# Visibility Calibrations With The Palomar Testbed Interferometer

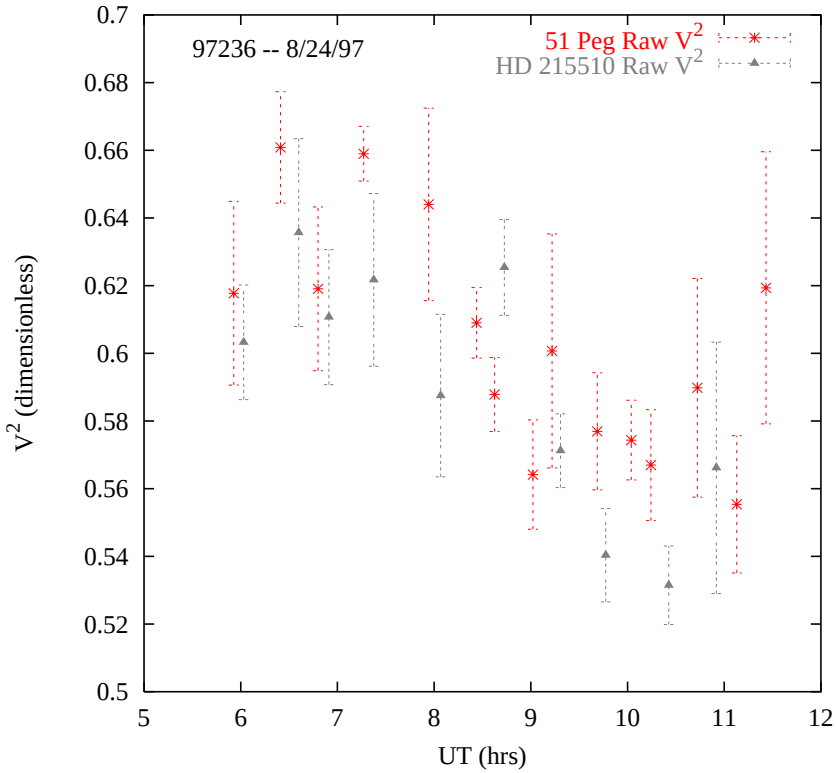
A.F. Boden, M.M. Colavita,
G.T. van Belle, M. Shao
Jet Propulsion Laboratory
C.D. Koresko
California Institute of Technology

# Introduction

- Visibility Amplitude ($V^2$) Measurements With PTI
- $V^2$ Calibration to the Response of an Idealized Interferometer
- Calibrator Selection
  - Accuracy vs Precision
- Science Results
  - Binary Stars
  - Giant Star Diameters

