

Search for long distance correlations from multi-track events

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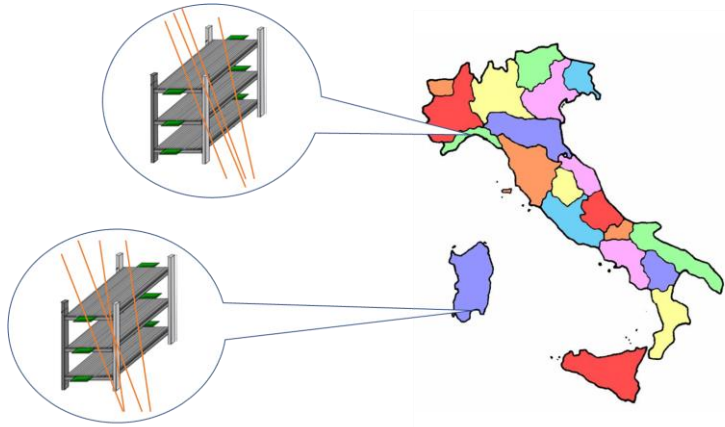
Chiara Pinto

Silvia Pisano

Franco Riggi

EEE Meeting – May 20th, 2021

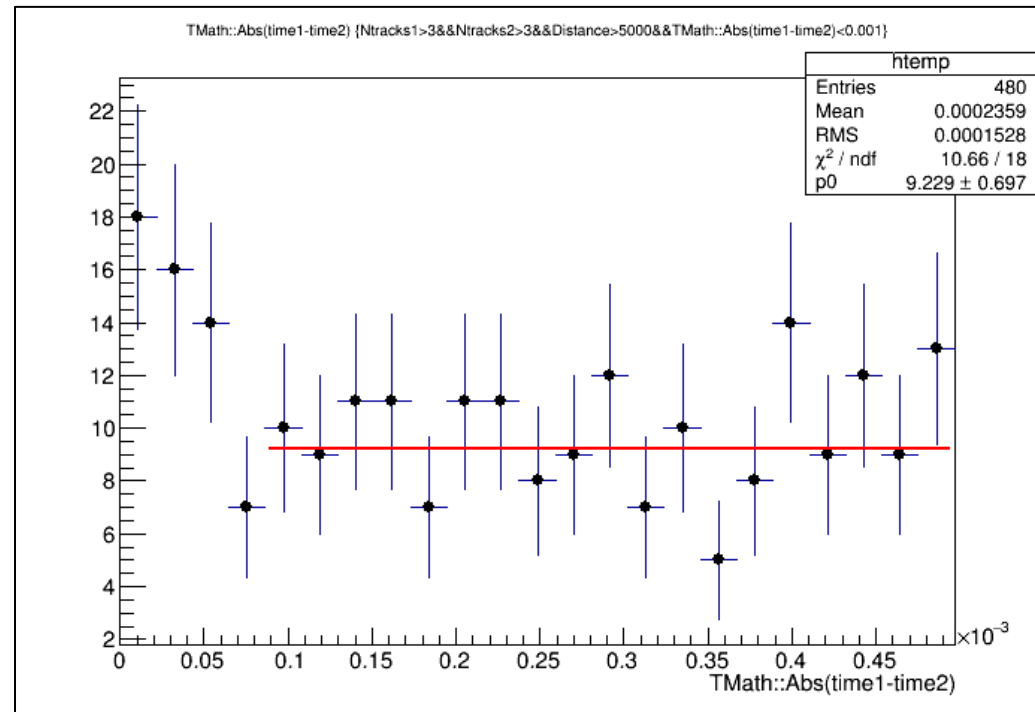
Long distance correlations between multi-tracks events



CUTS:

Distance between telescopes > 5 km

Number of tracks per event > 3



For $\Delta T = 8 \times 10^{-5} \text{ s} \rightarrow 55 \text{ (total)} - 37 \text{ (background)} = 18 \text{ (signal)} \pm 10$

