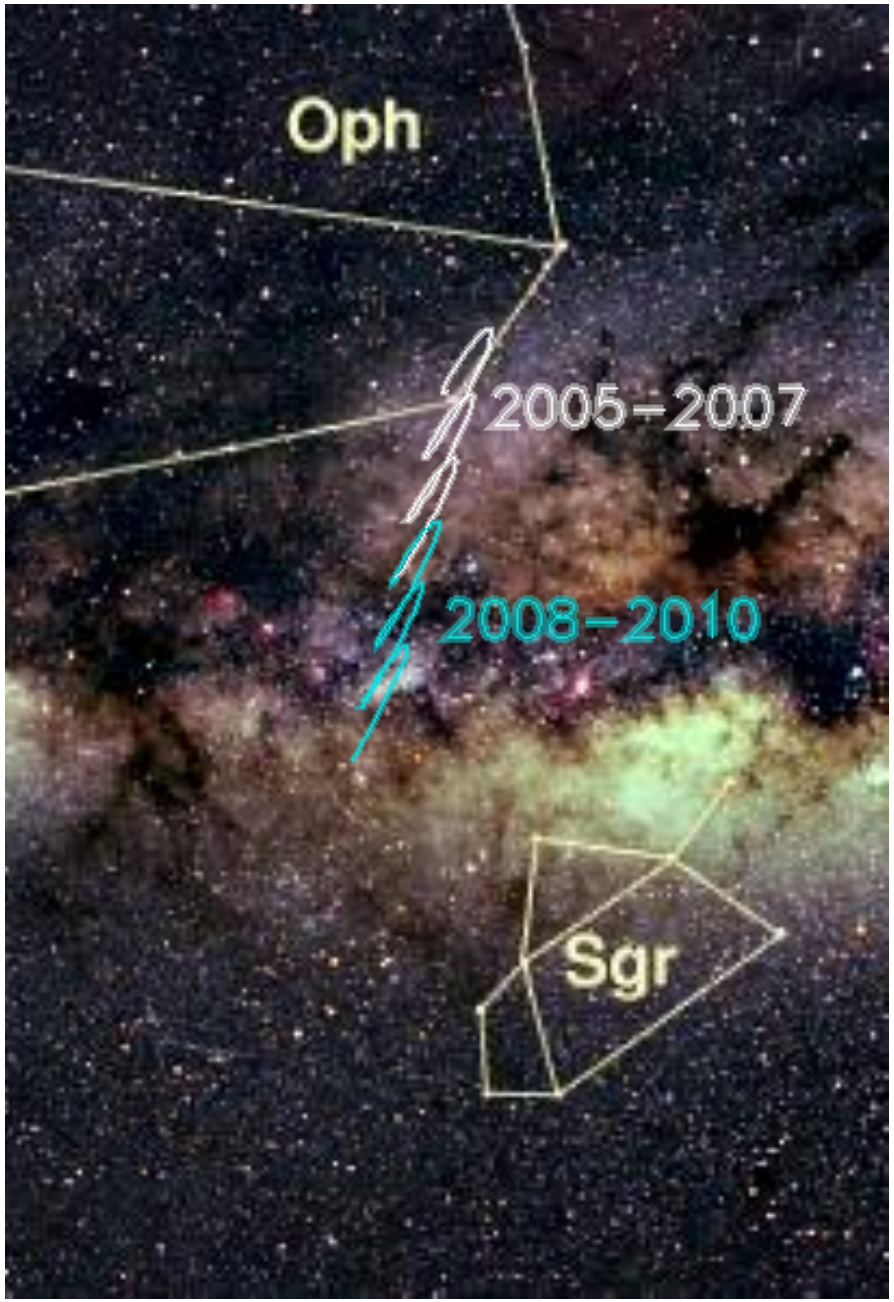
Results from the 2010 Feb 14 and July 4 Pluto Occultations

Leslie Young, B. Sicardy, T. Widemann,
M. J. Brucker, M. W. Buie, B. Fraser,
H. Van Heerden, R. R. Howell, K. Lonergan,
C. B. Olkin, H. J. Reitsema, A. Richter,
T. Sepersky, L. H. Wasserman, E. F. Young

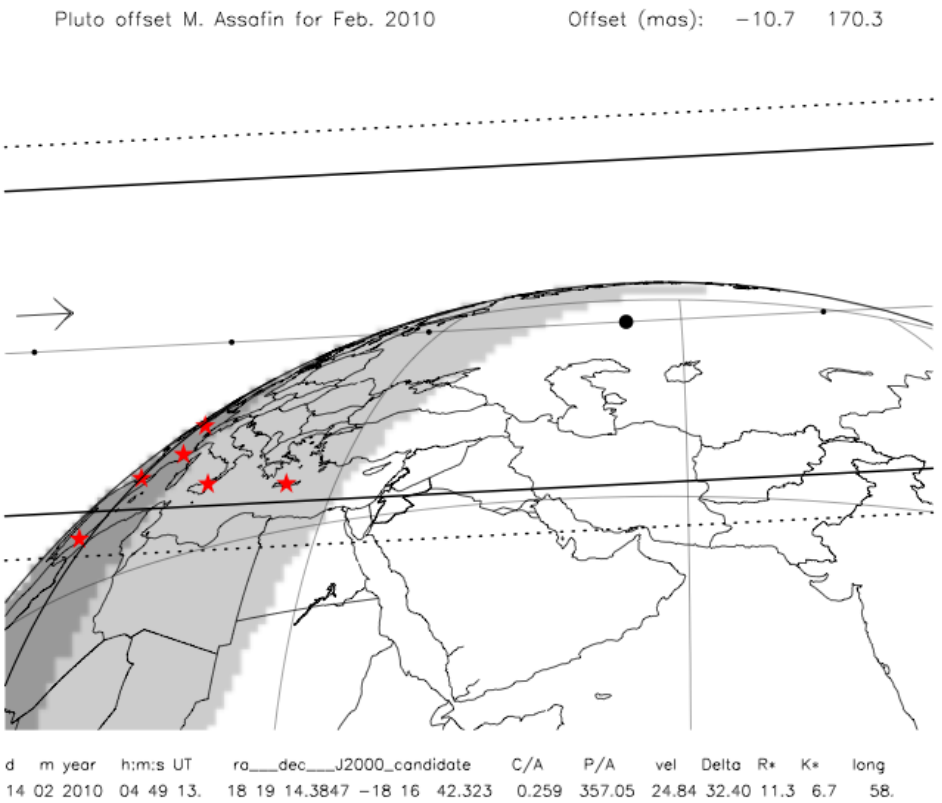
2010 - end of the dust lanes



- Every year - monitor Pluto's atmosphere for change.
  - One or more chords at SNR per scale height > 25
  - Supporting chords to establish the geometry
- If possible, observe events with SNR high enough to derive thermal structure (SNR/H > 60)
- If possible, observe near the shadow center to probe the deepest possible altitudes
- If possible, observe in multiple wavelengths

2010 Feb 14 - deployment overview

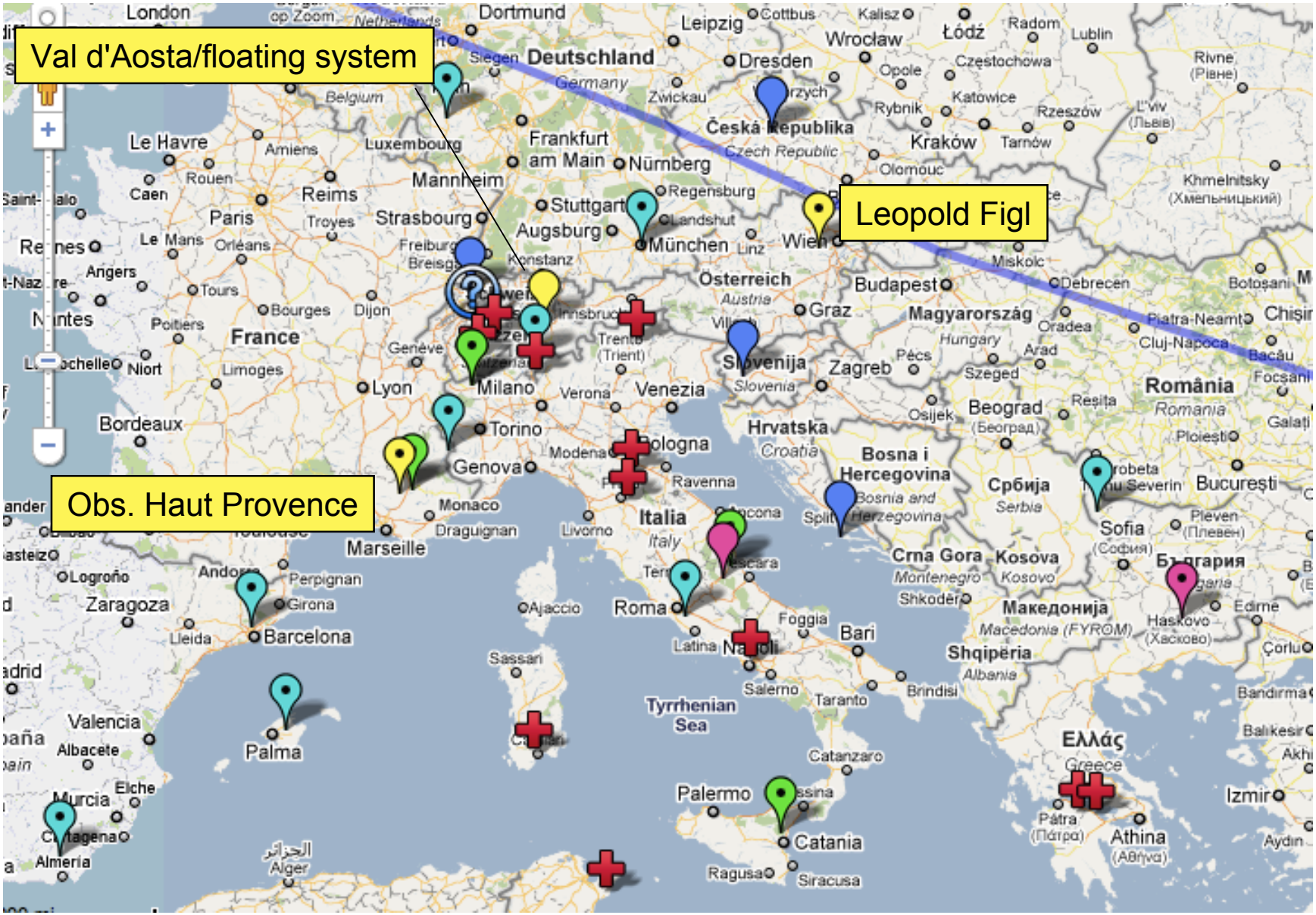
- Bright star. V=11.0, K=6.5
- Original PHOT prediction was much farther south, not as interesting
- January, Meudon group passed on new prediction
  - PHOT to contribute 3-5 sites in a Meudon deployment
  - New deployment strategy for these 2 groups
- Difficulties:
  - Low altitude
  - Twilight
  - Weather
  - One side of the center line



