connection to the sources by a new reading key

Abstract:

UHECR events are nearly four hundred. We overlap their arrival events on TeVs gamma anisotropies and known sources finding some key connections with nearby AGN and a few galactic sources; their bending confirm a light nuclei UHECR. We report also first hint of coherently bent and diluted UHECR events from Virgo.

D. Fargion, P. Oliva, G. Ucci

UHECR Astronomy: a pocker game Composition-B_map- GZK-CosmicMass_Map

- 1) Because UHECR are charged particles (and because there are NOT magnetic monopoles) …the large scale magnetic fields are making a distorted (coherently or random) bending maps in a smeared sky
- 2) The bending depends on energy and on the composition and for the latter
- ***3) Different GZK cut off and distances and spectra energy***
- ***4a) Fe: too much bending → No UHECR***

The meaning of the UHECR Hot Spots

A Light Nuclei Nearby Astronomy

Daniele Fargion[1,2,a], Graziano Ucci[1], Pietro Oliva[3], and Pier Giorgio De Sanctis Lucentini[4]

[1] *Physics Depart., Rome University 1, Sapienza, Ple. A. Moro 2, 00185, Rome, Italy*
[2] *INFN, Ple. A. Moro 2, 00185, Rome, Italy*
[3] *Engin. Depart., Niccolò Cusano University, Via Don Carlo Gnocchi 3, 00166 Rome, Italy*
[4] *GUBKIN Uni. of Oil and Gas, Leninsky prospekt 65, Moscow, Russia.*

arXiv:1412.1573

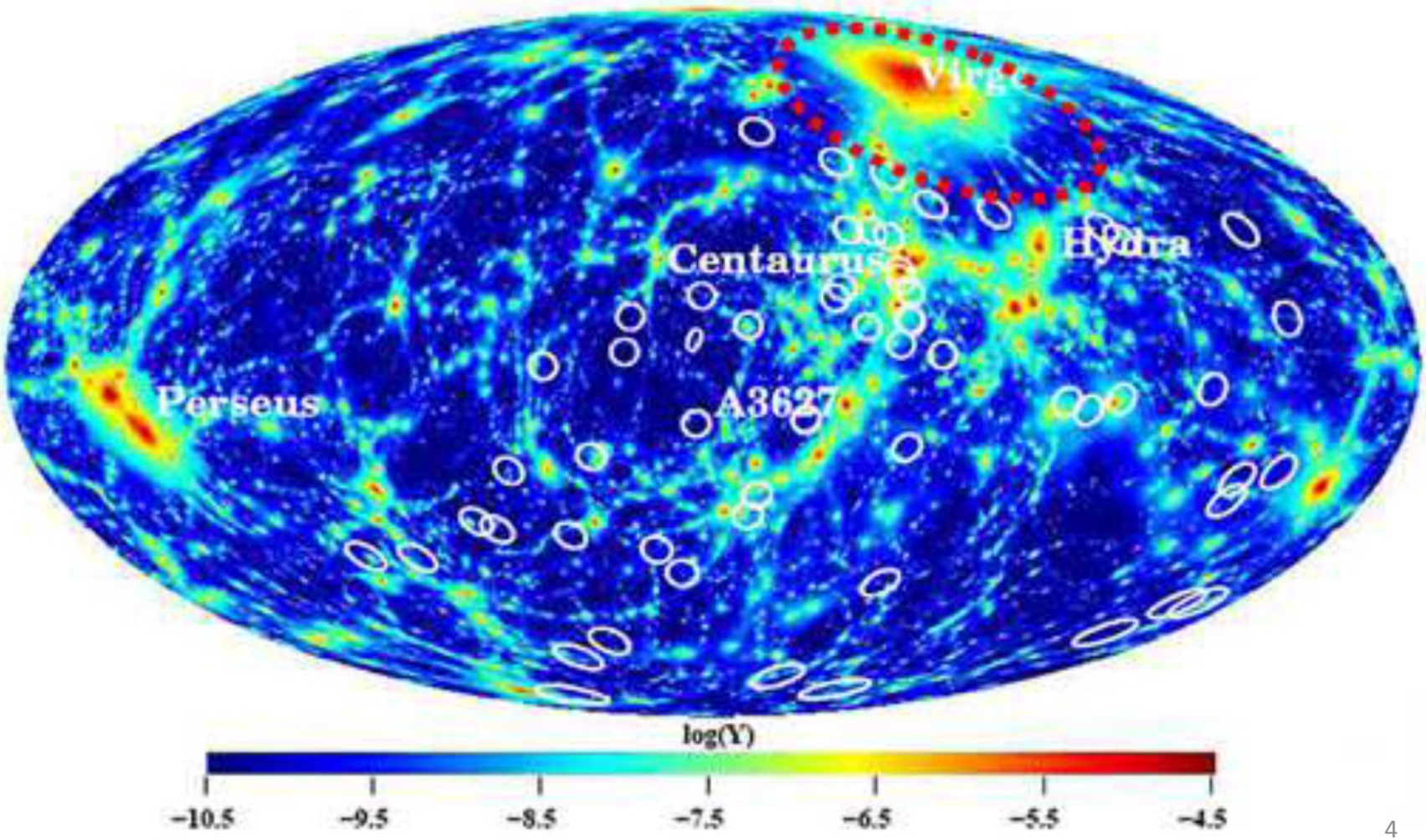
EPJ Web Conf. 99 (2015) 08002

Abstract. In this paper we review all the up-to-date Ultra High Energy Cosmic Ray (UHECR) events reported by AUGER, the Telescope Array (TA) and AGASA in common coordinate maps. We also confirm our earliest (2008-2013) model, where UHECRs mostly comprise light nuclei (namely He, Be, B), which explains the Virgo absence and confirms M82 as the main source for the Northern TA Hot Spot. Many more sources, such as NGC253 and several galactic sources, are possible candidates for most of the 376 UHECR events. Several correlated maps, already considered in recent years, are reported to show all the events, with their statistical correlation values.

UHECR: WHY LIGHT NUCLEI?

Infrared Galaxy maps, GALACTIC coordinate, versus first data

The SCANDAL of VIRGO ABSENCE (AUGER-Science 2007)

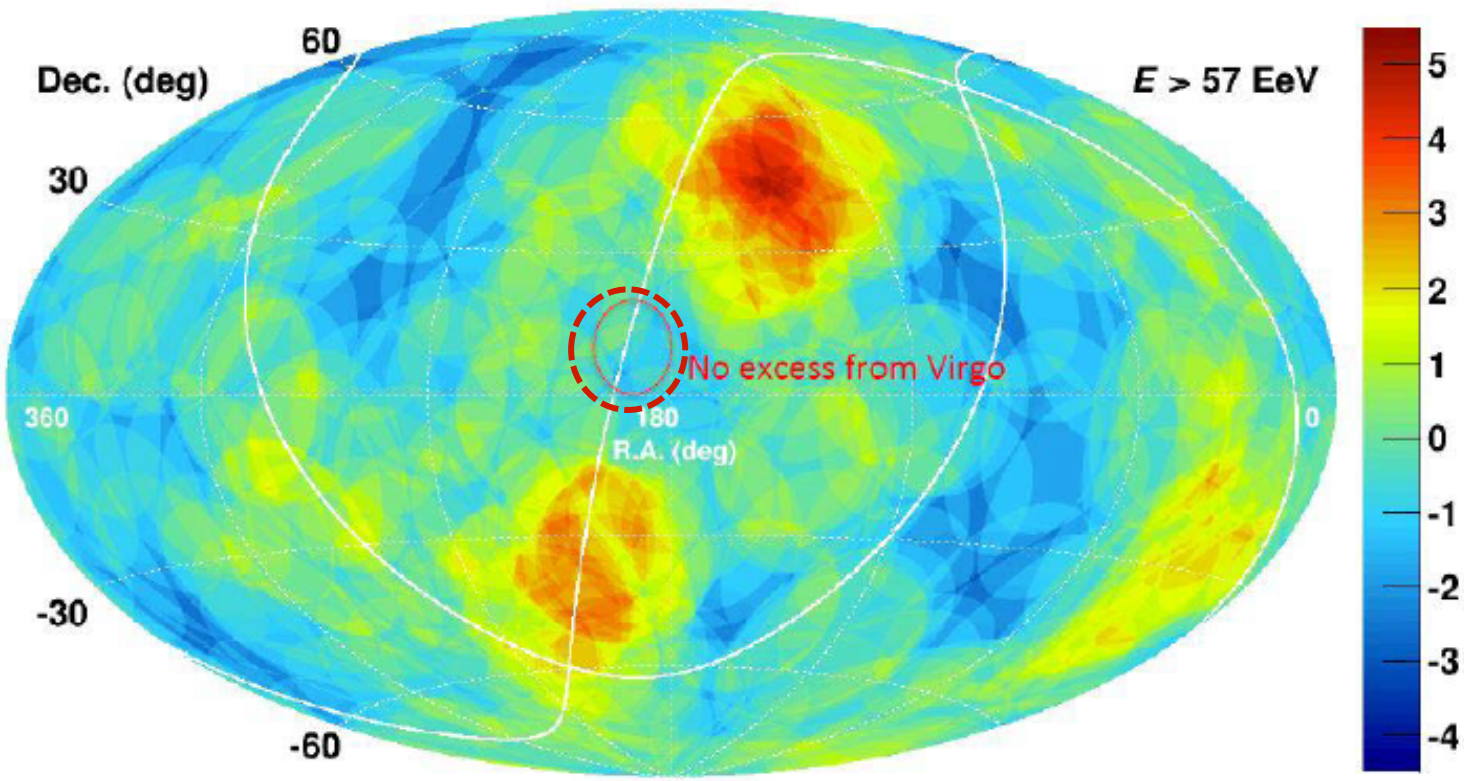


North and South at 50 EeV

The very PERSISTENT SCANDAL (celestial coordinates) of VIRGO ABSENCE

TA 6 Years + Auger 10 Years

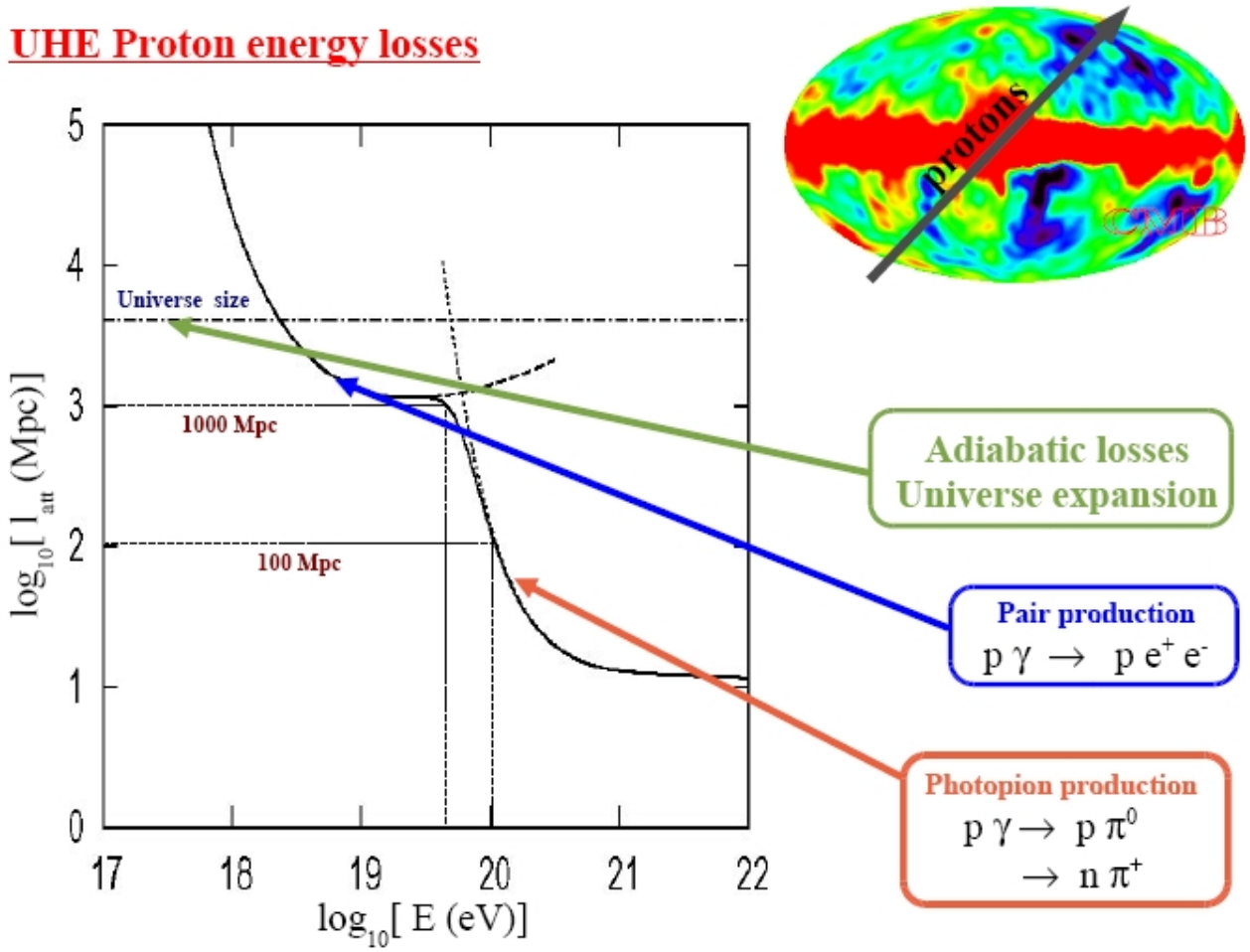
ATTENTION: MOLWEIDE versus HADER—Celestial HADER here-GALACTIC LATER



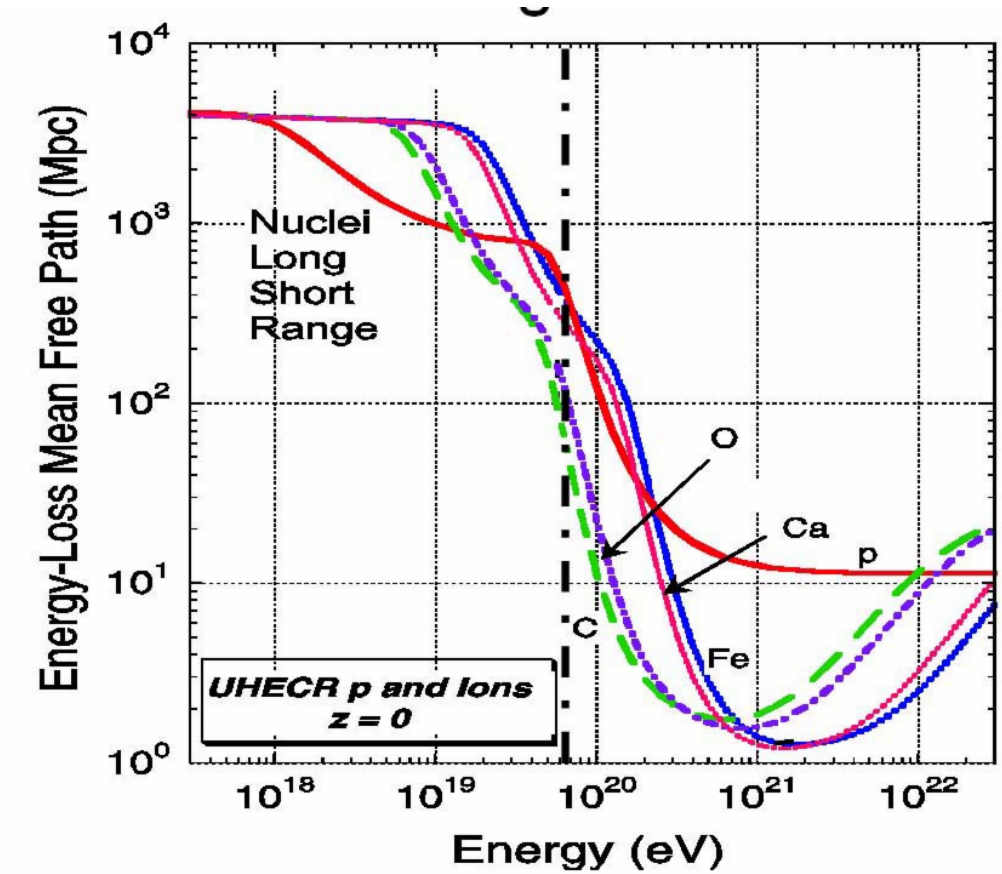
North: $S_{MAX} = 5.19\sigma$, (R.A, Dec.) = (148.4°, 44.5°)
South: $S_{MAX} = 3.57\sigma$, (R.A, Dec.) = (210.9°, -48.2°)

A.Aab et al, arXiv:1411.6111v1
K.Kawata, 2014/12/17

UHECR because of GZK cut off must be in a near (40 Mpc).. Universe (4 Gpc)

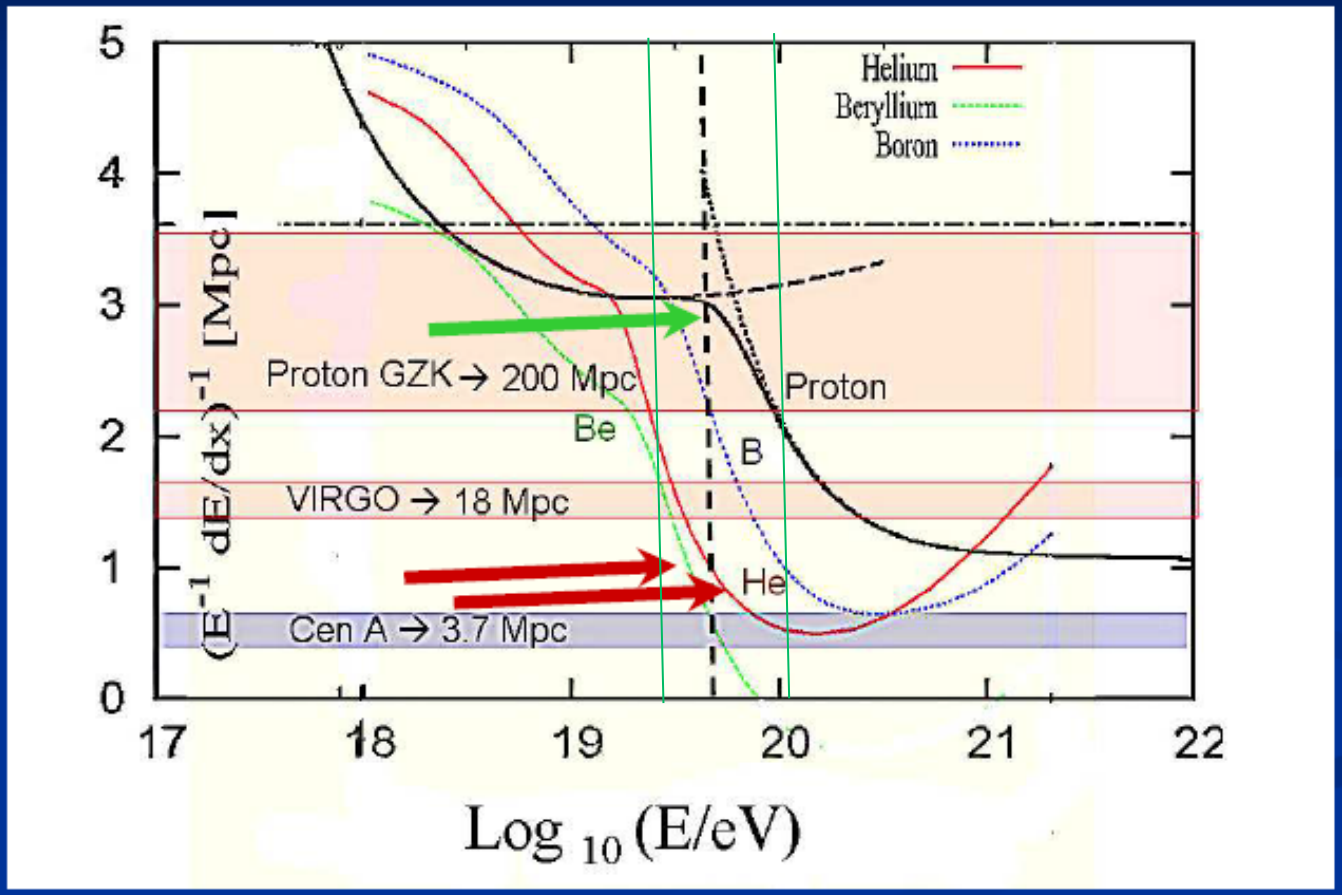


Iron UHECR are much bent (90 degree) hiding any UHECR Astronomy,
Light Nuclei suffer of a more severe GZK cut off (4-10 Mpc) but minor smearing deflections

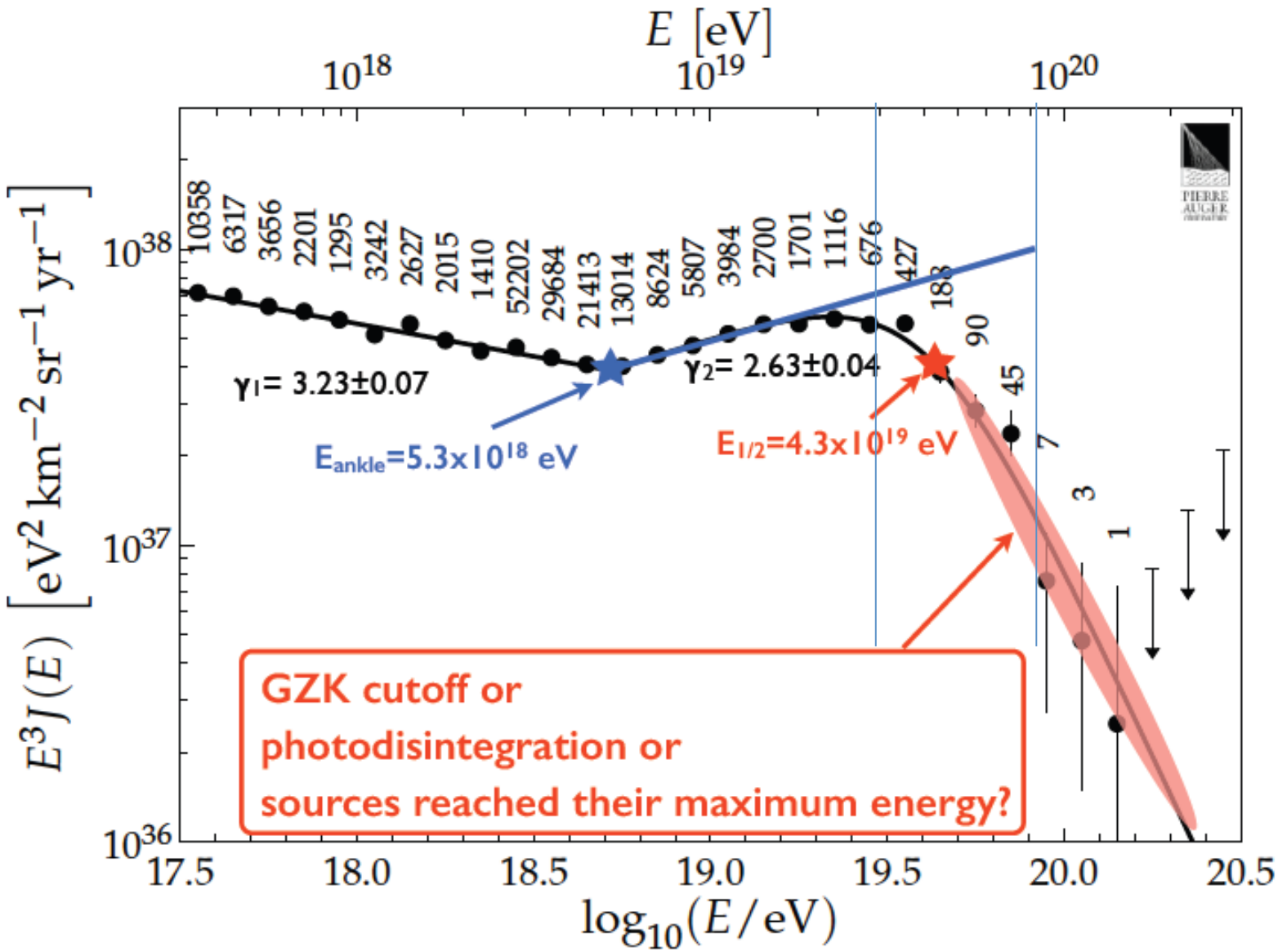


The lightest nuclei: the best filter to mask Virgo

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



Energy spectrum - what is causing the suppression?



