European Research Group

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Towards High Energy Astroparticle Physics European Network:

Tasks

16-Dec-2004

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GDRE+ (Group de Recherche Européen) concerns the activitity in Astroparticle Physics reasearch:

- High energy γ-ray, ν, charged and neutral cosmic ray composition, their origin, acceleration and propagation, discovery of new particles in the Universe.
- To reach this goals, accurate measurements of all messengers are requested in a large energy range with complementary information.

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- Correlation of measurements in different experimental situations, using natural detection media as:
- Earth atmosphere
- Ice
- Sea water
- Satellites
- International Space Station

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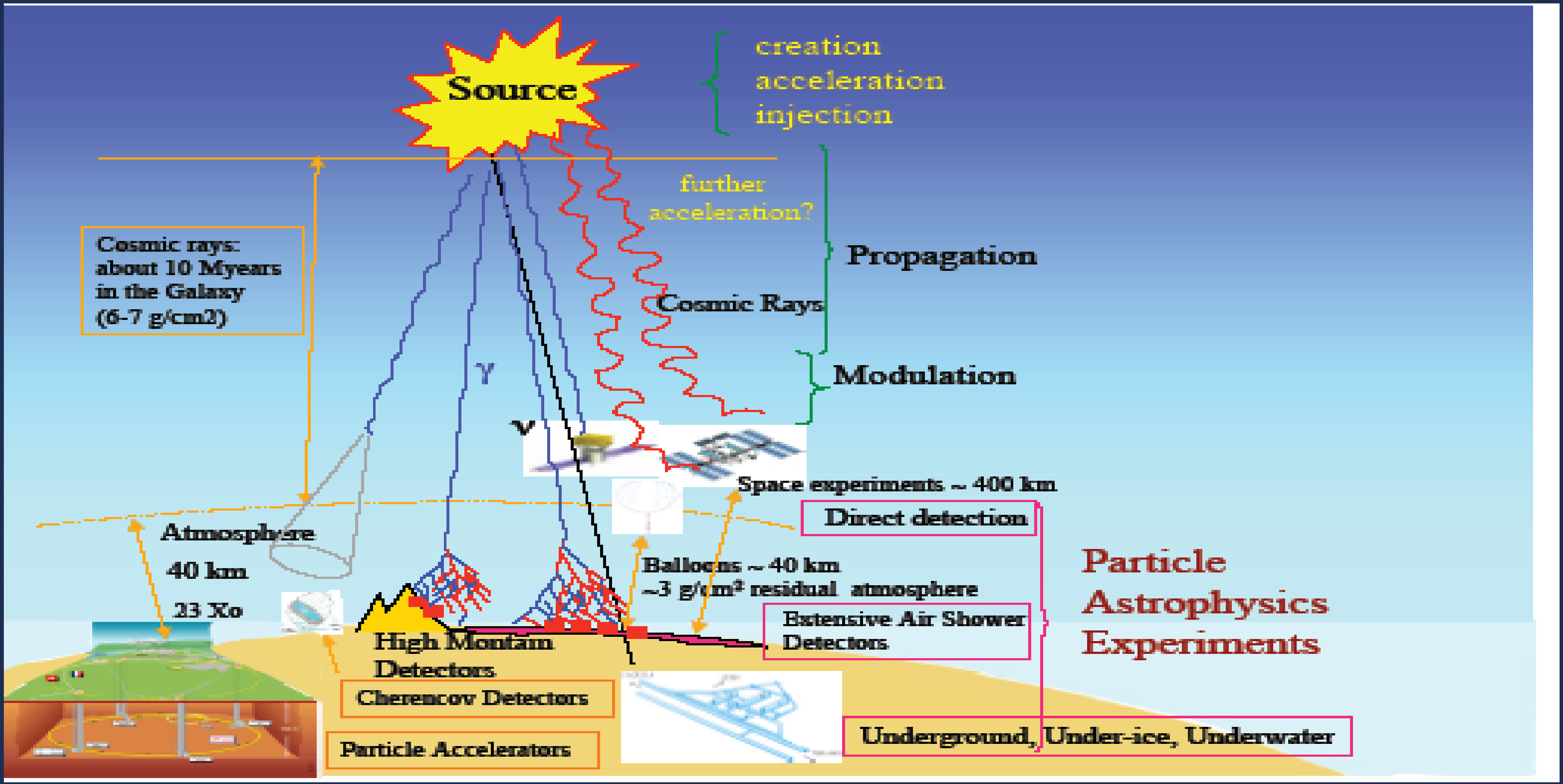

A. Morselli

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- Observation of same phenomena from different point of view

Basic Motivation to propose this research group

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- The proposed group includes the following experiments and projects:
- AGILE, ARGO, AMS, GLAST, HESS, MAGIC (γ-rays)
- AMANDA/ICECUBE, ANTARES,NEMO (ν)
- AMS, AUGER, CASCADA-Grande, EUSO, PAMELA (cosmic ray).

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Aim of group:

- Merge & correlate different cosmic messenger observations
- Establish links among different group to act as catalysis for the astroparticle physics community
- Coordinate strategy for next generation experiments

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Laboratory from:

- Czech republic
- Denmark
- Finland
- France
- Germany

- Italy
- Portugal
- Spain
- Sweden
- Switzerland

•Austria, Belgium, Greece, Norway, Poland, UK. ???

PROJECT TASKS

1. Gamma-ray observatory & detection
2. High energy neutrino detection
3. Cosmic rays detection
4. Physics and new observables (theory interface)
5. Detection (3JRA)
6. DACQ (1JRA)
7. Computing (1JRA)
8. Transnational access (1JRA)

