Real-time Modeling

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Importance

- Helps observers to see the progress of events
- Provides criteria to select events of importance
- Basis to set up follow-up observation strategy

Current situation

- Previous analysis
  - on a handful number of events of greatest interest
  - Basic models
  - Major contributors: S. Dong; D. Bennett; A. Gould

- Currently
  - on nearly all anomalous events
  - In-depth modeling (second-order effects)
  - major persons: V. Bozza; M. Dominik;
    my group (I.-G. Shin;J.-Y. Choi);
    T. Sumi; N. Kain; J. Yee

Progress

Achieved by

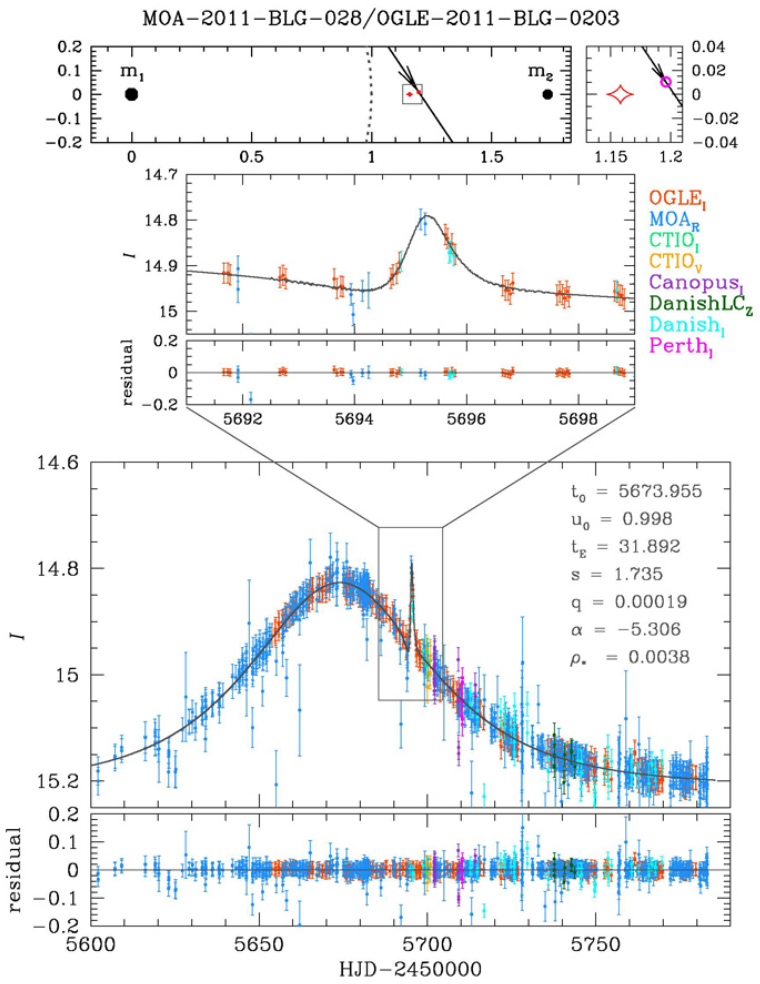
- Researchers' devotion & devotion
- Advance in methodology (e.g., automated system by Bozza; parallel computing by using MPI)
- Increased computing power (three 150-CPU clusters)
- Now microlensing researchers became to see the progress of on-going events in real time.

http://astroph.chungbuk.ac.kr/~cheongho/modelling/model_2011.html

~80 events in 2011

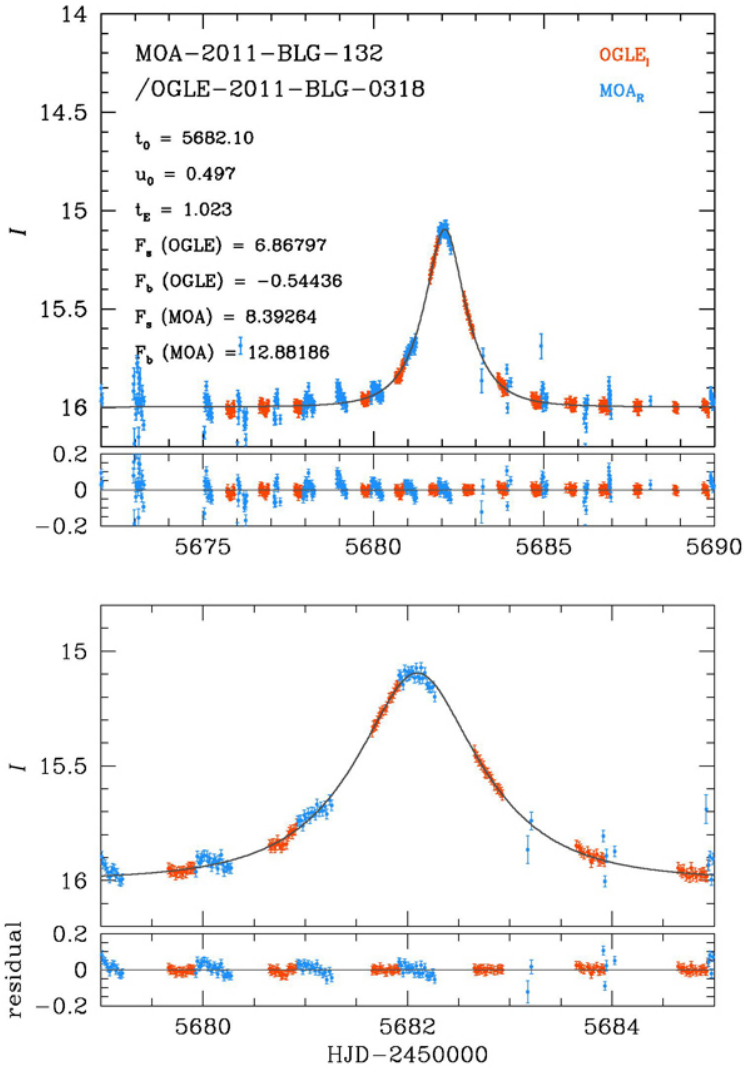
- Login: "microlenser"
- Password: "welcome"

