Research on Galactic Cosmic Rays from the “knee” to the “cutoff” (10^{16}-10^{19}) eV at the Aragats Cosmic Ray Observatory;

Measurements of the ultra -high energy Cosmic Rays by hybrid particle detectors located on the Earth surface.

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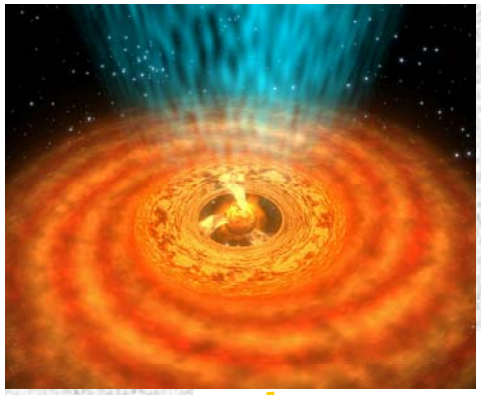
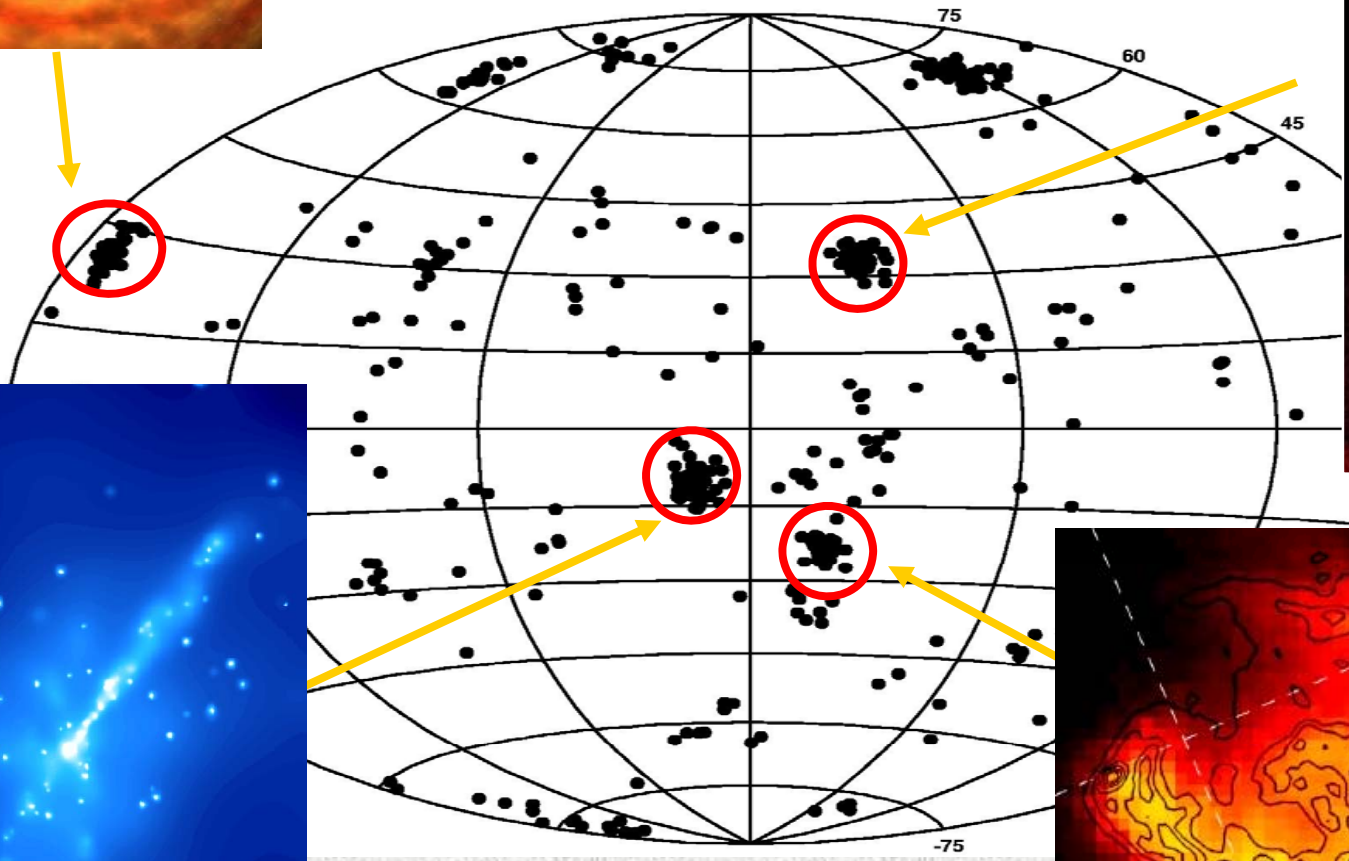
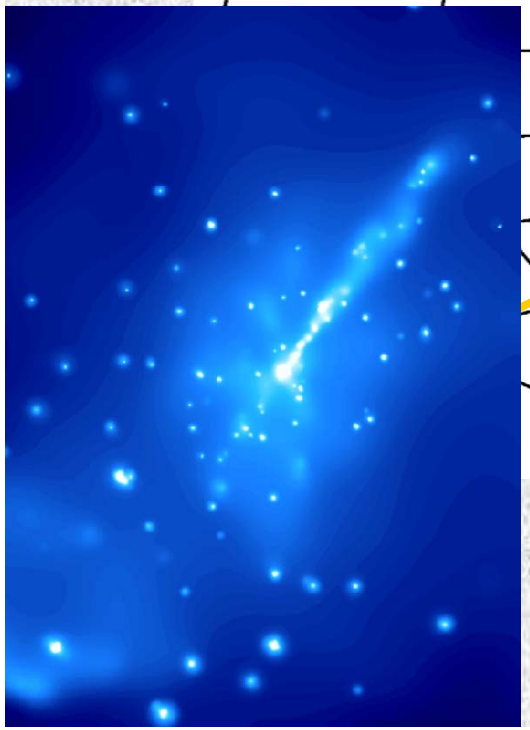
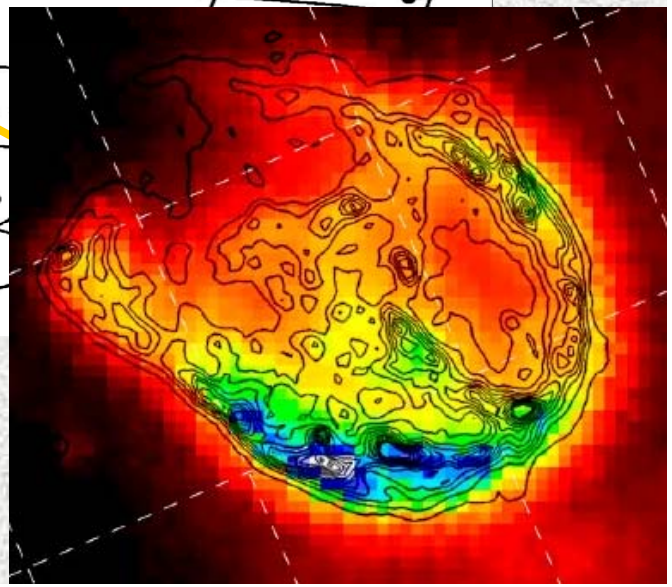
Particle Astronomy