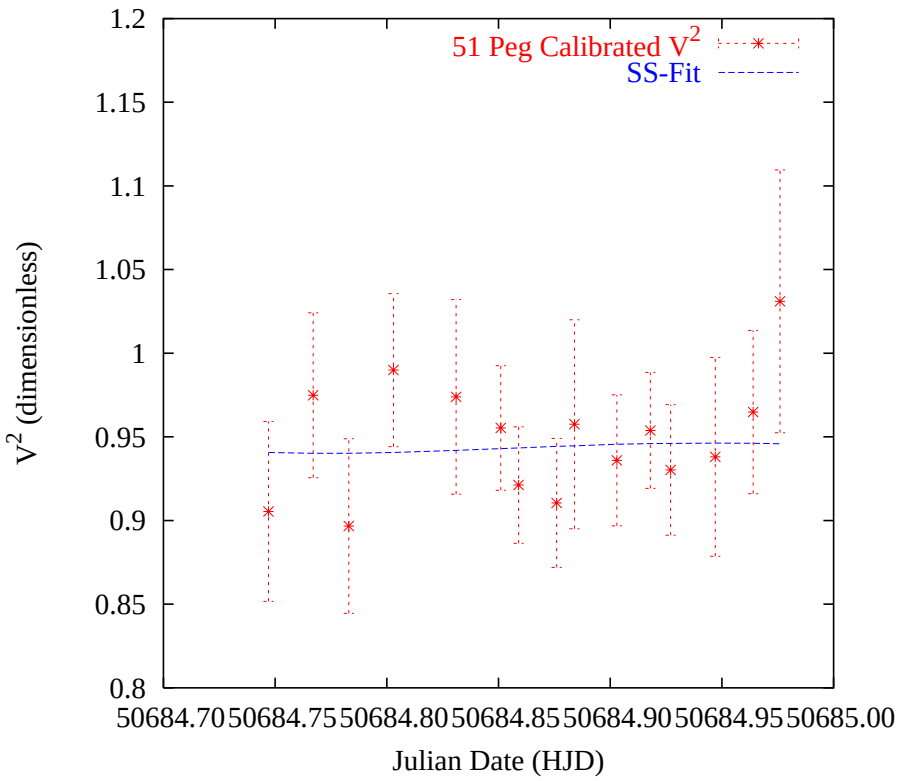
# Raw $V^2$ Measurements

- The Fundamental Amplitude Observable With PTI is $V^2$
- Raw $V^2$ Measurements Computed From Detector Fringe Quadratures
- Susceptible To Seeing, Vignetting, Thermal Drifts



# Calibrated $V^2$ Measurements

- *Simple* Sky Objects as "Fiducials" With ***Model*** Sizes
- Locality (!!!)
- Divide $V^2$ Values...
- Calibrator Continuity Within a Program (Precision if not Accuracy)

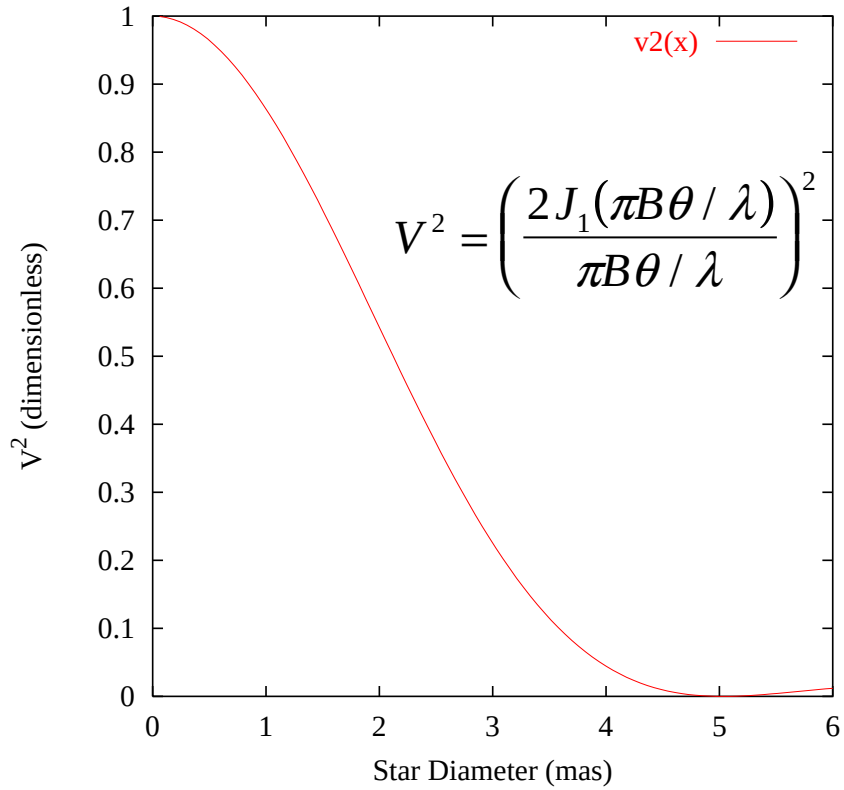


# 1997 PTI Hardware Upgrades (Aimed at Improving $V^2$)

- Single-Mode Fiber on Spectrometer Side of the Split
  - "Get Rid of the Bad Photons and Keep the Good Ones"
- Siderostat Accelerometers To Reduce Jitter Anisotropy