Planetary events: MB11028/OB110203



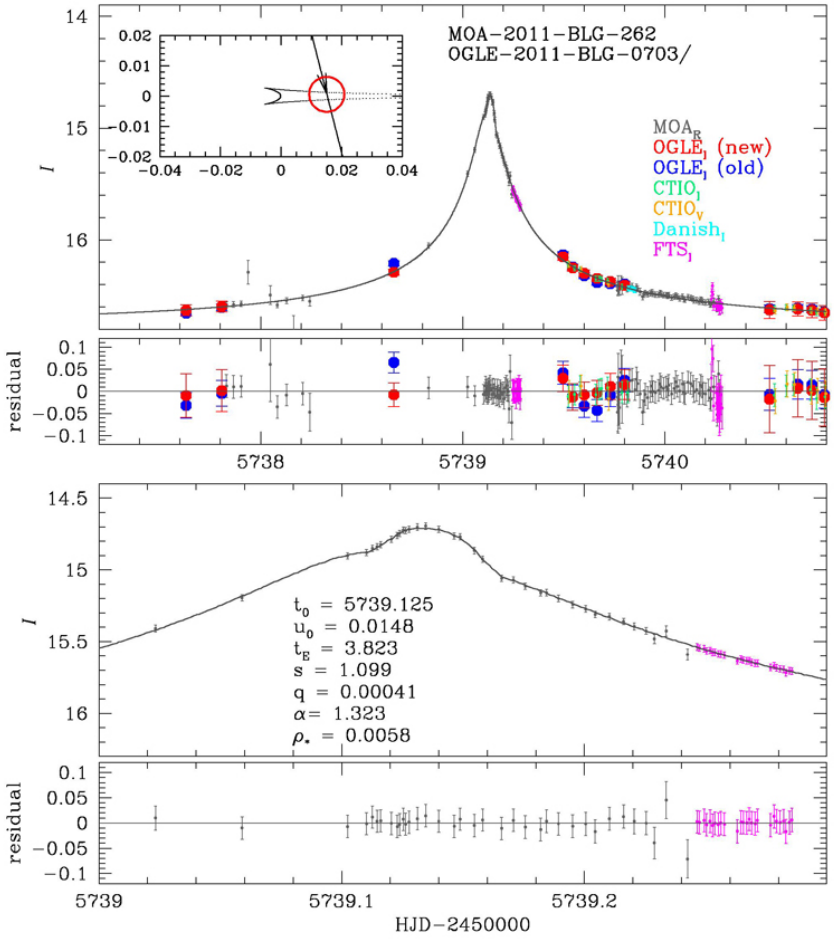
- First planetary event in 2011
- $s \sim 1.7$, $q \sim 1.9 \times 10^{-4}$
- Very low mass ratio
- Perturbation induced by the planetary caustic
- Mostly covered by survey observations
- OGLE in analysis

Planetary events: MB11132/OB110318



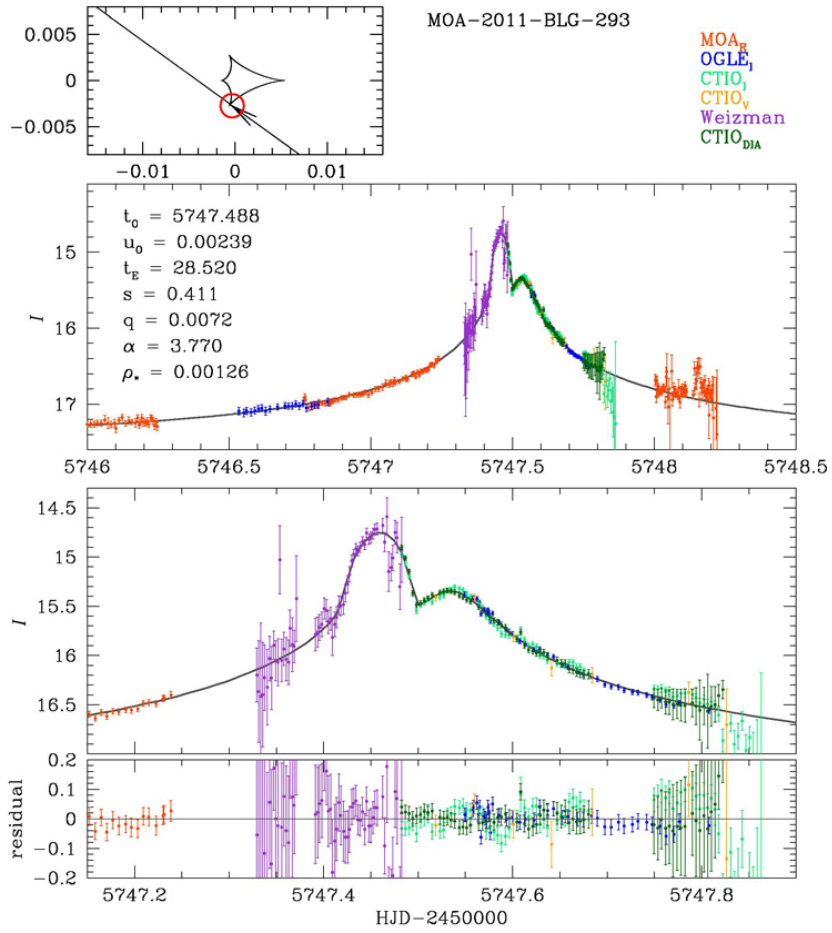
- Very short time scale: t_E ~ 1.0^d
- Candidate free-floating planet
- Solely covered by survey → demonstration of the power of new survey strategy
- Analysis (??)

Planetary events: MB11262/OB110703



- Short time scale: t_E ~ 3.8 days
- Central perturbation with a low-mass companion: q ~ 4.1x10^{-4}
- Possibility of a lowest-mass planet, or even the first satellite
- Perturbation covered by MOA survey data
- MOA in analysis

Planetary events: MB11293

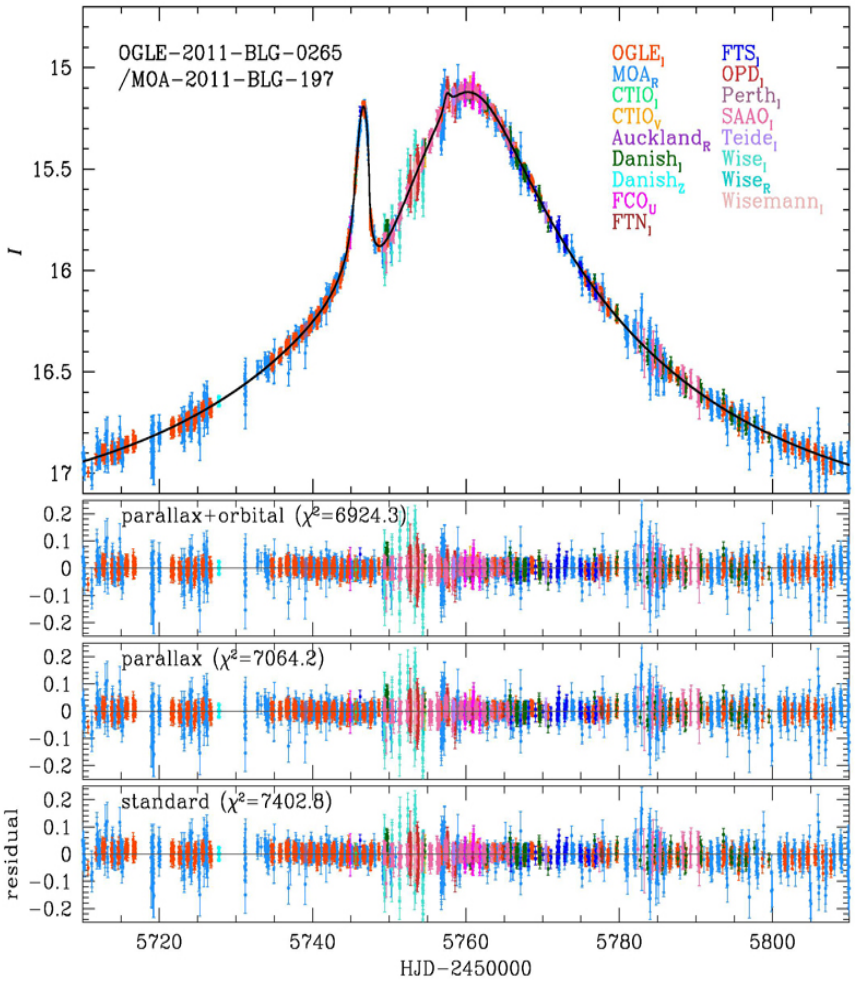


- q~7.2x10^{-3}, s ~ 0.41
  (possible close/wide degeneracy)

