



# SUSI Update

Michael Ireland... plus:

Peter Tuthill, Gordon Robertson, Bill Tango, Theo ten Brummelaar, Yitping Kok (PhD Student), Aaron Rizzuto (honours student), David Prabhakar (Undergrad), Anthony Cheetham (Undergrad), Cedric Laliberte (Canadian Undergrad) and a couple of ring-ins.





# In Memory of John Davis



Passed away on Jan 15, 2010, age 77... having given much of his life to developing long baseline optical interferometry.



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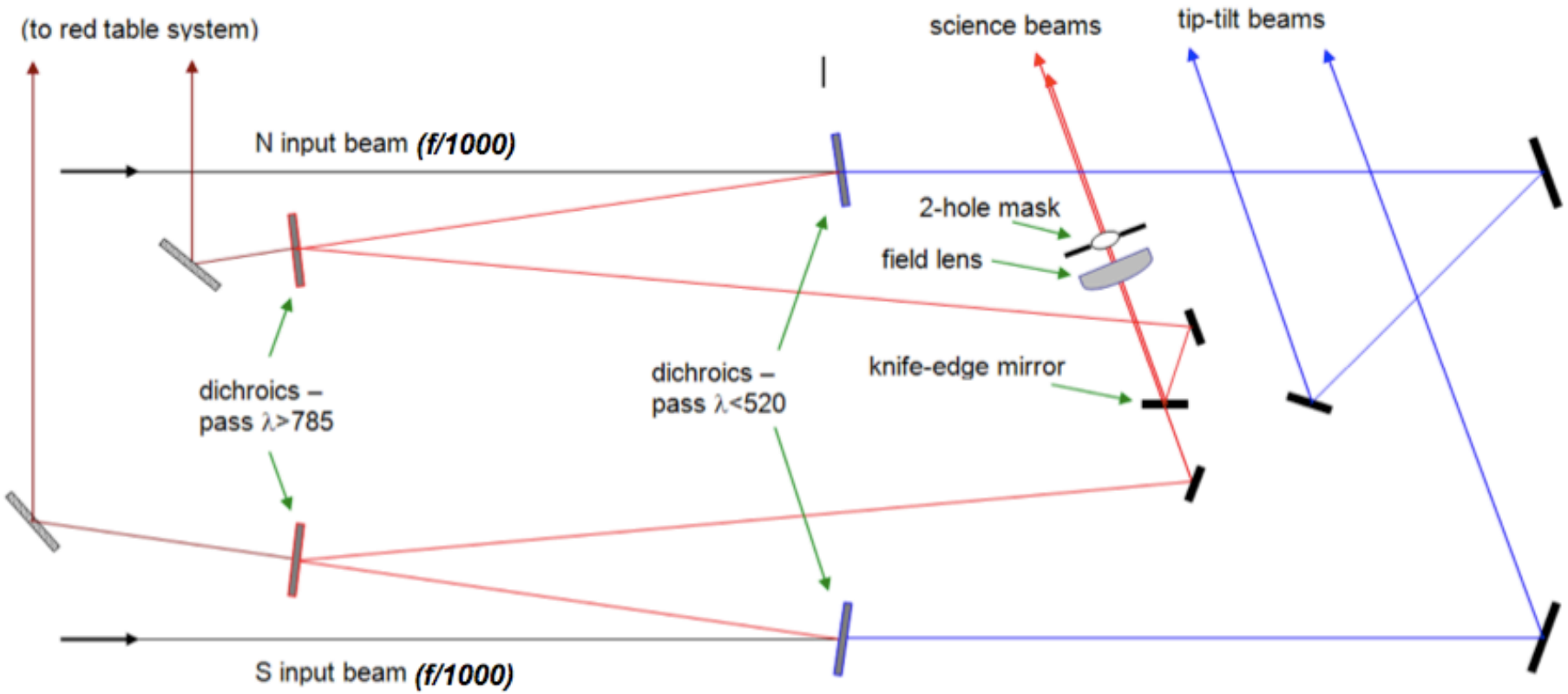
# Main Changes since 2009

1. PAVO@SUSI works routinely. Baselines up to 80m in use. 160m should work.
2. Longitudinal dispersion corrector (the “glass” or the LDC) upgraded and working.
3. Remote observing fully commissioned... except from GSU.



