

# Spectrum Management for Radio Astronomy

NAOJ

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NINS

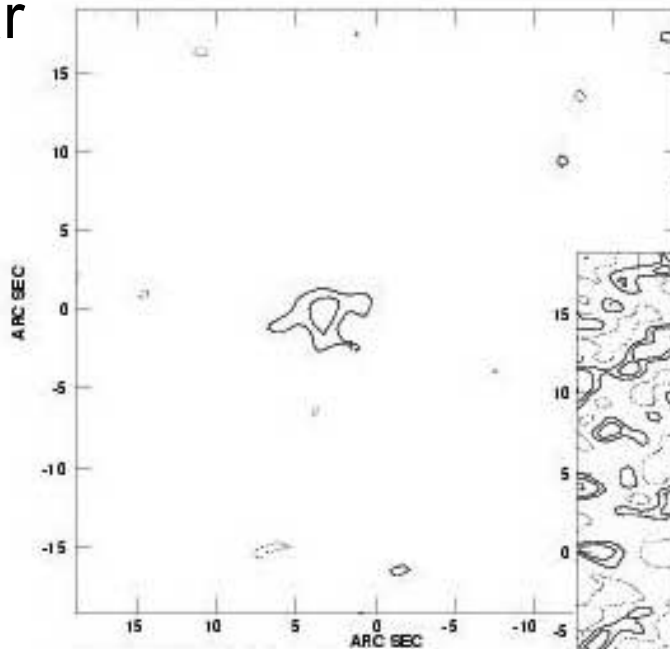
大学共同利用機関法人

自然科学研究機構

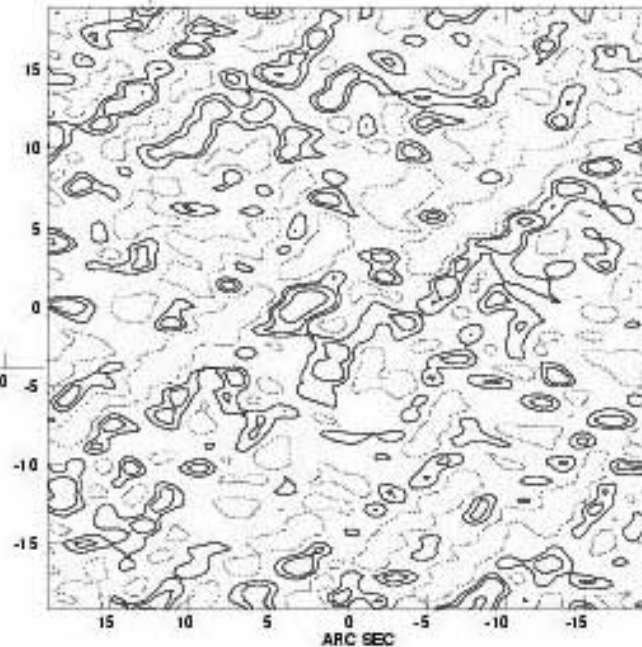
# Interfered image at VLA

Credit: G.B. Taylor, NRAO/AUI/NSF.