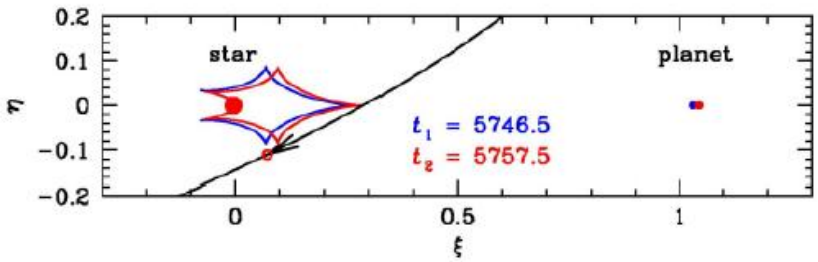
- Weizman survey data cover the perturbation

- J. Yee et al., in preparation

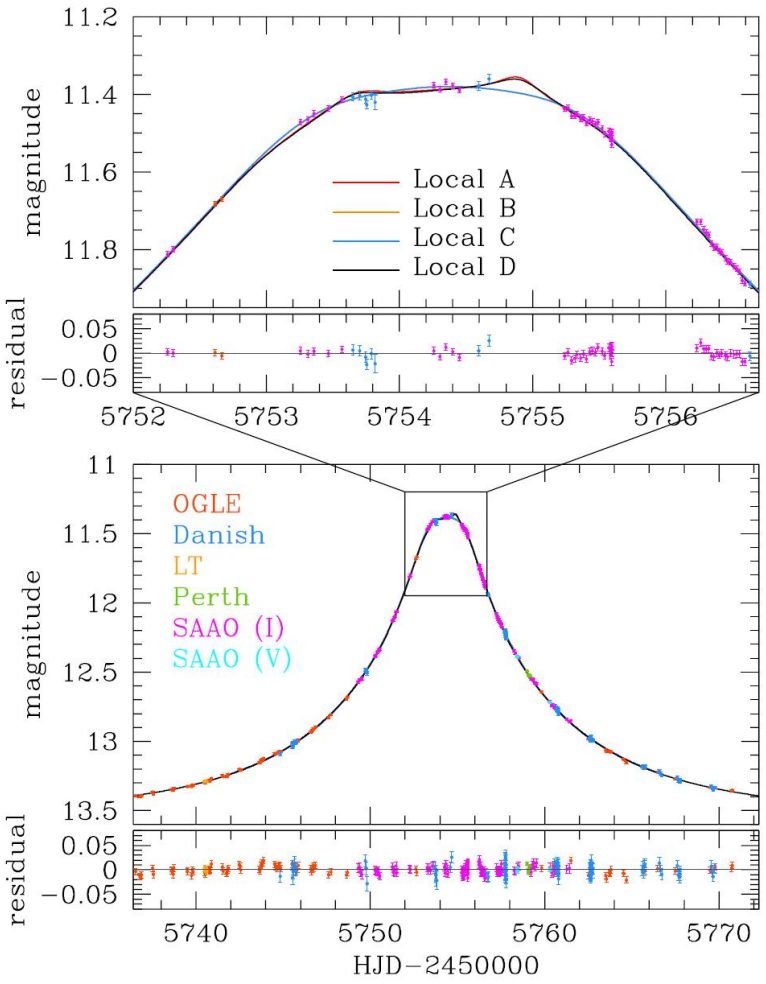
Planetary events: OB110265/MB11197

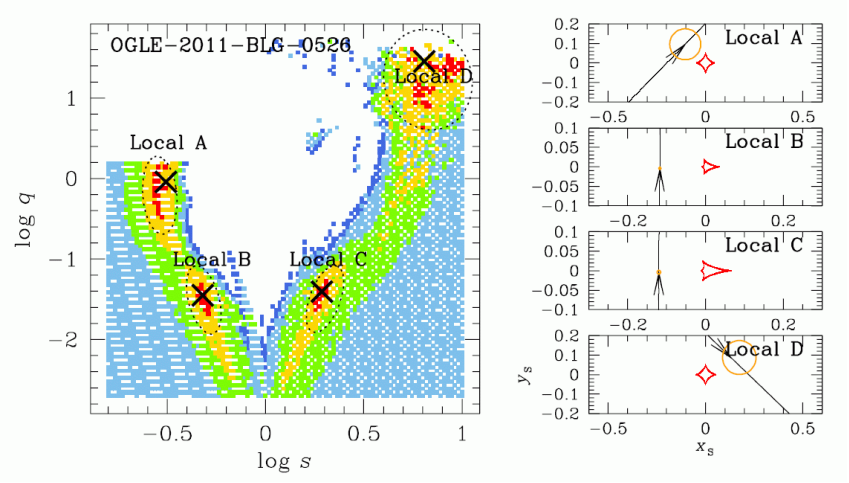


- A distinctive planetary signal
- $s \sim 1.0$, $q \sim 4.2 \times 10^{-3}$
- Both parallax and orbital effects clearly detected
- Physical parameters
  - $M_* \sim 0.12\ M_\odot$
  - $M_p \sim 0.52\ M_J$
  - $D_L \sim 2.3 \pm 0.3$ kpc
- Possibly a planet orbiting around the lowest-mass star
- OGLE in analysis



