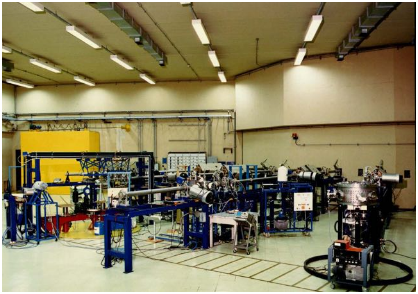
Facilities in Latin America



Xavier Bertou
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Laboratorio Detección
de Partículas y Radiación

Centro Atómico Bariloche
CNEA/CONICET

8th CERN Latin-American
School of High-Energy Physics
Ibarra, Ecuador, 4-17 March 2015

Astroparticle Facilities in Latin America

Plan of the talk

- Why talk about Astroparticle Facilities in Latin America
- Current Astroparticle Facilities in Latin America
  - The Pierre Auger Observatory
  - The Latin American Giant Observatory (LAGO)
  - The High Altitude Water Cherenkov (HAWC)
- Future Astroparticle Facilities in Latin America
  - HAWC Southern Hemisphere Site
  - The Cherenkov Telescope Array (CTA)
  - The ANDES Deep Underground Laboratory

WE WANT YOU!

Why talk about Astroparticle Facilities in Latin America

What is Astroparticle Physics?

Astroparticle physics, [...], is a branch of particle physics that studies elementary particles of astronomical origin and their relation to astrophysics and cosmology. It is a relatively new field of research emerging at the intersection of particle physics, astronomy, astrophysics, detector physics, relativity, solid state physics, and cosmology. (Wikipedia)

Astroparticle physics is a new multidisciplinary field of research that deals with the study of particles coming from the Universe. (ASPERA)

Astroparticle physics is Astrophysics done by Particle Physicists (Common knowledge)

Why do Particle Physicist do Astrophysics?

- Because they think they will find new physics
  - Dark Matter search in Gamma Ray observatories
  - Top-down Cosmic Ray production
- Because they want to stay in small collaborations
  - More visibility in individual work
  - More responsabilities in the projects
- Astroparticle Physics needs Particle Physics detectors

Note: After 20 years, Particle Physicists found the Higgs, Astroparticle Physicists are doing Astrophysics

Note 2: Even if new Astroparticle projects start to be huge (1200 members for CTA), there are still many frontier small experiments in Astroparticle Physics

Particle Physics Facilities in Latin America

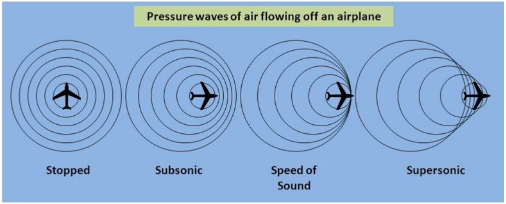
- Laboratorio Tandar
- Laboratório Nacional de Luz Síncrotron
- Central Nuclear Almirante Álvaro Alberto
- Centro Atómico Bariloche
- ...

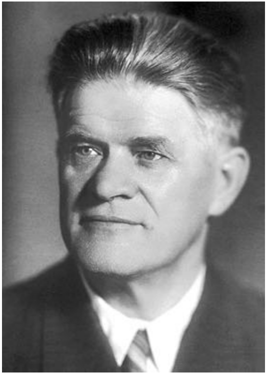
Particle Physics experimental facilities becoming too large to be handled by single institutions

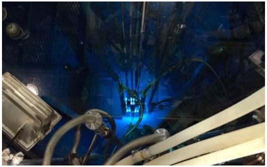
No "true" Particle Physics experimental facility in Latin America (neither now nor in the near or not-so-near future)

Current Astroparticle Facilities in Latin America

Parenthesis on the Cherenkov effect





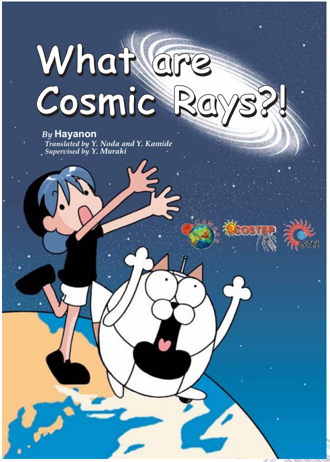


The Pierre Auger Observatory

The Cosmic Ray Enigma

- CR are energetic radiation from space
- Discovered in 1912 by Victor Hess
- Named Cosmic Rays by Millikan

Reading for your kids:



http://www.telescopearray.org/media/cosmicrays_e.pdf

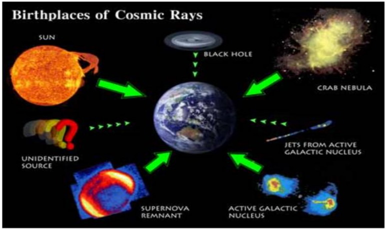
What are Cosmic Rays?

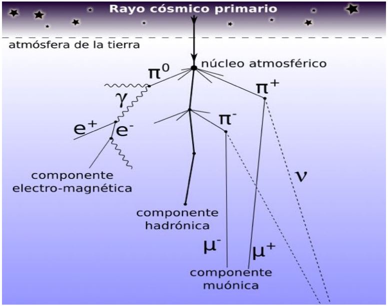
Primaries

- Proton
- Nuclei (He... CNO... Fe)
- Gammas
- Neutrinos...

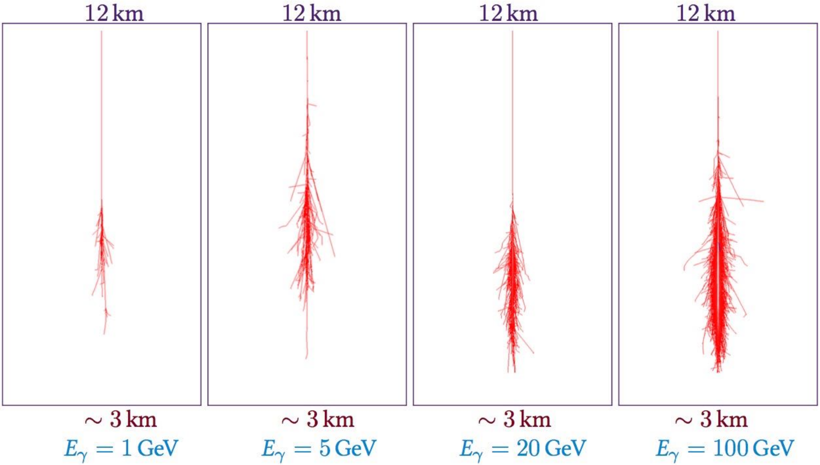
Secondaries

- muons
- electrons/positrons
- gammas
- neutrons
- neutrinos
- ...

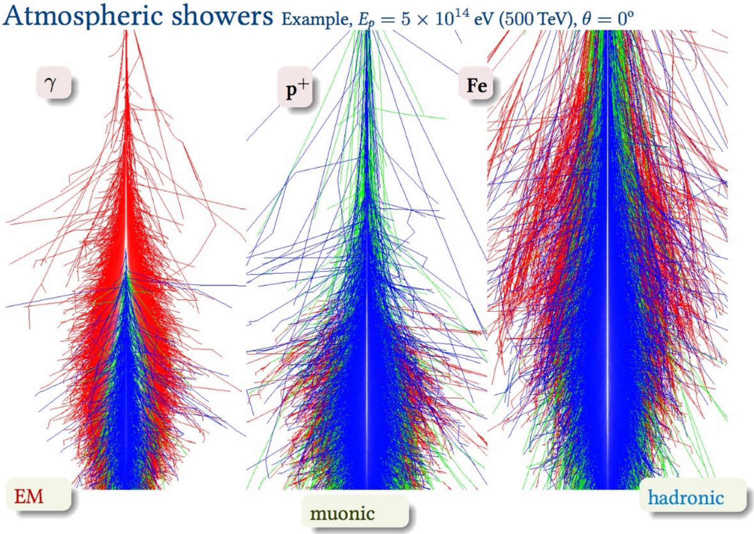




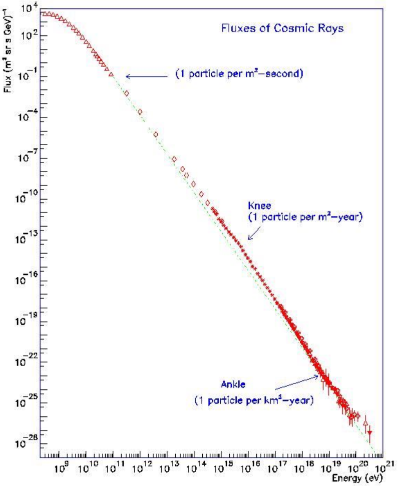
Cascade simulation vs Energy



Extended Air Shower components



Cosmic Rays Spectrum



- Power law with index 2.7
- 12 orders of magnitude in energy
- 32 orders of magnitude in flux
- only few features
  - Knee: 1 event/m^2/year
  - Ankle: 1 event/km^2/year

