Welcome to the FIFI-LS Data Workshop

21.10.2016
Green Building, ARC

Motivation & Goals

- Get data published
- Feedback for debugging & upgrading the pipeline
- Improve your future proposals

Today

- Presentations
- Discussions
- Tutorial

Before we start ...

Logistics

- Lunch break
- Coffee Break
- Dinner ?
- WebEx
- Participants
- Wifi & Links

Agenda

10:30	10	Welcome and Objectives	Alfred
10:40	15+5	FIFI-LS Overview and Latest News	Alfred
11:00	25+5	Science with FIFI-LS	Randolf
11:30	30+15	Observing Modes and How to Use Them	Christian
12:15	10+5	Options for Improvement of FIFI-LS	Sebastian
12:30	60	Lunch (Mega Bites)	
13:30	45+15	FIFI-LS Data Products	Dario
14:30	30+15	Evaluating the Data with Fluxer	Christof
15:15	15	Break	
15:30	75	Interactive Data Session (yours or example data set)	All
16:45	15	Summary	Alfred/Randolf
17:00		Adjourn	

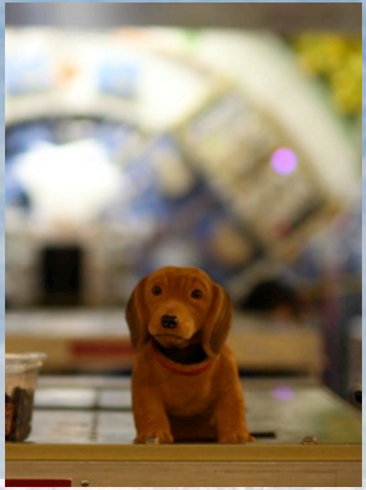
FIFI-LS

An Instrument for SOFIA

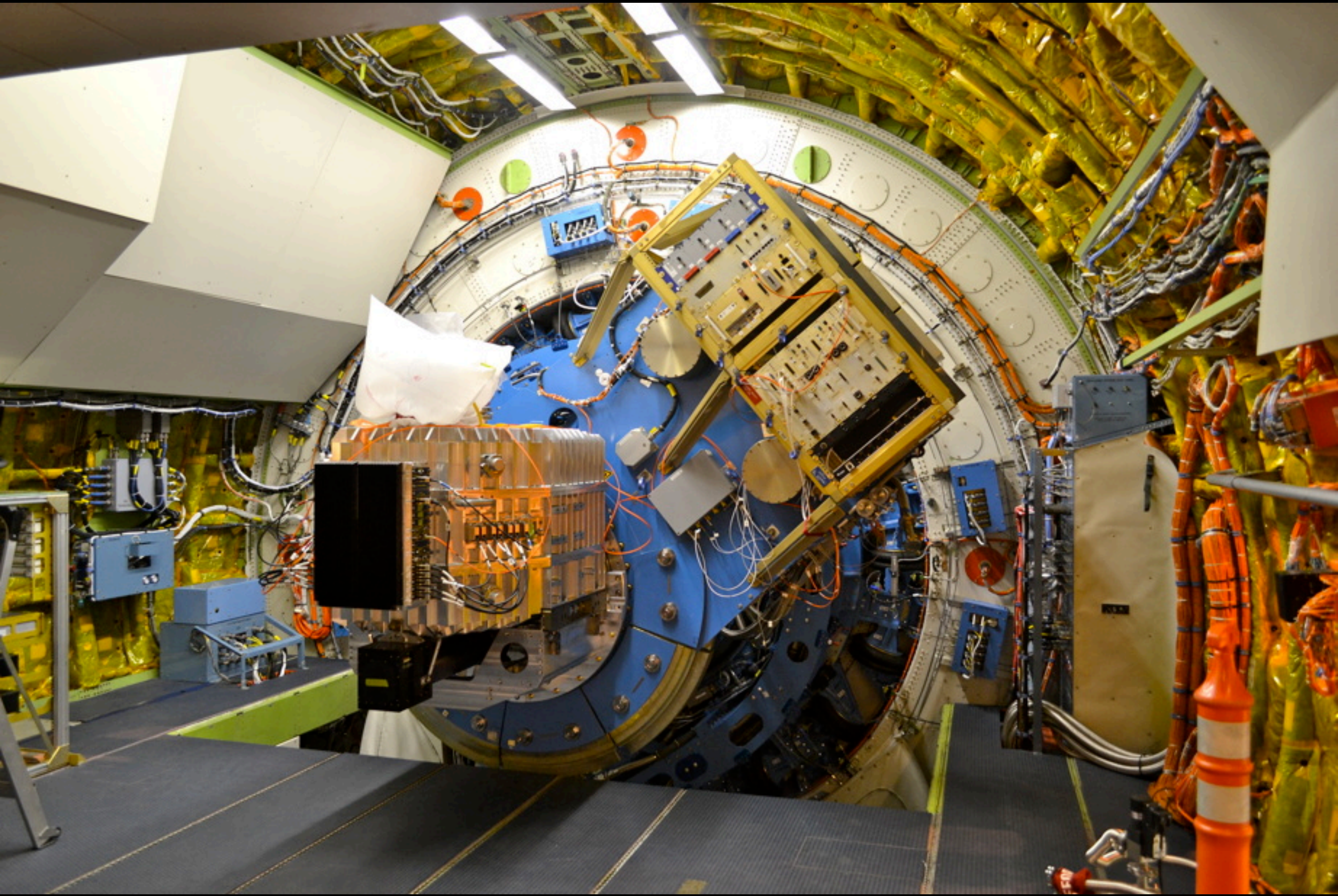
Alfred Krabbe

FIFI-LS PI n.a.

IRS, Univ. Stuttgart



FIFI-LS

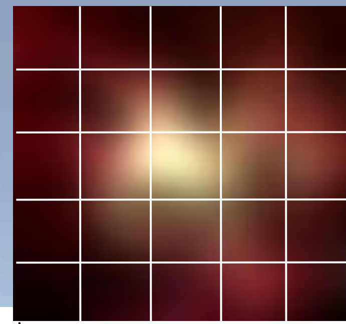


The active FIFI-LS Team

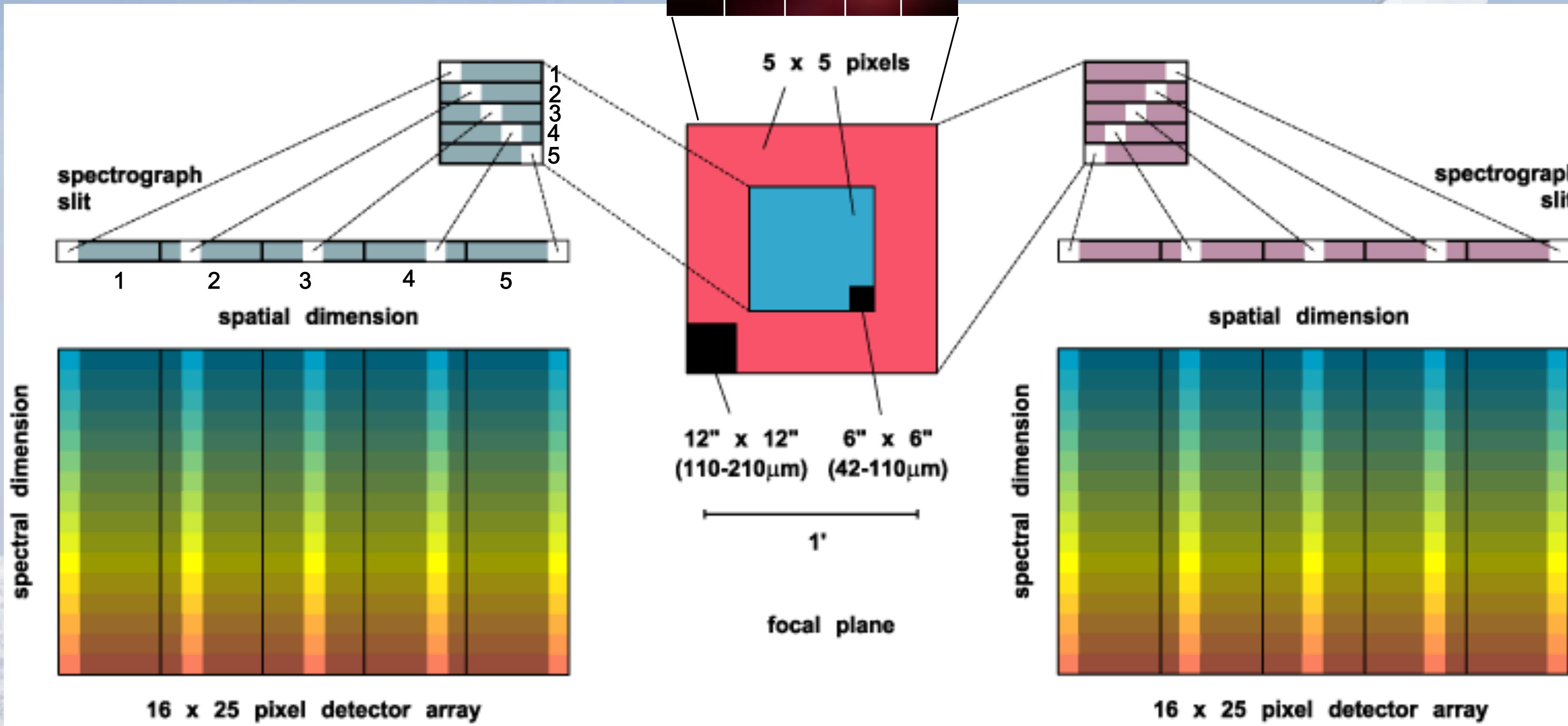
Simon Beckmann	IRS	Electronics	ST
Aaron Bryant	IRS	Astronomy, Scripts	ST
Sebastian Colditz	IRS	Improvements, Operations	Ames
Christian Fischer	IRS	Project Engineer, Timing	AFRC
(Norbert Geis)	MPE	Optics & Mechanics,	M
Thomas Henning	MPIA	Astronomy, → Hendrik Linz	HD
Rainer Hönle	IRS	Detector Module	M
Christof Iserlohe	IRS	Data Pipeline, Fluxer, Science	C
Randolf Klein	USRA	Instrument Sciencentist,	Ames
Alfred Krabbe	IRS	Strategy, Science	ST
Leslie Looney	UIUC	Science	Ill
Albrecht Poglitsch	MPE	Science, Consultant	M
Felix Rebell	IRS	Cryomechanics & Test	ST
Bill Vacca	USRA	Pipeline, Science	Ames
Chris Trinh	USRA	Operations	AFRC

