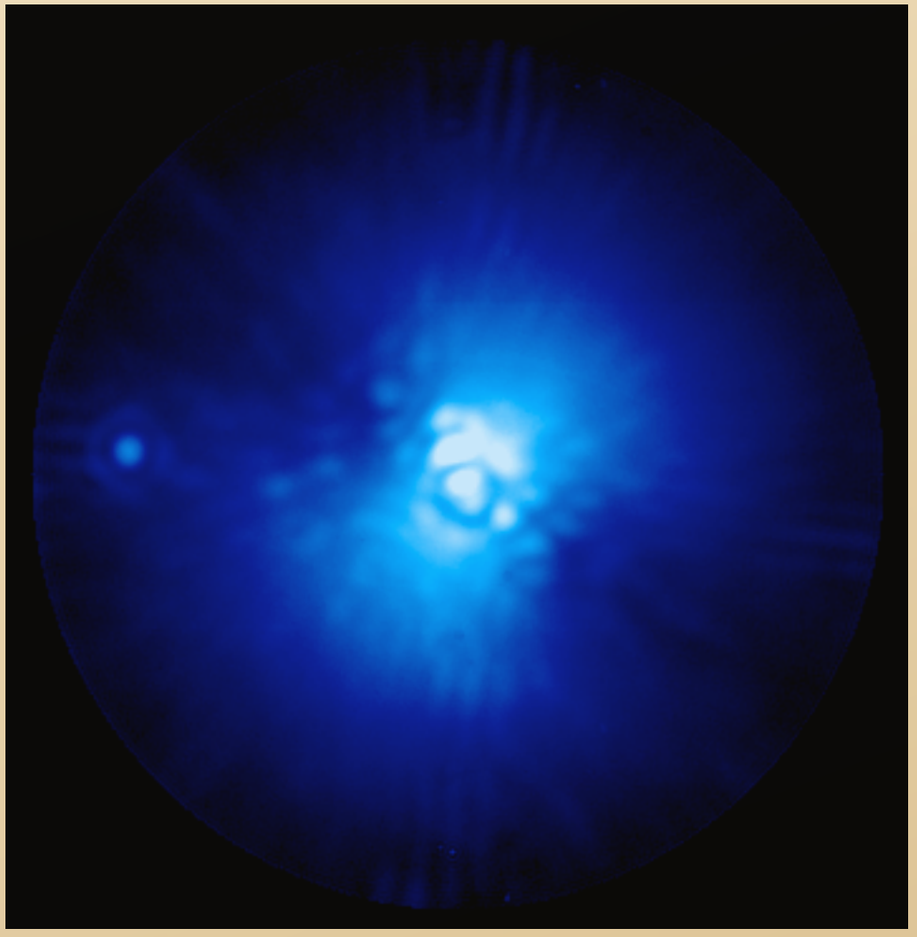
THE LYOT PROJECT

AMERICAN MUSEUM ō NATURAL HISTORY

TOWARD EXPLORATION OF OTHER WORLDS

High Contrast AO Coronagraphy *Today:*

Lyot Project Status & Preliminary Results



Marshall D. Perrin
UC Berkeley

Outline

What is the Lyot Project?

Instrument Design

Performance:

- Achieved Contrast
- Semi-Static Speckles

Speckle Suppression:

- Polarimetry

Science Results

THE LYOT PROJECT

AMERICAN MUSEUM & NATURAL HISTORY

TOWARD EXPLORATION OF OTHER WORLDS



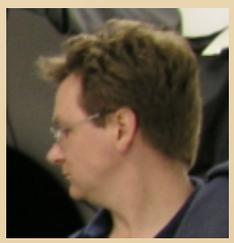



Ben R. Oppenheimer, Anand Sivaramakrishnan, Remi Soummer, Andrew P. Digby, Sasha Hinkley, Douglas Brenner, Michael Shara — AMNH



Russell B. Makidon — Space Telescope Science Institute

Marshall Perrin, Paul Kalas, James R. Graham — UC Berkeley



James P. Lloyd — Cornell

Jeffrey R. Kuhn, Kathryn Whitman — IfA, University of Hawaii

Lewis C. Roberts, Jr. — The Boeing Company

And thanks to: NSF, AFOSR, CfAO, AMNH, & Michelson Science Center!

What is the Lyot Project?

"The world's first optimized diffraction-limited coronagraph"

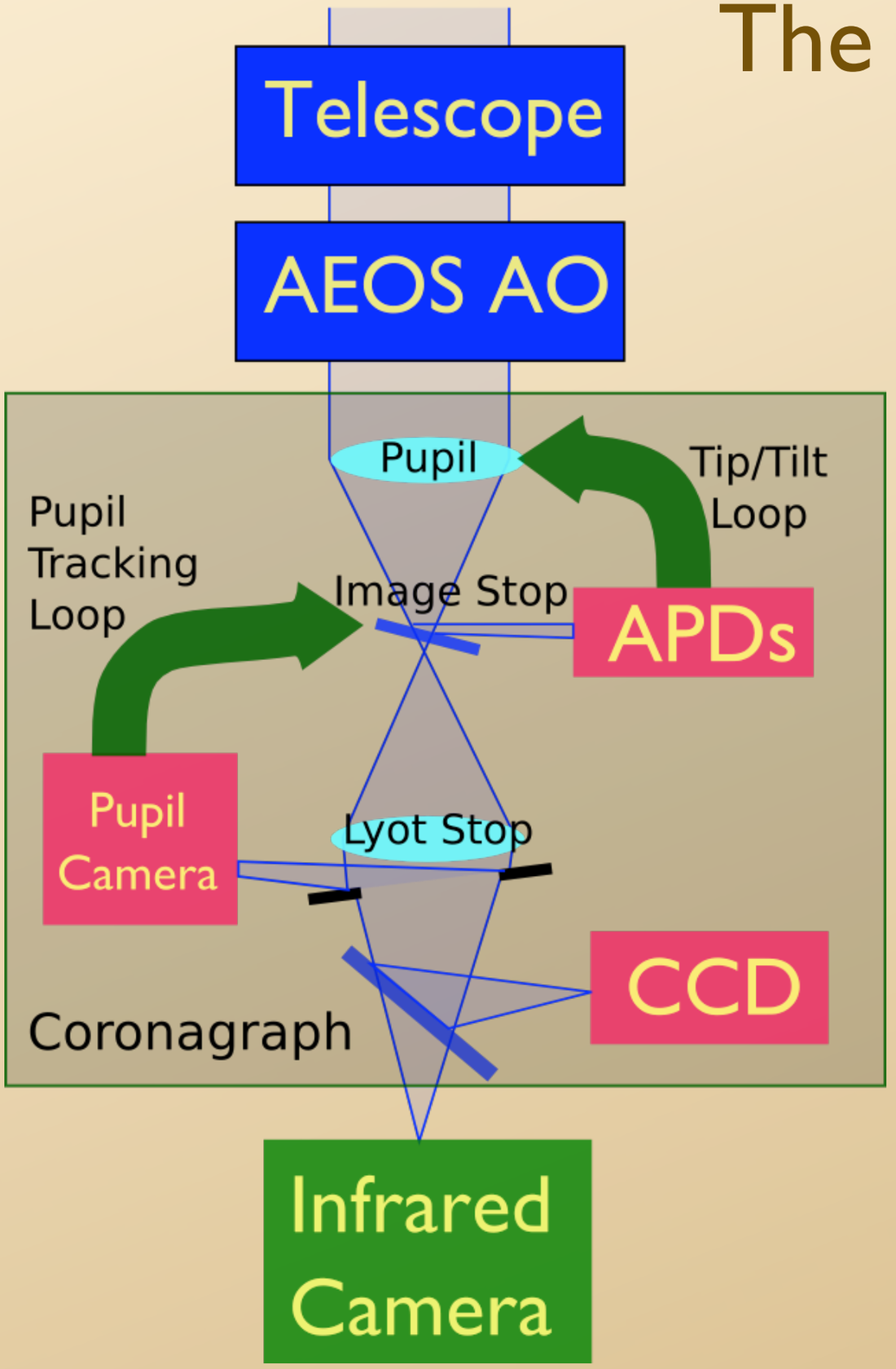
High contrast imaging using the highest-order astronomical AO system available today.

