SPICA

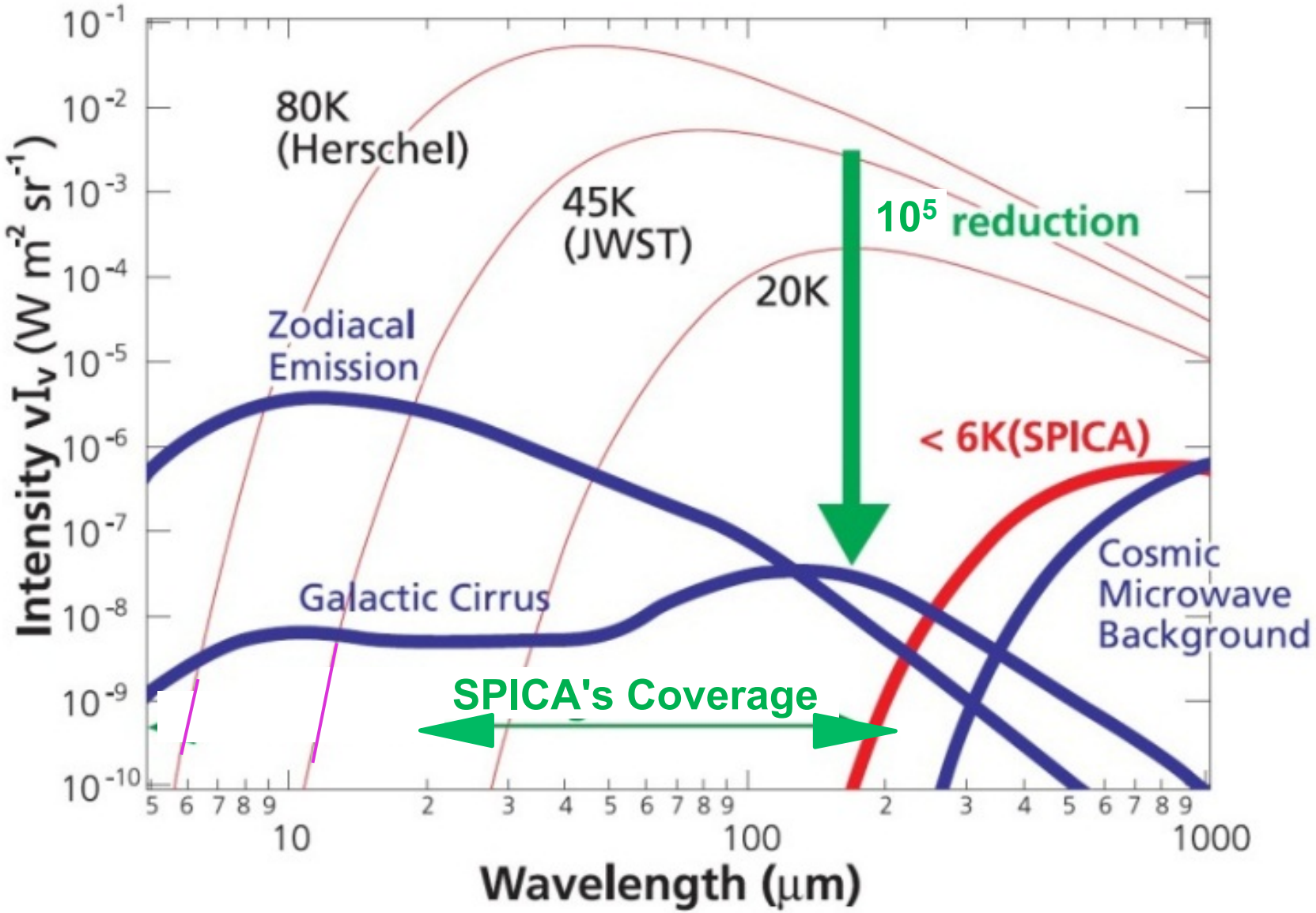
2014-12-31
Hiroshi Shibai
(PI of SPICA Project)

Presented 2015-1-4
by Matt Bradford
COPAG @ AAS Seattle

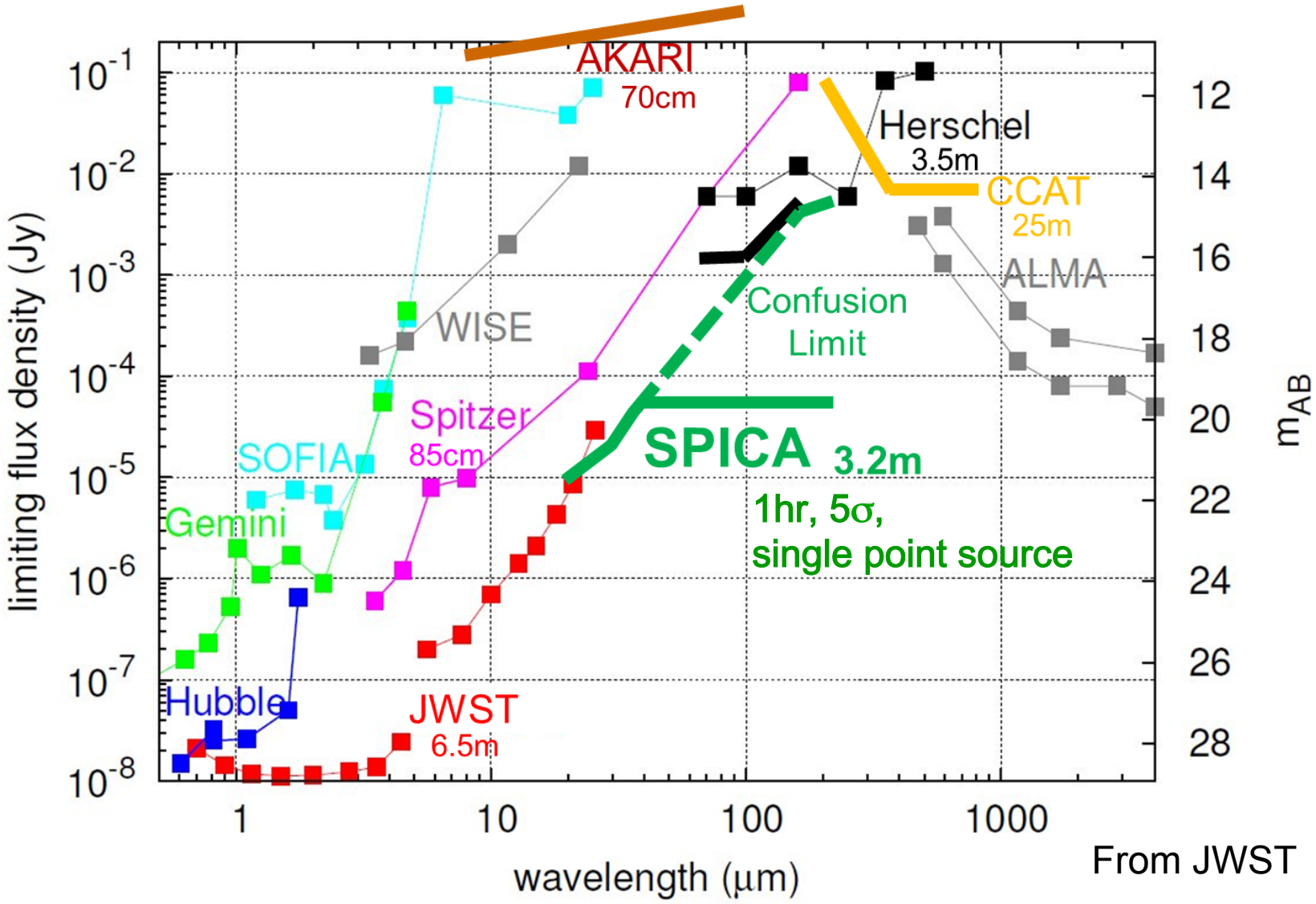
Telescope diameter:	2 - 3 m
Telescope temperature:	< 6 K
Wavelength:	20-210 μm (or wider)
Total mass:	< 3.7 t
Orbit:	Halo orbit around liberation point S-E L2
Launch:	in FT2025 or later by JAXA's H-X
Operation:	3 years (nominal), 5 years (goal)

