The Status of Transneptunian Automated Occultation Survey

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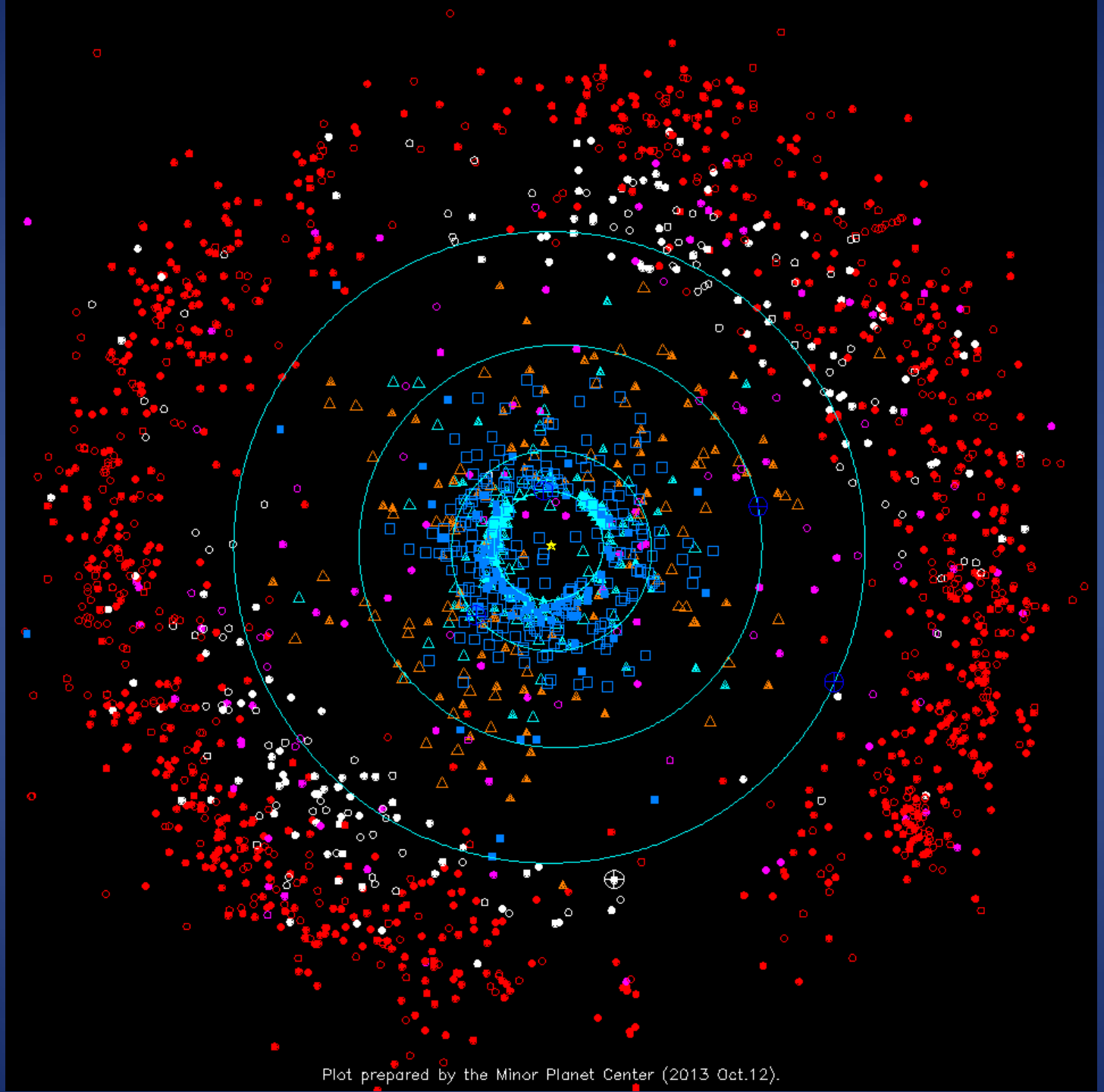
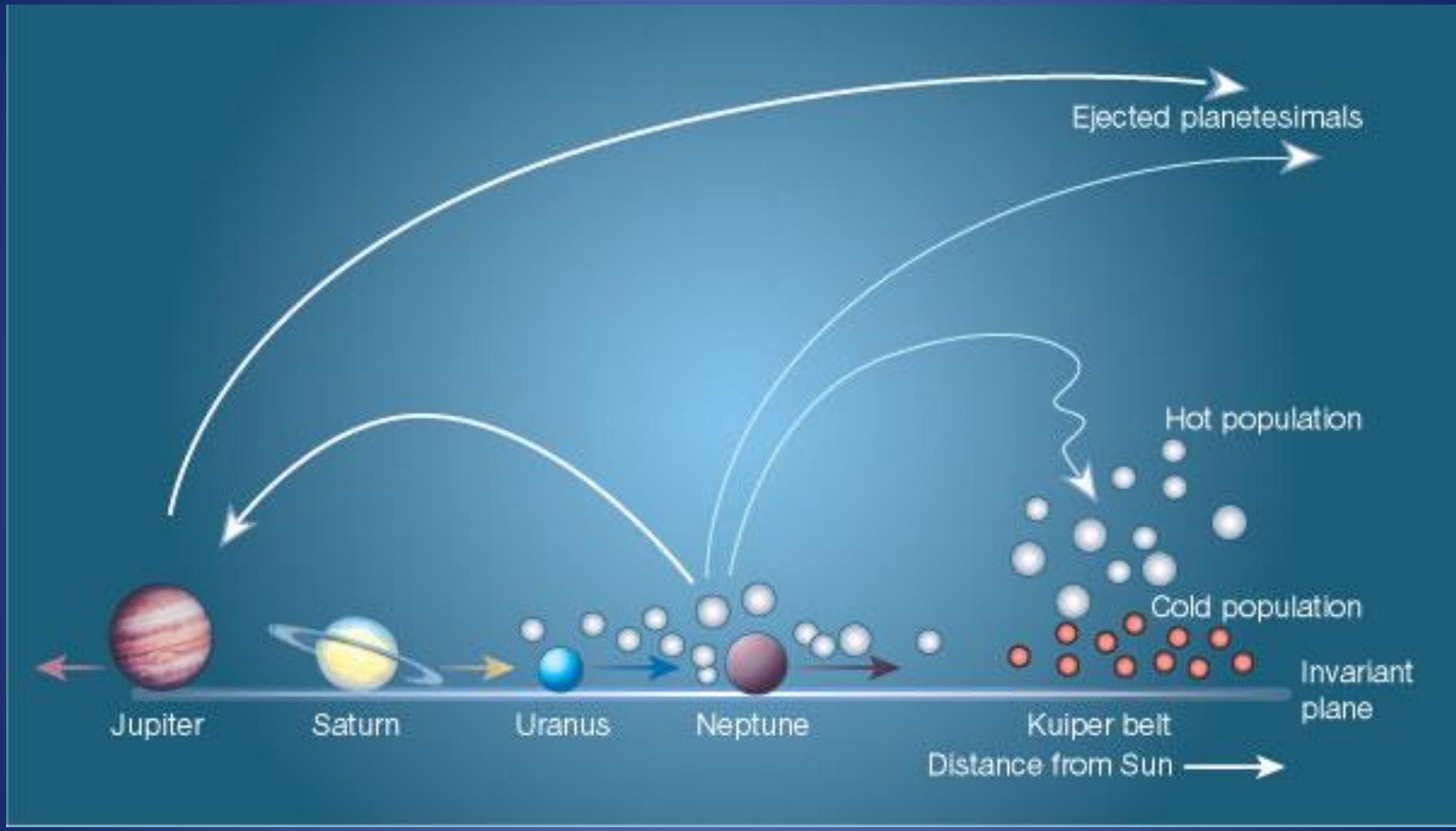
