

UniverseNet: Activities on the Origin of Cosmic Rays

- Oxford: Dependence of high energy neutrino fluxes on primary cosmic ray composition
- APC Paris: Cosmic Ray Propagation and Secondary photon fluxes at GeV and EeV energies, constraints on Lorentz symmetry violation from the photon fraction in EeV cosmic rays
- Trieste and Annecy: Galactic positron and anti-proton fluxes from dark matter annihilation
- Gran Sasso: Cosmic Ray Spectra from Supernova Remnants

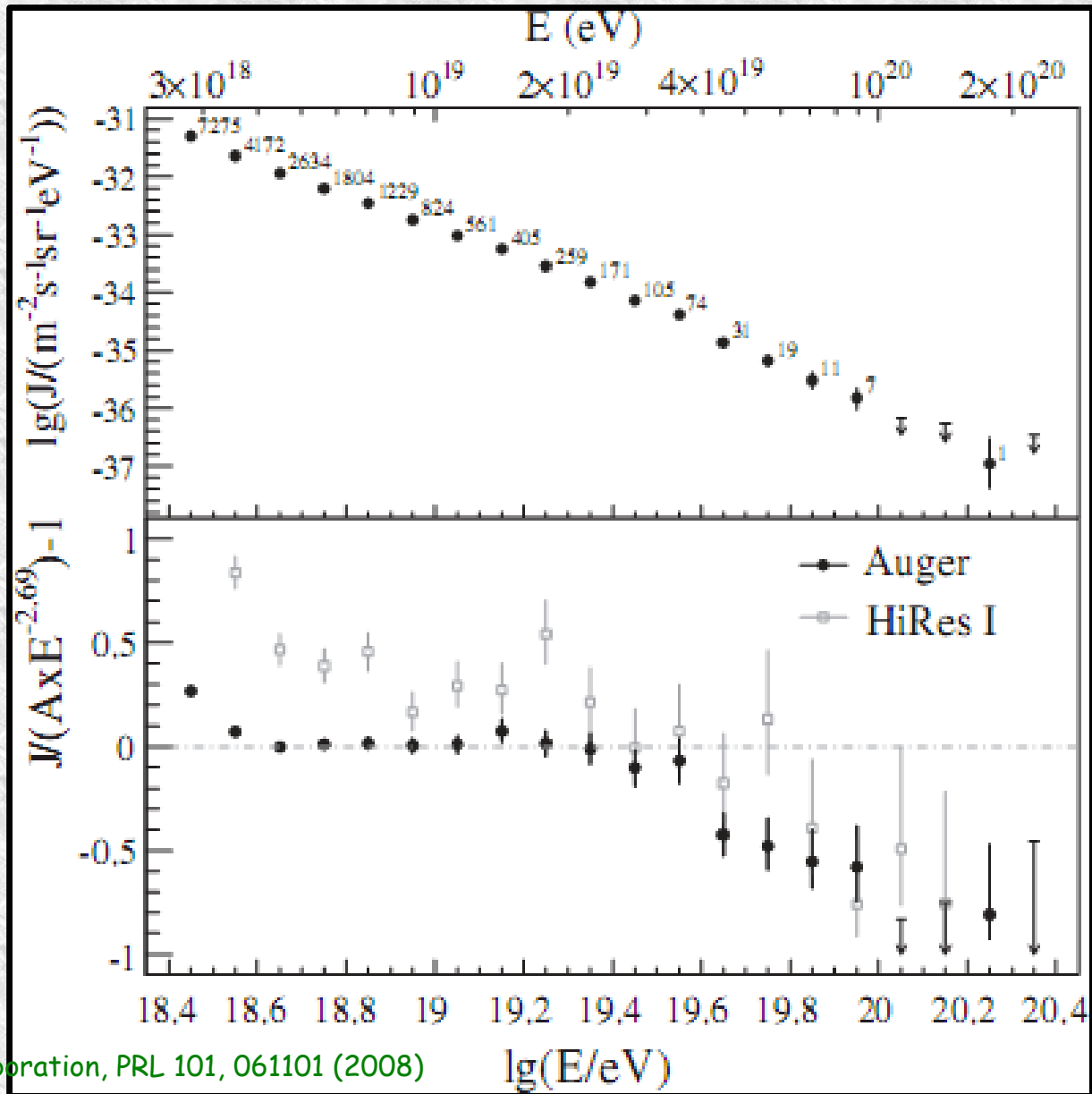
Günter Sigl

**II. Institut theoretische Physik, Universität Hamburg and
APC (Astroparticule et Cosmologie), Université Paris 7**

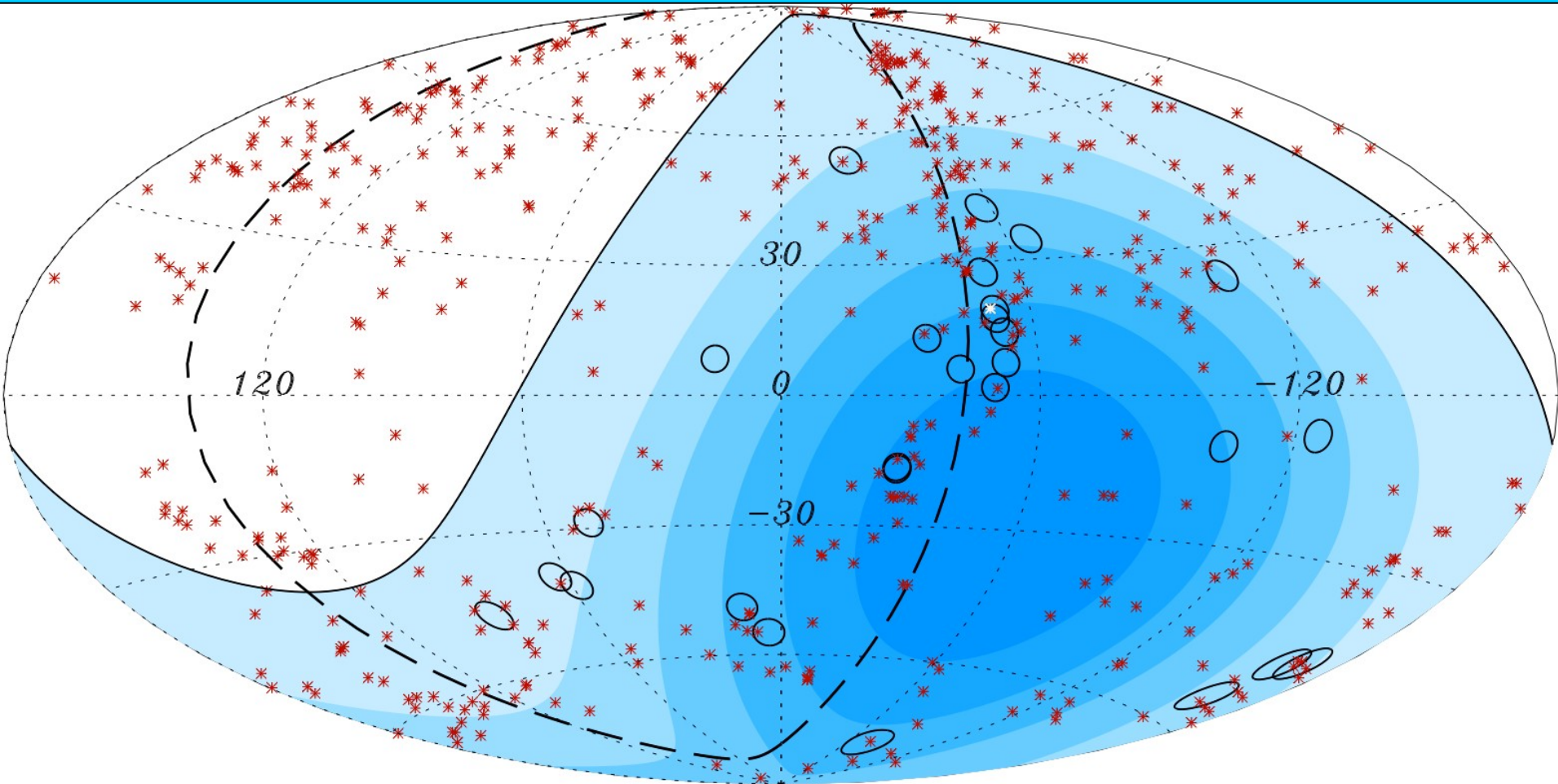
<http://www2.iap.fr/users/sigl/homepage.html>

