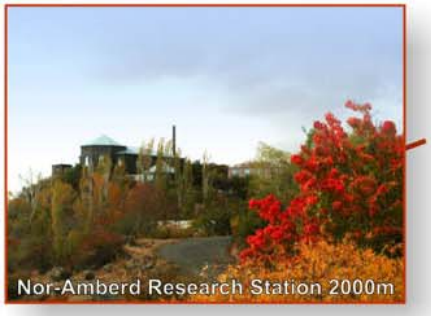
Map of Armenia

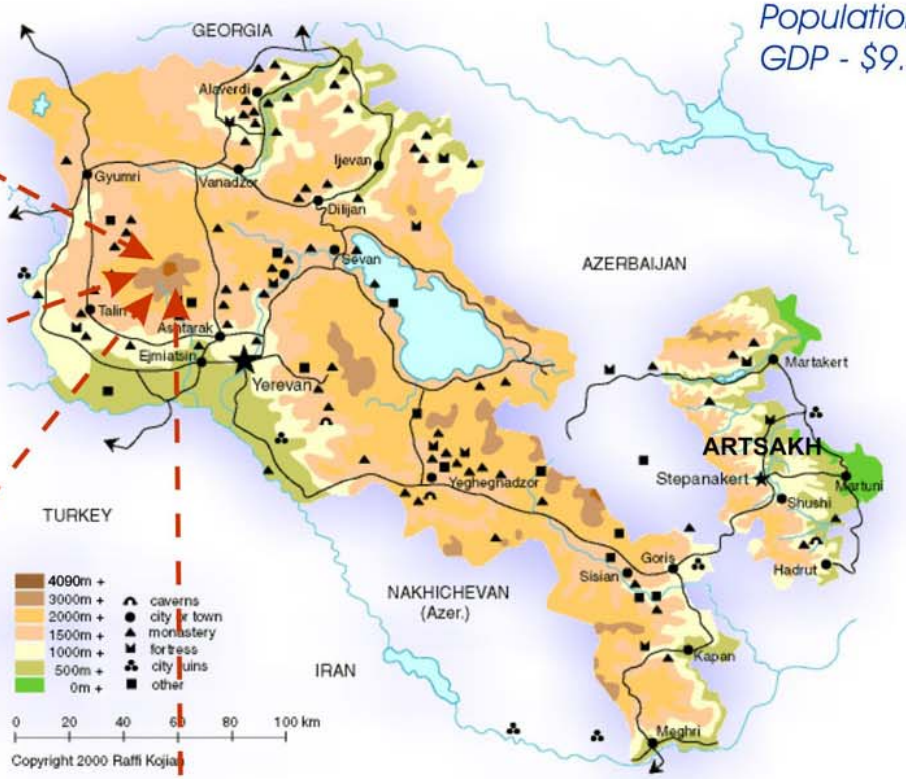

Aragats Research Station 3200m


Nor-Amberd Research Station 2000m


North Peak of Mt. Aragats 4020m.

Area:
total: 29,800 sq km
land: 28,400 sq km
water: 1,400 sq km

Population - 3.000.000
GDP - $9.2 billion



Mt. Aragats

CRD Research Profile

- Cosmic Ray Astrophysics – Research of Cosmic Ray Sources and Acceleration Mechanisms by ground based surface detectors.
- Solar Physics – Detection on Earth by neutron monitors and muon telescopes Solar Energetic Particles.
- Monitoring and Forecasting of the Space Weather.
- Multivariate Data Analysis - Monte Carlo Statistical Inference

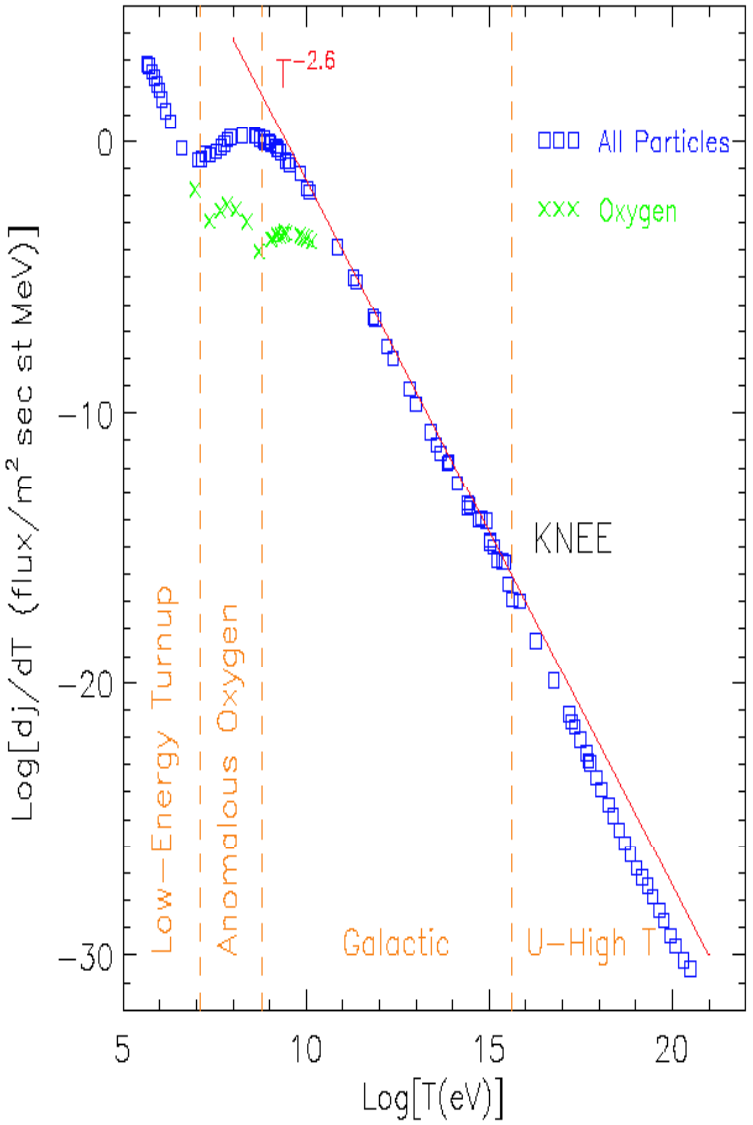
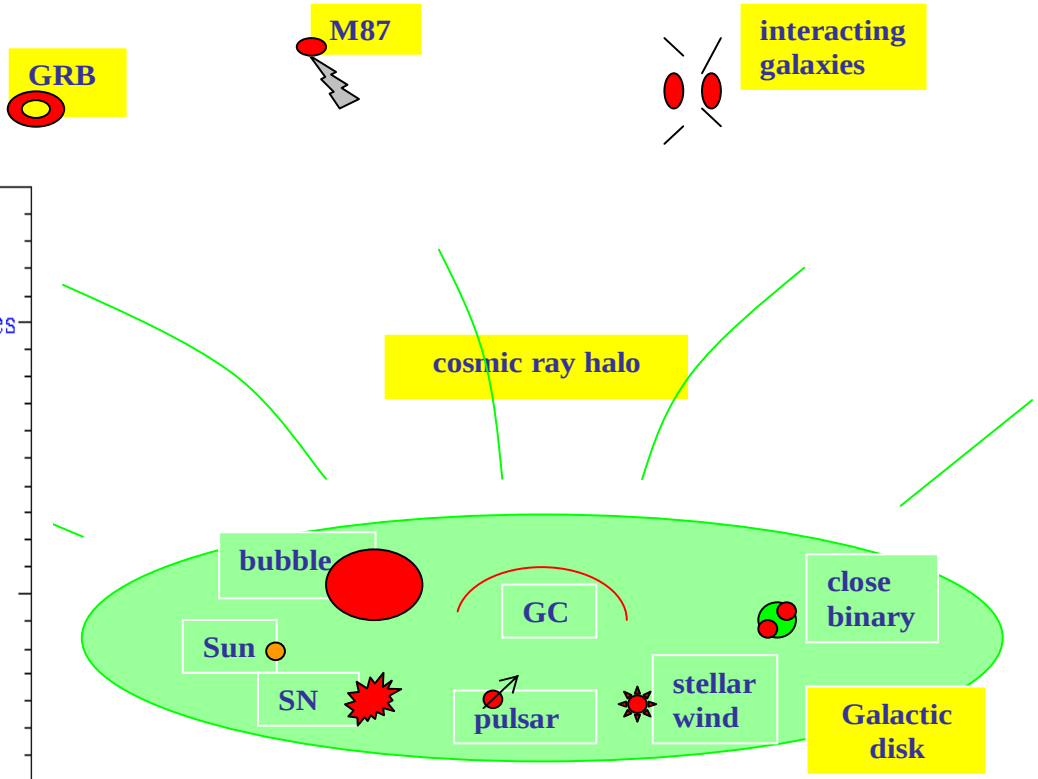


Figure 1 Energy spectrum of cosmic rays measured at the Earth (Jokipii 1989).



$N_{cr} \sim 10^{-10}$ cm^{-3} - total number density

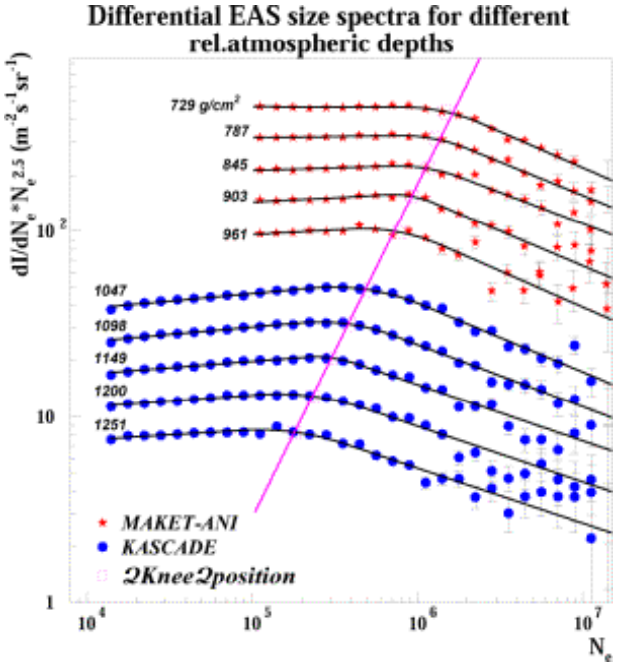
$w_{cr} \sim 1.4$ eV/cm^3 - energy density

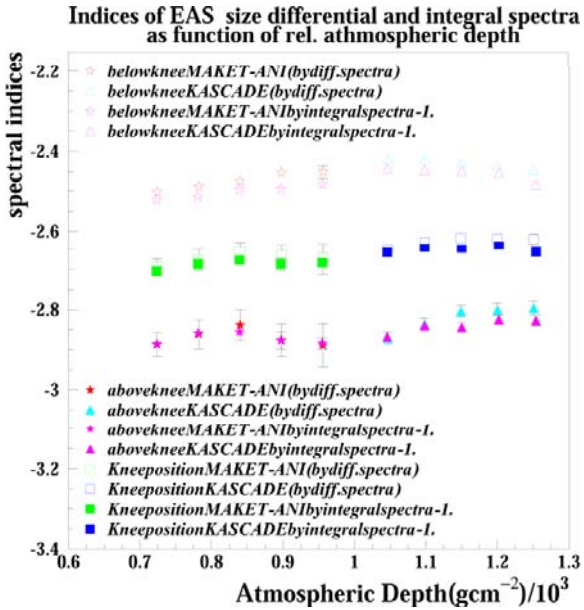
$E_{max} \sim 3 \times 10^{20}$ eV - max. obs. energy