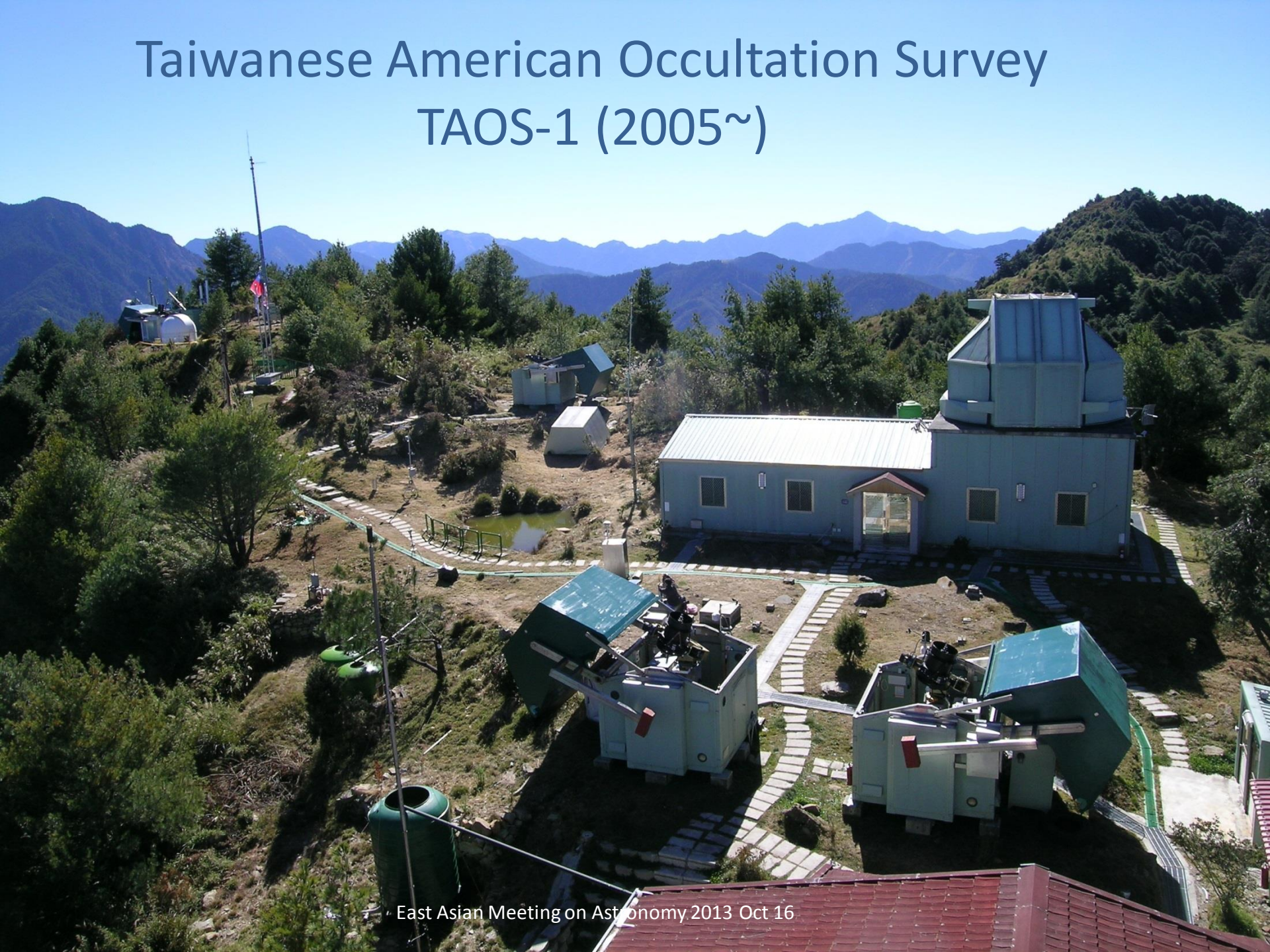
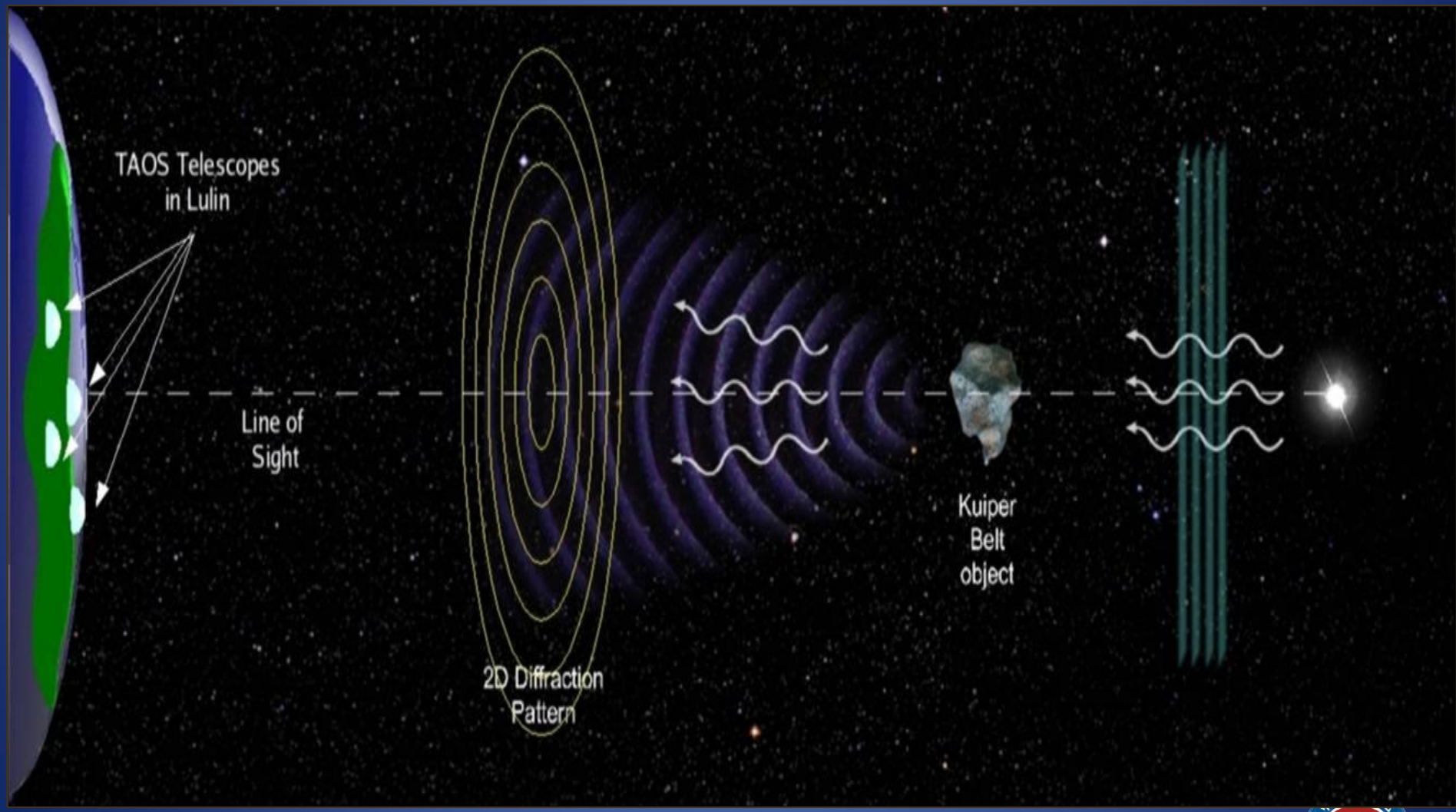

