Physics Activities in Armenia-Germany collaborations.
ARBRA 2018 4-8 June 2018
Summer School & Contact Fair

Astro-particle physics
Geo-particle physics

Aragats Cosmic Ray research center, Armenia, 3200 m above sea level, established in 1942- 75 years of continuous Cosmic Ray detection!.

Particle physics techniques in Planetary and Atmospheric physics

- Solar energetic particles, Space Weather & Space climate;
- Thunderstorm Ground Enhancements (TGE) monitoring of of gamma rays, electrons and neutrons by networks of particle detectors, field meters and meteo stations;
- Atmospheric electricity, Global Electrical circuit, Vertical and horizontal cloud electrification, stochastic charging;
- Atmospheric discharges, Lightning initiation;
- Solar-terrestrial connections, global change;
- **GEO-PARTICLE:** EAS and IACT exp., Carbon dating, Seismic precursors, Aircraft safety, etc…

First expedition to Aragats in 1942: Investigating of the Attenuation of Cosmic Rays in Water

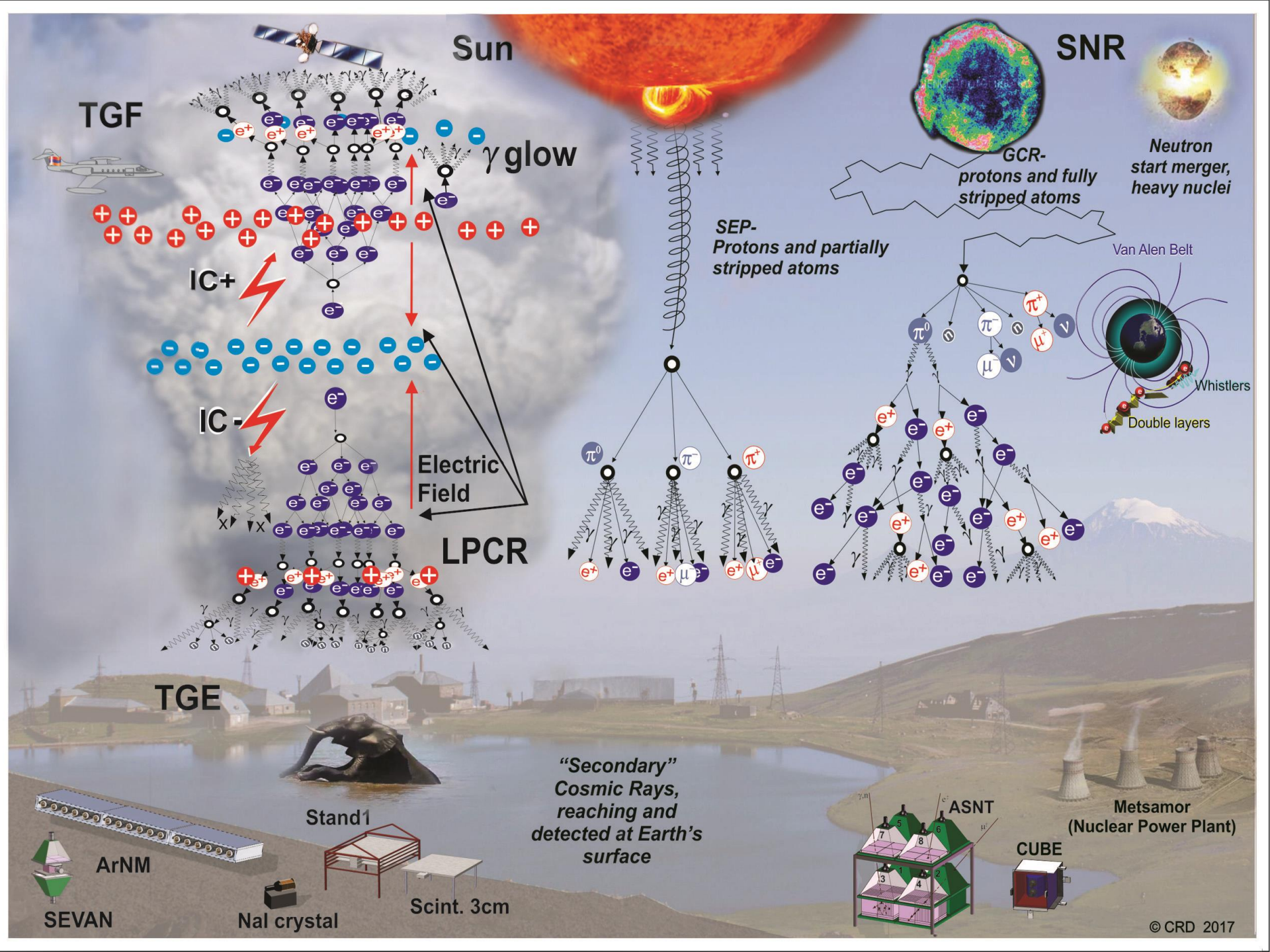
(T.L.Asatiani, born on 12 March 2018)

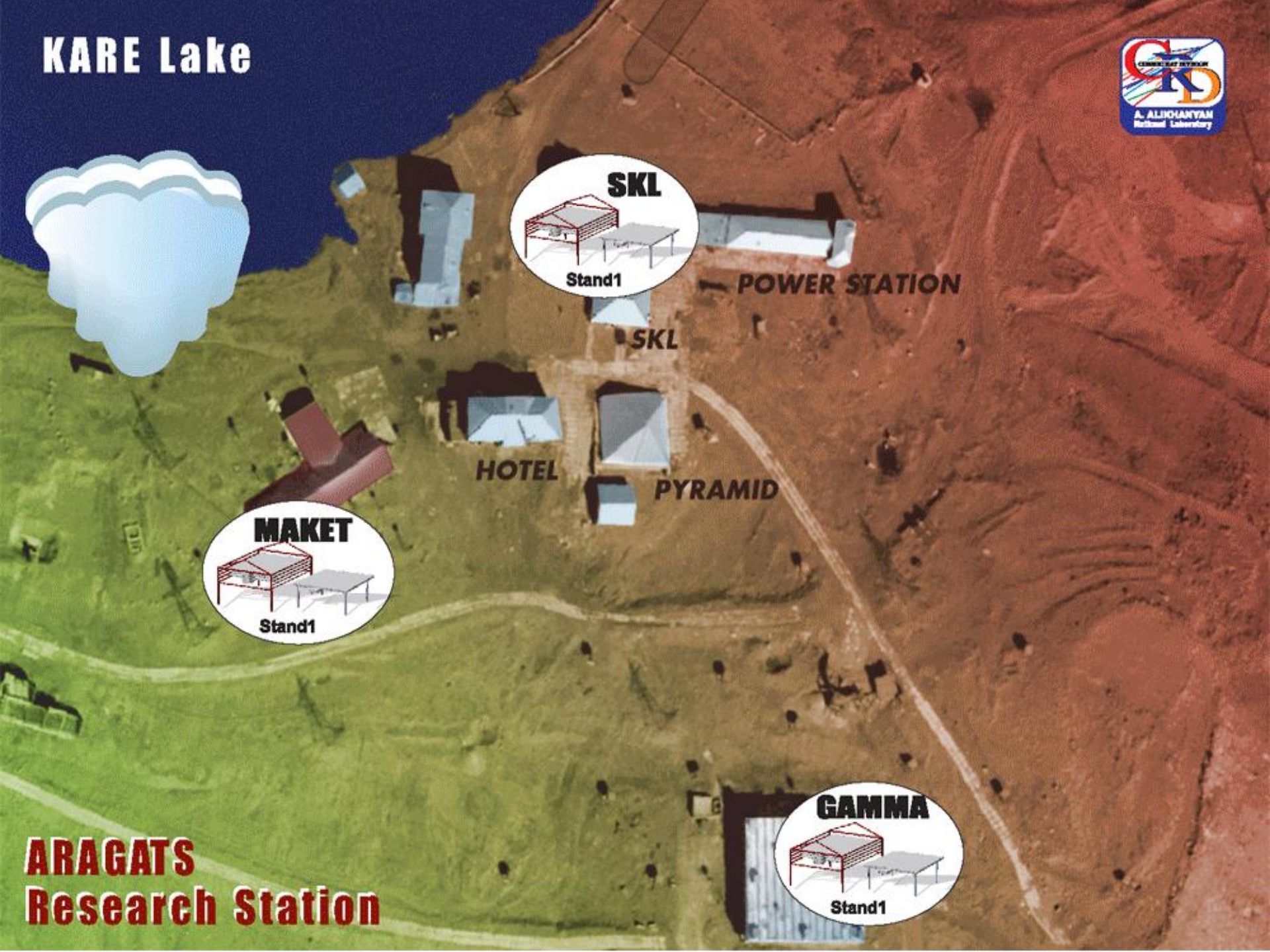
A.Chilingarian, R. Mirzoyan and M. Zazyan,
Cosmic Ray research in Armenia,
Advances in Space Research 44 (2009)
1183–119

