ASTROMETRIC EXOPLANET DETECTION EFFORTS WITH VLTI

Neil Zimmerman, MPIA
Heidelberg-Grenoble Colloquium
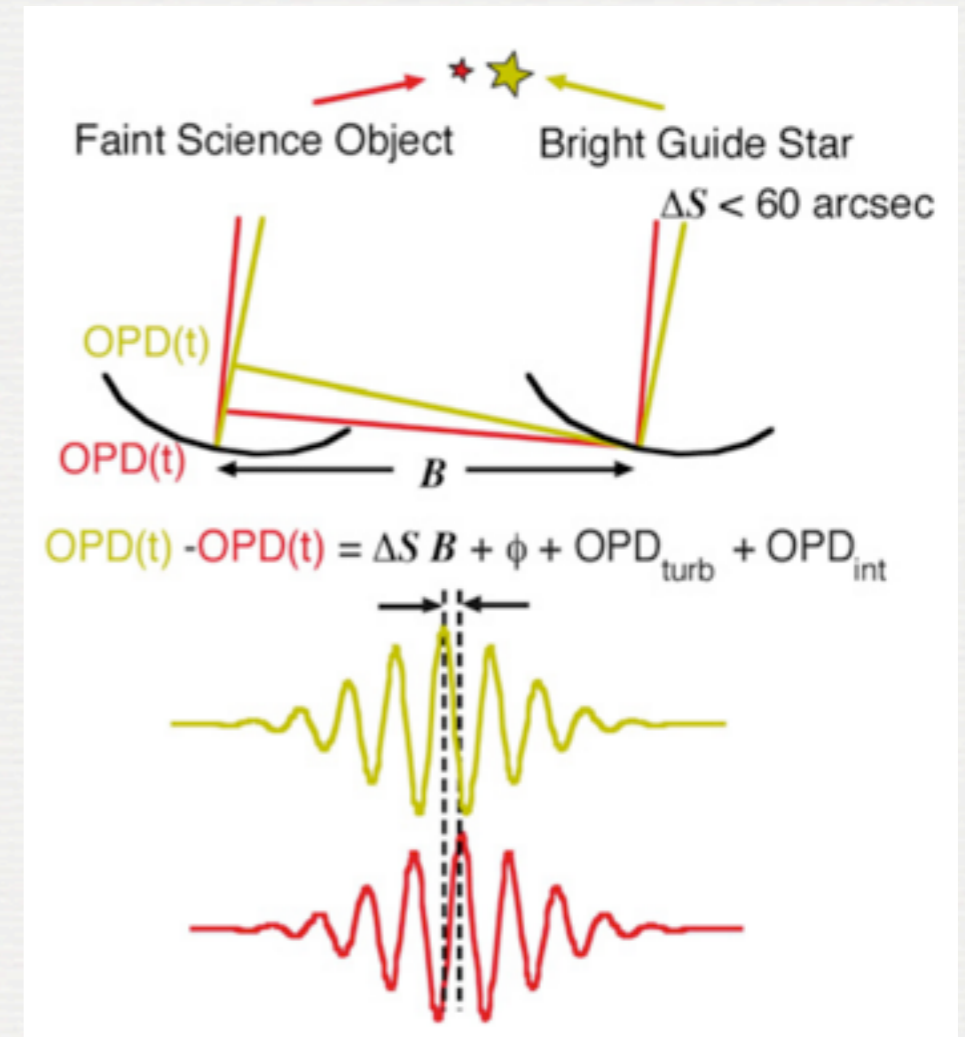9 Oct 2012

THE CASE FOR ASTROMETRY

- Can survey nearby stars of a wide range of age and mass

- Constrain orbits and masses of known planets

- Complement direct imaging by probing separations < 5 AU

REQUIRED PRECISION

- Barycentric motion of a Sun-Jupiter analog @ 50 pc: 0.1 mas

- Same system, but 2-yr orbit: 0.03 mas

RELATIVE ASTROMETRY WITH A DUAL-FEED INTERFEROMETER

- Shao & Colavita (1992): measure the angular separation of two stars within an isoplanatic patch, over a long baseline