} Tomorrow

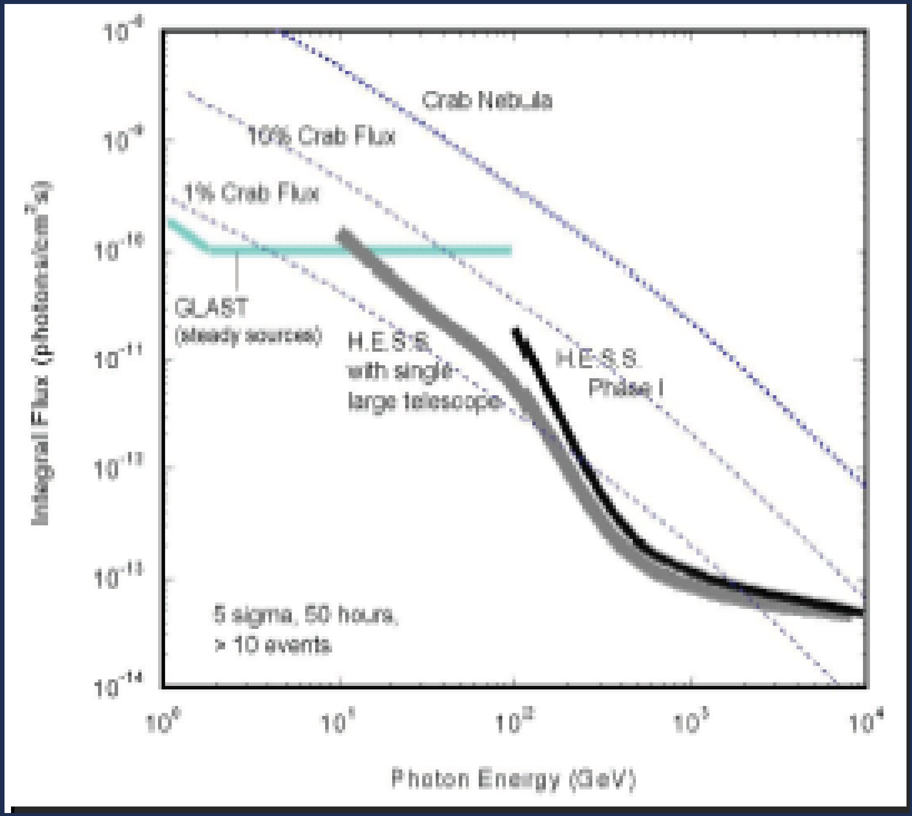
PROJECT TASKS

1. Gamma-ray observatory & detection

1.1 Correlate observation from southern and northern hemispheres

1.2 Develop observation methods for transient sources: alert systems and combination of space (AGILE/ARGO/GLAST/AMS)
And
Ground observations (HESS, MAGIC)

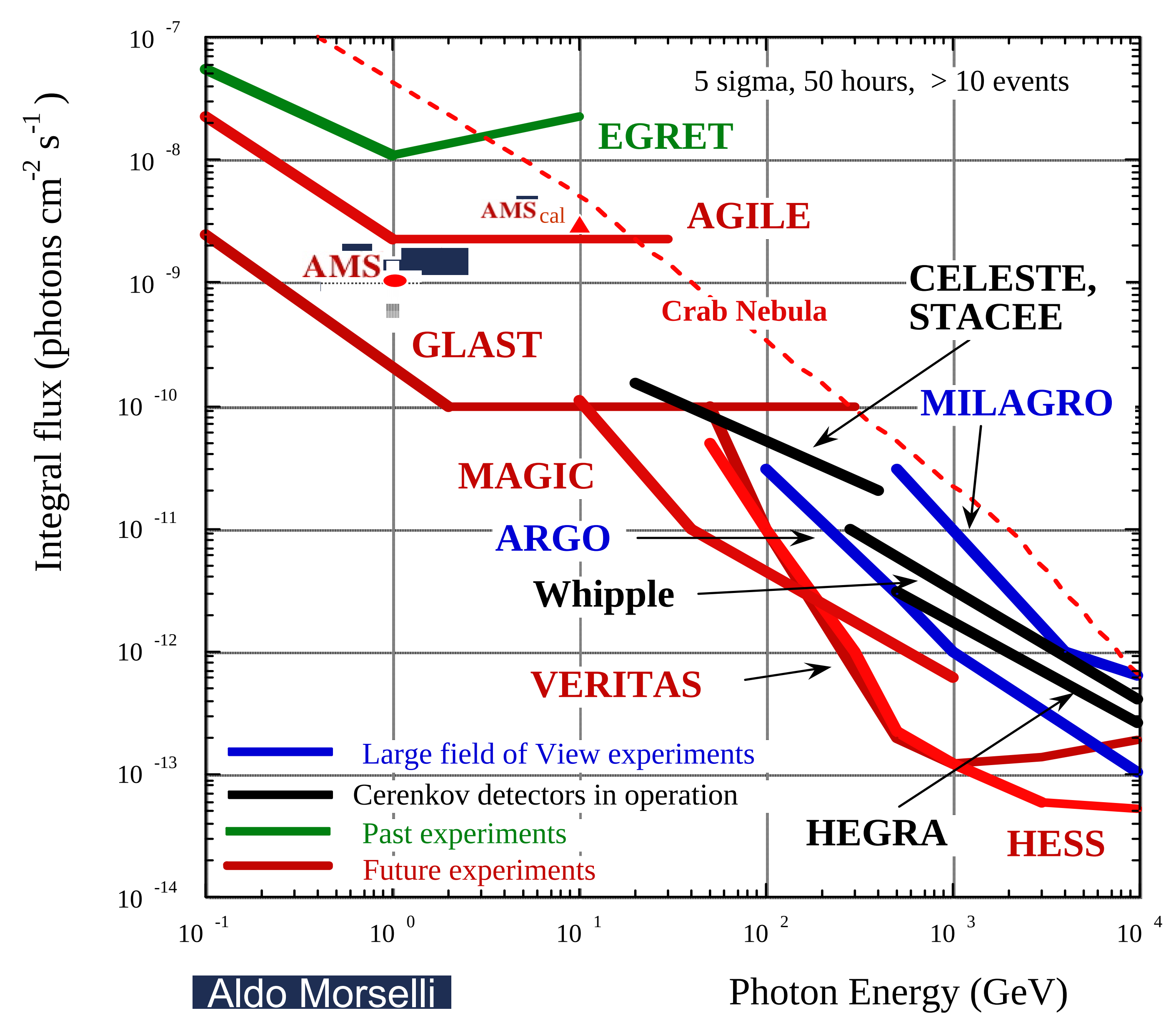
Very large telescope



A. Djannati-Atai

Sensitivity of γ-ray detector

Aldo Morselli 8/04



Aldo Morselli

All sensitivities are at 5σ.
Cerenkov telescopes sensitivities (Veritas, MAGIC, Whipple, Hess, Celeste, Stacee, Hegra) are for 50 hours of observations.
Large field of view detectors sensitivities (AGILE, GLAST, Milagro, ARGO, AMS are for 1 year of observation.

