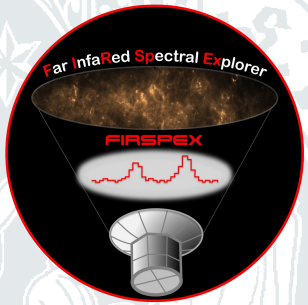
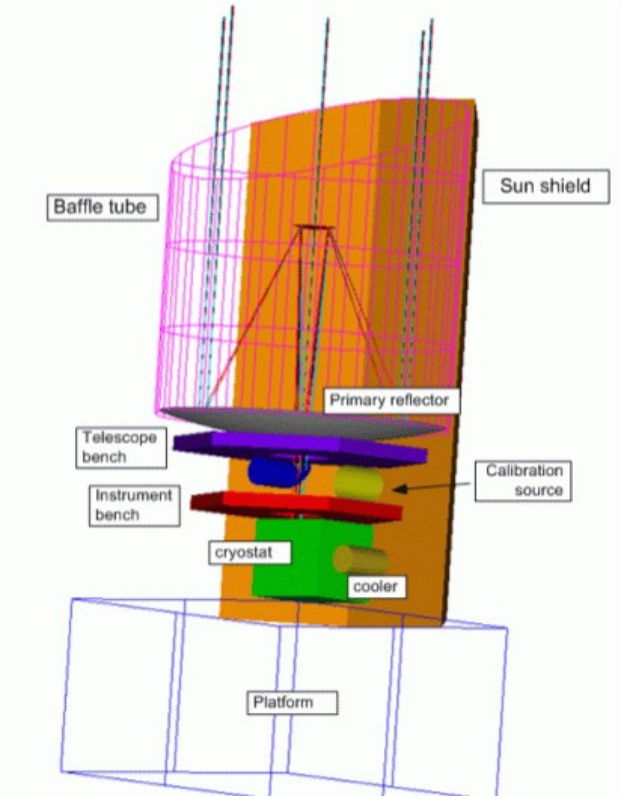
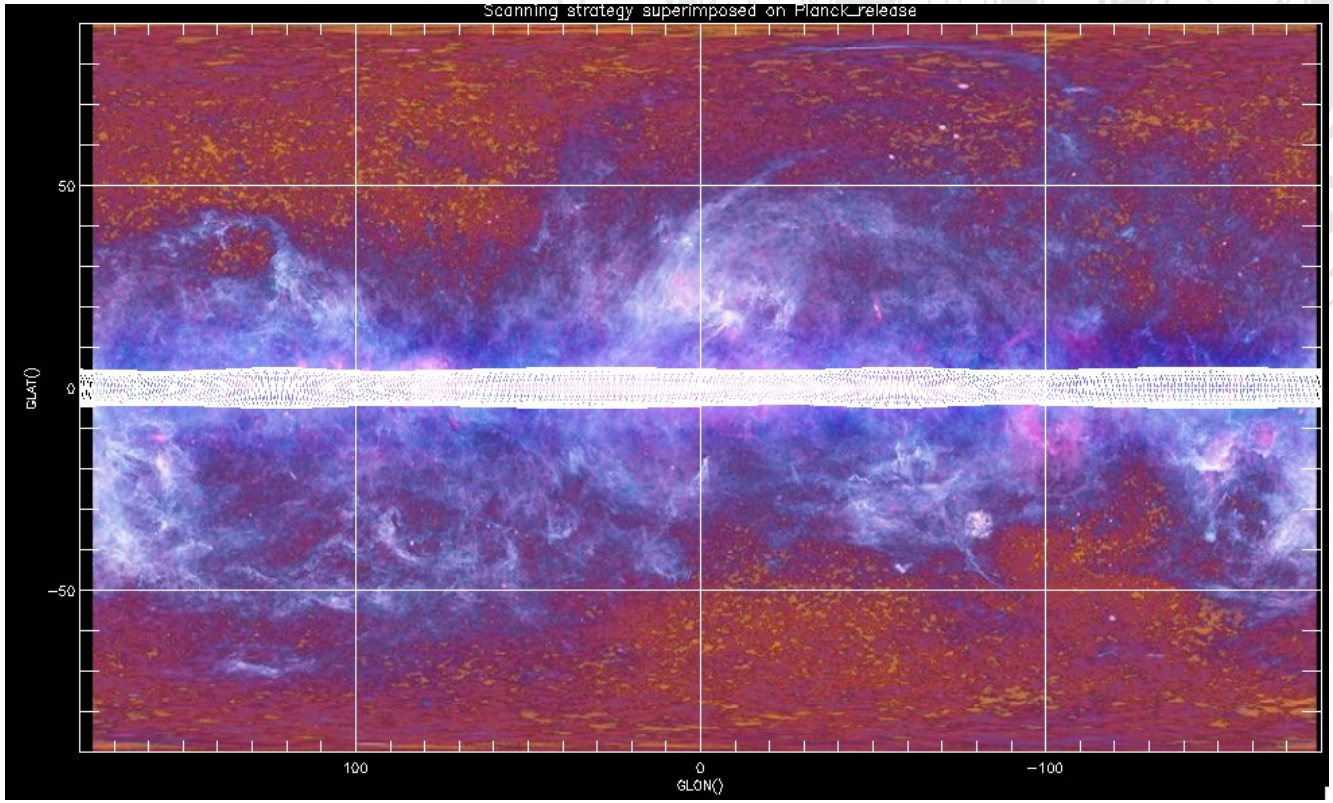
FIRSPEX

(Far-Infrared Spectral Explorer)







PI: Dimitra Rigopoulou (University of Oxford, Rutherford-Appleton-Laboratory)

