The Submillimeter Array
From SMA to wSMA

Naomi Hirano (ASIAA)
+
SMA team (ASIAA|SAO)

Since 2003

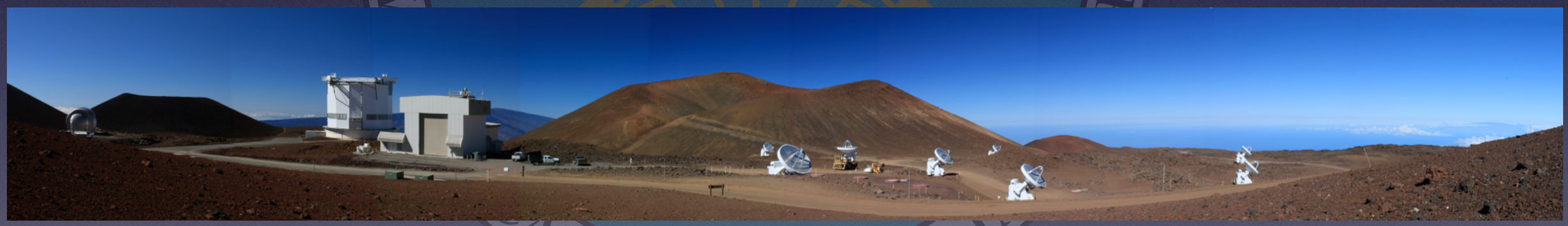
Array configurations

θ (radian) ~ λ (wavelength) / D (diameter)

SMA in the sub-compact

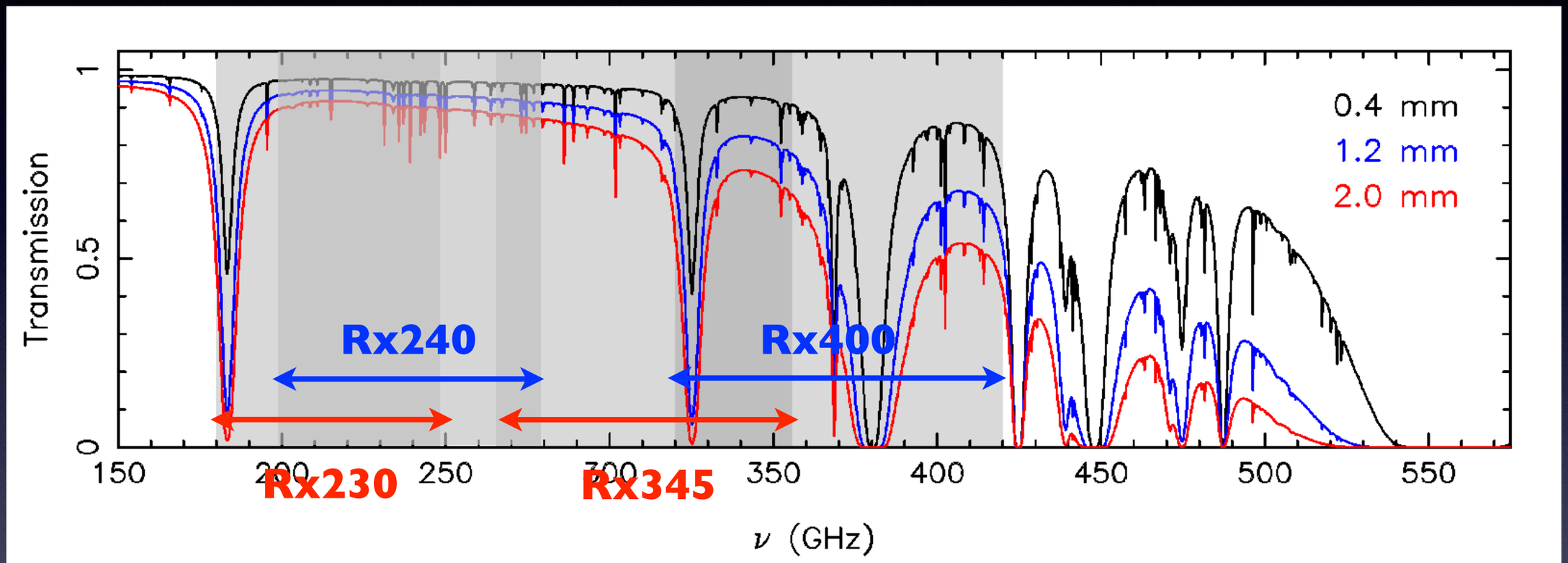
Shortest baseline: 9.5 m

SMA in the very extended



Longest baseline: 509 m

Receiver bands/Atmosphere



Port A
Rx 230 (LO: 194–240 GHz)
Rx 345 (LO: 258–351 GHz)

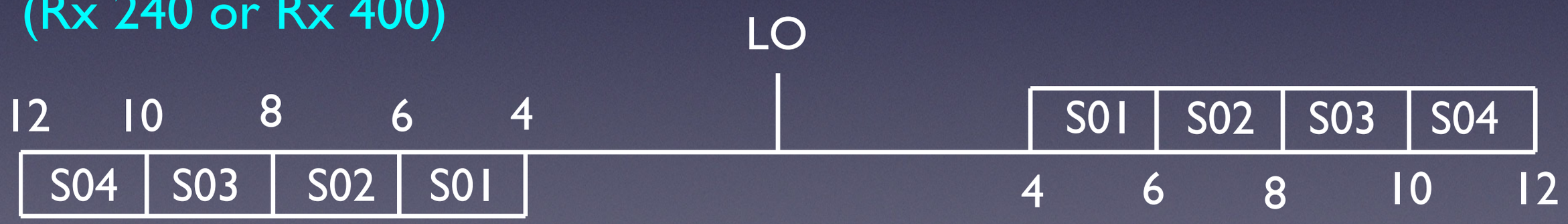
Port B
Rx 240 (LO: 210–270 GHz)
Rx 400 (LO: 336–408 GHz)

Dual receiver mode

Port A receiver
(Rx 230 or Rx 345)