Auger Spectrum

Exposure= 2 x HiRes = 4 times AGASA exposure

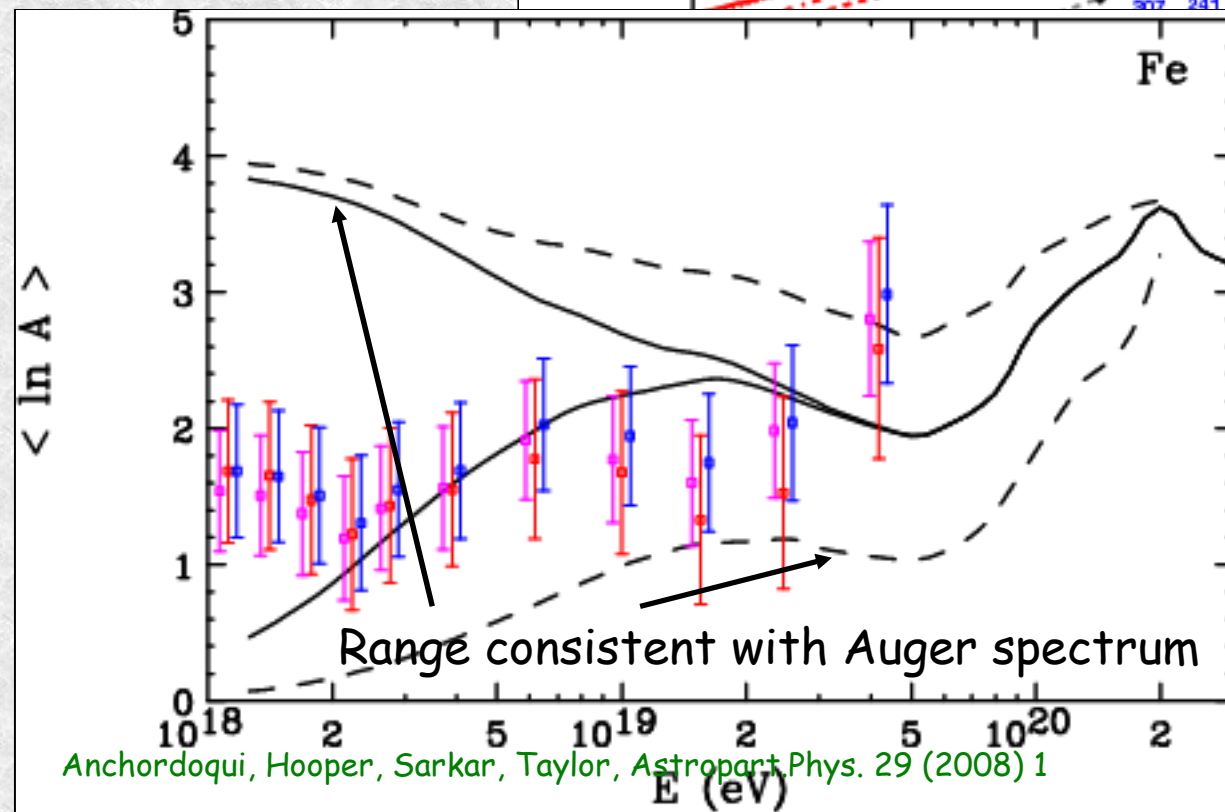
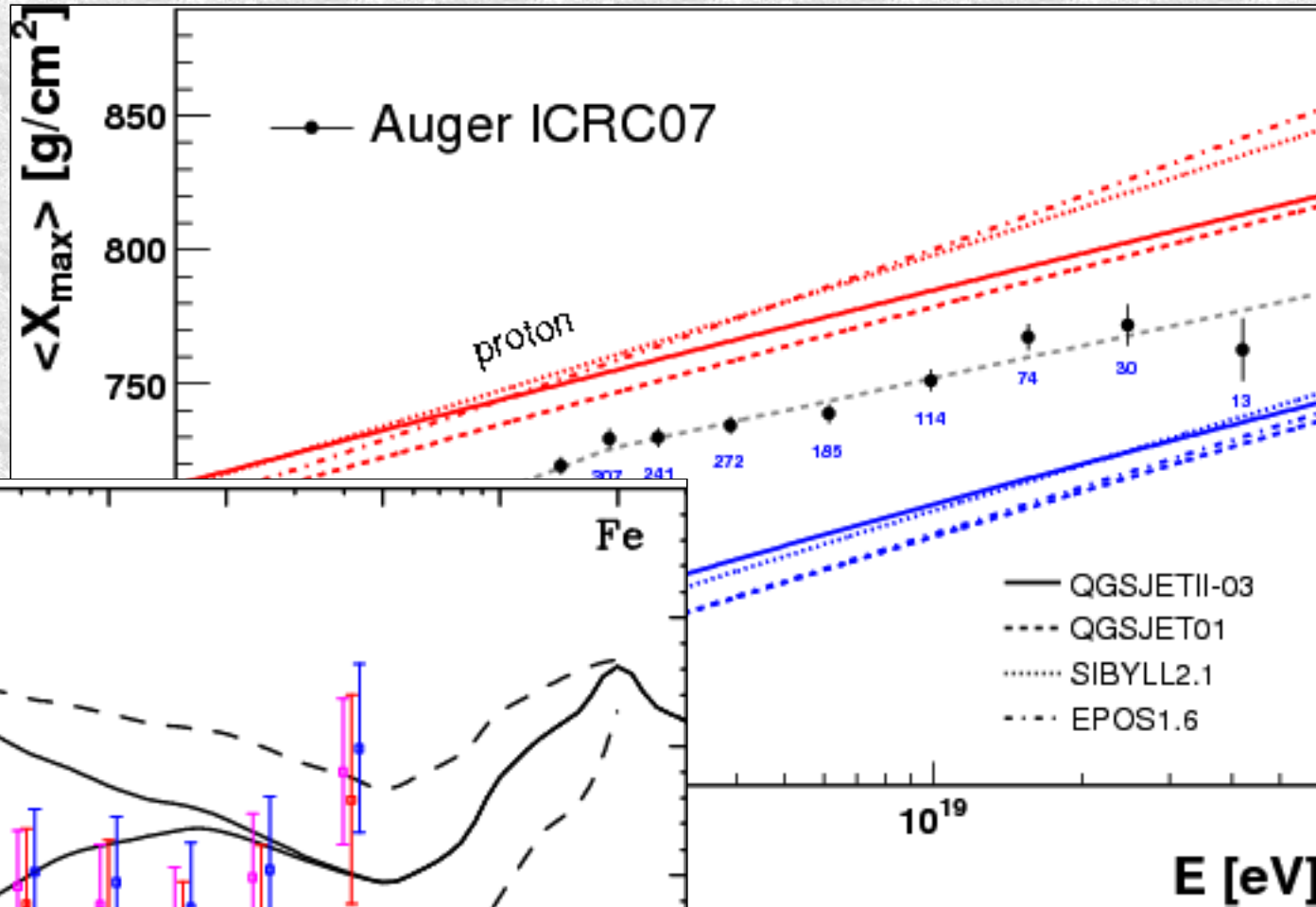


Auger sees Correlations with tracers of large scale structure !