$\delta_{cr} \sim 10^{-3}$ at 10^{12} - 10^{14} eV - anisotropy

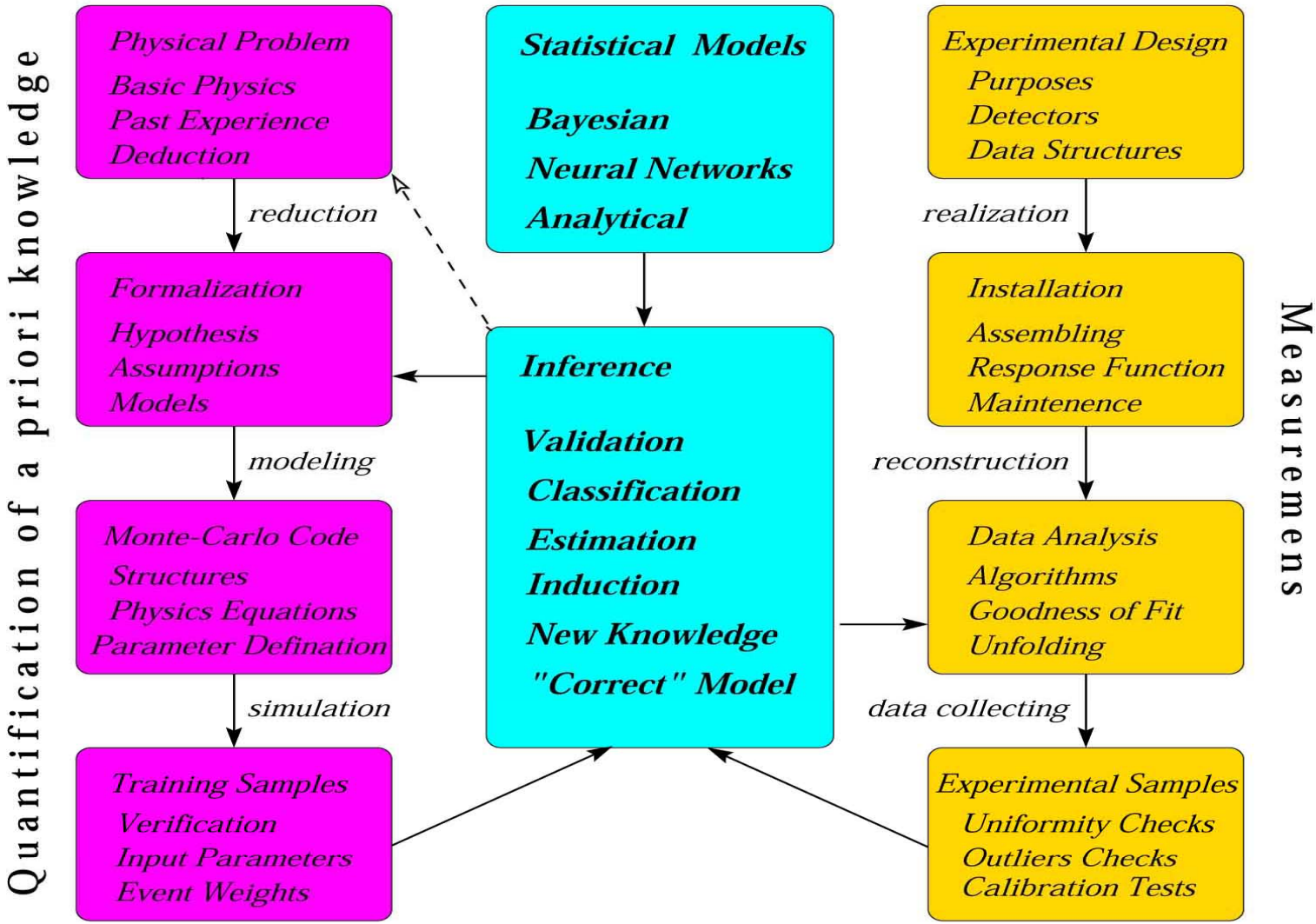
$r_g \sim 1 \cdot E/(Z \times 3 \times 10^{15}$ eV) pc - Larmor radius

