
Accurate diameter measurement of Betelgeuse using the VLTI/AMBER instrument

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The logo for the Laboratoire d'Astrophysique de Grenoble (LAOG) features the letters 'LAOG' in a bold, orange, sans-serif font. A thin orange line extends from the top right of the letter 'O'.

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 - Uniform disk + Spot model or Jitter ?
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Goals

- Demonstrate AMBER capability to precisely measure low contrast visibilities
- Validate P2VM method
- Give a very accurate measurement of Betelgeuse diameter

Betelgeuse

- Apparent magnitude (V) +0.3 to +1.2
- Spectral type M2Iab(3600K)
- Variable type SR c (Semi-regular)
- Distance approx. 130 pc



Sirius (calibrator)

- Apparent magnitude (V)
 - A = -1.47
 - B = 8.44
- Variable type Eclipsing binary
- Spectral type
 - A = A1V (9,900K)
 - B = DA2 (25,200K)
- Distance approx. 2.64 ± 0.01 pc



Observations

February 2006, AT1-AT3, R=1500

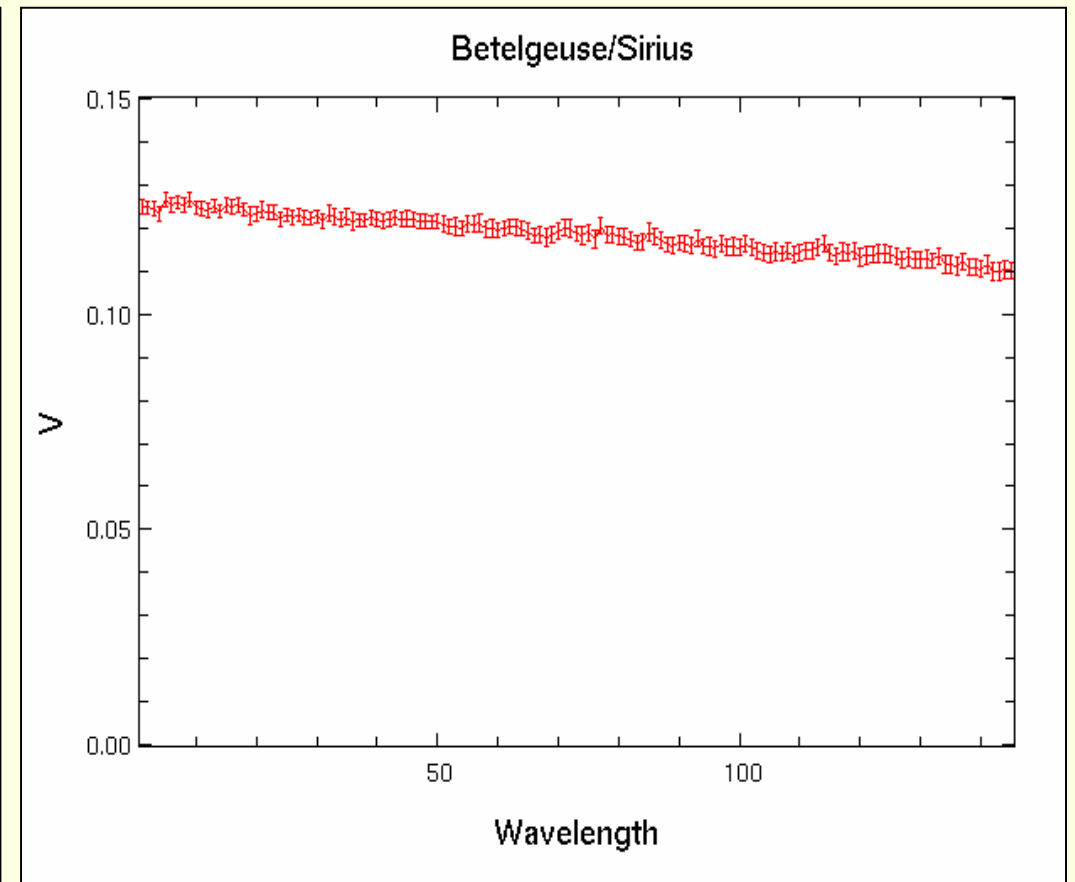
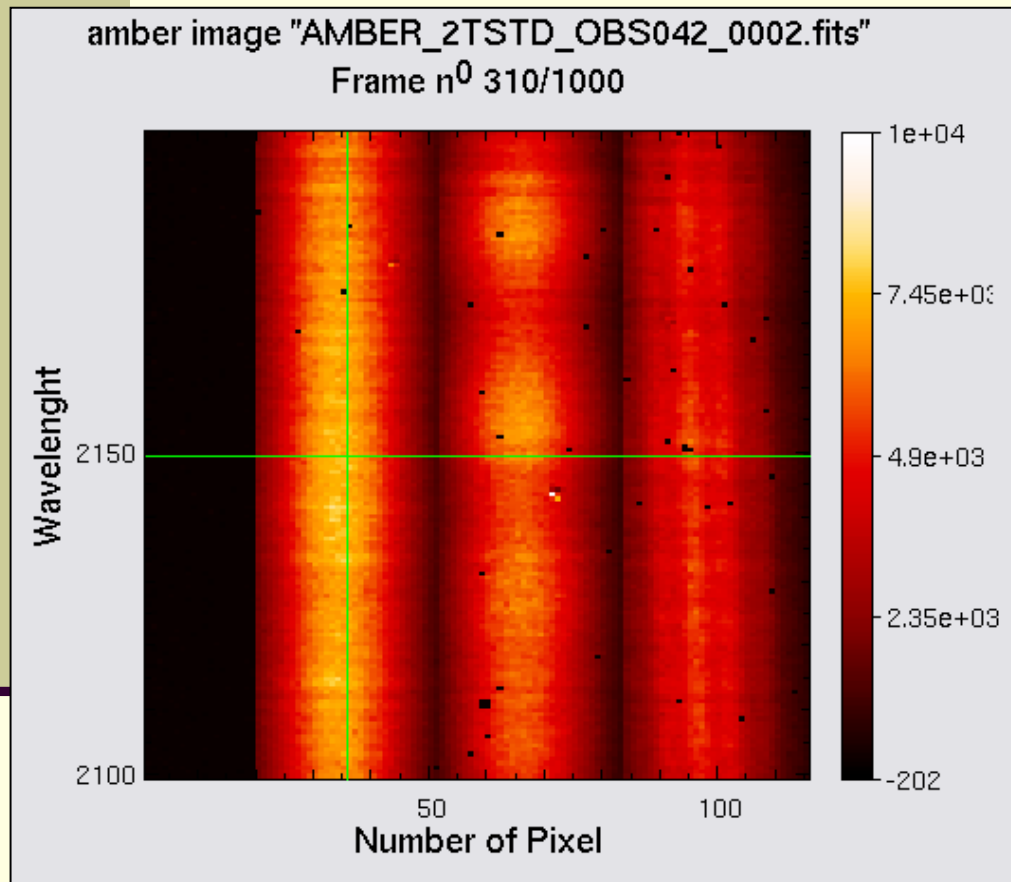
Betelgeuse

