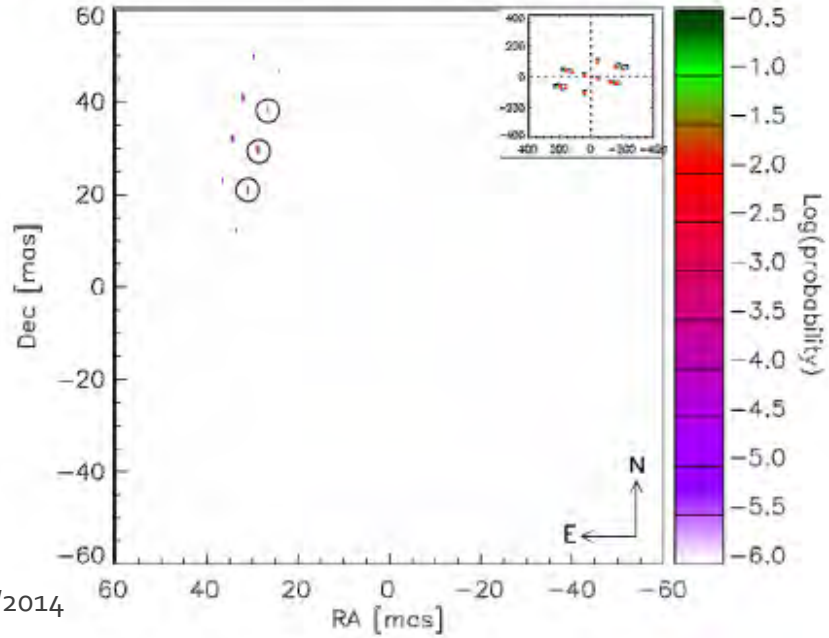
S. Lacour, L. Gauchet, G. Martin, N. Courjal et al....

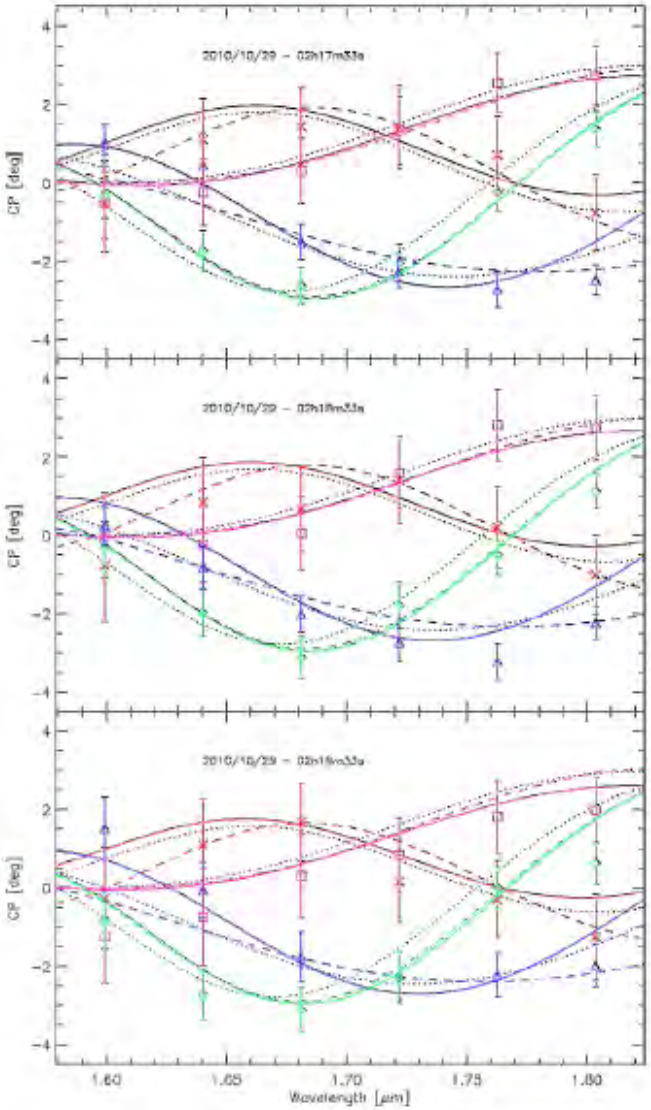
PIONIER and Nulling
Is it a bad idea?

