Detecting Persistent Trains from Meteors

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2021-08-16

Optical Persistent Trains (PTs)

- Long-lasting trails seen after a meteor
  - Can last minutes to an hour
- Exothermic chemical reaction between ablated meteor metals and oxygen
  - Self-emitting, not due to reflected sunlight
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- Evolution governed by wind
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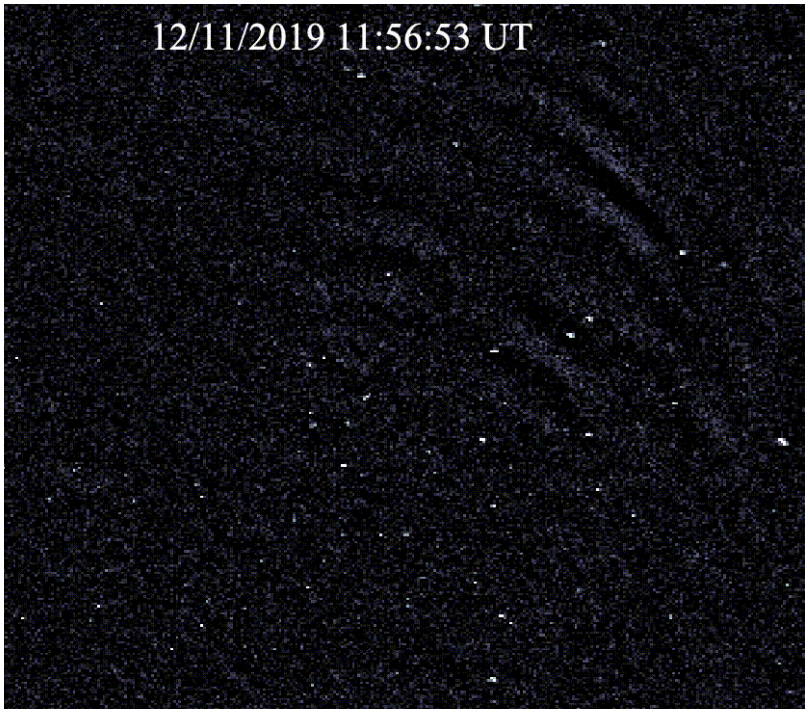


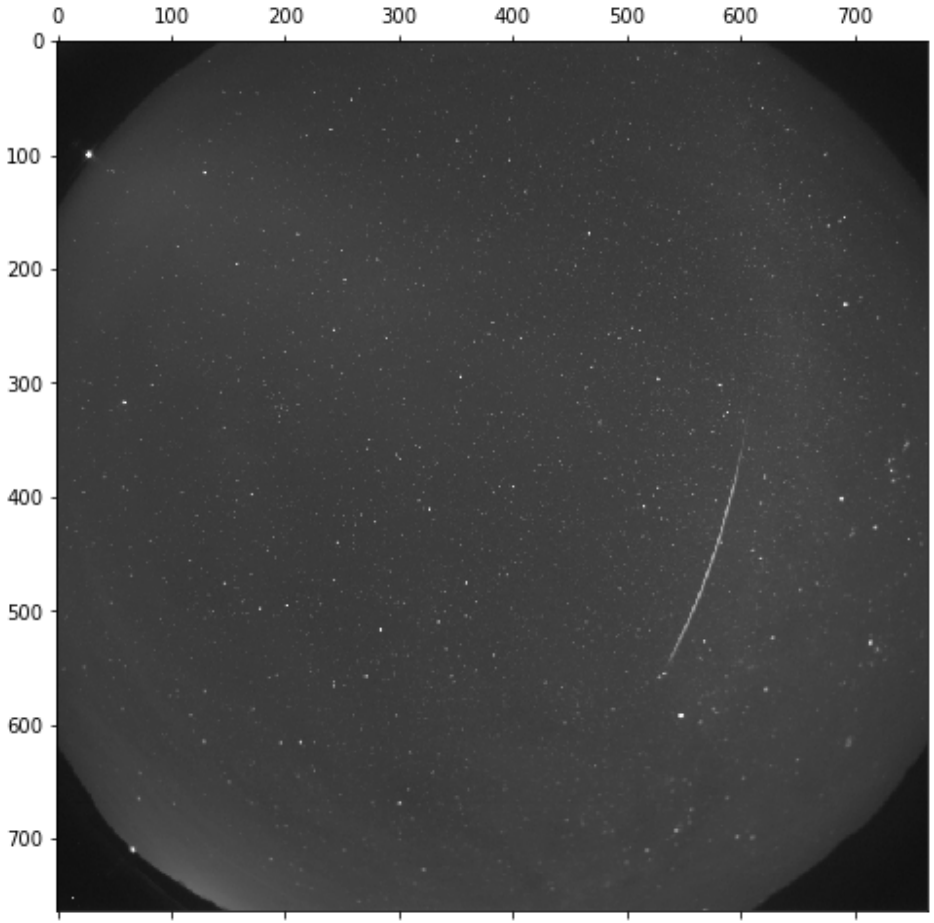
Obenberger et al. 2020

Why search for Persistent Trains?