Alikhanov-Alikhanyan “Big” magnet; brought from Germany in 1945; used for research of particles with masses between electron and proton on Aragats

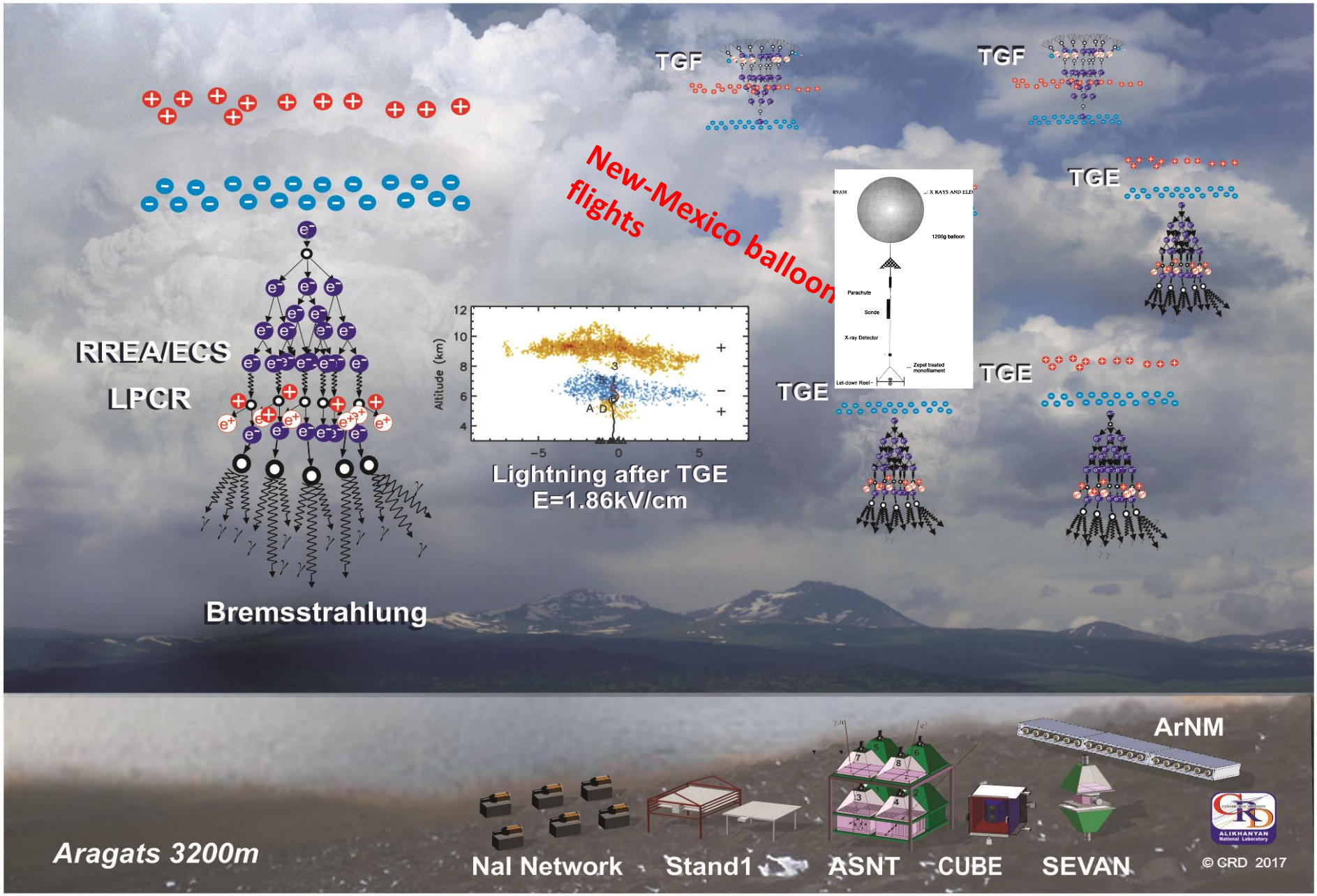
The “muon” detector building on Aragats: build by German war prisoners in 1949-1952

In 70-ths was measured the energy spectrum and charge ration of cosmic ray muons; now abandoned waiting investor for repair


Sun
SNR
TGF
γ glow
Neutron
start merger,
heavy nuclei
GCR-
protons and fully
stripped atoms
SEP-
Protons and partially
stripped atoms
Van Allen Belt
Whistlers
Double layers
IC+
IC -
Electric
Field
LPCR
TGE
"Secondary"
Cosmic Rays,
reaching and
detected at Earth's
surface
Stand1
ArNM
SEVAN
Nal crystal
Scint. 3cm
ASNT
CUBE
Metsamor
(Nuclear Power Plant)
© CRD 2017


KARE Lake
SKL
Stand1
POWER STATION
SKL
HOTEL
PYRAMID
MAKET
Stand1
GAMMA
Stand1
ARAGATS
Research Station

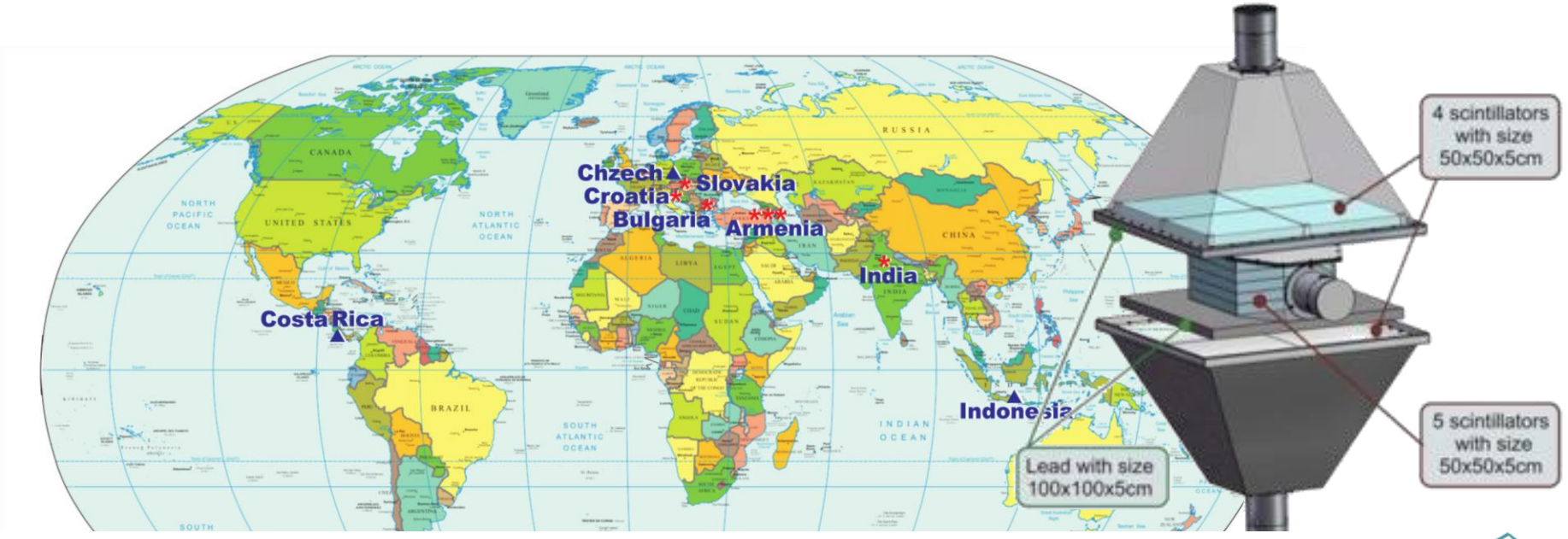
Only small fraction of RB/RREA become TGE, but many random emerging radiating regions in the cloud give raise to ionization and open path to the lightning leaders!




