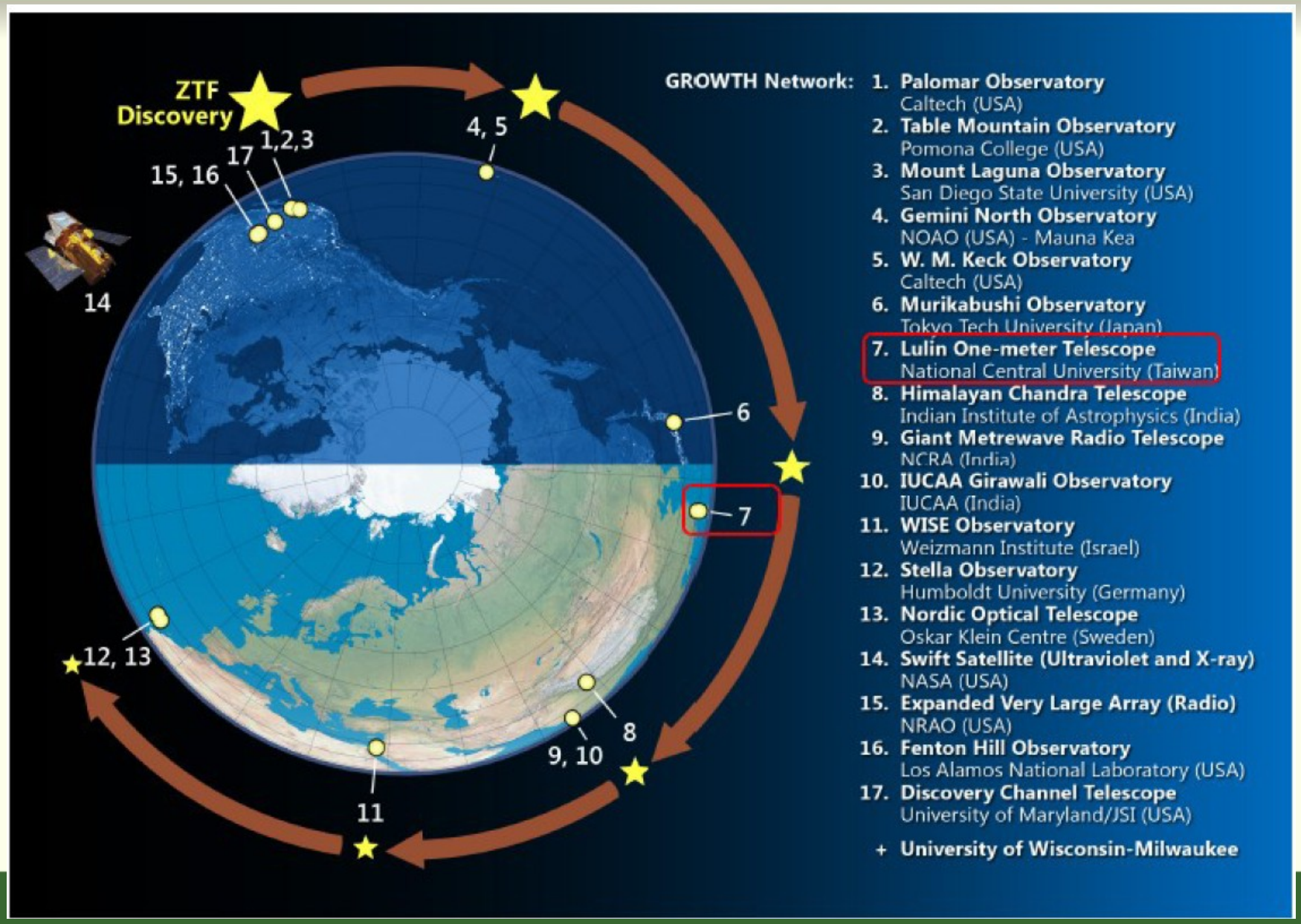
Graduate Institute of Astronomy, NCU
國立中央大學天文研究所

GROWTH
Global Relay of Observatories Watching Transients Happen

GROWTHing the Lulin Telescope

Chow-Choong Ngeow
(National Central University)

