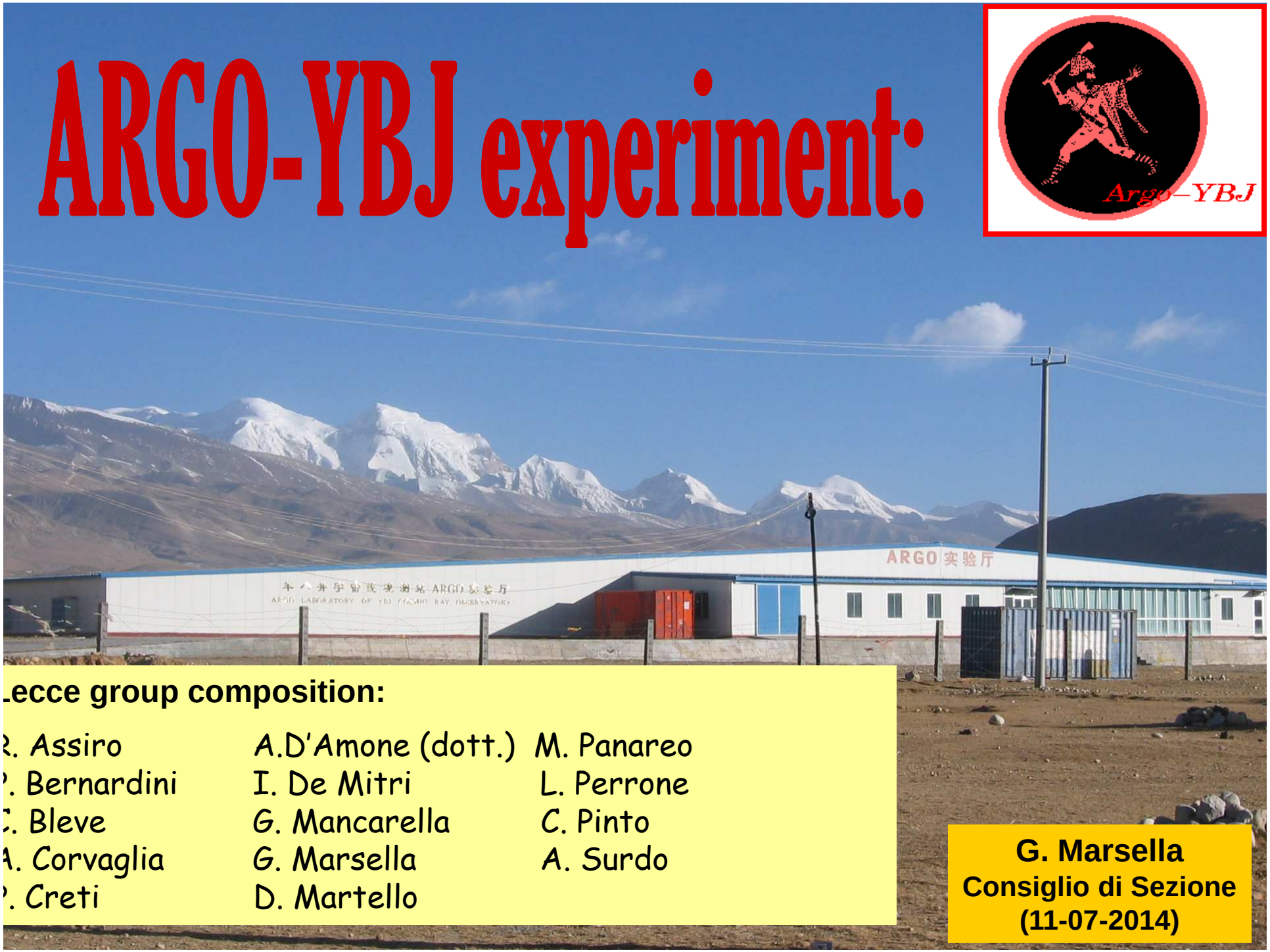
ARGO-YBJ experiment:



Lecce group composition:

R. Assiro	A.D'Amone (dott.)	M. Panareo
P. Bernardini	I. De Mitri	L. Perrone
C. Bleve	G. Mancarella	C. Pinto
A. Corvaglia	G. Marsella	A. Surdo
P. Creti	D. Martello	

G. Marsella

Consiglio di Sezione (11-07-2014)

Detector story

Detector completely installed since 2007
(central carpet + guard-ring, 153 clusters)

Data taking

Since July 2006 with the central carpet
Since November 2007 with the guard-ring

Analog charge readout installed and in data taking:

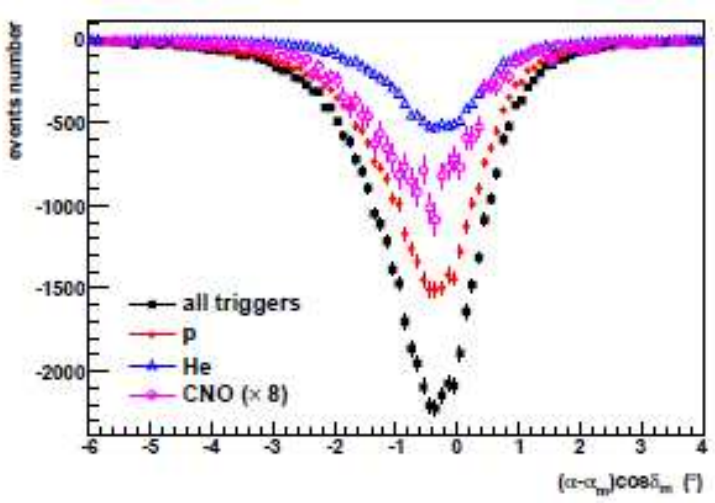
- on central carpet (130 cl) since Nov. 2009
- on the guard ring (monitor/calibration) since Sep. 2011

February 2013 Stopped activity in YBJ

RISULTATI

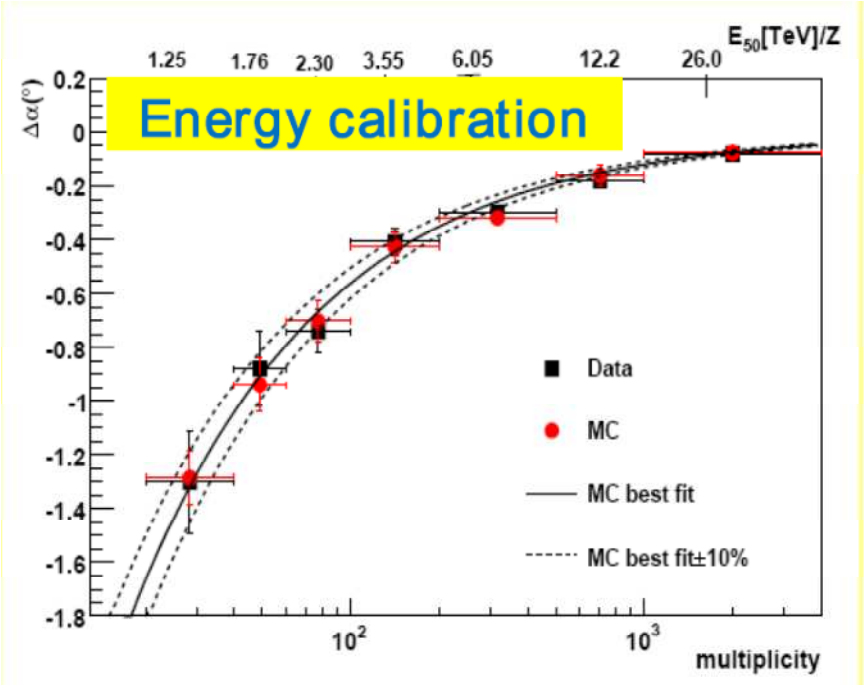

The shadow of the Moon

E-W displacement: energy scale calibration



Contribution of different primaries to the Moon shadow (Nstrip>100)

Statistical Significance of the maximum deficit: ~71 s.d.