# Calibration Objects

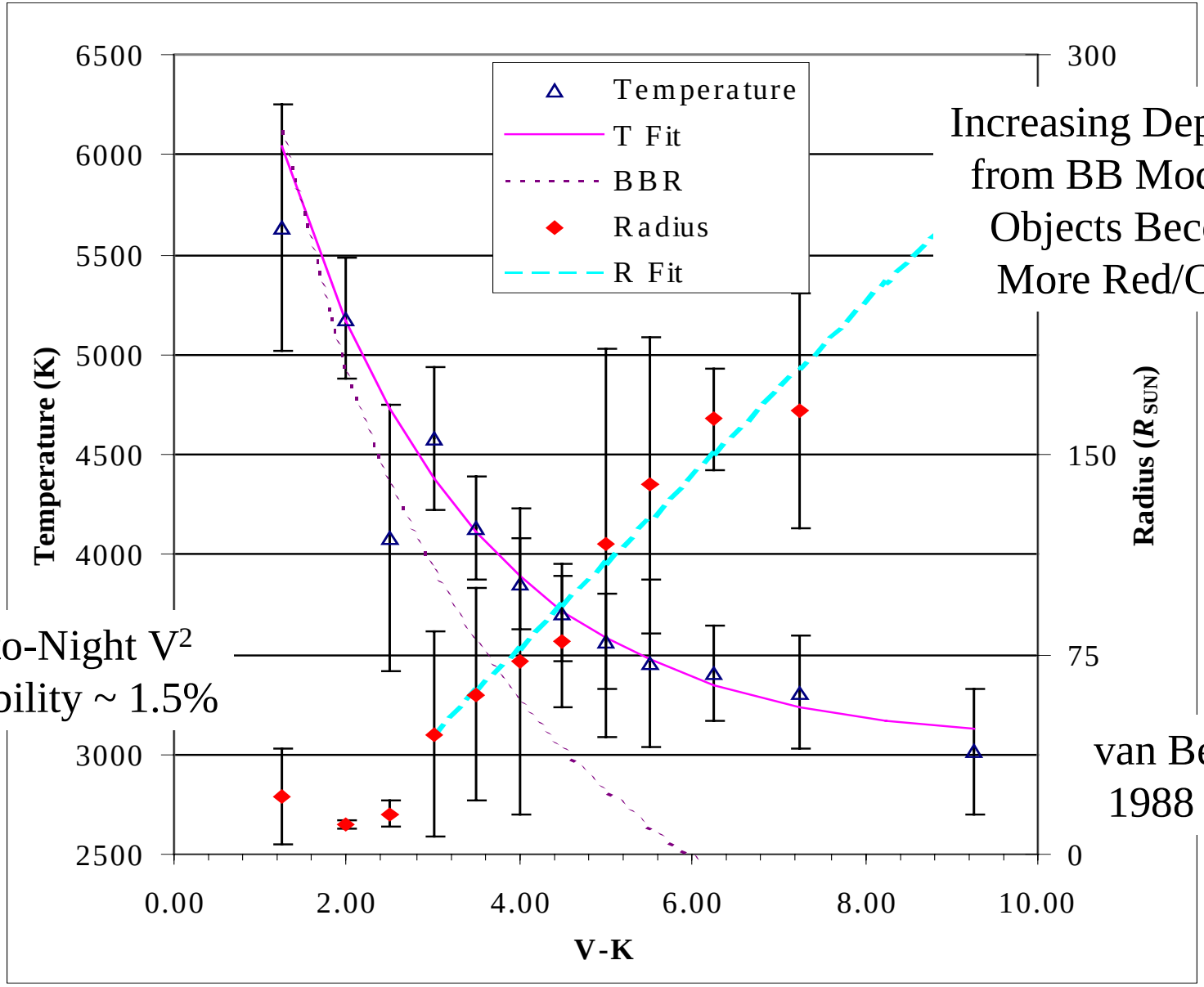
- The Ideal Calibrator is:
  - Bright (~ target)
  - Small (unresolved)
  - Close To Target
- They Don't Exist (At Least For PTI)!
  - 110 m/K ~ 4.5
- Compromise -- 2 Tiers:
  - Primary: Nearby (~5deg), Partially Resolved
  - Secondary: Farther (~15deg), Unresolved



# PTI Science Sampler

- Giant Star Diameters (GVB)
- Two Systems in Pegasus
  - 51 and ι Peg (AB)
- RS CVn Objects (CK)

