


# Part 2: spectral setup, receivers and correlator

German ARC: ALMA community days (March 2017)

A wide-angle photograph of the ALMA observatory site in a high-altitude desert. The foreground and middle ground are filled with numerous large, white, parabolic radio telescope dishes. In the background, there are several reddish-brown hills and a prominent, snow-capped mountain peak under a clear, light blue sky.

# Outline

## **Part 1:** by Á. Sánchez-Monge

- Introduction to aperture synthesis
- Interferometers: spatial filters

## **Part 2:** by Á. Sánchez-Monge

- Interferometers: spectral setup
- An overview of receivers and correlator

## **Part 3:** by Y. Pidopryhora

- The sensitivity of an interferometer



# Spectral setup in the almaOT

The screenshot displays the ALMA Observing Tool (Cycle5) interface. The main window title is "ALMA Observing Tool (Cycle5) - Project". The top menu bar includes "File", "Edit", "View", "Tool", "Search", and "Help". The top toolbar contains various icons for file operations and navigation. The left sidebar, titled "Project Structure", shows a tree view with "Project" expanded to "Planned Observing" and "ScienceGoal (Science Goal)", with "Field Setup" selected. The main area is divided into "Editors" and "Project Structure". The "Editors" panel has tabs for "Spectral", "Spatial", and "Field Setup", with "Field Setup" active. The "Field Setup" tab contains the following fields and controls:

- Input source details and mapping info or use the Visual Editor on the spatial tab. You must choose between checking 1 Rectangular Field on all sources or none. Check 1 Rectangular Field on the first source before adding others to put rectangular mosaics around multiple sources.**
- SinglePoint** (tab)
- Source** (section)
- Source Name: [Text Field] [Resolve]
- Choose a Solar System Object?  Name of object: [Unspecified]
- System: [ICRS] Sexagesimal display?  Parallax: [0.00000] [mas]
- Source Coordinates: RA: [00:00:00.0000] PM RA: [0.00000] [mas/yr]; Dec: [00:00:00.000] PM DEC: [0.00000] [mas/yr]
- Source Radial Velocity: [0.000] [km/s] [lsrk] z: [0.000000000] Doppler Type: [RADIO]
- Target Type:  Individual Pointing(s)  1 Rectangular Field
- Expected Source Properties** (section)
- Peak Continuum Flux Density per Synthesized Beam: [0.00000] [Jy]
- Continuum Polarization Percentage: [0.0] per cent
- Peak Line Flux Density per Synthesized Beam: [0.00000] [Jy]
- Line Width: [0.00000] [km/s]
- Line Polarization Percentage: [0.0] per cent
- Field Center Coordinates** (section)
- Coord Type:  Relative  Absolute
- Offset Unit: [arcsec]
- #Pointings: [1]



# Spectral setup in the almaOT

The screenshot displays the ALMA Observing Tool (Cycle5) interface. The top menu bar includes 'File', 'Edit', 'View', 'Tool', 'Search', and 'Help'. The main window is divided into two panes: 'Project Structure' on the left and 'Editors' on the right. In the 'Project Structure' pane, the 'Spectral Setup' folder is highlighted with a red circle and a red arrow pointing to the text 'SPECTRAL SETUP' below it. The 'Editors' pane shows the 'Field Setup' tab, which contains a form for configuring a source. The form includes fields for 'Source Name', 'Source Coordinates' (RA and Dec), 'Source Radial Velocity', 'Target Type', and 'Expected Source Properties'. A large blue diagonal watermark reads 'WE ALREADY KNOW HOW TO FILL THIS'.

**SPECTRAL SETUP**

**WE ALREADY KNOW HOW TO FILL THIS**

# Spectral setup in the almaOT

The screenshot displays the ALMA Observing Tool (Cycle5) interface. The top menu bar includes File, Edit, View, Tool, Search, and Help. The title bar shows "ALMA Observing Tool (Cycle5) - Project" and the system tray displays the date and time as "Mon 27 Mar 10:05" along with the user name "Alvaro Sanchez".

The interface is divided into two main panes:

- Project Structure:** A tree view on the left showing the project hierarchy. The "Spectral Setup" folder is selected under "Planned Observing" > "ScienceGoal (Science Goal)".
- Editors:** The main workspace on the right, currently showing the "Spectral Setup" editor. It features a "Visualisation" section with a plot of "Observed Frequency" (100,000 to 900,000) and "Rest Frequency" (100,000 to 900,000). The plot shows several spectral lines and shaded regions labeled 03 through 10. Below the plot are controls for "Overlays" (Receiver Bands, Transmission, DSB Image, Spectral Lines), "Water Vapour Column Density" (Automatic Choice, Manual Choice, 5.186mm (7th Octile)), and "Viewport" (Pan to Spectral Window, Zoom to Band, Reset).