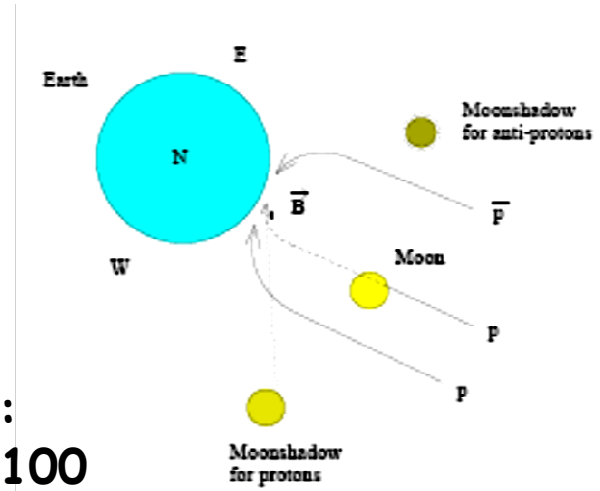
The energy scale uncertainty is estimated to be at level of 13% in the rigidity range (1-30) TeV/Z

Published in:

PRD 84 (2011) 022003


Cosmic rays

Antiproton/proton ratio



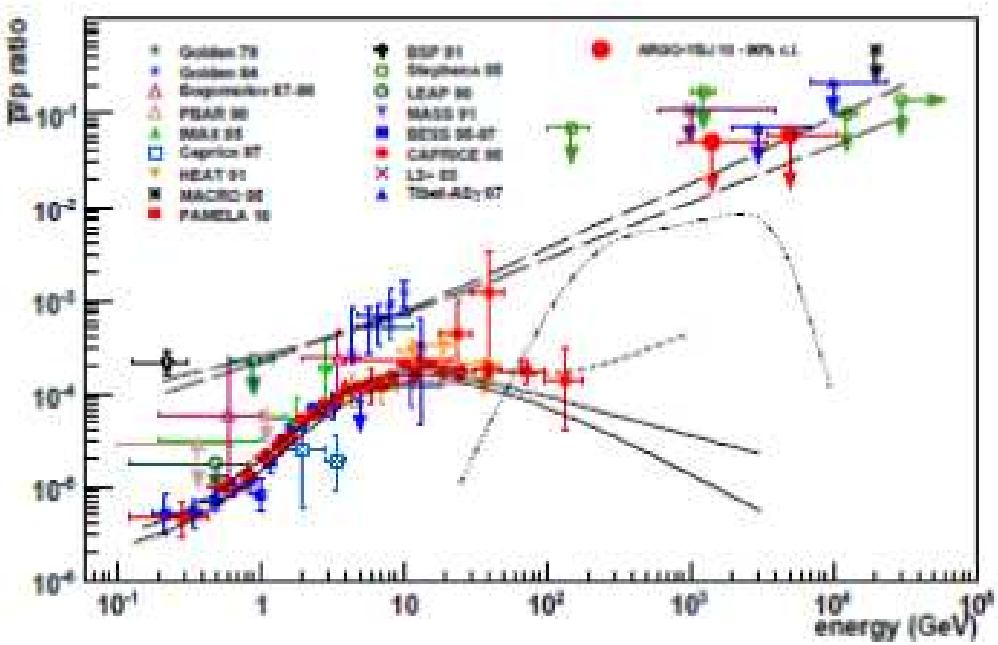
p and anti-p Moon shadow: Symmetry

⇒ Measurement of proton/antiproton ratio

From MC, the fraction of protons to all cosmic rays:
73% for 100>nHit>40 71% for nHit > 100

Results: 40<nHit<100 (median E ~1.4 TeV): 90% C.L. Upper limit 5%

100<nHit (median E ~5 TeV): 90% C.L. Upper limit 6%



1. Dashed lines: antistars models for different rigidity, 0.6, 0.7 respectively
2. Dotted line, the heavy DM particle contribution.

Published in:
PRD 85, 022002 (2012)

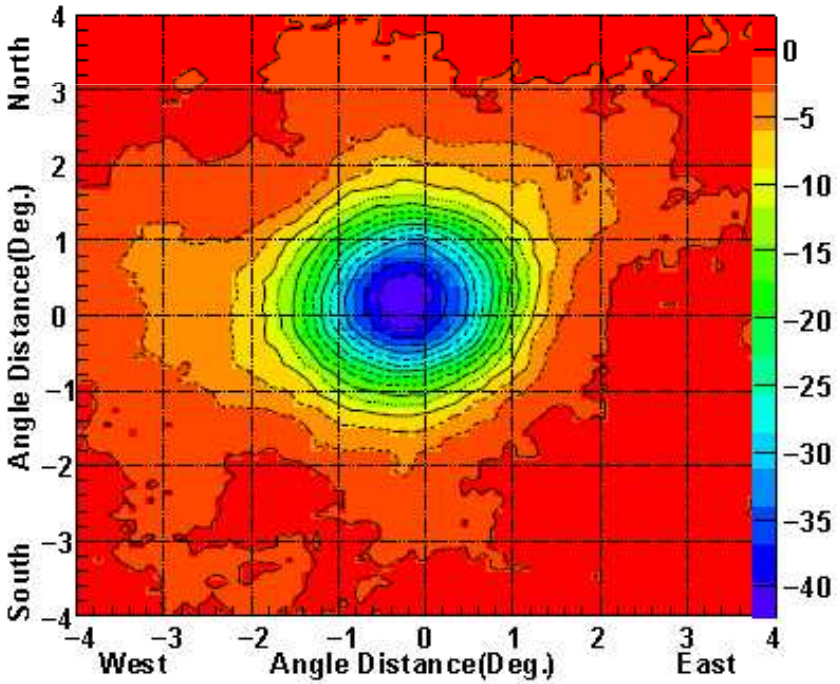
The Sun shadow

✓Measuring the Interplanetary Magnetic Field

✓Exploring the Solar Magnetic Field

✓The deficit significance and position correlated with solar activity

Data set 2007 – 2009: particularly quiet phase between 2 solar cycles

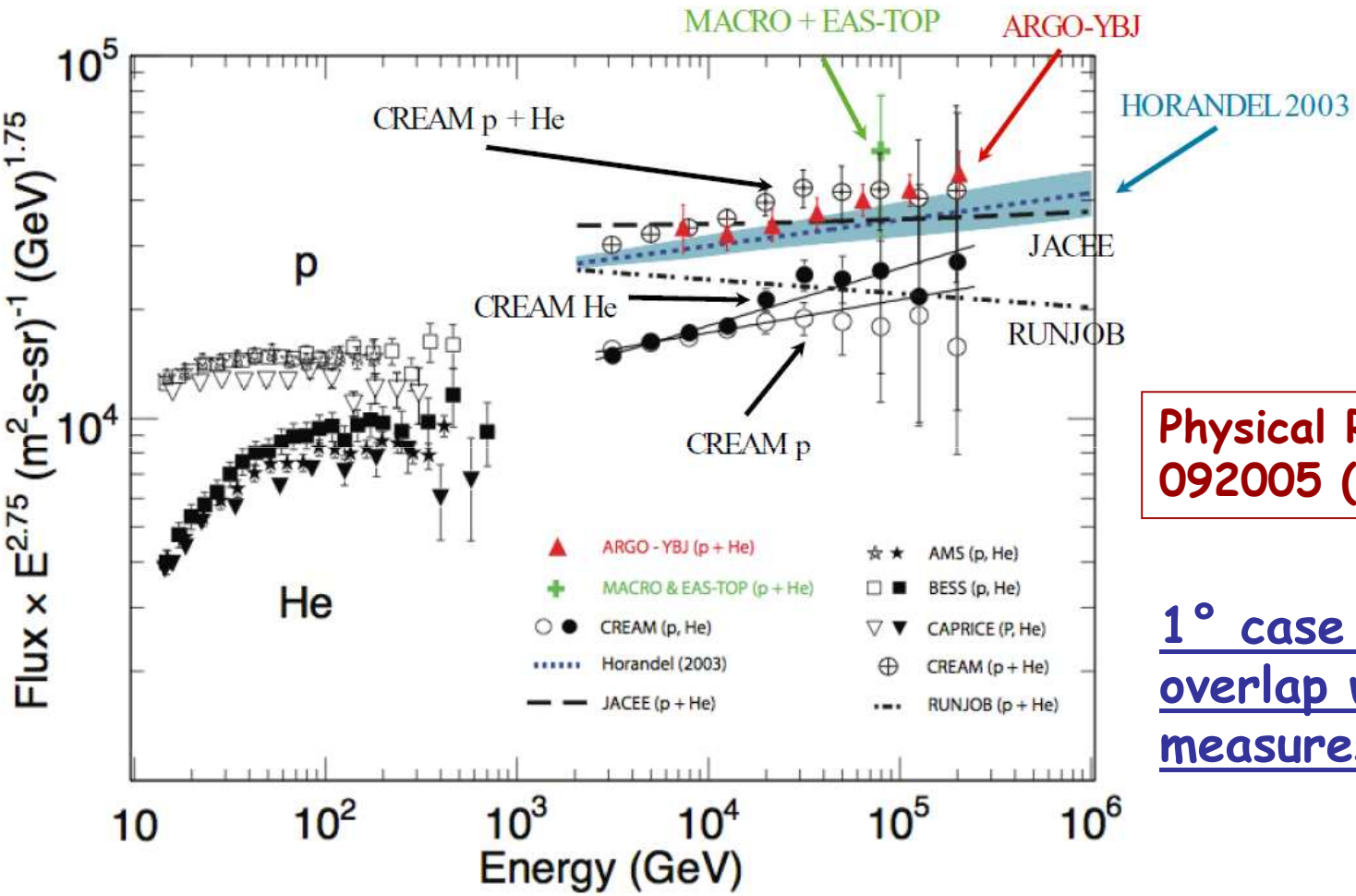


$N_{hit} > 100$ Zenith < 50°

- Observed N-S displacement of the shadow from the Sun position mostly due to the IMF (measuring such field)
- Modulation caused by SMF (depending on the solar activity)