- Baseline 16m
- 5 observation files
- 1000 frames/file

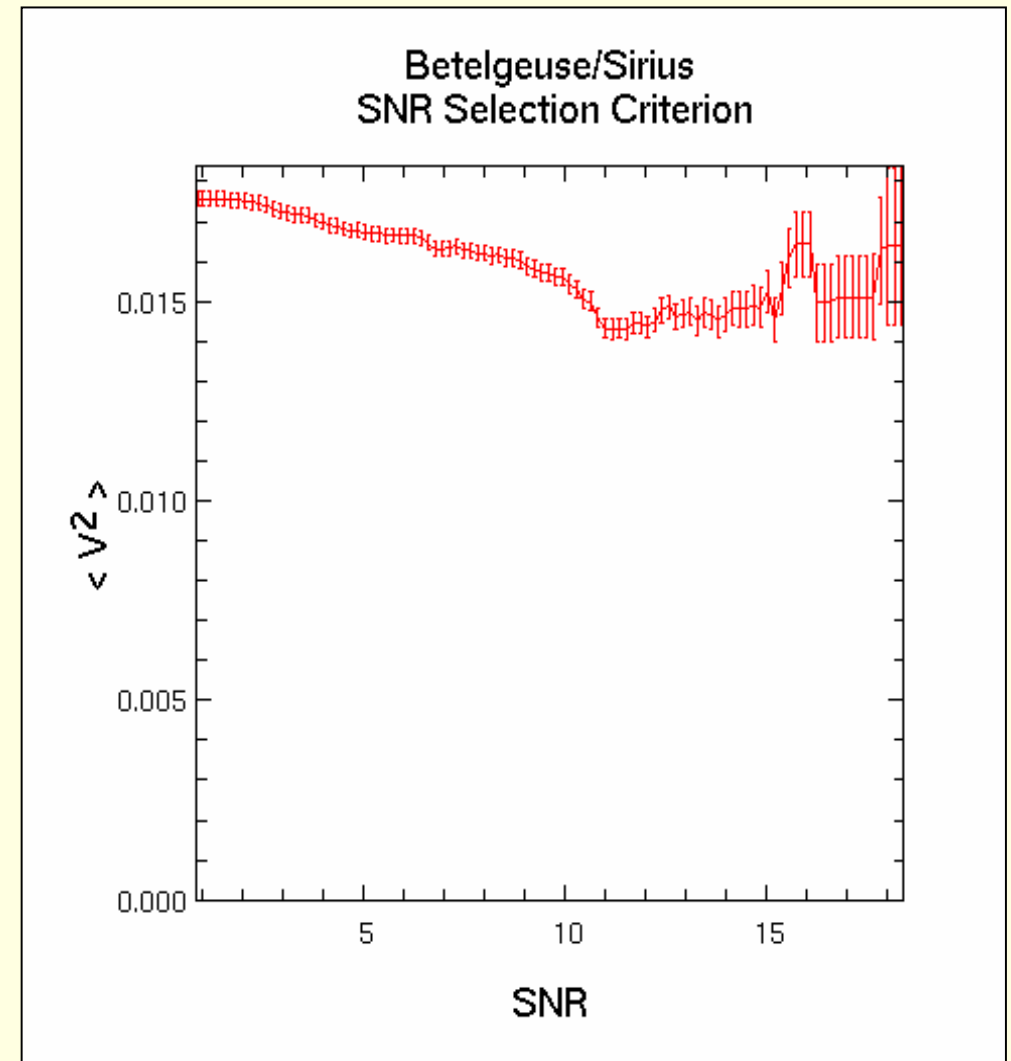
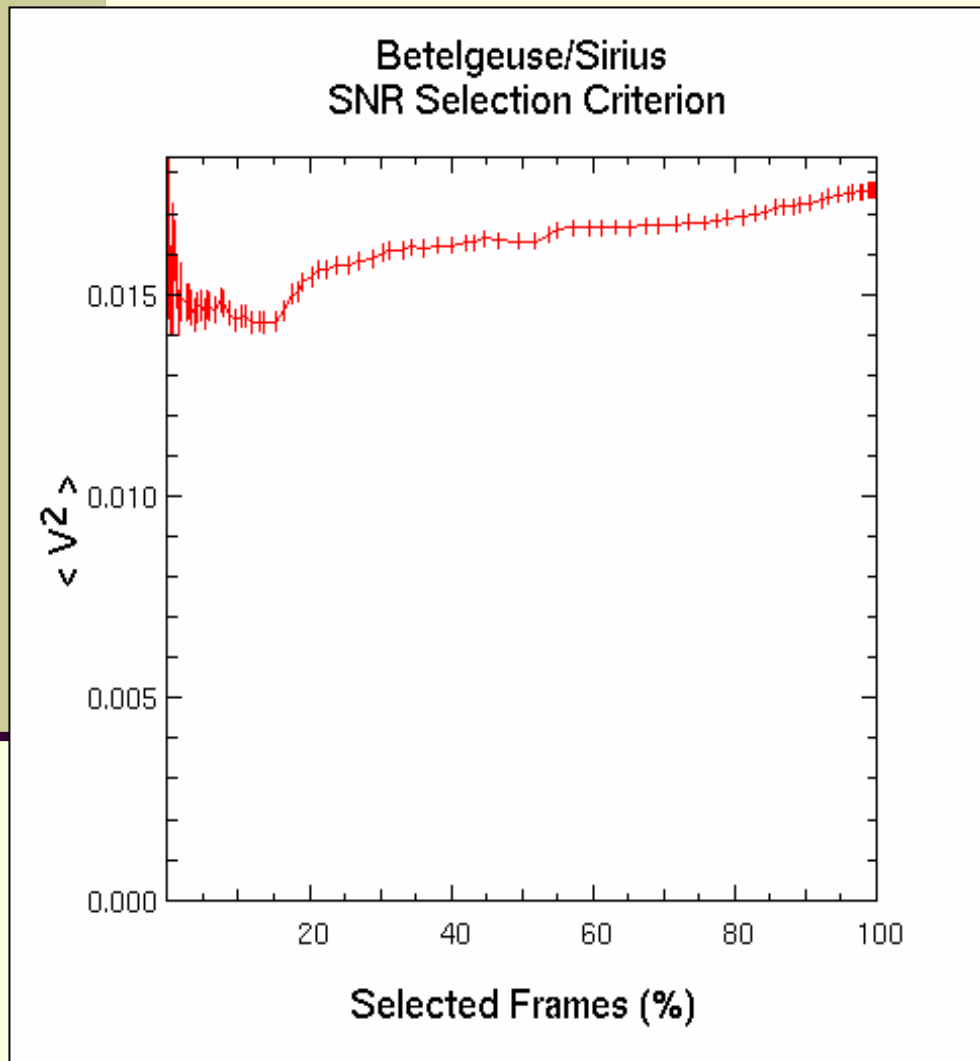
Sirius