Red crosses = 472 AGNs from the Veron Cetty catalogue for $z < 0.018$
circles = 27 highest energy events above 57 EeV.
20 events correlated within 3.1° , 7 uncorrelated of which most in galactic plane

There may be a significant heavy component at the highest energies:



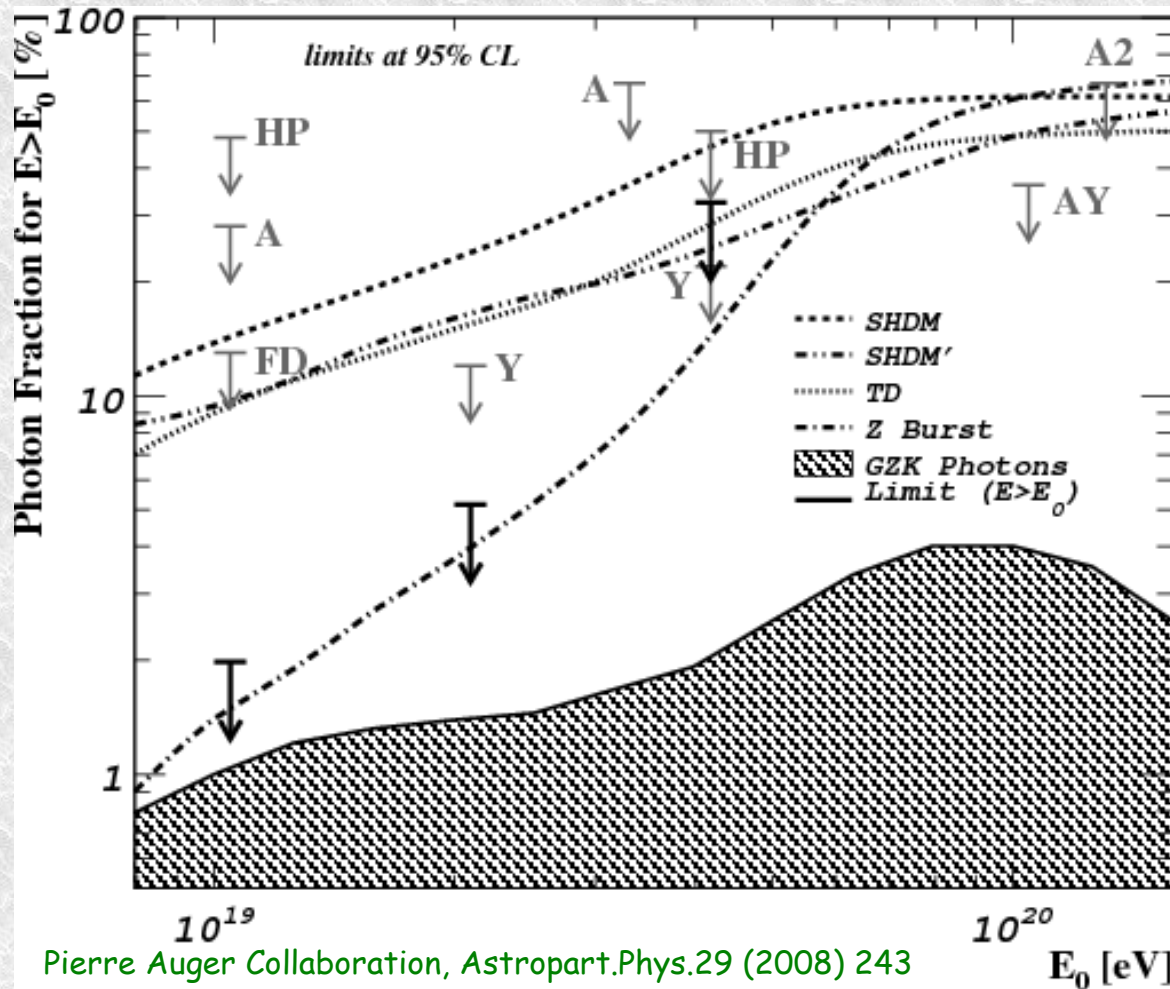
Open Question: Reconcile following observational indications:

a) If correlated AGN are sources, primaries should be protons to avoid too much deflection in galactic field

b) air shower measurements indicate mixed composition

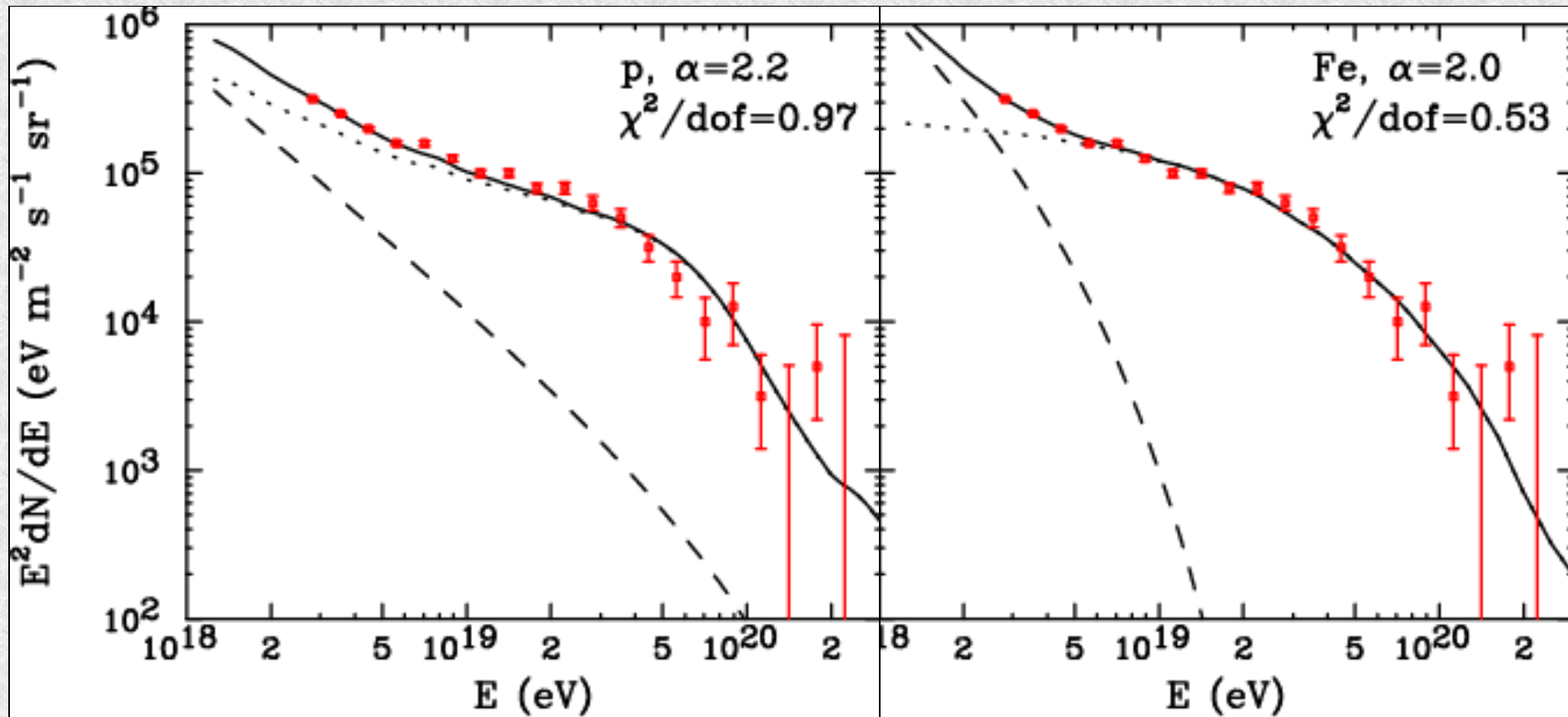
c) Theory of AGN acceleration seem to necessitate heavier nuclei to reach observed energy

Current upper limits on the photon fraction are of order 2% above 10^{19} eV from latest results of the Pierre Auger experiments (ICRC) and order 30% above 10^{20} eV.