Astrophysical Journal 729 (2011) 113

The light component spectrum

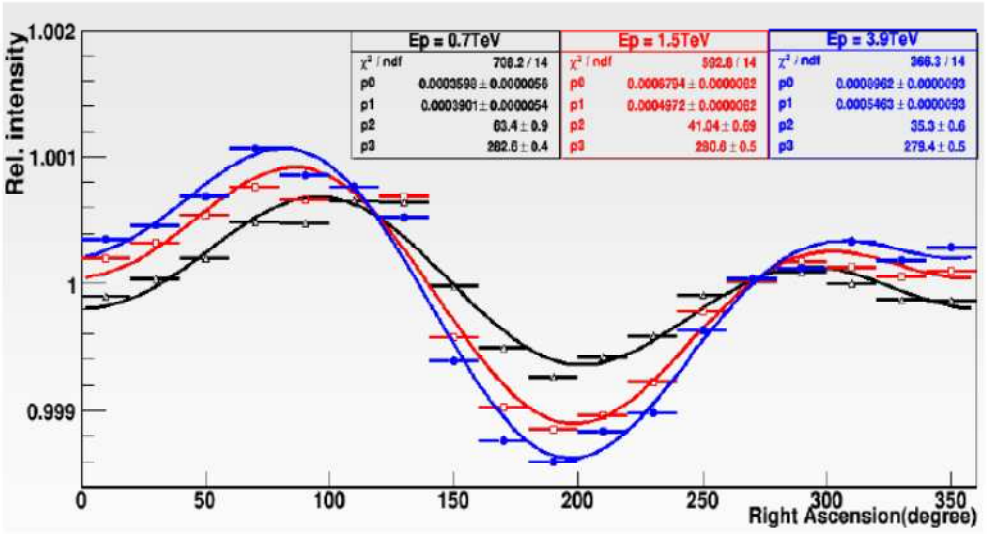


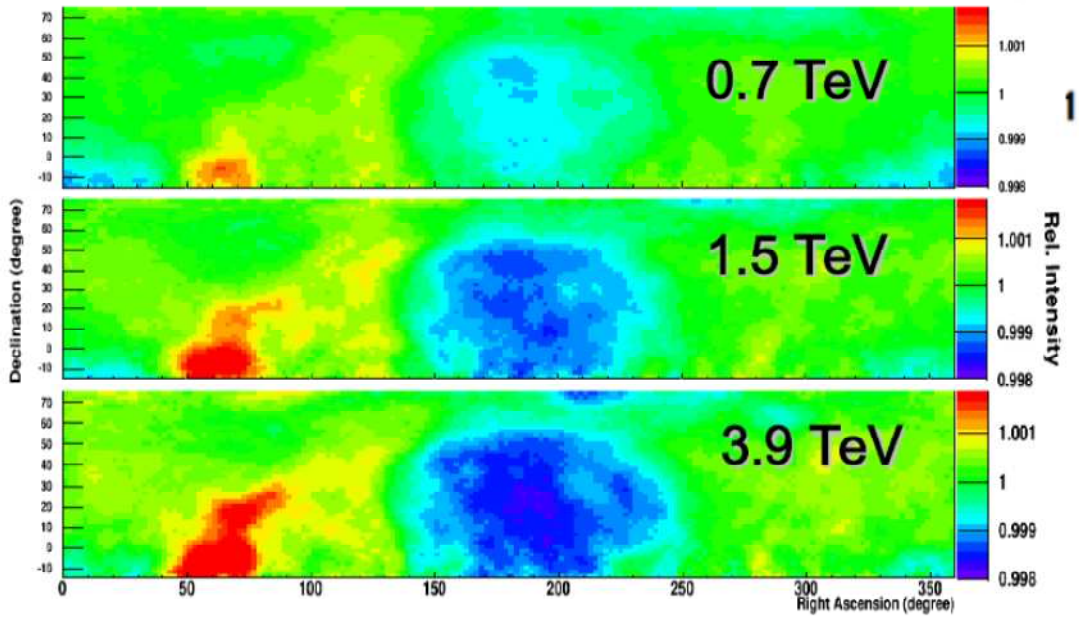
Physical Review D 85, 092005 (2012).

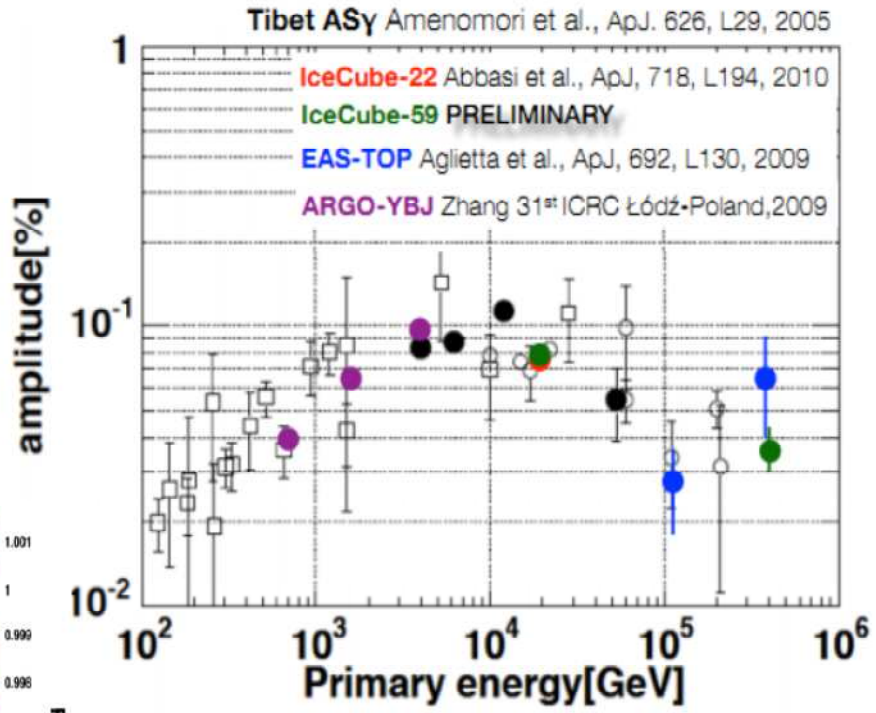
1° case of a wide overlap with direct measures !

Unfolding the energy spectrum by a Bayesian approach

CR anisotropy vs energy







Medium Scale Anisotropy in the TeV cosmic ray flux obseved by ARGO-YBJ.Phys. Rev. D 88 (2013) 082001.


γ-astronomy

Mrk421

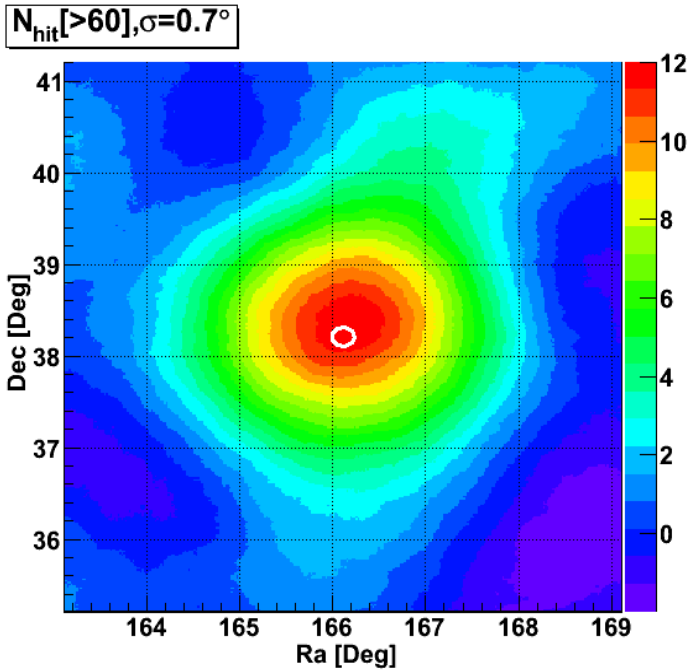
AGN monitored by ARGO-YBJ on a long time scale.

Several big flares have been observed :

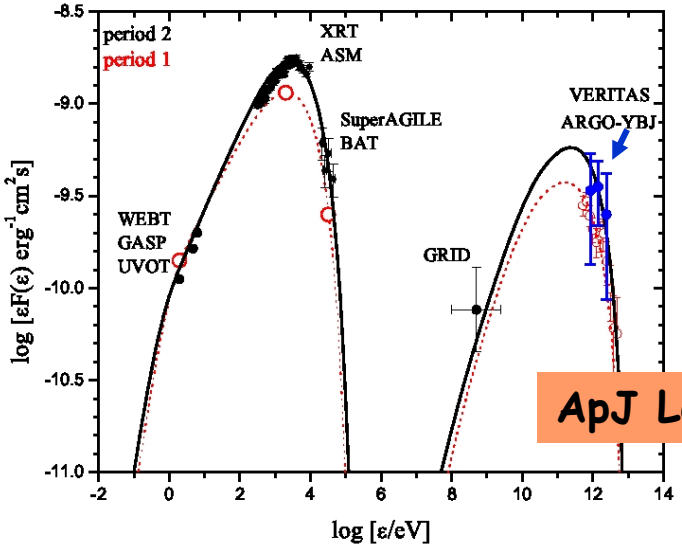
1. June 2006
2. October 2006
3. Feb/Mar 2008
4. June 2008
5. June 2009
6. Feb/Apr 2010

The total significance is 12σ (in ~2.5 y)

⇒ Mrk421 best candidate for ARGO-YBJ to study the Blazar emission mechanism, flux variability, correlation with X-ray flux, evolution of SED.



