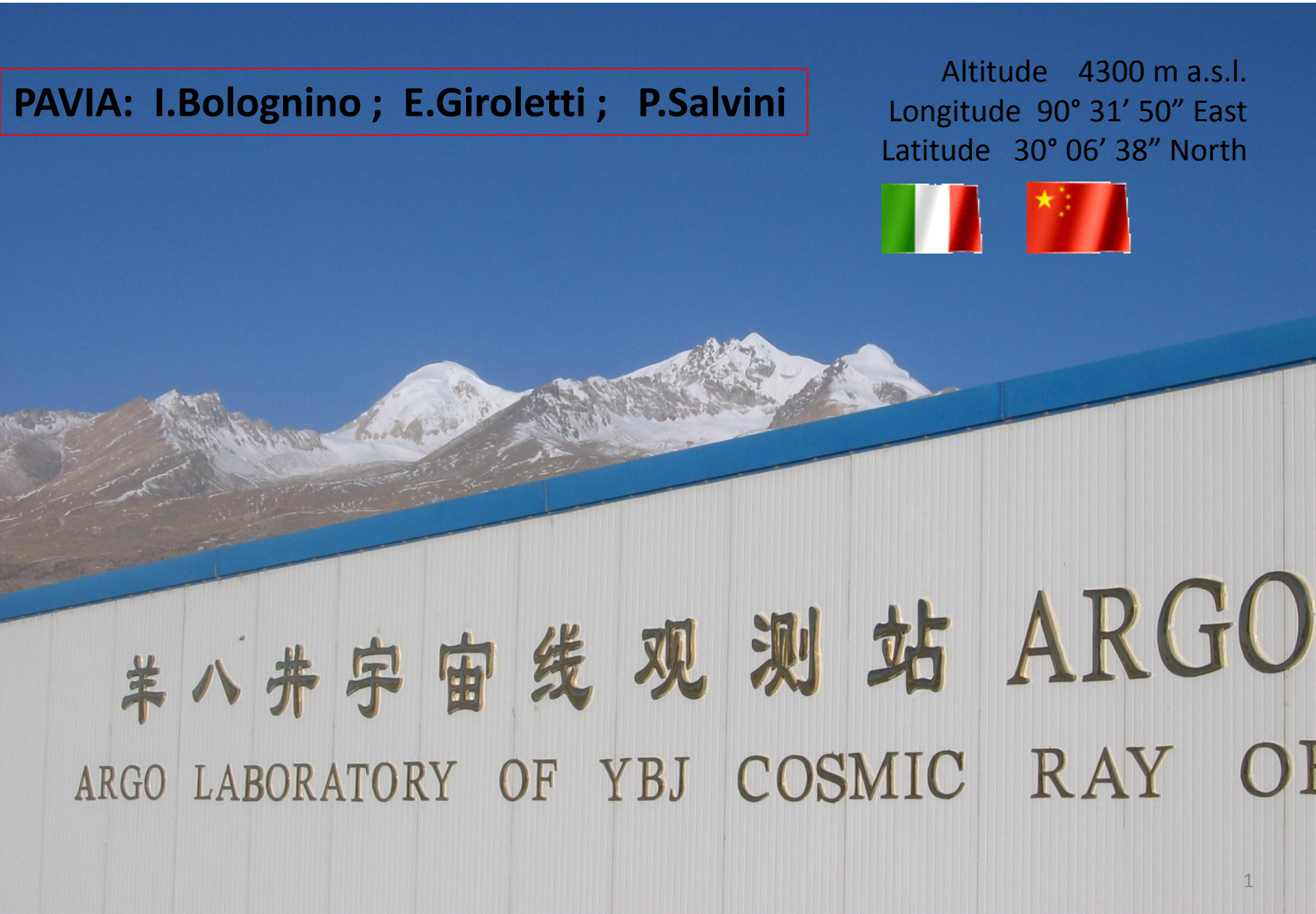
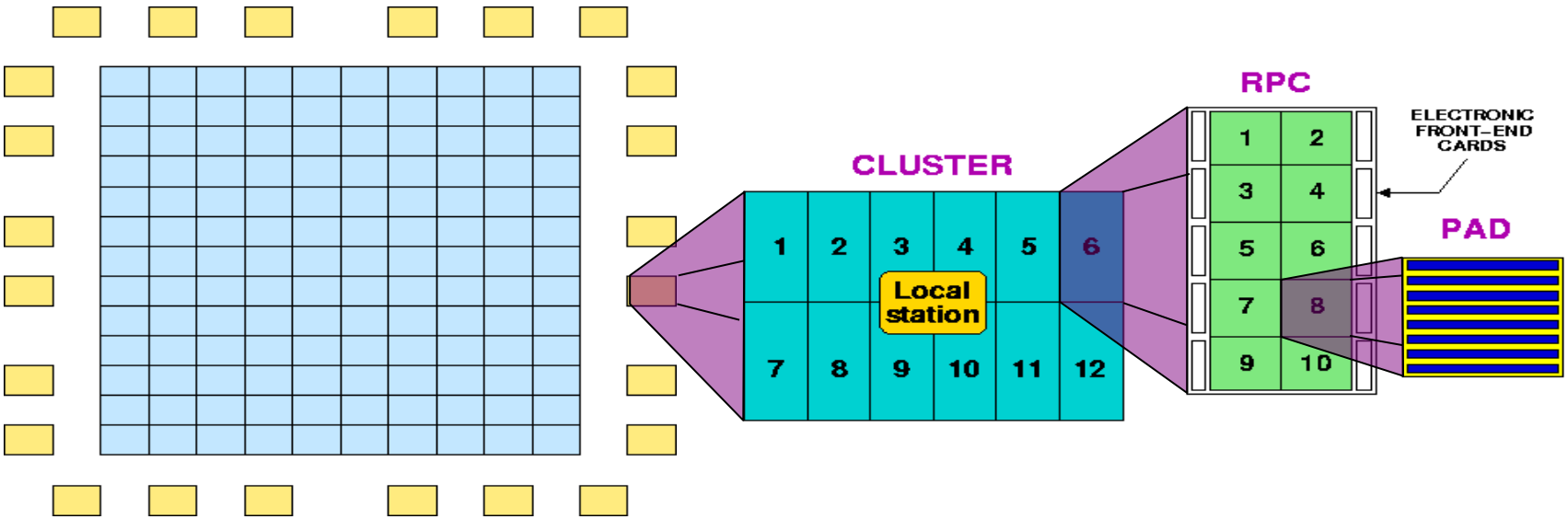
Astrophysical **R**adiation with **G**round-based **O**bservatory at **Y**ang**B**a**J**ing

PAVIA: I.Bolognino ; E.Giroletti ; P.Salvini

Altitude 4300 m a.s.l.
Longitude 90° 31’ 50” East
Latitude 30° 06’ 38” North



The ARGO-YBJ experiment



- ✓ Layer of Resistive Plate Chambers (RPC)
- ✓ Active area : central carpet ~ 5600 m^2
  sampling guard-ring ~ 1000 m^2
- ✓ Data taking : since July 2006
- ✓ Dynamical range for protons by means of pads, strips and big pads : ~ 1 - 10^4 TeV
- ✓ Space pixel: single strip (7 62 cm^2)
- ✓ Time pixel: pad (56 62 cm^2) is the OR of 8 strips, with a resolution of ~ 1.8 ns

Papers published during the year:

- ✓ **Measurement of the cosmic ray antiproton/proton flux at TeV energies with the ARGO-YBJ detector => Phys. Rev.D85,022002(2012)**

- ✓ **Observation of TeV Gamma Rays from the Cygnus region with the ARGO-YBJ experiment => Astr.Journ.Lett.745(2012)L22**

- ✓ **The light component spectrum of the primary cosmic rays in the multi-TeV region measured by the ARGO-YBJ experiment => accepted by Phys.Rev.D**

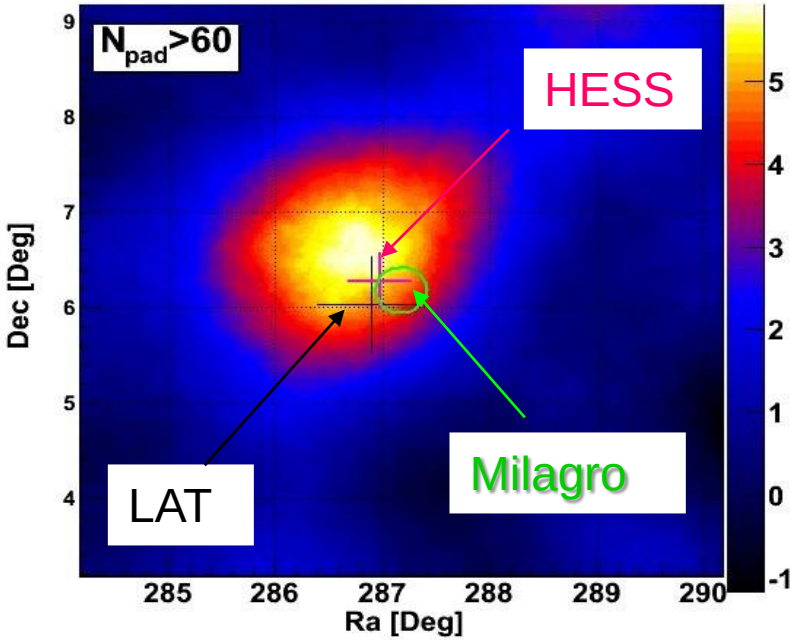
- ✓ **Observation of the TeV Gamma-ray source MGRO J1908+06 with ARGO-YBJ => accepted by ApJ with minor revisions**

- ✓ **Radon contribution to scaler mode counts of the ARGO-YBJ detector => accepted by ApJ with minor revisions**

MGRO J1908+06 => Extended source, Milagro (2007) observed at 6.2 σ in 4years

- ✓ Position consistent with previous measurements of Milagro and Hesse
- ✓ size consistent with Hesse
- ✓ spectrum power law [1-20 TeV] consistent with Milagro but the flux [1-10 TeV] is 2.5σ larger than the Hesse measurement

Consistent with the hypothesis
of pulsar wind nebula of PSR J1907+0602



$dN/dE = 6.1 \cdot 10^{-13} \cdot \exp(-E/4\ \mathrm{TeV})^{-2.54} \mathrm{sec}^{-1}\ \mathrm{cm}^{-2}\ \mathrm{TeV}^{-1}$

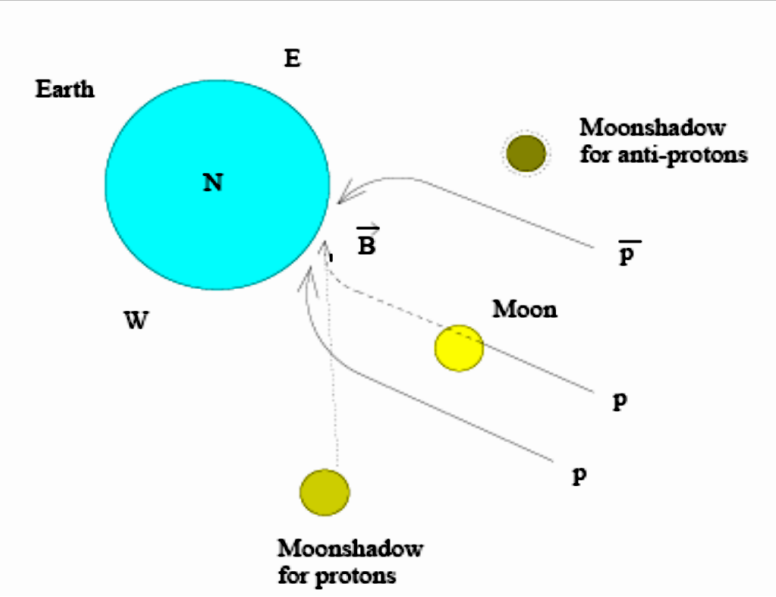
$\bar{p}/p$ ratio at TeV energies

Using data on Moon shadow, limits on antiparticle flux can be derived. Protons are deflected towards West, antiprotons are deflected towards East → 2 symmetric shadows expected.

