a metal disk into a telescope, so that we can create a reconstruction of a solar eclipse. A diaphragm completes the device, correcting any light diffraction problems in the lenses. The Coronograph has given us a better understanding of the characteristics of the sun's corona outside of eclipses (barely an hour per century!) and has allowed us to measure a temperature of two million degrees.



The One-Meter Telescope

A coronagraph is a telescopic attachment designed specifically to block out the harsh, direct light from a star, so that nearby objects can be resolved without burning out the telescope's optics.
The name comes from the fact that the first coronagraphs were used to image the corona of the sun.
Coronagraphs are useful for imaging coronas, near-solar comets, and even extrasolar planets.

A view of the Observatory

The Earth And The Pic

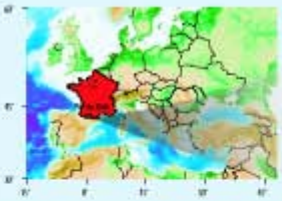
Some terrestrial research activities are also carried out at the Pic du Midi.
The high altitude, the Pic du Midi's outlying position in relation to the Pyrenees, the quality of its atmosphere and its relative distance from any large human built-up areas make it the ideal place to study many different parameters:

- the atmosphere and ozone and pollution in particular
- meteorology, especially high altitude forecasts
- atmospheric electricity, by measuring the electrical field in the earth's atmosphere, storms and lightning
- high altitude medicine
- the seismicity of the Pyrenees

Atmospheric electricity

Meteorological station

The seismicity of the Pyrenees



The History
Pic du Midi Laboratory

Altitude 2.887 m asl
Latitude N 43° 04'
Longitude E 0° 09'

Located on the summit of Pic du Midi mountain, Pyrenees, France

Built in 1873

The Pic's had a history of meteorology even before it became involved in astronomy. We know that as early as 1774 G. Monge and J. Darcet, French scientists, climbed the Pic to study atmospheric pressure and that in 1873, Charles Champion De Nansouty installed a temporary meteorological station here, where he measured pressure, temperature, humidity and various other values used in meteorology. The meteorological station is now part of the Météo France network. The first astronomy work only began to take place from 1881 onwards. Gradually the Observatory became a real centre not only for astronomy but also for sciences such as botany or cosmology. Ever larger instruments giving increasing levels of performance were installed.

From 18th century, the summit of the Pic appears as an ideal site for observation research, thanks to a particular clearness of the atmosphere. In the 1873 General Champion de Nansouty organizes a first meteo campaign at the Pic and a meteo stand " Plantade " was founded at Sencours pass. In the 1878 the first stone of the observatory was set, a wish of both Nansouty and ingenier Vaussenat.

View of the observatory in the 1885

Vaussenat at the meteorological blockhaus

In the 1908 the first dome has been build

In the 1927 Opening of the Tournaliet - Sencours road, that allows bringing up people and equipment.
Transport is made possible by a winding trail.

In the 1930 Bernard Lyot invents coronograph and starts observations research.

In the 1949 an elevating platform was build in order to bring up staff and equipments from the Laspets to the summit, and in the 1952 a cable car between La Mongie / Taoulet and the Pic was opened.

1957:
Installation of radio/TV transmitter on the summit.

In the 1963 NASA chose the Pic du Midi as the centre for detailed cartography of the moon's surface in preparation for the Apollo missions.
It was installed a 106 cm telescope under Gentil dome.

Aerial View of the observatory in 1978, the centenary of the Observatory

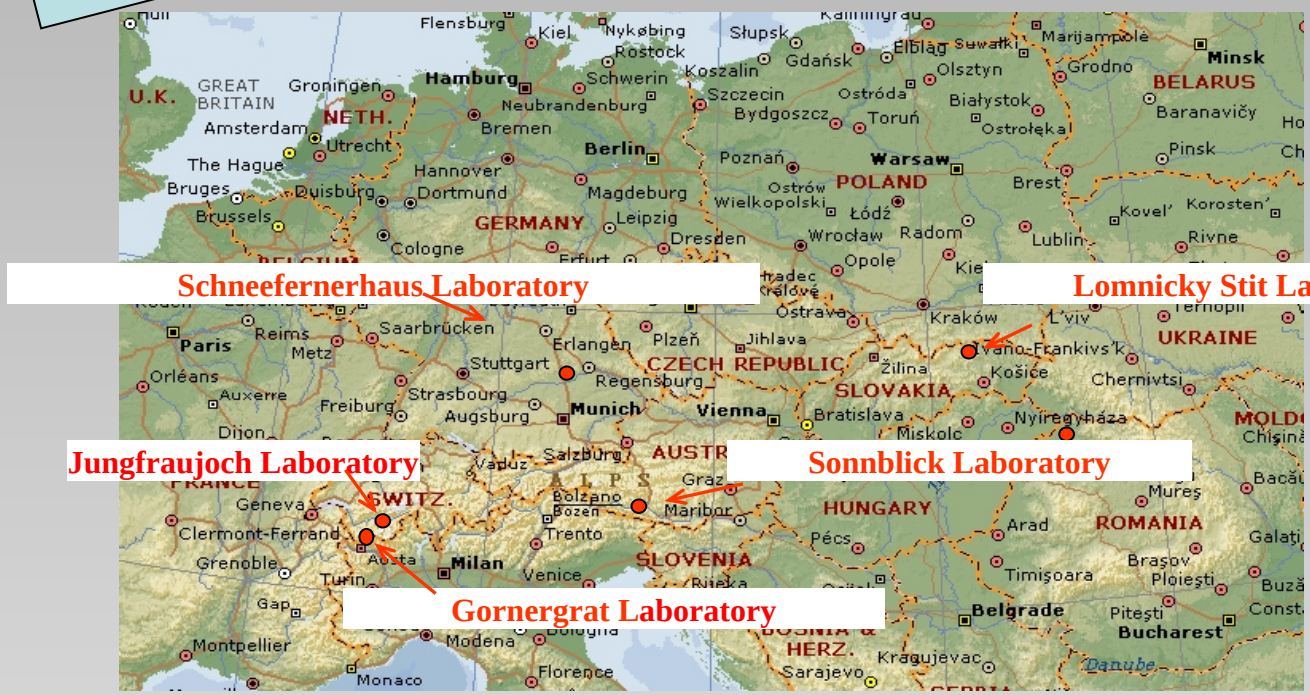
The model of the 106 cm telescope known as the "1 metre" telescope. It was thanks to the images obtained from the Pic in the thirties and forties that we were able to conclude that the soil on the moon was covered with a layer of dust.

In the 1980 TBL
(Bernard Lyot Telescope 2 m) has been put into service.
It was the biggest telescope of metropolitan France.

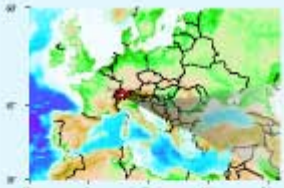
SALA 2

Observatories in the Alps

LABORATORY	LOCATION	COUNTRY
Jungfraujoch Sphinx	Altitude, m 3454 asl	Switzerland
Gornergrat	Altitude, m 3012 asl	Switzerland
Schneefernerhaus	Altitude, m 2650 asl	Germany
Sonnblick	Altitude, m 3106 asl	Austria
Lomnicky Stit	Altitude, m 2634 asl	Slovakia



High Alpine Research Station Jungfraujoch



Altitude 3.454 m asl
Latitude N 46° 33'
Longitude E 7° 59'

adjacent to Eiger, Mönch & Jungfrau
Bernese Alps, Switzerland

Activities

environmental research
astrophysics, meteorology,
glaciology, material sciences

High Altitude Research Station Jungfraujoch

The High Altitude Research Station Jungfraujoch, at 3454 meters above sea level, with Europe's highest-altitude railway station, adjacent to Eiger, Mönch & Jungfrau, the most magnificent mountain chain in the Alps, and at the border of the UNESCO World Heritage Jungfrau - Aletsch - Bietschhorn, offers unique conditions for successful research of international standard that requires high altitude and/or a high alpine environment.

High Altitude Research Station Jungfraujoch

Meteorology instruments at Jungfraujoch

Lidar at Jungfraujoch

Research at Jungfraujoch

Due to its unique location and the unspoiled high alpine environment, the year-round accessibility via the Jungfrau Railways, and the excellent infrastructure, Jungfraujoch is of great importance for environmental researchers and for astrophysicists, as well as for meteorologists, glaciologists, and researchers in material sciences.

Jungfraujoch is the only accessible observation point in Europe with adequate infrastructure that is within the free troposphere most of the year.

It has established itself as a centre for environmental research and is playing a key role in a number of internationally coordinated programs, e.g. the GAW Global Atmosphere Watch and the NDSC Network for the Detection of Stratospheric Change.

On the average, scientists from more than 25 different national and international teams spend about 1000 working days every year at Jungfraujoch.

More than 20 research projects are primarily based on automatic measurements. Research activity at Jungfraujoch results in about 100 scientific publications each year.

HFSJG High Altitude Research Stations Jungfraujoch & Gornergrat

The International Foundation High Altitude Research Stations Jungfraujoch and Gornergrat (HFSJG)

Restaurant, railway station and research station at Jungfraujoch

The International Foundation High Altitude Research Stations Jungfraujoch and Gornergrat (HFSJG) was founded in 1930. The aim of the Foundation is to make possible scientific research that must be carried out at high altitude or in high alpine environment. At Jungfraujoch the Foundation runs the Research Station and the Sphinx Observatory, and at Gornergrat two astronomical observatories and a container laboratory.

Sphinx Observatory at Jungfraujoch

Members of the Foundation

Austria (Oesterreichische Akademie der Wissenschaften, Wien)
Belgium (Fonds National de la Recherche Scientifique, Bruxelles)
Germany (Max-Planck Gesellschaft, München)
Great Britain (The Royal Society, London)
Italy (Istituto Nazionale di Astrofisica INAF, Roma)
Switzerland (Swiss Academy of Sciences scnat, Bern; Jungfrau Railways, Interlaken; Gornergrat Bahn, Brig; Burgergemeinde Zermatt, Switzerland's substantial fee is paid by the Swiss National Science Foundation.)