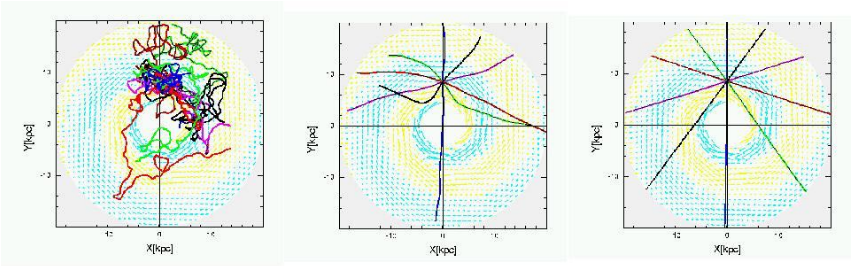
UHECR

- At 10^{20} eV: 1 event/km^2/century?
- First event: Volcano Ranch, 1962

UHECR Astronomy

Magnetic fields

At low energies, CR are deflected by galactic and extra-galactic magnetic fields.
UHECR (protons in particular) should point to the source

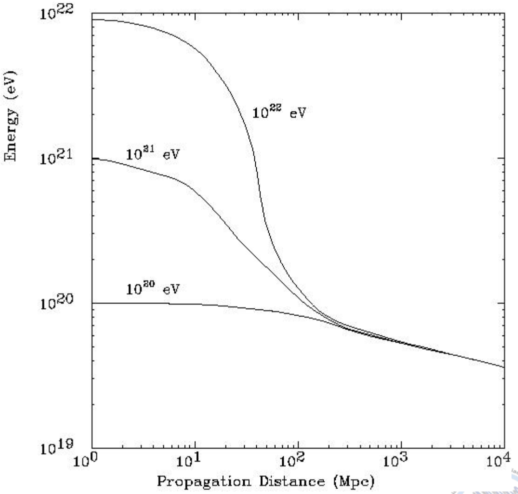


10^{18} eV $\quad$ 10^{19} eV $\quad$ 10^{20} eV

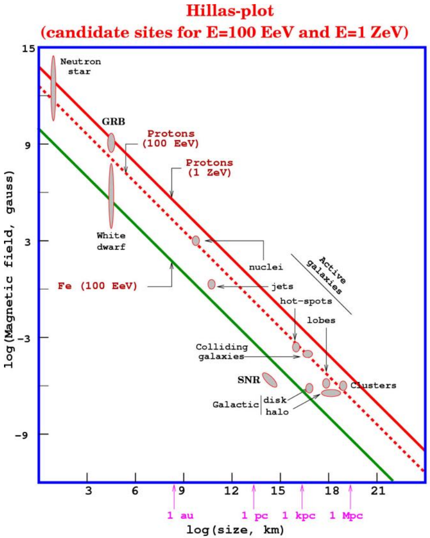
GZK cut-off

At UHE, protons interact with CMB photons by photo production, and nuclei with CMB and IR photons through photo dissociation

UHECR should lose energy quickly on short distances ($< 100\,\mathrm{Mpc}$)



UHECR Sources?



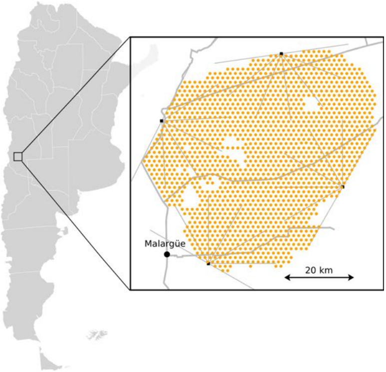
Bottom-Up

- $E_{max} \simeq Z\,B\,L$

Top-Down

- Super massive particle
- Topological Defect
  - neutrinos
  - photons

The Pierre Auger Observatory



Design

- UHECR study ($E \geq 10^{18}$ eV)
- Construction over in 2008

UHECR hybrid detection

- Ground detectors (SD): 1600 Water Cherenkov Detectors covering 3000 km^2 on a 1500 m triangular grid
- Fluorescence detectors (FD): 24 fluorescence telescopes in 4 sites observing over the SD area

In Malargüe (Argentina)

- 69.3$^{\mathrm{o}}$ W, 35.3$^{\mathrm{o}}$ S
- 1400 m a.s.l. (870 $\mathrm{g\,cm^{-2}}$)

Ground detectors: WCD

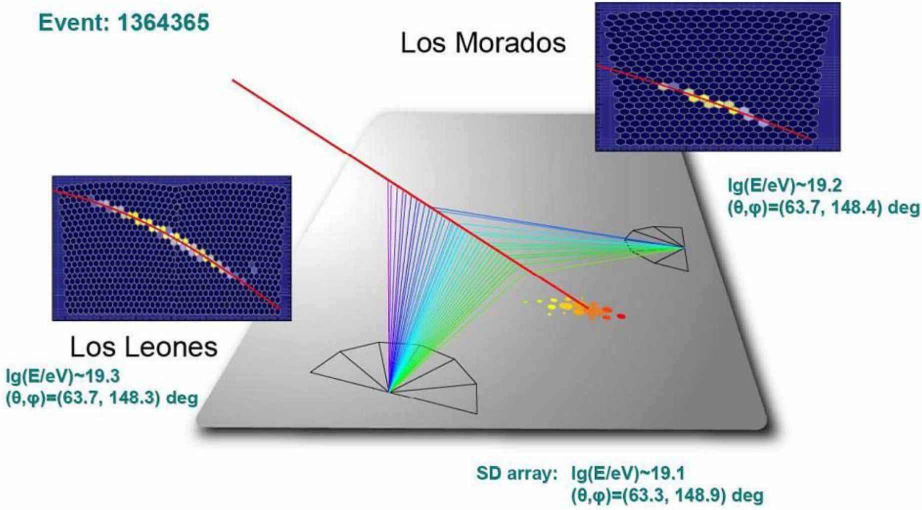
- 10 m^2 area rotationally molded polyethylene tanks
- 12 m^3 ultra pure water in a diffusive bag
- Cherenkov light collected by three 9" PMTs
- 40 MHz FADC digitization
- Radio wireless communication
- GPS based timing
- Battery and solar panel powered

Fluorescence telescopes

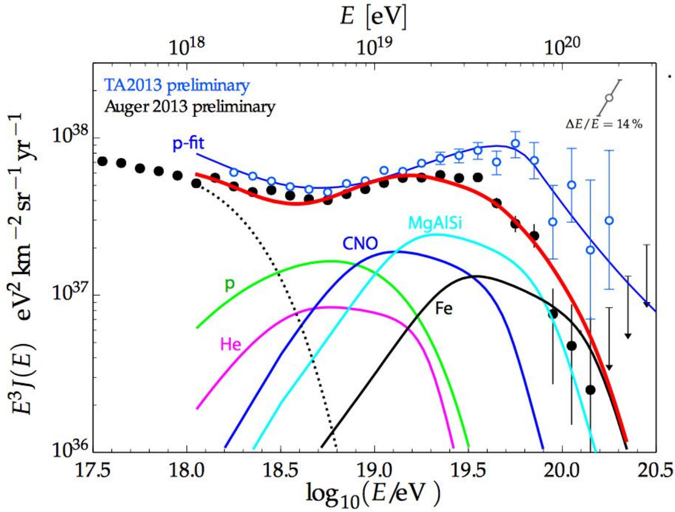
- 4 FD buildings
- 6 cameras per building
- UV filters
- 440 PMT per camera

- $180^\circ \times 30^\circ$ field of view
- 10% duty cycle
- Observes longitudinal development
- Calorimetric energy measurement
- Composition measurement (X_{max})

Hybrid events



Spectrum and possible composition interpretation



Pierre Auger Observatory main results

- UHECR are regular nuclei (H $\rightarrow$ Fe), no γ, no ν
- UHECR are produced by astrophysical sources
- UHECR look heavy at the highest energies
- Cut at highest energies isn't necessarily the GZK cutoff
- UHECR flux might not extend (much) after 10^{20} eV:
  ≈ 1 event/km^2/millennium
- Astronomy with heavy primaries will be tough
- Current game at UHECR is in composition measurements
- Beyond 2015 Auger upgrade plan:
  - Add Scintillator detector on each WCD
  - Measure muon and EM components
  - Composition event by event

Other results from the Pierre Auger Observatory

- High energy interaction model studies
- Proton-air cross section measurements
- Muon component in Extensive Air Showers
- No excess from Galactic Center
- Point sources with neutral primary (neutrons, photons)
- Radio detection of EAS (geosynchrotron - MHz, molecular bremsstrahlung - GHz?)
- Atmospheric studies
- Solar physics
- TLE/Elves/Lightning physics

- Not only an observatory, a complete research facility

The Latin American Giant Observatory (LAGO)

Slides from H. Asorey

The Latin American Giant Observatory (LAGO)

