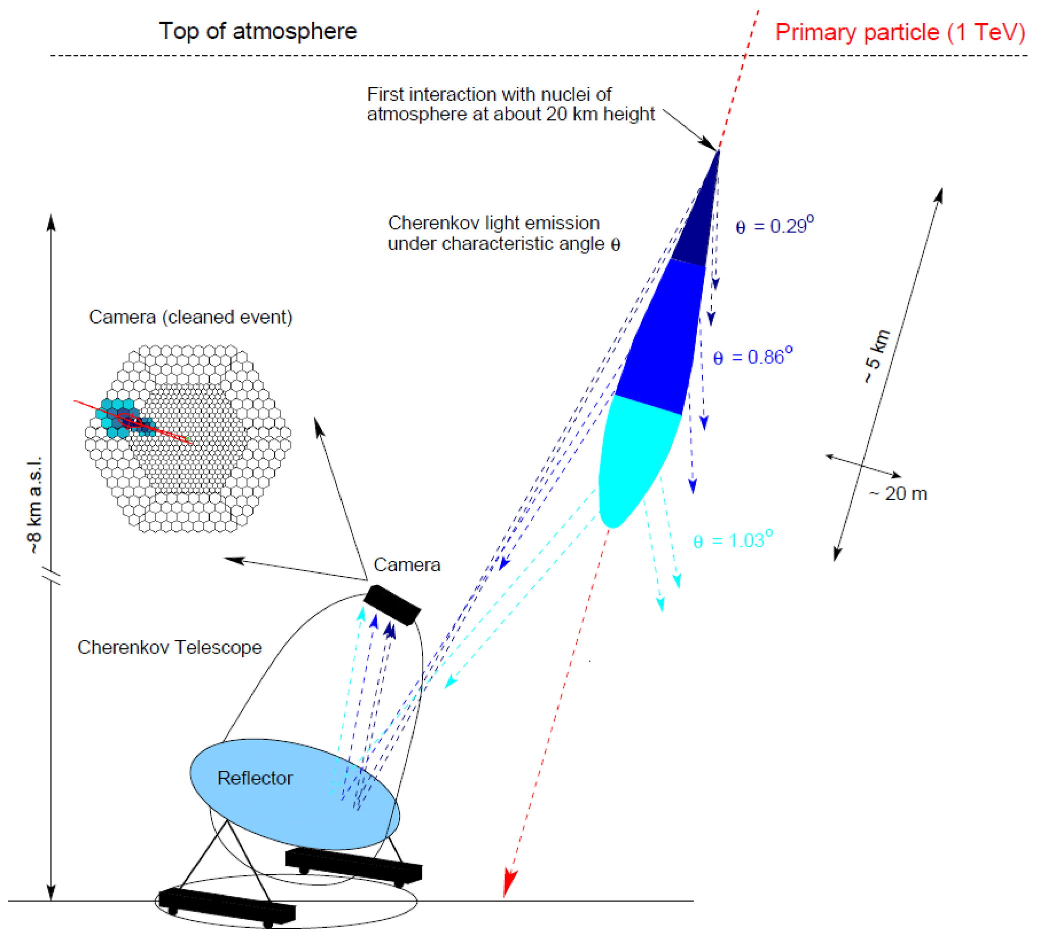
The energy spectrum of cosmic $e^{\pm}$ measured with MAGIC

Motivation

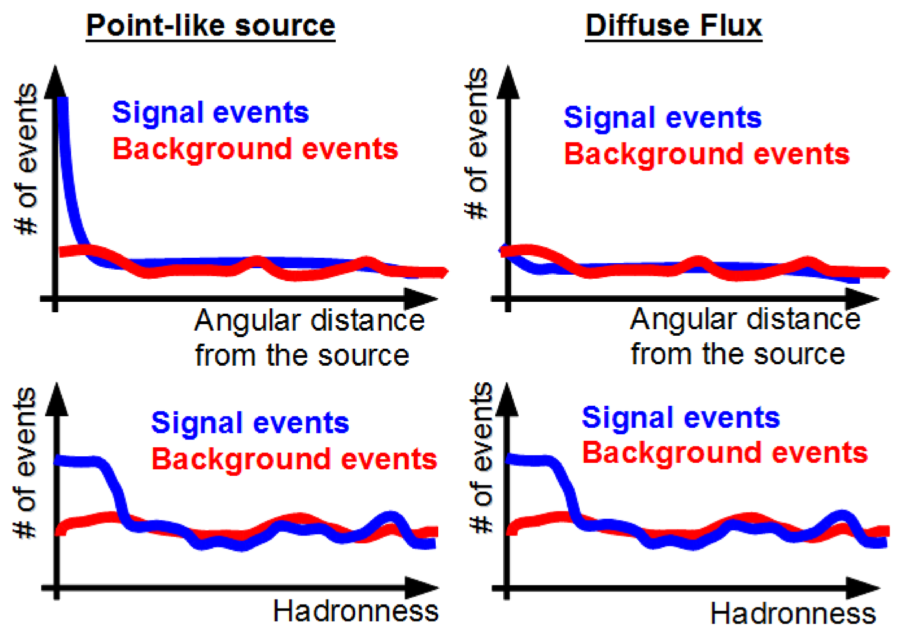
- Excess of high-energy electrons measured in the range between 100 GeV and a few TeV not in agreement with ΛCDM-model.
- Excess could come from decaying or annihilating Dark Matter within our galaxy.
- Current generation of satellite & balloon experiments are limited in energy range (1 GeV -1 TeV).
- Only ground-based Cerenkov telescopes reach energies higher than 1 TeV.
- Dark Matter models fitting the current electron energy spectrum differ at energies above 1 TeV.
- More measurements at high energies are needed to validate or contradict these models.