Technology Development

Companion Survey to Nearby Stars

Circumstellar Disk Imaging

The Lyot Project Coronagraph

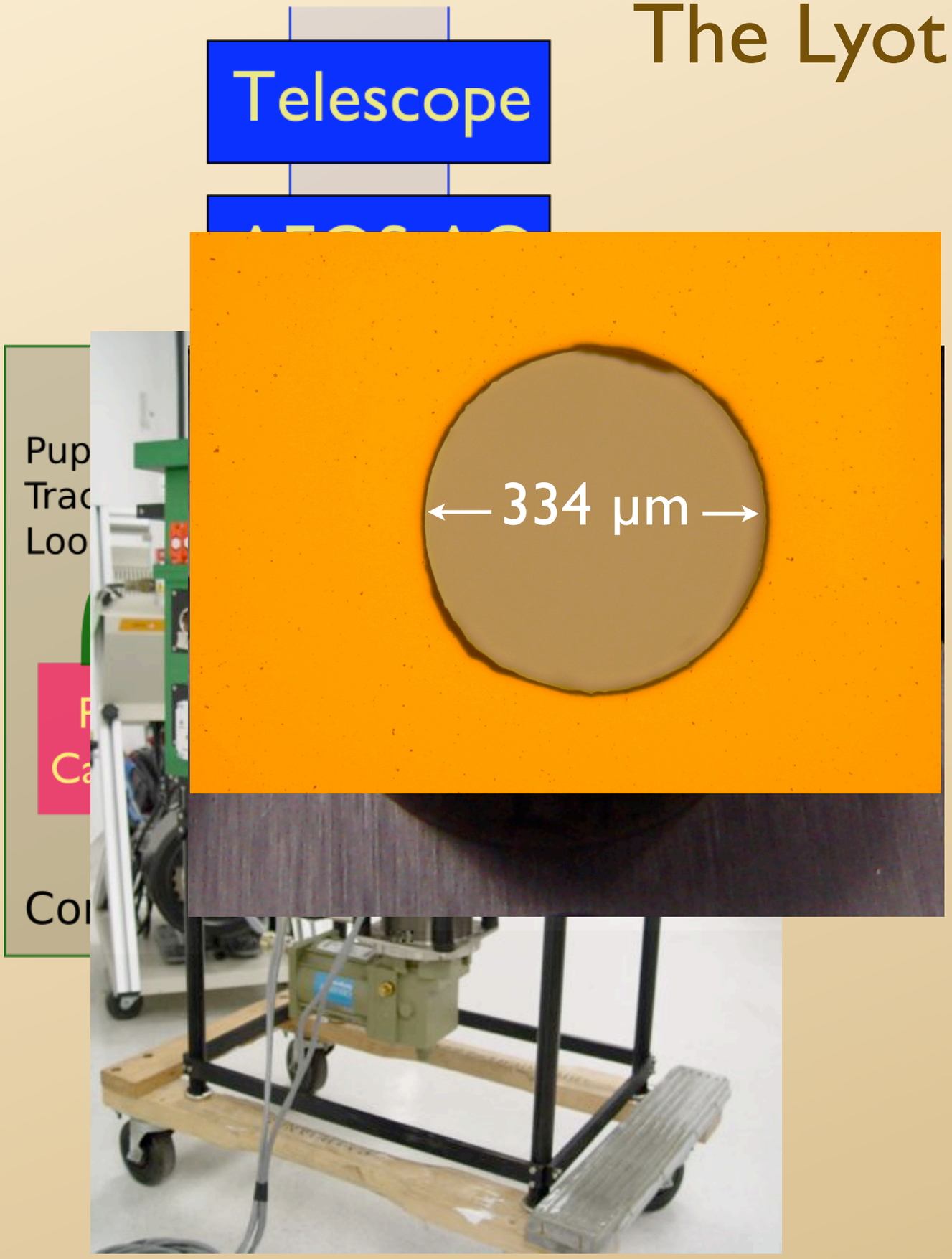


Active control system

Internal Strehl 0.98
(32 nm RMS WFE)

IR Science Camera:
Kermit
2048^2 pix Hawaii-2
J, H, Ks imaging

The Lyot Project Coronagraph



Active control system

Internal Strehl 0.98
(32 nm RMS WFE)

