CAMS COVERAGE FOR BRAMS METEOR ECHOES

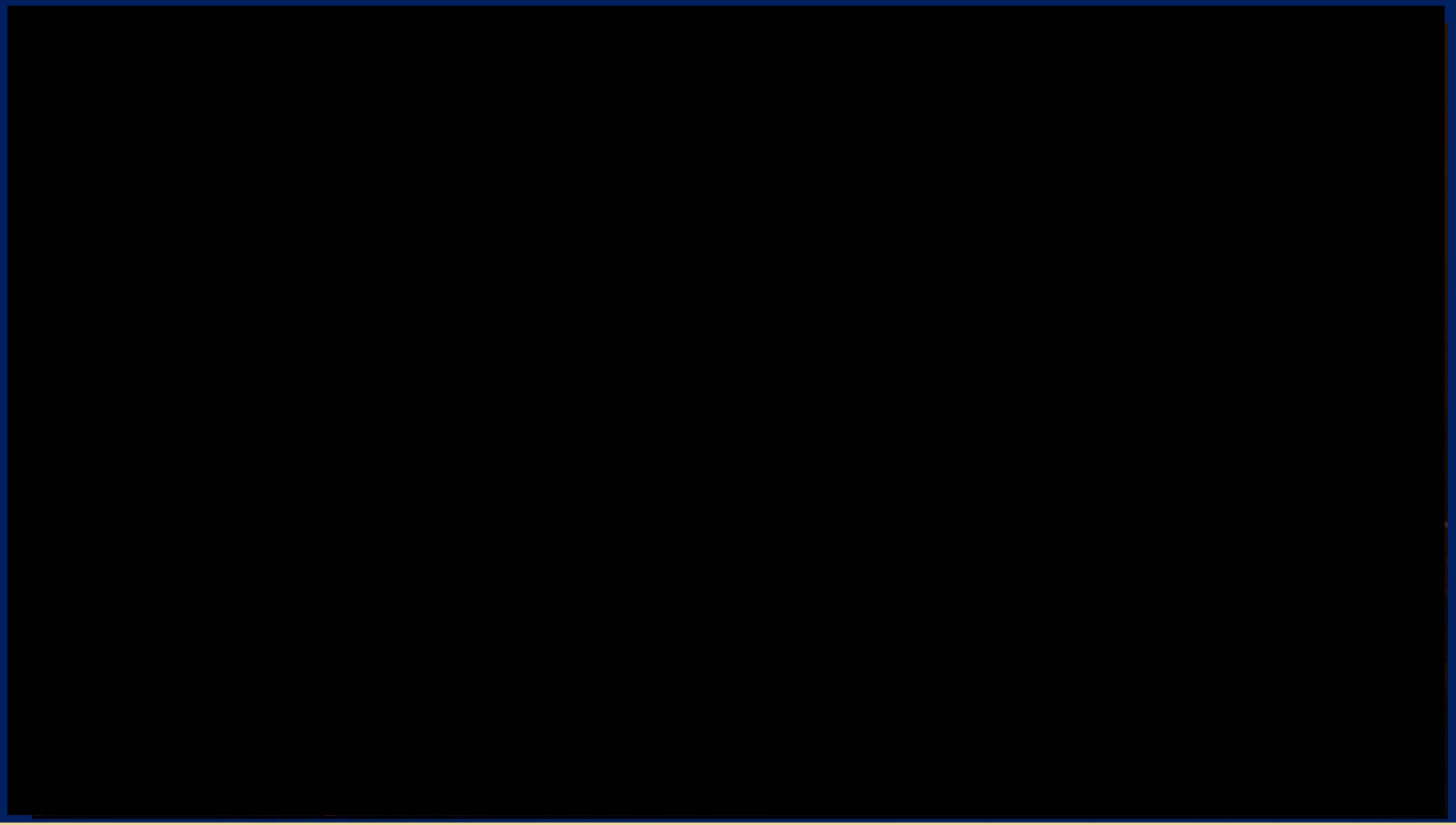
- CAMS in 2018
- Rpi Meteor Camera for future extensions
- Case studies

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

- 26 Stations
- 8 Remote controlled
- 19 Using AutoCams
- 102 Cameras
- 2 Stations destroyed
- 2 Stations in renovation
- 3 Stations with problems
- Many small issues
- ~20% not operational

