

# *Calibrator Selection*

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*Michelson Summer School*

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# Brief Overview



- ⌘ Why and how to pick a calibrator?
- ⌘ MSC calibration tools
  - ☑ PTI, KI, CHARA, NPOI and VLT
- ⌘ Target vetting criteria
- ⌘ Special cases and other considerations

# What exactly is calibration?

⌘ Interferometer system response to an unresolved source is system visibility

☑ Perfect Interferometer  $V^2 = 1$

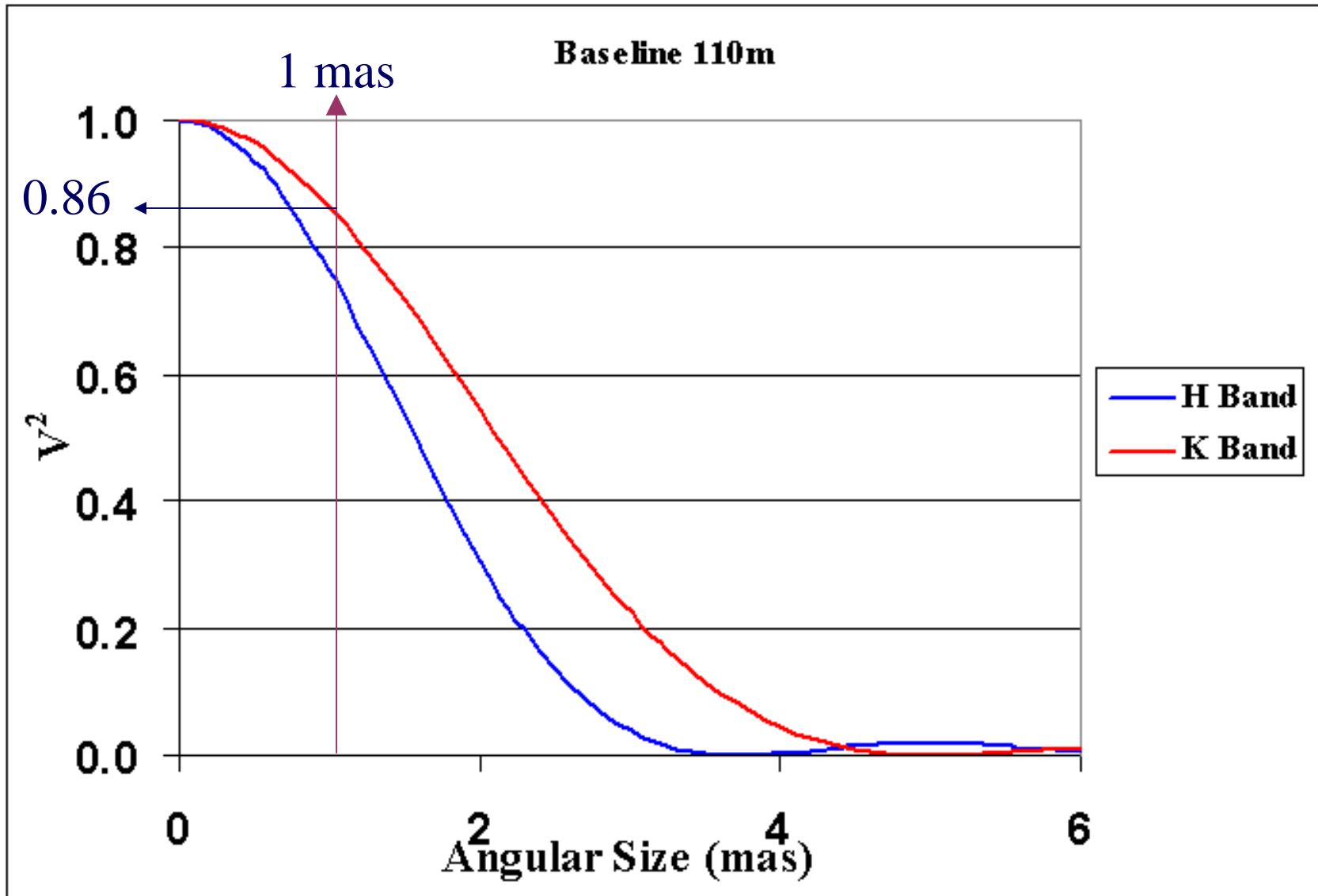
☑ Real Interferometer System  $V^2 \sim 0.75$

⇒ ***Pick only unresolved calibrators to first order***

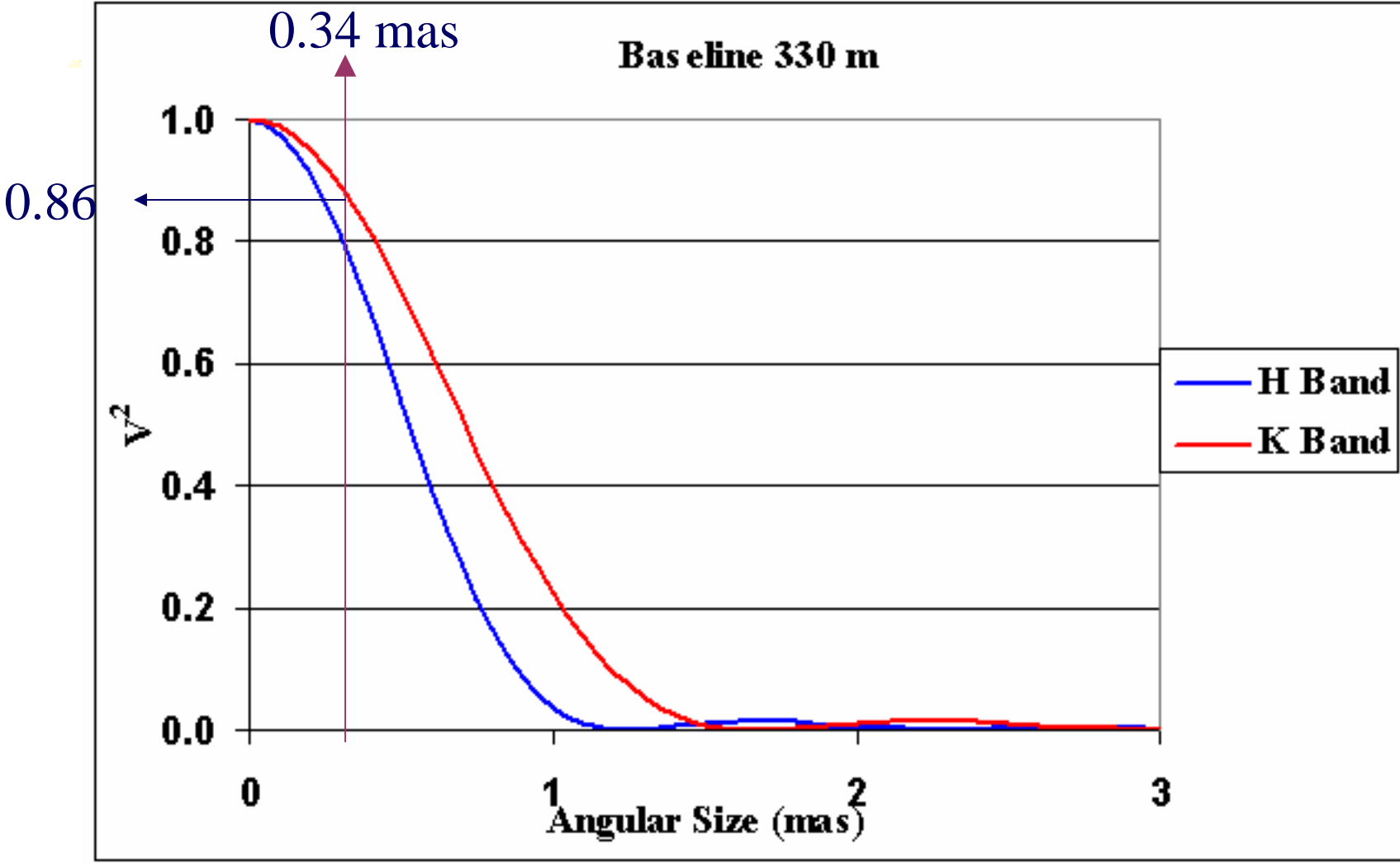
⌘ This may not be possible in practice

☑ e.g. PTI calibrators, CHARA calibrators

# Unresolved sources for PTI



# Unresolved sources for CHARA



# Comparison from getCal



## ⌘ PTI

- ☑ 1.0 mas K band size  
(for 110 m baseline)
  - ☒ 63 potential calibrators  
all LC in randomly  
chosen 20° FOV
- ☑ This assumes limiting  
K mag of 5.0

## ⌘ CHARA

- ☑ 0.34 mas K band size  
(for 330 m baseline)
  - ☒ 4 potential calibrators  
all LC in same randomly  
chosen 20° FOV using K  
mag of 5.0
- ☒ 47 potential calibrators  
in same FOV if K mag is  
raised to 7.0

# Why do we care about calibration?

## ⌘ Interferometer response function

⊞ system visibility - uniform disk model

⊞  $|V|^2 = (2 J_1(x) / x)^2$  where  $x = \pi B \vartheta / \lambda$

## ⌘ System response

⊞ geometry with respect to target

⊞ brightness

⊞ color (spectral type)

⊞ bolometric flux -  $F_{\text{bol}} = \pi \sigma T^4 / m$  where  $m$  -  
best fit factor

# What helps us?

## ⌘ Known Solutions

- ☑ binaries, resolved stars, circularly symmetric, simple geometry, limb-darkening, etc.