FIFI-LS

2D field of view becomes 1D slit



The footprints of the red and blue channel are concentric



2D detector contains a 3D data cube

Top Level Design Features of FIFI-LS

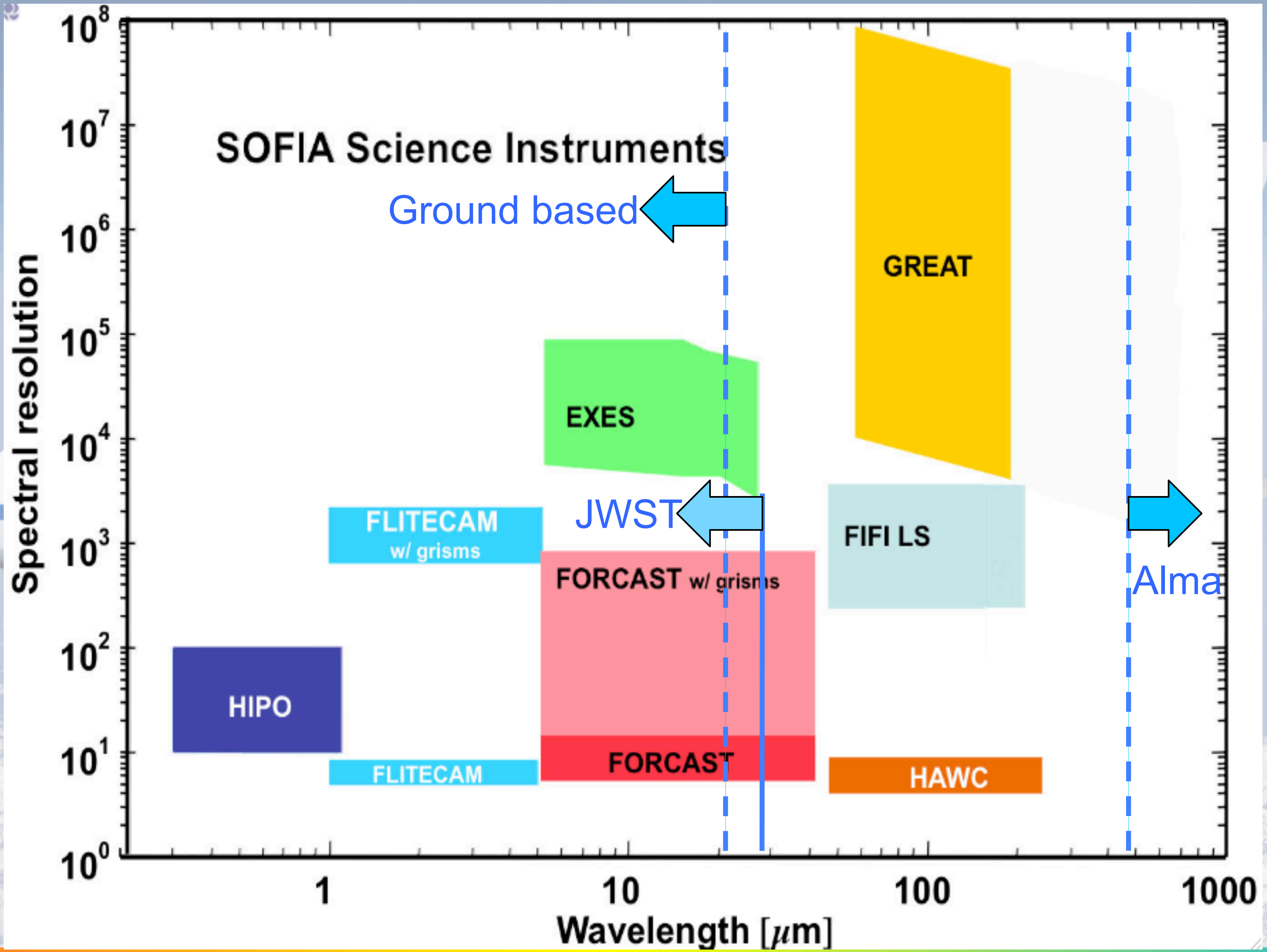
- **Two Light Paths**: 51 - 120 µm and for 110 - 200 µm, simultaneous observations
- **Simultaneous Spatial Imaging**: 30" x 30" and 60" x 60" FOV, for each light path respectively.
- **Each field of view resolved with 5 x 5 pixels**.
- **Spectral Resolution**: R ~800-2000 in each band (velocity resolution of 150-300 km/s).
- **16 pixels of spectral resolution**: Required to resolve spectral features in, e.g., galaxies.
- **Instantaneous Spectral Coverage**: of 1500 km/s covers, e.g. the velocity distribution in entire galaxies and provide good baseline coverage on both sides of any spectral line in both bands.
- **3-D Imaging Capability**: Simultaneous imaging in both spatial and the spectral domains for all 400 pixels in each band.
- **2 Ge:Ga Photoconductor Arrays**: 25x16 pixels each, unstressed & stressed.
- **Littrow-Mount Grating Spectrographs**: One for each spectrometer, compact design, operating in 1st or 1st/2nd order (for the long and short wavelength bands respectively).

FIFI-LS versus PACS Spectrometer/Herschel

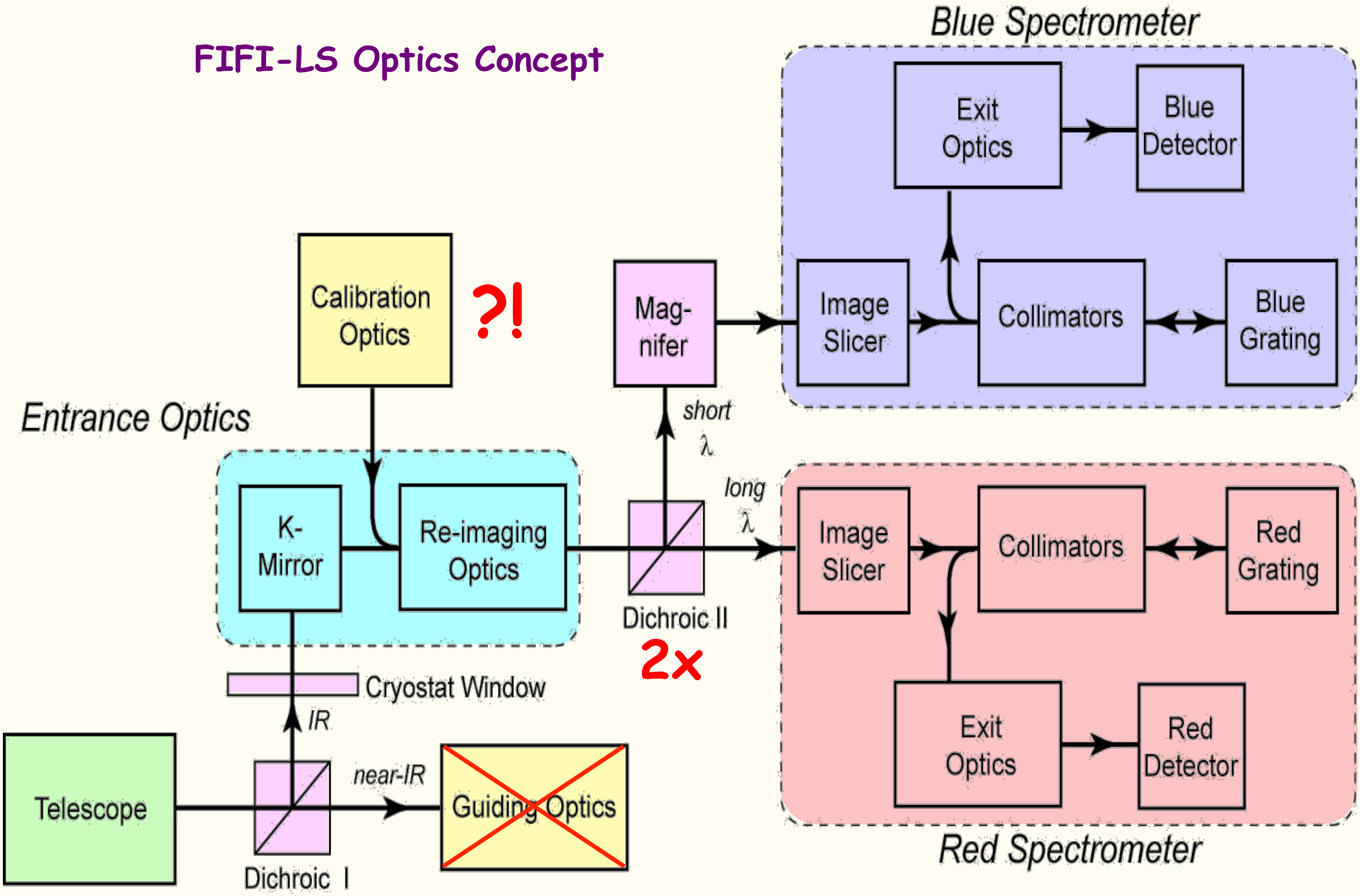
FIFI-LS	PACS
2 gratings blue & red channel independent	1 grating blue & red channel coupled
5x5 pixel FOV	5x5 pixel FOV
6”x6” & 12”x12”pixel	9.4”x9.4” pixel
2 channel 16x25 detectors	2 channel 16x25 detectors
50 – 205 µm	50 – 200 µm
shortest observation ~5 sec	shortest observation ~7 min
mapping speed high	mapping speed low
Multiple settings per target	one or few settings per target
upgradable	history

Due to the faster mapping speed and shorter integration times, FIFI-LS is expected to be only 3-5 times less sensitive (and not 8 times) compared with PACS on extended targets.