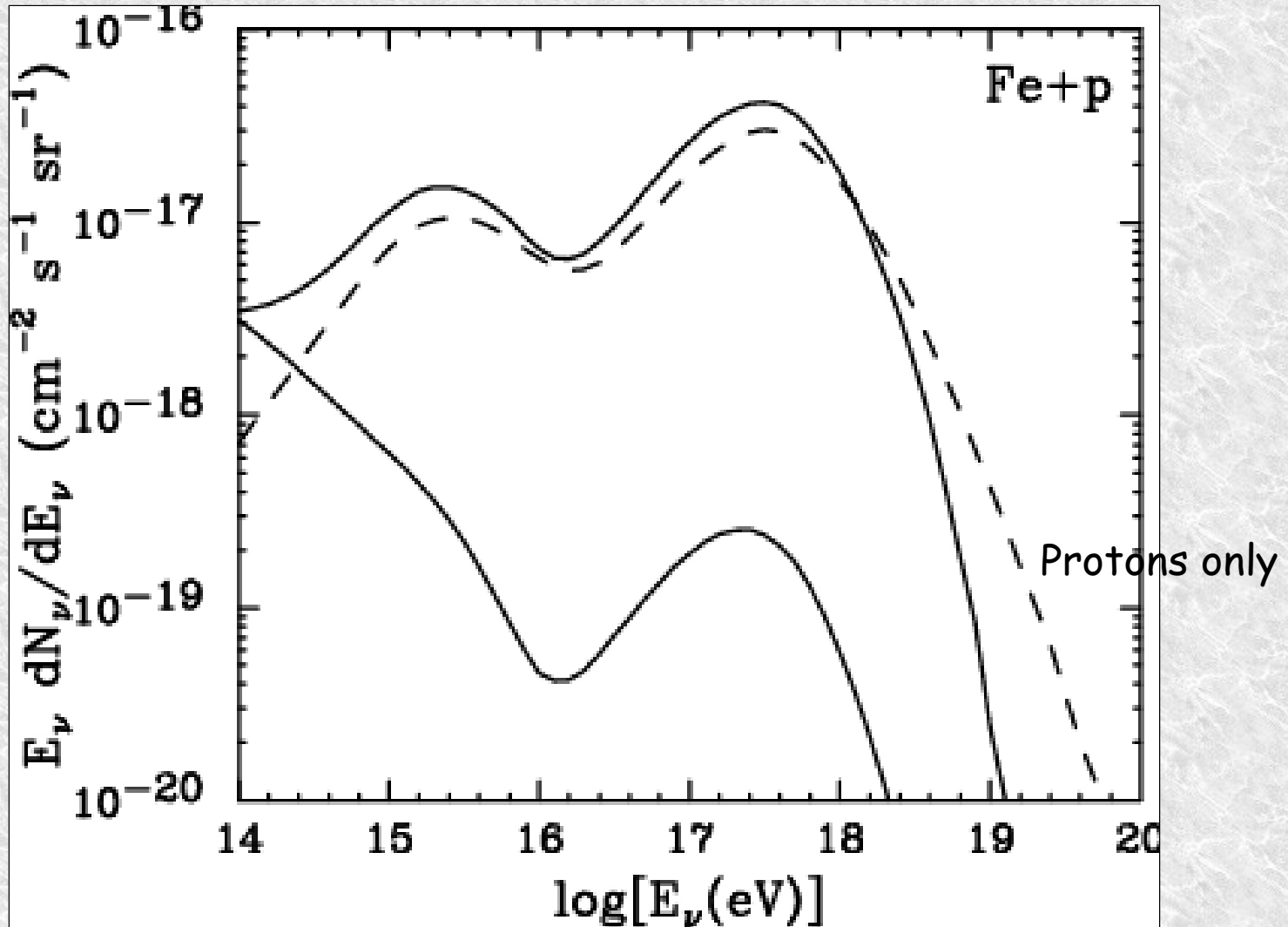
Rules out many top-down scenarios and Lorentz symmetry violation in the photon sector

Chemical Composition and Cosmogenic Neutrino Flux



Best fits to Auger spectrum for proton and iron injection with $E_{\text{max}}=(Z/26)10^{22}$ eV

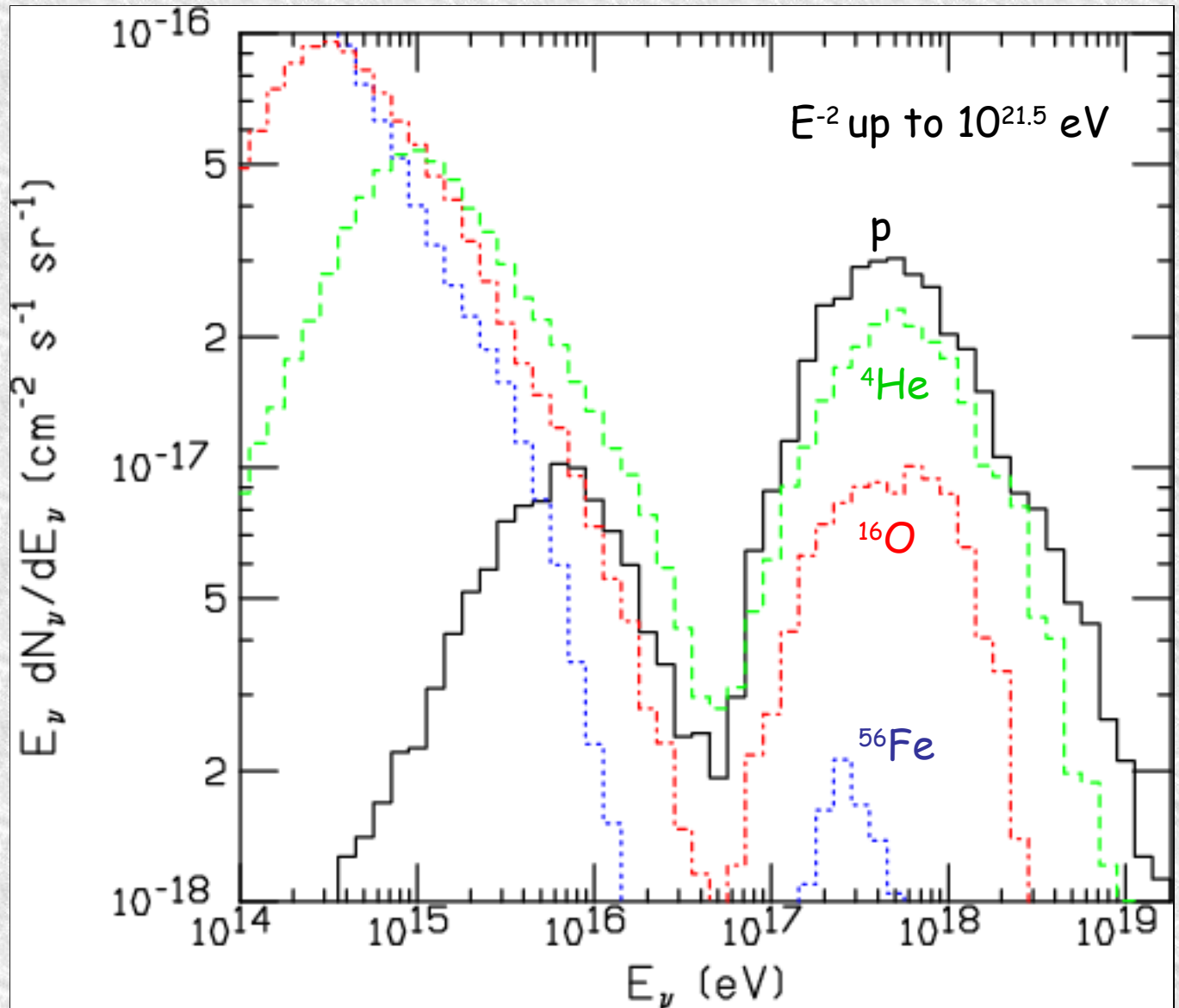
Range of cosmogenic neutrino fluxes consistent with PAO spectrum and composition



