Mid Infrared Imaging of YSOs using Sparse Aperture Interferometry: Keck Segment Tilting Experiment.

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Scientific Goals.

- Obtain Mid-Infrared sizes for a sample of Herbig Ae/Be stars.

- Combine them with near-IR sizes and elucidate the temperature structure of the circumstellar disks.

Challenges.

- At 10 microns the Rayleigh diffraction limit on Keck (in the absence of atmospheric turbulence) is about 270 mas.

- To image and resolve the disks around a realistic sample of stars we need a resolution of 50 mas or better.

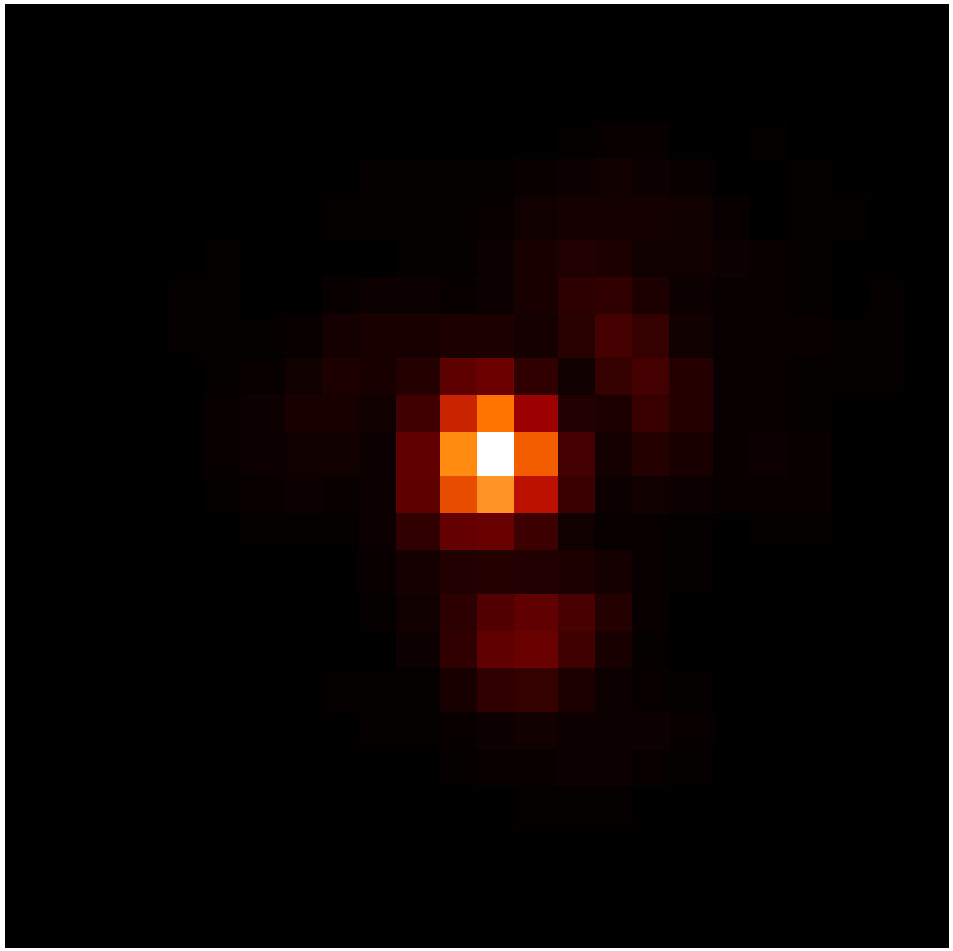
Effects of Seeing.

10 arc-seconds

10 arc-seconds

Effects of seeing.

