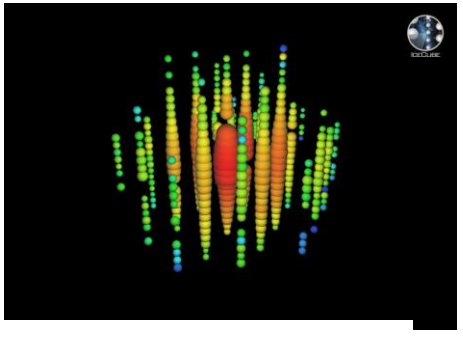
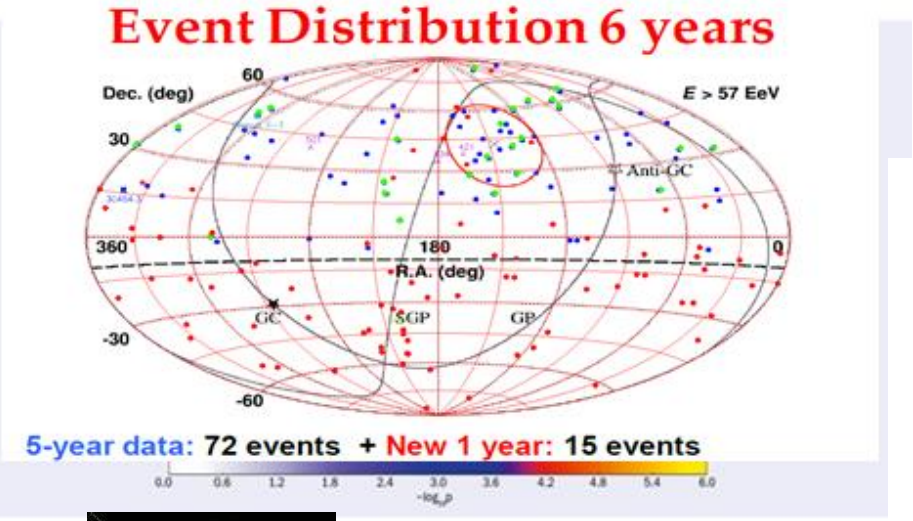
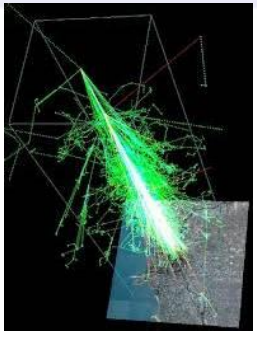
The birth of a near Universe
UHECR Astronomy?

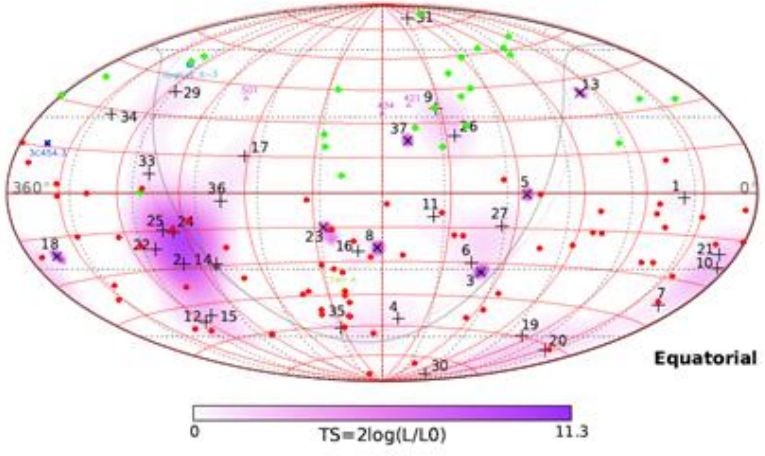
(Uhe neutrino should wait..)







Last 21-5-2014-equatorial



DI

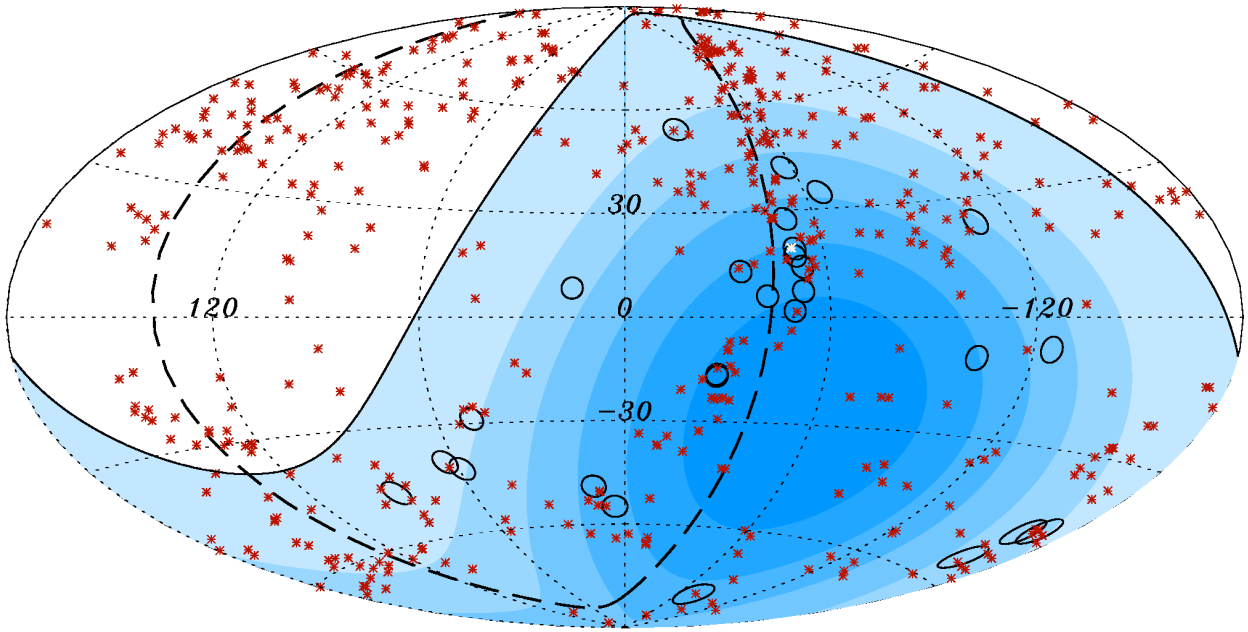
Astronomy need to recognize the sources name: UHECR attractive sample today

News; TA=87; AUGER=69: a rich UHECR map sky

- Most UHECR modelling are dealing just with spectra, composition, Galactic or Extragalactic Nature, possible source engine
- GRBs,AGN, Starburst Galaxy,BL Lac..
- did not fit the expectations
- Few are advocating UHECR relics decay (to day above PeV masses) to feed neutrinos at PeVs
- ***No one (longer) try to pont to any real location and correlation with known source for UHECR***
- ***Where are the source candidate (even bent ones)?***
- ***I will try to show map with bending reading key finding a few candidate sources for most UHECR***

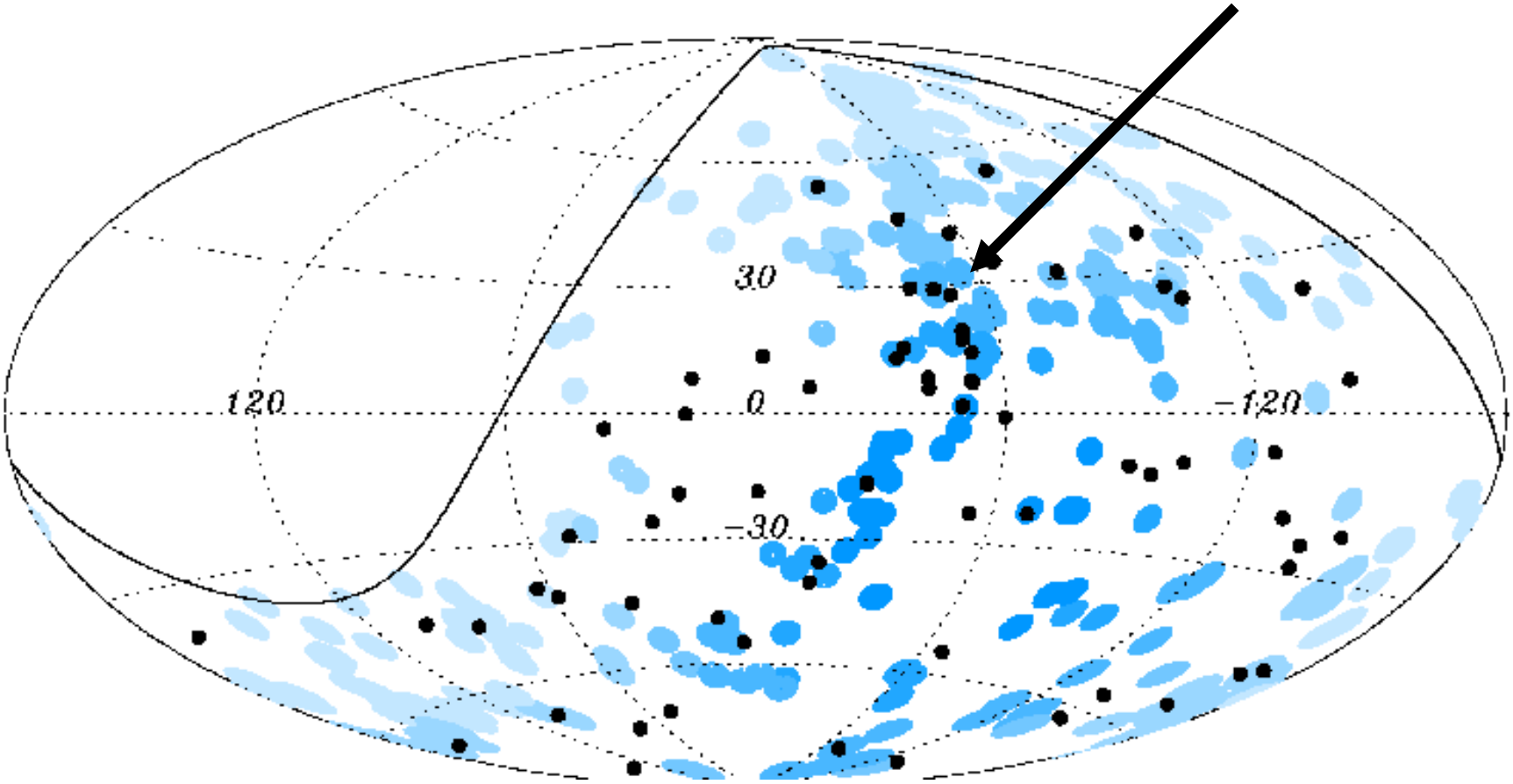
Correlation of the Highest-Energy Cosmic Rays with Nearby Extragalactic Objects

Science November 2007

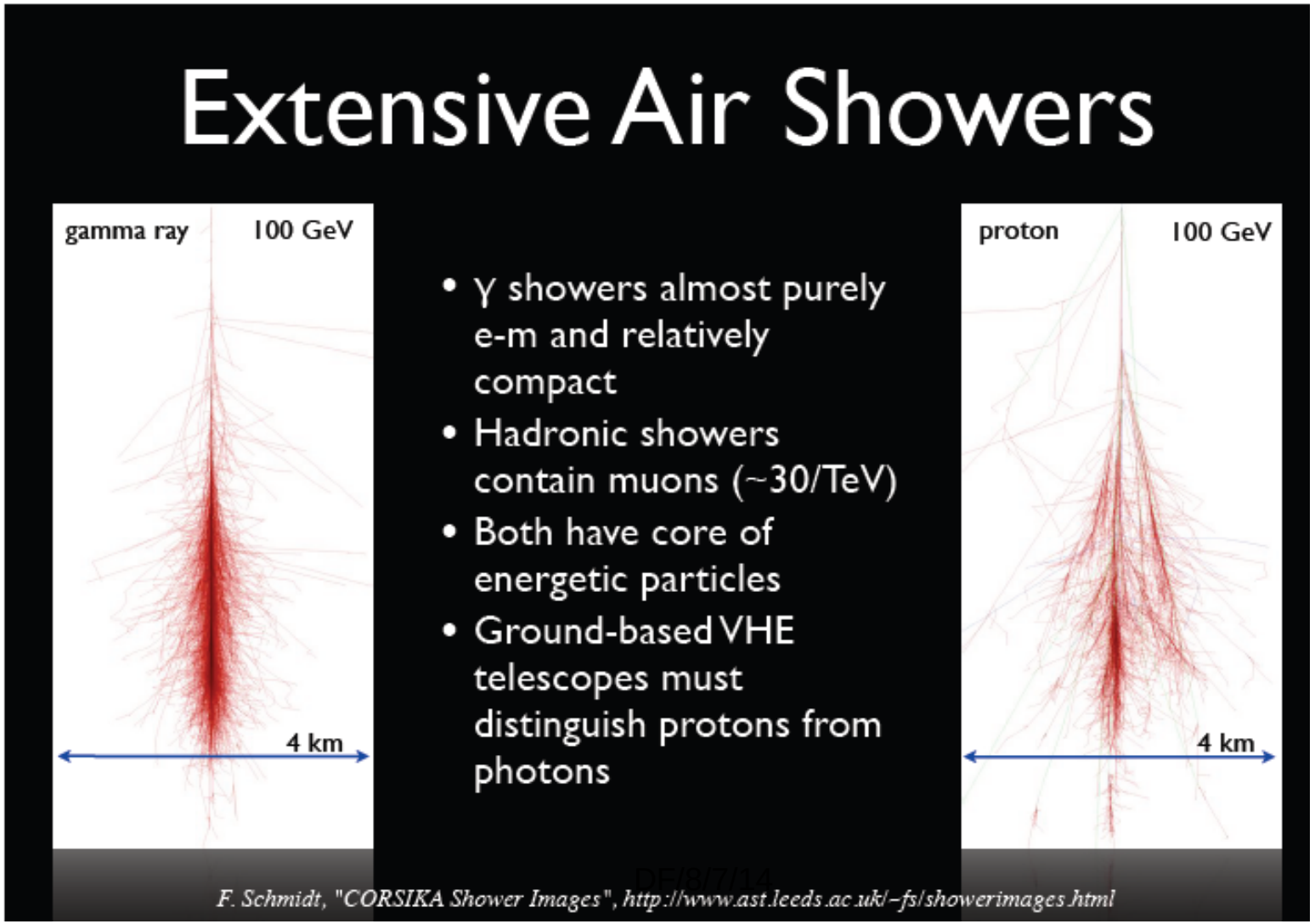


An apparent Super Galactic Plane connection

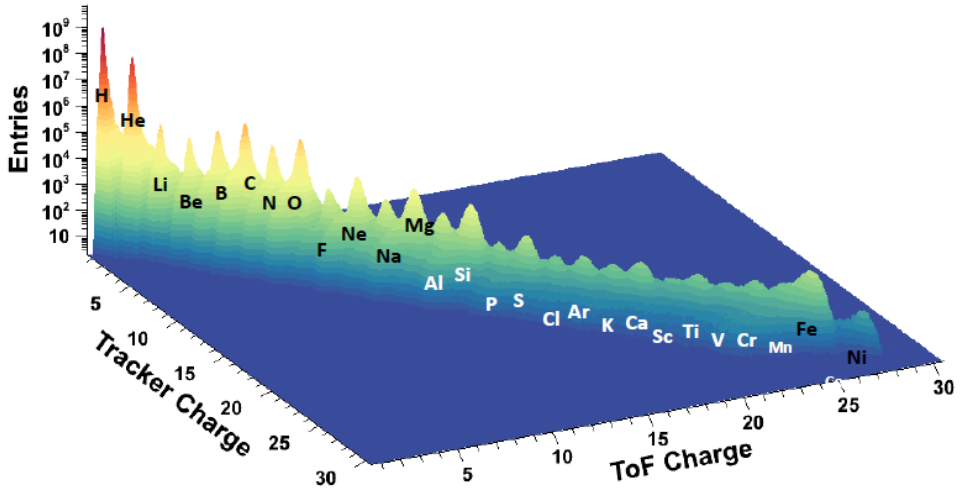
2011 AUGER in Galactic coordinates: no longer SGP, but just Cen A cluster