Influence of Composition on Cosmogenic Neutrinos

The highest rates are 1 event/year in ICECUBE for protons

Rates comparable if $E_{\text{max}}/Z = \text{const}$, but 10-30 times lower for iron if E_{max} independent of Z .

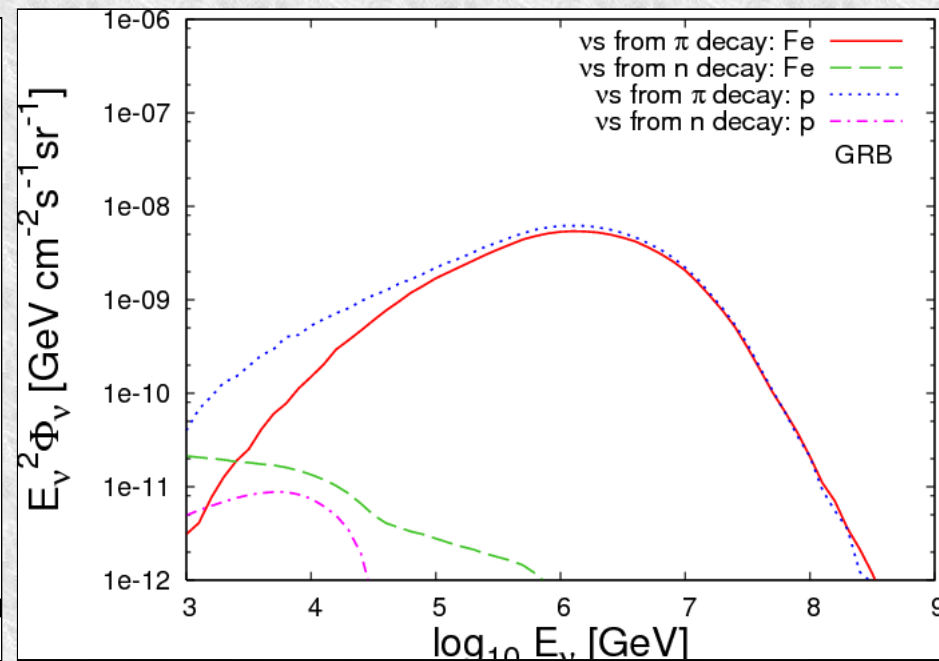
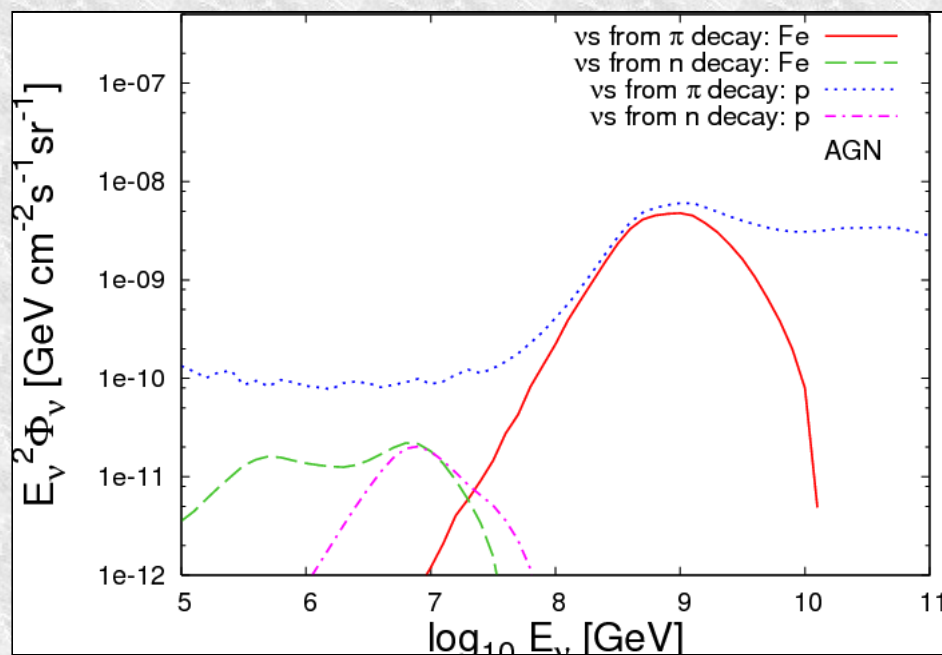


Chemical Composition and Source Contributions to the Ultra-High Energy Neutrino Flux

