

TeV Gamma anisotropy connection with UHECR by ultrarelativistic radioactive Nuclei?

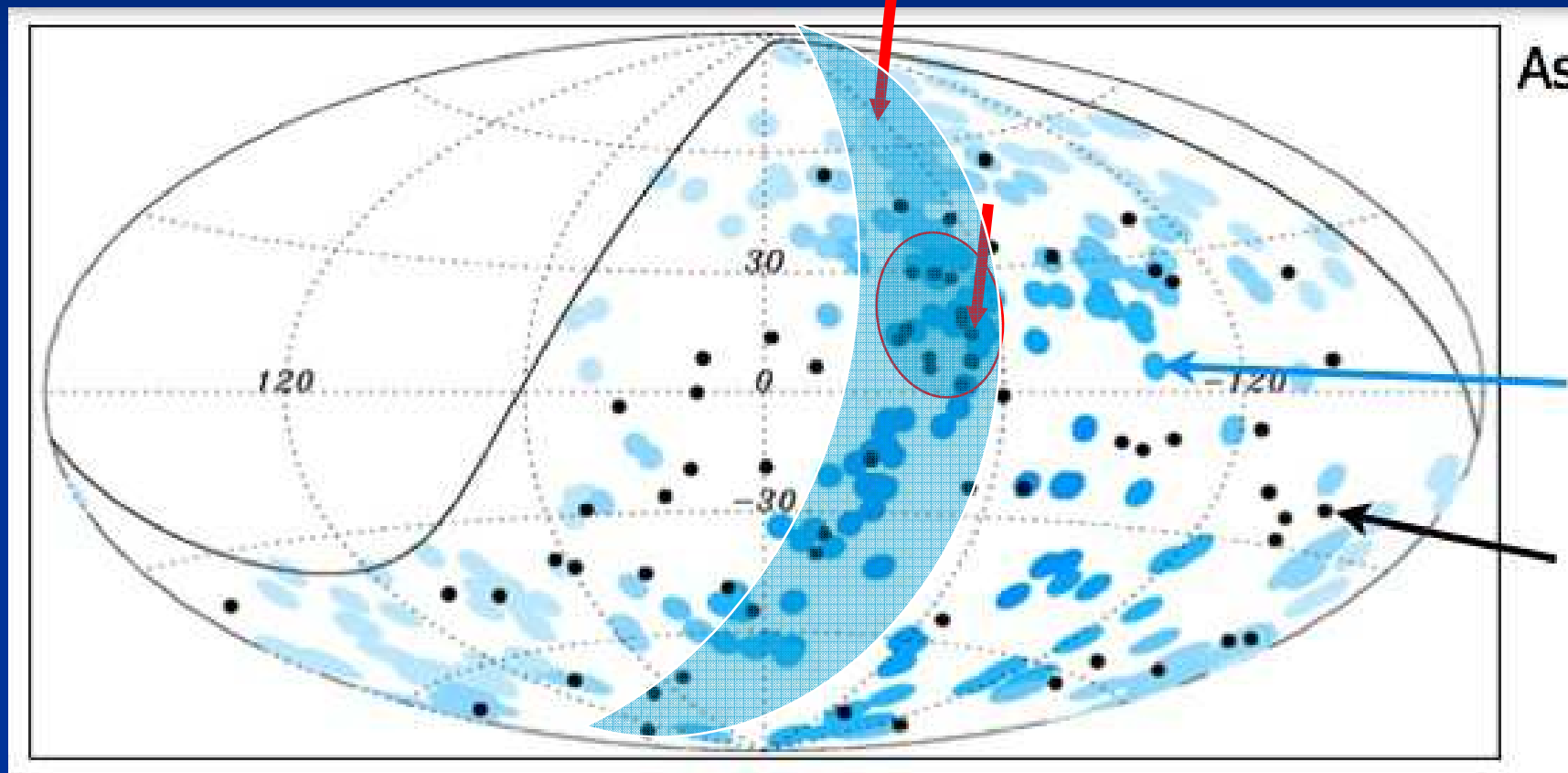
and UHECR multiplets by Lightest Nuclei fragments By D.Fargion

- [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

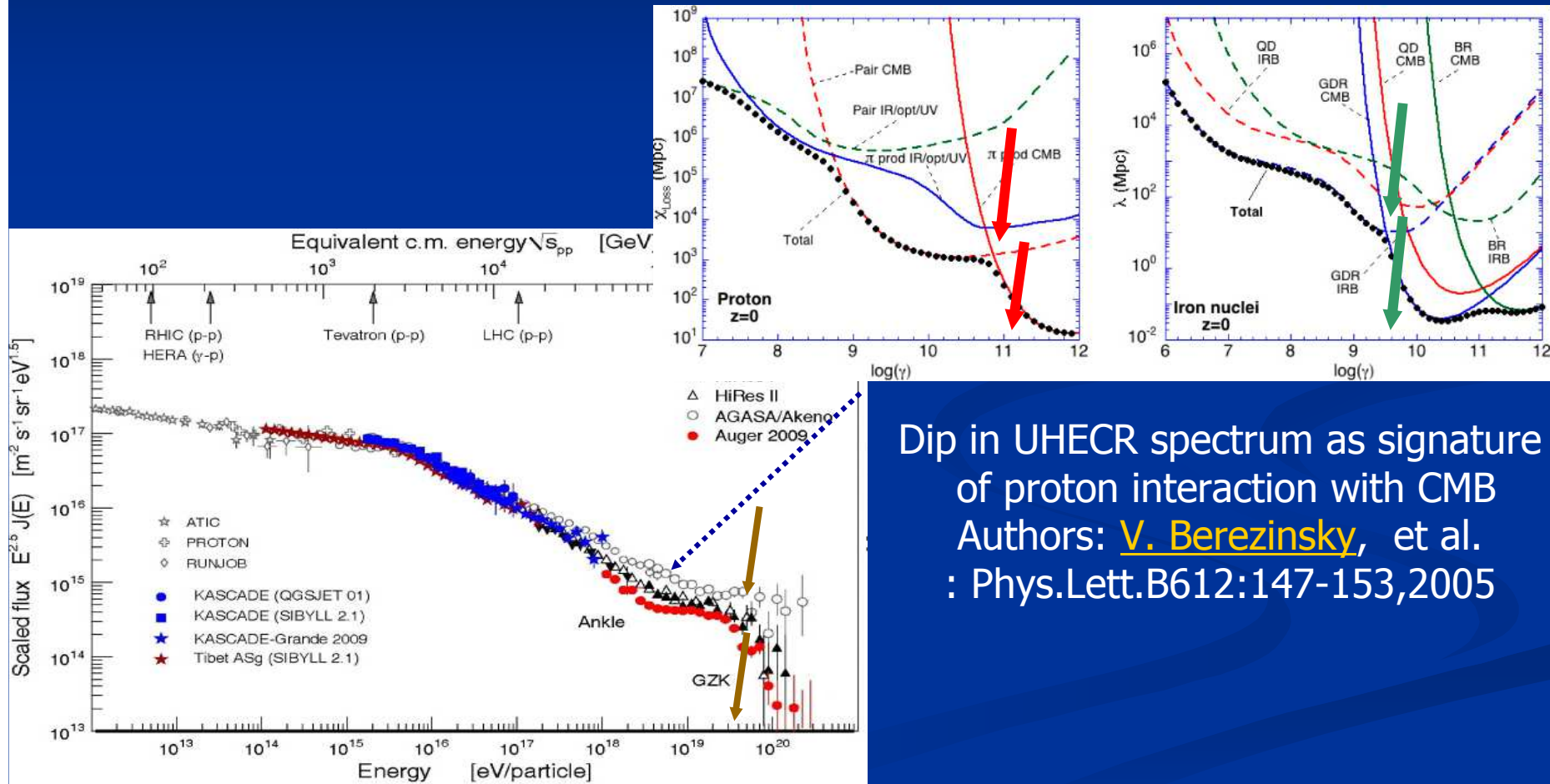
- UHECR Cen A clustering, Virgo absence-> LIGHT NUCLEI
- Such He UHECR breaks into fragment-> Multiplet clustering observed at Cen A-2011
- Heavy Radioactive Nuclei may shine at TeV
- Also Lightest nuclei fragment may be decaying into neutron whose decayed tens PeV electron may also shine tens TeV gamma
- 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 (?) or with Cen A?
see our earliest disclaim 2008



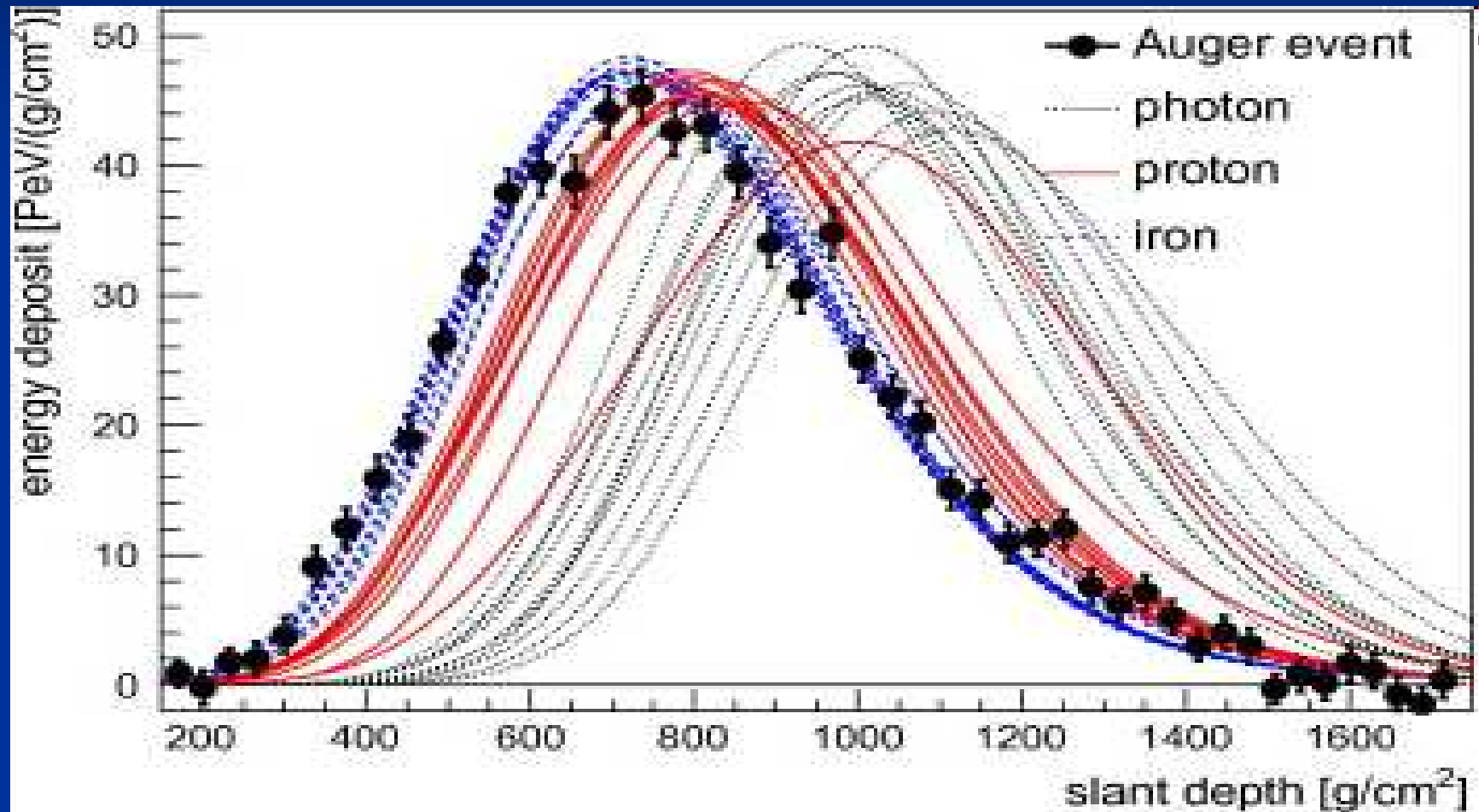
Correlation suggesting NUCLEON as the UHECR courier---BUT

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

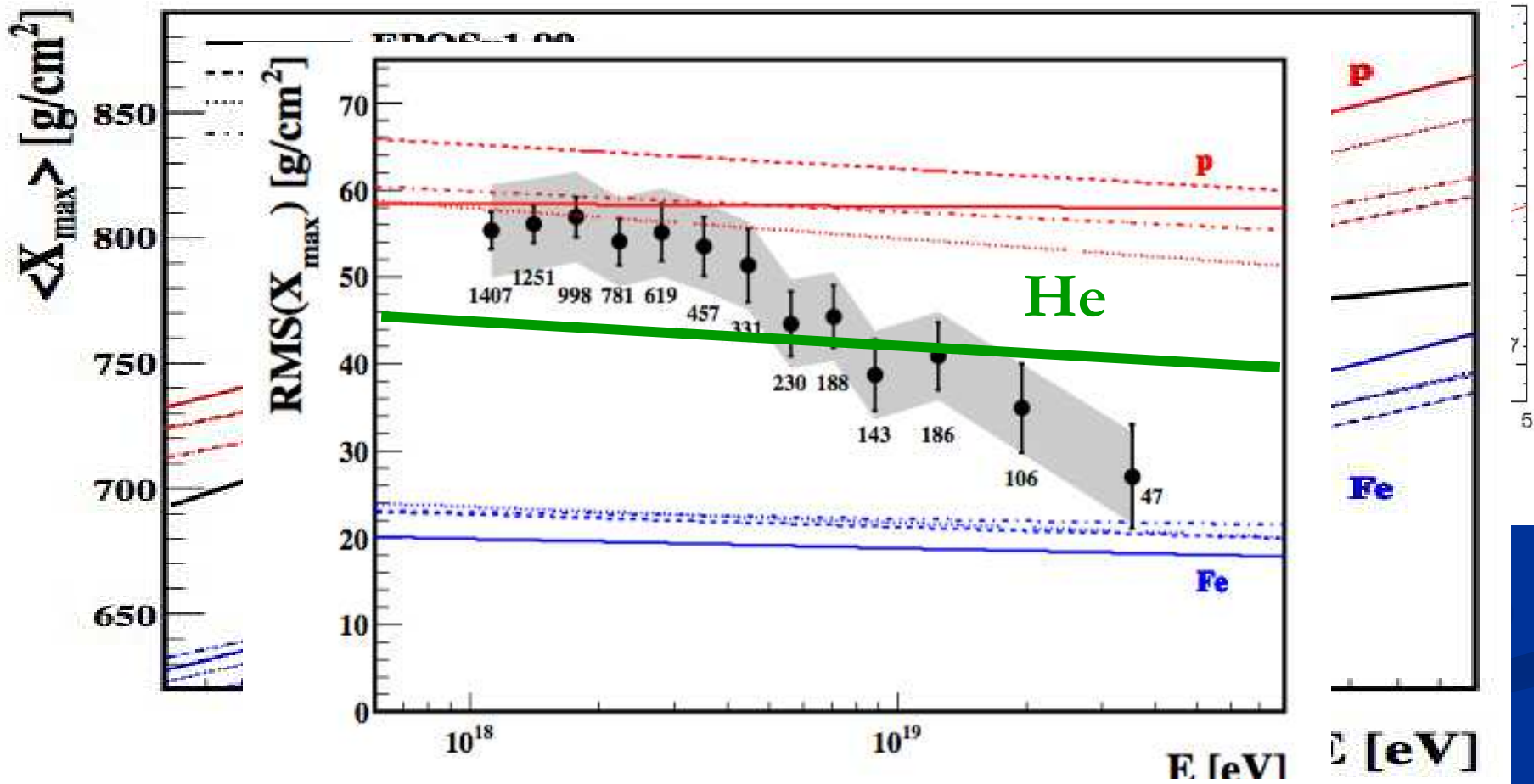
How to disentangle the composition



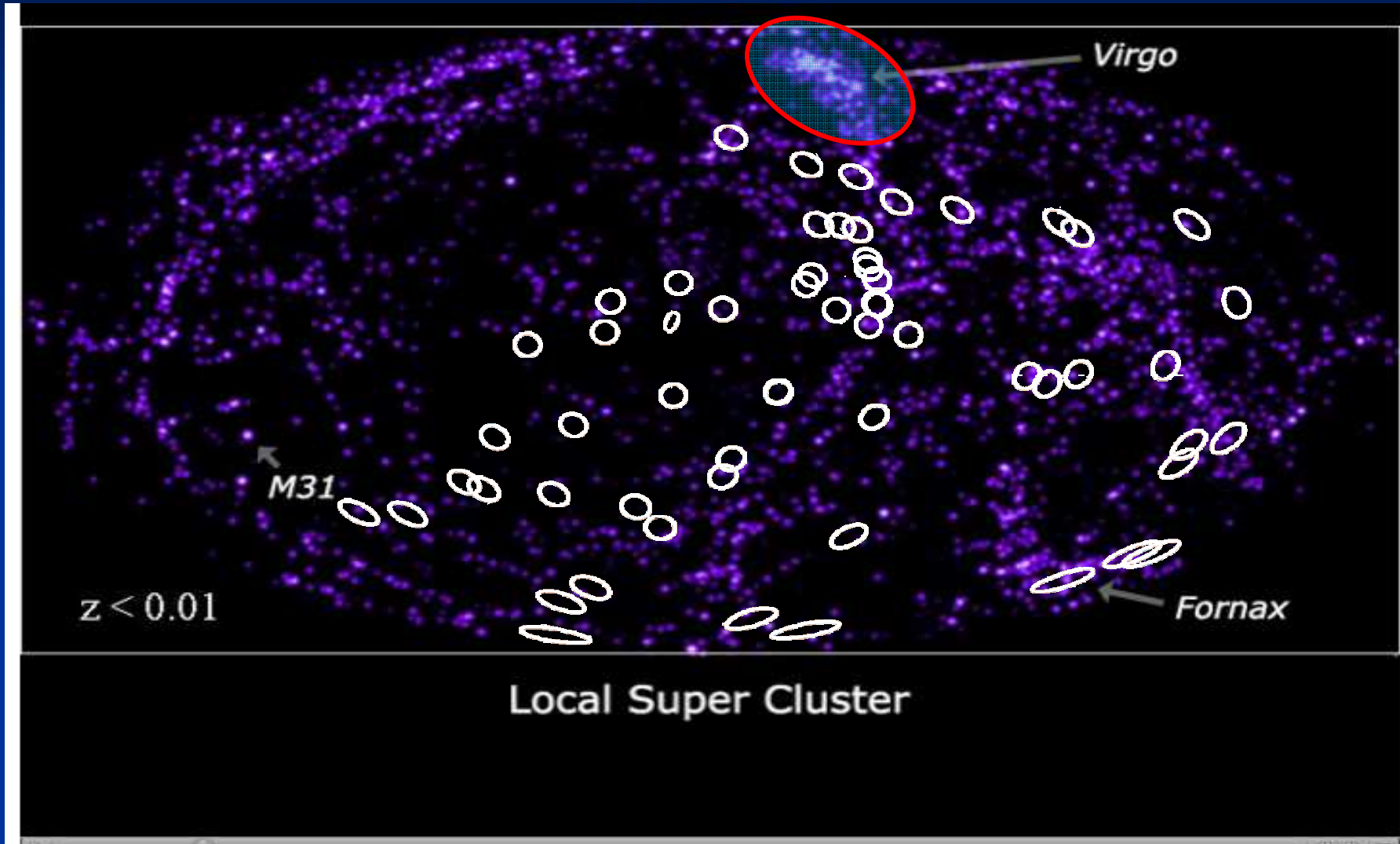
WHY NOT just a GZK Volume
as (old?) AUGER belief = proton+ SGP?