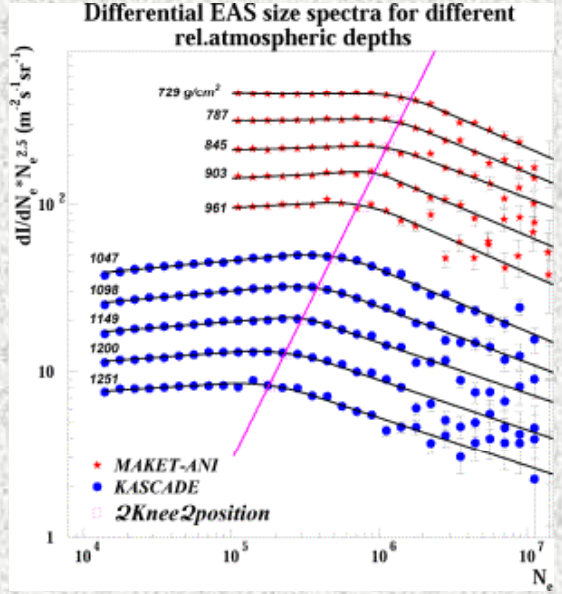


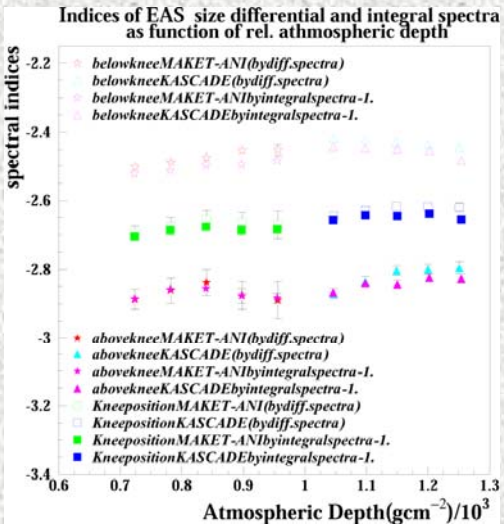




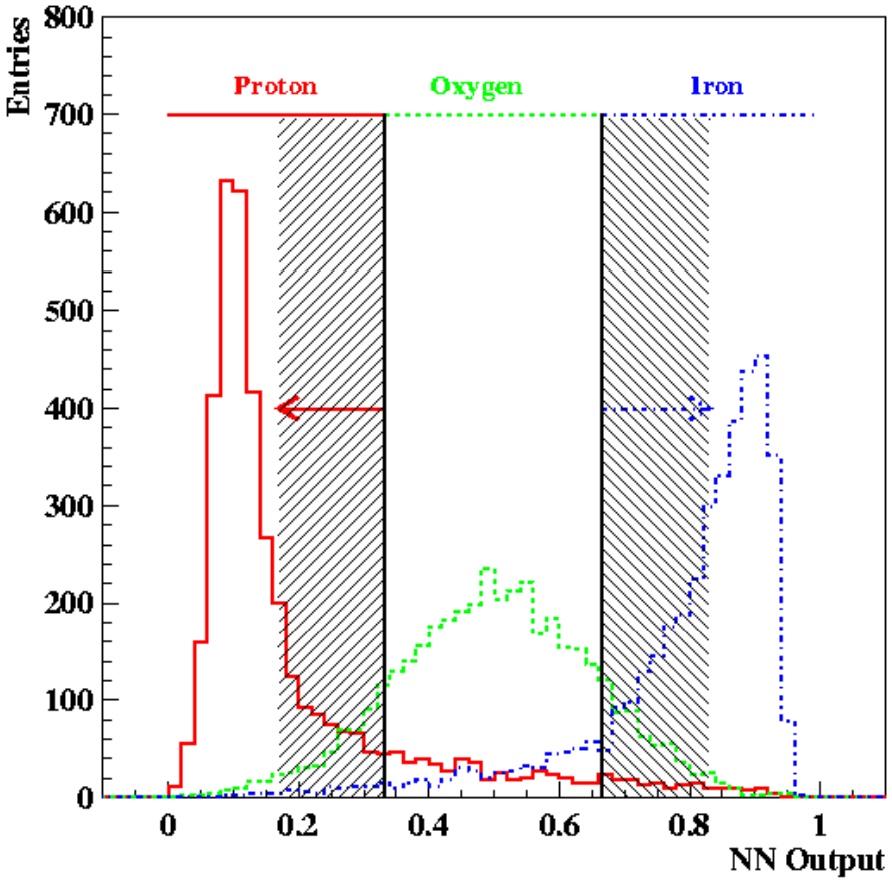


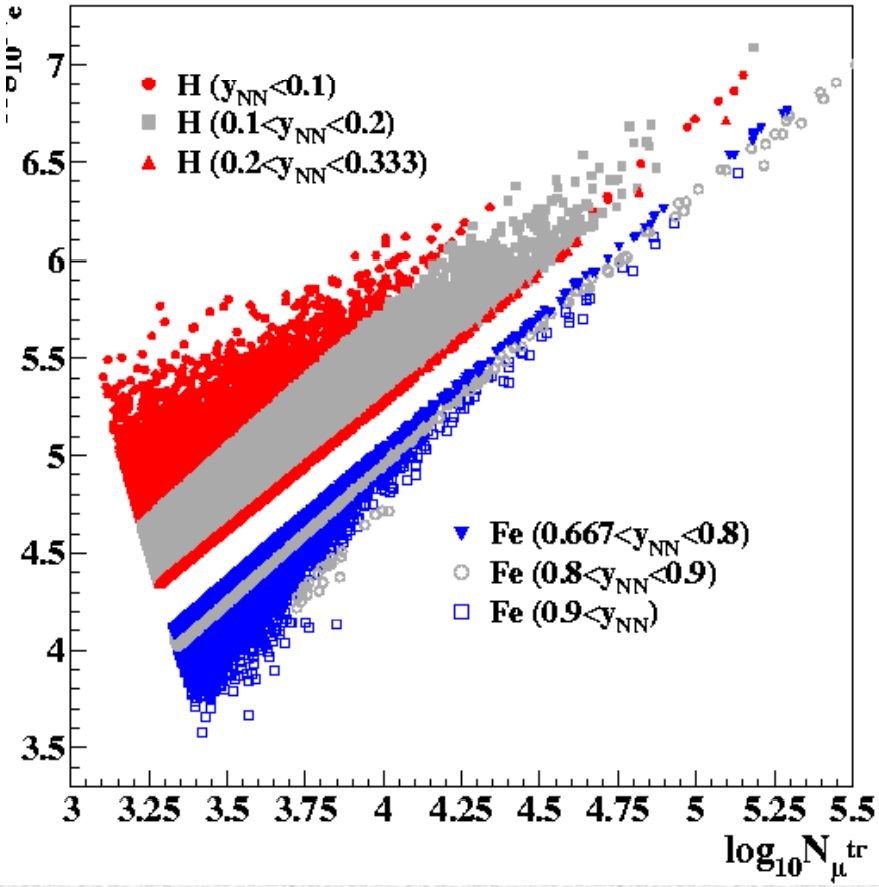
Extensive Air Showers detected by Surface Arrays: knee region physics





