CREDO science case

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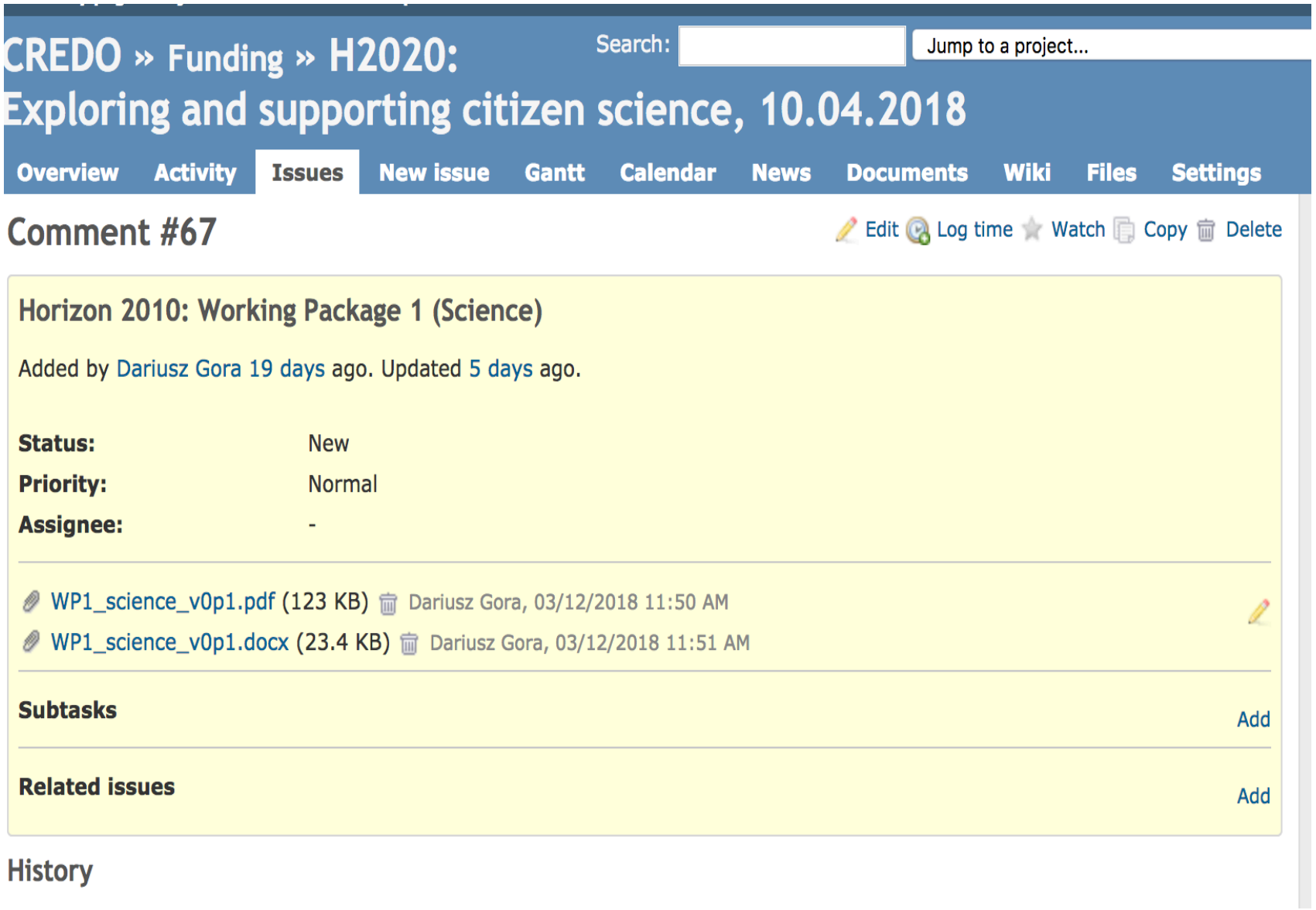
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Exploring and supporting citizen science, 10.04.2018
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Horizon 2010: Working Package 1 (Science)
Added by Dariusz Gora 19 days ago. Updated 5 days ago.
Status: New
Priority: Normal
Assignee: -
WP1_science_v0p1.pdf (123 KB) Dariusz Gora, 03/12/2018 11:50 AM
WP1_science_v0p1.docx (23.4 KB) Dariusz Gora, 03/12/2018 11:51 AM
Subtasks
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Related issues
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History

