# *COAST*
# *Coronagraphic Off Axis Space Telescope*

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# Mission philosophy

The utlimate goal of exoplanetology is the search for life on exoplanets.

For a better characterization of exo-lifes, it is necessary to have a good knowledge of their environmental conditions.

COAST: Precursor to:

- Darwin/TPF science
- TPF-C science and technology

# Science goal

Physical characterization - understand how planets work:

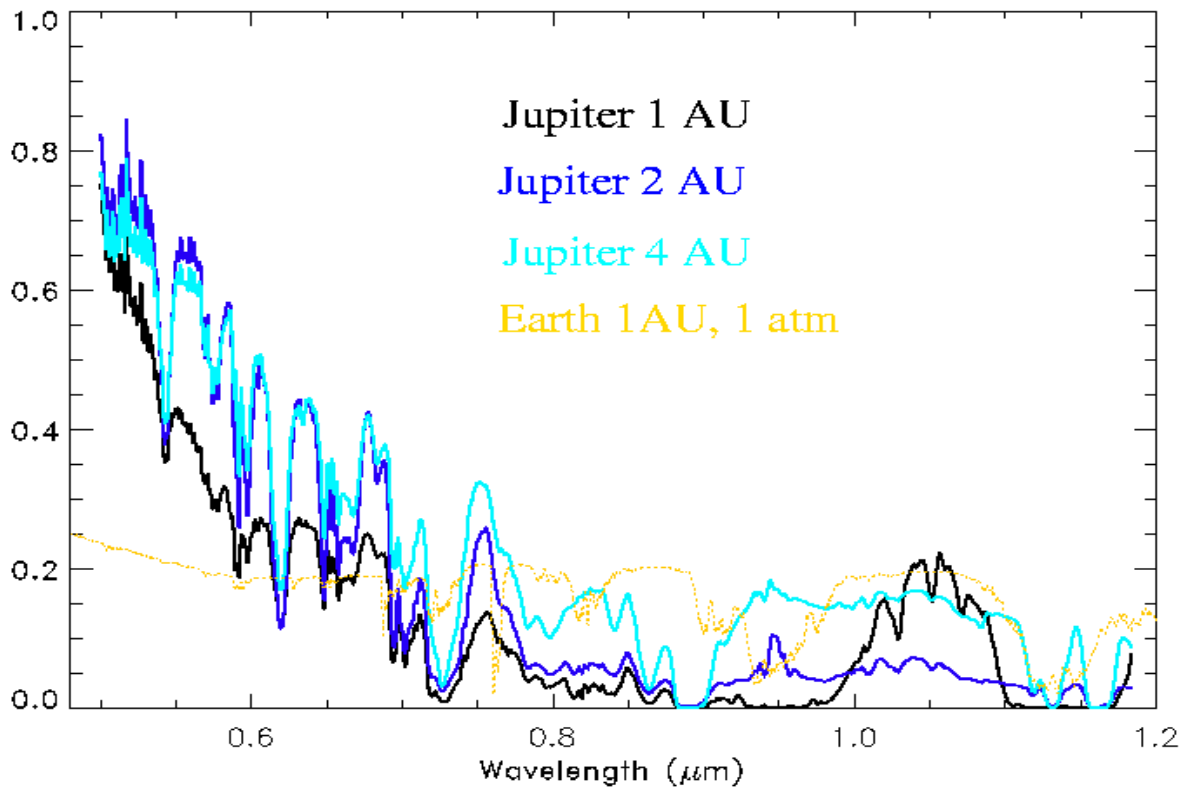
- Atmospheric gas: composition, density, ..
- Clouds: opacity
- Variabilities (seasonal, random)