COSMIC RAY DIVISION
A. ALIKHANYAN
National Laboratory
Gyumri
Գյումրի
Spitak
Սպիտակ
Vanadzor
Վանաձոր
Dilijan (1500m)
Դիլիջան
Artik
Արթիկ
Sevan (1900m)
Սևան
Aragats (3200m)
Արագած
Nor Amberd (2000m)
Նոր Ամբերդ
Lake Sevan
Sevan National Park
Yerevan (1090m)
Երևան
Vagharshapat
Վաղարշապատ
Garni
Գառնի
Martuni
Մարտունի
Vardenis
Վարդենիս
Kalbajar District
Armenia
Vedi
Վեդի
Jermuk
Ջերմուկ
Areni
Արենի
Yeghegnadzor
Եղեգնաձոր
Stepanakert
Ստեփանակերտ
Martuni
Shushi (850m)
Շուշի
Sisian
Սիսիան
Tatev
Տաթև
Jabrayil
Kapan
Կապան
A. ALIKHANYAN
National Laboratory
ARMENIAN
GEOPHYSICAL NETWORK

Space Environmental Viewing and Analysis Network (SEVAN)

A network of middle to low latitude particle detectors called SEVAN (Space Environmental Viewing and Analysis Network) is planned in the framework of the International Heliophysical Year (IHY), to improve fundamental research of the Solar accelerators and Space Weather conditions. The program of TGE detection with SEVAN network started in 2016.



COSMIC RAY DIVISION
Alikhanyan Physics Institute,
Alikhanyan Brothers 2,
Yerevan 375036, Armenia

Type: any | Start date: 15-05-2018 04:47 | End date: 15-05-2018 14:35 | submit

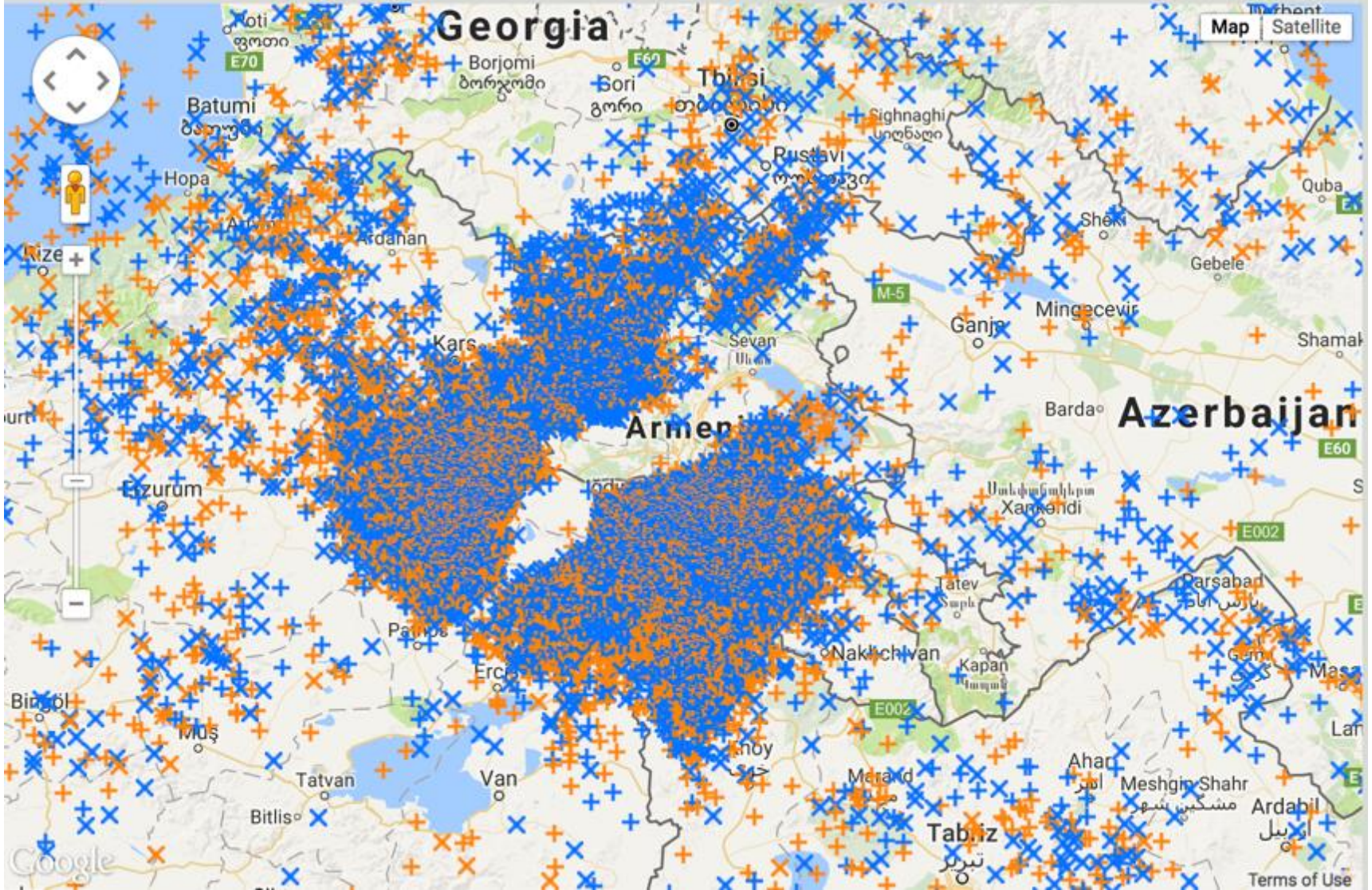
Between **Start date** and **Start date + 15 minuts**.