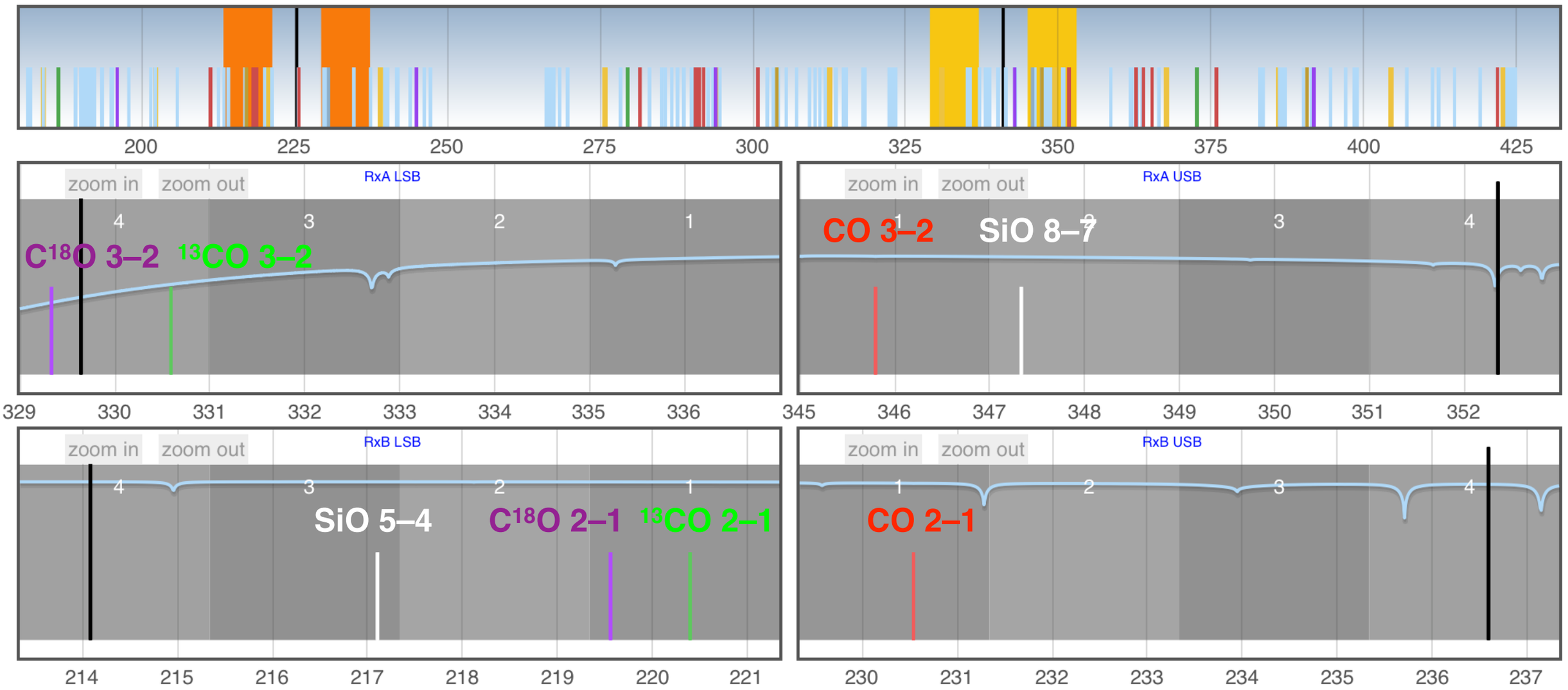
+

Port B receiver
(Rx 240 or Rx 400)



4 SWARM correlators: 2 GHz BW each
fixed channel width of 140 kHz

```
tuning: 345.796, sideband: usb, band: s1, offset: 0.2000
tuning: 230.538, sideband: usb, band: s1, offset: -0.2000
(dopplerTrack -r 345.796 -u s1 -f 0.2000 -h 10 -R h -r 230.538 -u s1 -f -0.2000 -h 10)
```



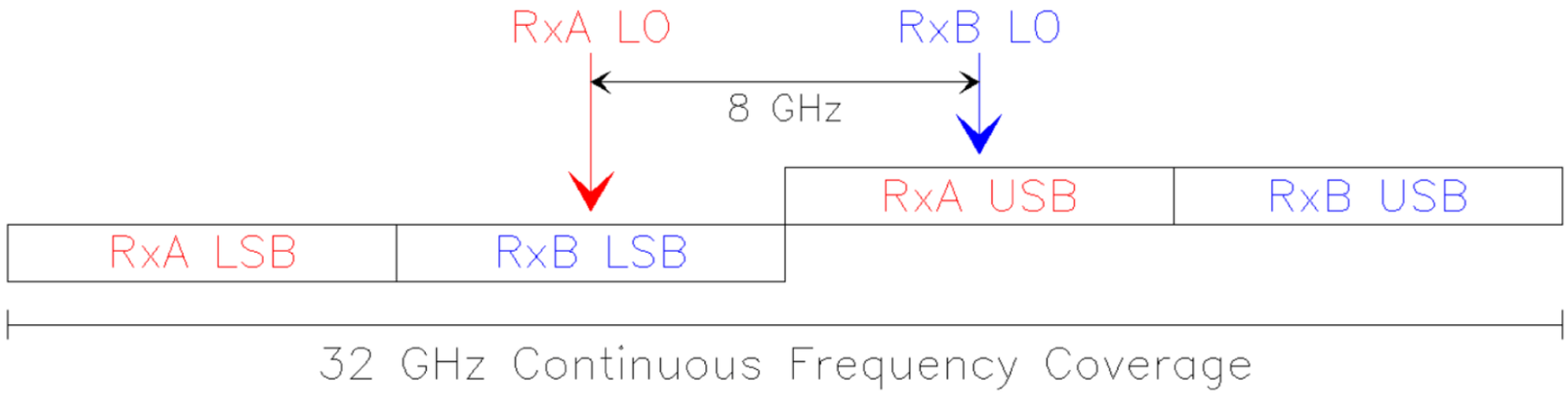
Show molecule ID on mouse hover over tips of lines