- method can theoretically achieve 10 microarcsec precision

- previous efforts: Keck Interferometer and Palomar Testbed Interferometer

Faint Science Object   Bright Guide Star

$\Delta S < 60$ arcsec

OPD(t)

OPD(t) ← B →

$OPD(t) - OPD(t) = \Delta S\, B + \phi + OPD_{turb} + OPD_{int}$

Delpancke 2008

PRIMA

VLTI's facility for **p**hase-**r**eferenced **i**maging and **m**icroarcsecond **a**strometry

ESPRI - **E**xoplanet **S**earch with **PRI**ma (MPIA, LSW, and Obs. Geneve; P.I.s Henning, Quirrenbach, and Queloz)
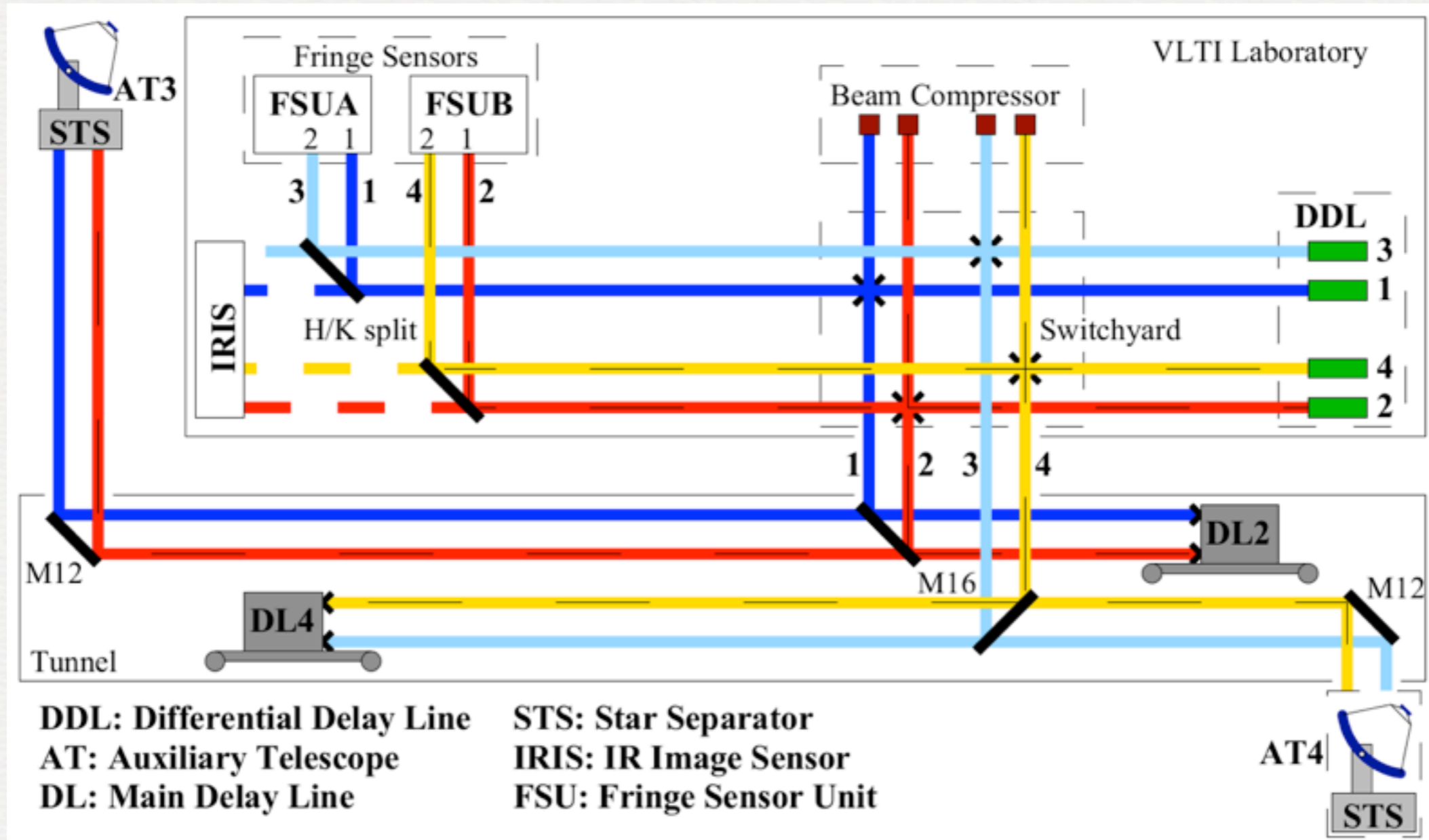

2008: subsystem testing begins
2010: first fringes
2011: astrometry commissioning begins

PRIMA

Facility Block Diagram

Sahlmann et al., in prep

ESPRI: GTO SURVEY PLAN

- 31 stars with published RV exoplanet candidates whose orbits we will have the sensitivity to characterize.