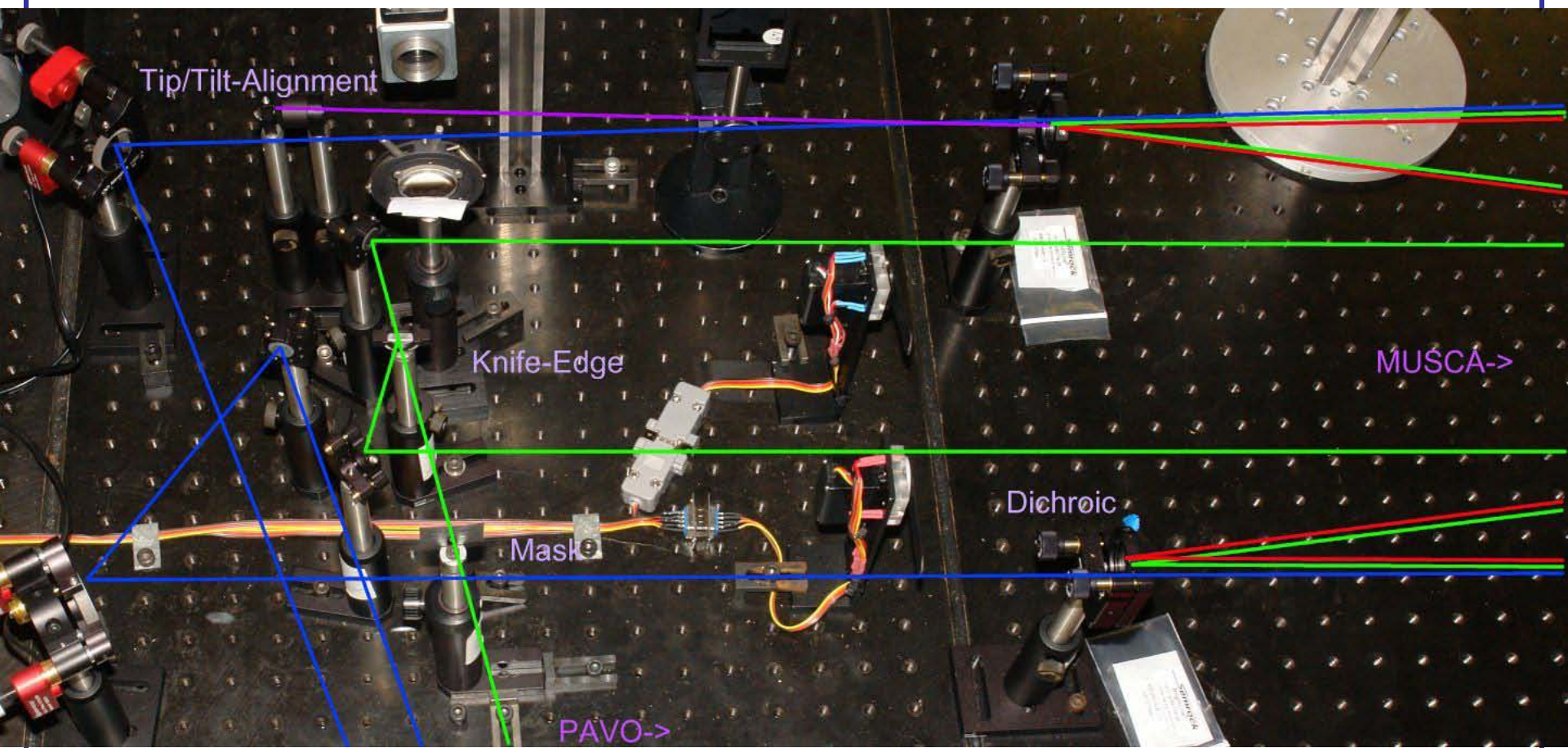


# PAVO@SUSI: Fringes and tip/tilt with small beams.



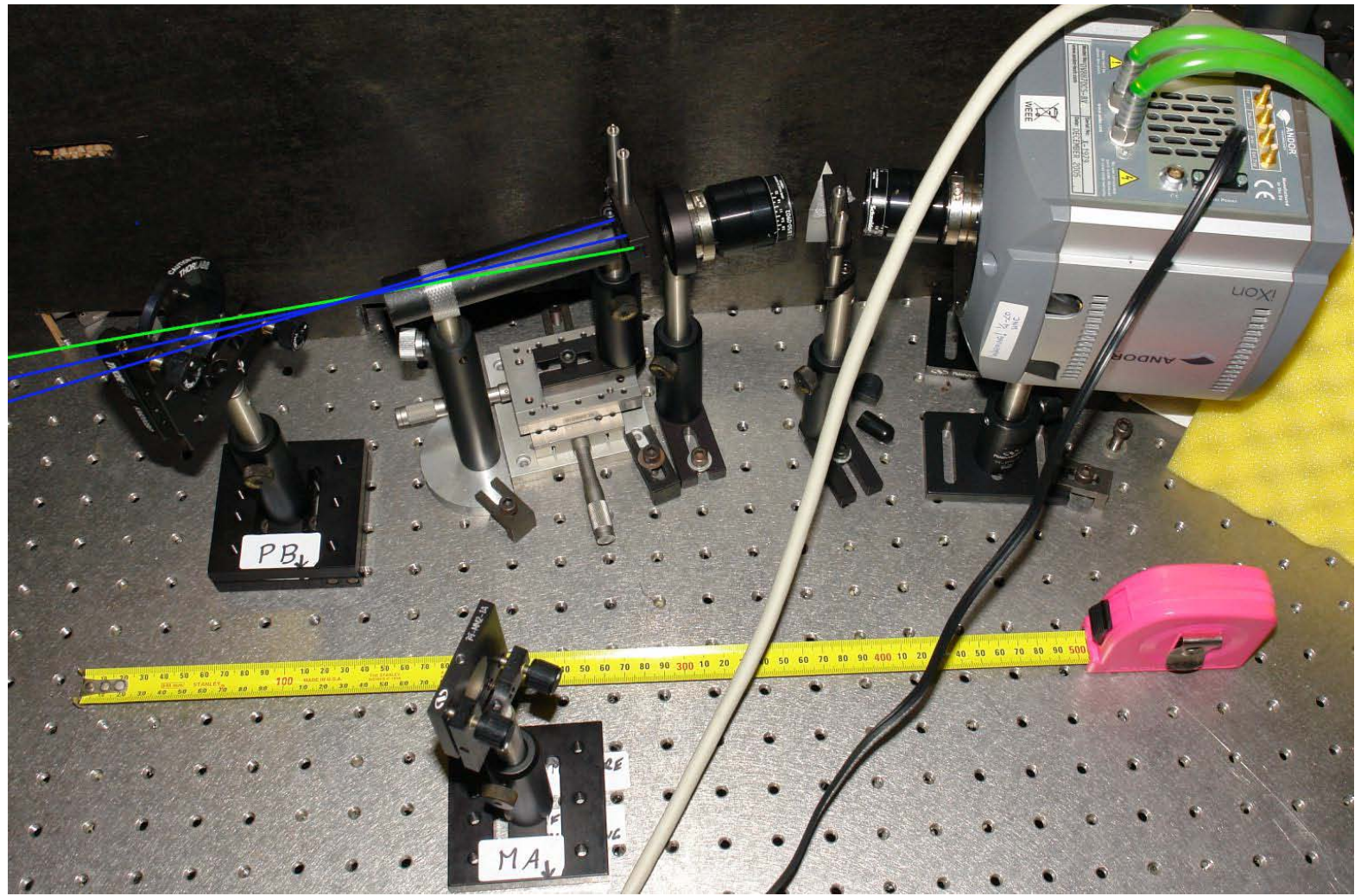


# PAVO@SUSI Mask and Tip/tilt





# PAVO@SUSI Back-End





# SUSI ROCS Observations

VIDMON

CAM ON	TV ON
22.92 Fm/S	
CAM ON	CAM OFF
TV ON	TV OFF
S1_CAM	S2_CAM
S3_CAM	S4_CAM
PING	REOPEN
QUIT	

VIDMON

LUVView(c) Laurent Pinchart

VIDMON

TV ON
0.04 Fm/S
CAM OFF
TV OFF
N3_CAM
STUN_CAM
REOPEN
QUIT

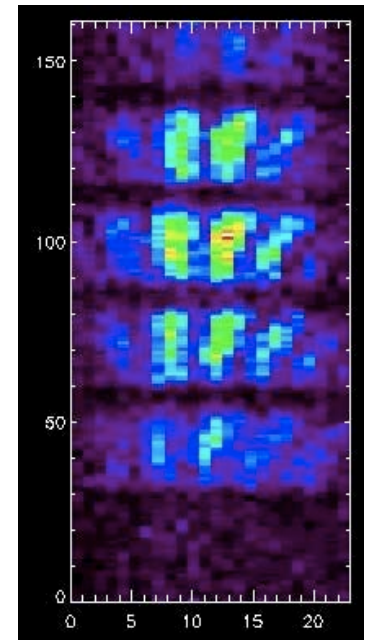
VIDMON





# PAVO@SUSI Observations

- ~60 nights with some on-sky data, max half night, but often testing one or two things after sunset. No full night's observing yet (or planned).