- 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**



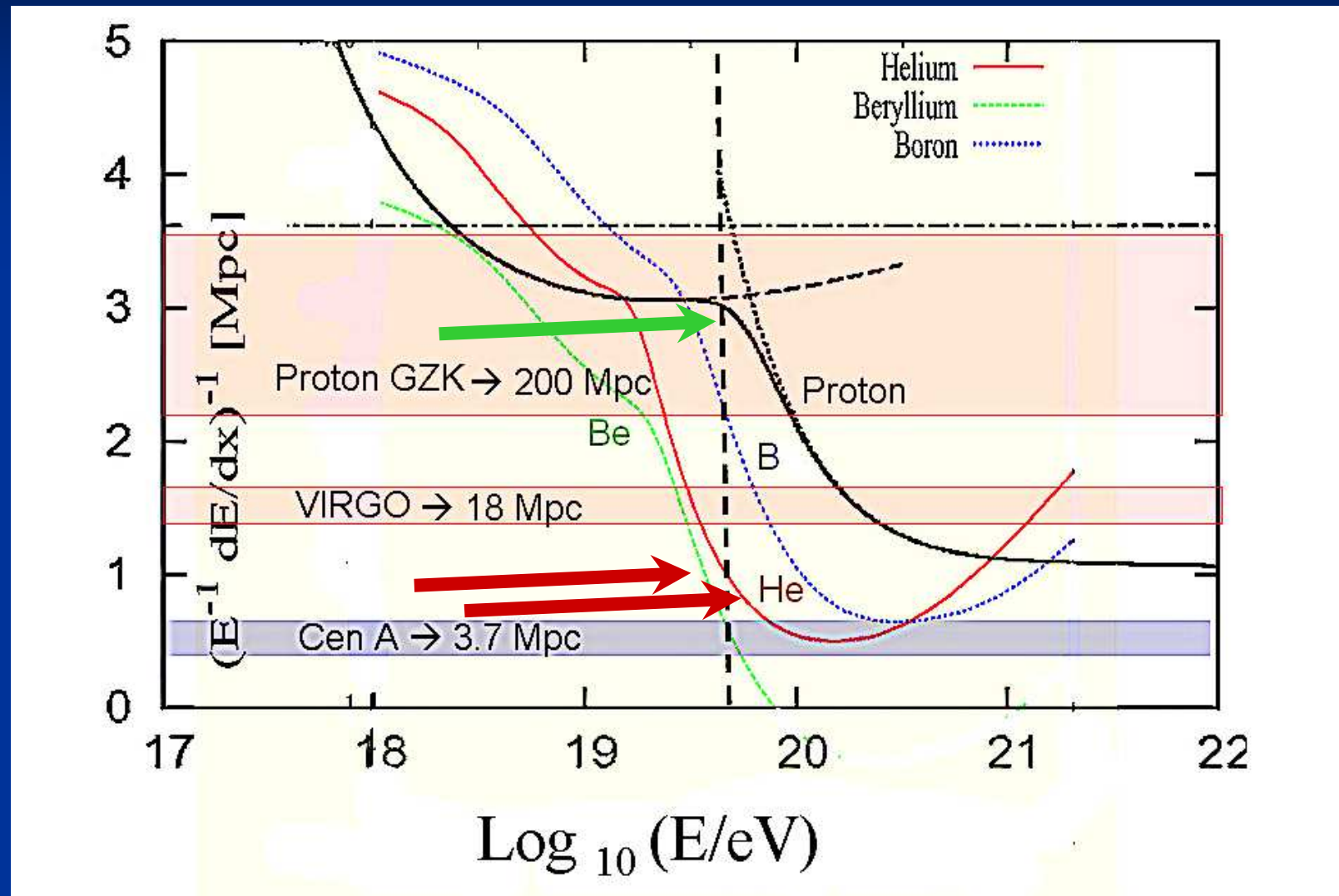
The Virgo Absence in near Universe



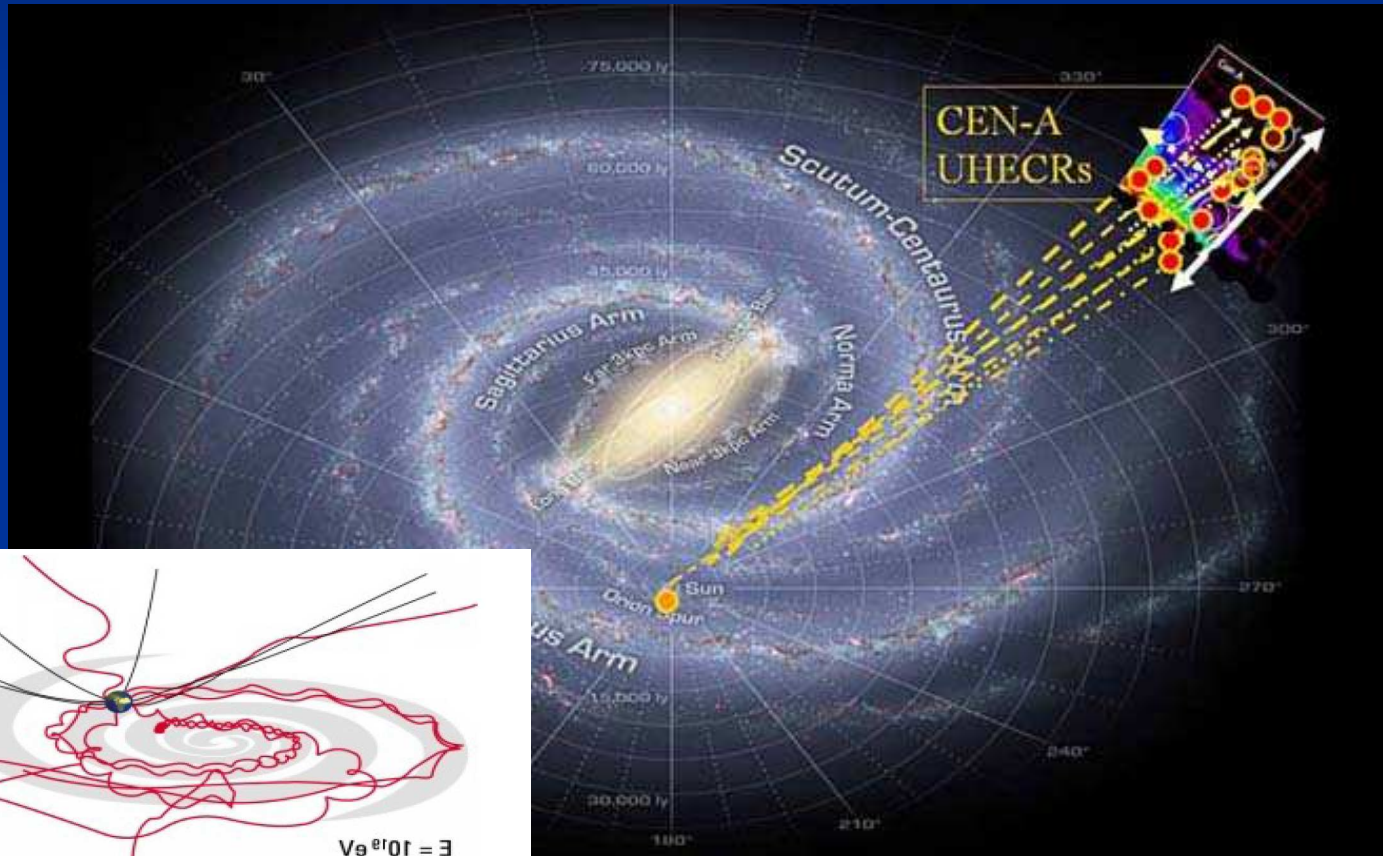
*How LIGHT NUCLEI explain the Virgo
Absence and the Cen a vertical spread
clustering?*

- *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 $\delta_{rm} \geq$:

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

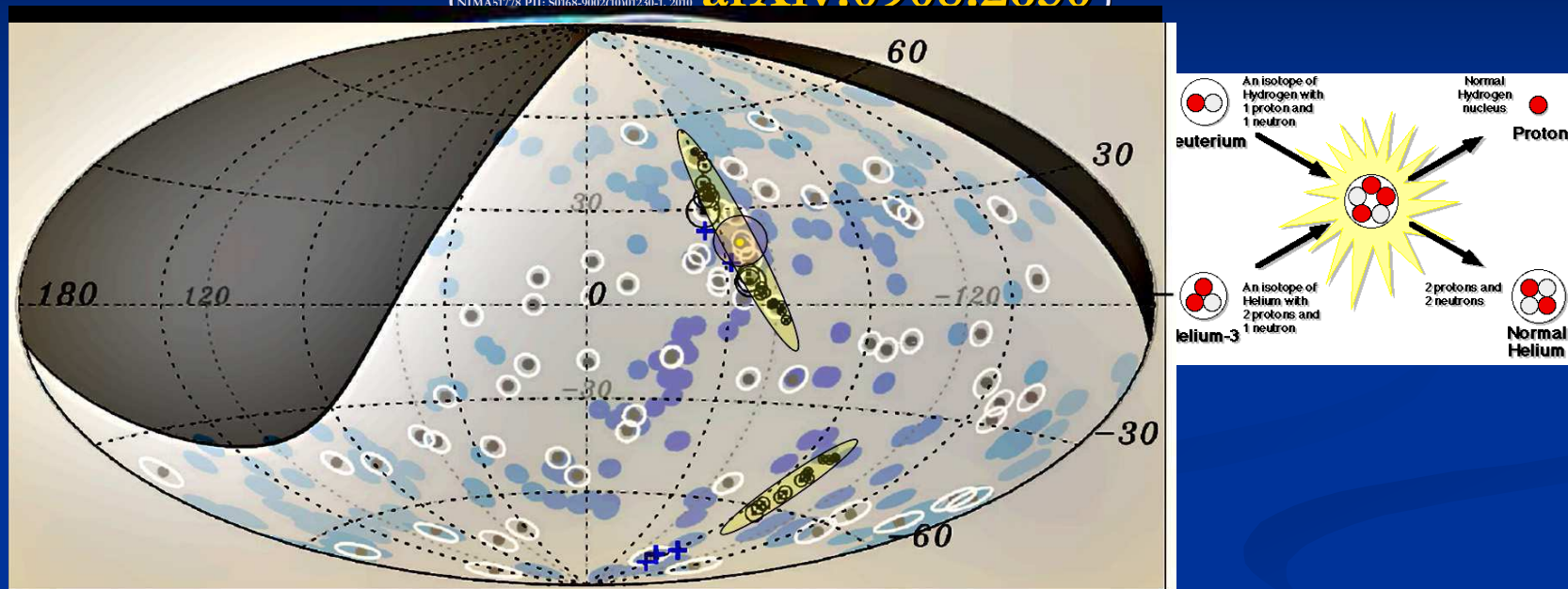
$$16.95^\circ \cdot \frac{Z}{Z_{Li^3}} \cdot \left(\frac{6 \cdot 10^{19} eV}{E_{CR}} \right) \left(\frac{B}{3 \cdot \mu G} \right) \sqrt{\frac{L}{20 kpc}} \sqrt{\frac{l_c}{kpc}} \quad (2)$$

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

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

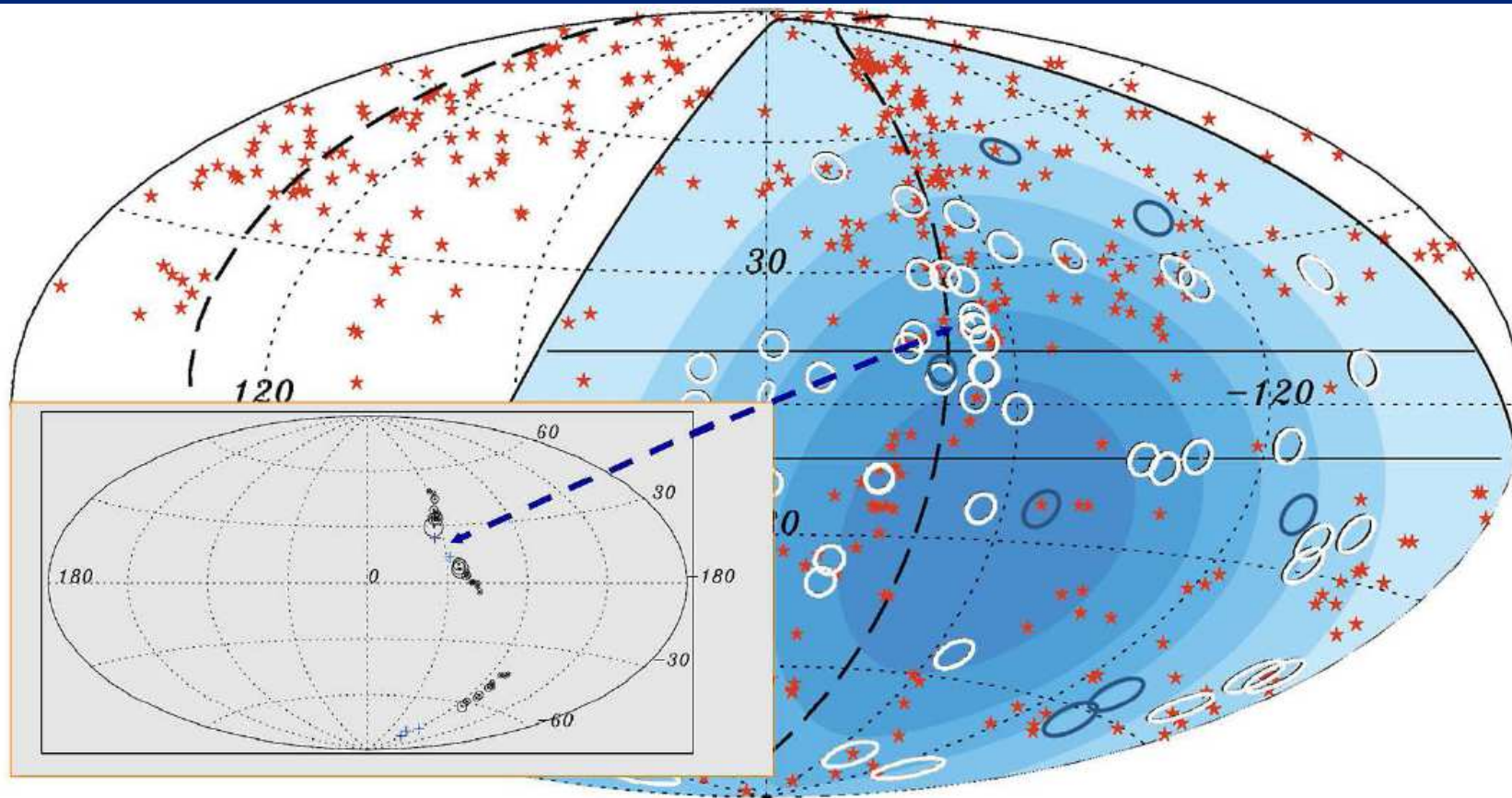
Foreseen He fragility and D,p: fragments and multiplet

