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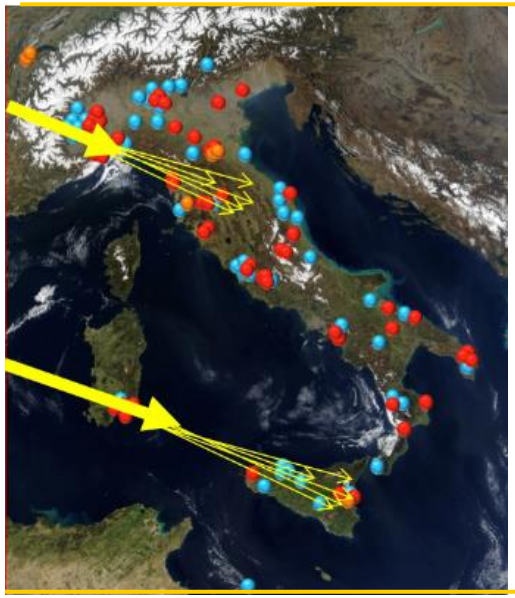

Search for long distance correlations by selecting multi-tracks events

P.La Rocca and F.Riggi

ANALYSIS STRATEGY

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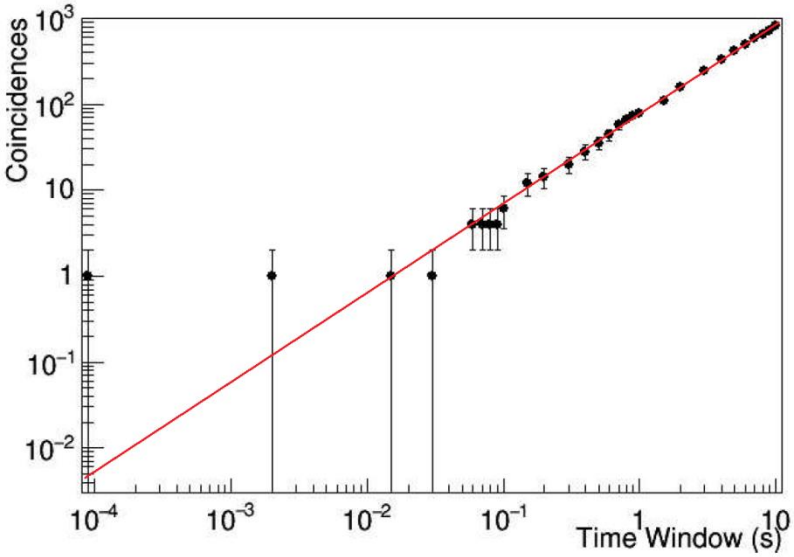
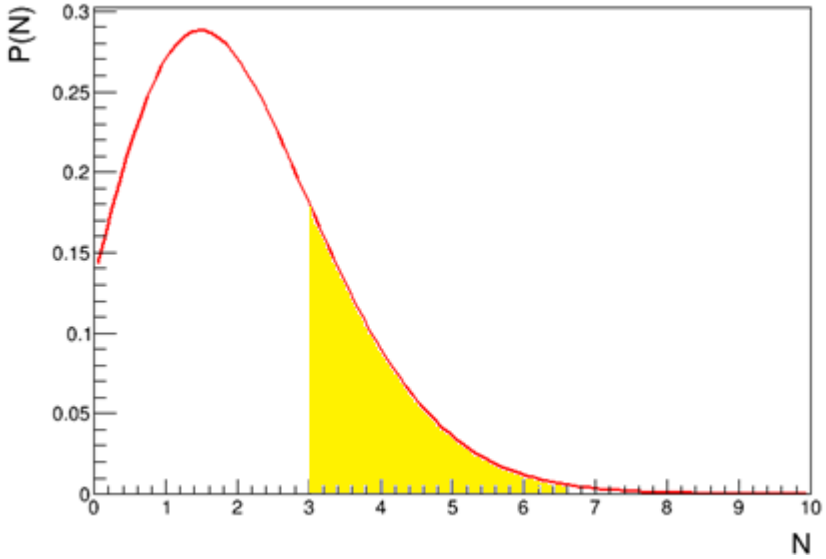
- **Search for coincidences between EEE sites**
- **Coincidence time window compatible with the distance between the sites**

d ~ 10 km → 33 us
d ~ 1000 km → 3.3 ms





N_{obs}
N_{exp}

$\Rightarrow$ **p-value = P ($N \geq N_{obs}$, $\mu = N_{exp}$)**

ANALYSIS STRATEGY

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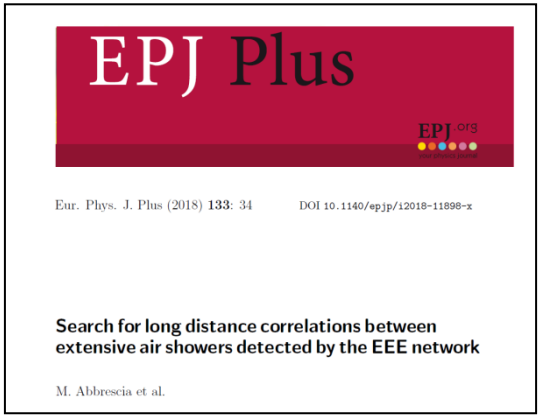
- **Rare events → negligible background needed!**
- **Possible analysis strategies:**
  - **Correlation between independent telescopes**
  - **Correlation between a single muon and a two-track event in another telescope**
  - **Correlation between two-track events in both telescopes**
  - **Correlation between telescope pairs (extensive air showers) ✓**
- **First results published on EPJ Plus in February 2018**
  - **Coincidences between all the possible 45 pairs of the 10 EEE cluster sites hosting at least two telescopes**
  - **3968 days of time exposure**
  - **5 candidate events with a p-value<0.05**


EPJ Plus

EPJ.org

Eur. Phys. J. Plus (2018) 133: 34 DOI 10.1140/epjp/i2018-11898-x

Search for long distance correlations between extensive air showers detected by the EEE network

M. Abbrescia et al.

MULTI-TRACKS EVENTS

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Selection procedure for multi-tracks events in EEE telescopes→ Thanks to Francesco

