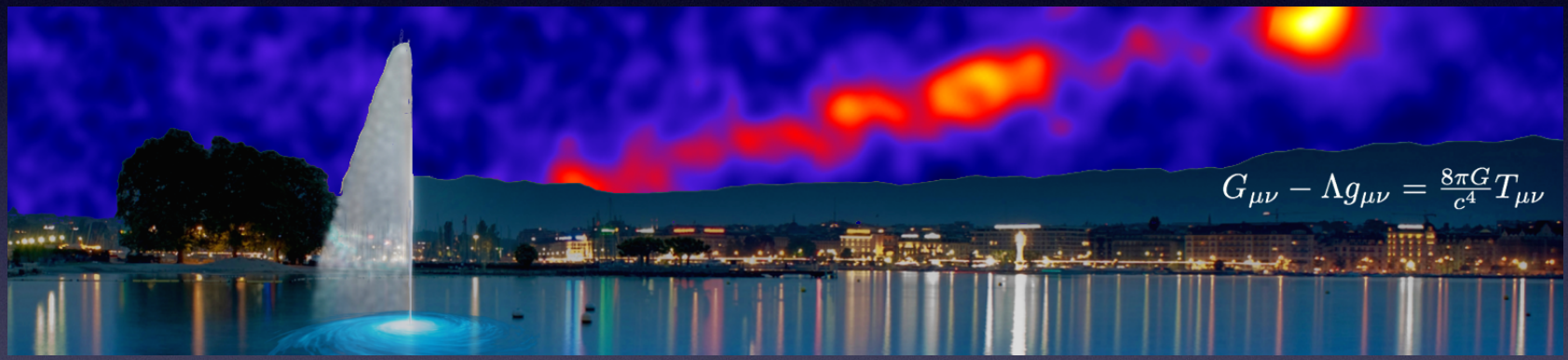
# Highlights from the *Very High Energy and Cosmic Rays* session (session 19)

T. Montaruli and E. Prandini
U. of Geneva



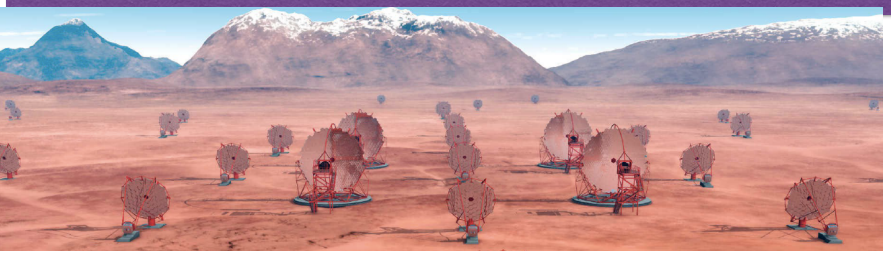

- 29 oral presentations
- 3 posters

- IACT experimental results and future
- Neutrinos and Gamma rays
- Cosmic Rays
- New theoretical models

# Some of the facilities

- HESS
- MAGIC
- VERITAS
- FACT
- CTA

IACT



Direct γ-detection

FERMI

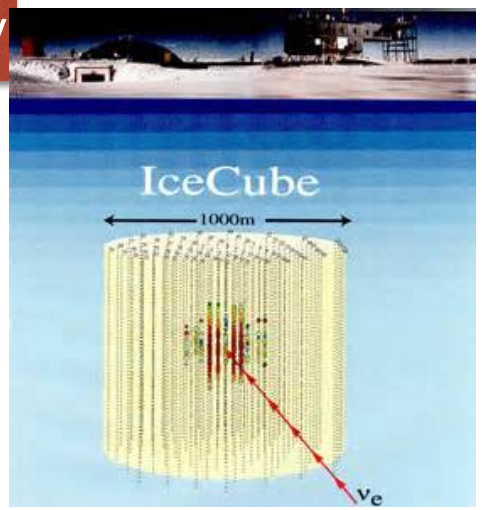
Shower particle interception

Wide Field of View, Continuous Operations

HAWC
ARGO

UHECR EAS

Pierre Auger Observatory



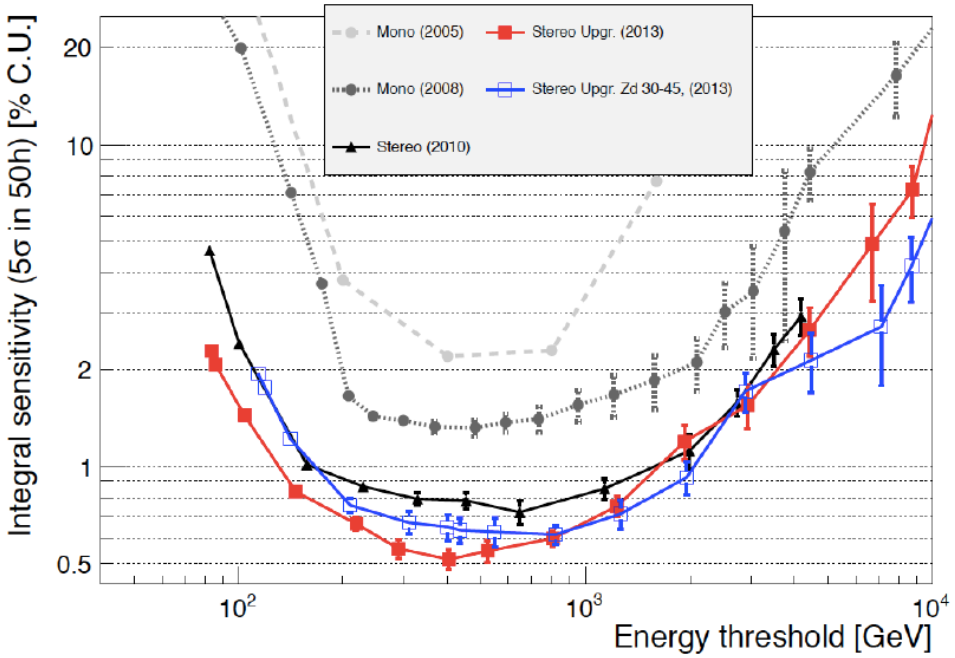

Shower imaging
Precision

Neutrino Telescopes

ANTARES
IceCube

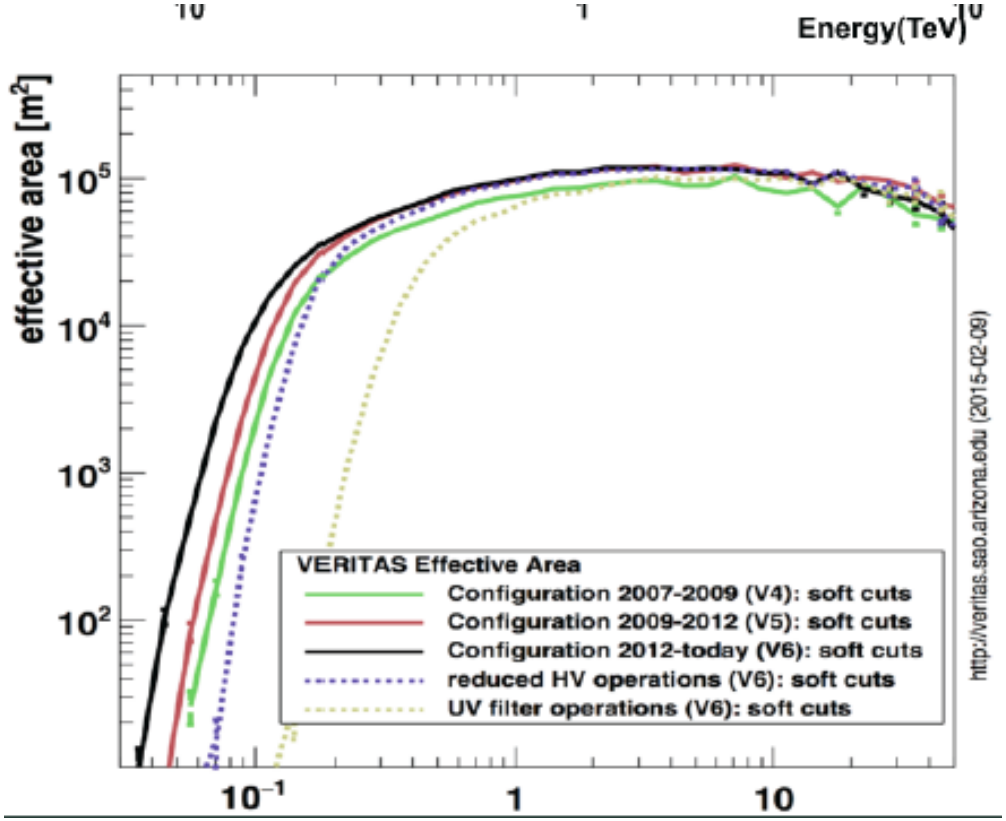
# Recent improvements of TeV instruments

Aleksić et al. (MAGIC) Astropart.Phys, 72, 2016




MAGIC II (Oscar Blanch Bigas)