Galactic Cosmic Rays

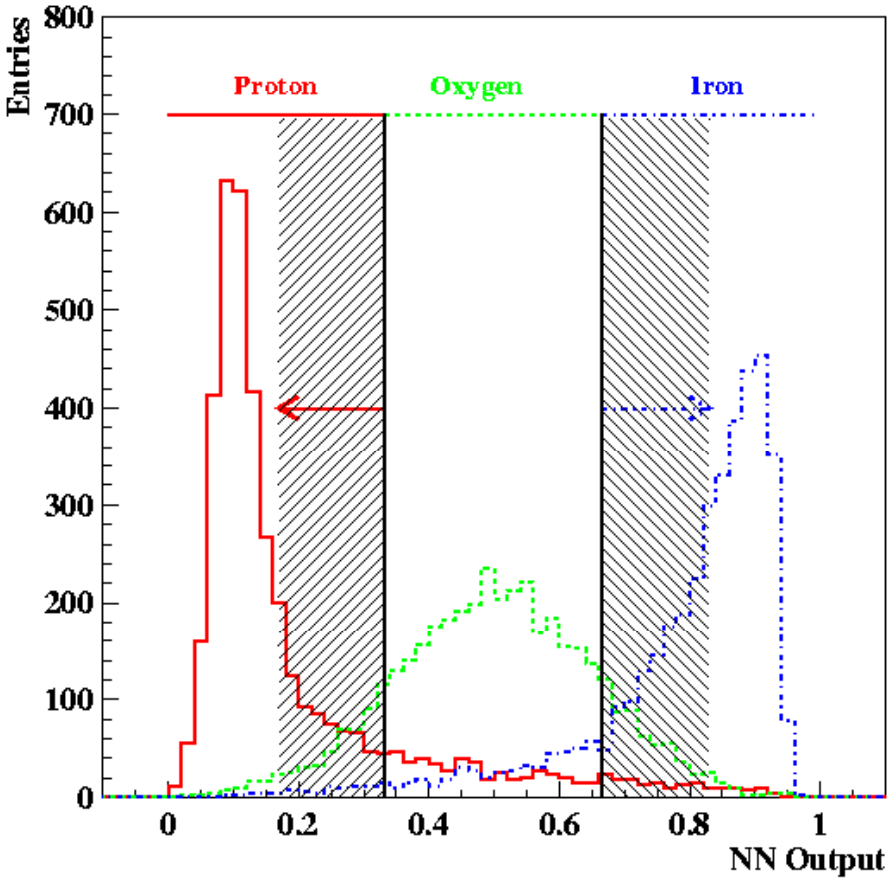


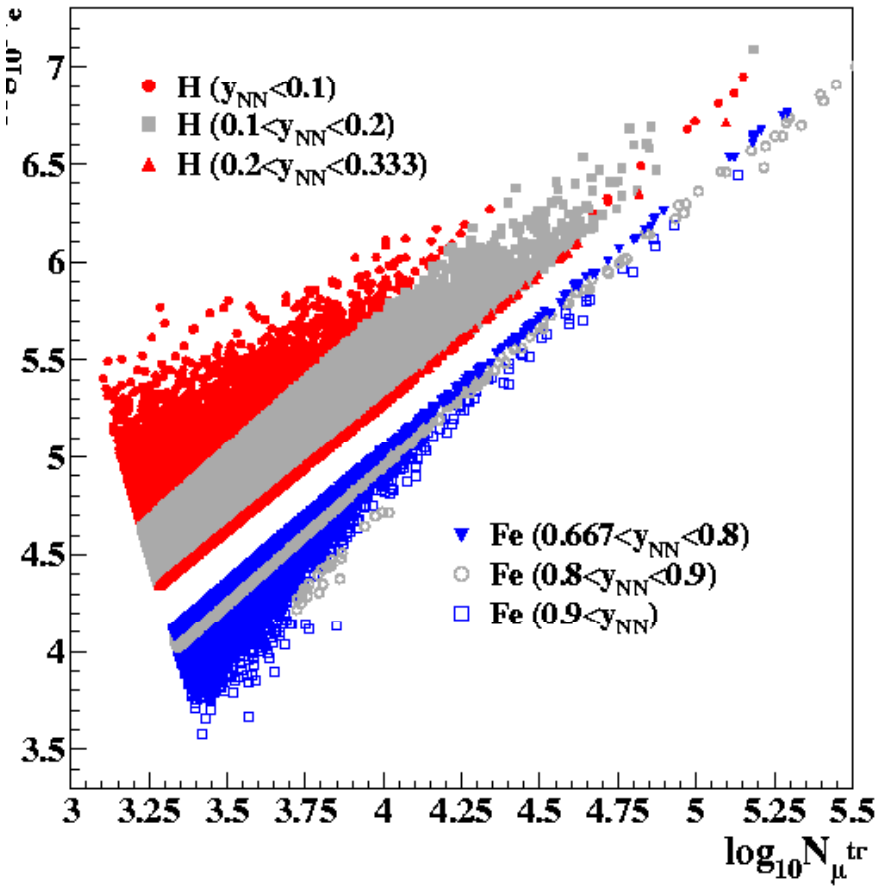


Monte Carlo Statistical Inference

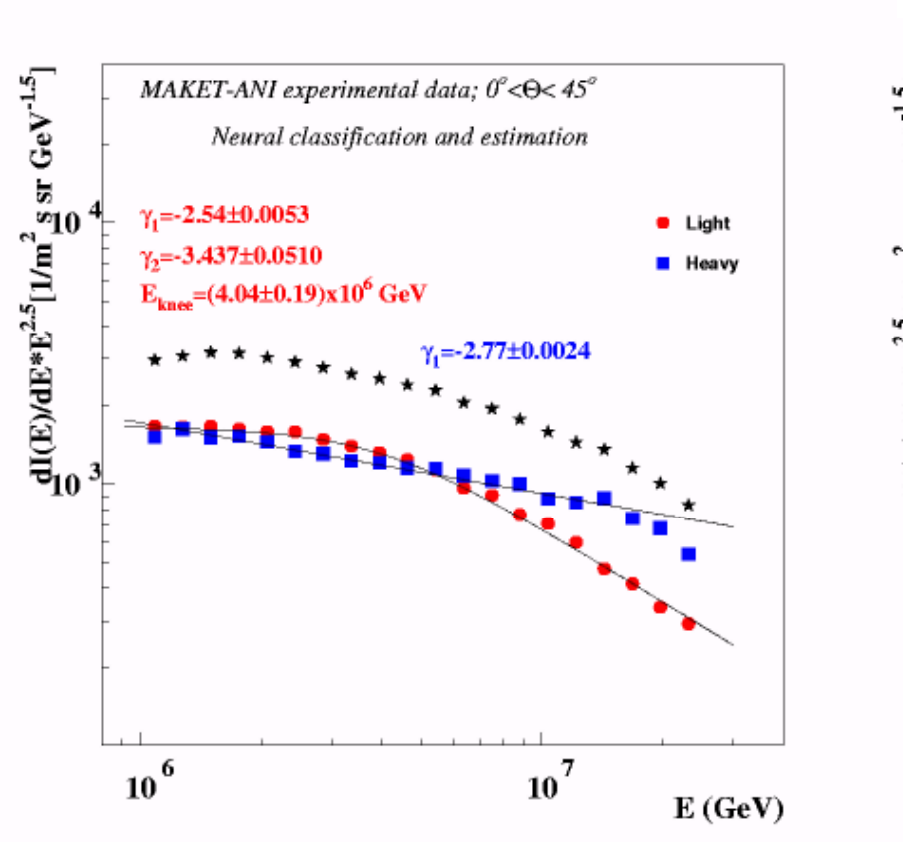


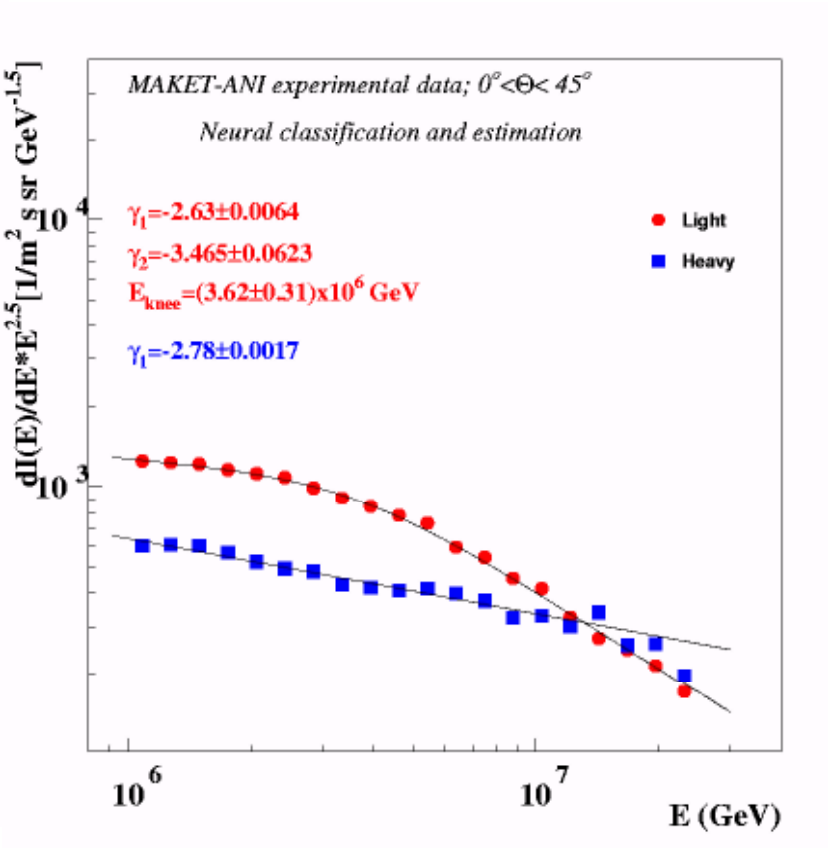
Separation of Cosmic Ray into 3 Nuclear groups by KASCADE Experiment



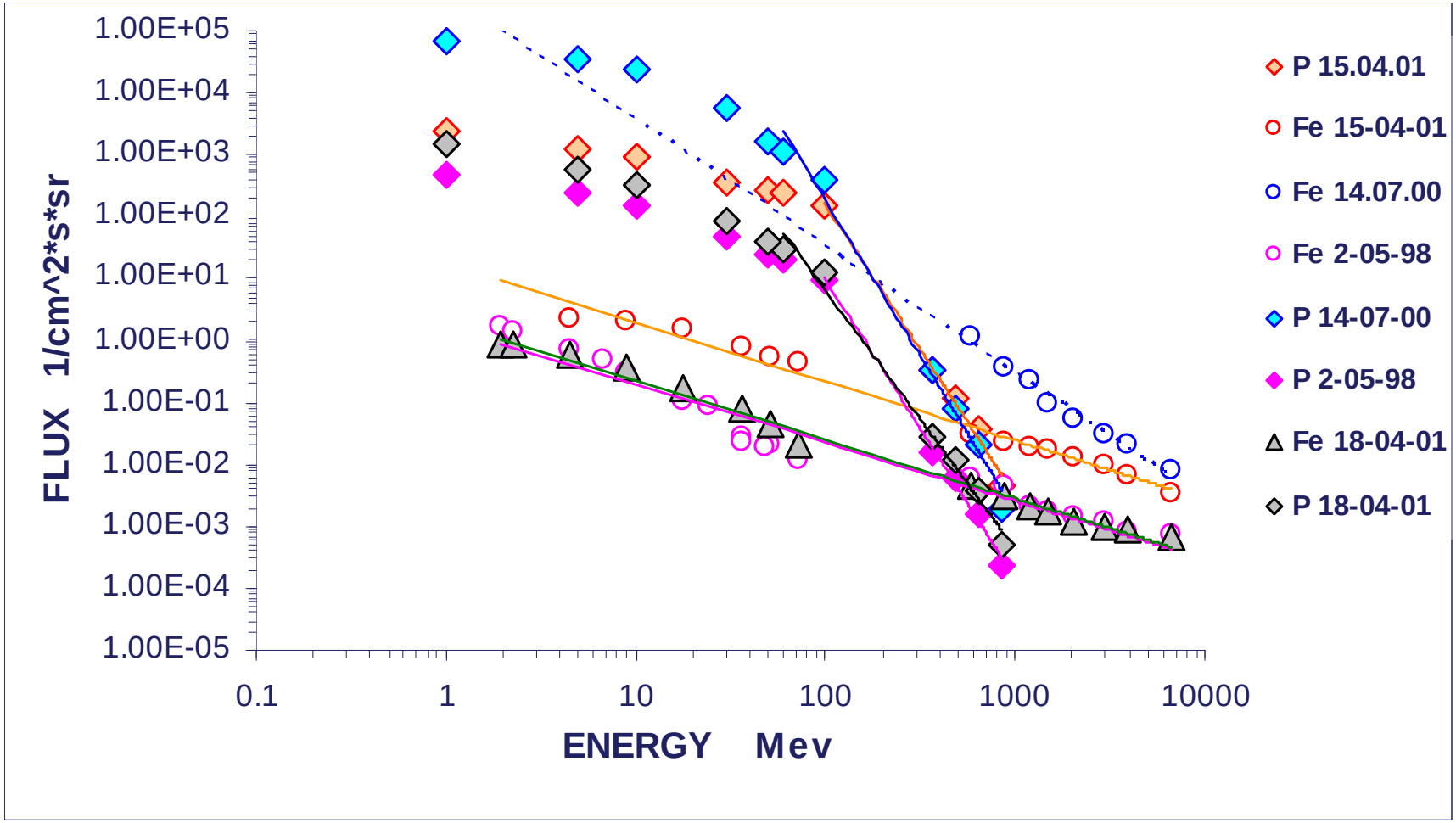


Light and Heavy Primaries, by MAKET-ANI Experiment





Spectral knees in Solar Ions
Fluxes of current 23-rd cycle



Current problems of the High Energy Astrophysics Studiers

- Modernization of the DAQ electronic of MAKET-ANI and GAMMA detectors;
- Preparation of detailed simulation data base electron, neutron and muon components of EAS;
- Measurements of the muon and neutron content of EAS;
- Crosschecks and calibration of obtained results on size spectra of light and heavy components;
- Comparative analysis of the primary and energy estimators based on consideration of different subsets of EAS parameters;
- Searches for the anisotropy of the CR flux;
- Joining efforts in EAS simulations and multivariate statistical methods will provide possibility to develop unique system of physical inference from sophisticated indirect experiments.

Space Weather can affect satellites

- For semiconductor microelectronics, the electric charge induced when a heavy ion passes through the part, or when particle has a nuclear interaction in the part, is often comparable with the spurious charge moving in device circuits. Thus, the device's state can be changed. This can result in various types of transient or permanent single event effects (SEE) such as upset, latchup or burnout of the device.
- Space weather can raise temperatures in the outer reaches of the atmosphere, causing the atmosphere to expand, snatch satellites from orbit by increasing drag.
- The other main danger to satellites is charging and electrical shorts caused by the magnetic activity and accelerated particles.

Space Weather can effect everyday lives

- Solar events occur at a magnitude of violent force and energy that equals the power of a billion hydrogen bombs, fortunately people on the ground are not at risk from solar storms, protected by the magnetosphere and atmosphere, but…
- space Storm Causes Power Outages, a power grid in Canada was tripped by a 1989 storm, and electricity to the entire province of Quebec was lost for about 9 hours;
- airline passenger can experience as much radiation as 10 chest X-rays elevated doses of radiation can be experienced on high-altitude flights, caused airlines to reroute commercial flights;
- radio communications were disrupted, at least two key U.S. communications satellites were disabled by solar weather in the late 1990s, causing failures in personal pagers, television broadcast and some airline traffic communications;
- increase the probability of latent cancer formation in the astronaut/space traveler cohort.

Space Weather Effects October-November 2003, Solar spot group 486

- Storm's magnetic orientation was southward, opposite to that of Earth's magnetic field. This opposing setup allows a storm to more intensely penetrate Earth's protective magnetosphere and to threaten satellites and ground communication systems;
- Japanese military satellites costing M140 USD lost;
- Residents of the International Space Station took cover from the storm for several 20-minute periods. They retreat to the Zvezda service module, where radiation protection is the best;
- The last wave was powerful enough to generate a magnetic storm all the way out to Saturn, almost ten times farther from the Sun than Earth is;
- Later this year the blast should reach the true edge of the solar system, some 4.8-6.4 billion kilometers beyond Voyager 1. There the storm will meet head-on with a heliopause and radio disturbances caused by that interaction then might be picked up by the Voyager craft, giving scientists their first measurement of where the edge really is;
- Today solar spot group 604 is of size of Jupiter and pose danger of very violent flares.

Protective actions after Space Weather Alert

- Satellite operators put satellites to sleep. They rotated some so vulnerable solar panels were better protected, and made arrangements to switch signals to backup satellites if necessary;
- elevated doses of radiation can be experienced on high-altitude flights, caused airlines to reroute commercial flights
- Astronauts should retreat to the most well-protected module

Surface Monitoring of the Secondary Cosmic Ray Fluxes

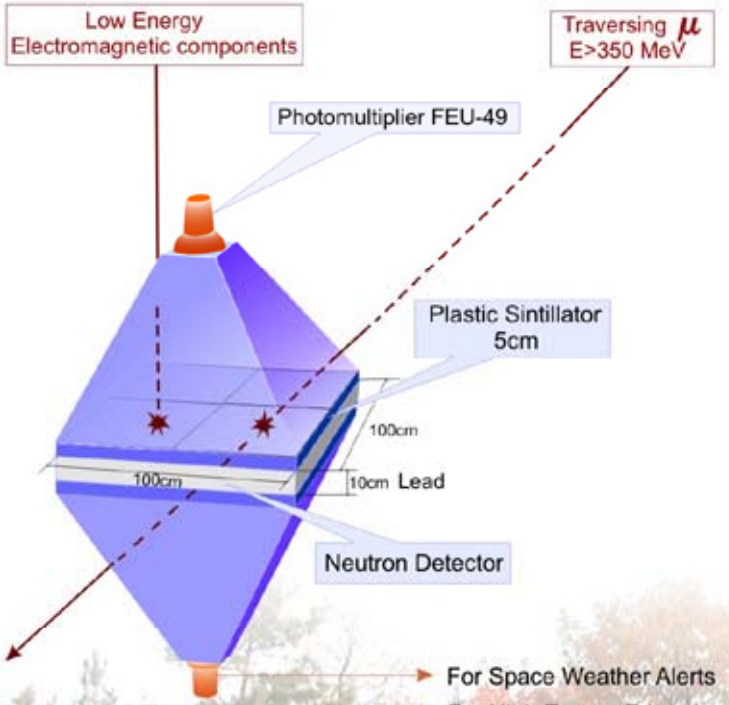
- Put a satellite closer to the Sun to predict a space storm's magnetic field earlier, but…
- Some instruments aboard SOHO were shut down during powerful flares to prevent damage. Others are operating at reduced capacity;
- Some devices produce less-than-perfect images because they get covered with "snow" that represents the charged particles streaming out from the Sun;
- Most energetic particles detected by surface monitors brings information about upcoming storms 10 hours prior shock arrival.

