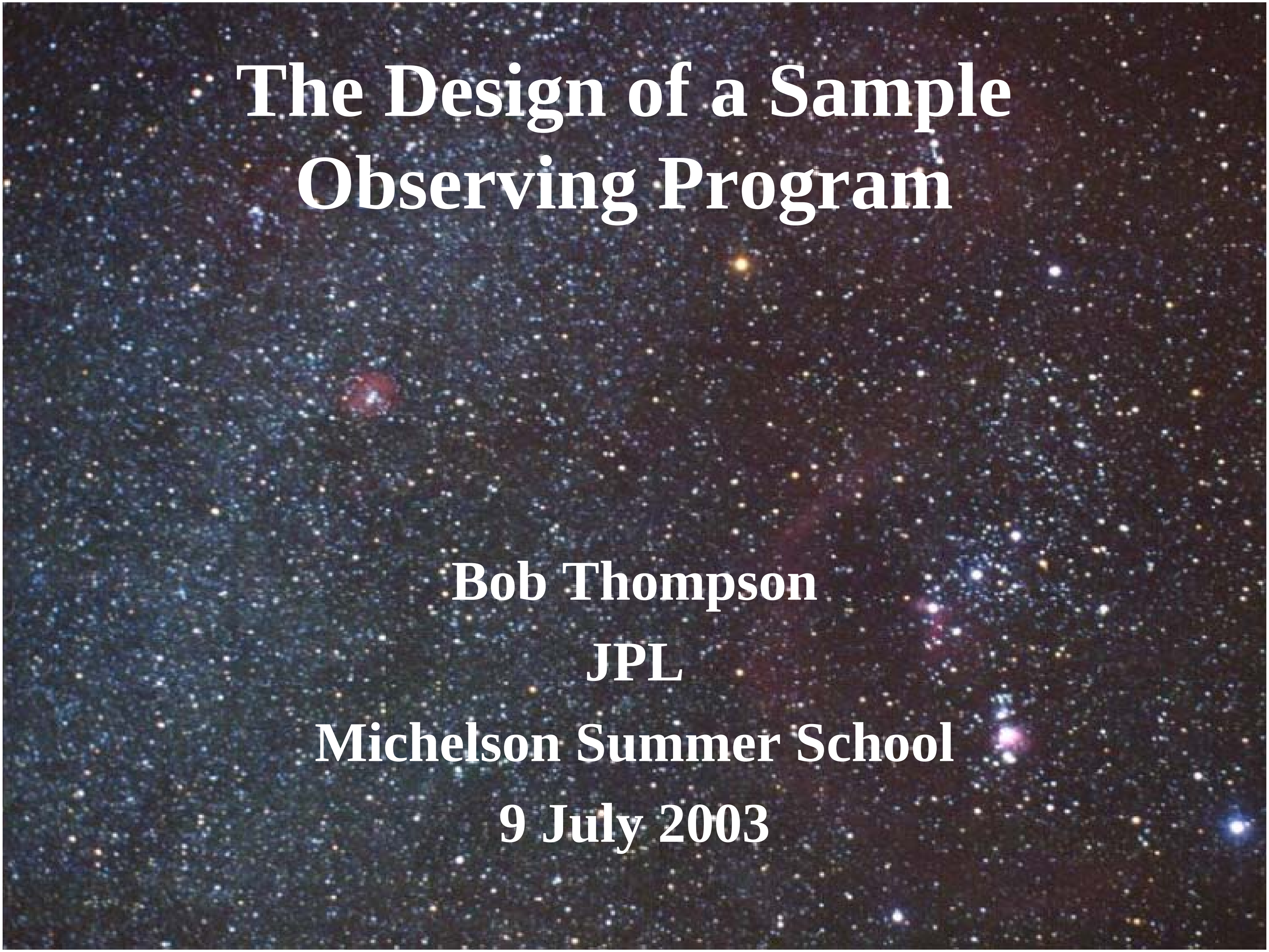

The Design of a Sample Observing Program

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JPL
Michelson Summer School
9 July 2003