IR Science Camera:
- Kermit
- 2048^2 pix Hawaii-2
- J, H, Ks imaging

The Lyot Project Coronagraph

Timeline

2003

April 2003:
Kermit First Light

Coronagraph Built

March 2004:
Coronagraph First Light

Shipped to Maui

2004

May 2004: Observing Run

Sept 2004: Observing Run

Polarimetry Added

2005

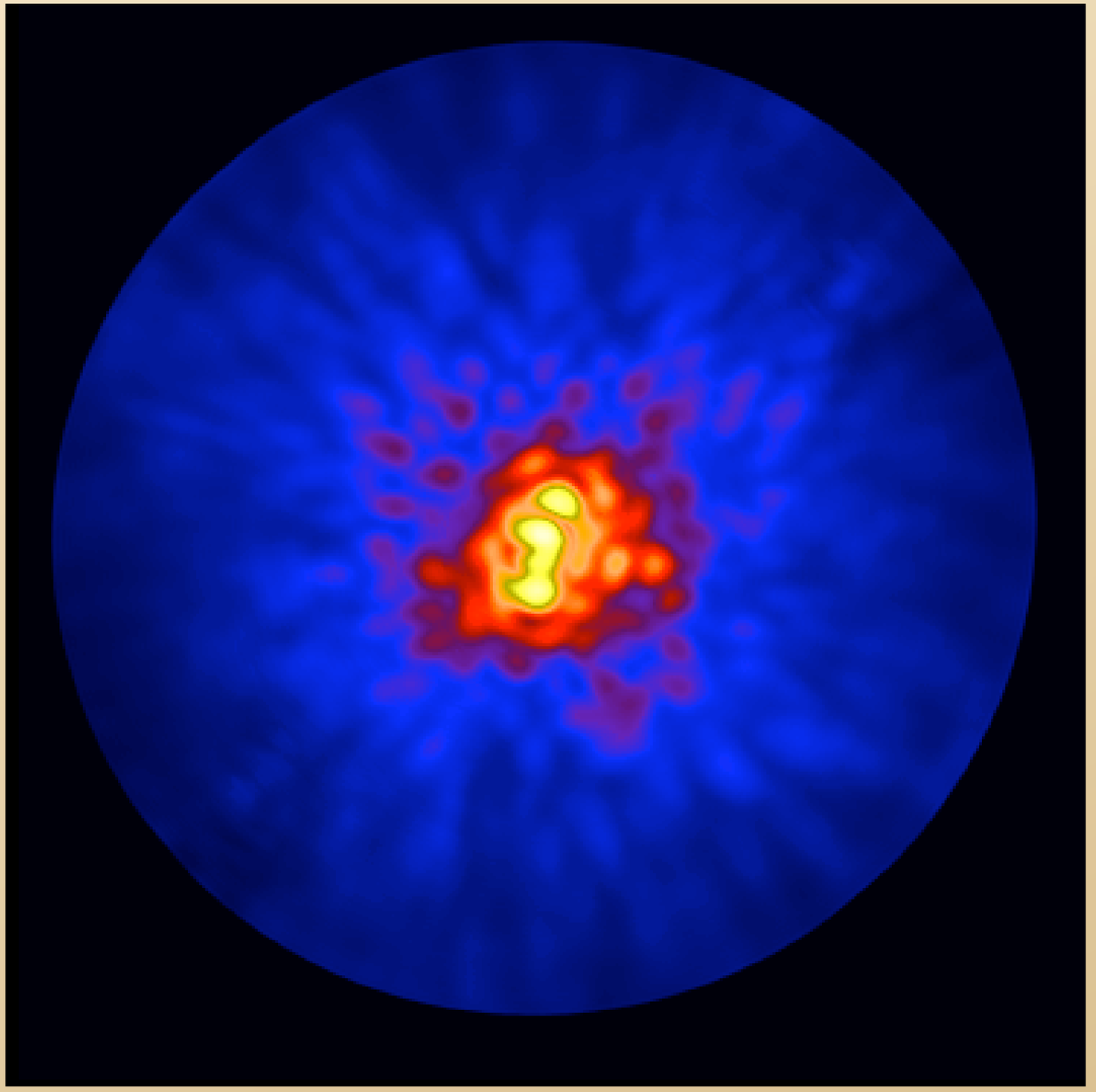
Jan 2005: Observing Run

May 2005: Observing Run

AMNH lab renovated
IFU funding approved

Jan 2006: Observing Run

Data!