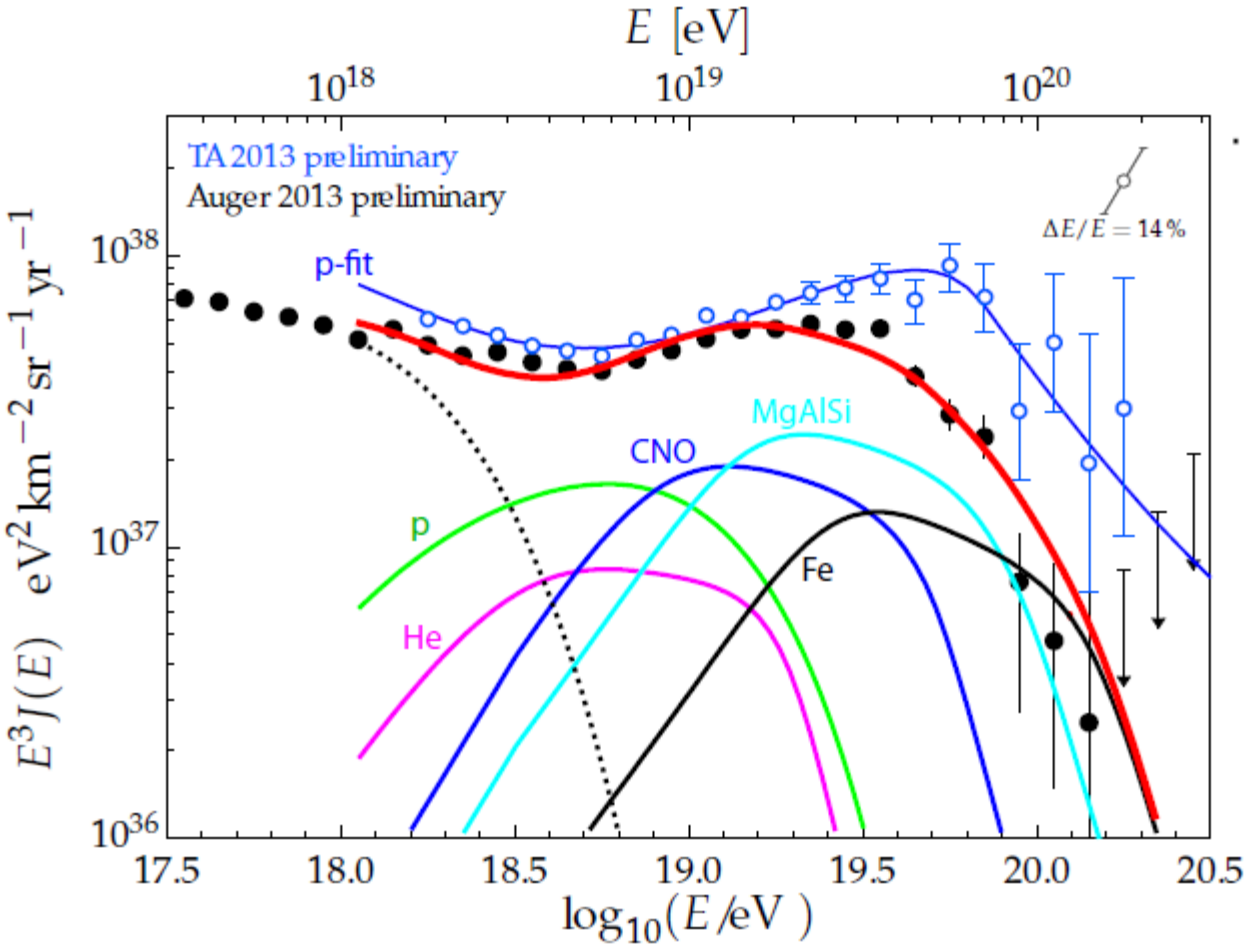
COMPOSITION PUZZLE : the history

- **For a decade AUGER claimed: Fe+p composition (2004-2014)**
- **TA claimed only proton UHECR (2005-2015)**
- ***This year*** last **AUGER declaration**: UHECR are
- We suggested 2008- mostly
- He (lightest nuclei)

Our old claim: Lightest Nuclei, Virgo, the Cen A smearing

- **Light Nuclei solving Auger puzzles. The Cen-A imprint (2008) Physica Scripta..up to..**
- ***EPJ Web Conf. 99 (2015) 08002***

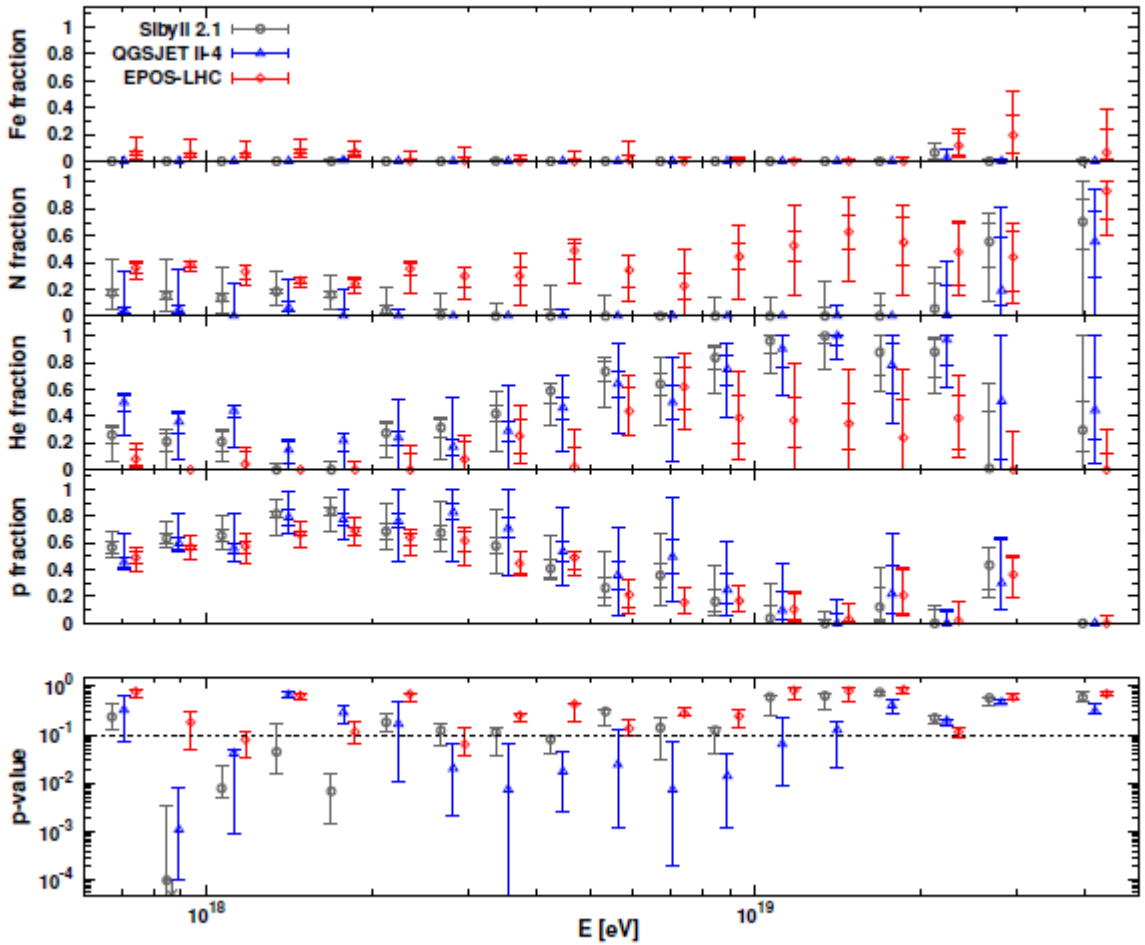
Origin of Ankle and Flux Suppression?



Kampert&Tinyakov, CRP **15** (2014) 318; Aloisio, Berezinsky & Blasi, JCAP 1410 (2014) 10, 02

composition

Composition Fit (X_{max} distribution)



Pierre Auger Collaboration, PRD **90** (2014) 12, 122006

Bending By Random or Coherent B

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^2_4, Li^3_6, Be^4_8, ( ) by spiral galactic magnetic fields along the plane is $\delta_{rm} \geq$:

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

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

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

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

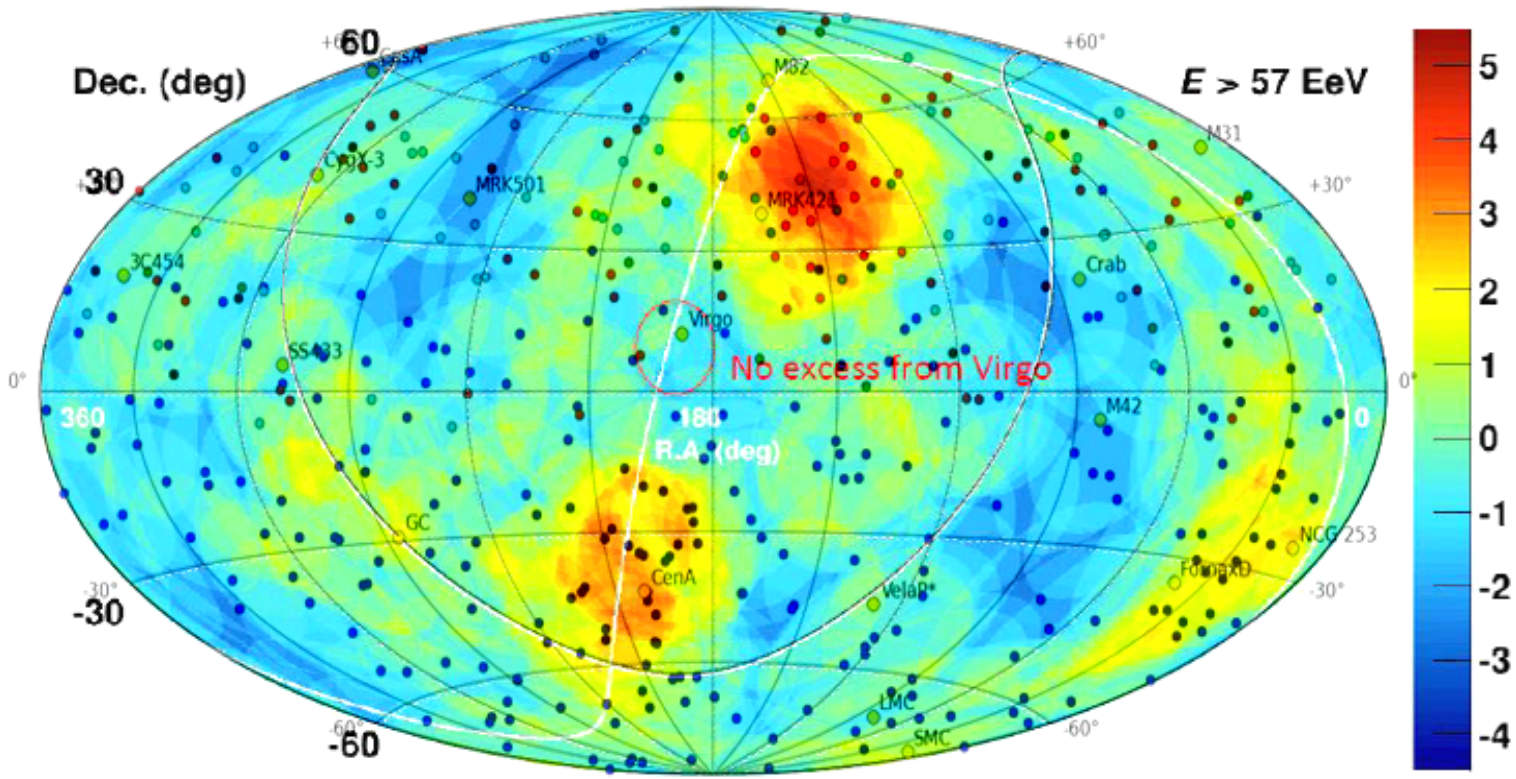
North and South at 50 EeV

The PERSISTENT SCANDAL (celestial coordinates) of VIRGO

ABSENCE

TA 6 Years + Auger 10 Years

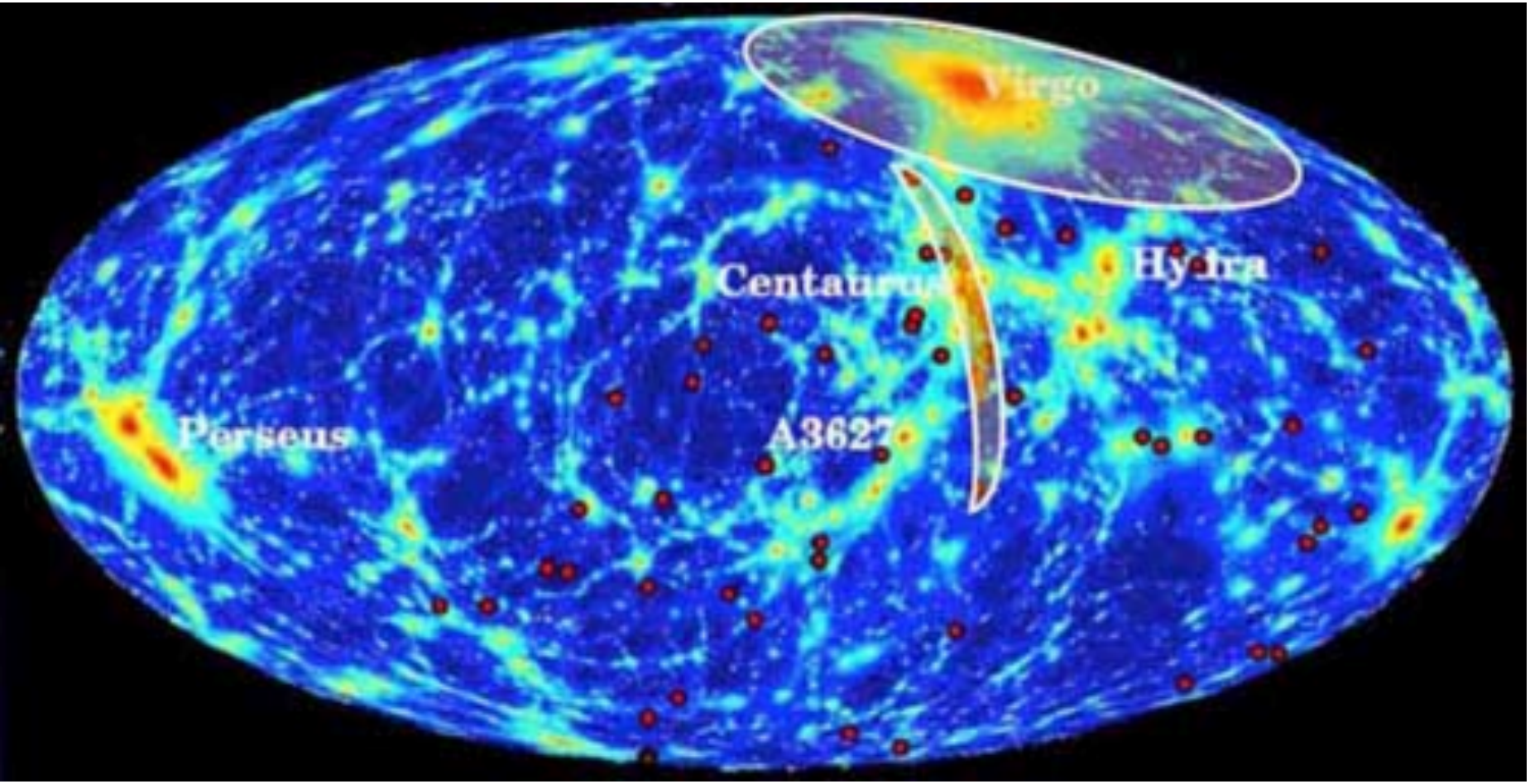
ATTENTION: MOLWEIDE versus HADER—Celestial HADER here-GALACTIC LATER



North: S_{MAX} = 5.19σ, (R.A, Dec.) = (148.4°, 44.5°)
South: S_{MAX} = 3.57σ, (R.A, Dec.) = (210.9°, -48.2°)

A.Aab et al, arXiv:1411.6111v1
K.Kawata, 2014/12/17

Past 2008-2009 foreseen maps (observed on 2011)
Cen A and Virgo Absence

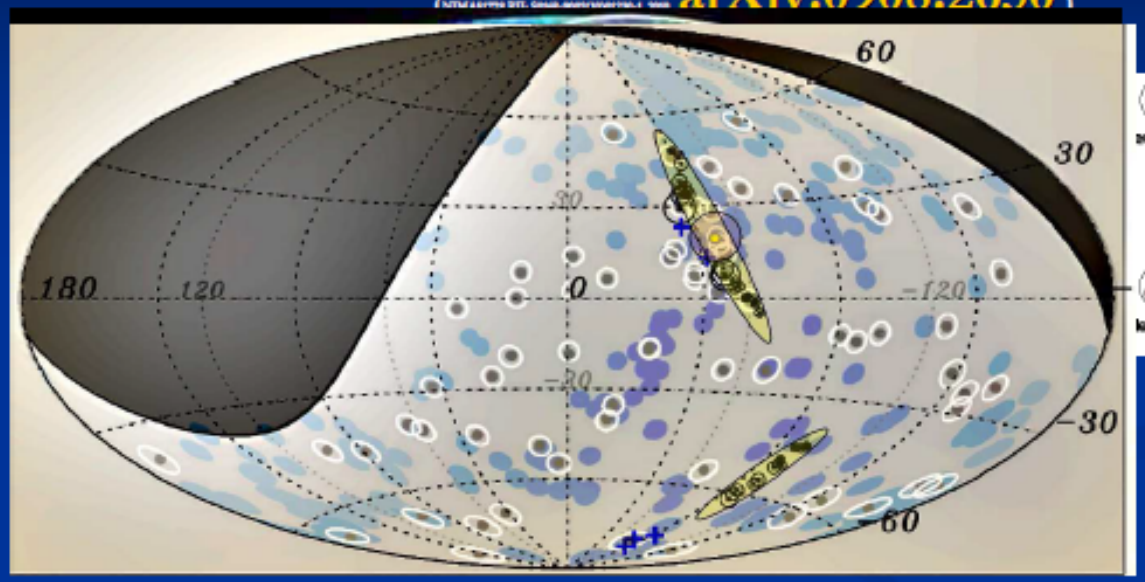


Coherent and random UHECR Spectroscopy of Lightest Nuclei along CenA: …
- Fargion, D.Nucl.Instrum.Meth. A630 (2011) 111-114 arXiv:0908.2650

Foreseen He fragility and D,p:

fragments and multiplet

arXiv:0908.2650



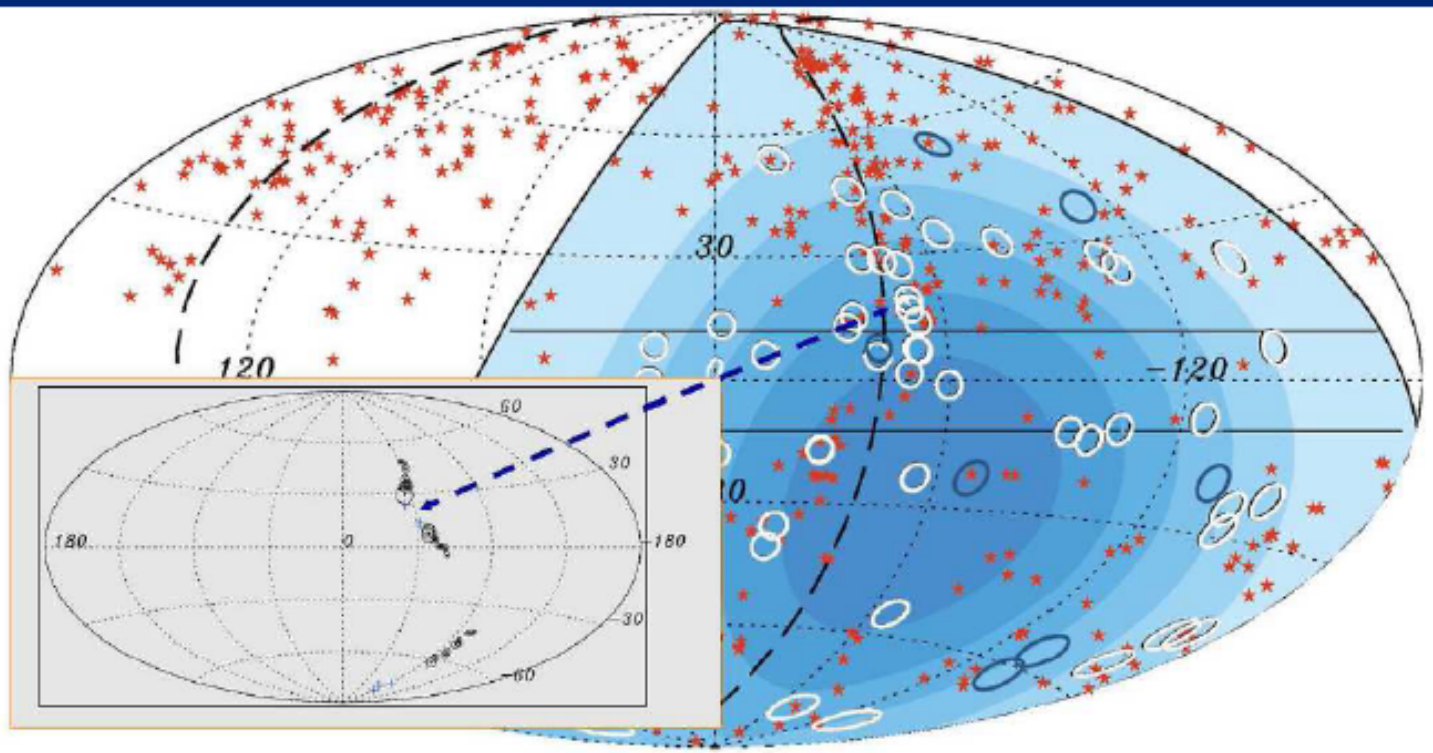
- UHECR He at 60 EeV flying few Mpc

maybe broken into fragments:

- Half energy and half mass → 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 fom AUGER: *arxiv1107.4805*

Multiplets tail around Cen A at 20 EeV

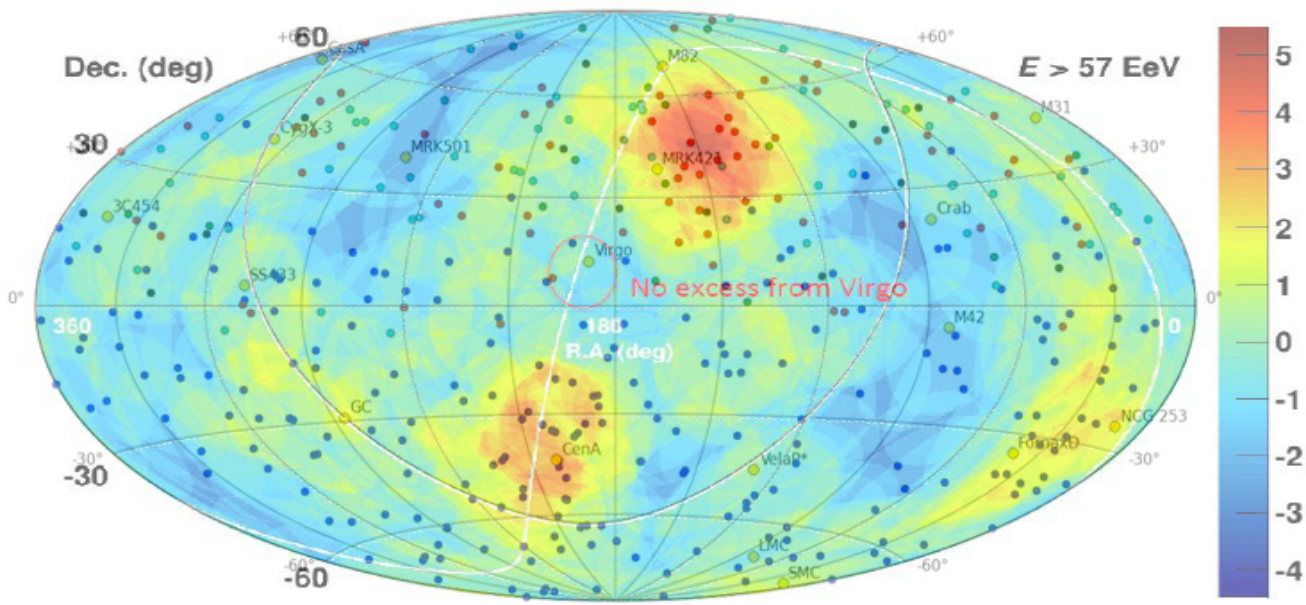


for the presence of multiplets arising from magnetic deflections in the present data.