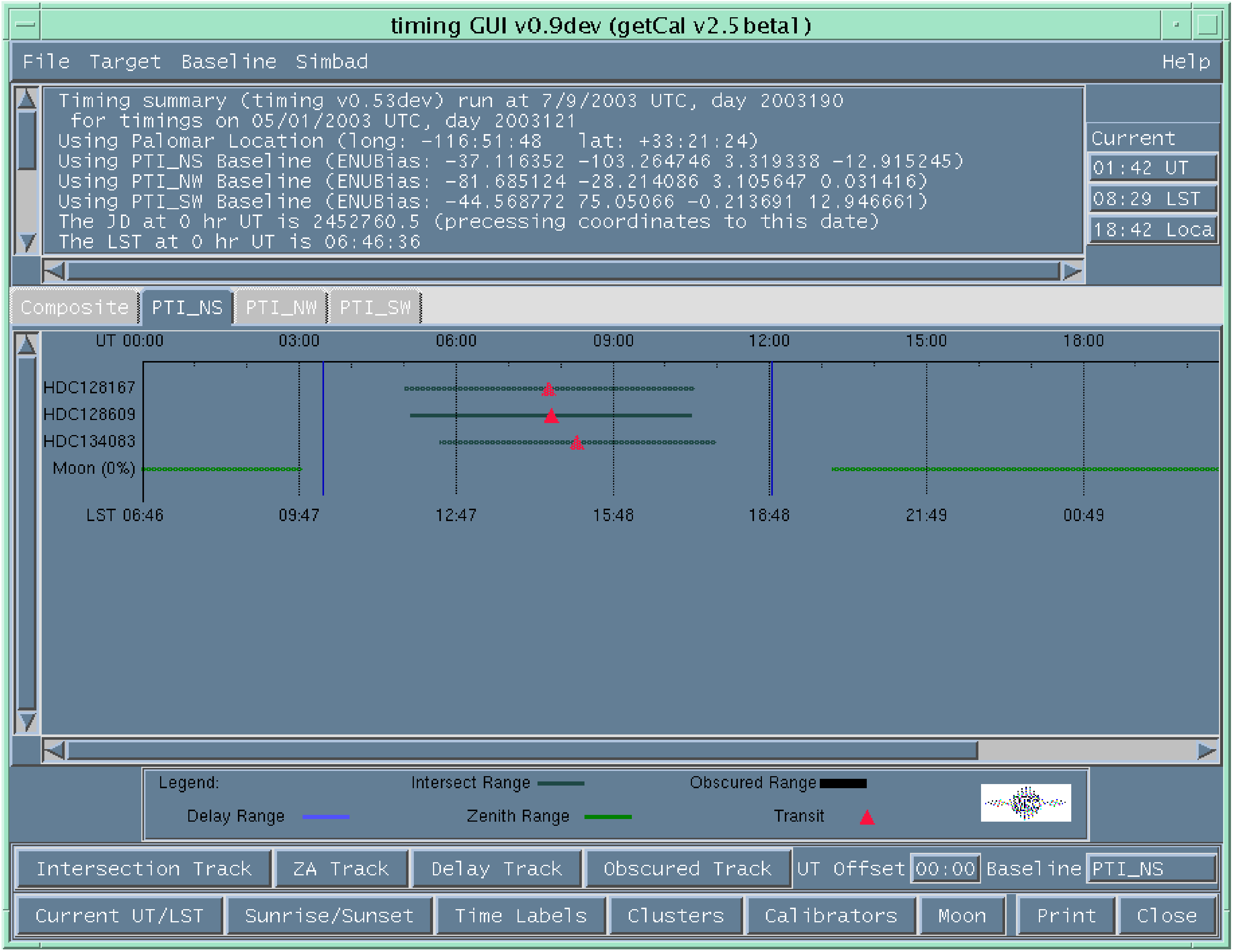
Target Selection

- Choose scientifically interesting targets that are viable for the interferometer you’re using.
- Make sure your science program hasn’t already been done before.
- Utilize previous studies in the literature to gain as much information on your target as possible. Single baseline interferometry requires *a priori* assumptions about your target: (Uniform disk? Binary modeled as two point sources? Thin disk with point source? etc etc)

Viability

- For a source changing in brightness (variable stars), use available photometry to predict when your target can be viewed by the interferometer.
- Example: The sizes of pulsating Mira stars can be predicted based on their V-K color. Predict when size is within resolution range of IF, and predict when bright enough to stay tracked. (Also true of Cepheids, pulsating supergiants, etc.)
- Use a V^2 prediction program for binary stars and for target with non-circular symmetry.
- Anticipate the results before you get the data, and compare theory to observation.

Is the target viewable?

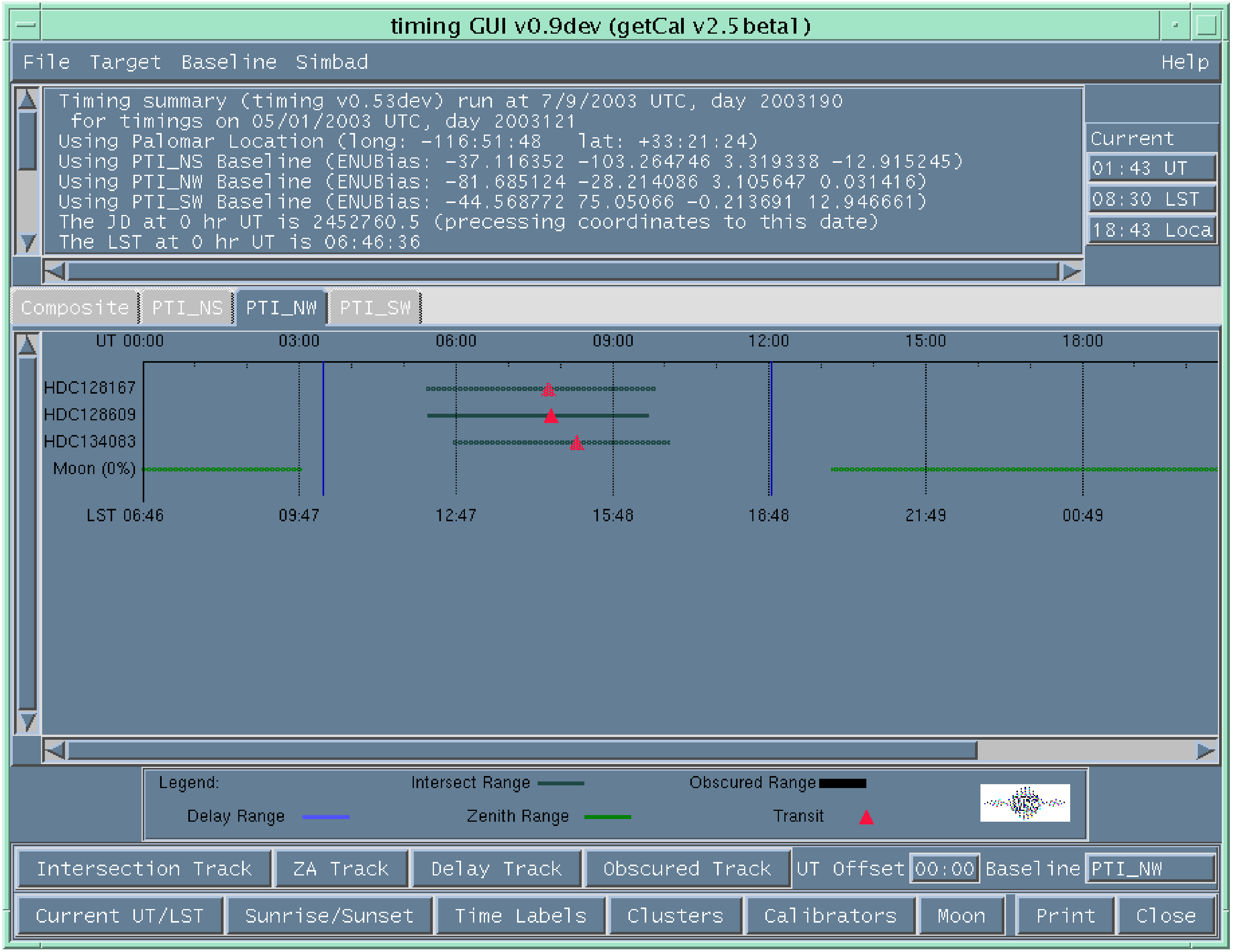


```
Timing summary (timing v0.53dev) run at 7/9/2003 UTC, day 2003190
 for timings on 05/01/2003 UTC, day 2003121
Using Palomar Location (long: -116:51:48   lat: +33:21:24)
Using PTI_NS Baseline (ENUBias: -37.116352 -103.264746 3.319338 -12.915245)
Using PTI_NW Baseline (ENUBias: -81.685124 -28.214086 3.105647 0.031416)
Using PTI_SW Baseline (ENUBias: -44.568772 75.05066 -0.213691 12.946661)
The JD at 0 hr UT is 2452760.5 (precessing coordinates to this date)
The LST at 0 hr UT is 06:46:36
```