(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

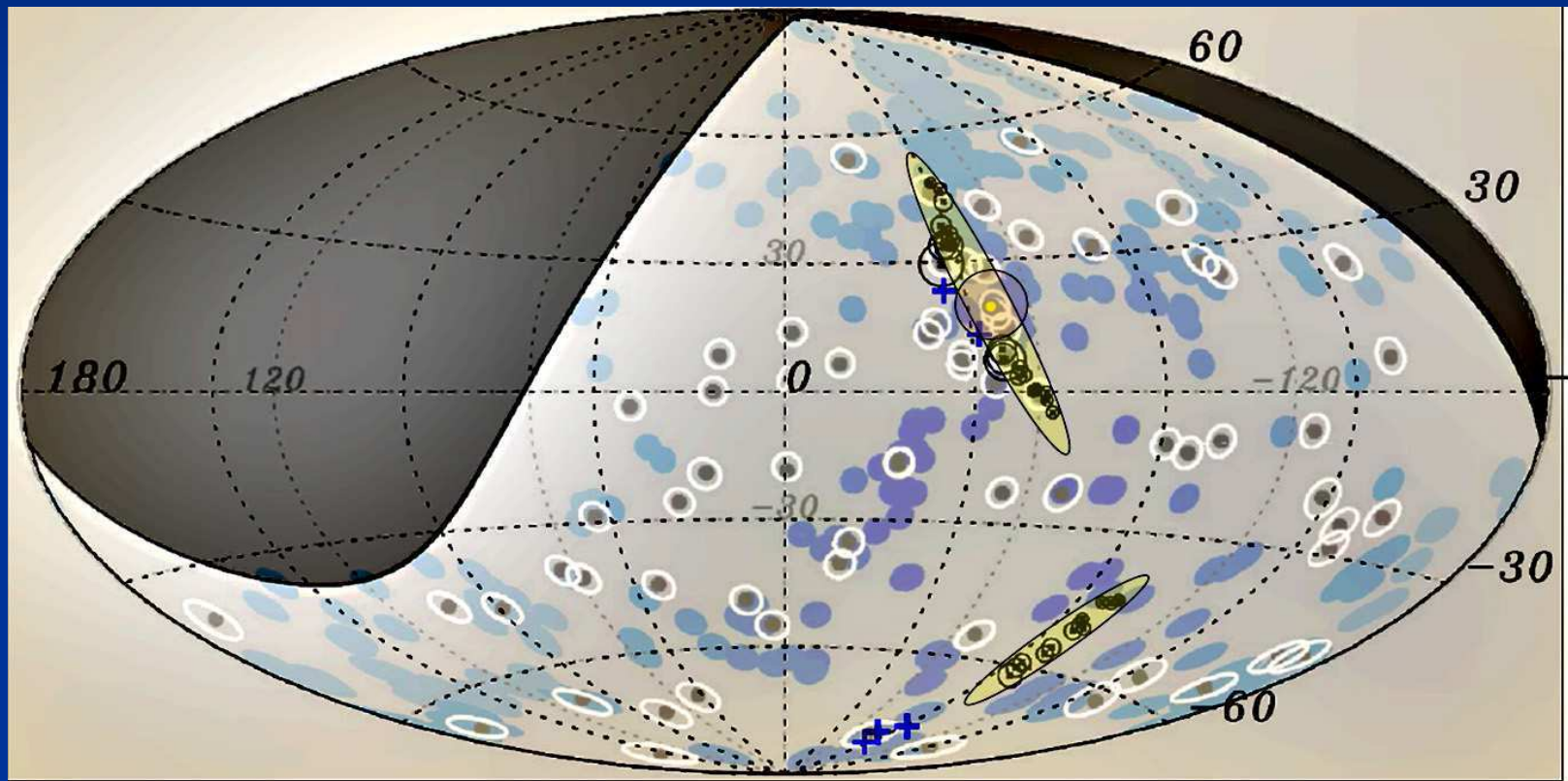
A new input from AUGER: *arxiv1107.4805* *Multiplets tail around Cen A at 20 EeV*



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).

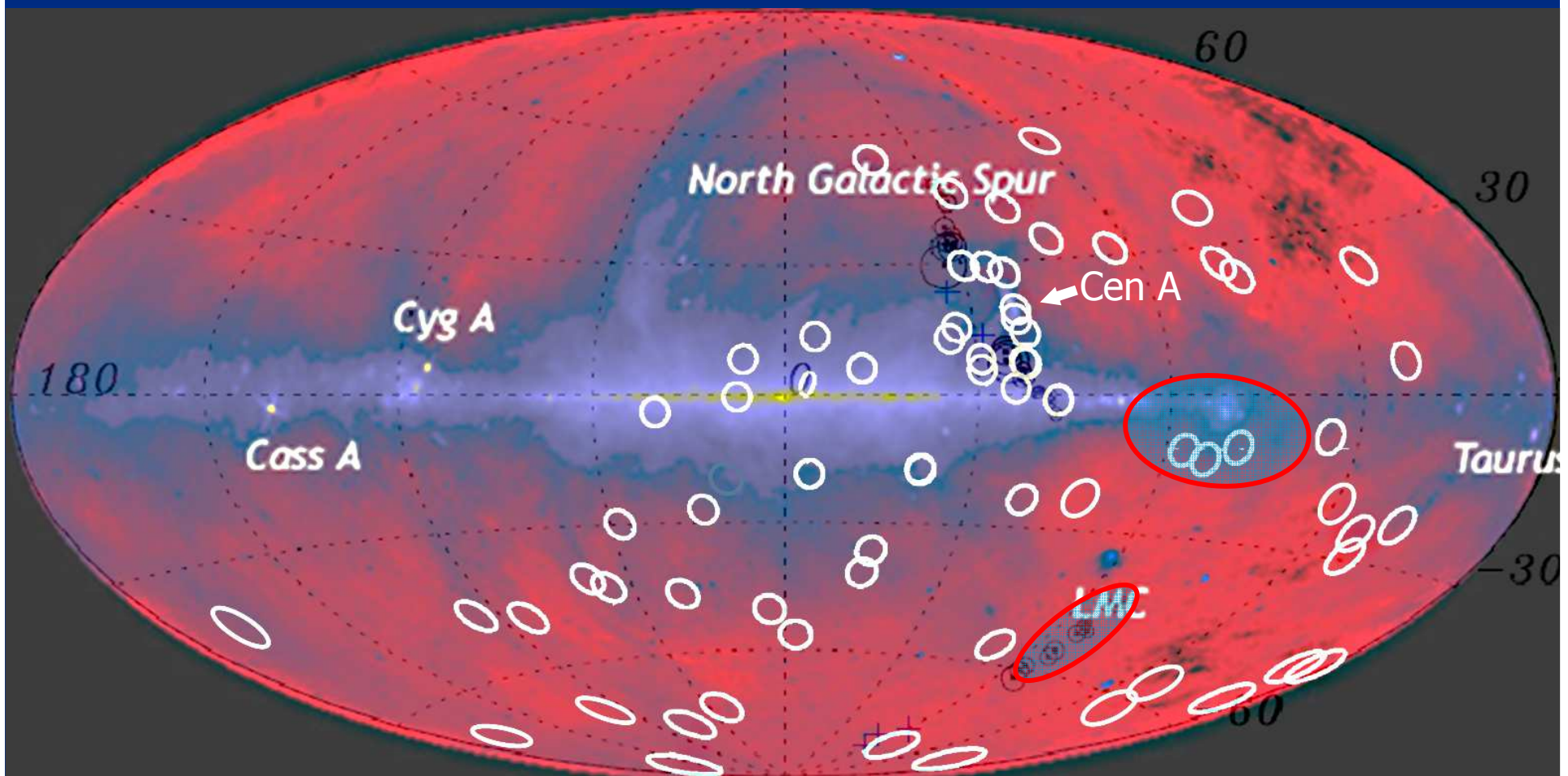
- $\delta_{\text{p}} (20 \text{ EeV}, Z=1) = \delta_{\text{D}} (20 \text{ EeV}, Z=1) =$

- $11.3 * 3 / 2 = 17..$

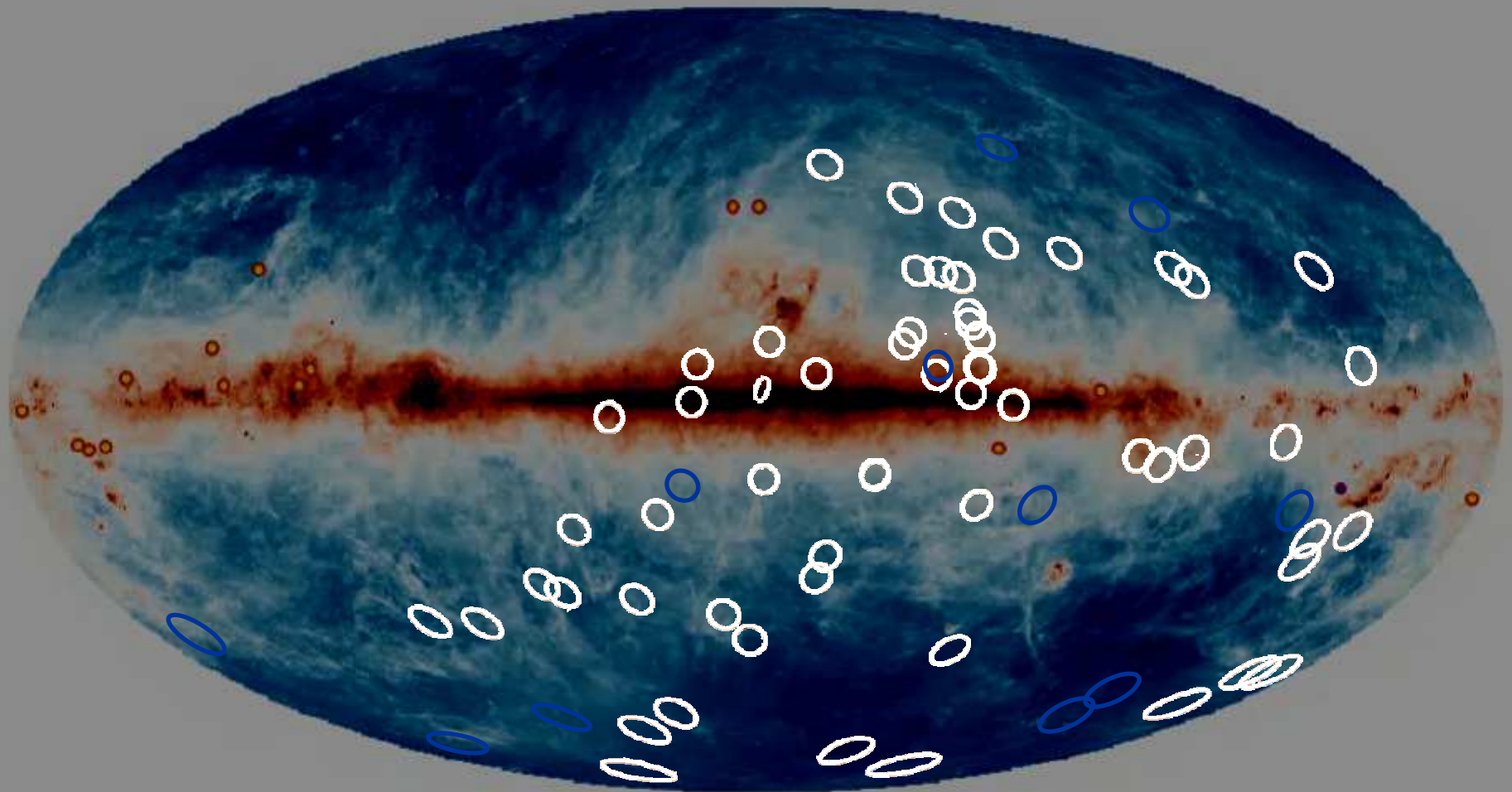
A posteriori Cen A correlating multiplet

