PDS/SBN
Comet Data Review

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13-14 January 2014

LEISA

- nh-x-leisa-2-plutocruise-v1.0
- nh-x-leisa-3-plutocruise-v1.0

LEISA Documentation: Date

- In the ~/nh-x-leisa-2-plutocruise-v1.0/aareadme.txt file, it is reported

Introduction
==========
This document provides an overview of this dataset of
the New Horizons (NH)
LEISA PLUTOCRUISE Calibrated VERSION 1.0
Data Archive, including a general listing of the dataset contents.
This data set contains flight data leading up to and including the
pluto cruise
for the
Linear Etalon Imaging Spectral Array
instrument of the New Horizons mission. These data were collected
from
2007-06-23T00:00:00
up to
2010-07-18T00:00:00
. See the Mission catalog file NH.CAT in the /CATALOG/ directory for a
description of the New Horizons mission, including a description of
mission phases (LAUNCH, JUPITER, PLUTOCRUISE, PLUTO_CHARON, etc.).

LEISA Documentation: Date

However in the NH.cat document the phases are

Mission Phases
==========

Summary of mission phases

Name Start(1) Stop(2) Description

LAUNCH 2006-01-19 2006-12-31 Post-launch checkout

JUPITER 2007-01-01 2007-06-26 Jupiter encounter

PLUTOCRUISE 2007-06-27 2014-12-31 Jupiter-Pluto/Charon Interplanetary Cruise

Therefore if PLUTOCRUISE data are being archived, then the starting date should be 2007-06-27 instead of 2007-06-23T00:00:00

LEISA Documentation: Date

- In the ~/nh-x-leisa-2-plutocruise-v1.0/aareadme.txt file, it is reported

These data were collected from

2007-06-23T00:00:00

up to

2010-07-18T00:00:00

The same concept is expressed in

~/nh-x-leisa-3-plutocruise-v1.0/catalog/dataset.cat

However

The first file in the folder data has

START_TIME = 2007-09-18T22:05:01.447
STOP_TIME = 2007-09-18T22:05:10.447

first frame

While the last one has

START_TIME = 2010-06-25T01:13:31.062
STOP_TIME = 2010-06-25T01:13:32.062

last frame

LEISA Documentation: Filename

- In the ~/nh-x-leisa-2-plutocruise-v1.0/aareadme.txt file, it is reported "This file is located in the /DOCUMENT/ directory of this

  data set and its filename is SOC_INST_ICD.DOC."

  In the DOCUMENT folder there is soc_inst_icd.pdf

LEISA Documentation: Data content; Files Fits: header

- Check that the content in the DATA folder is correctly described by the documentation

In ~/nh-x-leisa-3-plutocruise-v1.0/catalog/dataset.cat

Summary:
========
- Science observations
- Uranus with MVIC at phase angles not available from Earth
- Neptune with MVIC at phase angles not available from Earth

- Calibrations and other tests with possible science targets
- Neptune as a navigation test target
- Sun in SIA
- Vega (star)
- M6 and M7 (clusters)

- Functional tests

In the folder data, I find observations of:

EARTH, SUN, RADEC=279.23,38.78=Vega, RADEC=89.31,21.94=SUN, RADEC=110.00,85.00

Why the Earth is not listed above?

Who is RADEC=110.00,85.00? And why is not listed

LEISA Documentation: Data content

- Check that the content in the data folder is correctly described by the documentation

In ~/nh-x-leisa-3-plutocruise-v1.0/catalog/dataset.cat (Below AC=Annual CheckOuts)

Details:

========

RALPH Calibrations and other observations:

1. During ACO1, ACO2 and ACO4, RALPH took LEISA calibration data using the star Vega as a source; During ACO-2 and ACO-4, RALPH took MVIC calibration data using the clusters M7 and M6.--> **LEISA Vega**
2. During ACO1 and ACO2, the RALPH instrument observed flat field data for both MVIC and LEISA using the Solar Illumination Aperture (SIA). However these data were not useful for flat fielding because there was varying structure in the images i.e. the light was not evenly illuminating the field of view, and details of the flat are dependent on the position of the Sun in the SIA.--> **LEISA Sun**
3. In ACO1, RALPH observations for calibration, characterization and interference goals included a stray light test with the sun at an angle of 20-90 degrees from the FOV, to characterize the light leak of LEISA on the incoming and outgoing encounter asymptote, and an interference test between the LEISA and ALICE instruments. --> **LEISA Sun**

LEISA Documentation: Data content

1. During ACO2, RALPH observed Neptune in pan frame mode as an optical navigation test.
2. In ACO2, another stray light test was performed. The geometries simulated observations from the outgoing encounter asymptote with an elongation angle of 13 degrees (sun-spacecraft-target).
3. During ACO3, RALPH had no 3-axis (spacecraft not in spinning mode) observations, only the functional test as described below.
4. In ACO4, RALPH performed a dark current test, taking data while the focal plane cooled down, from 2 to 20h after the decontamination heaters were turned off. RALPH also performed an interference test, simultaneously operating LEISA, LORRI and ALICE. MVIC took color observations of Uranus and Neptune at a phase angle not accessible from Earth and optical navigation images of Neptune using the pan frame array. MVIC performed a stray light test as a ride-along to the LORRI observation in ACO4, and LEISA performed a light leak test at an angle of 9 degrees from the sun. RALPH also did an interference test between the MVIC TDI and LORRI modes of operation.--> **LEISA light leak test at an angle of 9 degrees from the sun**

Why the Earth is not listed above?

Who is RADEC=110.00,85.00? And why is not listed?

LEISA Files Fits: header

- Regarding the header TARGET = 'RADEC=110.00,85.00' / Target object

In ~/nh-x-leisa-3-plutocruise-v1.0/catalog/dataset.cat

Visit Description, Visit Number, and Target in the Data Labels

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The observation sequences were defined in Science Activity Planning (SAP) documents, and grouped by Visit Description and Visit Number. The SAPs are spreadsheets with one Visit Description & Number per row. A nominal target is also included on each row and included in the data labels, but does not always match with the TARGET_NAME field's value in the data labels. In some cases, the target was designated as RA,DEC pointing values in the form ``RADEC=123.45,-12.34'' indicating Right Ascension and Declination, in degrees, of the target from the spacecraft in the Earth Equatorial J2000 inertial reference frame. This indicates either that the target was either a star, or that the target's ephemeris was not loaded into the spacecraft's attitude and control system which in turn meant the spacecraft could not be pointed at the target by a body identifier and an inertial pointing value had to be specified as Right Ascension and Declination values. The PDS standards do not allow putting a value like RADEC=... in the PDS TARGET_NAME keyword's value; in those cases the PDS TARGET_NAME value is set to CALIBRATION.

The documentation explains the reason of target designated in the header by RADEC, however I am not sure it is fine from the PDS point of view

LEISA Documentation: Data content

- In ~/nh-x-leisa-3-plutocruise-v1.0/catalog/dataset.cat

```
END_OBJECT = DATA_SET_INFORMATION


..
OBJECT = DATA_SET_TARGET
TARGET_NAME = "CALIBRATION"
END_OBJECT = DATA_SET_TARGET
OBJECT = DATA_SET_TARGET
TARGET_NAME = "EARTH"
END_OBJECT = DATA_SET_TARGET
OBJECT = DATA_SET_TARGET
TARGET_NAME = "STAR"
END_OBJECT = DATA_SET_TARGET
OBJECT = DATA_SET_TARGET
TARGET_NAME = "SUN"
END_OBJECT = DATA_SET_TARGET

OBJECT = DATA_SET_HOST
INSTRUMENT_HOST_ID = "NH"
INSTRUMENT_ID = "LEISA"
END_OBJECT = DATA_SET_HOST

END_OBJECT = DATA_SET

END
```

At the end of the document the right target list appear

LEISA Labels: Units

- In the ~/nh-x-leisa-2-plutocruise-v1.0/aareadme.txt file, it is reported

Calibrated data are in scientific or engineering units, such as radiance (W/(m**2 um sr)) or impact particle mass (GRAMs). The conversion to calibrated data from raw data was performed according to an instrument performance model, which was developed from scientific analysis of ground- and inflight-calibrations, and which is documented in files in this data set under the /DOCUMENT/ and /CALIB/ subdirectories. Refer to to /DOCUMENT/DOCINFO.TXT and /CALIB/CALINFO.TXT for pointers to more information.