star



Satellite interference  
25 deg away from the star



No interference

# Car radar experiment @ NRO

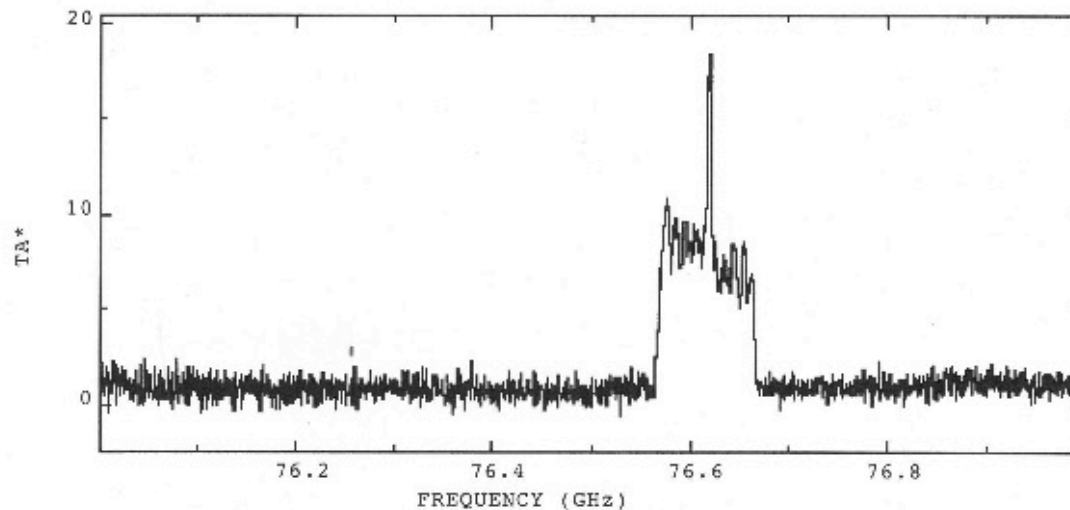
```
F76hv-n    F7679
Comments
Spectrum-id = 00011 (
Ref. coordinate = RA,DEC
RA offset +00d00'00.0"
DEC offset +00d00'00.0"
Center freq. = 76.500000(GHz)
r.m.s. = 0.4151(K)
Baseline order = *
```

```
F76hv-n .INTEG
) : DATE(M D Y) = 05 19 15
  : P.A. = 0.000d
  : RA (2000) = +00h00m00.0s : l = 0.000D
  : DEC(2000) = +00d00'00.0" : b = 0.000D
  : ARY-All : v = 100000'00.0"
  : Integ time(O
  : Scaling fact:
```

15.5.19 13:26 All  
477m

**~76 GHz !!**

477m from 45m tel.



Radio astronomers want to observe all frequency range.

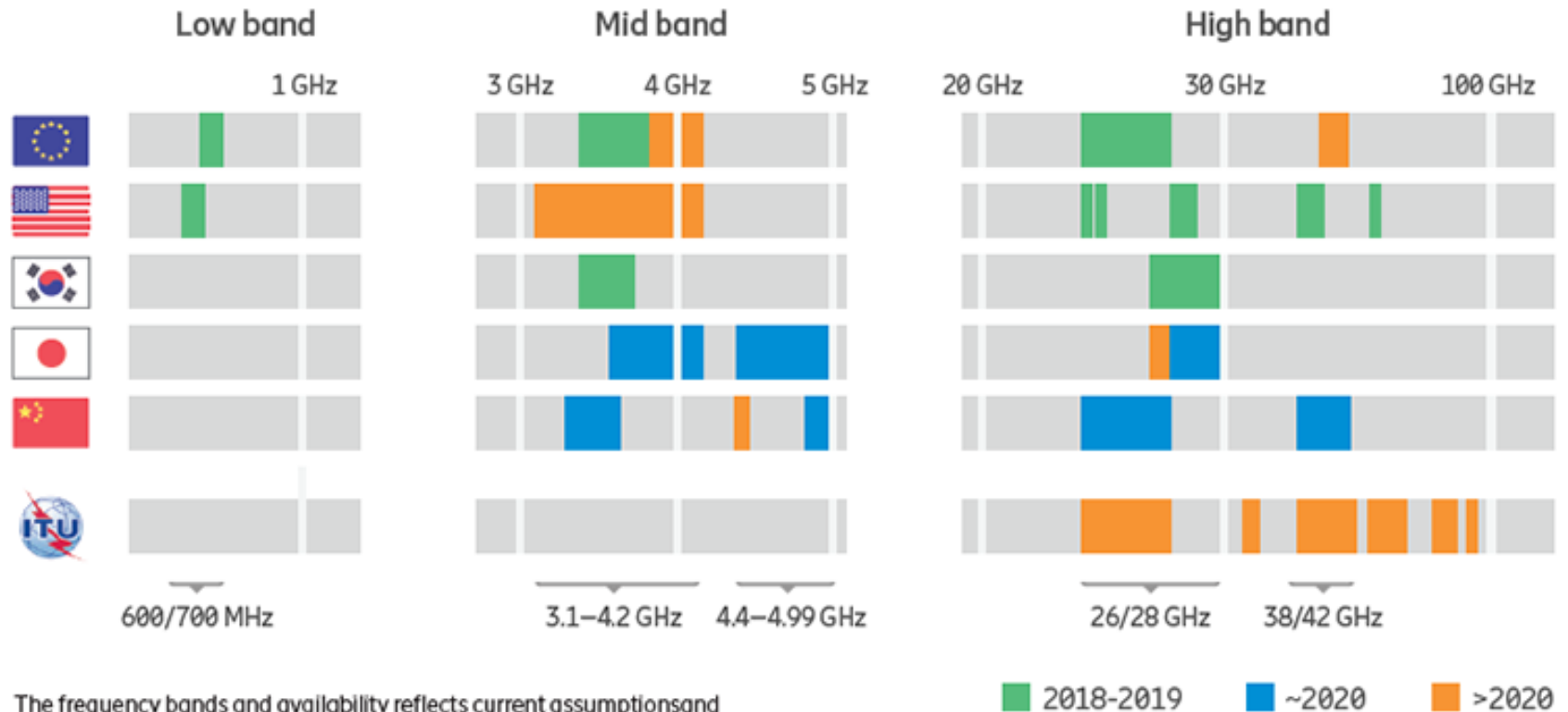
Other radio users may want to emit at all frequency range.

