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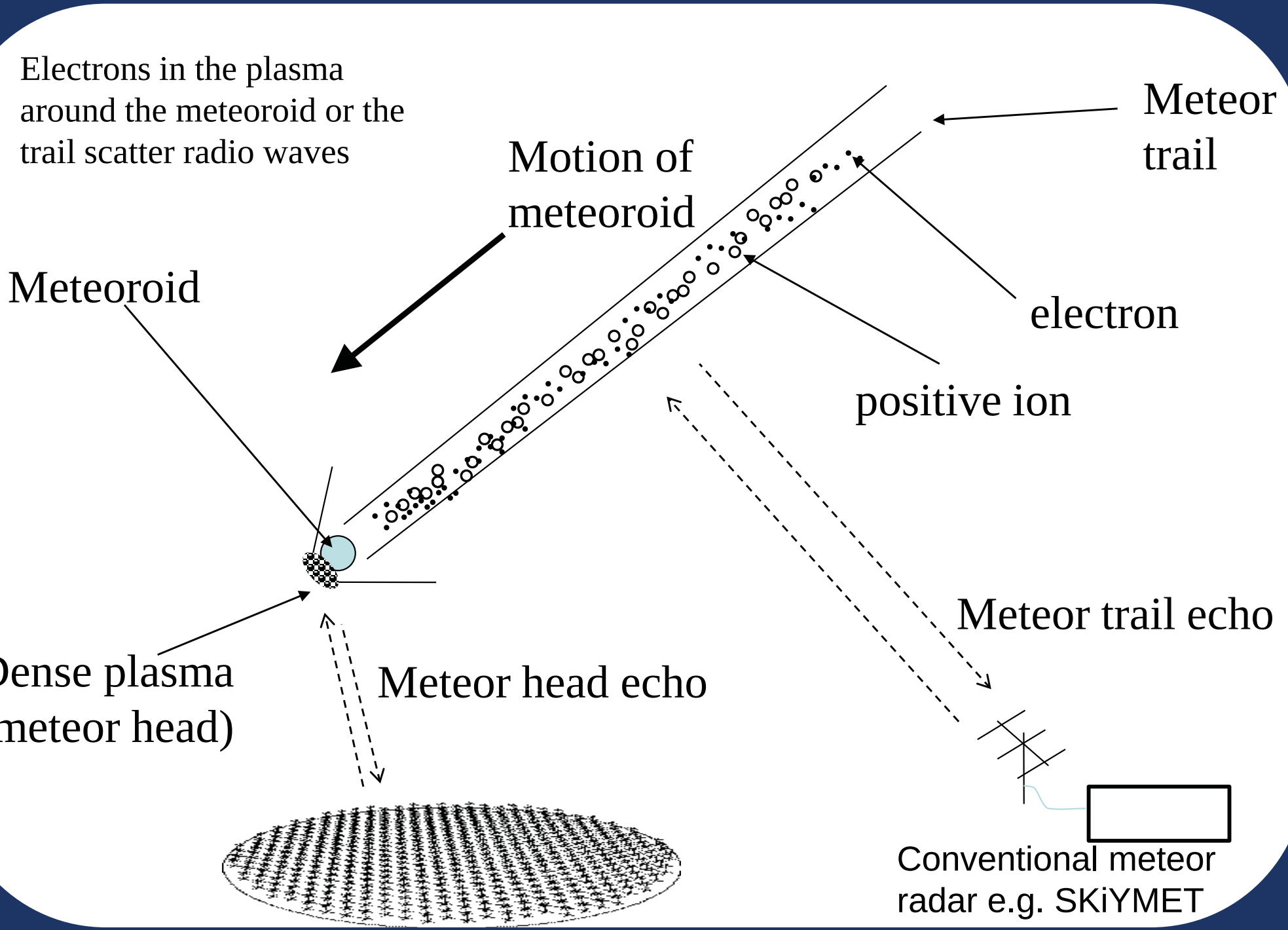
Meteor head echo observations with the MU radar and future possibilities with EISCAT_3D

Meteor head and trail echoes



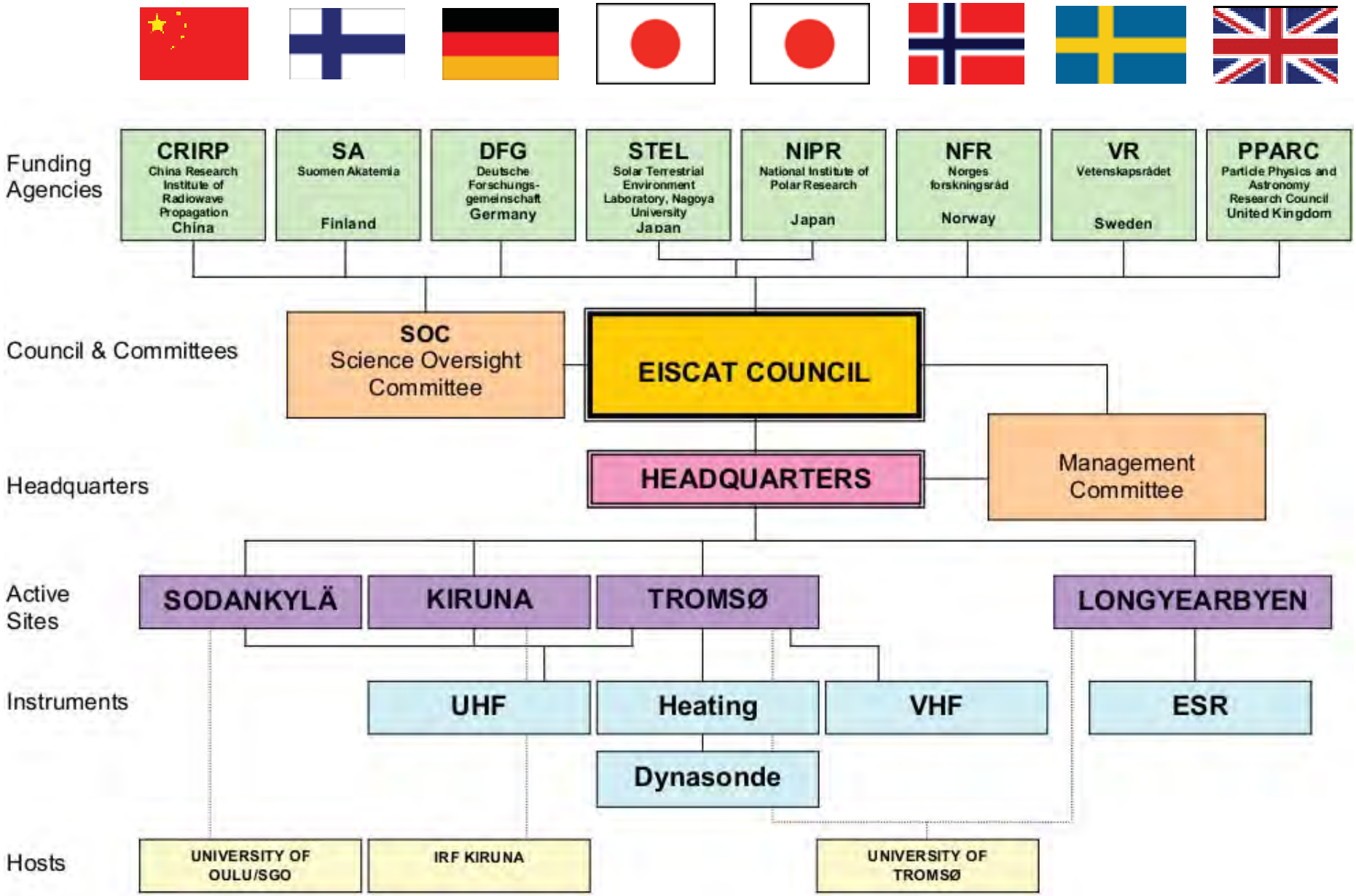
EISCAT meteor head echo observations

EISCAT VHF 224 MHz

EISCAT UHF 930 MHz

European Incoherent SCATatter (EISCAT)

Organogram from 2009:



- EISCAT_3D
- The Concept
- The Science
- The Project
  - Preparatory Phase
  - Design Study
- Documents
  - Project Plan
  - Science Case
  - Performance Specification
  - Handbook of Measurement Principles

EISCAT_3D is a project led by EISCAT Scientific Association. EISCAT_3D is a three-dimensional imaging radar to be located in the northernmost parts of Europe. It will be making continuous measurements of the geospace environment and its coupling to the Earth's atmosphere from its location in the auroral zone at the southern edge of the northern polar vortex.

www.eiscat3d.se

In concept, EISCAT 3D users must find access to the instrument, data, and computational power to be direct, web-based, real-time, transparent, and simultaneous (i.e. fully multi-user)

MU radar (Middle and Upper atmosphere)

Monostatic coherent pulse Doppler radar
Antenna aperture: 8330 m2
Pulse length: 1 – 500 μs