I could not find the Units of W/(m**2 um sr) in the label of calibrated data

LEISA Documentation: Wavelength map

- In the document ~/nh-x-leisa-3-plutocruise-v1.0/document/soc_inst_icd.pdf

8.1 Overview

LEISA is an infrared imaging spectrometer. The detector is a 256x256 pixel array. Spectral separation is done with a wedged optical etalon filter placed in close proximity to the detector array. The filter is made of two pieces, a high spectral resolution ($\lambda/\Delta\lambda$=580) segment and a low spectral resolution ($\lambda/\Delta\lambda$=280) segment, bonded together. The detector-filter assembly is located at the plane of focus of the Ralph telescope where a 2-D image is recorded simultaneously with the infrared spectrum of the scene. The layout for the filter assembly is shown in Figure 8-1: Layout for LVF Filter Assembly. The wavelength range of the sensor is 1.225-2.5 nm for the low resolution segment and 2.1-2.25 µm for the high resolution segment. The wavelength of transmission of the filter varies along one axis and is constant in the other. Lines of constant wavelength are aligned with the row direction of the detector array. The number of pixel-limited spectral channels is the number of rows of the detector, excluding a number of rows (4) obscured by opaque adhesive at the bond joint between the two filter segments.

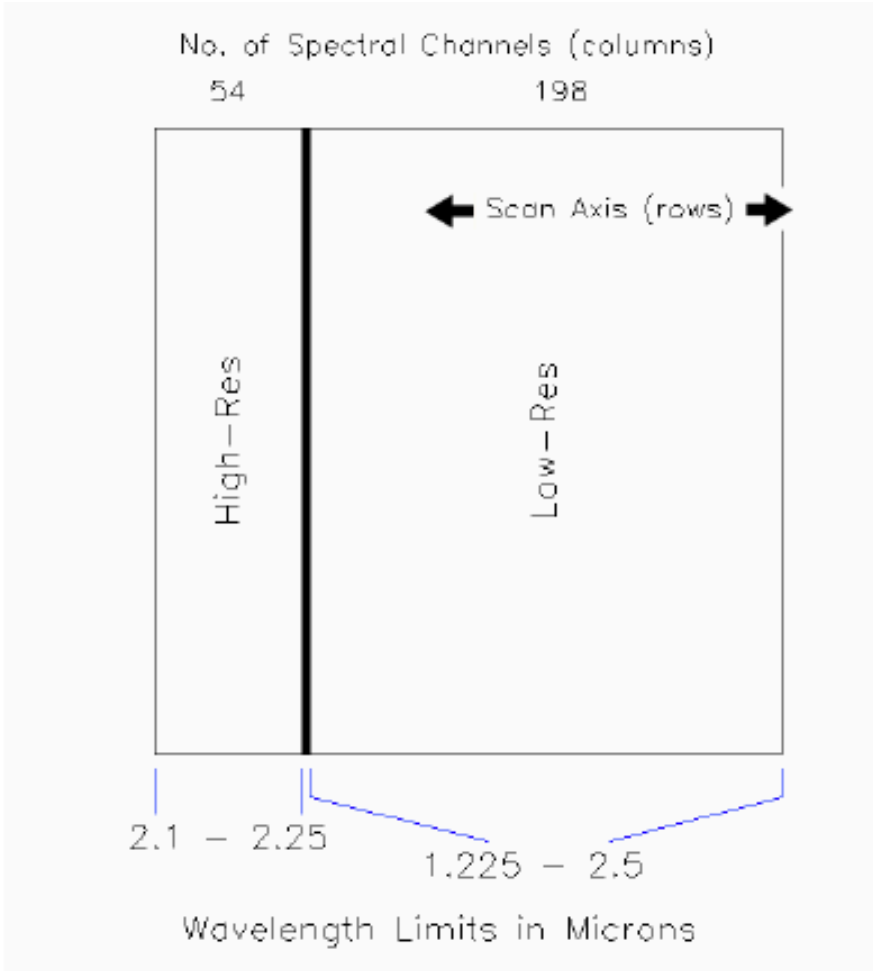


Figure 8-1: Layout for LVF Filter Assembly

It should be number of columns

LEISA Documentation: Wavelength map

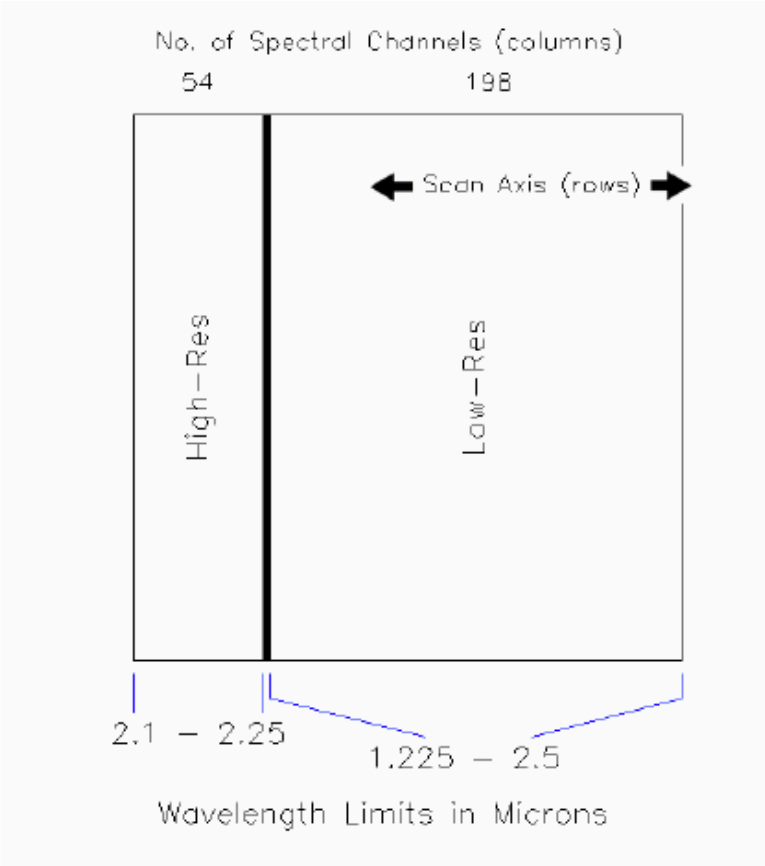
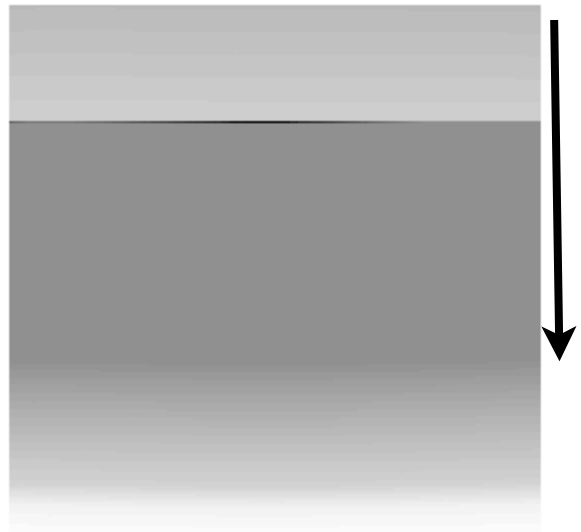


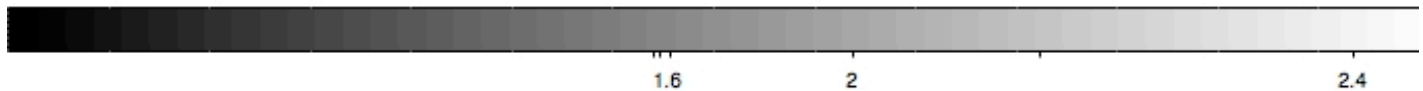
Figure 8-1: Layout for LVF Filter Assembly

Wavelength map extracted from the data



Increasing wavelength

Why the wavelength map extracted from the data is rotated with respect to the figure in the manual?