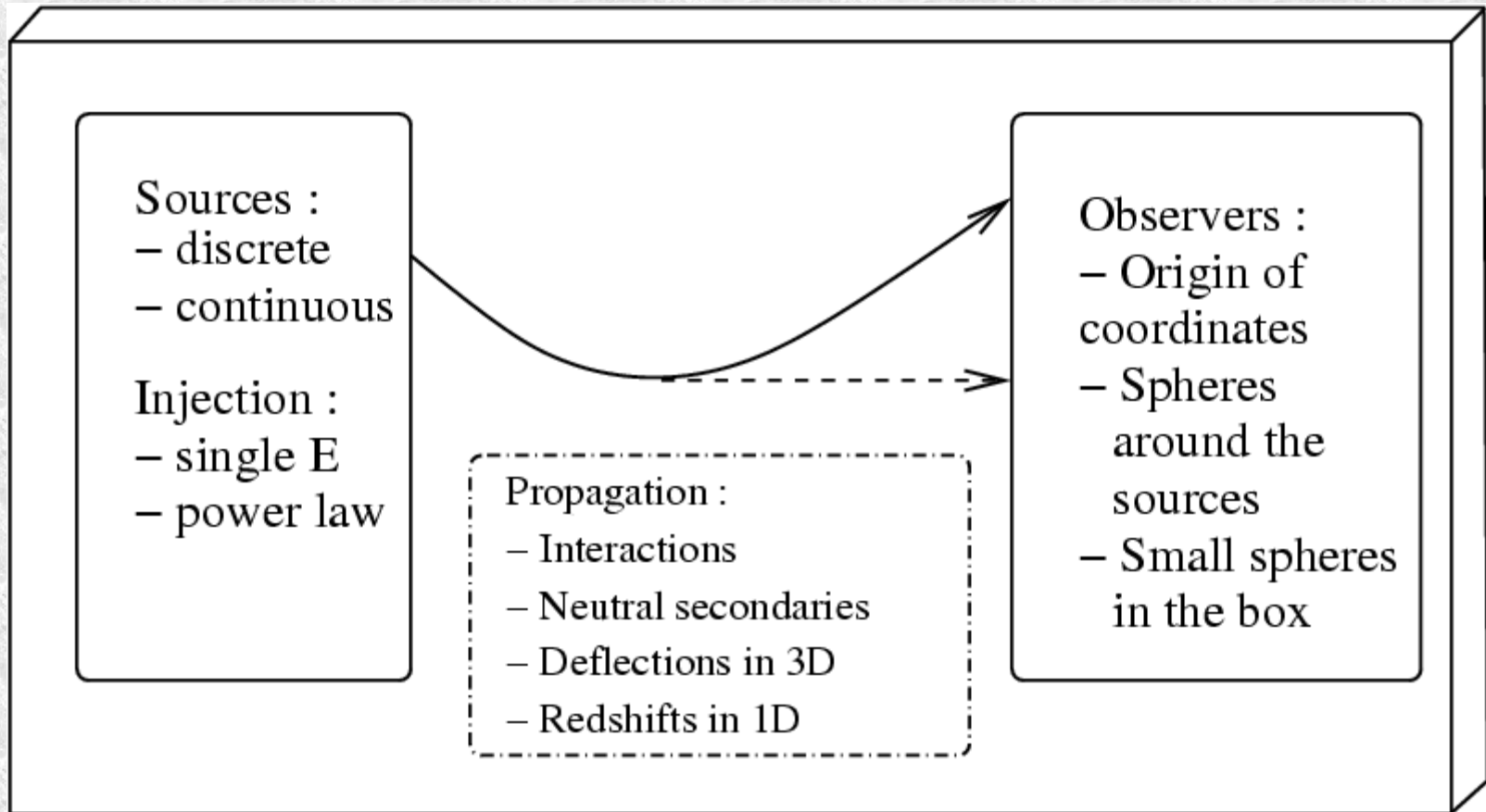
In AGN sources, nuclei are disintegrated above $\sim 10^{19}$ eV

In GRB sources, all nuclei are practically disintegrated (compact source)

In starburst galaxy sources, very few nuclei are disintegrated



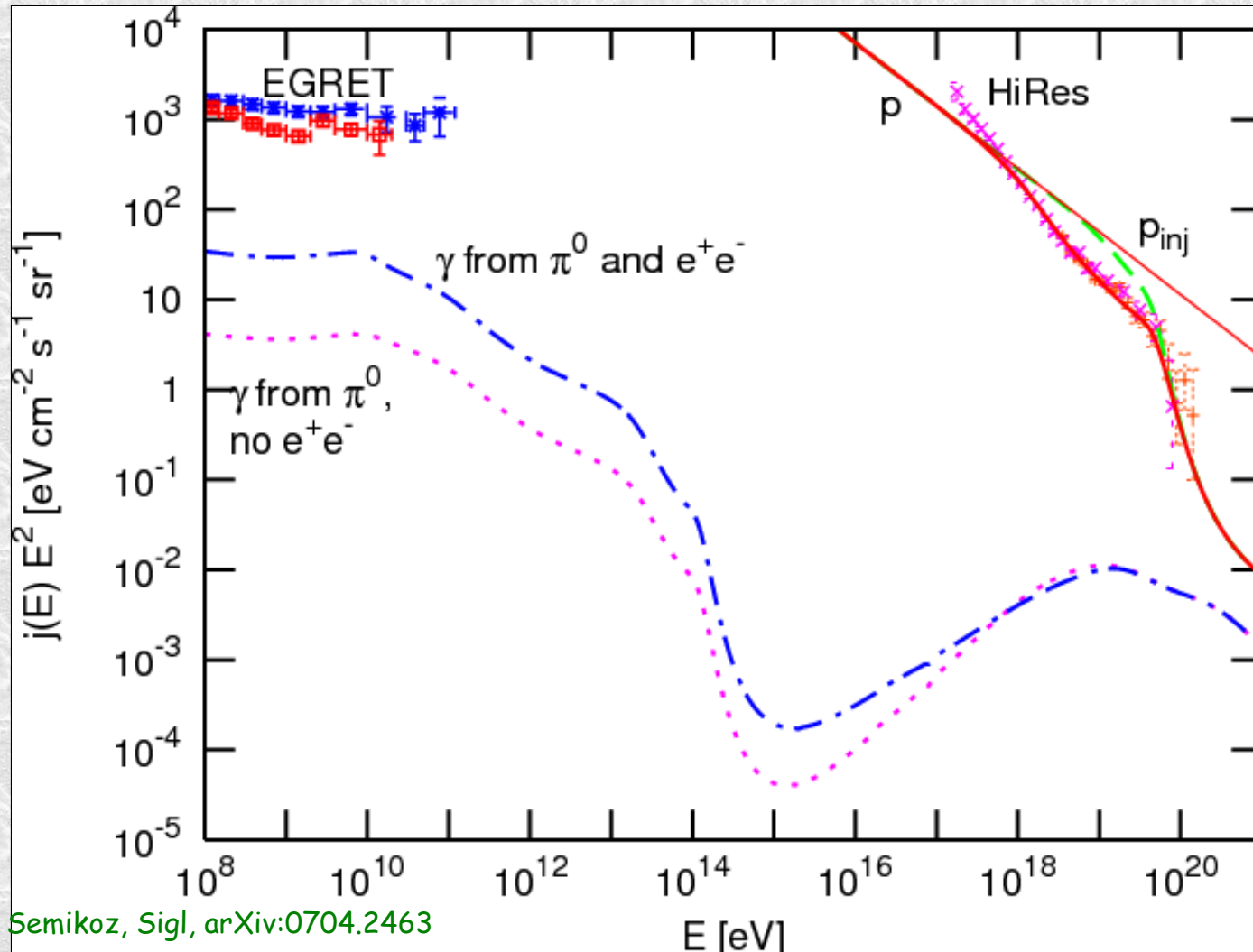
CRPropa is a public code for UHE cosmic rays, neutrinos and γ -Rays



Eric Armengaud, Tristan Beau, Günter Sigl, Francesco Miniati,
Astropart.Phys.28 (2007) 463.