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

House of Jos Nijland with his CAMS & all-sky

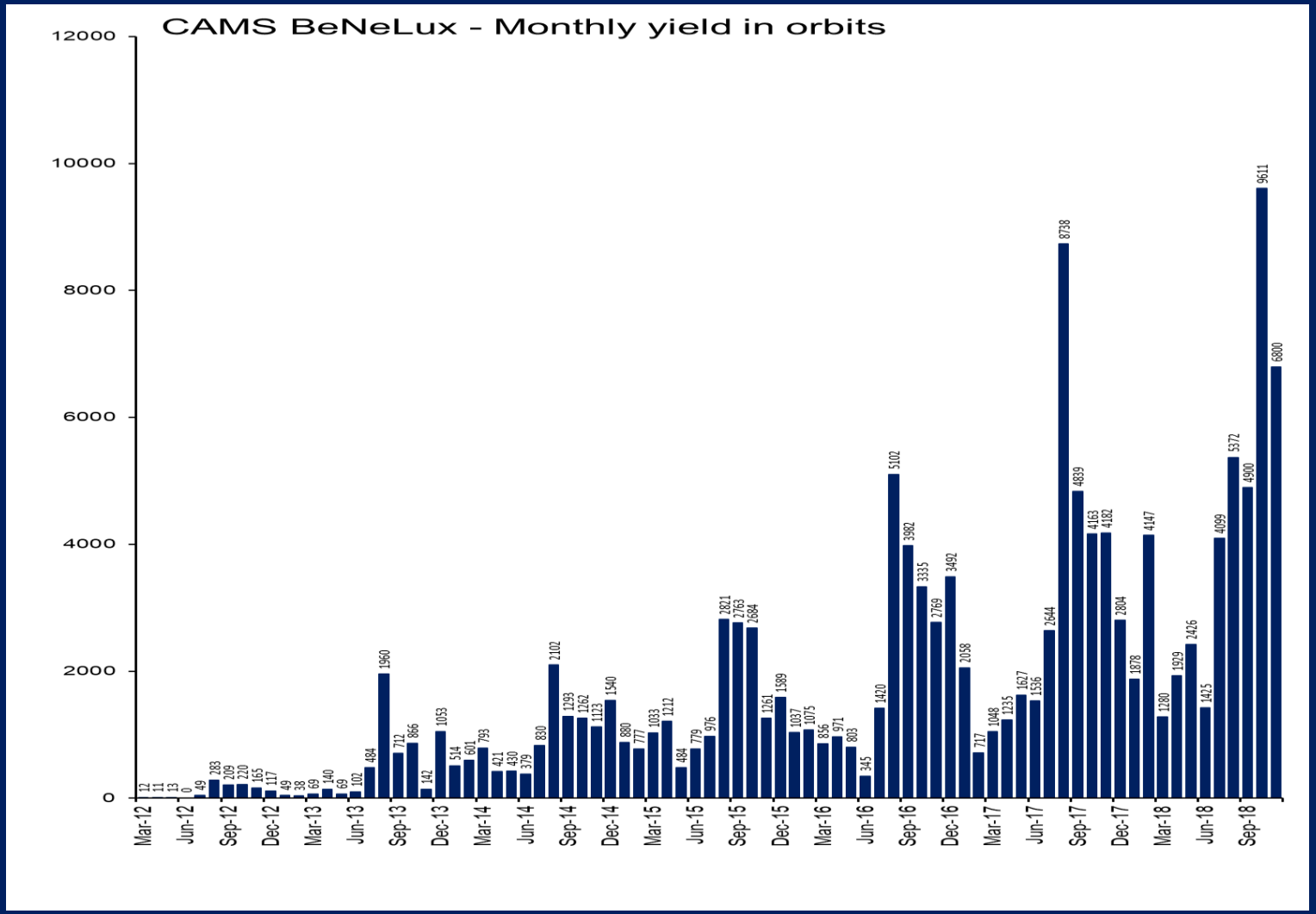


CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

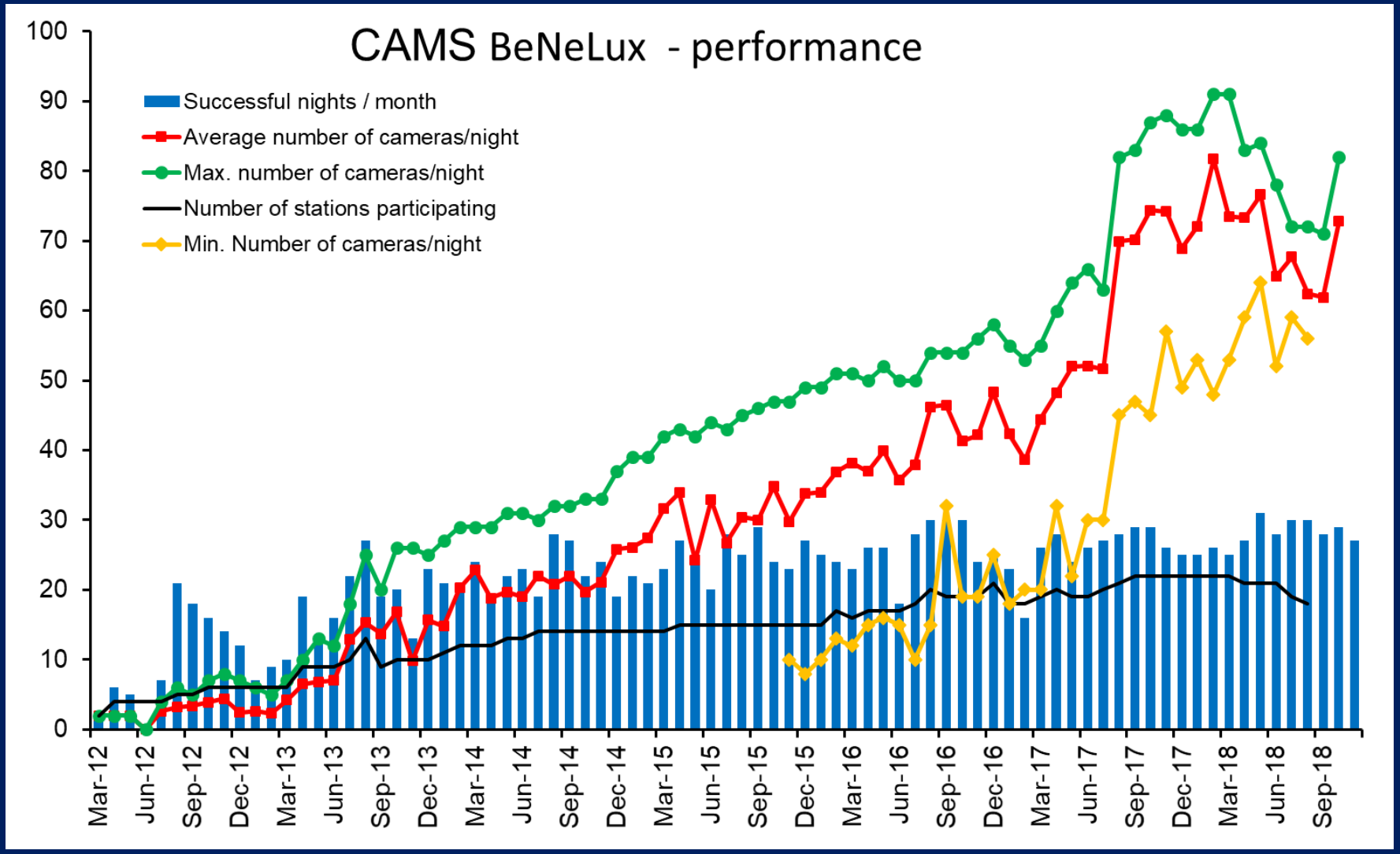
Lessons for the future

- **<u>Pay attention to risks of overheating</u>**
- Make sure to have spare dongles (frame grabbers)
- Do not rely on automatic pilot !!!
- Check log-files on regular bases
- Keep your Windows under control: Updates, anti-malware, defragmentation OFF

