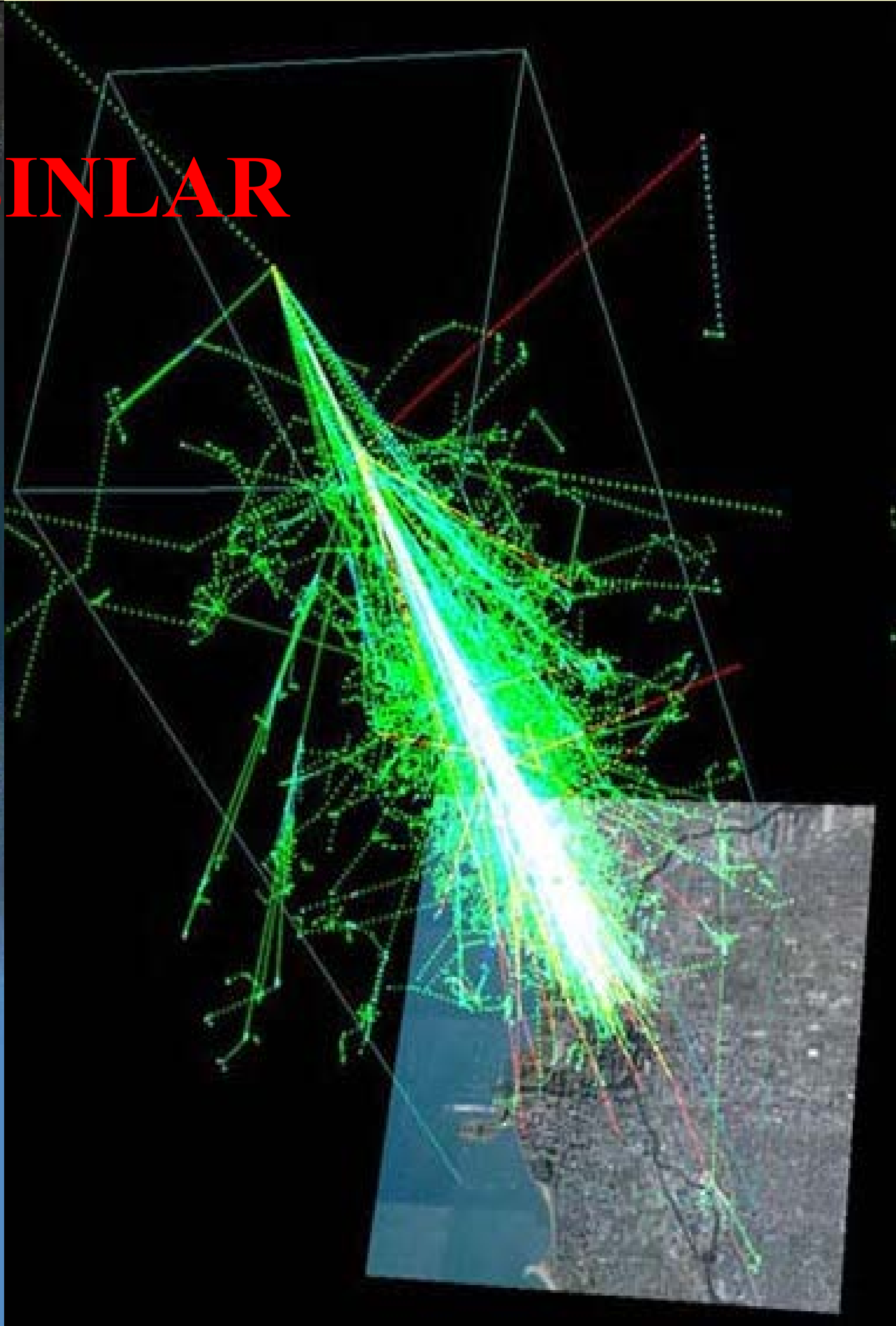
KOZMİK IŞINLAR



Kozmik ışınların kaynağı:

Cosmic rays are **charced** energetic, *i.e.* **very high speed**, **particles** originating from deep space objects such as supernova explosions, active galactic nuclei.

İçerikleri;

90% protons,

9% helium nuclei (α particles),

1% electrons

Ve çok az miktarda da diğer atomların çekirdekleri, C, O, Fe, Ni, Li, Be, gibi.

Adlandırmadaki "**ışın**" kelimesi yanlış kullanılmıştır. Aslında bunlar çok yüksek hızlara ivmelendirilmiş **yüklü** parçacıklardır. .

Dolayısıyla, Güneş'in, Yer'in hatta Samanyolu'nun manyetik alan çizgileri, bunların orijinal yollarından sapmalarına neden olur.

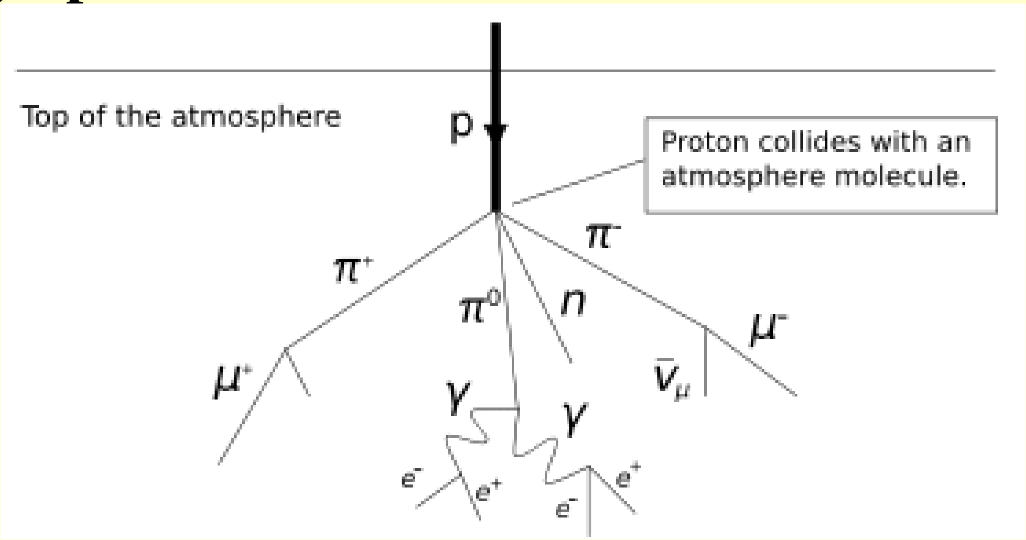
The cosmic rays can be divided into two sub-groups: Primary and secondary CRs.

Secondary CRs are the product of primary CRs' interaction with interstellar matter .

Observations of CRs: When CRs enter Earth atmosphere, they strongly interact with the nuclei of atmospheric molecules, mainly O and N.

This interaction, called as atmospheric **particle shower** or **air shower**, results in **pions, kaons and muons**.

