Status report
DIMS Meteor Observing Camera

S. Abe[a*], D. Barghini[c,g], M. Bertaina[c], M. Casolino[e,f], A. Cellino[g], C. Covault[r], T. Ebisuzaki[e], M. Endo[a], M. Fujioka[j], Y. Fujiwara[h], D. Gardiol[g], M. Hajdukova[i], M. Hasegawa[a], Y. Iwami[j], **F. Kajino**[b] , M. Kasztelan[q], K. Kikuchi[a], S.-W Kim[k], M. Kojro[l], J.N. Matthews[m], M. Mori[j], I.H. Park[n], L.W. Piotrowski[o], M. Przybylak[q], H. Sagawa[p], K. Shinozaki[q], D. Shinto[j], J.S. Sidhu[r], G. Starkman[r], Y. Takizawa[e], Y. Tameda[j], T. Tomida[s], S. Valenti[c] and M. Vrabel[q], N. Kobayashi[t], Y. Mori[t] and N. Takahashi[t]

**presenter*

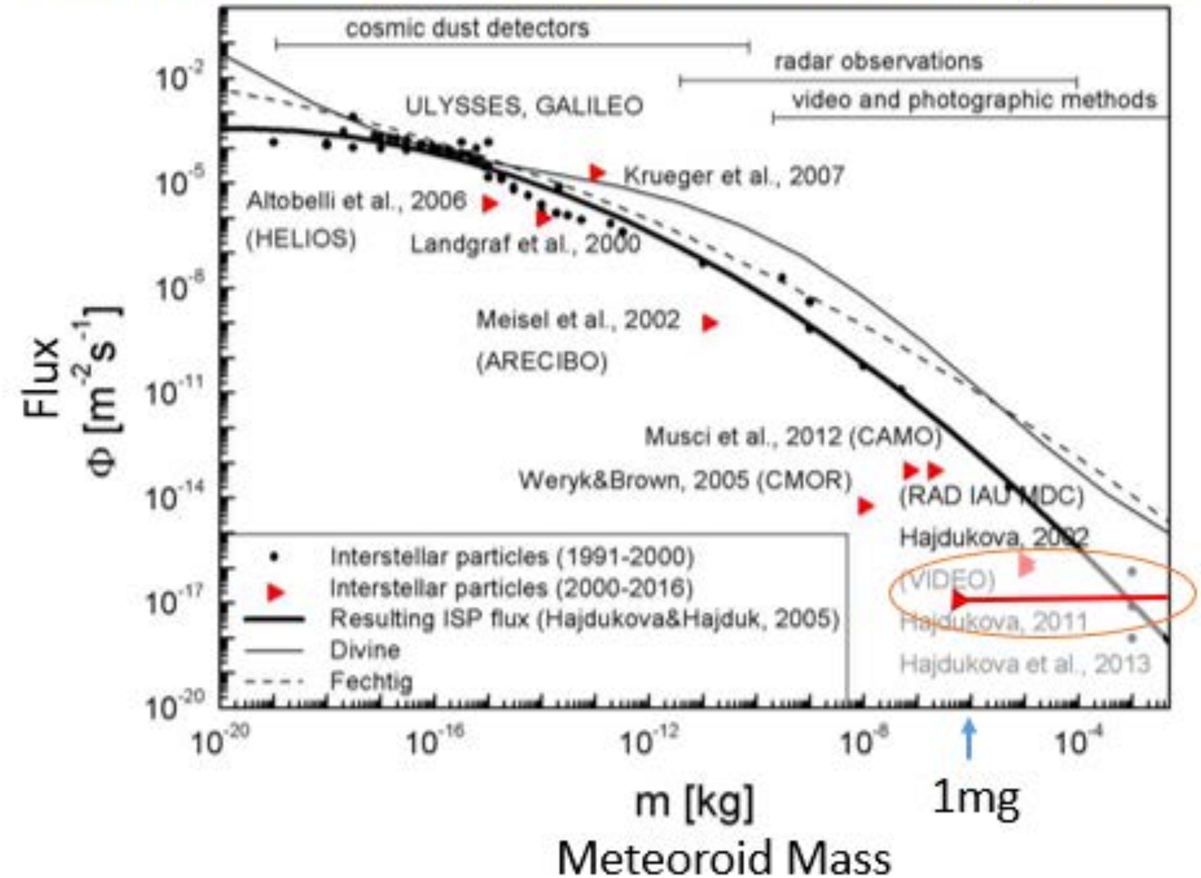
a Department of Aerospace Engineering, Nihon University, Japan
b Department Of Physics, Konan University, Japan
c Department of Physics, University of Turin, Italy
d National Institute for Nuclear Physics (INFN) – Turin, Italy
e RIKEN (Institute of Physical and Chemical Research), Japan
f National Institute for Nuclear Physics (INFN) – Rome Tor Vergata, Italy
g Observatory of Turin, National Institute for Astrophysics (INAF), Italy
h Nippon Meteor Society (NMS), Japan
i Astronomical Institute, Slovak Academy of Sciences, Slovakia
j Department of Engineering and Science, Osaka Electro-Communication University, Japan
k Korea Astronomy and Space Science Institute, Republic of Korea
l Faculty of Physics and Applied Informatics, University of Lodz, Poland
m Department of Physics and Astronomy, University of Utah, USA
n Department of Physics, Sungkyunkwan University, Republic of Korea
o Department of Physics, University of Warsaw, Poland
p Institute for Cosmic Ray Research, University of Tokyo, Japan
q National Center for Nuclear Research (NCBJ), Poland
r Department of Physics, Case Western Reserve University, USA
s Department of Engineering, Shinsyu University, Japan
t Kiso Observatory, The University of Tokyo, Japan

Collaboration with 37 members from Japan, USA, Italy, Poland, Slovakia and Korea

2022 Kiso Schmidt Symposium

July 5 – 6, 2022

Possibility to Observe Interstellar Meteoroids from Outside the Solar System

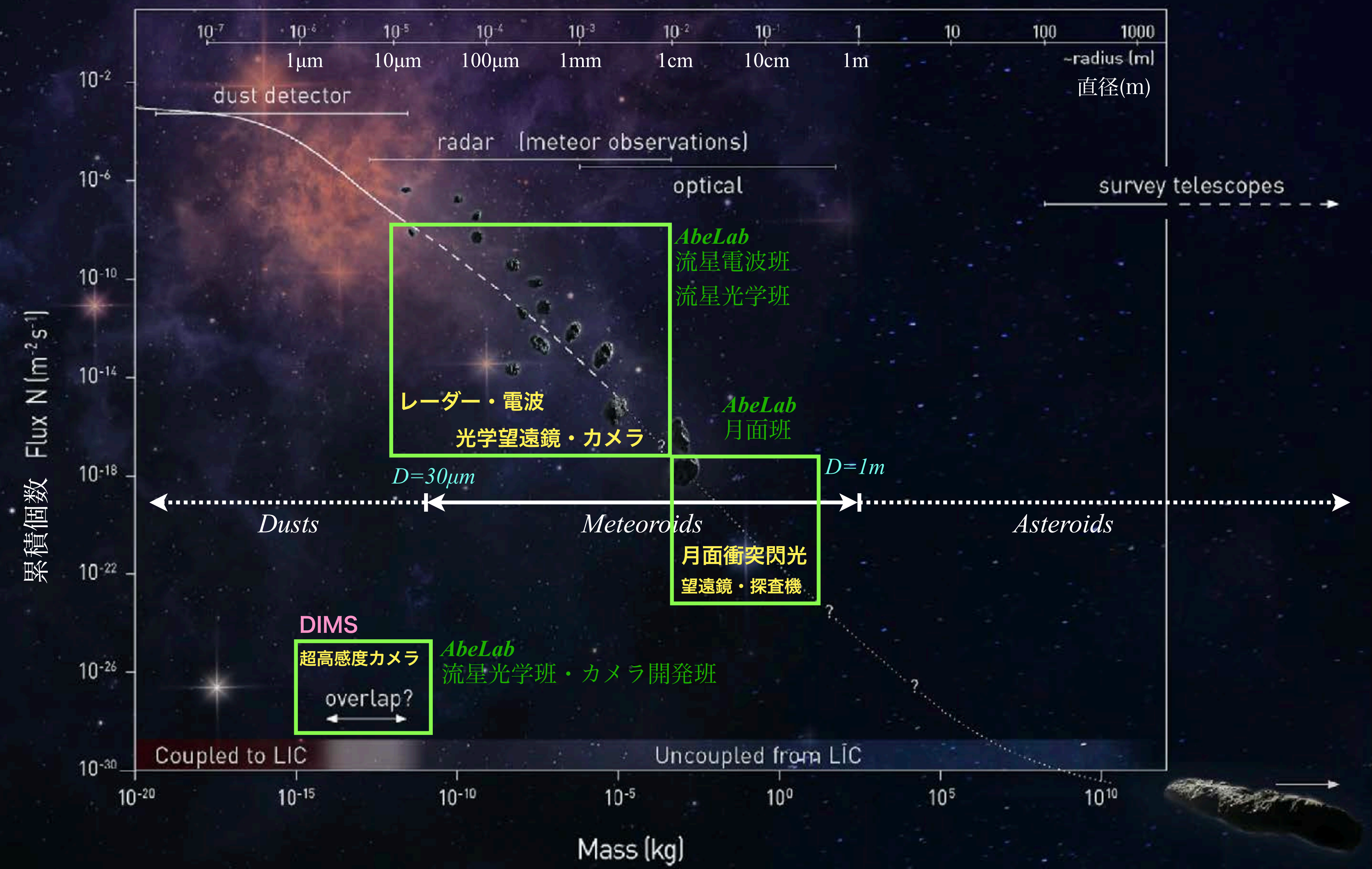


Expected flux limits with 1 year observation

No.1 System : 1.3×10^{-17} $m^{-2} s^{-1}$

(Observation efficiency in time is assumed to be 0.09)

太陽系内・太陽系外ダストのサイズ分布と観測手法



modified from M. Hajdukova et al. (2020)

DIMS Observation Concept

Meteoroids evaporate in the atmosphere resulting in light emission by ionized gas

"Ordinary" meteors are bound in the Solar System
Heliocentric **V**$_{\textbf{ordinay meteors}}$ < 42 km/s (escape v.)

Heliocentric **V**$_{\textbf{interstellar meteoroids}}$ > 42 km/s

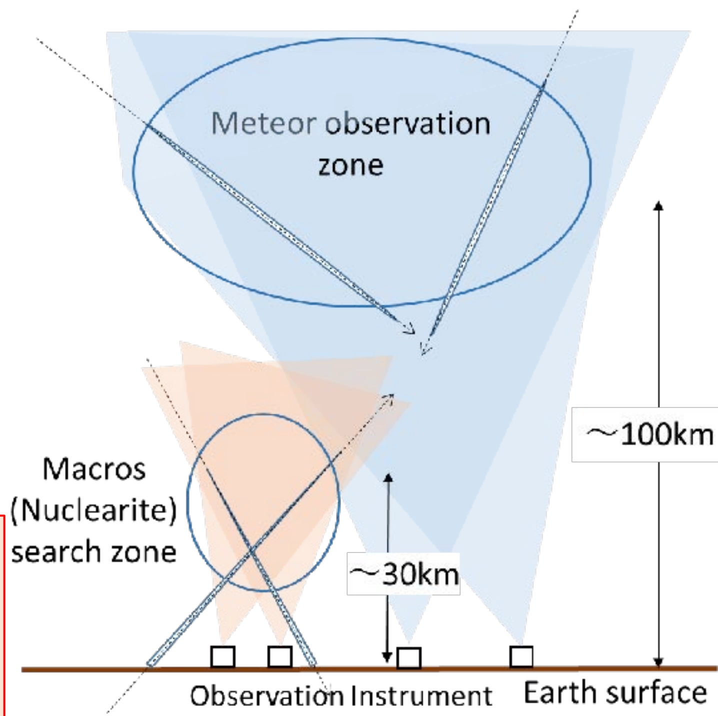
Luminous altitude: ~80 -- 120 km

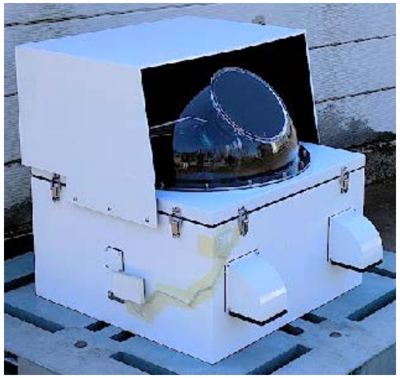
SQM (Nuclearites) (a) quasi-elastically collide with the ambient atoms resulting in black-body radiation from an expanding cylindrical thermal shock (A. De Rujila et al.)

Macroscopic dark matters are bround in Milky Way Galaxy
V$_{\textbf{macros}}$ ~ 250 km/s in the Galaxy frame

Luminous altitude: < ~30 km for mass of our interest

(b) The light production is caused by a result of the formation of a plasma channel due to the passage of the macro and the consequent re-absorption of the electrons in the plasma by the nitrogen ions (J. Sidhu et al.)