Plot prepared by the Minor Planet Center (2013 Oct.12).

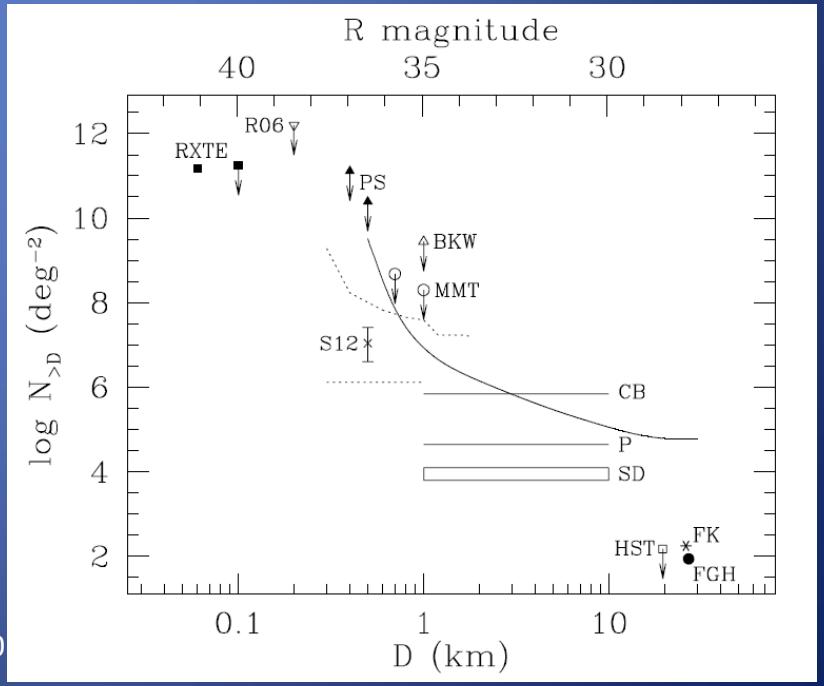

Ejected planetesimals
Hot population
Cold population
Invariant plane
Jupiter
Saturn
Uranus
Neptune
Kuiper belt
Distance from Sun

Taiwanese American Occultation Survey
TAOS-1 (2005~)




TAOS Telescopes
in Lulin
Line of
Sight
2D Diffraction
Pattern
Kuiper
Belt
object

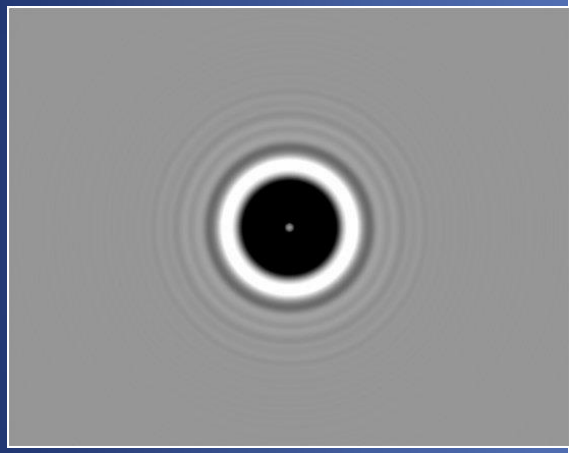
- 4 50 cm robotic telescopes
- ~1000 stars monitored @ 5Hz simultaneously
- More than 1 million star hour data collected
- No occultation event detected

