

# NOEMA

9th IRAM mm interferometry school – 10-14 Oct. 2016



- IRAM is funded by **CNRS** (France) – **Max-Planck-Gesellschaft** (Germany) – **IGN** (Spain)
- Two mm (70-375 GHz) observatories: 30-m on Pico Velata (Sierra Nevada, Spain) and interferometer on Plateau de Bure (French Alps)
- Technical/software/support center in Grenoble, France

**Additional partner for NOEMA :  
University of Michigan**



## **Northern Extended Millimeter Array** Extension of the IRAM Plateau de Bure interferometer



## Northern Extended Millimeter Array

- Double the number of 15 m antennas from 6 to 12
- New receivers:
  - 4 bands covering 70-370 GHz
  - Each band is 2 polar x 2SB x 8 GHz = 32 GHz/ant
- New correlator:
  - Full low-resolution coverage (continuum, line surveys)
  - *and* (up to 128) high-resolution spectral windows
- Dual-band operations
- Extension of the baselines from 0.8 to 1.6 km
- New WVRs, upgrade of antennas 1-6

## Advanced mm astronomy calls for

- an **ALMA-competitive array in the northern hemisphere**
  - with sensitivities within a factor of 2-3 (same science)
  - provides full-sky coverage in the [mm + intermediate ang. resolution]
- an instrument **optimized for mm astronomy**, which allows for **large surveys**
  - source surveys (high-z/nearby galaxies/star forming regions...)
  - spectral surveys
- an instrument that allows rapid and efficient **technological upgrades** (small number of antennas)

# NOEMA factsheet

Collecting area		
	Interferometry	Short spacings
ALMA/ACA	5655 m <sup>2</sup>	914m <sup>2</sup>
NOEMA/30m	2121 m <sup>2</sup>	707m <sup>2</sup>

Bandwidth per polarization	
PdBI	4 GHz
ALMA	2 x 4 GHz
NOEMA/30m	2 x 8 GHz

# NOEMA factsheet

## Sensitivities NOEMA vs ALMA

Line observations	NOEMA rms < 3 ALMA rms
Continuum observations	NOEMA rms < 2 ALMA rms

## Unique NOEMA features

Larger bandwidth	Gain factor 2 in observing time for spectral surveys
Dual-band observations	Gain factor 2 in observing time for multi-bands projects
Correlator	Full continuum sensibility for all observations
Correlator	High flexibility : many high-resolution lines simultaneously



