

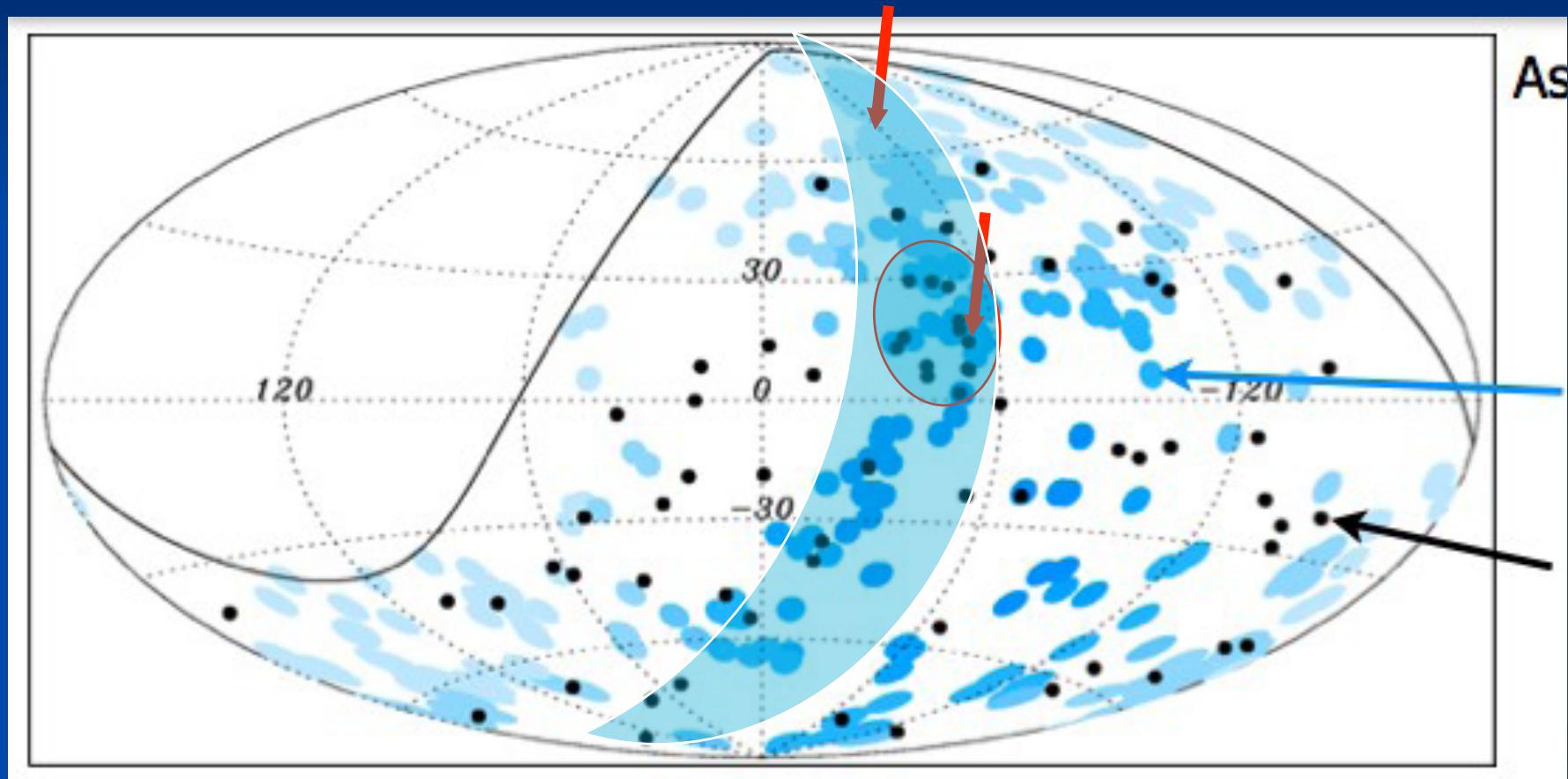
UHECR event maps and multiplets over gamma-TeV anisotropies: Lightest Nuclei fragments and Heaviest Radioactive Galactic Nuclei? By D.Fargion

- [arXiv:1112.0244](#): Is Cen A surrounded by tens EeV multiplets?
Progress in Particle and Nuclear Physics-2012. DF
- [arXiv:1112.6388](#) : Apart Cen A are UHECR mostly radioactive and heavy galactic nuclei? In press 2012. DF
- [arXiv:1201.0157](#) : TeV sky versus AUGER one: are UHECR also radioactive, heavy galactic nuclei? NIMA 2012- DF

Outline of the Talk

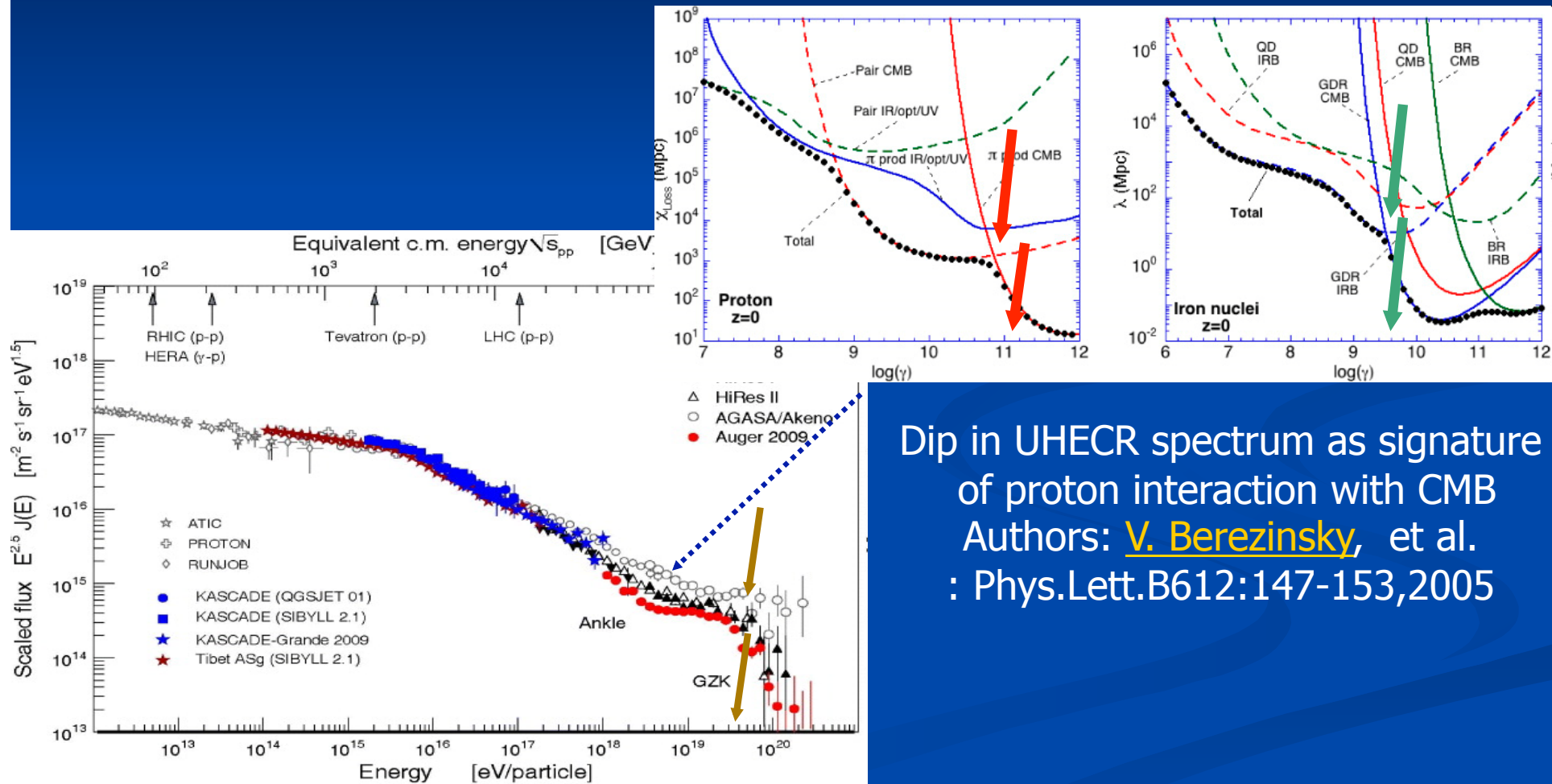
- UHECR Cen A clustering, Virgo absence-> LIGHT NUCLEI
- Such He UHECR breaks into fragment-> Multiplet clustering observed at Cen A-2011
- Heavy Radioactive Nuclei may shine at TeV
- Lightest nuclei fragment may be decaying into neutron whose decayed tens PeV electron may also shine tens TeV gamma
- TeV maps overlaps UHECR events? See last May map.
- Some-Most UHECR Ni-Co radioactive Galactic ?
- UHE Neutrino better observable by Tau airshowers at PeVs, not in EeV; ASHRA-AUGER-TA-ARGO

November 2007 : AUGER correlations with the Super Galactic Plane (?) and with Cen A



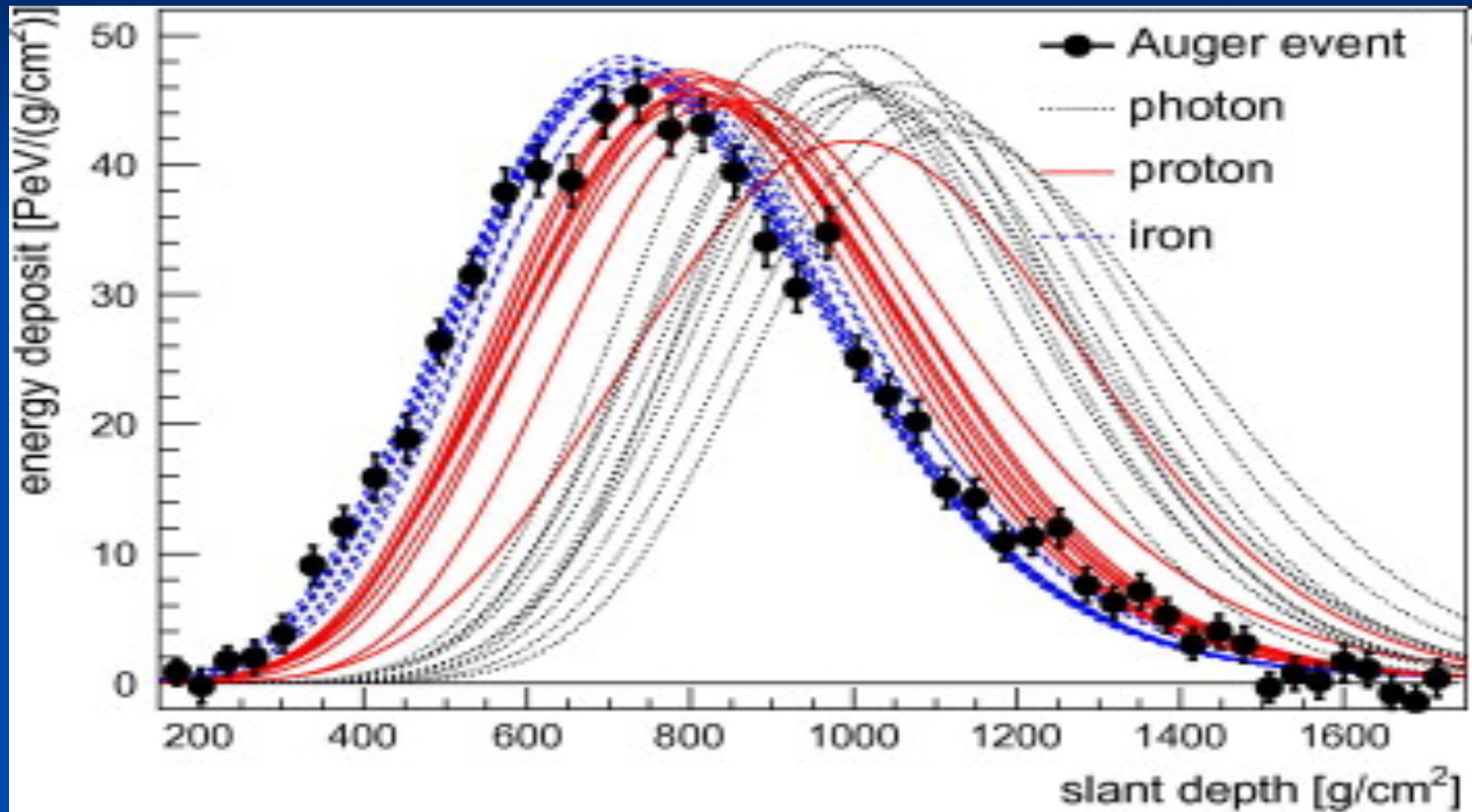
Correlation suggesting NUCLEON as the UHECR courier---BUT

On the Observed (?) (by HIRES and AUGER) GZK cut spectra and UHECR composition



Dip in UHECR spectrum as signature
of proton interaction with CMB
Authors: [V. Berezhinsky](#), et al.
: Phys.Lett.B612:147-153,2005

