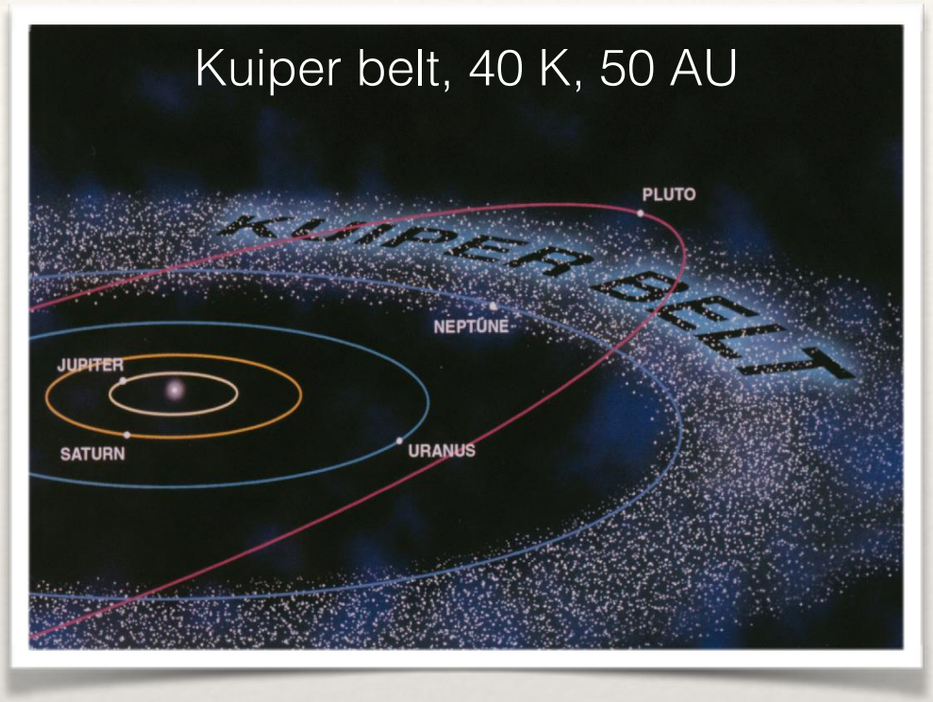
Belgian Interferometry Day, 12 March 2014

A survey of hot exozodiacal disks with the VLTI

Olivier Absil
Université de Liège

Context: debris disks

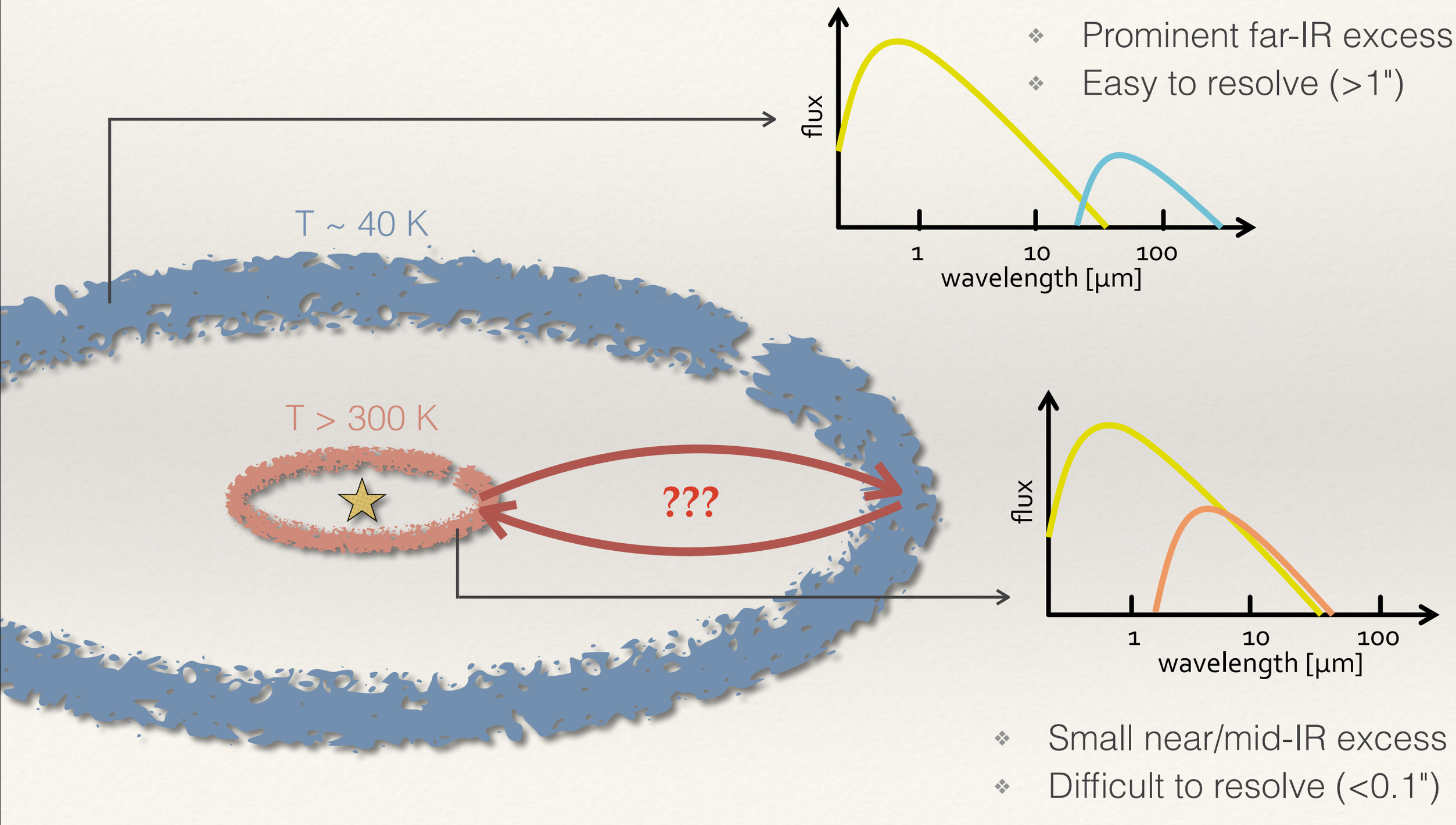
- We all live in a debris disk
  - 2nd generation dust (asteroids, comets)
- Dust is luminous (much more than planets)
- Dust is expected in all planetary systems



