Heavy Quark and Leptons in the Universe and their eventual trace in LHC

- This talk has is being summirized in the first 9 slides: present bounds on LHC and new results on dark matter candidates makes Heavy Quarks and Leptons proposal (within Standard Model) in difficulties. Therefore we shall discuss in our main presentation Nuclear Composition role in UHECR.

Earliest ideas: 4th Leptons and Quarks
in a Sinister Universe (brief remarks) since 2005
or

TeraLeptons Shadows over Sinister Universe

by D.Fargion and M.Khlopov** in **hep-ph/0507087
and
more recent

Dark matter with invisible light from heavy double charged leptons of almost-commutative geometry?

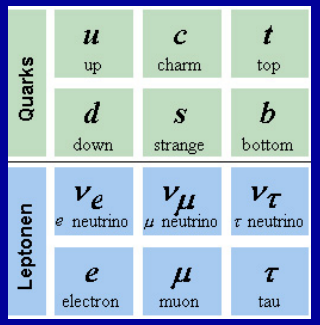
M.Yu. Khlopov∗C.A. Stephan† D. Fargion

arXiv:astro-ph/0511789v2 20 Nov 2006

The paper was inspired by**:**
Sheldon L. Glashow and Andy Cohen
A Sinister Extension of the Standard Model to SU(3)XSU(2)XSU(2)XU(1)
in
hep-ph/0504287

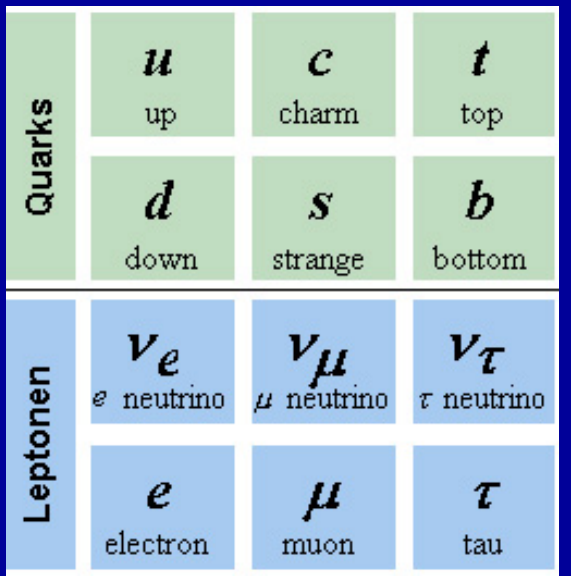
Abstract on 4th family

- ***The role of Sinister Heavy Fermions in 2005 Glashow's SU(3)*SU(2)*SU(2)'*U(1) model is to offer in a unique frame relic Helium-like products (an ingenious candidate to the dark matter puzzle), a solution to the See-Saw mechanism for light neutrino masses as well as to strong CP violation problem in QCD. Their mass are million times larger than common ones***
- ***The Sinister model requires a three additional families of leptons and quarks, but only the lightest of them Heavy U-quark and E-"electron" are stable.***



U

E



Why Heavy relic are useful? Because old dark matter Problem (galactic rotation) and very recent candidates DAMA-(50-100-GeV)---CREST (20-40 GeV): room for heavy Neutrinos, not tera-quarks..however the sinister scenario offered..

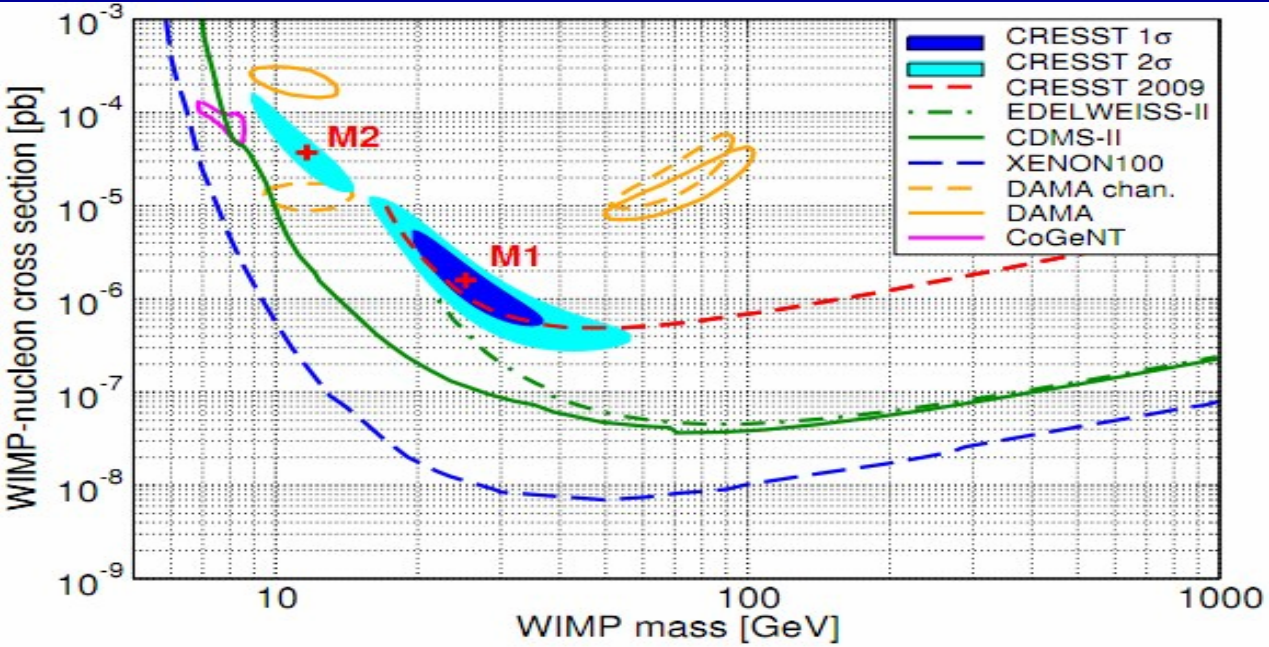


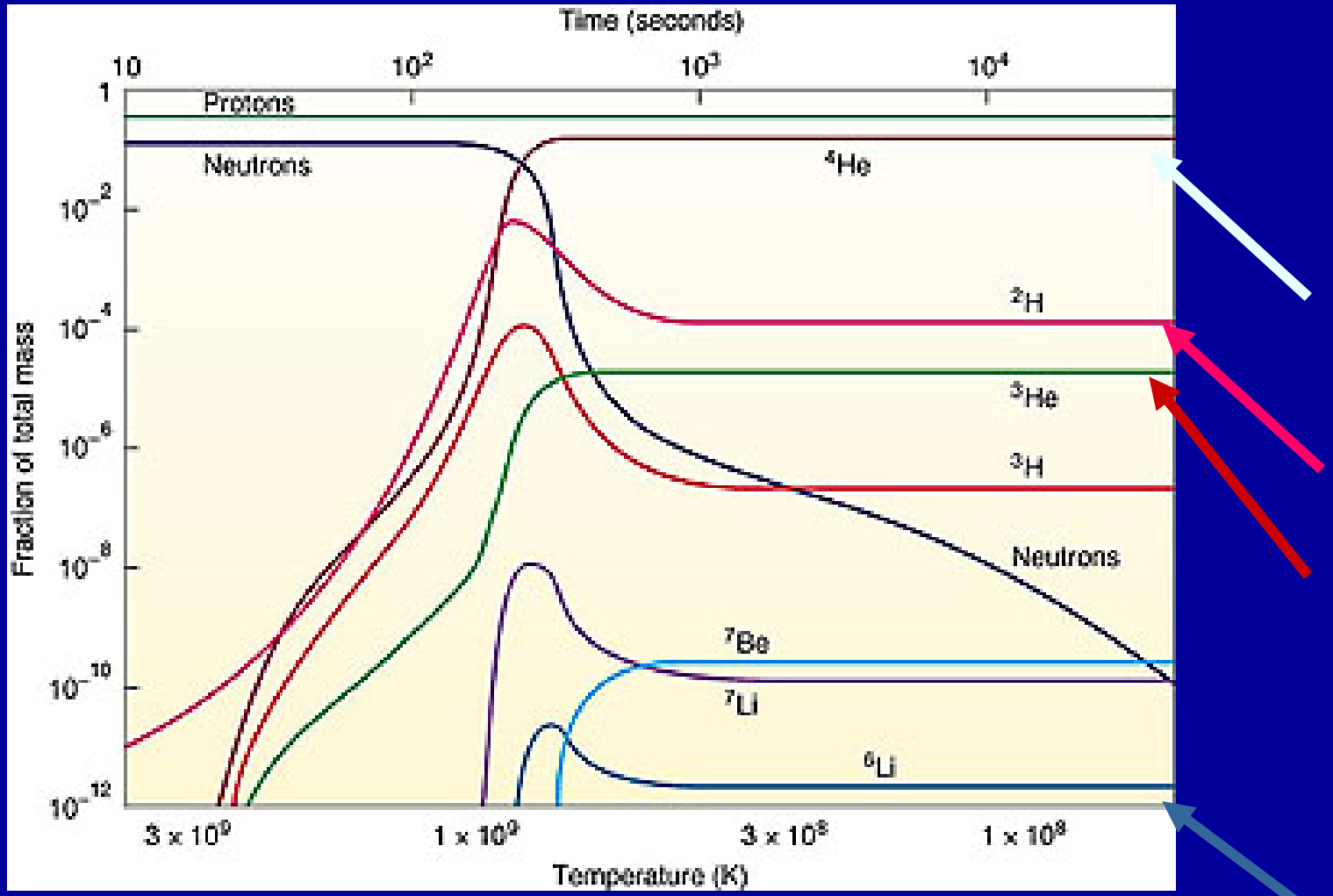
Fig. 13. The WIMP parameter space compatible with the CRESST results discussed here, using the background model described in the text, together with the exclusion limits from CDMS-II [12], XENON100 [13], and EDELWEISS-II [14], as well as the CRESST limit obtained in an earlier run [1]. Additionally, we show the 90% confidence regions favored by CoGeNT [15] and DAMA/LIBRA [16] (without and with ion channeling). The CRESST contours have been calculated with respect to the global likelihood maximum M1.

Final neutral Helium-like UUUEE state is an ideal evanescent dark-matter candidate **(200-900 GeV).**

Why Tera-helium is a good Dark Matter gas?

- Teraparticles do not have normal W and Z interactions and do not contribute into SM parameters, so they can not be excluded by precision measurements of SM parameters
- CP' symmetry of Glashow's model helps to solve strong CP violation problem in QCD.
- Tera-neutrino is unstable, because it gives Dirac see-saw mass to normal neutrino.
- UUU as the new form of hadron - bound by ChromoCoulomb forces. It's size is about 1/alpha_QCD m_U about 10^-16 cm and it weakly interacts with hadrons.

However UUUEE it is reached by multi-body interactions along a tail of more manifest secondary frozen blocks in analogy to He,Li,D. They should be now here polluting the matter.



New ideas surviving cosmic bounds, based on twin heavy Lepton

- Dark matter with invisible light from heavy double charged leptons of almost-commutative geometry
- M Yu Khlopov1,2, C A Stephan3 and D Fargion
- **M Yu Khlopov *et al* 2006 *Class. Quantum Grav.* 23 7305**

However there are reasons to stop for speculations on the presence of New Family Quarks/Leptons at LHC and to consider hot UHECR nuclear adventure:

UHECR composition and Multiplets

- Since a century we do not know the source of Cosmic Rays.
- UHECR at 10-100 EeV may hold directionality offering a new astronomy.
- **GZK cut off will make UHECR sources near:40Mpc**
- HIRES and Auger now gave or seem to show the GZK cut off

However Nuclear composition is an unresolved key problem

As well as new UHECR and multiplets maps

UHECR spectra composition and maps by lightest nuclei from nearest universe

..see arxiv1106.3749

..and

-by ICRC 2011....

