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 meters 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

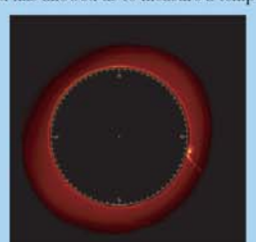
The Siderostat

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:

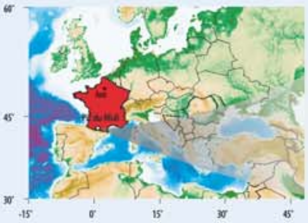
- the atmosphere and ozone and pollution in particular
- meteorology, especially high altitude forecasts
- atmospheric electricity, by measuring the electrical field in the earth's atmosphere, storms and lightning
- high altitude medicine
- the seismicity of the Pyrenees

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, Pyrénées, 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 1884 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 ingeneer Vaussenat.

View of the observatory in the 1885

Vaussenat at the meteorological blockhaus

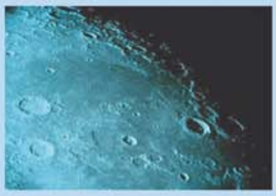
In the 1908 the first dome has been build.

In the 1927 Opening of the Tourmalet - 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 observation research.

In the 1949 an elavating platform was build in order to bring up staff and equipments from the Laquets 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 at 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 Gentili 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.

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
astrophysicis, 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 center 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)

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.


Restaurant, railway station and research station at Jungfraujoch


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 senat, Bern; Jungfrau Railways, Interlaken; Gornergrat Bahn, Brig; Burgergemeinde Zermatt. Switzerland's substantial fee is paid by the Swiss National Science Foundation.)

www.ifjungo.ch

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 Monch 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 Junfraujoch was inaugurated on August 1, 1912.

The Jungfrau railway project Guyer-Zeller.

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)

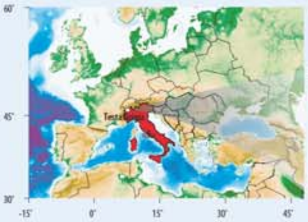
Daniel Chalonge, astrophysicist at the Observatoire de Paris.

He 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 AltitudeResearch StationS of Jungfrajoch and Pic du Midi.

In 2001 the Jungfrau-Aletsh-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.

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 Mattherhorn

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.

Ground-Based Telescope for mm-Infrared Observations
Università di Roma "La Sapienza"


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

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

Spectrometry and Dosimetry of Neutrons from Cosmic Rays
INFN-Sezione di Torino, APAT – Roma

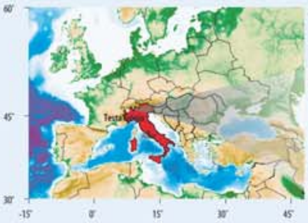
The measurement of neutron spectra at various altitudes in atmosphere is important for many dosimetric applications: the radioprotection of the aircrew on intercontinental flights, astronauts dosimetry in space mission, evaluation of human exposure in high altitude countries


Bubble detectors for neutron dosemetry


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

The Testa Grigia Laboratory at the beginning

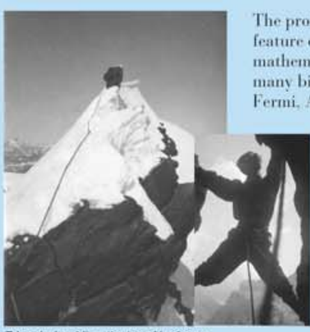
1957 - 1958 G. Wataghin and G. Piragino
Measurement of absorption curve of penetrating component of cosmic rays

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 at 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 constituens 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



Edoardo Amaldi on the top of Lyskamm, Monte Rosa range (August 1932)

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…

Whithout 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

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.

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)

1955
The Plateau Rosa cableway

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

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.