Kuiper belt, 40 K, 50 AU


Zodiacal disk, 300 K, 1 AU

Inner vs. outer debris disk

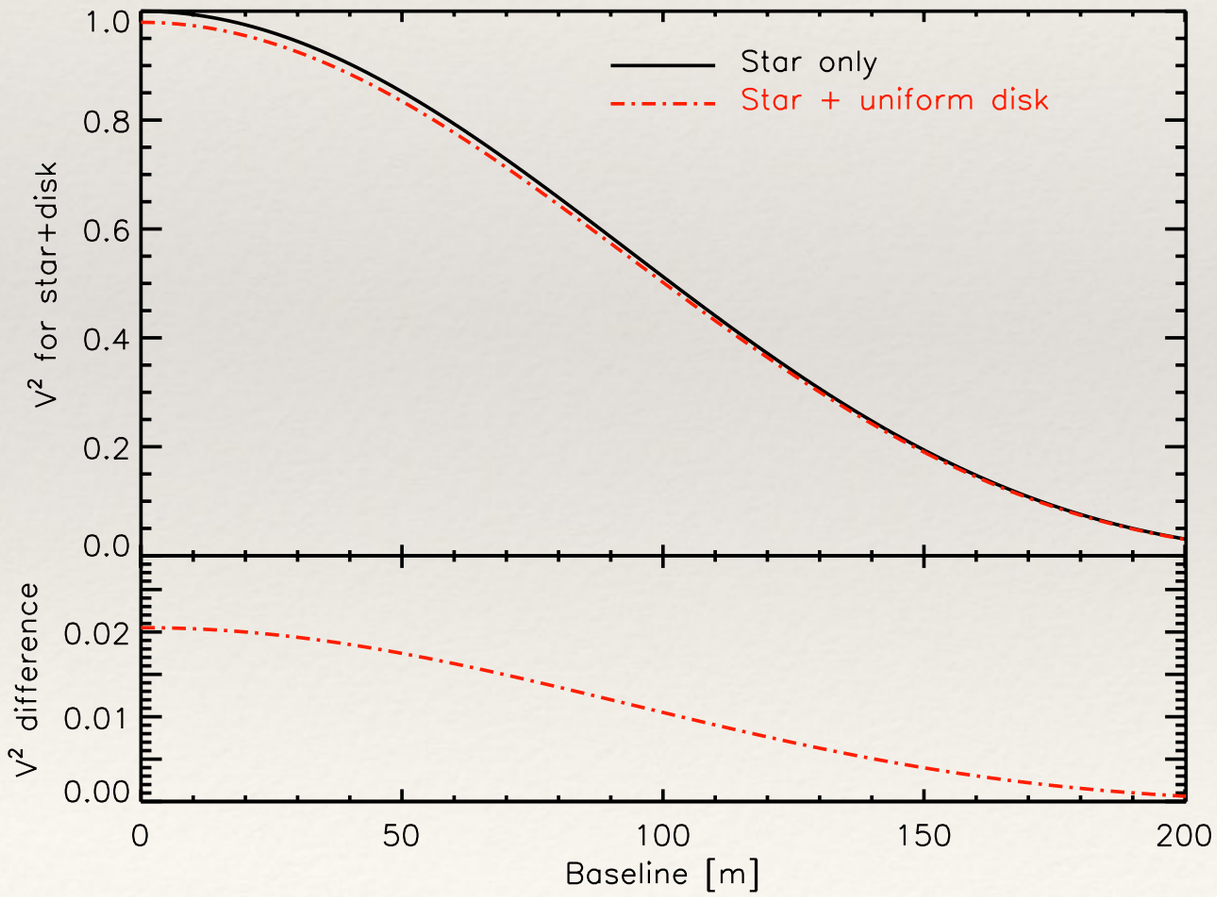


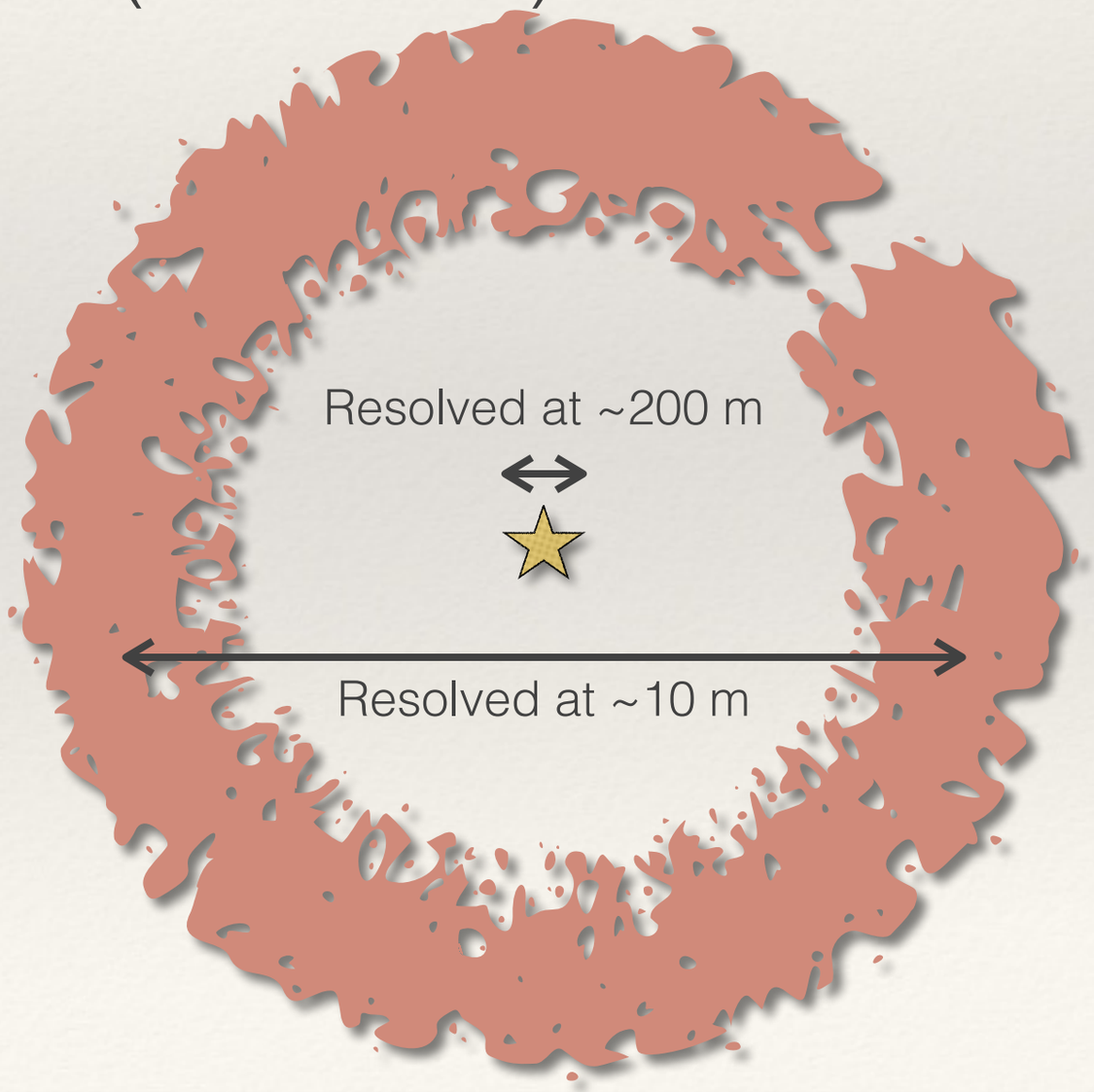
- Prominent far-IR excess
- Easy to resolve (>1")