The "Spectral Setup" editor also includes a "Spectral Type" section with radio buttons for "Spectral Line", "Single Continuum", and "Spectral Scan".

# Spectral setup in the almaOT

The screenshot displays the ALMA Observing Tool (Cycle5) interface. The title bar shows the application name and the user's name, Alvaro Sanchez. The menu bar includes File, Edit, View, Tool, Search, and Help. The toolbar contains various icons for file operations and navigation. The Project Structure pane on the left shows a tree view with folders for Proposal, Planned Observing, and ScienceGoal (Science Goal), with sub-items like General, Field Setup, Spectral Setup, Calibration Setup, Control and Performance, and Technical Justification. The Editors pane on the right is active, showing the Spectral Setup tab. The Spectral Setup tab contains a Visualisation section with a plot of Observed Frequency vs Rest Frequency. The plot shows several spectral lines and bands, with bands 03 through 10 labeled. Below the plot are controls for Overlays (Receiver Bands, Transmission, DSB Image, Spectral Lines), Water Vapour Column Density (Automatic Choice, Manual Choice), and Viewport (Pan to Spectral Window, Zoom to Band, Reset). The Spectral Type section has radio buttons for Spectral Line, Single Continuum, and Spectral Scan. A checkbox at the bottom is labeled 'Produce image sidebands (Bands 9 and 10 only)'.

ALMA Observing Tool (Cycle5) - Project

File Edit View Tool Search Help

Project Structure

Proposal Program

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observing
      - ScienceGoal (Science Goal)
        - General
        - Field Setup
        - Spectral Setup
        - Calibration Setup
        - Control and Performance
        - Technical Justification

Editors

Spectral Spatial **Spectral Setup**

Visualisation

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3 to 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Left/right click to zoom in/out, grab sliding bar to pan  
Note: Moving LO1 here is for experimentation only - actual setup determined by the windows

Observed Frequency

Rest Frequency

Overlays:  Receiver Bands  Transmission  DSB Image  Spectral Lines [Select Lines to Overlay](#)

Water Vapour Column Density:  Automatic Choice  Manual Choice 5.186mm (7th Octile)

Viewport: [Pan to Spectral Window](#) [Zoom to Band](#) [Reset](#)

Spectral Type

Spectral Line  
 Single Continuum  
 Spectral Scan

Produce image sidebands (Bands 9 and 10 only)

# Spectral setup in the almaOT

The screenshot displays the ALMA Observing Tool (Cycle5) interface. The main window is titled "ALMA Observing Tool (Cycle5) - Project" and shows the "Spectral Setup" configuration window. The interface includes a menu bar (File, Edit, View, Tool, Search, Help), a toolbar with various icons, and a "Project Structure" panel on the left. The "Spectral Setup" window is divided into several sections:

- Text:** "In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other."
- Spectral Type:** Radio buttons for "Spectral Line" (selected), "Single Continuum", and "Spectral Scan".
- Produce image sidebands (Bands 9 and 10 only):** A checkbox that is currently unchecked.
- Polarization products desired:** Radio buttons for "XX", "DUAL" (selected), and "FULL".
- Spectral Setup Errors:** A red message: "No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]".
- Spectral Line Table:** A table with columns: "Fraction", "Centre Freq (rest,lsrk)", "Centre Freq (sky,bar)", "Transition", "Bandwidth, Resolution (smoothed)", "Spec Avg.", and "Repre Wi".
- Baseband-1:** A section containing the table and buttons: "Add spectral window centred on a spectral line", "Add spectral window manually", "Delete", and "Show image spectral window".
- Baseband-2:** A section containing the table and buttons: "Add spectral window centred on a spectral line", "Add spectral window manually", "Delete", and "Show image spectral window".



# Spectral setup in the almaOT

The screenshot shows the ALMA Observing Tool (Cycle5) interface. The main window is titled "ALMA Observing Tool (Cycle5) - Project" and displays the "Spectral Setup" configuration window. The interface includes a menu bar (File, Edit, View, Tool, Search, Help) and a toolbar with various icons. The "Project Structure" pane on the left shows a tree view of the project files, with "Spectral Setup" selected. The "Editors" pane on the right shows the "Spectral Setup" configuration window.

