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Abstract

Modern Terrestrial Cerenkov Telescopes and Array Scintillators facing the Horizons may soon reveal far Cosmic Rays or nearer PeVs-EeVs Neutrino Showers Astronomy. Also UHE neutrino interactions in air, leading to Horizontal Showers, may take place through several channels: the main Glashow resonant $\nu_e - e \rightarrow W^-$ one, the charged nuclear interactions $\nu_e + N \rightarrow e^- + X$, $\nu_\mu + N \rightarrow \mu + X$, $\nu_\tau + N \rightarrow \tau + X$, and the neutral current events $\nu_e + N \rightarrow \nu_e + X$, $\nu_\mu + N \rightarrow \nu_\mu + X$, $\nu_\tau + N \rightarrow \nu_\tau + X$. Analogous events occur also for $\bar{\nu}$-nucleon events. These interactions are producing hadronic or electromagnetic showers at the far horizons and their correlated secondaries Cerenkov flashes; additional double showering in air may occur by rare tau decay in flight. Comparable interactions $\nu_\tau + N \rightarrow \tau + X$ are producing, inside the Earth, the Horizontal, but Up-going ultra-relativistic tau, whose decay in flight is source of $\tau$ Air Showers (Uptaus and HorTaus); Horizontal Tau Air-Showers are rarely (one-two order of magnitude) enhanced by highest mountain chains at horizons, as in AUGER experimental site; their hadronic or electromagnetic traces are preferentially at PeV-EeV energies; their tracks are amplified by their muon-gamma bundles whose signals are above the random noises and better disentangled by Cerenkov flashes in time coincidence. More exotic UHE SUSY interactions $\chi^0 + e \rightarrow \tilde{e} \rightarrow \chi^0 + e$ at tens PeVs-EeV energy may blaze at Horizons if $\tilde{e}_R$ has a mass comparable with gauge boson $W^-$ one (within
a top-down model for UHECR). Anyway common High Energy Cosmic rays at PeVs-EeVs energy must traces their presence in Magic-like Cerenkov Telescopes at horizons; every night these telescopes may observe tens of clustered C.R. showers at $87^\circ - 90^\circ$ zenith angle by the far precursor Cerenkov flashes and later (micro-second) muon rings (hitting inside the telescope) and—or decay (into electron) in flight leading to near-by mini-gamma showers. They may be a first probe to calibrate a Novel rare Neutrino Astronomy below the horizons. Present Magic Telescopes facing the Horizons are, at equal given time, almost comparable with the Amanda underground neutrino detector.

1 Cosmic Ray Flashes above the Earth edges

Ultra High Energy and High Energy Cosmic Rays (UHECR) Showers (PeVs - EeVs band energy) born at high altitude in the atmosphere may be detected by telescopes such as Magic provided that they are pointed above the horizon. These Cerenkov telescopes, set in a crown circular array toward the Horizons, may be correlated by an analogous scintillator ones able to trace muons and electromagnetic shower particles. The earliest gamma and Cerenkov lights produced by any down-ward horizontal, zenith angle ($85^\circ - 90^\circ$), cosmic rays (CR), observed by a high (> 2 km) mountain (whose C.R. nature is mainly hadronic), while crossing the atmosphere are severely absorbed by the thick horizontal air column depth ($10^4 - 5 \cdot 10^4 g \cdot cm^{-2}$). However the most energetic CR blazing Cerenkov shower must survive and also revive during their propagation. Indeed one has to expect that these CR showers contain also a diluted but more penetrating component made of muon bundles, which can be detected in two ways: a) by their Cerenkov lights emitted after they decay into electrons near the Telescope; b) by the same muons hitting inside the Telescope, blazing ring or arc by the same muon Cerenkov lights. The latter muon bundles are less abundant compared to the peak gamma bundles produced in the shower (roughly $10^{-3}$ times lower). They are mostly produced at an horizontal distance of 100 – 500 km from the observer (for a Magic site placed at 2.2 km above the sea level and a zenith angle of $85^\circ - 91.5^\circ$). Therefore these hard muon bundles (each one at tens-hundred GeV energy) might spread in large areas of tens - hundred $km^2$ while they travel towards the observers. They are partially split and bent by the local geomagnetic field, along an axis orthogonal to the field and along their propagation direction; a fraction of them may decay into electrons producing luminous mini-optical Cerenkov
flashes. The geo-magnetic spread of the shower leads to an early aligned Cerenkov blaze whose shape (a twin split shower) and inclination may probe the magnetic field "polarization" and the CR origination. Such a characteristic signature may be detected by the largest gamma telescope arrays as Hess, Veritas, or the forthcoming stereoscopic version of Magic. We argue that their Cerenkov flashes, either single or clustered, must take place, at detection threshold, at least tens or hundreds times a night for Magic-like Telescope pointing toward horizons at a zenith angle between 85° and 90°. Their easy "guaranteed" discover may offer, we believe, a new tool in CR and UHECR detection. At zenith angle between 85° and 80° by an accurate statistics there is the possibility to disentangle the cosmic ray spectra and composition at PeV-EeV energy windows. Their primary hadronic signature might be hidden by the distance but its late tail may arise in a new form by its secondary muon-electron-Cerenkov of electromagnetic showering.

