

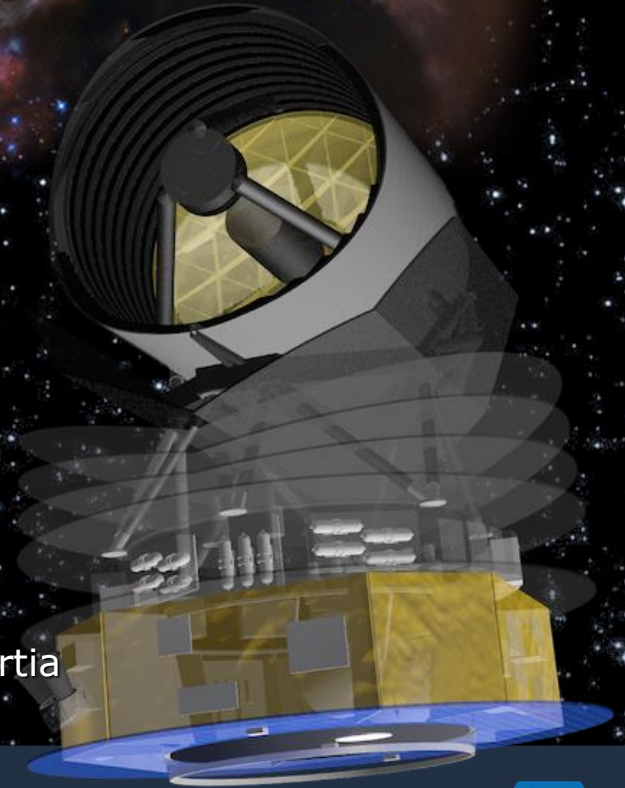
The SPICA infrared space observatory – project status



Peter Roelfsema

SAFARI Principal Investigator

SPICA European consortium lead
on behalf of the SPICA/J and SAFARI consortia



Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research

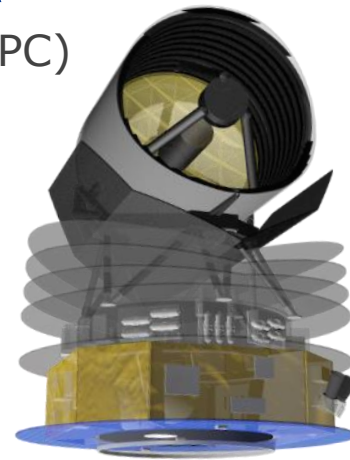


SPICA

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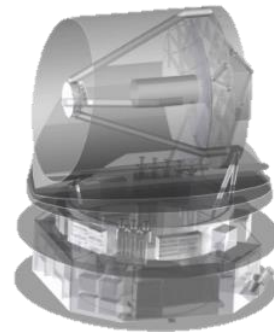
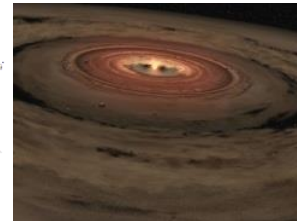
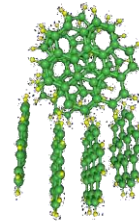
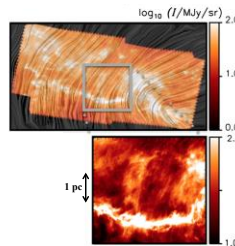
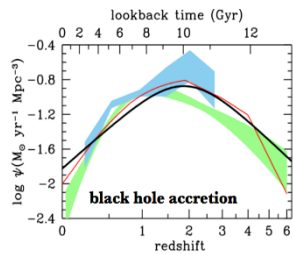
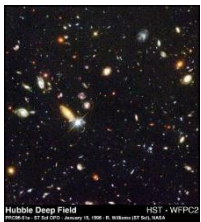
Contents

- The goal – a big cold IR facility; SPICA
- The heart of the matter – SPICA science
 - The science case for the (far) IR
 - Requirements for the mission and instruments
- Mission overview
 - Satellite concepts
 - Instruments, capabilities
- M5 proposal under evaluation at ESA
 - Expect candidate selection - June 2017 (SPC)
 - Next milestone; mission selection in 2019