SPICA
Space Infrared Telescope for Cosmology and Astrophysics

Suppression of Fore/Background

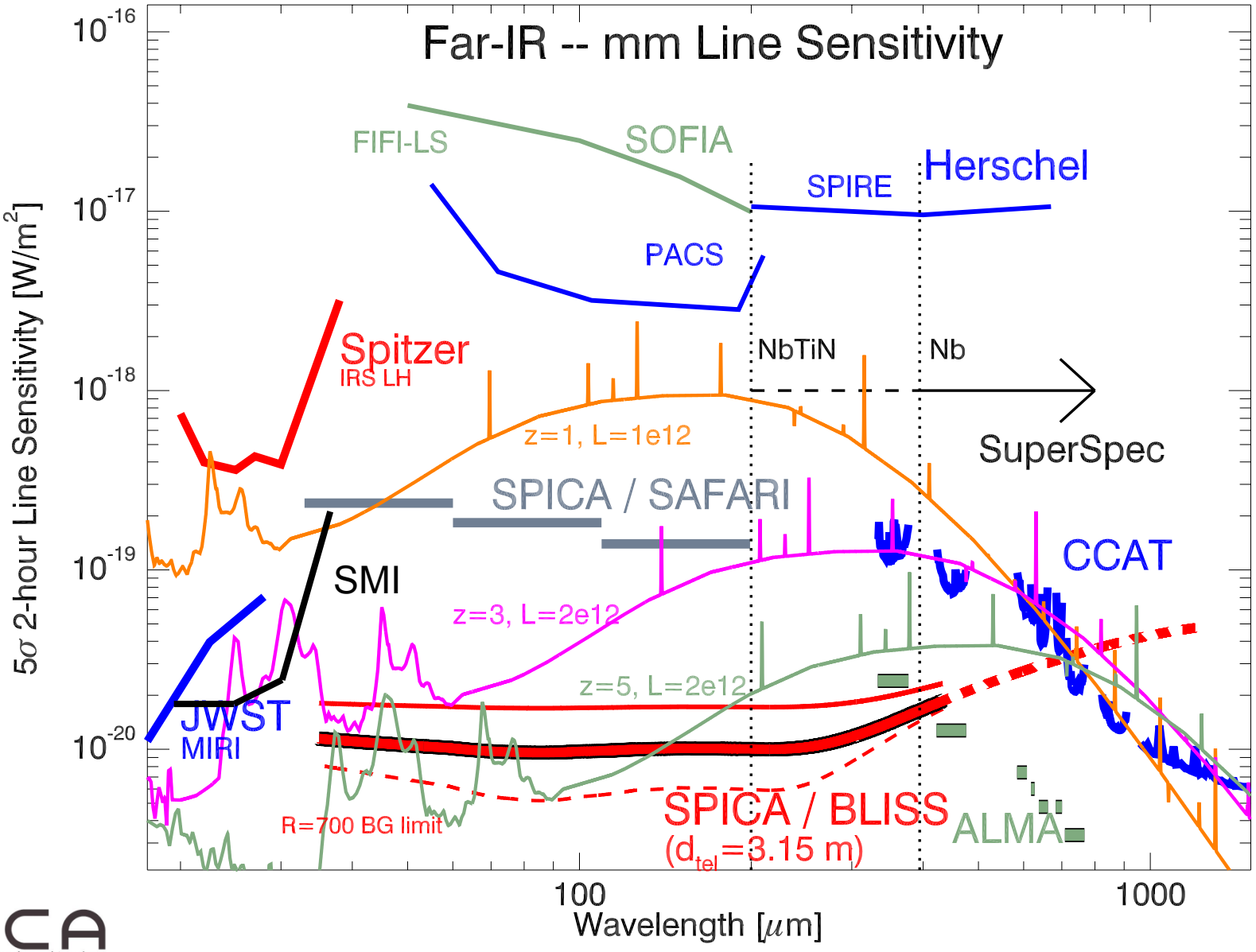


Continuum Sensitivities



From JWST

Spectral Line Sensitivities



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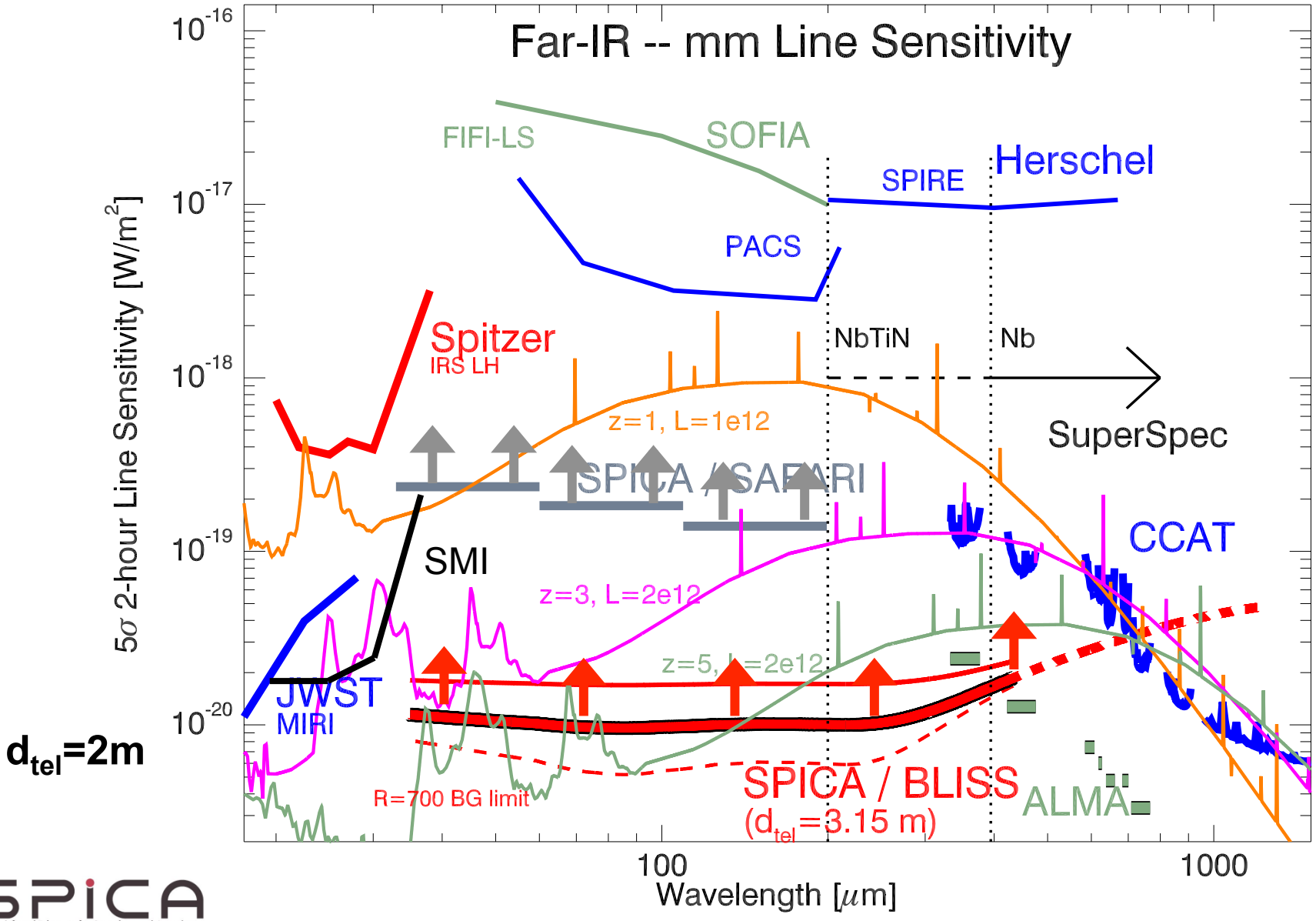
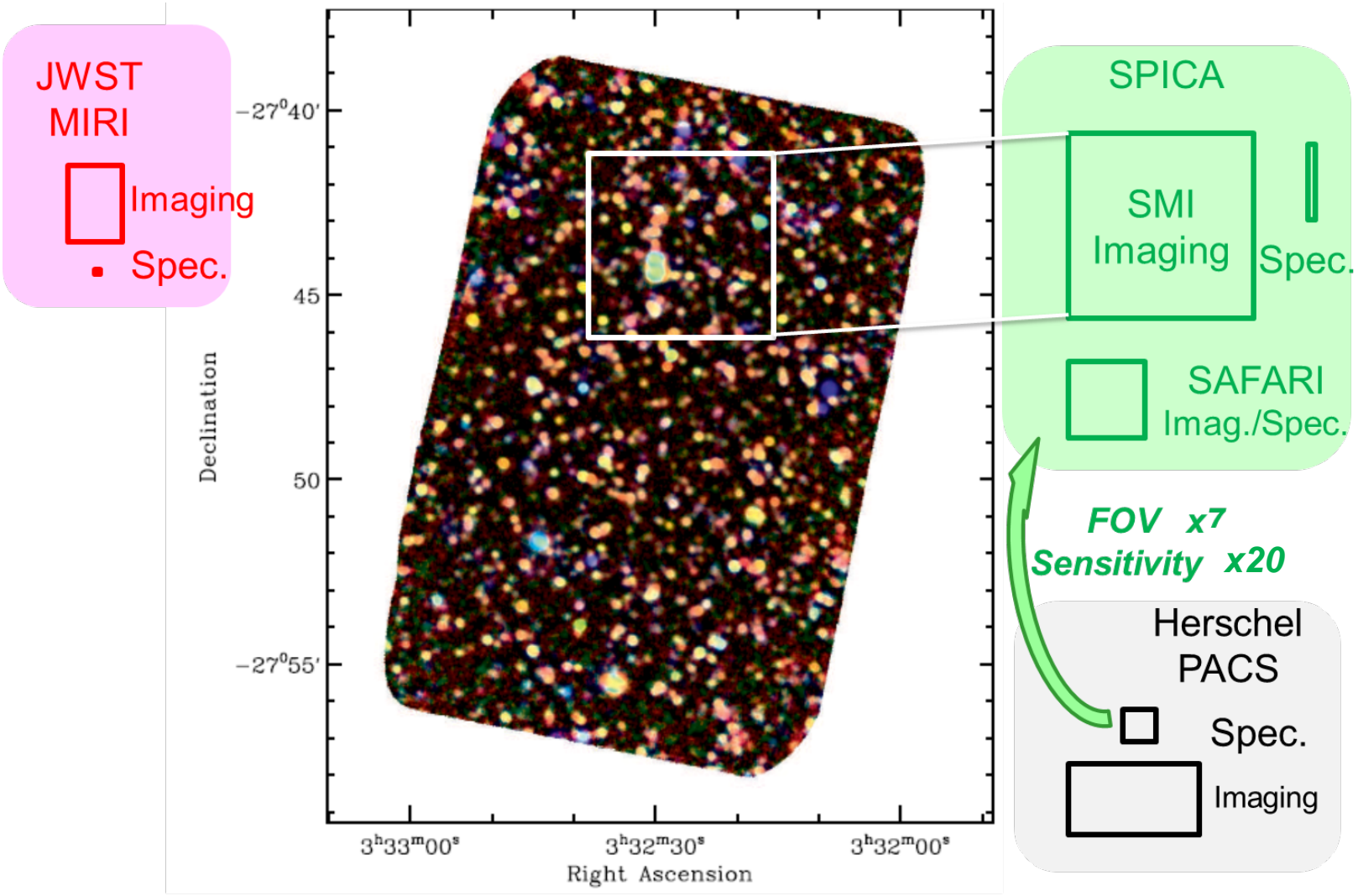
Spectral Line Sensitivities