- Evaluate all the possible 3-hits combinations
- Apply a cut on chi2 (<50)
- Select the track with the lowest chi2 value (used as seed)
- Sort all the other tracks from lower to higher chi2
- Select tracks if their scalar product with the seed track > 0.8 (parallelism constraint)
- Reject all the other tracks
- Evaluate the average direction
- Store events with Ntracks >= 3

ROOT file containing correlated multi-tracks events (within a 2 second time window) between all the possible telescope couples → Thanks to Francesco

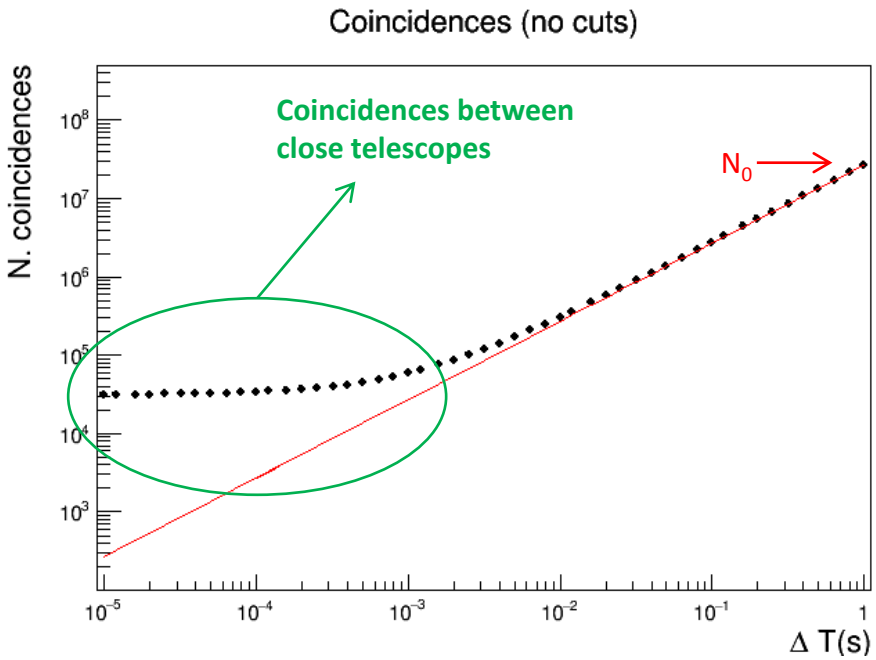
TREE Variables:

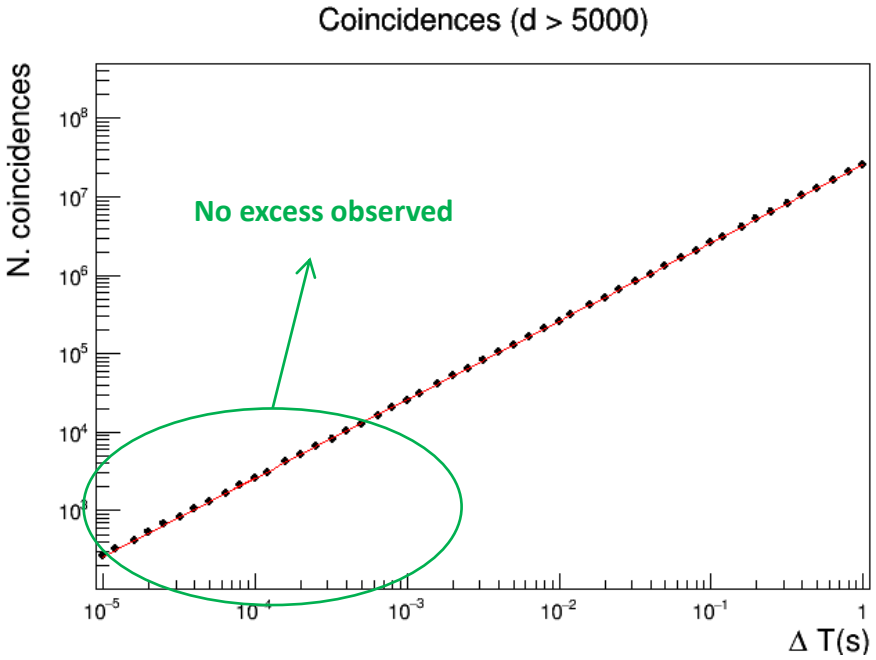
time1 : event time telescope 1
time2: event time telescope 2
sch1: code telescope 1
sch2: code telescope 2
Ntracks1: n. tracks telescope 1
XDir1: x average directional cosine telescope 1
YDir1 : y average directional cosine telescope 1
ZDir1 : z average directional cosine telescope 1

Ntracks2 : n. tracks telescope 2
XDir2 : x average directional cosine telescope 2
YDir2 : y average directional cosine telescope 2
ZDir2 : z average directional cosine telescope 2
XDirS: x average directional cosine wrt the Sun
YDirS : y average directional cosine wrt the Sun
ZDirS : z average directional cosine wrt the Sun
Distance: distance between the telescopes (in m)
Angle: angle between the 2 telescopes wrt the North