Mask diameter

5 λ/D at H

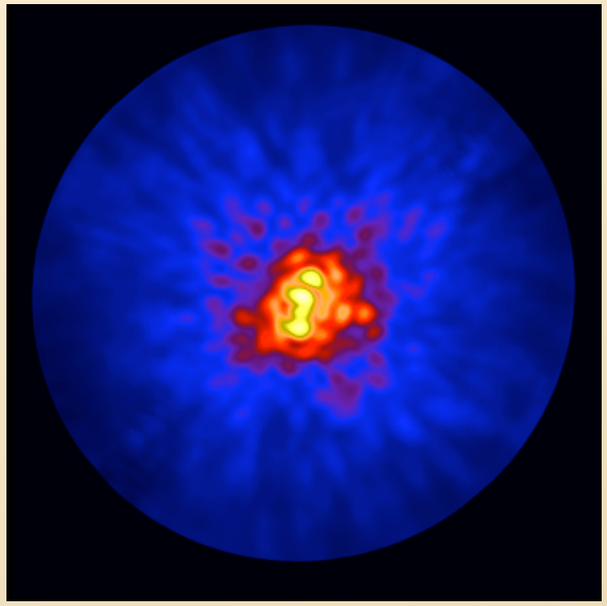
450 μm

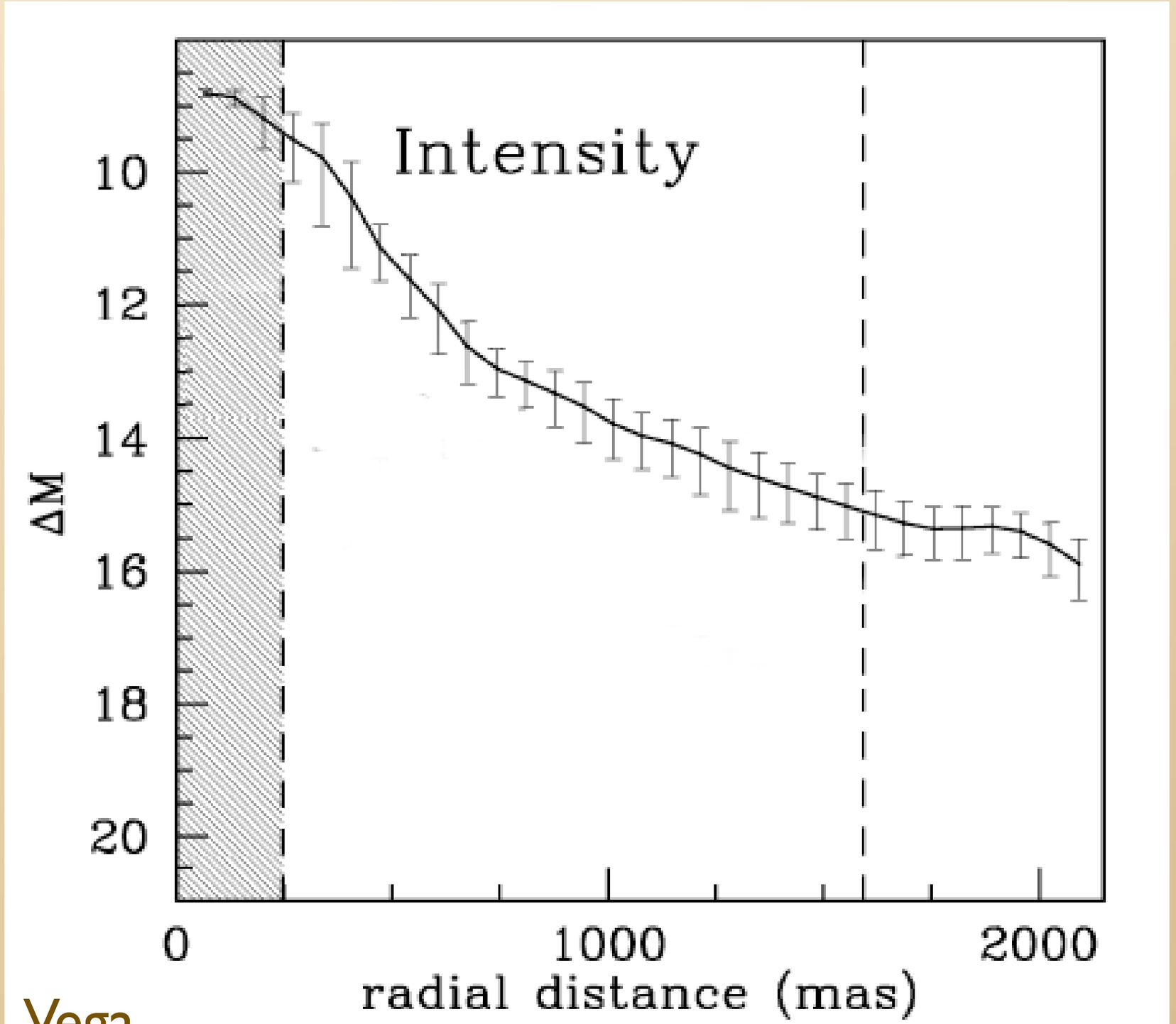
4.8 arcsec

100 x 8s
exposures

Vega, 2005 May 14 H band

Contrast





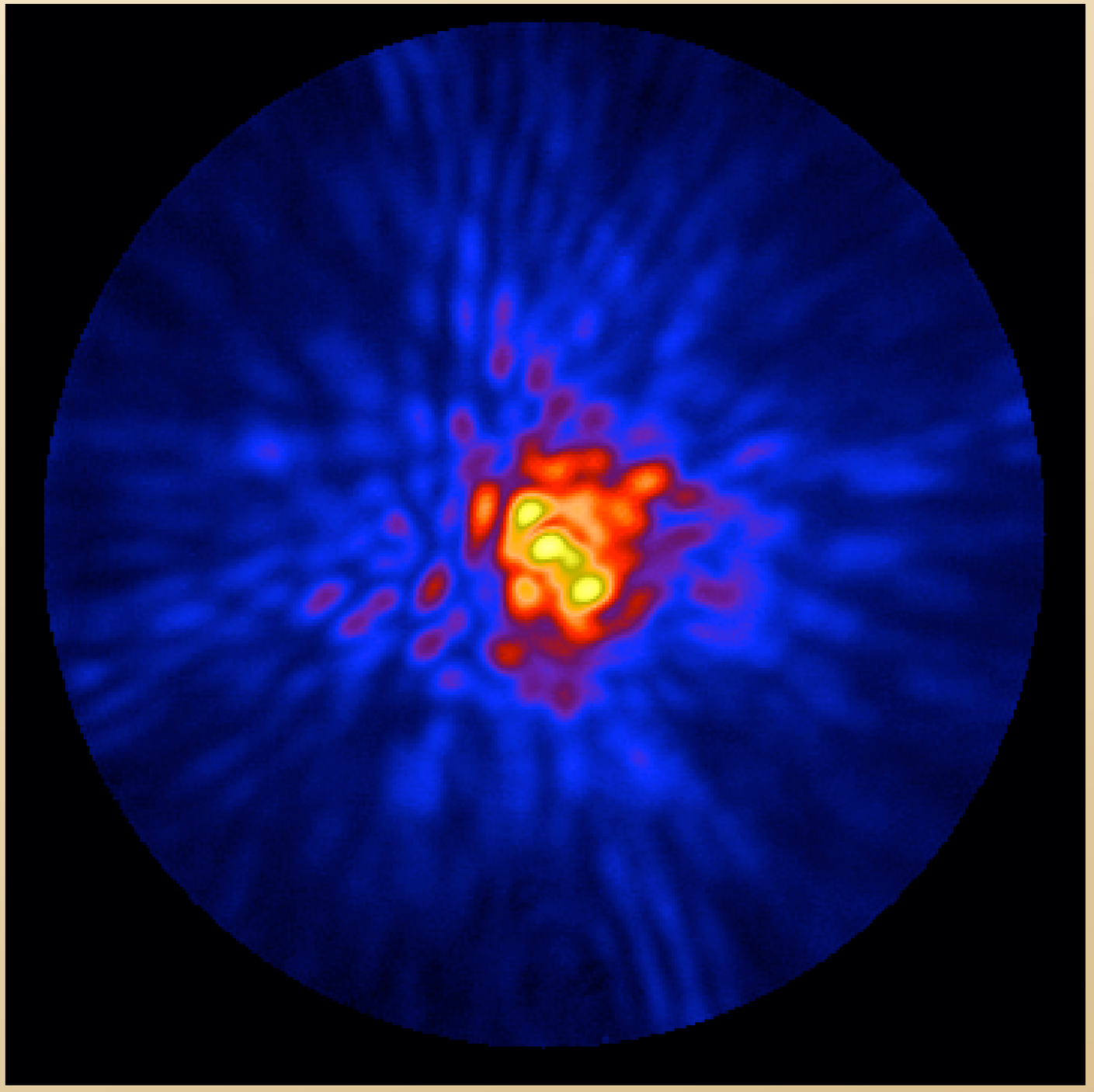
Vega

Hinkley et al., in prep

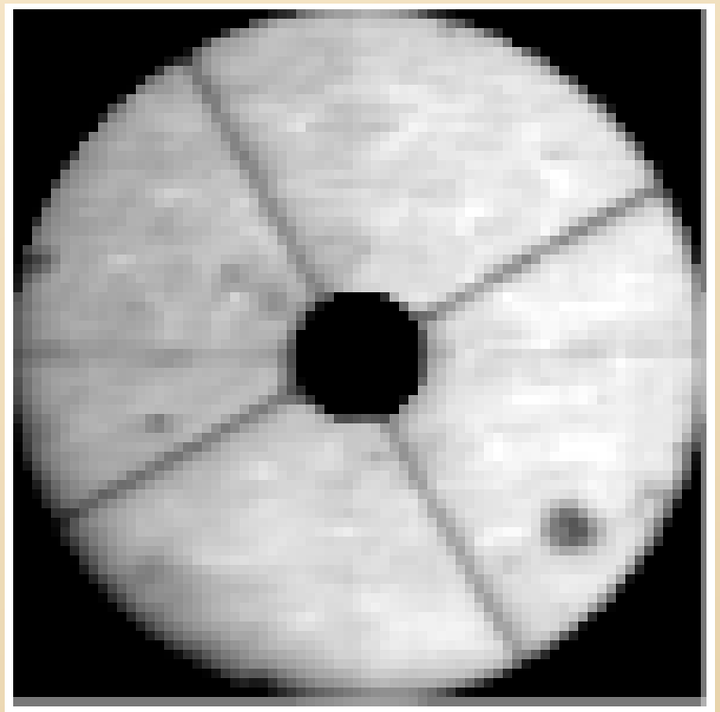