Separation of Primary Cosmic Rays into Nuclear groups by Neural Classification and Estimation – Event-by-event analysis of EAS

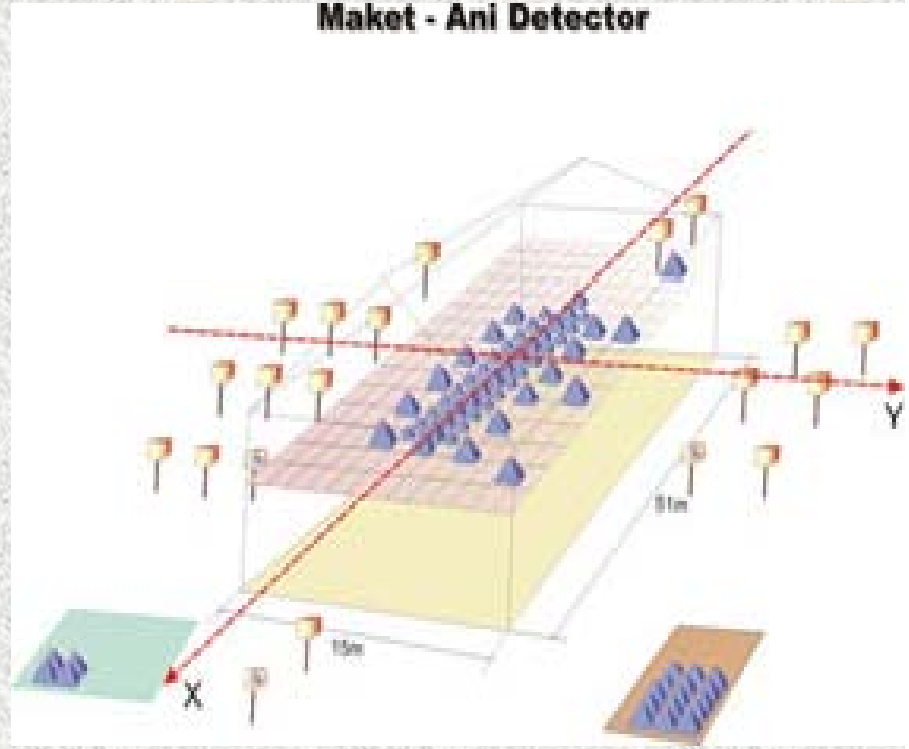




MAKET –ANI experiment

- **Consist – 92 plastic scintillation detector. 68 with 1m^2 area, and 24 – 0.09 m^2.**

  19 of 1m^2 area detectors for fast timing system.
- **CAMAC standard.**
- **Two types triggers are used:**
  - **for density detectors 7 from 11**
  - **for fast timing system 4 from 9**
- **Effective area for EAS collection ~900m^2 for N_e > 10^5.**