Atm Trans 1mmPWV | Atm Trans 2.5 mm PWV | Atm Trans 4mm PWV | Orion BNKL (CSO) survey | IRC+10216 (SMA) survey

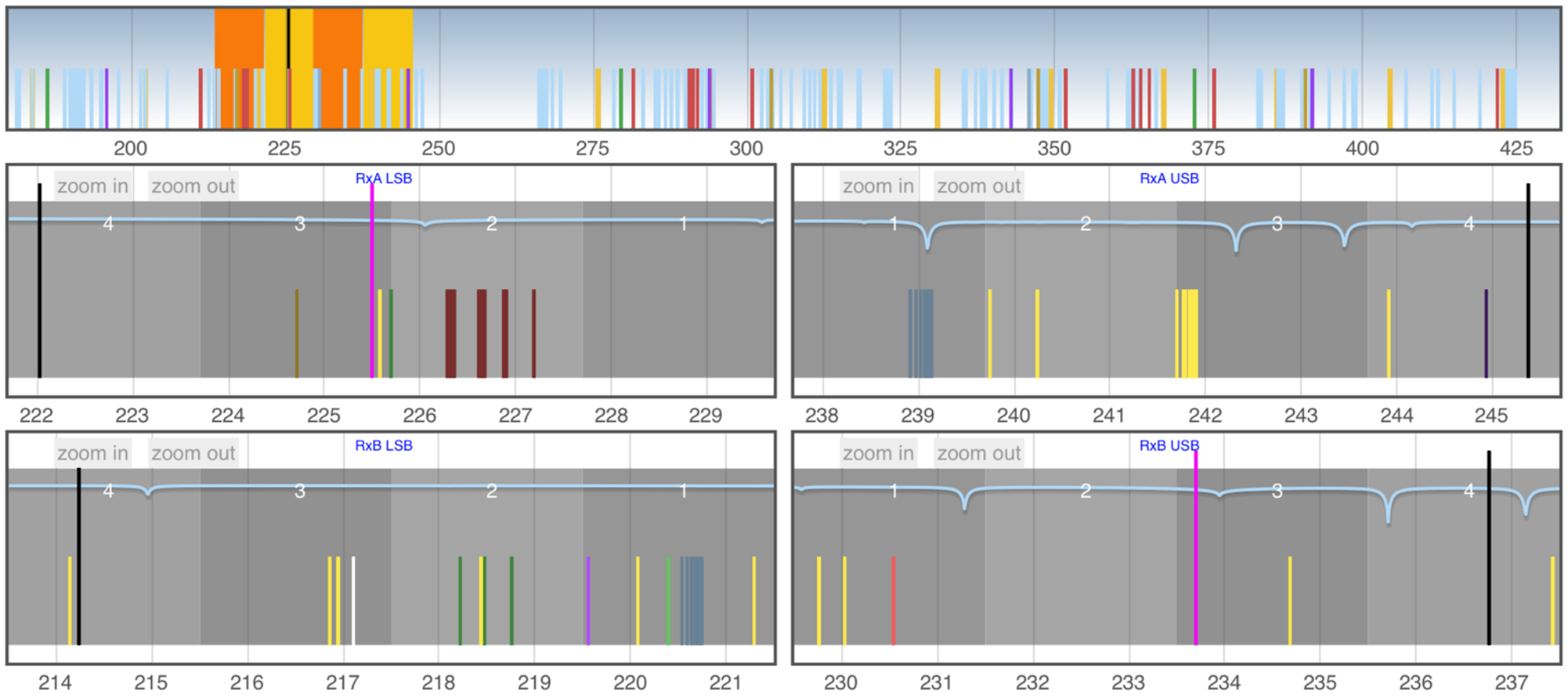
VY CMA (SMA) survey | SiS | SiCC | H_2CO | $H_2{}^{13}CO$ | CH_3OH | NH_3 | CO | ^{13}CO | $C^{18}O$ | $C^{17}O$ | CH_3CN | CN

H_2O | HDO | HCO^+ | $H^{13}CO^+$ | HCN | DCN | $H^{13}CN$ | $HC^{15}N$ | HC_3N | N_2H^+ | N_2D^+ | CS | ^{13}CS | SiO | SO | SO_2

Atm Trans 2.5 mm PWV | CO | ^{13}CO | $C^{18}O$ | CS | SiO | YIG spur | YIG spur | LO spur | LO spur




```
tuning: 238.5, sideband: usb, band: s1, offset: 0.2000
tuning: 230.5, sideband: usb, band: s1, offset: 0.0000
(dopplerTrack -r 238.5 -u s1 -f 0.2000 -h 10 -R h -r 230.5 -u s1 -f 0.0000 -h 10)
```



Show molecule ID on mouse hover over tips of lines

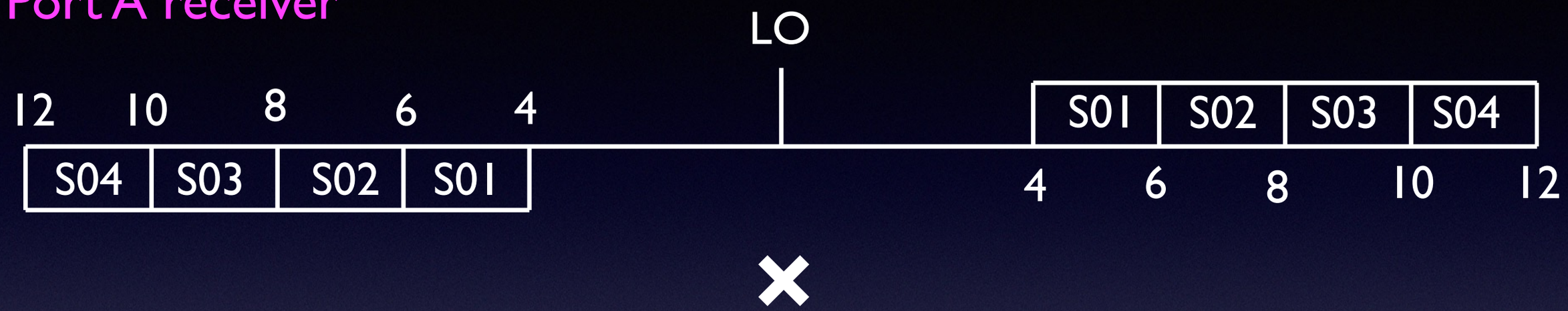
Frequency (GHz)

