The 2014 κ Cygnid meteor outburst

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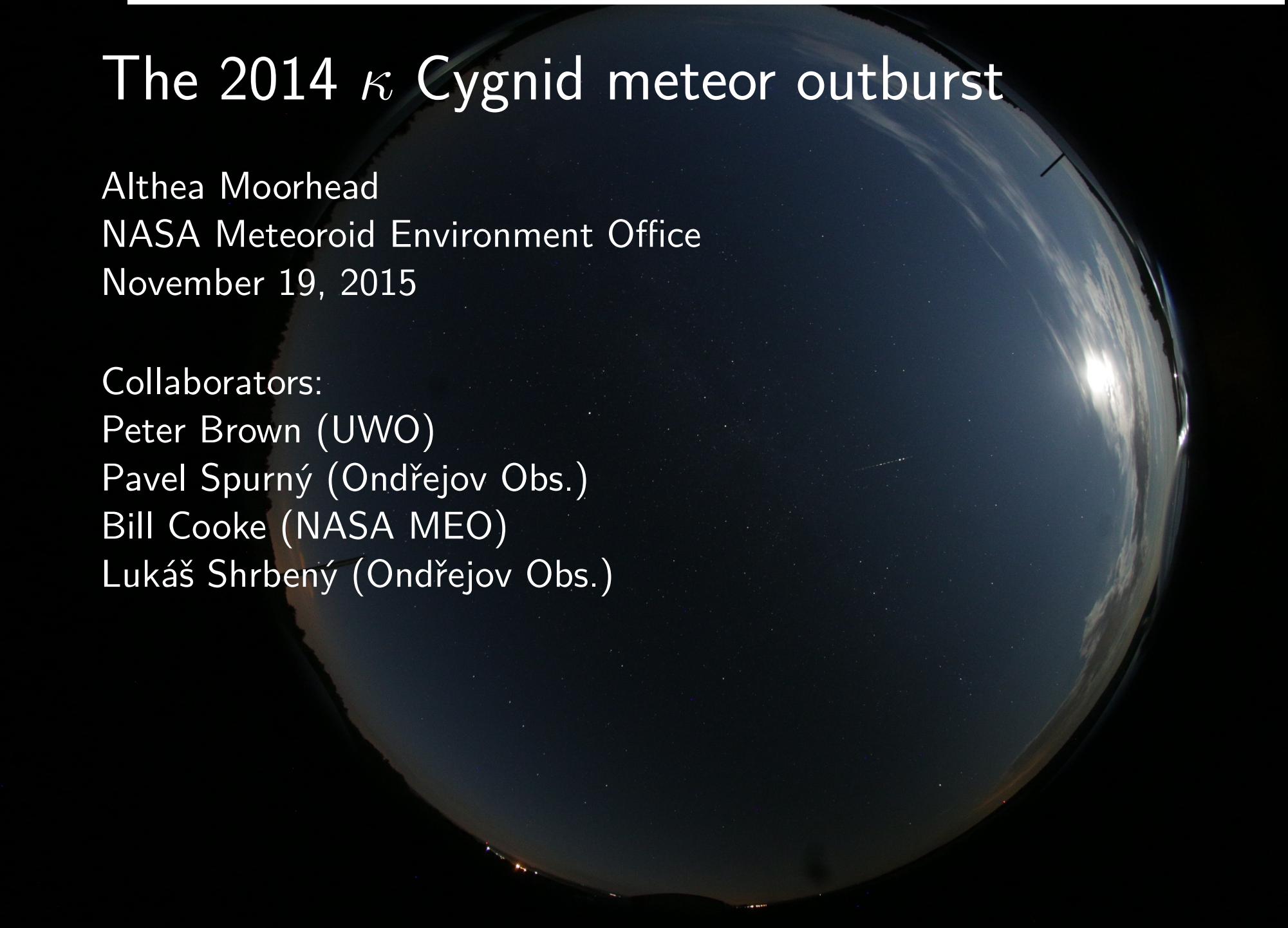


History

Historical observations:

- 1869: First observed (Denza)
- 1893: Outburst (Denning)
- 1922: Observed by three separate groups
- 1993: Outburst reported by Jenniskens
- Seen off and on in other years

Recent observations:

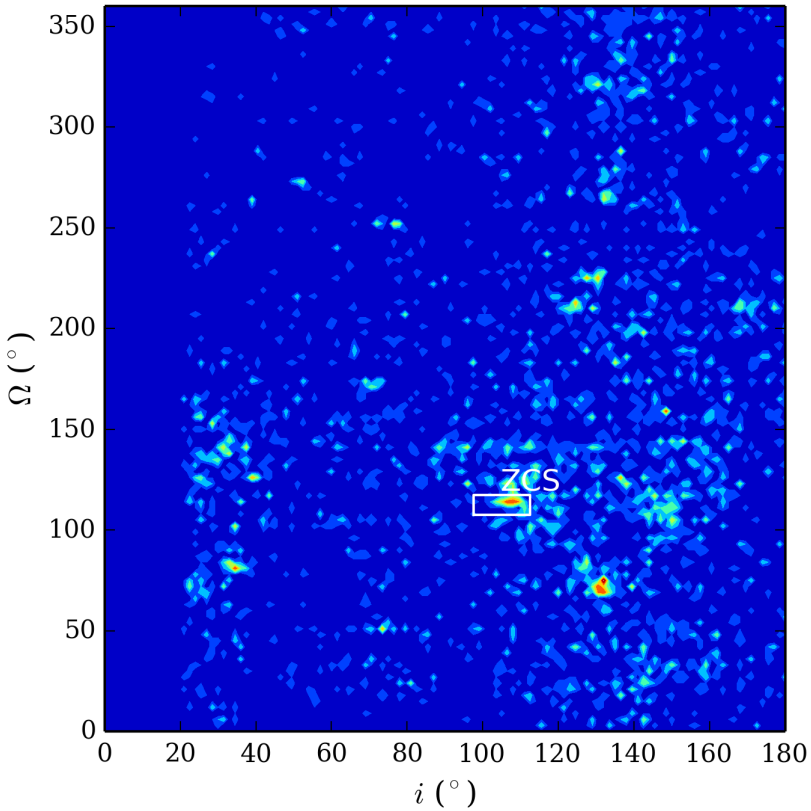
- 2007: Moderate CMOR activity
- 2014: Strong activity in all-sky, wide-field, CMOR, European Network.

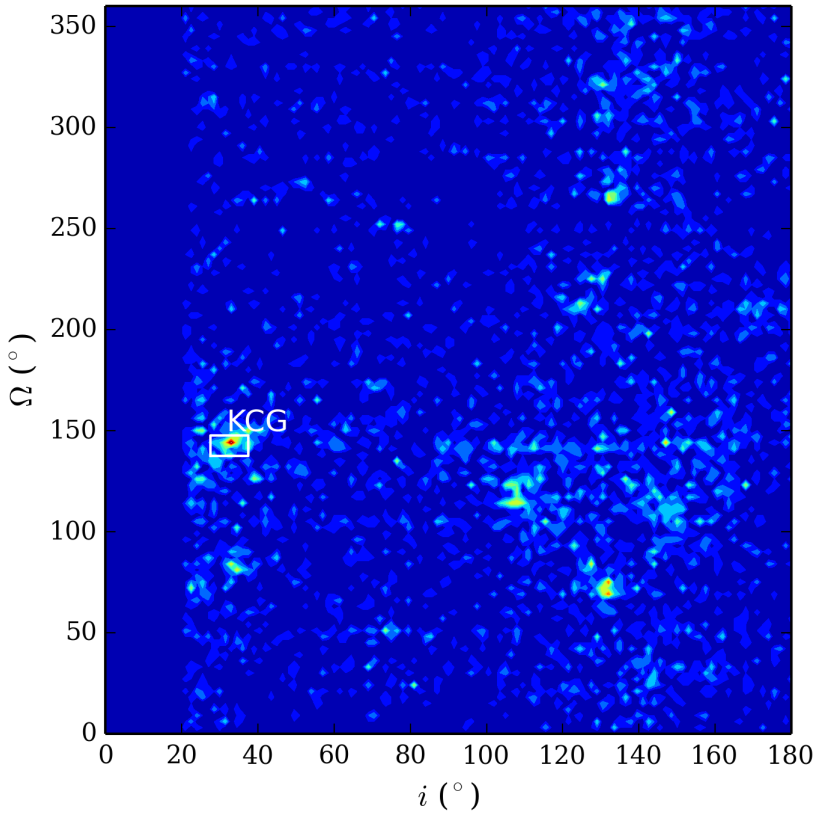
Publication history

- Jones et al. (2006):
  - Argued for up to 5 sub-streams, including the γ Draconids
  - Identified several parent candidates including 2001 MG1
- Jenniskens et al. (2008):
  - Argued for 2008 ED69 as a potential parent body
  - Hypothesizes a recently dead comet to match KCG "fragility"
  - Mentions proximity to 2:1 resonance
- The high-resolution trajectories we have for this year's KCGs enable us to do an improved characterization of the stream's dynamics