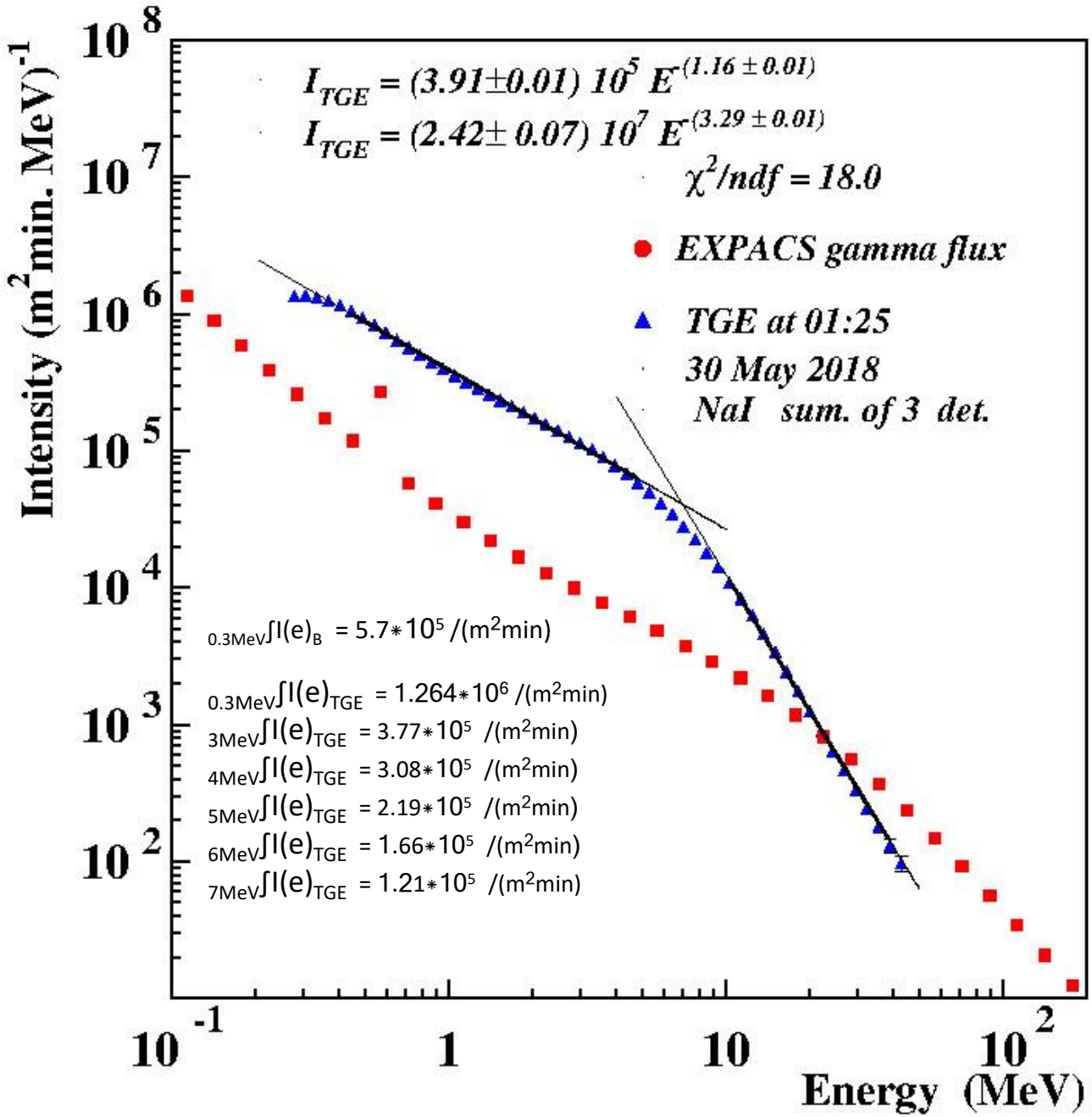
CG+ CG- IC+ IC-

Between **Start date + 15 minuts** and **End date**.

CG+ CG- IC+ IC-

Time Bar




$I_{TGE} = (3.91 \pm 0.01)\ 10^5\ E^{-(1.16 \pm 0.01)}$
$I_{TGE} = (2.42 \pm 0.07)\ 10^7\ E^{-(3.29 \pm 0.01)}$
$\chi^2/ndf = 18.0$
EXPACS gamma flux
TGE at 01:25
30 May 2018
NaI sum. of 3 det.
$_{0.3MeV}\int I(e)_B = 5.7*10^5\ /(m^2min)$
$_{0.3MeV}\int I(e)_{TGE} = 1.264*10^6\ /(m^2min)$
$_{3MeV}\int I(e)_{TGE} = 3.77*10^5\ /(m^2min)$
$_{4MeV}\int I(e)_{TGE} = 3.08*10^5\ /(m^2min)$
$_{5MeV}\int I(e)_{TGE} = 2.19*10^5\ /(m^2min)$
$_{6MeV}\int I(e)_{TGE} = 1.66*10^5\ /(m^2min)$
$_{7MeV}\int I(e)_{TGE} = 1.21*10^5\ /(m^2min)$
Intensity (m^2min. MeV)$^{-1}$
Energy (MeV)
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^{-1}
1
10
10^2

Armenian-German collaborations

- KASCADE experiment **FZK (KIT)**
- MAGIC experiments. **MPI Munich**
- SAND chip **FZK (KIT)**
- CTA **DESY**
- External board for the YerPhI development
- Conferences and Summer schools in Nor Amberd
- Instruments of collaboration: WTZ program; DAAD, NATO collaborative linkage grants, EU infrastructure grant, ISTC, DESY grants

Collaboration with KASCADE

- 1992 – IK3 director G.Schatz invites A.Chilingarian to deliver lectures on multivariate analysis and machine learning;
- Collaboration continued for 10 years for Investigations of the air-shower development in the primary energy region of PeV.
- ANI-KASCADE Symposia in Nor Amberd, 2 volumes of proceedings published by FZK (KIT)

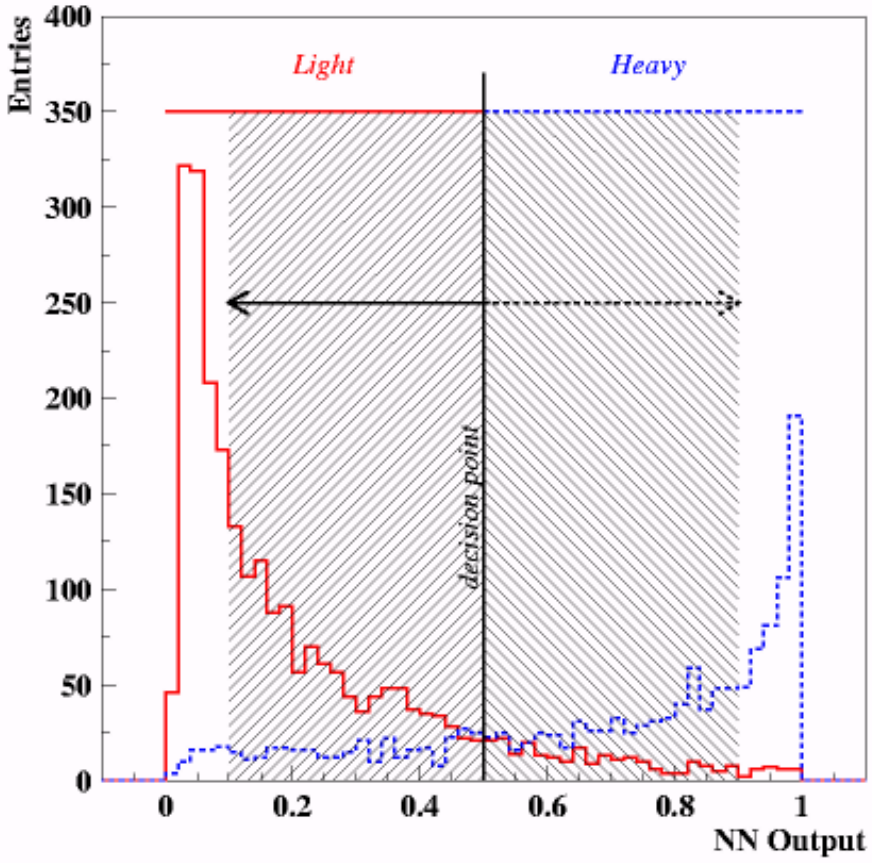
Best Lecturers of Nor Amberd Summer Schools: Johannes Knapp, Razmik Mirzoyan and Hartmut Gemmeke

