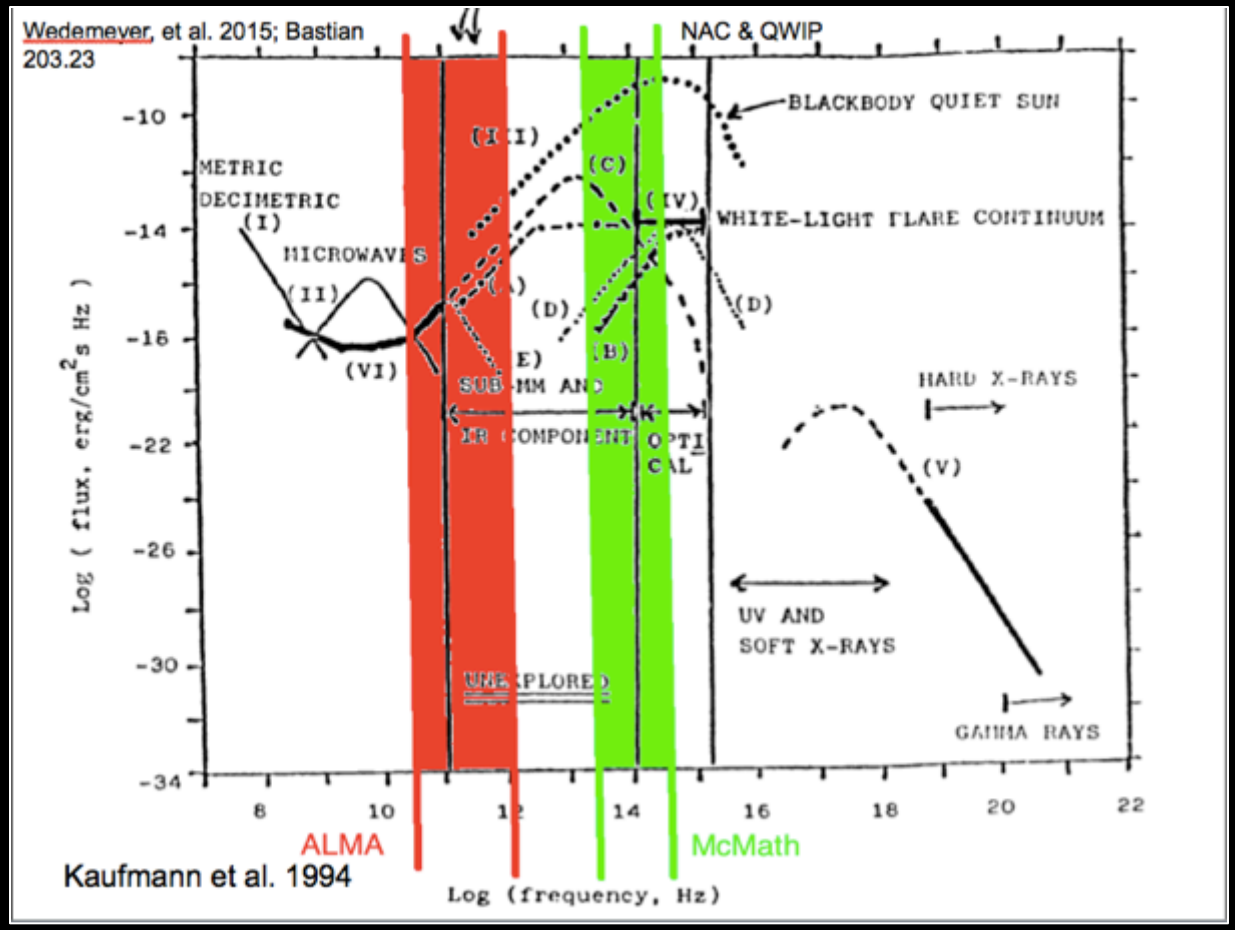
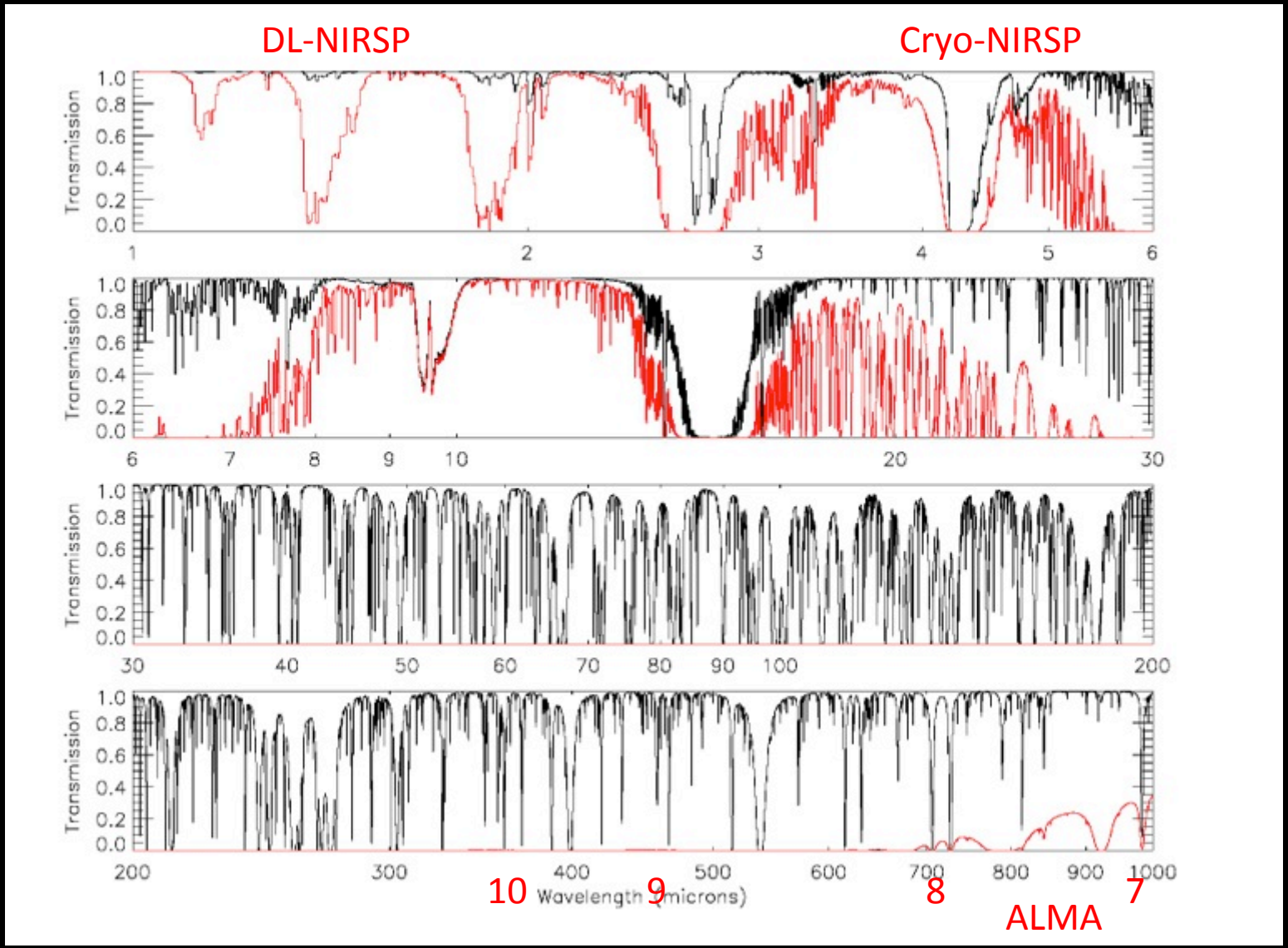
Ground-based thermal IR observations - connecting DKIST and ALMA

