地上観測と探査機観測の国際連携
~Time frame in 2016–2022 ~

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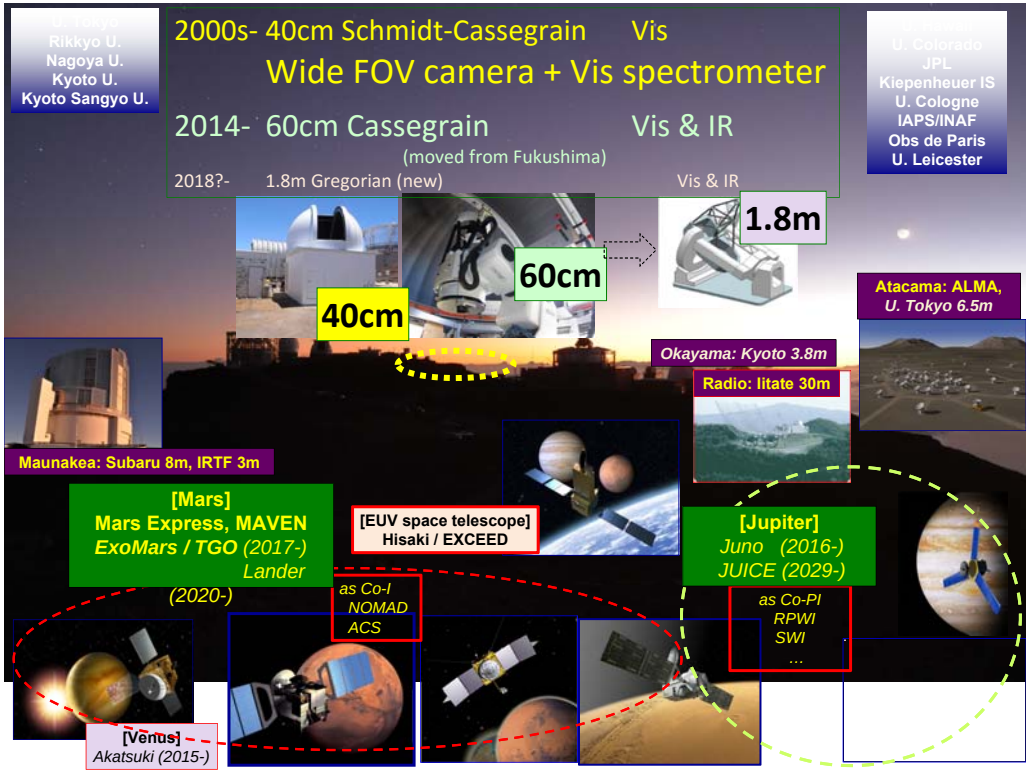
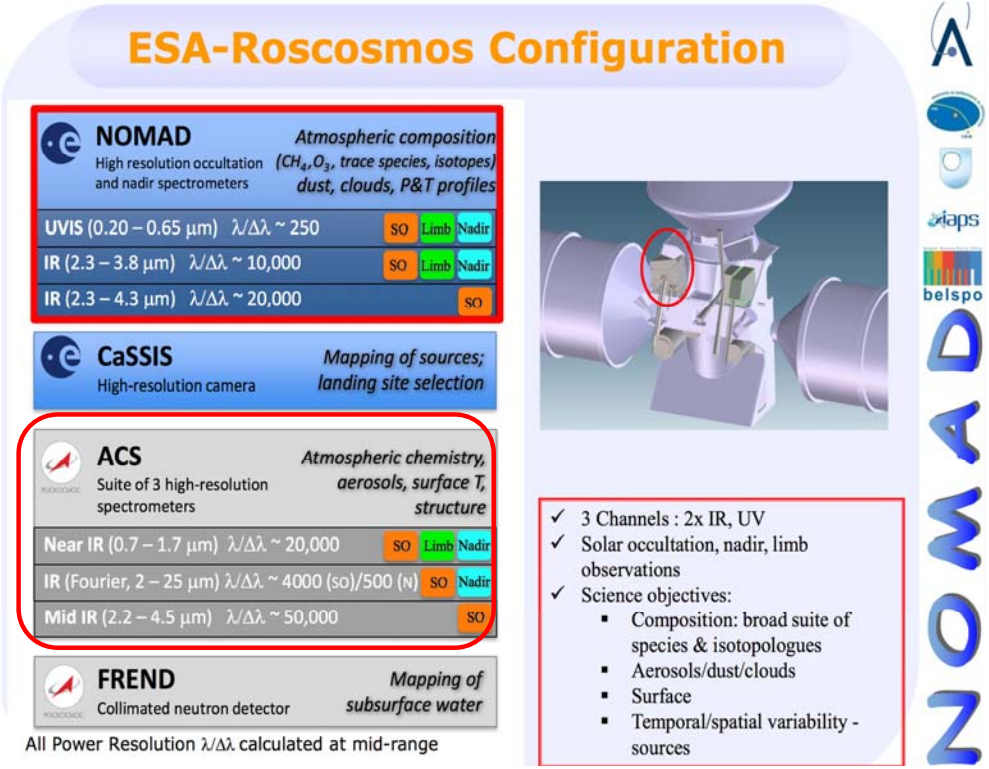
Possible link: 2016–2022