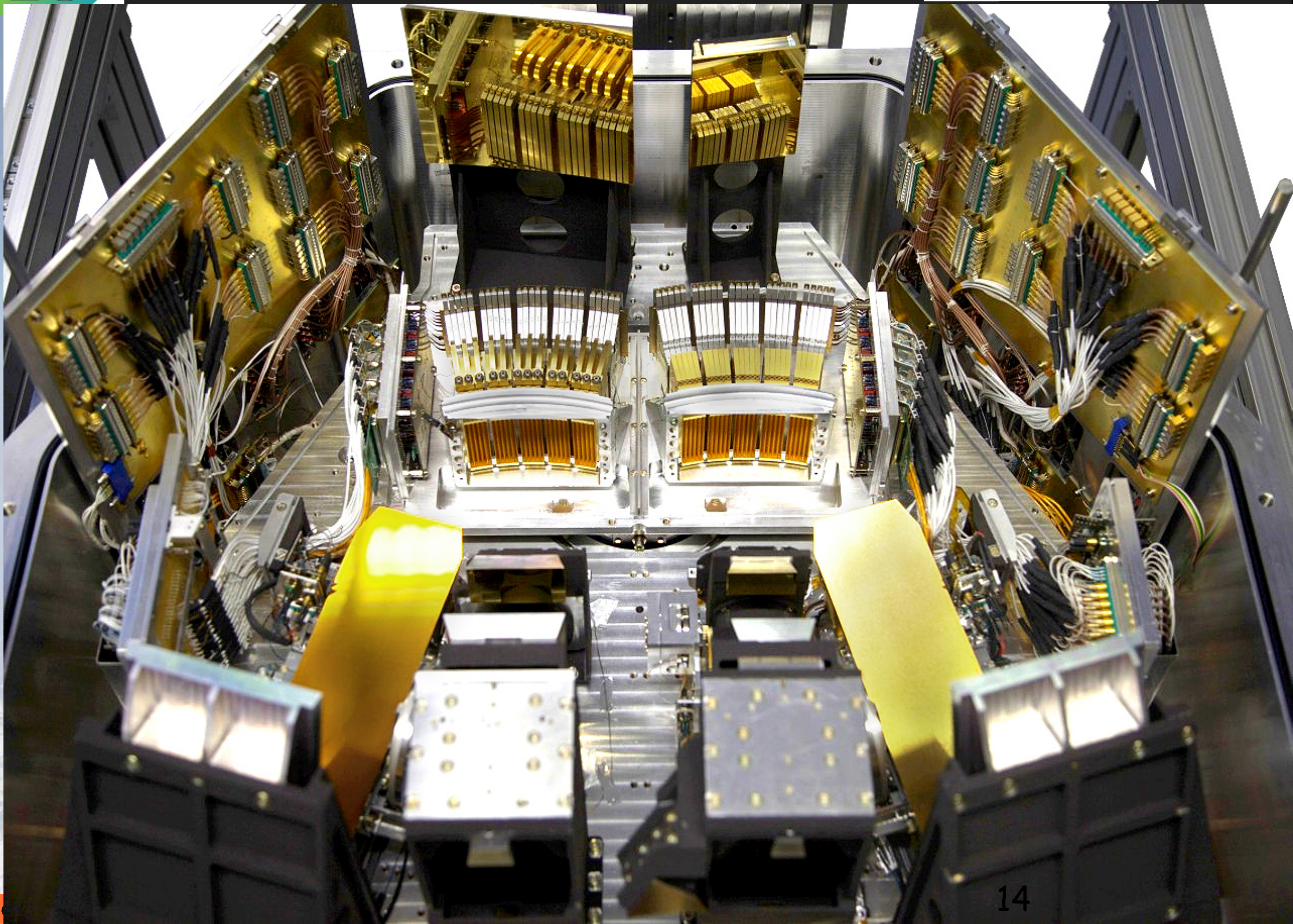
Context of SOFIA Science Instruments



FIFI-LS Optics Concept

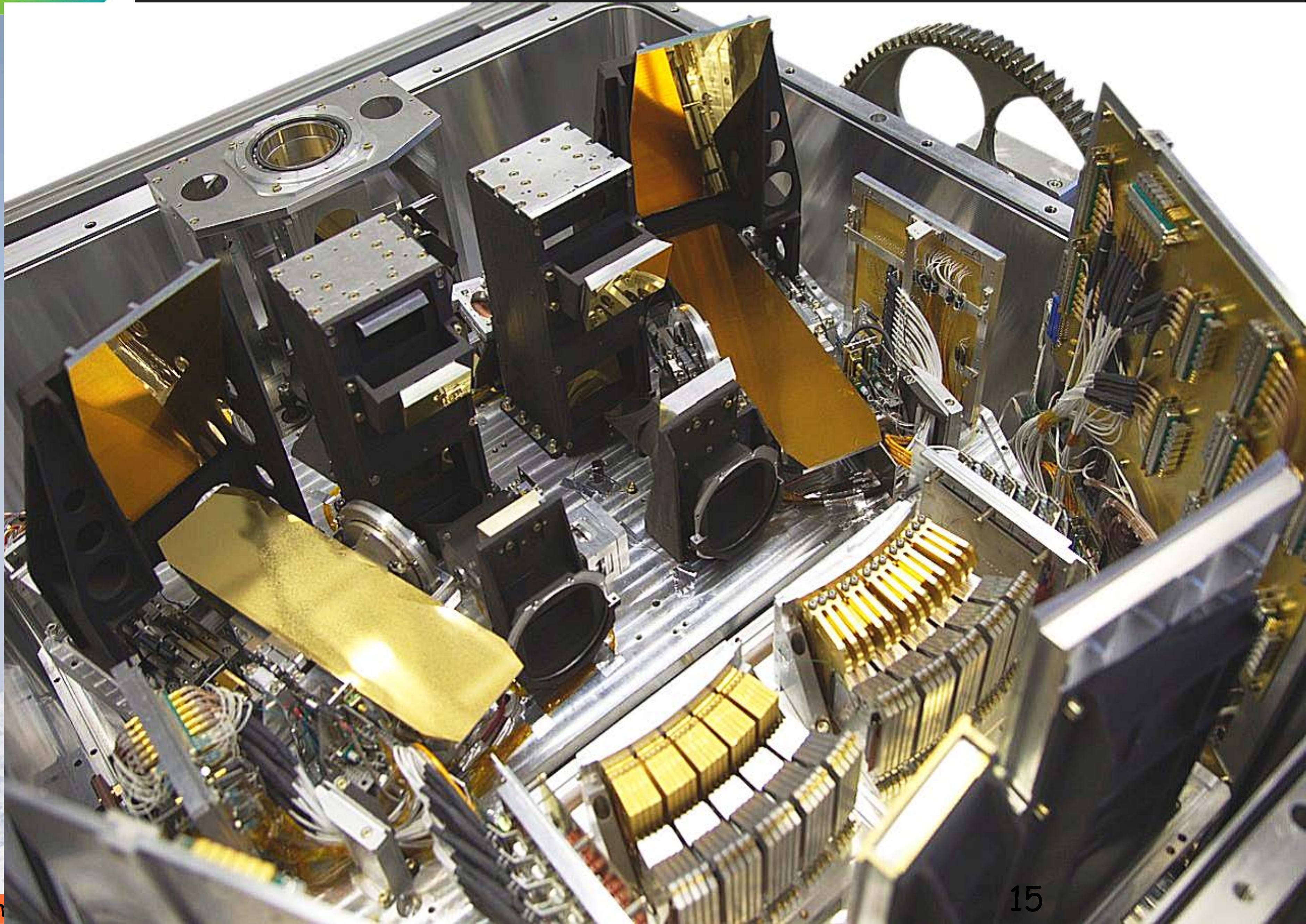


FIFI-LS

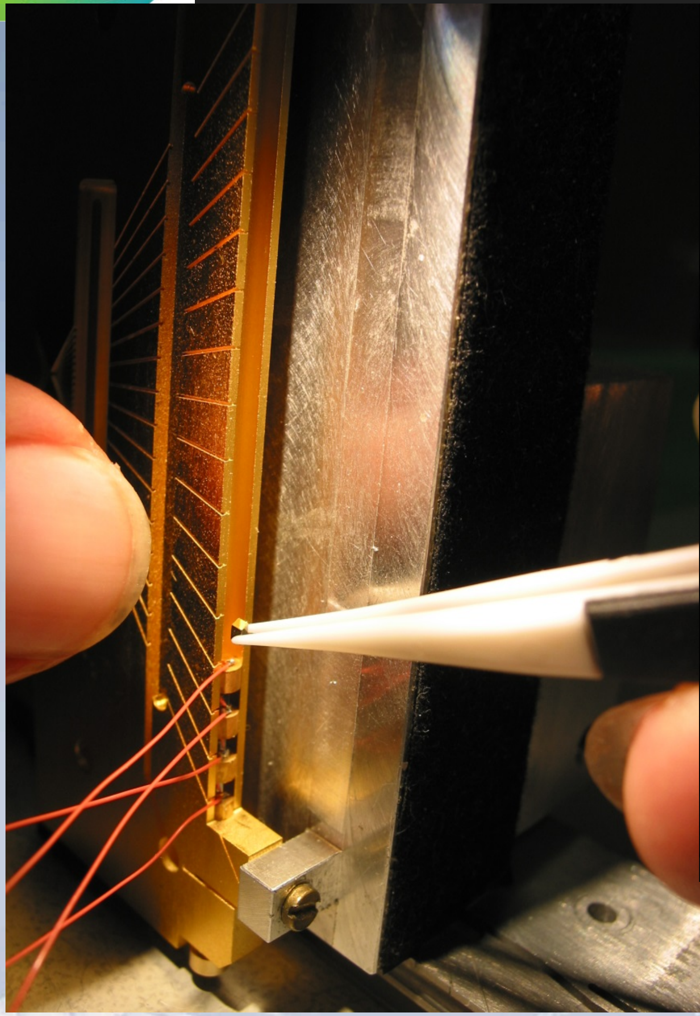


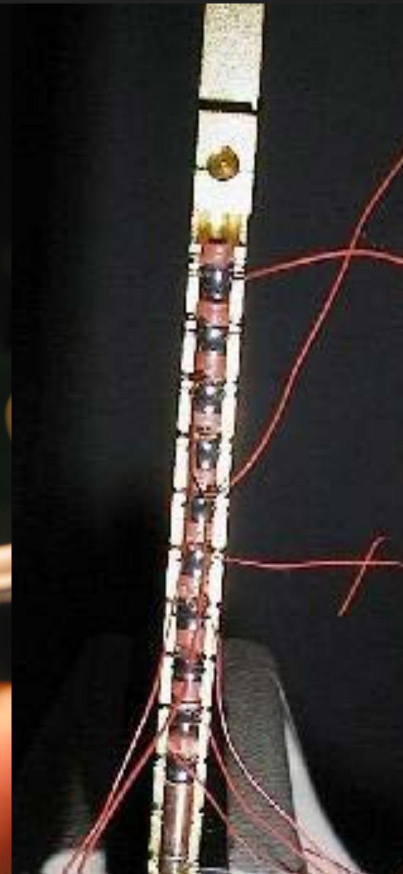
Am

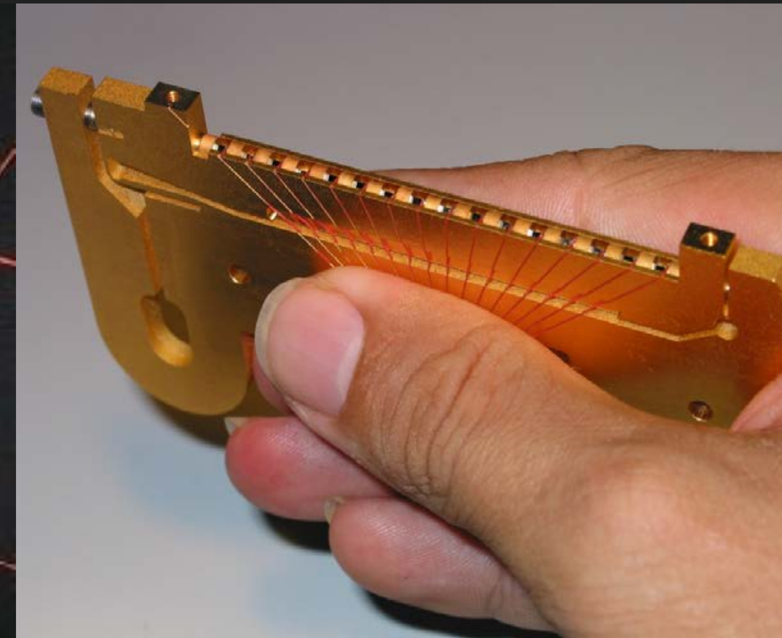
FIFI-LS



FIFI-LS

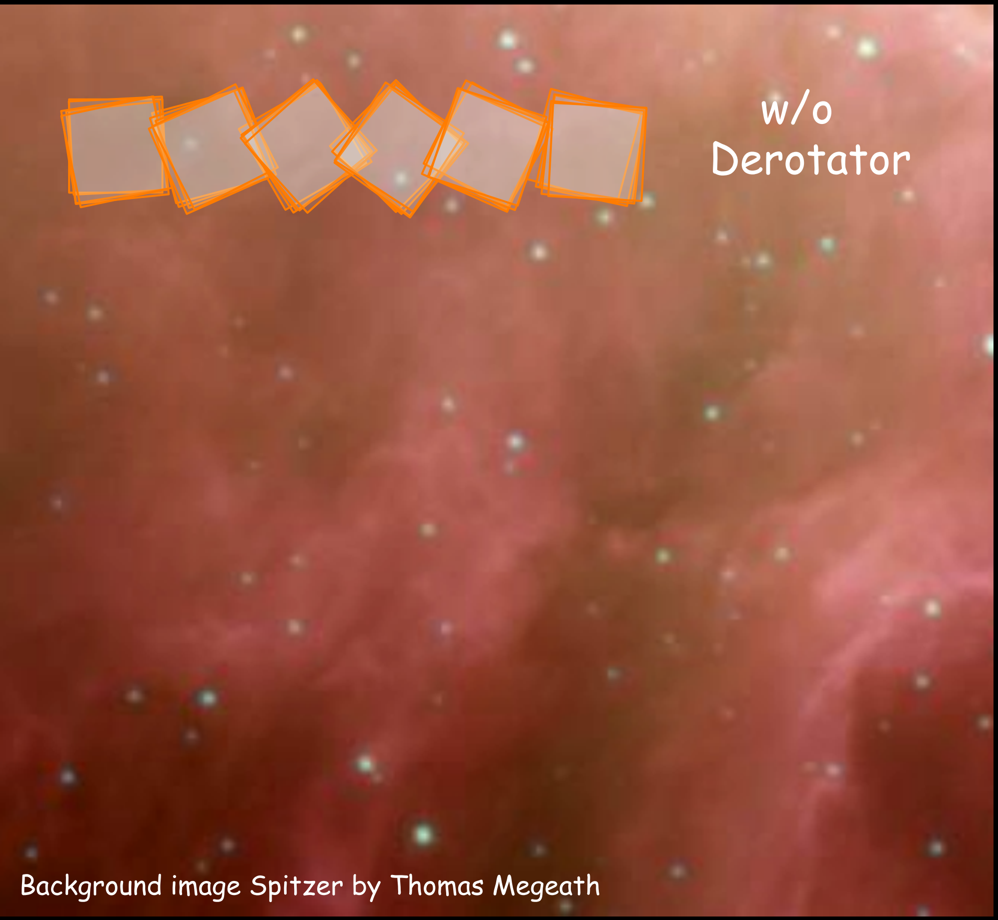


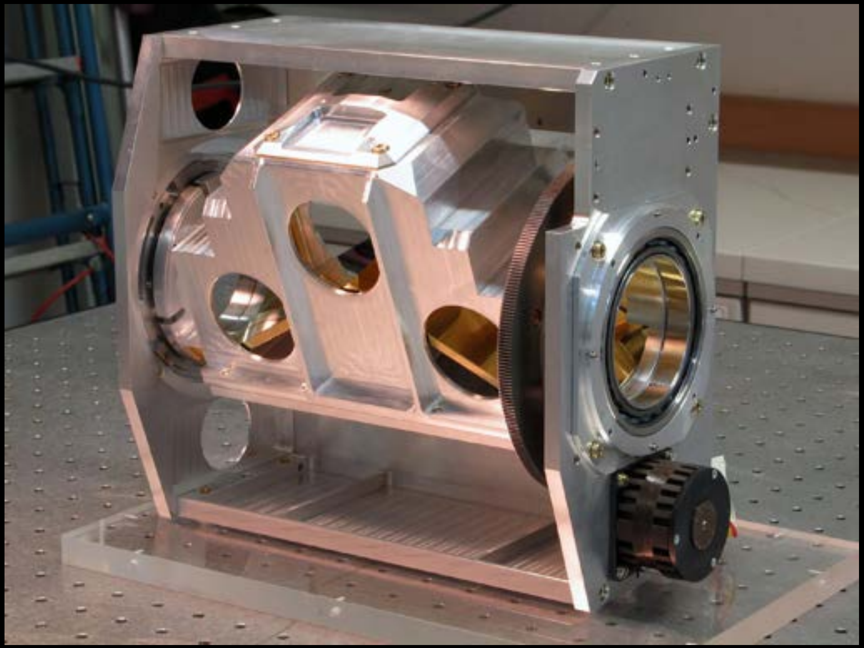


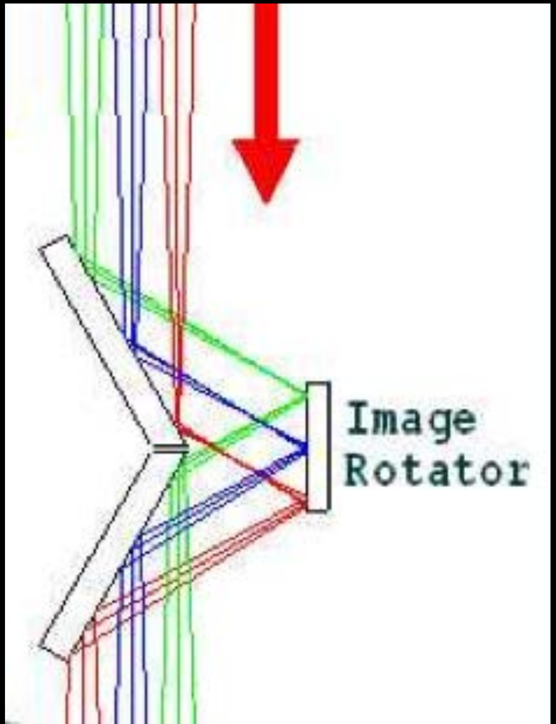