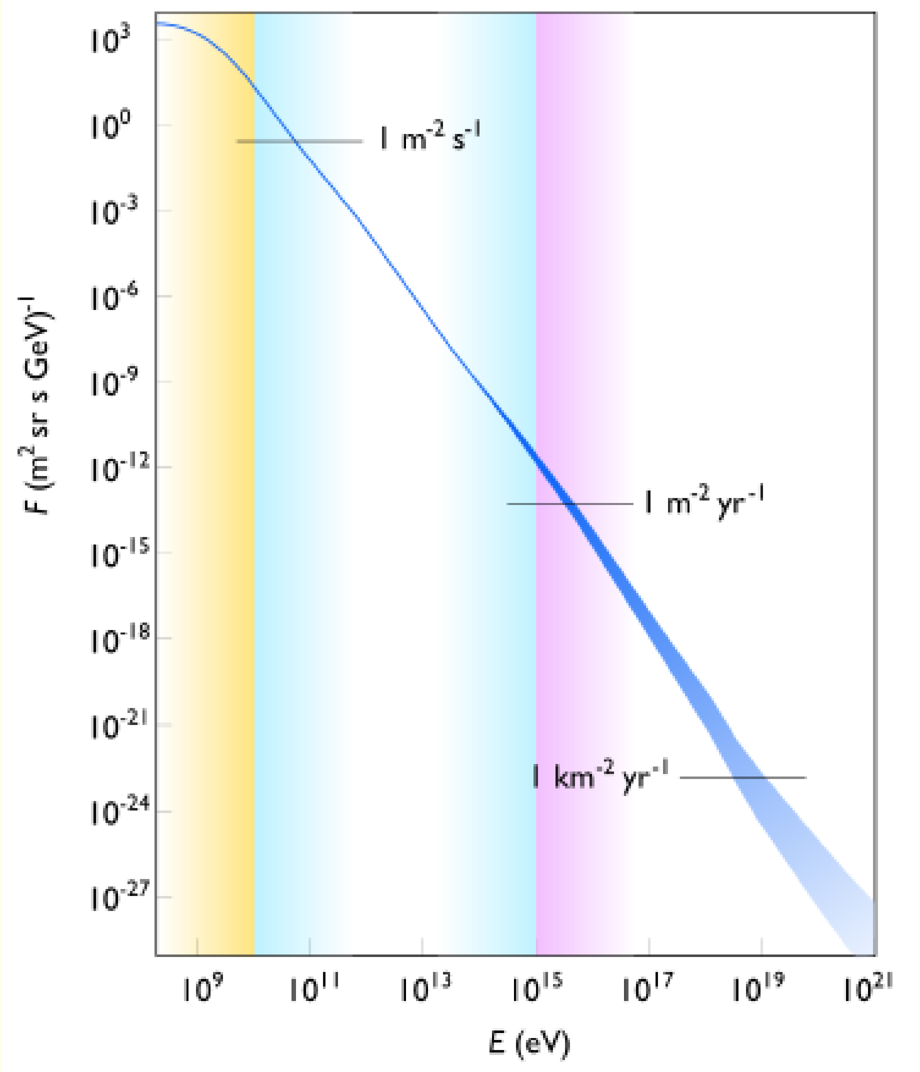
End product of muons is **radiation** which can be **recorded** by **stereographic dedectors** located on Earth surface.



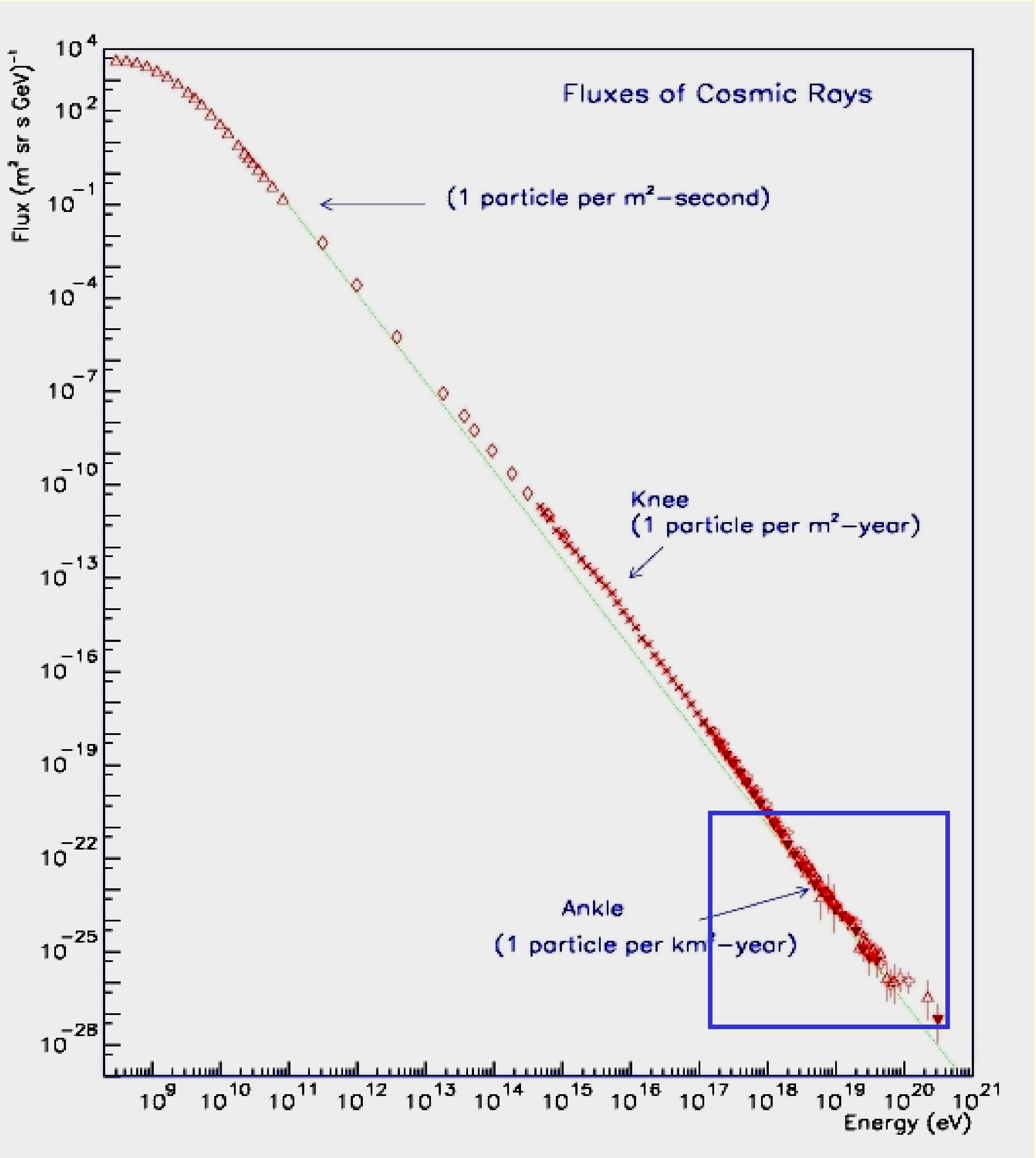
Cosmic rays were **discovered** in **1912** by Victor Hess, when he observed an **electroscope's charge** launched in a balloon.

This discovery brought him the Nobel Prize in 1936.