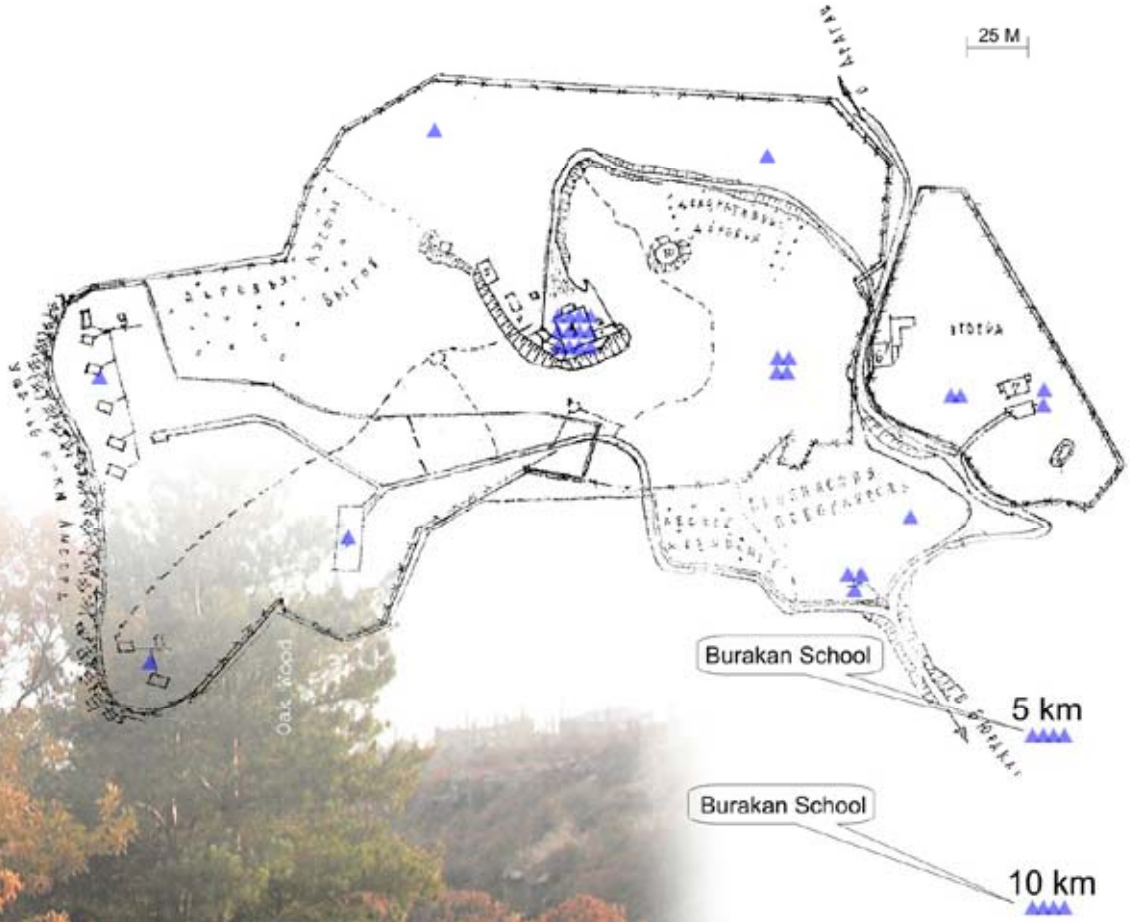
Neutron Monitors World-Wide Network

Aragats Space-Environmental Center

- Measure as much as possible secondary CR fluxes with different energy thresholds;
- Monitor not only changing count rates, but also correlations between changing CR fluxes;
- Measure directional information;
- Use same detectors for both SW and high energy CR studies;
- Perform simulation of the time-series registered by the ASEC monitors;
- Correlate surface and space-born detectors data assessable from the Internert;
- Be part of world-wide networks;
- Provide forecasting and alerts on severe conditions of the SW.

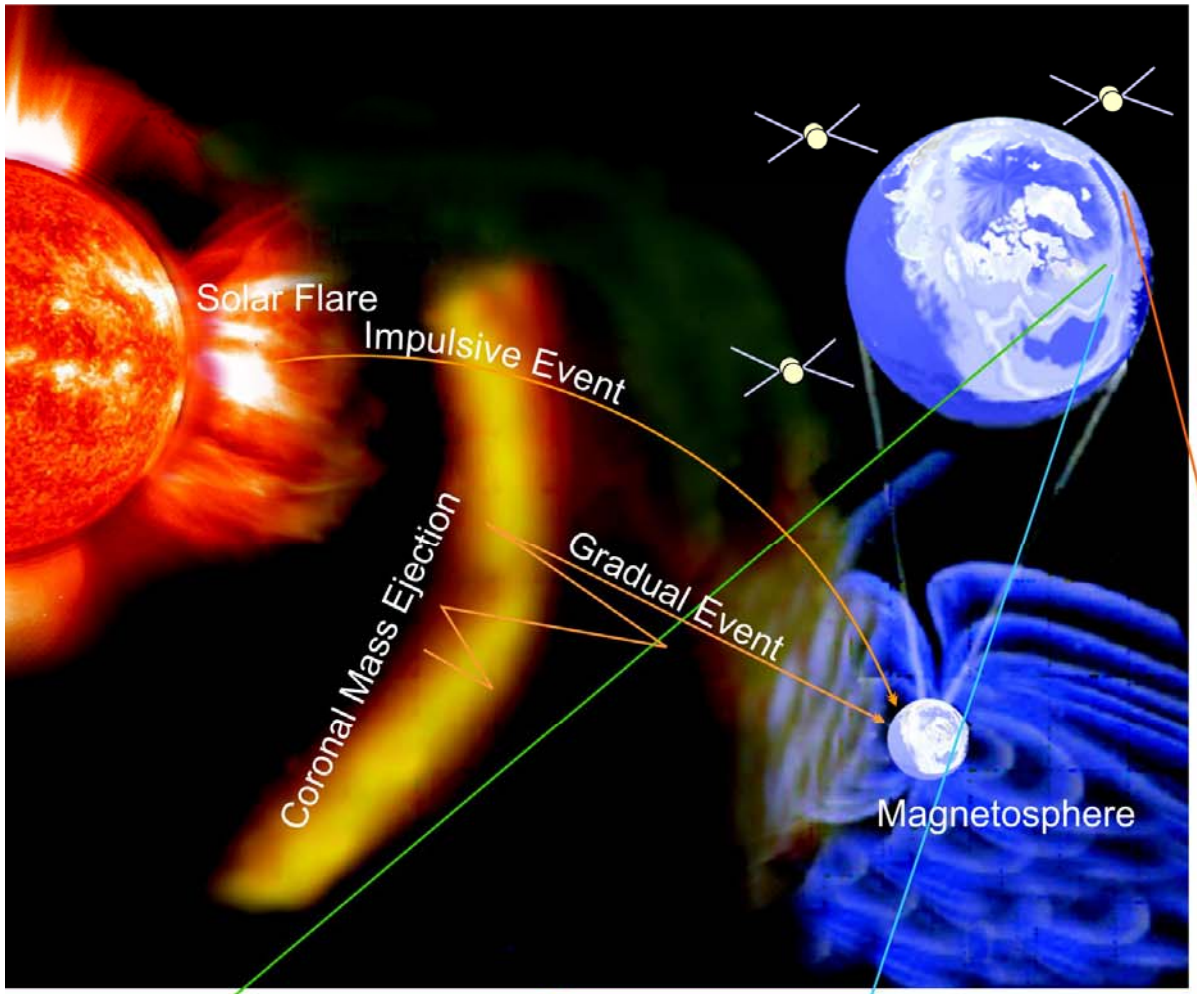
Nor - Amberd Detector for Space Weather and High Energy Astrophysics Studies

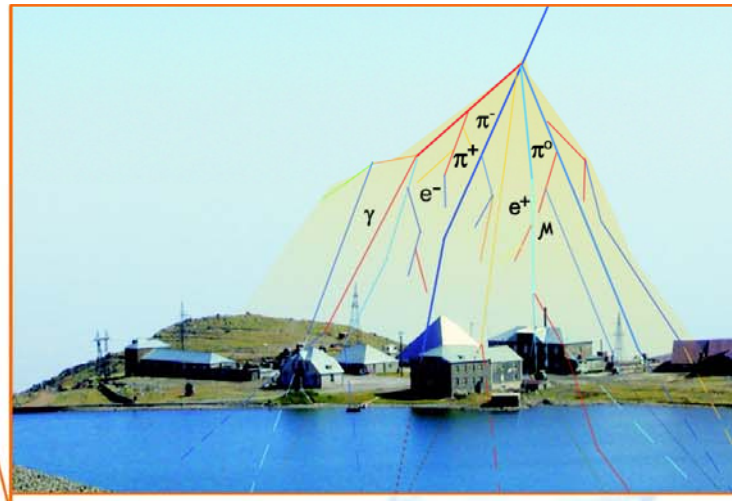




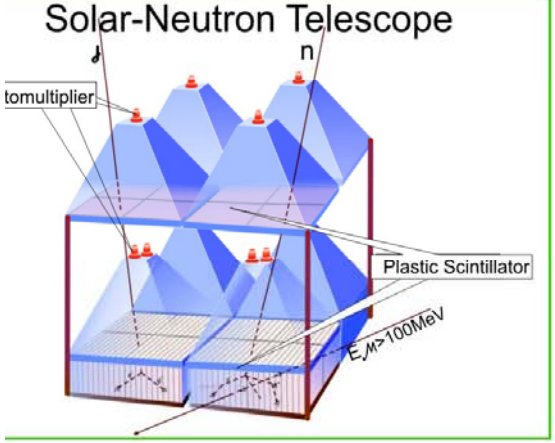
Concluding Remarks

- Most of technical progress in 21 century will come from Space Operations;
- New Space vision has Space Weather research and forecasting as a vital element for Space Operations;
- Information from networks of surface based detectors measuring secondary cosmic rays are compatible to data from space-born particle detectors and can be used for the reliable and timely SW forecasting;
- Developing countries should be a part of such networks to participate in the exploration of the Solar System and Universe;
- Necessary equipment is rather cheap and can be installed in scientific and educational institutions, schools, to make Space Research and Physics interesting and important for new generations