2.5 arc-seconds

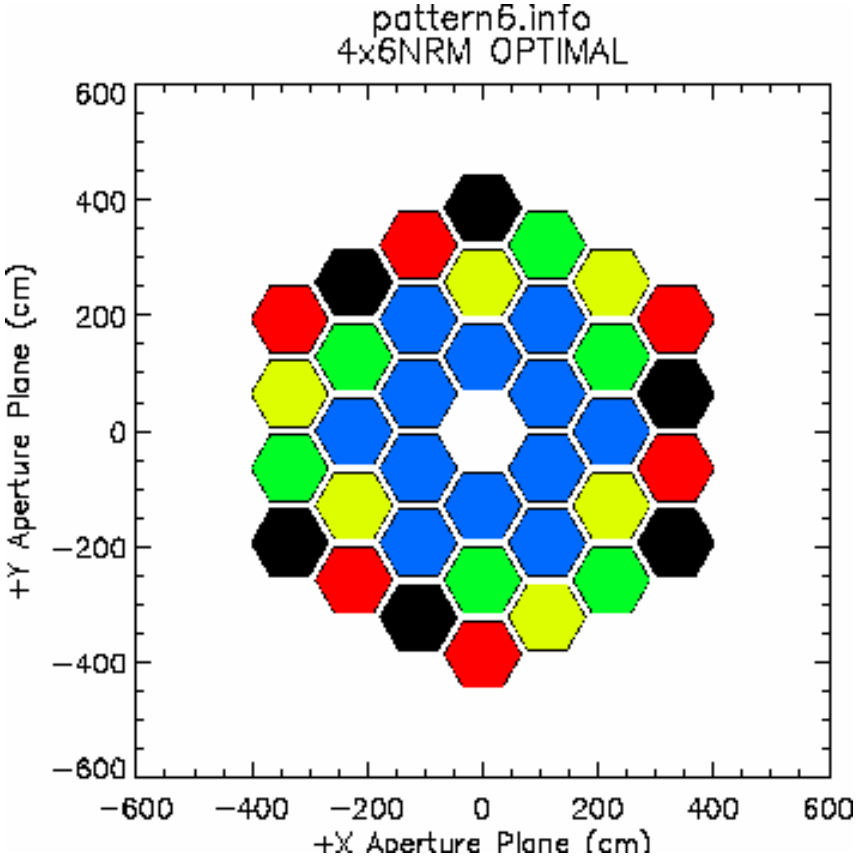


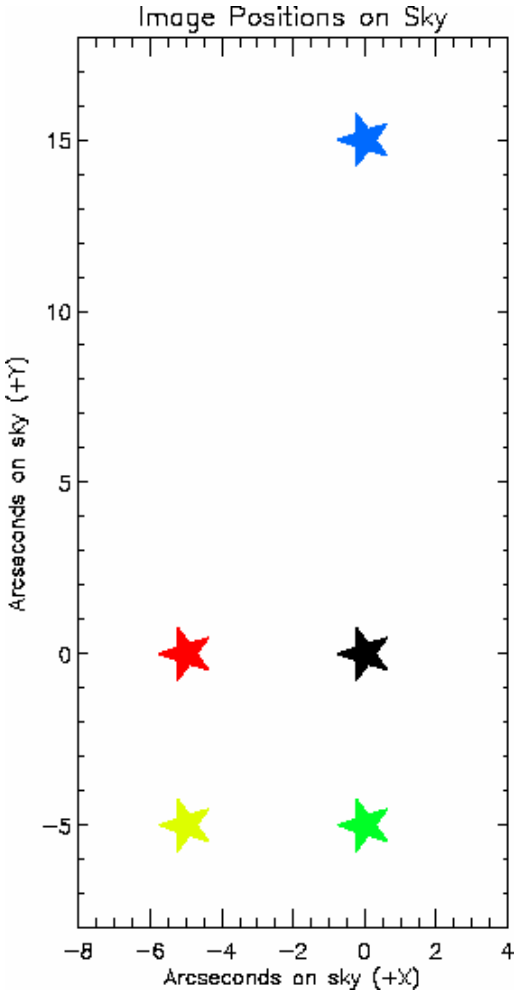
2.5 arc-seconds

Approach to tackle the problem.