- Small near/mid-IR excess
- Difficult to resolve (<0.1")

Exozodis with interferometry

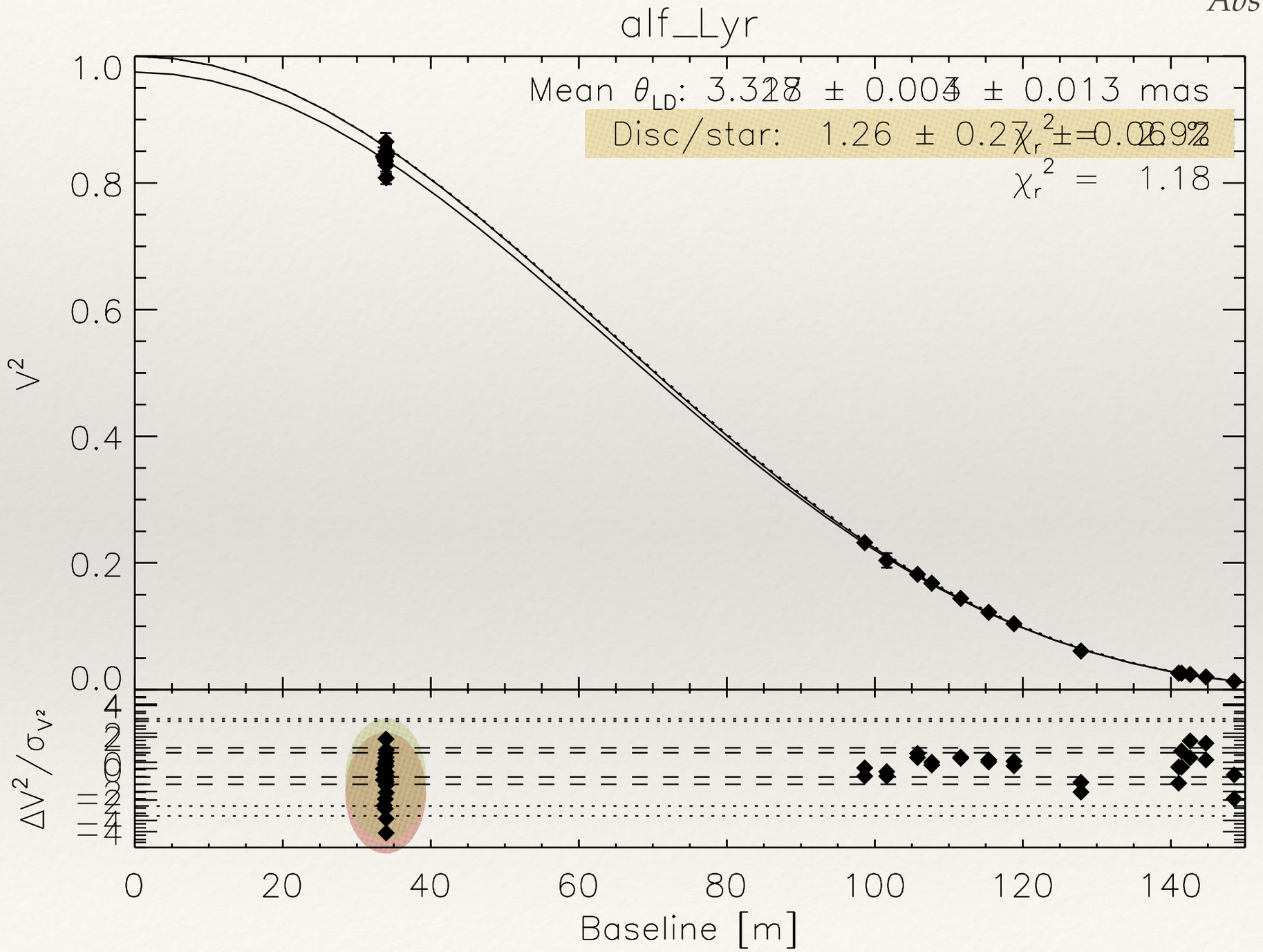
- Disk larger than λ/B → visibility drop
- Best detected at short baselines (~10-30 m)