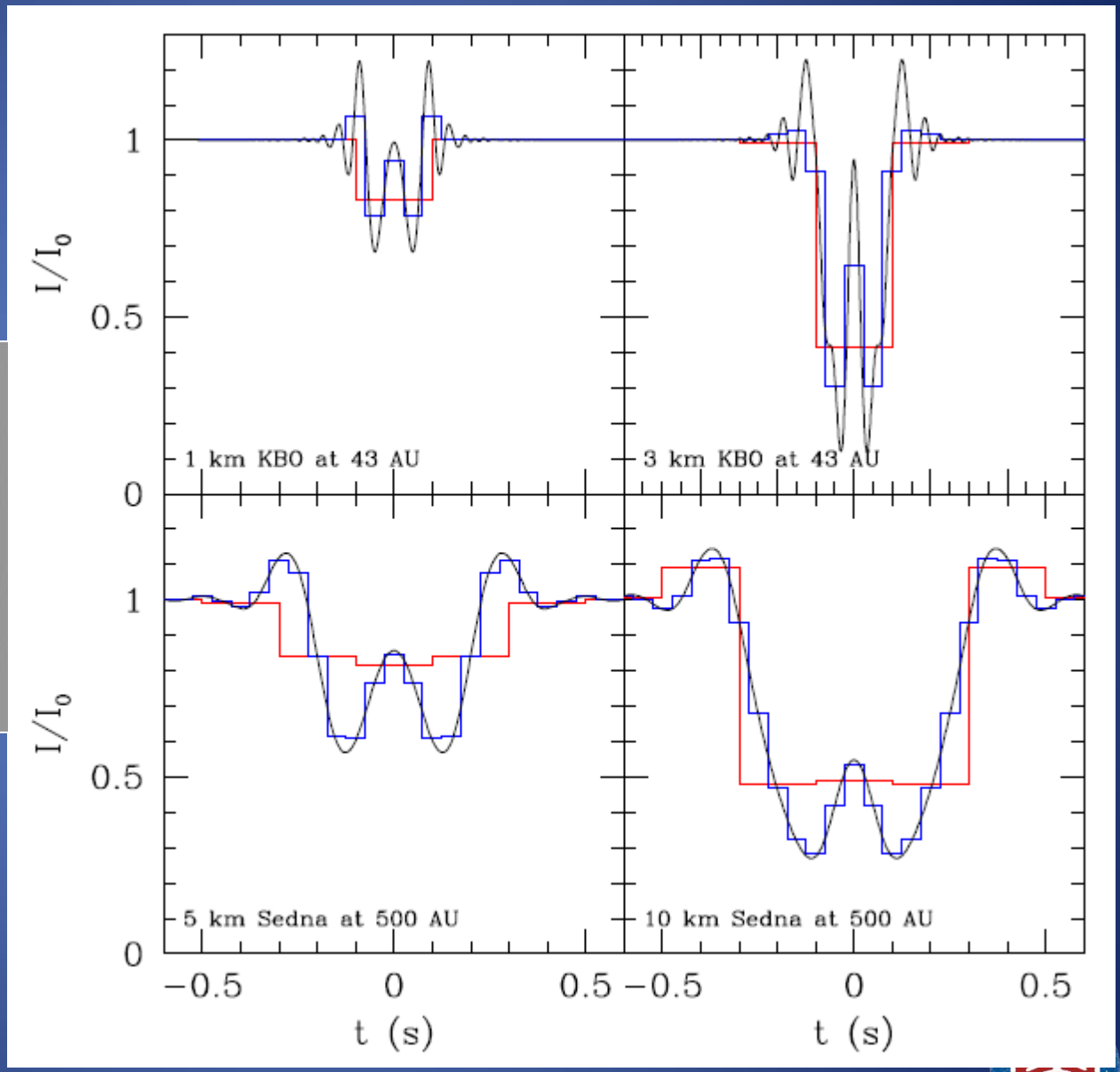


Trans-neptunian Automatic Occultation Survey
TAOS-2

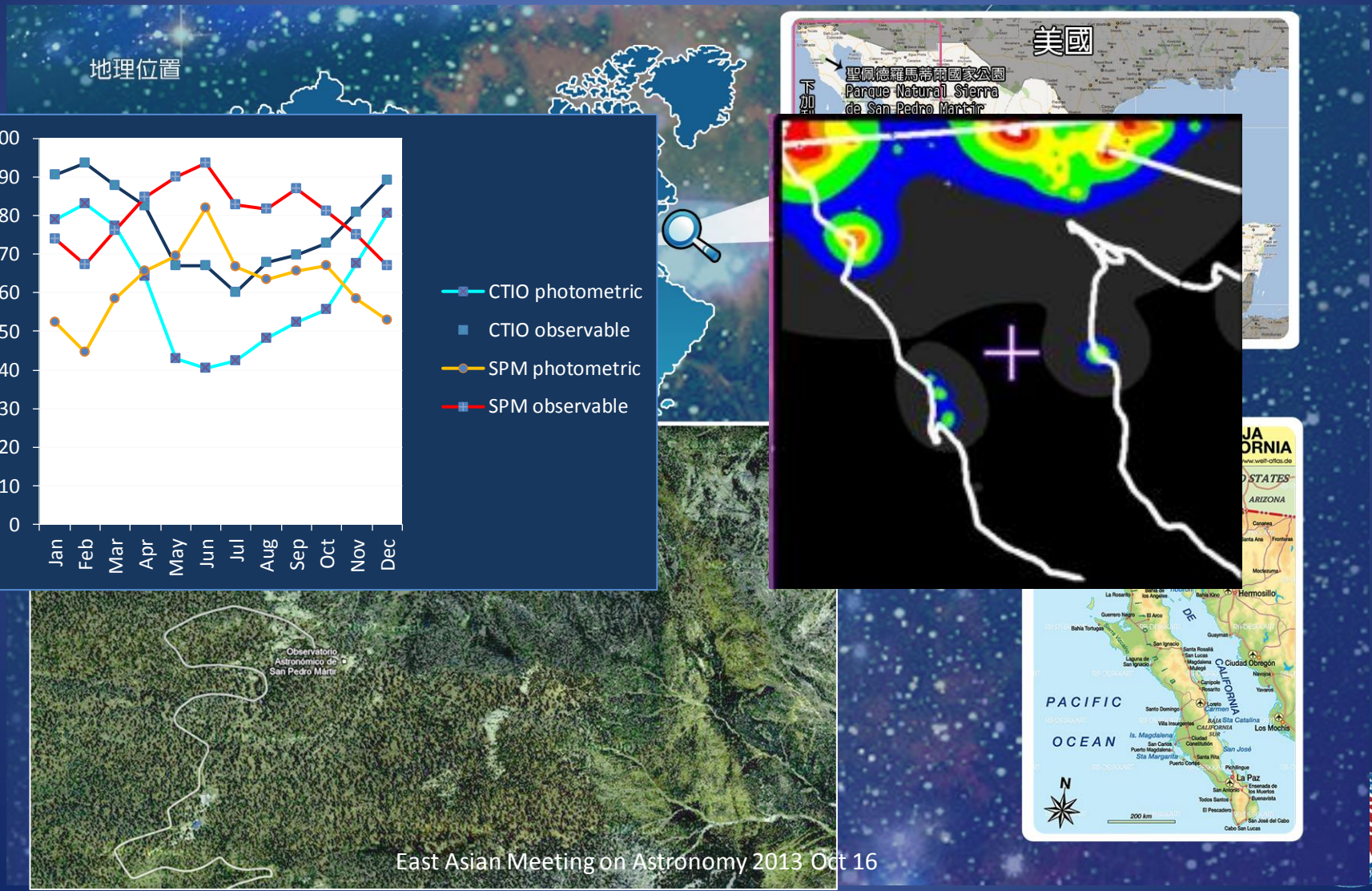
- 3 x 1.3m telescopes
- Monolithic CMOS sensor
- Monitoring ~ 10000 stars at 20Hz