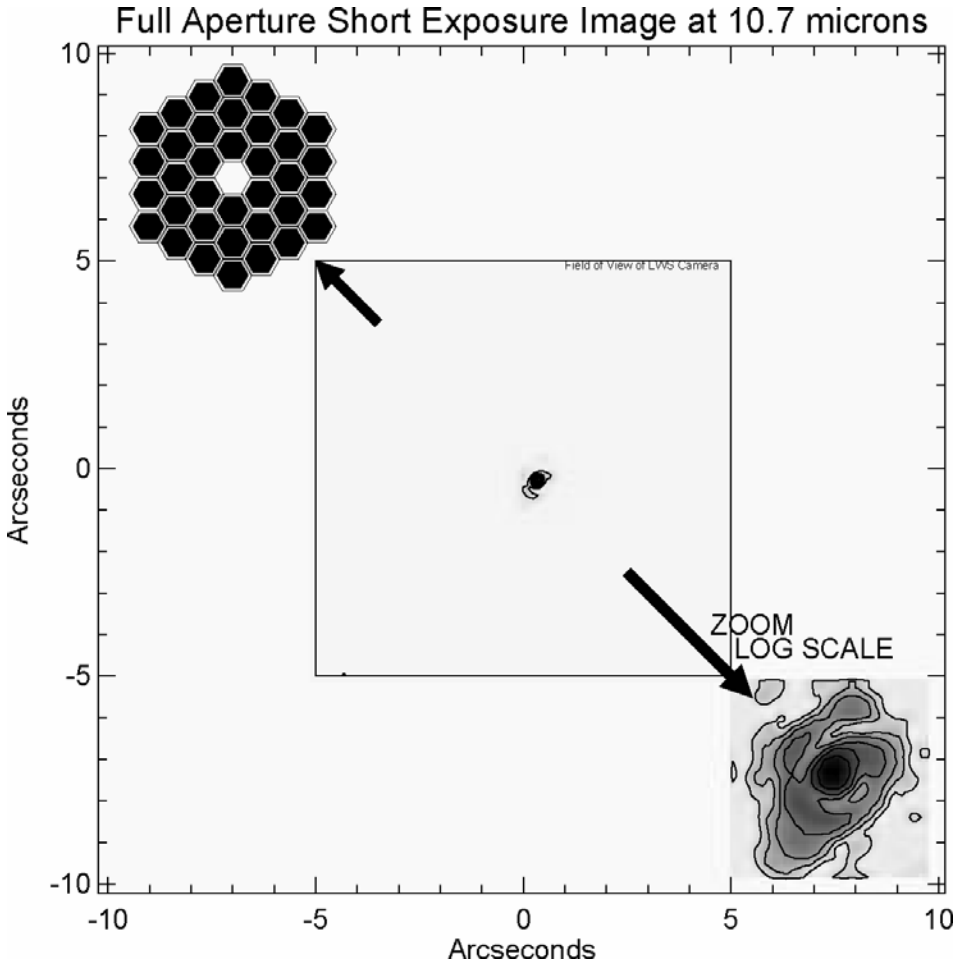
- Convert the 36 Keck mirror segments into four 6 segment interferometer units with non redundant baselines.
- Combine light from each unit at different location in the image plane.
- Since each mirror segment (1.8 m in diameter) is smaller than the atmospheric coherence length (~ 3.5m-4.0m), calibration is more robust to seeing.