Conclusions from the April 7th meeting

Time correction for EASs orientations does not improve S/N

1. Average direction of EAS pair

$$\phi_{Av} = (\phi_1 + \phi_2) / 2$$

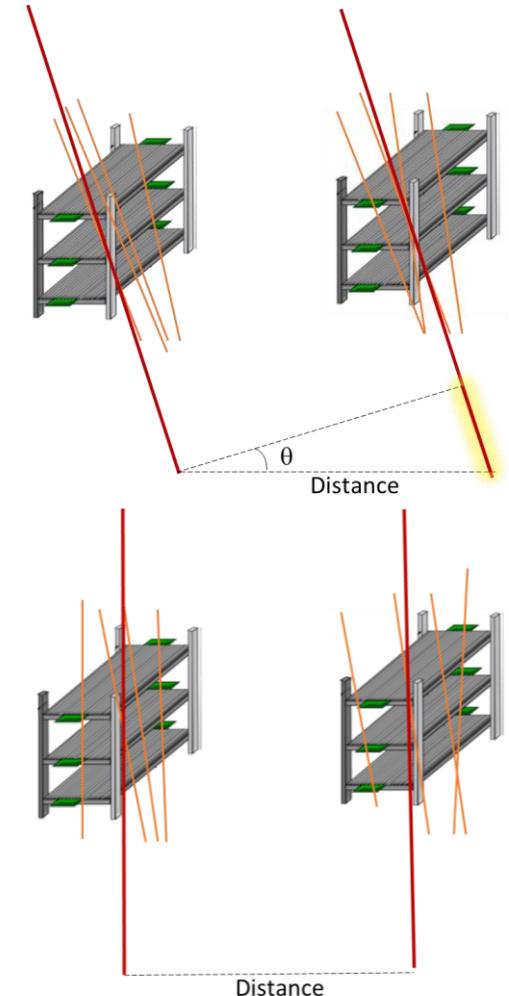
$$\theta_{Av} = (\theta_1 + \theta_2) / 2$$

2. Time correction

$$\text{corr} = \text{Distance} * \sin(\theta_{Av}) * \cos(\phi_{Av} - \text{Angle}) / c$$

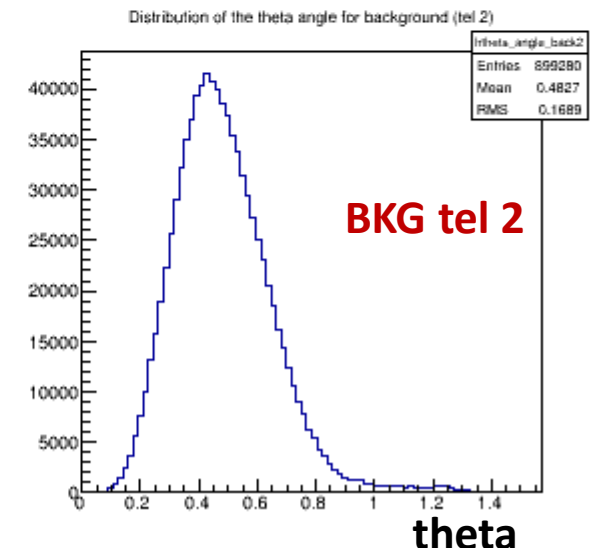
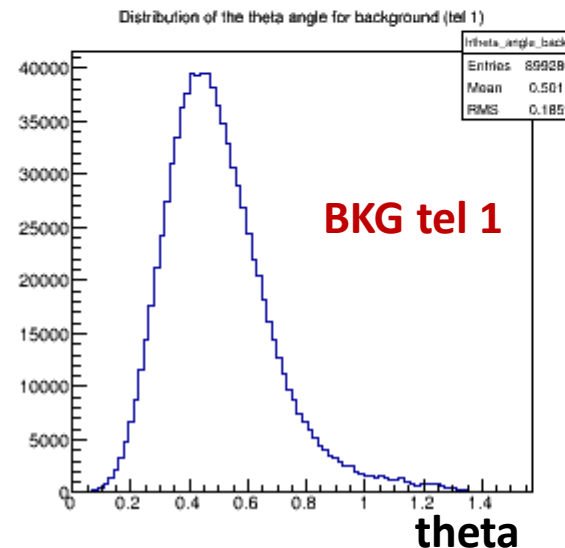
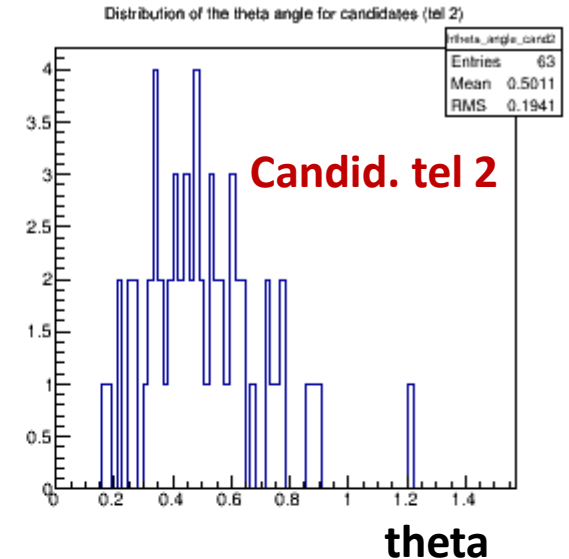
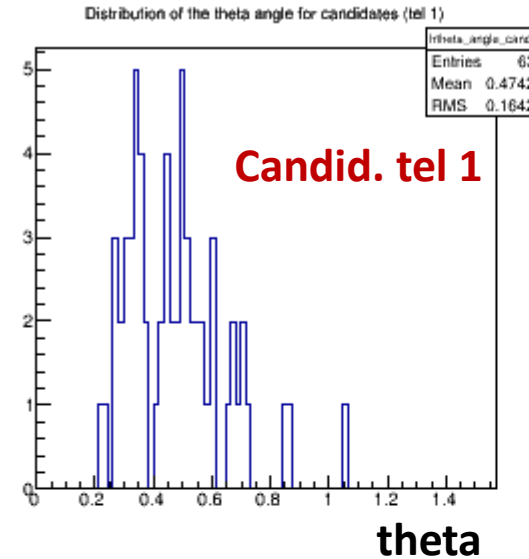
Possible interpretations:

1. The reconstruction of EAS orientation is not accurate enough
2. EASs are correlated in time but not in orientation (expected deflections due to solar and earth magnetic field)
3. The observed excess of events is due to something else (?)



Theta distributions for candidate and background events

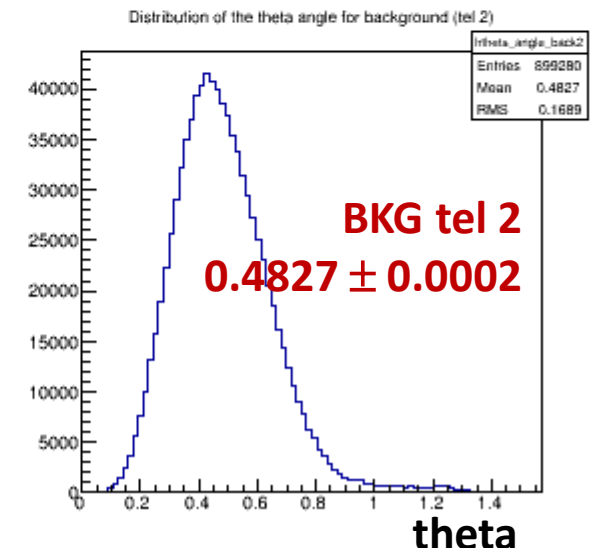
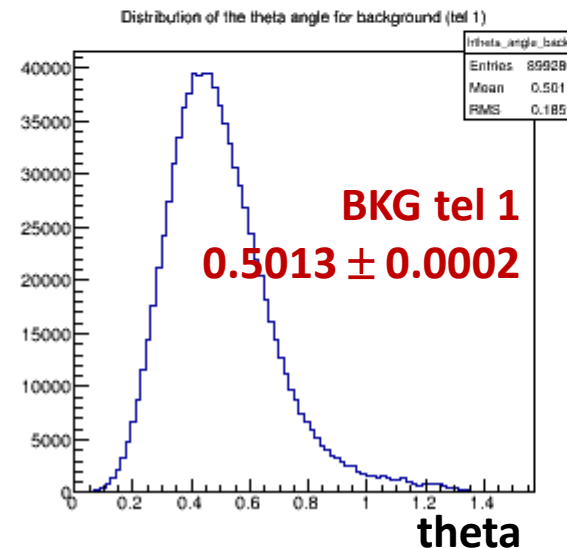
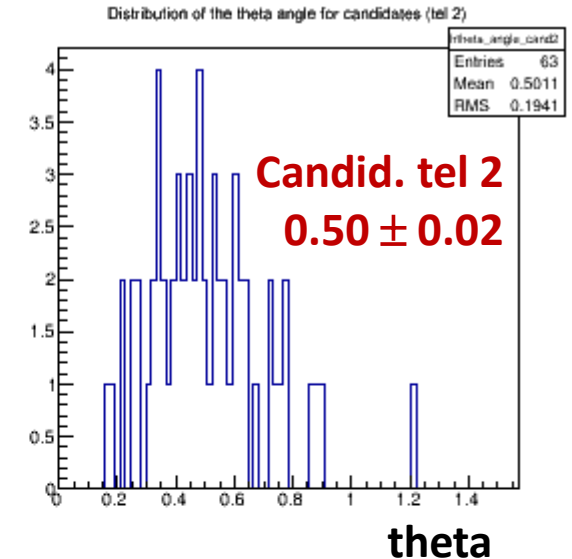