Hand crafting the detectors:
800 individual pixel

Image Derotator

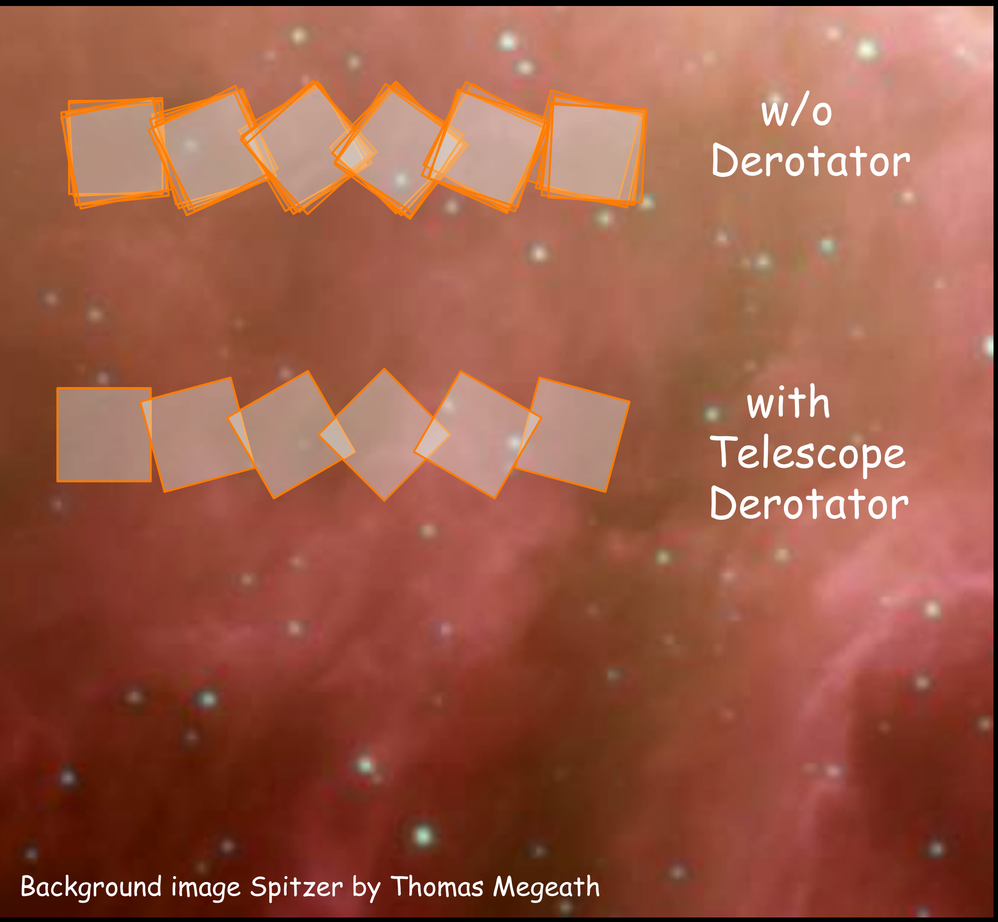


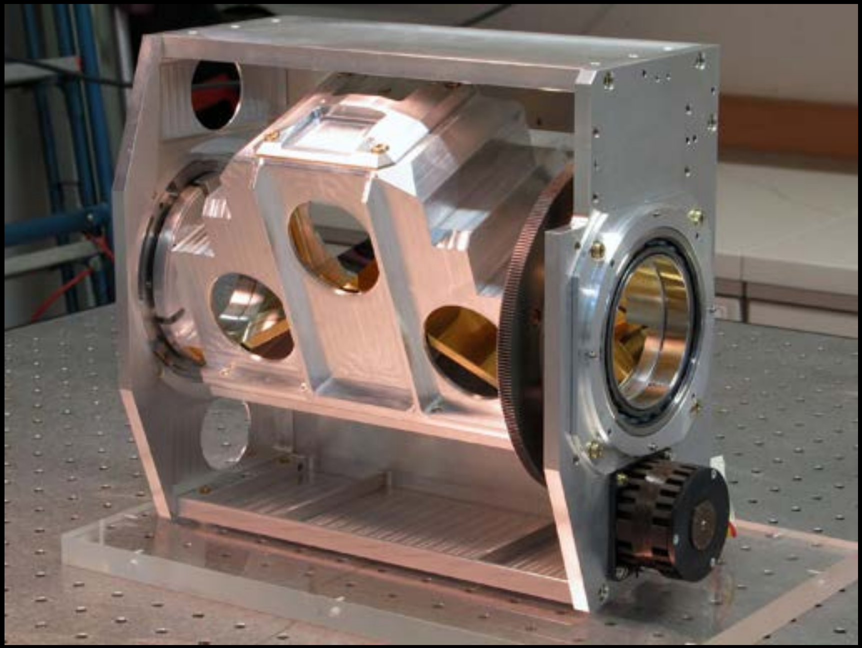


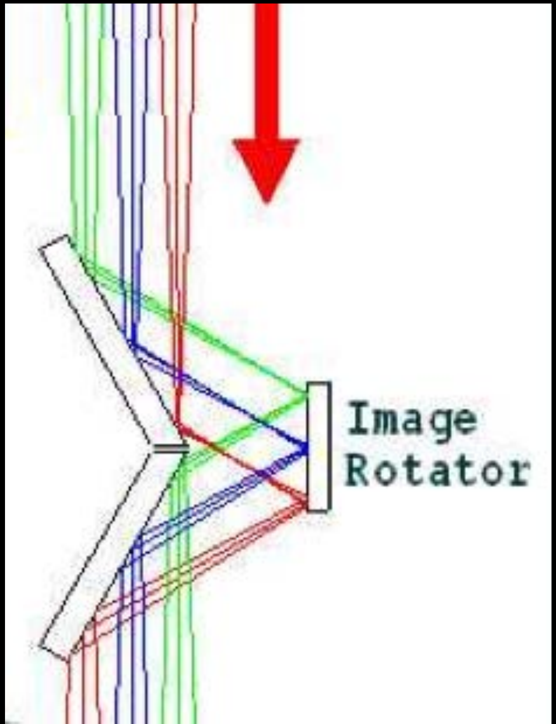


The parallactic angle changes with time

Image Derotator

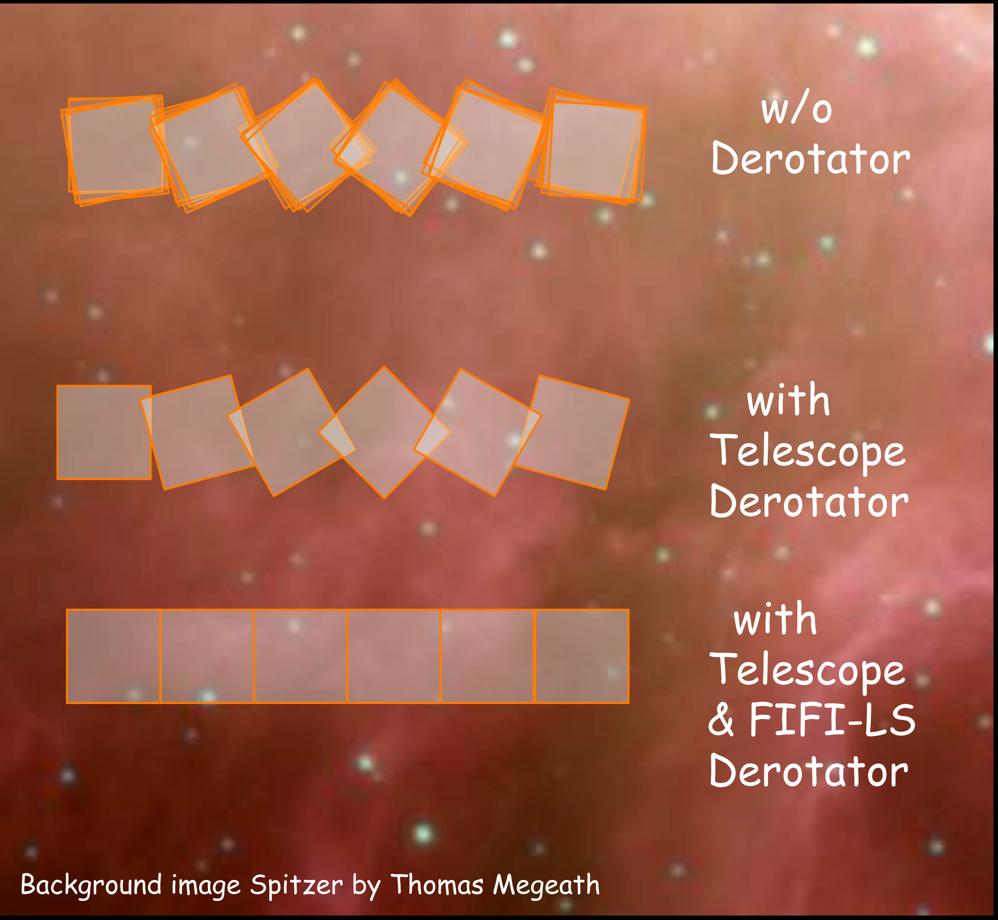


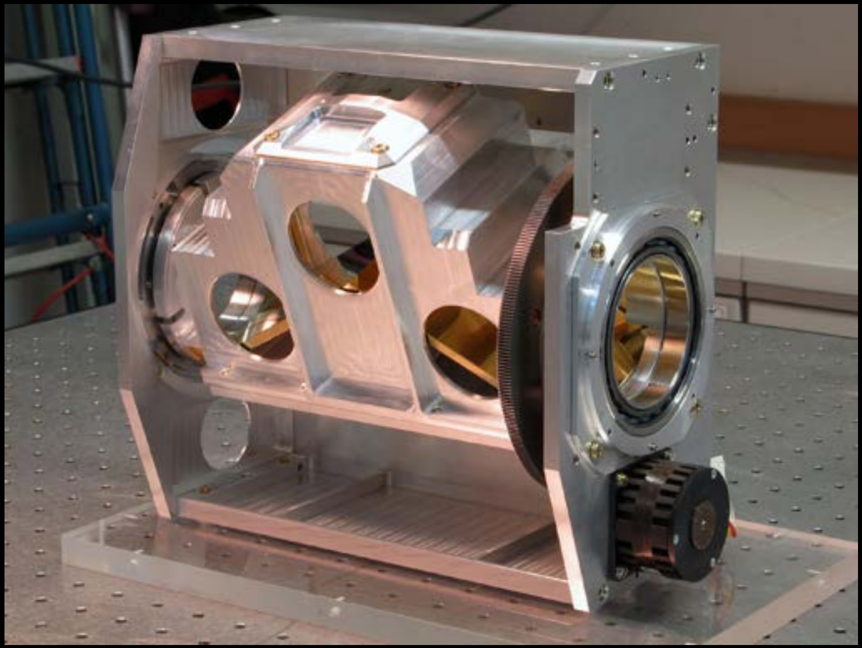


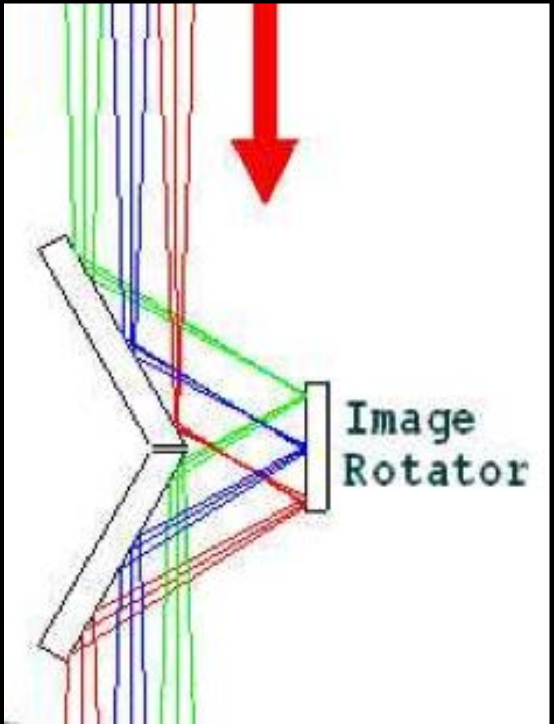


The FIFI-LS Derotator keeps the orientation of the FOV during observations