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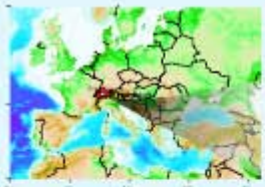


The History

High Alpine Research Station Jungfraujoch

Altitude 3'454 m asl
Latitude N 46° 33'
Longitude E 7° 59'

adjacent to Eiger, Mönch & Jungfrau,
Bernese Alps, Switzerland

Built in 1926

The Conquest of the Alpine Area

For a long time the alpine area was considered as hostile to humans, and proper equipment was not yet available.

It was only in the middle of the 19th century that scientists finally conquered the alpine area.

From 1838-1841 Louis Agassiz, who later became Professor at Harvard University in the USA, and who was the father of the then highly controversial glacial theory, led a scientific expedition to explore the glaciers of the river Aare and in the Jungfrau region.

Working and living conditions were harsh. It became clear that an adequate infrastructure was essential for successful research in the high alpine area.

The Jungfrau railway today

Adolf Guyer-Zeller

The Jungfrau Railways

The extensive and successful scientific activity at Jungfraujoch is a direct consequence of the easy access offered by the Jungfrau railway.

- Starting from approximately 1860 there were many different plans for a mountain railway on the Jungfrau.
- In 1894, the industrialist Adolf Guyer-Zeller received a concession for a rack railway, with a long tunnel through the Eiger and Mönch up to the summit of the Jungfrau.
- In 1896 the construction began.
- In 1898 the Jungfraubahn opened as far as the Eigergletscher station, at the foot of the Eiger. The station at Jungfraujoch was inaugurated on August 1, 1912.

A train emerging from one of the numerous tunnels on the Jungfrau Railway. Note the overhead cables supplying electric current at 5 kV to the train and the centre rack rail which engages with a toothed wheel on the driving axle of the power coach.

Rounding a steep curve on the Jungfrau line. This picture, taken from just above a tunnel entrance, indicates the nature of the gradients encountered, the maximum rise being as much as one foot in every four. The Jungfrau's sister peak, the Eiger, is in the background.

Kleine scheidegg station, the lower terminus of the Jungfrau Railway, is linked with Lauterbrunnen an Interlaken by another of the Swiss lines.
The wheeled telescope is often seen on mountain stations and is provided for the convenience of passengers.

The First Researchers at Jungfraujoch

As soon as the railway to Jungfraujoch was completed, researchers began to profit from the possibilities this exceptional site offered, and discussions started about the construction of a scientific station.

Alfred de Quervain, famous meteorologist and Greenland explorer, was the driving force. On his initiative, the Jungfraujoch Commission of the Schweizerische Naturforschende Gesellschaft (now Swiss Academy of Sciences, SAS) was founded in 1922.

Only four years later, a first 'meteorological pavillon' was constructed on the glacier. After the discovery of the cosmic rays by Victor Hess in 1912, high altitude locations became important for the study of the characteristics of this radiation.

The Jungfrau region was ideal to investigate the variations in intensity in dependence of altitude. In 1925 and 1926 Kolhörster and von Salis conducted two famous expeditions at Jungfraujoch and even to the summit of the Mönch.

Cosmic ray measurements by Kolhörster and von Salis, at the summit of the Mönch, 1926

Daniel Chalonge at Jungfraujoch (1950)

Daniel Chalonge, astrophysicist at the Observatoire de Paris, was a precursor and creator in France of the stellar spectroscopy and spectrophotometry of precision. Many of his experimental and theoretical results have been obtained at the High Altitude Research Stations of Jungfraujoch and Pic du Midi.

The research station in the 1930's

In 2001 the Jungfrau-Aletsch-Bietschhorn region was inscribed in the UNESCO World Heritage list.

This region is the most glaciated part of the Alps, containing Europe's largest glacier , a range of classic glacial features and the wonderful group of the Eiger, Mönch and Jungfrau peaks.

The Sphinx north before extension

Sonnblick Observatory

Altitude 3.106 m asl
Latitude N 47° 25'
Longitude E 12° 57'

Inside the national park
Hohe Tauern, Austria

Activities

atmosphere physics,
biology,
atmosphere chemistry

Overview of the laboratory

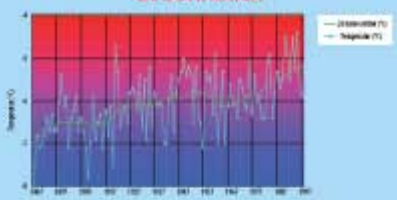
The Sonnblick Observatory at the national park Hohe Tauern developed within the last years to an unique centre of atmospheric research. Conditions at the observatory are undisturbed by any local emissions and the climatic record of the past 120 years gained at unchanged conditions proves to be very valuable in the climate change discussion. Today a number of more than 30 projects are carried out in and around the summit.

In its first 100 years the observatory contributed to detailed observation of the climate change in its quantity for temperature, pressure, sunshine duration and all their consequences, since approx. 20 years the question "why" the climate changed is addressed with a series of air chemical and other related projects ranging from biology to permafrost monitoring.

Atmosphere physics - Biology

(measurements done at Sonnblick)

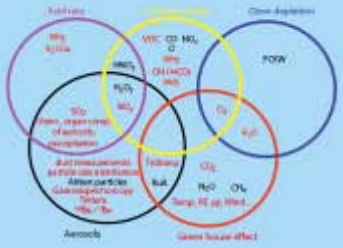
120 years of temperature records at Sonnblick



Temperature increase from 1886 to 2005 is approx. 1.6 °C.

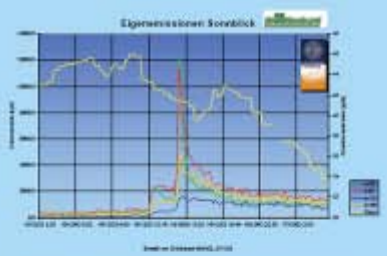
Atmospheric chemistry

(measurements done at Sonnblick)



Lidar measurements for vertical profile of aerosols.

Measurements are not only taken at the observatory, but also in its surroundings to understand local phenomena.



Running a background station is not an easy task; chemical concentrations are two orders of size less than in polluted lowland locations, in house pollution become easily dominating.

Graph shows the results of peak in house emissions of VOC (Volatile Organic Components)
Courtesy Umweltbundesamt Wien,
University of Innsbruck, Institute for Ion Physics.

ZAMG

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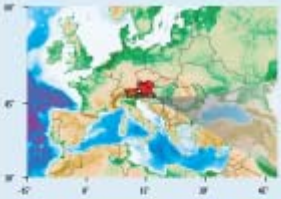

The history

Sonnblick Observatory

Altitude 3,106 m asl
Latitude N 47° 25'
Longitude E 12° 57'

inside the national park
Hohe Tuaern, Austria

Built in 1886

Ignaz Rojacher, owner of the Rauris goldmine built the Sonnblick Observatory in 1886.

Simon Neumayer, first observer of the observatory.

The observatory in the year at its completion 1886. Etching by S. Heil 1887.

Josef Pernter, later Director of the Austrian weather service was the first scientist to spend a winter at the observatory.

Room for the scientist to work, live and sleep. Only little changes were undertaken from 1886 to the late 1980.

Carrying material for the cable car in 1956.

Steel construction of the new building in 1981.

The Sonnblick observatory in its present form. Energy supply is electrical, the tower in the middle serves as wind mast and exhaust point for inhouse emissions.

Temperature changes in the rock caused permafrost to recede. The stability of the summit was endangered. 105 stainless steel anchors were placed underneath the observatory.

A cable car capable to carry up to 3 persons links since 1956 the Sonnblick observatory at 3105 m with the bottom station at 1500m.

ZAMG

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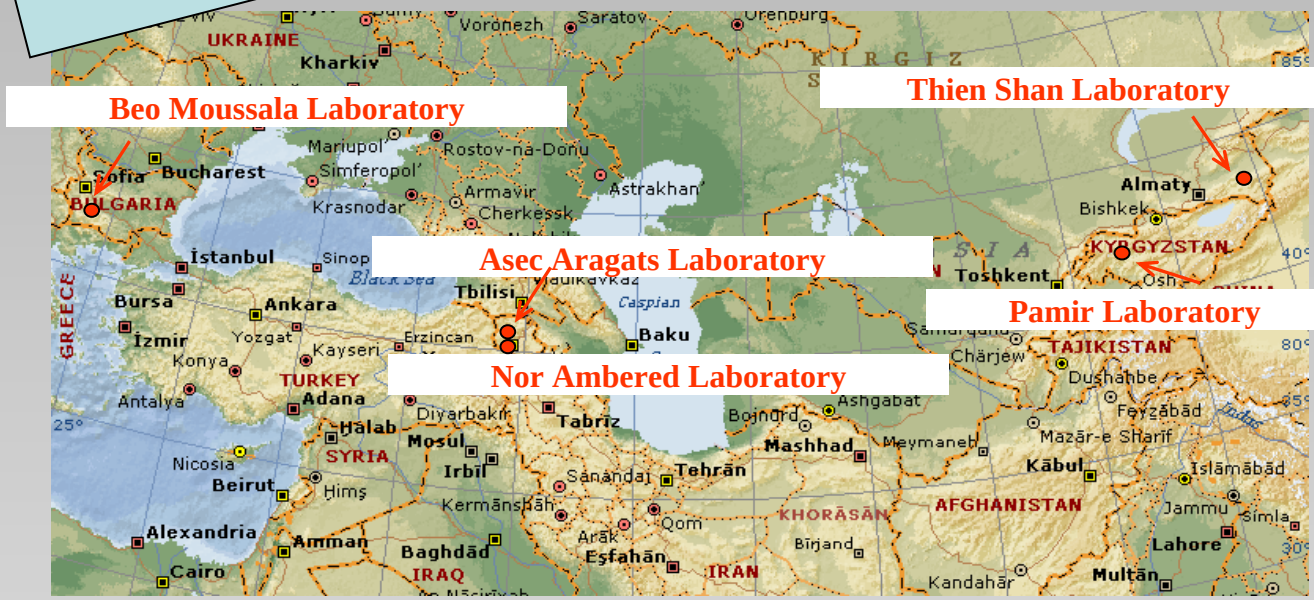
SALA 3

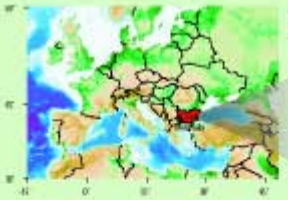
Observatories in Central Europe

LABORATORY	LOCATION	COUNTRY
BEO Moussala	Altitude, m 2925 asl	Bulgaria
ASEC Aragats	Altitude, m 3200 asl	Armenia
Nor Amberd	Altitude, m 2000 asl	Armenia
Pamir	Altitude, m 4380 asl	Kyrgyzstan
Thien Shan	Altitude m 3340 asl	Kazakhistan



BASIC ENVIRONMENTAL OBSERVATORY

BEO MOUSSALA



Altitude 2.925 m asl
Latitude N 42° 11'
Longitude E 23° 35'

located on the peak Moussala,
Rila mount, Bulgaria

Activities

Cosmic ray physics
Space Weather
Global change
Atmosphere measurements

The Moussala Research Station is located almost on the peak Moussala at an altitude of 2925 m. Moussala belongs to Rila massif (Rila means: the mountain of water), at south of Sofia and it is the highest peak of the all Balkan peninsula.

