Belgium and the EchO and SPICA space missions

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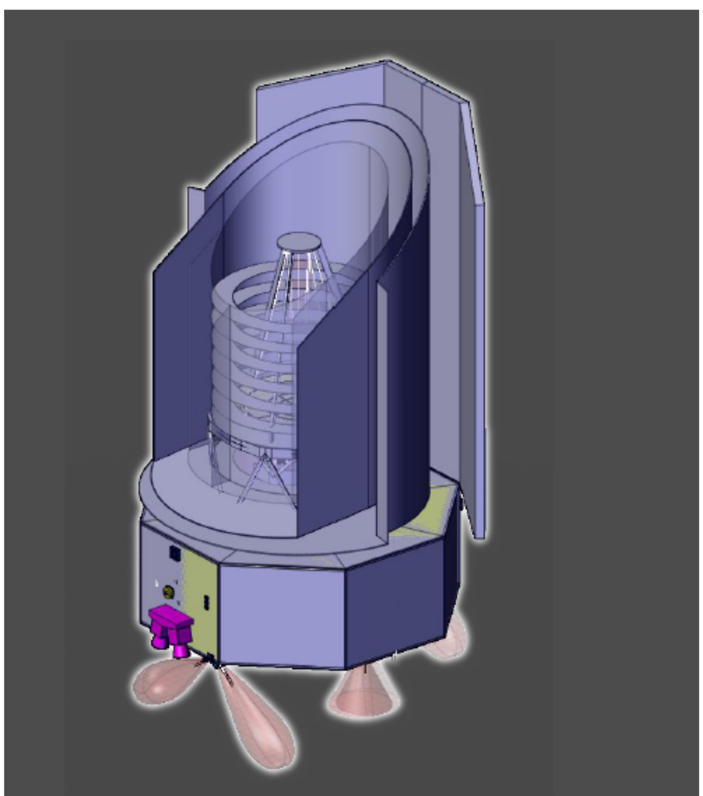
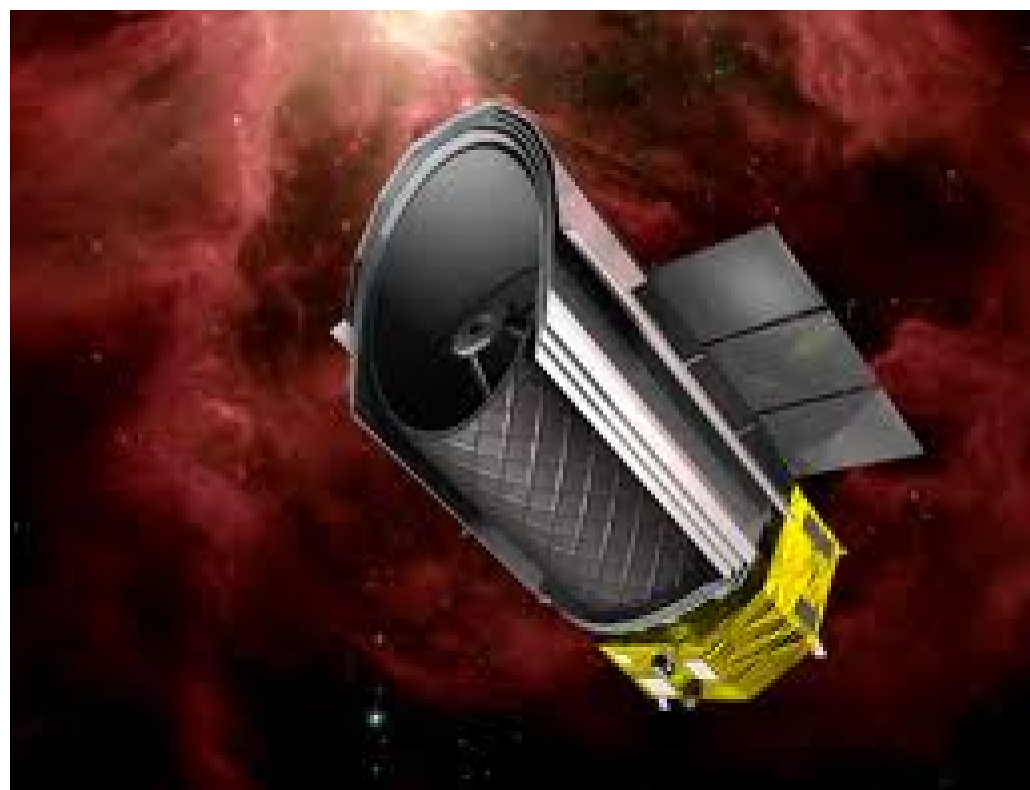
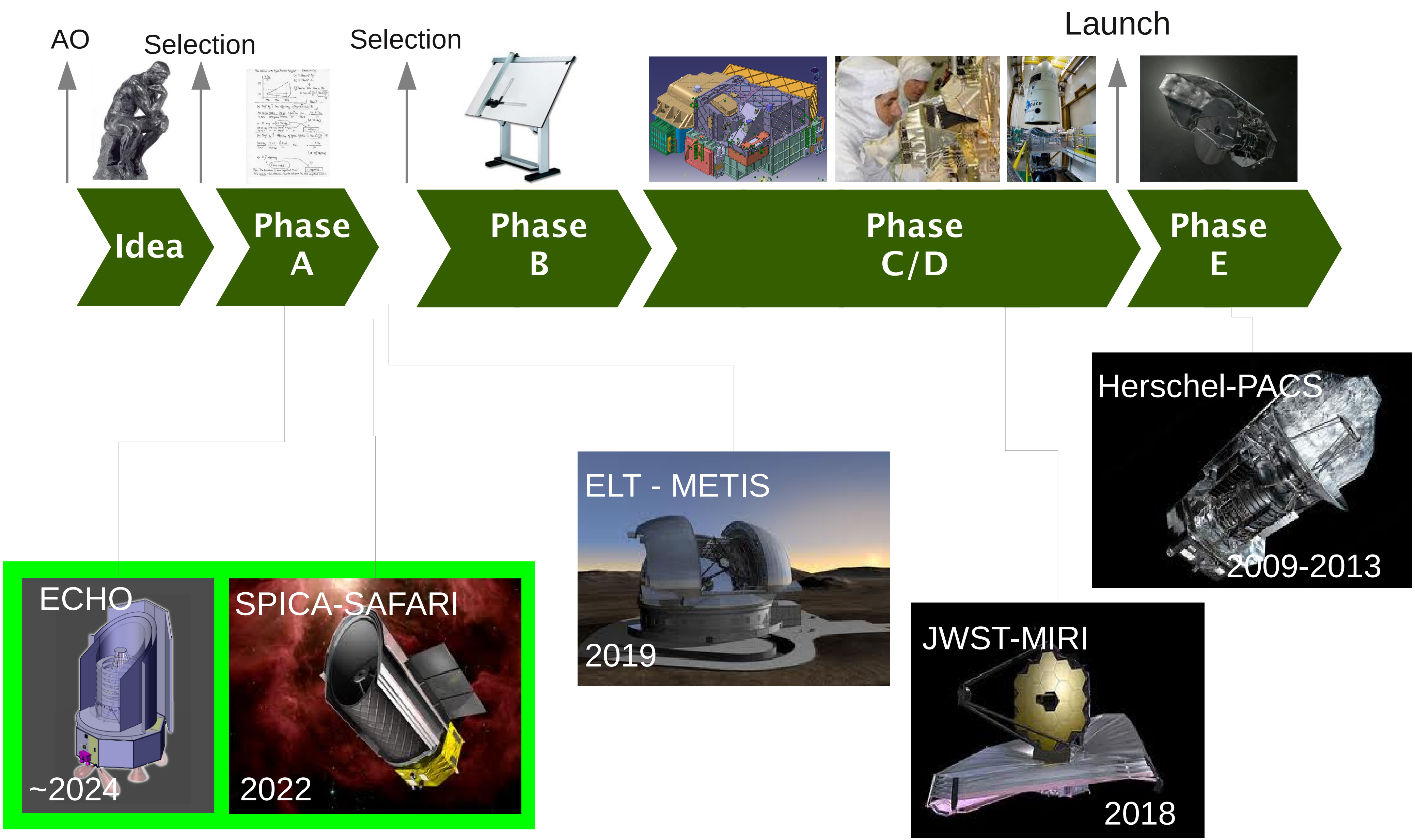
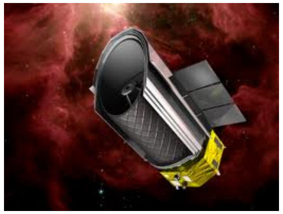