# Science goal

$$F_{pl}(\lambda)$$

## Jupiter-like planets

Detection of cold giant planets (> 1 AU and < 5AU) around nearby stars



# Science goal $F_{pl}(\lambda)$

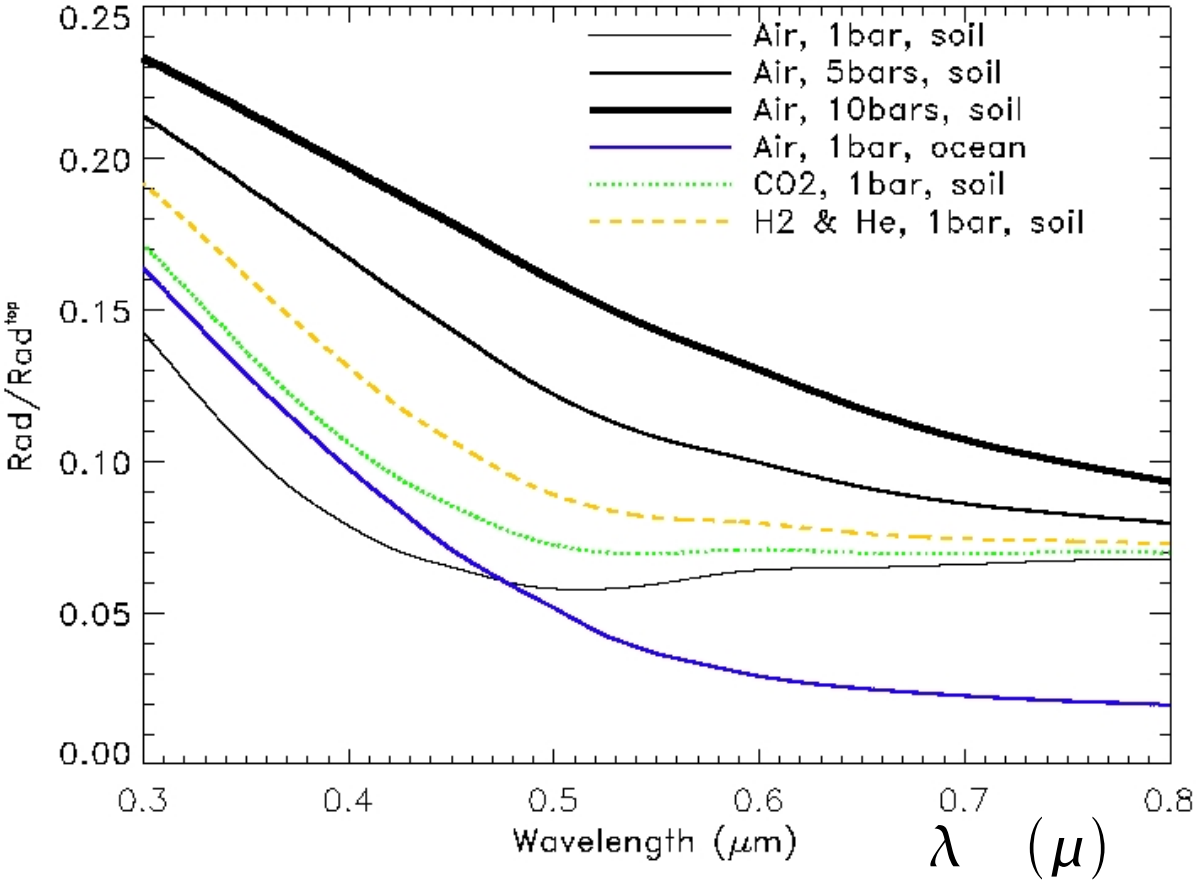
## Atmosphere transparency and clouds

Size parameter ~ a/λ