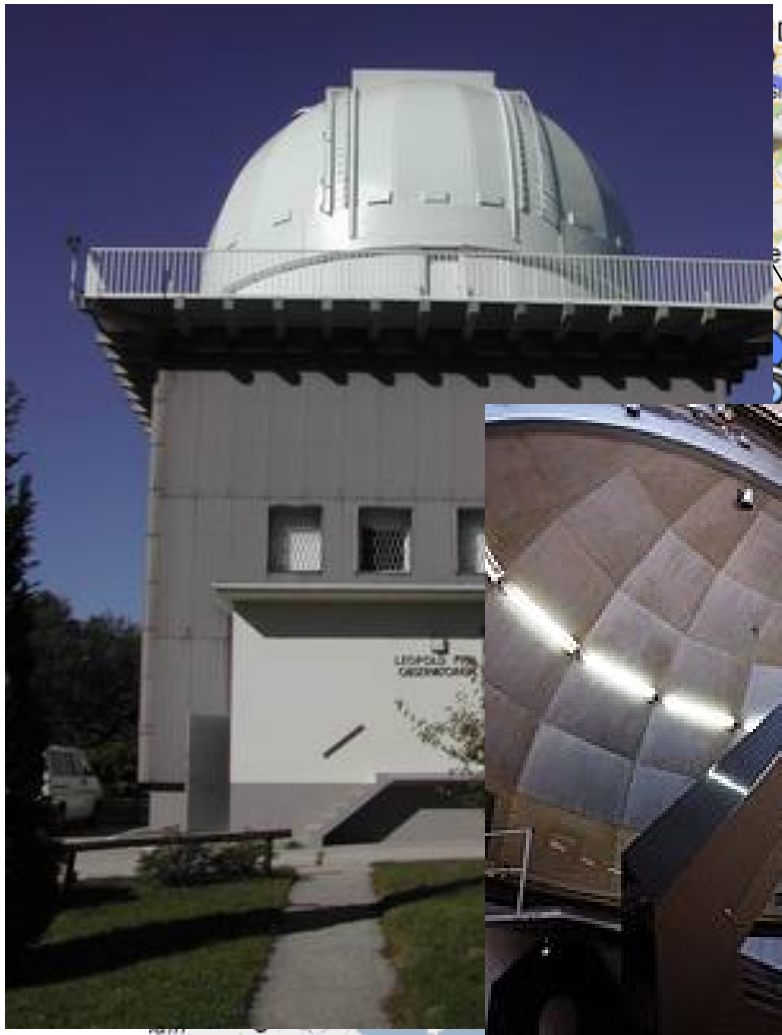
- Advantages
  - Bright!
  - Many telescopes and observers in Europe
  - Flexibility and mobility

Francois Colas, Cathy Olkin, Larry Wasserman, Paul Starkis, Eliot Young, Thomas Widemann
Bruno Sicardy Leslie Young
(not shown Harold Reitsema, taking the picture)

2010 Feb 14 - site planning as of Feb 9 (Yellow = PHOT, pink = IR)



2010 Feb 14 - site planning as of Feb 9
(Yellow = PHOT, pink = IR)



2010 Feb 14 - site planning as of Feb 9 (Yellow = PHOT, pink = IR)

Obs. Haut Provence

Leslie Young & Harold Reitsema
0.8-m telescope
Near Aix-en-Provence
Clouds, frozen dome