Mission science

Spectroscopic equivalent to Herschel continuum survey of Galactic Plane

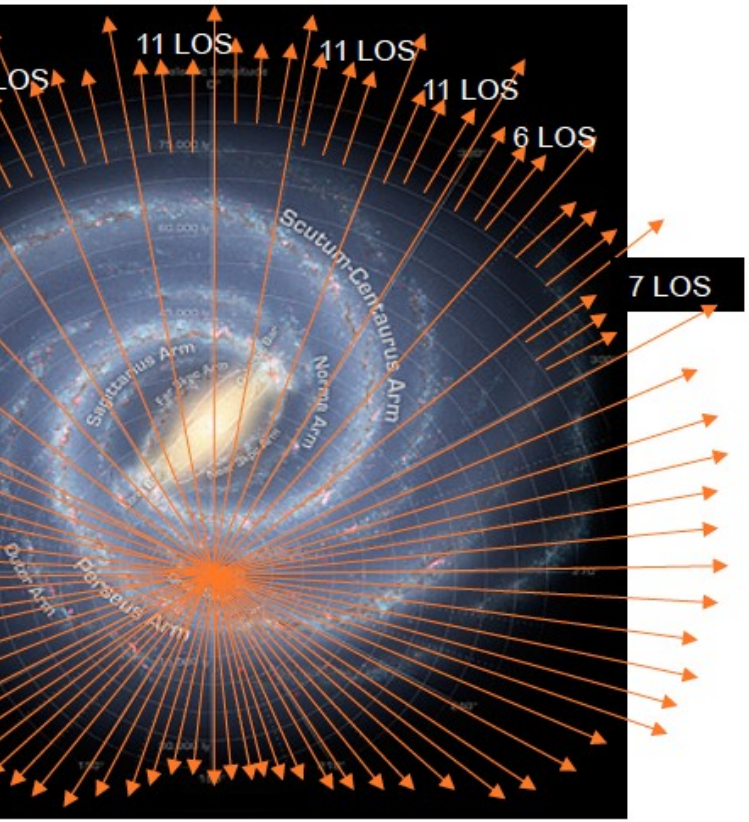
Channels: **[CII]** 158 μm, **[NII]** 205μm, **[OI]** 63μm, **[CI]** 370μm
Spectral resolution: ~10^6, spatial resolution: 2.4'

Science goals: "Decompose Galaxies" - tracing the phases of the ISM

- Distribution of fundamental elements: C, N, O
- First census of atomic, ionic, and molecular material
- Cold and warm material above the Galactic plane
- Follow assembly of clouds in the Milky Way
- Delineate the transition of atomic to molecular clouds
- Characterize environment of nearby galaxies

Motivation

HIFI and GREAT surveys of [CII]



GOT C+
(Pineda et al. 2010, 2013)

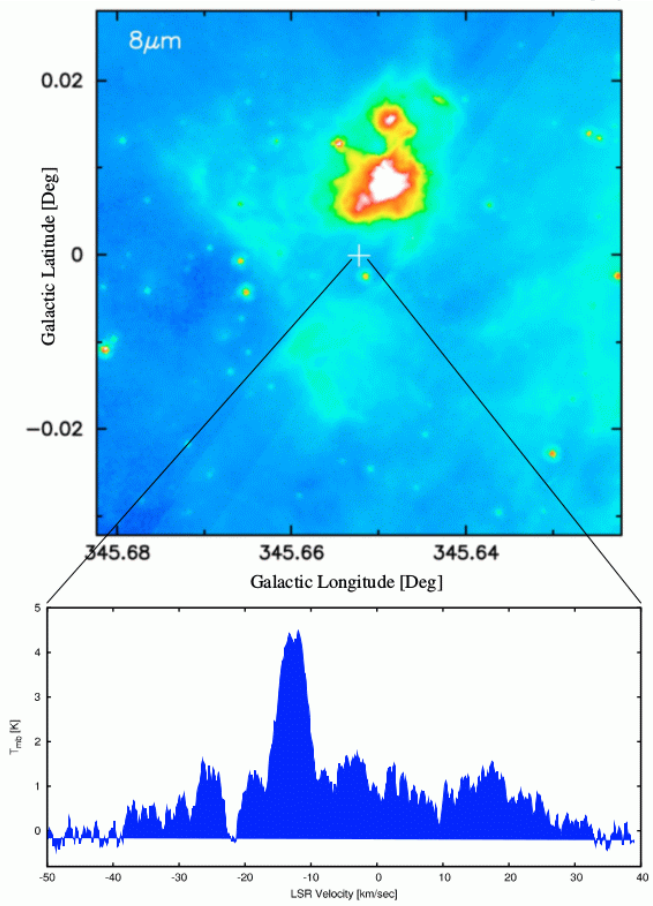
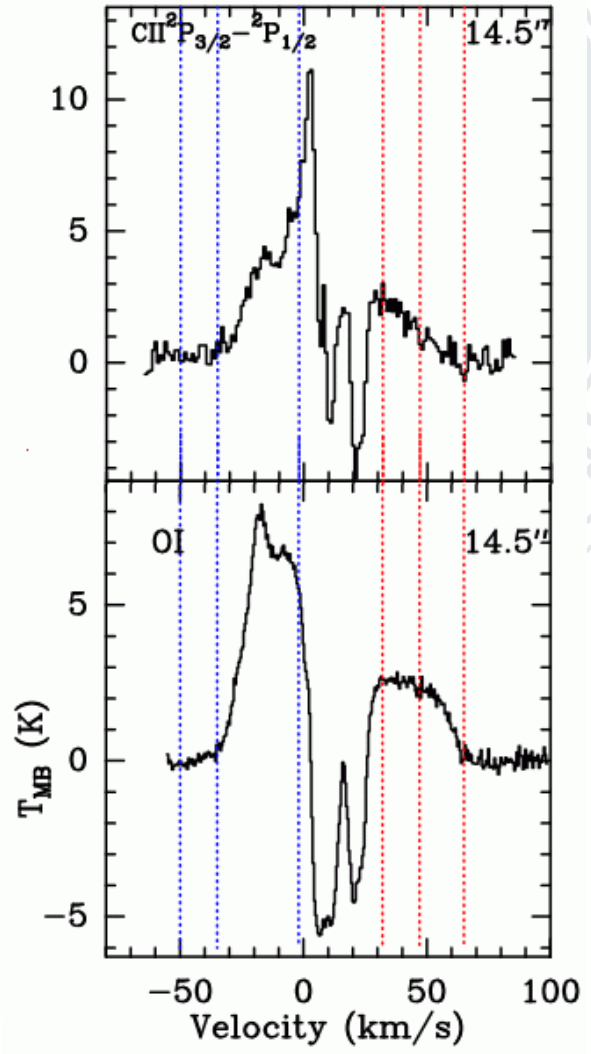


Fig. 3. Example of [CII] emission associated with a massive star-forming region. The line-of-sight G345.65+0.0 passes near several bright H II regions as shown in the *Spitzer* 8 μm image.