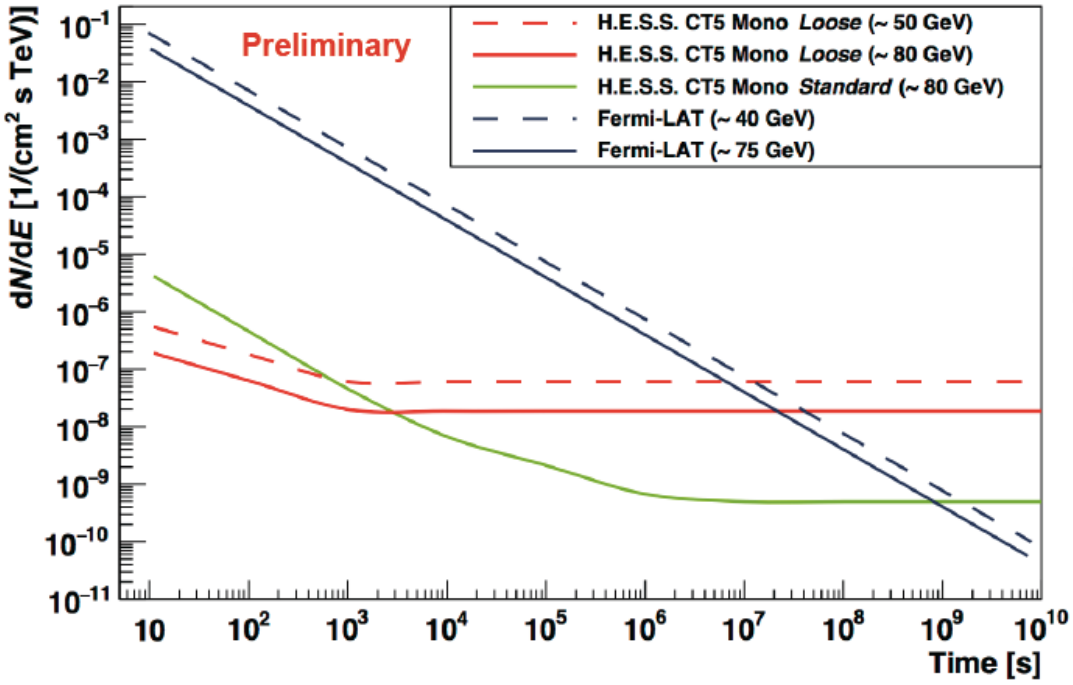
Sensitivity (50h): 0.7% Crab
$E_{th}$ = 25 GeV




VERITAS (J. Quinn):
Sensitivity (25 hrs) 1% Crab
$E_{th}$ = 85 GeV

**At this conference we heard about the benefit of pushing the Eth down for improved instruments.**

The largest telescope:
H.E.S.S. II in the time domain compared to Fermi

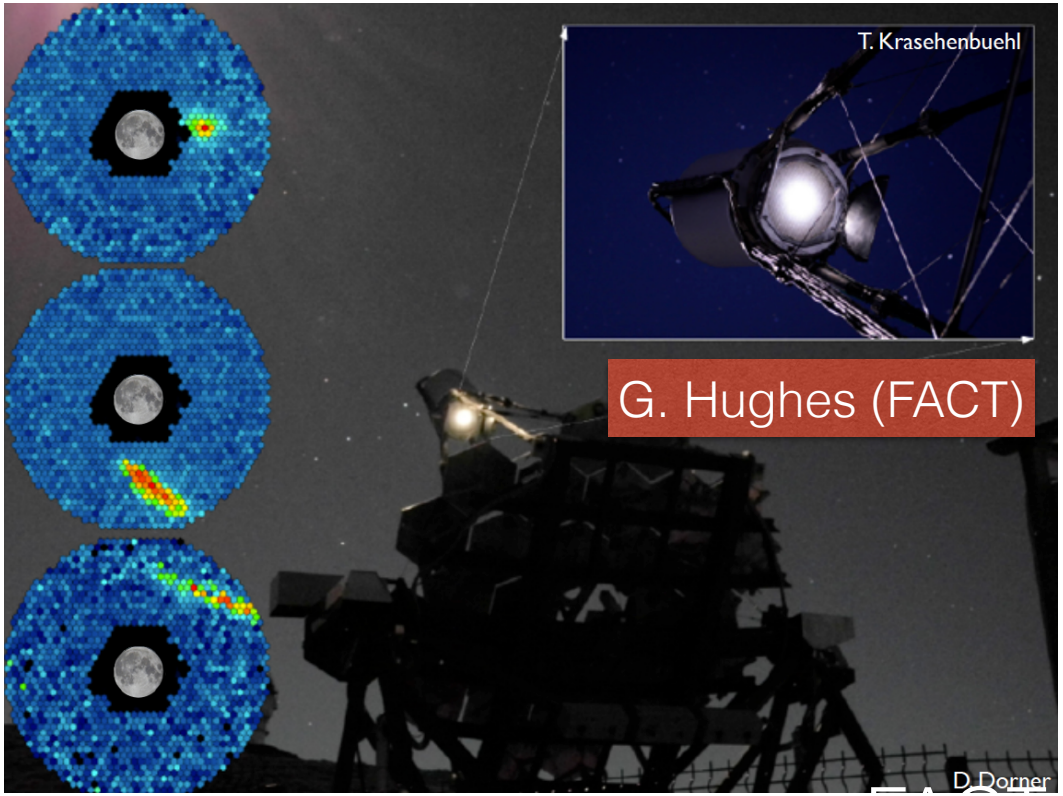



H.E.S.S. Sensitivity 0.5-2% of Crab Nebula Flux for Galactic plane survey

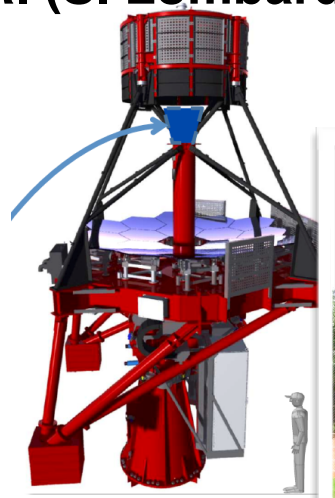
**We are ready to transit into the CTA precision era: it will push sensitivity an order of magnitude down and will be unbeatable in the time domain!**

# New Instruments almost completed!

- SiPM: new technology successfully applied to IACT cameras
- Future telescopes (CTA) will adopt this technology