VHF 46.5MHz, 1MW output
Beam width: 3.6 deg
475 antennas

Meteor data @ MU

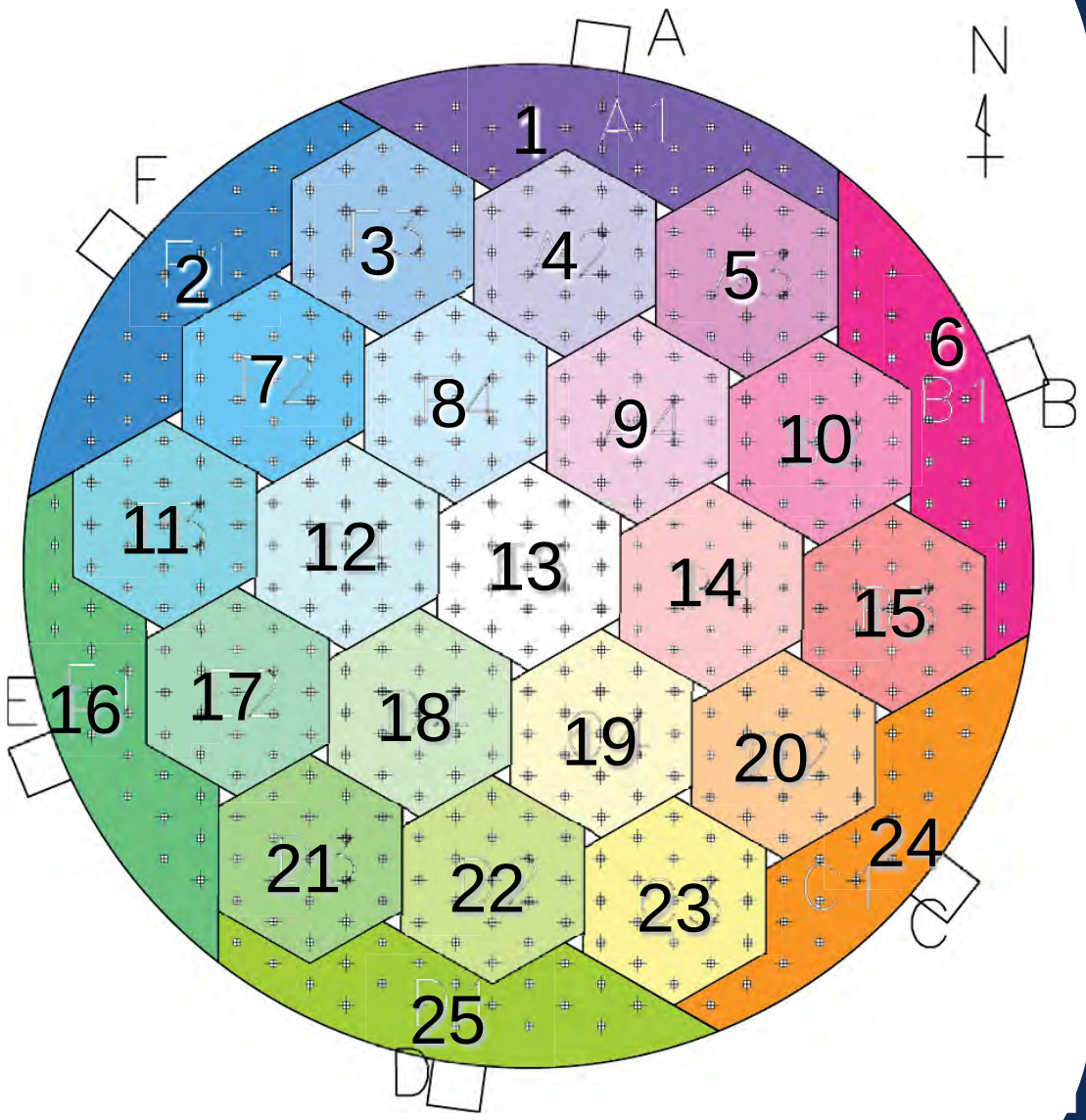
Time series of 32 bit complex voltages:

25 channels

85 ranges

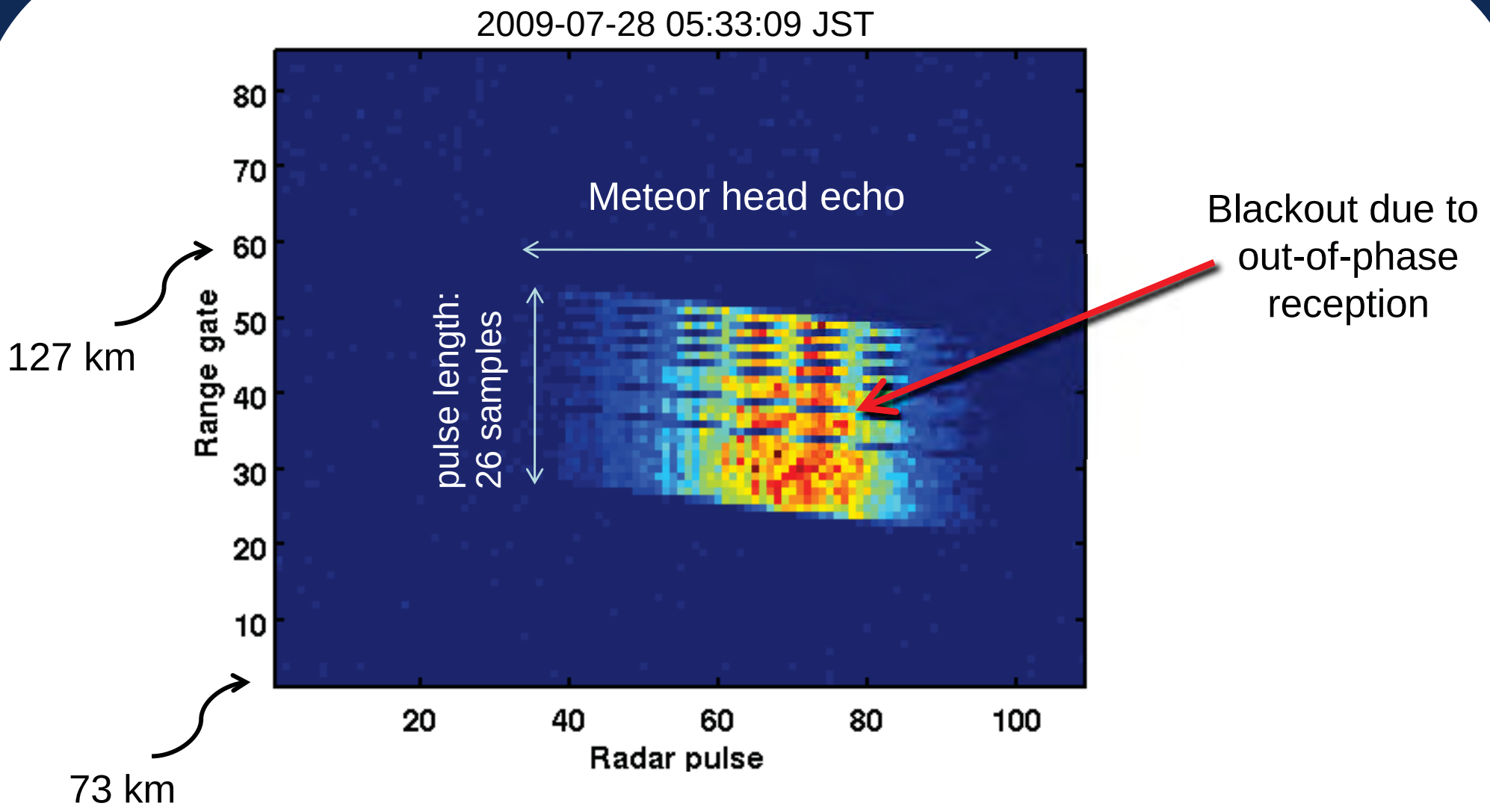
332 times per second

About 20 GB/hour

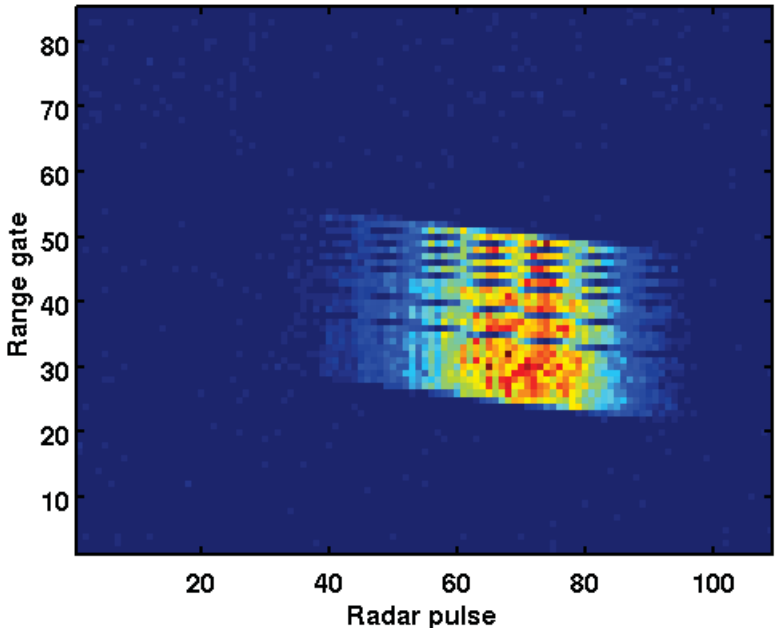


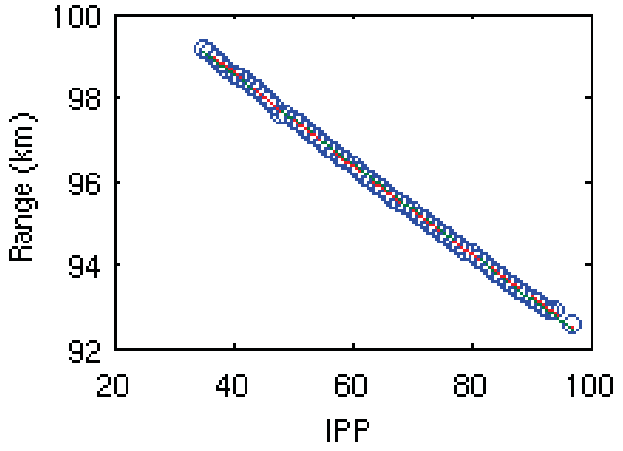
Kero et al. (2012a). *Ann. Geophys.*, 30, 639–659