From GROWTH Perspective



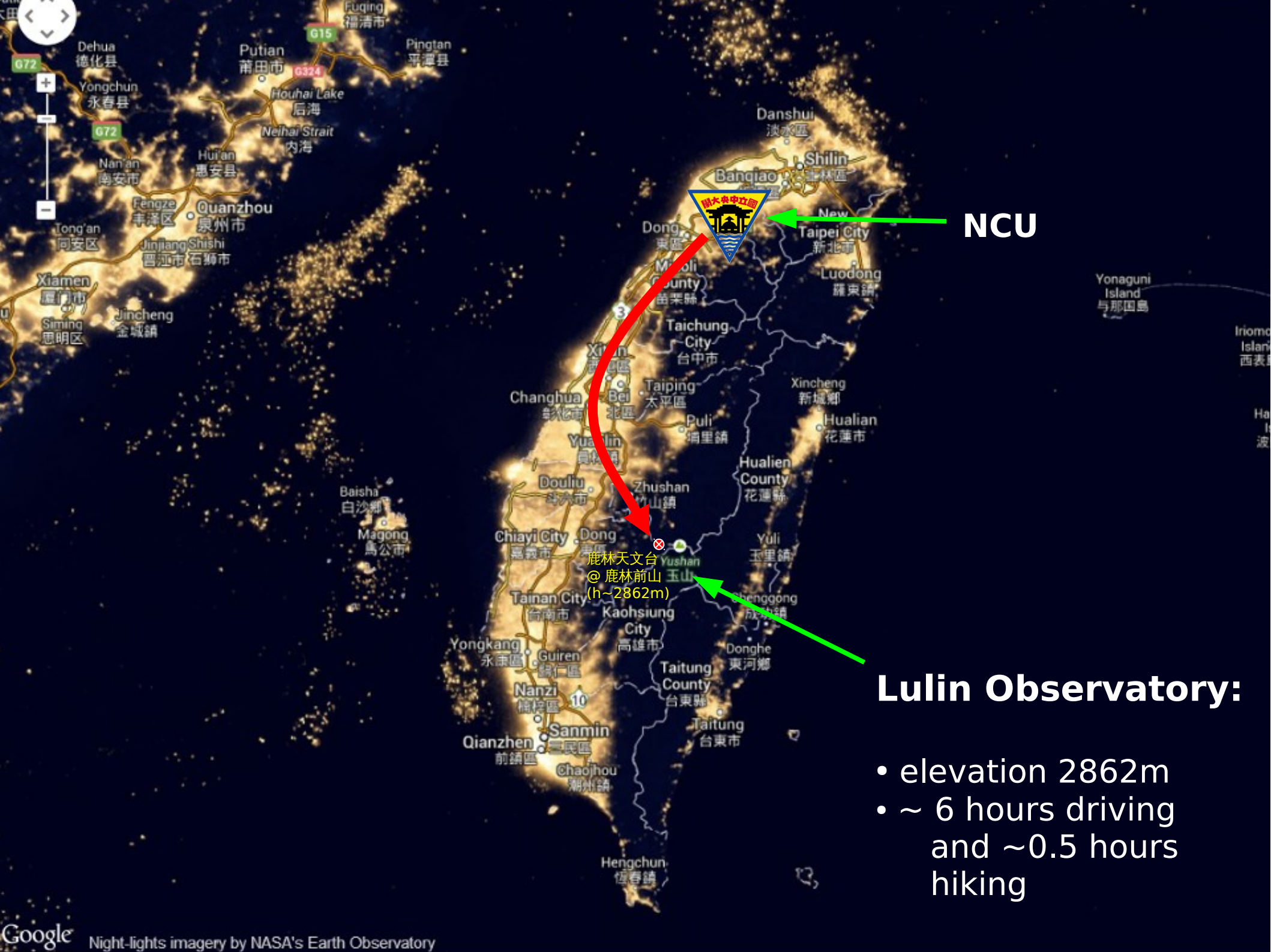
2-M Class Telescopes in Neighbourhood

→ Palomar @ 7am

Taiwan @ 10/11pm (same day)

Hawaii @ 4am (same day)

Courtesy of Wen-Ping Chen


NCU
Lulin Observatory:
• elevation 2862m
• ~ 6 hours driving and ~0.5 hours hiking
鹿林天文台
@ 鹿林前山 玉山
(h~2862m)
Google
Night-lights imagery by NASA's Earth Observatory


120m
600m
Hiking
!!! NO ROAD !!!

Lulin Observatory

中央氣象局
氣象中繼站

環保署
鹿林山大氣背景站
(Atmospheric Labs)

Proposed
2-m Dome

SLT
(0.4-m)

