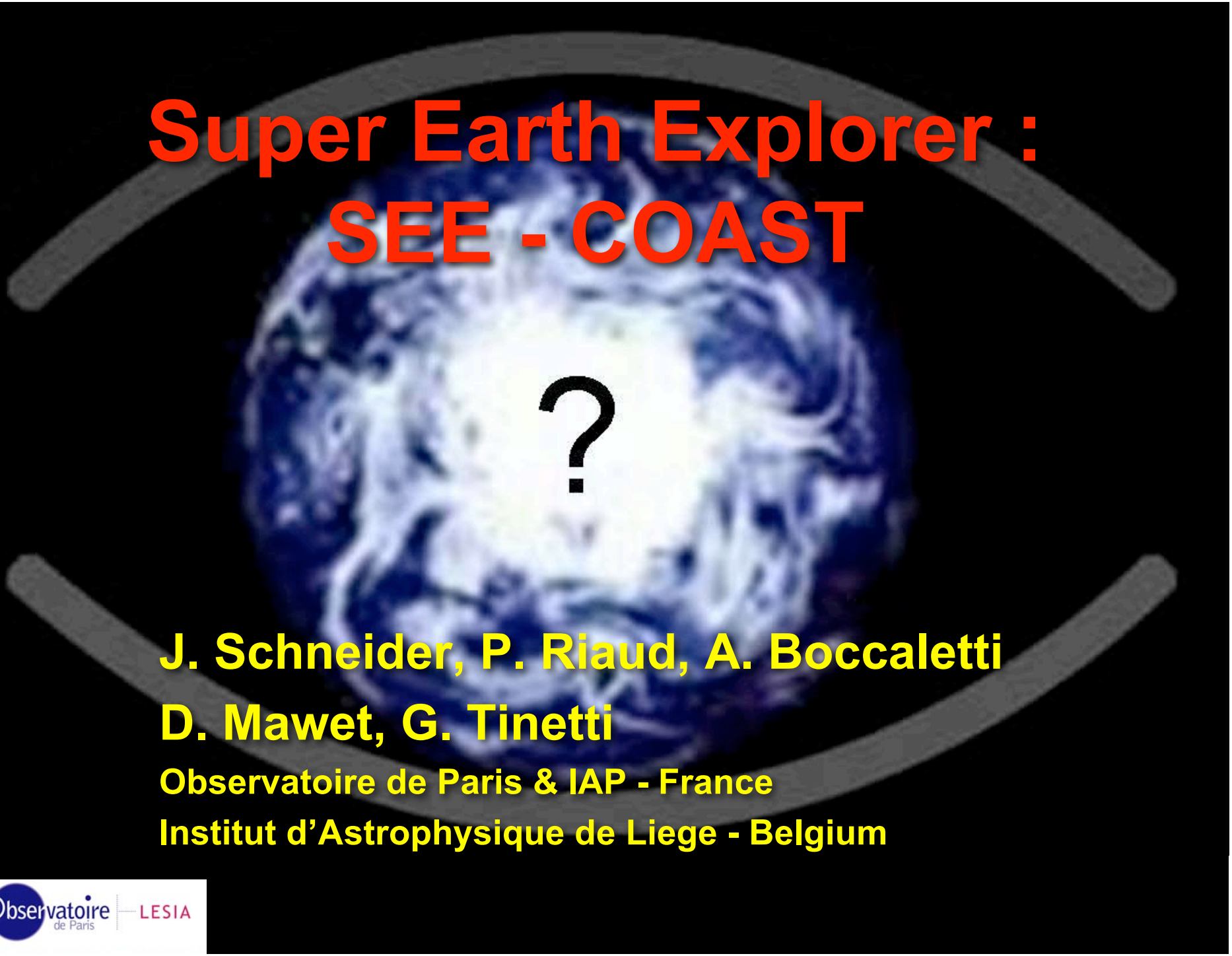
Super Earth Explorer : SEE - COAST



J. Schneider, P. Riaud, A. Boccaletti

D. Mawet, G. Tinetti

Observatoire de Paris & IAP - France

Institut d'Astrophysique de Liege - Belgium

l'Observatoire de Paris LESIA

Cosmic Vision

Cosmic Vision is the ESA roadmap for 2015-2025

- call for proposal in early 2007
- several mission class (Astrophysics, Solar System, Fundamental Physics) :