- 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



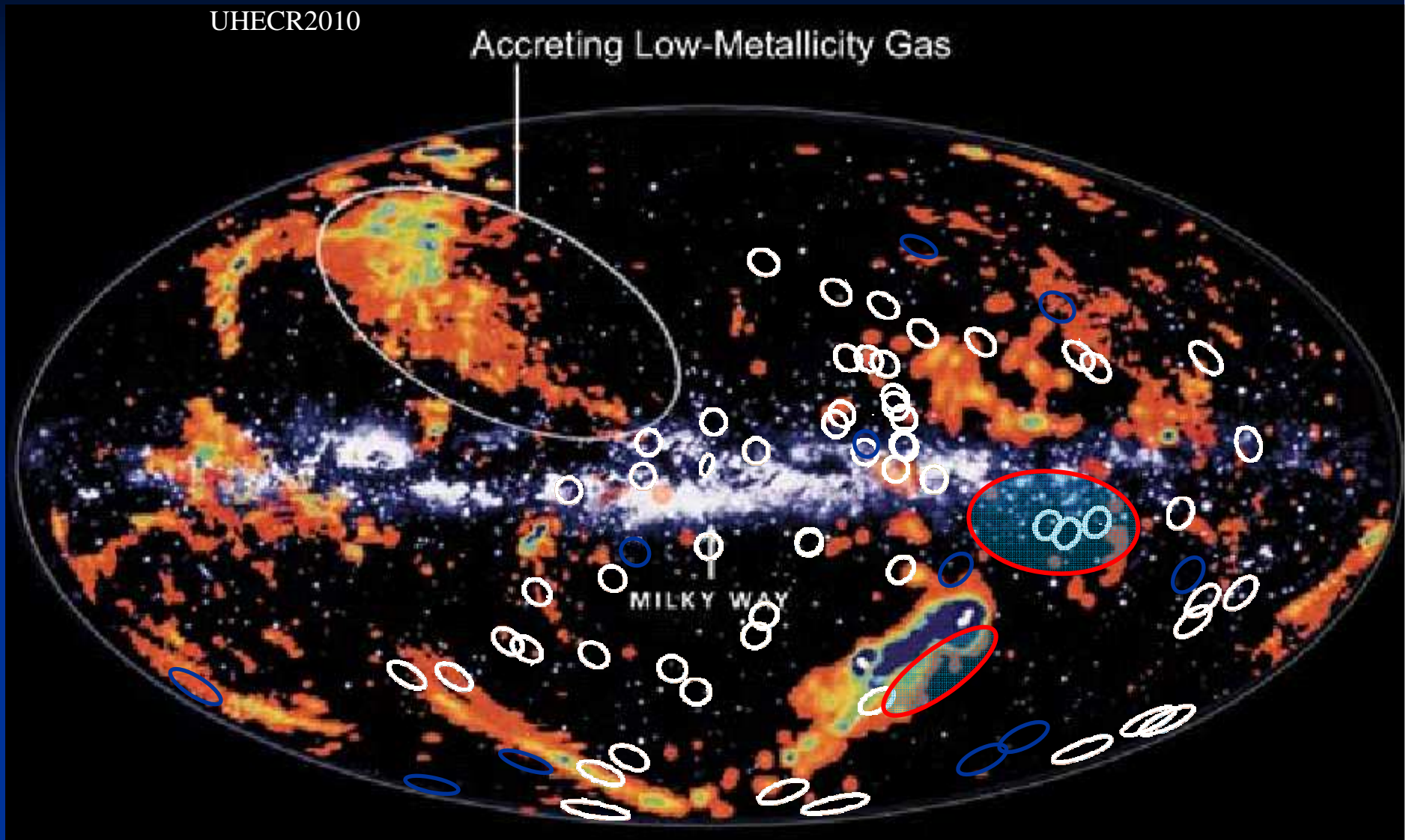
IR



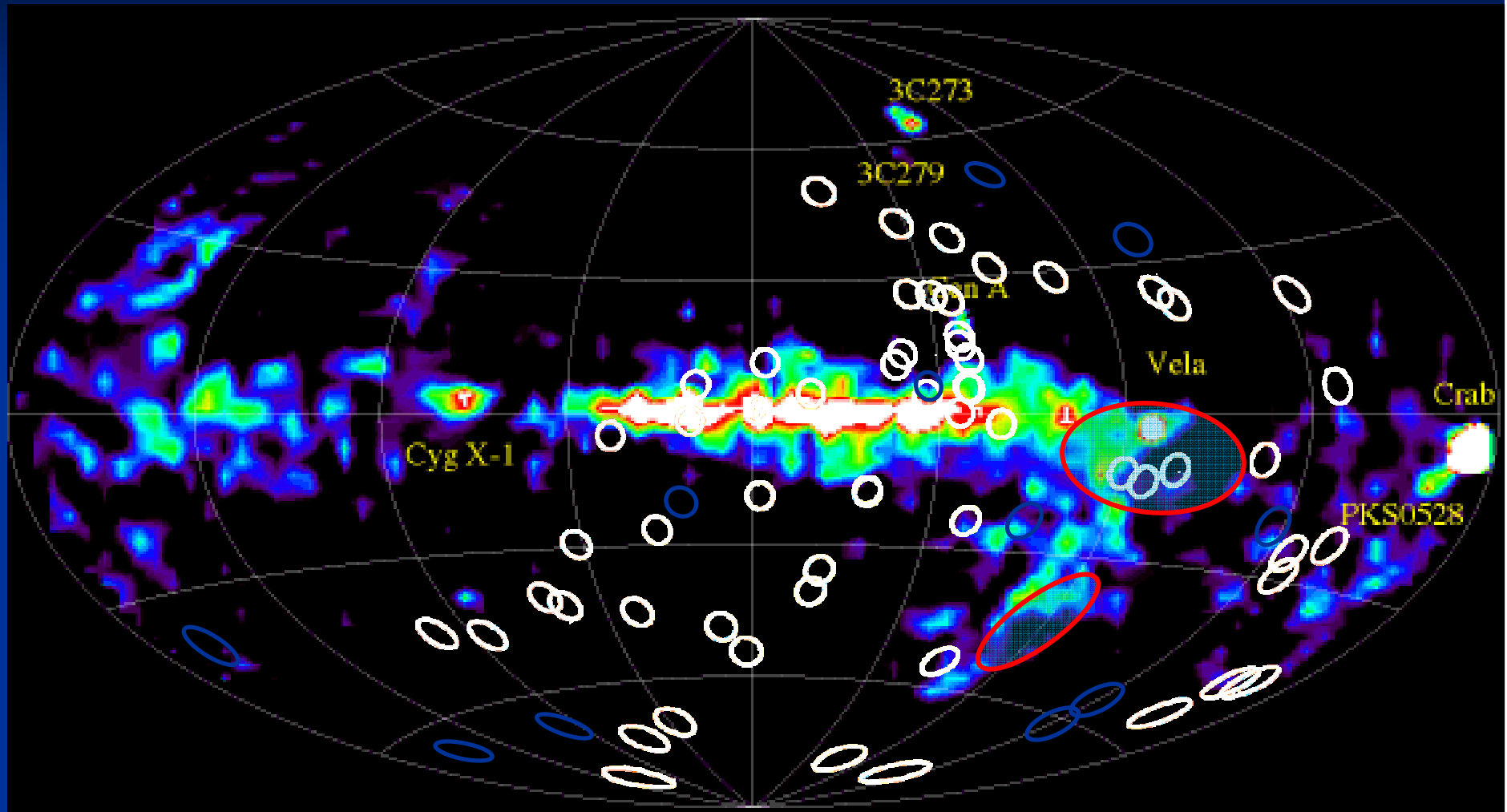
MAGELLANIC STREAM in METALLIC LINES

UHECR2010

Accreting Low-Metallicity Gas

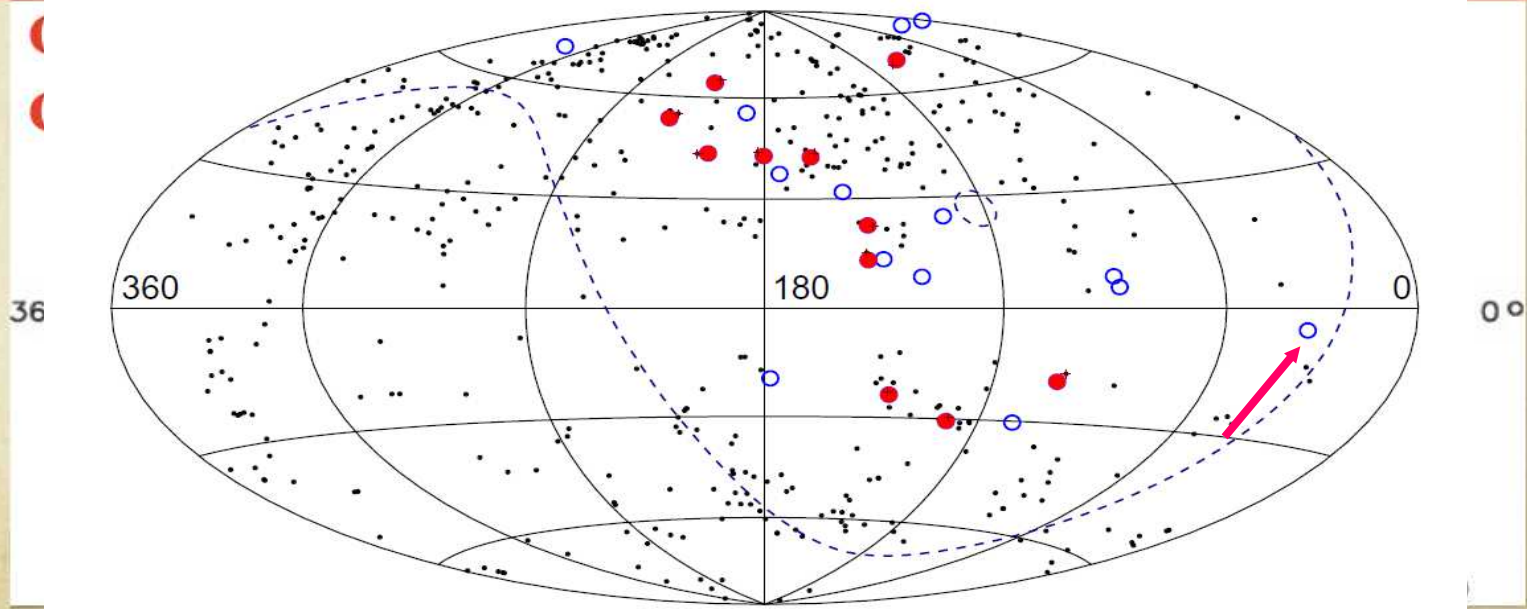
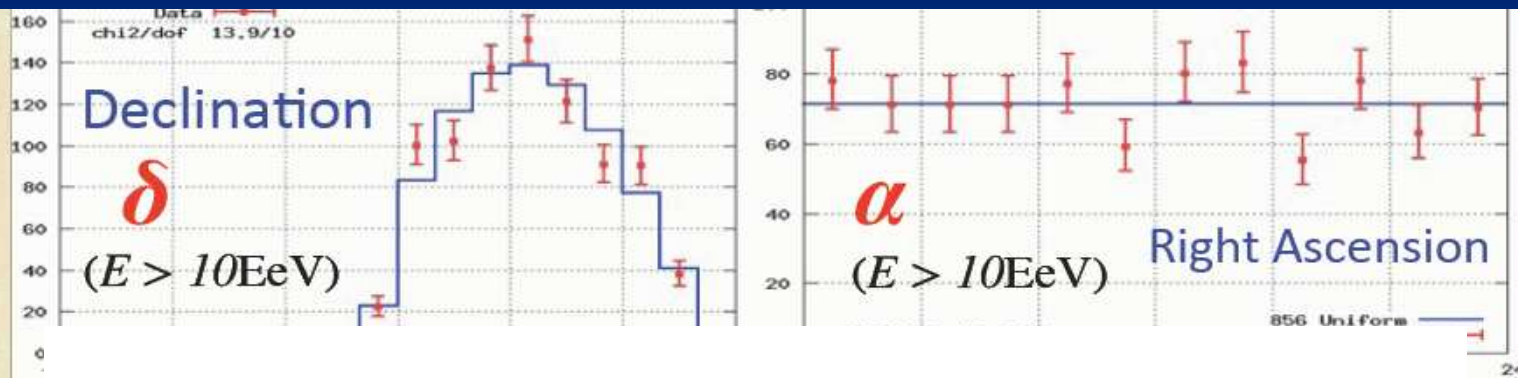


GAMMA COMPTEL . VELA AND MAGELLANIC STREAM- UHECR



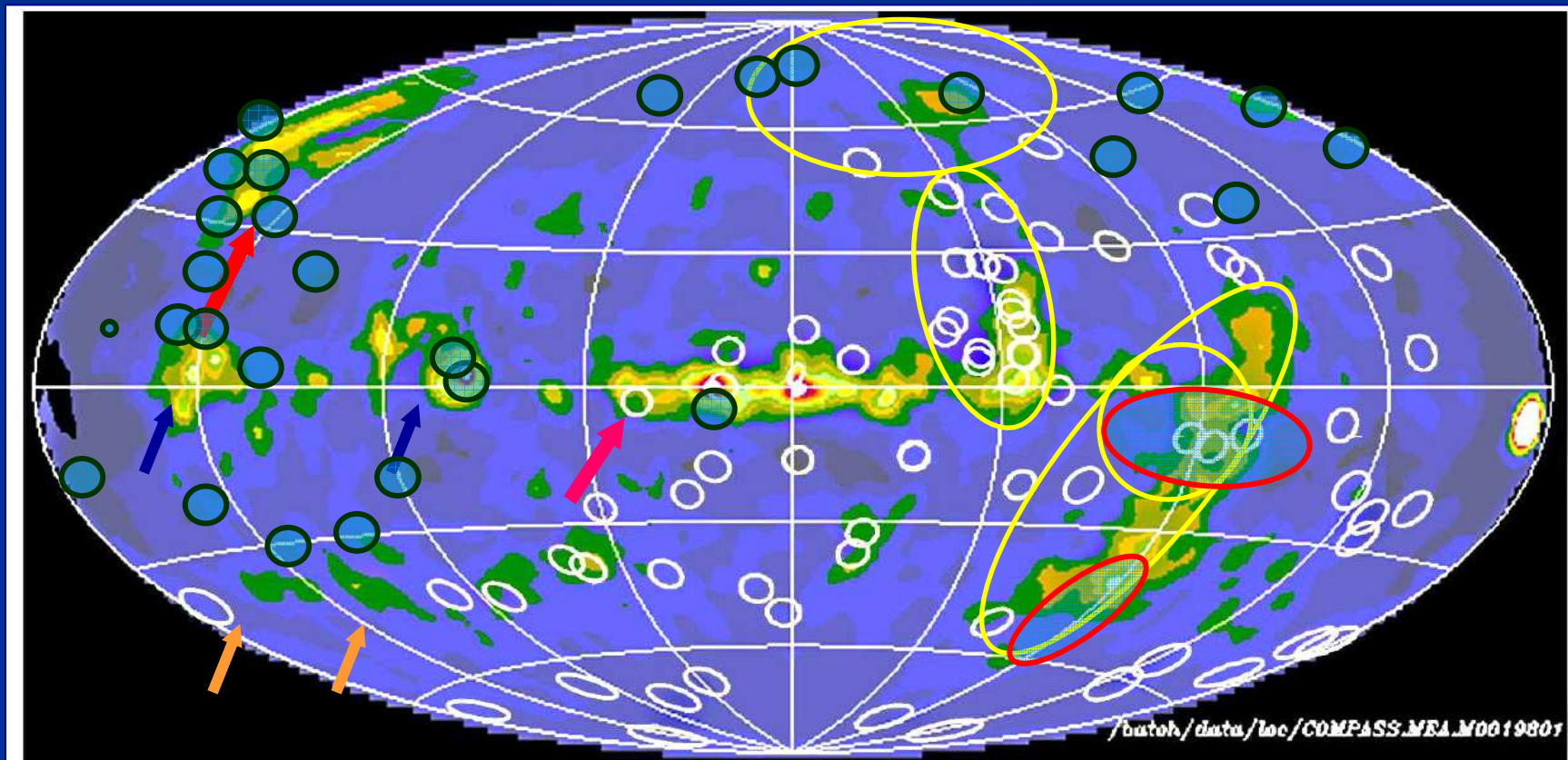
Telescope Array Map

To be rotated by 180 degree left..



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

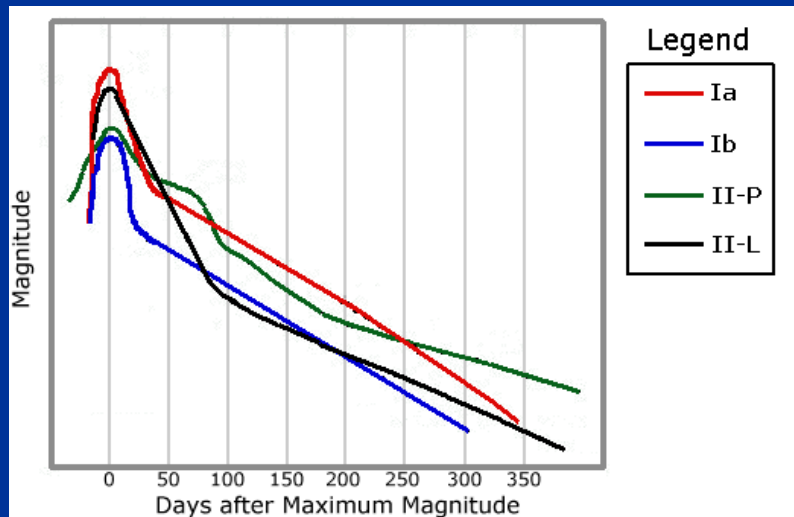
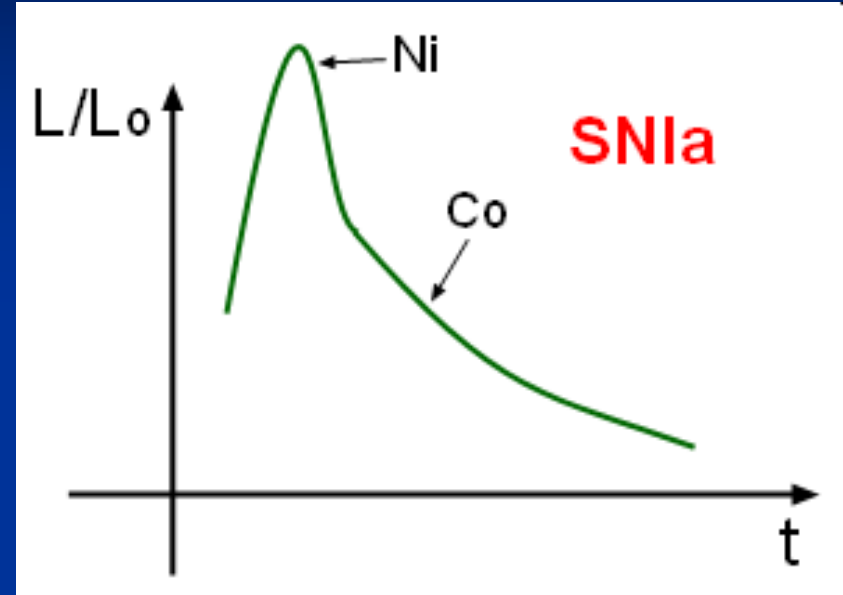
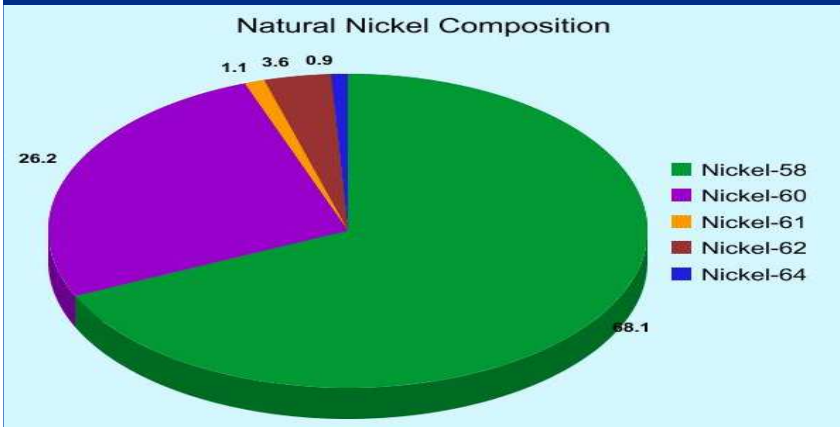
A hint of local galactic sources (Vela-Magellanic Clouds)?



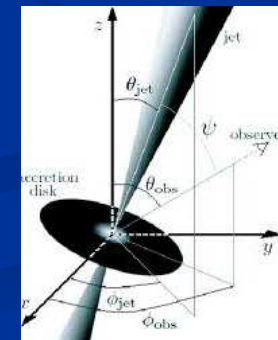
Finally: TEV connection with UHECR?

- 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

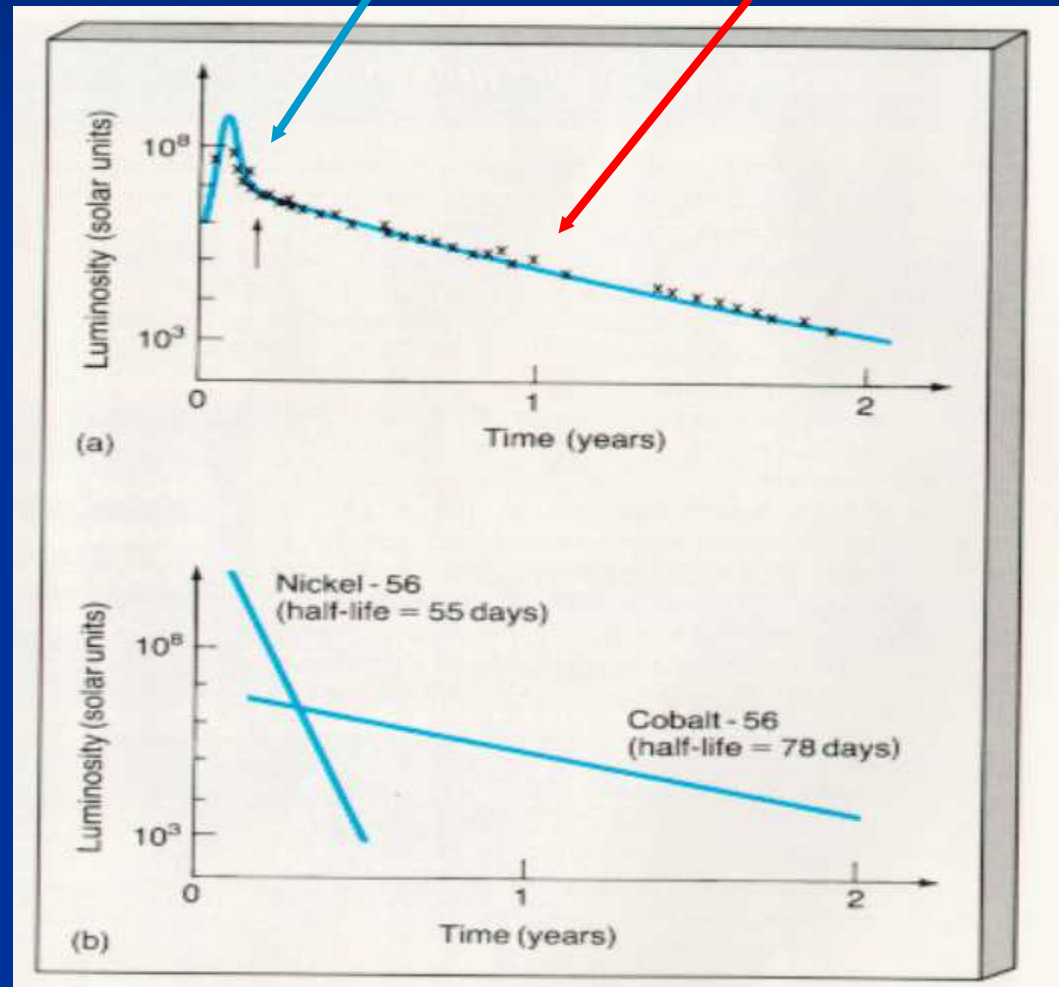
Heavy radioactive Nuclei in UHECR and huge energy release



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.