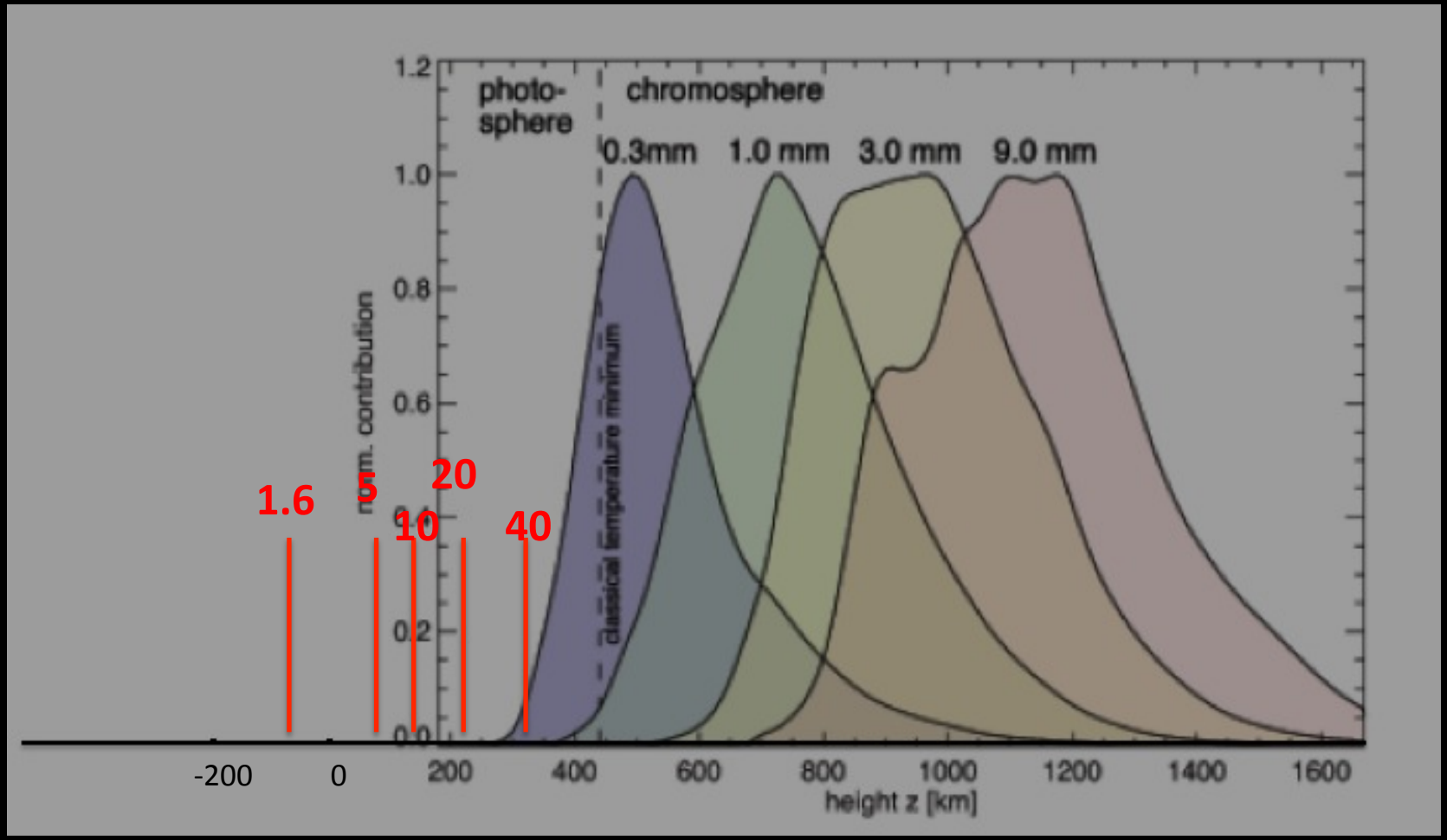
Jennings, Jhabvala, Lunsford, Hudson, Krucker, Kaufmann



Mauna Kea (4km) and SOFIA (13km) model transmission

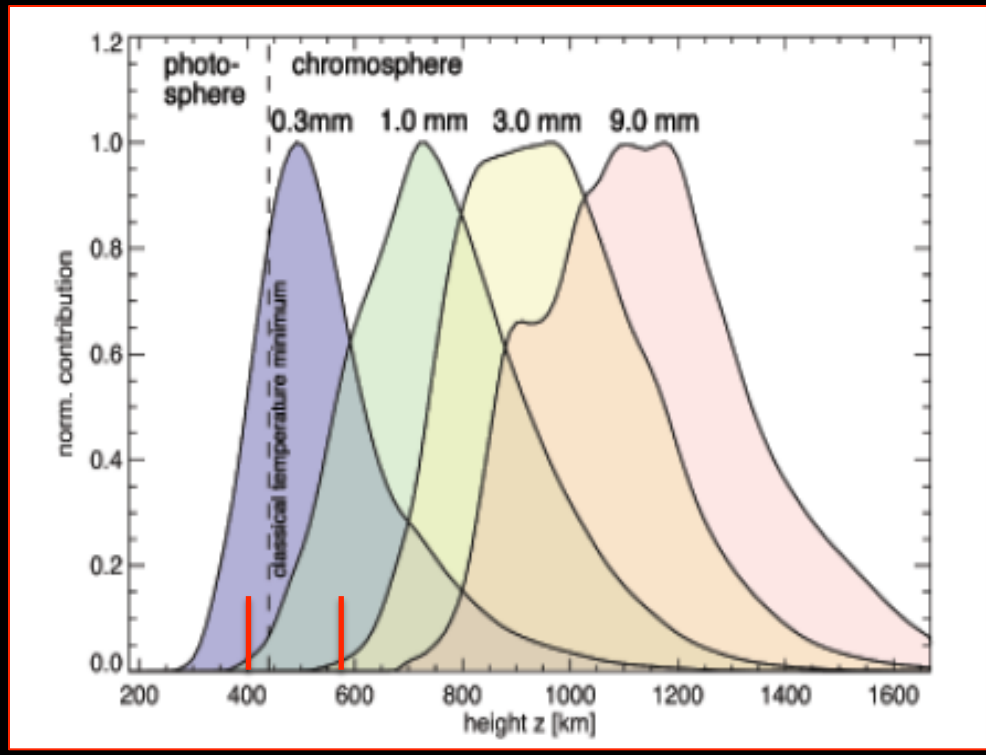


Closing the IR gap = closing the height gap



Acoustic waves and sunspot oscillations (G1 & G9) with IR continuum and velocity measurements

- Loukitcheva et al. 2004, 2008 and several of the Science Case G discuss observing intensity oscillations at 100GHz and 230GHz
- QWIP/McMP brightness at 5, 8 and 13 microns sample from 50 to 180km heights.
- CO spectral lines at 4666nm lines are formed at z=425-560km (Penn et al 2011)



- Now: QWIP & NAC @ McMP
- Soon: CYRA & NST + ?
- Later: Cryo-NIRSP & DKIST +?