  - medium : < 300M€ - launch 2018
  - large : < 650M€ - launch 2020
  - xlarge : > 650M€ - launch >2020 (+ other space agencies)

- proposal submission by June 2007
- down-selection by the end of 2007 (3 M missions out of 40)
- assessment phase by ESA in 2008
- 2009 : 2M missions out of 3
- definition study 2009 - 2010
- 2011 : 1M mission out of 2
- launch (medium class) : 2018

<u>Exoplanet proposals (main ones) :</u>

- Pegase (technology demonstrator, 2/3 spacecrafts) : medium class
- PLATO (improved CoRoT) : medium class
- DARWIN (4/5 spacecrafts) : xlarge

=> room/need for a scientific precursor to DARWIN : SEE-COAST

SEE - COAST management

SEE-COAST stands for :

Super Earth Explorer - Coronagraphic Off-Axis Space Telescope

- **a scientific precursor to DARWIN**

- **a technological precursor to TPF-C**

PI : J. Schneider (Obs. Paris)

A large European consortium :
(France, Belgium, Switzerland, Italy, Nederland, UK, Germany)

ULg / CSL / LESIA / LUTH / LUAN / ETH-Zurich / IAP / Obs. Geneva
U. Bern / UCL / ROE / U. Hertfords. / MSSL / SRON / Astron / U. Utrecht
LAOG / ONERA / DLR / U. Vienna / U. Nantes / U. Torino

International Collaboration : JPL, CSA

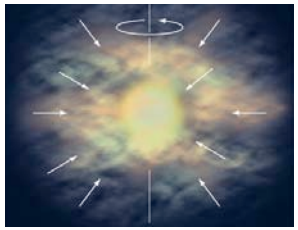
contact Jean.Schneider@obspm.fr

Philosophy and Science Goals

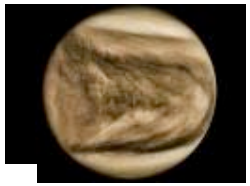
The ultimate goal of exoplanetology is the search for life on exoplanets

There is no reliable biosignature without a good physico-chemical characterization of the planet: the goal for SEE-COAST

Main objectives :
- Jupiter-like planets,
- exo-zodiacal disks,
- Super-Earths around nearby stars