TAOS-A/B

TAOS-C

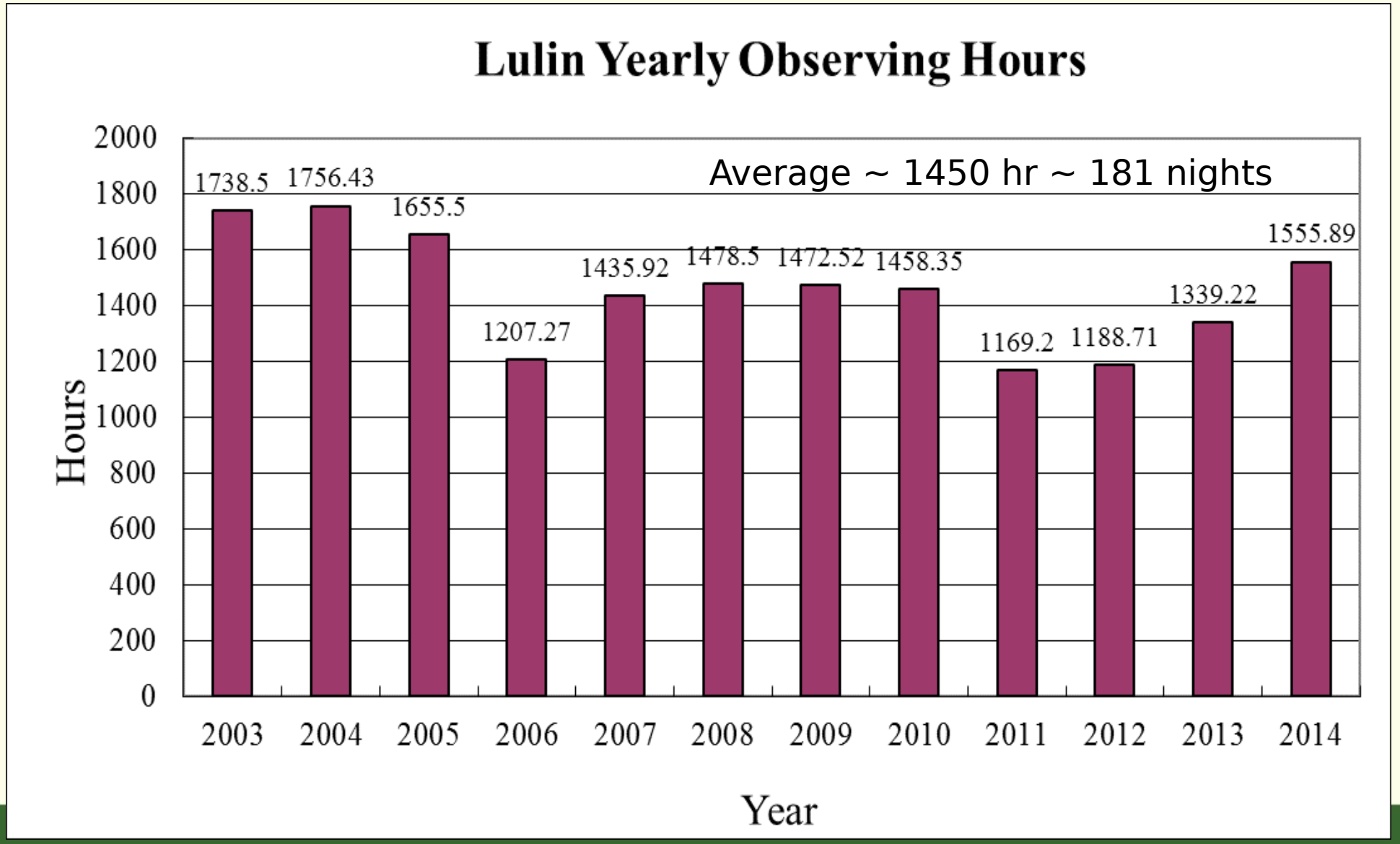
L35
(0.35-m)

TAOS-D
(0.5-m)

LOT
(1-m)

圖：環保署

Histogram of Observing Hours @ Lulin Observatory (2003-2014)