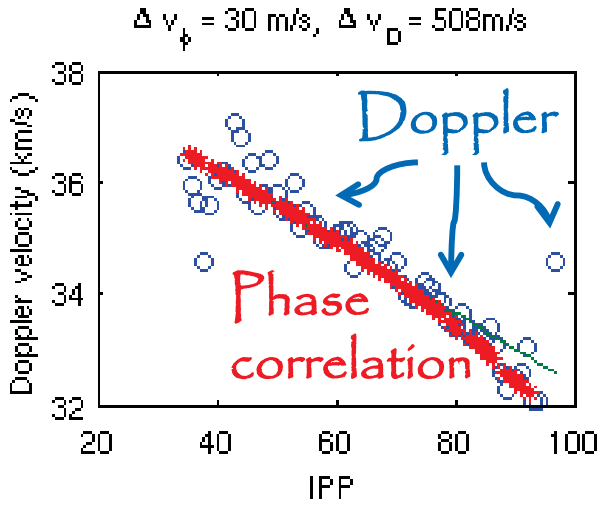
Meteor data @ MU

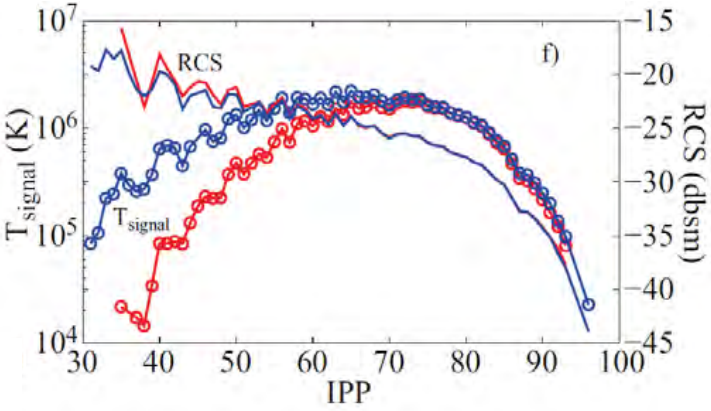


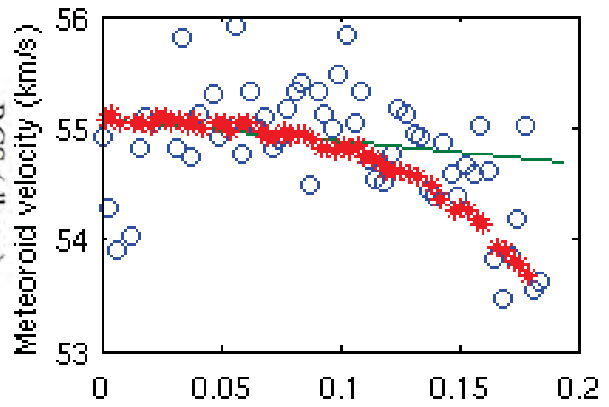
Transmission of 26x6μs:	156 μs pulse
Interpulse period:	3.12 ms
Range gate:	6 μs ≈ 900 m

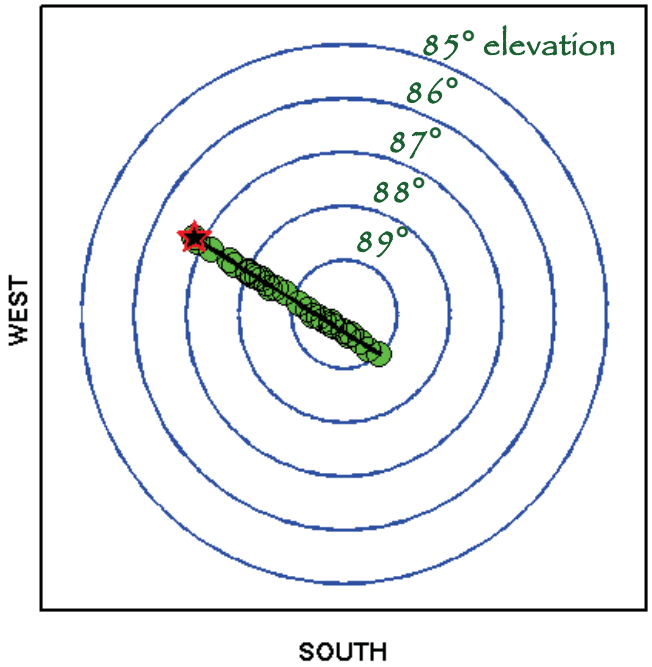

Range gate
Radar pulse

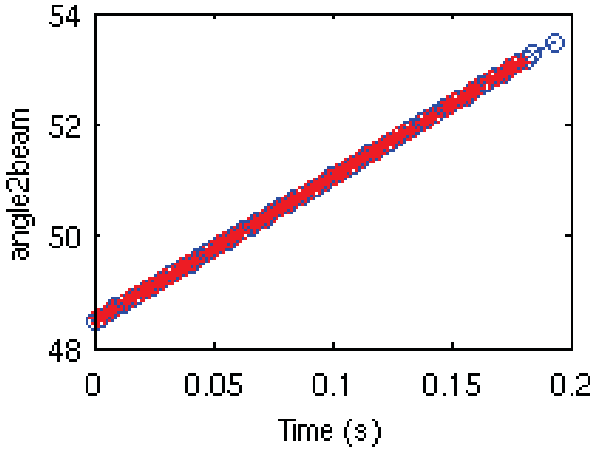

Linear fit: 34439m/s; Doppler: 34610m/s
Range (km)
IPP

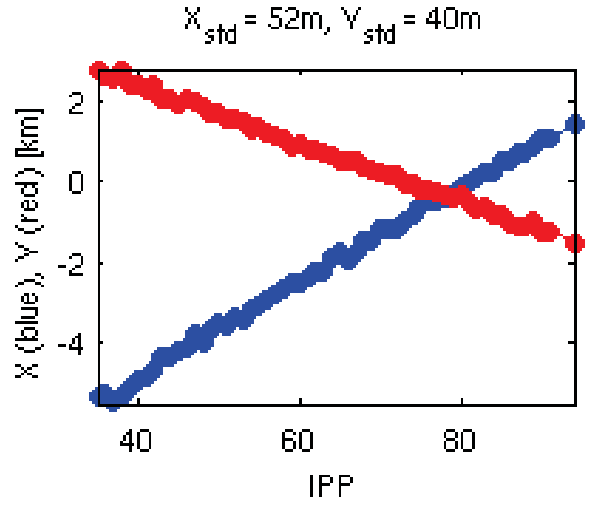

Δ v_ϕ = 30 m/s, Δ v_D = 508m/s
Doppler velocity (km/s)
Doppler
Phase correlation
IPP

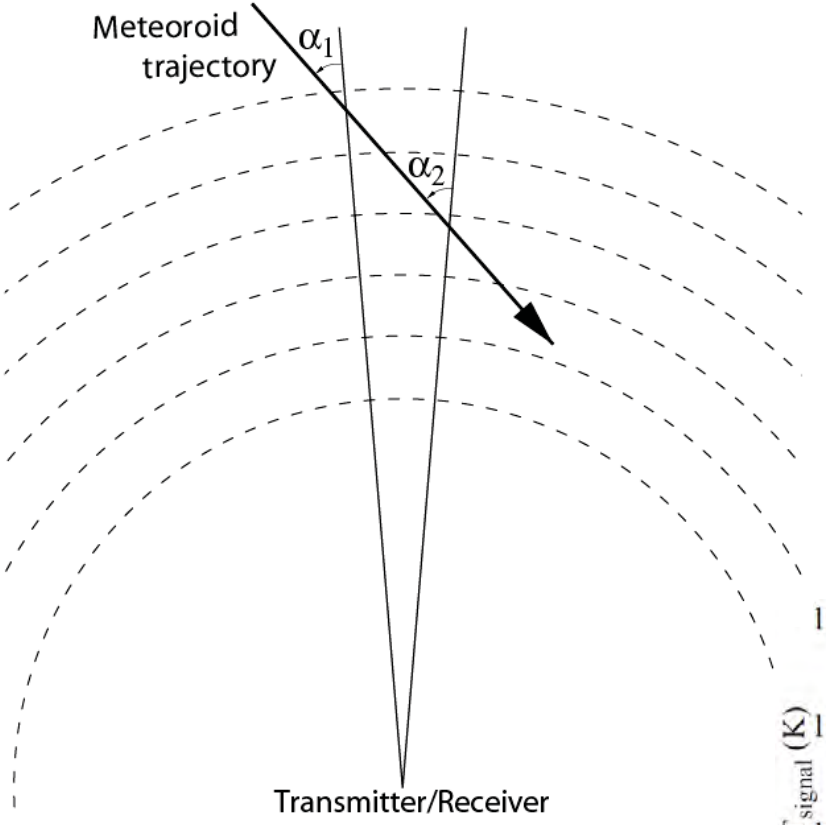

RCS
f)
T_signal (K)
RCS (dbsm)
IPP

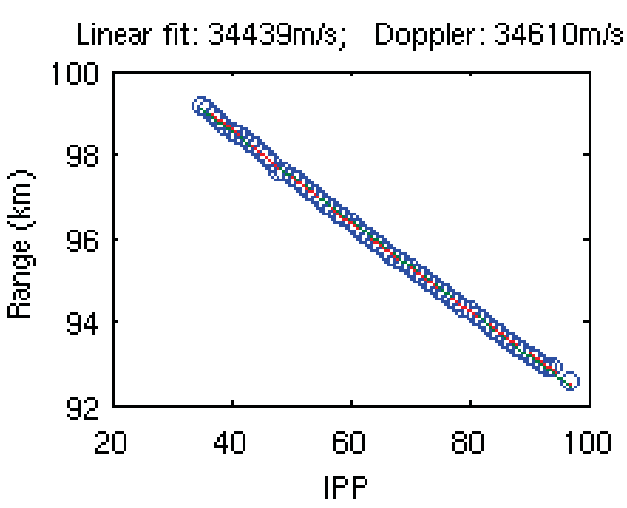

Meteoroid velocity (km/s)