UHECR fragment clustering

in multiplets tails

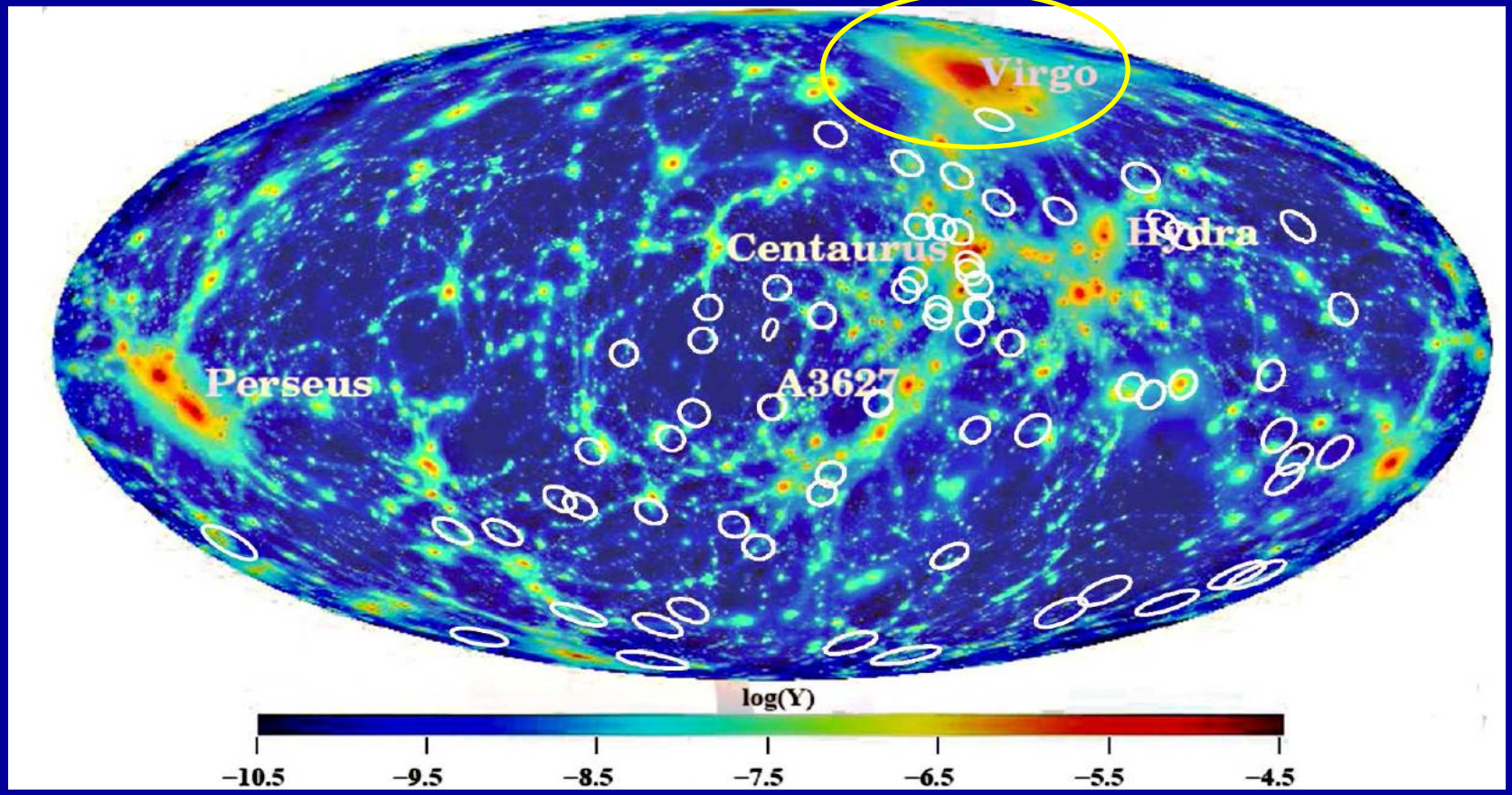
.. *arxiv1107.4805*

Daniele Fargion, Rome University Sapienza and INFN

Abstract and Summary

- ***UHECR should open a new astronomy window because of rigidity and nearby GZK Universe space.***
- ***2007 AUGER correlation with the super- galactic plane faded away in 2010.***
- ***UHECR composition (nuclei) on 2007 and 2010 disagree with directionality (proton).***
- ***Since 2007, Cen A is the only nearby (4 Mpc) source where UHECR events are clustering (15-20%),***
- ***Virgo events are (almost) absent.***
- ***We solve these puzzles assuming UHECR as He like nuclei Such UHECR He-like fragments at half energy should also cluster along UHECR tail…Has it been observed? arxiv1107.4805***
- ***GZK neutrino may rise by He nuclei fragmentation***
- ***at tens-hundred TeVs in Icecube and tau neutrino at PeVs by upward Tau airshower in fluorescence in Auger-TA-***

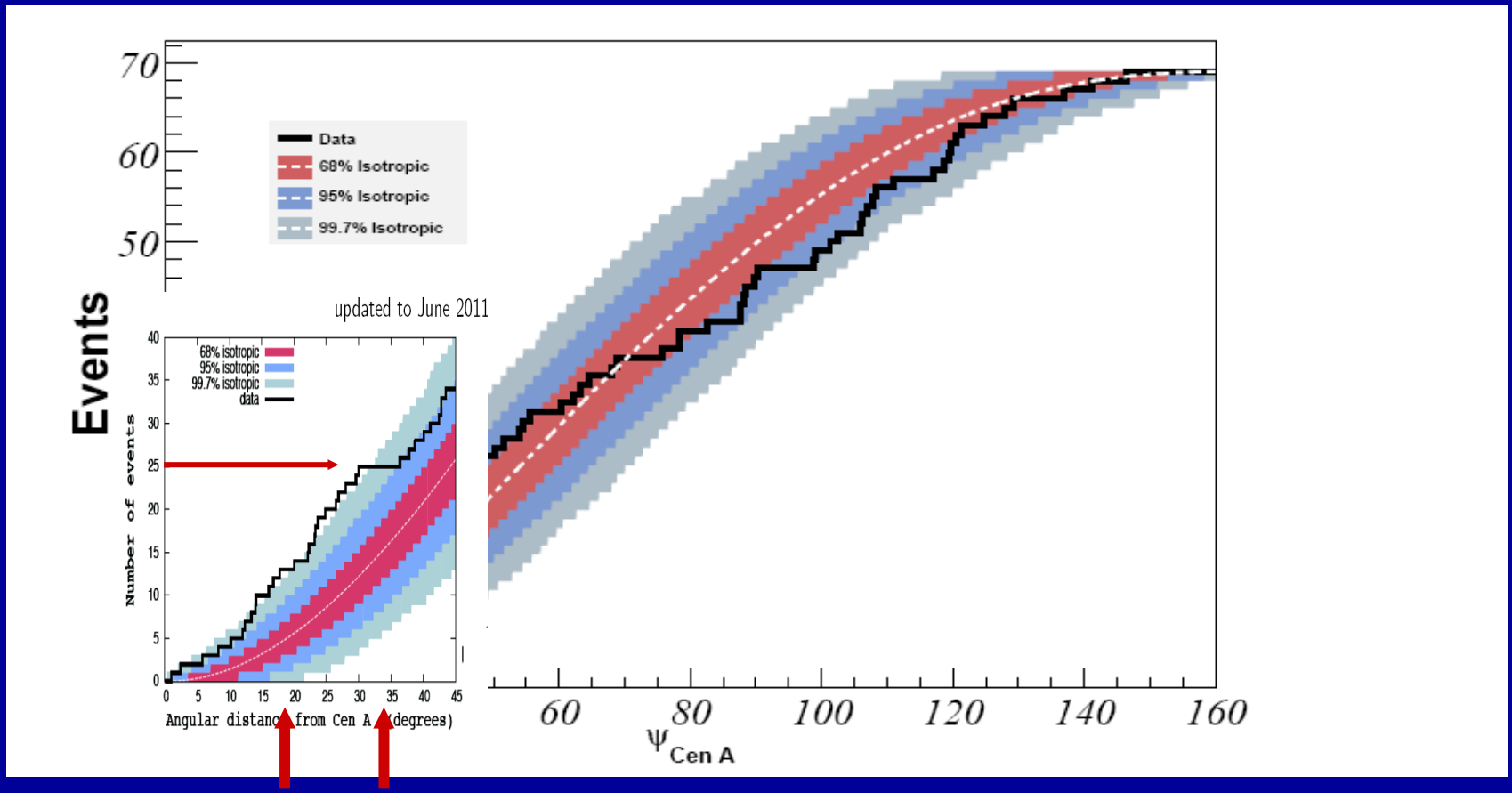
IR and UHECR. The Virgo Absence: only light nuclei may be cut-off



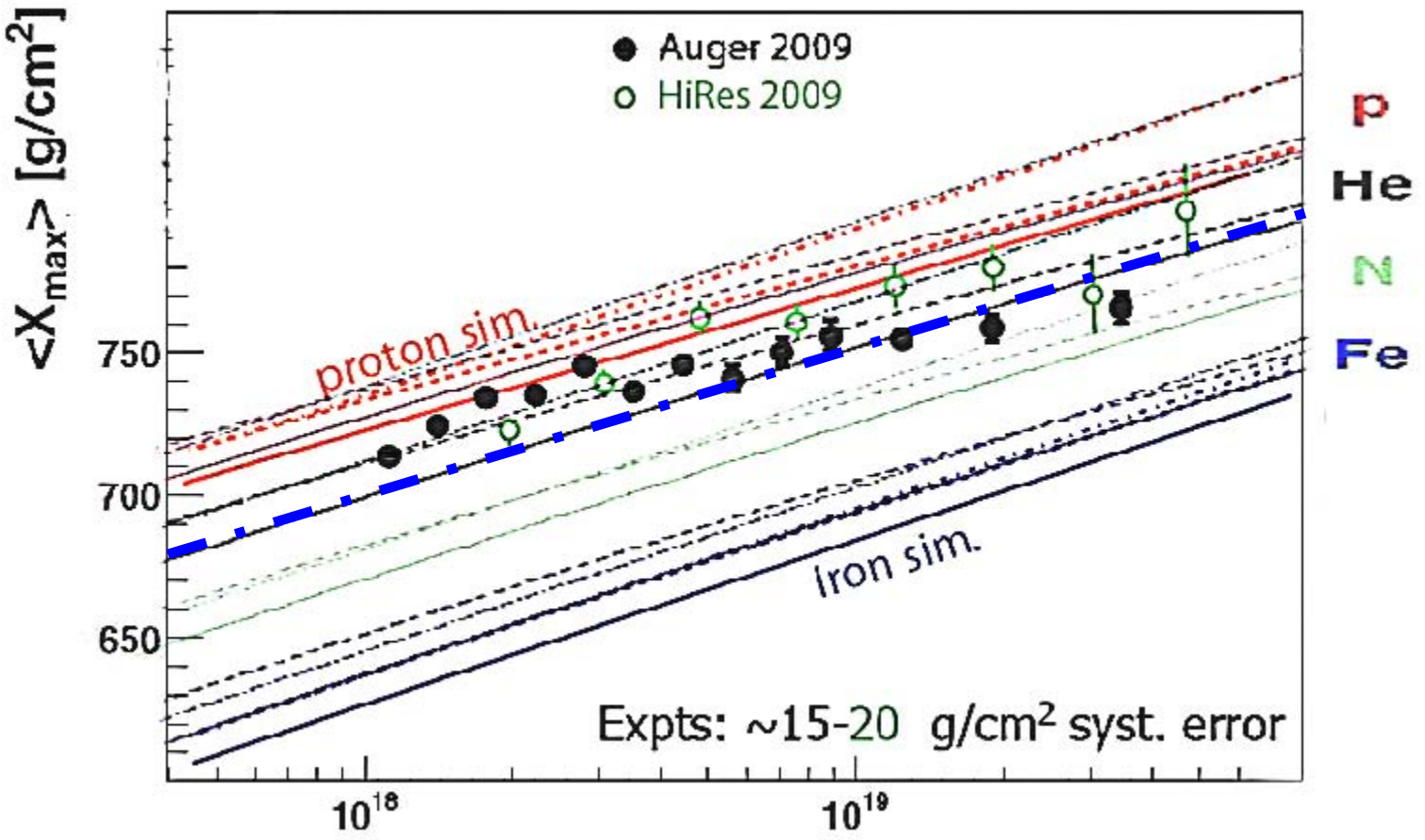
WHY NOT to agree with GZK Volume as AUGER belief = proton+ SGP?