LEISA Documentation: Wavelength map

Raw Dataset

The SOC stores the LEISA data cubes in Band Interleaved by Line (BIL) order, i.e. image frames are stored sequentially. To re-order LEISA images as received from the spacecraft, the SOC does the following to each frame of data:

1. de-interlace by quadrant
2. reverse the Y direction
3. rotate 180 degrees

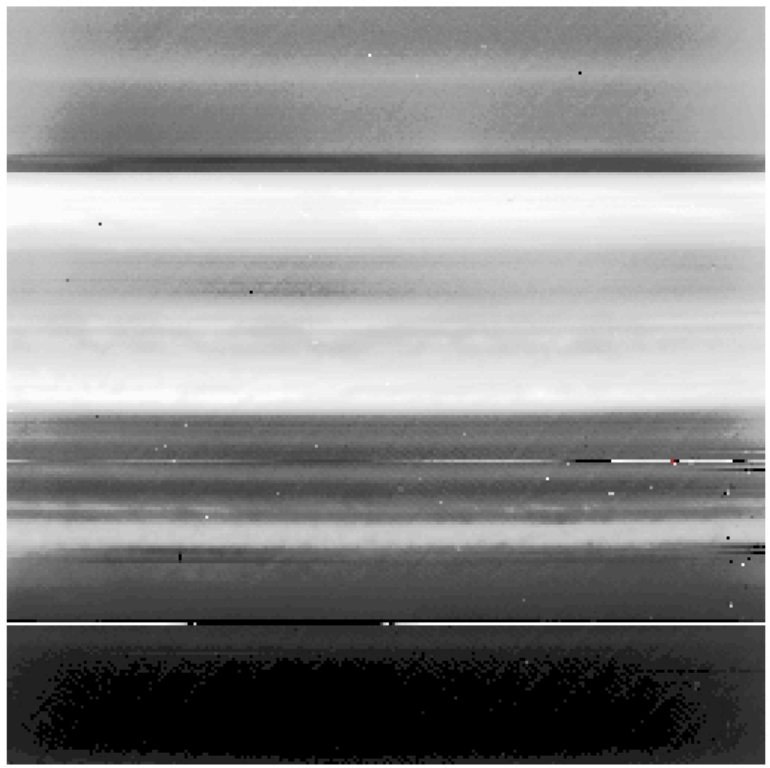
from ~/nh-x-leisa-3-plutocruise-v1.0/document/soc_inst_icd.pdf

This list of operation would not justify the different orientation between the wavelength map extracted from the data and that of Figure 8.1

LEISA Data analysis

- The image cube is recorded as a series of N image frames, with N determined by the length of the scan multiplied by the frame rate. Detector frame rate is adjustable between 0.25 and 8 Hz in 1 ms steps. Each frame covers the complete range of wavelengths. LEISA is normally operated in a scanning mode, with the target moving through the image plane, row by row.