Mirror Segment Pattern

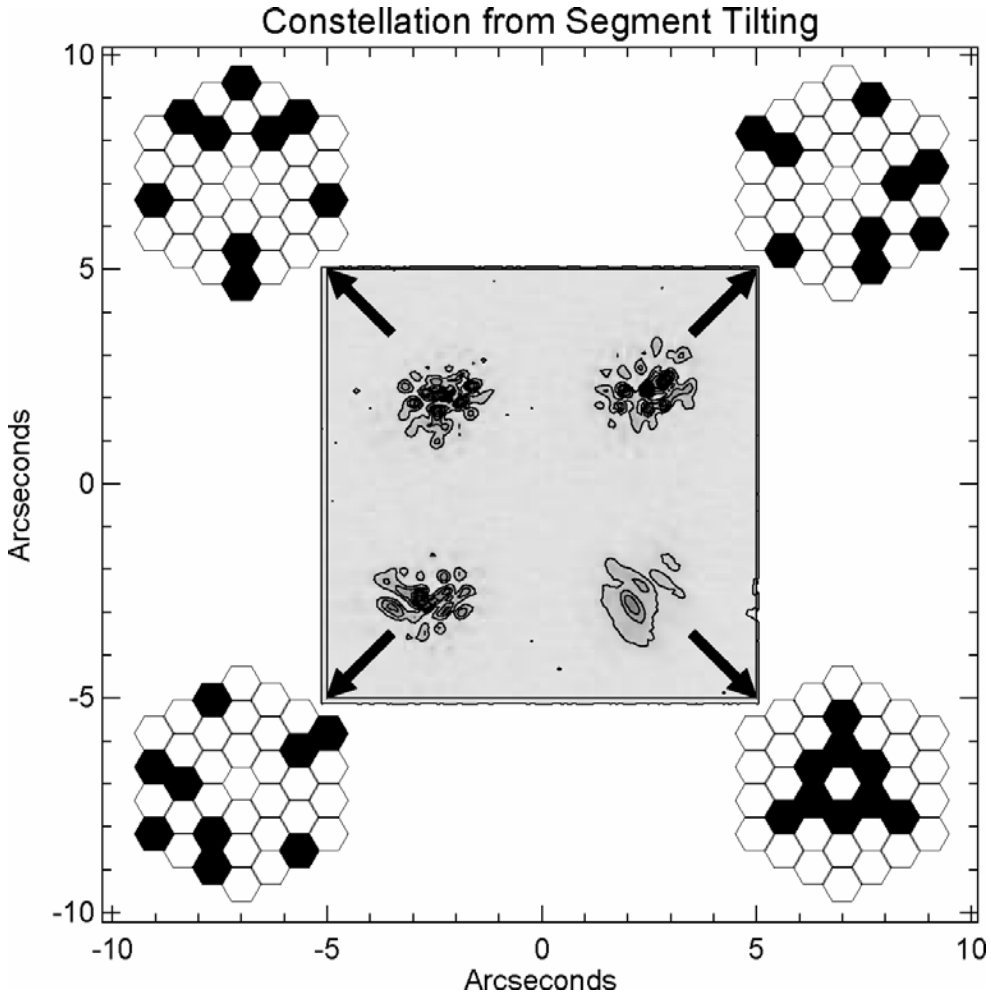




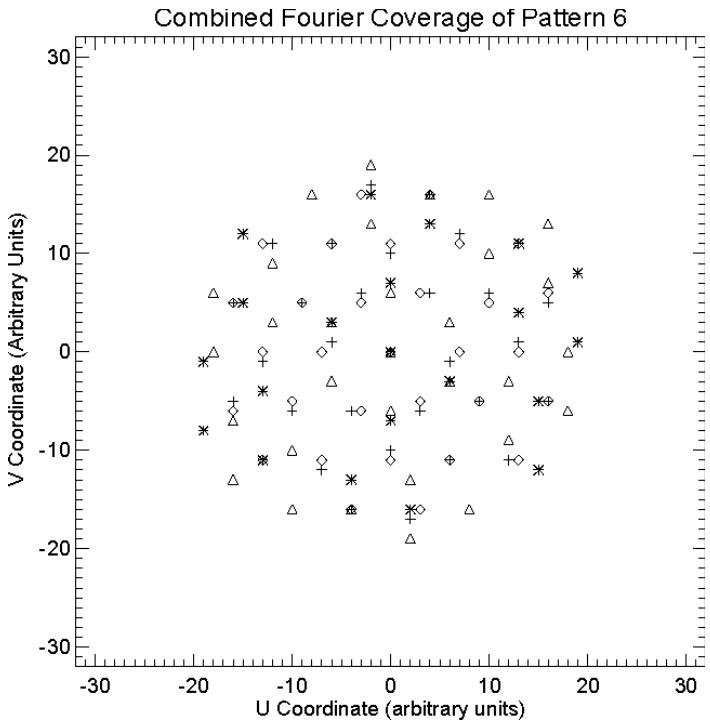
BEFORE

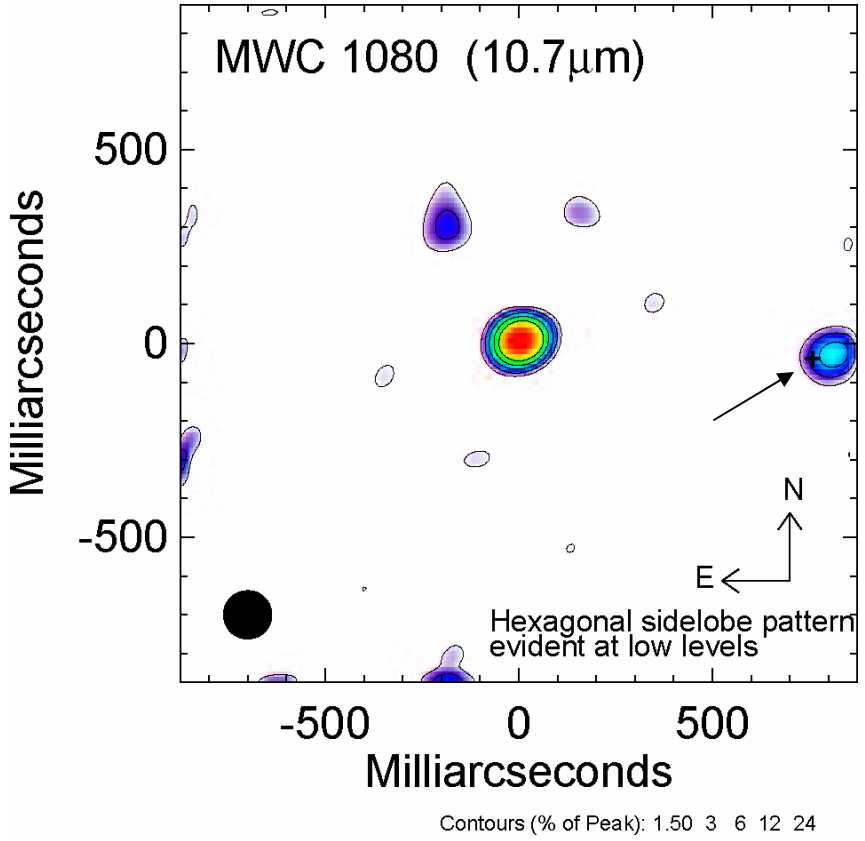

Full Aperture Short Exposure Image at 10.7 microns
Field of View of LWS Camera
ZOOM
LOG SCALE
Arcseconds
Arcseconds
10
5
0
-5
-10
-10
-5
0
5
10