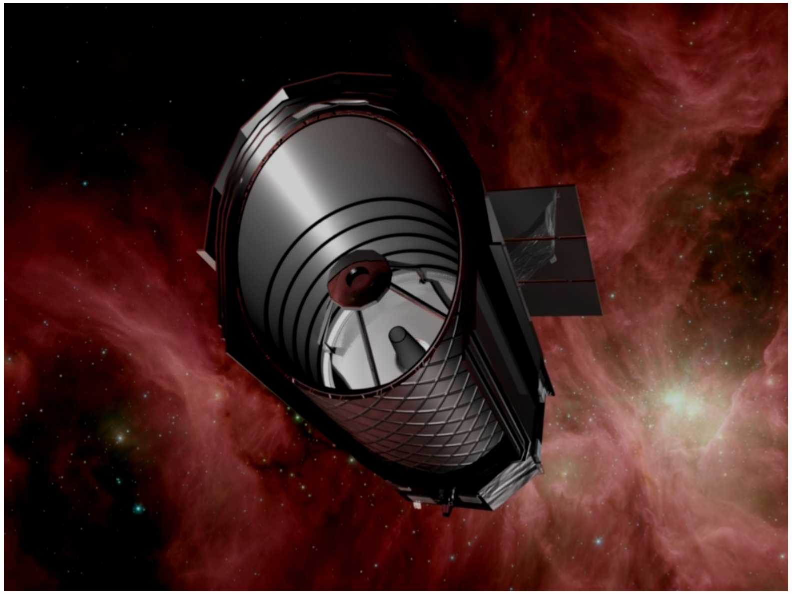


The big infrared observatories - timeline

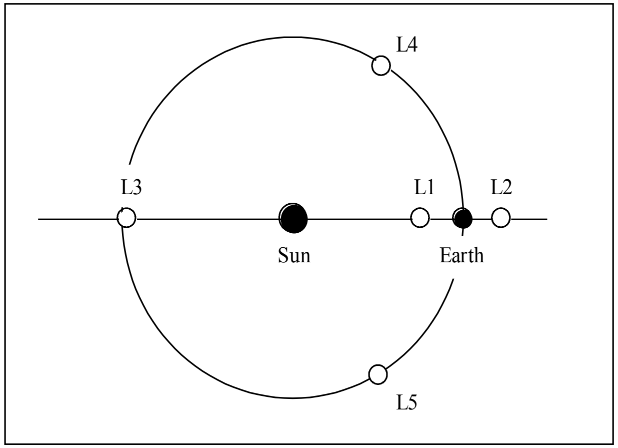


SPICA – overview

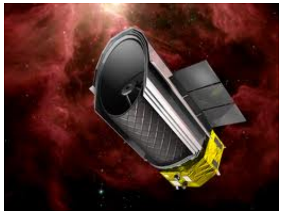




- Scientific objectives
  - Formation and evolution of galaxies
  - Planetary formation processes
- Telescope: 3.2m , cooled to 6K
  - Superior sensitivity
- Core wavelengths: 5-210um
  - MIR-instrument
  - Far-infrared instrument (SAFARI)
- Orbit: Sun-Earth L2
- Mission life 3 years nominal, 5 years goal
- Weight 3.7 tonnes
- International mission: Japan, Europe, Korea, Taiwan