June 2008 flare

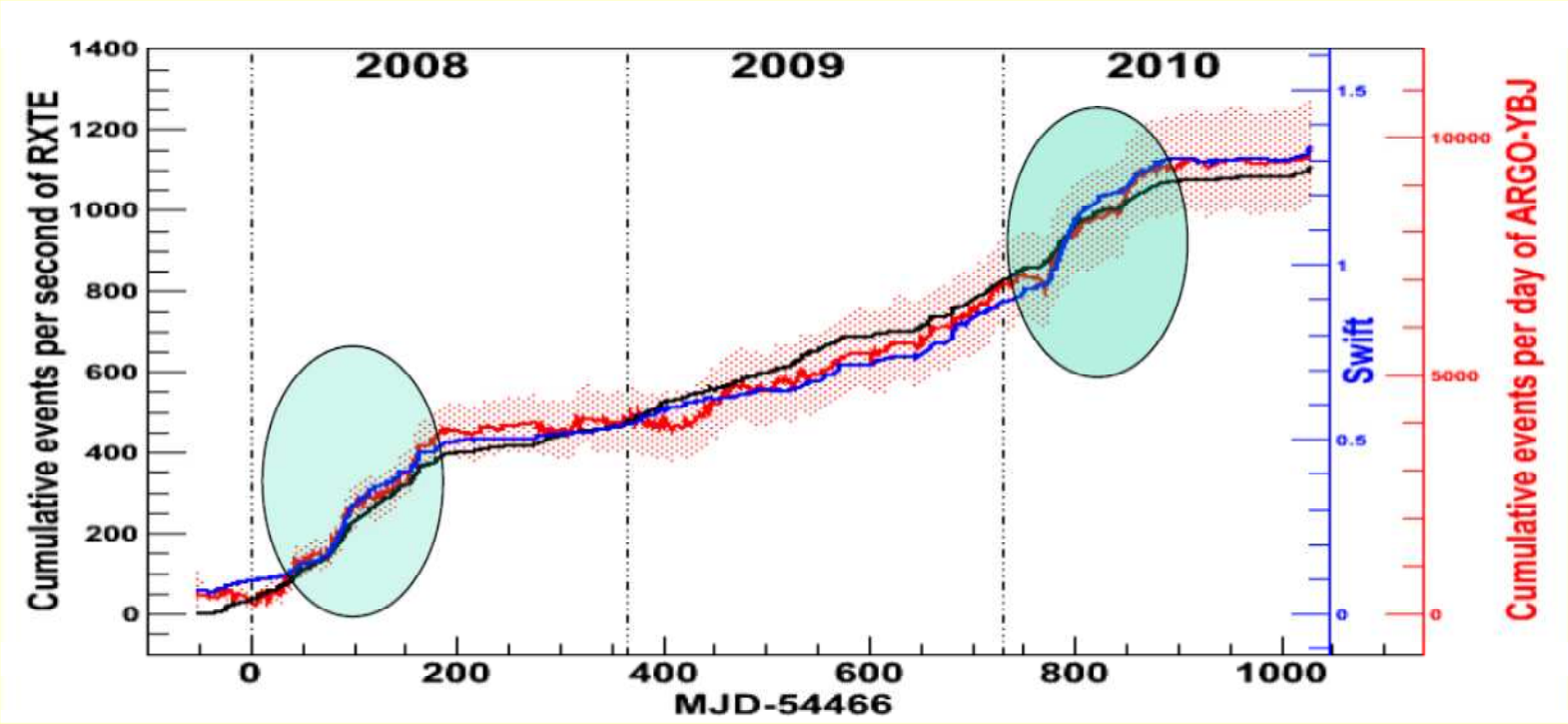


ApJ Lett. (2010)

Mrk421 long-term monitoring (Bartoli et al. ApJ 734 (2011) 110)

- ARGO-YBJ cumulative light curve (>TeV) compared with Swift and Rossi/RXTE data.
- Good correlation between TeV/X-ray data.
- Active and quiet periods are observed.

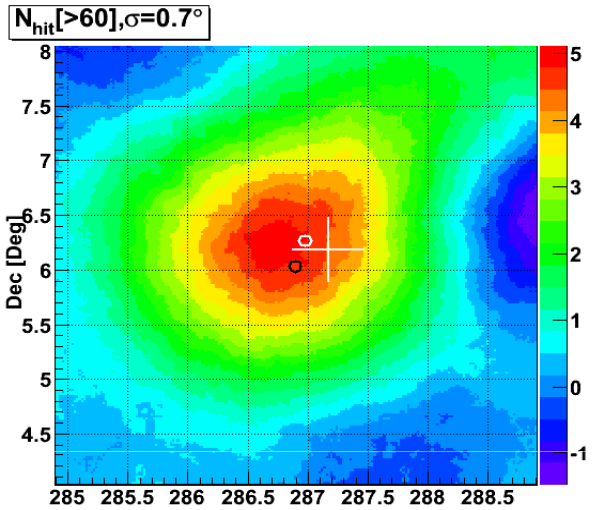
RXTE/ASM 2-12 keV
Swift/BAT 15-50 keV
ARGO-YBJ TeV



MGRO1908+06

Astrophysical Journal 760 (2012) 110

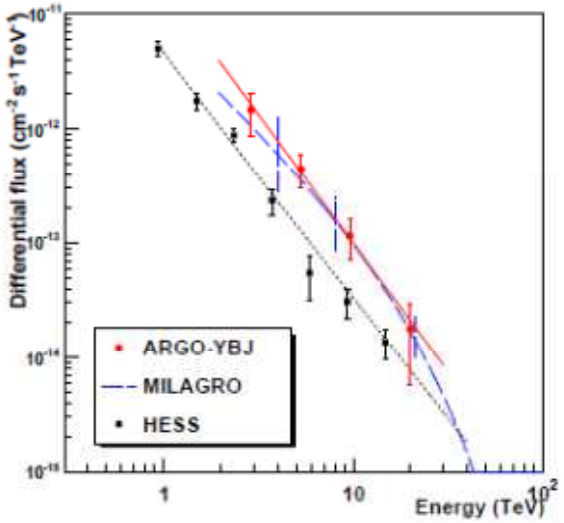
- **Discovered by Milagro, confirmed by HESS and VERITAS.**
- **Associated to the LAT pulsar with nebula PSR J1907.5+0602**
- **HESS result: extended source (0.34 deg), spectral index -2.1 up to 20TeV, no cutoff. Integral flux: 17%Crab for E>1TeV**
- **Milagro result: compatible with point-like, spectrum cutoff (~14 TeV) and a flux higher than HESS result.**



ARGO-YBJ results

- **Consistent to HESS for the extension diameter: σ_{ext} = (0.50 ± 0.35) degree.**
- **Energy spectrum by ARGO-YBJ:**

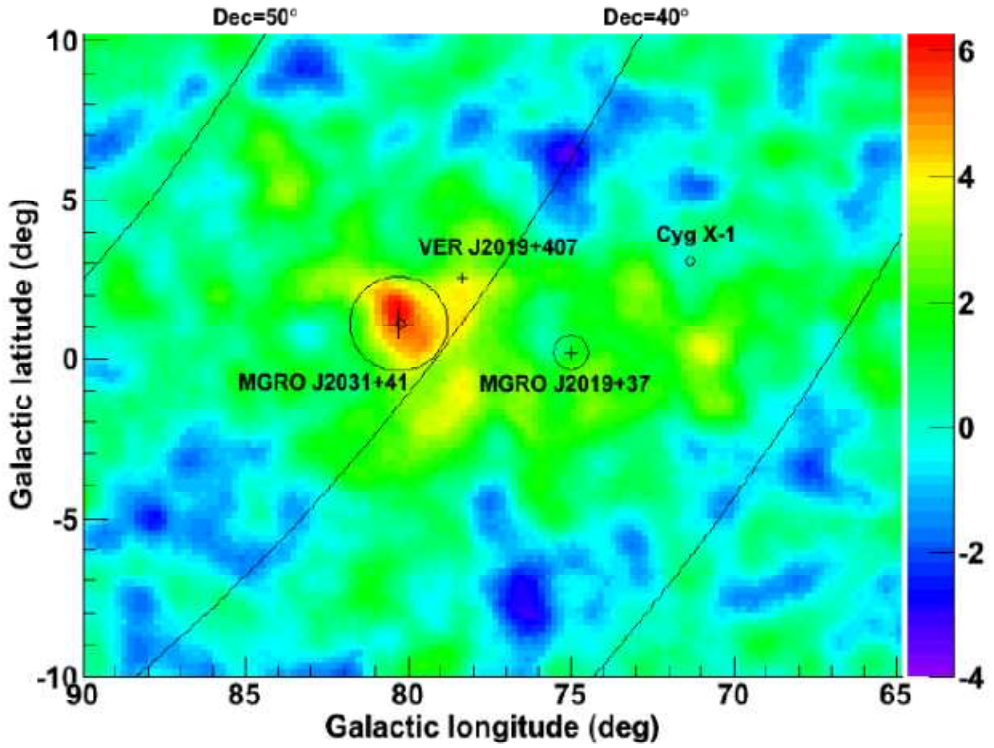
  in agreement with Milagro, marginally consistent with HESS



$$dN/dE = (2.2 \pm 0.4) \times 10^{-13} \, (E/TeV)^{-2.3 \pm 0.3} \; cm^{-2} \; s^{-1} \; TeV^{-1}$$