Number of coincidences between telescopes

No cuts applied



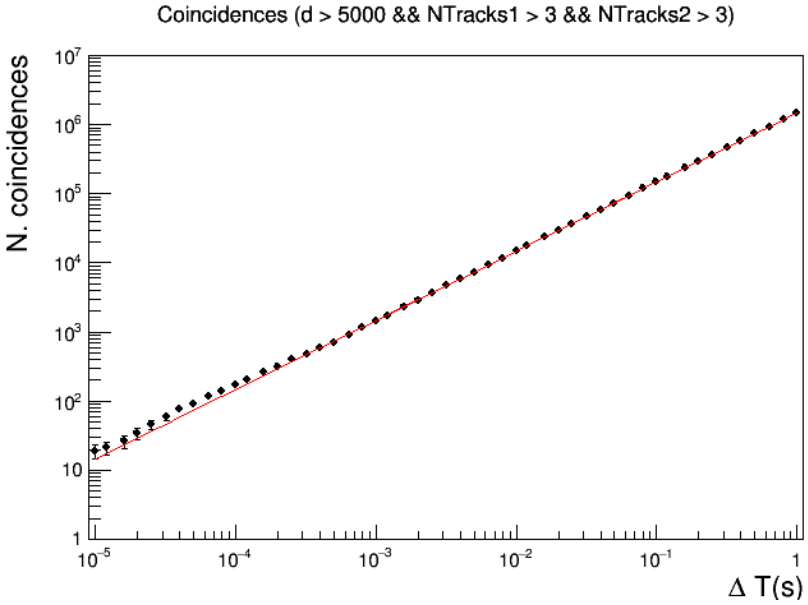


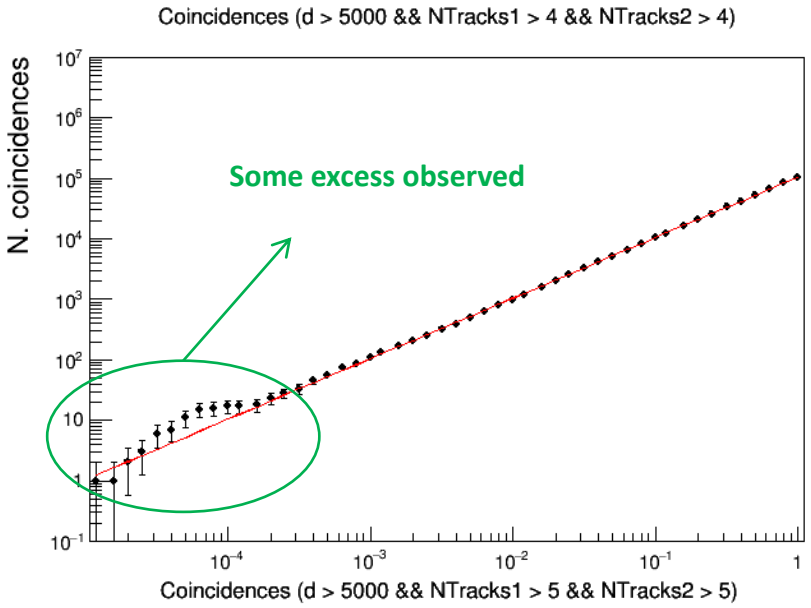
Expected noise trend

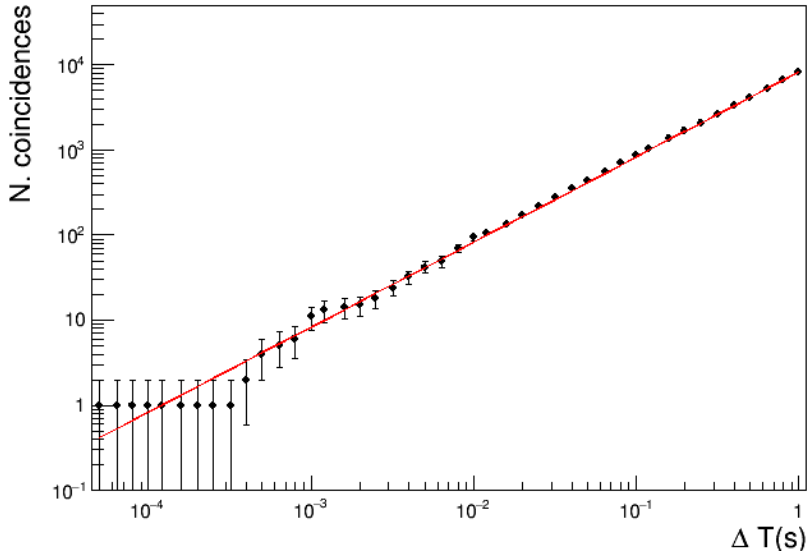
$N = (N_0 * \Delta T / \Delta T_0) \pm (\sqrt{N_0} * \Delta T / \Delta T_0)$

Number of coincidences between telescopes

Effect of a cut on Ntracks (same cuts on the 2 telescopes)