MAGIC sensitivity based on the availability of high efficiency PMT's

s.

Cerenkov telescope

Coordination of ground-based high-energy astrophysics instruments

Tasks include:

Coordination of:
Joint observation campaigns
Measurements to cross-calibrate the instruments

Initiation of:
The definition of a simple data format to allow exchange of data (at the event level) between the collaborations.
The data format and the tools developed in this context could be used later to make data publicly available.

A. Djannati-Atai

Paths of coordination

Paths of coordination/ Collaboration

Coodinations/Collaborations :

- Multi-lambda Observations are mandatory for understanding non thermal sources
- Ground-based instruments are complementary:
  - longitude coverage, weather conditions, cross-calibrations
- Ground-based and space borne instruments are complementary
  - Large fov (space) vs high sensitivity (ground)
  - Energy ranges will begin to overlap at the GLAST Era
- Transient Sources:
  - Space (IR,X,γ) : Alert network
  - TOO strategies :
  HETEII/SWIFT(GRBs only) , AGILE-GLAST-AMS

A. Djannati-Atai

PROJECT TASKS

2. High energy neutrino detection

2.1 Compare different detection techniques and results (AMANDA/ICECUBE, ANTARES, NEMO, NESTOR)

2.2 Develop observation methods for transient sources: alert systems and combination of space (AGILE/ARGO/GLAST/AMS)
And
Ground observations (HESS, MAGIC)

2.3 Evaluate the potential neutrino detectors for the neutrinos originating from supernovae or other violent explosions (Gamma Ray Bursts etc.) and correlate with other observatories.

Neutrino community proposal

Paolo Piattelli

- **Networking**
  - A collaboration between the european projects (Antares, Nestor, Nemo) has been already established with KM3NeT)
  - Increase collaboration with other neutrino projects (Baikal, Amanda, IceCube)
  - Develop collaborations with gamma ray and space based observatories
  - Other common fields of interest may be: massive computer simulations, development of common databases and source catalogues, development of computing and analysis tools
- **JRAs**
- **Transnational access**

PROJECT TASKS

3. Cosmic Ray Interface

3.1 Compare different detection techniques and results; (single and multiparticle detectors; particle, ions and isotopes)
3.2 Asses the complementarities of ground and space observatories (AUGER/KASCADE/AMS/PAMELA/EUSO)
3.3 Correlate with gamma, neutrino and radio observations.

PROJECT TASKS

3. Cosmic Ray interface (continued)

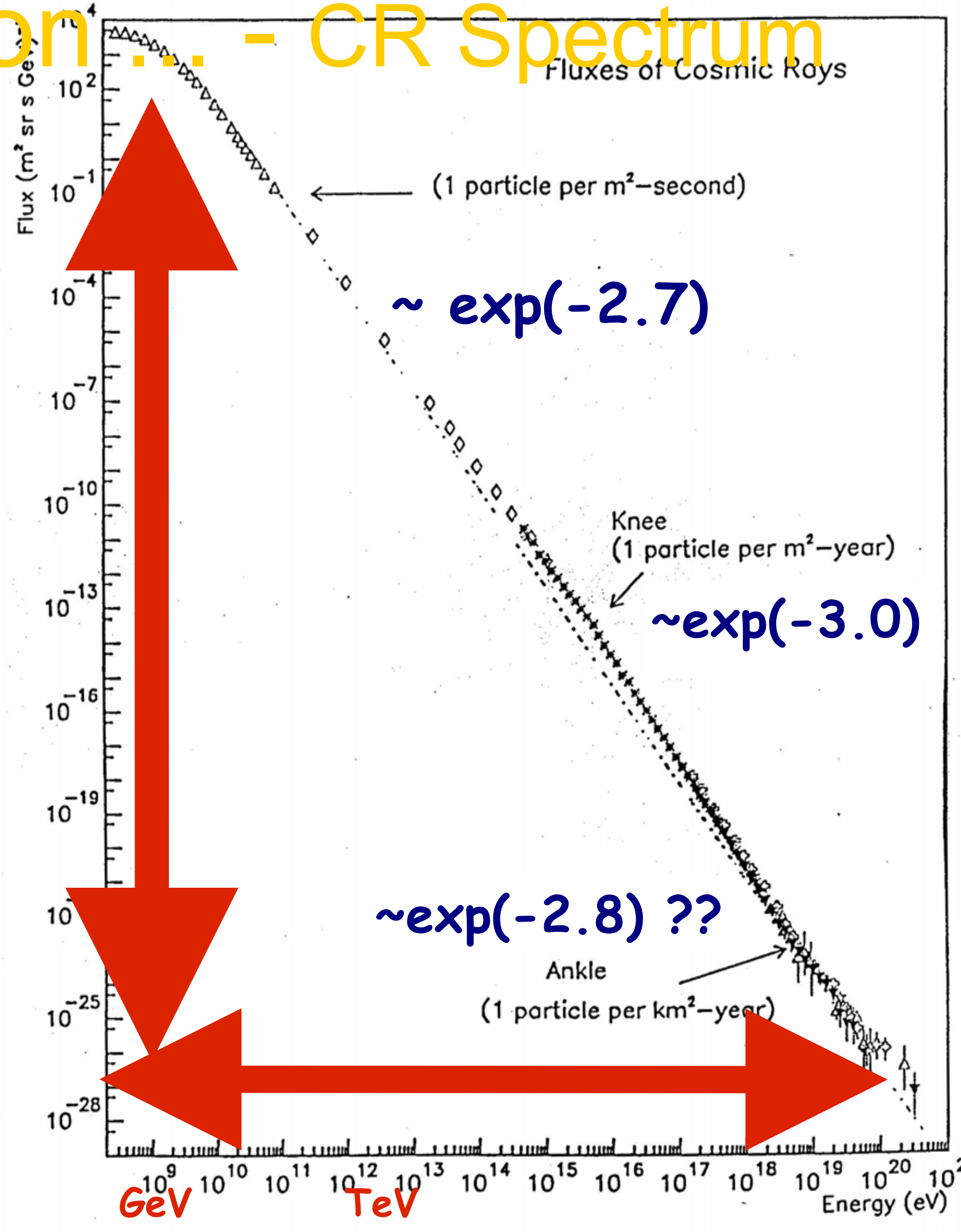
3.4 Asses the complementarities of radio and photodetection