SOFIA: Typical line profiles
(Leurini et al. 2015)

Spectral resolution is the key!

Mission science

2 Science programs:

- Deep Galactic Plane Survey
- 3D mapping of Nearby Galaxies

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Science Case Galactic Survey

V. Ossenkopf-Okada & P. Goldsmith

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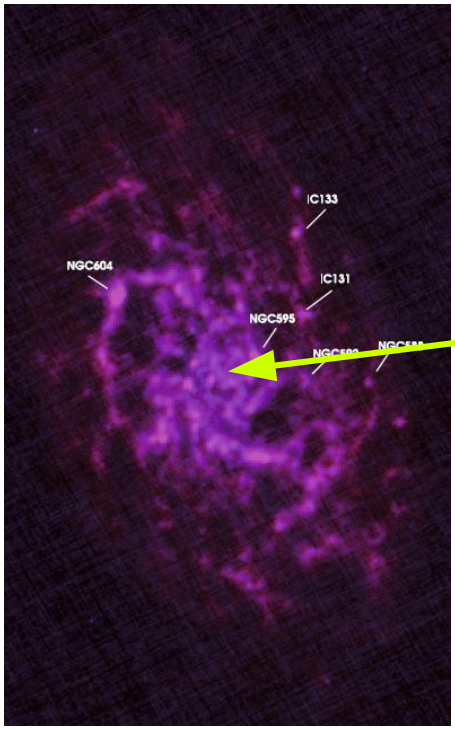
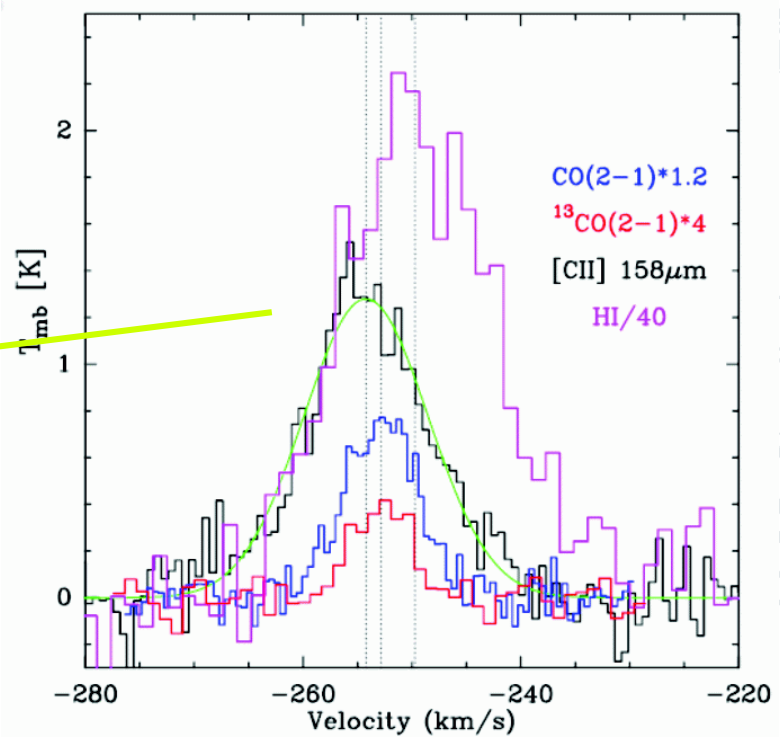
Mission science

Nearby Galaxy Survey

S. Viti & C. Kramer



M33 (Kramer et al. 2010, Mookerjea et al. 2013)