Moreover a rarer but more exciting PeV - EeV Neutrino $\nu_\tau$ Astronomy (whose flux is suppressed by nearly three-four orders of magnitude respect to CR one) may arise below the horizon with the Earth-Skimming Horizontal Tau Air-Shower (HorTaus); below the horizons one is not awaiting C.R. shower, because Earth opacity, at all. These UHE Taus are produced inside the Earth Crust by the primary UHE incoming neutrino $\nu_\tau$, $\bar{\nu}_\tau$, and they are generated mainly by the muon-tau neutrino oscillations from galactic or cosmic sources, [7][8], [15], [3], [10].

Moreover we expect also that just above (one-two degree) or below the horizon edge (half a degree), within a distance of a few hundreds of km, fine-tuned $\bar{\nu}_e-e \rightarrow W^- \rightarrow X$ Glashow resonance at 6.3 PeV might be detectable as horizontal air-showers; they are nearly two-three orders of magnitude below CR ones (for comparable incoming fluxes). The W main hadronic $(2/3)$ or leptonic and electromagnetic $(1/3)$ signatures may be well observed and their rate may be used to calibrate a new horizontal neutrino multi-flavour Astronomy [8]. Again we argue that such a signature of nearby nature (respect to most far away ones at same zenith angle of hadronic nature) would be better revealed by a Stereoscopic twin telescope such as Magic or a Telescope array like Hess, Veritas.

Additional Horizontal flashes might arise by Cosmic UHE $\chi_o + e \rightarrow \bar{\chi}_o + e$ electromagnetic showers within most SUSY models, if UHECR are born in topological defect decay or in their annihilation, containing a relevant component of SUSY particles. The UHE $\chi_o + e \rightarrow \bar{\chi}_o \rightarrow \chi_o + e$ behaves (for light $\bar{\chi}_o$ masses around Z boson ones) as the Glashow resonance peak [2]. The total amount of air inspected within the characteristic field of
view of MAGIC (2° · 2°) at the horizon (360 km.) corresponds to a (water equivalent) volume-mass larger than $V_w \simeq 44 km^3$. However their detectable beamed volume corresponds to a narrower thinner volume $V_w \simeq 1.36 \cdot 10^{-2} km^3$, yet comparable to the present AMANDA confident volume (for Pevs $\nu_e - e^+ \rightarrow W^- \rightarrow X$ and EeVs $\nu_\tau, \nu_\tau + N \rightarrow \tau \rightarrow$ showers).

