



A 2022 τ -Herculids meteor cluster

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Outline

- 1 - 2022 TAH airborne observations
- 2 - Cluster detection
- 3 - Cluster characterization



1 - 2022 TAH airborne observations

Airborne observation (see J. Toth's talk)

Mobile cameras from the MoMet device
(see Da Fonseca's talk, IMC2021)

2 stabilized cameras + RBpi + RMS
software

2 unstabilized cameras + continuous
recording on Mac

Basler acA1920-155um + 6mm f/1.4 or
12mm f/1.6 lens ; 20 fps



τ -Herculids meteors

4-hours data acquisition

165 τ -Herculids + 5 SPO

Stabilizer not stable enough for RMS to successfully detect meteors -> manual examination of the data (C. Loir)

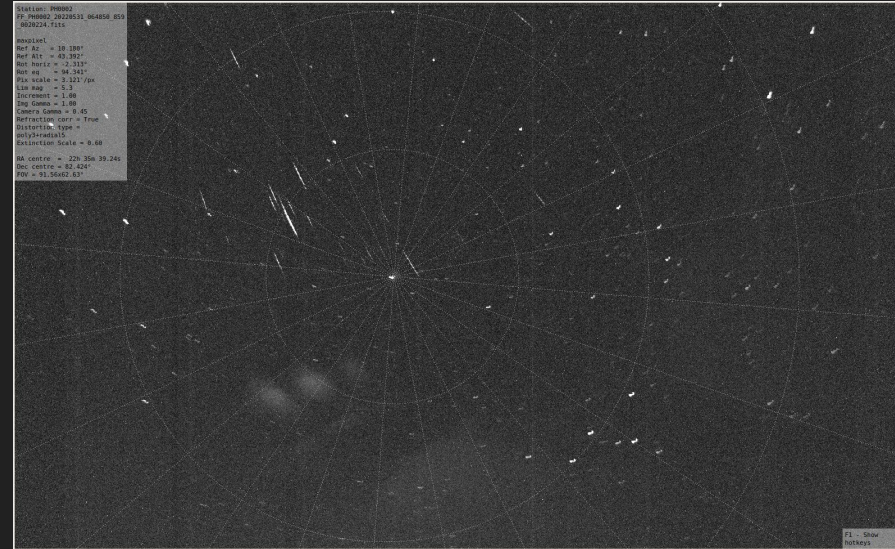


τ -Herculids Cluster detection

06:48:56 UT - 06:49:03 UT

34 meteors within 7 sec

Initially spotted in RMS fits image (max).



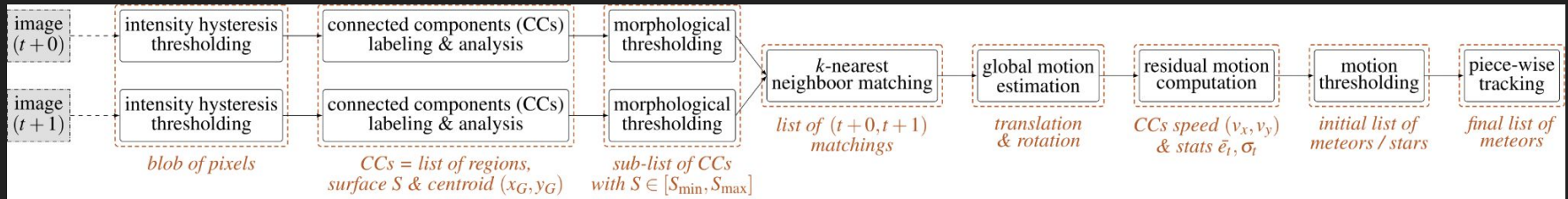
2022 TAH Cluster: the movie

TODO: INSERT MOVIE (NOT IN GOOGLESIDE...)