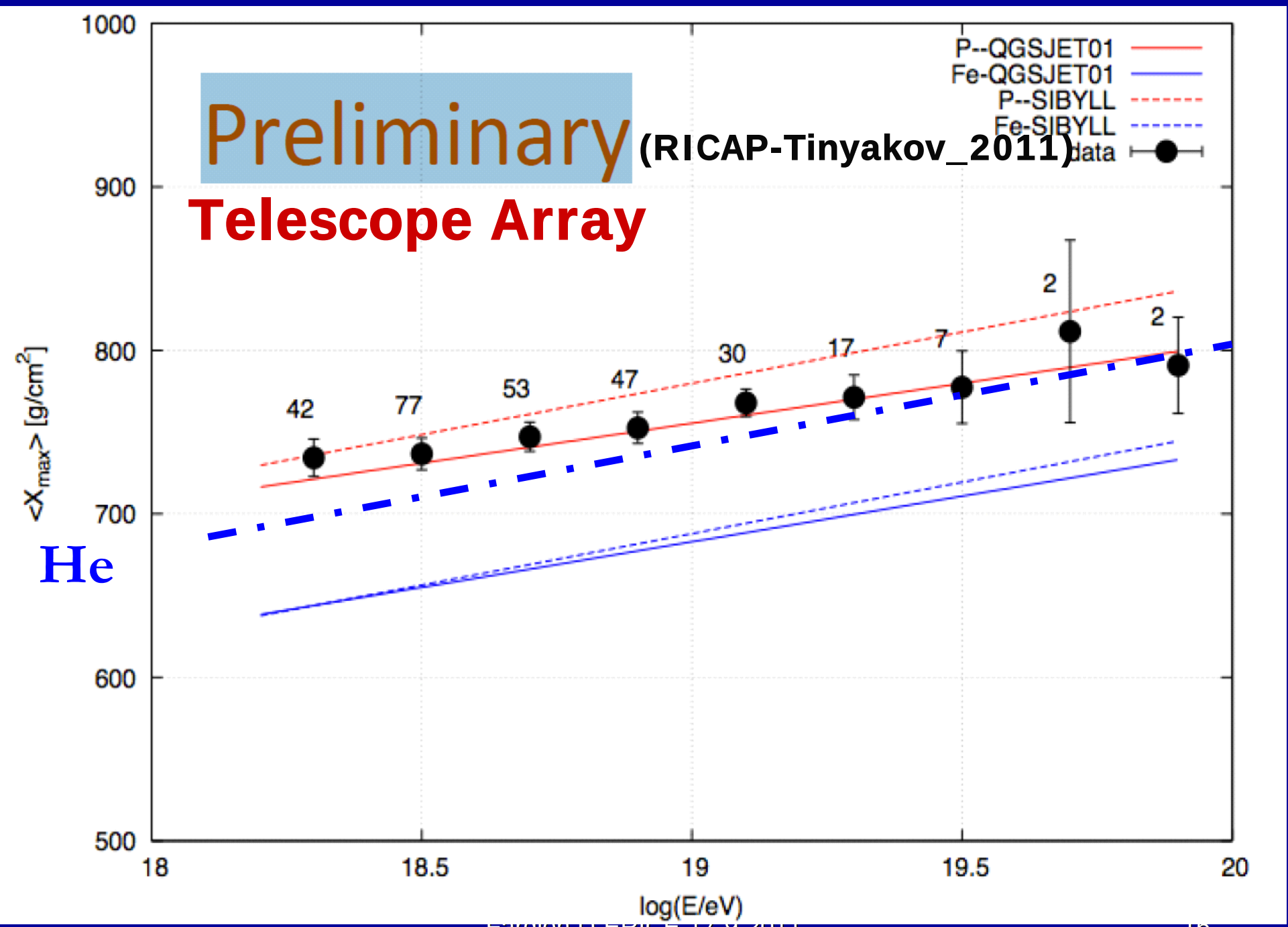
- MOSTLY BECAUSE THE SAME AUGER CLAIM FOR A HEAVY (A > proton) COMPOSITION IN UHECR

More evident the Cen-A spread angle imprint: not consistent with p nor Fe, but Ok with He UHECR—also last 84 events

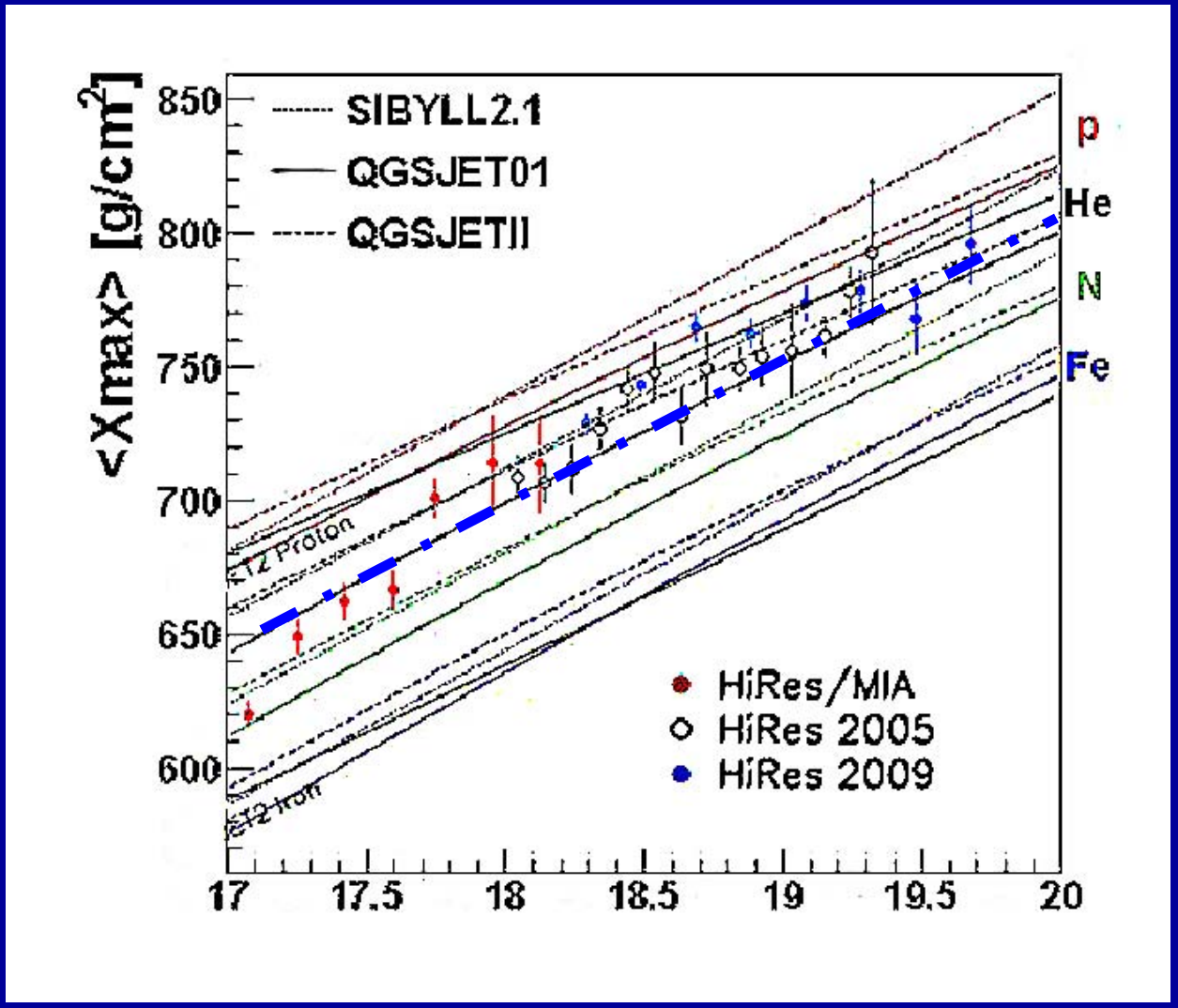


AUGER Composition updated: agree wiyh He




Preliminary
(RICAP-Tinyakov_2011)
Telescope Array
P--QGSJET01
Fe-QGSJET01
P--SIBYLL
Fe-SIBYLL
data
1000
900
800
700
600
500
18
18.5
19
19.5
20
log(E/eV)
<Xmax> [g/cm2]
42
77
53
47
30
17
7
2
2
He

Hires claim 2009



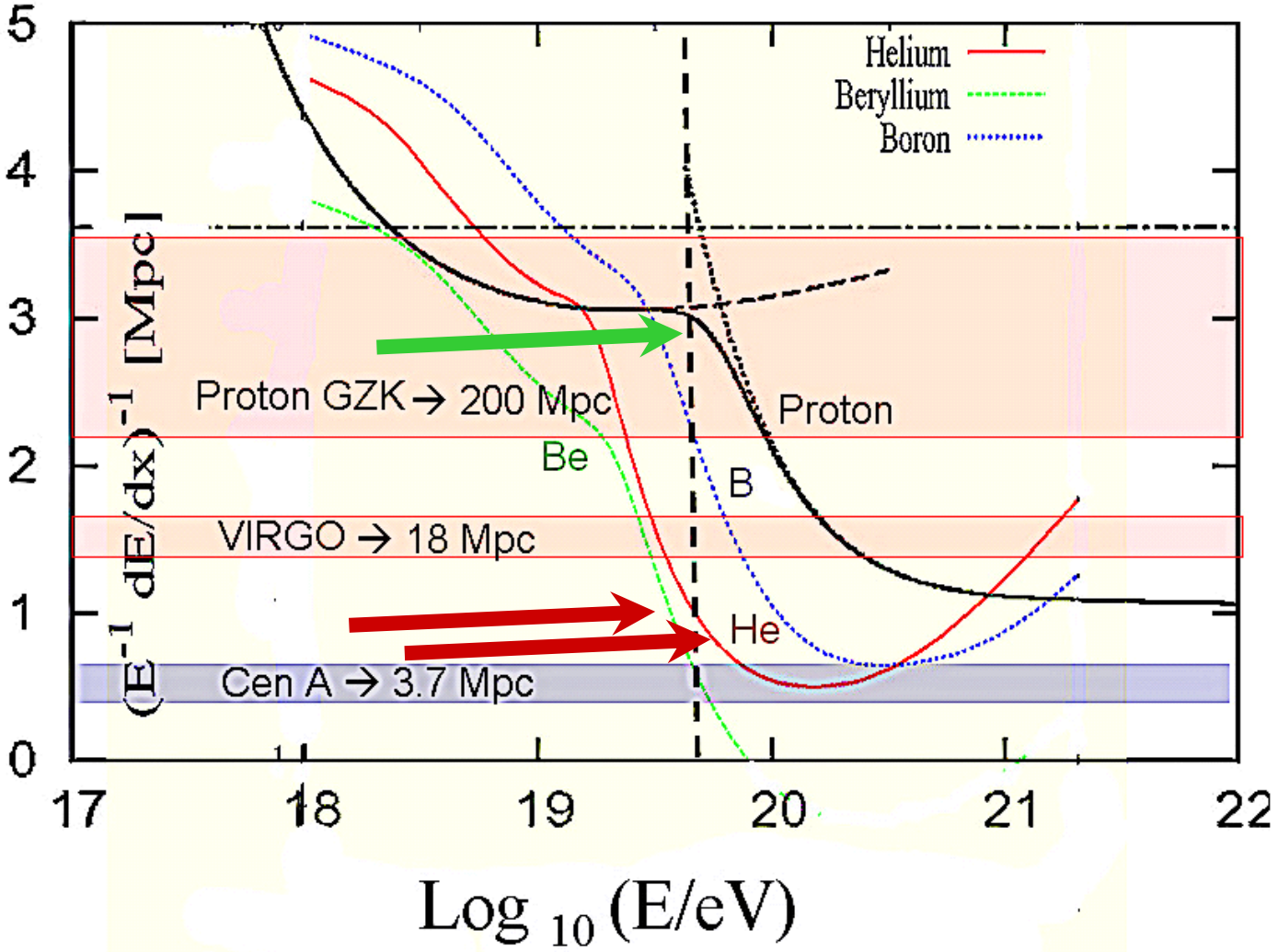
Why Not (as most believe) a mix: Proton and-or Fe?