## ⌘ Peripheral Knowledge

- ☑ estimated angular diameter
- ☑ astrophysics of source (e.g. variability, lines)
- ☑ spectral energy distribution (SED)
- ☑ Hipparcos/SIMBAD/ADS classifications

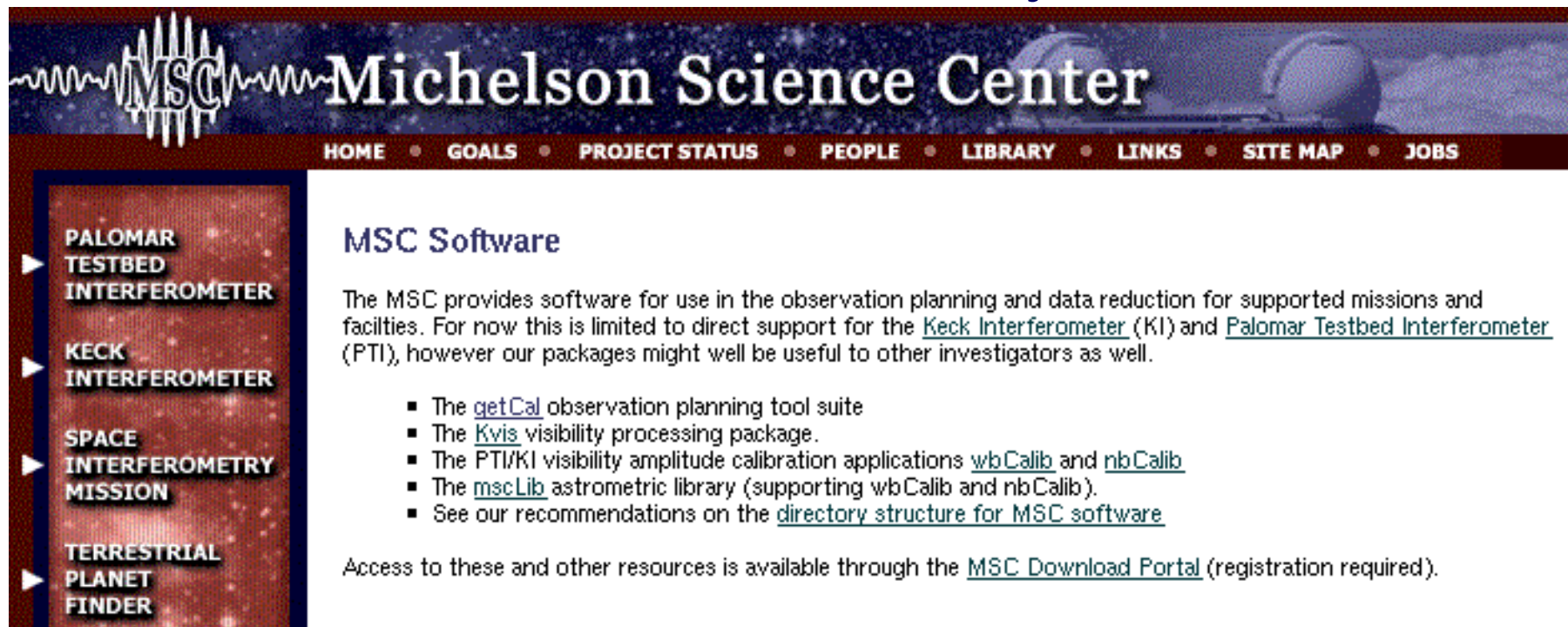
## ⌘ Scientific Experiment - clear goals



# Tools - getCal and gcGui

⌘ Written by A. Boden as part of PTI/KI reduction tools suite. Now upgraded and maintained by MSC at IPAC/Caltech for use with several interferometers.

- ☑ getCal is original command line interface
- ☑ gcGui is updated GUI with most common functions and additional modules for added functionality



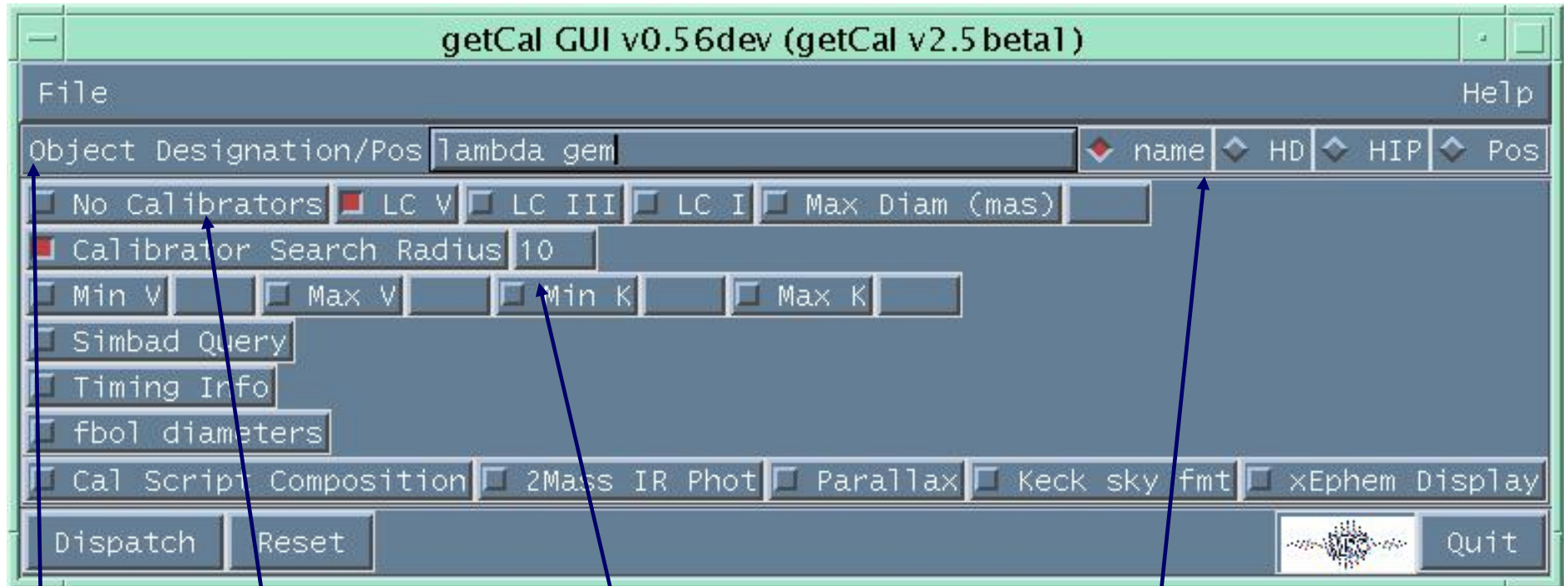
The screenshot shows the Michelson Science Center website. The header features the MSC logo and the text "Michelson Science Center". Below the header is a navigation menu with links: HOME, GOALS, PROJECT STATUS, PEOPLE, LIBRARY, LINKS, SITE MAP, and JOBS. On the left side, there is a vertical menu with four items: PALOMAR TESTBED INTERFEROMETER, KECK INTERFEROMETER, SPACE INTERFEROMETRY MISSION, and TERRESTRIAL PLANET FINDER. The main content area is titled "MSC Software" and contains the following text:

The MSC provides software for use in the observation planning and data reduction for supported missions and facilities. For now this is limited to direct support for the [Keck Interferometer \(KI\)](#) and [Palomar Testbed Interferometer \(PTI\)](#), however our packages might well be useful to other investigators as well.

- The [getCal](#) observation planning tool suite
- The [Kvis](#) visibility processing package.
- The PTI/KI visibility amplitude calibration applications [wbCalib](#) and [nbCalib](#)
- The [mscLib](#) astrometric library (supporting [wbCalib](#) and [nbCalib](#)).
- See our recommendations on the [directory structure for MSC software](#)

Access to these and other resources is available through the [MSC Download Portal](#) (registration required).

