Joint Scientific Space Mission CAS-ESA, 1st workshop

Searching for habitable planets: Bright Star Survey Telescopes (BSST)

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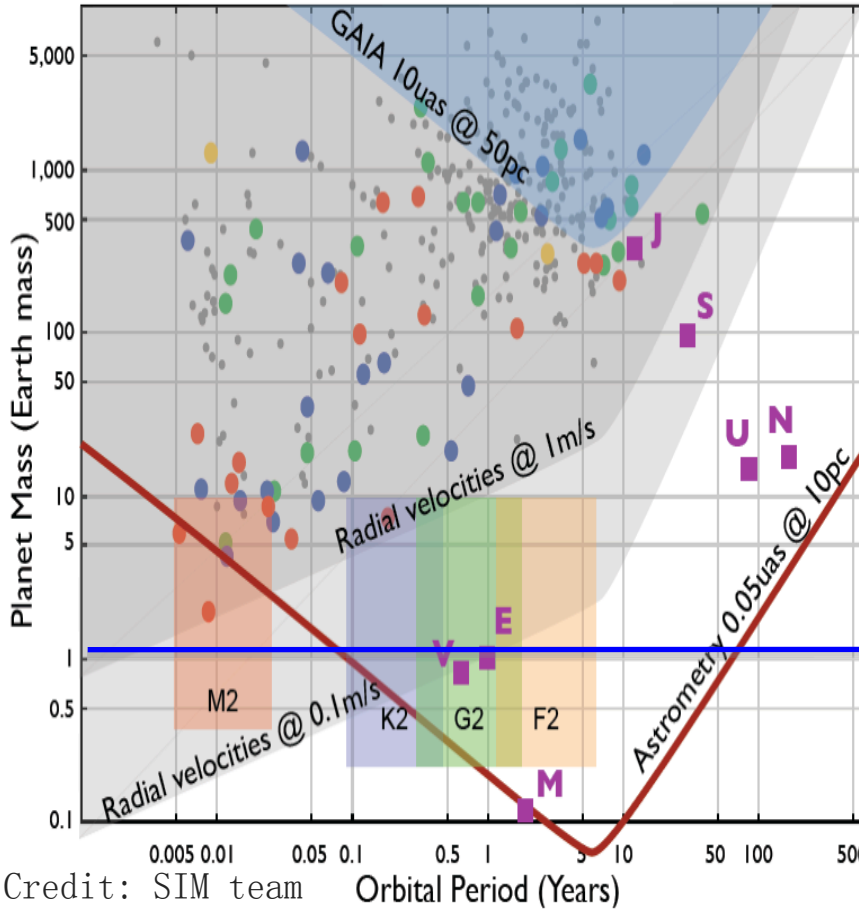
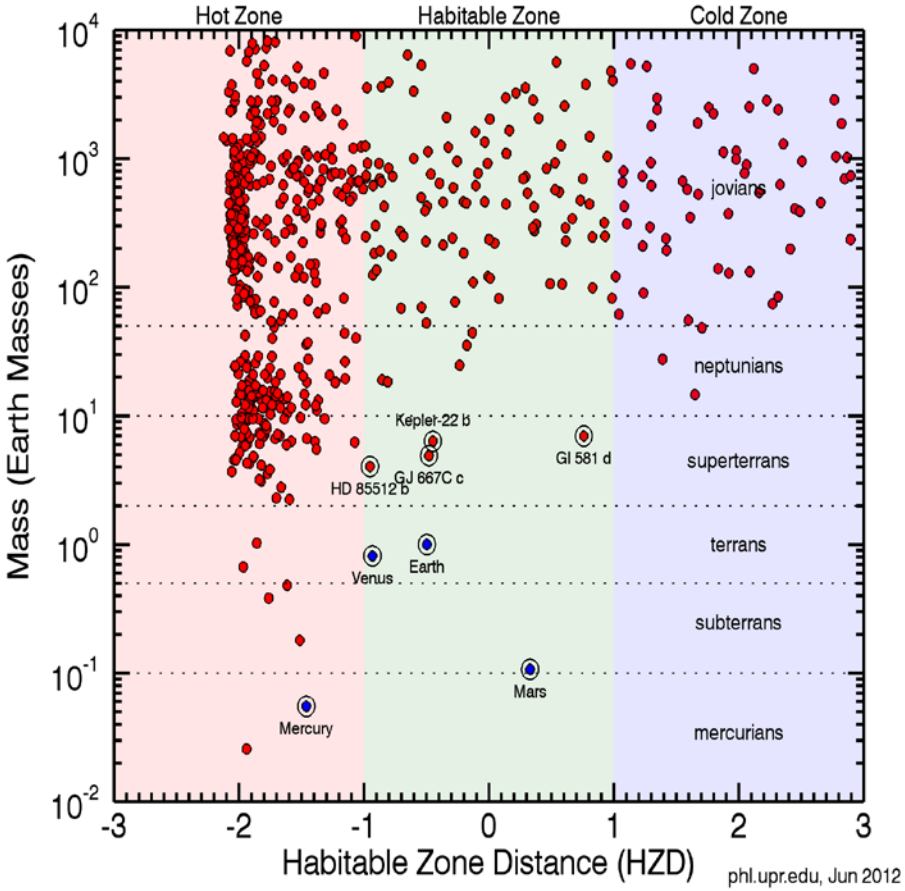
Why habitable planets?