Absil et al. 2011

A companion to δ Aqr

- Long period RV + astrometry
- Contrast 2.05% ± 0.16%
  - A3V + G5V system
- Position ambiguous





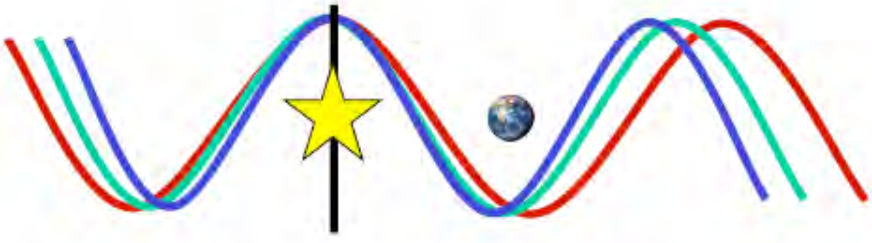
Astrophysical applications

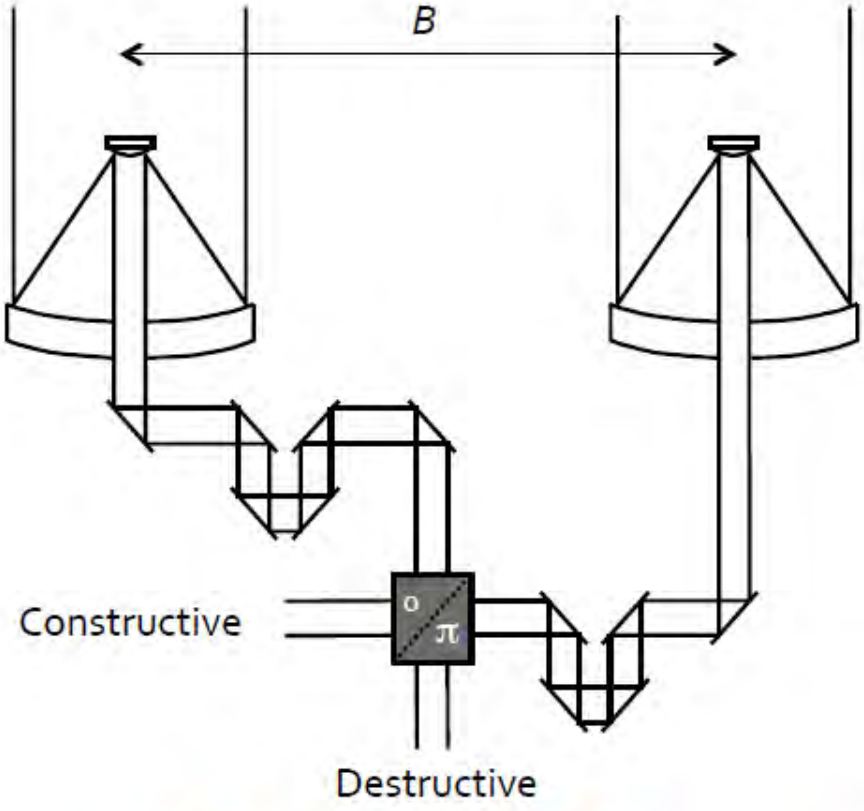
- Performance summary
  - Noise floor ~ 0.2°
  - Dynamic range ΔH~6
  - Valid up to H~6 (?)
- Warm BD/planets
  - Transition objects
  - Moving groups
  - Hot Jupiters … not yet
- Binary fraction of massive stars

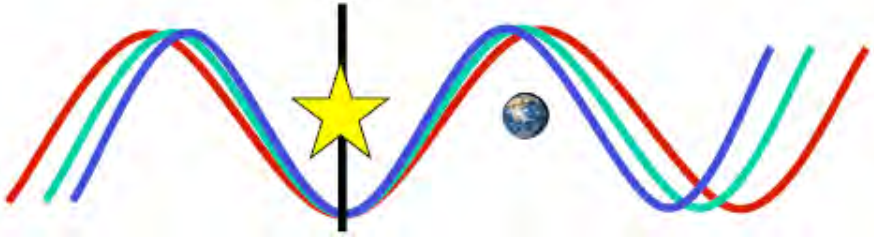
Age	AoV	GoV	MoV
10 Myr	0.09 M_{sun}	0.017 M_{sun}	0.012 M_{sun}
50 Myr	0.22 M_{sun}	0.043 M_{sun}	0.013 M_{sun}
200 Myr	0.35 M_{sun}	0.08 M_{sun}	0.030 M_{sun}