Planetary/Binary (?): OB110526



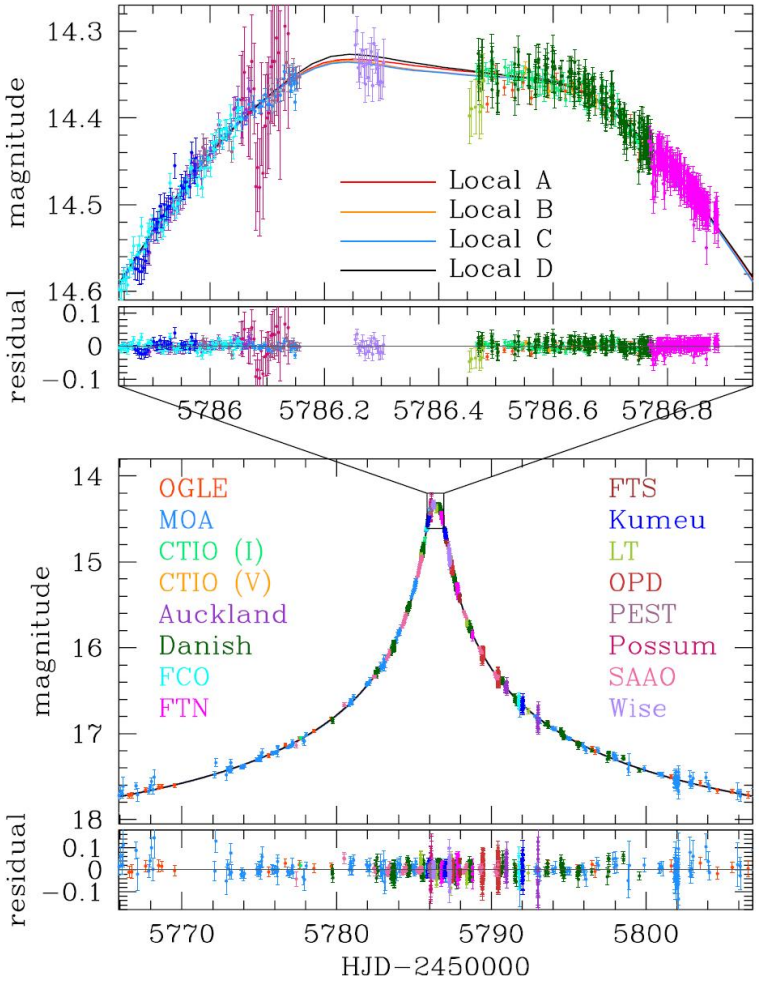


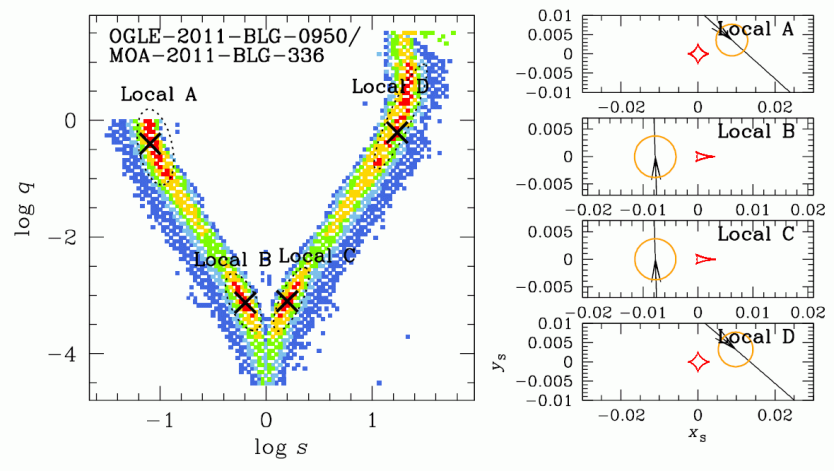
❖Ambiguity (4 local minima)

- local A (χ^2=423.6): s=0.31, q=0.91
- local B (χ^2=420.0): s=0.48, q=3.5x10^{-2}
- local C (χ^2=422.2): s=1.9, q=3.9x10^{-2}
- local D (χ^2=429.9): s=6.4, q=28.5
- very severe degeneracy

-A↔D : close/wide degeneracy
-B↔C : close/wide degeneracy
-A↔B (C↔D) : newly known degeneracy

Planetary/Binary (?): OB110950/MB11336



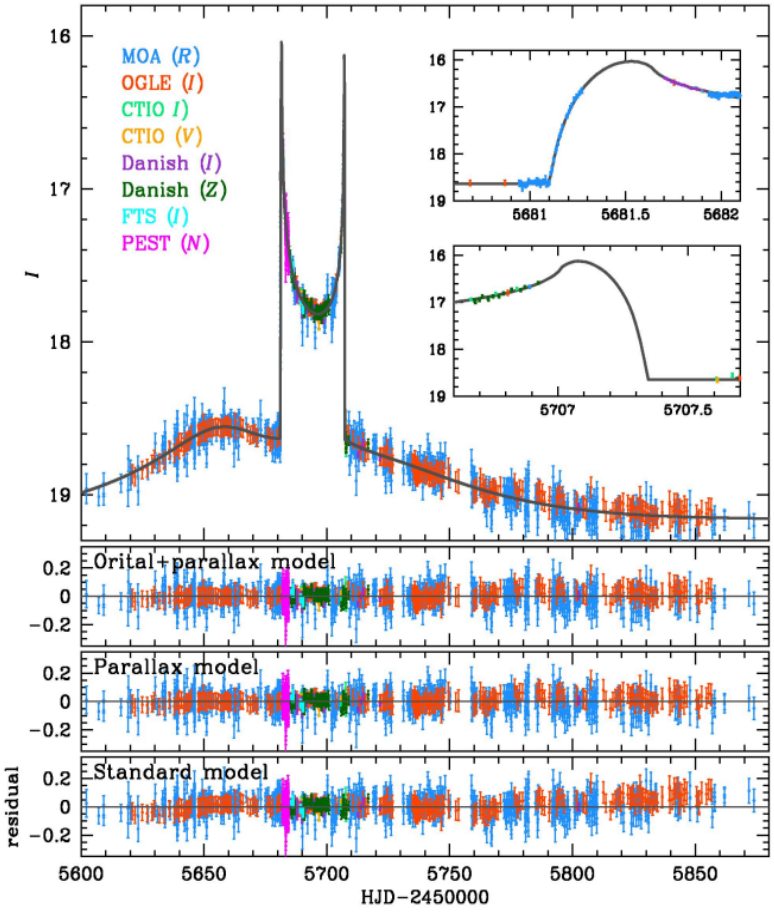


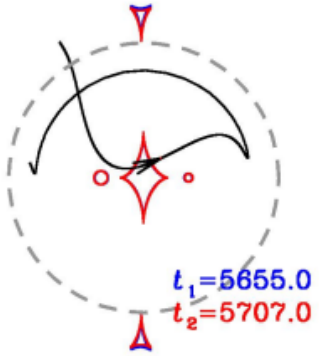
❖Ambiguity (4 local minima)

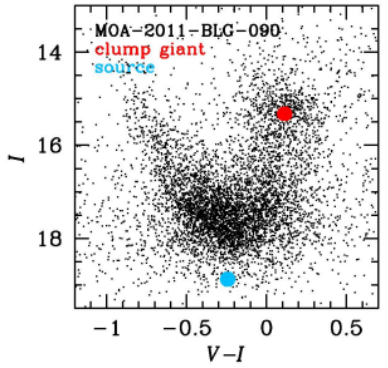
- local A (χ^2=2997.2): s=0.08, q=0.40
- local B (χ^2=2965.8): s=0.64, q=7.5x10^{-4}
- local C (χ^2=2965.4): s=1.58, q=7.9x10^{-4}
- local D (χ^2=2998.0): s=17.2, q=0.62