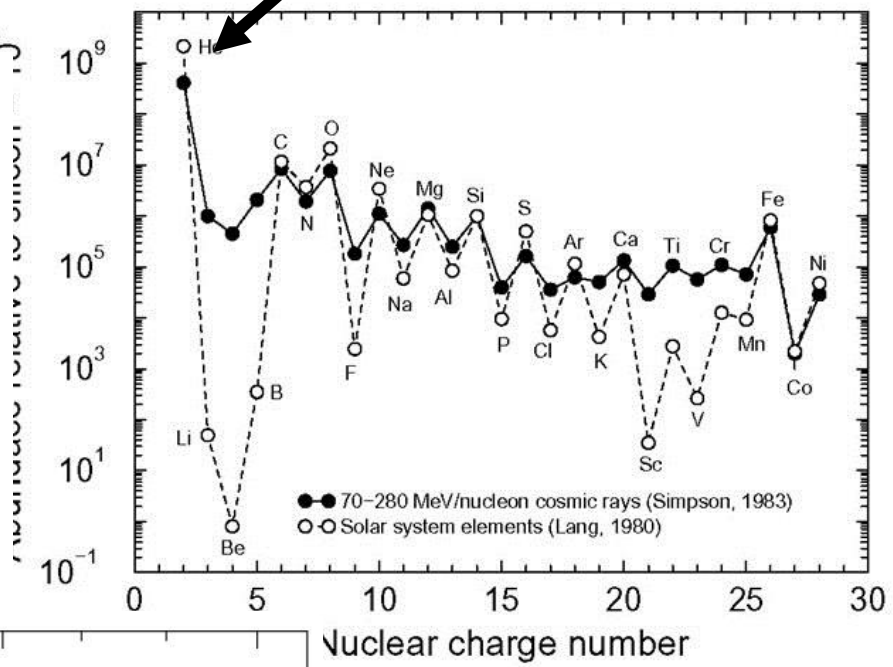


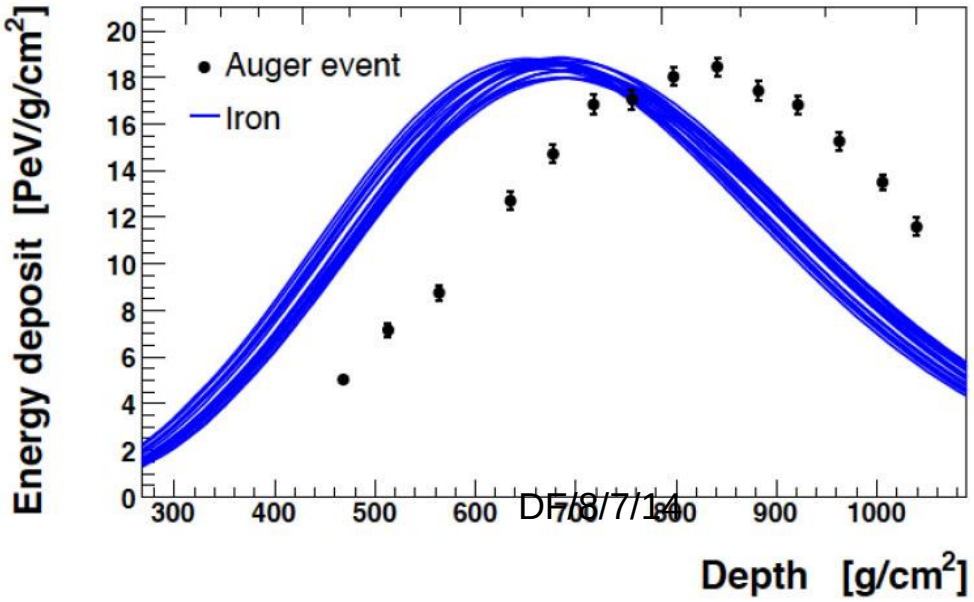
Photon and Charged nuclei or nucleon on Earth: Airshowers



Cosmic ray Composition and Showers: Define both Universe size and deflection angle







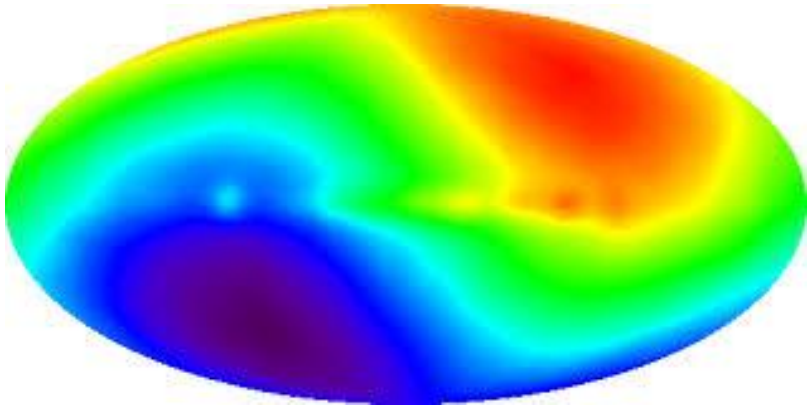
UHECR hopes for near-by bounded almost undeflected Astronomy

- Because at highest energy UHECR are almost unbent they may trace their origin
- However their composition may diffuse their arrival angle and define their arrival distances: ***the GZK cut off due to nucleon or nuclei opacity on relic photons***
- Clustering angle:

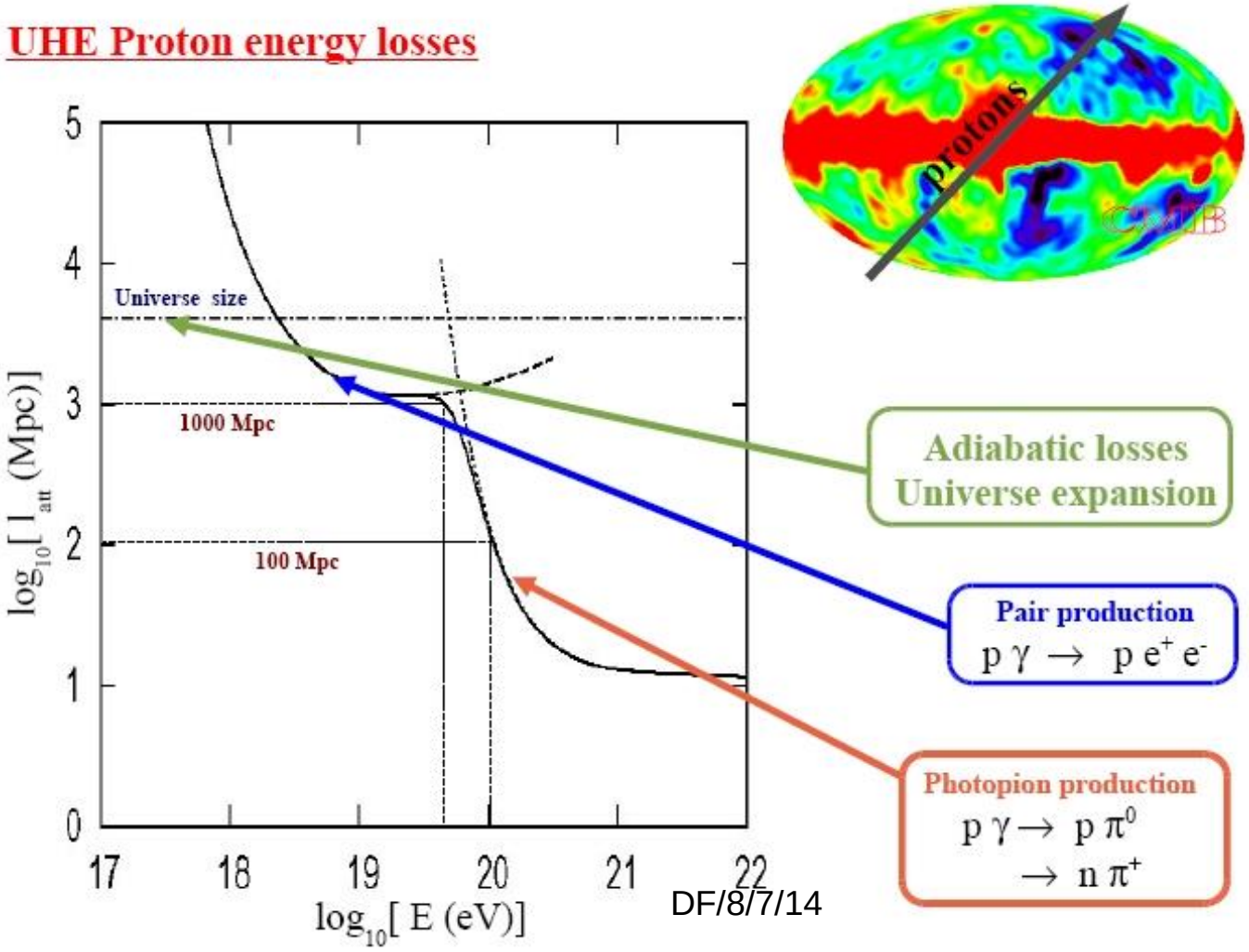
size related

to UHECR nuclei

Composition



The GZK cut off and the cosmogenic neutrinos



Lightest He UHECR in a very very ***Small*** sized Universe, few Mpc: easy to disentangle sources

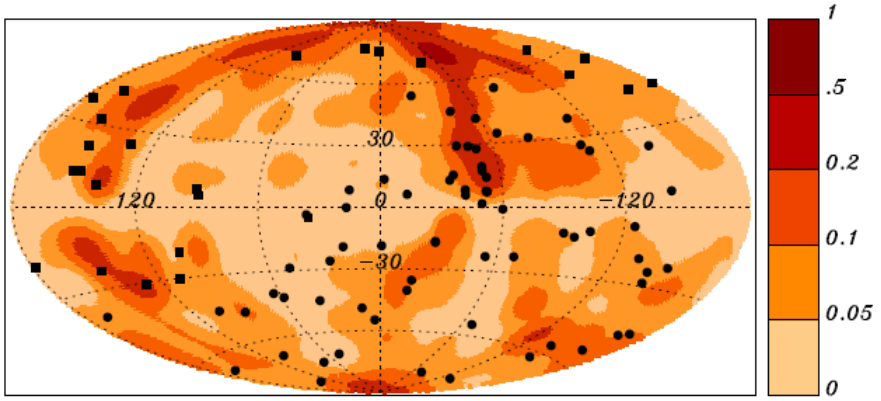
Proton: 2% of Universe

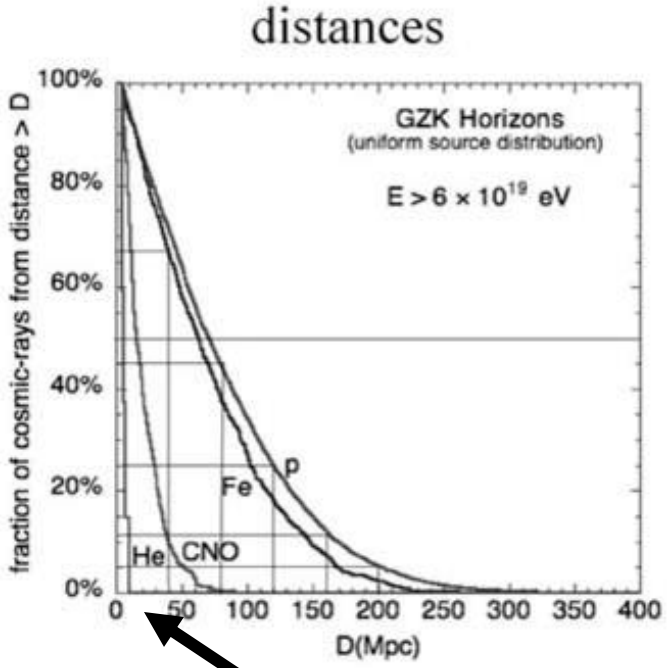
Fe: 2% but randomly smeared

He: 0.2 % of the Universe;

Virgo may be obscored

Harari June 2014:A





$$\alpha_{\rm rms} \simeq \frac{2}{\pi}\frac{ZeB}{E}(rl_c)^{1/2}$$

$$= 1^\circ.1Z\left(\frac{E}{10^{20}\ {\rm eV}}\right)^{-1}\left(\frac{r}{10\ {\rm Mpc}}\right)^{1/2}\left(\frac{l_c}{1\ {\rm Mpc}}\right)^{1/2}\left(\frac{B}{10^{-9}\ {\rm G}}\right). \quad (6)$$

Figure 5. Top panels: AGNs in the 70-month Swift-BAT [illegible] and taking into account the attenuation factor expected from the GZK

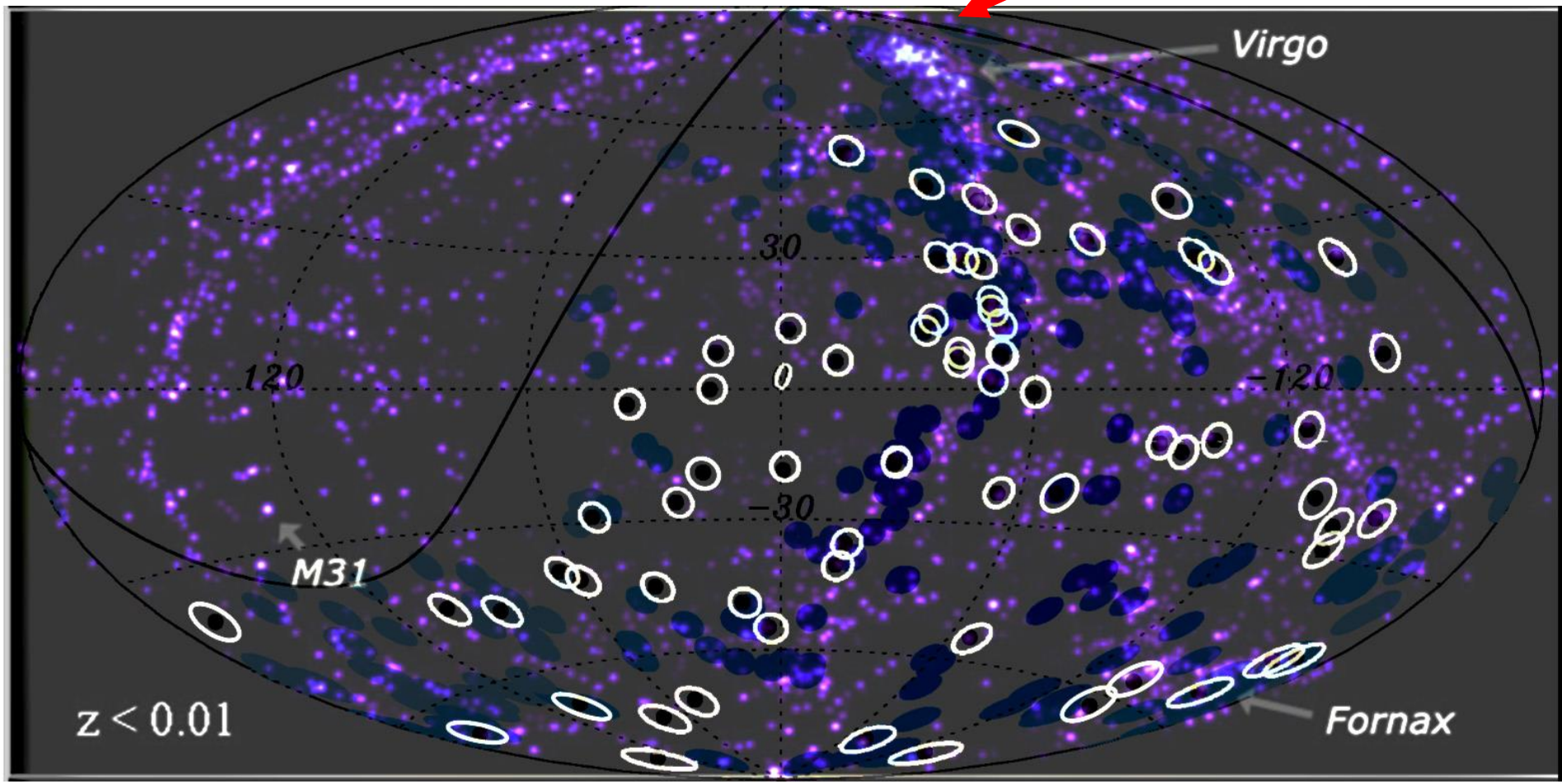
The case of ***Virgo***

- The name of a GW experiment
- The name of nearest and brightest (IR) cluster of Galaxies (thousands)
- The largest mass within the GZK cut off inside the Super Galactic Plane
- ***This wide sky region is nearly absent in UHECR: both in AUGER and TA !***

UHECR contradiction: The composition…and the

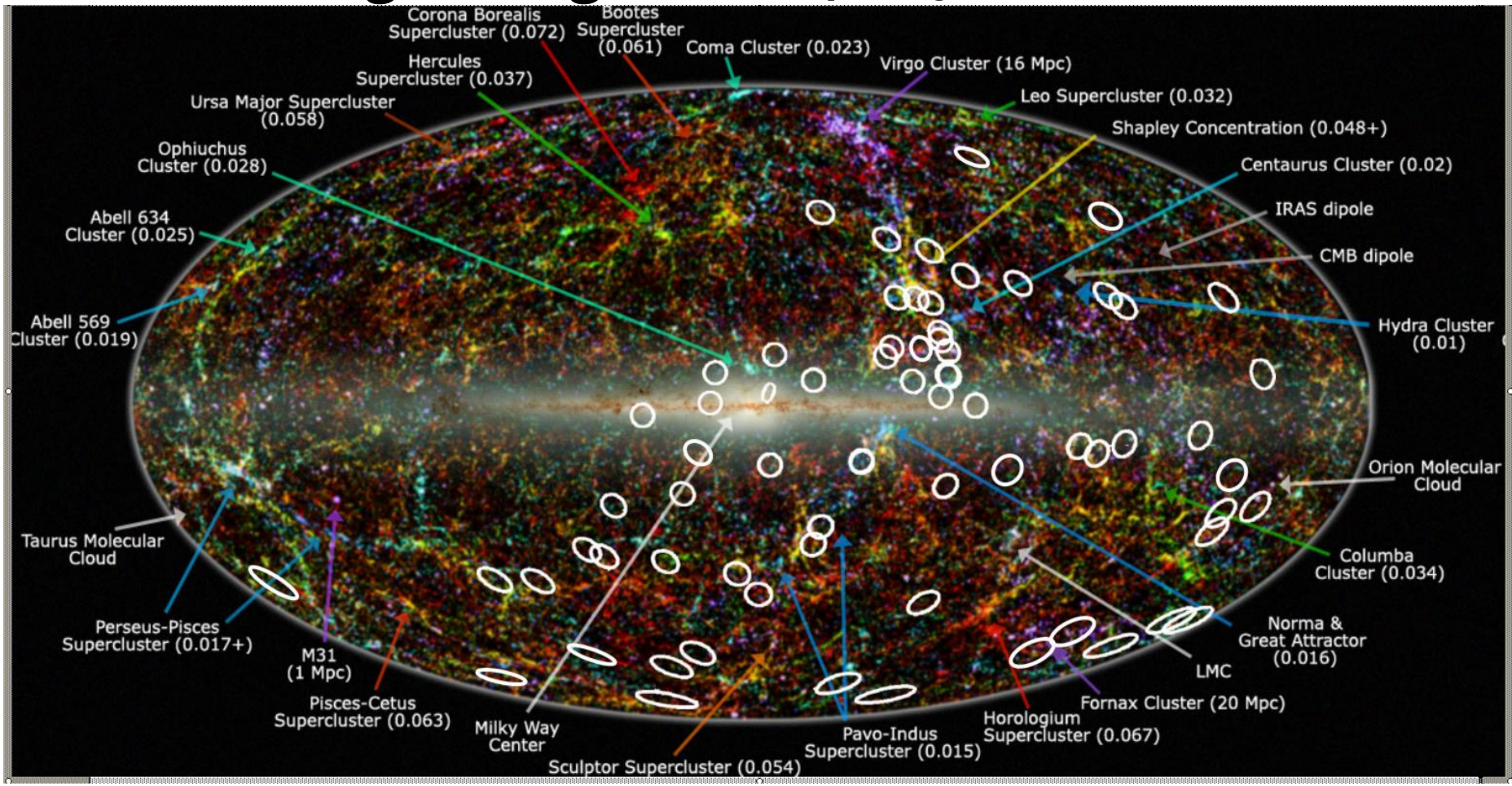
***absence of Virgo* and the apparent SGP ..2007..2009..2011.**