Atm Trans 1mmPWV | Atm Trans 2.5 mm PWV | Atm Trans 4mm PWV | Orion BNKL (CSO) survey | IRC+10216 (SMA) survey
VY CMA (SMA) survey | SiS | SiCC | H_2CO | $H_2{}^{13}CO$ | CH_3OH | NH_3 | CO | ^{13}CO | $C^{18}O$ | $C^{17}O$ | CH_3CN | CN
H_2O | HDO | HCO^+ | $H^{13}CO^+$ | HCN | DCN | $H^{13}CN$ | $HC^{15}N$ | HC_3N | N_2H^+ | N_2D^+ | CS | ^{13}CS | SiO | SO | SO_2

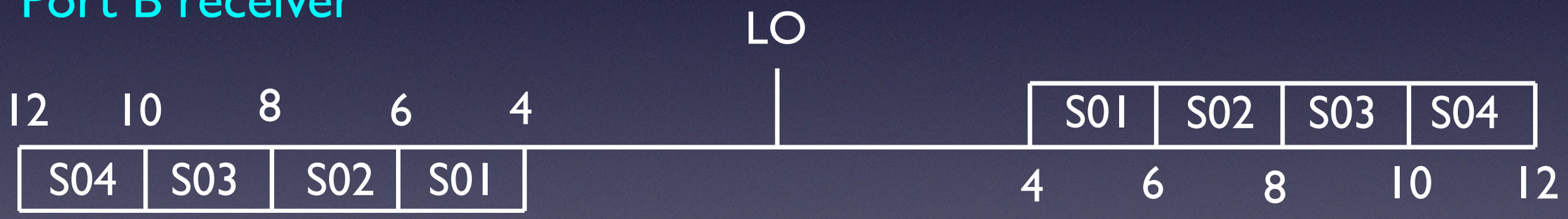
Atm Trans 2.5 mm PWV | H_2CO | CH_3OH | CO | ^{13}CO | $C^{18}O$ | $C^{17}O$ | CH_3CN | CN | CS | SiO | YIG spur | YIG spur | LO spur | LO spur

Full polarization mode

Port A receiver



Port B receiver



Rx 230 X Rx 240 or Rx 345 X Rx 400

From SMA to wSMA

From SMA to *w*SMA

Ultra-wideband Performance Improvement

Proposed system

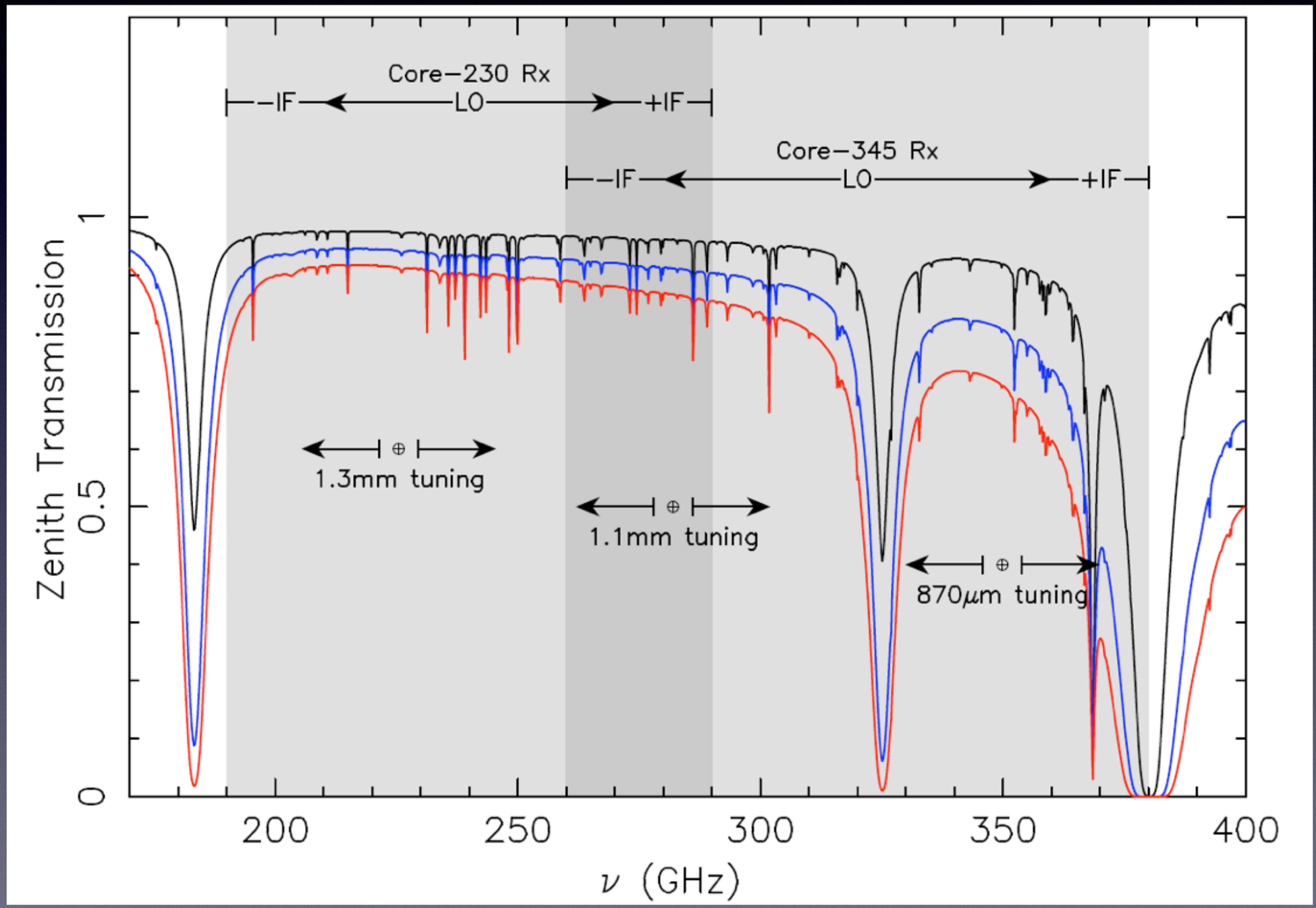
- Low band: 210–270 GHz
- High band: 280–360 GHz
  similar to ALMA band6 & 7

