ICRC

The Astroparticle Physics Conference

34th International Cosmic Ray Conference
July 30 - August 6, 2015
The Hague, The Netherlands

1220 Contribution (> 1000 participants)

→ 427 talks (5 parallel session + highlights + reports)

→ 793 posters

Scientific program

- Solar and heliospheric phenomena
- **Cosmic rays**
  - Direct measurements
  - **Air showers (10^{15} – 10^{20} eV)**
- **Gamma-ray astronomy**
  - **Space-based**
  - **Ground-based**
- Neutrino astronomy
- Dark matter searches

Slides from :
- talks
- rapporteur/Highlight talks
- summary by Fabian Schüssler

… very biased selection of results!!!

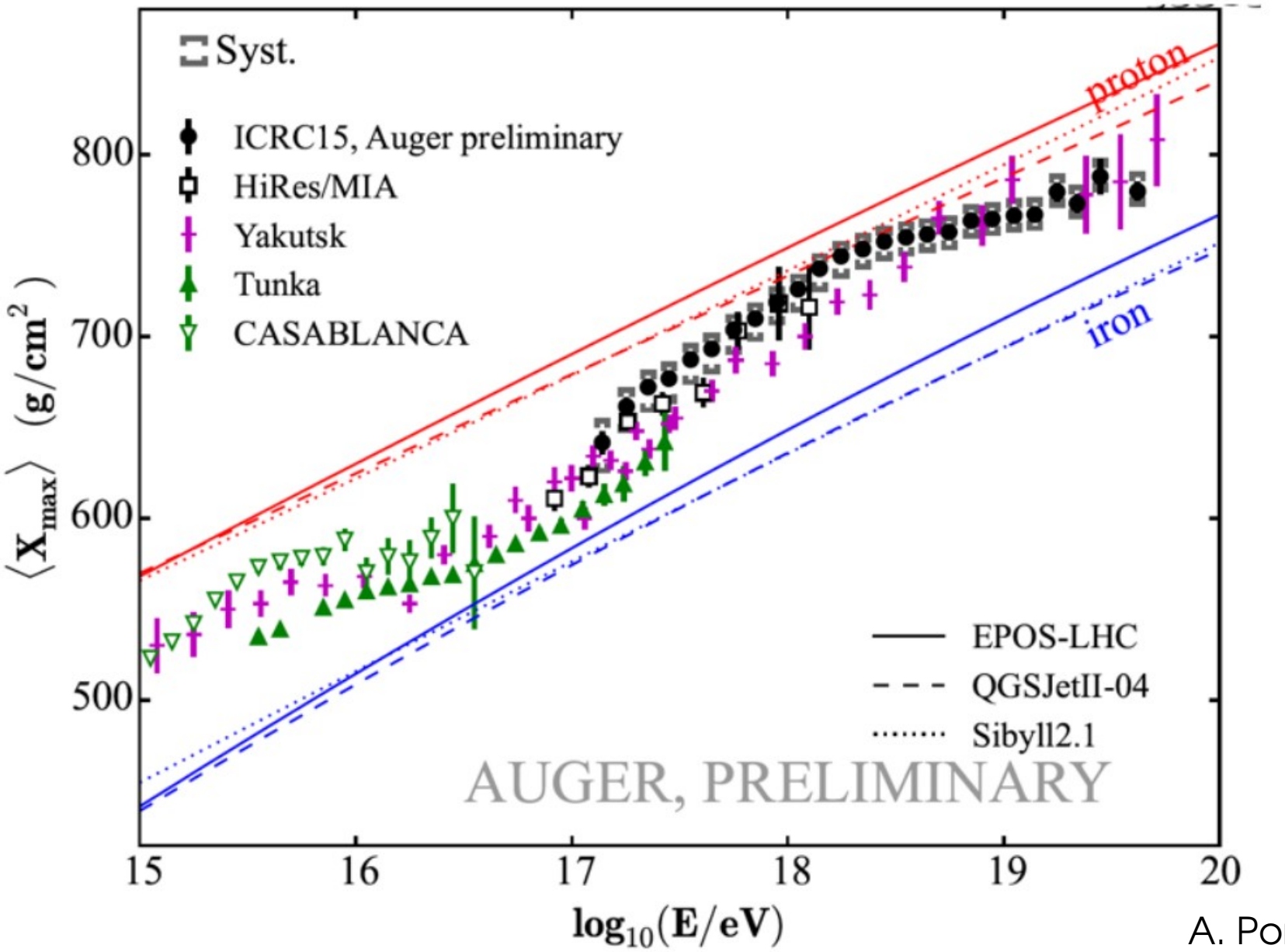
HE + UHE Cosmic rays

- Mass composition
  - Auger results down to 10^{17} eV
  - Tension between Auger and TA lifted

- Energy spectrum
  - Some tension between Auger and TA (highest energies)

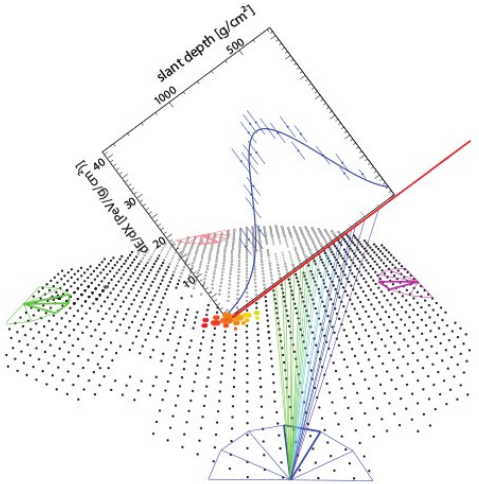
- Anisotropies
  - Energy dependent dipole (IceCube/IceTop)
  - HAWC: medium scale anisotropies
  - Large scale anisotropies found (Auger+TA: dipole; TA: hotspot)

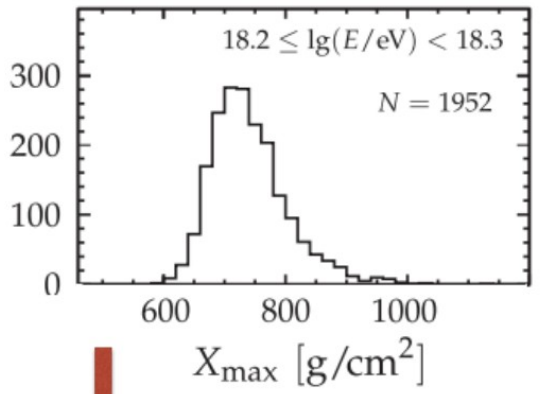
UHECRs : mass composition

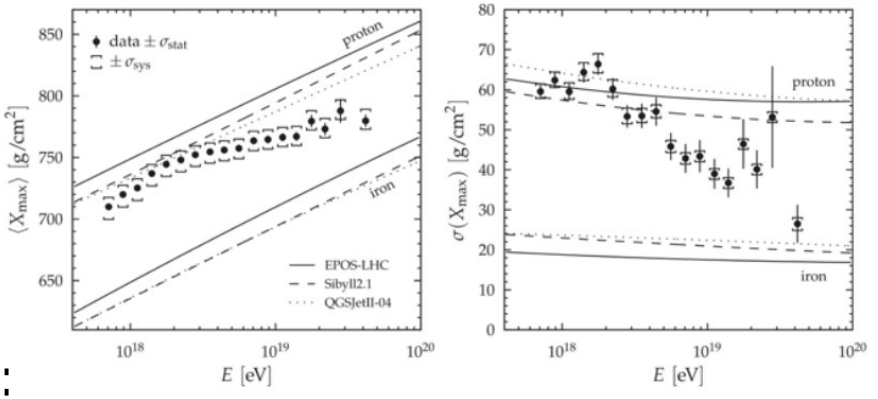


A. Porcelli

UHECRs: mass composition





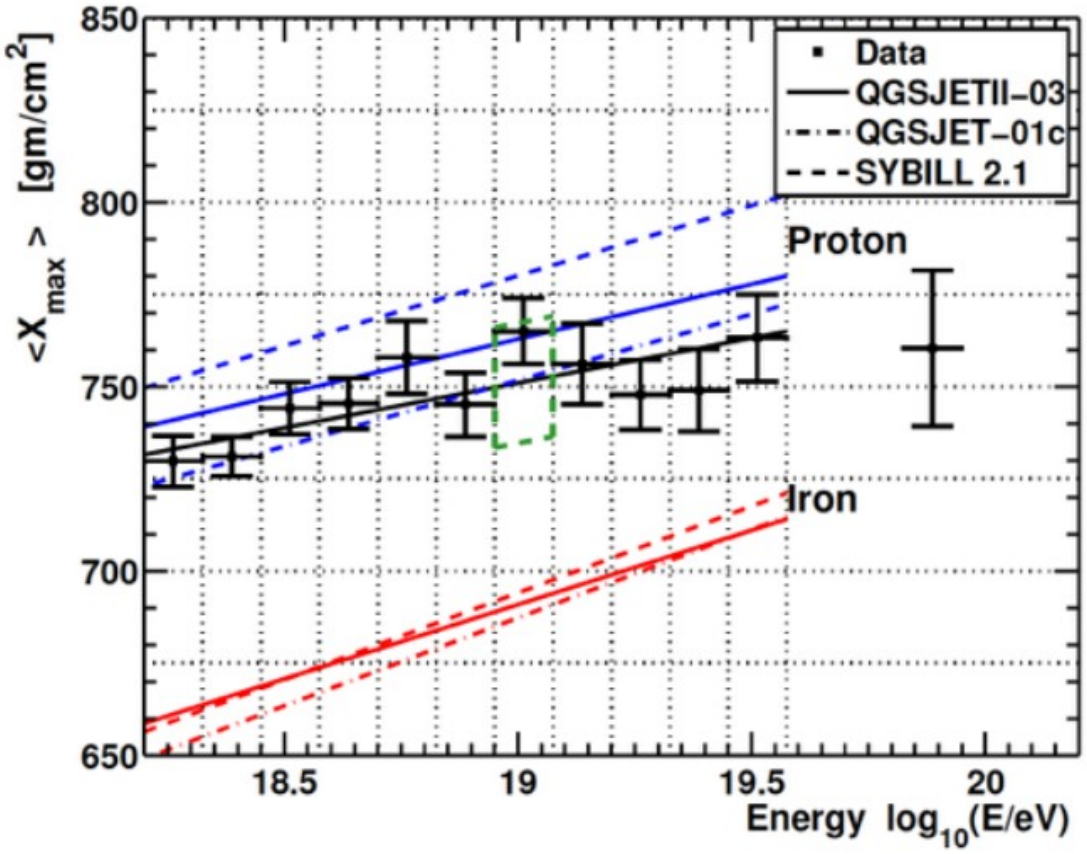


- Since several years :
  - Auger: composition is getting heavier above $10^{18.3}$ eV
  - TA: composition is compatible with pure protons

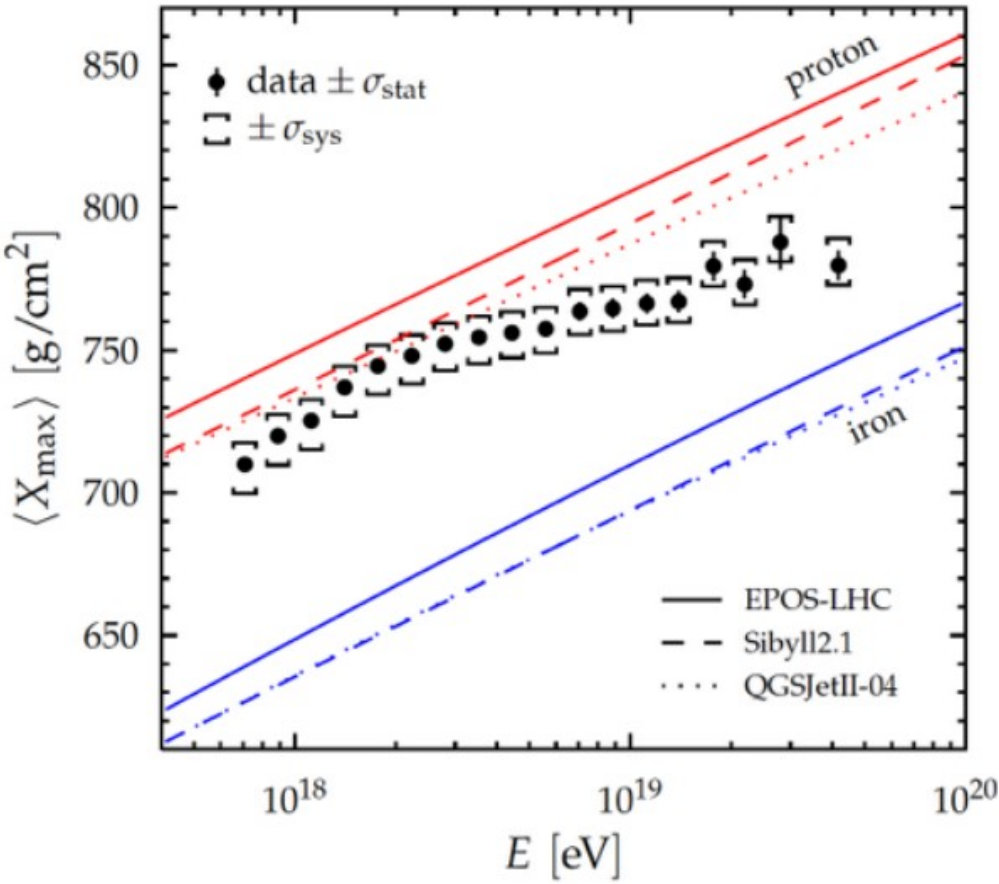
- Working group installed around UHECR 2012 (CERN)
  - different ways of comparing data with hadronic models
  - Auger: unbiased data compared directly to models
  - TA: biased data compared to forward-folded models