- Argentina, Bolivia, Colombia, Ecuador, Guatemala, Mexico, Peru & Venezuela

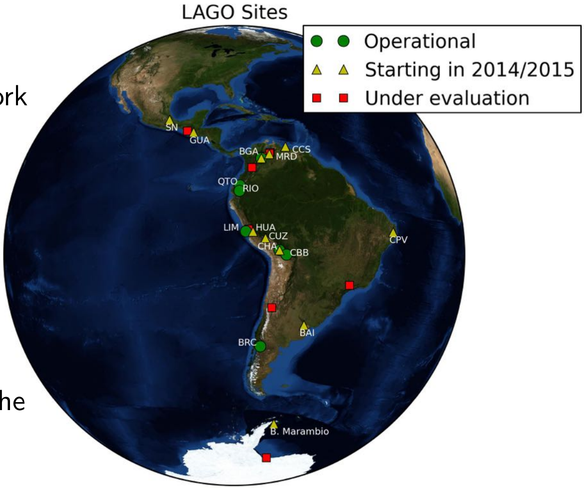
+ Brazil in 2015

- 70 members from 22 institutions at 9 Latin American countries
- Scientific goals:
  - Astroparticles up to the CR knee
  - Study background radiation, transient and long term Space Weather phenomena trough Solar modulation of Cosmic Rays
- Academic goals:
  - Train Latin American students in H.E. and Astroparticle techniques
  - Build a Latin American network of Astroparticle researchers

A very long baseline “array” of WCD

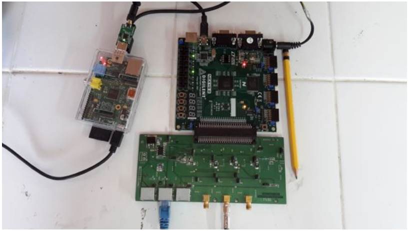
Organization:

- Non-centralized, collaborative network of institutions
- 3 working groups, 9+2 members coordination committee, 1 pi
- Developments, expertize and data are shared across the network



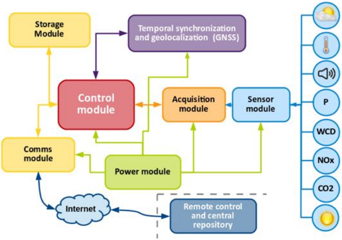
The detector: the sWCD (*s* as in *smart*)

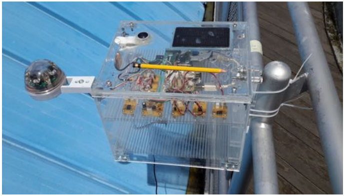
- Autonomous, reliable, simple and cheap detector
- Commercial tanks with $1.5\,\mathrm{m}^2 - 10\,\mathrm{m}^2$ of detection area filled with purified water
- Inner coating of Tyvek (UV diffusive and reflective fabric)
- PMT + Digitizer board (own design, openly available)
- FPGA + Raspberry Pi: detector control, telemetry, data acquisition and on board data pre-analysis



- Digitized signals by a 10-14 bits FADC at 40-100 MHz (10-25 ns)
- Temporal synchronization: GPS in PPS mode
- Power consumption: $\lesssim 8\,\mathrm{W}$

The station: the smart LAGO-WCD





- Arduino-One + environmental sensors (P, T, CO_2, NO_x, radiance, ...)
- Control (Raspberry Pi): data conformation, pre-processing and control
- Power: 15 W solar panel and batteries
- GNSS: geo-localization and time synchronization
- Comms by standard protocols: WiFi, GPRS (2.5G-3G-3.5G), 4G-LTE

LAGO Programs

LAGO-Extreme Universe

- Gamma Ray Burst HE monitor
- High energy astroparticles
- Towards CR knees region

LAGO-Space Weather

- Cosmic ray solar modulation
- Possible connections with physics of the atmosphere
- Background radiation at ground (and flight) level

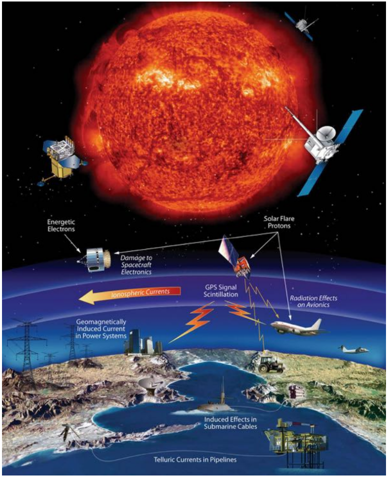
LAGO-Virtual

- Acquire, produce, collect and preserve LAGO data

LAGO-Universities

- Astrophysics and particle physics in undergraduate courses
- Data analysis and statistic
- Muon decay
- Detector physics and interaction of radiation with matter
- Construction and characterization of particles detectors

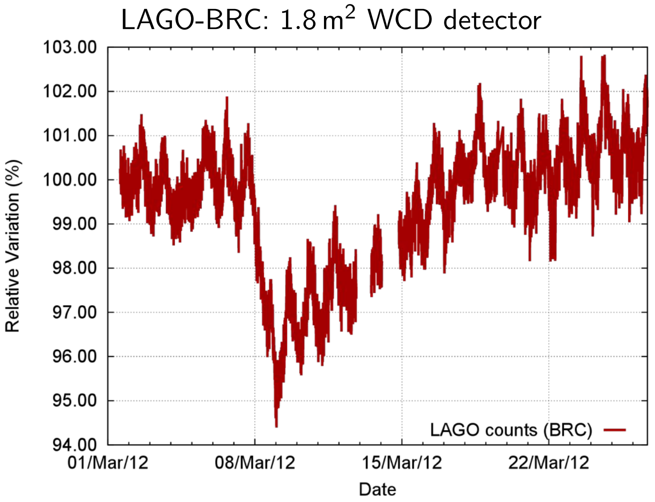
Space Weather



Sun-Earth connection

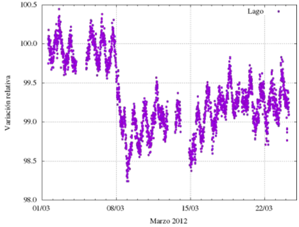
- Dynamic conditions in the Earth outer space environment:
  - Disruption of electrical power grids
  - Contribute to the corrosion of long pipelines
  - HF radio communications and GPS interferences
  - Operational anomalies and damage or degradation of critical electronics on spacecraft, satellites and even on board of commercial airplanes

Forbush decrease with a single LAGO WCD



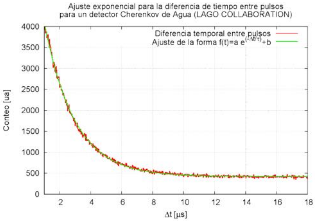
LAGO-Universities

Introductory Physics Course 2014
Universidad Industrial de Santander
python + gnuplot + data analysis



Particle Physics or Experimental Physics courses at UIS (COL), Balseiro (ARG) and UCV (VEN)

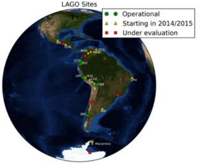
Electroweak theory + python + data analysis techniques

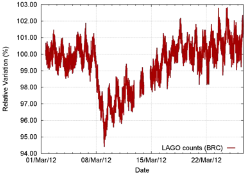


$$\tau_\mu = (2020 \pm 0.1)\ \mathrm{ns}$$

LAGO Summary

- sWCD and environmental stations: data for other communities
- Full simulation chain: from primary flux to detector signals
- Observation of Space Weather phenomena at ground by using sWCDs at different sites
- Ultra long baseline "array" of WCD from Mexico to Antarctica
- High and low altitude sites across the Andean range: Background radiation, Space Weather and HE
- Local to regional integration of Universities and Citizen Science
- Developing Astroparticle in as many LA countries as possible





The High Altitude Water Cherenkov (HAWC)

Slides from M. Mostafa

HAWC

High Altitude Water Cherenkov
Gamma-Ray Observatory

HAWC precursor

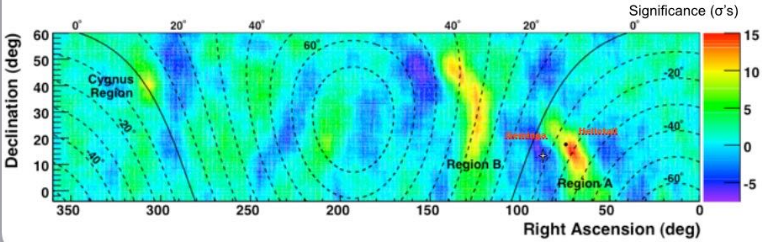
(site at 2650 m of altitude)

Scientific Motivation

- Constrain the **origin of cosmic rays** by measuring gamma-ray **spectra to 100 TeV**.
- Probe **particle acceleration** in astrophysical jets with **wide field of view, high duty factor** observations.
- Explore **new physics** with an **unbiased survey** of the **TeV sky**.