2 Flashes by Prompt Showers and Muons

The ultrahigh energy cosmic rays (UHECR) have been studied in the past mainly through their secondary particles ($\gamma, e^\pm, \mu^\pm$) collected vertically in large array detectors on the ground. UHECRs are rare events, however the multiple cascades occurring at high altitudes where the shower usually takes place, expand and amplify the signal detectable on the ground. On the other hand, at the horizon the UHECR are hardly observable (but also rarely searched). They are diluted both by the larger distance they have to cover and by the atmosphere opacity suppressing exponentially their electromagnetic secondaries (electron pairs and gammas); also their optical Cerenkov emission is partially suppressed by the horizontal air opacity. However this suppression acts also as a useful filter leading to the selection of higher CR events. Their Cerenkov lights will be scattered and partially transmitted ($1.8 \cdot 10^{-2}$ at 551 nm., $6.6 \cdot 10^{-3}$ at 445 nm.) depending on the exact zenith angle and the seeing: assuming an average suppression factor - $5 \cdot 10^{-3}$ for the air opacity and $10^{-3}$ for the 30 times larger distances, the nominal Magic threshold at 30 GeV does correspond to a hadronic shower coming from the horizon with an energy above $E_{CR} \simeq 6$ PeV. Their primary flux may be estimated considering the known cosmic ray fluxes at the same energy on the top of the atmosphere (both protons or helium) (see DICE Experiment referred in [17]) : $\phi_{CR}(E_{CR} = 6 \cdot 10^{15} eV) \simeq 9 \cdot 10^{-12} cm^{-2} s^{-1}$. Within a Shower Cerenkov angle $\Delta \theta = 1^o$ at a distance $d = 167 km \cdot \sqrt{\frac{h}{2.2 km}}$ (zenith angle $\theta \simeq 87^o - 88^o$) giving a shower area $[A = \pi \cdot (\Delta \theta \cdot d)^2 \simeq 2.7 \cdot 10^{11} cm^2 (\frac{d}{10 km})^2]$, the consequent event rate per night for a Magic-like telescope with a field of view of $[\Delta \Omega = (2^o \cdot 2^o) \pi \simeq 3.82 \cdot 10^{-3} sr.]$ is

$$N_{ev} = \phi_{CR}(E = 6 \cdot 10^{15} eV) \cdot A \cdot \Delta \Omega \cdot \Delta(t) \simeq 401/12 h$$

Thus one may foresee that nearly every two minutes a horizontal hadronic shower may be observed by Magic if it were pointed towards the horizon at zenith angle $87^o - 88^o$. Increasing the altitude $h$ of the observer, the horizon
zenith angle grows: \[ \theta \simeq [90^\circ + 1.5^\circ \sqrt{\frac{h}{2.2km}}] \]. In analogy at a more distant horizontal edges (standing at height 2.2km as for Magic, while observing at zenith angle \( \theta \simeq 89^\circ - 91^\circ \) still above the horizons) the observation range \( d \) increases: \[ d = 167\sqrt{\frac{h}{2.2km}} + 360km = 527km; \] the consequent shower area widen by more than an order of magnitude (and more than three order respect to vertical showers) and the foreseen event number, now for much harder CR at \( E_{CR} \geq 3 \cdot 10^{17} eV \), becomes:

\[ N_{ev} = \phi_{CR}(E = 3 \cdot 10^{17} eV) \cdot A \cdot \Delta \Omega \cdot \Delta(t) \simeq 1.6/12h \]

Therefore at \( \theta \simeq 91.5^\circ \), once per night, a UHECR around EeV energies, may blaze the Magic (or Hess,Veritas, telescopes). A long trail of secondary muons is associated to each of these far primary Cherenkov flash in a very huge area. These muons showering nearby the telescope, while they decay in flight into electrons, producing tens-hundred GeVs mini-gamma showers, is also detectable at a rate discussed in the following section.