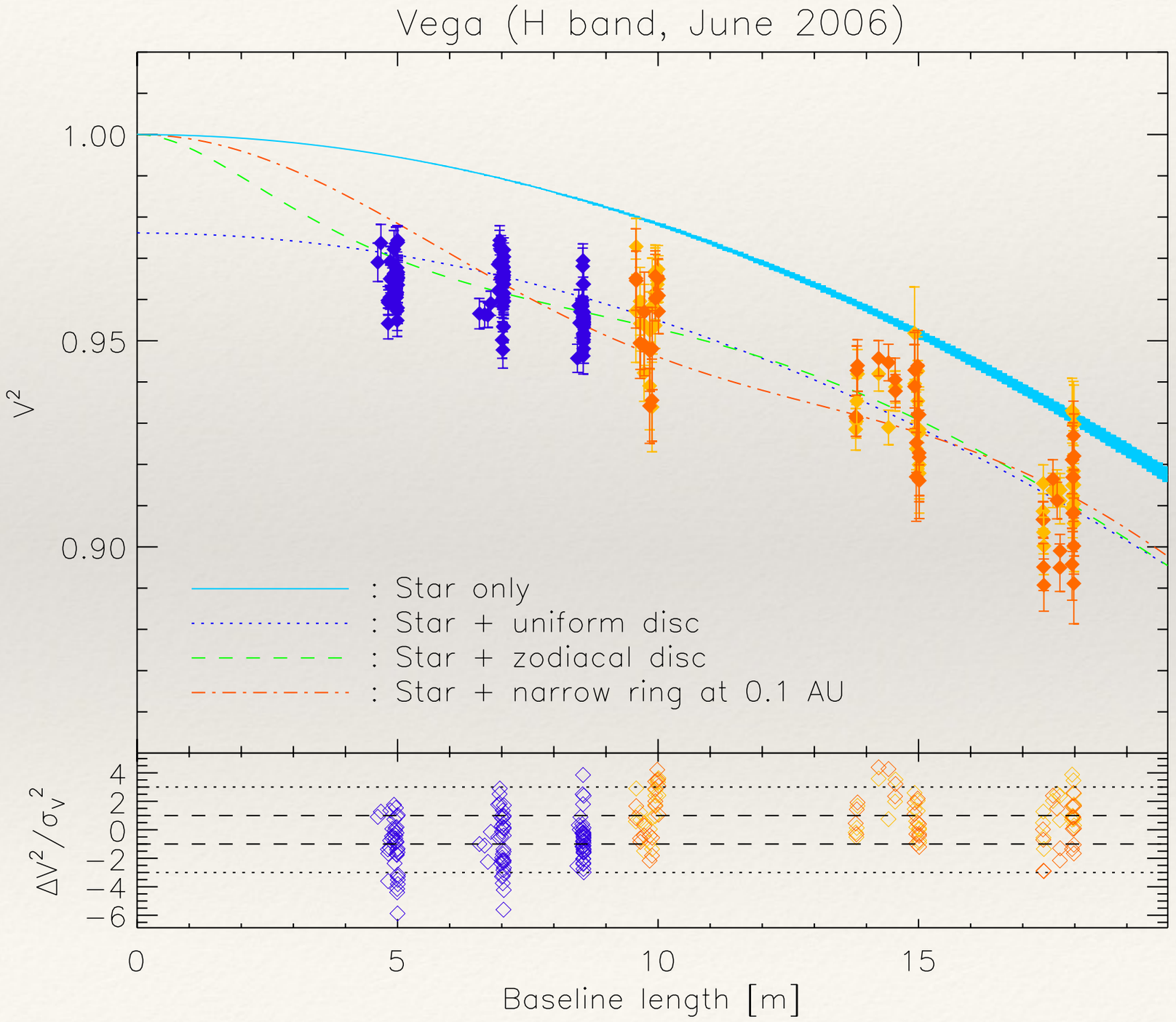
2005: 1st detection with CHARA/FLUOR

Absil et al. 2006



Morphology?