**Project Structure:**

- Project
  - Proposal
    - Planned Observing
      - ScienceGoal (Science Goal)
        - General
        - Field Setup
        - Spectral Setup
        - Calibration Setup
        - Control and Performance
        - Technical Justification

**Editors**

Spectral | Spatial | Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

**Spectral Type**

**Continuum or line ?**

Spectral Line  
 Single Continuum  
 Spectral Scan

Spectral Type

Produce image sidebands (Bands 9 and 10 only)

Polarization products desired  XX  DUAL  FULL

**Spectral Setup Errors**

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

**Spectral Line**

Baseband-1

Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Repre Wi

Add spectral window centred on a spectral line    Add spectral window manually    Delete     Show image spectral window

Baseband-2

Add spectral window centred on a spectral line    Add spectral window manually    Delete     Show image spectral window

# Spectral setup in the almaOT

ALMA Observing Tool (Cycle5) - Project

File Edit View Tool Search Help

Project Structure

- Proposal
- Program

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observing
      - ScienceGoal (Science Goal)
        - General
        - Field Setup
        - Spectral Setup
        - Calibration Setup
        - Control and Performance
        - Technical Justification

Editors

Spectral Spatial Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

**Continuum or line ?**

- Spectral Line
- Single Continuum
- Spectral Scan

**Polarization products ?**

Produce image sidebands (Bands 9 and 10 only)

Polarization products desired

- XX
- DUAL
- FULL

Spectral Setup Errors

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

Spectral Line

Baseband-1	Fractio	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Repre Wi

Add spectral window centred on a spectral line Add spectral window manually Delete  Show image spectral window

Baseband-2

Fractio	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Repre Wi	

Add spectral window centred on a spectral line Add spectral window manually Delete  Show image spectral window

# Spectral setup in the almaOT

**ALMA Observing Tool (Cycle5)**  
Mon 27 Mar 10:06 Alvaro Sanchez

File Edit View Tool Search Help

Project Structure: Unsubmitted Proposal, Project, Proposal, Planned Observing, ScienceGoal (Science Goal), General, Field Setup, Spectral Setup, Calibration Setup, Control and Performance, Technical Justification

Editors: Spectral, Spatial, Spectral Setup

Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

**Continuum or line ?**

- Spectral Line
- Single Continuum
- Spectral Scan

**Polarization products ?**

Produce image sidebands (Bands 9 and 10 only)

Polarization products desired:  XX  DUAL  FULL

Spectral Setup Errors

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

Spectral Line

Baseband	Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Repre Wi
Baseband-1							

**Rest frequency ?**

Buttons: Add spectral window centred on a spectral line, Add spectral window manually, Delete, Show image spectral window

# Spectral setup in the almaOT

**Project Structure**

- Project
  - Proposal
    - Planned Observing
      - ScienceGoal (Science Goal)
        - General
        - Field Setup
        - Spectral Setup**
        - Calibration Setup
        - Control and Performance
        - Technical Justification

**Editors**

Spectral | Spatial | **Spectral Setup**

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

**Continuum or line ?**

Spectral Type

Spectral Line  
 Single Continuum  
 Spectral Scan

**Polarization products ?**

Produce image sidebands (Bands 9 and 10 only)

Polarization products desired

XX  DUAL  FULL

**Spectral Setup Errors**

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

**Spectral Line**

Baseband	Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Repre Wi
Baseband-1							
Baseband-2							

**Rest frequency ?**

**Bandwidth, spectral resolution ?**

Add spectral window centred on a spectral line | Add spectral window manually | Delete |  Show image spectral window

# What do we need to know?

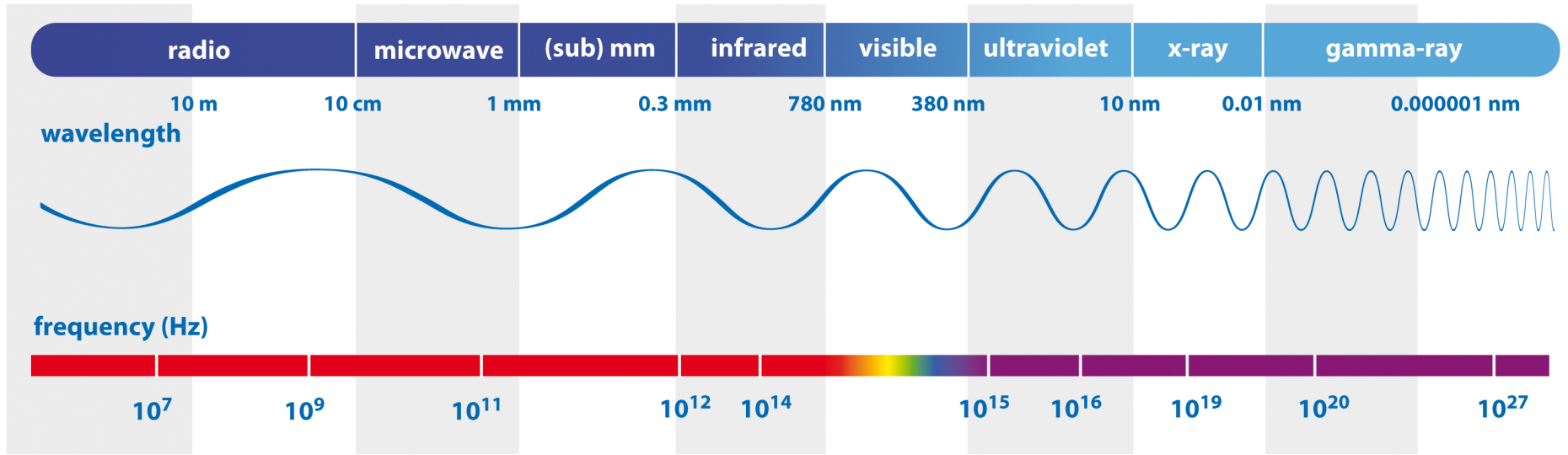
- continuum or line (both?)
- frequency of the lines to observe
- velocity / redshift of the source
- bandwidth / velocity coverage
- spectral resolution
- polarization products
- ...