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

1 **Introduction** given by

Milagro_ICECUBE



1 TeV

, **101**, 221101, 2008

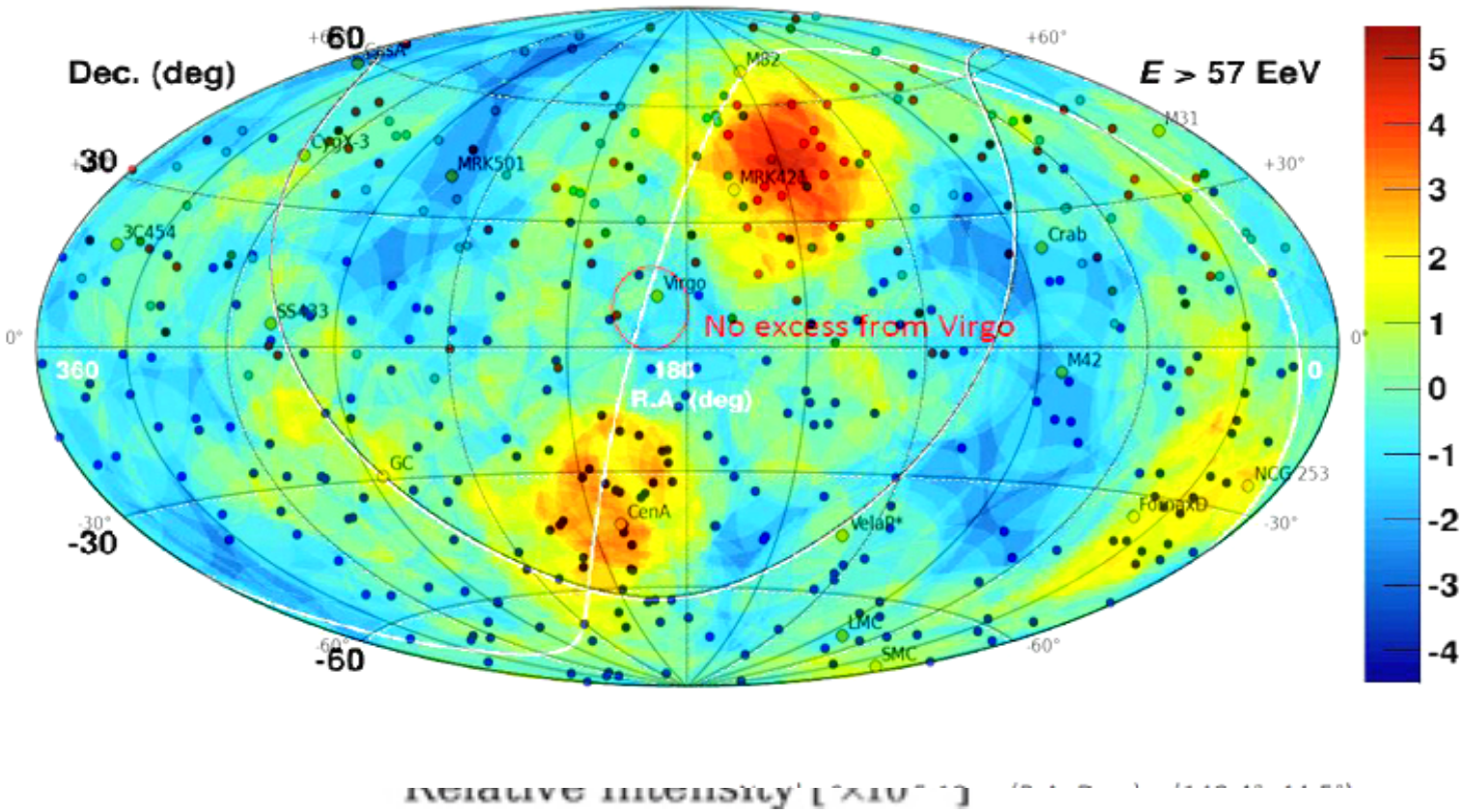
20 TeV

pJ, **740**, 16, 2011

significance [σ]

latest 231 AUGER UHECR (blue) with additional 72+15=87 latest TA (72 red and 15 green) records. A few potential sources are labeled.

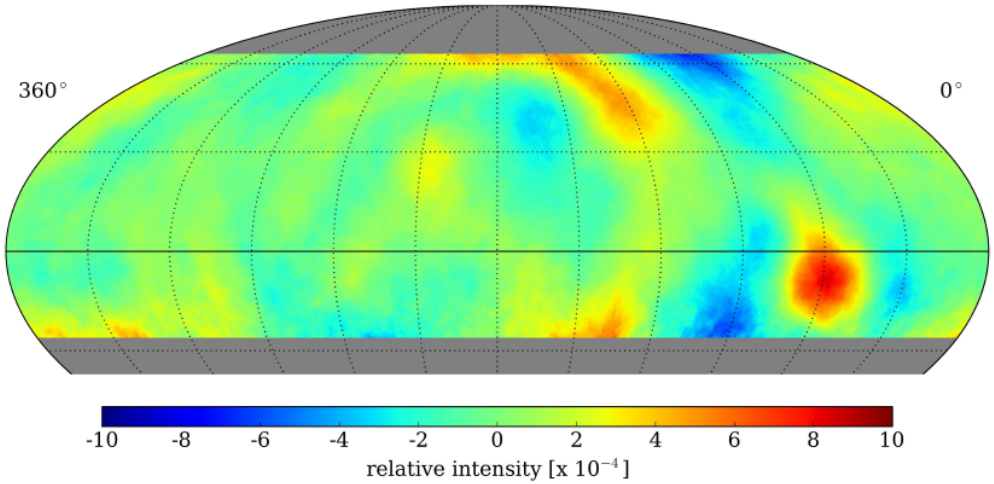
ARGO E ICECUBE over TA and AUGER



(b)

FIG. 2: ARGO-YBJ sky-map in equatorial coordinates for events with $N_{strip} > 25$. The maps have been smoothed with an angle given by the PSF of the detector. *Plot (a)*: statistical significance of the observation in s.d. The boxes represent the

Hawc anisotropy 2 : Virgo and C?



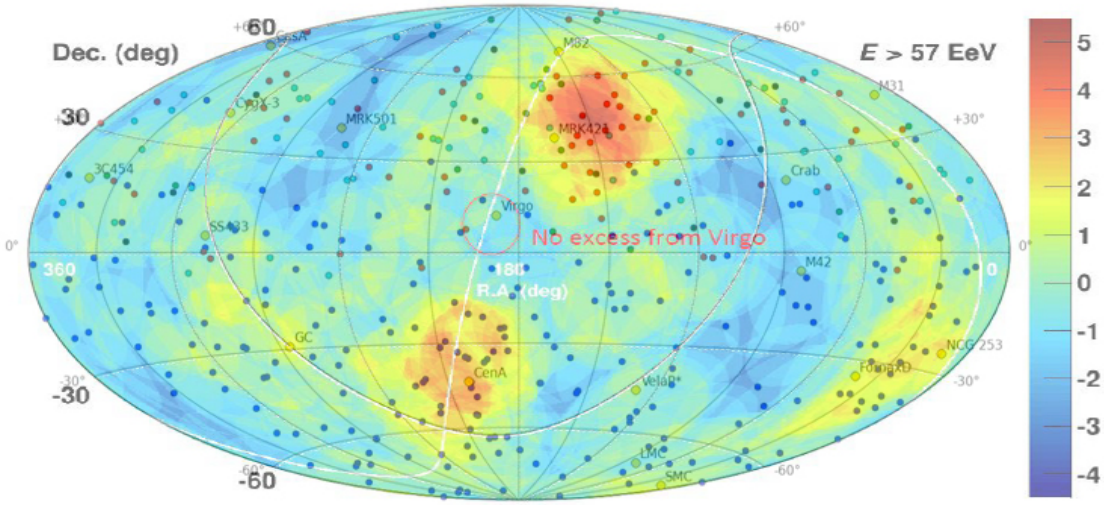
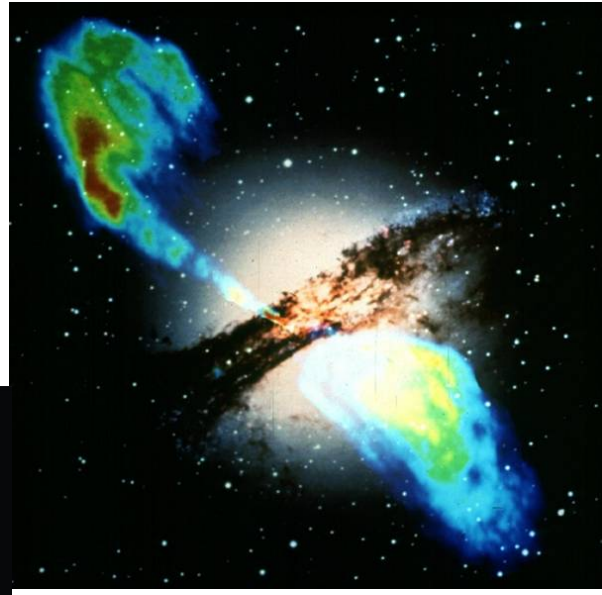


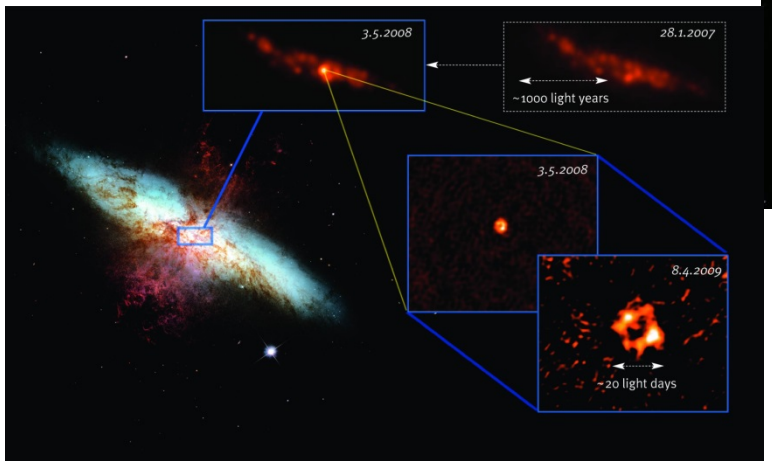
Figure
quadru

e dipole,

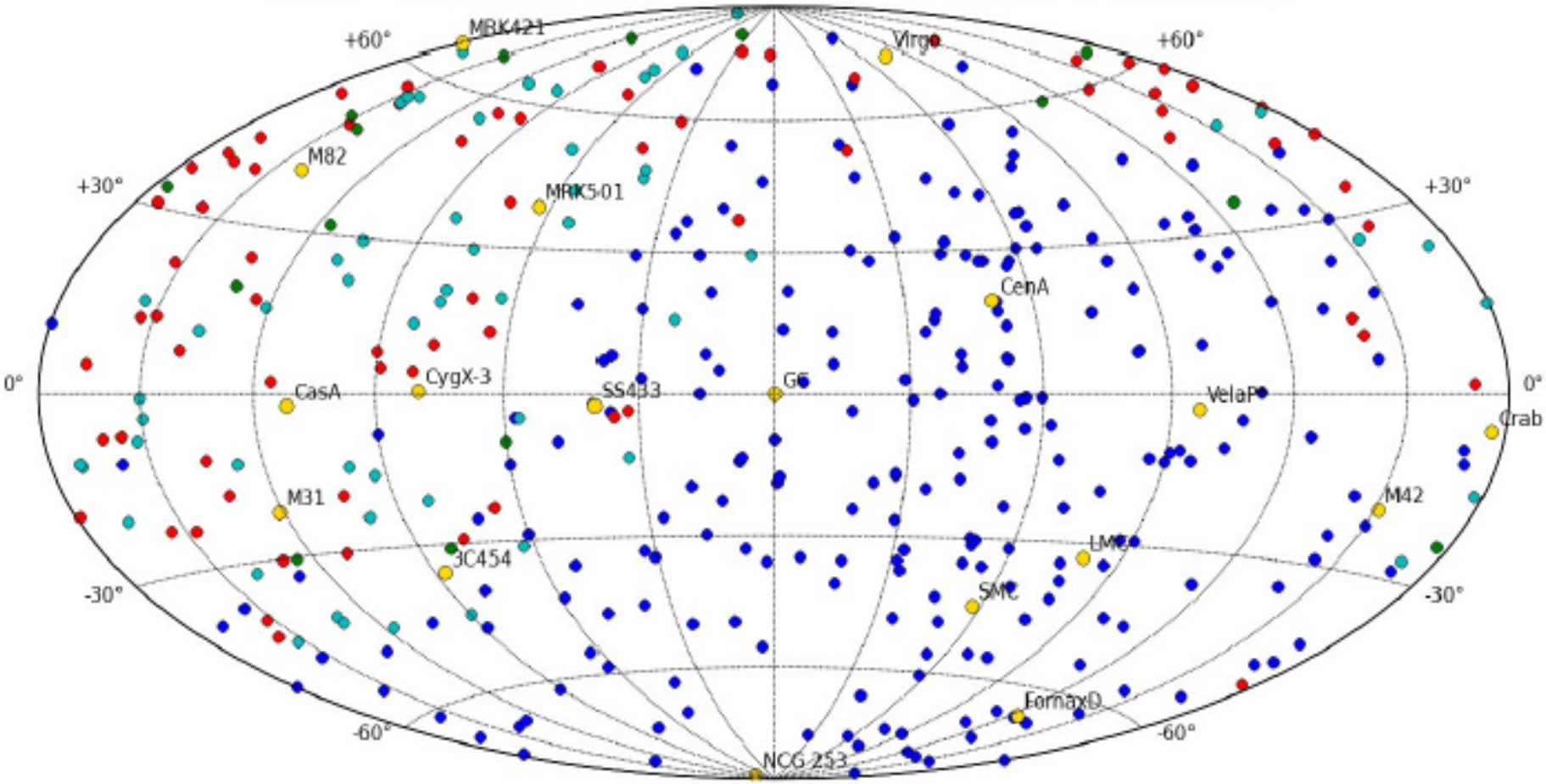
The Source Jets
AGN and NS (BH ?)



- Cen A
- M82
- Vela
- Crab
- SS433
- NGC 253
- D.Galaxy Fornax



Gamma COMPTON:OSSE halo



AUGER over Planck IR Galactic Map: The GC role

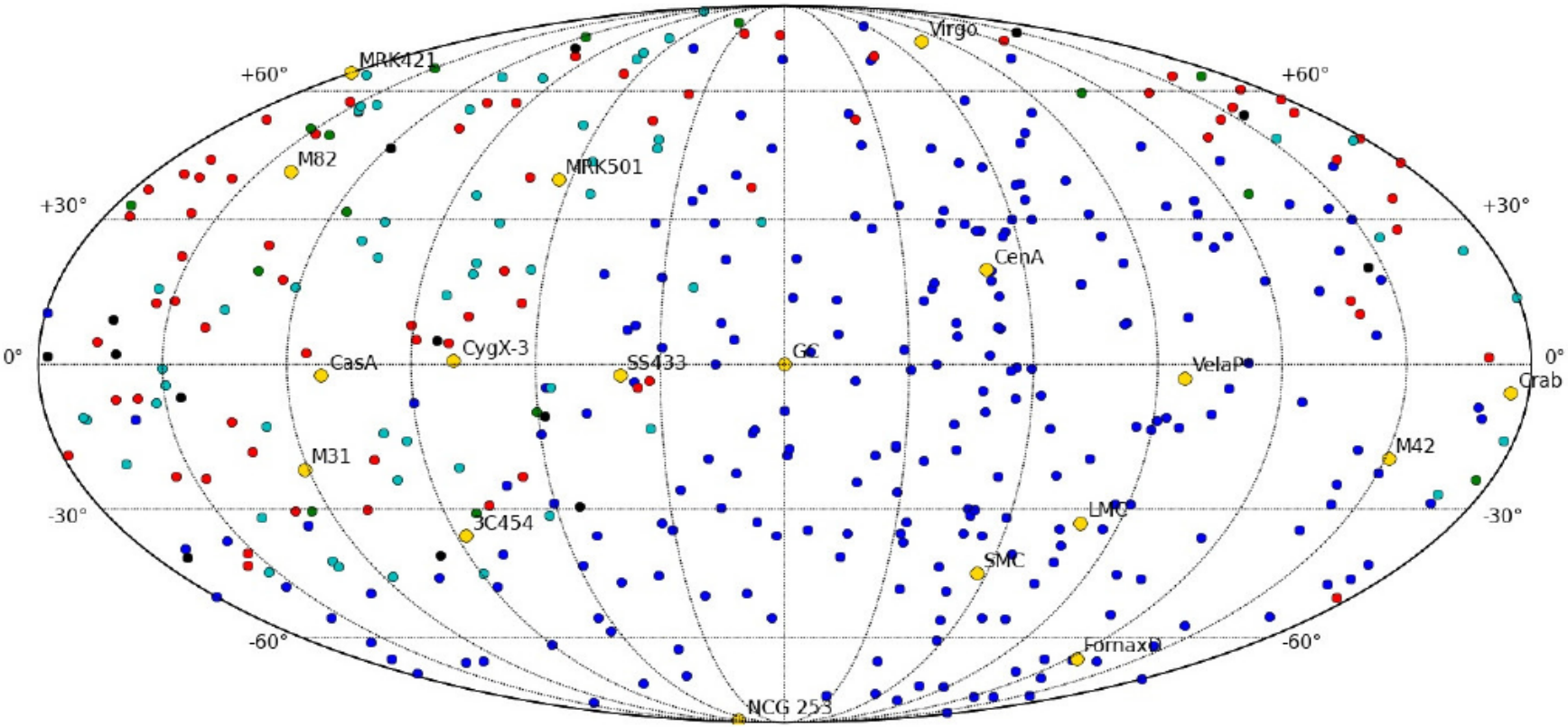


Figure 12. As above, in Mollweide Projection, Galactic Coordinate map for 231 AUGER UHECR, 72+15=87 TA, 58 AGASA

Galactic spur

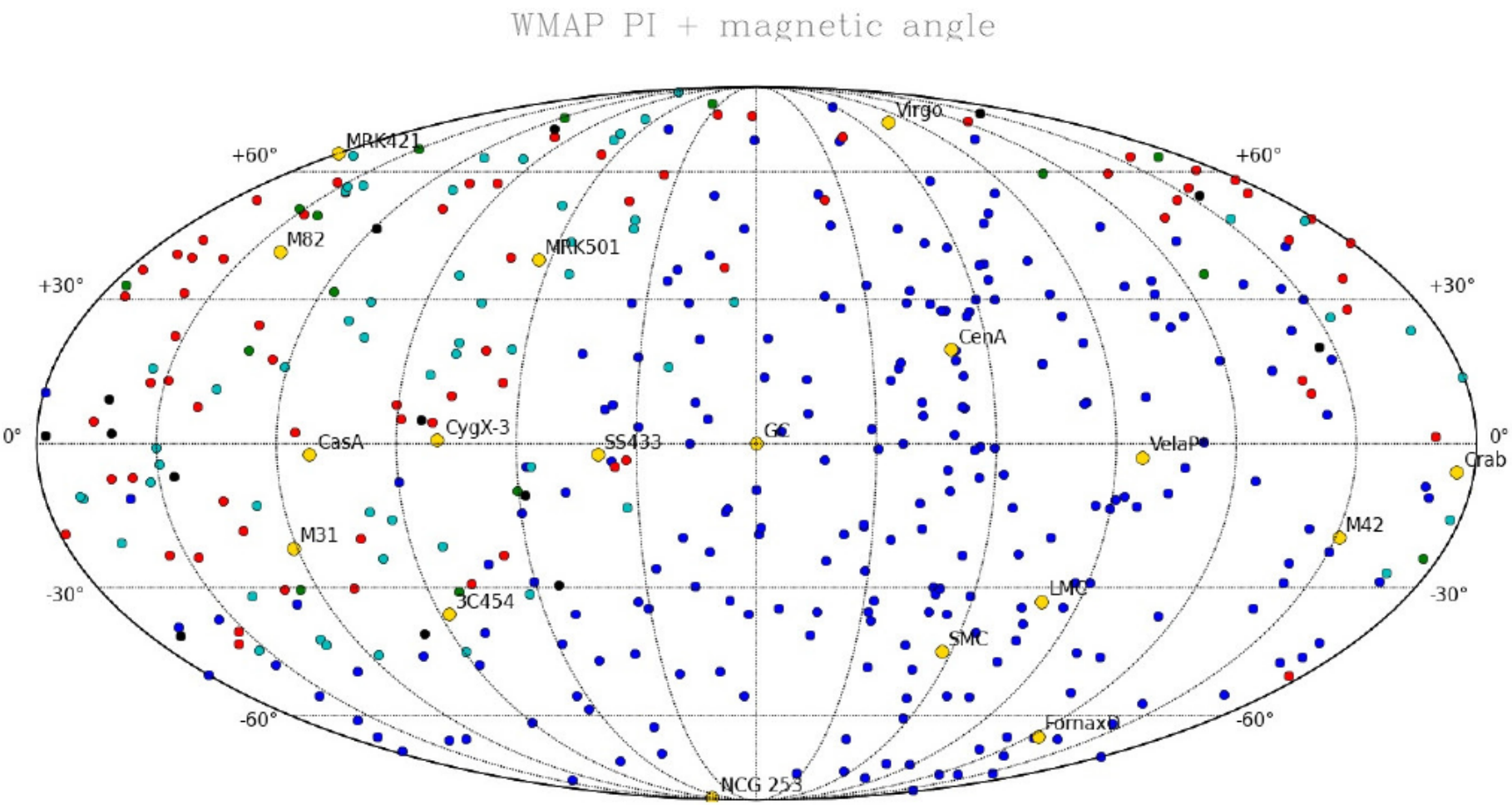


Figure 12. As above, in Mollweide Projection, Galactic Coordi-

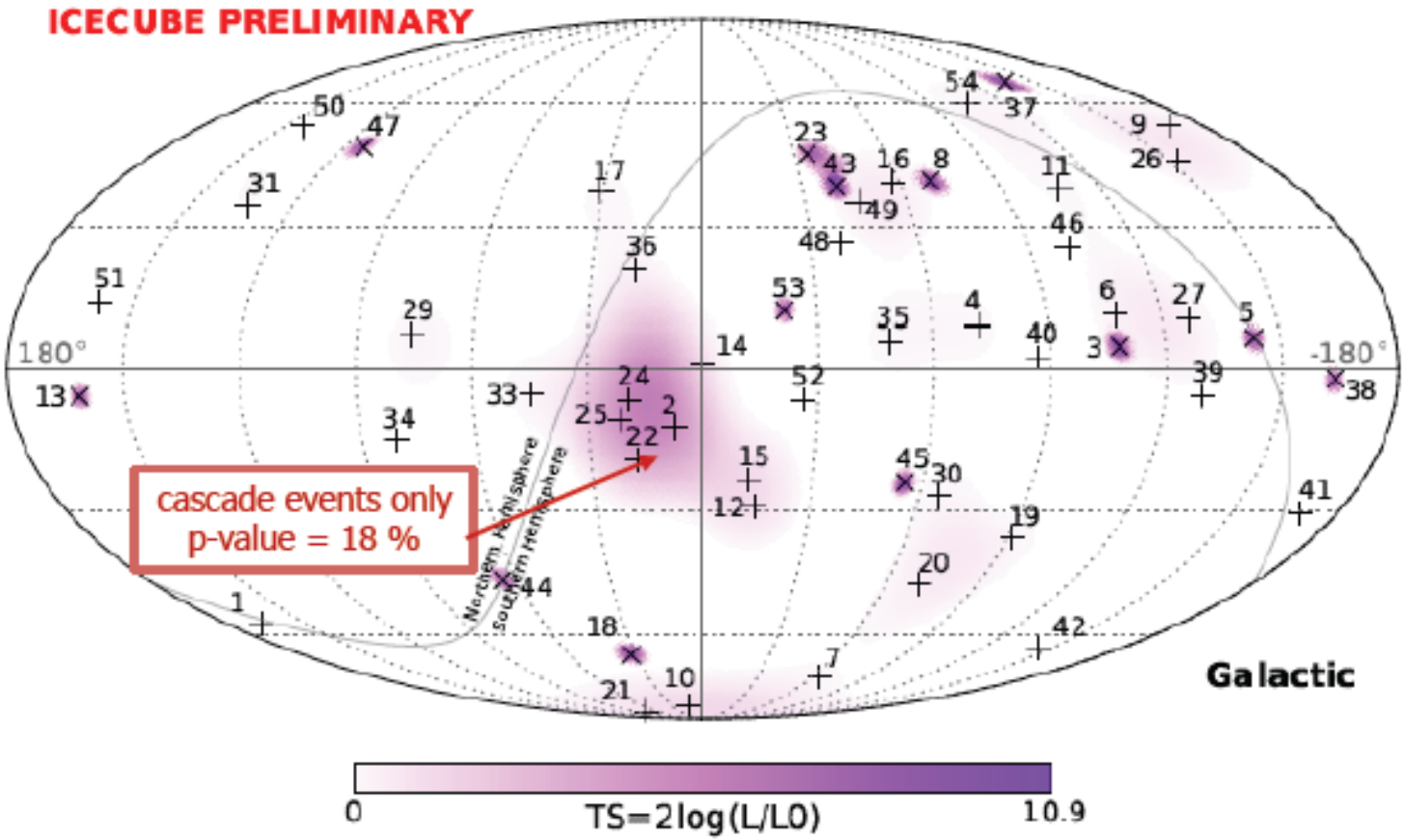
Light nuclei solving the AUGER puzzles: the Cen-A imprint--2008

- D Fargion
- **Published 30 September**

2008 • Physic

a

neutrino


ICECUBE PRELIMINARY
180°
-180°
Northern Hemisphere
Southern Hemisphere
cascade events only
p-value = 18 %
Galactic
0
TS=2log(L/L0)
10.9