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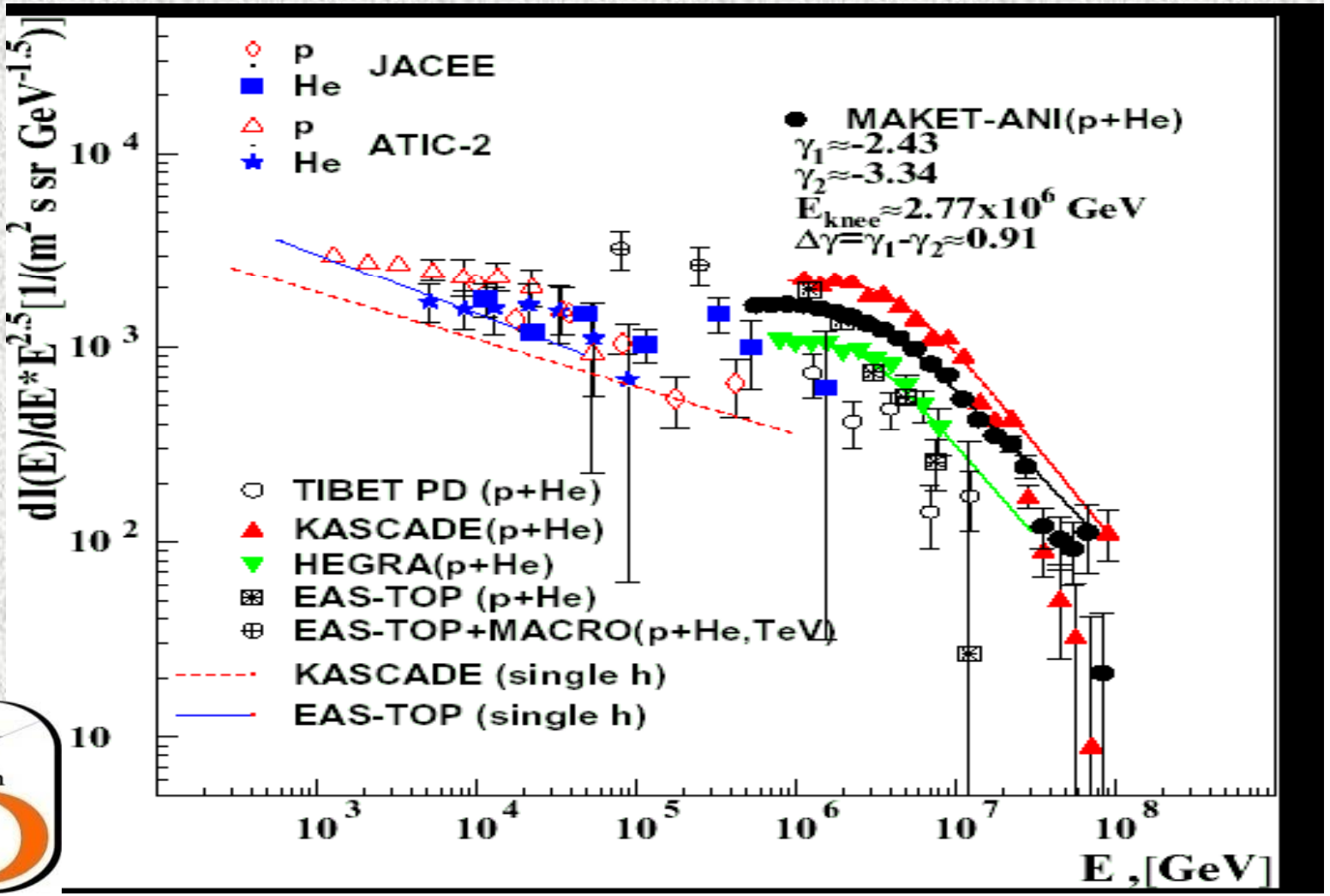
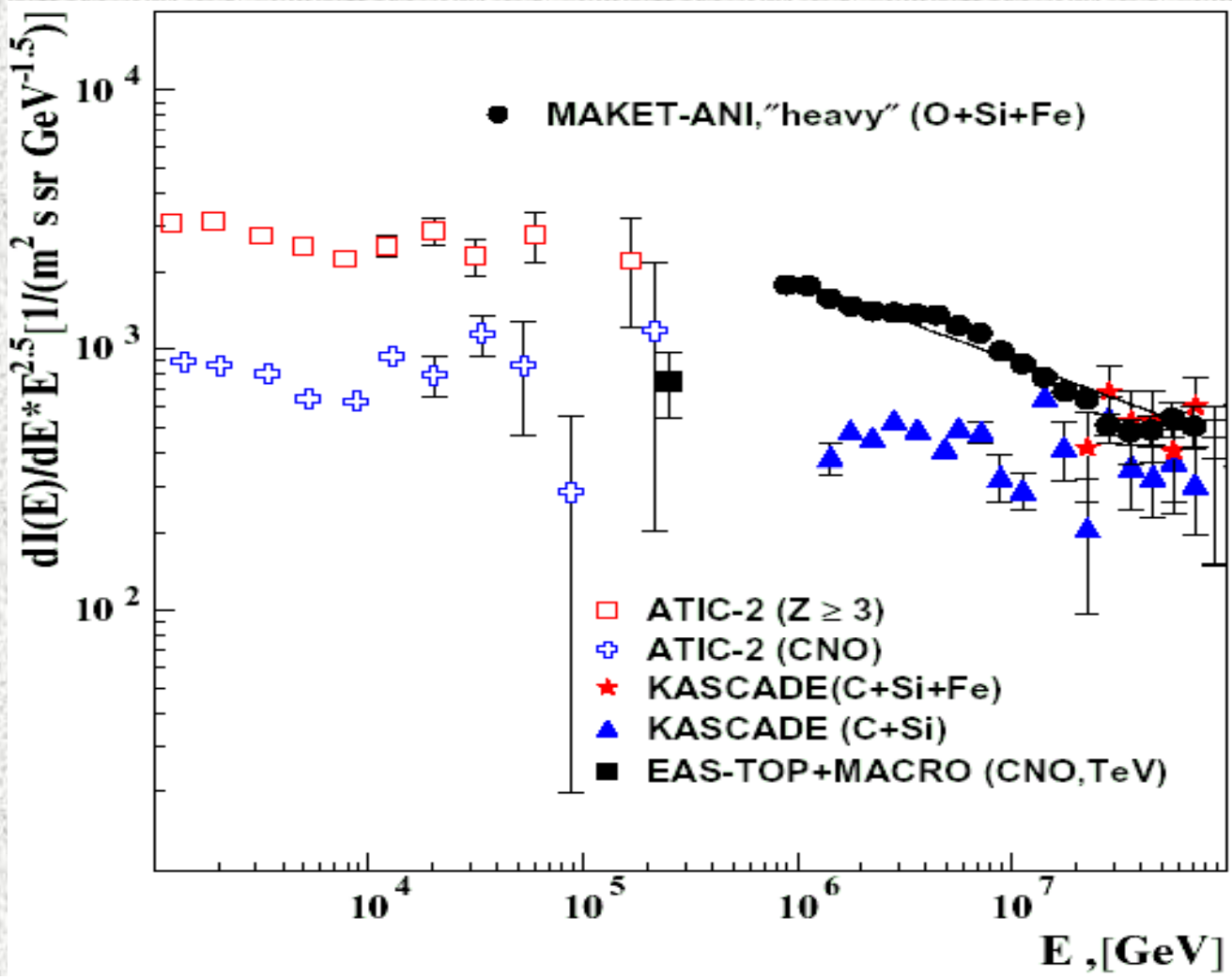
Primary LIGHT component (p+He) measured by the MAKET-ANI detector in comparison to the results from KASCADE, EAS-TOP, HEGRA, EAS-TOP+MACRO, TIBET and primary protons spectra approximations obtained by the single hadrons fluxes EAS-TOP and KASCADE. (All data based on CORSIKA QGSJet01 version). The direct balloon measurements by ATIC-2 and JACEE at 10^2 – 10^5 GeV also presented.



Cosmic Ray Division

The energy spectrum of the “heavy” nuclei group measured by the MAKET-ANI detector along with spectra from KASCADE , EAS-TOP+MACRO and ATIC.