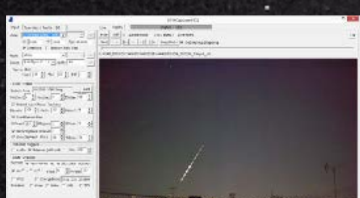




Key Elements of DIMS Detector

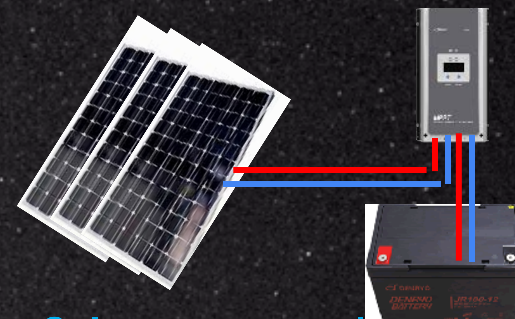
Canon ME20F-SH CMOS camera
- Max. sensitivity ~ ISO 4,000,000
  (ISO 204,800 for present setup)
- 1920 x 1080 pixels at 29.97 fps
- FOV ~57°x34° with 35 mm

Controlled by Windows PC



UFOCapture
- Motion capture software
  by sonotaCo.com

Camera box
- Acrylic dome with sunshade
- Accommodating camera, PCs, fans, heater, alt-azimuth mount, monitors



Solar power supply system
- AT-MA200A solar panels (200 W)
- Tracer6420AN charge controller
- JR130-12 batteries

(chikuden-sys.com, epever.com)

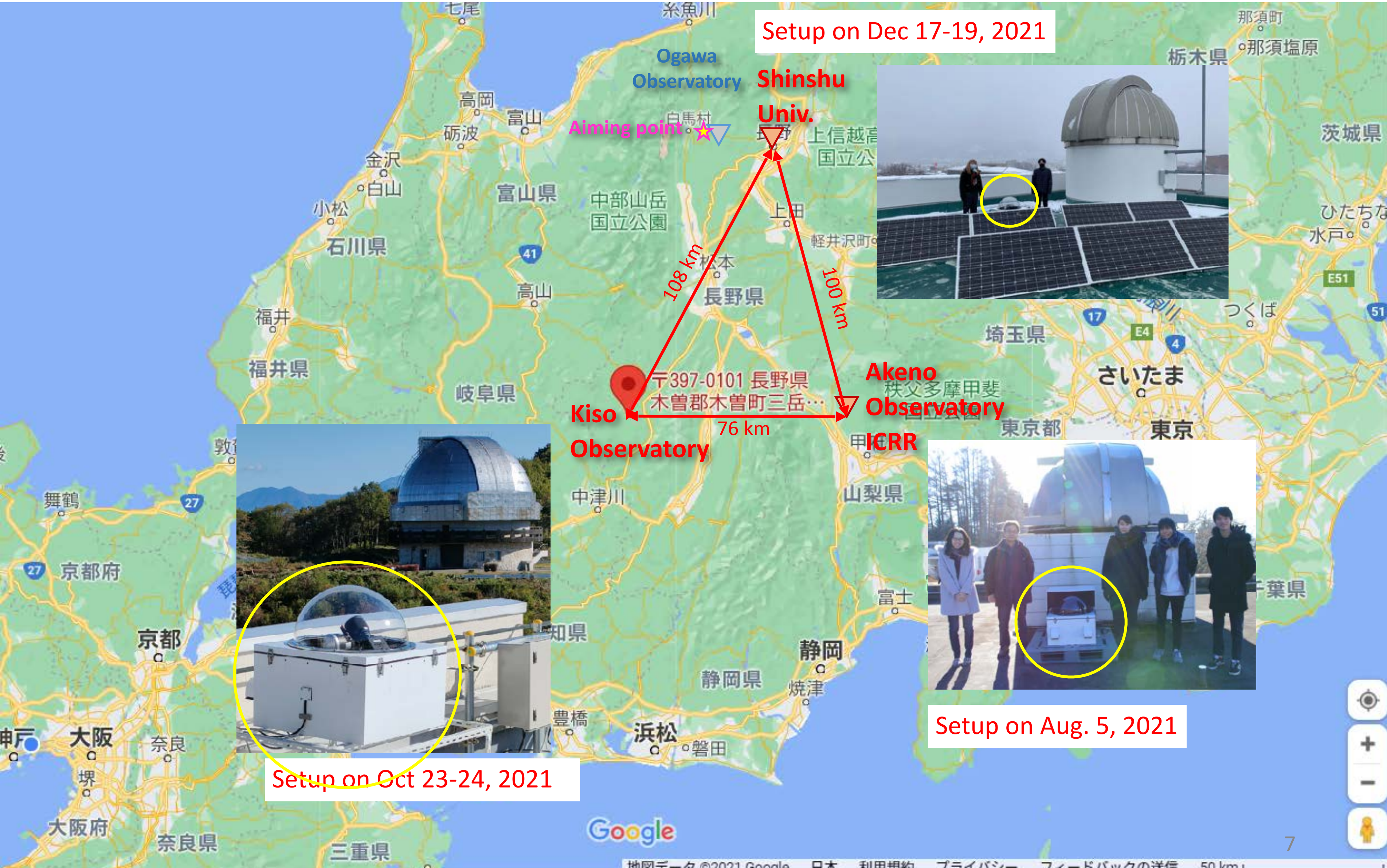
Self-supply system only required for the operation at Central Laser Facility

2019/09/01 10:34:04.4 00098 V00037+202 Canon_ME20F_SH EF35mm_F1.4L_II_USM Utah_UT2 N2 UFOCaptureHD2

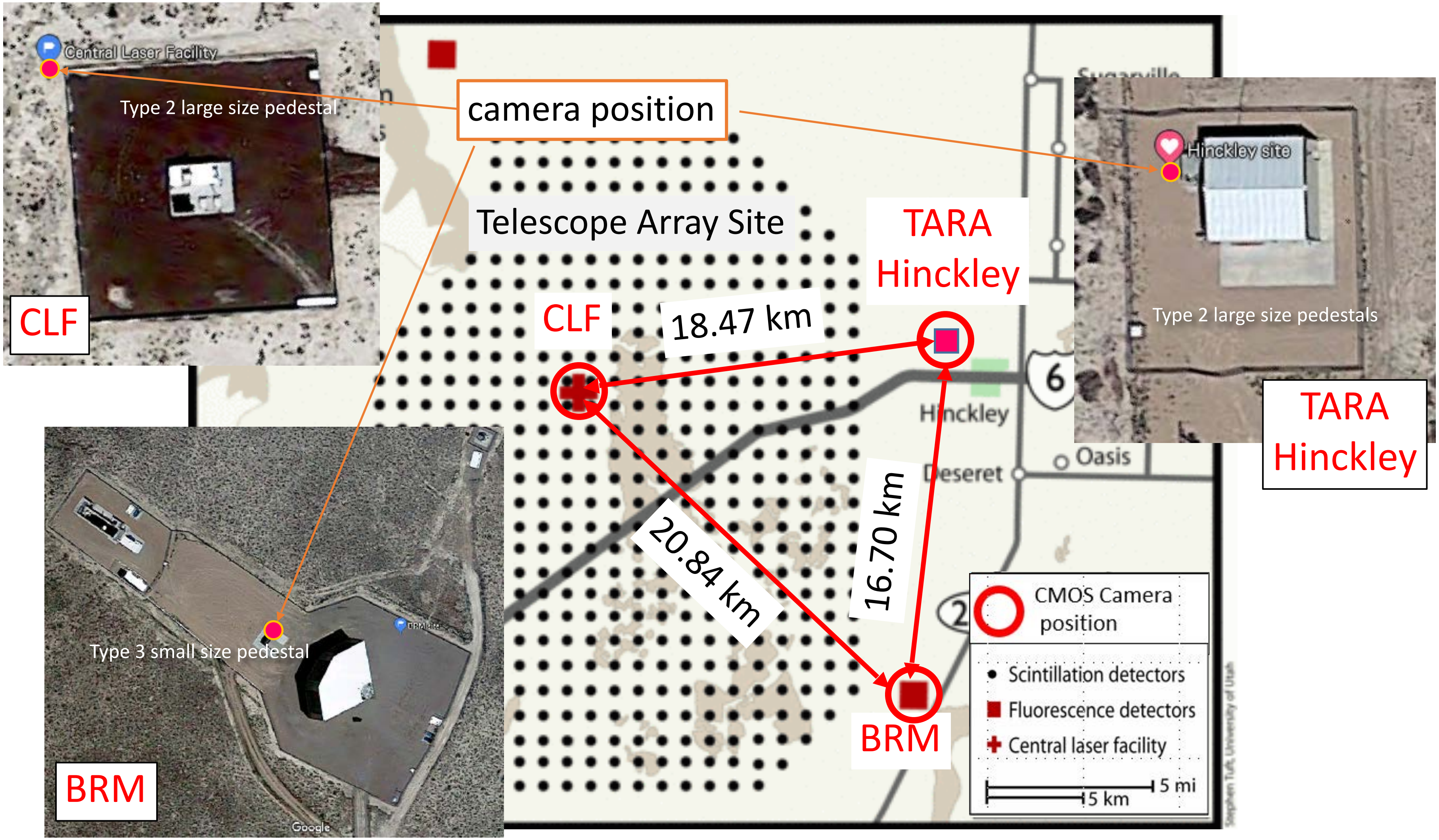
DIMS project

Present Setting of DIMS

The installation of the equipment in Utah has been delayed due to COVID-19.