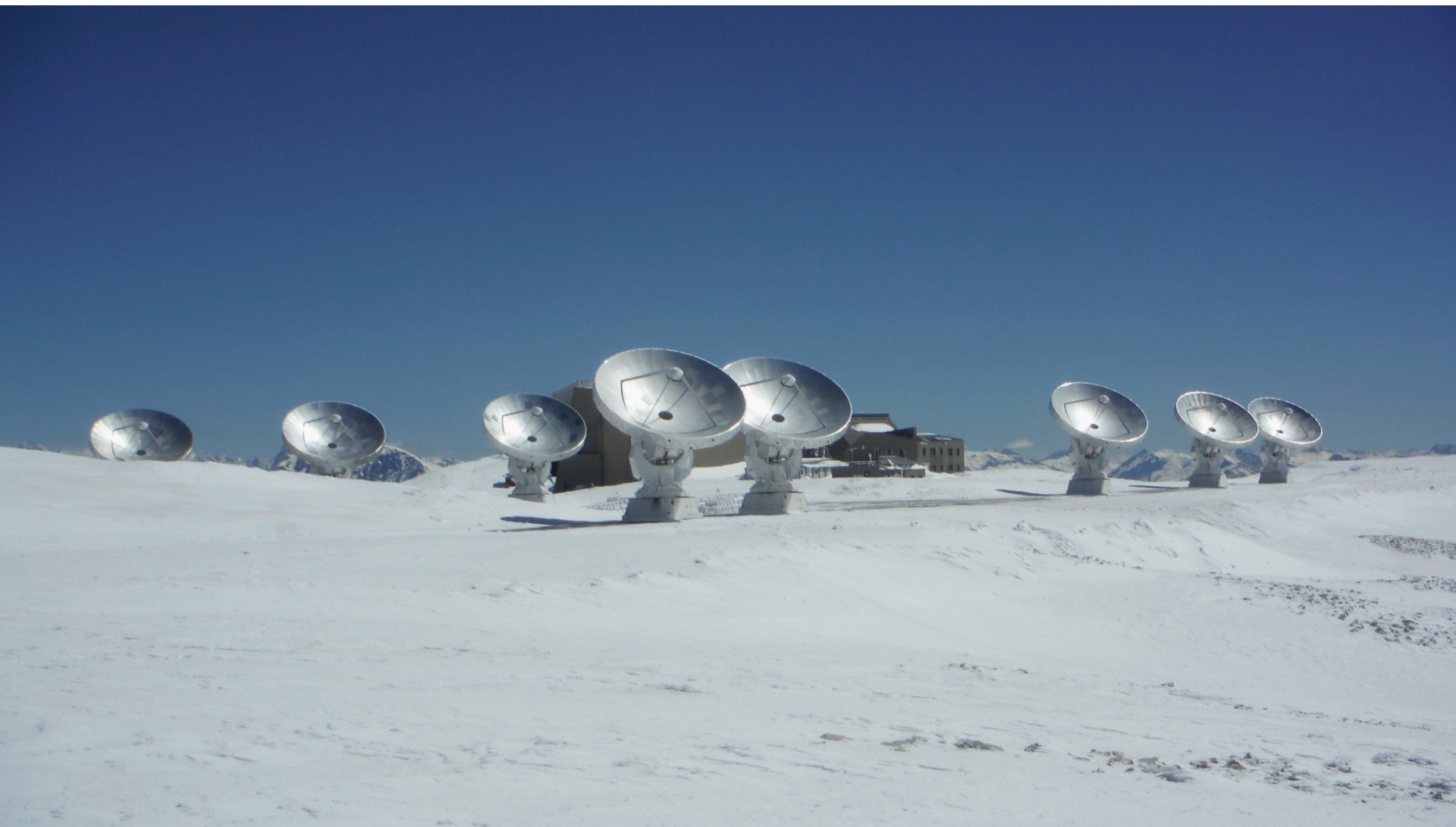


**NOEMA operated with 7 antennas since Spring 2015**



**Antenna 8**  
**6 Apr. 2016**



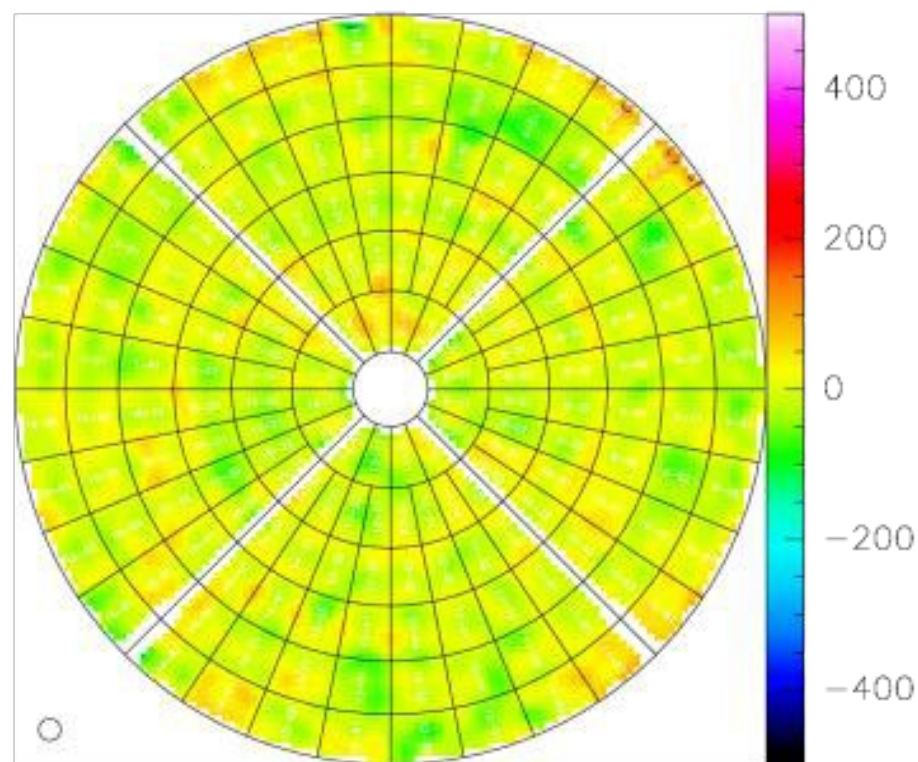
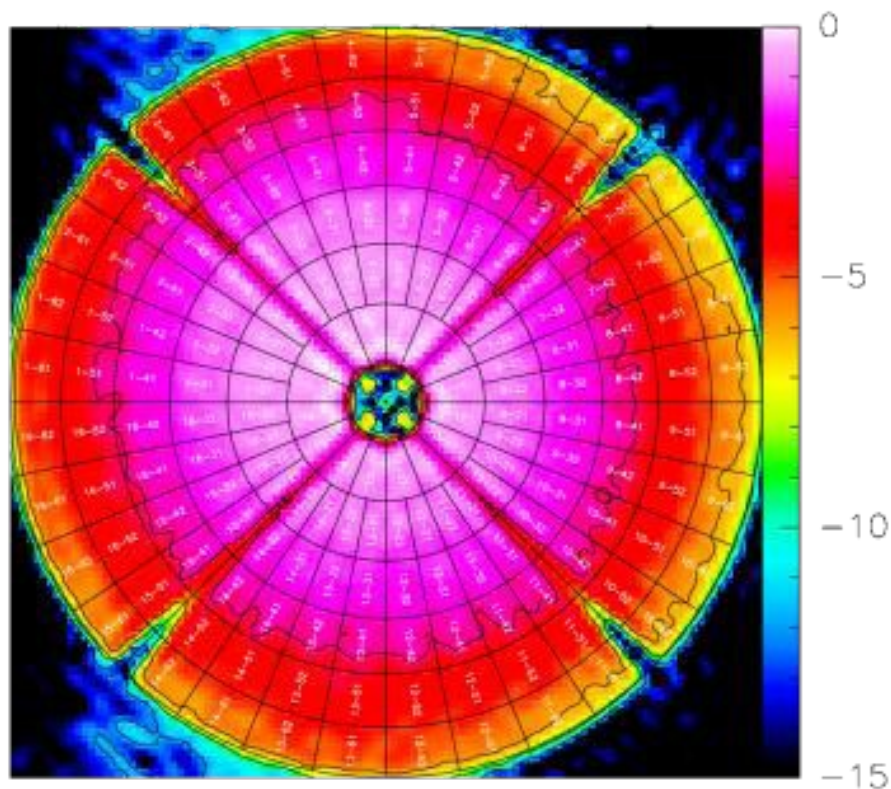