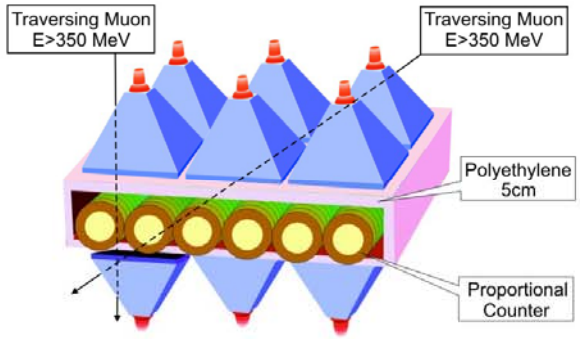




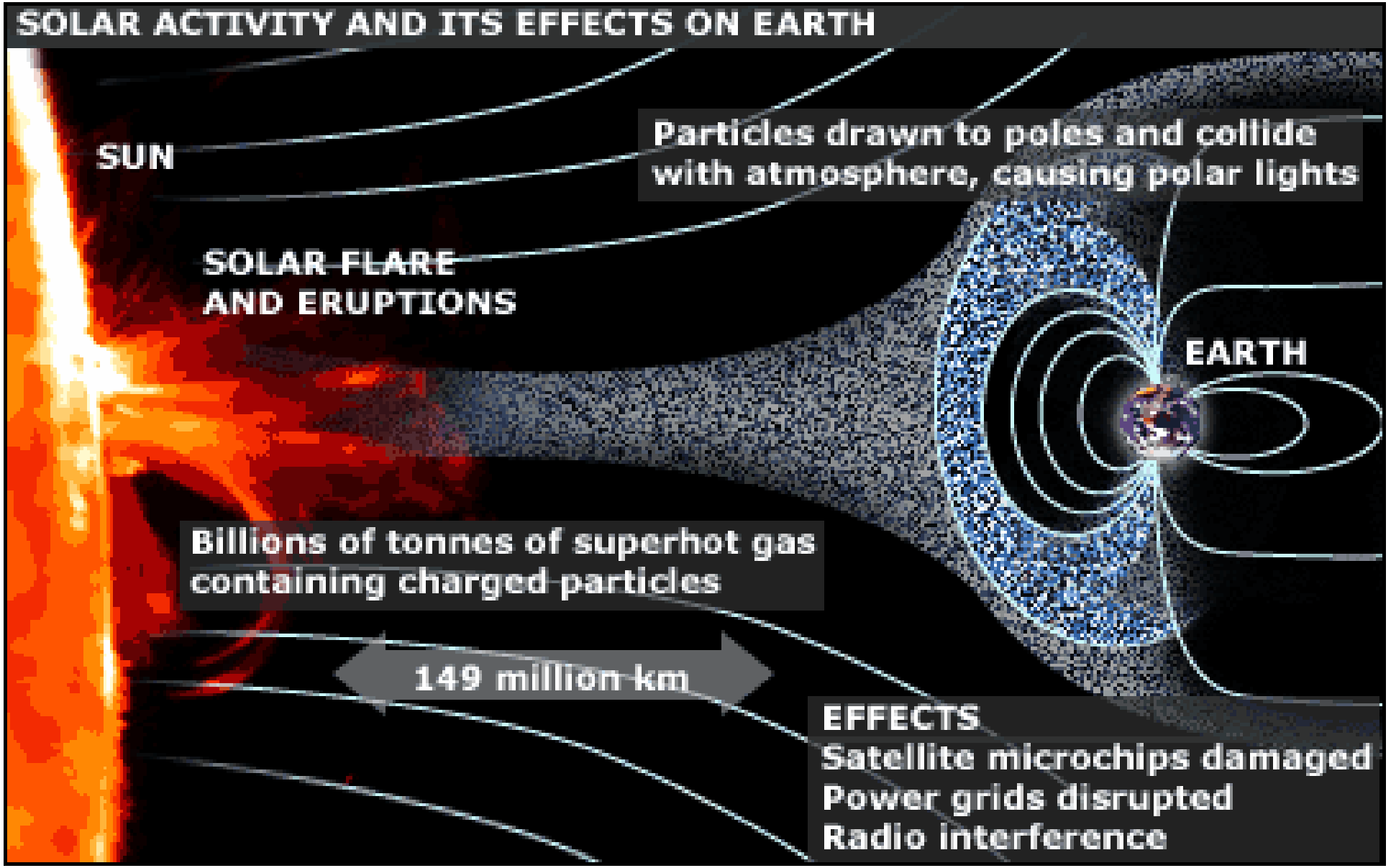
Solar-Neutron Telescope

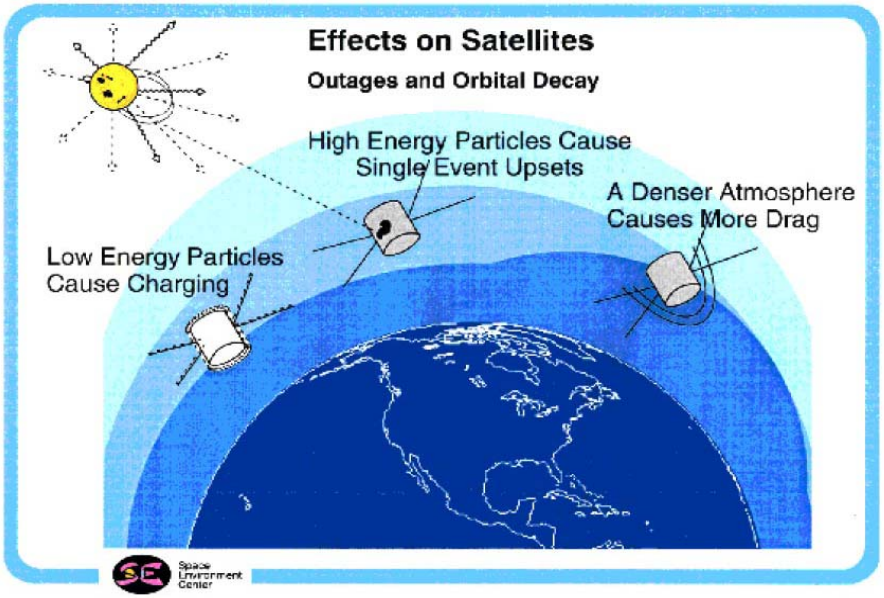


Nor-Amberd Multidirectional Muon Monitor

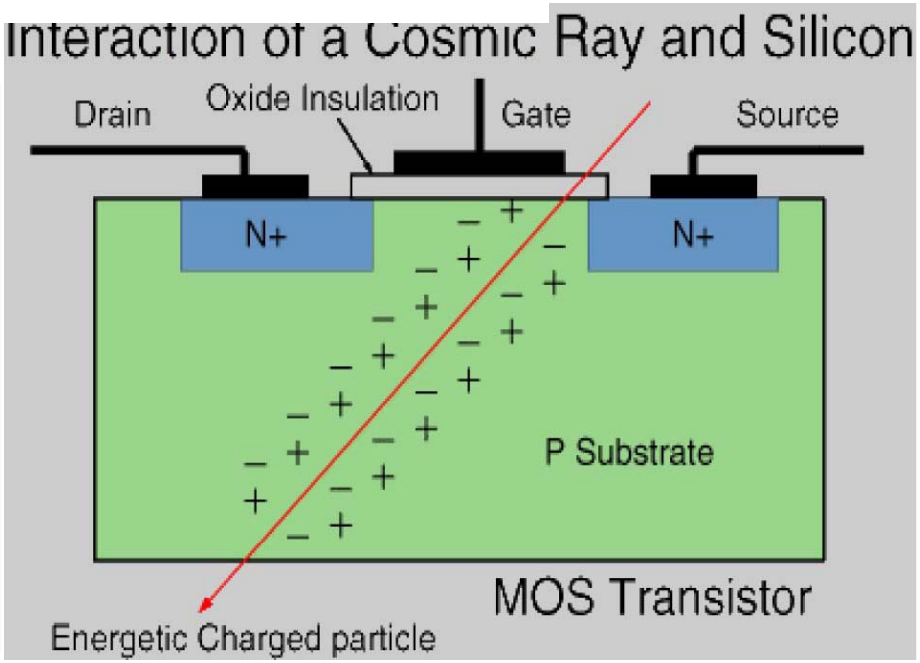


High energy cosmic rays open a window for the exploration of the d and forceful processes in the far-corners of the universe. The A Space-Environmental Center (ASEC) of the Cosmic Ray Division in Ar http://crdlx5.yerphi.am, conducts research in the field of Galactic Cosmi and Solar Physics. The two research stations, at 3200m and 2000m el on Mt. Aragats, are equipped with modern scientific detectors and instr which allow the scientists to make new discoveries in high energy astrop The ASEC explores the activity of our own star, the Sun, and is dev Space Weather forecasting and early warning systems and technique strategic geographic coordinates of the ASEC research stations and the based particle detector systems developed by the ASEC scientists, c with data from detectors in space and on the ground, will allow the inter community to develop a reliable and global Space Weather forecasting to protect astronauts and satellites in space and power grids on the grou