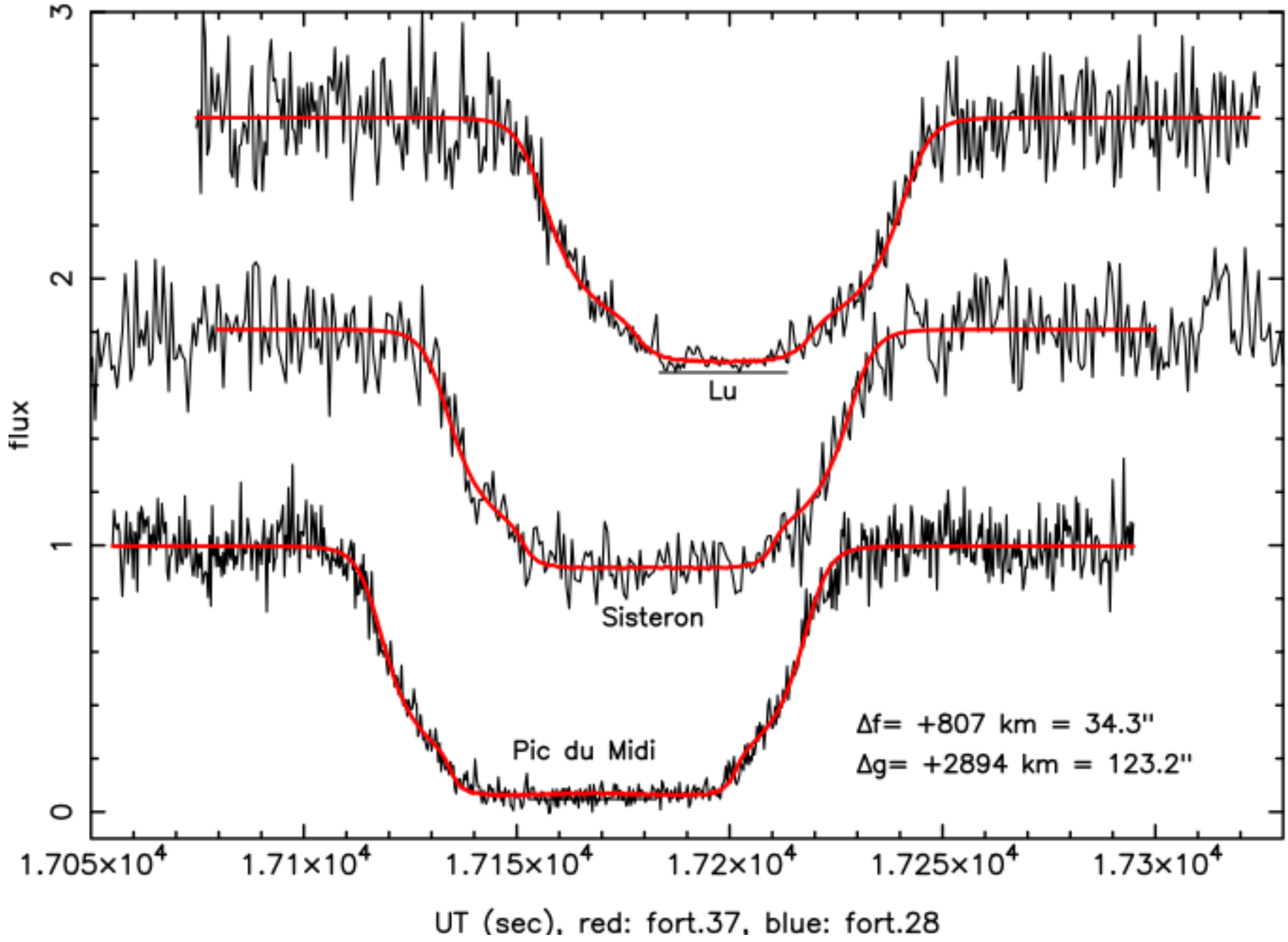
Lü, Switzerland

Lü, Switzerland

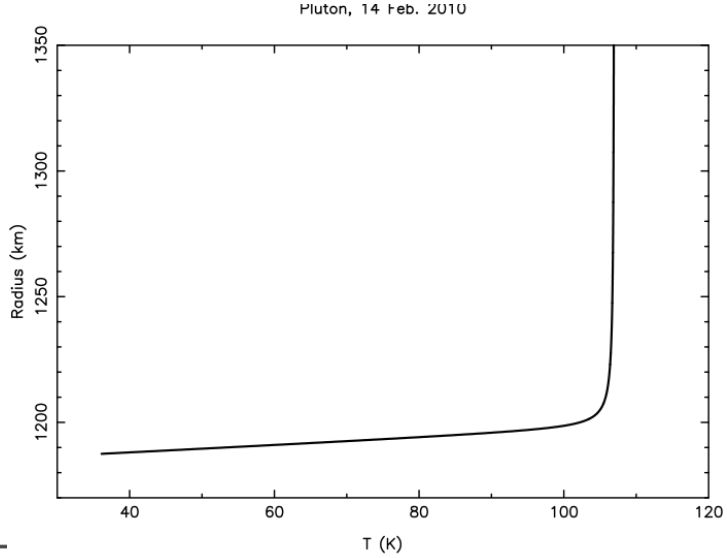
Falera

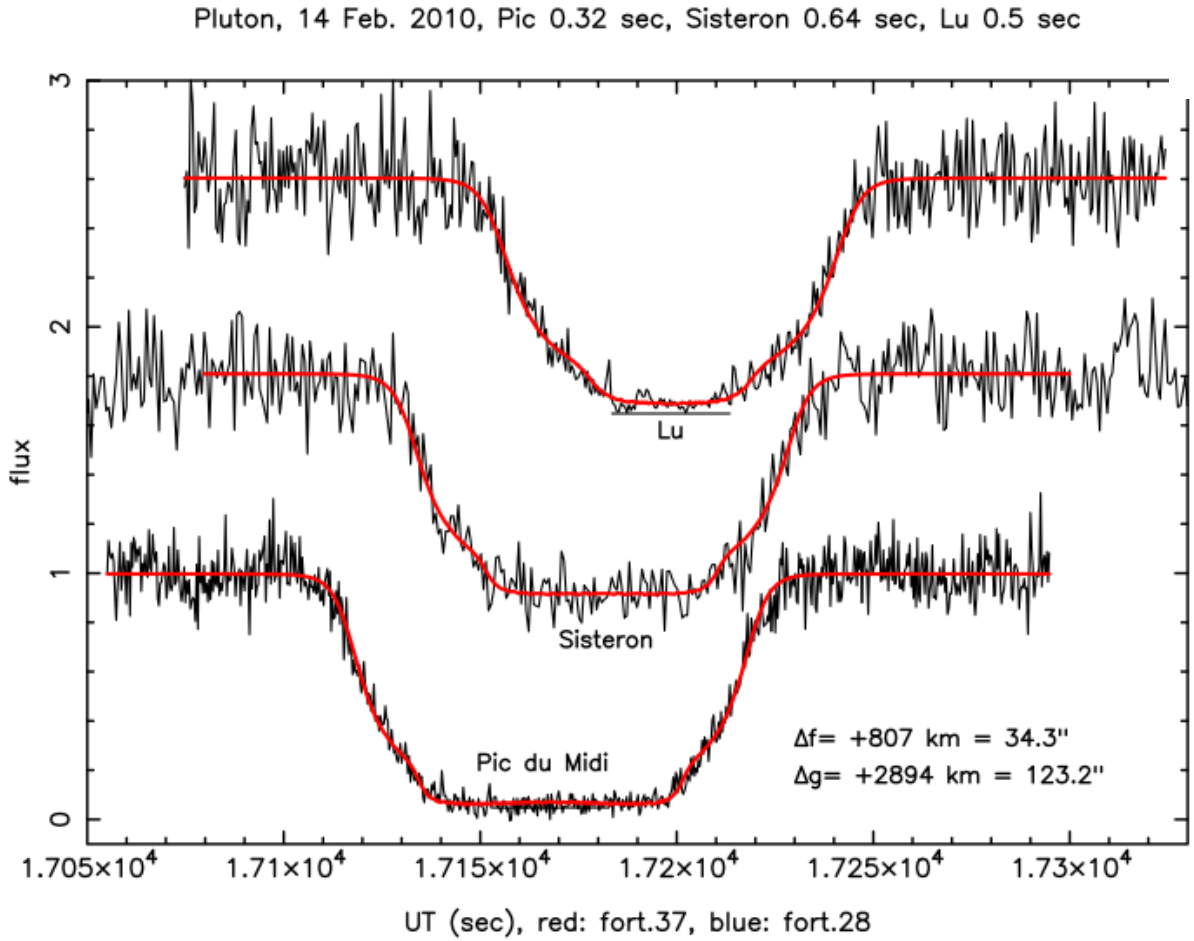
Cathy Olkin & Larry Wassermann
0.9-m telescope
Wall!

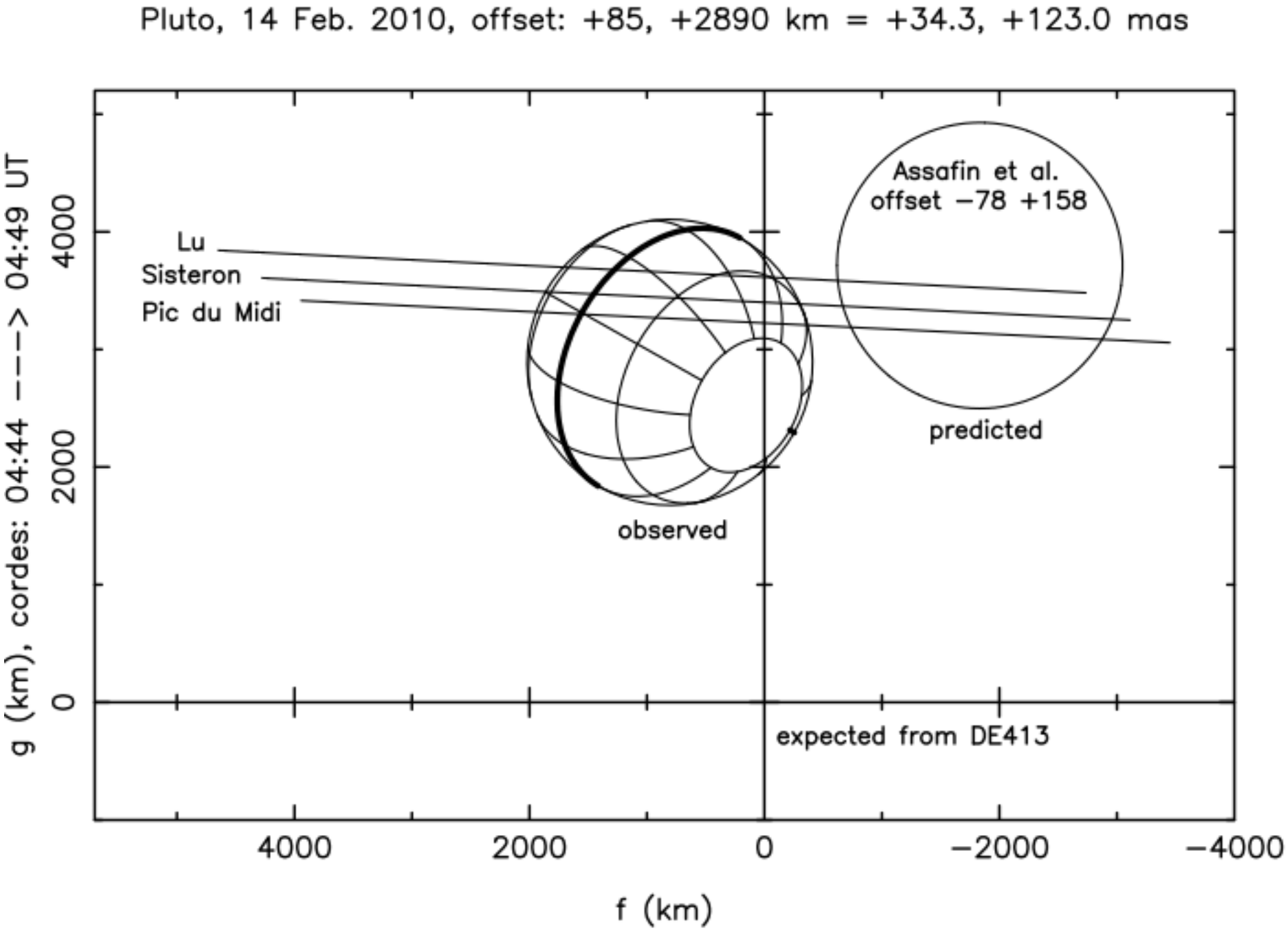
Cathy Olkin & Larry Wassermann
0.36-m telescope
Alpine Astrovilliage
Near Lü, Switzerland
Success!
SNR/H = 14


Pluton, 14 Feb. 2010, Pic 0.32 sec, Sisteron 0.64 sec, Lu 0.5 sec
flux
3
2
1
0
Lu
Sisteron
Pic du Midi
Δf= +807 km = 34.3"
Δg= +2894 km = 123.2"
1.705×10^4
1.71×10^4
1.715×10^4
1.72×10^4
1.725×10^4
1.73×10^4
UT (sec), red: fort.37, blue: fort.28