ARGO-YBJ result from Cygnus region

- MGRO J2031+41/TeV J2032 +4130 **6.3 s.d.**
- No signal from MGRO J2019+37

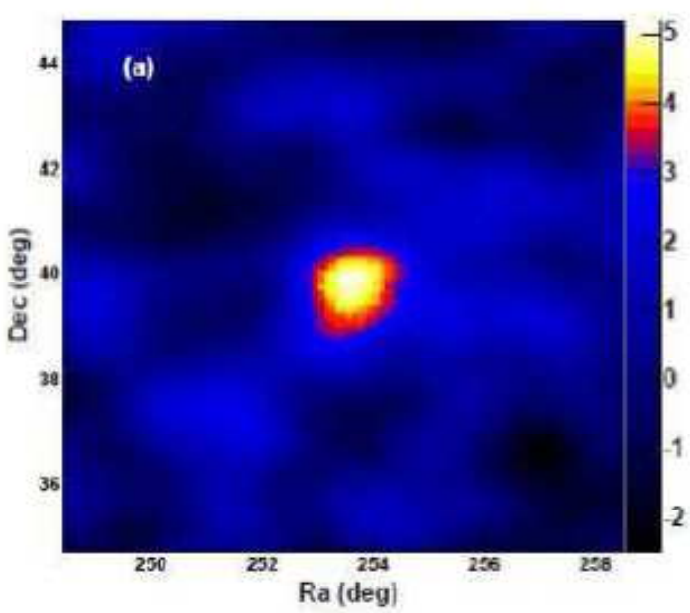


Astrophysical Journal Letters 745 (2012) L22

Mrk 501

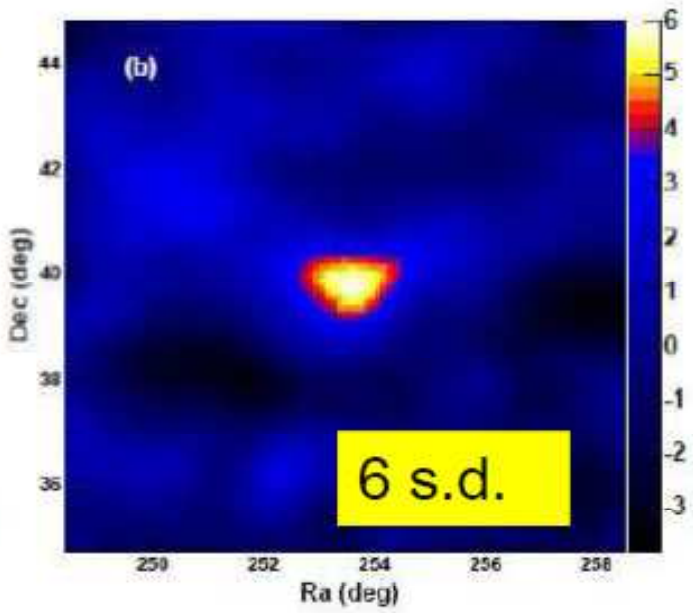
Astrophysical Journal 758 (2012) 2

Quasi-steady emission
3.2 years
August 2008 - October 2011



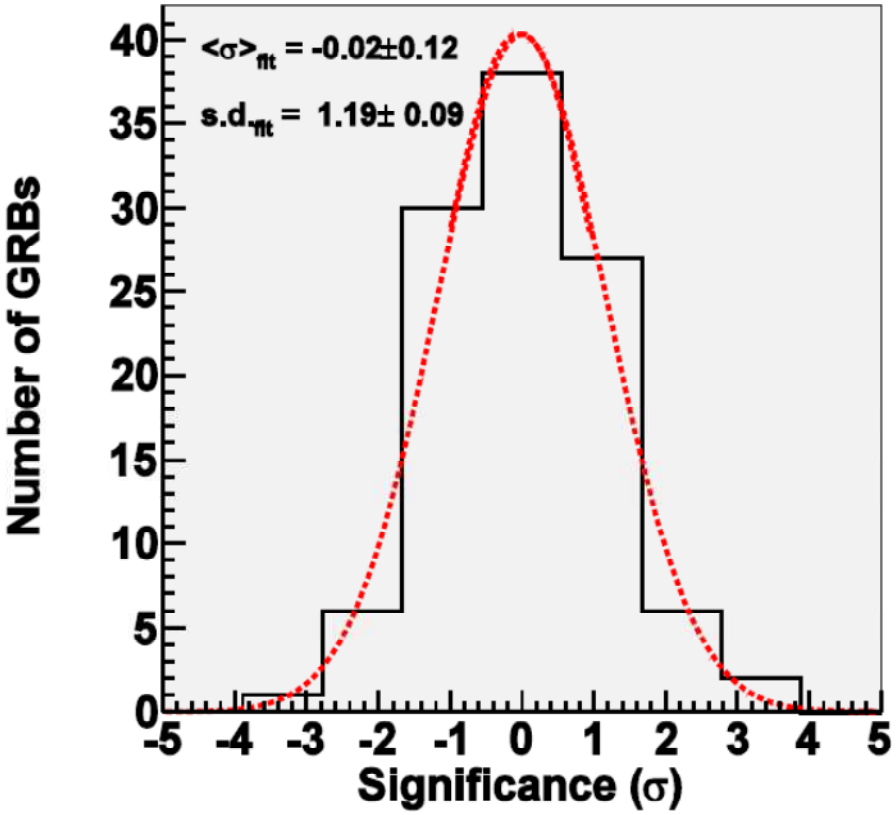
Average flux: 0.3 Crab

Flare : 17 Oct – 22 Nov 2001



Flare flux : 2.1 Crab

Search for GRBs in the GeV-TeV range



110 GRBs in the ARGO f.o.v. from Dec 2004 to Apr 2011

- With known redshift: 18
- Discovered by Fermi/GBM: 26
- Detected by Fermi/LAT: 4

- Long duration GRBs (>2s): 97
- Short duration GRBs (≤2s): 13

No evidence of coincident signal over the GRB T90 duration

In stacked analysis no evidence for any integral effect

ApJ 699 (2009) 1281-1287
Astroparticle Physics 32 (2009) 47-52

CR physics: analysis of Lecce group

4 contributing papers presented by components of the Lecce group in the 33rd International Cosmic Ray Conference (Rio de Janeiro, 2013).
For these items the analysis is in progress or near to be completed.
At least one paper to be published for each one is planned by our group:

1) Evidence of geomagnetic effect on extensive air showers in the ARGO-YBJ data P. Bernardini, G. Mancarella, L. Perrone, S.N. Sbano, G. Zizzi on behalf of the ARGO-YBJ Collaboration
2) Study of the time structure of EAS particles with ARGO-YBJ A.K. Calabrese Melcarne, G. Marsella, D. Martello, L. Perrone, S.N. Sbano on behalf of the ARGO-YBJ Collaboration (poster, CR-EX)
3) Mass composition and hadronic interaction studies with ARGO-YBJ A. D'Amone, I. De Mitri, G. Mancarella, M. Panareo, and A. Surdo on behalf of the ARGO-YBJ Collaboration (oral, CR-EX)
4) Study of the shower front structure at few meters from the core with ARGO-YBJ P. Bernardini, A. D'Amone, I. De Mitri, G. Marsella, and A. Surdo on behalf of the ARGO-YBJ Collaboration (poster, CR-EX)

1) Azimuthal modulation and Geomagnetic field

Evidence of a geomagnetic effect on extensive air showers detected with the ARGO-YBJ experiment.
Phys. Rev. D 89 (2014) 052005.

The Geomagnetic field acts on the (secondary) charged particles of the EASs, producing a lateral displacement.