Expected noise trend

$N = (N_0 * \Delta T / \Delta T_0) \pm (\sqrt{N_0} * \Delta T / \Delta T_0)$

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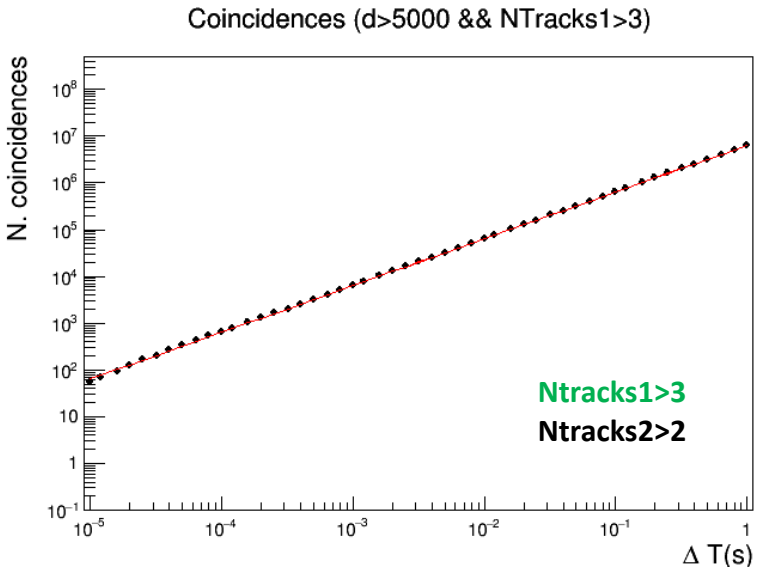
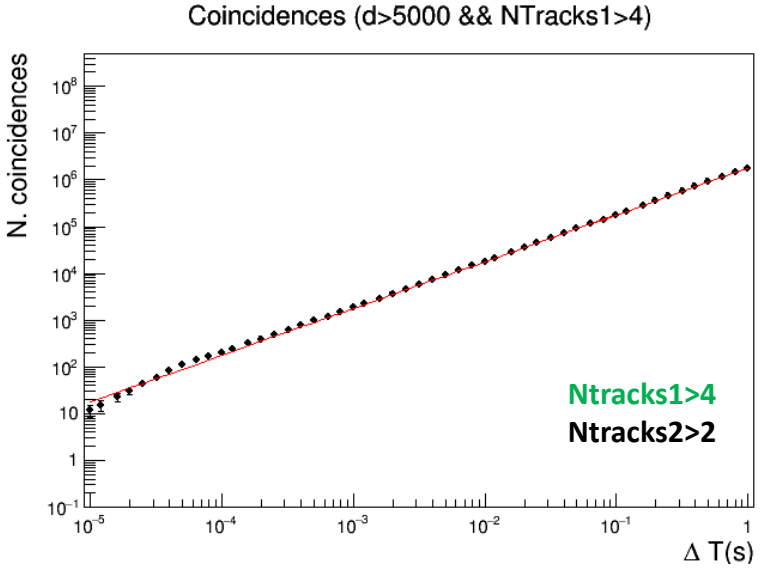
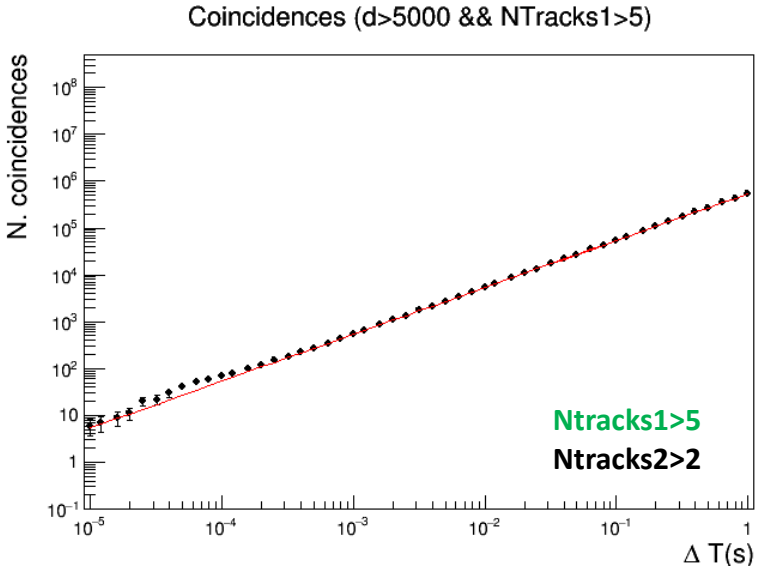
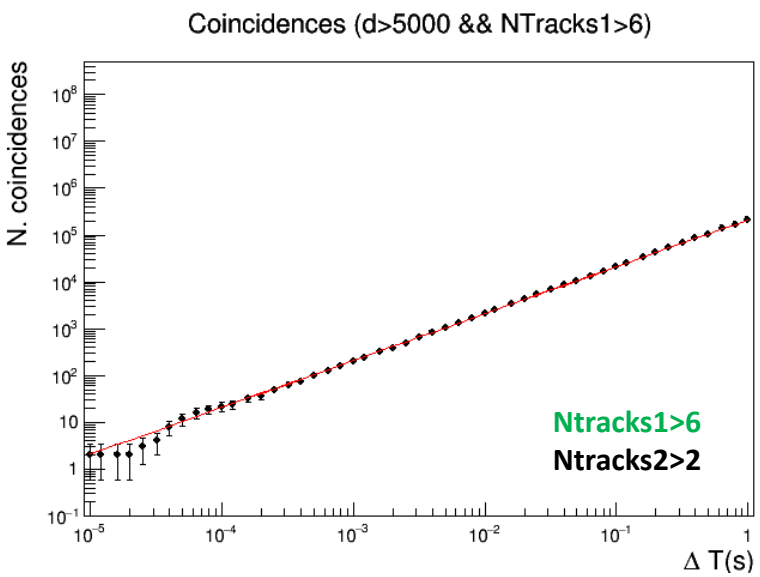
Number of coincidences between telescopes

Effect of a cut on Ntracks (different cuts on tel1 and tel2)