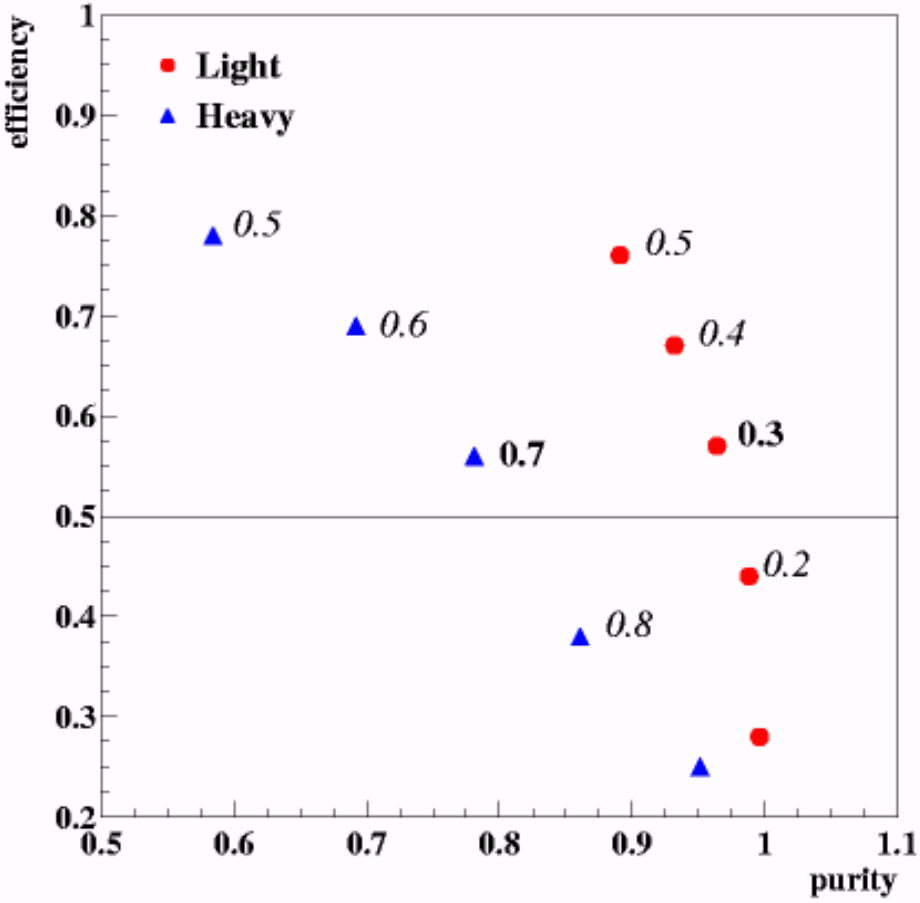

Venus transit
observations in Nor
Amberd
Johannes Knapp and
CRD students

MAGIC collaboration meeting in Nor Amberd

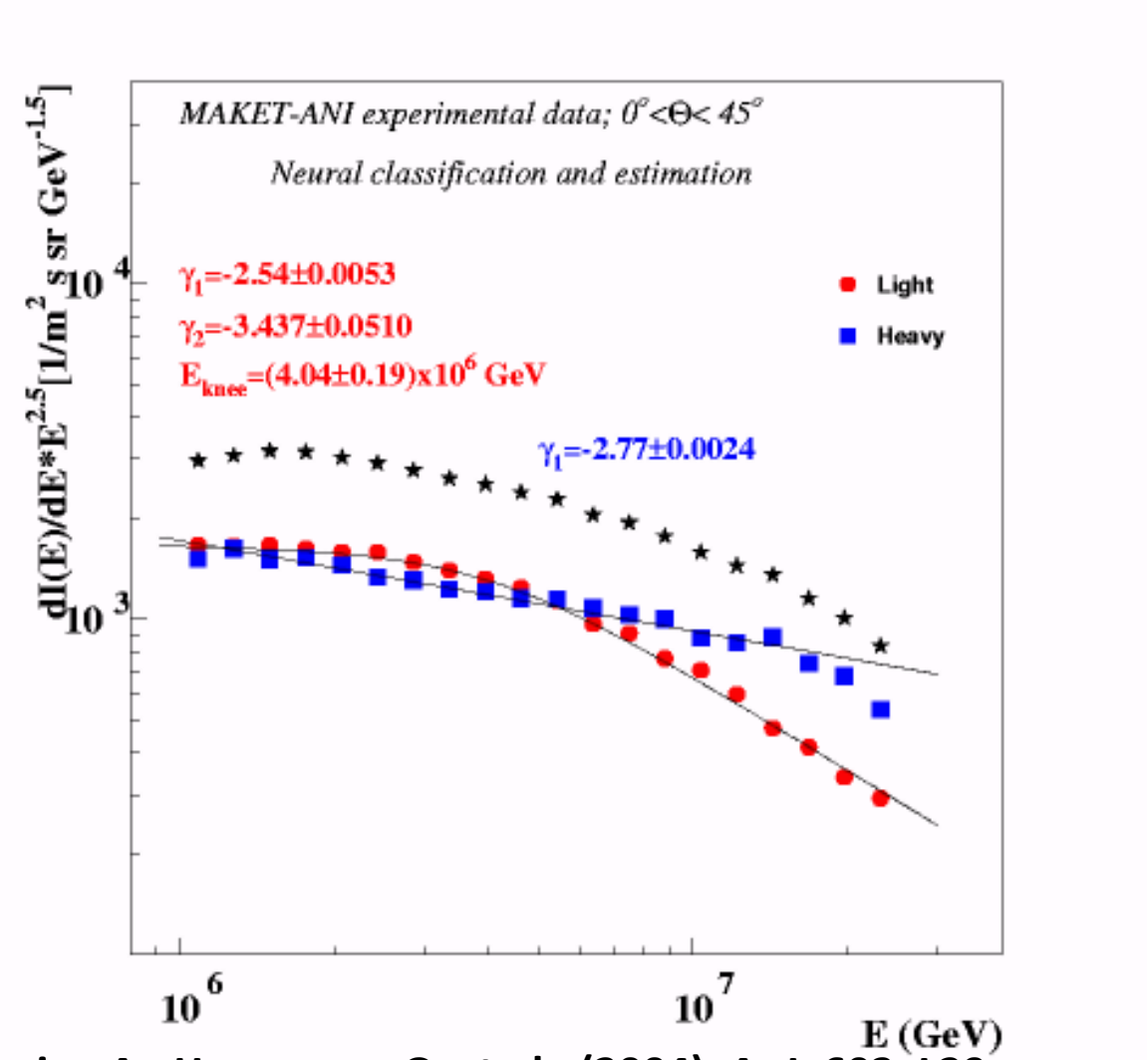
Excursion to Aragats. First IK3-CRD meeting (1996). Melkumyan Laura, Heinigerd Rebel, Zazyan Meri and Sanossyan Knkanos

Partial spectra: light and heavy nuclei:2-way Classification of MAKET-ANI data (Machine learning in astroparticle physics)