The research station consists in a two-storey building, each floor with an area of 360 m². The ground stone floor is intended for everyday life and for technical equipment and the second wooden floor accommodates the laboratory hall with an area of 100 m² and two bedrooms.
The BEO (Basic Environmental Observatory) is accessible by bus or car from Sofia to Borovetz, then 30m by lift and finally 3 1/2 to 5h walking, depending on season.

The water supply is from the abundant snow cover during 8-10 months of the year and in the rest time water is transported either by mules or via the cargo lift.

The BEO Moussala Observatory in winter

The Moussala peak

RESEARCH AT THE LABORATORY

Basic fields of research
Global change
Space weather
Sustainable development
Measurement devices and
systems development and enhancement

Gas concentration detector

BEO telecommunication system

EUROEP and BEO databases

Scintilator gamma spectrometer and
Air sampling

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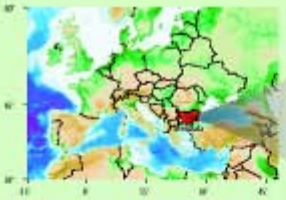
Institute for Nuclear Research and Nuclear Energy, BAS 72,
Tzarigradsko chaussee blvd. 1784,
Sofia, BULGARIA
fax: + 359 2 9753619

BEO Cassegrain telescope and UV meter calibration at Zugspitze UFS (Germany) and ALOMAR observatory (Norway)



THE HISTORY
BEO MOUSSALA

Altitude 2.925 m asl
Latitude N 42° 11'
Longitude E 25° 35.0'

located on the peak Moussala, Rila massif, Bulgaria

Built in 1959

Extract from Moussala region mountain chronicals

Famous French traveler and geologist Ami Boue visited the Rila Mt. for first time (1837).

Alpinist Bruennce von Watenville evaluated the great tourist and alpinist importance of the Rila Mt. (1883).

The first school on forestry was founded in Samokov in 1896.

Ivan Vazov, world famous Bulgarian writter, climbed Moussala Peak on August 2nd 1901 together with eminent scientists.

Samokov hosted the First Congress of the Juvenile Tourist Union from July 6th to 9th 1914.

Moussala pine-scrub hut was opened with solemnity – October 1925.

First time woman climbed the Moussala Peak in winter (1926).

Climbing the Moussala Peak on bicycles (1926).

Establishment of the Bulgarian Mountain Club (1927).

First participation of Bulgarian skier abroad in 1933 – Hristo Barzanov in Innsbruck.

Historical dates

1932 – Inauguration of Meteorological Station on Peak Moussala.
1959 – Opening of Cosmic Ray Station on Peak Moussala.
1983 – Destroy of Cosmic Ray Station (fire!)
1993 – Start of Bulgarian-French project OMZ for monitoring and management of high mountain ecosystems.
1999 – Inauguration of Basic Environmental Observatory (BEO) – Moussala.
2002 – Creation of BEO Centre of Excellence
2002-2003 – HIMONTONET and NUSES FP5 projects
2005 – BEOBAL FP6 project

1999 BEO inauguration

BEO architect
M. Kotzeva - Baycheva

The BEO Moussala founders and supporters (from right to left)
J. Stamenov, J.P.Cardonnel, M.Prantalerova, A.Djakov

RFI interview on top of the Balkans

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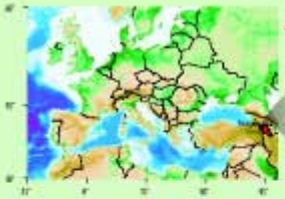
fax: + 359 2 9753619

ARAGATS and NOR-AMBERD STATIONs



Altitude 3,200 m asl and 2,000 m asl
Latitude N 44° 10'
Longitude E 40° 30'
located on the mount Aragat, Armenia

Activities

Cosmic ray physics
Space Weather Forecast
Solar physics

ARAGAT station (3200 m asl) and Nor Amberd station (2000 m asl) are both located on the mount Aragat at two different altitudes.

The Aragats station (3200 m asl) station in winter

The Nor Amberd station (2000 m asl) in fall

The Aragats station is located on the slope of Mt Aragats at 3200 m above sea level, 50 km far from Yerevan, in Armenia. The Aragats cosmic ray station include all the necessary conditions for stable year-round operation: electrical network, computer network, facilities for the detectors, but also heated dormitories, restaurants, conference rooms and a hostel.

Nor Amberd station is at 2000 m above sea level and it is equipped with detectors for the study of cosmic ray variations. The station is also used as an intervening point on the way to Aragats station in winter and has such infrastructures as auxiliary and storage premises garage, fuel and lubricant repositories, cross-country vehicles and related spare parts.

The installations of the Cosmic Ray Division of the Yerevan Physics Institute on Mt. Aragats provide optimal conditions to detect the galactic and solar cosmic rays. The main project on Mt Aragats are geared towards studying the most intriguing issues in astro-particles physics.

SPACE WEATHER FORECAST

Predictions of solar activity are important for various technologies, including of operation of low-Earth orbiting satellites, electric power transmission grids, high-frequency radio communications and radars.

The Nor Amberd station and the Aragats station are center of excellence for space weather research and belong to the worldwide network for Space Weather Forecast.

Mount Aragats

Mount Ararat

The Aragats station (3200 m asl) station in winter

SCIENTIFIC EXPERIMENTS

Space weather forecast

New particle detector for the world-wide network of Space Weather research, measuring charged and neutral content of cosmic rays and directional information

The ANI Experiments

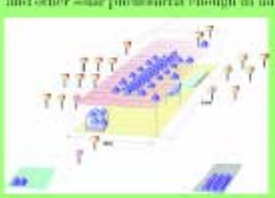
The ANI experiment studies the physics of cosmic ray origin and acceleration mechanisms. The fluxes of electrons and muons originating from the interaction of primary nuclei with the atmosphere are called Extensive Air Shower (EAS). The ANI Experimental Complex is one of the largest experimental complex in the world aimed at fundamental investigation of high energy cosmic rays.

The Aragats station (3200 m asl) station in winter

The high energy Muon Detector

Aragats Space Environmental Center

The project is aimed to establish the Space Environment Center (SEC) that will detect and on-line analyze the correlation between intensity of the high-energy Cosmic Ray (CR) fluxes and potentially dangerous geomagnetic and radiation storms. The goal is to forecast geomagnetic storms and other solar phenomena enough in advance to take mitigating action.



Solar Neutron Telescope

MAKET-ANI and GAMMA Extensive Air Shower detectors, 18 NM64 Neutron Monitor, Solar Neutron Telescope, high energy muon telescope

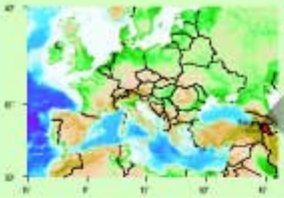
Investigations of Solar-Terrestrial Connections

The main purpose of the project is the investigation of the solar-terrestrial connections, in particular the correlation of solar activity with cosmic ray particles fluxes and the detection of solar particles (high energy neutrons and protons) emitted during solar flares.

Forecasting of solar activity is extremely complicated problem due to the irregularity of solar cycles, so information on high energy particle fluxes will provide valuable information on prediction.

The Aragats station (3200 m asl) in winter

ARAGATS and NOR-AMBERD STATIONs



Altitude 3,200 m asl and 2,000 m asl
Latitude N 44° 10'
Longitude E 40° 30'
located on the mount Aragat, Armenia

Built in 1943

Cosmic Ray research at the high altitude station on Mt. Aragats was initiated by Alikhanyan brothers, the famous Armenian physicists, in 1943.
Since then research at Cosmic Ray Division (CRD) has been carried out at two high-altitude stations on Mt. Aragats as well as the headquarters in Yerevan. CRD has entered the new millennium, well equipped to partner with the international community to conduct research and offer its clients alerts regarding solar energetic phenomena.

Donkeys transporting physical equipment - 1948

First expedition to Aragats?investigating attenuation of Cosmic Rays in water

Artem Alikhanian, one of the founders and first director of the Yerevan Physics Institute, was born on June 24, 1908.

The two brothers initiated a scientific mission on Mt.Aragats in order to search for the third (proton) component of cosmic rays. Together with T. Asatiani A. Alikhanian found so called narrow showers in cosmic rays, established the first evidence of the existence in cosmic rays of the particles with masses between that of muon and proton.

In 1943 the two brothers participated in the foundation of the Armenian Academy of Sciences, established in the frames of the Academy the Yerevan Physics Institute. A. Alikhanian became its Director for the next 30 years.

In 1945 A. Alikhanov and A. Alikhanian were awarded the USSR State Prize for the investigation of cosmic rays.