UHECRs: mass composition

Auger vs Telescope Array



Telescope Array Collaboration, APP **64** (2014) 49

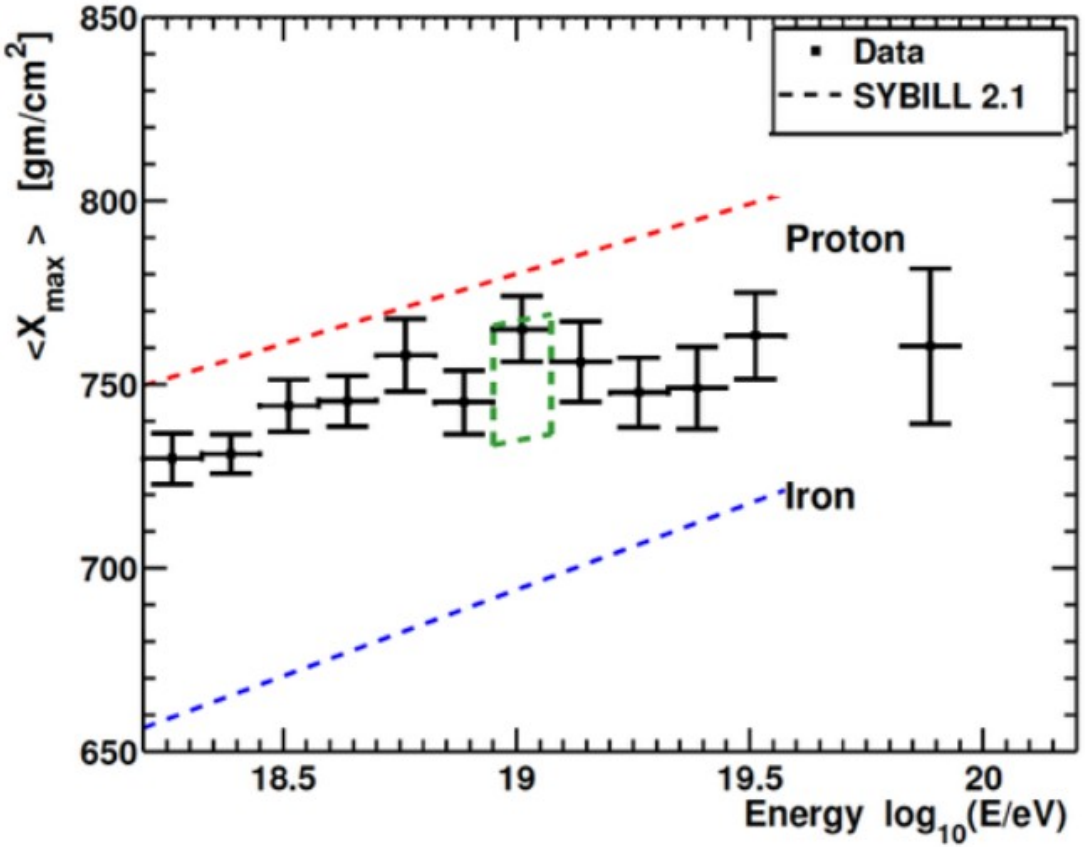


Pierre Auger Collaboration, PRD **90** (2014) 12, 122005

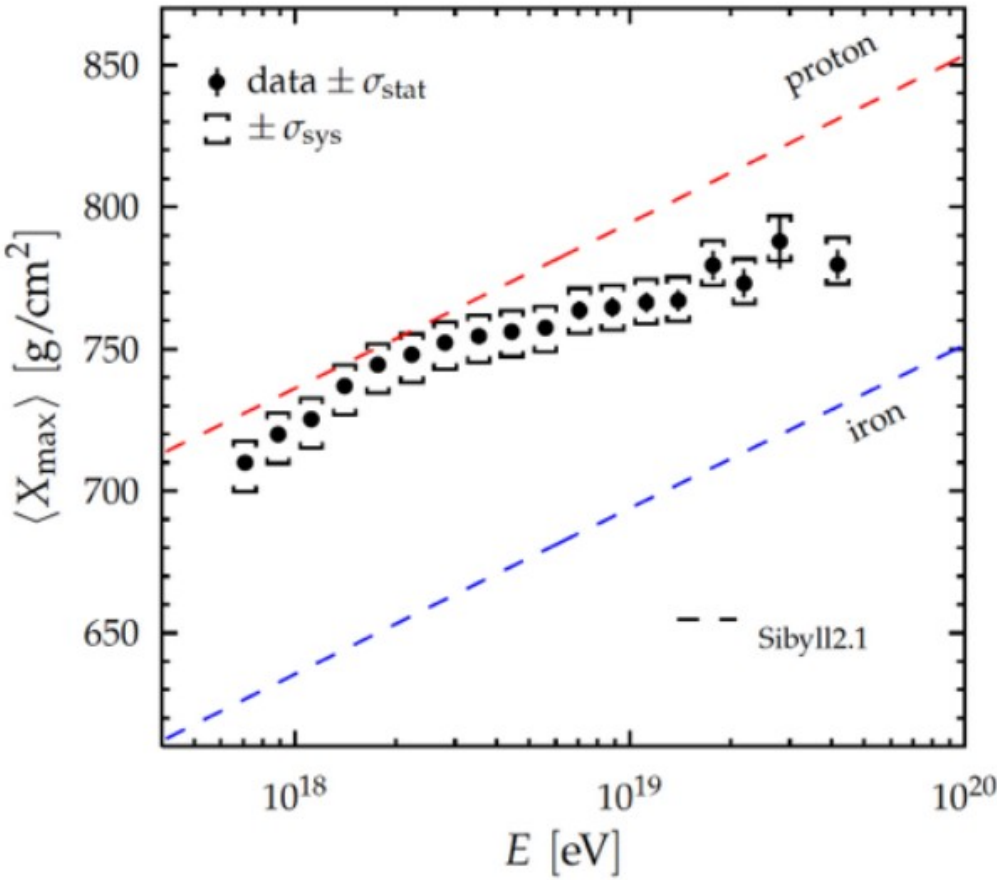
M. Unger

UHECRs: mass composition

same data, comparison to the same hadronic model



Telescope Array Collaboration, APP **64** (2014) 49

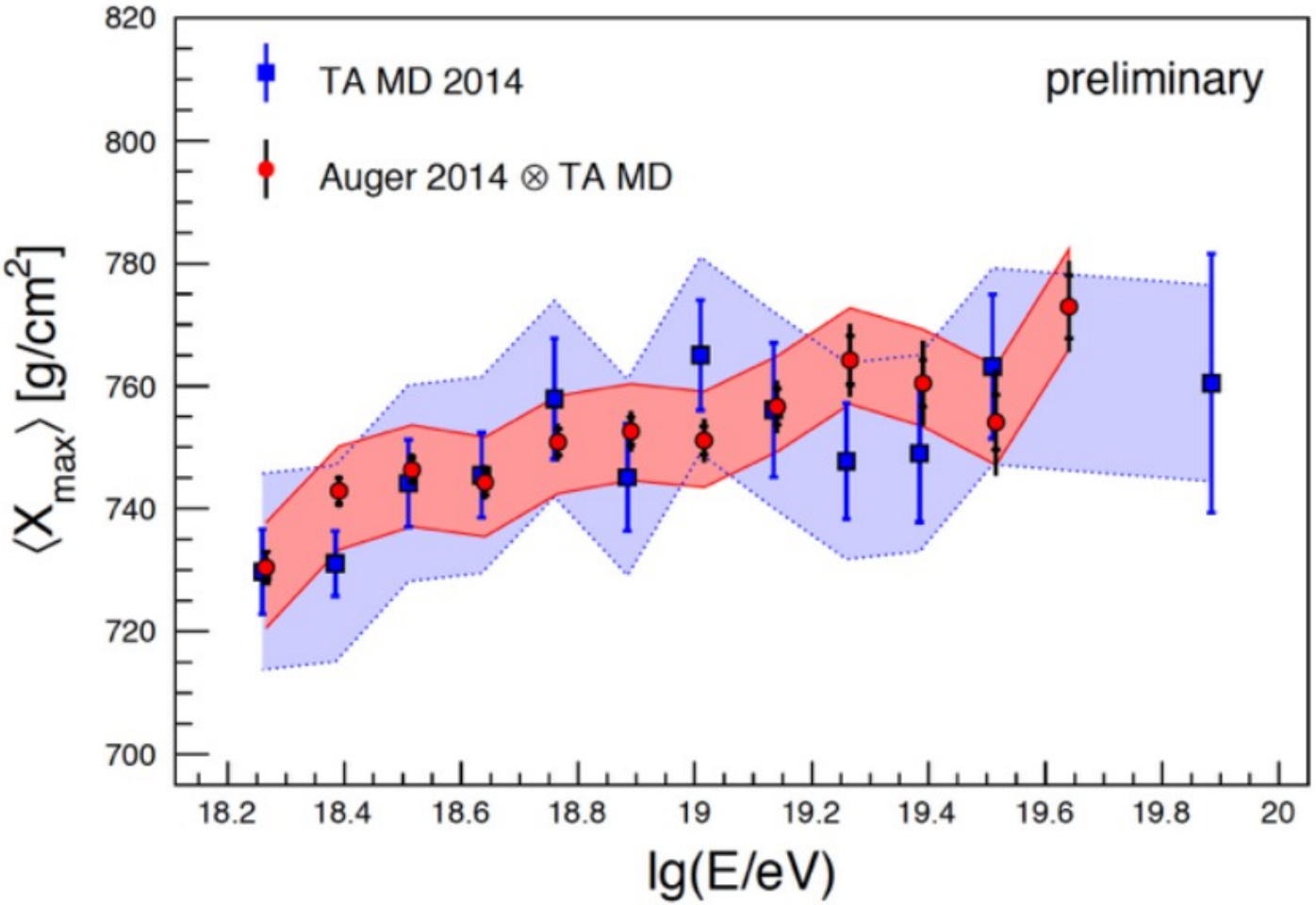


Pierre Auger Collaboration, PRD **90** (2014) 12, 122005

M. Unger

UHECRs: mass composition WG

- Constructing Xmax distributions compatible with Auger data
- passing these distributions through the TA analysis chain
- comparison with TA data



average difference: $\langle \Delta \rangle = (2.9 \pm 2.7\ (\text{stat.}) \pm 18\ (\text{syst.}))\ \text{g/cm}^2$

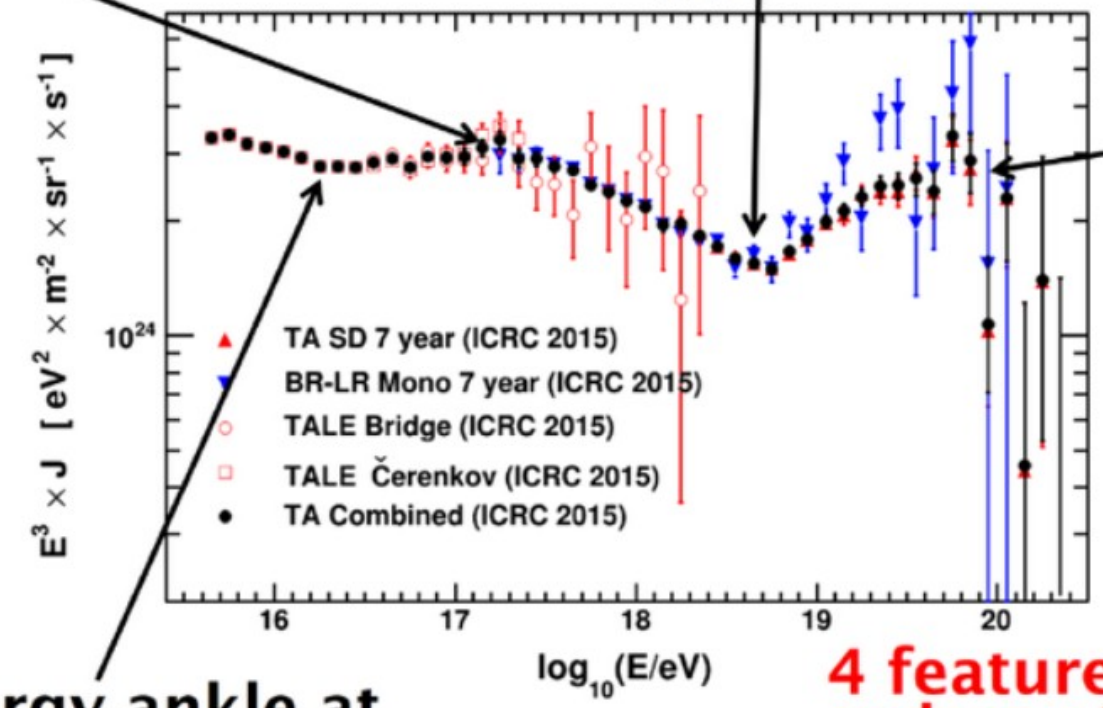
UHECRs: energy spectrum

Second knee at E = $10^{17.3}$ eV

Ankle at E = $10^{18.72}$ eV

D. Ivanov, 349

C. Jui, highlight



Break at $10^{19.8}$ eV

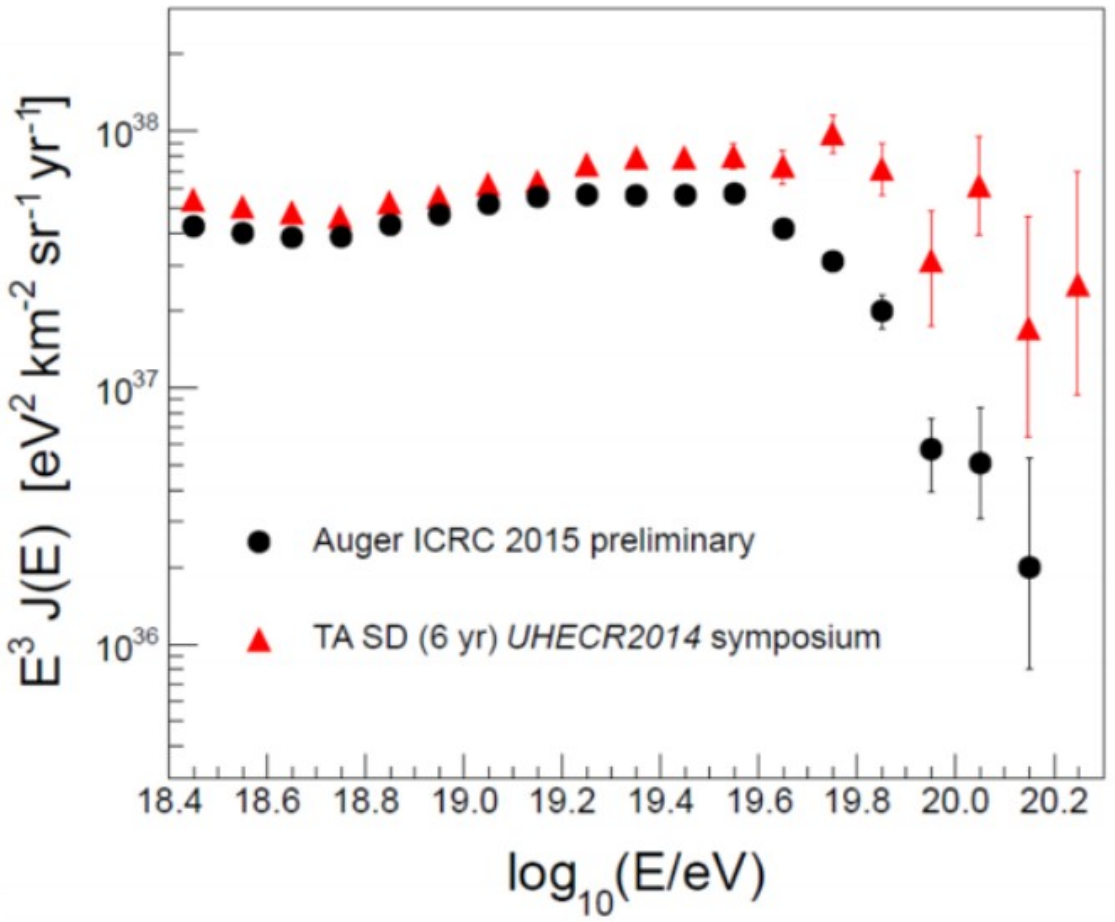
Z. Zundel, 445
T. AbuZayyad, 422
T. Fujii, 320
FD BR-LR Mono
D. Ikeda, 362 Hybrid

Low energy ankle at $10^{16.34}$ eV

4 features over 4.7 orders of magnitude in energy

UHECRs: energy spectrum

- TA and Auger spectra largely agree within uncertainties but show some differences at the highest energies



	Ankle [EeV]	E1/2 [EeV]
Auger	4.8±0.1±0.8	**24.7**±0.1 $^{+8.2}_{-3.4}$
TA	5.2±0.25	**60.2**±7.3

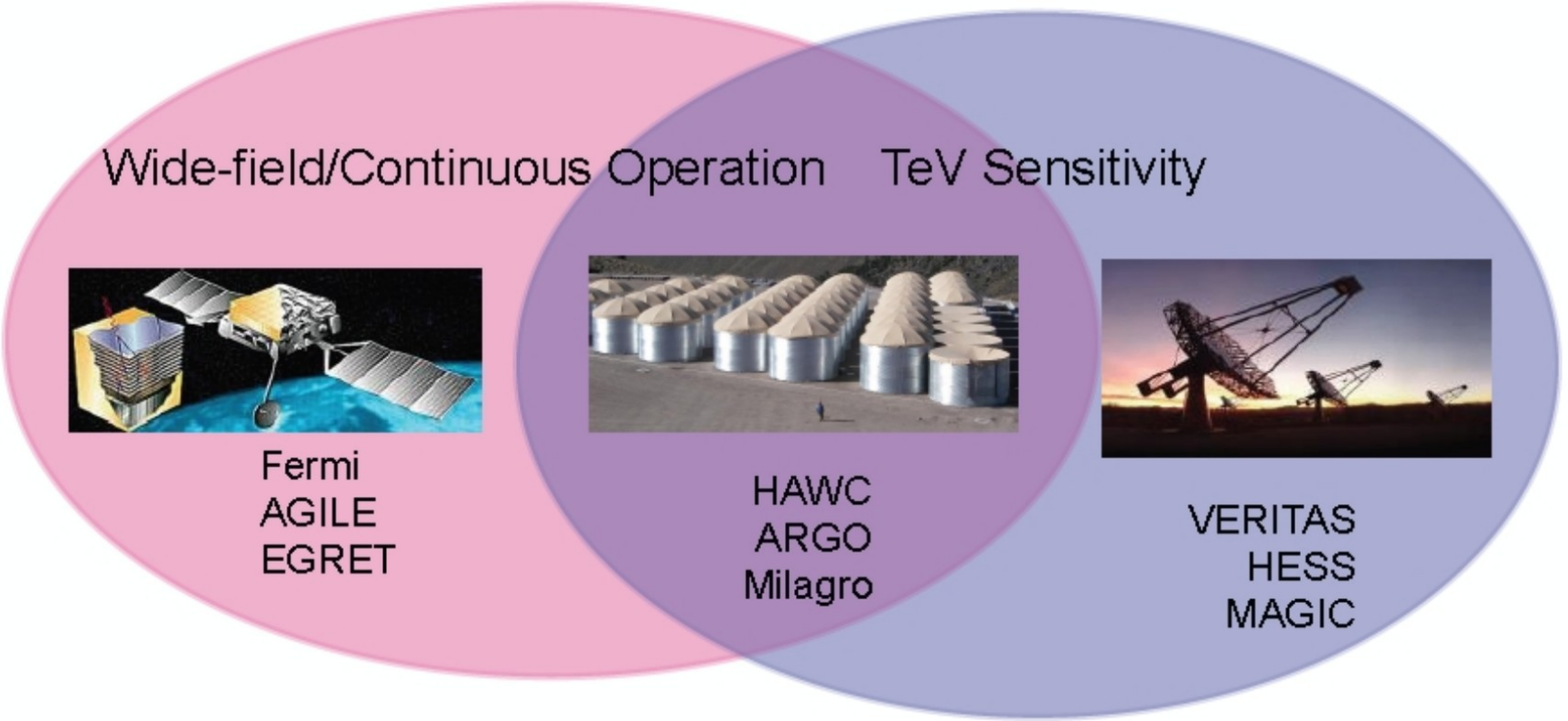
Auger: no declination dependence of the energy spectrum