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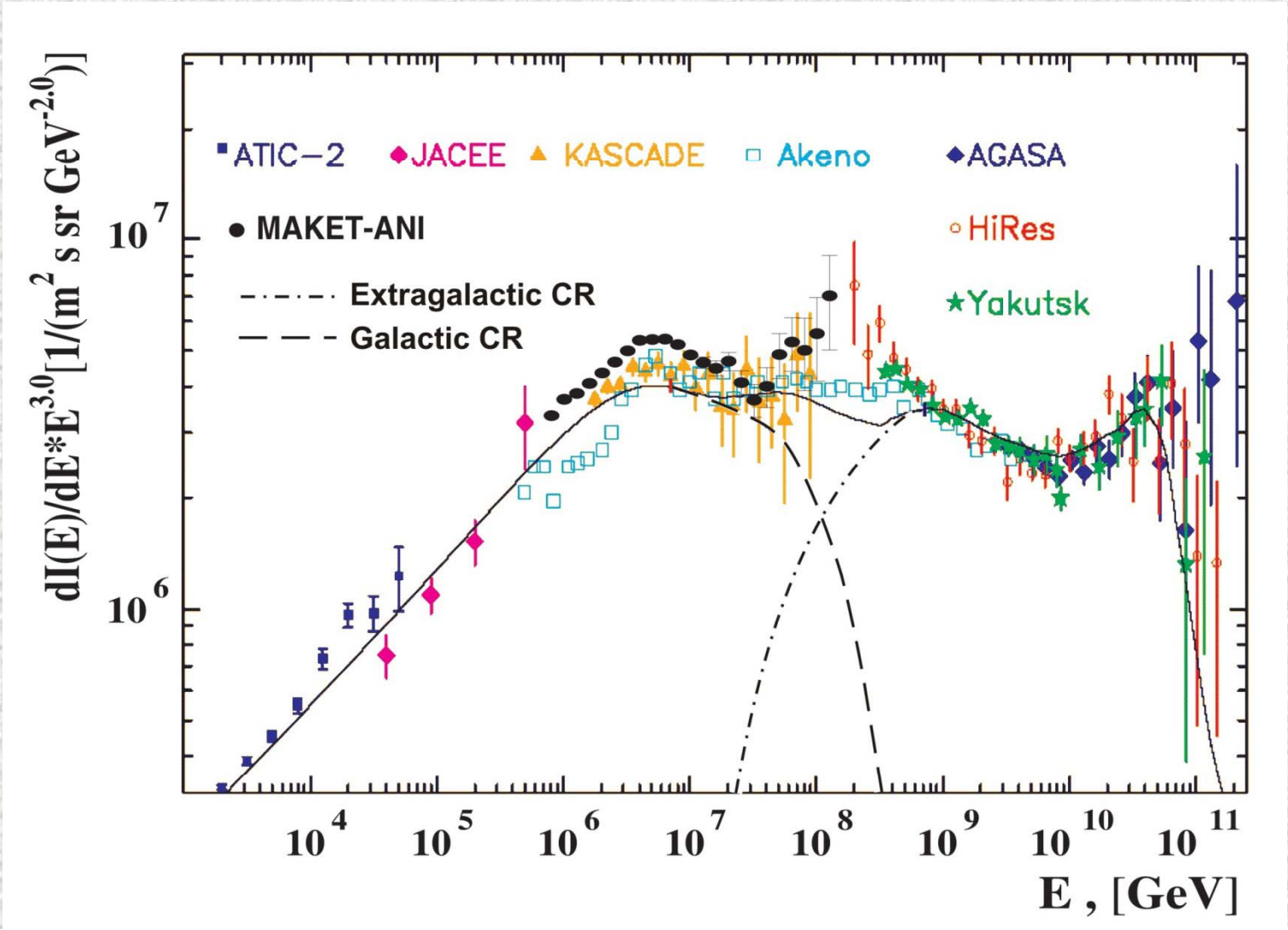
Summary of MAKET-ANI detector results

- From 1997 up to the end of 2004 the MAKET – ANI experiment has taken data with exposition time of ~1.46·10 ^{8} s. The total number of the registered shower events was ~1.2·10^{7}. A smaller sample of the data (~1.3·10^6) with Ne ≥10^5 and θ ≤46.8^{o} was used for the in-depth analysis of the LDF and size spectra. By 7.2·10^{5} near the vertical (θ ≤30^{o}) EAS were obtained the energy spectra of light and heavy nuclei groups.
- The obtained dependence of the shower age on shower size pointed to the weighting of the primary flux mass composition after the knee of the "all particle" spectrum;
- The size spectra show evidence of a "knee" at shower size ~10^{6} particles. As the zenith angle enlarges, the knee position is moving to smaller sizes, according to the EAS attenuation length =211±38 g/cm^{2}.
- The difference of the power low spectra before and after the knee is constant with high precision Δγ = 0.45 ±0.02.
- The estimated energy spectrum of the light mass group of nuclei shows a very sharp knee: $\Delta\gamma \sim 0.9$, compared to $\Delta\gamma \sim 0.4$ for the all-particle energy spectra.
- The energy spectrum of the heavy mass group of cosmic rays shows no knee in the energy interval of 10^{15} –10^{16} eV.

All-particle GCR intensity as a function of the particle energy



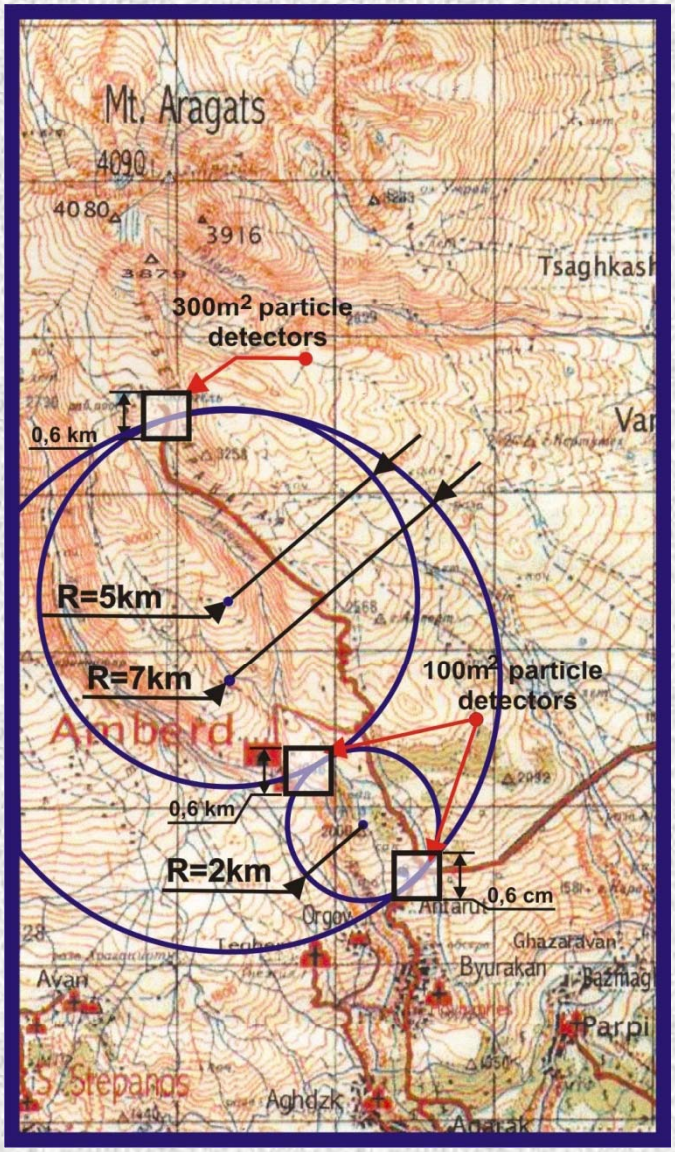
Repporteur Talk OG1, Pasquale Blasi

- ✓ THE GROUND ARRAYS WILL REMAIN CRUCIAL, WITH ALL TROUBLES ON EXTRACTING THE INFORMATION AND DEALING WITH HADRONIC MODELS (may be improvements from LHC?)
- ✓ CRUCIAL ALSO TO REACH AS HIGH AS THE TRANSITION REGION (10^{17}-10^{18}eV)
- ✓ ON THE SIDE OF ACCELERATION IN SNR, VERY IMPRESSIVE DEVELOPMENTS (NONLIN DSA AND B-FIELD AMPLIFICATION)… BUT ALSO LOTS OF THINGS WE ARE FAR FROM UNDERSTANDING, despite nice model fittings!