where *a* from $10^{-4}$ μ
to ~ 100 μ

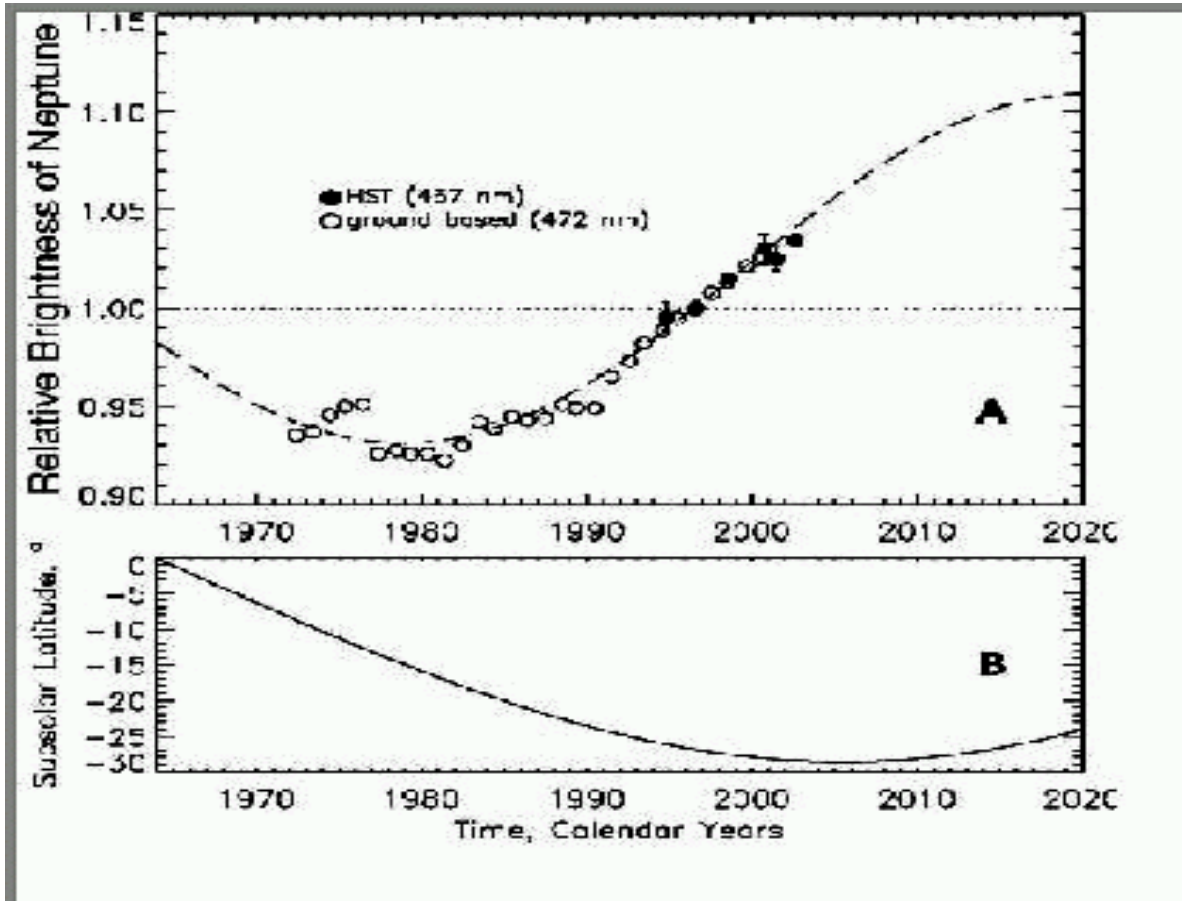
==>

Pressure, surf. reflectivity



# Science goal $F_{pl}(t)$

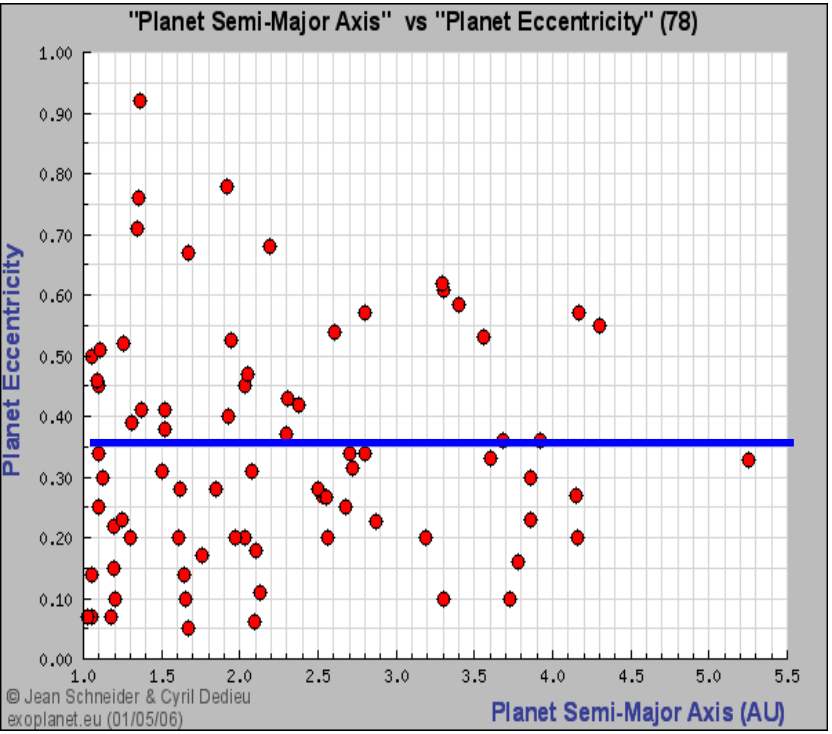
« Climat » variation: example of Neptune