Scientific program

- Solar and heliospheric phenomena
- Cosmic rays
  - Direct measurements
  - Air showers (10^{15} – 10^{20} eV)
- **Gamma-ray astronomy**
  - **Space-based**
  - **Ground-based**
- Neutrino astronomy
- Dark matter searches

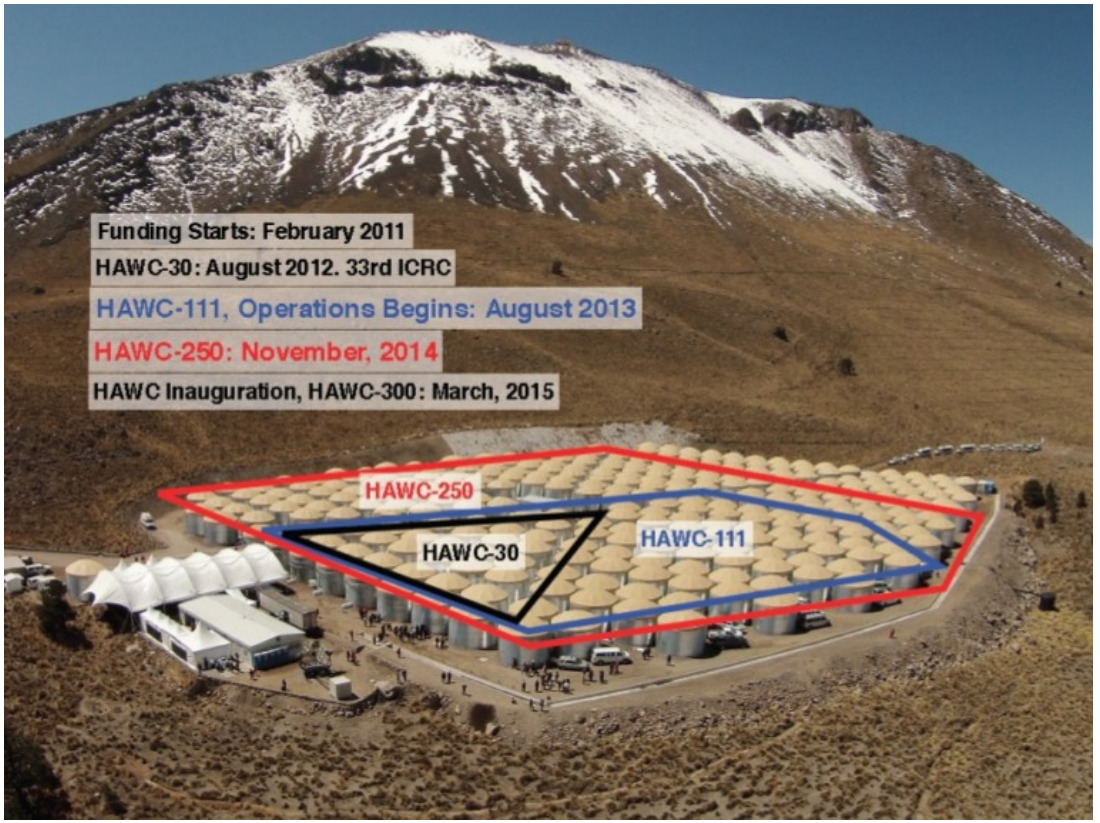
Gamma-ray astronomy

- Space-based detectors : continuous full-sky coverage in GeV
- Ground-based detectors have TeV sensitivity
  - Current Imaging Atmospheric Cherenkov Telescopes (IACTs) have excellent energy and angle resolution, but FoV of 0.003 sr and duty cycle of 10%
  - Particle detectors have an aperture > 2 sr and duty cycle of 90% but angular resolution of ~0.6° (@ 1 TeV)



HAWC News

- HAWC
  - Detector complete
  - First results : maps, fluxes (no spectra yet)



Public release of all-sky data in 2017

J. Pretz - HAWC Highlight talk

The “era of catalogs”

3FGL catalog 4 yrs >100 MeV

1050 Ballet

D³PO 6.5 yrs >600 MeV

602 Vacca

Catalogs for population:

- Active Galactic Nuclei

  Based on 3FGL

  1236 Gasparrini **783 Brown**
- Super Novae Remnants

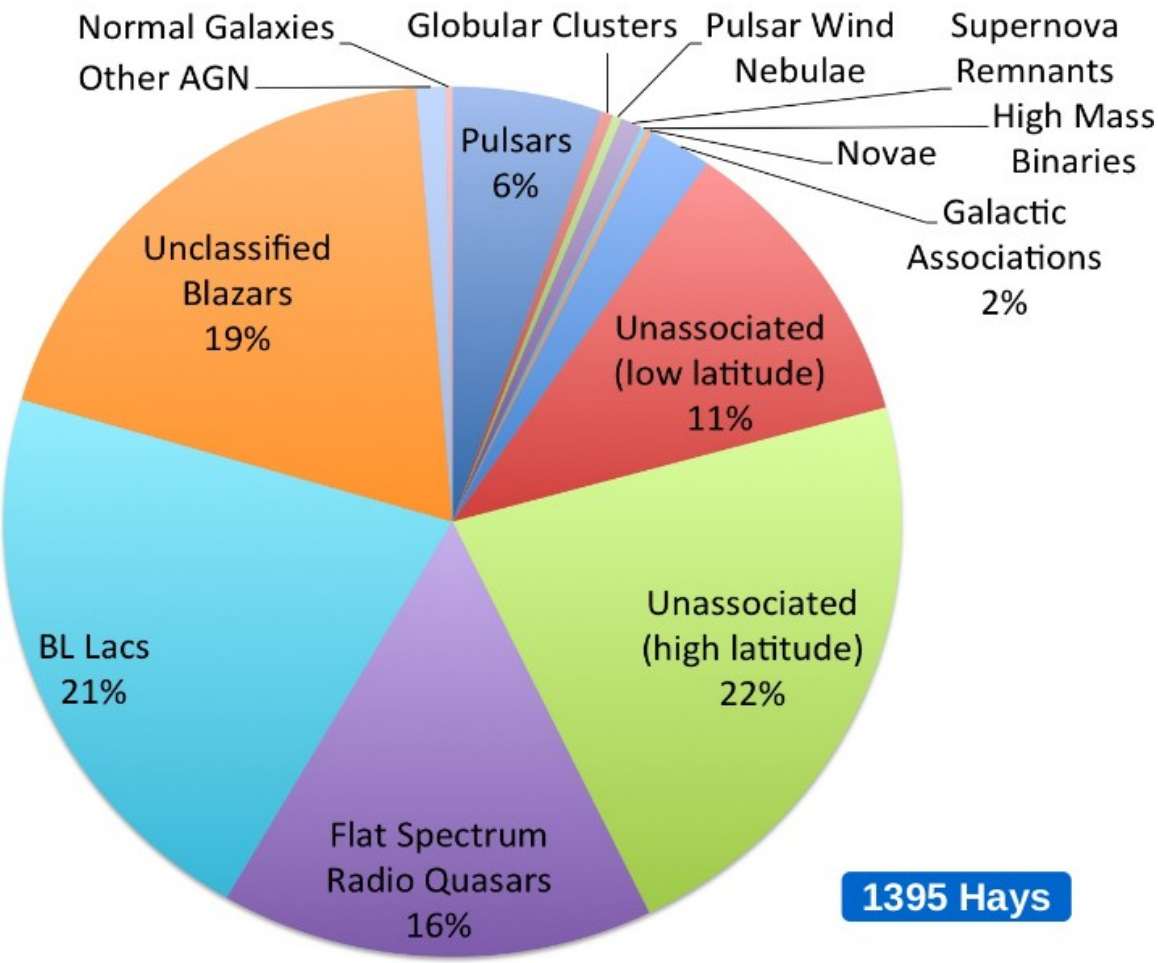
  3.5 yrs >1GeV

  259 De Palma **798 De Palma**
- Gamma-ray Bursts

  GBM > 20 keV LAT >100 MeV

  728 Bissaldi
- Millisecond Pulsars

  1019 Renault-Tinacci



1395 Hays

The “era of catalogs” + Surveys

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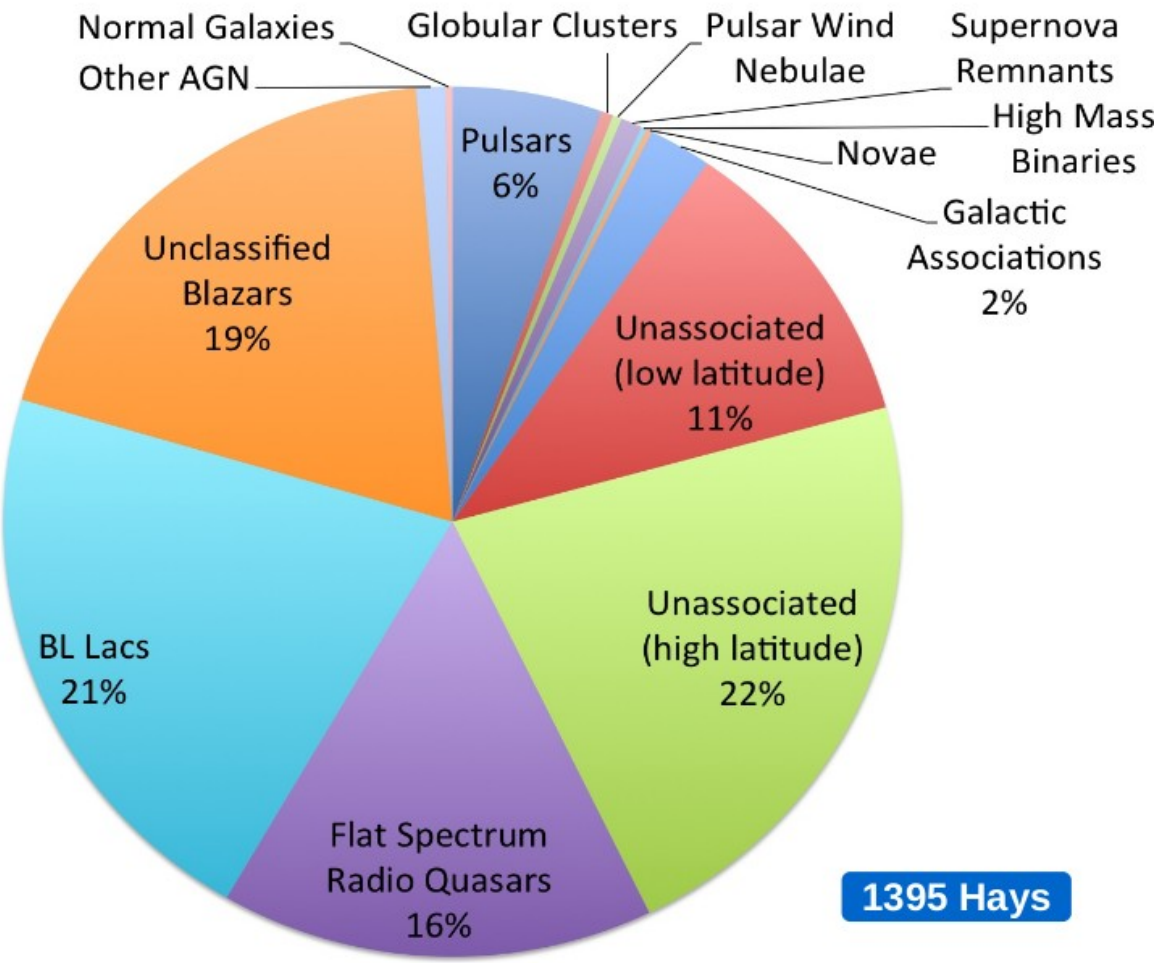
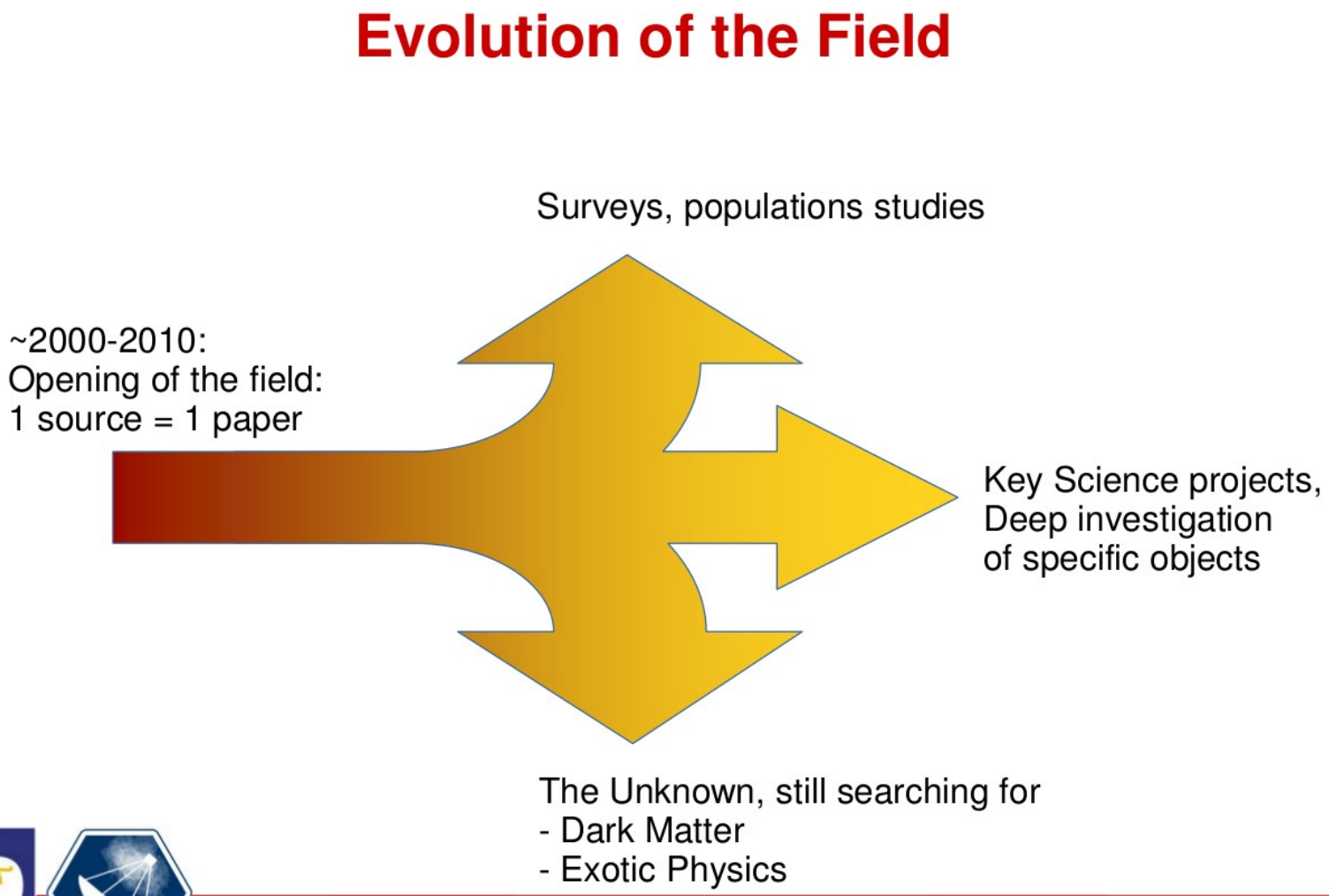