- Work by Obenberger et al. 2020 finds an association between PTs and meteor radio afterglows (MRAs)
- MRAs were found via a pipeline, and their corresponding PTs were found manually by looking in location of MRAs
- Not all PTs have an associated MRA however - need a way to independently detect them
  - Analyze them statistically to see relationship to MRAs
- Purpose of this work is to develop pipeline to detect PTs from optical images

Detecting PTs

- Images taken by the Widefield Persistent Train camera (WiPT) deployed at LWA-SV
- 5 second exposure time
- Images captured for moonless, nighttime conditions
- Noise has apparent magnitude of about 10



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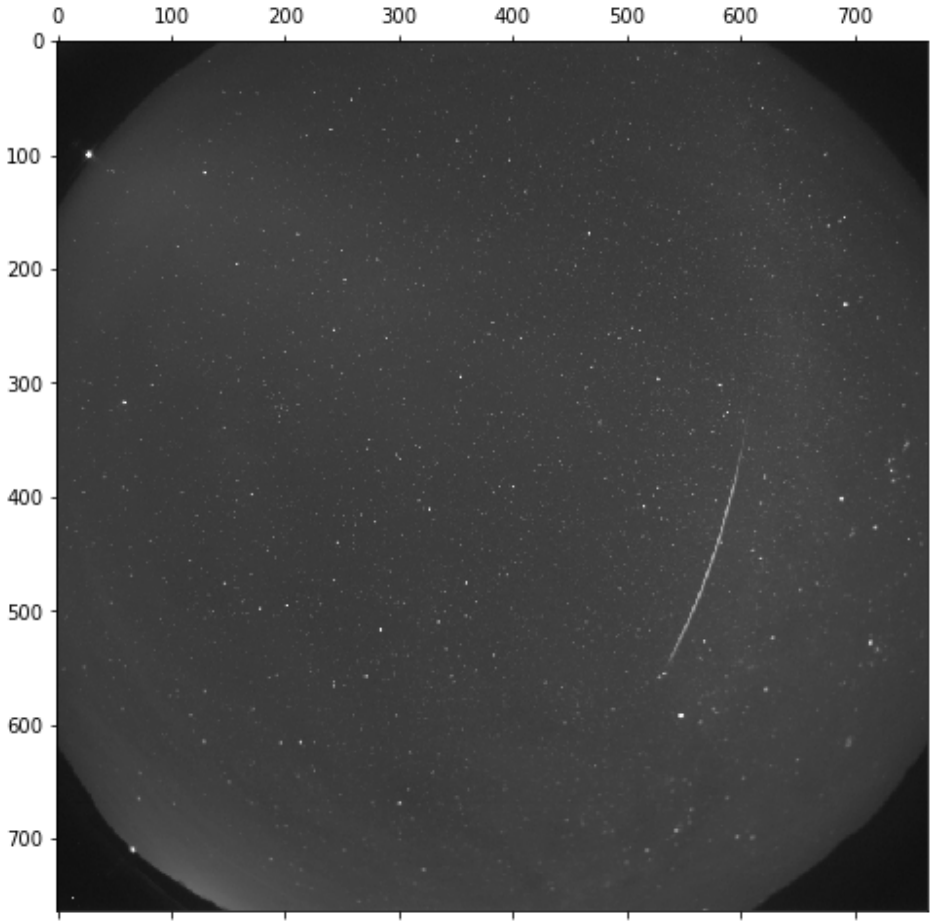

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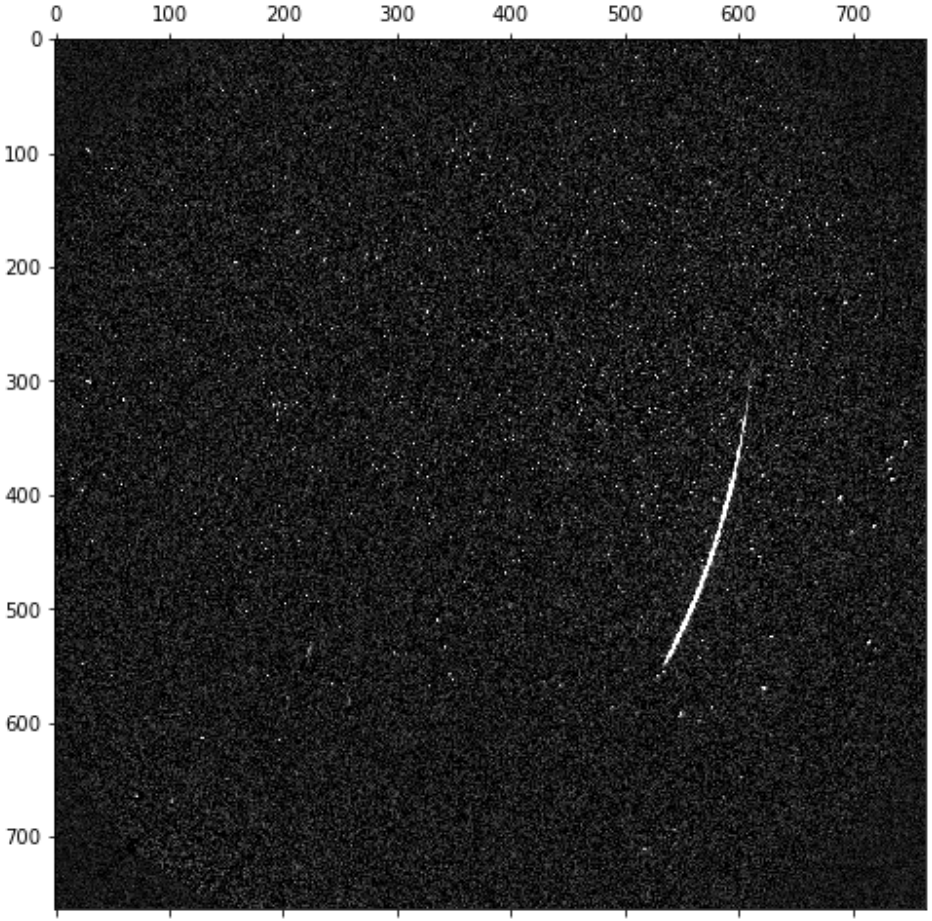