Current
01:42 UT
08:29 LST
18:42 Loca

UT Offset 00:00
Baseline PTI_NS

Check other baselines…



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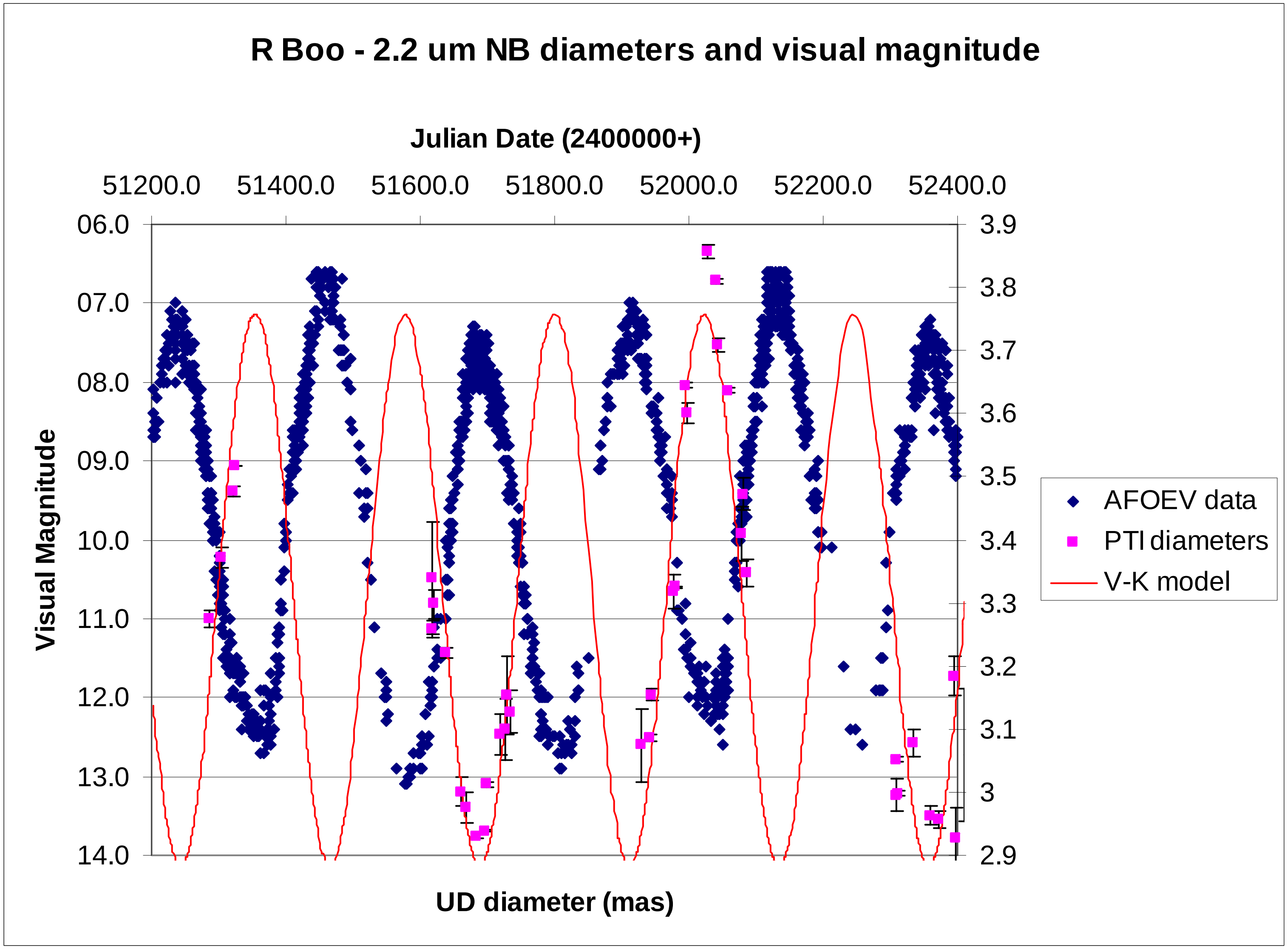
Current
01:43 UT
08:30 LST
18:43 Loca

UT Offset 00:00
Baseline PTI_NW

Predicting angular sizes: R Bootis (V-K) Oxygen-rich model

(Thompson et al, 2003)



Binary stars

Let’s say we wish to resolve a binary star orbit. We assume the two stars are uniform disks (UD), such that

$$|V|^2 = \left(2 \frac{J_1(\pi \mathrm{B} \theta / \lambda,)}{\pi \mathrm{B} \theta / \lambda} \right)^2$$

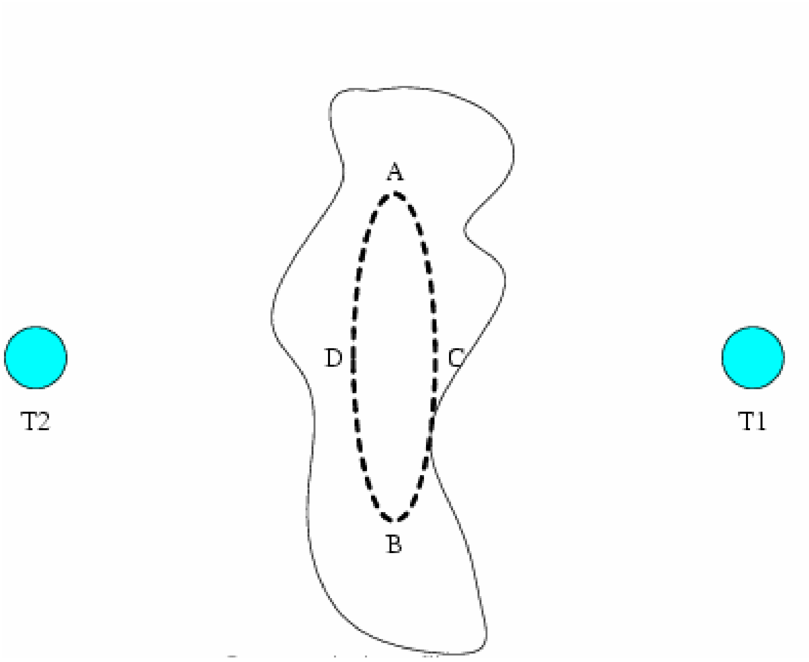
The expected squared visibility of a binary star is given by:

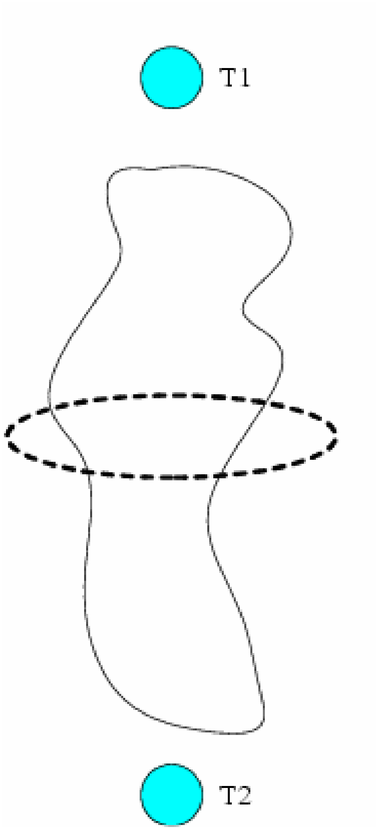
$$V_{nb}^2 = \frac{V_1^2 + V_2^2 r^2 + 2 V_1 V_2 r \cos(\frac{2\pi}{\lambda} \vec{B} \bullet \vec{s})}{(1 + r^2)}$$

where V_1 and V_2 are the visibility moduli for the two components, r is the apparent brightness ratio, B is the projected baseline vector, and s is the primary-secondary angular separation vector on the plane of the sky.