Founders of the Yerevan Physics Institute (1944)
Abram (left) and Artem Alikhanyans

Free time at Aragats 1949

In 1956 A. Alikhanian (together with A. Alikhanov and V. Hambartsumian) initiated the creation of the Yerevan Synchrotron with 6 GeV energy of electrons and headed the design and construction of this machine, that was accomplished in 1967.

A. Alikhanian paid much attention to the development of the new experimental methods. For the works on wide-gap track spark chambers in 1970 A.Alikhanian (together with the colleagues from Yerevan, Moscow and Tbilisi) was awarded the Lenin Prize.

Later he initiated the works on x-ray transition radiation detectors, based on the theoretical predictions made at YerPhI and experiments carried out at Yerevan synchrotron.

The detectors of such type were widely used in accelerator and cosmic ray experiments at many centres worldwide. A. Alikhanian also supported applied research using the beams from Yerevan synchrotron, mainly on solid state physics and biophysics.

Road to Aragats and tuning the particle detectors
June 1959

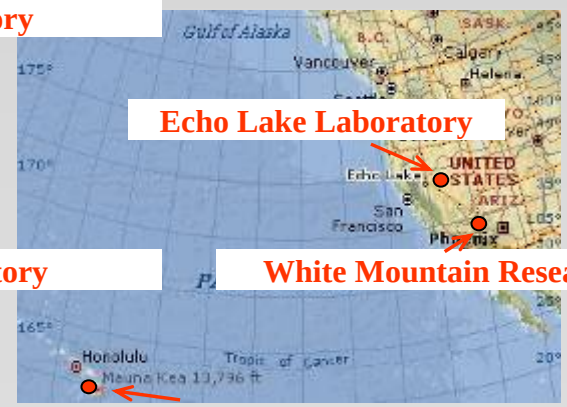
The laboratory today

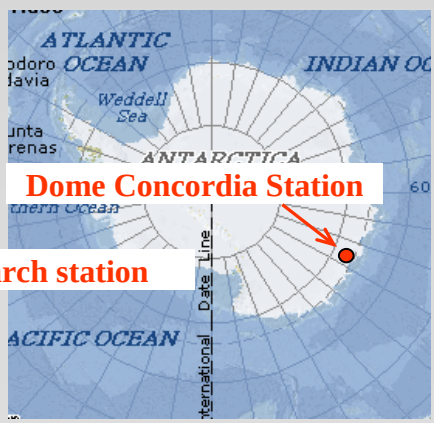
The foundation of cosmic ray station on Mt. Aragats at 3250 m above sea level was one of the steps aimed on the development of nuclear and particle physics in Armenia. This station remains the main national cosmic ray centre until now.

SALA 4

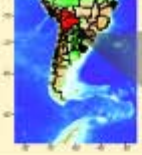
Observatories in the World

LABORATORY	LOCATION	COUNTRY
Chacaltaya	Altitude, m 5230 asl	Bolivia
Norikura	Altitude, m 2770 m asl	Japan
Echo Lake	Altitude, m 4312 asl	USA
Mauna Kea	Altitude m 4200 asl	Hawaii
INCAS Putre	Altitude m 3600 asl	Cile
Dome Concordia	Altitude m 3280 asl	Antarctic
Enrico Segre	Altitude m 2025 asl	Israel
Pyramid	Altitude, m 5050 asl	Nepal
White Mountain	Altitude, m 4340 asl	USA
Yangbajing	Altitude, m 4300 asl	Tibet





The Chacaltaya Laboratory



Altitude 5.230 m asl
Latitude S 16° 29'
Longitude W 68° 8'

located on the Chacaltaya mountain, Bolivia

Activities

cosmic ray physics and dosimetry,
atmosphere physics and chemistry

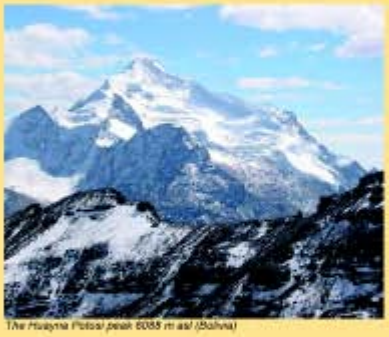
The highest research site in the world

The Chacaltaya laboratory is the highest laboratory in the world, at 5230 meters above sea level. It is located on the Chacaltaya mountain, which is one of the mountains in the Bolivian Andean plateau, in the middle of Cordillera Real.

The Chacaltaya Laboratory 5230 m asl, Bolivia

The old Club Andino Boliviano near the laboratory 5260 m asl

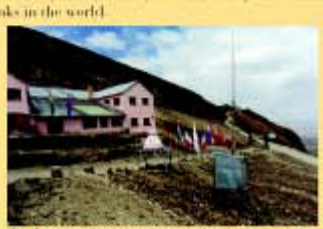
Alpacas on the Bolivia plateau



The Huayna Potosi peak 6088 m asl (Bolivia)

Chacaltaya is considered the overlook of Cordillera Real, with numerous wonderful peaks over 5000 meters and many other over 6000 meters. The landscape from Chacaltaya reaches out from Illimani (6462 m) to Mururata (5775 m) to beyond Condoriri (5696 m), but the best view is the Huayna Potosi (6088 m), one of the most beautiful peaks in the world.

The Illimani mountain (6462 m) with the moon



The Chacaltaya laboratory during the International congress on Cosmic Rays (2000)

Overview of the laboratory

SCIENTIFIC EXPERIMENTS

The geography characteristics of the Andean plateau, allow a research of high level in the space field, with important outcomes for the international scientific community in terms of discoveries and prospective of new knowledge.

Transport of instrumentation at the laboratory

BASJE (Bolivian Air Shower Joint Experiment)

Japanese-Bolivian collaboration

High energy gamma research by the detection of Extensive Air Showers (EAS) produced by primary cosmic rays in atmosphere.

Researchers at work at muon detectors system in the Chacaltaya laboratory

EAS detectors

The neutron monitor in the laboratory

INCA (Investigation of Cosmic Anomalies)

University of Turin (Italy) and Universidad Mayor de San Andres (UMSA) La Paz

Detection of Gamma Ray Burst to investigate the explosions of enigmatic objects in our universe.

SLIM (Search for Light Magnetic Monopoles)

INFN Torino-Bologna and University of Turin

Since 2000 the Search for Light Magnetic Monopoles (SLIM) has been carried out at Mount Chacaltaya. A passive nuclear track detector (400 m2) made of sheets of plastic material is used to detect magnetic monopole, and strange quark matter or "nuclearite" in the cosmic radiation. The experiment will allow to investigate the nature of the "dark matter".

SASP (Surface Air Sampling Program)

Universidad Mayor de San Andreas (UMSA) of La Paz

Chacaltaya laboratory is one important SASP sampling location. The program was established in 1957 to track the global dispersion of radioactive debris resulting from atmospheric testing of nuclear bombs. In the 1970's, the program focused on the global distributions of the naturally occurring radionuclides, beryllium-7 and lead-210.

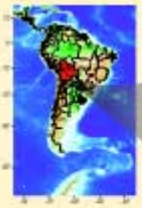
PHANTOM

(Dosimetry in anthropomorphic phantom)

INFN Torino and Universidad Mayor de San Andreas (UMSA)

An anthropomorphic phantom is used to assess the human exposure to cosmic radiation in high altitudes.

The experiment allows to get data on the dose distribution in critical organs of the human body. The same technique can be used for dose evaluation in high altitude flight and in space aircraft.



The history
Chacaltaya Laboratory

Altitude 5.230 m asl
Latitude S 16° 29'
Longitude W 68° 8'

located on the Chacaltaya mountain, Bolivia

Built in 1942

The Club Andino Boliviano. The skier is the physicist F. Handel (~1950)

The laboratory was founded in September 1942 by Ismael Escobar. At first it was used as a meteorological station.
Soon afterwards, a road was built to give access to a ski station opened in 1940 by the Club Andino Boliviano.

The Chacaltaya laboratory

On the left: the Club Andino Boliviano today.
On the right: the old building.
On the background: The Illimani mountain

THE DISCOVERY OF THE PION (1947)

1950 - Cesare Lattes (on the right) with other physicists inside the laboratory. Ismael Escobar on the left

The name of Chacaltaya became famous among cosmic rays physicists because of the discovery in 1947 of an important subatomic particle, the pion, and its decay.

The pion was discovered through the method of nuclear emulsion. Protagonists of this important event were the physicists Cesare Lattes, Giuseppe Occhialini and Cecil Powell which provided the confirmation of Yukawa theory.

1950. Cesare Lattes at Chacaltaya

THE NOBEL PRIZE

The discovery of Lattes, Occhialini and Powell enabled Powell and Yukawa to win the Nobel Prize.

After that, the laboratory reached an international importance in the field of cosmic rays research

Occhialini, Powell (Nobel, 1950)

Yukawa (Nobel, 1949)

Early '60s Prince of Edinburgh visiting the Chacaltaya laboratory

THE HIGH ENERGY PHYSICS

Cesare Lattes (at the desk) and F. Handel at Chacaltaya

At Chacaltaya, Lattes and his colleagues wanted to study particles (the cosmic rays) with energies thousands times higher than the energies reached by the accelerators of that time (60 GeV).

Lattes, with Brazilian colleagues and a Japanese group, including Yukawa, established a long-term program at Chacaltaya, working mainly with nuclear emulsion layers, to study the interaction of very high energy particles.

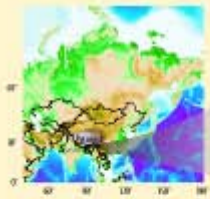
In the following years, the Chacaltaya laboratory hosted numerous cosmic physics experiments, in collaboration with Japan Universities.

The Italian researcher Bruno Rossi, which had a great part in the experiment BASJE.

In the In '60s, Experiment BASJE (Bolivian Air Shower Experiment), began as a collaboration Bolivia - USA - Japan that set the beginning of the research on very high energy gamma.