UHECR versus UHE neutrino

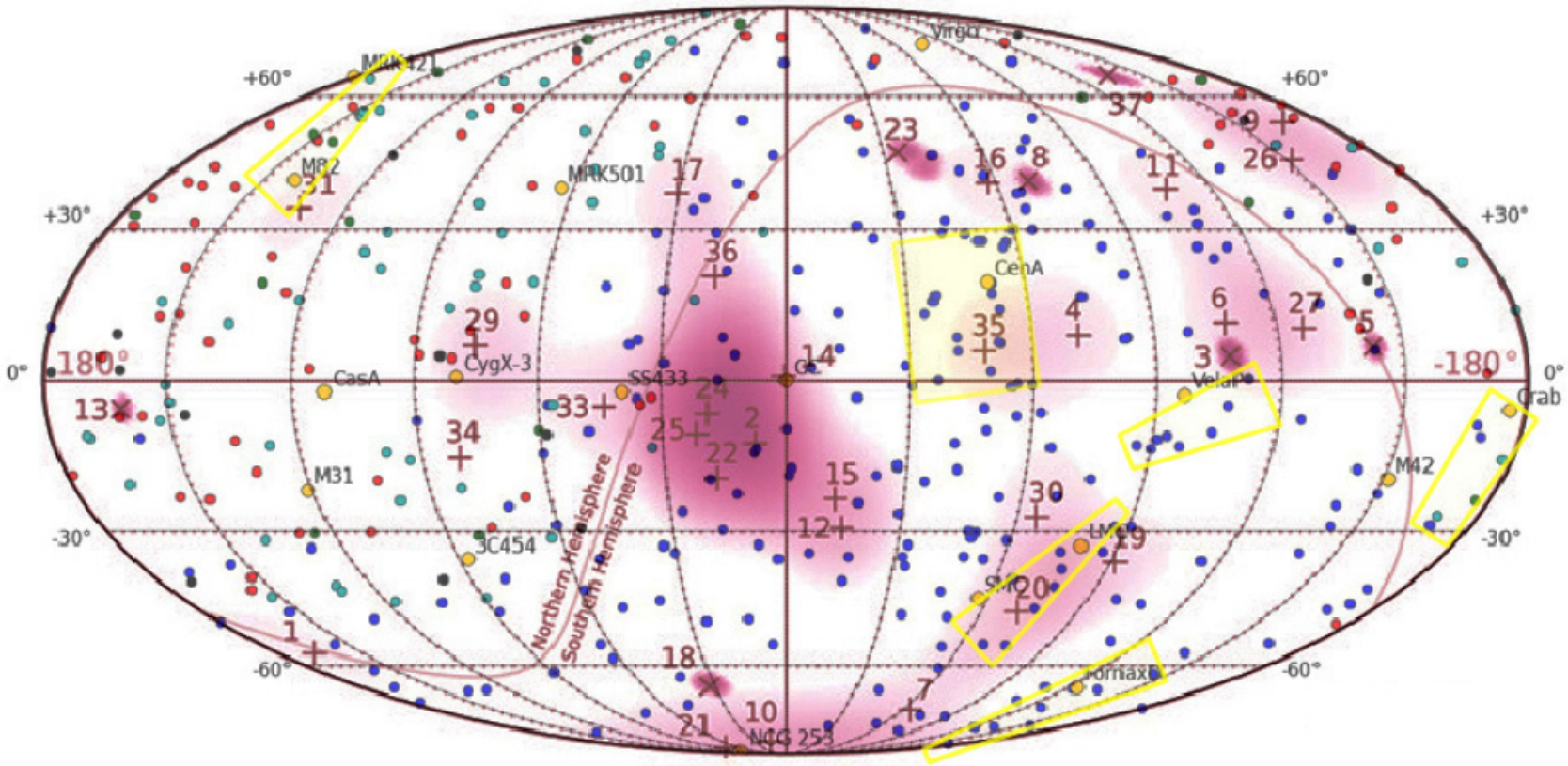
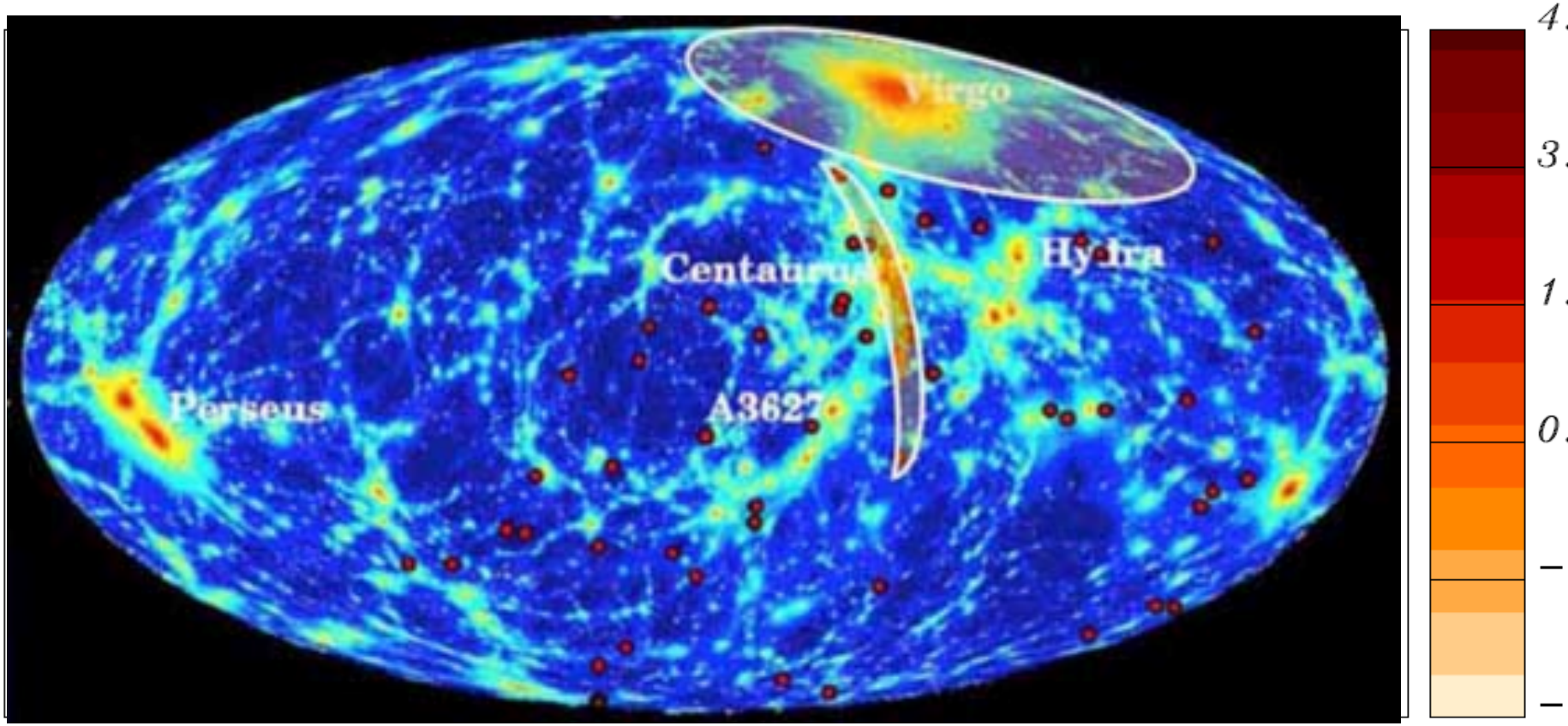


Figure 13. All oldest UHECR by AGASA, AUGER, TA, in galactic Mollweide coordinate with several candidate sources with label: blue AUGER, red 72 events by TA, green last 15

Overlapping Highest and Lower UHECR in Galactic Coordinate versus newest 54 ICECUBE Highest Energy Neutrino

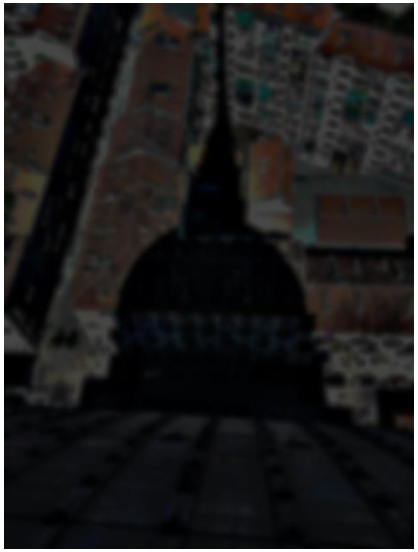


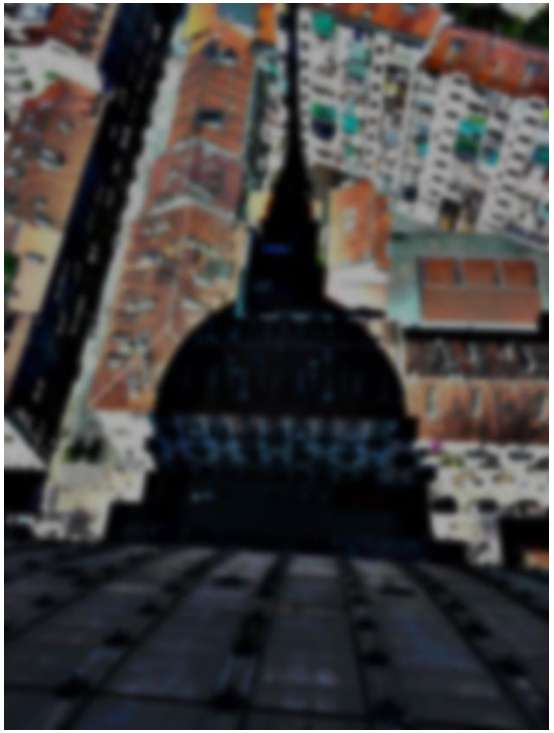
TS=2log(L/L0)

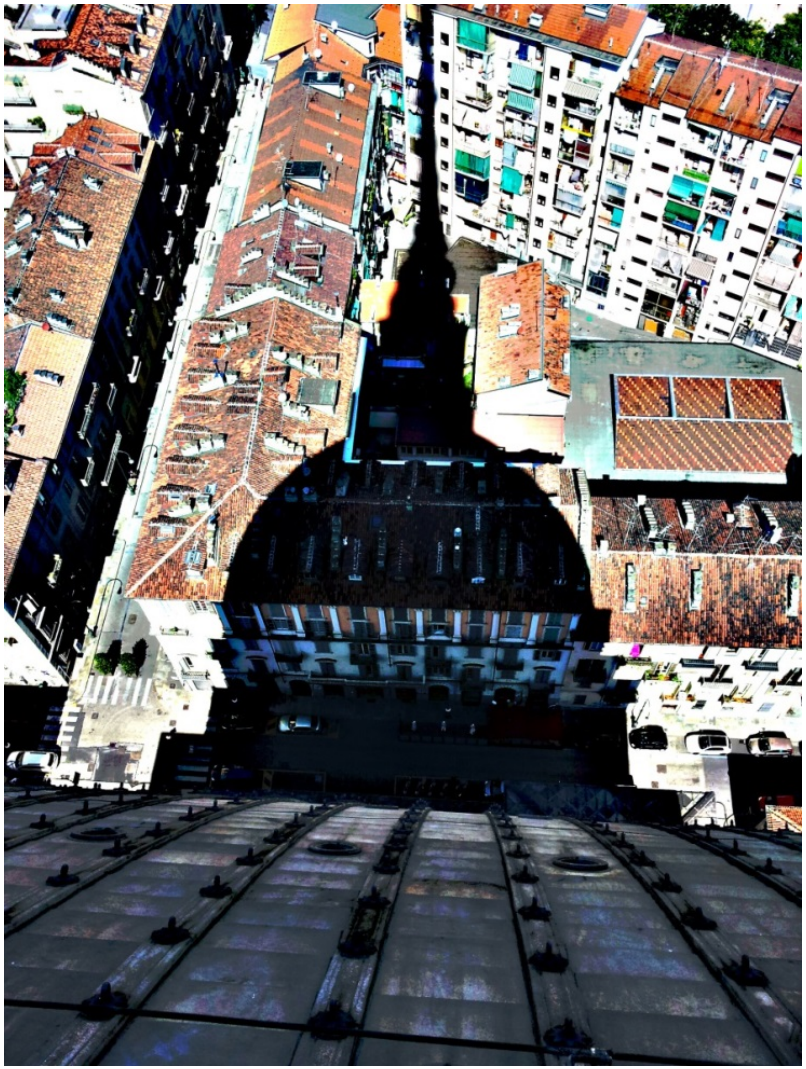
Summary

- ***We overlap nearly 400 UHECR and their arrival events on different maps as TeVs gamma anisotropies and known sources, finding some first key connections with nearby***
- ***AGN Cen A, M82, NGC 253, and Fornax Dwarf galaxy.***
- ***Their bending confirm a light nuclei UHECR as most recent AUGER simulations on UHECR compositions.***

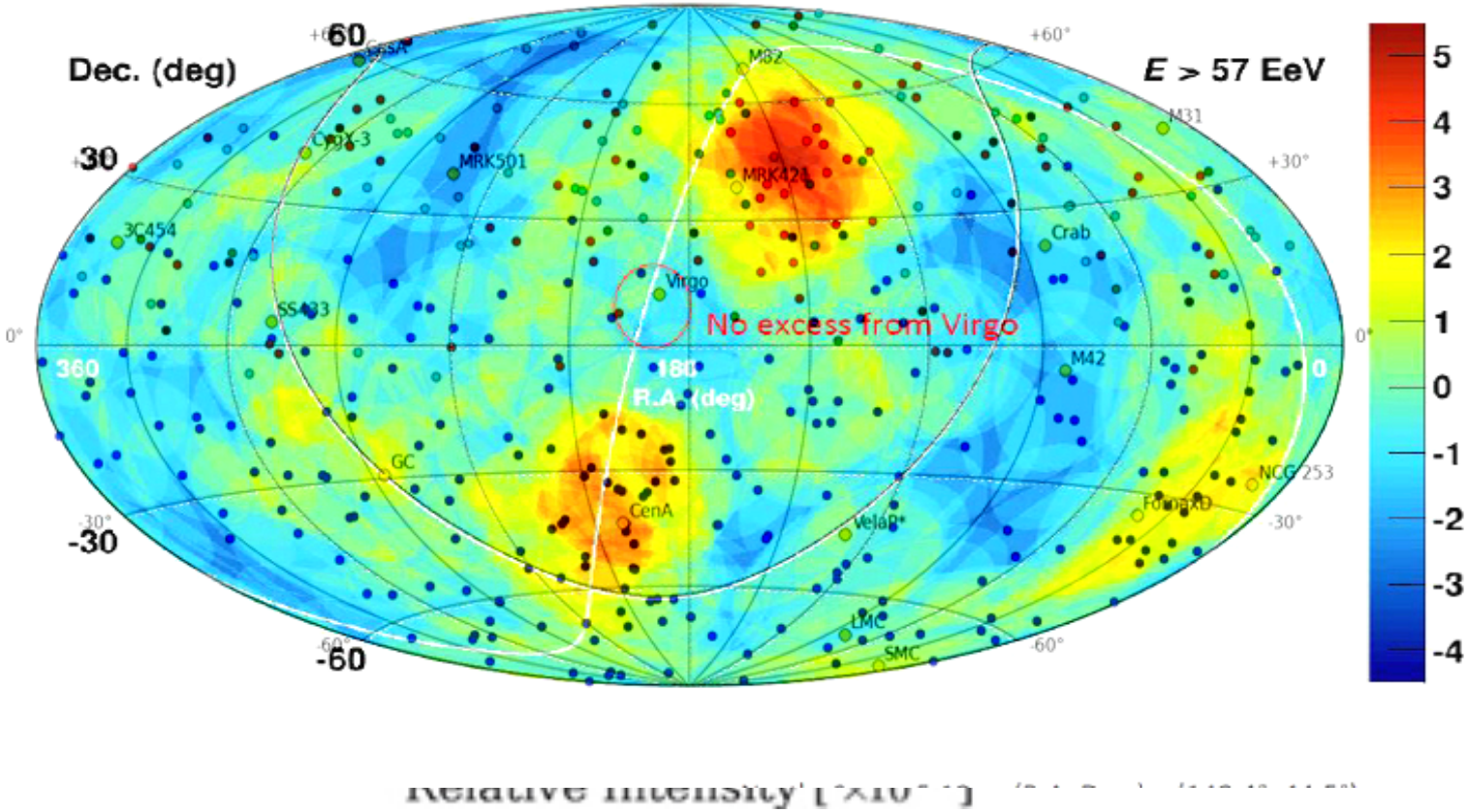
Thank you for the *sharp* attention







ARGO E ICECUBE over TA and AUGER



(b)

FIG. 2: ARGO-YBJ sky-map in equatorial coordinates for events with $N_{strip} > 25$. The maps have been smoothed with an angle given by the PSF of the detector. *Plot (a)*: statistical significance of the observation in s.d. The boxes represent the

End

Planck

Synchrotron Emission

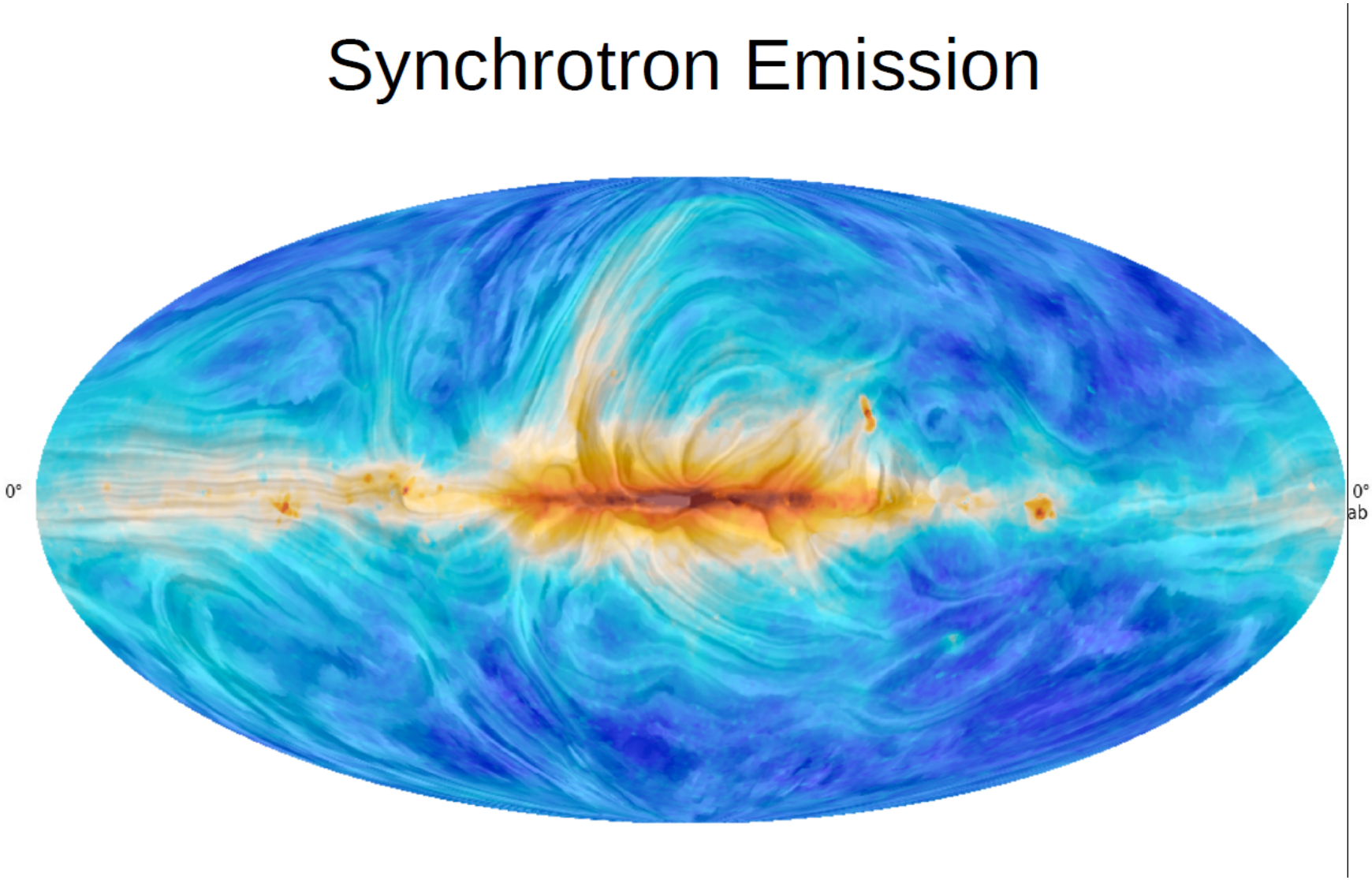
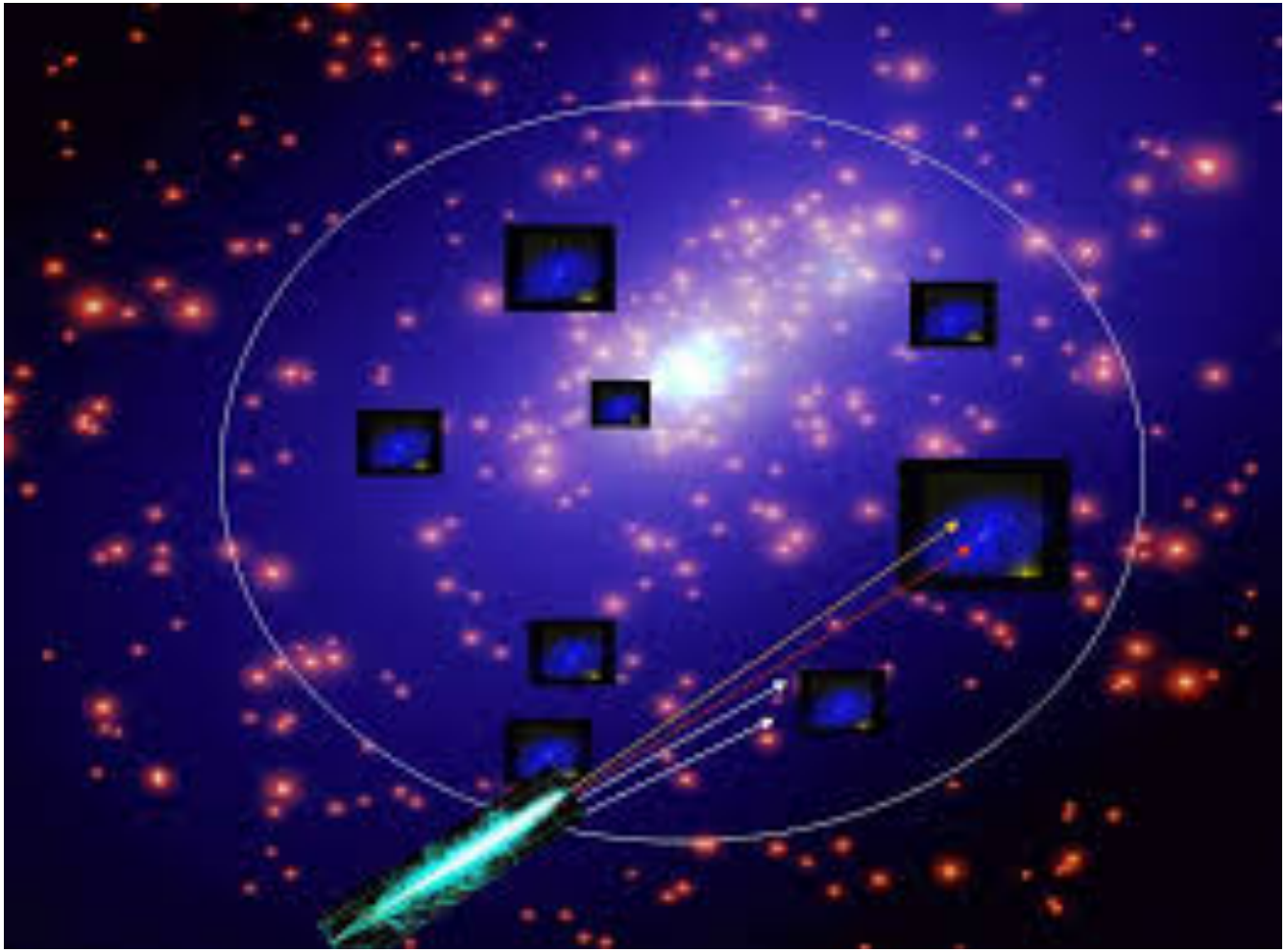


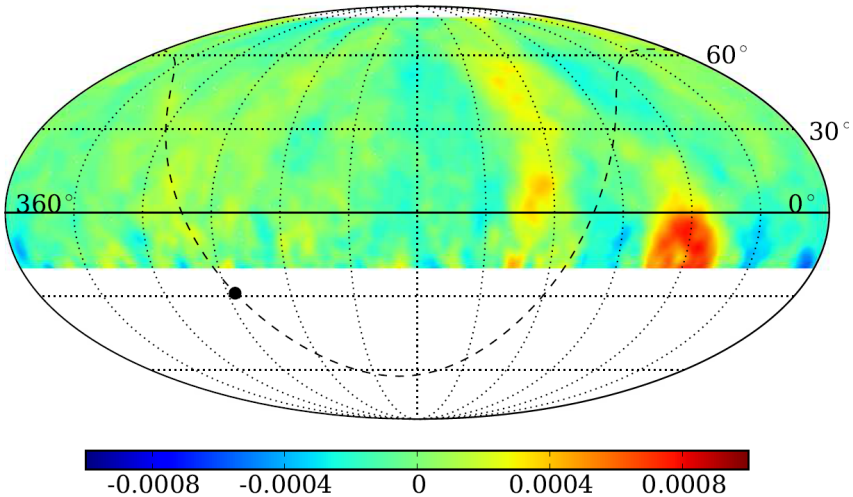
Figure 12. As above, in Mollweide Projection, Galactic Coordi-