水星	[ESA/JAXA	BepiColombo (obs: 2024–5)]
金星	JAXA	Akatsuki
火星	NASA	MAVEN (upper), …
	ESA	Mars Express
		ExoMars Orbiter & Lander (lower)
	JAXA	[Phobos Sample Return (obs: 2025?–)]
木星	JAXA	Hisaki
	NASA	Juno [Europa (obs: 2030s)]
	ESA	[JUICE (obs: 2029–33)]
土星	NASA	Cassini (obs: –2017)

天王星/海王星/Planet Nine　　Volcanic & Icy moons incl. Plume, Titan, …

Asteroids　several　[DAWN, ESA M5 study (obs: 2030s)]





Our current targets for Mars ~ Observations & Simulations ~

Global dynamics
Dust Cycles

- GCM, Thermal Tides etc.
- Vertical coupling
  Gravity Waves etc.
- Mesosphere:
  wind & temperature

by MEX/PFS with MRO, …
ACS/IRVIM - YES!　with Wide LT-coverage

by VEX Radio-Sci., ISS/AirGlow (Earth), IRTF (Jup.)
NOMAD & ACS in UV & IR – YES!　with Vertical res.

by MAVEN
by MIR heterodyne, mm/submm
(ground based MIR/mm/submm + Models)

Water / CO_2 Cycles
Minor elements

- H_2O & CO_2 clouds
- H_2O/HDO
- $^{12}CO_2/^{13}CO_2$
- H_2O_2 (with CH_4)

by MEX: PFS with OMEGA
NOMAD & ACS: YES!
with higher spectral & vertical resolutions

by SUBARU(, ALMA)
by MEX/PFS
NOMAD & ACS: PERFECT!
complete exploration !!

with modeling studies & the development of Radiation-Transfer code

Related coordinated telescope observations [1] (on going)

(1) SOFIA/EXES observations

✓ **SOFIA** is an **Airborne observatory** (2.5m telescope) flying at altitudes of **12 km**. It allows us to significantly reduce the effect of the terrestrial atmosphere. **EXES** is a high spectral resolution spectrometer (R~90,000) working in the mid-infrared ranges. It enables us to perform sensitive search of CH4 and map of HDO/H2O.

✓ We will have **SOFIA/EXES** observations **for HDO/H2O (PI: *Encrenza*)** and **CH4 (PI: *Aoki*) in late January 2017**. The observing dates are not decided yet, but EXES is currently scheduled for Mars observations in January 2017 with 7 flights between **Jan-19 and Jan-31**.