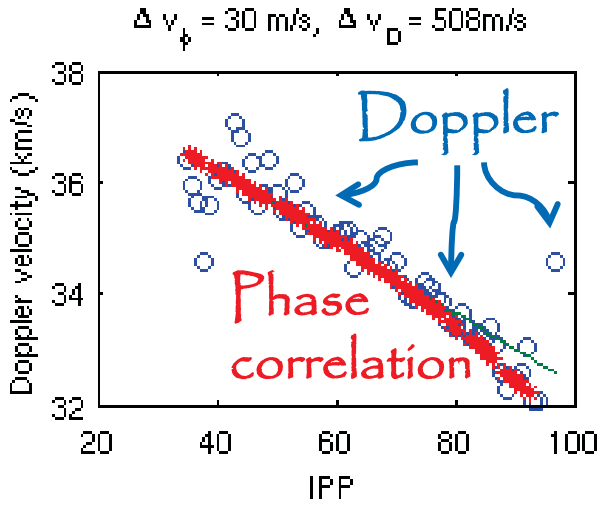

85° elevation
86°
87°
88°
89°
WEST
SOUTH

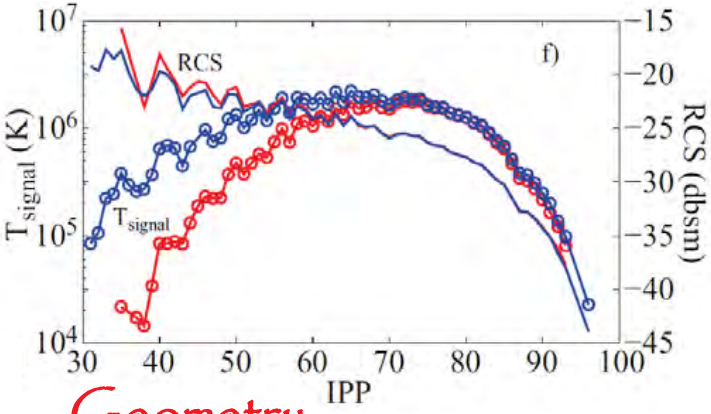

angle2beam
Time (s)