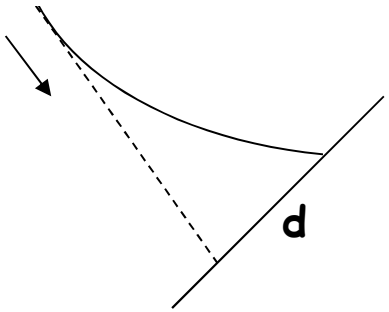
This is not negligible with respect to the Coulomb scattering when the shower is young ⇒ increase of effect for high altitude observations.

Different density and space/time pattern of charged particles
⇒ different trigger efficiency of EAS detectors
⇒ azimuthal modulation (in ARGO-YBJ data)

Average shift (d) of a charge in the shower plane:

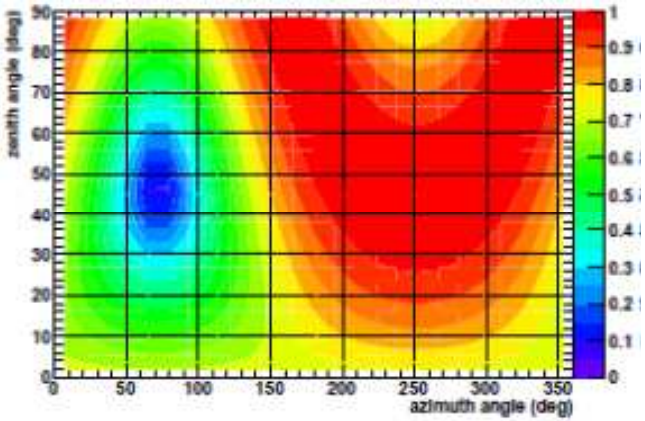
$$d = \frac{qh^2 B \sin\chi}{2E_e \cos^2\theta}$$

where χ is the angle between B and the particle v,
q: electric charge, h: average verticle height,
E_e: average energy, θ: zenith angle

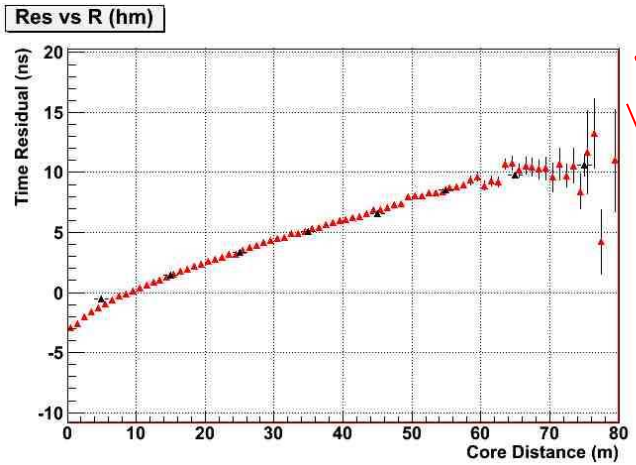


Azimuthal distribution:

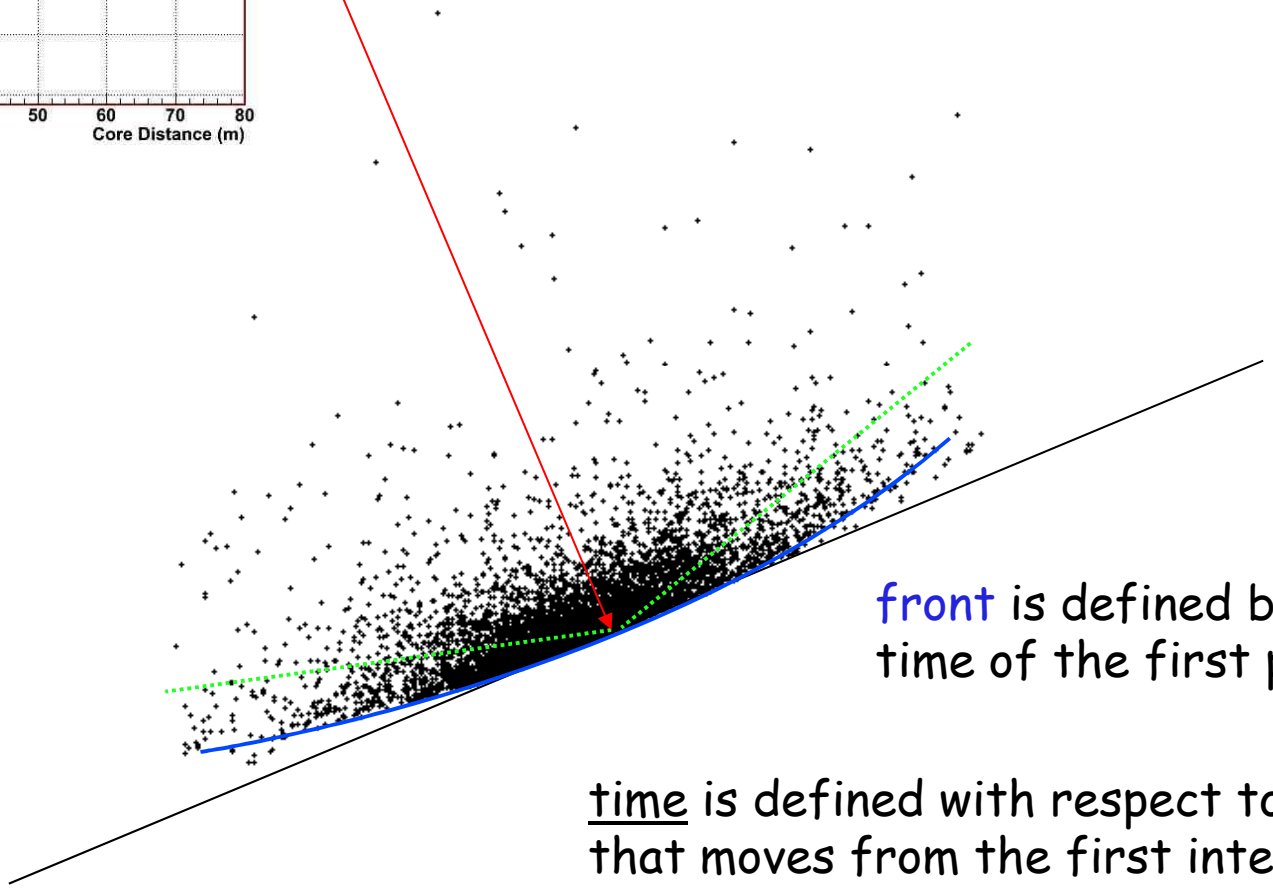
$$\frac{dN}{d\phi} = N_0 \left(\alpha - \beta \sin^2\chi\right)$$



SHOWER FRONT TIME STRUCTURE STUDIES



"conicity" results from the combination of the curvature of the front and the arrival time distribution of shower partic

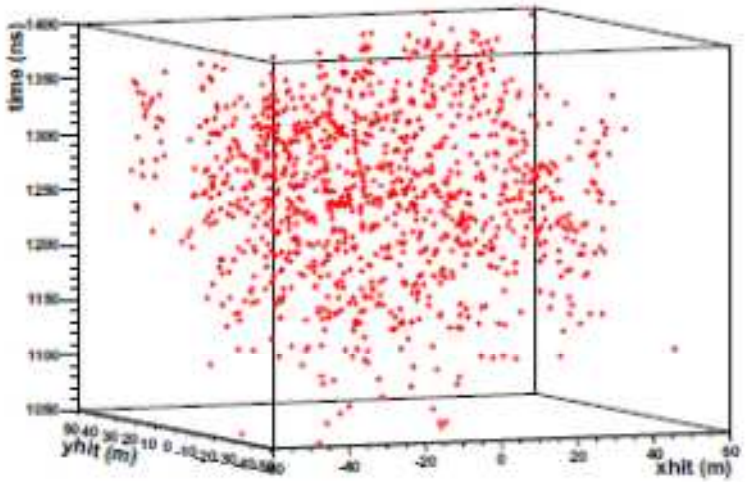


front is defined by the arrival time of the first particles

time is defined with respect to a plane that moves from the first interaction point ground at the speed of light

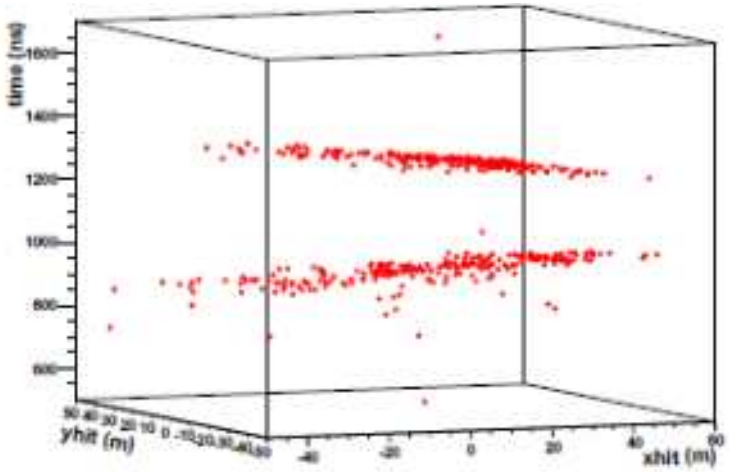
EAS phenomenology

The detailed shower topology and time structure detection allow to investigate a variety of shower phenomenologies



Wide shower

(peculiarity in longitudinal shower development?)