Finding habitable exoplanets is one of the most important goals in Human history.

- With radial velocity method, there are > 800 exoplanets confirmed (exoplanets.org)
- None of them are confirmed to habitable.

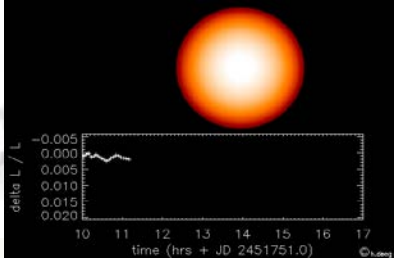


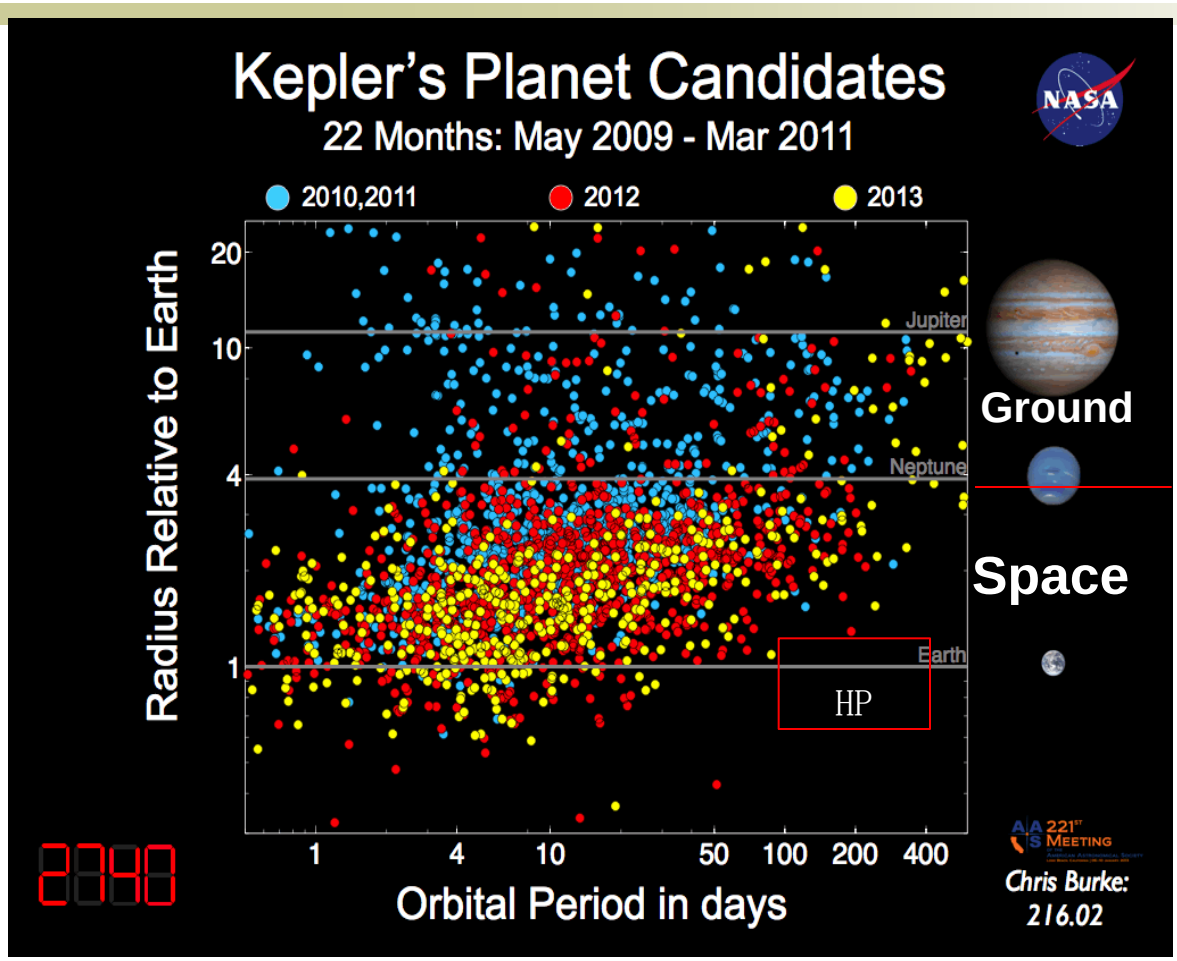
Credit: SIM team



phl.upr.edu, Jun 2012

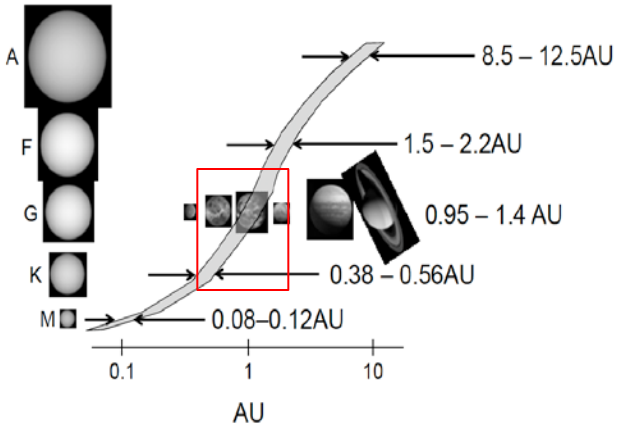
Achievement of Kepler Mission





Credit: NASA Kepler team

- Kepler Mission detected > 3600 candidates;
- Most of them are around dim stars, so only 246 are confirmed.
- It only searched for 105° of sky.



Search for HP with a photometry of 0.01%, it can only achieved by Space Missions.

There are similar projects proposed after Kepler:

Credit: PLATO team

massachusetts institute of technology

MITnews

search

engineering science management architecture + planning humanities, arts, and social sciences campus press video connec

TESS

NASA selects MIT-led TESS project for 2017 mission

$200 million project will launch telescopes to perform full-sky search for transiting exoplanets.

News Office

April 5, 2013

Share

Following a three-year competition, NASA has selected the Transiting Exoplanet Survey Satellite (TESS) project at MIT for a planned launch in 2017. The space agency announced the mission — to be funded by a $200 million grant to the MIT-led team — this afternoon.

TESS team partners include the MIT Kavli Institute for Astrophysics and Space Research (MKI) and MIT Lincoln Laboratory; NASA's Goddard Spaceflight Center; Orbital

Artist's rendering of TESS in orbit

ILLUSTRATION: CHET BEALS/MIT LINCOLN LAB

"The selection of TESS has just accelerated our chances of finding life on another planet within the next decade."

Sara Seager, a professor of planetary science and physics at MIT and TESS project member

today's news

One order of steel; hold the greenhouse gases

Steelmaking, a major emitter of climate-altering gases, could be transformed by a new process developed at MIT.