Semi-Static Speckles

80x
real time

~1500 s

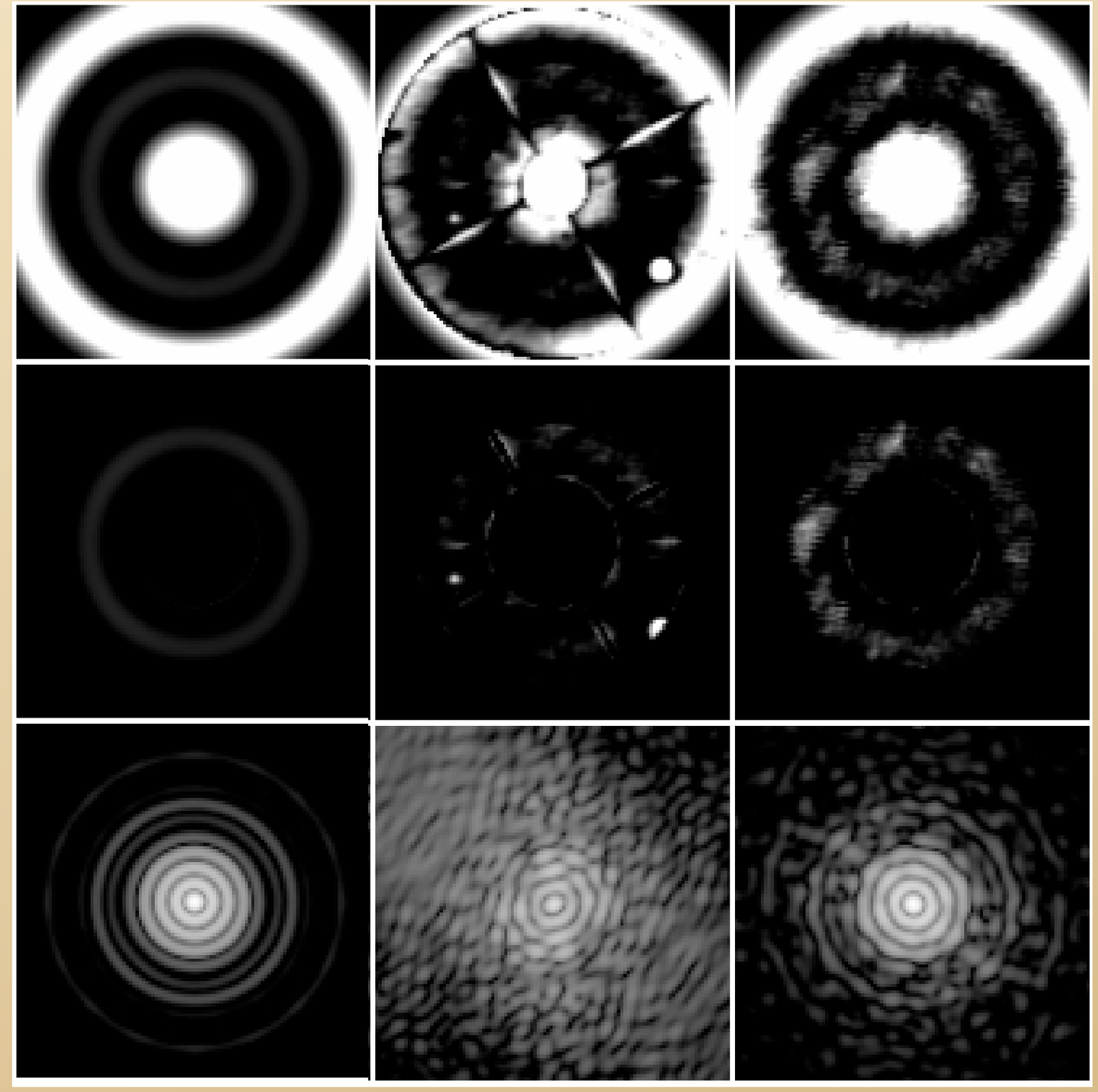


Semi-Static Speckles



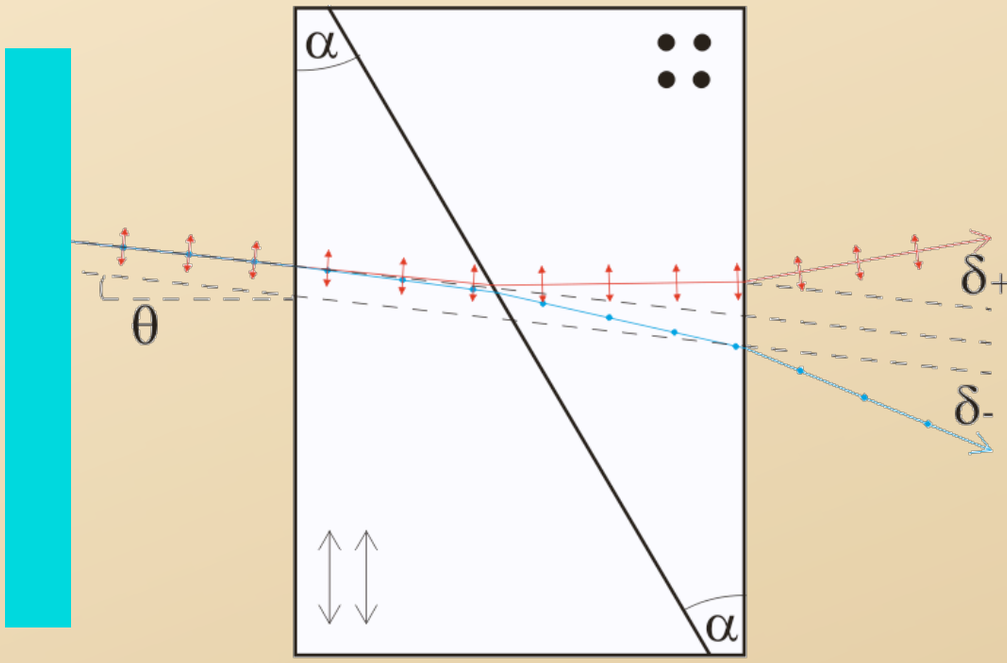
Actual AEOS
Pupil Illumination

Ideal | Real Pupil | Scintillation



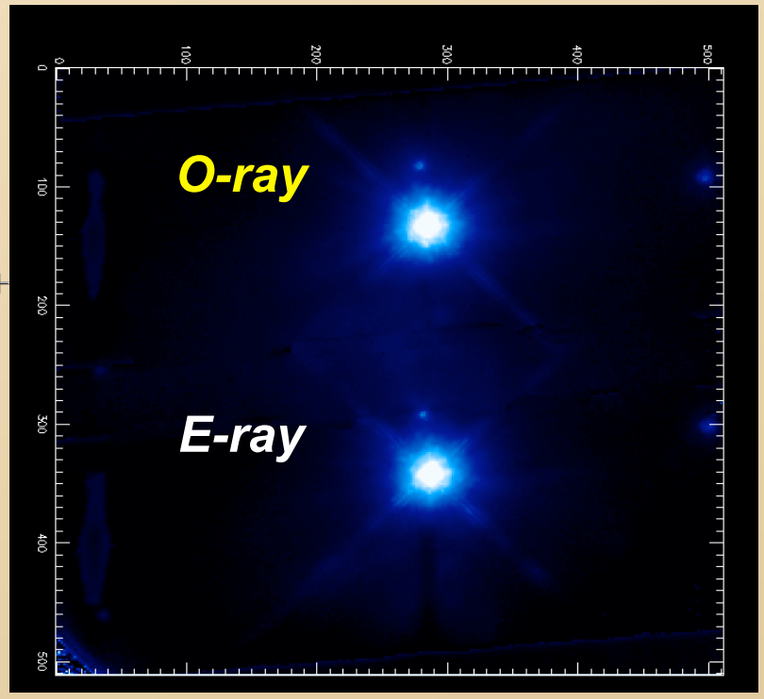
Sivaramakrishnan et al. 2005 Proc. AMOS Conference