Jupiter



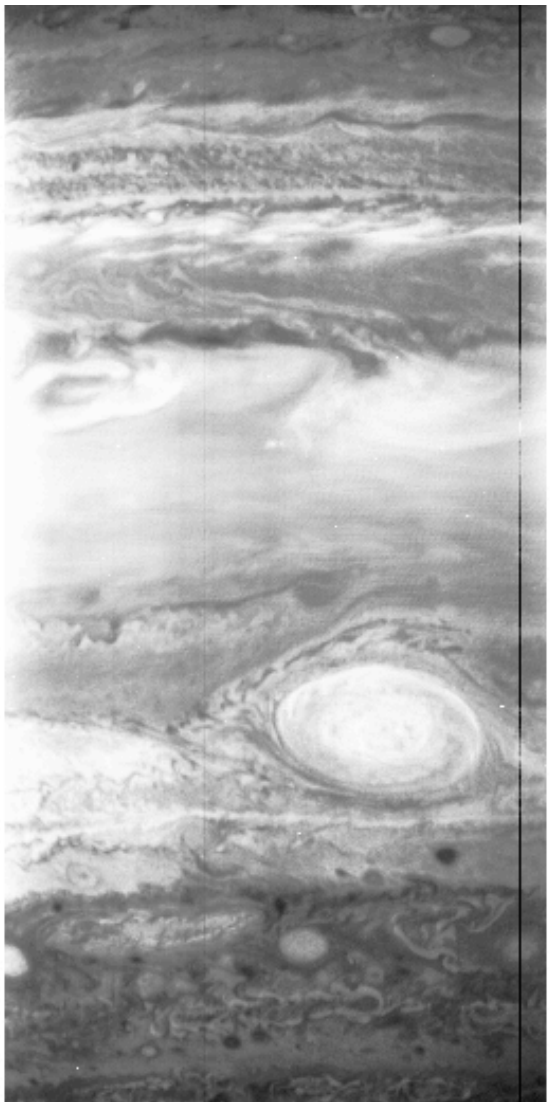
wavelength

spatial direction

temporal direction

LEISA Data analysis

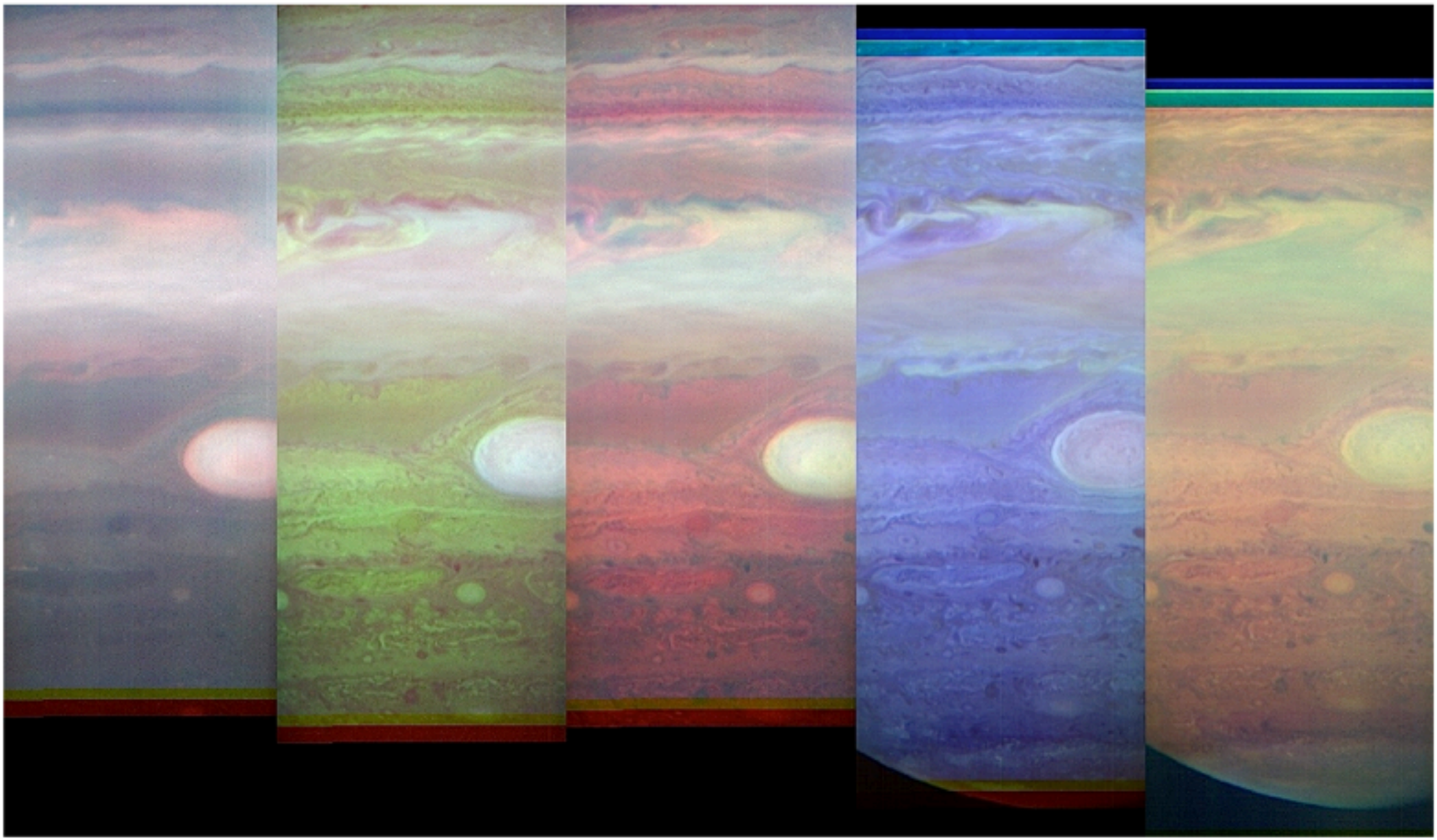
Scanned image of the target at several wavelengths



Jupiter

Jupiter in the NIR with LEISA

- Random wavelengths to illustrate the richness of the data



LEISA Data analysis

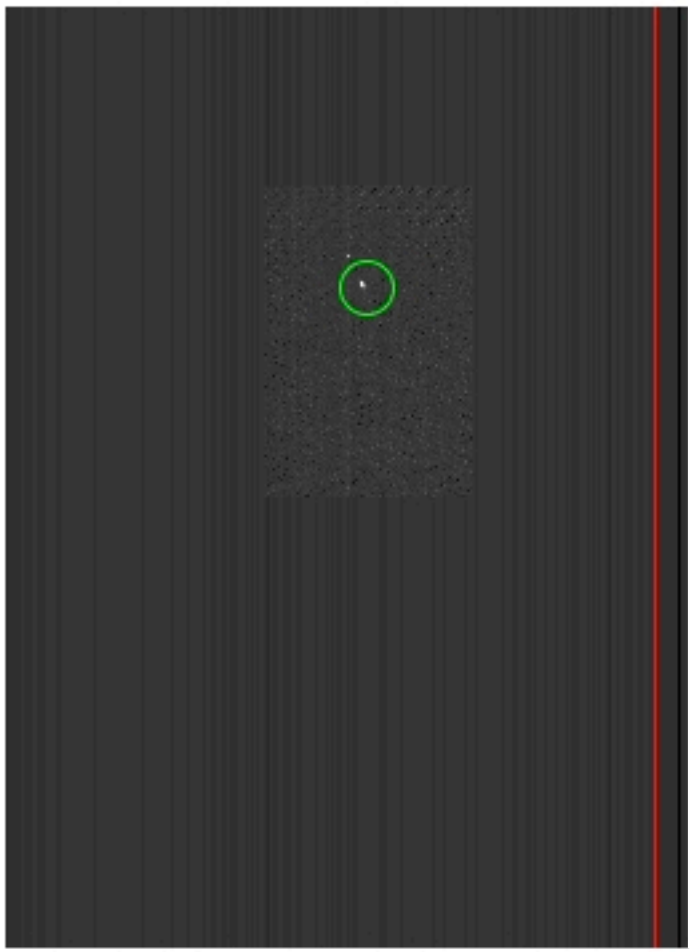
- ~nh-x-leisa-3-plutocruise-v1.0/document/soc_inst_icd.pdf

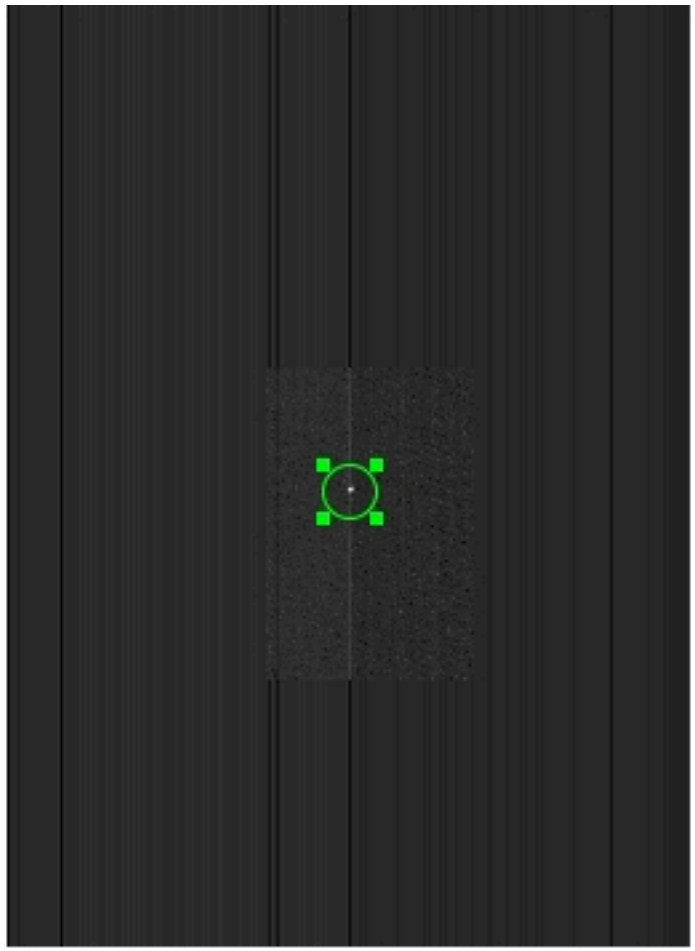
Compute pointing data

The pointing for each pixel of each frame is computed using the timing information from the observation, reconstructed ephemeris and attitude files, and knowledge of the optical distortion of the instrument. One array is generated giving the cartesian pointing vector of each pixel in the LEISA array. This is a function only of the optical distortion of the system. A second array is generated giving the rotation quaternion of the instrument boresight into the J2000 reference frame for the middle of each exposure. By rotating the pointing vector of a pixel by the quaternion for the image frame, the J2000 pointing vector of each pixel can be derived

I computed the J2000 pointing vector for each pixel and each frame. However, it was not trivial. Is there another way to co-register data images at different wavelengths?