All radio users, including astronomers, have to **SHARE** the frequency resource.

# RA bands to be protected

Frequency Bands(MHz)	Frequency Bands(GHz)
13.360 - 13.410	10.6 - 10.7
25.550 - 25.670	14.47 – 14.50 (H <sub>2</sub> CO)
37.5 - 38.25	15.35 - 15.4
73 - 74.6	22.21- 22.50 (H <sub>2</sub> O)
150.05 - 153	23.6 - 24.0 (NH <sub>3</sub> )
322 - 328.6	31.3 - 31.8
406.1 - 410	42.5 - 43.5 (SiO)
608 - 614	76 - 116
1 400 - 1 427 (HI)	123 - 158.5
1 610.6 - 1 613.8 (OH)	164 - 167
1 660 - 1 670 (OH)	200 - 231.5
2 655 - 2 700	241 - 275
4 800 - 5 000 (H <sub>2</sub> CO)	

# Frequency bands for 5G Mobile

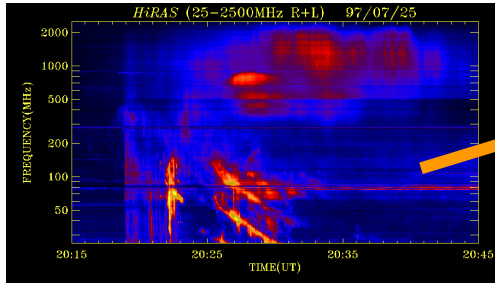


The frequency bands and availability reflects current assumptions and are based on indications from different countries/regions

# Coordination

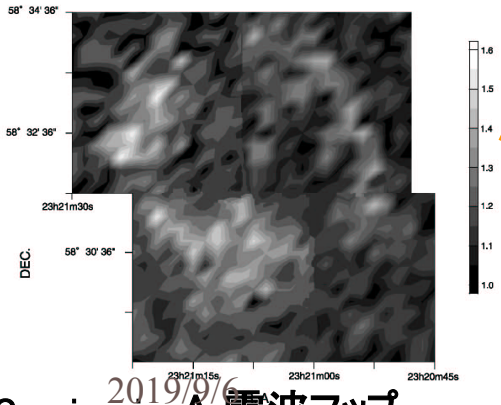
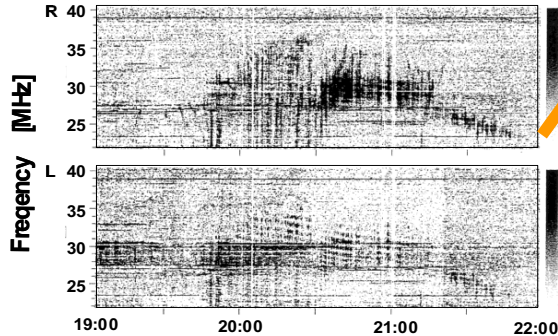
- International
  - Global: International Telecommunication Union @ Geneva
  - Regional: Asia-Pacific region, Europe, Americas, Arab league, African union
- National (Japan)
  - Ministry of Internal affairs and Communication (総務省) → Radio act (電波法)