:…..the Super Galactic Plane on 2011.. fade away



No any clear UHECR (69 events) correlation at 40 Mpc Universe volumes

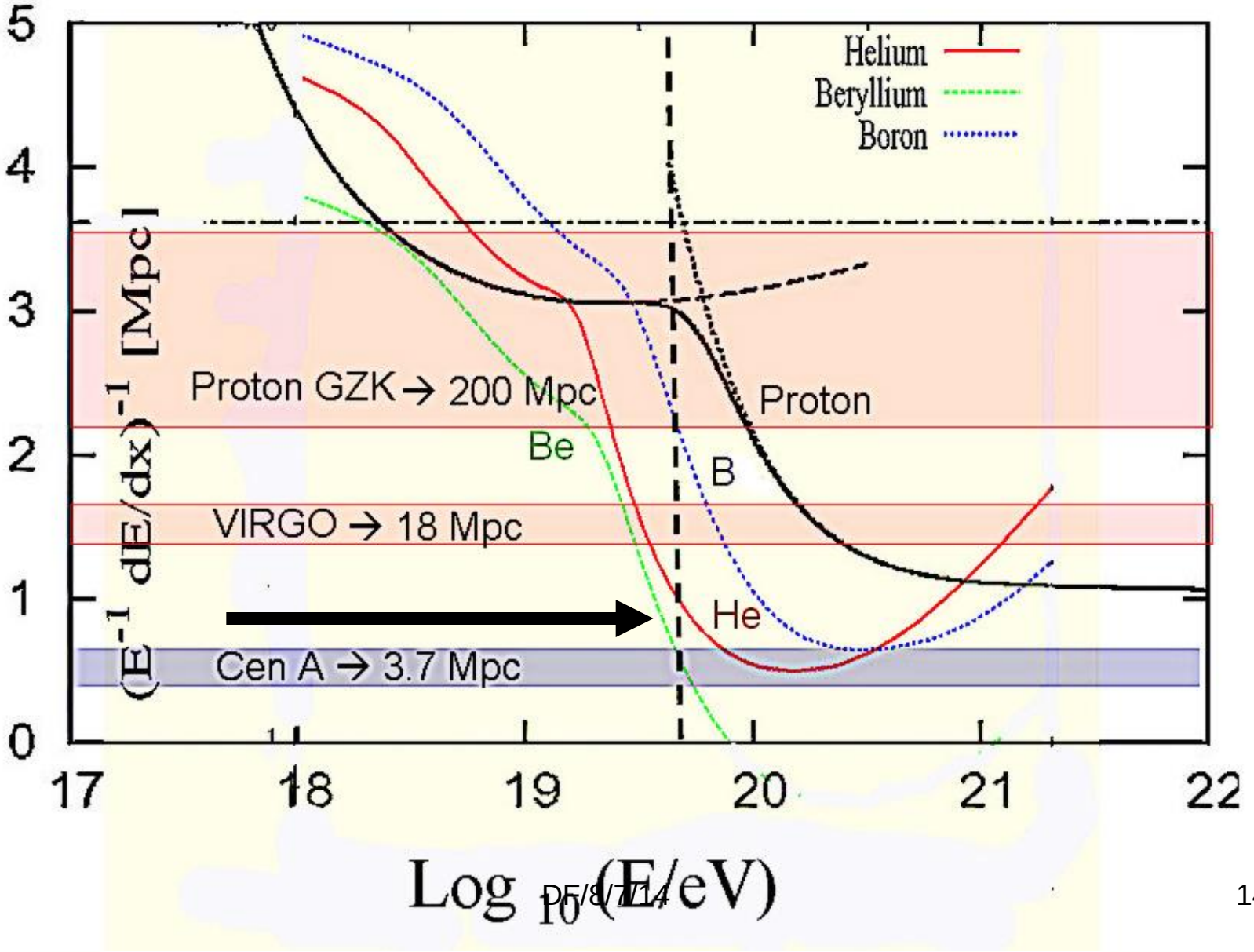
Few ***clustering along Cen A,*** *maybe Vela*



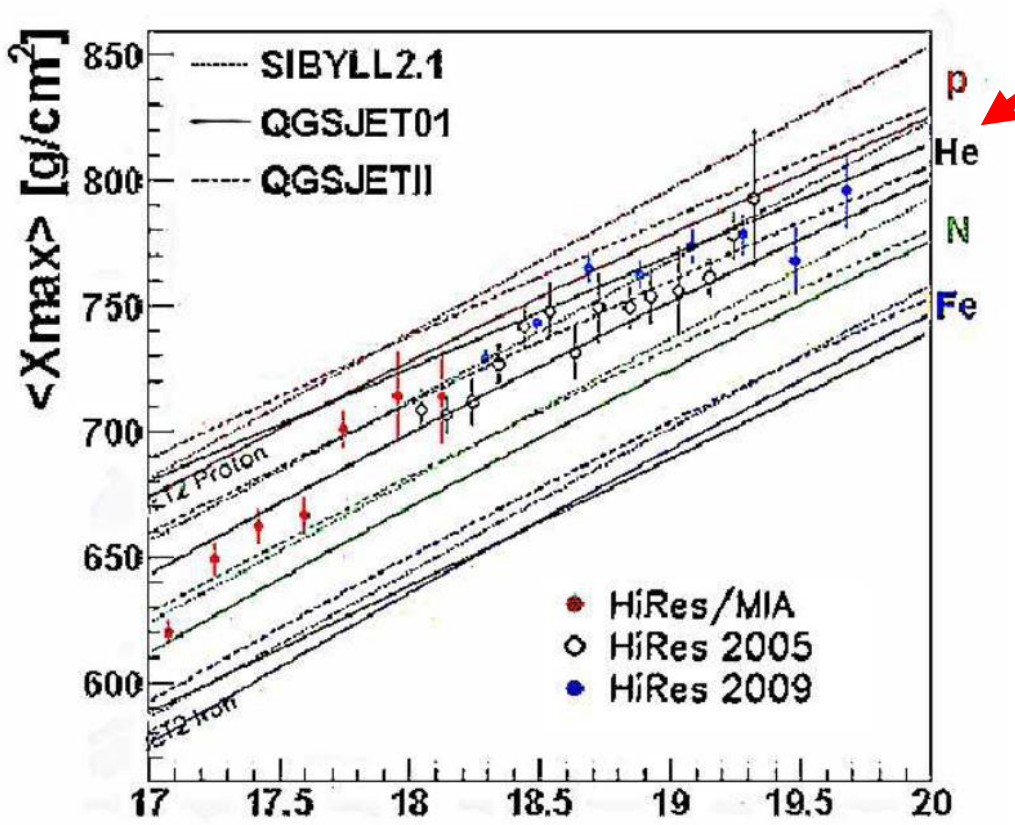
A possible solution to Virgo absence by GZK light nuclei dissociation cut off

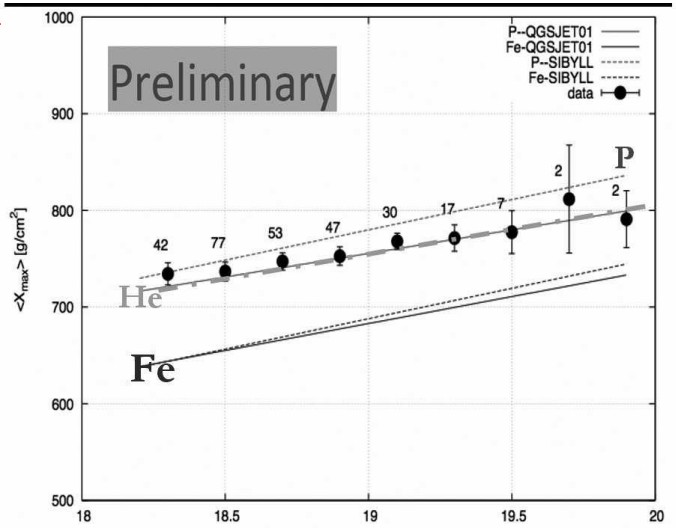
- Physica Scripta Volume 78 Number 4
- D Fargion 2008 *Phys. Scr.* **78** 045901 :
- **Light nuclei solving the AUGER puzzles: the Cen-A imprint**
- **Virgo absent because He UHECR are absorbed**

Lightest Nuclei for Cen A-Virgo GZK cut off may solve the **Virgo absence**



Composition updated
Hires 2010 and TA 2011, 2014
Light Nuclei fit both AUGER and TA





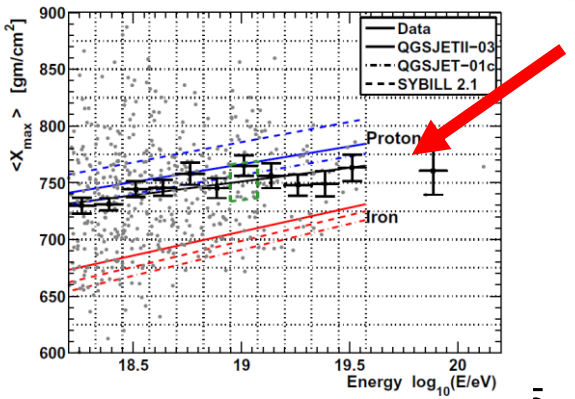
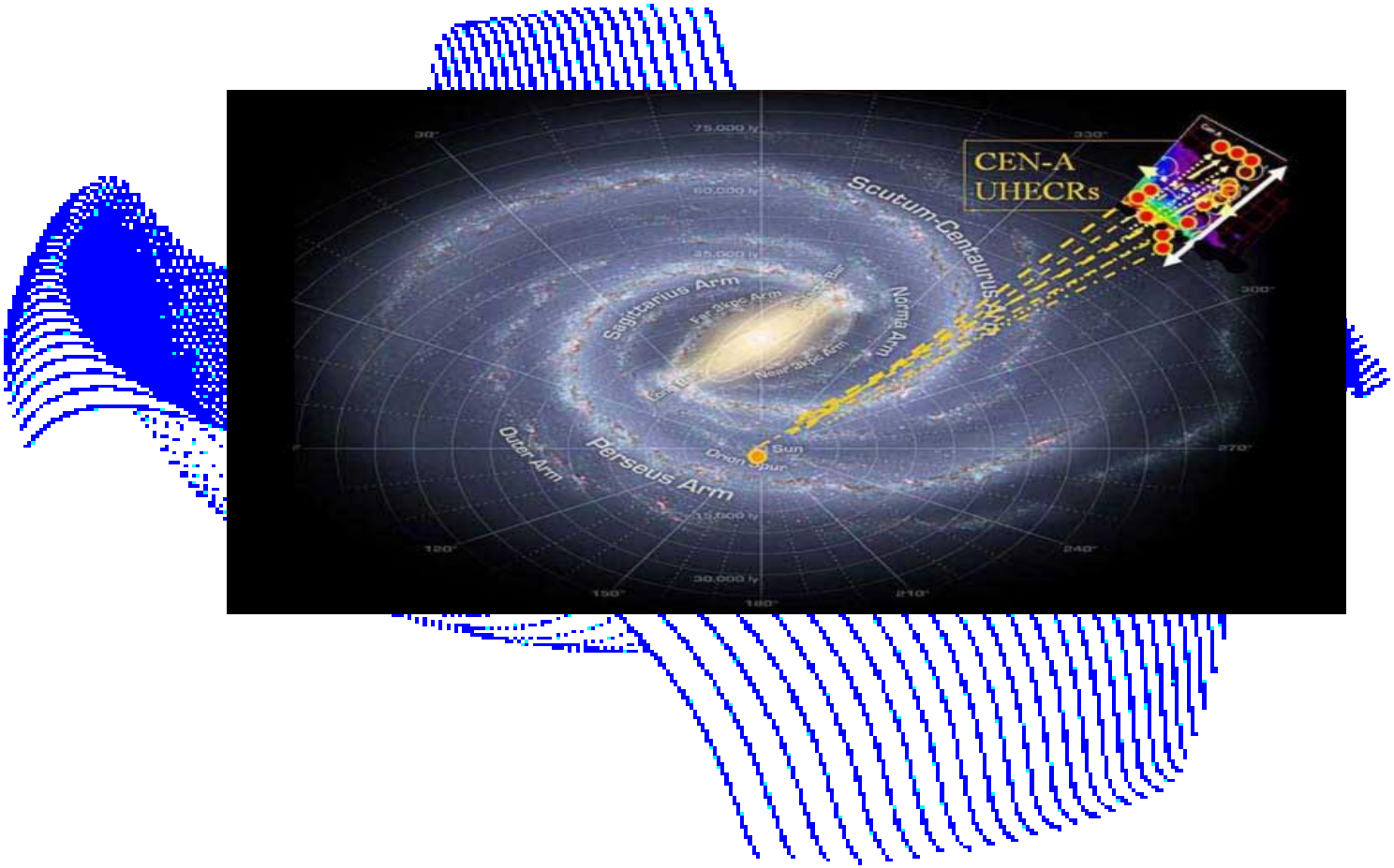


Figure 28: The final Middle Drum hybrid composition result using geometry and pattern recognition cuts for QGSJET-01c, QGSJETII-03, and SIBYLL 2.1 hadronic

Alternate spiral magnetic fields in our galaxy making CenA events by He nuclei UHECR spread up-down in an oval shape



Random Bending along Galactic plane and spliral arm fields: the He UHECR bending

$$\delta_{rm-He} \simeq 16^{\circ} \cdot \frac{Z}{Z_{He^2}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}}\right)\left(\frac{B}{3 \cdot \mu G}\right)\sqrt{\frac{L}{20kpc}}\sqrt{\frac{l_c}{2kpc}}$$

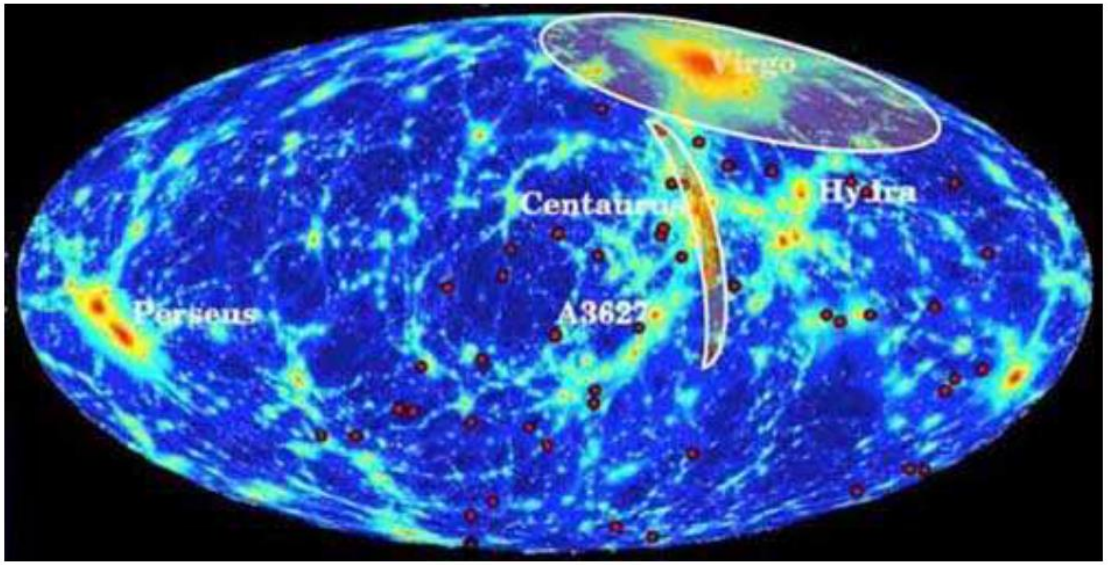
The He fragments of the UHECR at 20 EeV energy will be one third lower energy and half charged: three half the previous value

$$\delta_{rm-D} = \delta_{rm-p} \simeq 24^{\circ} \cdot \frac{Z}{Z_{D1}} \cdot \left(\frac{2 \cdot 10^{19} eV}{E_{CR}}\right)\left(\frac{B}{3 \cdot \mu G}\right)\sqrt{\frac{L}{20kpc}}\sqrt{\frac{l_c}{2kpc}}.$$

Coherent and random UHECR Spectroscopy of Lightest Nuclei along Cen_A:

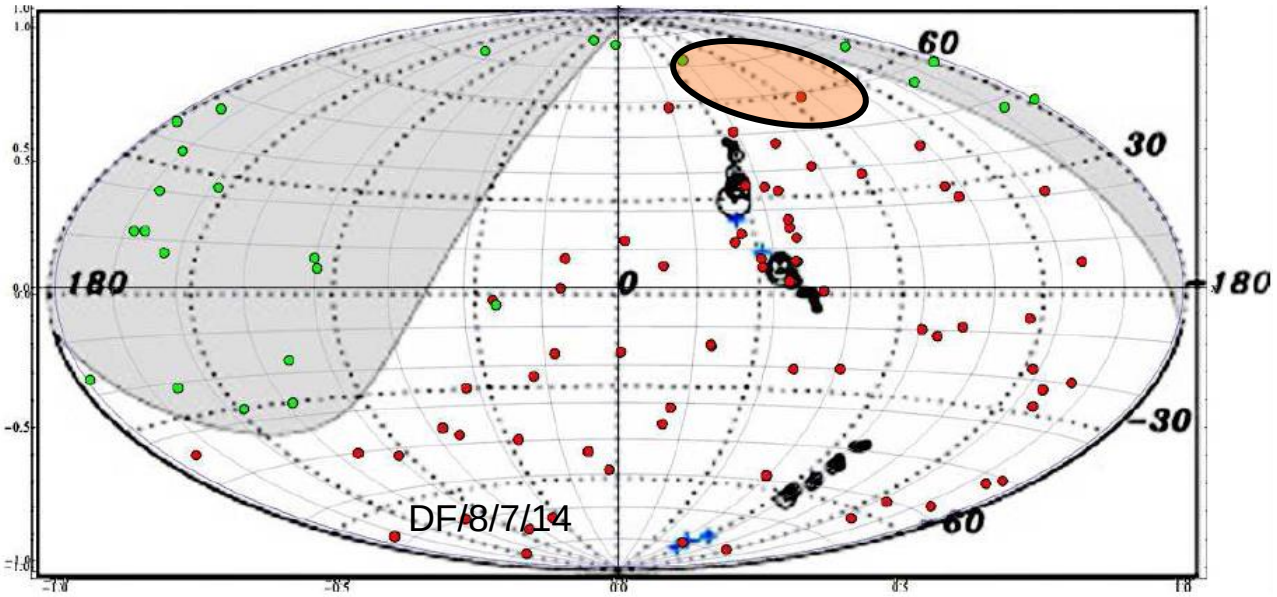
Foreseen He fragments since 2009:

2008 DF arXiv:0908.2650 , NIMA51778 PII: S0168-9002(10)01230-1, 2010



Observed by AUGER on 2011

AUGER Coll., (TAUP 2011) , IOP Publishing
Journal of Physics: Conference Series
375,(2012) 052002



Additional hints:TeVs Gamma may tag UHECR?