1395 Hays

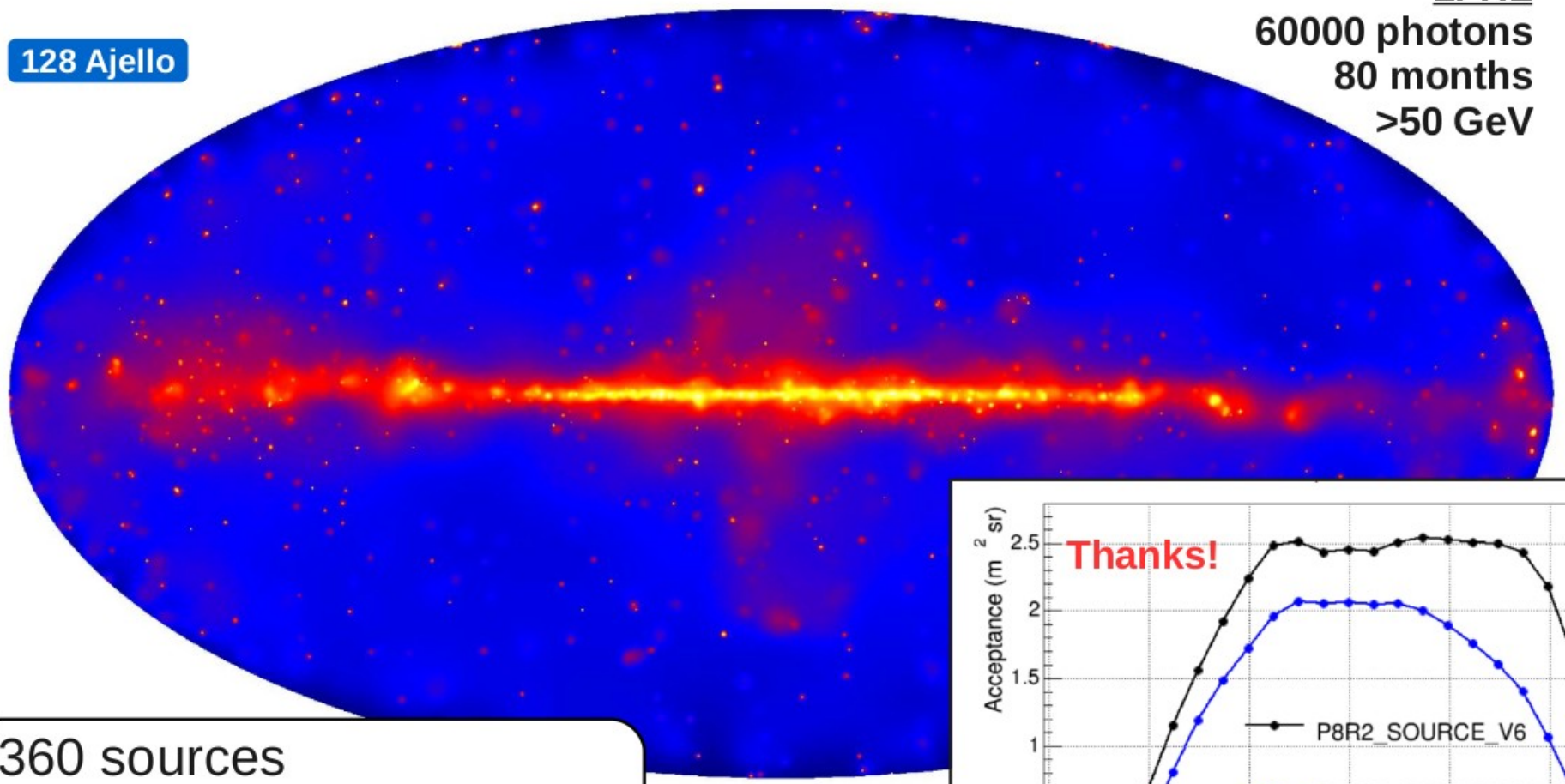
The "era of catalogs" + surveys



Hard sources catalog

2FHL
60000 photons
80 months
>50 GeV

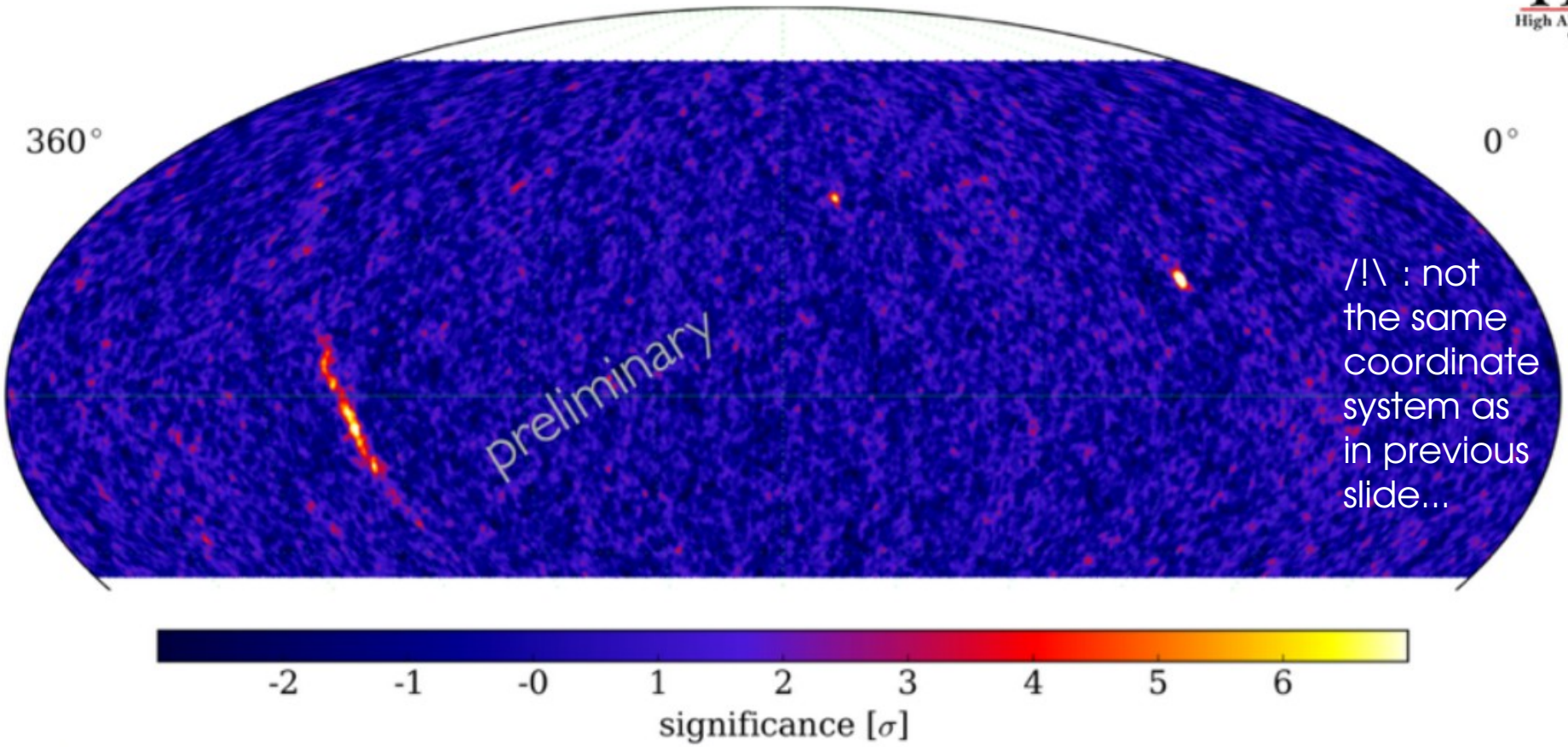
128 Ajello



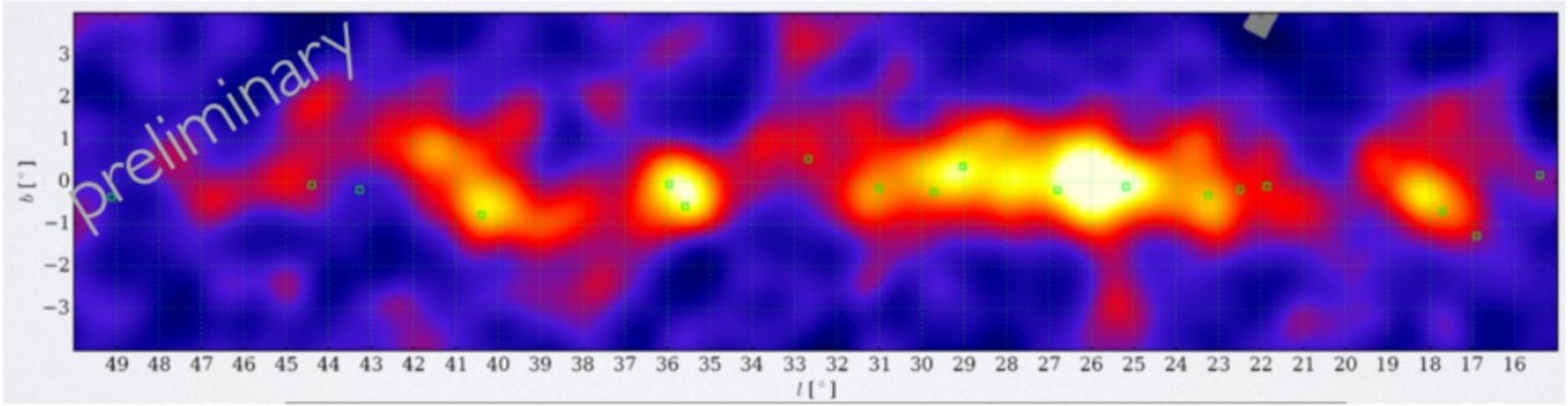
360 sources
78 detected also by IACTs
57 new sources

- Skymap from 280 days of data taken with 1/3 of the HAWC array.
- Point-source analysis optimized on the Crab Nebula.
- Crab Nebula is >20σ, details in F. Salesa's talk in GA03 Pulsar session.

HAWC
High Altitude Water Cherenkov
Gamma-Ray Observatory

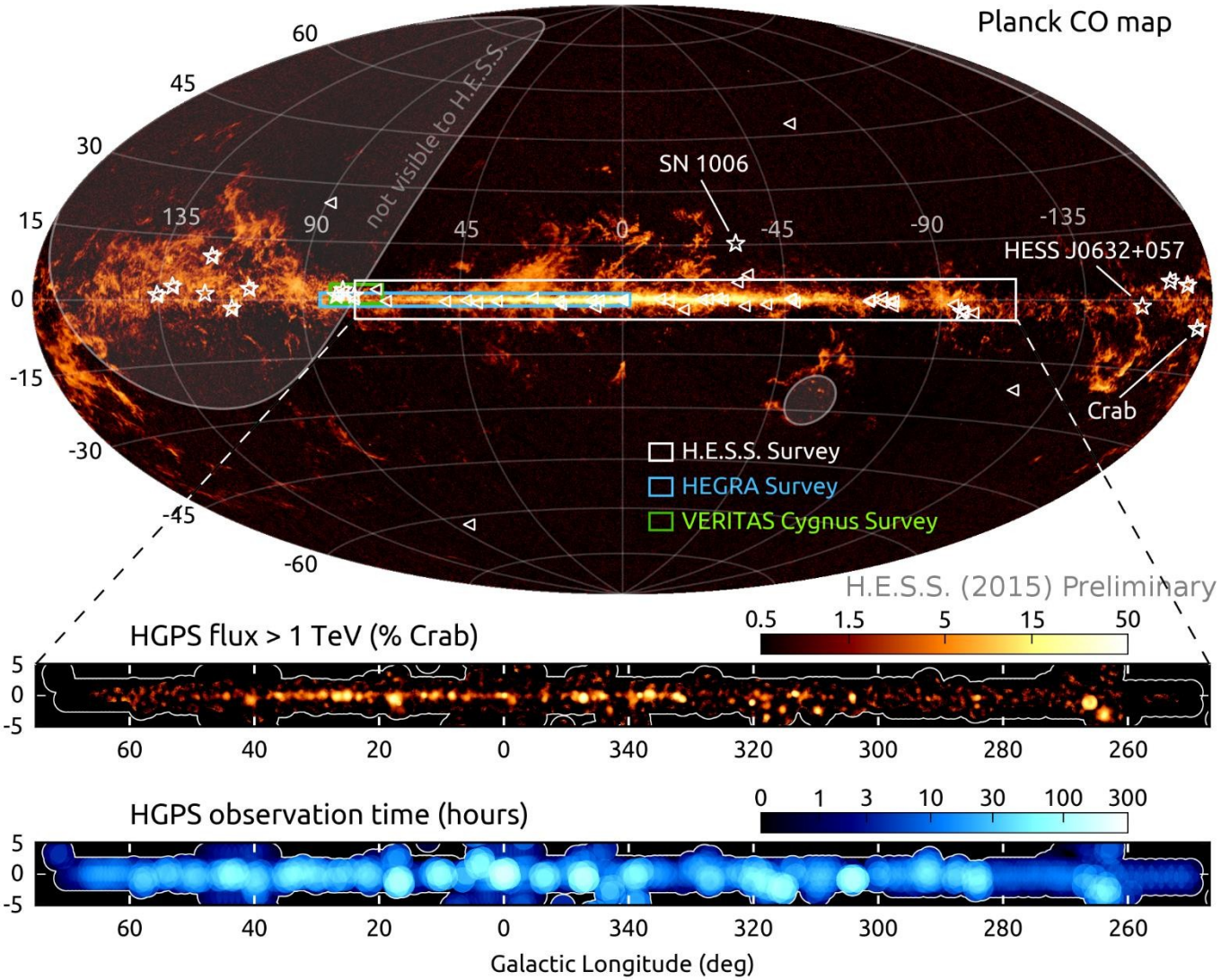


/!\ : not the same coordinate system as in previous slide...