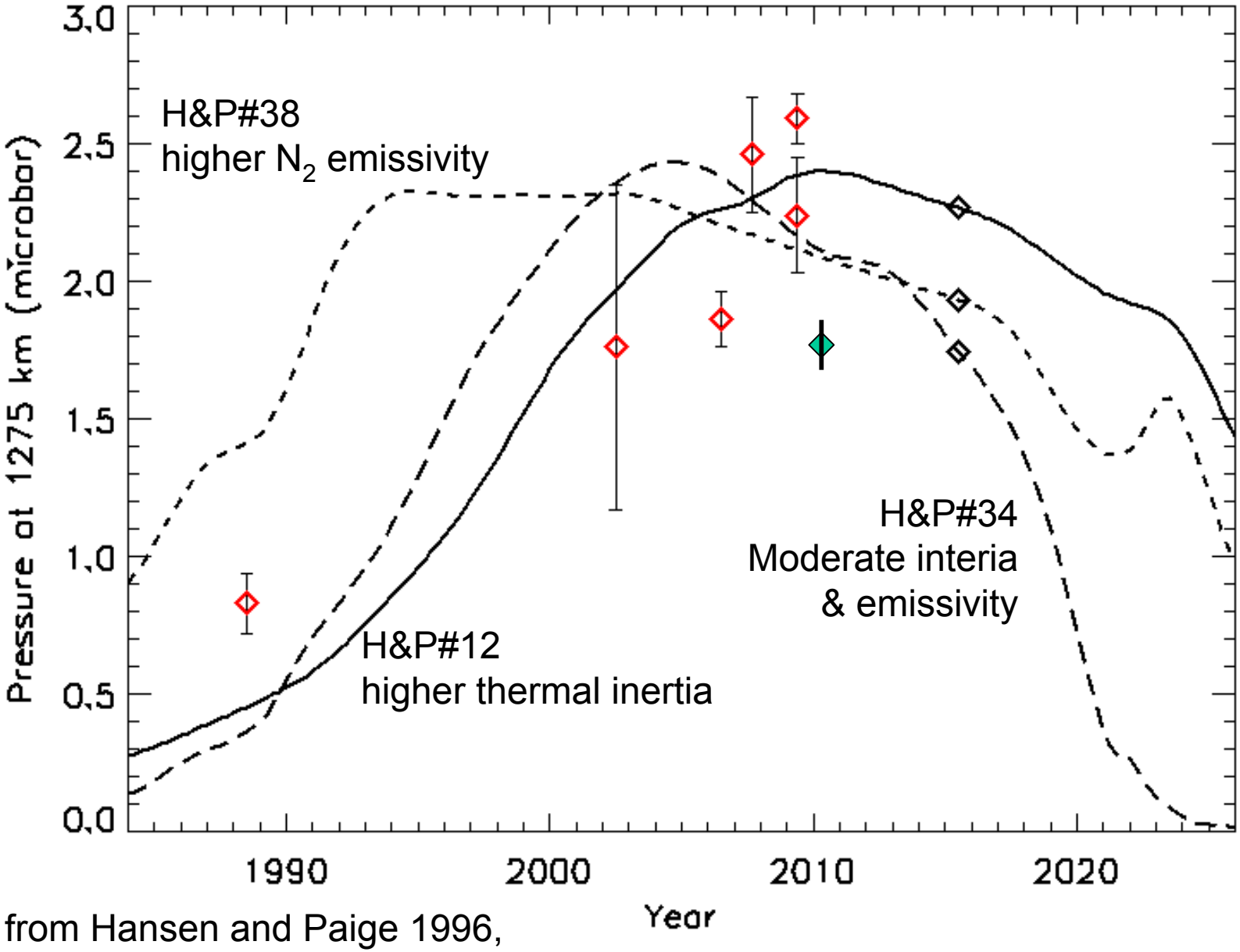
- Meudon method: Take a standard T(z) and fit for the astrometric offset and pressure scaling factor to all lightcurves.
- Half-light radius 1218.6±10 km
- Pressure at 1275 km 1.787±0.076 μbar





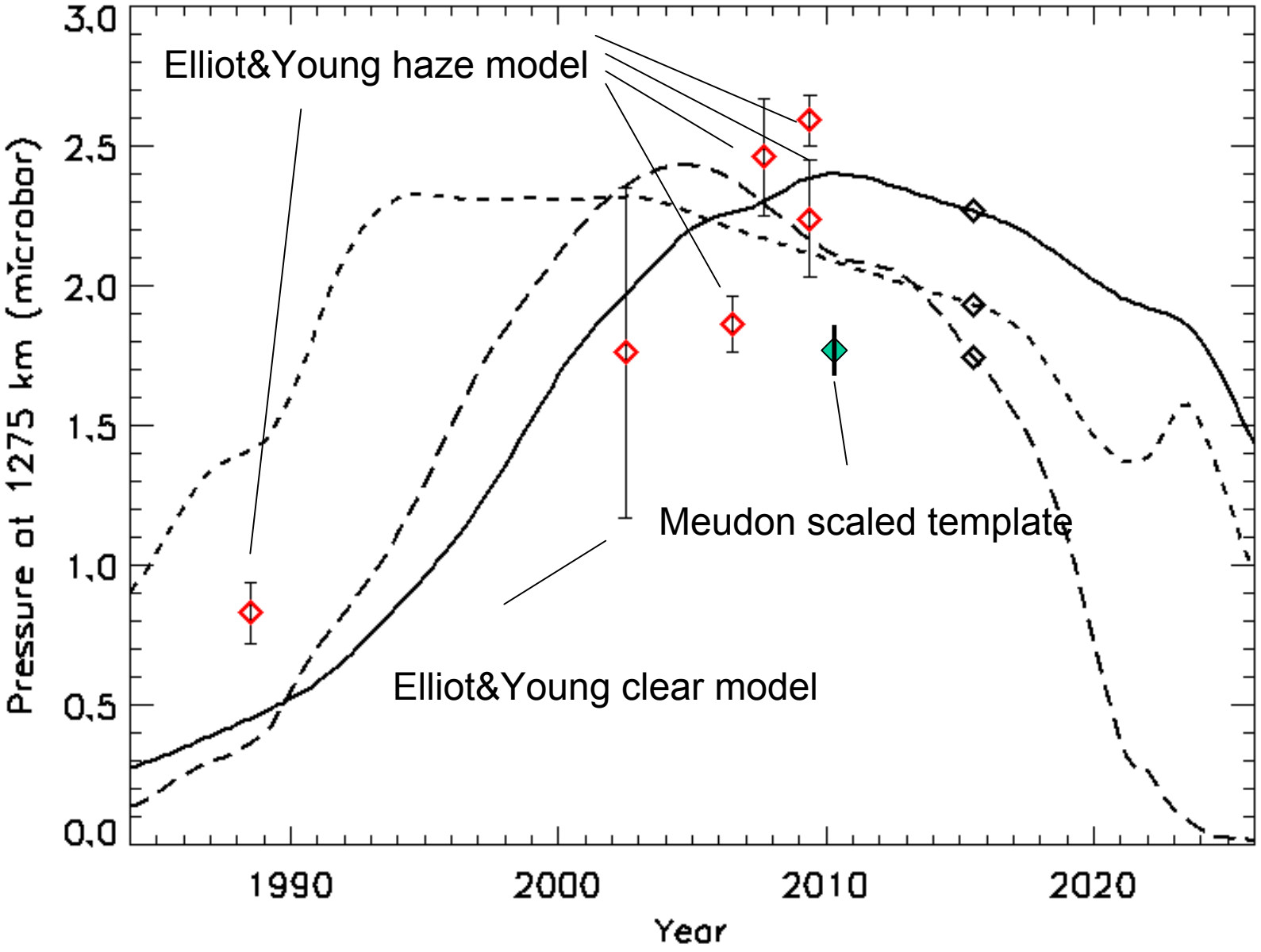

Pluto, 14 Feb. 2010, offset: +85, +2890 km = +34.3, +123.0 mas
Assafin et al.
offset −78 +158
Lu
Sisteron
Pic du Midi
predicted
observed
expected from DE413
g (km), cordes: 04:44 ----> 04:49 UT
4000
2000
0
4000
2000
0
−2000
−4000
f (km)