Image Derotator

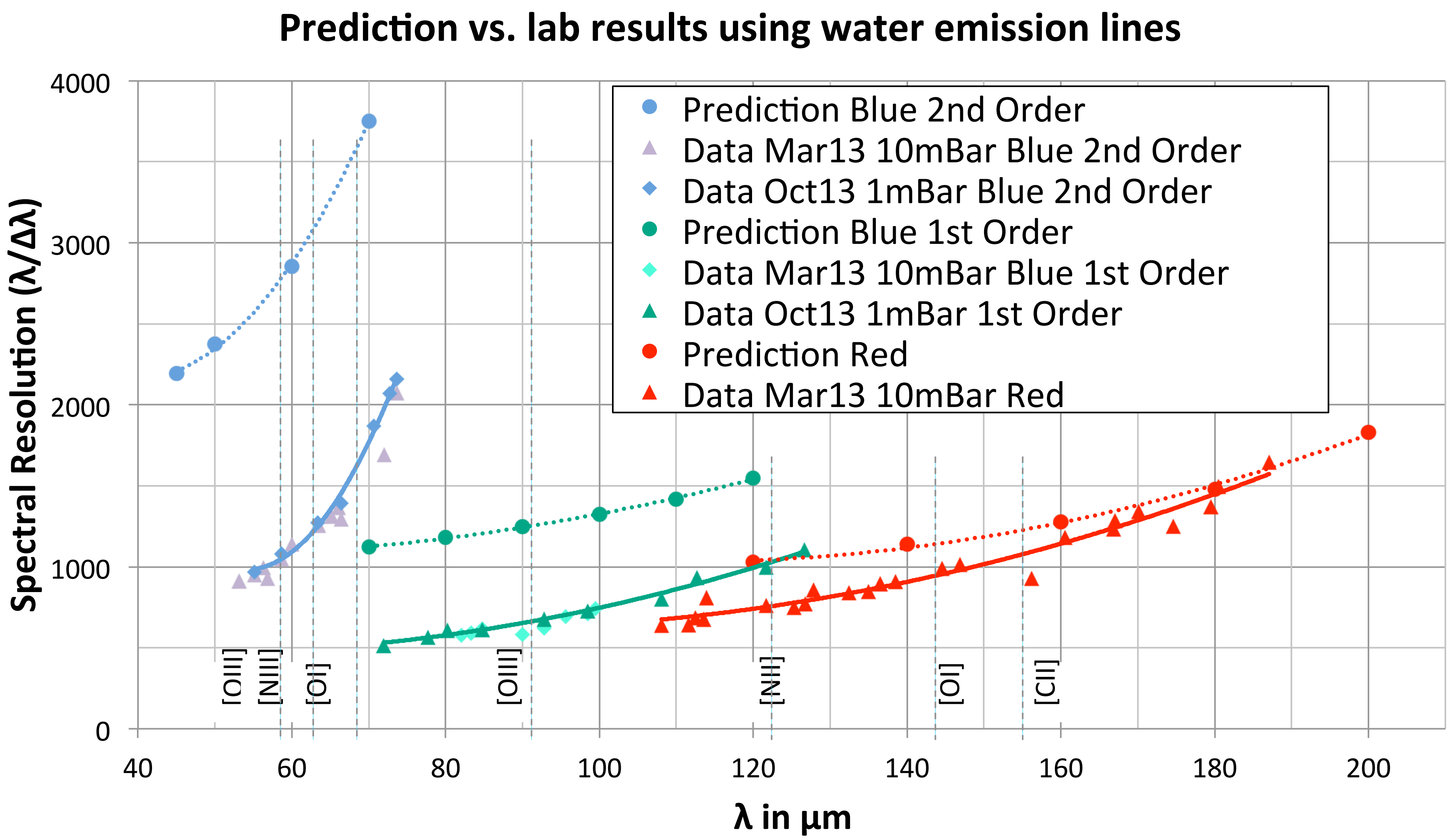




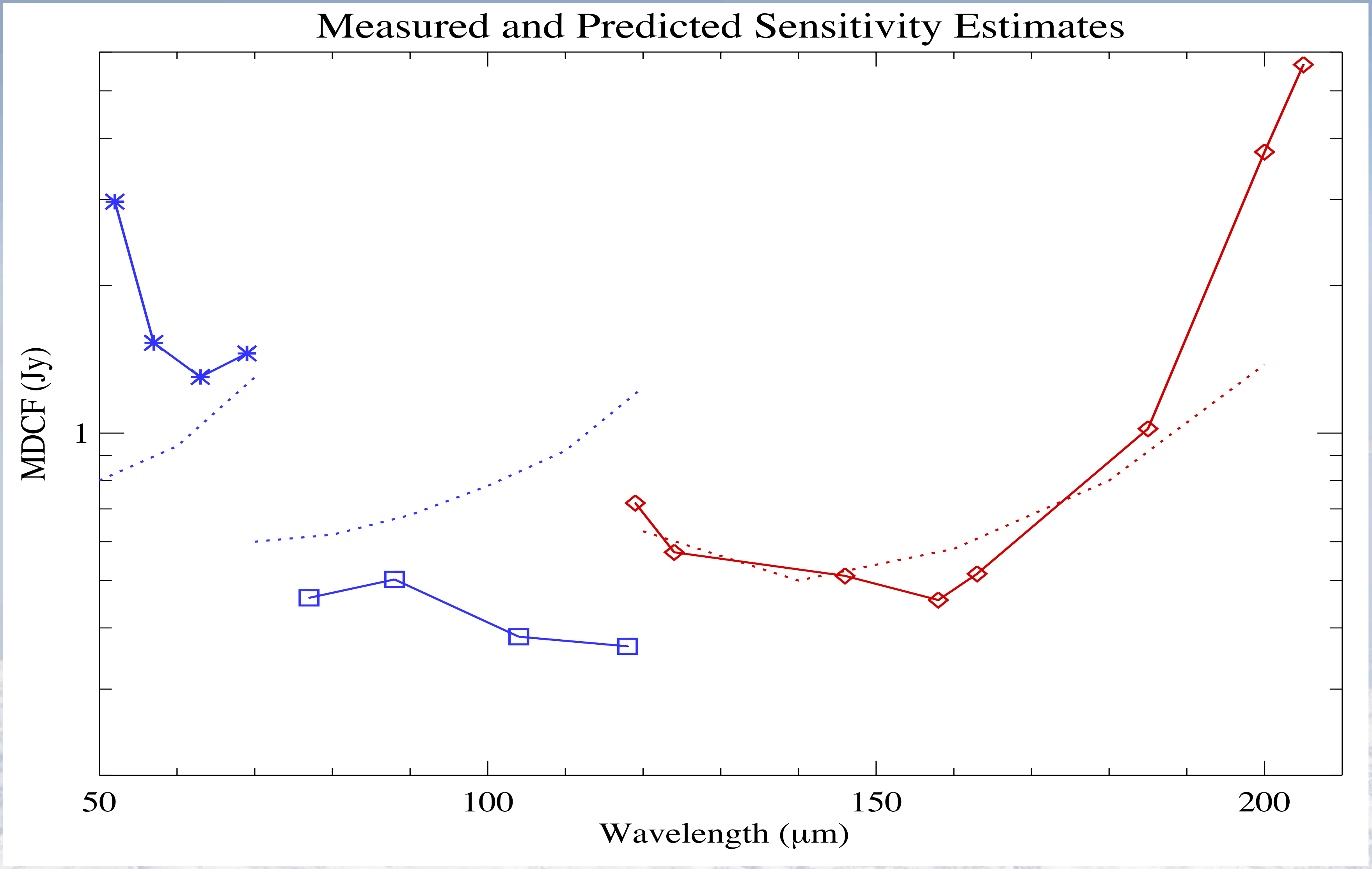


With the FIFI-LS Derotator the FOV can be oriented according to the science requirements

Spectral Resolution

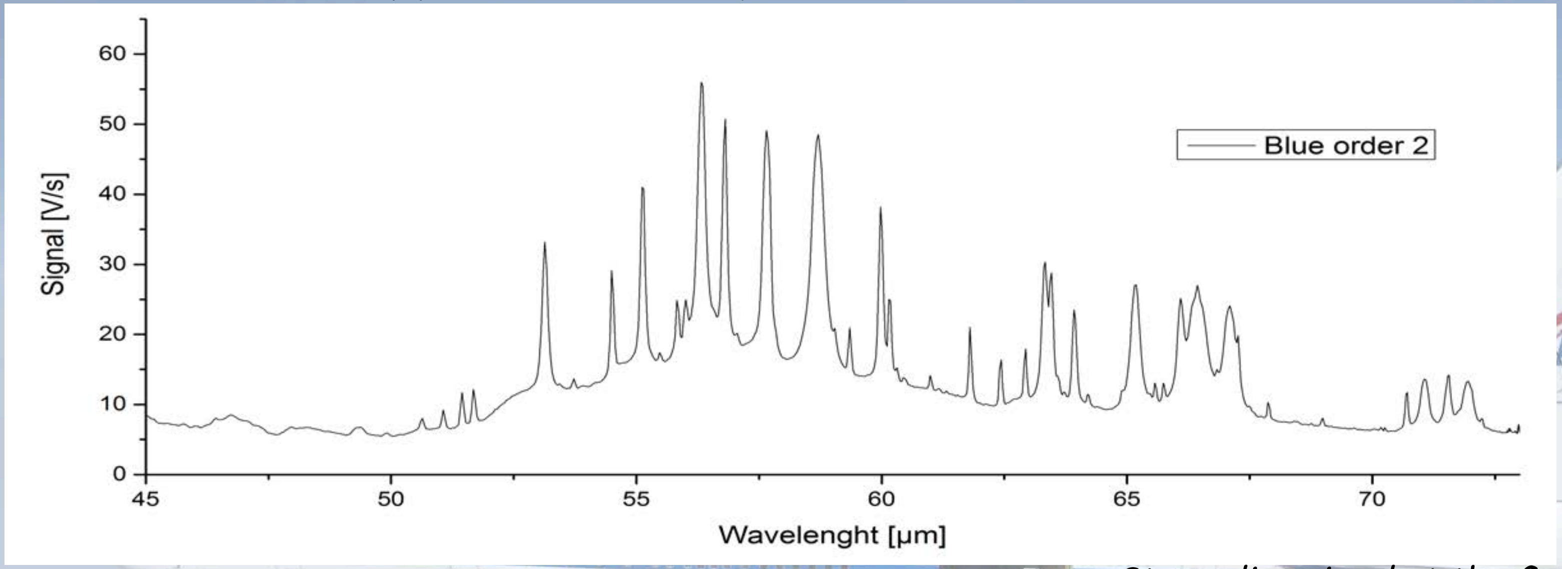


FIFI-LS Sensitivity



FIFI-LS Performance

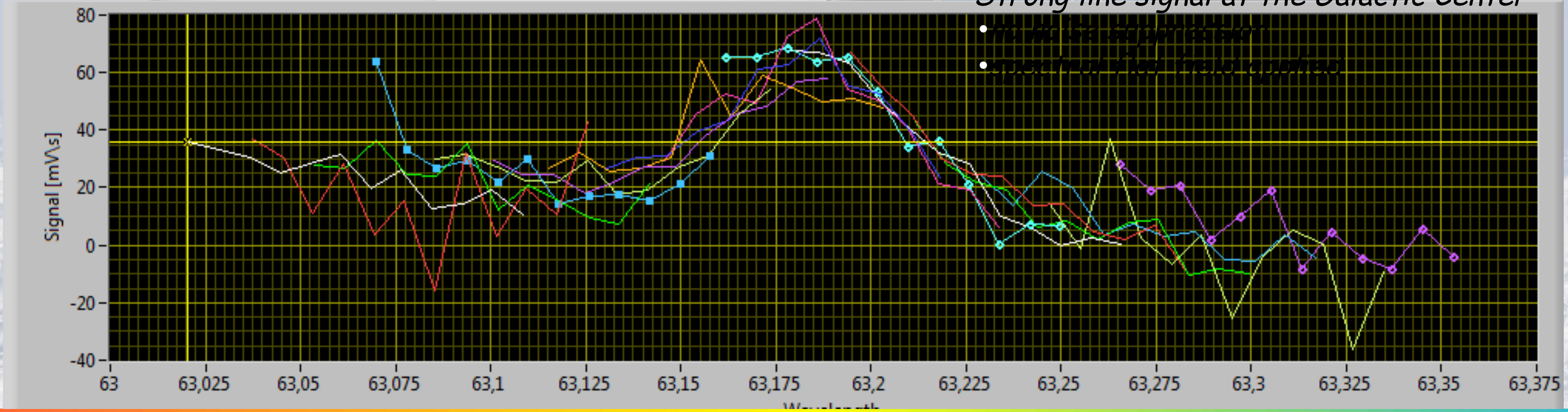
- Background is typically at least 100 times more than signal