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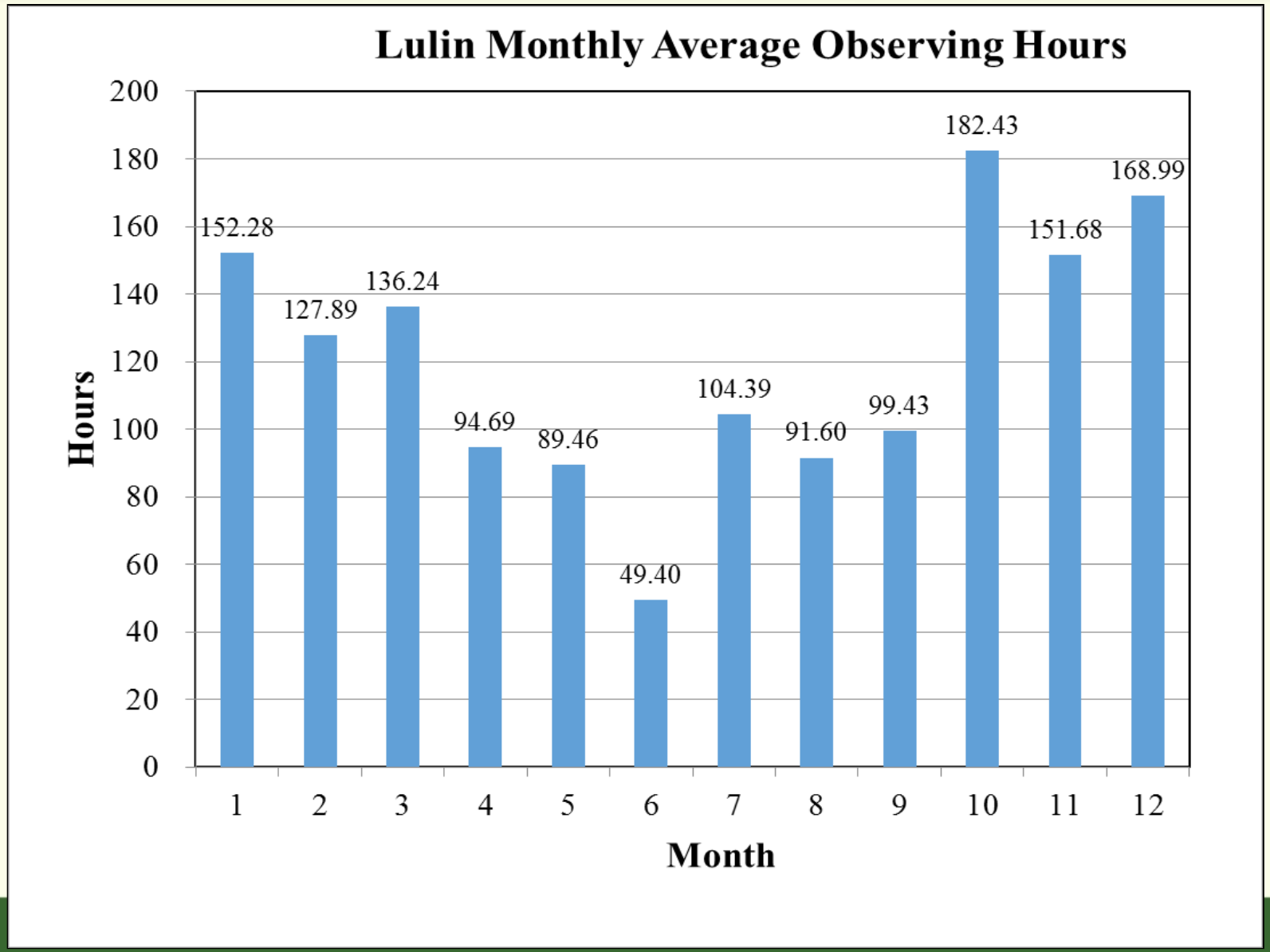
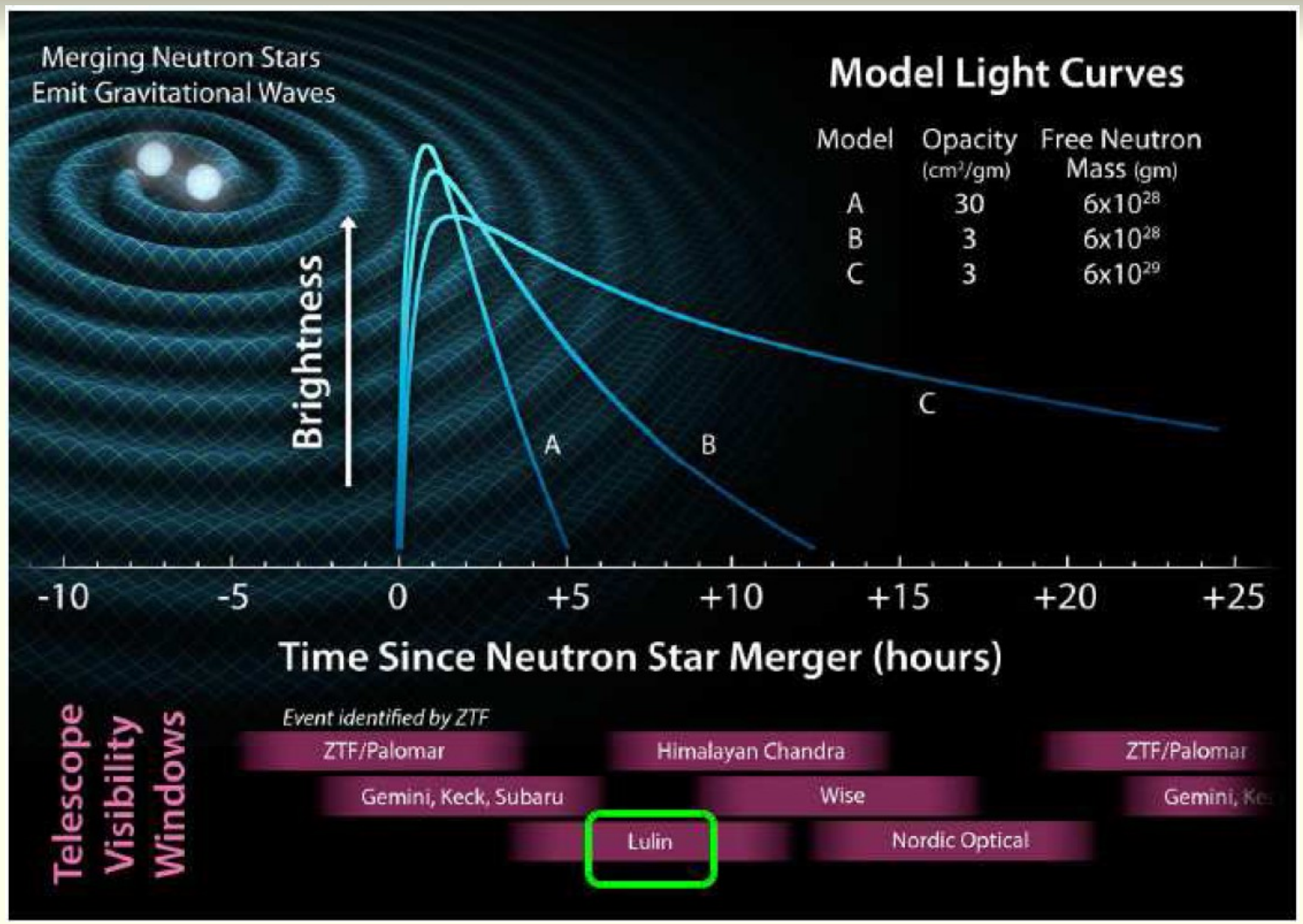