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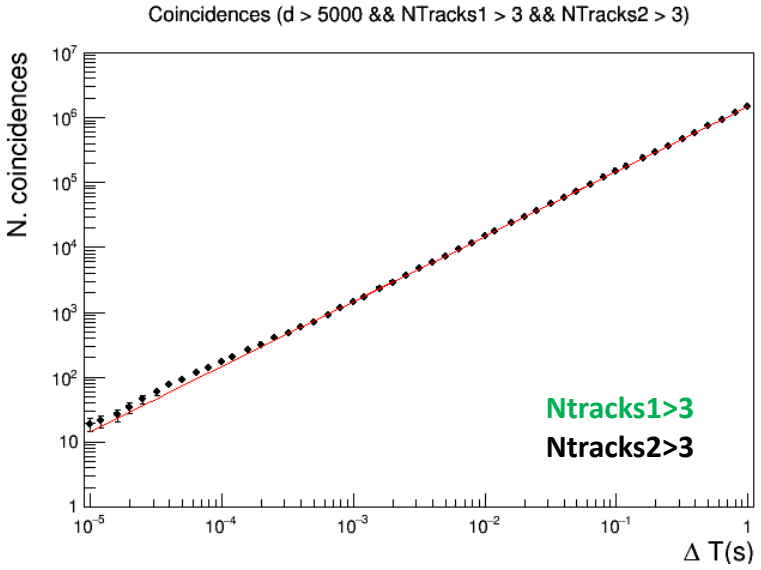
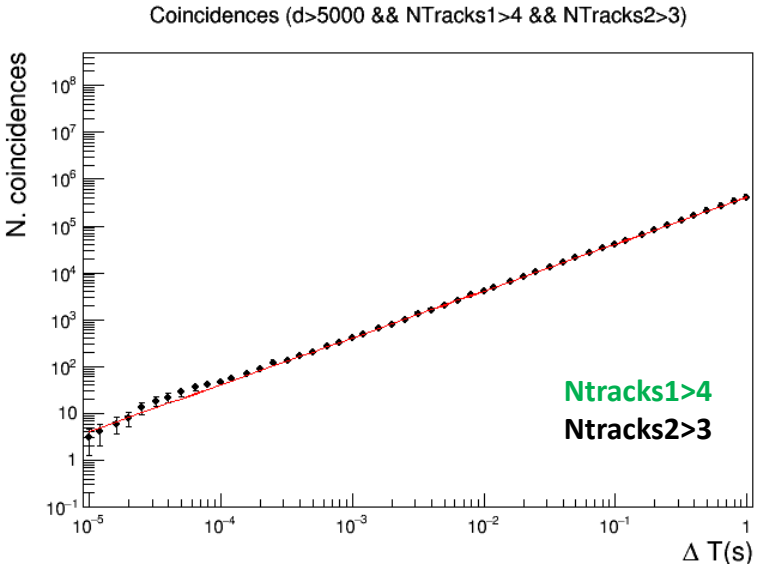
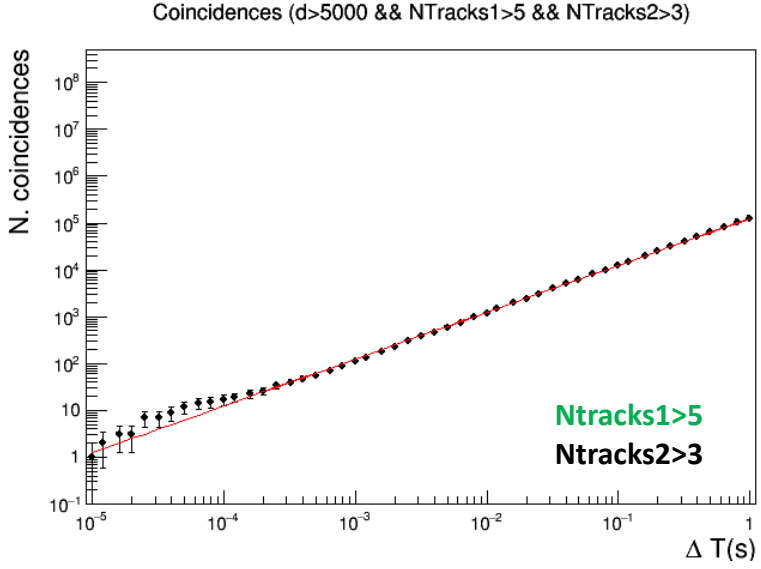
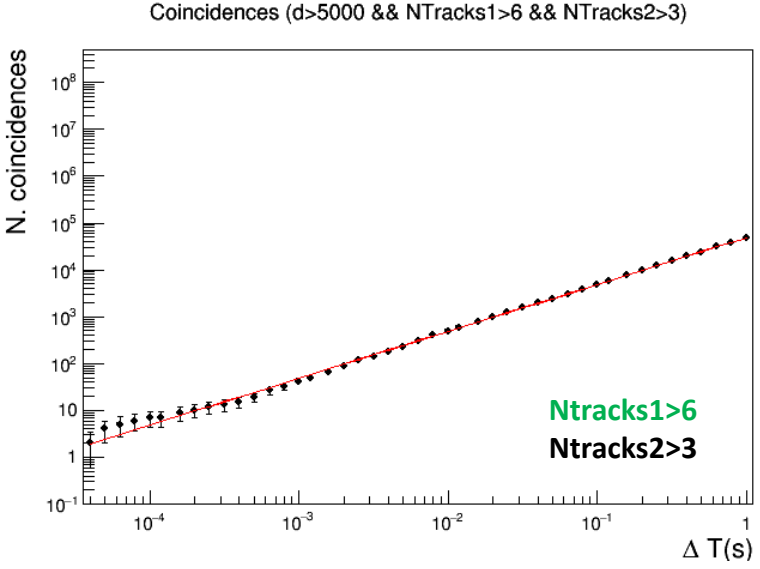
Number of coincidences between telescopes

Effect of a cut on Ntracks (different cuts on tel1 and tel2)