Temporal Overlap

- 21 Mar 2017

- ALMA: 13:30 – 16:30 UT
- McMP: 13:30 – 26:00 UT
- NST: 14:45 – 25:00 UT
- (DKIST: 17:30 – 27:40 UT)

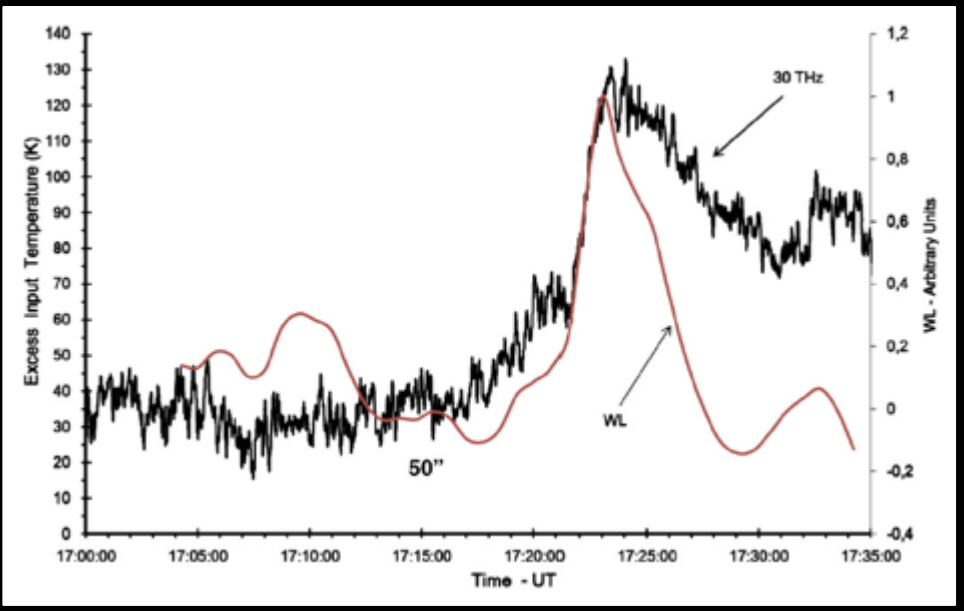
- 21 Dec 2017

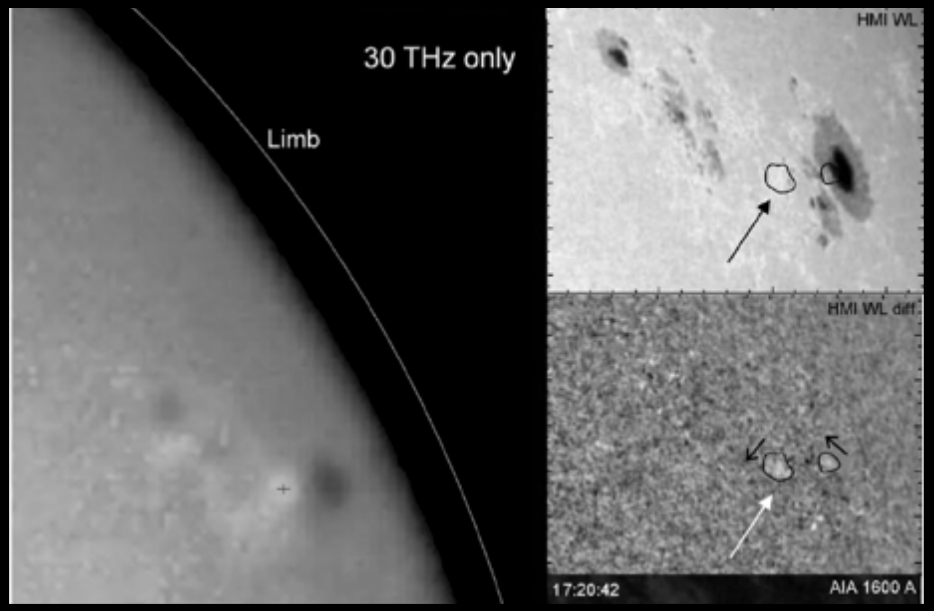
- ALMA: 13:30 -- 20:00 UT
- McMP: 14:20 – 24:30 UT
- NST: 15:50 – 23:30 UT
- (DKIST: 18:30 – 26:30 UT)

- McMP could be available in one scenario until 31 Mar 2017.

- After 30 Sep 2017 McMP is no longer available to NSO.

Flare evolution and spectra (H2 & H4) with IR continuum observaitons (5,8 & 13 microns)





SOL2012-03-13 (M8)

Kaufmann et al. 2013
Trottet et al. 2015

- 30 THz (or 10 microns) (15cm telescope)
- Impulsive-phase burst timing
- White-light flare in HMI

Dual-channel NASA/GSFC QWIP at the 90cm East Aux telescope of the McM/P facility.