Current Instruments on LOT

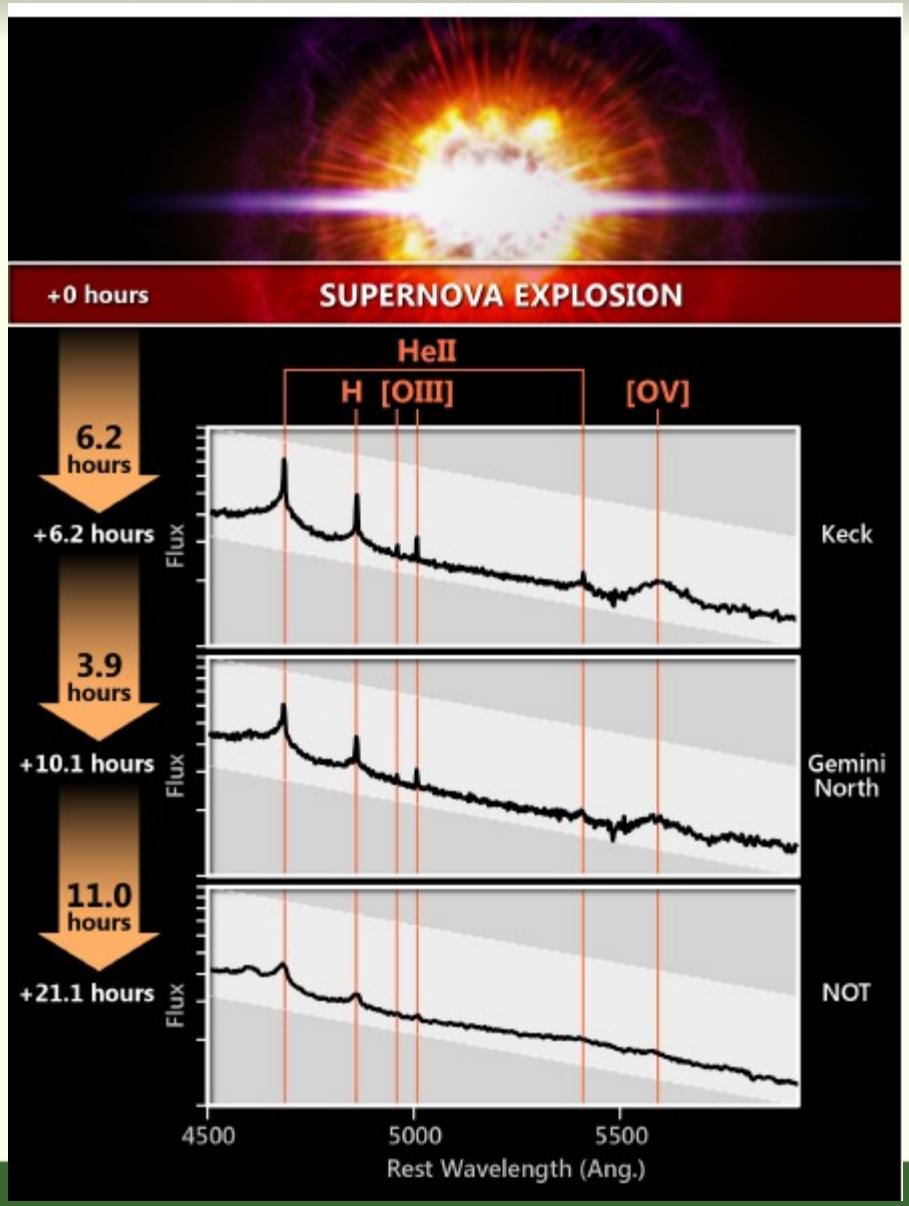
- Apogee 2k x 2k U42 CCD with standard broadband filters (Johnson's UBVRI and SDSS's ugriz)
- Low resolution (R=333,1333) spectrograph – Hiyoyu
- TRIPOL2 – gri-band simultaneous polarimeter
- Use commercial software suites for telescope operations:
    - MaximDL, The SKY, ACP, focusmax and etc