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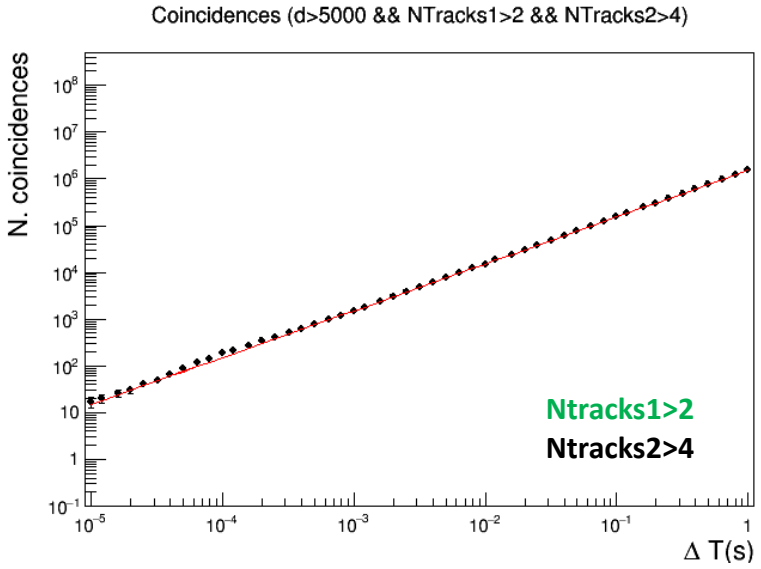
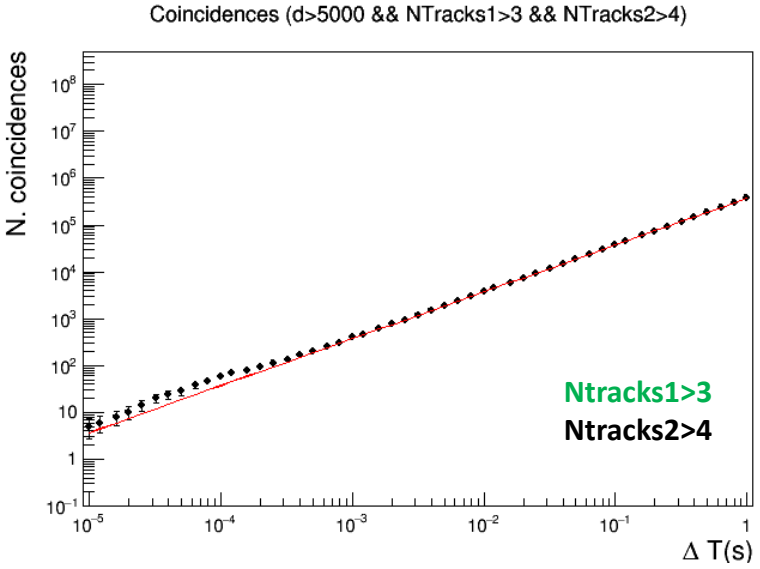
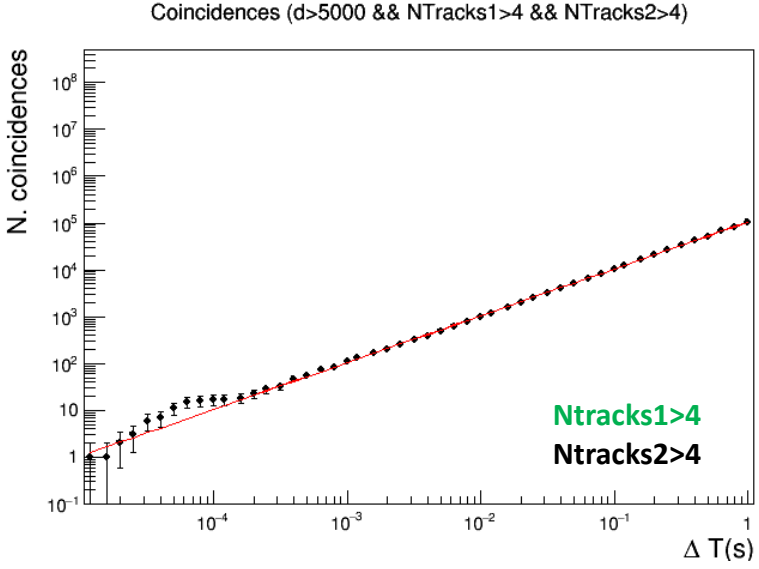
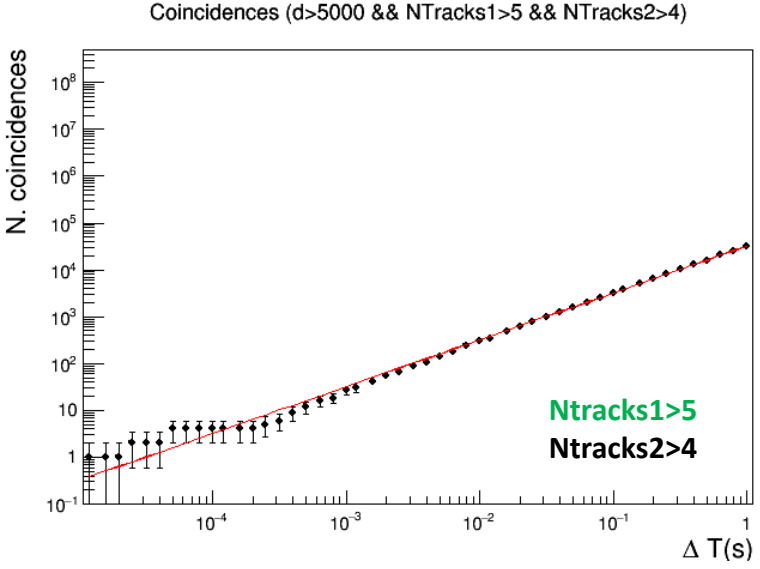
Number of coincidences between telescopes

Effect of a cut on Ntracks (different cuts on tel1 and tel2)









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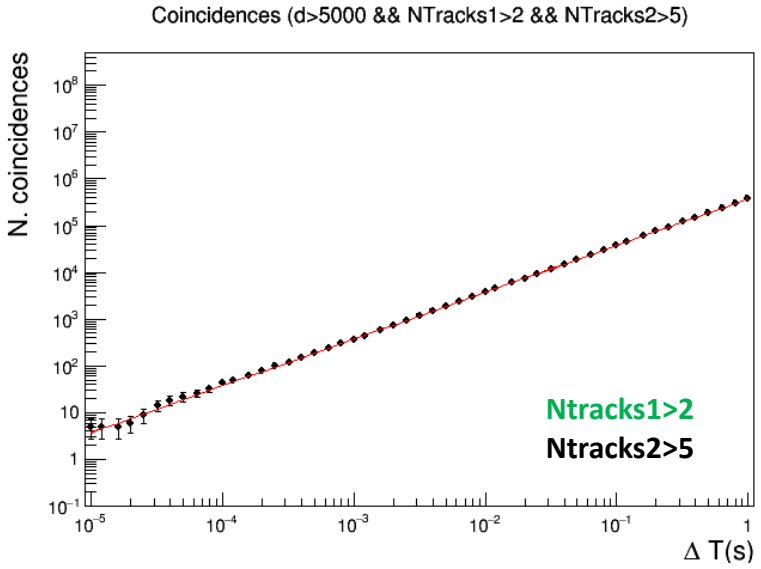
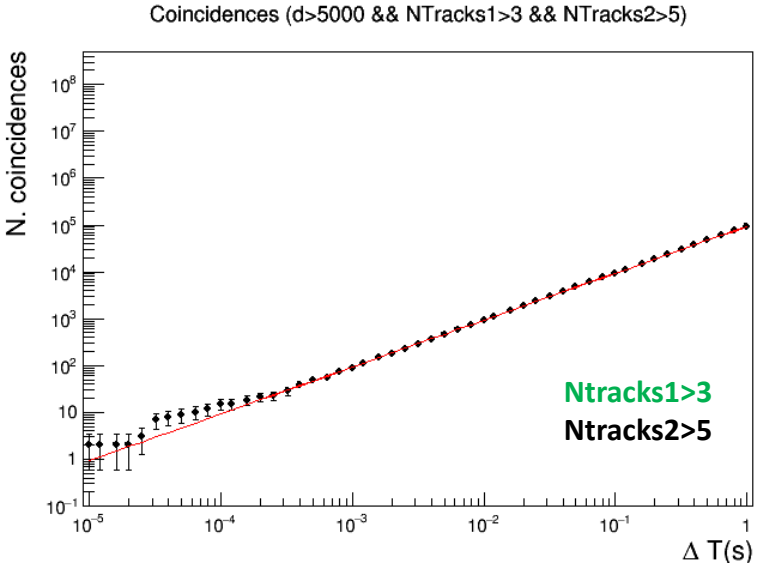
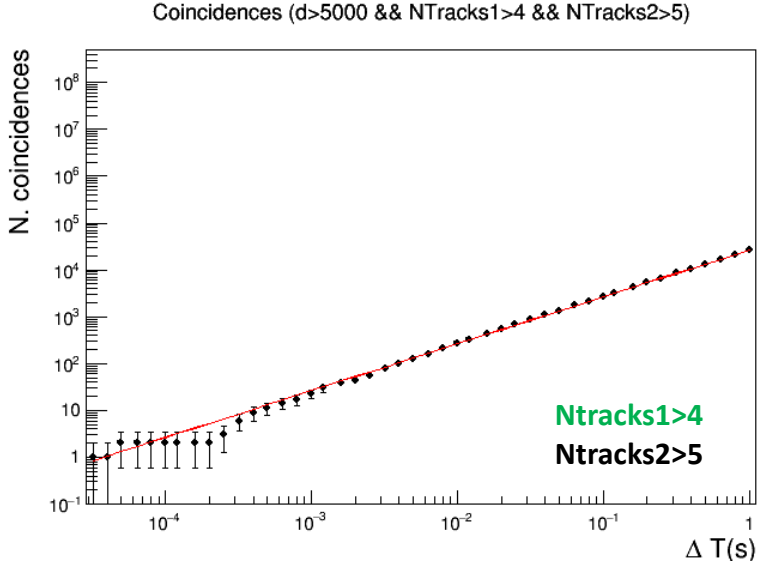
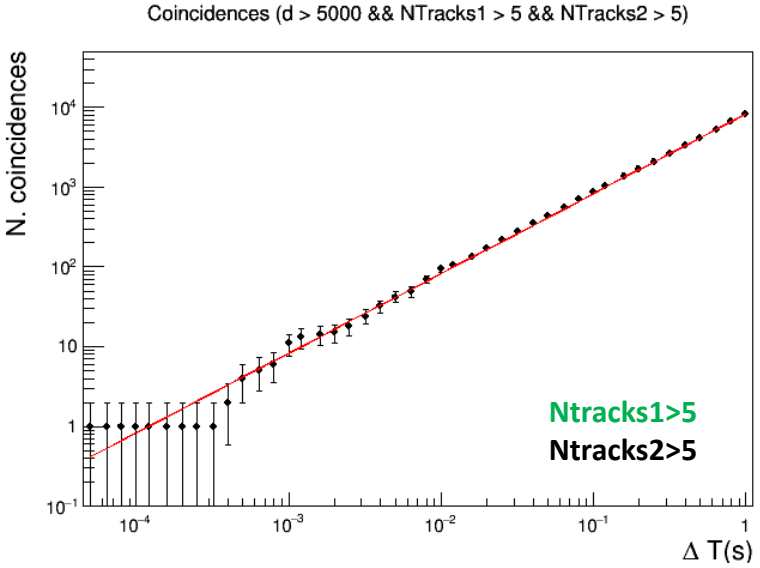
Number of coincidences between telescopes