Differential Polarimetry



Modulator

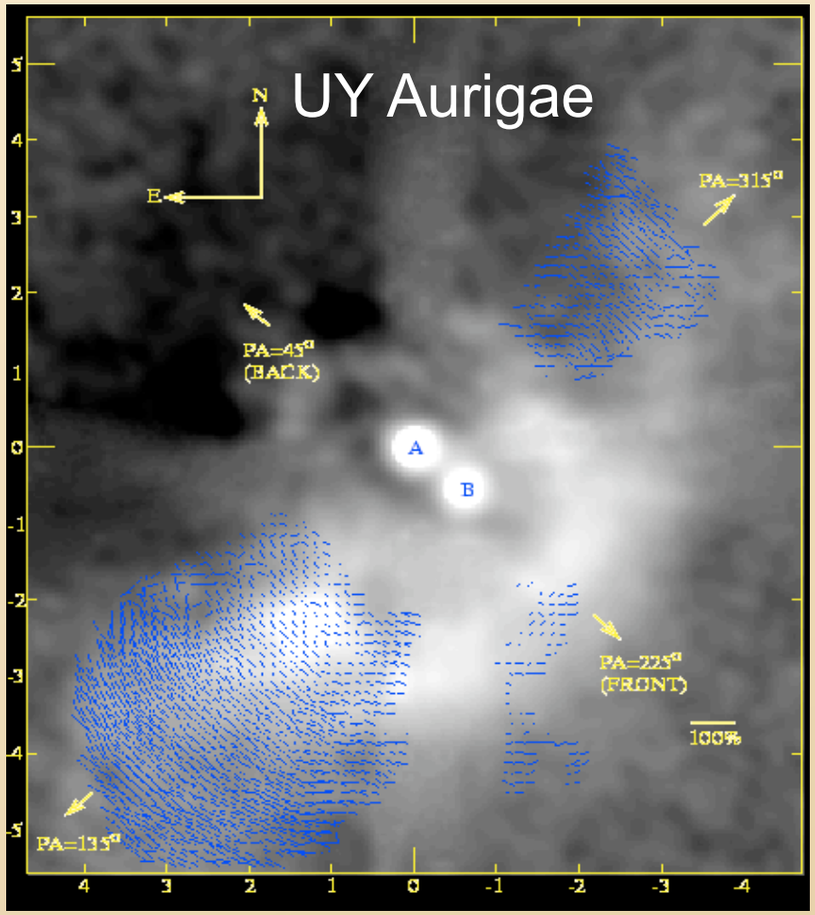
Wollaston prism



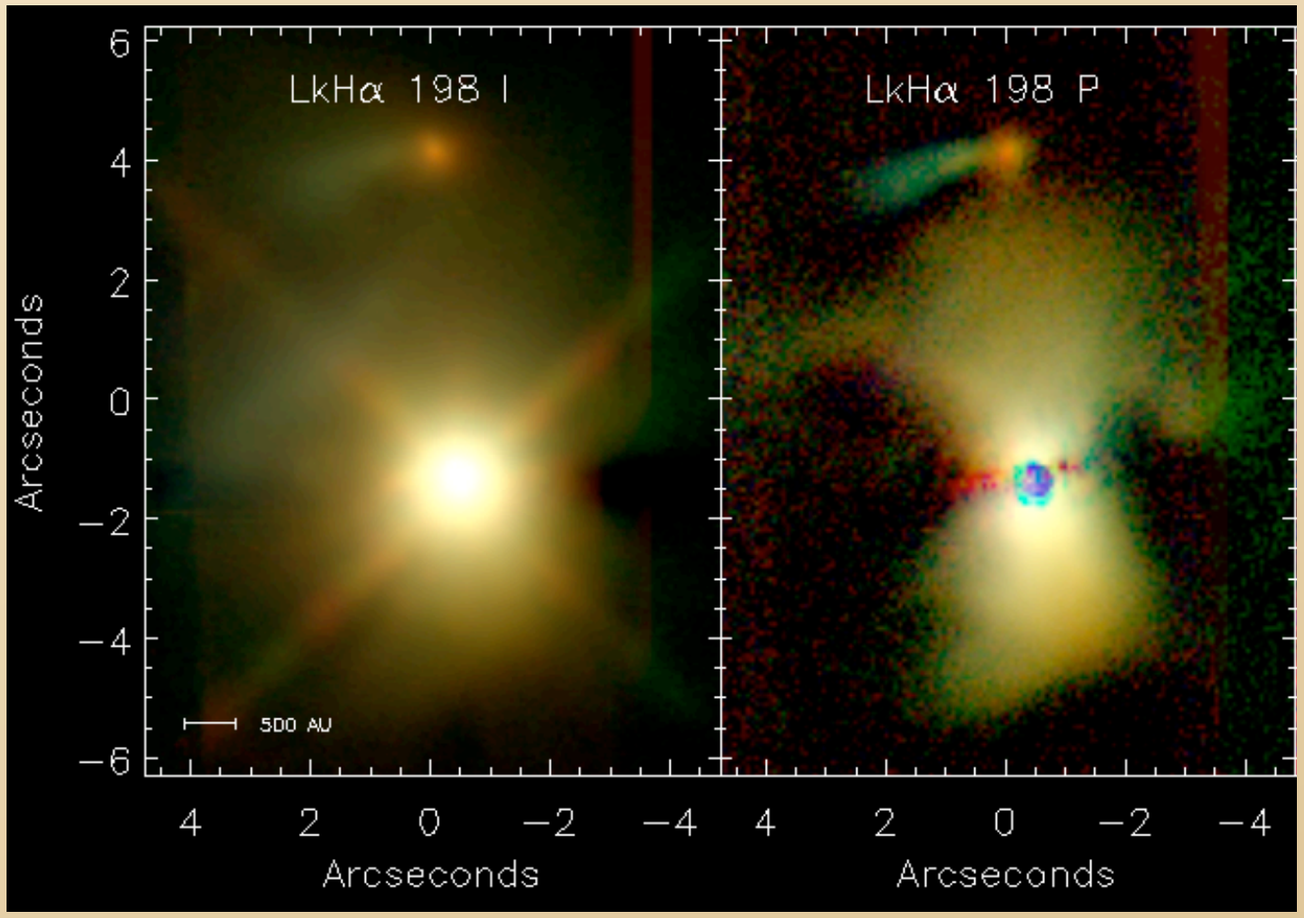
Dual images

Speckles are unpolarized, so they will vanish in the difference of two perpendicular polarizations (a Stokes parameter image)

Differential AO Polarimetry Results

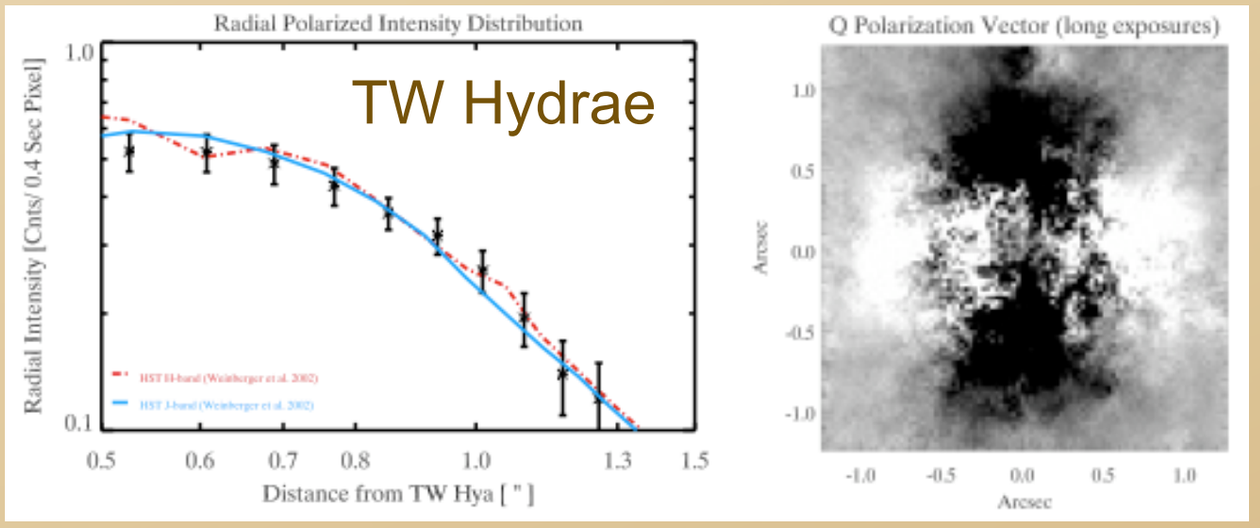


Potter et al. 2000



Perrin et al. 2004

Apai et al. 2004



Lyot Project Polarimetry

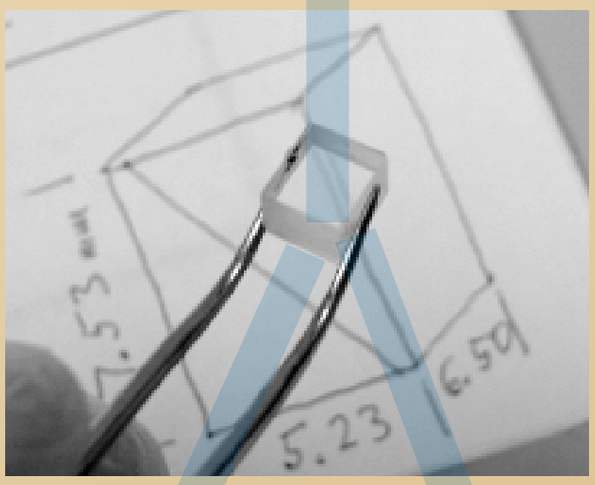
Modulator:

Liquid Crystal Variable Retarders (LCVRs)

located before image stop

Pro: no moving parts

Con: somewhat chromatic & temp. sensitive

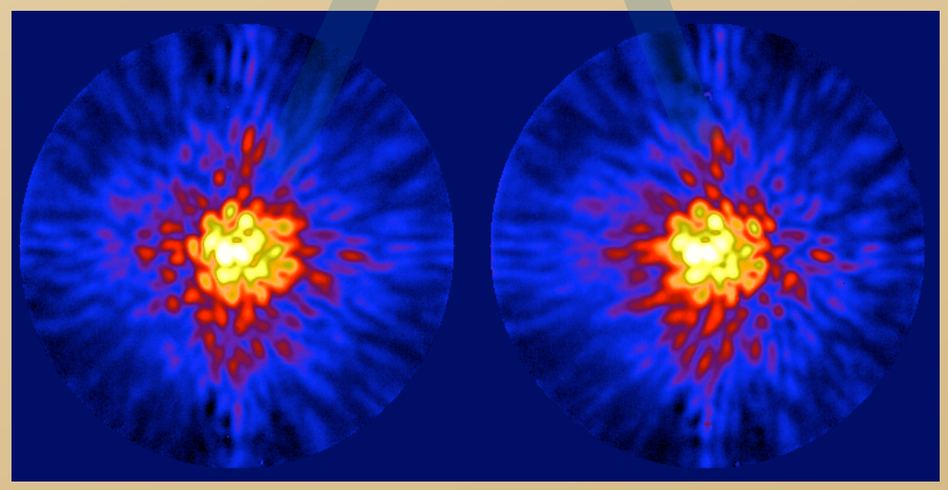


Analyzer:

Wollaston Prism

located immediately after Lyot Stop

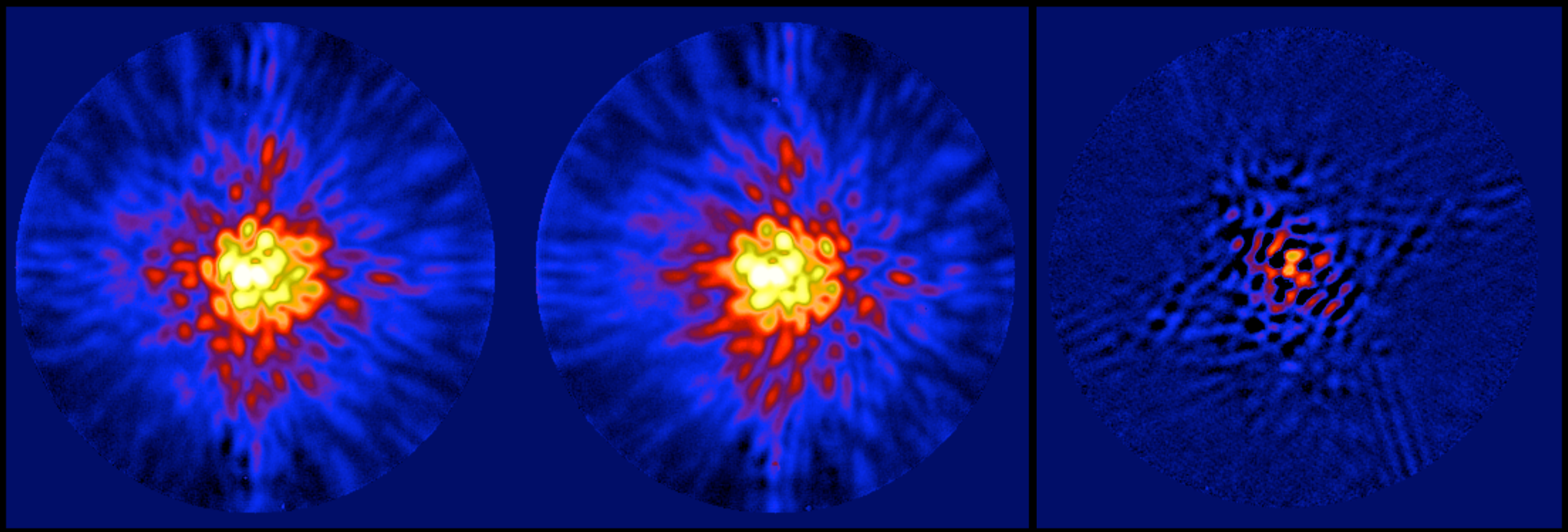
Calcite



Polarimetry Performance

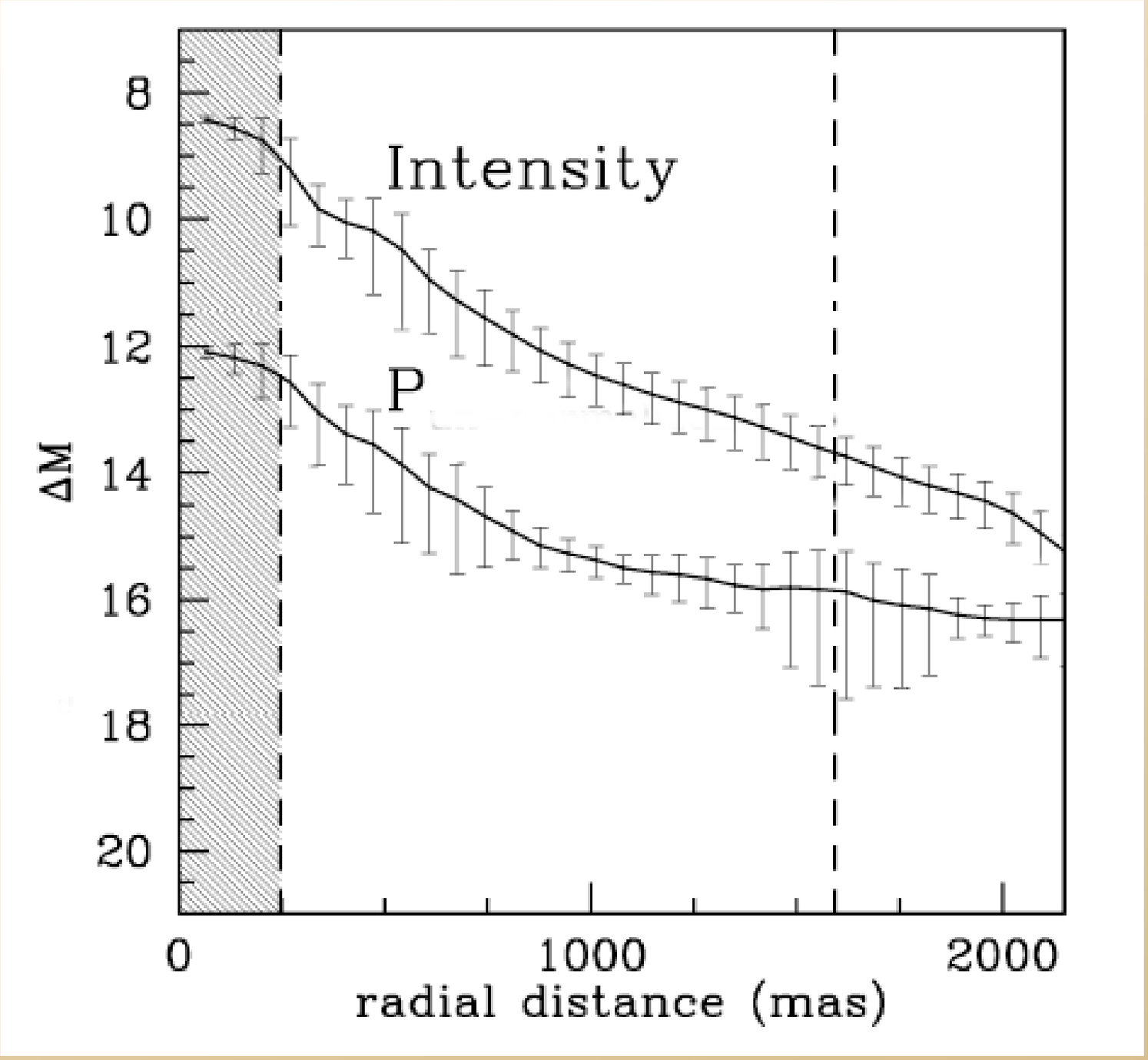
Perpendicular Polarizations

Double Difference



HIP 67927

Polarimetry Performance



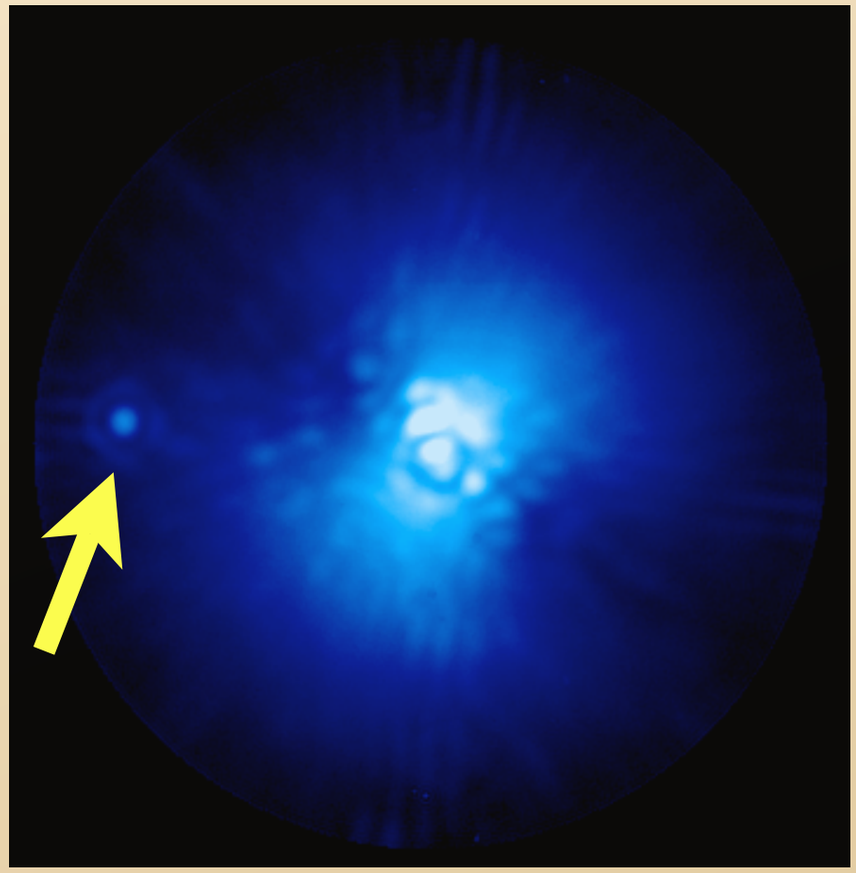
HIP 67927

Hinkley et al., in prep

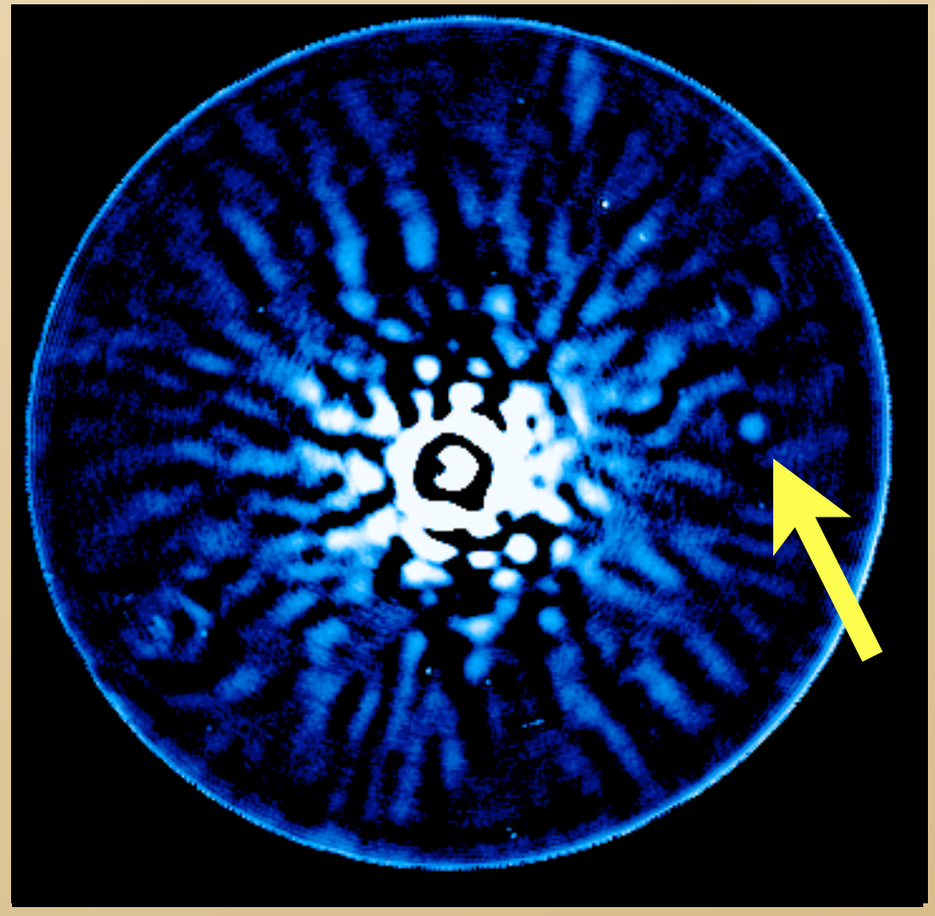
Science Results

54 stars surveyed,
30 with polarimetry

Several potential companions



AB Aur disk



2006

2007

2008

The Future

2006: More observing runs
Data reduction
Publish!

2006: IFU final design
2007: IFU assembly
2008: IFU science

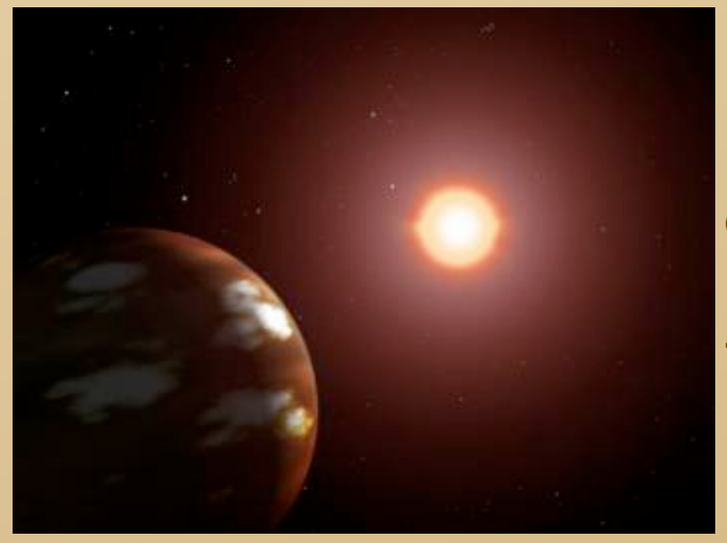


figure by NASA