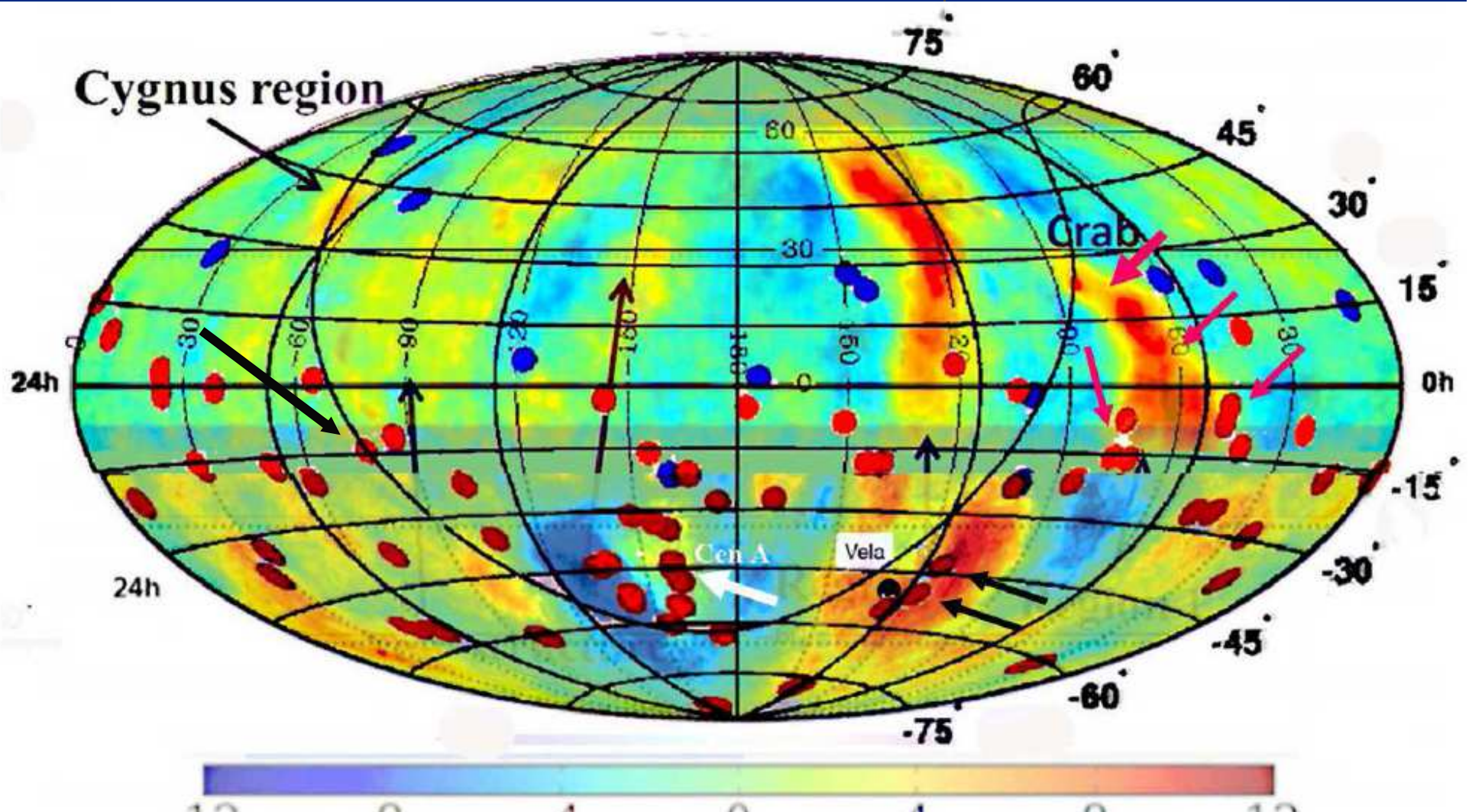
- **15 EeV** Neutron **n** decay in 150 kpc and their **e** electron radiate

- at **Tens PeV e** electron by synchrotron radiations and inverse Compton radiation shining **at tens TeVs**, gamma as observed.

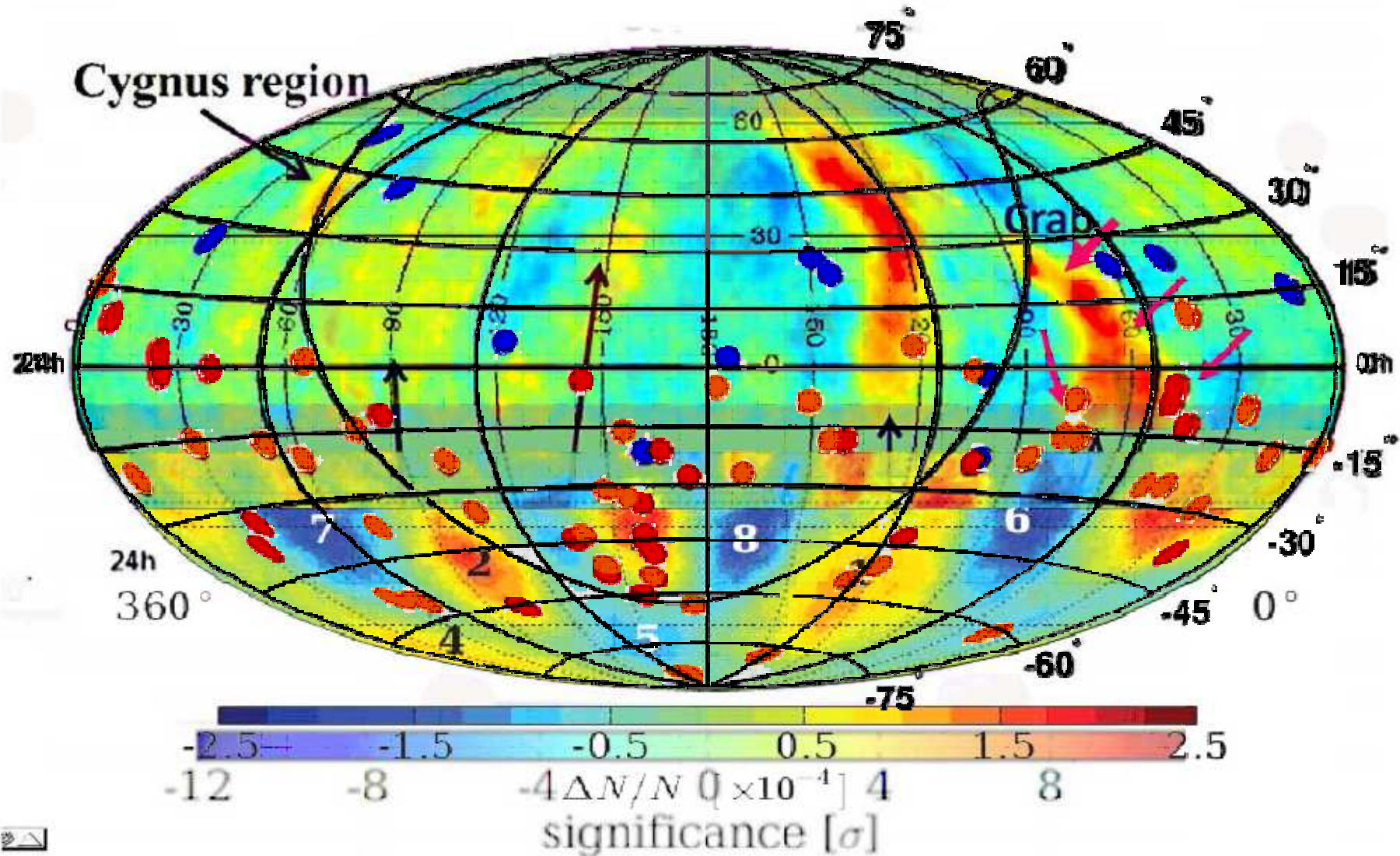
Di Sciascio-ARGO Taub 2011

A new Crab connection?

+ ICECUBE ANISOTROPY



A **NEW**er-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)

Una rondine..

- Una rondine non fa primavera...
 - A robin doesn't make any spring
 - An UHE electron or a muon neutrino are not making any spring in Neutrino astronomy...
 - Why?
 - Because the huge dominant atmospheric neutrino noise
 - A tau neutrino (Tau Airshower) makes a guaranteed Spring in Neutrino Astronomy..
- why?
- Because no atmospheric tau noise.

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!

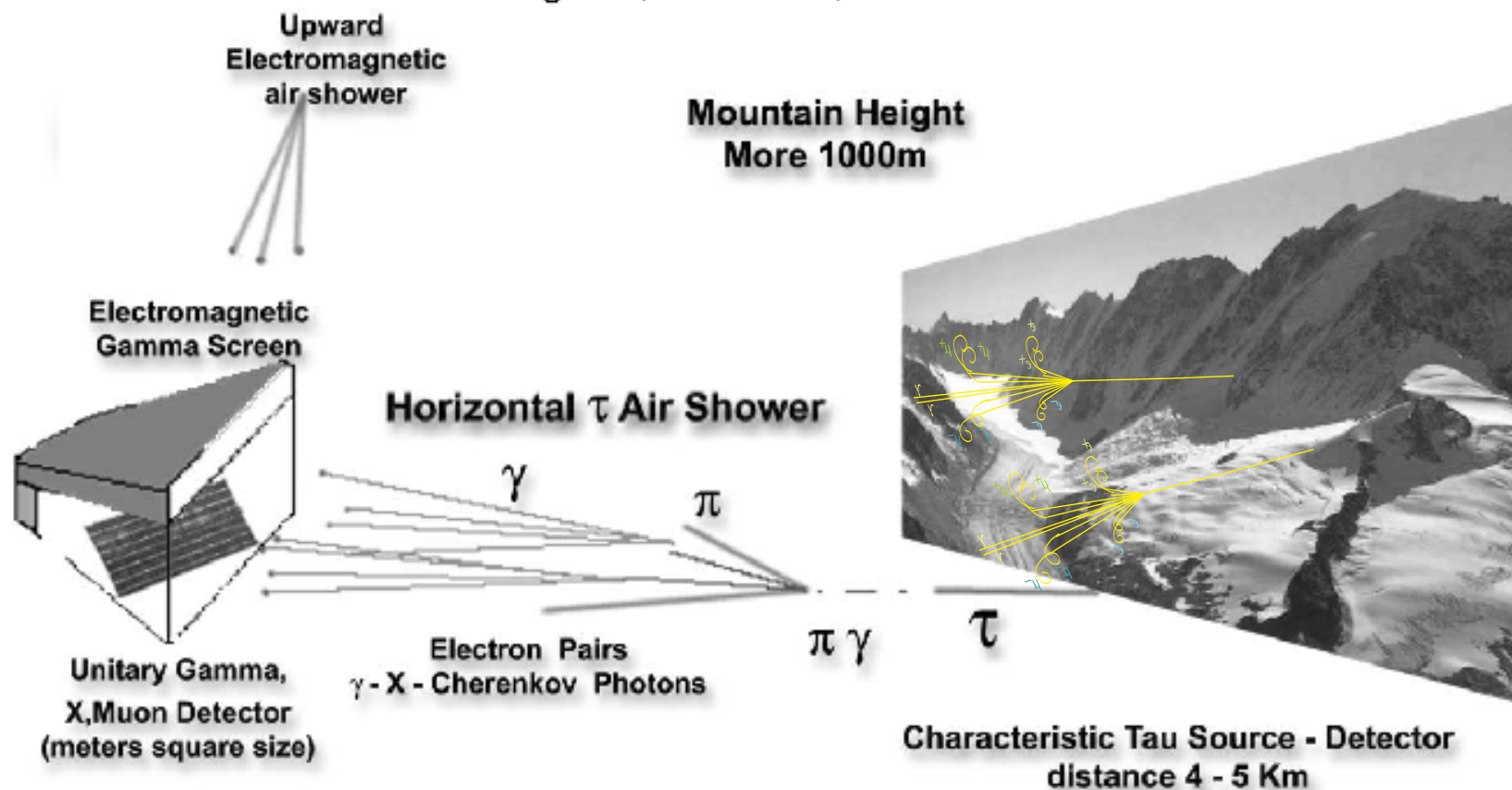
Astrophysical Tau neutrinos are born by Muons ones in a noise free sky!

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

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?

DF- ApJ 2000-2002-2004

AMIGA: Auger Muons and Infill for the Ground Array

Simulated acceptance



ay 1500m

y 750m

ional detectors

3.5 km²

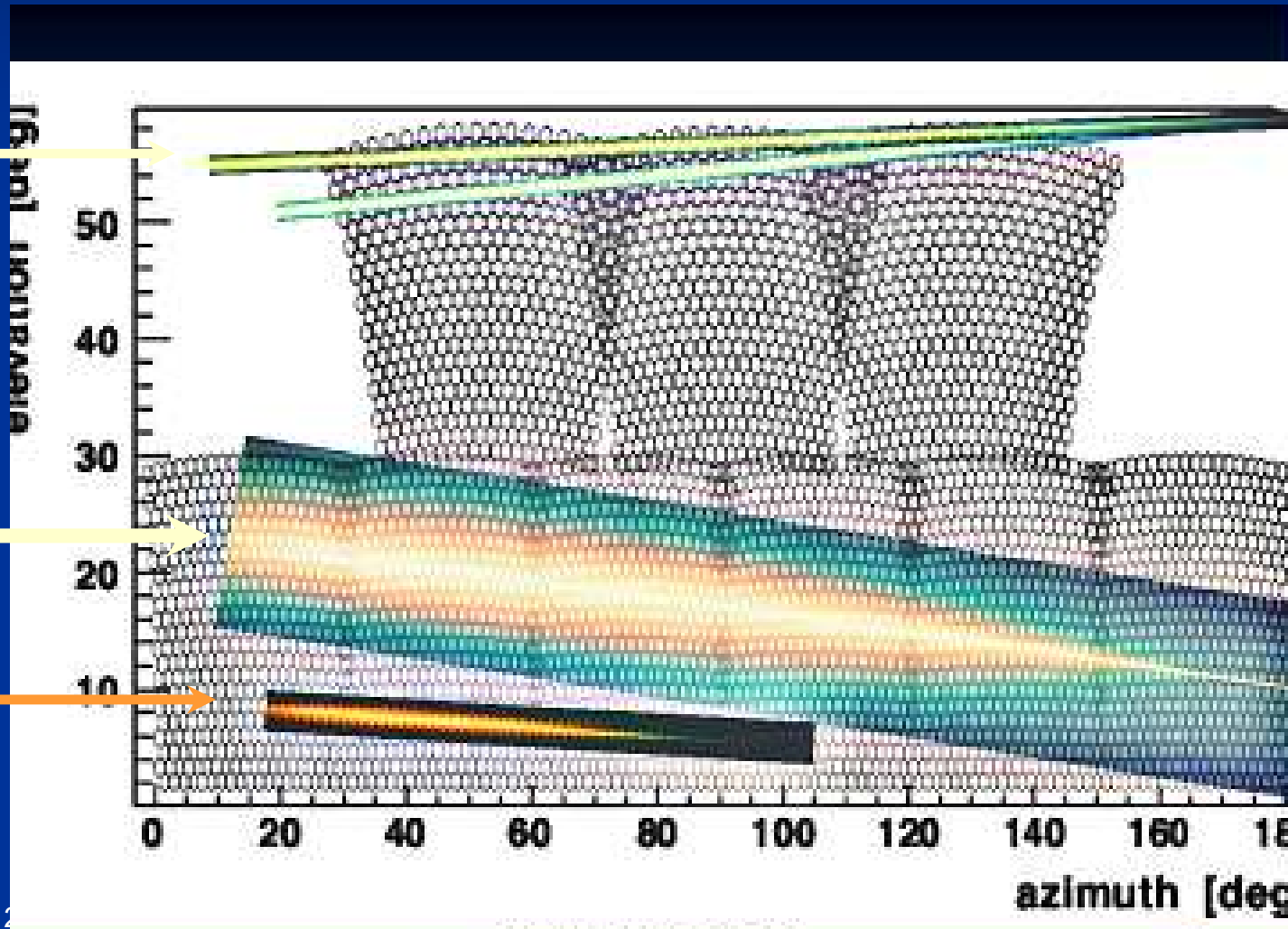
n of the 85 detectors:

of Cherenkov tank

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 fluorescence 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:

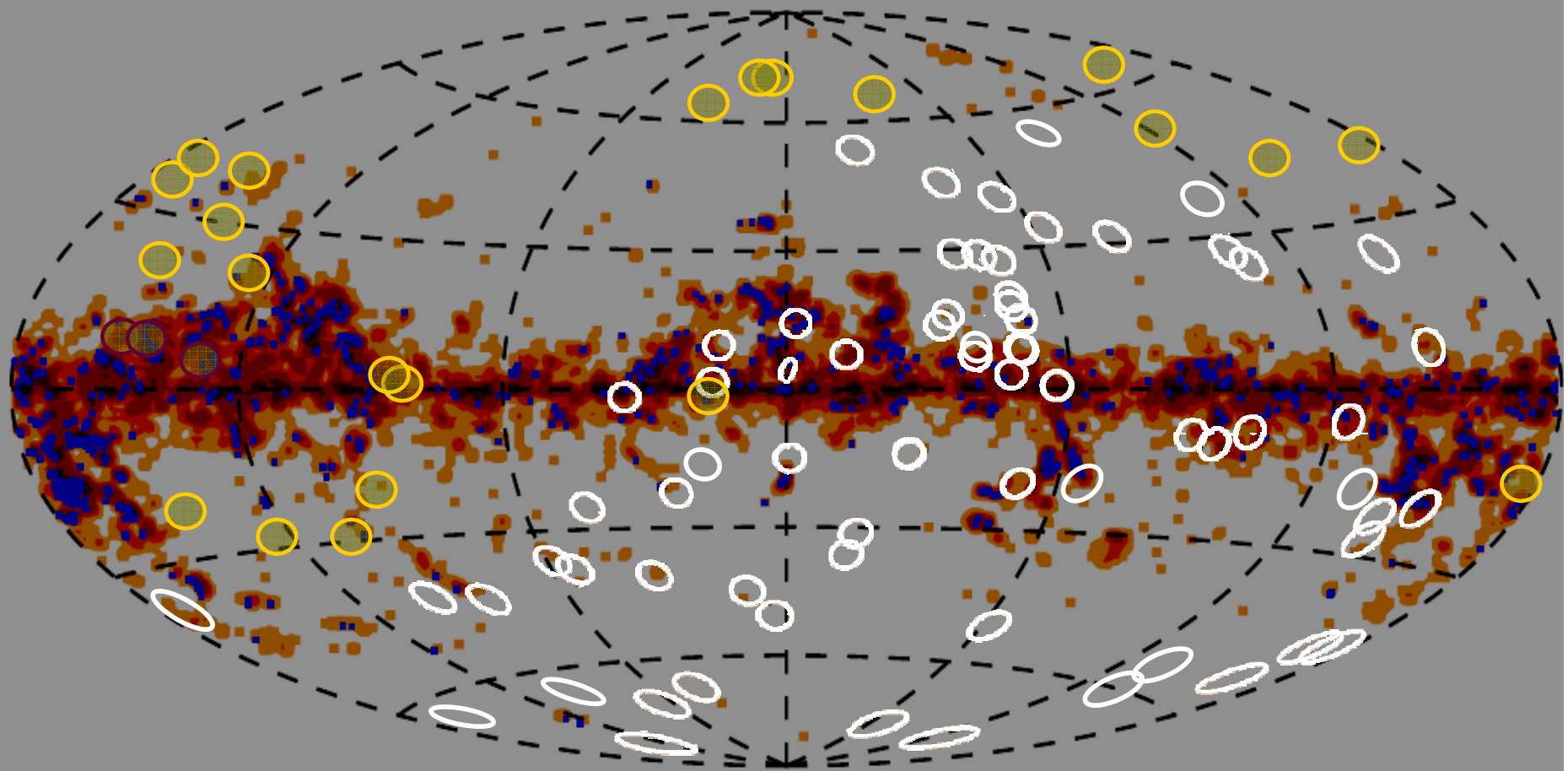
- UHECR maybe, apart Cen A, mostly **HEAVY RADIOACTIVE** nuclei whose decay in flight light at TeV energy..see ARGO –ICECUBE.

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.

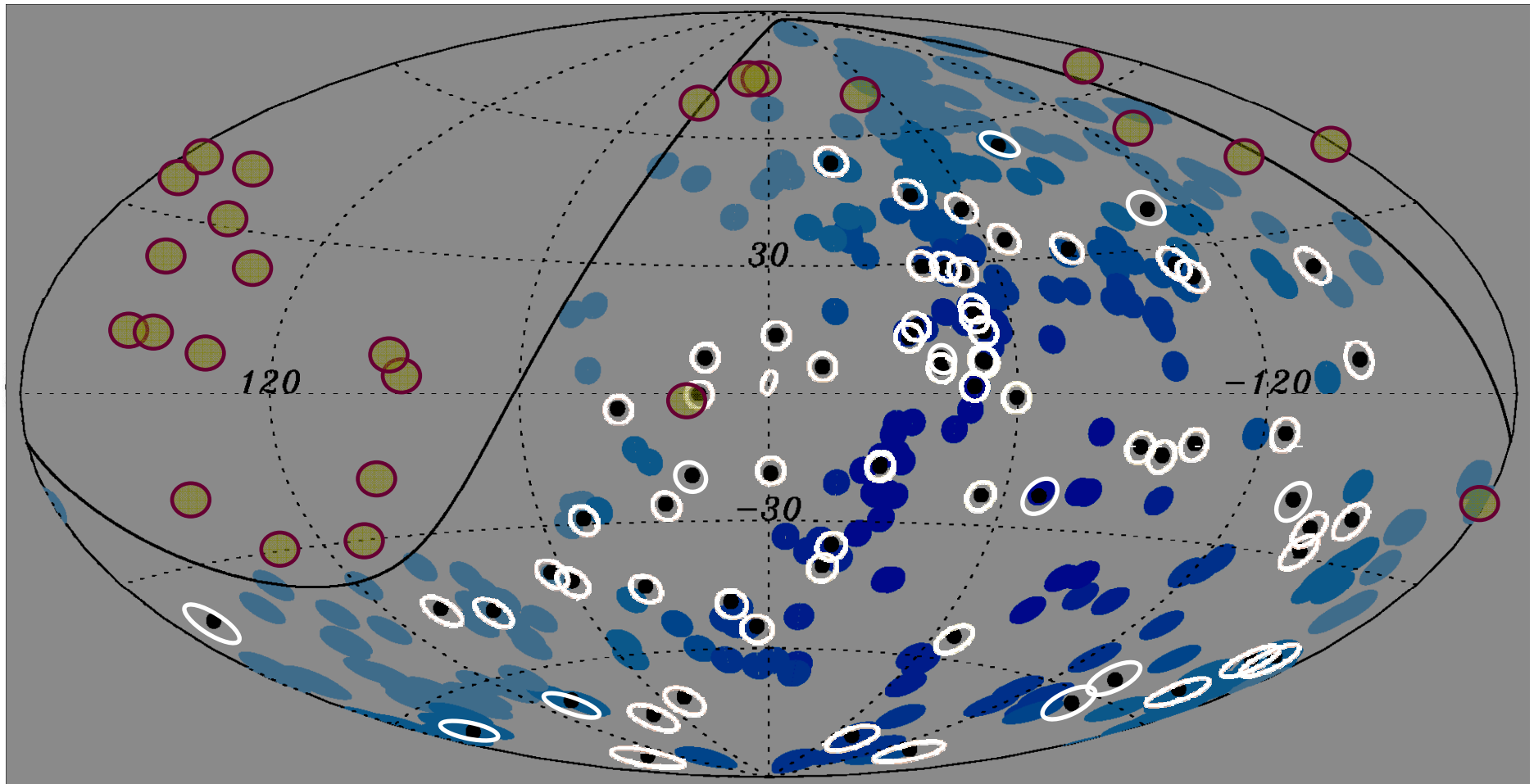
In ARGO-ASHRA-AUGER and TA

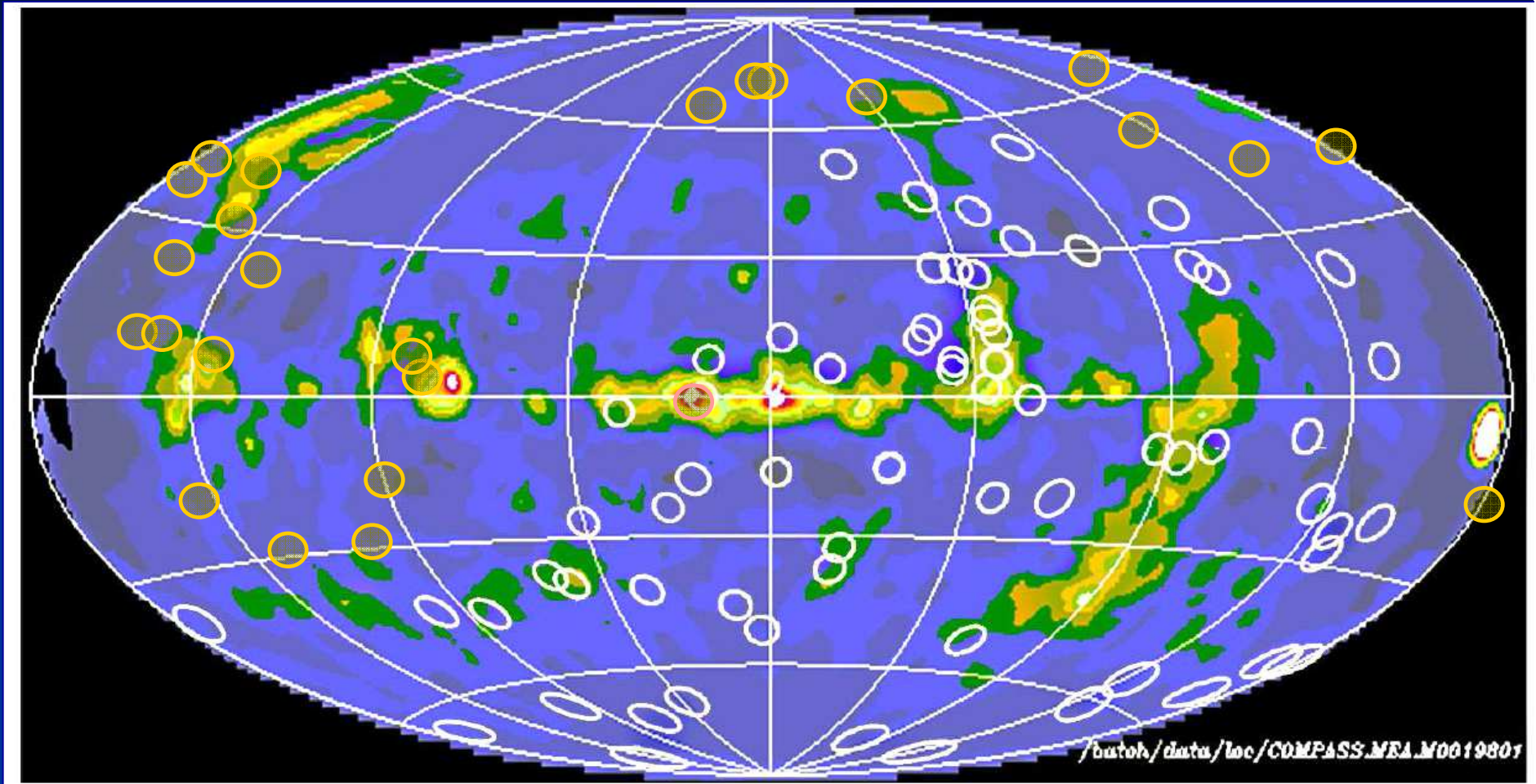
All-Sky Distribution



All-sky map of the number of
C3PO objects per square degree
(10783)

■ ECC Selection
(915)

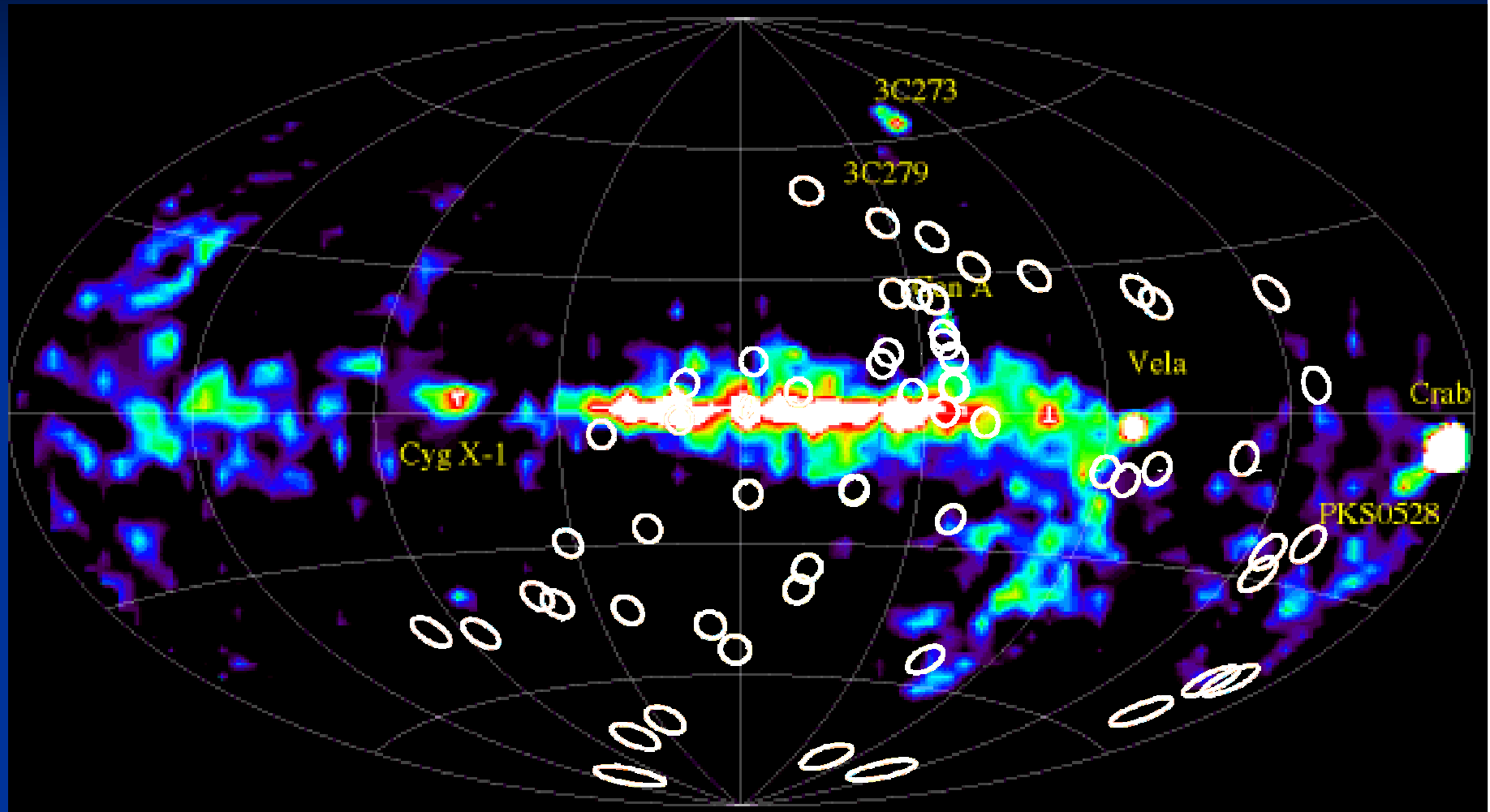


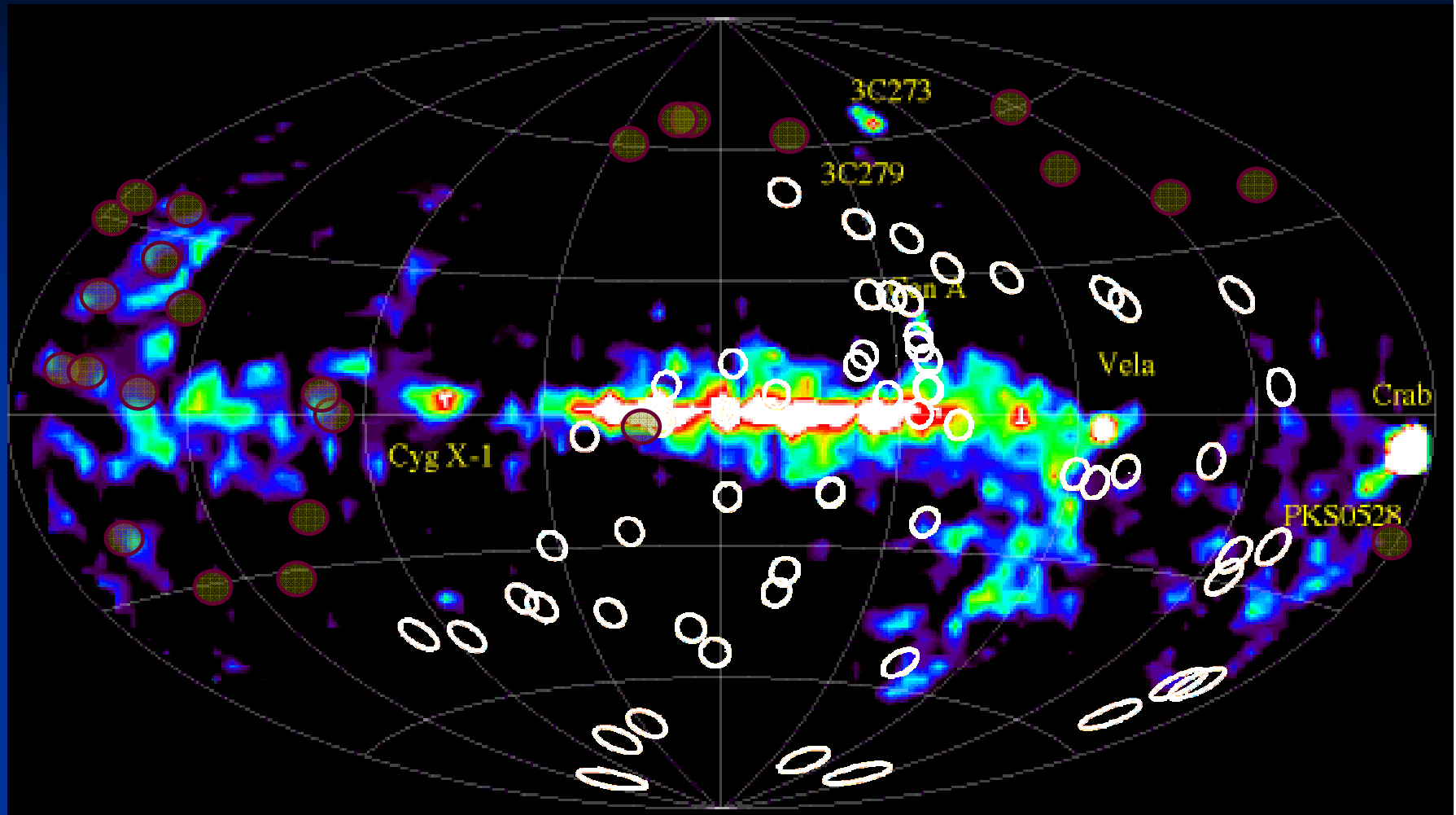


Conclusions

- UHECR maybe mostly radioactive Galactic nuclei
- Beta decay at tens PeVs may shine at tens TeV
- Few Galactic sources maybe correlated but bent:
- Vela (very probable), Cygnus, AqX1, Crab(?)
- TeV gamma may be tracing UHECR bent tracks
- TeV by Cen A neutron decay in flight by He fragments
- PeVs neutrinos may shine as a trace of nuclei decay
..also associated to farthest GRBs, observable by Deep core. Or by Tau Airshowers in ASHRA, AUGER, TA.