Field of Views (Survey Speed)



Far-Infrared Deep Survey of GOODS-S Field by Herschel PACS, 200hrs Integration,
False-color Image made with MIPS 24μm, PACS 100μm, 160μm, Magnelli et al. (2013)

Current Status

- Reorganization of the Science Teaming
  - The SPICA team (Japan) & the SAFARI consortium (Europe+) will be unified into a 'New Consortium' to be the proposer both for the ESA's M5 mission and for a JAXA's science mission.
- Reorganization of the Science Program
  - The telescope aperture will be reduced.
  - Major core science cases are, however, able to be kept after this size reduction, by employing a new program for the extragalactic survey.
  - A part of original science goals of SPICA must be affected by the reduction.
- Current Schedule
  - Jan 2015 Science Meeting (Osaka)
  - Mar 2015 End of CDF study
  - Consortium Meeting (Utrecht)
  - Jan 2016 Submission of M5 Proposal to ESA
  - 2015/2016 Several Reviews for Next Project Phases in JAXA

ESA-JAXA Joint Technical Study

- Purpose of this Study
  - To find Cryogenically Cooled Telescope solution(s) that is(are) technically feasible and financially affordable by JAXA's Science Mission plus by ESA's M-Class
- Facility & Period
  - Employing ESA's CDF (Concurrent Design Facility) with Inputs of the original SPICA design from JAXA
  - Fall 2014 - Spring 2015

    (Technical sessions have already finished. Report will come soon)
- Condition
  - Telescope: 2 m (nominal) or Larger, at < 6 K
  - Wavelength: 20 - 210 μm (nominal) or Wider
- Output
  - The report will be opened to public for M-Class proposers

Role of International Partners in New Framework (To be Changed)

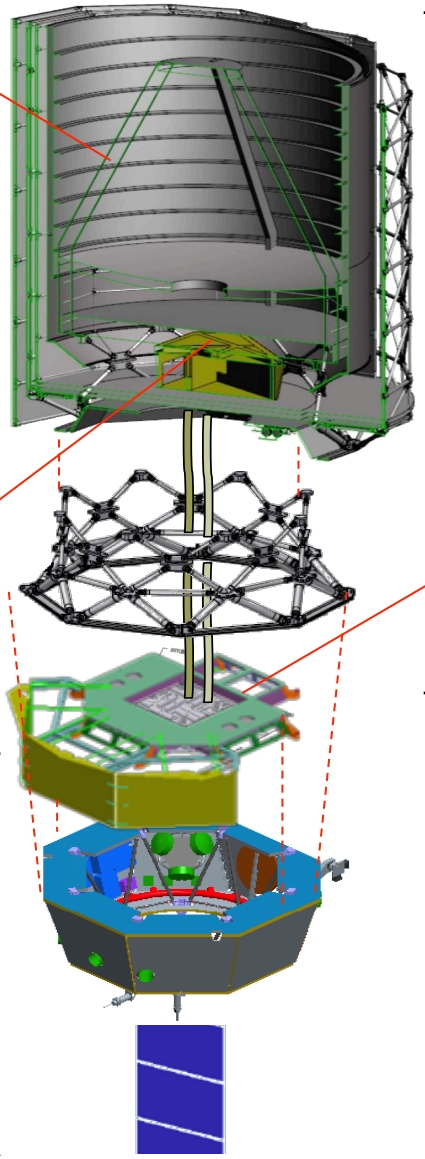
Telescope Assembly (STA)

Focal Plane Instrument Assembly（FPIA）

SPICA Far-IR Instrument（SAFARI）
Netherlands & European consortium（13 countries in total)

SPICA Mid-IR Instrument（SMI）

Bus Module (BM)



Payload Module (PLM)