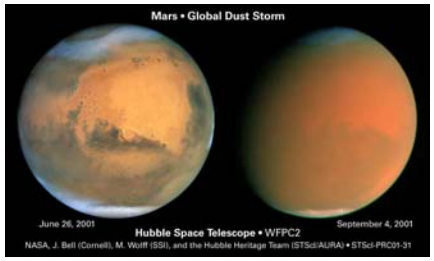
✓ The observing date will be determined by the flight plans, which we will start planning in **November**. The MCO period may be already finished at that period, but If it is possible to arrange a time for a coordinate observation with NOMAD, we can impose that as a constraint on the Mars observations.

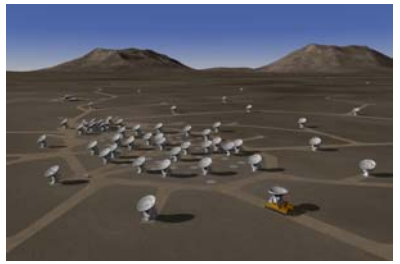
Related coordinated telescope observations [2] (on going)

(2) ALMA observations:

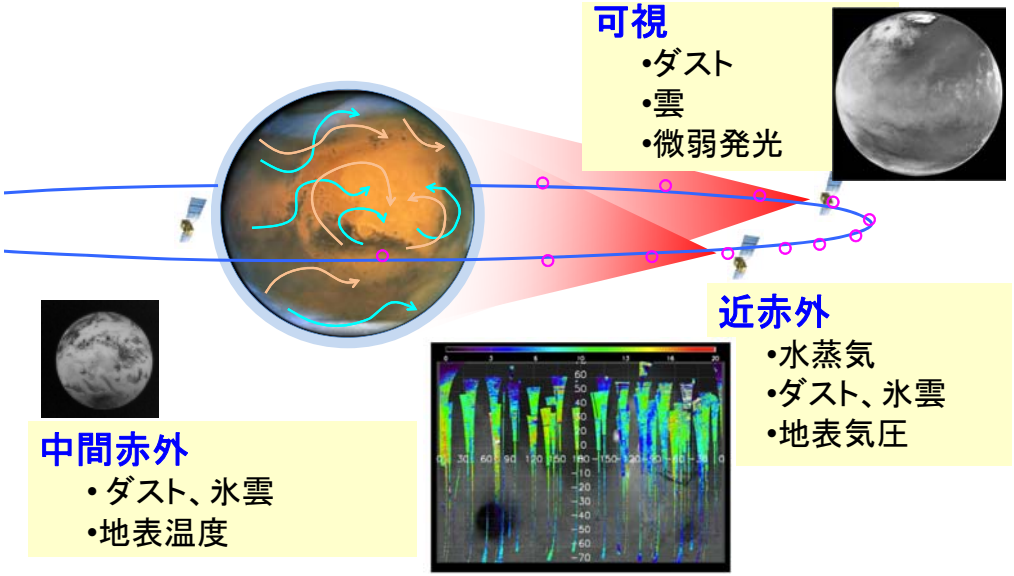
✓We have submitted an observing proposal for **ALMA** telescope (**PI: *Aoki***).The target is to investigate the **temperature**, **doppler wind**, and **CO abundance** when the disk is covered by a **global dust storm**. The proposal was submitted to "Target of Opportunity" category, means that we can perform the observations when a global dust storm is occurred.

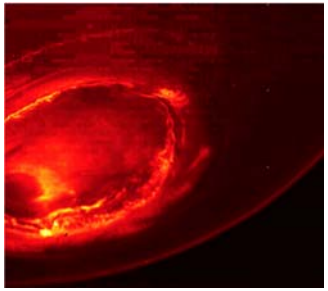
✓ Considering the preliminary announced ALMA antenna configuration, we'll have a chance to observe Mars in a period **between late November 2016** and **end of January 2017**. It will be a unique opportunity to perform joint observation for global dust storms between TGO/NOMAD and ALMA especially because the dust opacity becomes almost transparent at sub-millimeter range.