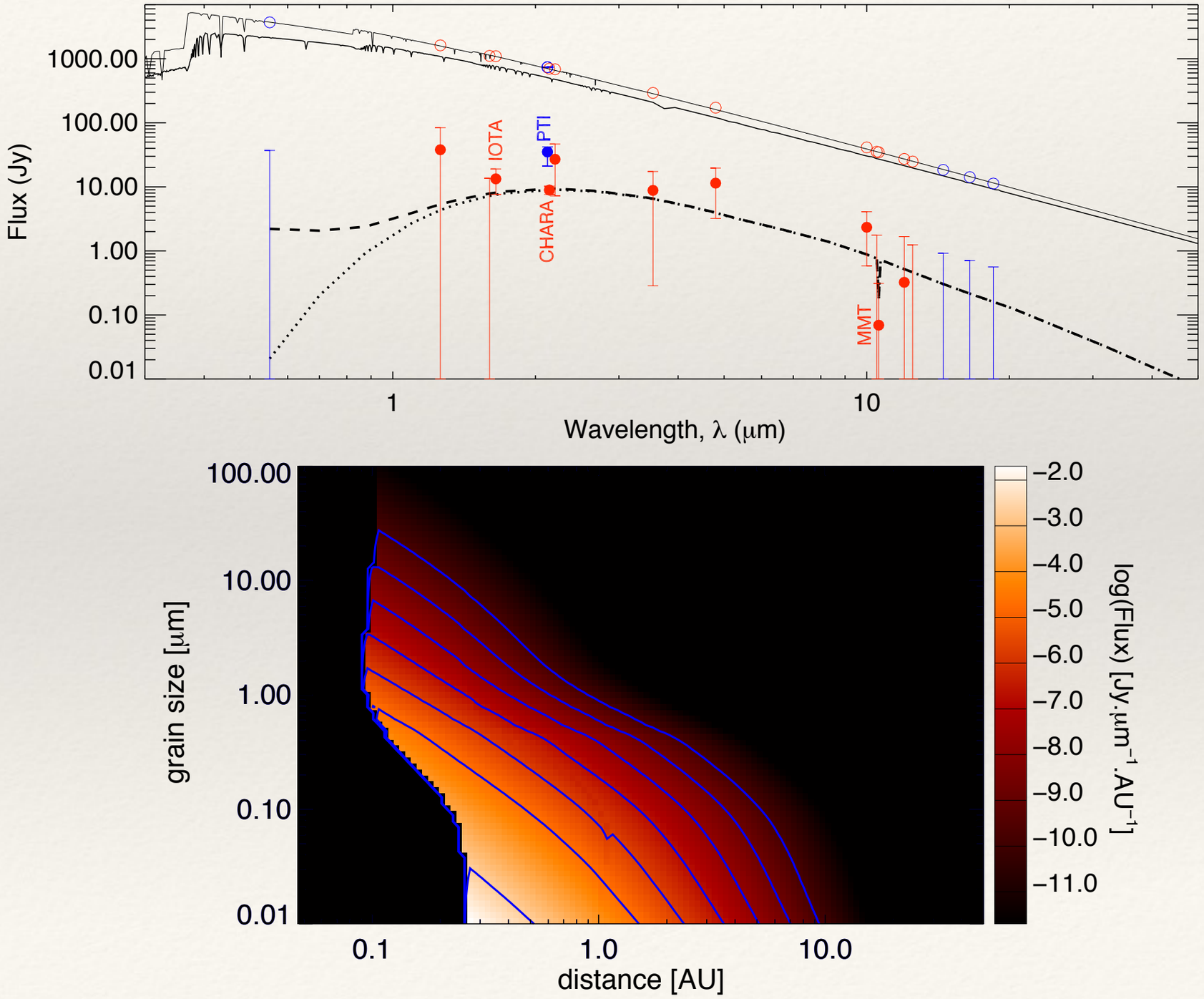
Defrère et al. 2011



Deduced properties

- Hot grains (> 1000 K)
- Grains smaller than blowout
- Distance ~ 0.1 to 0.5 AU
- Steep density power law (ring-like?)
- Small mass (~10^{-9} M_{Earth})