Nulling interferometry

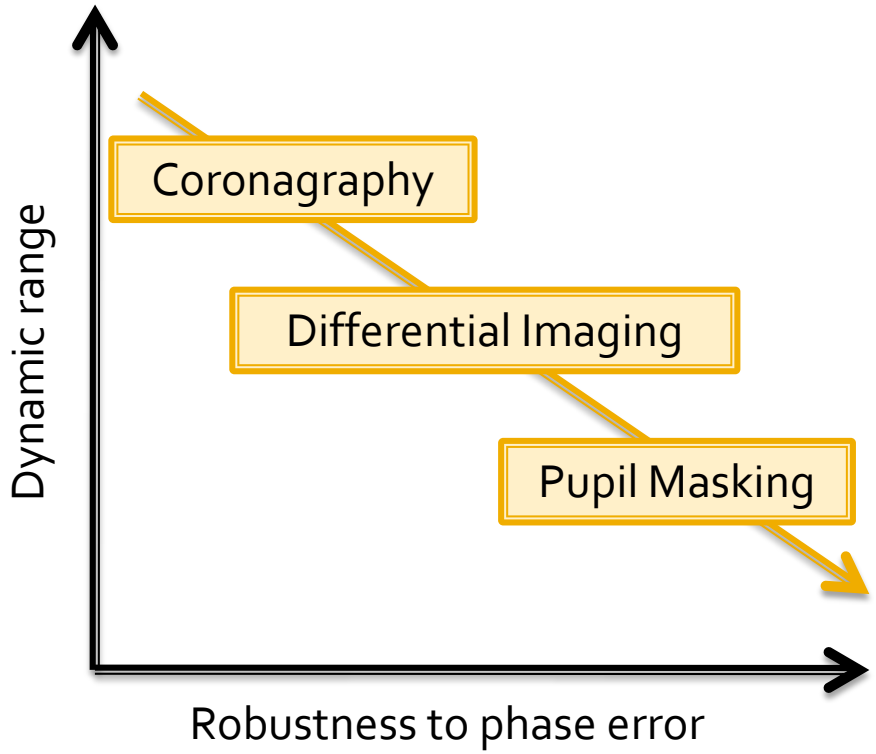
- Put the 2 beams in phase and lock them
- Introduce achromatic π phase shift
- Dynamic range ≥ 10^3:1 (Palomar Fiber Nuller)