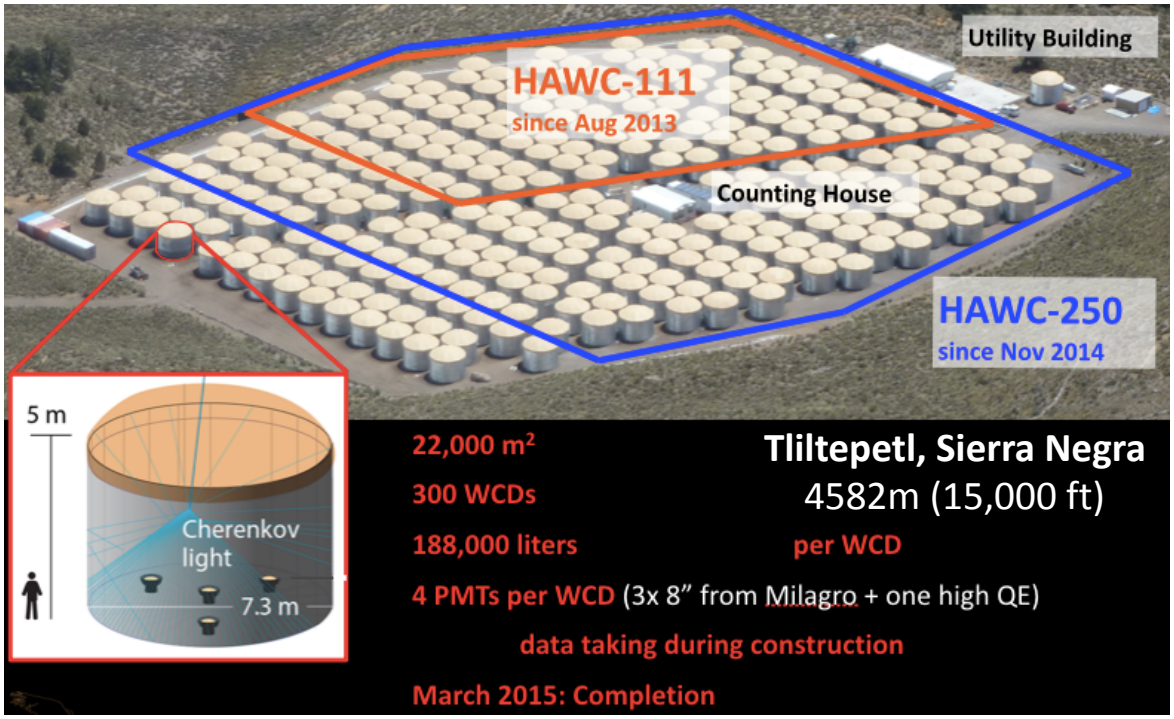

**ASTRI (S. Lombardi)**



**SST-1M (M. Heller)**

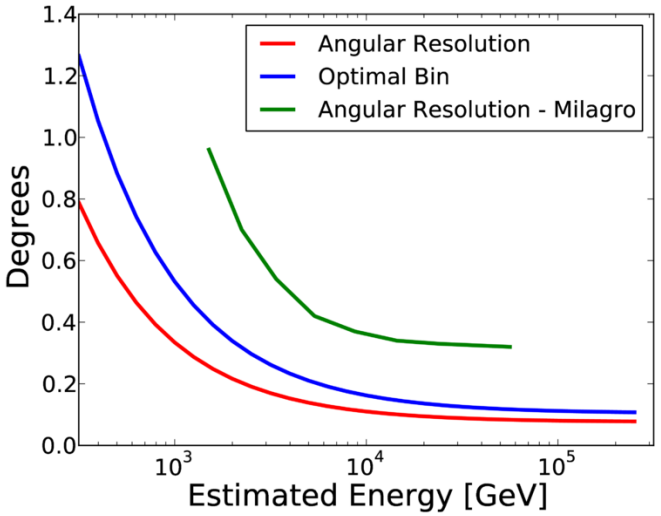
**GCT (J. Hinton)**

# HAWC first science!

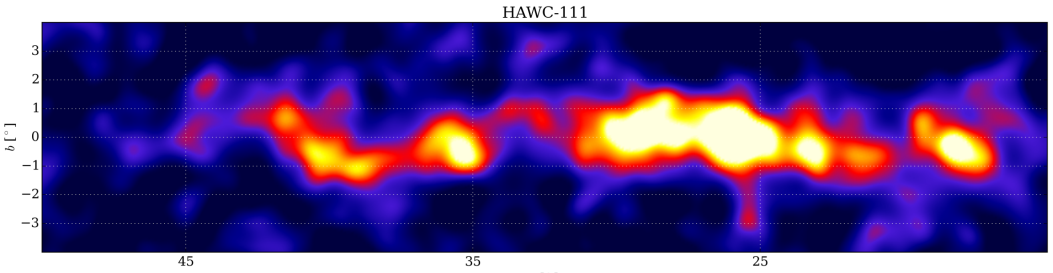



**2 sr instantaneous FoV**

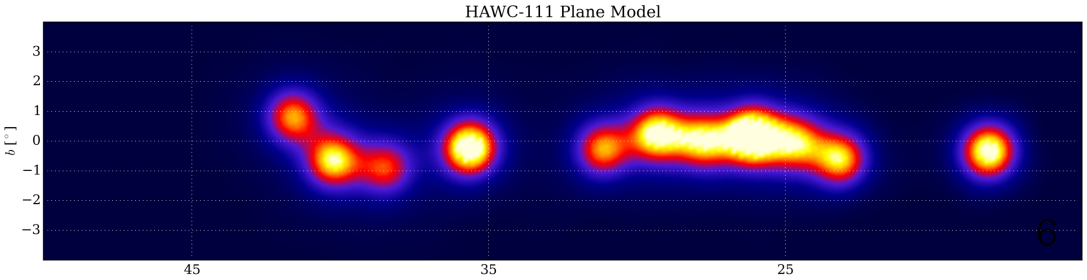
**2/3 of the sky each day**

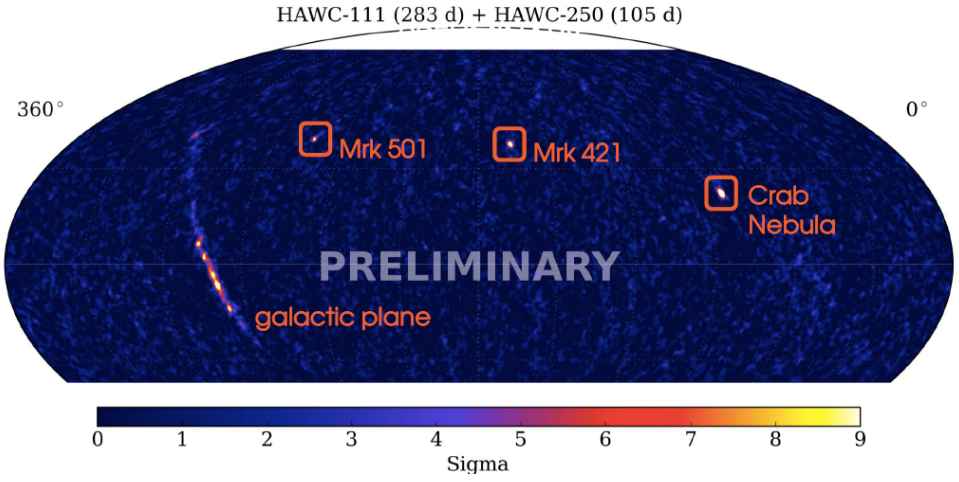



Newer data




1/3 HAWC: after likelihood analysis

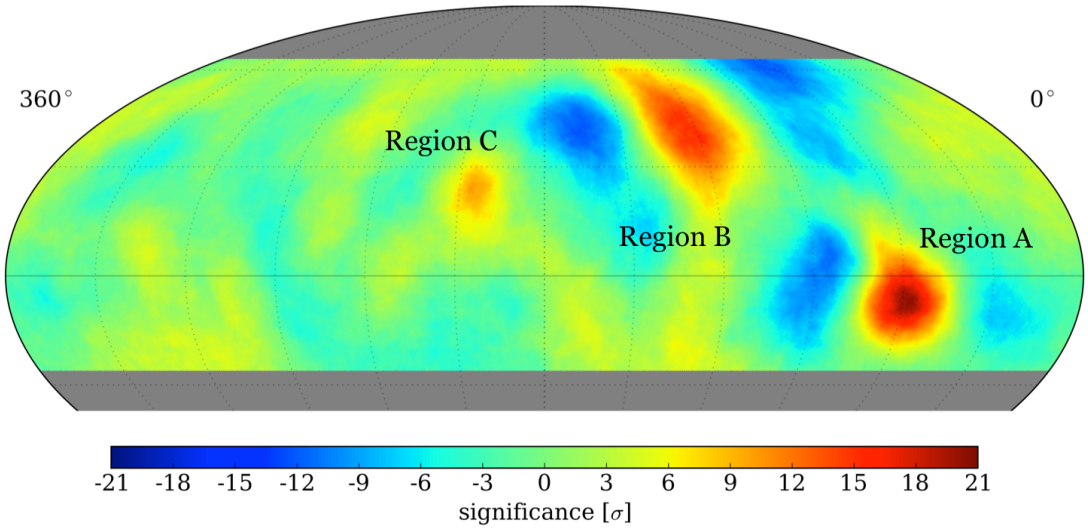


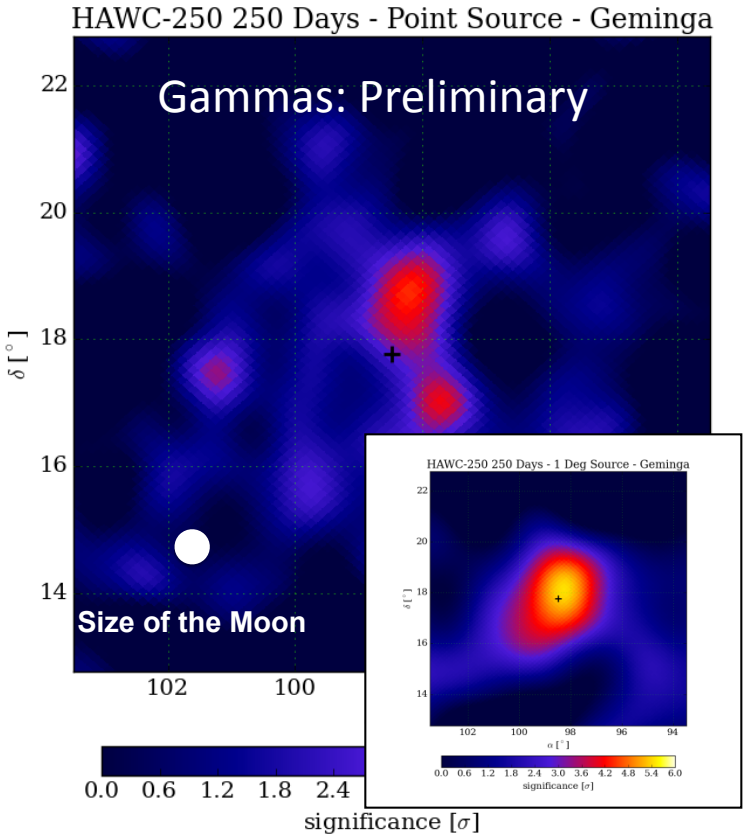




**R. Lauer**

# Great potential for extended sources: Geminga

## Cosmic ray anisotropies



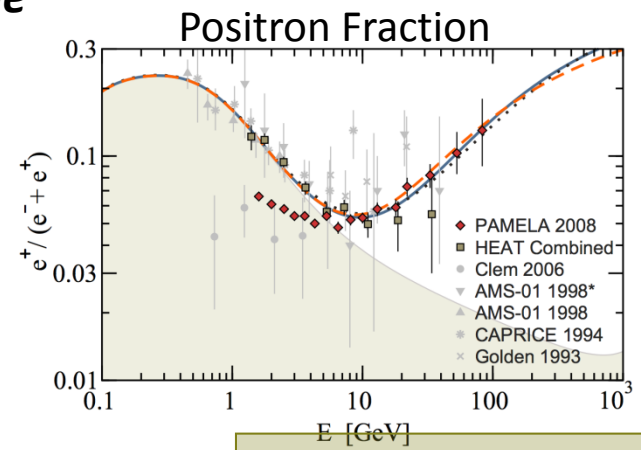




**86 billion events**, collected over **181 sidereal days** with ~1/3 of the array

Large scale (>60°) removed (dipole,quadrupole,octupole)