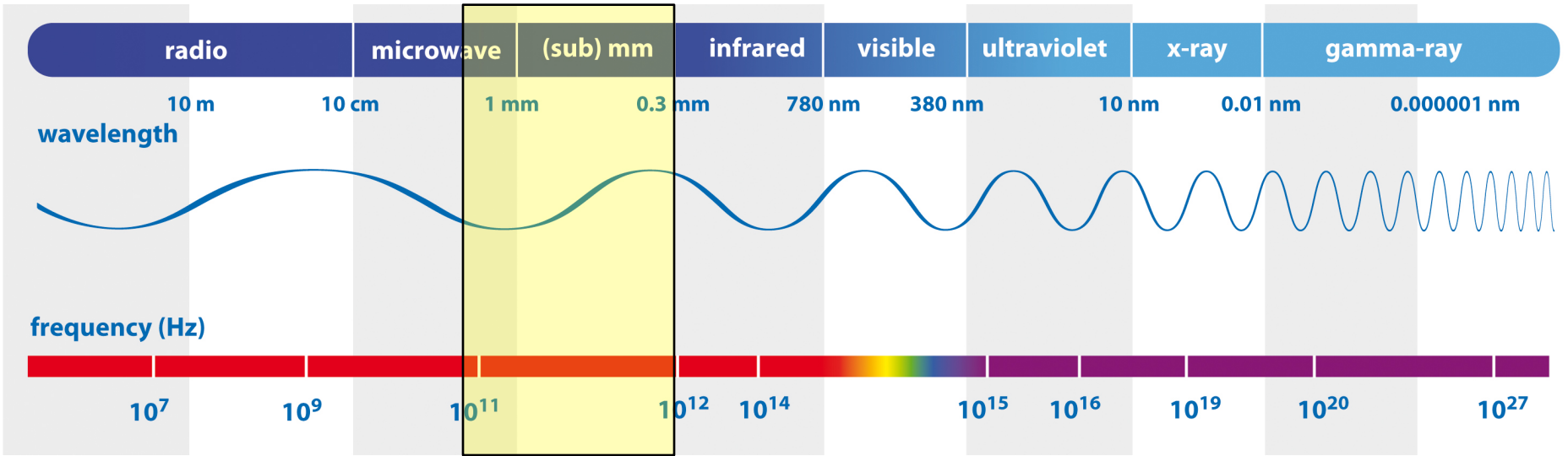


# What do we need to know?

- **continuum or line (both?)**
- frequency of the lines to observe
- velocity / redshift of the source
- bandwidth / velocity coverage
- spectral resolution
- polarization products
- ...