# getCal GUI: The Basics



name of object

Do you want  
calibrators for it?

max search radius

name type/position

# List of potential calibrators

```
getCal Return -- lambda_gem
/proc/msc/mscSoftware/src/tools/planning/getCal/getCal-2.5/getCal -targetName lambda_gem -
### GUI catalog from getCal v2.5beta1 ###
# Resolving target lambda gem via SIMBAD
# target HD 56537
HDC56537 07 18 05.579 +16 32 25.379 -0.048 -0.038 3.6 3.5 0.11 A3V... 0.0 xxx xxx trg
# HIP 33202 (HD 50635) has his multiple component flag set to C
# the C designation indicates solutions were found for individual components
# 2 components:
# A component -- V= 4.792
# B component -- V= 7.803 at sep 7.19 arcsec/PA 146 deg
HDC50635 06 54 38.636 +13 10 40.178 0.072 -0.078 4.7 4.0 0.32 F0Vp 6.6 0.55+/-0.2 cal HD
# HIP 34608 (HD 54563) has his multiple component flag set to 0
# Warning: the 0 designation indicates an orbital solution was found
# with photocentric SMA 4.24 mas, 113.3460 day period
HDC54563 07 10 06.679 +21 14 49.147 -0.187 -0.473 6.4 4.5 0.88 G9V 5.1 0.36+/-0.4 cal HDC
# HIP 34909 (HD 55383) has his variability flag set (2)
# with 0.105 mag scatter in 88 observations
# HIP 34909 (HD 55383) has his multiple component flag set to C
# the C designation indicates solutions were found for individual components
# 2 components:
# A component -- V= 5.711
# D component -- V= 5.801 at sep 0.12 arcsec/PA 14 deg
# HIP 34909 (HD 55383) has his astrometric source flag set to S
# with solution quality listed as B
# and a listed separation between components of 0.121 arcsec
HDC55383 07 13 22.276 +16 09 32.278 0.015 -0.042 5.1 2.7 1.65 K3V 1.2 0.78+/-1.5 cal HDC
HDC57006 07 19 47.646 +07 08 34.611 0.062 -0.059 5.9 4.6 0.54 F8V 9.4 0.33+/-0.3 cal HDC
# HIP 36188 (HD 58715) has his variability flag set (1)
# with 0.005 mag scatter in 65 observations
HDC58715 07 27 09.043 +08 17 21.536 -0.051 -0.038 2.9 3.1 -0.10 B8Vvar 8.5 0.74+/-0.4 cal
```

Save Simbad Browser Close



# List of potential calibrators

```
getCal GUI v0.56dev (getCal v2.5beta1)
getCal Return -- lambda_gem
/proj/msc/mscSoftware/src/tools/planning/getCal/getCal-2.5/getCal -targetName lambda_gem -

### GUI catalog from getCal v2.5beta1 ###
# Resolving target lambda gem via SIMBAD
# target HD 56537
HDC56537 07 18 05.579 +16 32 25.379 -0.048 -0.038 3.6 3.5 0.11 A3V... 0.0 xxx xxx trg
HDC48843 06 45 54.198 +12 41 36.821 -0.002 -0.003 6.5 4.8 0.34 A9III 8.7 0.29+/-0.3 cal H
HDC49606 06 49 49.836 +16 12 10.396 -0.016 -0.010 5.9 4.2 -0.14 B7III 6.8 0.43+/-0.3 cal
HDC49738 06 50 25.499 +13 24 47.437 -0.002 -0.008 5.7 2.7 1.33 K3III 7.4 1.10+/-1.4 cal H
# HIP 33082 (HD 50371) has his multiple component flag set to G
# the G designation indicates acceleration or higher-order terms in astrometric solution
HDC50371 06 53 22.401 +10 59 47.940 -0.000 -0.120 6.3 4.0 0.96 K0III 8.2 1.00+/-0.3 cal H
# HIP 33179 (HD 50482) has his multiple component flag set to C
# the C designation indicates solutions were found for individual components
# 2 components:
# A component -- V= 6.730
# B component -- V=10.021 at sep 1.28 arcsec/PA 188 deg
HDC50482 06 54 21.322 +21 09 40.777 0.027 -0.056 6.5 4.0 1.40 K1III 7.3 1.02+/-0.3 cal H
# HIP 33202 (HD 50635) has his multiple component flag set to C
# the C designation indicates solutions were found for individual components
# 2 components:
# A component -- V= 4.792
# B component -- V= 7.803 at sep 7.19 arcsec/PA 146 deg
HDC50635 06 54 38.636 +13 10 40.178 0.072 -0.078 4.7 4.0 0.32 F0Vp 6.6 0.55+/-0.2 cal HD
HDC50607 06 54 39.776 +15 50 16.604 -0.014 -0.012 6.6 4.4 0.92 G8III 5.7 0.65+/-0.1 cal H
HDC51101 06 56 59.778 +24 38 34.067 -0.029 -0.026 6.8 4.5 0.95 K0III 9.5 0.73+/-0.1 cal H
HDC52556 07 02 17.493 +15 20 09.629 0.005 -0.025 5.8 3.3 1.14 K1III: 4.0 1.04+/-0.4 cal
HDC53536 07 05 55.794 +15 10 53.276 -0.007 -0.007 7.0 4.7 1.00 K0III 3.2 0.63+/-0.0 cal H
HDC53561 07 06 05.032 +13 59 08.827 -0.008 -0.006 7.4 3.8 1.46 K5III 3.9 0.86+/-0.2 cal H
HDC53472 07 06 11.597 +24 51 36.526 0.010 -0.013 6.9 3.2 1.47 K8III 8.8 1.15+/-0.8 cal H
HDC54079 07 07 49.489 +07 28 16.370 0.007 -0.033 5.7 3.4 1.18 K0III: 9.4 0.99+/-0.3 cal
# HIP 34608 (HD 54563) has his multiple component flag set to 0
```

Save Simbad Browser Close

# List of potential calibrators

```
getCal Return -- lambda_gem
/proc/msc/mscSoftware/src/tools/planning/getCal/getCal-2.5/getCal -targetName lambda_gem -
### GUI catalog from getCal v2.5beta1 ###
# Resolving target lambda gem via SIMBAD
# target HD 56537
HDC56537 07 18 05.579 +16 32 25.379 -0.048 -0.038 3.6 3.5 0.11 A3V... 0.0 xxx xxx trg
# HIP 33202 (HD 50635) has his multiple component flag set to C
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HDC55383 07 13 22.276 +16 09 32.278 0.015 -0.042 5.1 2.7 1.65 K3V 1.2 0.78+/-1.5 cal HDC
HDC57006 07 19 47.646 +07 08 34.611 0.062 -0.059 5.9 4.6 0.54 F8V 9.4 0.33+/-0.3 cal HDC
# HIP 36188 (HD 58715) has his variability flag set (1)
# with 0.005 mag scatter in 65 observations
HDC58715 07 27 09.043 +08 17 21.536 -0.051 -0.038 2.9 3.1 -0.10 B8Vvar 8.5 0.74+/-0.4 cal
```

Save Simbad Browser Close



## Hipparcos Flags

- ⌘ Variability (V) - classed as a number depending upon mag. of variations
- ⌘ Orbital solution (O) - orbital solution found with SMA separation and period
- ⌘ Components solution (C) - individual components in multiple system resolved and separated with PA
- ⌘ Stochastic Motion (X)
- ⌘ Acceleration or higher order terms (G)

# Bolometric flux information

```
getCal GUI v0.56dev (getCal v2.5beta1)
getCal Return -- lambda_gem
/proj/msc/mscSoftware/src/tools/planning/getCal/getCal-2.5/getCal -targetName lambda_gem -
### GUI catalog from getCal v2.5beta1 ###
# Resolving target lambda gem via SIMBAD
# target HD 56537
# Simbad Search HD 56537: HD 56537 -- Variable Star A3V V=3.581
HDC56537 07 18 05.579 +16 32 25.379 -0.048 -0.038 3.6 3.5 0.11 A3V... 0.0 xxx xxx trg

### Bolometric Flux Diameter Fit results ###
# option png
# option stdin
# 2 command line arguments processed
#
# Star Teff(K) ChiSqr /DOF DOF F_bo1 (10^-8 erg/cm2/s) Ang Size (mas) Filters
# 1 HD_56537--A3V 11418 +/- 177112 100.64 68 0.8072 +/- 37.2 0.04 +/- 0.48 .....

### Simbad query results ###
# Simbad Search HD 56537: HD 56537 -- Variable Star A3V V=3.581

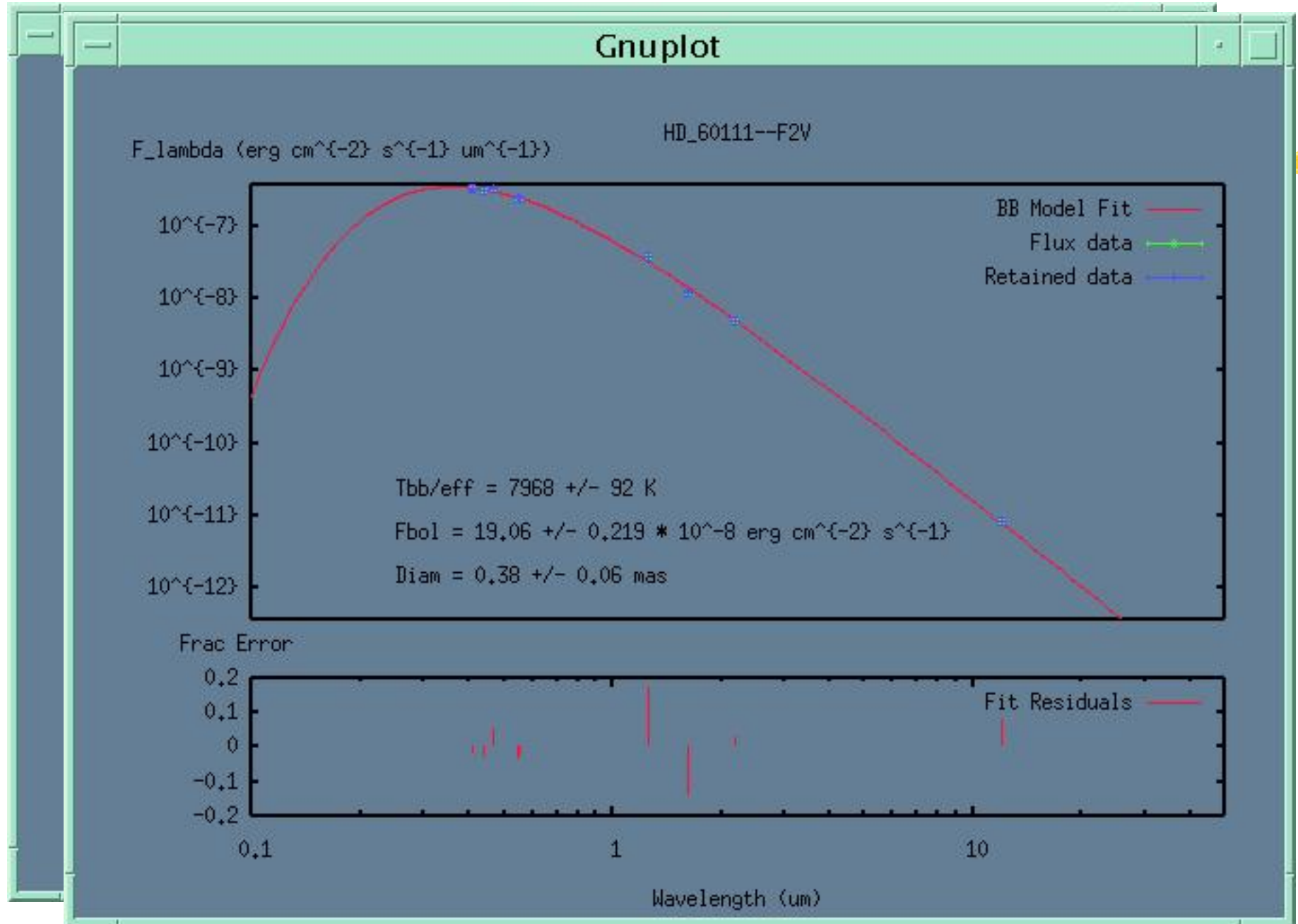
SIMBAD Query Result

[3]CDS · [4]Simbad · [5]VizieR · [6]Aladin · [7]Catalogues · [8]Nomenclature · [9]Bibliography

Object query :
simbad search HD 56537
```