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

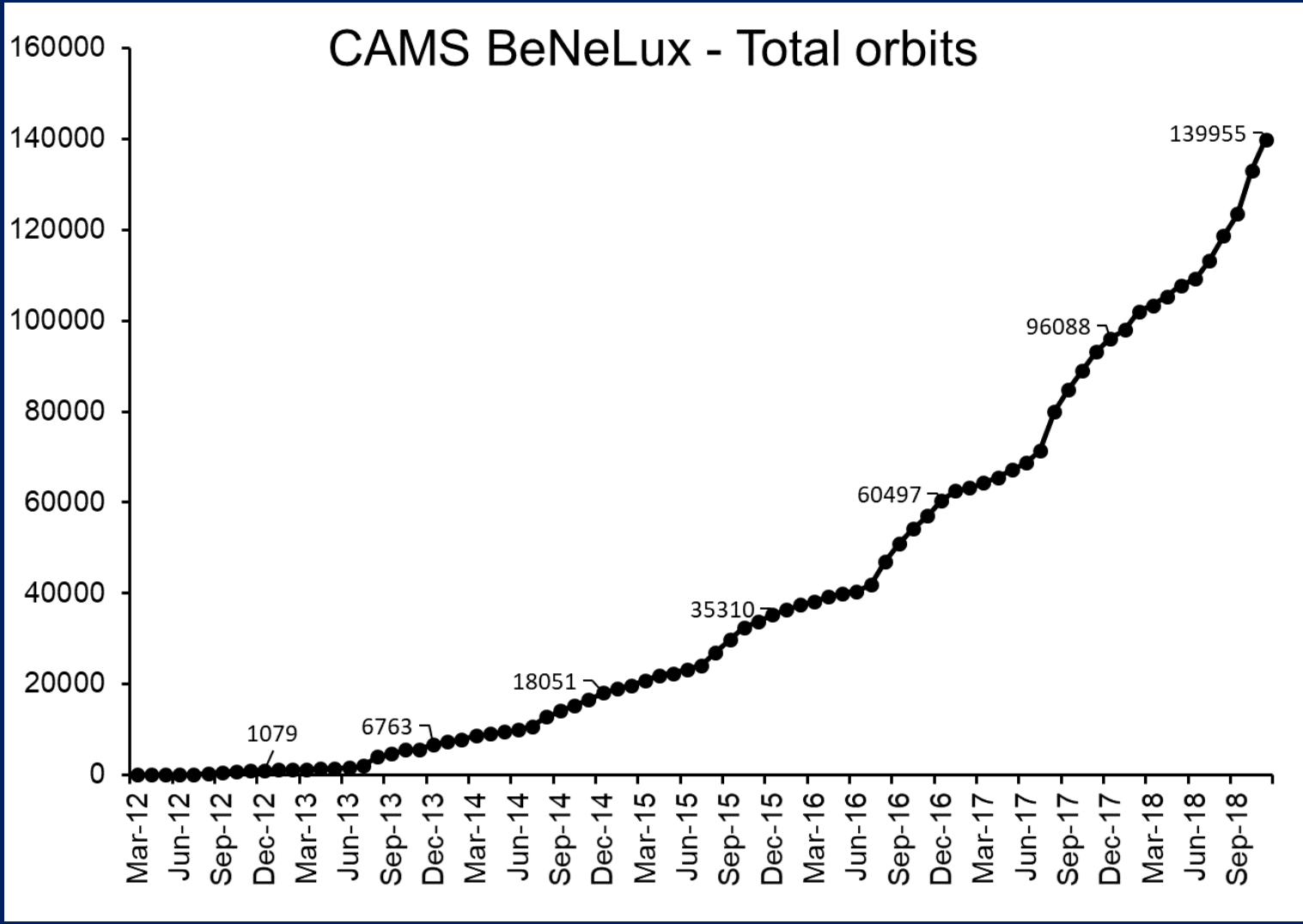


CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018



CAMS COVERAGE FOR BRAMS METEOR ECHOS

CAMS IN 2018



CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

CAMS BeNeLux = team work by 20 volunteers

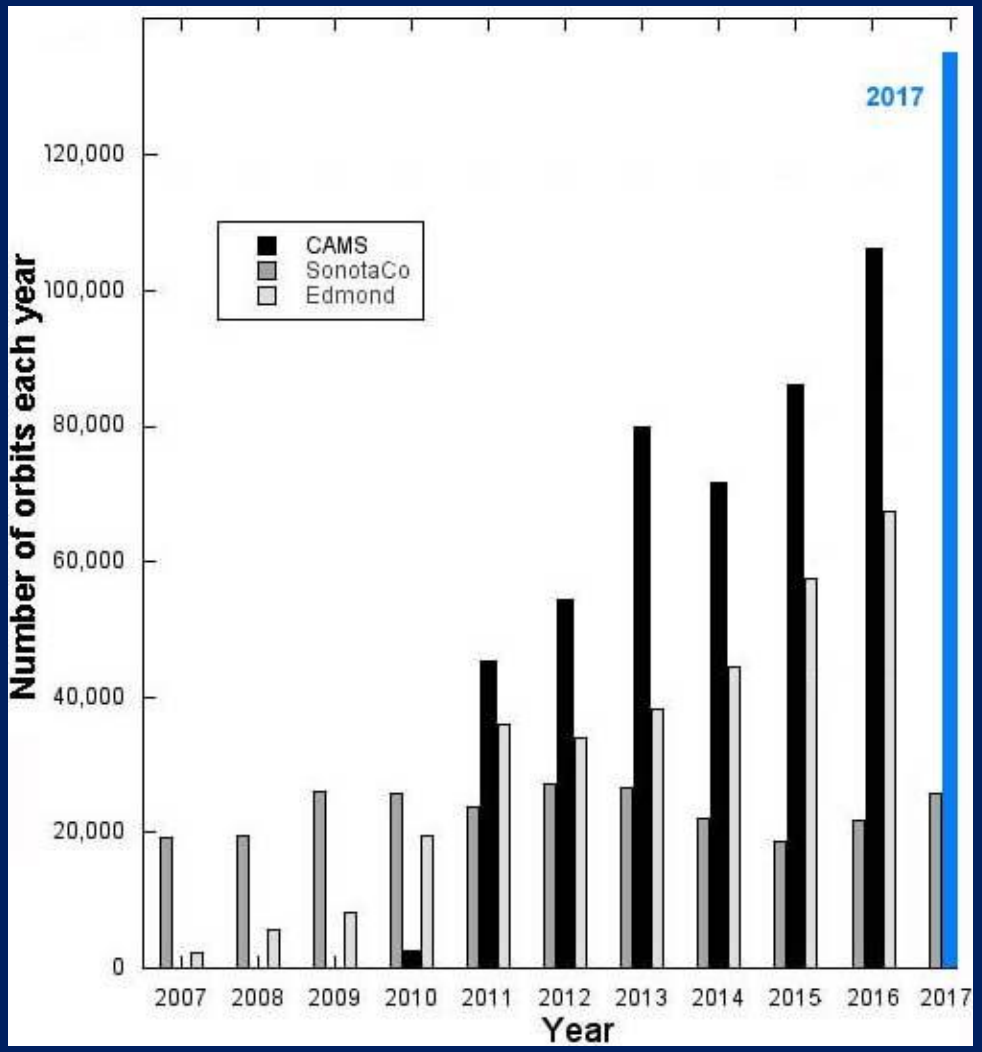
Self-financing guarantees strong commitment

Year	Number of orbits collected	Maximum number of operational cameras	Number of CAMS stations	Number of nights with successful recorded orbits
2012	1079	8	6	101
2013	5684	26	13	198
2014	11288	37	14	269
2015	17259	49	15	294
2016	25187	58	21	309
2017	35591	86	22	307
2018	*44000*	*91*	*22*	*306*
TOTAL	***~140000***			***1784***

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

- CAMS 2010 - 2018:
  ~700.000+ orbits
- EDMOND 2006 - 2016:
  317.830 orbits
- SonotaCo 2007 - 2017:
  257.010 orbits

CAMS = 2/3 of all orbits,
and expanding!

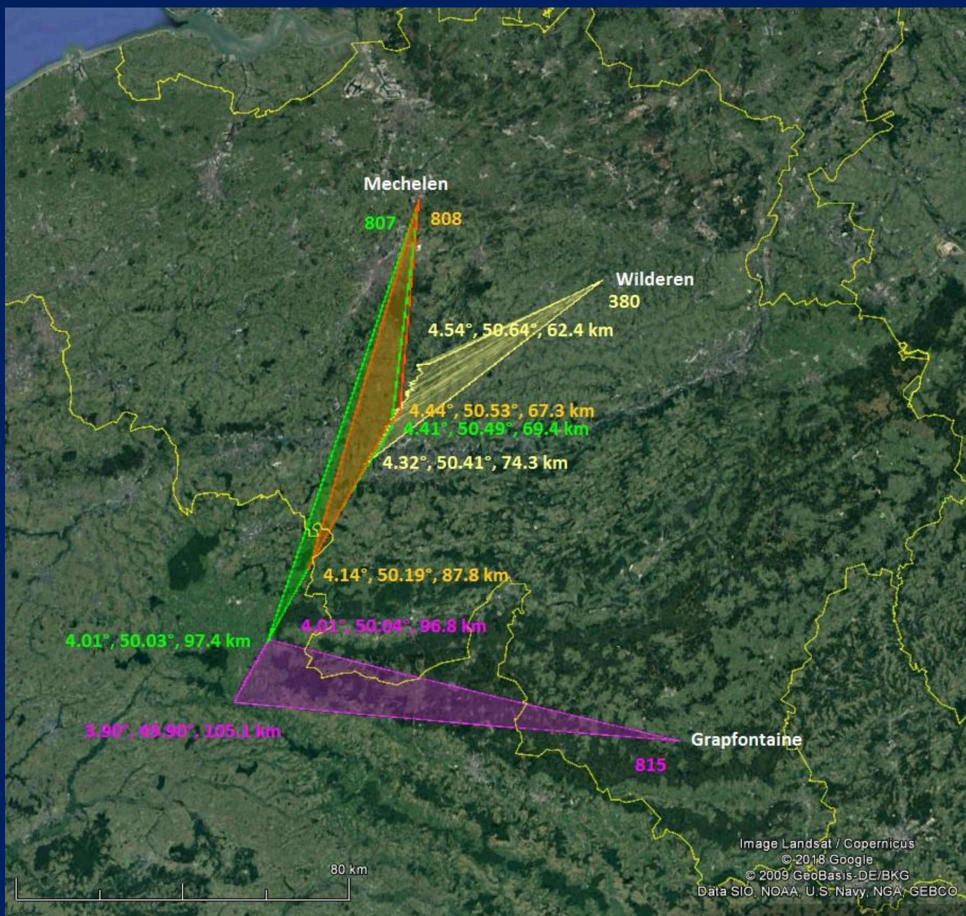


CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

New CAMS network in Arizona at Lowell Observatory and Barringer meteor crater

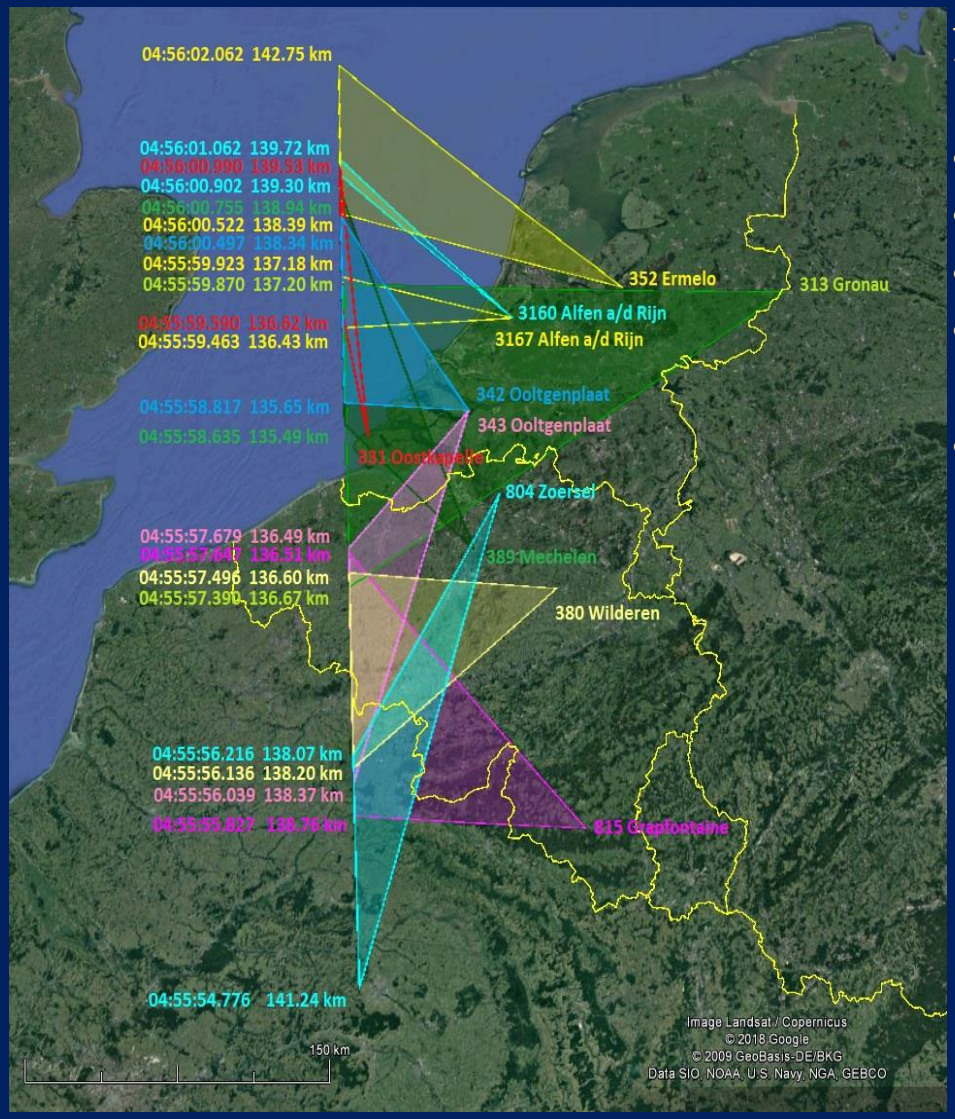
CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