- Baseline 13m
- 5 observation files
- 500 frames/file

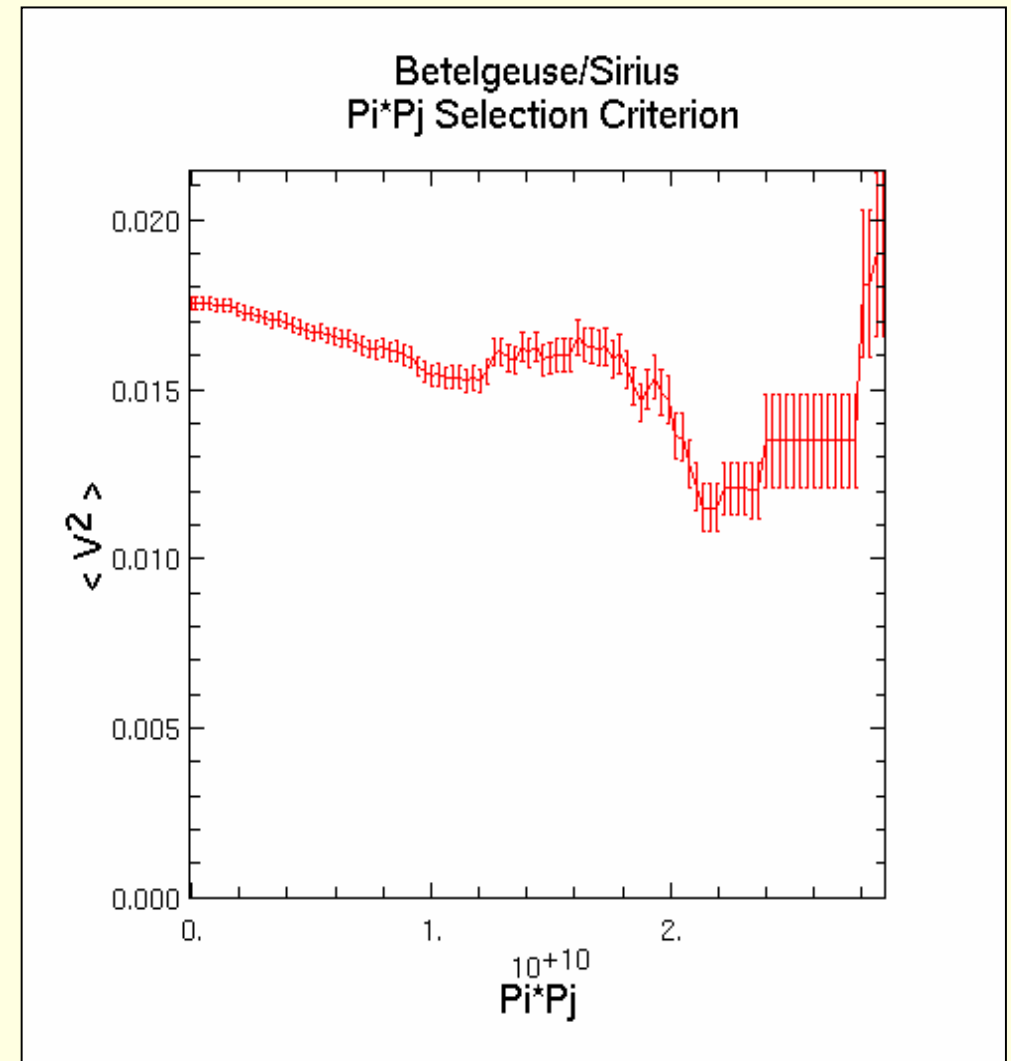
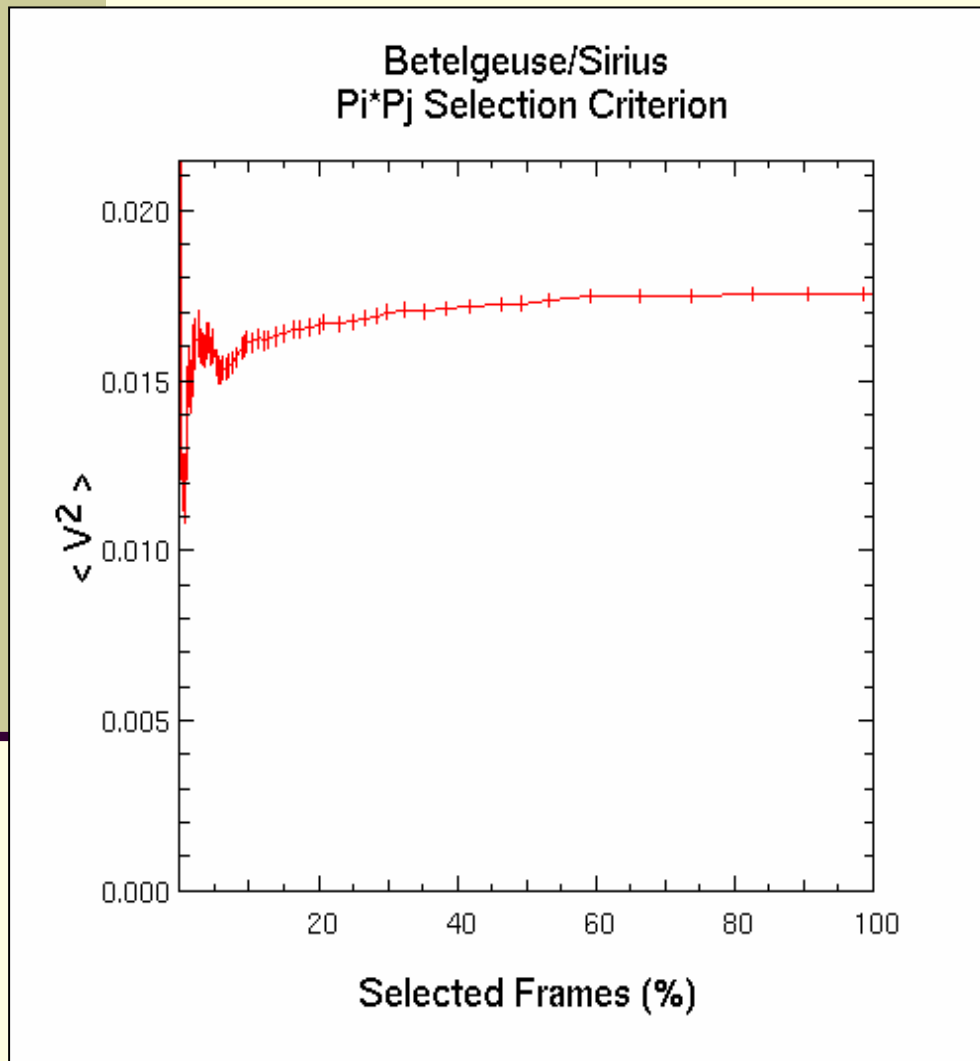
Raw data & final visibility