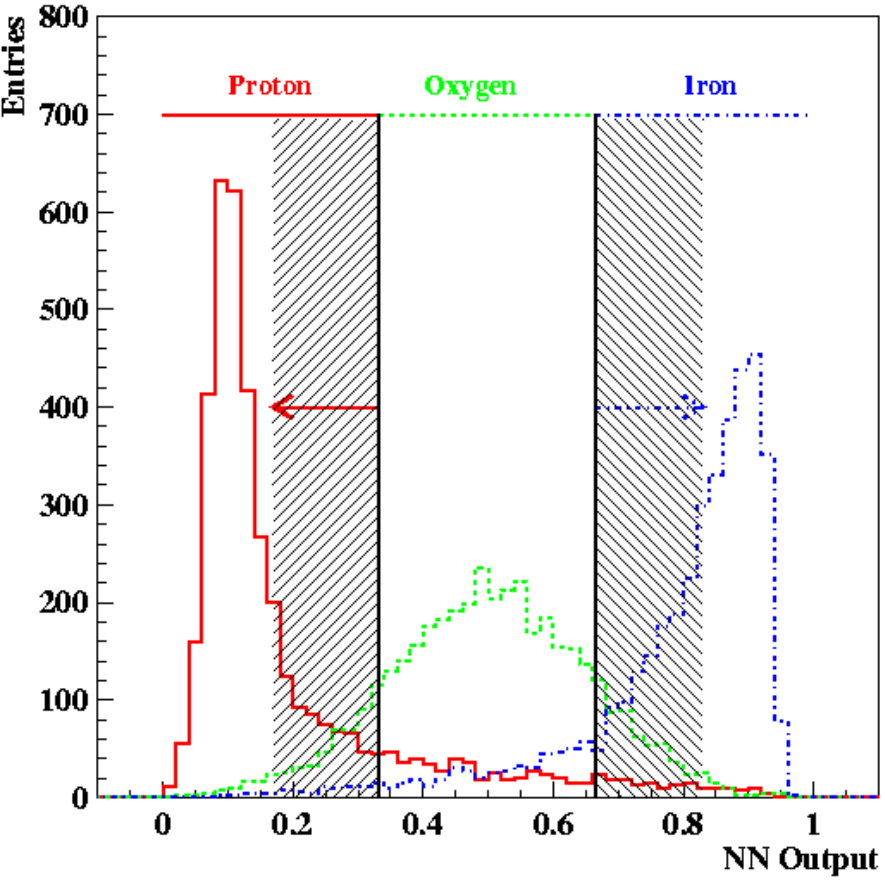


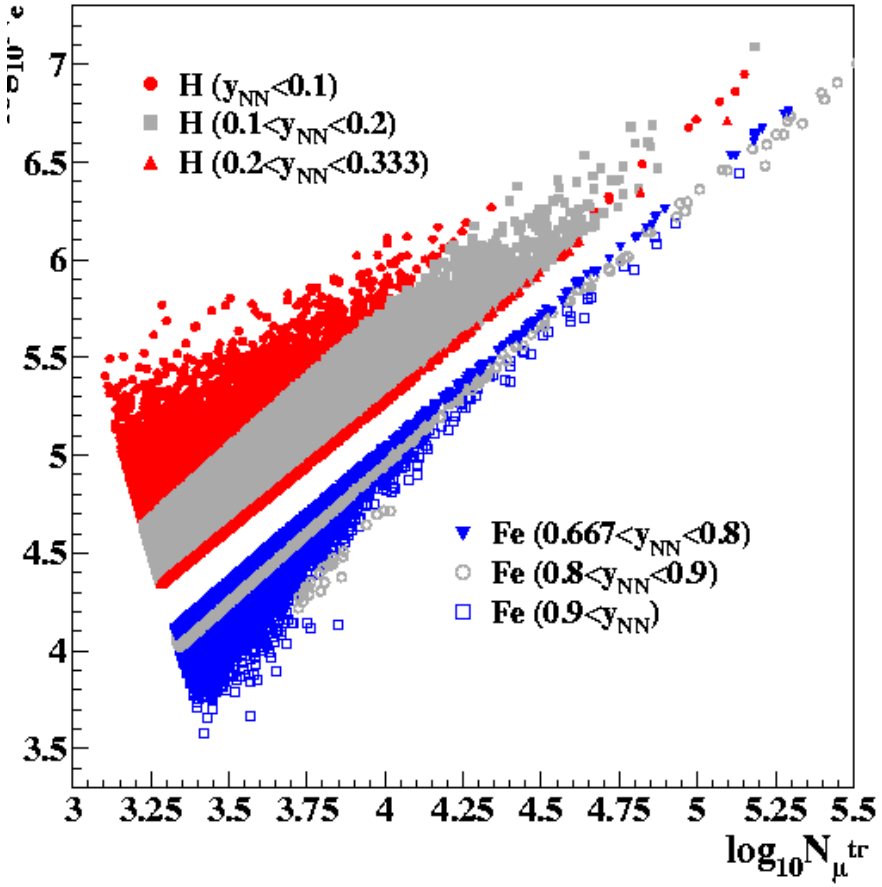
Unfolding the all particle energy spectra to Light and Heavy Nuclei



Credit, Chilingarian A., Hovsepyan G. et.al., (2004), ApJ, 603, L29

3-way KASCADE Data Classification





SAND group: CRD and IPE FZK

Prof.Dr. Hartmut Gemmeke, IPE, KIT

Neural Chip SAND in online data processing of EAS

W. Eppler, T. Fischer a, H. Gemmeke, S. Chilingaryan, A. Vardanyan, Computer Physics Communications 126 (**2000**) 63–66

Forschungszentrum Karlsruhe, Germany

Yerevan Physics Institute, Armenia

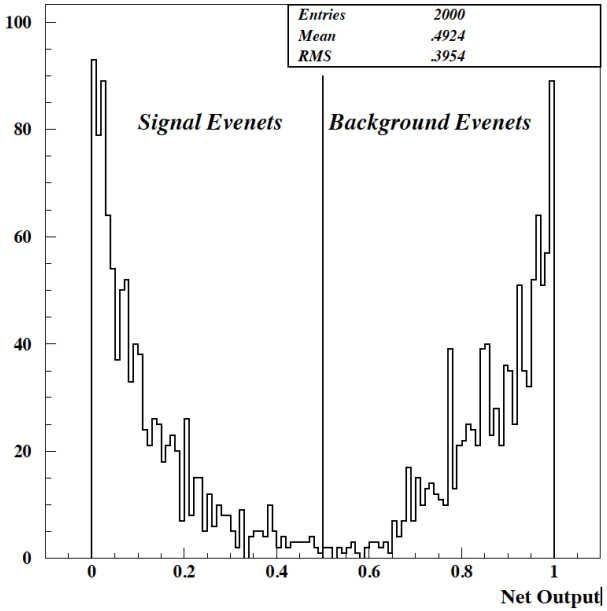


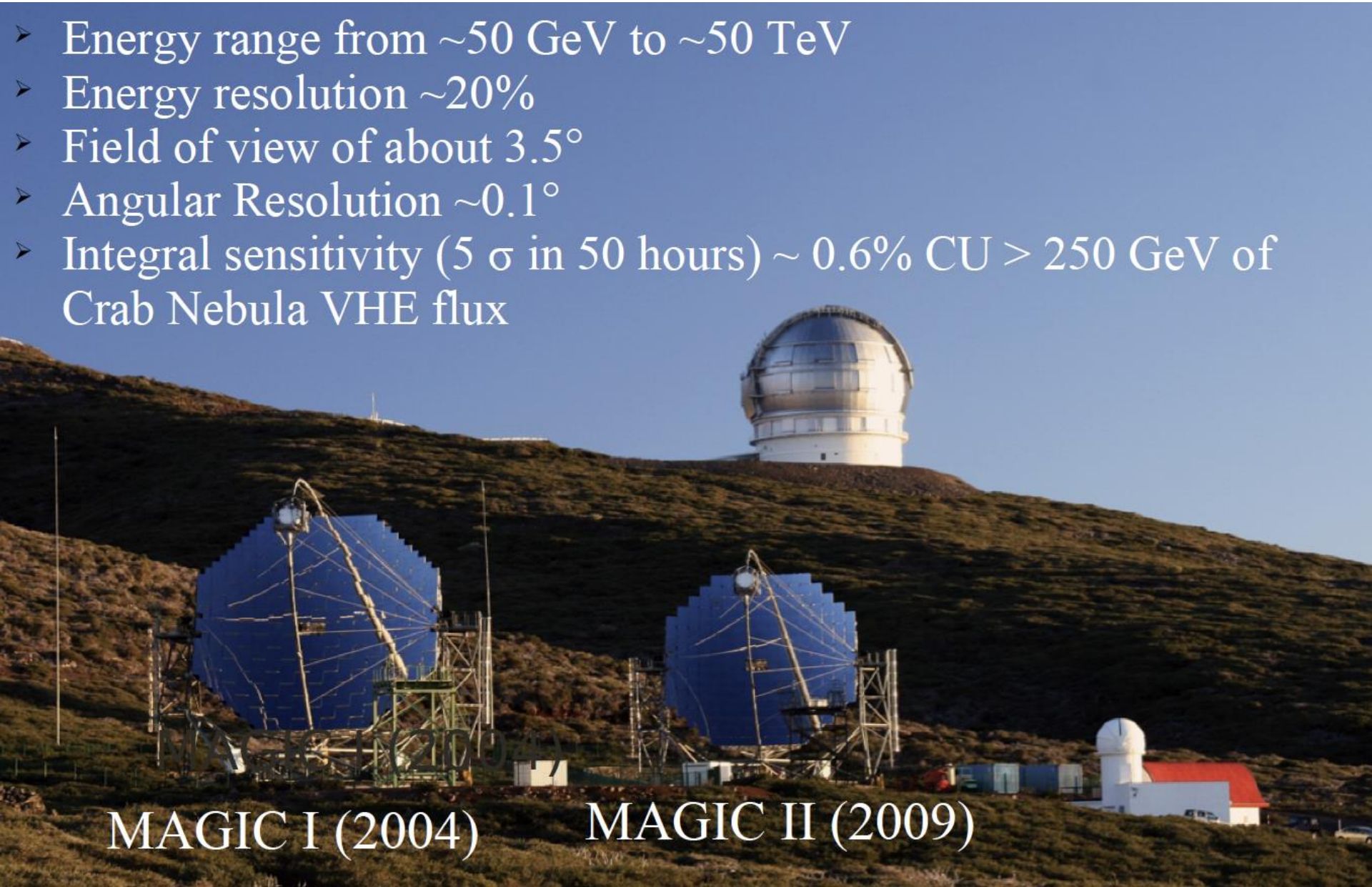
Figure 8: *NN output distribution for the 400 MAGIC matrix (left - "signal" events, right - "background")*

SAND is able to implement feedforward neural networks with a maximum of 512 input neurons and three hidden layers; SAND over performed CELERON 433 MHz 10 times