Dust in the clouds

related

Read the NASA release

Kavli Institute for Astrophysics and Space Research

Lauch 2017, http://web.mit.edu/

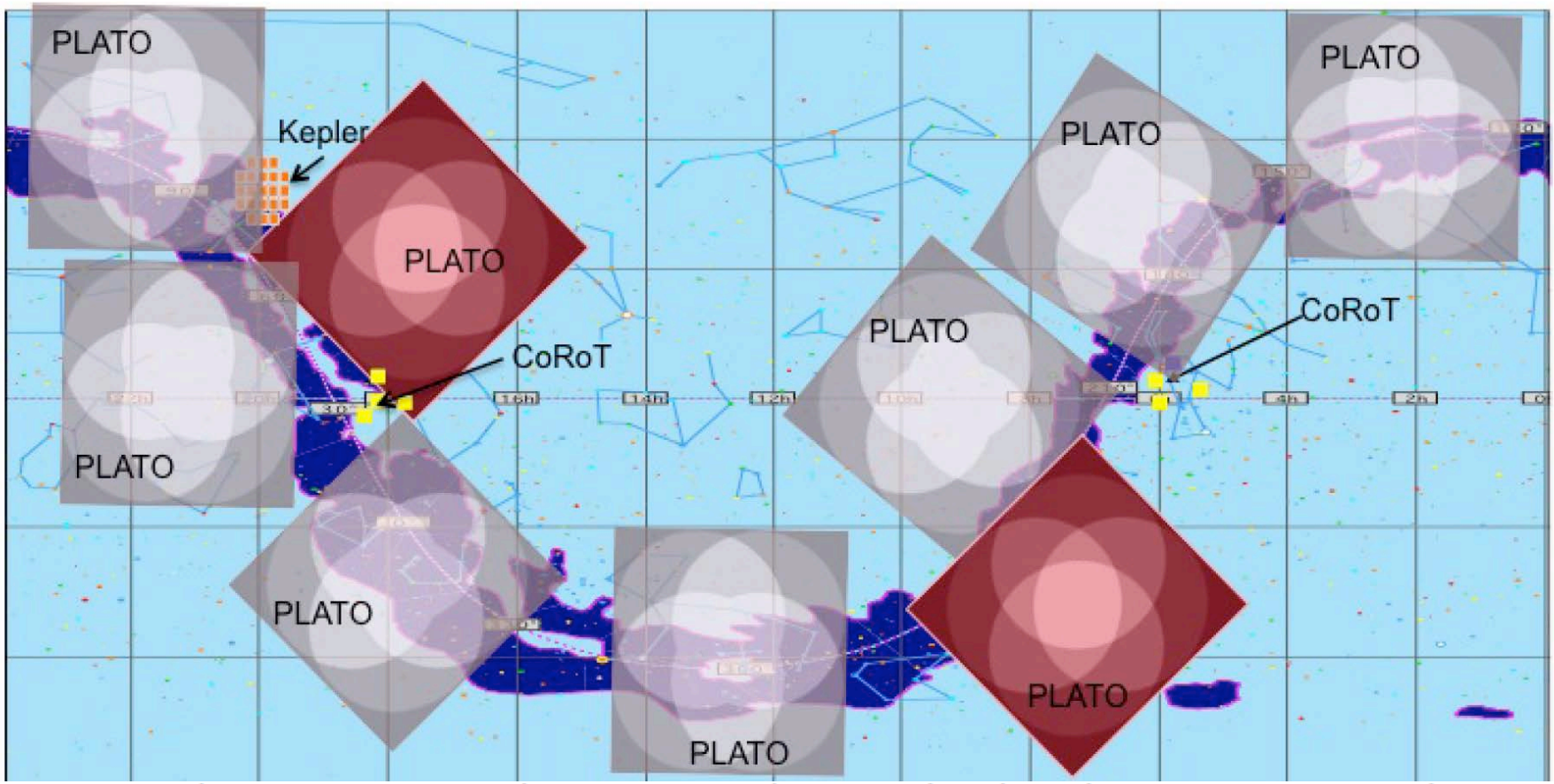
Planed at: 2020-2022年

TESS : a full sky survey, aiming at mostly short period orbits
Location: Earth lunar 2:1 resonance orbits