- 35 nearby main sequence stars for which we will have the sensitivity to detect a Saturn- mass planet in a 4-year orbit.

- 32 nearby young stars for which we will have the sensitivity to detect a Jupiter-mass planet in a 4-year orbit.

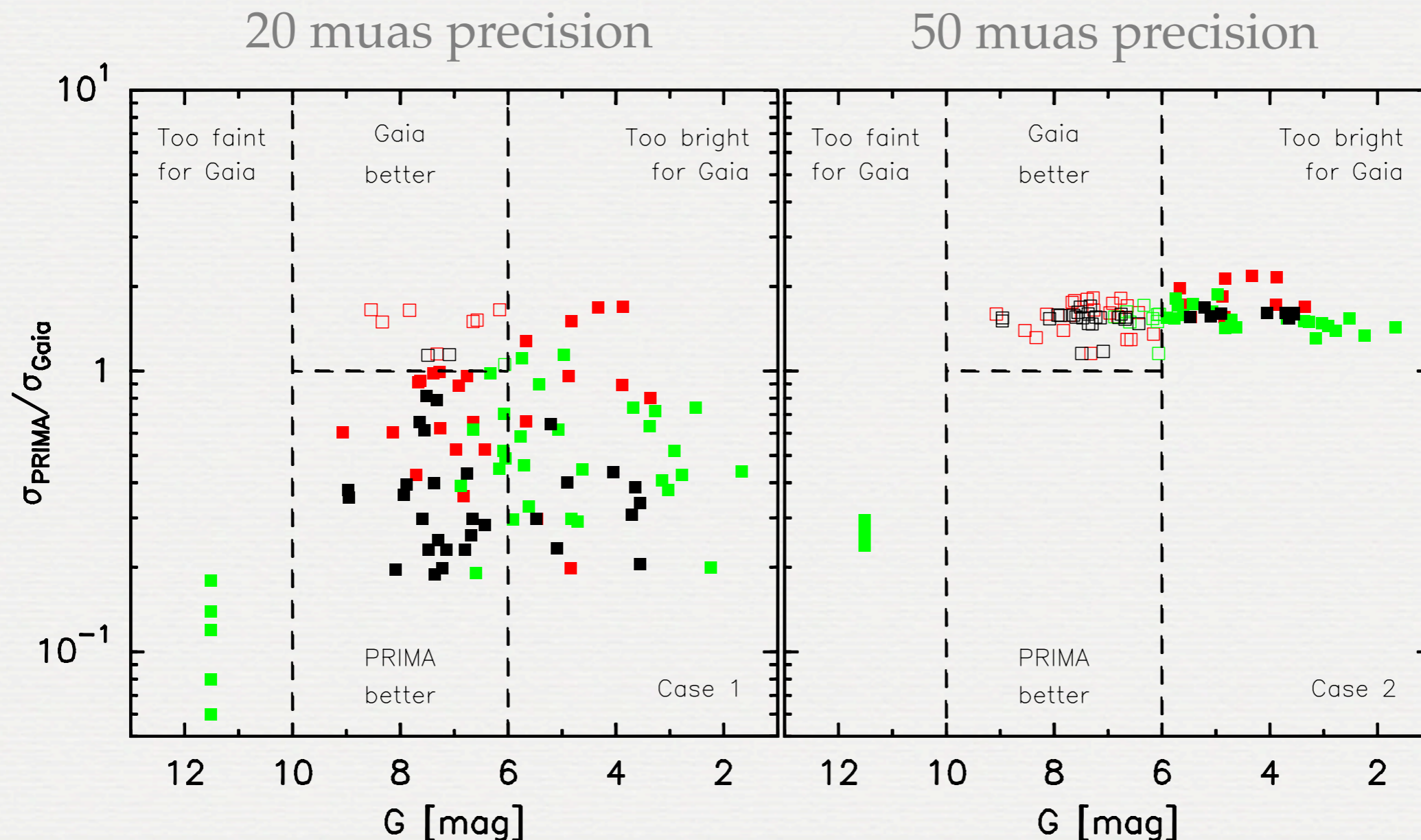# ESPRI: GTO SURVEY PLAN