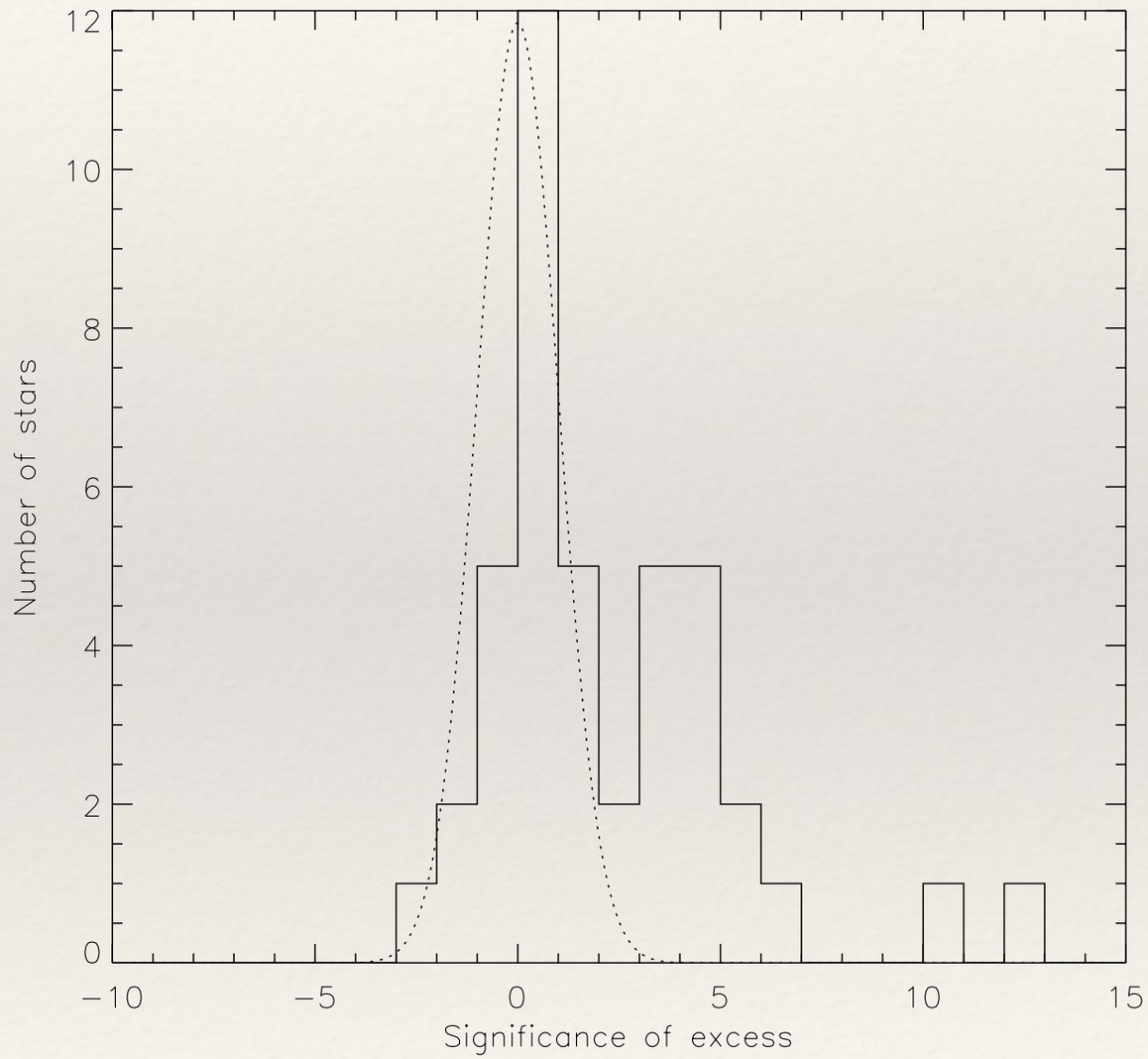
Defrère et al. 2011



2006-2011: the CHARA survey

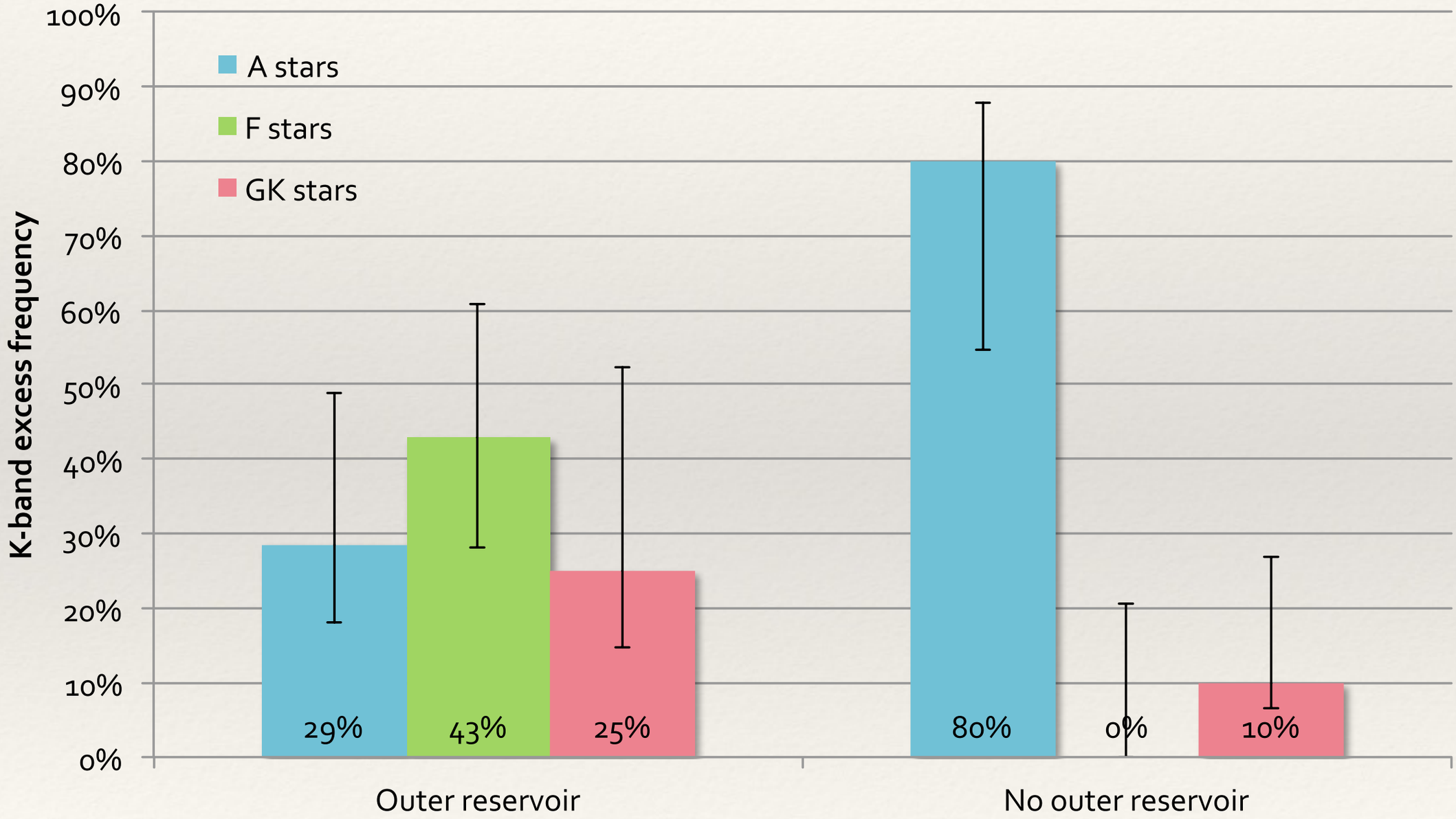
Absil et al. 2013

- FLUOR instrument
- Magnitude-limited sample (K < 4)
- Equal amount of stars with and without cold dust
- 40 stars, evenly spread between type A, F, G-K
- Avoid all types of binaries
- Mean sensitivity: 0.27% (1σ)