Still today, at Chakaltaya laboratory is being carried out advanced research in cosmic ray and astrophysics from worldwide scientists, with the logistic support and the scientific collaborations of the UMSA (Universidad Mayor de San Andres).

PYRAMID Everest



Altitude 5.050 m asl
Latitude N 27° 59'
Longitude E 86° 57'

located on the Everest range, Nepal

Activities

medicine and biology

The Himalayan mountain system is the planet's highest and home to all fourteen of the world's highest peaks, the Eight-thousanders, including Mount Everest. Mount Everest is the highest mountain on Earth, meaning its summit is higher above sea level than that of any other mountain. Its summit ridge marks the border between Nepal and China.

View of Pyramid laboratory

Mount Everest as seen from the Rongbuk Monastery, Tibet

The Italian Pyramid is located at 5050m in the Khumbu valley of Nepal.

Brief history and use of the research station

The first idea of building an Italian high-altitude research station came in 1987, by the famous Italian Physicist Ardito Desio, the man who headed the Italian conquest of K2 in 1954, and the original aim was to measure and monitor the exact height of Mt.Everest (and K2).

The laboratory which is now run by a cooperation between Italian ("Ev-K2-CNR project") and Nepalese (RONAST) Institutions, became operative in 1990 and since then, more than 450 scientific expeditions have contributed to the scientific advancement in many different fields, spanning from physics and natural sciences to anthropology and medicine.

The Pyramid is a glass and aluminium structure, measuring 13.22 m at the base and 8.40 m height. Its geometric shape provides stability and resistance to the elements such as winds, snow and rain. The outer covering of reflective glass makes the structure environment-friendly.

Desio to the base camp after the conquest of the K2

Tiemboche monastery (3800 m)

On the road to the Pyramid

Research activites

The laboratory is divided in three floors whose space is dedicated to small and large laboratories and to radio and satellite communication systems.

The Pyramid is fully independent, using only renewable power sources: water, sun and wind.

The study of European subjects with or without special practice of respiratory control (yoga), and native populations with prevalently active lifestyle (Himalayan Sherpas) and with more contemplative lifestyle and practices of respiratory control (Buddhist monks) was investigated.

Different strategies of adaptation to high altitude induced by culture and lifestyle were founded, with Himalayan subjects (particularly Buddhist monks) and European yoga practitioners showing advantages due to more efficient respiration which limited the altitude-induced reduction of oxygen in the blood.

The participants were medical scientists from different Italian, German and US Institutions.

Scientists examining native Himalayan subjects (Sherpas and Buddhist Monks)

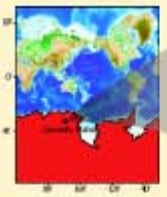
A group of researchers examining patients and doing research with the native population in the villages below the Pyramid Laboratory

Permanent GPS Station at the Pyramid Everest Laboratory

This GPS station can be a reference for other researchers operating in the area and in the long term will provide information on the tectonic movements of the area if compared with other GPS Stations located in Nepal, Tibet and in India.

In spring and autumn the Laboratory is visited by researchers that carry out scientific projects in medicine, physiology, glaciology and also sedimentology in the several lakes of the surrounding areas.

All through the year the laboratory hosts a meteorological station that collects data for the study of the development and the variations of the monsoon along the Himalayan chain.



CONCORDIA STATION

Altitude 3.233 m asl
Latitude S 75° 06'
Longitude E 123° 24'

located on the high Antartic plateau, Antartica

Activities

Glaciology
Earth science
Atmospheric sciences
Astronomy and Astrophysics
Remotesensing
Biology and medicine

The Antarctic plateau provides unique opportunities for Science.

The French and Italian Antarctic programmes have developed a scientific base located on the high Antarctic plateau: Dome C (75°06' S 123°24' E), at 3.233 m above sea level.

Concordia Station night June 05

SCIENTIFIC EXPERIMENTS

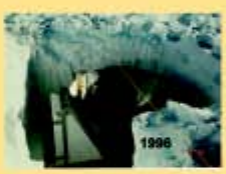
Six areas of scientific research have already been selected by the Concordia Steering Committee

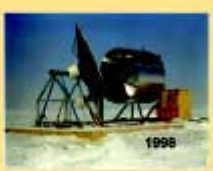
Glaciology

The European Project for Ice Coring in Antarctica (EPICA) has obtained the longest continuous record of past atmosphere and climate changes by drilling a 3270.2 m ice core. Another interesting feature is the presence of several sub-glacial lakes

Earth Science

A seismic observatory will detect earthquakes and will study the internal structure of the Earth. A magnetic observatory will permit studies of the Earth's magnetic field and magnetic storms.





Atmospheric Sciences

The atmospheric science programmes study of the evolution of the ozone hole, the physical chemistry of the troposphere

Astronomy and Astrophysics

Dome C is an ideal site for astronomical observations. Italian activities pioneered the millimeter Astrophysics in Antarctica. The French-Italian collaboration opens a new extremely interesting perspective. A new mm telescope will be installed during next antarctic summer (Dec 2006).

Remote Sensing

Dome C is an ideal site for calibrating and validating satellite sensors operating in the visible and the infrared. The physical parameters involved in the interactions between the electromagnetic radiations and the snow will be studied

Human biology and medicine

These programmes aim at understanding human adaptation to hostile conditions, related especially to the cold, the altitude and the isolation

http://www.dianet.it/dlnp/pages/concordia.asp http://www.concordiastation.org
http://www.paca.it/

Historical Instruments

Astronomical instruments (1800)

from Osservatorio Astronomico di Pino Torinese - Italy

Fraunhofer azimuthal refractor

Teodolite universale

Cerchio verticale Reichenbach-Ertel

Bussola Allemano

Angelo Mosso (1846-1910) Instruments

From Torino University

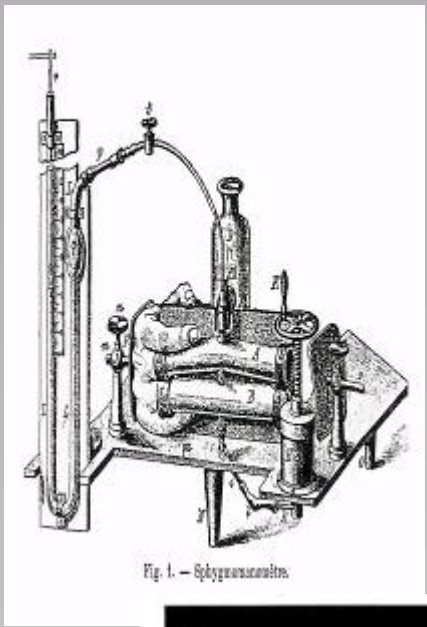
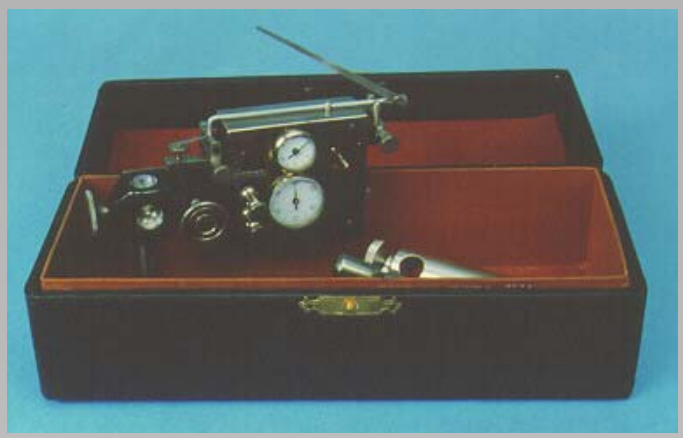
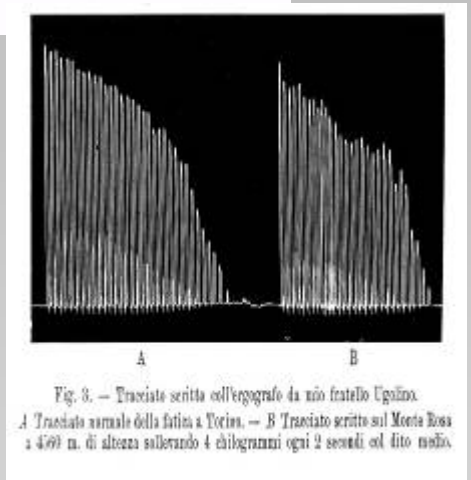


Fig. 1. — Sphygmomanometre.



Sfigmometro



A B

Fig. 3. — Tracciato scritto coll'ergografo da mio fratello Ugolino.
A Tracciato normale della fatica a Torino. — *B* Tracciato scritto sul Monte Rosa a 4560 m. di altezza sollevando 4 chilogrammi ogni 2 secondi col dito medio.

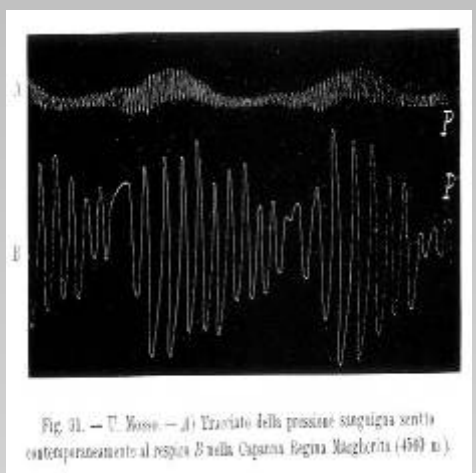


Fig. 31. — V. Mosso. — *A* Tracciato della pressione sanguigna scritto contemporaneamente al respiro *B* nella Capanna Regina Margherita (4560 m.).