- Because Cen_A cluster spread too large for a proton
- Because Cen_A spread too small for iron
- Because He-Li-Be explain Virgo Absence..
- Because He bending coexist with the Cen_A spread angles

How we did 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 resplect 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, opacque to Virgo..just He, Li, Be



A new, 2-months ago, input fom AUGER:

arxiv1107.4805

Multiplets tail around Cen A at 20 EeV

32ND INTERNATIONAL COSMIC RAY CONFERENCE, BEIJING 2011

Search for energy-position correlated multiplets in Pierre Auger Observatory data

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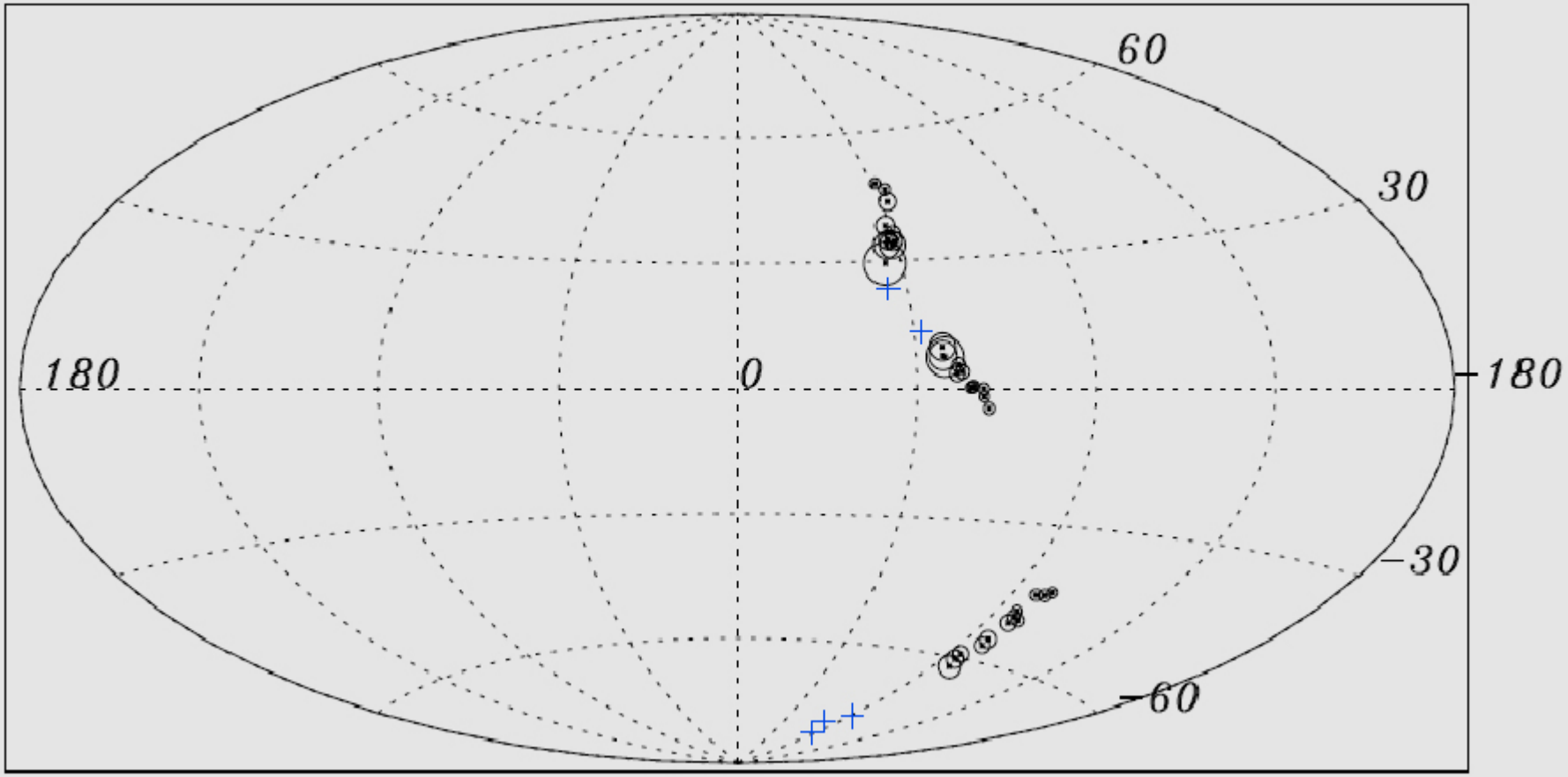
[1]*Centro Atómico Bariloche, Instituto Balseiro (CNEA-UNCuyo-CONICET), S. C. de Bariloche, Argentina*
[2] *Observatorio Pierre Auger, Av. San Martín Norte 304, 5613 Malargüe, Argentina*
(Full author list: http://www.auger.org/archive/authors_2011_05.html)
auger_spokespersons@fnal.gov

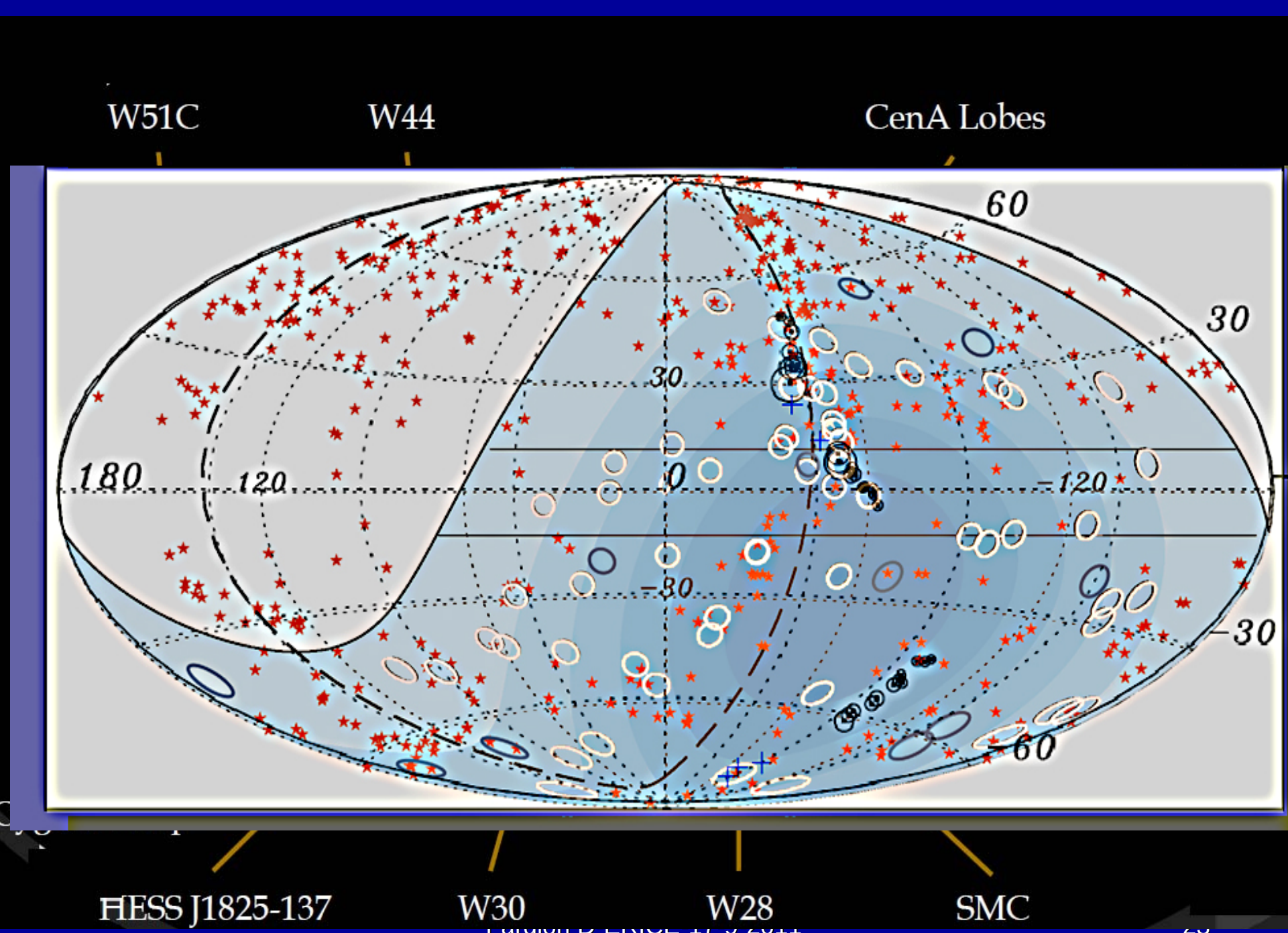
Abstract: We present the results of an analysis of data recorded at the Pierre Auger Observatory in which we search for groups of directionally-aligned events (or 'multiplets') which exhibit a correlation between arrival direction and the inverse of the energy. These signatures are expected from sets of events coming from the same source after having been deflected by intervening coherent magnetic fields. We here report the largest multiplets found in the data and compute the probability that they arise by chance from an isotropic distribution of events. There is no statistically significant evidence for the presence of multiplets arising from magnetic deflections in the present data.

