



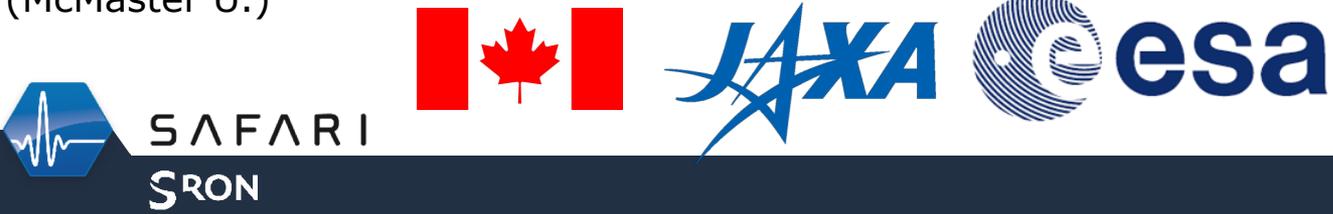
# The Next Great Infrared Space Observatory

## An opportunity for Canada

On behalf of David Naylor and the Canadian SPICA team

Slides from Peter Roelfsema and David Naylor

**Canada:** M. Bannister (Queen’s U. Belfast), S. Baum (U. of Manitoba), J. Cami (U. of W. Ontario), S. Chapman (Dalhousie U.), J. Di Francesco (NRC Herzberg), D. Haggard (McGill U.), M. Halpern (U. of British Columbia), M. Houde (U. of W. Ontario), D. Johnstone (NRC Herzberg), G. Joncas (U. Laval), B. Matthews (NRC Herzberg), S. Metchev (U. of W. Ontario), C. O’Dea (U. of Manitoba), E. Peeters, (U. of W. Ontario), R. Plume (U. of Calgary), A. Pon (U. of W. Ontario), E. Rosolowsky (U. of Alberta), M. Sawicki (St. Mary’s U.), D. Scott (U. of British Columbia), G.R. Sivakoff (U. of Alberta), L. Spencer (U. of Lethbridge), C. Wilson (McMaster U.)



# The SPICA 'sweet spot' – the dusty universe

## A unique observatory

looking through the veils, enabling transformational science

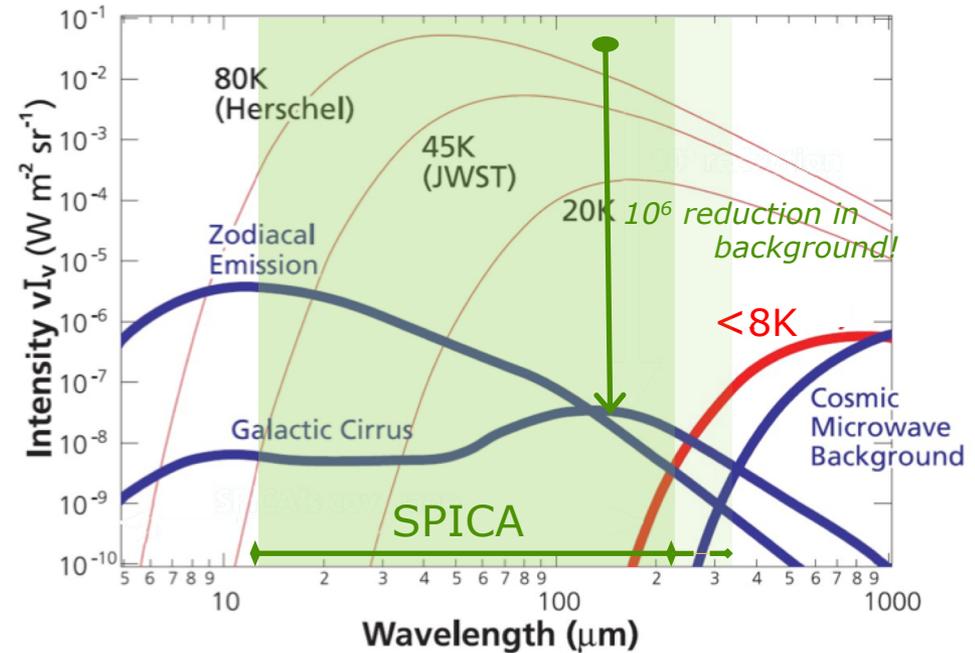
...imagine going

**a factor 100+ deeper**

than Herschel!