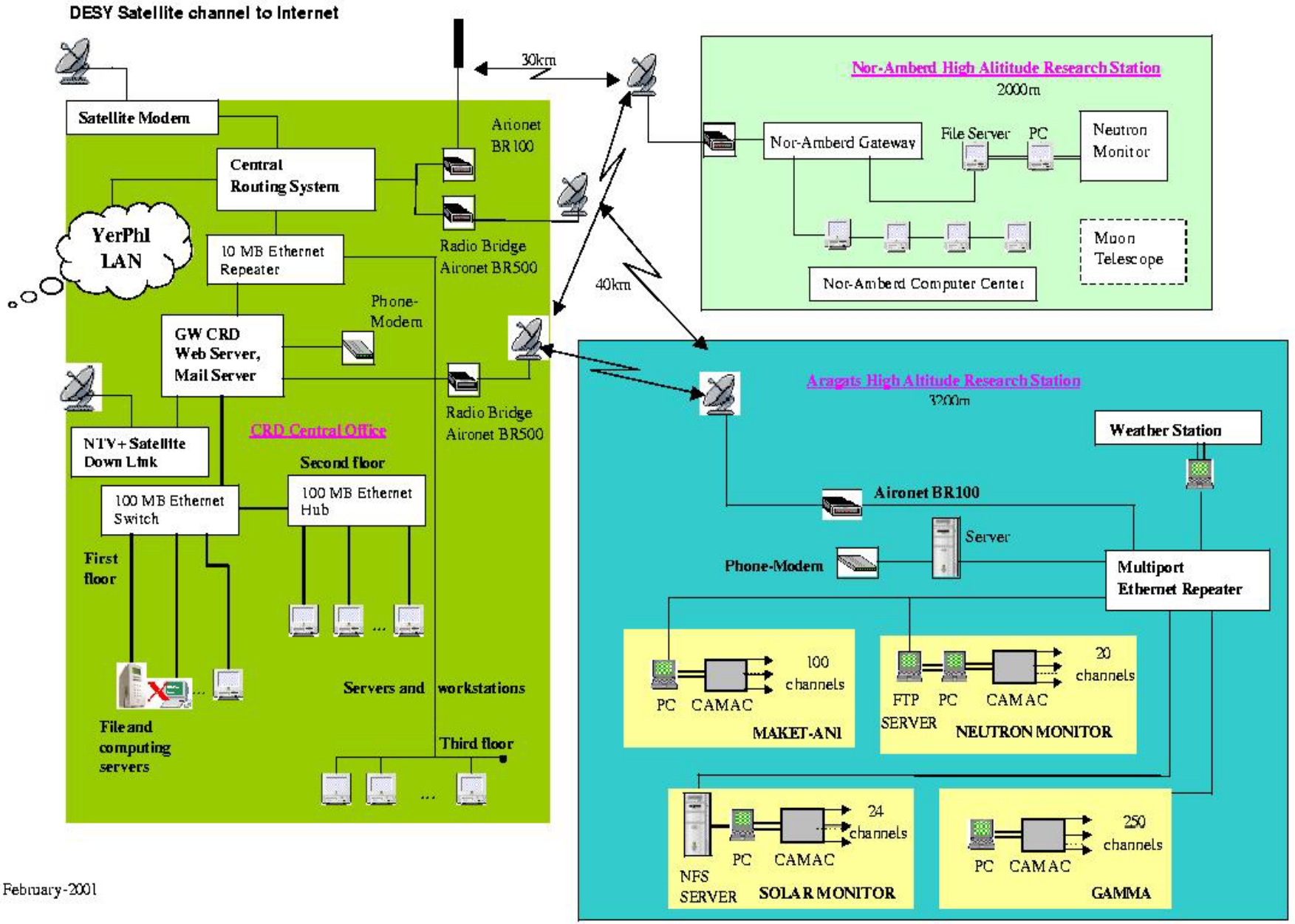

SOLAR ACTIVITY AND ITS EFFECTS ON EARTH
SUN
Particles drawn to poles and collide with atmosphere, causing polar lights
SOLAR FLARE AND ERUPTIONS
EARTH
Billions of tonnes of superhot gas containing charged particles
149 million km
EFFECTS
Satellite microchips damaged
Power grids disrupted
Radio interference


Effects on Satellites
Outages and Orbital Decay
High Energy Particles Cause
Single Event Upsets
A Denser Atmosphere
Causes More Drag
Low Energy Particles
Cause Charging
Space Environment Center


PJM Public Service
Step Up Transformer
Severe internal damage caused by
the space storm of 13 March, 1989.

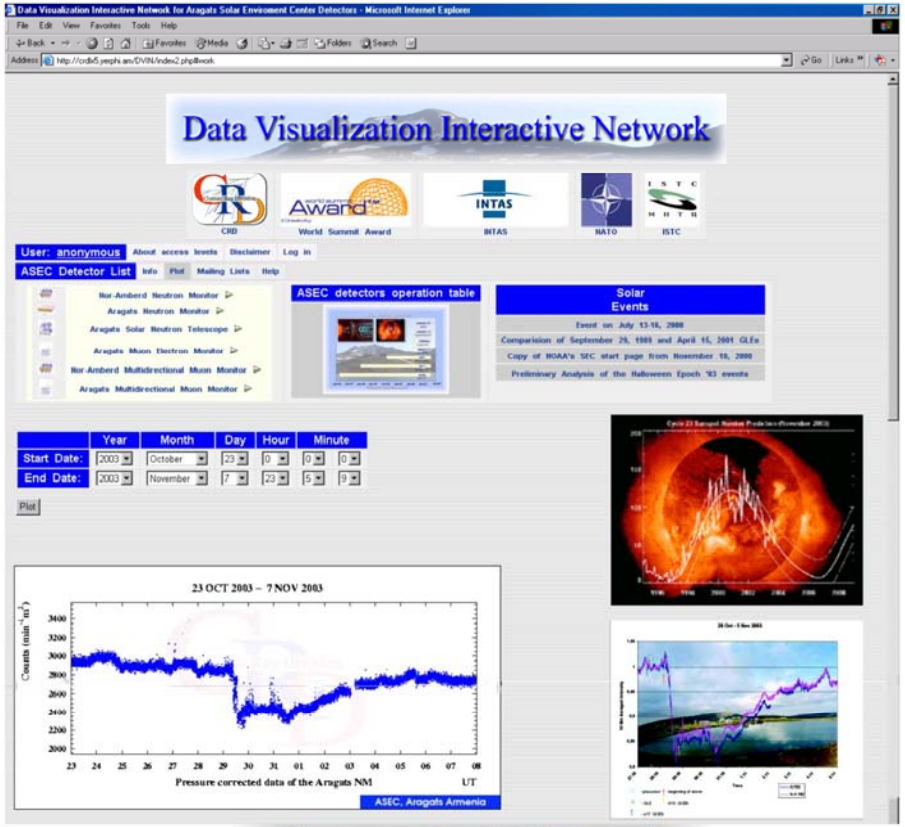

Interaction of a Cosmic Ray and Silicon
Drain
Oxide Insulation
Gate
Source
N+
N+
P Substrate
MOS Transistor
Energetic Charged particle

Structure of the CRD Local Area Network

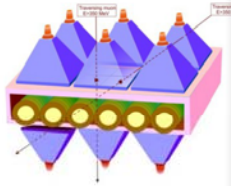


February-2001

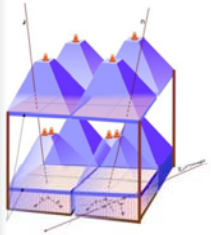
The Data Visualization Interactive Network (DVIN) of the Aragats Space-Environmental Center (ASEC) has been elected by the World Summit Award Grand Jury from 803 nominations presented by 136 countries as one of the 5 best projects in the category of e-Science.



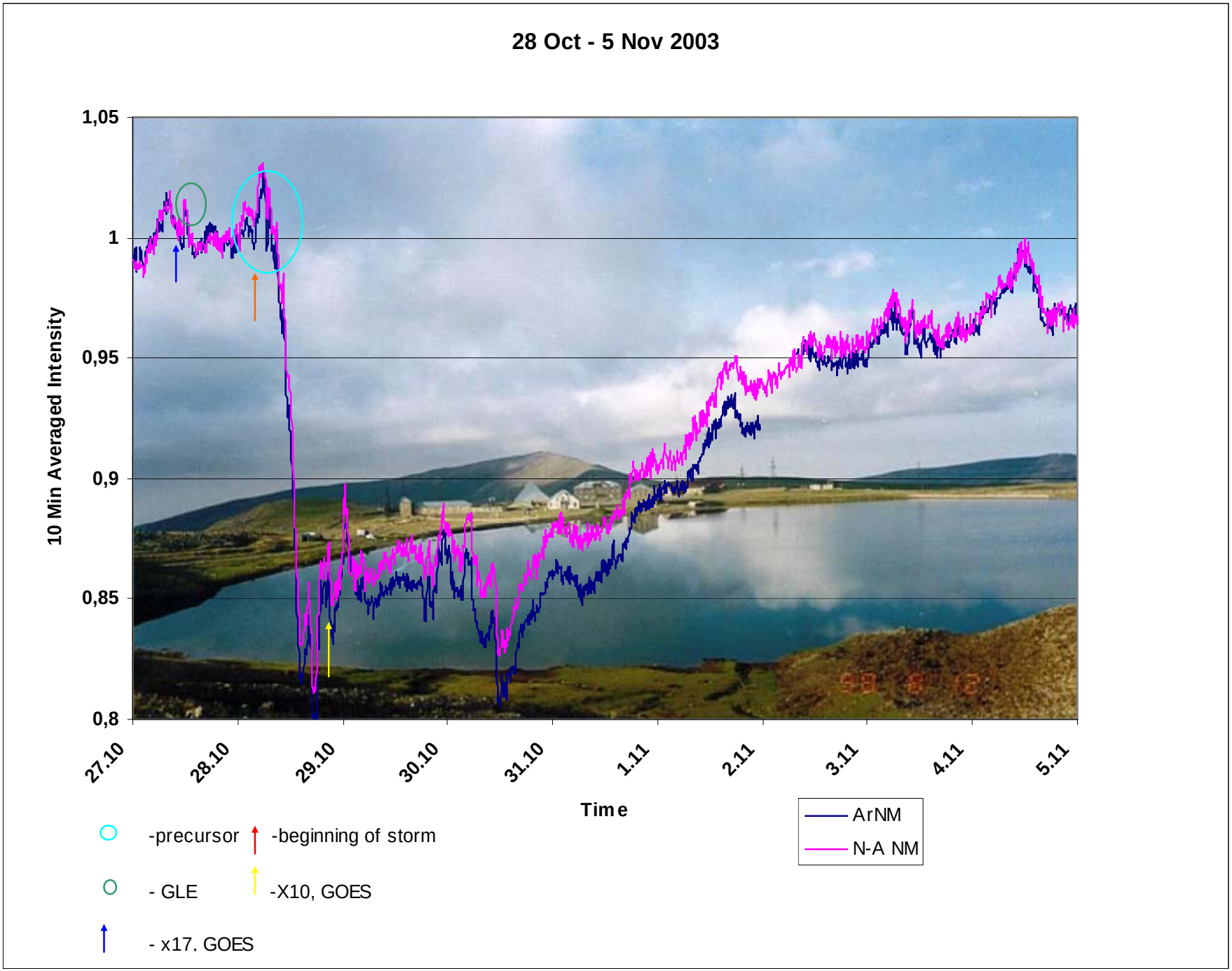
Nor- Amberd Multidirectional Muon Monitor