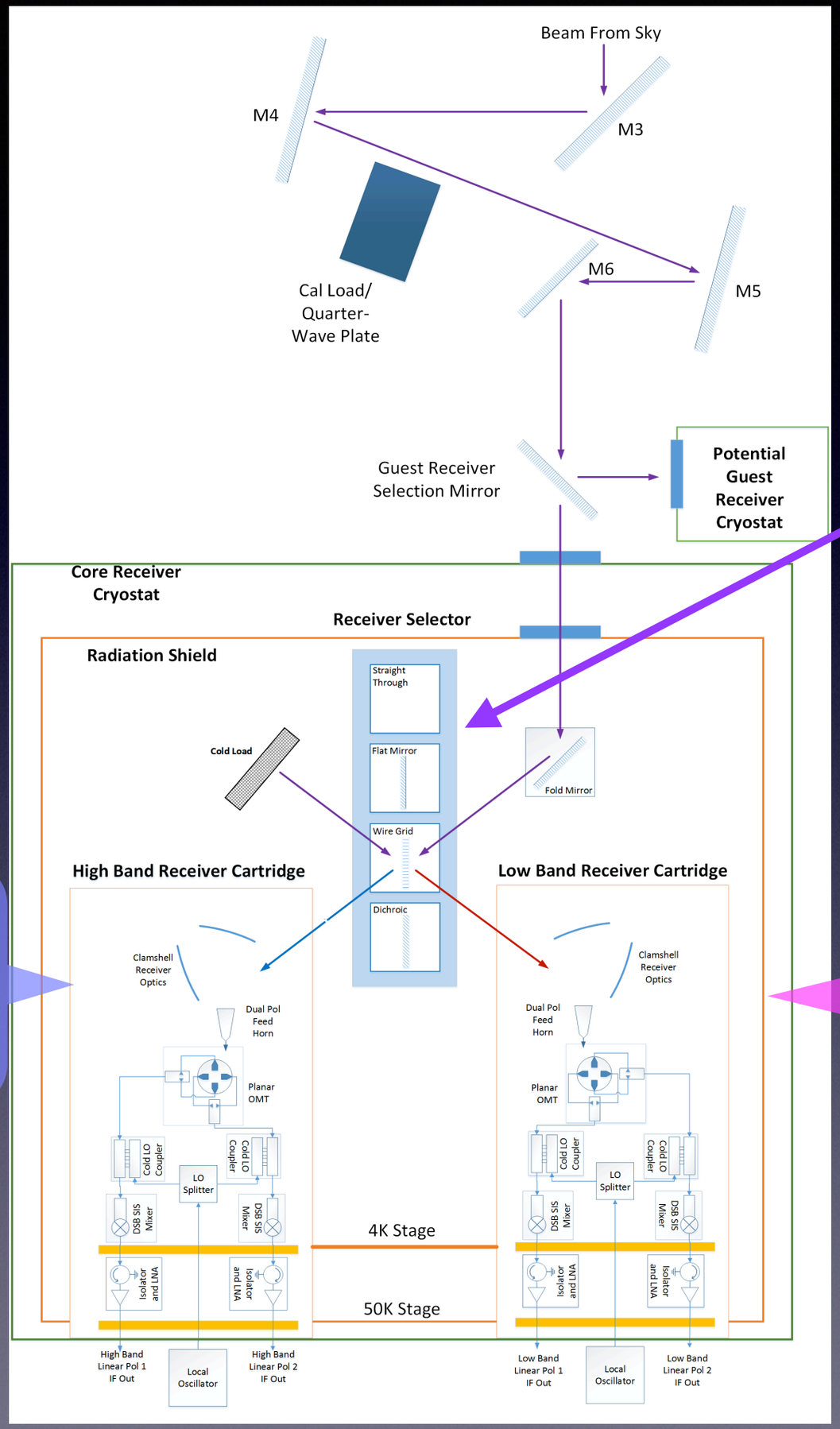
- 14 GHz (USB) + 14 GHz (LSB) x 2 pols.
→ 56 GHz bandwidth
- Simultaneous operation of 230 and 345 GHz receivers
→ 112 GHz instantaneous coverage

	year	receiver bandwidth	bands × polarizations	total bandwidth	continuum rms (μJy) 230 GHz	345 GHz
stage 0	2004	2 GHz × 2 sidebands	2	8 GHz	600	1250
stage 1	2016	8 GHz × 2 sidebands	2	32 GHz	230	520
stage 2	2020	16 GHz × 2 sidebands	4	128 GHz	140	330