- Han, C. in analysis

Mass measurement of Binary Events: MB11090





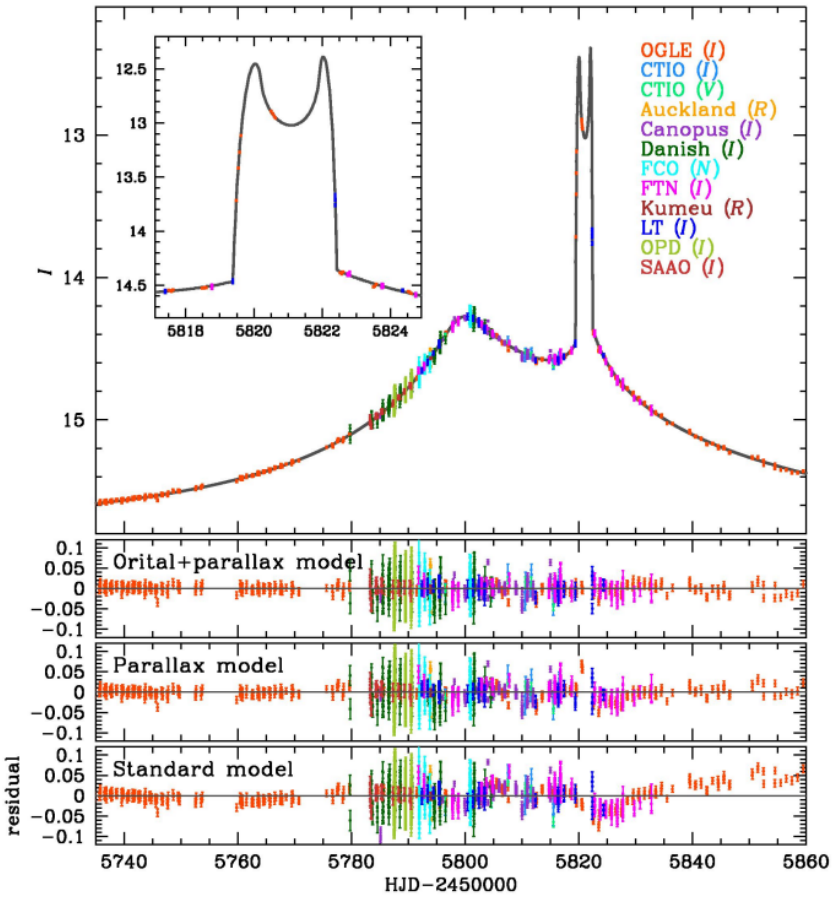


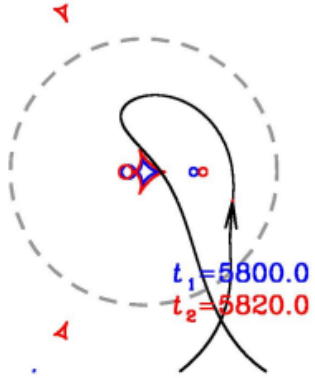
- Caustic-crossing ⟶ Einstein radius
- Long t_E (188^d)⟶ parallax, orbital effects

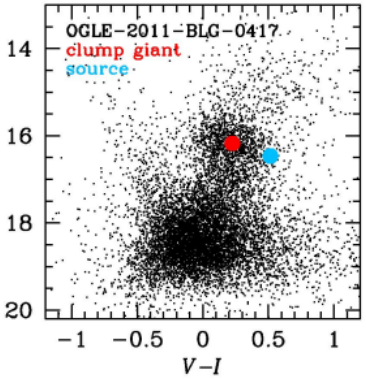
- Physical parameters
  - M_1=0.22±0.01 $M_\odot$ (M4V)
  - M_2 =0.21±0.01 $M_\odot$ (M4V)
  - D_L =2.35±0.07 kpc
  - a =0.99±0.03 AU
  - P =1.50±0.06 yrs
  - e =0.59±0.05
  - i (deg)=86.3±2.3

- Shin, I.-G. in analysis

Mass measurement of Binary Events: OB110417

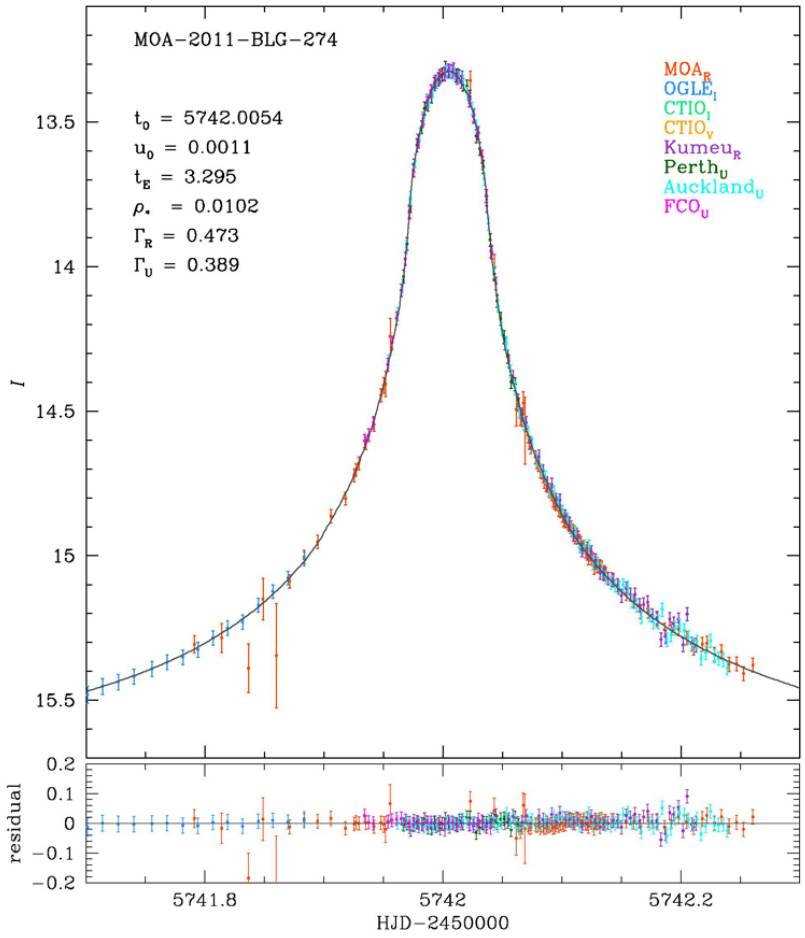






- Caustic-crossing, long t_E (92^d) ⟶ lens parallax, orbital effect
- Physical parameters
  - M_1=0.47±0.02 $M_\odot$ (M2V)
  - M_2 =0.14±0.01 $M_\odot$ (M4V)
  - D_L =0.55±0.02 kpc
  - a =0.88±0.02 AU
  - P =1.05±0.03 yrs
  - e =0.65±0.02
  - i (deg)=68.9±0.8
- Shin, I.-G. in analysis