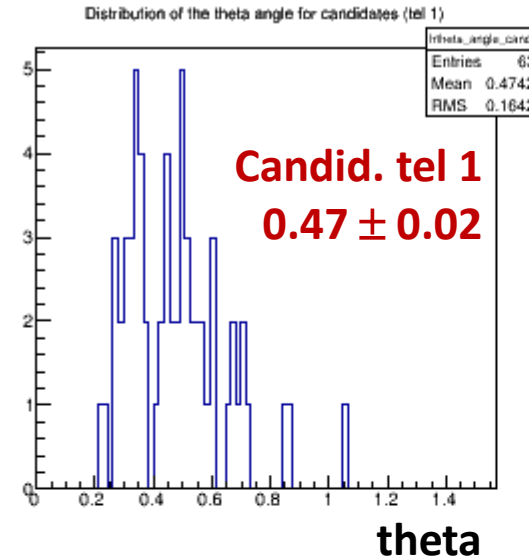
Hypothesis: since the time correction for EASs orientations seems to degrade S/N, the excess of events could be related to vertical showers



Theta distributions for candidate and background events

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→ **Not true**



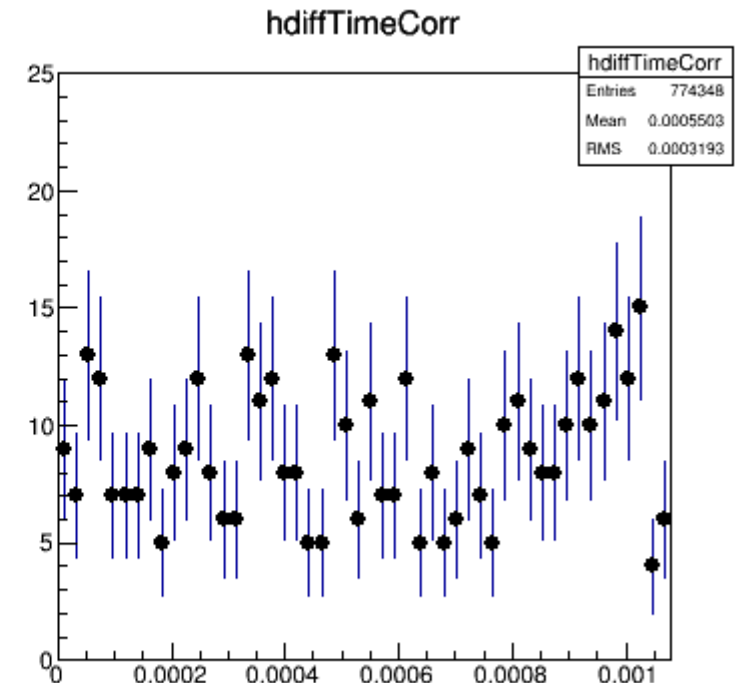
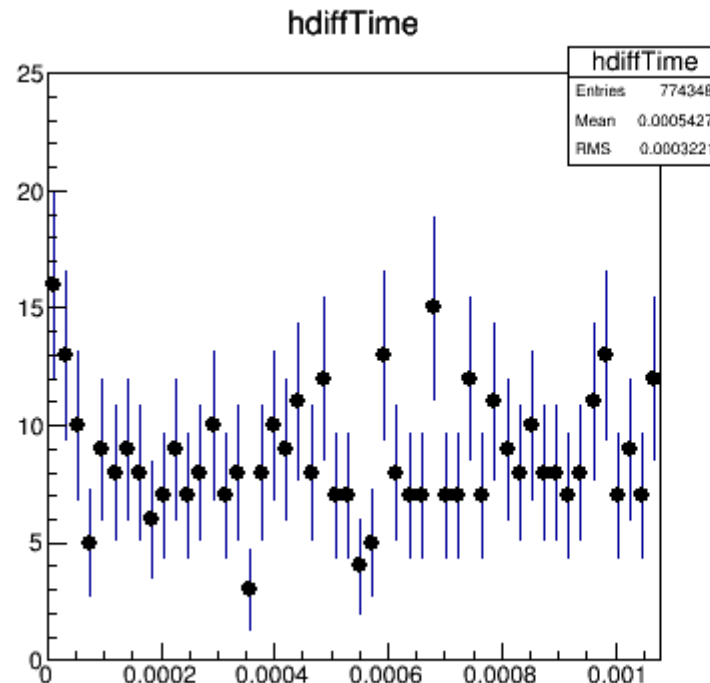
Use of the seed track as EAS axis