If the displacement is large and the angular resolution small enough we can distinguish between the 2 shadows.

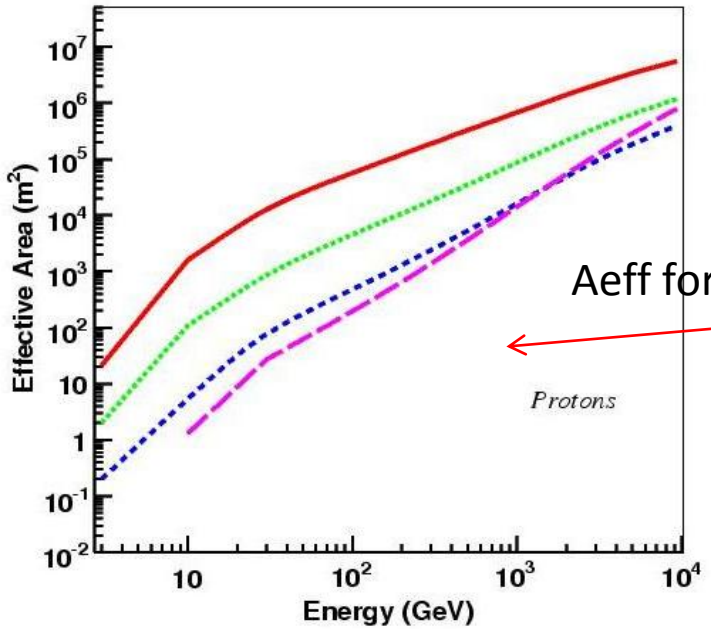
If no event deficit on the antimatter side is observed an upper limit on antiproton content can be calculated.

5% at 1.4 TeV at 90% c.l.
6% at 5 TeV at 90% c.l.

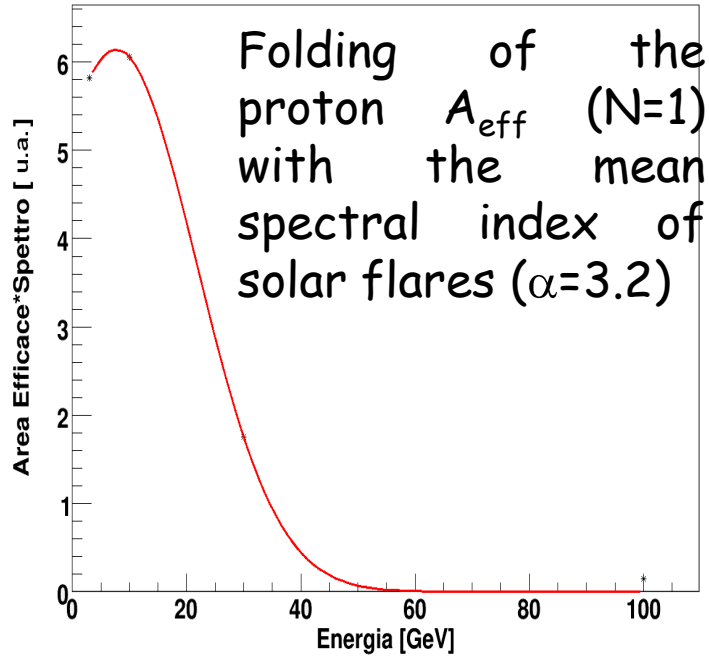


In the few-TeV energy range these limits are the lowest available.

Attività "pavese" => Gestione ed analisi dati di Scaler



Aeff for the 4 multiplicities

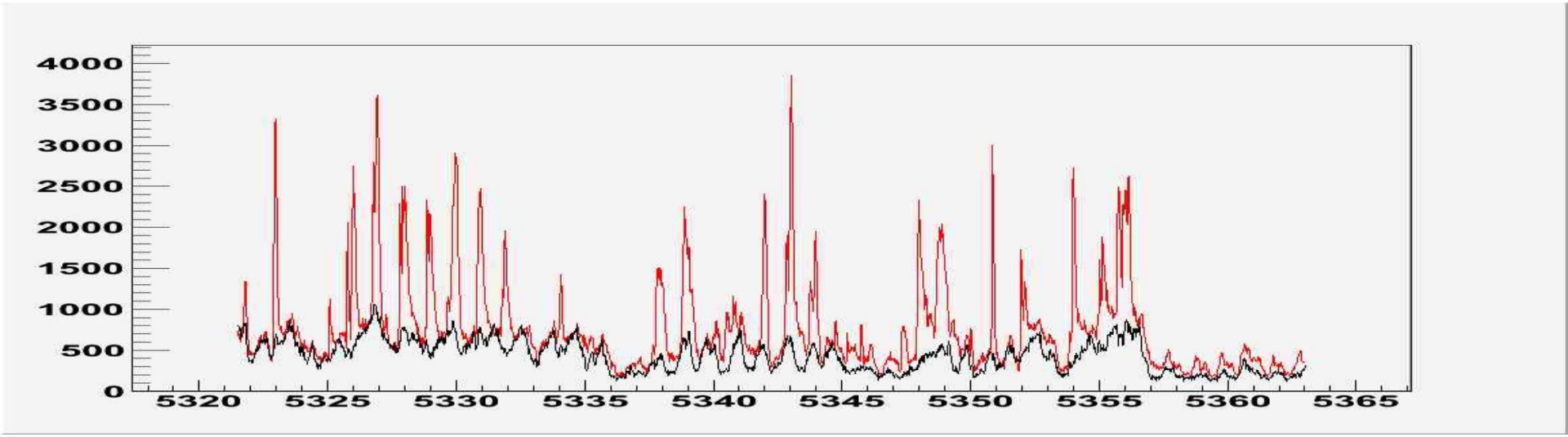


Folding of the proton A_{eff} (N=1) with the mean spectral index of solar flares (α=3.2)

- ✓ Correzione dati di scaler di più bassa molteplicità tenendo conto dell'effetto dei figli del Radon (articolo sottomesso recentemente)
- ✓ Monitoraggio fenomeni solari
- ✓ Relazione tra variazioni di campo elettrico atmosferico e conteggi

Monitoraggio Radon :

effettuato da 2 celle di Lukas poste al centro del tappeto e all'estremità Nord del capannone



Correzione su "single counting" :
circa 1Hz per Bq/m^3 di
concentrazione di ^{222}Rn

Monitoraggio Campo Elettrico:

Novembre 2011 =>

✓ installazione rivelatore di fulmini (relazione tra variazione campo elettrico e scarica a terra tramite fulmine) **Boltek LD -250**

✓Modifica range dei rivelatori di campo elettrico pre-esistenti

Problemi nel montaggio all’esterno causa tempesta di vento !!!!!!!!

Solar phenomena

On the start of the 24th solar cycle :

- Forbush decrease February 2011

(detected by Oulu, Moscow and Catania)

- No GLE observed up to now, many flares detected by satellite

•June 2011 (class M2)

•January 2012 => flares of M9 and X1 class

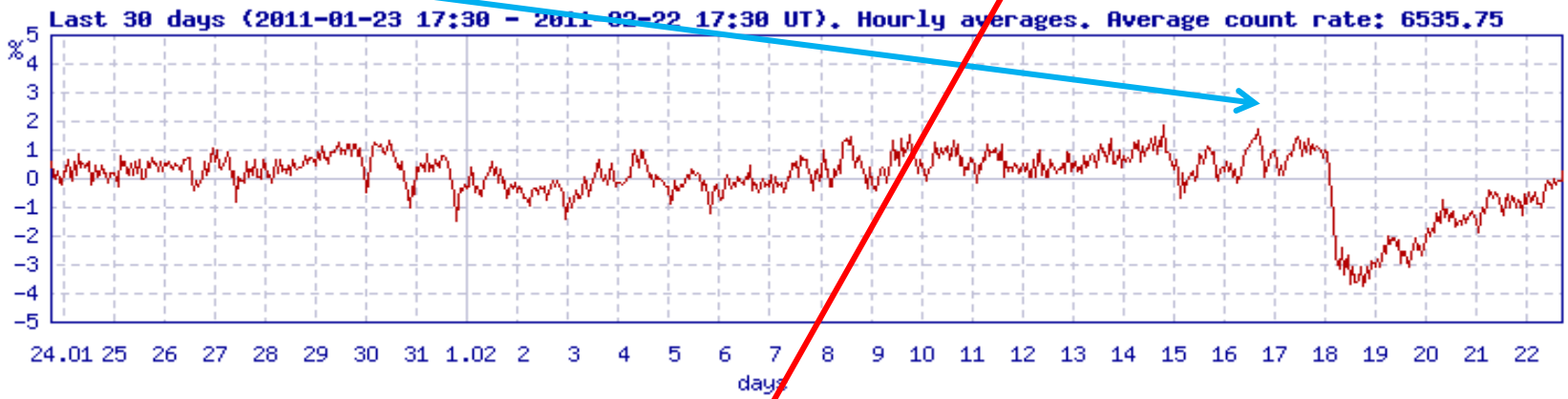
•6-7 March X5 class

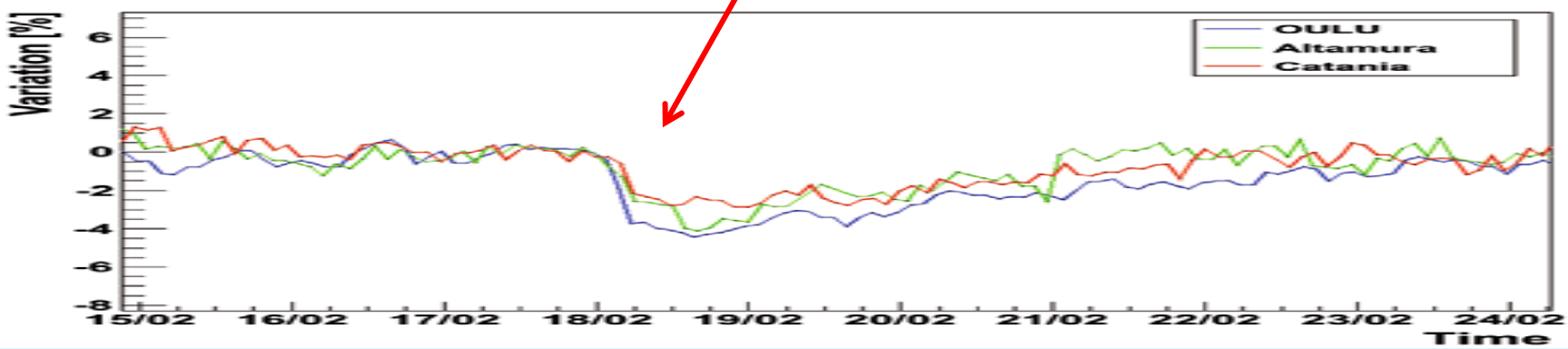
• 16 April 2012 (M1 class)