<https://lip6.fr/adrien.cassagne/data/tauh/tracks.ts>

Computer-Vision Detection : Presentation

- Real time software detection chain
 - Fast Meteor Detection Toolbox (FMDT), open source (<https://github.com/alsoc/fmdt>)
- Based on the **combination of well-known algorithms** in image processing



Key points :

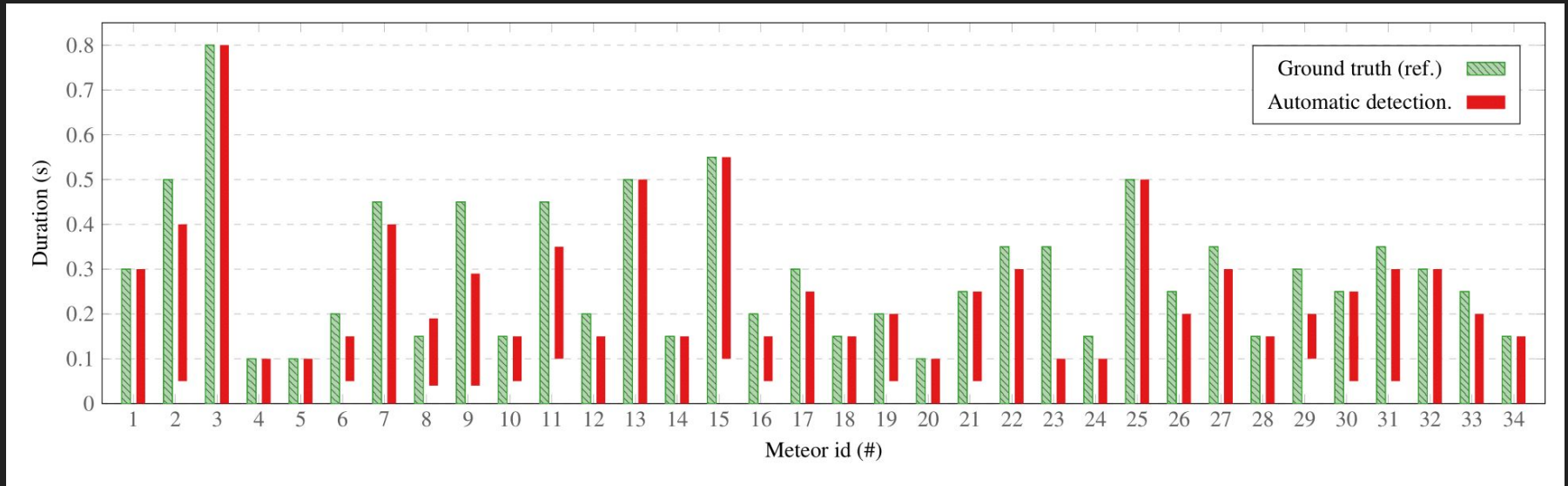
- ➔ **Motion estimation and compensation** based on “stationary” stars
- ➔ **Energy efficient chain: designed for embedded systems**

Computer-Vision Detection : Detection Results

- **100 % of meteors detection (34/34)**
- 4 false positive detections
 - Because of the reflection of the light in the plane window
- **Automated detection helped to detect more meteors !**
 - Initial observation : 28 meteors
 - After automated detection : 34 meteors
 - 20% of the meteors were missed in the initial observation
- Encouraging results
 - Worked surprisingly well on the 2022 TAH video sequence
- **Let's keep one's feet on the ground (even if we look at the stars ★)**
 - Mitigated results on some other video sequences (parameters overfitting?)
 - **Young detection system (2022)**, need time (and work) to get more mature

Computer-Vision Detection : Tracking Rate

The tracking rate is the duration while the detection system successfully tracks a meteor. In the 2022 TAH video sequence, the obtained tracking rate is 80.4%.