Spectral profile of CRs : →

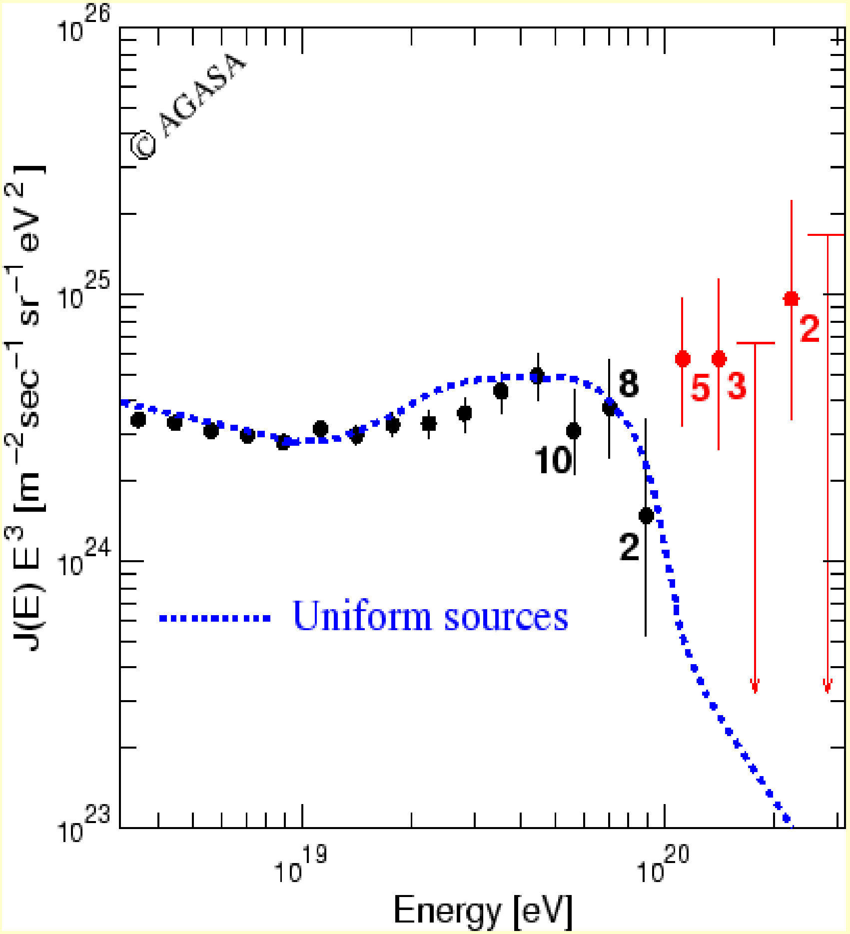


Cosmic Ray Energy Spectrum



Cosmic Ray Energy Spectrum

GZK (*Greisen–Zatsepin–Kuzmin*) **cutoff**: **Cosmic rays** with energies over the threshold energy of **6×10^{19} eV** would **interact** with **cosmic microwave background photons** to produce pions.

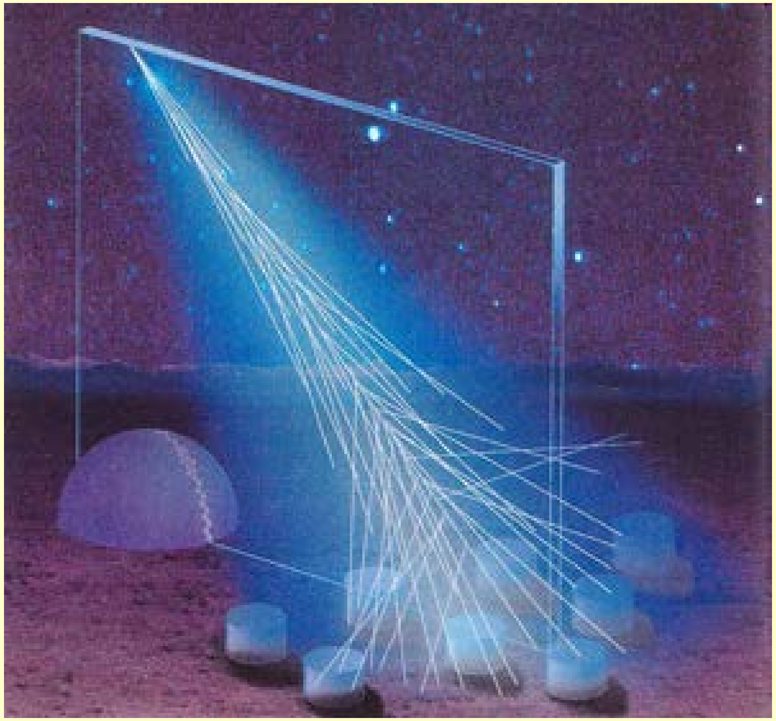


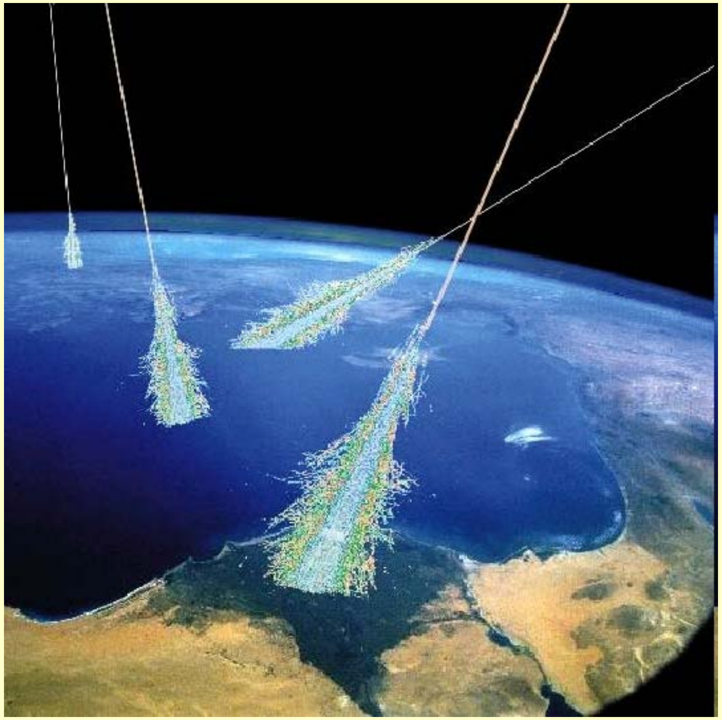
Cosmic rays with **energies above 10^{14} eV** are studied with large "**air shower**" arrays of detectors **distributed over many square kilometers**.

The number of particles in air showers:

100 events per m^2 per year **for energies >10^{15}** eV

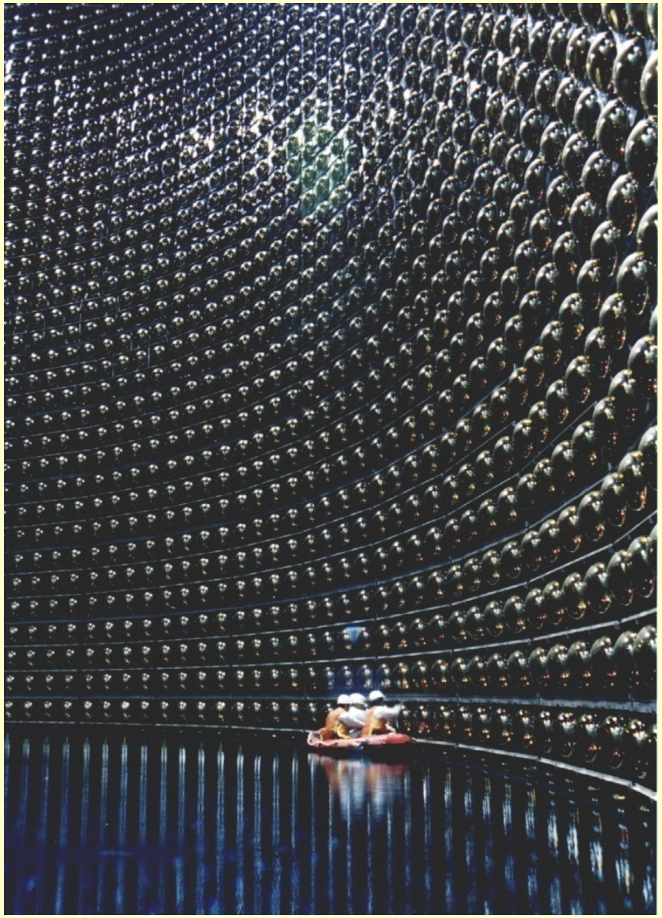
1 event per **km^2 per century for energies beyond 10^{20}** eV!