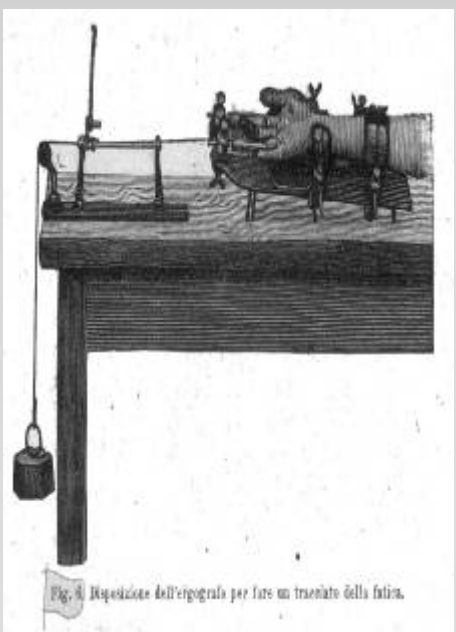


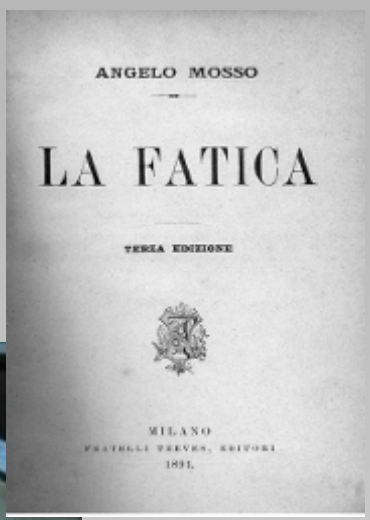
Fig. 8. Disposizione dell'ergografo per fare un tracciato della fatica.

Ergografo

Daniel Chalonge (1895-1977) instruments
(from Observatoire de Paris)

The historical Documents

Angelo Mosso Documents



Daniel Chalonge Documents

Angelo Mosso and Physiology

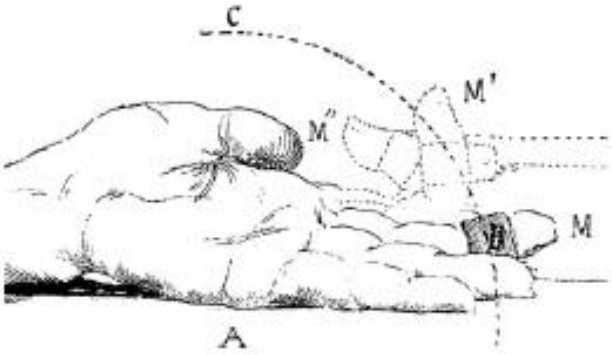


Fig. 3. Diagram of middle finger movements when a subject performed a fatigue test with the Mosso ergograph. A, support platform; M, M', and M'' represent the movement pathway of the middle finger with muscle contraction; B, leather loop that surrounds the finger and connects the finger to the cord that raises the weights.

muscles removed from the body. However, normal muscle function could not be reproduced in frogs, and thus mechanical work in humans could not be imitated. From muscle tracings, Mosso observed that the onset of fatigue could be determined, that the work performed could be measured, and that fatigued muscles remained contracted longer, thus exhibiting longer ascending and descending phase durations.

Motivated by Hugo Kronecker's studies on muscular fatigue with isolated muscles from experimental animals and convinced that the error of measurement was too great with the use of dynamometers, Mosso "sought to construct an instrument which would measure exactly the mechanical work of the muscles of man and the changes which, as the effects of fatigue, may be produced during the work of the muscles themselves" (38). In addition, he wanted a unit that could record more than the effects of isometric contractions. Consequently, he developed the ergograph (work recorder), which was designed to record and quantify the concentric contractions performed by the flexor muscles of the index finger. It consisted of two parts: one that stabilized the hand and was ~50 cm long and 17 cm wide and one that recorded the contractions. The muscles were isolated by fixing the hand with two brass tubes through an internal lumen between 18 and 22 mm depending on the circumference of the subject's finger (Fig. 3). The index and ring fingers of the right hand were introduced in the lumen while the second phalange of the middle finger was inserted within a leather ring tied to a gut-like wire (similar to the ones used for violoncellos) passing through a pulley. At the end, a 3- to 4-kg weight was attached. The stylus recorded the degree of flexion of the middle finger on a cylinder rotating following the rhythm of a simple pendulum or metronome (Fig. 4). The smoked paper turned slowly following a clock and recorded the fatigue profile of the experimental subject. Mosso found that each individual had a different fatigue profile depending on the test conditions and reported that the "Ergograph through its ergograms furnishes us the writing of the most intimate of the characteristics of an individual and how some resist to work and how others stop suddenly, in other words the way we get fatigued" (38). Mosso's favorite experimental subjects were Prof. Aducco and Dr. Maggiora, who performed various fatigue tests for 7 years. In fact, the ergographic tracing of muscular fatigue shown in Fig. 5*C* has become a "classic;" it is located on the cover of *Exercise Physiology: People and Ideas* (46) and was obtained

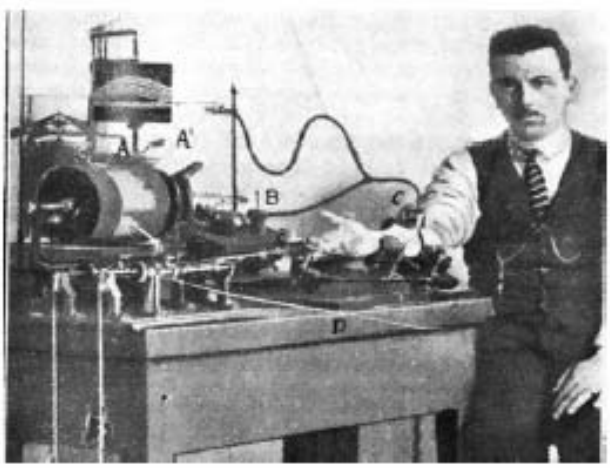
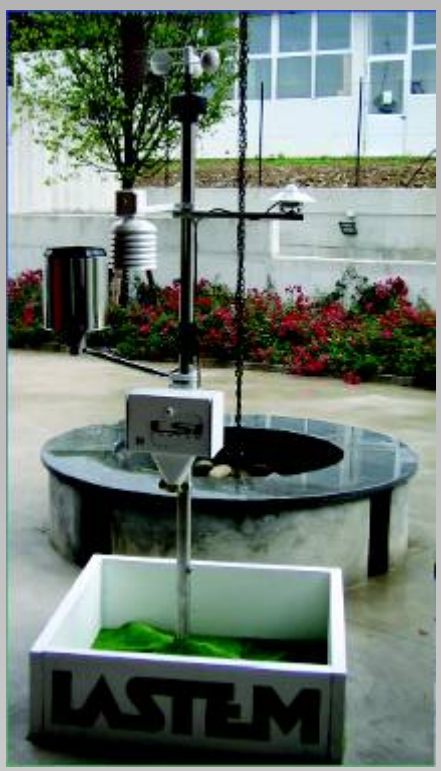


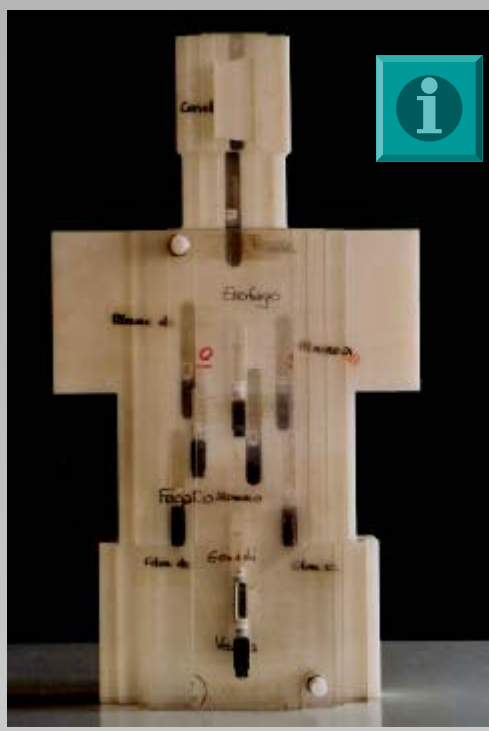
Fig. 4. Ergograph. A and A', electrical contacts that control the movement of the kymograph; B, transmission tubing from the arm to record volume changes on the kymograph located at the *top left*; D, rope connected to weights to lighten loads. [Original figure was provided by the University of Turin.]

Modern Instrument

GPS System
Ev-K2



Metereological station
Ev-K2



Jimmy Phantom
INFN

Infrared Solar Ray Monitoring
INAF

Snow and Ice Monitoring
Ev-K2

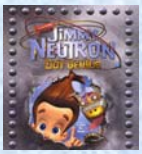
JIMMY: UN FANTOCCIO ANTROPOMORFO PER DOSIMETRIA NEUTRONICA

INFN sezione di Torino, Via P. Giuria 1, 10125 Torino (zanini@to.infn.it)

Jimmy Neutron

Guido Crepax (1933 - 2003) uno dei più grandi disegnatori di fumetti, famoso in tutto il mondo, crea nel 1965 un personaggio simpatico e avventuroso: Philip Rembrandt, conosciuto come Jimmy Neutron, è un detective con speciali capacità a causa della sua esposizione accidentale ai *neutroni*.

La ragazza di Jimmy Neutron è Valentina Rosselli, il personaggio più noto ideato da Guido Crepax.



In un film recente (2001), Jimmy Neutron è un ragazzino geniale. Sarà proprio lui a salvare i genitori di tutti i bambini del mondo rapiti dagli alieni.

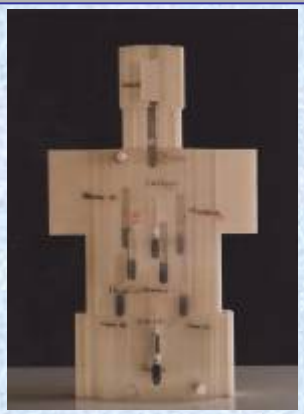
Jimmy Phantom

Jimmy è un fantoccio antropomorfo con speciali capacità: è in grado di misurare la dose rilasciata dai neutroni al corpo umano.