UHE ZeV neutrino scattering on 0.4 eV relic neutrino showering Z resonance

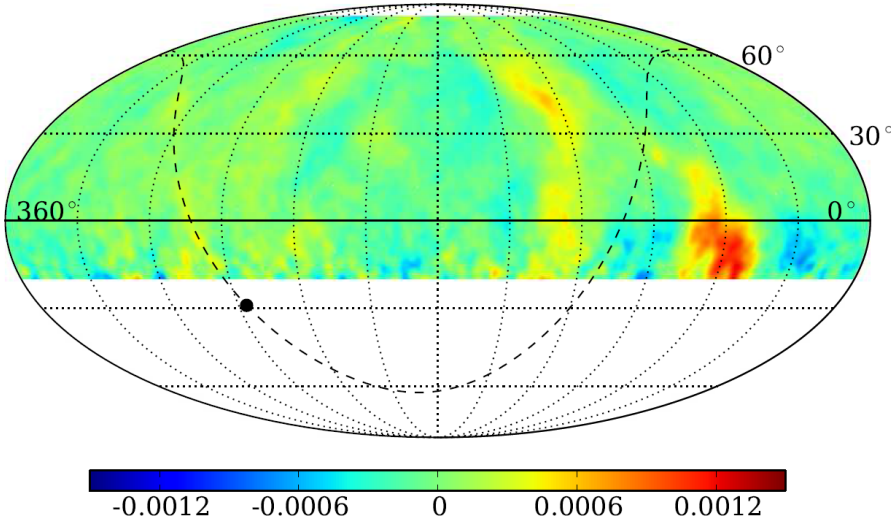


ARGO LOW _HIGH energy

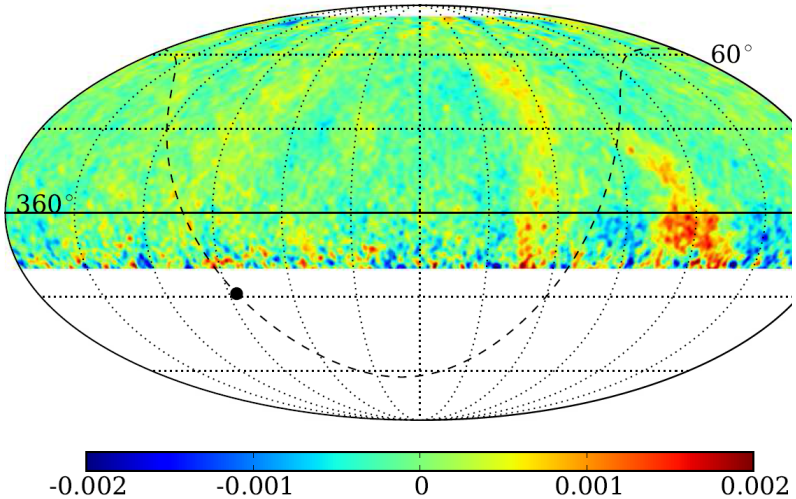
FIG. 5: The fractional CR excess with respect to the estimated background is shown for different shower multiplicities: (a) 25 - 39, (b) 40 - 99, (c) 100 - 249, (d) 250 - 629 fired strips on the ARGO-130 central carpet. *Mollweide projections.*



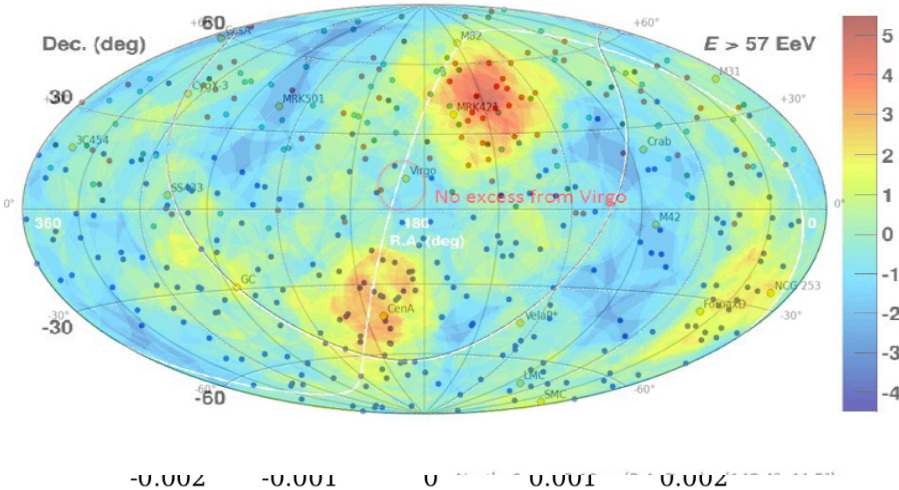
(a)



(b)



(c)



(d)

Dust Intensity & Polarization

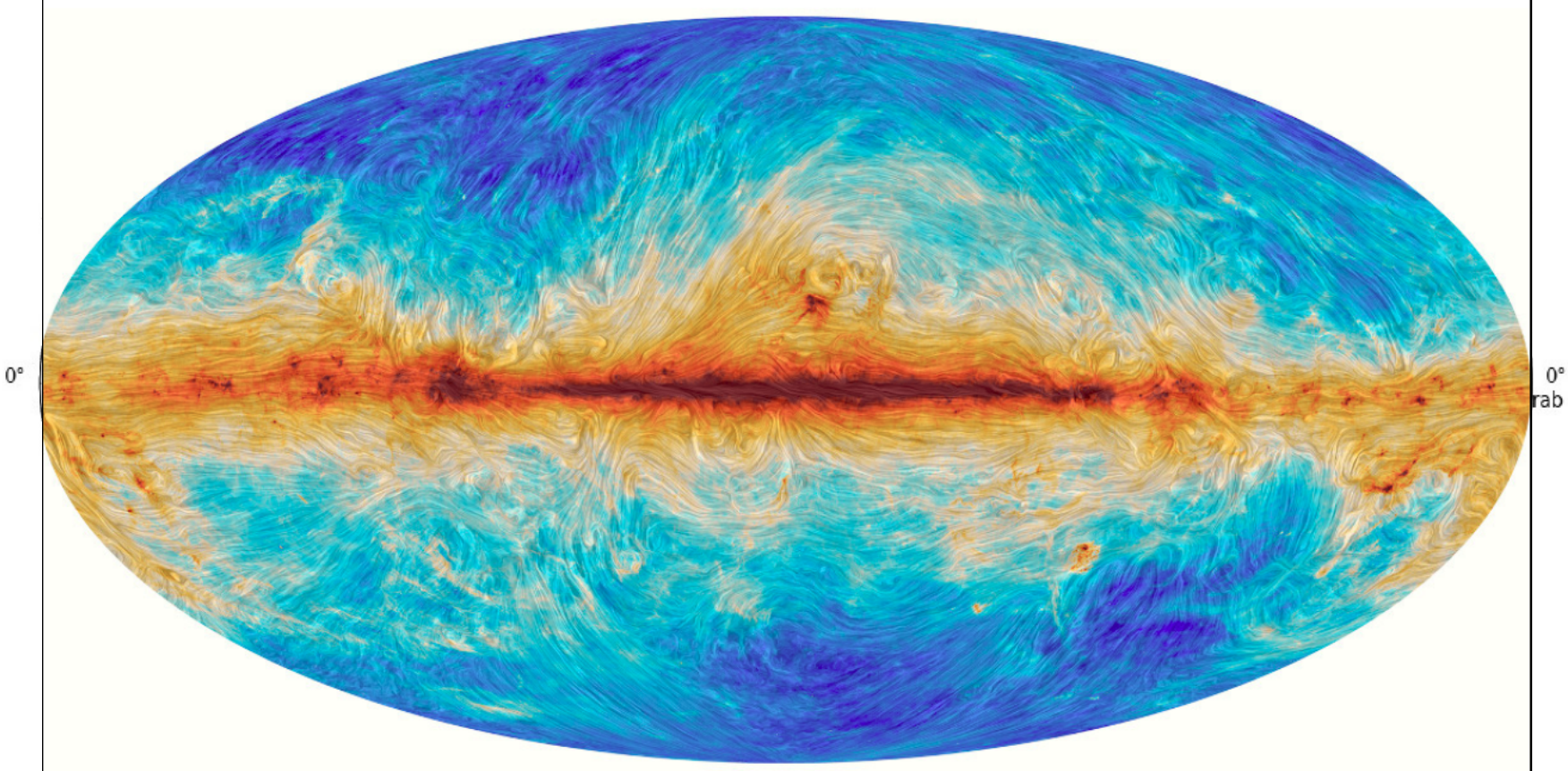


Figure 12. As above, in Mollweide Projection, Galactic Coordi-

Crab source or Milagro hot spot?

- WHERE THE ANISOTROPY COME FROM?

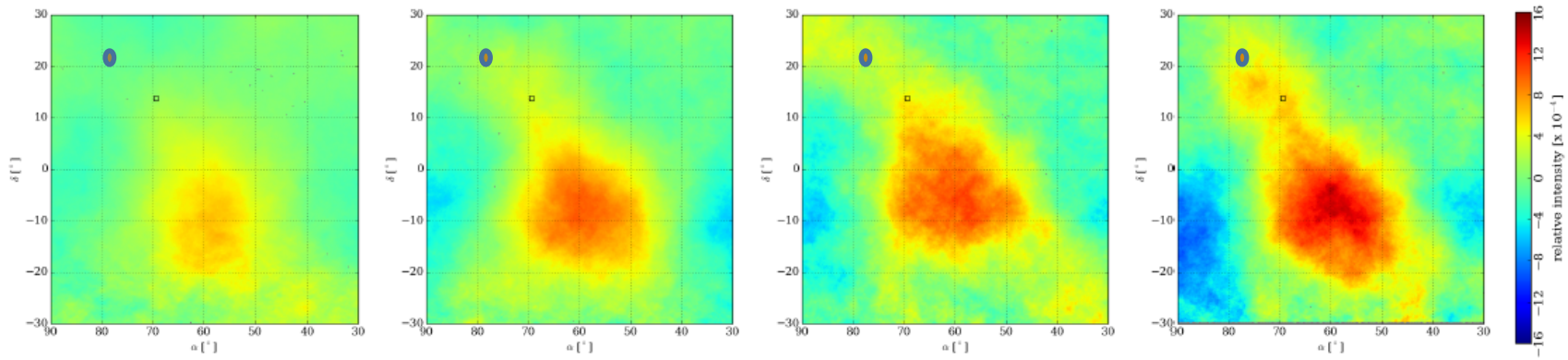


Figure 5: Relative intensity of Region A for 4 different energy-proxy bins. The square mark denotes the location of the centroid of Region A as reported by Milagro ($\alpha = 69.4°$, $\delta = 13.8°$) at 10 TeV. The median energy of the data in each plot from left to right is $1.7^{+6.6}_{-1.3}$ TeV, $3.2^{+10.9}_{-2.4}$ TeV, $5.6^{+14.2}_{-3.9}$ TeV, and $14.1^{+28.7}_{-9.9}$ TeV.

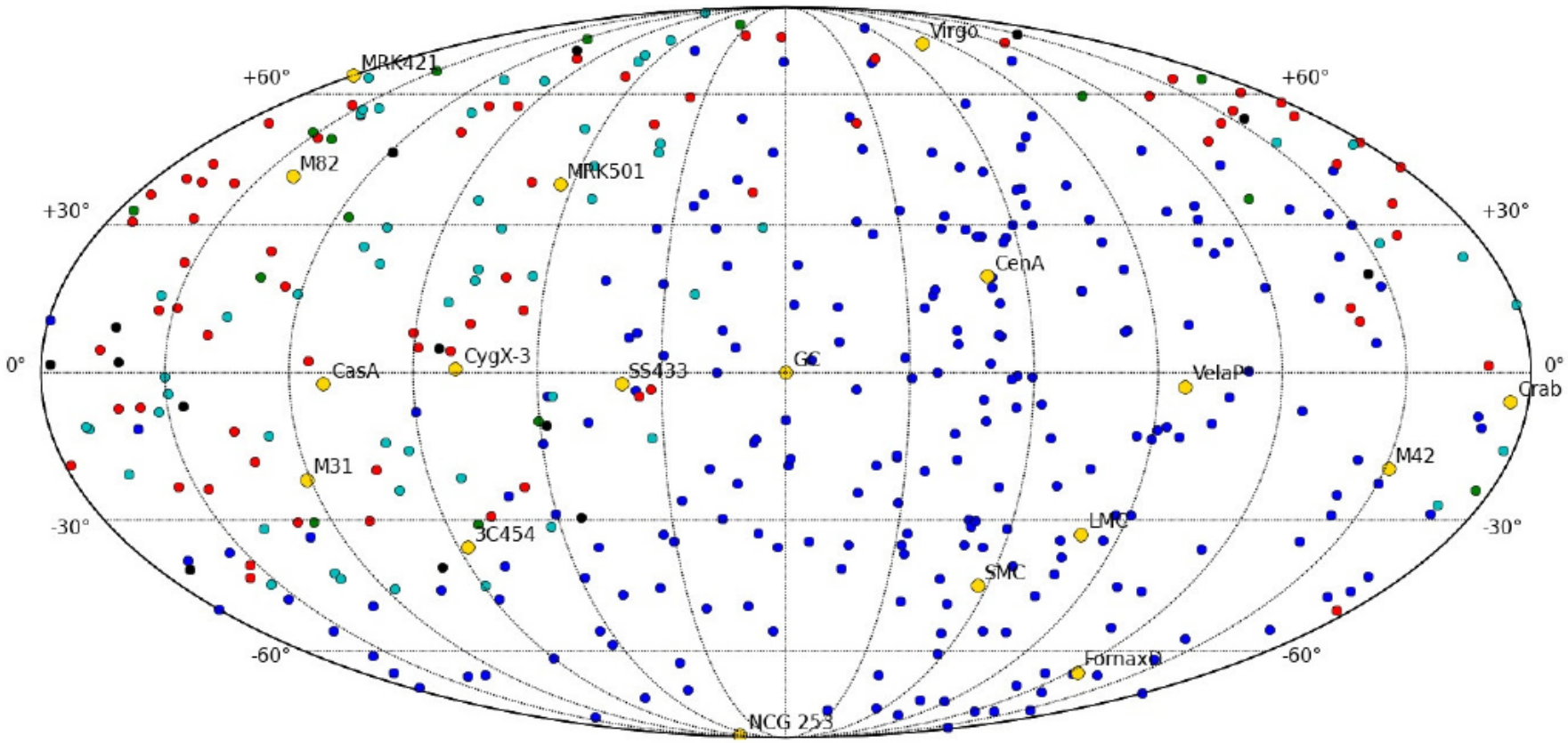
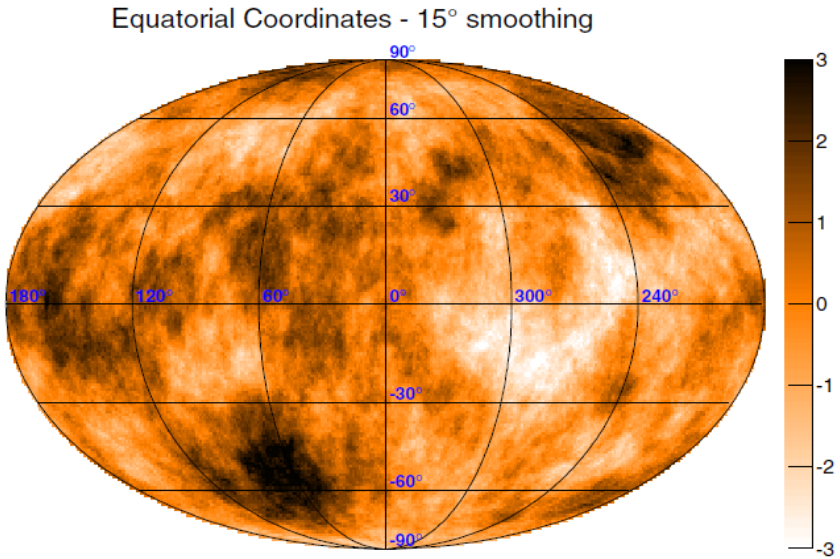
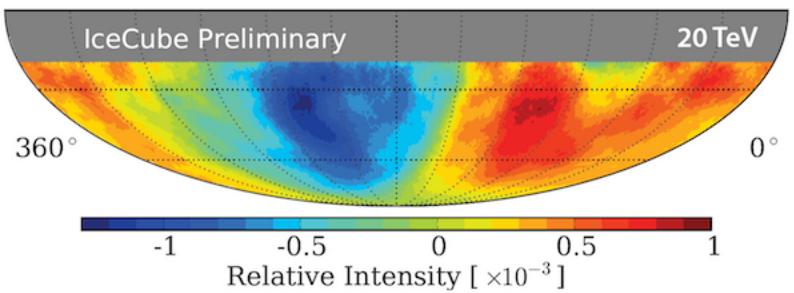
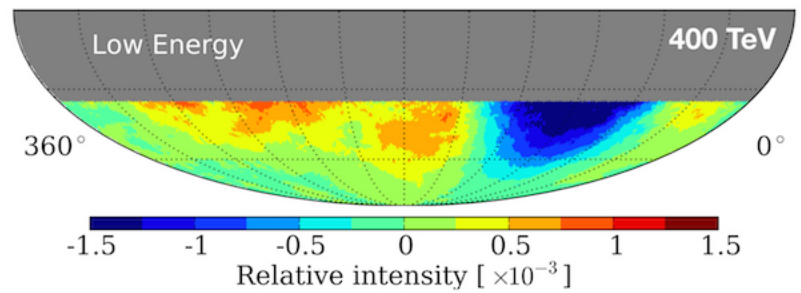


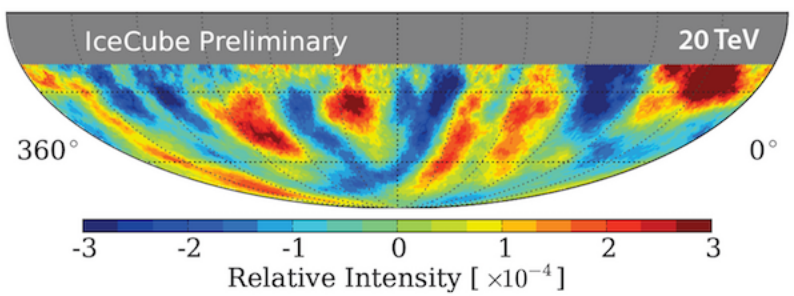
Figure 12. As above, in Mollweide Projection, Galactic Coordinate map for 231 AUGER UHECR, 72+15=87 TA, 58 AGASA

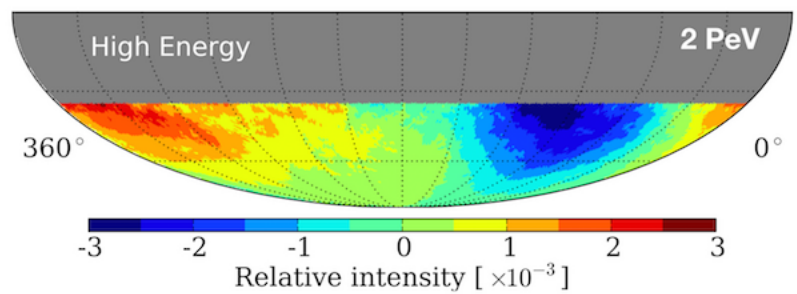


ısion up to $\ell = 4$. Right: significance sky map smoothed out at a 15° angular scale.

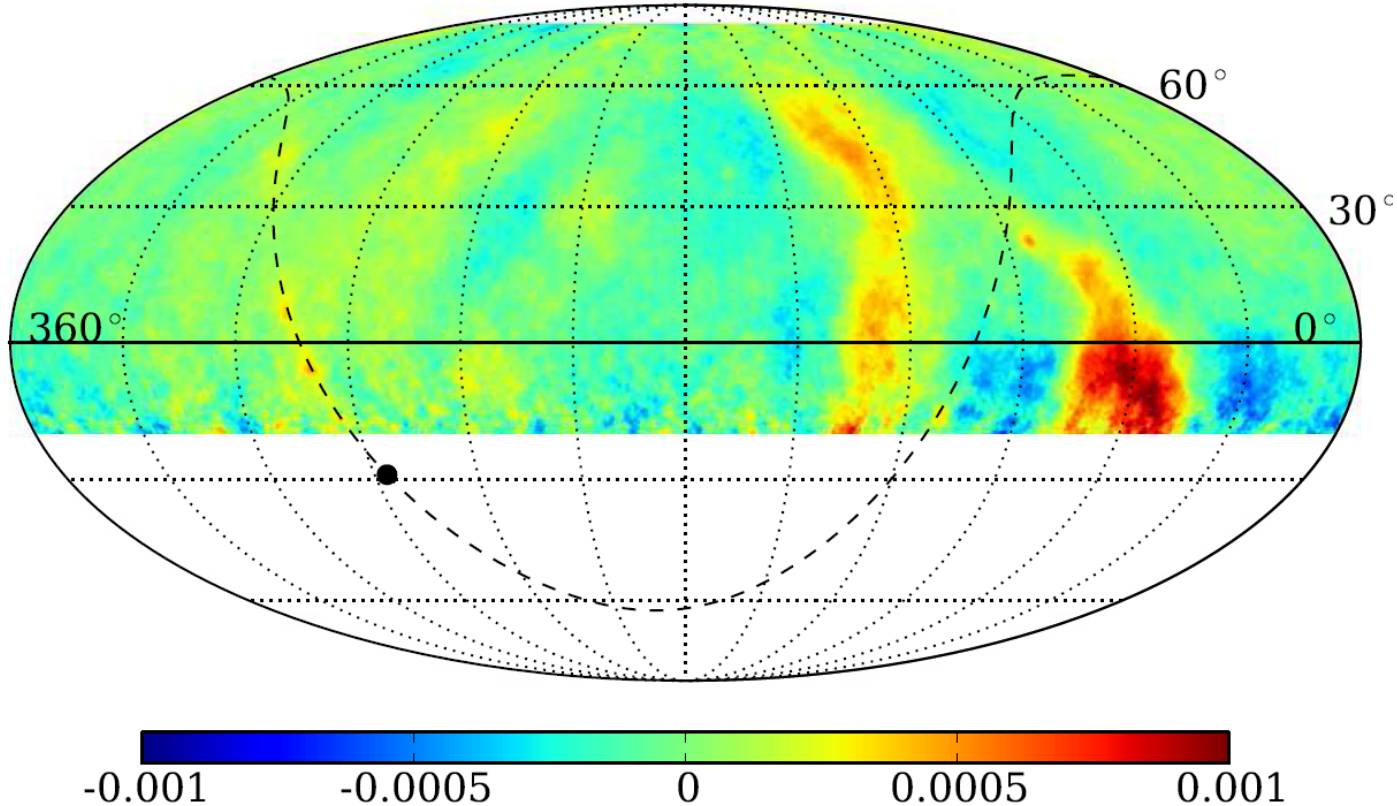








ARGO



(b)

FIG. 2: ARGO-YBJ sky-map in equatorial coordinates for events with $N_{strip} > 25$. The maps have been smoothed with an angle given by the PSF of the detector. *Plot (a)*: statistical significance of the observation in s.d. The boxes represent the