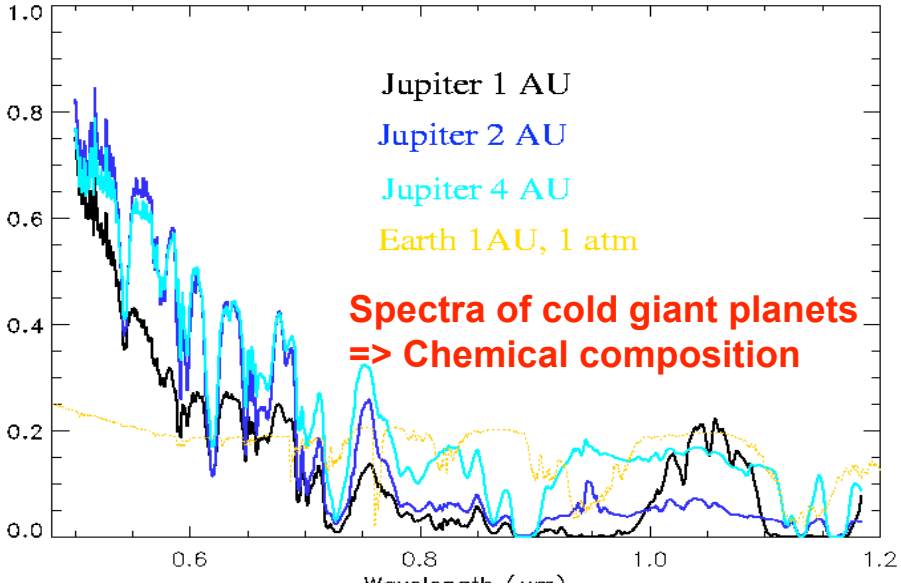


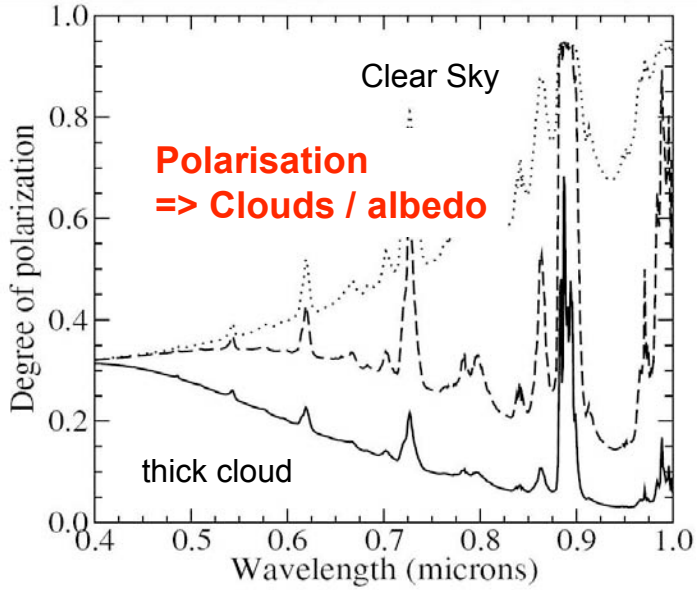
Explore diversity of planets in 0.4 - 1.2μm:
- atmospheric composition, clouds, (spectra)
- atmospheric pressure : (Rayleigh scat.)
- albedo & internal structure
- surface conditions (colour, inhomogeneities)
- polarization
- variabilities (seasonal, random)
- surroundings (rings, companions)