Caratteristiche fisiche

Peso totale: 37.1 kg

- 6 lastre in plexiglas (21.6 kg)
  8% H, 32% C, 60% O
- 1 lastra spessa in polietilene (14.2 kg)
  14.4% H, 85.6% C
- 1 polvere d'osso in corrispondenza della colonna vertebrale (1.2 kg)
  0.2% H, 41.4% O, 18.5% P, 39.9%Ca
- Dimensioni :
  testa: 13.5x15x19 cm^3
  collo: 11x10x13.5 cm^3
  tronco: *altezza* 59 cm, *larghezza* 36 cm, *spessore* 20 cm



Jimmy Phantom

Il fantoccio antropomorfo Jimmy è stato progettato e realizzato presso l'INFN, sezione di Torino, in collaborazione con il JRC (Joint Research Center) Ispra (Va).

E' costituito da lastre in plexiglas e polietilene, con inserti di polvere d'osso in corrispondenza della colonna vertebrale, secondo le indicazioni dell'ICRU (International Commission on Radiation Units and Measurements).

All'interno del fantoccio sono presenti delle cavità, in corrispondenza degli organi critici, in cui possono essere alloggiati dosimetri passivi, quali dosimetri a bolle, TLD , CR39 e campioni biologici, per la misura della dose agli organi.

Composizione di Jimmy

Composizione di vari tessuti sostitutivi (percentuale in massa di H, O, C, N)

	H_2O	Polyethylene	PMMA	TE-liquid	Jimmy	Tessuto ICRU
H	11.2	14.4	8	10.2	10.2	10.1
C	88.8	85.6	60	12	67.9	11.1
O			32	74.2	18.7	76.2
C + N					86.6	87.3
N				3.6		2.6
Boro					3.2	
Densità (g/cm³)	1	0.920	1.190	1.070	1.056	1

I neutroni interagiscono con i nuclei atomici

Per neutroni di energia compresa tra 10 keV e 20 MeV il contributo più importante alla dose assorbita è dovuta all'idrogeno.

I neutroni si comportano allo stesso modo con ossigeno e carbonio:

La composizione di Jimmy è una buona approssimazione del tessuto ICRU di riferimento (raccomandazione dell'International Commission on Radiation Units and Measurements)

I vantaggi di Jimmy

- ✓ **Fantoccio economico, di facile utilizzo e ideale per misure di routine.**
- ✓ **E' possibile valutare la dose agli organi critici.**
- ✓ **E' possibile misurare gli spettri neutronici in corrispondenza degli organi critici.**
- ✓ **Si possono inserire diversi dosimetri passivi (TLD, dosimetri a bolle (BDS, BD-PND), fogli di policarbonato).**
- ✓ **Si possono inserire dei campioni biologici.**

Campioni biologici

Perché fare dosimetria neutronica?

- I neutroni hanno un'alta efficacia biologica.
- Il fattore peso per neutroni dipende dall'energia.
- **I neutroni danno un contributo importante alla dose da radiazione cosmica.**
- I neutroni rappresentano una componente non trascurabile in alcune applicazioni mediche.

Fattori peso degli organi critici

Organi	w_T
Gonadi	0.20
Polmone	0.12
Stomaco	0.12
Colon	0.12
Vescica	0.05
Fegato	0.05
Esofago	0.05
Mammelle	0.05
Tiroide	0.05
Pelle	0.01
Superficie ossea	0.01
Parti rimanenti	0.05

Fattori peso della radiazione

Tipi di radiazioni	Fattori peso w_R
Fotoni	1
Elettroni	1
Muoni	1
Neutroni	
< 10 keV	**5**
10 – 100 keV	**10**
100 keV – 2 MeV	**20**
2 – 20 MeV	**10**
> 20 MeV	**5**
Protoni	5
Particelle alfa, frammenti di fissione, nuclei pesanti	20

Ogni organo ha una diversa radiosensibilità

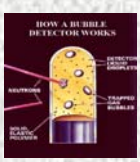
La dosimetria neutronica è molto complessa

Occorrono strumenti specifici

Montaggio di Jimmy:

Vengono inseriti nelle cavità del fantoccio dei dosimetri a bolle per neutroni.

I dosimetri a bolle



- **I dosimetri a bolle sono costituiti da fialette di policarbonato (diametro 1.8 cm, altezza 8 cm) riempite con un gel tessuto-equivalente in cui sono disperse delle goccioline di liquido sovrariscaldato (Freon).**
- **I neutroni interagiscono con il gel generando particelle cariche secondarie (particelle alfa e protoni) che provocano la formazione di bolle visibili a occhio nudo.**
- **Il dosimetro viene calibrato su sorgenti di neutroni di intensità nota.**
- **Il numero delle bolle è proporzionale alla dose neutronica.**

Questo strumento (Jimmy+dosimetri) permette di misurare l'energia depositata dai neutroni (o dose neutronica) nel tessuto biologico a diverse profondità, in corrispondenza degli organi critici.

JIMMY PER LA MISURA DELLE RADIAZIONI NELLO SPAZIO

INFN sezione di Torino, Via P. Giuria 1, 10125 Torino (zanini@to.infn.it)

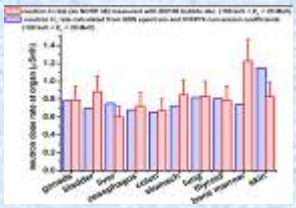
Dosimetria con Jimmy

1. Voli Alitalia

2 voli - rotta polare
Roma-Tokyo
41° 48' N 12° 14' E - 35° 78' N 140° 32' E
h_{media}= 10649 m

2 voli – rotta equatoriale
Roma - Buenos Aires
41° 48' N 12° 14' E - 34° 49' S 58° 32' W
h_{media}= 10433 m

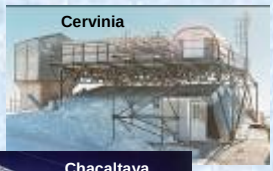
Jimmy a bordo degli aeromobili ALITALIA



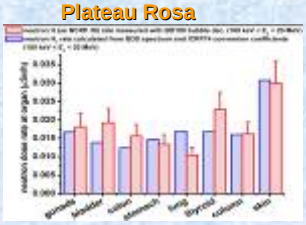
2. Laboratori di alta montagna

Plateau Rosa (Cervinia, Italia)
Stazione di ricerca Testa Grigia
h=3480 m,
45° 56' N, 7° 42' E

Chacaltaya, La Paz (Bolivia)
h=5400m, 16° 21' S



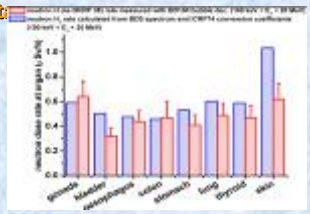
Jimmy a Chacaltaya e Plateau Rosa



3. Voli su palloni stratosferici (ASI)

Trapani-Siviglia
h_{max} = 38000 m
h_{media} = 29400 m

Jimmy sul pallone stratosferico (rotta Trapani - Siviglia)



Il flusso di raggi cosmici dipende da:

Altitudine (cresce all'aumentare dell'altezza s.l.m.; gli strati dell'atmosfera diventano più sottili e aumenta l'esposizione alla radiazione cosmica).

Attività solare (flussi minimi con attività solare massima).

Latitudine (flussi maggiori ai poli e minori all'equatore in funzione del campo magnetico terrestre).

Dosimetria ad alta quota… perchè?

Sono in continuo aumento le attività umane che espongono gli individui alla radiazione cosmica.

Voli commerciali:

- aumentano i tempi di volo, il numero dei passeggeri, le quote di volo.

Voli militari:

- la nuova generazione di aerei militari raggiunge i 20 - 30 km (Tornado).

E inoltre…

…Esplorazione dello spazio

…Turismo spaziale

…Viaggi su Marte

Le commissioni internazionali (ICRP e ICRU) hanno:

1. abbassato i limiti annuali d'esposizione massimi consentiti

da 50 mSv a 20 mSv per i lavoratori esposti

da 5 mSv a 1 mSv per la popolazione

2. raccomandato attenzione all'esposizione prolungata alle basse dosi

Un po' di numeri

Fondo di radiazione naturale in Piemonte 1 – 2 mSv/anno

Per ricevere una dose di 1 millisievert
17 mesi a Parigi
6 mesi in alta quota (Bolivia, Tibet)
7 voli A/R Parigi-Tokyo o San Francisco (h 10000 m – 12000 m)
13 voli A/R Paris-New York a bordo del Concorde (18000 m)
circa 1 giorno a bordo della stazione spaziale MIR (quota 400 km)

Limiti di esposizione

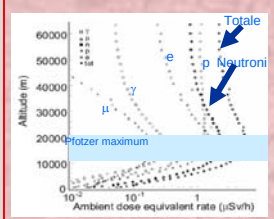
Occupazione	Esposizione annua (mSv/anno)
Addetti centrali nucleari	4.76
Tecnici di radiografia industriale	3.34
Personale reparti medicina nucleare	1.22
Piloti e assistenti di volo	1-5

Dosi nelle missioni spaziali

Programma	Quota media in km	Numero di membri dell'equipaggio	Dose-rate in mSv/day	Dose totale in mSv
Apollo		**33**	**1.3 (3.9)**	**12.2 (33)**
Skylab	**381 (435)**	**9**	**1.2 (2.1)**	**72 (170)**
MIR	**341(355)**	**4**	**0.72 (1.0)**	**100 (140)**
ISS	**360 (450)**	**280**	**0.5 (1.0)**	**80 (180)**
Mars		**4 (8)**	**1.5 (2.0)**	**400 (1200)**

I valori massimi sono riportati in parentesi. Essi dipendono principalmente dall'attività solare e dall'orbita; la dose totale dipende dal numero di giorni di permanenza.

Profili vertcali di dose per le particelle che compongono i raggi cosmici secondari in atmosfera

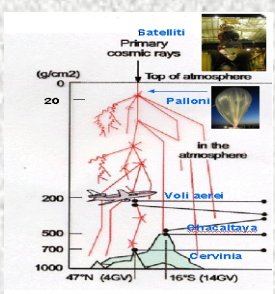


Il massimo della dose da raggi cosmici è tra 10000 m e 20000 m.