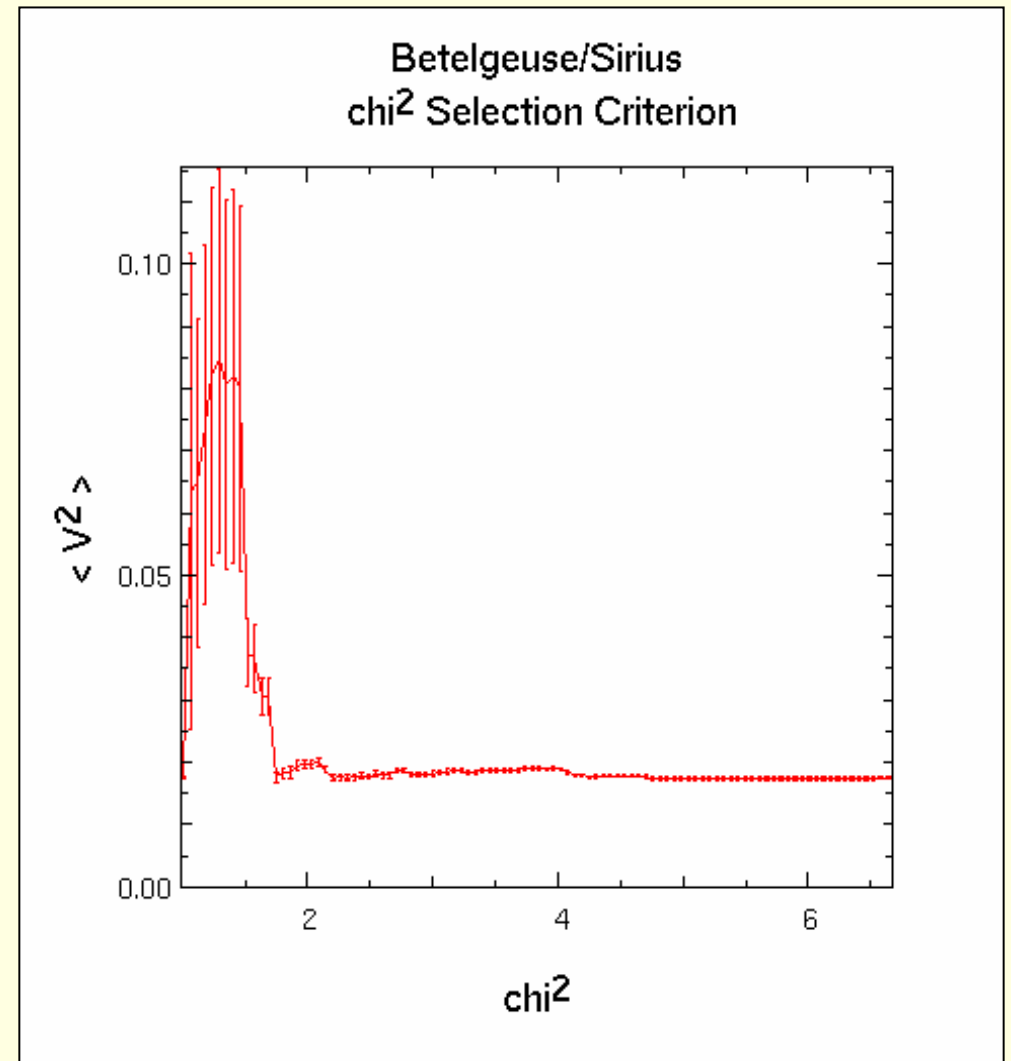
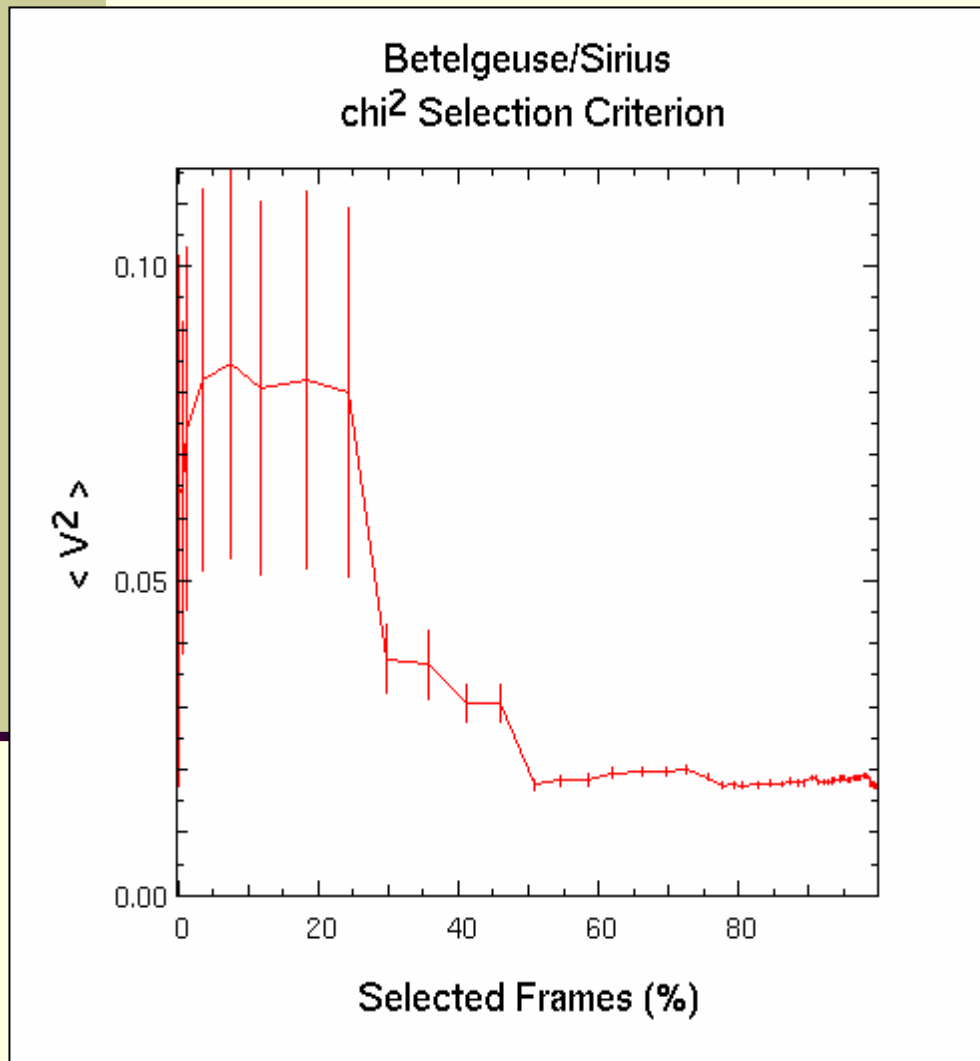
Frame selection - SNR



