PROSPECTS FOR THE MEASUREMENT OF COSMIC LEPTONS

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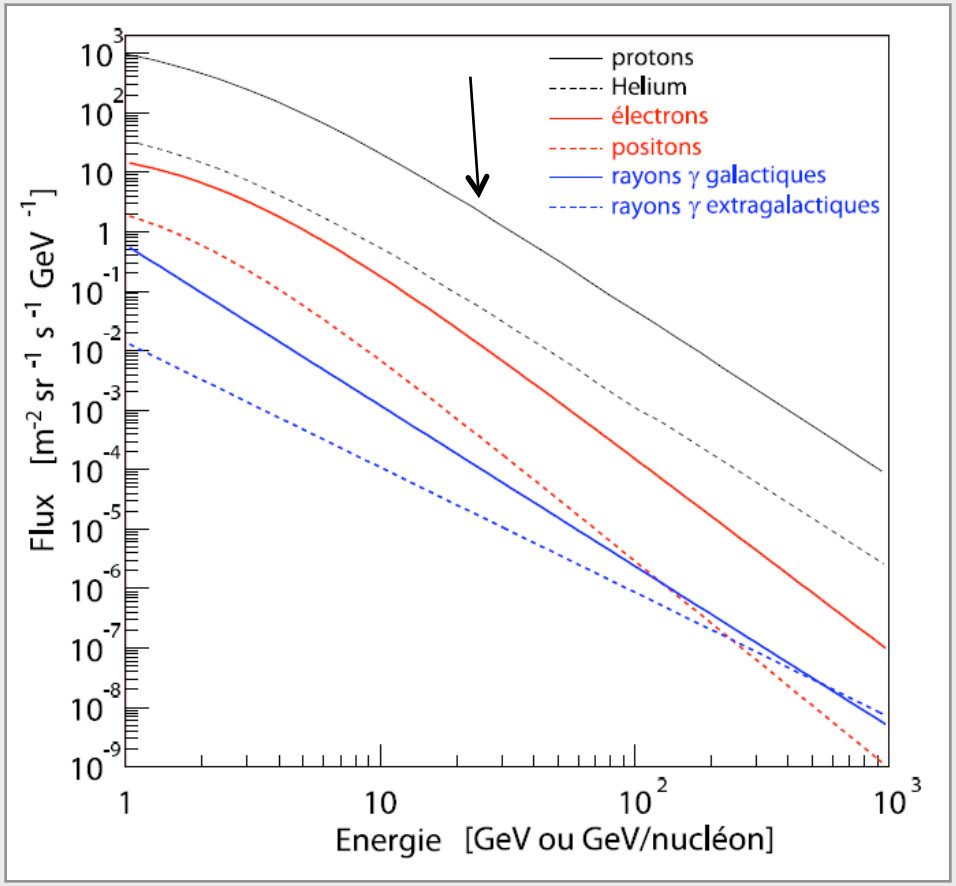
Outline

- The cosmic leptons problem : ATIC and PAMELA
- How can we go beyond : rerouting the γ-ray telescopes
- Fermi/GLAST measurement of $e^- + e^+$
- HESS measurement of $e^- + e^+$

Backgrounds for E^+ & E^-



Main background : PROTONS!

2 types of measurements:

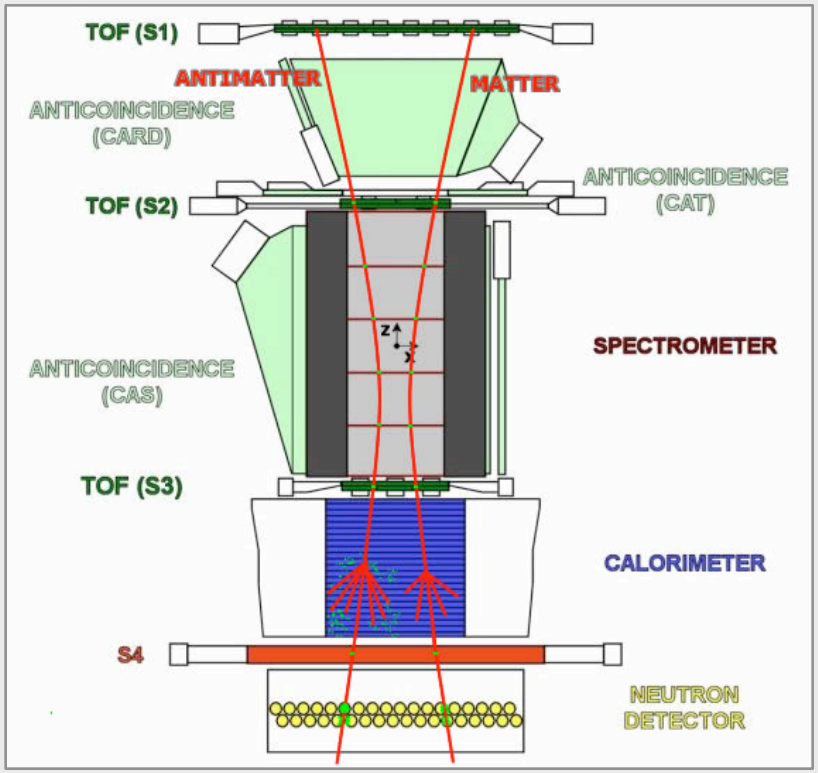
- electrons
- positron fraction

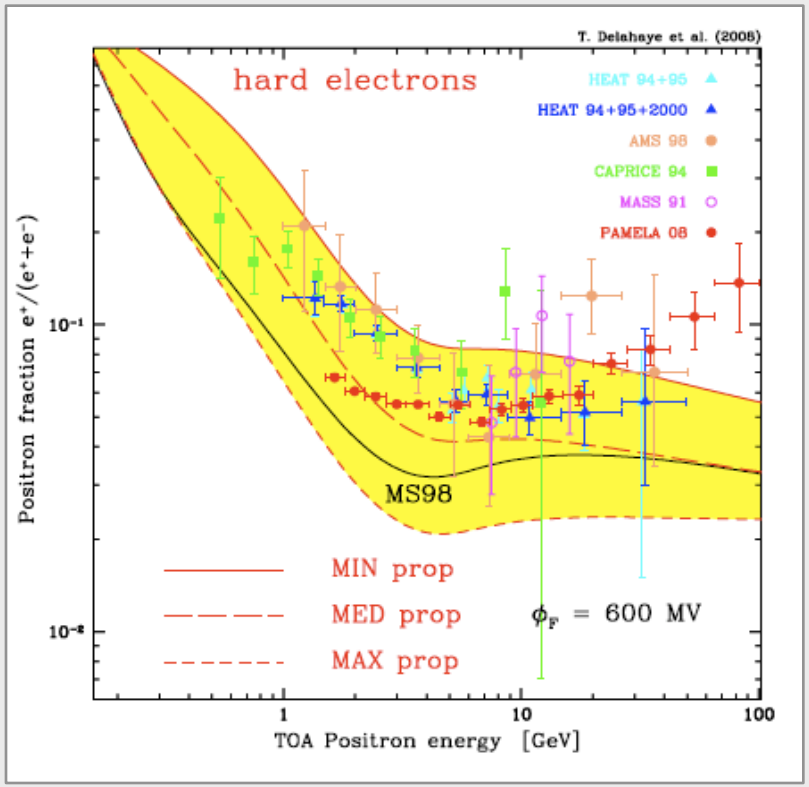
ATIC
Tracker/
calorimeter

PAMELA
Magnetic
spectrometer

PAMELA MEASUREMENTS

Recent release of PAMELA measurement of e^+ fraction:



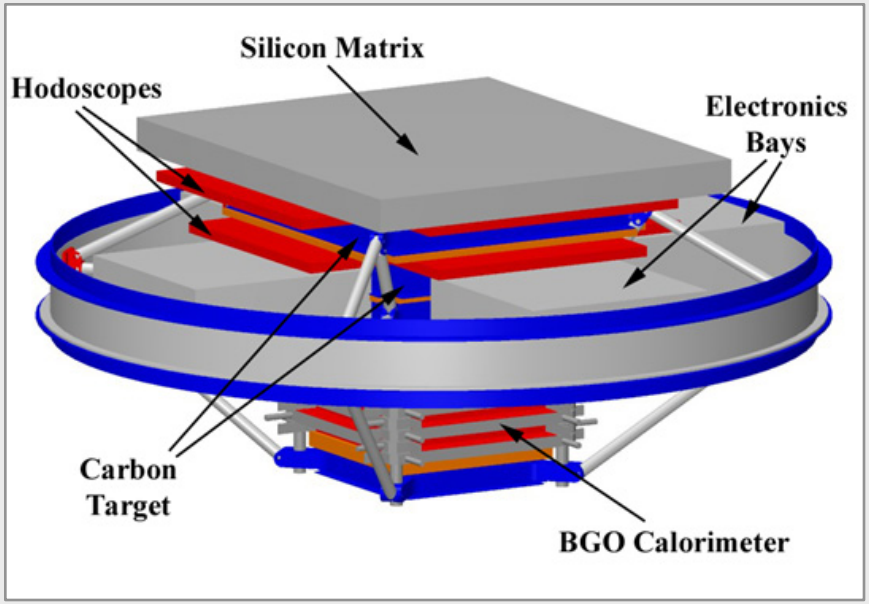


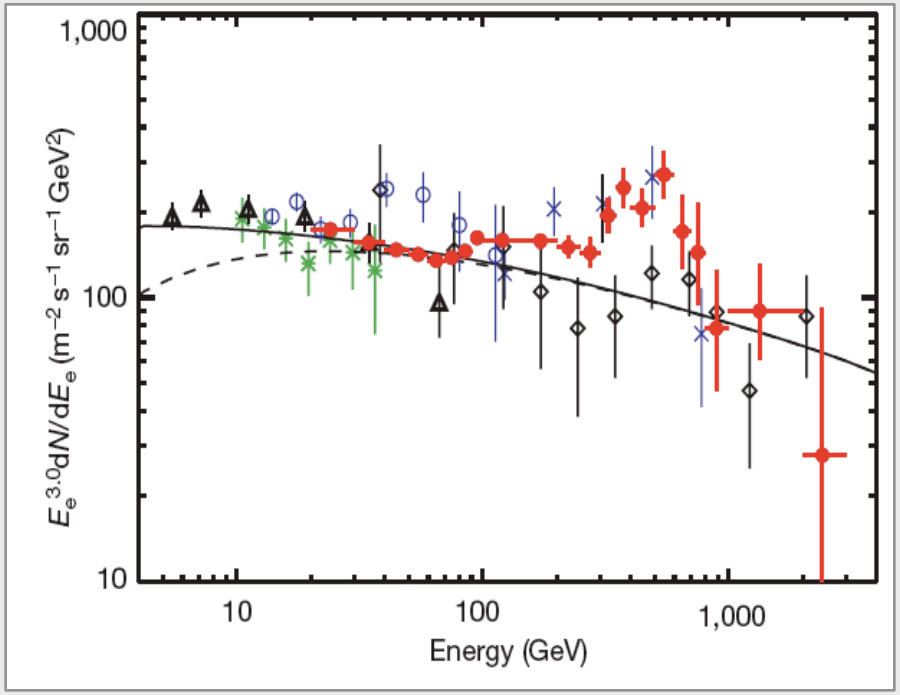
T. Delahaye et al., 2008

Charge separation
Smaller acceptance
(~20 $cm^2 sr$)

Hint for the presence of a primary source!

ATIC measurements





J. Chang et al., 2008

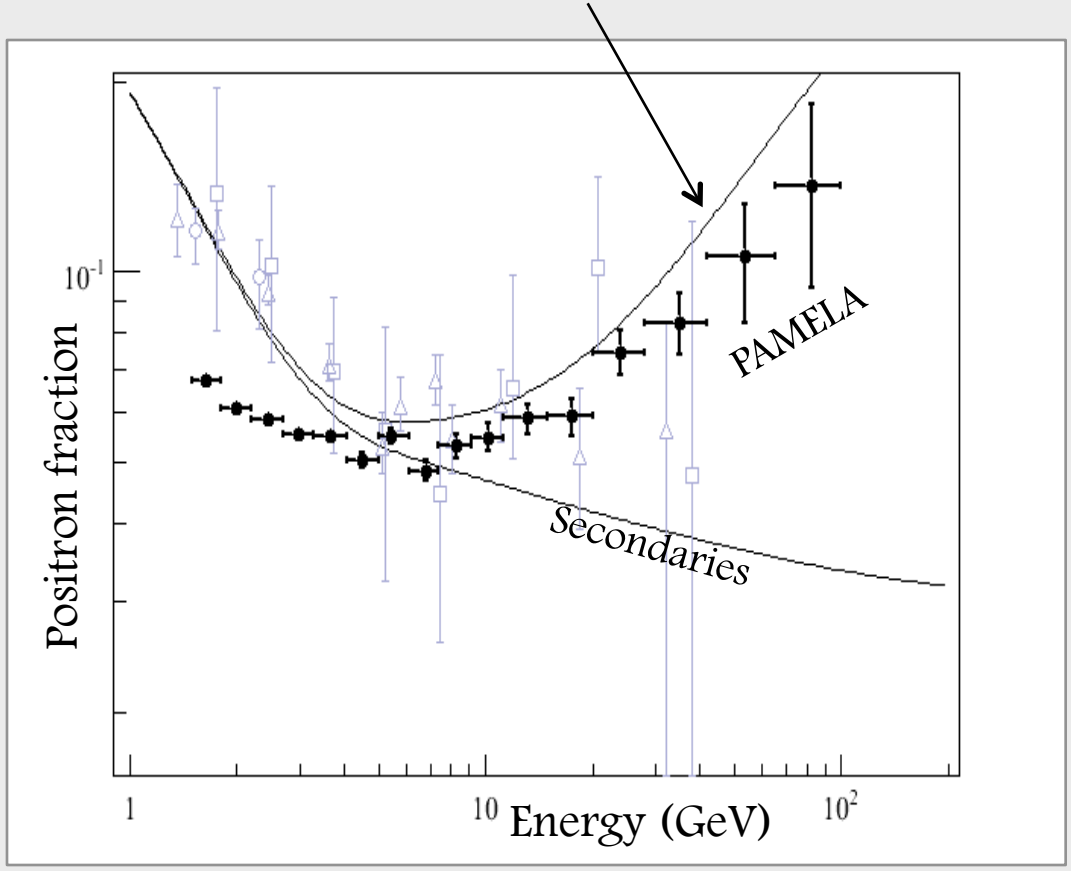
No charge separation
Simpler, higher acceptance :
(~3.10^3 $cm^2 sr$)

Evidence for a spectral feature!