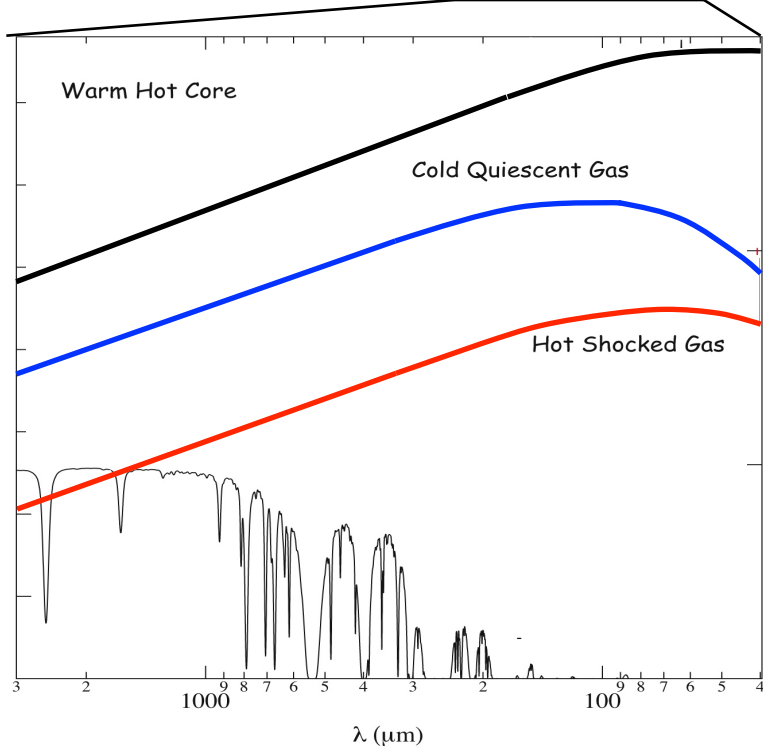
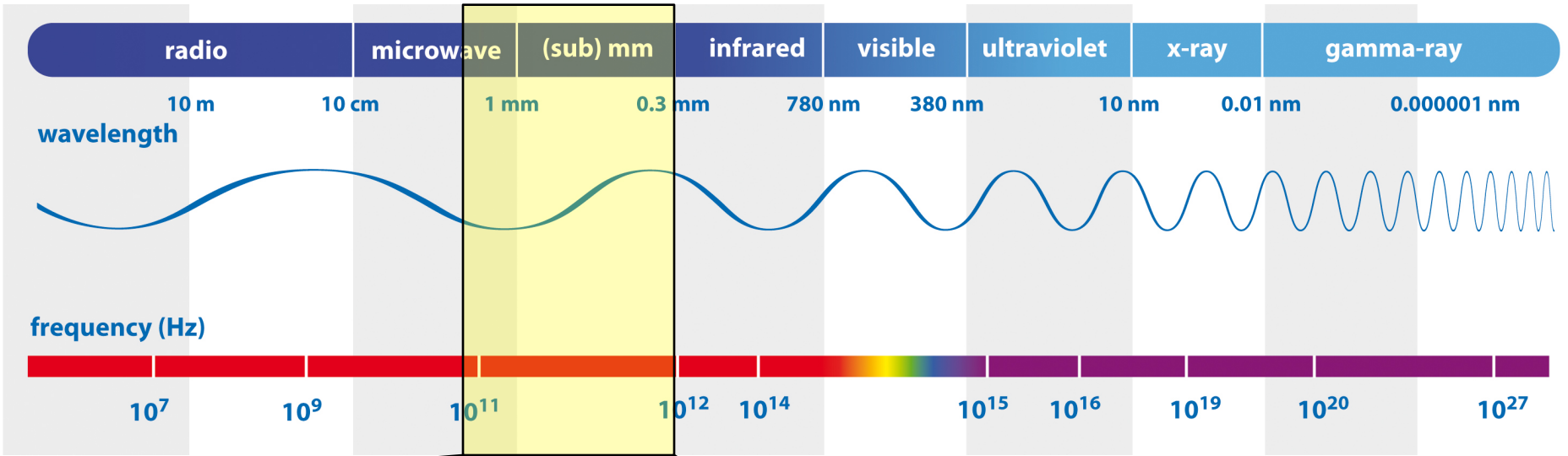