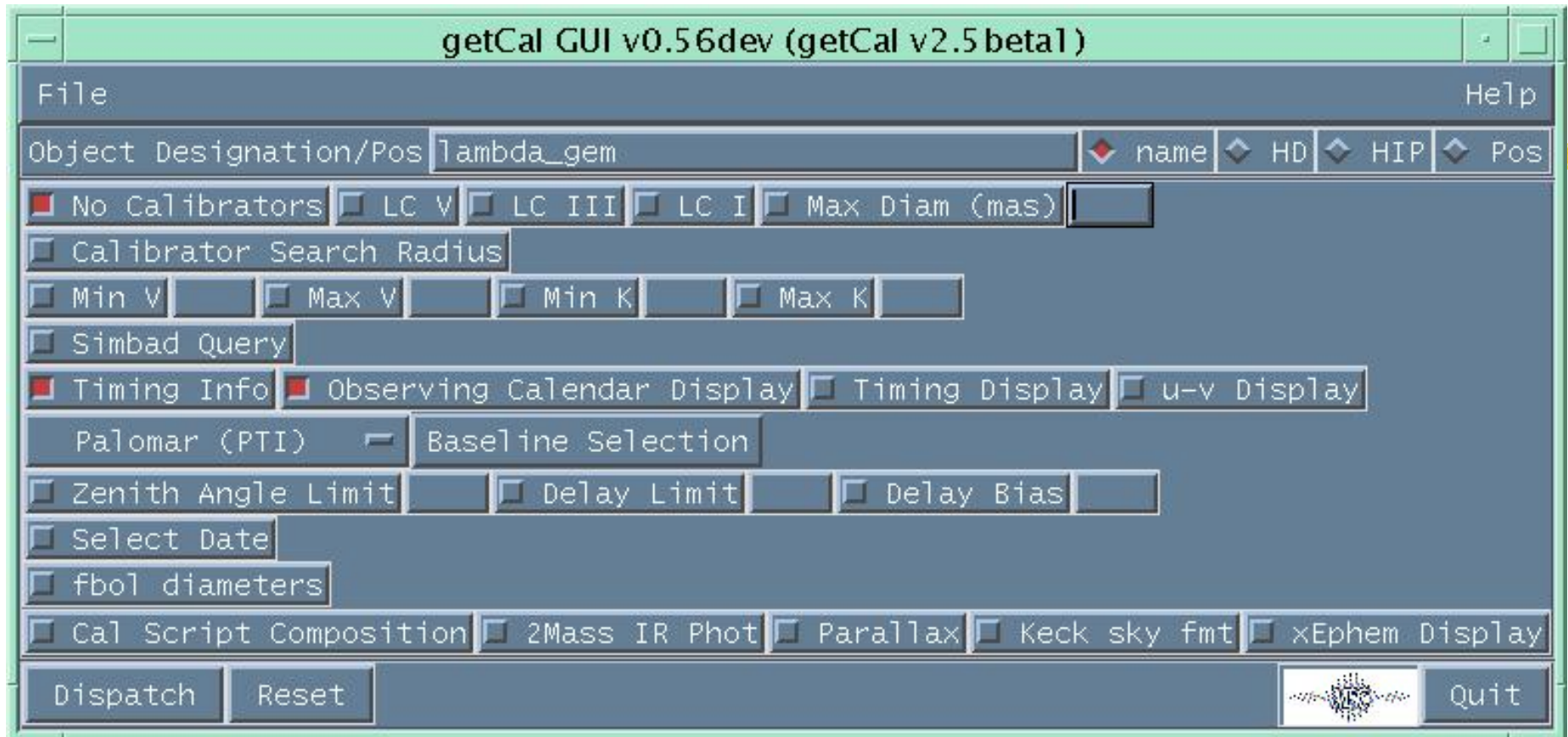
Save Simbad Browser Close

# Photometric fits...

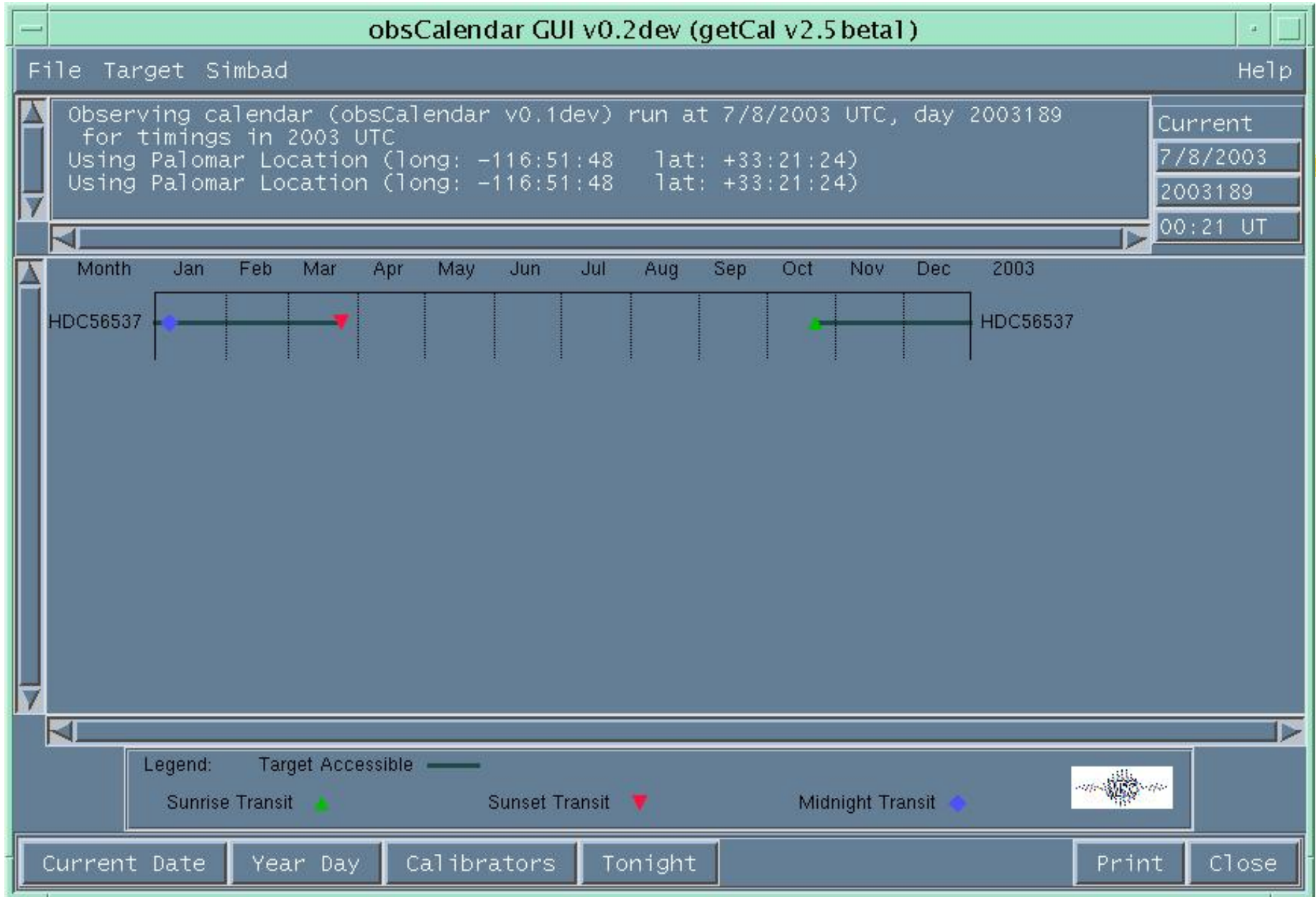




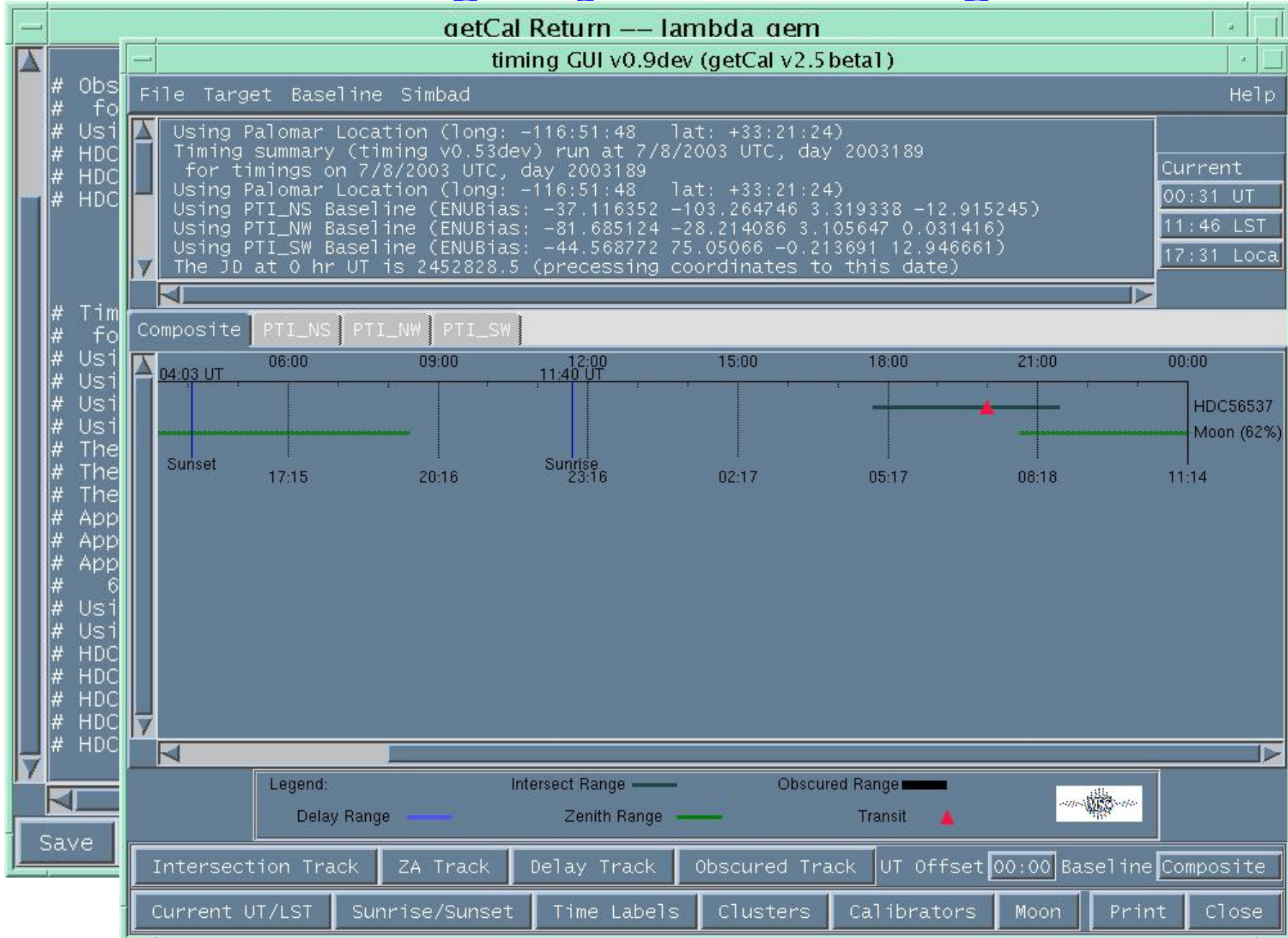
# Sky coverage - annually and nightly



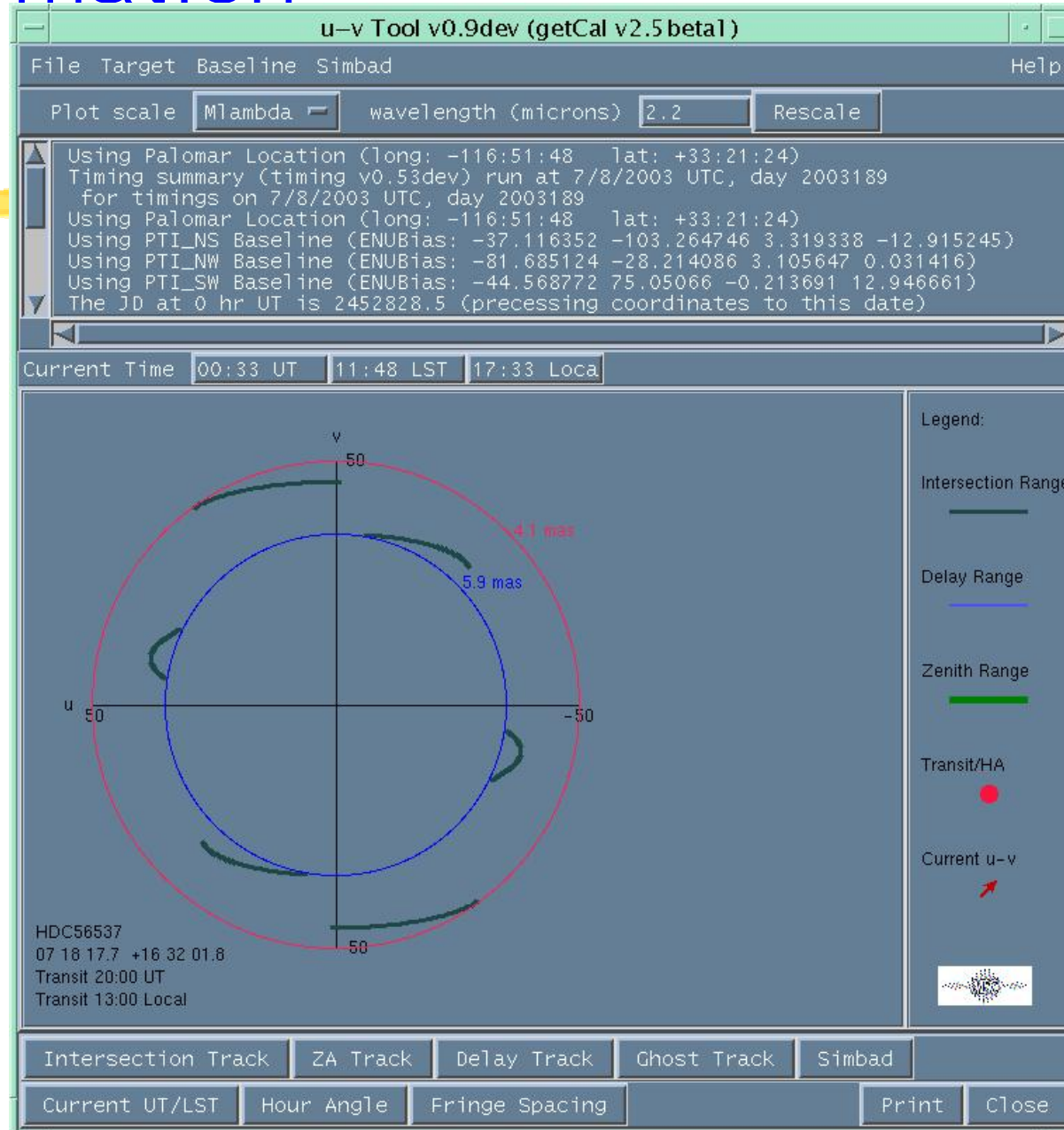
# Annual calendar



# Nightly scheduling



# UV Information





# Check your target

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: <http://simbad.u-strasbg.fr/sim-id.pl?protocol=html&Ident=lam+> What's Related

Internet Lookup New&Cool

**SIMBAD Query Result**

[CDS](#) · [Simbad](#) · [VizieR](#) · [Aladin](#) · [Catalogues](#) · [Nomenclature](#) · [Biblio](#) · [StarPages](#) · [AstroWeb](#)

Object query: **simbad search lam gem**  
====> Your identifier (lam gem) is translated into : \* LAM GEM

*Available data:*    [Basic data](#)    [Identifiers](#)    [Plot & image tools](#)    [Bibliography](#)    [Measurements](#)    [External archives](#)

Basic data : **HD 56537 -- Variable Star**     with radius  arc min.