AFTER


Constellation from Segment Tilting
10
5
0
-5
-10
-10
-5
0
5
10
Arcseconds
Arcseconds

Proof of Method





Reference: Leinert et al, 1997.

Comparison with Other Techniques.

Speckle Interferometry: Members from our group and a few other groups have tried using this method to resolve disks. But, calibration is a big problem.

Adaptive Optics: Adaptive optics at Mid-IR wavelengths would be a great solution providing a larger FOV and much more spatial information. But this has been implemented at a very few places (MMTAO - Kenworthy et al 2004).

Long Baseline Interferometry: This gives the highest spatial resolution (Leinert et al 2004). But, the number of baselines is very limited.

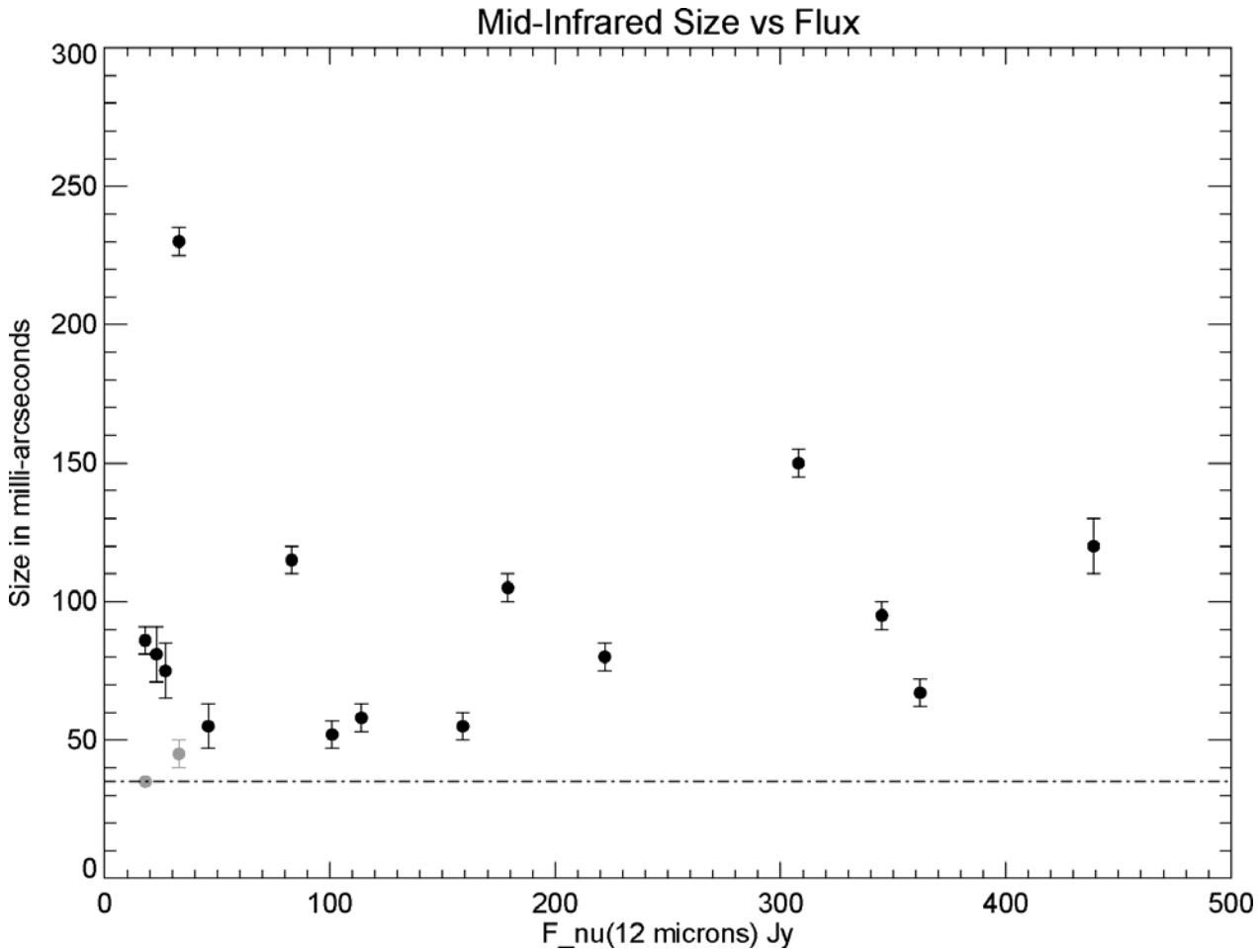
Science Targets

- The data presented here is from a run in Aug/Sept 2004.