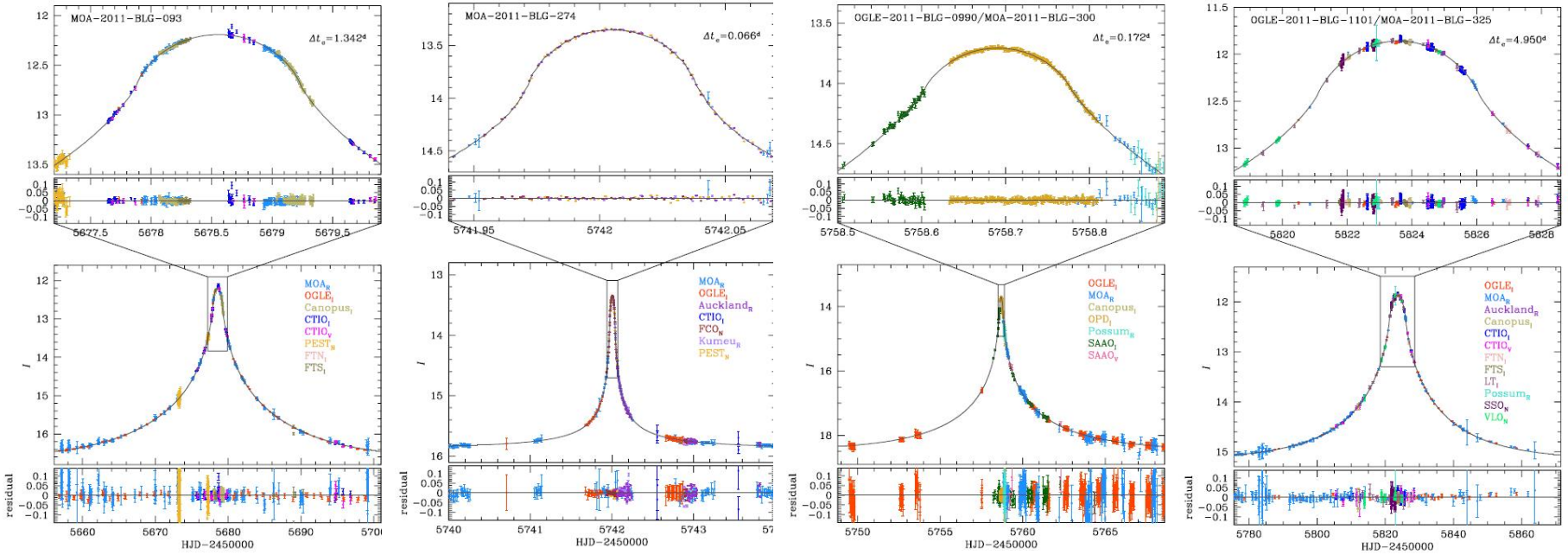
Mass measurement of a single-lens event: MB110274



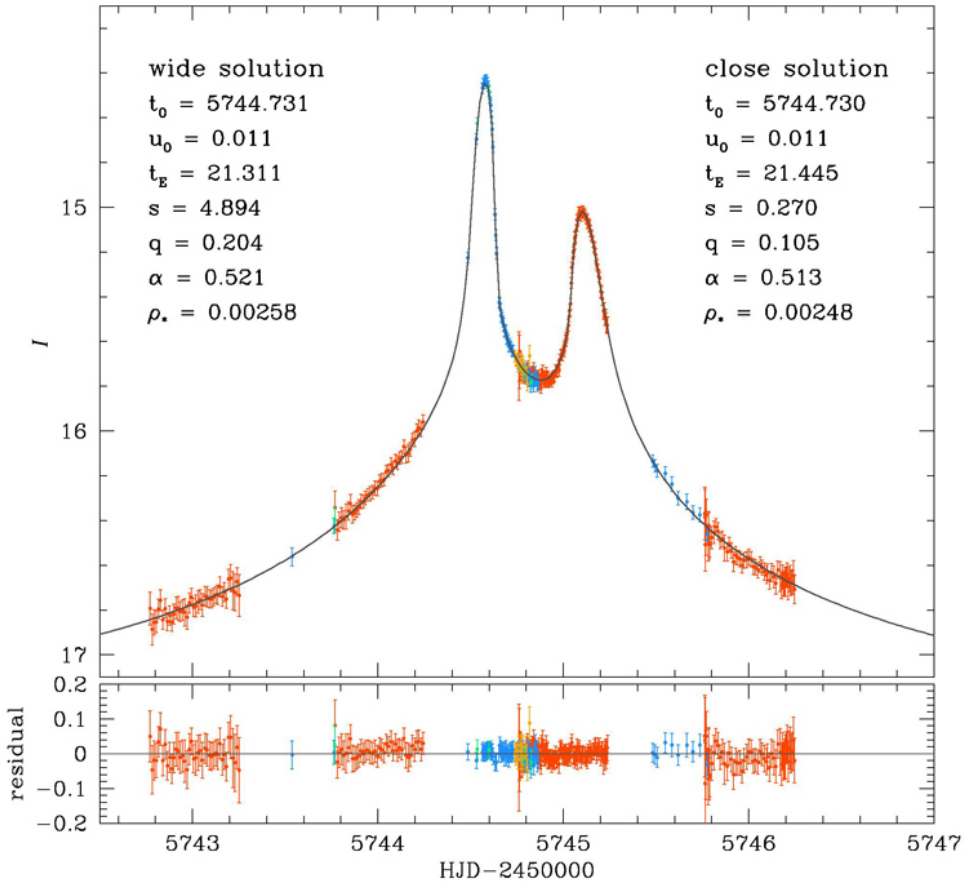
- Time scale t_E~3.3 days
- Einstein radius: θ_E~0.07 mas
  ⟶ Possible free-floating planet
- Very high-magnification
- Analysis
  ⟶ terrestrial parallax (A. Gould, private communication)
  ⟶ M. Freeman

Single finite-source event:
MB110093, MB11274, OB110990/MB11300, OB111101/MB11325

- Limb-darkening measurement
- Choi, J.-Y., et al. 2012, ApJ, submitted



Low mass-ratio binary companion (q<0.2): MB11278



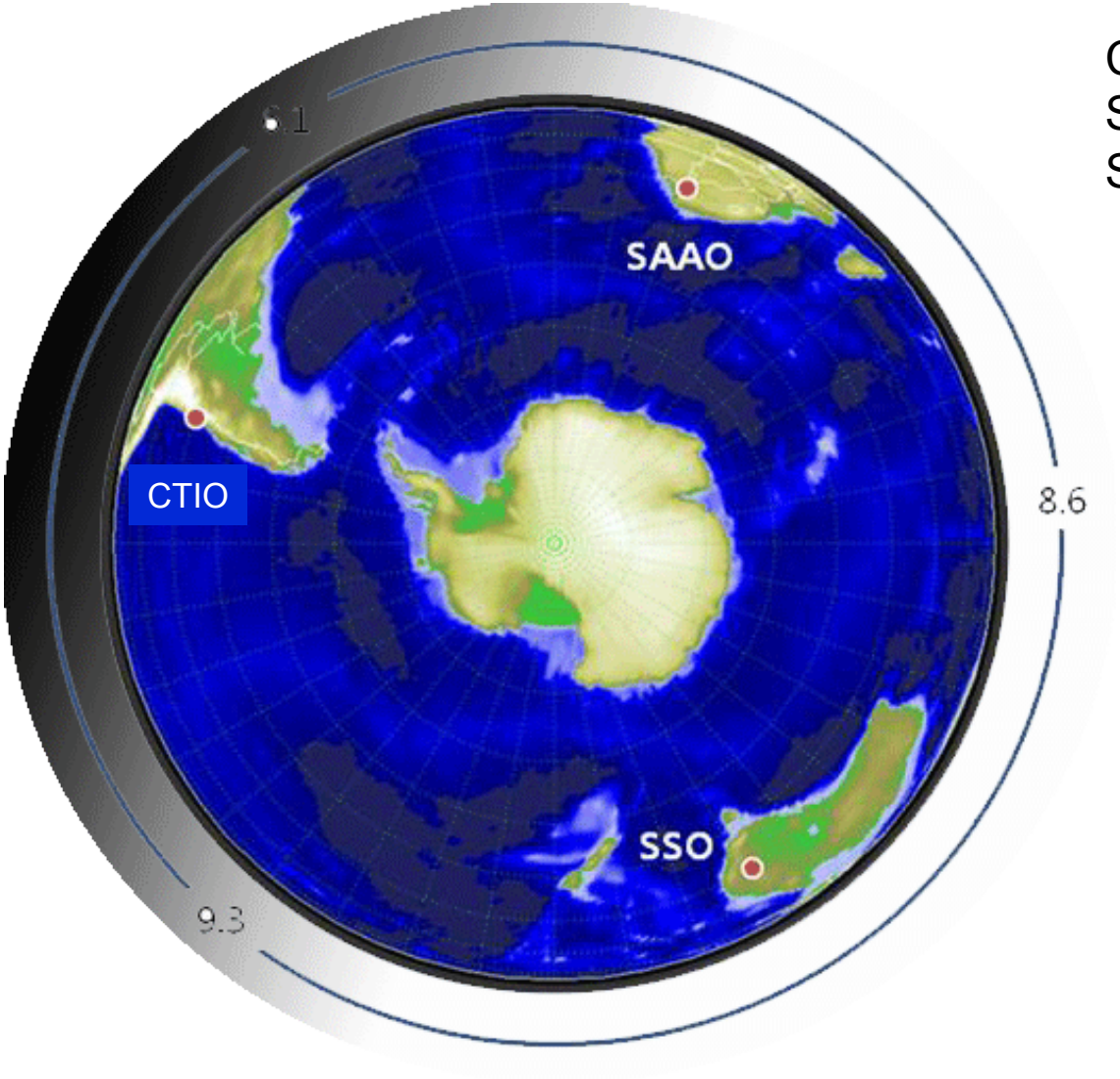
- Low mass ratio
  - Close model: q=0.11
  - Wide model: q=0.20

