FIFI LS - SOFIA'S FACILITY FAR-INFRARED SPECTROMETER

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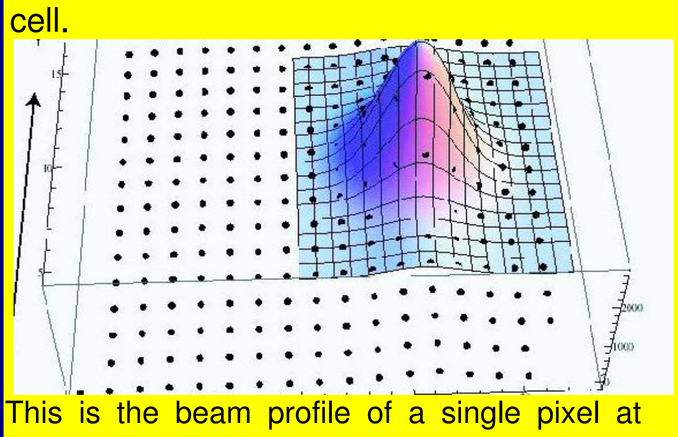
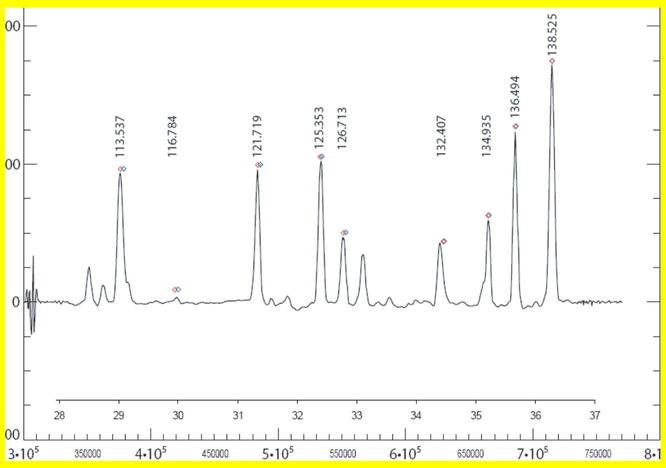
Status of *FIFI LS*

FIFI LS is fully integrated and the performance of the long wavelength spectrometer is characterized. The tests of the short wavelength spectrometer will follow in July 2010 at the MPE with a full characterization later in Stuttgart.

The spatial and spectral resolutions of the long wavelength spectrometer have been measured using a calibration source employing a movable point source and a gas cell.



This is the beam profile of a single pixel at 160µm. The FWHM is 4mm at this wavelength as expected. The pixels are 3.6mm.

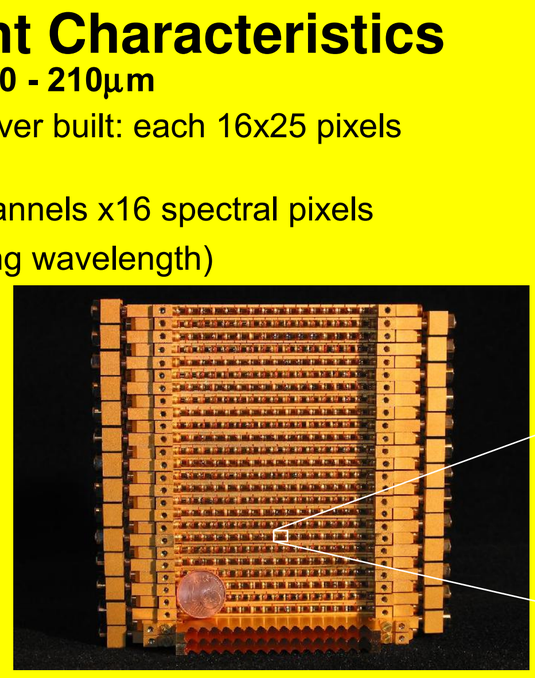


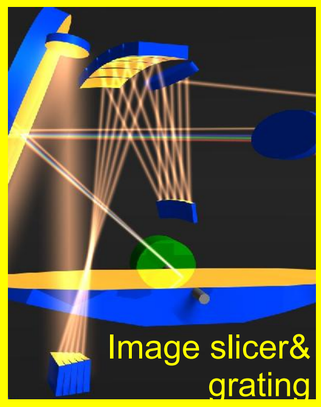
This water spectrum as measured with FIFI LS provided the initial spectral calibration.