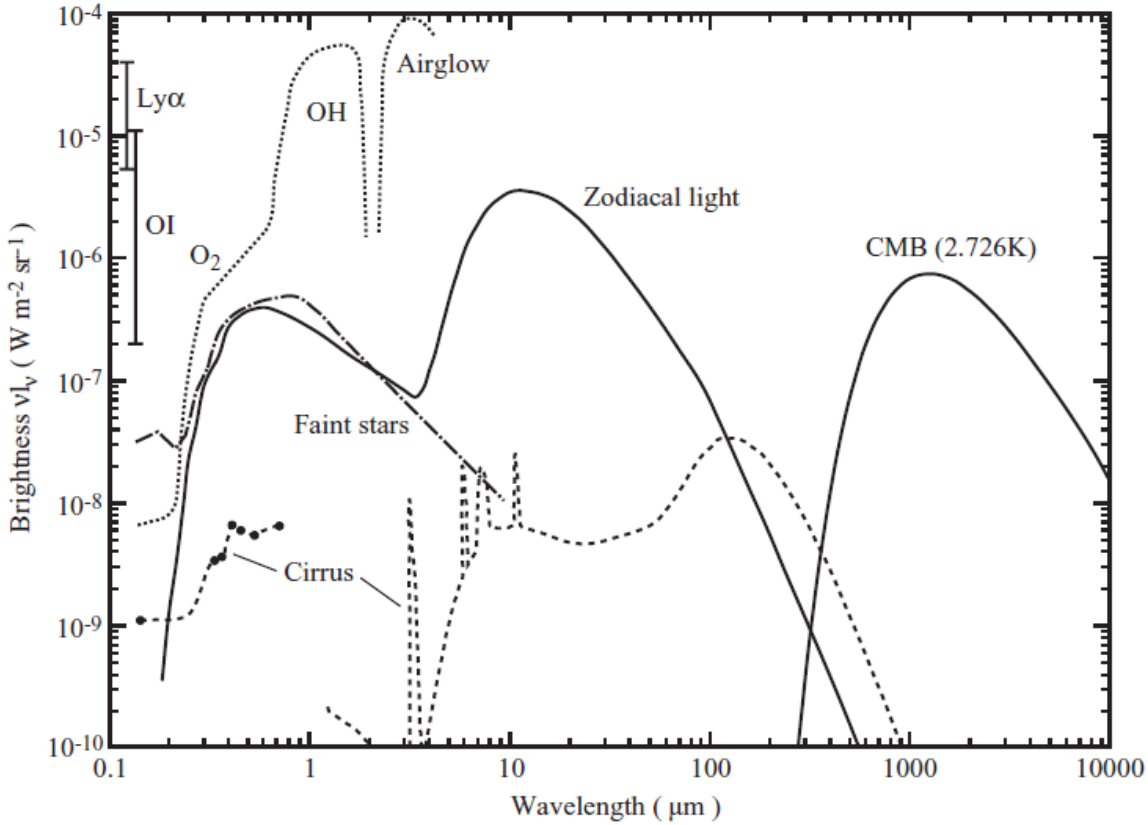
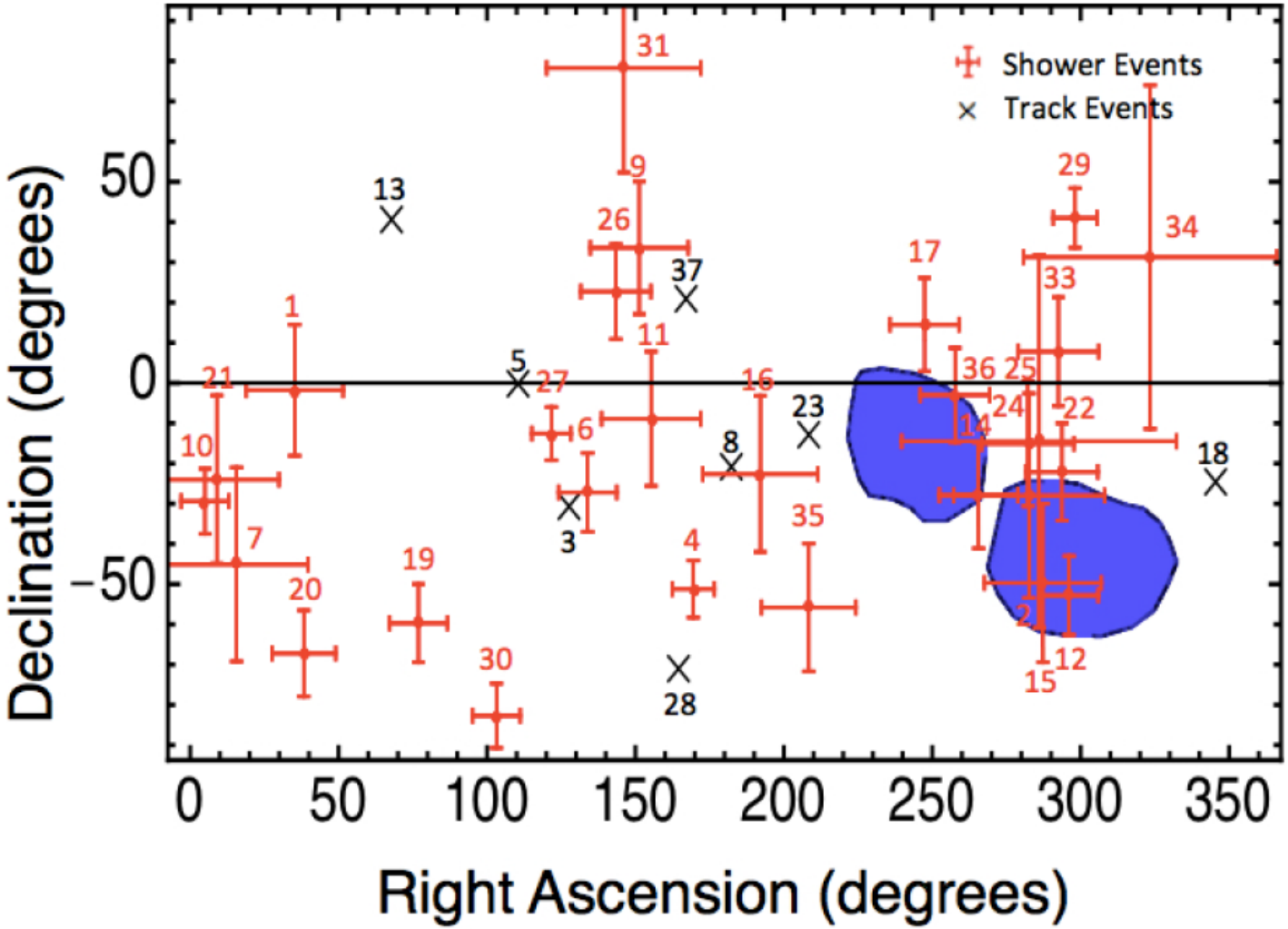


Fig. 1. Overview on the brightness of the sky outside the lower terrestrial atmosphere and at high ecliptic and galactic latitudes. The zodiacal emission and scattering as well as the integrated light of stars are given for the South Ecliptic Pole ($l = 276°$, $b = -30°$). The bright magnitude cut-off for the stellar component is $V = 6.0$ mag for $0.3 - 1$ μm. In the infrared, stars brighter than 15 Jy between 1.25 and 4.85 μm and brighter than 85 Jy at 12 μm are excluded. No cut-off was applied to the UV data, $\lambda \leq 0.3$ μm. The interstellar cirrus component is normalized for a column density of 10^{20} H-atoms cm^{-2} corresponding to a visual extinction of 0.053 mag. This is close to the values at the darkest patches in the sky. Source for the long-wavelength data, $\lambda \geq 1.25$ μm, are COBE DIRBE and FIRAS measurements as presented by Désert et al. (1996). The IR cirrus spectrum is according to the model of Désert et al. (1990) fitted to IRAS photometry. The short-wavelength data, $\lambda \leq 1.0$ μm, are from the following sources: zodiacal light: Leinert & Grün (1990); integrated starlight: $\lambda \leq 0.3$ μm, Gondhalekar (1990), $\lambda \geq 0.3$ μm, Mattila (1980); cirrus: $\lambda = 0.15$ μm, Haikala et al. (1995), $\lambda = 0.35 - 0.75$ μm, Mattila & Schnur (1990), Mattila (1979). The geocoronal Lyman α(121.6 nm) and the OI(130.4, 135.6 nm) line intensities were as measured with the Faint Object Camera of the Hubble Space Telescope at a height of 610 km (Caulet et al. 1994). The various references for the airglow emission can be found in Sect. 6


Shower Events
Track Events
Declination (degrees)
Right Ascension (degrees)
50
0
−50
0
50
100
150
200
250
300
350
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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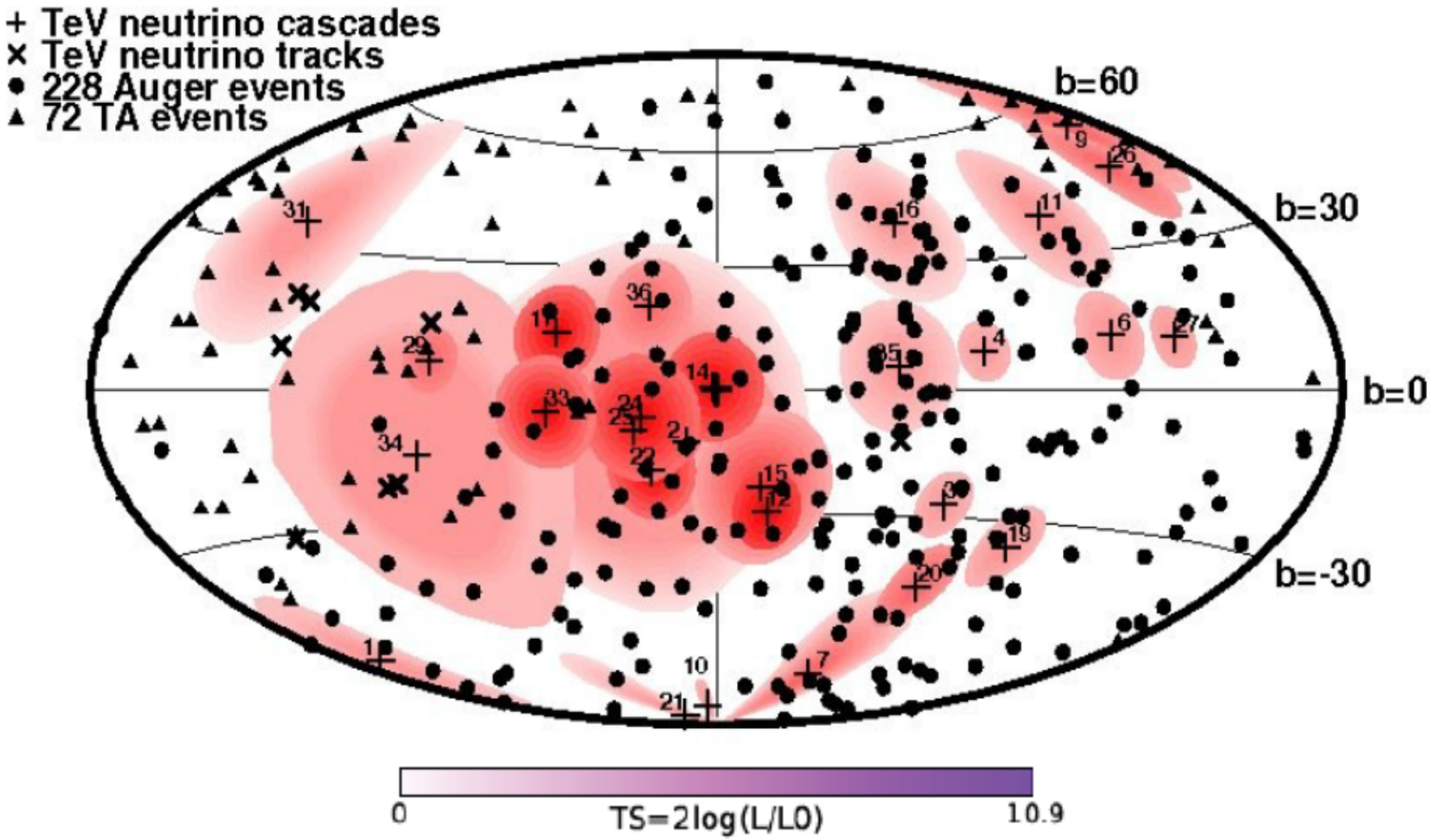
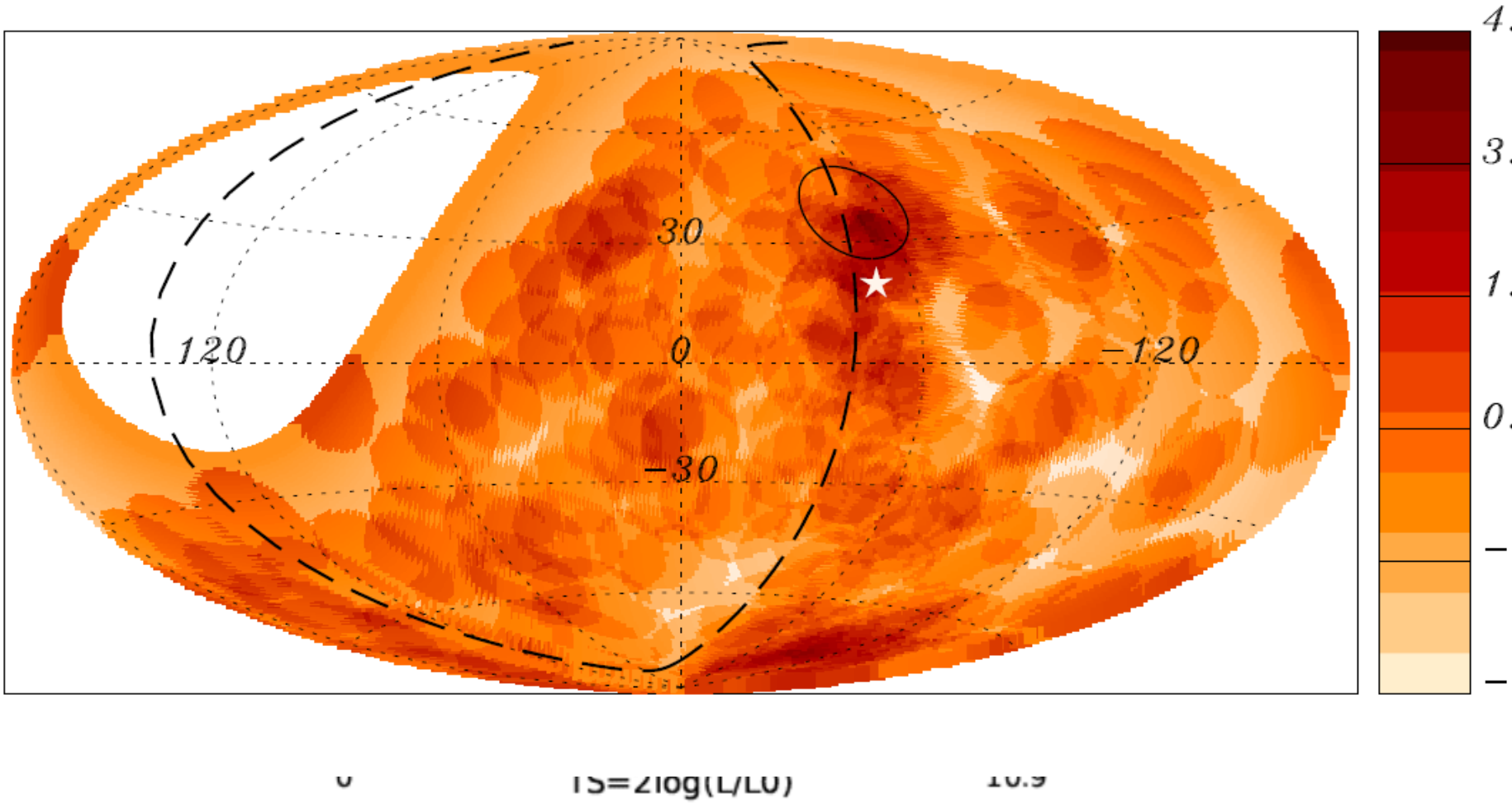
37

Stanev May 2015



latest 231 AUGER UHECR (blue) with additional 72+15=87 TA

Overlapping Highest and Lower UHECR



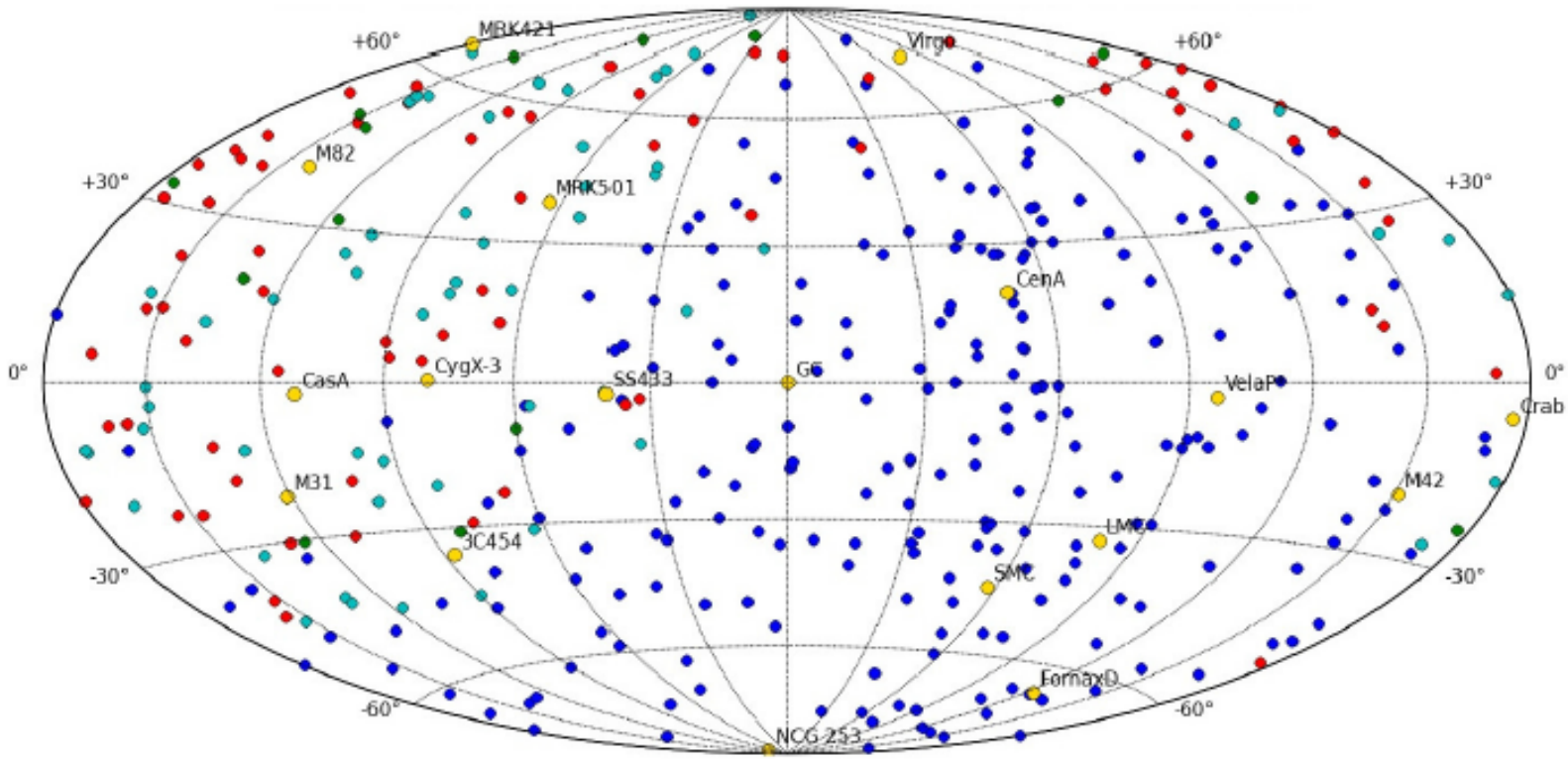
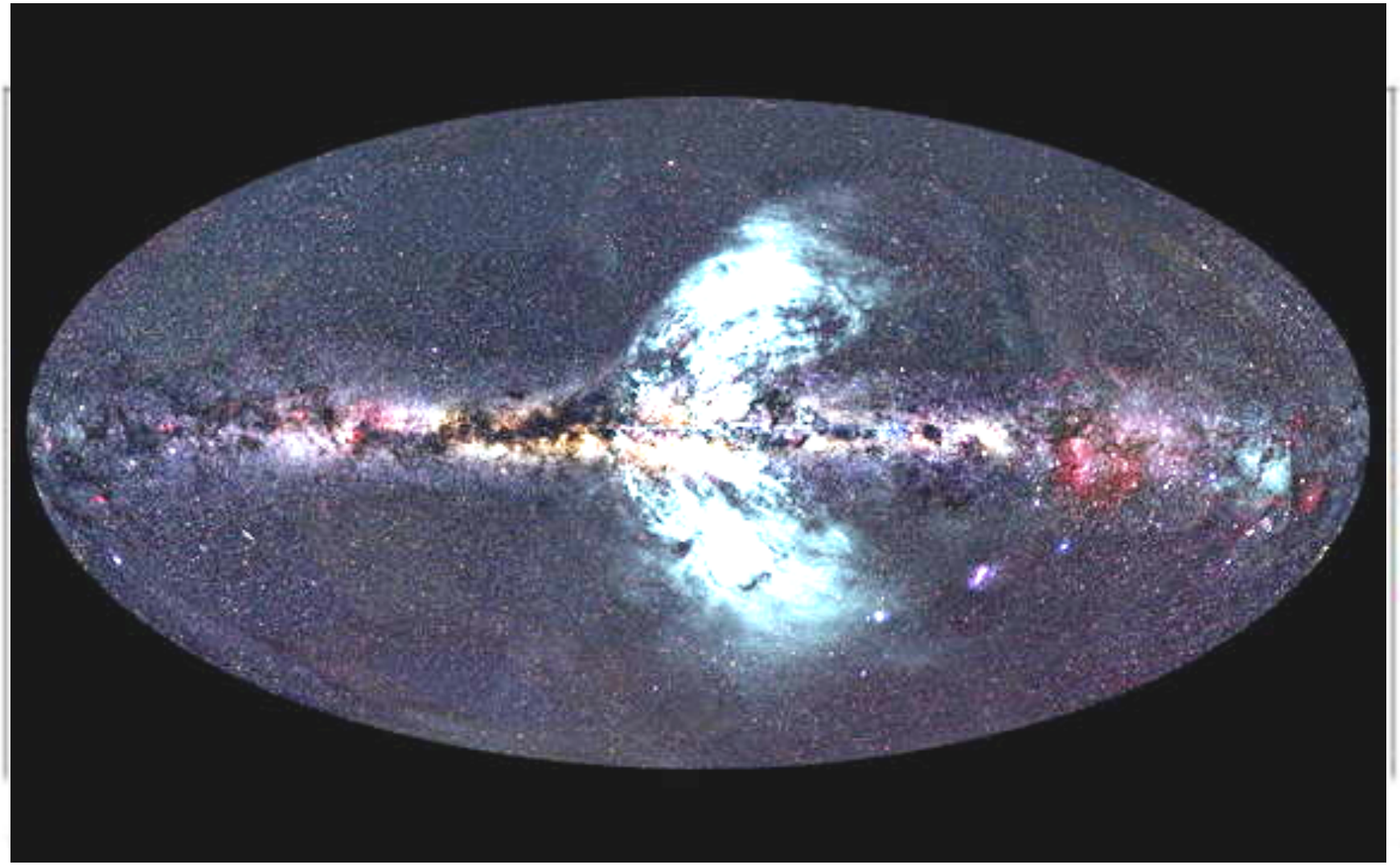


Figure 2. Hammer Projection in Galactic coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 TA (72 blue and 15 green) and 58 AGASA (cyan) records, in a total of 376 events. A few potential sources are labeled.