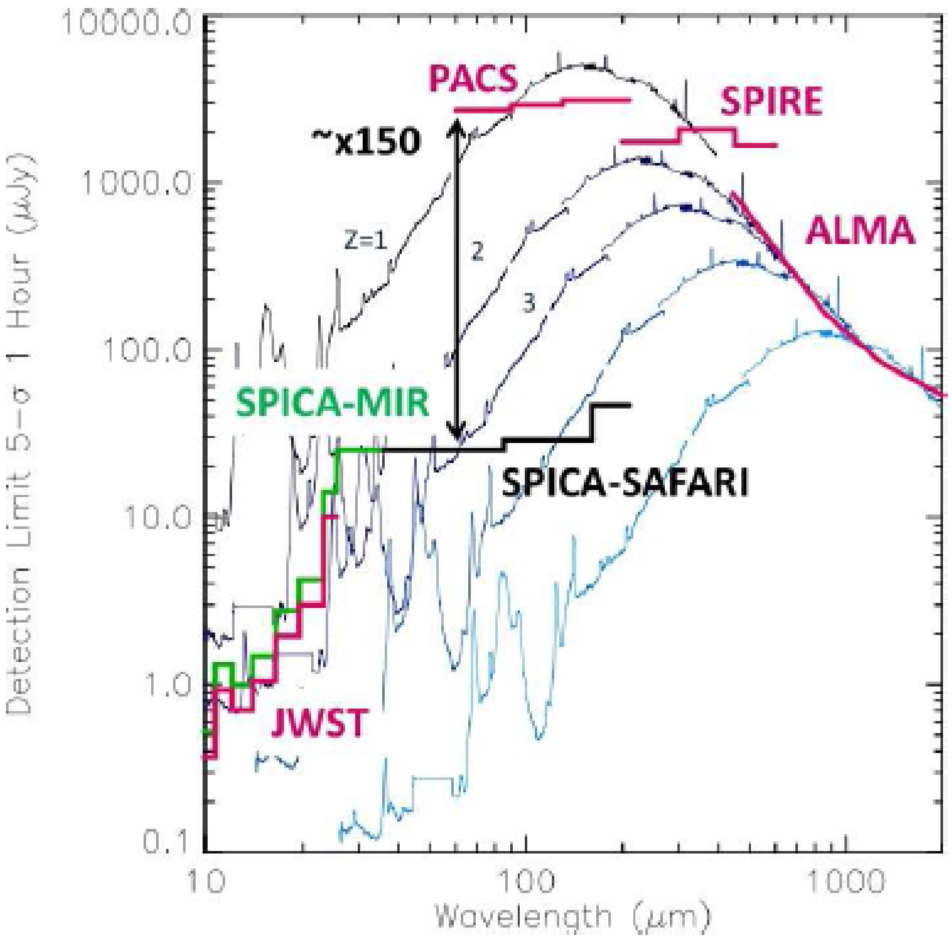


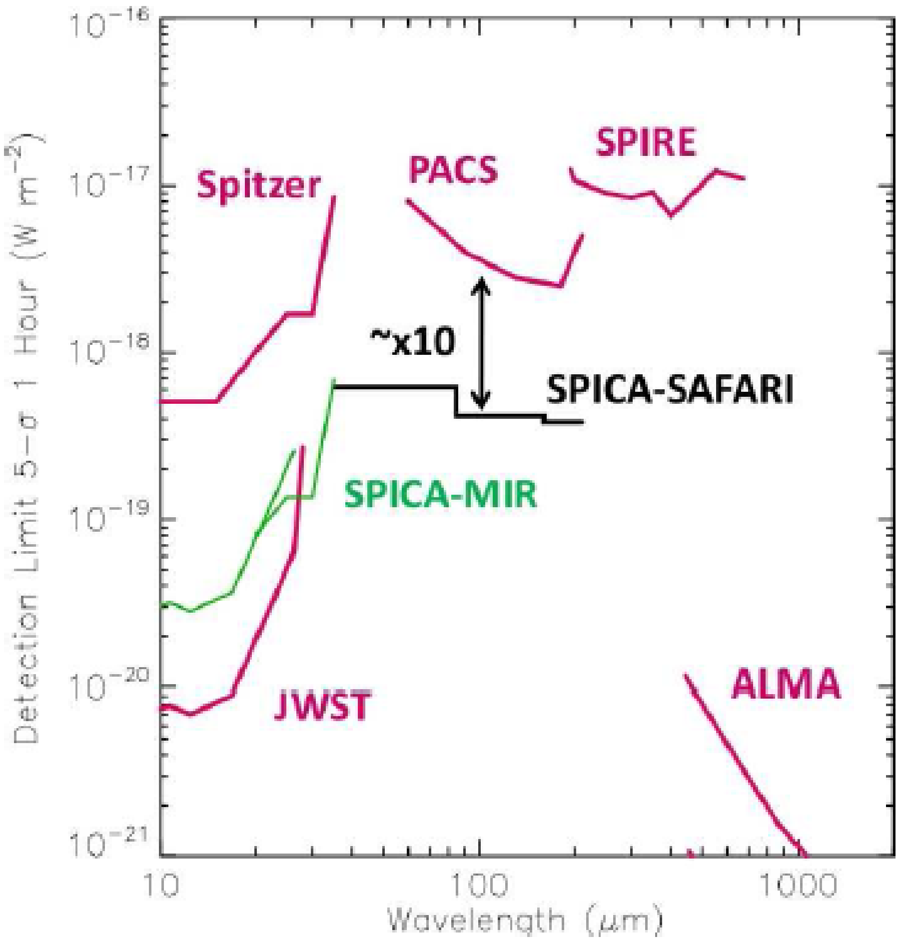
SPICA – the next far-IR mission



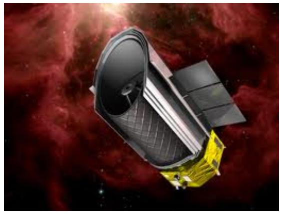
SPICA (< 5 K) → "Cooled Herschel":

- Much lower background → deep spectroscopy possible