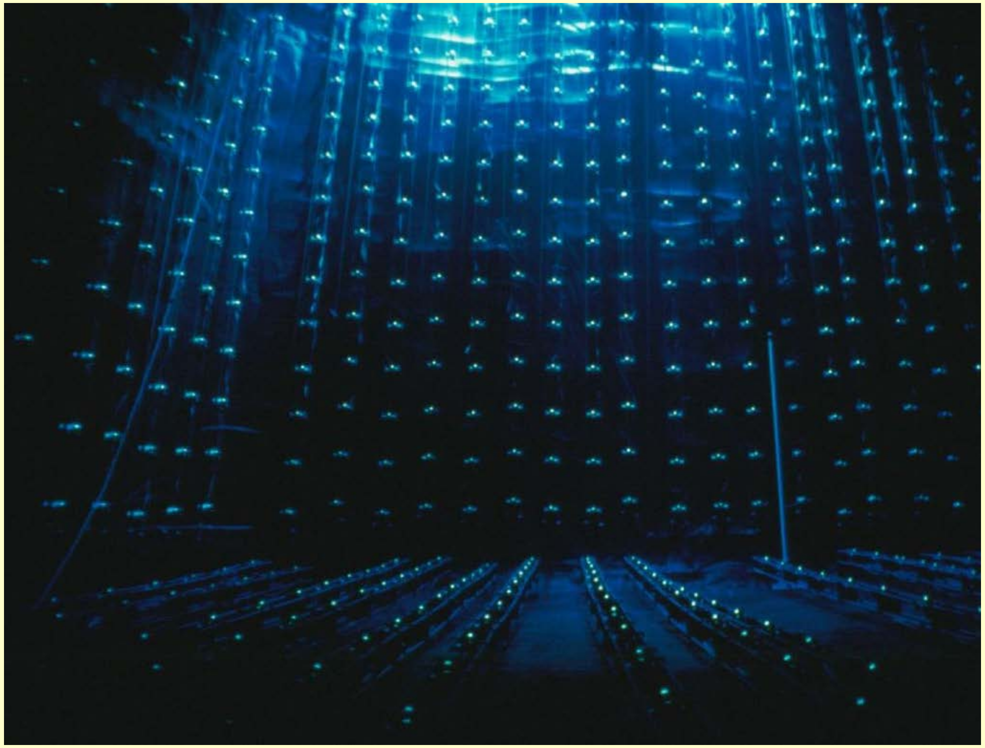




Few selected CR dedectors/observatories : **Super-K Neutrino dedector**

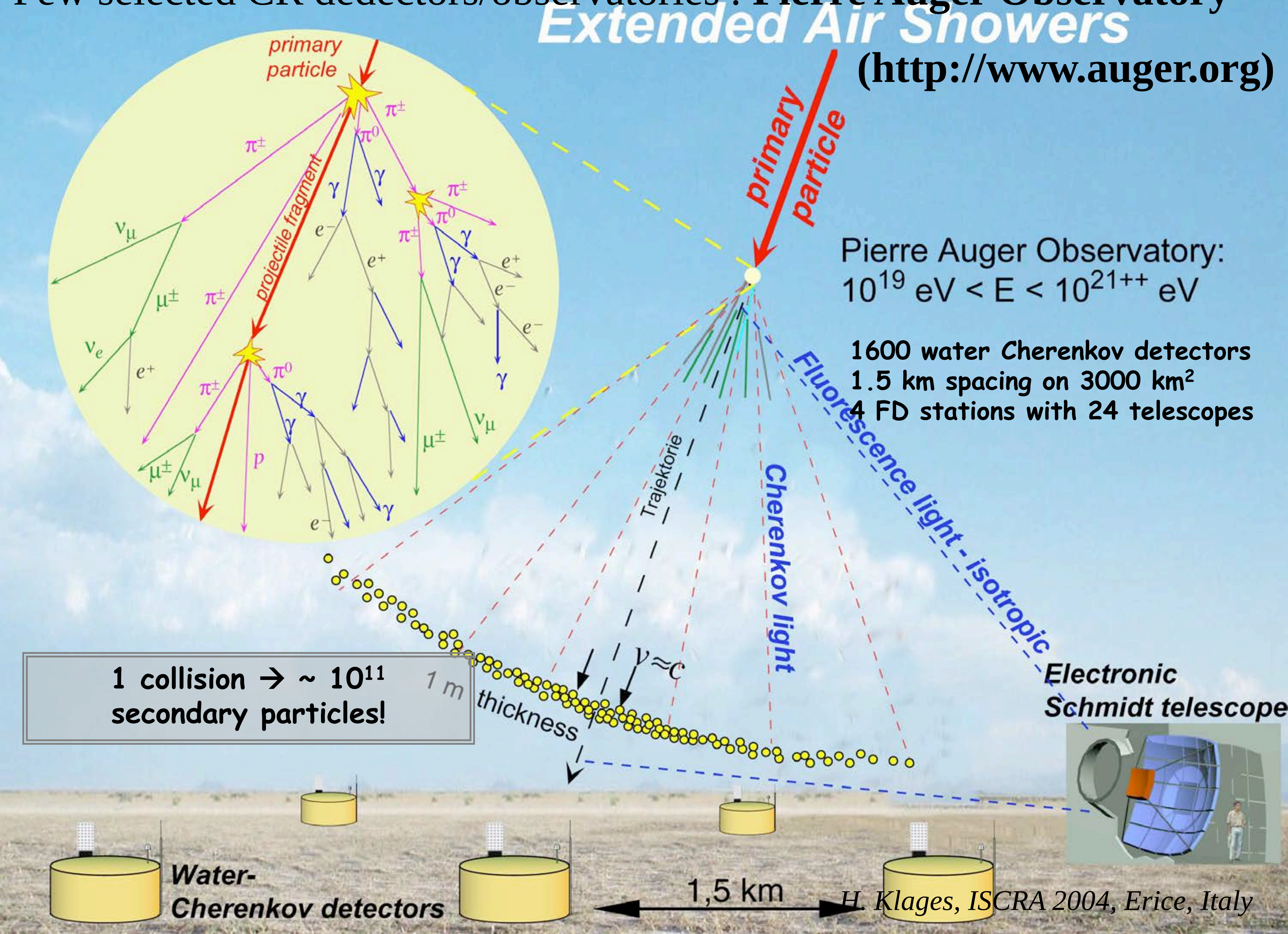
Neutrinos as the result of cosmic ray interactions can be **detected** by large area detectors **placed in underground** mines or **under water**.