3 Muon’s Arcs and Gamma Flashes by \( \mu^\pm \rightarrow e^\pm \)

As already noted the photons from a horizontal UHECR may be also replenished by the secondary tens-hundred GeVs muons: they can either decay in flight as a gamma flashes, or they may hit the telescope and their muon Cerenkov lights ”paint” arcs or rings within the detector. Indeed these secondary very penetrating muon bundles may cover distances of hundreds km (\( \simeq 600km \cdot \frac{E_{\mu}}{100GeV} \)) away from the shower origin. To be more precise a part of the muon primary energy will be dissipated along their path in air of 360 km (nearly a hundred GeV energy loss); thus a primary 130 – 150 GeV muon is necessary to reach a final 30 – 50 GeV energy at the minimal Magic threshold value. Let us remind the characteristic multiplicity of secondary muons in a shower: \( N_{\mu} \simeq 3 \cdot 10^5 \left( \frac{E_{\mu}}{100GeV} \right)^{0.85} \) [6] for GeV muons. For the harder component (around 100 GeV), the muon number is reduced almost inversely proportionally to energy \( N_{\mu}(10^2 \cdot GeV) \simeq 1.3 \cdot 10^4 \left( \frac{E_{\mu}}{10GeV} \right)^{0.85} \). These values must be compared to the larger peak multiplicity (but much lower energy) of electro-magnetic showers: \( N_{e^+e^-} \simeq 2 \cdot 10^7 \left( \frac{E_{\gamma}}{1\text{TeV}} \right) ; N_{\gamma} \simeq 10^8 \left( \frac{E_{\gamma}}{1\text{TeV}} \right) \). As mentioned before, most of the electromagnetic tail is lost (exponentially) at horizons (for a slant depth larger than a few hundreds of \( \frac{\rho}{cm^2} \)), excluding re-born, upgoing \( \tau \) air-showers [10],[11] to be discussed later. Therefore gamma-electron pairs are only partially regenerated by the penetrating
muon decay in flight, $\mu^\pm \rightarrow \gamma, e^\pm$ as a parasite electromagnetic showering [5]. Indeed $\mu^\pm$ may decay in flight (let say at 100 GeV energy, at 2−3% level within a 12−18 km distances) and they may inject more and more lights, to their primary (far born) shower beam. The ratio between $\gamma$, $\pm e$ over $\pm \mu$ offer a clear hint of the Shower evolution [11]. These tens-hundred GeVs horizontal muons and their associated mini-Cerenkov $\gamma$ showers are generated by: (1) either a single muon mostly produced at hundreds of kilometers by a single primary hadron with an energy of hundreds GeV-TeV; (2) rarer muons, part of a wider horizontal bundle of large multiplicity born at TeVs-PeV or higher energies, as secondary of an horizontal shower. Between the two cases there is a smooth link. A whole continuous spectrum of multiplicity begins from a unique muon up to a multi muon shower production. The dominant noisy "single" muons at hundred-GeV energies will lose memory of their primary low energy and hidden mini-shower, (a hundreds GeV or TeVs hadrons); a single muon will blaze just alone. The frequency of muon "single" rings or arcs is larger than the muon bundles and it is based on solid observational data ([18]; [17], as shown in Fig.2 see also the references on the MUTRON experiment therein. The event number due to the "noise" is:

$$N_{ev-\mu}(\theta = 90^o) = \phi_\mu(E \simeq 10^2eV) \cdot A_{Magic} \cdot \Delta \Omega \cdot \Delta(t) \simeq 120/12h$$

The additional gamma mini-showers around the telescope due to a decay of those muons in flight (with a probability $p \simeq 0.02$), is even a more frequent source of noise (by a factor $\geq 8$):

$$N_{ev-\mu \rightarrow \gamma} \geq \phi_\mu(E \simeq 10^2eV) \cdot p \cdot A_\gamma \cdot \Delta \Omega \cdot \Delta(t) \simeq 960/12h$$

These single background gamma-showers must take place nearly once per minute (in a negligible hadronic background) and they represent a useful tool to calibrate the possibility of detecting Horizontal CR.

4 Showers precursor and their late Muon tails

On the contrary PeVs (or higher energy) CR shower Cerenkov lights maybe observed, more rarely, in coincidence both by their primary and by their later secondary arc and gamma mini-shower. Their 30−100 GeV energetic muons are flying nearly undeflected $\Delta \theta \leq 1.6^o \cdot \frac{100GeV}{E_{\mu}} \cdot \frac{d}{900km}$ for a characteristic horizons distances $d$, partially bent by the geo-magnetic fields (~}
0.3 Gauss). As mentioned, to flight through the whole horizontal air column depth (360 km equivalent to 360 water depth) the muon lose nearly 100 GeV; consequently the initial muon energy should be a little above this threshold to be observed by Magic: (at least $130 - 150$ GeV). The deflection angle is small: $\Delta \theta \leq 1^\circ \cdot \frac{150 \text{ GeV}}{E_\mu \cdot 300 \text{ km}}$. Given the area of Magic ($A = 2.5 \cdot 10^6 \text{cm}^2$) we expect roughly the following number of events due to direct muons hitting the Telescope, flashing as rings and arcs, each night:

$$N_{ev} = \phi_{CR}(E = 6 \cdot 10^{15} \text{eV}) \cdot N_\mu(10^2 \cdot \text{GeV}) \cdot A_{\text{Magic}} \cdot \Delta \Omega \cdot \Delta(t) \simeq \frac{45}{12}h$$

to be correlated (at 11% probability) with the above results of 401 primary Cerenkov flashes at the far distances. Moreover, the same muons are decaying in flight at a minimal probability 2% leading to mini-gamma-showers in a wider area ($A_\gamma = 10^9 \text{cm}^2$). The related number of events we expect is:

$$N_{ev} = \phi_{CR}(E = 6 \cdot 10^{15} \text{eV}) \cdot N_\mu(10^2 \cdot \text{GeV}) \cdot p \cdot A_\gamma \cdot \Delta \Omega \cdot \Delta(t) \simeq \frac{360}{12}h$$

Therefore, at $87^\circ - 88^\circ$ zenith angle, there is a flow of a few dozens of primary CR (at $E_{CR} \simeq 6 \cdot 10^{16} \text{eV}$), whose earliest showers and consequent secondary muon-arcs as well as nearby muon-electron mini-shower take place at comparable rate (one every 120 s). Therefore they may occur in time coincidence. Sometime also a bundle of arcs may better point to the C.R. Shower arrival. A well known analogy occurs in meteor showers by their group perspective pointing at their origination. The time arrival of the prompt Shower respect the late muon one may be estimated by geometrical and relativistic arguments and may reach a detectable delay value [1]. These certain, clustered, signals offer an unique tool for calibrating Magic (as well as Hess,Cangaroo,Veritas Cerenkov Telescope Arrays) for Horizontal High Energy Cosmic Ray Showers. Some rarer events may contain at once both Rings,Arcs and tail of gamma shower as well as a Cerenkov far primary shower. It is possible to estimate also the observable muon-electron-Cerenkov photons from up-going albedo muons observed by the most recent ground experiments [21] [22]; their flux is already suppressed at zenith angle $91^\circ$ by at least two orders of magnitude and by four orders for up-going zenith angles $94^\circ$. Pairs or bundles are nevertheless rarer (up to $\phi_\mu \leq 3 \cdot 10^{-13} \text{cm}^{-2} \text{s}^{-1} \text{sr}^{-1}$ [21] [22]). They are never associated to up-going showers (excluding the case of tau air-showers or the Glashow $\nu_e - e \rightarrow W^-$ and the comparable $\chi^0 + e \rightarrow \bar{\nu})$. 


5 Glashow $\bar{\nu}_e + e \rightarrow W^-$ Neutrino Astronomy

We note that UHE neutrinos may interact hitting nucleons and shower on air while crossing longest horizontal column depth ($\simeq 360 \text{gcm}^{-2}$) by charged and neutral currents; a defined competitive horizontal events by UHE $6.3 \text{PeV}$, Glashow $\bar{\nu}_e - e \rightarrow W^- \rightarrow \text{(hadrons or electromagnetic showers)}$ are also taking place; one should remember that at Glashow’s peak resonance the probability conversion is $\simeq 5 \cdot 10^{-3}$ at 360 km air distance and the consequent event number is:

$$N_{ev} = \phi_{\bar{\nu}_e}(E = 6 \cdot 10^{15} \text{eV}) \cdot A \cdot \Delta \Omega \cdot \Delta(t) \simeq 5.2 \cdot 10^{-4}/12h$$