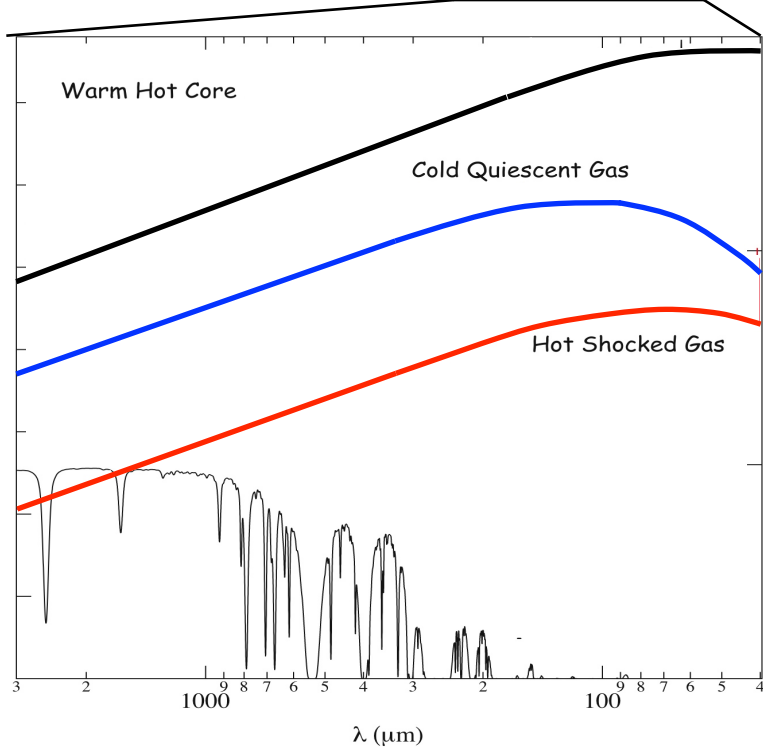
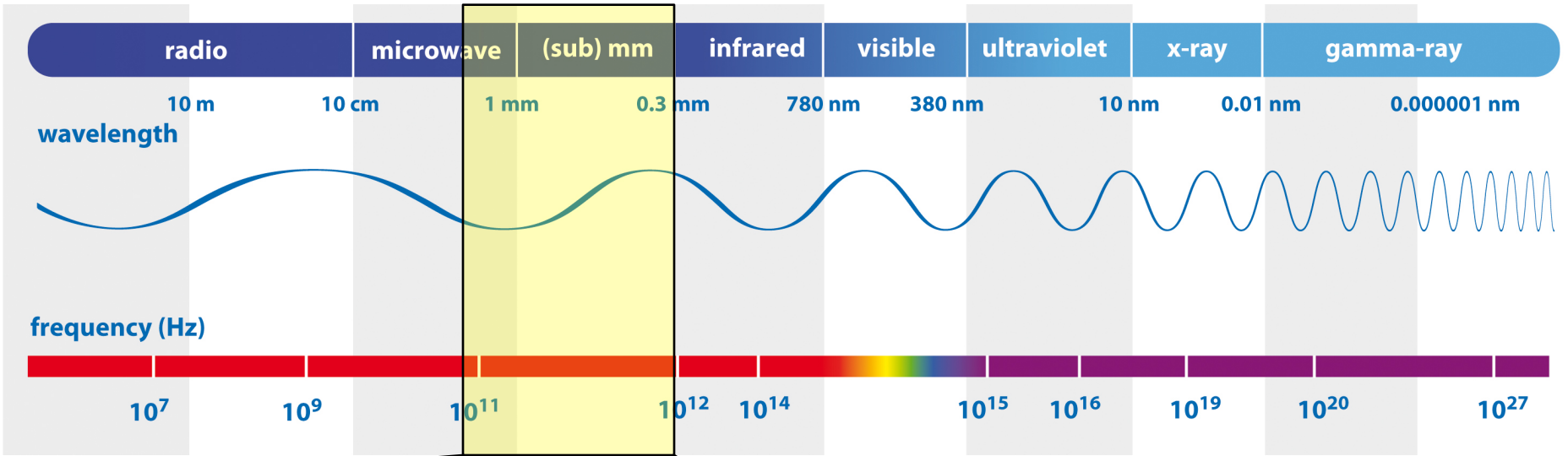