# Temperature, Radius versus V-K Color



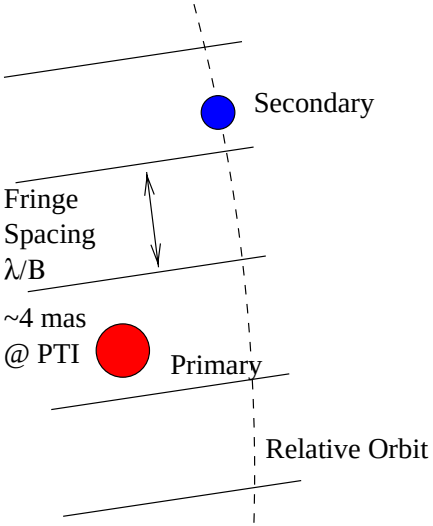

Increasing Departure from BB Model as Objects Become More Red/Cool

Night-to-Night $V^2$ Repeatability ~ 1.5%

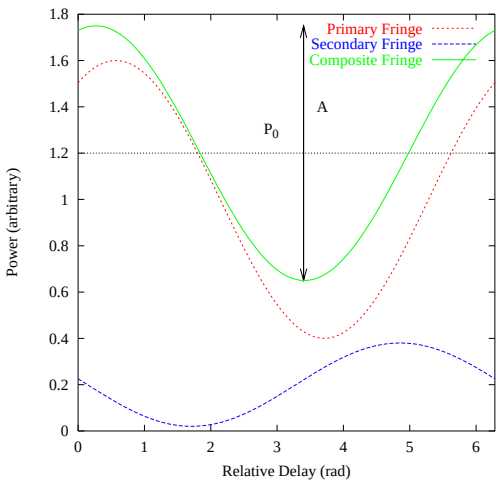
van Belle et al 1988 in Prep

3/23/98 A.B.

# $V^2$ Observable on Binary Systems




$$V^2 = \left(\frac{A}{2P_0}\right)^2$$




Both the Binary System and the Fringe Pattern on the Sky Evolve with Time.

Composite Fringe from Superposition of Primary and Secondary Object Fringes.

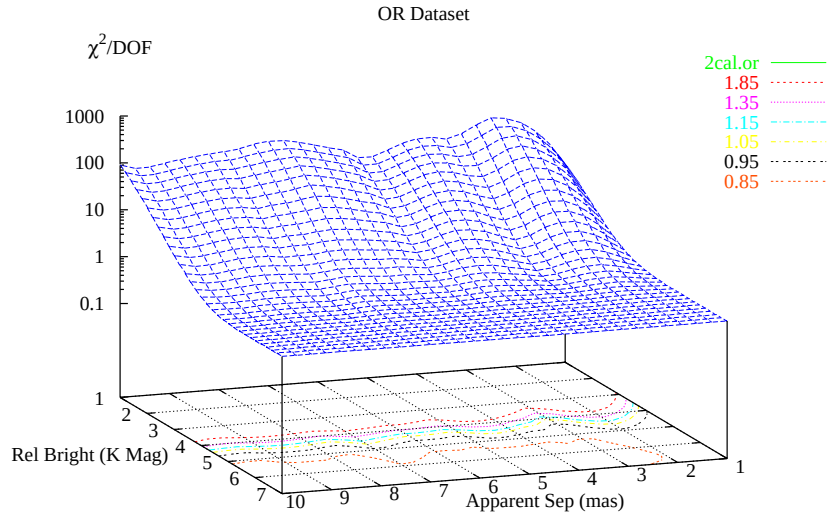
$$V_{comp}^2 = \frac{V_p^2 + V_s^2 r^2 + 2V_p V_s r \cos\left(\frac{2\pi}{\lambda} B \bullet s\right)}{(1+r)^2}$$