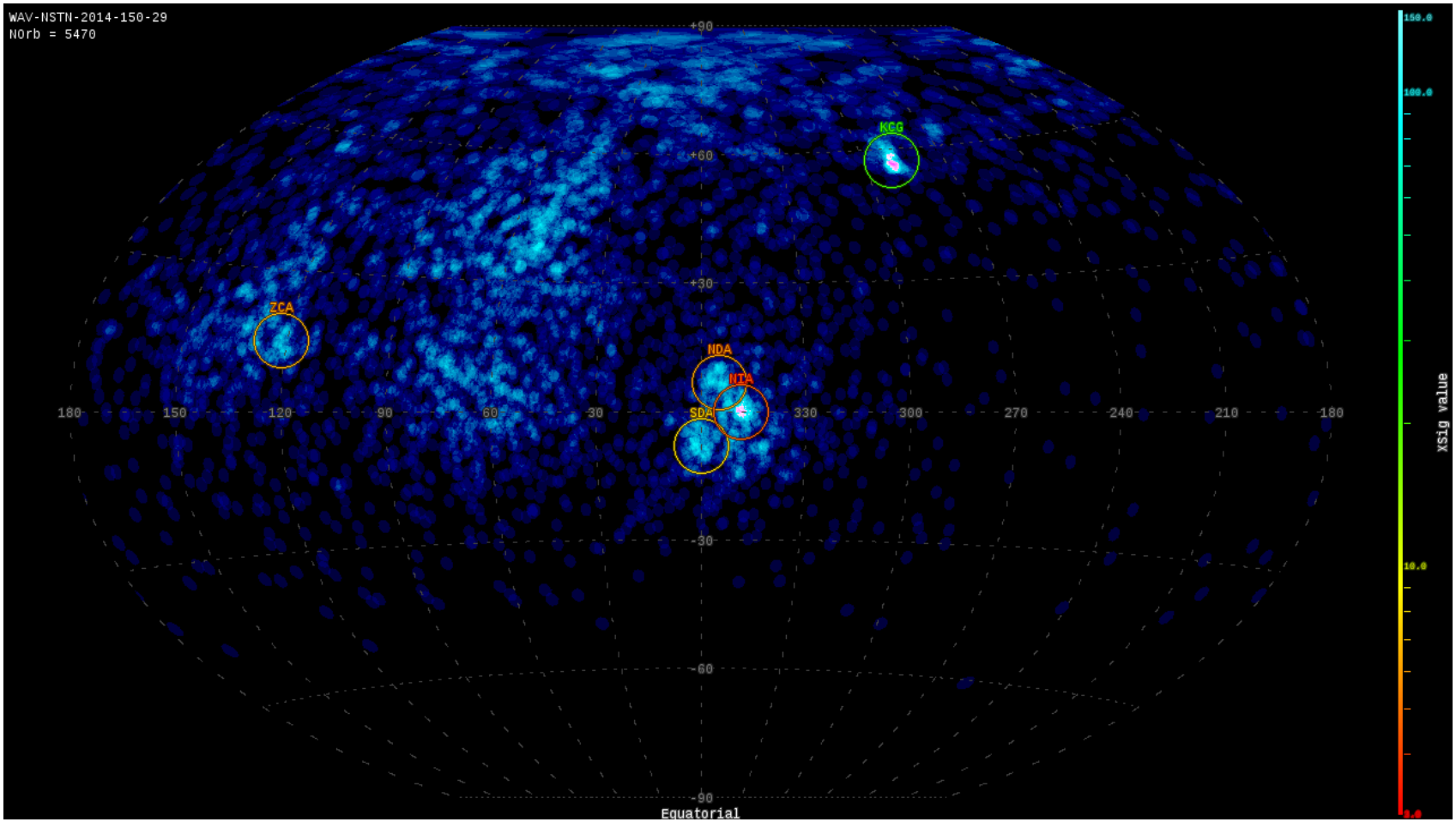
2014 Outburst:

NASA All-Sky Fireball Network
Southern Ontario Meteor Network





2014 Outburst:
Canadian Meteor Orbit Radar (CMOR)



2014 Outburst:
European Network (Czech portion)

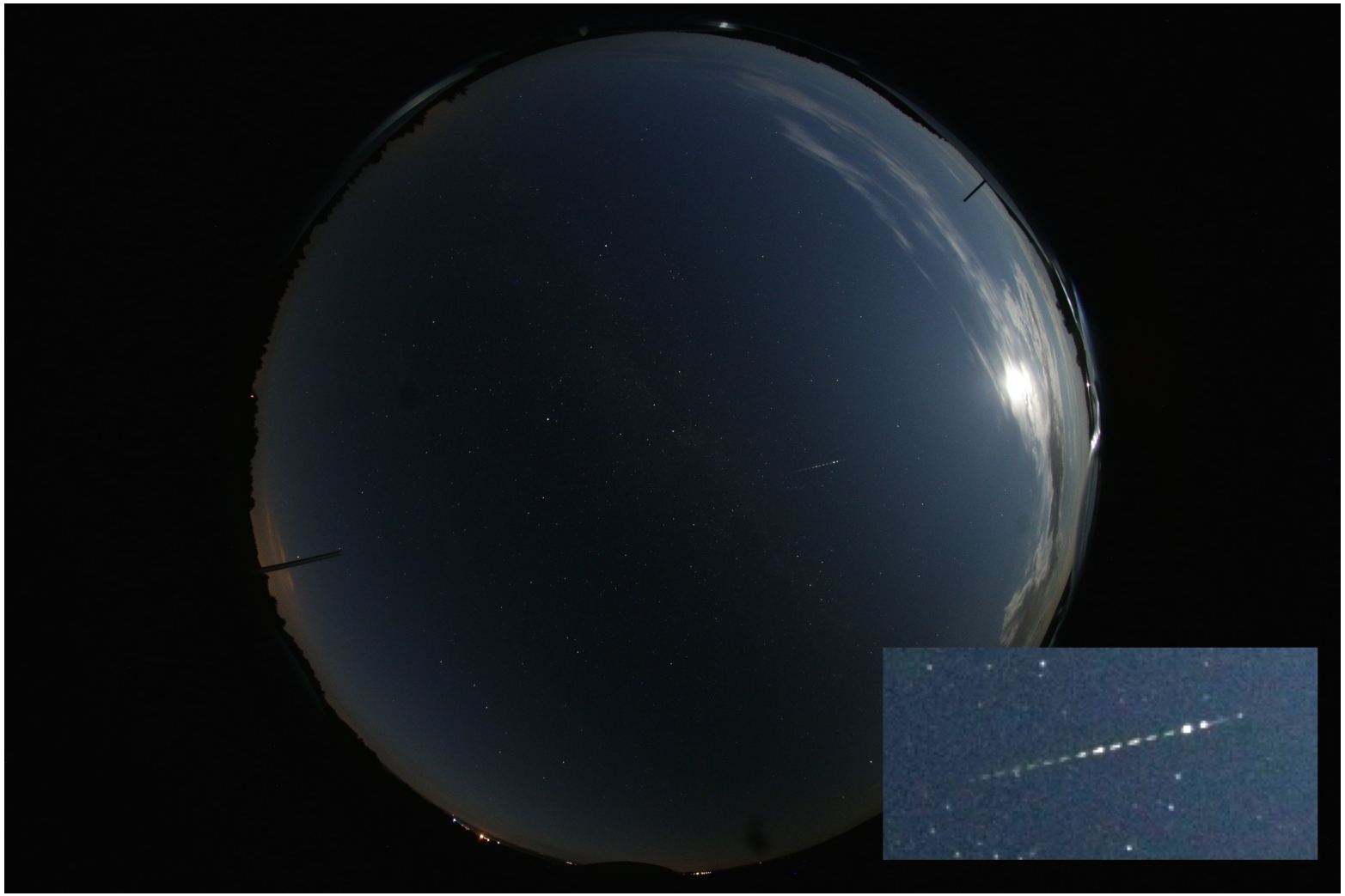
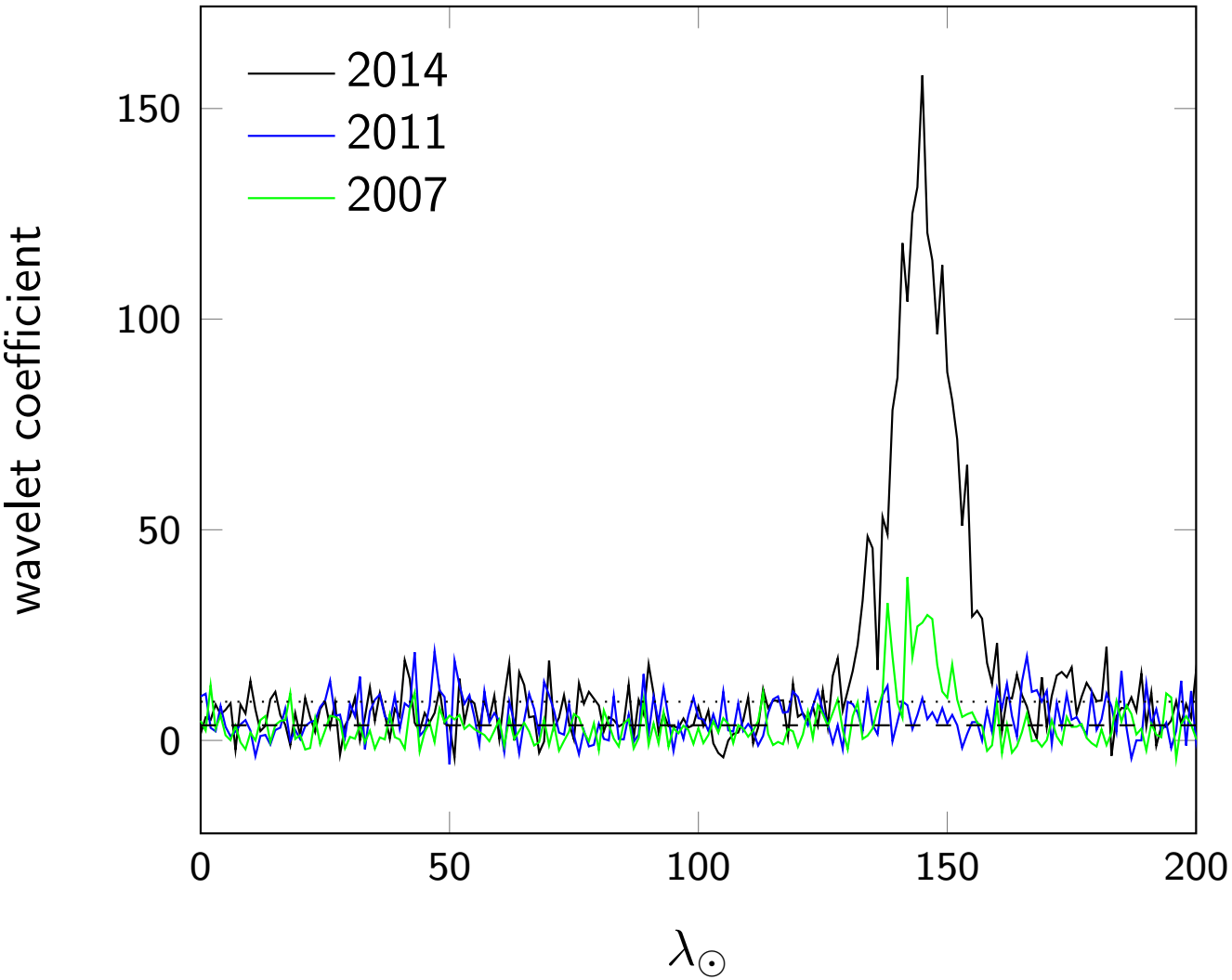
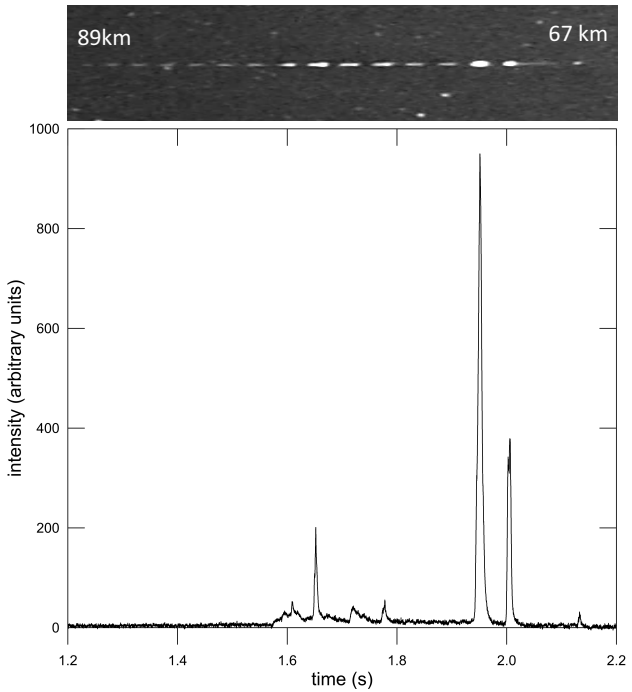