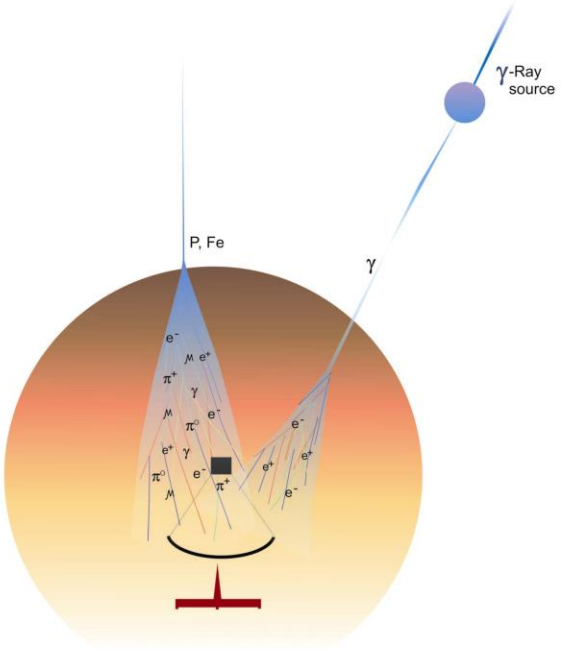
RAZ-200 – device for measuring near-surface electric field

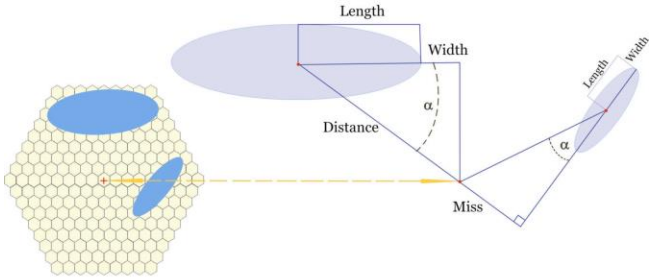
HEGRA_HESS_MAGIC_CTA

- Energy range from ~50 GeV to ~50 TeV
- Energy resolution ~20%
- Field of view of about 3.5°
- Angular Resolution ~0.1°
- Integral sensitivity (5 σ in 50 hours) ~ 0.6% CU > 250 GeV of Crab Nebula VHE flux