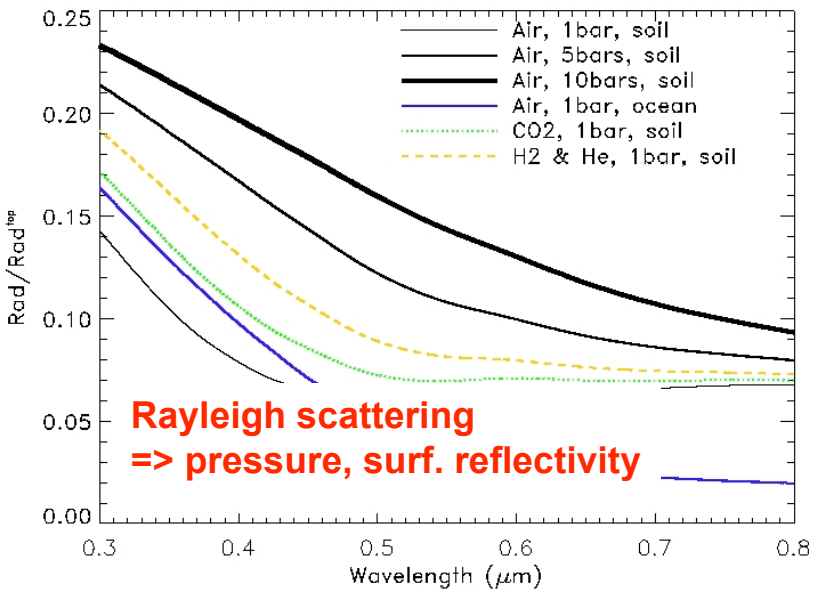


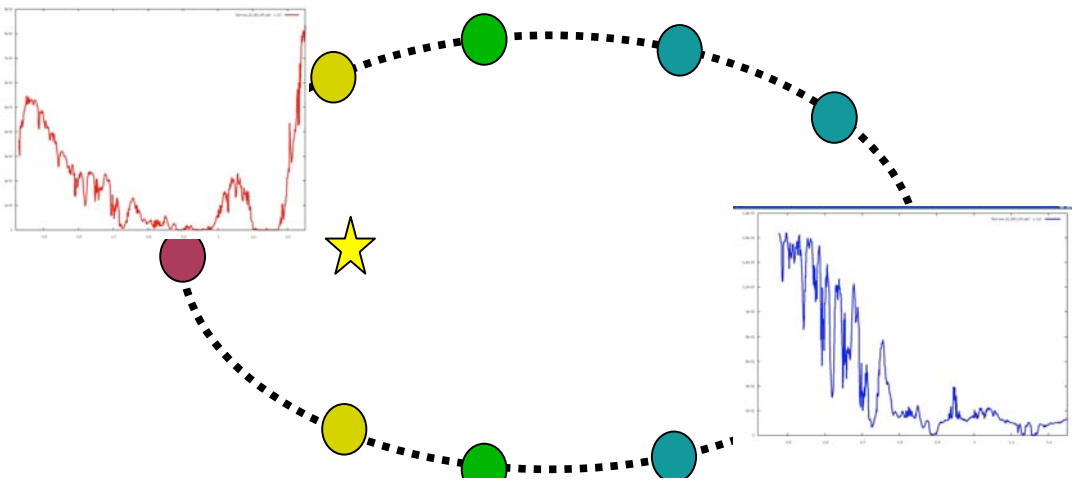
=> not feasible with : SPHERE/GPI, JWST, ELTs ?