GROWTH Science and LOT I



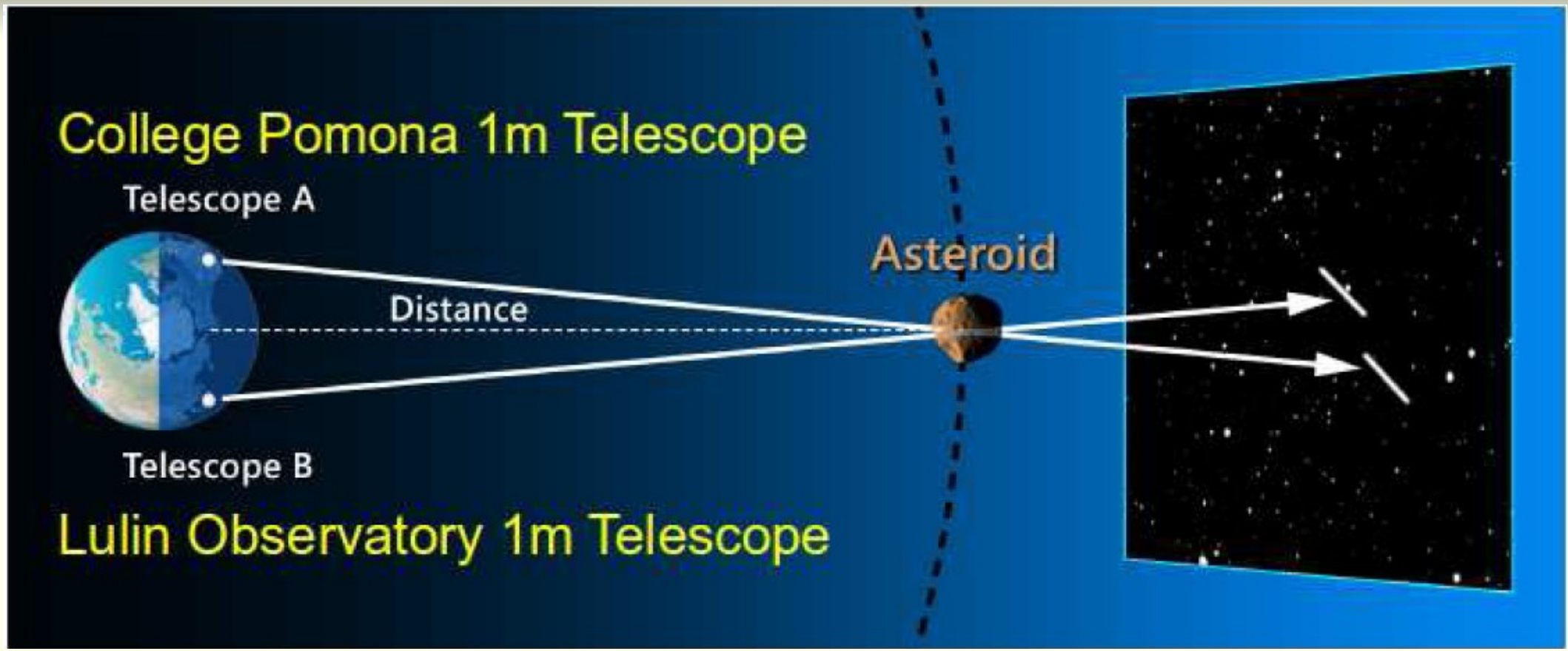
YES: ~ 12' x 12' FOV; 5 min exposure can reach ~21 mag in V

GROWTH Science and LOT II



NO: LOT + Hiyoyu can only reach ~12mag targets

GROWTH Science and LOT III



YES: focal reducer can be added to increase FOV

Challenges for LOT

- Current “problems”:
  - LOT operates in classical mode → either users or telescope operator run the observations
  - LOT will change instruments → 2-3 times per month
  - ToO mode not well implemented
- Plan for LOT is to robotize it → suggestions/experience welcome!
  - Also need to integrate to GROWTH Marshal
  - Some test observations on follow-up?

In-Progress for Automation

- With help for GROWTH 2016 Summer Student – **Atharva Patil**

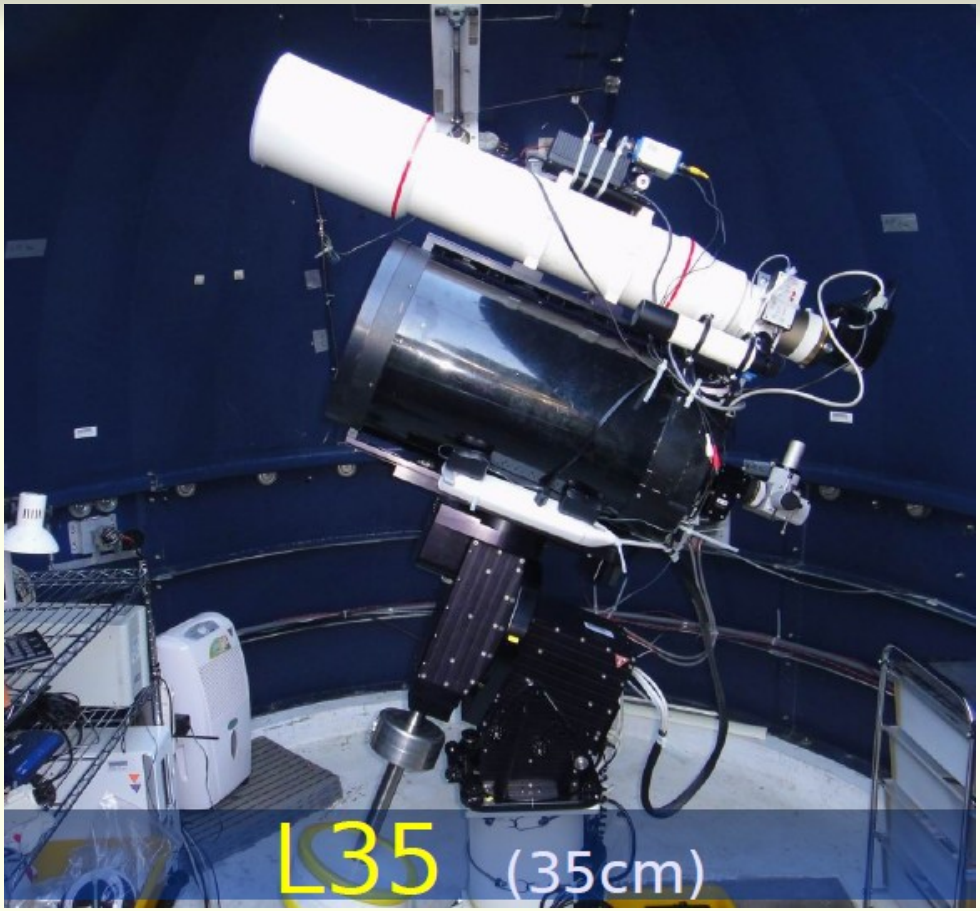
  implement and test on the small telescope (L35) first (before trying on LOT)