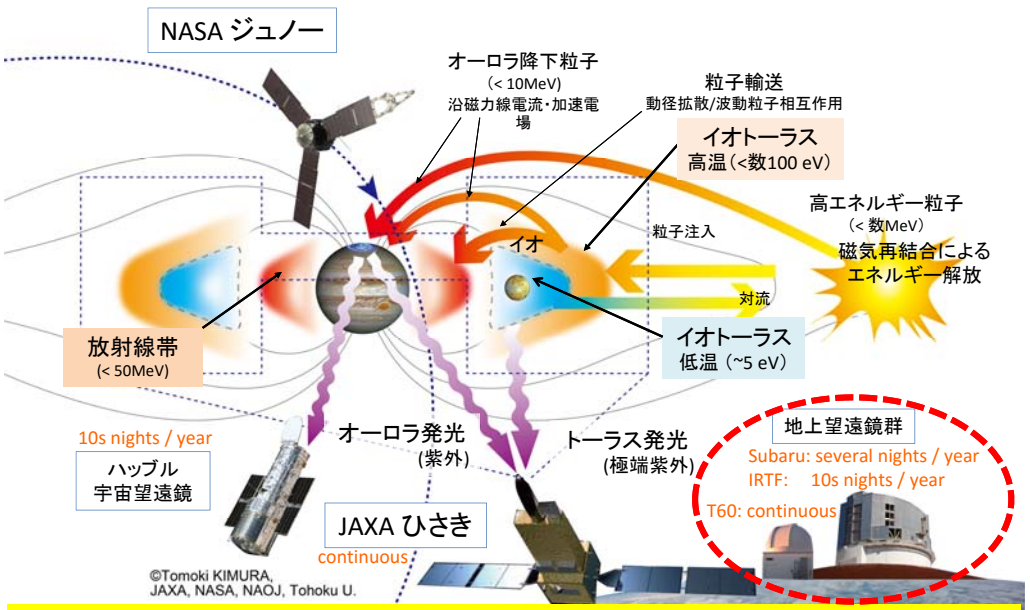
連続性・継続性のある地上観測 and/or Next mission?



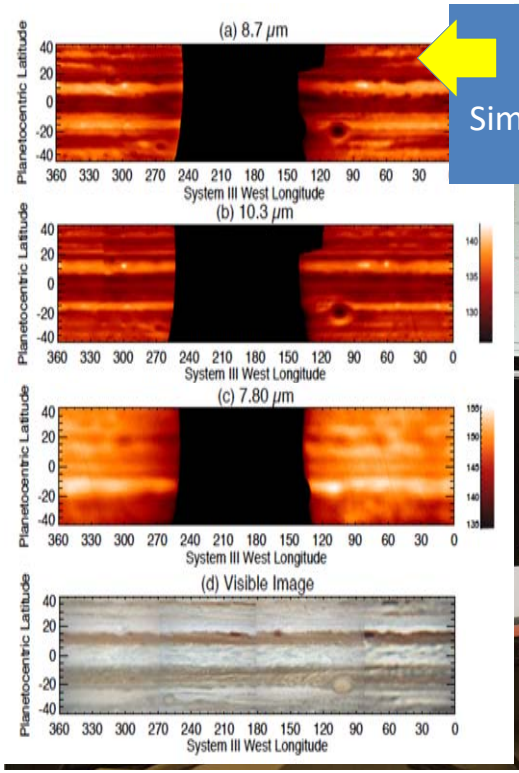


4 July 2016	Entered into Jovian orbit
27 Aug 2016	First perijove (PJ1)
…	
20 Feb 2018	PJ37 → Deorbit (going to Jovian atmosphere)