Milagro Results

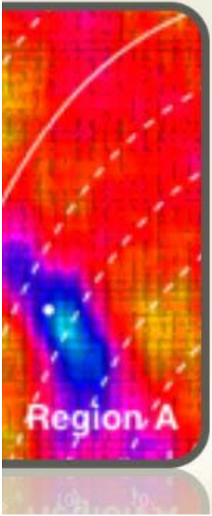
Map of significances for the Milagro (cosmic rays) data set



Milagro observes anisotropy in **10 TeV** cosmic rays.
HAWC will have **better energy resolution** plus a **higher rate**

Milagro Collaboration, Physical Review Letters **101** (2008) 221101

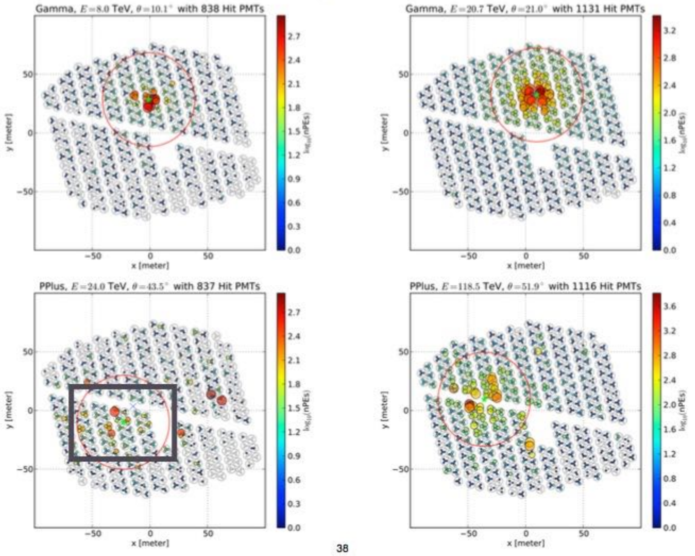
Milagro Discoveries

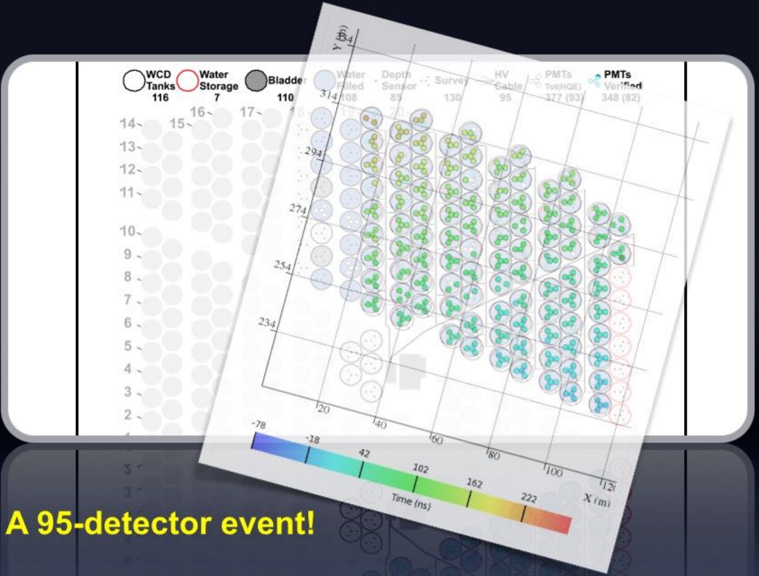


- over a dozen **TeV sources**
- **diffuse TeV emission** from the Galactic plane
- directional **excess of cosmic rays**

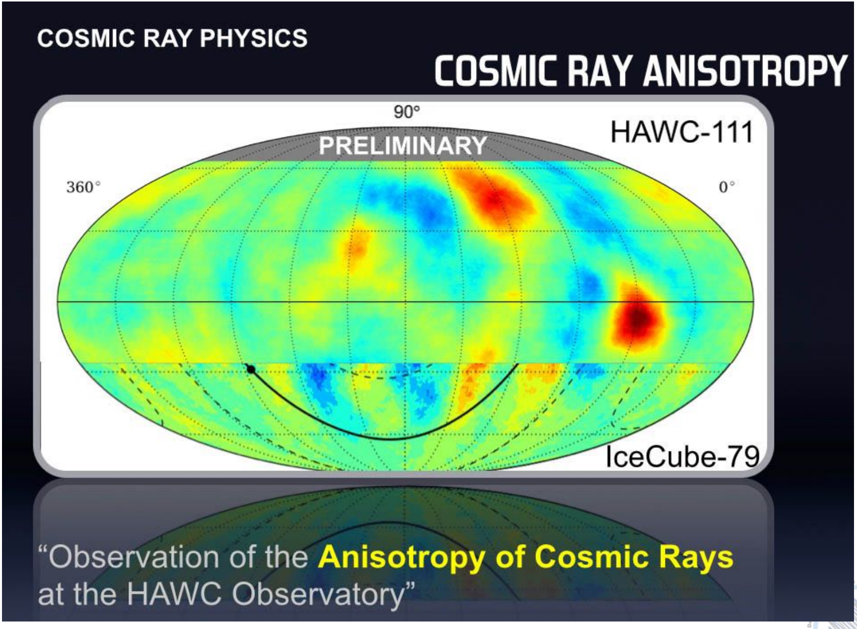

HAWC tanks
Auger tank

γ/h separation





A 95-detector event!

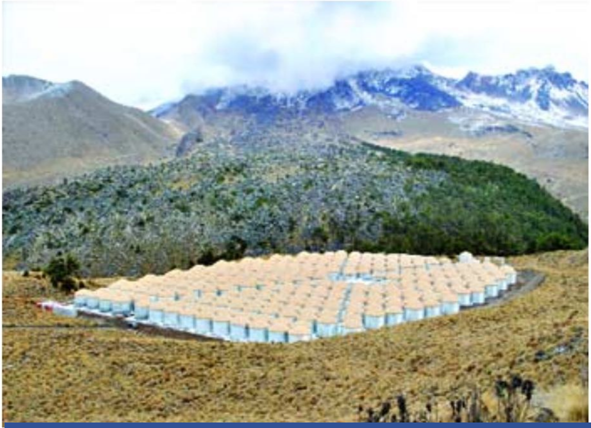

COSMIC RAY PHYSICS
COSMIC RAY ANISOTROPY
90°
HAWC-111
PRELIMINARY
360°
0°
IceCube-79
“Observation of the Anisotropy of Cosmic Rays at the HAWC Observatory”

HAWC Science

- Discover the **origin of cosmic rays** via **HAWC's observations of γ-rays up to 100 TeV** from discrete sources and the Galactic plane.
- Understand **particle acceleration** in astrophysical jets with **HAWC's** (wide field of view, high duty factor) **observations of transient sources**, such as gamma ray bursts and supermassive black holes.
- Explore **new TeV physics** via **HAWC's unbiased survey** of ½ the sky.

HAWC Summary

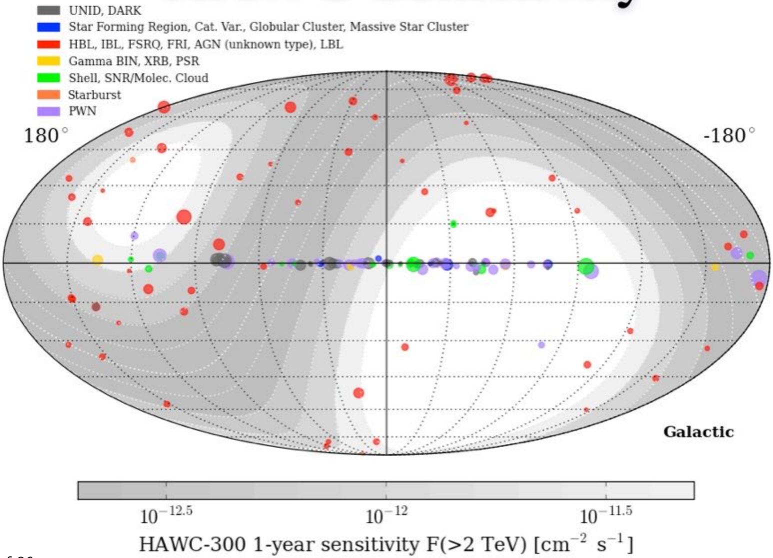
- HAWC is the largest wide field gamma ray observatory
- HAWC just got complete (300 detectors, inauguration next Friday)
- Results to come on a regular basis for 10 years