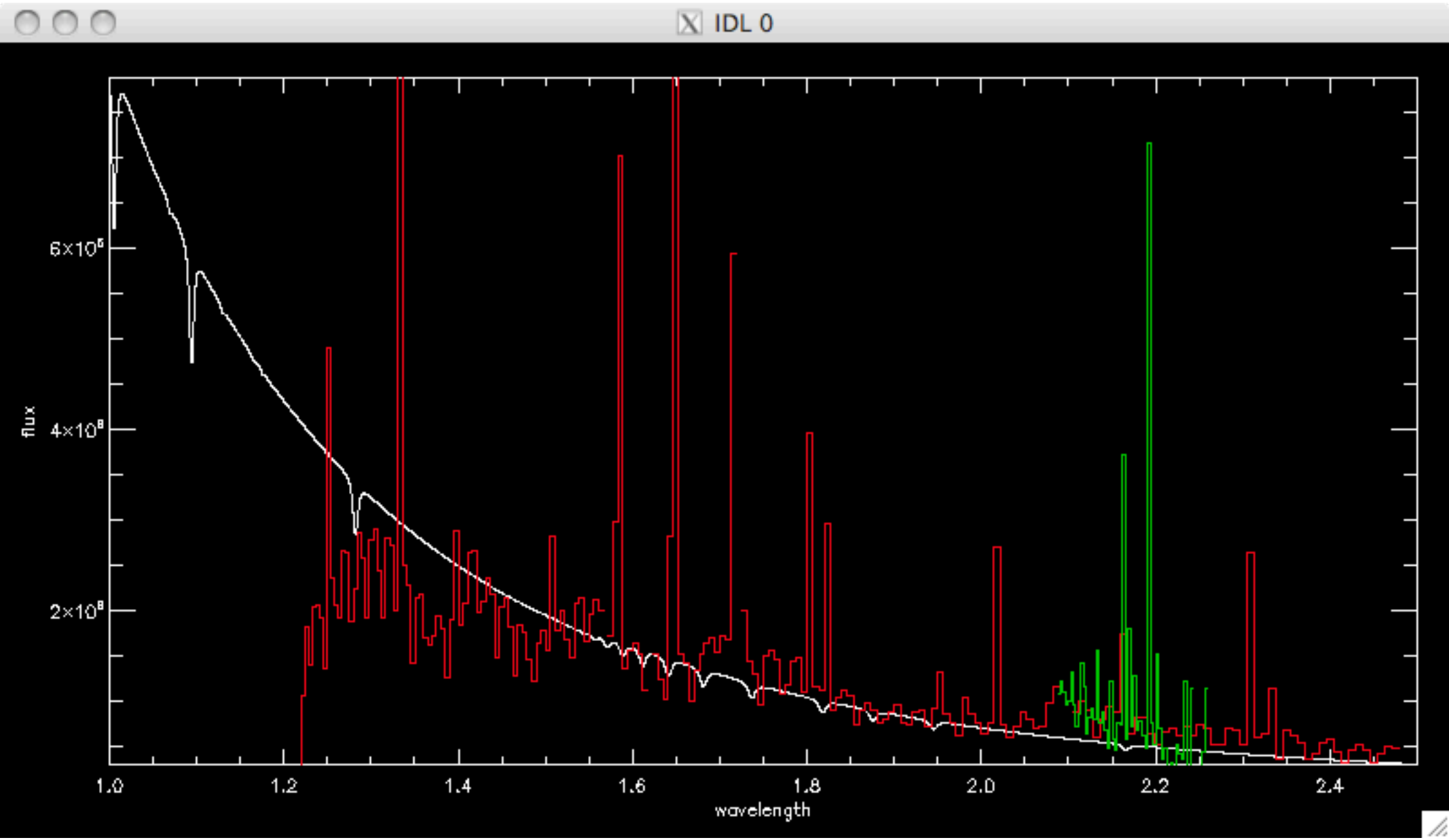
LEISA Data analysis





Vega

LEISA Data analysis



CH_3D ice absorption coefficients

laboratory spectra at wavelengths of 2.47, 2.87, and 4.56 microns to study CH3D. We report
temperature-dependent absorption coefficients of these bands when the
CH3D is diluted in CH4 ice and also when it is dissolved in N2 ice.