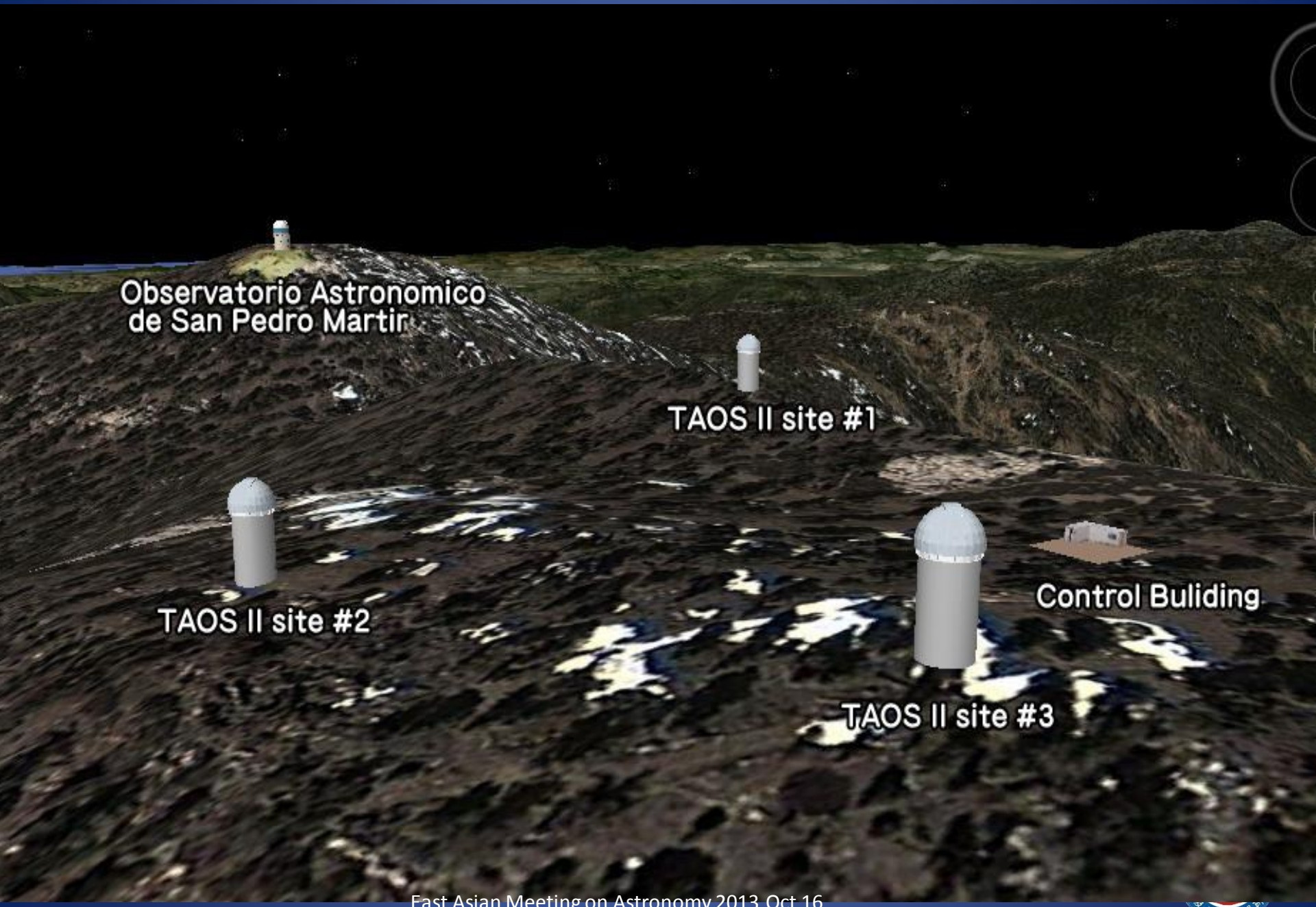
Design	TAOS 1	TAOS 2	F_R
Observable nights	50nts/yr	250nts/yr	5
Aperture	0.5m	1.3m	6.2
Background	16e-	2e-	7.28
Exposure time	105ms	50ms	0.47
Detection limits	0.7 km	0.4 km	2
Field of view	1.7°x1.7°	1.7° ϕ	0.785
Total			>100




1 km KBO at 43 AU
3 km KBO at 43 AU
5 km Sedna at 500 AU
10 km Sedna at 500 AU
I/I0
t (s)
0
0.5
1
−0.5

San Pedro Martir Observatory




Observatorio Astronomico
de San Pedro Martir
TAOS II site #1
TAOS II site #2
Control Buliding
TAOS II site #3

East Asian Meeting on Astronomy 2013 Oct 16

TAOS 2 telescope

- 1.3 m f/4 system
- 39.8 arc sec/mm
- The fully shielded and unvignetted field of view (FOV) will be 154-mm in diameter (1.7-degrees).
- The energy concentration will be 80% of incident light to fall within 1.0 arc second diameter.

Telescopes in the Factory

- Telescope acceptance this week and will be delivered in Nov.