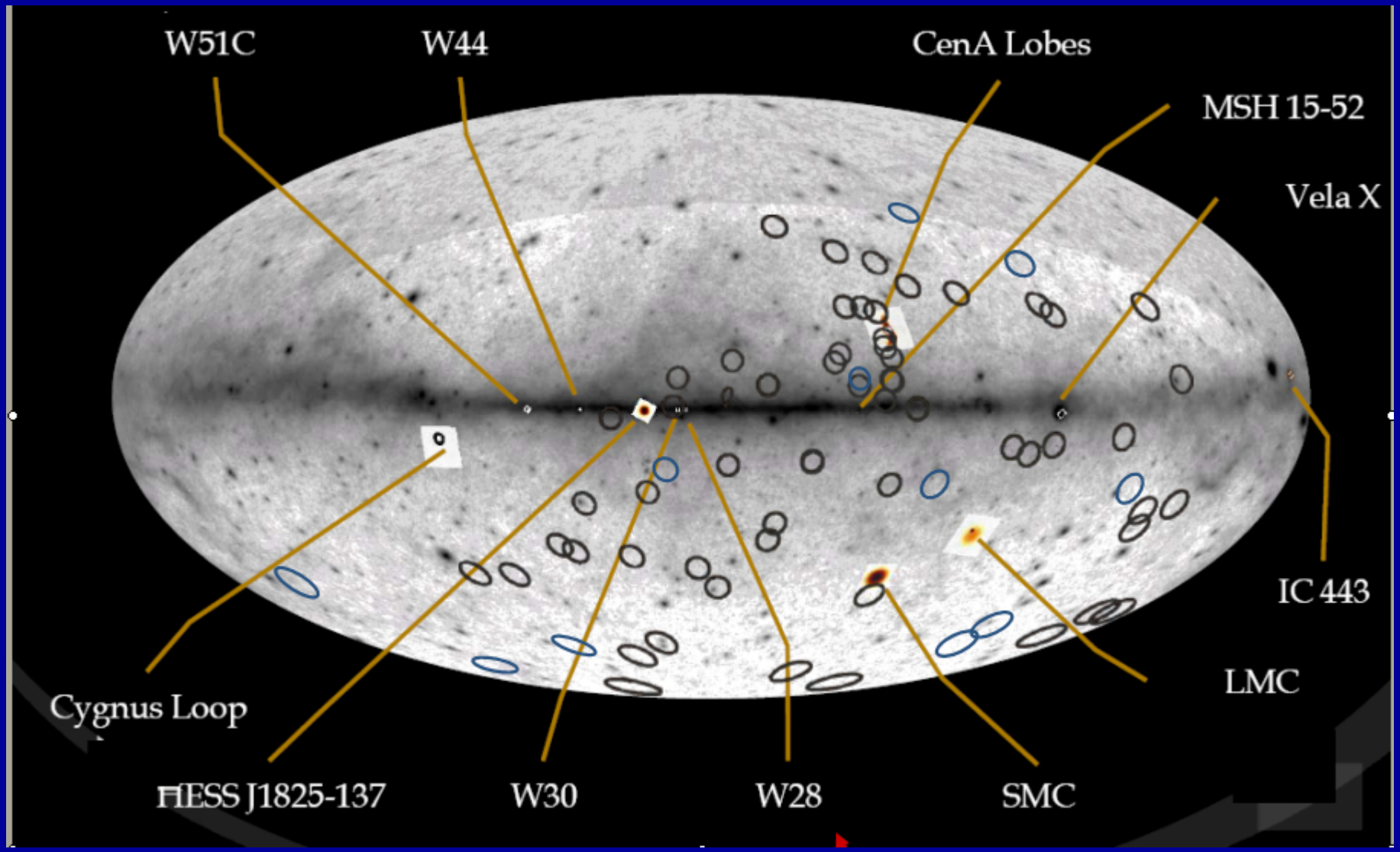
Keywords: Pierre Auger Observatory, ultra-high energy cosmic rays, magnetic fields, multiplets.

1 Introduction given by

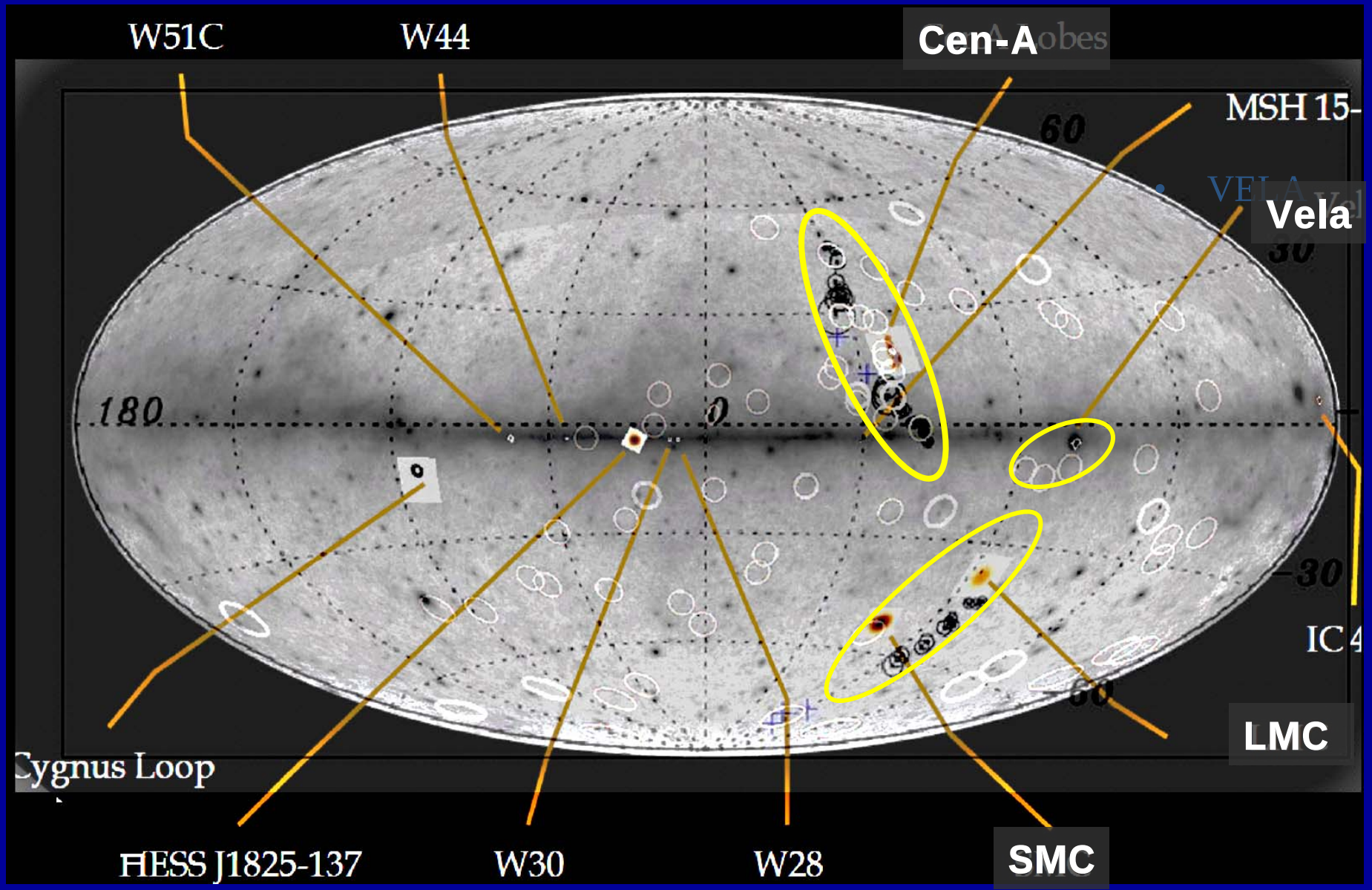
20 Eev Multiplets (dozen event tail)



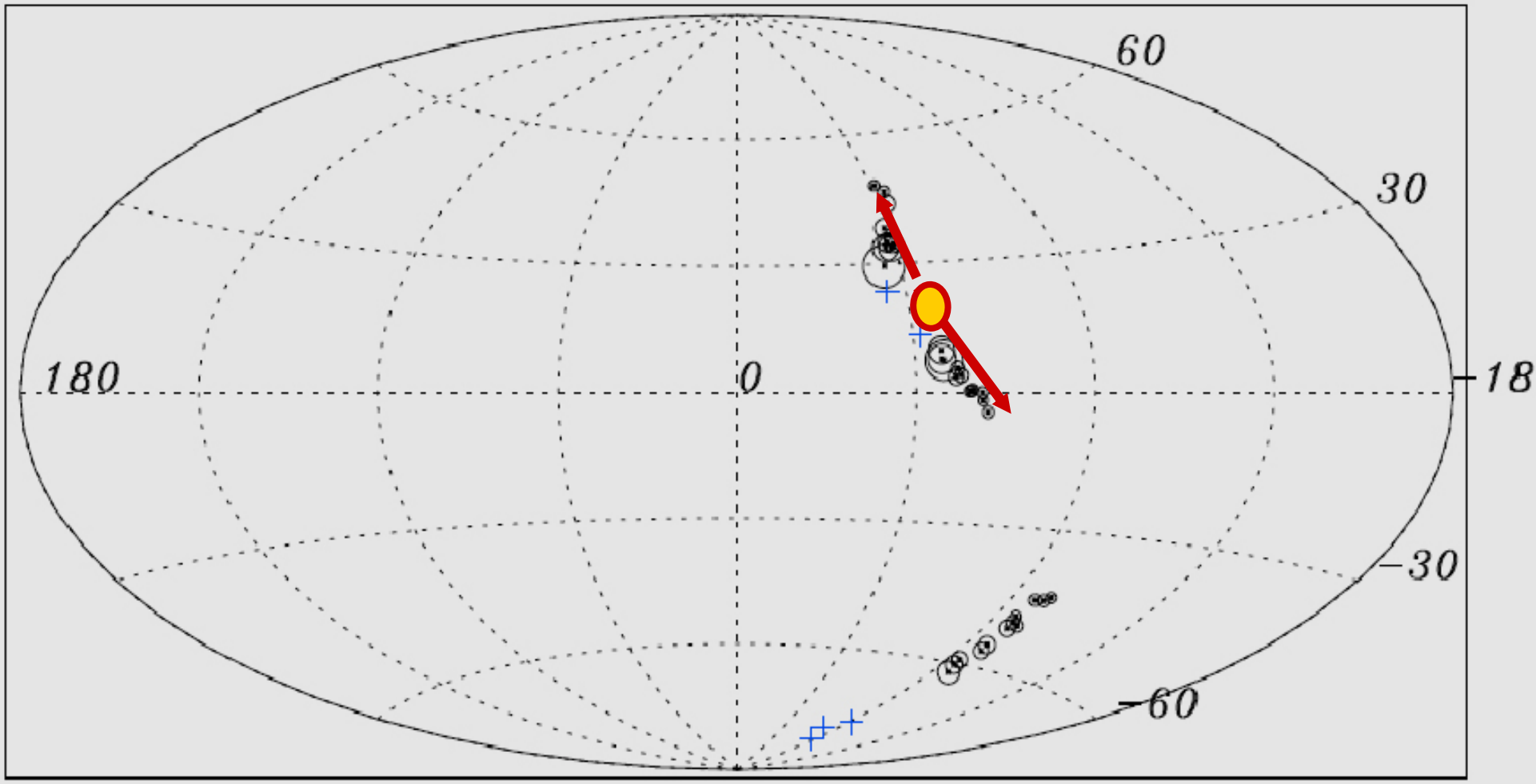

W51C
W44
CenA Lobes
60
30
30
180
120
0
−120
−30
−60
HESS J1825-137
W30
W28
SMC


W51C
W44
CenA Lobes
MSH 15-52
Vela X
IC 443
LMC
SMC
W28
W30
HESS J1825-137
Cygnus Loop

- OVERLAPPING MULTIPLETS UHECR at 20 EeVs- FERMI-X-Gamma and AUGER



USTERS-UHECR2010 and Multiplets 2011-bent 1.5 times more?