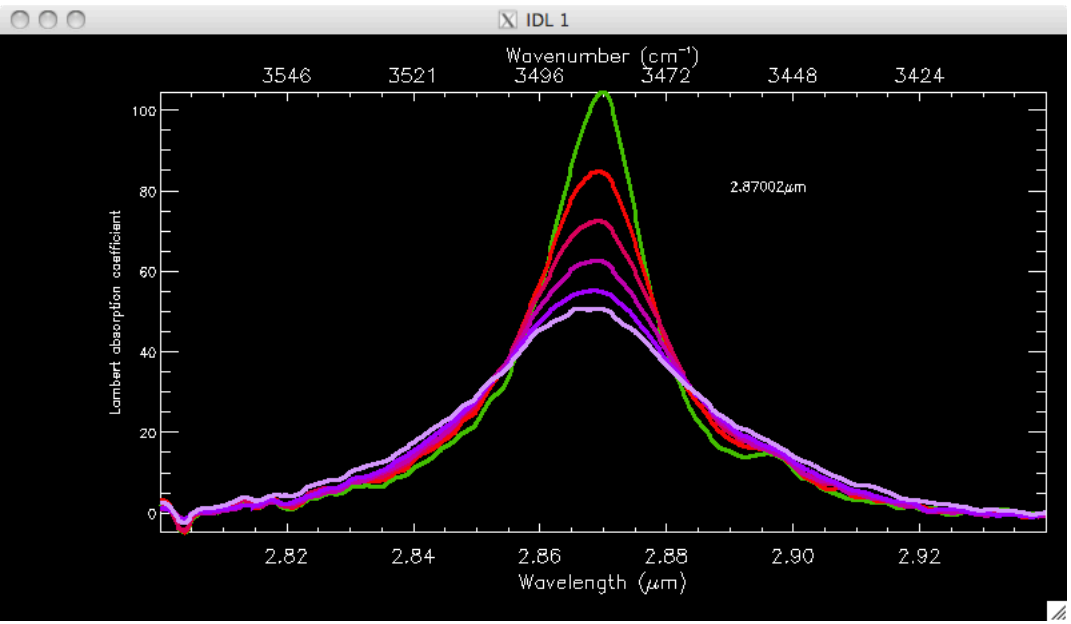
- ear-x-i2041-5-ch3dicespec-v1.0

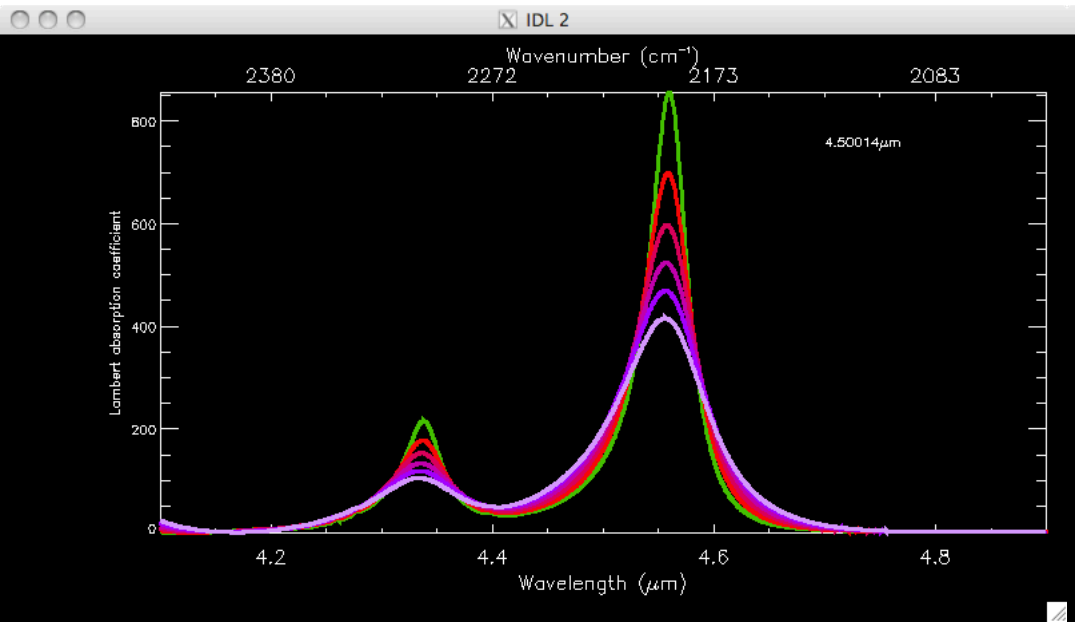
CH_3D ice absorption coefficients

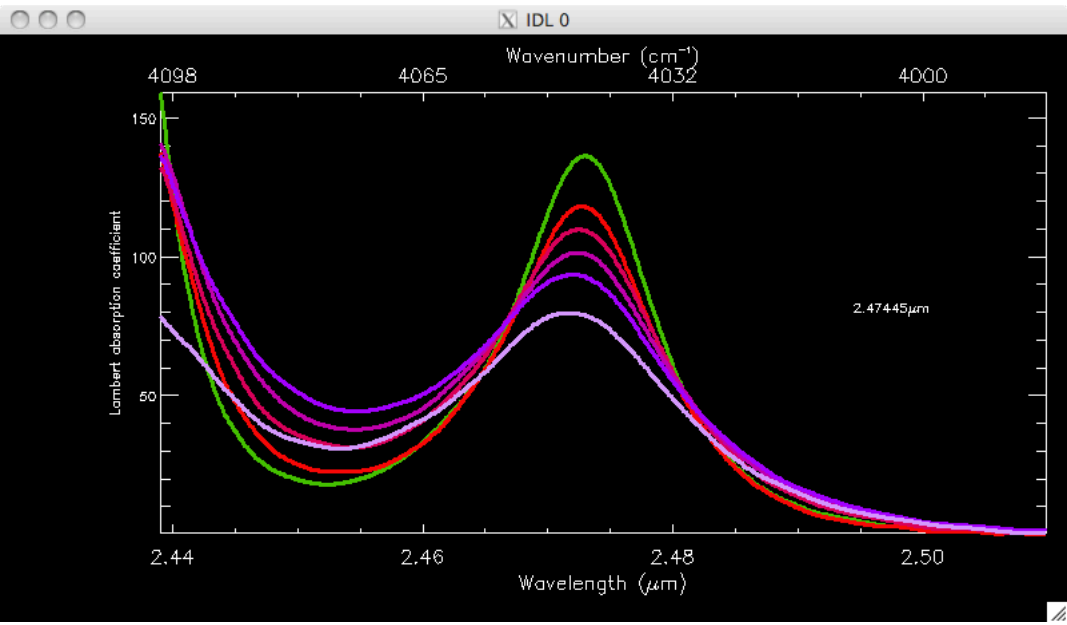
- data
  - ch3d_in_ch4