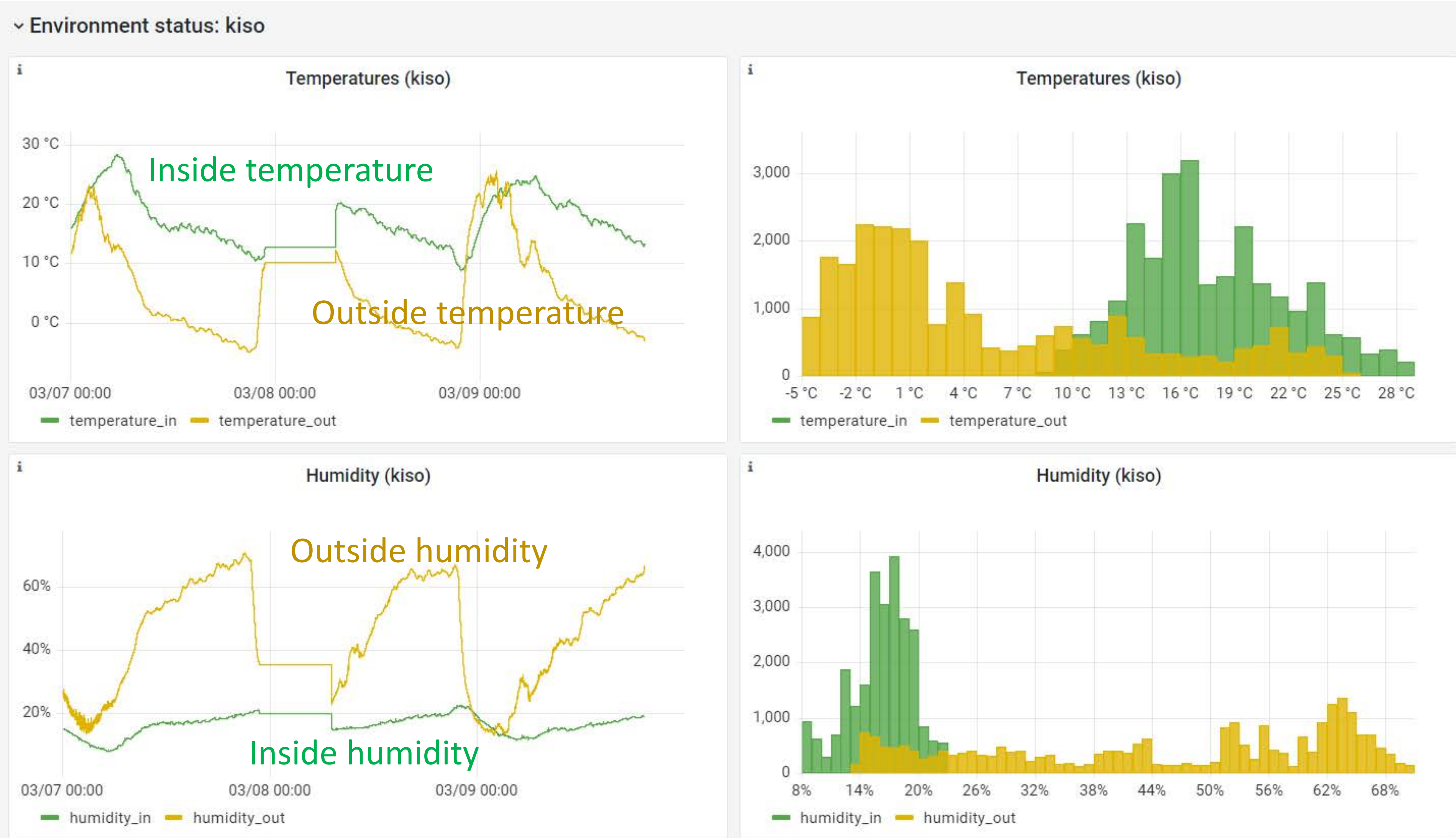


Test Observation at TA Site in Utah in 2022-

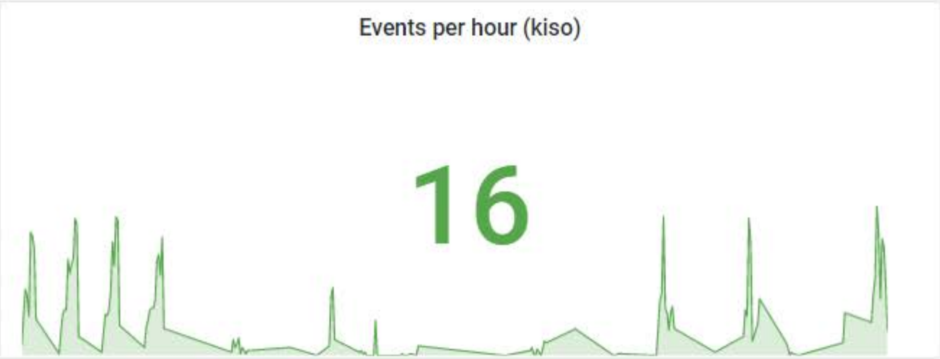


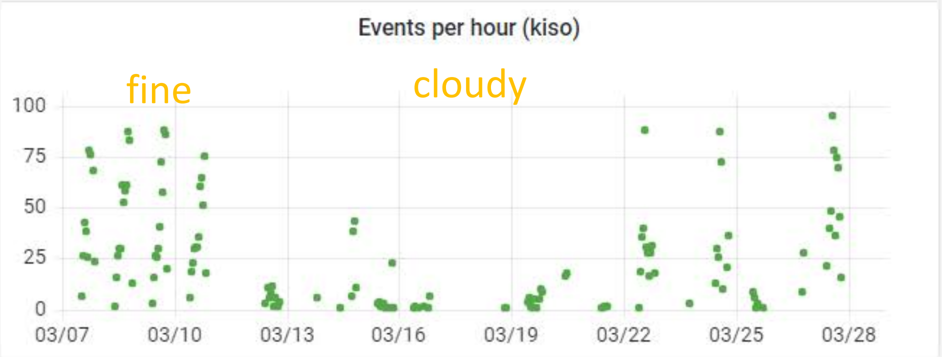
2 cameras were used at a time for the observation.

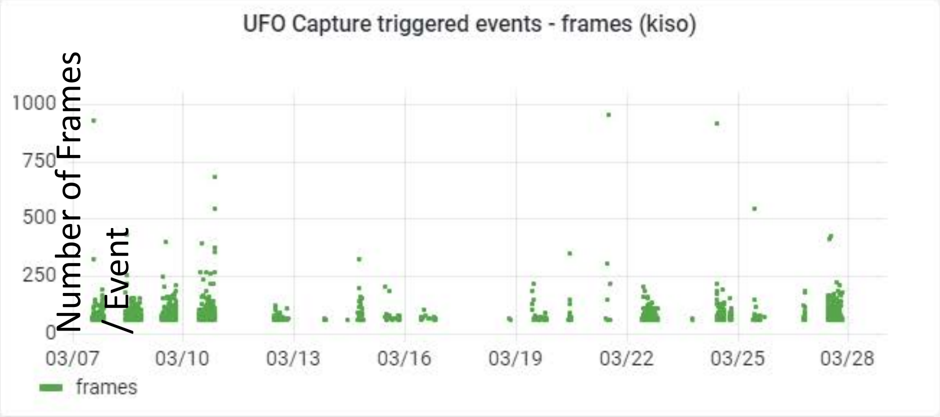
DAQ Monitoring

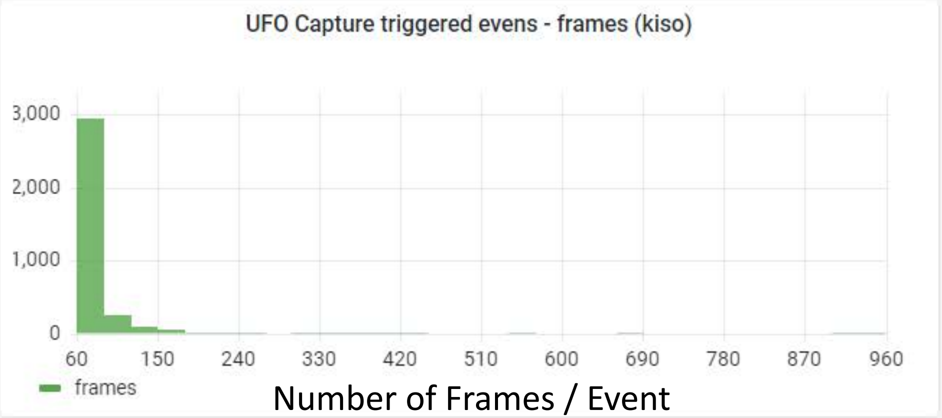


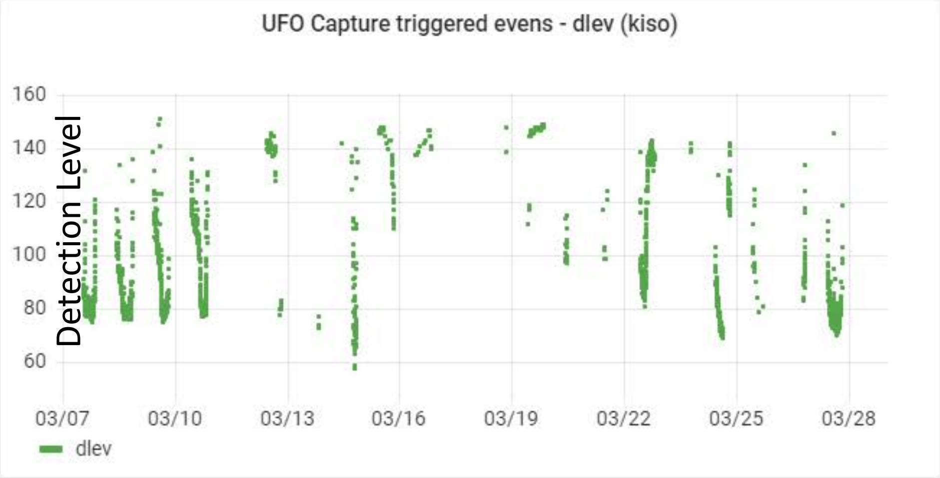
Data Acquisition (DAQ) Monitoring

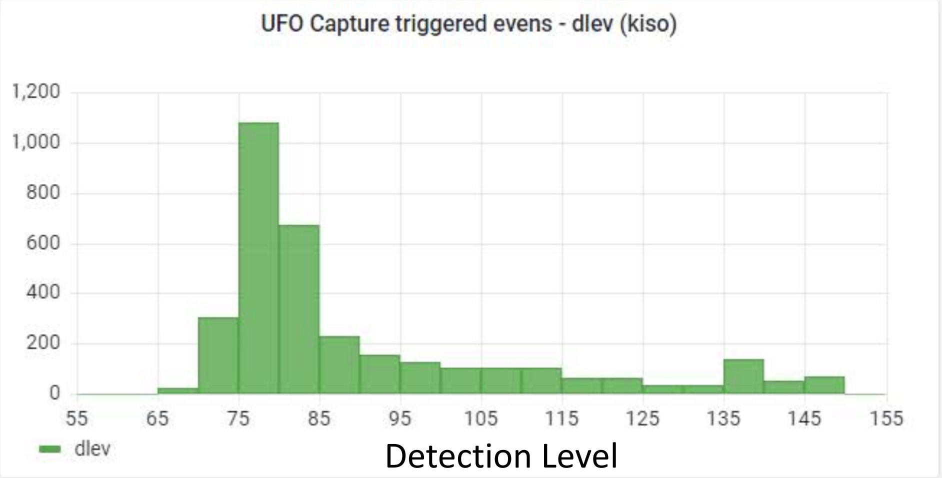






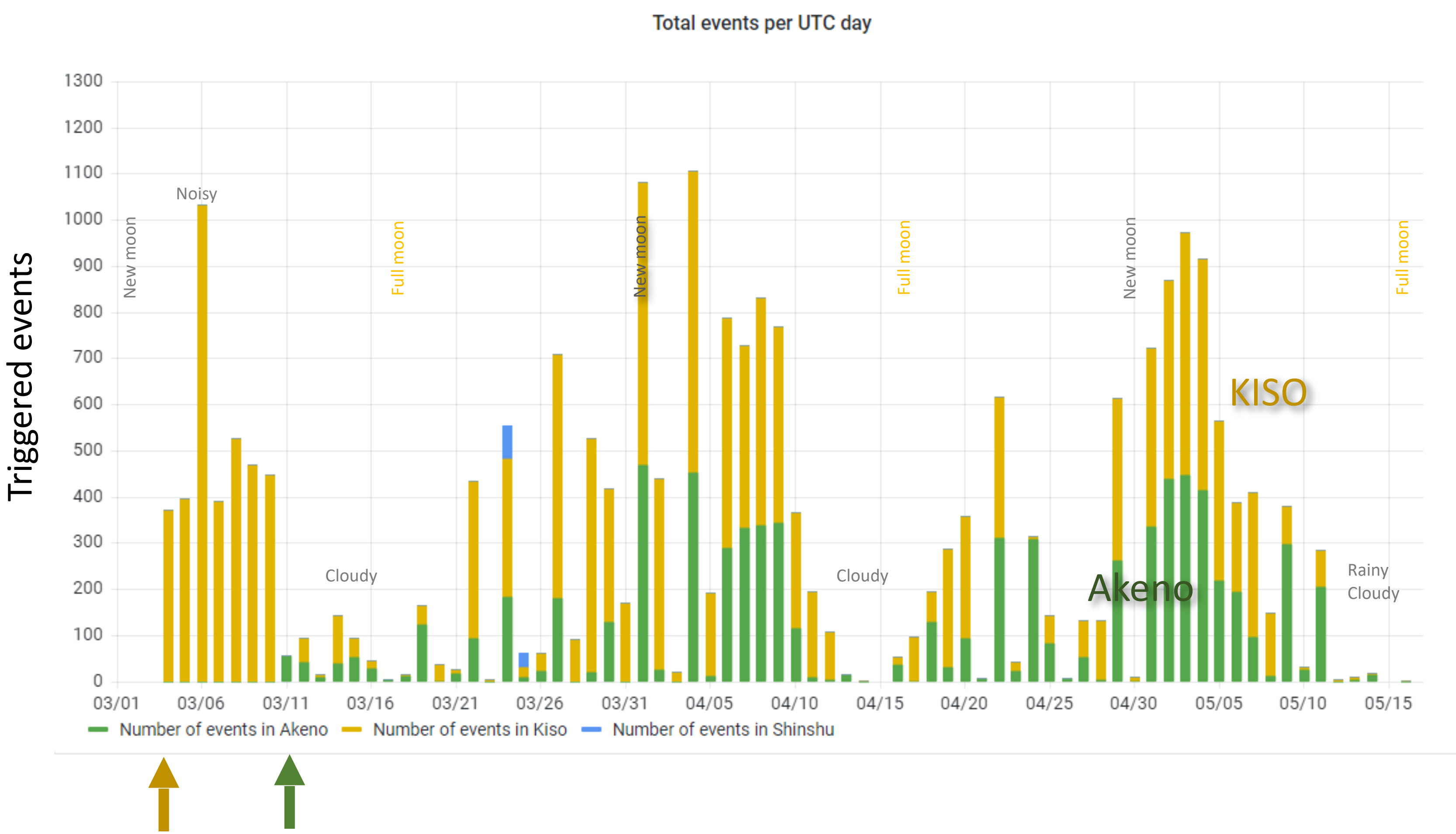






Triggered Events at Akeno and Kiso

Mar. 4th - May 16th for 74 days



DAQ monitoring software was installed.