Topics

1) CRPropa standard / exotic CRE: conditions

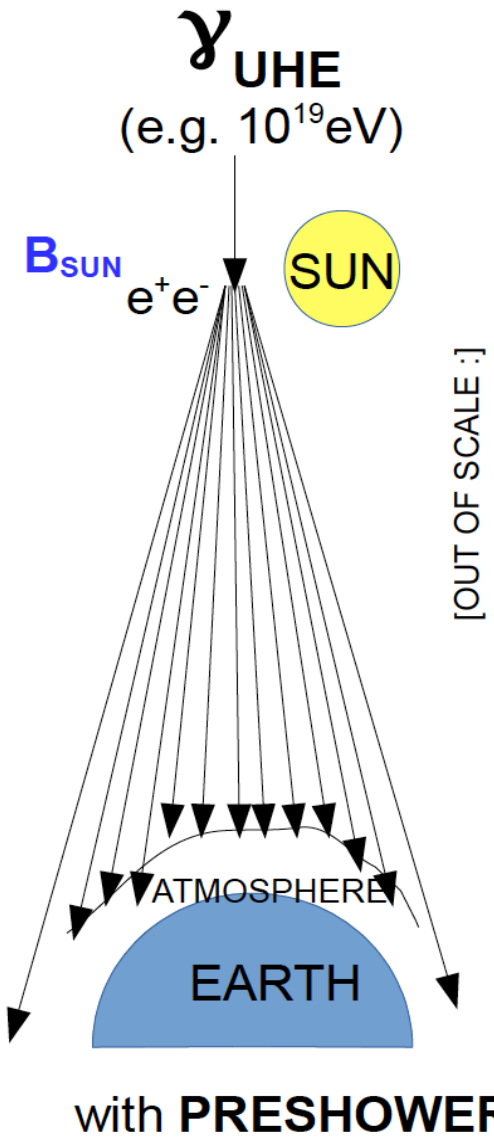
2) looking for Sun Cosmic Ray Ensambles

3) clusters in time: any time scale suspected

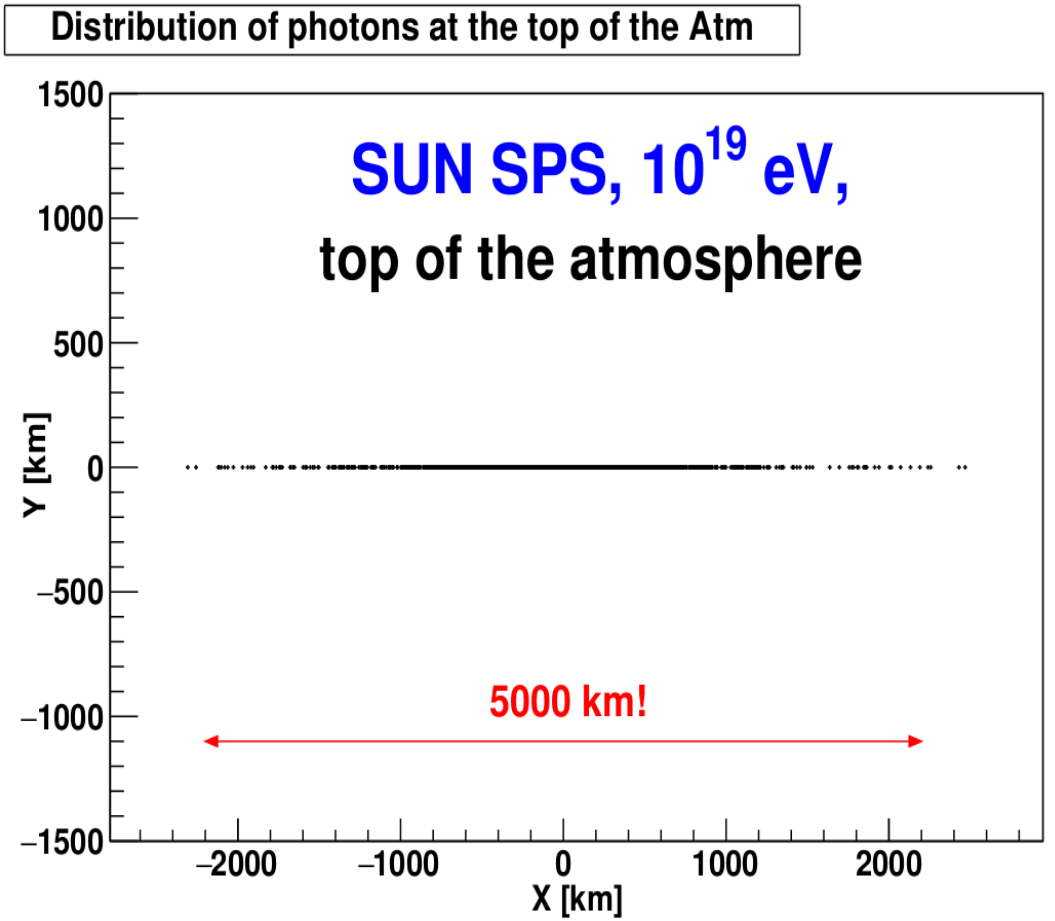
4) Integration of data from different experiments: Credo monitor

5) search for correlations: cosmic / GMF / weather / sun activity / seismic effects