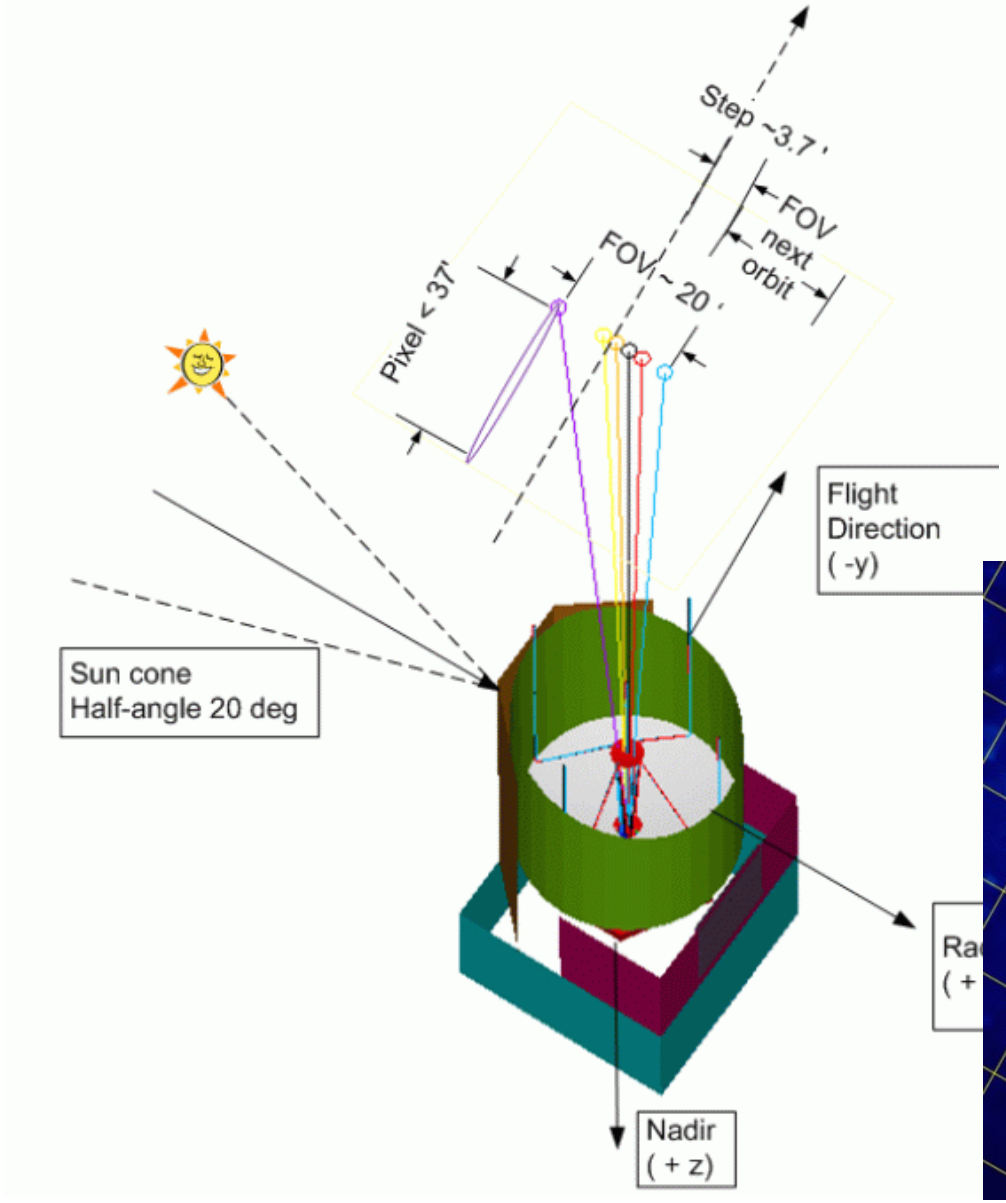


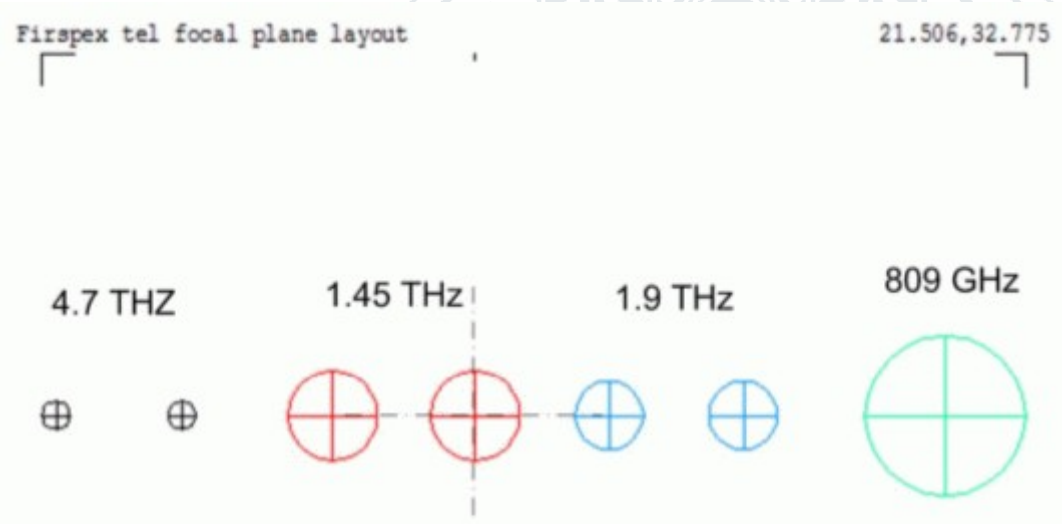
- Quantify the amount of each phase of the ISM in a range of galaxies.
- Obtain the mass and characteristics of the gas contained within each component for different type of galaxies.
- Determine how the contributions of each ISM phase differs across types.
- Deduce how these properties affect Star Formation Rates.