240x195 arcsec FOV; 0.8 arcsec/pix

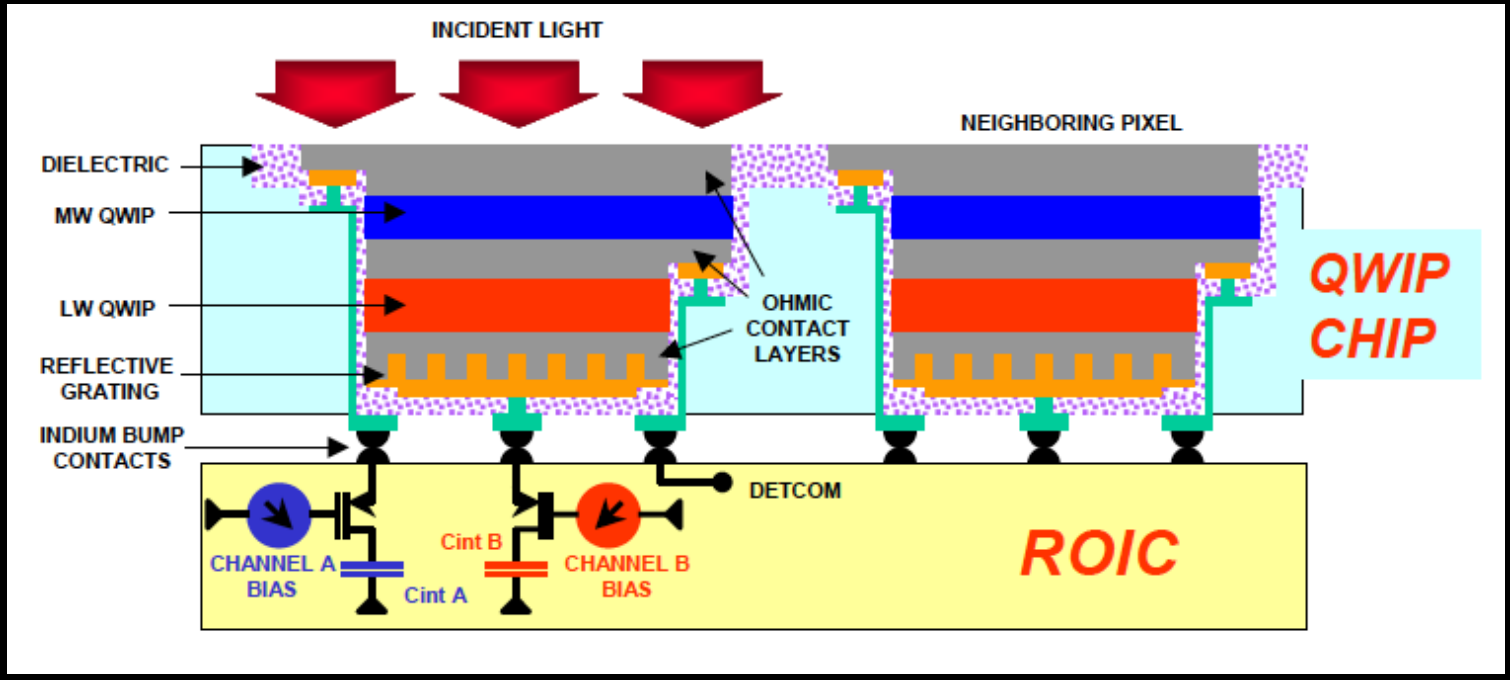
Images at 15 frames/sec

Sunrise to sunset observations

About 50% of East Aux time is available

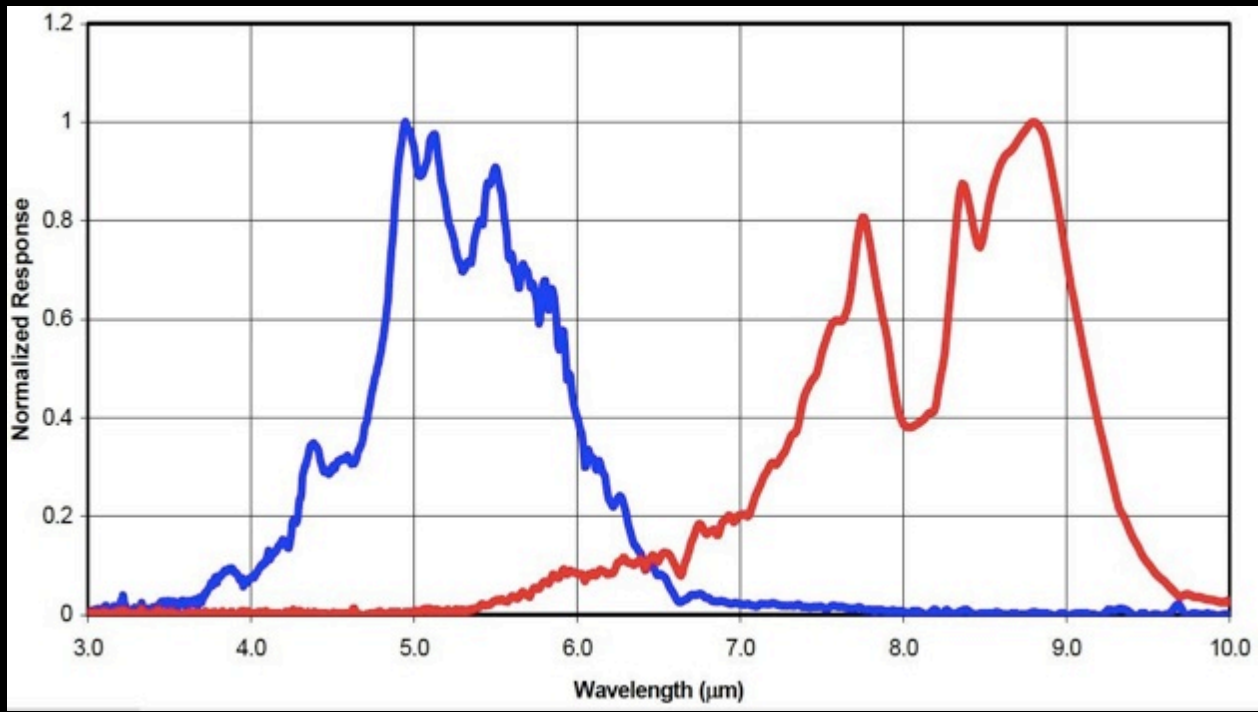
Remote operations possible.

21-31 Mar second QWIP (13microns) will be installed for remote operations.