•9th May 2012 (M5)

FORBUSH decrease 18-23 February 2011

Observed by Oulu (65°N) , Moscow (55°N) and Catania (37°N) [YBJ (30°N)]



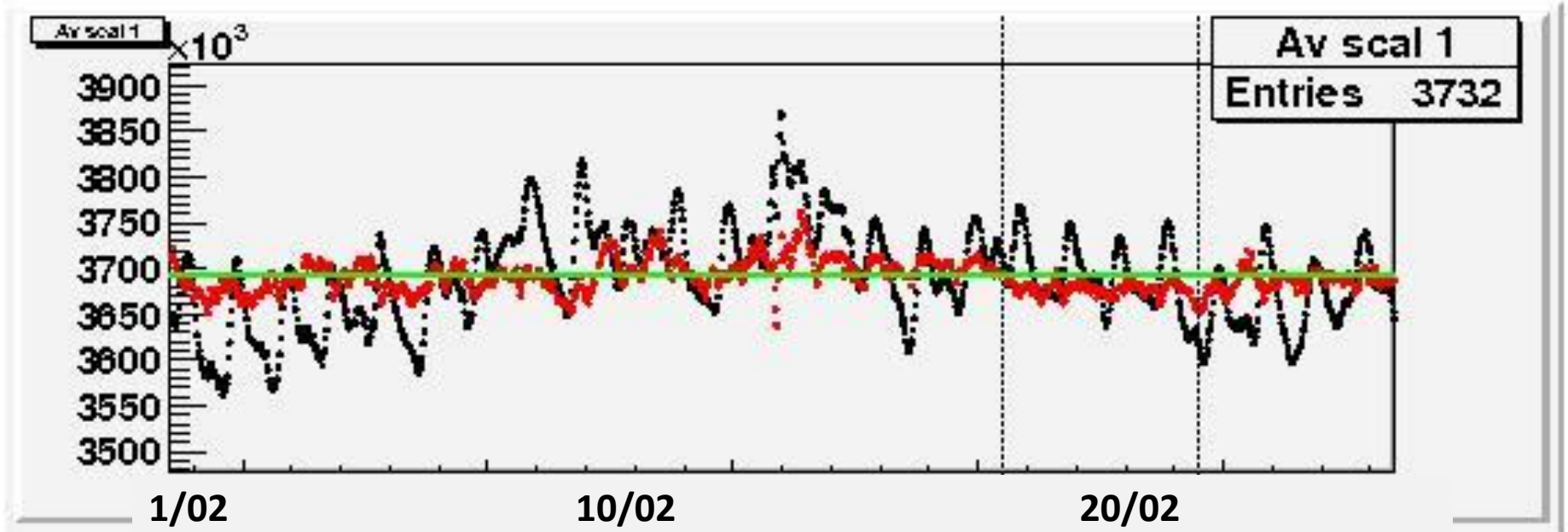


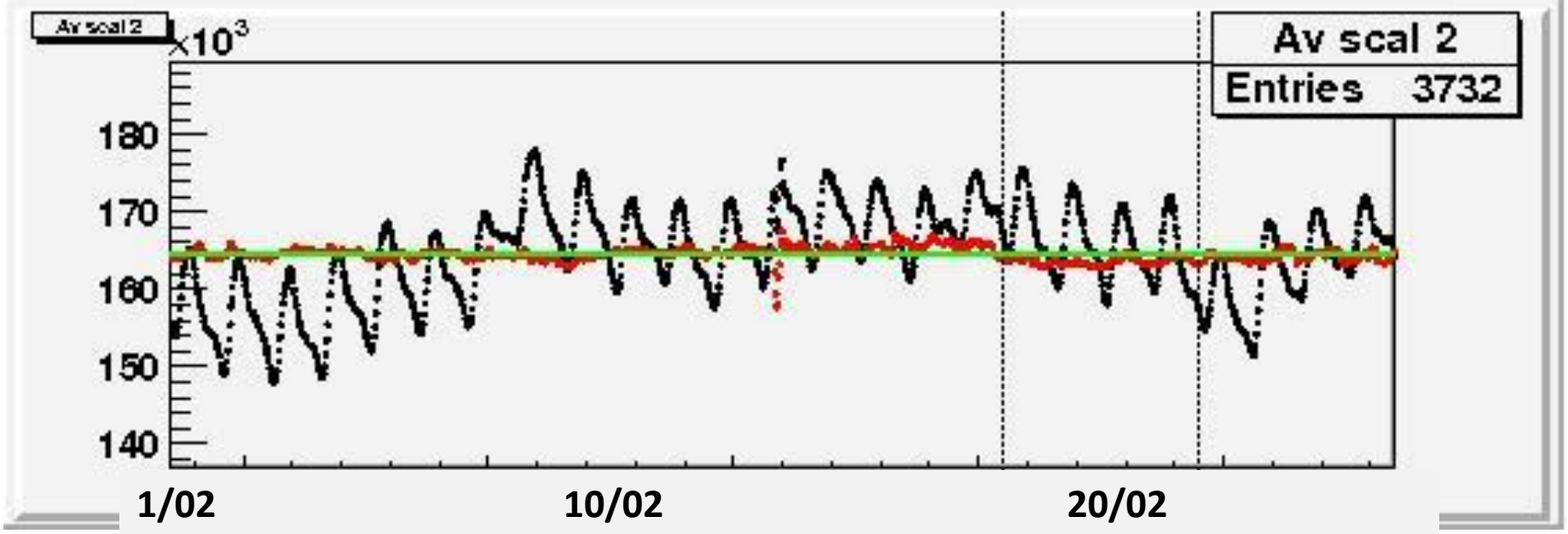
- Oulu observed about 3% decrease on the 18/2
- Catania&Altamura observed a slight decrease in correspondance with Oulu.

Other telescope from EEE project are not reported (30 telescopes in all)

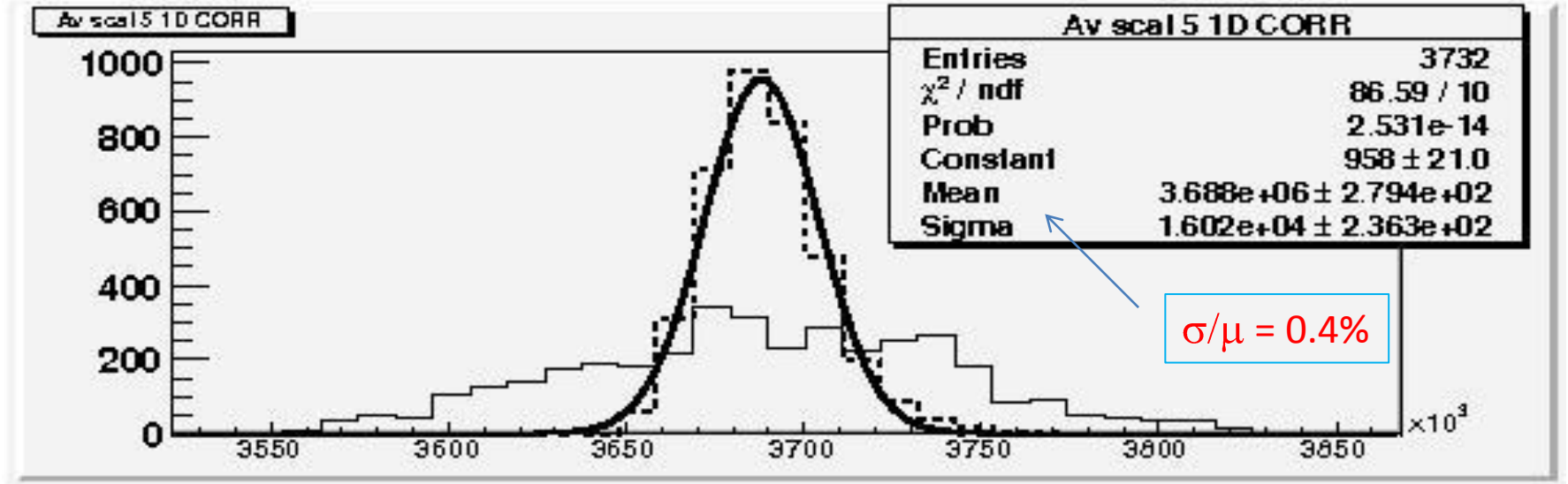
Ref.EPJ Plus 126(2011)61

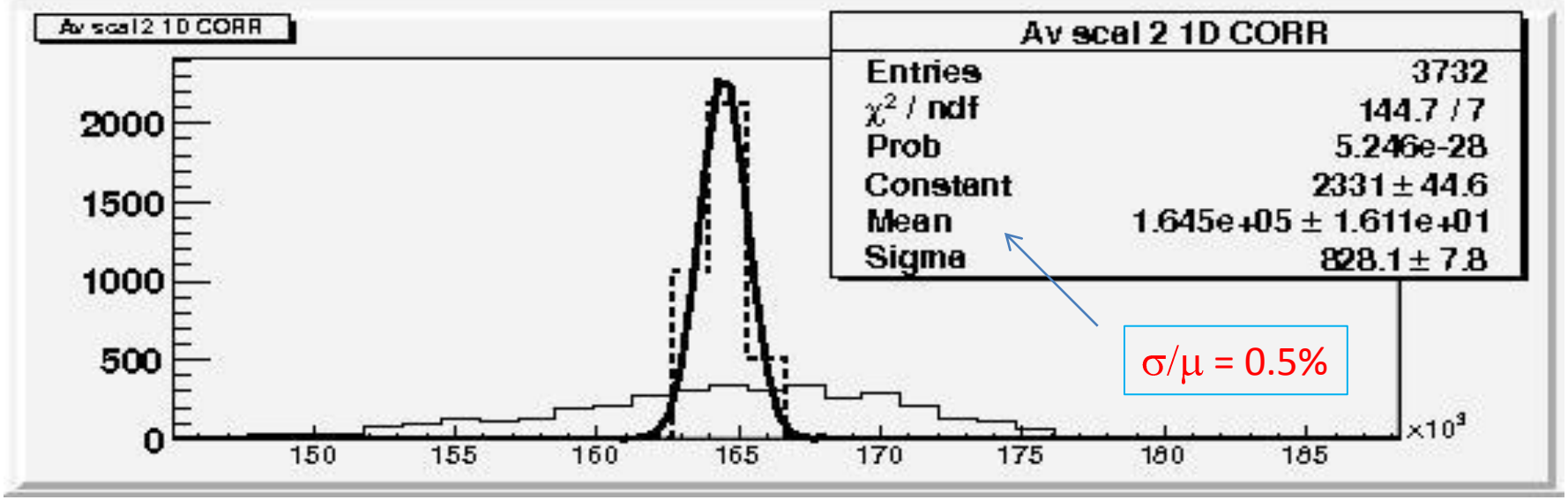
Scal1 – Scal2 P,T,Rn corrected 95 cluster