ALMA observable range  
**“Cold Universe”**

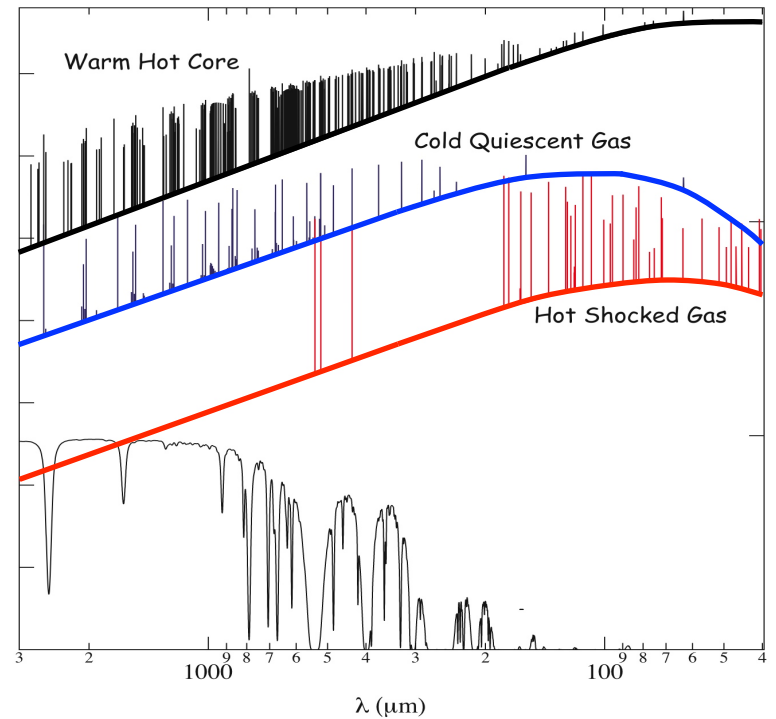




continuum emission

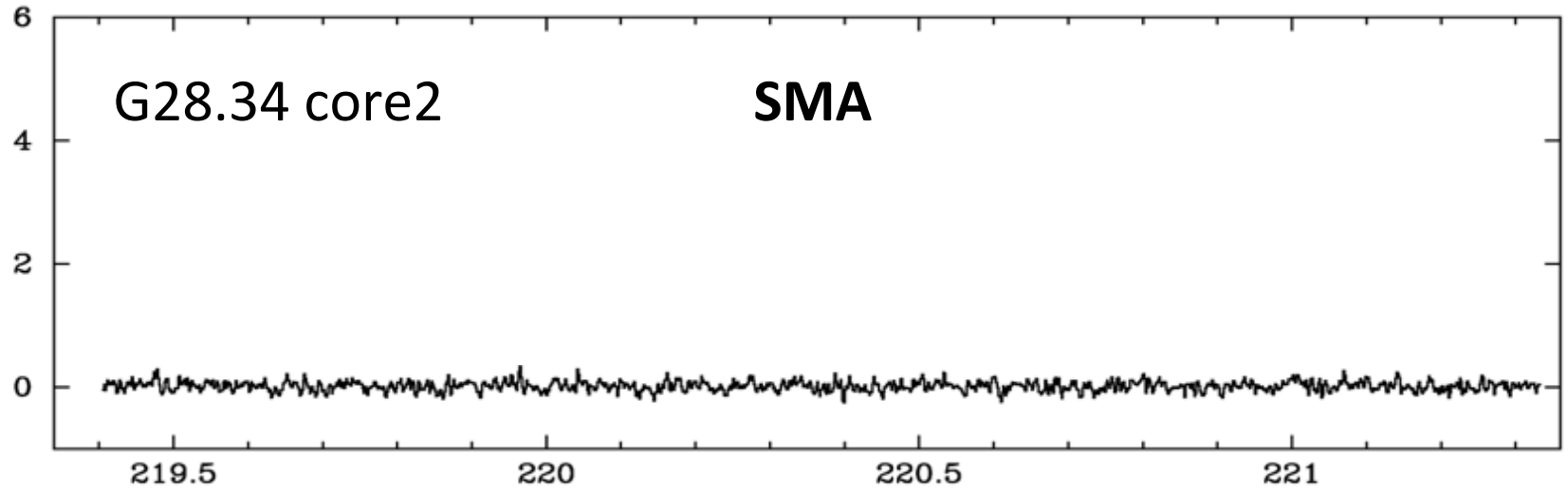


continuum emission



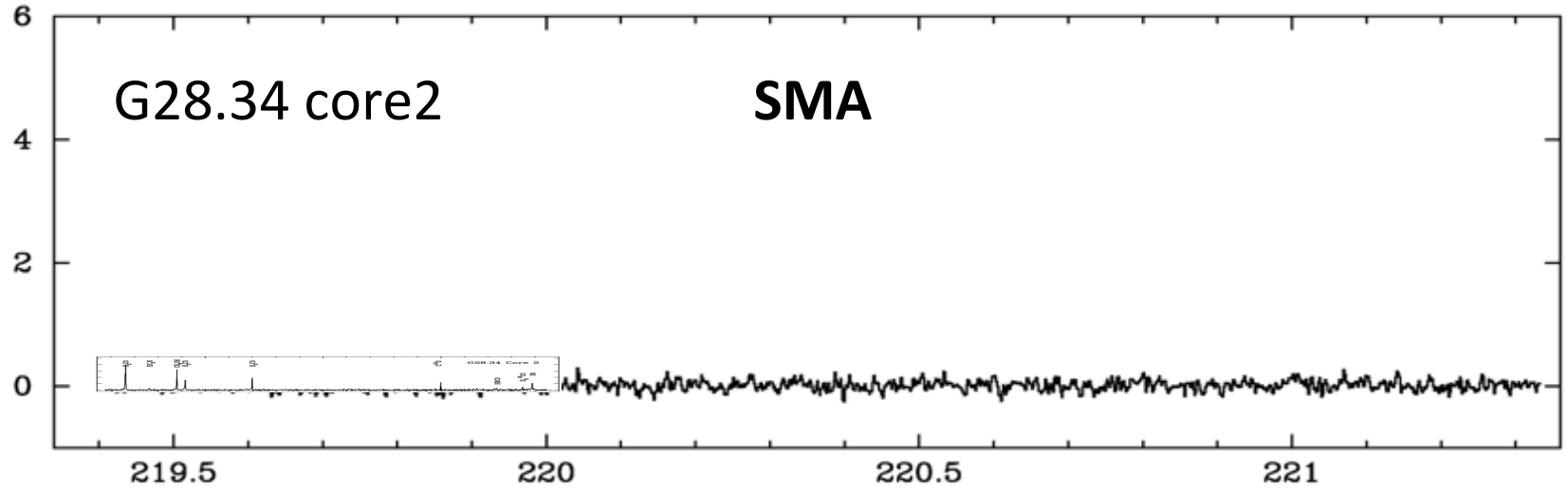
line emission