Hypothesis: the precision in the reconstruction of the EAS orientation could be affected by low quality tracks

Alternative approach: use the seed track as estimation of the EAS axis

Time correction

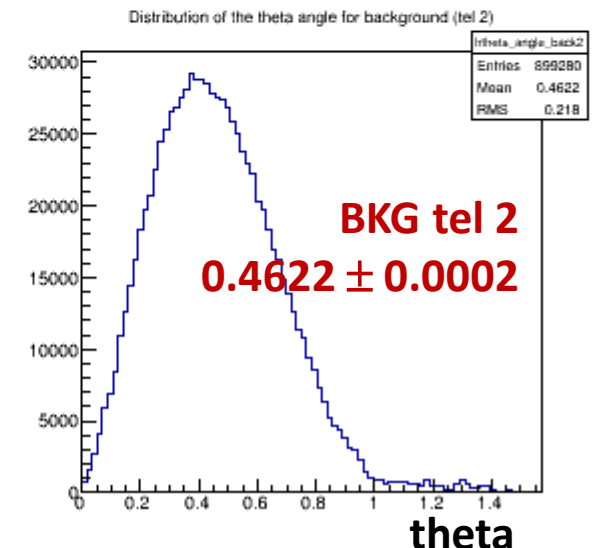
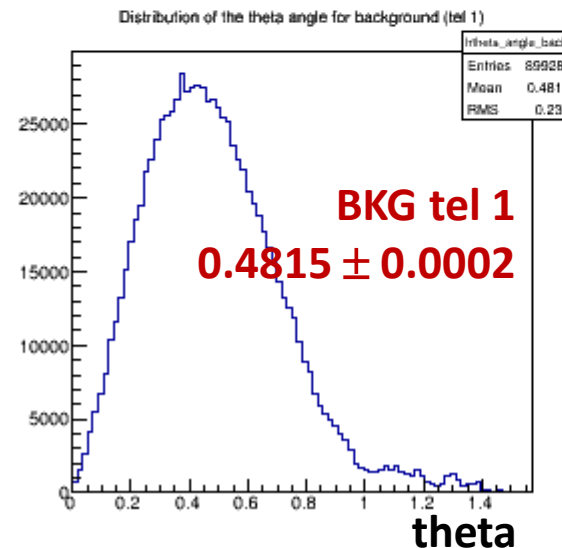
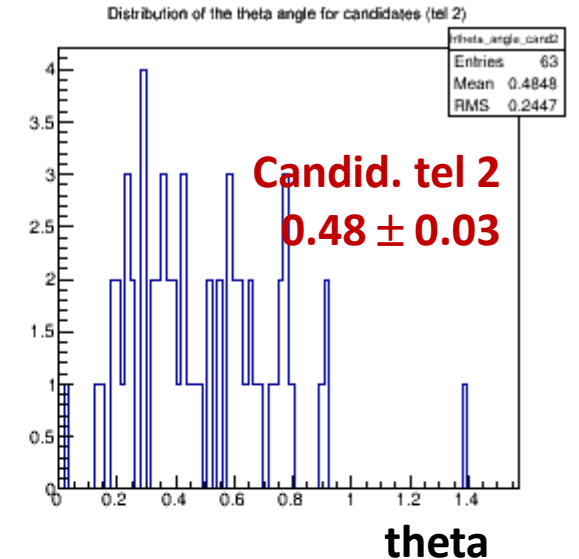
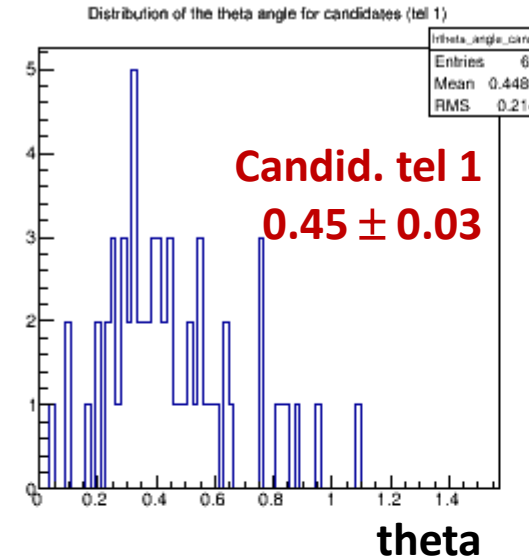
$$\text{corr} = \text{Distance} \times \sin(\theta_{\text{Seed}}) \times \cos(\phi_{\text{Seed}} - \text{Angle}) / c$$