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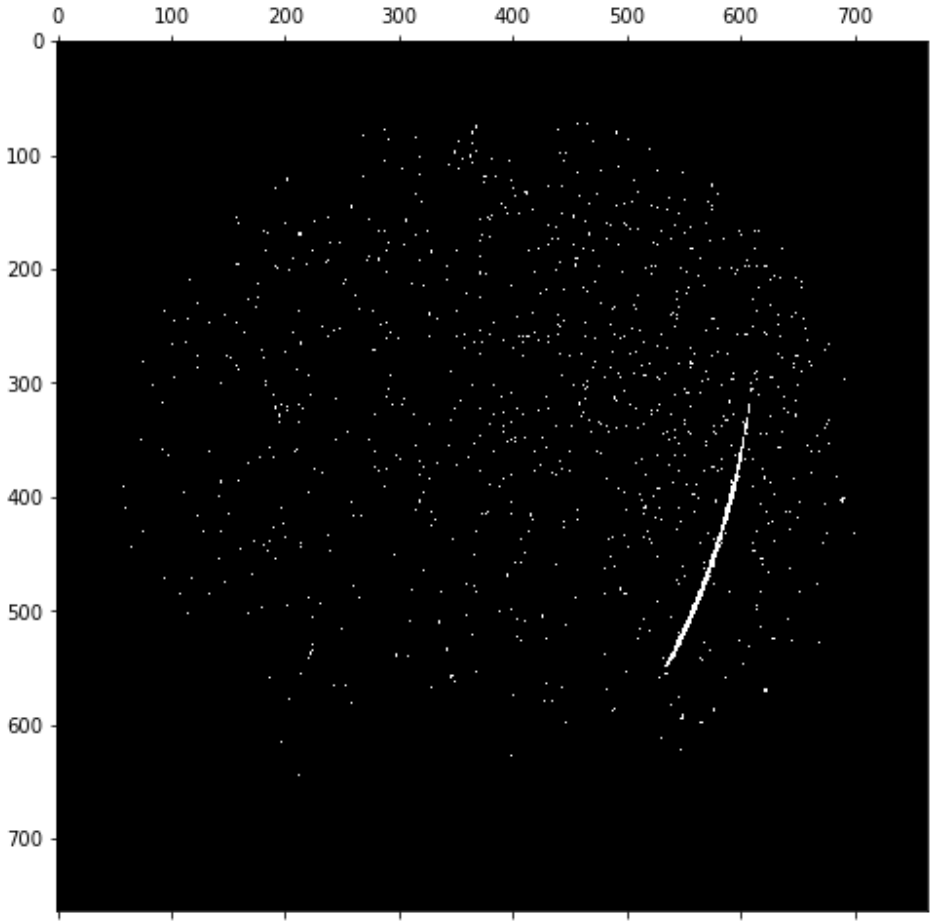
  - MAD more robust against outliers than standard deviation
  - Cut off horizon (more on this later)



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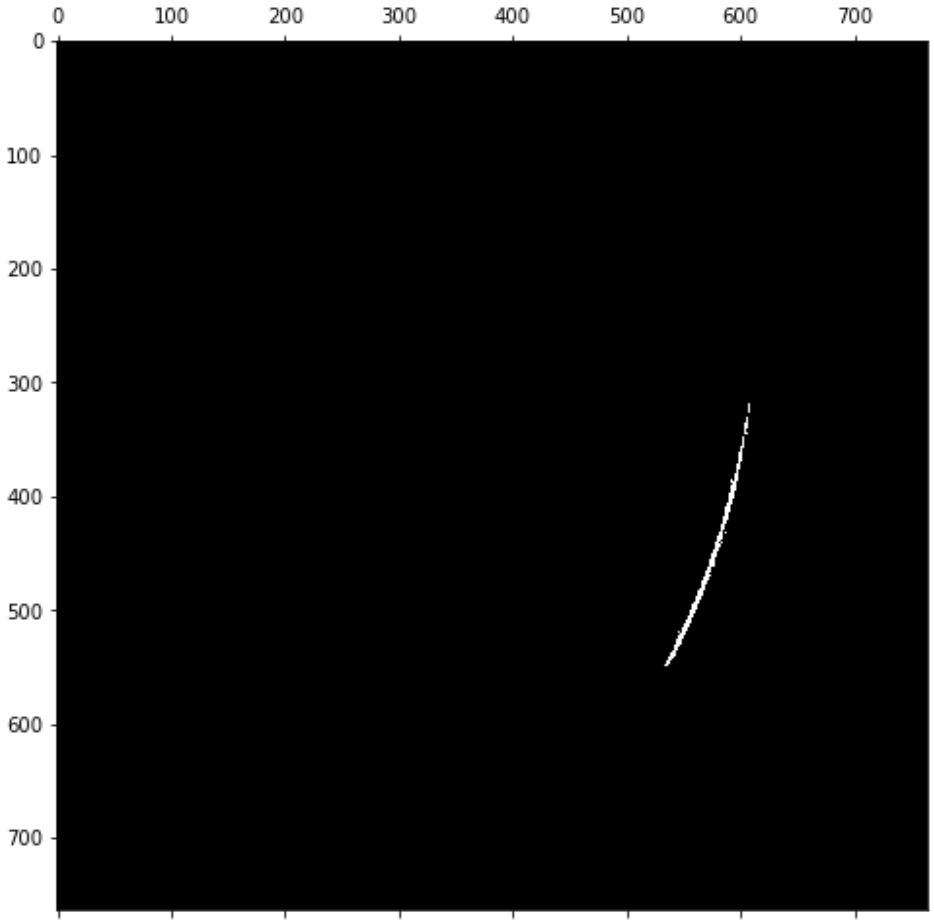