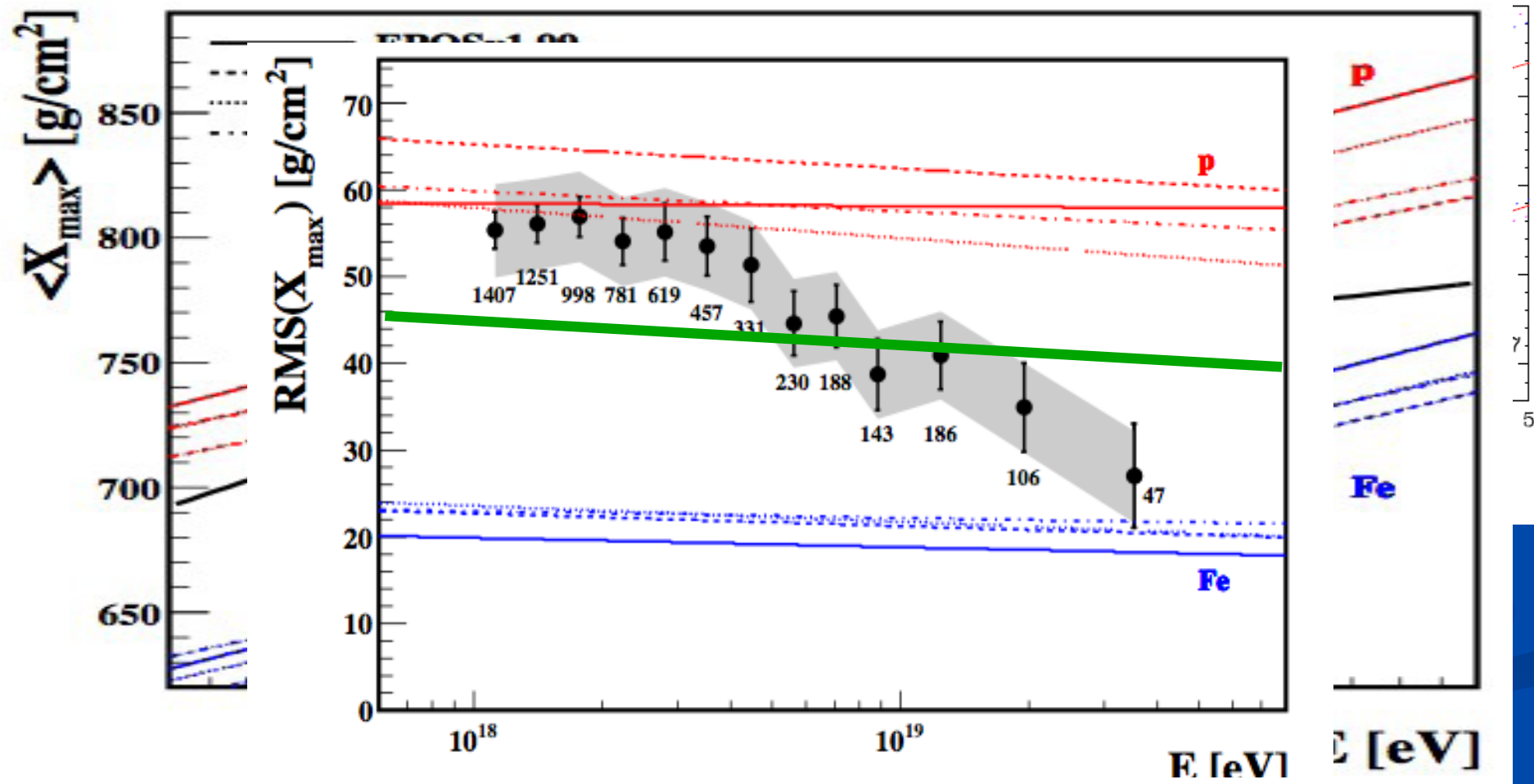
How to disentangle the composition



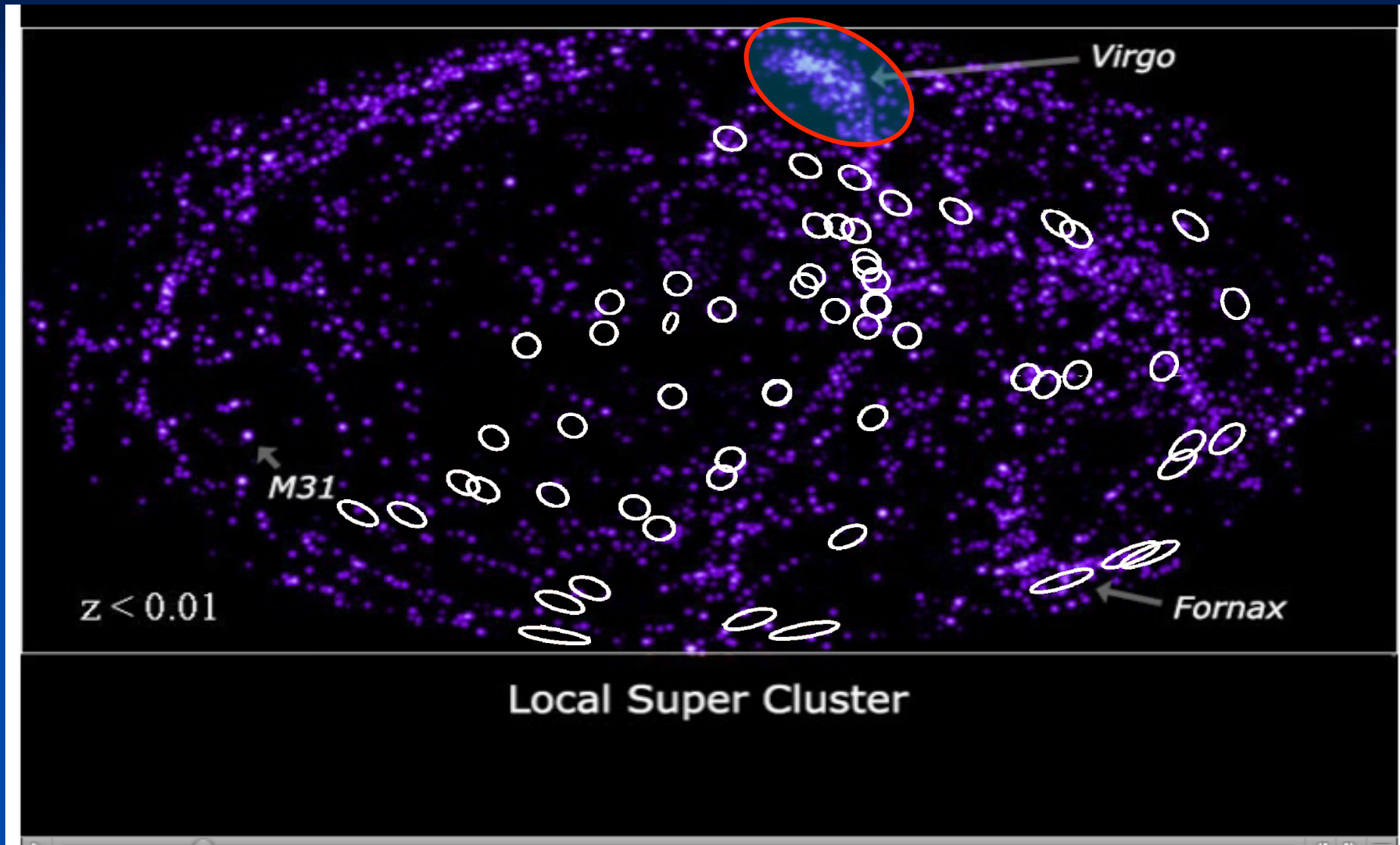
WHY NOT just a GZK Volume
as AUGER belief = proton+ SGP?

- MOSTLY BECAUSE THE
SAME AUGER CLAIM
FOR A HEAVY (>>
proton) COMPOSITION
IN UHECR

Indeed at same time the AUGER 2007-2011 composition suggest **NUCLEI**, not a **PROTON**