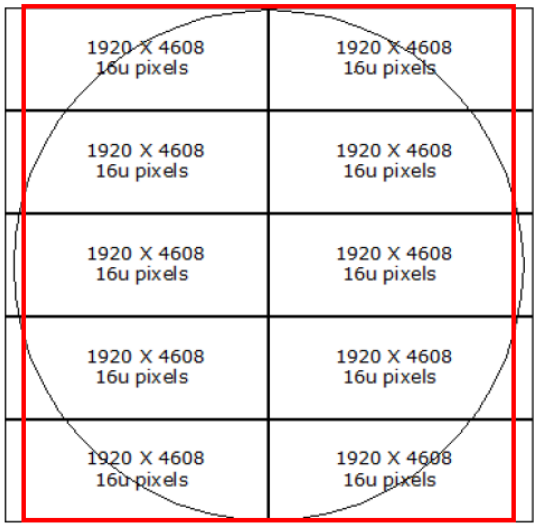
Camera for TAOS 2

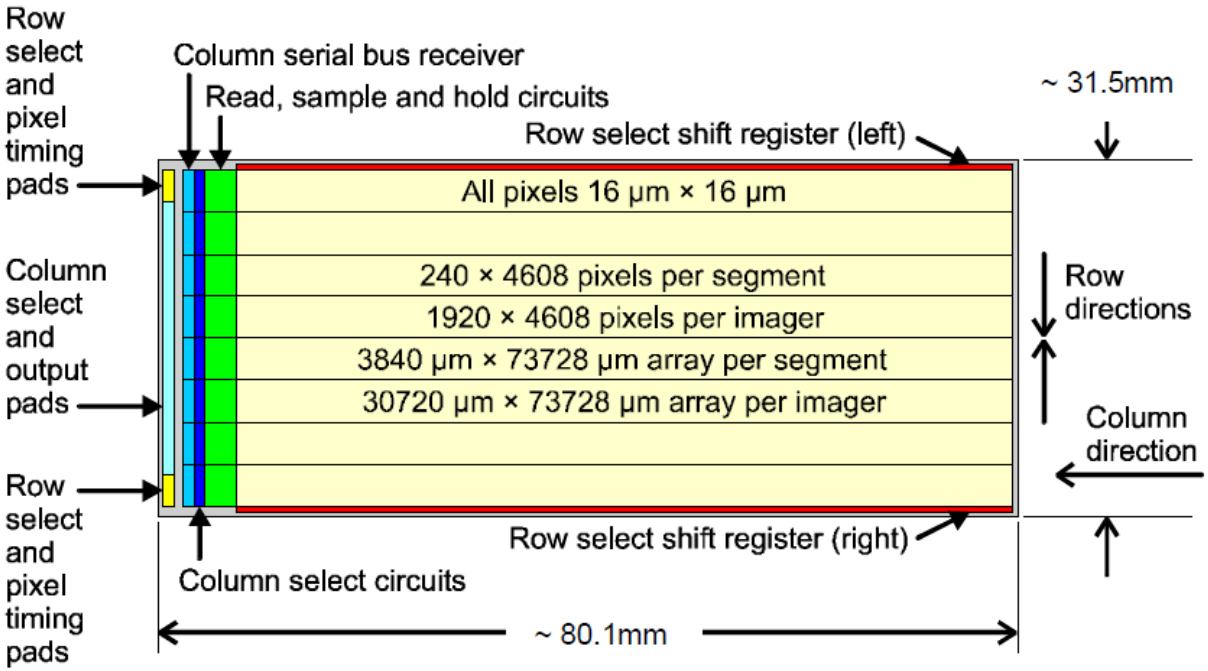
- Basic requirements:
  - 20Hz sampling
  - 10~16 micron pixels (0.4”~0.64”)
  - Cover 1.7 degree field, 2.27 square degrees
  - Readout noise limited, read noise should be as low as possible
  - Dark level < 0.1 e-/frame
- Preferable feature
  - Different sampling rate for different stars
  - Possibility to read the whole frame very few minutes

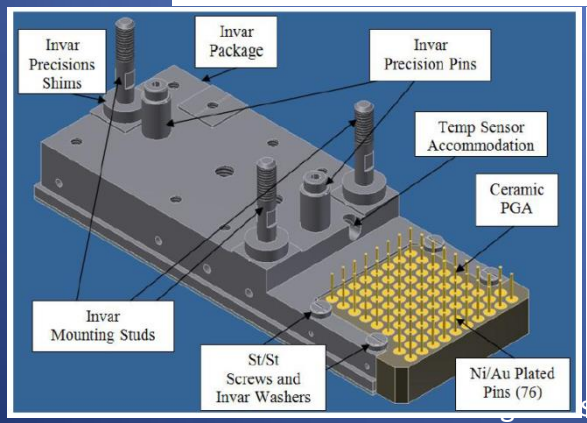
E2v CMOS sensor

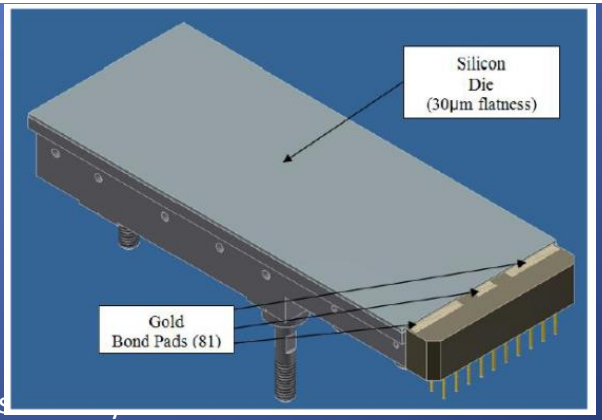
- Format : 4.5K x 2K
- Pixel size : 16 microns
- QE : > 80% from 450~700nm
- Read noise : ~5e-
- Full well : > 15000e-
- Window switching time : ~0.1ms
- Total pixel rate : 160Mpixel/s
- Dark rate : < 1e-/s
- Destructive read mode only