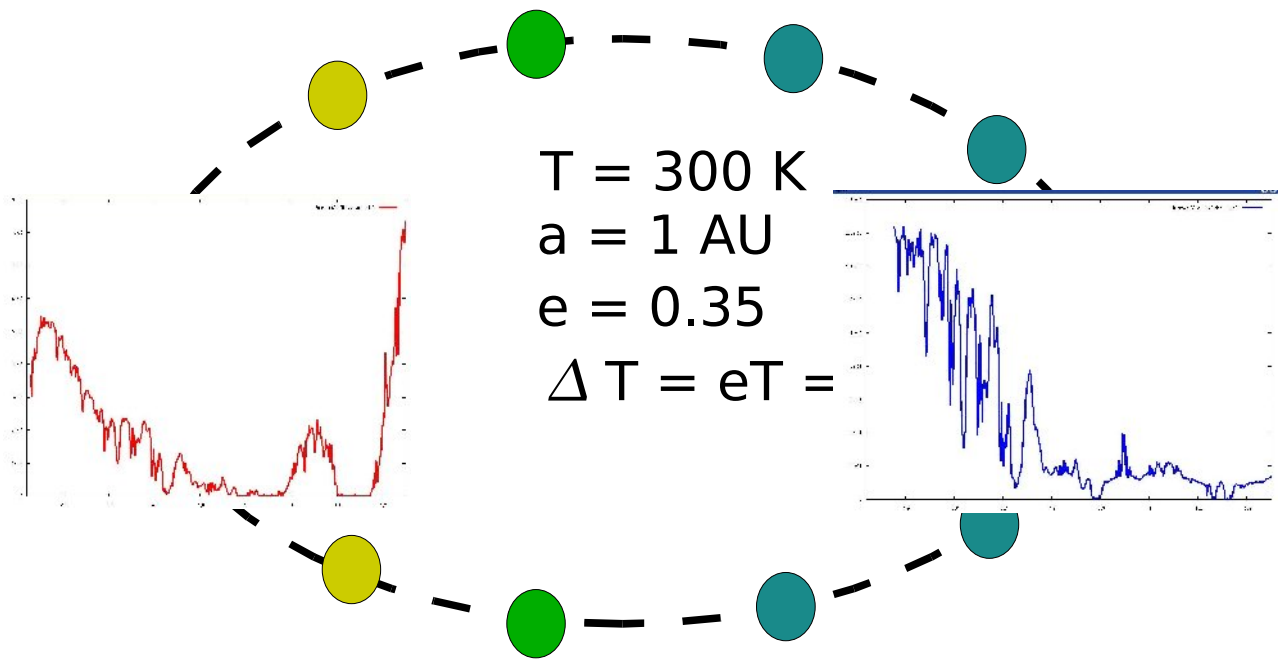
# Science goal

$$F_{pl}(t)$$

50 % of orbits have an eccentricity > 0.35



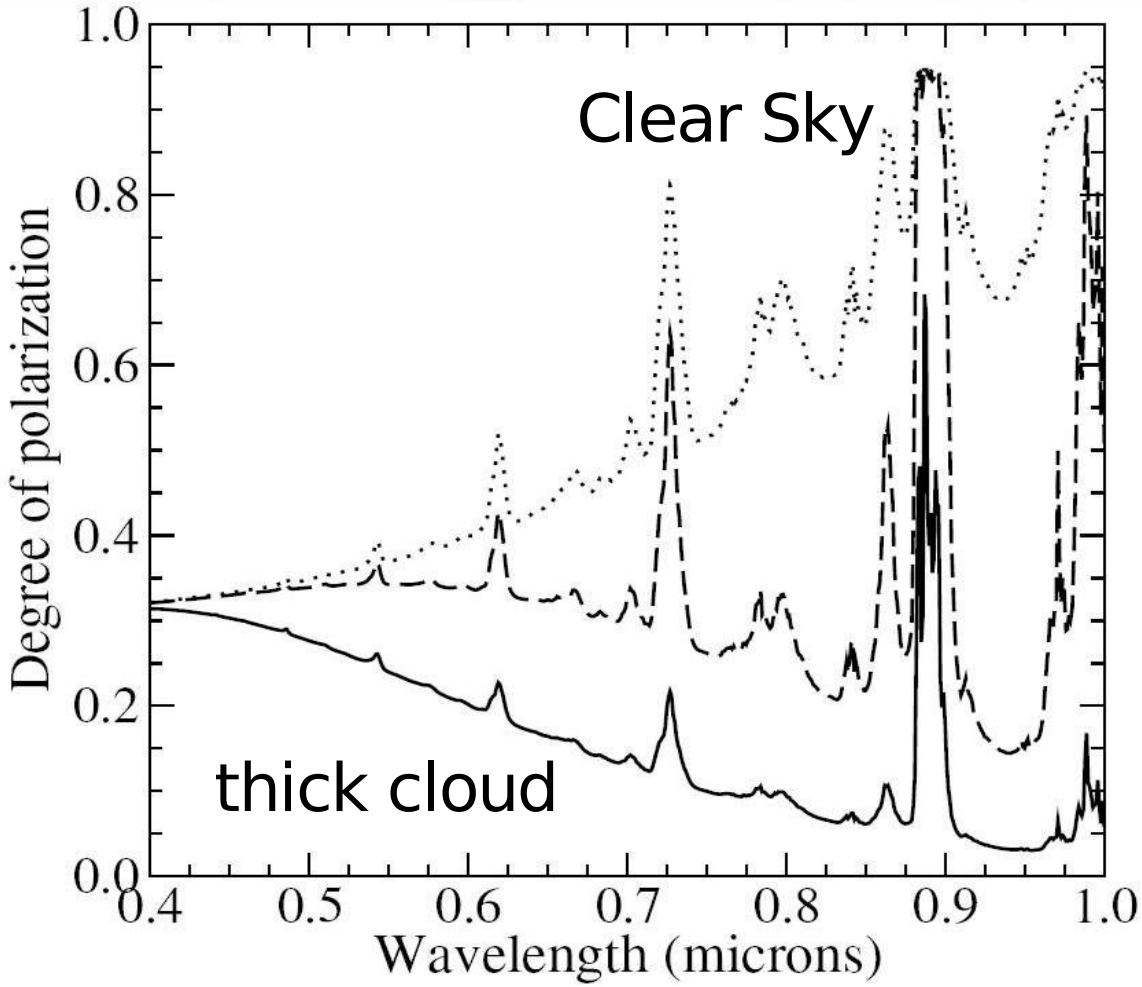

Time variation of the spectrum along the orbit