ICRS 2000.0 coordinates **07 18 05.5787 +16 32 25.379** [8.36 5.10 87] A [1997A&A...323L..49P](#)  
FK5 2000.0/1950.0 coordinates **07 15 13.06 +16 37 54.4** [8.36 5.10 86]  
FK4 1950.0/2000.0 coordinates **07 18 05.69 +16 32 27.3** [48.71 30.43 89]  
Galactic coordinates **200.92 +13.23**  
Proper motion (*mas/yr*) [error ellipse] **-46.09 -37.90** [.96 .60 89] A [1997A&A...323L..49P](#)  
B magn, V magn, Peculiarities **3.692, 3.581**  
Spectral type **A3V**  
Radial velocity (*v*: Km/s) or Redshift (*z*) **v -9.2** [ 2] B [1953GCRV..C.....0W](#)  
Parallax (*mas*) **34.59** [.93] A [1997A&A...323L..49P](#)

100%

category

spectral type

distance

# Do your homework...

File Edit View Go Communicator Help

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Bookmarks Location: [http://adsabs.harvard.edu/abstract\\_service.html](http://adsabs.harvard.edu/abstract_service.html) What's Related

Internet Lookup New&Cool

**NASA ADS Astronomy Query Form for Mon Jul 7 21:33:59 2003**

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**Hint:** If you want to know how to submit an abstract or insert a comment for your reference, go to the [Feedback](#) link on the query page.

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Databases to query:  [Astronomy](#)  [Instrumentation](#)  [Physics/Geophysics](#)  [ArXiv Preprints](#)

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**Authors:** (Last, F.I., one per line)  
[Middle Initial name search](#)  
 Require author for selection  
( OR  AND  [simple logic](#))

[SIMBAD](#)  [NED](#)  [LPI](#)  [IAUC Objects](#)  
[Object name/position search](#)  
 Require object for selection  
(Combine with:  OR  AND)

**Publication Date** between  and   
(MM) (YYYY) (MM) (YYYY)

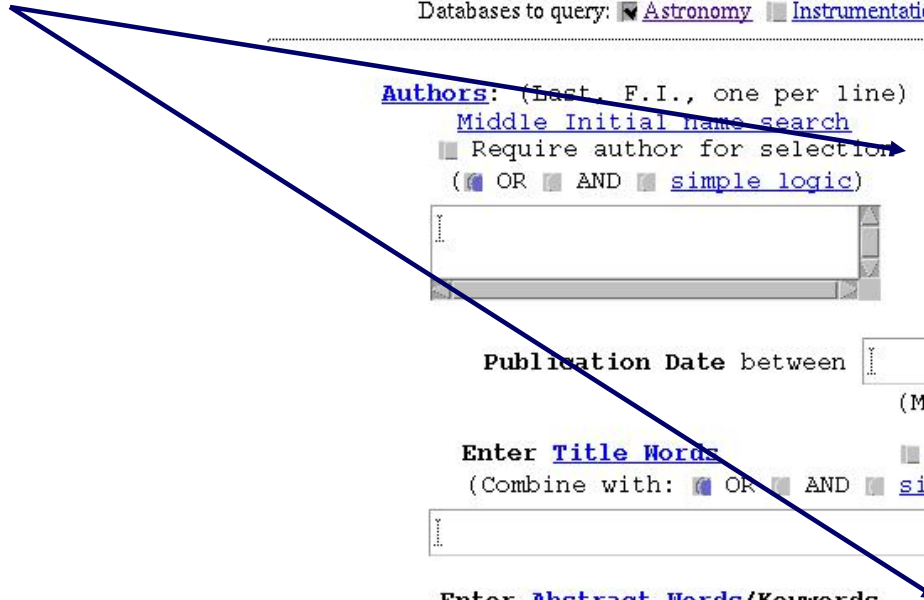
**Enter [Title Words](#)**  Require title for selection  
(Combine with:  OR  AND  [simple logic](#)  [boolean logic](#))

**Enter [Abstract Words/Keywords](#)**  Require text for selection  
(Combine with:  OR  AND  [simple logic](#)  [boolean logic](#))

Return  items starting with number

100%

Use this feature!



# Beware certain results!

File Edit View Go Communicator Help

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Bookmarks Location: [http://adsabs.harvard.edu/cgi-bin/nph-abs\\_connect?db\\_key=AST&si](http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?db_key=AST&si) What's Related

Internet Lookup New&Cool

Richichi, A.; Calamai, G.; Lemert, C.; Stecklum, B.; Trunkovsky, E. M. New binary stars discovered by lunar occultations. II.

<input type="checkbox"/> <a href="#">1994A&amp;AS..108..359G</a>	0.562	12/1994	<a href="#">A</a>	<a href="#">F</a>	<a href="#">G</a>	<a href="#">R</a>	<a href="#">C</a>	<a href="#">S</a>	
Ginestet, N.; Carquillat, J. M.; Jaschek, M.; Jaschek, C.	Spectral classifications in the near infrared of stars with c MK standards.								
<input type="checkbox"/> <a href="#">1984PASP...96..105H</a>	0.562	01/1984	<a href="#">A</a>	<a href="#">F</a>	<a href="#">G</a>	<a href="#">R</a>	<a href="#">C</a>	<a href="#">S</a>	
Hartkopf, W. I.; McAlister, H. A.	Binary stars unresolved by speckle interferometry. III								
<input type="checkbox"/> <a href="#">1958ApJ...128..572B</a>	0.562	11/1958	<a href="#">A</a>	<a href="#">F</a>	<a href="#">G</a>	<a href="#">D</a>	<a href="#">R</a>	<a href="#">C</a>	<a href="#">S</a>
Bahng, J. D. R.	Multicolor photoelectric photometry of stars with compo.								
<input type="checkbox"/> <a href="#">1954ApJ...119..146S</a>	0.562	01/1954	<a href="#">A</a>	<a href="#">F</a>	<a href="#">G</a>	<a href="#">C</a>	<a href="#">S</a>	<a href="#">U</a>	

100%

Occultation and spectroscopic binary with 6.1 year period, unresolved via speckle techniques

# Calibrator Vetting Criteria



## ⌘ Basic Information

- ☑ Resolved/Unresolved
  - ☒ Spectral Type, SED & distance
- ☑ Singular or apparently so (Hipparcos/Simbad)
- ☑ Sky coverage - compatibility with target(s)
  - ☒ UV Track & Annual availability
- ☑ Magnitude (SNR)
  - ☒ Different if fringe tracking or scanning



## ⊞ Estimated Angular Diameter

- ⊞ Spectral Type

- ⊞ Estimated bolometric flux

## ⊞ SIMBAD/ADS - Red Flags

- ⊞ Sanity check (SpTy, distance, magnitudes)

- ⊞ Variability

- ⊞ Double/confused

- ⊞ Fast rotator

- ⊞ Calibration standard

- ⊞ Papers - how many, what types, anything odd

## ⊞ Real data - acid test

- ⊞ (un)resolved nature from data

- ⊞ nightly and long-term variations

- ⊞ SNR, color, other "gotchas"

# Real world example

The image shows a screenshot of a web browser window displaying the SIMBAD Query Result for HD 60803. The browser is Netscape Communicator. The address bar shows the URL: `http://simbad.u-strasbg.fr/sim-id.pl?protocol=html&Ide`. The page title is "SIMBAD Query Result". The main content area shows the object query: "simbad search HD 60803". Below the query, there are several navigation links: "Available data:", "Basic data", "Identifiers", "Plot & image tools", "Bibliography", "Measurements", and "External archives". The "Basic data" section is expanded, showing the following information:

**Basic data : HD 60803 -- Star**

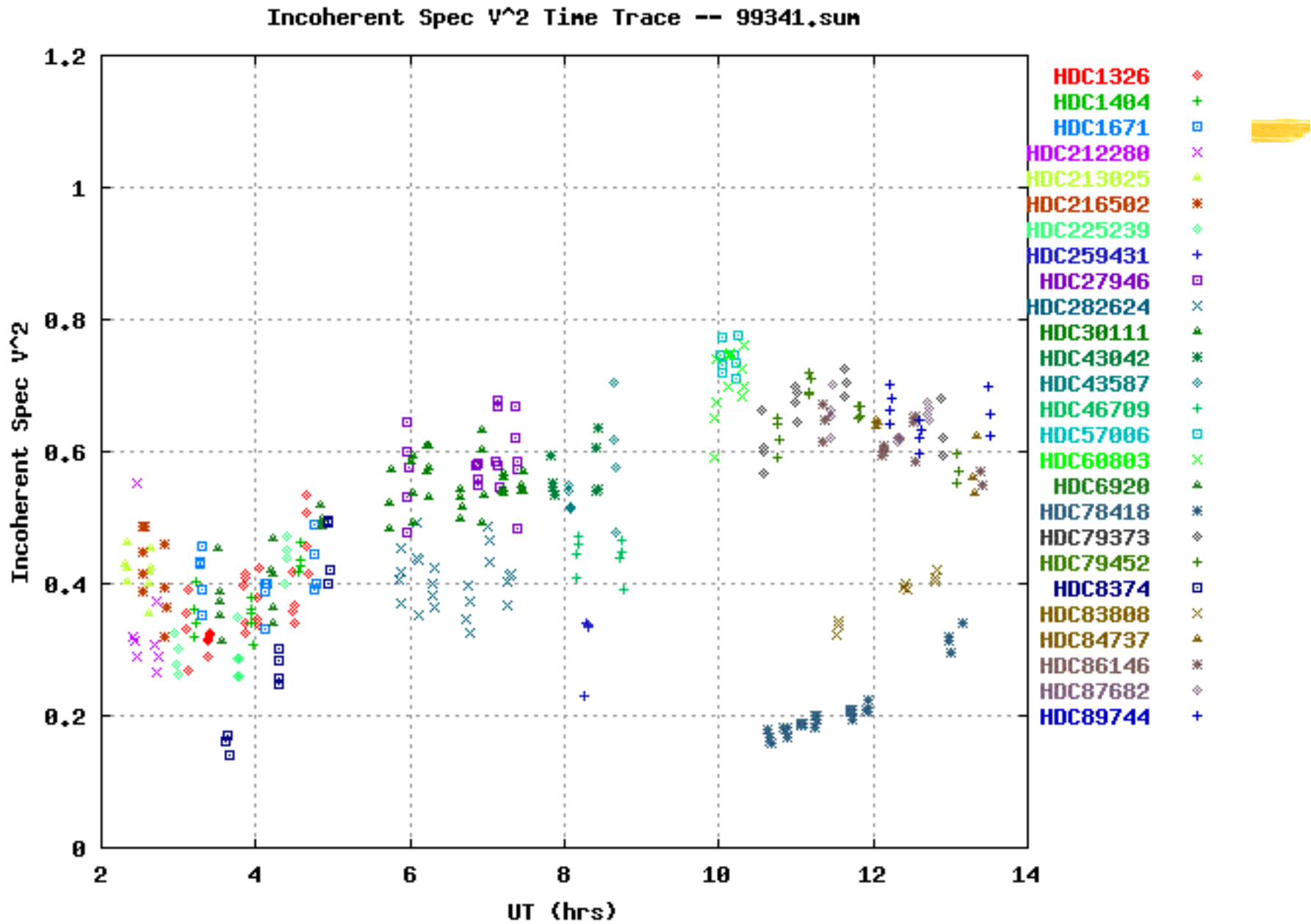
ICRS 2000.0 coordinates **07 36 34.7063 +05 51 43.817** [7.31 3.15 84] A [1997A&A...323L..49P](#)  
FK5 2000.0/1950.0 coordinates **07 33 54.64 +05 58 28.5** [7.31 3.15 83]  
FK4 1950.0/2000.0 coordinates **07 36 35.02 +05 51 42.5** [45.09 19.75 82]  
Galactic coordinates **212.81 +12.70**  
Proper motion (*mas/yr*) [error ellipse] **-108.76 27.66** [.89 .39 82] A [1997A&A...323L..49P](#)  
B magn, V magn, Peculiarities **6.467, 5.916**  
Spectral type **G0V**  
Radial velocity (*v*: Km/s) or Redshift (*z*) **v +3.6** [ 2] B [1953GCRV..C.....0W](#)  
Parallaxes (*mas*) **22.92** [.89] A [1997A&A...323L..49P](#)

On the left side of the browser window, there is a terminal window showing the following text:

```
### GUI catalog from  
# target HD 60803  
# Simbad Search HD  
HD60803 07 36 34 7
```

Below the terminal window, there is a plot showing the flux density  $F_{\lambda}$  (erg cm<sup>-2</sup> s<sup>-1</sup>) versus wavelength. The y-axis is logarithmic, ranging from 10<sup>-12</sup> to 10<sup>-7</sup>. The x-axis is linear, ranging from 0.1 to 1.0. A red curve shows the flux density, which increases sharply as wavelength increases. The plot is labeled "F\_lambda (erg cm<sup>-2</sup> s<sup>-1</sup>)" and "Frac Error".

# Take some data



# I didn't do my homework...

[NASA Astrophysics Data System \(ADS\)](#)

Query Results from the Astronomy Database

Selected and retrieved 10 abstracts.

<b>Bibcode</b>	<b>Score</b>	<b>Date</b>	<a href="#">List of Links</a>
<b>Authors</b>	<b>Title</b>		<a href="#">Access Control Help</a>
<input type="checkbox"/> <a href="#">1999Obs...119..272G</a>	1.000	10/1999	<a href="#">F</a> <a href="#">G</a> <a href="#">R</a> <a href="#">C</a> <a href="#">S</a> <a href="#">O</a> <a href="#">U</a>
Griffin, R. F.	Spectroscopic binary orbits from photoelectric radial velocities. Paper 148: HR 7955		
<input type="checkbox"/> <a href="#">1999Obs...119...81G</a>	1.000	04/1999	<a href="#">F</a> <a href="#">G</a> <a href="#">R</a> <a href="#">S</a> <a href="#">O</a> <a href="#">U</a>
Griffin, R. F.	Spectroscopic binary orbits from photoelectric radial velocities. Paper 145: HR 6797		
<input type="checkbox"/> <a href="#">1997Obs...117..288G</a>	1.000	10/1997	<a href="#">F</a> <a href="#">G</a> <a href="#">R</a> <a href="#">C</a> <a href="#">S</a> <a href="#">O</a> <a href="#">U</a>
Griffin, R. F.; Mayor, M.; Pont, F.; Udry, S.	Spectroscopic binary orbits from photoelectric radial velocities. Paper 136: HD 7000		
<input type="checkbox"/> <a href="#">1997Obs...117..208G</a>	1.000	08/1997	<a href="#">F</a> <a href="#">G</a> <a href="#">R</a> <a href="#">C</a> <a href="#">S</a> <a href="#">O</a> <a href="#">U</a>
Griffin, R. F.	Spectroscopic binary orbits from photoelectric radial velocities. Paper 135: HR 2918		

# Next Steps



- ⌘ Collect and verify integrity of data
- ⌘ Have at least two calibrators
  - ☑ estimate angular sizes to get system visibility
  - ☑ check for consistency
- ⌘ Choose a model for your target observation (uniform disk, gaussian, binary system, etc.)
- ⌘ Reduce, analyze & publish!

# How do you resolve conflicts in calibrator sizes?

$$\chi^2 = \sum_i \left[ \frac{\theta_i - \hat{\theta}_i}{\sigma_{\hat{\theta}_i}} \right]^2 + \sum_i \sum_{j < i} \left\langle \frac{V_{sys,i}^2(\theta_i) - V_{sys,j}^2(\theta_j)}{\sigma_{V_{sys}}} \right\rangle^2$$

working diameter estimates

a priori diameter estimates

system visibilities on calibrators derived from observations

estimated uncertainties

⌘ Minimize chisquared function for all calibrators

# Special Circumstances

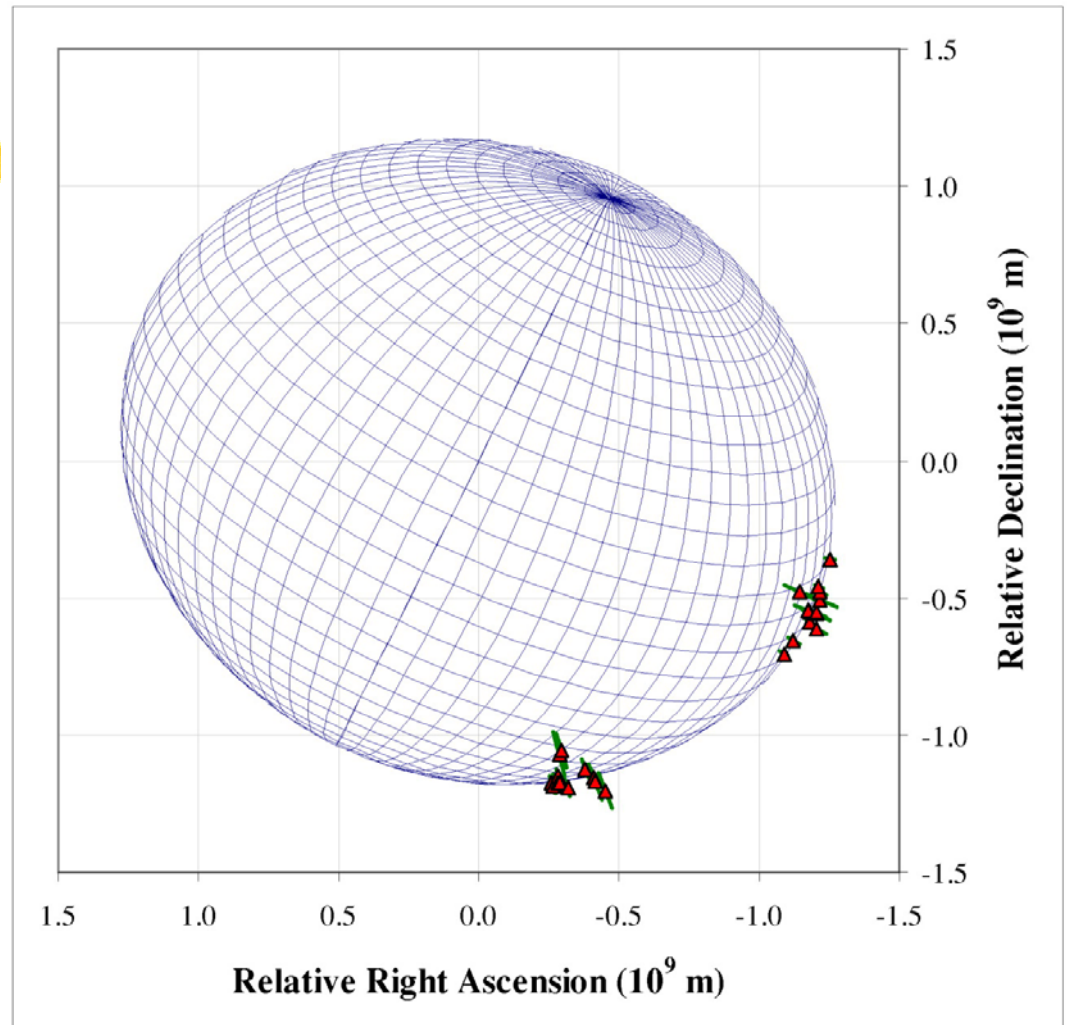


⌘ Sometimes to do the experiment correctly you need a calibrator (control star) that lacks some special feature you expect your target has