Image provided by Pavel Spurný

Activity profile



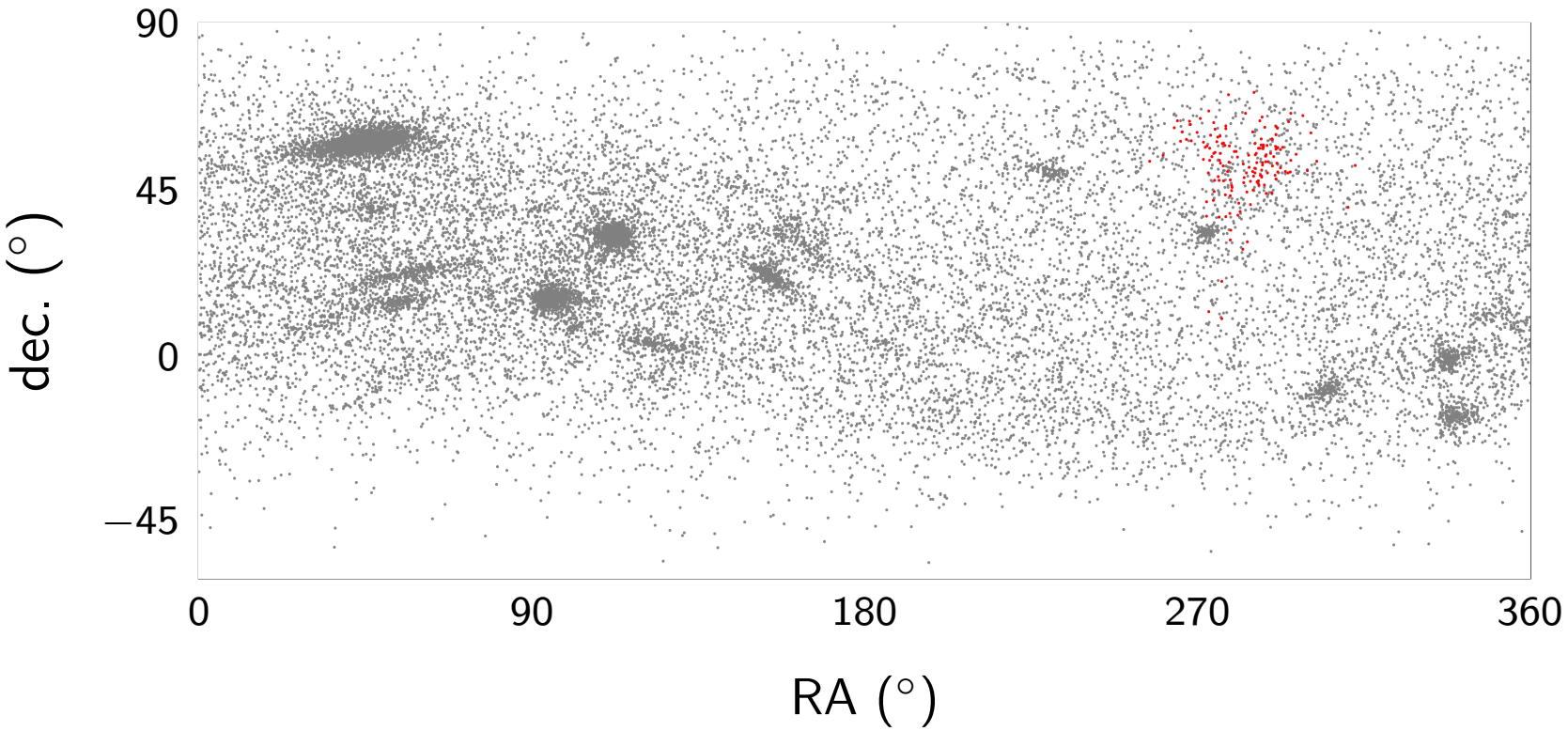
Meteor properties



- $v_g \sim 24$ km/s
- short trajectories
- multiple flares
- "cometary" properties
- Despite short, flaring trajectories, we obtained 75 high quality ($\delta v_g \leq 0.3$ km/s) KCG trajectories:
  - 69 from CMOR
  - 16 from the European Network
  - 5 from NASA & SOMN