Planck one-year all-sky survey

esa

(c) ESA, HFI and LFI consortia, July 201

Random Deflections inside our Galaxy and along Galactic Plane 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

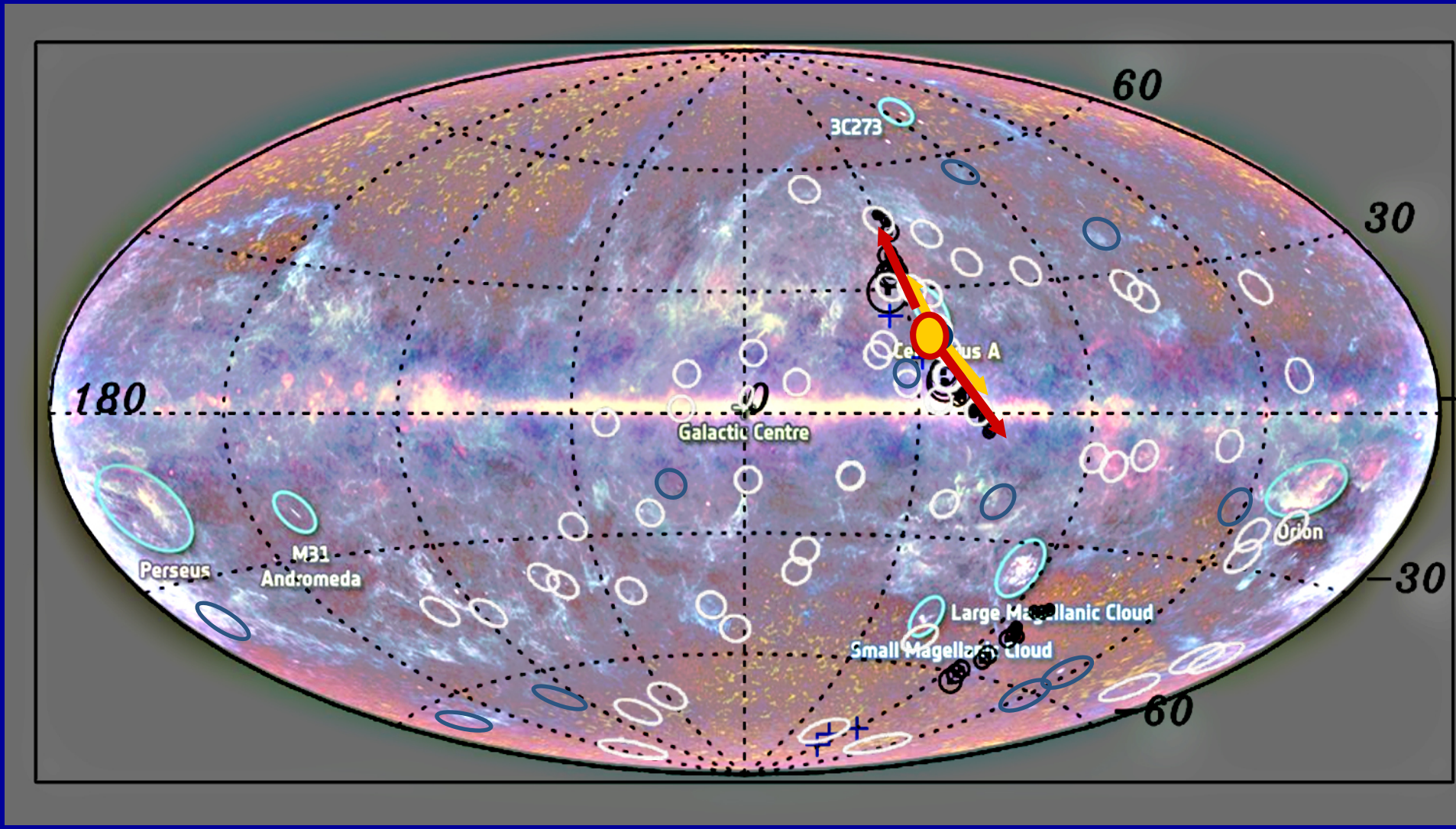
Fragment deflection at 20 EeV respect 60 EeV: factor 1.5;

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

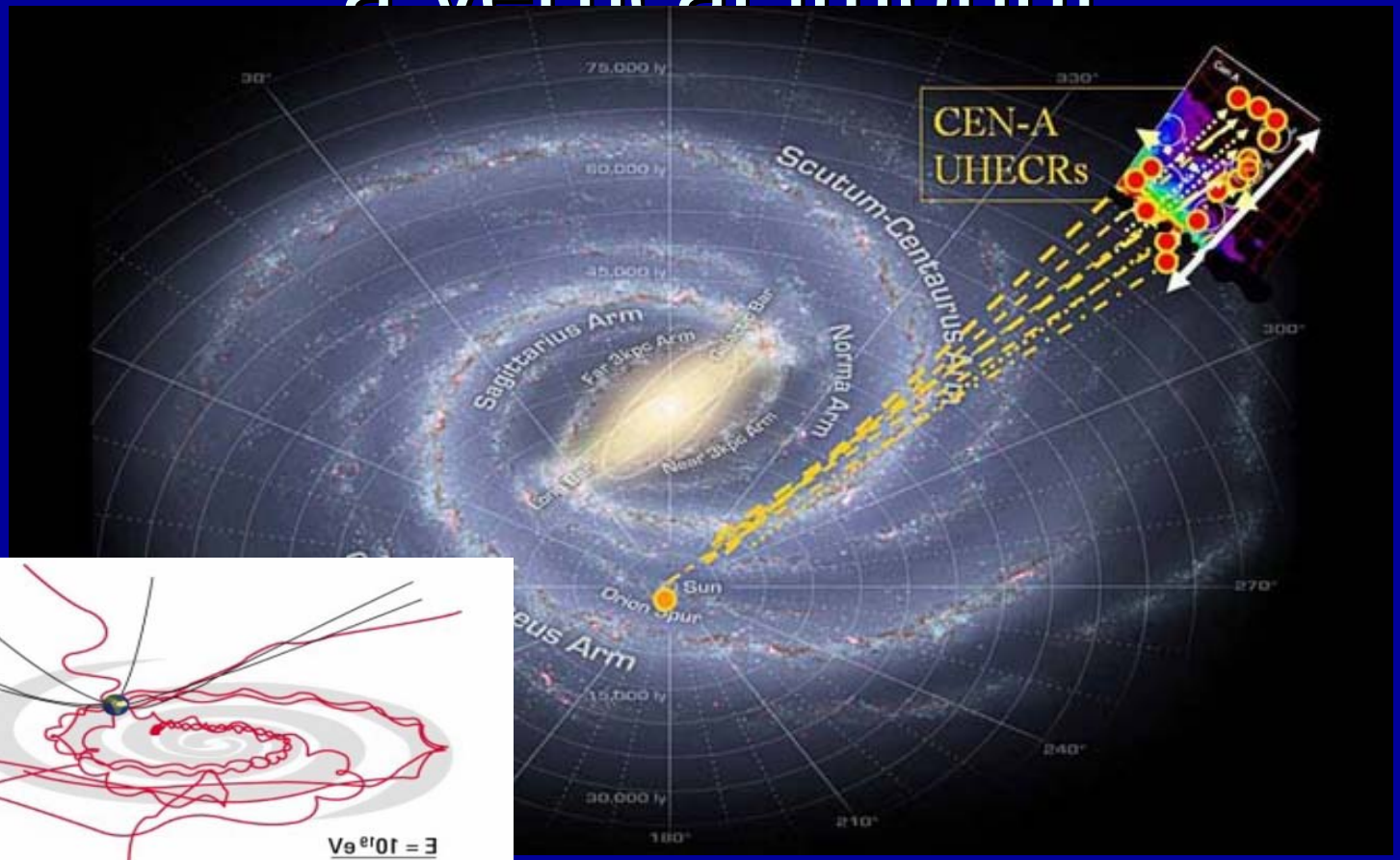
- δ_ He = 11.3 (60 EeV, Z=2).
- δ_ He = 34 (20 EeV, Z=2).

- **δ_ p (20 EeV, Z=1)= δ_ D (20 EeV, Z=1)=**
- **11.3 * 3 /2= 17..**

CLUSTERS-UHECR2010 and Multiplets 2011-bent 1.5 times more?



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



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)**

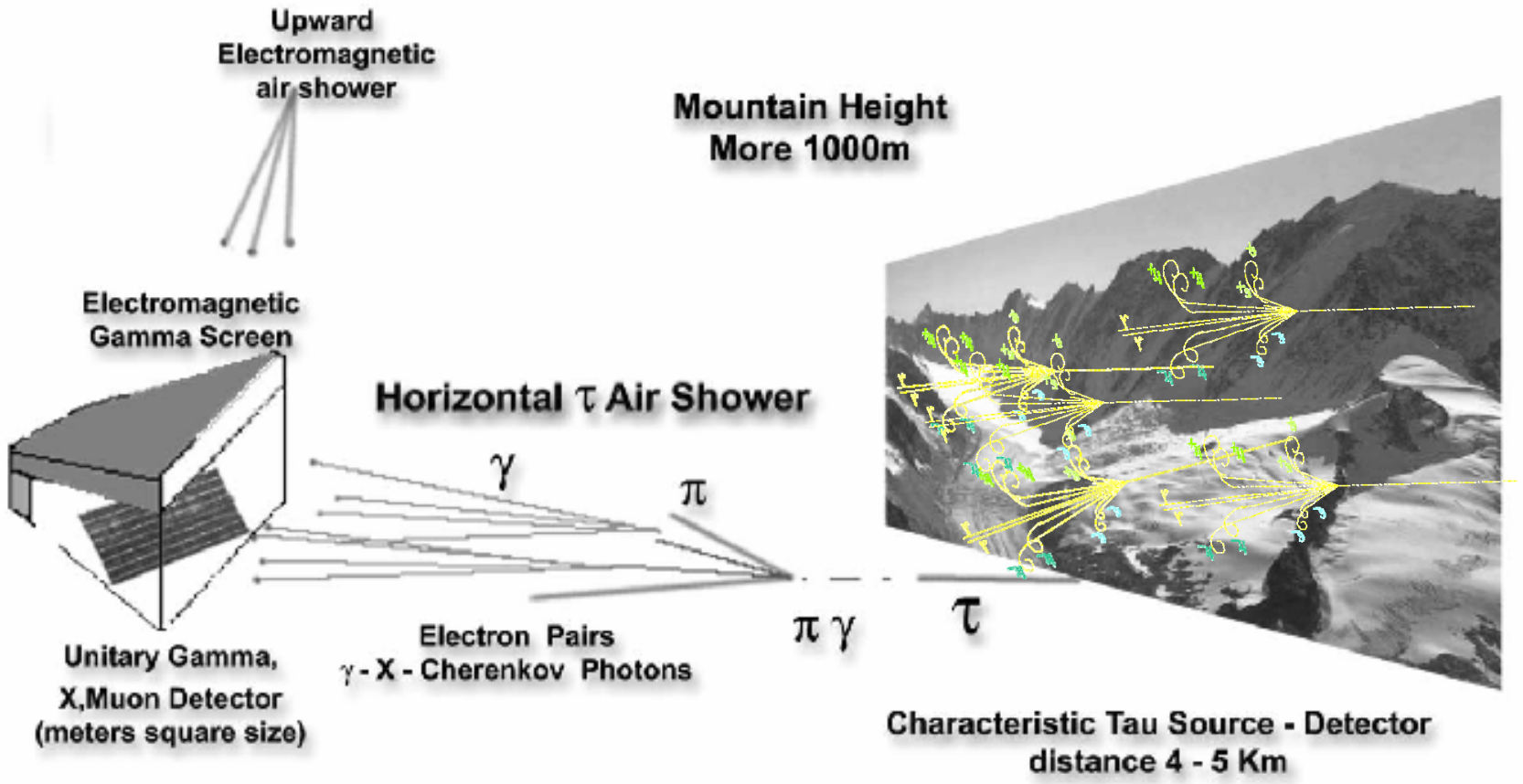
Because mixing, even a minimal neutrino mass splitting guarantees the flavour transformation from Muon Neutrinos to the Tau Neutrinos.. Above hundreds TeVs only Galactic and cosmic distances are large enough for a complete neutrino oscillation lenghts. No atmospheric Tau! Astrophysical Tau neutrinos are born by Muons ones in a noise free sky!