Sensor layout

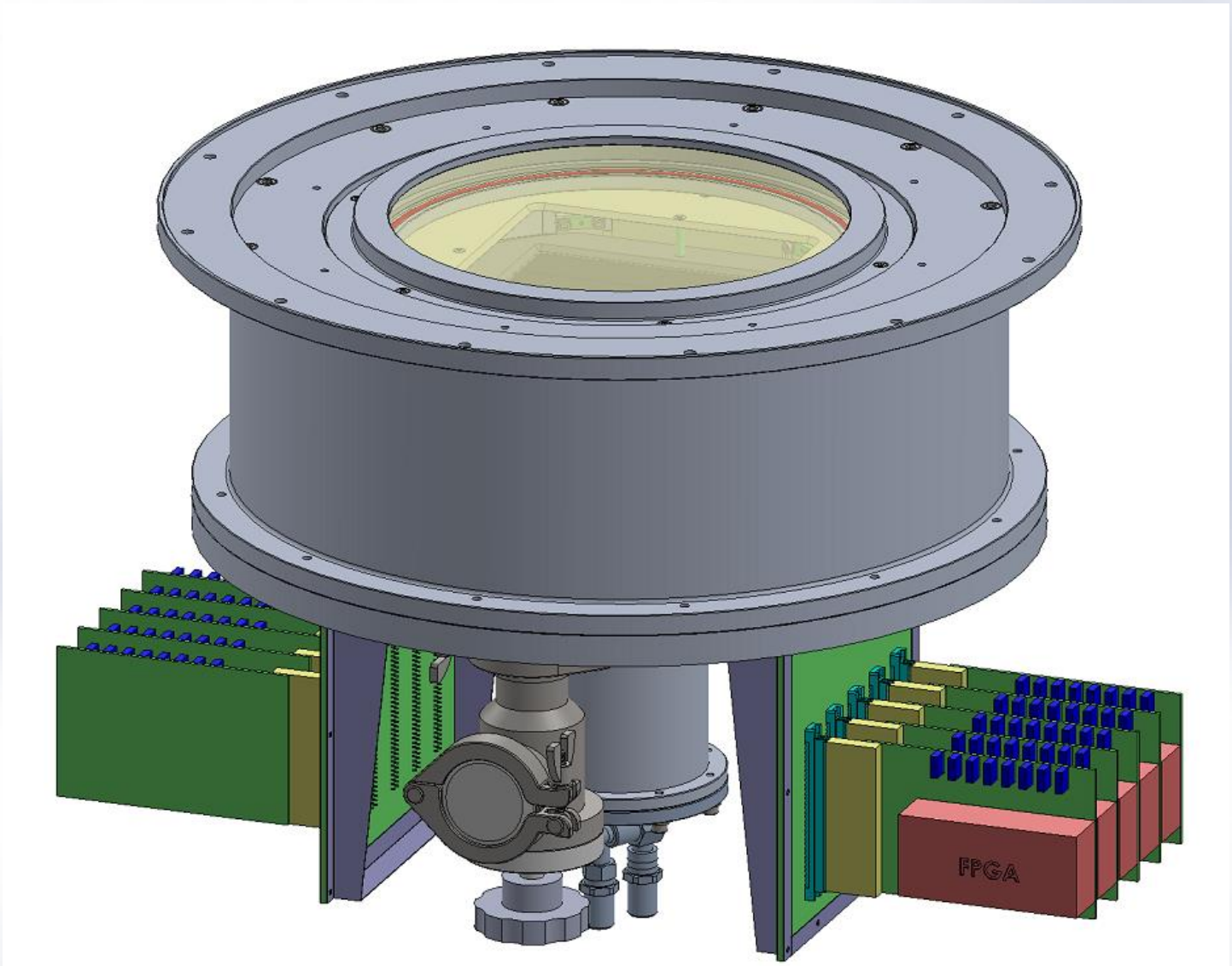




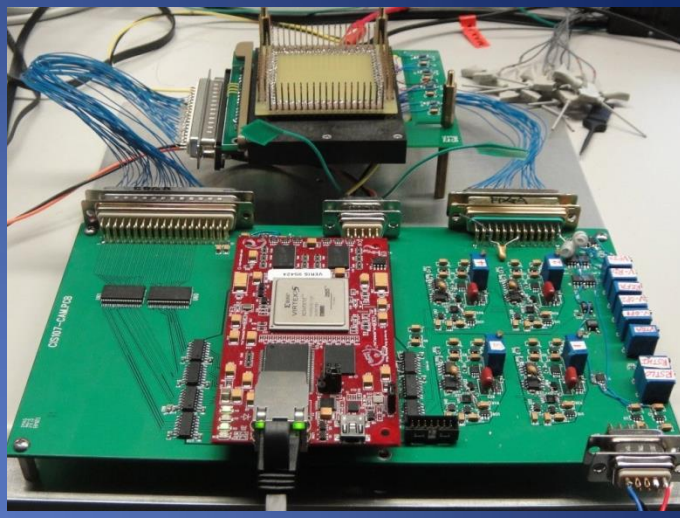




Dewar design



Control electronics



- FPGA based digital circuit
  - Timing control and clock generation
  - On board flux calculation
- 10 FPGA modules per camera
  - Synchronization signal between each of them
  - Each FPGA equipped with one host computer
- 80 video channels in each camera
  - Differential output for each channel with pixel reference and signal levels
- 2.5Mbytes/s X 3 telescopes
  - 0.5TB per year

Prospect

- Site preparation will be finished spring 2014.
- Telescopes to be installed within 2014.
- Prototype camera will be installed for performance evaluation
- Wide field cameras will be installed in 2015
- TNO survey completed in 2020
  - > 100 TNO occultation events detected
  - Long term light curves of 200000 stars @20Hz
- Collaborations are welcome