EQUATORIAL MAPS

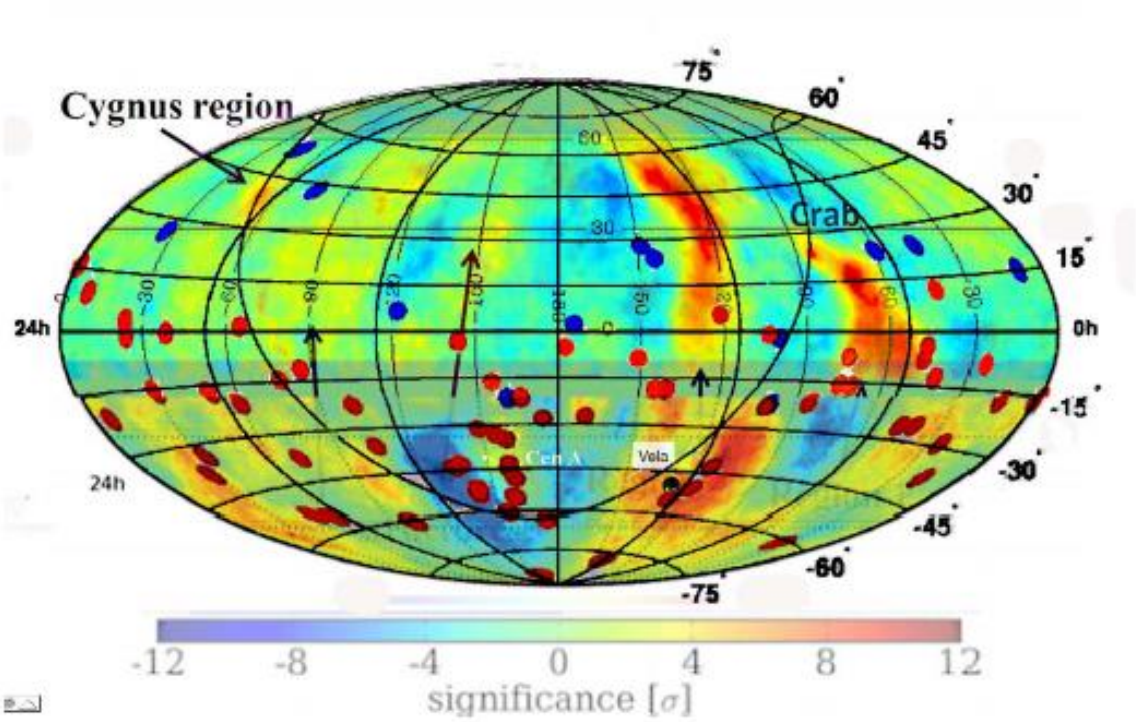


Figure 2. The AUGER 2010 UHECR (red) and Hires (blue) event map in celestial coordinate on recent (2010) TeV diffused CR map (ARGO-Milagro-ICECUBE) and labels. See [6],[20], and references. The triplet UHECR event clustering toward Vela and the TeV spread activity around is remarkable. The Cen A clustering at the fig. center is the main feature in the UHECR map. ARGO TeV anisotropy born around Crab connect and overlap the UHECR events in nearby Orion TeV region. Note doublet along the galactic plane and the TeV near Cygnus and Cas A regions, where Hires did and we foresee TA may detect UHECR events.

Also a Coherent Bending for heavy He,Fe while crossing vertically in our galaxy

UHECR and Astronomy

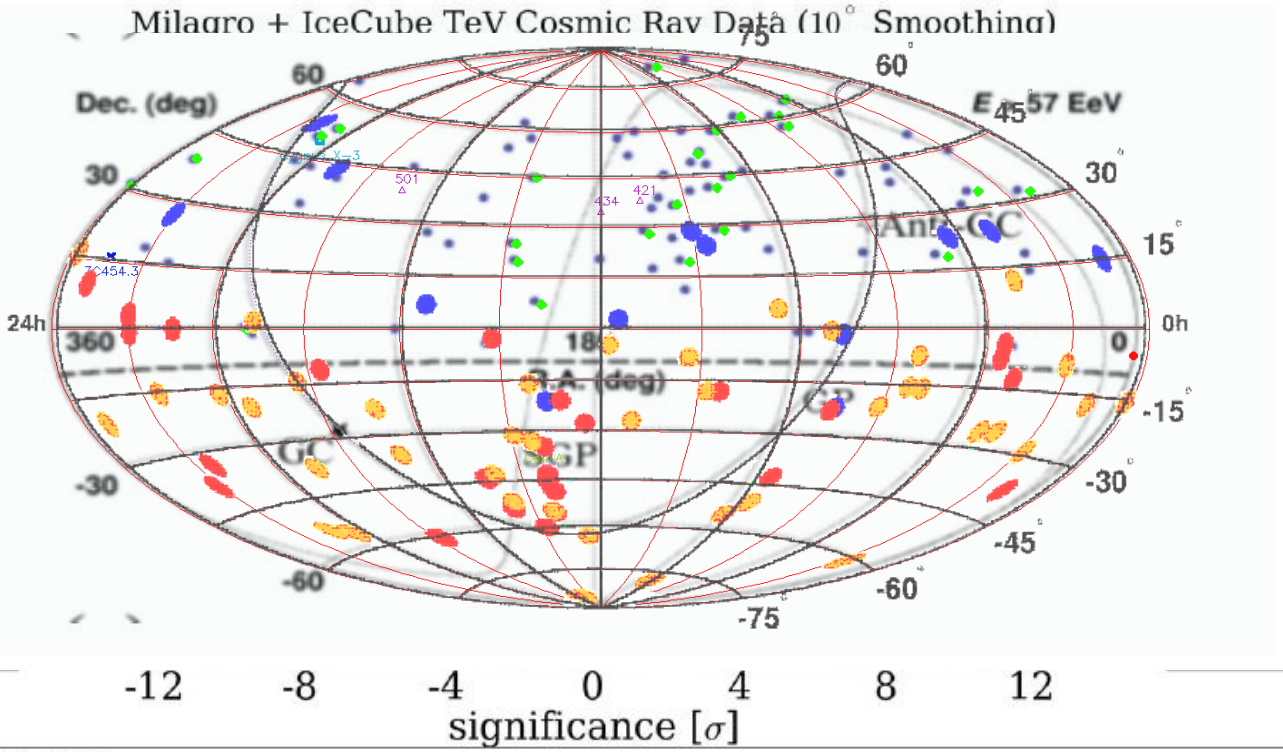
- UHECR are bounded by GZK cut off
- UHECR are less bent by magnetic fields
- They may point back to the source
- If Nucleons: A narrow coherent bending angle
- If nuclei as heavy one Fe, Ni a large one if near, very large bending if far away

$$\delta_{Coh-p\cdot} \simeq 2.3^\circ \cdot \frac{Z}{Z_H} \cdot \left(\frac{6\cdot 10^{19} eV}{E_{CR}}\right)\left(\frac{B}{3\cdot \mu G}\right)\frac{l_c}{kpc}.$$

$$\delta_{Coh-Ni} \simeq 18,7^\circ \cdot \frac{Z}{Z_{Ni^{28}}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}}\right)\left(\frac{B}{3 \cdot \mu G}\right)\left(\frac{l_c}{0.29kpc}\right)$$

$$\delta_{Coh-Ni} \simeq 129^\circ \cdot \frac{Z}{Z_{Ni^{28}}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}}\right)\left(\frac{B}{3 \cdot \mu G}\right)\left(\frac{l_c}{2kpc}\right)$$

Overlap of UHECR TA, Hires,AUGER in celestial coordinate 2014

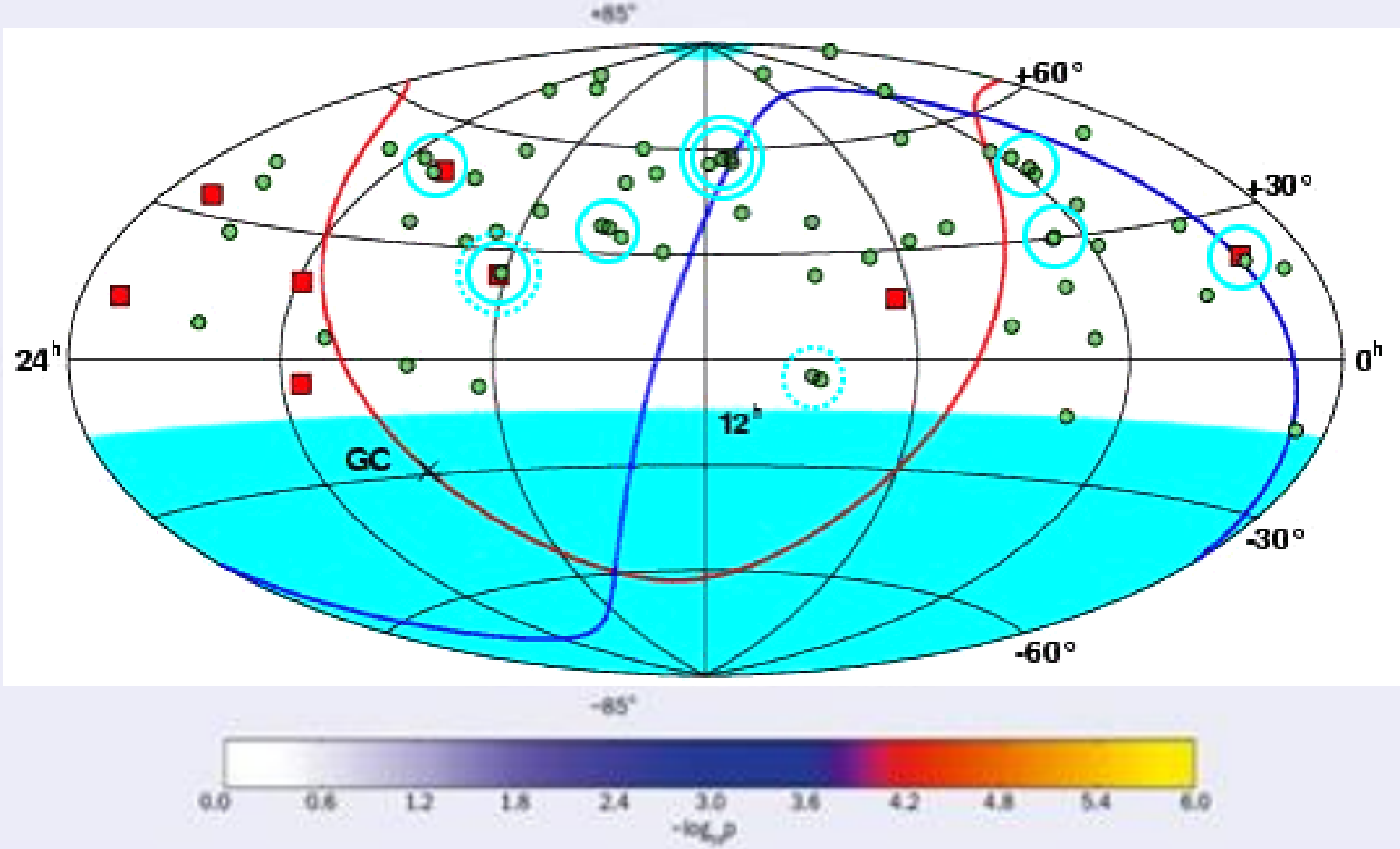


1 TeV
21101, 2008

20 TeV
, 16, 2011

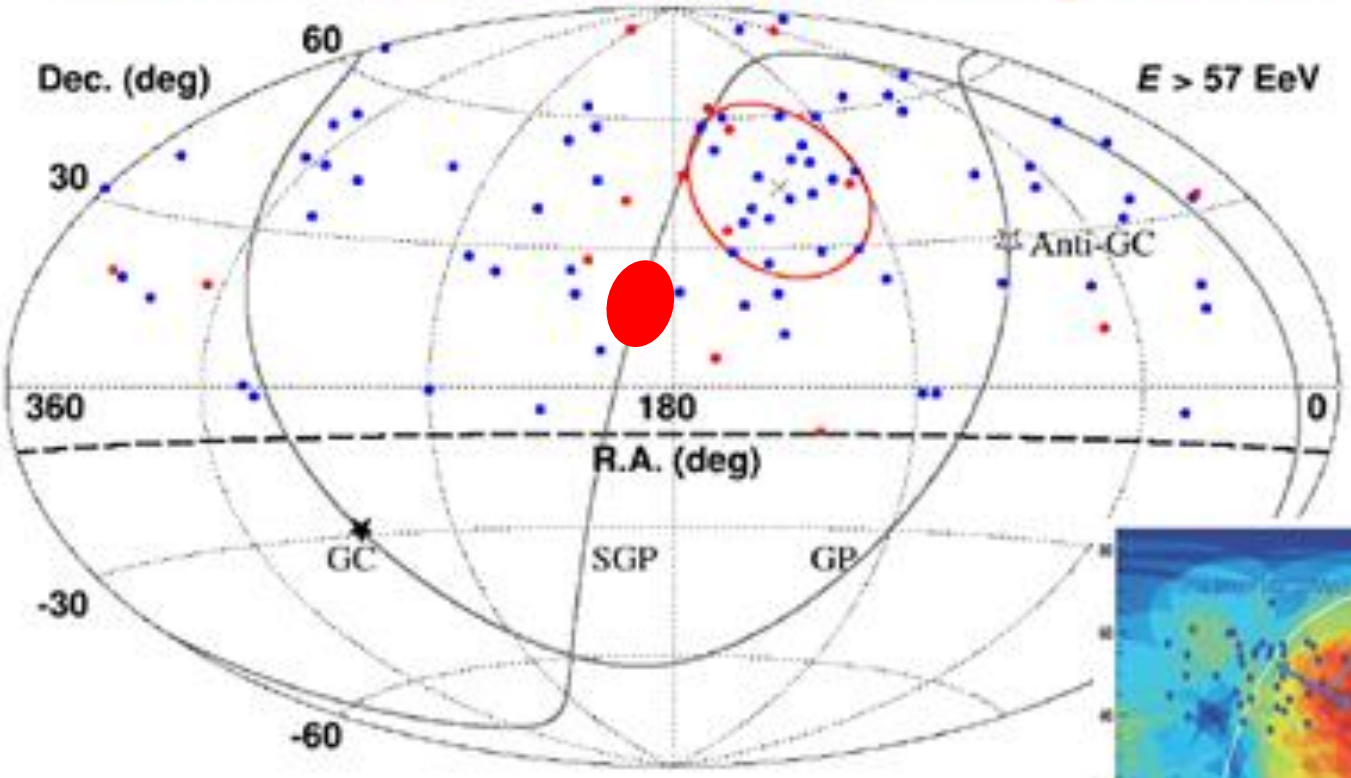
cance

Thursday, January 31, 2013

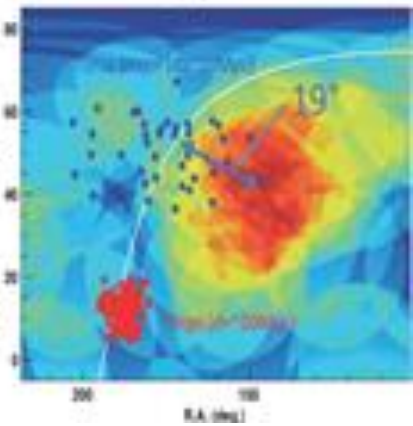

+85°
+60°
+30°
24h
0h
12h
GC
-30°
-60°
-85°
0.0
0.6
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
6.0
-log10 p