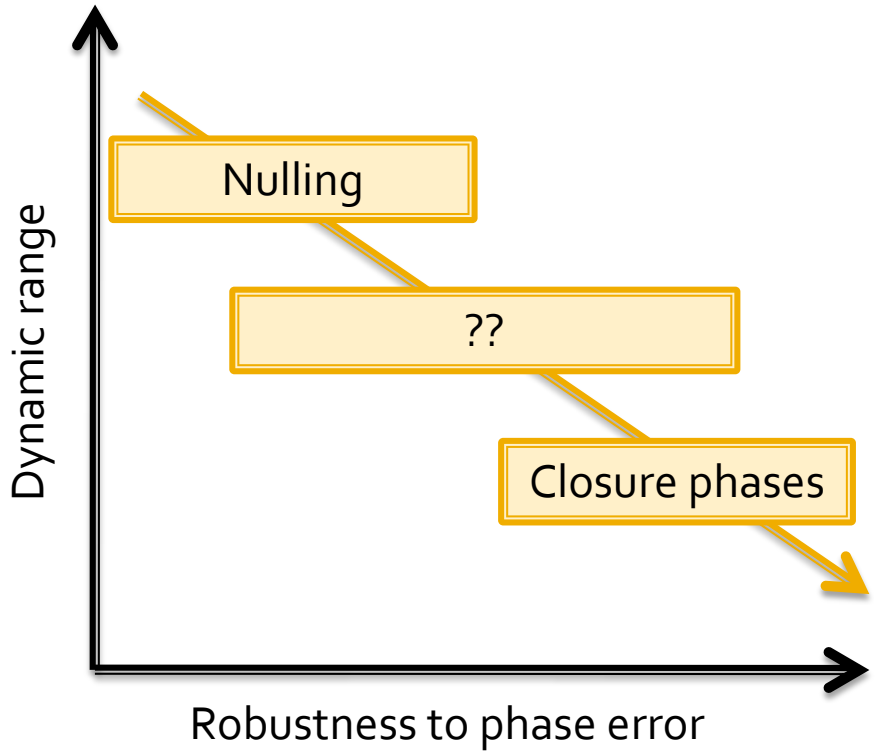




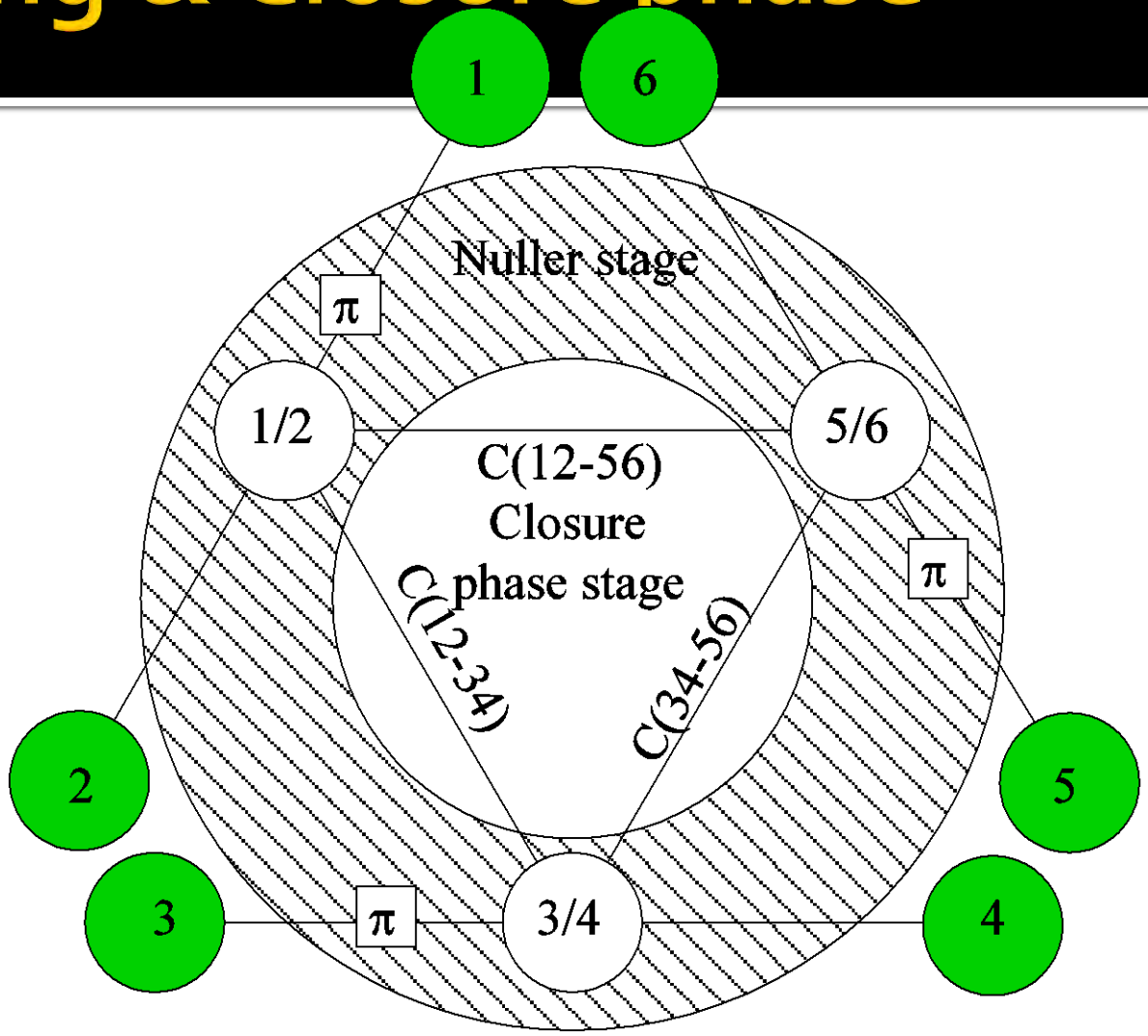
Dynamic range with a telescope



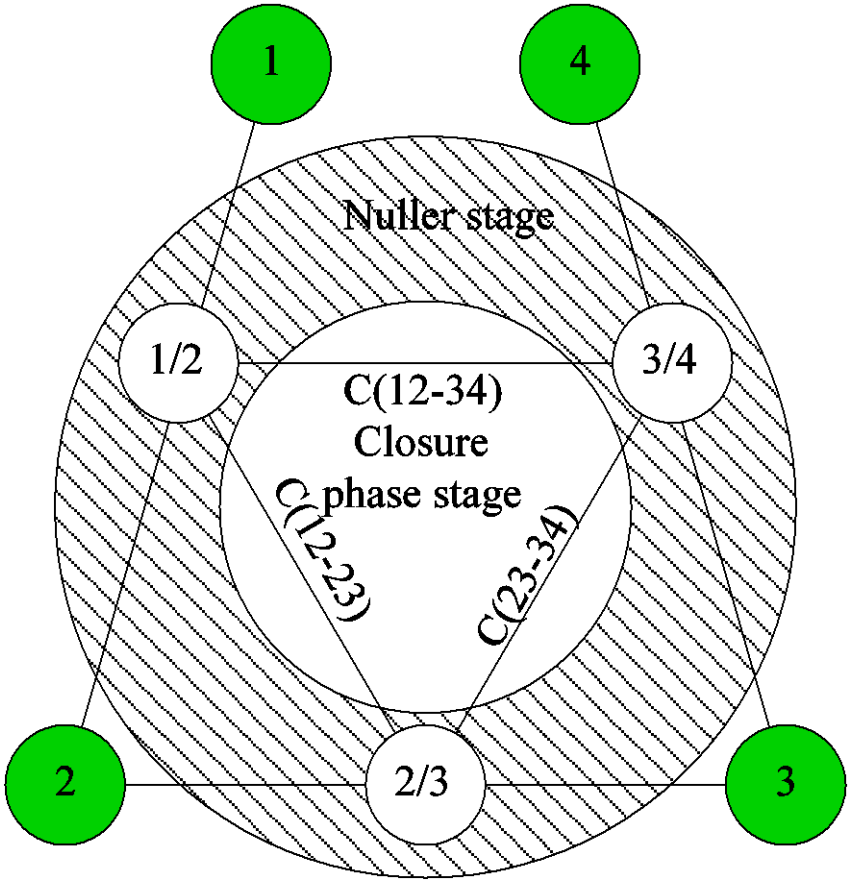