Stanev May 2015

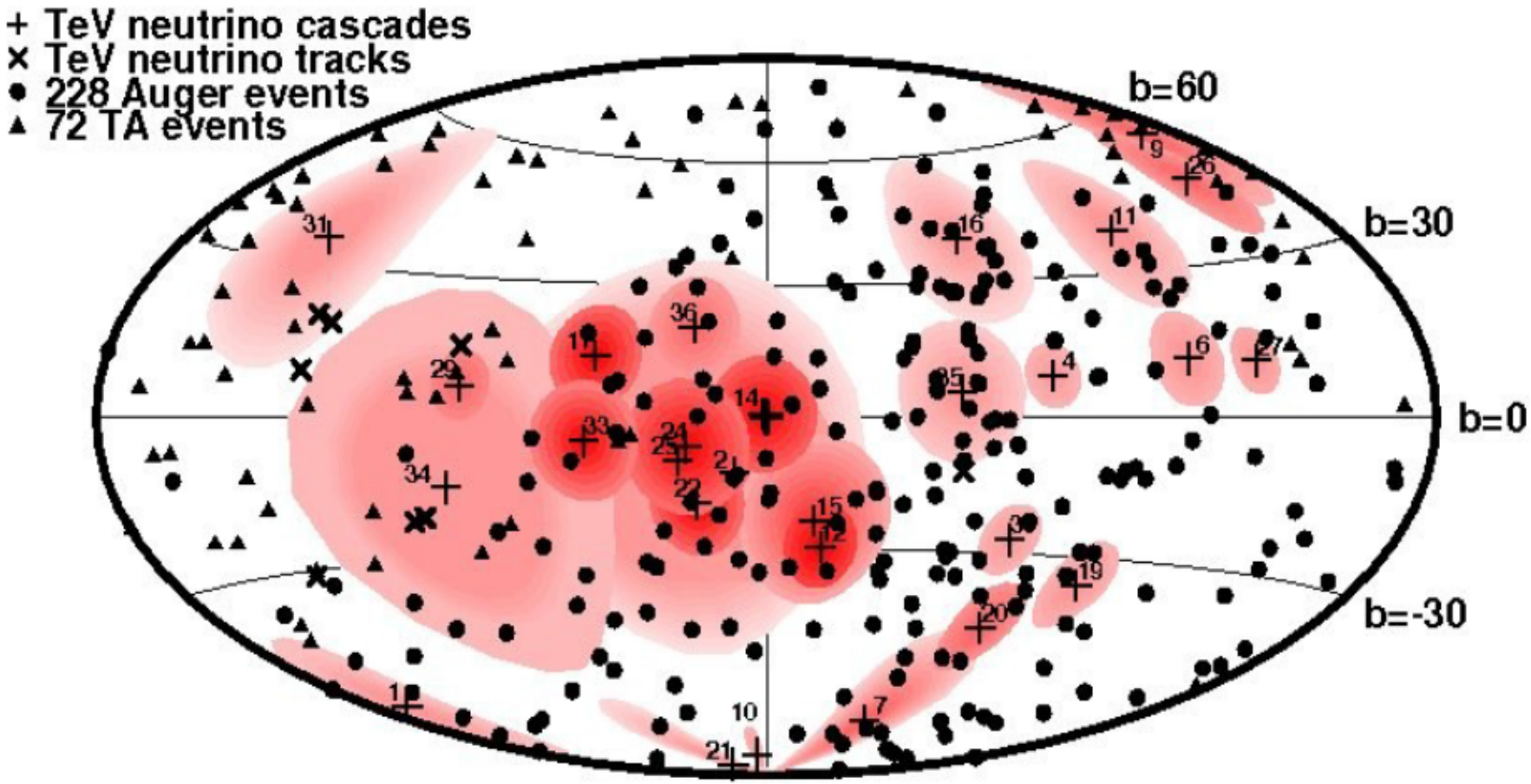


Figure 2. Hammer Projection in Galactic coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 TA

Planck and ICECUBE

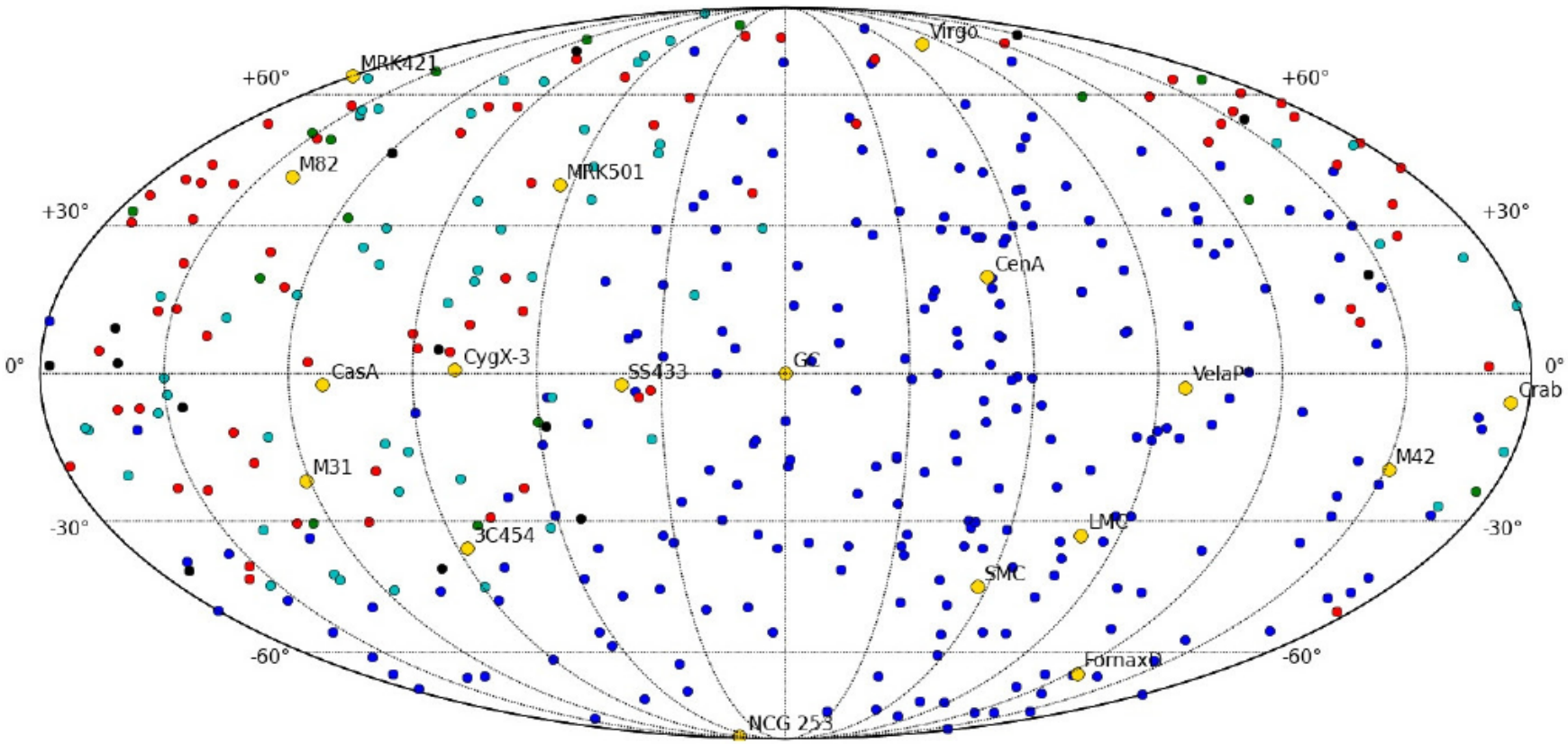
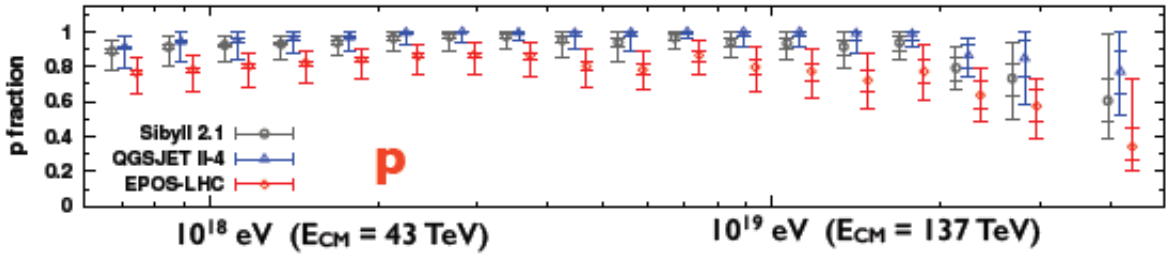
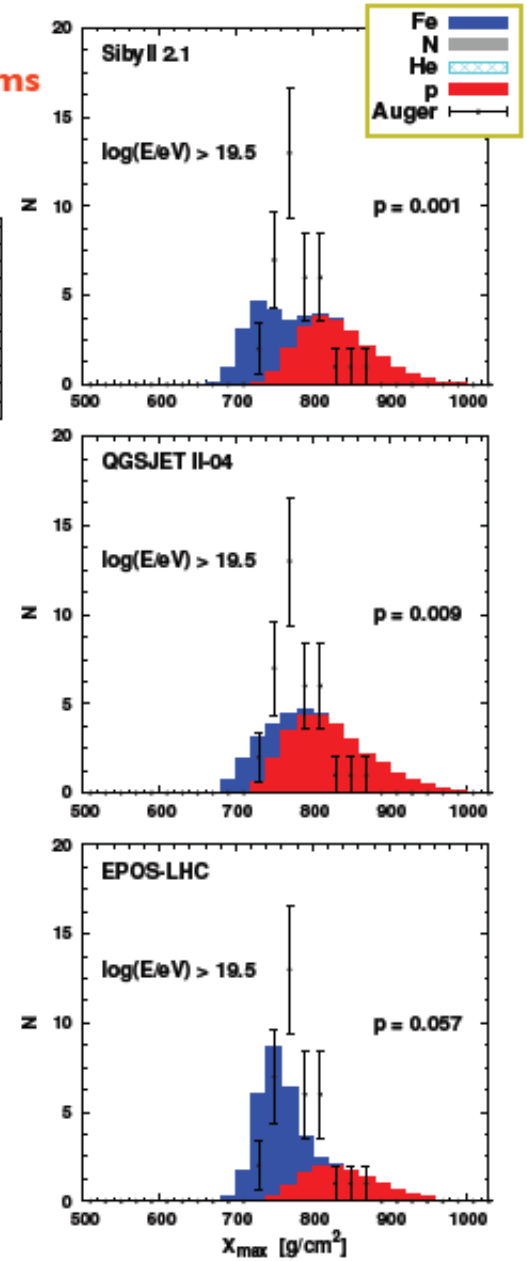


Figure 12. As above, in Mollweide Projection, Galactic Coordinate map for 231 AUGER UHECR, 72+15=87 TA, 58 AGASA

Lack of Fe nuclei

Stacked histograms



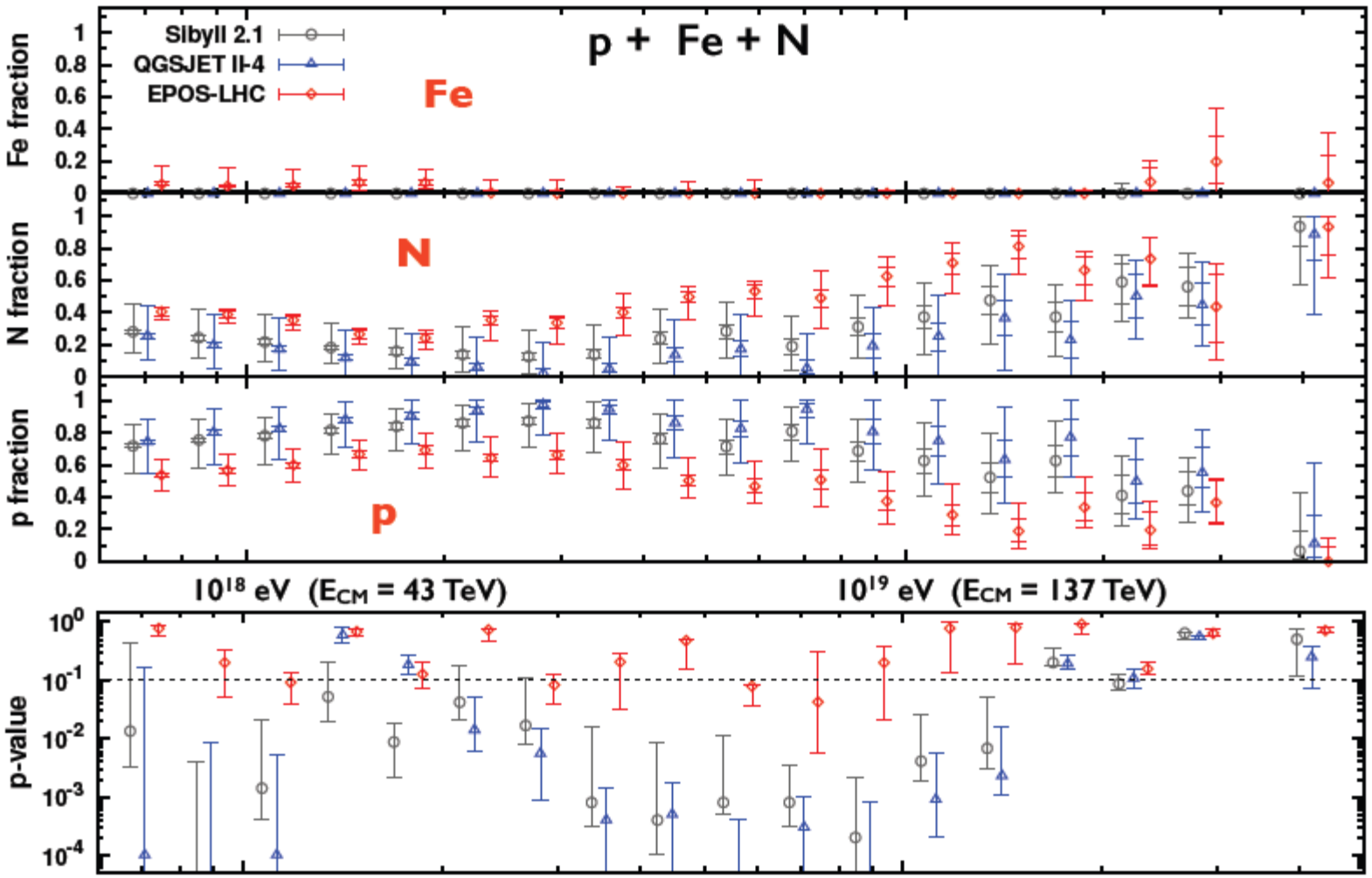


Fe distribution:

- too shallow (small X_{max})
- peaks at smaller X_{max} than data
- wider than data

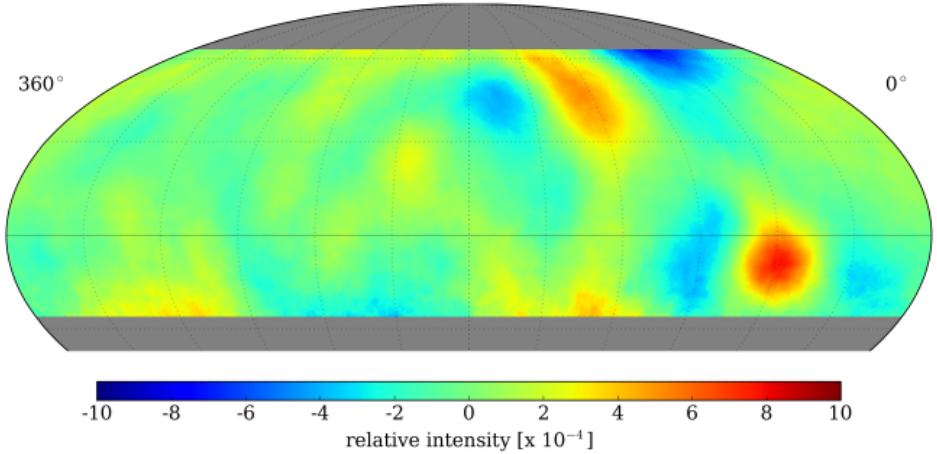
} for all models considered

➡ Data need a distribution that is deeper (larger X_{max}) and narrower



- Better fit quality for EPOS-LHC, but not for Sibyll 2.1 & QGSJET II-4

Hawc 2015 –TEVS-icrc



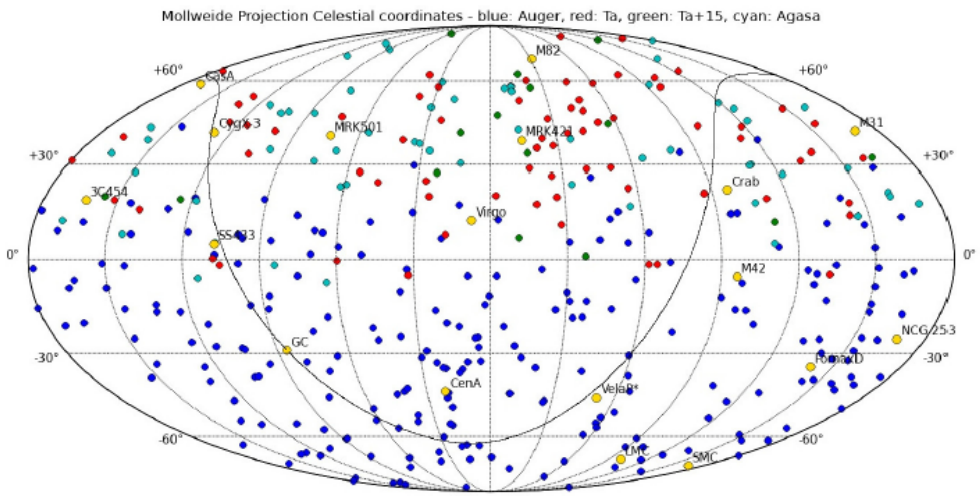
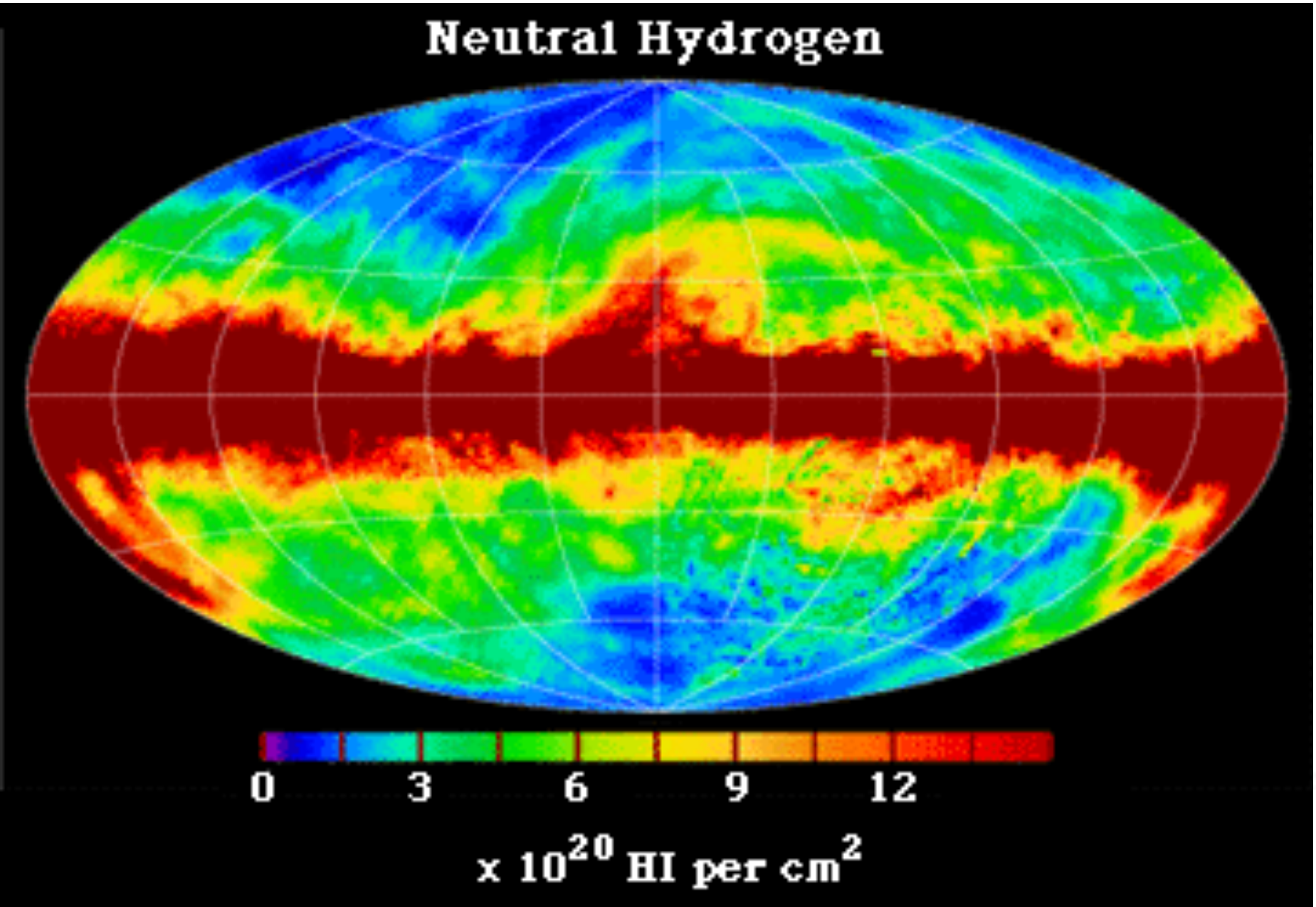


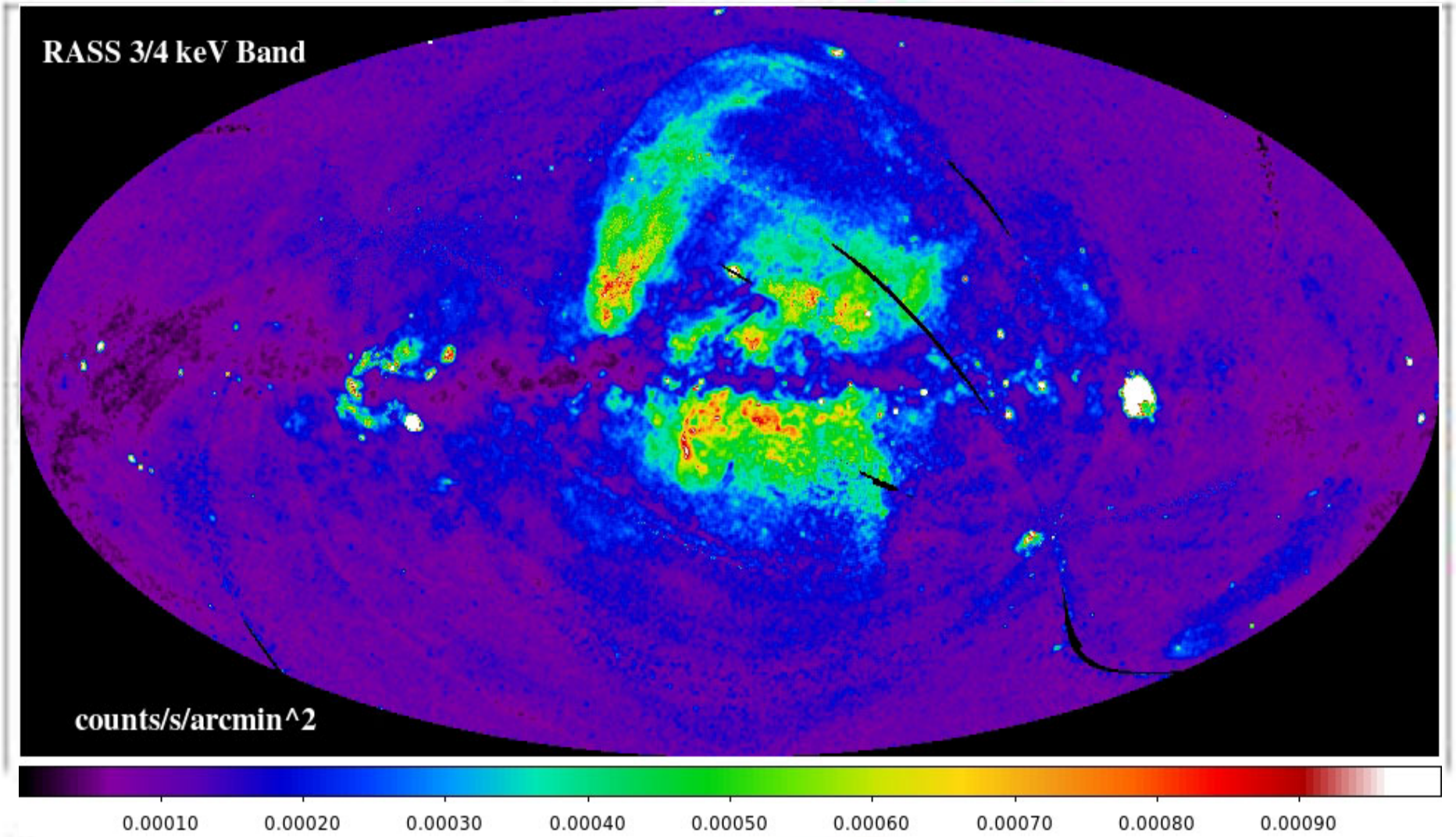
Figure 2: Rela
subtraction of tl
with 10° smootl

Figure 3. Mollweide Projection in Celestial coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 latest TA (72 red and 15 green) records. A few potential sources

flux after fit and
he map is shown

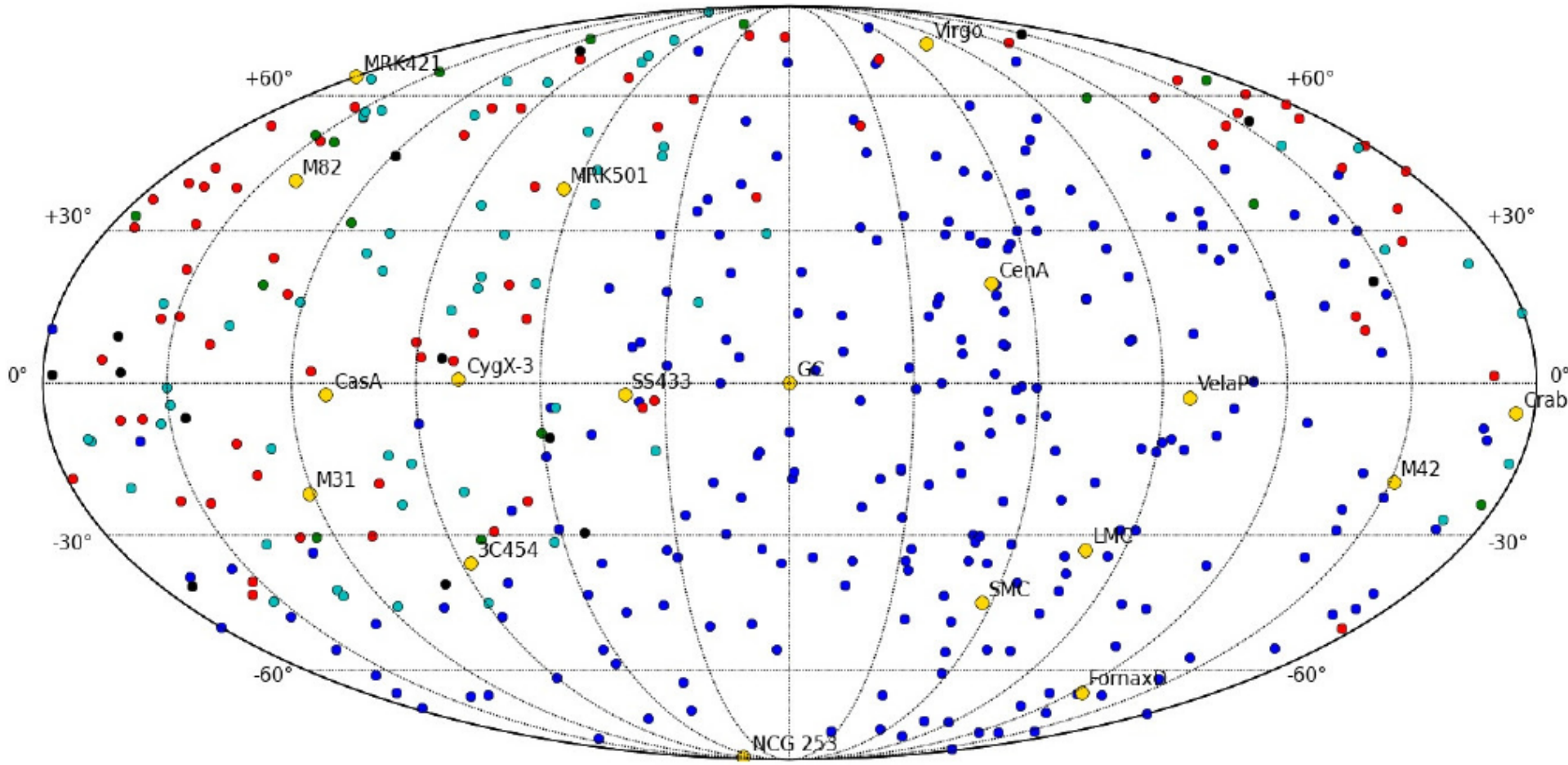

Neutral Hydrogen
0
3
6
9
12
x 10^20 HI per cm^2

0.75 KeV


RASS 3/4 keV Band
counts/s/arcmin^2
0.00010
0.00020
0.00030
0.00040
0.00050
0.00060
0.00070
0.00080
0.00090