10° radial smearing and multipole subtraction of large scale anisotropy

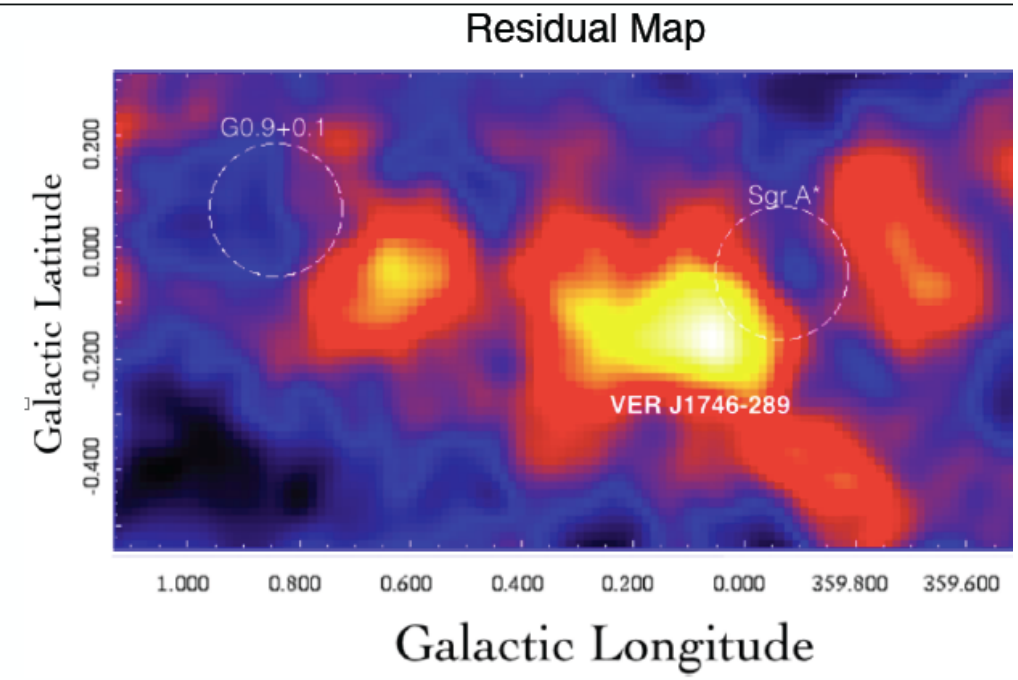
***Contributor to the Positron Excess?***




Yuksel, Kistler & Stanev, PRL. (2009)

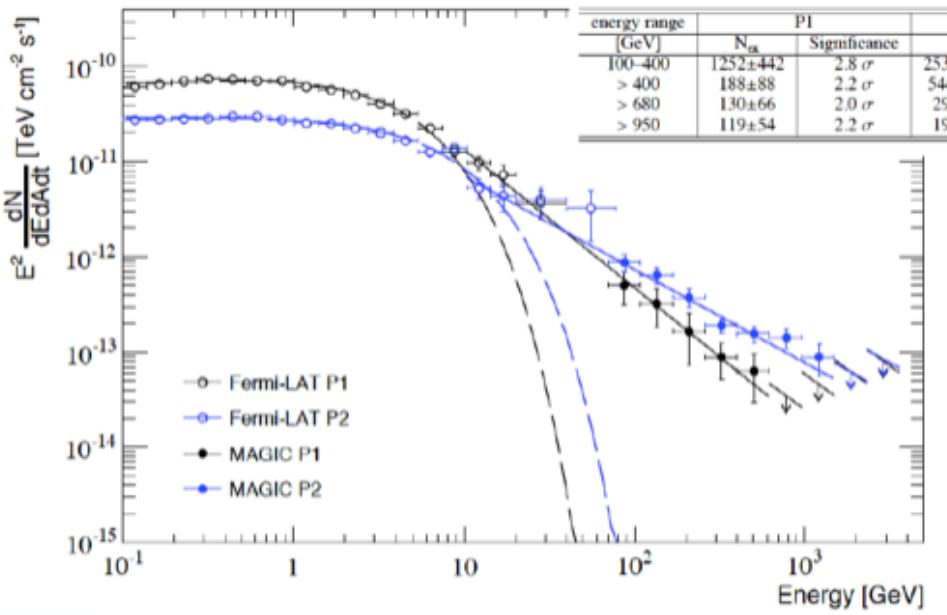
# Galactic sources

**J. Quinn**




Ansoldi et al. (MAGIC) accepted in A&A

**O. Blanch Bigas MAGIC**




**Crab Pulsar pulsations (its wind?) measured to the TeV!**

**Galactic Centre in the TeV: VER J1746-289 new veritas source at 7.8σ (J. Quinn)**

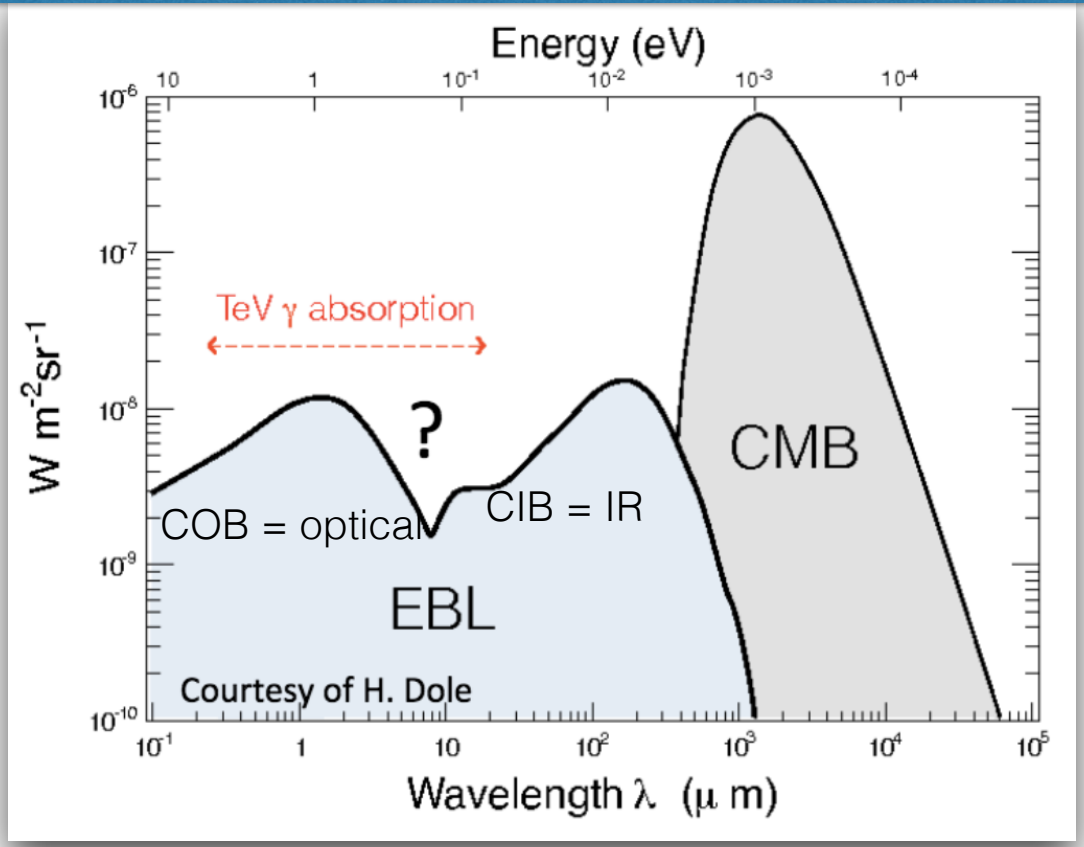
**Improved IACT capabilities at low energy matter due to 40 GeV region (Fermi excess - DM? J. Hinton's talk)**

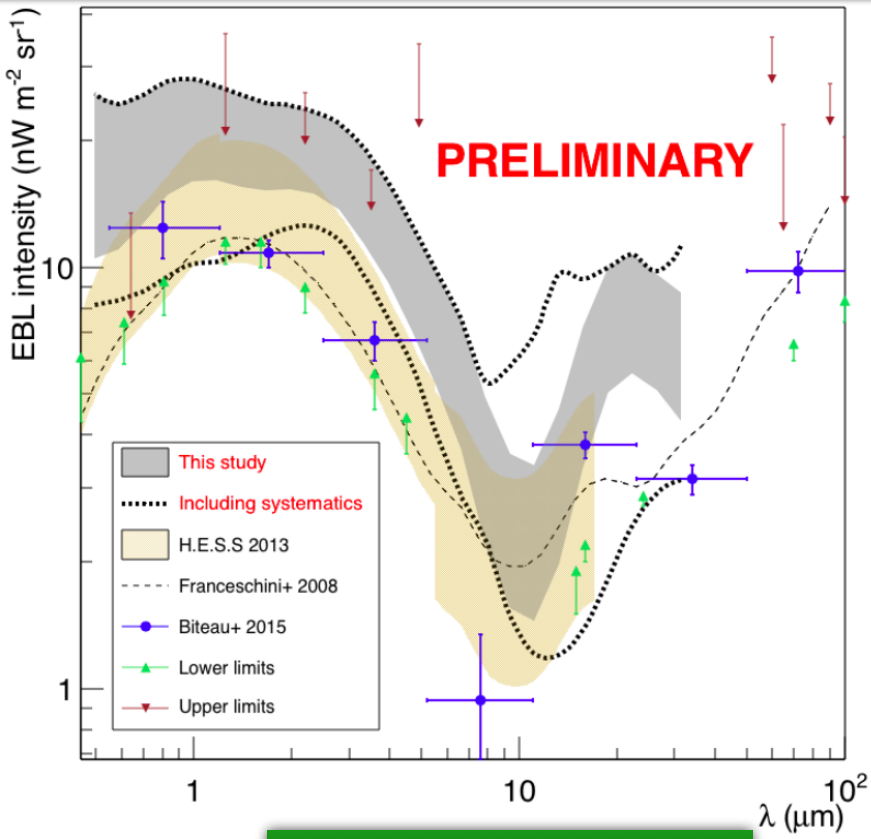
**But main focus of the session has been on extra-galactic sources…**

