Improving CTA event reconstruction at the highest energies to benefit PeVatron searches

CTA-Oz Meeting #1

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My background

- 1 year Honours + 5 years PhD with the Pierre Auger Observatory (submitting soon!)
- Supporting event reconstruction by improving our measurements of vertical aerosol profiles
- Understanding how attenuation affects cosmic-ray air showers (energy, X_{max})

This project

- Optimise the reconstruction/identification of the highest energy γ-ray events
- When within or near the array, existing stereoscopic techniques should handle well
- Very rare but very bright, so *can* be seen from long distances...
- But might be seen by only one telescope ("mono"), or shower images may be "truncated" by edge of FOV of telescopes

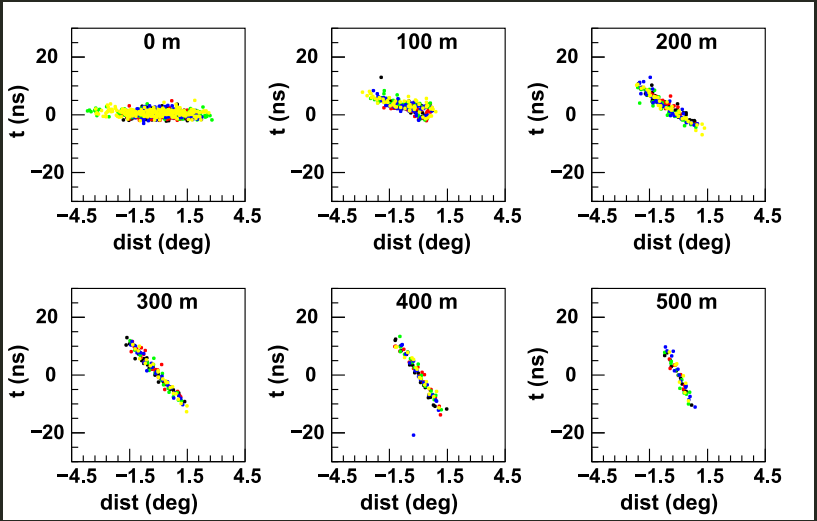
How can we recover these events?

The per-pixel timing information is underutilised right now, but CTA (and to an extent even H.E.S.S. after the sample-mode upgrade) will have very good time resolution.

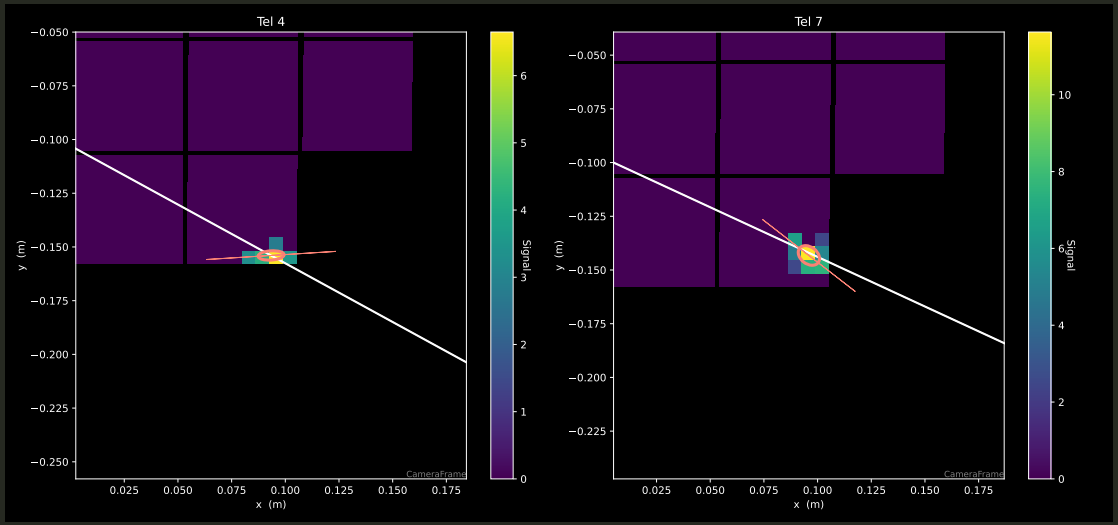
This can be applied in a number of innovative ways:

- Time gradient – correlates with core distance
- Time RMS – correlates with γ-score
- Rejecting "out-of-time" pixels as an extra image cleaning step can improve results
- Timing might also be capable of improving determination of shower axis for truncated images

A 2011 study showed how the gradient of the pixel peak time vs distance along shower axis correlates strongly with core distance. This could benefit mono reconstructions.

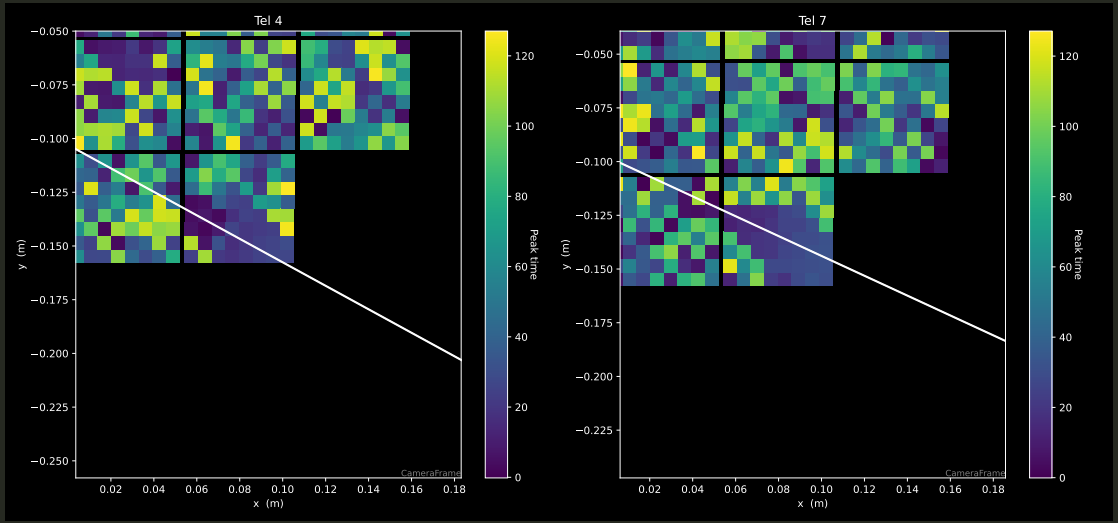


Hillas parametrisation uses (clean) signal only – axis angle can be wrong at camera edge.



White line = MC true shower axis. Red line = Parametrised shower axis.

Pixel peak times reveal extended structure that could guide definition of the axis.



White line = MC true shower axis. Red line = Parametrised shower axis.

Conclusion

- Only a few months into my postdoc so far
- Numerous ways in which pixel time information could be used to optimise CTA/H.E.S.S. event reconstruction
- Exploring some unconventional ideas as well
- Looking forward to my next few years in γ-ray astronomy!