Project objectives

- *Creation of a particle detector network for continuous measurements of cosmic rays of ultrahigh energies;* 10^{16} - 10^{19} eV;
- *Determination of mass composition and energy spectra of the ultrahigh energy cosmic rays;*
- *Determination of the characteristics of the “iron knee”;*
- *Search for point sources of ultra-high energy cosmic rays: CR astronomy;*
- *Investigation of the “fine structure” of the partial energy spectra;*

Layout of Aragats Cosmic Ray Observatory



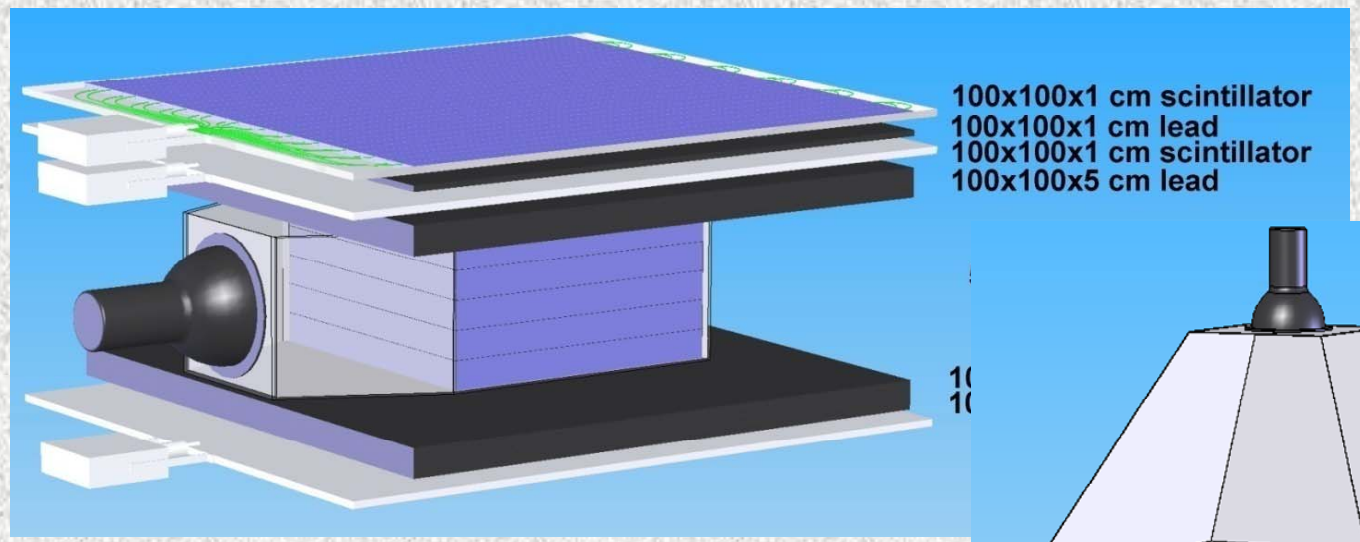
Within 3 squares with area ~350 m^2 of plastic scintillators will be deployed. Each array will be able to detect EAS with number of electrons up to several units of 10^8, corresponding to primary particle with energy up to 10^{17} eV.

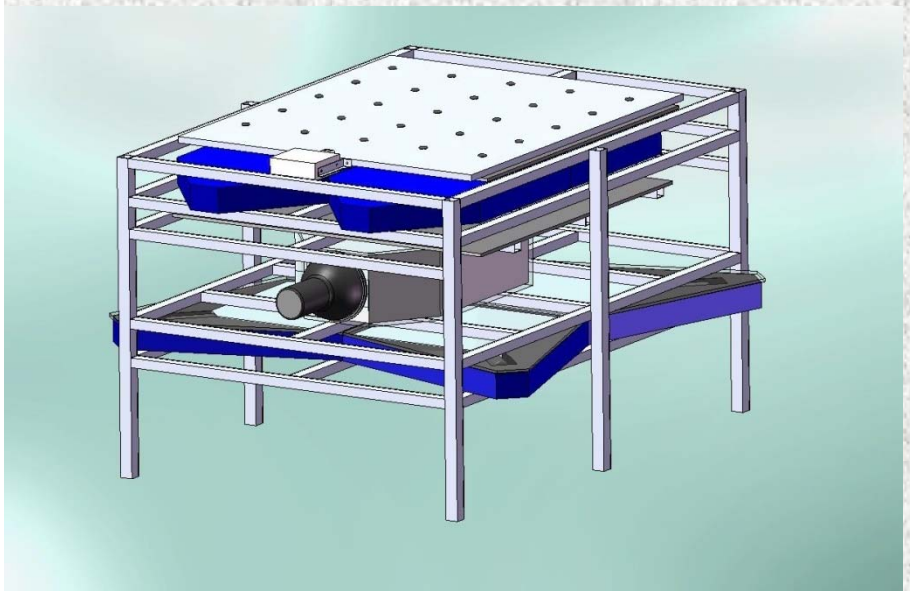
From area of small circle with radii 2 km EAS cores will be selected initiated by primaries with energy up to 10^{19} eV. These EAS should give signals in both Nor Amberd and Antarut arrays.

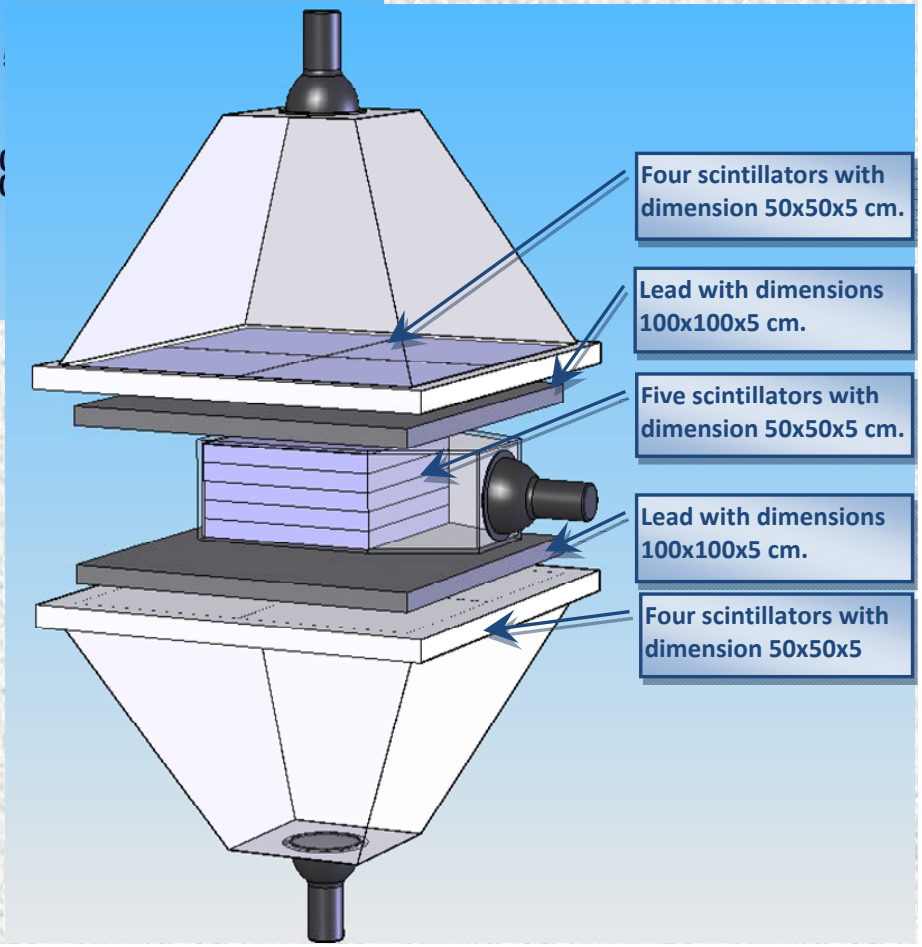
EAS axes fallen in the bigger circle of 5 km radii will be registered by 2 arrays located at Aragats and Nor Amberd if primary energy will be above 10^{19} eV.