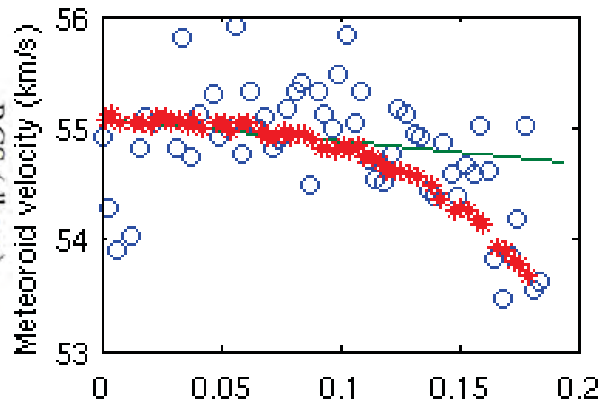

X_std = 52m, Y_std = 40m
X (blue), Y (red) [km]
IPP



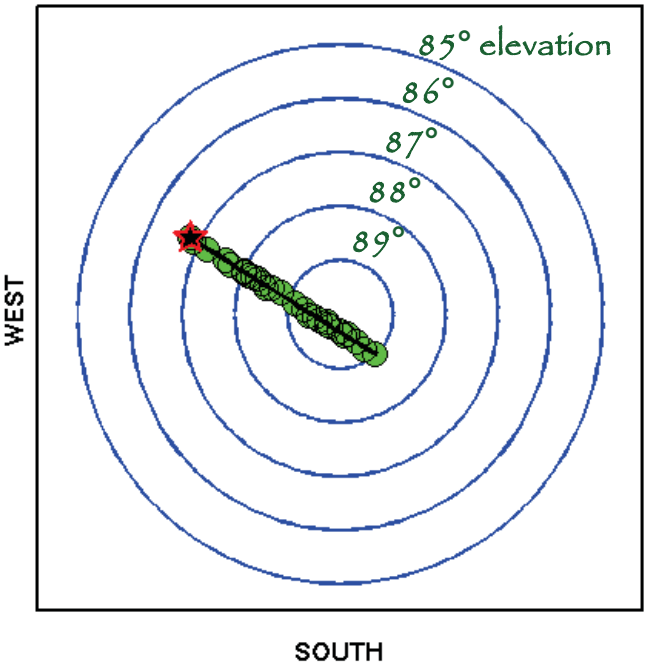


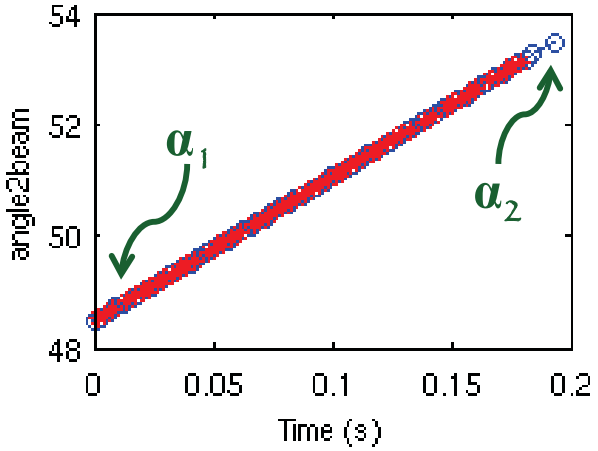


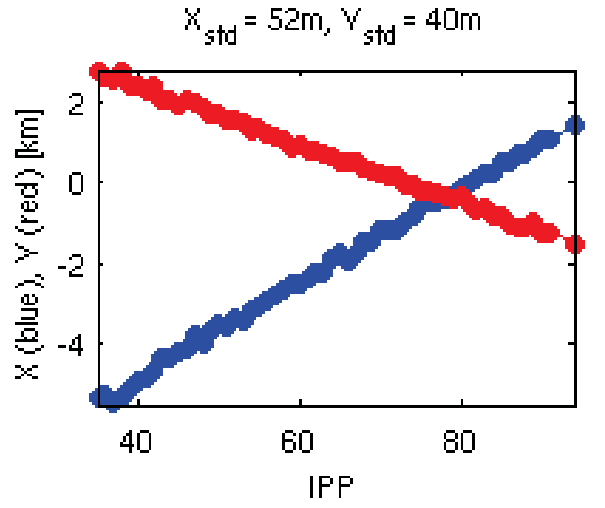




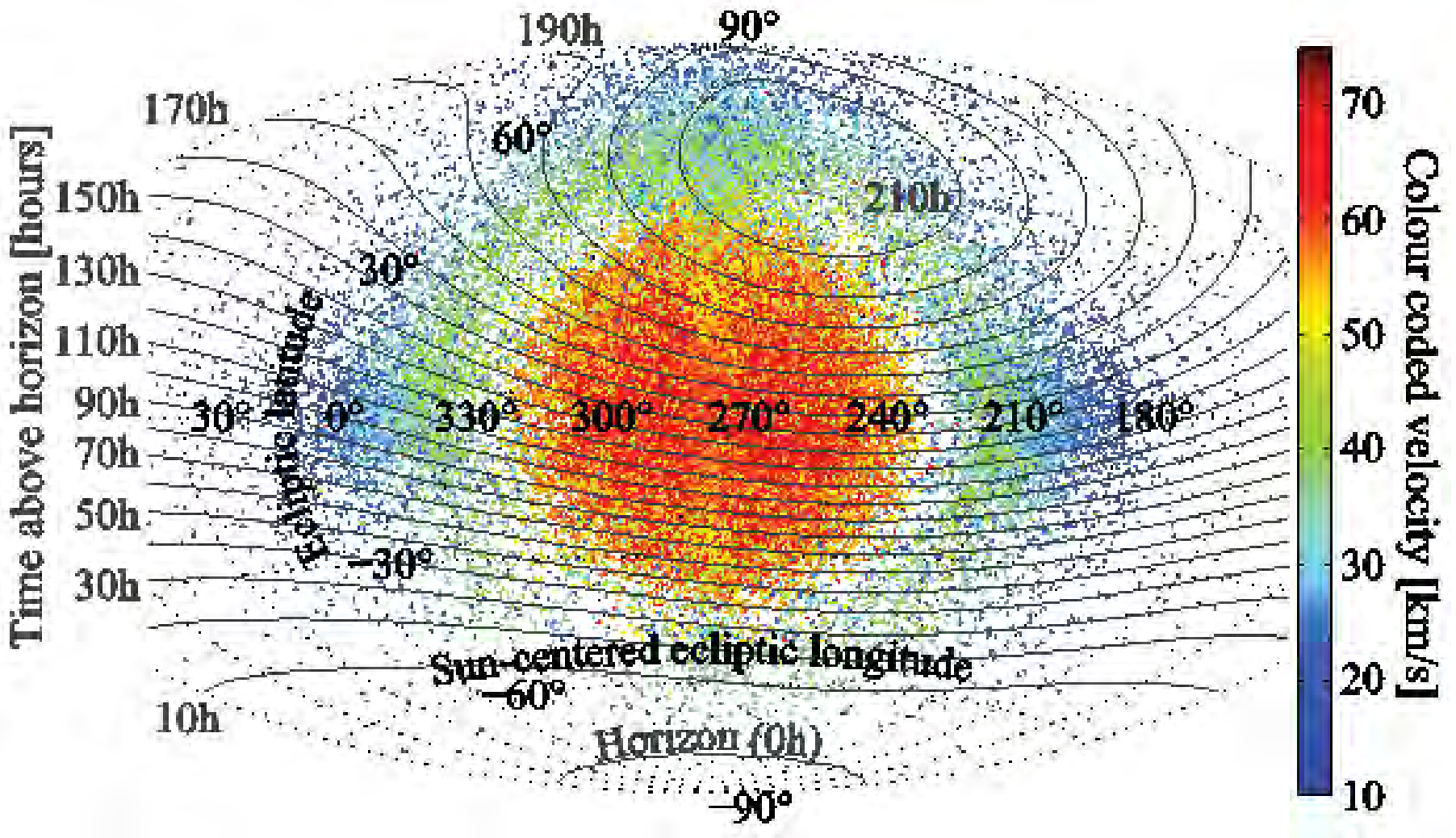
Geometry considerations







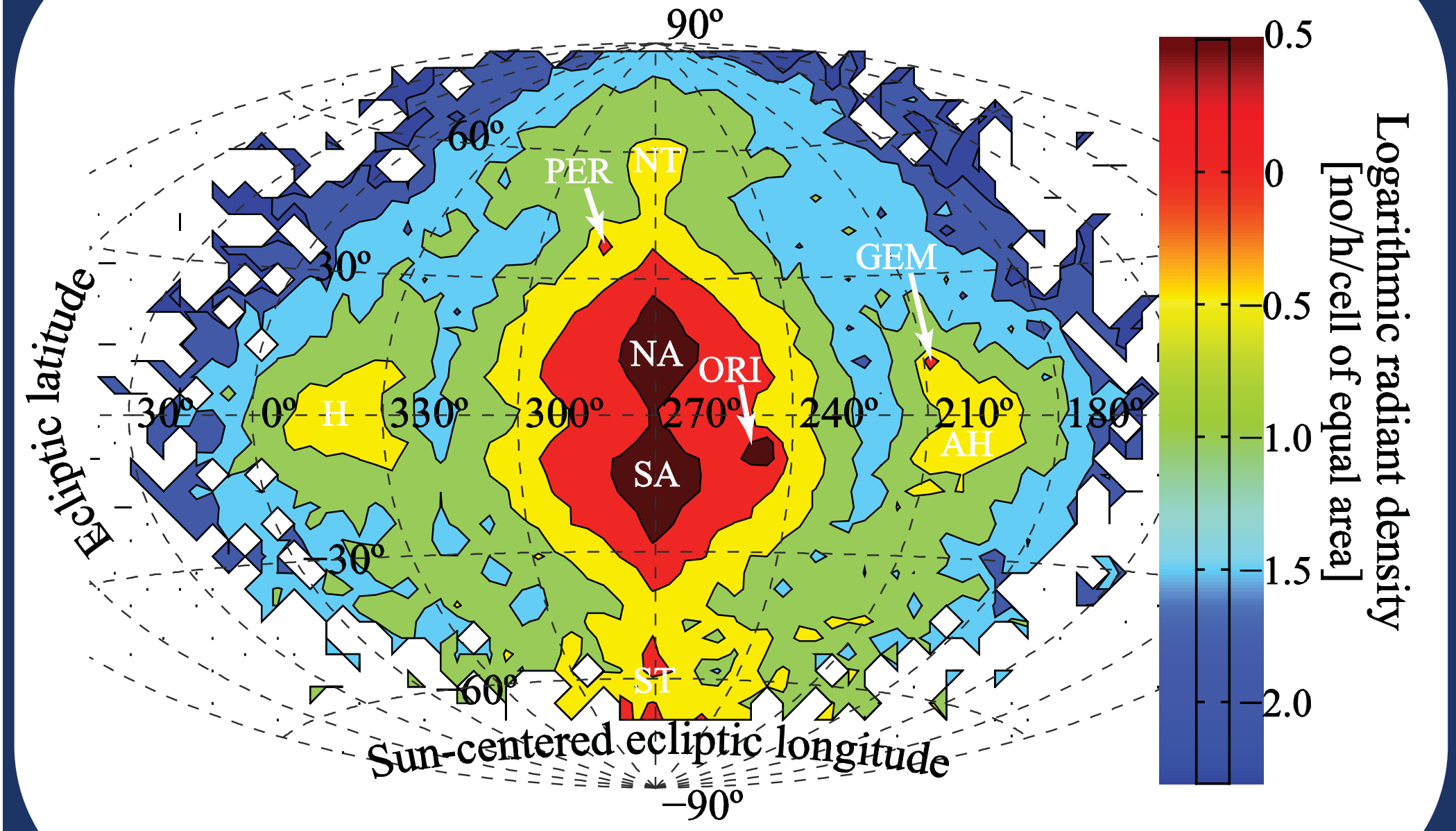
MU radar 2009-2010 meteor radiants