Dynamic range with an interferometer

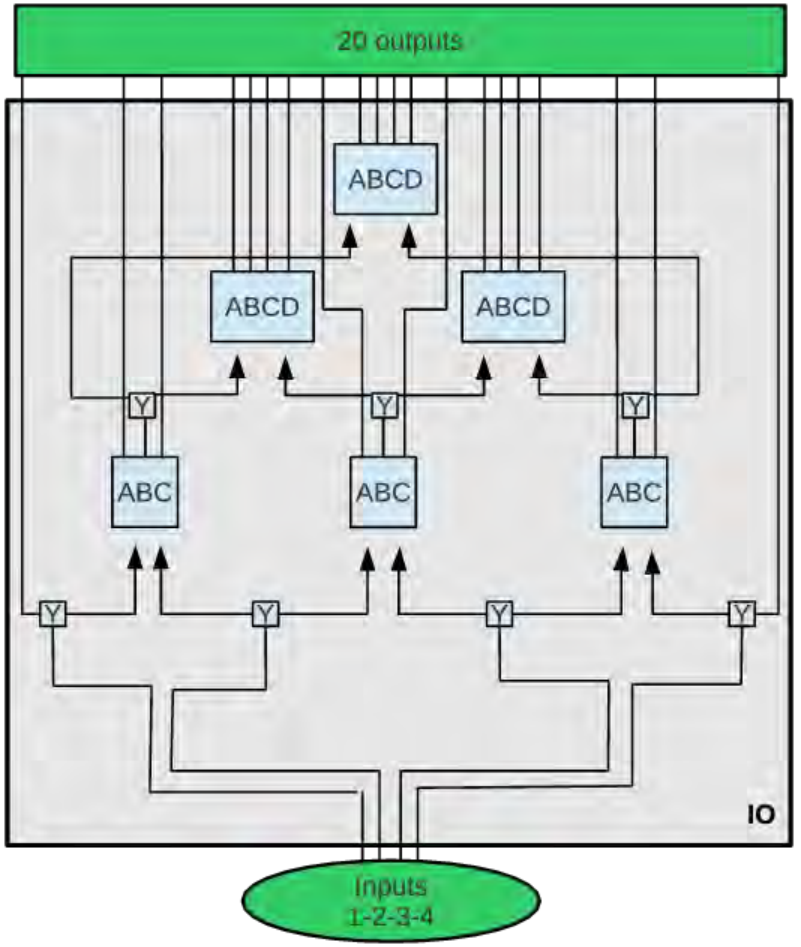


Nulling & Closure phase

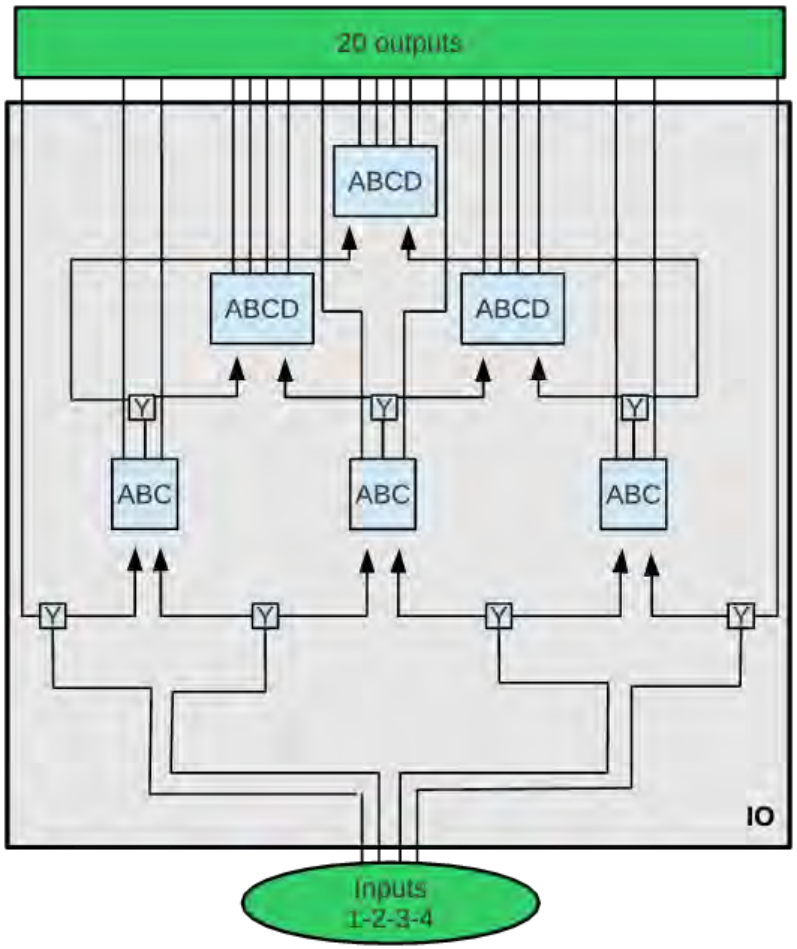


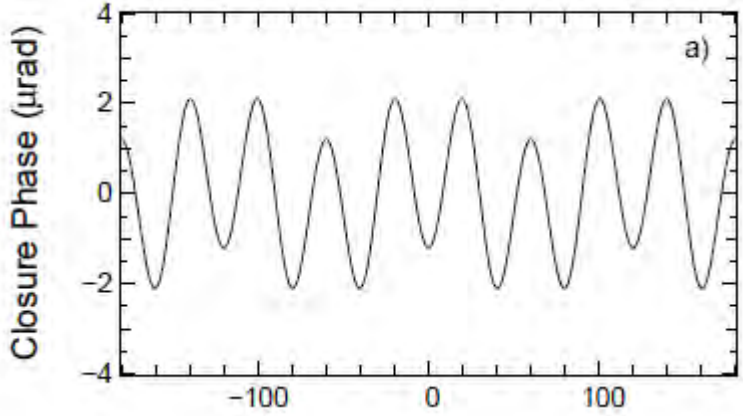