3.5 Plan possible future charged cosmic ray observatory

3.6. Evaluate potential discovery and physics outcome-

... Introduction ... - CR Spectrum

- Cosmic Rays (CR) from ~1 GeV
- produced and accelerated in supernovae explosions
- >12 orders in Energy
- >30 orders in Flux
- Power law
- Knee region not yet well understood:
  - Acceleration mechanism
  - Propagation mechanism
  - Elementary composition
  - a new particle
- Ankle region stat. limited



HECR Plans for the Future

Kampert

- **10^{14}-10^{16} eV** (knee-region)

  No new experiment presently planned for knee-region

- **10^{16}-$10^{18 (\ldots 19)}$ eV** (transition-region)

  Electronic upgrades in KASCADE-Grande

  Upgrade (E-downgrade) **plans discussed in Auger**

- **> 10^{19} eV** (GZK- and trans GZK-region)

  Auger North R&D started (many EU-Institutions involved),
  construction to be started 2006

  EUSO: R&D going on

  enormous interest in radio-technique

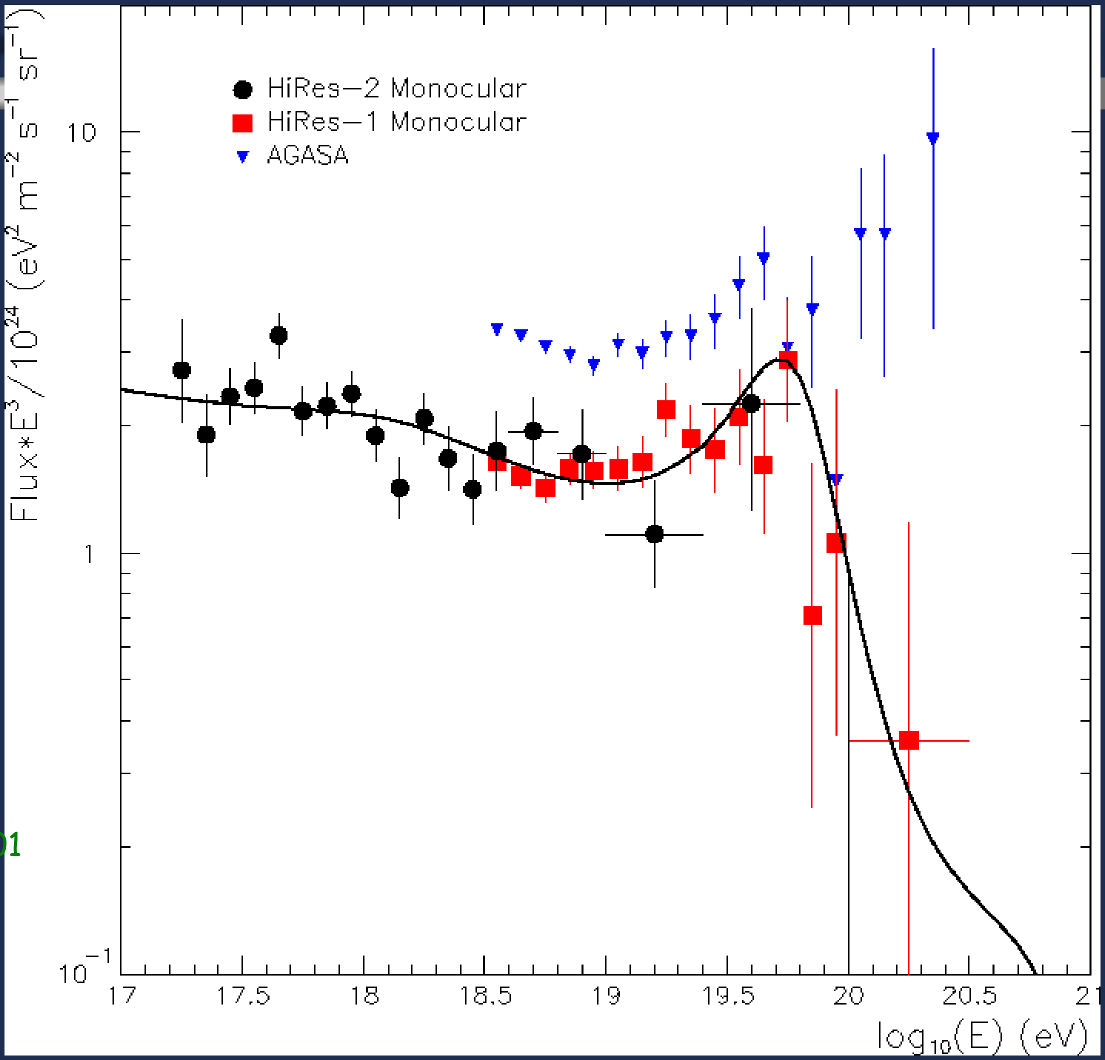
  (if cheap, simple, and reliable,
  go to ~20 000 m^2 or more (in Europe?))

The Ultra-High Energy Cosmic Ray Spectrum

Gunter Sigl

The continuation of
the UHECR spectrum
at the highest energies
is currently unclear
due to lack of statistics.