Diffuse radiant

- Diffuse radiant makes membership determination tricky



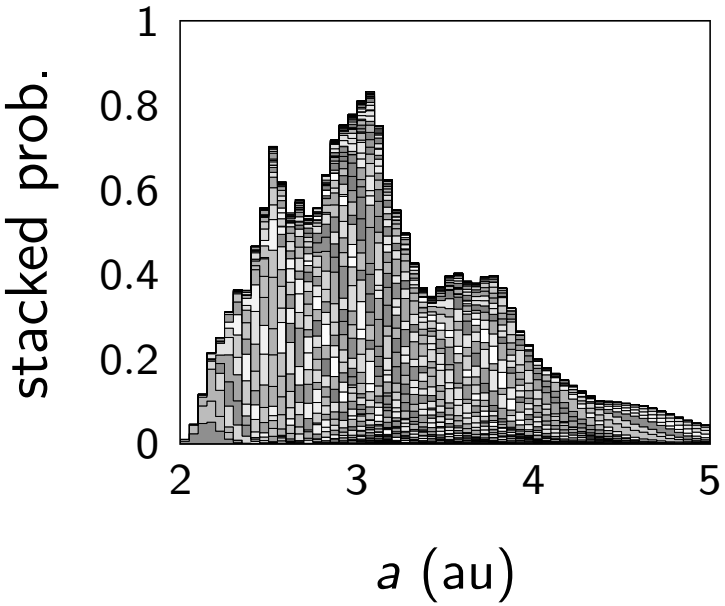
Shower member selection

Method 1: Use established shower orbit(s) to select members

$$D \leq 0.125$$

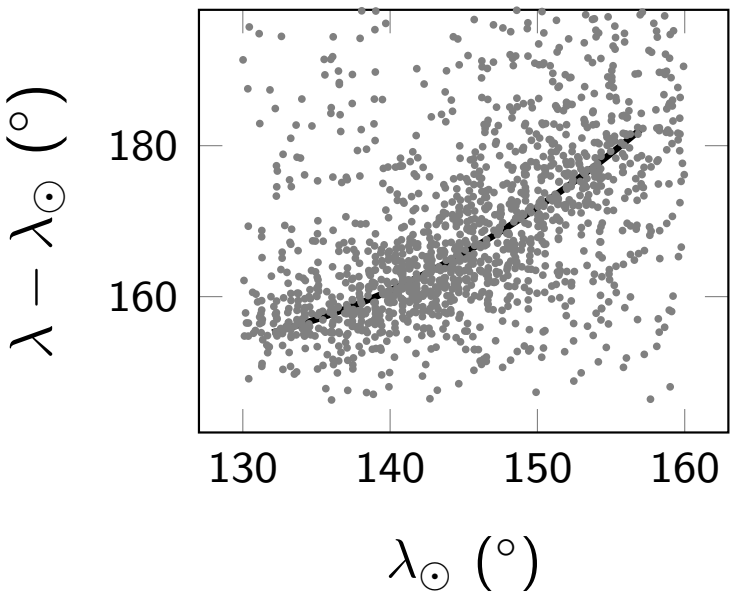
$$D^2 = \left(\frac{\Delta q}{\Sigma q}\right)^2 + \left(\frac{\Delta e}{\Sigma e}\right)^2 + \left(\frac{I_{a,b}}{\pi}\right)^2 + \bar{e}^2 \left(\frac{\theta_{a,b}}{\pi}\right)^2$$

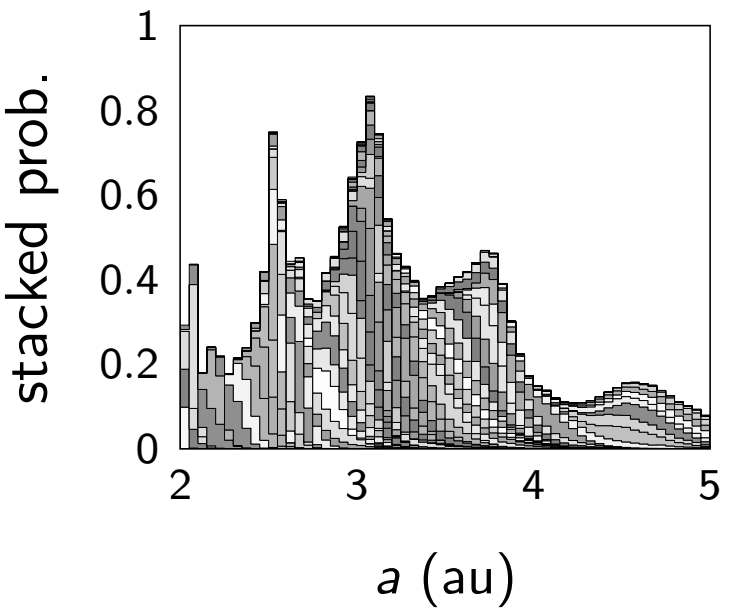
(Drummond 1981)