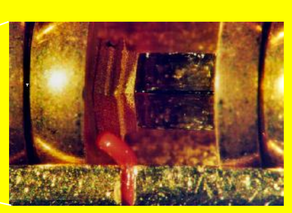
Schweitzer et al. (2008) SPIE Proc. Vol 7014, 70140Z

FIFI LS: Instrument Characteristics

- Two parallel Spectrometers: **42 - 110µm & 110 - 210µm**
- Two of the **largest photoconductor arrays** ever built: each 16x25 pixels (unstressed/stressed Ge:Ga)
- Integral field spectroscopy with 5x5 spatial channels x16 spectral pixels
- Pixel scale: 6″ (short wavelength) and 12″ (long wavelength)
- Simultaneous observations in both bands
- 2 Reflective image slicers + long slit, Littrow mounted grating spectrometer
- Resolving power: R = 1000 - 3000, instantaneous coverage of ~1500 km/h
- Point source detection Limit (5σ/1h):
  - $5x10^{-17}$ W/m^2@ 63µm
  - $2x10^{-17}$ W/m^2@158µm
- WWW: http://fififls.mpe.mpg.de



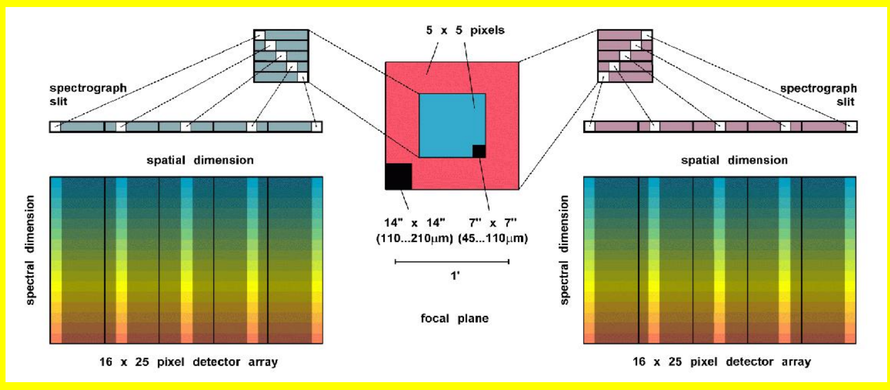




16x25 Stressed Array

FIFI LS cyrostat in laboratory cart

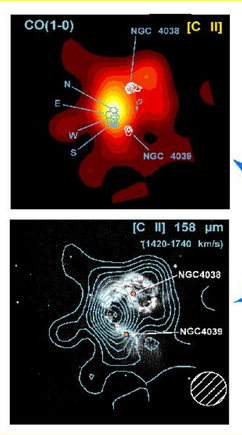
Field-Imaging Concept



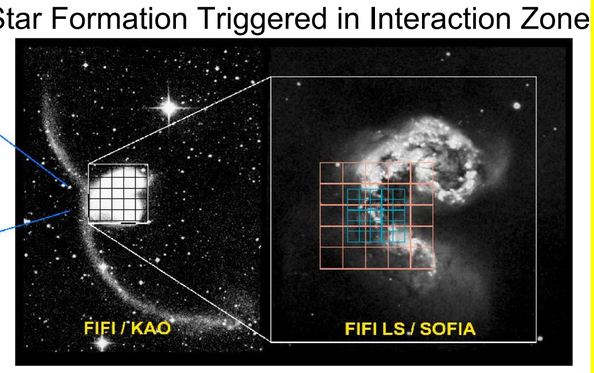
FIFI LS Science: Star Formation on all Scales

Observations with FIFI LS in the far-infrared, which is largely unaffected by dust extinction, will allow us to explore the physics in a number of astronomical regions. For example:

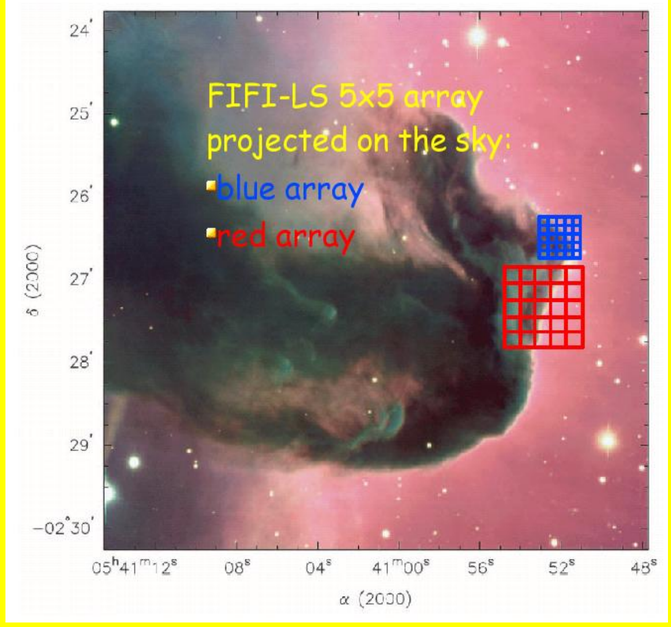
- Triggered star formation and the interstellar medium in merging/interacting galaxies.
- The relationship between active galactic nuclei and starburst galaxies.
- A multi-species investigation of the interstellar medium and star forming regions - both local and extragalactic.
- Star formation in nearby galaxies and the interstellar medium in low-metallicity environments (such as dwarf galaxies).