Jupiter like planets





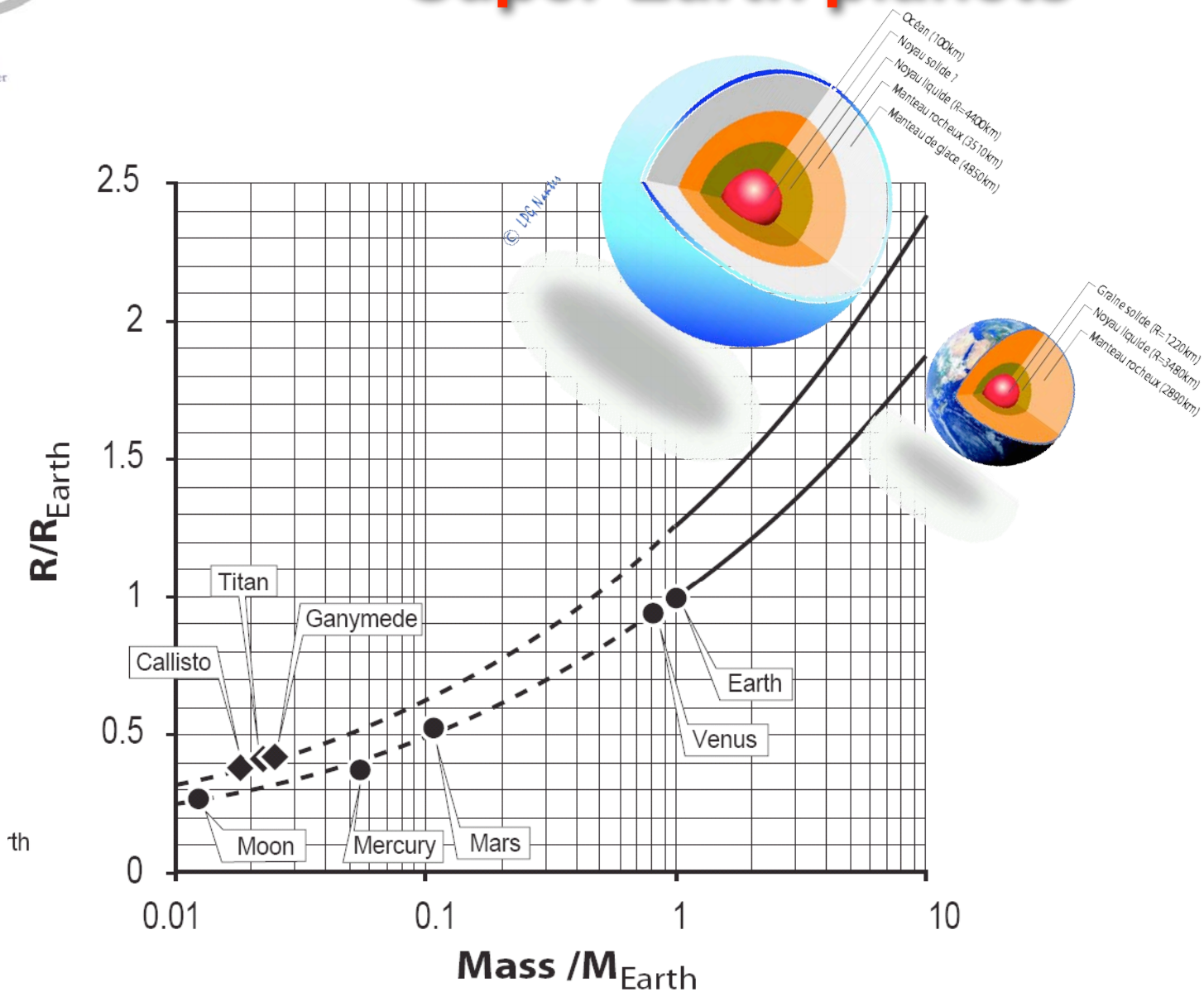