Possibly consistent with DM annihilation

Are these results compatible?

Take the best ATIC DM fit : what signal in PAMELA energy range ?



Standard assumptions on the e^+/e^- backgrounds

No claim that it is DM but likely : same origin!

Are there other measurements that could help in the near future?

Which detector is the most appropriate?

To observe a feature in the leptons channel

Small detector
Charge separation
A_1

$\longleftrightarrow$?

Big detector
No charge separation
A_2 ($>A_1$)

$$\sigma_1 = \frac{\Phi^{dm}_{posit} \times A_1}{\sqrt{\Phi^{std}_{posit} \times A_1}} \qquad \sigma_2 = \frac{\Phi^{dm}_{elec} \times A_2}{\sqrt{\Phi^{std}_{elec} \times A_2}}$$

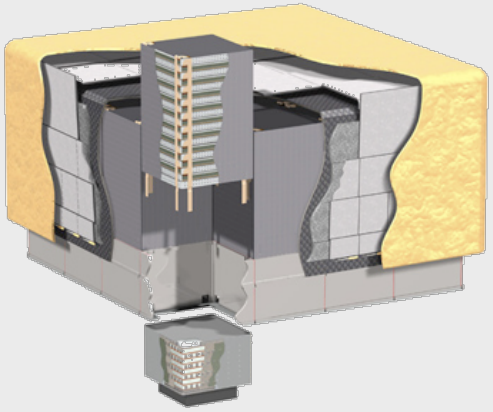
A_2 is statistically best as long as :

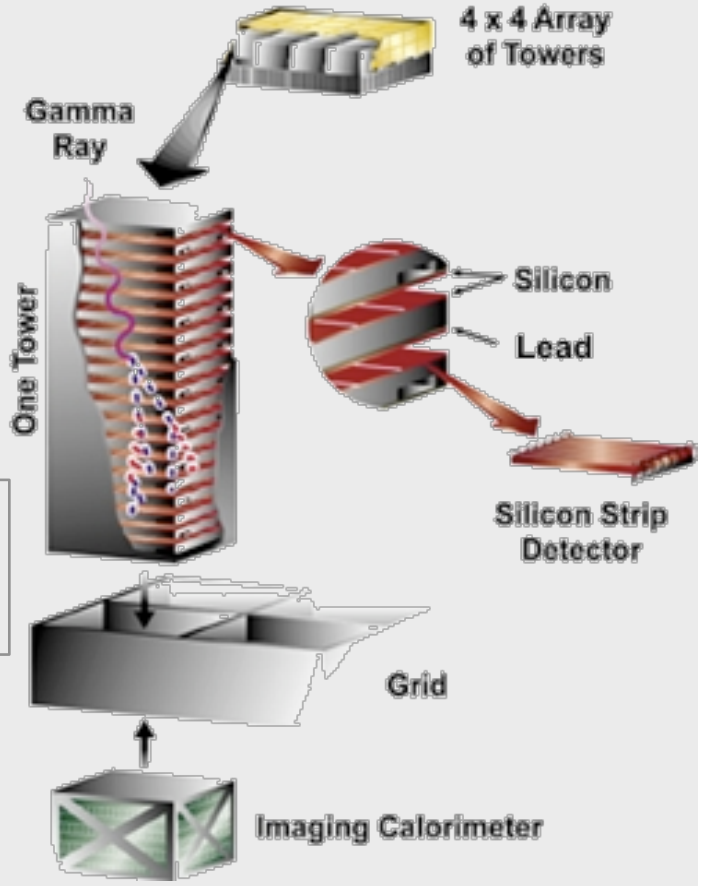
$$\frac{A_2}{A_1} > \frac{\Phi^{std}_{elec}}{\Phi^{std}_{posit}}$$

~100 to 1000 for leptons

Fermi LAT

Fermi LAT : very good electron detector



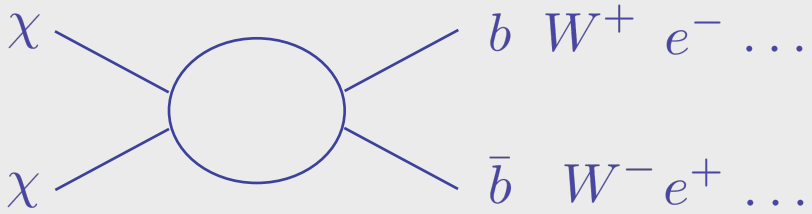


Electrons are rejected for gamma ray studies
What if we kept them?