- Limits bias voltage especially close to atmospheric features
- Noise suppression is key to good data reduction



Spectral scans of the atmosphere at an elevation of 41000 feet and 35° zenit angle. The scan was obtained in DC mode, i.e. without chopping. (R. Hönle)

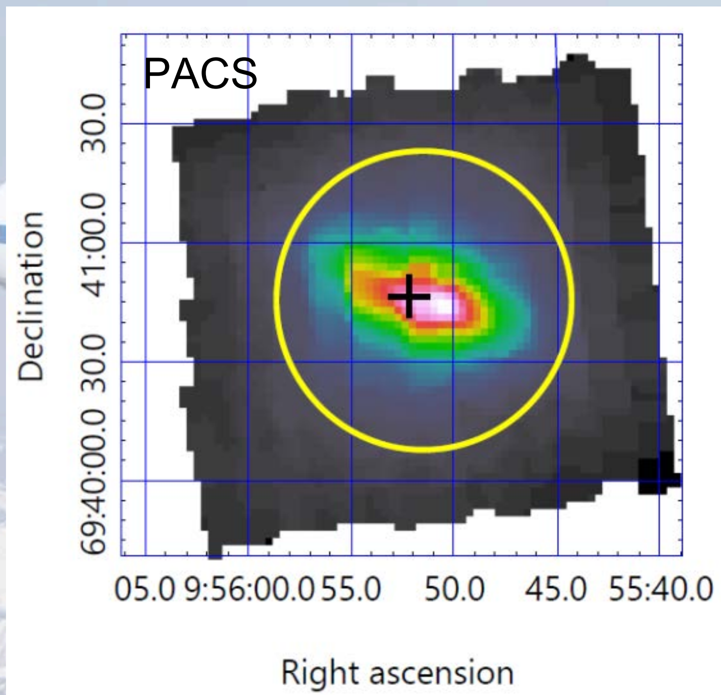
Strong line signal at the Galactic Center

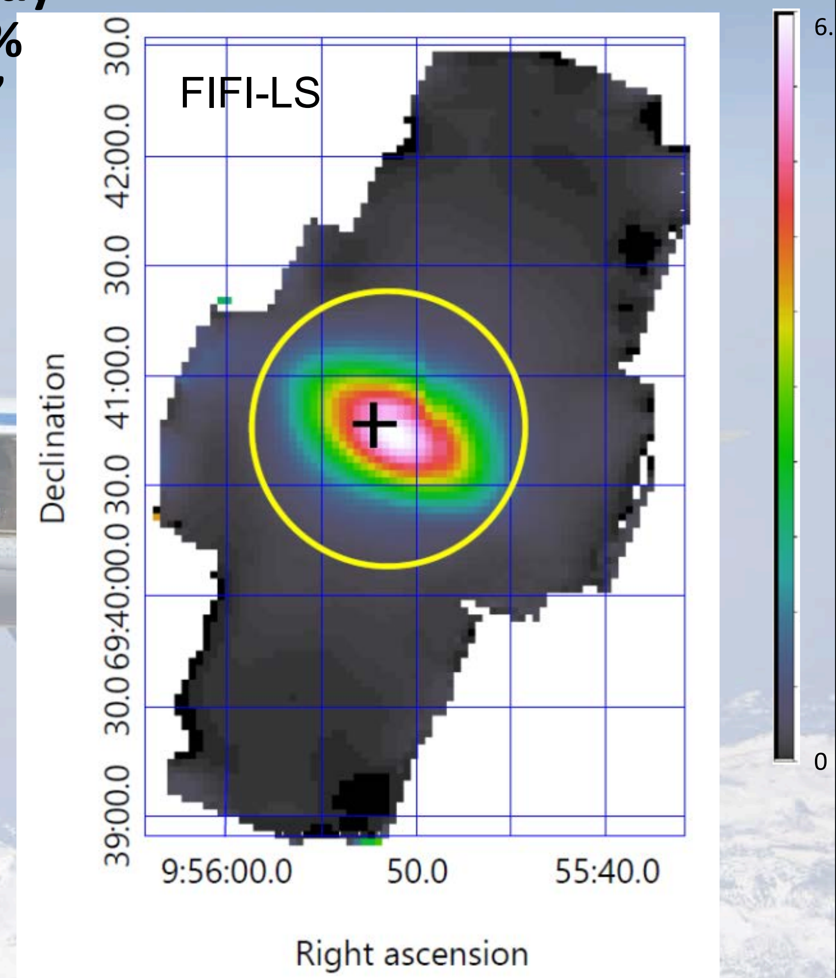
- *no noise suppression*
- *spectral flat field applied*