**NOEMA with 8 antennas (19 Apr. 2016)**



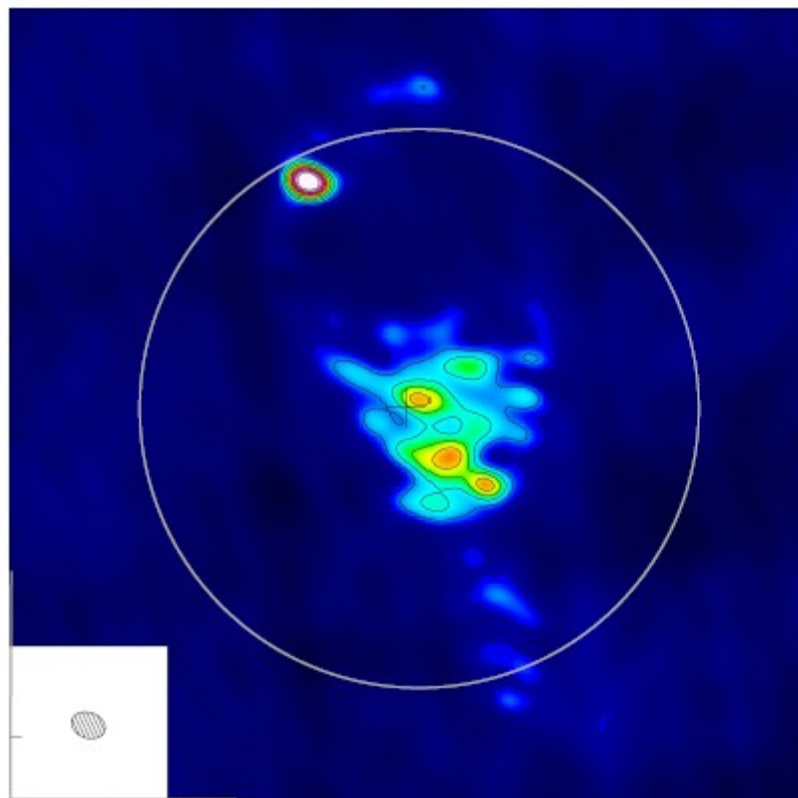
Rms/ring: 29.5 23.1 22.8 22.5 25.5 31.8  
 Amplitude (back view)  
 -15.000 to 0.000 by 3.000