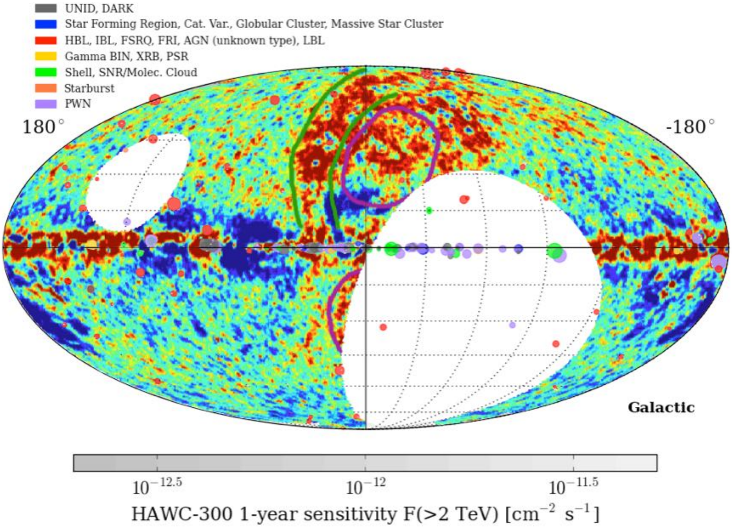
Future Astroparticle Facilities in Latin America

HAWC Southern Hemisphere Site

HAWC Sensitivity



Fermi bubbles



HAWC South needs a 4000 m+ site

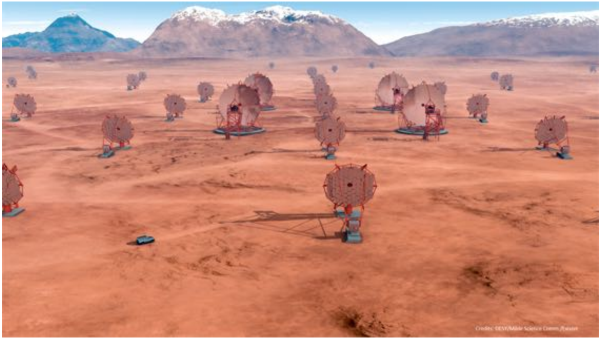
- Numerous options in South America:
  - Argentina
  - Bolivia
  - Chile

  → More than 11000 flat km^2 to choose from
- Well proven technique, well known detector
- Science output guaranteed
- Systematic studies on common sky with HAWC

→ Natural follow-up of HAWC
(could also be a follow-up of LHASSO)

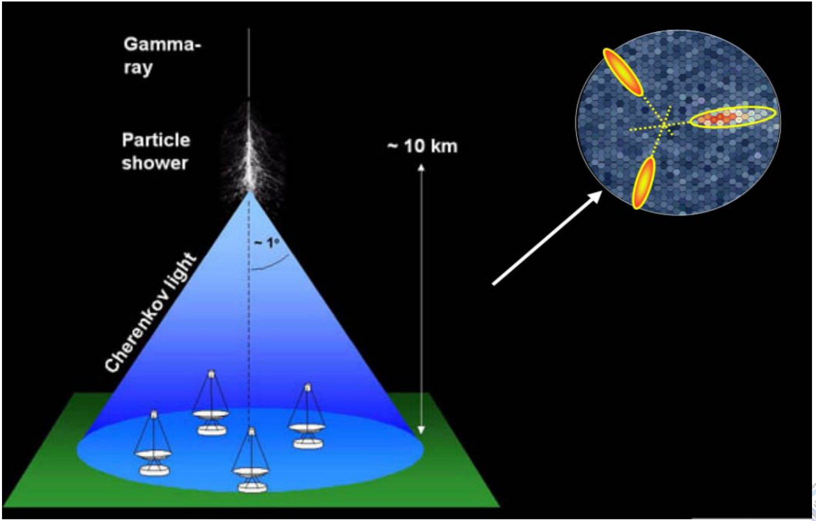
→ Great opportunity for Latin America

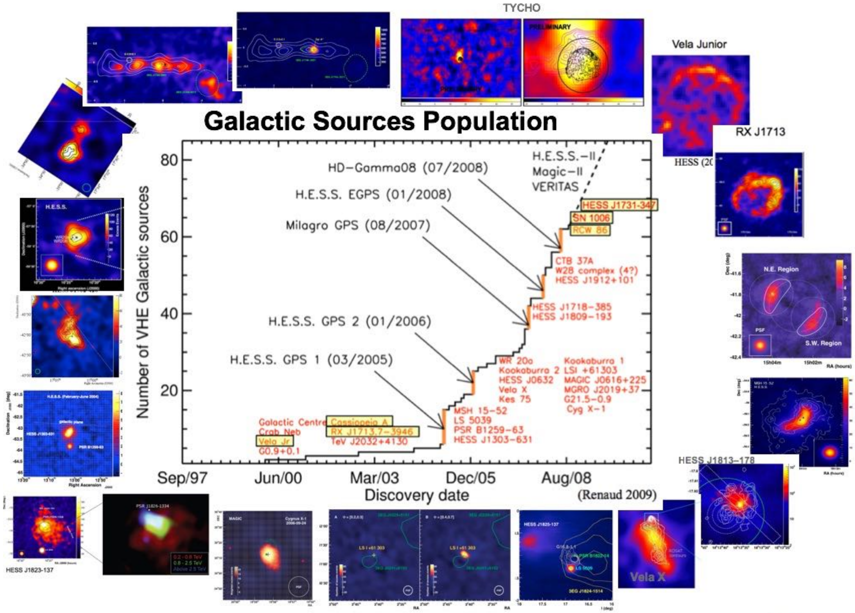
The Cherenkov Telescope Array (CTA)



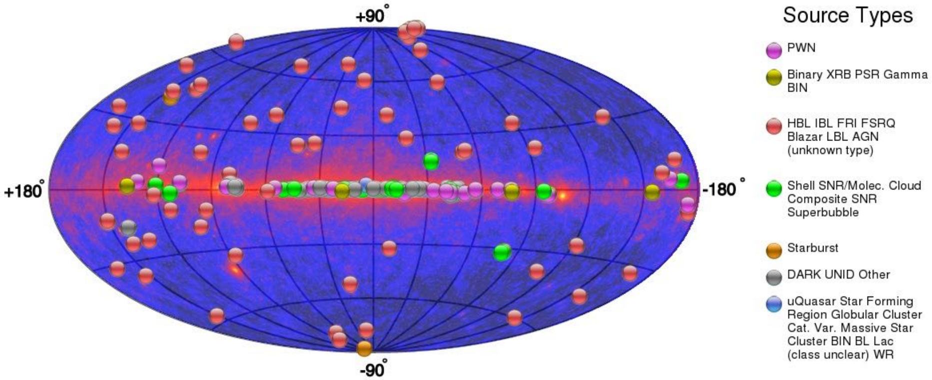
Slides from C. Medina

Imaging Atmospheric Cherenkov Telescopes (IACT)

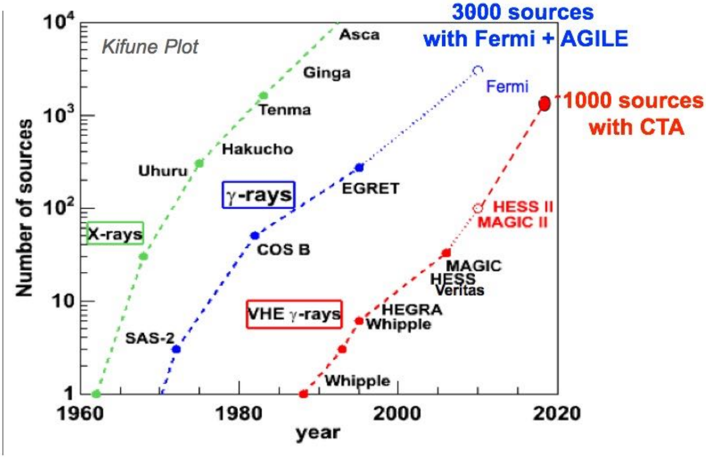



TYCHO
Vela Junior
RX J1713
Galactic Sources Population
Number of VHE Galactic sources
Discovery date
Sep/97
Jun/00
Mar/03
Dec/05
Aug/08
(Renaud 2009)
H.E.S.S.-II
Magic-II
VERITAS
HD-Gamma08 (07/2008)
H.E.S.S. EGPS (01/2008)
Milagro GPS (08/2007)
H.E.S.S. GPS 2 (01/2006)
H.E.S.S. GPS 1 (03/2005)
HESS J1731-347
SN 1006
RCW 86
CTB 37A
W28 complex (4?)
HESS J1912+101
HESS J1718-385
HESS J1809-193
WR 20a
Kookaburra 2
HESS J0632
Vela X
Kes 75
Kookaburra 1
LSI +61303
MAGIC J0616+225
MGRO J2019+37
G21.5-0.9
Cyg X-1
MSH 15-52
LS 5039
PSR B1259-63
HESS J1303-631
Galactic Centre
Crab Neb
Vela Jr
G0.9+0.1
Cassiopeia A
RX J1713.7-3946
TeV J2032+4130
H.E.S.S.
N.E. Region
S.W. Region
PSF
HESS J1813-178
HESS J1823-137
PSR J1826-1334
MAGIC
Cygnus X-1
LS I +61 303
HESS J1825-137
Vela X