ALL AUGUST 2014

Event Distribution 6 years



5-year data: 72 events + New 1 year: 15 evel



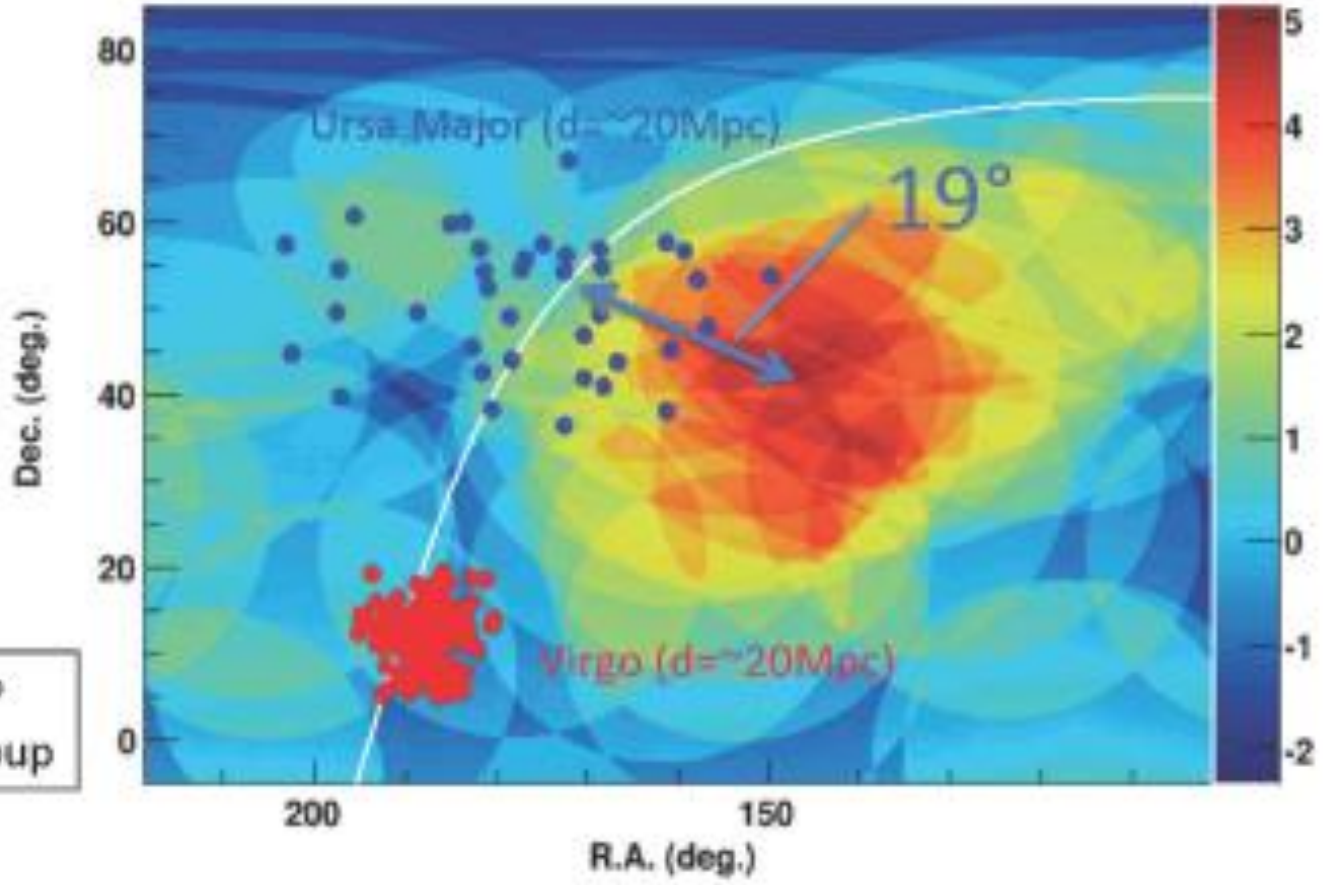
Who is feeding by bending UHECR the TA Hot Spot?

Ursa Major Supercluster

Krause et al.,
A&A, 551, 143 (2013)

http://
www.atlasoftheuniverse.com/galgrps/vir.html

Solid curve : SGP
Point: galaxy group

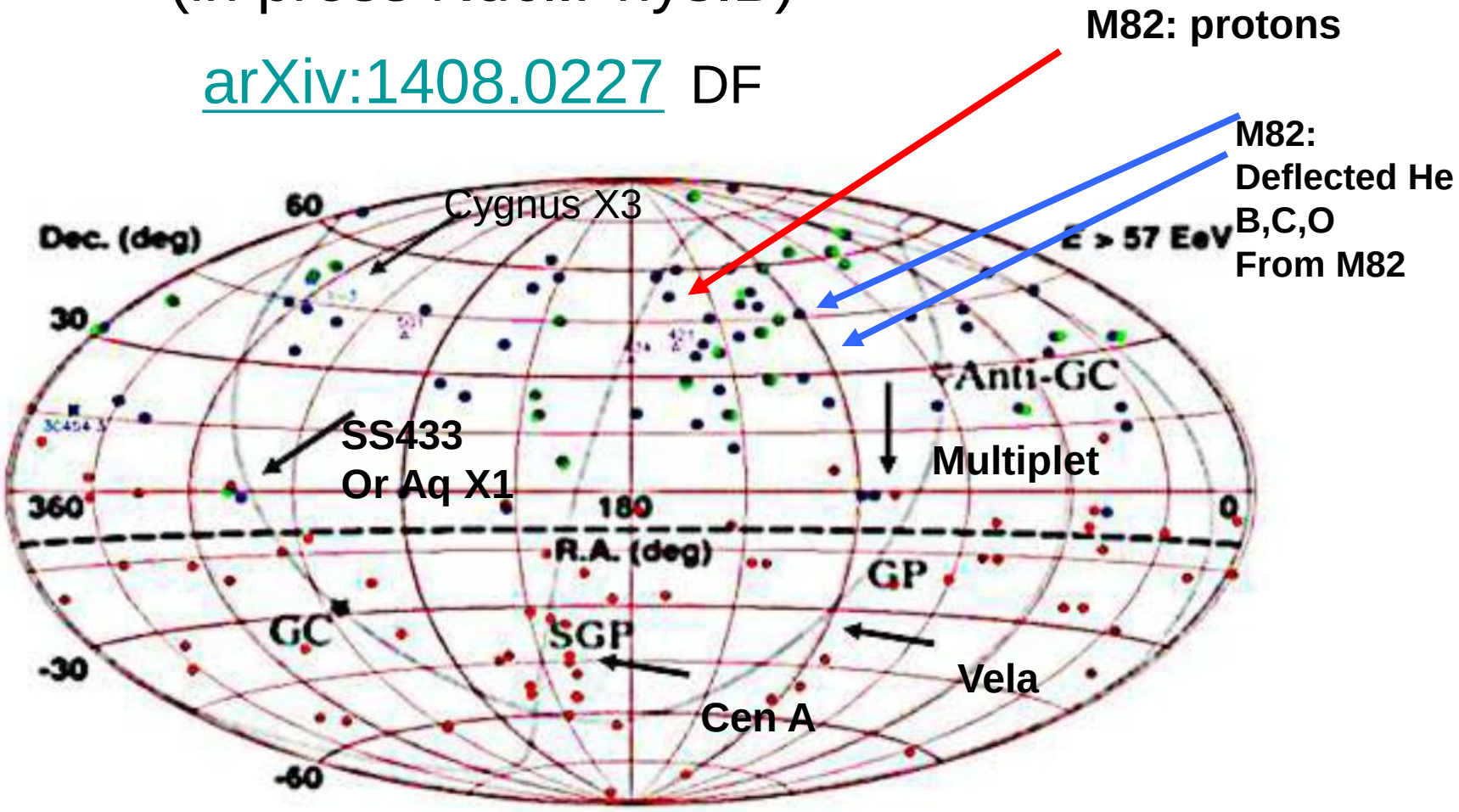


He UHECR solving the TA Hot Spot puzzle?

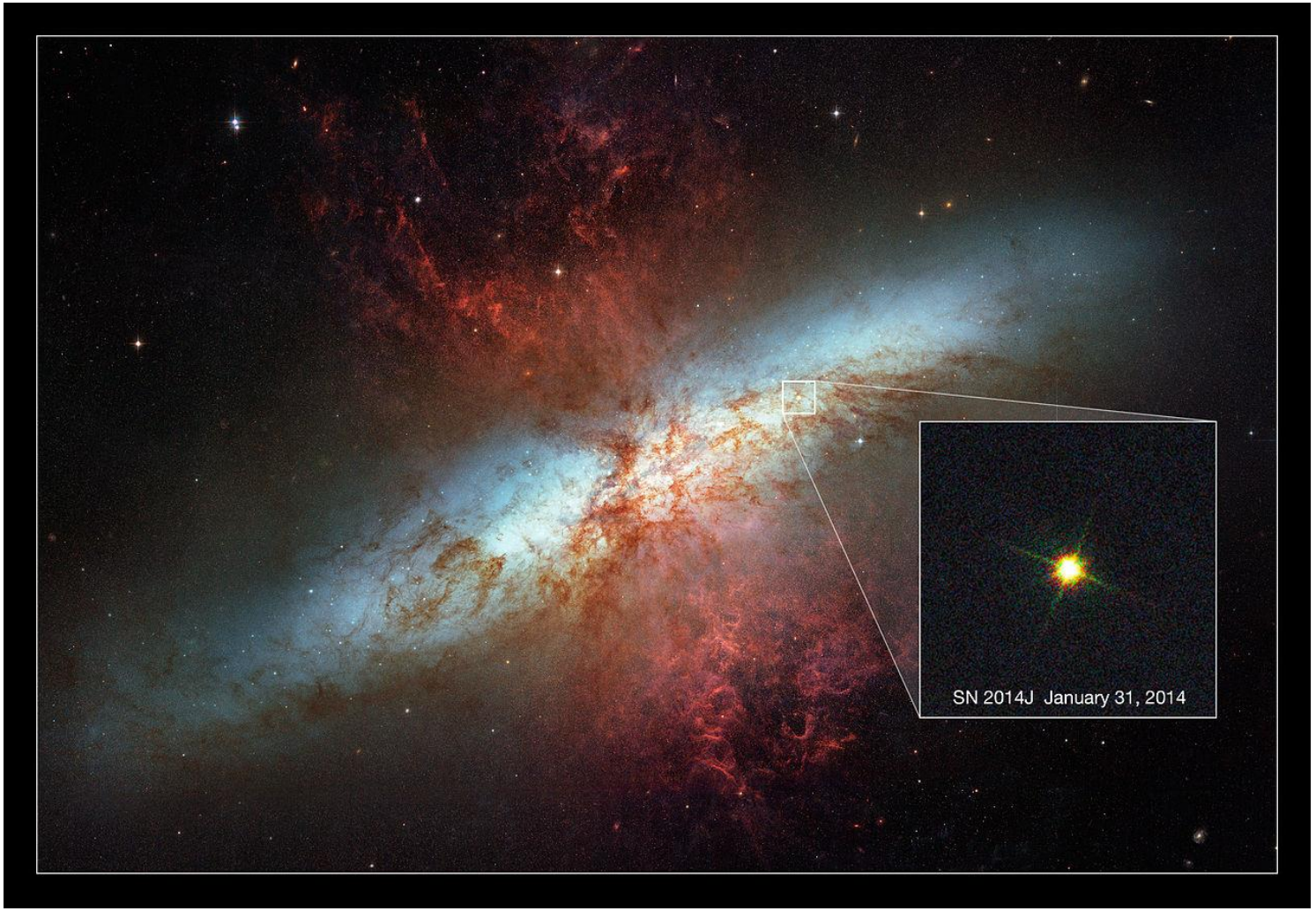
- ***The UHECR TA events are not spread events of any spread cluster but they are probably the spread random walk of one main source: It suffer few Coherent bending while crossing at vertical galactic B fields***
- **He photo-nuclear fragility avoid UHECR to arrive from Virgo** (as well from URSA Majoris, 60 My), but UHECR **He**,(Be,B) may still arrive scrambled and deflected ***from near M82*** at 11 My a few degree (p,D) or at larger ones (He,Be,B) as they are observed in the TA ***Hot spot***

Most recent Proposal (in press Nucl.Phys.B)

arXiv:1408.0227 DF



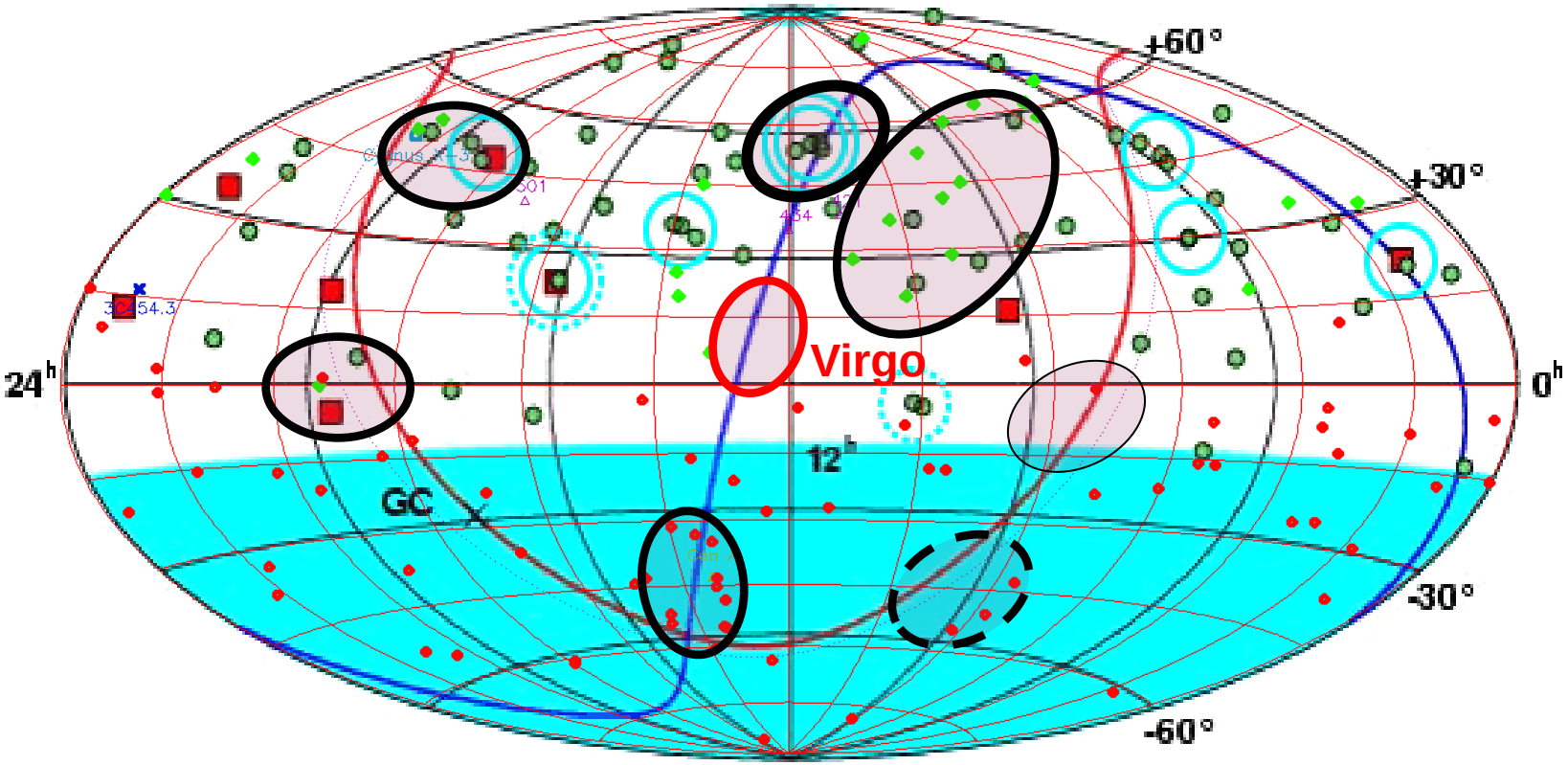
M82: Nearest brightest nearest Starburst Galaxy (*distance* of 12 million light years)



Last Nature letter 2 days ago

- **There's a bit of a mystery buried in the heart of the Cigar Galaxy, known more formally as M82 or Messier 82. Shining brightly in X-rays is a black hole (called M82 X-1)** that straddles an unusual line between small and huge black holes, new research has revealed.
- The new study reveals for the first time just how big this black hole is — about 400 times the mass of the sun — after about a decade of struggling to figure this out.

Event Distribution 6 years



5-year data: 72 events + New 1 year: 15 events

Conclusion 1

- ***UHECR astronomy is possibly born***: lightest nuclei are their main courier: Mostly **He, D, p** and maybe **B,C,O** too. Galactic **Ni,Fe** may also rise but rarely and near. Just a few sources in action within narrow **He GZK**
- They are few known sources, somehow off-axis:
- ***Cena A (nearest AGN)***
- ***Vela ?(nearest, brightest gamma pulsar)***
- ***Aq-X1 or SS433,nearest and powerfull jets***
- ***Cygnus X3 , brightest binary in TeV milagro, ARGO map***
- ***M 82 (nearest star burst galaxy)***
- ***INTERMEDIATE MASS BH Jet may play a role***

Most UHECR spread clustering are just spectroscopically , coherently spread events correlated with narrow cluster as for M 82.