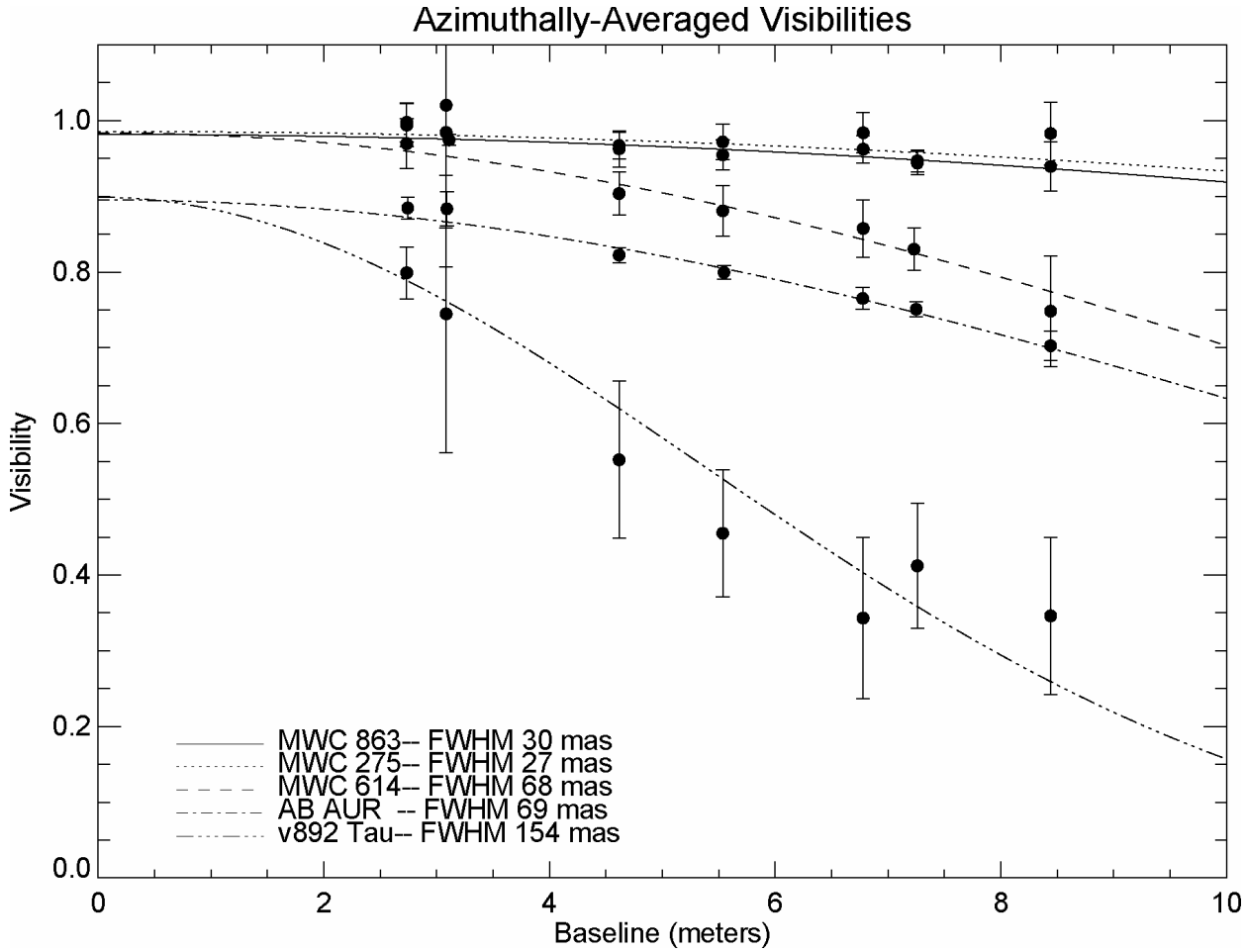
- Besides YSOs a number of evolved stars and Wolf-Rayet stars were also observed.