Radial Velocity Planet Targets

Launhardt et al., in prep.
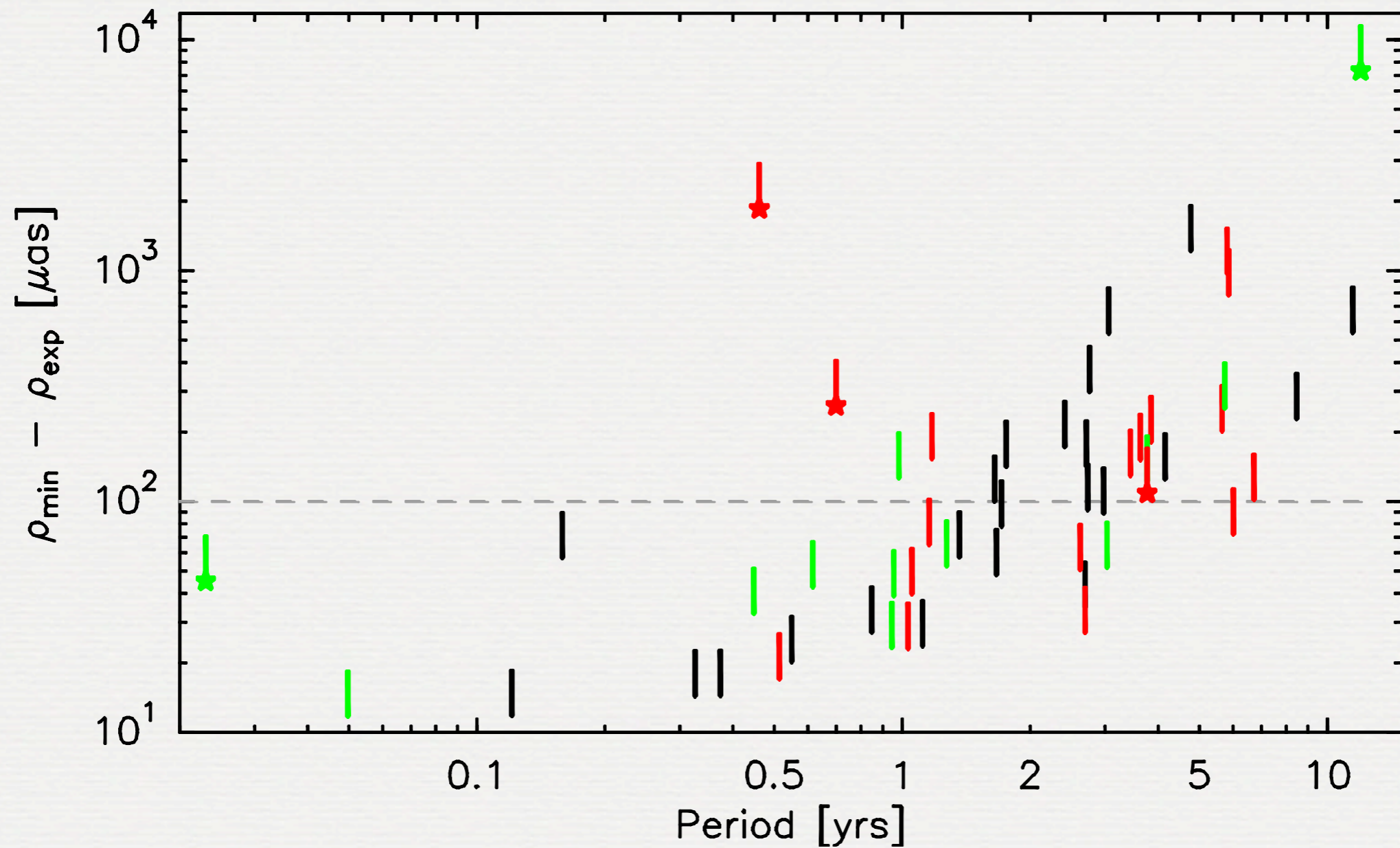
ESPRI: GTO SURVEY PLAN

Comparison to Gaia sensitivity:
## RV targets, nearby star targets, young star targets

Launhardt et al., in prep.