Imaging ACTs: hadron and gamma image separation

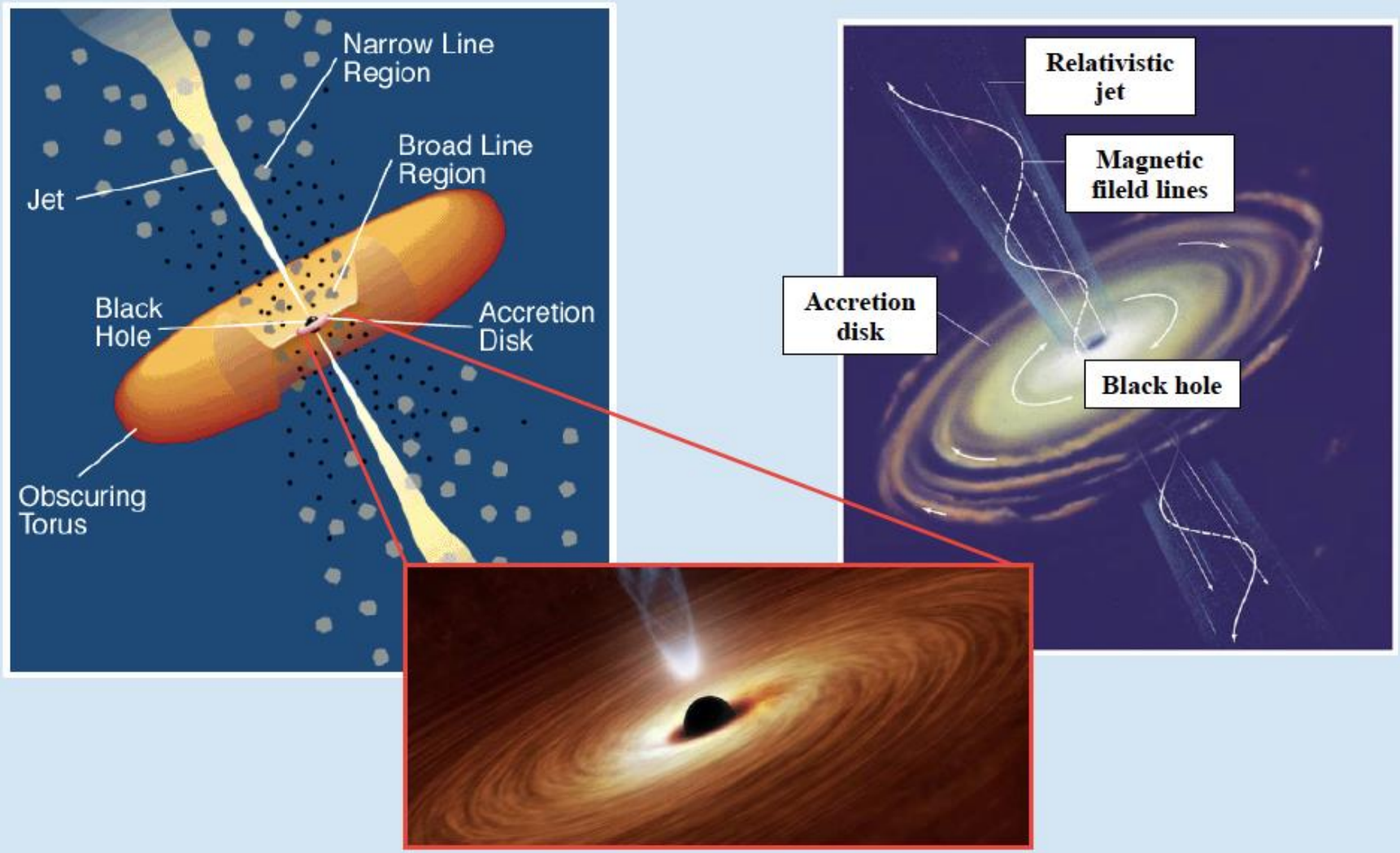




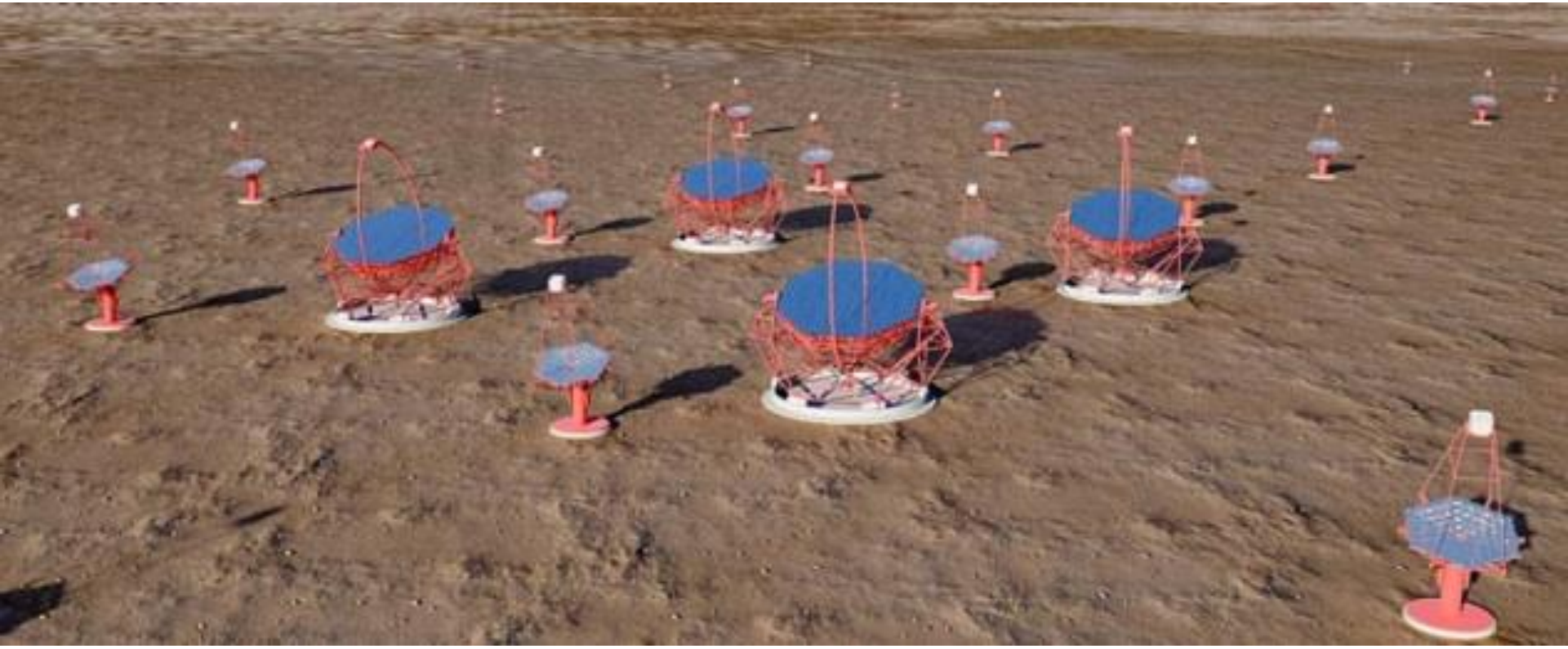
Hadron and γ-ray images

First-time detection of VHE gamma rays by MAGIC from a direction consistent with the recent EHE neutrino event IceCube-170922A

ATel #10817; ***Razmik Mirzoyan for the MAGIC Collaboration***
*on **4 Oct 2017; 17:17 UT***



Cherenkov Telescope Array, http://www.isdc.unige.ch/cta/ Atacama Desert



CTA will consist of two arrays of differently-sized telescopes (one in the Northern Hemisphere and one in the Southern Hemisphere) that will detect the Cherenkov radiation that is produced when a gamma ray interacts with molecules in our atmosphere. The Southern site, in Chile, will have 99 large, medium, and small-sized telescopes, while the Northern site, in Spain, will only have 19 medium and small ones. (This discrepancy is because the inner regions of our Galaxy, one of the key science targets, is only visible in the Southern hemisphere).

German physicists helping YerPhI to find its role in fast changing world: Meeting of the International Commission of Experts on the Perspectives of the Yerevan Physical Institute 22-25 July 2009

Chairmen of DESY directors board Albrecht Wagner, YerPhI director Ashot Chilingarian and senior astrophysicist Johannes Knapp

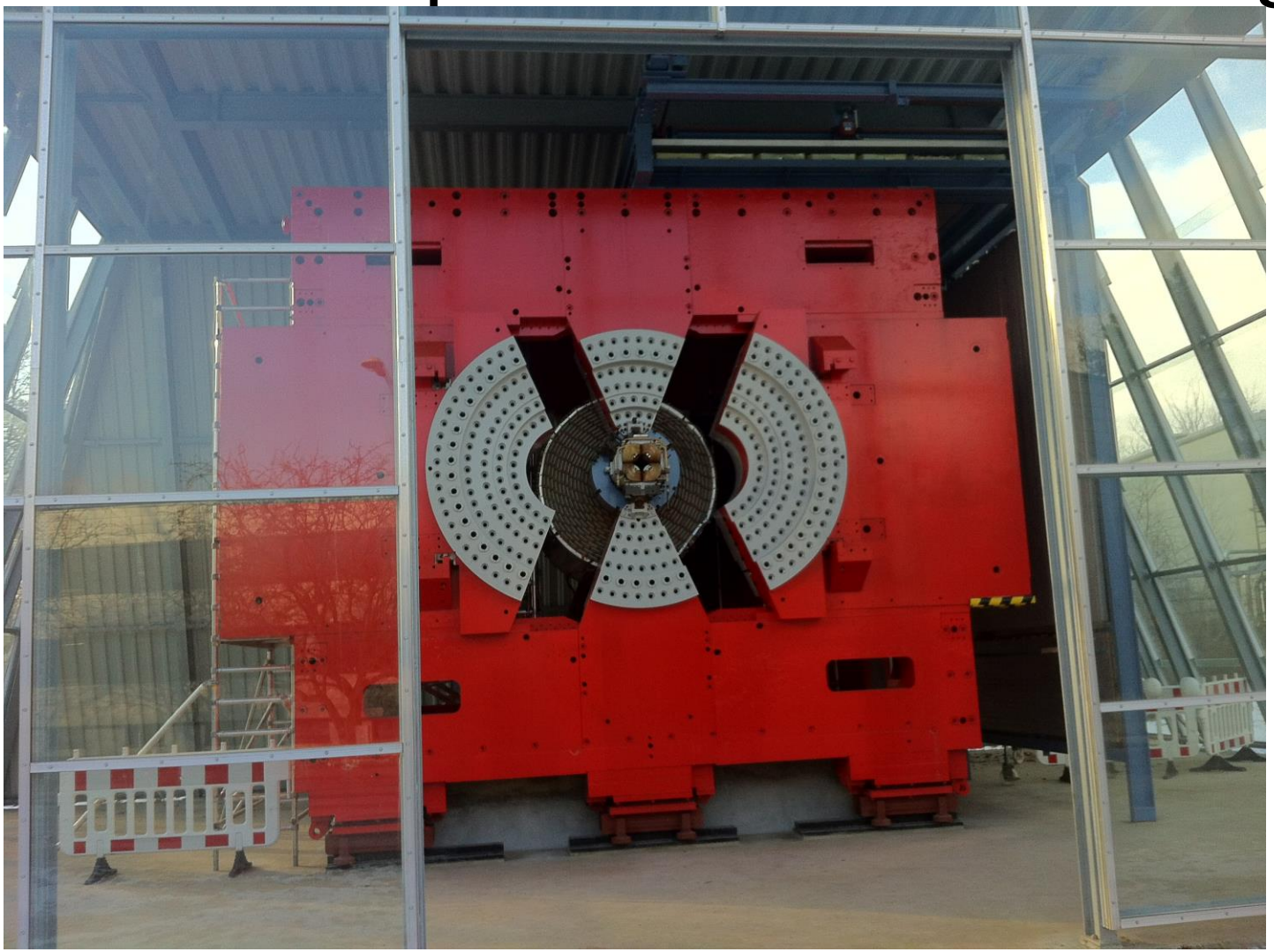
Robert Avagyan, Nerses Yeritsyan, Albrecht Wagner and Ani Abrahamyan

Conclusions and Recommendations

- Once again InComEx underlines the fact that with its 66-year history, active scientific activities in different fields of modern physics, with the search for fields of applying the achievements of physics in interdisciplinary sciences and technologies, YerPhI with its infrastructure offers ***a unique basis for further development of science and science intensive technologies in Armenia***.
- The participation of the physicists of YerPhI in large scientific projects, in investigations carried out by large collaborations at the accelerator complexes in Europe and in the USA, the designing and manufacturing of modern experimental facilities are the direct and most efficient way to transfer the achievements of world leading science and of advanced technologies in many projects of national scale. Such connections should be realized via YerPhI, which is located in the capital of the country and is closely connected with its scientific, educational and technical structure.
- ***For this reason, there is no doubt that the functioning and the development of this center should be continued.***
  - InComEx accepts the following ***Vision for YerPhI*** as appropriate and proposes it to the Armenian authorities for consideration:
    - YerPhI should be transformed into a National Laboratory of Armenia (NLA)
    - NLA should primarily ensure scientific excellence at an international level
    - NLA's role: to develop and maintain research infrastructures for fundamental physics
    - (particle, nuclear, astroparticle), accelerator science and their applications
    - NLA's role: as node that connects Armenia to the international physics community -
    - enabling participation in world leading projects
    - NLA should be a channel for bringing new developments to Armenia – e.g., nuclear
    - medicine, GRID with the National Academy of Sciences, and opportunities for
    - developing a technology base for Armenia, etc...
    - NLA should be a node for training students in fundamental physics, related technologies,
    - informatics
    - NLA's activities would be essential for the knowledge economy of Armenia.

First Internet comes to Armenia via DESY !

Armenian technicians dissembled the ARGUS magnet opening place for the OLYMPUS experiment at DORIS rings



Professors Christian Spirieng and Manfred Fleisher