NGC 4038/39 "Antennae"
Star Formation Triggered in Interaction Zone



FIFI LS analysing a PDR



FIFI LS gives access to all the diagnostic FIR fine-structure lines and has the spatial resolution to study the detailed morphology of e.g. the horse-head nebula photon-dominated region (PDR). In a few hours, the PDR can be mapped in several lines. To obtain information on individual velocity components, higher resolution observations of one of the lines would be needed.

FIFI LS becomes a Facility Instrument

FIFI LS is developed by the team around the PI Albrecht Poglitsch at the MPE. The instrument itself is fully integrated and ready for testing. Recently, it has been decided that *FIFI LS* can become a full Facility Science Instrument (FSI). Alfred Krabbe at the University of Stuttgart will complete the instrument characterizaion and prepare it for first flight. He will also lead *FIFI LS* through its commissioning FSI for SOFIA. The team at UC Berkeley is developing the additional software needed to make *FIFI LS* compliant with FSI requirements.

Additionally to the core functionality, UC Berkeley adds for the community:

- Observing modes and associate AOTs/AORs (astronomical observing templates/request) which represent the best practices for the instrument.
- A software interface between the SOFIA scheduler and the *FIFI LS* control software to translate AOTs/AORs to the FIFI LS software.
- A data reduction pipeline to automatically reduce the raw data to a readily usable data cube (eg. RA, DEC, lambda) in a 3D-FITS format.
- Observing and data reduction manuals.

After commissioning *FIFI LS* is available through all SOFIA proposal calls.

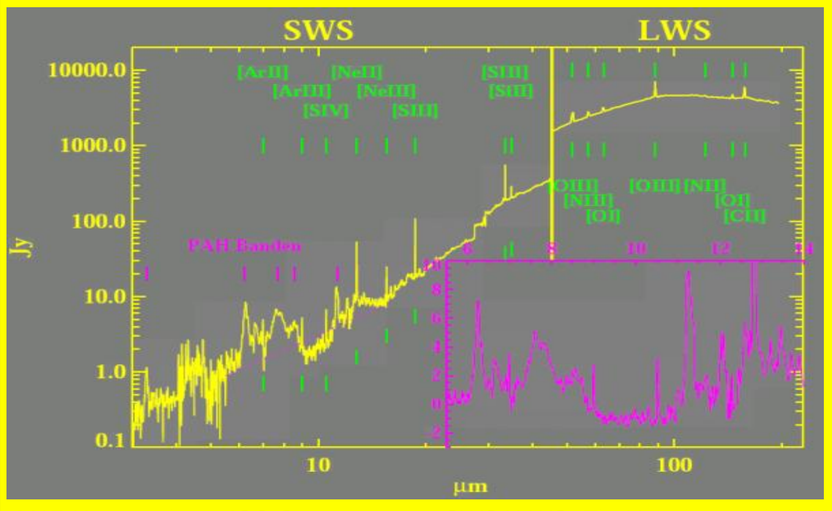
FIFI LS' wavelength range

The FIR exhibits fine-structure lines from collisionally excited levels within the ground state of the atoms/ions. These lines are not only ***important cooling-lines***, but especially the line pairs allow direct

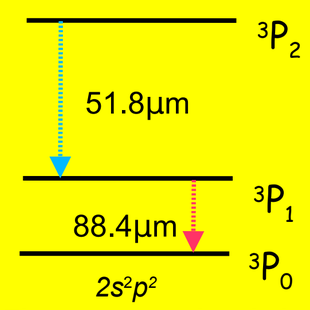
- ***density*** and ***temperature*** measurements, and
- ***abundance*** and ***excitation*** estimates.

The line intensities are temperature and/or density dependent. Using the ratio of two transitions from the same species takes out the uncertainty in abundances.

Below is a complete MIR/FIR spectrum of star-forming core in M17. The many FIR fine structure lines rising above the continuum are marked. Find the line pairs!



M17-North with the ISO Spectrometers SWS&LWS (Th. Henning et al. (1998), A&A, 332, 1035)



Fine-structure levels in the ground state of O^{2+}

Latest SPIE Papers: Schweitzer at al. Proc. SPIE, Vol. 7014, 70140Z (2008)
Klein et al. Proc. SPIE, Vol. 6269, 62691F (2006)