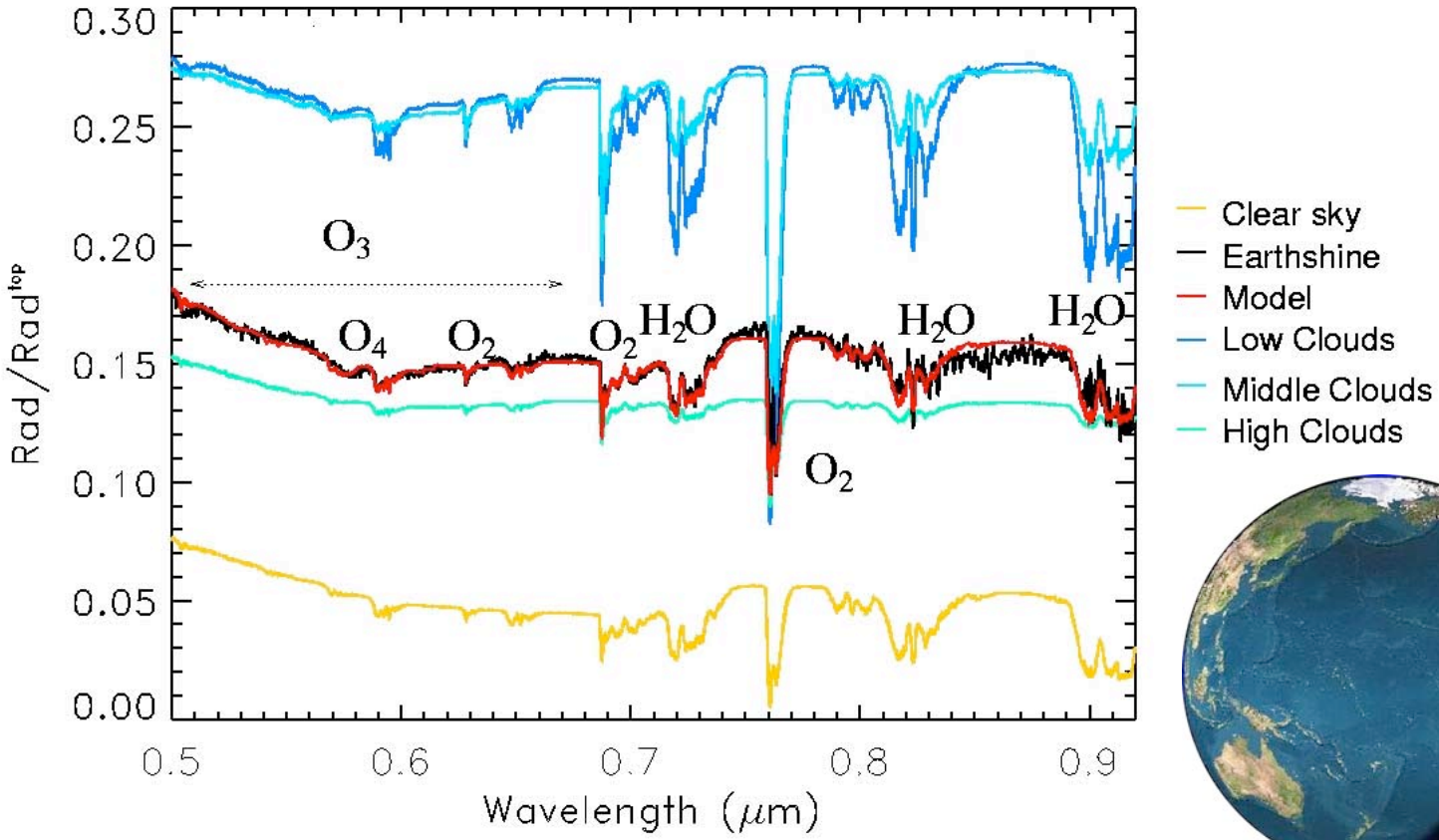
Time variation
=> variation of temperature