# Gamma-rays: Deep EBL studies by IACTs

http://www.nasa.gov/feature/goddard/nasas-fermi-satellite-kicks-off-a-blazar-detecting-bonanza

**Breaking the distance record! VHE gamma rays from redshift ~1 (PKS 1441+25)**
**Becerra - MAGIC**




J. Chevalier, H.E.S.S.

EBL tested up to redshift 1

**TeV observations are in agreement with EBL models —> Probes structure formation and Intergalactic Magnetic Field (Neronov & Semikoz 2009, Oikonomou)**

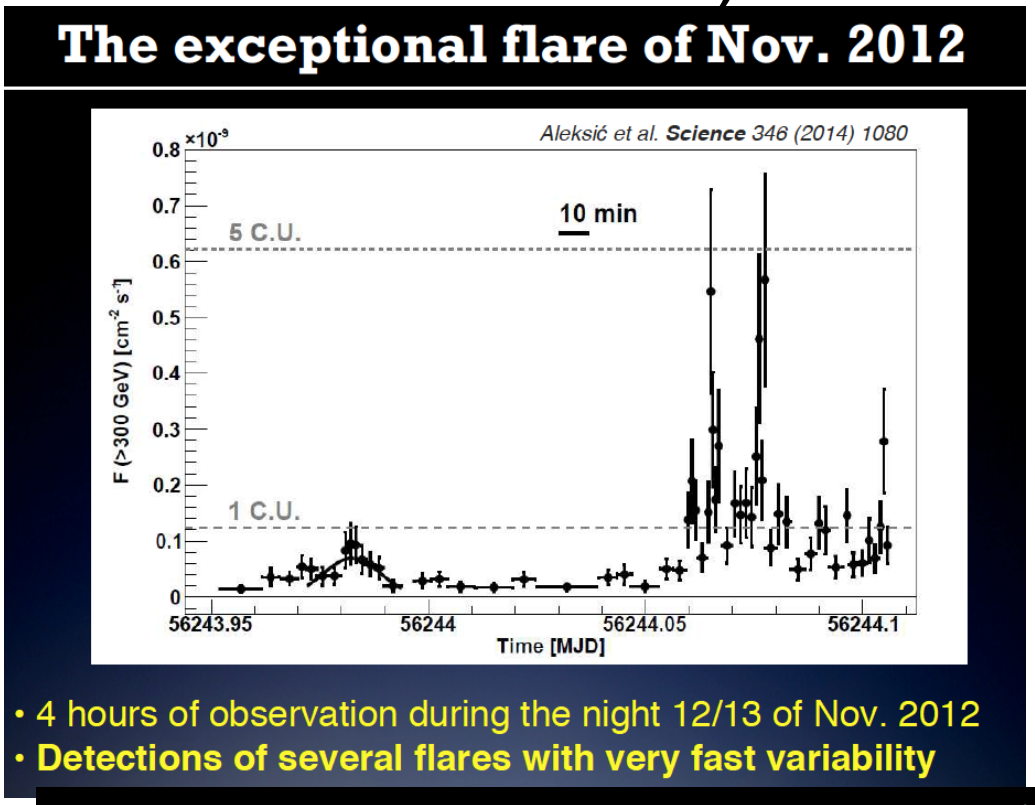
Pueschel (VERITAS): 10 sources, redshifts z=0.044-0.49

O. Blanch Bigas (MAGIC)

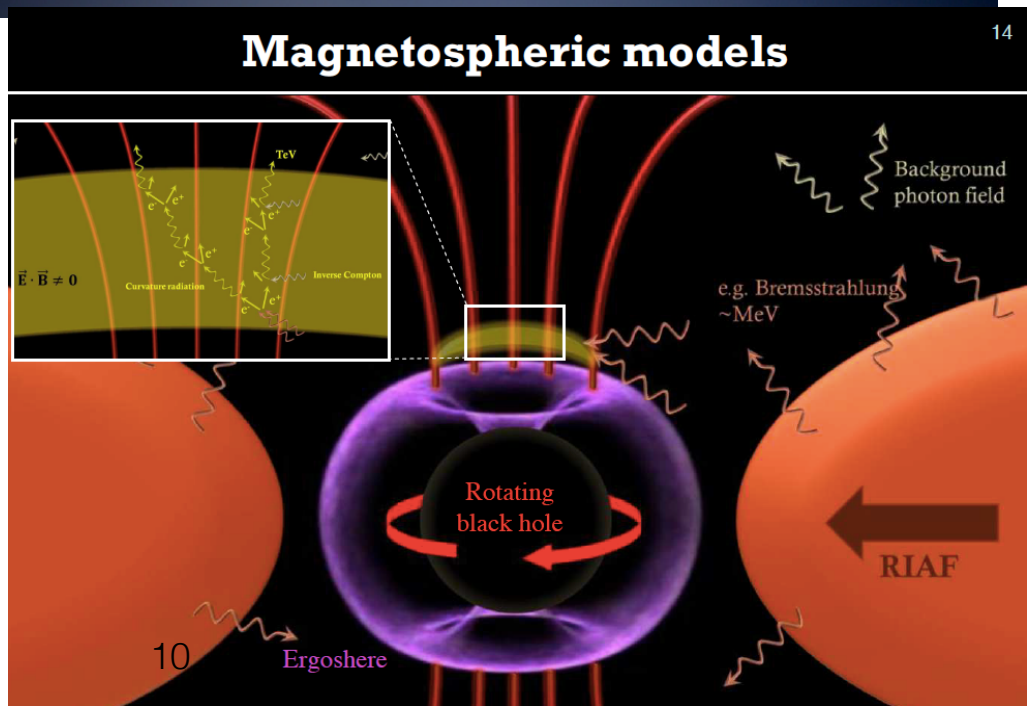
# IC 310 (Perseus Cluster)

**IC 310: MINUTE VARIABILITY FROM A MIS-ALIGNED (Θ = ~10-20°) RADIOGALAXY**

P. Colin (MAGIC)




Tension with shock-in-jet model (δ<6).
Alternatives: magnetic reconnections (but limited doppler factor…) or magnetospheric model (similar to aligned magnetic rotator pulsar model)