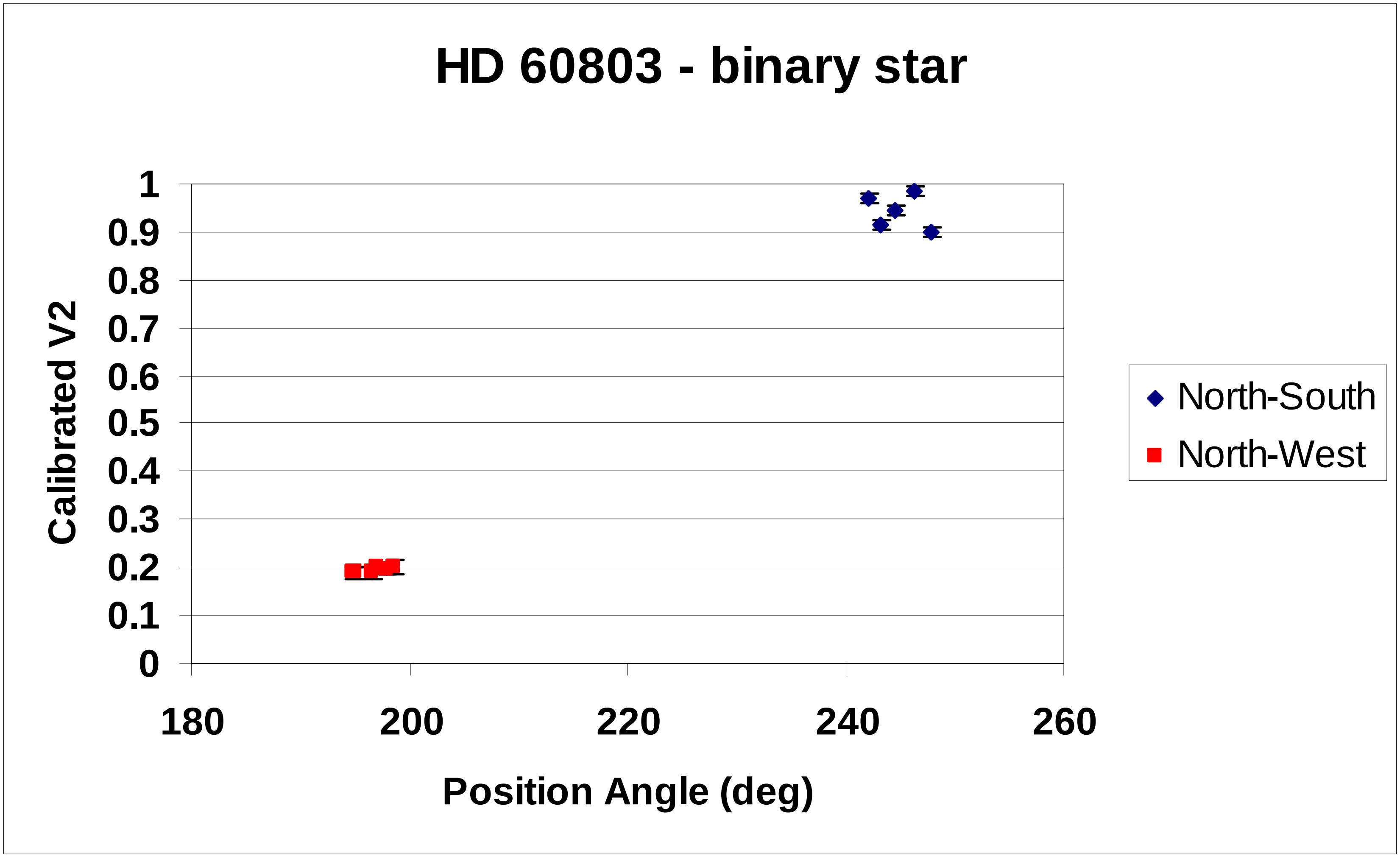
Location, Location, Location

- **Decide which baseline is best suited for your target (geometrical studies may require multiple baseline data).**
- **Beam undersamples object** **Beam reoriented for better resolution**