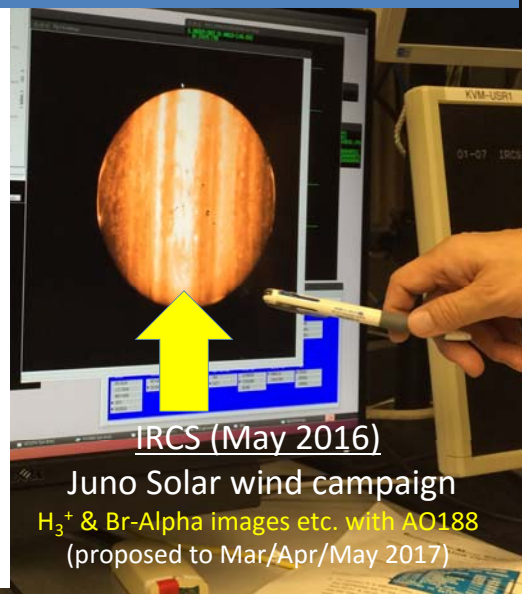
JAXA Hisaki (2013) → Juno (2016-) + HST + X-ray + Ground-based



Juno's limitation — In-situ: continuous, but
Remote: only snapshot at **perijoves**



COMICS (Jan 2016)
Feasibility checks →
Simultaneous with Juno in Jan 2017
(proposed to Feb/Mar/Apr 2017)



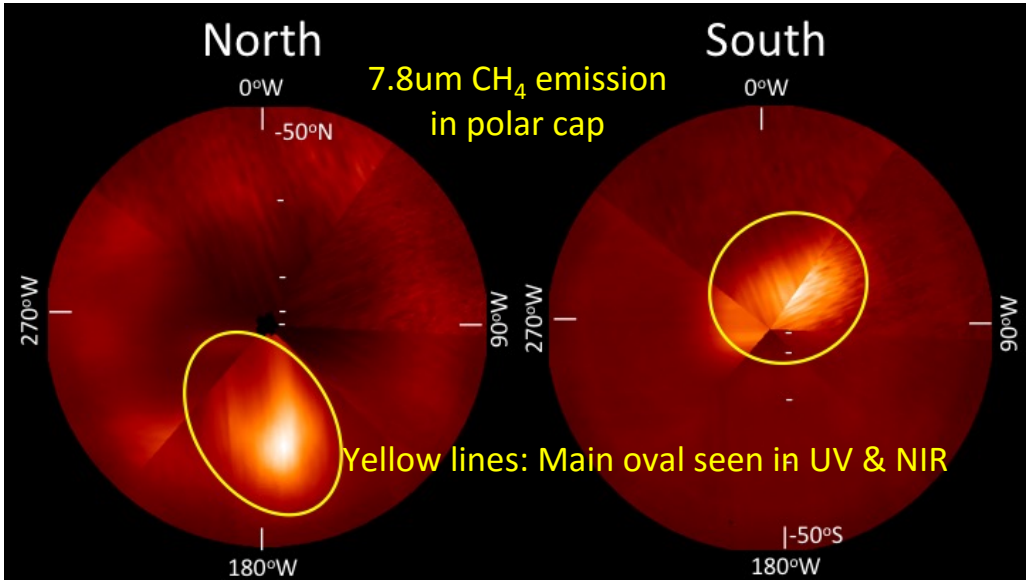
IRCS (May 2016)
Juno Solar wind campaign
H_3^+ & Br-Alpha images etc. with AO188
(proposed to Mar/Apr/May 2017)

MIR (& submm), not observed by Juno (and recent orbiters)

from Planetary Stratosphere: Link between

Upper by UV (H/H_2/...), NIR (H_3^+, H_2, ...), X-ray (heavy ions)

Bottom by Vis (haze / cloud [0.1 - several atm]) – MW (below)