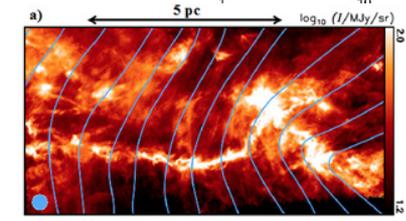
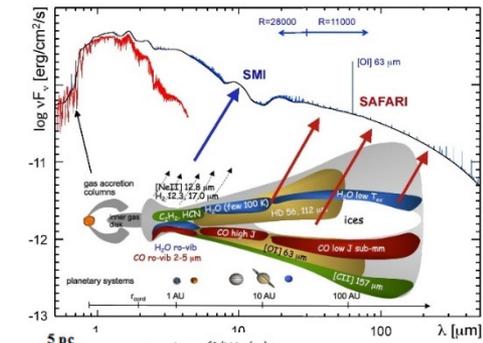
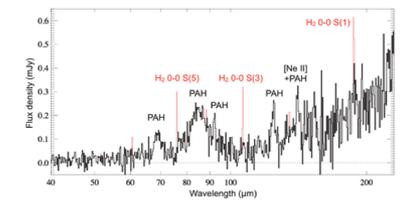
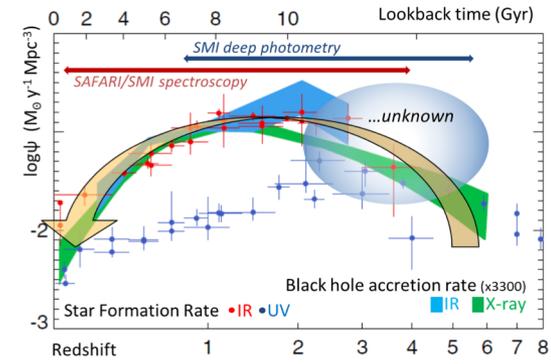
Why is this so unique?

- A **COLD, big** mirror
  - true **background limited** Mid/Far-IR observing
- $\sim 20$  to  $\sim 350$   $\mu\text{m}$  **inaccessible** for any other observatory
  - the wavelength domain where obscured matter shines fill the blind spot between **JWST** and **ALMA** @  $R \sim \text{few } 1000$



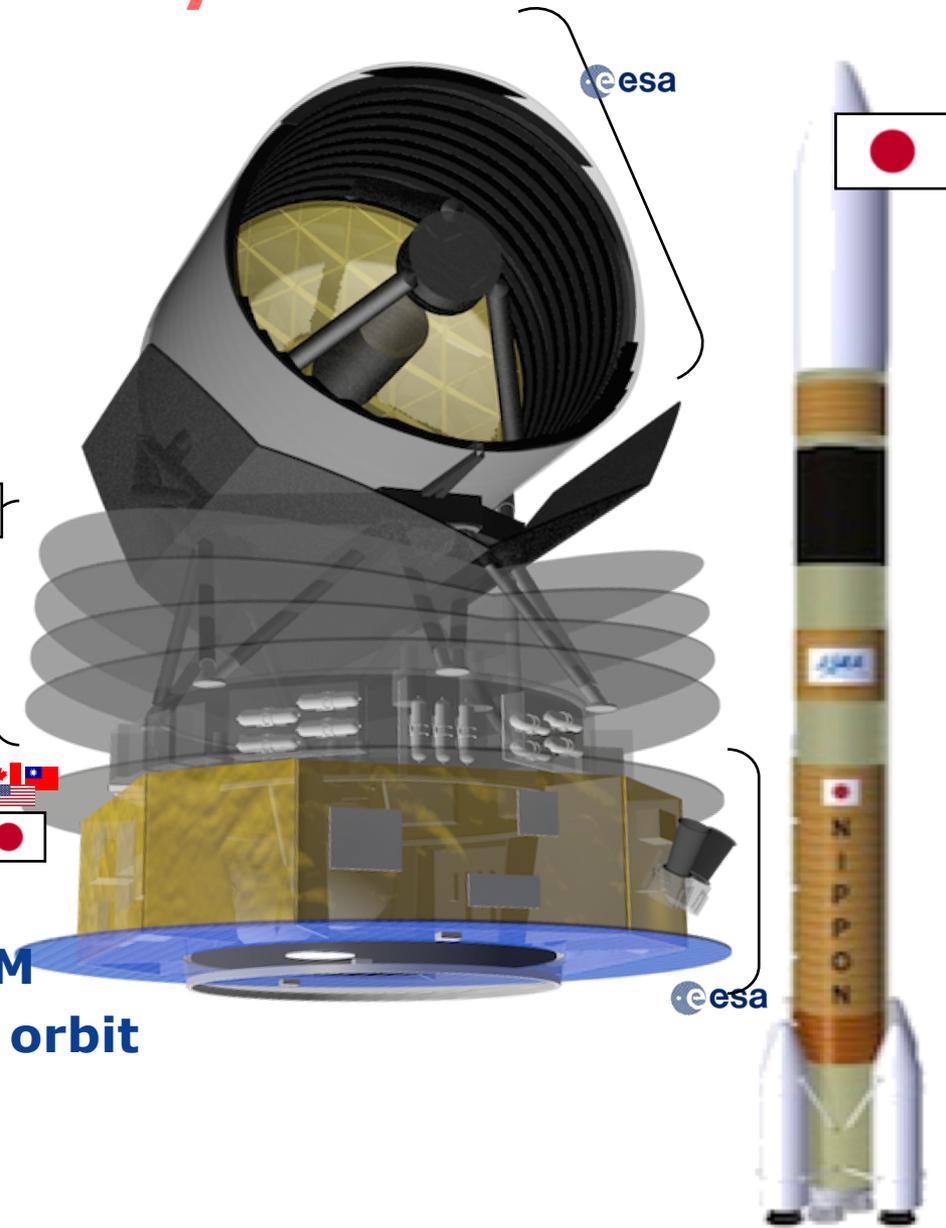
# Science objectives – SPICA mission design drivers