Normal errors (back view)  
 -500.000 to 500.000 by 100.000



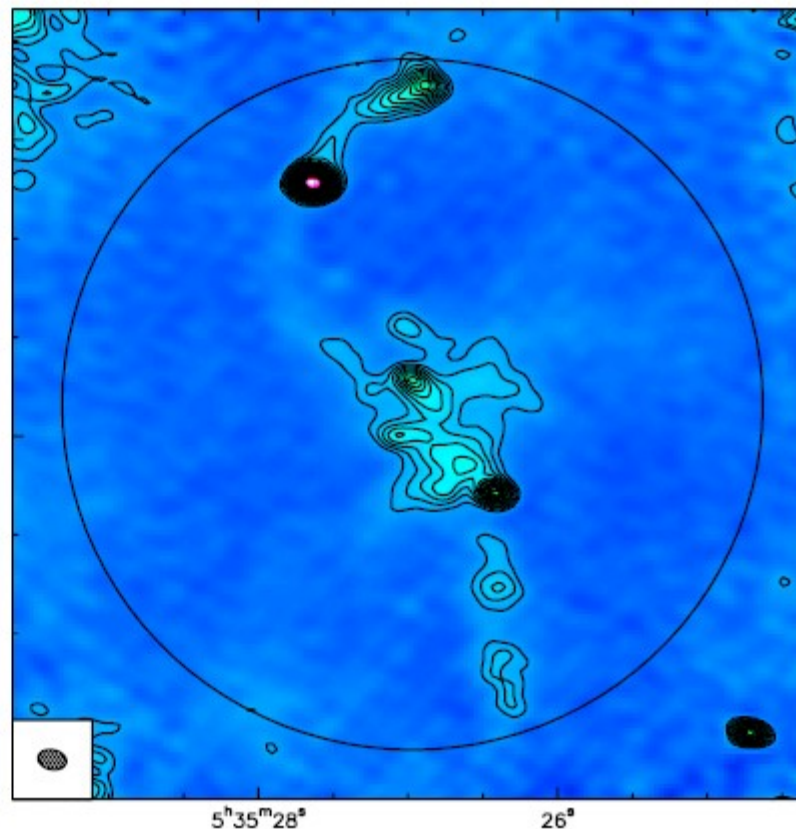
Surface rms Antenna 8 = **26  $\mu\text{m}$**

## NOEMA8



OMC2-FIR4, SOLIS LP  
Caselli & Ceccarelli, B1  
RMS = 0.10 mJy/(3.5x2.7'')

## ALMA35 Cy 3



OMC2-FIR4, Ceccarelli  
2015.1.00261.S, B3  
RMS = 0.15 mJy/(2.9x2.0'')





**Construction Antenna 9 (Apr. 2016)**





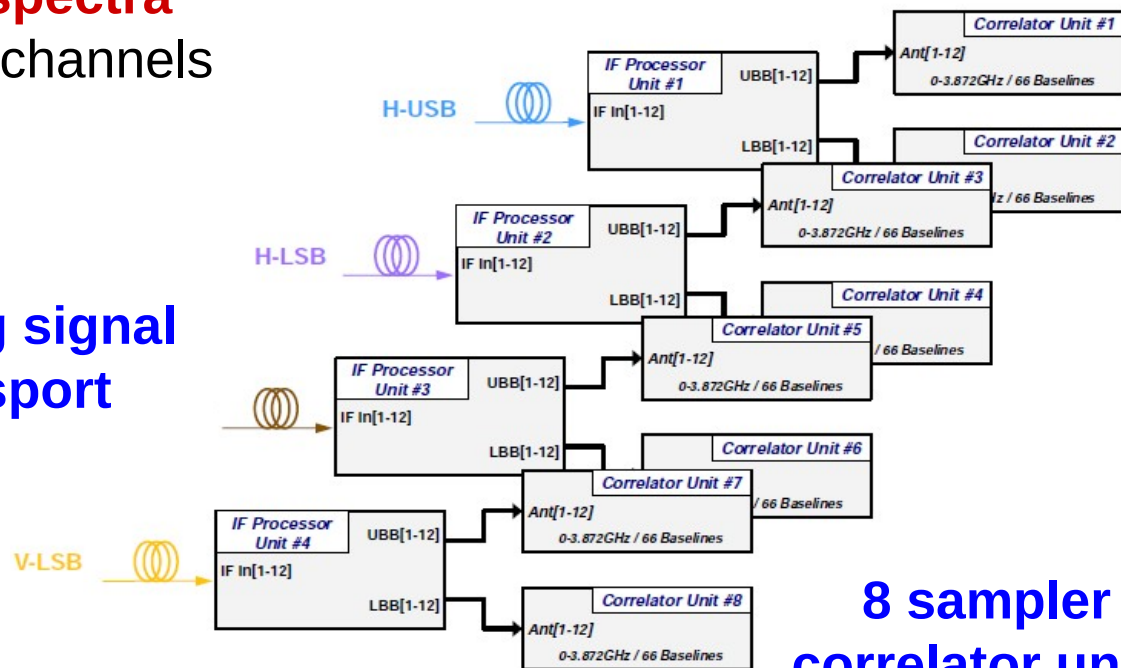
**Construction Antenna 9 (Oct. 2016)**



# NOEMA correlator: PolyFix

- New generation correlator based on **FPGAs**
- FX architecture
- **Simultaneous continuum and line capabilities**
  - **Low-resolution spectra**
- Up to 150000 spectral channels