Proper baseline orientation: HD 60803



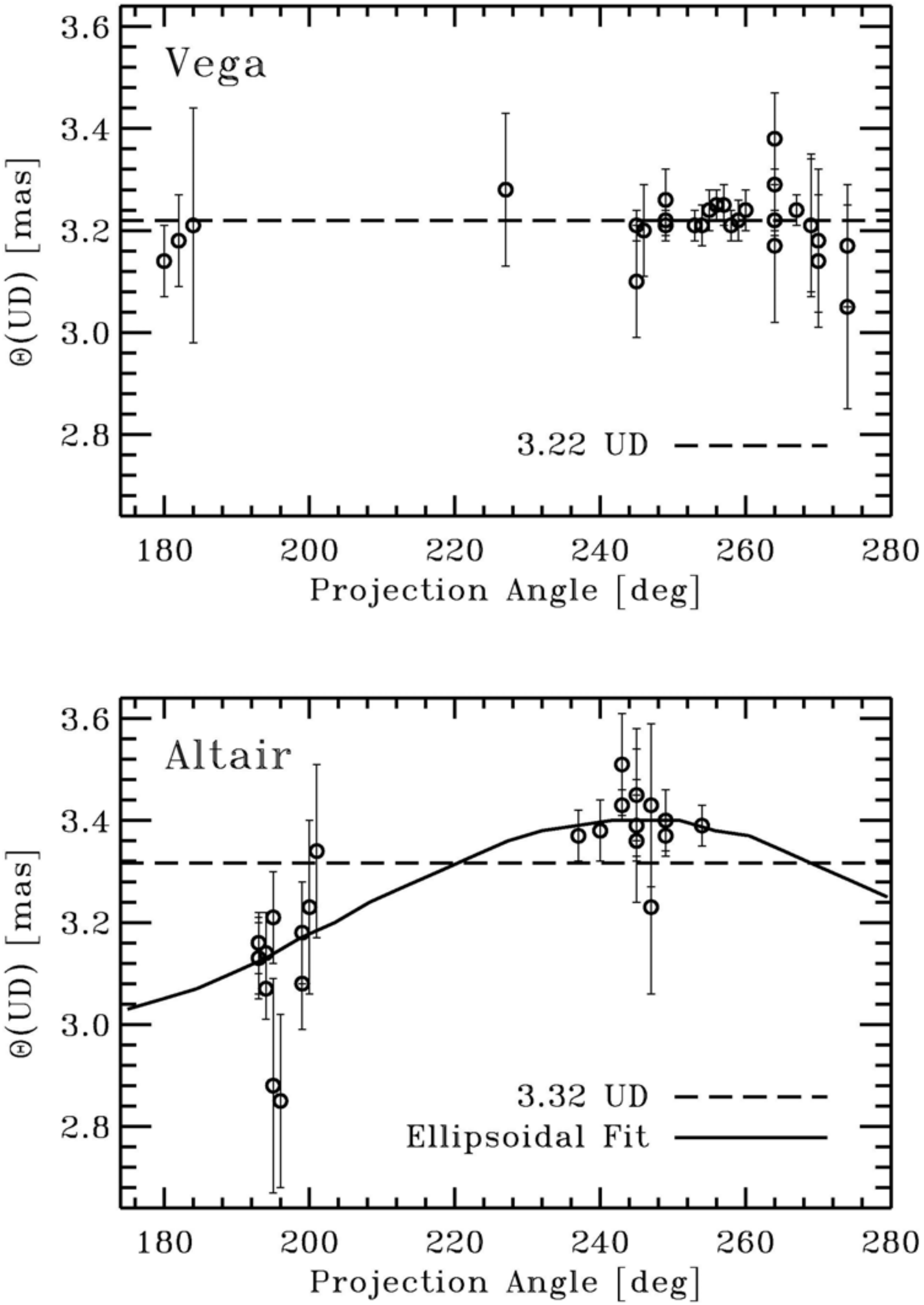
Sampling of target

- For static targets (ie: non-pulsating stars), a few scans over a few nights may be enough to determine UD diameter.
- Long-term variables (P ~ 200-500d): a few scans every few weeks to sample the full pulsation period.
- Short-term variables may be sampled a few times per night over the course of their pulsation period (10 - 50 d).
- Binaries: know thy orbital period!
- *Decide on how well you wish to determine* V^2 *changes* (Every 5% of period? Every 10%?)
- Departures from UD? Get long coverage over a night, change baseline orientation, repeat.

Multi-baseline observations

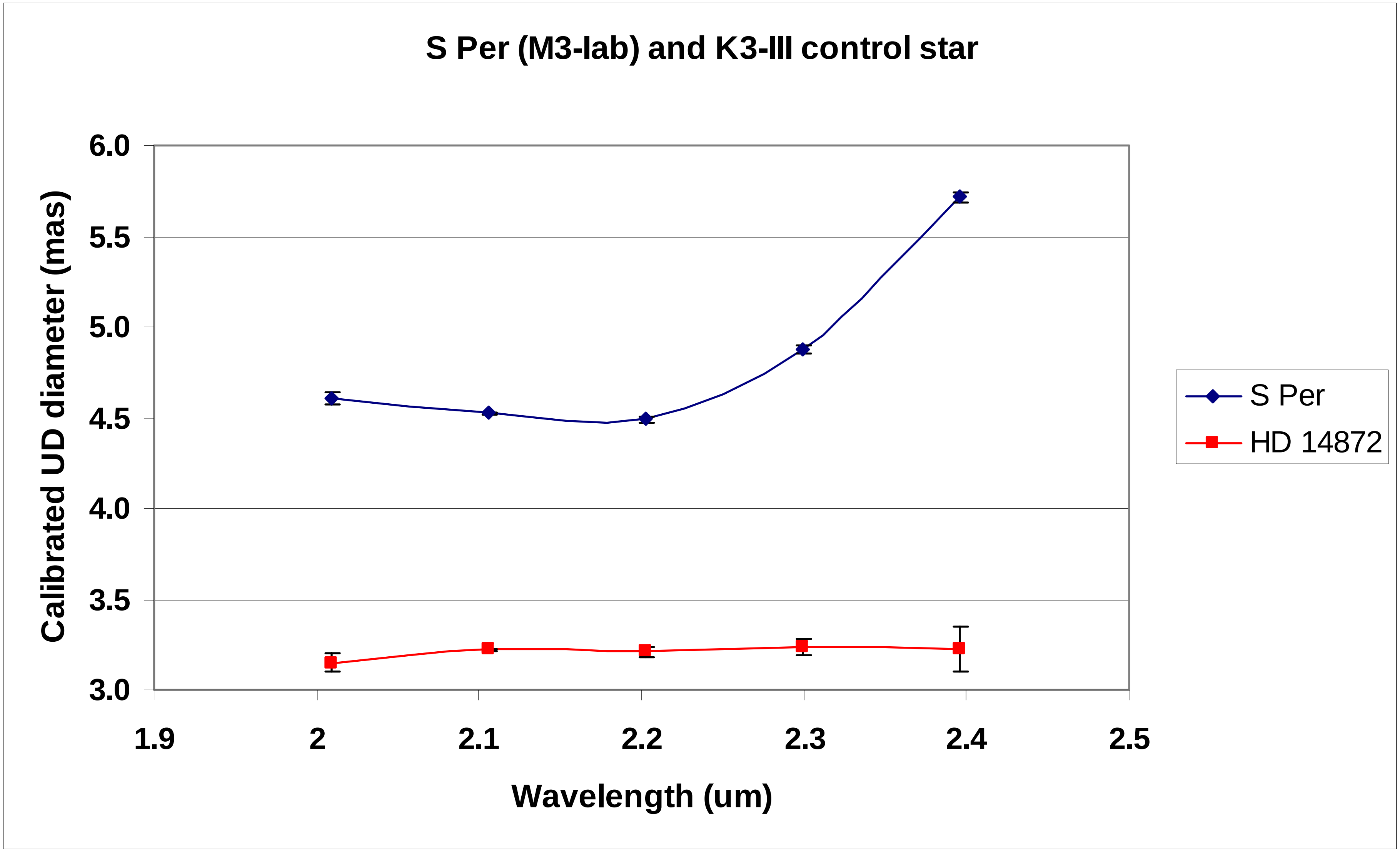
The rapidly-rotating star Altair was observed using two baselines rotated 50 deg to each other, indicating ellipticity. The top panel is the *control star*, Vega, showing no such effect with change in baseline.

(van Belle et al 2001)



Control stars

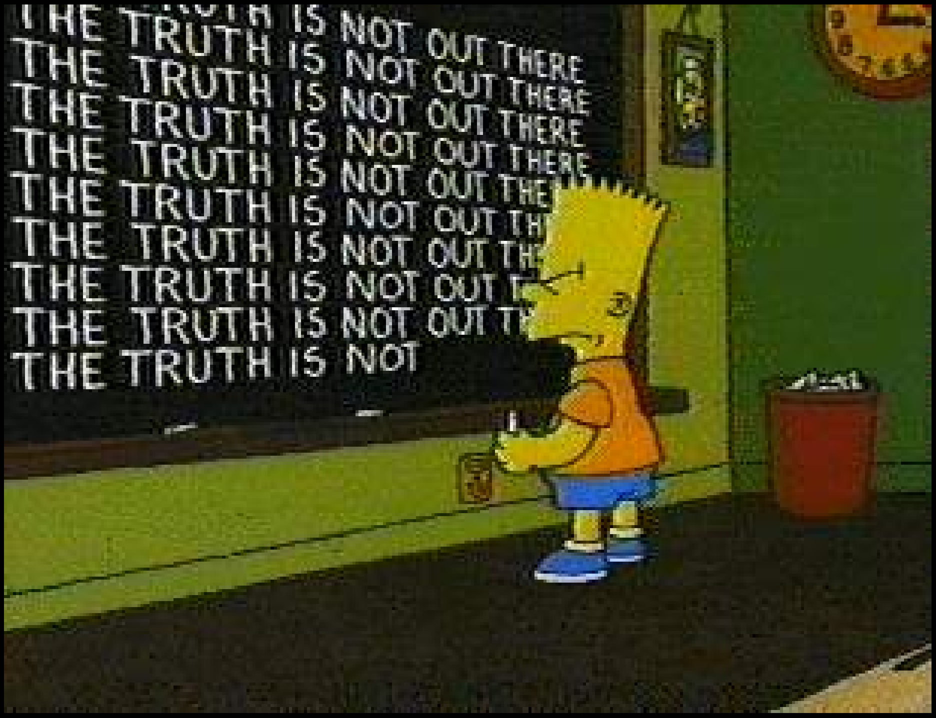
Include these stars into your program to check system w.r.t. spectral and/or geometric considerations