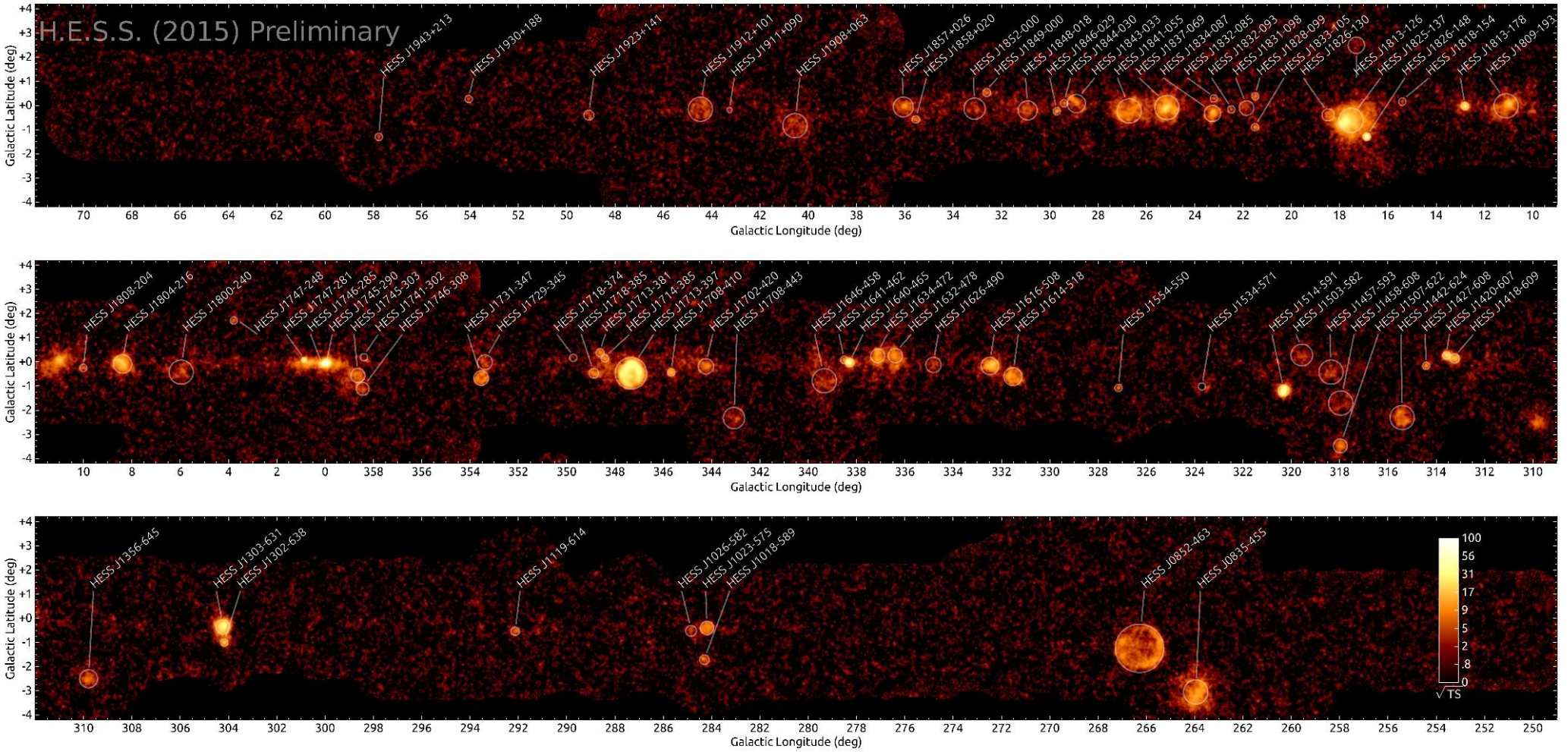
M. Hui

H.E.S.S. Legacy Survey



C. Deil

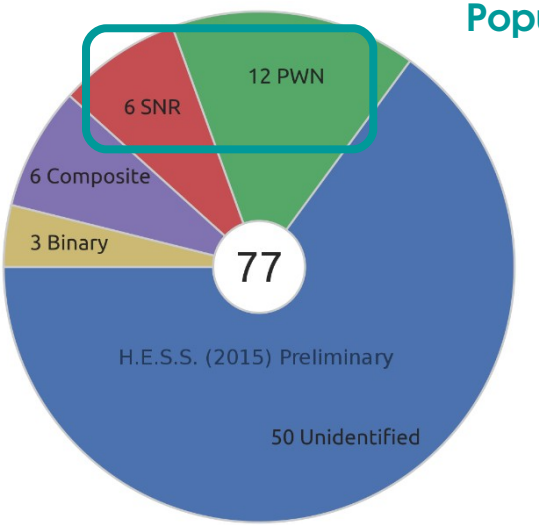
H.E.S.S. Legacy Survey



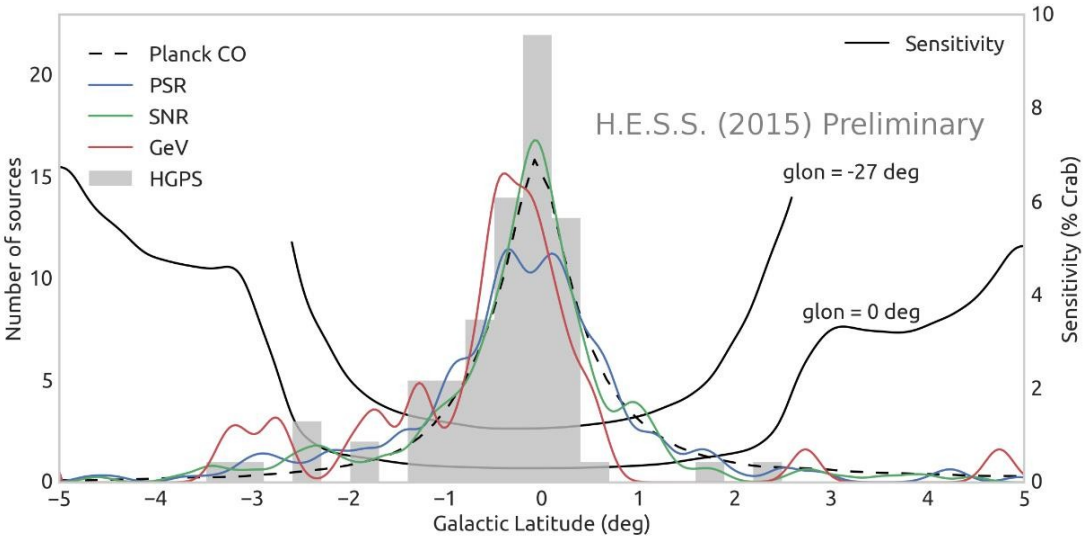
C. Deil

H.E.S.S. Legacy Survey

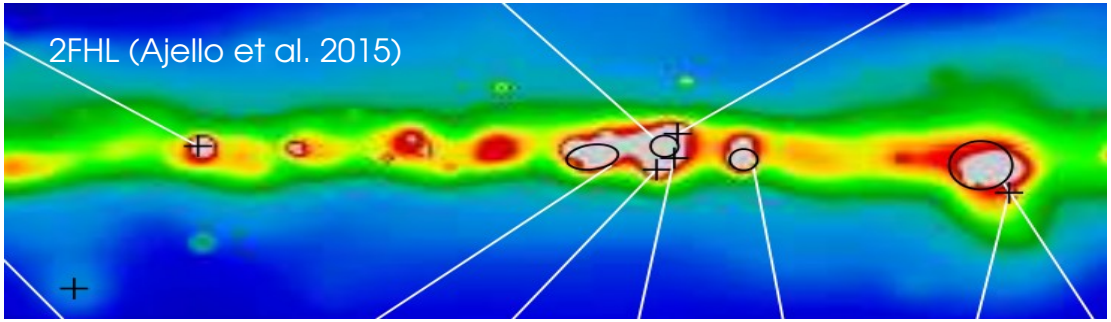
- "Final" HESS catalog of survey sources
  - Data collected 2004 – 2013
  - 2673 h after quality selection
  - Significance and flux maps
  - Automatic pipeline for source extraction
  - Likelihood fit : Gaussian components + diffuse background
- 66 VHE sources + 11 complex sources (e.g. shell SNR) excluded from pipeline



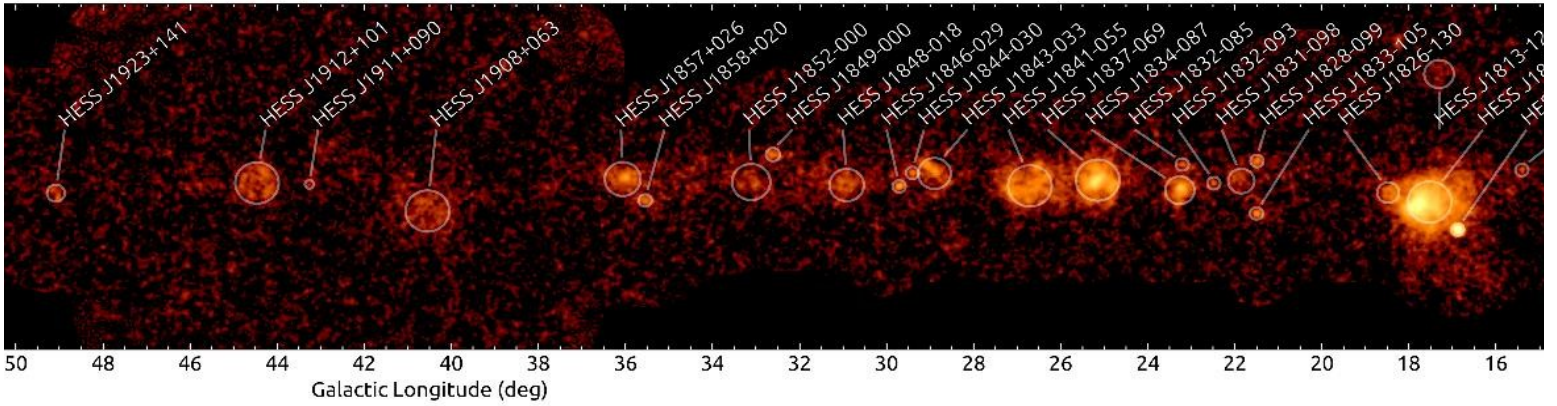
Population studies (Hahn et al., Klepser et al.)



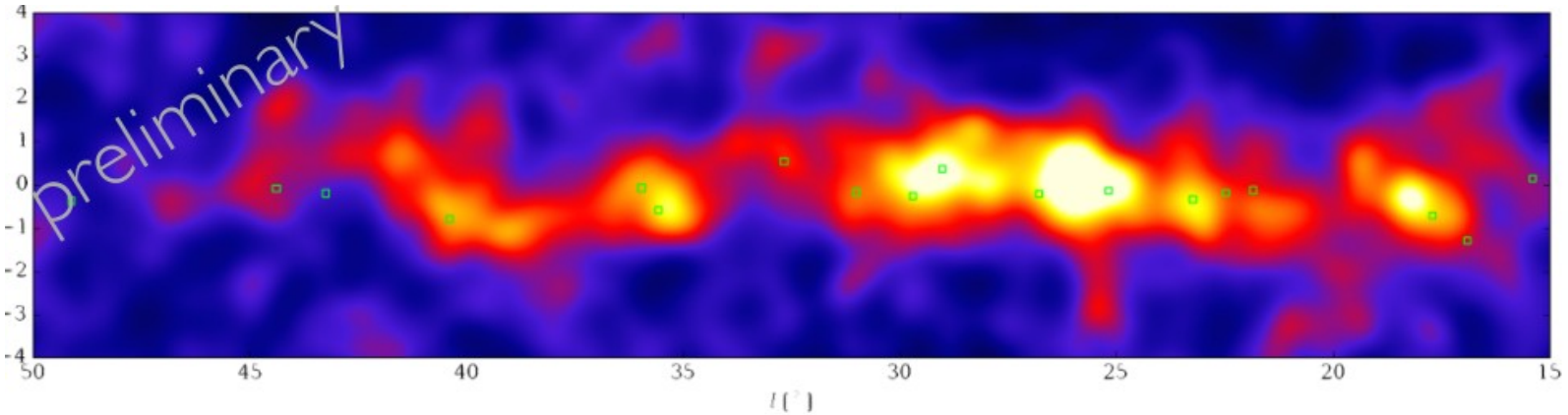
Combination/comparison of Fermi (2FHL), HESS and HAWC data in the Galactic plane will be very interesting !



H.E.S.S.



HAWC



Individual Galactic sources

- Galactic Center :
  - Excess at GeV : no clear interpretation yet but many hypothesis :

Models: source distribution, anisotropy, photon fields etc. ? 228 Gaggero

Population of unresolved Millisecond pulsars ? 1234 Weniger 1304 Tuffs

Activity of the central black hole ? 431 Macias 1140 Calore

Dark Matter ? Not covered here, see 1392 Cirelli 1174 Wood

Individual Galactic sources

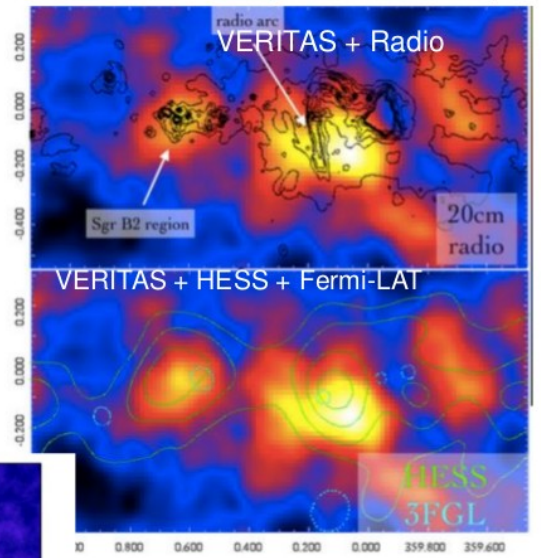
- Galactic Center :

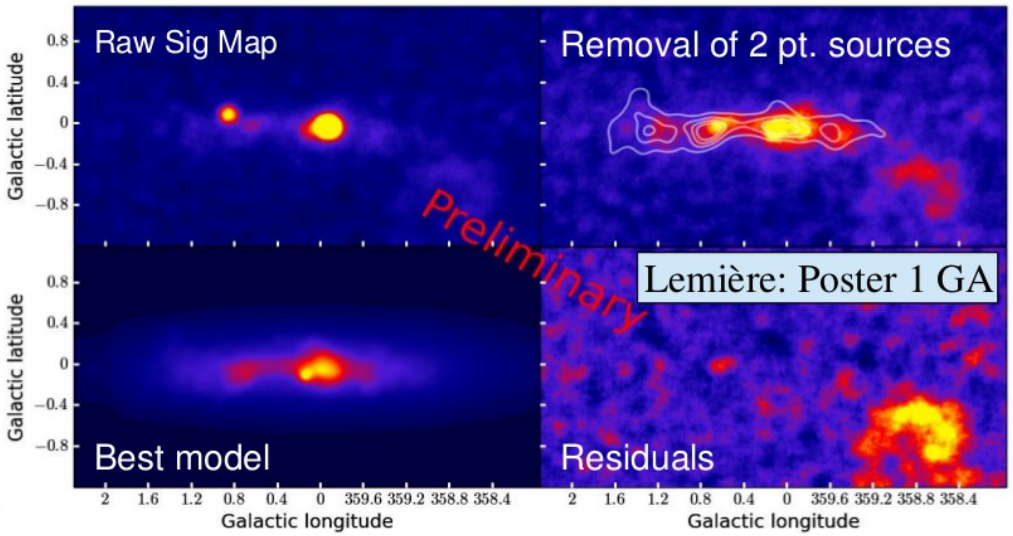
Galactic Centre

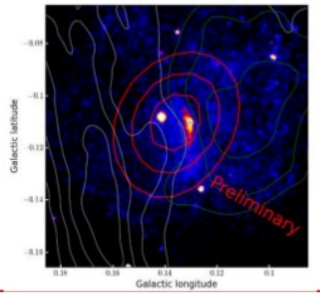
- Complex morphology
  - VERITAS: correlation with radio, 3FGL & HESS
  - MAGIC observations at high zenith angle
  - HESS: Deep observation (250h)
    - Diffuse emission (interaction of CRs with Molecular clouds)
    - Detection of Arc Source (HESS J1746- 285) above CMZ contribution (likely PWN)

Fruck: GA14

Smith: GA10







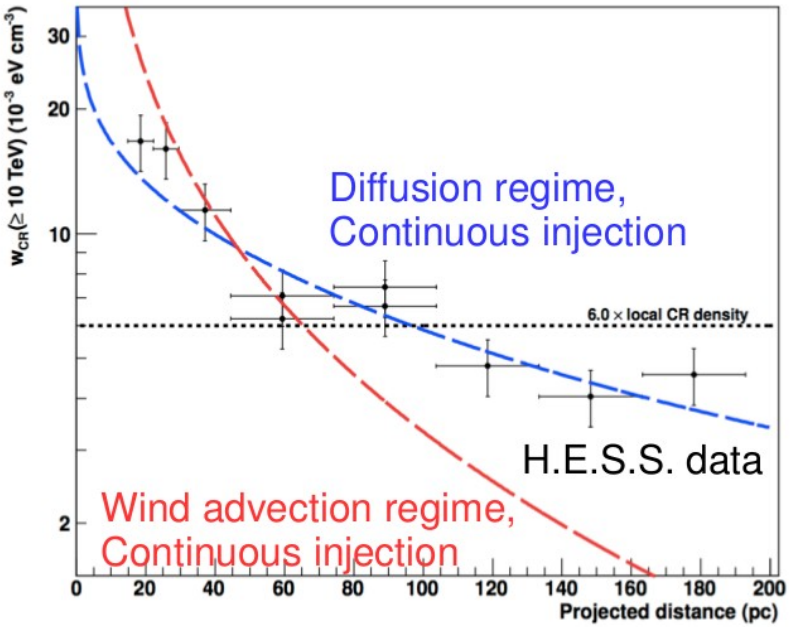
Individual Galactic sources

- Galactic Center :

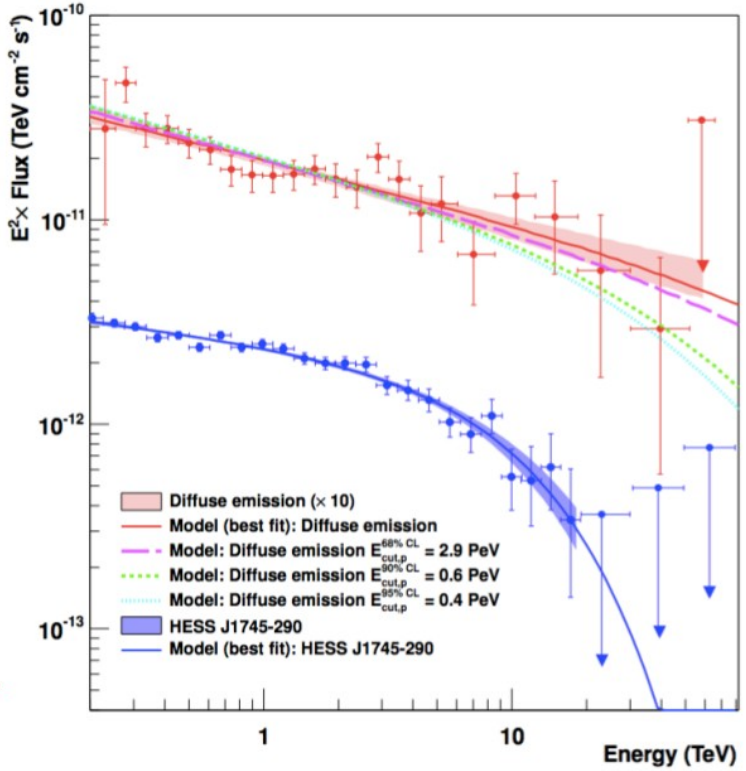
Galactic Centre with H.E.S.S.