  - ch3d_in_n2

CH_3D ice absorption coefficients

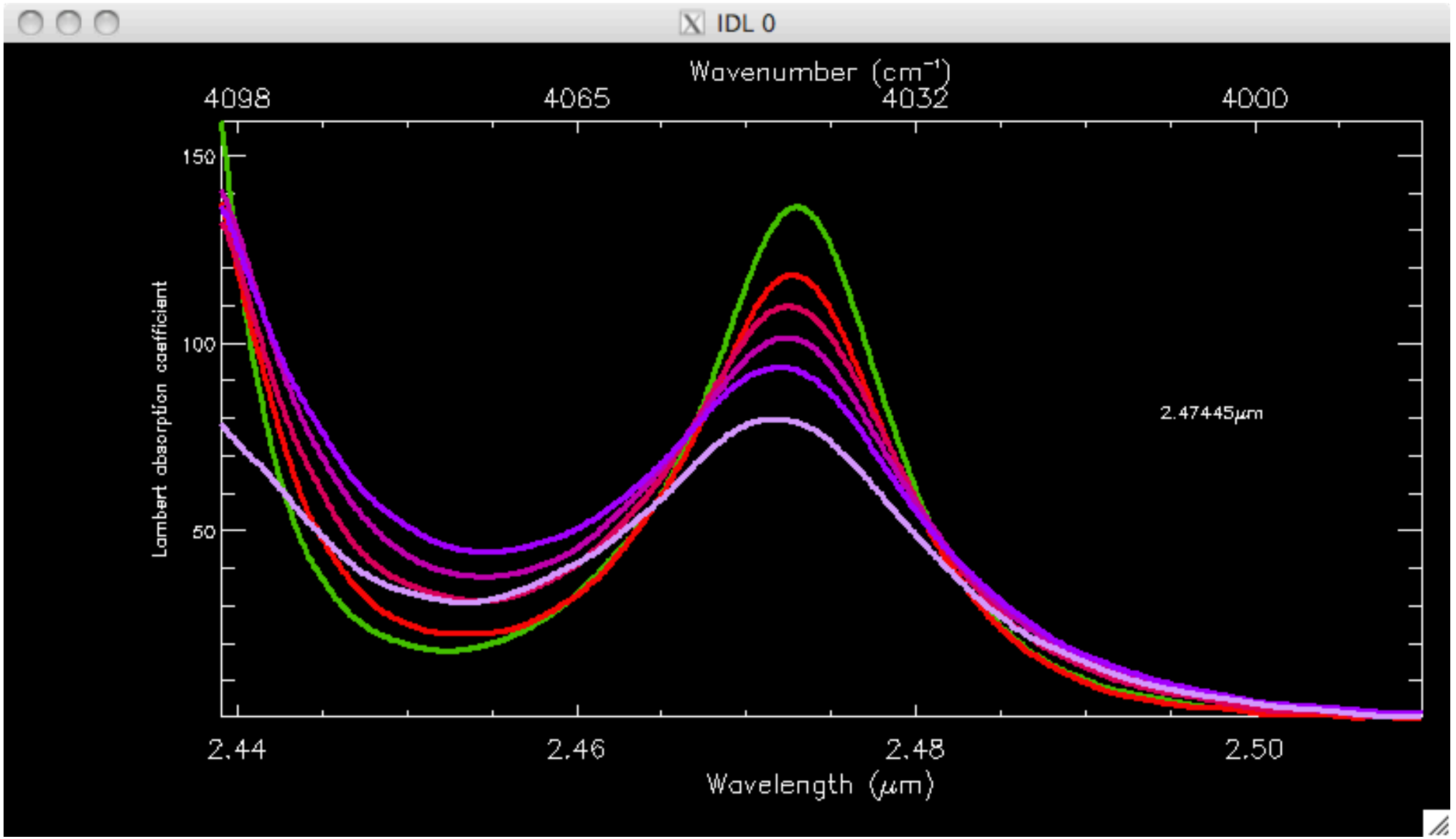
CH_3D diluted in CH_4



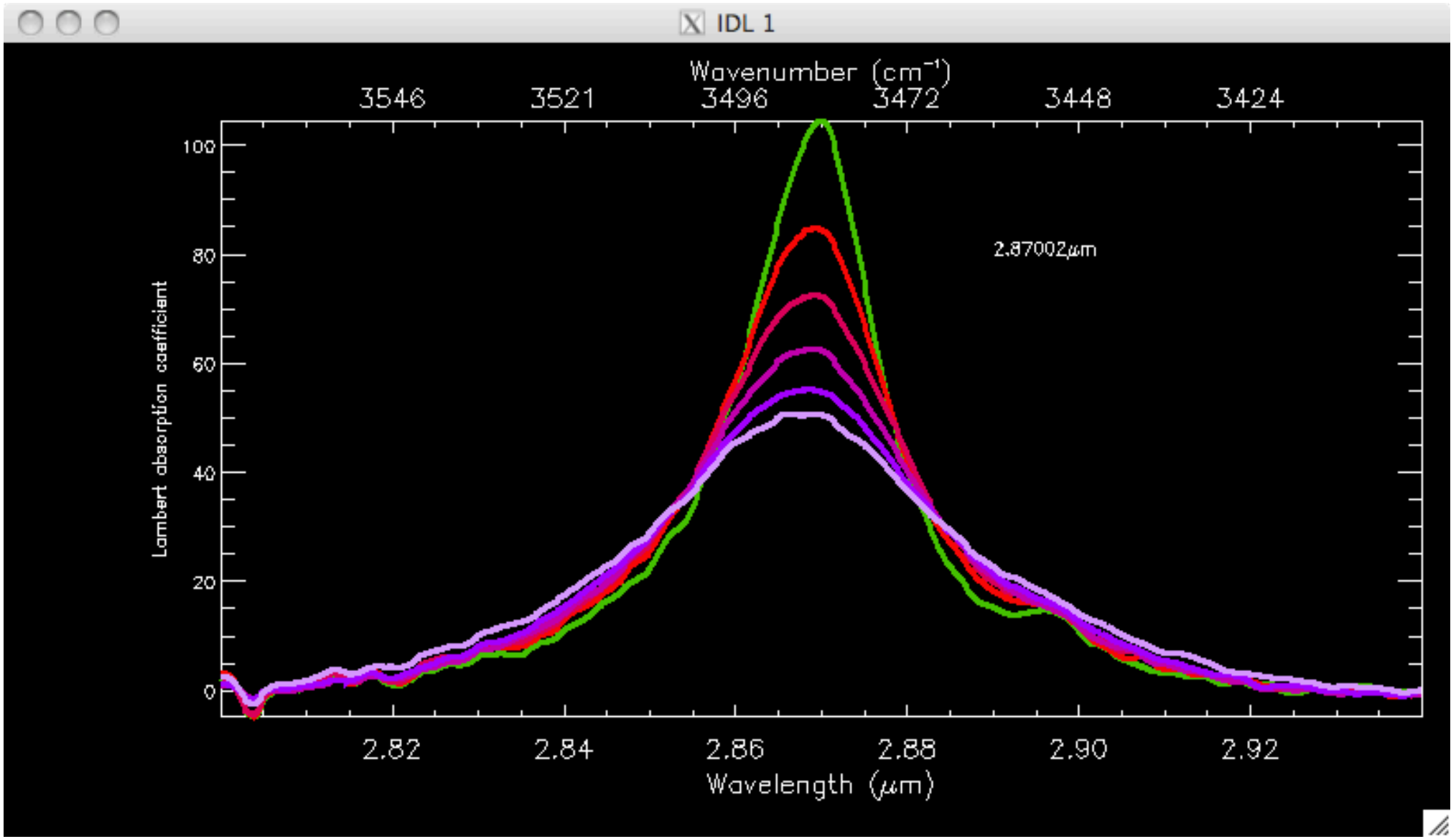




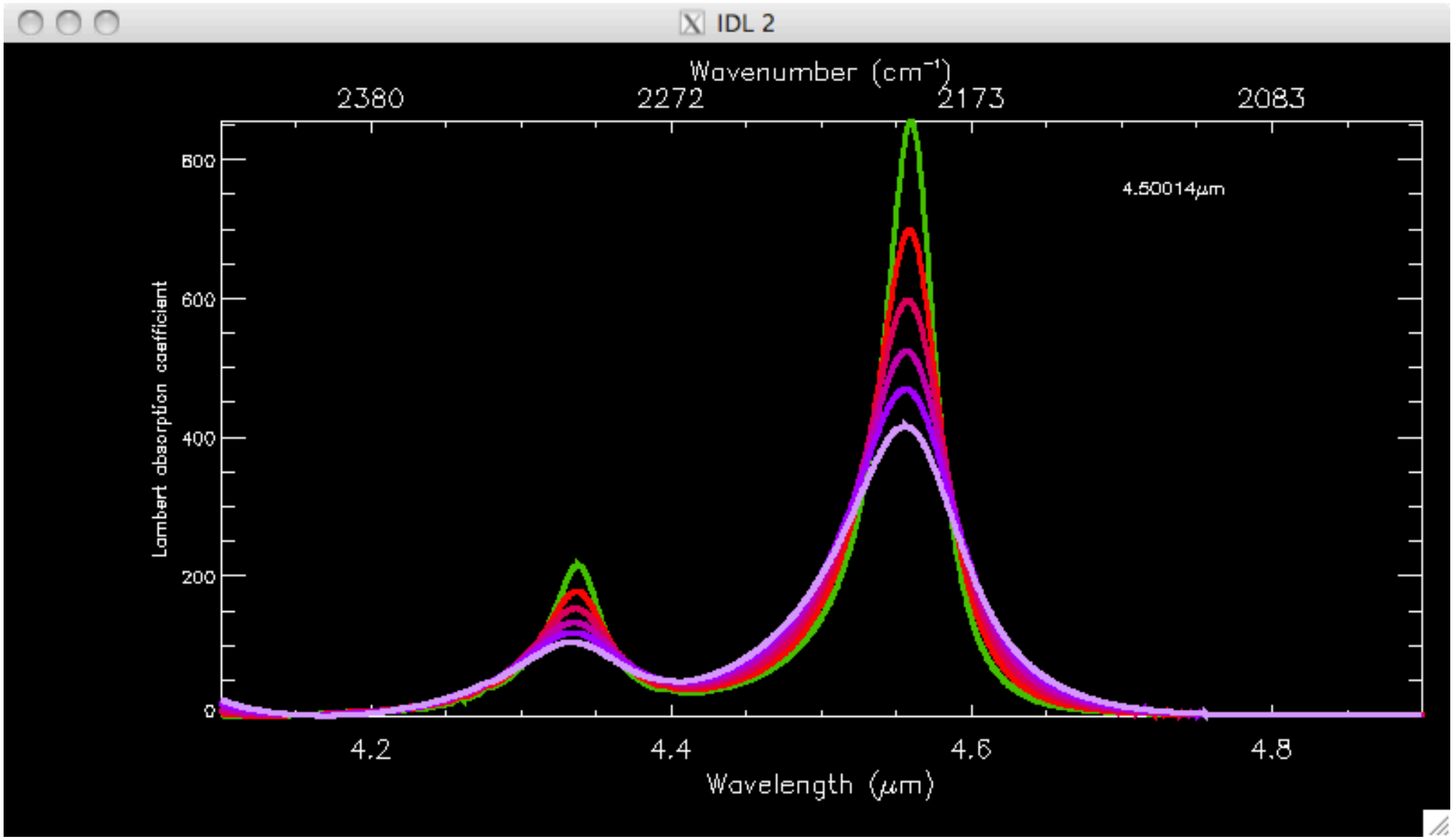