Few selected CR dedectors/observatories : **Pierre Auger Observatory**

(http://www.auger.org)

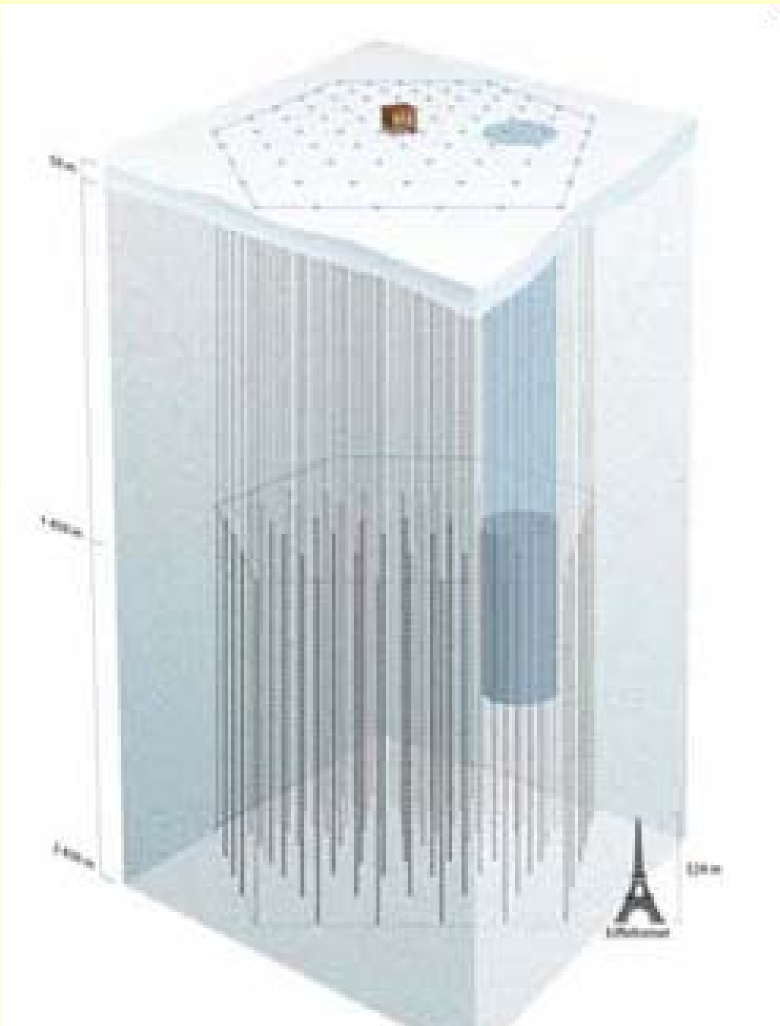


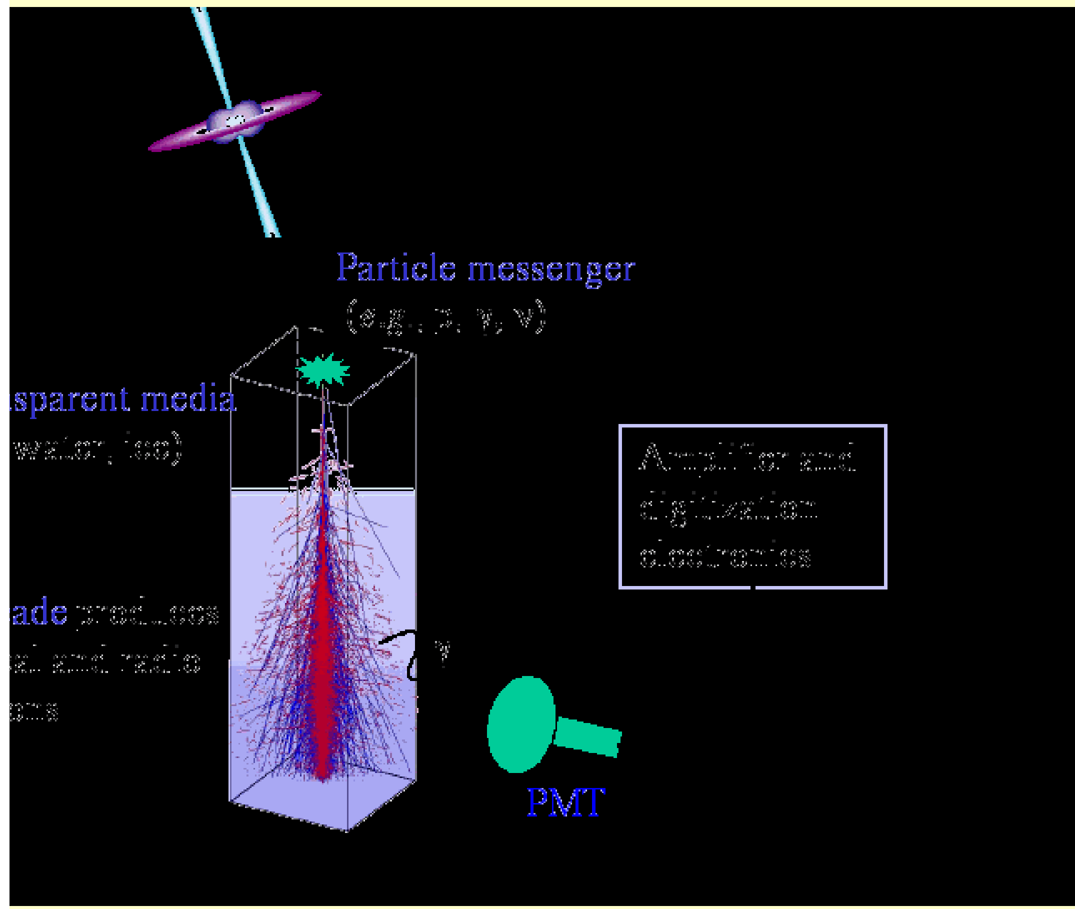
H. Klages, ISCRA 2004, Erice, Italy

Few selected CR dedectors/observatories : **AMANDA II**

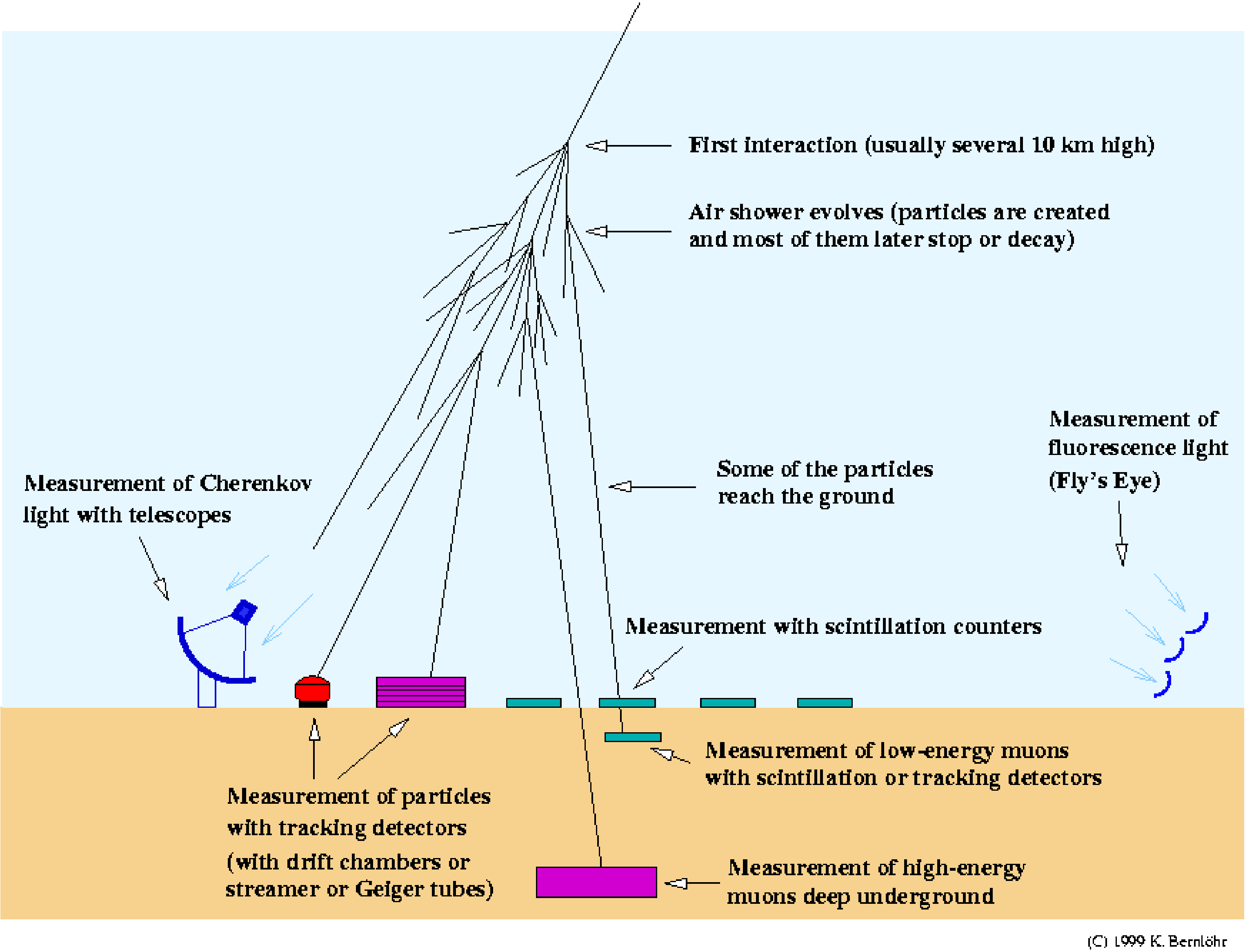
Constructed into the Antarctic ice! (http://amanda.uci.edu)