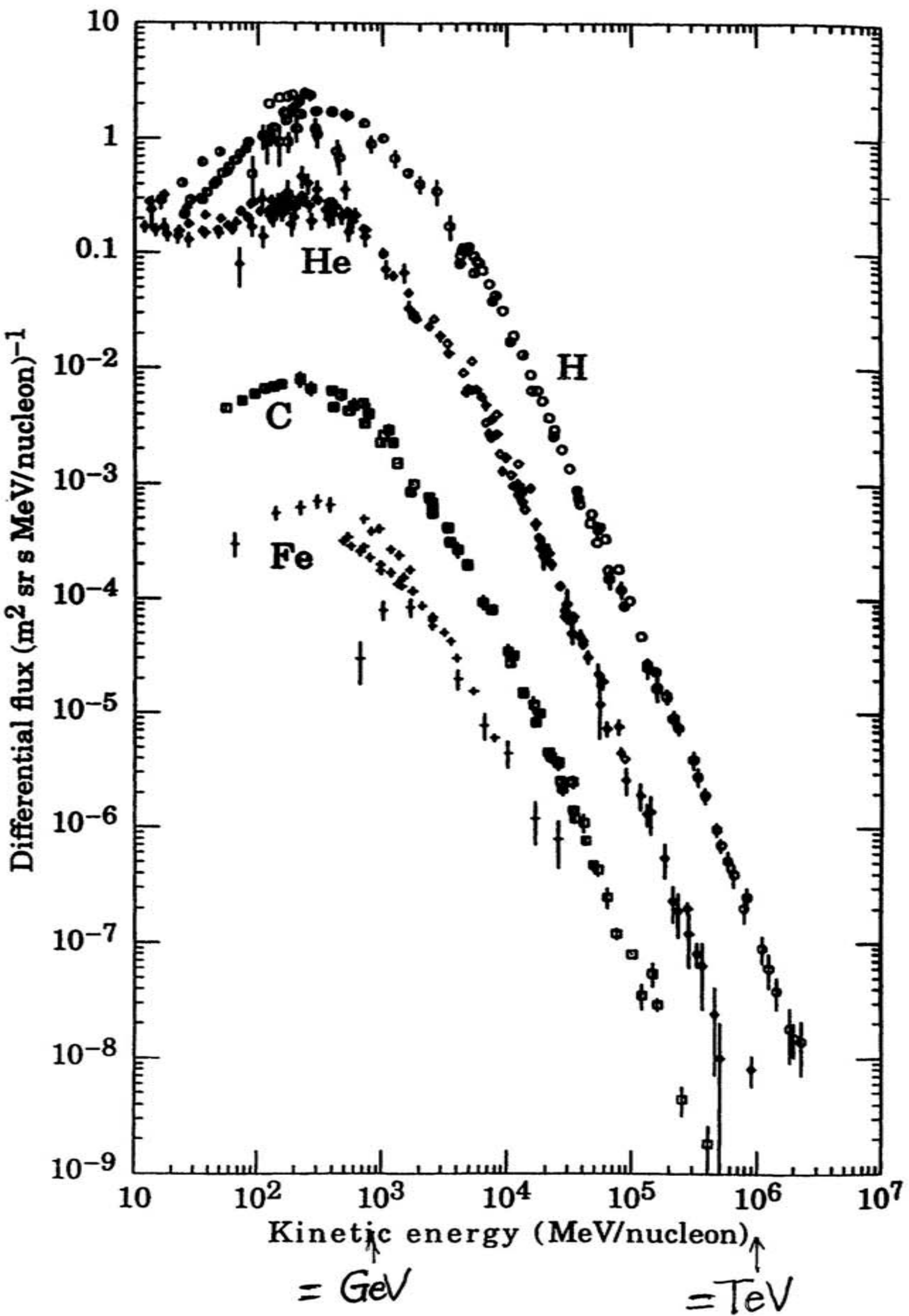
HiRes collaboration, astro-ph/0208301



May need an experiment combining ground array with fluorescence such as the Auger project to resolve this issue.

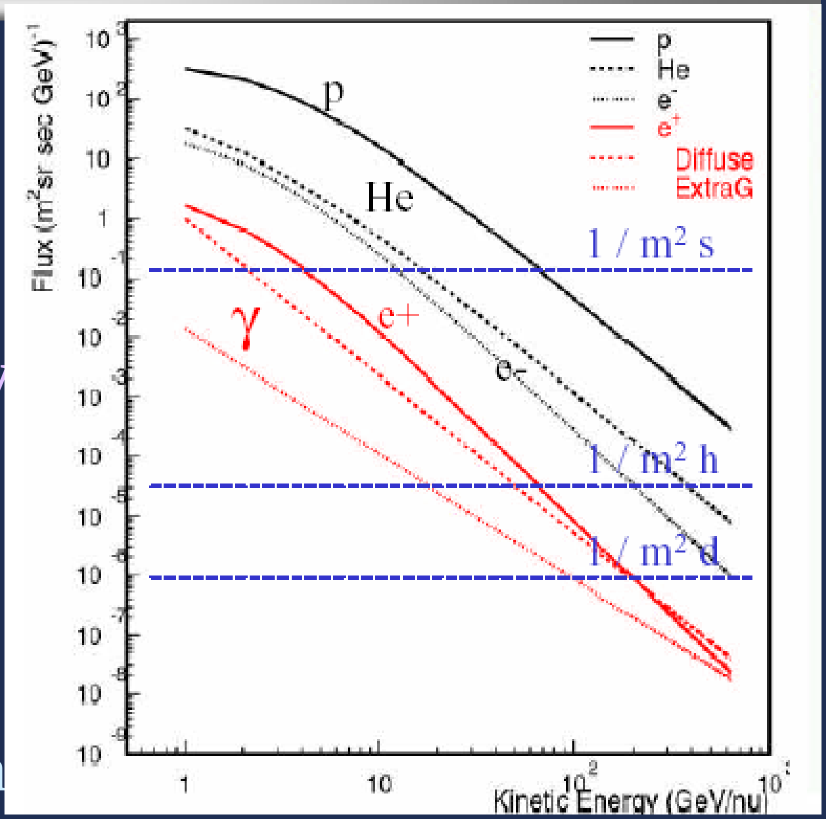
Motivations

- *p and He nuclei are* ***dominant*** *(90% p, 9% He)*
- *All elements are present up to Uranium*
- *Atoms reach heliosphere* ***fully ionized***
- *Absolute fluxes and spec-trum shapes are funda-mental for calculation of atmospheric ν fluxes*



