US proposed instrument(s)

- **BLISS for SPICA**: Sensitive Far-IR Spectroscopy Reveals the Cosmic History of Galaxies and Organic Elements
  - PI: Charles(Matt) Bradford (Caltech/JPL)
  - **µ-Spec**: A Revolutionary Far Infrared Spectroscopic Capability for SPICA
    - PI: Samuel(Harvey) Moseley (NASA/GSFC)

- **WISPIR**: Wide-field Imaging SPectrograph for the InfraRed
  - Co-PI: Lee Mundy (University of Maryland) and Dominic Benford (NASA/GSFC)
  - FIR/sub-mm spectrometers with dispersion elements
  - Superconducting detectors with ultra-high sensitivity

- Sep 2010: Final study reports of Galaxies and Organic Elements
- Never participation to SPICA.
- High sensitivity of **BLISS** is owing to high sensitivity of superconducting TES bolometer and new technology of wave-guide grating spectrometer.

BLISS overview

- BLISS (The Background Limited Infrared Submillimeter Spectrograph)
  - Sensitive Far-IR Spectroscopy Reveals the Cosmic History of Galaxies and Organic Elements
  - BLISS is a 38-433 µm grating spectrometer (R=700)
  - Fills gap between JWST / SPICA-MIR and ALMA with comparable sensitivity.
  - The BLISS grating architecture provides maximum sensitivity.
  - BLISS-SPICA is the only way to study a meaningful sample of the tens of thousands of high-redshift galaxies and protoplanetary systems now being discovered with Herschel and other imaging systems.
  - BLISS is compact, low mass, and has simple interfaces.
  - Only moving part is a chopping mirror.
  - Cold mass less than 30 kg, size 45x40x40 cm, bolts to 4.5 K instrument bench and recools heat to SPICA 1.7 K cold finger.
  - BLISS uses TES bolometer arrays with a now-standard SQUID multiplexer.
  - Systems issues proven in several scientific instruments.
  - Clear path to achieving the uniquely sensitive bolometers required for BLISS.

WISPIR overview

- WISPIR: Wide-field Imaging Spectrometer for the InfraRed
  - Objectives: high-z galaxies
  - & molecular lines in local universe
  - Imaging FT spectrometer
  - 35-210µm (3 bands), R=1000-6000
  - GSFC TES bolometer & SQUID MUX
  - NEP=4x10^{-20} W/Hz
  - 50mK/300mK tandem cooler (ASTRO-H)
  - High sensitivity with slit-trap prism
  - Improvement of SAFARI

Scientific objectives

- **BLISS**: Sensitive Far-IR Spectroscopy Reveals the Cosmic History of Galaxies and Organic Elements
  - μ-Spec: A Revolutionary Far Infrared Spectroscopic Capability for SPICA
  - PI: Charles(Matt) Bradford (Caltech/JPL)
  - SOLWIFS/PI: Charles(Matt) Bradford (Caltech/JPL)

μ-Spec overview

- **μ-Spec**: A revolutionary Far Infrared Spectroscopic Capability for SPICA
  - Objectives: similar to BLISS
    - Very high redshift objects (out to z=20)
    - H2O, O3 molecular lines in ISM
  - Ultra-high sensitivity & high resolution with compact system
  - Novel technologies
    - λ = 250–700µm
    - Micro-strip delay-line spectrometer (R=1500)
    - MKD (Microwave Kinetic Inductance), several times higher sensitivity than TES
    - Ultra compact spectrometer module fabricated on a ~100mm2 Si-wafer
  - 50mK ADR / 300mK He tandem cooler system (ASTRO-H)

μ-Spec technology

- **New technologies**
  - MW(RI) microstrip delay-line spectrometer
  - RF filter bank
  - MKDs, NEP=4x10^{-20} W/Hz
  - HEMT amplifier, 3-GHz readout

- **μ-Spec technology specifications**
  - Line sensitivity (5σ, 1h) = 1x10^{-20} Wm^{-2}
  - Resolving power (R/Δλ) = 1500
  - Spectral coverage: 250-700 um
  - Number of beams: 177 TBD, Diffraction ltd.
  - Detector format: 4000
  - Detector sensitivity: 1x10^{-20} W/Hz
  - Detector technology: MKD
  - Readout: Microwave HEMT
  - Spectrometer: Delay line spectrometer
  - Cooler: ~300mK TBD