Fermi 2 years

Fermi two-year all-sky map



Hammer Galactic

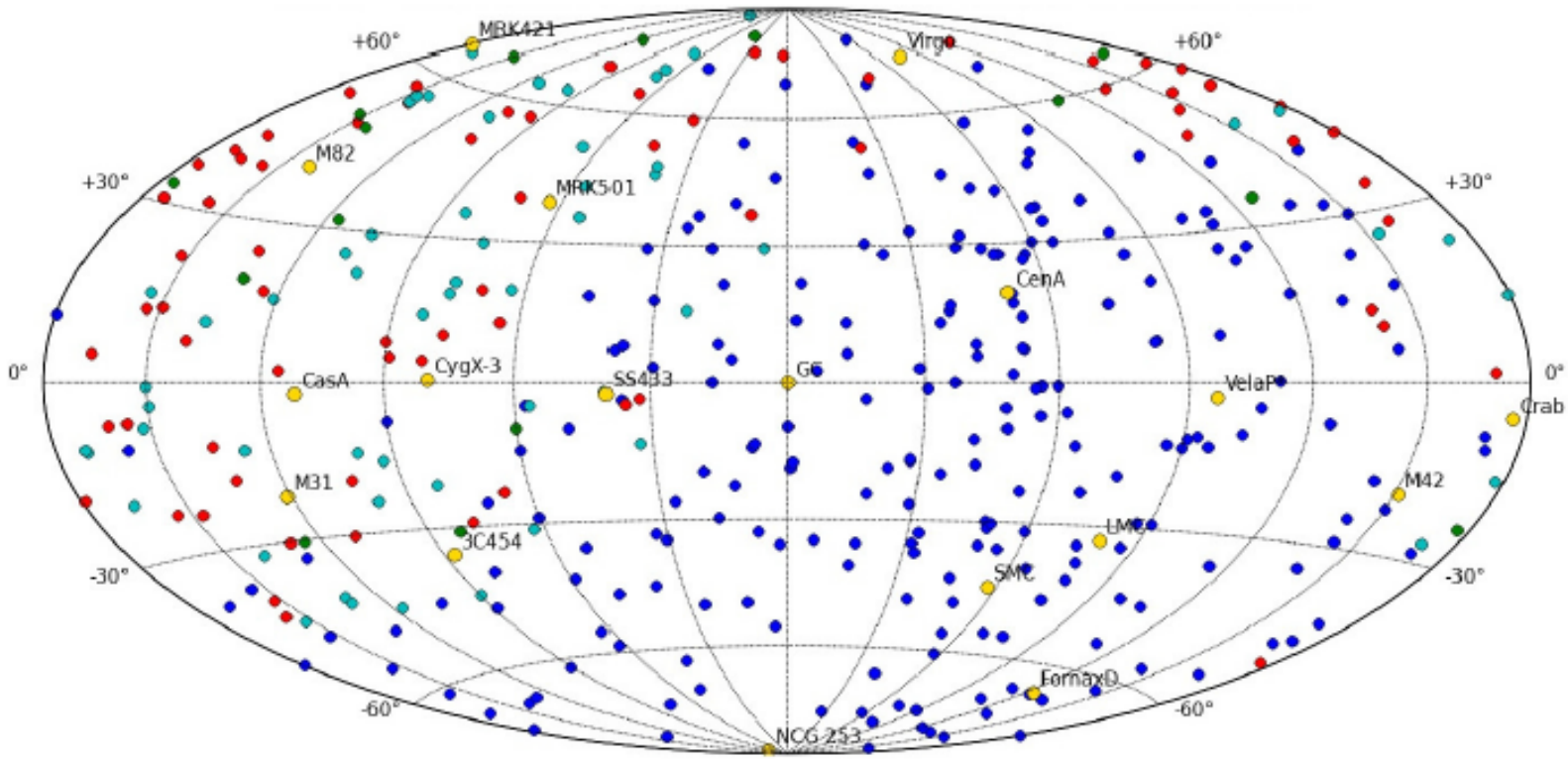
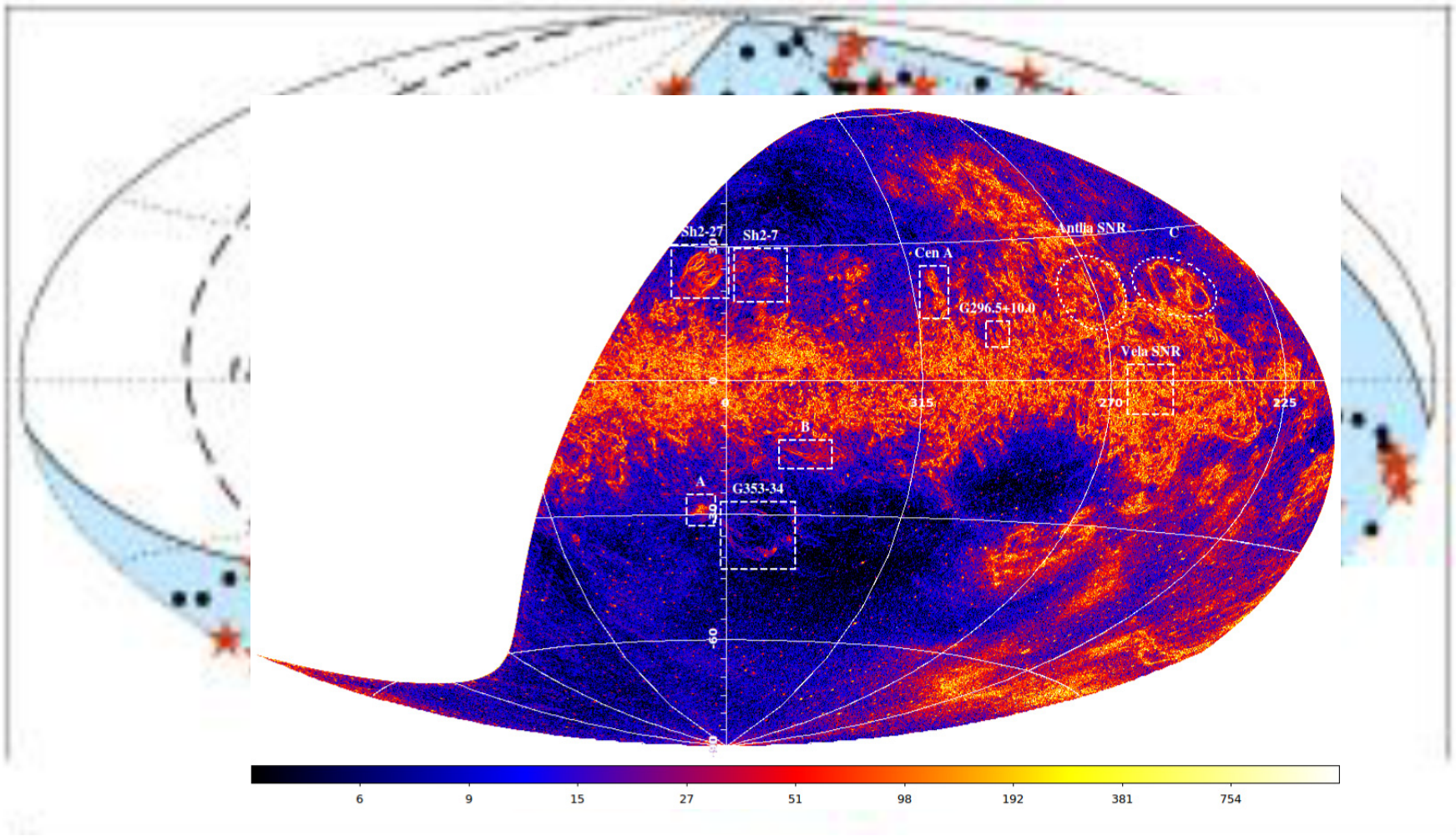


Figure 2. Hammer Projection in Galactic coordinates for the latest 231 AUGER UHECR (blue) with additional 72+15=87 TA (72 blue and 15 green) and 58 AGASA (cyan) records, in a total of 376 events. A few potential sources are labeled.

Radio plasma turbolence



Dust Intensity & Polarization

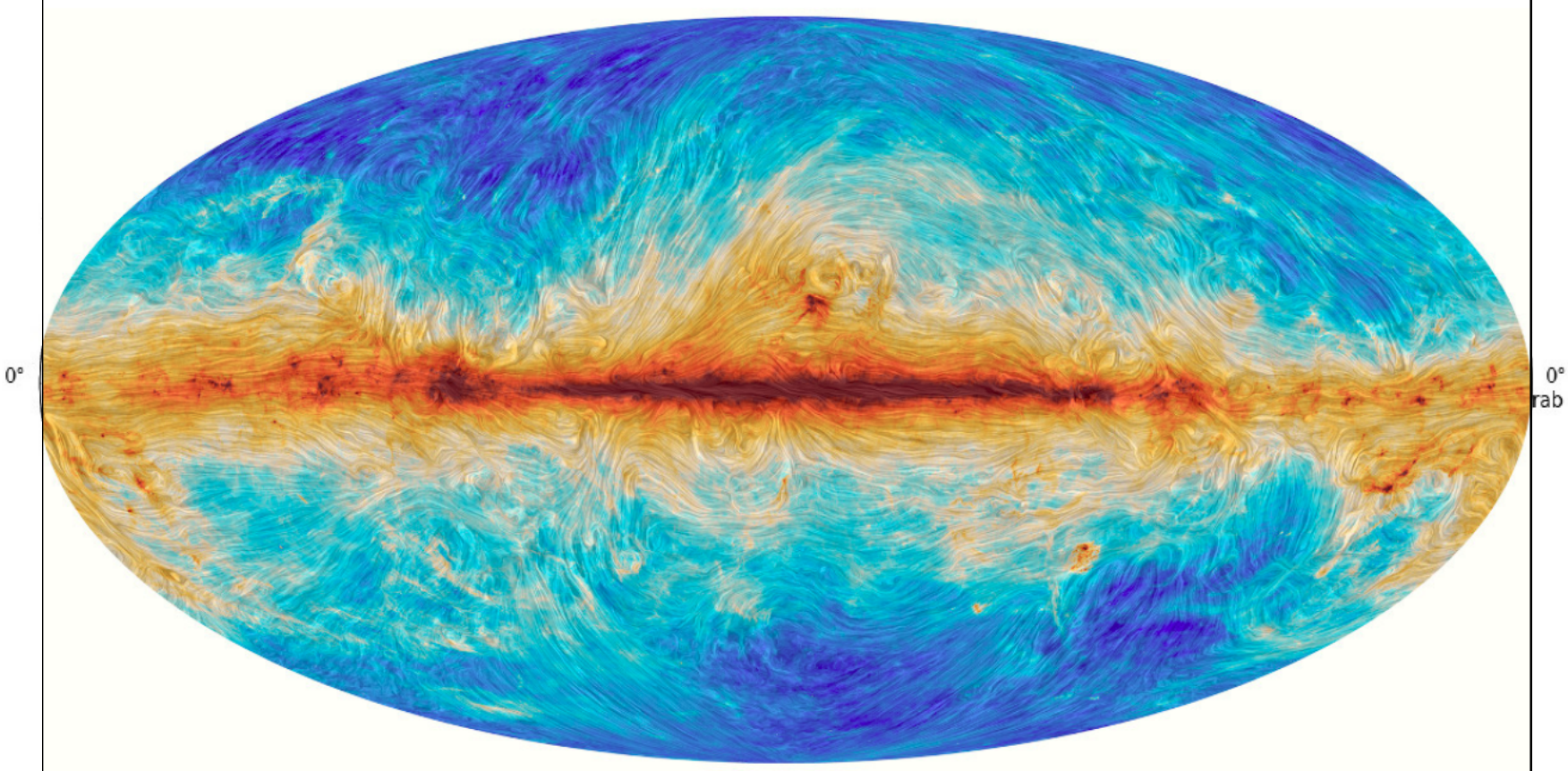
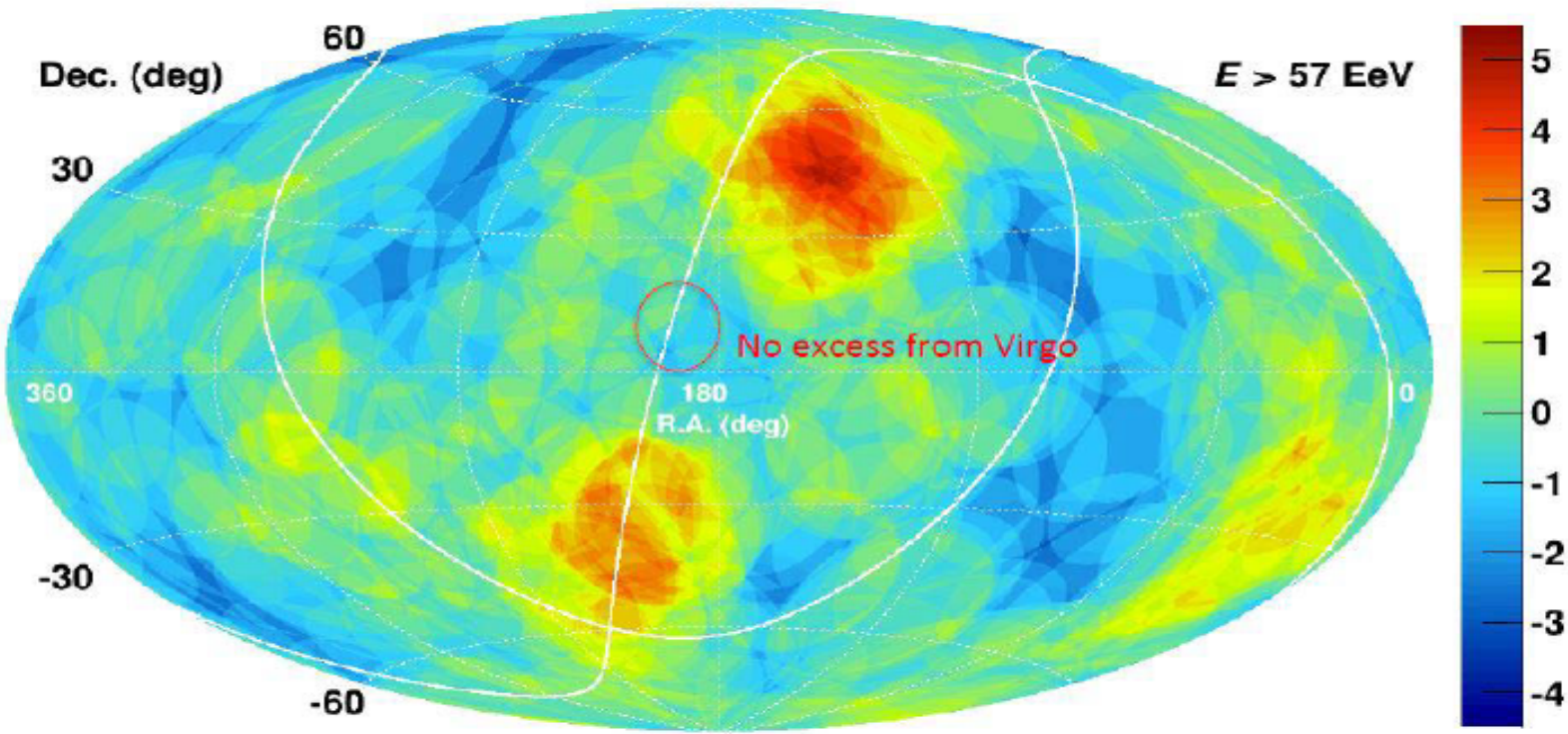


Figure 12. As above, in Mollweide Projection, Galactic Coordi-

First TeVs-UHECR connections 2012

Cen A persistence and Virgo

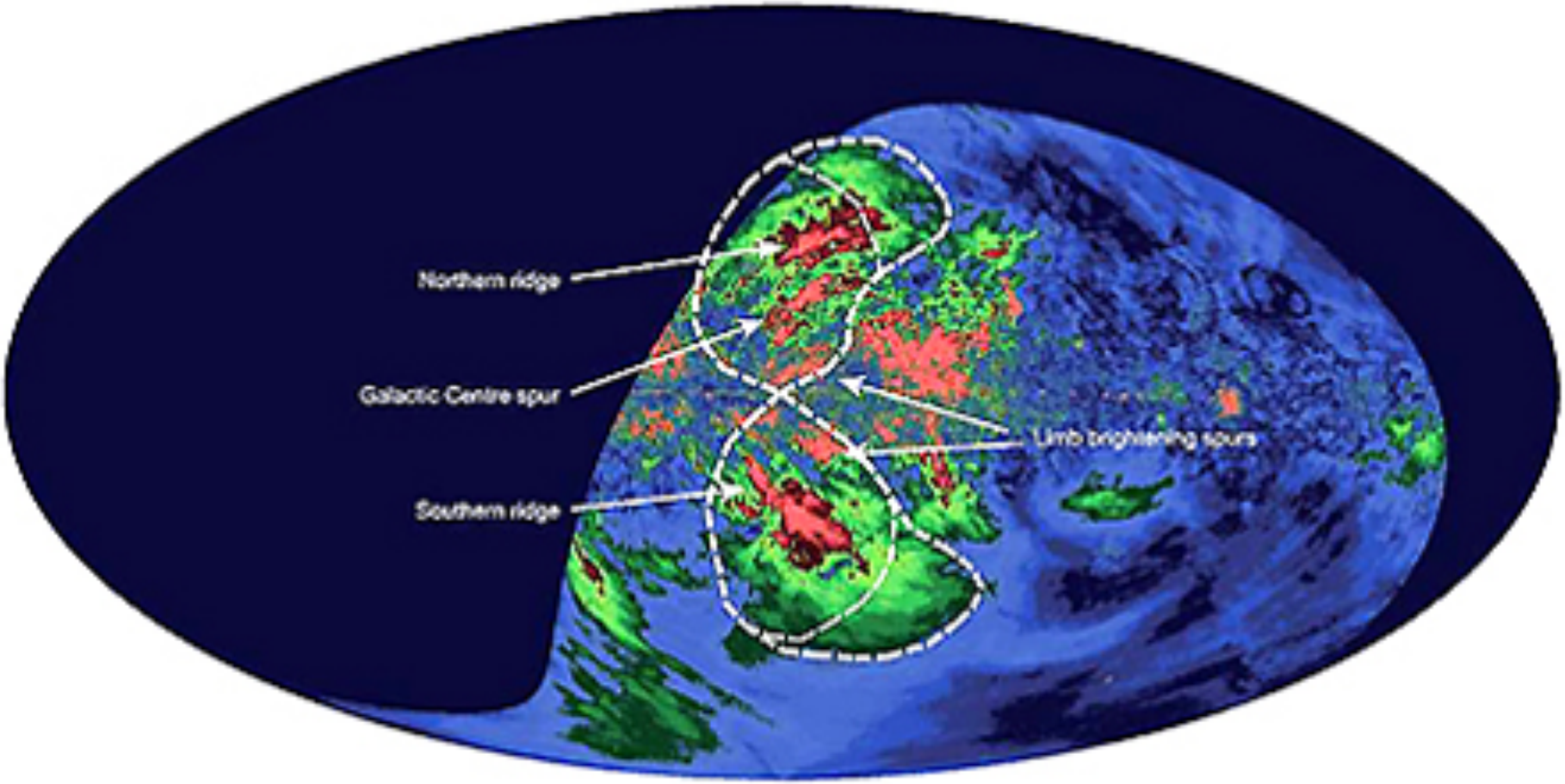
TA 6 Years + Auger 10 Years



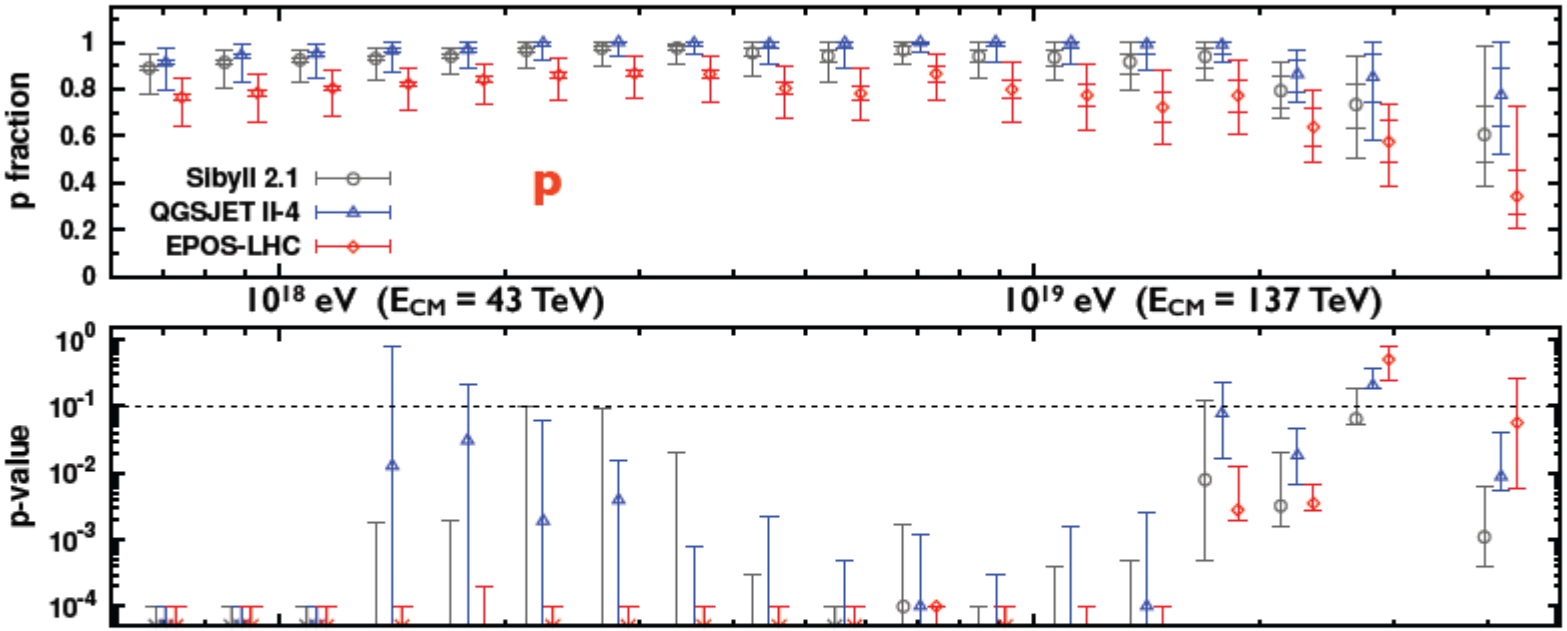
North: S_{MAX} = 5.19σ, (R.A, Dec.) = (148.4°, 44.5°)
South: S_{MAX} = 3.57σ, (R.A, Dec.) = (210.9°, -48.2°)

A.Aab et al, arXiv:1411.6111v1

Radio Fountain



p + Fe hypothesis



- Mostly to mainly protons for E < 10^{19} eV
- Poor quality fit: hadronic interaction models cannot describe data with p & Fe

  ➡ hypothesis of **only p and Fe not feasible** - something else required