157 TeV sources as of last week

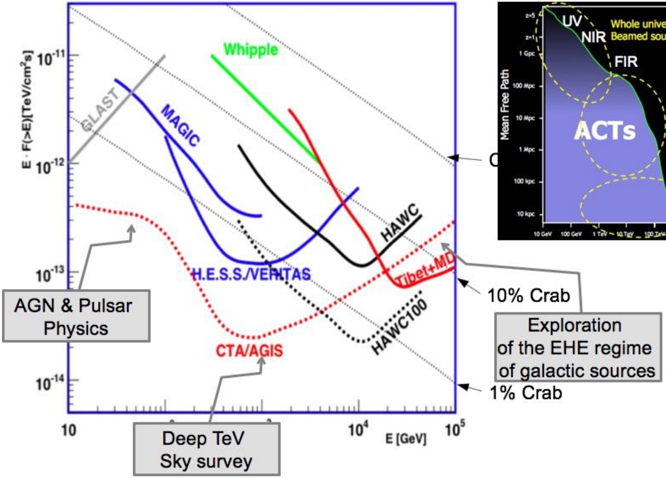


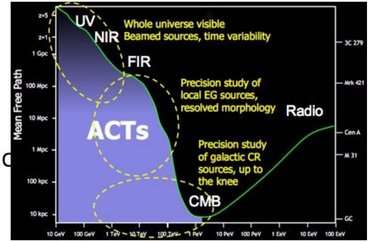
Source demographic grow



The next generation of IACT arrays needs to function like a true observatory:
Observation time for astro-physical/particle community
Open access data at different levels

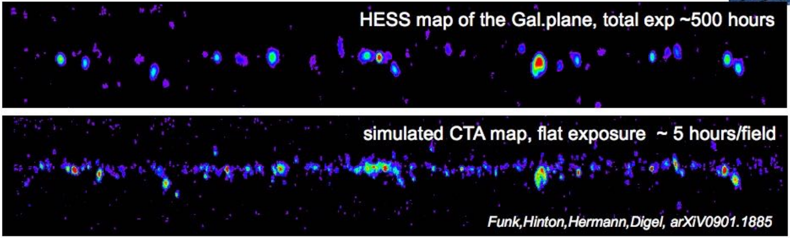
CTA sensitivity





Expectations for galatic survey

~ 300 sources in -30° ≤ l ≤ 30°



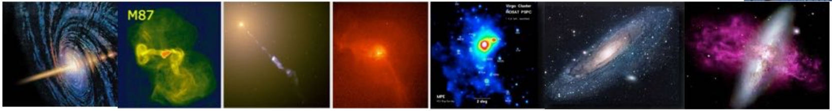
SNRS:

- CTA Galactic plane survey, currently known shell SNRs detectable to 10–15 kpc (i.e. throughout most of the Galaxy)
- If shells shine 2000 yr in TeV, ~40 TeV shells in Galaxy; ~25 detectable (vs 6 currently known)

Pulsar Wind Nebulae

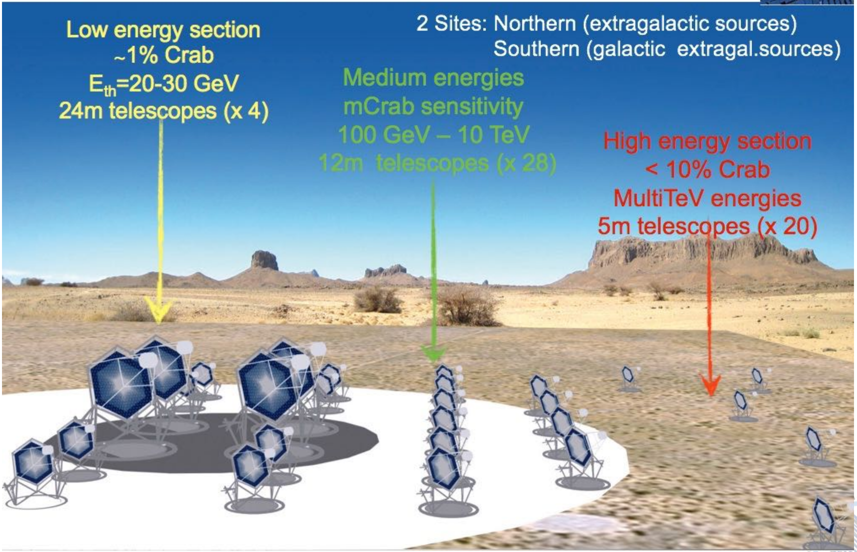
- CTA will detect luminous PWNe like the Crab to the distance of the Large Magellanic Cloud luminosity-limited survey
- If PWNe shine 10 000 yr in TeV, ~200 TeV PWNe in Galaxy (75% detectable by CTA)
- In a CTA Galactic plane survey, weaker PWNe like Kes 75 detectable to ~13–15 kpc (i.e. in large fraction of Galaxy)

Extragalactic studies with CTA:
Active Galaxies, Cosmic Radiation Fields and Cosmology



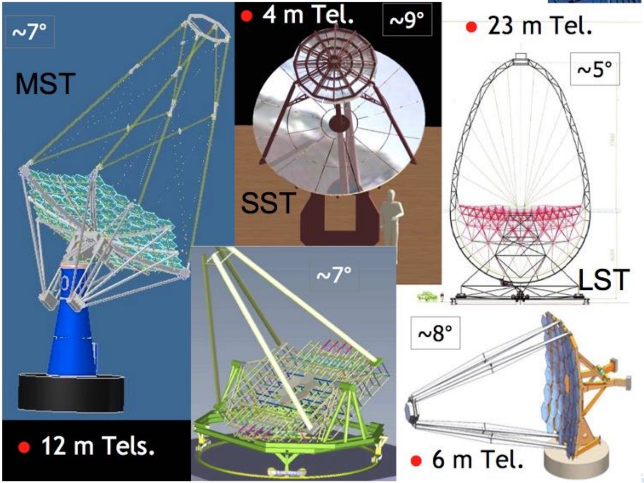
- **Study of different AGN classes at VHE (unification, "blazar sequence")**
  - today: ~30 BL Lacs, 3 FSRQ, 3 radio galaxies
- **Starburst Galaxies**
  - VERITAS and H.E.S.S. have observed TeV gamma-rays from the nearest starburst galaxies.
- **GRBs**
  - Fermi LAT → emission above 10 GeV from many GRBs
- **Dark matter search**
  - DM can annihilate or decay to detectable gamma-rays. Large dark matter densities → detectable fluxes, (i.e. annihilation rate $\propto$ square of the density).

CTA basic layout



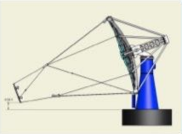
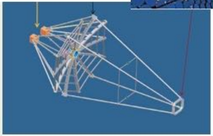
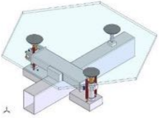
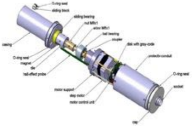
CTA Technology (Telescopes)

- MST
  - Middle Size
  - 1500 pixels
  - 2.5 ton camera
  - f/d ~ 1.4
- LST
  - Large Size
  - 2500 pixels
  - 2 ton camera
  - f/d ~1.2
- SST
  - Small Size
  - 1300 pixels



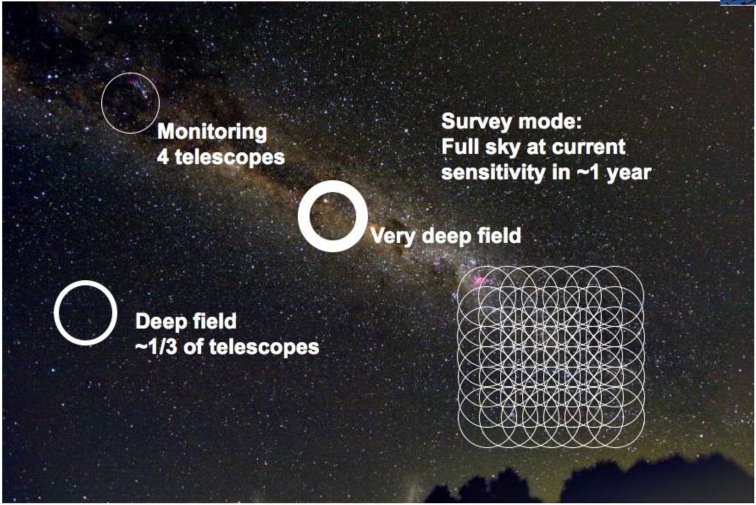
Telescope Technology

- Mount & Dish
  - Mounting system & drivers
  - Dish design and camera support
- Telescope optics
  - Mirrors
  - Alignment system
- Photon detection
  - Electronics
  - Triggering
  - Camera integration
- Calibration and monitoring