Pressure Trends with Time

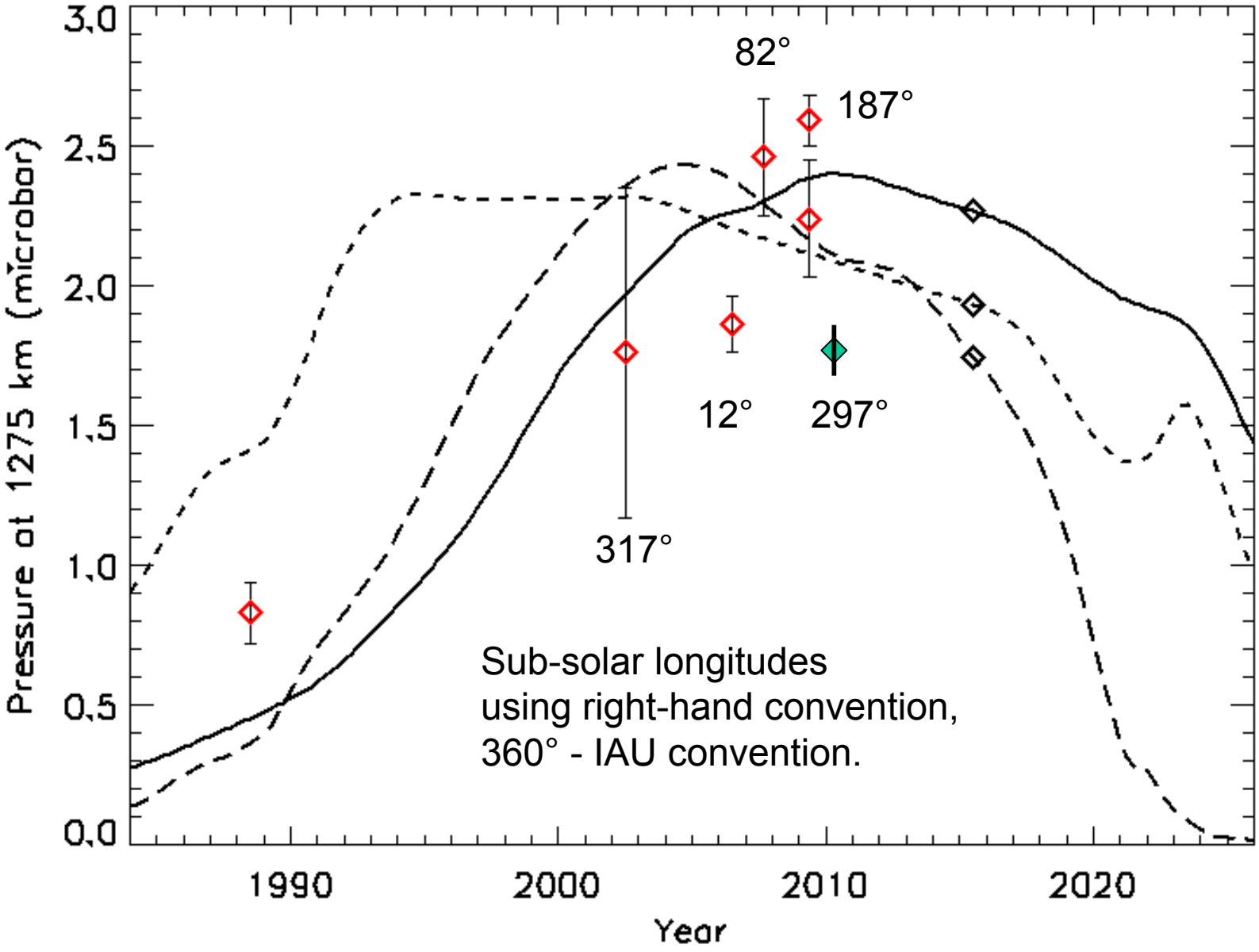


Models from Hansen and Paige 1996,

Pressure Trends with Time

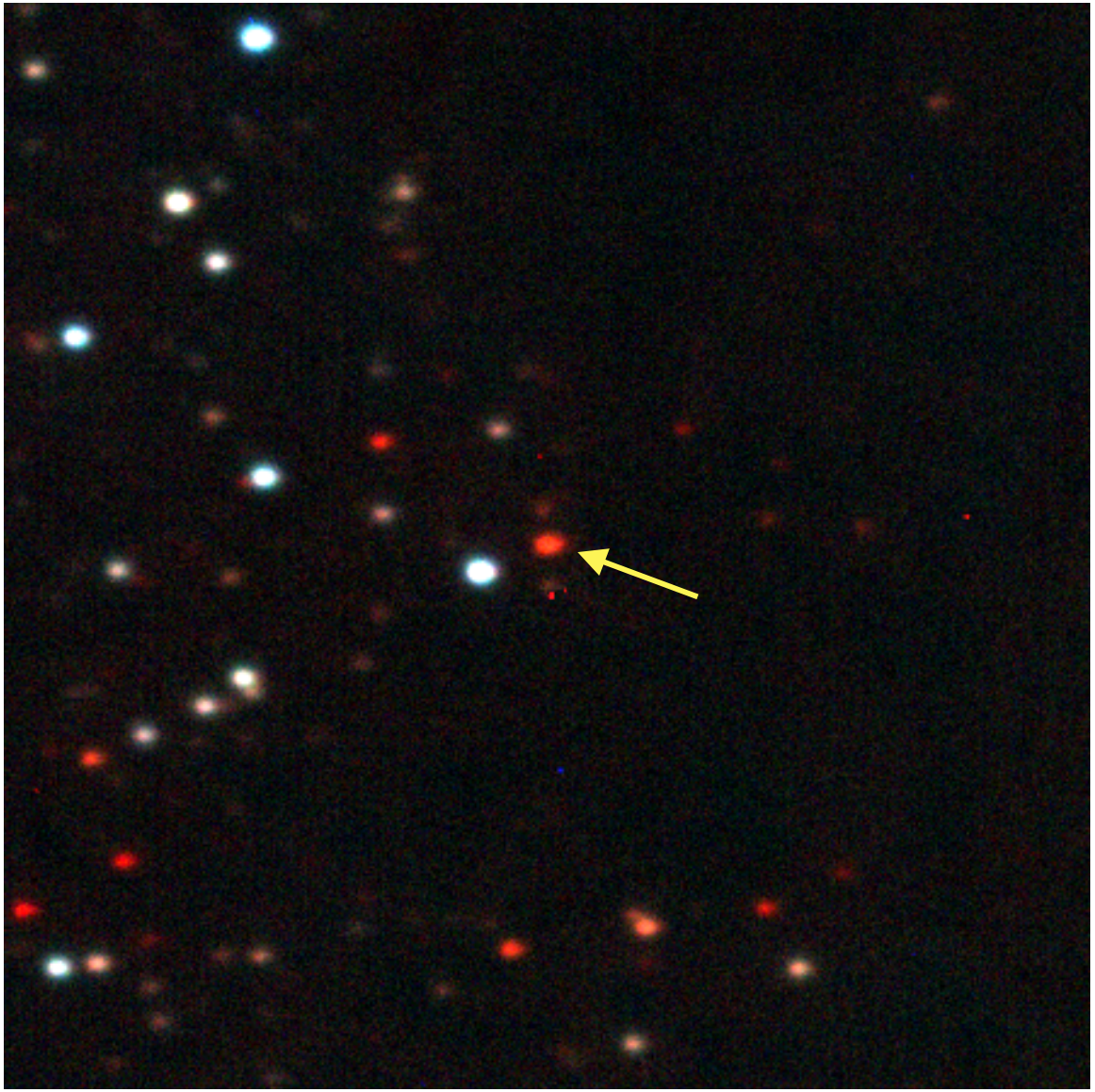


Pressure Trends with Time



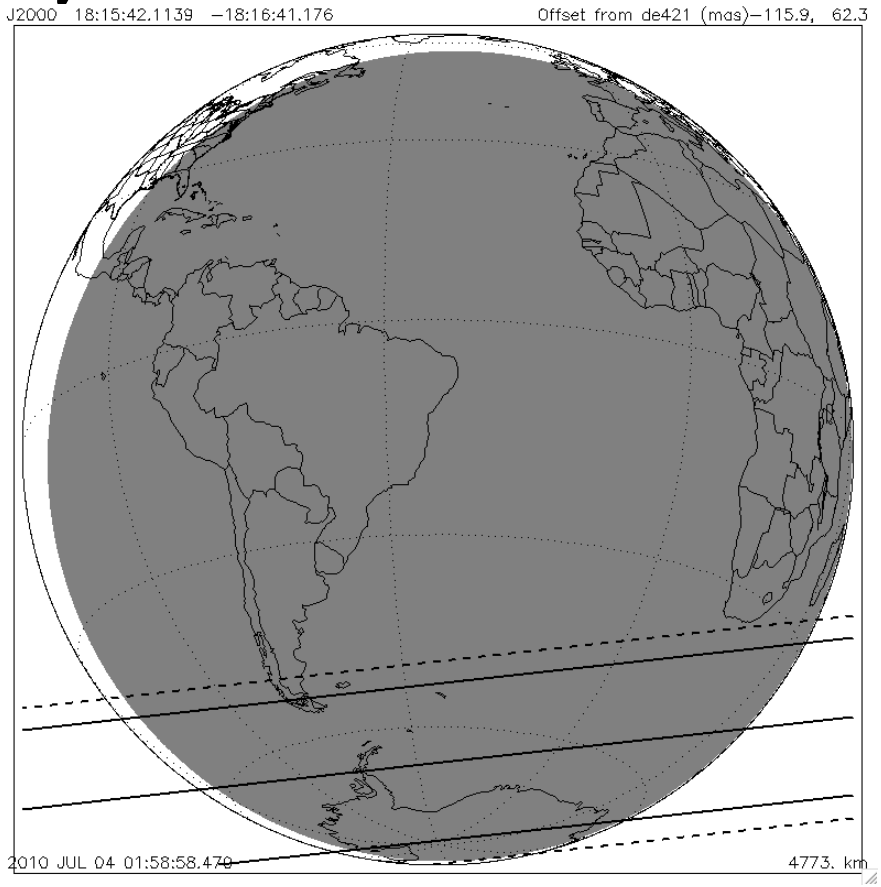
New PHOT astrometric list, Lowell 31"

- Lowell 31" robotic telescope
- 3 Filters: B, V, and CH4 filters
- Marc Buie and Larry Wasserman set up observing program, perform astrometry.
- 2010 July 4 star------>