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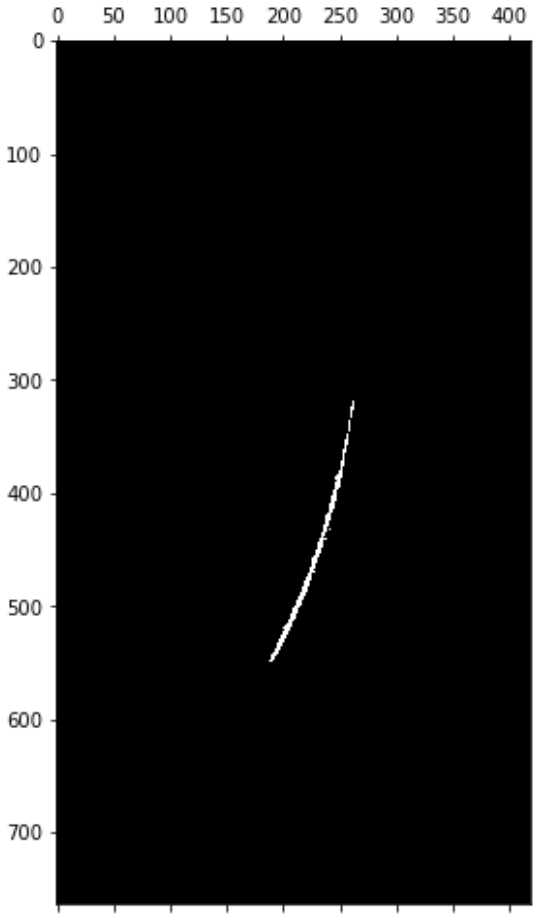
- Zoom in on region of interest
- Do linear Hough transform
  - Determines whether the clump of connected cells are in a line
  - First line of defense against clouds



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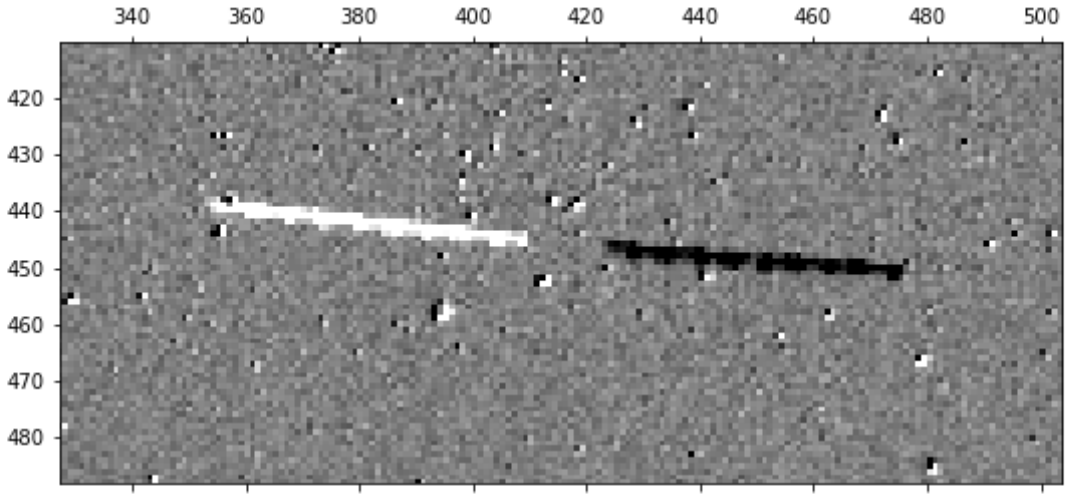

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- Luckily, they move slowly enough to span multiple images
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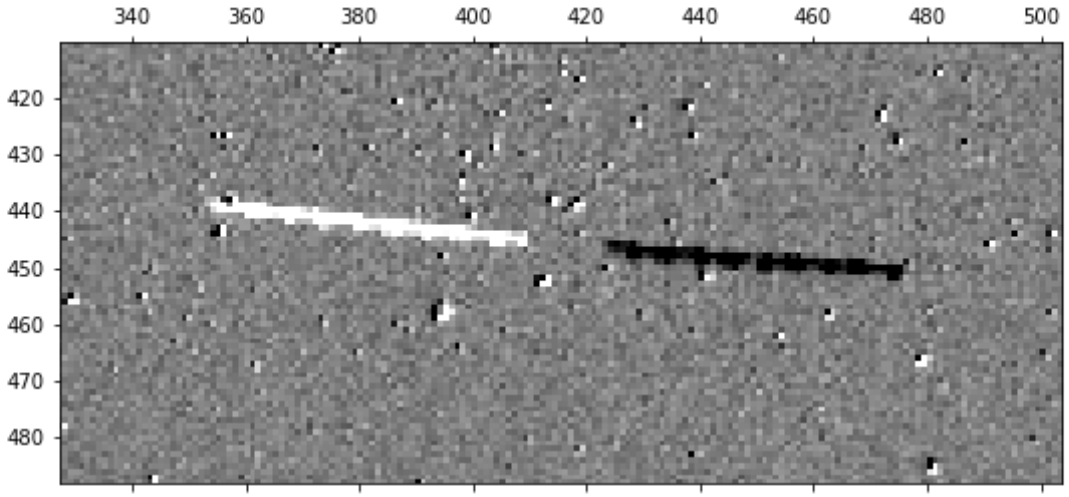

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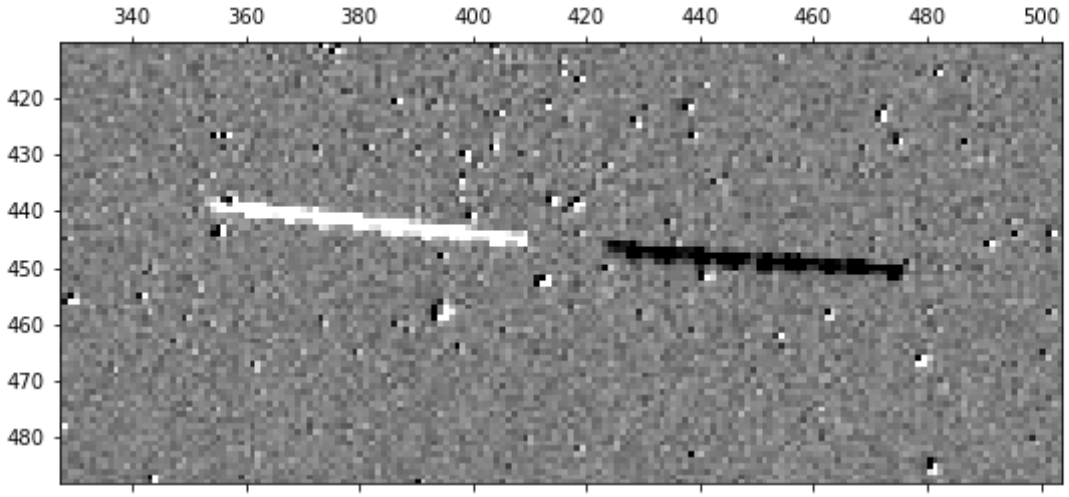