- Closing the far-IR gap in the JWST – ALMA sensitivity ballpark

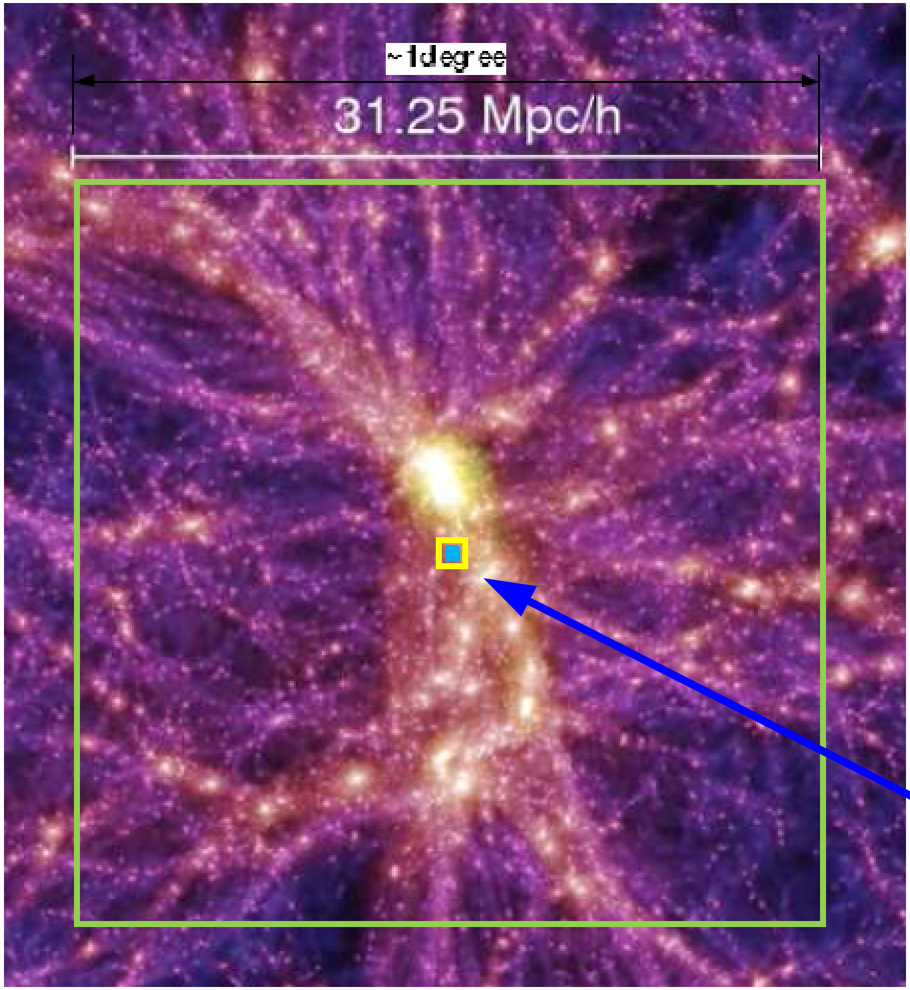




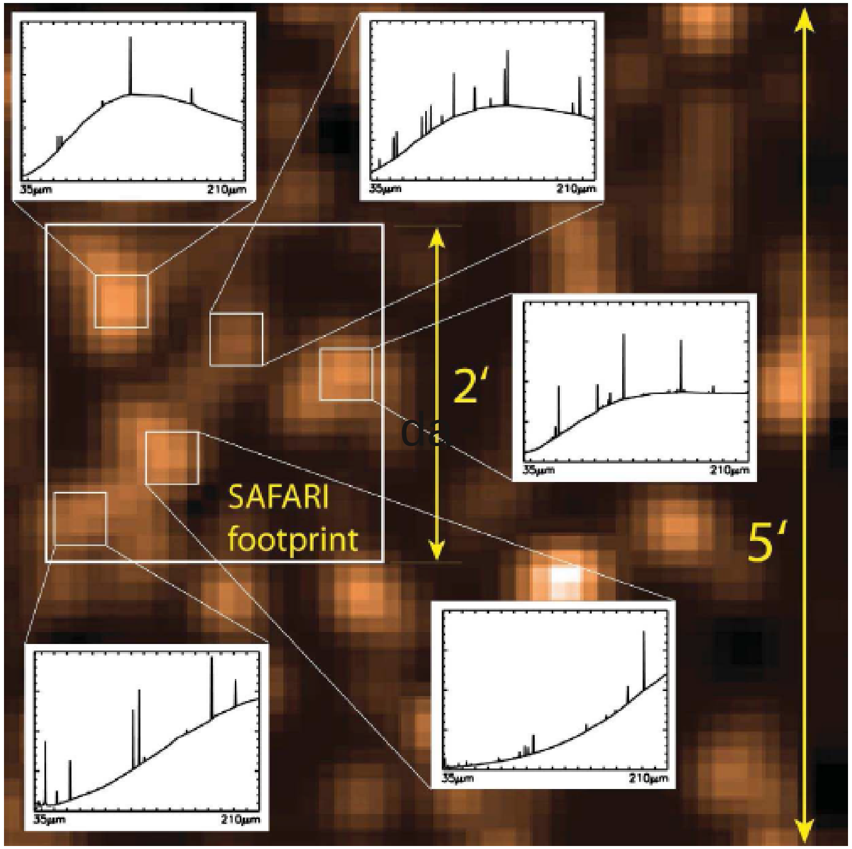
SPICA – deep cosmological spectral surveys down to z=4