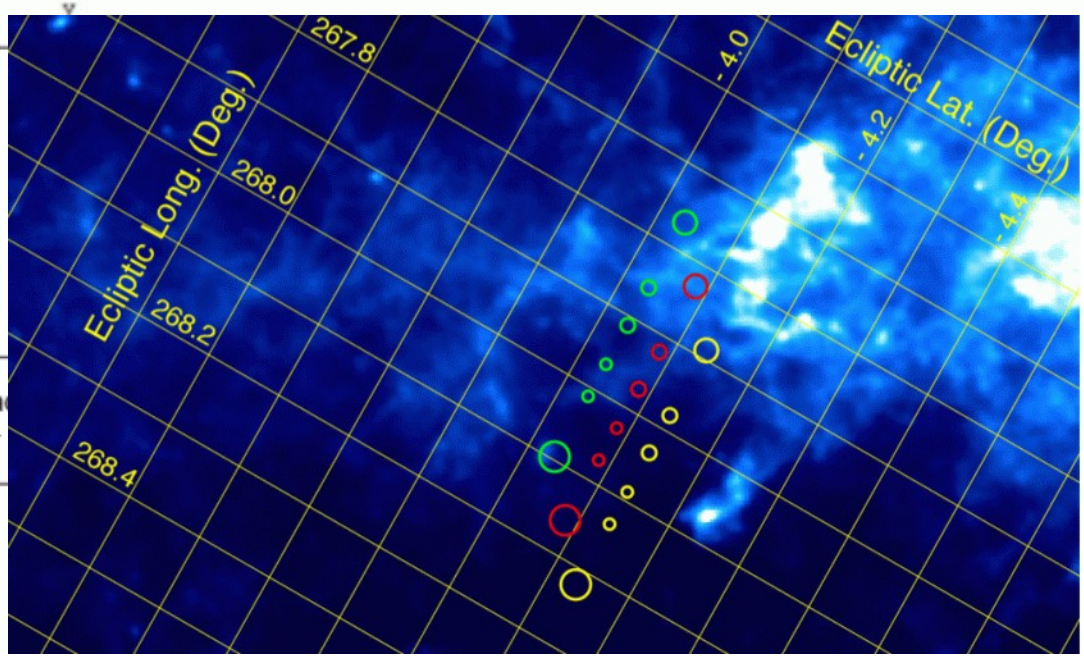
Problem: very limited tuning range

Mission design

Scan large field by spinning satellite

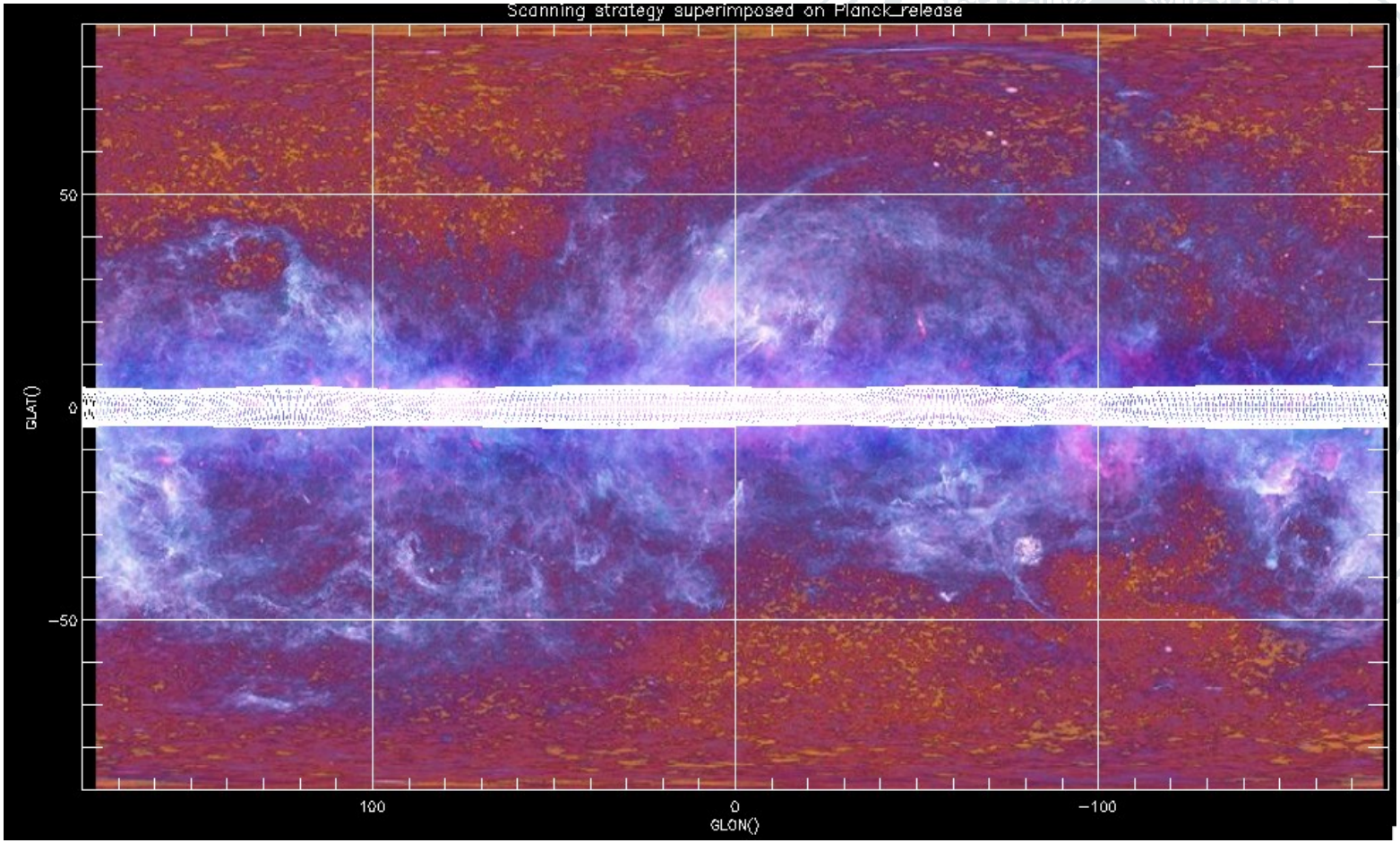






Mission design

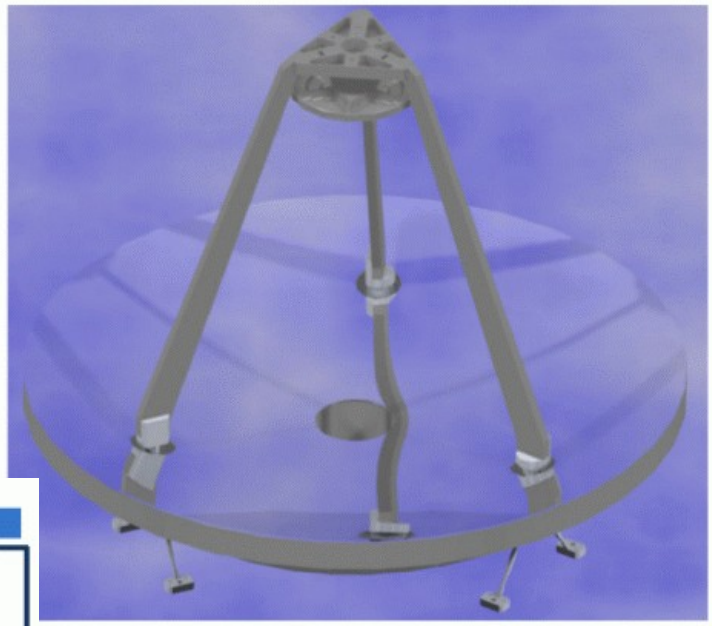
Deep Galactic Plane Survey



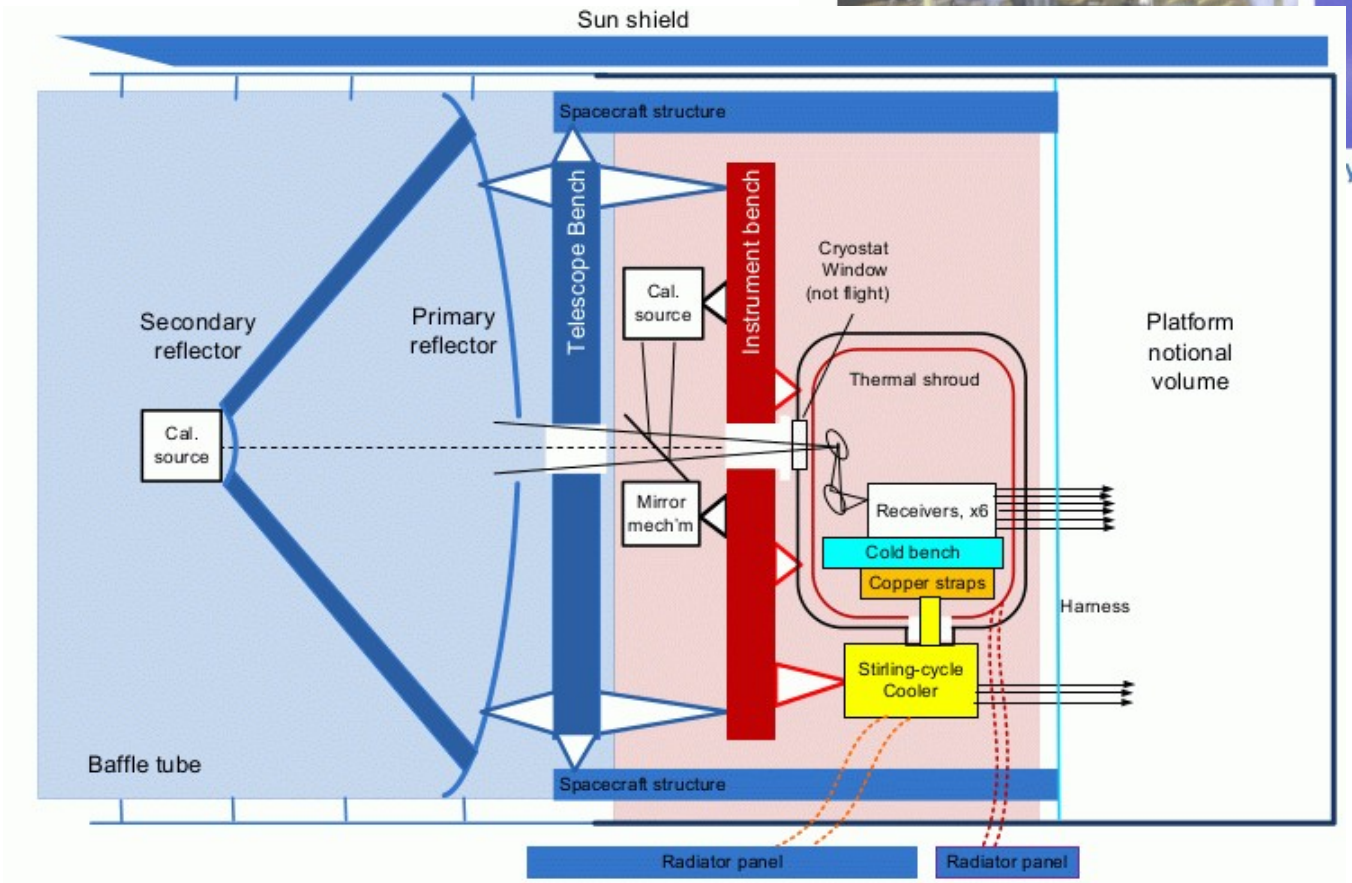
- Effective spatial resolution 2.4' (telescope beams smaller 0.3 – 1.9')