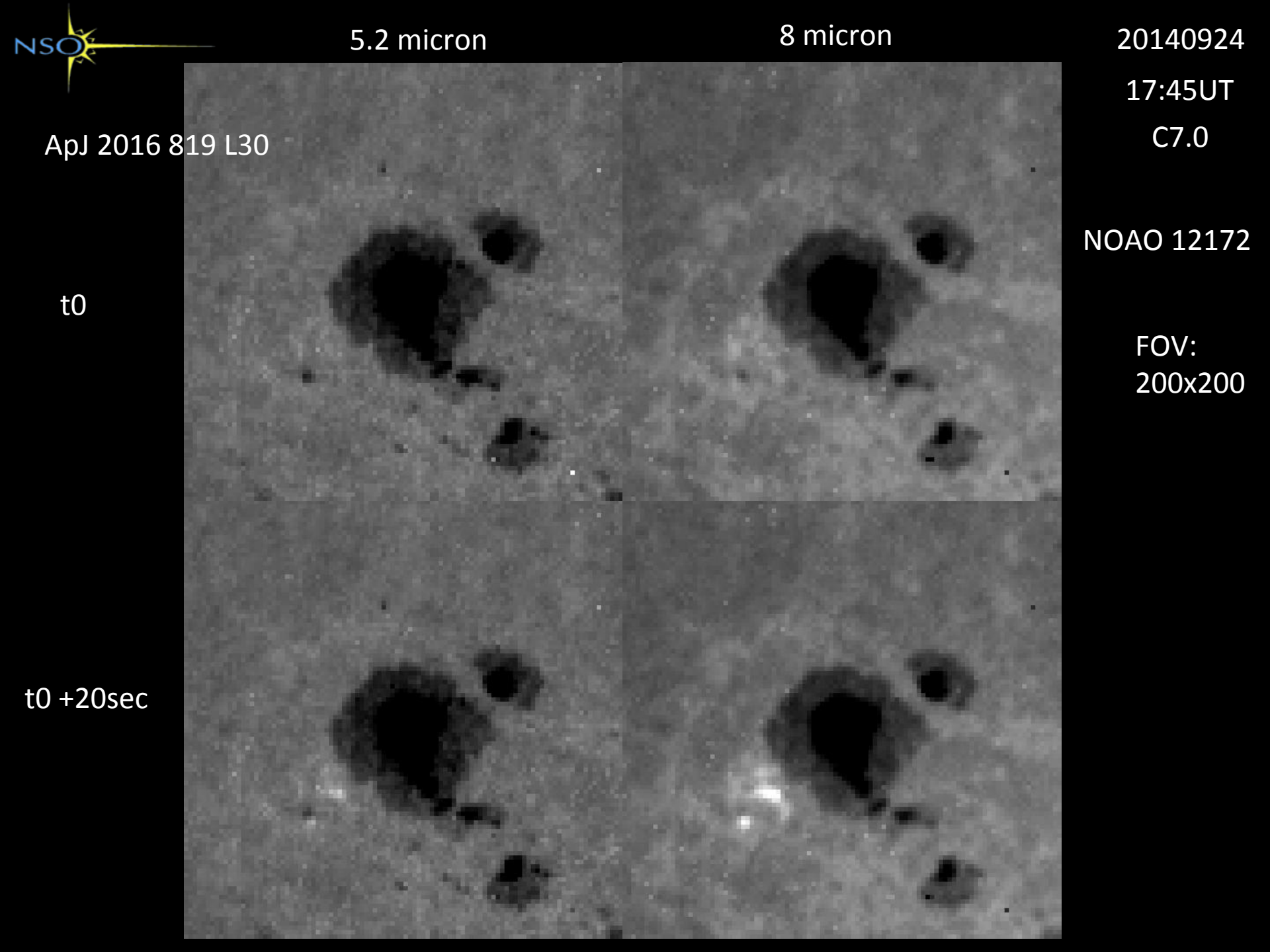
Bundas et al 2006

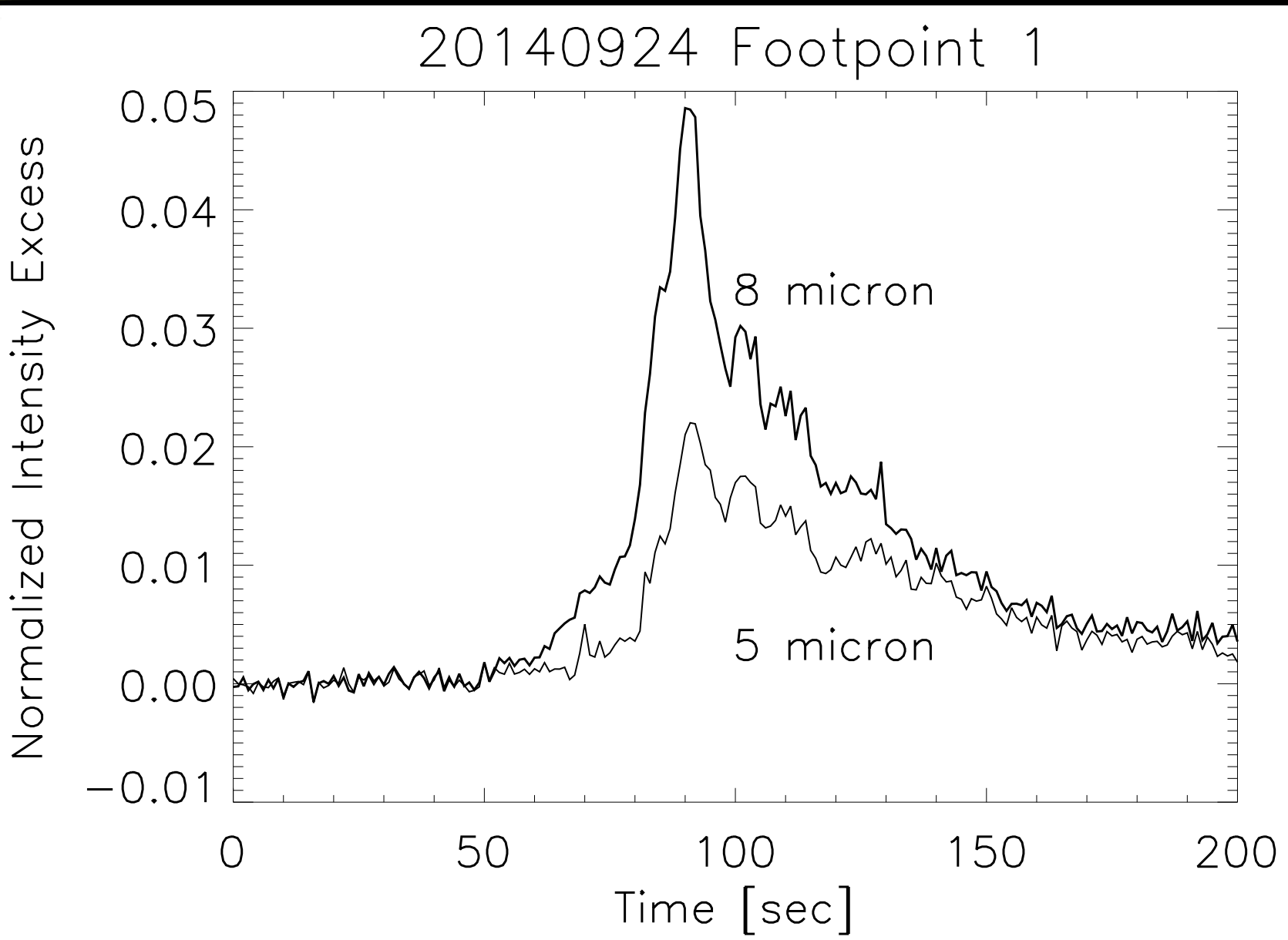
SPIE Defense &
Commercial Sensing Conf.

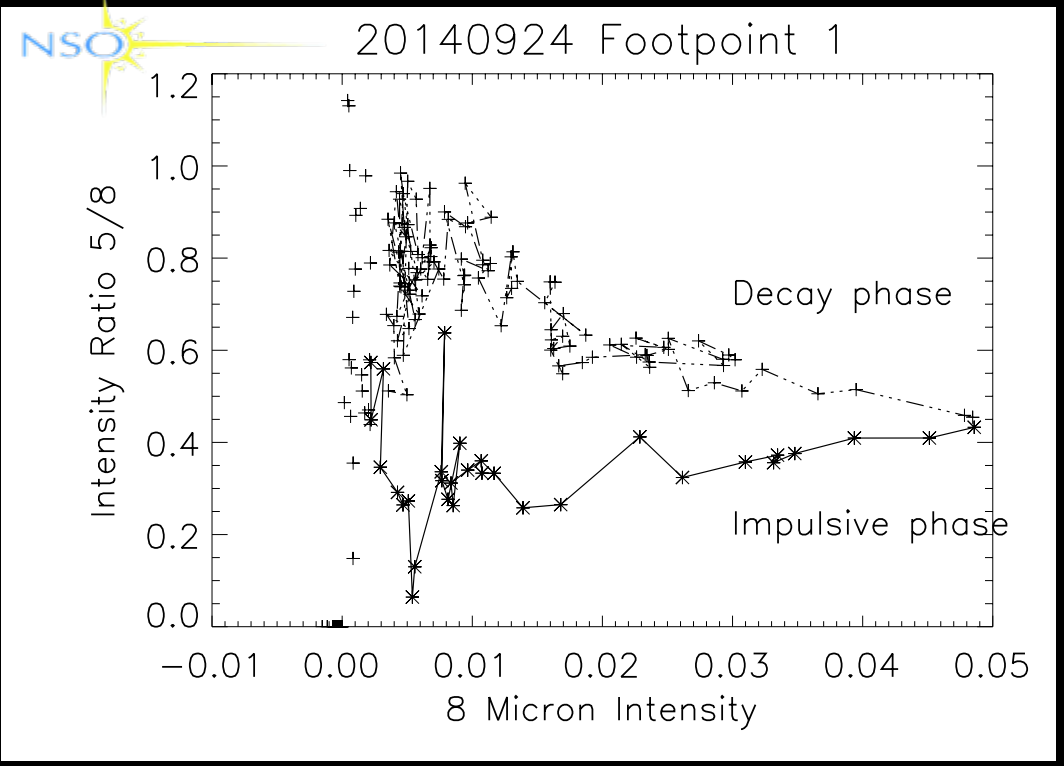


Remote IR observations in Jan 2015 from Joseph Putko's class at Dublin School, New Hampshire