An international collaboration involving institutions from the US, Germany, **Sweden**, Belgium, and Venezuela.

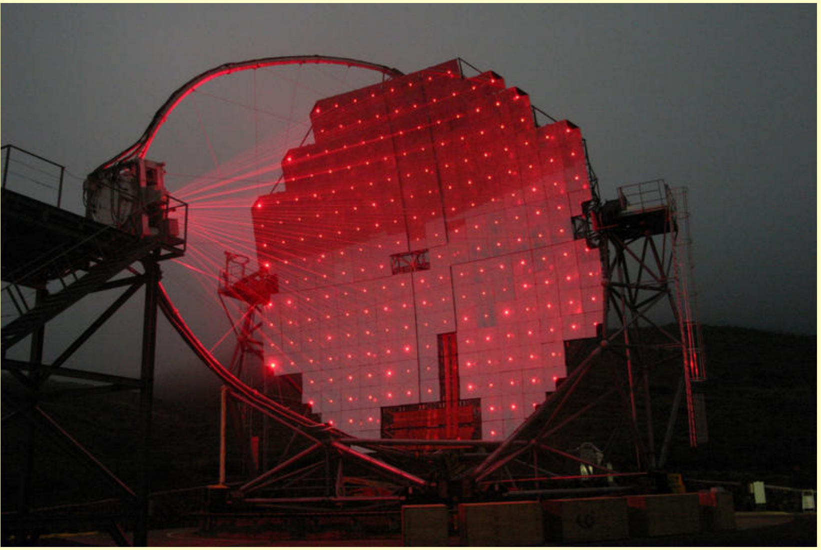


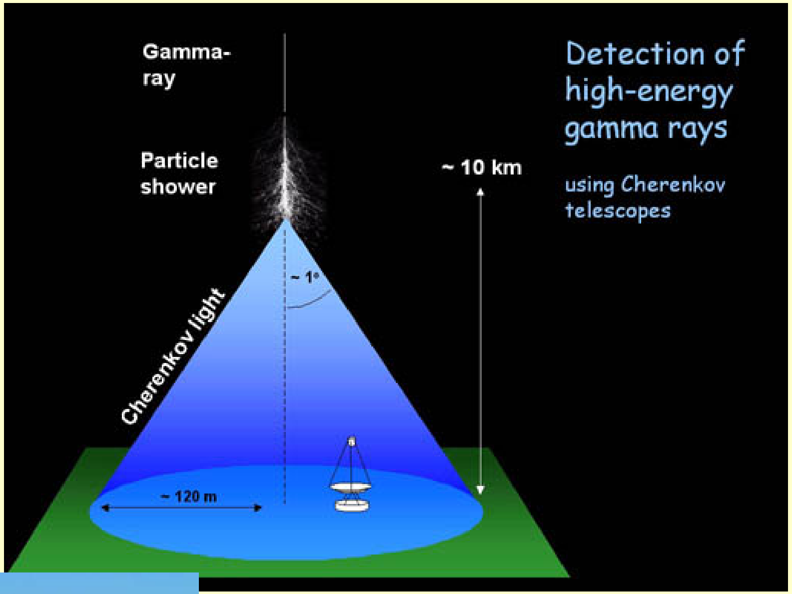


Measuring cosmic-ray and gamma-ray air showers

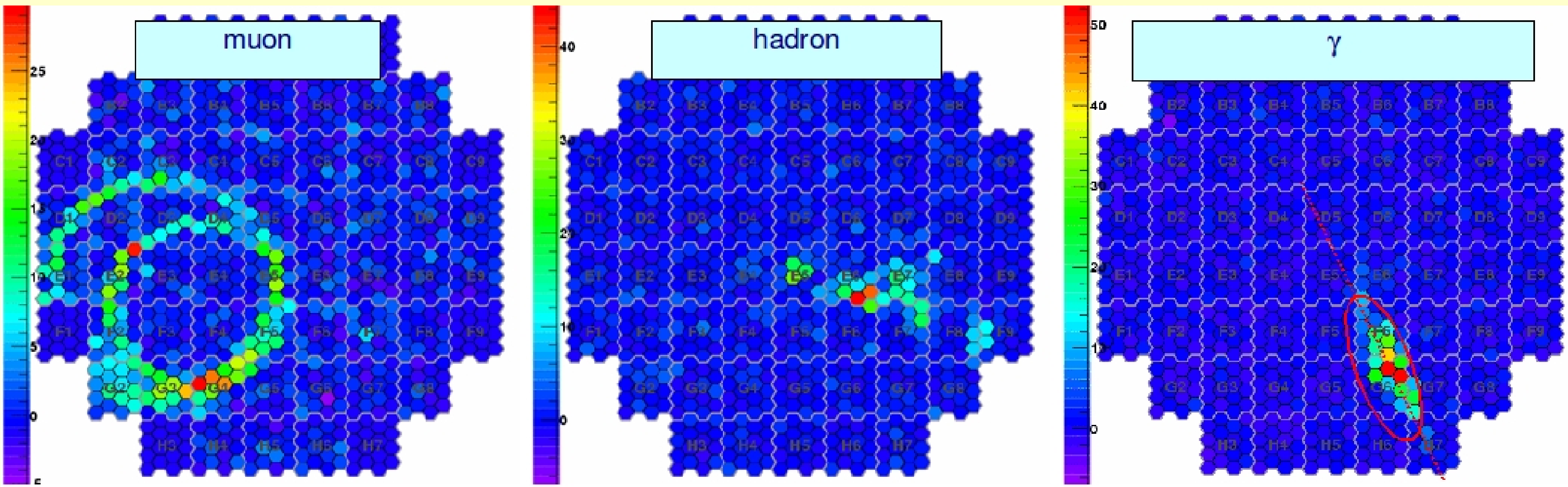


Hava Duşu Cherenkov Teleskop Dizileri

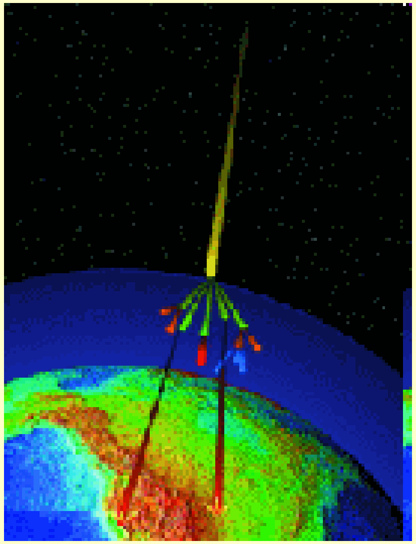




Elde edilen görüntülerden parçacığın türü tahmin edilebilir.