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

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

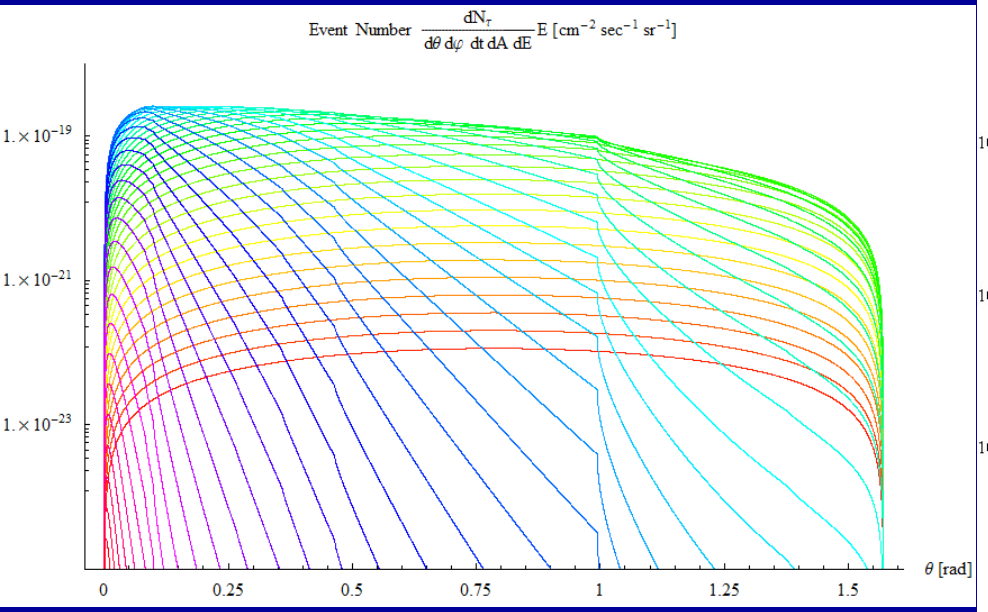


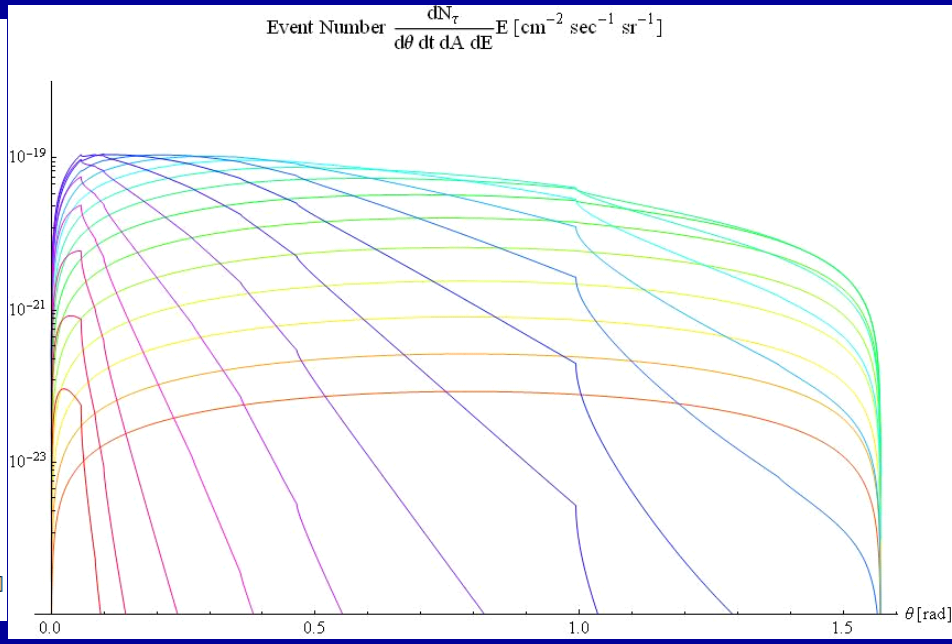
DISCOVERING ULTRA-HIGH-ENERGY NEUTRINOS THROUGH HORIZONTAL AND UPWARD τ AIR SHOWERS: EVIDENCE IN TERRESTRIAL GAMMA FLASHES?

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

ν_τ Taus and Anti-ν_e into Taus: Testing CPT in our Universe

Upward Tau Air Showers from Earth , : D. Fargion, et al.
Journal-ref: Astrophys.J. 613 (2004) 1285-1301 ;
Nuclear Physics B. (Proc.Suppl.) 136 (2004) 119-128





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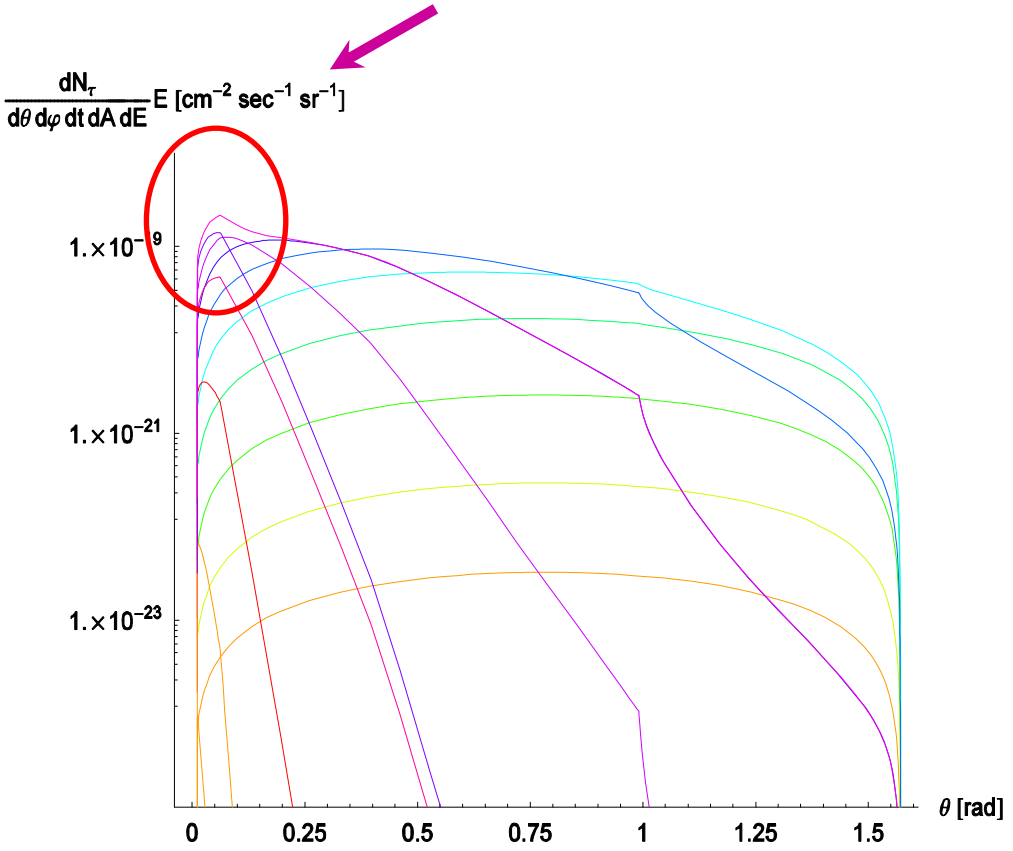
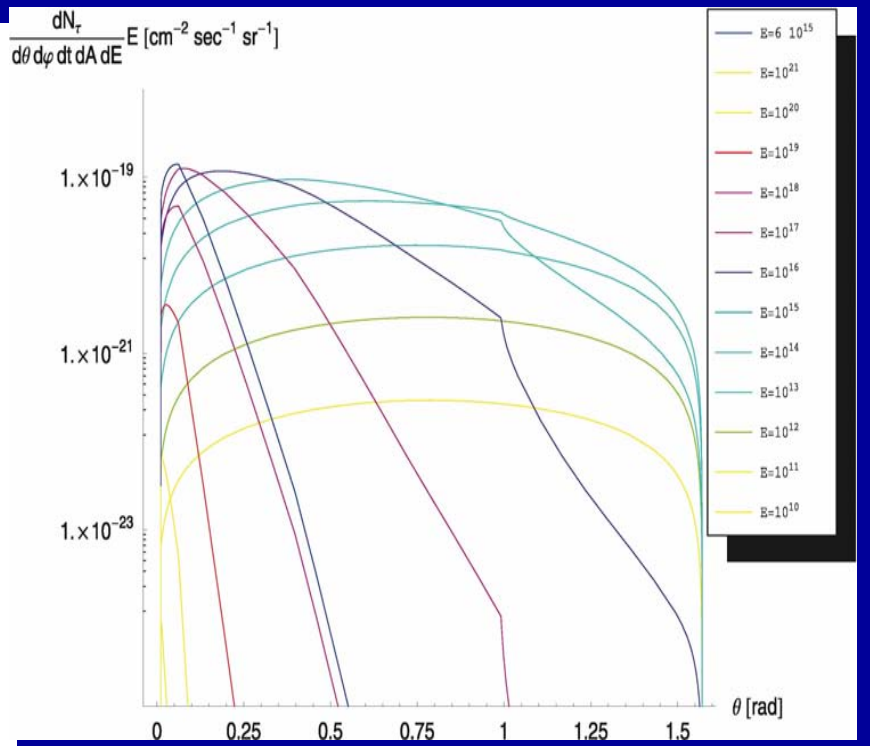
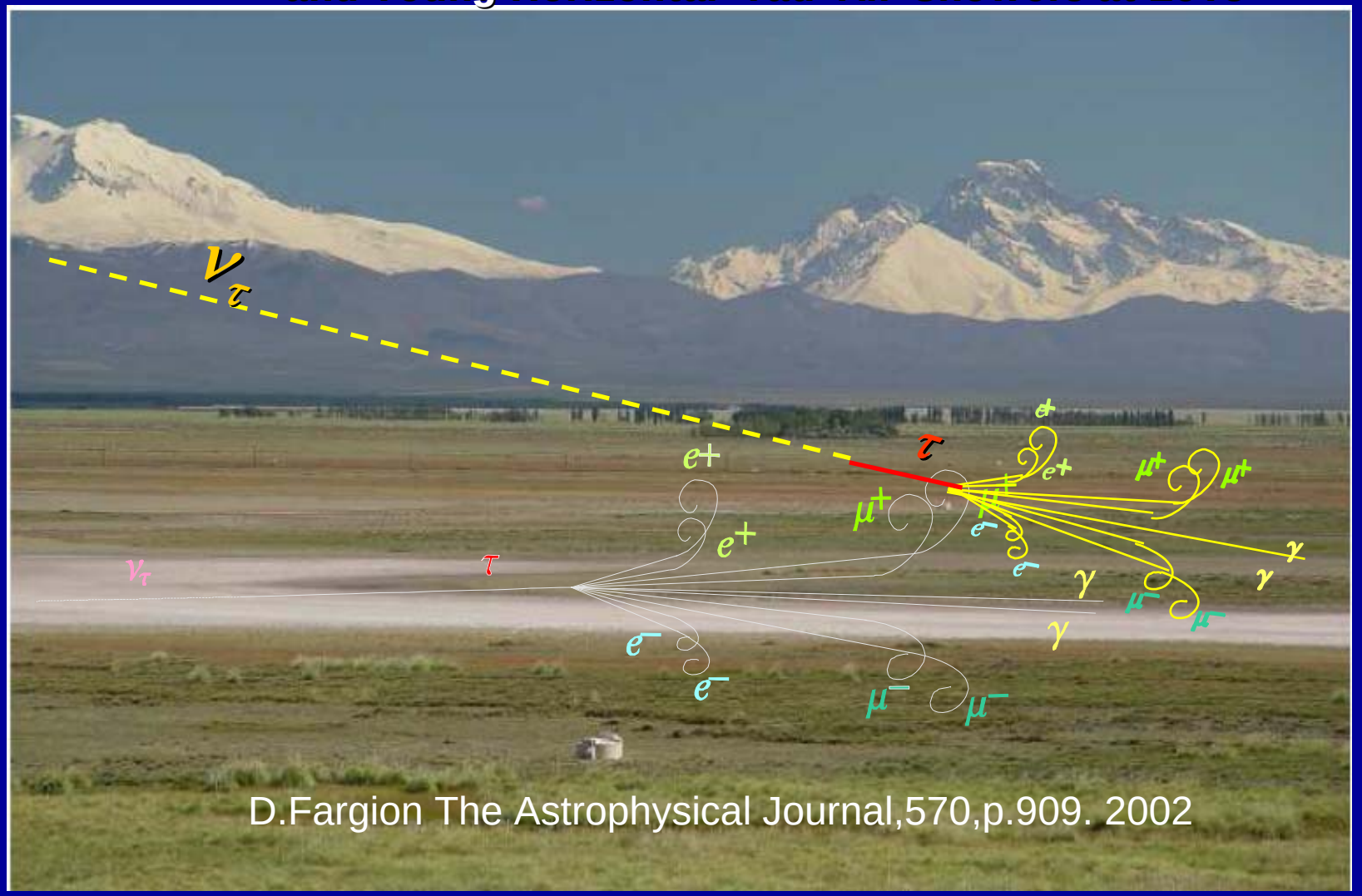
DF et al. Nuclear Physics B. (Proc.Suppl.) (2009)