Young Stellar Objects	
AB Aur	MWC 614
AFGL 490	MWC 863
AFGL 2591	MWC 1080
IRC – 20454	R CRa
LkHa 101	RY Tau
MWC 275	S140 IRS 1
MWC 297	v376 Cas
MWC 300	v645 Cyg
MWC 342	v892Tau
MWC 349	v921 Sco
MWC 480	v1685 Cyg

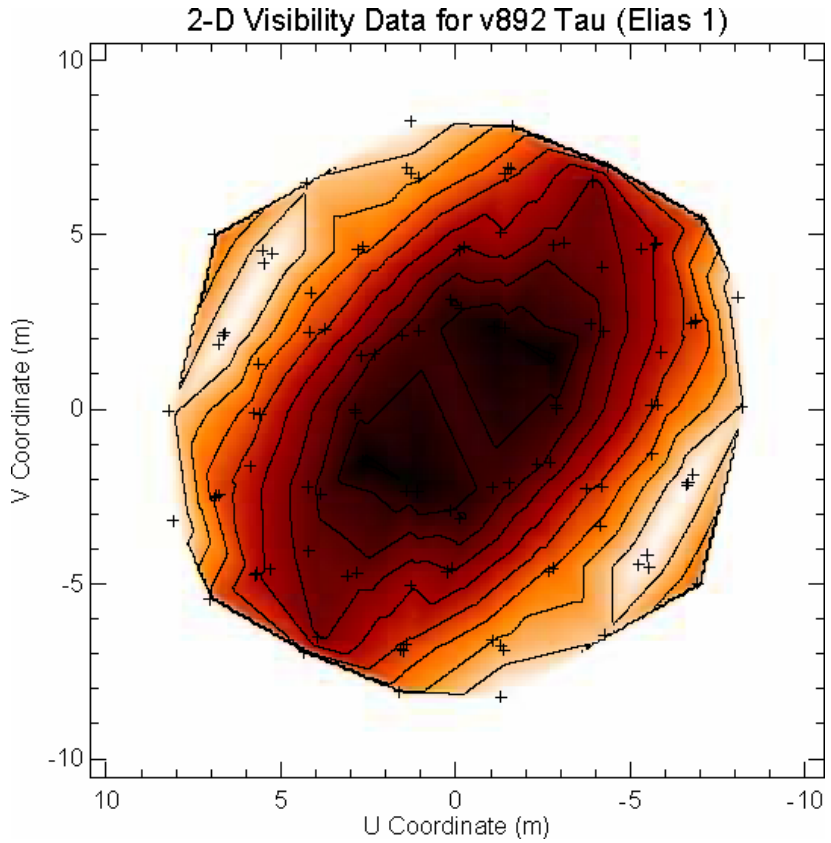
Preliminary Results

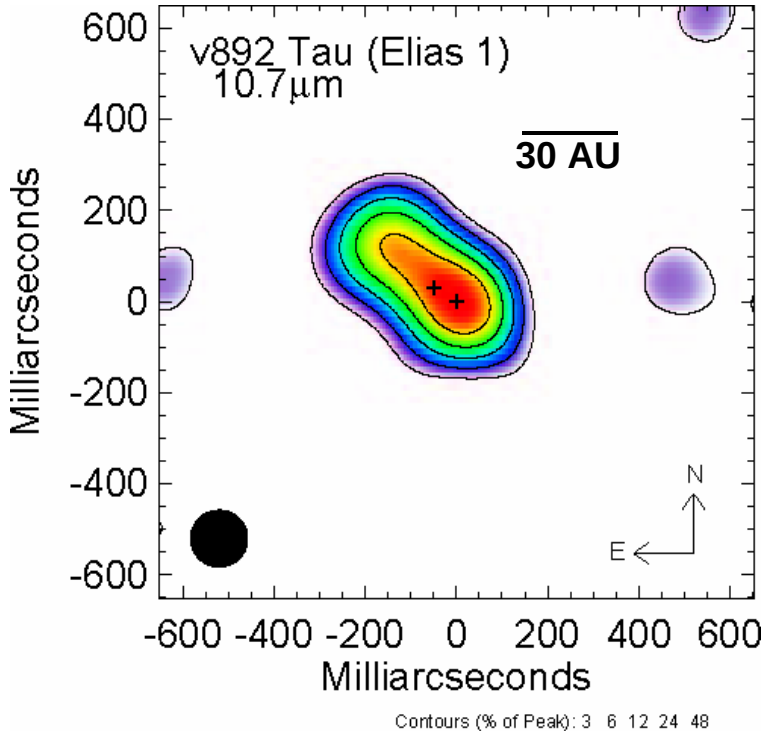


Visibilities as a function of baseline size (preliminary analysis).