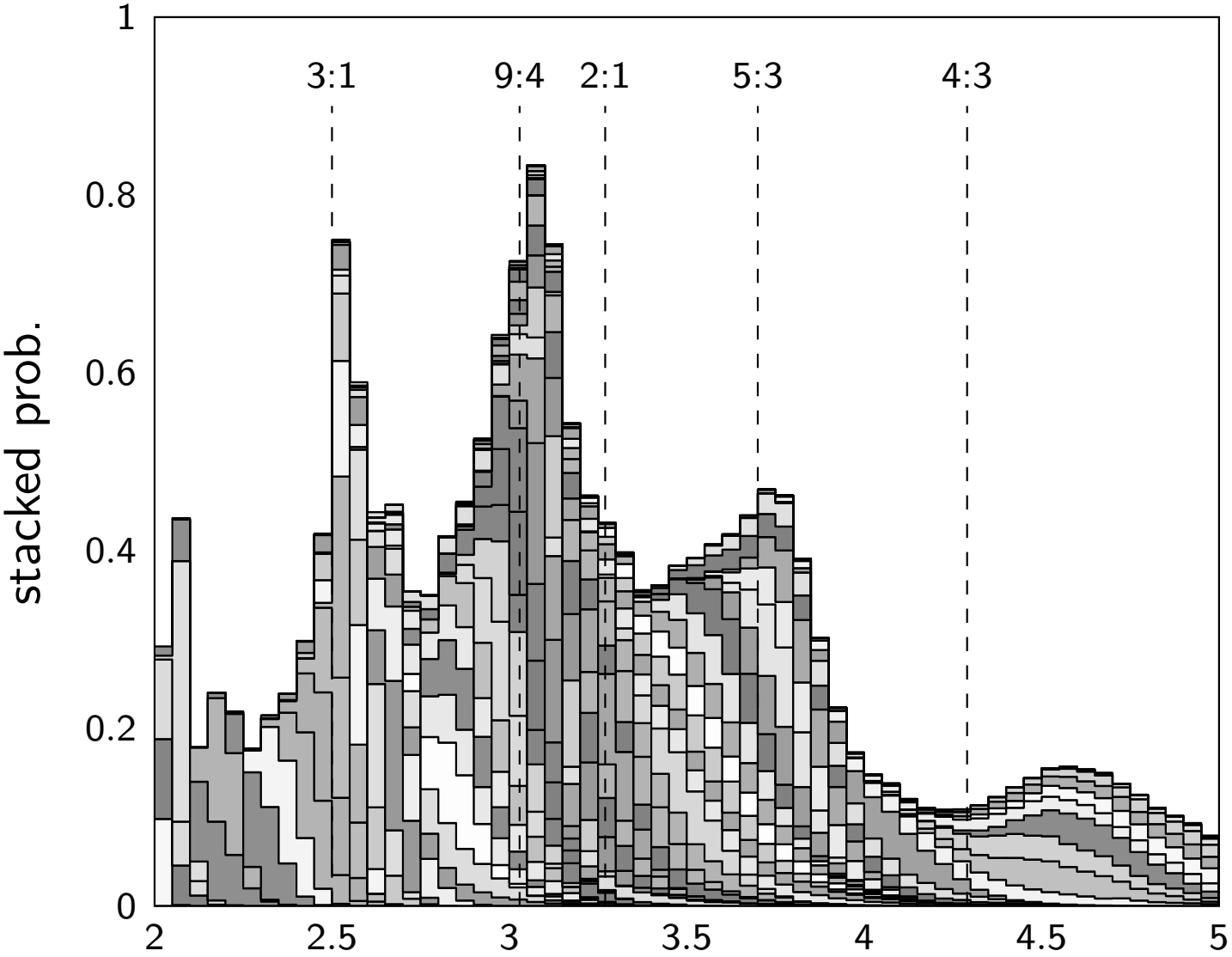
Shower member selection

Method 2: Use observed radiant and velocity to select shower members

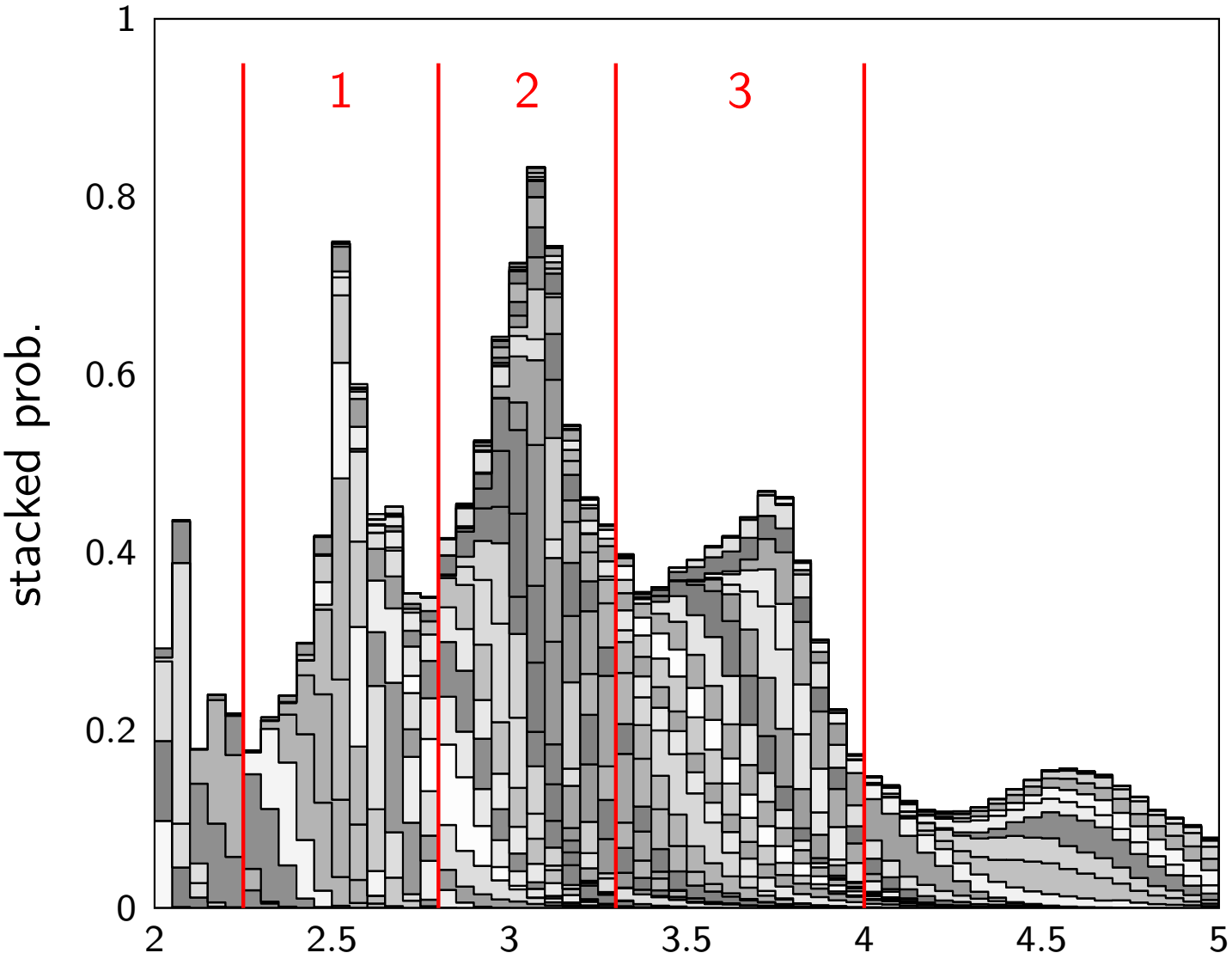




Peaks near resonances



Division into subgroups



Division into subgroups

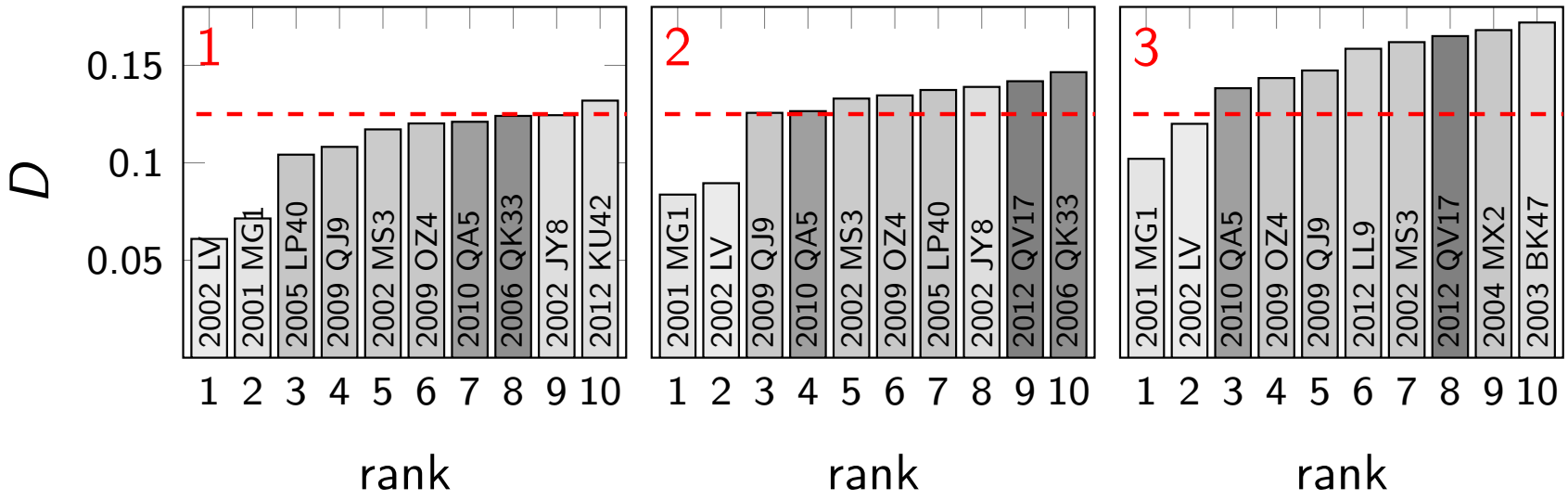
"Later" KCGs have higher inclination and eccentricity

Group	a	e	i (°)	ω (°)	Ω (°)
1	2.53	0.62	33.7	204.7	143.5
2	3.00	0.68	34.7	202.2	143.4
3	3.59	0.73	36.8	202.5	146.3

(Jopek et al. 2008)

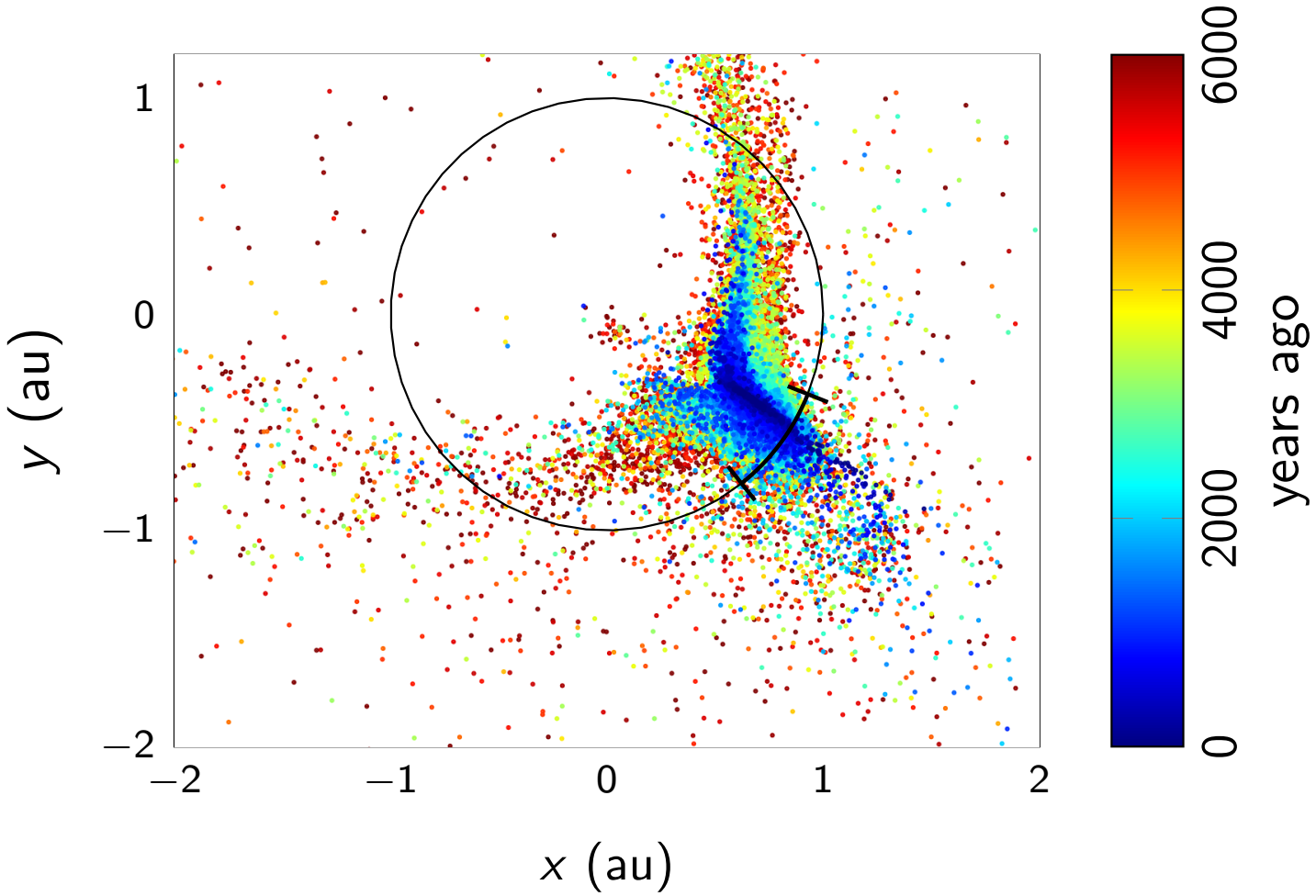
Parent body search

- Use D parameter to rank objects from JPL Small Body Database.
- 2002 LV and 2001 MG1 closest matches
- Also among the brightest (2008 ED69 has similar H)