SPICA's science

M5; unveiling dusty matter in the universe



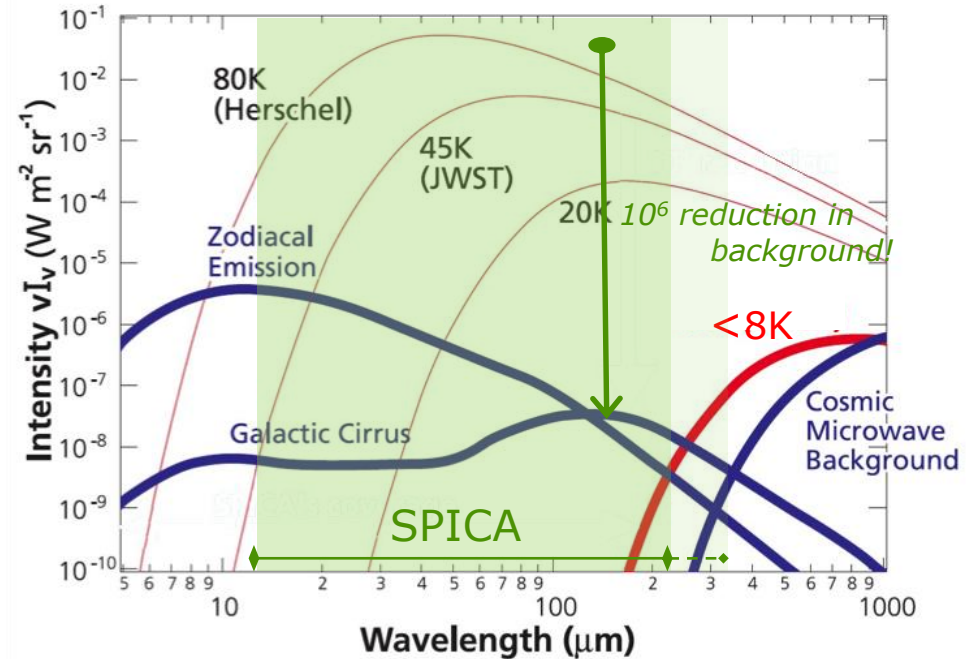
The SPICA 'sweet spot' – the dusty universe

A unique observatory

looking through the veils, enabling
transformational science

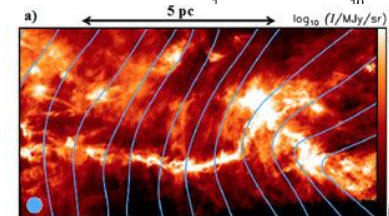
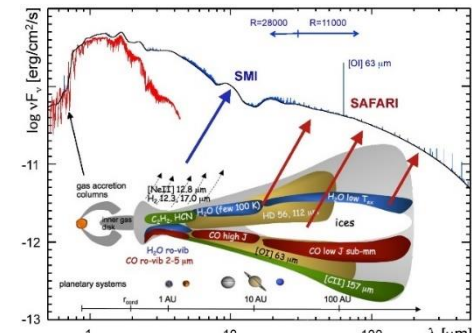
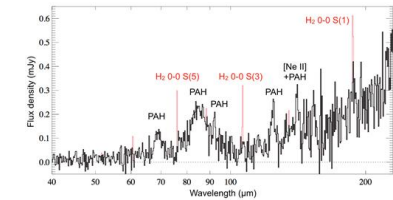
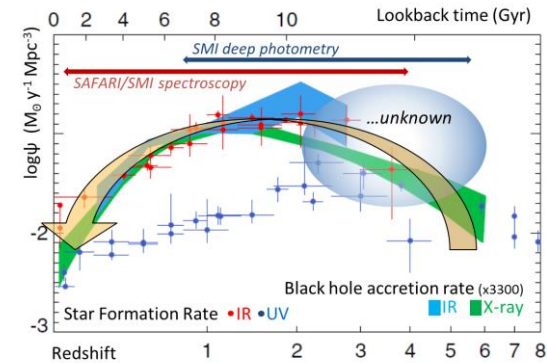
What is so unique?

- A **COLD, big** mirror
 - **true background limited** Mid/Far-IR observing
 - >2 orders of magnitude better raw sensitivity than Herschel
- ~20 to ~350 μm **inaccessible for any observatory**
 - the wavelength domain where **obscured matter** shines fill the blind spot between JWST and ALMA @ $R \sim \text{few } 1000$

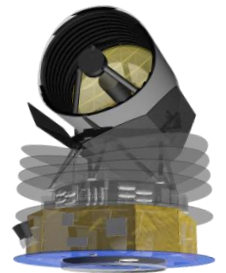
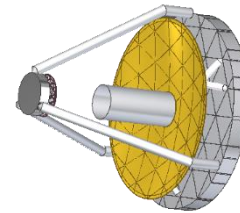
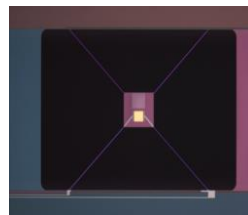
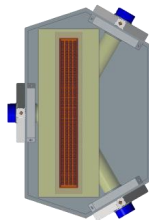
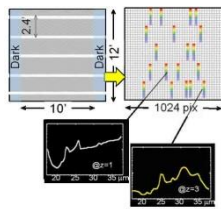
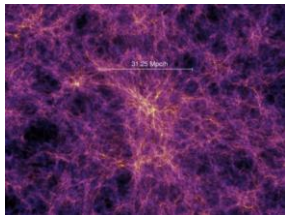


Science Objectives – mission design drivers

- What processes govern **star formation across cosmic time**
 - what starts it, controls it, and stops it?
 - What are the major physical processes in the most obscured regions of the universe?
 - How is this related to the enrichment of the universe with metals
- What is the **origin** and composition of **the first dust**, how does this relate to present day dust processing?
- What is the thermal and chemical **history** of the **building blocks of planets**?
- What is the role of magnetic fields in dust filaments?