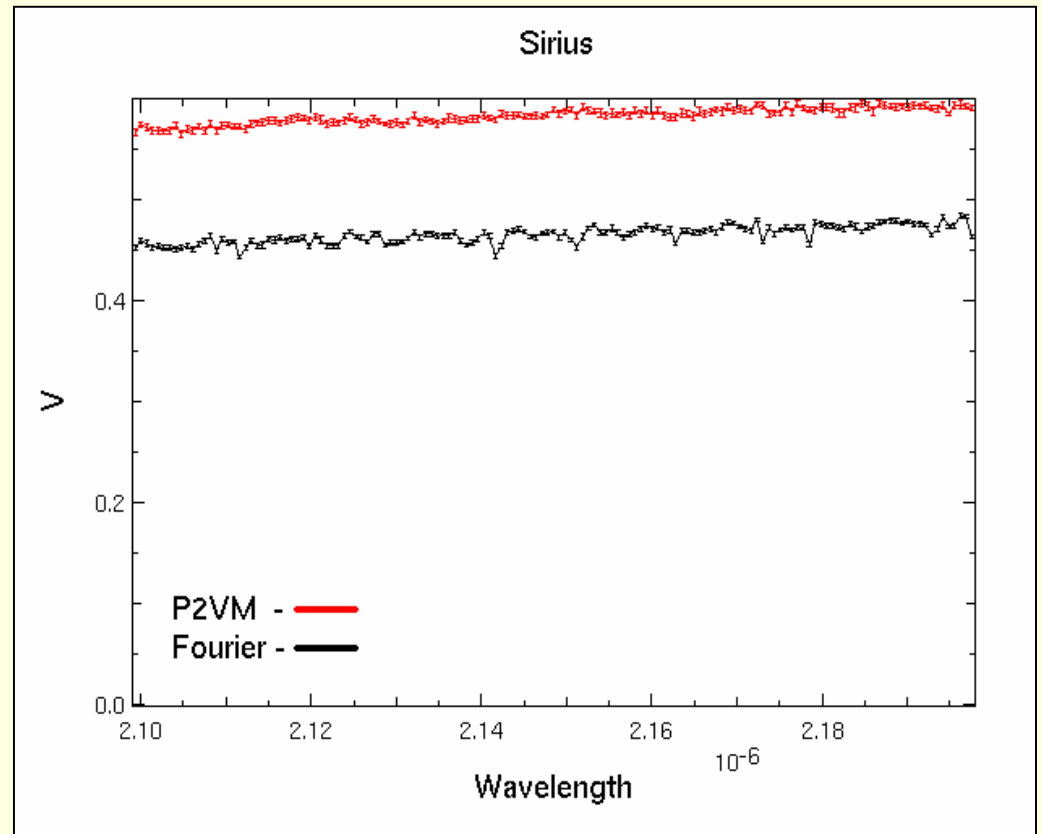
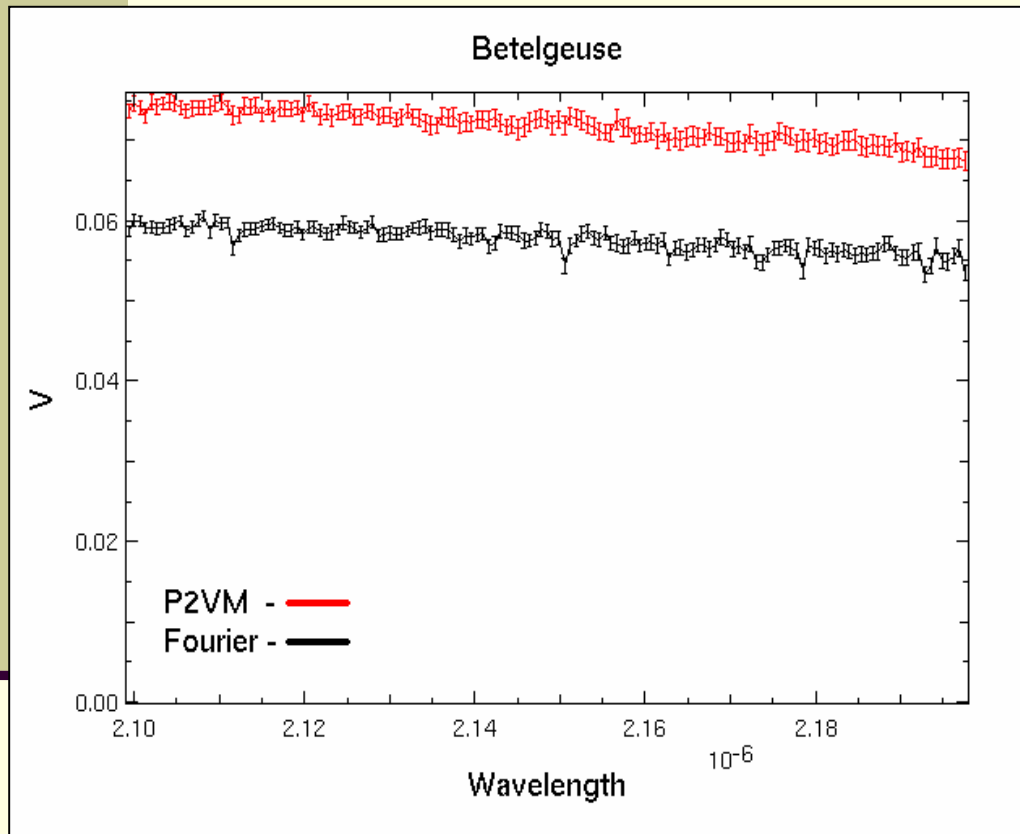
Frame selection - Flux