**Analog signal  
transport**



**IF processor  
4 GHz bands**

**8 sampler +  
correlator units  
processing  
12 ant x 4 GHz**

# NOEMA correlator: PolyFix

**Mode 1 :  
continuum +  
lines**

**complete 16 GHz coverage in each polar. with 2 MHz channels**

**AND**

**128 windows of 64 MHz** (= 8 GHz coverage) with 62.5 kHz channels, each window tunable individually in steps of 64 MHz\*

**Mode 2 :  
survey mode**

**complete 16 GHz coverage in each polar. with 250 kHz channels**

**Mode 3 :  
continuum +  
high-res. lines**

same as mode 1, but with 64/32/16 windows of 64 MHz with 32/15/8 kHz channels

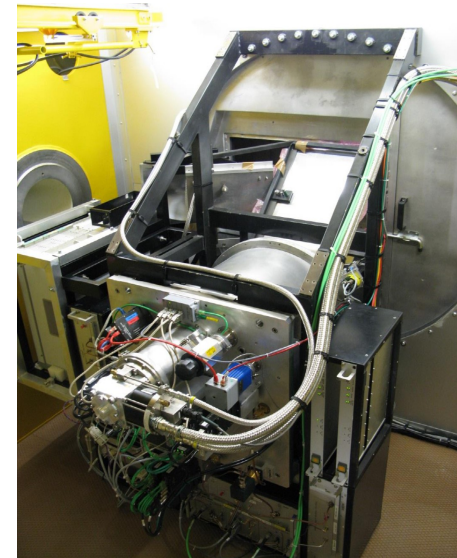
\* With the constrain of having 16 windows in each of the 8 4 GHz-wide correlator units



# NOEMA receivers

- **2 polar x 2 sidebands x 8 GHz = 32 GHz/antenna**

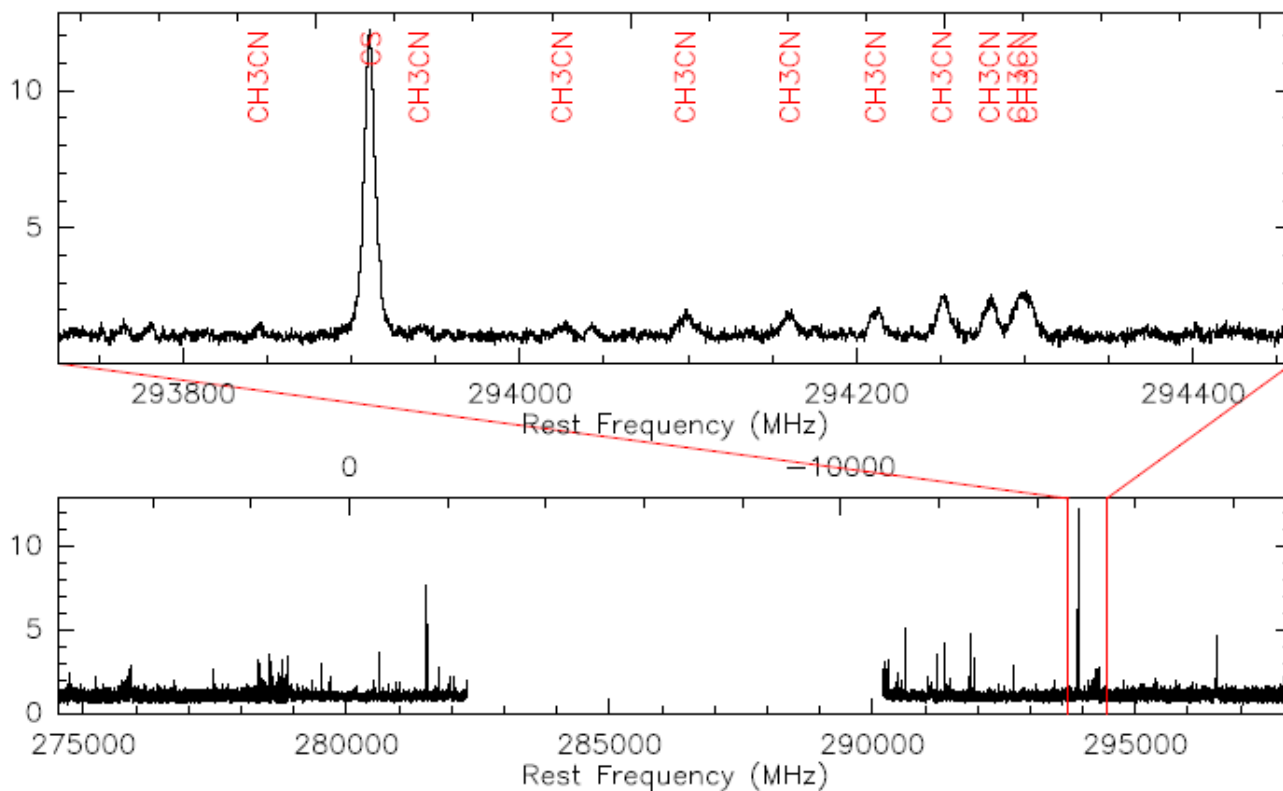
NOEMA receivers		
Band 1	3 mm	72-116 GHz
Band 2	2 mm	127-179 GHz
Band 3	1.3 mm	200-276 GHz
Band 4	0.8 mm	275-373 GHz