SPICA/SAFARI: Spectral survey of 1x1° in 900 hours down to 5E-19 W/m^2



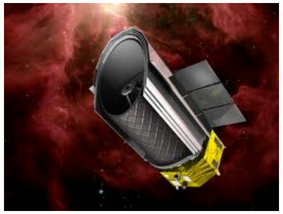
Millennium simulation z=1.4 (Springel et al 2006)



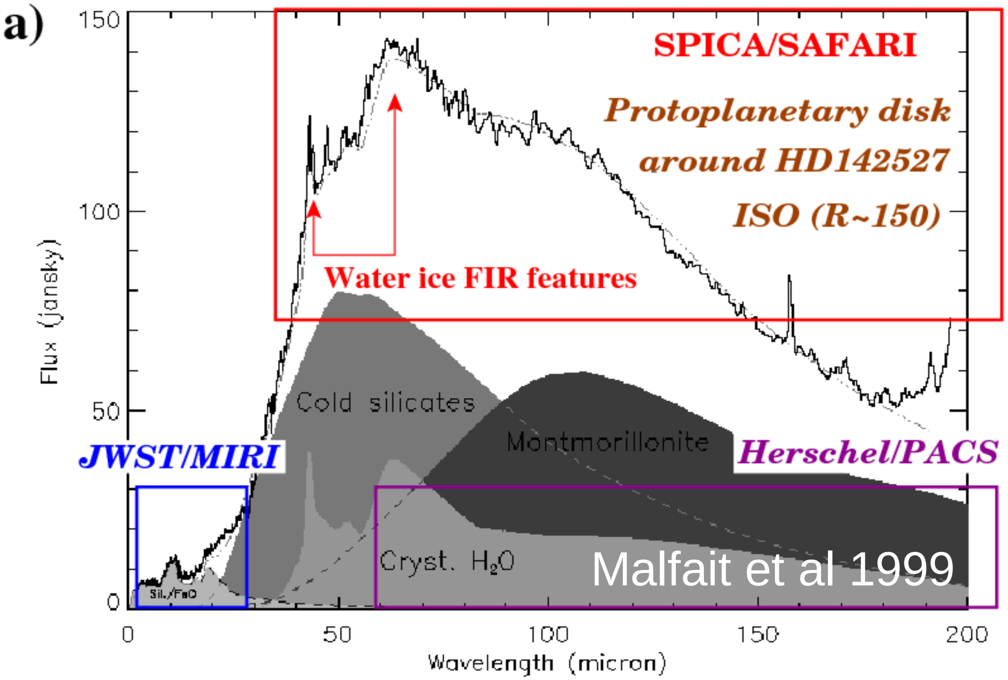
Herschel-SPIRE 250um – Hermes consortium

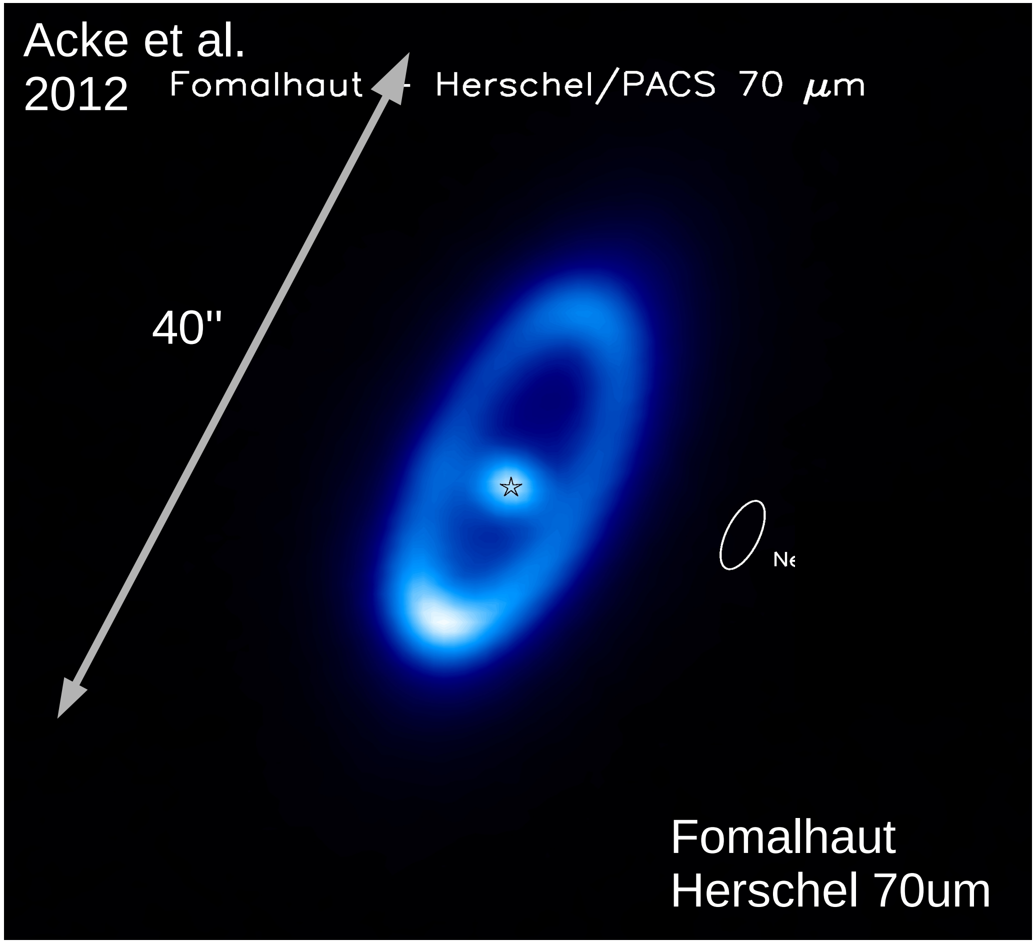
Compare: HERSCHEL-PACS : 1800 hours for 1'x1' to same depth