Scal1 – Scal2 P,T,Rn corrected 95 cluster





Scaler in Aprile – Maggio 2012

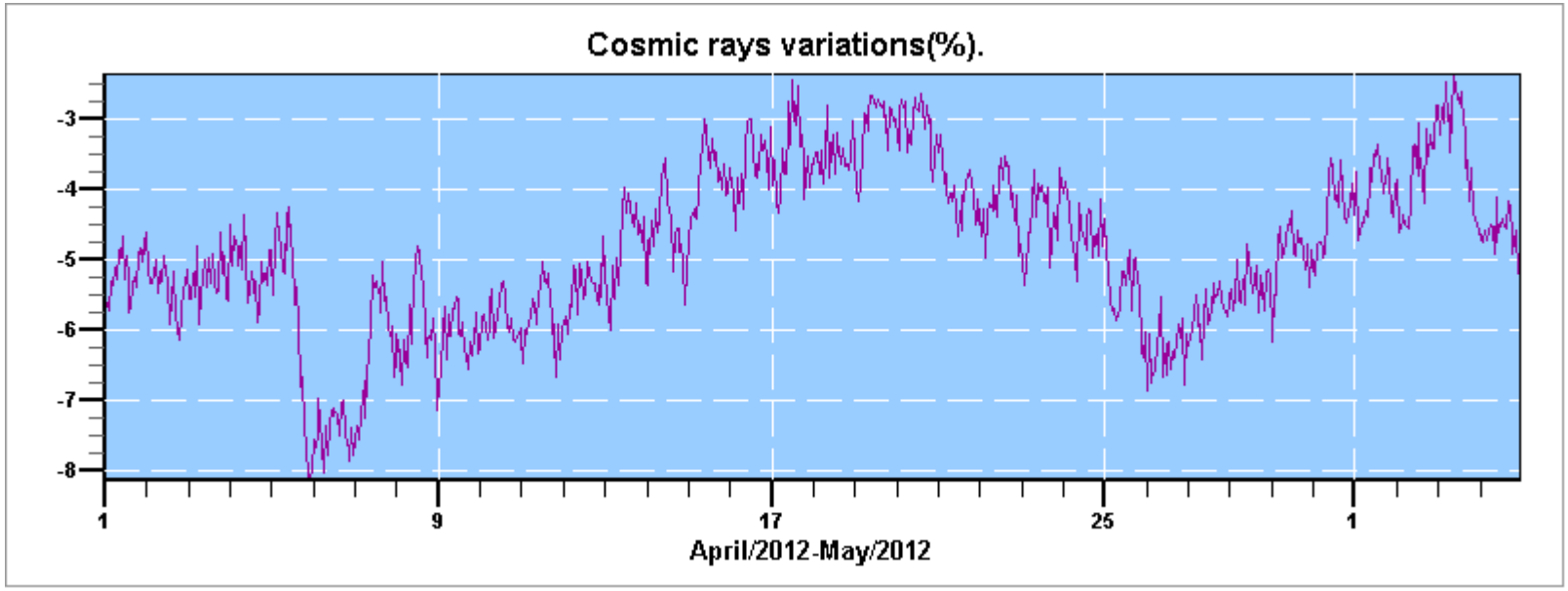
18-19 Gennaio 2012 (M1.7 class, SDO)
22-23 Gennaio 2012 (X1.7 class , SDO)

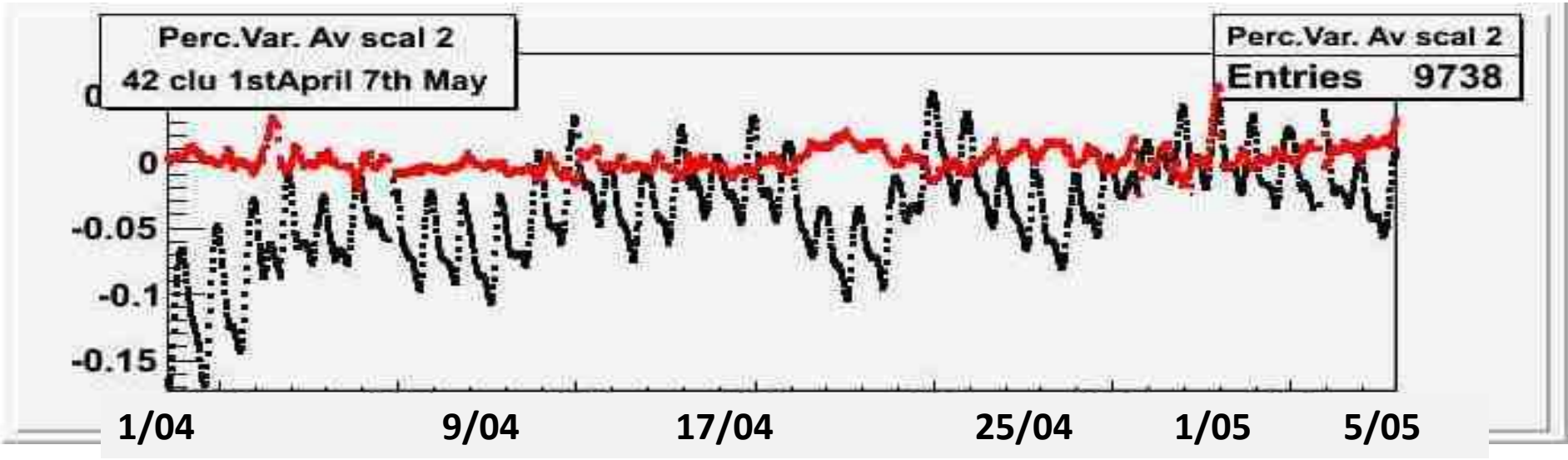
5-6 Marzo 2012 (X 5.4 class, SDO)

16 Aprile 2012 (M1 class, SDO)
24-25 Aprile 2012 (M1 class, SDO)
1 Maggio 2012 (M1.7 class, SDO)

9 Maggio 2012 (M5 flare)
17 Maggio 2012 (M5 flare & CME , SOHO)

Oulu Neutron Monitor





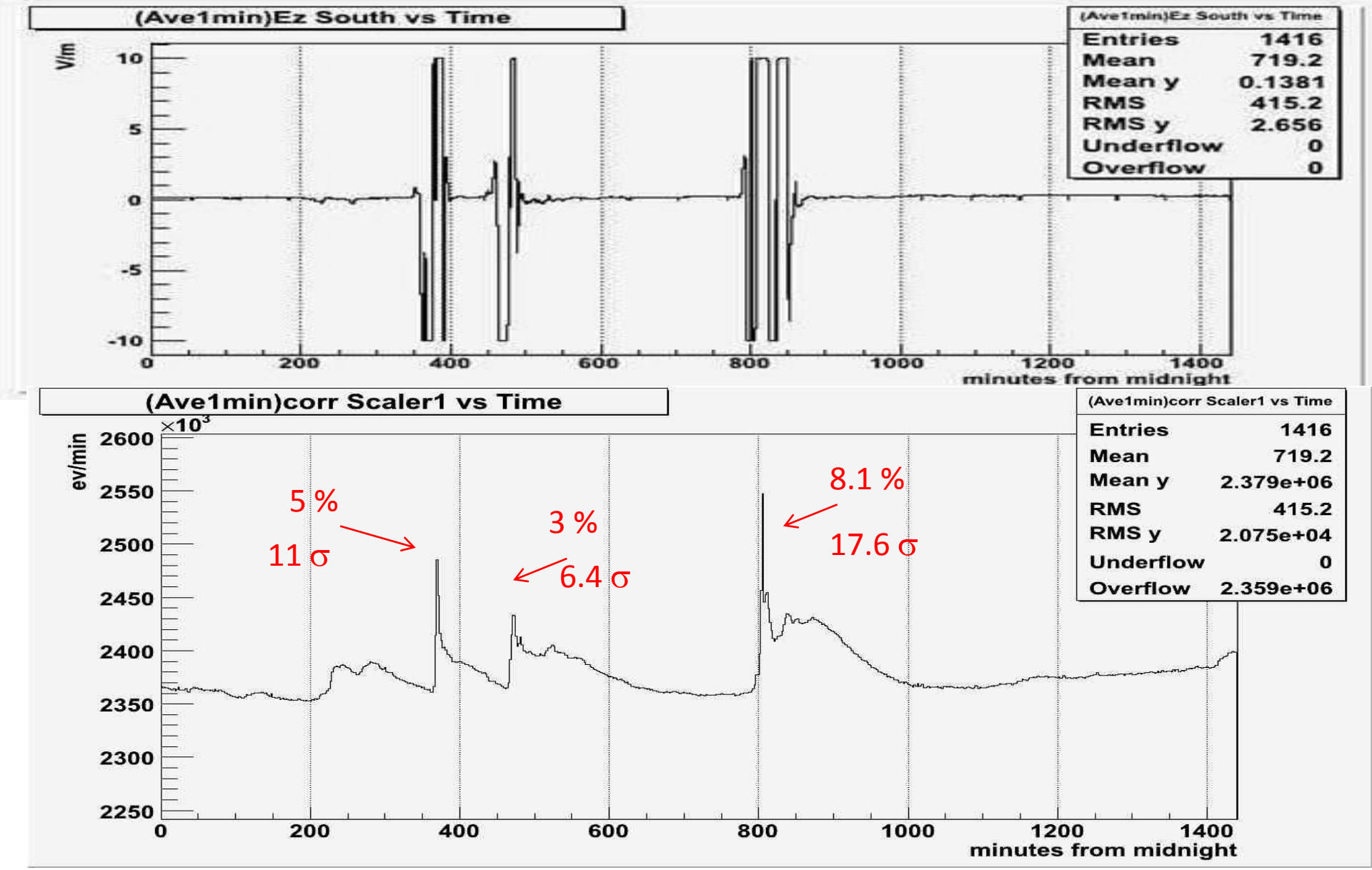
Electric field variations

- Variations in cosmic rays countings have for long been observed in correspondance with thunderstorms, rain or electric field variations