Nulling & closure phase



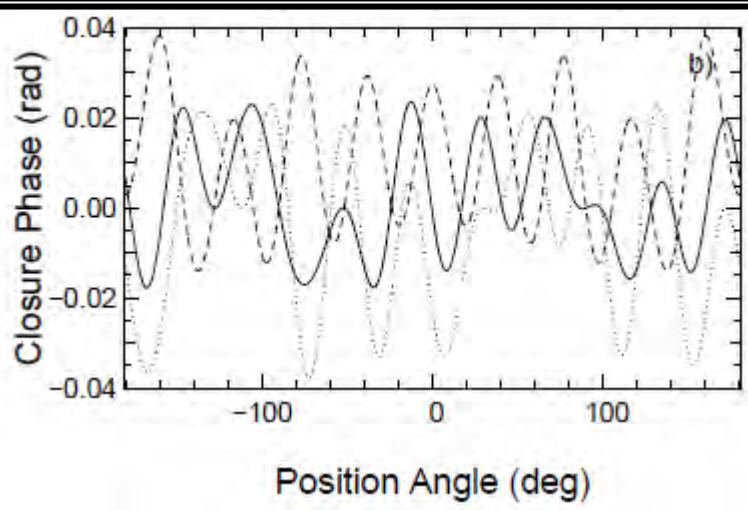


Nulling & CP



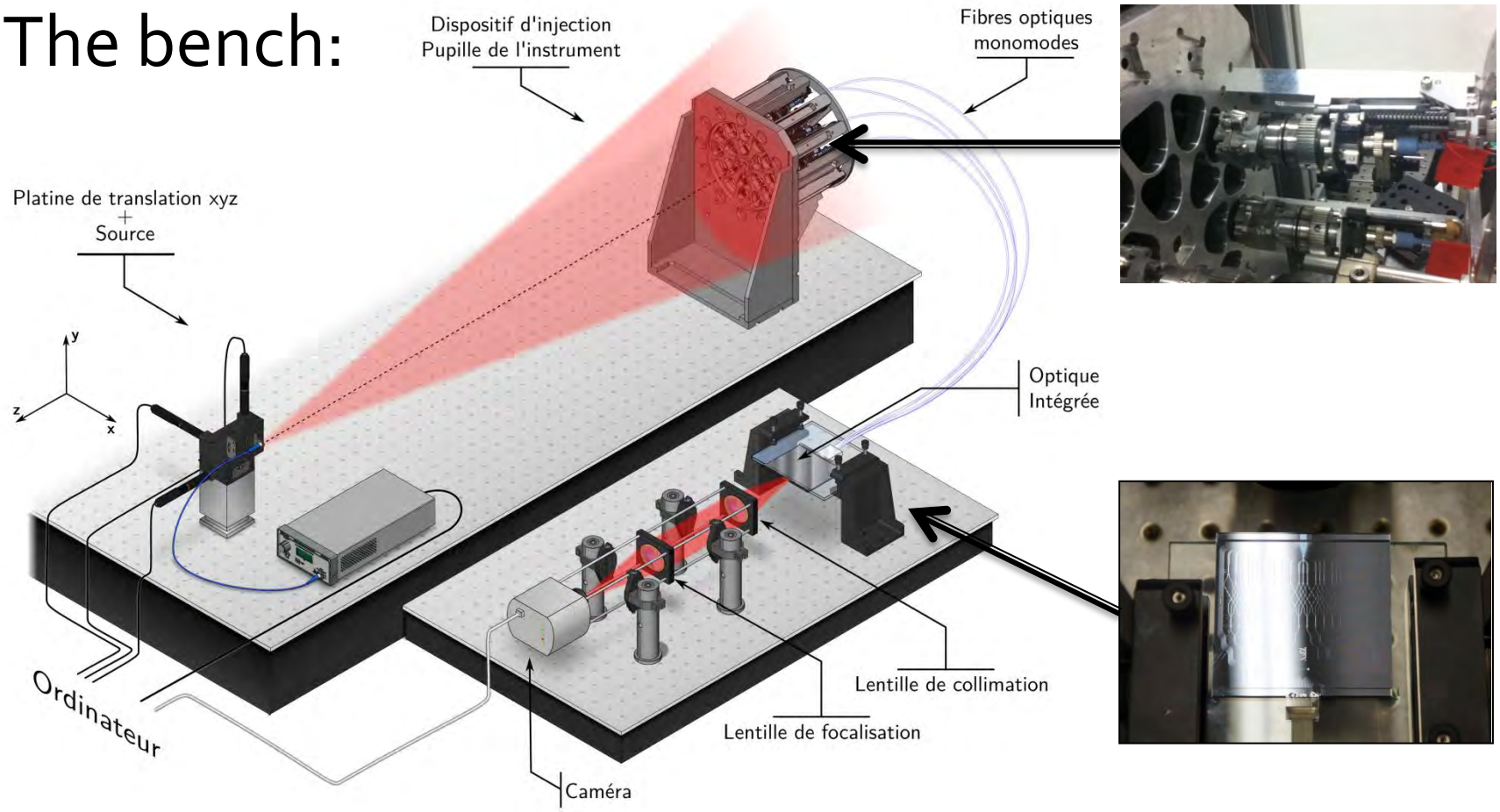


Companion with Flux ratio 10^6
Cophasing accuracy 0.01 rad (half a deg)