Double front event

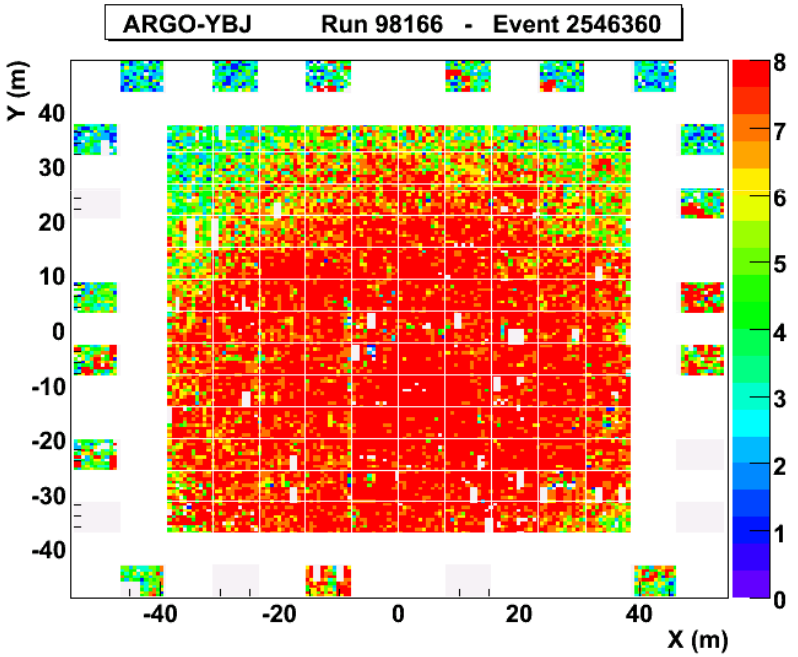
(exotic physics?)

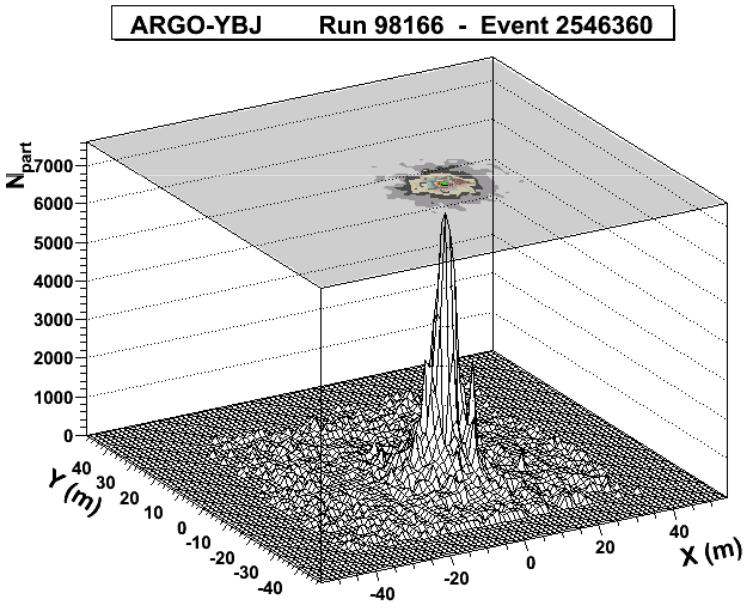
2) Hadronic interaction studies

RPC analog charge readout:

(a) extention of Energy range up to ~ PeV

(b) measure of particle densities up to ~10^4 (strip info saturated)





Analysis of Analog data useful to investigate hadronic interactions

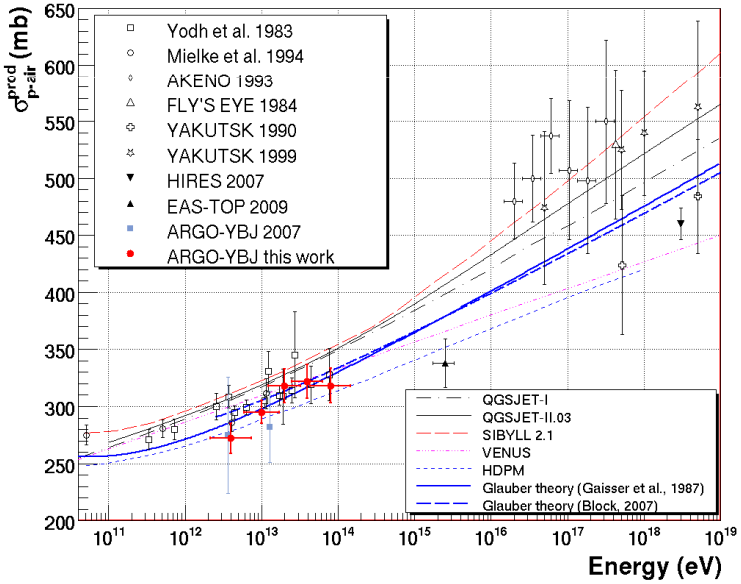
p-air (and p-p) cross section measurement

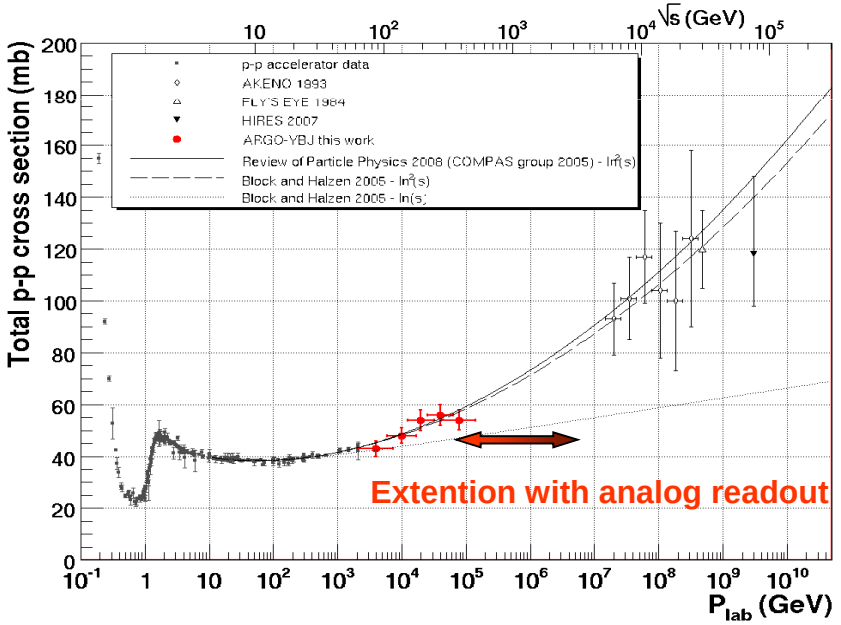
Main objective: estend the p-air (and total p-p) cross section measurement of at least one decade in Energy (through shower rate attenuation as a function of zenith angle, i.e. atmospheric tickness)

Already measured up to ~ 100TeV (Lab E)

ARGO-YBJ Coll.

Phys. Rev D 80, 092004 (2009)