Cosmic Rays

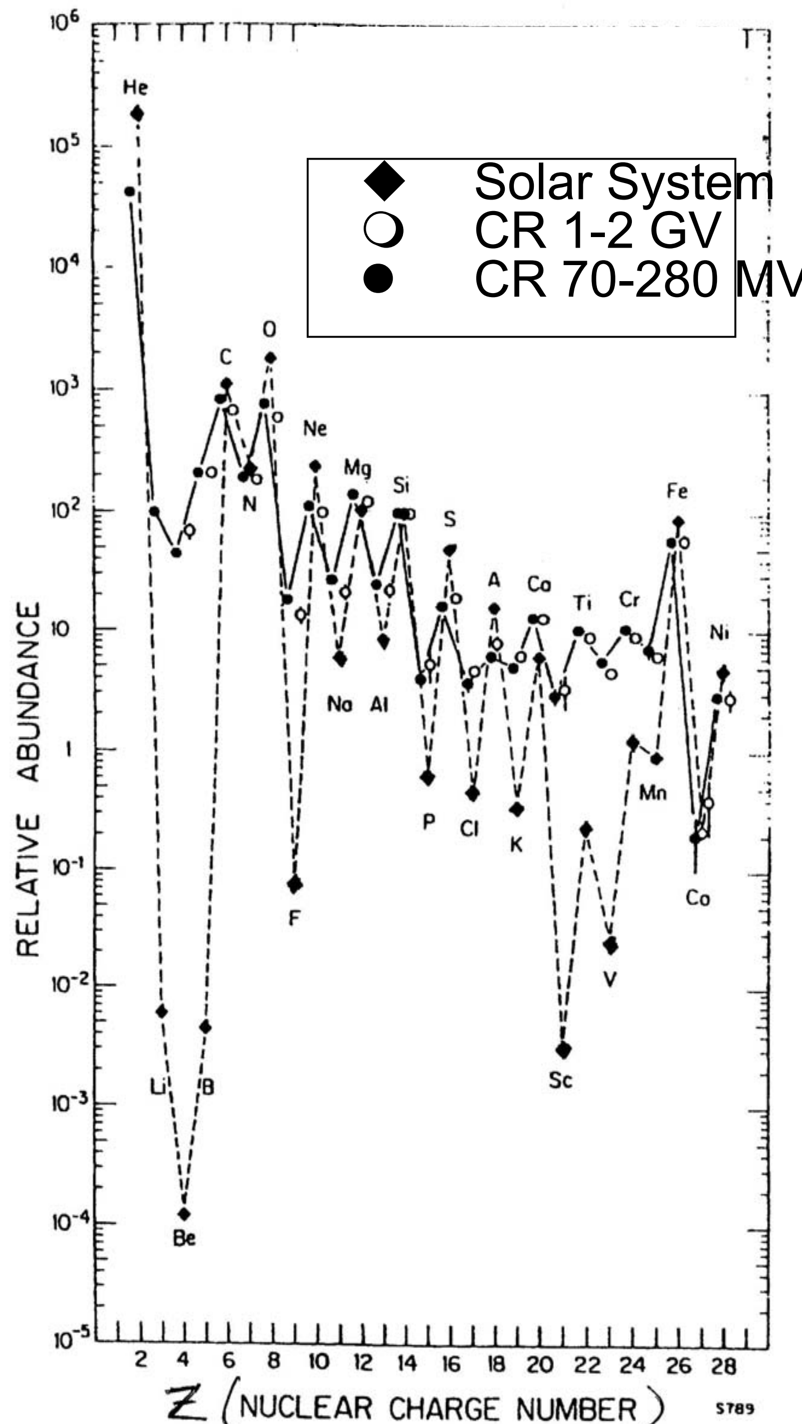
- Cosmic Rays spectrum follows a power law E^{-x} $x = 2\text{-}3$.
- Protons Dominant Component:
  protons 89%, electrons 1%.
  He 5% of protons flux at 10 GeV
  p- ~ 10^{-3} % of proton flux
- Ordinary matter (p,He,electrons): backgrounds.
- Heavy Ions measurements to constrain propagation/acceleration model
- New physics:Antimatter and gamma rays, anti-D signal



Astroparticle studies embedded in Cosmic Ray Physics

Cosmic Ray Composition

- ***Chemical composition of CR similar to solar elements, but:***
  1) ***Li, Be, B** enriched*
  2) *Sc, Ti, V, Cr, Mn enriched*
- ***These ions (apart** Li**) are not produced in primordial nucleo-synthesis, nor in stars***
  1) produced by *spallation reactions* between p, α with C, N, O in *supernovae explosions*
  2) *spallation* from Fe, produced in *interstellar medium*



Introduction - GCR Propagation

- ***GCRs must propagate through ISM before they can reach us***
- ***Diffusive transport equations describe both Propagation and Acceleration***
- ***Current models are:***
  - *Leaky Box Model (LBM): GCRs propagate freely in the containment volume, constant density in volume (often good enough)*
  - *Diffusion Halo Models (DHM): diffusion operator not constant, thus density of CRs decreases with distance from the galactic plane, more realistic!*
- ***Isotopes like ^{10}Be can be used to study propagation models, they serve as 'propagation clocks'***

Cosmic Ray Propagation

- **The goal is to achieve a reliable physical description of the CR propagation through the Galaxy**
- **From the measured fluxes in the heliosphere derive source composition, injection spectra & galactic parameters**
- **Reliable propagation model is needed for accurate background evaluation for rare signal searches in CR**
- **Particularly useful measurements to validate propagation models and to constrain their free parameters are flux measurements in a wide energy range of**
  - **Primary (injected at CR sources)**
  - **Secondary (products of CR interactions with the ISM)**
  - **Radioactive (provide time information)**

Common Need Cosmic Ray

Particle Propagation & EAS Simulations:

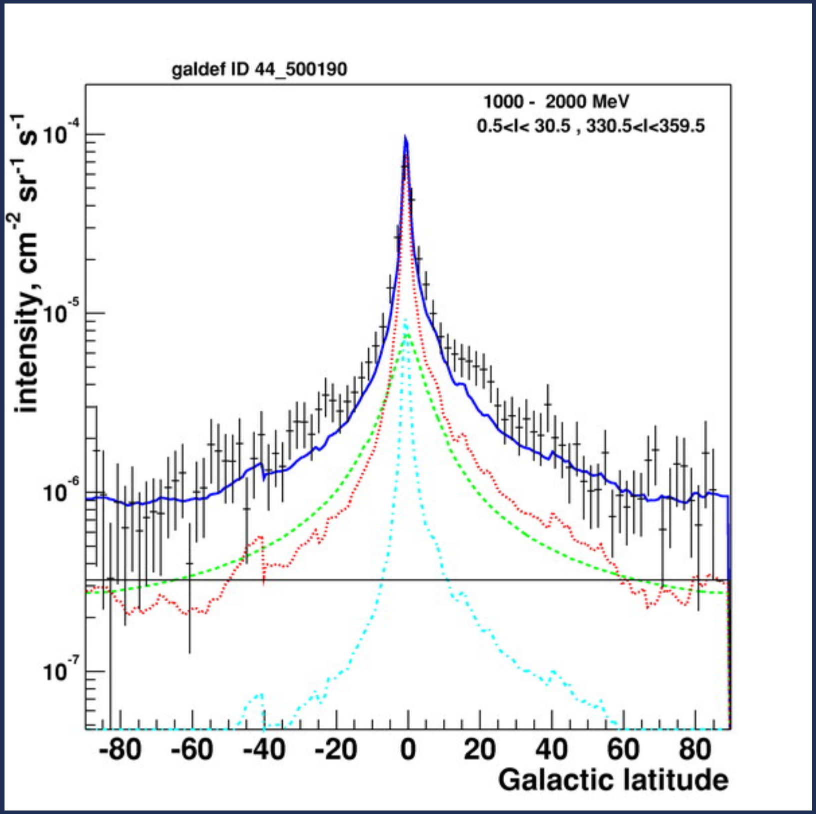
- Presently, systematic uncertainties of EAS experiments dominated by poorly known properties of hadronic interactions

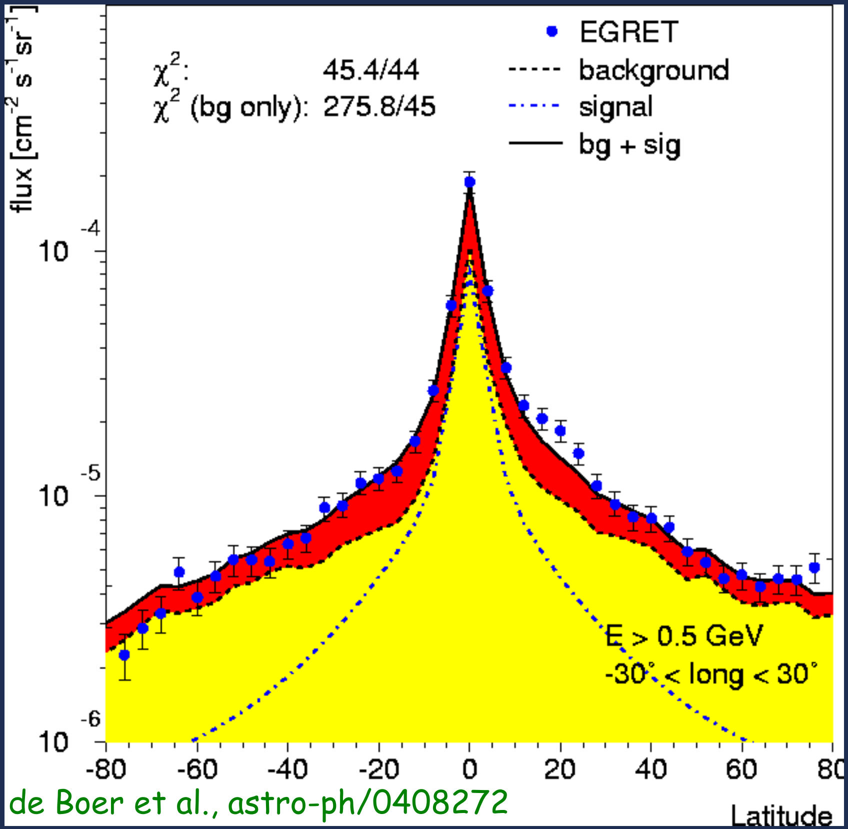
→ Accelerator data and collaborations with HEP community required

- High- & low energy interaction models crucial
- Muon- and Neutrino propagation in matter
- New fast EAS simulation techniques to be developed

Kampert

Backgound Modelling





Optimized astrophysical model leaves no room for new component.

G.Sigl

In contrast, conventional astrophysical model allows for a dark matter annihilation component.

PROJECT TASKS

4. Physics and new observable (theory interface)

4.1 Interconnect results from different experiments in order to search for common (astrophysical or other) sources and mechanisms for observed radiation or particles (catalogue as deliverable, books ..)

4.2 Evaluate dark matter potential of discovery for different observatories and correlate with direct searches.

4.3. Correlate with accelerator searches and develop the strategies after possible discoveries.

4.4. Evaluate new sites, (for instance Concordia in Artica) for Deployment of new cosmic ray observatories.

PROJECT TASKS

4. Physics and new observable (theory interface) (continued)

4.5 Develop better modelling for cosmic ray propagation in space, atmosphere, earth, ice and sea water detector.

4.6 Measure and develop models for Ultra-High-Energy.

4.7. Create collaborations with particle physicist in order to obtain better models for particle interactions at high energies.

4.8. Define a possible common strategy for the next generation experiments in view of the 7th program with an eye on new European Countries.