Topic 1: Preshower in vinicity of Sun

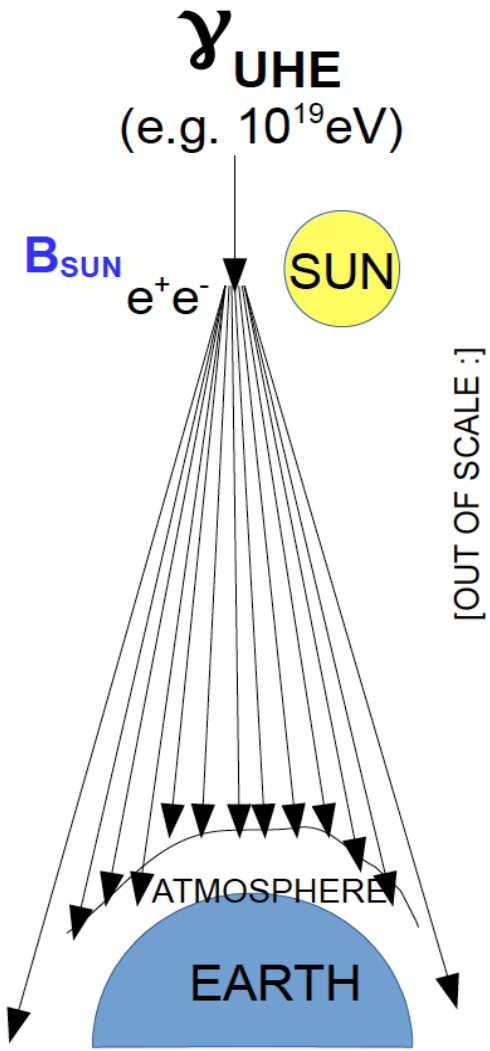


with **PRESHOWER**



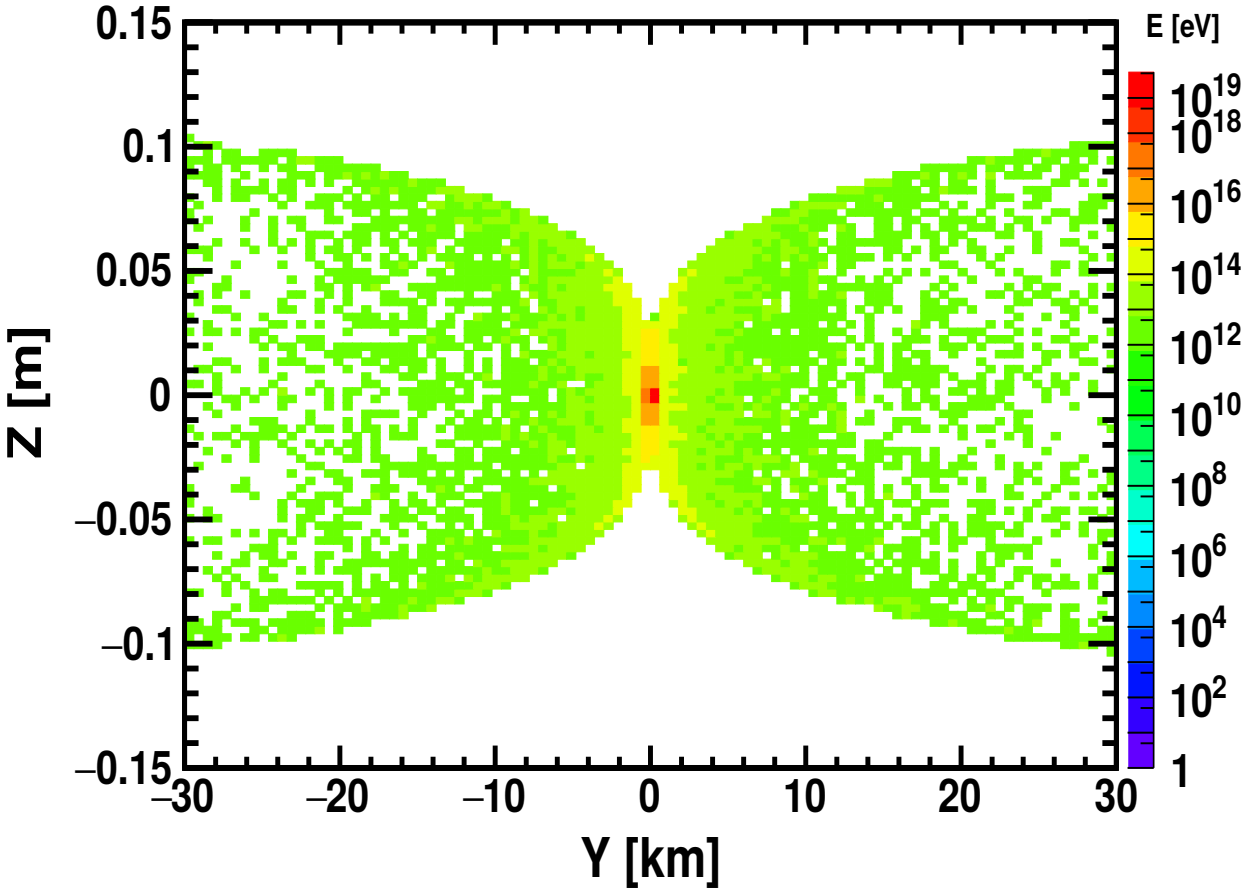
Distribution of photons ($E > 10^{13}$ eV) at the top of the atmosphere.
$E_\gamma = 10$ EeV, Impact parameter $= 2.5 R_S$.