- New receivers already installed on Antenna 7, 1, 2, 8, 3, 4
- Antennas 5, 6 equipped before end of 2016

# NOEMA receivers : IF

16 GHz per polarization – already available with EMIR @ 30 m since 2012



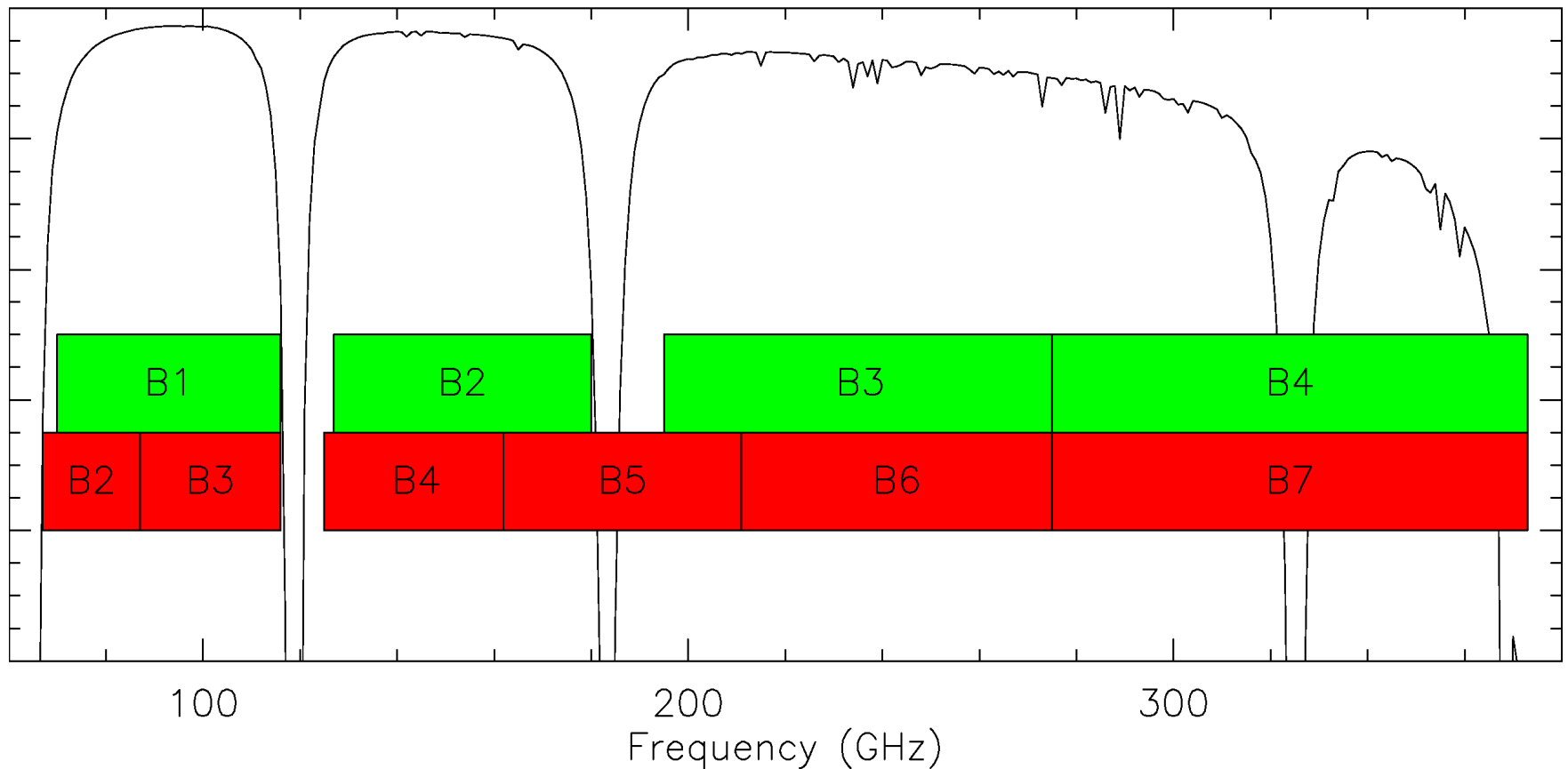
(EMIR 230 GHz band tests 2012, Kramer et al.)