# Science goal

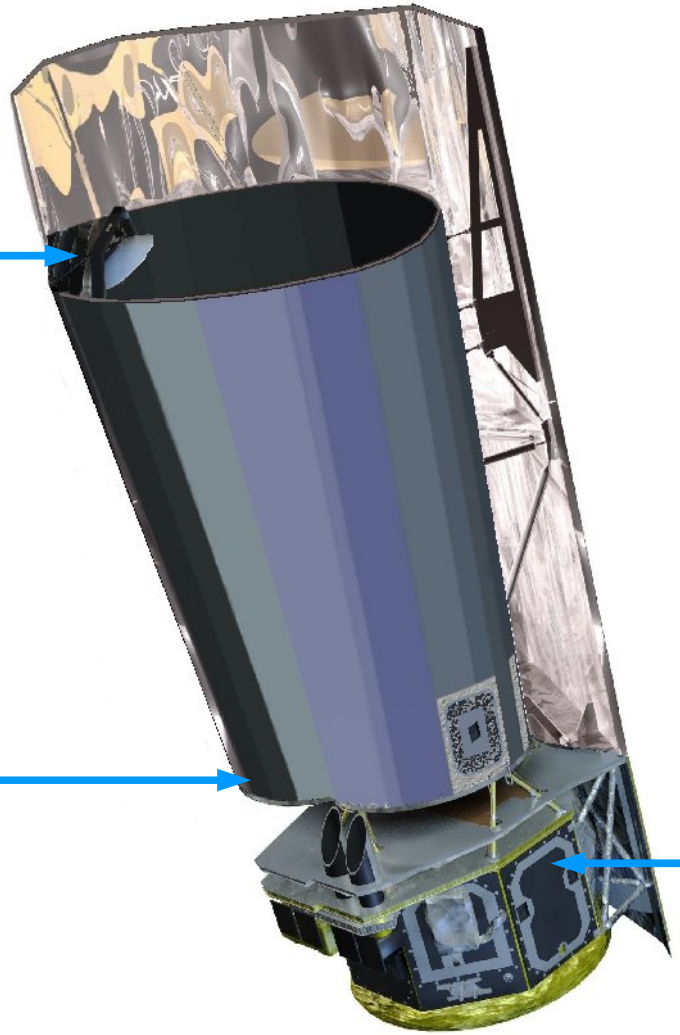
$$F_{pl}(\vec{P})$$

Jupiter at 1 AU (orbital phase 90°)



# Payload Concept:
# Coronagraphic Off-Axis Telescope
# COAST

Secondary mirror
( $\phi = 0{,}35$ m )