Orbit: Solar-Earth L2

2250°X2=4500°

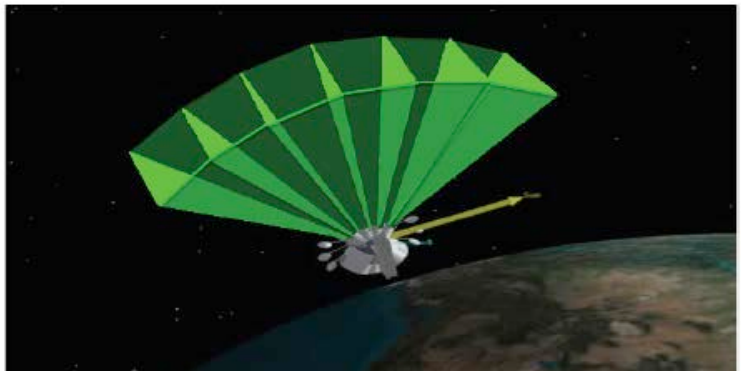
Credit: PLATO team

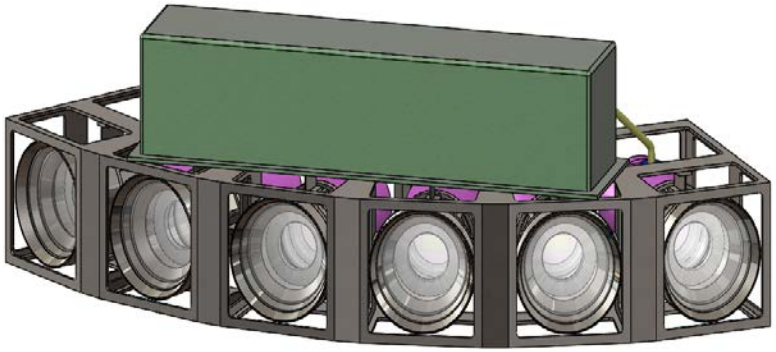


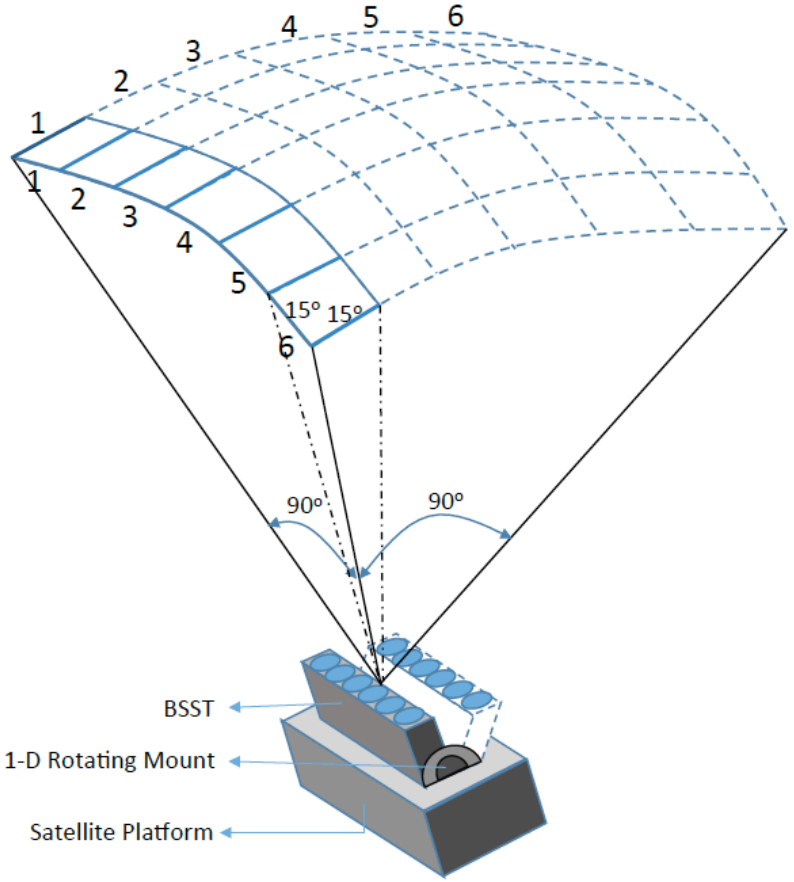
In its nominal science operation phase, PLATO 2.0's current baseline observing strategy combines:

- Long-duration Observation Phases, consisting of continuous observations for two sky pointings, lasting a minimum of 2 years with a maximum of 3 years for the first pointing, and 2 years coverage for the second pointing.
- Step-and-Stare Operation Phases, consisting of shorter-period observations of several sky fields which will last 1-2 years total, depending on the duration of the long duration phases. Sky fields in this phase will be observed for at least 2 months, up to a maximum of 5 months.

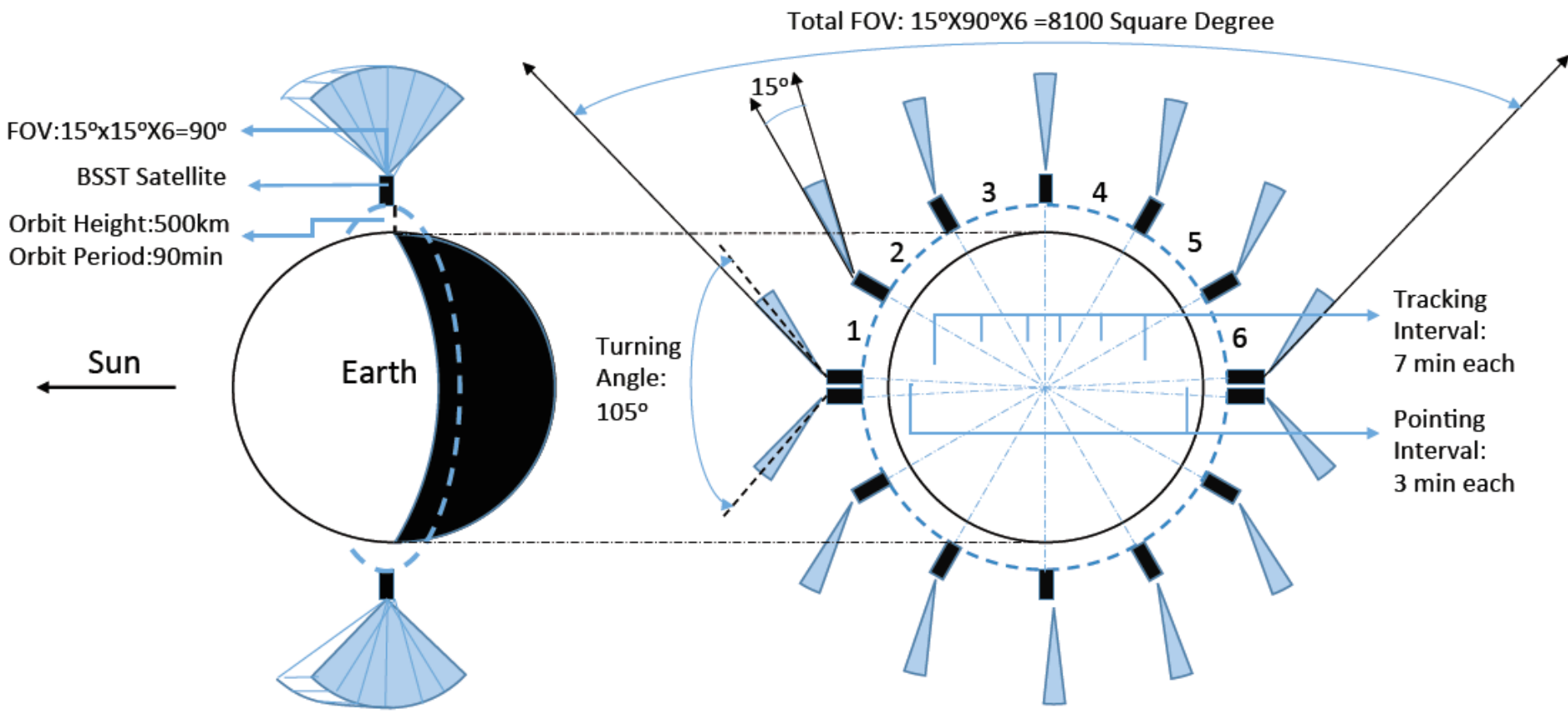
BSST(Bright Stars Survey Telescopes)