Several shower outbursts, some new showers discovered or confirmed, peculiar meteors and major fireball events… CAMS never gets boring.



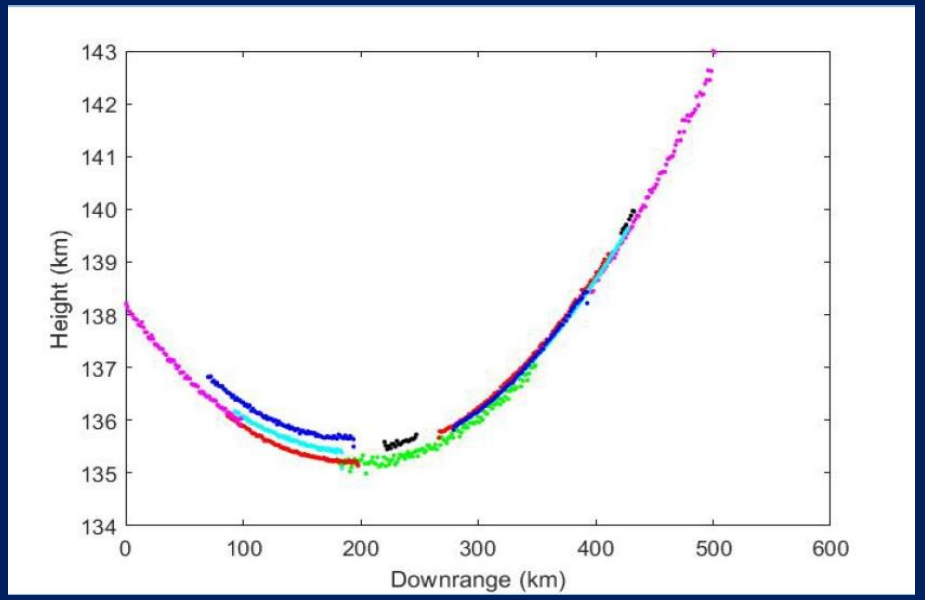
Fireball 2018 February 24

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CAMS IN 2018

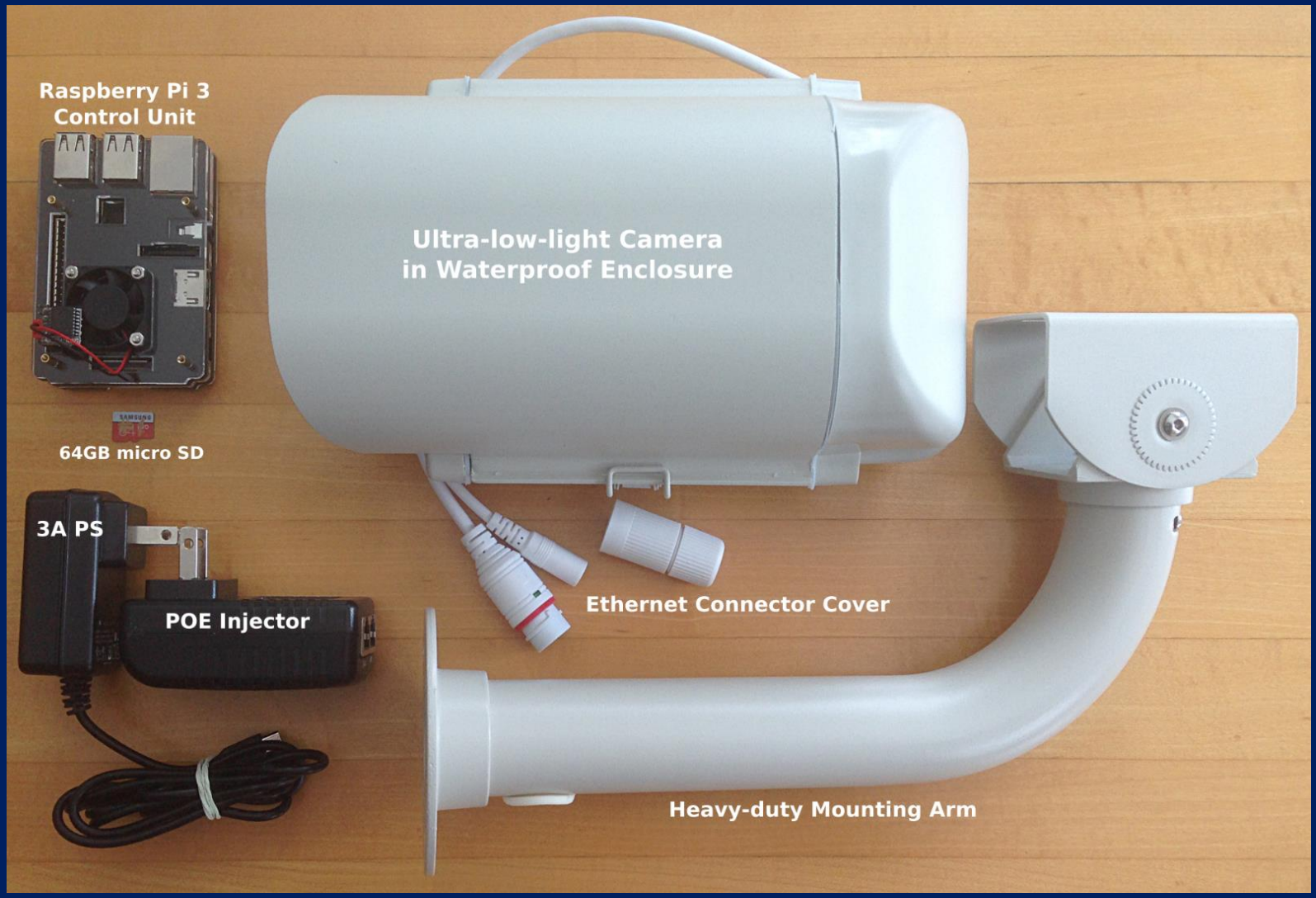


Extraterestrial visitor 2018 February 16

- Above hyperbolic speed
- Exceptional high ablation height
- Remarkable spinning behavior
- Leaving our atmosphere at higher elevation than it entered
- See you later aligator, near another star



CAMS COVERAGE FOR BRAMS METEOR ECHOES
RPI METEOR CAMERA



CAMS COVERAGE FOR BRAMS METEOR ECHOES
RPI METEOR CAMERA

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CASE STUDIES

Investigating a particular meteor shower among 1 million orbits available

- ✓ Make a preliminary search to **determine lower and upper limits**
  - Time interval: $20° < \lambda_O < 45°$;
  - Radiant area: $259° < a < 286°$ & $+25° < \delta < +43°$;
  - Velocity: $40\ \text{km/s} < v_g < 52\ \text{km/s}$.
- ✓ **Select all orbits** within the activity period, with a radiant and with a geocentric velocity **within these limits**
- ✓ Calculate the **median values** for the orbital elements for all selected orbits, excluding hyperbolic orbits
- ✓ Calculate the **similarity criteria** for each orbit relative to the median values which serve as reference orbit
- ✓ Recalculate the median values for those orbits that satisfy criteria
- ✓ Few iteration until best representative 'average' orbit is obtained