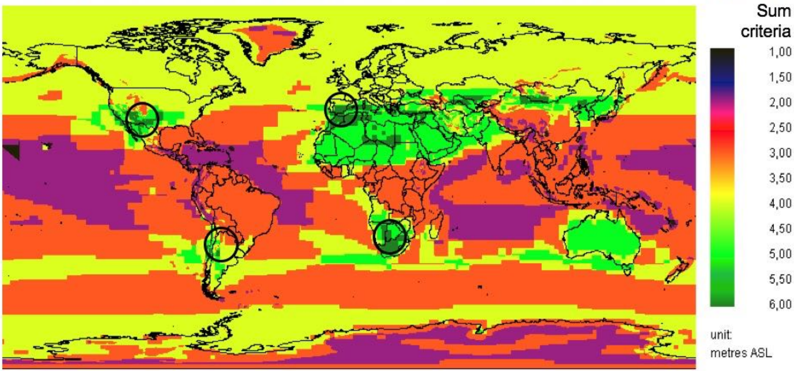


Several operation modes



CTA Site Search

Not so high (<1500 m) / No seismic risk / More than 60% of clear days (until 2025) / Nice air temperatures (~20° C) / Not so windy



Made with FriOWL (2007), IAP, Bern

CTA Summary

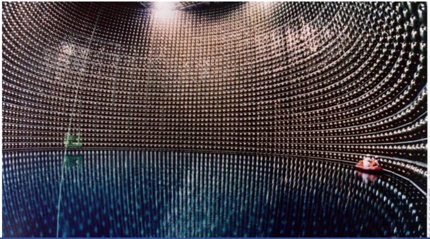
- CTA is built on the success of last generation of IACT: HESS, Veritas, MAGIC...
- CTA will be the major observatory in VHE gamma ray astronomy in the 2020s with both guaranteed astrophysics and a significant discovery potential
- CTA received excellent reviews and high rankings in Science Roadmaps in Europe and across the world
- CTA is an acknowledged ESFRI project and features high on roadmaps of future projects of ApPEC, ASPERA and ASTRONET
- CTA design well advanced, ending preparatory phase, and starting prototype construction
- Southern site to be decided this year: ESO (Chile) or Namibia, Argentina as backup solution

The ANDES Deep Underground Laboratory

Cosmic rays as noise

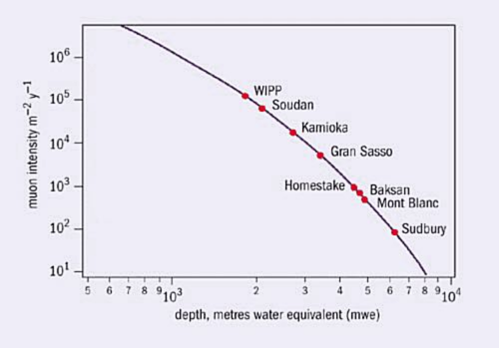
In a $12\,\mathrm{m}^3$ detector like Auger WCD, one detects every day:

- 10^8 muons
- 10^8 gammas/electrons/positrons
- 10^6 neutrons
- 10^{-2} neutrinos
- 10^{-6} supernova neutrinos
- maybe tens of dark matter particles
  (there is no multi-ton-scale dark matter detector currently)



Muon flux vs depth

Muon flux at sea level: a few $100\,\mathrm{m}^{-2}\,\mathrm{s}^{-1}$



Muon flux at 5000 m.w.e. underground:
$1\,\mathrm{m}^{-2}\,\mathrm{day}^{-1}$

Cosmic rays as noise

Ibarra, Ecuador
1 particle per millisecond-m^2

Roger Waters at River Plate
110 dB

Modane Underground laboratory
1 particle per day-m^2

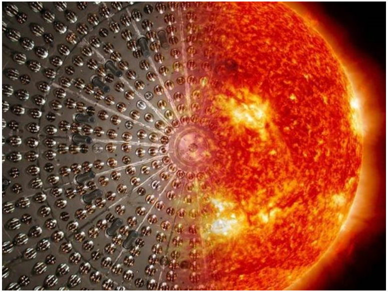
Patagonia (without wind)
30 dB

Hearing whispers from the Universe

Neutrino underground experiments

Sources

- neutrinos from nuclear reactors
- neutrinos from particle accelerators
- atmospheric neutrinos
- solar neutrinos
- supernovae neutrinos
- geoneutrinos



Physics

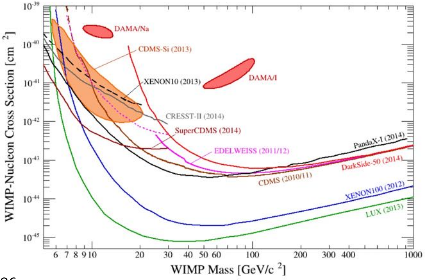
- neutrino oscillation
- neutrinos mass
- neutrino nature
- geophysics

Experiments in underground laboratories - DM

Dark Matter search

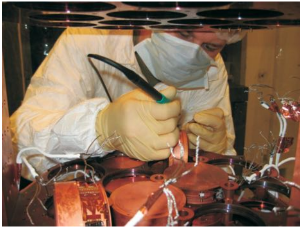
- 24% of Universe, 85% of matter

- different detector techniques
  (cryogenics, noble gas/liquids, ...)
- "new" exotic techniques
  (bubble chambers, CCD, ...)



WIMP search

- direct detection
- indirect search
  (modulation)



The Big Bang Theory

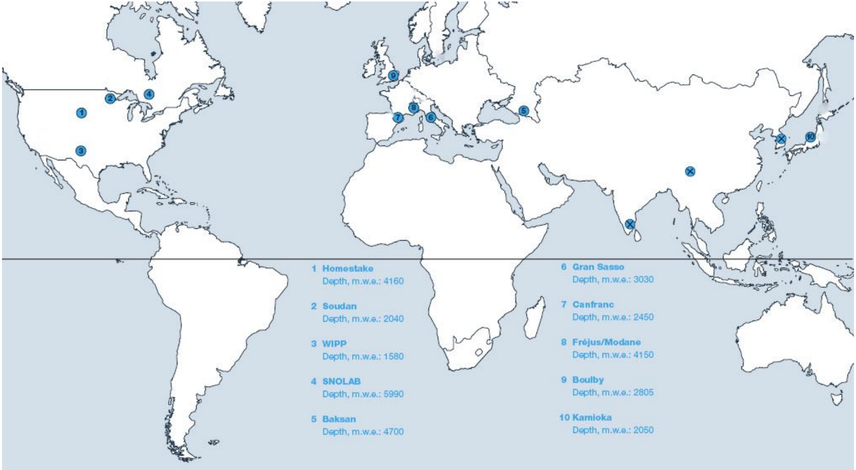
Season 4, episode 4

- *Raj (to Sheldon):* I'm telling you, if xenon emits ultraviolet light, then those dark matter discoveries must be wrong.

Season 2, episode 15

- *Leonard:* I think you'll find my work pretty interesting. I'm attempting to replicate the dark matter signal found in sodium iodide crystals by the Italians.
- *Mother:* So, no original research?
- *Leonard:* No.
- *Mother:* Well, what's the point of my seeing it? I could just read the paper the Italians wrote.

Underground Laboratories



- All in the northern hemisphere

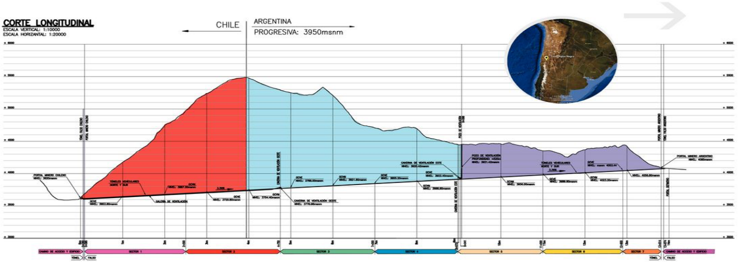
The planned Agua Negra tunnel

The Agua Negra tunnel recent history

- Pre-feasibility study done in 2005, feasibility in 2008
- Cristina Fernández de Kirchner and Michelle Bachelet signed a Bi-National Integration treaty, including the San Juan - Coquimbo option, in October 2009, voted later on by both countries
- August 2010 MERCOSUR meeting was in San Juan and a strong support for the Agua Negra tunnel was given, with Luis Inácio Lula da Silva pushing for the tunnel tender
- Since 2011 the Argentine congress votes every year a 800 MU$D guarantee fund for the Agua Negra tunnel
- In March 2012, Cristina Fernández de Kirchner and Sebastián Piñera signed an international agreement asking for the tender of the tunnel
- In January 2013, the call for tender process was officially started
- In December 2014, the protocol for construction was agreed upon
- Total cost estimated to about 1250 MU$D

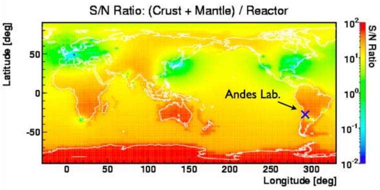
Tunnel proposed

- 2 tunnels, 12 m ⌀ each, separated by 60 m, ≈ 14 km long
- Argentine entry point at the Quebrada San Lorenzo, 4085 m a.s.l.
- Chilean entry point on a ridge, at ≈ 3600 m a.s.l.
- Internal connexion galleries every 500 m
- Deepest point at ≈ 1750 m depth
- Tender in 2013-2015, Construction 2015-2024



A scientific opportunity in the south

- Opportunity for a big AND deep laboratory
- Only deep underground laboratory in the south
  - opposite weather modulation (dark matter)
  - complementary for supernovae neutrinos
- Geoneutrinos
  (Low neutrino flux from nuclear power plants)
- Geoactive region
  - Deep underground geophysics international laboratory



The Consorcio Latinoamericano de Experimentos Subterráneos (CLES)

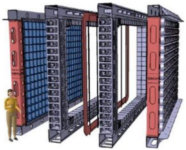
- Excellent opportunity to have an international laboratory
  expand the MERCOSUR (UNASUR) aspect of the tunnel to the ANDES laboratory
- The CLES would be the seed of a "CERN" focused on underground science (high energies, geology, biology, technology...)