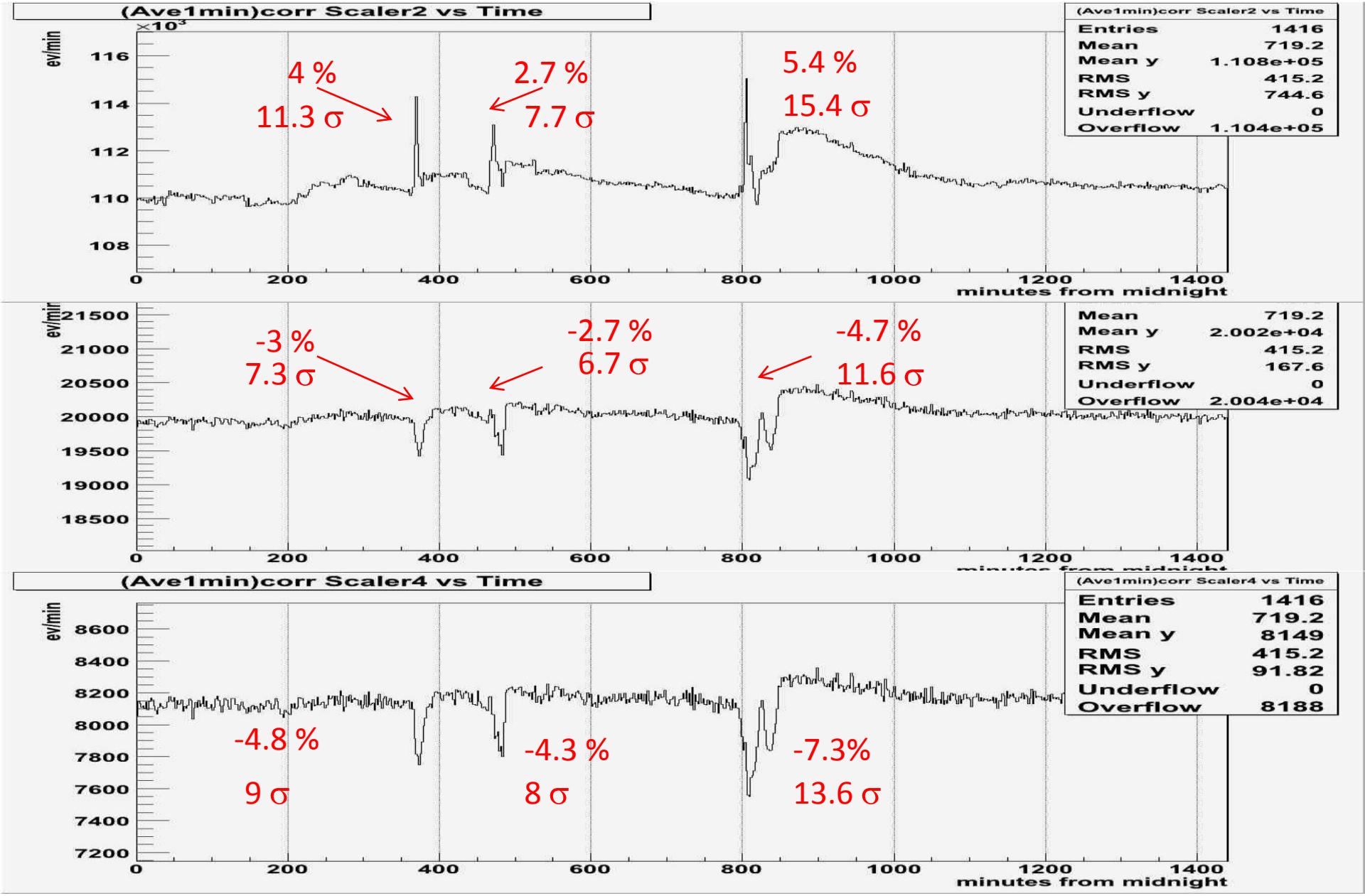
- We modified range of our Ez detector to reach 100kV/m ,