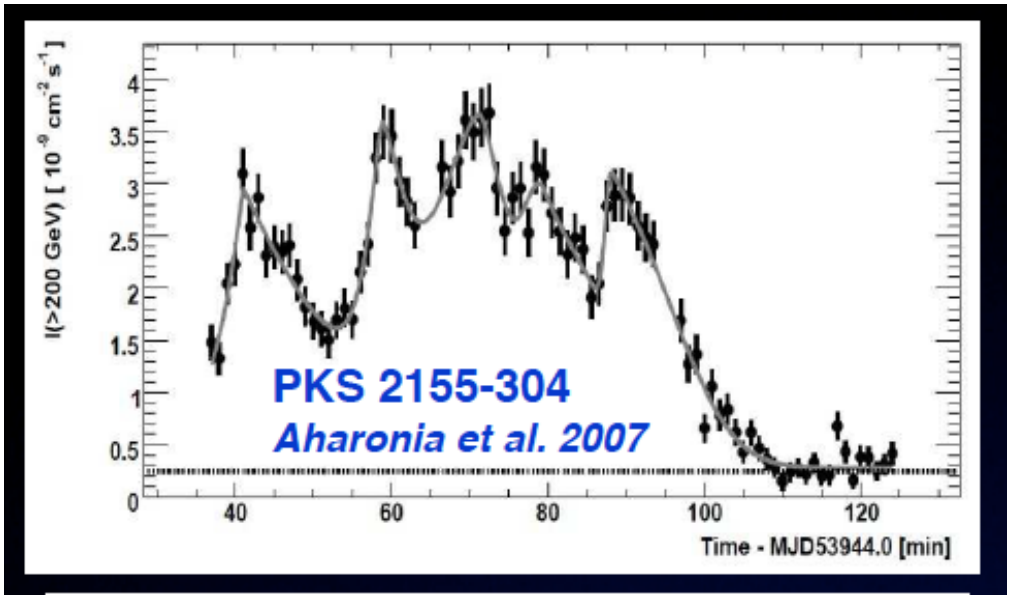


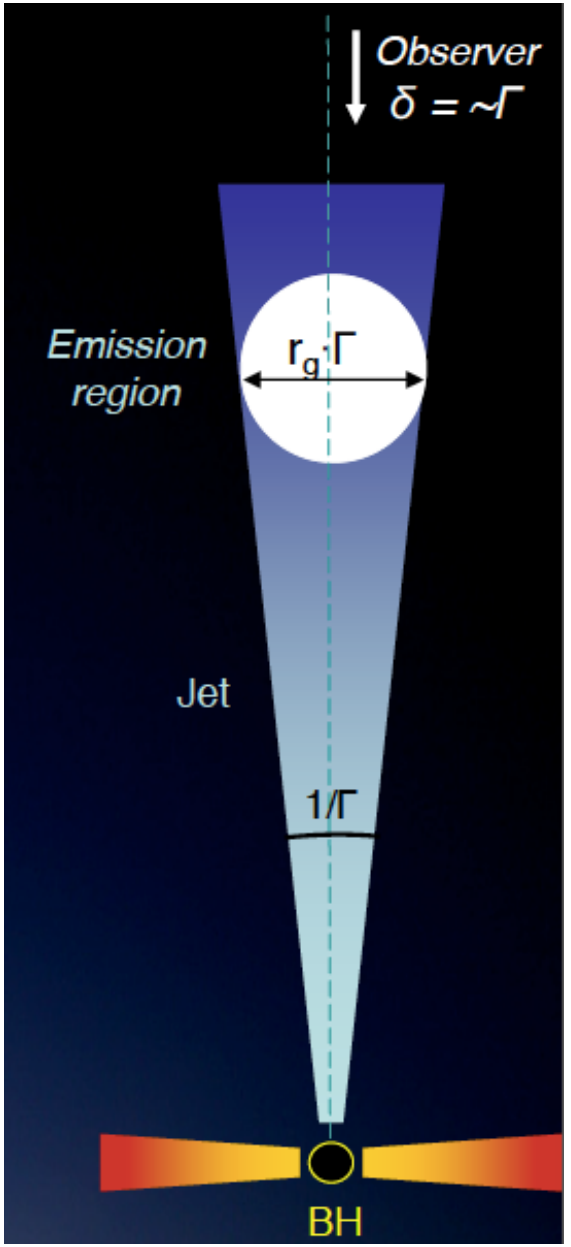
For Mrk501 & PKS 2155-304 minute variability:

- Lorentz factor $\Gamma \geq 50$
- View angle $\theta \leq 1°$

## Additional issues:

- If typical blazar $\Gamma$>10, we should see much more mis-aligned Blazar than observed




**We heard also about a flare reaching 35 x Crab if it was at the distance of Mrk 421**
**VERITAS after Fermi's alert for B2 1215+30 in Feb 2014 (F. Zefi)**

**Alerts are FUNDAMENTAL!!!**

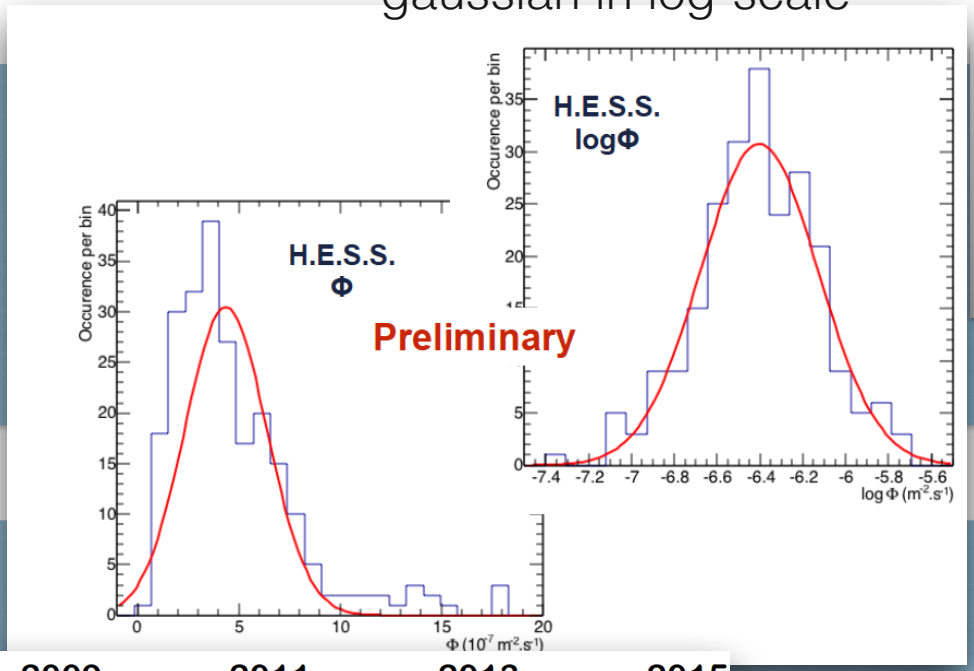
**Also Multi-messengers ToO (IceCube-VERITAS, MAGIC, HAWC)**

# The study of VHE variability in AGNs

J. Chevalier (H.E.S.S.)

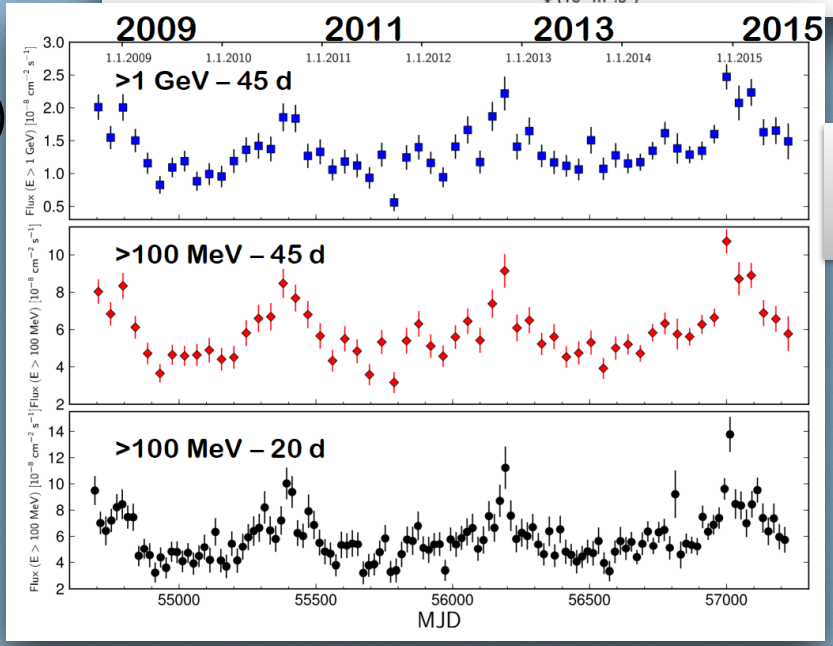
- **LOGNORMALITY BEHAVOUR OF VHE FLARES?**

gaussian in log-scale

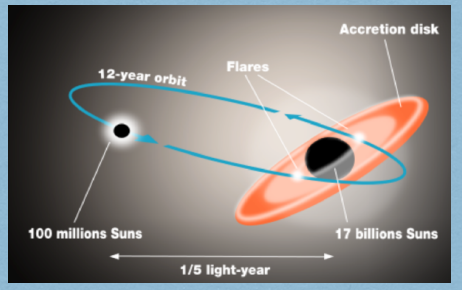



**Imprint of cascade-like events in the disk onto the jet in a blazar?**

- **PERIODICITY**
  - PG 1553+113(TeV)
  - Mrk 421(optical)




Binary supermassive black hole system?




M. Charisi (Poster)

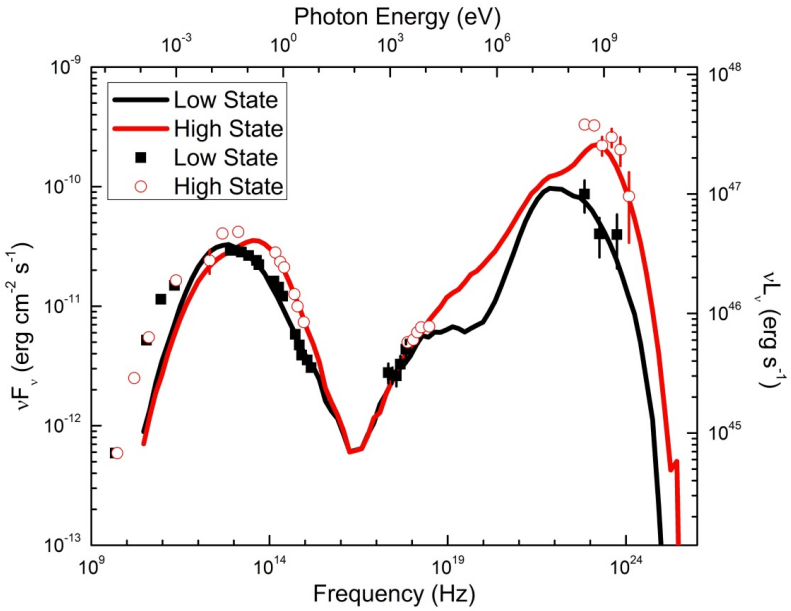
G. Hughes (MAGIC)
Stamerra (Fermi)

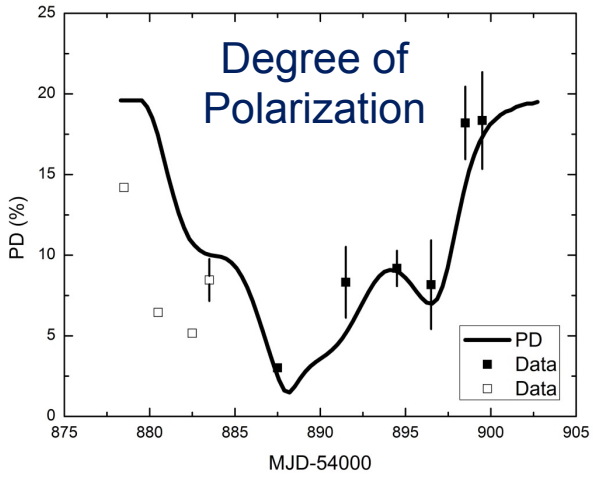
# Acceleration mechanism and flares

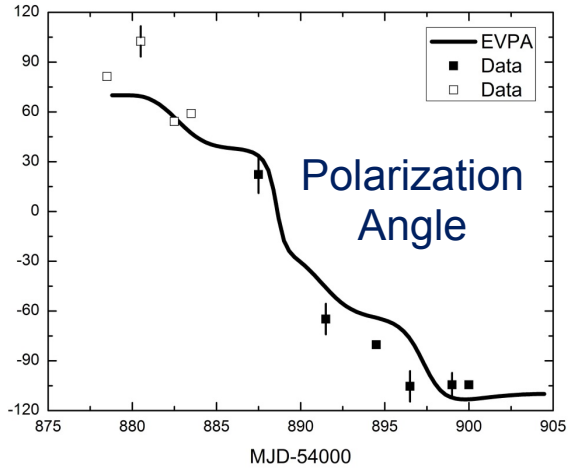
Combining information on SED during flares and steady states (no big change in synchrotron region) and polarization signatures of magnetic reconnection can be identified (M. Botcher)

## Application to 3C279

Requires particle acceleration
and reduction of magnetic field,
as expected in magnetic reconnection!