Conclusion

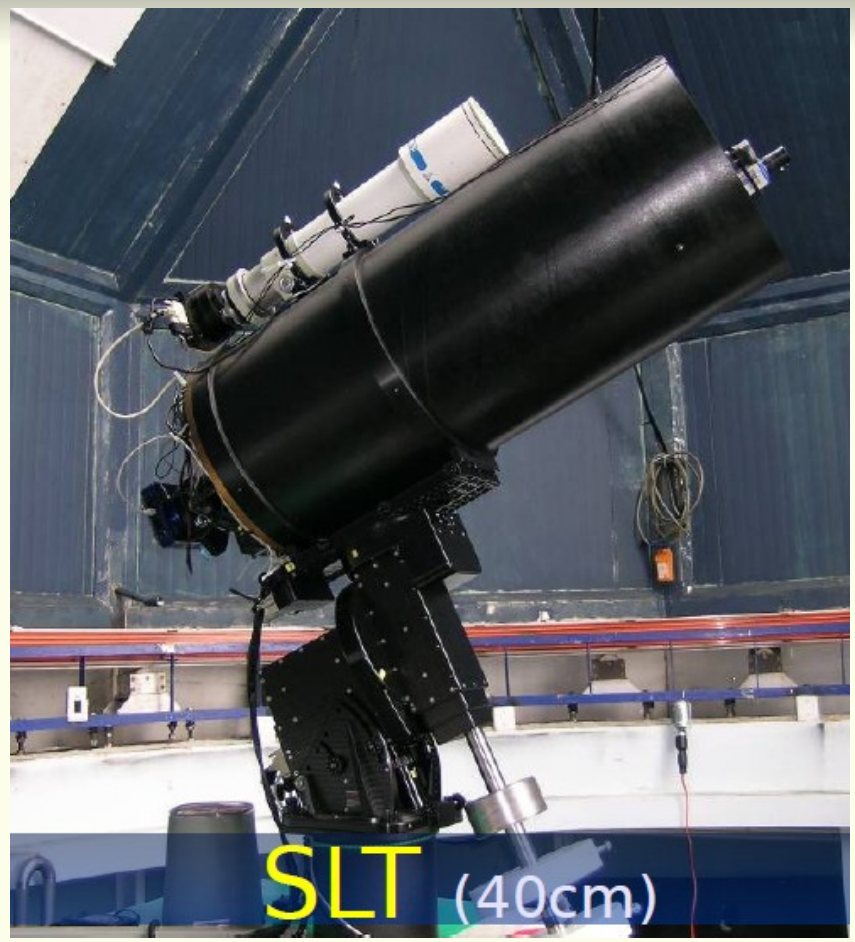
- LOT is part of the GROWTH telescopes: imaging follow-ups
- Need to fully robotize LOT for GROWTH purpose
    - Now is progress; suggestions + helps are welcome
- Science interest at NCU:
    - Fast transients/EWGW: myself and Po-Cheih Yu (postdoc)
    - Asteroids: number of experts (Solar-System minor objects)
        - Faculty: 1+0.5+0.5 out of 8 (1=D. Kinoshita)
        - Research associate: 2 out of 2 (asteroid and comet)
        - Postdoc: 1 out of 7
        - Students: a number of them in this area

[Backup Slides]