Review of data

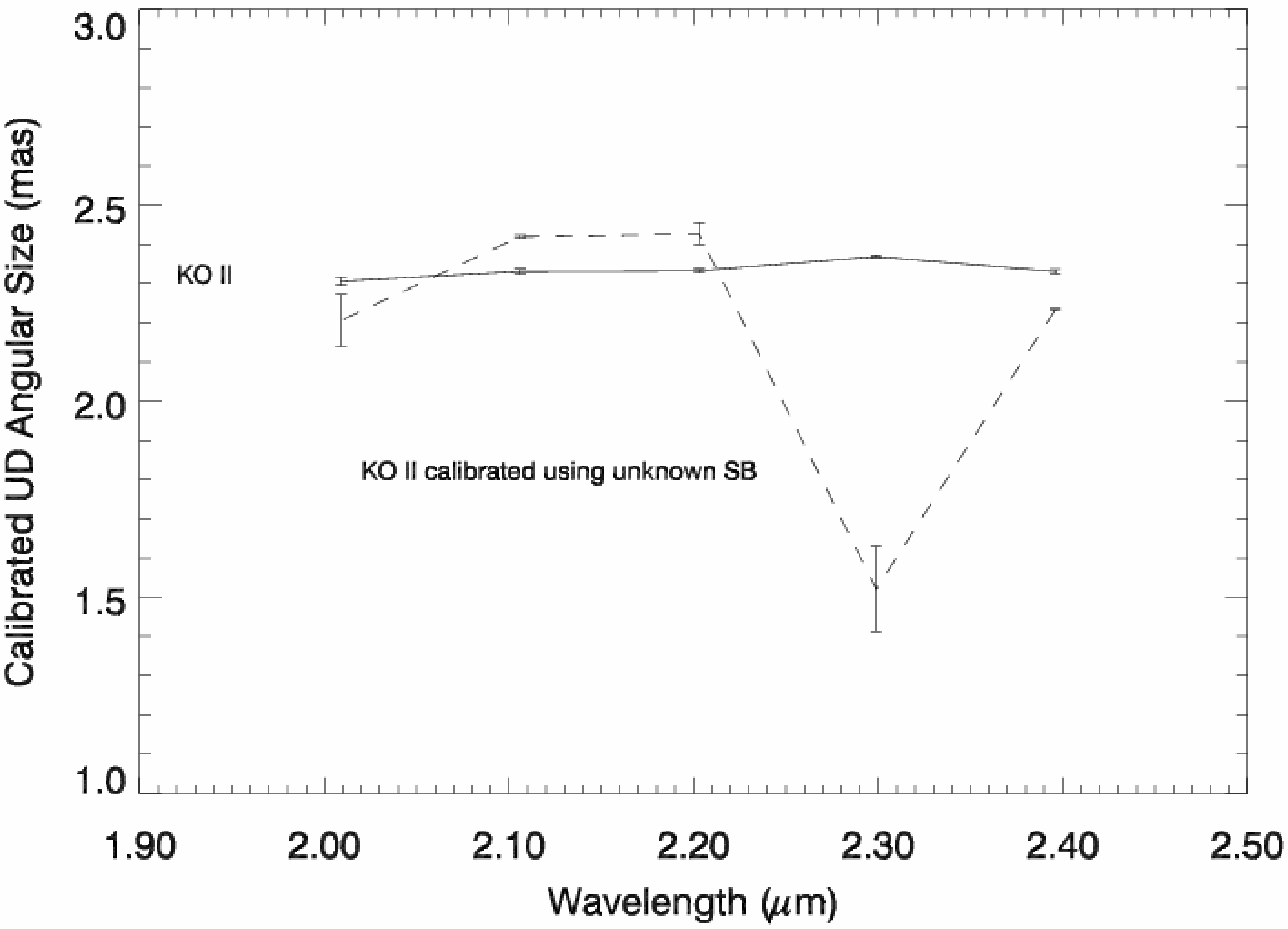
- Look at data as soon as it is possible!
- Review V^2 behavior of calibrators (Are they changing? Why?)
- Review V^2 behavior of target (Did you expect this behavior? Why or why not?)
- Don’t wait until you’ve collected a year’s worth of data on a target before you discover your choice of calibrators was poor, thus rendering all that good target data useless!