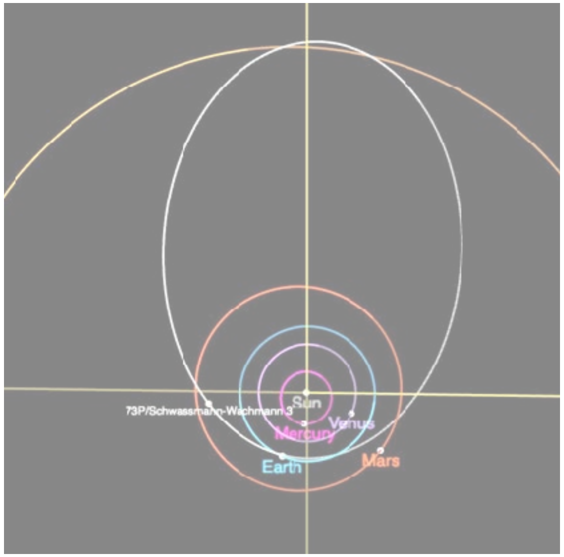
2022 τ-Herculids observed by DIMS

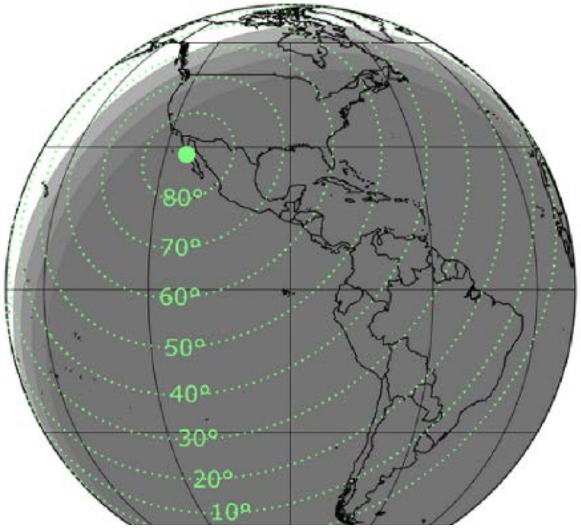
Comet 73P/Schwassmann-Wachmann 3, a member of the Jupiter family of comets orbiting the Sun about every 5.4 years.

The τ-Herculids meteor shower is known to be caused by the comet 73P/SW3.

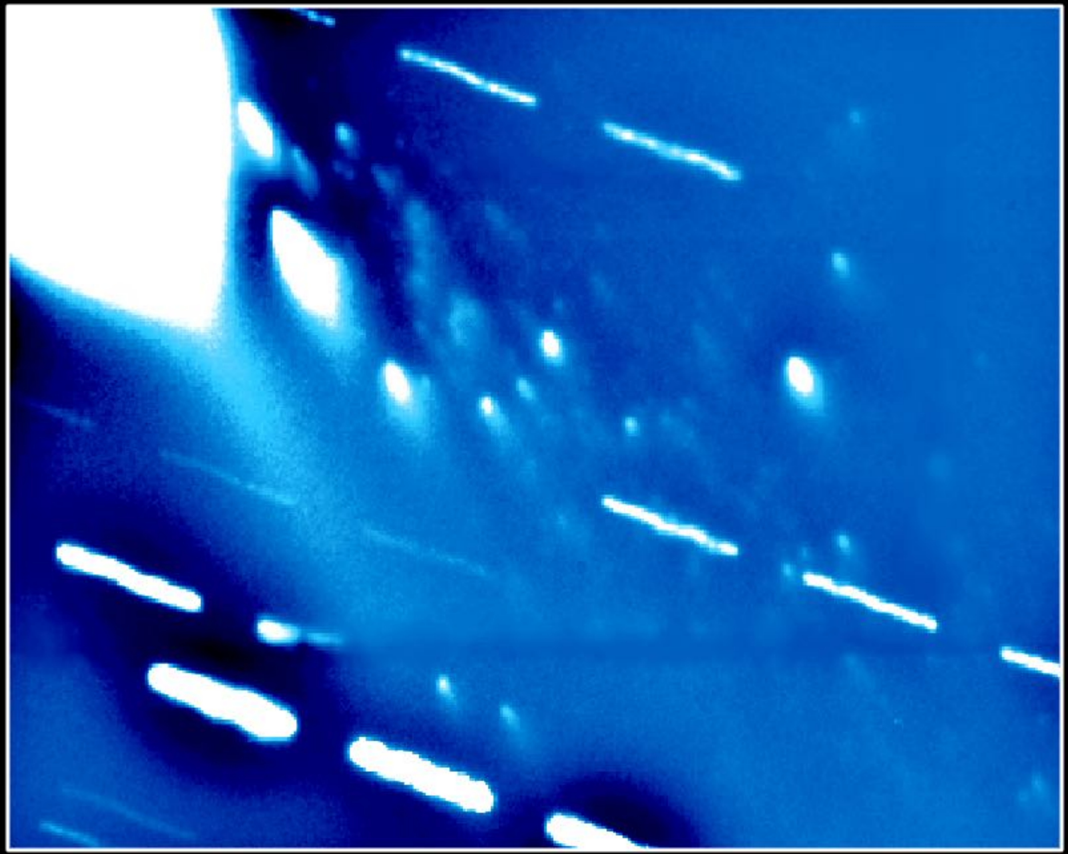
The comet is famous for having an important outbursts in 1995, resulting in several fragments, particularly well observed during the 2006 perihelion return.

A dramatic increase in the comet's intrinsic brightness was then seen, suggestive of a massive expulsion of dust on May 31, 2022.





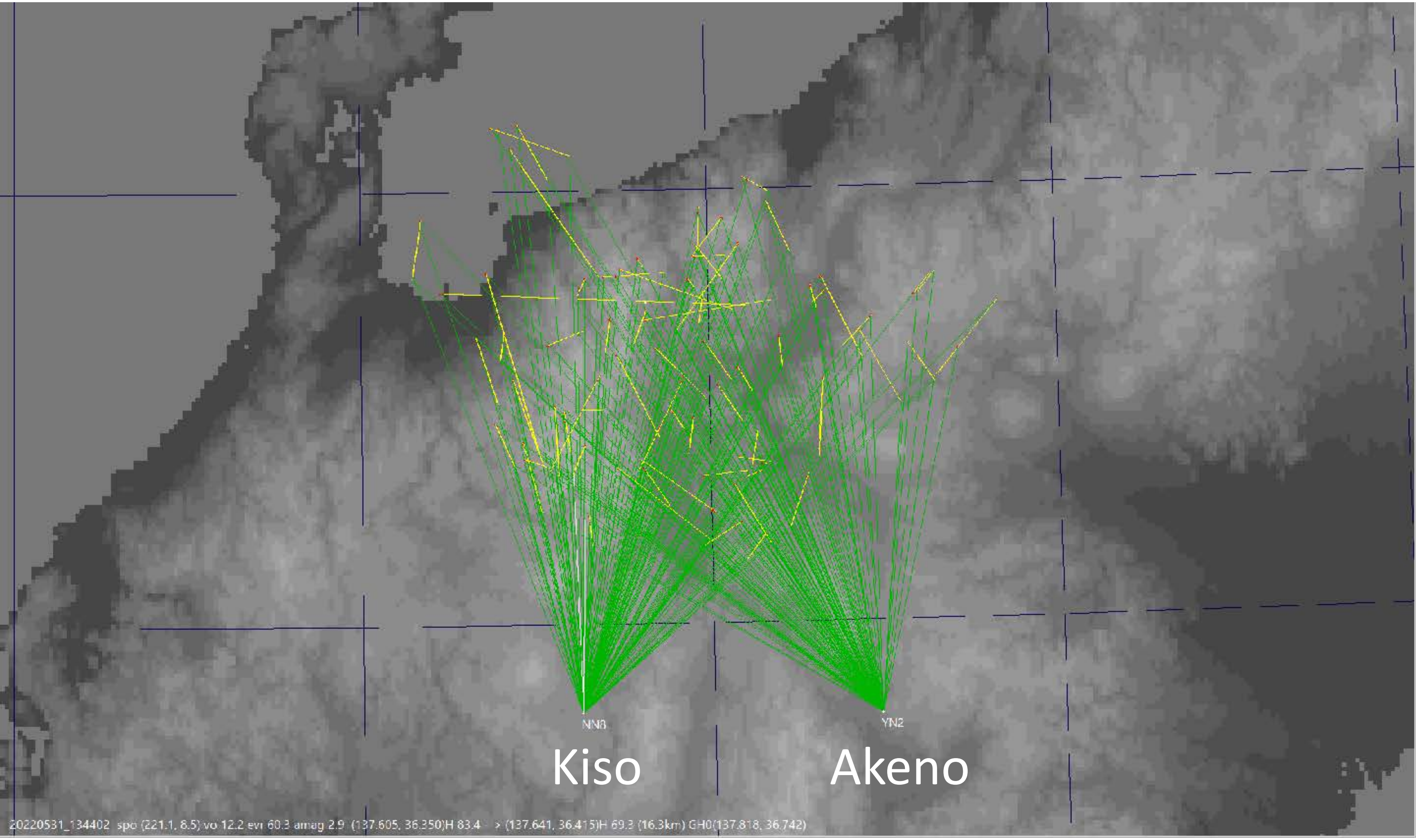
シュヴァスマン・ヴァハマン第3彗星
(Schwassmann-Wachmann 3, 周期5.4年)は
1995年と2000年の太陽接近時にバースト
68個の核に分裂している



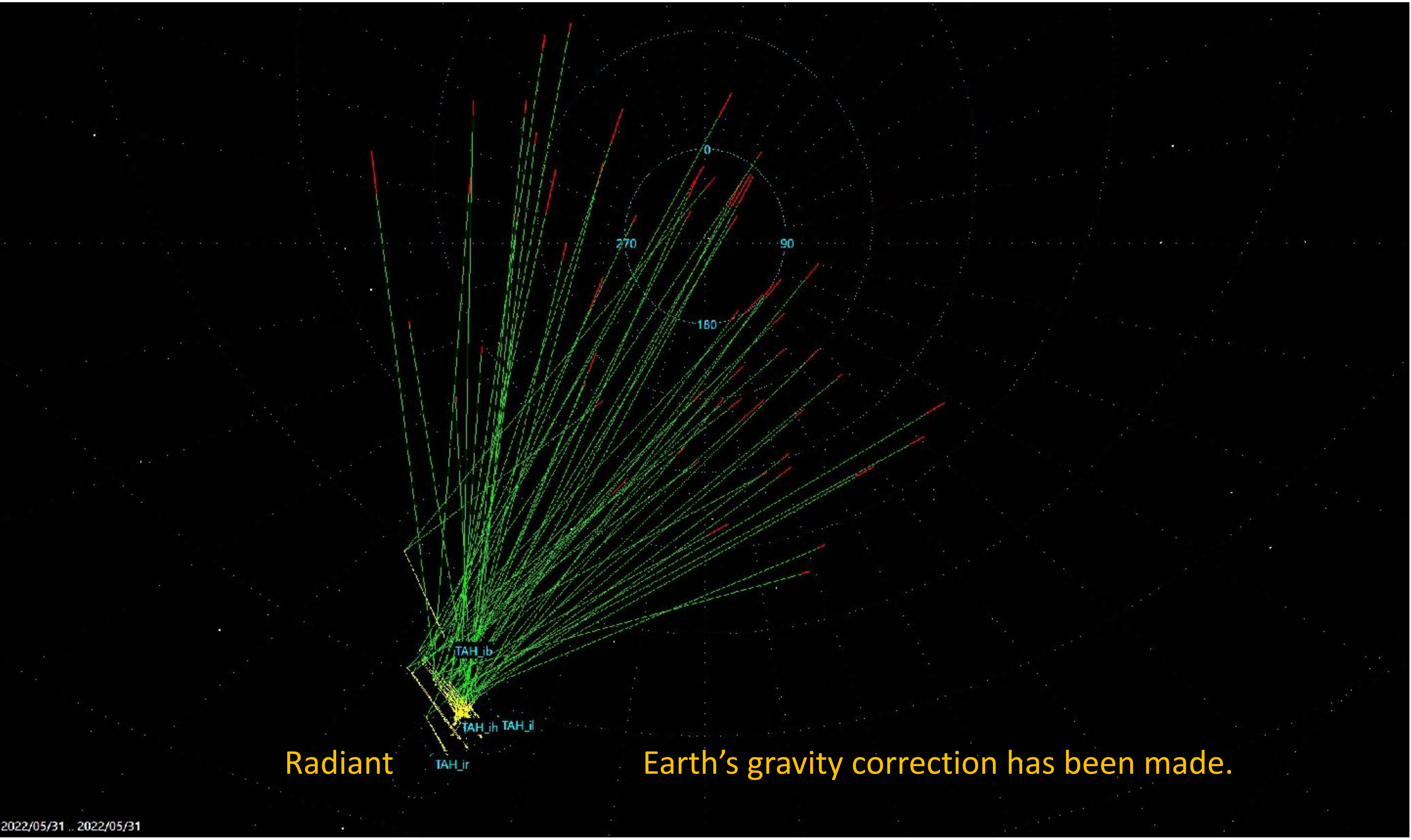
More Than 50 Small Fragments Split from Fragment B of Comet 73P/Schwassmann-Wachmann 3