=> Gain 10^4 in contrast



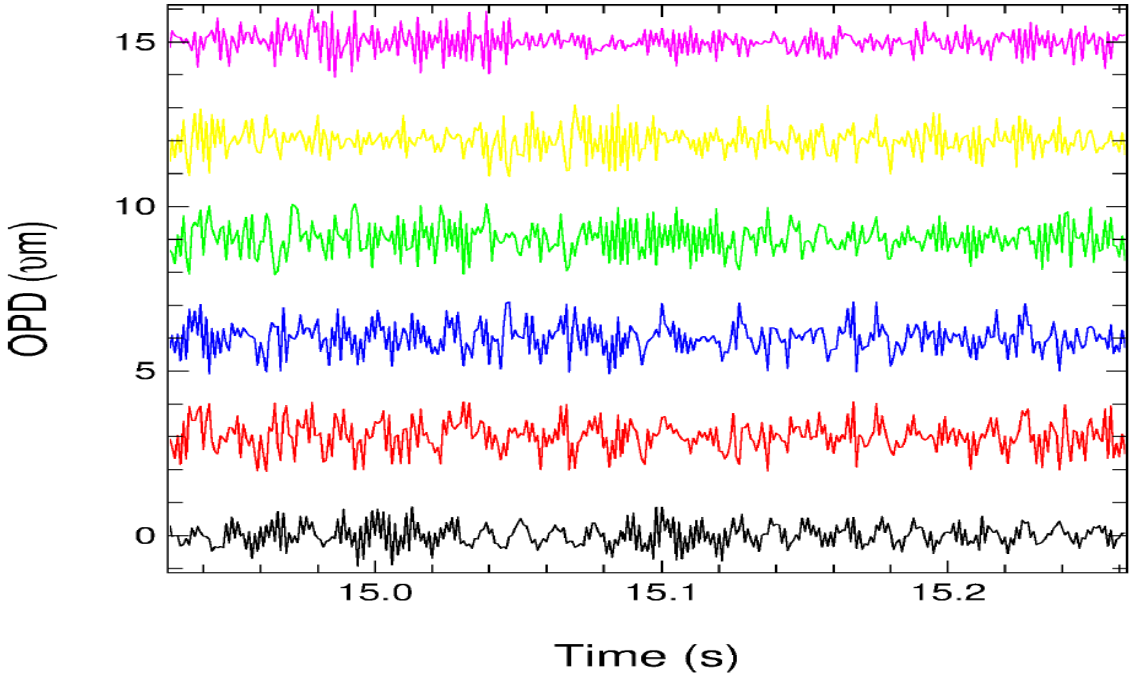
Testing in progress

- The bench:



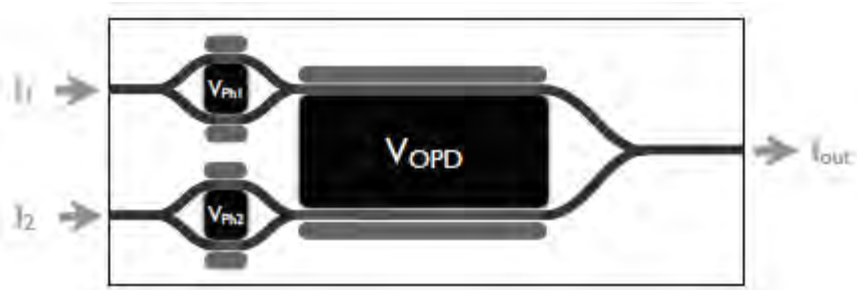
On PIONIER?