Comparison of Flux between FIFI-LS and PACS at [CII]

- Fitted line flux of [CII] at 157.741 µm
- Black cross marks center of the galaxy at *9h55m52.2s 69d40m46.6s*
- Maximum flux levels match almost perfectly
- Total fluxes in yellow circle are within 15 %
- Flux is shown in W/m² per PACS 9.4''x9.4'' spaxel
- General topology matches well





Pipeline

IDL version of pipeline built on earlier code written by R. Klein and K. Nishikida

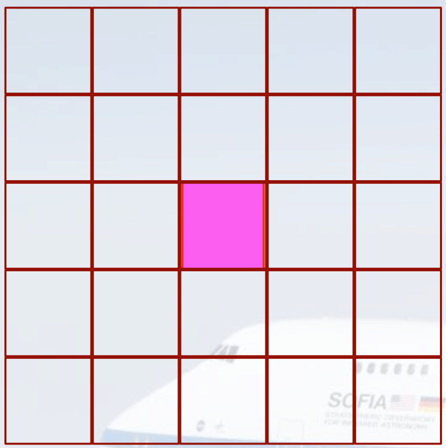
Current version incorporates many of the algorithms in the raw data LabView reduction code written by R. Hönle

Works within existing DPS infrastructure (REDUX)

More: See talk by Dario

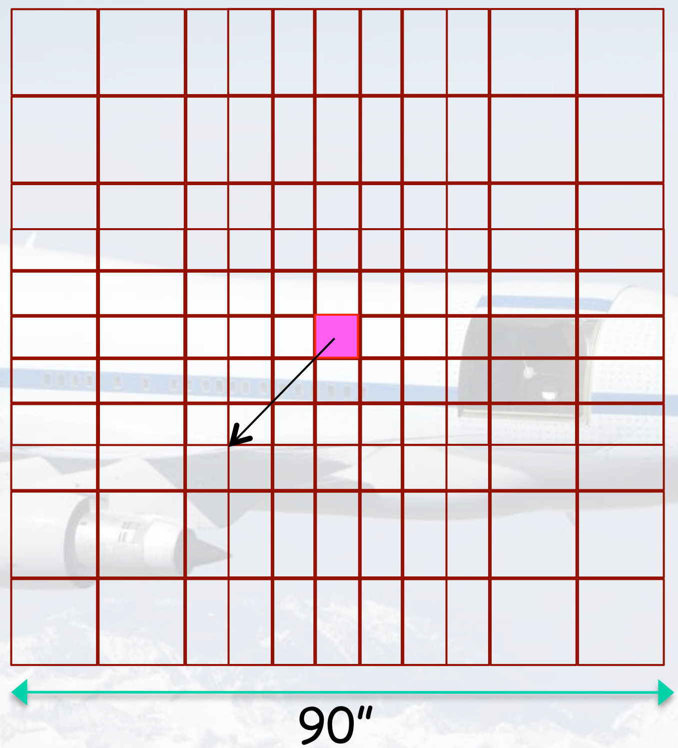
Mosaiking for Beginners I

5x5pixel, 60"x60"FOV



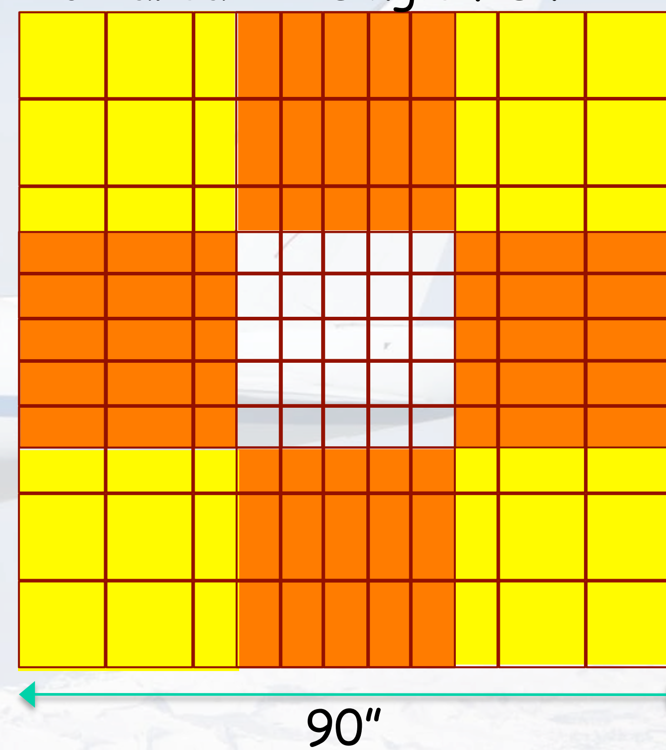
Center

Offsets ["]:
-15/+15
+15/-15
+15/+15
-15/-15



1x 2x

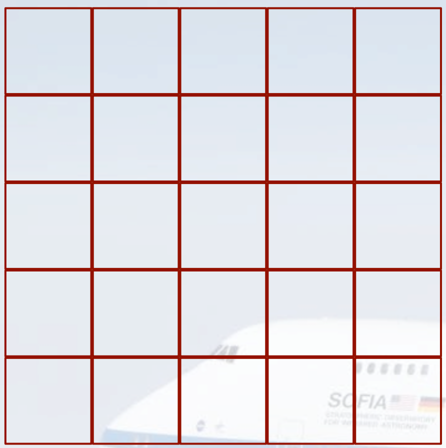
1 ov-area = 1 single FOV



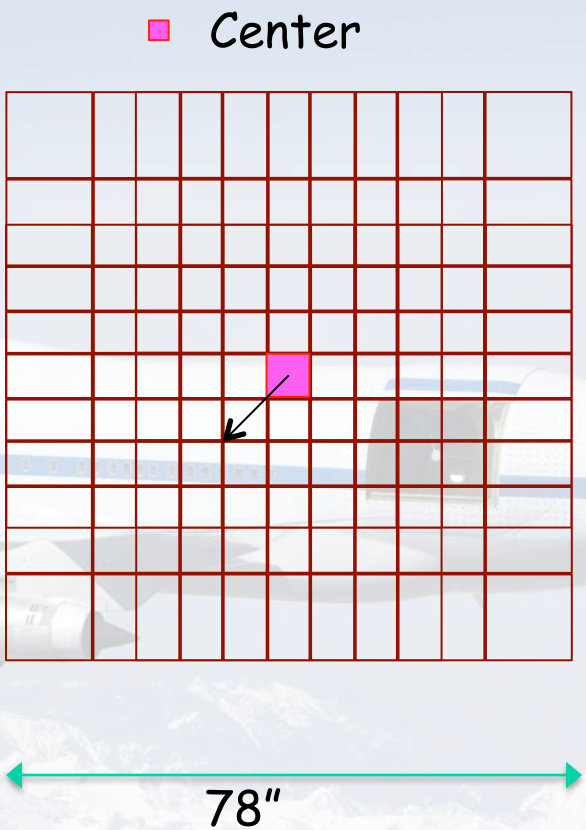