SPICA – mineralogy of protoplanetery and debris disks

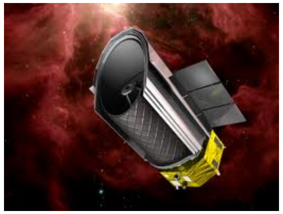


- Large surveys of faint protoplanetary disks
  - sensitivity to solid state features
  - gas lines (H2O, OI, CII, ...)
- Spectral mapping of resolved objects → determine snow line in debris disks

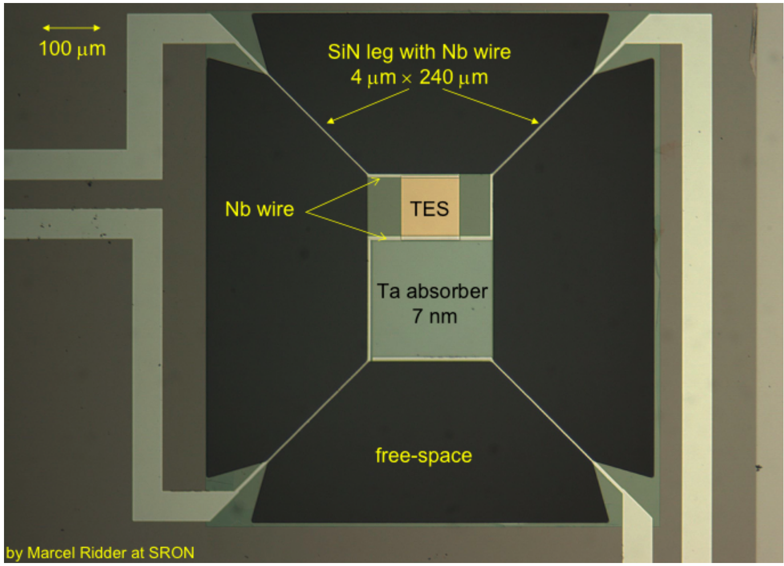


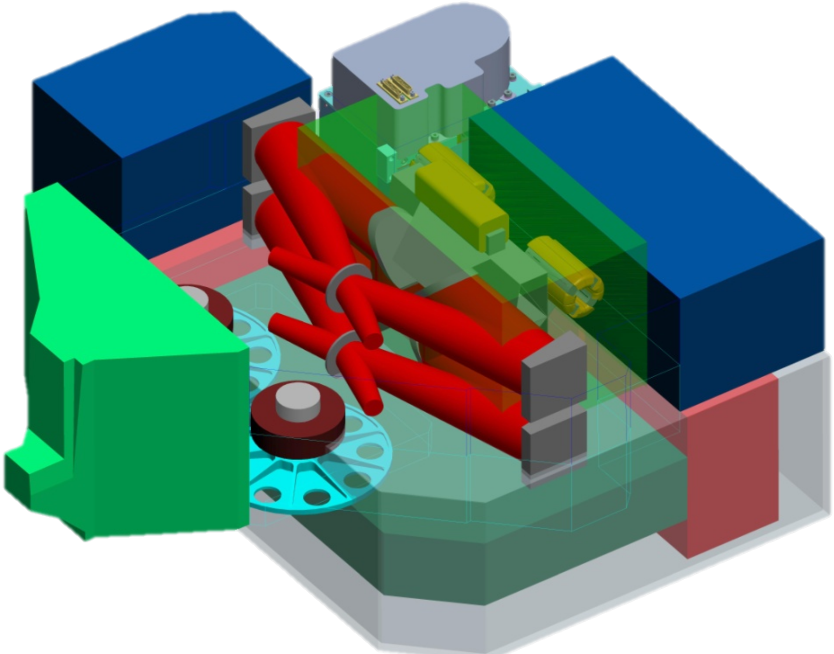


SPICA – the SAFARI instrument

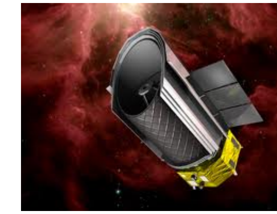


- Imaging Fourier Transform Spectrometer FTS
- Wavelength coverage of ~34-210mm
- 3-detector arrays, TES bolometers
- Range not covered by JWST or ALMA!
- Field of view of 2' x 2'
- Spectroscopy R up to ~2,000 at 100 μm
- Photometry (R~3)
- Filter options for photometry under study
- Sensitivity:
  Unresolved lines 5s-1hr: few x 10-19 W/m2
  Photometry 5s-1hr : <50mJy