- Is phase tracking possible?
  - Phase fluctuation (Vibrations, atmosphere…)
  - Intensity fluctuation (Injection)

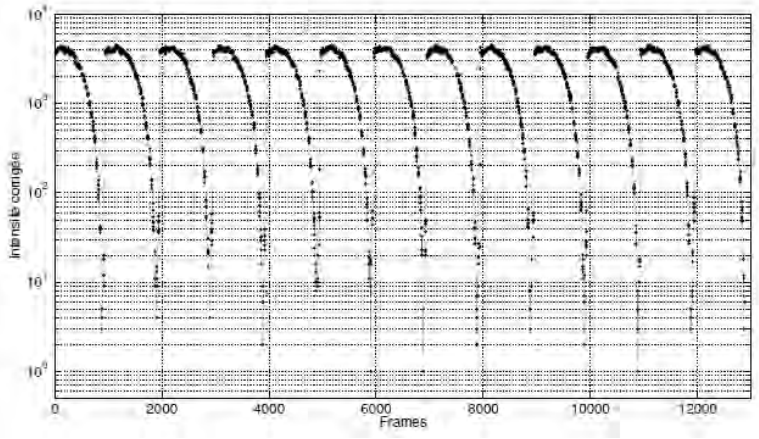


On PIONIER?

- Is phase tracking possible?
  - Phase fluctuation (Vibrations)
  - Intensity fluctuation (Injection)
    - Solution : Active optics



Double Mach-Zehnder (Lithium Niobate)

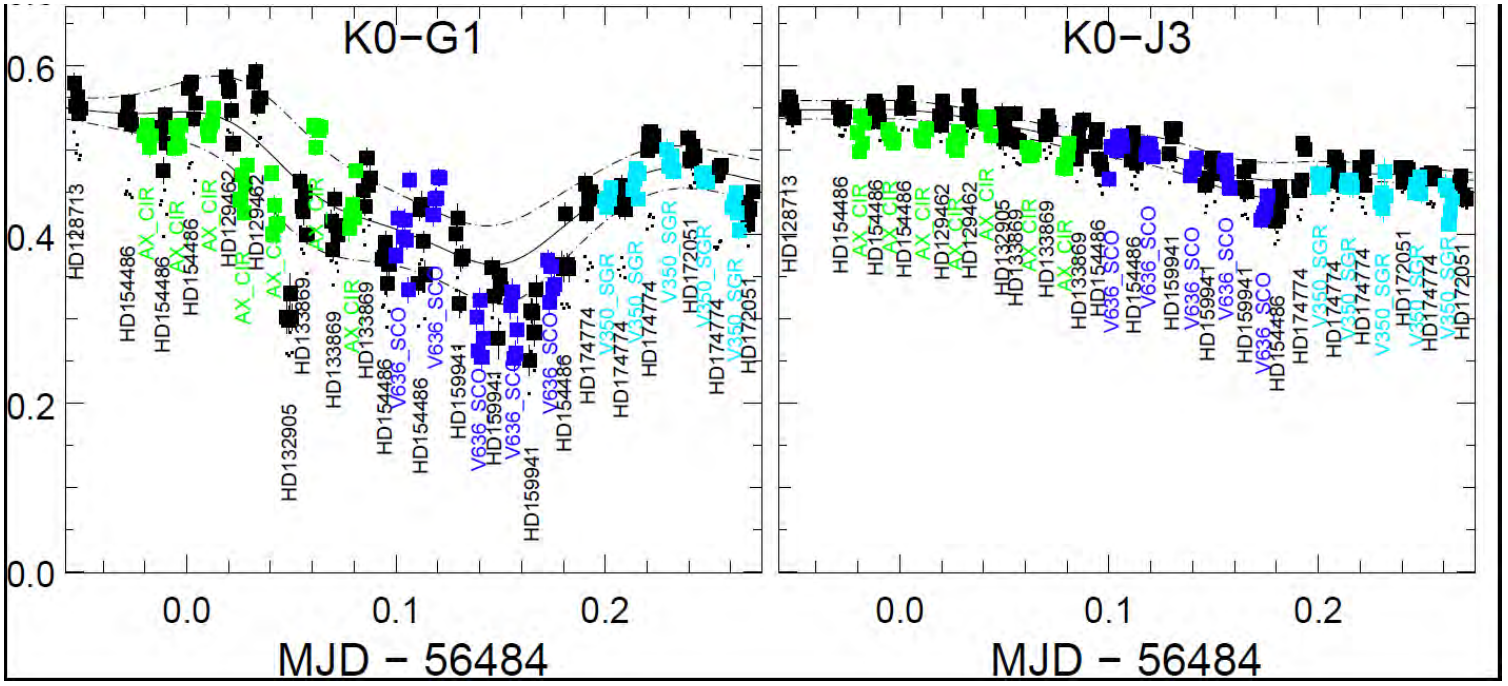


36 db attenuation (3.4µm)

Samuel Hiedman PhD Thesis, 2013

On PIONIER?

- Is phase tracking possible?
- Can we have 100% contrast?



On PIONIER?

- Is phase tracking possible?
- Can we have 100% contrast?

- Shall we try?
  - Needed: PIONIER as it is + RAPID + Lithium Niobate components

Polarisation control Phase control Intensity modulators