First Pevatron

- Central source: cut-off @ 10 TeV
- Diffuse emission shows no cut-off well > 10 TeV
- Emission likely due to propagation of protons accelerated around central black hole and diffusing away (projected radial distribution matches)
- Parent proton population up to 1 PeV (2.9 PeV @ 68% CL)



Viana: GA16

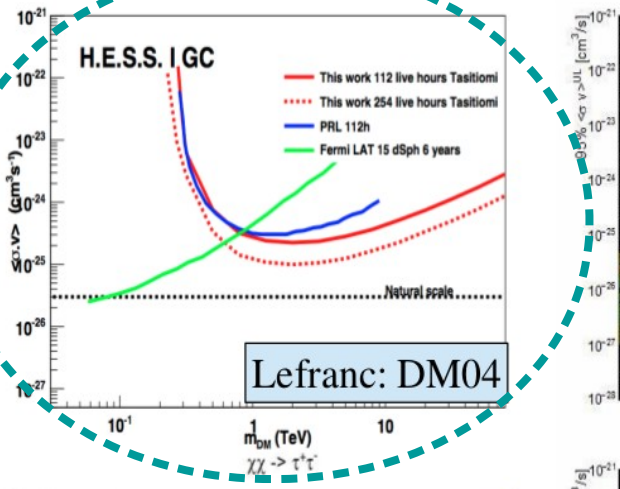


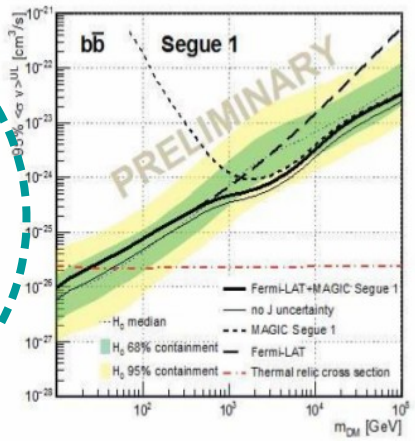
Individual Galactic sources

- Galactic Center :

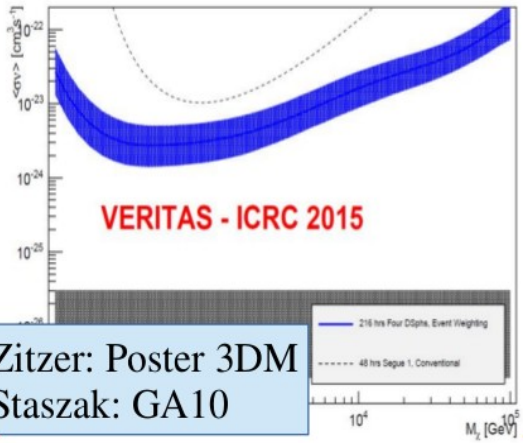
Dark Matter Searches

- Current target:
  - Galactic Centre Halo (H.E.S.S.)
  - Dwarf spheroidals
- Strategies
  - Deep observations (≥200 h)
  - Optimal statistical treatments
  - Search for annihilation lines
  - MAGIC: Combination with Fermi-LAT
- Next step: combine results from H.E.S.S., MAGIC, VERITAS & Fermi-LAT

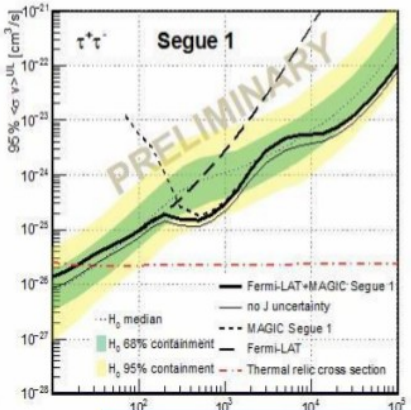




Kieffer: GA05



Zitzer: Poster 3DM
Staszak: GA10

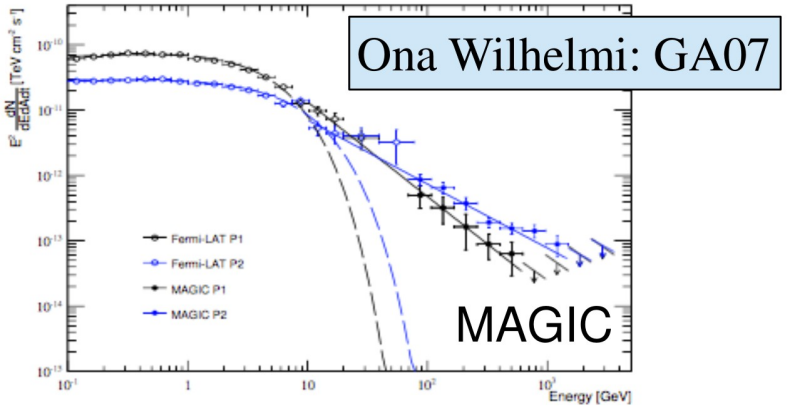


Wood: Poster DM04

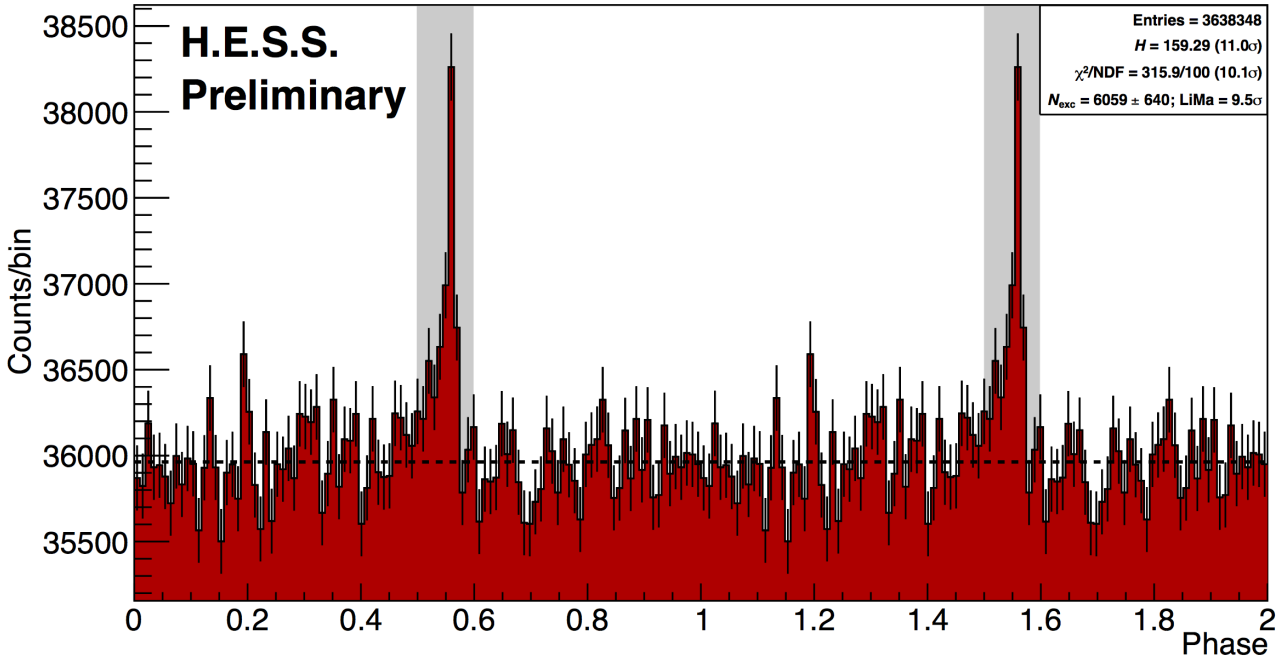
Most constraining limits

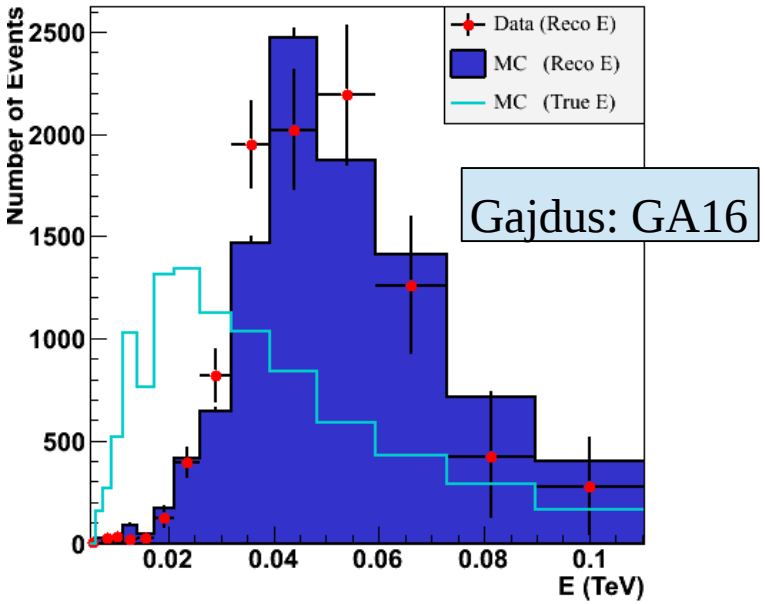
Pulsars

- Claim by MAGIC of Crab pulsar > 1 TeV
  - Not confirmed by VERITAS



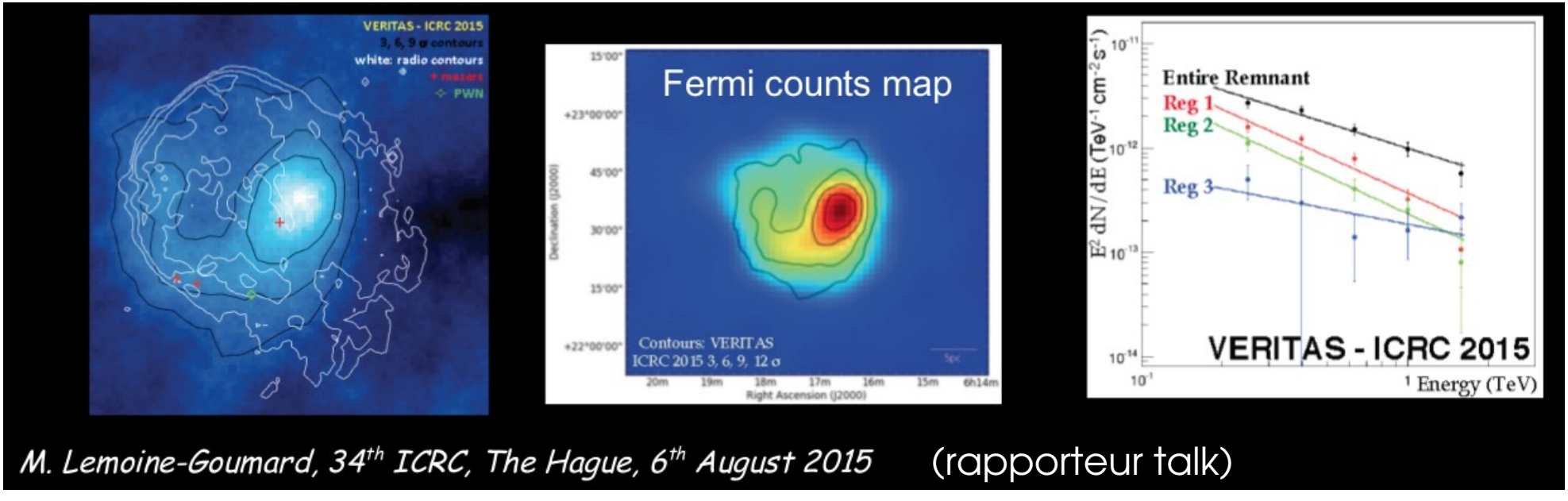
- Second VHE pulsar : Vela with H.E.S.S. II





Supernova Remnants

- New TeV Shells from the H.E.S.S. Galactic plane Survey
- IC 443 (VERITAS – B. Humensky)
  - Deep observations
  - Similar morphology above 5 GeV with Fermi-LAT PASS 8 data
  - Can extract spectra from different regions to probe the environmental dependence of cosmic-ray diffusion



M. Lemoine-Goumard, 34th ICRC, The Hague, 6th August 2015 (rapporteur talk)

Supernova Remnants

γ-rays hadronic or leptonic?

RCW 86 leptonic models preferred

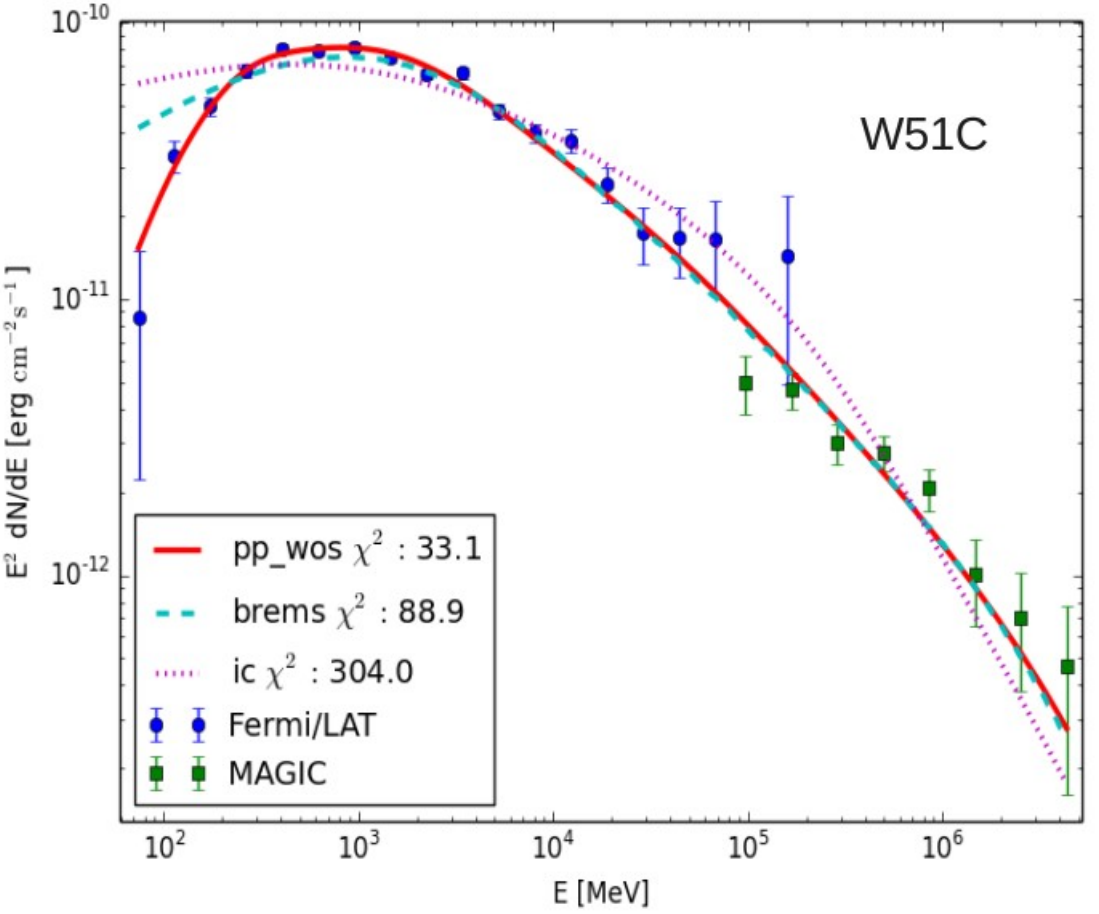
423 Condon

W51C and W49B show “pion bump”, hadronic origin preferred

1311 Jogler **1136 Brun**

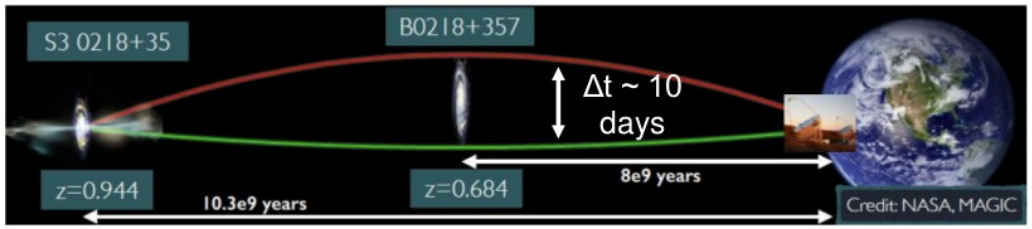
SNRs accelerate both, what dominates in γ-rays depends on environment and age of the system