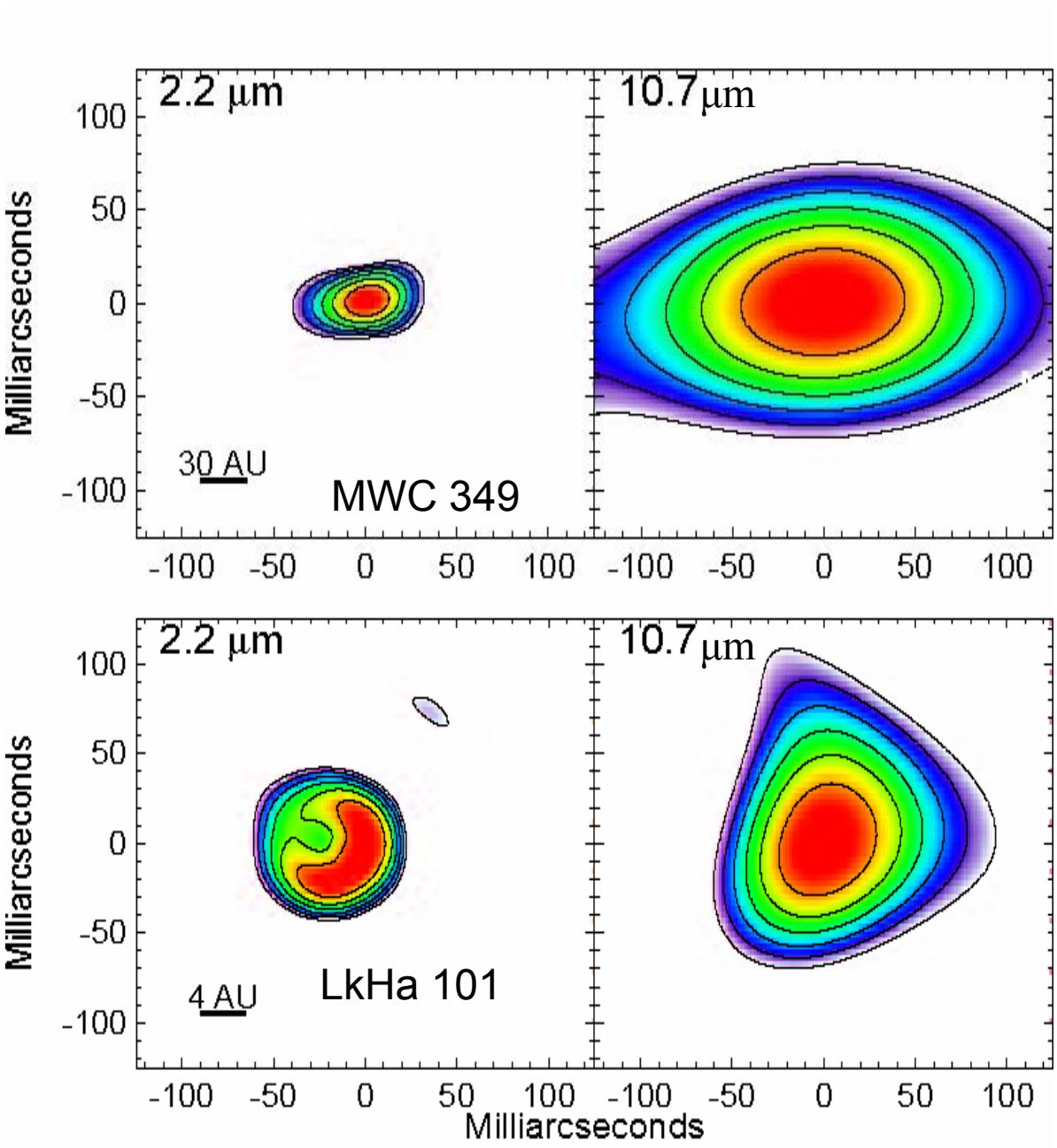


v892 Tau (preliminary results)





Reference:
Danchi et al 2002



Reference:
Tuthill et al 2002
Tuthill et al 2001

Mid-IR plots are preliminary

Future Work

- In a recent run (Feb 2005) more data was obtained for winter sources.
- Mid-IR results will be combined with the near-IR information to get a better understanding of disk structure.
- As part of my thesis work we will be doing detailed radiative transfer modeling (using TORUS, a Monte Carlo Code by Tim Harries) for YSOs on a case by case basis. Effects of grain growth and settling will be investigated. This will help constrain current models and motivate new ones.

References

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