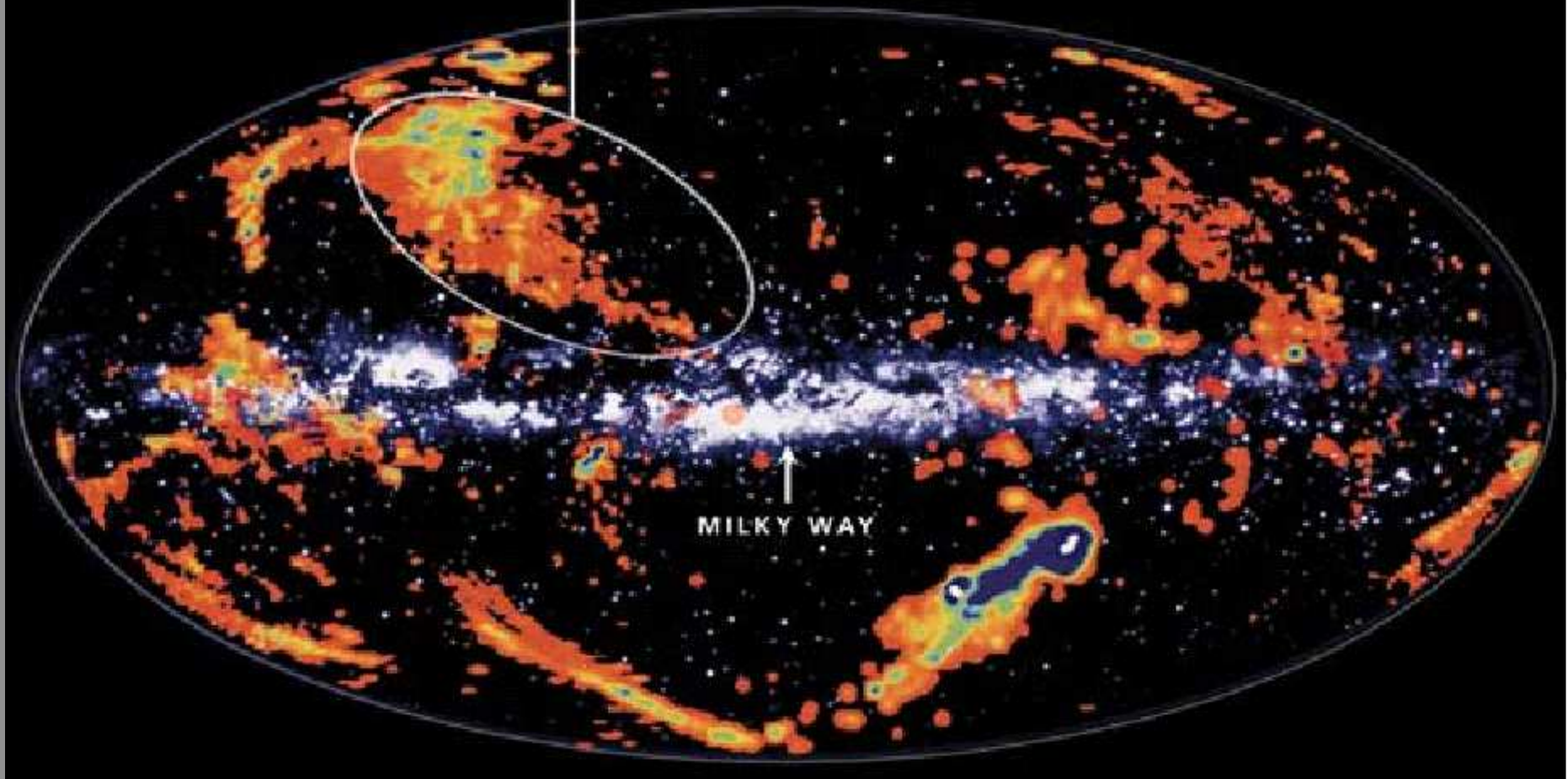
Troitsky revolution: three week ago: 30-5-2012





All-Sky Distribution

Accreting Low-Metallicity Gas



All-sky map of the number of
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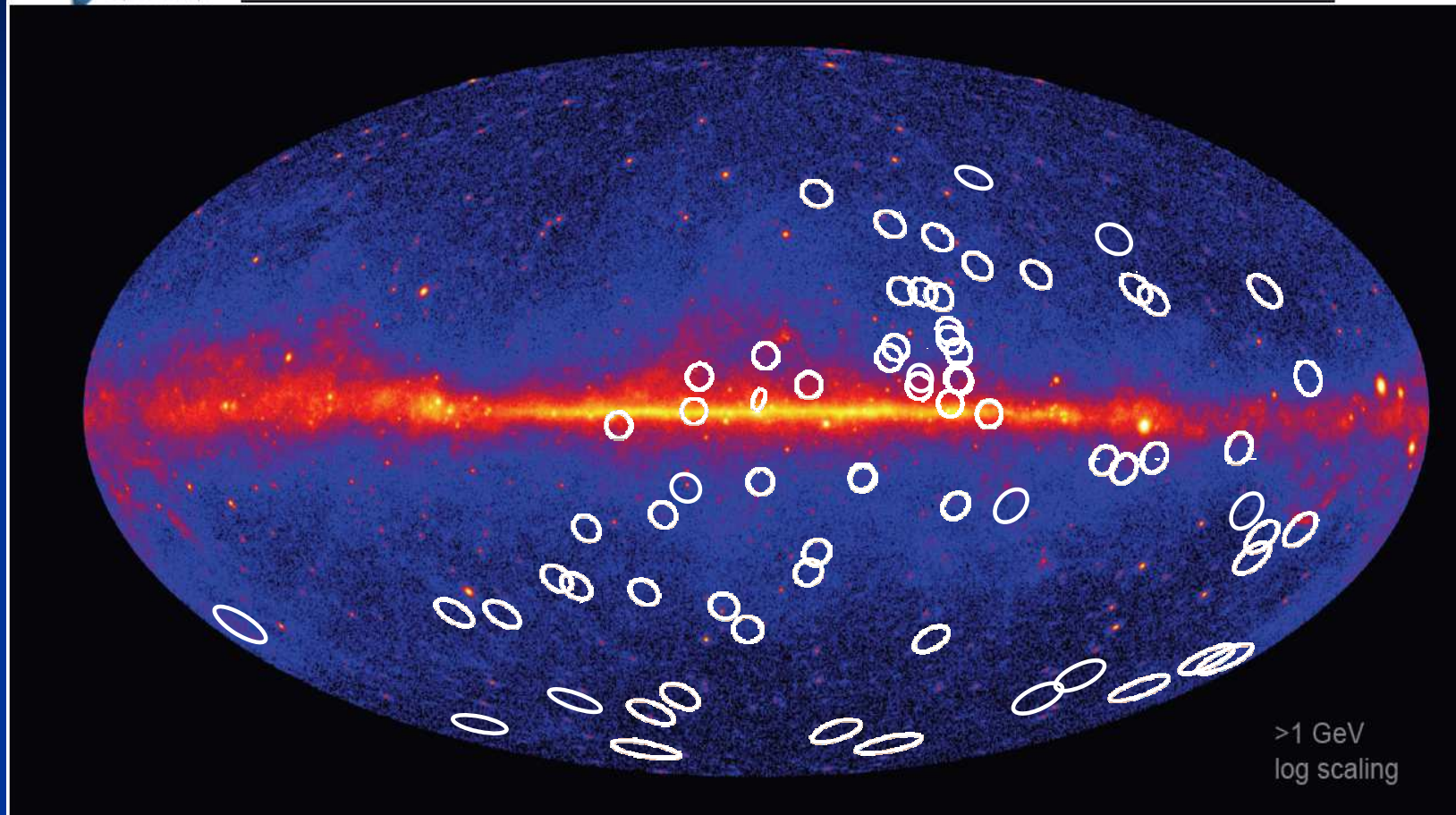
Thank you again

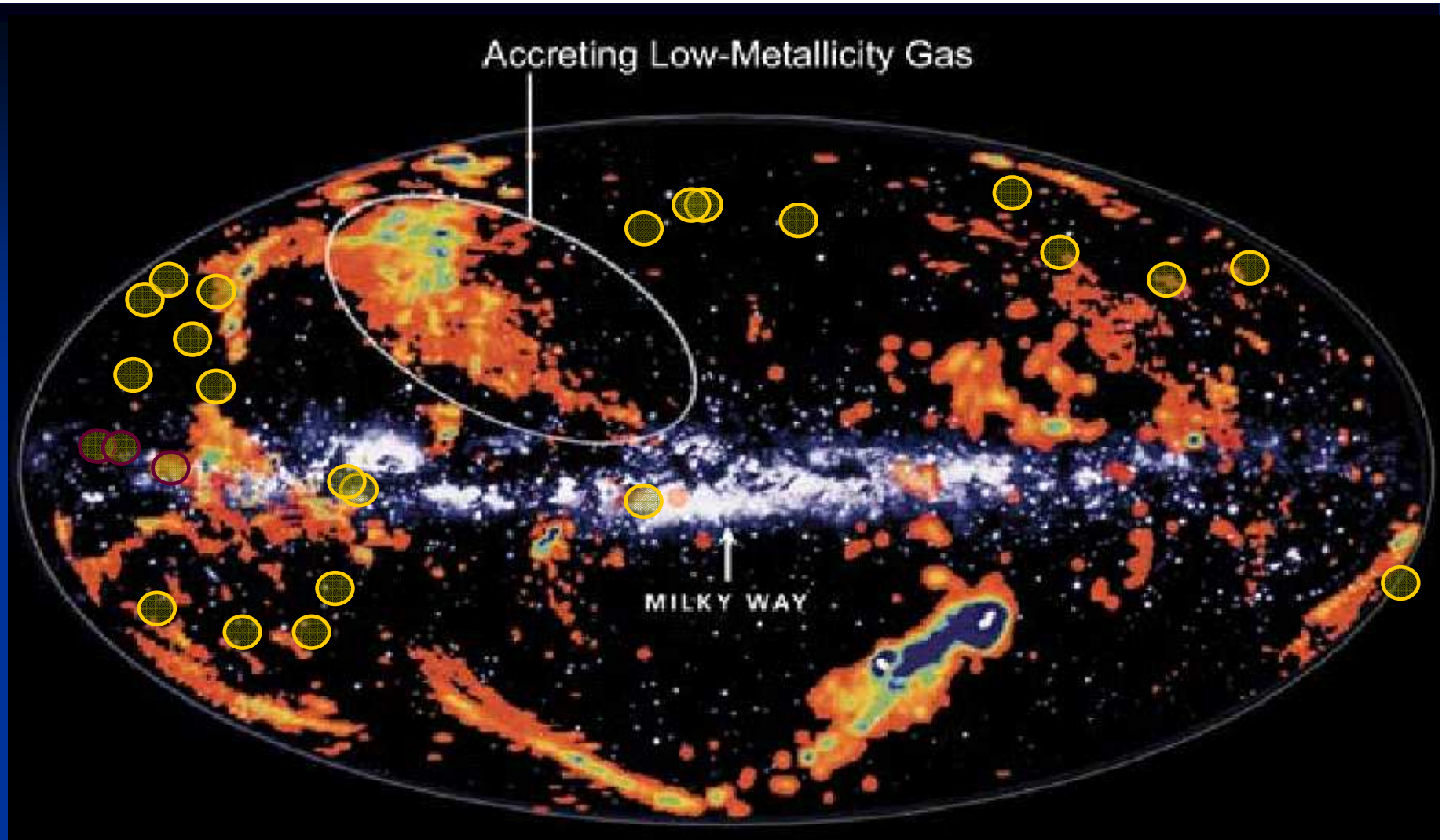
- For the patience..

New TA event

- date & time (UTC) □ (deg) E (EeV) l (deg) b (deg)
- 2008-06-25 19:45:52 32.8 82.6 178.6 -19.4
- 2008-07-15 05:26:31 34.4 57.7 90.5 8.0
- 2008-08-10 12:45:04 38.0 122.6 102.7 -19.2
- 2008-11-08 14:30:41 15.5 60.0 198.0 43.1
- 2008-12-30 10:49:32 4.5 59.7 187.0 55.3
- 2009-01-22 22:54:22 31.3 58.0 89.3 5.2
- 2009-03-28 04:36:08 34.2 81.2 152.8 22.5
- 2009-03-29 03:43:34 20.7 75.0 158.1 31.9
- 2009-05-19 02:19:52 42.5 64.6 25.8 77.3
- 2009-09-19 08:45:52 34.7 62.0 140.5 8.4
- 2010-01-08 07:17:31 19.5 57.5 175.6 37.2
- 2010-01-21 03:53:51 23.4 61.2 149.8 13.1
- 2010-02-22 07:10:34 14.5 63.5 165.7 42.0
- 2010-08-29 21:20:45 36.5 69.9 180.3 42.4
- 2010-08-30 20:50:45 20.0 93.3 98.3 69.7
- 2010-09-19 07:05:00 23.6 66.8 129.1 -30.6
- 2010-09-21 20:37:06 21.1 163.0 2.8 76.0
- 2011-01-05 00:56:23 9.3 67.4 110.0 -30.4
- 2011-02-28 16:16:26 39.3 137.6 35.5 -5.0
- 2011-04-17 20:20:29 34.2 74.7 153.7 12.9
- 2011-07-13 19:12:34 42.6 65.6 132.1 24.7
- 2011-07-22 22:15:41 11.6 62.2 204.5 64.6
- 2011-07-24 23:17:22 36.3 61.8 316.5 69.5
- 2011-07-28 15:21:08 19.6 89.0 147.0 -23.7
- 2011-08-28 21:14:19 31.6 63.3 215.6 53.2