- Main Payload : 10cmx10 Telescopes ,FOV 15°x15°X4=1350°
- Orbit: NEO >200km


Total FOV: 15°X90°X6 =8100 Square Degree
FOV:15°x15°X6=90°
BSST Satellite
Orbit Height:500km
Orbit Period:90min
Sun
Earth
15°
Turning
Angle:
105°
1
2
3
4
5
6
Tracking
Interval:
7 min each
Pointing
Interval:
3 min each

Sky Coverage: 1350^{o}x6x2=16200^{o}

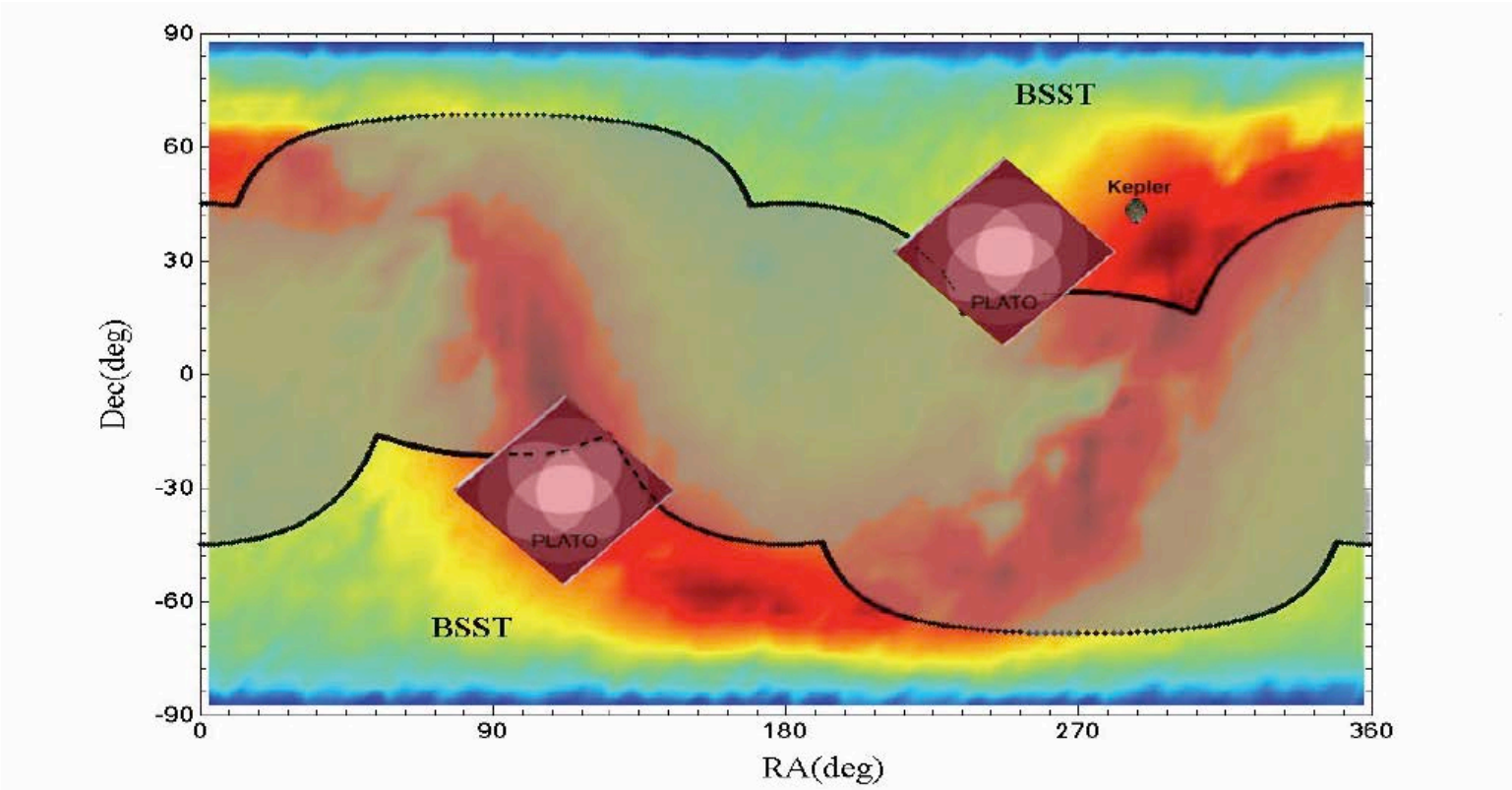


Figure 2: The observed regions (~16,200 square degrees, top and bottom bright area) of BSST as compared with the 3-year observation area of PLATO 2.0 (two pink squares) and Kepler.