Subaru Telescope, National Astronomical Observatory of Japan

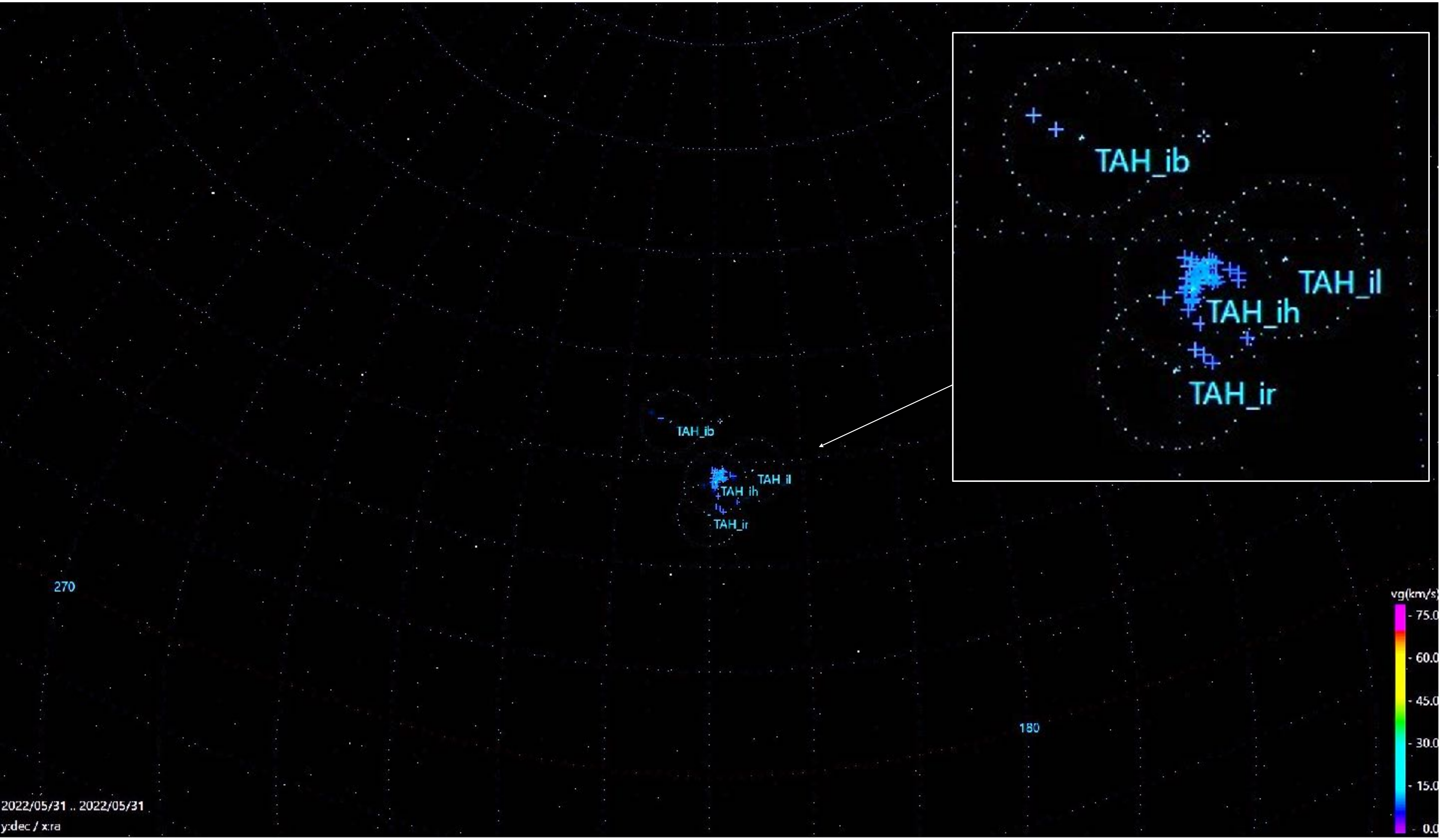
Suprime-Cam (R)
April 24, 2007


NN8
YN2
Kiso
Akeno
20220531_134402 spo (221.1, 8.5) vo 12.2 evi 60.3 amag 2.9 (137.605, 36.350)H 83.4 -> (137.641, 36.415)H 69.3 (16.3km) GH0(137.818, 36.742)

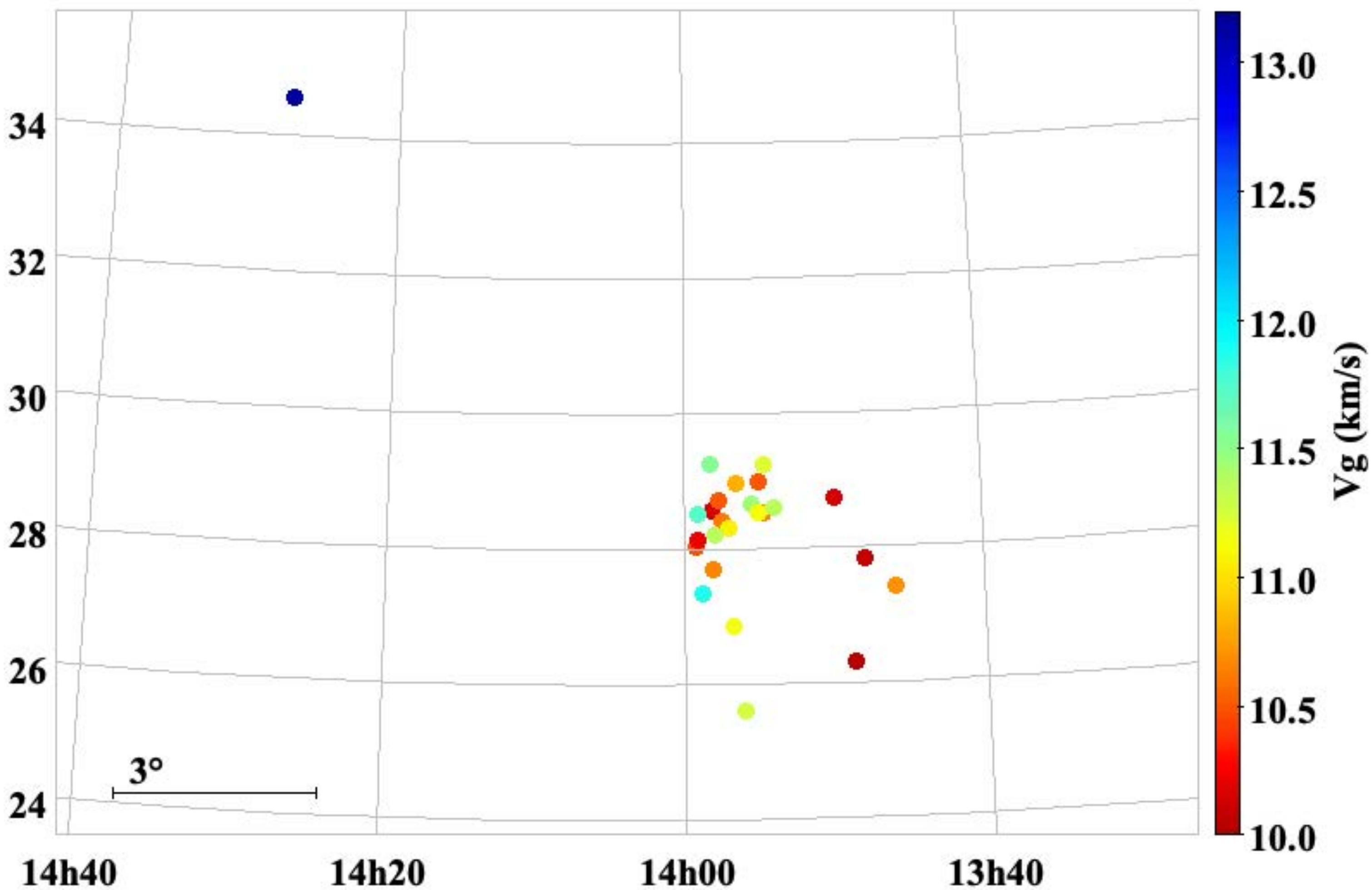
Radiant

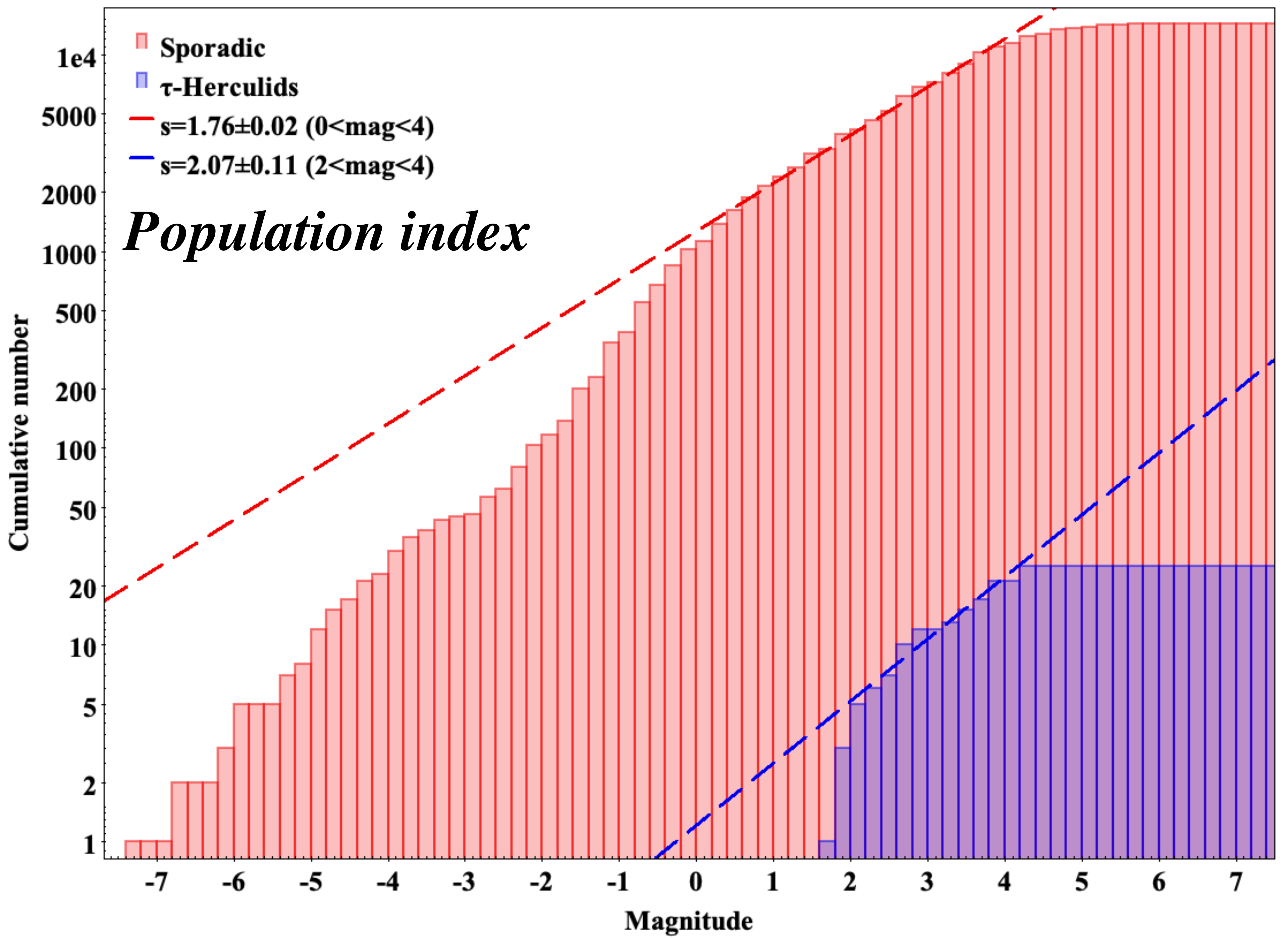

0
270
90
180
TAH_ib
TAH_ih TAH_il
TAH_ir
Radiant
Earth’s gravity correction has been made.
2022/05/31 .. 2022/05/31