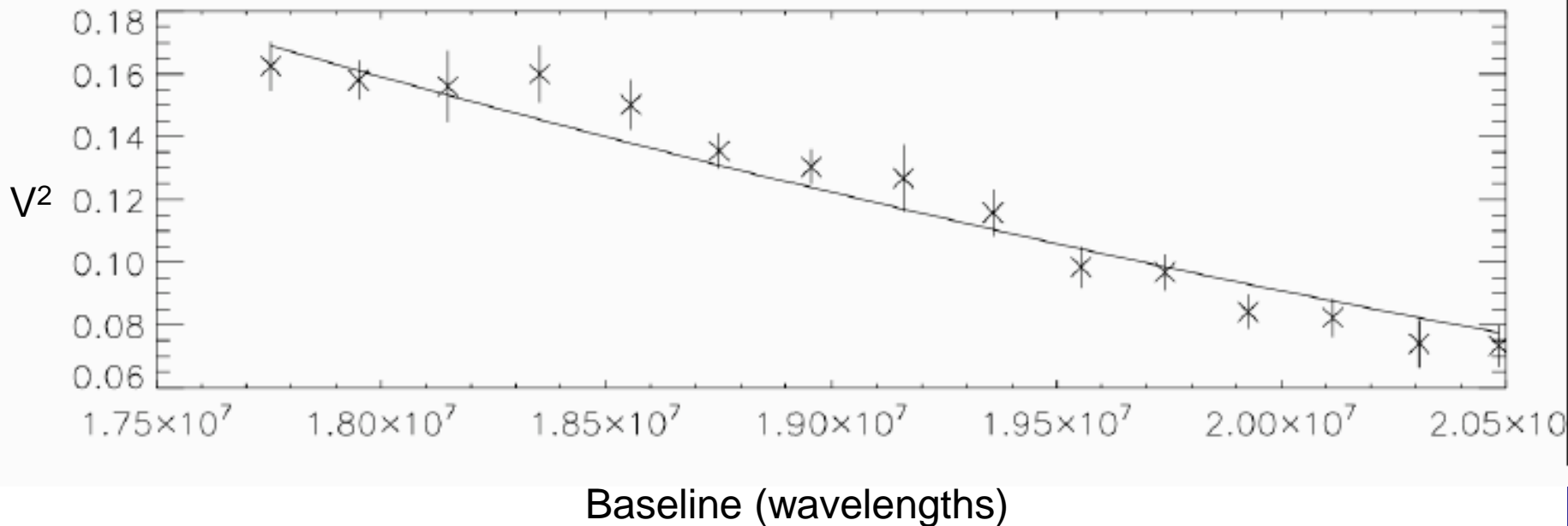
7ms of raw Fomalhaut data. Obviously plenty of S/N...





# Preliminary Science 1: Alpha TrA

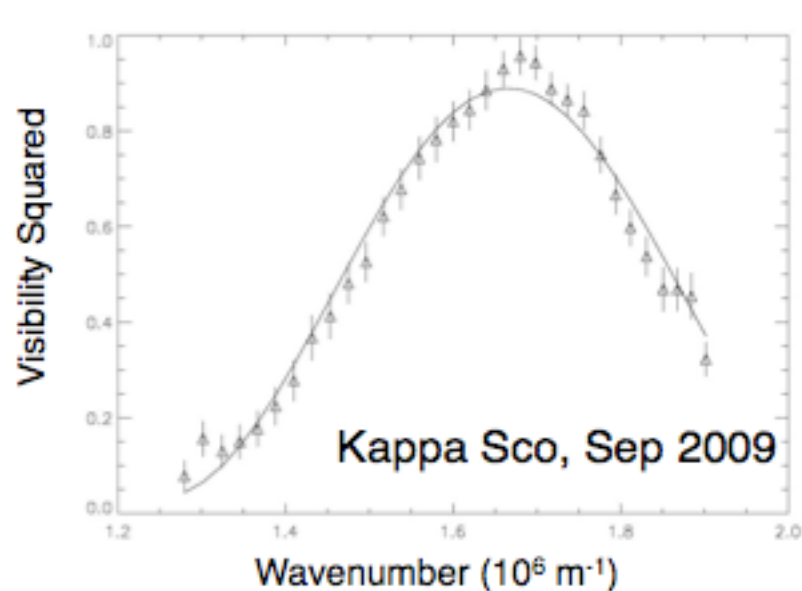
- Pulsating K-giant, a “hybrid bright giant” that is UV-bright and has a wind that is both cool and hot (coronal). Precision diameter required for asteroseismology collaboration with Tim Bedding/Graham Harper
- UD Diameter  $9.08 \pm 0.07$  compared with Cohen’s  $8.98 \pm 0.1$  mas LD estimation. Double checking wavelength scale calibration before publication...