# Targets and Intensities

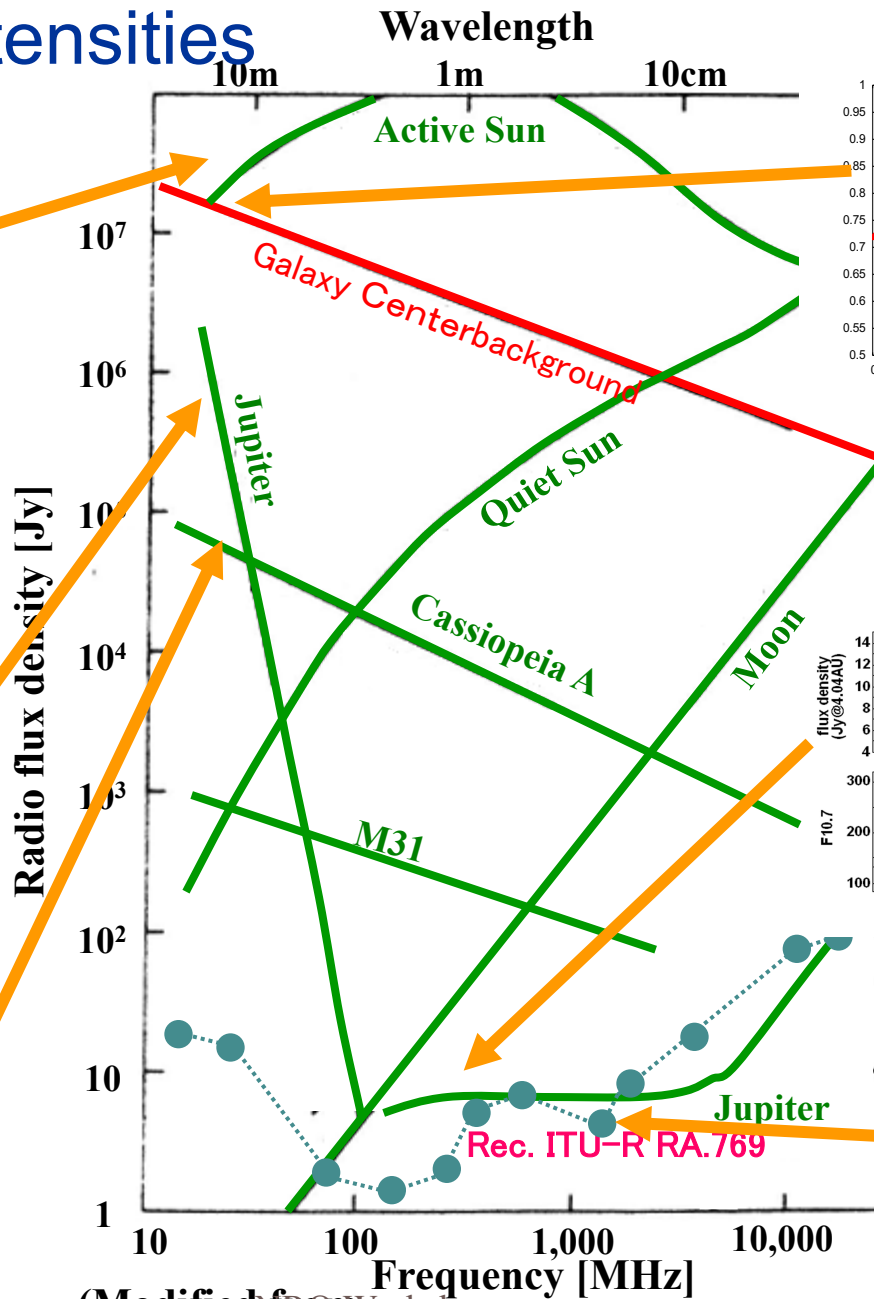


↑太陽電波バーストスペクトル  
(<http://sunbase.nict.go.jp>)

↓木星電波バースト  
(Konno et al. 2002)