Primary mirror
( $\phi = 1{,}5$ m )

Electronics and
instrumentation

# Spacecraft philosophy

Visible off-axis Telescope

1,5 m in diameter

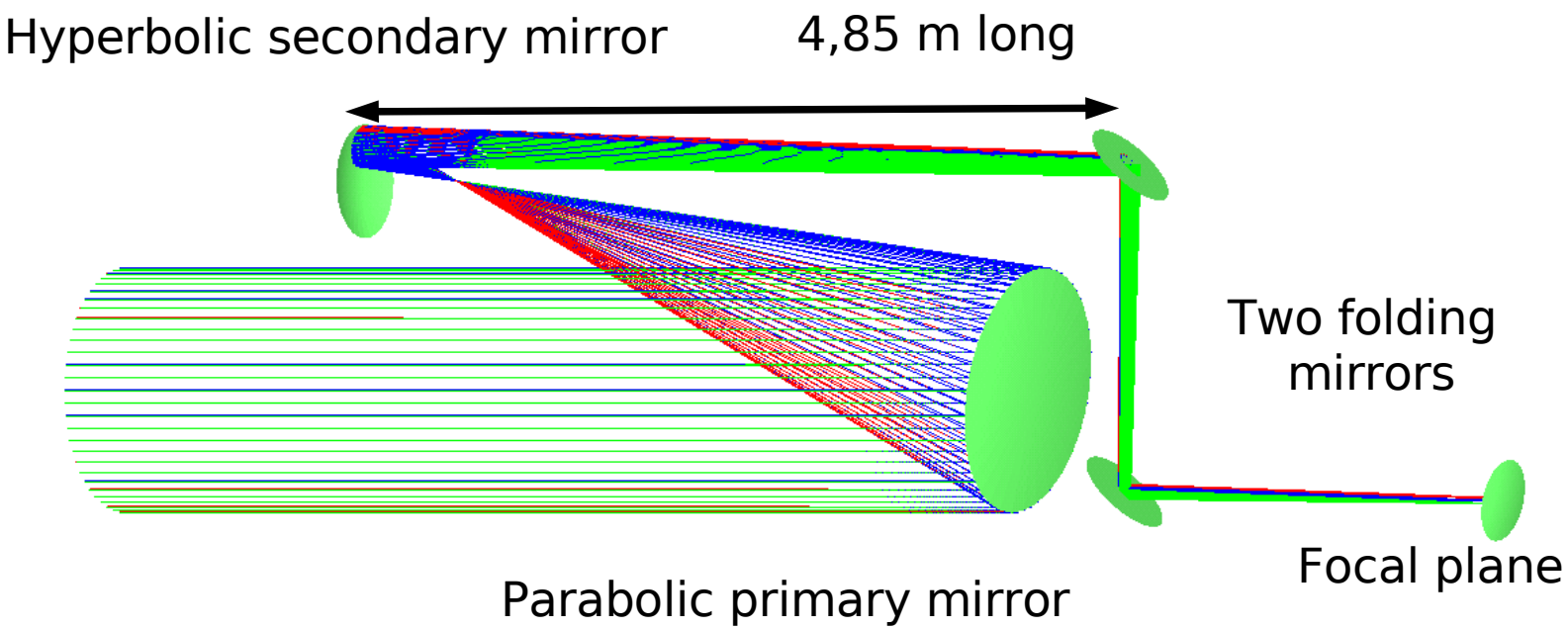
Optimized for High contrast imaging (Coronagraphy)

Ultra-smooth mirror ( WFE $\lambda$/100 rms @ 633 nm )