PRIMA: RECENT COMMISSIONING RESULTS

- demonstrated single-measurement precision of 40 microarcsec on 15-minute time scale

- several millarcsec systematic errors on > 1-hr time scales preclude start of planet survey

- ESO task force has identified error sources in optical train, in process of revising metrology

FUTURE DEVELOPMENTS: GRAVITY

- collaboration between ESO, MPE, LESIA, MPIA, IPAG, U. Lisbon, and U. Cologne

- will combine the four VLT UTs to achieve 10 microarcsec astrometry

- MPIA responsible for wavefront sensor
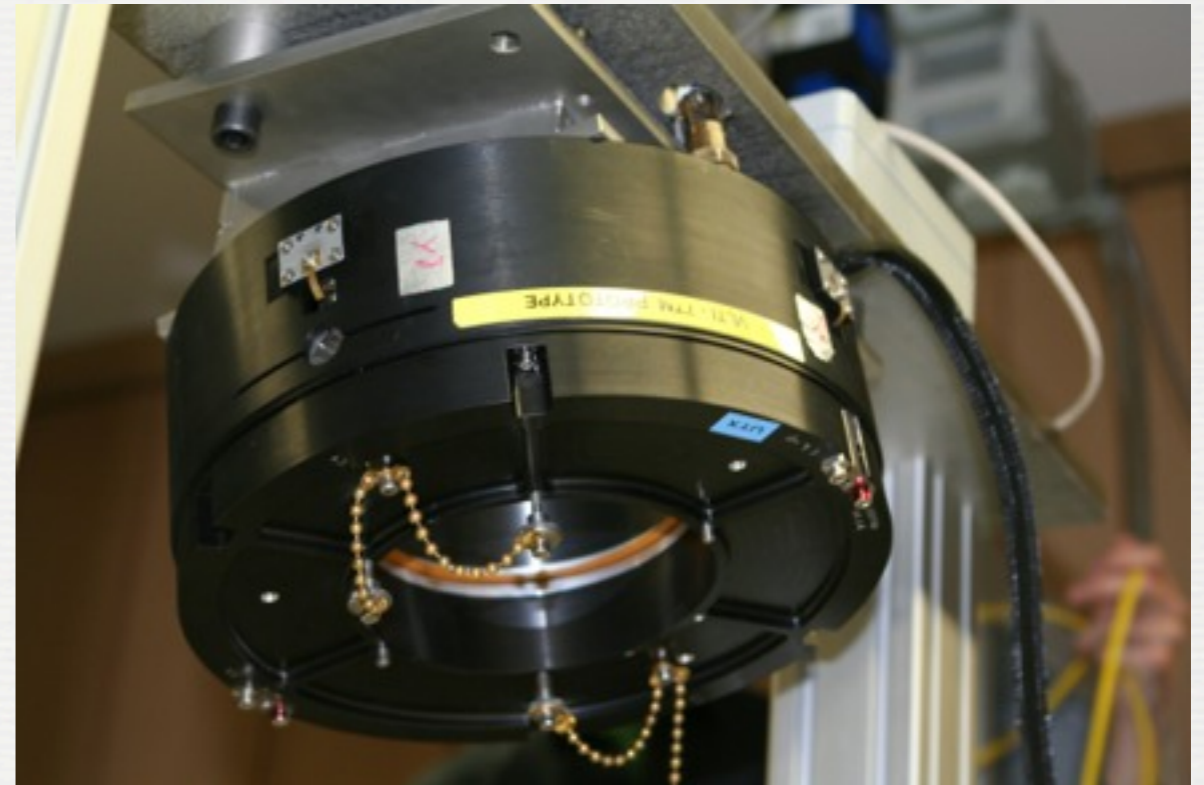
MACAO deformable mirror installed in MPIA's AO lab