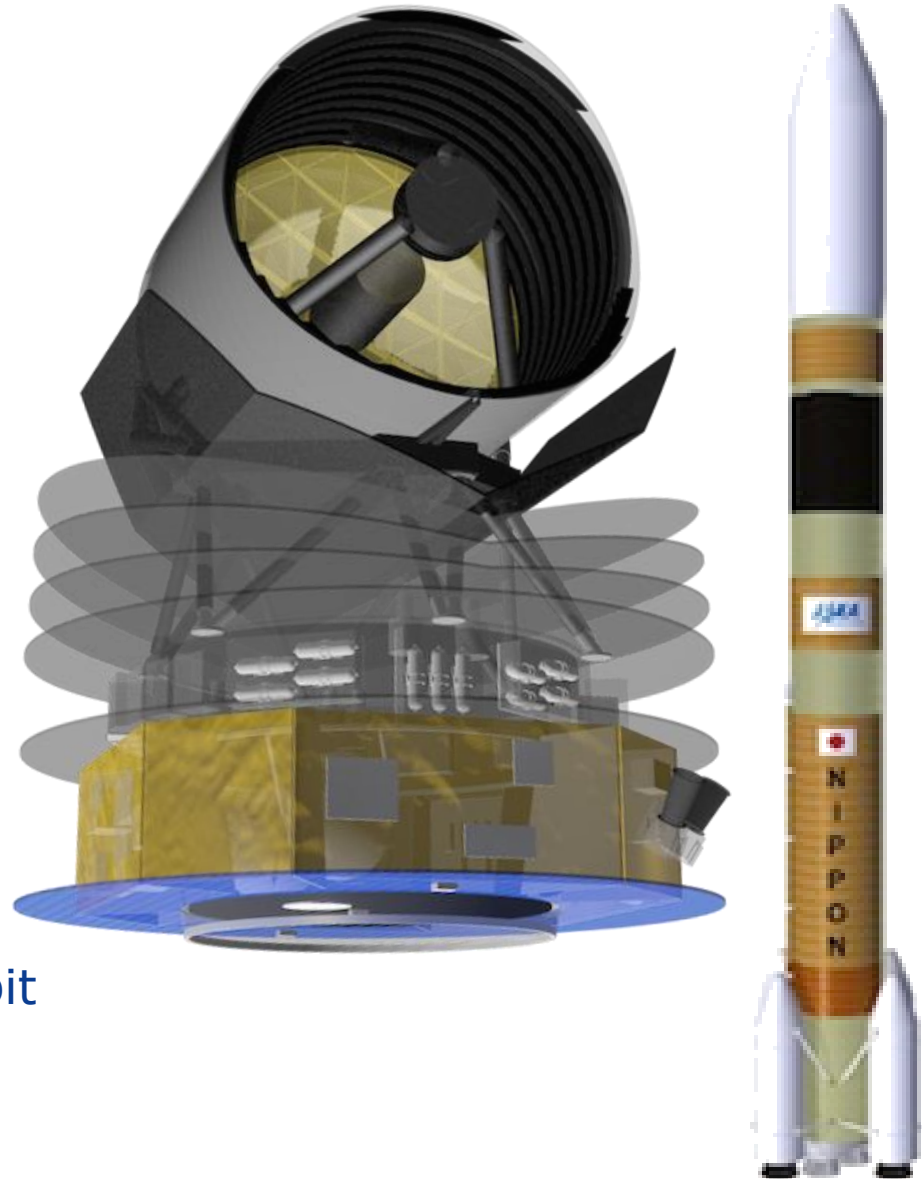


The SPICA mission the M5 configuration

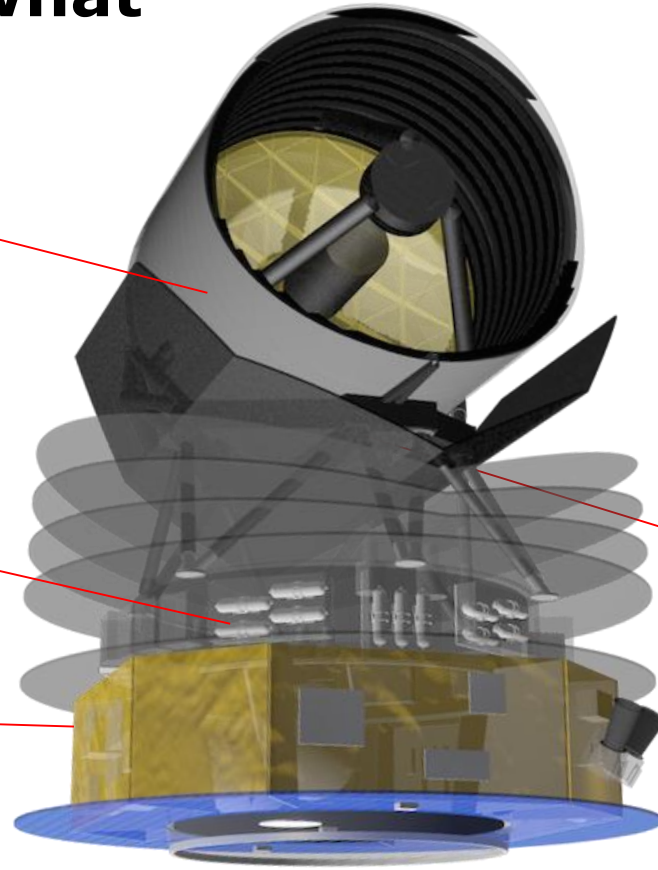


SPICA – proposed to ESA/M5

- ESA-led mission
 - with large JAXA contribution
- ‘PLANCK configuration’
 - Size - $\Phi 4.5$ m x 5.3 m
 - Mass - 3450 kg (wet, with margin)
 - V-grooves
- 2.5 meter telescope, < 8K
 - Warm launch
- 12 - 230 μm spectroscopy
 - MIR imaging spectroscopy – SMI
 - FIR spectroscopy – SAFARI/SPEC
 - FIR polarimetry – SAFARI/POL
- ‘standard’ Herschel/Planck SVM
- Japanese H3 launcher, L2 halo orbit
- 5 year goal lifetime



Who provides what





 Telescope (ESA)


 Payload Module

 Cryocooler