- 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 all of 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 are the roles of **magnetic fields** and **turbulence** in determining star formation?



# SPICA – under development by ESA and JAXA

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



# SPICA – under development by ESA and JAXA

Mission well defined

Instrument complement in final iteration

Europe: consortium submitted M5 proposal 5 Oct 2016

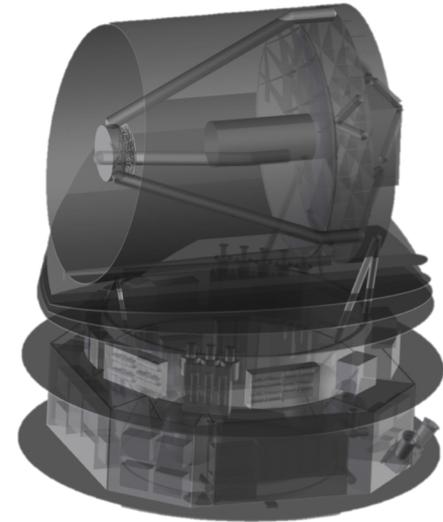
European/Canadian/US instrument - SAFARI

Joint ESA-JAXA mission

***Selected as Mission candidate - 7 May 2018***

Mission final selection 2021

Launch 2029?



Japan: SPICA has passed the Mission Definition Review

SPICA officially in 'Pre-project' phase (~phase A)

2027/2028 H3 slot tentatively assigned to SPICA

Japan will support an ESA SPICA mission at the ~300M\$ level

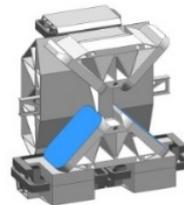
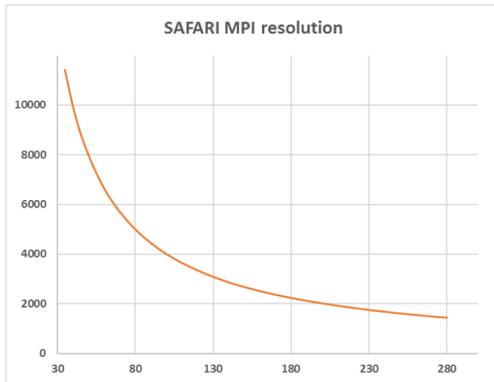
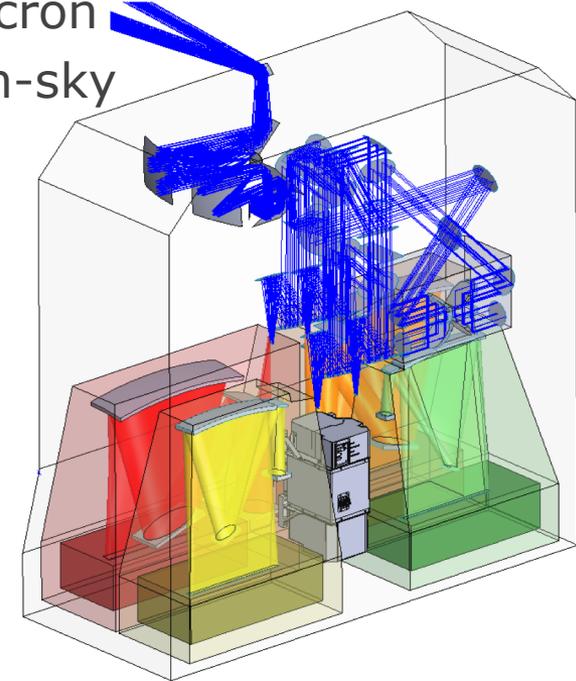
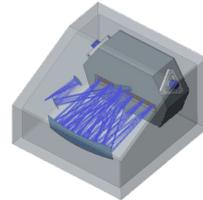
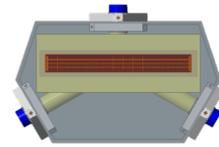