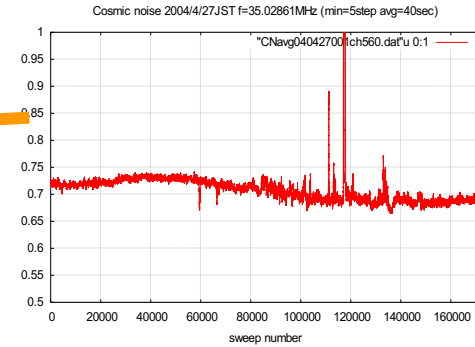


2019/9/6  
Cassiopeia-A 電波マップ  
(Oya & Iizama, 2003)



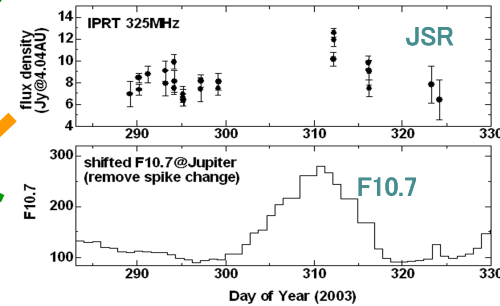
(Modified from Kraus, 1986)

$(1\text{Jy}=10^{-26}\text{W}/\text{m}^2/\text{Hz})$



↑銀河電波雑音レベル  
(Hiyama, 2004)

↓木星シンクロトロン放射



Jovian synchrotron radiation  
(top) and solar f10.7 (bottom)

Threshold for  
RAS obs.



# Spectrum Management for Radio Astronomy

- In April, 2019, NAOJ has established a new division, **Spectrum Management Office (周波数資源保護室)**.
  - A unified gateway to the international/national coordination
  - More radio use in higher frequency ranges
- Before April, 2019, the frequency sub-committee took the role on a voluntary basis.

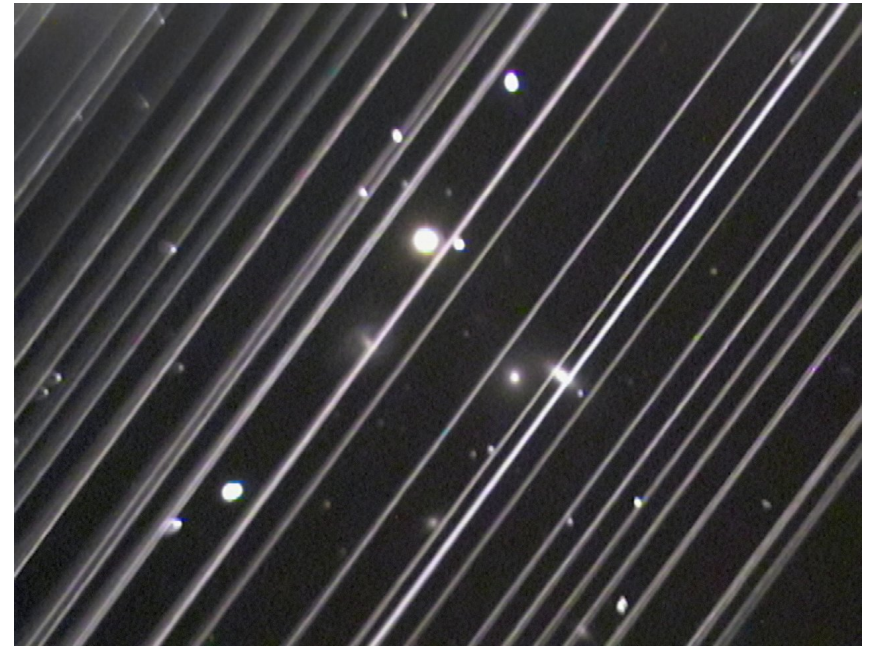
# Example of Recent Coordination



- 60 GHz sensors:  
57-66 GHz, 10mW
- 2<sup>nd</sup> harmonic falls into  
CO J=1-0  
→ requested to  
reduce power of the  
2<sup>nd</sup> harmonic  
→ sensors must be  
shut down within the  
NRO premise