Now →

Spectral coverage of the *w*SMA





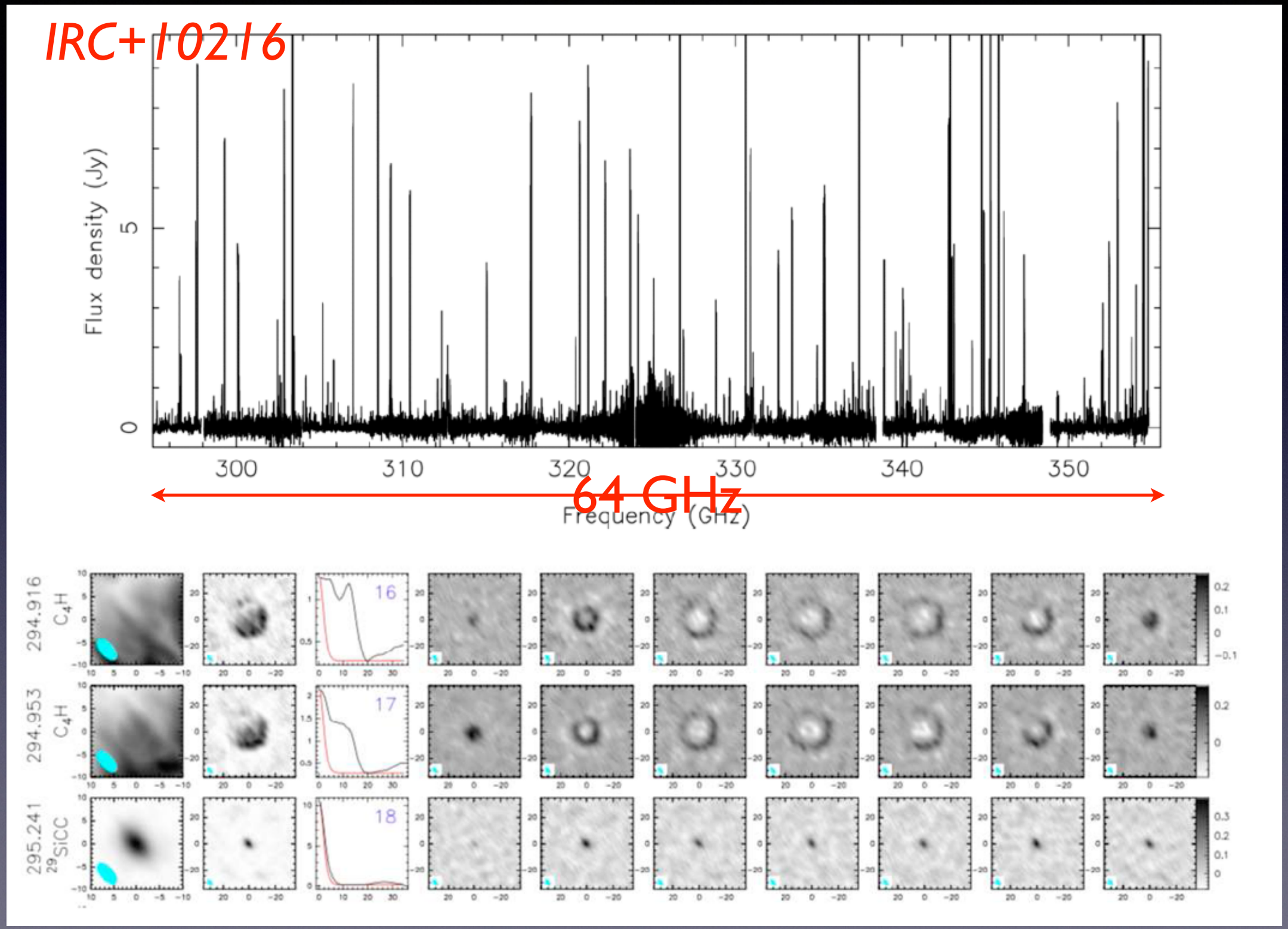
Cryogenic Receiver Selector

Selection	Lo Band Rx	Hi Band Rx
Thru	Cold Load	Dual Pol
Grid	Pol. #1	Pol. #2
Dichroic	Dual Pol	Dual Pol
Mirror	Dual Pol	Cold Load

- Core-345
  Dual Pols.
  280–360 GHz
  IF: 4–18 GHz

- Core-230
  Dual Pols.
  210–270 GHz
  IF: 4–18 GHz

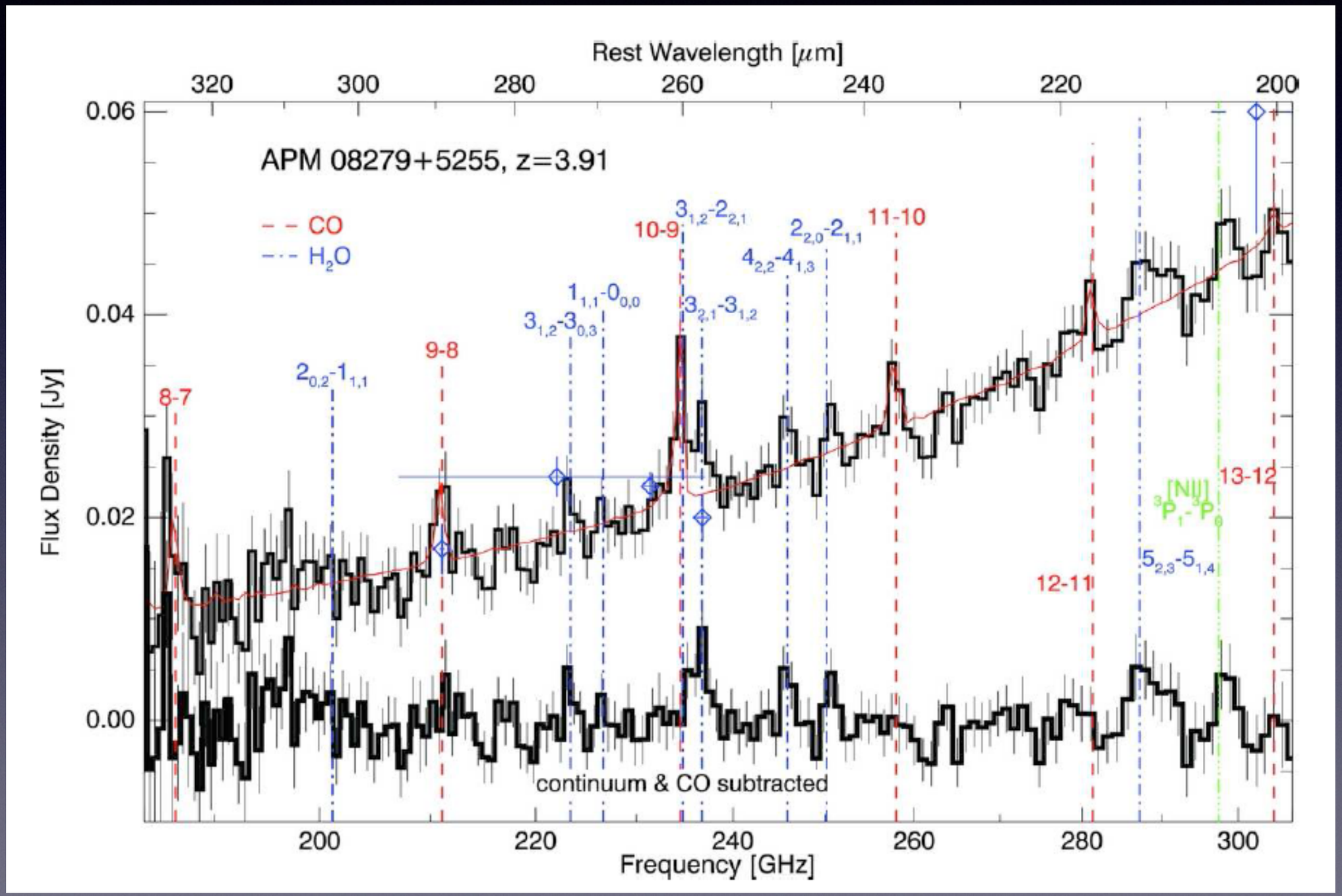
*w*SMA Science Examples – *Imaging Spectral Line Survey*