Thank you for the kind attention

Conclusion 2 on UHE neutrino

- ***UHE neutrino are only partially galactic** and possibly **rarely correlated to UHECR** as Vela (event 3,6), Cen A, Galactic center, Aq-X1 or SS433..UHE neutrinos are mostly cosmic, often uncorrelated or difficult to pick up in time (GRB, BL Lac flare) but within precursor events.*
- *UHE crossing muons at horizons (several dozens) may soon help to disentangle their maps (foreseen and observed)*
- *Present ICECUBE test at TeV-PeV mostly crossing muons are polluted by atmospheric events: useless*
- ***Precessing jets for GRB and SGR are long life**: they may be still consistent with UHE neutrino and AGN flare at few-ten percent.*
- ***Neutrino may shed in future light on Cosmic Rays but already UHECR light nuclei may shed light to UHE light neutrino***
- ***Thank you for the kind attention***

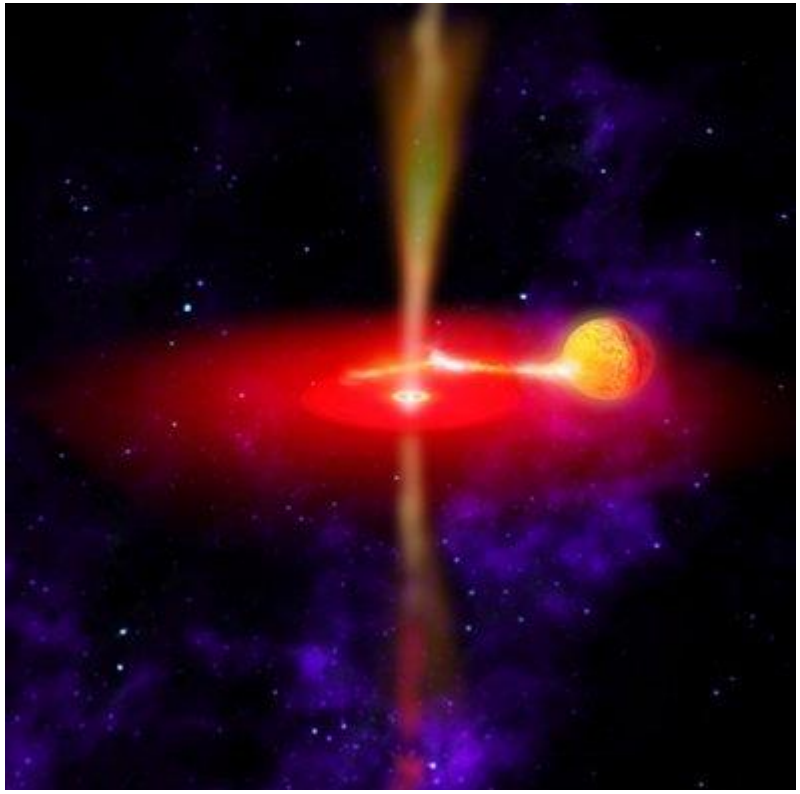
Nature ,17 August 2014

- **M82 X-1, the brightest X-ray source in the galaxy M82, has been thought to be an intermediate-mass black hole** (100 to 10,000 solar masses) because of its extremely high luminosity and variability characteristics1, 2, 3, 4, 5, 6, although some models suggest that its mass may be only about 20 solar masses3, 7. The previous mass estimates were based on scaling relations that use low-frequency characteristic timescales which have large intrinsic uncertainties8, 9. For stellar-mass black holes, we know that the high-frequency quasi-periodic oscillations (100–450 hertz) in the X-ray emission that occur in a 3:2 frequency ratio are stable and scale in frequency inversely with black hole mass with a reasonably small dispersion10, 11, 12, 13, 14, 15. The discovery of such stable oscillations thus potentially offers an alternative and less ambiguous means of mass determination for intermediate-mass black holes, but has hitherto not been realized**. Here we report stable, twin-peak (3:2 frequency ratio) X-ray quasi-periodic oscillations from M82 X-1 at frequencies of 3.32 ± 0.06 hertz and 5.07 ± 0.06 hertz.** Assuming that we can extrapolate the inverse-mass scaling that holds for stellar-mass black holes, we estimate the black hole mass of M82 X-1 to be 428 ± 105 solar masses. In addition, we can estimate the mass using the relativistic precession model, from which we get a value of **415 ± 63 solar masses.**

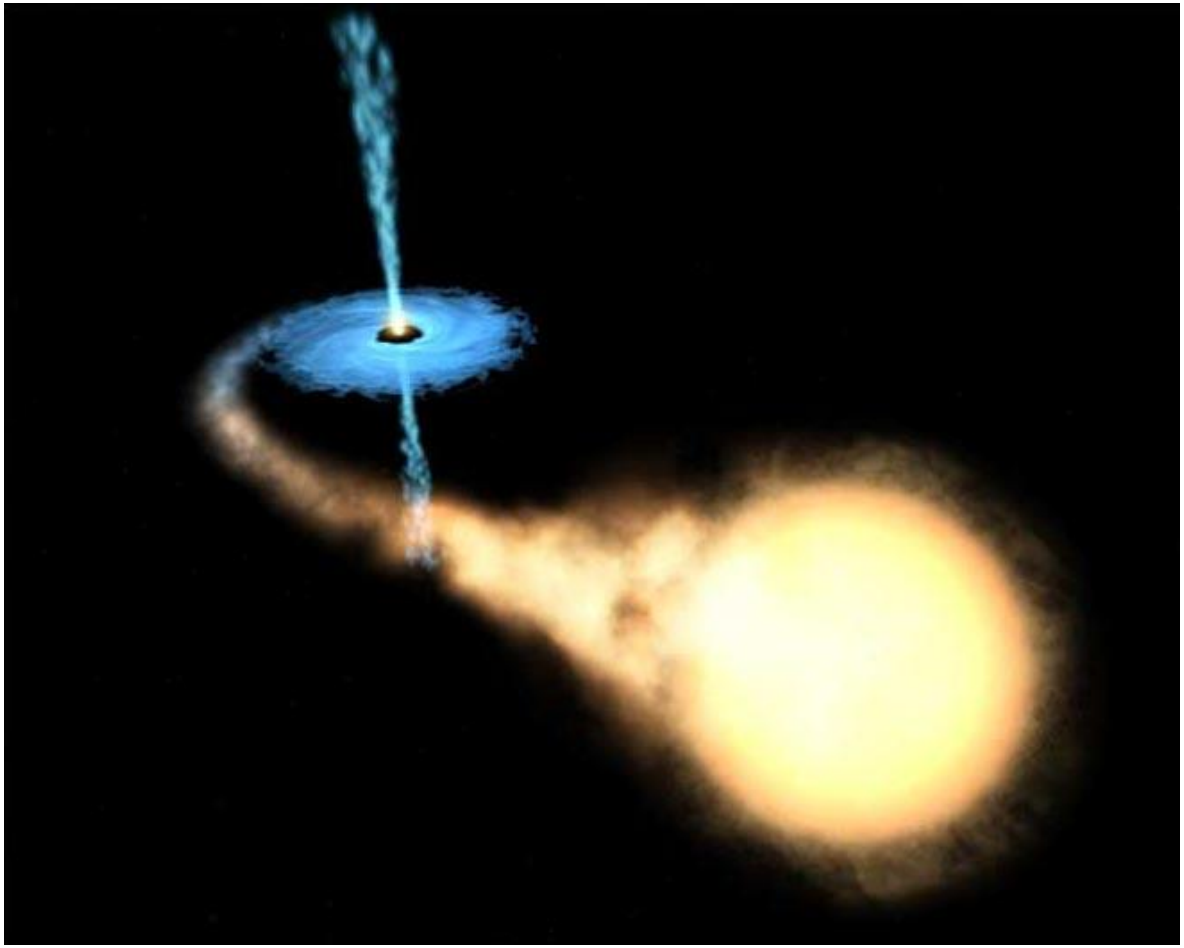
- **Intermediate BH at thousand solar Mass may be the UHECR sources**