# Starlink

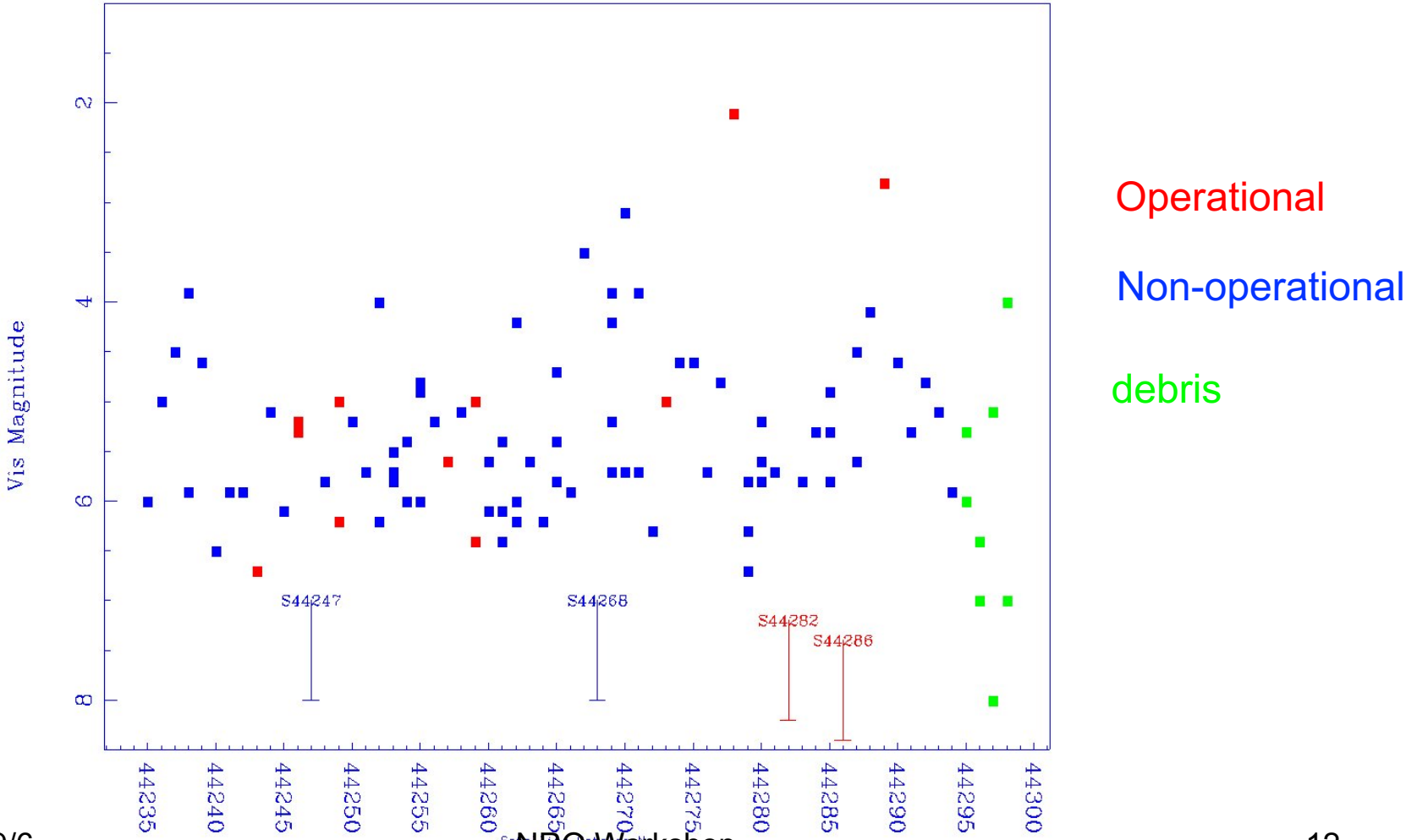
- A project by Space X for providing fast internet service worldwide through 12,000 satellite constellation.
- Concerns not only on radio observations (by satellite downlink) but optical observations.



NGC 5353/4 at Lowell Observatory

# Optical data on Starlink

Starlink Observed Magnitudes



# For more information

- Spectrum Management Info:  
<https://prc.nao.ac.jp/fregras/index.html>
- Position statements on Starlink  
<https://www.iau.org/news/announcements/detail/ann19035/?lang>  
<https://www.nao.ac.jp/news/topics/2019/20190709-satellites.html>