 Bus Module


 Launcher

SPICA Data Center
 

 Focal Plane Attitude Sensor

Focal Plane Instrument Assembly

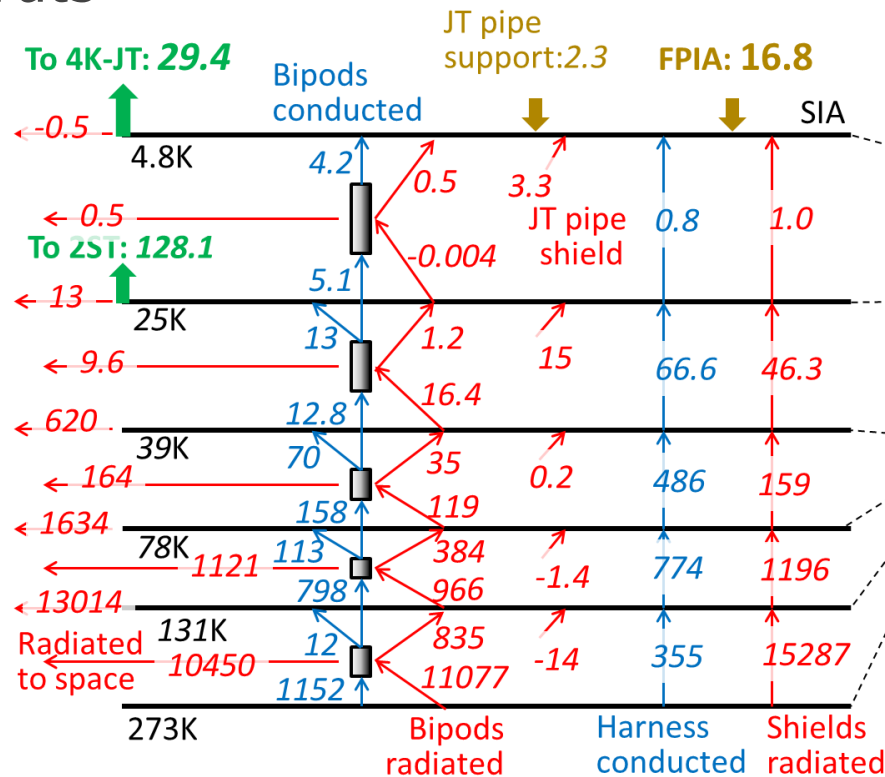
FIR Spectrometer (SAFARI)
    
 NL + European countries + Canada, US, Taiwan

MIR Instrument (SMI)


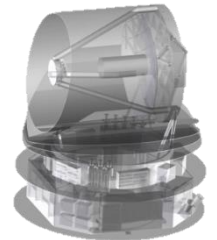
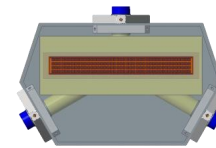
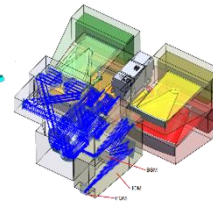
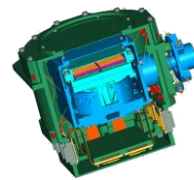
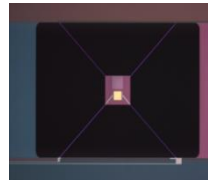
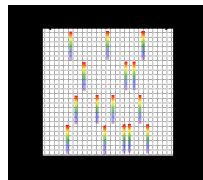
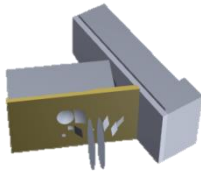
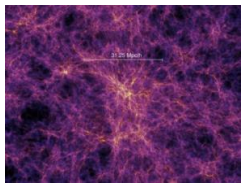
Complexity in responsibilities and interfaces
 → challenging AIV program