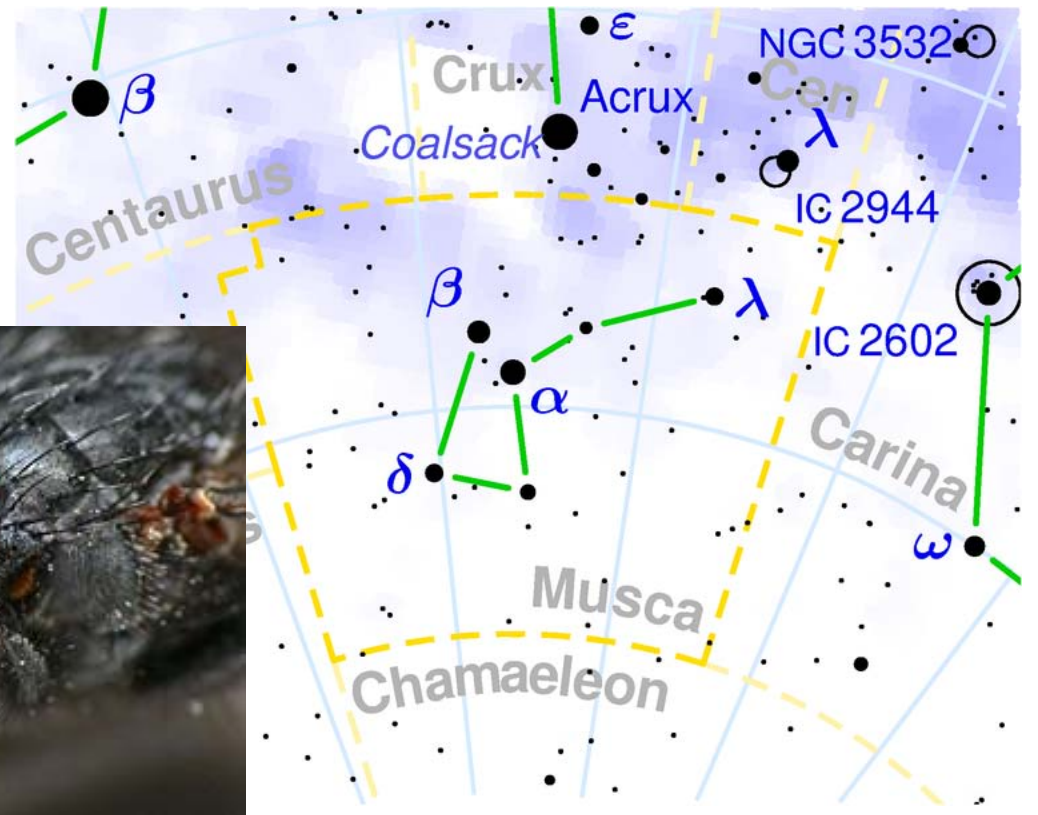
# Preliminary Science 2: Sco-Cen

- Preliminary Sco-Cen survey on a 15m baseline for companions.
- No new companions, but 2 that were not in major catalogs (kappa Cen, ups Sco)
- The major effort for 2010 (Rizzuto thesis)