106139 meteors

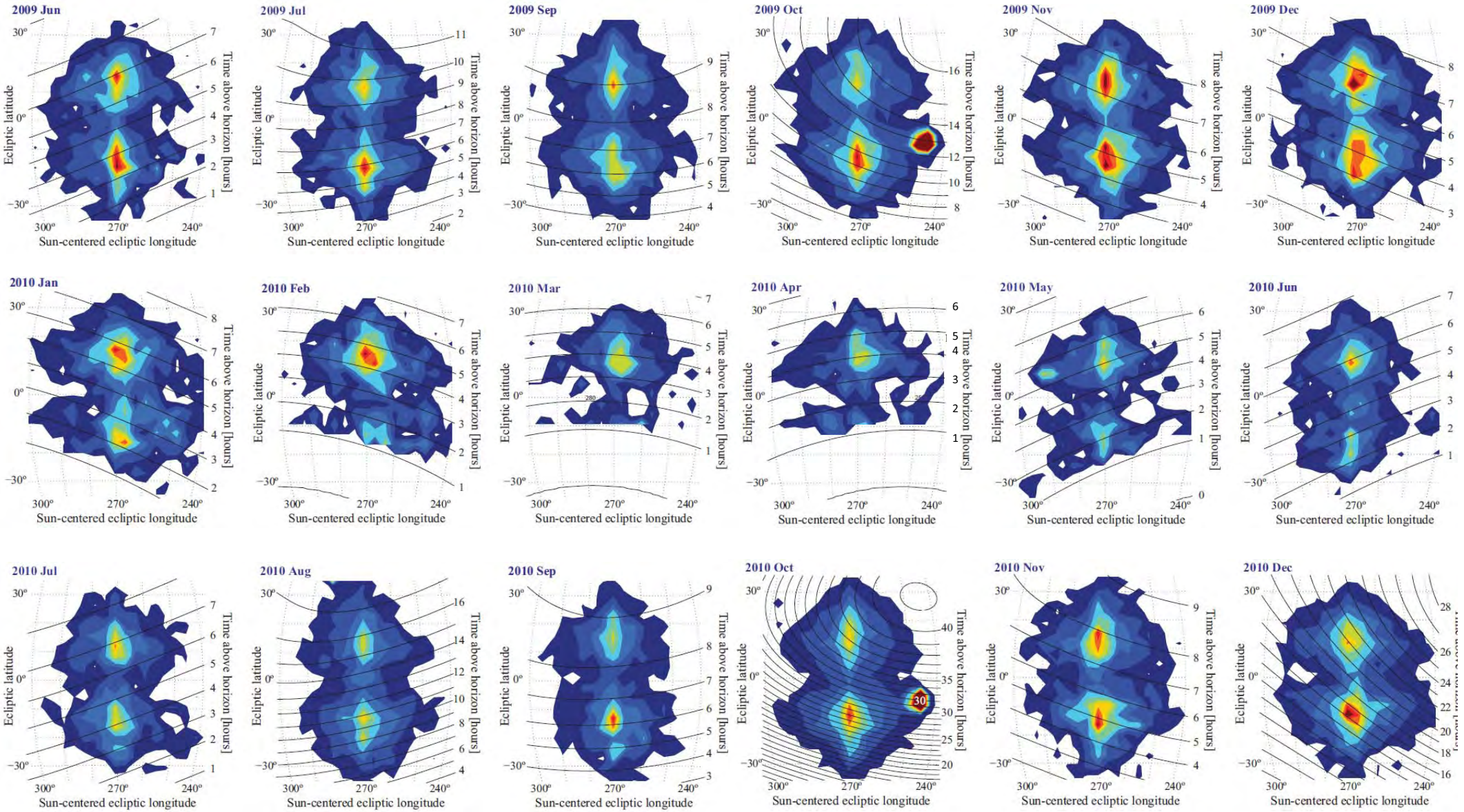
Kero et al., 2012b, MNRAS

MU radar 2009-2010 meteor radiant density



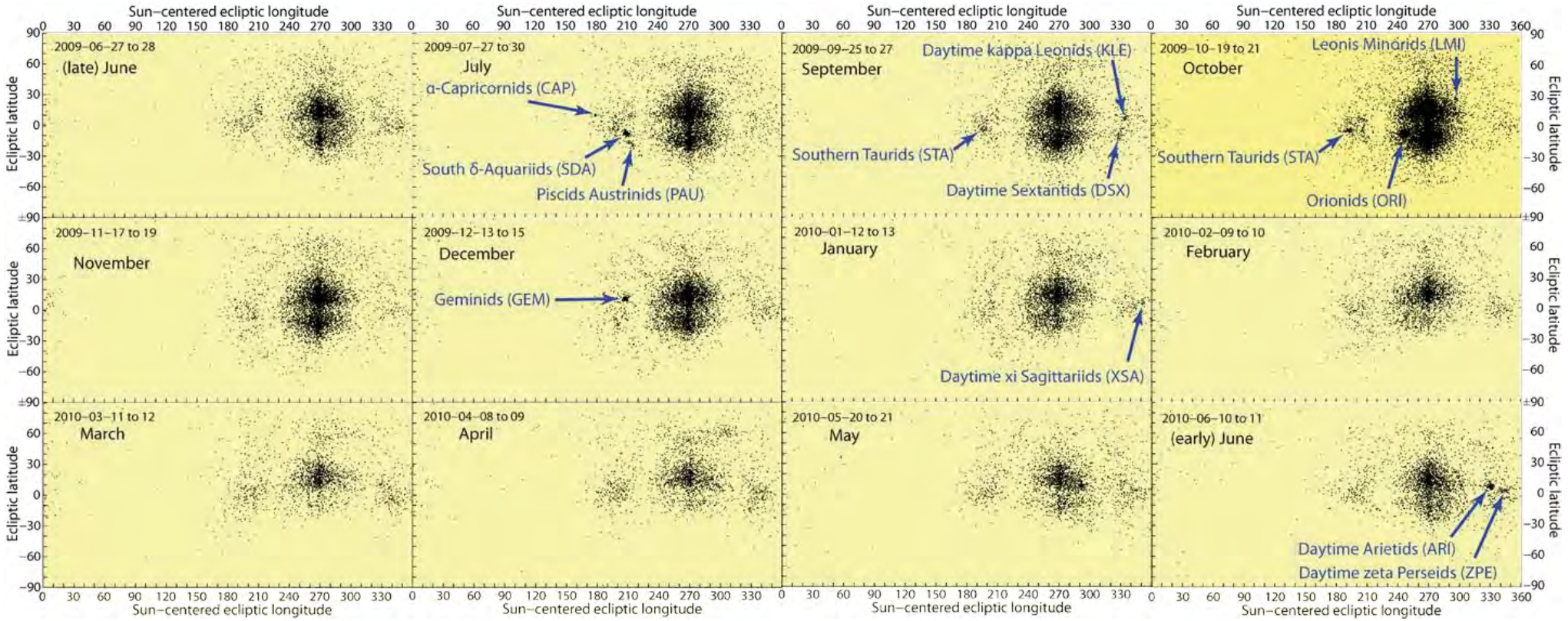
Kero et al., 2012b, MNRAS

MU radar monthly meteor radiant density

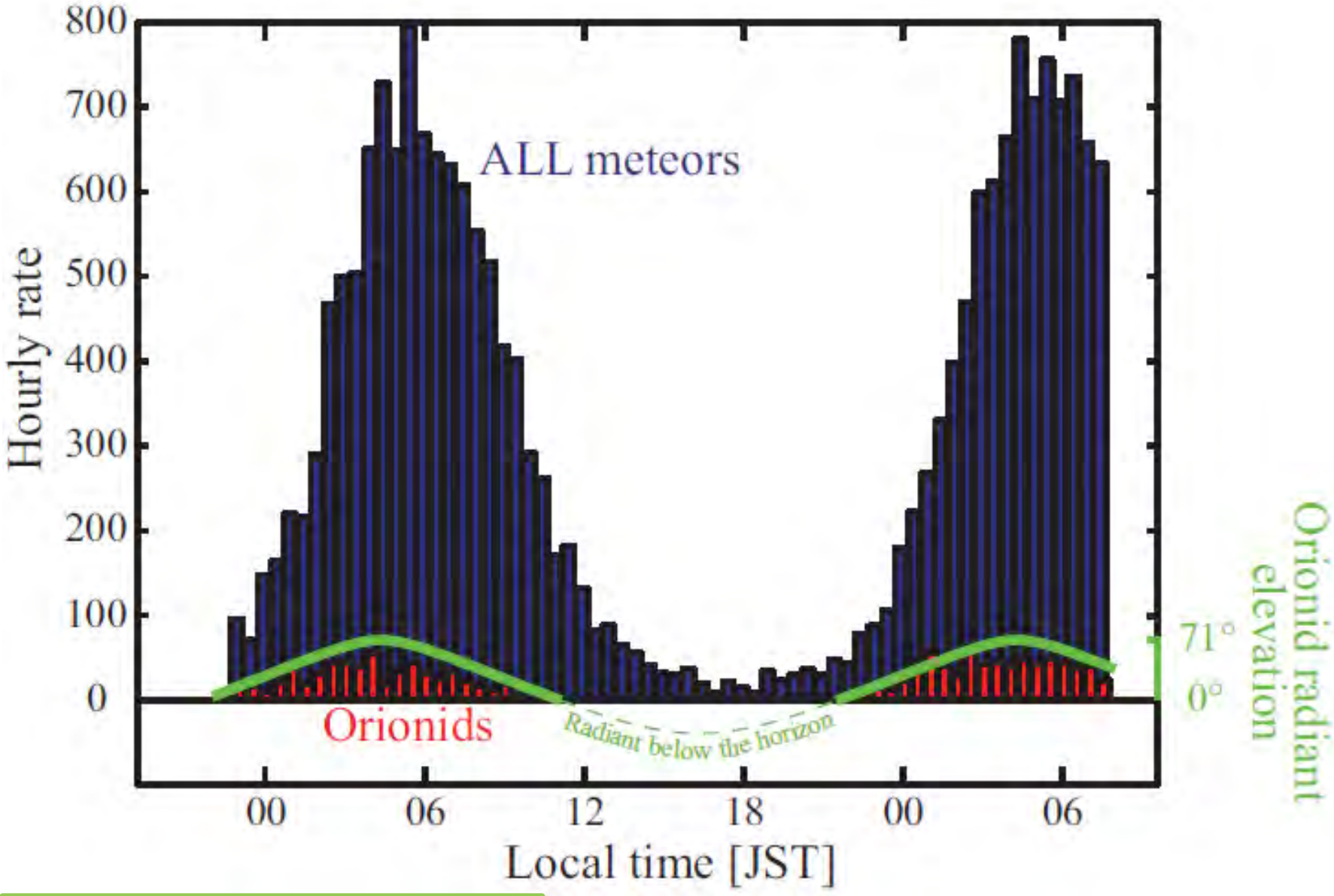


Kero et al., 2012b, MNRAS

MU monthly radiant distributions