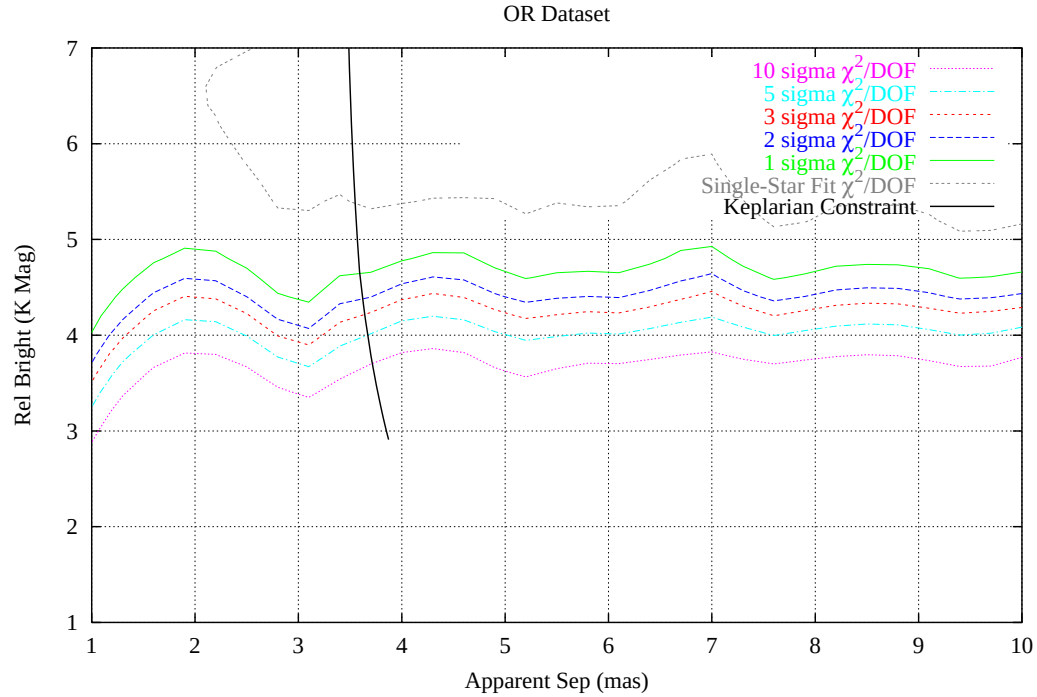
$$V_p = \frac{2J_1(\pi B \theta_p / \lambda)}{\pi B \theta_p / \lambda}$$

r = Intensity Ratio

# 51 Pegasi

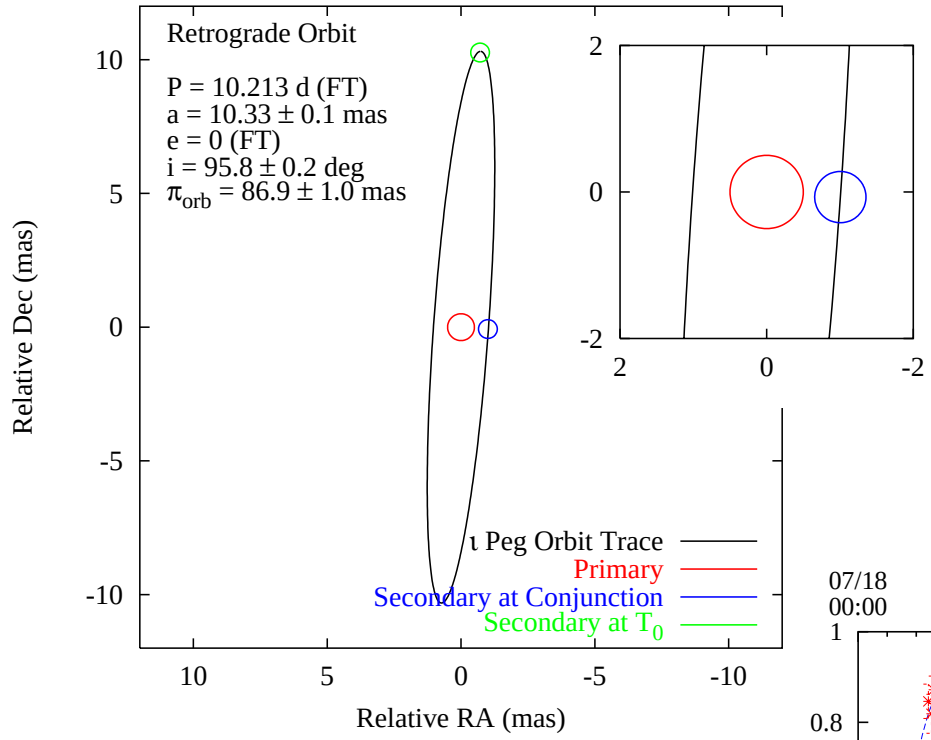
- Experiment With 51 Peg, Two Nearby Calibrators To Test Binarity
- Rationalized All Diameters to Model 51 Peg Diameter (Precision, Not Accuracy)
- 51 Peg No More Variable Than Calibrators -- Consistent With SS Hypothesis (2.9% $V^2$ Scat)
- Upper Limit on Binary Companion: 4.4 Relative K, 0.22 $M_{sun}$ (99% CL) (Boden et al 1998 ApJ in Press)