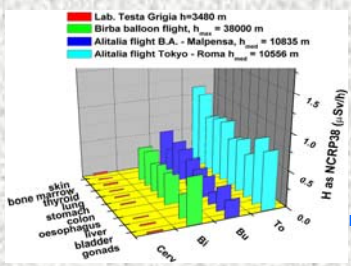
In questo range si raggiunge un equilibrio tra la produzione di particelle e l'attenuazione dovuta all'atmosfera

E' importante l'accurata valutazione della dose alle quote dei voli aerei

Tratto da M. Pelliccioni et al.. "Calculation of the radiation enevironment caused by galactic cosmic ray for determing aircrew exposure" Rad. Prot. Dos Vol 93, N. 2 (2001)



Risultati delle esposizioni di Jimmy Ratei di dose agli organi



Per ogni esposizione è stata misurata la dose agli organi.

Dose neutronica massima: Volo ALITALIA Roma-Tokio (rotta polare)

4TH BERGAMOSCIENZA EDITION
28 September – 15 October

LA RICERCA "D'ALTA QUOTA“

PROGETTO E REALIZZAZIONE

INFN, Torino
INAF-IFSI, Roma
Università degli Studi di Torino
Otto Comunicazione
Comitato Ev-K^2-CNR

The Nobel Prize in Chemistry 1995 Paul J. Crutzen visiting the exhibition LA RICERCA "D'ALTA QUOTA" with Jimmy the Phantom (12th October 2006)

Divulgation conferences

20th November 2006

Angelo Mosso and human fisiology

Paolo Cerretelli Department
of Medicina, University of Pavia

1900-Experiment at Capanna Margherita
4500 m a.s.l.

27th november 2006

Fisiology at high altitude:
from Ande to Himalaya

Luciano Bernardi, Department
of Medicina, University of Pavia

Himalayan people-Ev K2 obs.
5000 m a.s.l.

30th november 2006

Astronomy at the high
mountain observatories

Attilio Ferrari, Dipartimento
di Fisica Generale, Università di Torino

Mauna Kea Observatory -Hawaii
3400 m a.s.l.

4th december 2006

From high mountain observatories
to space missions

Vincenzo Guarnieri,
Alcatel Alenia Space-Italia

2006-Experiment on ISS- 386 Km a.s.l.

The press and media communication

- TORINO7 dossier of national newspaper "LA STAMPA"

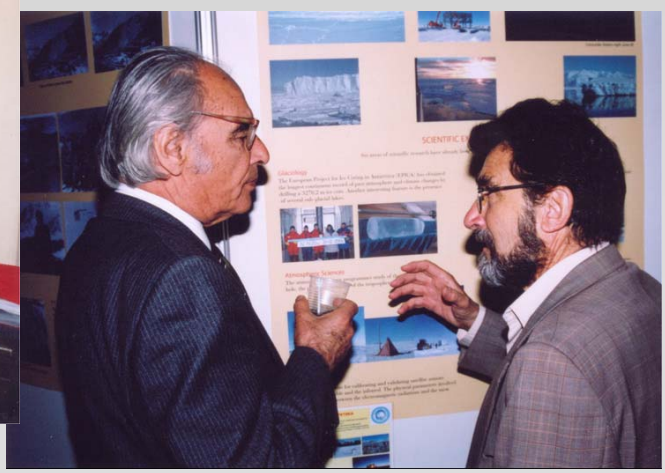
The press and media communication

- EV-K2-CNR report

- TG LEONARDO national newsreel TG3

The public

Students from schools and universities, scientists, generic audience, members from University of the Third Age…



Exhibition locations

- **TORINO (ITALY)**

9th of February 2006 - 20th of March 2006

- **SOFIA (BULGARIA)**

3rd of July – 21st of July 2006

- **BERGAMO (ITALY)**

1st of October – 15th of October 2006

- **CHIERI (ITALY)**

23rd of November – 6th of December 2006

Future Locations

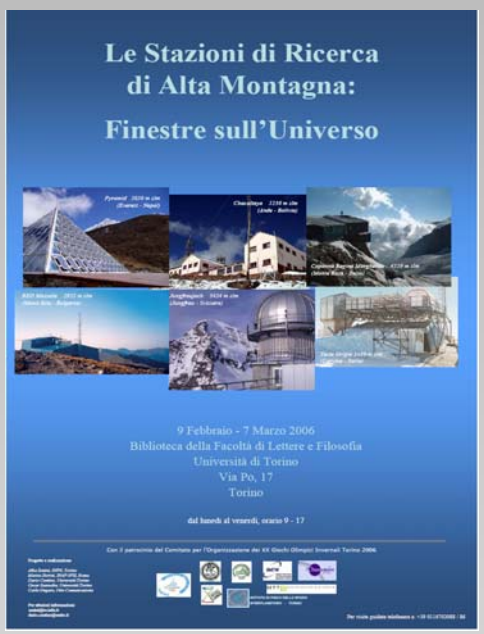
- **PARIS (FRANCE)**
- **YEREVAN (ARMENIA)**
- **LA PAZ (BOLIVIA)**
- **GENOVA (ITALY)**

Exhibition Places

Torino (Italy) **9th of Februry 2006 – 20th of March 2006**

Presso la Biblioteca di Lettere e Filosofia dell'Universita' di Torino

Sponsored by the Organizing Committee for the XX Winter Olympic Games.



Torino (Italy)

11st of February 2006, Mrs Bush at the Library during her visit at the University of Turin

University of Turin,

Torino-Italy 9th of Februry 2006 – 20th of March 2006

Exhibition Places

SOFIA (BULGARIA), 3rd – 21st JULY 2006

Bulgarian Republic President and Bulgarian Accademy President (BAS) during their visit to the exhibition

Bulgarian Accademy of Science, Sofia (Bulgaria)

Exhibition Places

SOFIA (BULGARIA), 3rd – 21st JULY 2006

Exhibition Places

BERGAMO (ITALIA), 1st – 15th OCTOBER 2006

Bergamo (Italy)

CAI, Club Alpino Italiano, Bergamo

- **Bergamoscienza**

BergamoScienza is an important review of scientific spreading, that is carried out annually in Bergamo. (60.000 visitors)

Bergamoscienza and CAI (Italian Alpine Club) Bergamo

BergamoScienza is a review of scientific spreading, than it is carried out annually to Bergamo. The cultural engagements that the association proposes itself are:
-to create an "open culture" of the scientific spreading that experiments covered new
- to realize a science "for all" without cultural, political or social barriers .

"Italian Alpine Club (C.A.I.) founded in Turin in the year 1863 for initiative of Quintino Sella, has for scope the mountain in its every manifestation, the knowledge and the study of mountains, especially of those Italians, and the defense of their environment".

Exhibition Places

BERGAMO (ITALIA), 1st – 15th OCTOBER 2006

Exhibition Places

CHIERI (ITALY),
23rd NOVEMBER – 6th DECEMBER 2006

Chieri cathedral (Italy)

City hall library - Chieri

CHIERI (ITALY),
23rd NOVEMBER – 6th DECEMBER 2006

Angelo Mosso and Human Physiology

160 years from Mosso Birthday

Next exhibition places

- Observatoire de Paris (FRANCE)
- Hotel de Ville Paris (FRANCE)
  9 May 2007
  Journee' de l'Europe
- Yerevan (ARMENIA)
- UMMSA La Paz (BOLIVIA)
- Science Festival – Genova (ITALY)
  28 October 2007
  50 years from Sputnik launch celebration

… PARIS (FRANCE)

OBSERVATOIRE DE PARIS (FRANCIA), May 2007

Astrophysics International School "Daniel Chalonge" – director prof. Norma Sanchez

Observatoire de Paris

HOTEL de VILLE
9th of May 2007
Journee de l' Europe

Hotel de Ville -Paris

… YEREVAN (ARMENIA)

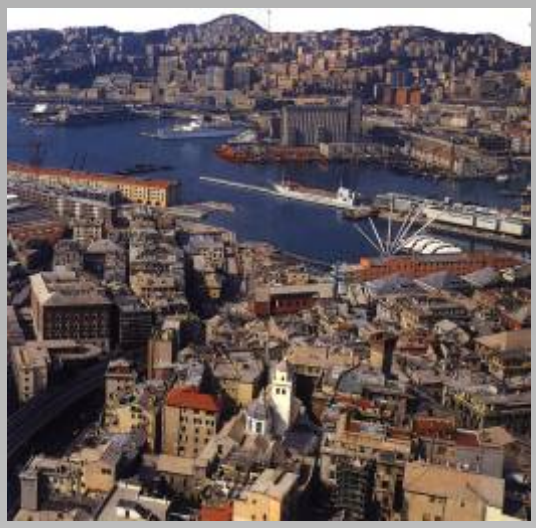
ARAGAT OBSERVATORY (ARMENIA), JUNE 2007

… A LA PAZ (BOLIVIA)

UMSA Universidad Mayor de San Andreas

CHACALTAYA LABORATORY (BOLIVIA), AUGUST 2007

… GENOVA (ITALY)



FESTIVAL DELLA SCIENZA (ITALY), OCTOBER 2007

GENOA SCIENCE FESTIVAL

Discovery is the main theme of Science Festival, which will be held in Genoa from october 28 to november 9 2007.
Exhibitions, laboratories, shows and special events: the Science Festival is planning a series of events that will explore the planet of science from every angle. Science and education meet in a range of "hands-on" experiments in natural science, physics, chemistry, and astronomy laboratories, and in many exhibitions.

Conclusions

The HMO Network is an excellent tool for science communication activities because of:

- Wonderful landscapes
- Various science fields
- Historical documents
- Advanced research
- Integration in Space Science
- Integration in Earth Observation Systems
- Sensibilization to the Environment
- New approach to Global Change
- High public interest

Aknowledgments

We thank:

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- Prof. Norma Sanchez (Observatoire de Paris)
- Prof. Gianni Losano (Torino University)
- Prof. Ester Antonucci (Astronomical Observatory Pino Torinese)

for the historical instruments and documents exposed during the exhibitions