- For a typical lens: M dwarf
  ⟶ companion may be a BD

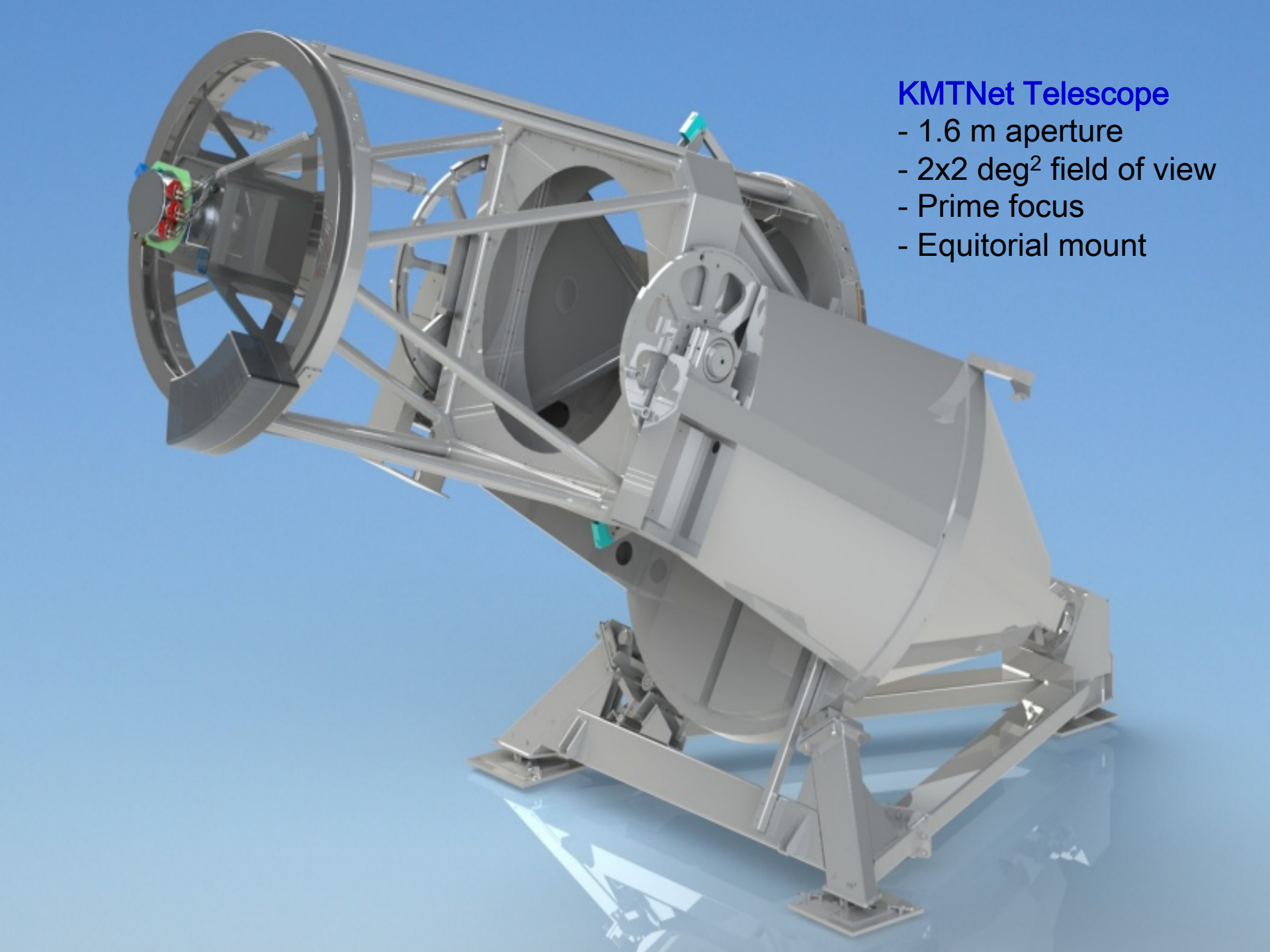
- Systematic search (Park, S.-Y., in preparation)