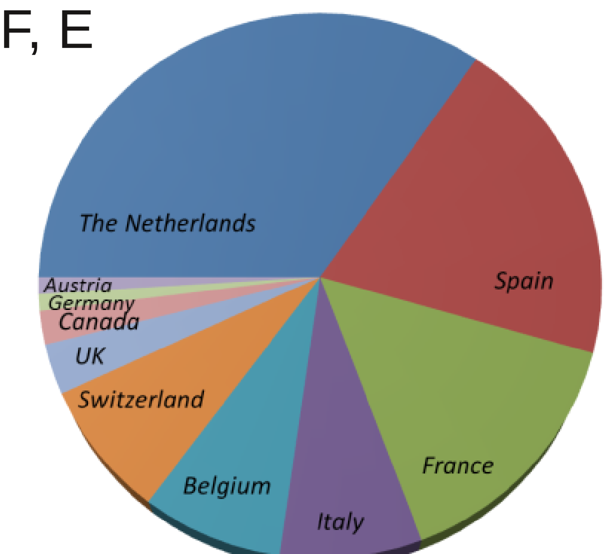
SPICA – programmatics



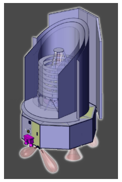
Idea → Phase A → Phase B → Phase C/D → Phase E → Post ops

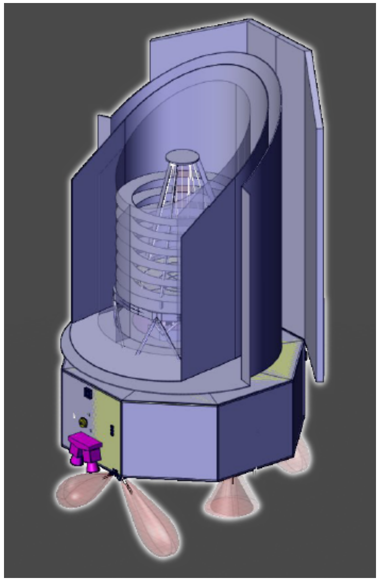
2008 2013 2015 2022

- Currently: Risk Mitigation phase @JAPAN
  - Following lessons learnt after ASTRO-G: resolve potential showstoppers as early as possible
  - Detailed studies thermal, EMC, pointing
- Phase-B kick-off ~spring 2013 after phase-up review
  - ESA: SPICA = Mission of opportunity – needs to fit in Cosmic Vision, not as M-class
- SAFARI instrument: full funding secured in NL, largely in F, E
- Belgian involvement in SAFARI instrument
  - CSL: lab test equipment, delay line
  - MicroMega/CSL: delay line mechanisme
  - KU Leuven : calibration, observing modes, software
  - KU Leuven + UGent: science case



EChO – overview

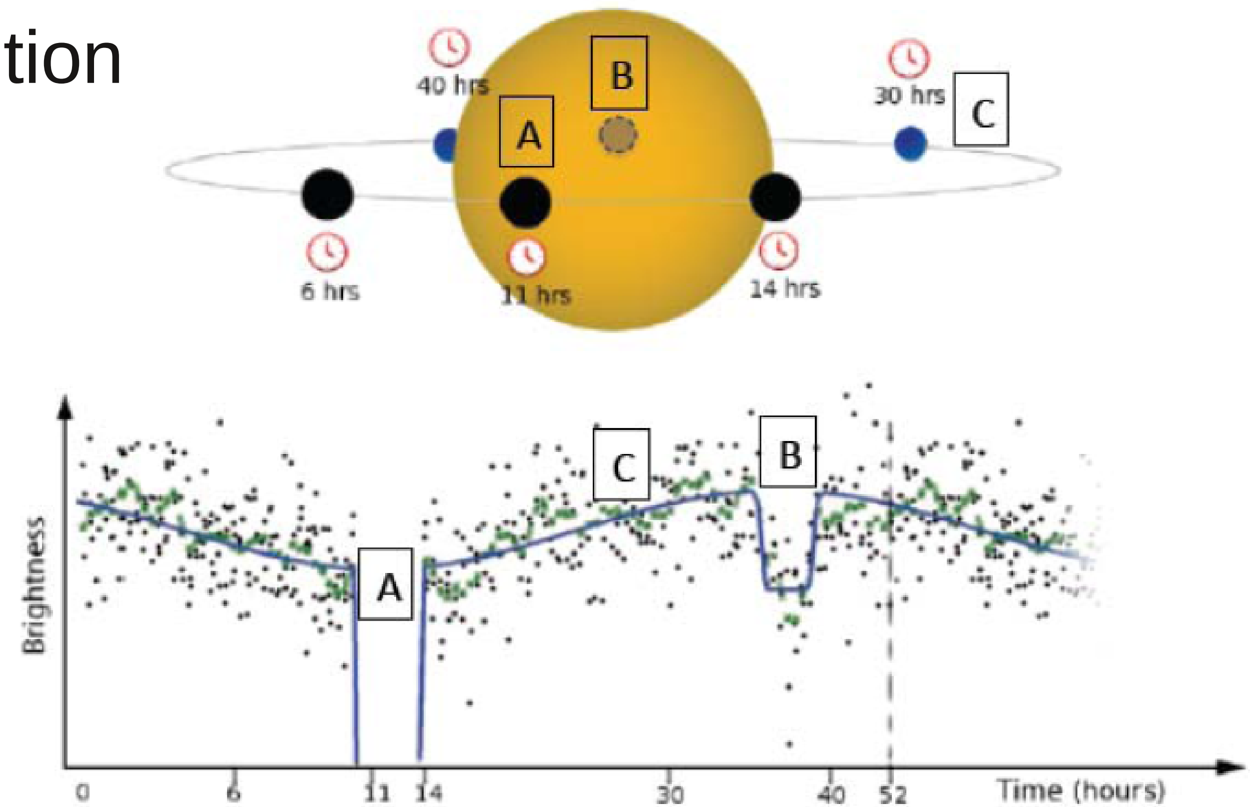




- Scientific objectives
  - Spectroscopy of exoplanets
- Telescope: 1.26m, passive cooling at 45K
- Wavelengths
  - 0.4 – 5 micron, R=300
  - 5 to 16 micron, R=30
- Orbit: Sun-Earth L2, Soyuz launch from Kourou
- Mission life 3 years nominal, 5 years goal