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CASE STUDIES

$$\Gamma = \begin{cases} +1, & |\Omega_p - \Omega_m| \leq 180^{\mathrm{O}} \\ -1, & |\Omega_p - \Omega_m| > 180^{\mathrm{O}} \end{cases}$$

$\psi = \arccos\left[\cos i_p \cos i_m + \sin i_p \sin i_m \cos(\Omega_p - \Omega_m)\right]$ *(angle orbital planes)*

$\Pi = \omega_p - \omega_m + 2\Gamma \arcsin\left(\cos\frac{i_p+i_m}{2}\sin\frac{\Omega_p-\Omega_m}{2}\sec\frac{\psi}{2}\right)$ (*angle between perihelia*)

$\lambda = \Omega + \arctan(\cos i \tan\omega), \beta = \arcsin(\sin i \sin\omega)$ (*ecl. coord. perihelia*)

$$D_{SH}^2 = (q_p - q_m)^2 + (e_p - e_m)^2 + \left(2\sin\frac{\psi}{2}\right)^2 + \left(\frac{e_p + e_m}{2}\cdot 2\sin\frac{\Pi}{2}\right)^2,$$

$$D_D^2 = \left(\frac{e_p - e_m}{e_p + e_m}\right)^2 + \left(\frac{q_p - q_m}{q_p + q_m}\right)^2 + \left(\frac{\psi}{180^\circ}\right)^2 + \left(\frac{e_p + e_m}{2}\right)^2 \cdot \left(\frac{\theta}{180^\circ}\right)^2,$$

$$D_H^2 = (e_p - e_m)^2 + \left(\frac{q_p - q_m}{q_p + q_m}\right)^2 + \left(2\,sin\frac{\psi}{2}\right)^2 + \left(\frac{e_p + e_m}{2}\right)^2 \cdot \left(2\,sin\frac{\Pi}{2}\right)^2.$$

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CASE STUDIES

The D-criteria used are these of Southworth and Hawkins (1963), Drummond (1981) and Jopek (1993). We consider five different threshold levels of similarity:

Low: $D_{SH} < 0.25$ & $D_D < 0.105$ & $D_H < 0.25$;

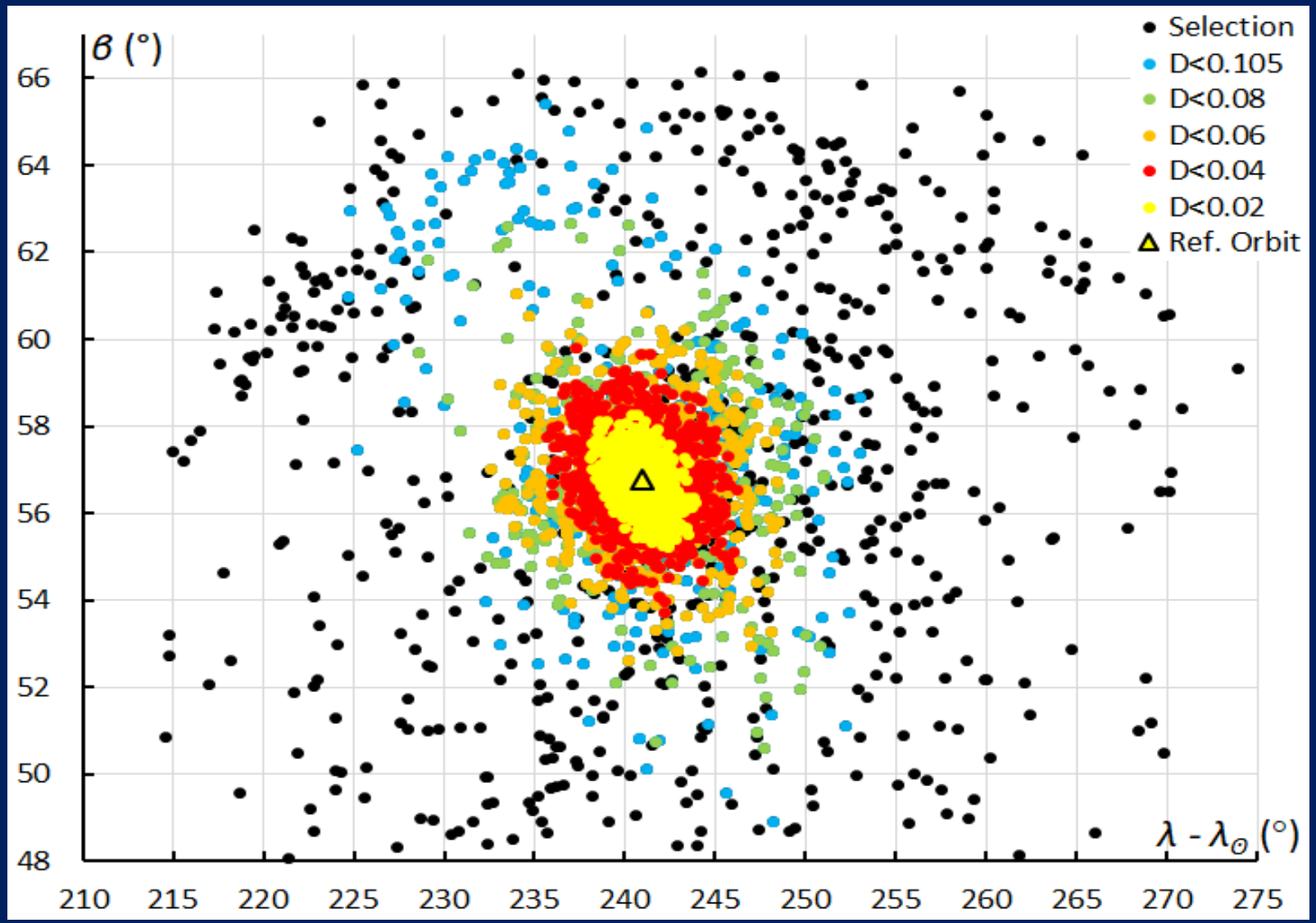
Medium low: $D_{SH} < 0.2$ & $D_D < 0.08$ & $D_H < 0.2$;

Medium high: $D_{SH} < 0.15$ & $D_D < 0.06$ & $D_H < 0.15$;

High: $D_{SH} < 0.1$ & $D_D < 0.04$ & $D_H < 0.1$.

Very high: $D_{SH} < 0.05$ & $D_D < 0.02$ & $D_H < 0.05$.