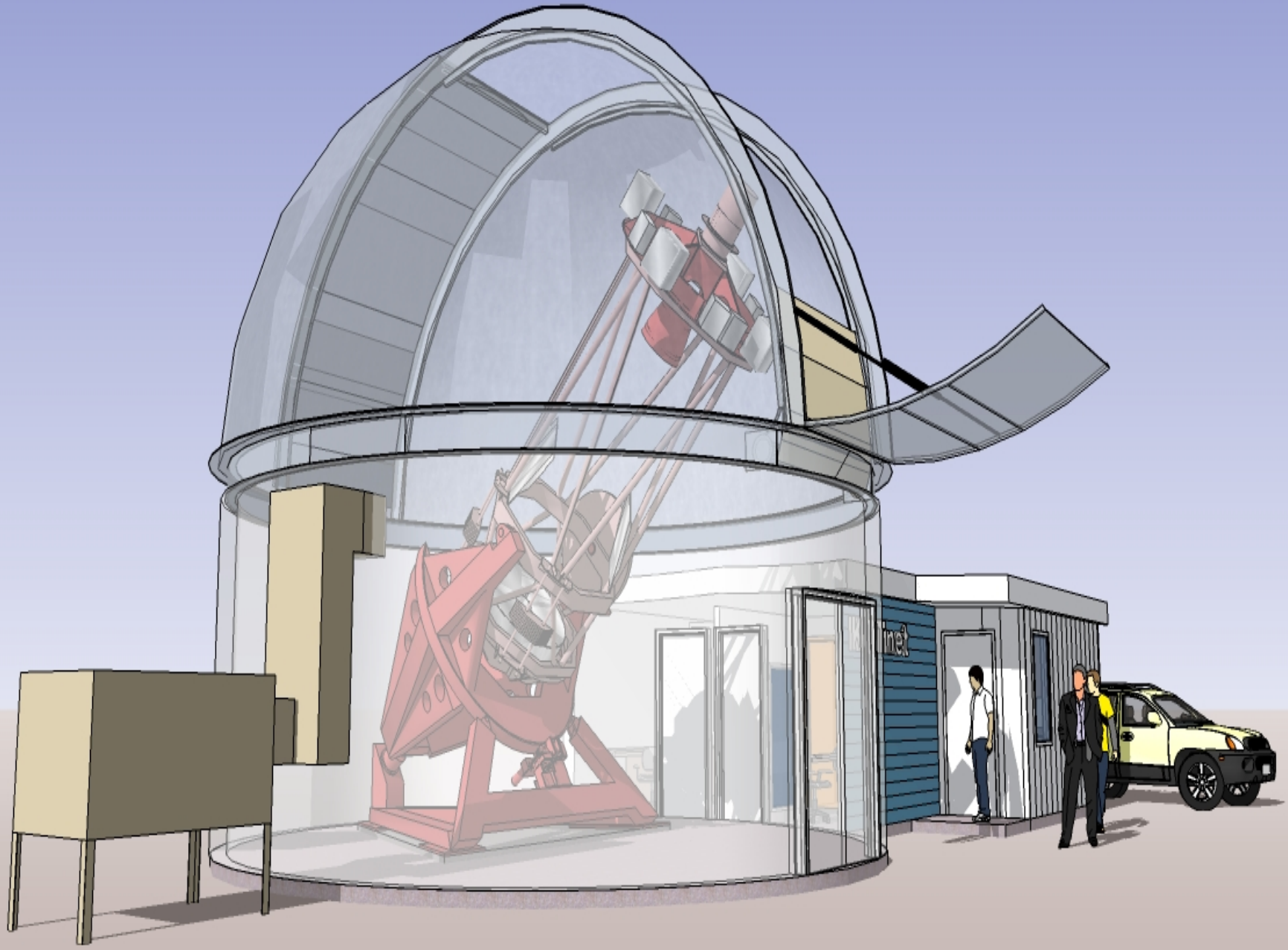
KMTNet (Korea Microlensing Telescope Network) Timetable

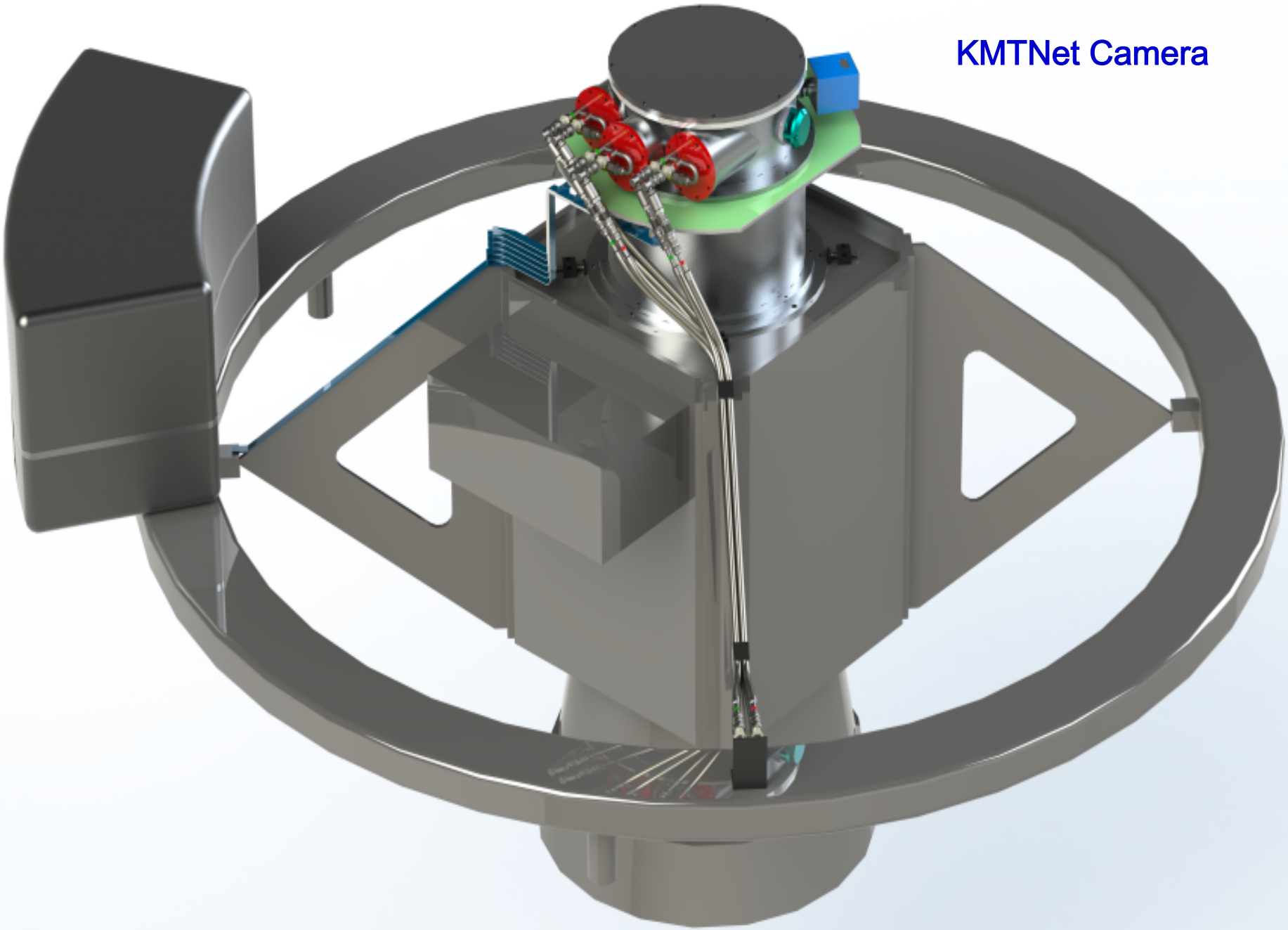
year	plan	comments
2012	□ Test camera (Jun) □ 1st Telescope (Dec)	• 4Kx4K • CTIO, Chile
2013	□ 1st Camera (Aug) □ 2nd Telescope (Aug)	• 18Kx18K, E2V • SAAO, South Africa
2014	□ 1st telescope in operation (Mar) □ 2nd Camera (Jan) □ 3rd Telescope (Jan) □ 3rd Camera (Mar) □ In full operation in 2014 season	• - • - • SSO, Australia • - • -



CTIO (Chile)
SAAO (S. Africa)
SSO (Australia)


KMTNet Telescope
- 1.6 m aperture
- 2x2 deg^2 field of view
- Prime focus
- Equitorial mount




KMTNet Camera