Few selected CR dedectors/observatories : **SLAC, Stanford Linear Accelerator Center**

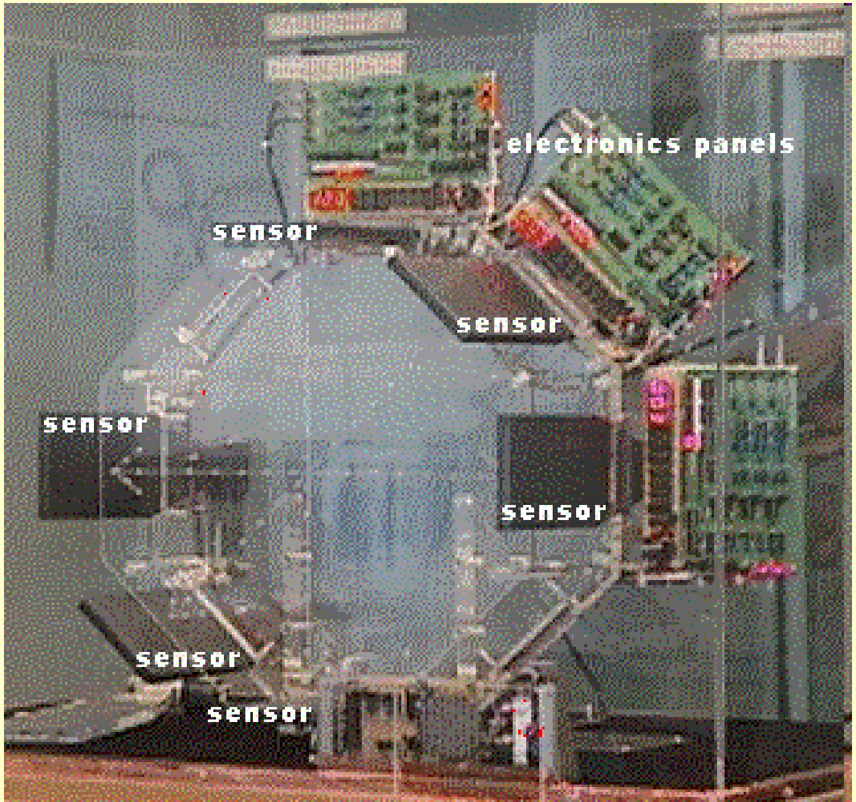


When a **proton** (yellow) **hits** the air in the Earth's upper atmosphere, it produces many particles.

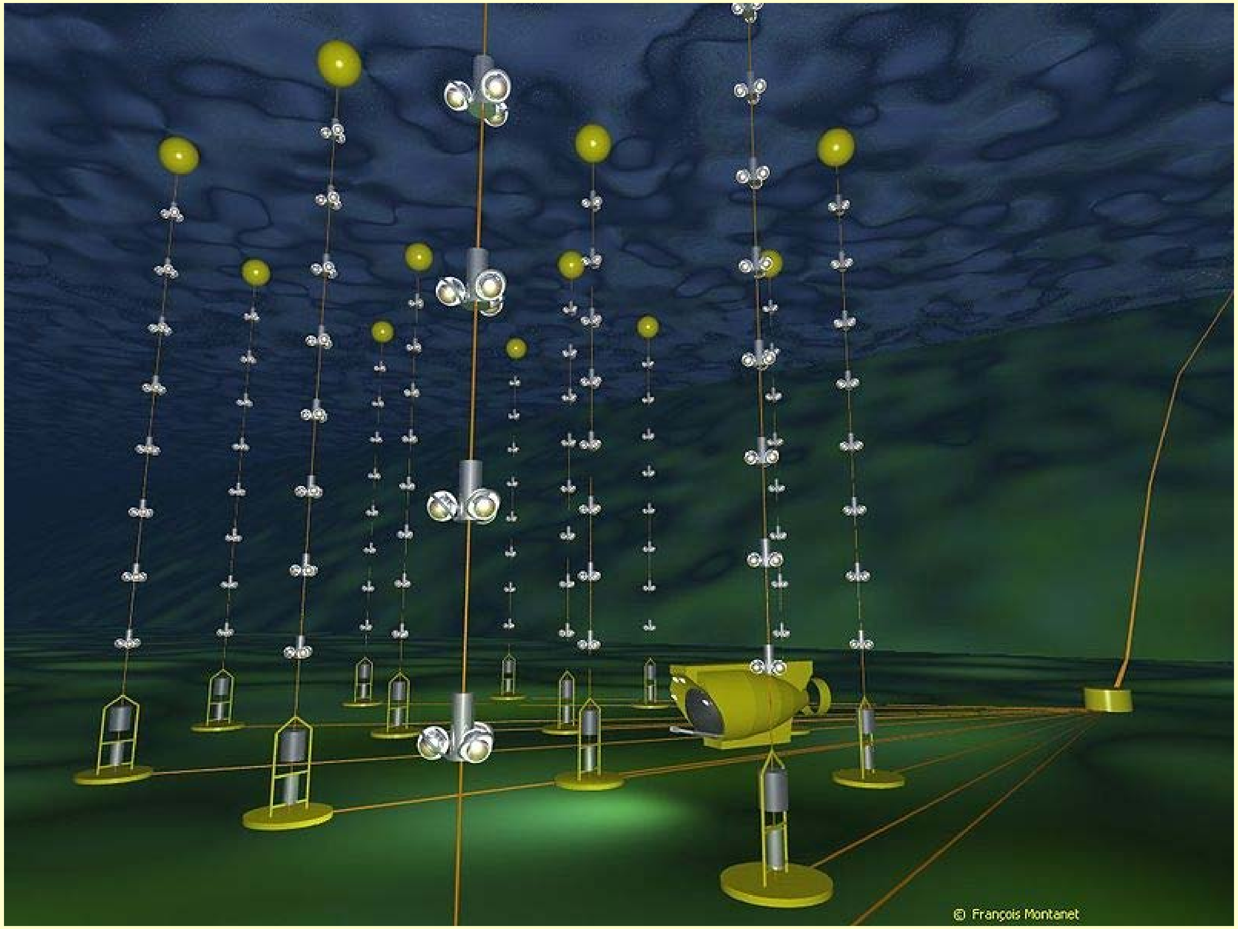
Most of these decay or are absorbed in the atmosphere.

One of these particles, **muons** (red), has long lifetime (2.2×10^{-6} s) to reach the Earth's surface.