CAMS COVERAGE FOR BRAMS METEOR ECHOES
CASE STUDIES



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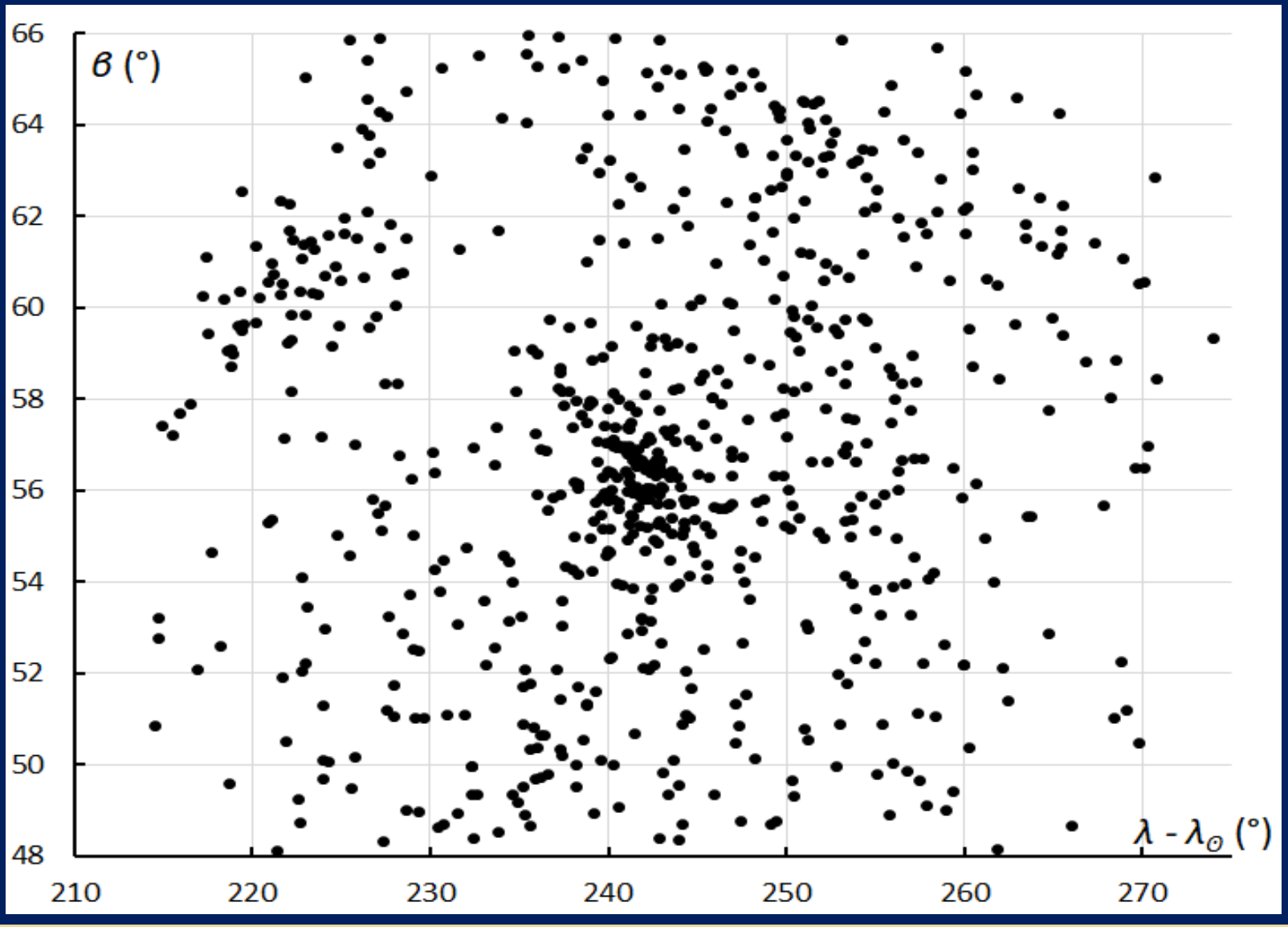
CASE STUDIES



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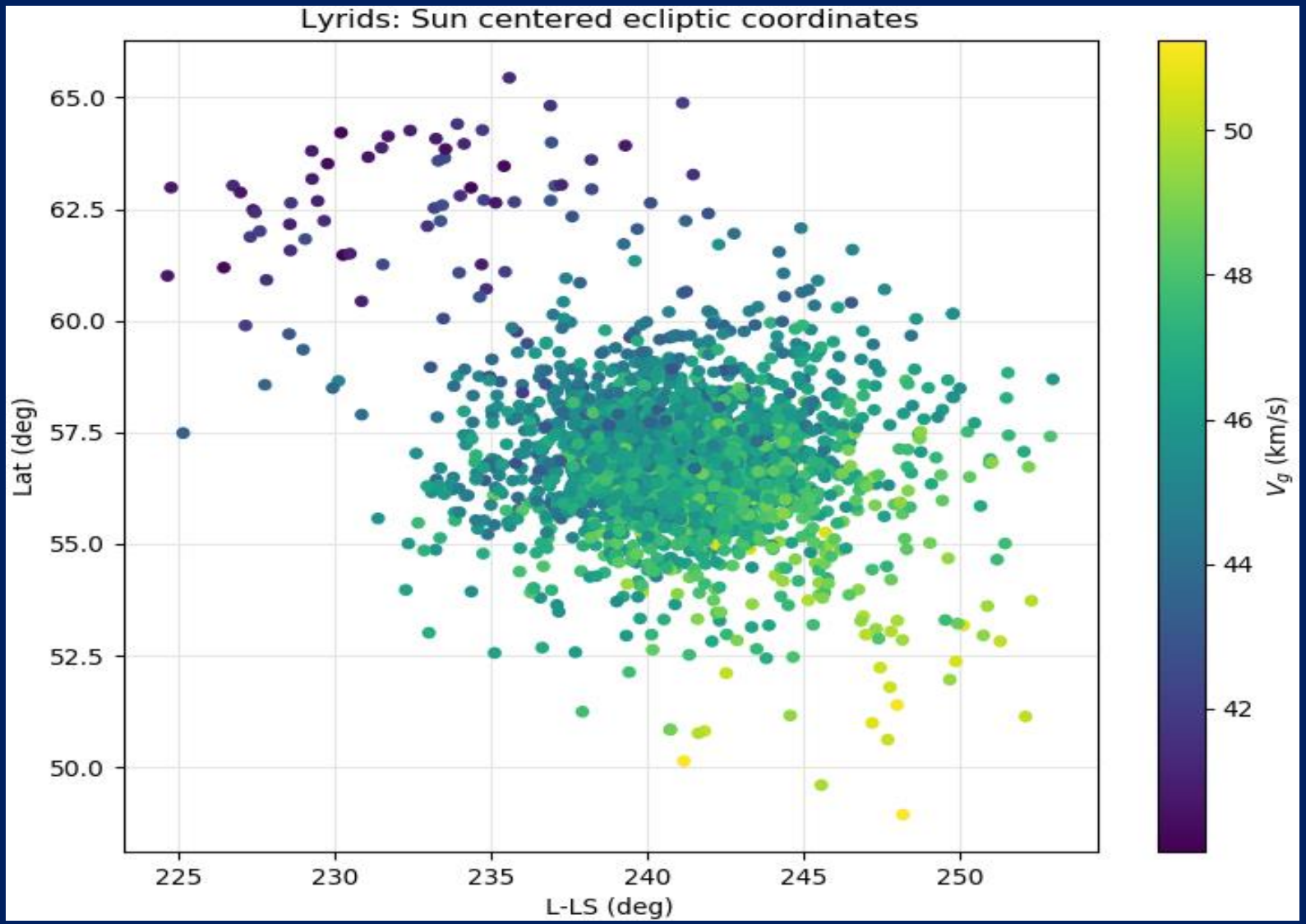
CASE STUDIES



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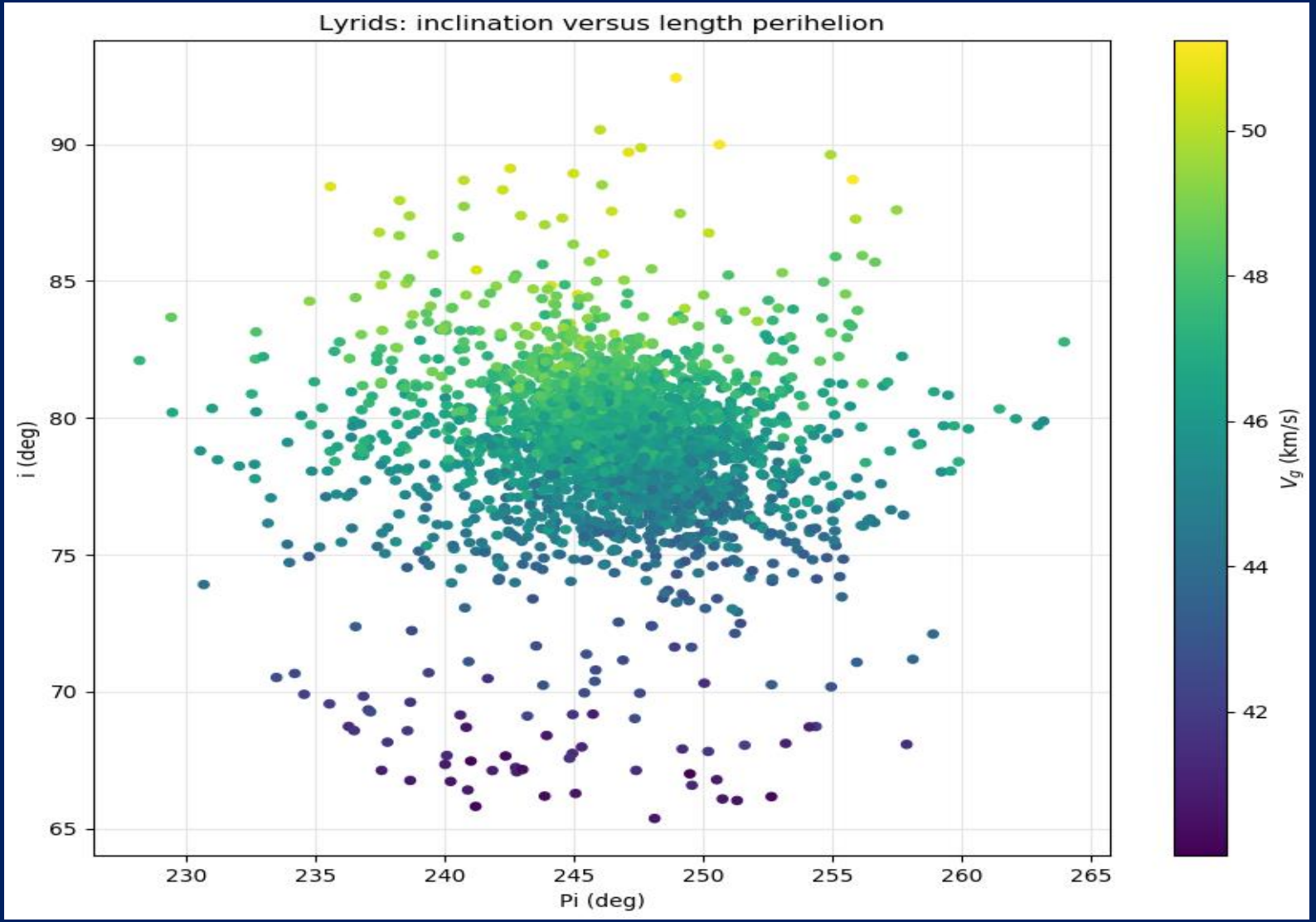
CASE STUDIES