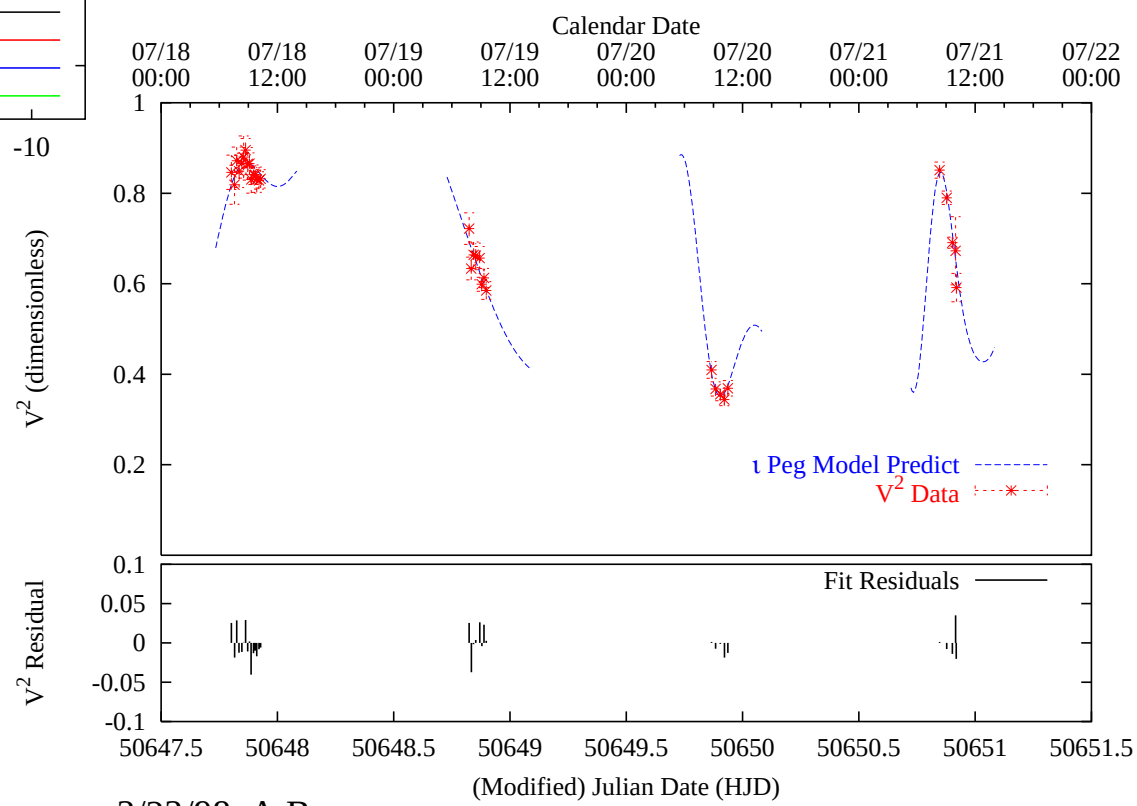




3/23/98 A.B.

# ι Pegasi




Well-Known Binary System
"Possibility of Eclipses" Inferred By Fekel and Tomkin (1983)




Average Absolute $V^2$ Residual 1.4% Over 114 Scans (Boden et al 1998 ApJ Submitted)

3/23/98 A.B.

# RS CVn Binaries

- Short-Period, Mass-Transfer Binary Systems With Radio Emission
- PTI Observed 6 Systems In 1997
- Resolved And Estimated The Orbit Of TZ Tri
- Possible Suprises With Regard to the Mass Of The System
- Koresko et al in Prep

# Summary

- PTI Has Been Successful in Producing Precise (and Accurate) $V^2$ Measurements
- Primarily Attributable To:
  - Single-Mode Fiber
  - Siderostat Accelerometers
  - Experimental Technique
- We Look Forward To A Busy 1998 Observing Season -- We Have A Lot of Fun Stuff Planned