Radiants for the τ-Herculids Events

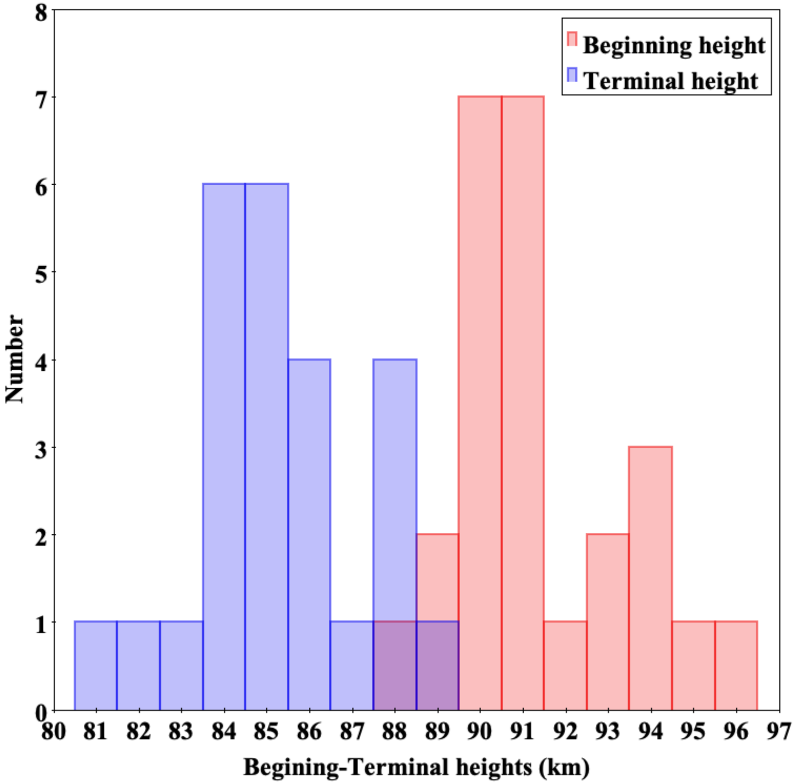


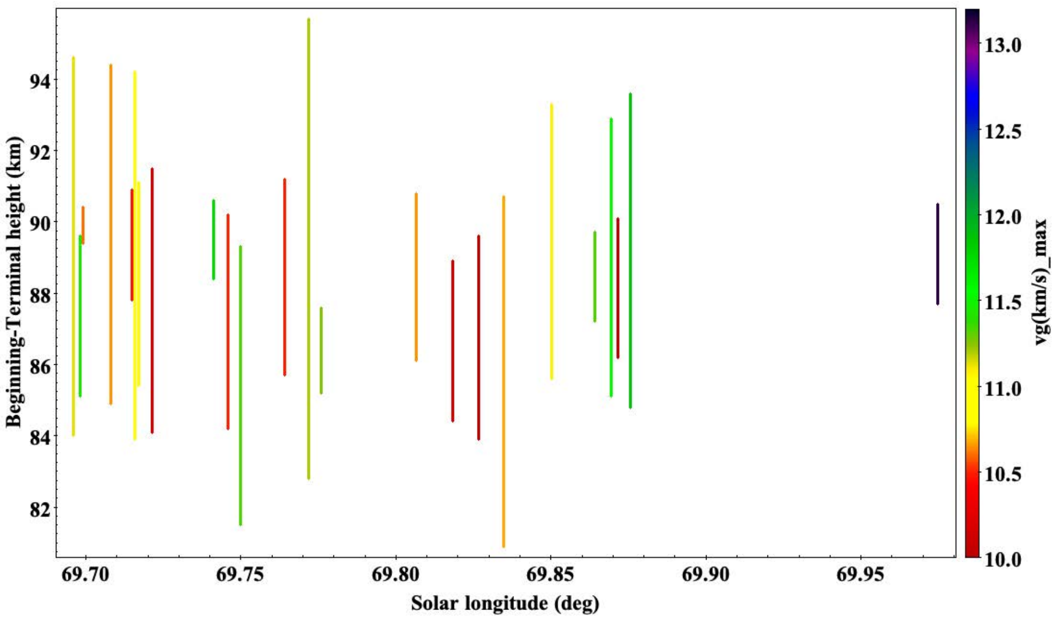
Radiants and Velocities of the τ-Herculid meteor shower




Sporadic
τ-Herculids
s=1.76±0.02 (0<mag<4)
s=2.07±0.11 (2<mag<4)
Population index
Cumulative number
1e4
5000
2000
1000
500
200
100
50
20
10
5
2
1
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
Magnitude