The biggest circle will “select” showers initiated by the primaries with energy up to 10^{20} eV detected by all 3 “small” arrays. We expect to detect ~150 events with energy 10^{19} eV per year.

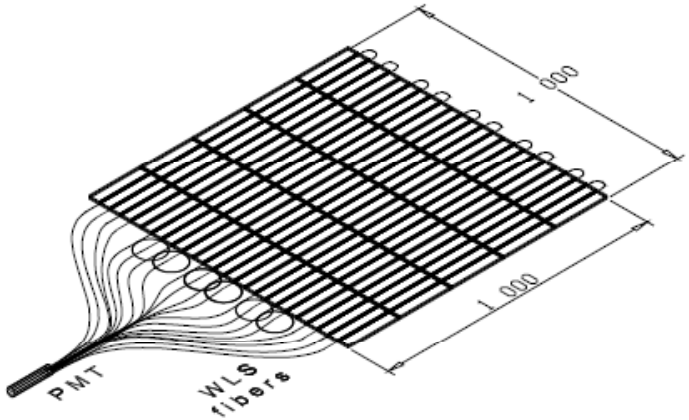
Hybrid Particle Detectors (unit cost ~ K10$)

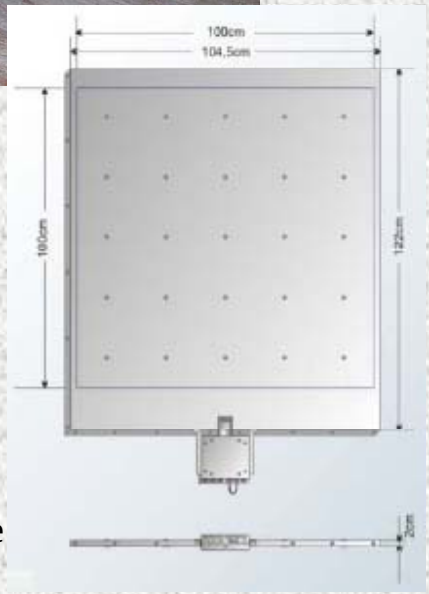






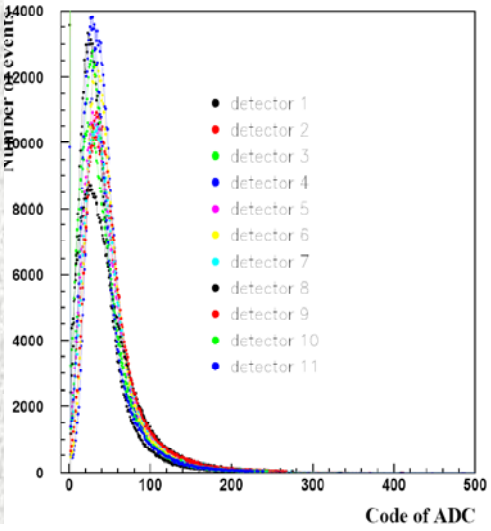
4-layered multiparticle detector: 1 cm thick molded polyester with wavelengh shifting fibers



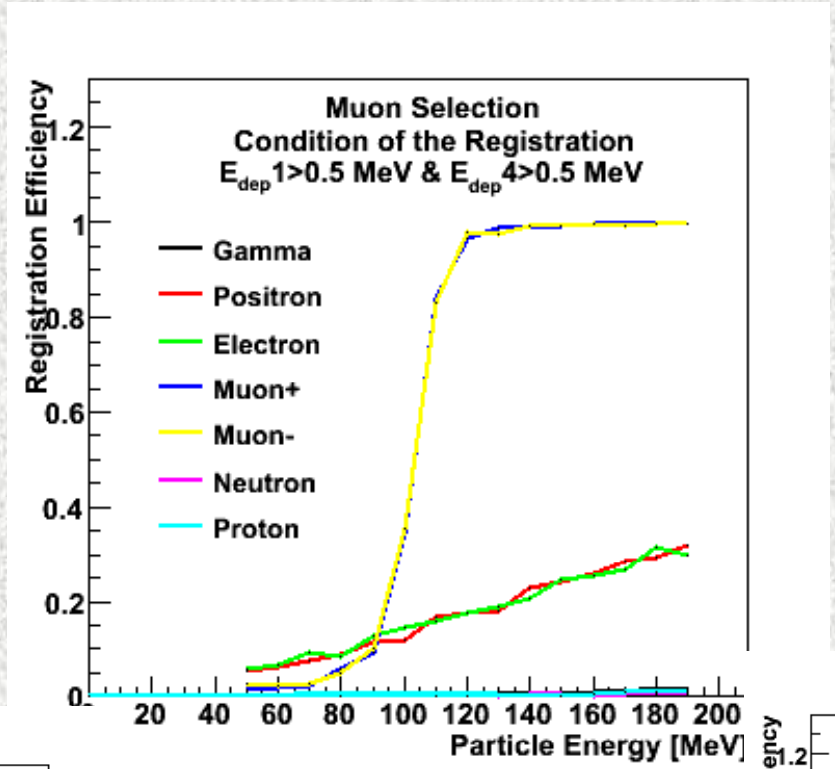


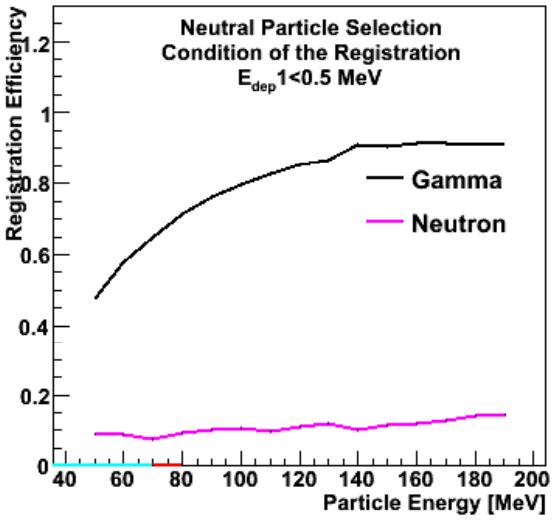
8-channel Programmable Threshold Comparator and Counter