assuming the minimal GZK neutrino flux : $\phi_{\bar{\nu}_e}(E = 6 \cdot 10^{15} \text{eV}) \simeq 5 \cdot 10^{-15} \text{cm}^{-2}\text{s}^{-1}\text{sr}^{-1}$; the consequent GZK flat spectra energy fluency is assumed as : $\phi_{\bar{\nu}_e} \cdot E = 30 \text{eVcm}^{-2}\text{s}^{-1}\text{sr}^{-1}$. A comparable number of events are also taking place smoothly at PeVs neutrino energies by nucleon charged current interactions (and marginally, by neutral current ones): $\nu_e + N \rightarrow e^- + X$, $\nu_\mu + N \rightarrow \mu + X$, $\nu_\tau + N \rightarrow \tau + X$, and $\nu_e + N \rightarrow e^- + X$, $\nu_\mu + N \rightarrow \nu_\mu + X$, $\nu_\tau + N \rightarrow \nu_\tau + X$. Naturally the air column depth at 360 km distance is too dim to let the Cerenkov signal to survive the Magic threshold, but more muons bundle and showering or additional stereoscopic array (or wider telescope area as $10^3 \text{m}^2$ ones ) may still record such a far shower. The full night year record of 60 or more Magic like telescope may reach a dozen of events with a quite guaranteed $\bar{\nu}_e - e \rightarrow W^- \rightarrow \text{(hadrons or electromagnetic showers)}$ channel.

5.1 SUSY $\chi^0 + e \rightarrow \tilde{e} \rightarrow \chi^0 + e$ electromagnetic showers

Therefore in a year of observations, provided that the data are taken at night, assuming a minimal GZK flux, a full crown array of a 90 Magic-like telescopes set on a circle ($2 \cdot \pi = 360^\circ$) and facing the horizon, would give a number of events comparable to a $Km^3$ detector, (more than a dozen per year). Indeed the present unique Magic Telescope pointing at the horizon offers a detection comparable to the present AMANDA $\simeq 1\% Km^3$ effective volume. It should be noted that up-going $\bar{\nu}_e - e \rightarrow W^-$ and $\chi^0 + e \rightarrow \tilde{e}$ below the horizons are possible within nearly $1^\circ$ because the Earth is not totally opaque at those small angles for these two tuned resonant interactions. The event number might be comparable with the $\bar{\nu}_e - e \rightarrow W^- \rightarrow \text{(hadrons or electromagnetic showers)}$, provided that UHECR are originated in SUSY neutralino as UHE neutrinos in top-down models.
6 Discovering UHE $\nu_{\tau}$ by Horizontal Tau Showers

The appearance of horizontal UHE neutrino $\tau$ interaction in matter $\bar{\nu}_{\tau} + N \rightarrow \tau^{\pm}$ leading, in air, to air-showers (Hortaus or Earth-Skimming neutrinos) has been widely studied [7],[8],[3],[15]; see also [9],[10],[19],[23],[20] and more recent [11] ; Their rise from the Earth is source of rare clear signals for neutrino UHE astronomy. The higher the observer is located the wider is the view angle of the underneath Earth. The consequent up-going muon flux, by tau air-showers, are changing with quota [11]. The upward gamma and electron pair showering may be also a very solid probe of the $\tau$ air-shower nearby showering [11]; nevertheless the long lived muon bundle trace, correlated also with the Cerenkov flashes below the horizons, may allow to confirm the UHE neutrino origination of the Horizontal blazing and its muon detection and arrival timing may better define its primary energy.

6.1 Polarization Filters rejecting reflected Cerenkov Flash

One should take into account the noise due to any inclined down-ward CR shower mirrored by the Sea leading to apparent up-going Cerenkov flashes; this mirror noise signal will be disentangled by the co-presence of the twin up (above horizons primary Shower) and down image (reflected image) by the different muon versus Cerenkov arrival direction. An additional misleading signal may occur also by the muons bent by geomagnetic fields or by albedo scattering on the Earth. The very discriminant filter of fake mirrored Cerenkov showers is offered by their extreme polarization imprinted by the planar reflection (either sea or a ground). Therefore it must be considered a polarization filter of the arrival photons.