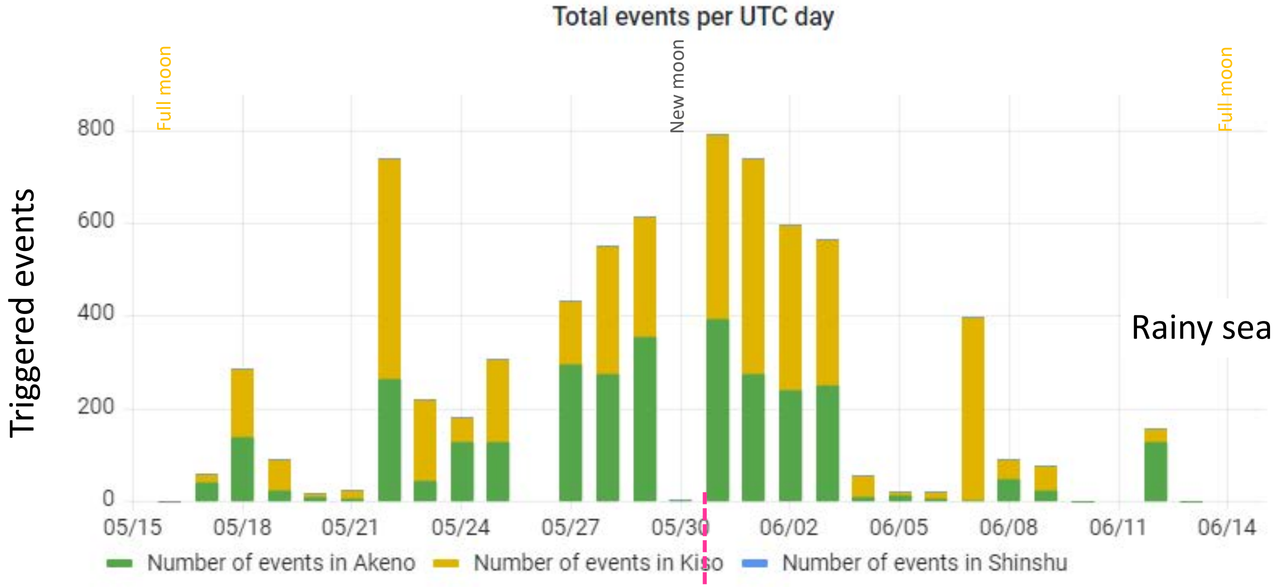
Beginning and Terminal Hight of Meteors



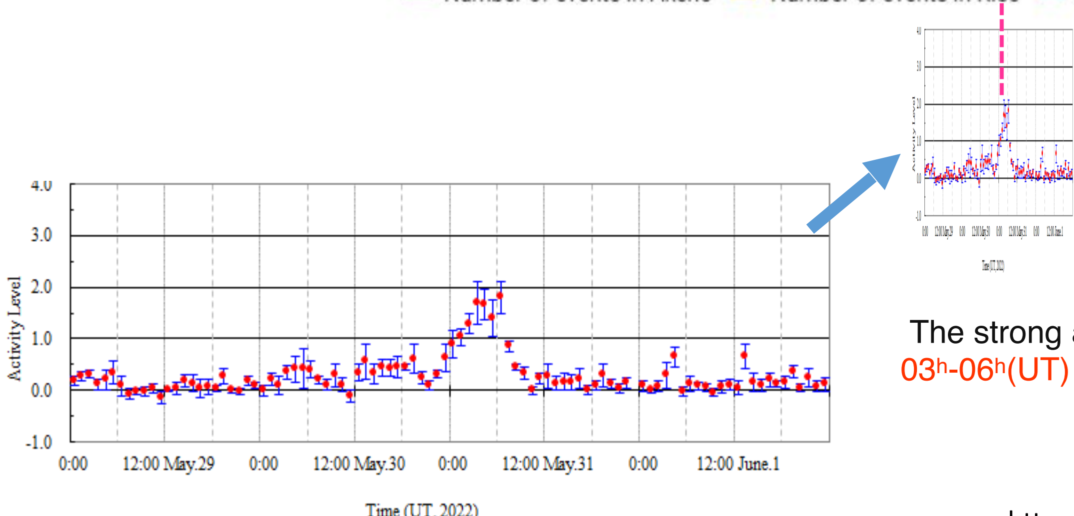


DIMS Events vs. τ-Herculids Activity

May 16th - June 13th for 29 days



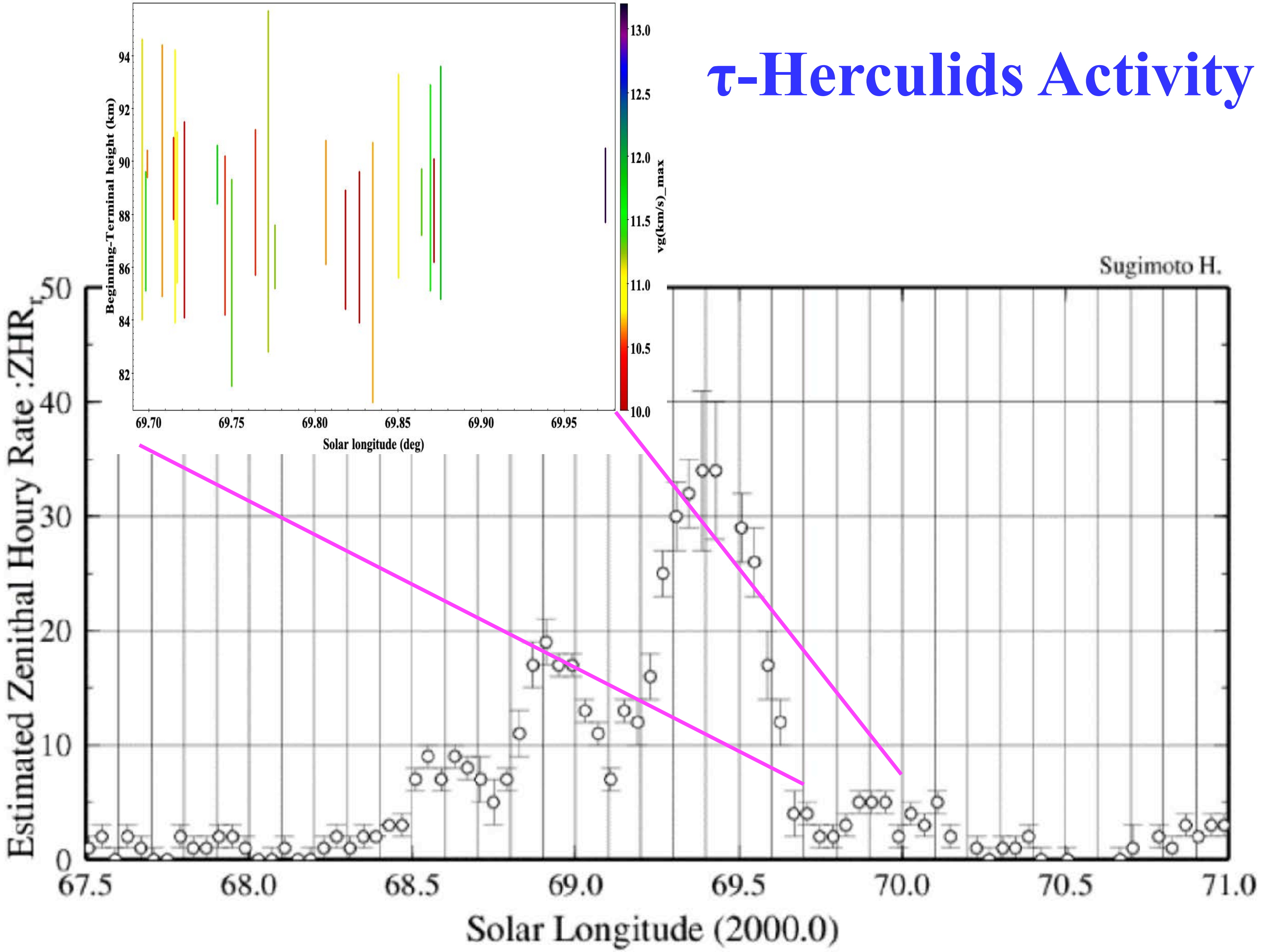
Rainy season started



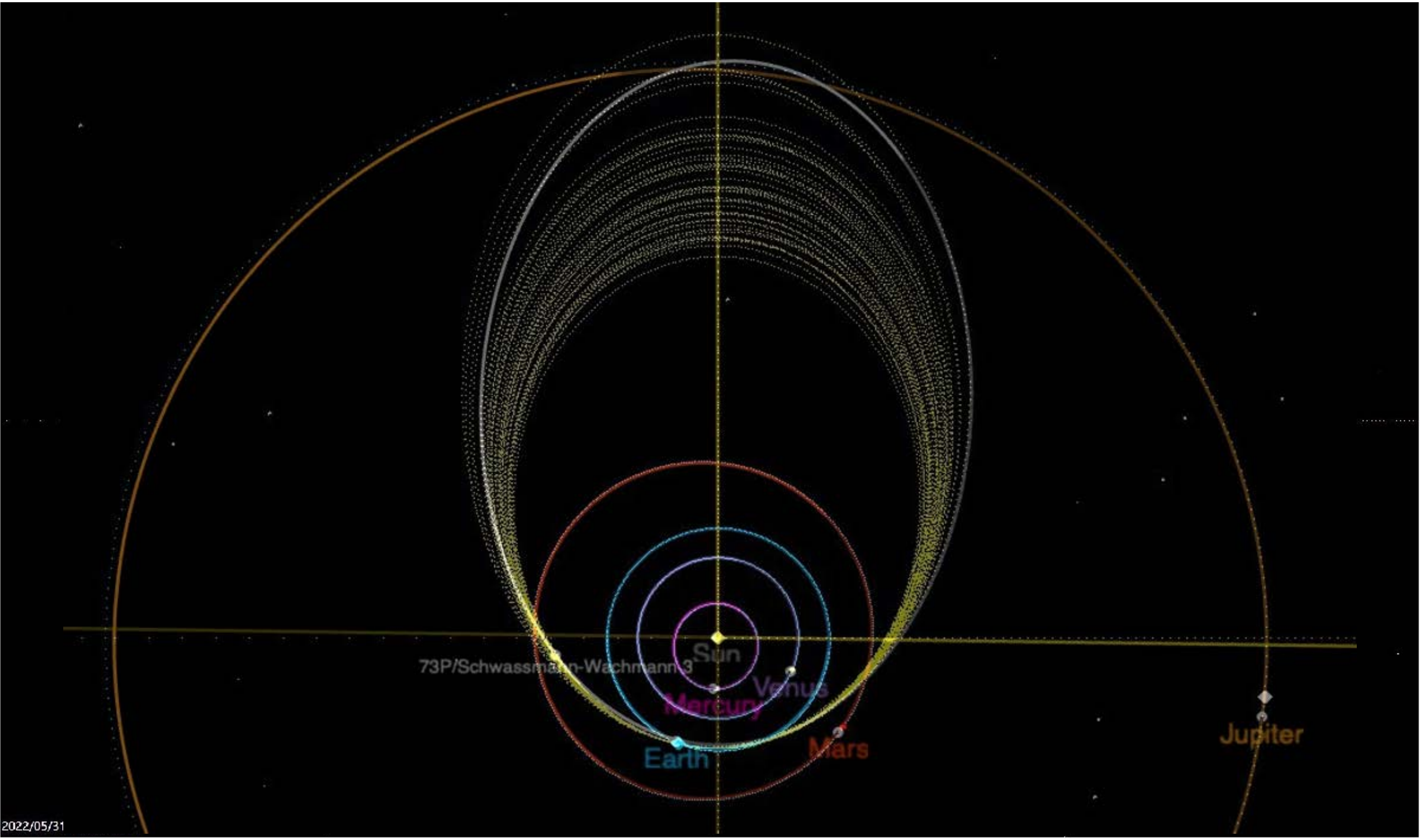
The strong activity of τ-Herculids 2022 showed around 03h-06h(UT) on 31st May by Radio Meteor Observations

https://www.iprmo.org/flash/061tah-2022.html

τ-Herculids Activity

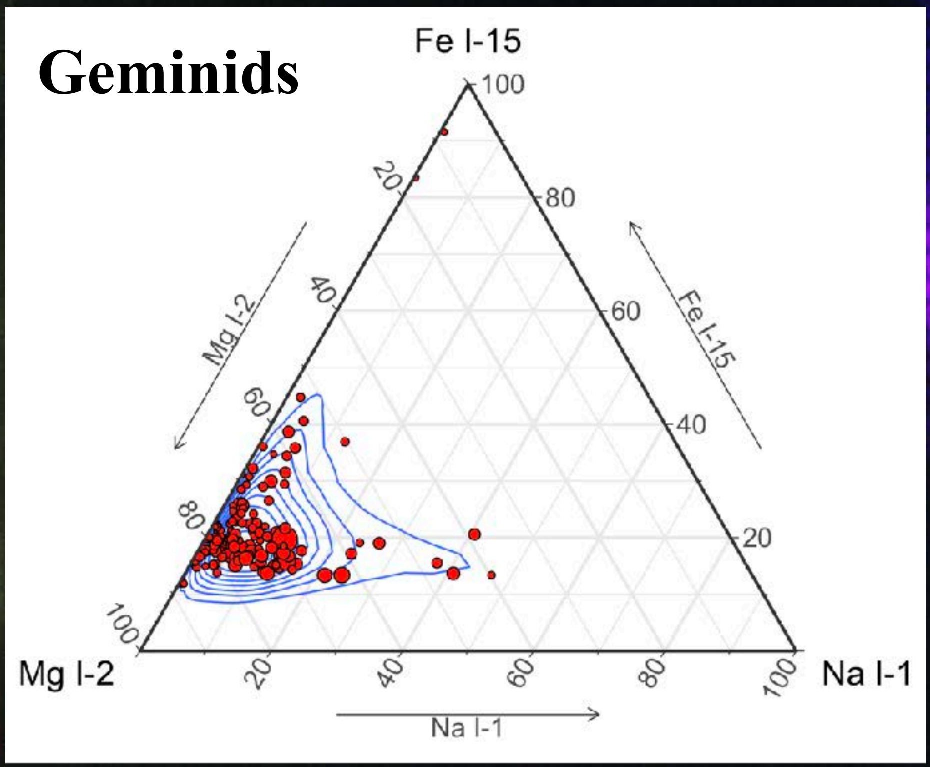


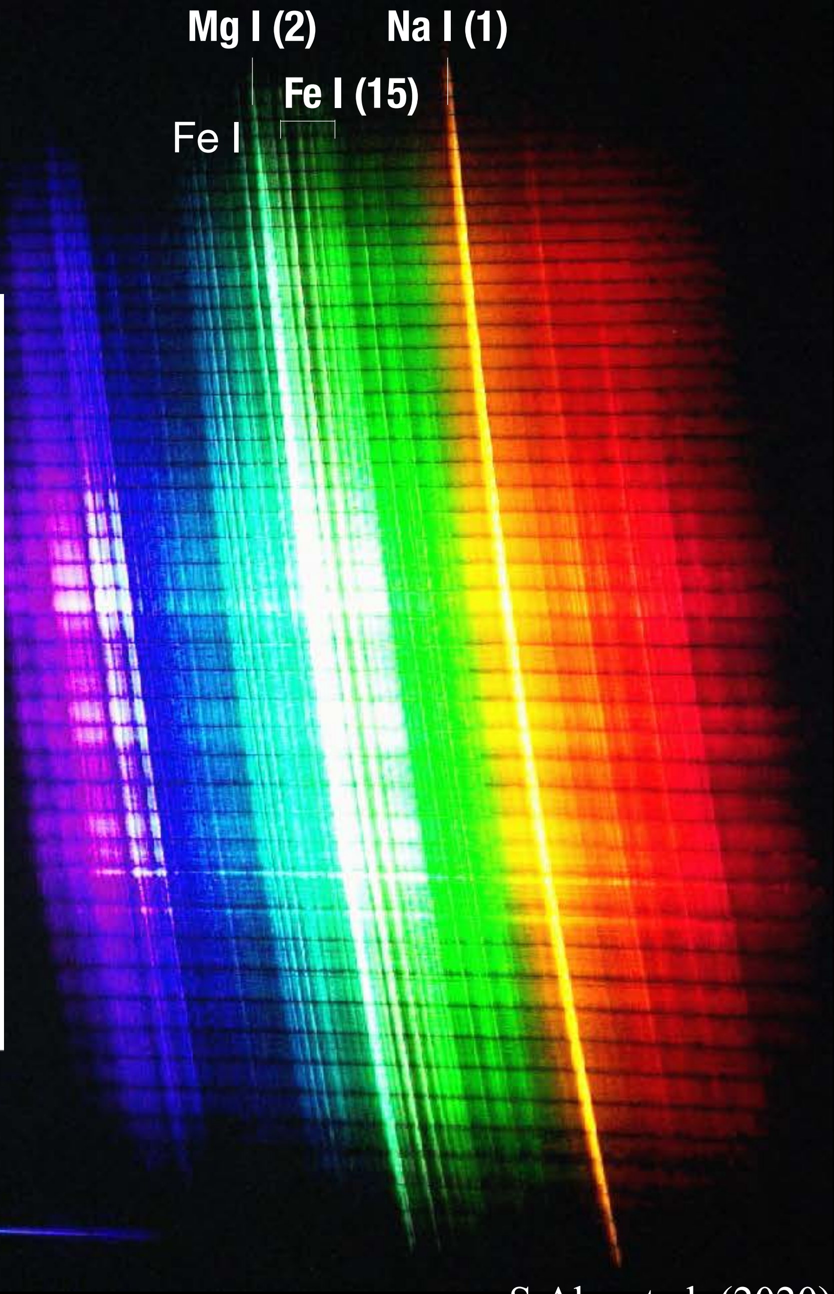
Orbits of the τ-Herculids meteoroids



Meteor Spectroscopy

組成



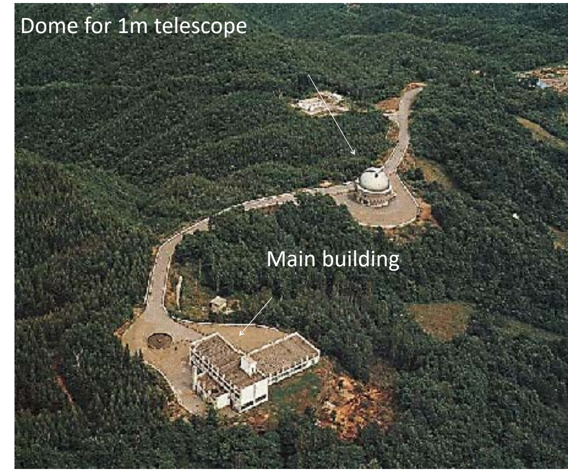


S.Abe et al. (2020)

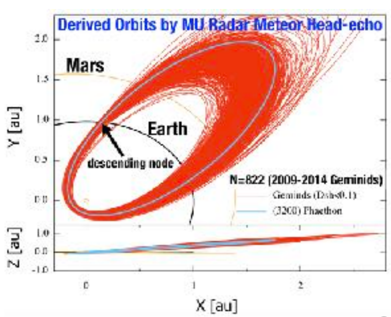
微光流星のサイズ分布と軌道

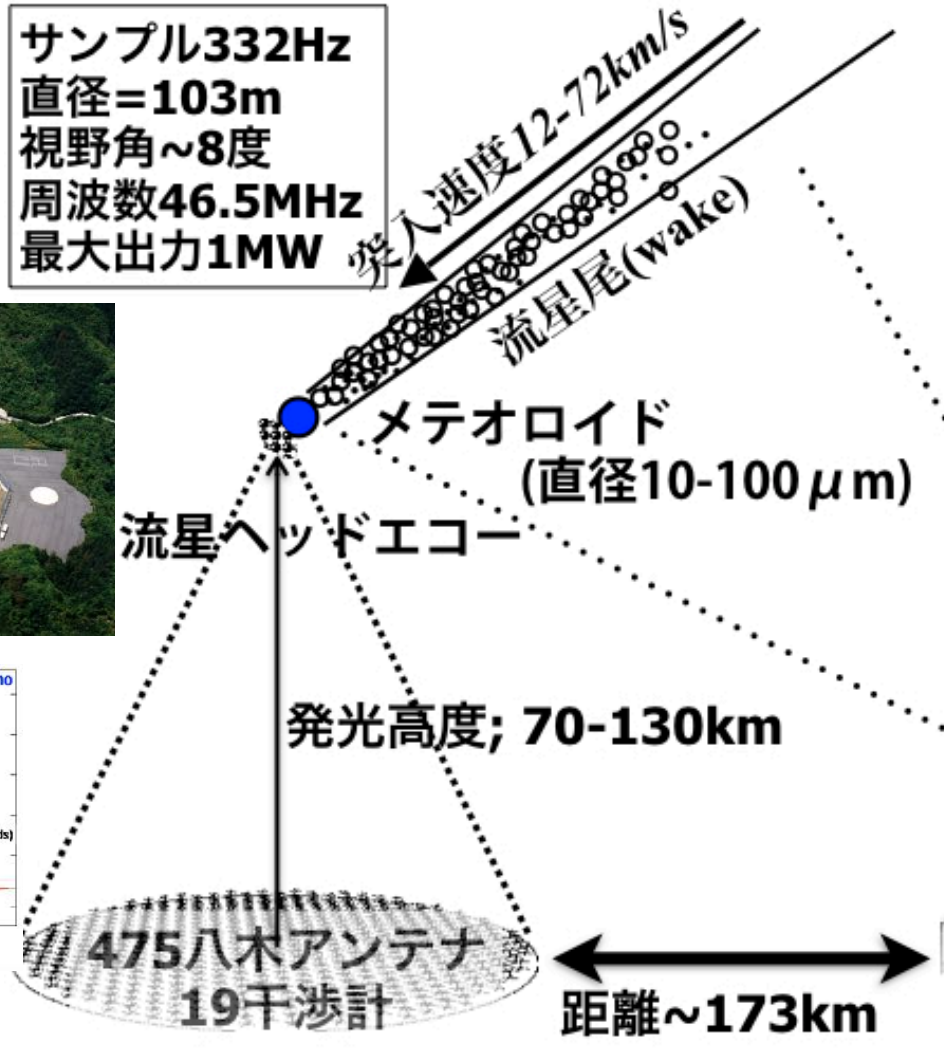
共同研究; 東大・スウェーデン宇宙物理研究所・極地研・国立天文台・京大

観測対象; ふたご座流星群



サンプル332Hz
直径=103m
視野角~8度
周波数46.5MHz
最大出力1MW





露光0.5秒
口径=1.05m
視野角~9度
波長400-700nm
最微等級~19等
最微流星~13等

京大・MU レーダ観測所

東大・木曽観測所

DESTINY＋

ふたご座流星群の母天体; 活動小惑星ファエトン

「はやぶさ」、「はやぶさ２」に続く日本の小惑星探査計画は、2024年度の打上げを目指している深宇宙探査技術実証機「DESTINY＋（デスティニープラス）」である。このミッションでは、ファエトンの高速フライバイ追尾撮像を行うと共に、日心距離1天文単位付近の宇宙塵やファエトン周辺の塵粒子の物理化学特性を直接分析する。活動小惑星から放出されるダストの組成を明らかにすることは、地球の水の起源や太陽系初期の微惑星形成過程の理解にも繋がる重要な探査である。