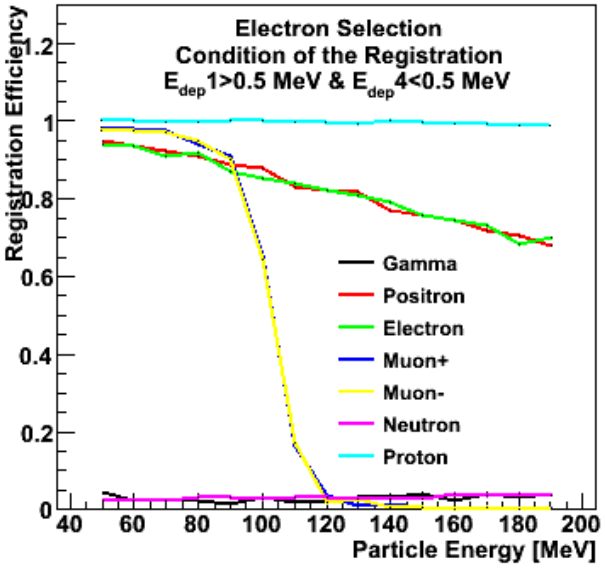
Atmel Tiny Little AVR32 Board (NGW 100)

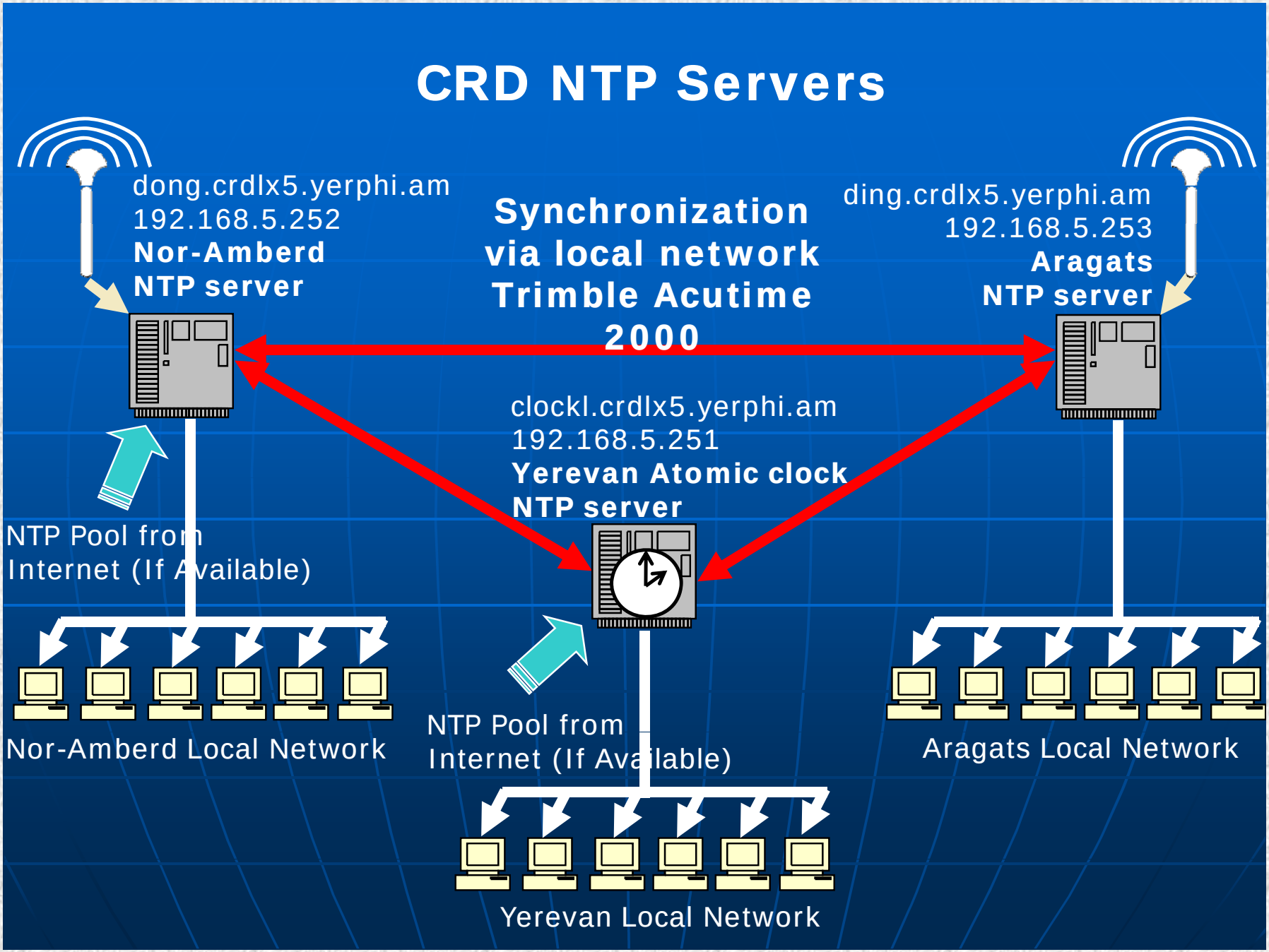


4-layered multiparticle detector - simulations





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dong.crdlx5.yerphi.am
192.168.5.252
Nor-Amberd
NTP server
Synchronization
via local network
Trimble Acutime
2000
ding.crdlx5.yerphi.am
192.168.5.253
Aragats
NTP server
clockl.crdlx5.yerphi.am
192.168.5.251
Yerevan Atomic clock
NTP server
NTP Pool from
Internet (If Available)
NTP Pool from
Internet (If Available)
Nor-Amberd Local Network
Aragats Local Network
Yerevan Local Network

Conclusion: status of “ANI-new” collaboration

- Legal issues with land solved;
- Basic detector assembled, now under tasting: will measure neutrals, muons, electrons; cost ~10-15K$;
- DAQ; synchronization; wireless systems also under testing;
- EAS Simulations did not started yet;
- Negotiations with scintillator producer under way: 40 additional detectors will be ordered in 2009 – cost ~1,500 - 2,000$;
- Cherenkov telescopes; radio - antennas; robotic optics – negotiations started.
- Collaboration – to be formed till 20010.