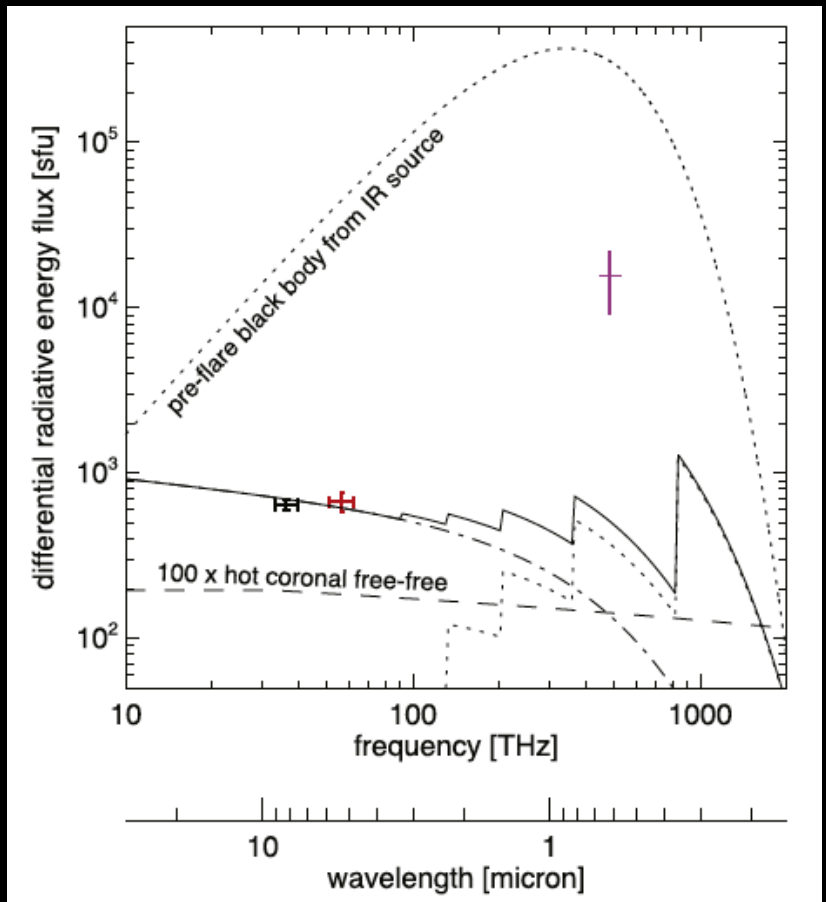
Remote IR observations in Nov 2014 by Nick Irvin from Cienega HS, Vail School District, Arizona


5.2 micron
8 micron
20140924
17:45UT
C7.0
ApJ 2016 819 L30
NOAO 12172
t0
FOV:
200x200
t0 +20sec


20140924 Footpoint 1
Normalized Intensity Excess
0.05
0.04
0.03
0.02
0.01
0.00
−0.01
8 micron
5 micron
0
50
100
150
200
Time [sec]

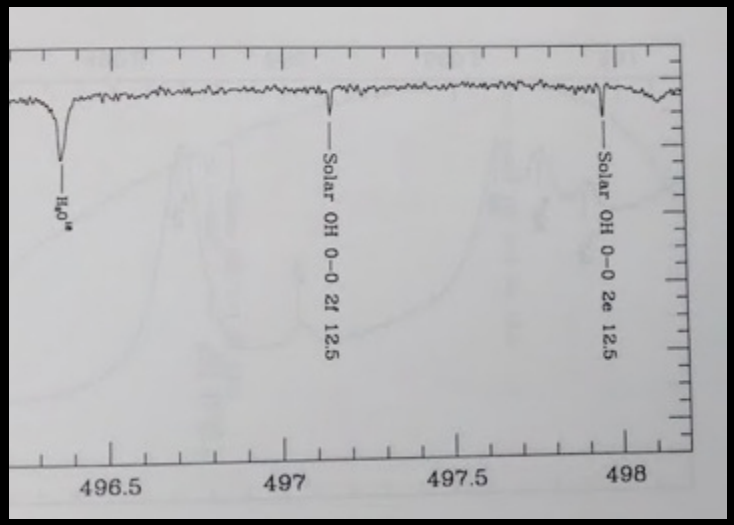


- Now: QWIP & McMP
- Soon: ?
- Later: ?