When bad things happen to good data…

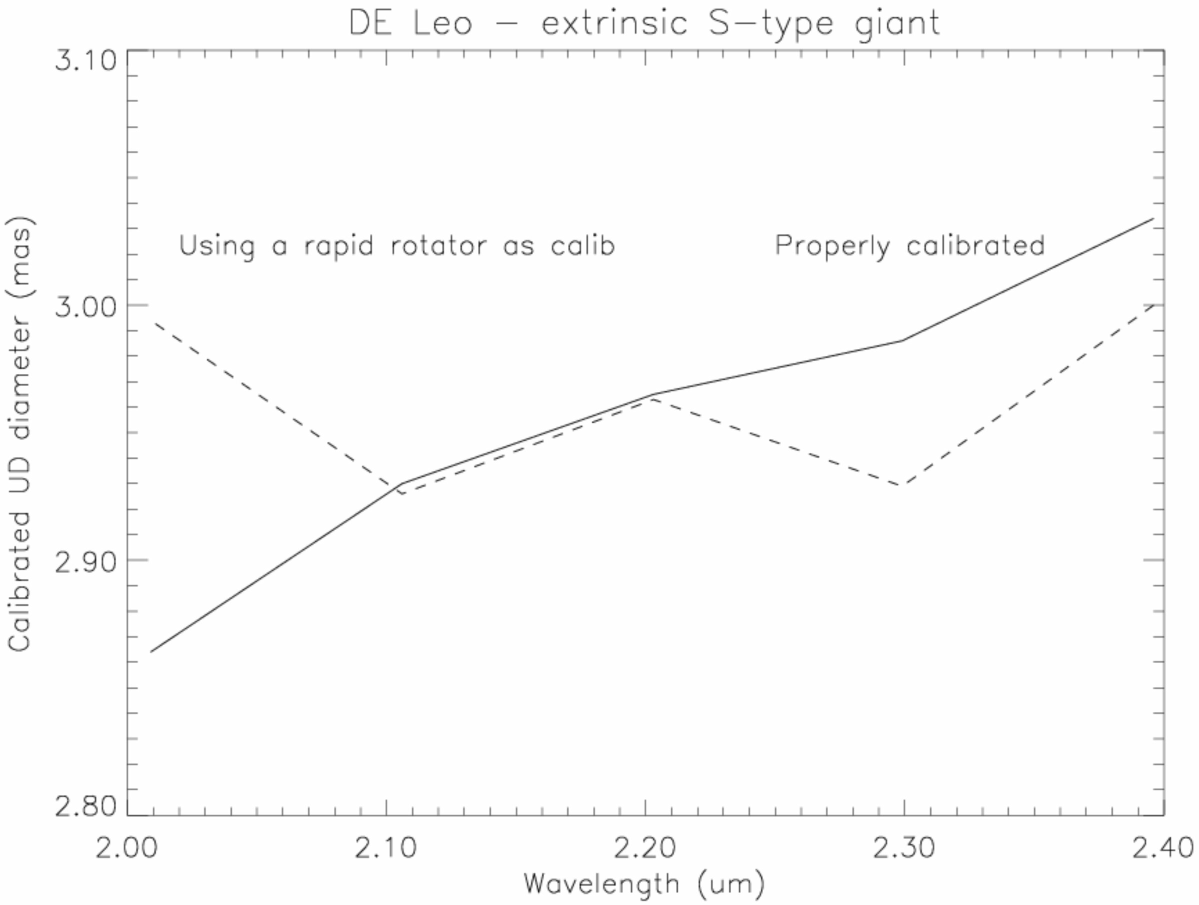


Bad calibrator choice:

calibrating a giant with an SB



Bad calibrator choice:
calibrating a giant with a rapid rotator

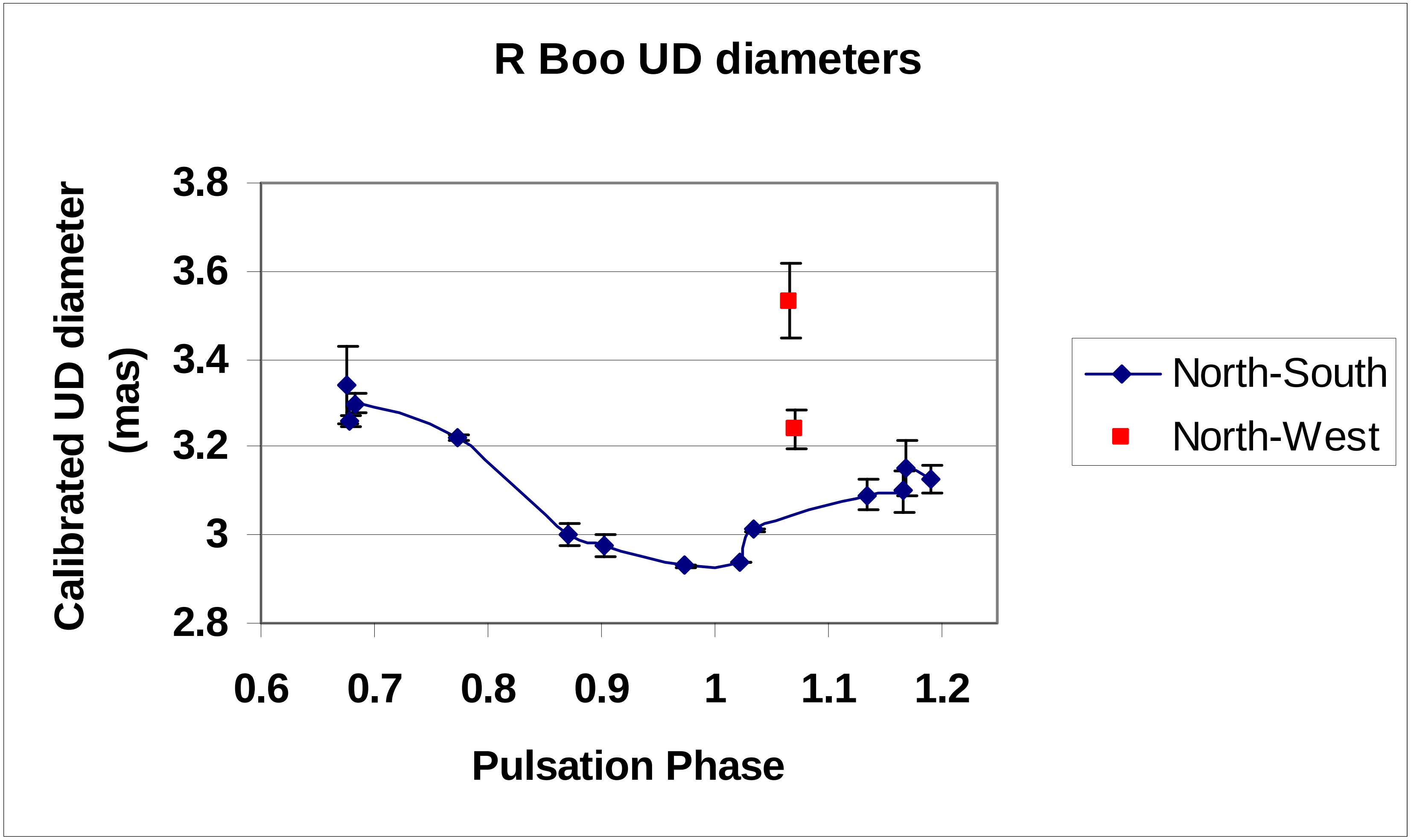


- I have calibrators that are stable in visibility over time.
- My target visibility is in the “sweet spot” of the visibility curve.
- The observations of my target agree with my predictions.