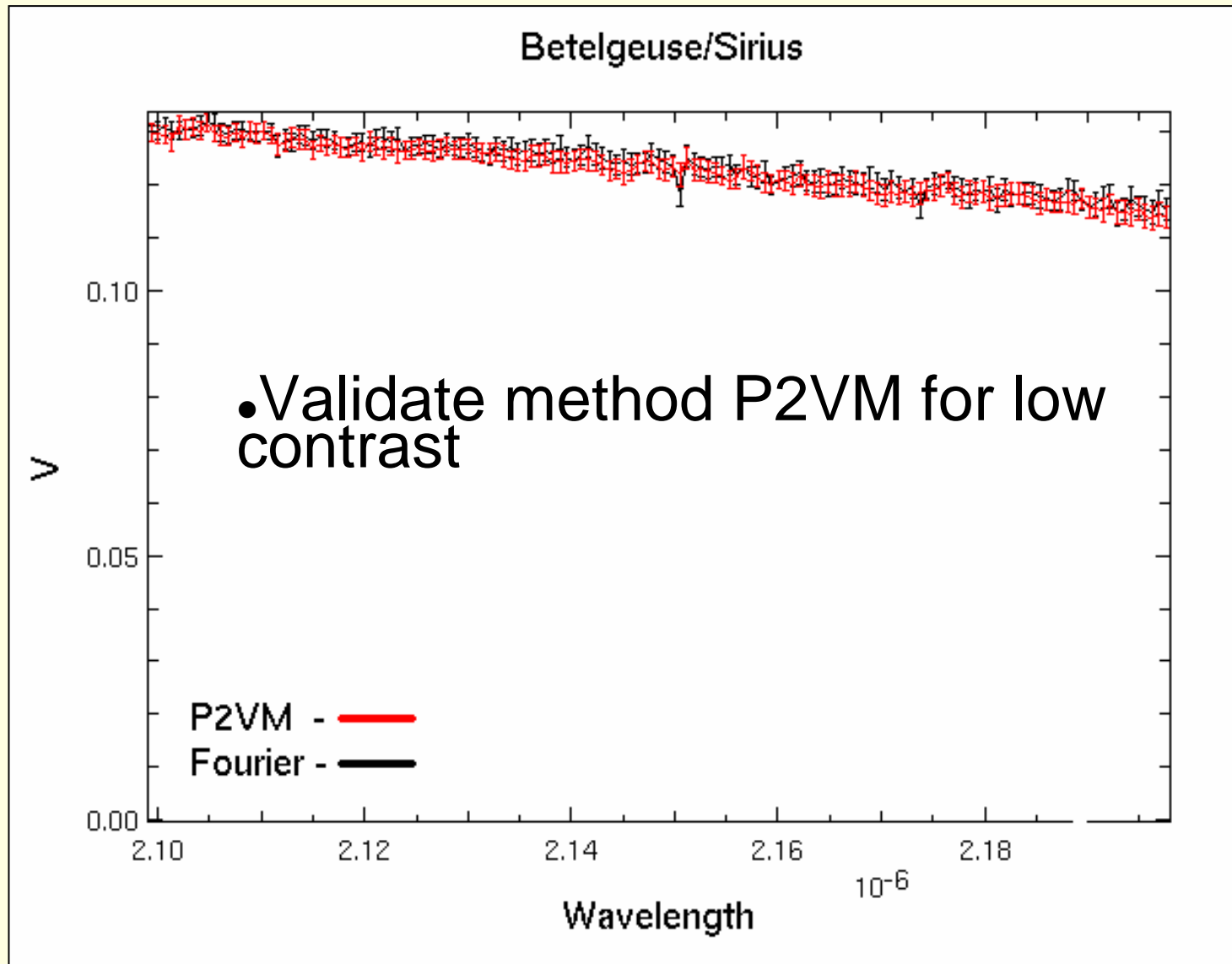
Frame selection – P2VM χ^2



P2VM vs. Fourier



Betelgeuse calibrated visibility



Uniform disk diameter

Perrin et al. 2004

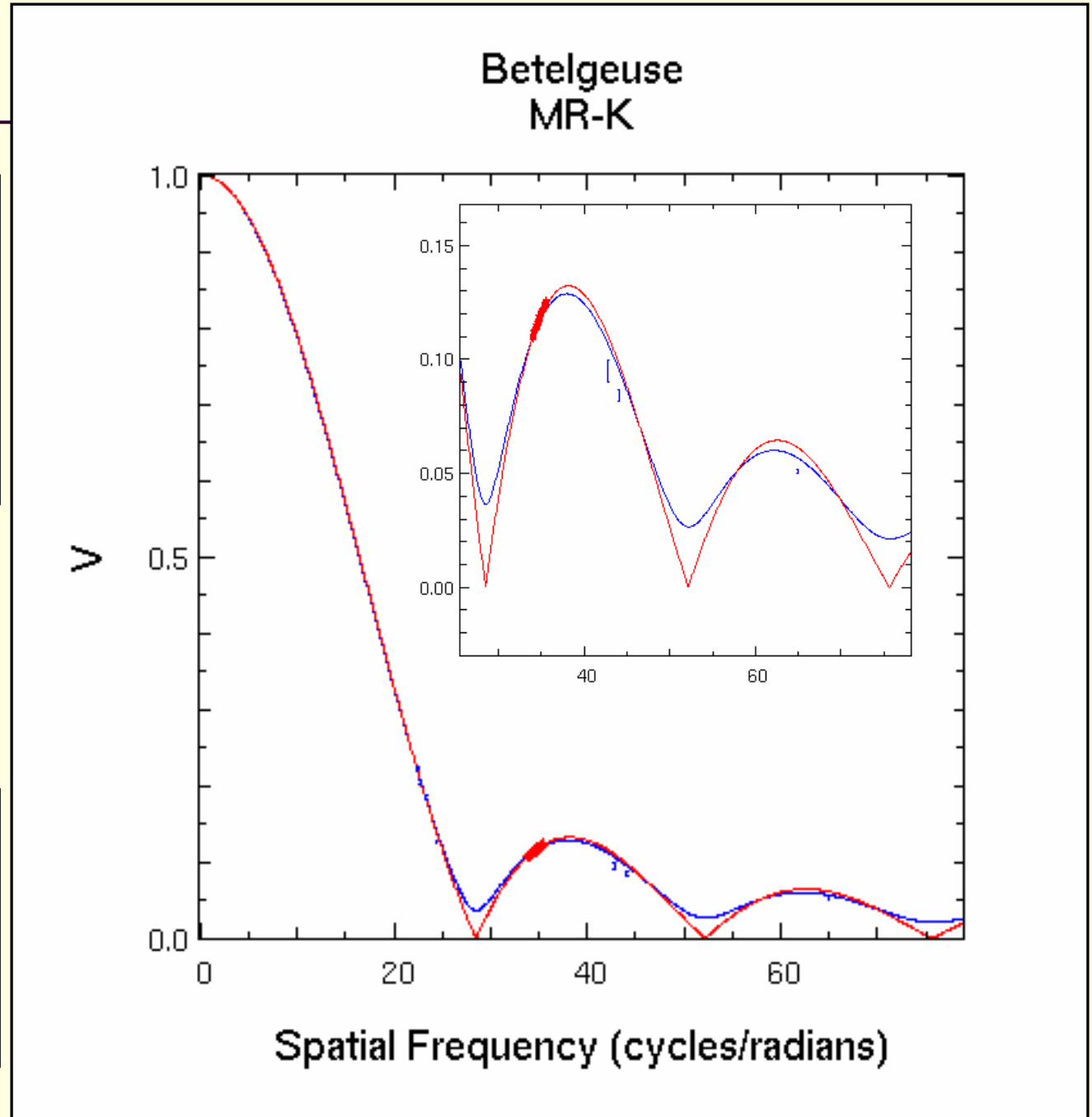
$\theta = 43.33 \pm 0.04$ mas

(blue)