Main challenge – <8K telescope thermal design

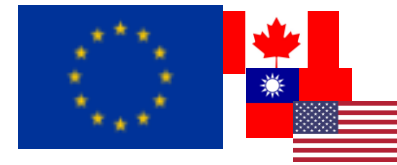
- Active cooling to 4K and 1.7K
 - Detector modules at 50mK with dedicated mK coolers (SAFARI)
- V-grooves – passive cooling to 40K
- Detachable support struts



The SPICA Instruments

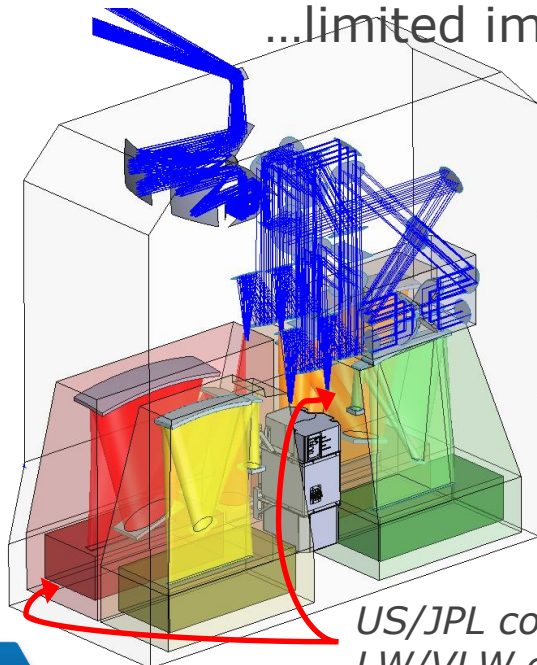
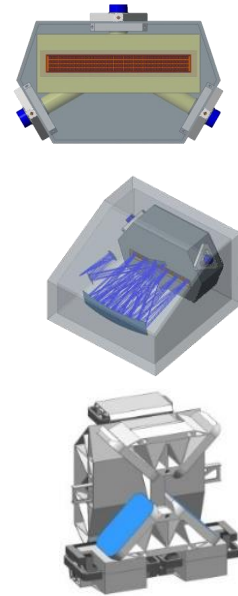


The Far-IR instrument SAFARI



SAFARI/SPEC - high sensitivity grating spectrometer

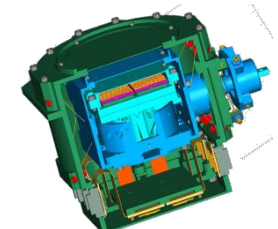
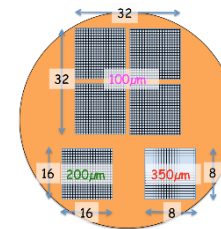
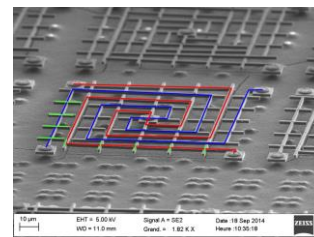
- Basic $R \sim 300$ mode \rightarrow 1hr/5 σ **$-5-7 \times 10^{-20} \text{ W/m}^2$** (4.6 m 2)
 - Improves with better TES performance!
 - Martin Puplett Interferometer to provide High-R mode
 - Backup: Fabry-Pérot Interferometer
 - 4 bands *instantaneously* covering 35-230 micron
- ...limited imaging capability: 3 pixels on-sky



US/JPL contribution:
LW/VLW grating modules

SAFARI/POL - imager polarimeter

- Polarization sensitive bolometers
 - 3 bands: 110, 220, 350 μm
- FPA architecture designed and tested
- Readout analogous to PACS system



SAFARI
SRON

The Mid-infrared Instrument SMI

- **SMI/LR-CAM** – large area low resolution surveyor

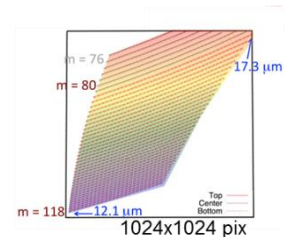
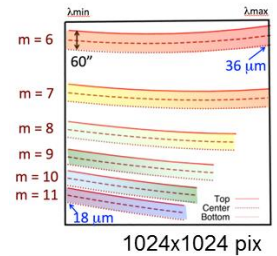
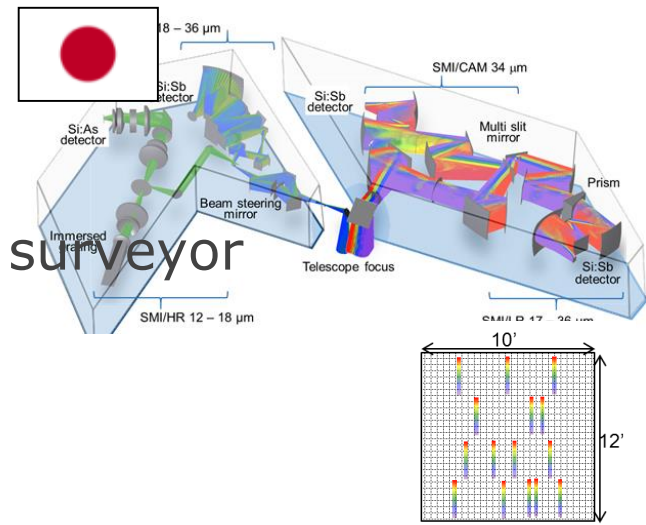
- 17 – 36 μm , $R = 50 - 120$
- 4 slits (10' long) with prism
- Detector: Si:Sb
- Camera mode 10'x12' FoV