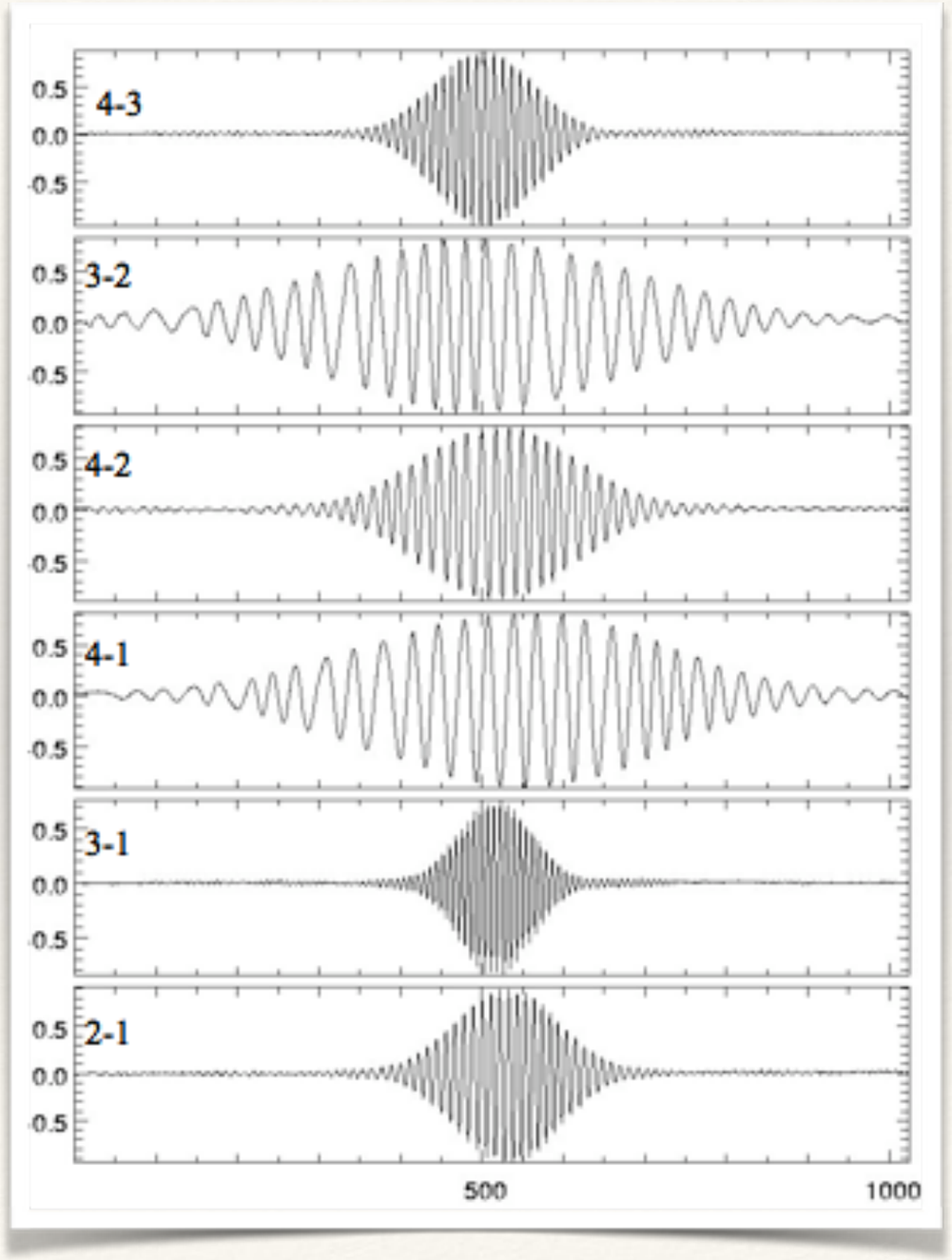
Statistical trends

Absil et al. 2013



Comes PIONIER…

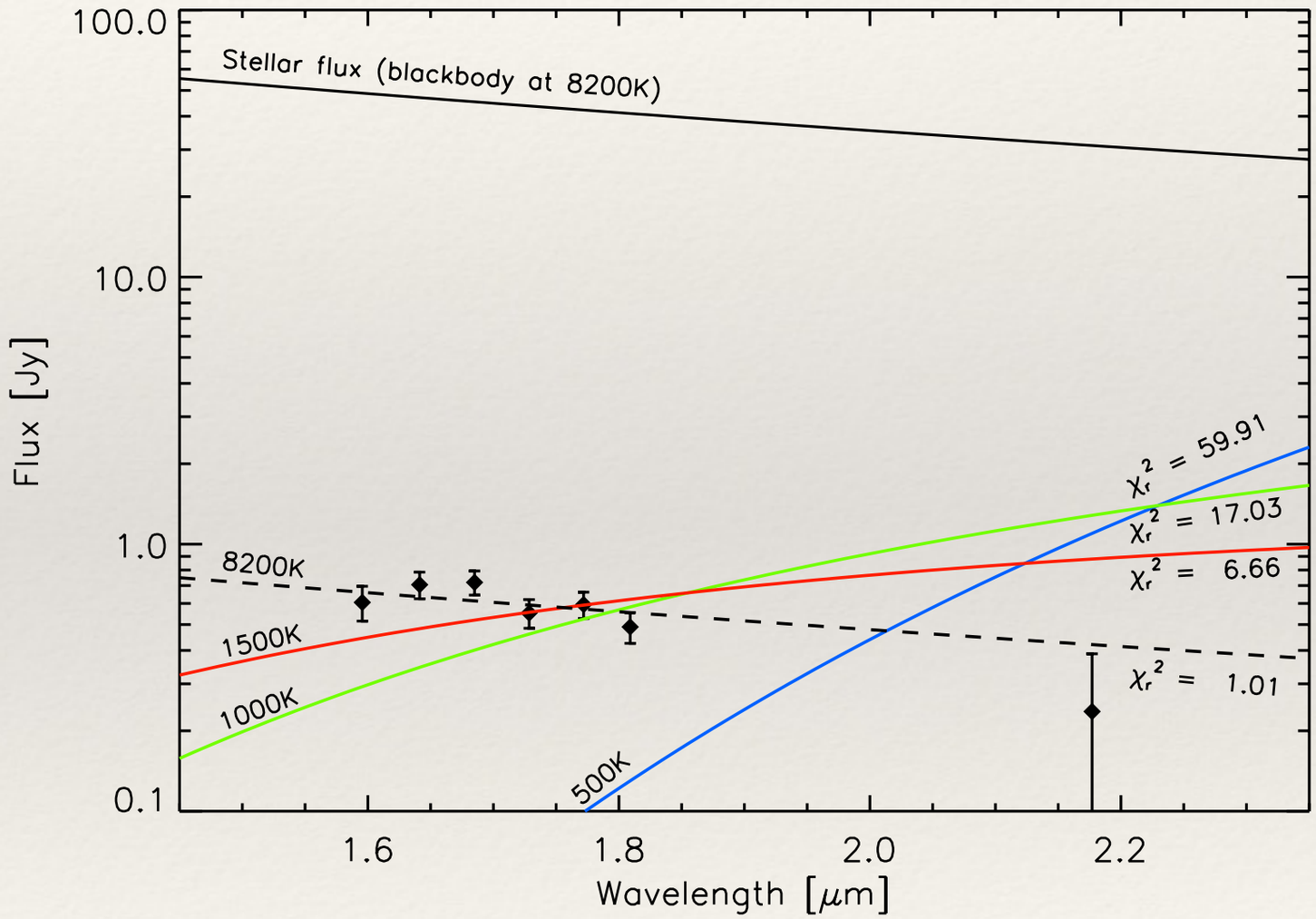
- First high-accuracy interferometer at VLTI
  - Single-mode fibers, fringe scanning à la FLUOR
- 4 telescopes
  → 6 baselines at a time
- Low spectral resolution
- Limiting magnitude H ~ 6 for high accuracy