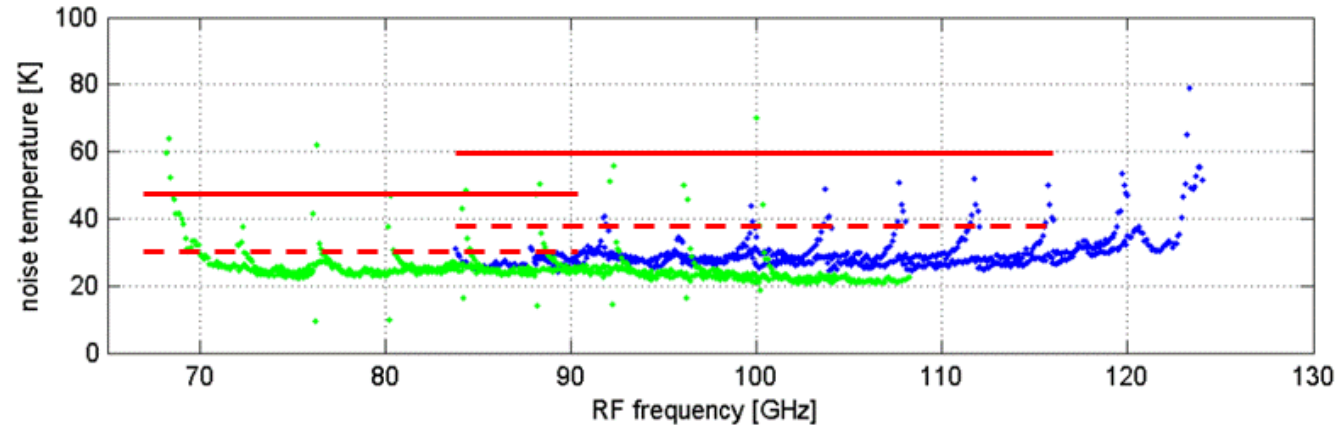
# NOEMA receivers : IF *and* RF

NOEMA IF=16 GHz

ALMA IF=8 GHz



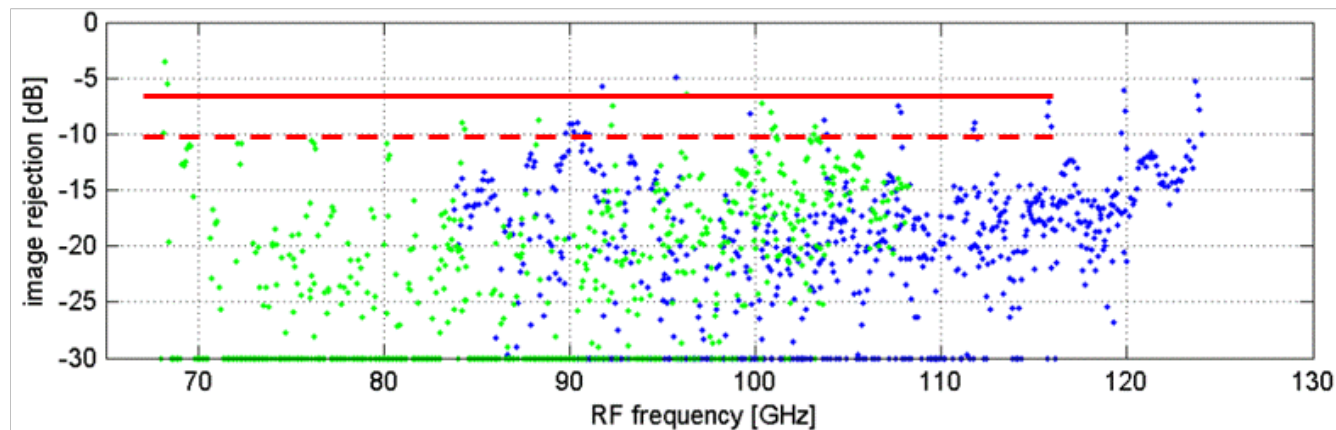
# NOEMA receivers : Band 1



NOEMA/EMIR Band  
1 mixer (Maier et al.)