- lightening detector measuring distance of lightenings

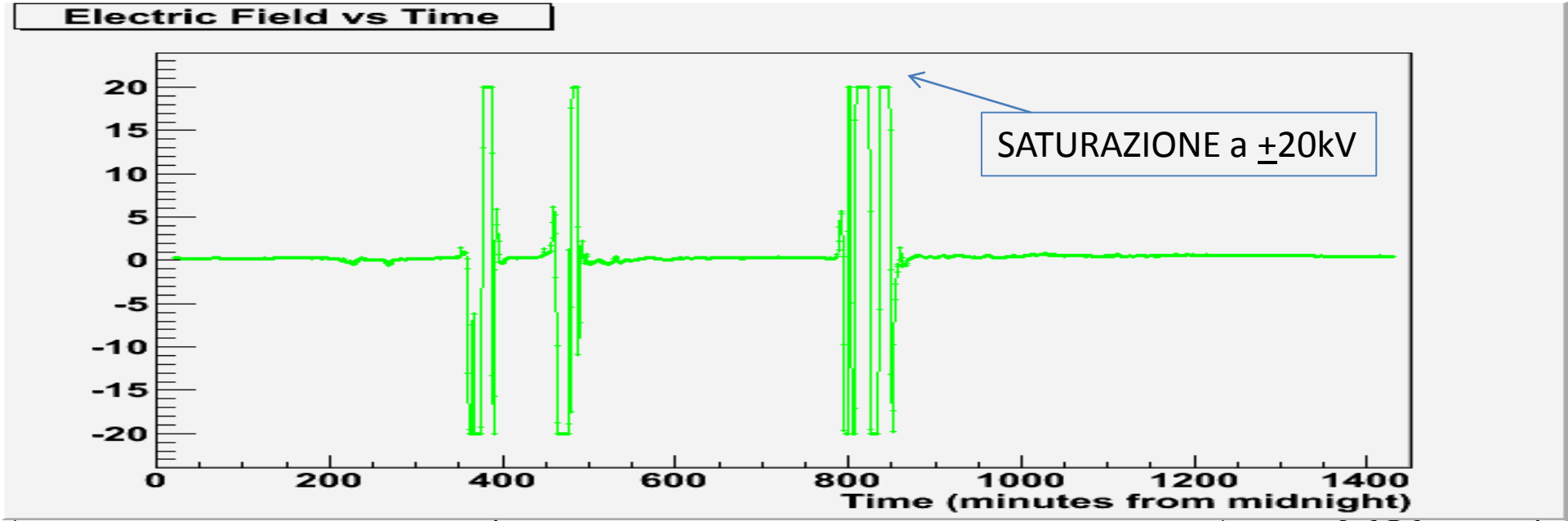
24 may 2010 – electric field variations

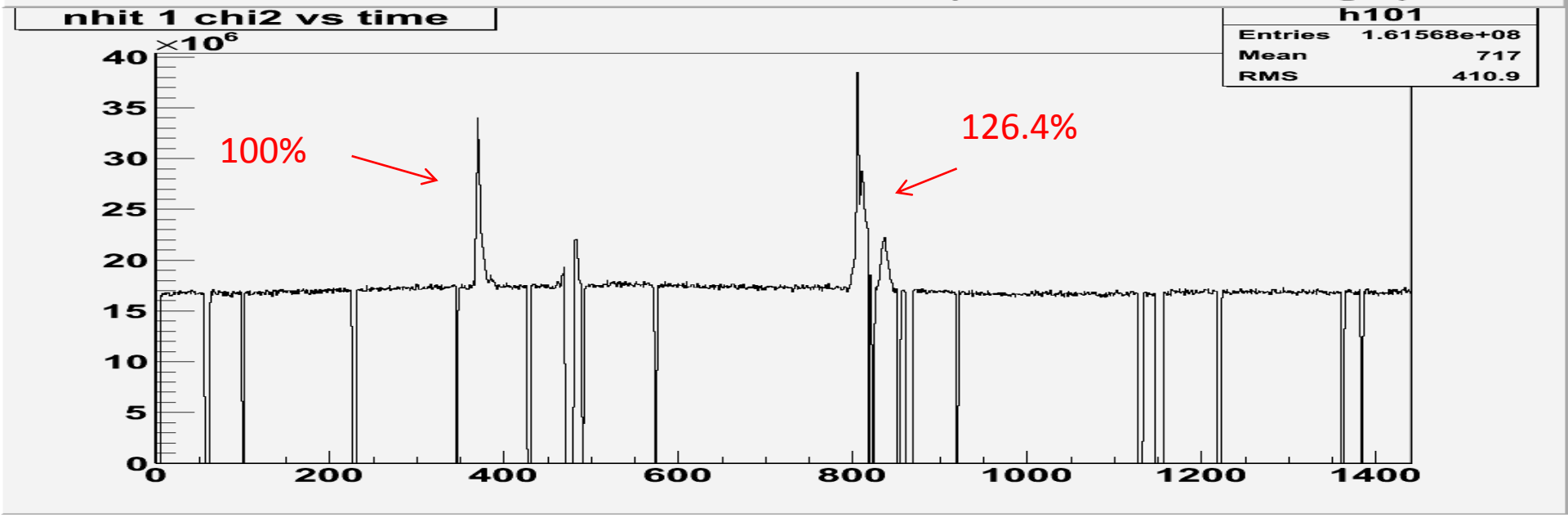


24th May 2010 – counting/minute averaged over all clusters

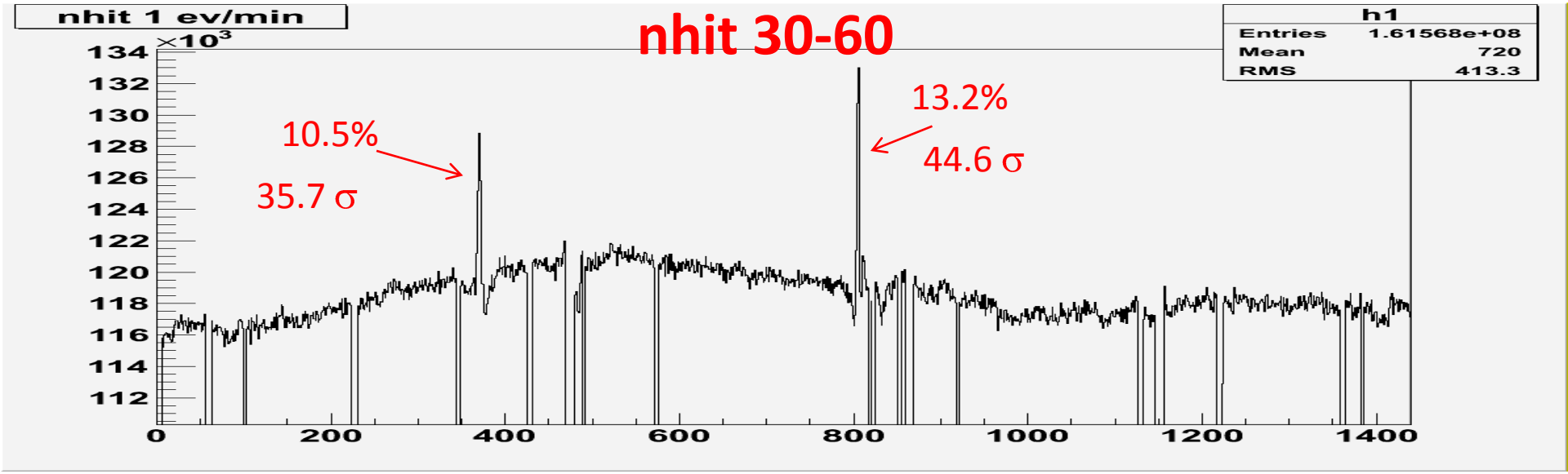


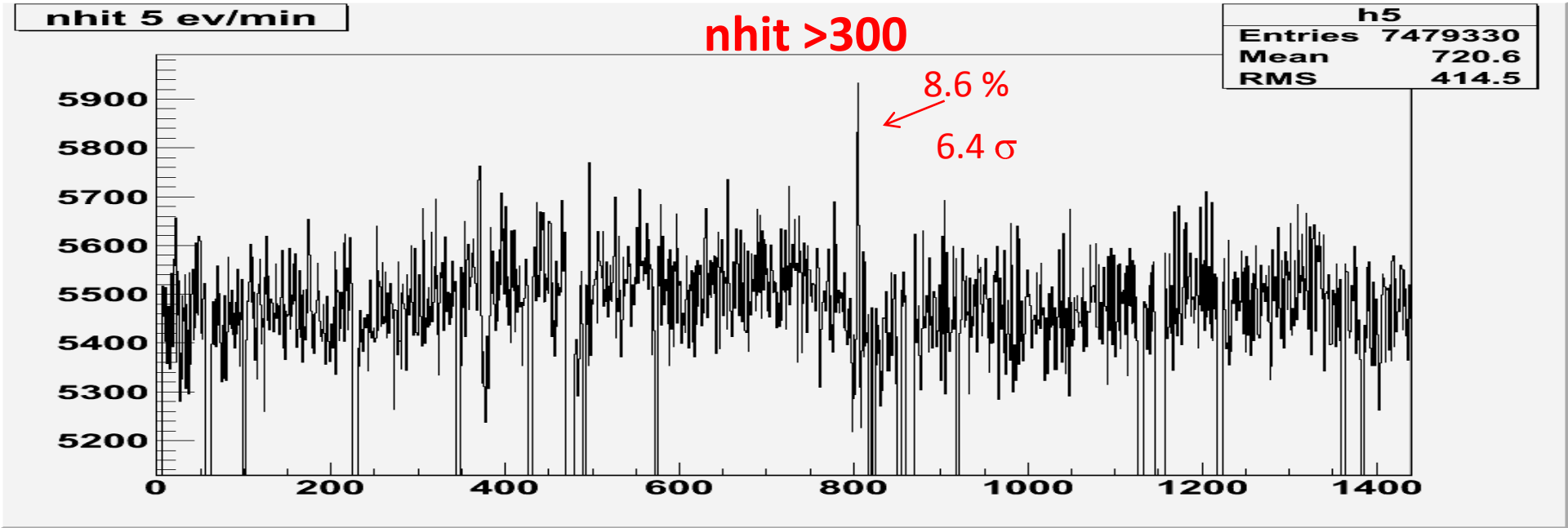
Showers : Chi square vs Time 24th May 2010



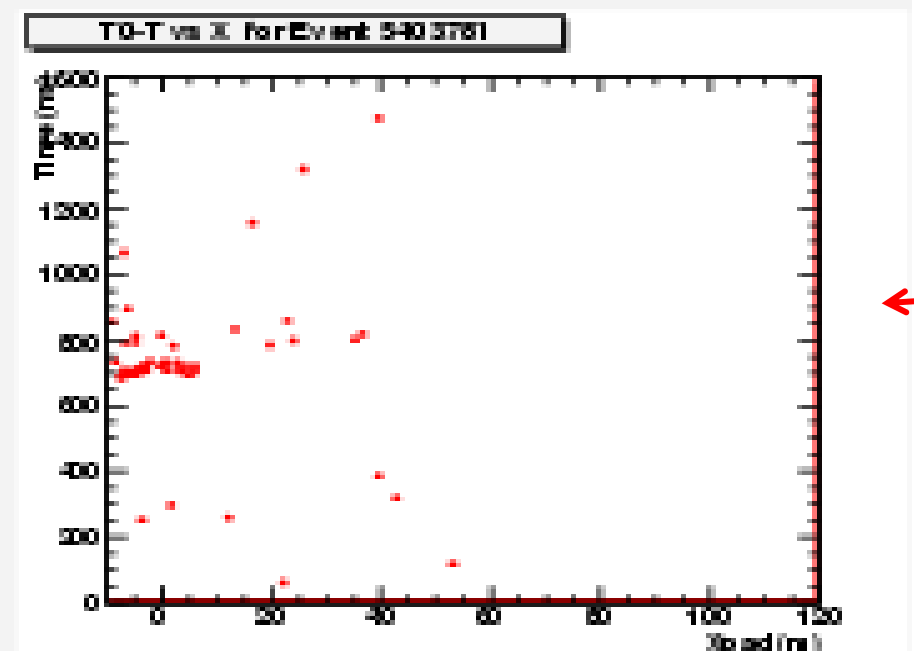


SHOWERS – 24th May 2010



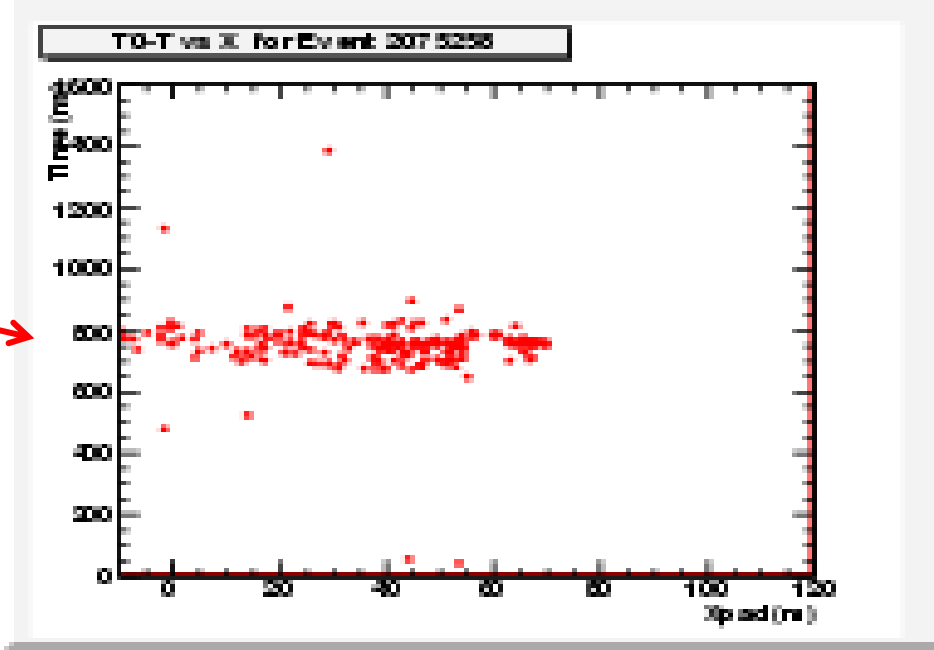


24th May 2010 => Observation in Shower mode
Display: time vs. (x-y location)



PEAK

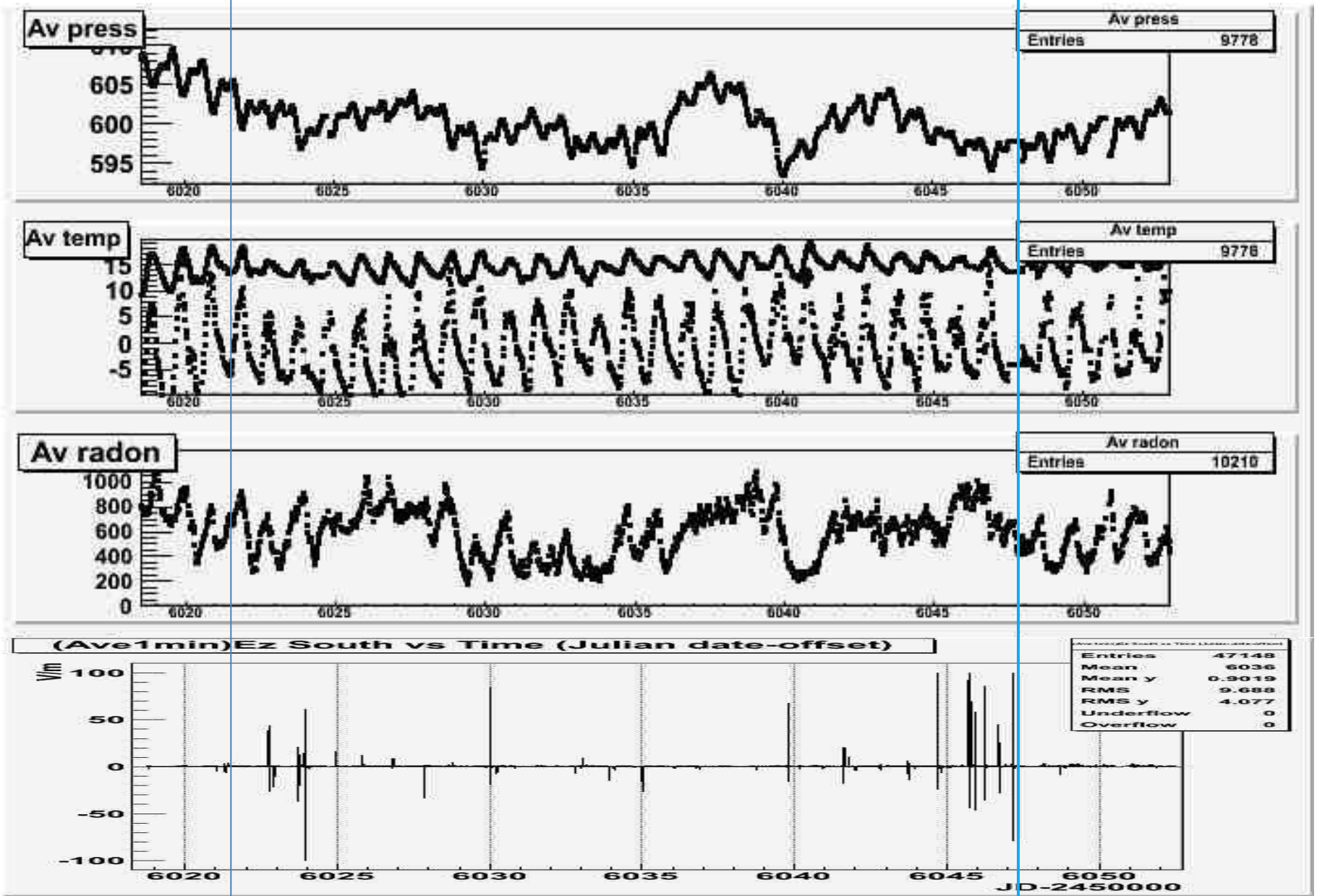
OFF PEAK



4 Aprile

Environmental parameters

30 Aprile h12



Per il futuro :