<http://apcauger.in2p3.fr/CRPropa/index.php>

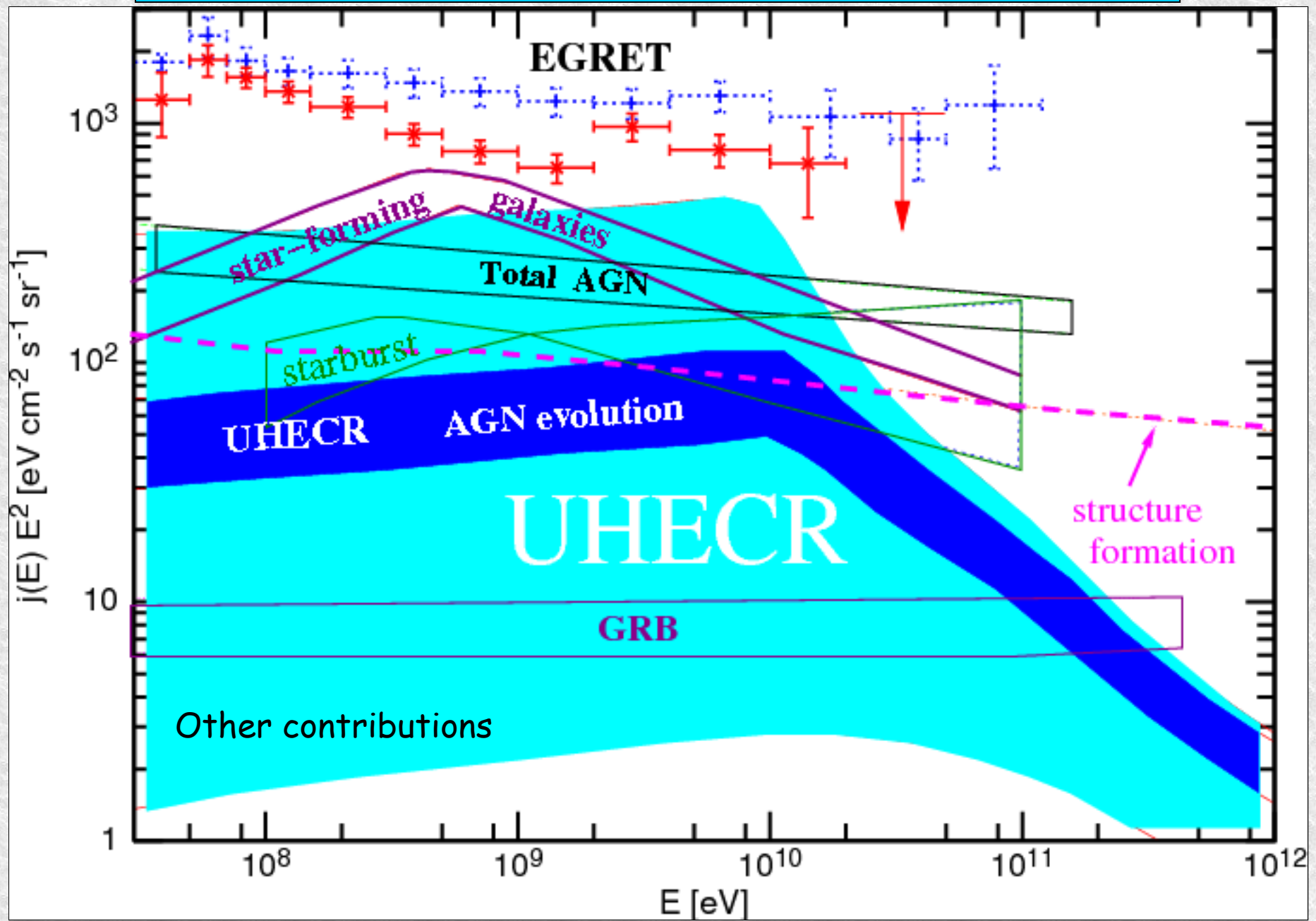
Ultra-High Energy Cosmic Ray Contributions to the MeV-TeV γ -ray background



Kalashov, Semikoz, Sigl, arXiv:0704.2463

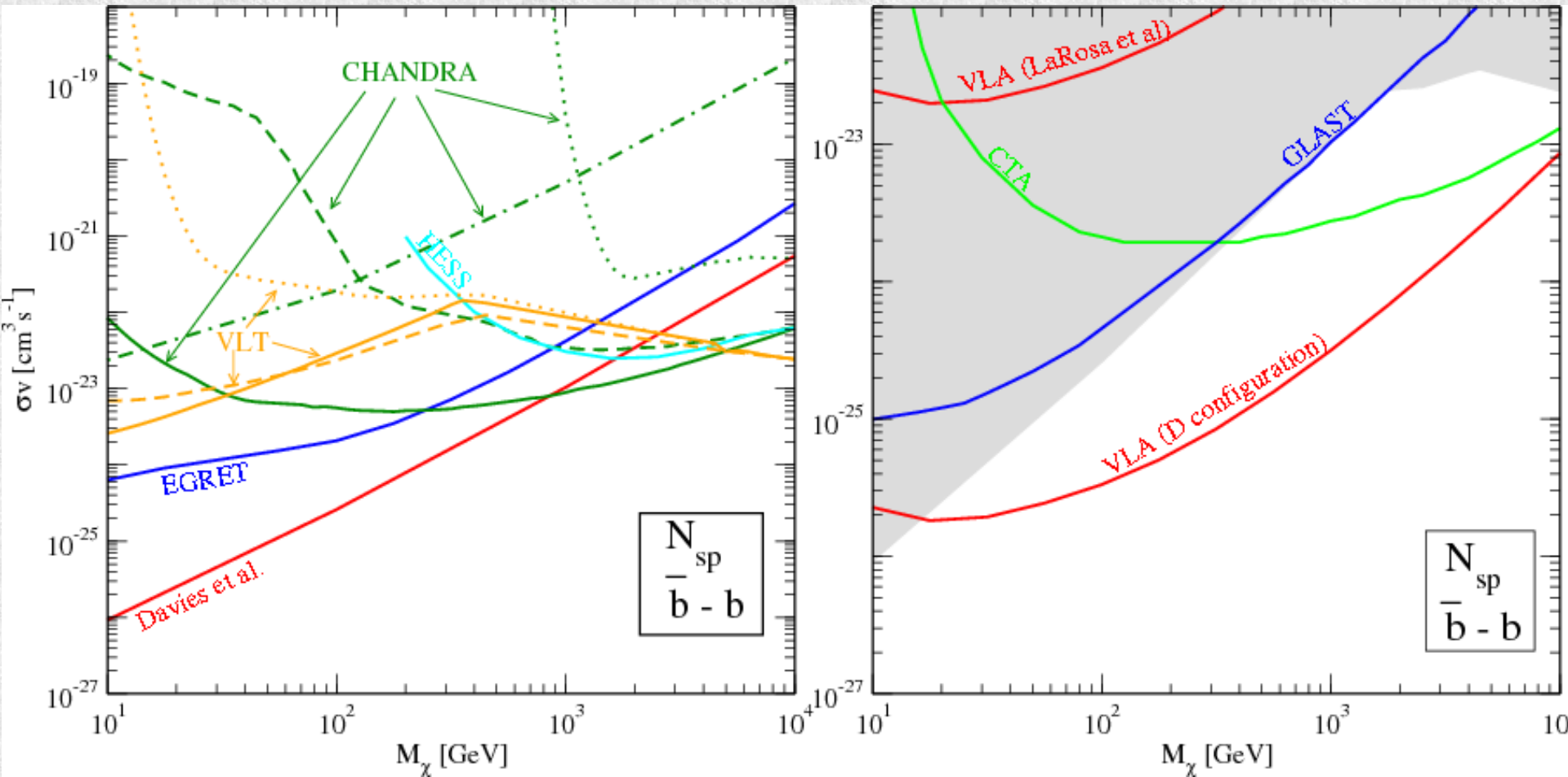
Unstructured, homogeneous sources: $E^{-2.6}$ proton injection for $10^{16} \text{ eV} < E < 10^{21} \text{ eV}$ with constant comoving injection power.