Acceptance ~5.10^5 cm^2sr

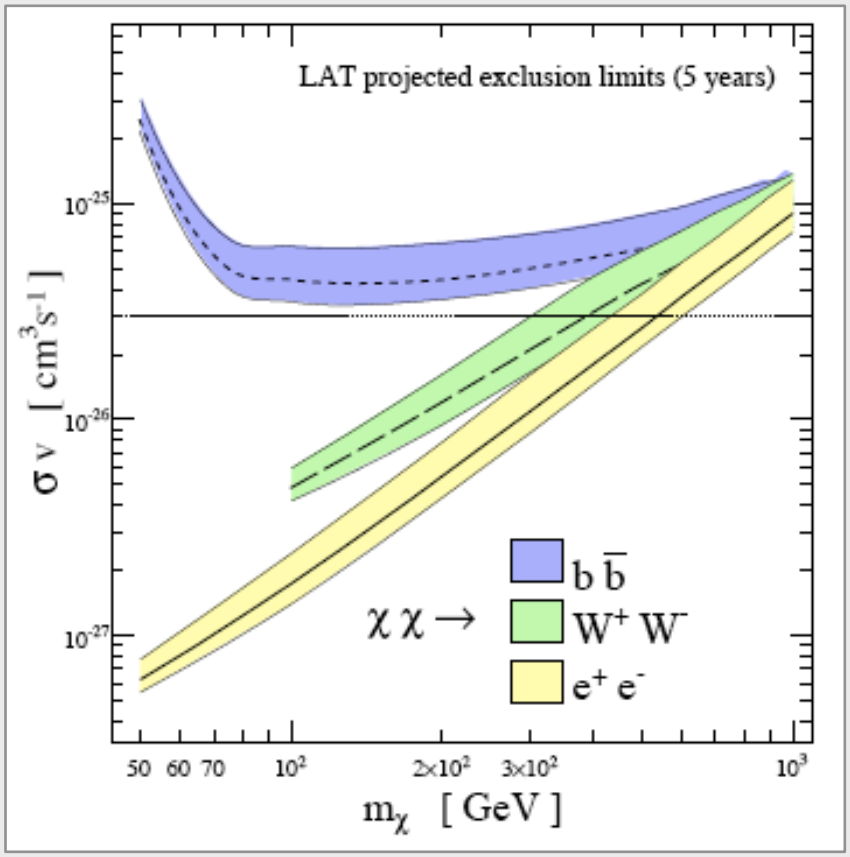
Electron ID up to a few TeV

LAT SENSITIVITY TO DARK MATTER



Generic parameters of the DM particle model :
$\langle \sigma v \rangle$, m_χ

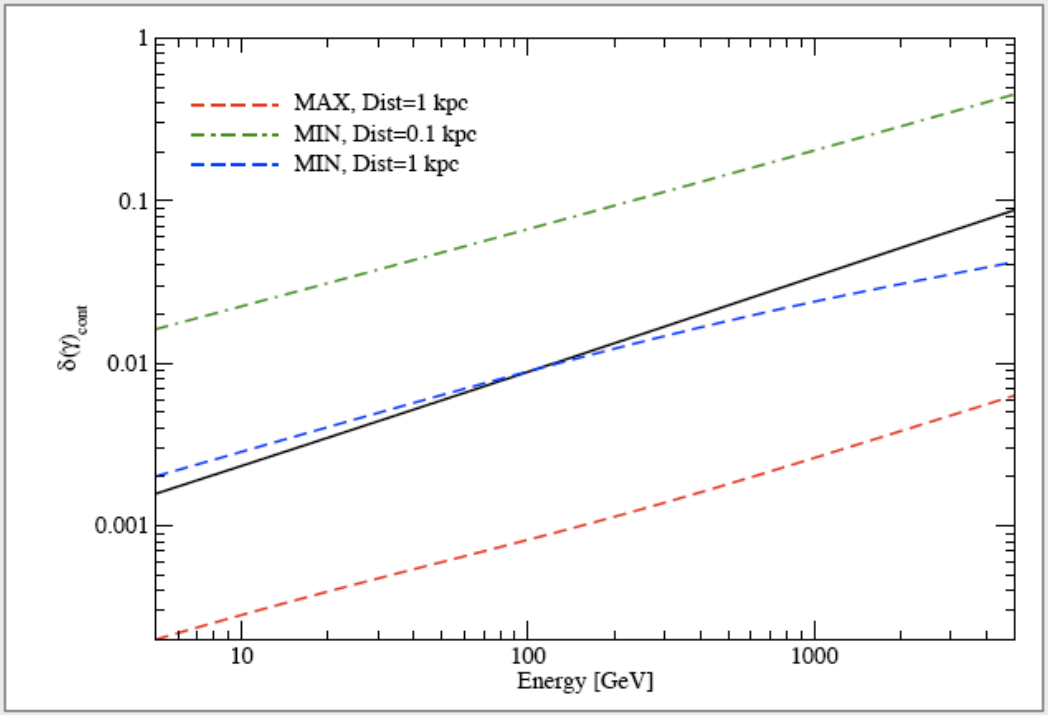
Constraints on these parameters with Fermi e⁻ measurements :