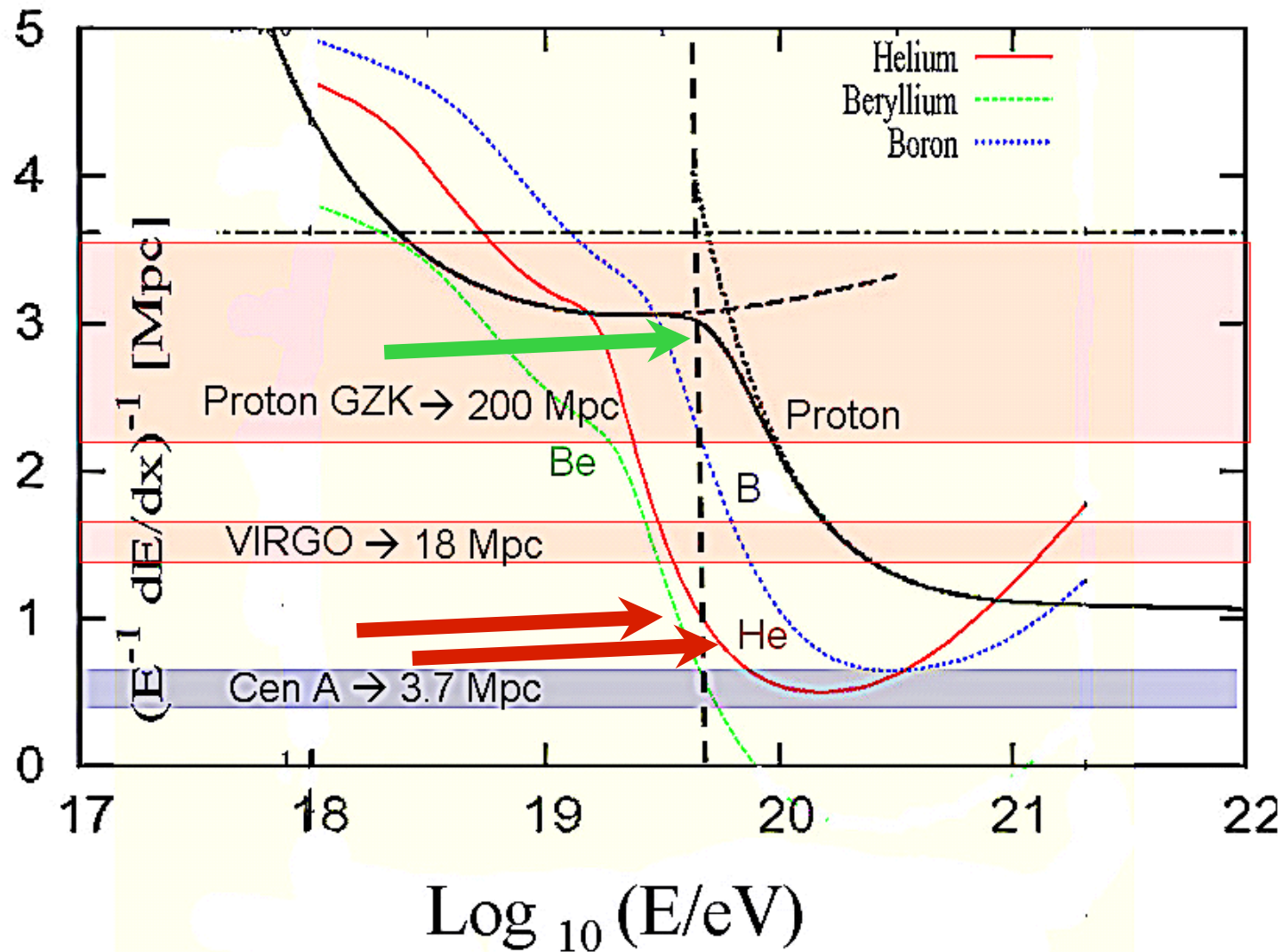
The Virgo Absence in near Universe



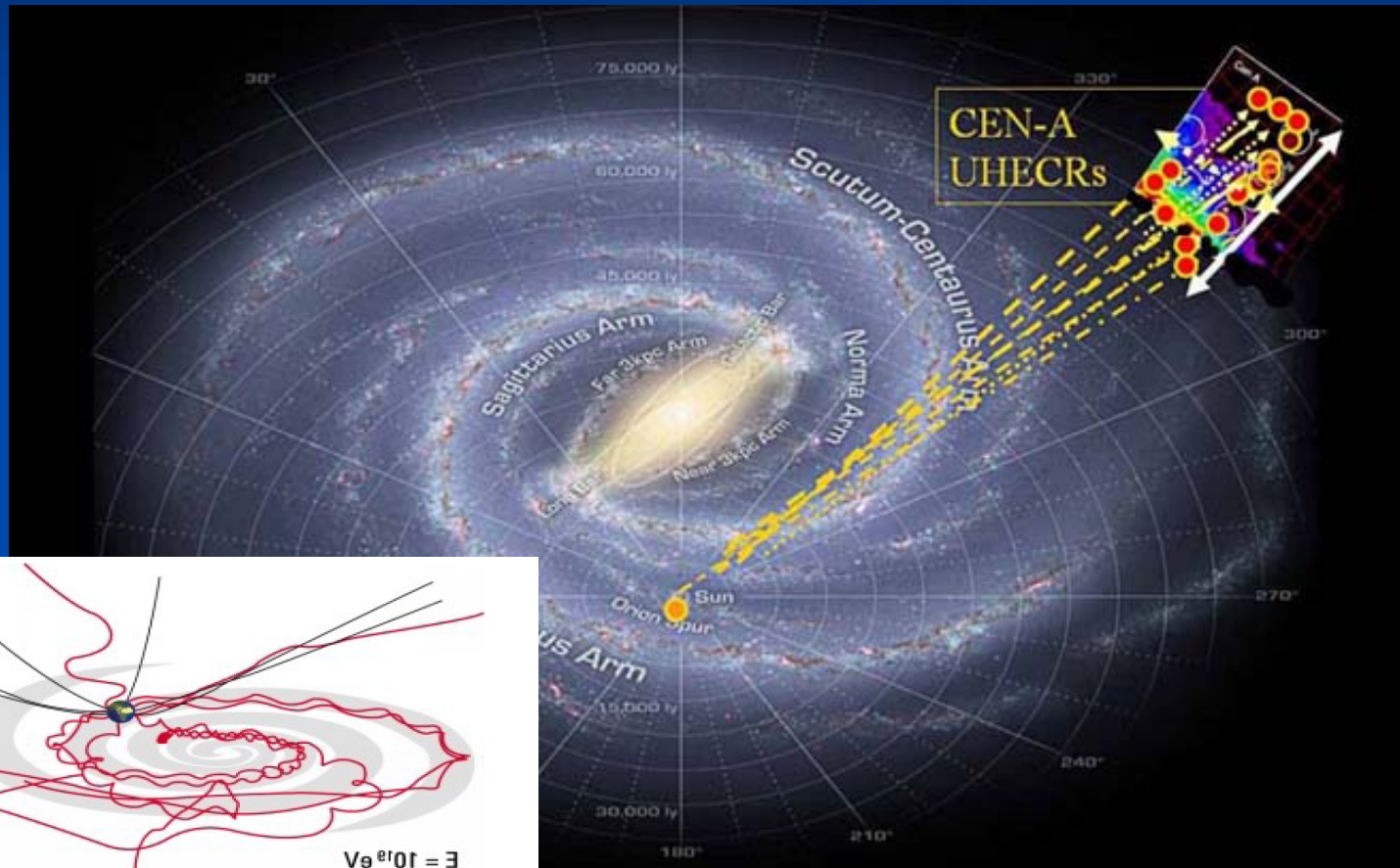
How LIGHT NUCLEI explain the Virgo Absence and the Cen a vertical spread clustering?

- *He nuclei UHECR cannot flight as far as Virgo (20 Mpc) because of photonuclear opacity. But they come nevertheless from Cen A (3 Mpc).*
- *He-like nuclei suffer of a random magnetic bending on horizontal spiral galactic plane in a nearly vertical axis respect galactic plane, as the observed ones..*
- *The HE UHECR random bending, up and down, ranges near ten degree aperture angles: the size and the vertical direction agreed to UHECR records..*

Composition—Distance: Surviving from Cen A, opaque to Virgo..just He, Li, Be



Coherent and Random UHECR deflections by horizontal spiral B: a vertical imprint..



Random Deflections inside our Galaxy and along horizontal Galactic Plane in vertical axis toward Cen A

by **LIGHTEST NUCLEI: He, Li, Be**

same Super-Galactic Arm , just apparently from far 80 Mpc Centaurs Cluster. The mean random angle bending He_4^2, Li_6^3, Be_8^4 , () by spiral galactic magnetic fields along the plane is $\delta_{rm} \geq$:

$$\longrightarrow \left(11.3^\circ \cdot \frac{Z}{Z_{He^2}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}} \right) \left(\frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}} \right) \quad (1)$$

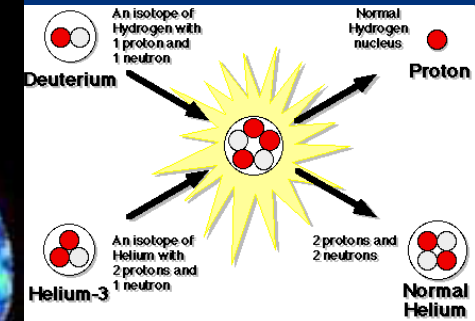
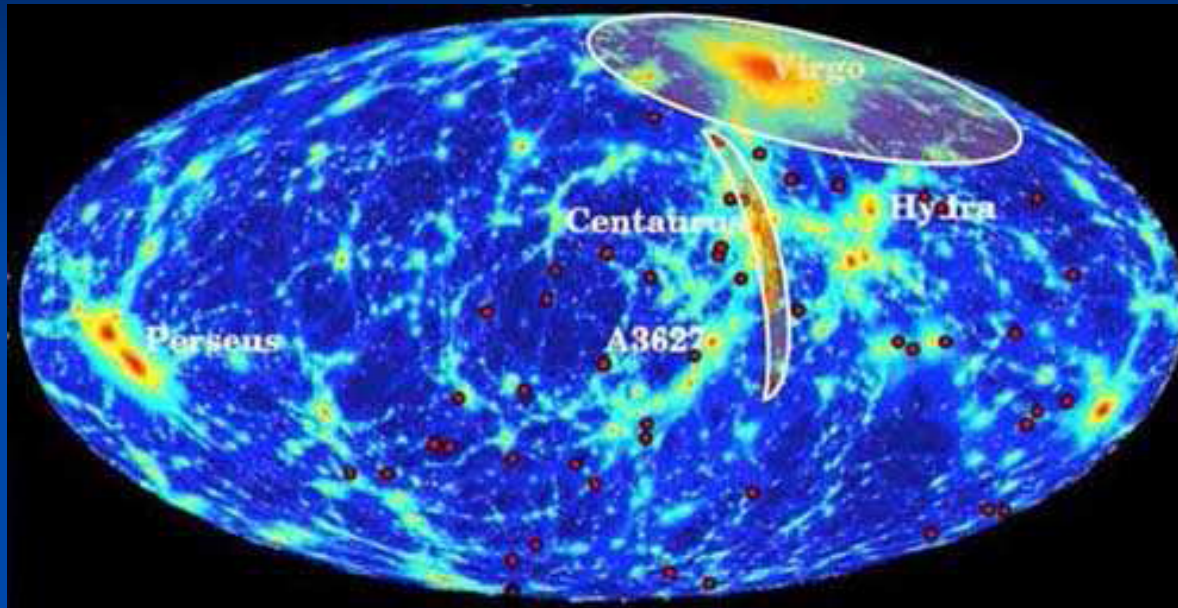
$$16.95^\circ \cdot \frac{Z}{Z_{Li^3}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}} \right) \left(\frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}} \quad (2)$$

$$\left(22.6^\circ \cdot \frac{Z}{Z_{Be^4}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}} \right) \left(\frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}} \right) \quad (3)$$

This *Lightest Nuclei for Highest Cosmic Rays* model implies and foresees among the other, additional clustering of UHECR events around the nearest AGN Cen-A

Predicted He fragility and D,p: fragments and multiplet

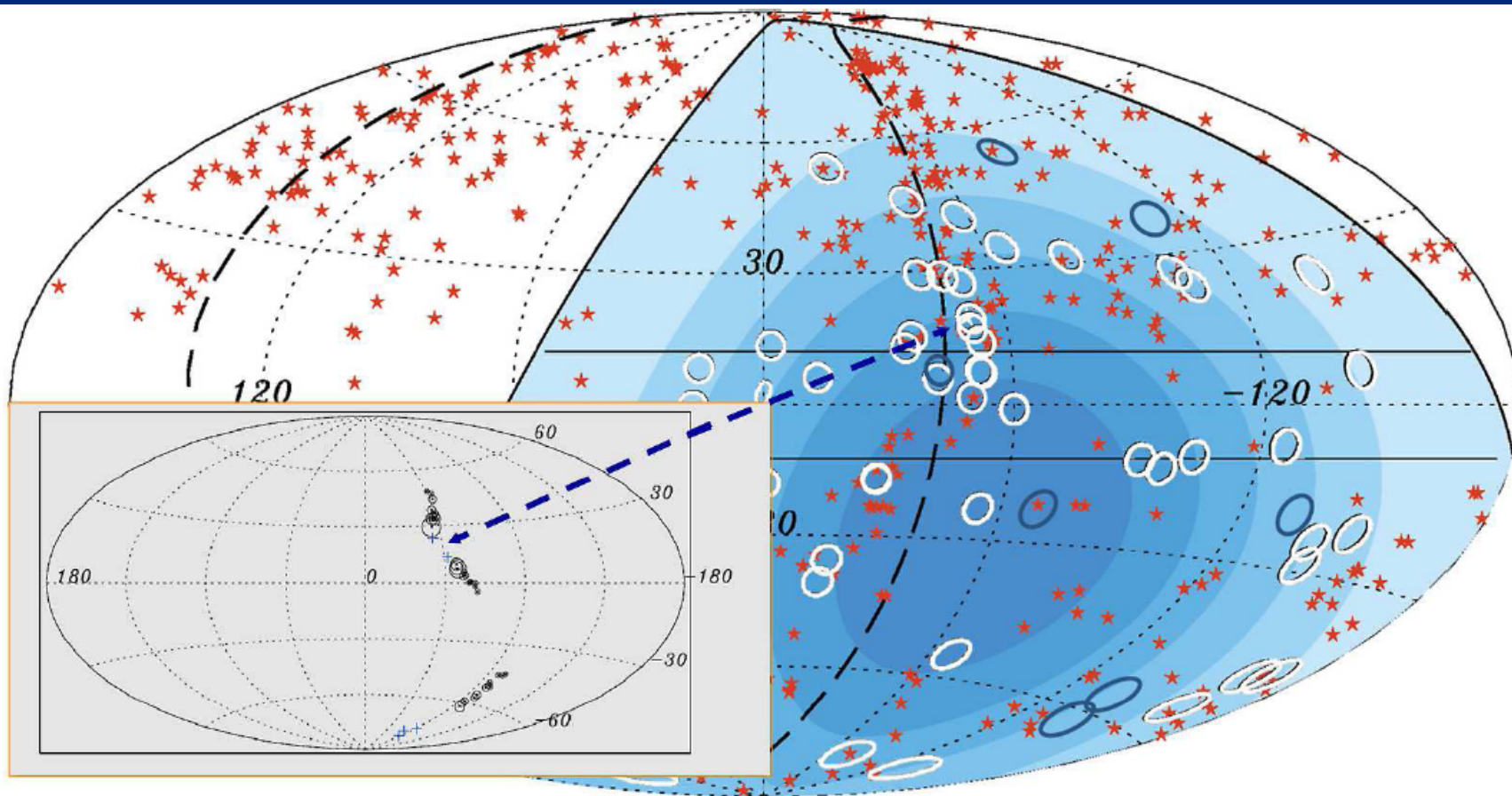
(NIMA51778 PII: S0168-9002(10)01230-1, 2010 [arXiv:0908.2650](https://arxiv.org/abs/0908.2650))



- UHECR He at 60 EeV flying few Mpc maybe broken into fragments:
- Half energy and half mass \rightarrow same Lorentz deflection (as p,D, 30-40 EeV)
- A fourth of energy and half a charge: double deflection (p, 20 EeV)
- Correlated in angle spread and direction