Other Contributions to the MeV-TeV γ -ray background



Galactic Cosmic Ray Propagation and Signatures of Dark Matter Annihilation

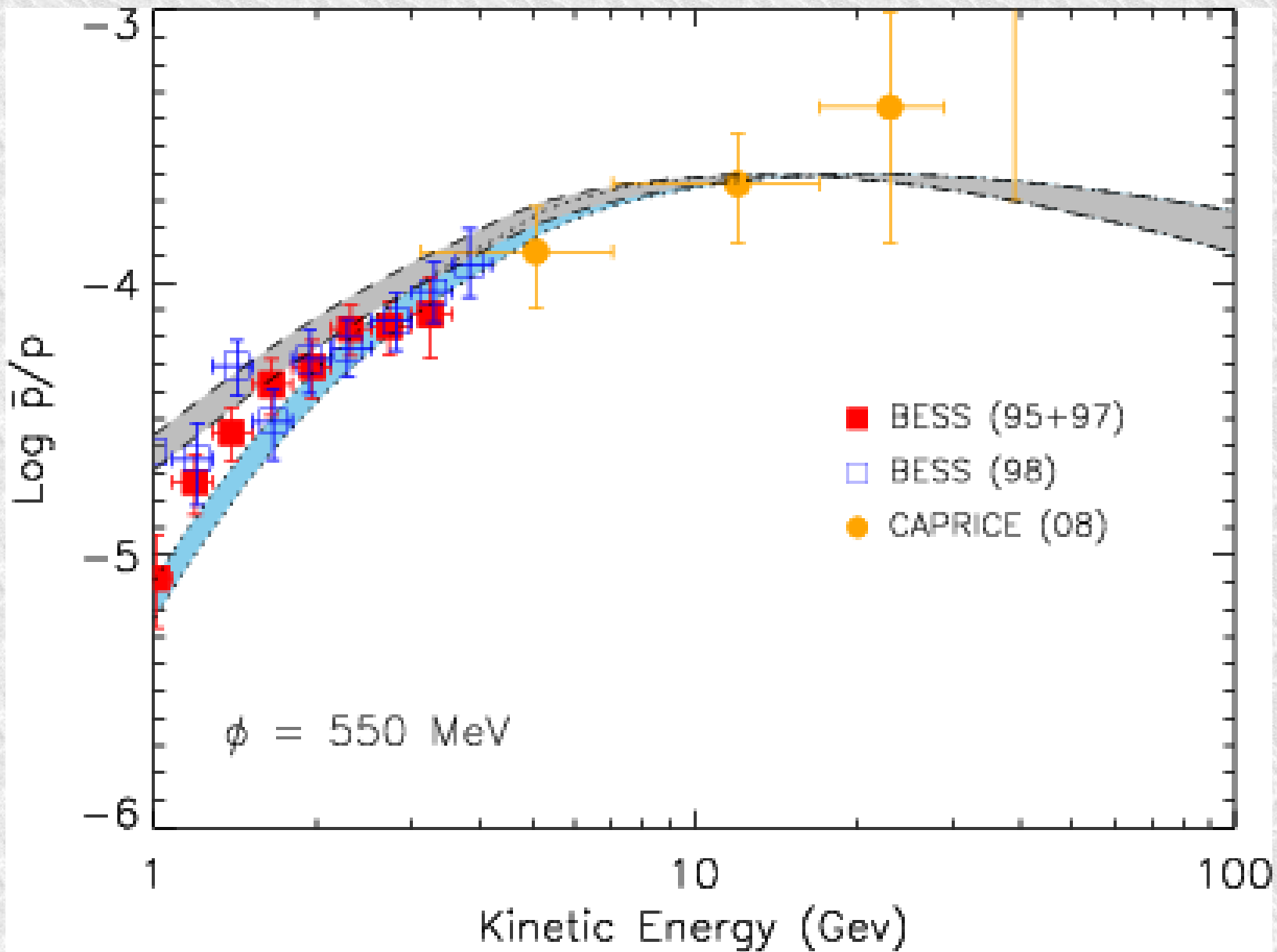
A detailed multi-wavelength study has been performed in
Regis, Ullio, Phys.Rev.D78, 043505 (2008):



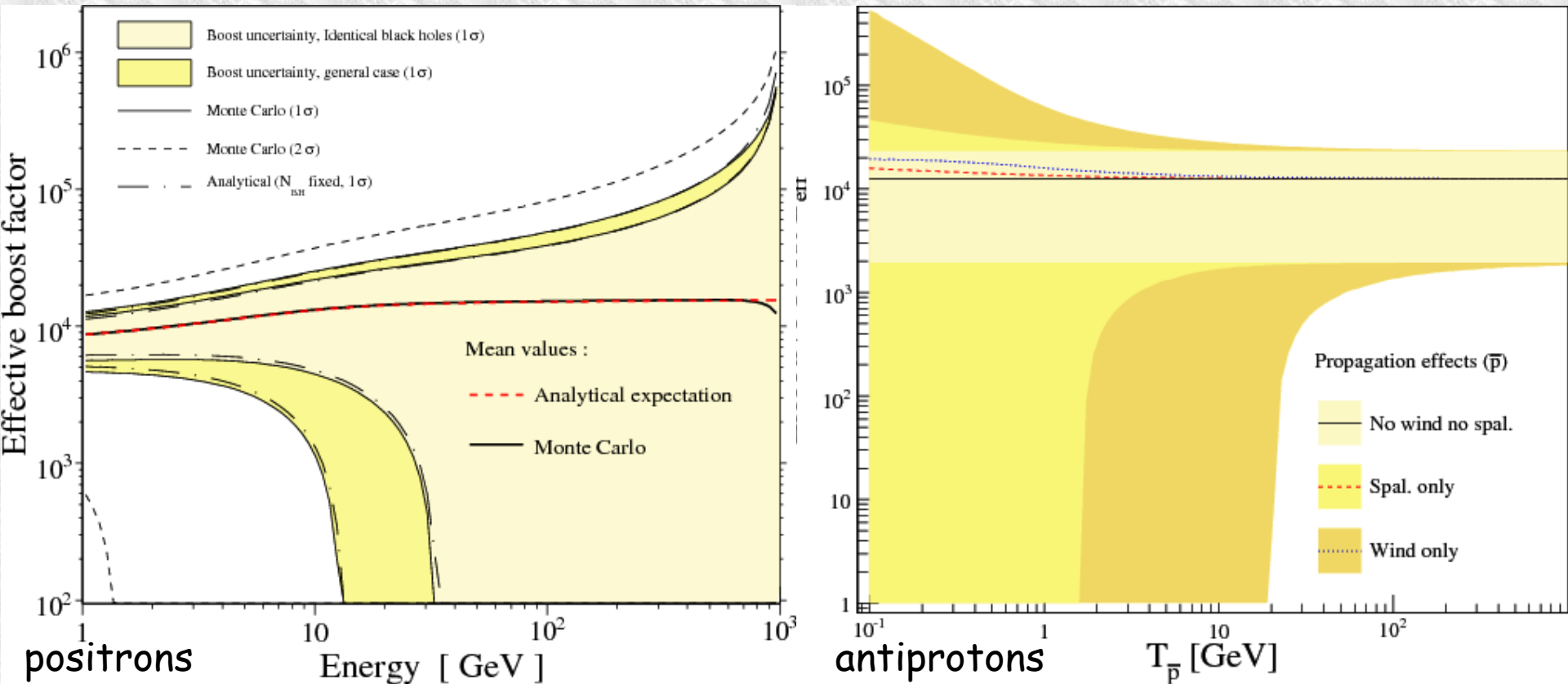
Current constraints

Future sensitivities

Astrophysical background of anti-matter from galactic cosmic ray interactions



Boost Factors for Galactic Positron and Antiproton Fluxes from Dark Matter Spikes around intermediate mass black holes



Conclusions

- 1.) Many activities on the origin of cosmic rays and related topics at several participant labs.
- 2.) Cross-connections to dark matter activities via indirect detection by annihilation products
- 3.) ESR Philipp Mertsch at Oxford working on ultra-high energy neutrino cross sections.