7 GRBs and UHECR correlated with UHE $\nu$ and Upward Shower

While the persistent UHE gamma sources, as BL Lacs are a natural target for UHE neutrino Astronomy to follows, the rare GRBs are a more powerful, but rarer and unexpected sources. However the fast follow up of GRB direction by Magic Telescope, may be fast enough to catch a PeV neutrino showering at the horizons as well as an upward one from the Earth. Indeed the rare and sharp presence of a UHE neutrino scattering in air, by Glashow
resonance at horizons, may be quite rare but above the noise at edge zenith $91.5^\circ - 92.5^\circ$. The tau neutrinos may come at PeVs-EeVs energy from a much wider angle windows, and they are observable, in principle, from $91.5^\circ - 120^\circ$ angle view. We may expect a few rare discover of GRBs or SGRs blazing from the dark horizons or from the Earth a year, if a wide zenith angle windows will be realized. The same events might be searched in correlation with UHECR: therefore it might be interesting to search for UHECR event arrival directions that may contains UHE neutrinos in correlated time while arriving at Horizons or beneath the Earth. This might be possible because the fast tracking of Magic telescopes and the possibility to bend the mirror below to the Earth side. This may occur in correlated TeV activities of BL Lacs sources[14].

8 Conclusions

The Horizontal shower detection may be improved projecting a coexistence of a scintillator Crown Array (for muons and electromagnetic secondaries) aligned with Crown Magic Telescope Array; they will able to verify the electromagnetic and muon shower nature in coincident arrival time with optical Cerenkov flashes. The Crown Array may encompass a large area as hundreds square meters array (see last figure) and its structure may be added around the Cerenkov Crown telescope array at the same mountain top. Its ability to discover muons (sometimes in correlation with the Cerenkov telescope) as well as the electromagnetic trace $\gamma, e^+, e^-$ nature and ratio, for a total area of $63 \ m^2$, is superior by a factor two respect a (single) Magic telescope, because it enjoys a larger solid angle and a longer recording time. Magic-Crown and Muon Crown array may reveal tens of thousands horizontal CR shower and a ten of up-going neutrino induced air-shower a year (for GZK minimal fluxes). Finally the possible detection of up-going (a few-ten GeV) muons induced neutrino hitting the Earth-Ground energetic Solar Flare at a rate $\phi_\mu \simeq 10^{-10} \ cm^{-2}s^{-1}$ for a thousand of seconds, during the maximal solar flare activity, might also be a target of such future Muon-Cerenkov astronomy [24] based on largest telescopes looking on the nights down-ward the Earth toward the Sun. To conclude, while Magic looks upward to investigate the exciting Low Gamma GeVs Astronomy, the same telescope looking at the horizon must discover higher (PeVs-EeVs) CR at high frequency, and rarely along the edge, GZK $\bar{\nu}_e - e \rightarrow W^- \ \text{air-showering neutrinos}$; some times looking downward also most power-full Solar flare, as
the last 28th Oct. 2004 and 20th Jan. 2005 ones, may shine neutrinos whose up-going muons may be observable well below the horizons.

In conclusions new array of crown detectors might be better tuned for the horizons and below the horizons seeking $\nu_\tau \rightarrow \tau, \bar{\nu}_e - e \rightarrow W^-$ Earth-Skimming air-showers Astronomy and, surprisingly even SUSY $\tilde{e}$ air-showering lights.

Figure 1: The Earth view from Canarie sites for a Magic-like Crown Telescope Array facing the Horizons, blazed, in dark nights, by CR showers and rare up-going Tau Air-Shower Cerenkov flashes; the telescopes in circular array (of tens telescopes at $360^\circ$) may test a wide area volume, nearly a $km^3$ of air mass. The present (real) single Magic telescope is located in the bottom left corner of the picture.

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Figure 2: A schematic figure of a Crown circular detector array located in Balloon [13] or on the top of a mountain (possibly screened by a roof to avoid vertical cosmic electro-magnetic C.R. noise) by a $\approx 20 - 30$ meter radius size, whose inner-outer aligned tiles are able to reveal, by time of flight, the crossing and the azimuth directions of horizontal muons (and electron pairs and gamma) bundles; in the picture one observe a downward C.R. (a proton, label by $p$) and an upward Horizontal Tau Air-Shower (label by $\tau$); the 360° tile disposal guarantees a wide azimuth solid angle view. The twin (upper and lower) rings distance (height of tens or hundred meters at the mountain top) is able to better disentangle the zenithal arrival direction of the Horizontal Shower particles above or below the Earth edges. A smaller twin scale device maybe dressed around present AUGER detectors to improve their zenith angular resolution to Horizons, in order to disentangle Tau induced showers from the Andes [7],[8],[3].

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