A new input from AUGER: *arxiv1107.4805*

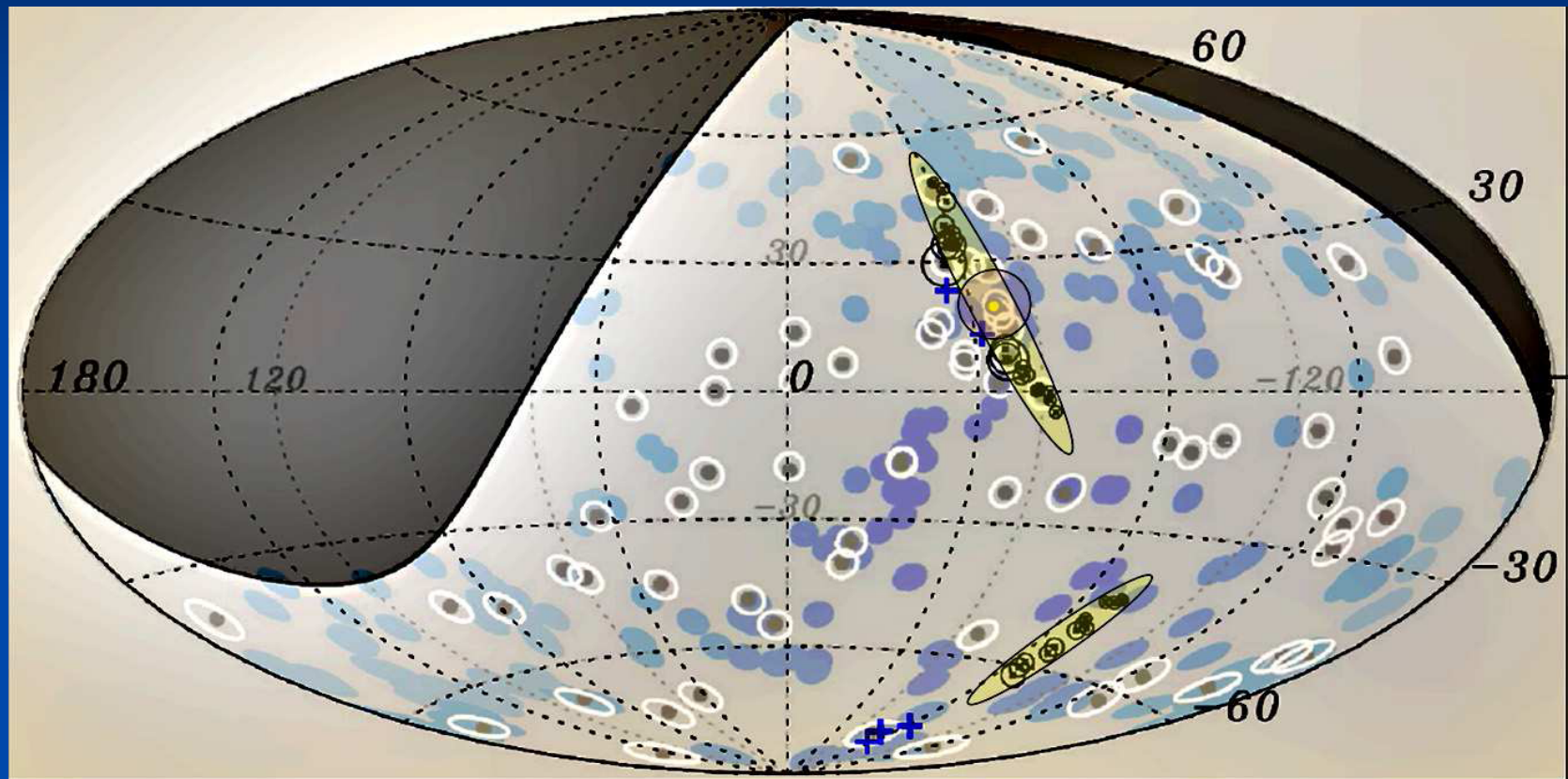
Multiplets tail around Cen A at 20 EeV



for the presence of multiplets arising from magnetic deflections in the present data.

Keywords: Pierre Auger Observatory, ultra-high energy cosmic rays, magnetic fields, multiplets.

November 2007-2011 : AUGER correlations with Cen A clustering multiplet, as foreseen..



Correlation suggesting NUCLEON as the UHECR carrier---BUT

We foresee UHECR He Fragment **deflection** at 20 EeV
respect 60 EeV: factor 1.5;

Or a larger deflection (factor 3 larger) for He .

■ $\delta_{\text{He}} = 11.3$ (60 EeV, $Z=2$).

■ $\delta_{\text{He}} = 34$ (20 EeV, $Z=2$).

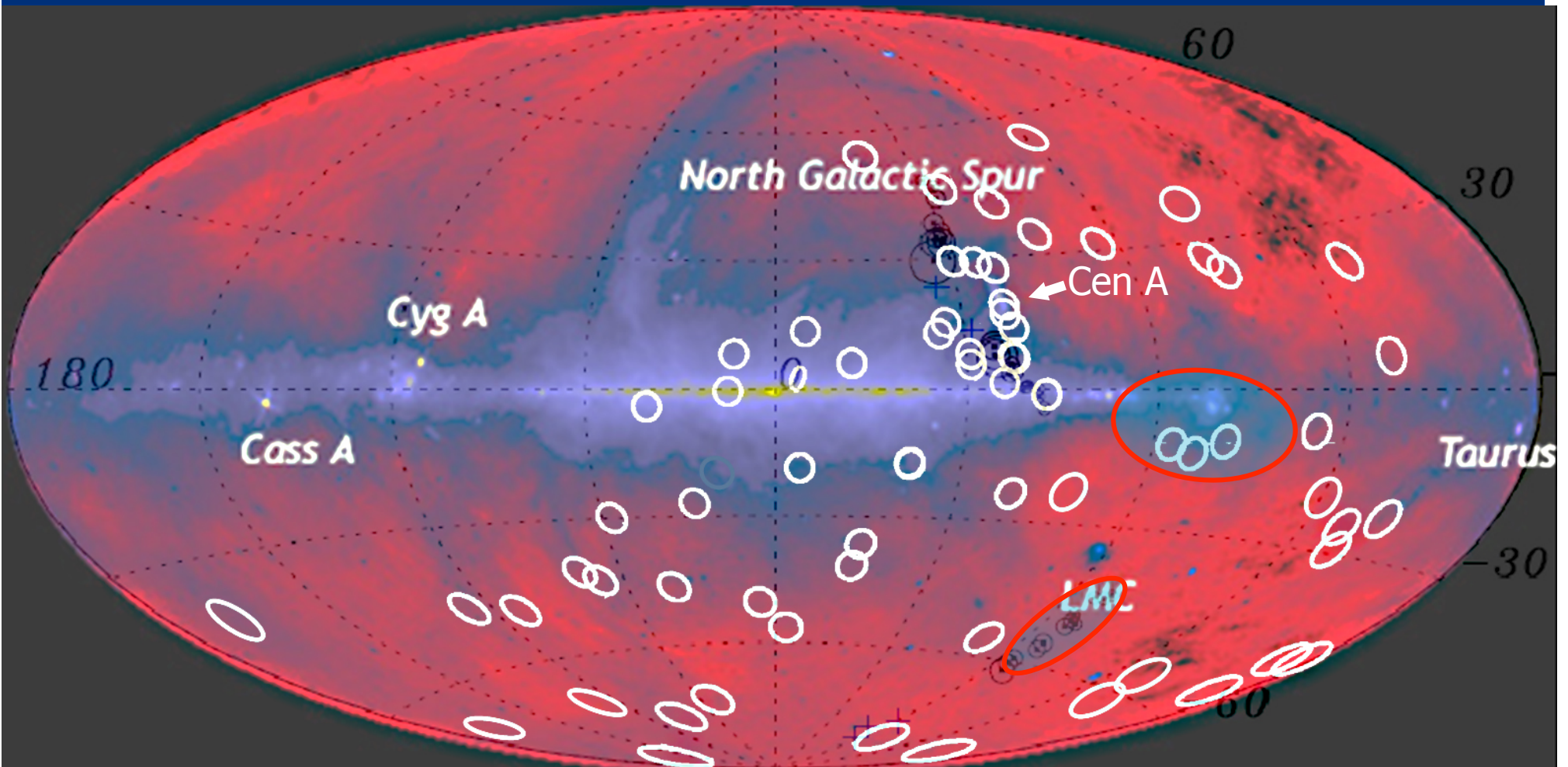
■ $\delta_{\text{p}} (20 \text{ EeV}, Z=1) = \delta_{\text{D}} (20 \text{ EeV}, Z=1) =$

■ $11.3 * 3 / 2 = 17..$

A posteriori Cen A correlating multiplet

- circle around Cen A containing the two (of three) multiplet (see Fig.1) has a radius as
- small as 7.5 degree, it extend in an area that is as smaller as 180 square degrees, well below 1% of the
- observation AUGER sky . The probability that two among three multiplet sources fall inside this small area is offered by the binomial distribution: $P(3, 2) \approx 3 \cdot 10^{-4}$.
- Moreover the same twin tail of the multiplet events are aligned almost along UHECR: $P(3, 2) \approx 3 \cdot 10^{-5}$.

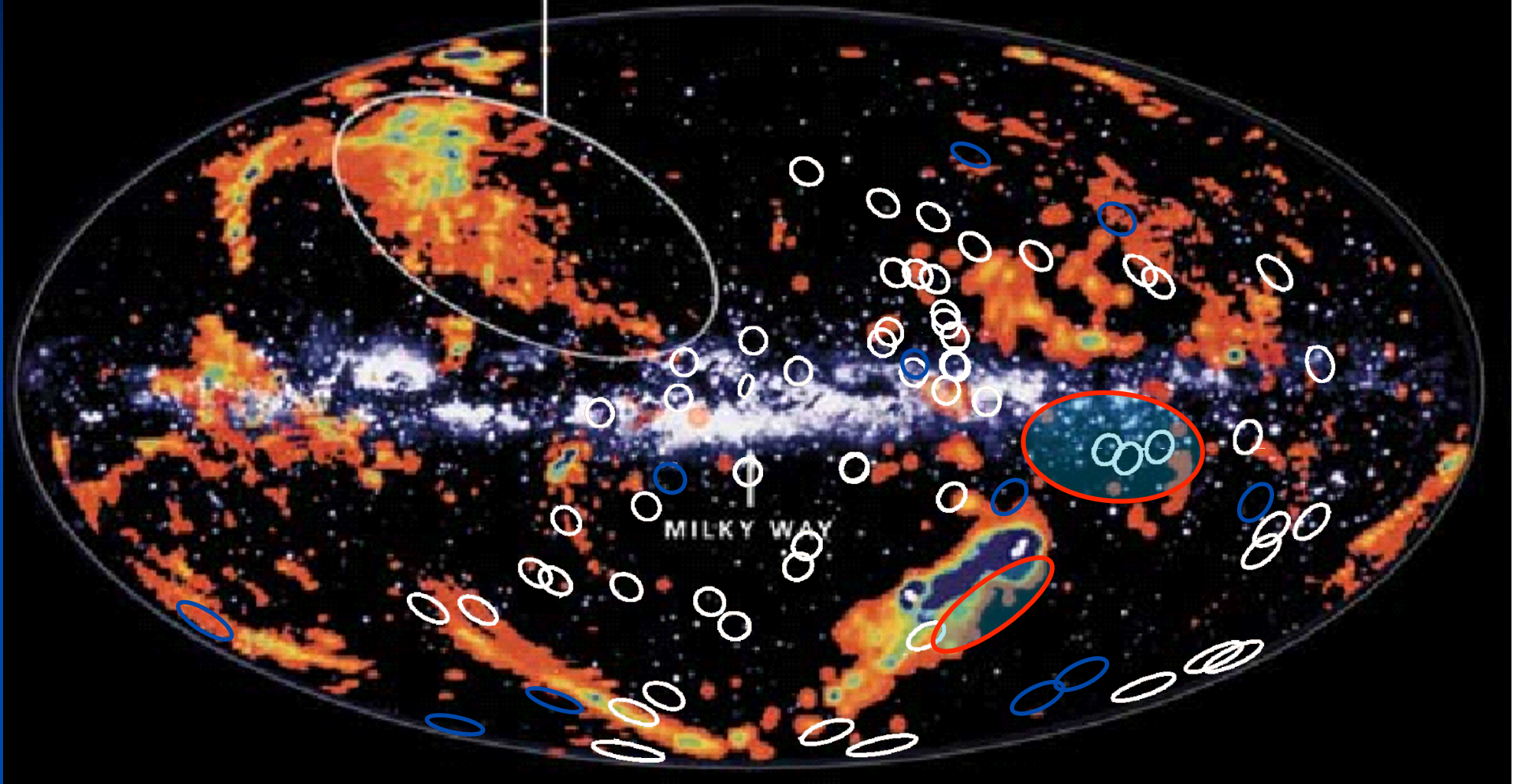
UHECR and Radio 408 Mhz and multiplets: the galactic Vela hint