LAT : ANISOTROPY

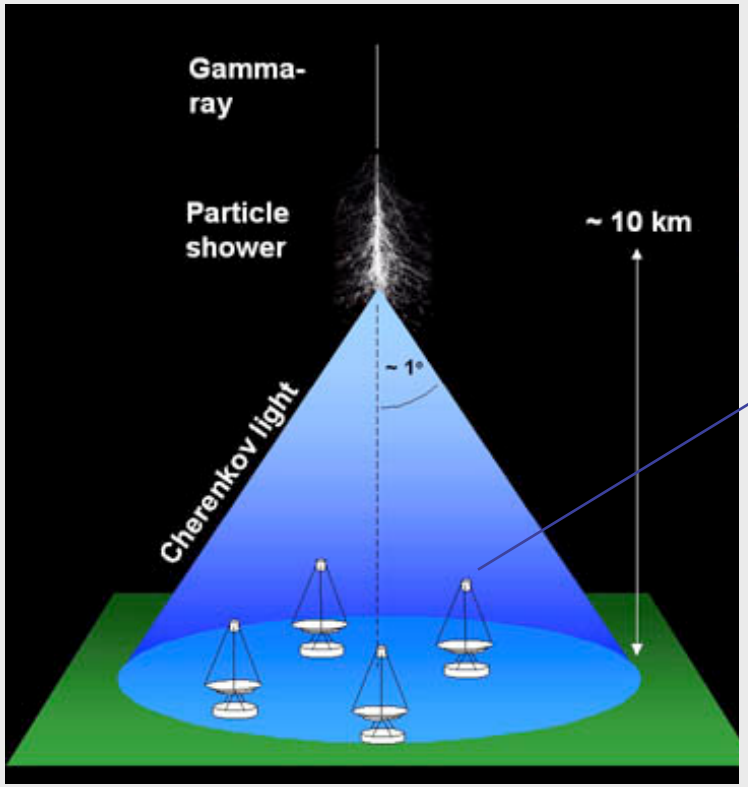
A small dipole (few %) should be detectable with Fermi LAT

Preliminary estimates:

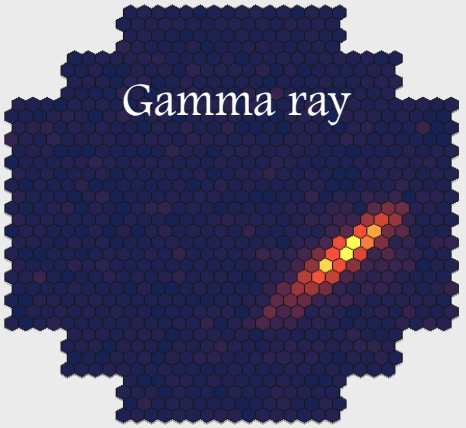


Ground based gamma ray astronomy

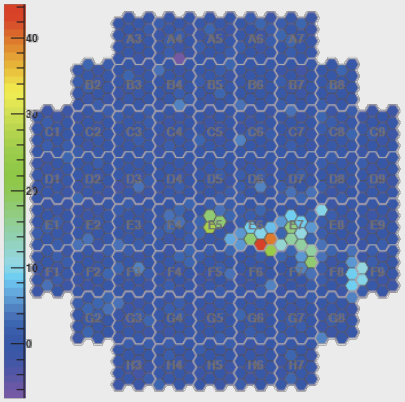
HESS observes gamma-ray induced showers



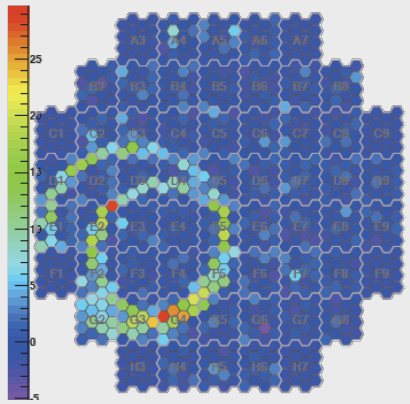
Focal plane of the cameras



hadron



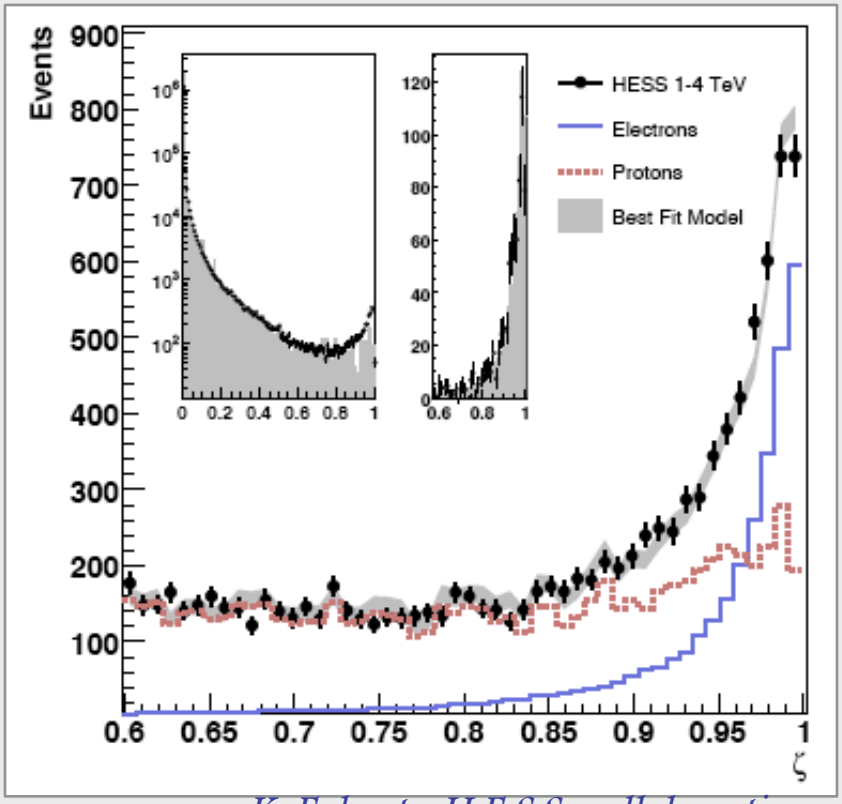
muons



Electron showers are very similar to gamma showers !

Some issues on electron measurements

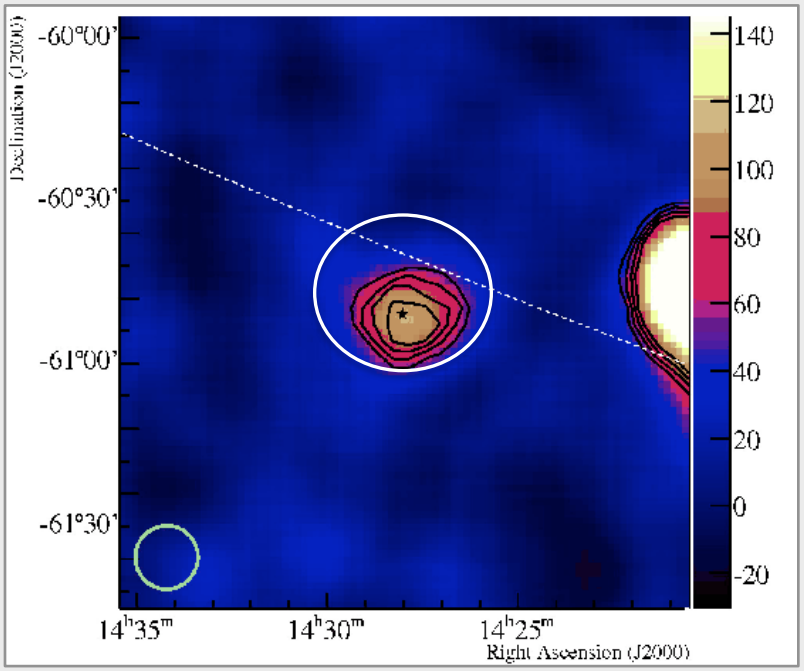
- No on/off : need for a high level of background rejection
  - ⇝ Use of a random forest statistical method