Cygnus X 3

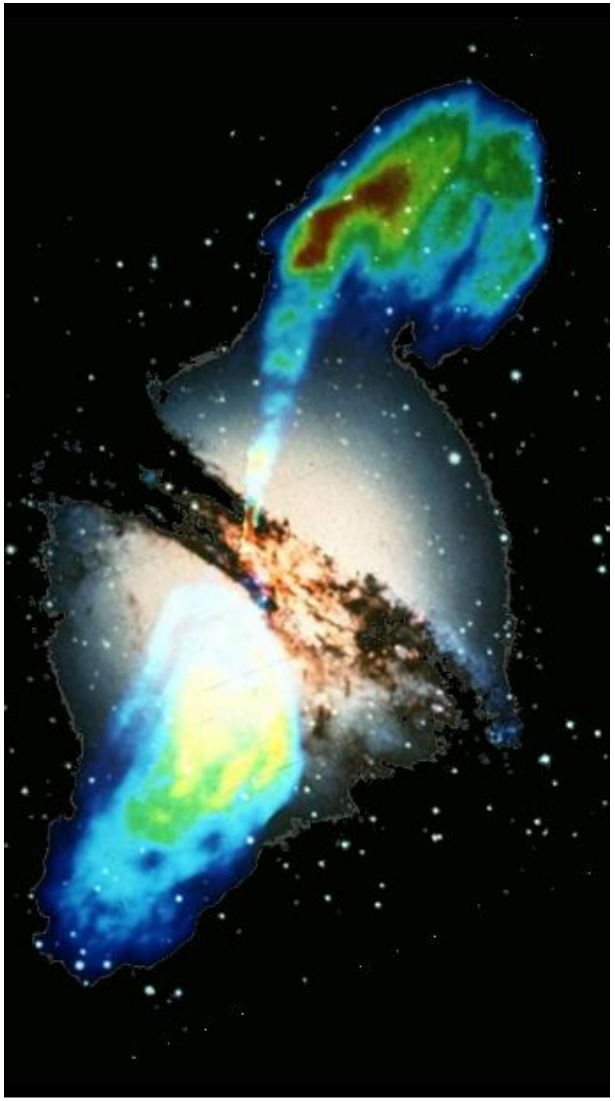
- Bynary system jet

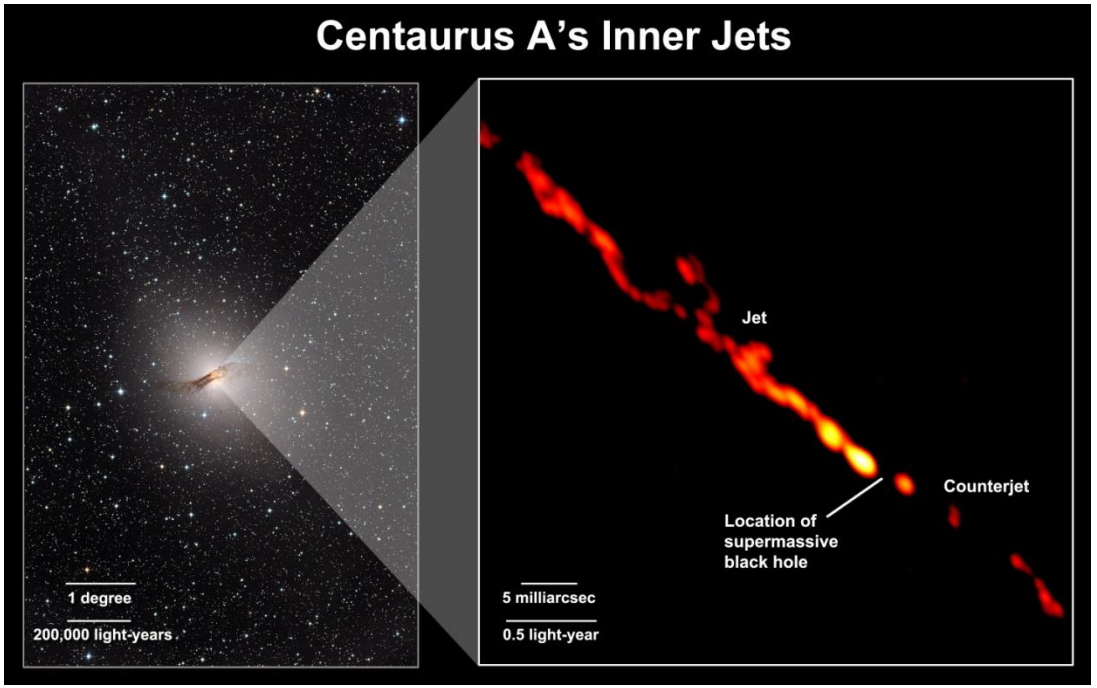


SS433 as Aq X1: bynary precessing jet

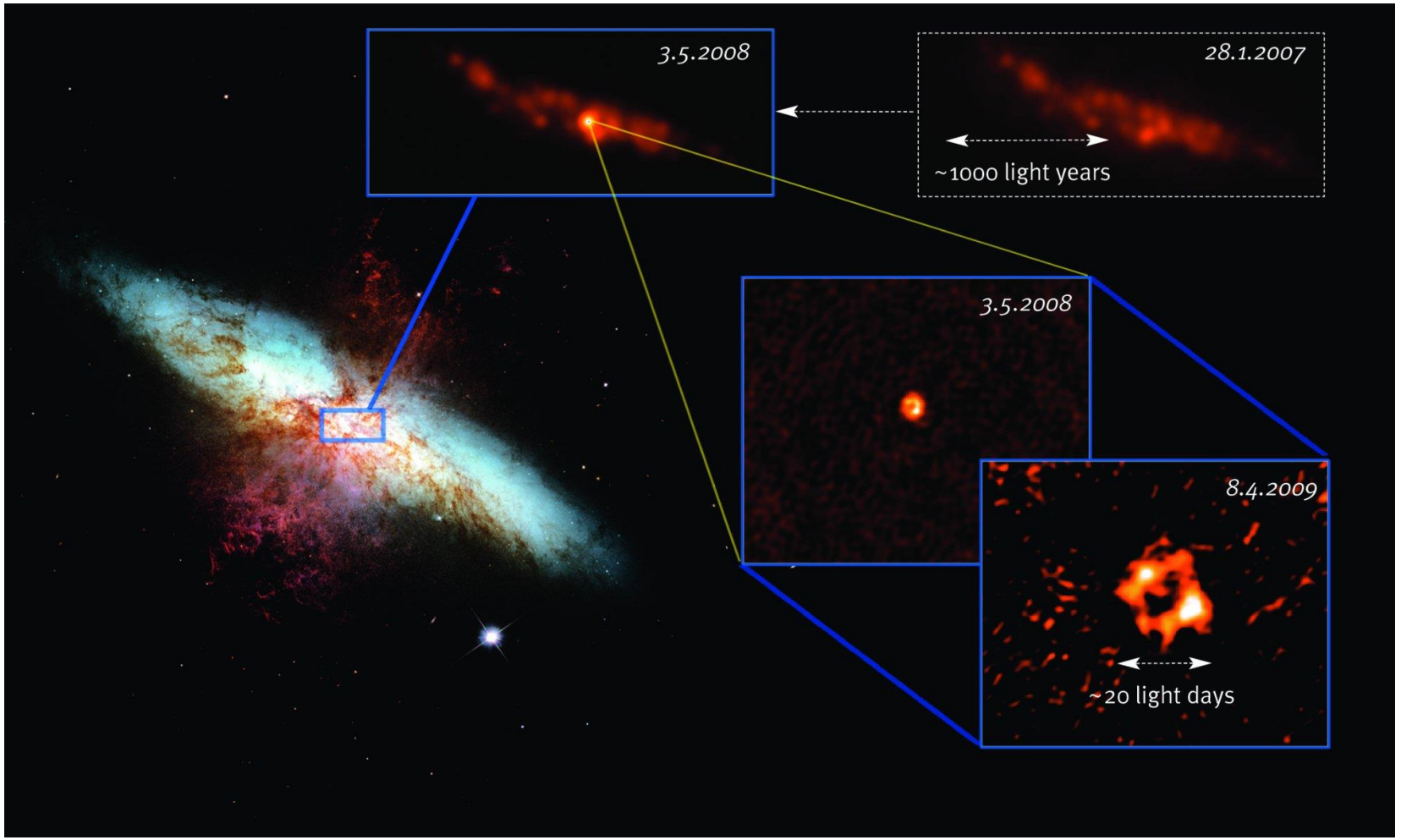


Cena A: Our nearest AGN





M82: nearest star burst, inner core



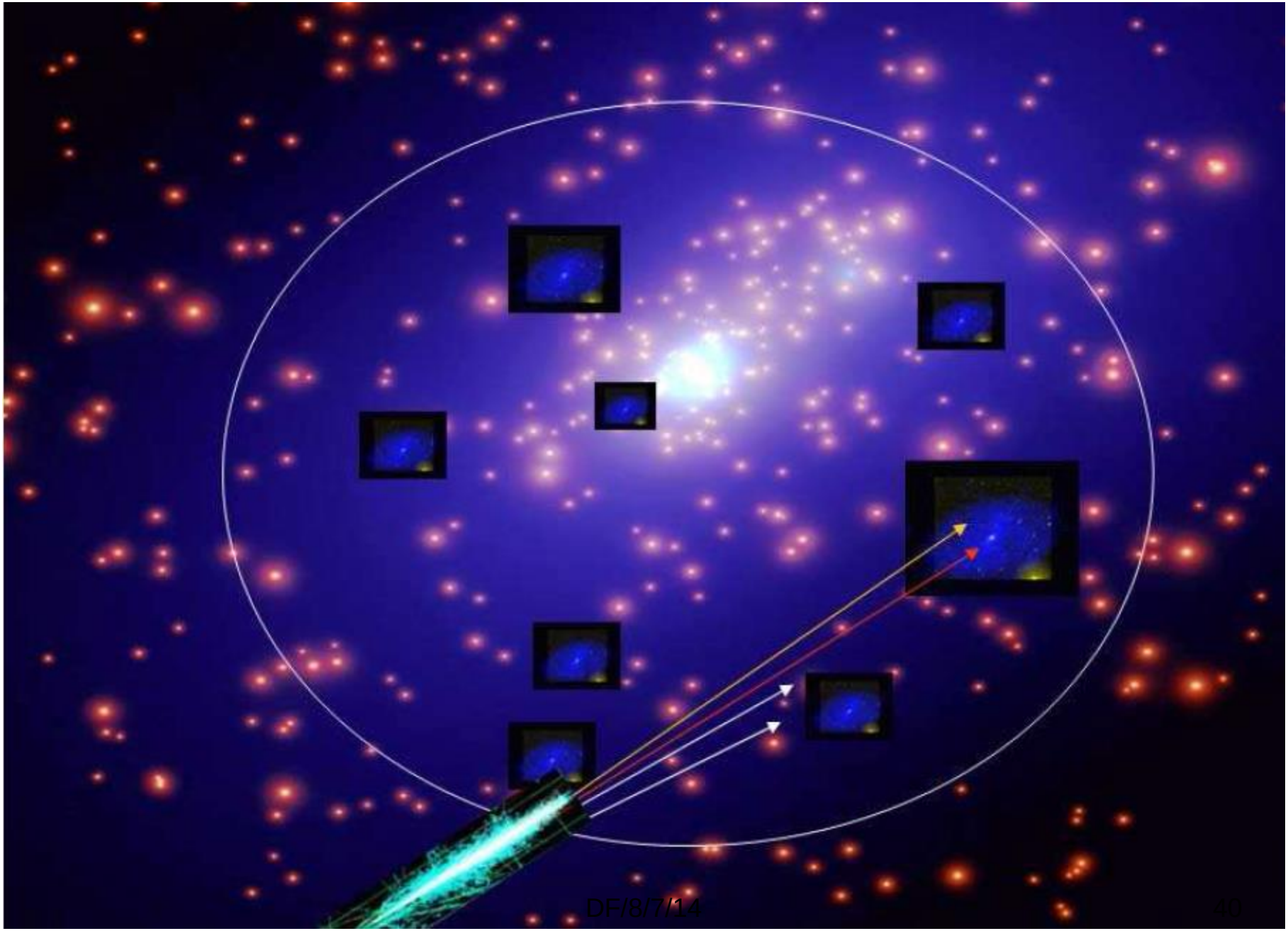
Additional slides

Ursa cluster versus M82

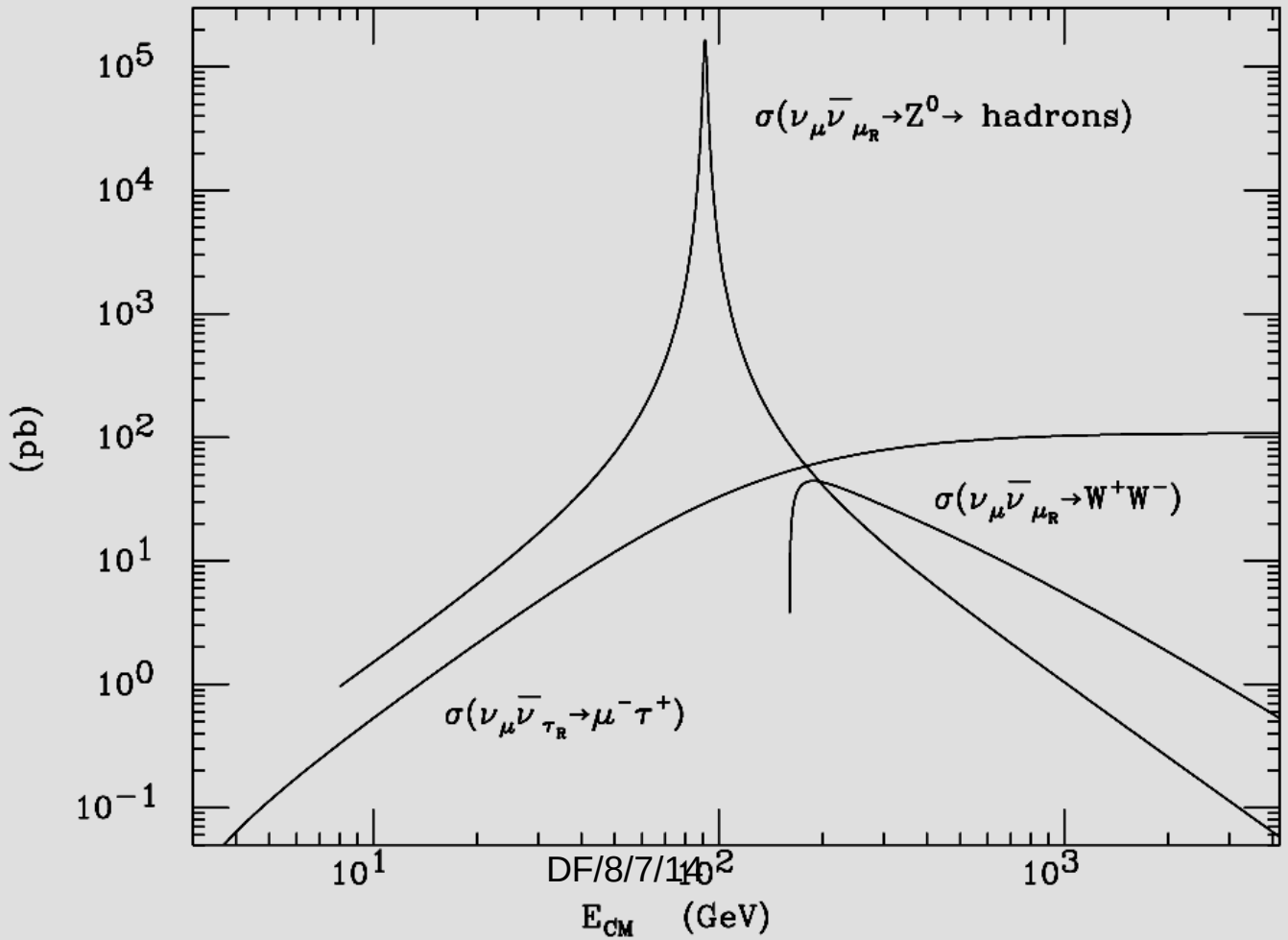
- The **Ursa Major Cluster** (Ursa Major I Cluster, UMa I ClG) is a spiral-rich galaxy cluster of the Virgo Supercluster.
- Some of its largest members are NGC 3631, NGC 3953, M109 on North (M109 Group) and NGC 3726, NGC 3938 NGC 4051 on South.
- The Ursa Major cluster is located at a distance of 18.6 megaparsecs (60 million light years) and contains about 30% of the light but only 5% of the mass of the nearby Virgo cluster.:
- ***THEREFORE: WHY NOT VIRGO?***

*Historical puzzle of Fly's Eye: Correlation with AGN above GZK? The Fly's Eye **1995 discover***

- THE ASTROPHYSICAL JOURNAL, *517:**1999**:*
  Received 1997 October 9; accepted 1999 January 4, DF,B.Mele,A.Salis
- ***UltraHigh-Energy Neutrino Scattering onto Relic Light Neutrinos in the Galactic Halo as a Possible Source of the Highest Energy Extragalactic Cosmic Rays—(so called Z burst model)***
- ***D. F, B. MELE, AND A. SALIS;***
- **Weiler Thomas J**. Cosmic Ray Neutrino Annihilation on Relic Neutrinos Revisited: A Mechanism for Generating Air Showers above the Greisen-Zatsepin-Kuzmin Cut-off (figures)
  Astropart.Phys***. 11 (1999) 303-316 (22 Oct 1997-July 1999)***



Ultrahigh energy neutrino scattering onto relic light neutrinos in galactic halo as a possible source of highest energy extragalactic cosmic rays



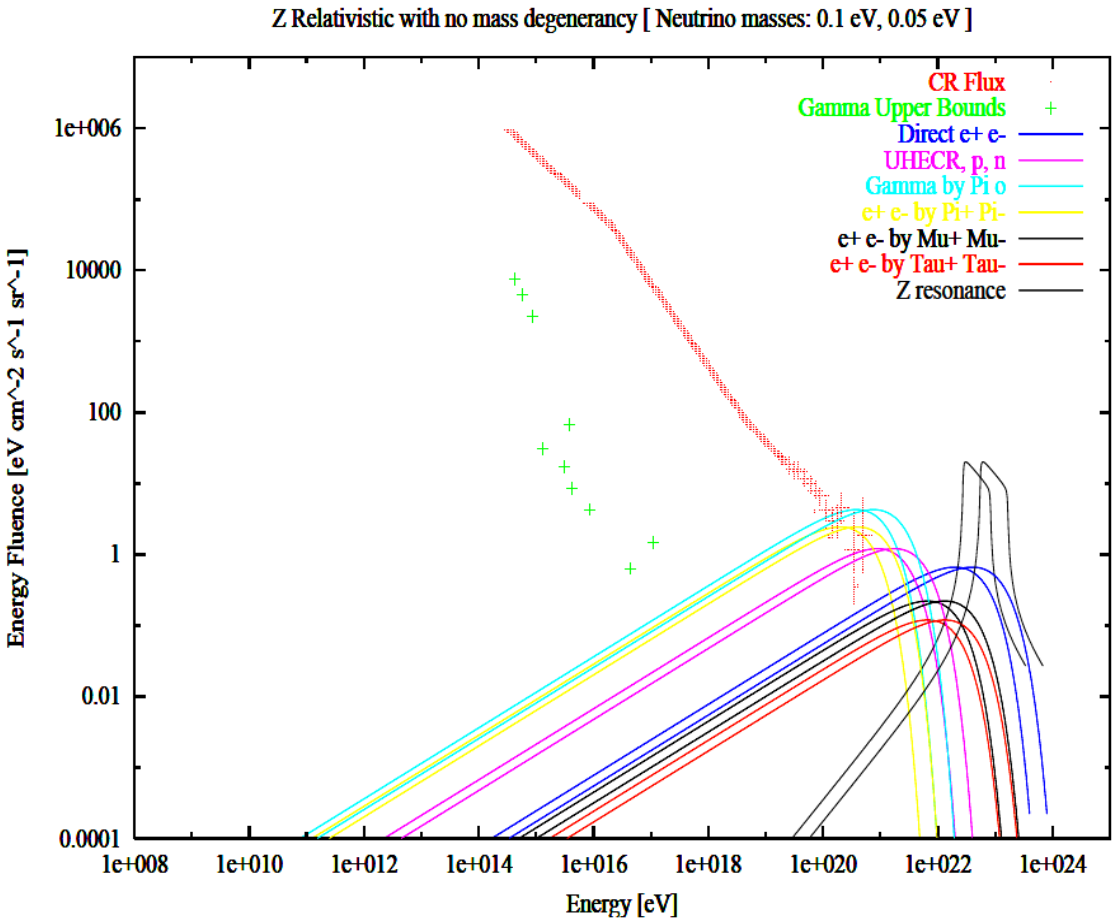
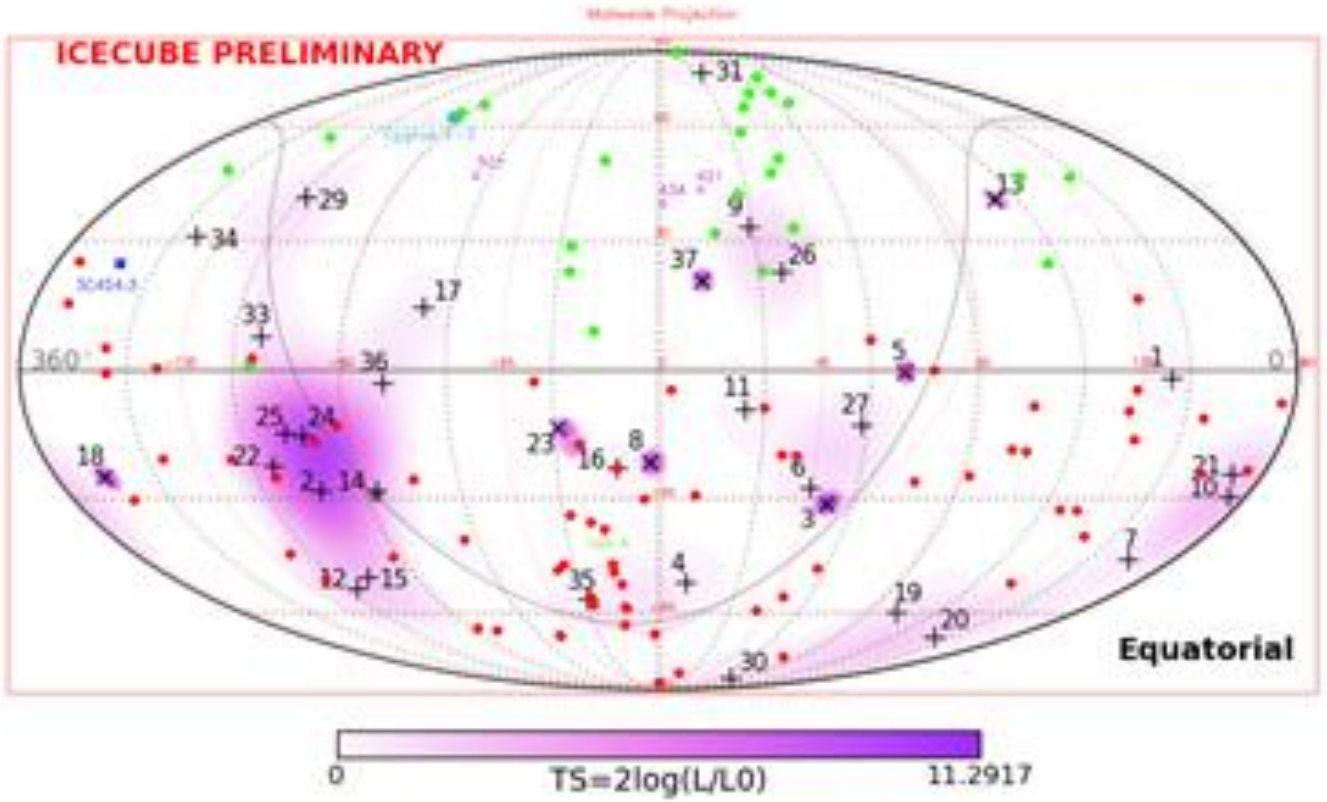


Figure 1. Twin Z-Burst Showering [15] occurs at different peak energy (resonance energies $E_{\nu_i} = M_Z^2/2 \cdot m_{\nu_i} \simeq 4 \cdot 10^{22} (\frac{m_{\nu_i}}{0.1eV})^{-1}$ eV,) for non degenerated neutrino masses, as 0.1 and 0.05 eV; its consequent secondary spectra (γ, nucleons, electron pairs) inject ZeV UHECR $(p,\ n) E_p \simeq 8 \cdot 10^{20} \cdot (m_{\nu_i}/0.1eV)^{-1}$ eV, and γ, $E_\gamma \simeq$ a few $10^{19} \cdot (\frac{m_{\nu_i}}{0.1eV})^{-1}$ eV (by π^0). [12]

Any correlation of UHE neutrinos with UHECR?

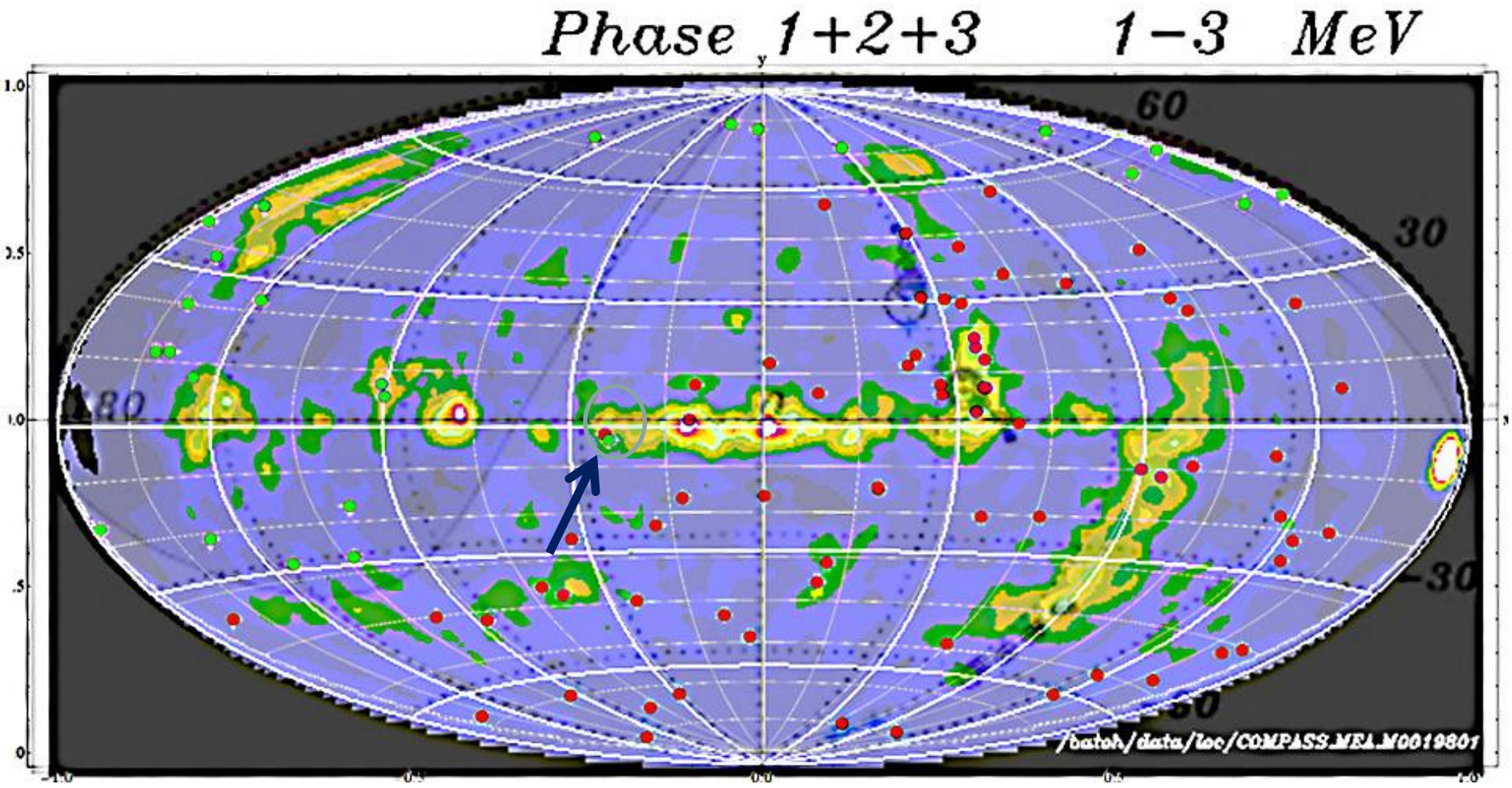
Possible Clustering at Vela and GC?
The role of UHECR?