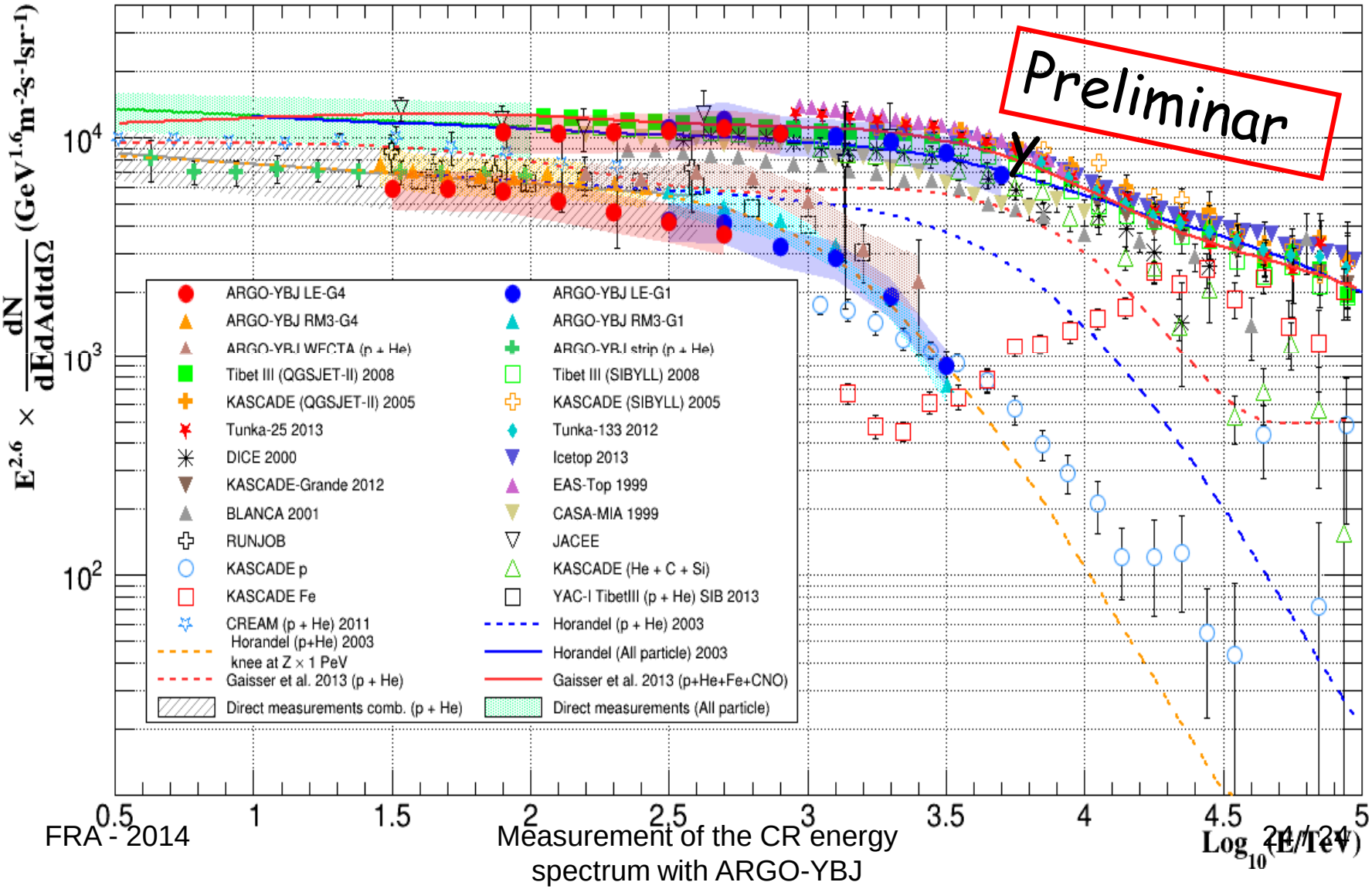




✓ No data from accelerators available at these energies

✓ The $\log^2(s)$ asymptotic behaviour is favoured

The overall picture



Last Conference contribution by Lecce group

P. Bernardini, G. Mancarella, L. Perrone, S.N. Sbano, G. Zizzi on behalf of the ARGO-YBJ Collaboration" **Evidence of geomagnetic effect on extensive air showers in the ARGO-YBJ data**", XXXIIIrd ICRC, 2013, Rio de Janeiro (Brazil)

A.K. Calabrese Melcarne, G. Marsella, D. Martello, L. Perrone, S.N. Sbano on behalf of the ARGO-YBJ Collaboration "**Study of the time structure of EAS particles with ARGO-YBJ**", XXXIIIrd ICRC, 2013, Rio de Janeiro (Brazil) Poster

A. D'Amone, I. De Mitri, G. Mancarella, M. Panareo, and A. Surdo on behalf of the ARGO-YBJ Collaboration," **Mass composition and hadronic interaction studies with ARGO-YBJ",** XXXIIIrd ICRC, 2013, Rio de Janeiro (Brazil)

P. Bernardini, A. D'Amone, I. De Mitri, G. Marsella, and A. Surdo on behalf of the ARGO-YBJ Collaboration," **Study of the shower front structure at few meters from the core with ARGO-YBJ**", XXXIIIrd ICRC, 2013, Rio de Janeiro (Brazil) Poster

A..Surdo on behalf of the ARGO-YBJ, "**Hadronic interactions and Cosmic Ray mass composition studied by ARGO-YBJ",** EPS-HEP 2013, Stockholm (Sweden)

I. De Mitri (on behalf of the ARGO-YBJ coll.)"Cosmic Ray Physics with ARGO-YBJ" presented at the"4th International Workshop on Air Shower Detection at High Altitude" Naples, January 31- February 1, 2013

I. De Mitri (on behalf of the ARGO-YBJ coll.) "Latest Results on Cosmic Ray Physics from the ARGO-YBJ experiment" presented at the "RICAP 2013 - Roma International Conference on Astroparticle Physics"
Rome, May 22-24, 2013

ARGO Papers

10) ARGO-YBJ constraints on very high energy emission from GRBs. Astroparticle Physics 32 (2009) 47.

9) Search for Gamma Ray Bursts with the ARGO-YBJ detector in Scaler Mode. Astrophysical Journal 699 (2009) 1281.

8) Software timing calibration of the ARGO-YBJ detector. Astroparticle Physics 30 (2009) 287.

7) Scaler Mode Technique for the ARGO-YBJ detector. Astroparticle Physics 30 (2008) 85,

6) Layout and performance of the RPCs used in the ARGO-YBJ experiment. Nucl. Instr. Meth. A562 (2006) 92.

5) Results from the ARGO-YBJ test experiment. Astroparticle Physics 17 (2002) 151,

4) **The ARGO-YBJ experiment in Tibet** Il Nuovo Cimento 24C, 4-5, 739 (2001), Proc. of the "Chacaltaya Meeting on Cosmic Ray Physics", La Paz (Bolivia) July 23-27, 2000.

3) Results from the analysis of data collected with a 50 m ^{2} RPC carpet at YangBaJing Nucl. Instr. Meth. A456 (2001) 121, Proc. of the "5th International Workshop on RPCs and Related Detectors", Oct. 1999, Bari (Italy).

2) High Altitude test of RPCs for the ARGO-YBJ experiment Nucl. Instr. Meth., A443 (2000) 342,

1) ARGO-YBJ Detector and High Energy GRBs Astronomy & Astrophysics, Suppl. Series 138, 597 (1999), Proc. of the Workshop "Gamma Ray Bursts in the Afterglow Era" Nov. 1998 - Rome (Italy). Preprint: astro-ph/9904373

ARGO Papers

20) Highlights from the ARGO-YBJ experiment.
Nucl. Instr. Meth. A 661 (2012) S50.
19) Measurement of the cosmic ray antiproton/proton flux ratio at TeV energies the ARGO-YBJ detector. Physical Review D 85, 022002 (2012).
18) Observation of TeV Gamma Rays from the Cygnus region with the ARGO-YBJ experiment. Astrophysical Journal Letters 745 (2012) L22.
17) Early warning for VHE gamma-ray flares with the ARGO-YBJ detector. Nucl. Instr. Meth. A 659 (2011) 428.
16) Observation of the cosmic ray moon shadowing effect with the ARGO-YBJ experiment. Physical Review D 84 (2011) 022003.
15) Long-term monitor of Mrk 421 TeV emission using ARGO-YBJ experiment. Astrophysical Journal 734 (2011) 110.
14) Mean Interplanetary Magnetic Field Measurement Using the ARGO-YBJ Experiment. Astrophysical Journal 729 (2011) 113.
13) Gamma-Ray Flares from Mrk421 in 2008 observed with the ARGO-YBJ detector .Astrophysical Journal Letters 714 (2010) L208.
12) Proton-air cross section measurement with the ARGO-YBJ cosmic ray experiment. Phys. Rev. D 80 (2009) 092004.
11) Temperature effect on RPC performance in the ARGO-YBJ experiment. Nucl. Instr. Meth. A608 (2009) 246.

ARGO Papers

29) **Evidence of a geomagnetic effect on extensive air showers detected with the ARGO-YBJ experiment**.Phys. Rev. D 89 (2014) 052005.

28) **Energy spectrum of cosmic protons and helium nuclei by a hybrid measurement at 4300 m a.s.l**.Chinese Physics C 38 (2014) 045001.

27) **TeV Gamma-Ray Survey of the Northern Sky using the ARGO-YBJ detector** Astrophysical Journal 779 (2013) 27.

26) **Medium Scale Anisotropy in the TeV cosmic ray flux obseved by ARGO-YBJ**.Phys. Rev. D 88 (2013) 082001.

25) Observation of the TeV gamma-ray from the unidentified source HESS J1841-055 with the ARGO-YBJ experiment
Astrophysical Journal 767 (2013) 99.

24) Observation of the TeV gamma-ray source MGRO J1908+06 with ARGO-YBJ
Astrophysical Journal 760 (2012) 110.

23) Long-term monitoring of Mrk 501 for its very high energy gamma emission and a flare in 2011 October Astrophysical Journal 758 (2012) 2.

22) Light-component spectrum of the primary cosmic rays in the multi-TeV region measured by the ARGO-YBJ experiment.
Physical Review D 85, 092005 (2012).

21) Calibration of the RPC charge readout in the ARGO-YBJ experiment.
Nucl. Instr. Meth. A 661 (2012) S56.

- GRAZIE A TUTTI COLORO I QUALI HANNO CONTRIBUITO AL SUCCESSO DI QUESTO ESPERIMENTO