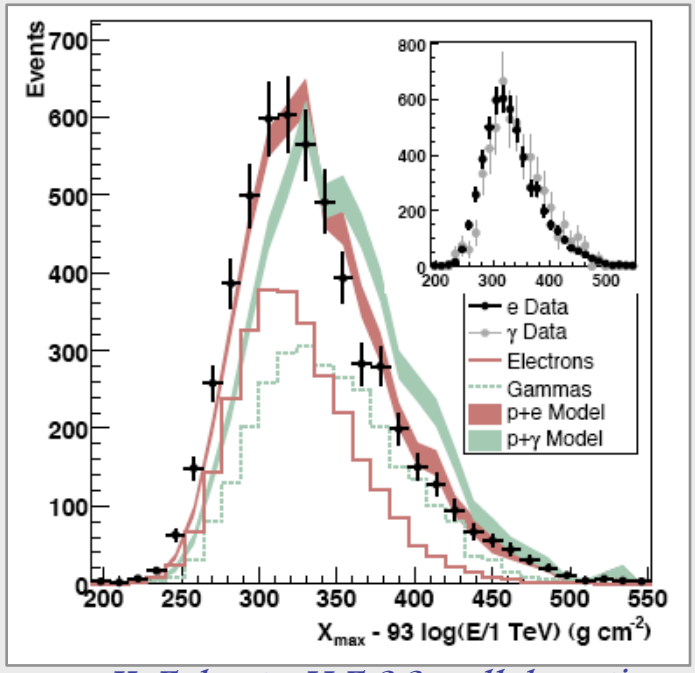


K. Egberts, H.E.S.S. collaboration

Some issues on electron measurements

- Potential problems with diffuse gamma
  - ⇝ Off-source regions
  - ⇝ Extragalactic observations
  - ⇝ Use of Xmax to perform gamma/electrons separation

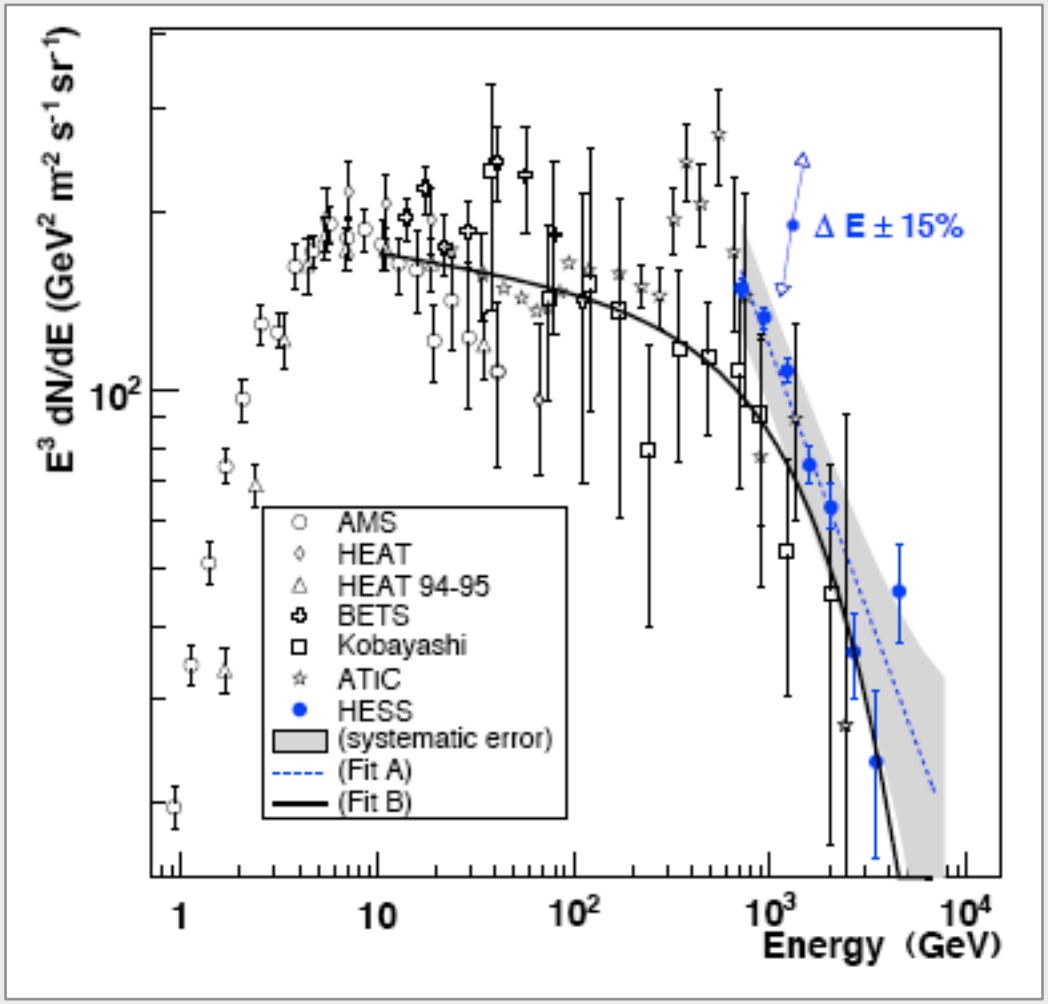




K. Egberts, H.E.S.S. collaboration

HESS RESULTS FOR ELECTRONS

- 240 hours of live time
- 600 GeV threshold
- S ~10^9 cm^2
- Compatible with ATIC
- Needs further analyses to test the bump



K. Egberts, H.E.S.S. collaboration
arXiv:0811.3894

Summary

- PAMELA & ATIC results very exciting!
- H.E.S.S. provides a good measurement of electron flux

In the near future:

- Fermi-LAT measurement of $e^- + e^+$
- Further analyses with H.E.S.S.