# The Far-IR instrument SAFARI

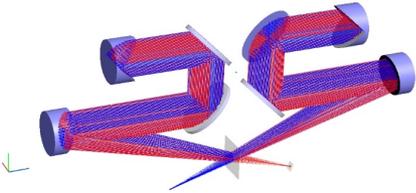
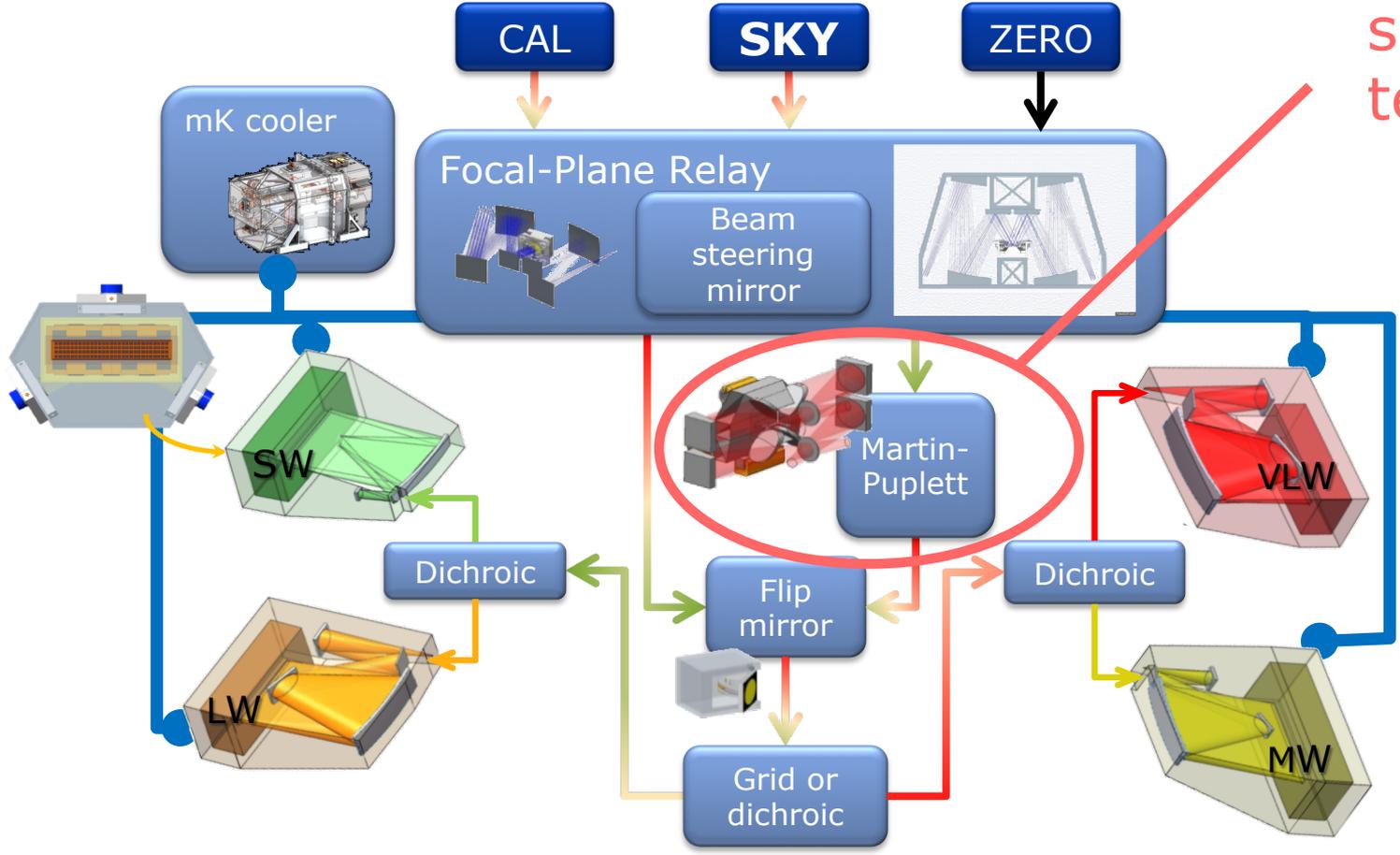