- **SMI/MR** – medium resolution mapper

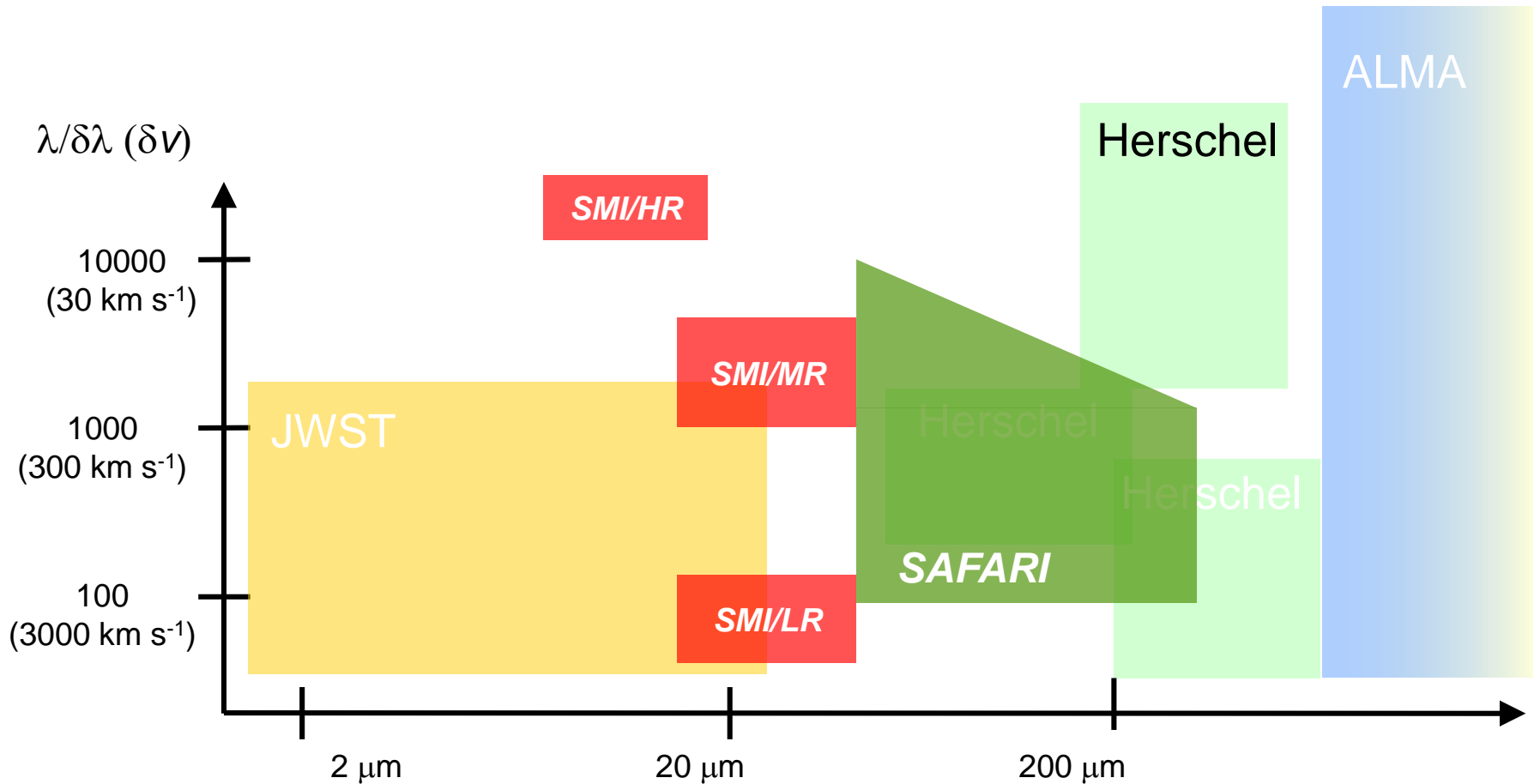
- 18 – 36 μm , $R = 1200 - 2300$,
- 1 slit (1' long) with grating
- Detector: Si:Sb