259 De Palma

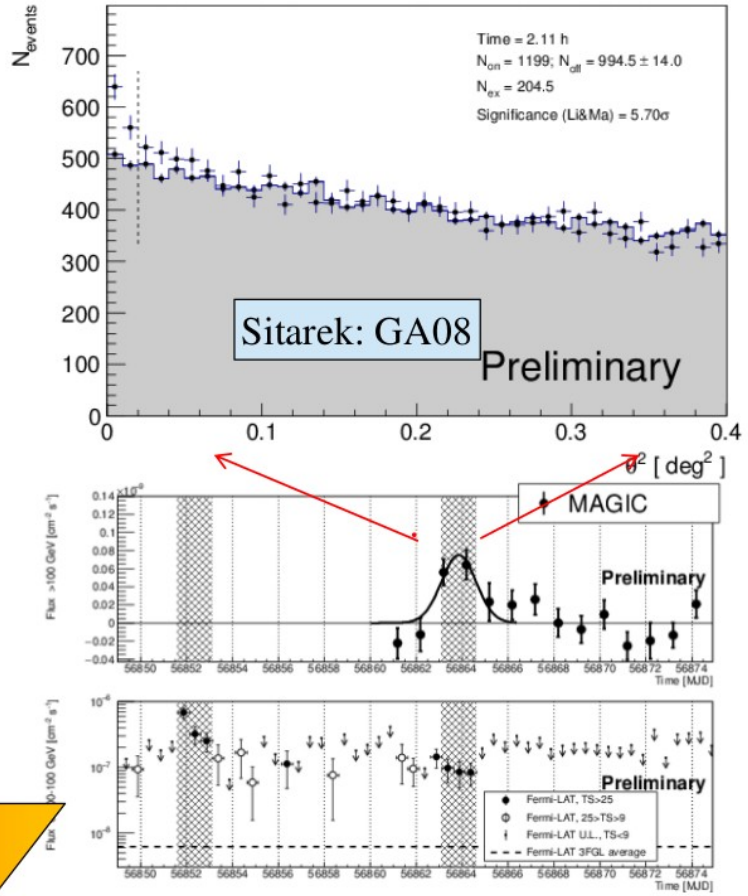


Extragalactic sources

QSO B0218+357: Gravitationally lensed blazar @ z = 0.944 !



- ~11.5d delay between the direct & lensed components (Fermi – 2012)
- Observations with MAGIC performed during the 2nd flare: detection of sub-TeV lensed emission
  - much more prominent emission than by Fermi
  - VHE emission from z~1 is strongly attenuated above ~100 GeV
  - GeV + sub-TeV observations can put constraints on the EBL models at z ≤ 0.94
  - impact on cosmology models



First lensed TeV blazar

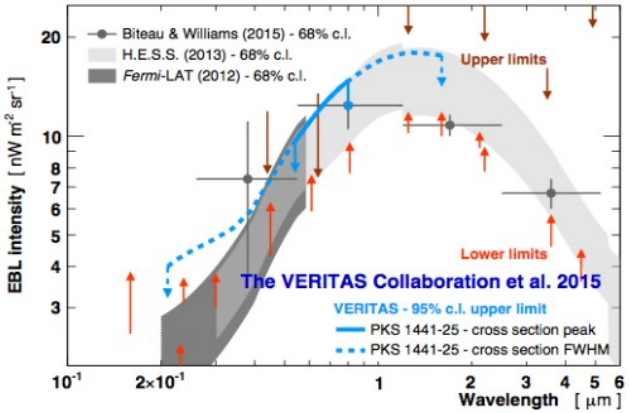
- Still no GRBs detected at TeV...

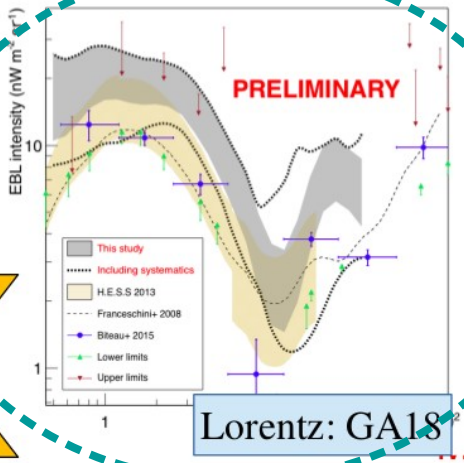
Extragalactic sources

EBL constrains

- Absorption of VHE γ-rays by pair creation on EBL/CMB
- Achievable Constrains:
  - Single sources at large distance provide upper limits
    - PKS 1441-25 (VERITAS & MAGIC)
    - 1ES 1101+496 (MAGIC)
  - Measurement of several sources at different distances allow to measure the EBL (HESS)

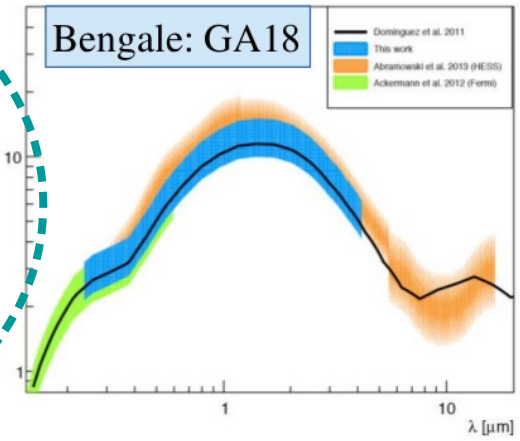
Benbow: GA10





Lorentz: GA18

Bengale: GA18

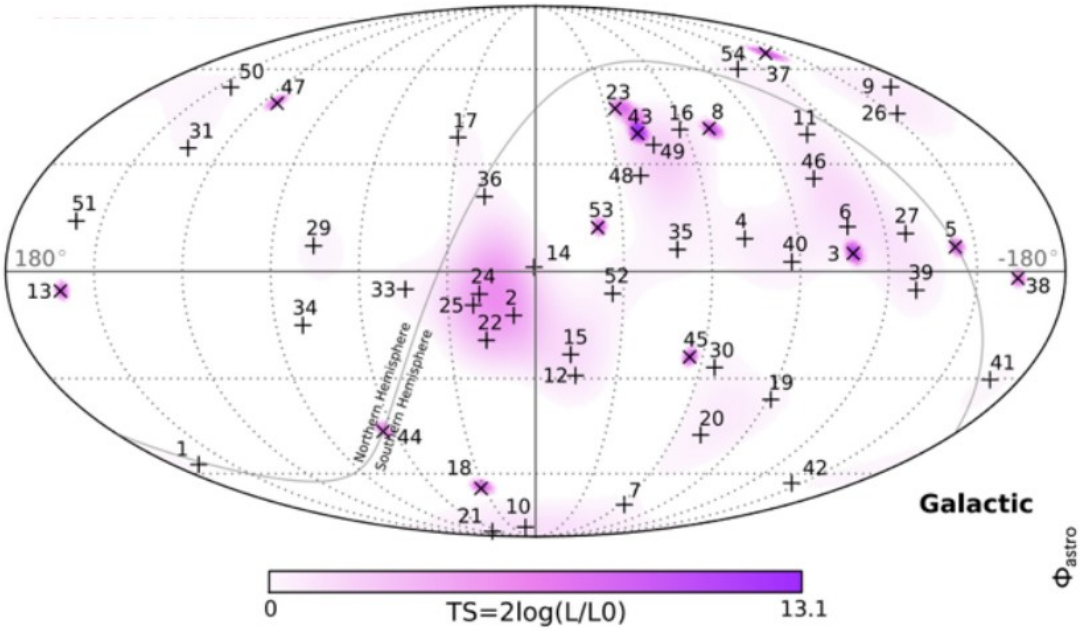


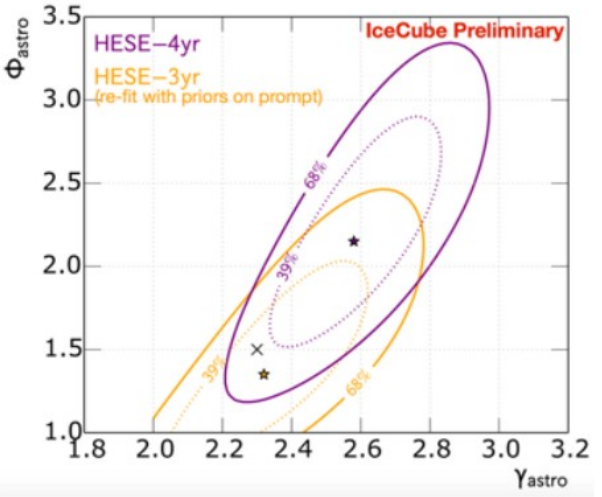
First actual measurement of EBL

Additional slides...

Neutrino astronomy

IceCube HESE events





- excess towards GC gets weaker
- spectrum gets softer

C. Kopper

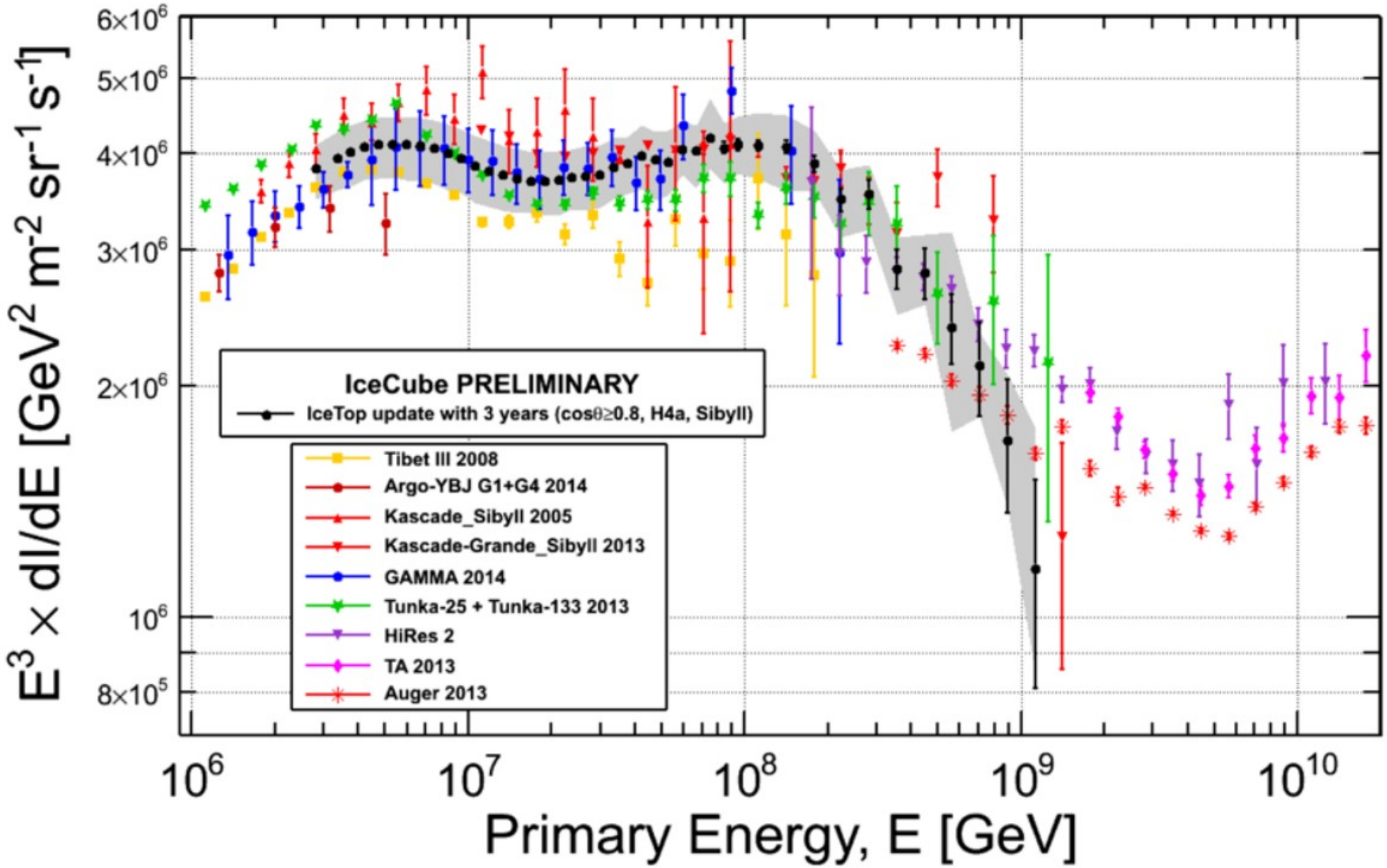
Neutrino astronomy

Conclusions

- The observations of steady beam of neutrinos from (somewhere in) the Universe activated many studies in this field to answer questions:
  - What are the flux shape and flavor?
  - What is the origin of the neutrino flux being measured by IceCube?
  - Is there any other neutrino flux from different origin?
- Many theoretical works and follow up/correlation multi-messenger studies
- Still, larger next generation detectors are needed:
  - KM3NeT
  - IceCube-Gen2
  - BIKAL-GVD
  - The higher energy/cosmogenic neutrino projects
    - ARA, ARIANNA, ANITA, GNO, EVA….