## **SAFARI** - *high sensitivity* grating spectrometer

- Basic  $R \sim 300$  mode  $\rightarrow$  1hr/5 $\sigma$   **$-5-7 \times 10^{-20}$  W/m<sup>2</sup>** (4.6 m<sup>2</sup>)
  - Improves with better TES performance!
- **Martin Puplett Interferometer** to provide High-R mode
- 4 bands *instantaneously* covering 35-230 micron
  - ...limited imaging capability: 3 pixels on-sky
- Consortium: Europe-**Canada**-US-Taiwan
  - PI P. Roelfsema/SRON
  - Canada D. Naylor (Lethbridge)



Canadian signature technology



# The Canadian SPICA story thus far...

1. June 2008: first SPICA contract awarded to Lethbridge following competition for Canadian contributions to ESA Cosmic Vision call.
2. Tasked with identifying a meaningful role for Canada in the SPICA mission. Initially conceived as similar scope to Herschel (\$10-20 M).
3. 2009: funding issues resulted in SPICA lead moving from UK to Netherlands. SRON suggested passing High Resolution Fourier Transform Spectrometer (FTS) package to Canada.  
Larger contribution with significantly greater ROI.
4. Prestigious role was well matched to Canadian signature technology and is mission critical, David Naylor brought this opportunity to CSA's attention; tasked with exploring where this might lead.
5. 2008 to May 2016. Lethbridge received three successive SPICA study contracts.
6. May 2016 CSA support for SPICA ended. At present using NSERC & Lethbridge funds to continue to serve as the SPICA SAFARI co-I and Canadian Head of Nation to hold the beachhead in the project.

# The Canadian CSA/Industry Situation ...

1. SPICA FTS Mechanism Phase 0 (Industrial contract awarded to ABB ended June 2015).
  2. 2015 -STDP 9 (PT17) –Cryogenic Translation Mechanism for Future Far Infrared Astronomy Missions (ABB end date fall 2018).
  3. 2016 -SPICA FAST Grant (A07 UL) Cryogenic Fabry-Perot for SAFARI (through March 2019).
- Final M5 submission deadline summer 2021.
  - We now have 3 years to raise the TRL of critical subsystems, including the FTS, to TRL5/6.
  - Imperative that subsystem work starts immediately. Failure to reach TRL 5 in any subsystem is expected to result in mission failure.

## The Canadian situation moving forward.

*From 2008 to 2018, the CSA will have invested over **\$2.5M** in the SPICA project to **establish and preserve a potential role for Canada** in the SAFARI instrument.*

*Canada is positioned to build the **mission critical**, high resolution spectrometer of the high redshift engine for the leading infrared observatory of the next decade. **The FTS cannot be de-scoped.***

***SPICA is identified in the LRP** and supported by scientists from across Canada.*

*If Canada cannot confirm support for the next phase in a timely fashion, the subsystem will be offered to other nations in the consortium. **We have worked hard to reach this critical juncture and the decision time is upon us.***

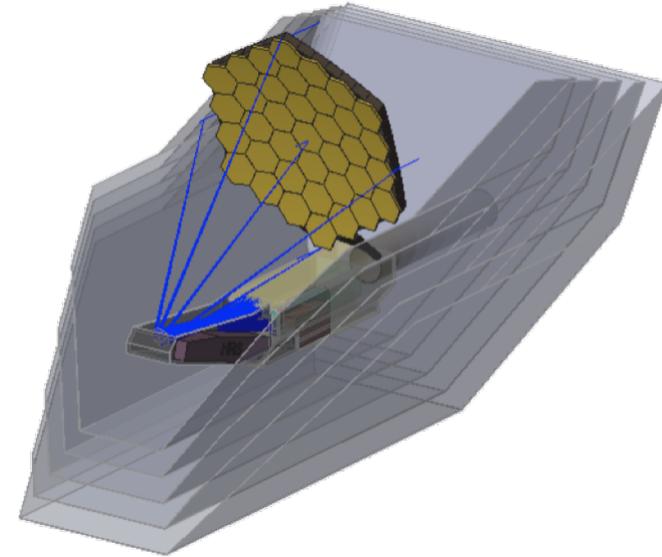
### What is needed?