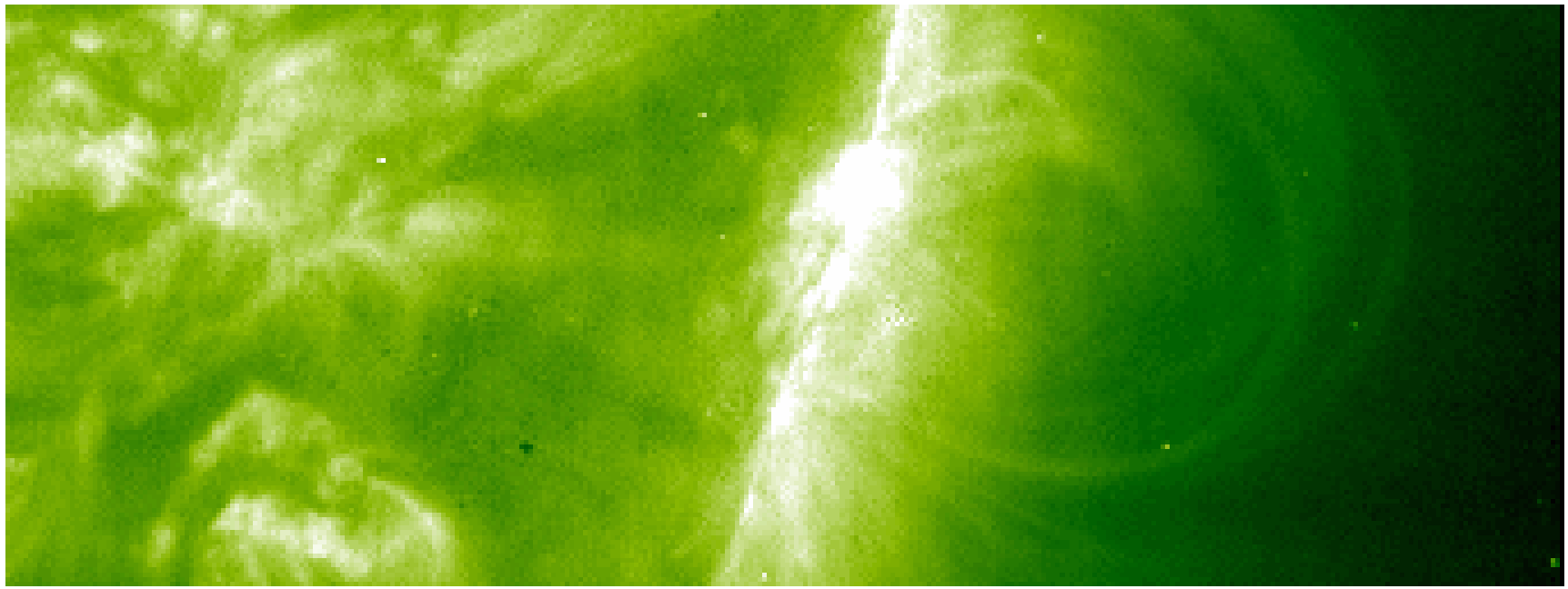
Aragats Solar Neutron Telescope



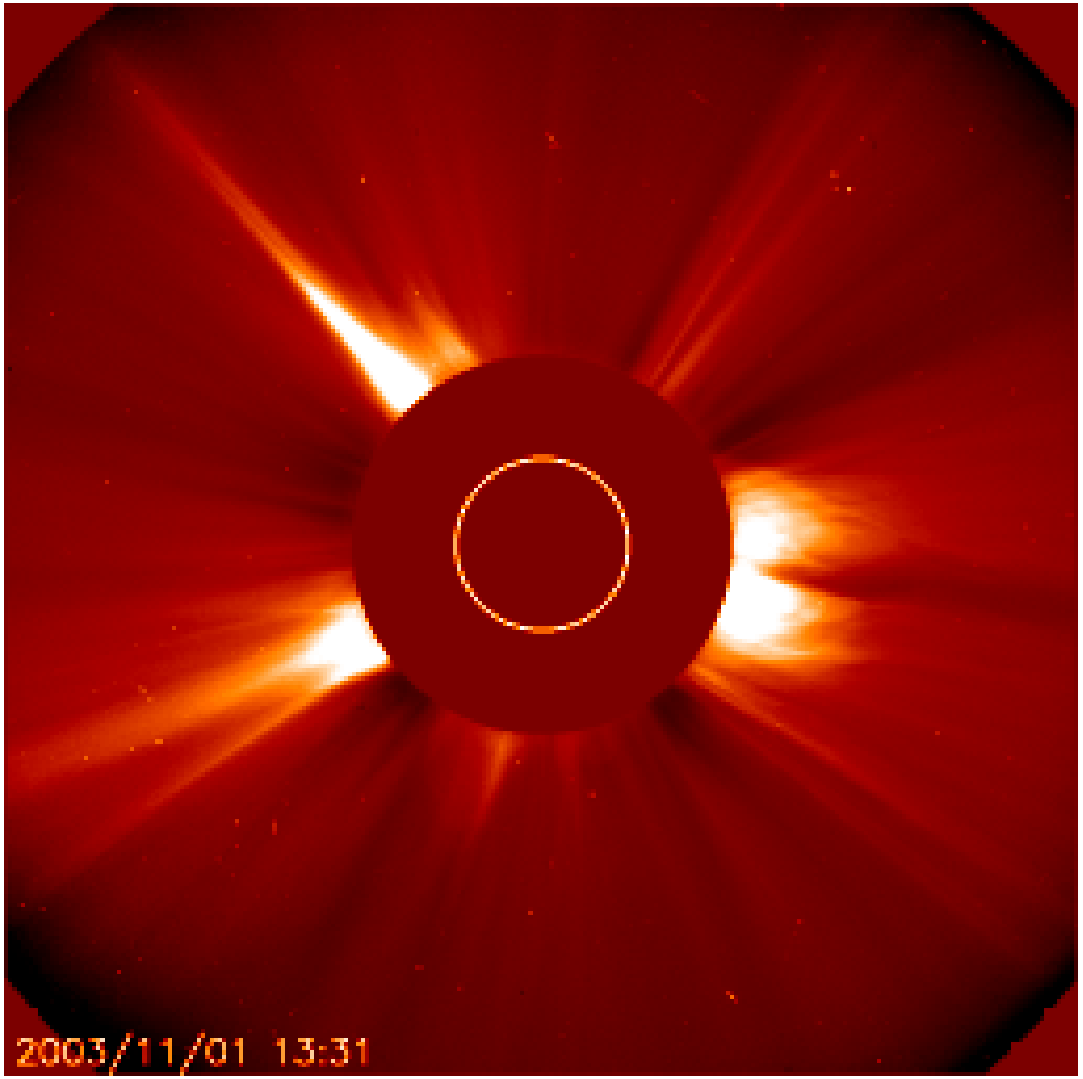
Cosmic Ray Division of Yerevan Physics Institute, Alikhanian Brothers 2, 375036 Yerevan36, Armenia. Tel. +3741-34-43-77, ASEC@crdlx5.yerphi.am
http://crdlx5.yerphi.am


28 Oct - 5 Nov 2003
1,05
1
0,95
0,9
0,85
0,8
10 Min Averaged Intensity
27.10
28.10
29.10
30.10
31.10
1.11
2.11
3.11
4.11
5.11
Time
ArNM
N-A NM
-precursor
-beginning of storm
- GLE
-X10, GOES
- x17. GOES

November 4 >X20 = X45 flare



Strongest Flare of Satellite Era



Solar Physics Space Weather Research

- Development of the operational models, describing solar energetic event. Estimation of particle arrival times and intensities of ion flux in vicinity of Earth.
- Performing multiple simulations of the particle traversal through atmosphere and detectors. Preparing of data bases for alternative input values of modeling algorithm, covering important energy ranges and particle types. Estimation of the detector response for different species of primary flux for the prototype detectors.
- Development of the Neural Network stochastic training algorithms. Improving of the multidimensional probability density estimation algorithms for the Bayesian decision making.
- Development of the advanced data processing and forecasting software. Establishing of data bases attached to the Internet portal with fast access modes. Development of the fast-computing system for enhanced collaborative environments and enhanced data sharing. Development of the data visualization and 3-dimensional data display. Mutual display of the surface and space detector data. Development of the methodology of fast comparisons and joint analysis of the space/ground astrophysical data.
- Modernization of ASEC experimental facilities allowing for precise correlated measurement of the different characteristic of electron, muon and neutron fluxes. Development of the fast microprocessor based electronics. Design and producing of printed circuit boards, high voltage power supplies and analog-to-digital converters. Installing of new on-line computers and powerful servers.
- Detection of the time series of the electron, muon and neutron fluxes. Investigation of the directional correlations of detected enhancements. Estimation of the significance of the detected peaks in time series of ASEC monitors.
- Investigations of the correlations of ASEC monitors count rate enhancements

CRD contribution to the world-biggest MAGIC Atmosperic Cherenkov Telescope

- Design and installation of the new "in-situ" programming software for the Active Mirror Control System;
- Improvement and maintenance of the hardware and software of the existing AMC system;
- Design of the new hardware and software for the AMC system of the
- MAGIC-Clone project;
- Exploring gamma ray fluxes from nearby SNR;
- Participation in data analysis and development of new methods of hadronic background rejection;
- Investigating of the MAGIC possibilities in new emerging field of Space Weather.

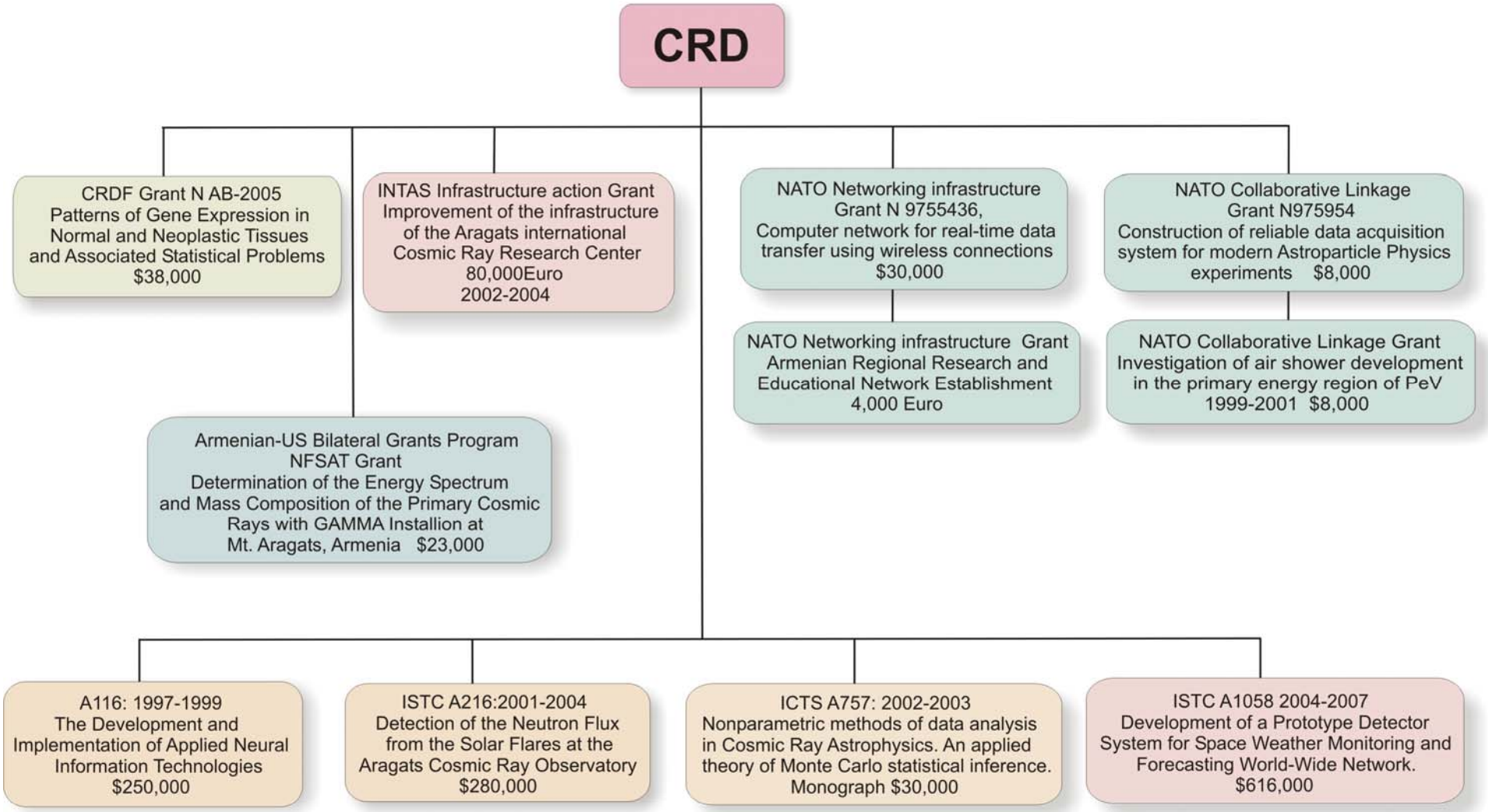
Cosmic Ray Division Research Profile

- Cosmic Ray Astrophysics – Research of Cosmic Ray Sources and Acceleration Mechanisms by ground based surface detectors.
- Solar Energetic Particles –Detection on Earth by Low Latitudes neutron monitors and muon telescopes and study of SEP acceleration and transport.
- Monitoring and Forecasting of the Space Weather.
- Investigation of Modulation Effects of Coronal Mass Ejections
- Multivariate Data Analysis - Monte Carlo