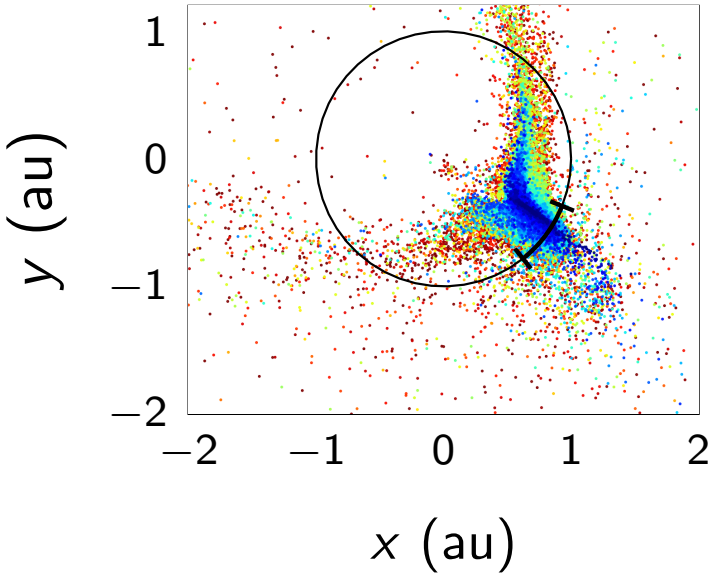
2008 ED69

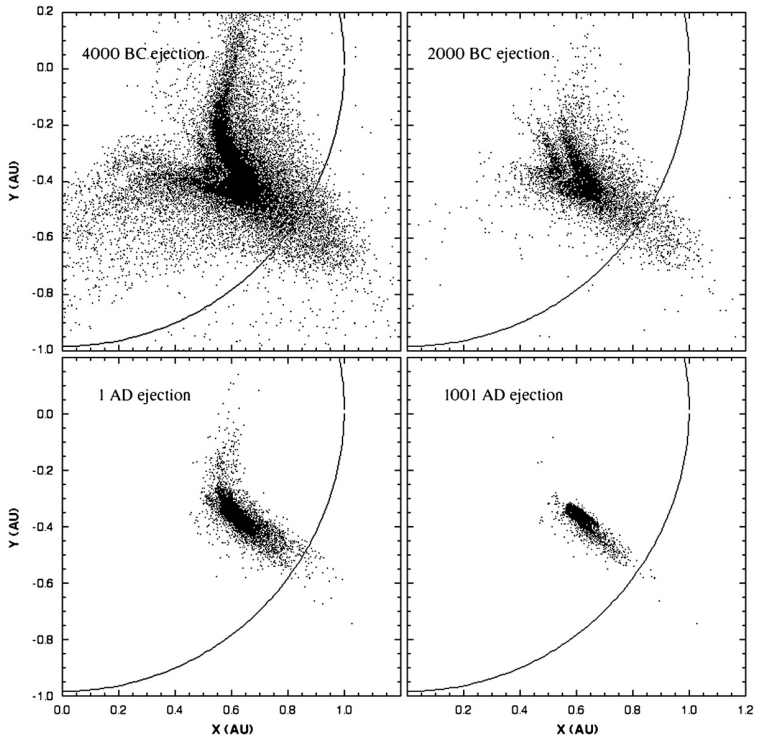
Descending node pattern



2008 ED69

Descending node pattern

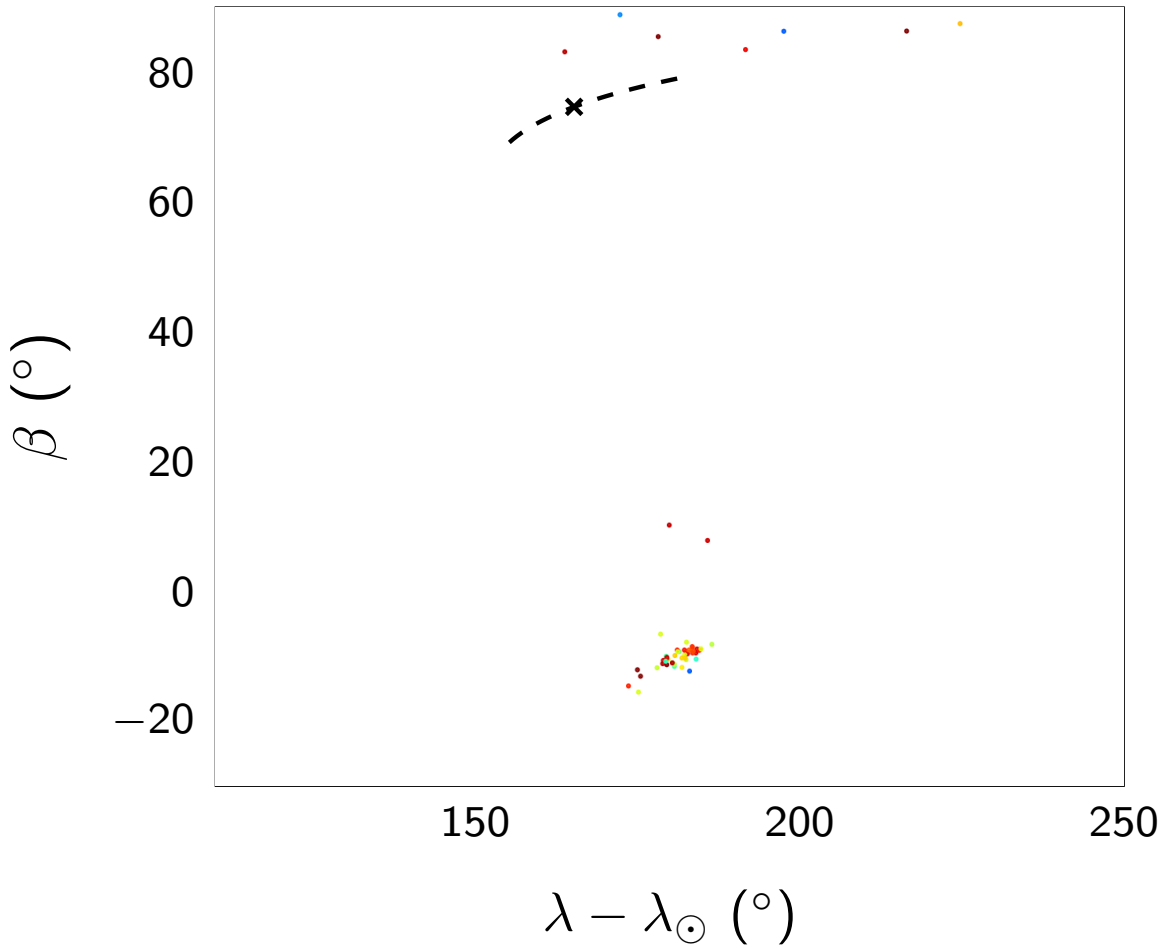




Jenniskens & Vaubaillon (2008)