Example of CRE : Preshower in vinicity of Sun



with **PRESHOWER**

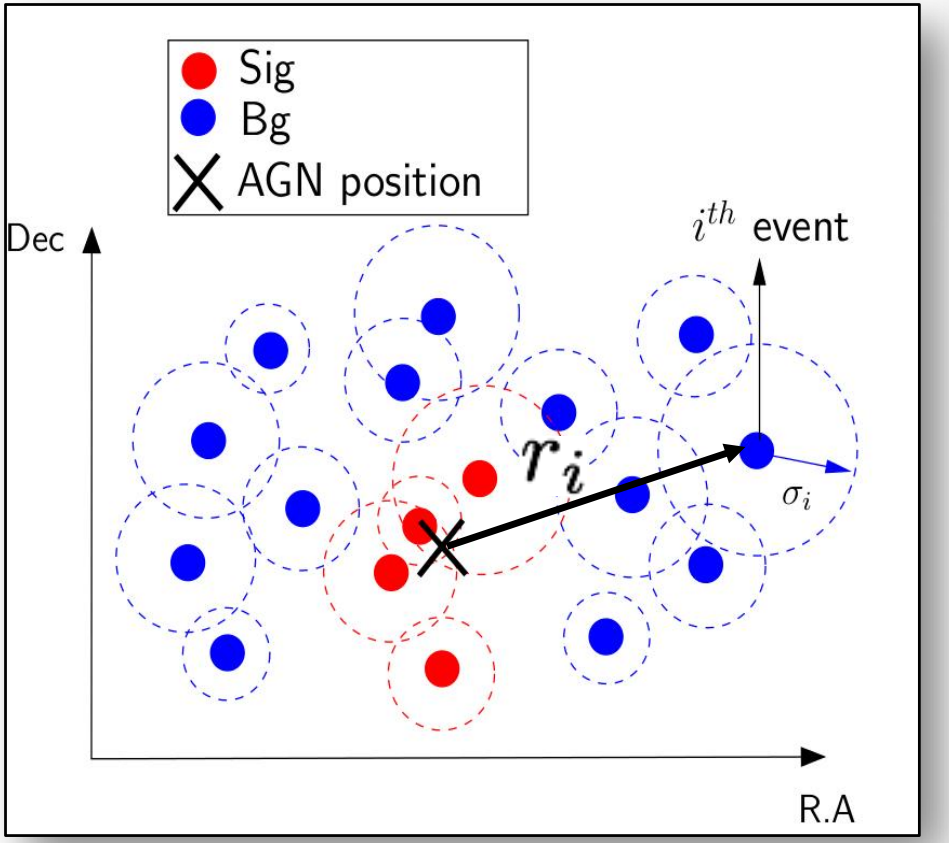
[OUT OF SCALE :]

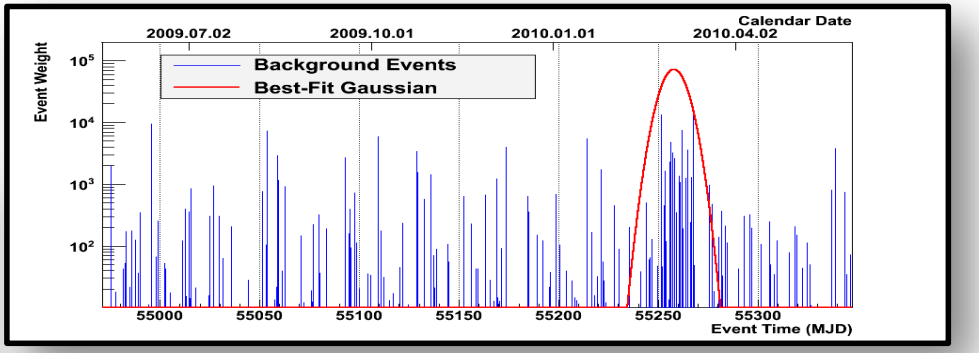


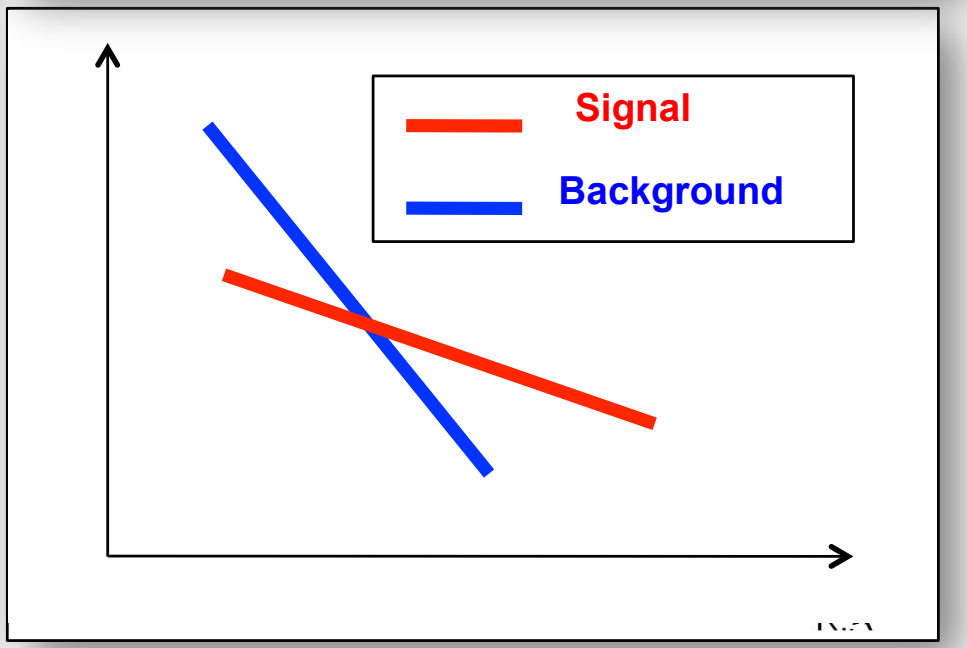
Topic3: Basic concept of point-source search filter