Mechanical Cryo-cooler System（MCS）

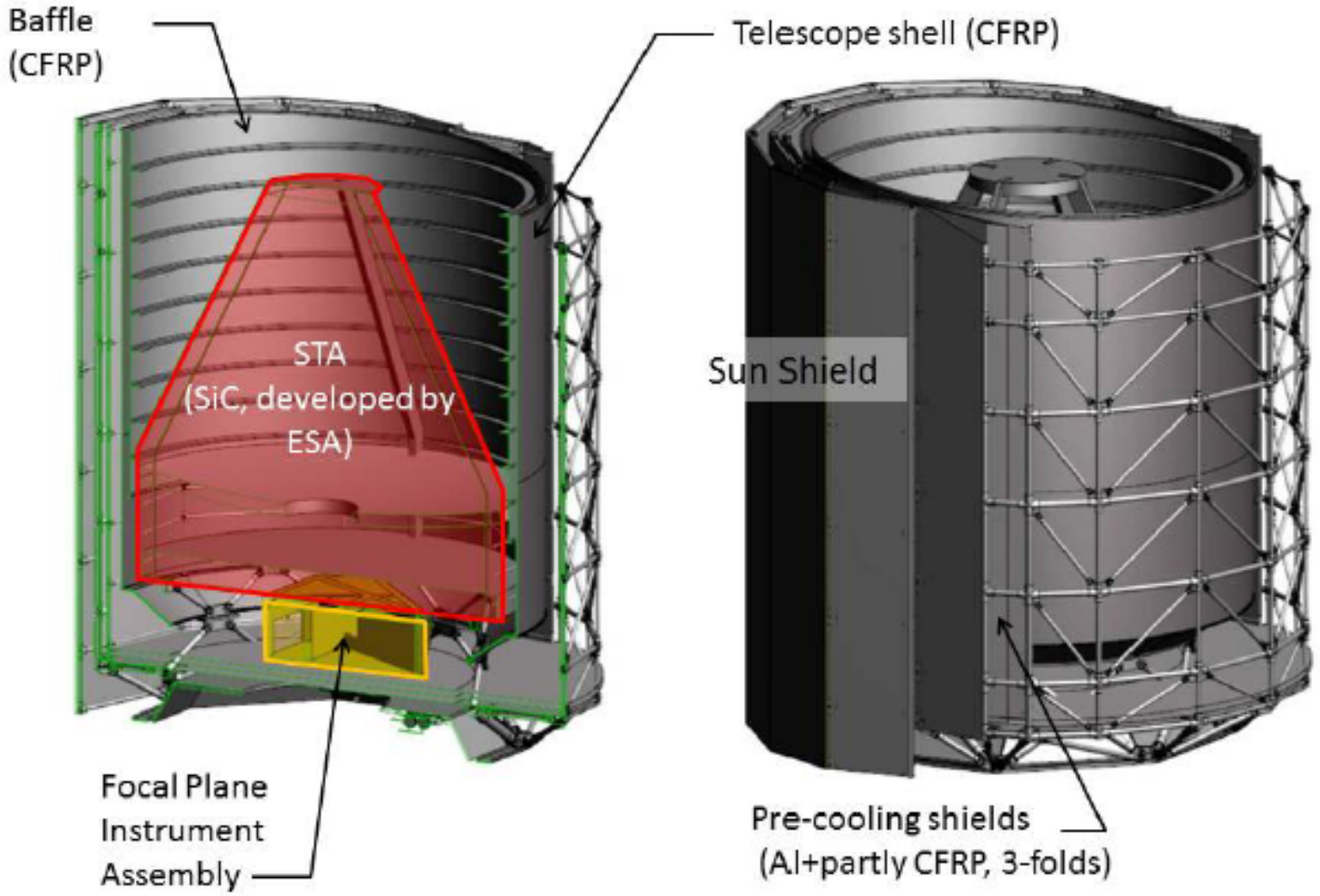
Launching Vehicle

SPICA Data Centre

Science Activities
+ S.Korea, Taiwan

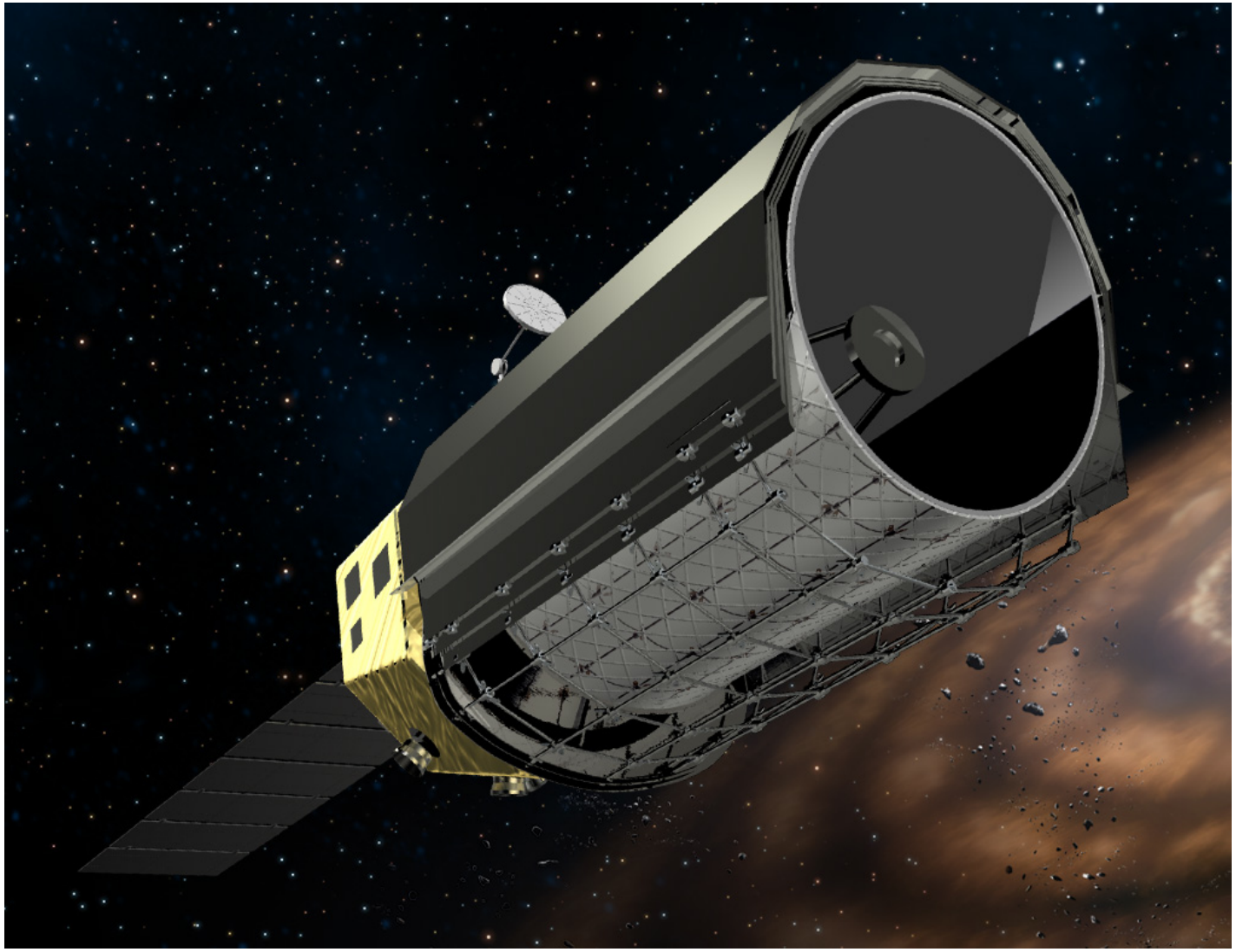
SPICA Space Infrared Tel

SPICA Concept as Developed in Japan

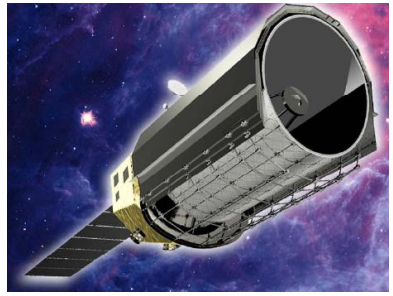


- Closed-cycle coolers with 20 K Stirling stages and JT stages at 4.5 K (40 mW EoL) and 1.7 K (^{3}He J-T, 10 mW EoL).
- Heat switches provide some redundancy against failure of a single cooler stage.

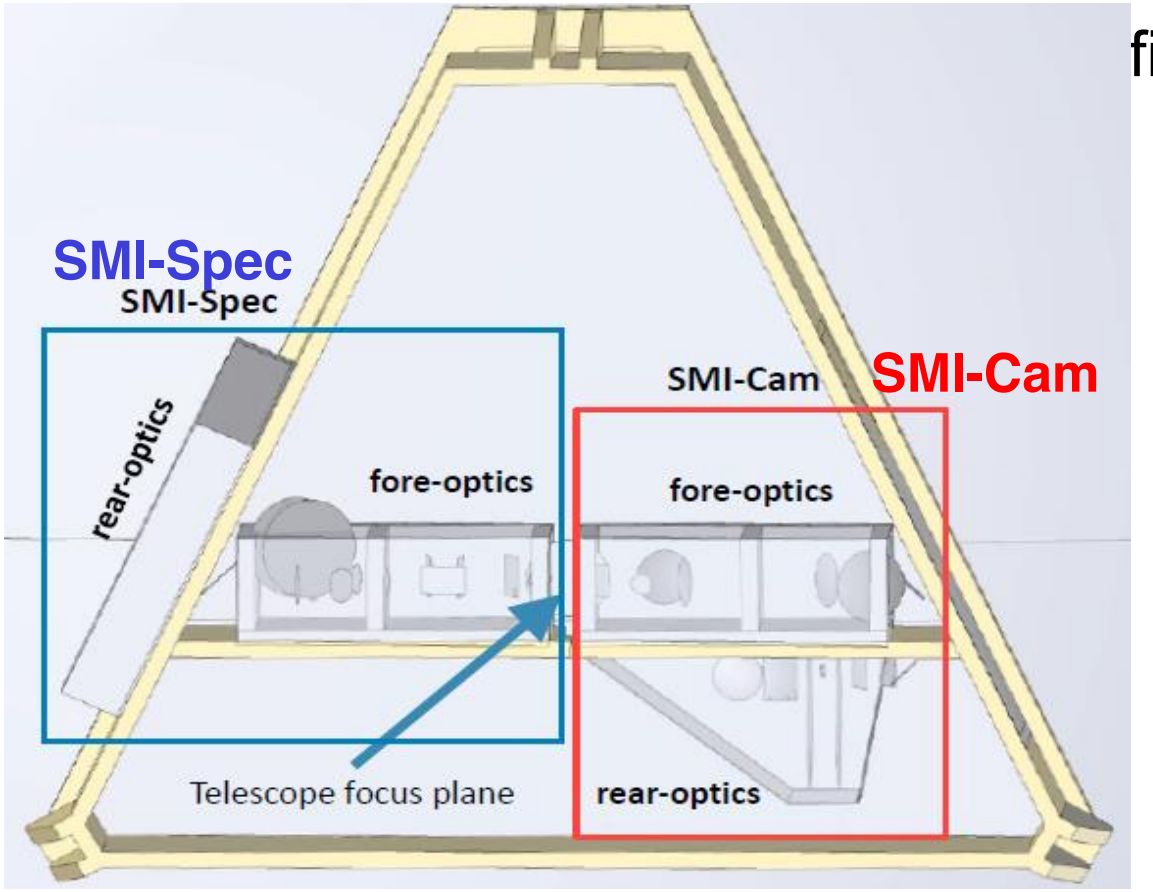
SPICA Concept as Developed in Japan



The SMI instrument – design, technical description, capabilities



Hidehiro Kaneda (Nagoya Univ.), the SMI consortium



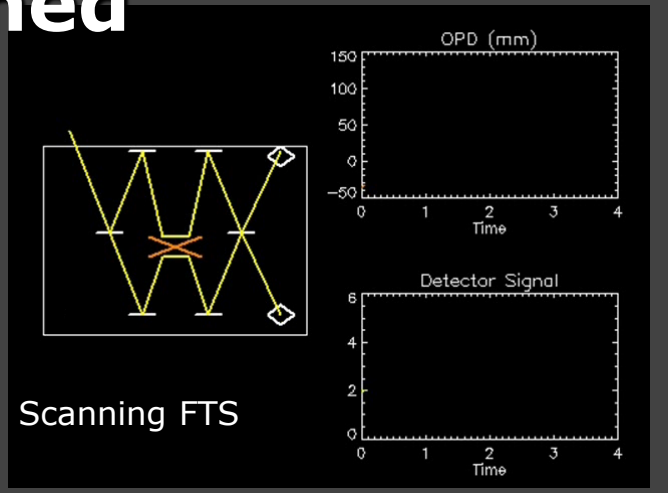
fined for new SPICA.

SMI	
20 – 37 μm FoV: 5'x5' R = 20	Cam
20 – 37 μm (17-20 μm optional) slit size: 150" x 3" R = 1000	Spec
N/A under discussion	

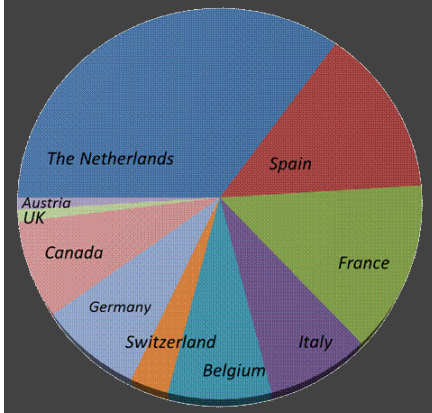
Focused on longer wavelengths and higher mapping efficiency.