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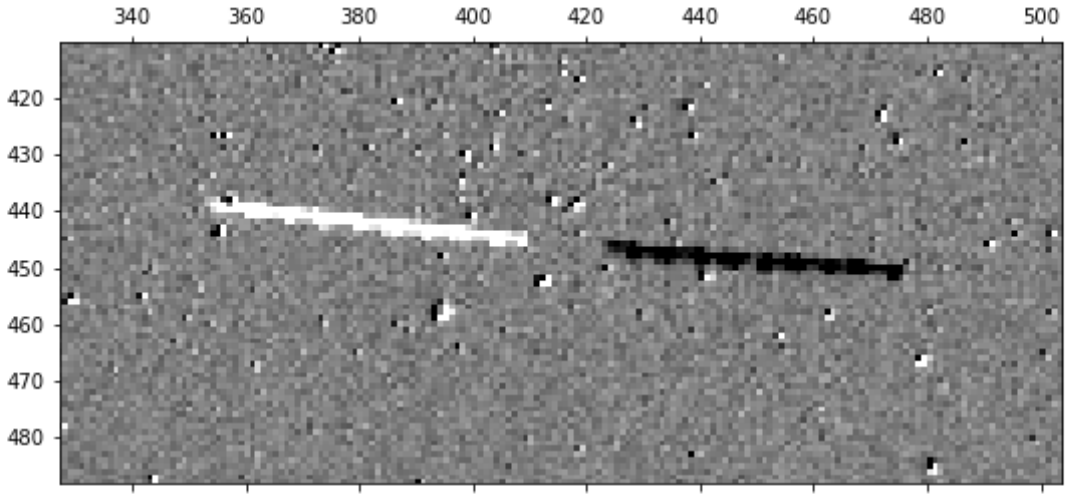
- Horizon is sliced off generously for this purpose



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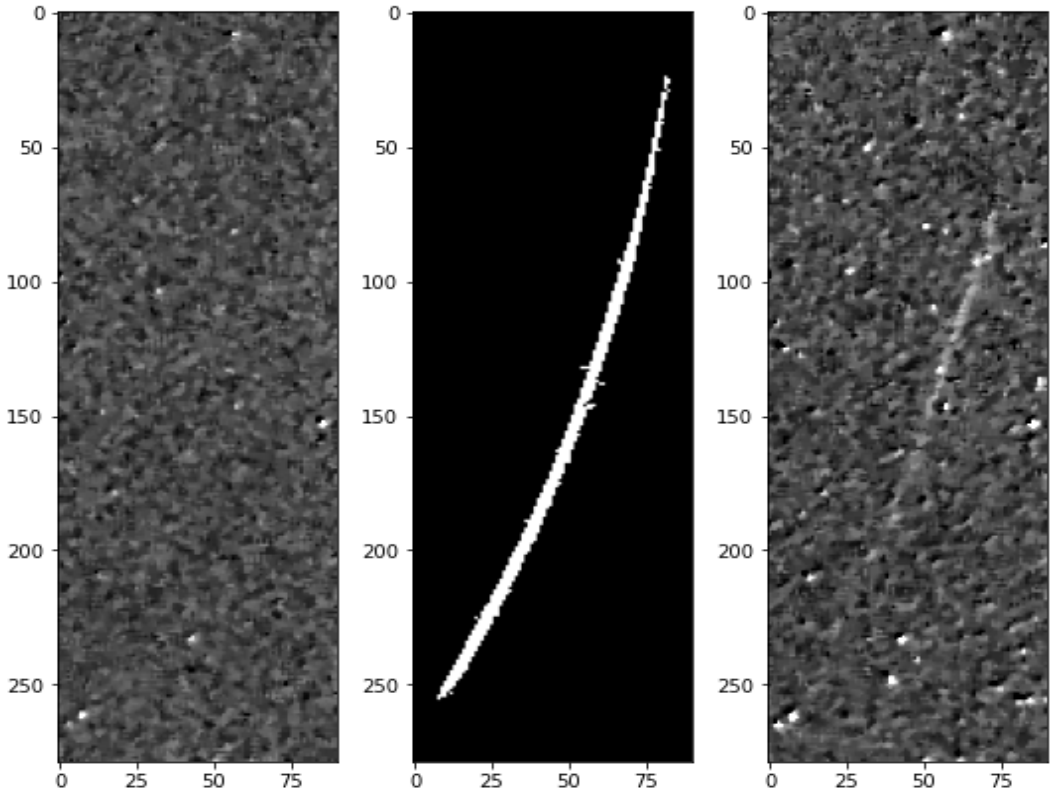