# The (funded) Micro-arcsecond University of Sydney Companion Astronomy (MUSCA) Instrument



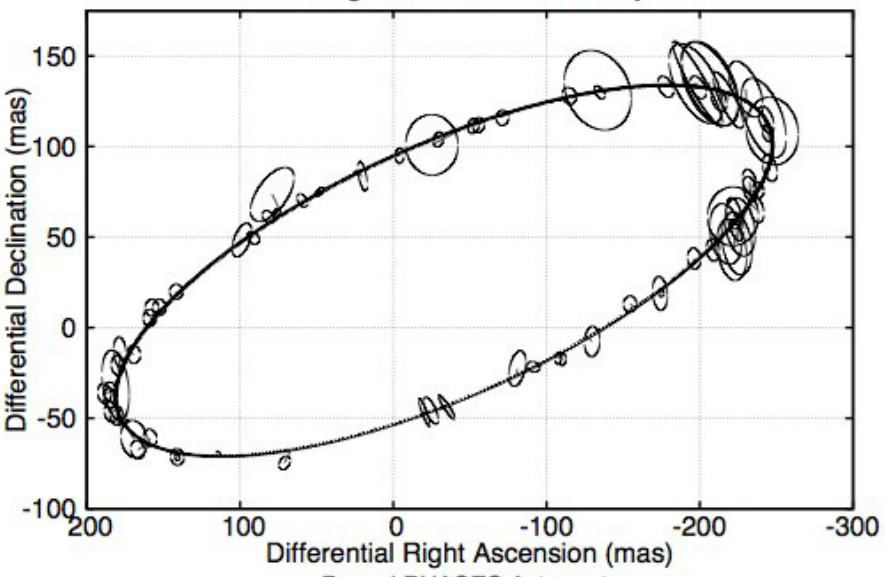


# Searching for companions

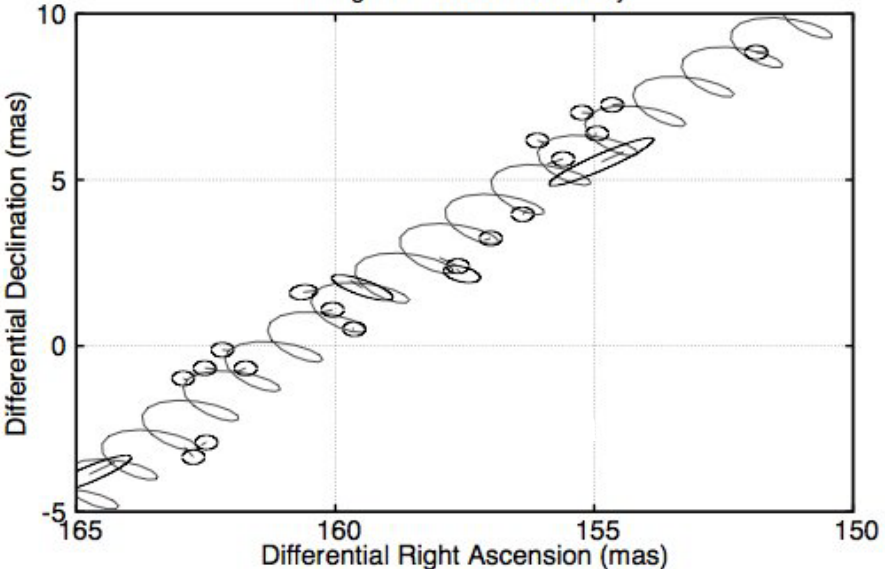
## astrometrically

- Side-to-side wobble, not back and forth wobble.
- Unlike radial velocity: gives inclination and a unique mass.

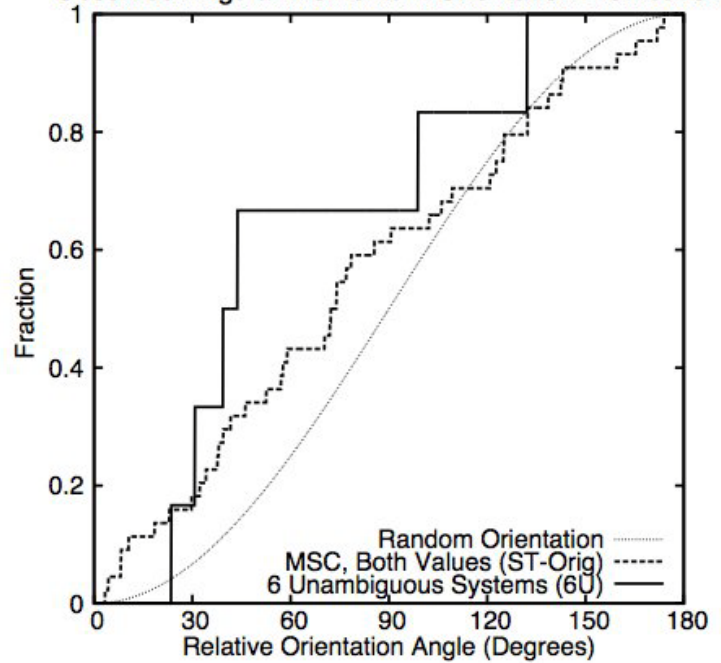
$\kappa$  Pegasi Previous Astrometry



$\kappa$  Pegasi PHASES Astrometry



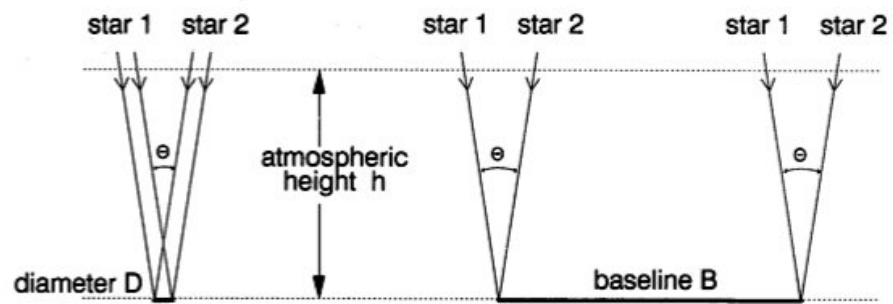
Observed Angular Momentum Orientation Distribution



LE!