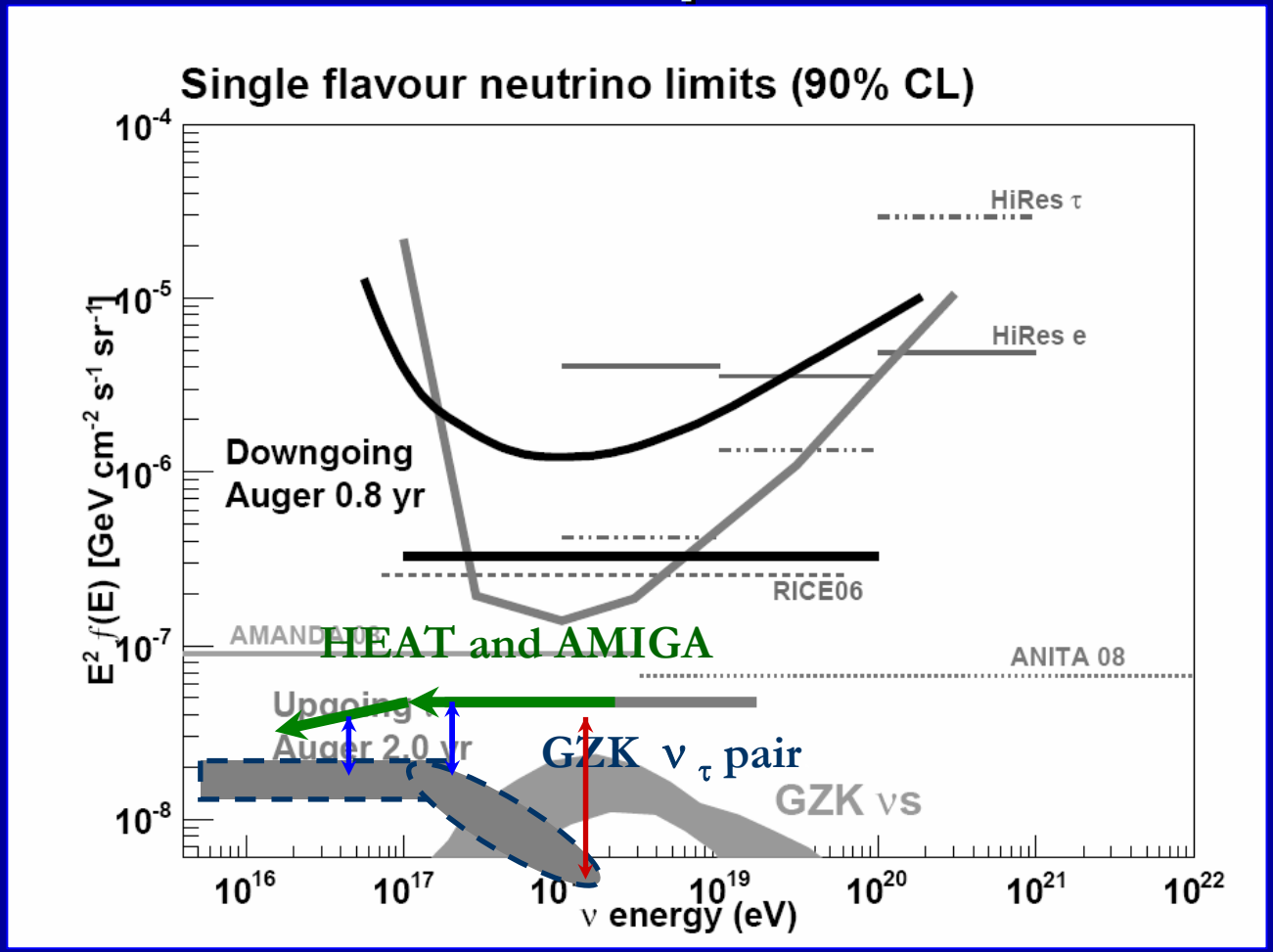


The Ande Mountains as a target for detecting UHE EeV neutrino tau by Horizontal Air-Showers at AUGER: ANDE SHADOWs (ring mask at horizons) on GZK Cosmic Rays from West and Young Horizontal Tau Air-Showers at EeVs



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

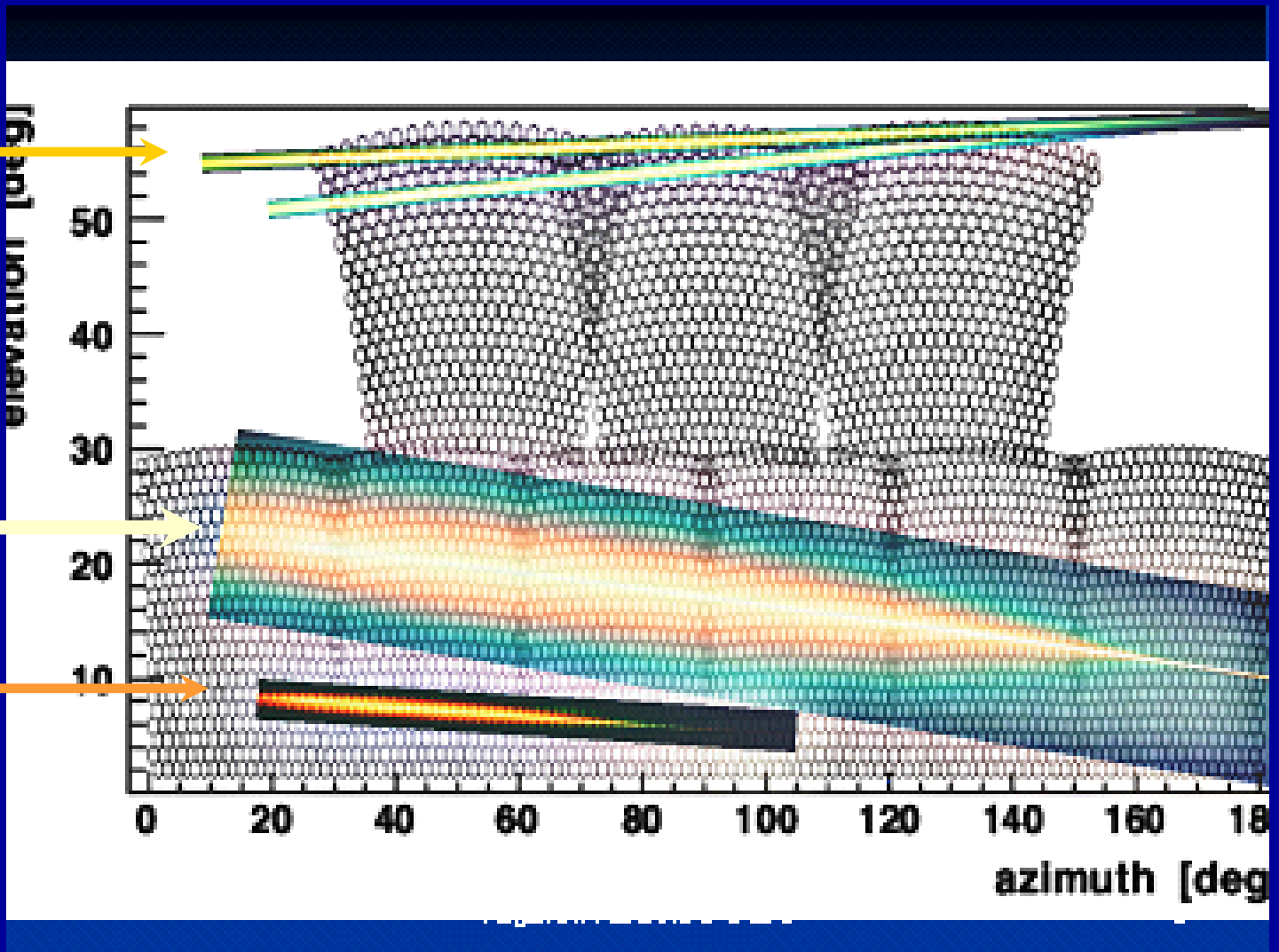
LAST auger icrc 2009 versus our expectations



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

AUGER Maps at UHECR if protons, may hint for UHE tau Neutrino at EeV (UHECR nucleons)

- But UHECR Mass Composition and Cen-A dominance preferr for UHE He-Li-Be nature.

Foreseen, probably observed : Tails of FRAGMENT CLUSTERING at 15-45 EeV .. *arxiv1107.4805..seen?*

- Consequence in UHE neutrino spectra at tens PeV.
- Detection by Tau air-showers
- at hand by AMIGA and HEAT, Telescope Array or F.D. Auger, ARGO arrays may discover it soon..
- Tens-PeV tau neutrino astronomy beyond the telescope and nearby, their discover at edge

References

..see 1106.3749..and

: UHECR Maps: mysteries and surprises ,D. Fargion

Journal-ref: AIP Conf. Proc. - March 26, 2010 - Volume 1223, pp. 149-158

arXiv:0911.4176 **UHECR besides CenA: hints of galactic sources** D.F

Journal-ref: Progress in Particle and Nuclear Physics 64 (2010) 363-365

arXiv:0908.2650 **Coherent and random UHECR Spectroscopy of Lightest Nuclei along CenA**: .. D.F

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

arXiv:0902.3290 **Lightest Nuclei in UHECR versus Tau Neutrino Astronomy**

D.Fargion, D. D'Armiento, P. Paggi, S. Patri'

Nuclear Physics B (Proc. Suppl.) 190 (2009) 162_166

arXiv:0801.0227 Light Nuclei solving Auger puzzles. The Cen-A imprint ,D. F.

Journal-ref: Phys.Scripta 78:045901,2008

About GRBs and UHE neutrino signal

- arXiv:1108.0638..last edition
  - GRBs by thin persistent precessing lepton Jets: the long life GRB110328 and the Neutrino signal

- Thank you for the kind attention..

UHECR Nuclei shine up Horizontally, up-ward Tau air-hower rise by a Neutrino Sky under our own Sky: the Earth , In a few years in AUGER-AMIGA-HEAT FD