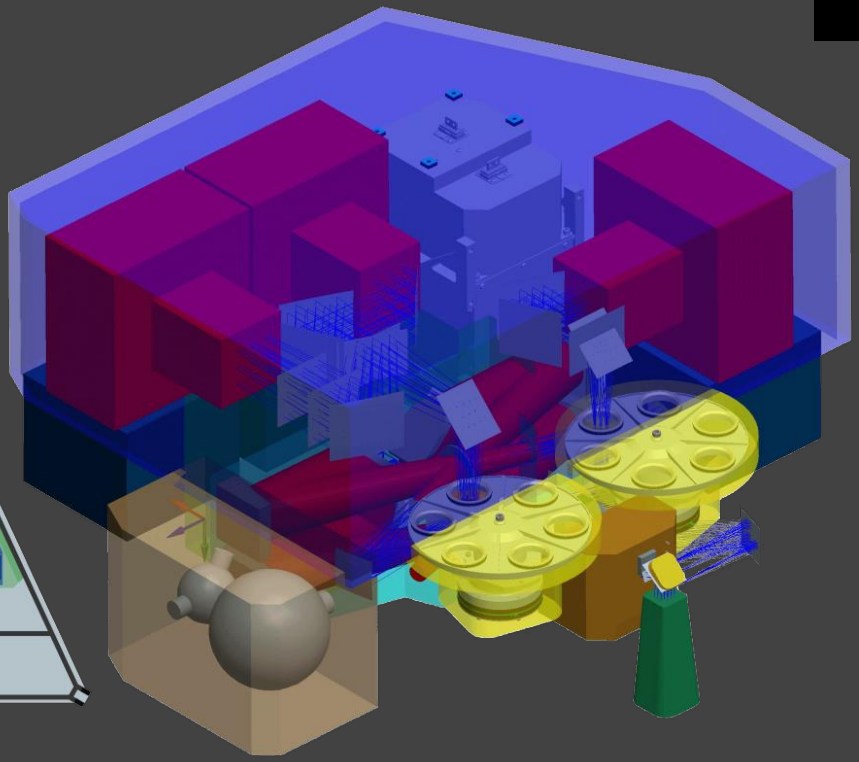
SAFARI reference design – very well established

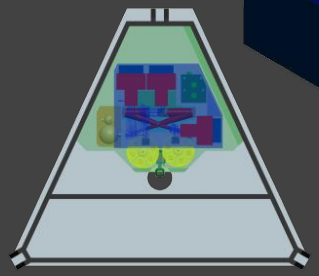
- Scanning Fourier Transform Spectrometer with 2'x2' FoV
- Simultaneously observing in 3 bands → 34-210μm
- TES detectors/SQUID read out at 50 mK
- Frequency Domain Multiplexing
- Dispersive element; slit/grism/FP to reduce background
- To be built by an SRON-led consortium
  - ~15 institutes in Europe, Canada, Japan - cost ~170M€

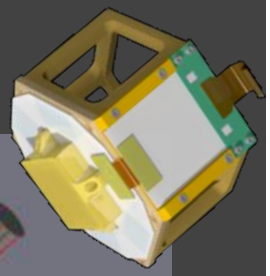


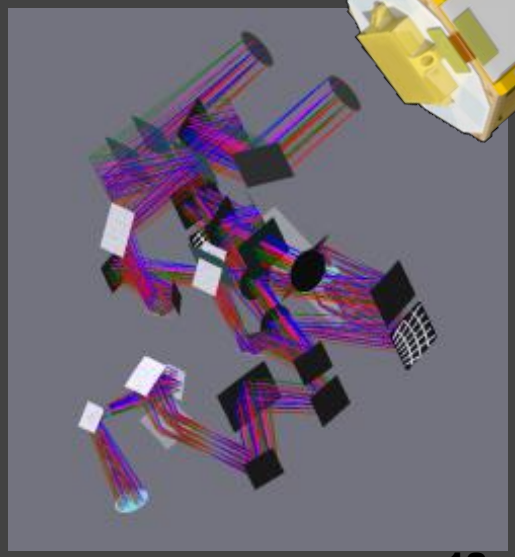
Scanning FTS







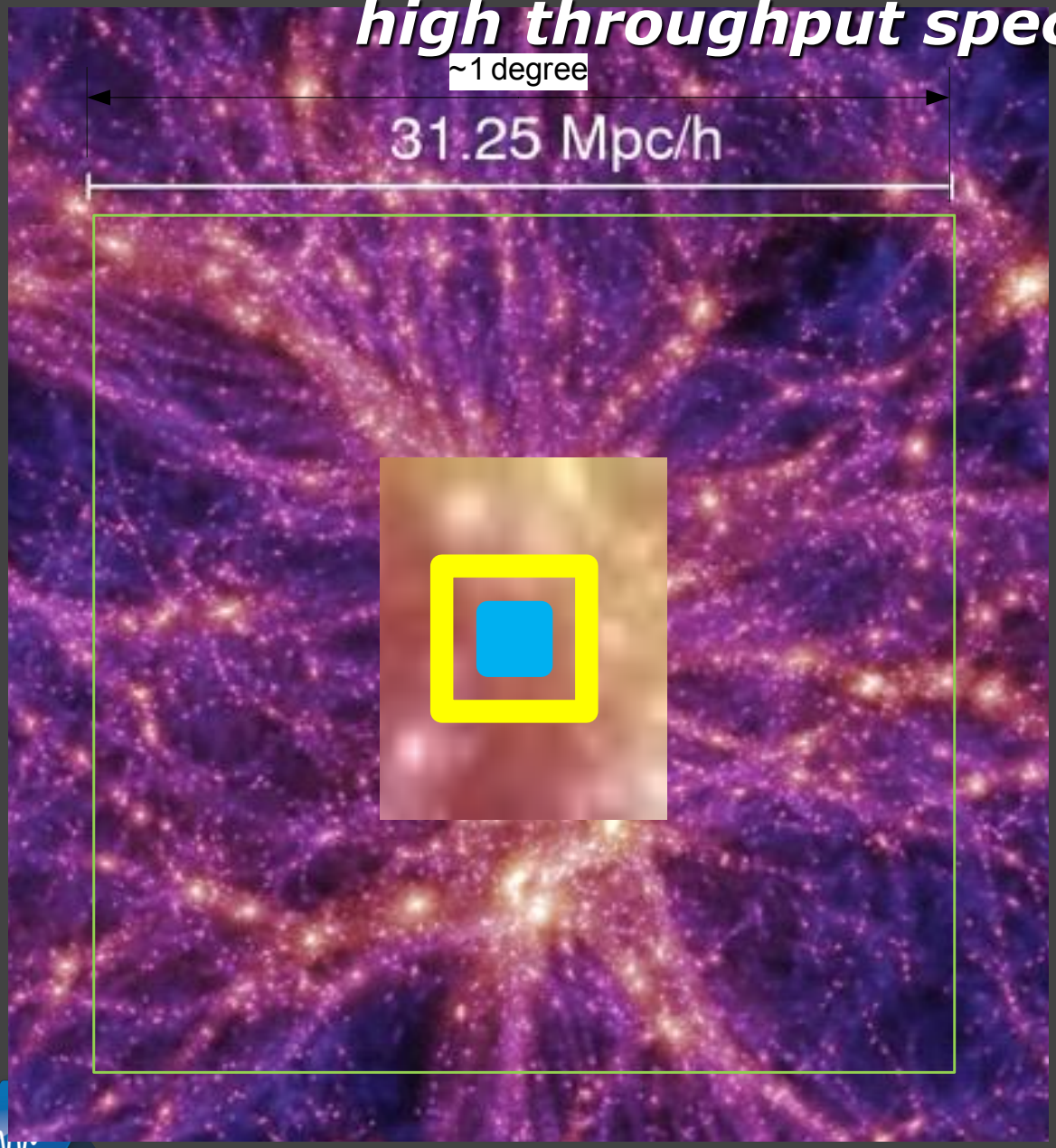




SAFARI
SRON

12

SPICA's true power – *high throughput spectroscopic* mapping



Field of view:

- SAFARI: yellow box
- PACS: blue dot

SAFARI

- **900 hours for 1°x1° field** to 5×10^{-19} W/m^2 (5σ)
- Full 34-210 μm spectra

...already >>1000 times faster!