3 - Cluster characterization

Assuming Poissonian distrib: $Proba < 1E-22$

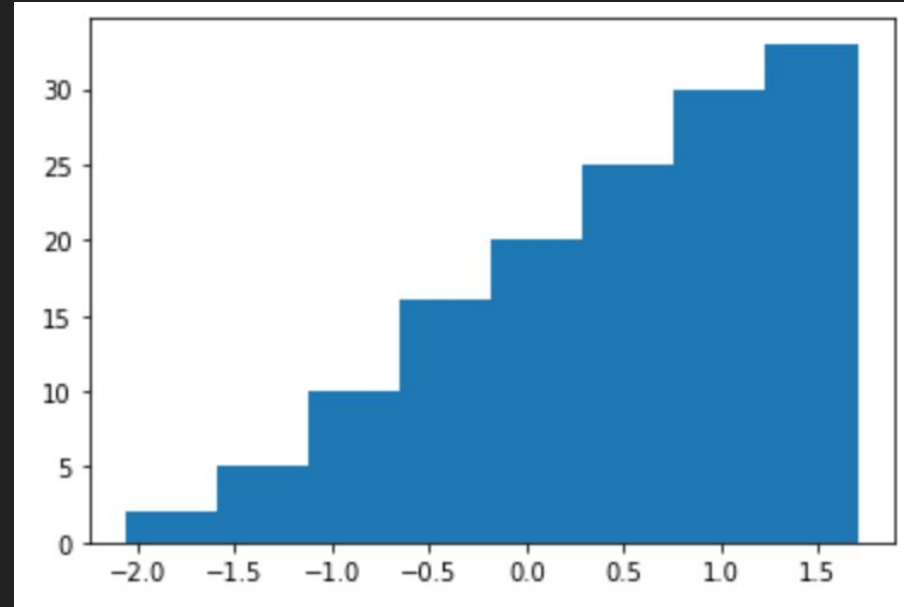
If alt=80 km, max distance between fragment: [185-200] km

Interplanetary self-disintegration within [4.9-5.2] days (see also Kotten et al. 2016)

Mag: [-2 ; 2]

Population index: $r=2.01$ (low)

Differential size distribution index $s=3.10$



Comparison with other meteor clusters

SPE - LPC ; Koten et al. 2017: 8 meteors in <2 s

LEO - HTC ; Kinoshita et al. 1999: 100-150 meteors in 2 s

PER - HTC ; Hapgood & Rothwell 1981: 3 meteors in 1.3 s

TAH - JFC ; this work: 34 meteors in 7 s

Koten et al. 2021: search for cluster in GEM: not conclusive (yet)

Origin: most likely thermal disruption: see Capek et al. 2022

Comparison of differential size distribution s

Ref	Obs Tech.	size range	environement	s
Koten et al. (2017)	meteor cluster	$> 100 \mu m$	interplanetary	1.77
This work	meteor cluster	$> 100 \mu m$	interplanetary	3.1
Merouane et al. (2016)	in situ (COSIMA)	$> 150 \mu m$	67P, $R_H > 3.5$	1.8
Hornung et al. (2016)	in situ (COSIMA)	$> 10 \mu m$	67P, pre- q	3.3
McDonnell et al. (1987)	in situ (GIOTTO)	$> 20 \mu m$	1P, at q	3.55
Fulle et al. (2004)	remote (vis, IR)	mm	67P, post q	3.5
Moreno et al. (2017)	remote (vis, IR)	$> mm$	67P, $R_H < 4.5$	3.6
Fulle et al. (2010)	remote (vis, IR)	$> mm$	67P	4.0
Vida et al. (2021a)	meteor fragmentation	$> 50 \mu m$	Earth atmosphere	6.4

Suggests s increases with gas environment

Conclusion

7th detected meteor cluster ; 4th “big” one in 20 years => 1 meteor in 10^6

Automated detection successful

Open source software <https://github.com/alsoc/fmdt>

Shallow size distribution: influence of gas flow around the meteoroid

Paper currently under referee (A&A)

Acknowledgements

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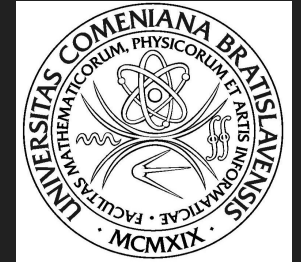
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