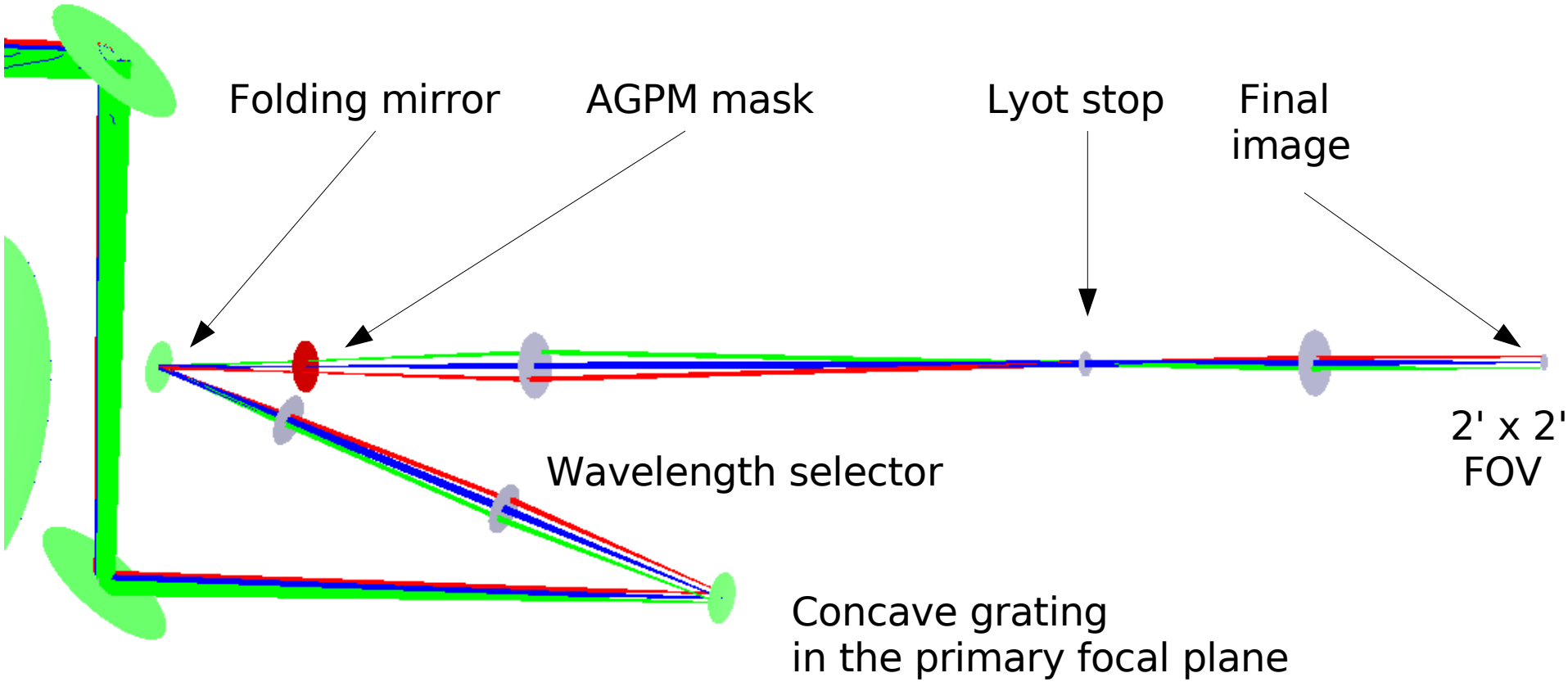
<u>No active correction</u>

Low resolution spectroscopy

# *Optical Concept (I)*



# *Optical Concept (III)*
# *example with the AGPM coronagraph*




Phase-Mask coronagraphs: FQPM / AGPM / PKC / Apodized ...



The HRCC camera possesses three wavelength bands

# *Instrument (I)*

| | HRCC<br>( High Resolution Coronagraphic Camera ) |
|---|---|
| Spectral Coverage<br>Detector Size<br>Type<br>Dynamic<br>Qe | 500 – 1000 nm<br>1 – 2048 x 2048<br>CCD (red – 16 bis)<br>$10^5$<br>~ 85% |
| | |
| FOV<br>IFOV<br>Angular resolution | 17'' x 17''<br>34 mas<br>68 mas |
| | Phase-mask coronagraphy |
| Readout noise<br>Dark current | 1 e- / Photon counting<br>10 e-/h |

The ***HRCC*** camera (Phase-Mask coronagraphy)
- option 1: near-IR channel (1-1.4 μm)
- option 2: blue channel (0.4-0.6 μm)

# *Optical Concept (II)*

## *Manufacturing accuracy:*

- ✔ GOAL: $\lambda/100$ rms @ 633 nm → **~$\lambda/200$ rms** per mirror
- ✔ Challenging but already demonstrated for VIRGO mirrors (diameter 15 cm)
- ✔ Ion-beam figuring (high accuracy – *CSL-AMOS* )
- ✔ Need refinements of metrology techniques (direct nulling)

## *Tolerancing:* active secondary+ tip-tilt mirror

# How to deal with Wave Front Errors ?

## Active correction or Speckle calibration ?

The main speckle limitation is the phase retrievial accuracy
(e.g. by S.-H.)