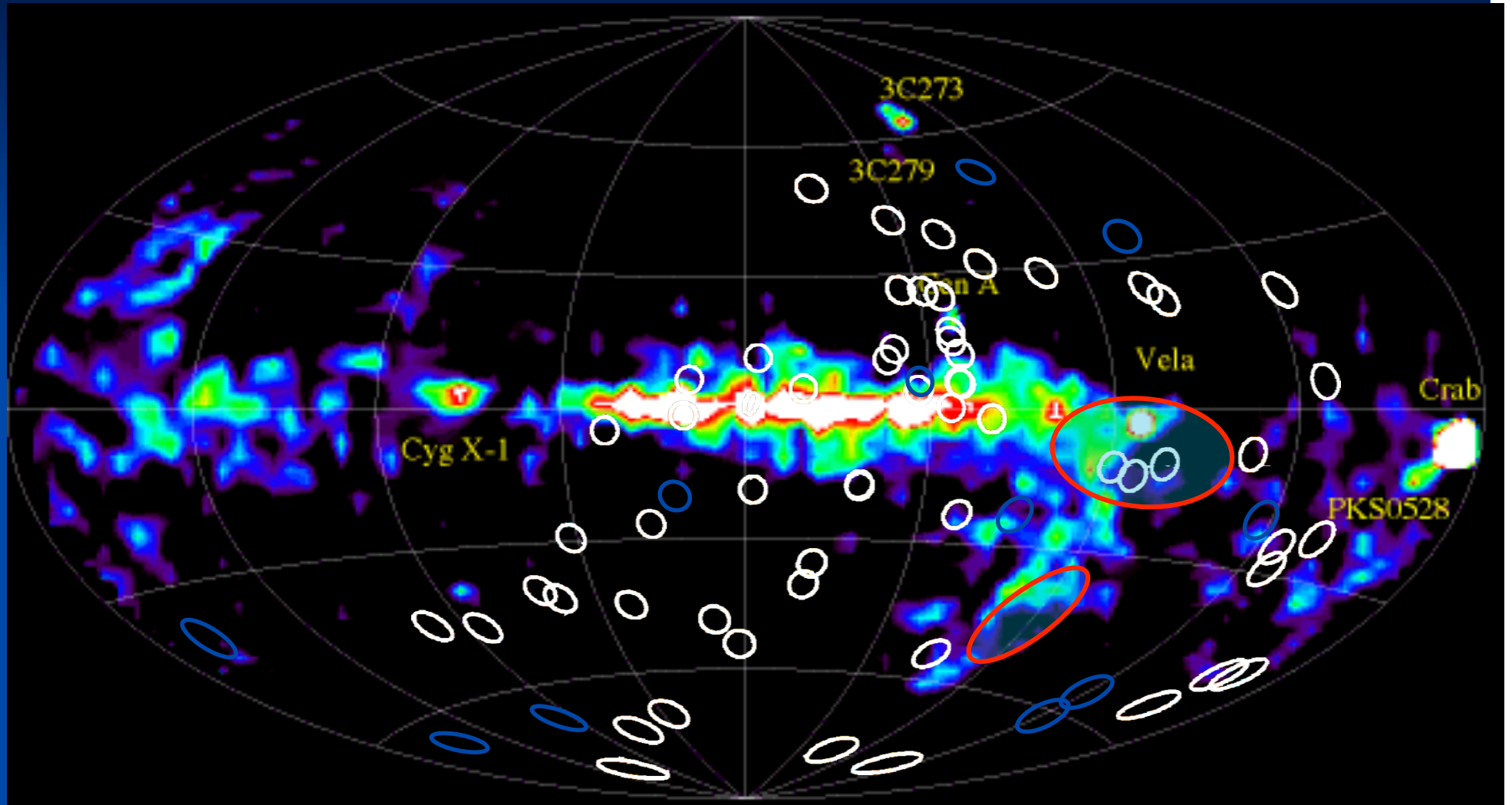
MAGELLANIC STREAM in METALLIC LINES

UHECR2010

Accreting Low-Metallicity Gas

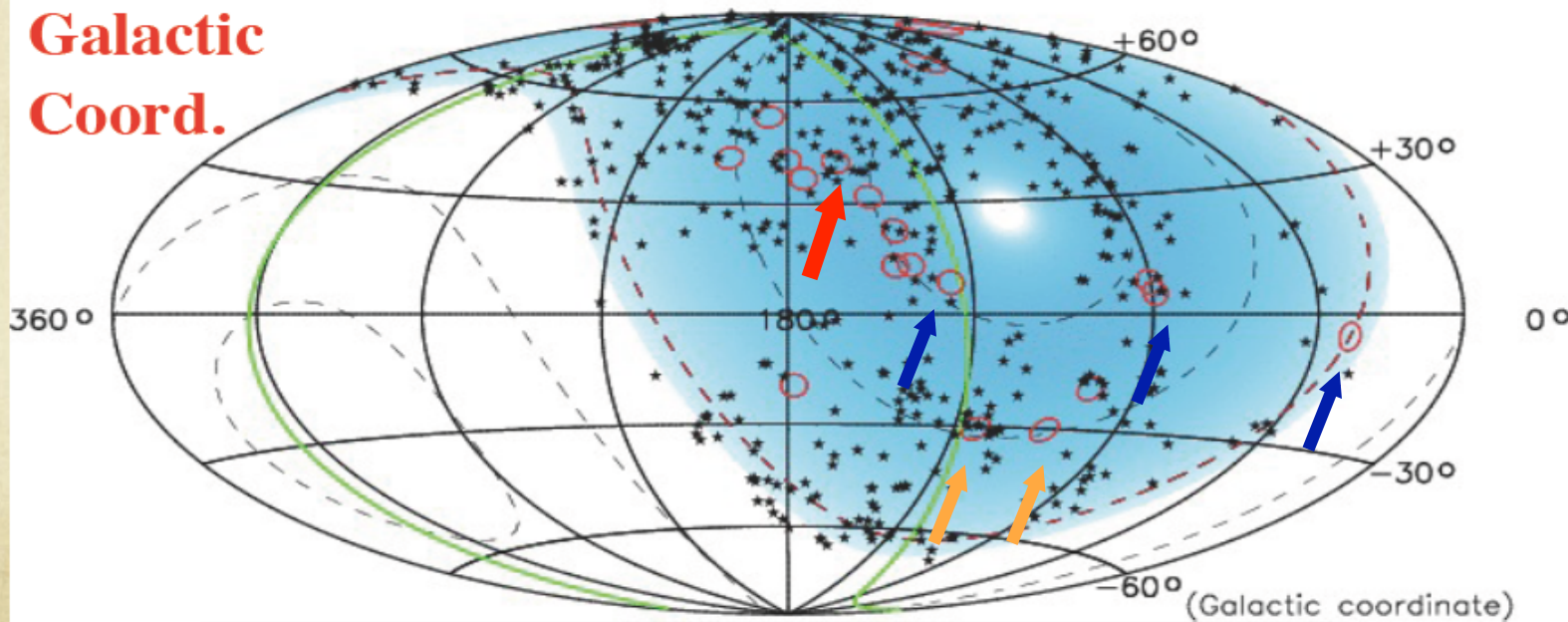
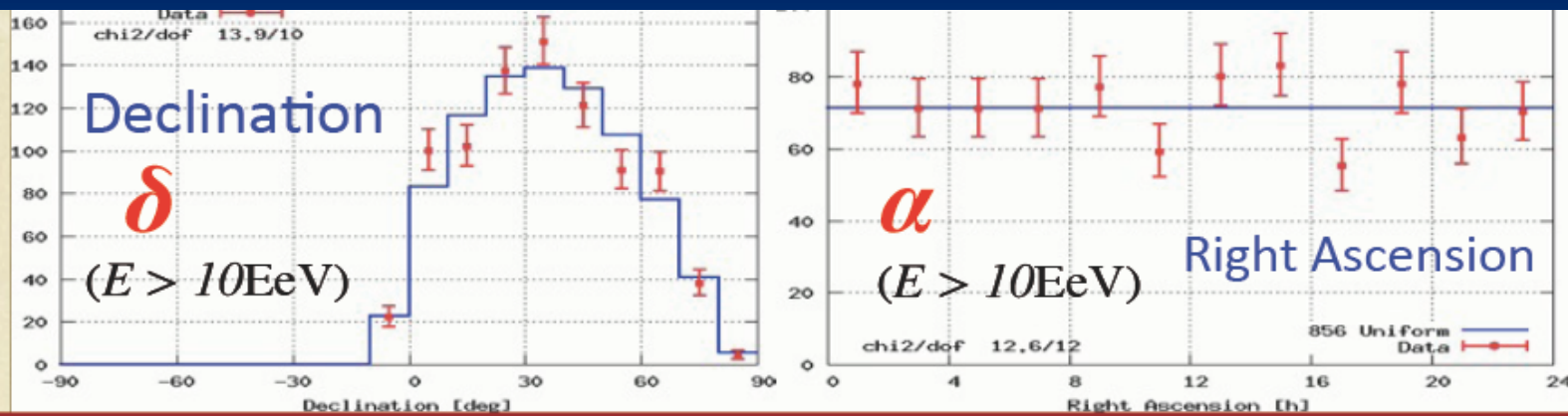


GAMMA COMPTEL . VELA AND MAGELLANIC STREAM- UHECR



Telescope Array Map

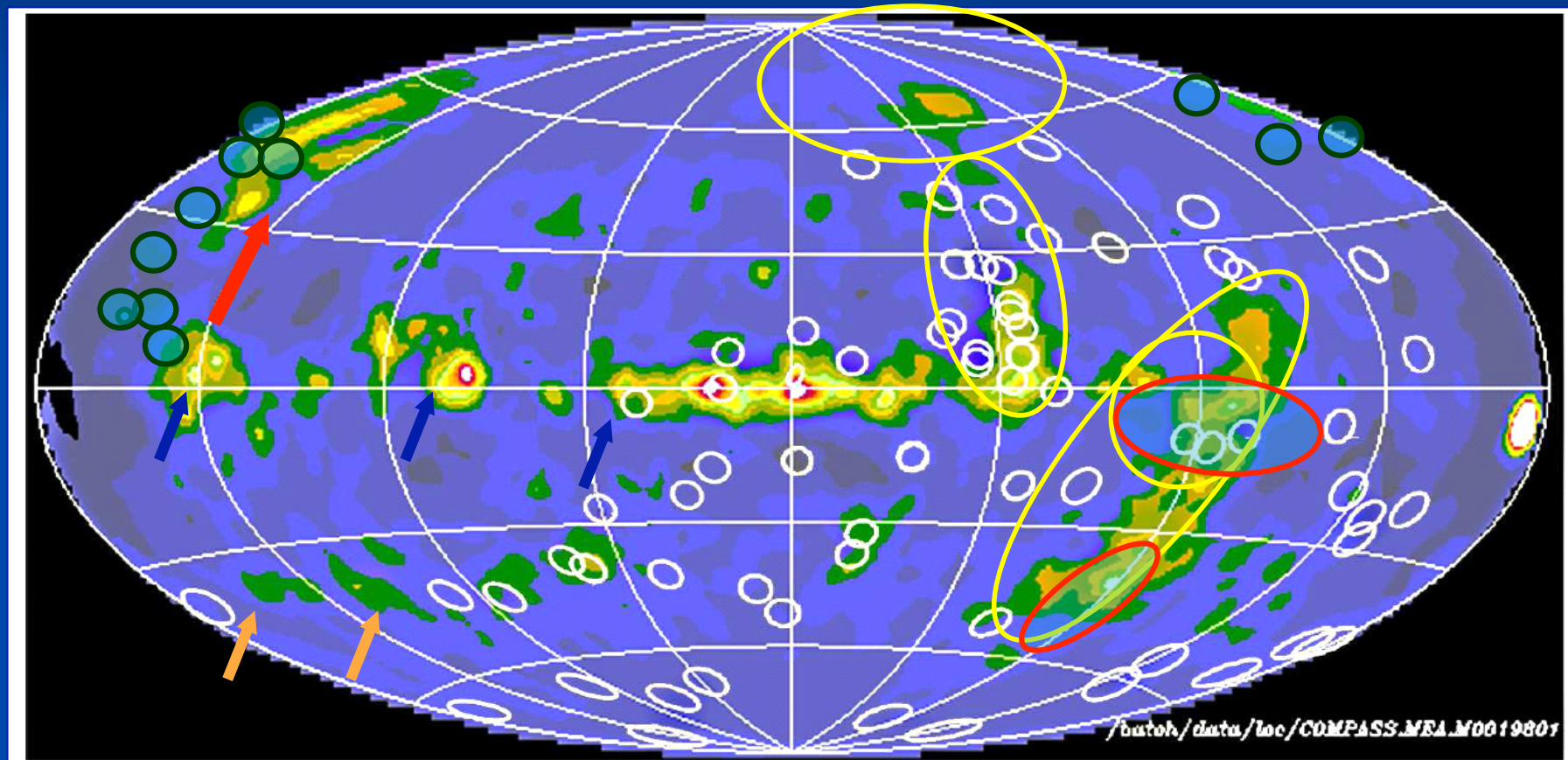
To be rotated by 180 degree left..



AGN and SD events (20 events, $>57 \text{ EeV}$, 3.1 radii)

Osse, Comptel MeV signals and UHECR clustering along Cen A...