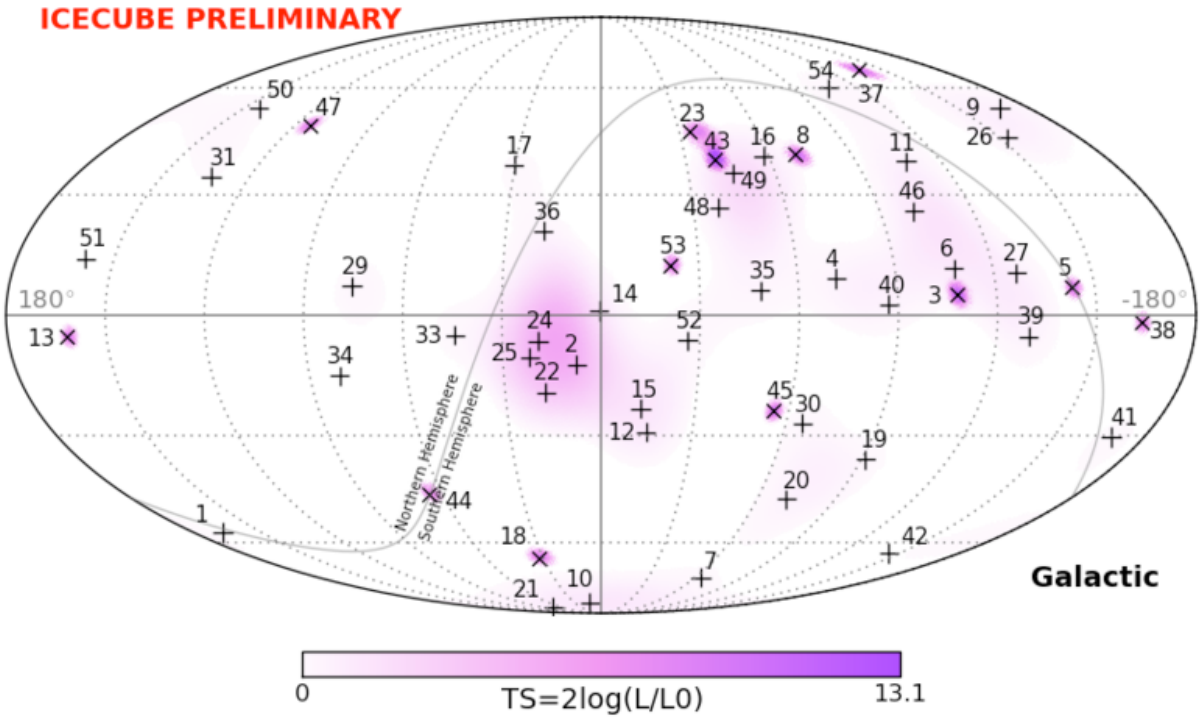




(Zhang et al. 2015)

# The new astronomy is ON

But where are the cosmic neutrinos from?



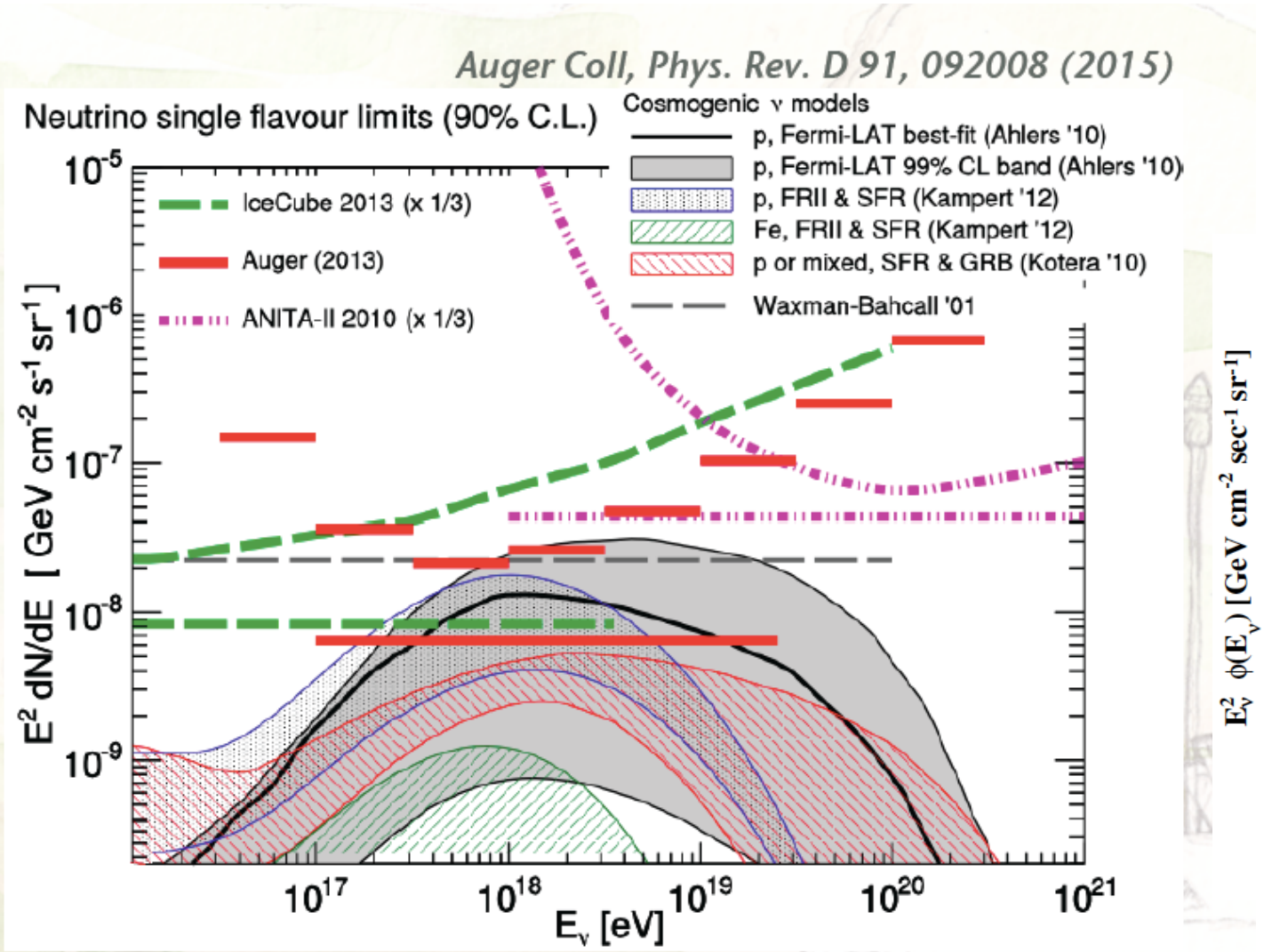

GRB disfavored as major high energy neutrino sources

Zhuo Li
Assuming photon-neutrino connection:
diffuse Galactic emission, <10%
Galactic point sources
GRBs, <10%
AGN jets, <10%
Starburst galaxies

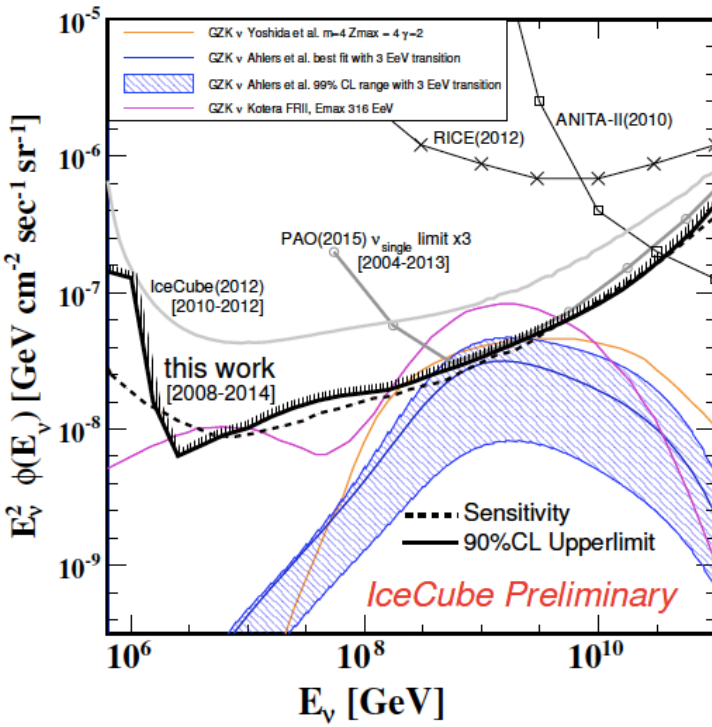
Halzen's talk

Clustering of 52 events: no significant evidence.
Galactic plane clustering test with fixed width of 2.5° around the plane (post trial p-value 7%) and using a variable-width scan (post trial p-value 2.5%).