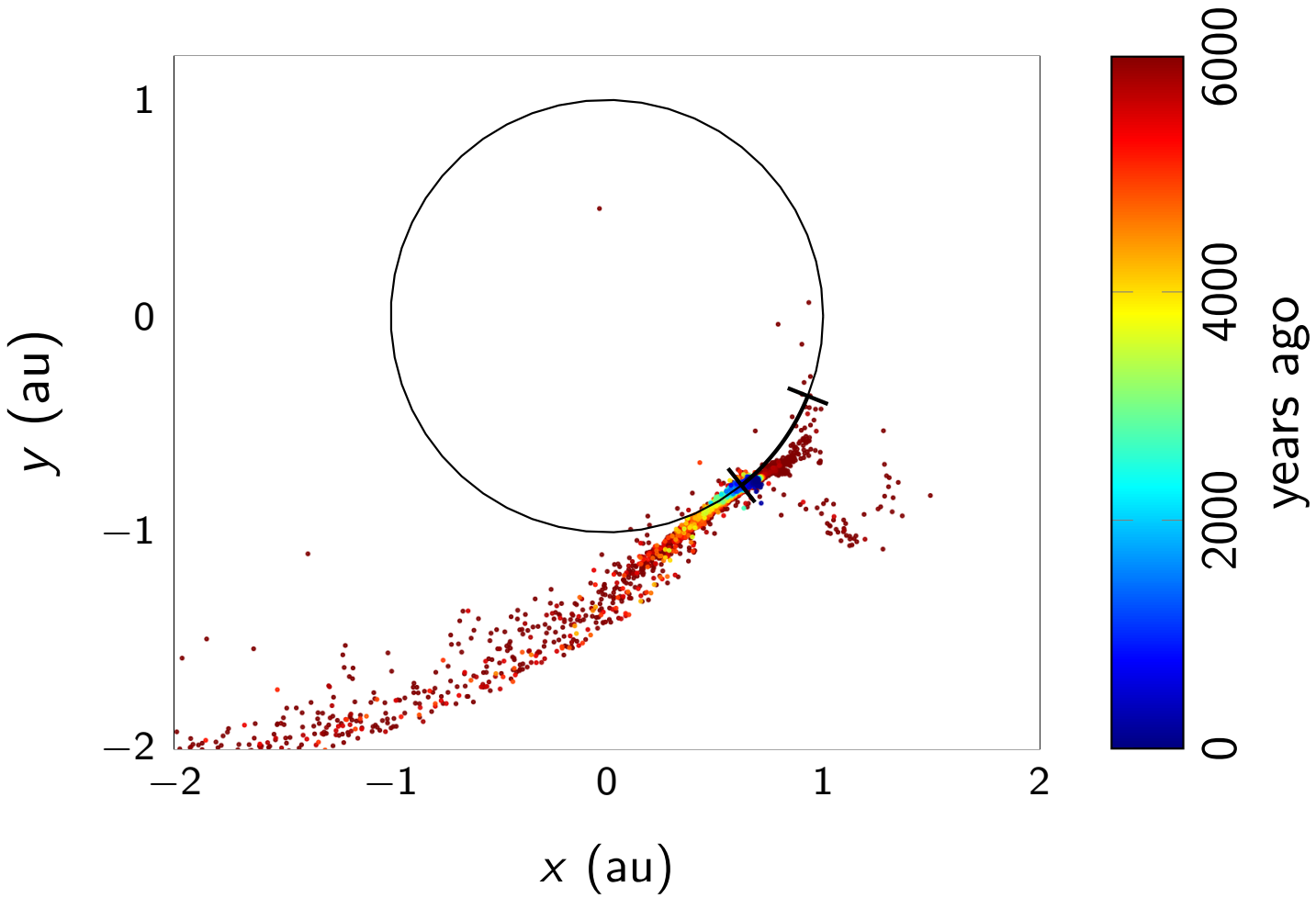
2008 ED69

Simulated meteor radiants



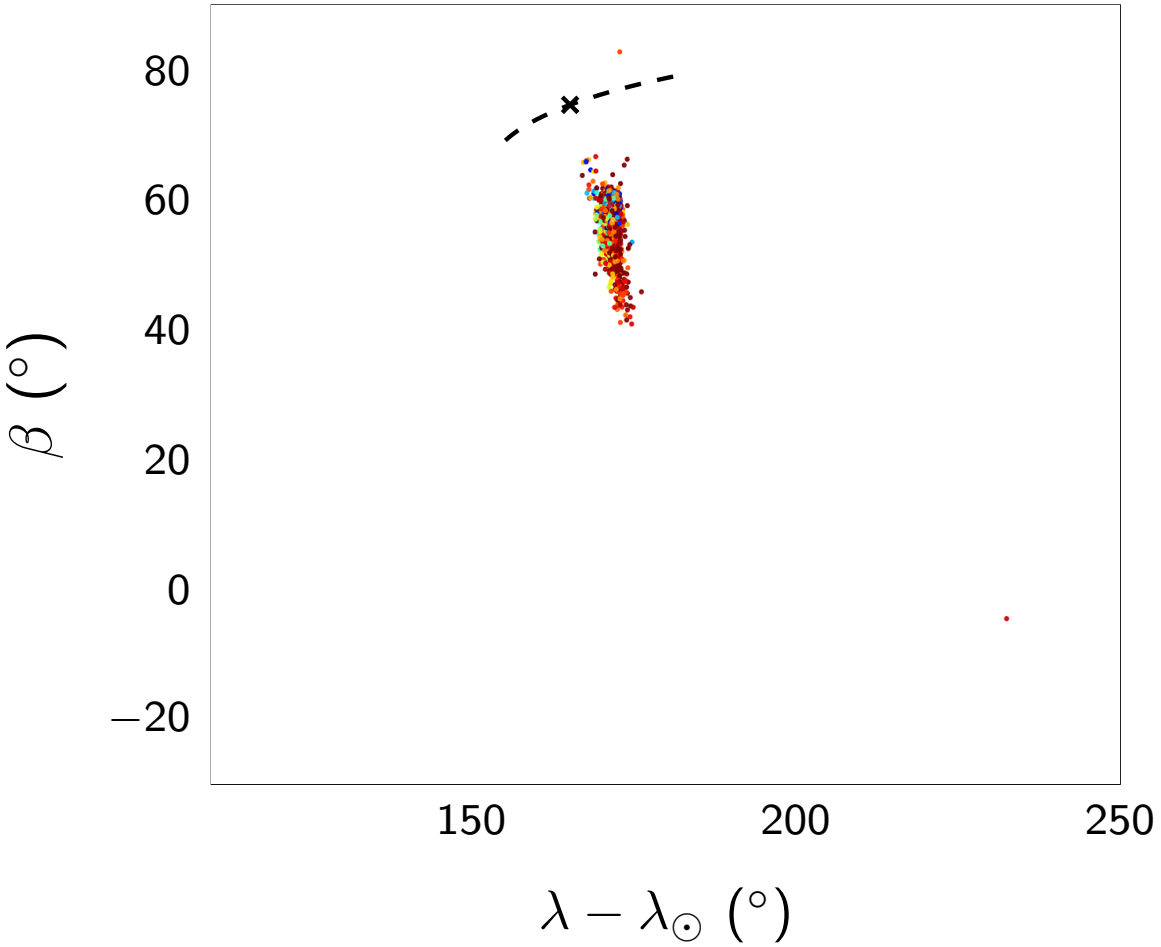
2002 LV

Descending node pattern



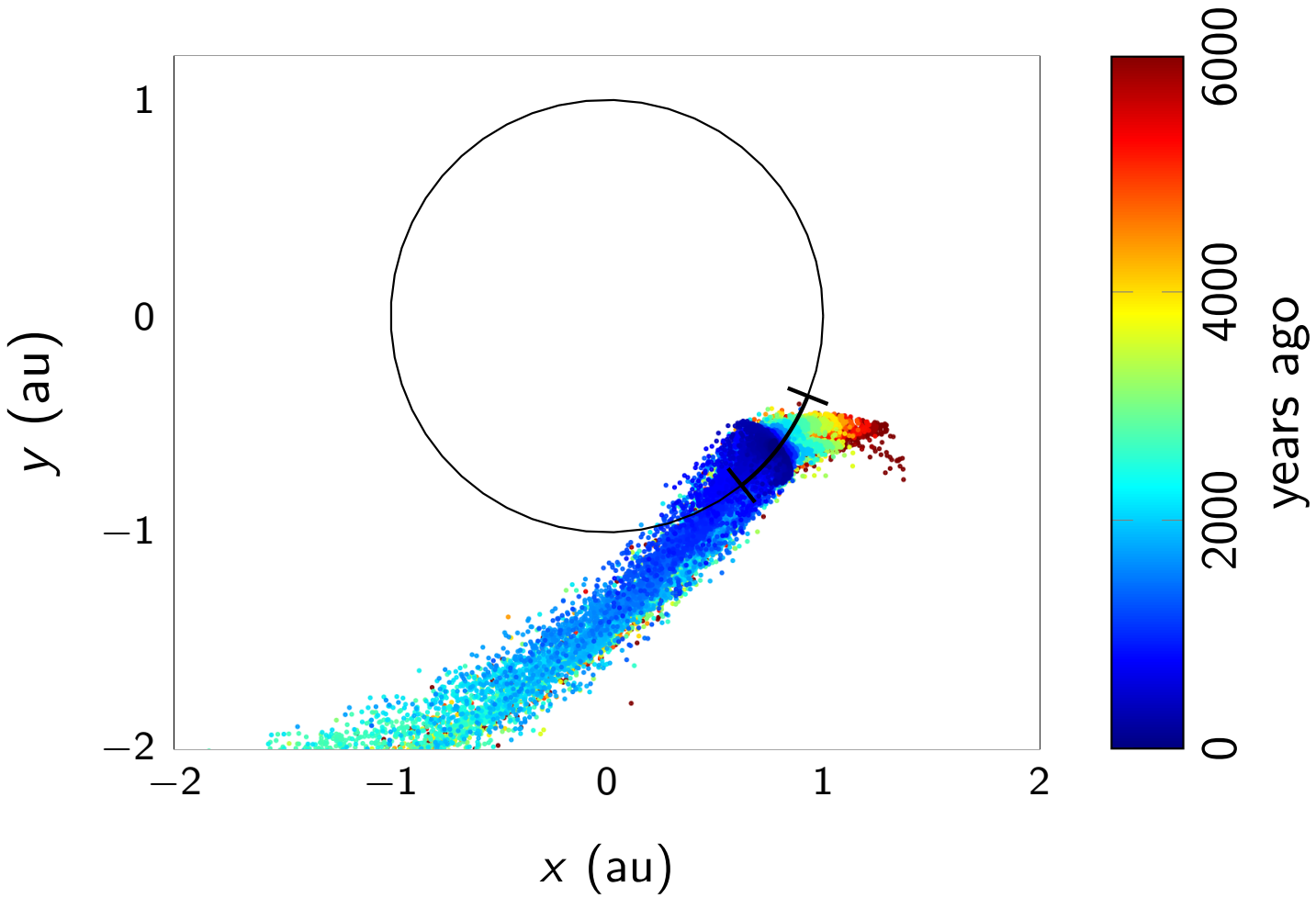
2002 LV

Simulated meteor radiants



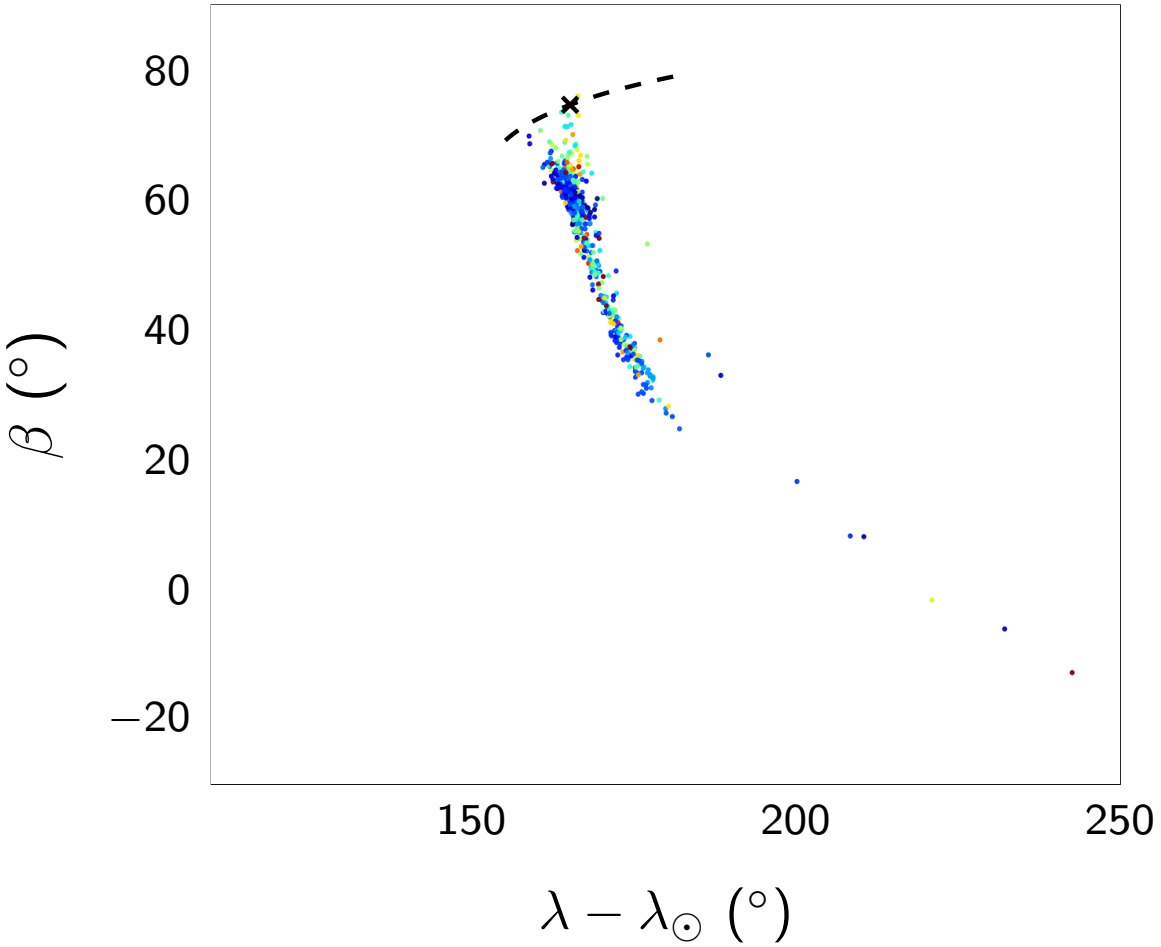
2001 MG1

Descending node pattern

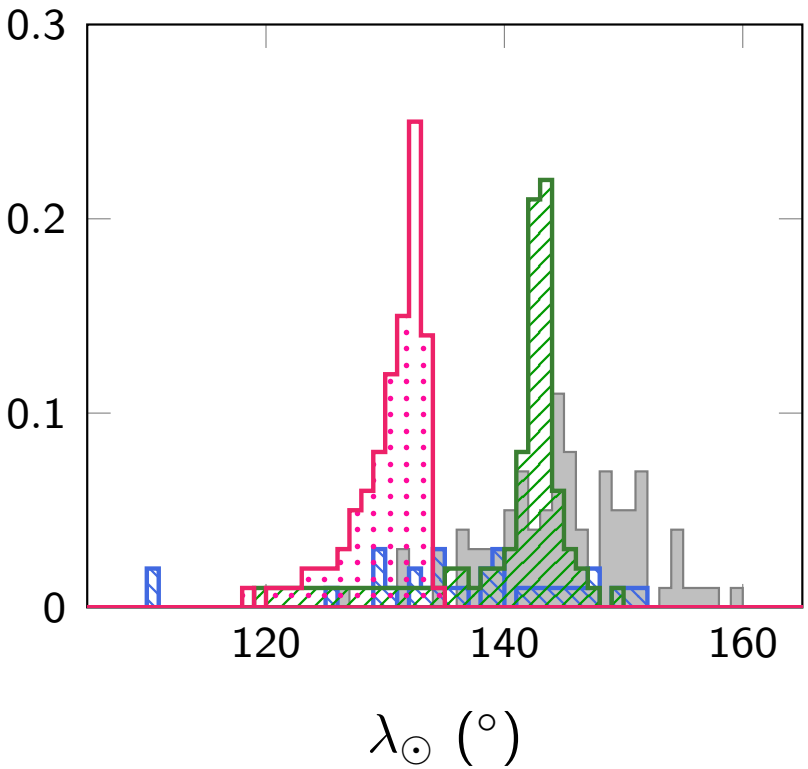


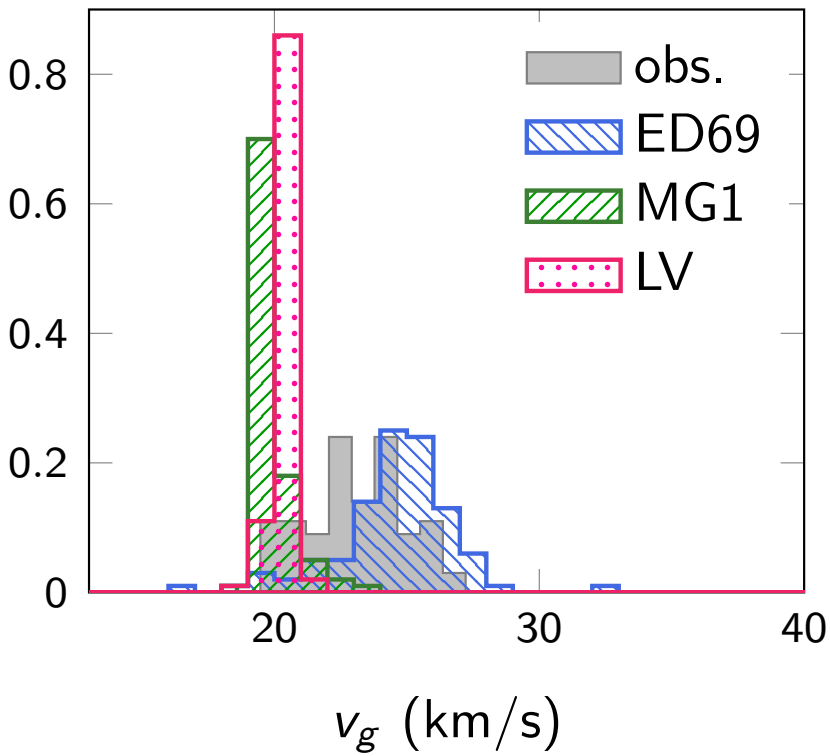
2001 MG1

Simulated meteor radiants



Simulated meteor times and velocities





Summary

- 2014 KCG outburst was observed over a broad size range, many networks (3 optical, 1 radar)
- Characterized activity profile, radiant drift, stream orbit, orbital element distributions
- History and *a* distribution point towards resonances
- Several asteroids resemble the stream, none match perfectly

	2008 ED69	2002 LV	2001 MG1
meteoroid transfer	low	high	high
timing	mixed	too early	good
velocity	a little high	too low	too low
radiant	very poor	poor	poor (hits peak)