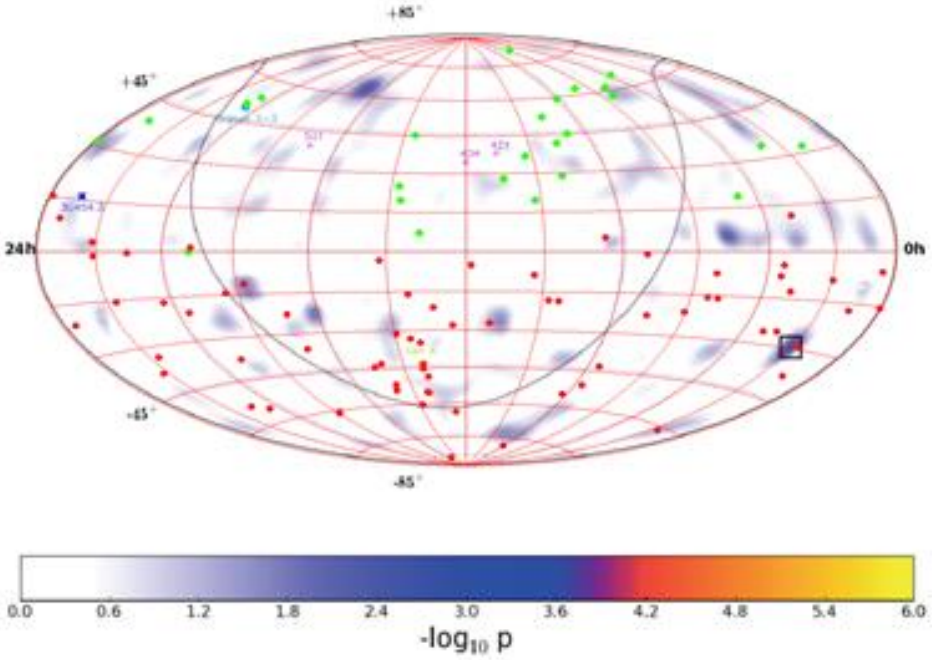
Conclusion 3

- *Tau neutrino cannot be born in Earth mixing because Earth size and tau mass threshold:* ***Tau astronomy is free of noise****.*
- *PeVs events exist* ***(not yet Glashow ones);***
- ***Tau airshower at PeVs difficult to be seen by fluorescence (AUGER,TA) but detectable by beamed Cherenkov flash.***
- ***Tau airshowers at ASHRA (now) and HAWC , HESS, MAGIC may be soon seen. The most clean neutrino astronomy of this decade.***

Possible MeV- (COMPTON Obs) –AUGER and TA UHECR connection



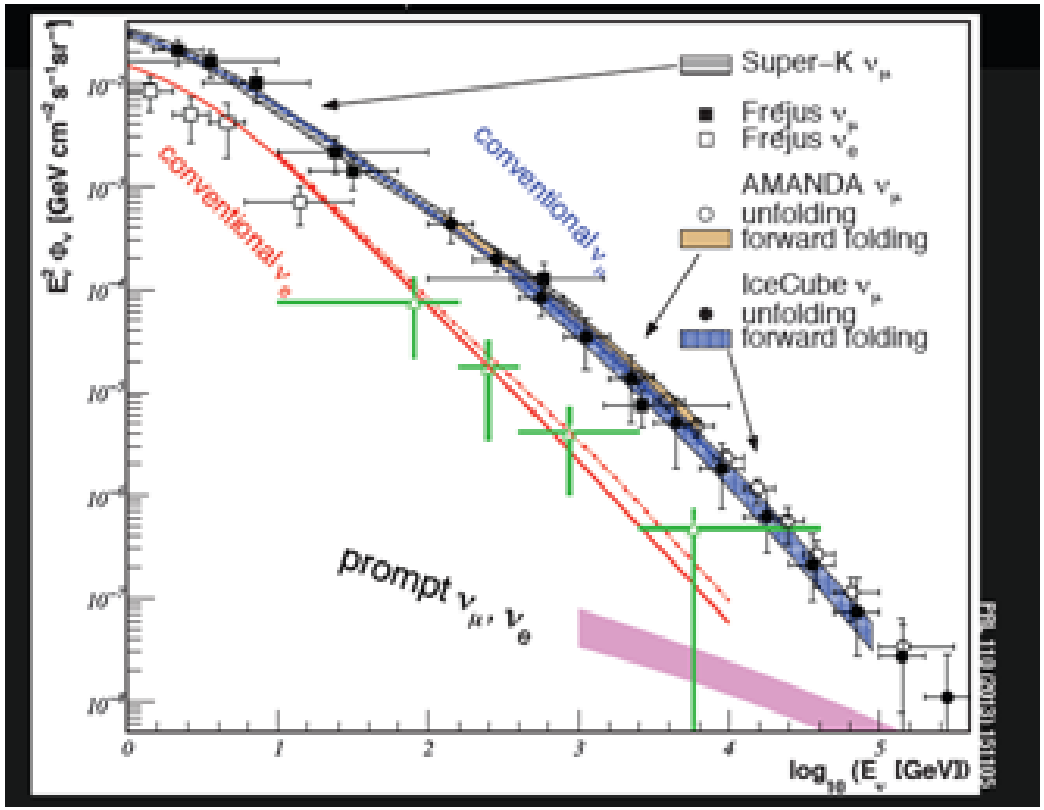
Very recent UHE neutrino anisotropy seem to avoid any correlation: Nevertheless. Energy polluted by atmospheric.1 TeV noise dominance..



. 9.— Same as Fig. 6 but for sources of 4° extension.

Muons Neutrino tracks and other Neutrino showers in ICECUBE

Reading new signal in a mess of cosmic rays noise secondaries



Flavor revolution at ICECUBE horizons?

Daniele Fargion and Paolo Paggi

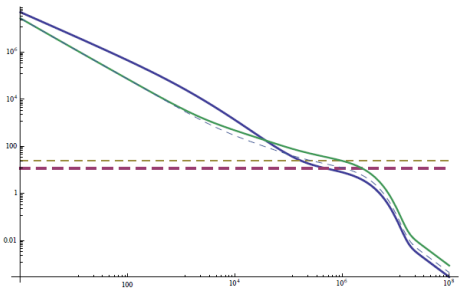
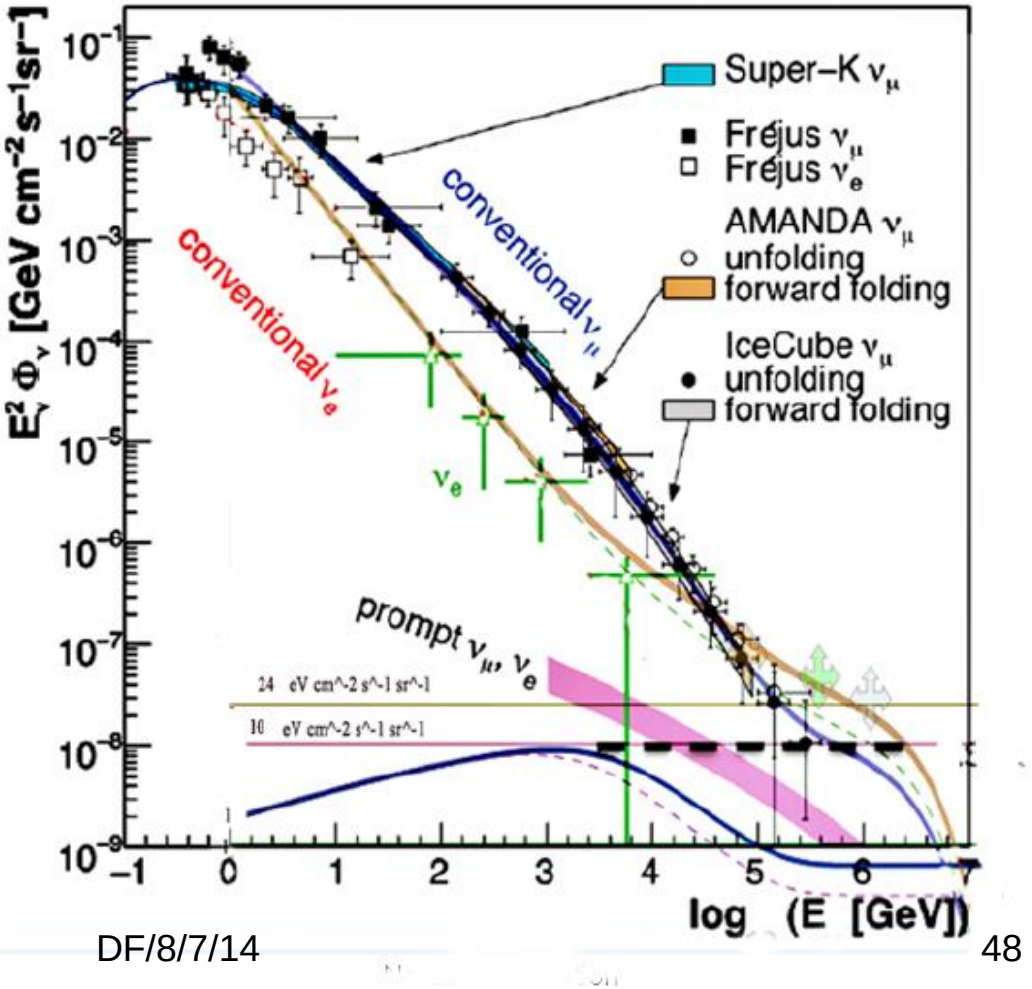


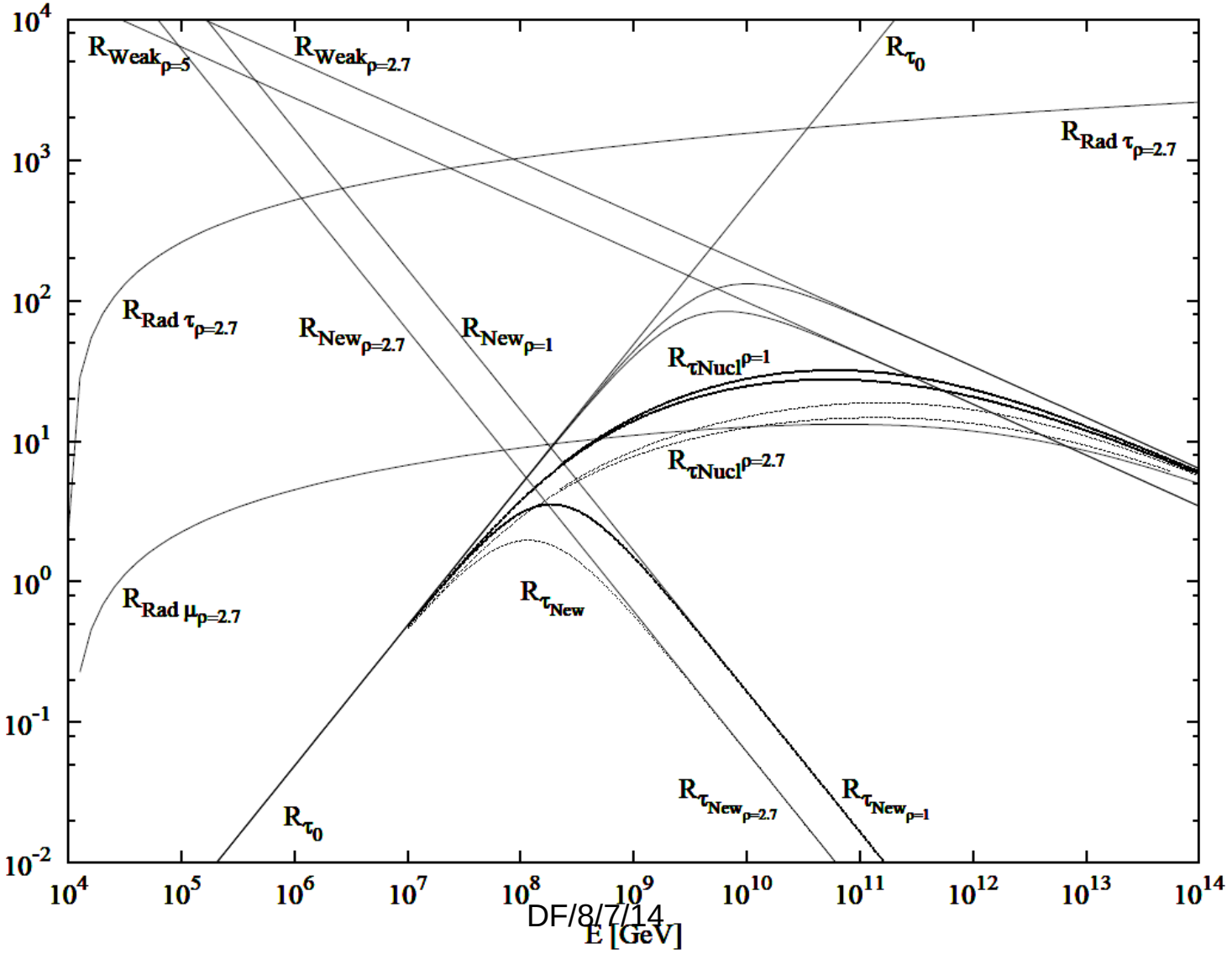
Figure 4: Energy Fluency for $\nu_e, \bar{\nu}_e, \nu_\tau\ \bar{\nu}_\tau$ flavor $\Phi_{\nu_e}, \Phi_{\nu_\mu}$ in $eV cm^{-2} s^{-1} sr^{-1}$ unity, as a function of the neutrino energy in GeV within a log-log graph. Note that the horizontal twin dashed lines stand for the observed fluency at highest ICECUBE energy for one or two flavor. The thin dashed curve describe the role of one (of the two) showering flavor fluency by present description model



The Tau neutrino role

- Because no atmospheric noise
- Because no possible to feed it by oscillation → No tau neutrino noise above TeV energy
- Above PeVs up to EeV energy their tract directions
- ***(50 m—10 Km) in matter make them an ideal probe to interact in mountains or Earth , escape and decay in flight; the Tau Airshower neutrino astronomy***

The lepton Muon, Tau Distances in matter with energy



The flavor Mixing occurs along large galactic distances

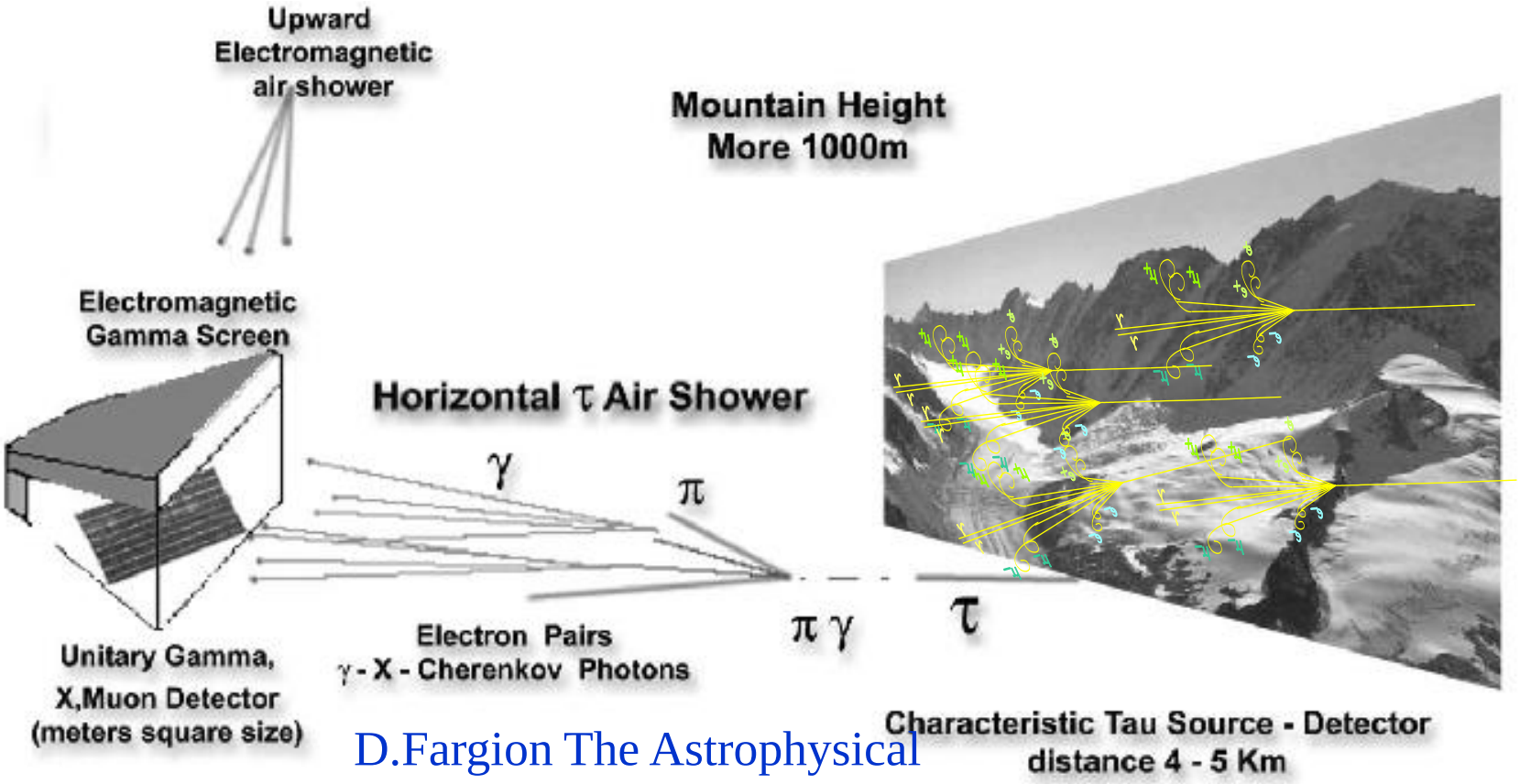
- Even at ZeV energy oscillation makes all flavor at same flux.

$$L_{\nu_\mu\text{-}\nu_\tau} = 4 \times 10^{-3}\ \mathrm{pc}\left(\frac{E_\nu}{10^{16}\ \mathrm{eV}}\right)\left[\frac{\Delta m^2_{ij}}{(10^{-2}\ \mathrm{eV})^2}\right]^{-1}. \quad (1)$$

Horizontal Tau air showers from mountains in deep valley: Traces of UHECR neutrino tau

ICRC 1999-Salth Lake_US

D. Fargion [1], A. Aiello [2], R. Conversano



D.Fargion The Astrophysical Journal,570,p.909. 2002

DISCOVERING ULTRA-HIGH-ENERGY NEUTRINOS THROUGH HORIZONTAL AND UPWARD τ AIR SHOWERS: EVIDENCE IN TERRESTRIAL GAMMA FLASHES?