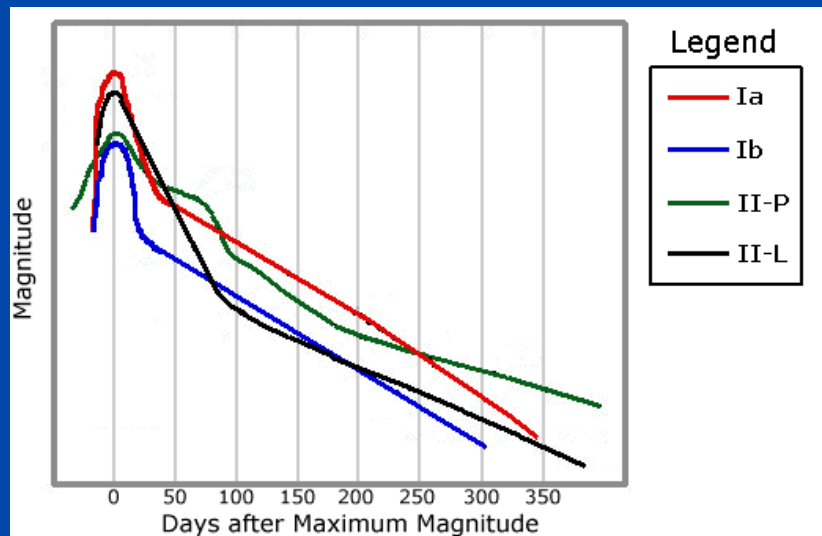
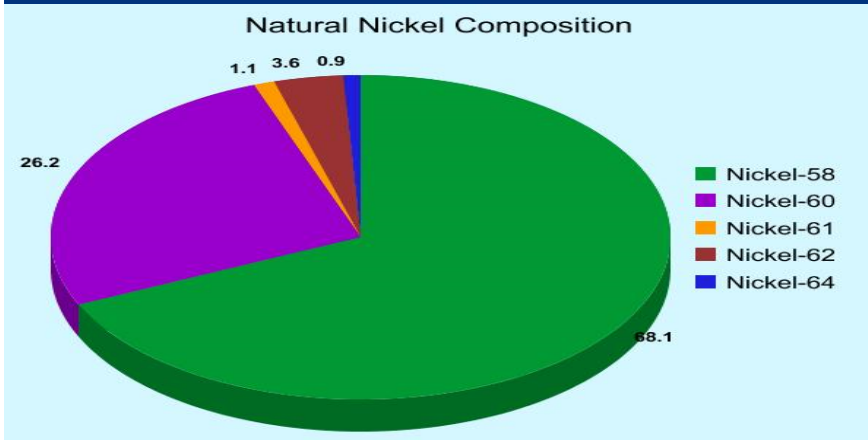
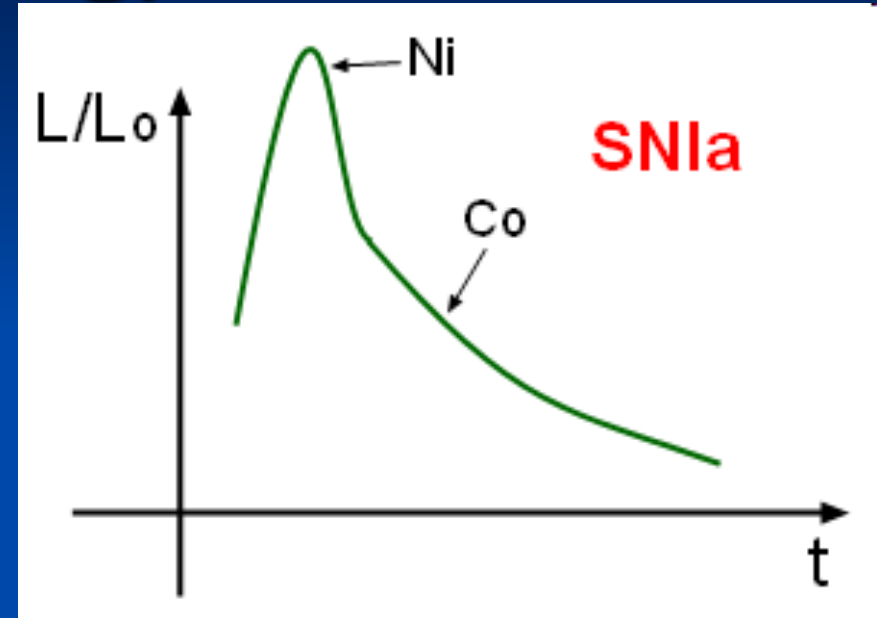
A hint of local galactic sources (Vela-Magellanic Clouds)?



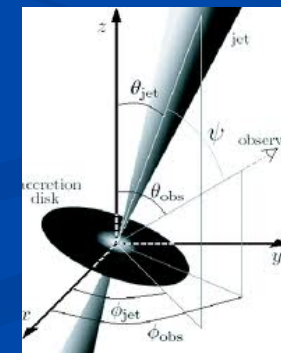
Finally: TEV connection with UHECR?

- It is possible that highest gamma imprint recall the UHECR event map? HOW TeV from UHECR nuclei?
- Yes: Light He making neutrons and their beta decay electrons....
- Yes: Heavy radioactive beta decay boosted by Lorentz billion factor

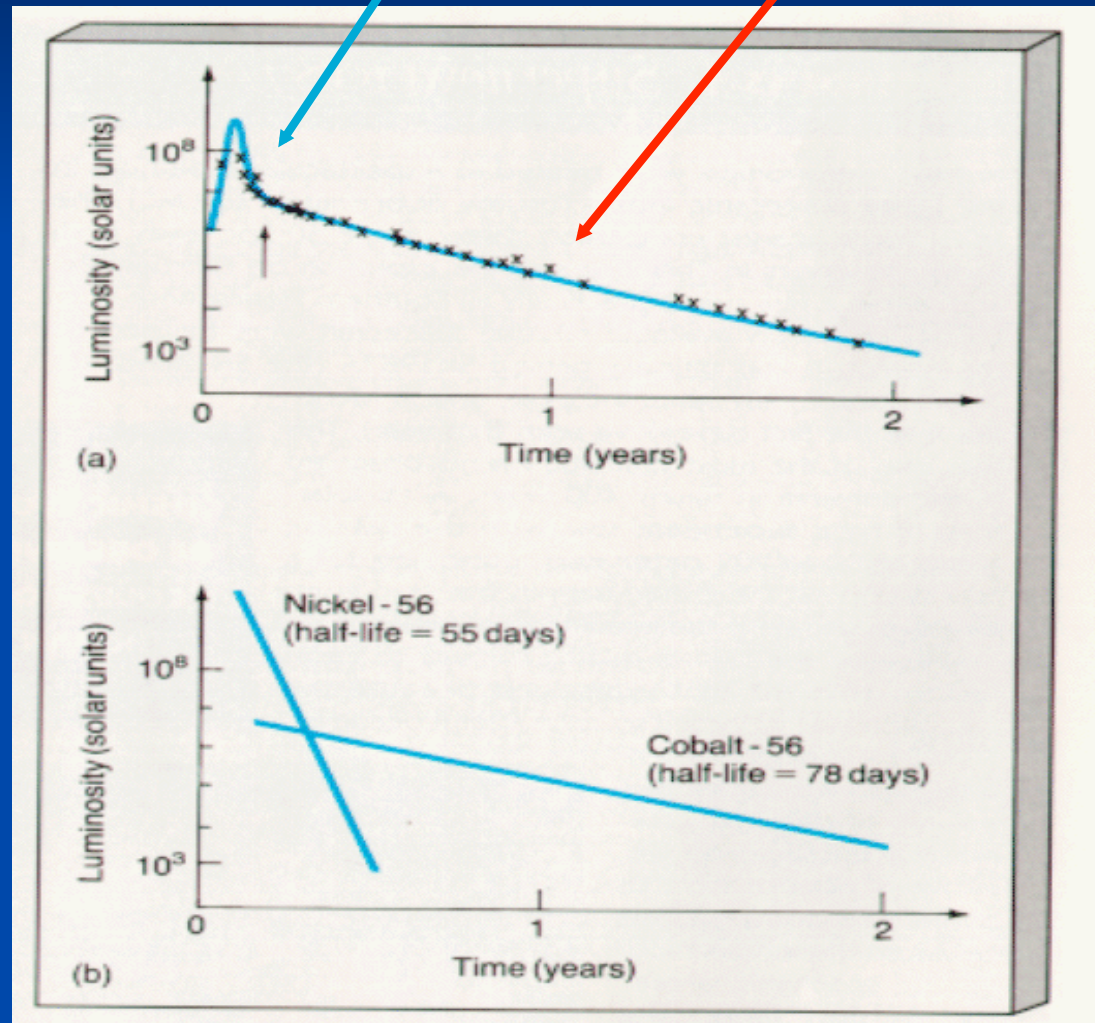
Heavy radioactive Nuclei in UHECR and huge energy release



SN-GRB-PULSAR-JET connection



Supernove-Radioactivity: Luminosity curve by Ni and Co in SN



Decay and boosted UHECR: from 100 keV to tens TeVs

Ni^{56} , Ni^{57} and Co^{57} , Co^{60}

huge Lorentz factor $\Gamma_{Ni} \simeq 10^9 - 10^8$

hundreds keV leading to TeVs gamma

How UHECR Lightest nuclei may shine at TeVs?

- Helium (or Alpha) radiation is mostly stable; therefore how can UHECR He from Cen A being also a (partial) gamma TeV source?
- As Cen A eject alpha He it also produce, by CMB scattering, fragments (as

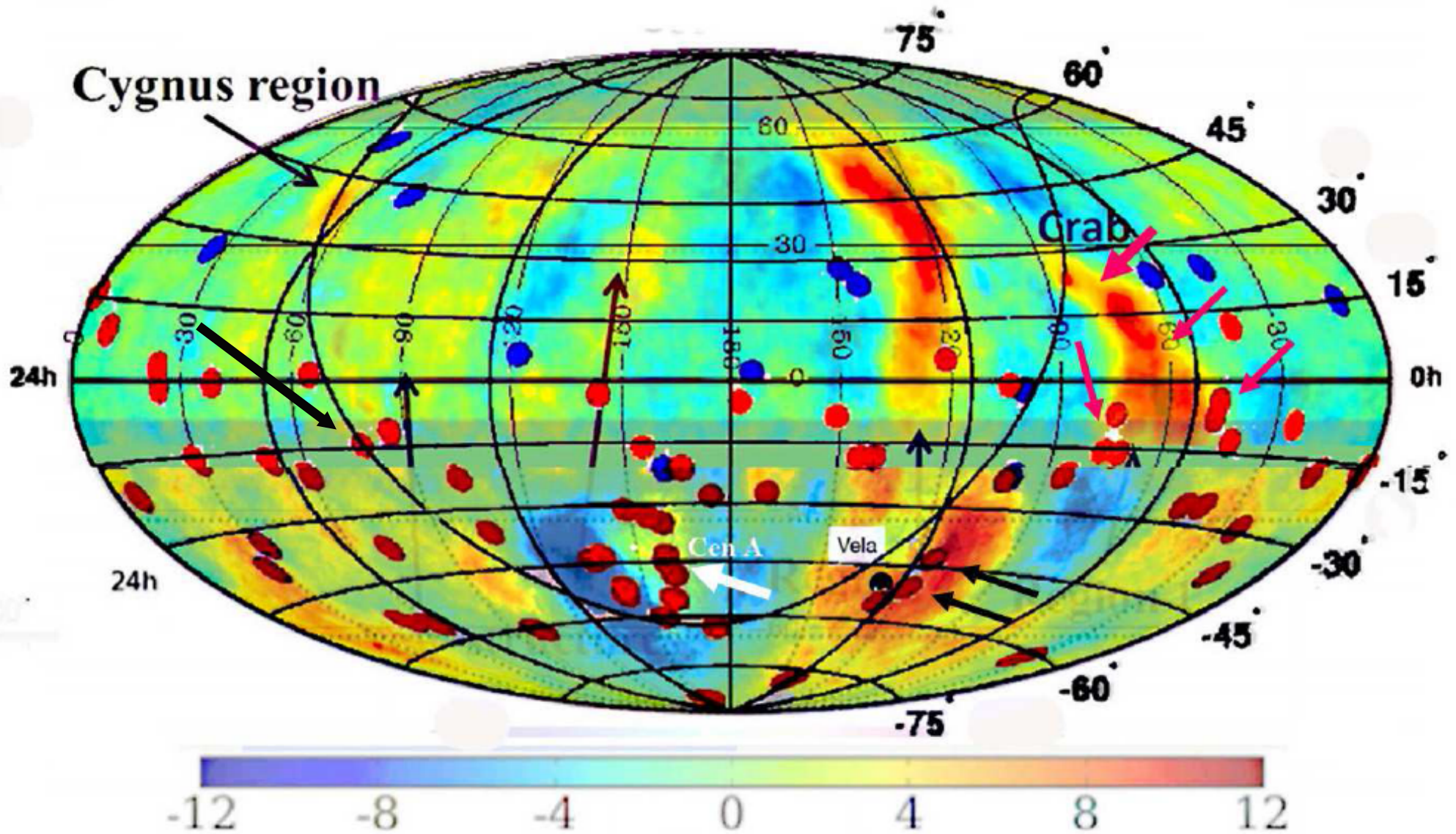
D,T,H,**neutron**) at 15 EeV or below.

- **15 EeV** Neutron **n** decay in 150 kpc and their electron radiate
- at **Tens PeV** electron by synchrotron radiations and inverse Compton radiation shining **at tens TeVs**, as observed.