1x overlay is useless, need at least 2x

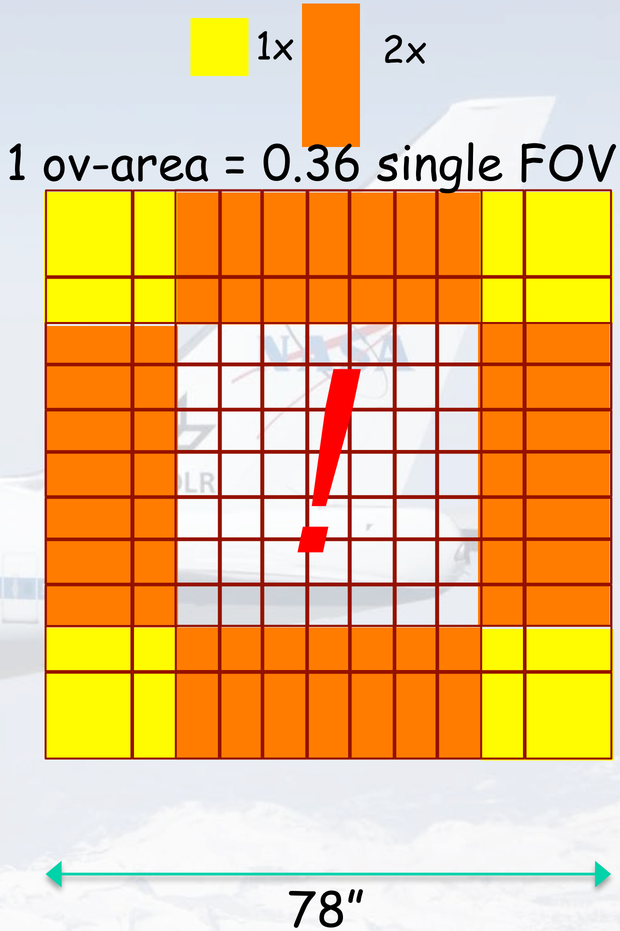
Mosaiking for Beginners II

5x5pixel, 60"x60"FOV



Offsets ["]:
- -9/+9
- +9/-9
- +9/+9
- -9/-9

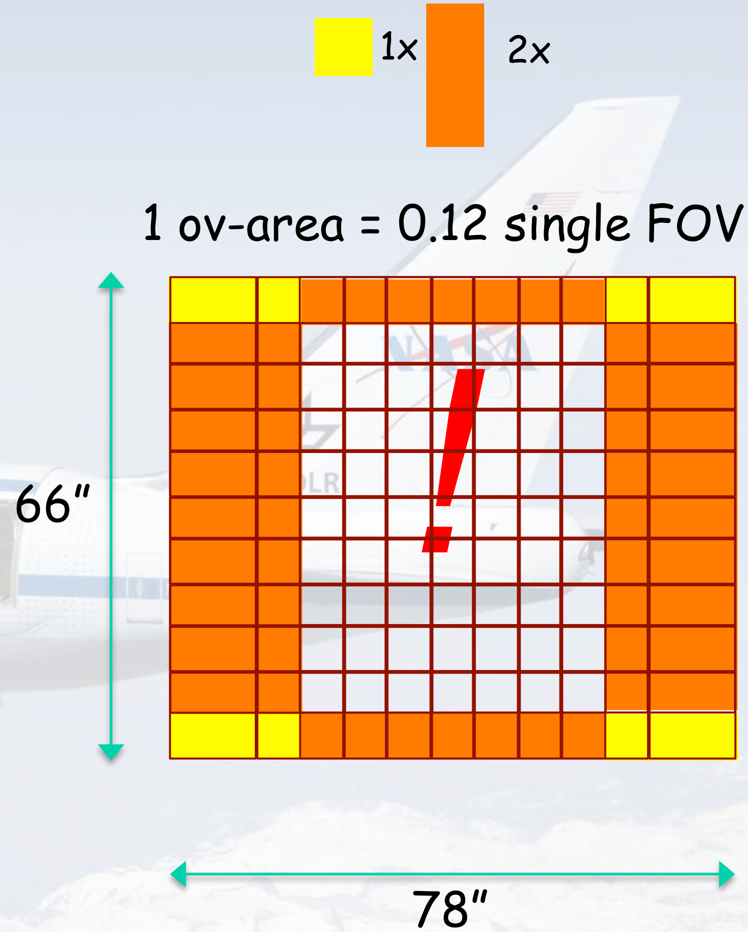




$(42"/30")^2 = 2$ → Doubled the area with 4 overlays

Mosaiking for Beginners III

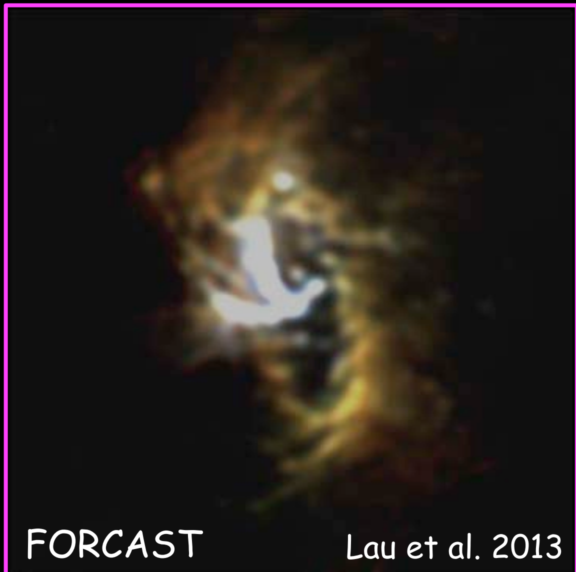
- Modulo half pixel shifts are desirable to better sample the PSF.
- Minimum shift: 1.5/0.5 to allow use of 1 nod for several fields.



Offsets ["]:
-9/+3
+9/-3
+9/+3
-9/-3

(54"/30")^2= 3.24 → More than triple the area with 4 overlays

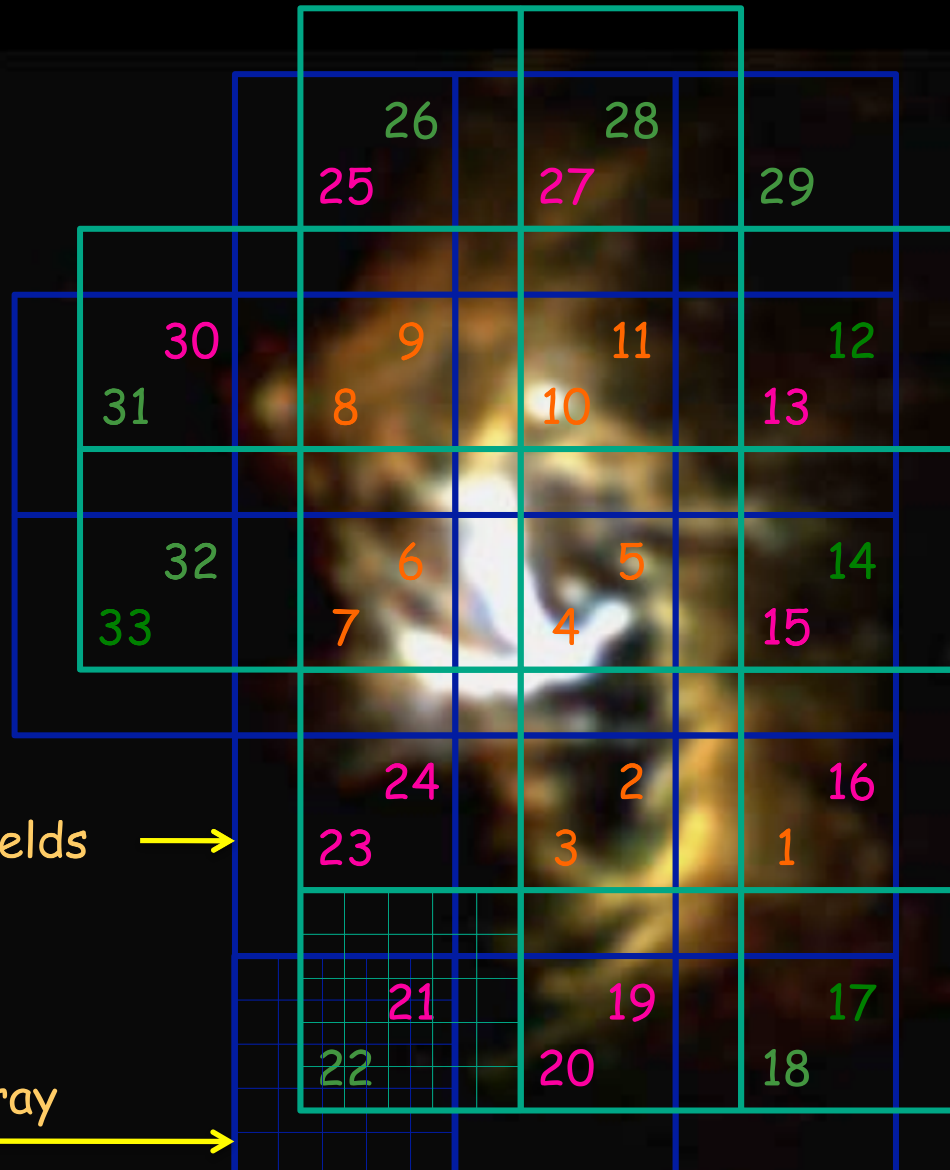
FIFI-LS GC



33 mosaic fields

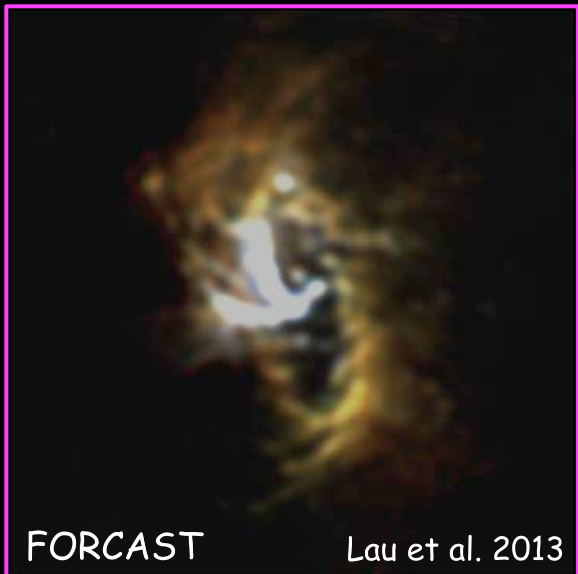
Table with
Offset Positions

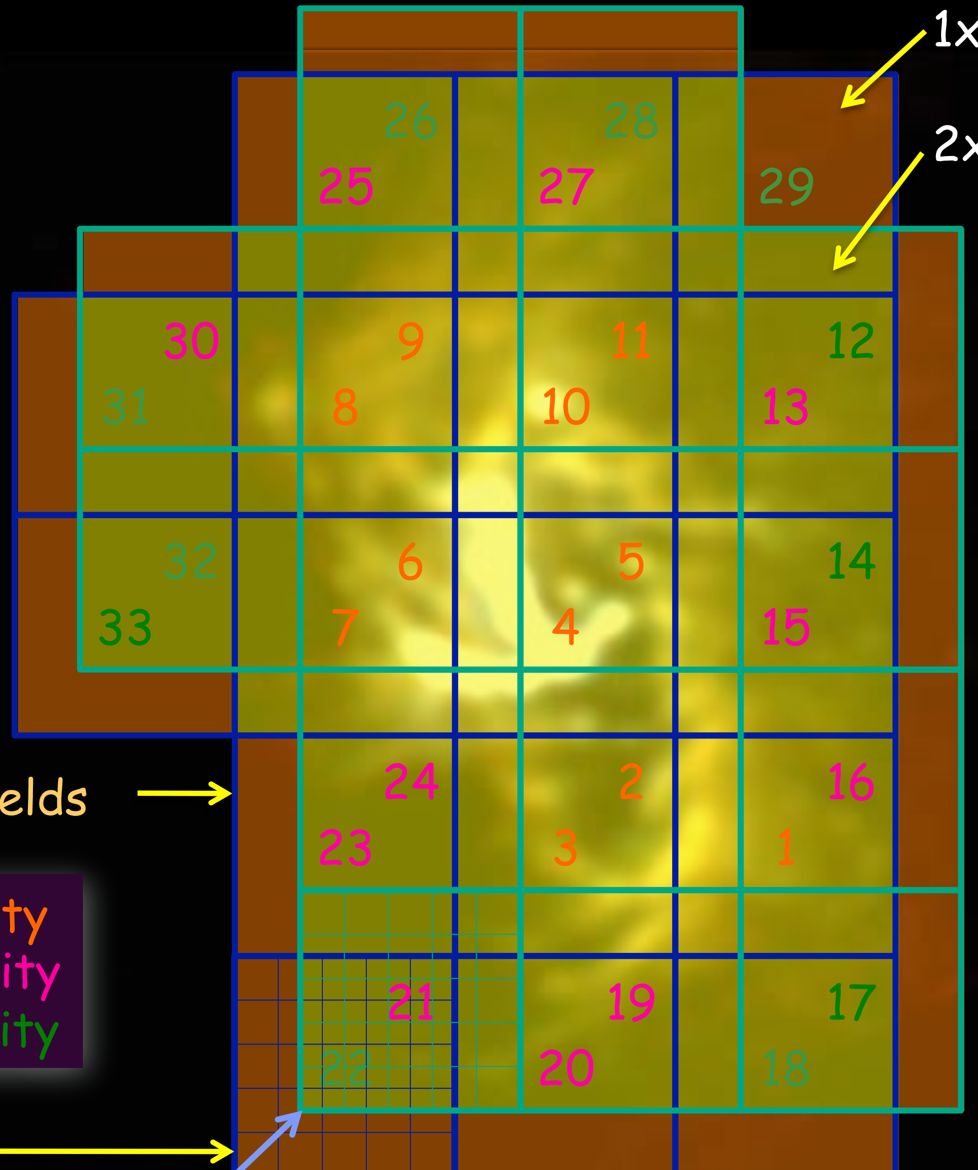
FOV blue array



FIFI-LS Mosaic

FIFI-LS GC





33 mosaic fields

Table with
Offset Positions

1st Priority
2nd Priority
3rd Priority

5x5 pixel FOV
blue Array

1.5 pixel shift

FIFI-LS Mosaic

Thank You !