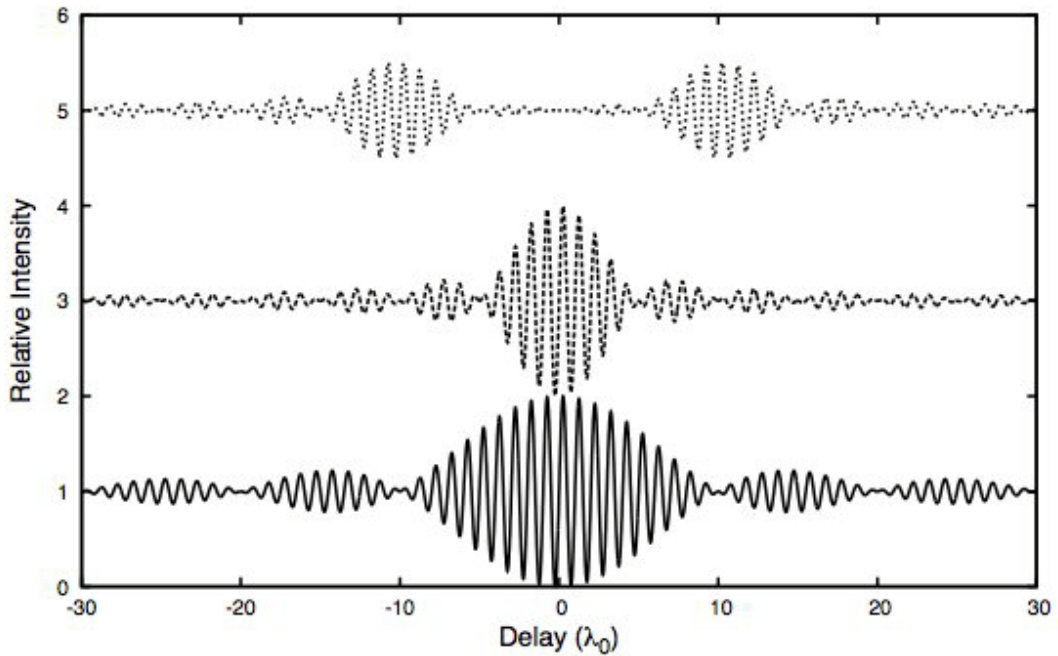


# Very Narrow Angle Astrometry with SUSI



**Traditional Narrow-Angle Regime**  
 $\Theta h \gg D$   
 error independent of D  
 error weakly dependent on  $\Theta$

**Very-Narrow-Angle Regime**  
 $\Theta h \ll B$   
 error decreases with increasing B  
 error linearly dependent on  $\Theta$



10% Bandwidth ———  
 20% Bandwidth - - - - -  
 20%, wide binary .....

# SUSI

1. PAVO tracks the phase for star 1. MUSCA measures the phase for star 1 and star 2.
2. Only the *difference* in optical path between two closely-spaced beams affects the astrometric measurement.
3. Corrections to the delay can be applied in post-processing (photon-counting).



# SUSI Planet Search

- Astrometric signature of Jupiter at 10pc is  $100\mu\text{as}$ .

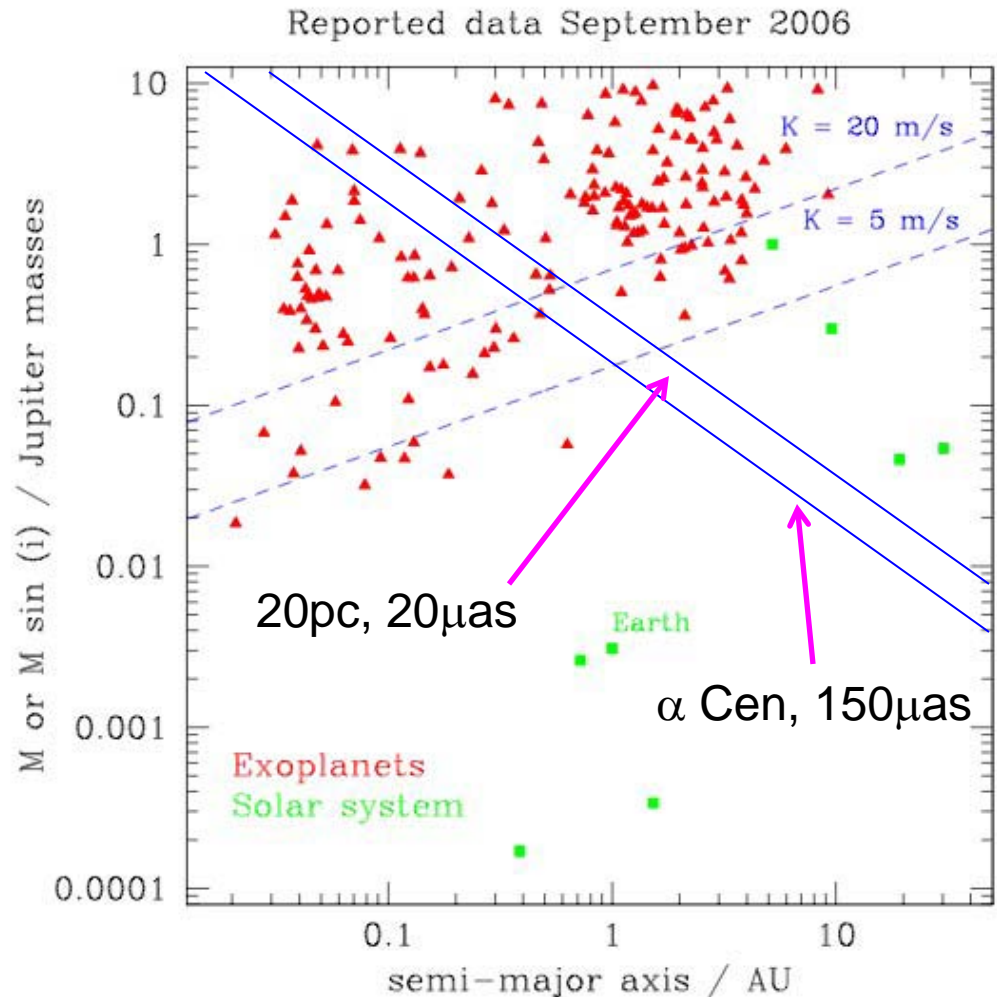
- Fundamental limits for 1 hour observing are:

- $2.6\mu\text{as}$  from photon-noise (S/N of 1 per scan)
- $3\mu\text{as}$  from anisoplanatism ( $1''$  binary).