2010 July 4 - deployment overview

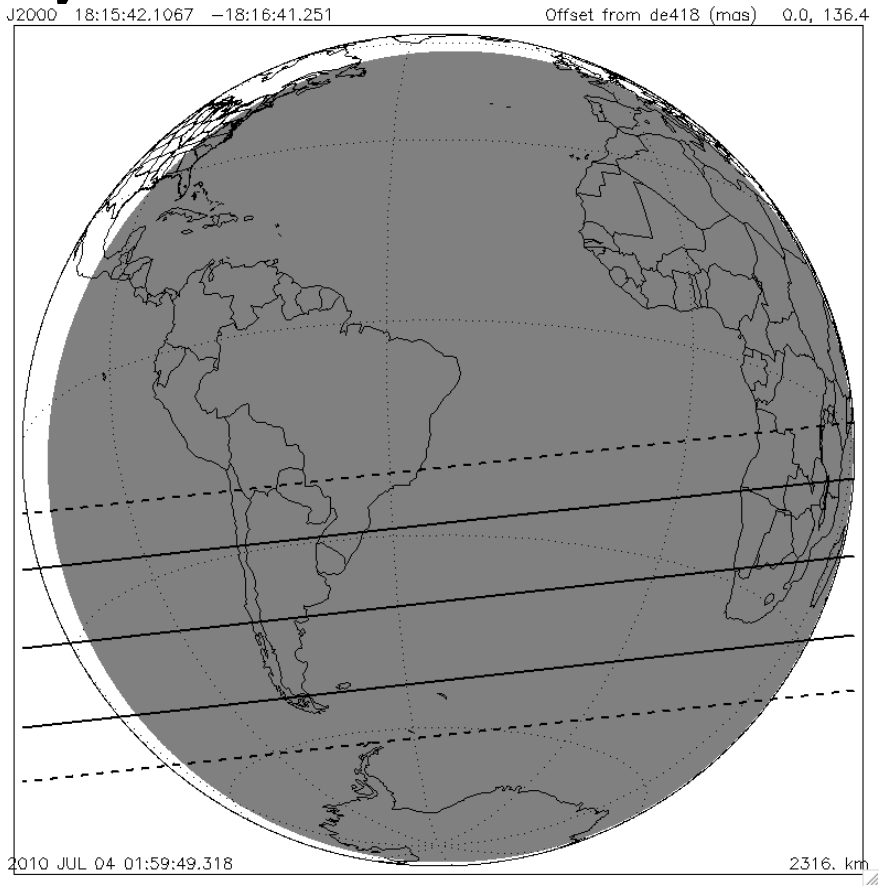
- Red star. I=13.2 (vs. Pluto I=13.3)
- PHOT predictions based on new astrometric catalog, taken at Lowell in 2009.
- POETS (MIT/Williams), Meudon, and PHOT deploying independently
  - POETS and Meudon passed on lists of sites already secured.
- Advantages
  - Sites covering a large cross-track distances
  - Expect good weather in southern Africa, northern Chile
  - Some familiar countries (Namibia, South Africa, Chile)



- Difficulties
  - World cup
  - Few large telescopes
  - Divergence of predictions
  - Two continents to consider

2010 July 4 - deployment overview

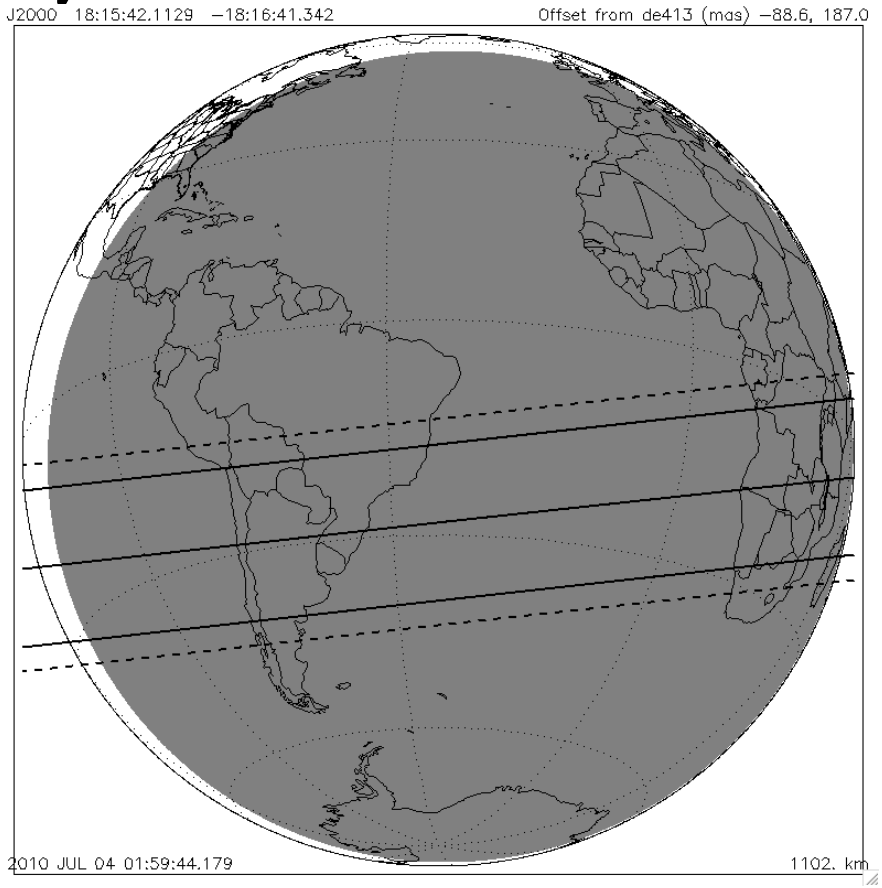
- Red star. I=13.2 (vs. Pluto I=13.3)
- PHOT predictions based on new astrometric catalog, taken at Lowell in 2009.
- POETS (MIT/Williams), Meudon, and PHOT deploying independently
  - POETS and Meudon passed on lists of sites already secured.
- Advantages
  - Sites covering a large cross-track distances
  - Expect good weather in southern Africa, northern Chile
  - Some familiar countries (Namibia, South Africa, Chile)



- Difficulties
  - World cup
  - Few large telescopes
  - Divergence of predictions
  - Two continents to consider