erkeley, 2007

Super Earth planets



Super Earth planets



from Woolf et al. (2002) and Tinetti et al. (2006)

Mission concept

Visible off-axis Telescope @ L2

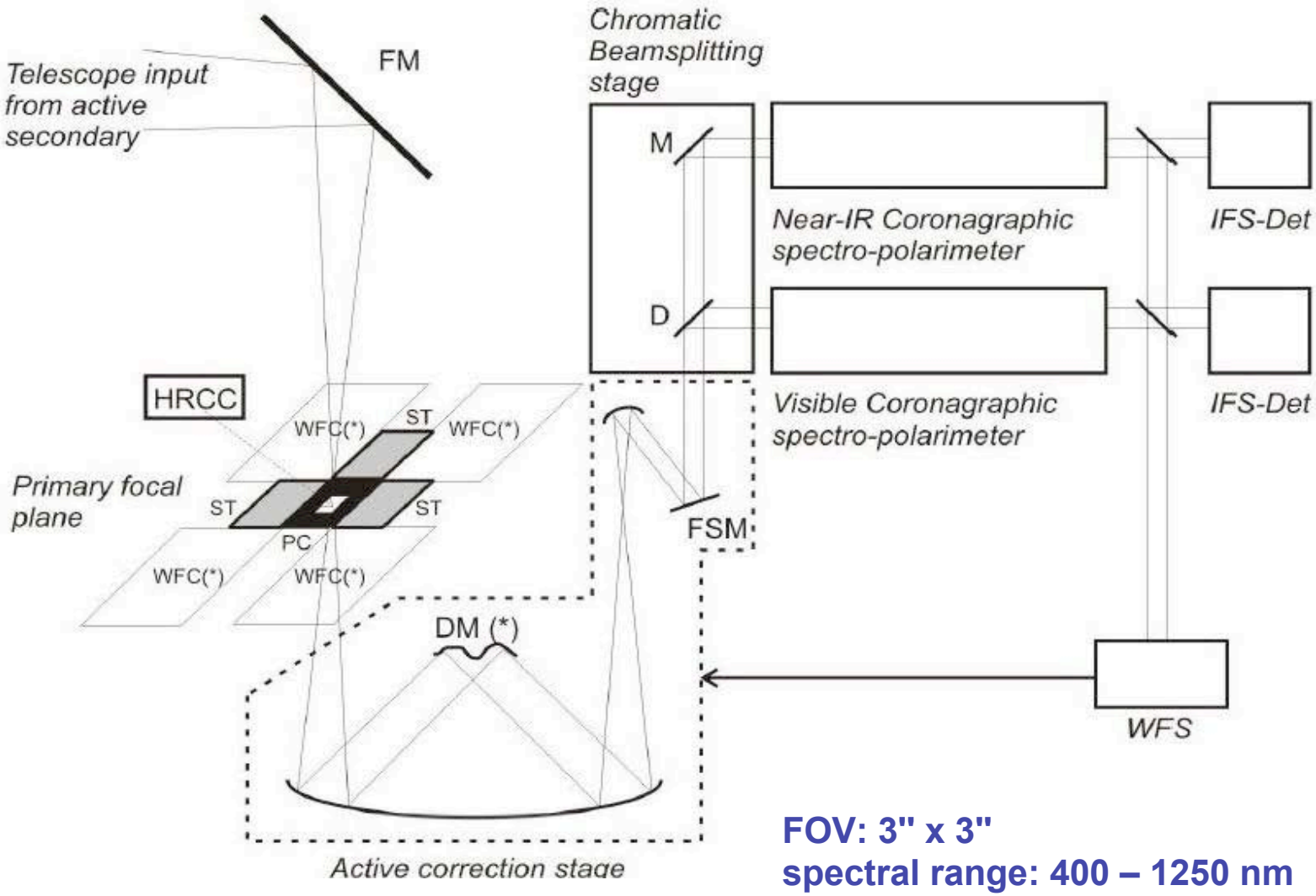
1,5 m in diameter (as a minimum)

Optimized for High contrast imaging

Ultra-smooth mirror (WFE $\lambda/100$ rms @ 633 nm)
+ calibration (differential imaging)
+ active correction