LHC & neutralino

HEP-PH/0306219
Battaglia,,Ellis, De Roeck,Gianotti,Olive,Pape

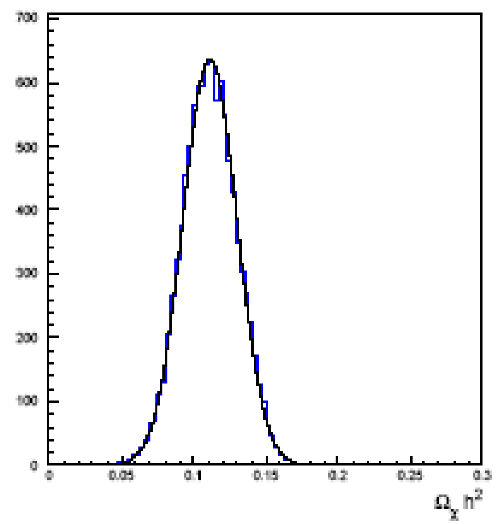
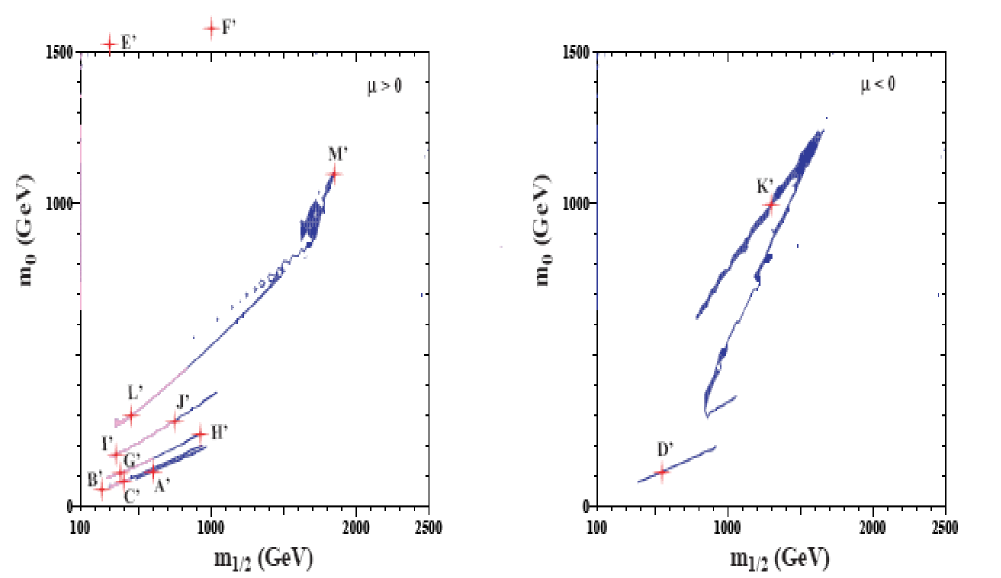
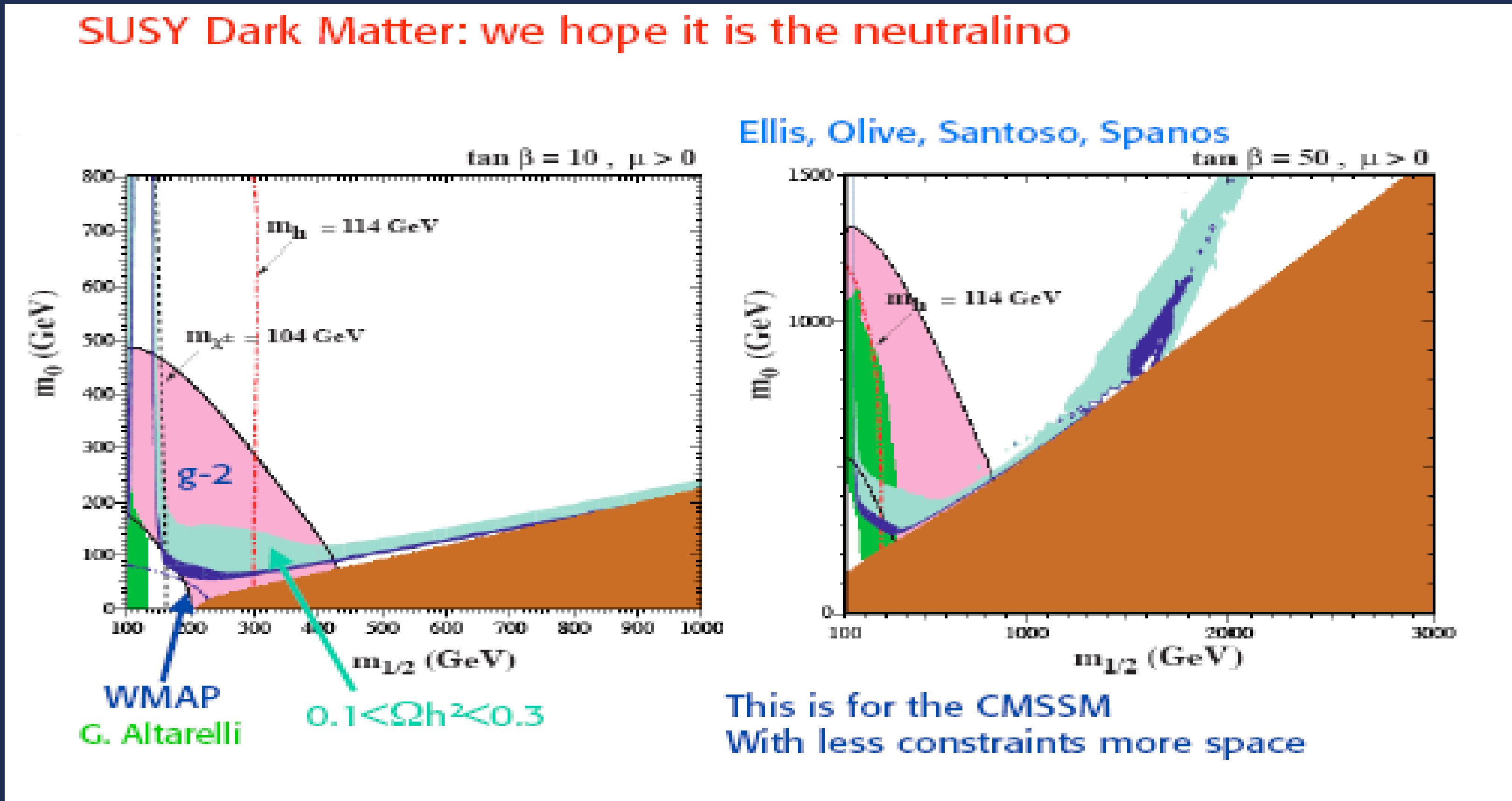


Figure 13: *The estimated accuracy with which $\Omega_\chi h^2$ could be predicted on the basis of LHC data for the updated benchmark point B, using the projected experimental errors reported in [40], a fit to* ISASUGRA 7.67 *parameters and the* Micromegas *code. We find similar results using* SSARD.



LHC & neutralino



Presented from A.Masiero

CONCORDIA

Concordia is a scientific base i artic continent, originated from a Italian French collaboration, is one of the key point of European research. T = -84 °C to – 30 °C.

It is located at 1000 Km from the cost. The wind is weak (<18 knots).

Memorandum and Understanding

- A proposal for a memorandum & understanding agreement among different countries is in preparation
- Carlo Bosio has prepared a draft .
- A discussion is need among few people

representatives of countries to circulate

It before Rome meeting and finalize there.

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- CONCLUSIONS