Patel et al. (2011)

*w*SMA Science Examples – *Zspec Mode Imaging*

A Zspec (CSO) spectrum of the z=3.91 lensed galaxy APM 08279+5255

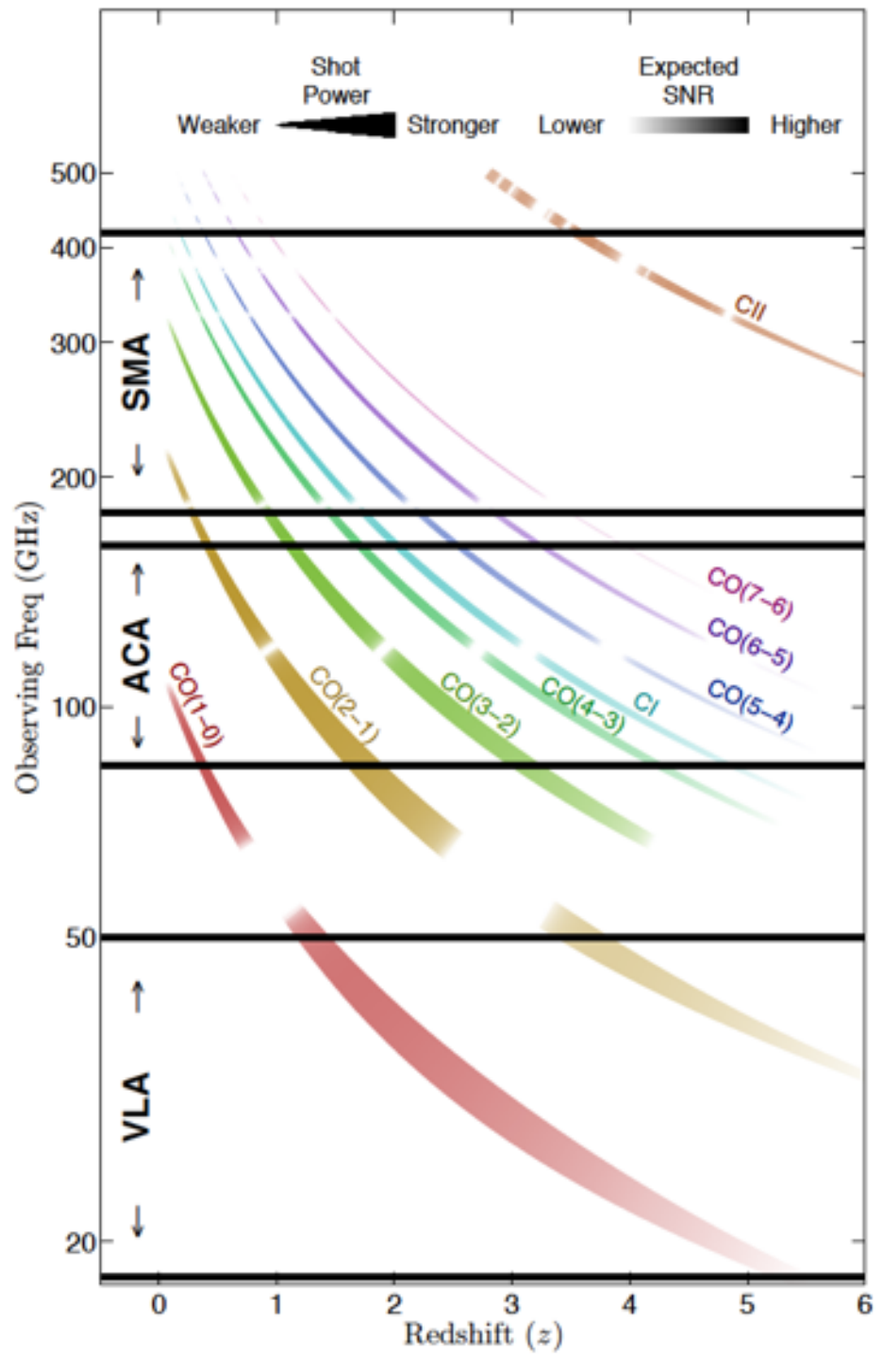


Bradford et al. (2011)

Future CO/[CII] Intensity Mapping

The Millimeter Intensity Mapping Experiment (mmIME):

"It only looks like there's nothing there"



VLA (1cm) **ACA/ALMA (3mm)** **SMA (1mm)**

VLA, ACA and SMA are **well-suited** for intensity mapping cross-correlation studies!