- 10° width (9% of the sky)
- Integration time: 4 x 4.8s (= 2 years)
- OTF-Load chop reference scheme
  - Noise in 0.8km/s channels: [CII] 0.05K, [OI] 0.09K, [NII] 0.04K, [CI] 0.02K

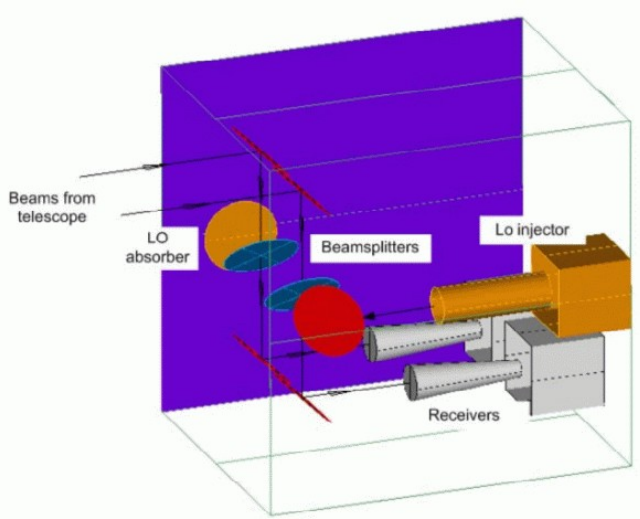
Technical design

- 120cm telescope
  - passively cooled
- J-T and Stirling coolers to 4K for receivers
- HEBs(SIS for 809GHz)
- FFTs