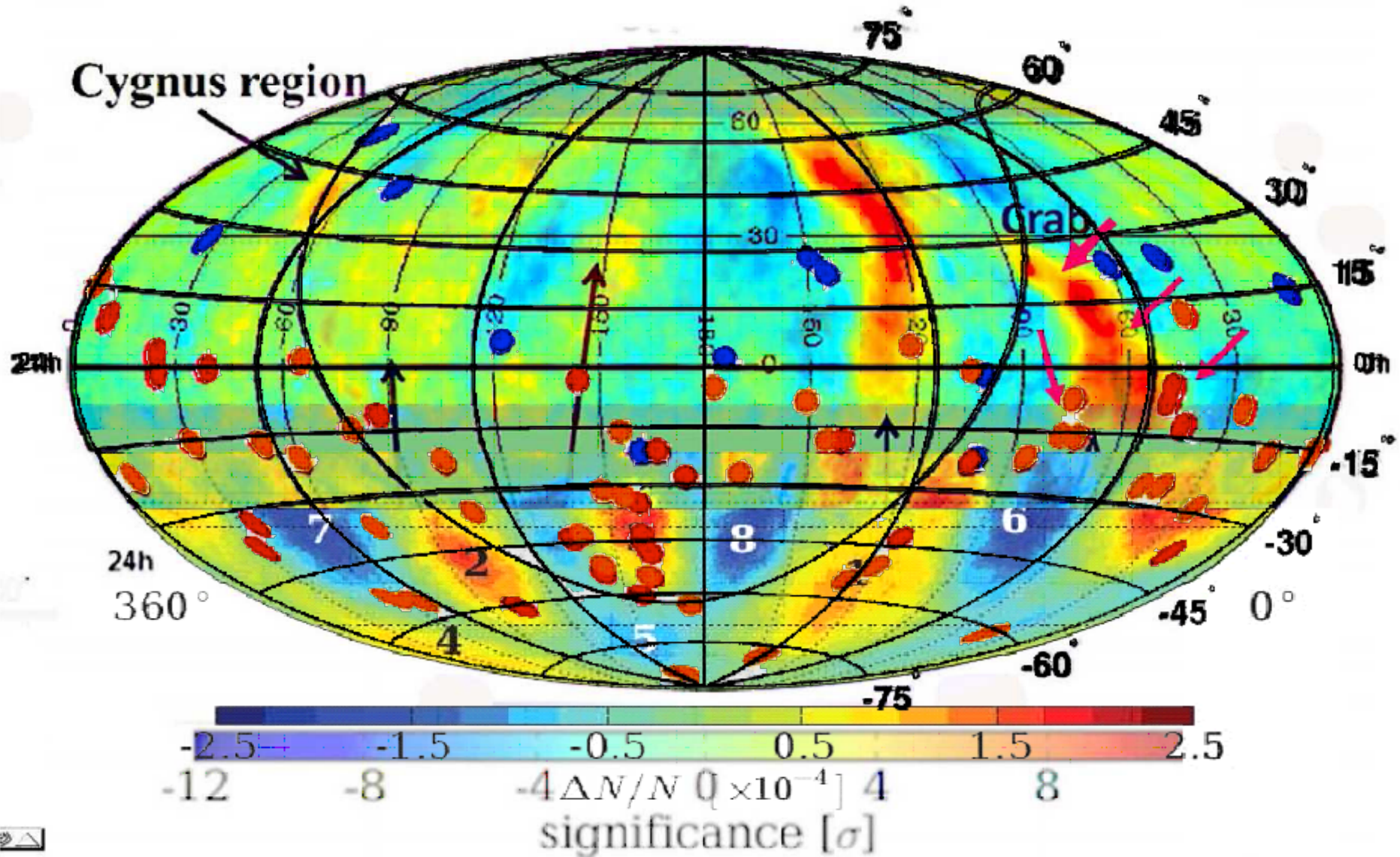
Di Sciascio-ARGO Taub 2011

A new Crab connection?

+ ICECUBE ANISOTROPY



A NEWer-just MAY 2012-Anisotropy of TeV and PeV by IceCube and IceTop: arXiv:1205.3969



The consequent UHECR-UHE neutrino Connection

- UHECR Map may mimic a UHE secondary neutrino map
- UHECR light Composition imply low energy GZK neutrinos tails (tens PeVs)
- EeV GZK Neutrino may show different clustering
...More point like sources, but at lower rate
- Tens PeVs Tau Neutrino secondaries maybe
- Spread like UHECR and discovered at AUGER, Hires or TA Fluorescence telescopes as well as in ARGO horizons by Tau Airshowers: they may trace tails as UHECR clustering mostly at far redshift.
- Tau Airshowers do not suffer of atmospheric nu noise
- (as muons) and are detectable at horizons
- (AUGER-HIRES-TA-ARGO)

Because mixing, even a minimal neutrino mass splitting guarantees the flavour transformation from Muon Neutrinos to the Tau Neutrinos..

Above hundreds TeVs only Galactic and cosmic distances are large enough for a complete neutrino oscillation lengths. No atmospheric Tau!

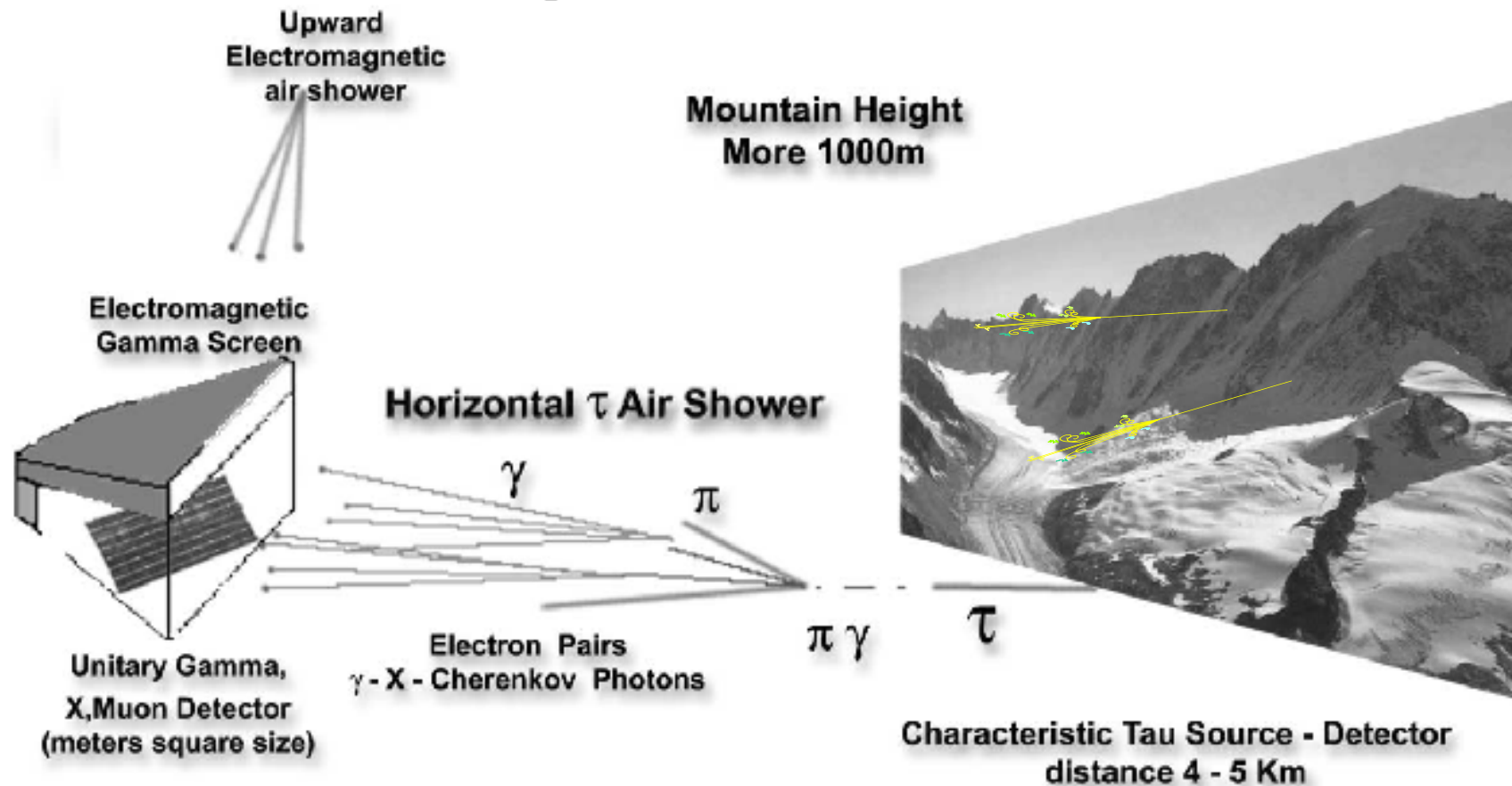
Astrophysical Tau neutrinos are born by Muons ones in a noise free sky!

$$L_{\nu_{\mu}-\nu_{\tau}} = \boxed{8.3 \text{ pc}} \left(\frac{E_{\nu}}{10^{19} \text{ eV}} \right) \left(\frac{\Delta m_{ij}^2}{(10^{-2} \text{ eV})^2} \right)^{-1}$$

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

D. Fargion¹, A. Aiello², R. Conversano

ICRC 1999-Salth Lake_US

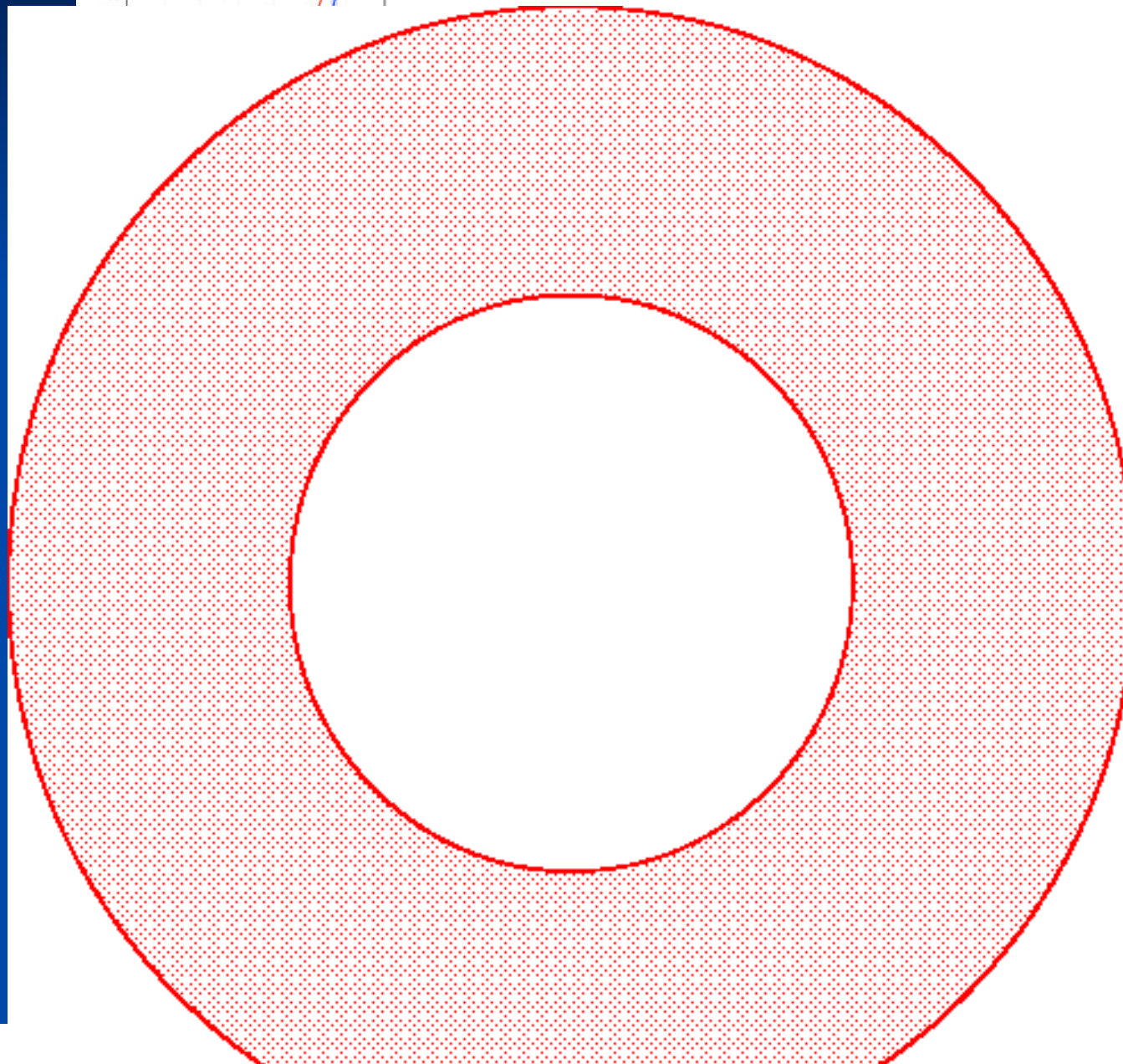
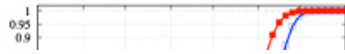


DISCOVERING ULTRA-HIGH-ENERGY NEUTRINOS THROUGH HORIZONTAL AND UPWARD τ AIR SHOWERS: EVIDENCE IN TERRESTRIAL GAMMA FLASHES?