σ_i - the angular uncertainty of event

r_i - the angular distance of event from source



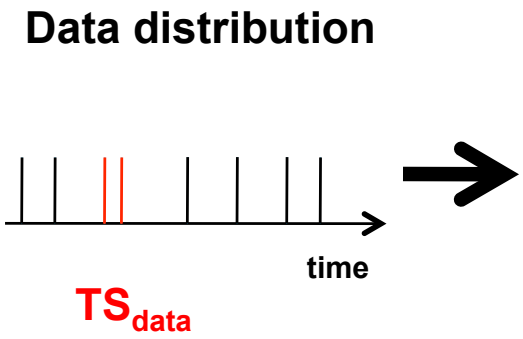


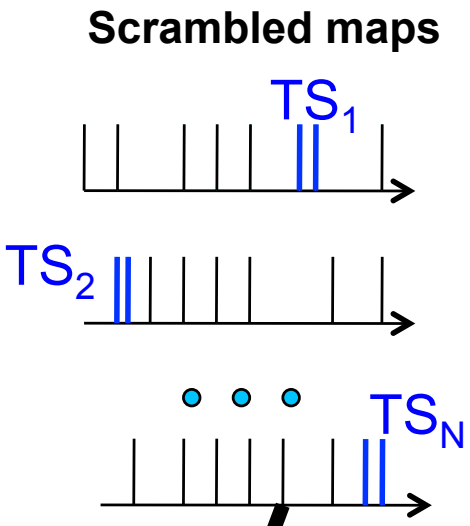


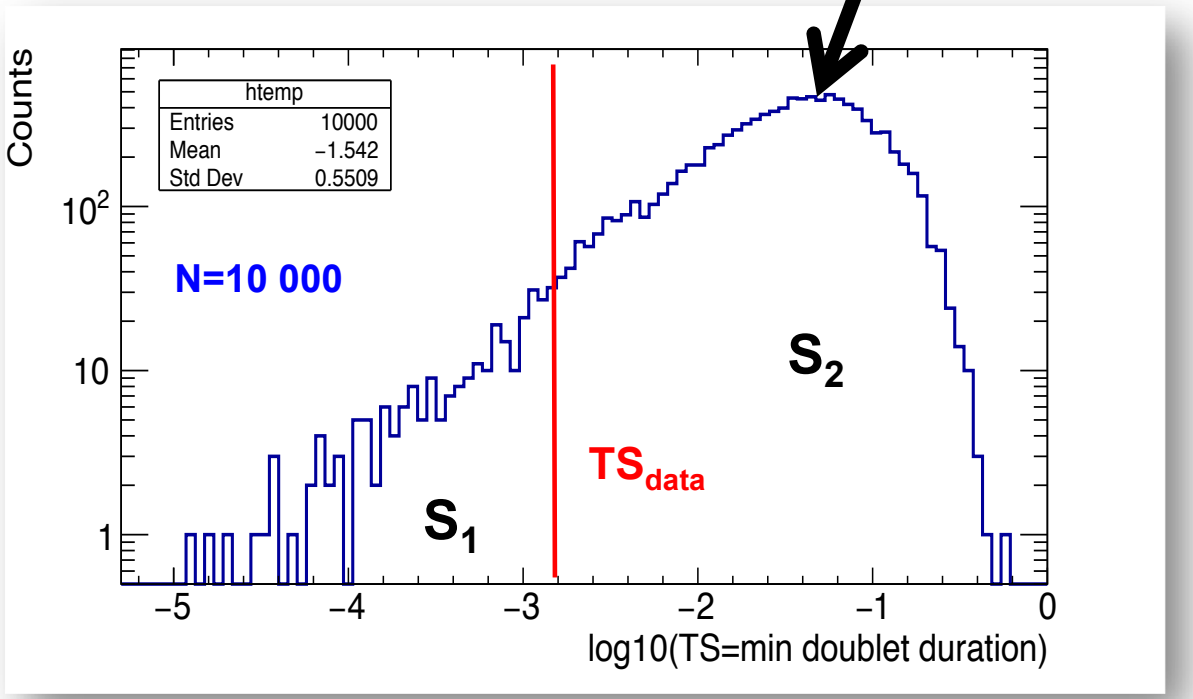
Finding point sources in the sky means to locate *an excess of events from a particular direction* over the background.

The signals events my present additional features: *different energy spectrum or time structure*

Simple method: search for time cluster







Test Statistics (TS)

TS := doublet duration*

*for other multiplets different definitions assumed

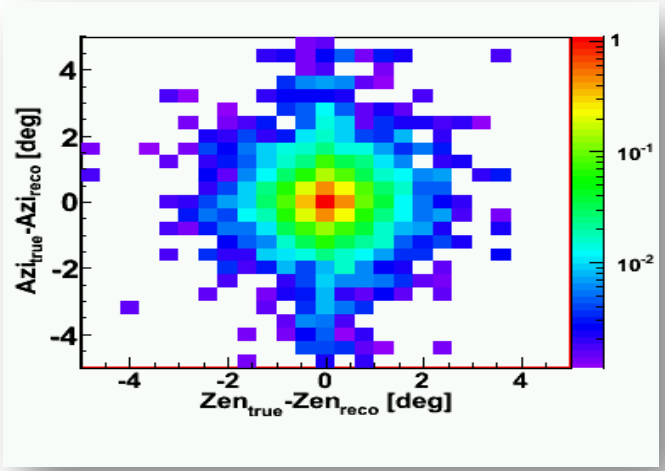
RESULT:
p-value as the fraction of events below TS_{data}

$$\text{P-value} = \frac{S_1}{S_1 + S_2}$$

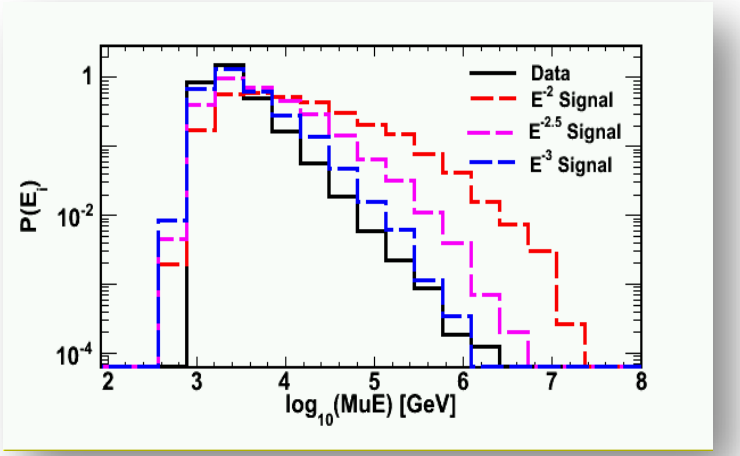
General method: an unbinned maximum likelihood