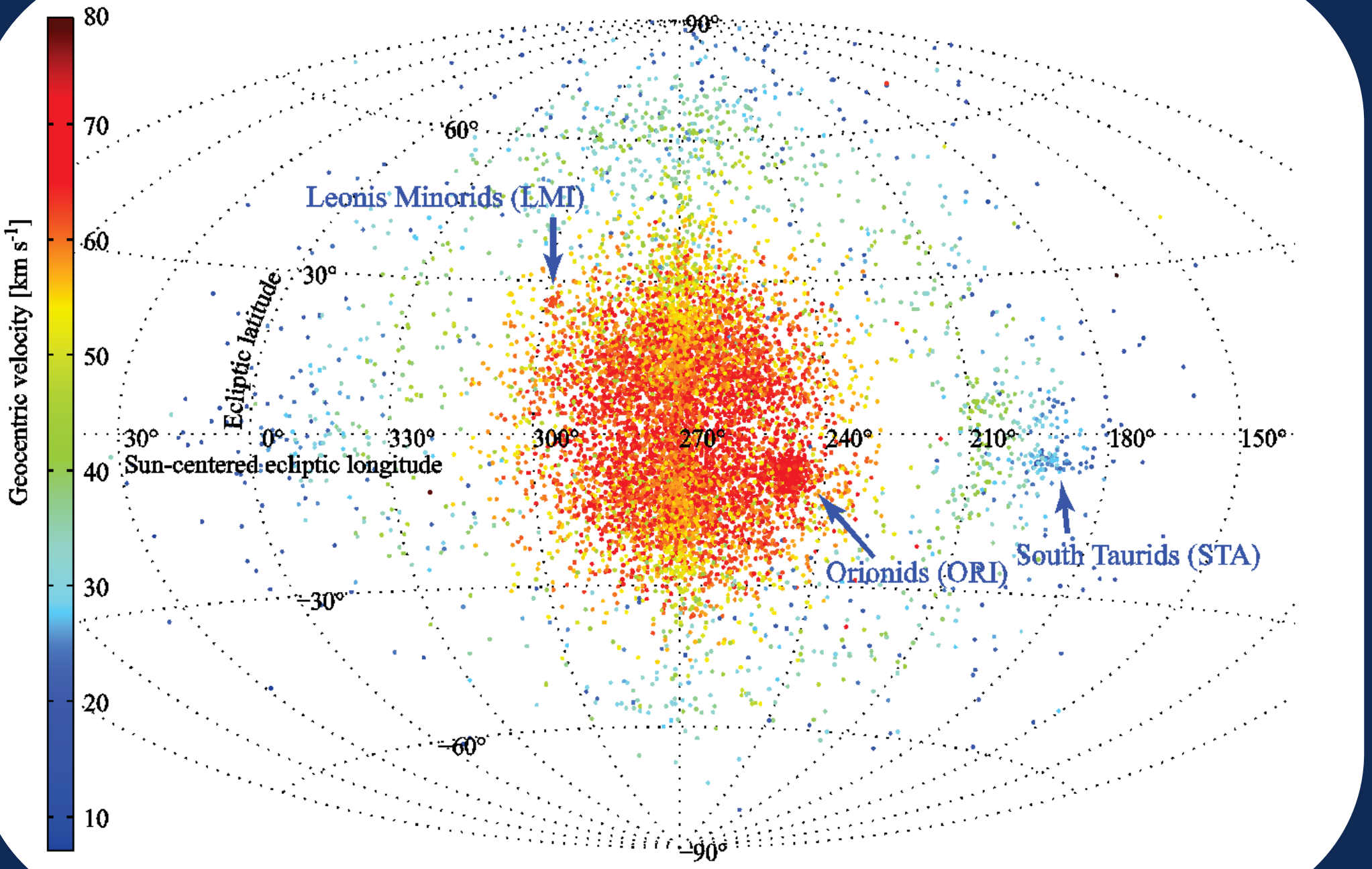


33 hours of MU data October 19-21, 2009



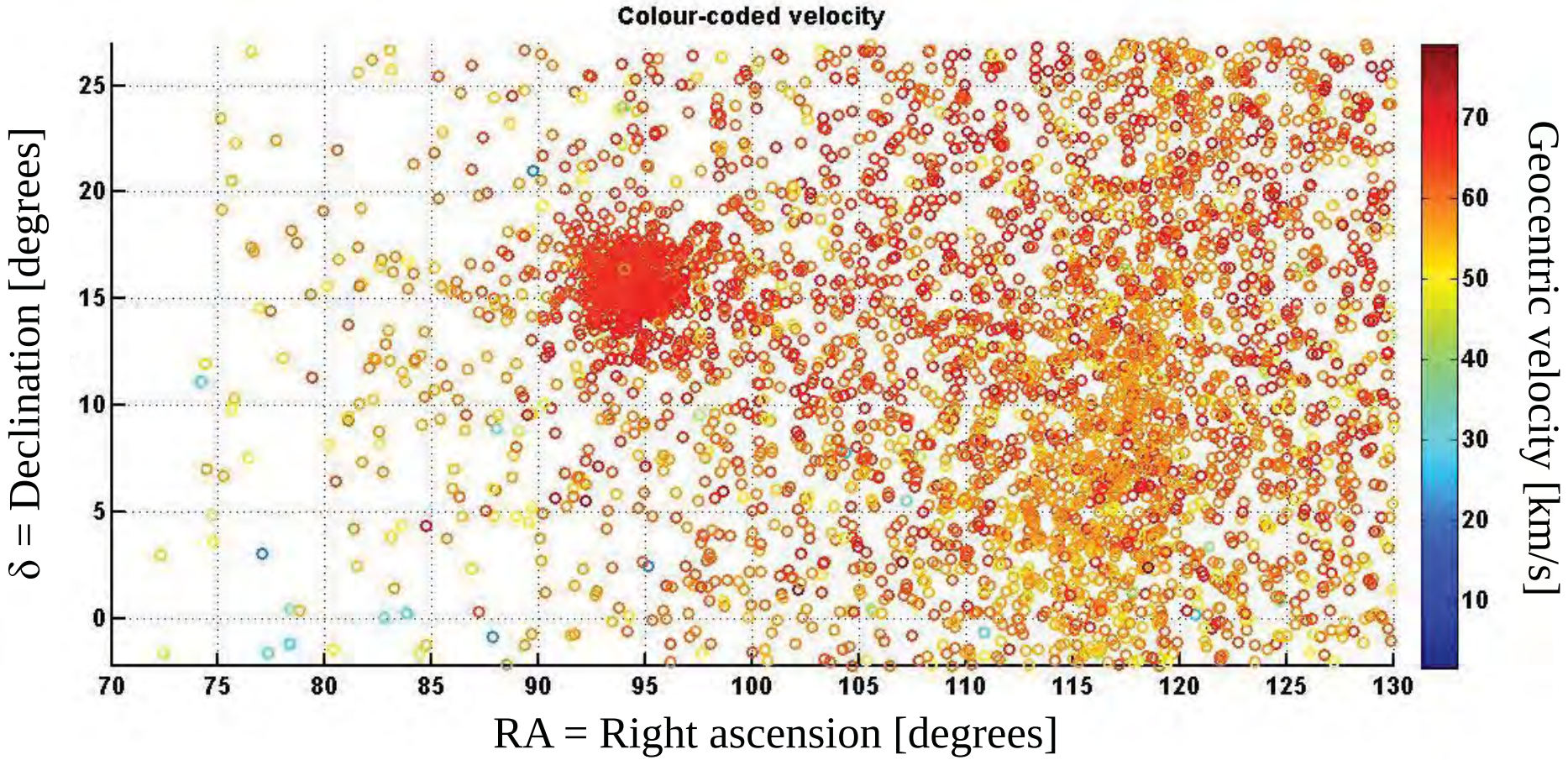
>10000 meteors of which
> 600 Orionids

33 hours of MU data October 19-21, 2009



Kero et al. (2011). *MNRAS, 416:2550–2559.*

Orionids 2009



Orionids 2009

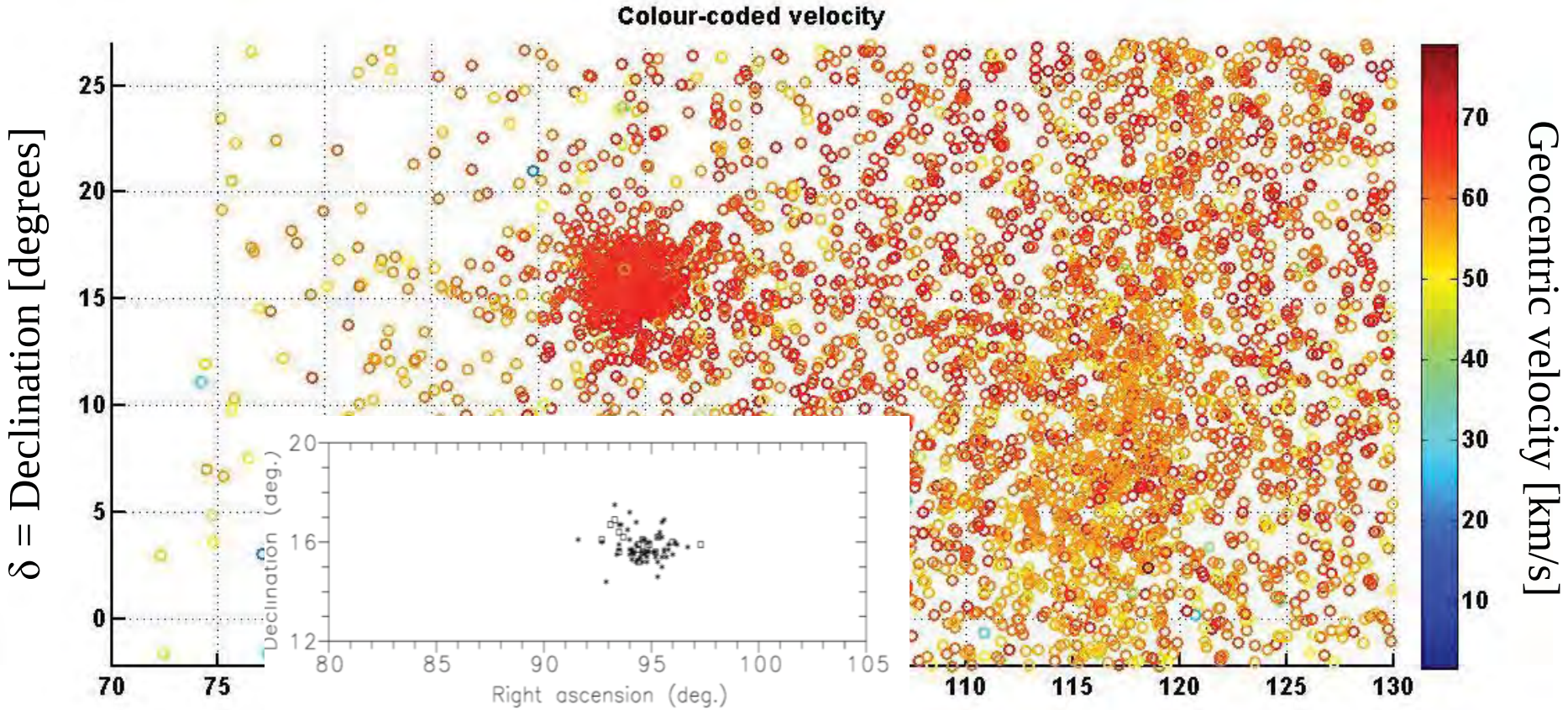
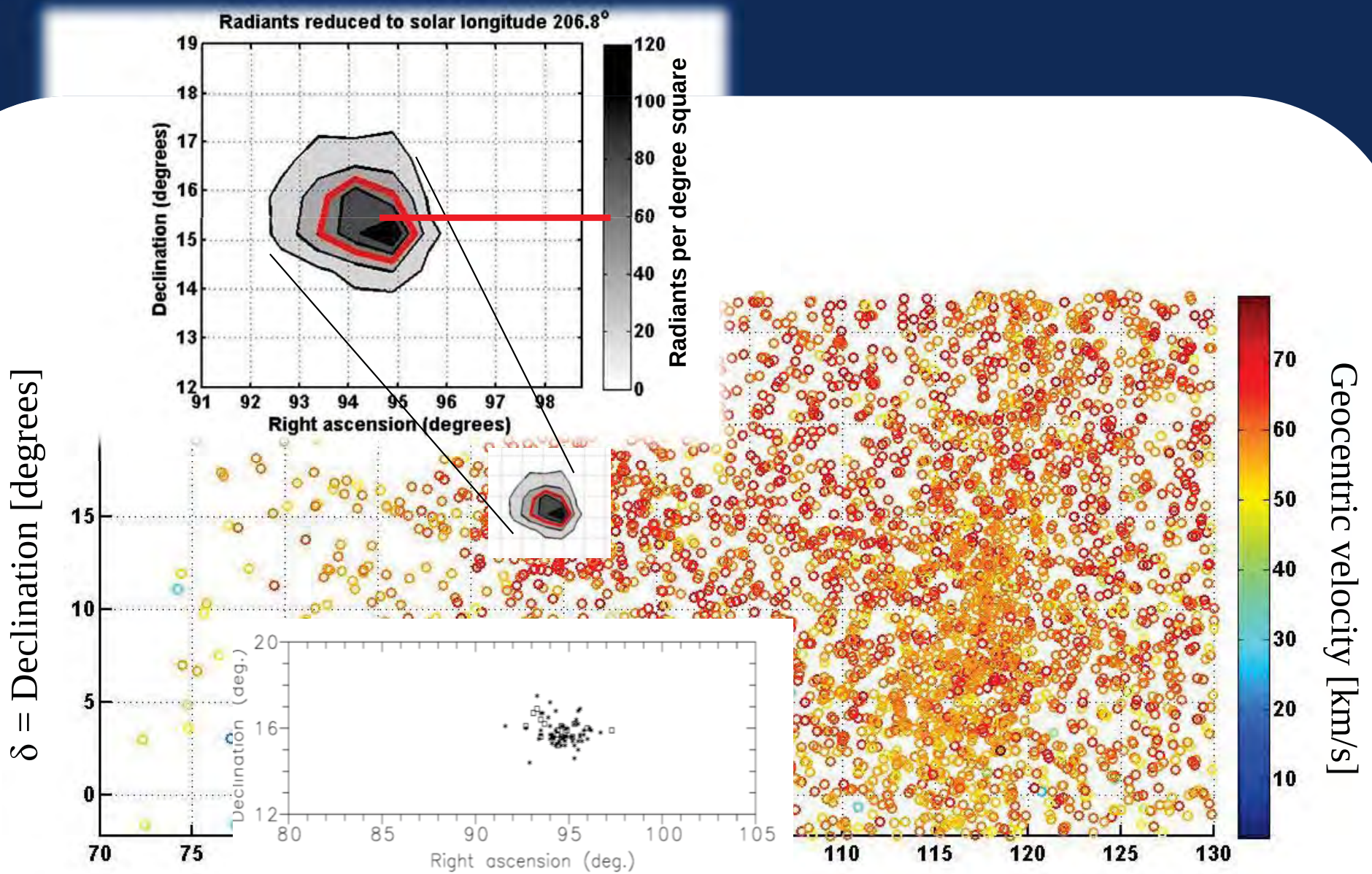