Effect of a cut on Ntracks (different cuts on tel1 and tel2)









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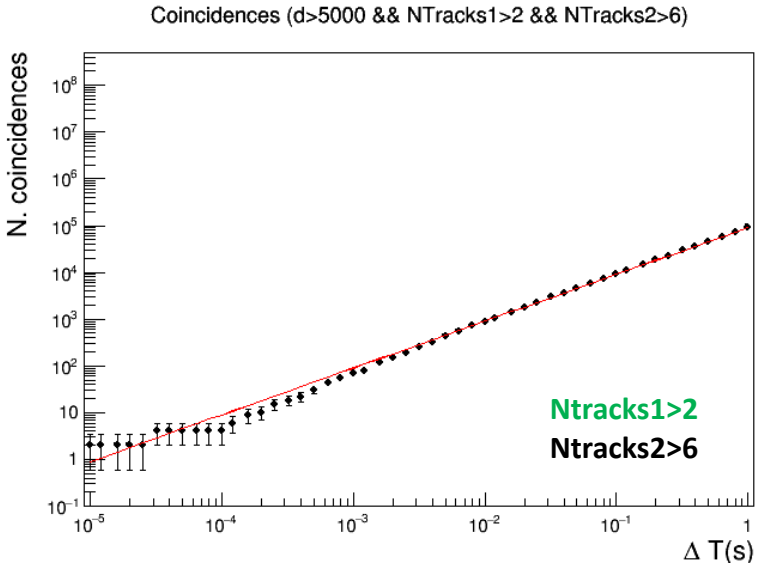
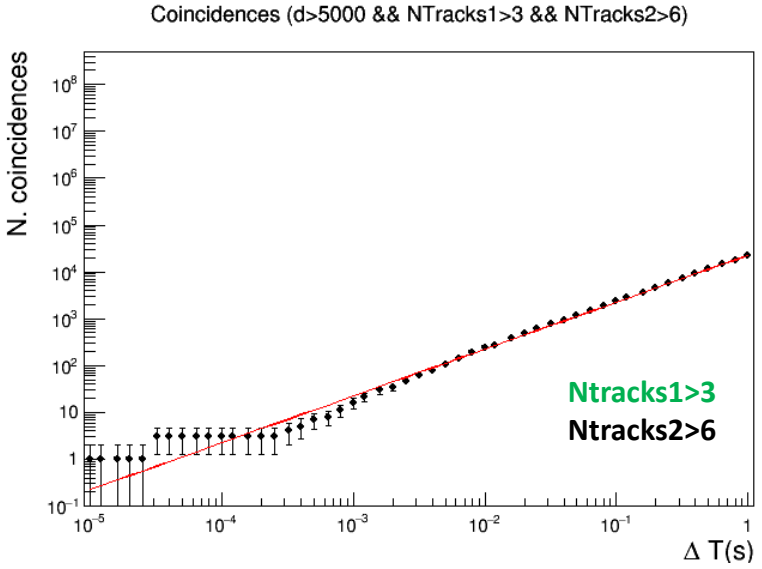
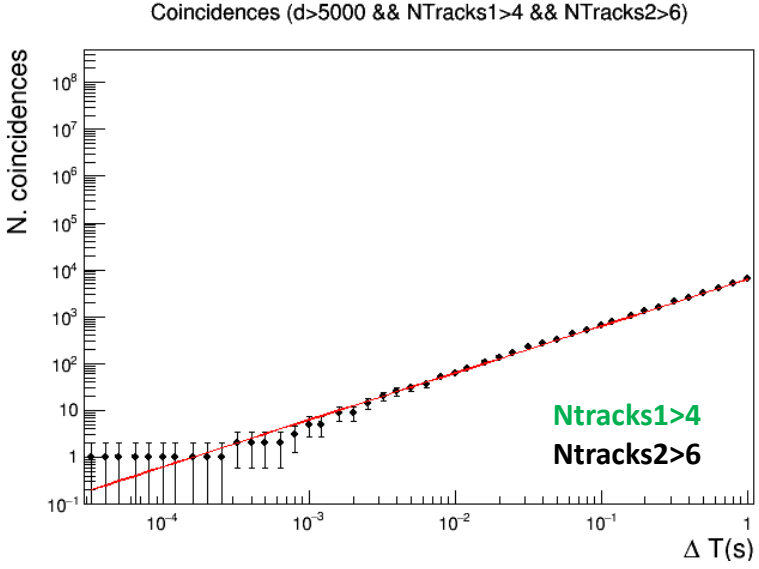
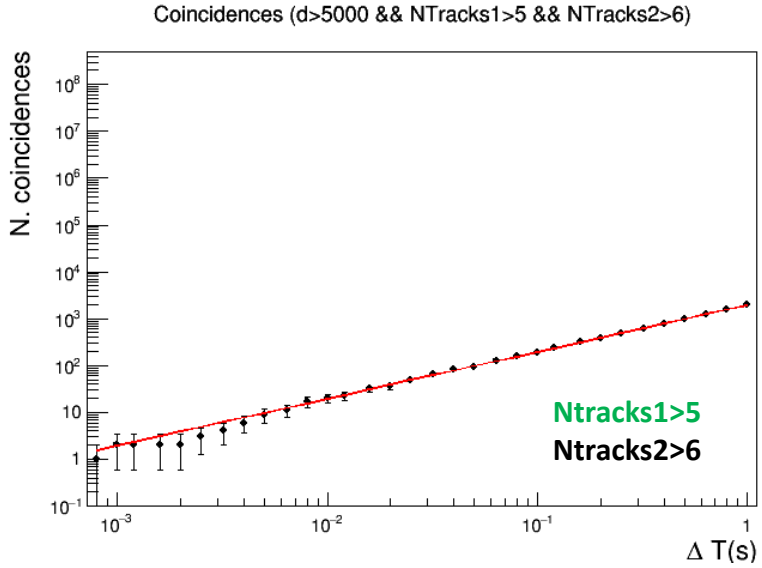
Number of coincidences between telescopes