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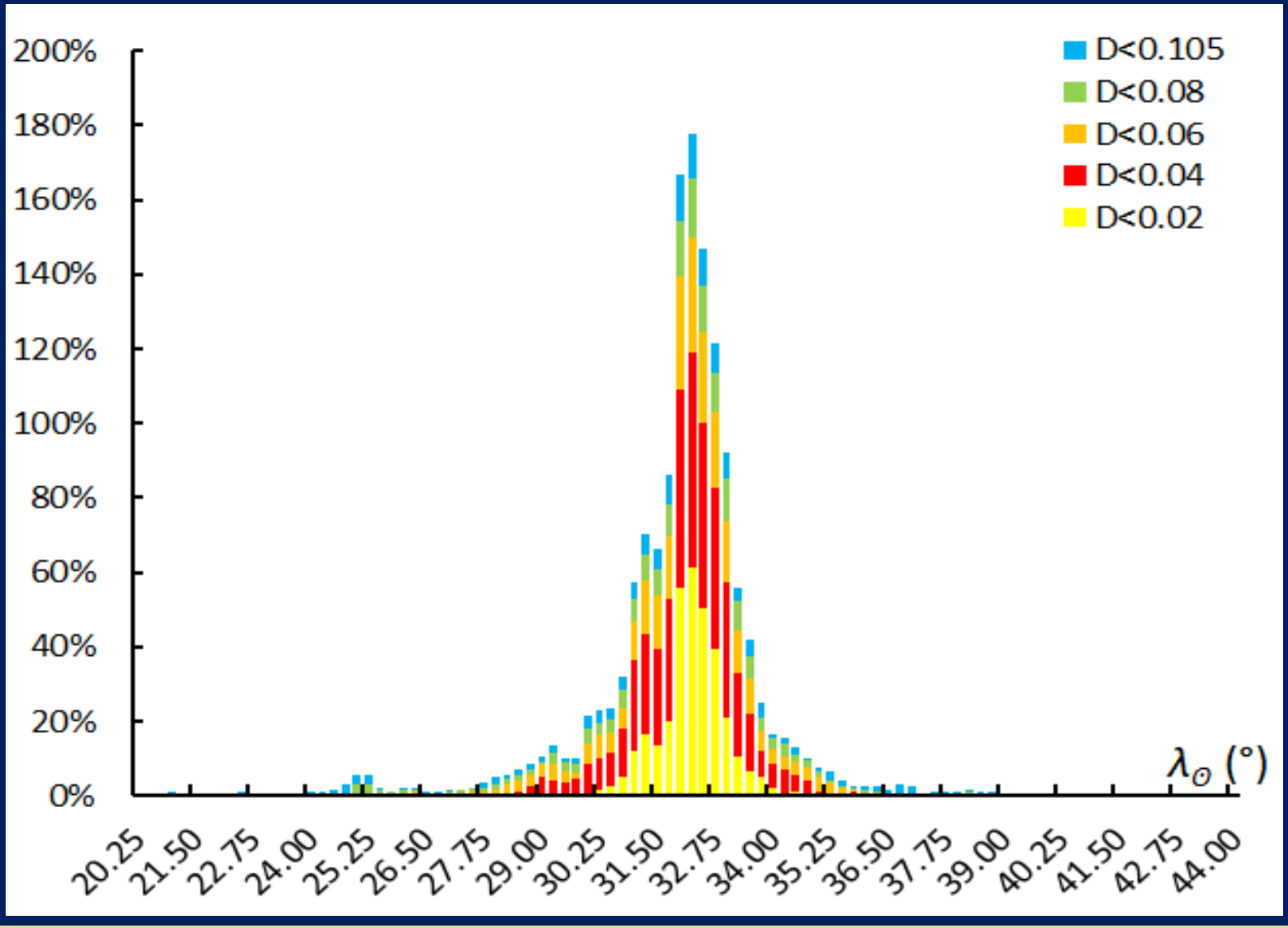
CASE STUDIES



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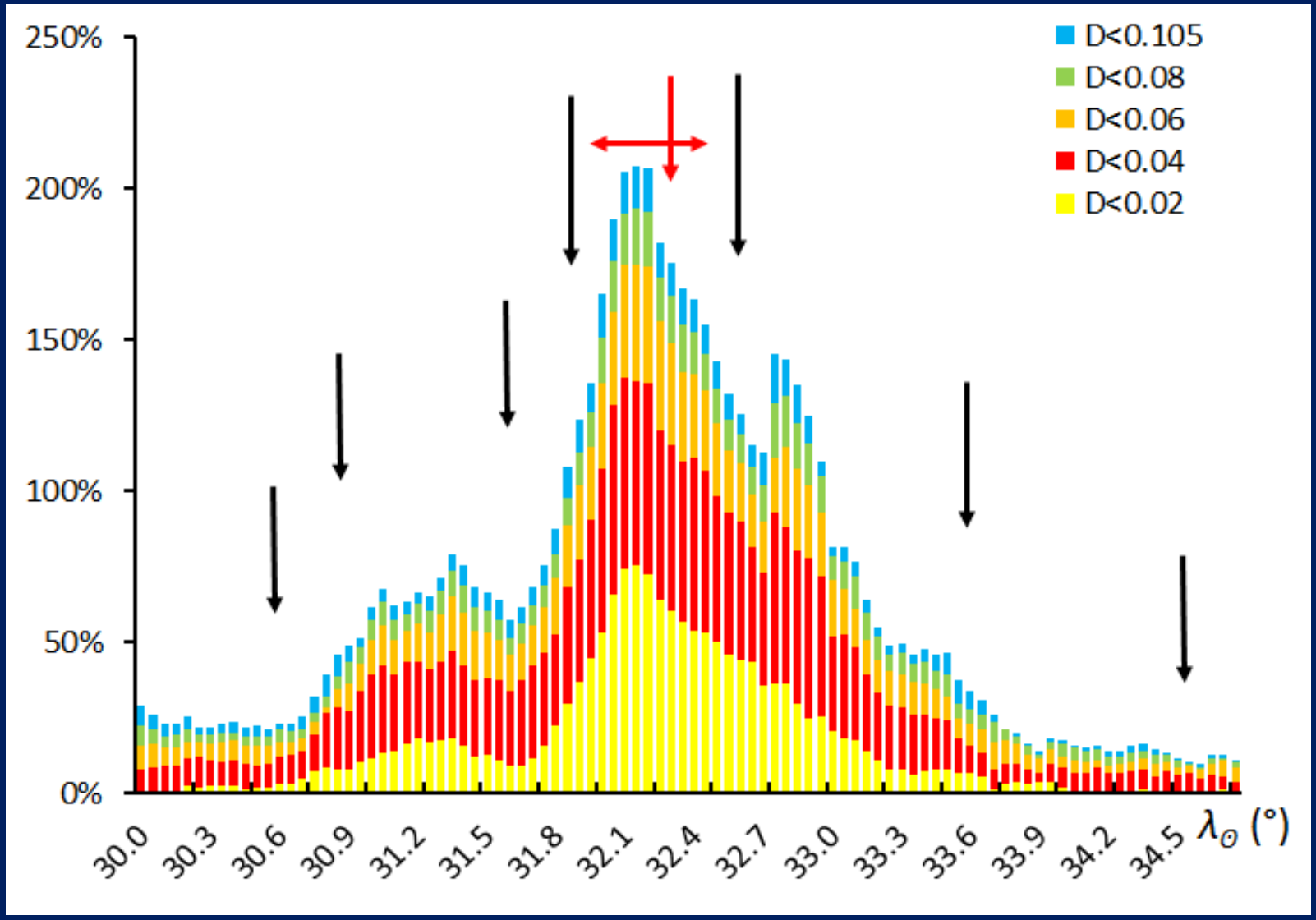