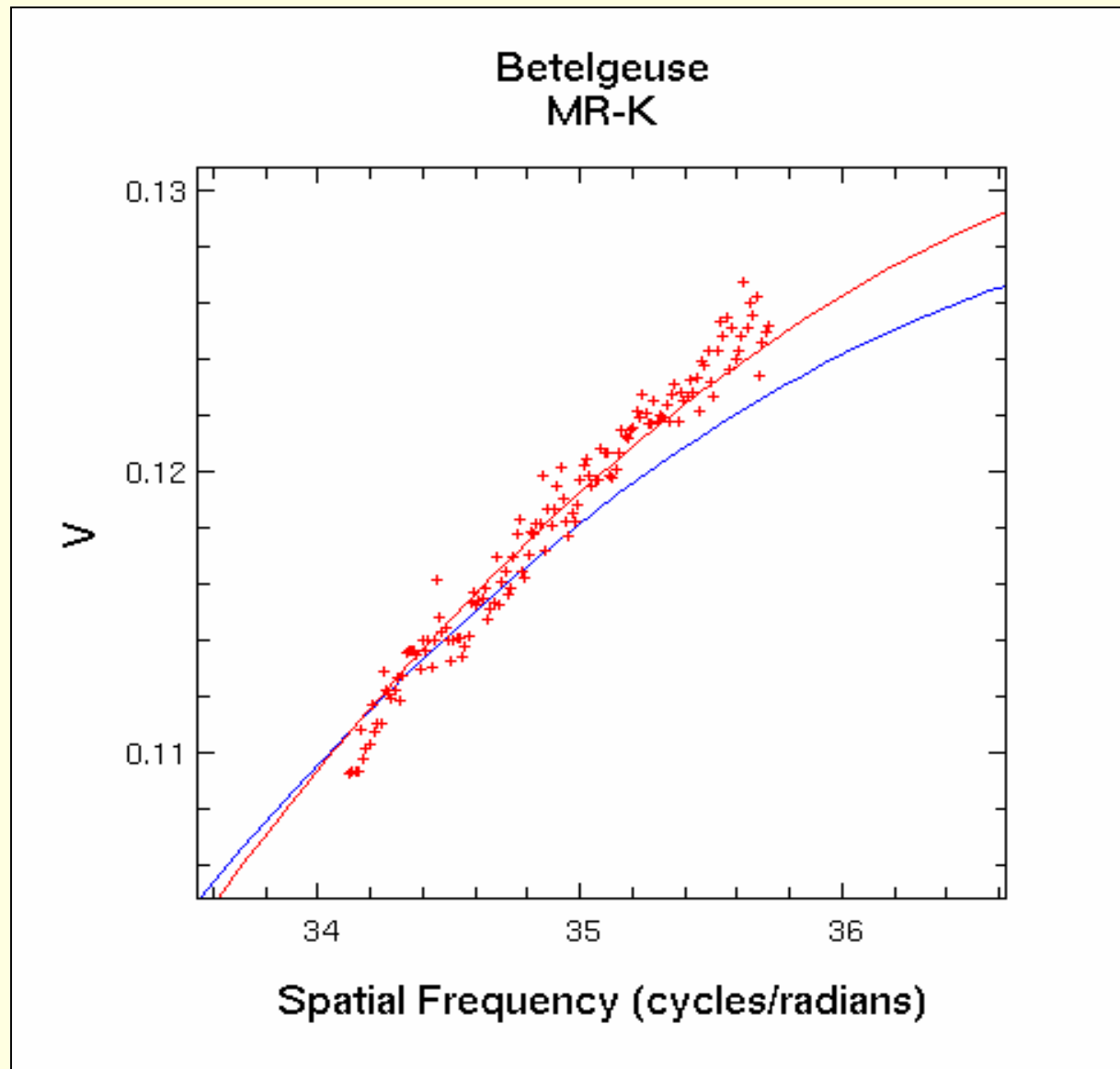
AMBER

$\theta = 42.85 \pm 0.02$ mas

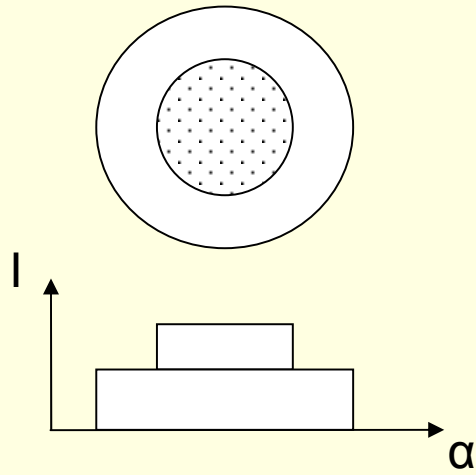
(red)