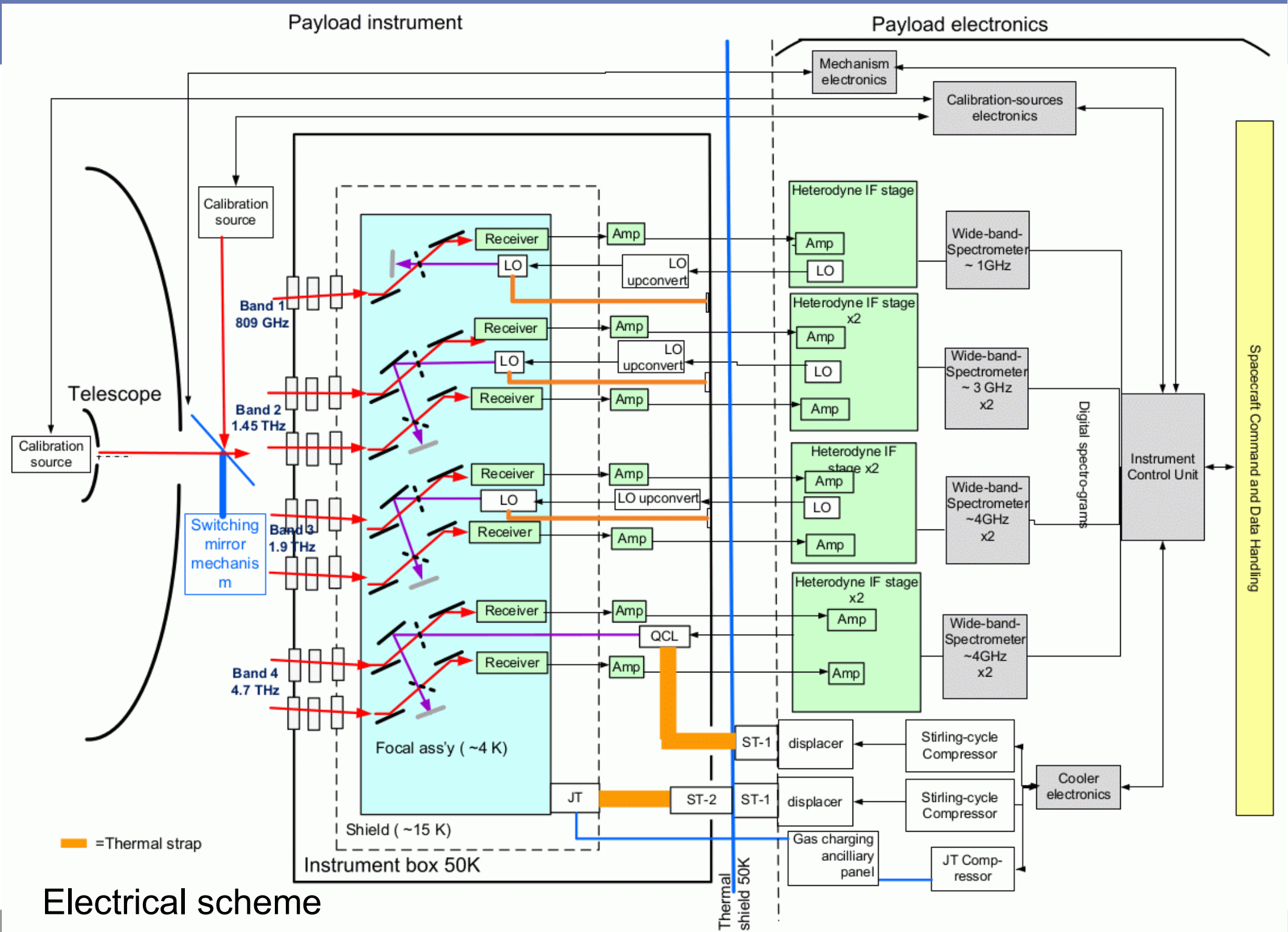


y Airbus-DS Toulouse. Right: Possible design for Firspex

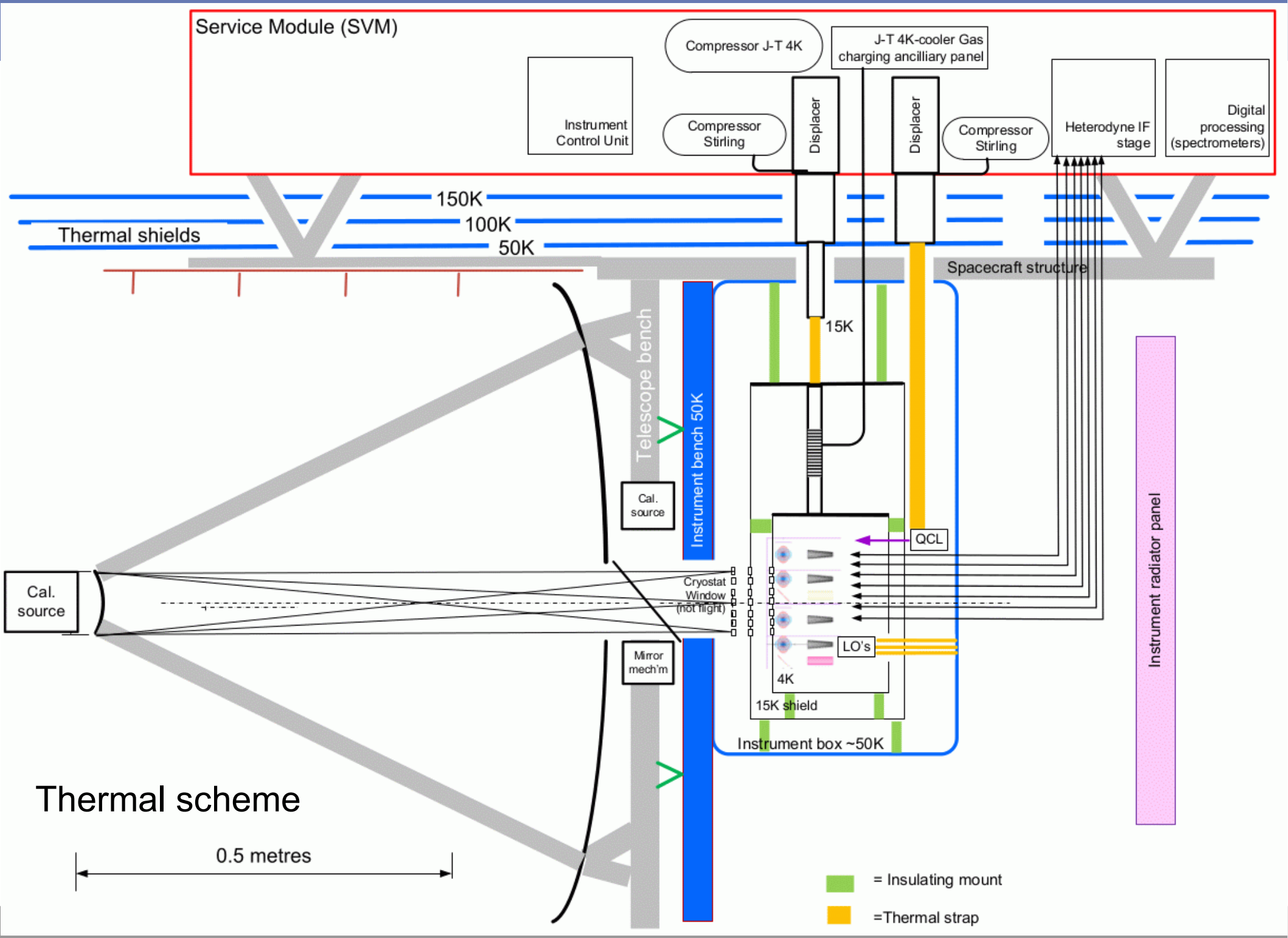




Possible mixer optics design



Electrical scheme


Service Module (SVM)
Compressor J-T 4K
J-T 4K-cooler Gas charging ancilliary panel
Instrument Control Unit
Compressor Stirling
Displacer
Displacer
Compressor Stirling
Heterodyne IF stage
Digital processing (spectrometers)
150K
100K
50K
Thermal shields
Spacecraft structure
15K
Telescope bench
Instrument bench 50K
Cal. source
QCL
Cal. source
Cryostat Window (not flight)
Mirror mech'm
LO's
4K
15K shield
Instrument box ~50K
Instrument radiator panel
Thermal scheme
0.5 metres
= Insulating mount
=Thermal strap

Work packages

Receivers											
Overall Receiver Architect Design	Primary Optics*	Channel	Principle Investigator / Design/Assembly/Test	Secondary Optics*	Horn / Lens*	Detector Units (SIS/HEB)	Mixer Block	Local Oscillator	LNA	IF Chain	Spectrometers
RAL	Maynooth (TBC)	4.7 THz	Cologne	Cologne (?)	subcontract RPG	Cologne	Cologne	Leeds	Yebes	??	Airbus Toulouse / OMNISYS / Star Dundee / Bonn (B. Klein)
		1.9 THz	LERMA		sub-contract industry	LERMA	sub-contract SAP	LERMA		LERMA	
		1.45 THz	Cologne		Cologne	Cologne	Cologne	RAL		??	
		0.809 THz	Oxford		Oxford	Cologne ???	RAL	RAL		??	

- **Mission lead by Oxford/RAL**
- **Major German contribution possible**
  - Exploitation of HIFI and GREAT background
  - Available infrastructure and know-how

    → Relatively low effort

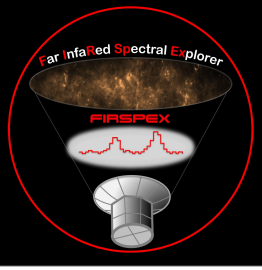
    (< 3 M€, mainly personnel)

System	Institute	Personnel	Nation
Principle Investigator	Oxford	Rigopoulou	UK