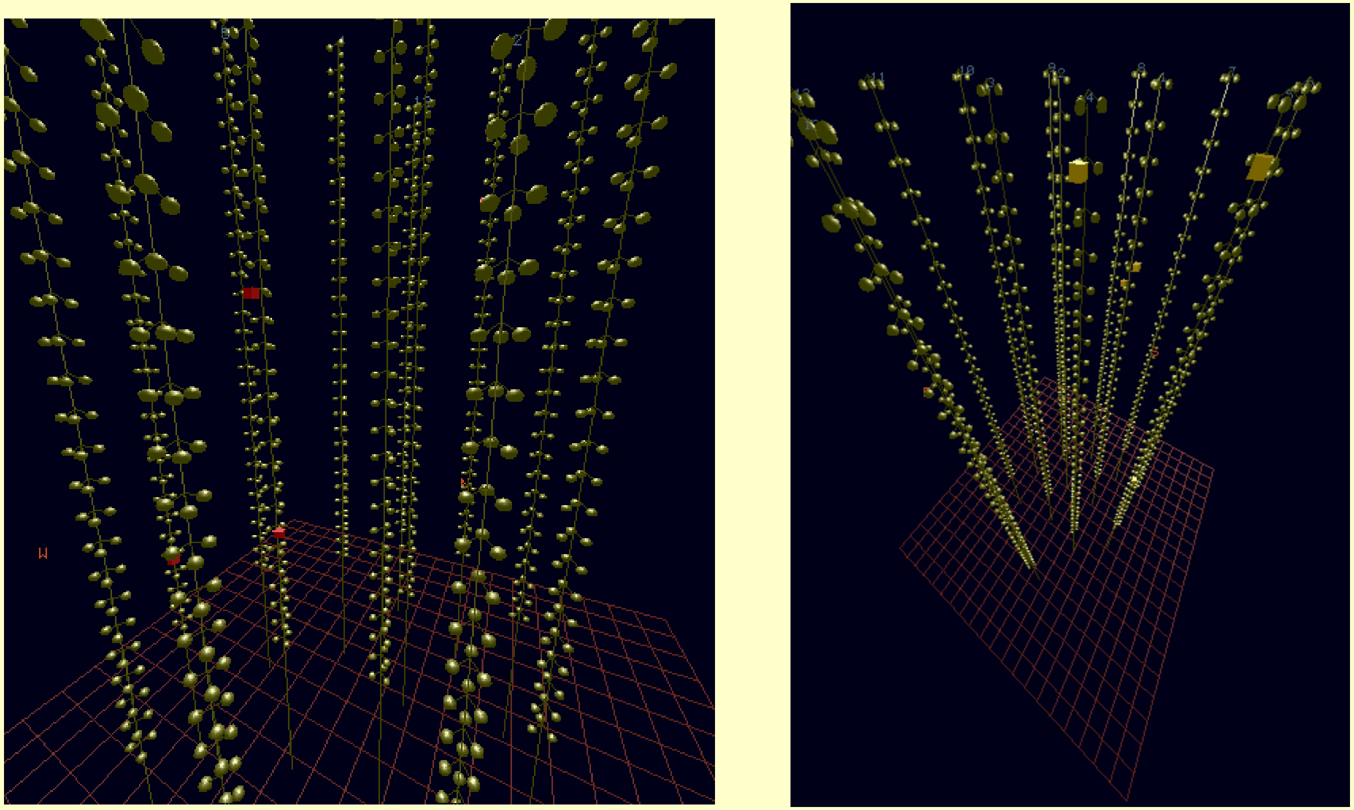
A muon dedector →




ANTARES (telescope)



Akdenizin 2.5 km altına, deniz dibine yerleştirilmiştir. 350 m uzunluğundaki12 ayrı hattın her birinin üzerinde, 75 adet optik tüp bulunur.



1.2 TeV’luk bir müon’nun Antares’ten geçişi.

Küre şeklinde gösterilen optik dedektörler, deniz dibindeki iletişim ağına (kırmızı ızgara) bağlanmıştır. Nötrinolar **sarı** çizgilerle gösterilirken, diğer tüm parçacıklar ve bunlar arasında birkaç metre serbest yola sahip tek parçacık olan müonlar, mavi renkte gösterilmiştir. Yüklü parçacıkların yaydıkları ışığın fototüpler tarafından algılanması, renkli küplerle gösterilmiştir. Kübün boyutu algılanan ışığın şiddetini göstermektedir.

Tüm bu parçacıklar ışık hızına yakın hızlarda hareket edeceğinden, olayın tamamı ancak **birkaç mikrosaniye** sürecektir.

OPERA (Oscillation Project with Emulsion-tRacking Apparatus) Deneyi

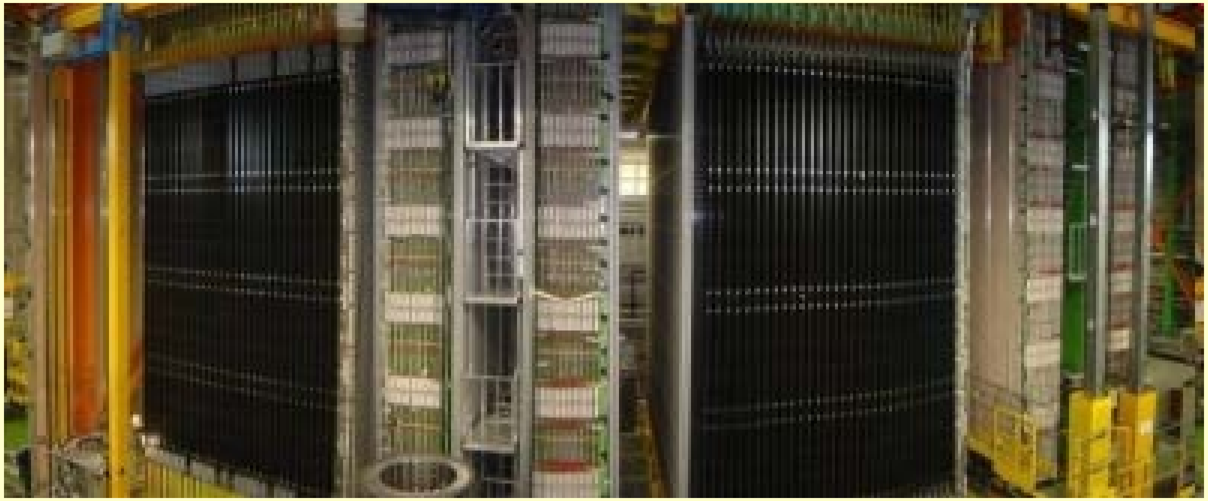
Müon nötrinolarının salınımı sonucunda oluşan tau nötrinolarını gözlemek için geliştirilmiş bir dedektördür. Italya Gran Sasso da yerin altına kurulmuştur.

Dedektörde, kurşun plakalarla birbirlerinden ayrılış olan nükleer emulsiyonlar ile tau nötrinoları yakalanmaya çalışılmaktadır.

31 mayıs 2010 da OPERA araştırmacıları, bir müon nötrinosu demetinin içerisinde ilk defa bir **TAU NÖTRİNOSU** gözlediler!

Eylül 2011 de **ışıktan (20/1 milyon kadar) hızlı** hareket eden müon nötrinoları gözledirler! Ancak daha sonra bunun bir **ölçüm hatasından** kaynaklandığı açıklandı.

OPERA deney düzeneği



CERN de üretilen müon nötrinosu demeti, 730 km uzaklıktaki OPERA deneyine yönlendirilir.

http://operaweb.lngs.infn.it/?lang=en

Why are CRs so important ?

LHC (CERN, the world's **largest particle physics laboratory**) : protons at an energy of **7 TeV/particle!**

Tevatron (at the Fermi National Accelerator Laboratory in Illinois) : **1 TeV**!

Whereas, **CRs** can **extend** up to **10^{20} eV**!

The more energy you reach, the more numbers of subatomic UNKNOWN particles you can discover!

Few references :

http://laspace.lsu.edu/ISCRA/ISCRA2004/

http://www.auger.org/

http://www.slac.stanford.edu/

http://amanda.uci.edu/

http://www-akeno.icrr.u-tokyo.ac.jp/AGASA/