PACS

- **~1800 hrs** same sensitivity for only **a single pointing**
- 60-210 μm

Summary and Outlook

- **ESA's CDF study results are encouraging and leave open a number of avenues towards a SPICA mission that the joint European/ Japanese SPICA team will be investigating in detail.**
  - (Not yet available for public release.)
  - Apertures between 2 and 3 meters under consideration.
  - Smaller Planck type mission was the baseline for the CDF study, found to be easily feasible in the M5 cost cap.
  - Study activities may also indicate that larger apertures are also affordable.
- January 12-13: SPICA science team meeting in Osaka to see how the CDF result (primarily mirror size) affects extragalactic science program.
- January – mid-March: consortium will develop 2 or 3 mission scenarios (trading mirror size with instrument package) for SPICA.
- **March 25-27: SPICA meeting in the Netherlands to decide which of these scenarios is most suitable for Cosmic Visions M5 Proposal**.
- **Details of instrument payload are still TBD. US participation welcomed if it can strengthen the mission and fit in the allocations.**
  - **Spectrometers and sensitive detectors a key unique capability.**

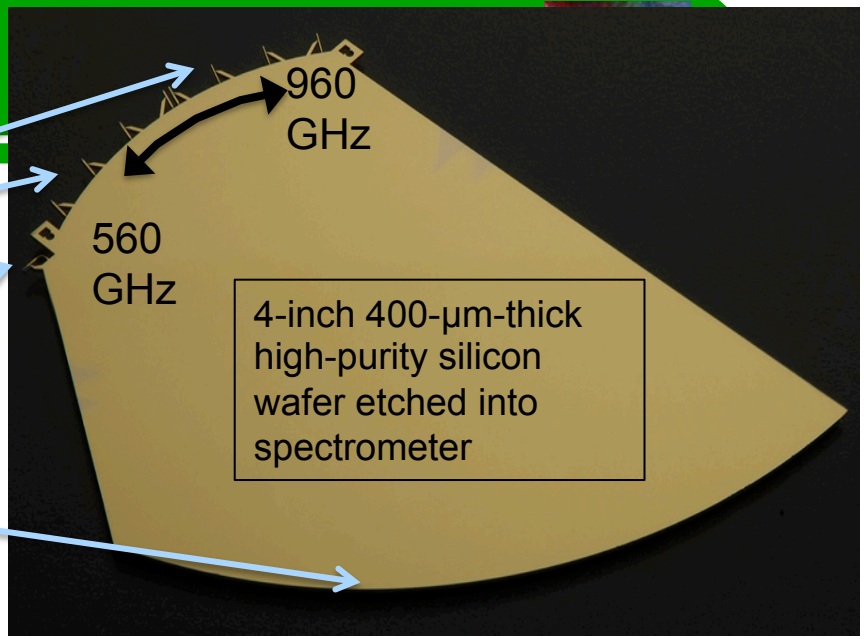
Technology for SPICA

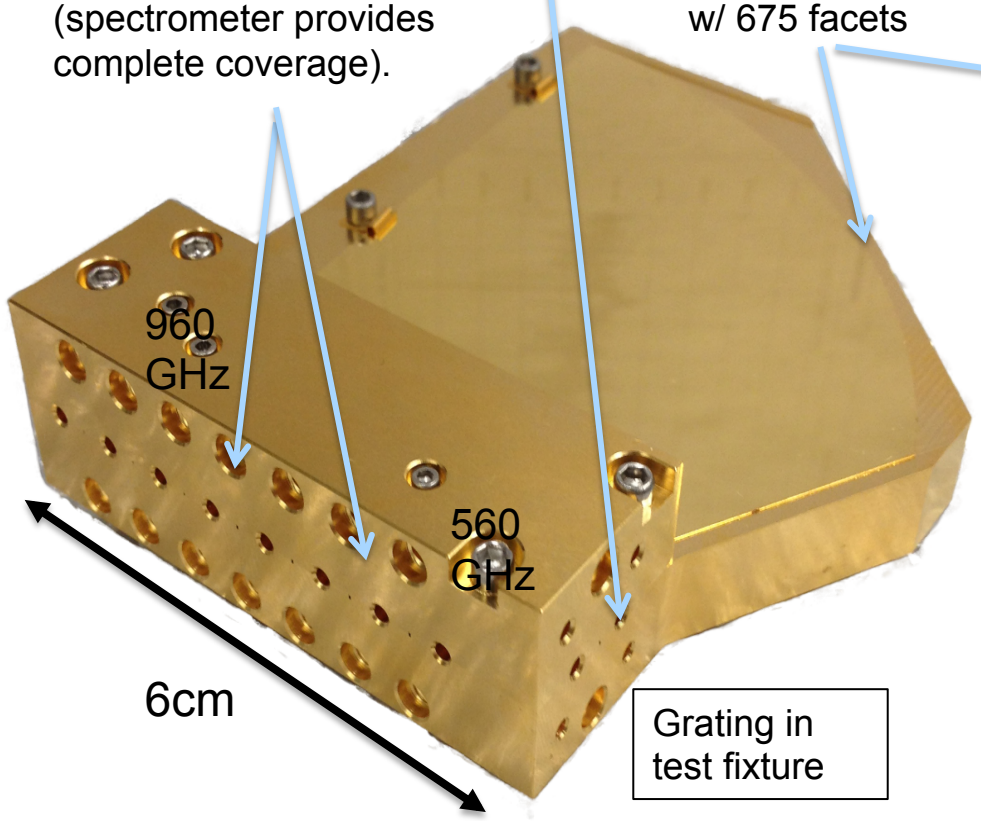
Silicon Waveguide Spectrometer

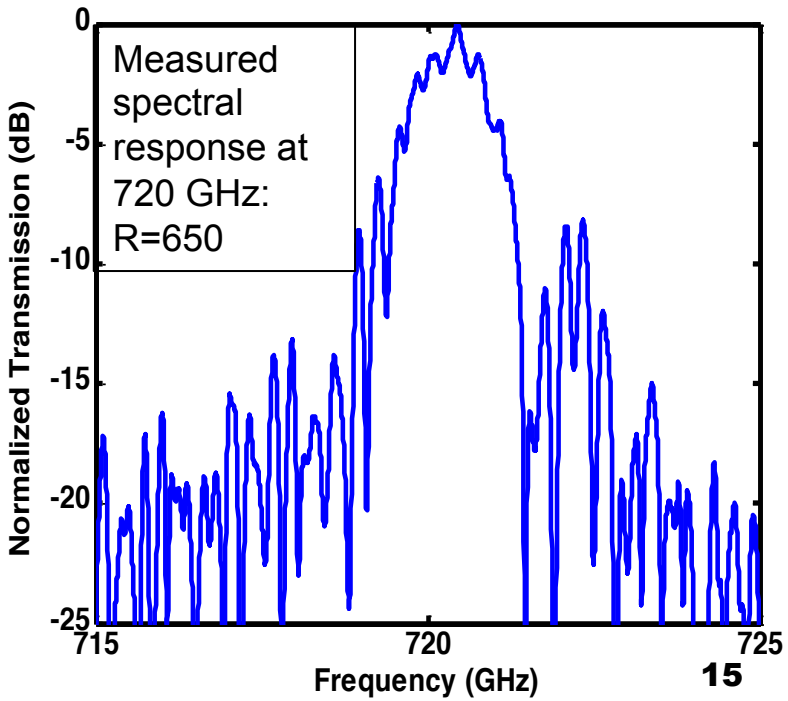
Output ports put at discrete frequencies for initial testing purposes (spectrometer provides complete coverage).

Input port

Etched grating arc w/ 675 facets







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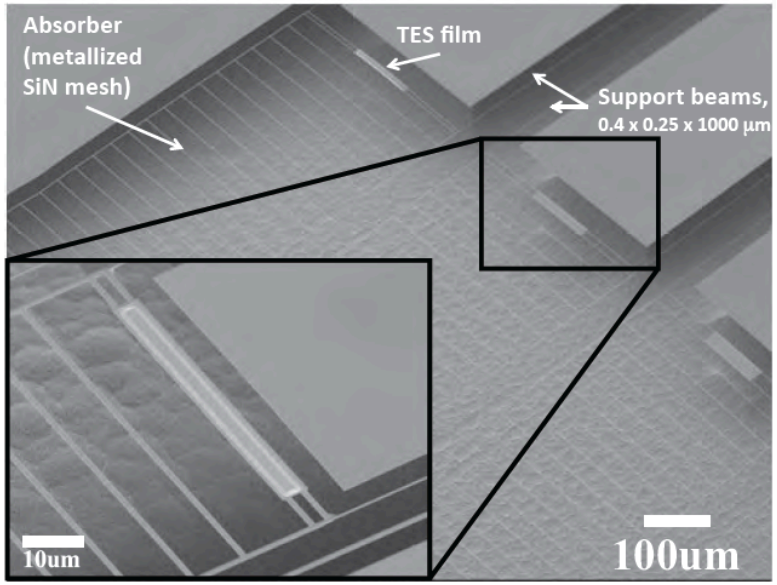
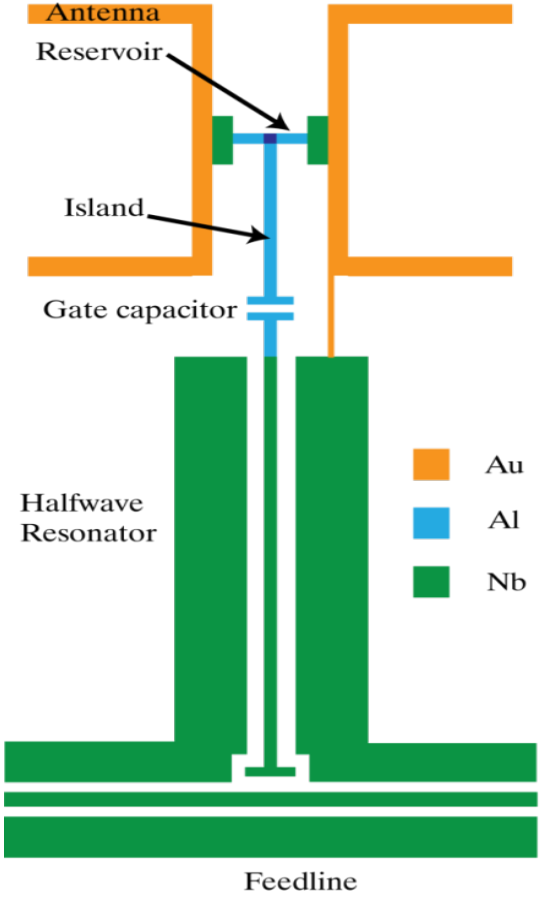
Technology for SPICA