Project Management	Airbus-D&S (Stevenage)	Sibthorpe	UK
Project Scientist	RAL	Pearson	UK
System Engineering	RAL	Caldwell	UK
Focal Plane Assembly		Ellison	
Instrument/Payload AIV	RAL	Ellison	
Instrument Optical Bench			
Instrument Control Unit	IAPS	Molinari	IT
Cooler and Thermal Hardware	RAL		
Cooler Electronics	RAL		
Calibration Source & Electronics	UCL	Savini	UK
Mechanism Electronics	?		
Science Data Centre & Calibration	**Institute**	**Personnel**	**Nation**
Pipeline Development	IRAP	Caux	FR
Calibration	??	??	??

Timeline

Event	Planned date
M5 Call released (cost cap 550 M€)	May 2016
Proposals due	October 5, 2016
National letter of endorsement due (DLR to ESA)	February 8, 2017
Selection of 3 proposals for study phase	June 2017
Phase 0+A completion (TRL 5)	June 2019
• Component and/or breadboard critical function verification in relevant environment	
Down-selection to one mission	November 2019
Phase B1 completion (TRL 8)	June 2021
• Model demonstrating the element performance for the operational environment	
Mission Adoption Reviews	September 2021
Mission adoption	November 2021
Launch	Mid–2029 to mid–2030
Mission lifetime	up to 2036

Credits



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l'Observatoire de Paris — LERMA
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UCL

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ph1 Universität zu Köln

CSIC
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University of Hertfordshire UH

The Open University

IAASARS

Dark Cosmology Centre

University of California Irvine

AIRBUS DEFENCE & SPACE

NASA Jet Propulsion Laboratory
California Institute of Technology