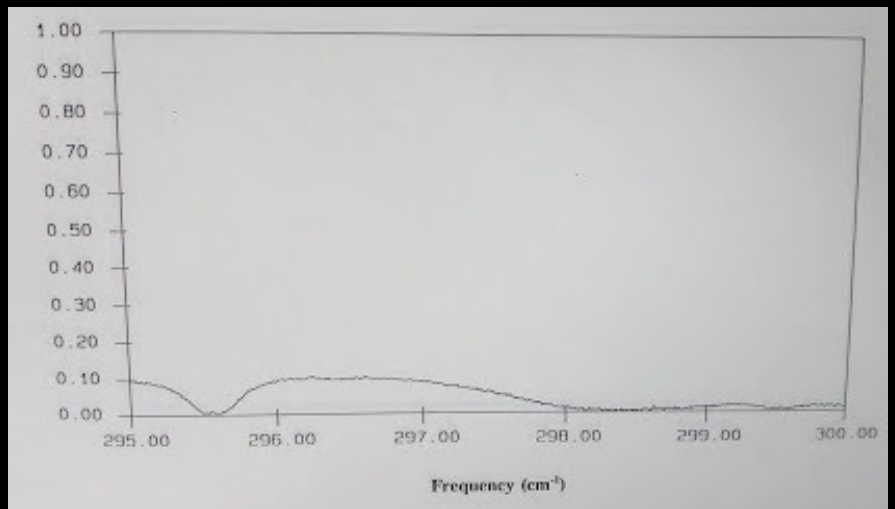


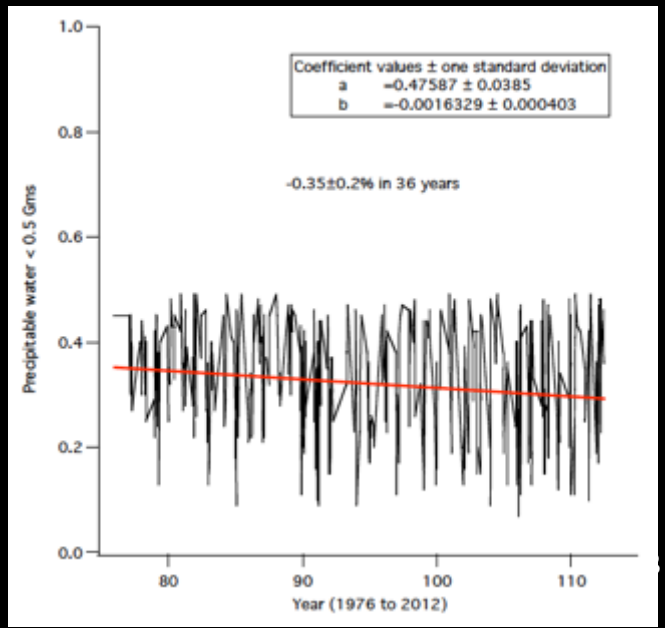
Bridging the gap; 13-40 microns

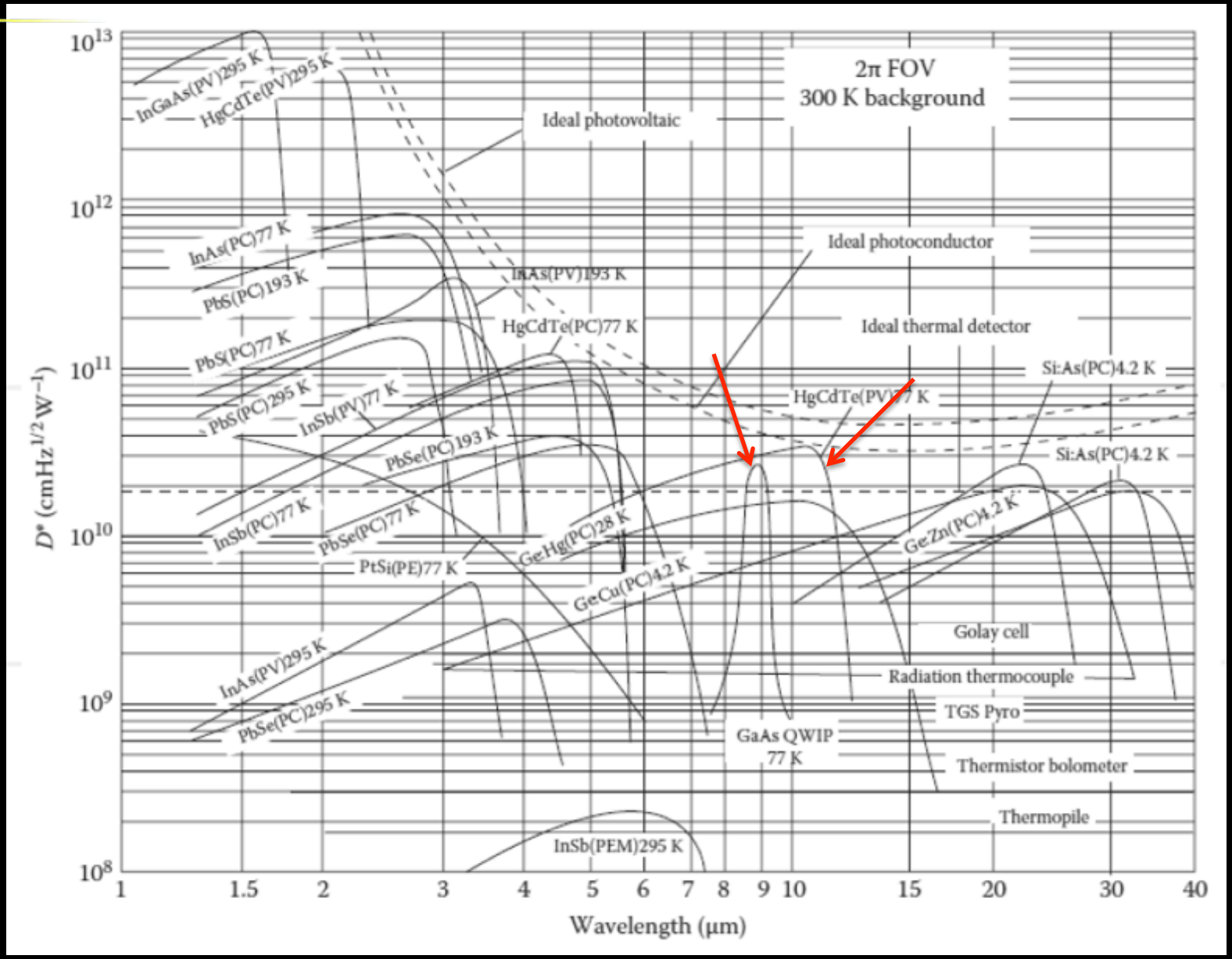
- Work from Livingston et al. (1994) shows solar absorption lines
  - Sun center OH 20.1152 microns
  - Sunspot OH 20.9367 microns



- Farmer et al. (1994) spectra from the ground at ISSJ (3580m, with PWV<1mm, <.1gm/cm^2) with weak signal at 33.8 microns







Now: ?

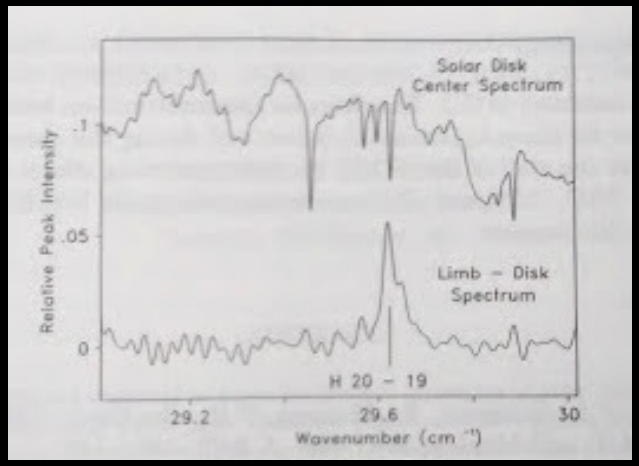
Soon: ?

Later: ?

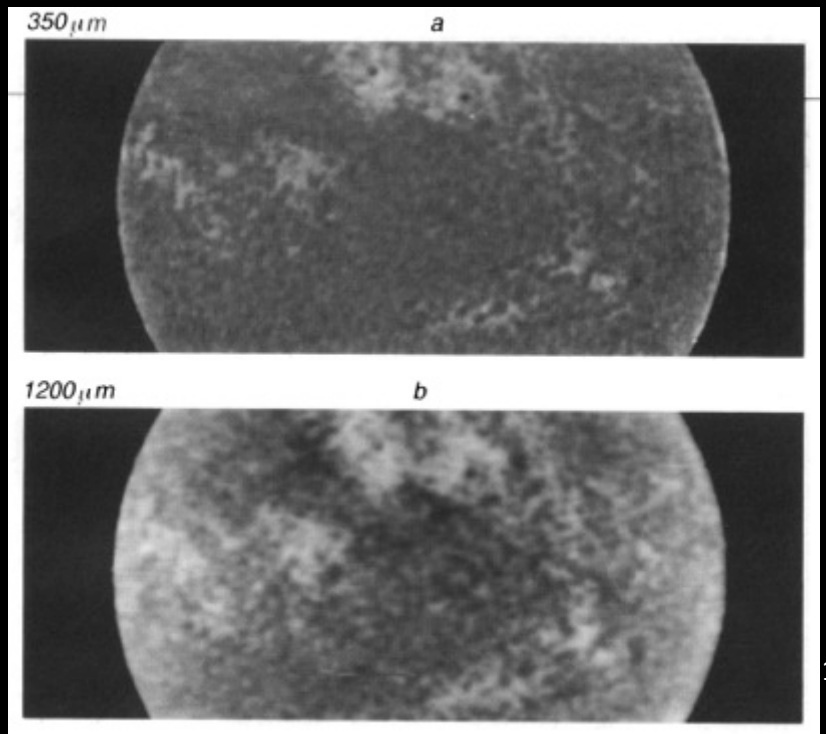
Dhar et al., 2013

Bridging the gap- 300 – 1200 microns

- Clark et al. 1994 used JCMT to observe the H20-19 spectral line in emission at the solar limb at 337 microns