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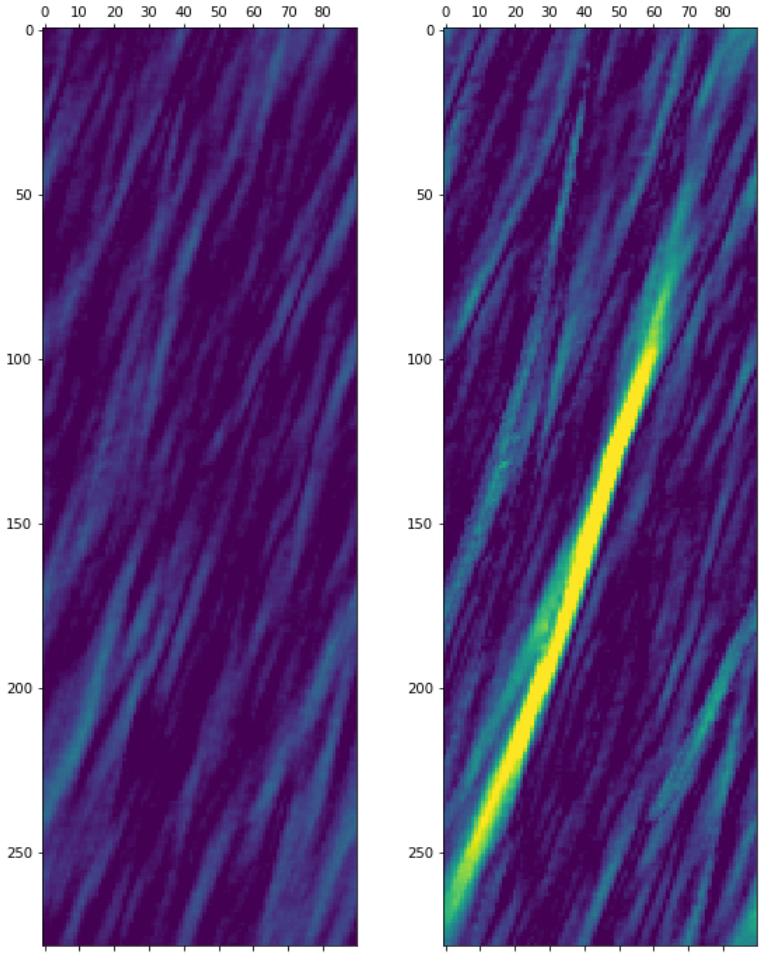

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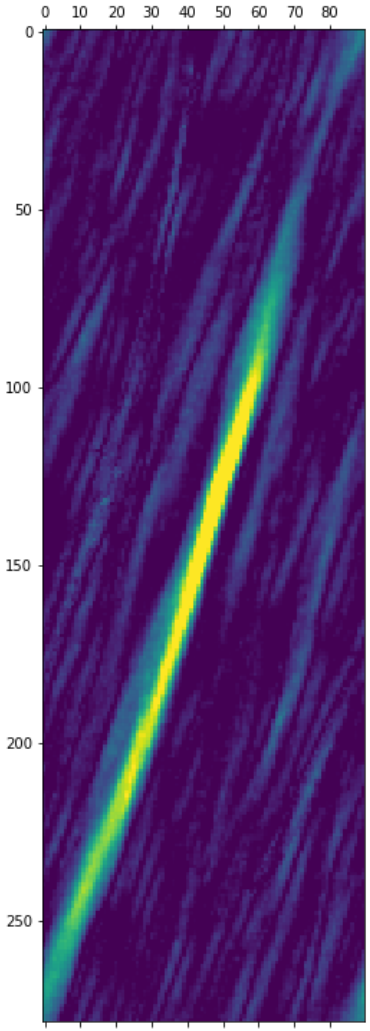

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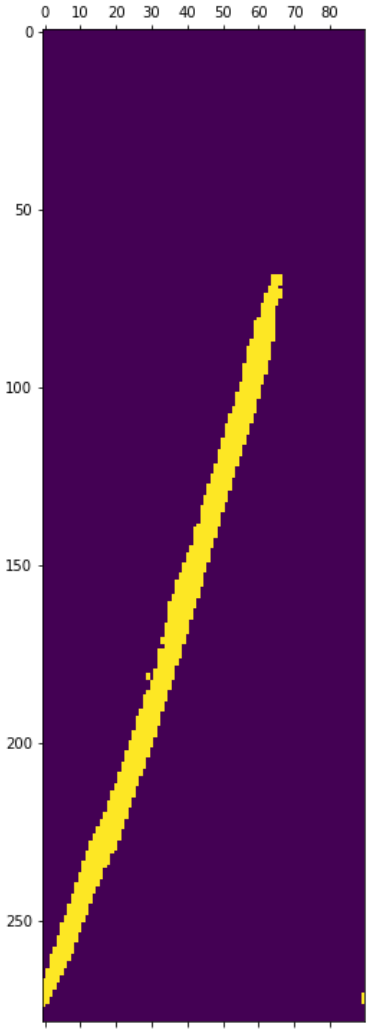

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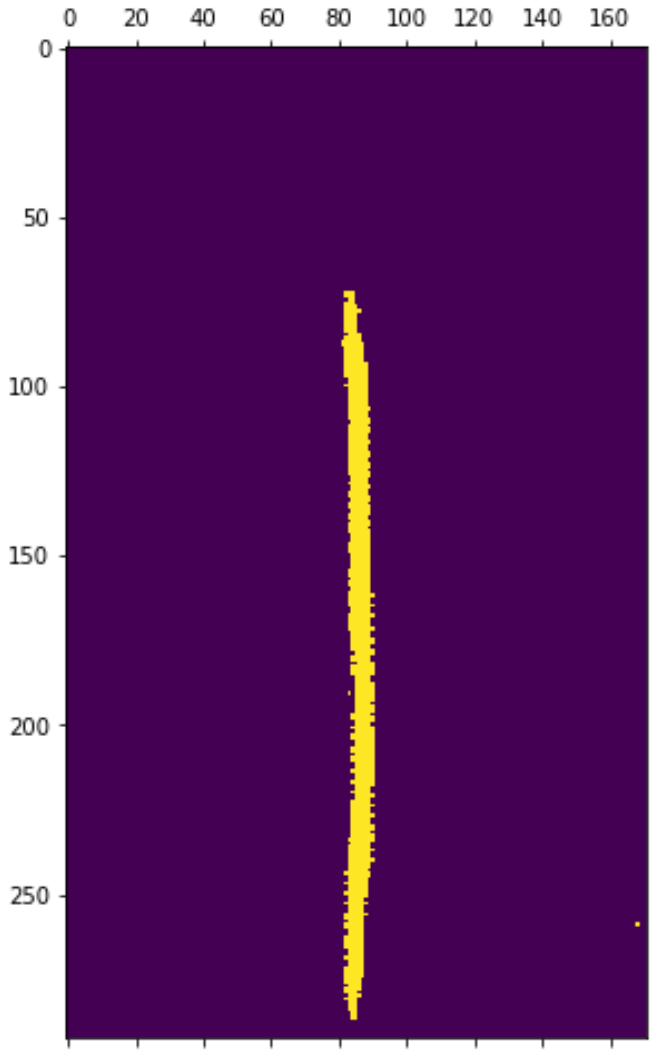