Effect of a cut on Ntracks (different cuts on tel1 and tel2)

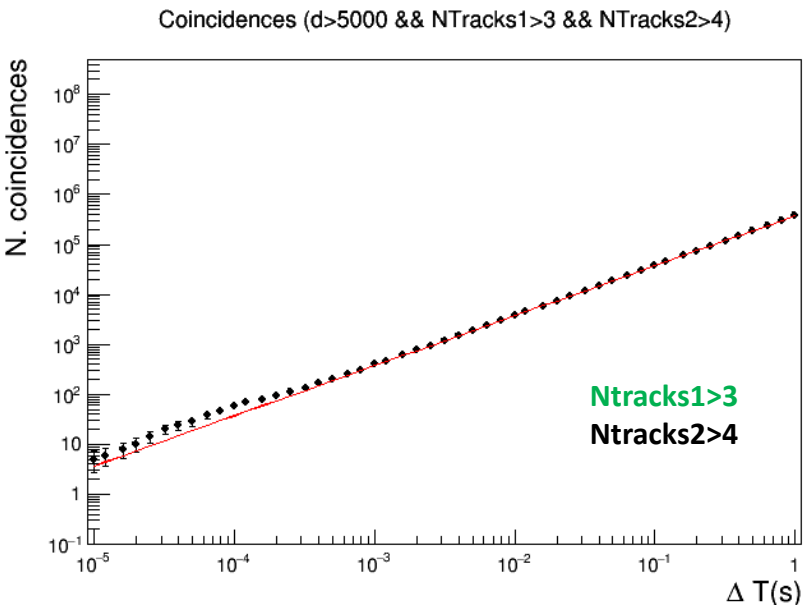


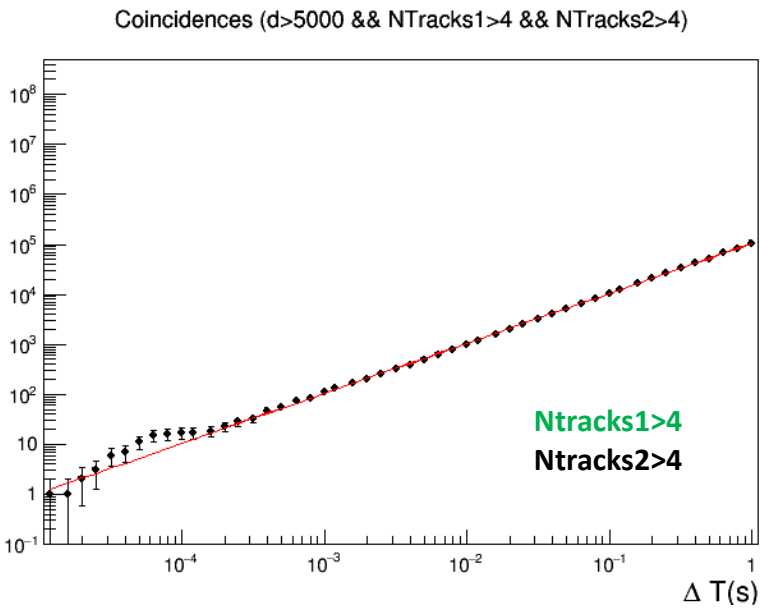






BEST CUTS ON NTRACKS





ΔT = 0.12 ms
N_{exp} = 44.9
N_{obs} = 69
p-value = 0.0005

ΔT = 64 us
N_{exp} = 6.7
N_{obs} = 15
p-value = 0.004

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NEXT STEPS

- **Systematic study of p-value**
- **Effect of a cut on the relative angle**
- **Effect of a cut on the telescope distance**
- **Detailed analysis of the significant events**