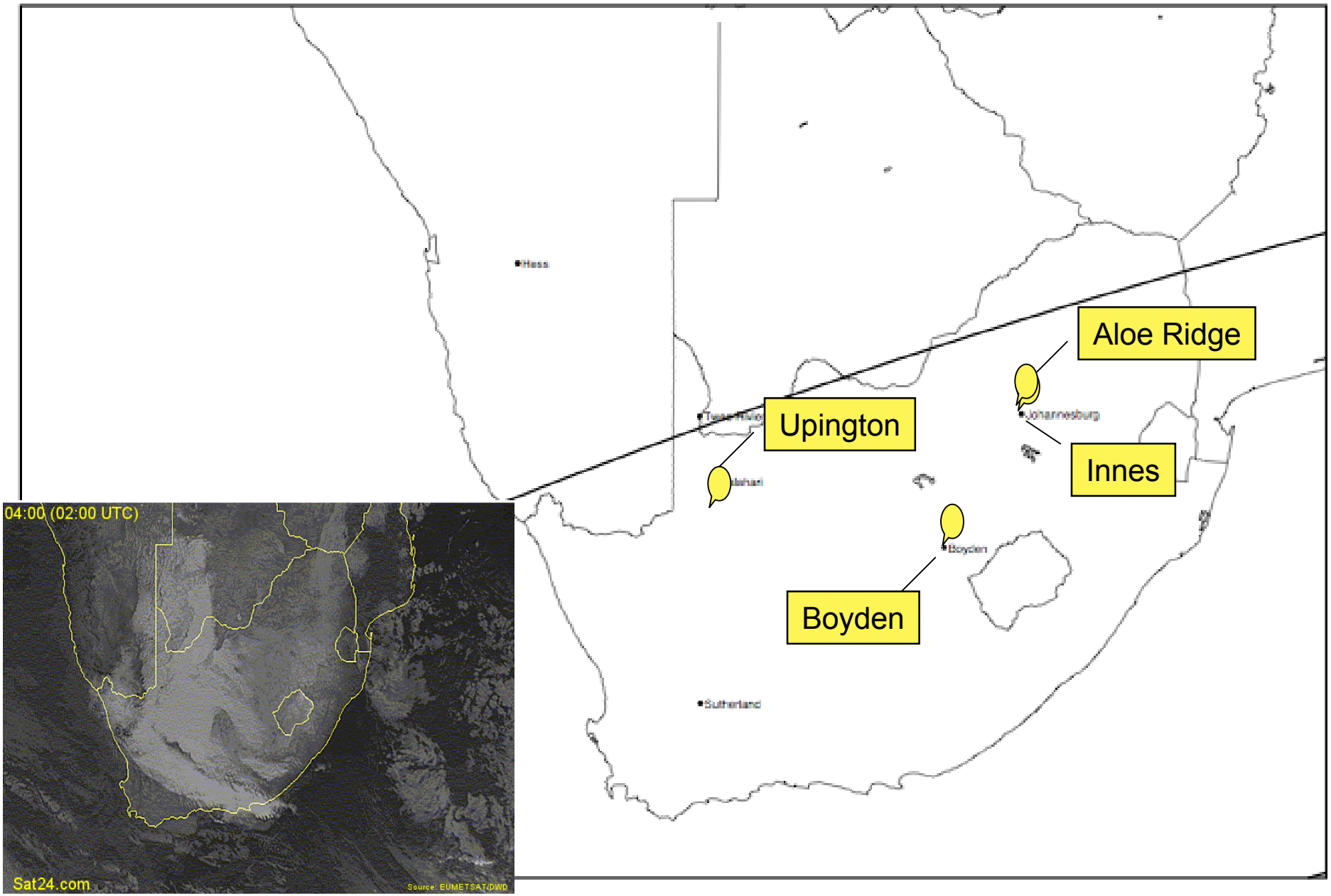
2010 July 4 - deployment overview

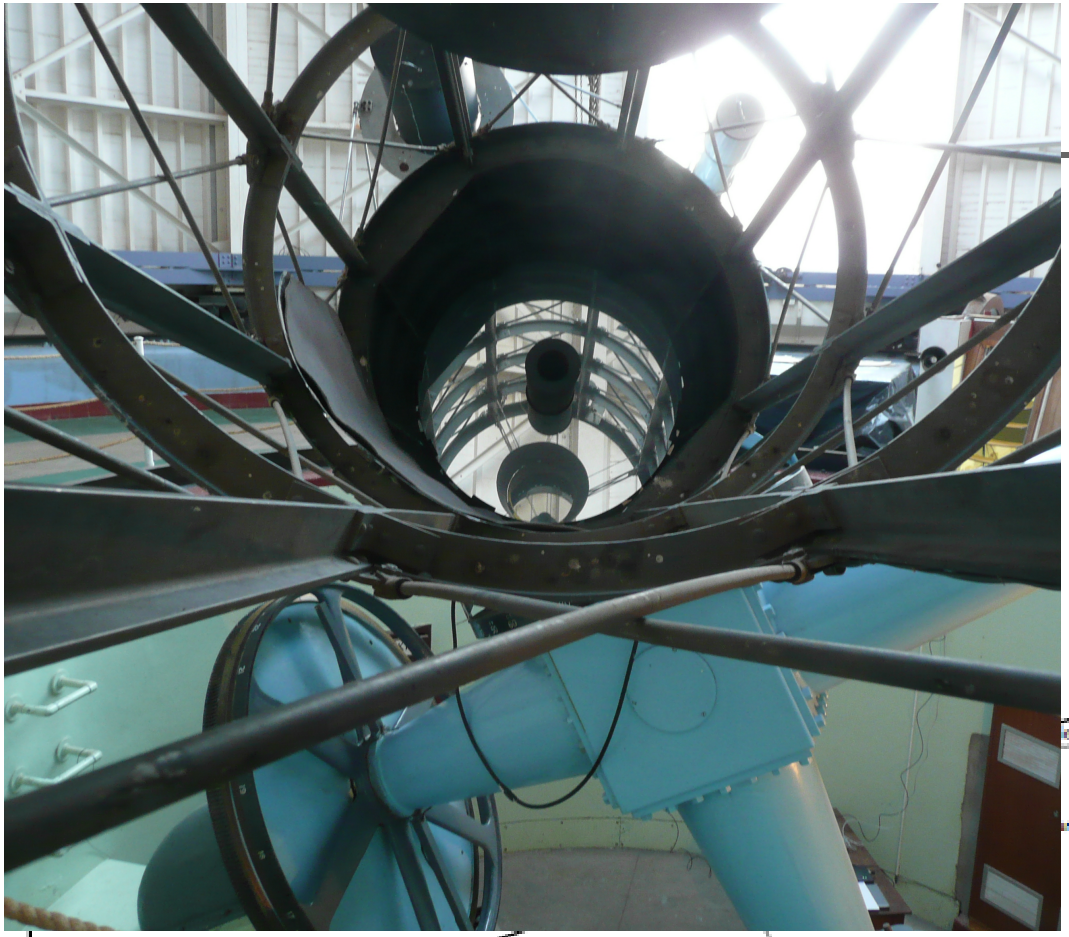
- Red star. I=13.2 (vs. Pluto I=13.3)
- PHOT predictions based on new astrometric catalog, taken at Lowell in 2009.
- POETS (MIT/Williams), Meudon, and PHOT deploying independently
  - POETS and Meudon passed on lists of sites already secured.
- Advantages
  - Sites covering a large cross-track distances
  - Expect good weather in southern Africa, northern Chile
  - Some familiar countries (Namibia, South Africa, Chile)



- Difficulties
  - World cup
  - Few large telescopes
  - Divergence of predictions
  - Two continents to consider

2010 July 4 - PHOT sites





Boyden

Leslie Young, Melissa Brucker, Pat v Heerden
1.5-m telescope
Near Bloemfontain
Clouds.

Marc Buie, Larry Wasserman
0.36-m telescope
Kalahari Desert
Clouds!