- ☑ non-spherically symmetric (resolved) stars (e.g. Altair, stars with outflows)
- ☑ pulsating (e.g. miras, cepheids)
- ☑ line emission or spectral features (e.g. P Cyg, narrow-band studies)

# Altair

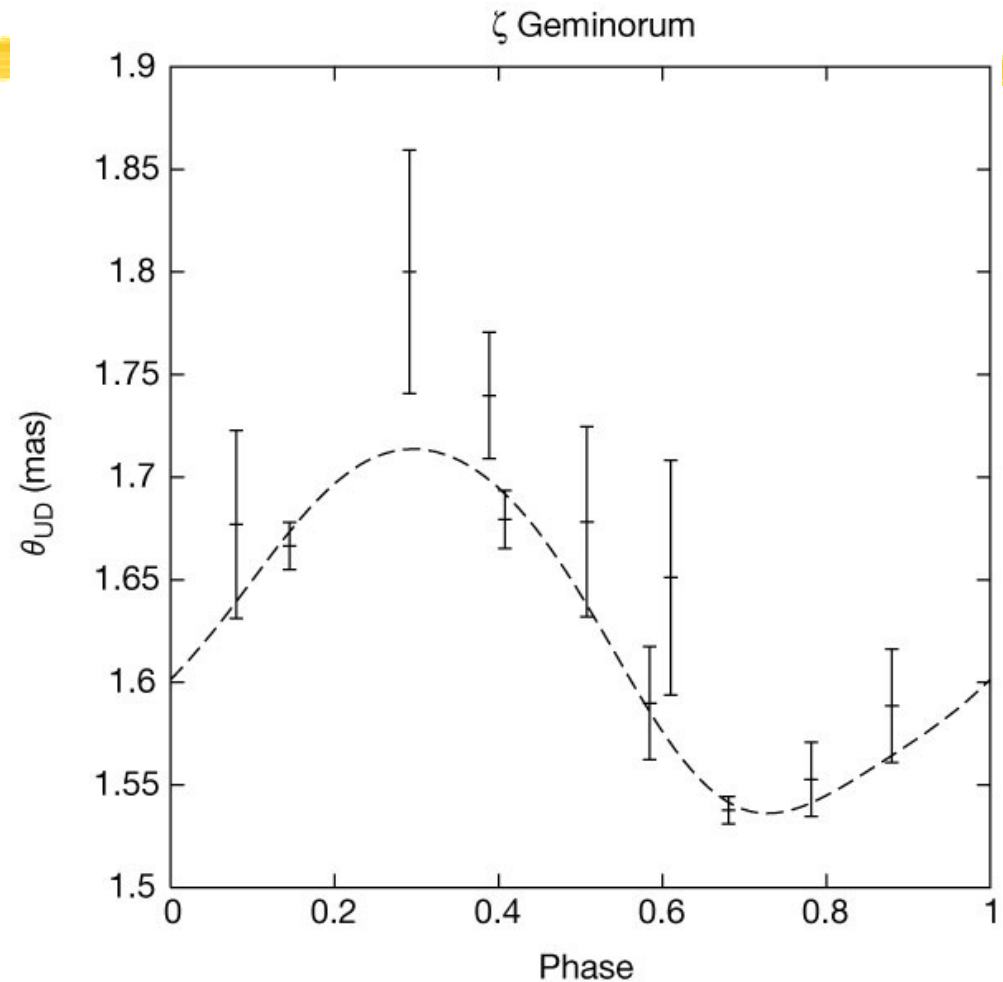
- ⌘ HD187691 - F8V @  $1.6^\circ$  sep. and about 0.72 mas in diameter
- ⌘ HD187923 - G0V @  $2.8^\circ$  sep. and about 0.55 mas in diameter
- ⌘ Comparison to Vega as a bright, nearby, resolved calibrator
- ⌘ van Belle et al., 2001, ApJ, 559, 1155.





# Zeta Geminorum

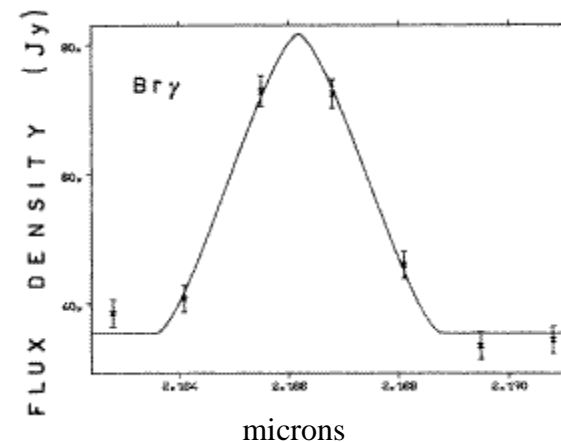
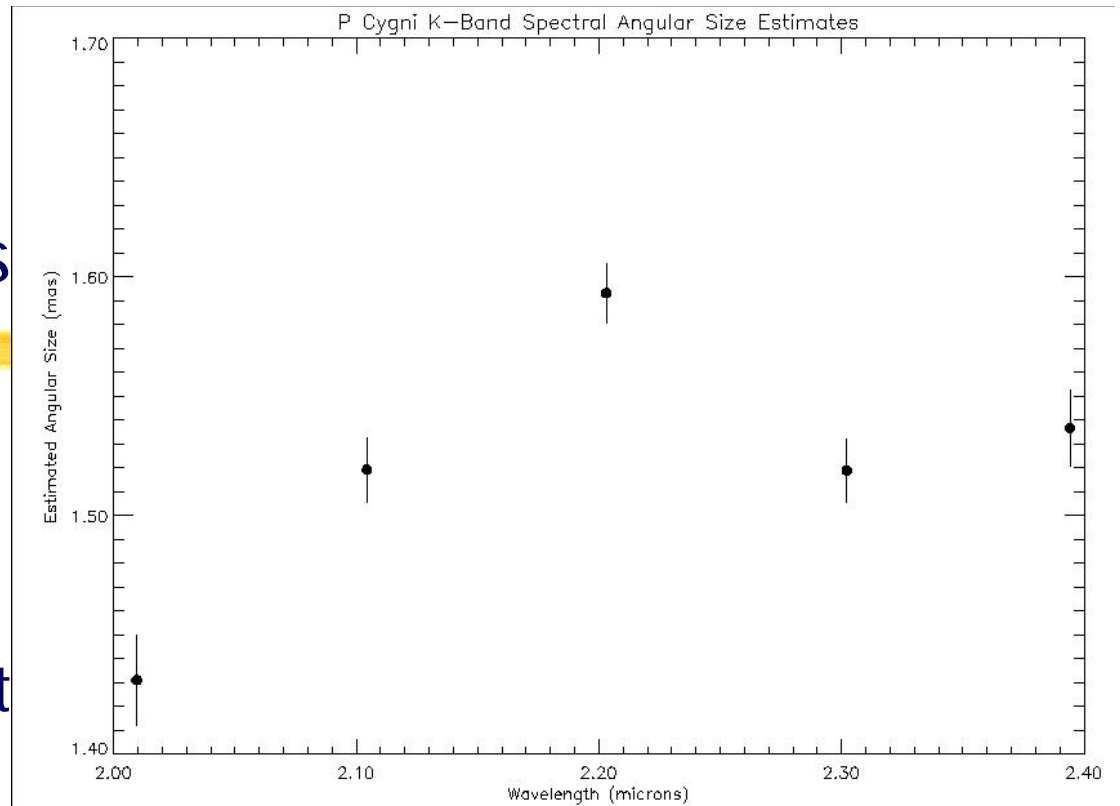
- ⌘ Classical GOIbvar cepheid
- ☑ clear evidence for pulsation
- ☑ possibly want to use a resolved calibrator of similar size to show interferometric stability
- ☑ Lane et al., 2000, Nature, 407.



# P Cygni

## ⌘ Prototypical Luminous Blue Variable - B2pe

- ☒ shows clear signs for emission in the narrow-band data
- ☒ used control stars that were slightly larger and smaller than the expected 2.17 $\mu$ m size to bracket the observation
- ☒ Serabyn & Creech-Eakman, 2000 AAS, 197, 4505.



# Summary

## ⌘ Choose calibrators carefully

- ☑ Use physical information (distance, spectral type, SED) and literature search to determine best calibrators for experiment

## ⌘ Consider goals of experiment

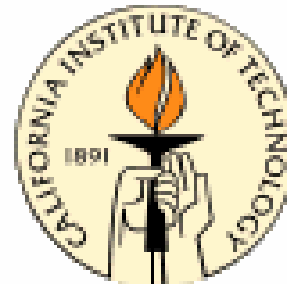
- ☑ spectral or spatial resolution may require control stars

## ⌘ Reduce data in a timely fashion

## ⌘ Publish, publish, publish!

## Software:

- ⌘ This work has made the use of software produced by the Michelson Science Center at the California Institute of Technology



Thank you for your attention!