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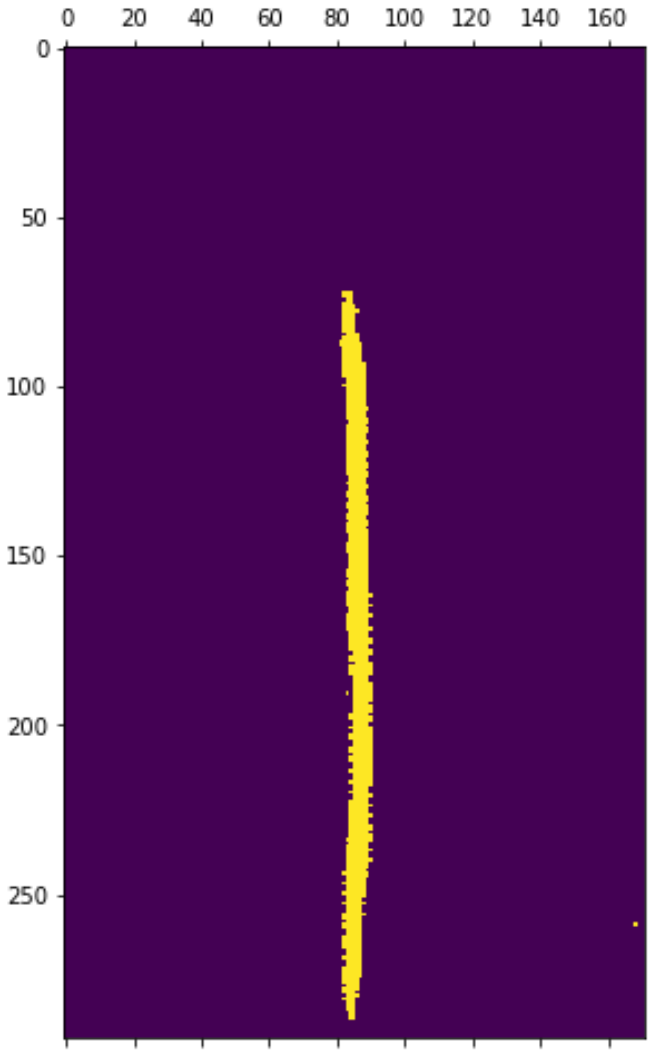
- Sum down the columns



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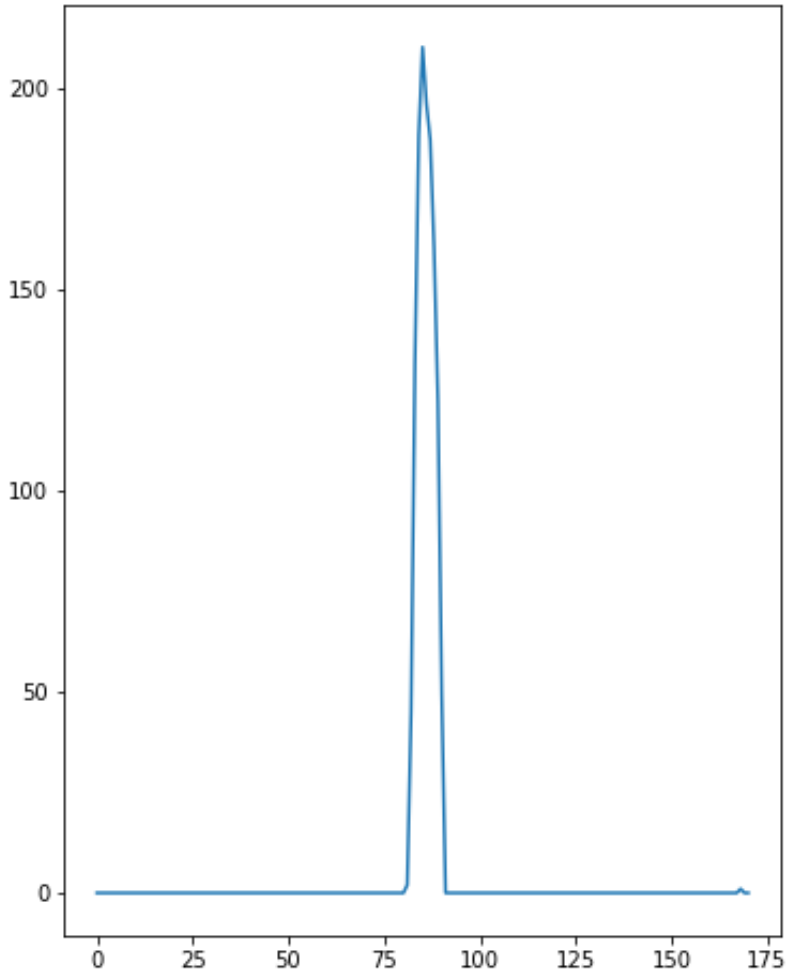