- **SMI/HR** – molecular physics/kinematics

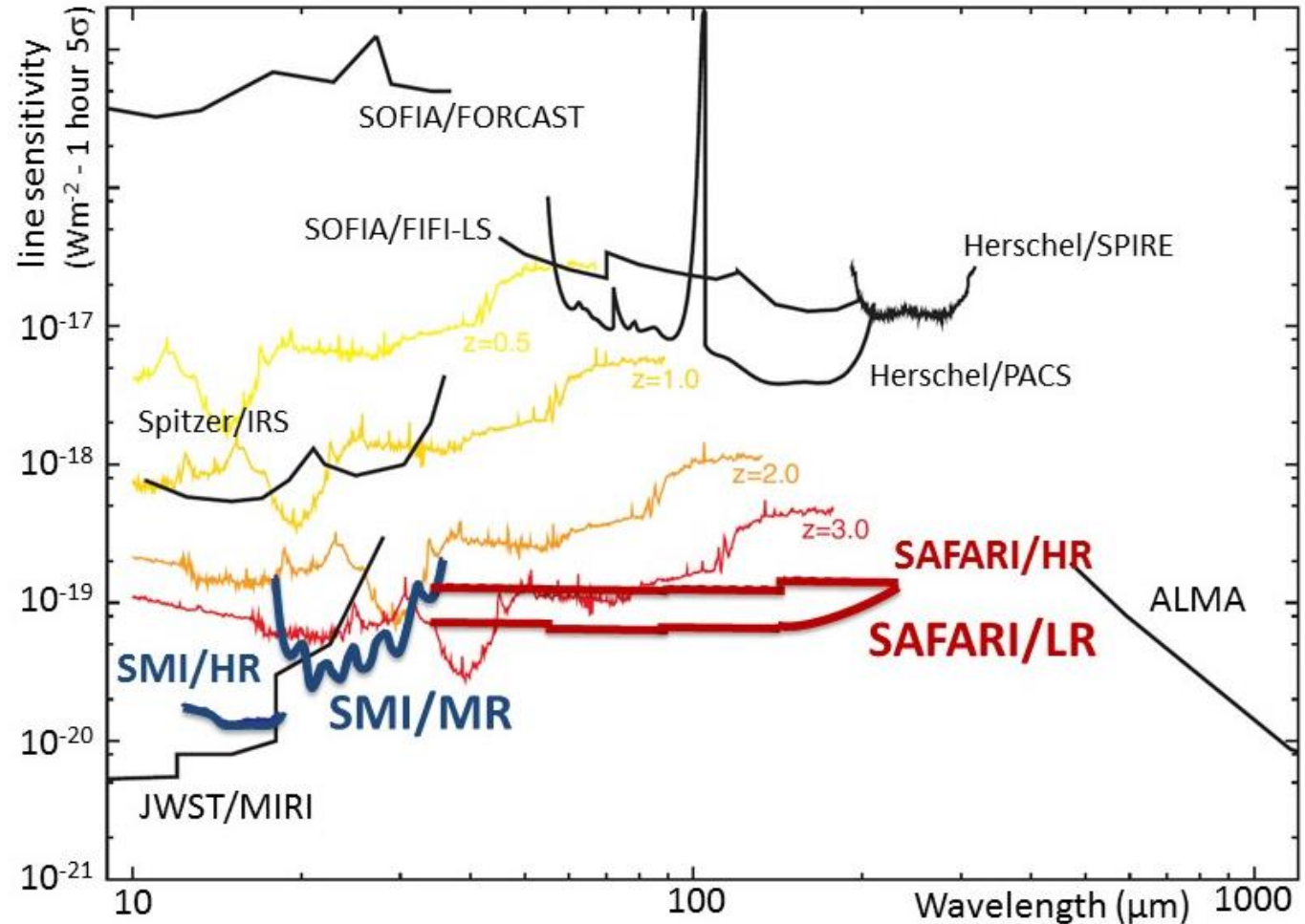
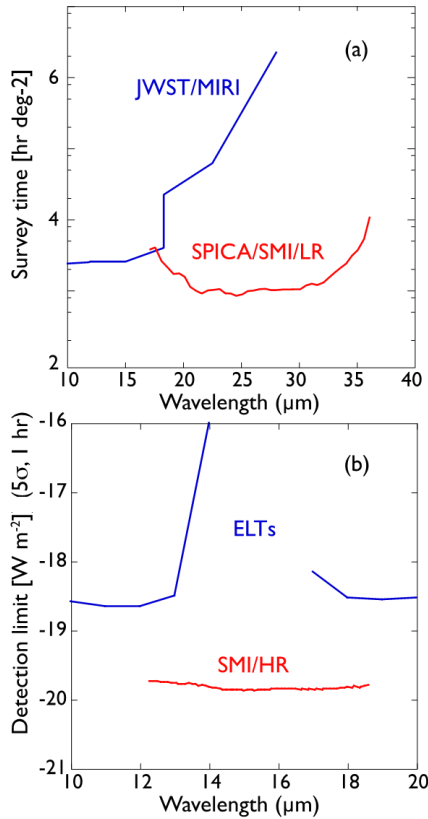
- 12 – 18 μm , $R = 28,000$
- 1 slit (4" long) with immersion grating
- Detector: Si:As