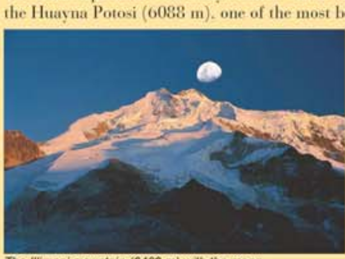
The Chacaltaya Laboratory 5230 m asl, Bolivia

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 reachs 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

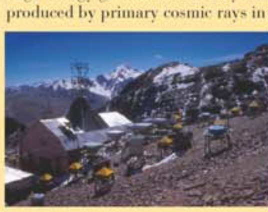
The geography characteristics of the Andean plateau, allow a research of high level in the space field, with important outcomes for the international scientific community in terms of discoveries and perspective of new knowledge.

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.



EAS detectors

Researchers at work at muon detectors system in the Chacaltaya laboratory

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 1980'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 Edimburgh 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.

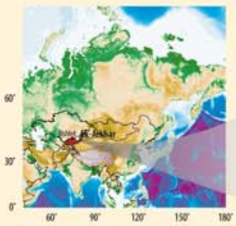
In the following years, the Chacaltaya laboratory hosted numerous cosmic physics experiments, in collaboration with Japan Universities.

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 collaboration of the UMSA (Universitad Mayor de San Andres).

Ak-Arkhar Pamir Research Station



Altitude 4.380 m asl
Latitude N 43°
Longitude E 77°

located on the Pamir range, Kyrgyzstan

Activities

cosmic ray physics

Located in Central Asisa, the Pamir Mountains are formed by the junction of the Tian_Shan, Karakoram, Kunlun, and Hindi Kush ranges. They are among the world's highest mountains. They are also known by the Chinese name of Congling.

The Pamir region is centered in the Tajikistani region of Gomo-Badakhshan. Parts of the Pamir also lie in the countries of Kyrgyzstan, Afghanistan, and Pakistan. South of Gorno-Badakhshan, the Wakhan Corridor runs through the Pamir region, which also includes the northern extremes of the North-West Frontier Province and the northern extremes of the Northern Areas of Pakistan.

Views of Pamir region

View of Pamir range from the satellite

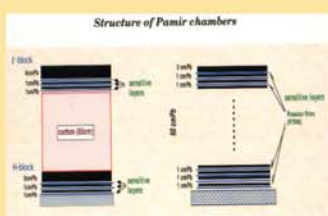
Kirkuz people

Camel with Pamir Mountains on the background

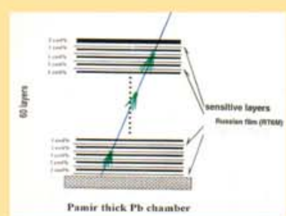
Its two highest mountains are Ismail Samani Peak, 7495 m (known from 1932-1962 as Stalin Peak, and from 1962-1998 as Communism Peak) and Lenin Peak, 7165 m

MAIN ACTIVITIES

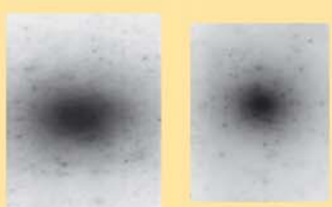
'Ak-Arkhar' high altitude experimental site at the Pamirs



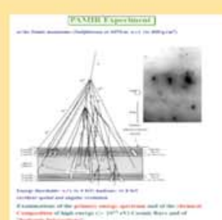
Two type of emulsion chamber detectors



A particle interaction in the emulsion chamber is visible in the lower part.