Method (J. Braun et al., Astropart. Phys.33:175,2010)

Space probability density function



Energy probability density function

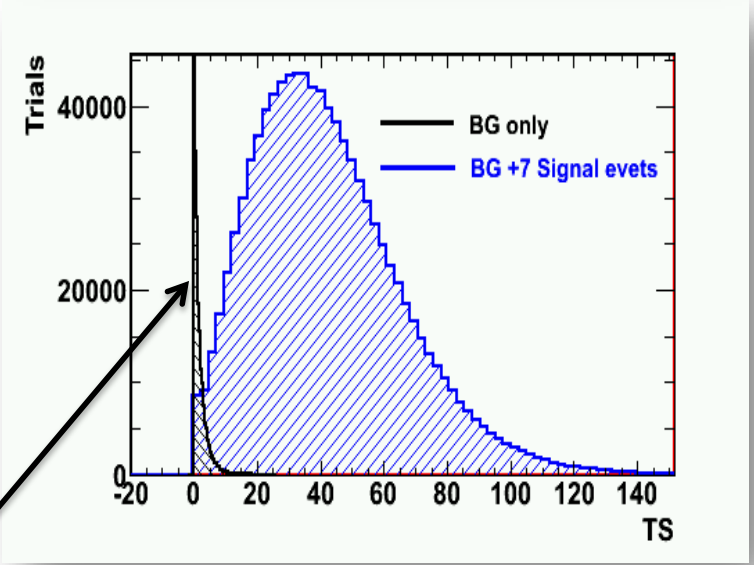


$$\mathcal{L}(n_s,\gamma) = \prod_{i=1}^{N}\left[\frac{n_s}{N}\mathcal{S}_i + (1-\frac{n_s}{N})\mathcal{B}_i\right]$$

$$\mathcal{S}_i = P^{space}(|x_i - x_s|,\sigma_i) \times P^{energy}(E_i|\gamma) \times P^{time}(\Delta t_j)$$

$$\mathcal{B}_i = \frac{1}{d\Omega} \times P_i(E_i) \times P^{time}(\theta,\phi,t_i)$$

$$TS = -2\log(\lambda) = -2\log\frac{\mathcal{L}(n_s=0)}{\mathcal{L}(n_s^f,\gamma^f)}$$



TS distribution for no signal events in data sample

Topic4:

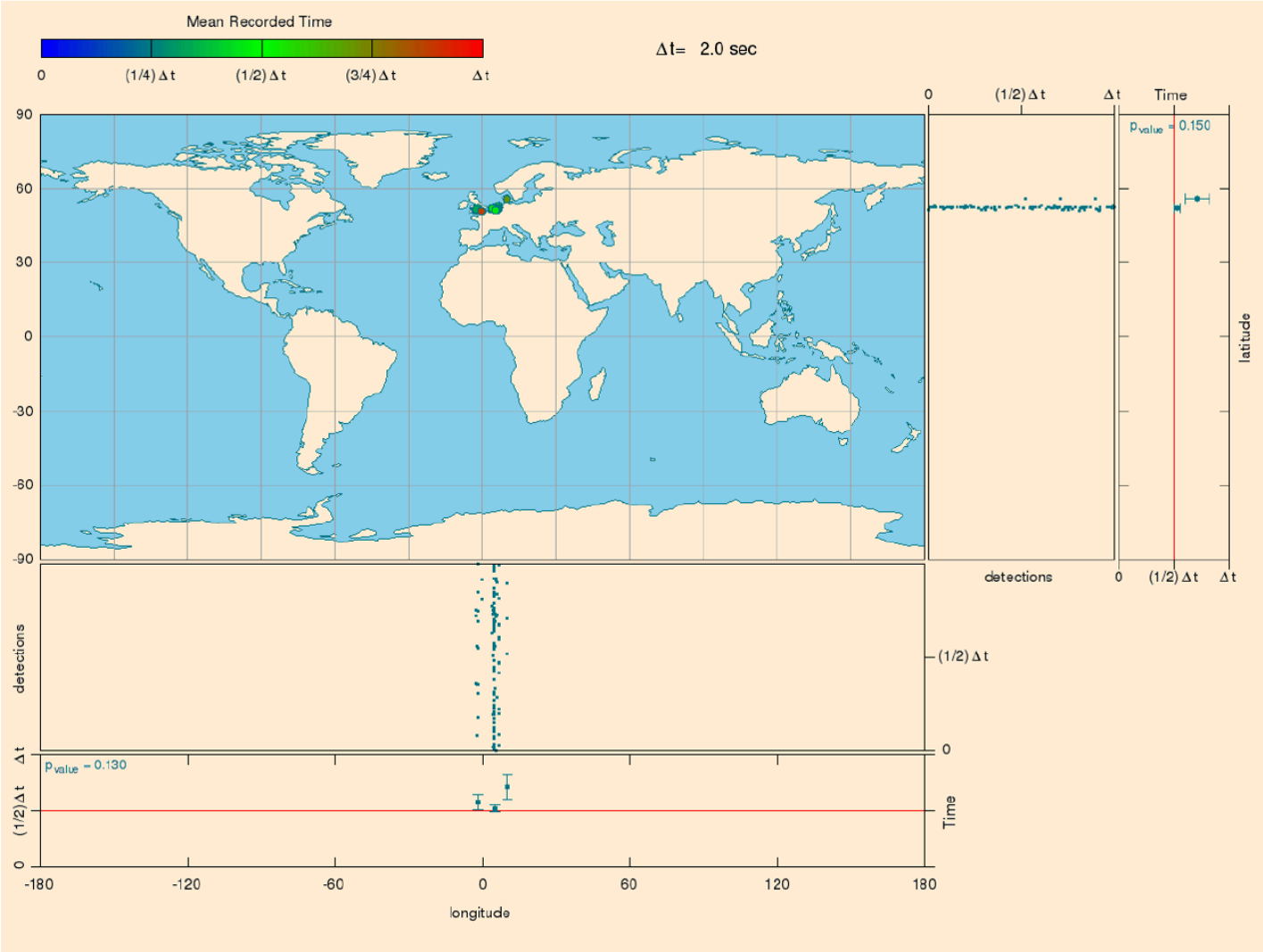
CREDO Monitor

CREDO monitor is a daily automated list of tasks whose ultimate objective is a search of Cosmic Ray Ensembles (CRE).

- **Data Acquisition/Migration:** Acquisition of data and transfer to the central server.
- **Data Conversion:** Conversion of data from different detectors/sources into a common format.
- **Data Preprocessing:** Data sorted in time and merged into the final form (daily sets).
- **Analysis:** A preliminary scanning done to look for possible CRE signatures.
- **Map Production:** Creation of maps for cosmic ray arrival time as a function of geographic locations.
- **Map Sharing:** Sharing the map for analysis/further classification.

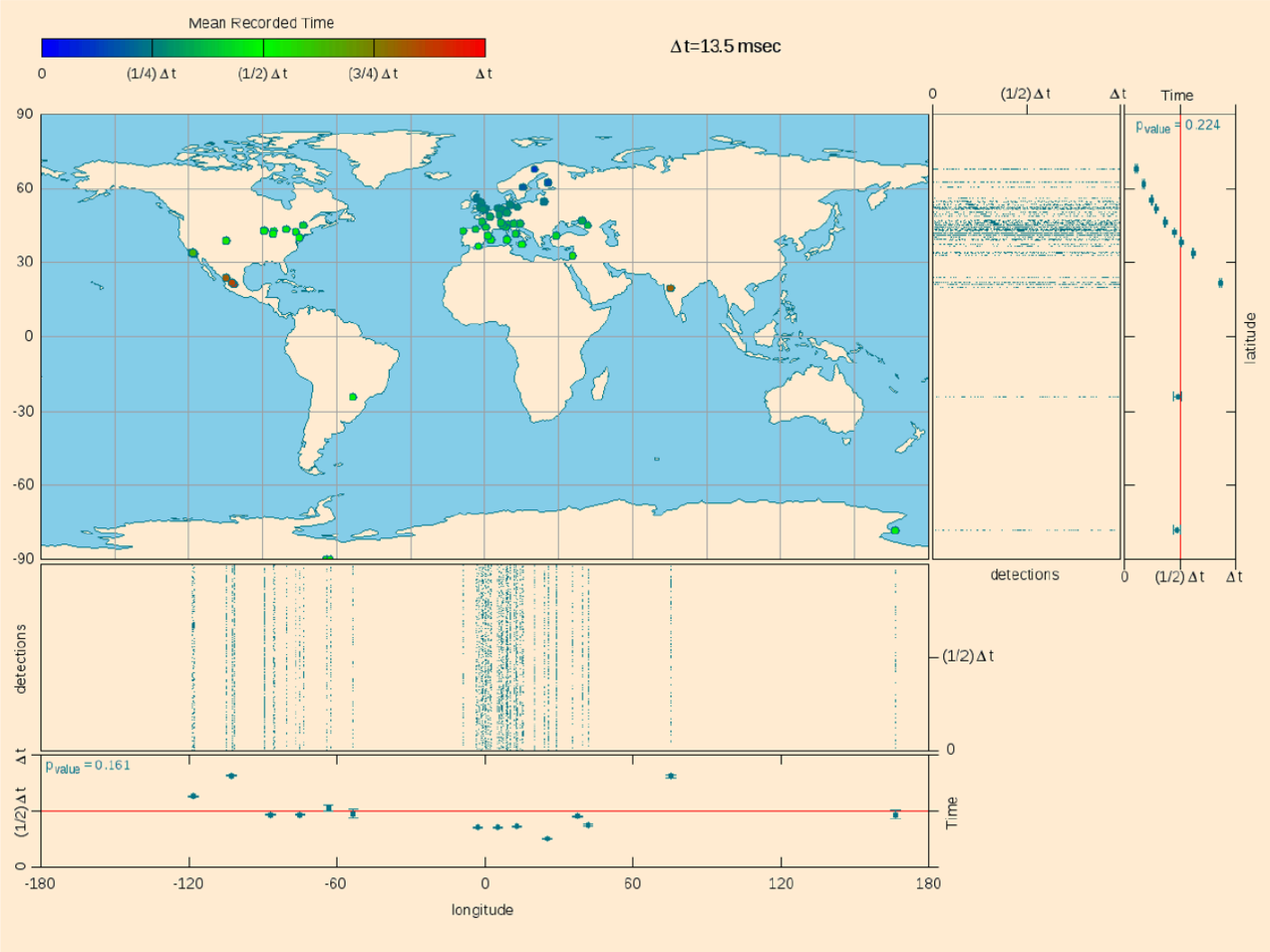
The storage, monitoring and computing tasks of CREDO are hosted by ACC Cyfronet AGH-UST.