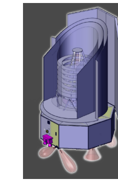
EChO – science goals

- 0.4 – 16 micron differential spectroscopy of transiting exoplanet atmospheres
  - Chemical composition
  - Energy budget
  - Abundances
  - Thermal structure
  - Optical albedo
  - Temporal variation
  - (Phase resolved)



- Requires ~10^{-4} – 10^{-5} photometric stability over eclipse (~10 hours)

EChO – science goals



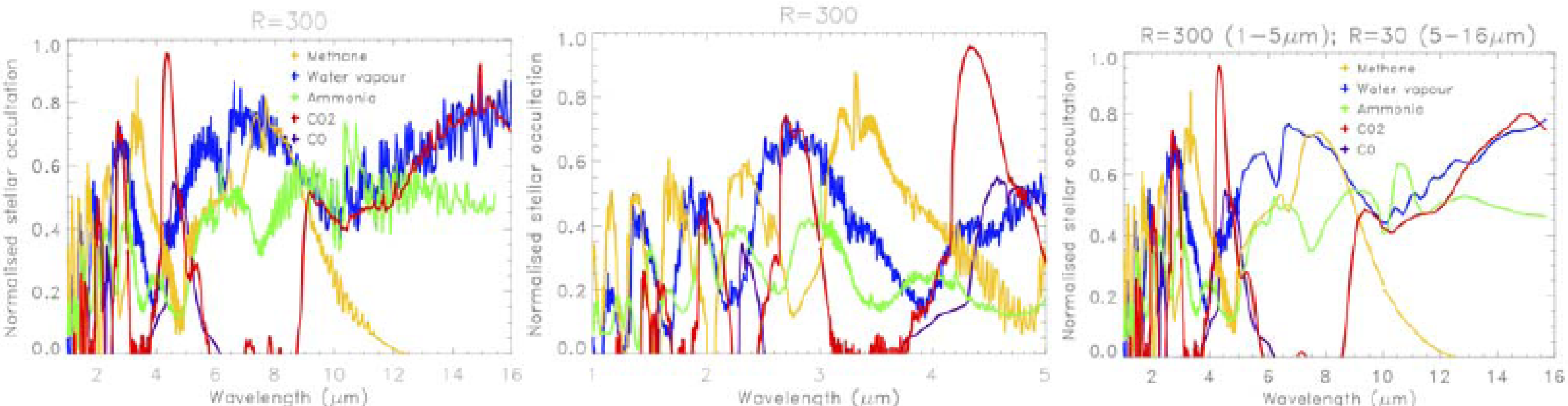
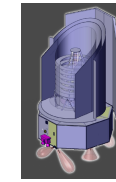


Figure 2: A simulation of typical exoplanet transmission spectra for a hot Jupiter as would be produced from primary transit observations, showing the wealth of spectral features from a selection of key diagnostic molecules that fall into the 1 – 16 micron wavelength range. Spectra have been normalised to the maximum atmospheric contribution in the 1 – 16 micron band. Left-hand panel: simulated spectra at a resolution of ~ 300 - absorption features increase in strength and width as one moves to longer wavelengths; Central panel: a zoom-in of the 1 – 5 micron waveband – features are closely packed and a resolution of a few hundred is needed to separate the different components; Right-hand panel: simulated spectra smoothed to a resolution of a few tens (~30) at λ > 5 micron (~300 below), illustrating that many features can still be resolved with quite modest resolution. Note: R is used to denote resolution in the figures.

EChO – reference sample

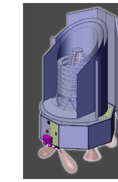


Temperature / Size	Jupiters	Neptunes	Super-Earths
Hot > 700 K	F, G, K, M	G, K, M	M
Warm: 400-700	F, G, K, M	G, K, M	M
Temperate: 250-350	F, G, K, M	G, K, M	M2, M3, M4, M5 . . .

If we would fly EchO today we already know suitable transiting exoplanet systems covering ~half of the sources in the reference sample

Over the next, several surveys will deliver the 'missing' or better targets (MASCARA,...)

EChO – programmatics



- Currently: Phase-A study
  - 2 parallel industrial studies (spacecraft, telescope)
  - 2 parallel payload studies (joint work on science case)
- Current Belgian activities in payload study team
  - With colleagues in D, NL, CH, A
  - CSL: Assembly, Verification and Manufacturing study
  - KU Leuven: calibration & observing modes, science case, stellar variability study
- Further downselections in 2013, 2015 for implementation as M3 mission
  - In competitition with LOFT (Large Observatory for X-ray Timing), MarcoPolo-R (asteroid sample return) and STE-QUEST (space-time curvature)

Summary

- Substantial Belgian involvement in early studies of two big infrared observatories for the twenties
  - SPICA / SAFARI
  - EchO
- Continues on the path securing access to the big observatories cfr Herschel, JWST for the Belgian community at large