2x8 GHz IF

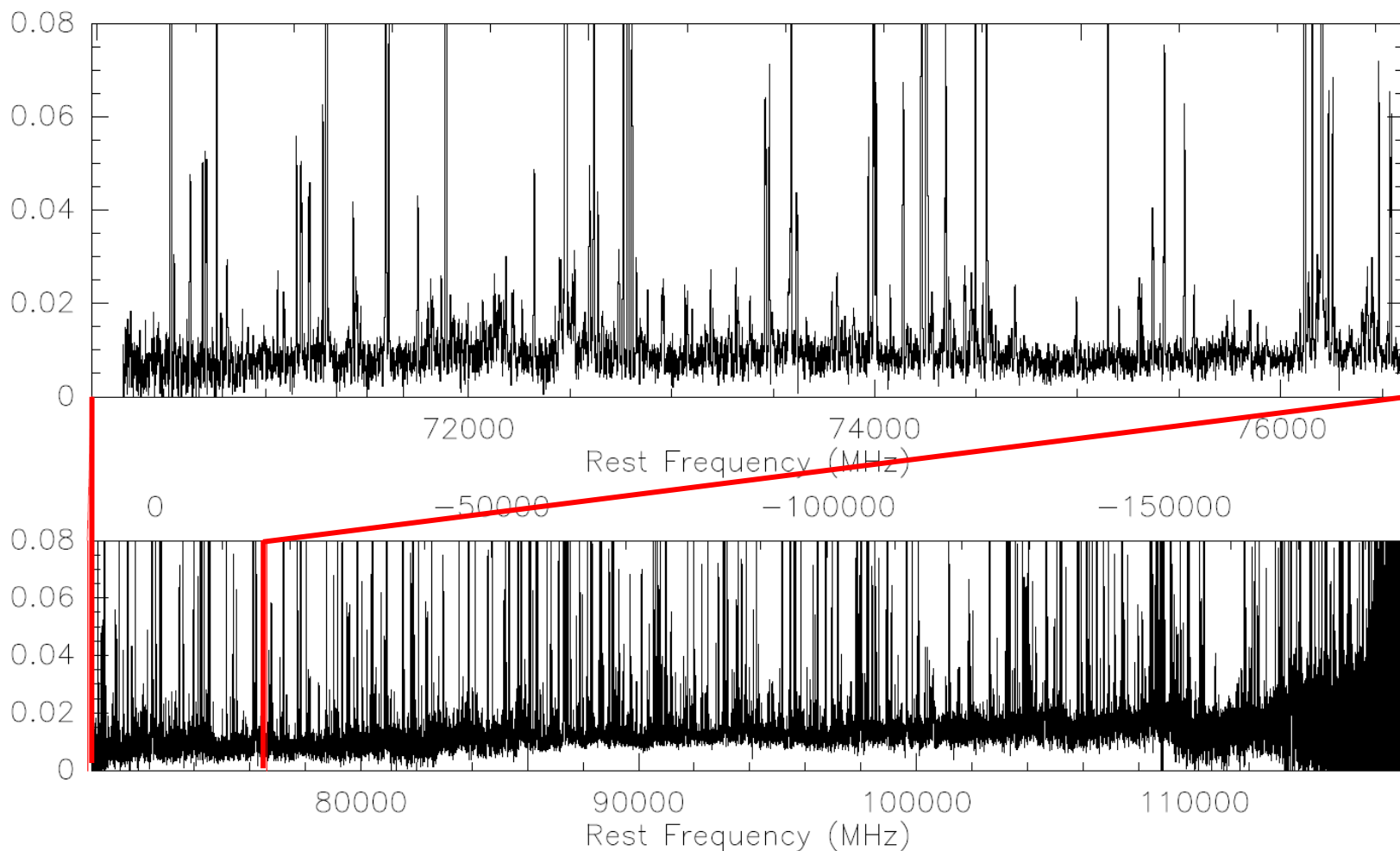
Covers **70-122 GHz**  
= (almost) full ALMA  
Band 2+3





# Band 1 EMIR @ 30 m

Upgrade of EMIR/30m December 2015 – IRC10216



# Timeline NOEMA