…and still things go wrong

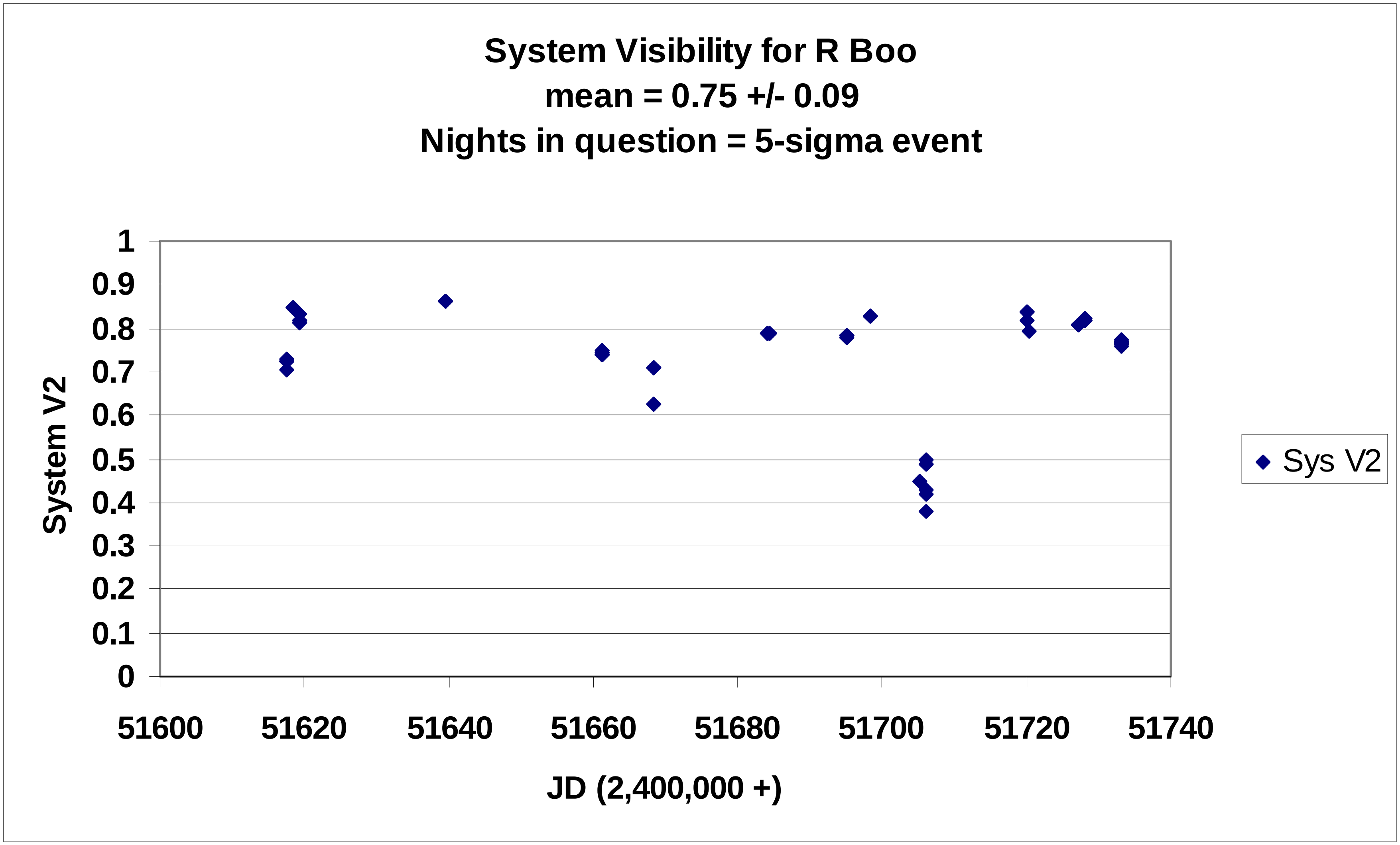
Possible ellipticity?

(two data points at phase 1.07 taken using different baseline)



Have to dig deeper…

The system visibility was very low for those two nights due to alignment drift.



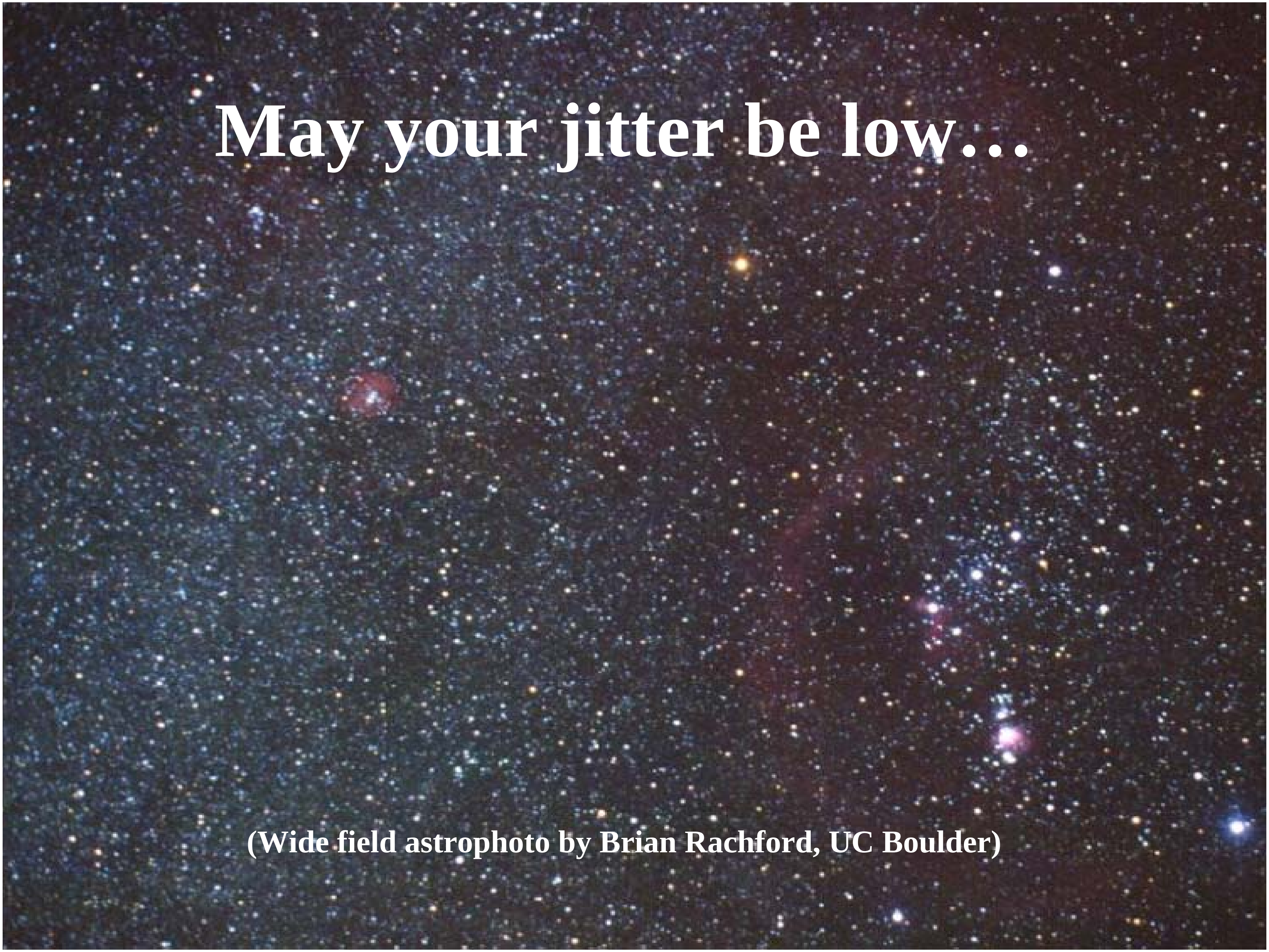
In such an event…

- Establish thresholds of what is considered "usable data", based on system visibility, SNR considerations, performance of instrument and atmospheric conditions.
- If it doesn't make the cut you established, THROW IT OUT.
- Remember, getting bad data is worse than getting no data at all. (Don't chase something that isn't there in the data.)

Summary

- *Know thy interferometer* (its limits, what it can and can’t do for you, and how it behaved during data collection for each night).
- *Know thy target* (the nature of your object, what you expect to see and when/how you can see it).
- *Know thy calibrators* (their nature and size over time, use multiple calibrators, weed out unstable calibrators <u>fast</u>).
- *Know thy reduced dataset* (theory vs. observations, set <u>thresholds of acceptability</u>, analyze departures immediately)
- *Know thy journal editor* (don’t overstate your dataset, such as using 4-component modeling of single-baseline visibilities).

May your jitter be low…



(Wide field astrophoto by Brian Rachford, UC Boulder)