Use of the seed track as EAS axis

Hypothesis: since the time correction for EASs orientations seems to degrade S/N, the excess of events could be related to vertical showers

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Conclusions from the April 7th meeting

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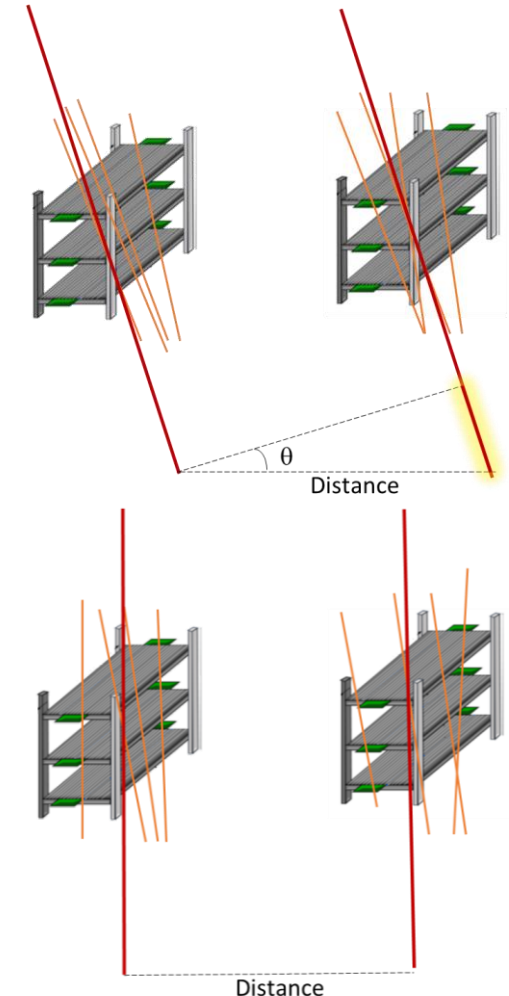
$$\text{thetaAv} = (\text{theta1} + \text{theta2}) / 2$$

2. Time correction

$$\text{corr} = \text{Distance} * \sin(\text{thetaAv}) * \cos(\text{phiAv} - \text{Angle}) / c$$