D.F. The Astrophysical Journal, 570, p.909. 2002
Vulcano-May-2012-Fargion

AMIGA: Auger Muons and Infill for the Ground Array

Simulated acceptance



radius 1500m

radius 750m
infill detectors
3.5 km²

radius of the 85 detectors:
radius of Cherenkov tank
radius of muon counter





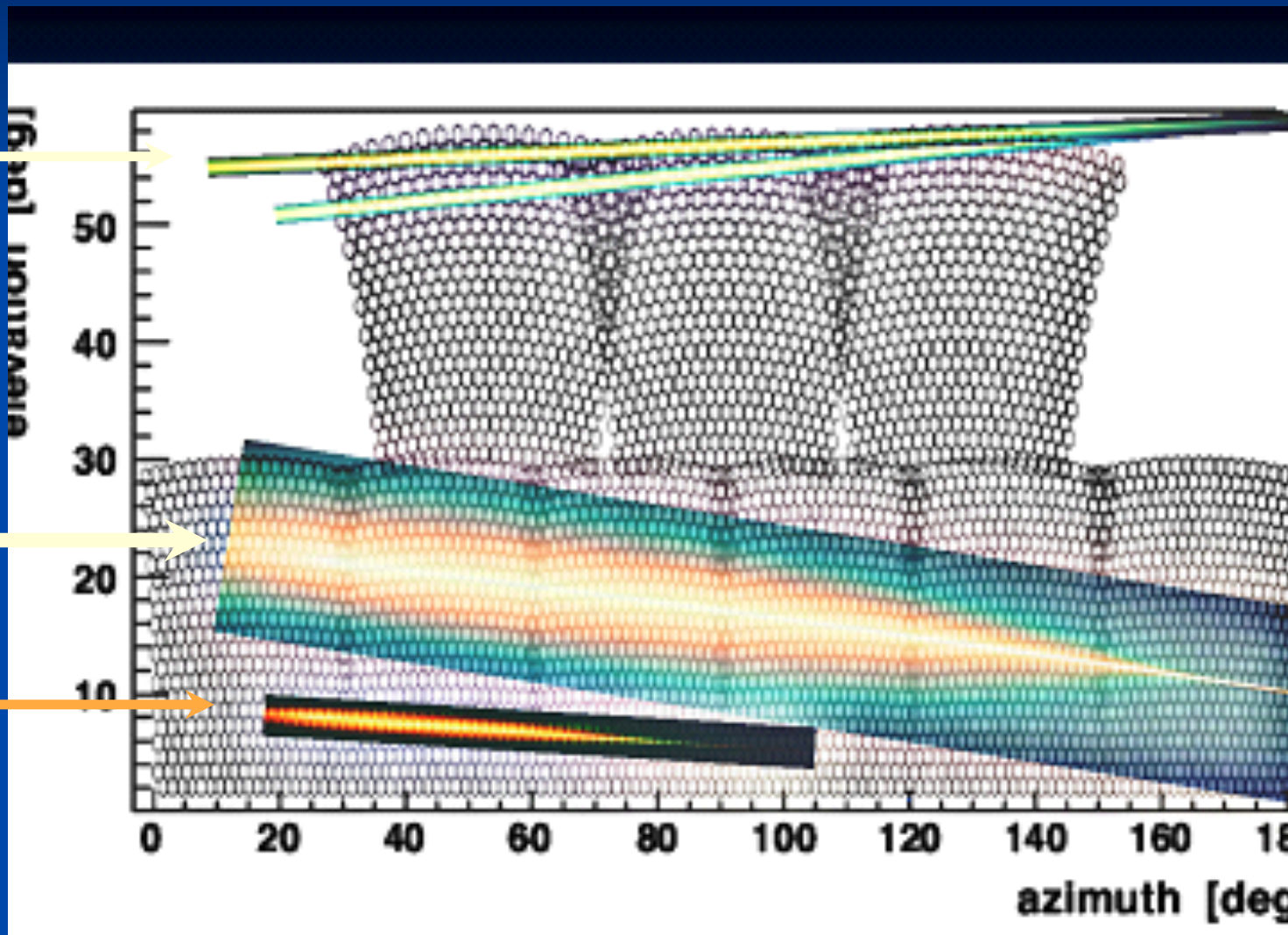
Horizontal Hadron Air-Showering splitted by geomagnetic field at high altitude(30 km)



EeV Tau far airshower: at low altitutde (2-5 km) nearly horizontal



Tens PeV Tau, inclined upgoing near telescopes fluorescense T.(1-3 km)



Summary

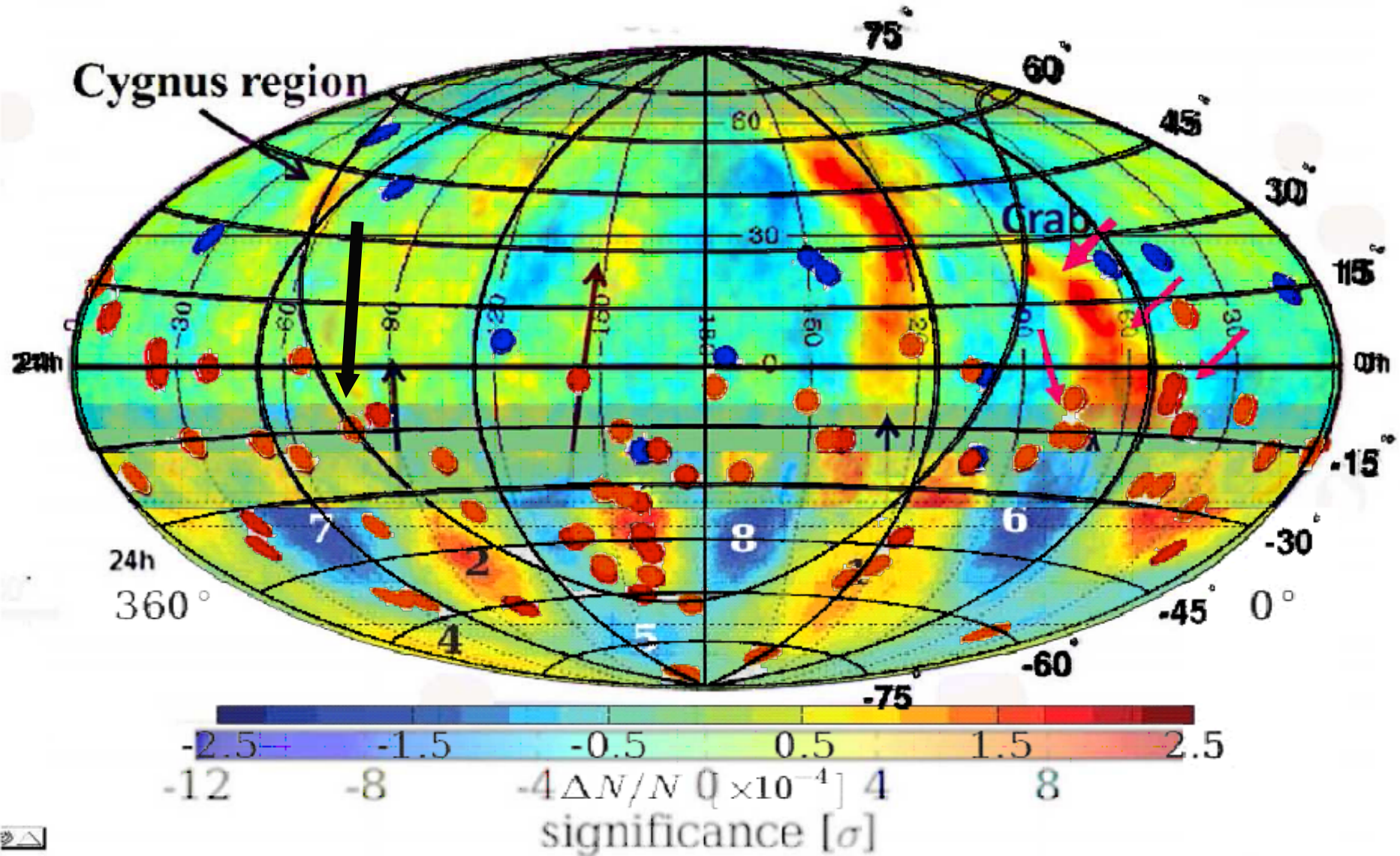
- Cen A nearby source of He-like UHECR
- Cen A fragments follow maps at a rare probability
- Vela triplet and few galactic connections with the gamma MeV and TeV anisotropy hint for Heavy galactic nuclei
THEREFORE:

- UHECR maybe, apart Cen A, mostly HEAVY RADIOACTIVE nuclei whose decay in flight light at TeV energy..see ARGO –ICECUBE.

Galactic center screened by bending of heavy Ni-Co : only galactic sources at far galactic edges may rise.

TAU NEUTRINOS MAY RISE AT tens PeV soon.
In ARGO-ASHRA-AUGER and TA

A NEW-just MAY-Anisotropy of TeV and PeV cosmic rays with IceCube and IceTop: arXiv:1205.3969



Are we observing a revolution in UHECR? TA data
A Moon Lights of this week and yeasterday..just a monster of surprises?

SEARCH FOR ANISOTROPY OF ULTRA-HIGH ENERGY COSMIC RAYS WITH THE TELESCOPE ARRAY
EXPERIMENT



Troitsky revolution: YEASTERDAY , 30-5-2012

Pis'ma v ZhETF

A doublet of cosmic-ray events with primary energies $> 10^{20}$ eV

S. V. Troitsky⁺¹⁾

⁺¹⁾Institute for Nuclear Research of the Russian Academy of Sciences,

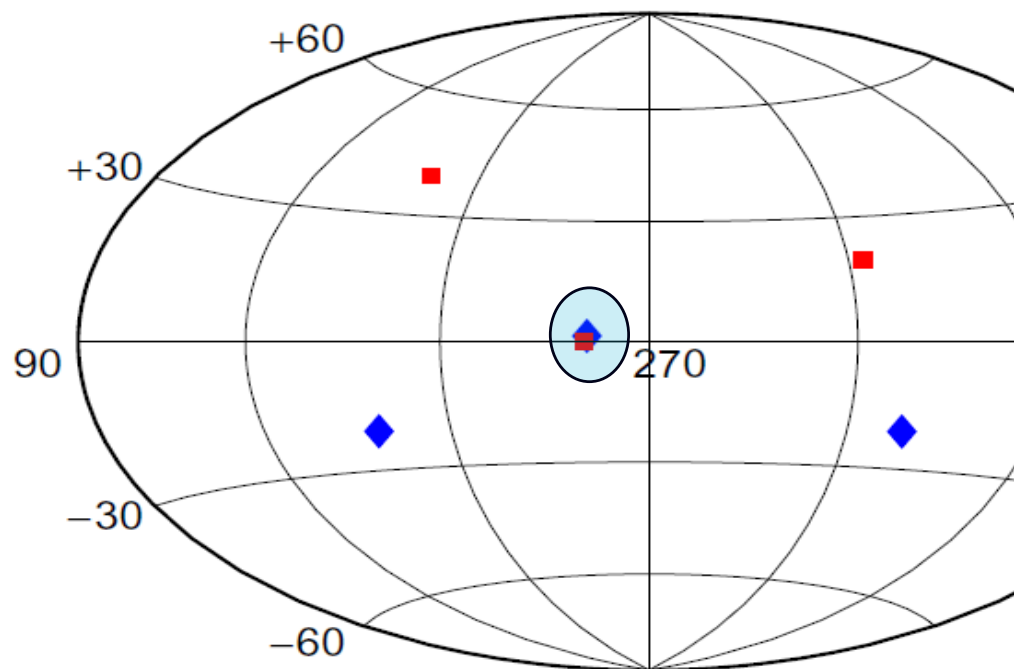


Figure 1. The sky map with arrival directions of the doublet of cosmic-ray events with primary energies $> 10^{20}$ eV (diamonds) and the TA events with $E > 10^{20}$ eV (boxes). The projection, equatorial coordinates.

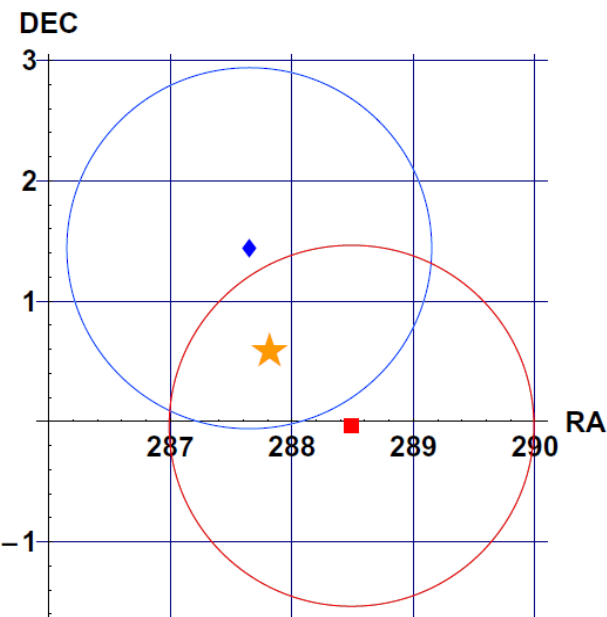


Figure 2. The sky map with arrival directions of the two events in the doublet: the PAO event (diamond) and the TA event (box). With a 68% probability, the true arrival directions are inside the corresponding circles. The star denotes the position of Aql X-1; no other strong X-ray or gamma-ray sources are seen nearby.

How far can we see? The End..

- Thank you for the kind attention