Other Smaller Telescopes

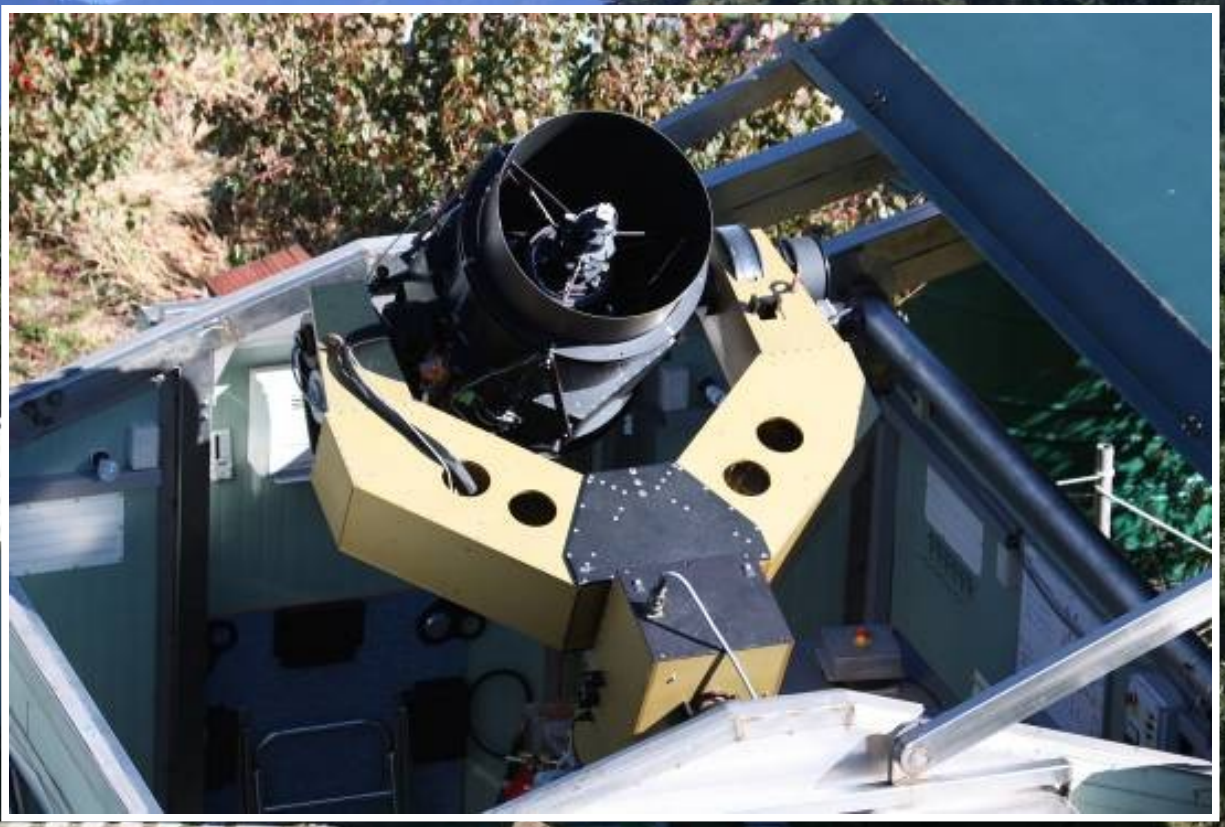


Both with CCD imagers and standard broadband filters



Discovered ~800 asteroid and Lulin Comet

- 0.5m aperture
- ~1 deg-sq FOV
- Single broad-band filter



Taiwan-America Occultation Survey (TAOS-I)

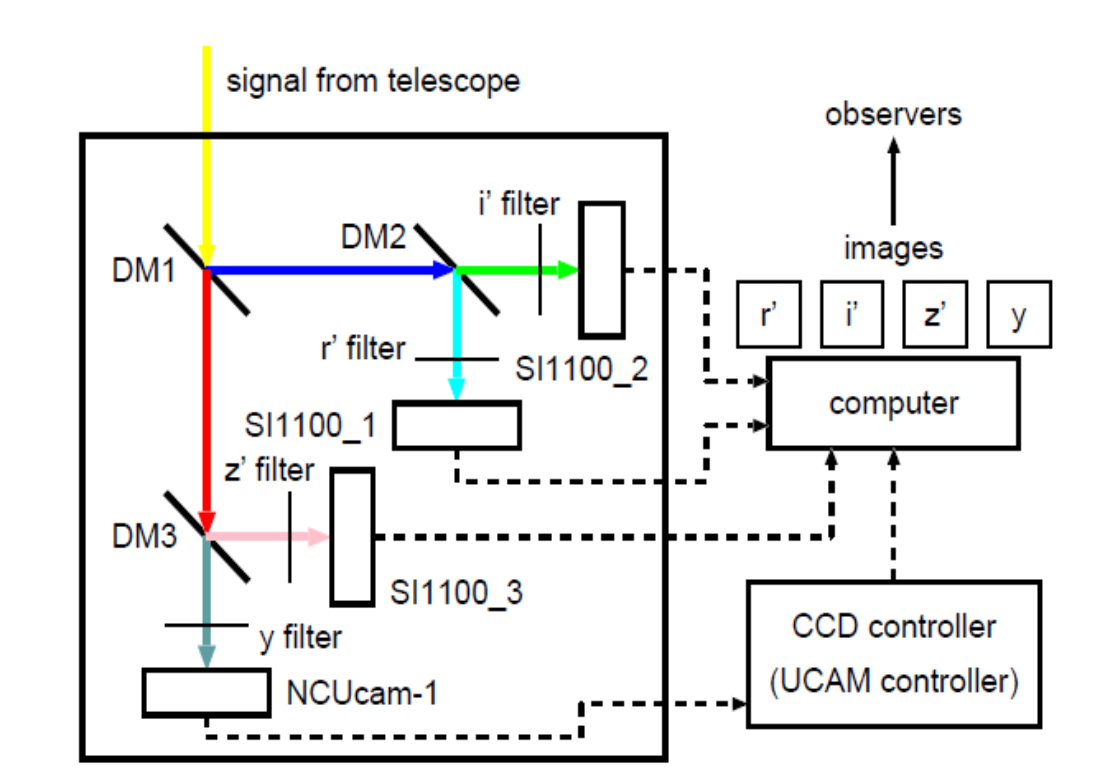
ASIAA YONSEI NCU LLNL CfA

Lulin 2-Meter Telescope Project

Finish the LAST piece of Lulin Observatory – the 2M Telescope

- 2016 construction begin
- 2018 construction end, 2M installation
- 2019 begin first light observation

Lulin 2M First-Generation Instrument: 4-Color Simultaneous Imager



Instrument: Lulin 1-m Telescope + NCUcam-1
Filters: PS1 r' (60 sec × 8), i' (60 sec × 8), z' (90 sec × 8)
Field-of-view: 26.4 arcmin × 13.2 arcmin
Date/Time: 14:53:42 – 15:37:02 on 06 July 2011 (UT)

3 commercial SI CCD cameras
1 in-house development CCD