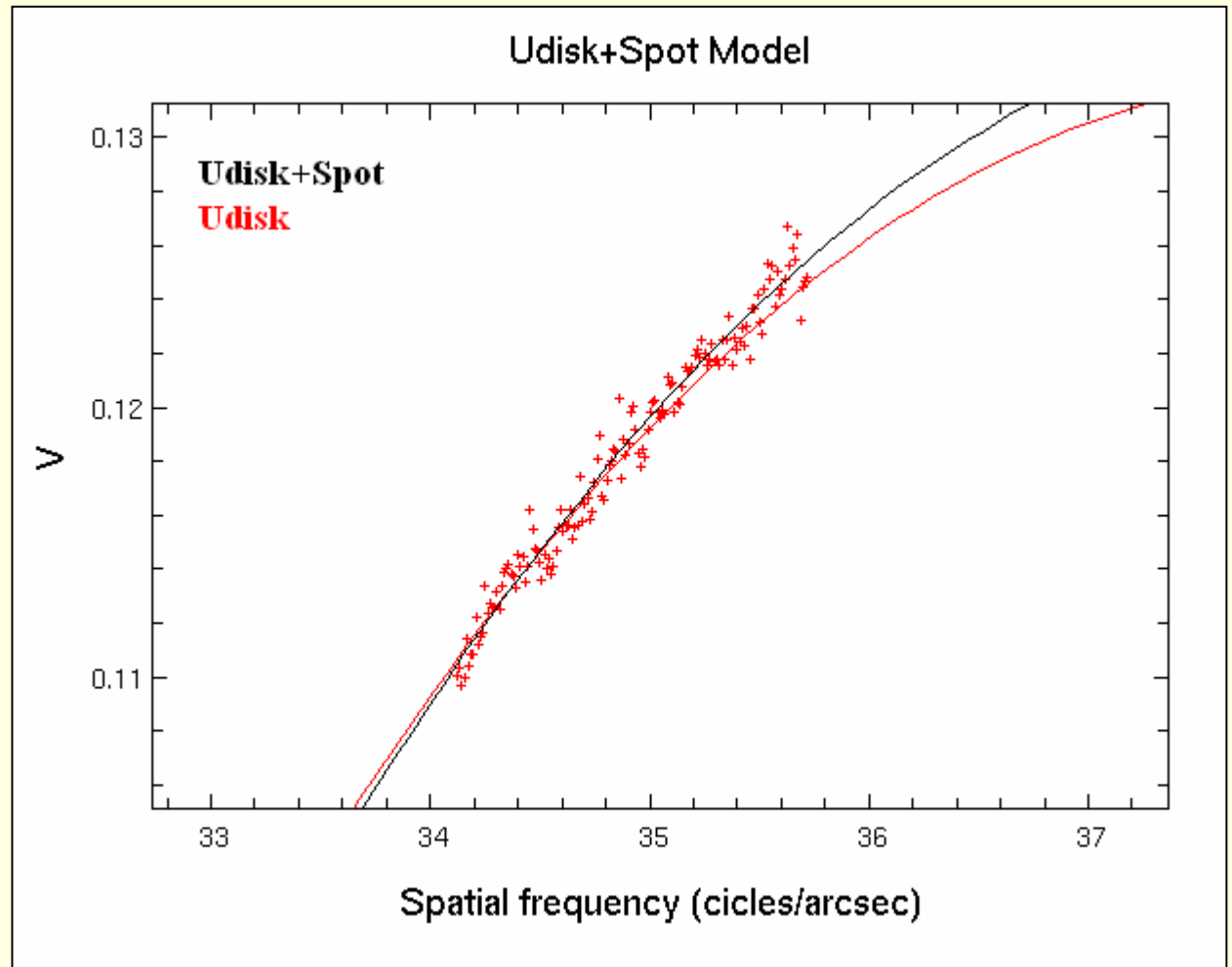
Uniform disk diameter – Slope?



Uniform disk + Spot



$$\theta = 42.50 \pm 0.02 \text{ mas}$$



Jitter correction

$$V_m = V_e - \left[\frac{2\pi^2 \sigma^2}{\lambda^2} \right]$$

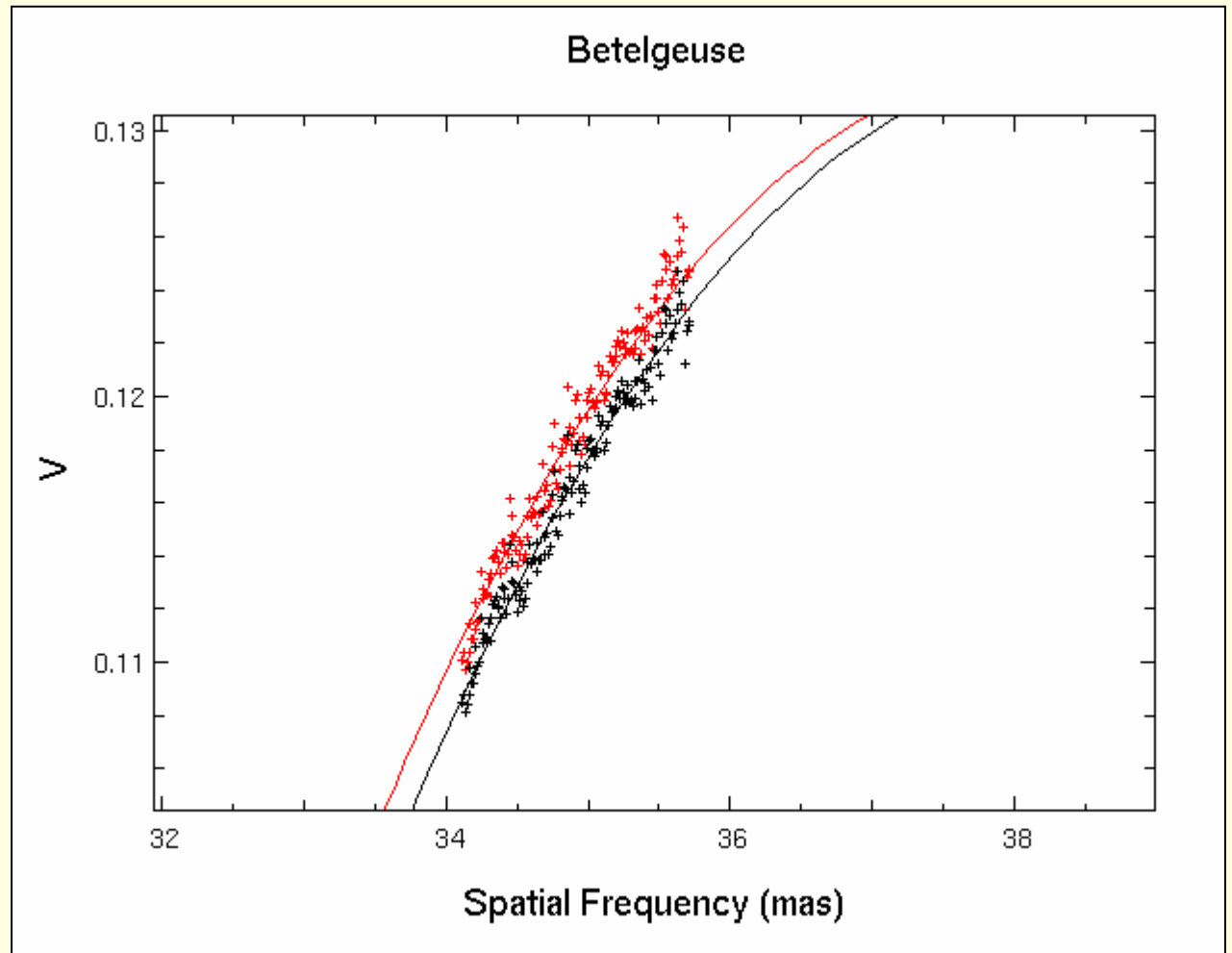
Sirius

$\sigma_s = 0.343 \mu\text{m}$

Betelgeuse

$\delta\sigma \sim 25\%$

$$\theta = 42.60 \pm 0.02 \text{ mas}$$



Conclusions

- AMBER is capable to give very low contrast visibilities in high flux conditions
- P2VM method is consistent with Fourier method
- P2VM validation can be used to properly measure the bias subtraction in low contrast and low flux data
- Betelgeuse diameter confirmed
 - $U_{\text{disk}} = 43.33 \pm 0.04$ mas (Perrin et al. 2004)

AMBER

- $U_{\text{disk}} = 42.85 \pm 0.02$ mas