UHECR2010 and Multiplets 2011-FERMI- GAMMA-

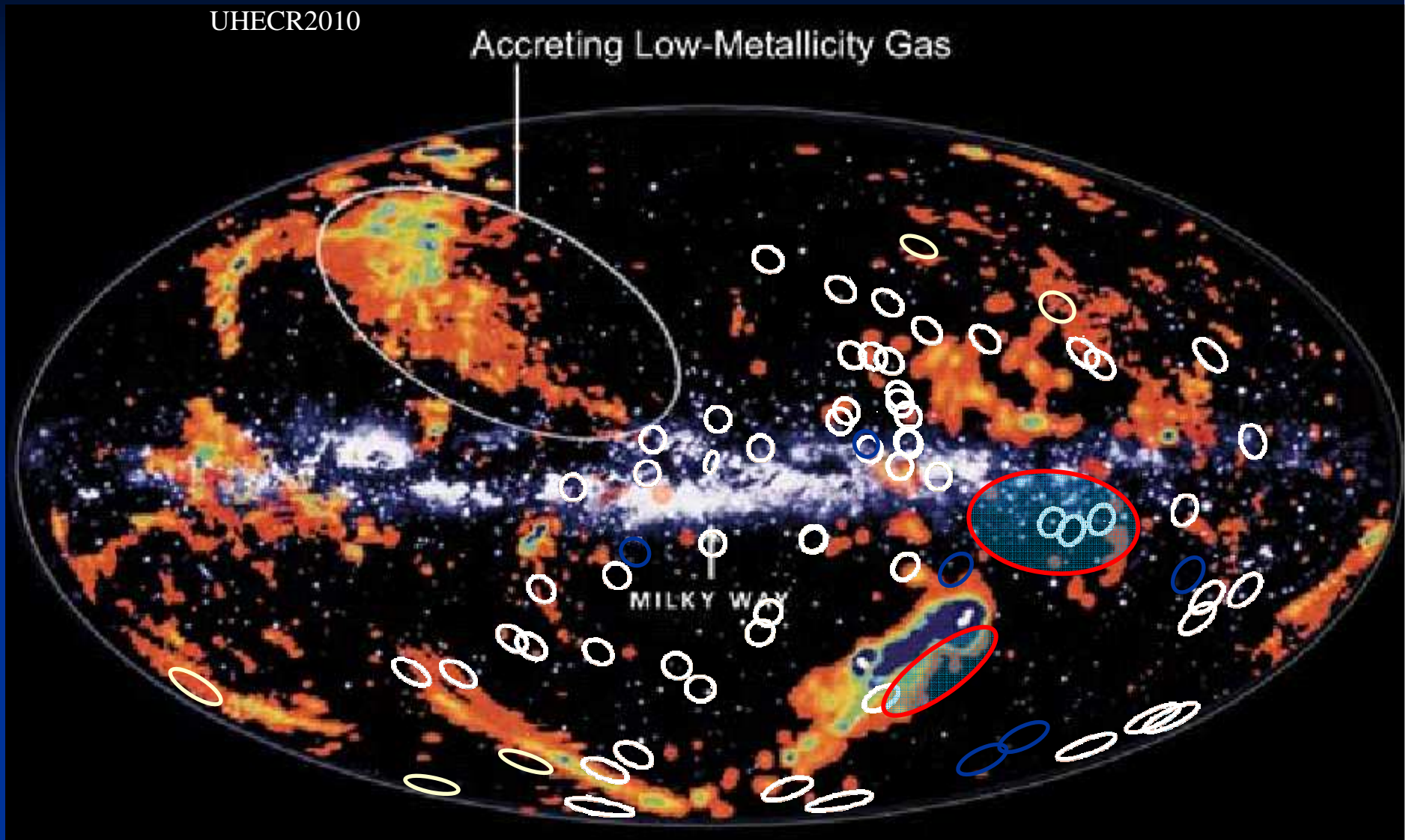




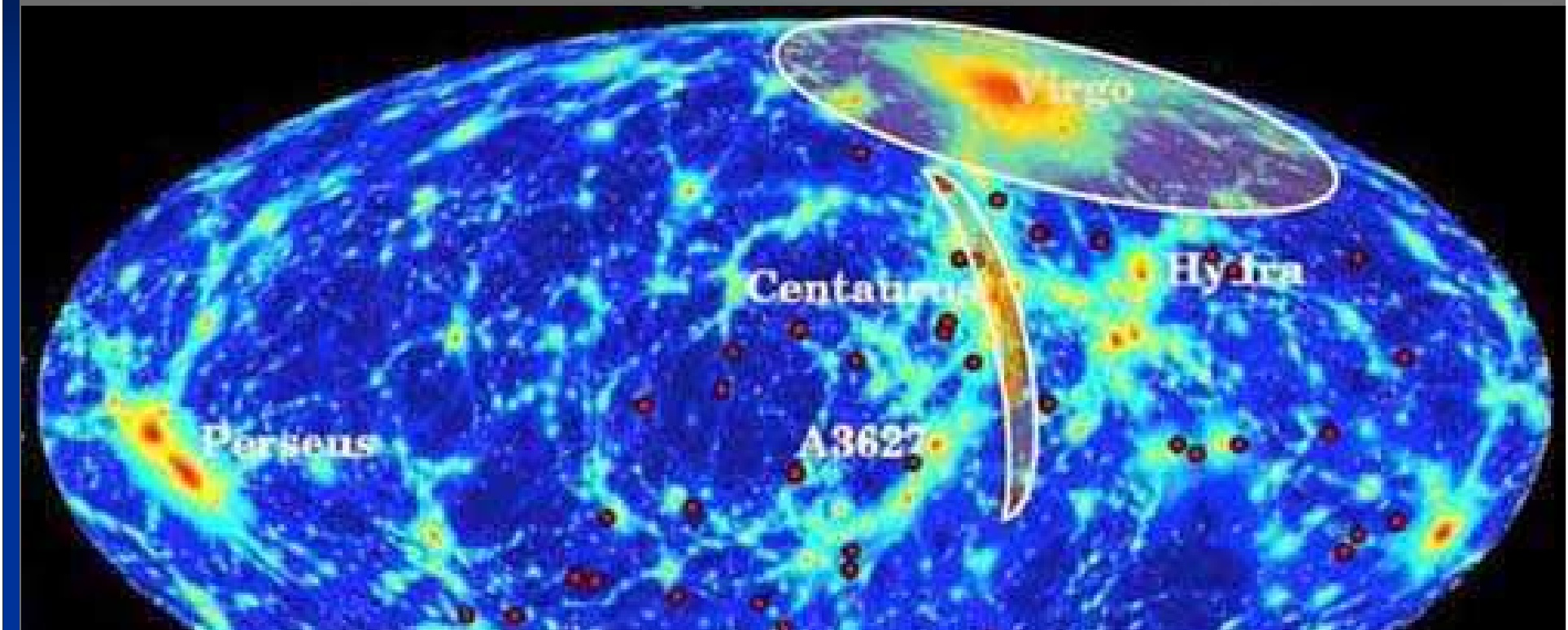
MAGELLANIC STREAM in METALLIC LINES

UHECR2010

Accreting Low-Metallicity Gas



**Foreseen Multiplet fragments 2009-:
20 EeV-bent 1.5 times more than 60 EeV**



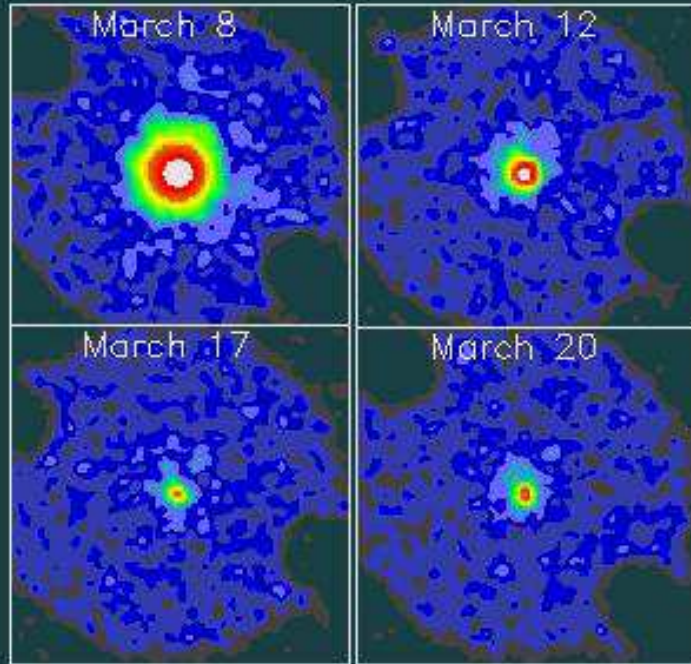
[arXiv:0908.2650](https://arxiv.org/abs/0908.2650)

Title: Coherent and random UHECR Spectroscopy of Lightest Nuclei along CenA...

Authors: [D. Fargion](#)

**Nuclear Inst. and Methods in Physics Research, A,
NIMA51778 PII: S0168-9002(10)01230-1, 2010**

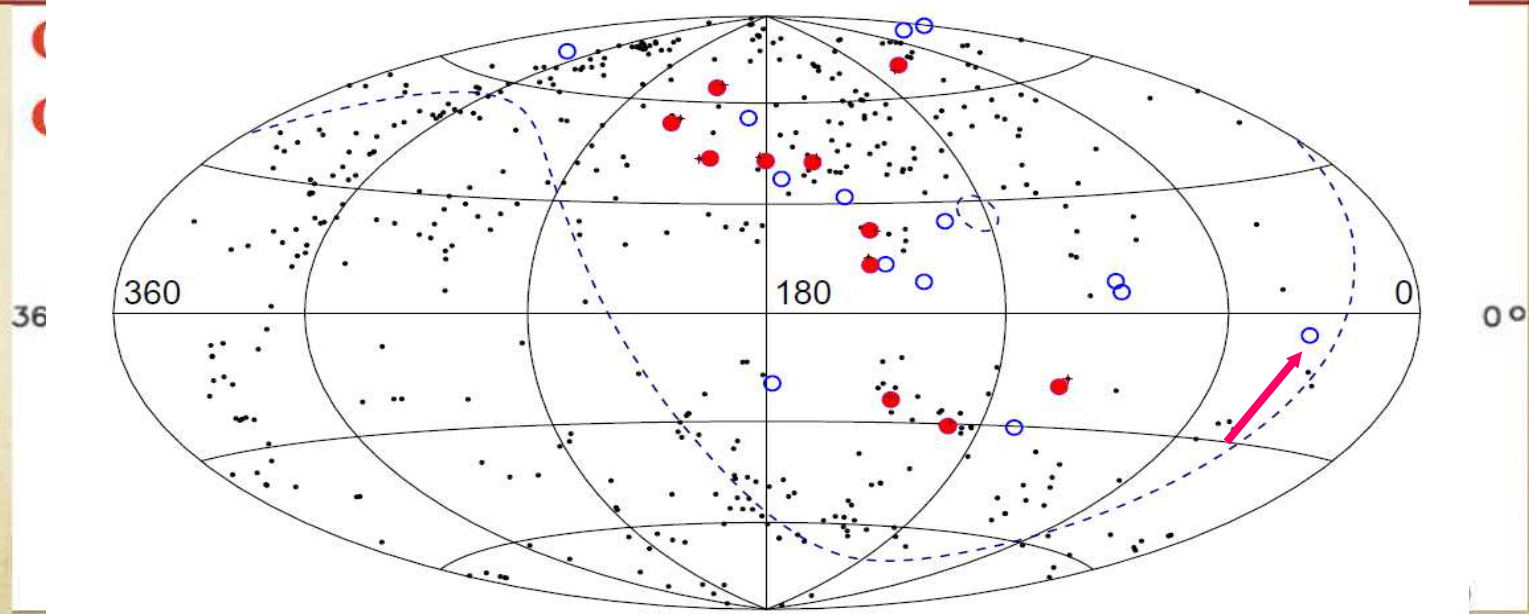
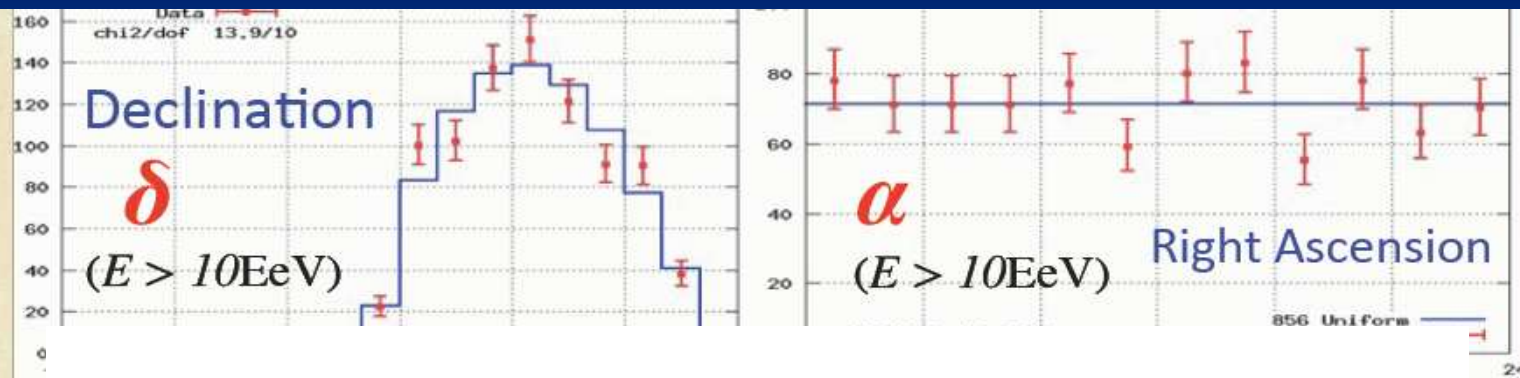
Aql X1



Aql X-1, the brightest X-ray source in the Aquilla constellation, is an X-ray millisecond pulsar in a binary system (see e.g. Ref. [22] for discussion and references). The system is located at the distance of $5.2_{-0.8}^{+0.7}$ kpc from the Earth [23]. It experiences quasi-periodic outbursts each 300 days roughly (see the X-ray light curve in Fig. 3). Though the object is one of only twelve known Galactic accretion-powered millisecond pulsars [25] and is well studied, it does not appear very exotic. It is singled out of this dozen only by a relatively large mass of the companion in the binary system, $M \gtrsim 0.45M_{\odot}$, and the correspondingly large orbital period of ~ 19 h. The estimated magnetic field on the neutron-star surface is $\sim (1 \dots 5) \times 10^8$ G [26, 27]. On the basis of X-ray timing and spectral properties, this object is classified as “atoll” (see e.g. Ref. [28] for a more detailed discussion of classifications). Accretion in these sources may have

Telescope Array Map

To be rotated by 180 degree left..



Aquila

- *The Fall of Aquila X-1*
- Objects called "Soft X-ray Transients" are composed of some type of compact object (probably a neutron star) and some type of "normal", low mass star (i.e. a star with a mass of some fraction of the Sun's mass). These objects show changing levels of low-energy, or "soft", X-ray emission, probably produced somehow by variable transfer of mass from the normal star to the compact object. In effect the compact object "gobbles up" the normal star, and the X-ray emission can provide the best view of how this process occurs. But because these objects vary it's difficult to catch them at crucial times. In February 1997 a soft X-ray transient in the constellation of Aquila known as Aql X-1 was detected in outburst by the [Rossi X-ray Timing Explorer](#). RXTE followed the slow decline from X-ray maximum; but when the RXTE observations ended the story was still not complete, since the star had not reached its normal "quiescent" level. This important gap was filled in by the [BeppoSAX X-ray satellite](#), which started to [observe Aql X-1](#) at the end of the RXTE observations. The image on the right shows the decline from X-ray maximum as seen by RXTE (green points) and BeppoSAX (red points). RXTE clearly shows a rather smooth decline though the last two data points do not follow the smooth decline but seem fainter than astronomers would have predicted. The BeppoSAX observations confirm the RXTE results and show that the decline to quiescence occurs much more rapidly than expected. The image on the left shows BeppoSAX images detailing the change in brightness of Aql X-1 through March 1997.

Troitsky revolution: three week ago: 30-5-2012

Pis'ma v ZhETF

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

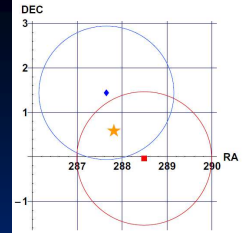


Figure 2. The sky map with arrival directions of the two events in the doublet: the PAO event (diamond) and the TA event (box). With a 68% probability, the true arrival directions are inside the corresponding circles. The star denotes the position of Aql X-1; no other strong X-ray or gamma-ray sources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

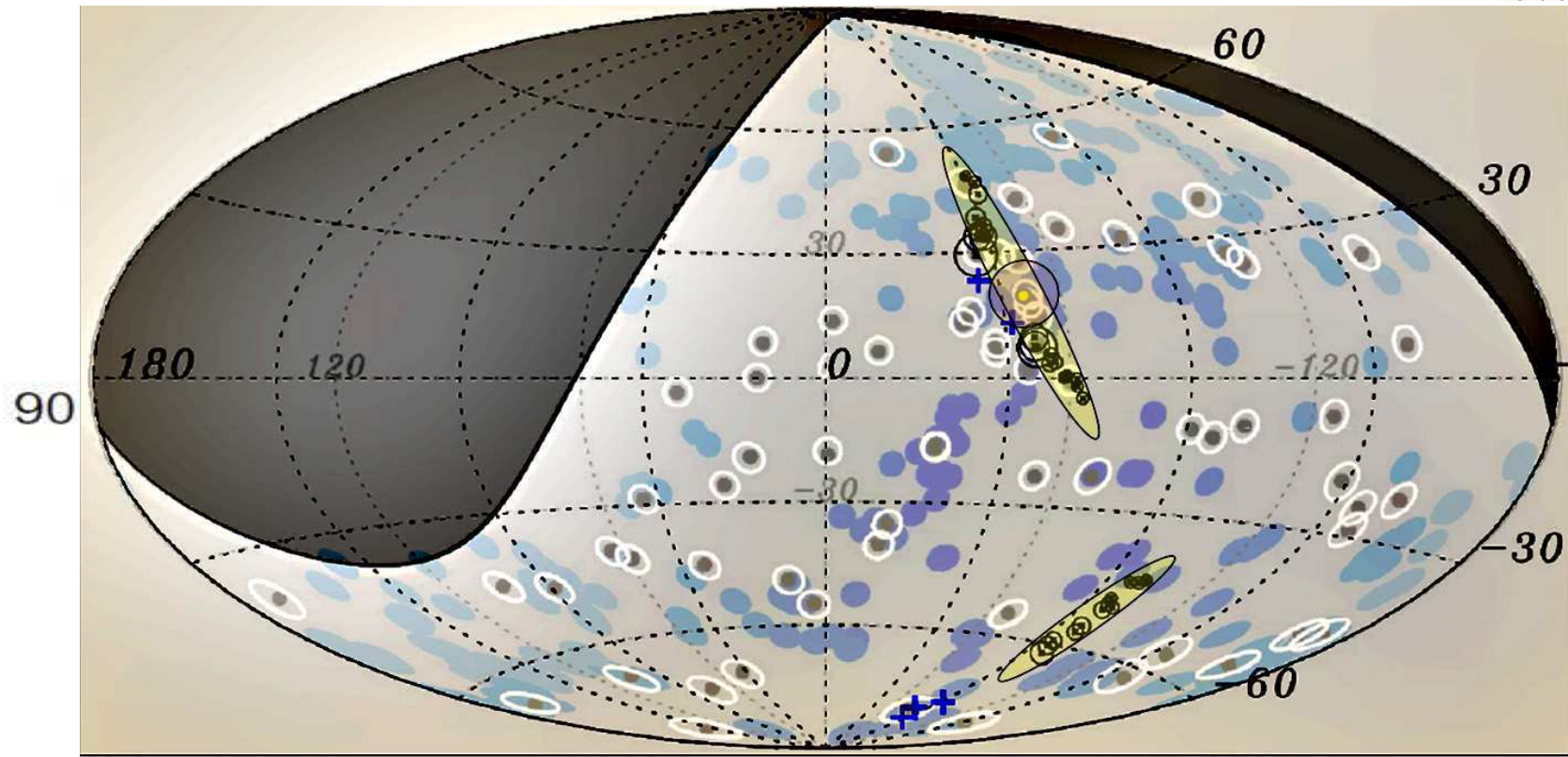


Figure 1. The sky map with arrival directions of three PAO events with $E > 10^{20}$ eV (diamonds) and three TA events with $E > 10^{20}$ eV (boxes). The Hammer projection, equatorial coordinates.

How far can we see? The End..TA news

- Thank you for the kind attention