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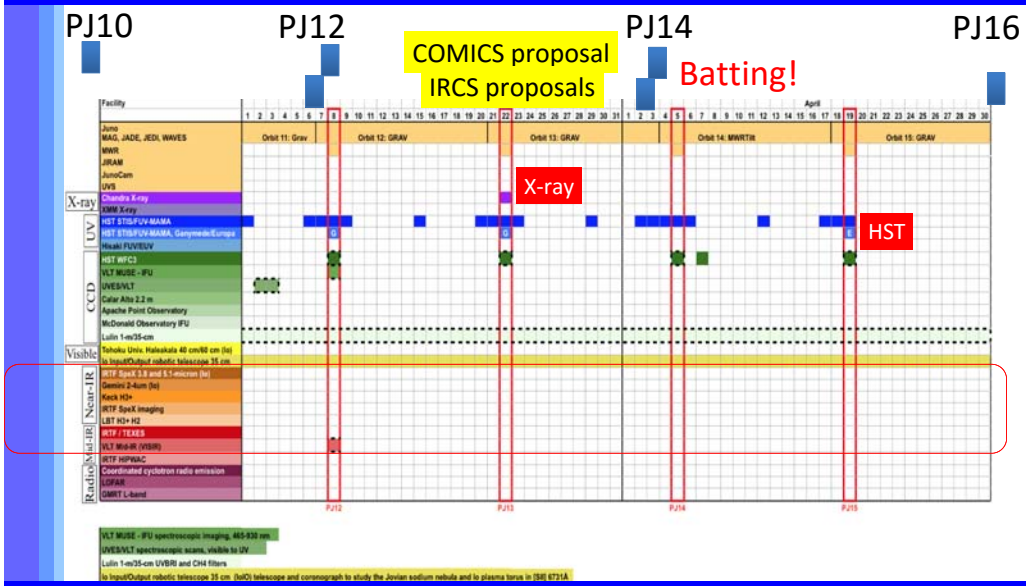
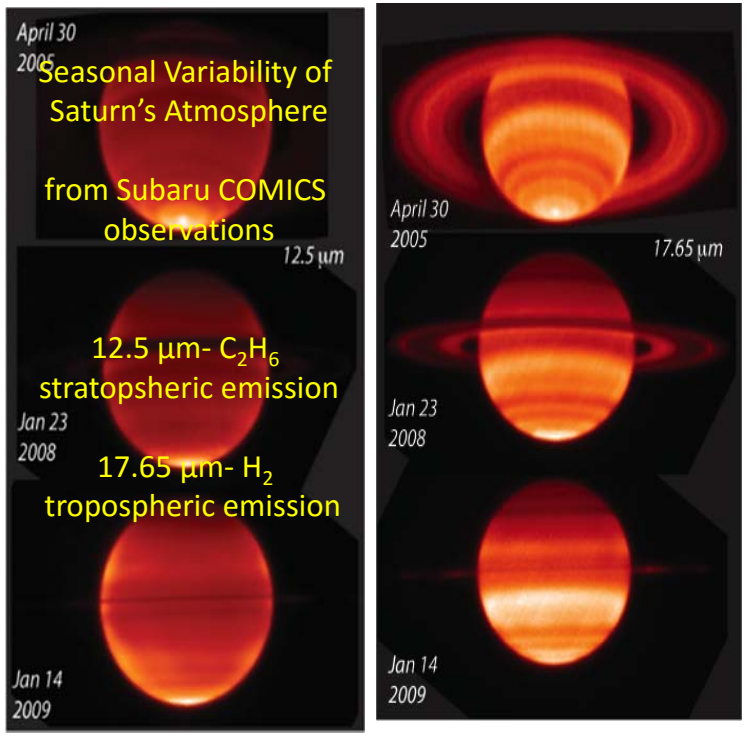
Example of International Support Campaign (e.g. April-May 2017)



Essential problem: Only spot use
Dark Night is almost 'forbidden'.
Going to "Shorter slit"

Long-term Variability

only traced by remote sensing from Earth



Possible link: 2016–2022 + Future extensions

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＊基盤B – 海外学術	（ハワイ）	～2017FY
＊基盤B	（火星–MAVEN連携）	～2017FY
＊基盤A or B	（金星・火星）	申請予定 （2017–2019FY）
＊日–ベルギー協力		申請 （2017–2018FY）