Scientific programme for ANDES

- Neutrino
  - host a double beta decay experiment
  - build a large Latin American neutrino detector
    - similar to KamLAND/Borexino
    - focused on low energies
    - solar/supernovae/geo-neutrinos
- Dark Matter
  - modulation measurements
  - new technologies
- Geophysics
  - Natural link of seismograph networks
  - "flat slab" study
- Biology
- Low radiation measurements
- Accelerator
  - Nuclear astrophysics/DAR neutrino beam?

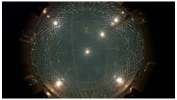
SuperNEMO double beta decay experiment

- based on NEMO-NEMO3 experience (LSM)
- 100 – 200 kg of ^{82}Se
- neutrino mass sensitivity: $\approx 0.05 - 0.1$ eV
- modular design: ≈ 20 modules
- demostrator for 2013

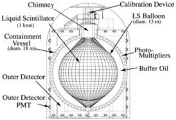


- design and schedule well adapted to ANDES
- strong interest from SuperNEMO representatives

Large Latinamerican Neutrino Detector

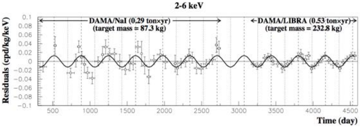


- similar design to Borexino and KamLAND
- 3 – 10 kton of scintillator volume
- unique site for geoneutrinos
- complementarity for supernova neutrinos analysis arXiv:1207.5454

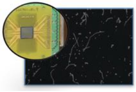


- design under study
- main topic of next ANDES Workshop

Dark Matter in ANDES



- host a copy of a DM experiment observing a modulation signal
- host a 3rd gen. DM experiment
- work on new technologies (fast evolving topic)

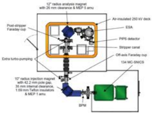


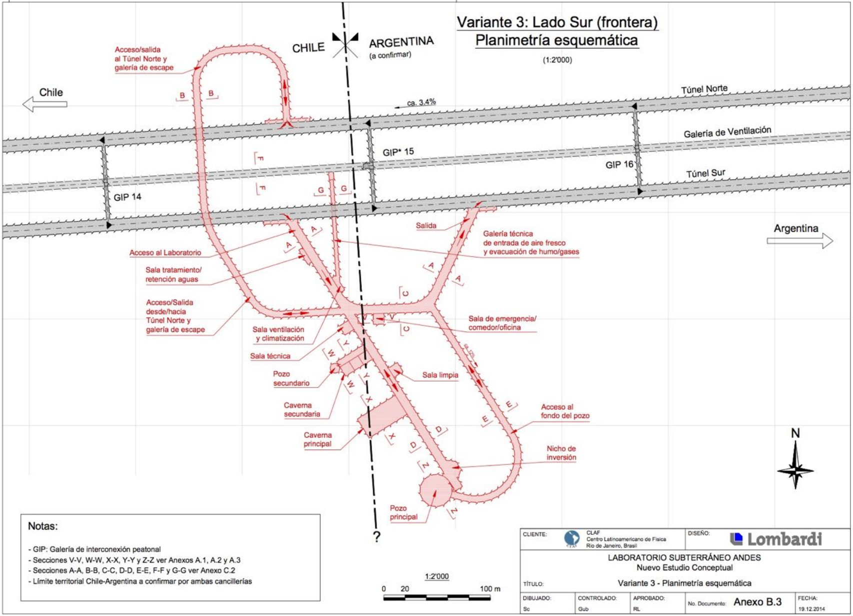
Nuclear Astrophysics

LUNA: Laboratory for Underground Nuclear Astrophysics

- installed at LNGS (Gran Sasso)
- 50 kV accelerator
- 400 kV (LUNA II)
  - study low energy nuclear reactions relevant for astrophysics (down to the Gamow peak)
  - ex: ^{3}He(^{3}He,2p)^{4}He below 21 keV

Proposal from Galindo-Uribarri, Padilla-Rodal and Vega for a 300 kV high intensity platform at ANDES



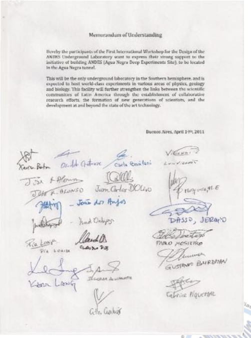


Variante 3: Lado Sur (frontera)
Planimetría esquemática
(1:2'000)
CHILE
ARGENTINA
(a confirmar)
Acceso/salida al Túnel Norte y galería de escape
Chile
Argentina
ca. 3.4%
Túnel Norte
Galería de Ventilación
Túnel Sur
GIP* 15
GIP 16
GIP 14
Salida
Galería técnica de entrada de aire fresco y evacuación de humo/gases
Acceso al Laboratorio
Sala tratamiento/ retención aguas
Acceso/Salida desde/hacia Túnel Norte y galería de escape
Sala ventilación y climatización
Sala técnica
Sala de emergencia/ comedor/oficina
Sala limpia
Pozo secundario
Caverna secundaria
Caverna principal
Acceso al fondo del pozo
Nicho de inversión
Pozo principal
N
?
Notas:
- GIP: Galería de interconexión peatonal
- Secciones V-V, W-W, X-X, Y-Y y Z-Z ver Anexos A.1, A.2 y A.3
- Secciones A-A, B-B, C-C, D-D, E-E, F-F y G-G ver Anexo C.2
- Límite territorial Chile-Argentina a confirmar por ambas cancillerías
1:2'000
0 20 100 m
CLIENTE: CLAF Centro Latinoamericano de Física Rio de Janeiro, Brasil
DISEÑO: Lombardi
LABORATORIO SUBTERRÁNEO ANDES
Nuevo Estudio Conceptual
TÍTULO: Variante 3 - Planimetría esquemática
DIBUJADO: Sc
CONTROLADO: Gub
APROBADO: RL
No. Documento: Anexo B.3
FECHA: 19.12.2014

Current Status

- International community support:
  - 19 support letters
    (underground lab directors, international projects spokespersons, national physics associations and academies...)
- Regional interest:
  - 26 letters from Latin American groups
- First workshop in Buenos Aires, April 2011
- Second in Rio de Janeiro, June 2011
- Third in Valparaíso, January 2012
- Fourth in México DF, January 2014
- Official support from Argentine MinCyT
  (Comisión Asesora Grandes Instrumentos)
- Official support from EBITAN
  (Entidad bi-nacional túnel Agua Negra)

Memorandum of Understanding (First workshop, Buenos Aires, April 2011)



Memorandum of Understanding

Hereby the participants of the First International Workshop for the Design of the ANDES Underground Laboratory want to express their strong support to the initiative of building ANDES (Agua Negra Deep Experiments Site), to be located in the Agua Negra tunnel.

This will be the only underground laboratory in the Southern hemisphere, and is expected to host world-class experiments in various areas of physics, geology and biology. This facility will further strengthen the links between the scientific communities of Latin America through the establishment of collaborative research efforts, the formation of new generations of scientists, and the development at and beyond the state of the art technology.

Buenos Aires, April 14th, 2011

Current status (cont.)

CLAF - ANDES Unit

- ANDES Unit created in CLAF in January 2014
- First step towards the CLES

Tunnel tender process started in January 2013

- International call issued in June 2013
- Process is finishing in 2015
- Construction planned to start end 2015

ANDES design studies with Lombardi

- Conceptual study, finished end 2014
- Detailed engineering study, mid 2015
- ANDES will go as an "adicional de obra"

Summary

- Latin America has state of the art Astroparticle Facilities
  - Largest and best UHECR observatory: Pierre Auger
  - Region-wide network for Science and Education: LAGO
  - Largest and best wide field Gamma ray observatory: HAWC
- Unique potential for the future
  - Southern sky wide field Gamma ray observatory: HAWC South
  - Ideal sky conditions for the next generation IACT: CTA
  - World class underground laboratory in final planning phase: ANDES
- It is by having state of the art local/regional facilities that the region will be able to better contribute to high energy physics worldwide
  - Synergy between Theory and Experiment, Particle physics and Astroparticle physics
  - We are living exciting scientific times in Latin America

Thanks for the invitation...

... and for the attention!