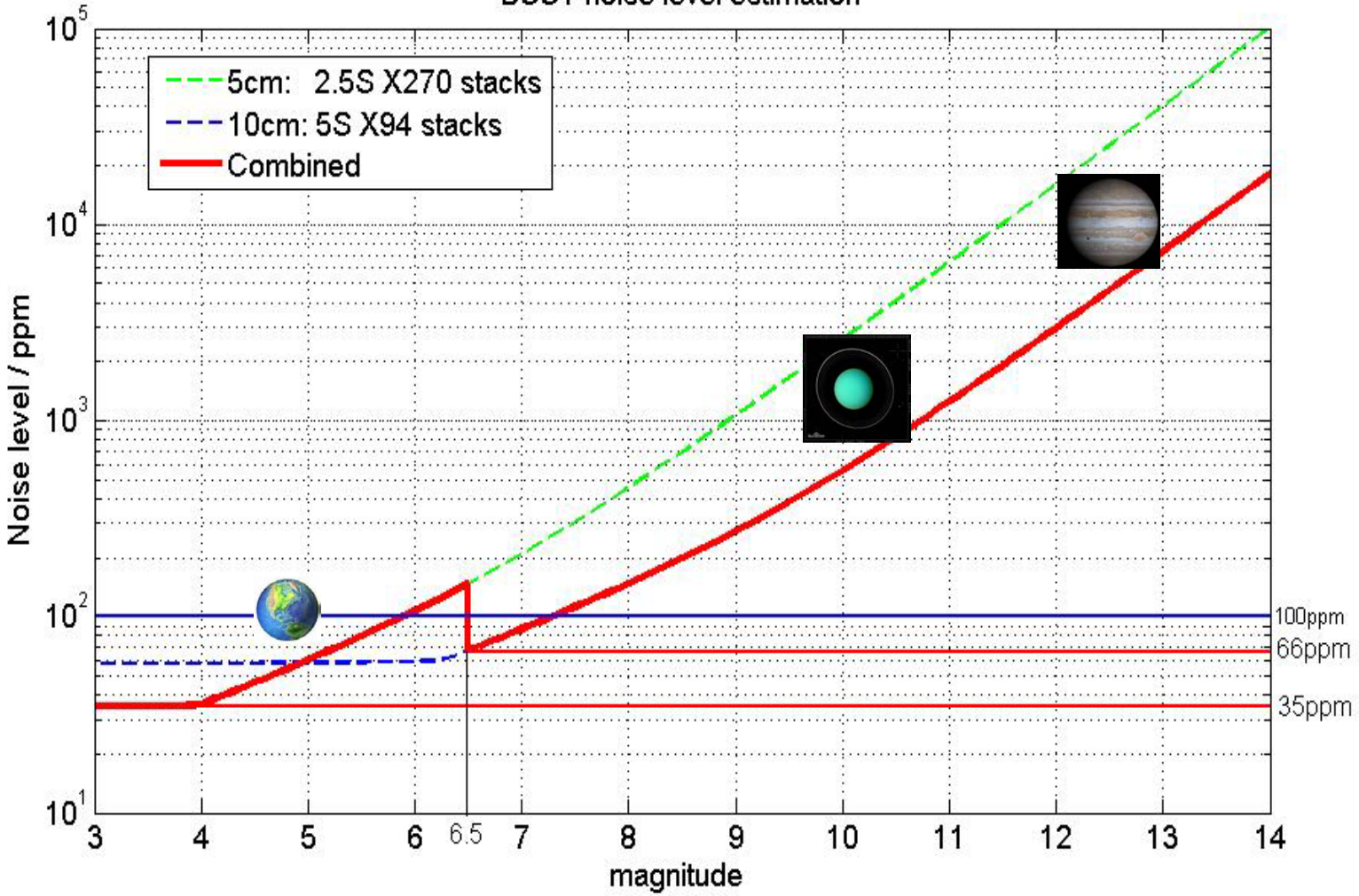

BSST noise level estimation
5cm: 2.5S X270 stacks
10cm: 5S X94 stacks
Combined
Noise level / ppm
magnitude
100ppm
66ppm
35ppm
6.5

Table 1: Predicted No. of planet candidates detected by BSST.

Vmag	Nstar	Nstar (G,K,M)	Precision	Predicted No. of planet candidates by BSST			
				<1.25Re	1.25-2Re	2-6Re	>6Re
6.5-8.0	14,000	7,600	0.01%	48	115	180	39
8.0-10.0	108,000	56,000	0.05%	0	880	1440	312
10.0-12.0	680,000	>28,000	0.5%	0	0	8800	1,900
Totally	800,000	90,000	-	48	995	10,420	2,251