# Not from the ‘granted neutrinos’: Cosmogenic Neutrinos



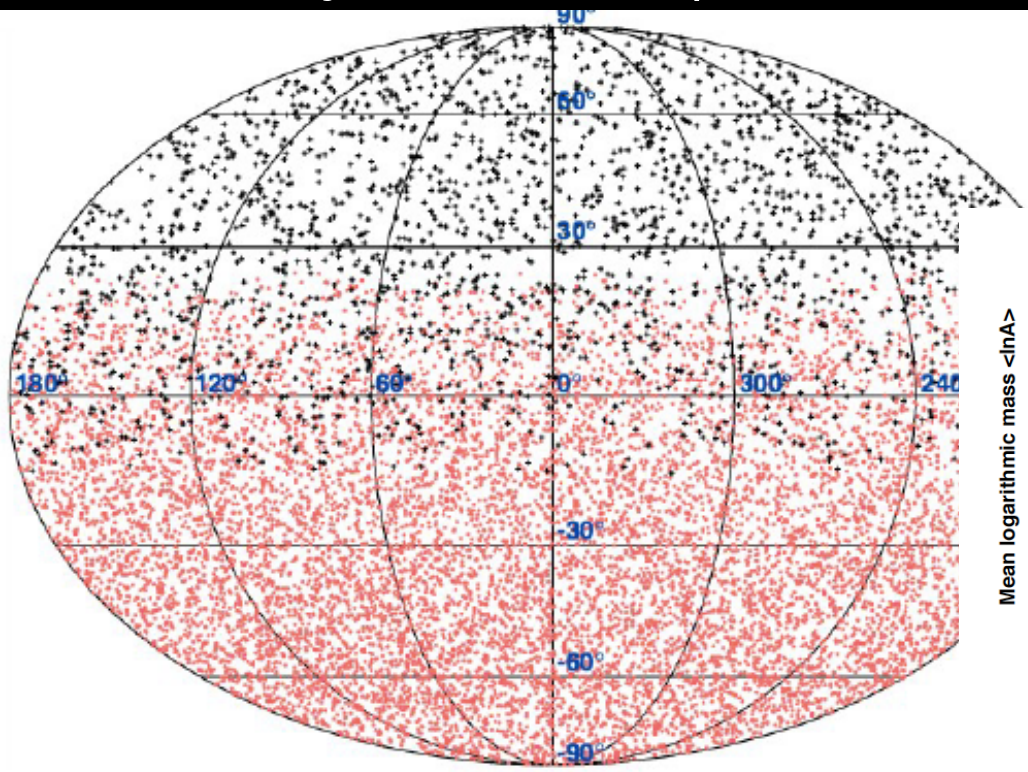

**Oikonomou**



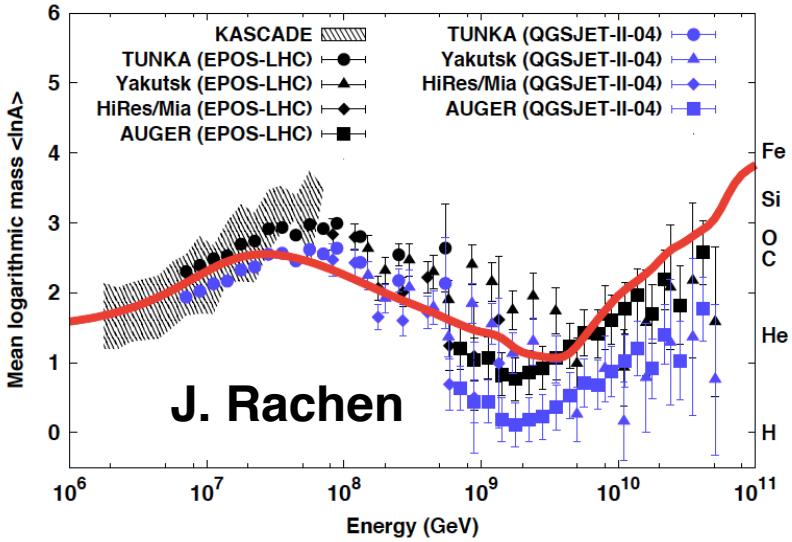

Auger first observatory to place limit below Waxman-Bahcall bound

# UHECR Sky surprisingly isotropic

## UHECR astronomy and composition still open issues




Petrera




*Auger and TA Collaborations, ApJ, 794, 172 (2014)*

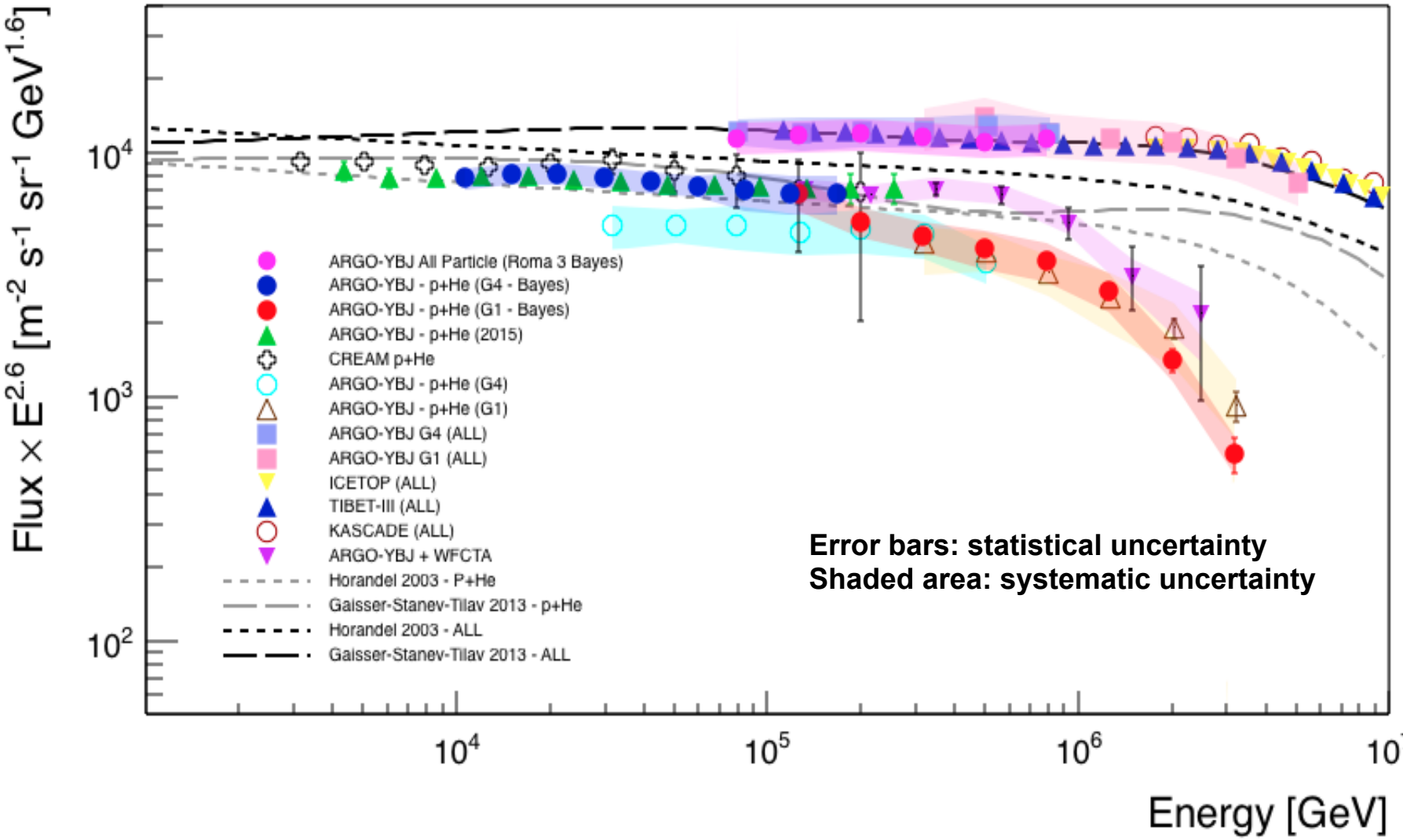
Arrival directions of **Auger** and **TA** events above $10^{19}$ eV in equatorial coordinates

4-8 EeV Isotropic distribution, Auger: ApJ 802:111 (2015)
8-10 EeV Dipole-like anisotropy:
Auger: p=6.4 $10^{-5}$
Auger and TA : p=5 $10^{-3}$
ICRC 2015

➪ 10 EeV sources are unlikely of Galactic origin (M. Kachelriess)

# ARGO-YBJ all-particle (80 TeV – 20 PeV) & (p+He - 3-300 TeV) spectra

- Evidence of a gradual change of the spectral index at energies around 700 TeV
- Can this hint to problems in hadronic models since high altitude experiments are closer to the maximum (less fluctuations) or too close to the maximum and missing part of the shower?



Apologizes to those we did not mention and to those of whom I had to miss the talk (we are high-energy mamas!!)