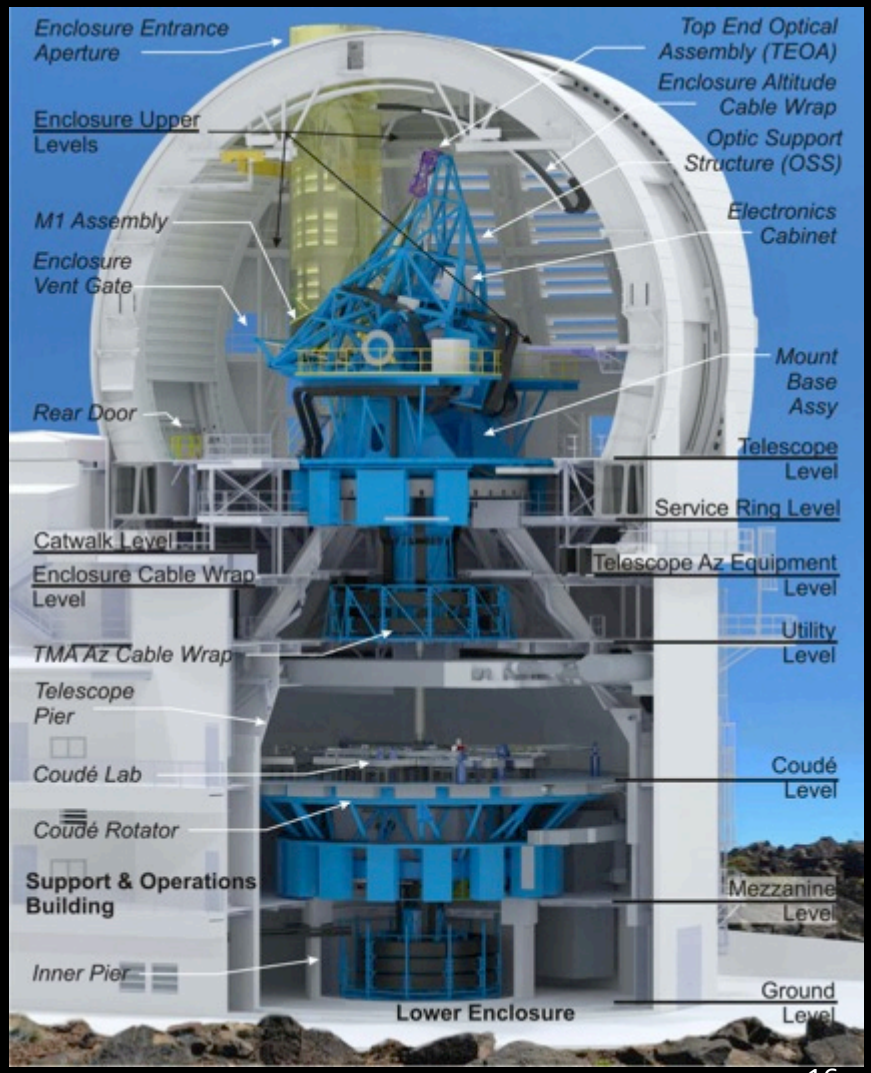
- Lindsey et al. 1995 mapped the solar disk with JCMT at 350, 850 and 1200 microns

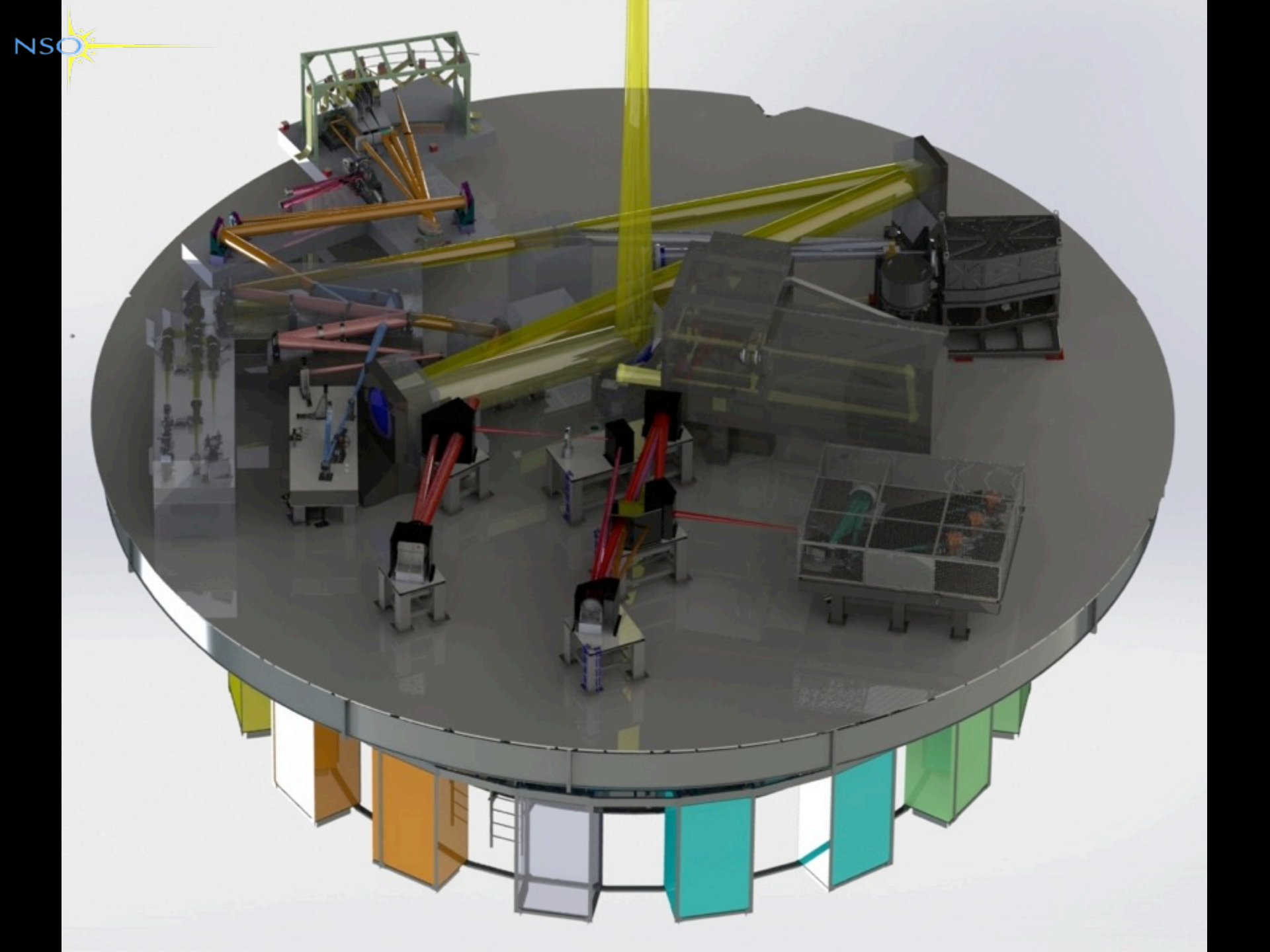


Now: ALMA Bands 6-10

Thermal Infrared Dynamics Experiment (TIDE)

- Second generation DKIST instrument: Thermal Imaging Dynamics Experiment (TIDE)
- Provide continuum oscillations measurements in support of ALMA Science Case G (waves)
- Provide statistical (and perhaps coincidental) measurements for Science Case H (flares)
- Will use currently wasted photons at DKIST




NSO

- There are key ground-based observations to be made in 2017 in support of acoustic wave and flare studies (Cases H and G)
  - (We could use some help with remote IR flare observations.)

- TIDE would continue our current abilities at DKIST, helping to bridge the IR gap and enabling significant collaborative science