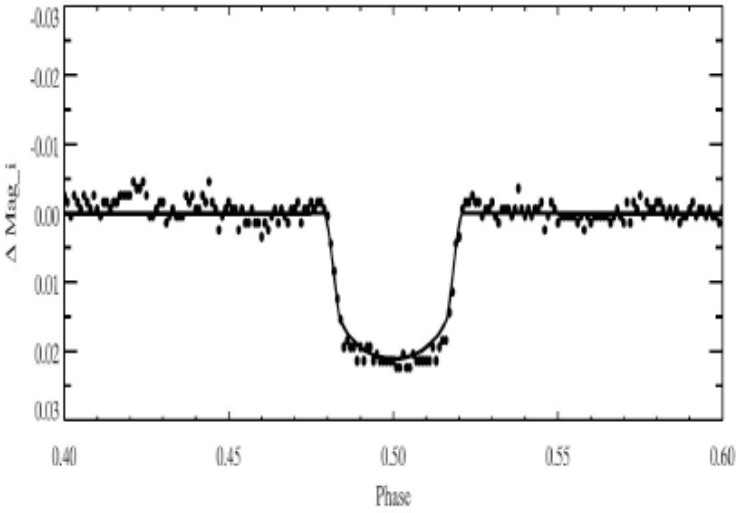
A comparison of TESS,PLATO,BSST

	TESS (Long)	TESS (Short)	PLATO (Long)	PLATO (Short)	BSST (Long)	BSST (短模式)
Sky coverage	3280^0	38,000^o	4500^o	15750^o	16200^o	
Orbit period	<2/3 year	month	1year	1 month	1year	
0.01% Precision	4.0-7.5 Mag	4.0-7.5 Mag	4.0-11.0 Mag	4.0-11.0 Mag	6.5-8.0Mag	
0.1% Precision	7.5-12 Mag	7.5-12 Mag	11.0-16.0 Mag	11.0-16.0 mag	8.0-12Mag	
Expected Terrestrial Planets	20(may be <2/3yr)		Total 60		48（mostly HP） (10 times less expensive)	
Launch time/Life time	2017 (USA)	4years	2020-2022(ESA)	6-8years	2020? (China+ESA?)	3 years

Scientific aim of BSST

- 1. Searching for exoplanet candidates: to searching for >10,000 candidates, ~48 Terrestrial plants, mostly in Habitable zone, and understanding planets system with precise stellar parameters;
- 2. Stellar seismology: >800,000 star's 3 year continues high-precision light curves; Variable stars;
- 3. Transient sources: Gammy Ray busts, supernova, …

Heritage from previous studies

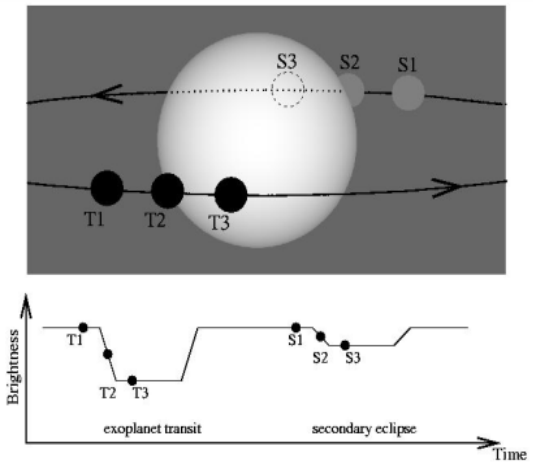


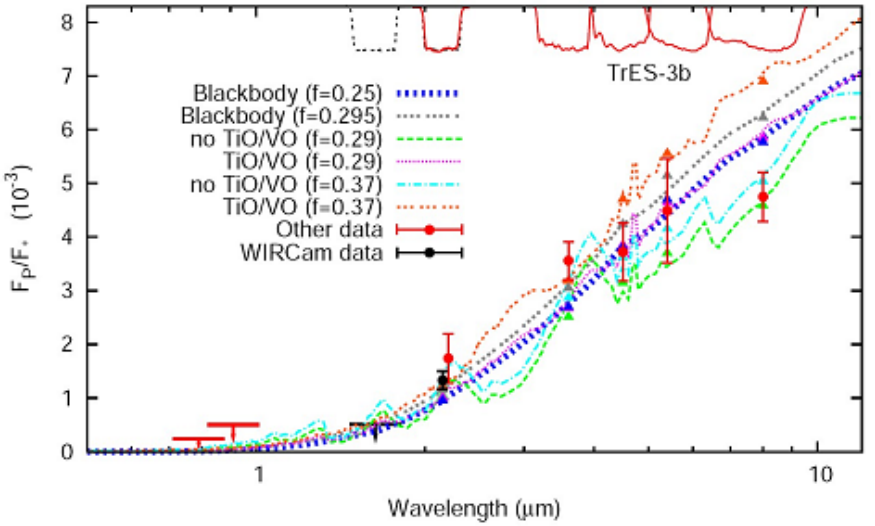
Wang et al. 2014

- NIATO has constructed 10cmx4 CSTAR, put in Dome A, Antarctic, and it worked > 4 years----Ground techniques are OK.
- With CSTAR 2008’s data, NJU obtained 10 planet candidates (Wang et al. ApJS, accepted) ---Software is ready.

Possible collaborators:

- Techniques: for space telescopes,
- Budget: RMB ~10M is enough for Payload.
- Possible collaborators in Europe: PLATO 2.0 group & Dome C exoplanet team
- Near Infrared Camera: Hot Jupiter's 2nd transit: Temperature => composition---- Unique Mission!





Emission spectroscopy (day side, secondary transit)

谢谢!

Thank you !

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