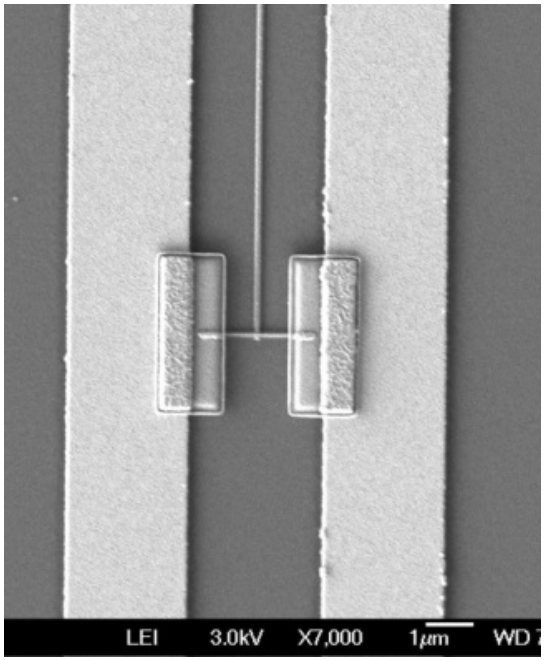
Low-NEP detectors enabling background-limited spectroscopy

TES bolometer



Quantum capacitance detector (QCD)





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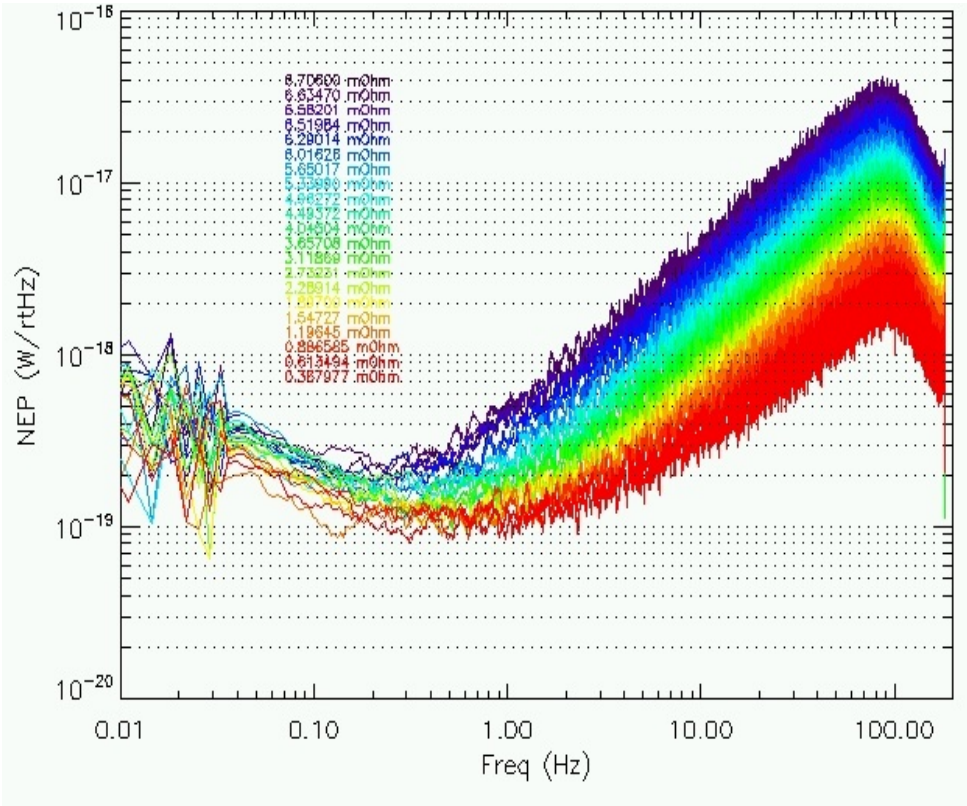

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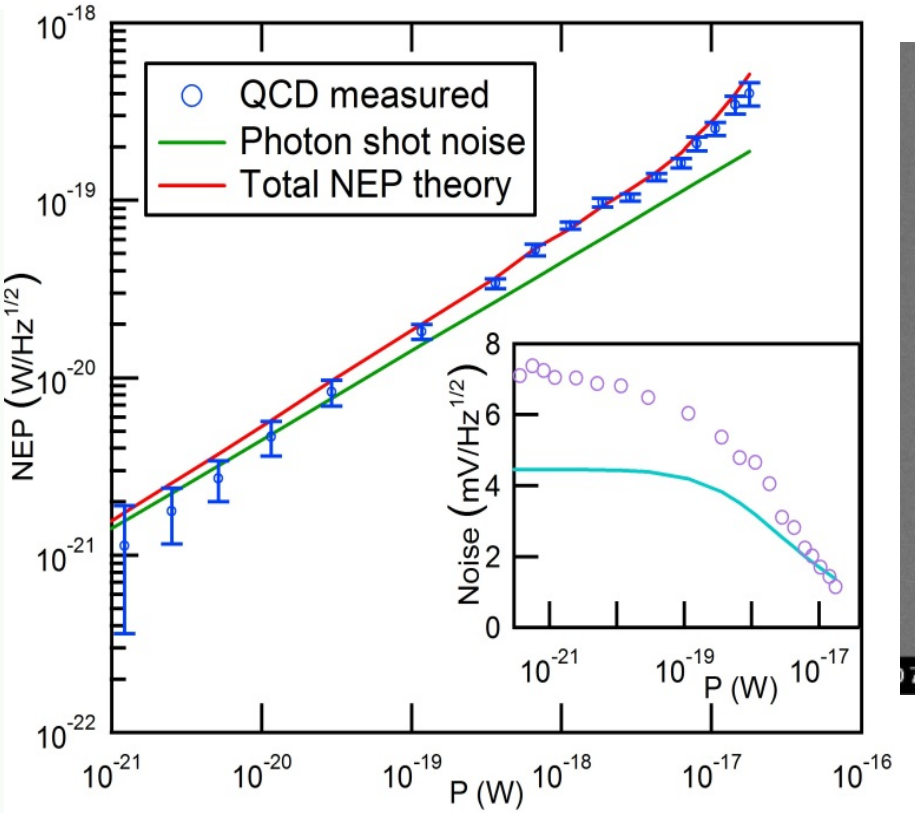
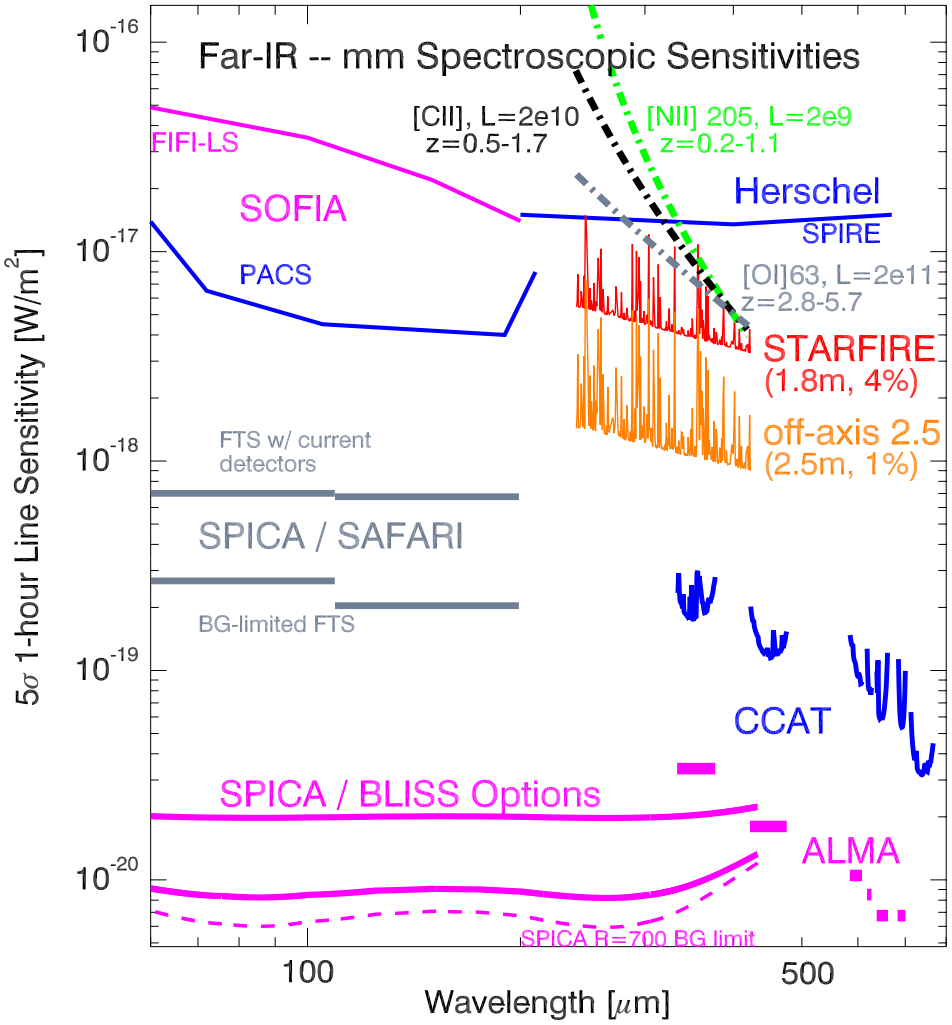
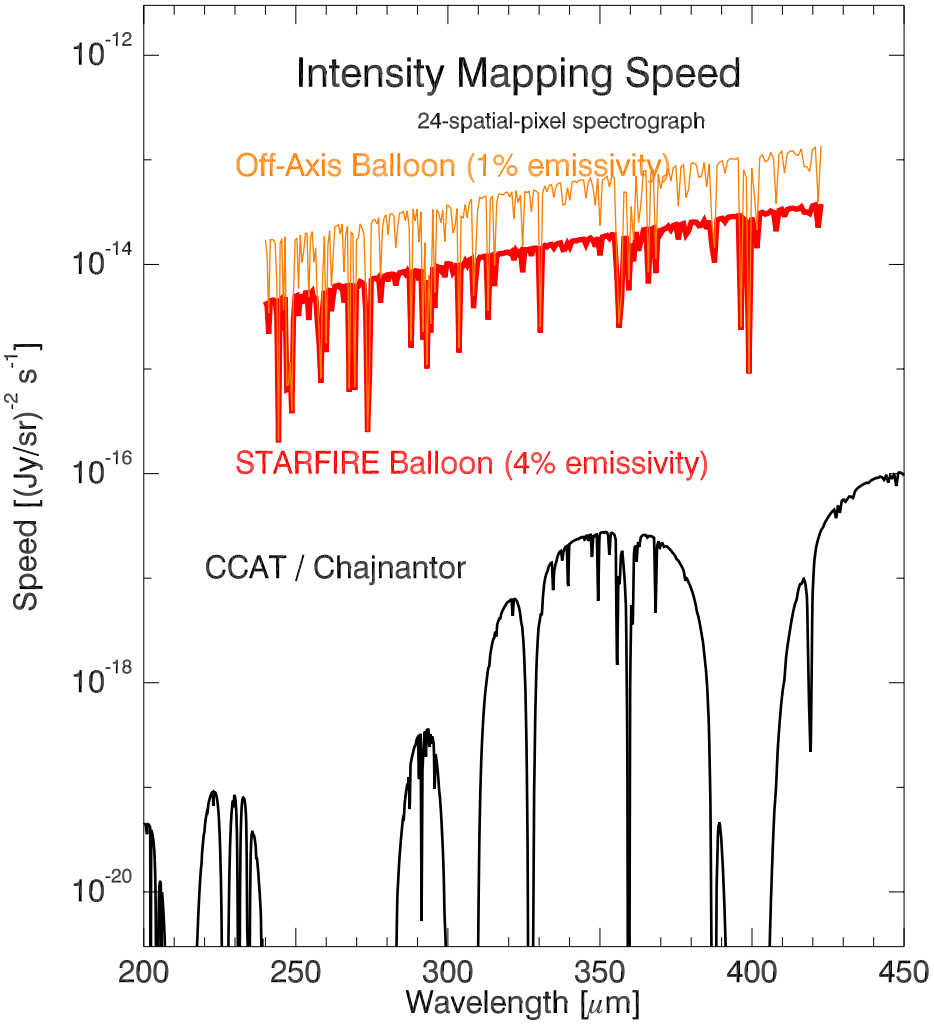