DESTINY＋探査機は、イプシロン級ロケットで地球周回長楕円軌道へ打ち上げられた後、イオンエンジンを使い約2年かけて地球を周回しながら徐々に高度を上げ、月の重力を利用してファエトンに向かう軌道に移り、さらに約2年かけてファエトンに接近する。

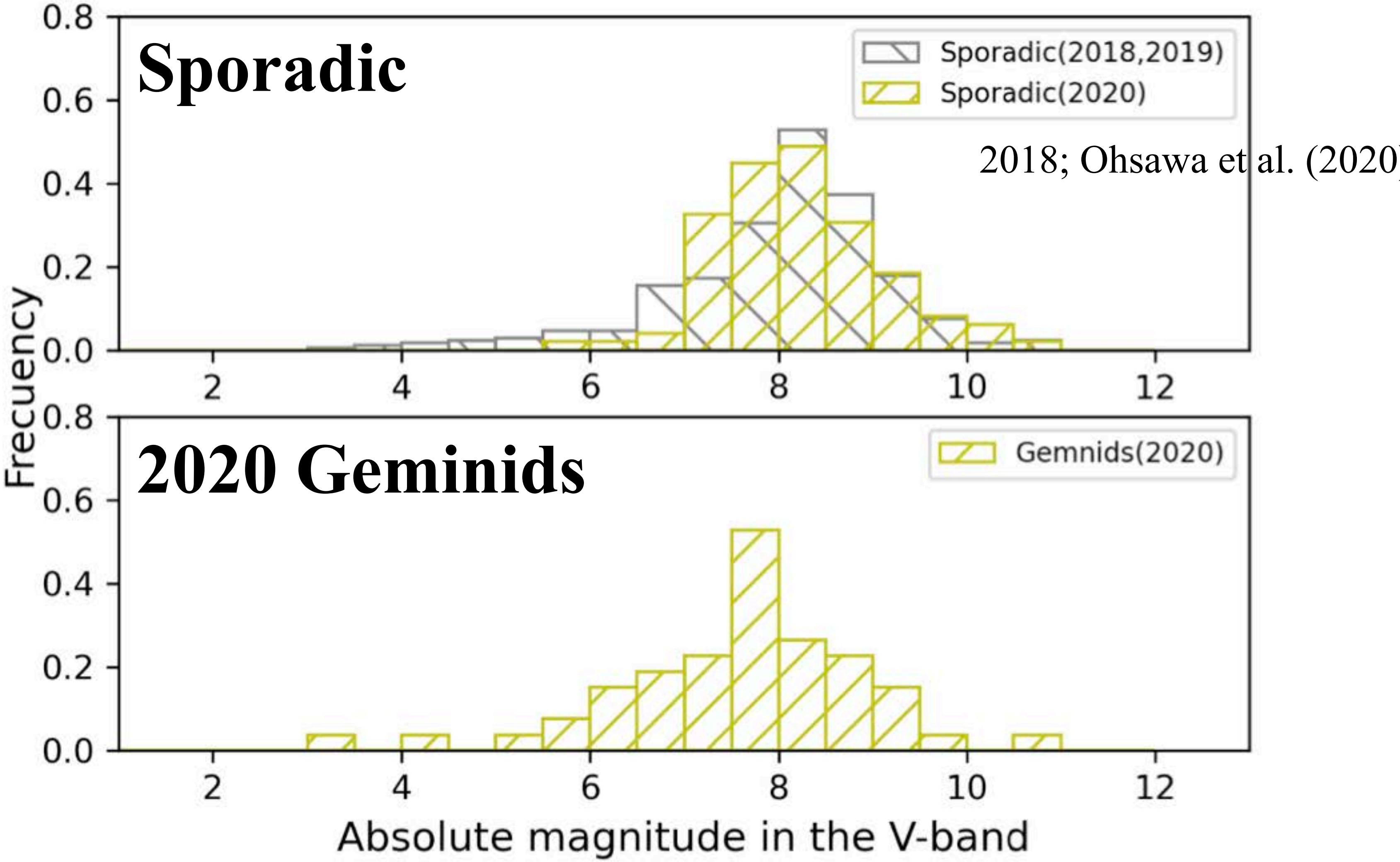


Figure 6.3 2020 年度と先行研究の等級分布の比較

協力

東京大学木曽観測所(大澤亮氏，酒向重行氏)

スウェーデン宇宙物理研究所 IRF(John Kero 氏，Daniel Kastinen 氏)

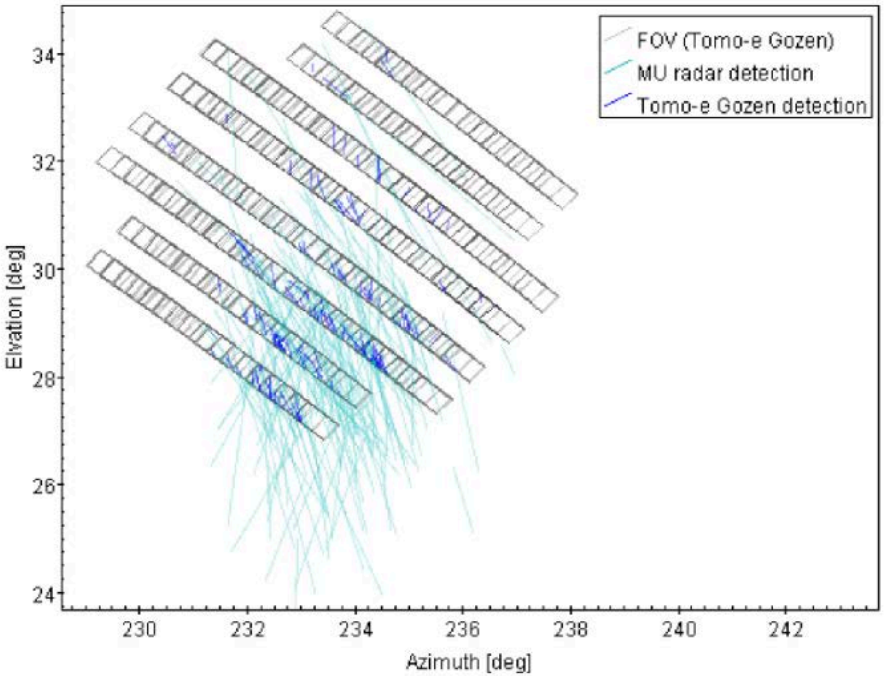


Figure 6.4 2020 年度における FOV と流星出現位置の関係

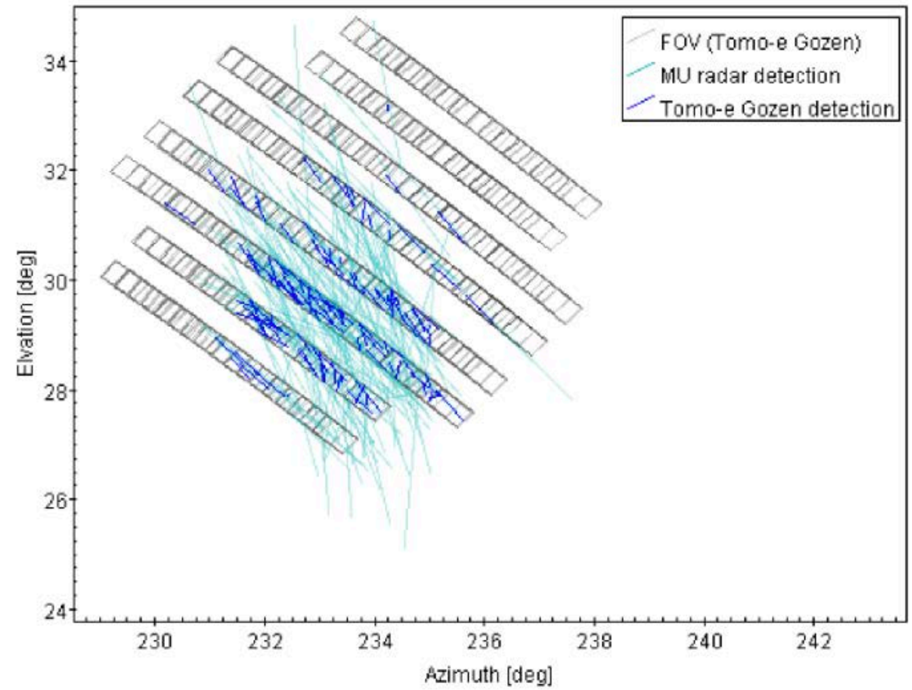
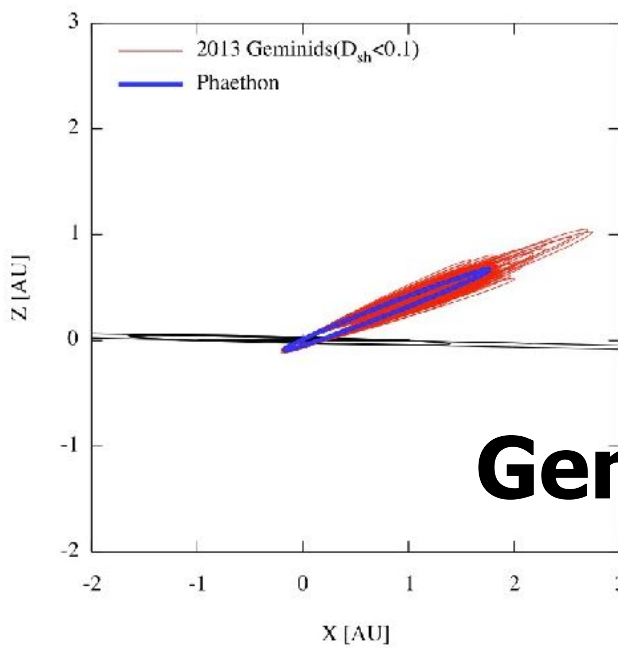
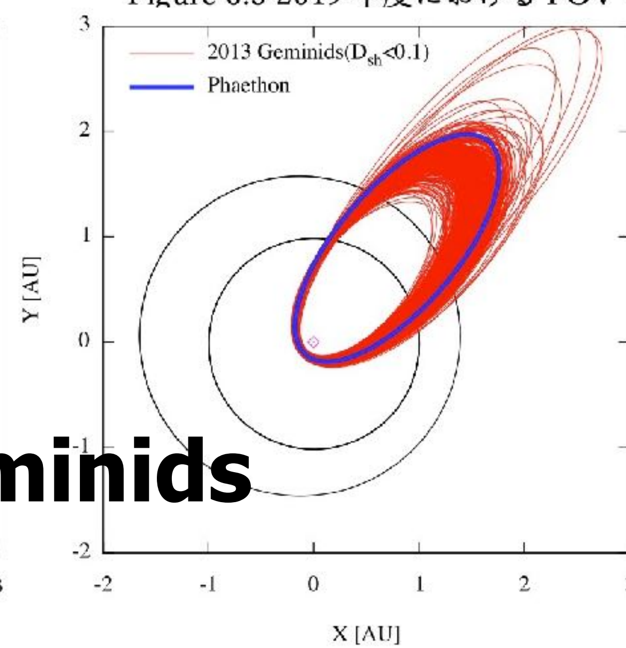


Figure 6.5 2019 年度における FOV と流星出現位置の関係





Geminids

Summary

- We are developing the DIMS project to search for macroscopic dark matter and interstellar meteoroids.
- Test operation is underway at three locations in Japan and at one location in Poland.
- 2-3 camera stations will be installed at Utah/USA in summer, 2022.
- DIMS can co-observe with JEM-EUSO program such as EUSO-TA, mini EUSO, K-EUSO …
- **Kiso-Akeno triangulation observation is continuing in 2022.**
- **Spectroscopic camera will be installed.**
- **We propose MU-Tom-e observation for 2020 Geminids which will be during Dec 12-14.**