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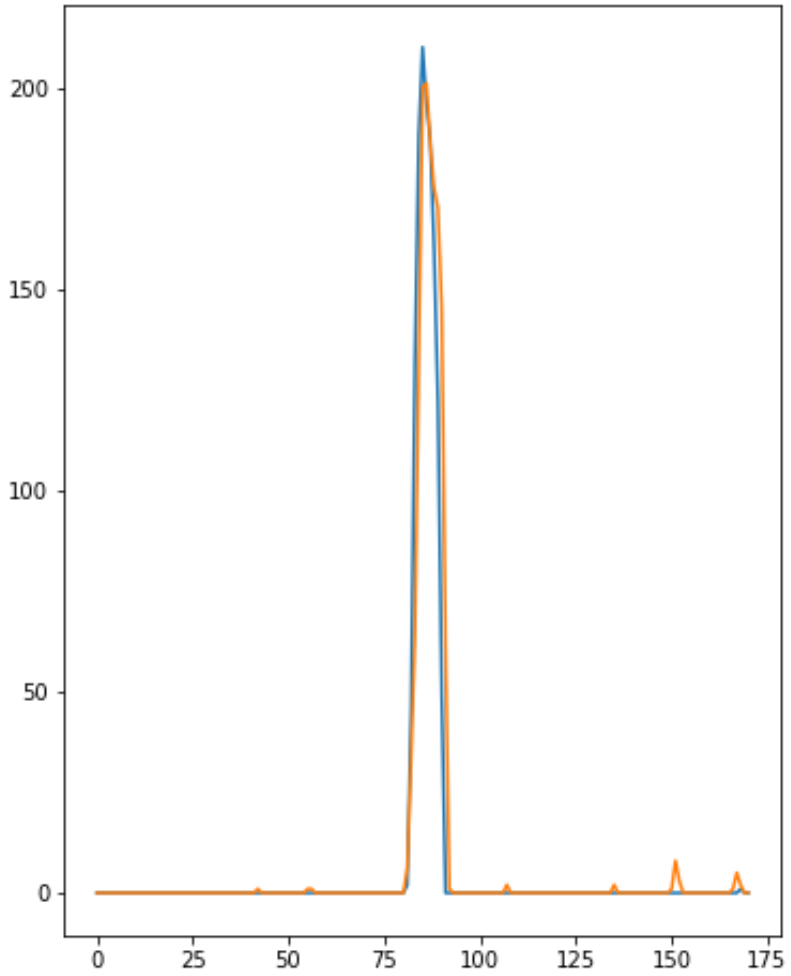
- This should give a single, clean peak if a persistent train is present
- Since PTs should last a while, correlate with the next frame as well
- Current check for PTs is whether both plots have a maximum value within the inner 30% of the plot
  - May be a better test based on peak shape



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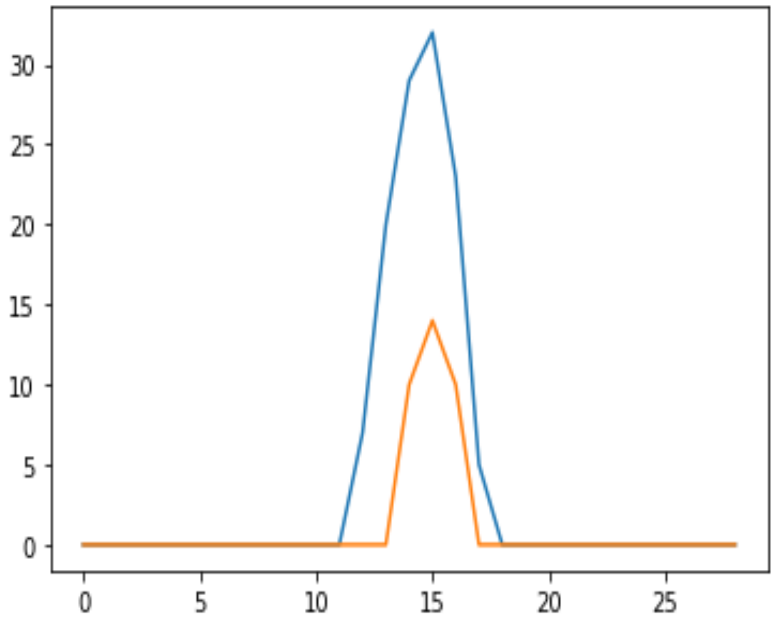

Results of cursory search

- 14 days (out of ~150) have been run through this the pipeline

- 3 of the 4 PTs reported in Obenberger et al. 2020 were flagged
  - Fourth one was too faint to pass the initial cut (meteor occurred between frames)

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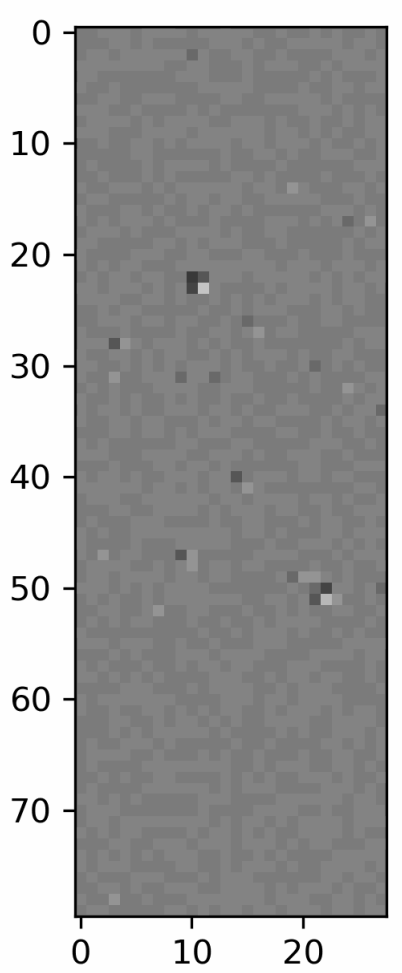

Next Steps

- Figure out best way to determine whether PT is present – e.g. shape of curve, location of maxima, some combination, etc.
- Once PTs can be reliably found, start processing all the historical data
- Modify code for new camera recently deployed at LWA-SV
- Analyze PTs statistically
  - Which meteors produce PTs, when most prevalent, association with MRAs

Questions?