ARGO terminerà la presa dati con i primi 4 mesi del2013 :

Continua il monitoraggio per i fenomeni solari

Modifica dell'installazione del rivelatore di fulmini

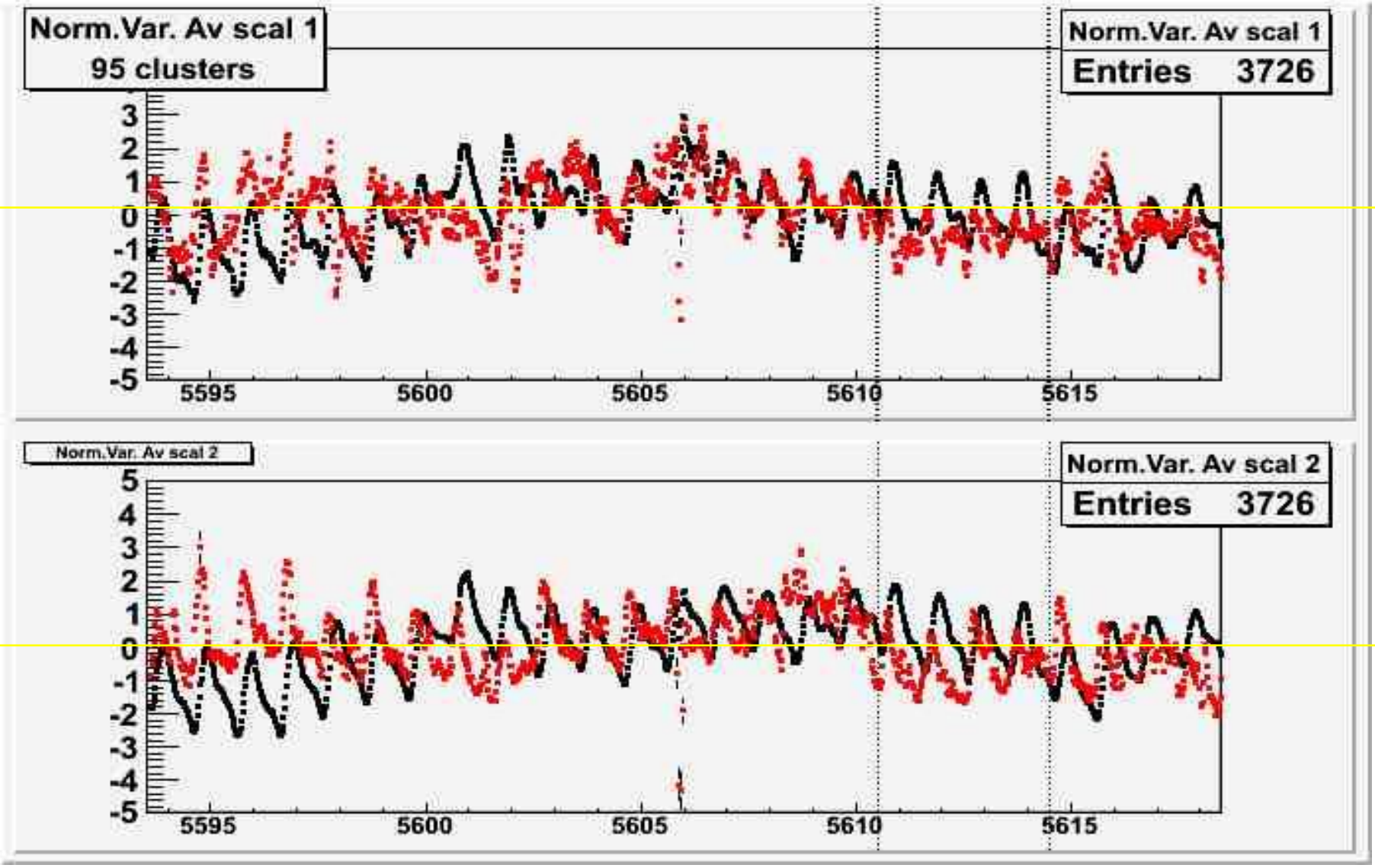
Relazione tra flusso dei cosmici e spikes di campo elettrico

Studio della modifica del fronte dello sciame in corrispondenza del temporale

(?) Valutazione della modifica dello spettro energetico …(?)

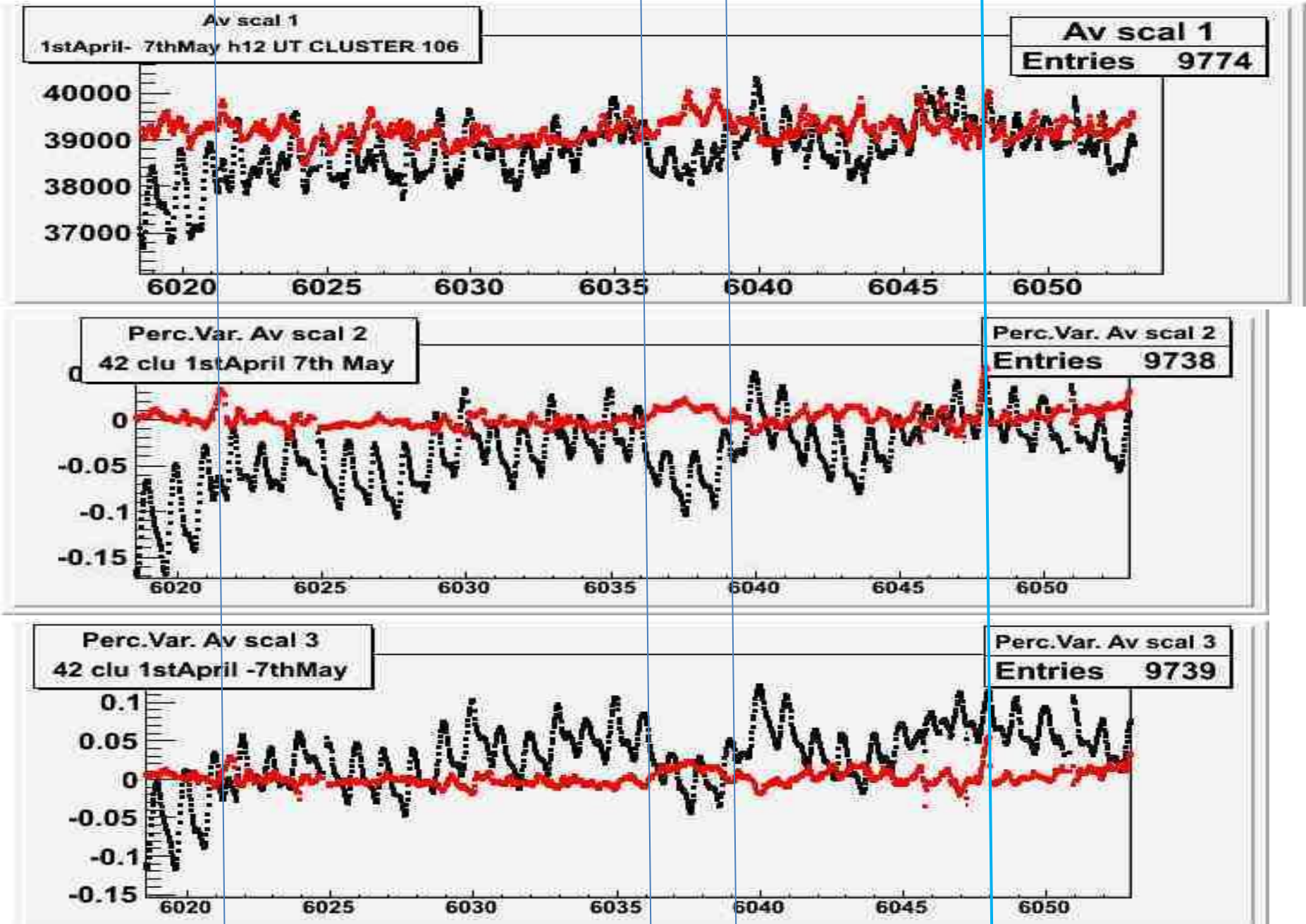
SCORTA !!!!!!!!!!!!!!!