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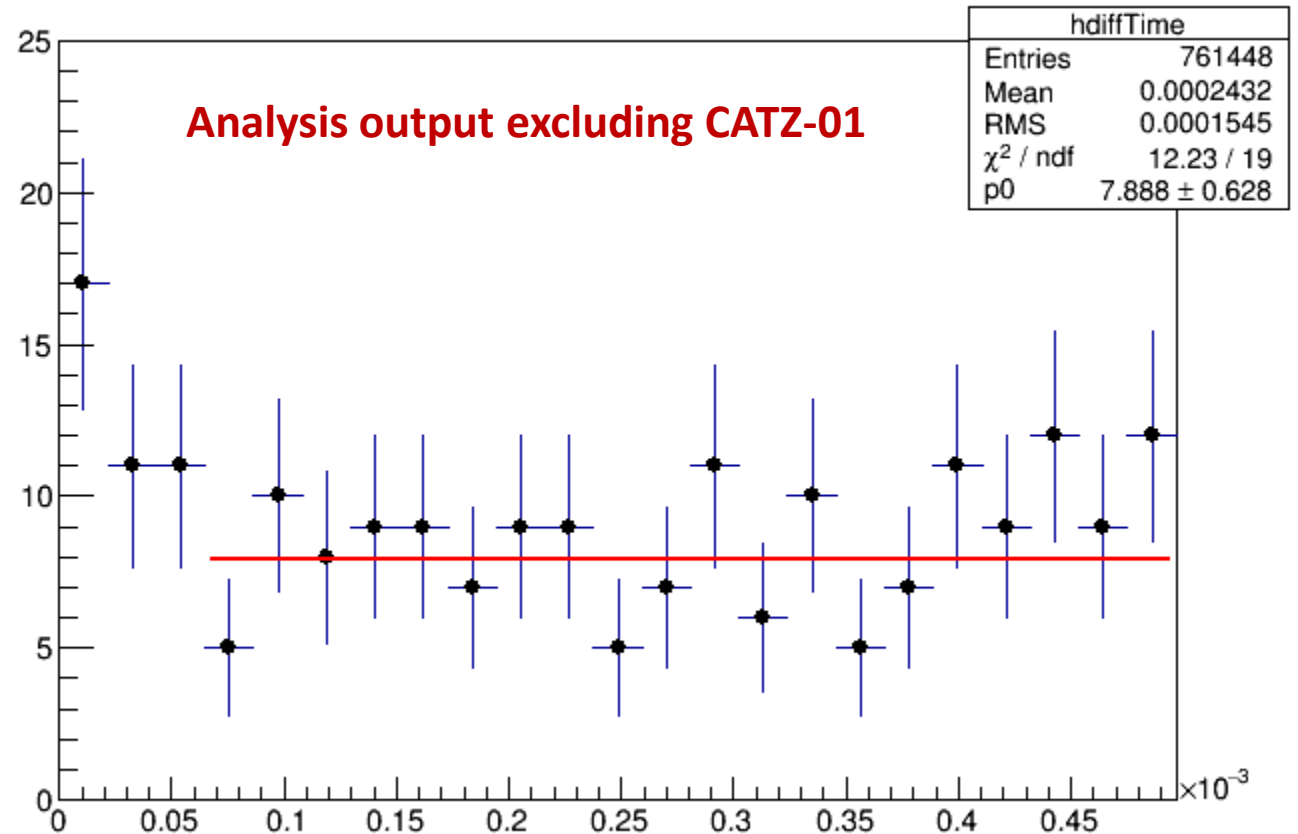
In-depth analysis of the candidate events

- 48 candidate events (for each event 2 telescopes involved)
- Check of GPS on a subset of events (+/- 300 sec) around each candidate event

15 anomalies in time distributions (over +/- 300 sec around the candidate events), 9 out of 15 are related to CATZ-01

13 anomalies (over +/- 1000 events around the candidate events), 9 out of 13 are related to CATZ-01

6 anomalies (over +/- 100 events around the candidate events), 4 out of 6 are related to CATZ-01



If all the telescopes showing anomalous time distributions (7 in total) are excluded from the analysis, the excess of events disappears → low statistics

Conclusions and Outlook

- Time correction for EASs orientations does not improve S/N
- Attempting to estimate EAS orientation using the seed track does not help
- Even excluding one telescope from the analysis (CATZ-01 because of unreliable GPS tagging), the excess of events survives
- Investigation of the characteristics of the candidate events **ongoing:**
 - **Check of events topology (tracks viewer is being developed)**
 - **Additional checks of telescopes operation**