Figure 3. Radiant positions reduced to solar longitude at maximum

Comparison with 60 photographic and 17 video Orionoids of the IAU Meteor Data Center
(Lindblad and Porubcan, CAOSP 29, p 77, 1999)



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Comparison with 60 photographic and 17 video Orionoids of the IAU Meteor Data Center
(Lindblad and Porubcan, CAOSP 29, p 77, 1999)

Conclusions

The IMO community is cordially invited to share experiences from visual, radar and multi-station video observations, and take an active part in the realization of a meteor observation programme at EISCAT_3D

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References:

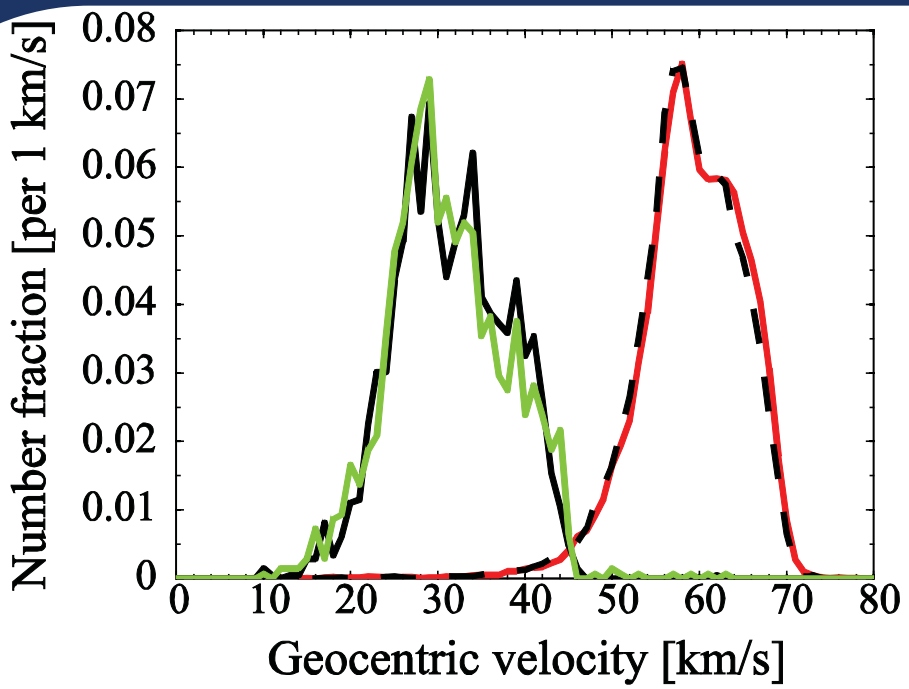
Kero, J., Szasz, C., Nakamura, T., Meisel, D. D., Ueda, M., Fujiwara, Y., Terasawa, T., Miyamoto, H., and Nishimura, K. (2011). **First results from the 2009-2010 MU radar head echo observation programme for sporadic and shower meteors: the Orionids 2009.** *MNRAS, 416:2550–2559.*

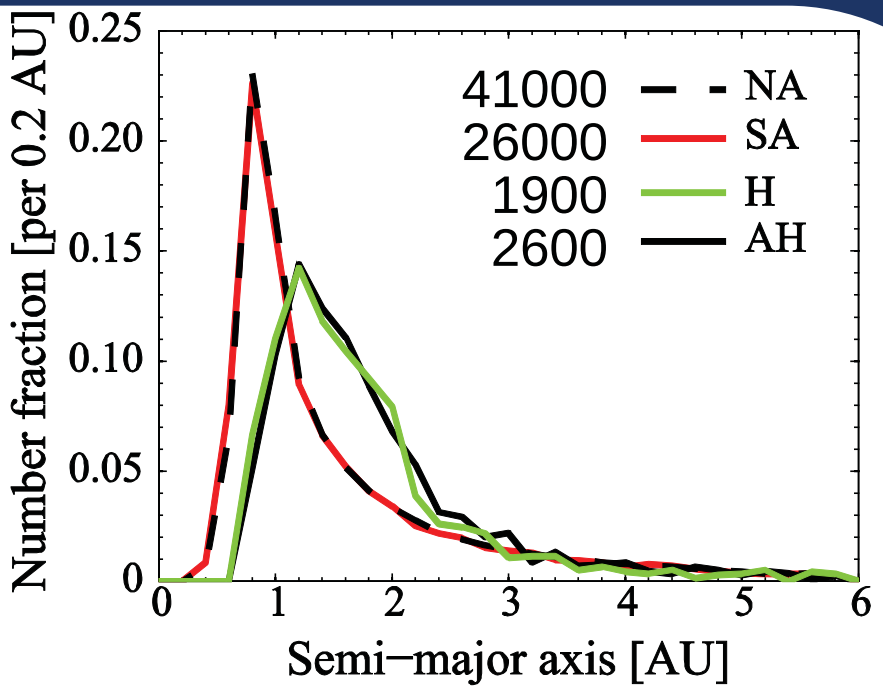
Kero, J., Szasz, C., Nakamura, T., Terasawa, T., Miyamoto, H., and Nishimura, K. (2012a). **A meteor head echo analysis algorithm for the lower VHF band.** *Ann. Geophys., 30:639–659.*

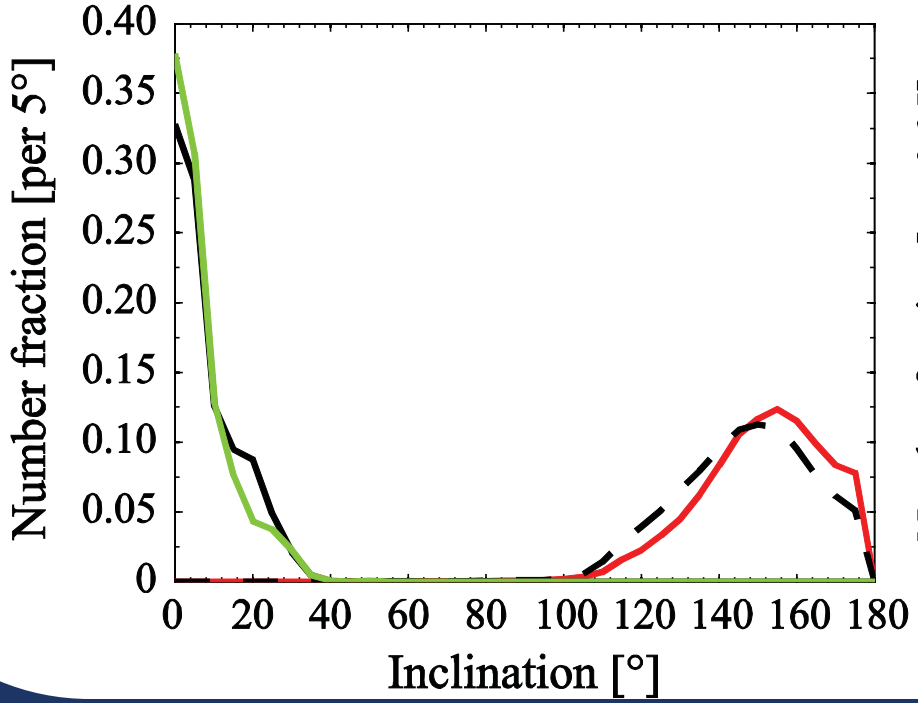
Kero, J., Szasz, C., Nakamura, T., Meisel, D. D., Ueda, M., Fujiwara, Y., Terasawa, T., Nishimura,K., and Watanabe, J. (2012b). **The 2009-2010 MU radar head echo observation programme for sporadic and shower meteors: radiants and diurnal rates.** *MNRAS, 425:135-146*

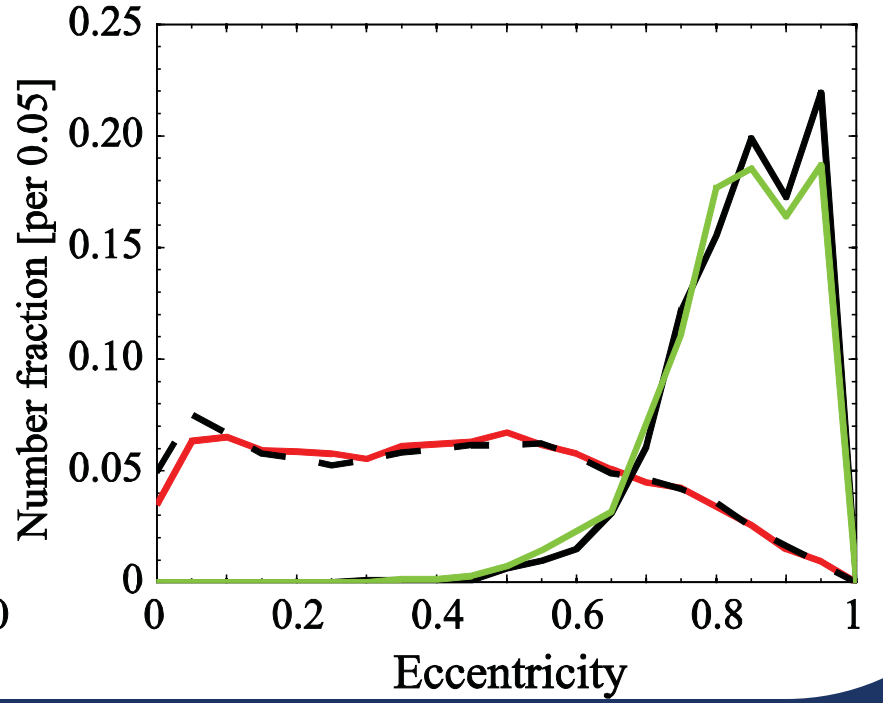
Kero, J., Fujiwara, Y., Abo, M., Szasz, C., and Nakamura, T. (2012c). **MU radar head echo observations of the 2011 October Draconids.** *MNRAS, 424:1799-1806*

Orbital elements of apparent sources









Orbital elements of apparent sources