- Practical limits will likely be  $10^{-5}$  fractional precision:  $10\mu\text{as}$  for a  $1''$  binary or  $75\mu\text{as}$  for  $\alpha$  Cen.

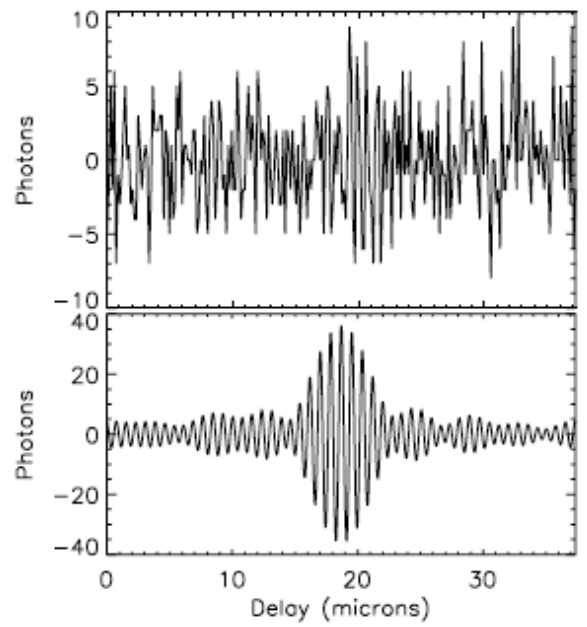
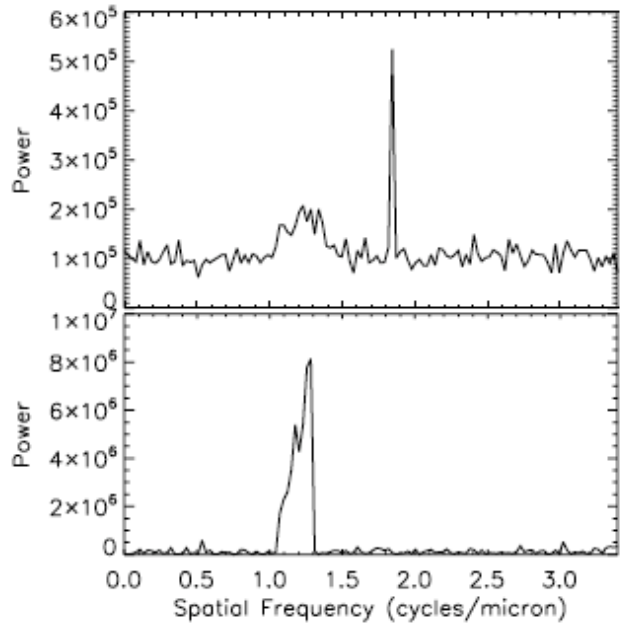
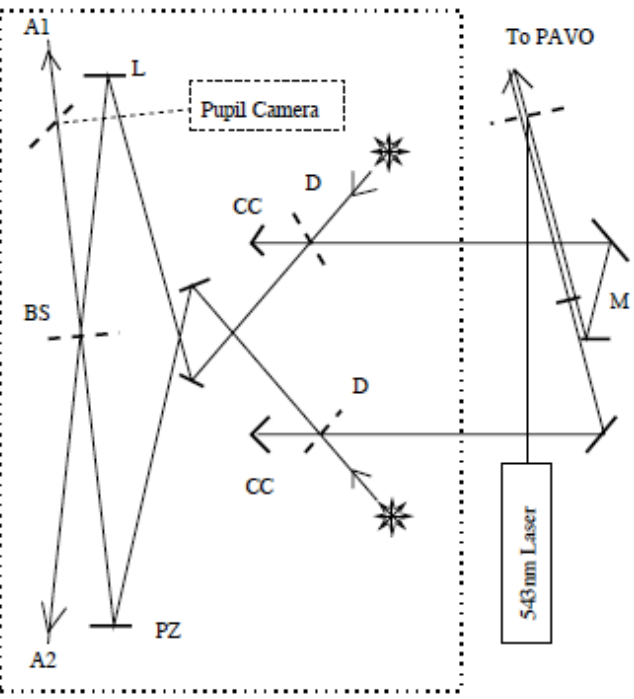
- Competitor (VLTI-PRIMA) will mostly focus on wider binaries.

- 50-100 targets





# MUSCA Concept



Optics concept, 4<sup>th</sup> mag, 50ms simulation with 543nm laser and reconstructed fringe.



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# Expected Progress in 2010

1. Routine operation from outside Australia.
2. The first PAVO@SUSI papers.
3. MUSCA commissioned, but operating within a limited FOV (no alpha Cen) until 2011

Questions now???