Balloon-borne Precursor (ICarIS / StarFire)

- Wideband spectroscopy of bright dusty galaxies in the far-IR band (shortward of ground-based windows).
  - e.g. C+ from z=0.5 to 1.5,
  - At least 3x more sensitive than Herschel PACS & SPIRE (>10 x faster)
  - Lensed far-IR sources easy.
- Power spectra of C+ in redshift: moments of galaxy luminosity functions.
- D~1.8m telescope (pointed), low (1-4%) emissivity,
- few to ~20 spatial beams, each with a wideband dispersive spectrometer.
- 2000-4000 background-limited detectors (TiN KIDs, lens-coupled)
- James Aguirre [PI], Mark Devlin, Simon Dicker: U. Penn: instrument + telescope + gondola
- Matt Bradford, Steve Hailey-Dunsheath, Chris McKenney: Caltech / JPL: detectors + instrument
- Bade Uzgil, U. Penn + JPL GSRP fellow: power spectrum analysis

Balloon Platform Sensitivity





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- extras

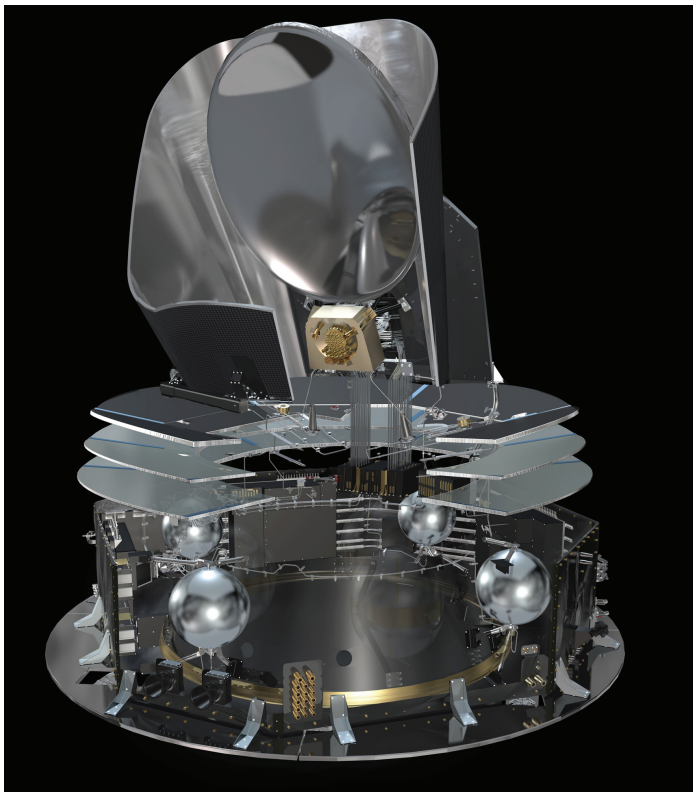
ESA CDF Study – Considering Planc

40 K

50 K
100 K
150 K

300 K

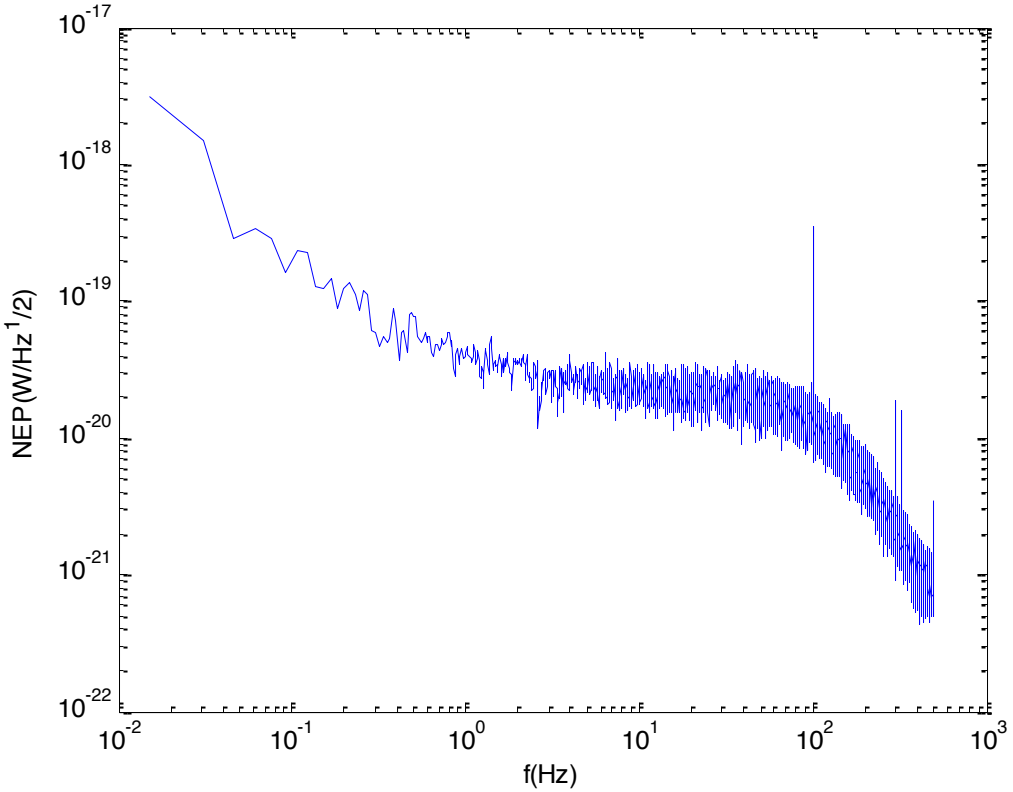
370 K



Sun, Earth, & Moon

QCD NEP measurement

NEP calculation:
Gate frequency 1 kHz; 2V pp (=1 Cq peak)
Modulation 100Hz; 10% duty cycle
Demodulation by SR830 lock-in; Time constant 1ms =500Hz bandwidth; looking at X output
Time stream: rate 1000Hz, 200000 samples (200s acquisition)



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