2011: early results

Defrère et al. 2012

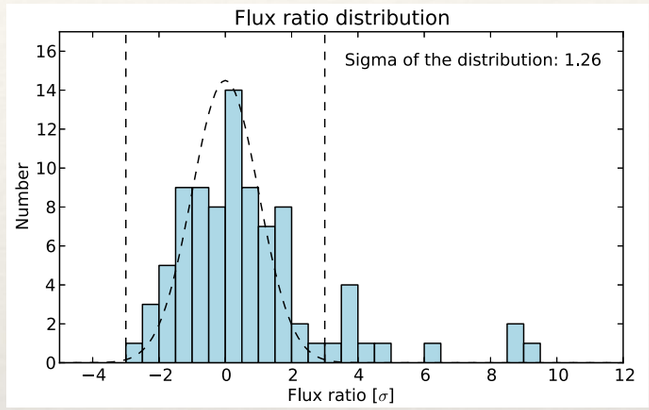
- 3n (GTO)
- Validate PIONIER performance
- Start scientific observations
  - First spectrum of hot exozodi (β Pic)
  - Mostly scattered light?

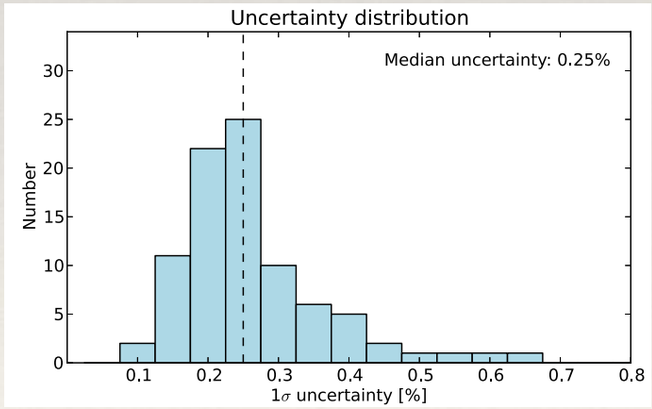


2012: the PIONIER survey

Ertel et al., in prep

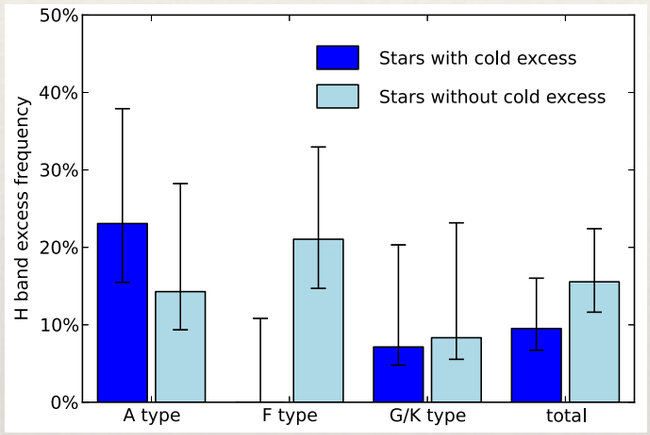
- 4 runs of 3n (GTO)
- 89 stars observed
  - Magnitude-limited at H < 5
  - Same selection criteria as CHARA/FLUOR survey
  - One non-dusty star for each dusty star
  - Avoid « bloated » stars
- Huge gain in observing efficiency wrt FLUOR

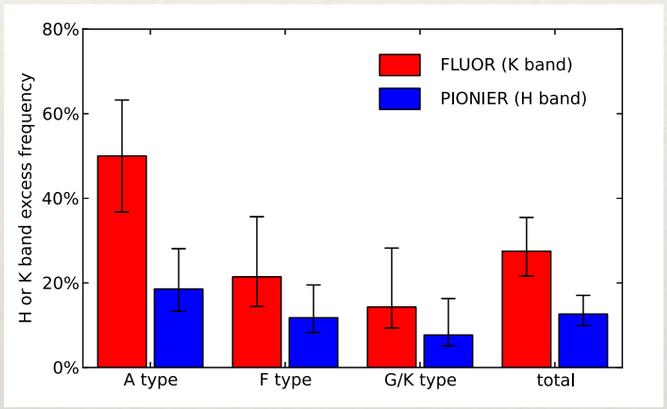




Preliminary survey results

Ertel et al., in prep





Open questions / follow-up

- Colors and physical properties of exozodiacal disks
  - Do H and K bands trace the same phenomenon? (5n in 2013)
  - Connection with « warm » (~300 K) disks? (9n GTO in 2014)
- Origin of hot exozodiacal disks still very mysterious
  - All « standard » dynamical models fail to reproduce their properties and occurrence rate
  - Trapping mechanisms = promising solution
- Are hot exozodiacal disks variable?
  - Variability survey on-going, may shed light on dust origin