A. Ishihara – Rapporteur talk

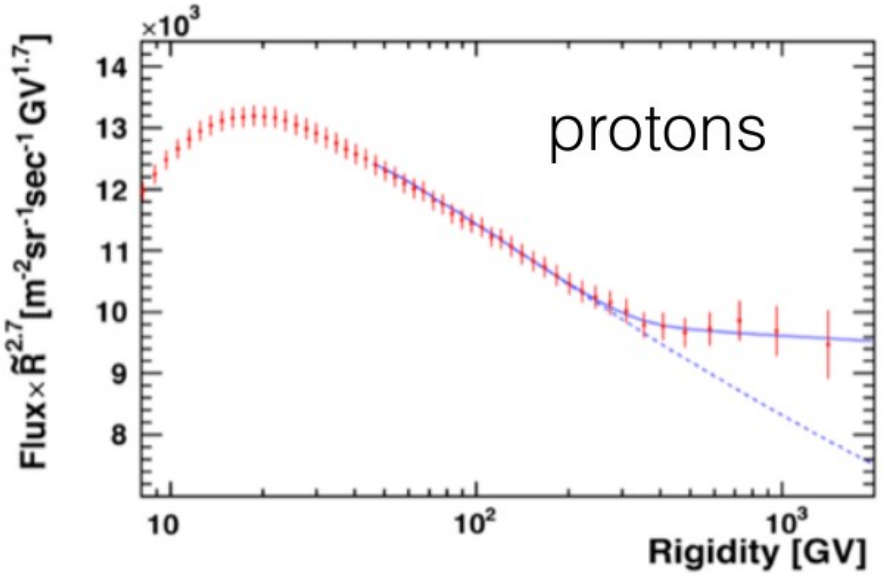
HECRs: energy spectrum

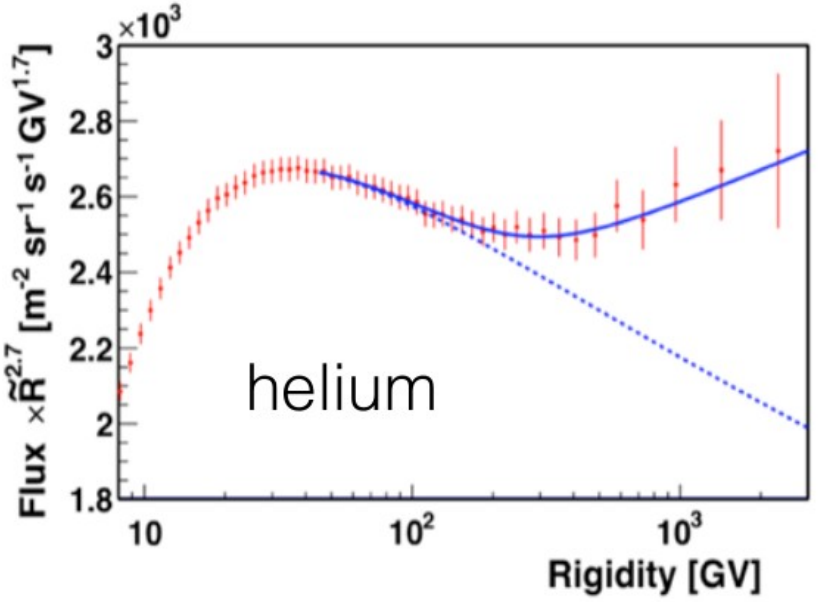


K. Rawlings

Cosmic rays : direct measurement

- AMS (e.g. highlight talk by S. Ting)
  - same results as presented at CERN (April 2015)

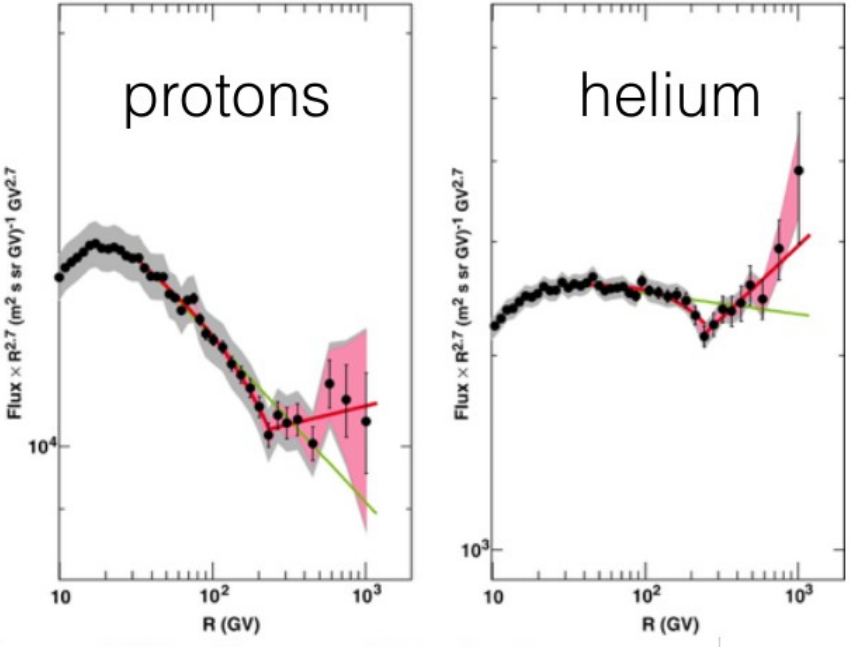




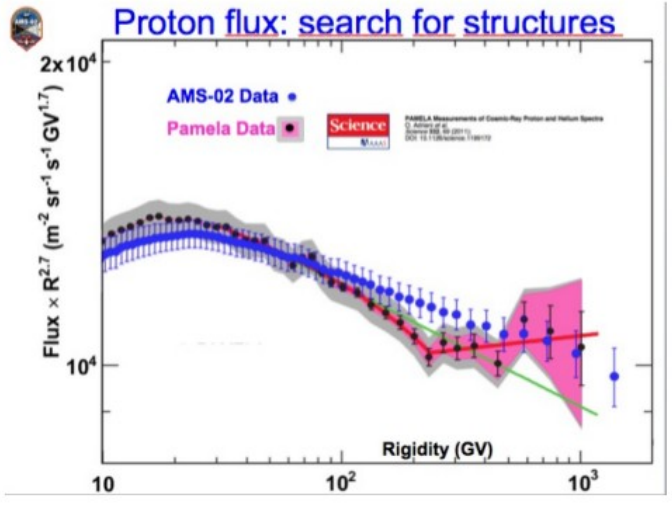
- no remark on changes between ICRC 2013 and 2015

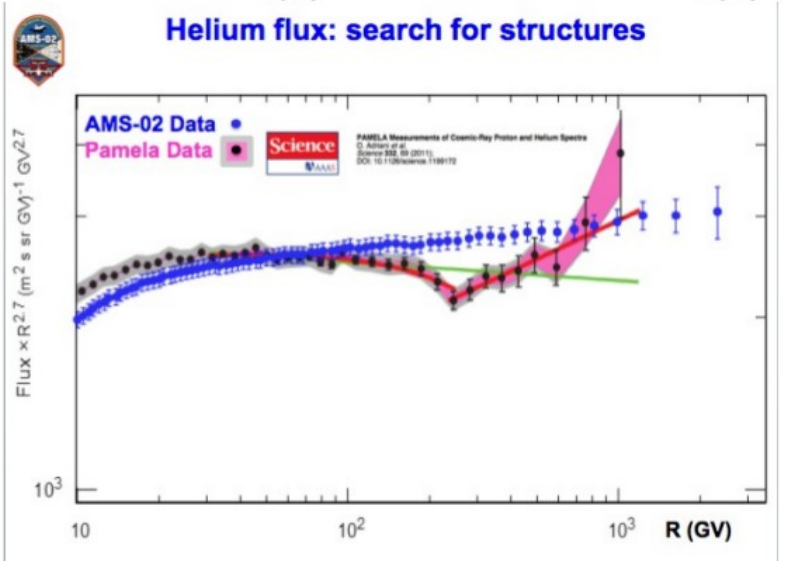
Cosmic rays : direct measurement

- Pamela (Science, 2011)

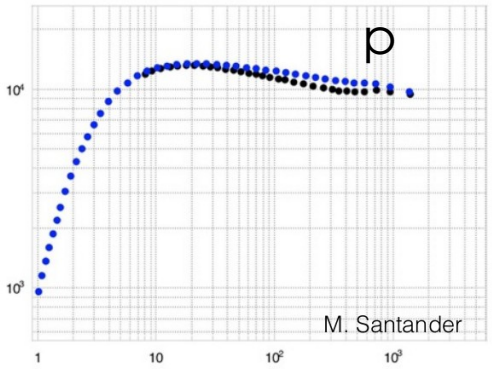


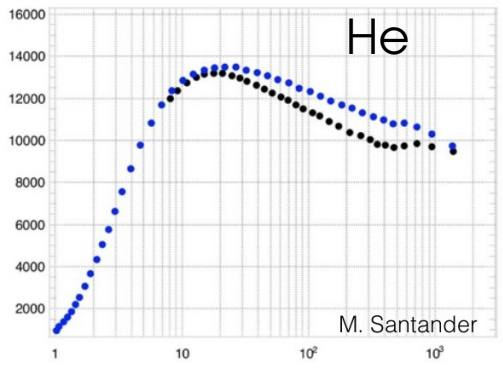
- AMS (ICRC 2013)





AMS proton flux 2013 vs 2015

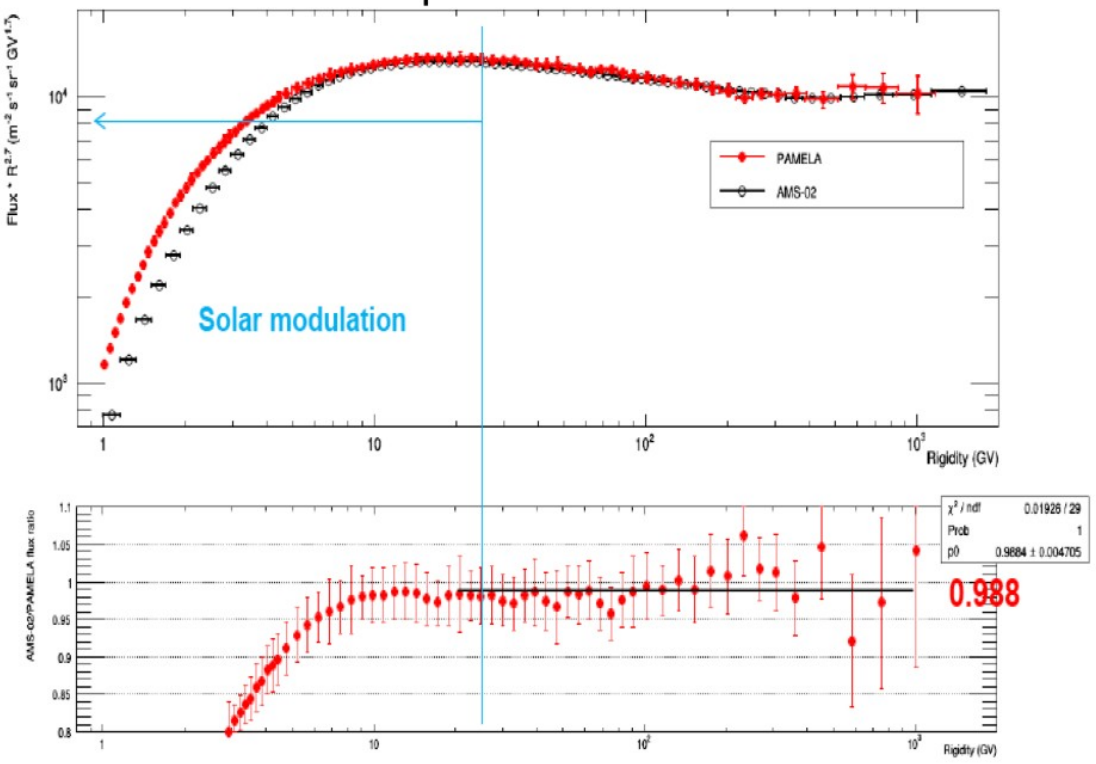




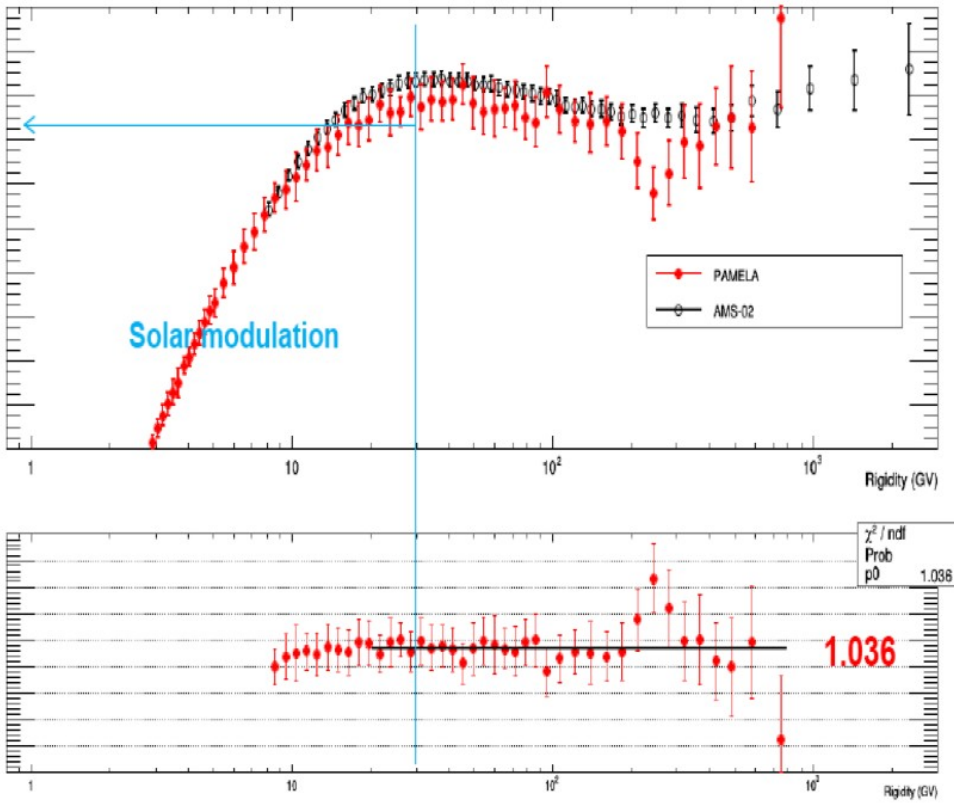
2015 : better agreement of AMS-02 data with PAMELA data

#1377 Boezio

proton



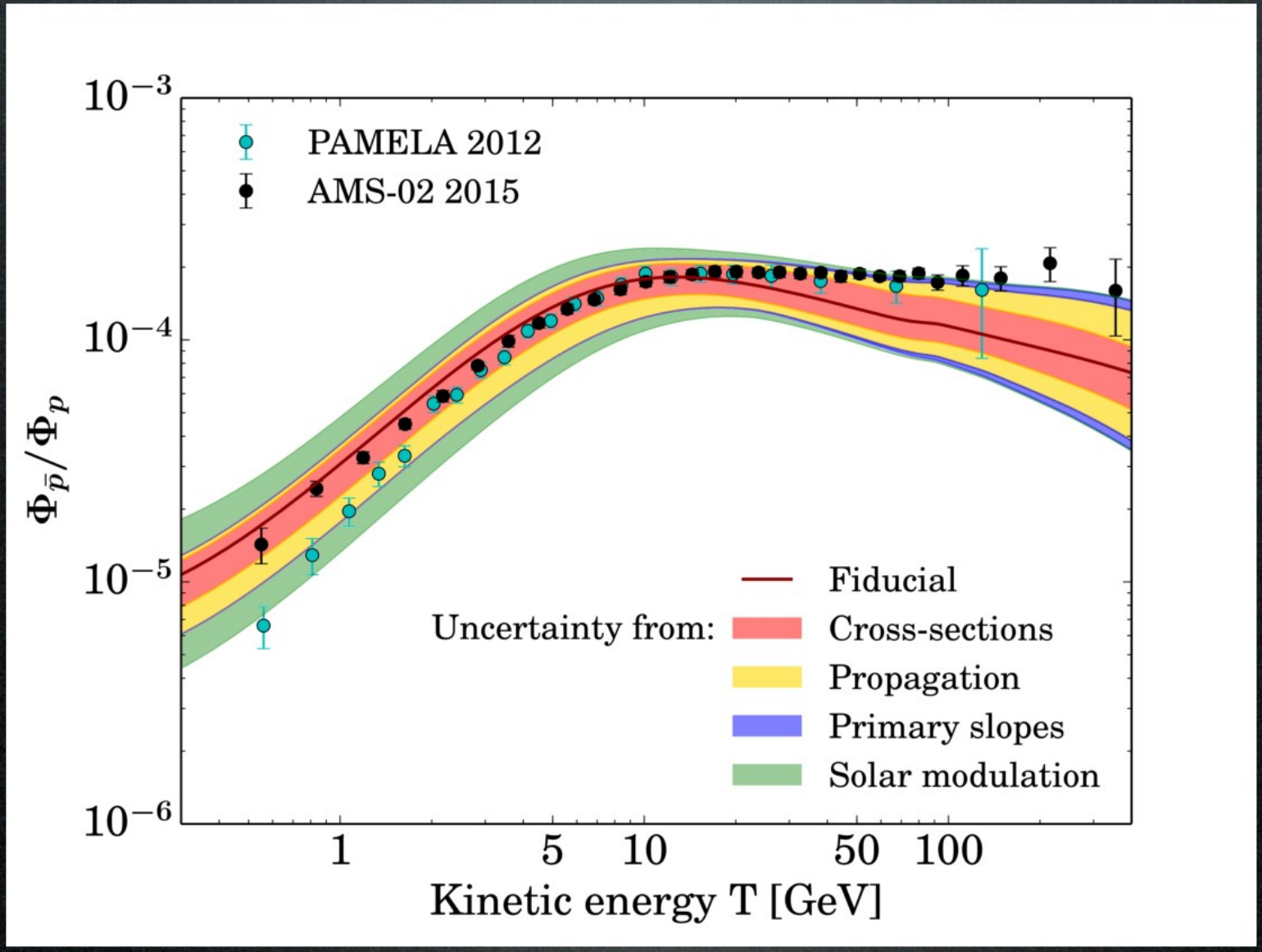
Helium



O. Adriani et al, Phys. Rep. (2014)

Antiproton data vis-à-vis the secondaries:

M. Boudaud - ICRC2015 #1184



No evident **excess**

Some preference for flatness

Giesen, Boudaud, Génolini, Poulin, Cirelli, Salati, Serpico 1504.04276

M. Cirelli – rapporteur talk