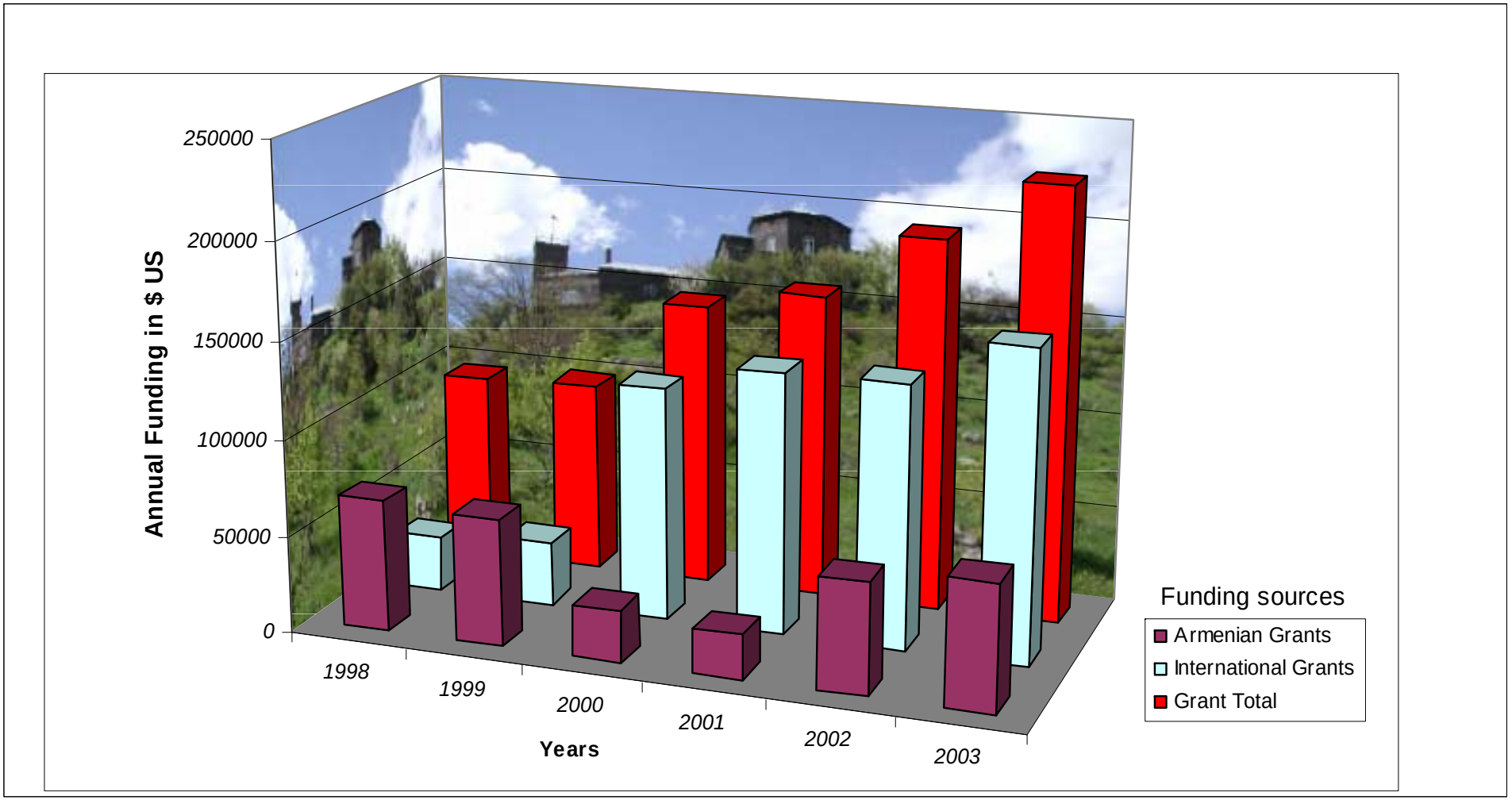
Cosmic Ray Division Advantages

- Broad research profile, included Galactic and Solar Cosmic Rays, Space Weather
- Experienced Scientific and technical staff, with a rich historic background and continuing future development.
- Favored altitude and geographic coordinates for signal to noise ratio enhancement (3200 m, 2000 m, N40º30’)
- Developed infrastructure allowing year-round operation.
- Reliable large area ground based detectors for various species of CR
- Recently added directional measurements of arriving CR
- Current Networking and Computing Facilities
- Transitioning to advanced microchip based Data Acquisitions Systems.
- Accurate GPS based timing systems to allow correlation of data from Space borne detectors and the Aragats large area ground based detectors.
- Developed and continuously upgraded multivariate data analysis methods
- Applications to other non-cosmic ray related fields such as Gene Expression Analysis, process optimization, etc.
- DVIN - interactive data analysis platform, winner of the World Summit on Information Society 2003 e-science category.
- Wide international scientific connections and collaborations.
- Inclusion of Yerevan State University undergraduate and graduate students in the CRD Research and Development programs.
- Very modest Annual funding required, ~ 500 000 USD per year which

Cosmic Ray Division International Projects



Cosmic Ray Division Funding in 1998-2003



Nor Amberd Research Station

Aragats Research Station

Opening of the Road to Aragats, May, 2003

Arctic Cat Snowmobile for risqué operations, present of USA Armenians

Moving of Aragats Neutron Monitor (ANM)

In 2002 ANM (40 ton of equipment) was moved from destroying beyond repair old building to the main experimental building. It not only risqué the unique facility, but also enables possibility to solve very important problem - measure neutron content of Extensive Air Showers. On the pictures the phases of monitor installation are displayed – the operation of ANM wasn't stopped during moving due to violent sun conditions, producing extremely interesting events, registered by Aragats monitors.

Enforcement of the MAKET Building

The MAKET building hosted 3 solar monitors and MAKET-ANI EAS facility. The major repair in 2002 consists in enforcement of the sough wall and enforcing the foundation and corners of the northern side. Also new control room was constructed inside the building.

Repairs and Settlement of Power Generators and Tractor

Two new power generators were installed at Aragats in 2002, enabling uninterruptible operation of all Aragats monitors. The bulldozers used for the Winter transportations were repaired.

Transformer Exchange: 35:0.2 to 35:0.4

The power supply of Aragats station was changed to new 220 v standard from old fashioned 123 v standard. 2 Power transformers working at station since 1956 were modernized and reinstalled. Cabling was revised and improved. Several transformers necessary for changing 0.2:0.4 was abolished and electrical scheme became more simple reliable.

Repaired Rooms in Nor-Ambered Research Station

Wood workshop

Repair of the Roof of Main Experimental Building

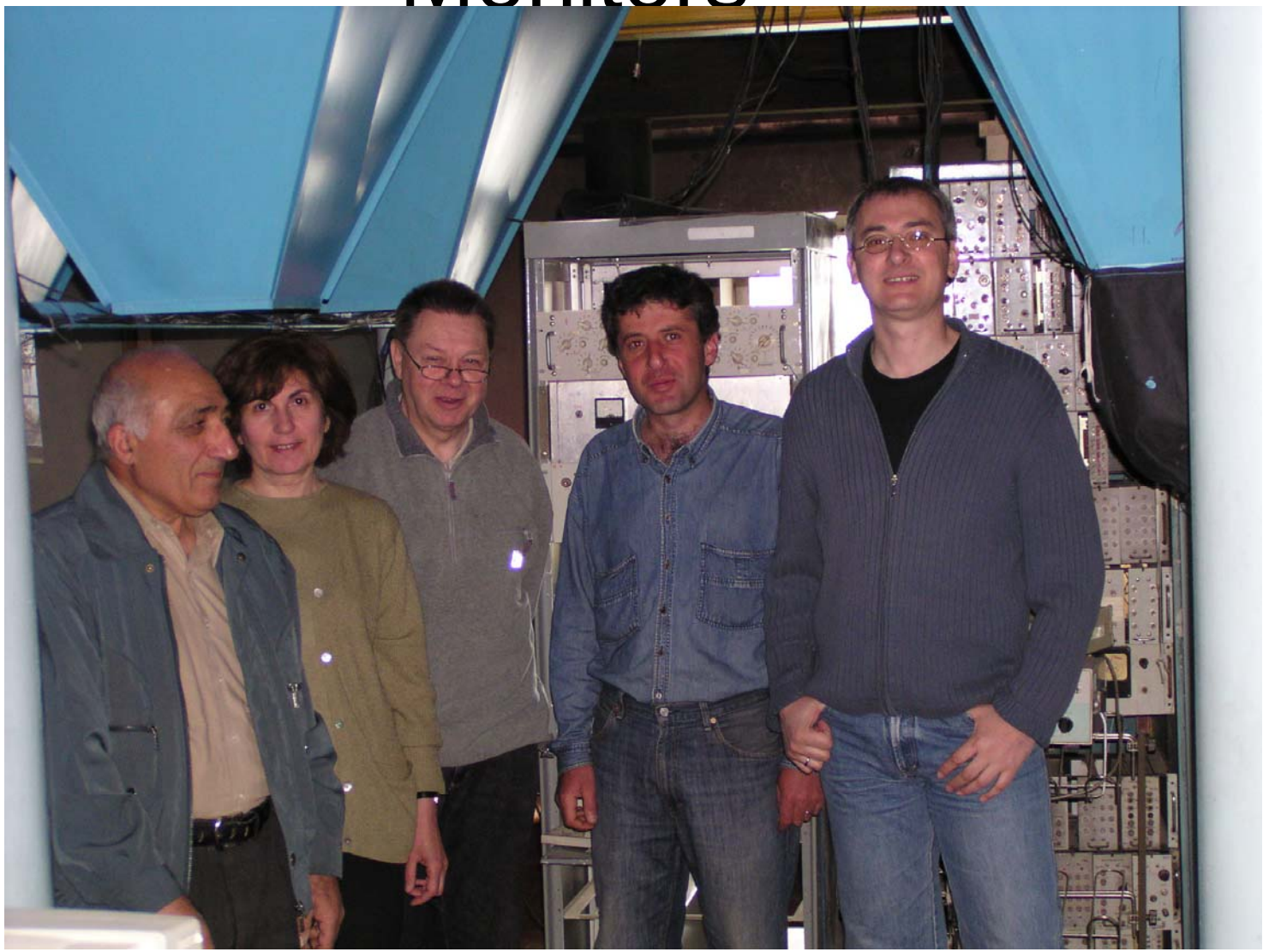
Still to be done…

The northern wall of Pion building is destroying, the Muon building is in very bad shape. In 2003 we plan to make necessary repairs for this and other Aragats station facilities.

CERN High Energy Physics School,
Nor Amberd, September 2003

Visitors from DESY and Lebedev Institute in Underground Hall of ANI experiment

Delegation from KASCADE Experiment at Nor Amberd Solar Monitors



Visitors fro the USA Embassy