- Confirmation from CSA that we are ready to support this next 3 year phase of SPICA.
- Restored SPICA funding to UL, Canadian lead institution. Focus: building up SPICA specific cryogenic test capabilities to verify SPICTM reaches >TRL 5.
- Funding industrial partner (ABB) to raise TRL of SPICTM to 5 by final submission deadline.

# The Origins Space Telescope

NASA decadal survey – flagship missions for the next decade

- Study teams set up for four concepts: UVOIR, HABEX, Lynx, OST
  - Decadal report/recommendation ~ 2021
  - Launch ~2035 (at best...)
- Origins Space Telescope
  - **Concept 1** → **HUGE!** ~10-20 x SPICA  
... and *far* too expensive
  - **Concept 2** → **Large**; <5 Bn\$
    - Much more modest ~6 metre telescope  
...actually starts to look like early SPICA
  - Decision process overlaps with M5 selection process  
All kinds of questions arise w.r.t. competition/combination/succession  
....none can be well answered at this time



*...need to rely continuous, **very good** contact between SPICA and OST*

**Doug Johnstone** is a Canadian science representative to **both** missions.



SAFARI

SRON

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# The M5 process towards mission selection

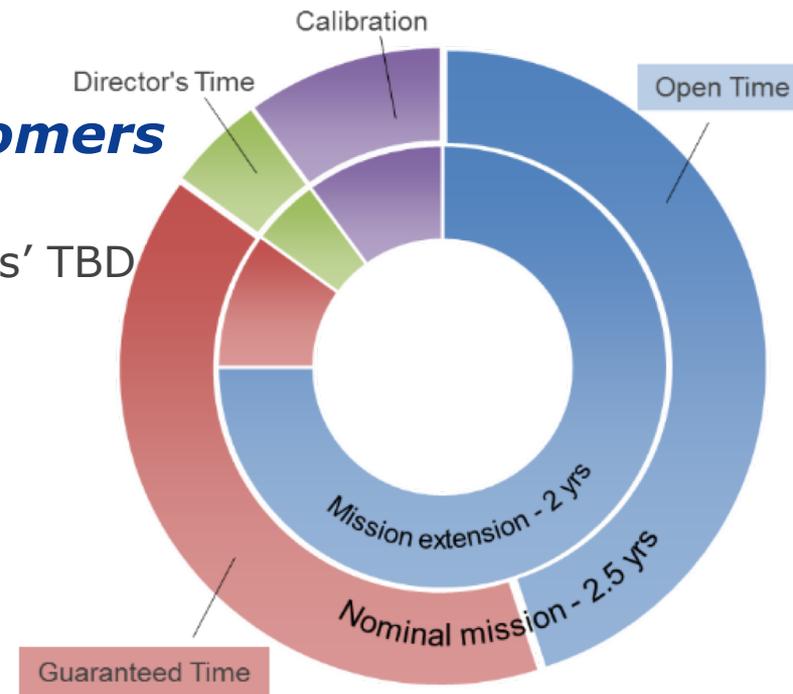
- ESA study team is now in place
  - Project team (Jaques Rouquet) and study scientist (Jan Tauber)
  - SPICA Science Study Team in place
- Phase 0 study ~3-5 months → **June – end 2018**
  - Preliminary mission definition and requirements
  - Concurrent Design Facility study
  - Preparation to kick-off Phase A with industry partners  
→ Mission Definition Review - 21 November (TBC)
- Phase A study ~ 1.5/2 years → **2019/2020**
  - Detailed study – all technical, programmatic and scientific aspects
  - Mission selection review – technical and programmatic  
→ critical items **need TRL5 by mid 2021**
  - Scientific peer review  
→ mission selection by SPC – **Nov. 2021**

# Harvesting and governance

- **Observing time:**

mission will be open for ***all astronomers***

- Guaranteed v.s. open time details TBD
- Detailed implementation of e.g. 'Key projects' TBD
- Time Allocation Committee



- **International mission → international oversight/cooperation**

- SPICA Science Study Team (ESA installed) – represent science community
- 3 instrument consortia + overall SPICA (science) consortium
- Science advisory committee
- Influence on project through a SPICA executive board