CREDO Monitor



Real data analysis

CREDO Monitor

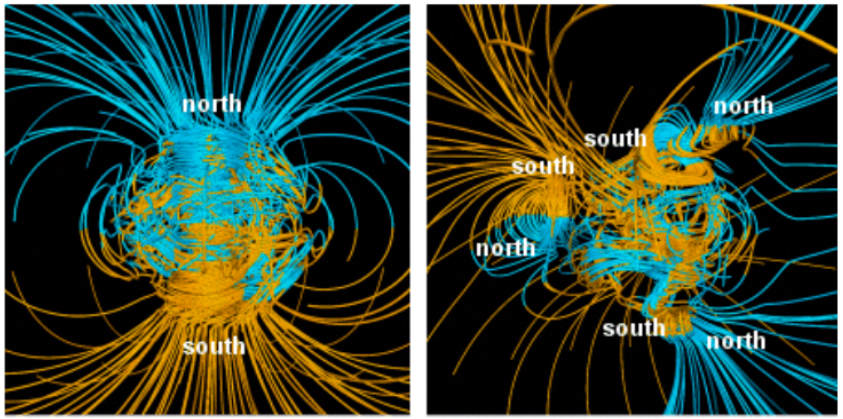


How a CRE signature can look like

Simulation

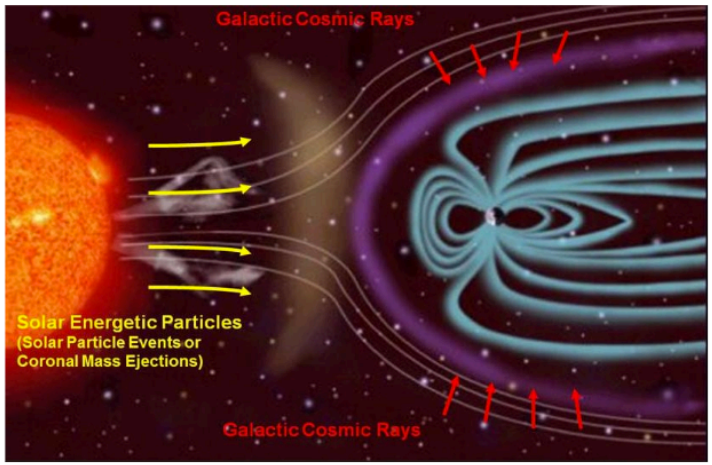
Topic 5:

Wikipedia: „Geomagnetic reversal”



between reversals during a reversal

Wikipedia: „Health threat from cosmic rays”



Earth outer core: Liquid (molten iron)
→ geomagnetism

↓

Impulse (tidal forces)
→ hydrodynamics: waves

↓

→ Mechanical wave upwards (slow, hours?)
→ Electromagnetic wave („instant”, ms)

↓

Local geomagnetic field vector changes
AND seismic effect might occur!

↓

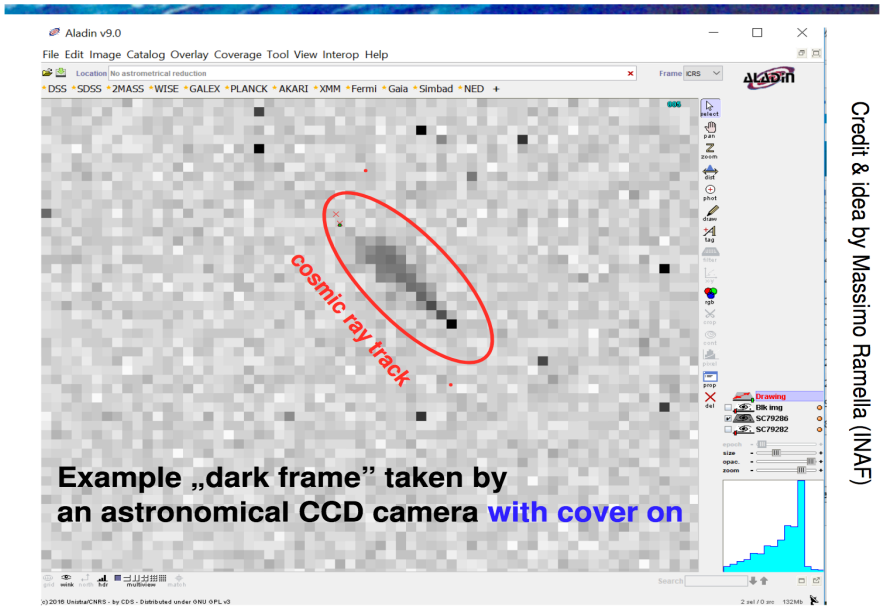
Variation of the CR rate!

↓

Earthquake precursors?

Varia:

CREDO attracts... astronomers!



Credit & idea by Massimo Ramella (INAF)

CREDO

THE QUEST FOR UNEXPECTED

... and gamma-ray astronomy