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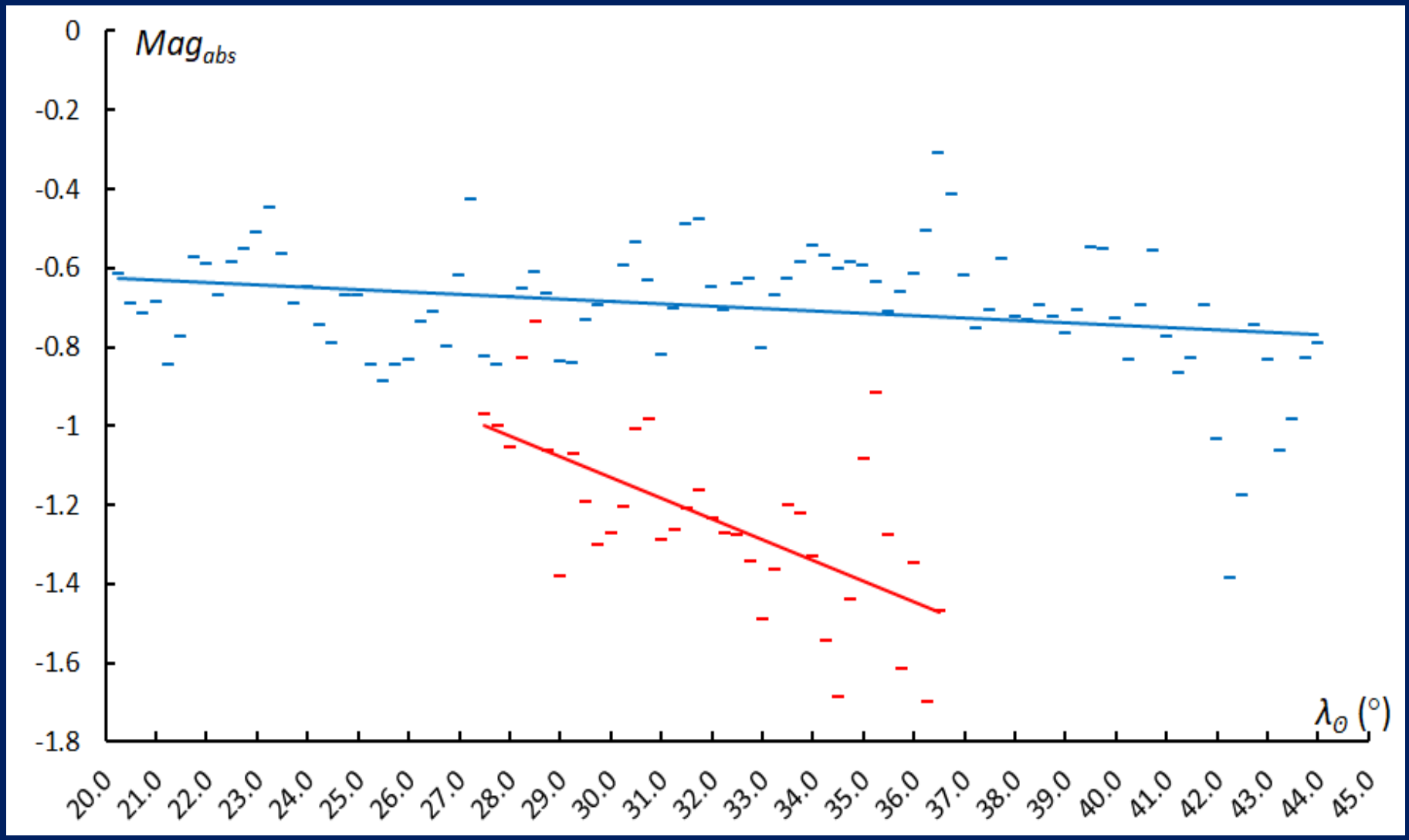
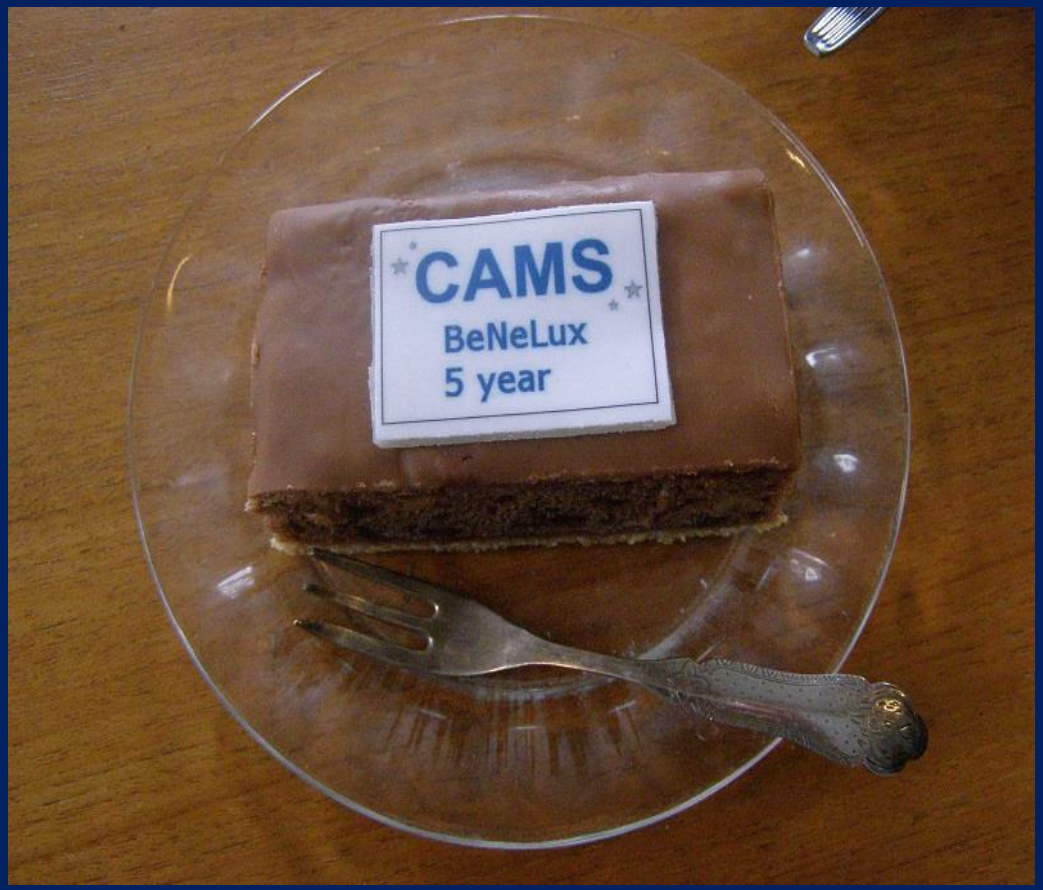
CASE STUDIES



CAMS COVERAGE FOR BRAMS METEOR ECHOES

CAMS, just for the taste of it ☺



CAMS COVERAGE FOR BRAMS METEOR ECHOES

CAMS, team work like many can only dream about

CAMS COVERAGE FOR BRAMS METEOR ECHOES

Next CAMS meeting:

MIRA Grimbergen on Sunday March 10, 2019

Interested? Welcome to join our team ☺

Thank you for your attention!

Any questions?