Upington

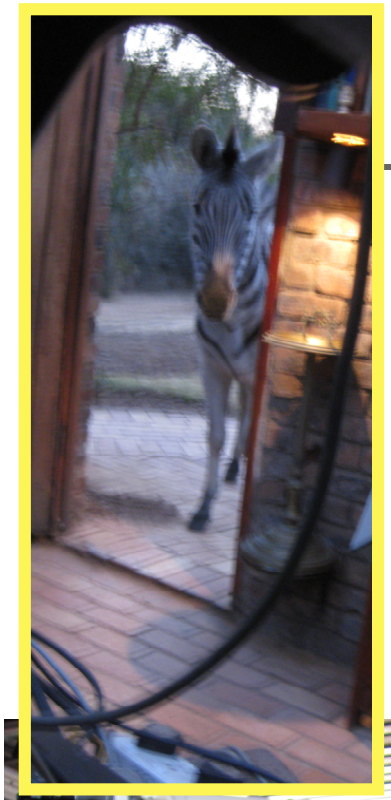
Johannesburg

Boyden

Sutherland

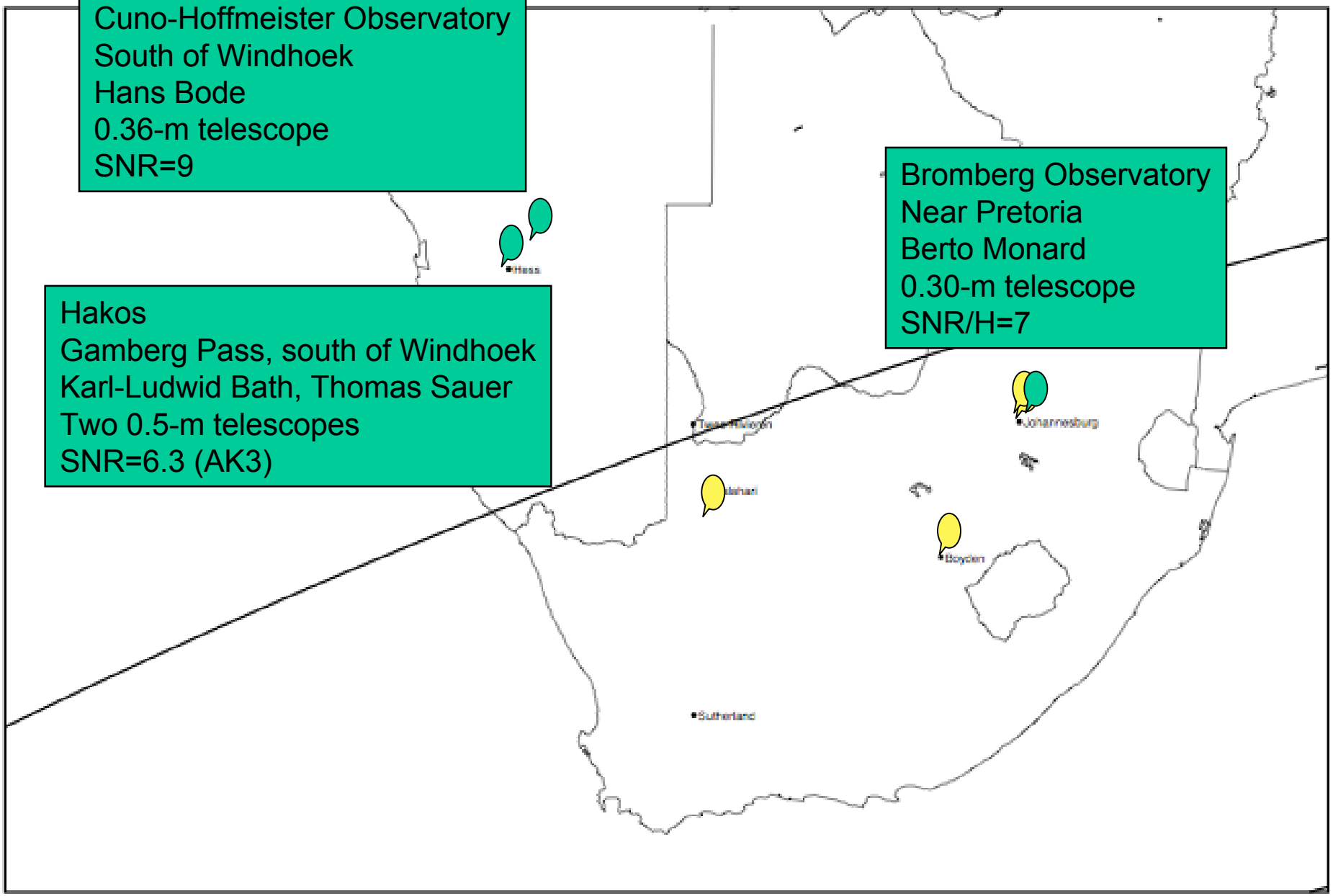
Innes

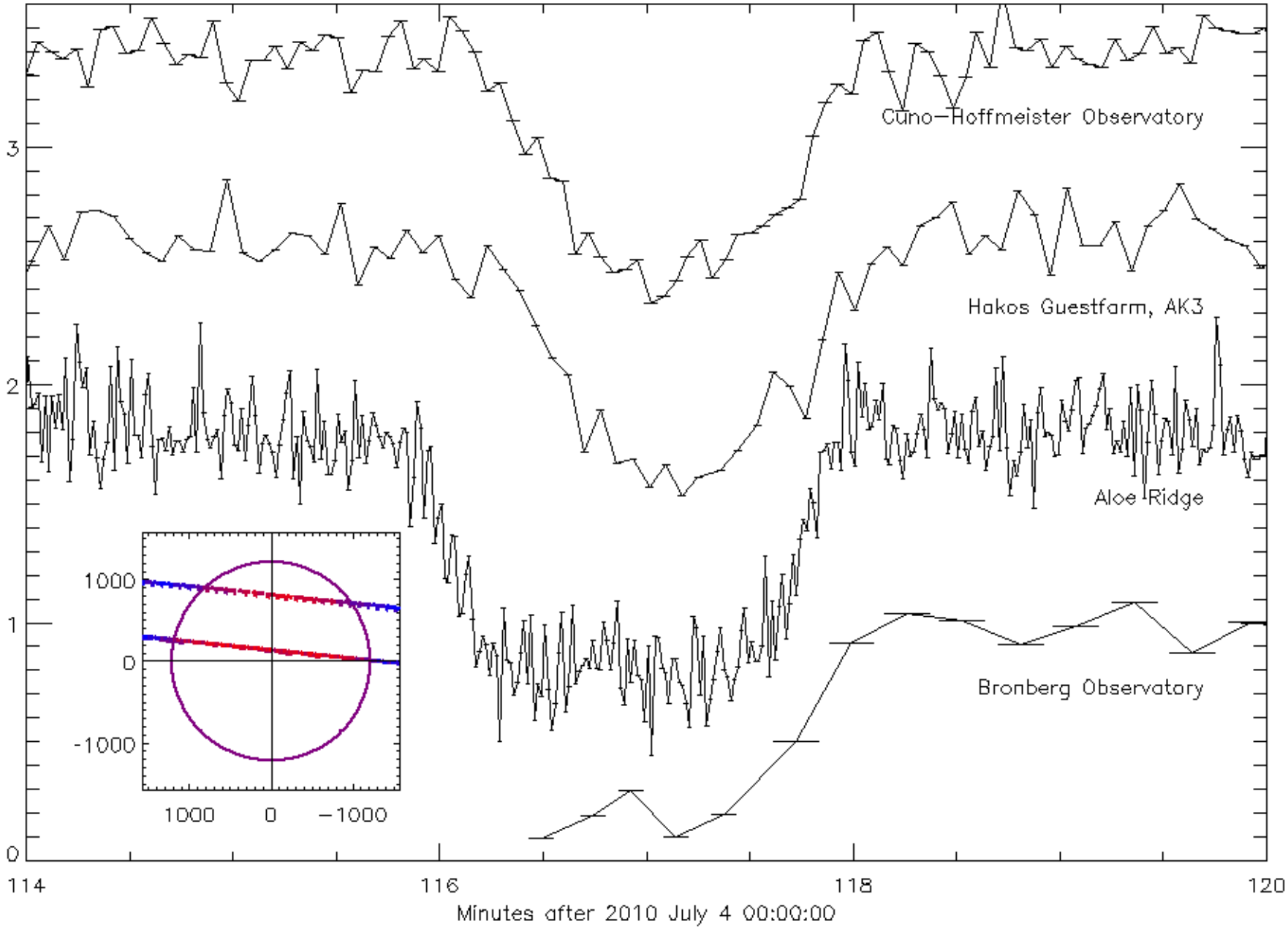
Talia Sepersky, Brian Fraser
0.67-m telescope (refractor)
In Johannesburg
Haze, damaged HA wheel



Bob Howell, Kate Lonergan, Alex Richter
0.65-m telescope
North of Johannesburg
Success! SNR=11.

2010 July 4 - other small telescopes



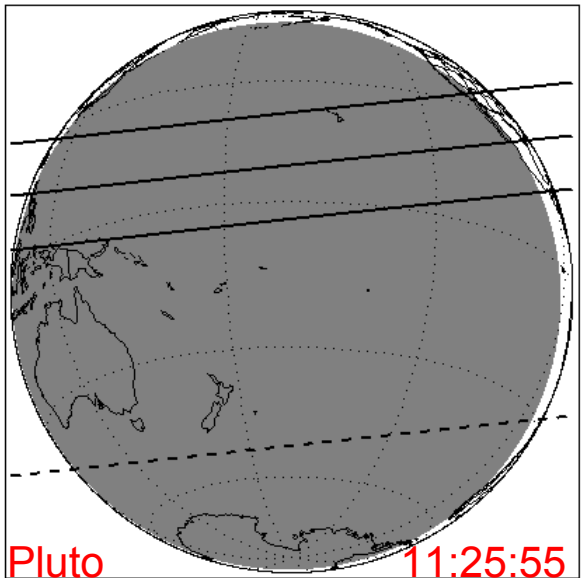

Cüno–Hoffmeister Observatory
Hakos Guestfarm, AK3
Aloe Ridge
Bronberg Observatory
3
2
1
0
1000
0
-1000
1000
0
−1000
114
116
118
120
Minutes after 2010 July 4 00:00:00

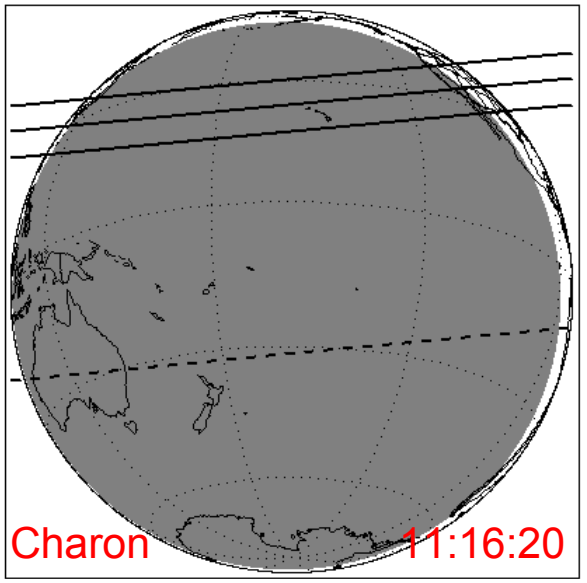
Conclusions

- PHOT team observed two occultations in 2010,
  - Feb 14, led by Meudon group (Sicardy, Widemann).
  - Jul 4, contributing light curve to Person et al. analysis.
- Lightcurves are qualitatively similar to 2002-2009
  - Shape of upper lightcurve similar to previous lightcurves => temperatures in upper atmosphere remain near 100 K
  - Lightcurves reach near zero flux level => haze or steep thermal gradient in lower atmosphere.
  - Central bulge in 2010 July 4 lightcurves from Johannesburg suggests little haze.
- Reported pressure at a radius of 1215 km in Pluto's atmosphere is similar to that in 2007, but *lower* in 2010 Feb 14 than in 2007, 2009.
  - 2.45±0.21 μbar in 2007, 1.78±0.01 μbar in 2010.
  - Differences in analysis techniques? => Need discussion of techniques for lower SNR lightcurves.
  - Real changes in Pluto, perhaps related to sub-solar longitude => Need occultations spaced to proble short-term variation.

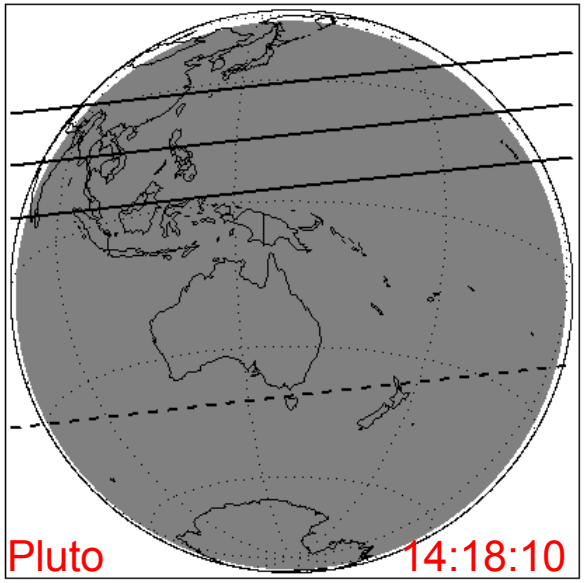
2011: bright stars, 4-day sample, satellites

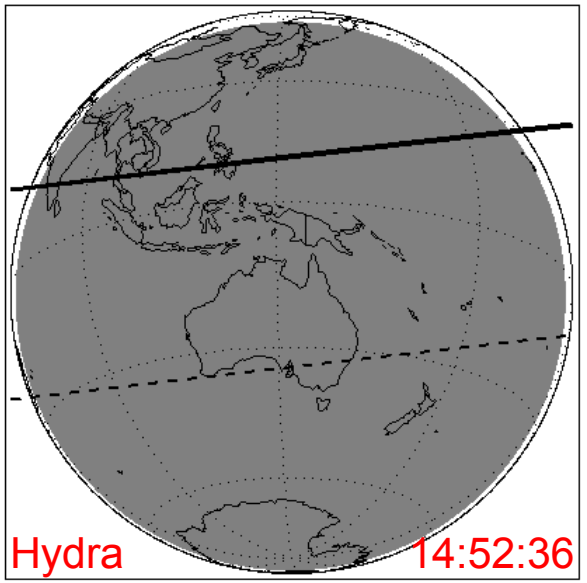
2011-06-23
I=12.7, K=9.7





2011-06-27
I=13.0, K=11.9





Predictions use Lowell catalog, and DE418/Plu017 + (0" ra, -0.15" dec)