Technique

- Cerenkov telescopes operate from few tens of GeV to $\mathcal{O}(10)$ TeV.
- Particle interacting with atmosphere yields a shower.
- Charged secondaries produce Cerenkov light.
- Light collected and focused onto a segmented imaging camera.
- The resulting measured light shower allows for reconstruction of:
  - Direction of the incoming particle,
  - Type (i.e. hadronic vs leptonic/photons),
  - Primary particle energy.



Data Analysis



Challenges

- Dark Matter related signals must be disentangled from astrophysical signals for most scenarios.
- Electrons are diffuse due to galactic magnetic fields.
- Electrons and gamma rays cannot be separated.
- Standard analysis optimized for point-like sources
  - Discriminator between signal (gammas) and background (hadrons) is the angular distance to source.
  - Background estimated by looking off source.

$\Rightarrow$ Standard analysis can not be used for the diffuse flux.

A new method

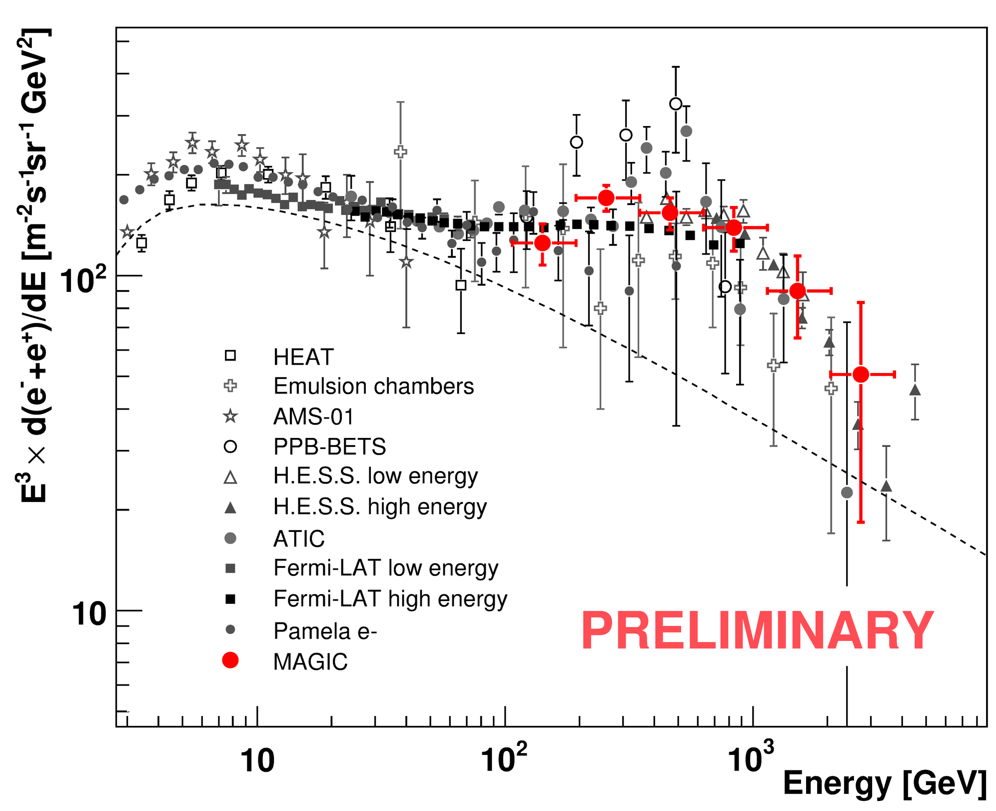
- A new method needs to be developed and optimized using a different parameter: Hadronness.
- Hadronness defines the likelihood of a particle to be hadronic.
- Observations with no gamma-ray signal from a point-like source were used as input data.
- Background is estimated from Proton Monte Carlo data. $\Rightarrow$ Difficult estimation. Large theoretical & systematic uncertainties.

Recent Results

First working prototype of analysis completed before I joined.

My contribution

- Indepedent cross check of previously obtained result.
- Selected new data for diffuse analysis.
- Compared parameter distribution of data & Monte Carlo.
- Compared different data cleaning procedures.
- Mass production of Monte Carlo.
- First results of the energy spectrum of cosmic electrons.



Outlook

- Extend spectrum to higher energies.
- Study & estimate systematic uncertainties of the analysis.
- Investigate Dark Matter interpretation of the results.
- Feasibility studies for MAGIC and CTA to differentiate between Dark Matter models.
- Apply concept of the diffuse flux analysis to Dark Matter searches for given extended sources (i.e. Perseus cluster).

Selected Talks

- Dark Matter and Fundamental Physics with the Cerenkov Telescope Array: Cold Dark Matter Signatures
  CTA Group meeting, Zeuthen, January 2012.
- Sommerfeld Enhancement and its implications for Dark Matter
  CTA Group meeting, Zeuthen, February 2012.
- Study of cosmic electrons and positrons with MAGIC
  Graduate School Mass, Spectra, Symmetry: Spring Block Course 2012, Bad Schandau -Krippen, March 2012.
- Feldman and Cousins - constructing classical confidence belts
  Graduate School Mass, Spectra, Symmetry: Spring Block Course 2012,Bad Schandau -Krippen, March 2012.
- Status of the electron energy spectrum
  MAGIC Collaboration Meeting,Santa Cruz de La Palma, November 2012.

Collaborations

- MAGIC
- CTA

Profit from the GK

- Advanced lectures on developments in particle physics and other current research (Blockcourses).
- Appropriate financing of research stays and trainings.
- Second supervisor.

Contact Details and further Information

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