SPICA capabilities - spectral resolution

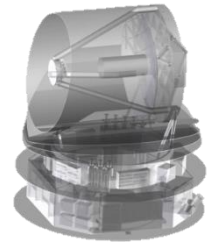
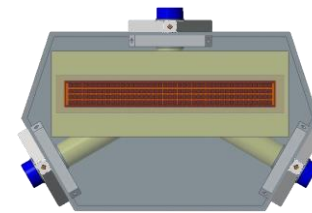
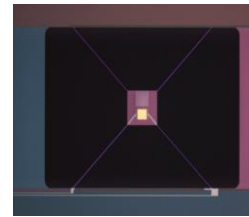
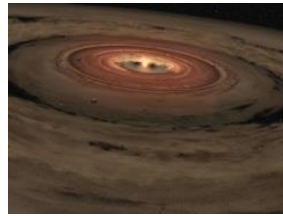
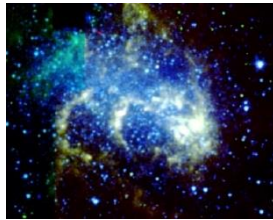
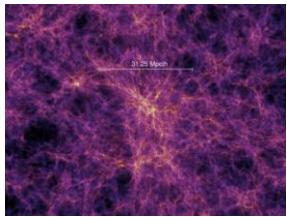


SPICA sensitivity/speed – a *huge* leap forward



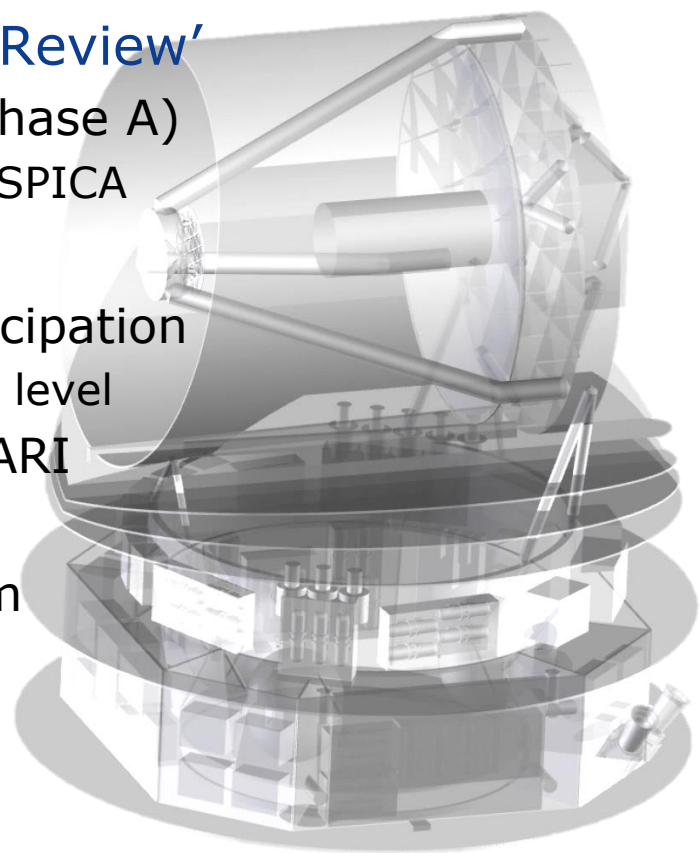
Raw sensitivity improvement **>2 orders** of magnitude
 Instantaneous full spectra → huge step in efficiency

The programmatic context and the outlook



Mission Status

- Mission well defined
 - Spacecraft elements, responsibilities
 - Instrument complement ready to start phase-A
- Japan: SPICA passed 'Mission Definition Review'
 - SPICA officially in 'Pre-project' phase (~phase A)
 - 2027/2028 H3 slot tentatively assigned to SPICA
- M5 proposal under evaluation
 - ESA-led mission (~550M€) with JAXA participation
 - JAXA *committed* to support at the ~300M\$ level
 - European/Canadian/US instrument - SAFARI
 - Mission candidate selection: June/2017
 - Phase A/B1 under ESA-led study team
 - Mission final selection: 2019
 - Launch: 2028/2029



Summary

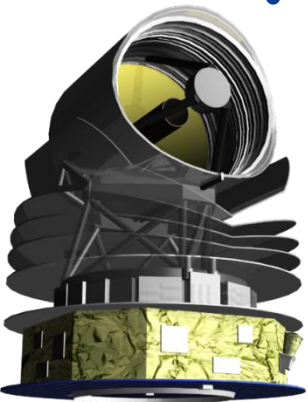
- SPiCA: a mid-far infrared space observatory
 - 2.5 m diameter mirror, actively cooled to 8 K
 - **unprecedented sensitivity** in **mid/far IR**
 - ESA/JAXA project with PI-provided instruments
 - Open for astronomical community
- SPiCA focus: spectroscopy of the obscured universe, straddling the gap between JWST and ALMA
 - SPiCA is proposed as a candidate for ESA M5
 - Candidate selection in June 2017, final selection Q4/2019
 - Launch ~2029

SPiCA supporters/joiners?

register at www.spica-mission.org

..contact Matt – bradford@submm.caltech.edu

or me – P.R.Roelfsema@sron.nl



SAFARI

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