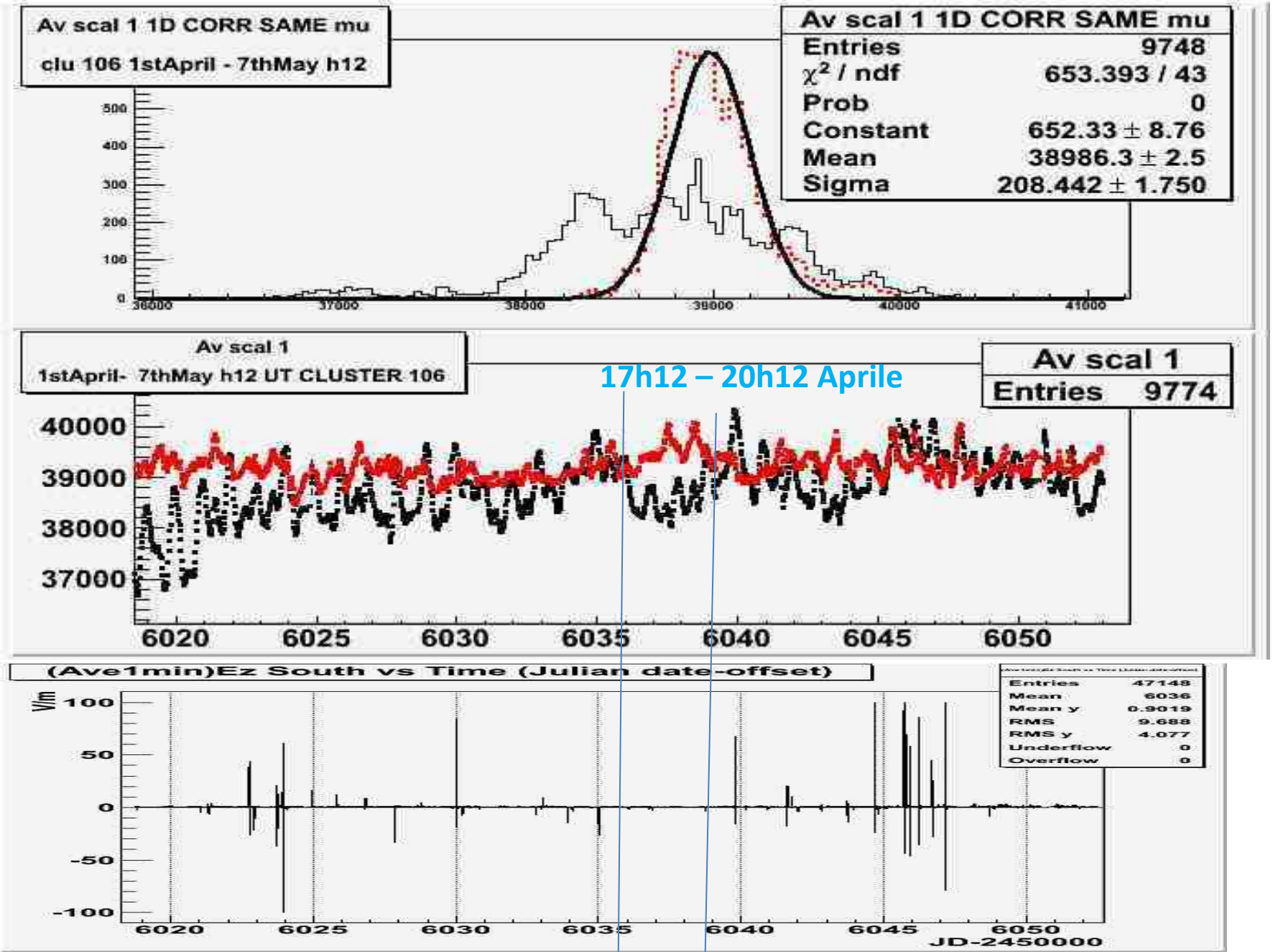
Scal1 – Scal2 Norm. Variations (95 cluster)



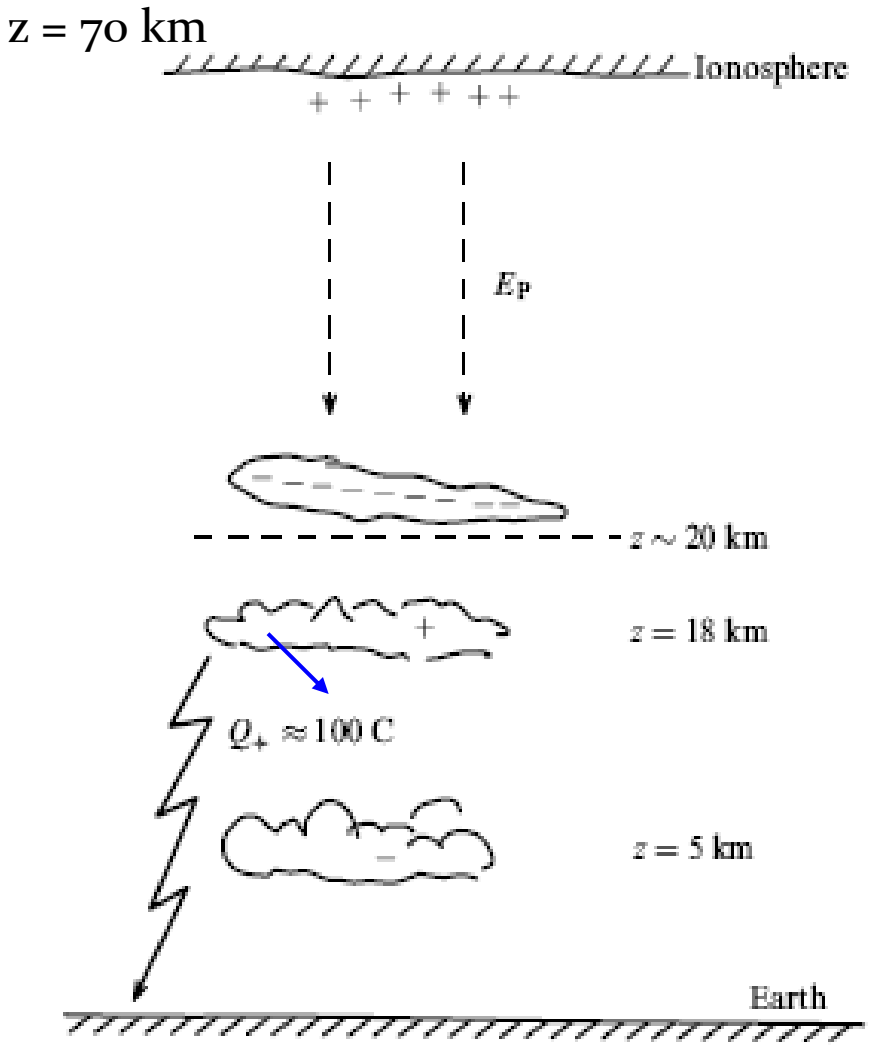
4 April 17 -20 April 30 April h12UT

Scaler 1stApril-7thMay 2012



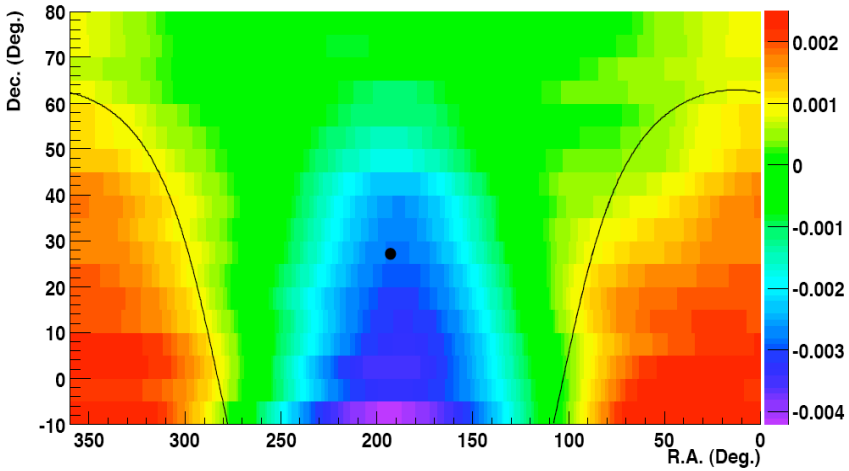

Av scal 1 1D CORR SAME mu
clu 106 1stApril - 7thMay h12
Av scal 1 1D CORR SAME mu
Entries 9748
χ² / ndf 653.393 / 43
Prob 0
Constant 652.33 ± 8.76
Mean 38986.3 ± 2.5
Sigma 208.442 ± 1.750
Av scal 1
1stApril- 7thMay h12 UT CLUSTER 106
17h12 – 20h12 Aprile
Av scal 1
Entries 9774
(Ave1min)Ez South vs Time (Julian date-offset)
V/m
Entries 47148
Mean 6036
Mean y 0.9019
RMS 9.688
RMS y 4.077
Underflow 0
Overflow 0
JD-2450000

VARIAZIONI DI CAMPO ELETTRICO ATMOSFERICO

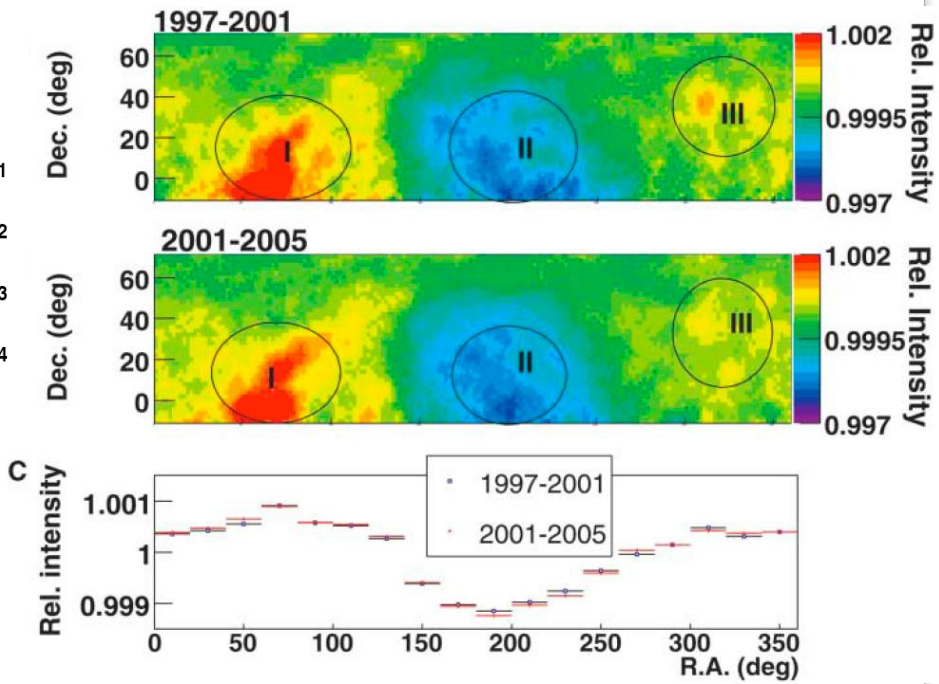


- e- accelerati da E iniziano un processo di ionizzazione a cascata ("runaway breakdown")
- Condizioni a Patm. : circa 2eV di energia di e- per un campo E circa 20kV/cm
- I raggi cosmici secondari possono funzionare da innesco
- Studio dell'effetto dei fulmini sulle diverse componenti dei raggi cosmici secondari fornisce informazioni sulla dinamica dei fenomeni atmosferici

Observations of CR anisotropies



MILAGRO - 2009 *ApJ* **698** 2121
Median energy around 6TeV
Width 5° in dec.



Tibet AS-γ - *Science* 20 October *2006*:
Vol. 314 no. 5798 pp. 439-443