Two large cosmic ray events detected at Pamir



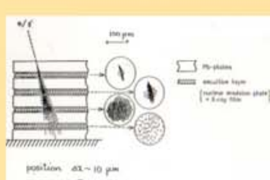
An example of very high energy interaction of cosmic ray in air and detected by the emulsion chamber

Pamir-Chacaltaya International Research Center
(4380 m asl)

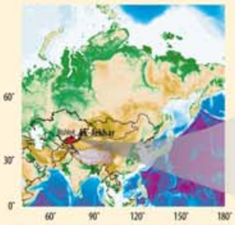
Experimental Setup:

Large-scale X-ray emulsion chambers
(1500 tons of rolled lead plates, 640 tons of rubber blocks)

$S_{exp} \sim 1000\ m^2$



Gamma ray interaction with chamber



The history

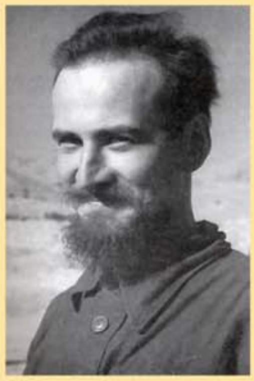
Ak-Arkhar Pamir Research Station

Altitude 4.380 m asl
Latitude N 43°
Longitude E 77°

located on the Pamir range, Kyrgyzstan

Built in 1946

Director of Pamir Station:
Sergei Slavatinski (1926, 2006)



G.T. Zatsepin. "Russian astrophysicist known for his contribution to the development of Greisen-Zatsepin-Kuzmin limit.

Georgi Zatsepin, with a cable around his neck, prepares the Pamir air shower experiment in Russia in 1946.

Views of Pamir Cosmic Ray Station

Scientists tent 1947

Scientists group 1947

S.Nikolski 1948

S.N. Vernov, D.V. Skobeltsyn (1949)

Meeting of Cosmic Ray Scientist in Moscow 1959
First line on the right: A. Chudakov. Third line on the left: V. Wataghin

S.N. Vernov started studying cosmic rays in 1931 when he entered post-graduate school .

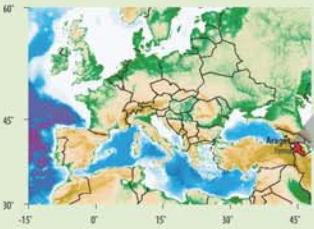
The experiments done by D.V. Skobeltsyn on a Wilson camera in a magnetic field had shown that at the sea-level cosmic rays are high energy charged particles fluxes.

Young S.N. Vernov had a choice to improve the methods of studying cosmic rays at the sea level or try to put some experiments in the stratosphere, closer to primary cosmic rays. S.N. Vernov decided to choose a new direction - that is studying cosmic rays in the stratosphere and this choice has greatly influenced his life.

The development by S.N. Vernov of a new method of studying in the stratosphere has built a new experimental base for a wide range of experiments, fisrt of all the investigation of the nature of primary particles. In 1946 under the leadership of Sergei Vernov unique devices were constructed to study the proton interaction: electron-photon , muons, nuclear fission component of the shower.

In 1949 S.N. Vernov received The State Bonus and in 1953 was elected to be a correspondent-member of The Acaddemy of Science of the USSR.

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 netwotk, 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 variation. 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

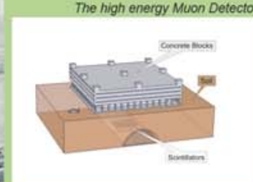
New particle detector for the world-wide network of Space Weather research, measuring charged and neutral content of cosmic rays and directional information.

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.

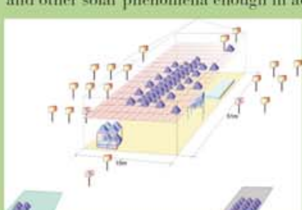
The Aragats station (3200 m asl) station in winter

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

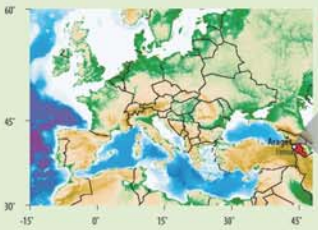
Investigations of Solar-Terrestrial Connections

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 Alikhanyn 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 - 1946

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 1948 A. Alikhanov and A. Alikhanian were awarded the USSR State Prize for the investigation of cosmic rays.

Founders of the Yerevan Phusics 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 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.

The laboratory today