CH_3D diluted in CH_4



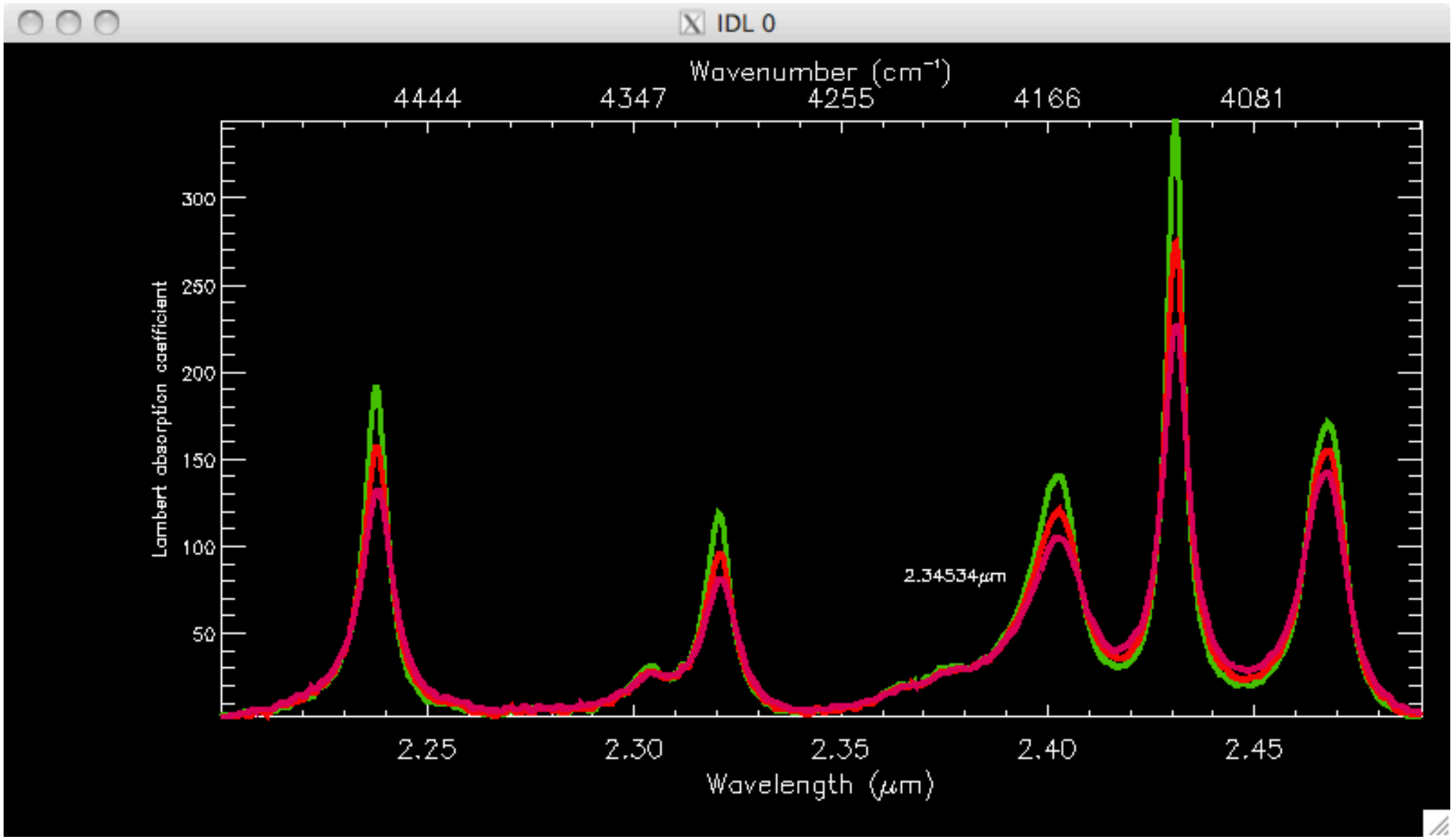
CH_3D diluted in CH_4



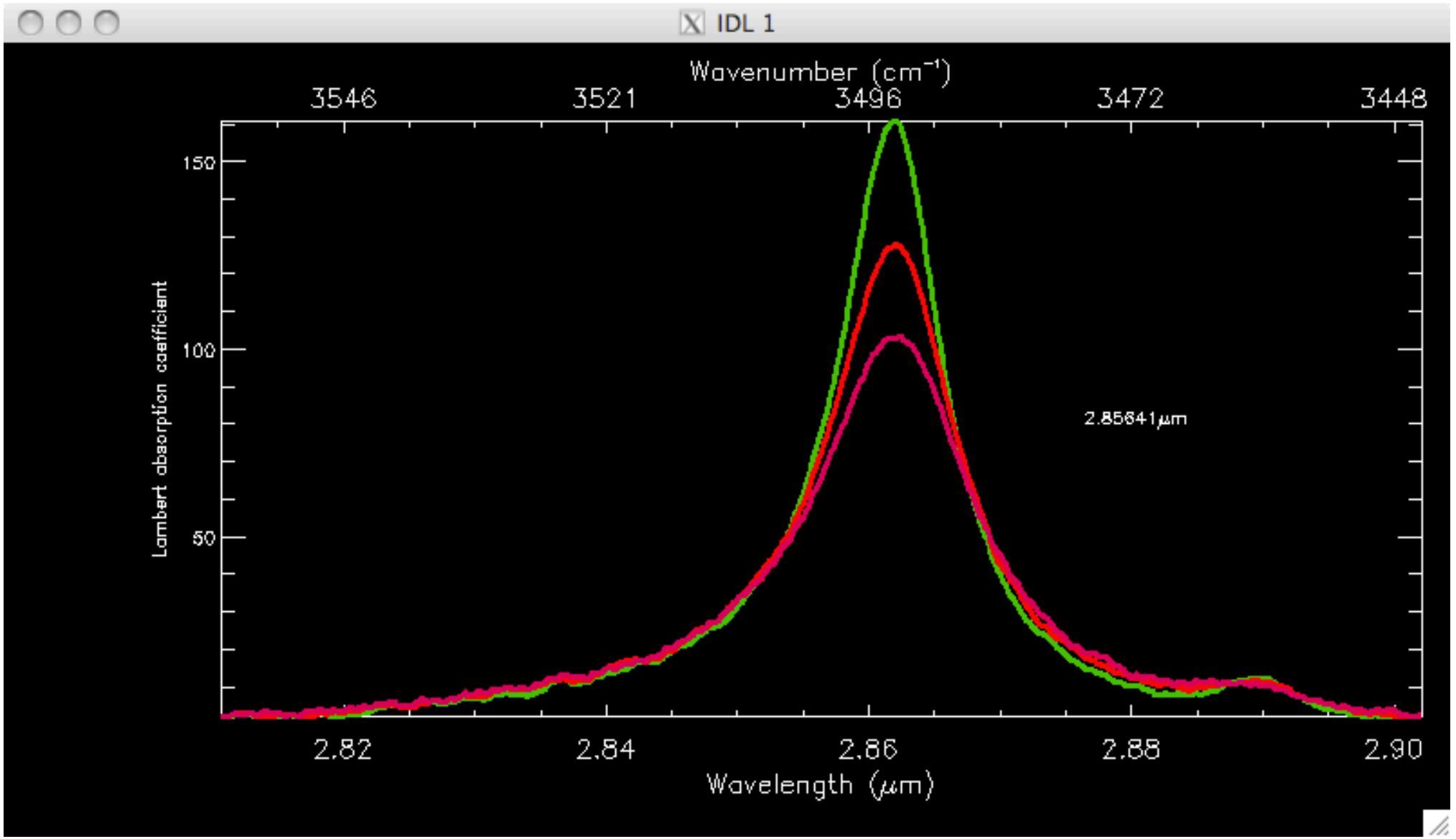
CH_3D diluted in CH_4



CH_3D diluted in N_2



CH_3D diluted in N_2



CH_3D diluted in N_2