- Both for AO system of calibration in the final coronagraphic image

- COAST choice: final calibration in the final coronagraphic image:

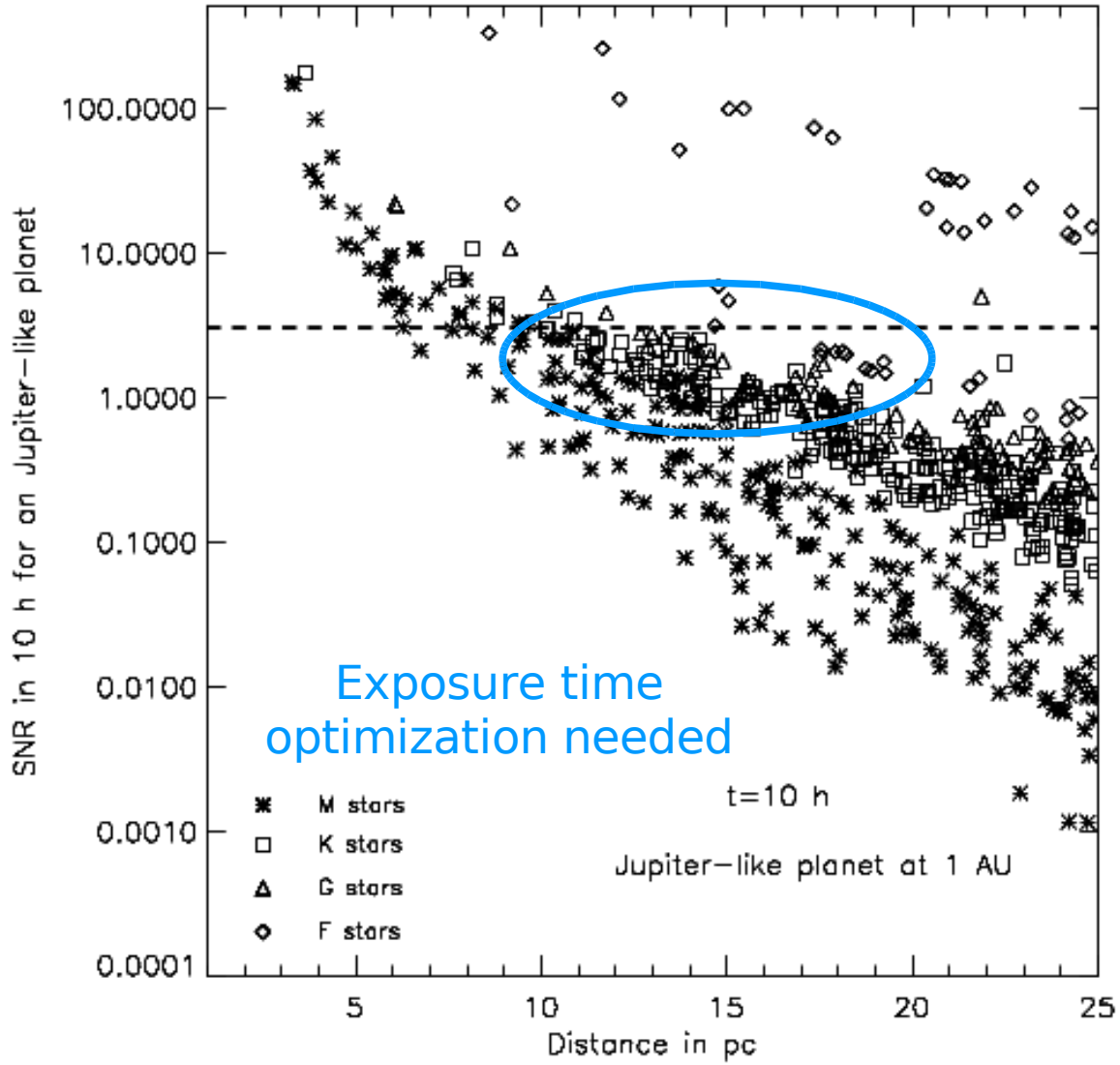
  - More throughput than AO system
  - Some optical schemes exists: multi-wavelength imaging , Zimpol

  - if the speckle realization is faster than 1 minute,
    it seems to be more accurate to use AO system.

- The case of L2-orbit allows high stability (low speckles)

**Open issue:** in the case of $10^{-10}$ level , what the speckle coherence time ?

# Results of CoastSim



# Present status

- To be submitted to ESA «  Cosmic Vision  » call for mission
- Launch forseen for 2016