Karto Keating (PI; CfA/SAO)

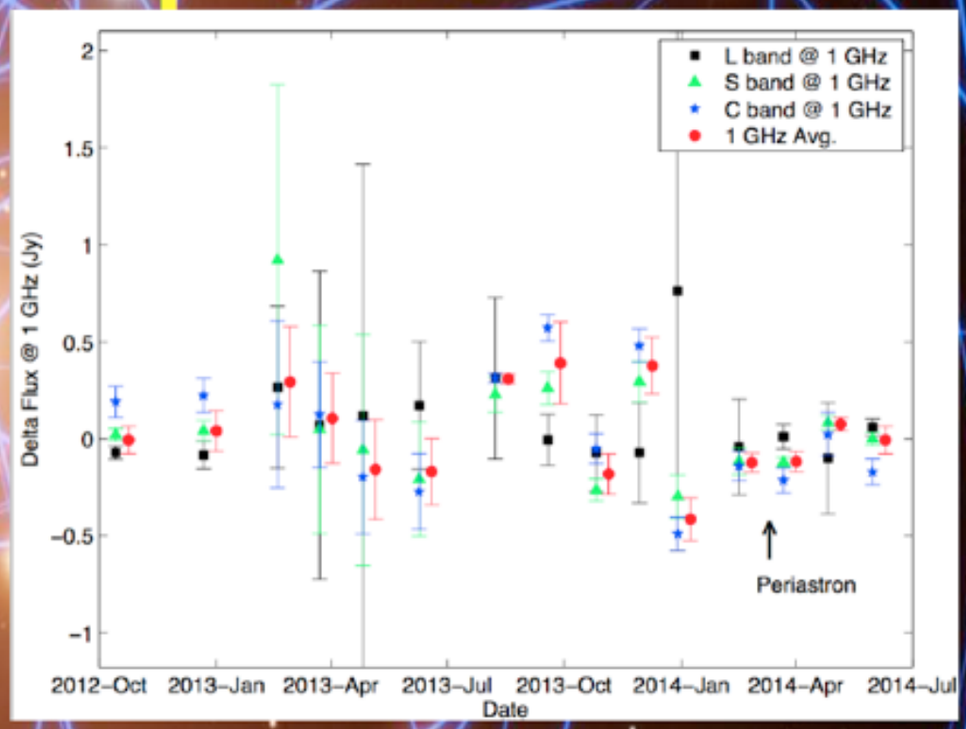
Geoff Bower (ASIAA)
Tzu-Ching Chang (ASIAA)
Anastasia Fialkov (CfA)
Avi Loeb (CfA)
Natalie Mashian (CfA)
Dan Marrone (Arizona)

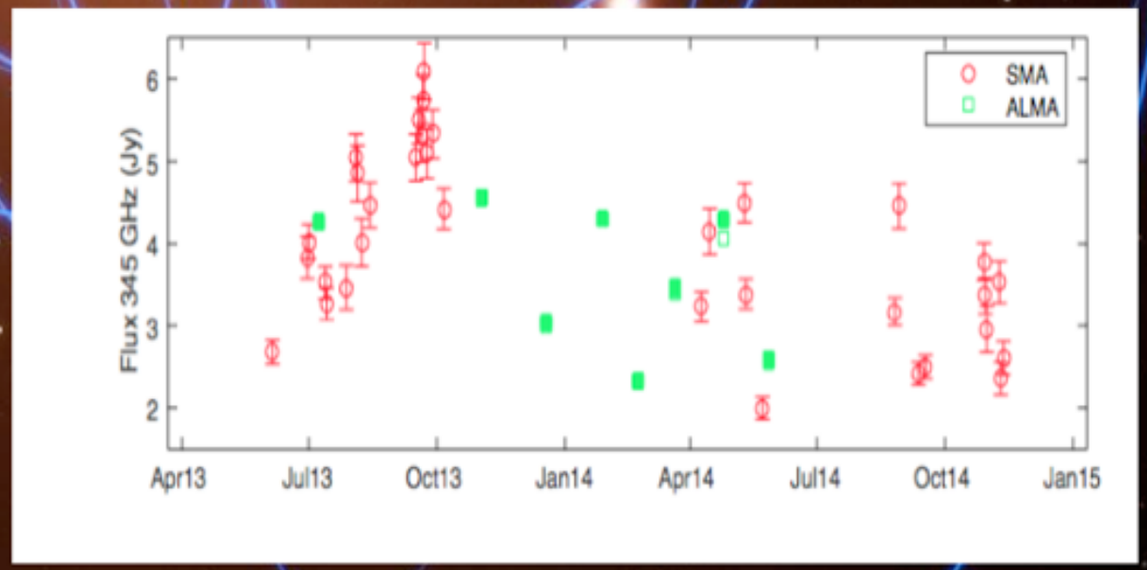
*w*SMA Science Examples – *Time Domain*

Monitoring the SgrA* activity

Searching for the G2 Impact

- VLA, SMA, and ALMA monitoring show no evidence for enhanced Sgr A* activity through G2 periastron between 1 and 350 GHz
- This supports the compact or bound cloud hypothesis
- Bower et al. 2015 ApJ





中央研究院
天文及天文物理研究所
ACADEMIA SINICA
Institute of Astronomy and Astrophysics

Deadline: August 31, 2016

SMA Science in the Next Decade

image credit: Wei-Hao Wang

Home | wSMA Specification | Program | Presentation | Participants | Photo | ›ASIAA Website

SMA science in the Next Decade

October 27-28, 2016

ASIAA Auditorium, Taipei, Taiwan

More science cases with the wSMA are available in

http://events.asiaa.sinica.edu.tw/workshop/20161027/

Call for SMA Science Observing Proposals from East Asia

- **2017A semester (2017 May 16 – 2017 Nov. 15)**
  Call for proposals: 2017 Jan.
  Deadline: 2017 Feb. 9 *(just passed)*
  China – 4, Japan – 2, Korea – 1

- **2017B semester (2017 Nov. 16 – 2018 May 15)**
  Call for proposals: 2017 Jul.
  Deadline: 2017 Aug.

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The Submillimeter Array (SMA) is an 8-element radio interferometer located atop Maunakea in Hawaii. Operating at frequencies from 180 GHz to 418 GHz, the 6m dishes may be arranged into configurations with baselines as long as 509m, producing a synthesized beam of sub-arcsecond width. Each element can observe with two receivers simultaneously, with up to 8 GHz bandwidth each per sideband. The digital correlator backend provides a uniform resolution as high as 140 kHz. The Submillimeter Array is a joint venture of the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics.

http://sma1.sma.hawaii.edu