Low resolution spectroscopy and polarimetry

Scientific Payload

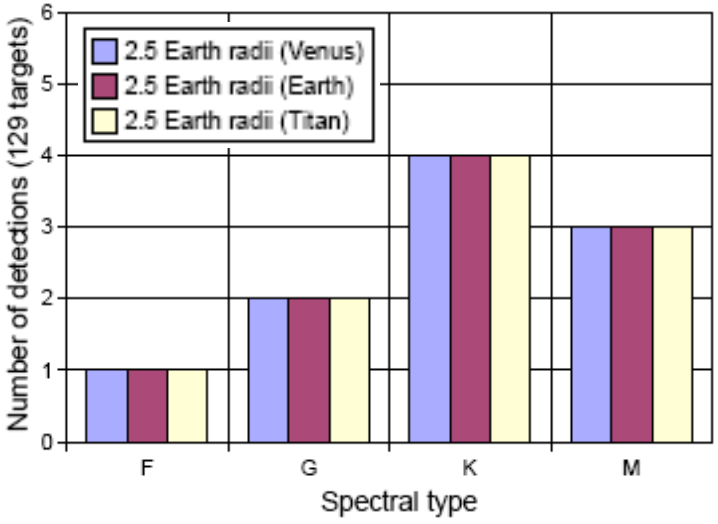


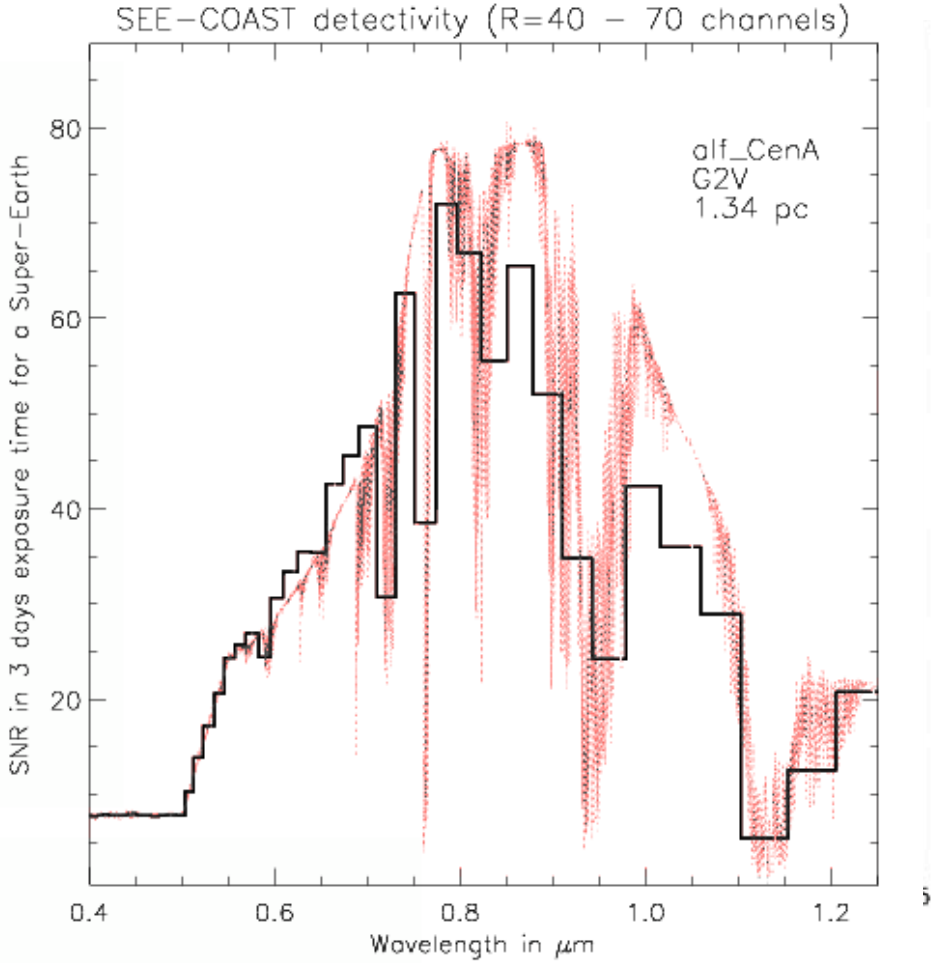
FOV: 3" x 3"
spectral range: 400 – 1250 nm
spectral resolution: 40

Performance estimates

Preliminary simulations :

- > 600 targets considered (FGKM)





=> a few Super Earths potentially detectable

Conclusions

Challenges :

- super-polished mirror (λ/200 rms)
  - already achieved on EUV mirrors (ø 40cm)
  - Ion Beam figuring
  - development for Eclipse
- Active control with DMs (Trauger et al.) => feasibility in space

Key technologies :

- Achromatic coronagraphs
  - . Zero Order Gratings : 4QPM and AGPM in development for SPHERE (see poster by D. Mawet)
  - . attenuation of 10^5, R=2 achieved with a proto. (talk by P. Baudoz)
- Integral Field Spectrograph (heritage of SPHERE / GPI)
- differential polarimetry (heritage of SPHERE)

Complementary to :

- SPHERE / GPI (2010-2011) : giant planets (>1M_J), very young or nearby. NIR
- JWST NIRCAM / MIRI (2013) : older giant planets (T>300-400K). NIR & MIR
- ELTs (>2016-2018) : giant planets to rocky planets (super Earths) : NIR

US collaboration is mandatory ! (primary mirror, active correction, …)