# Can we detect spectral lines?

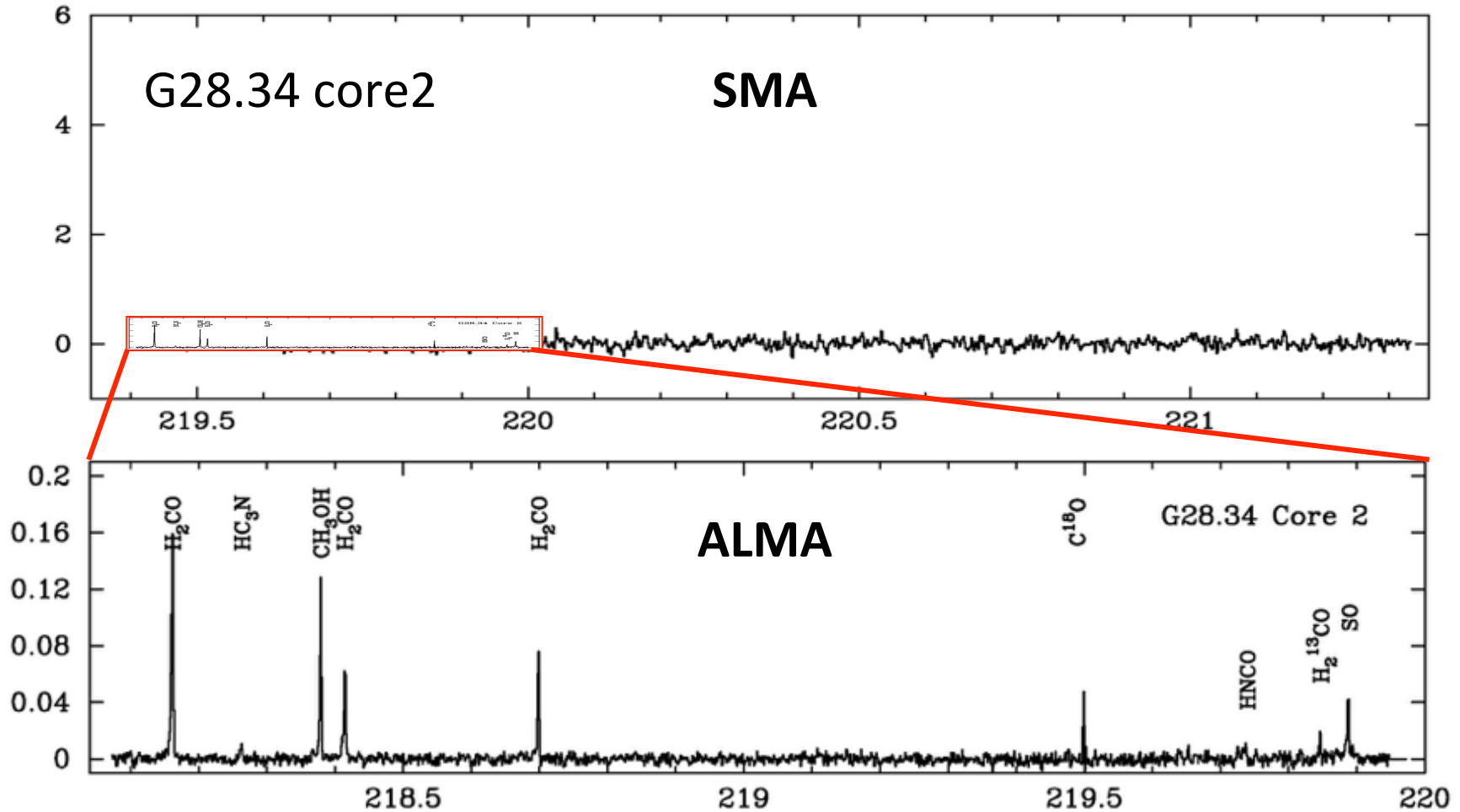


Zhang et al (2008)

# Can we detect spectral lines?



# Can we detect spectral lines?

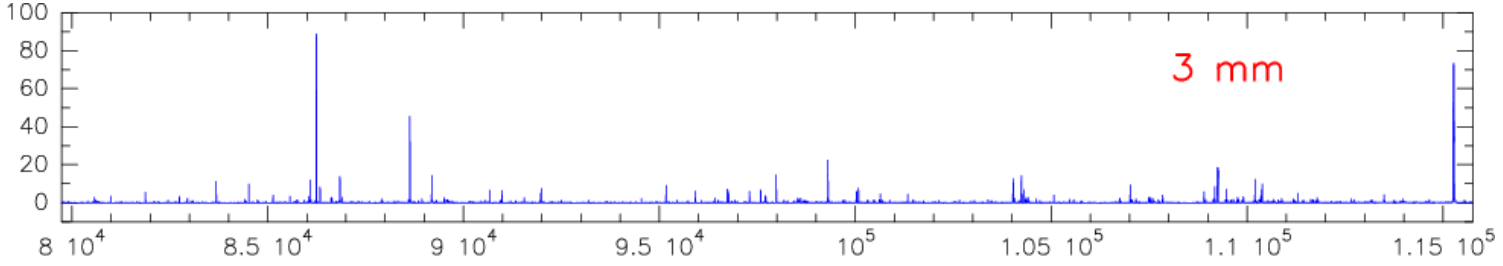


Zhang et al (2008)

Zhang et al (2014)

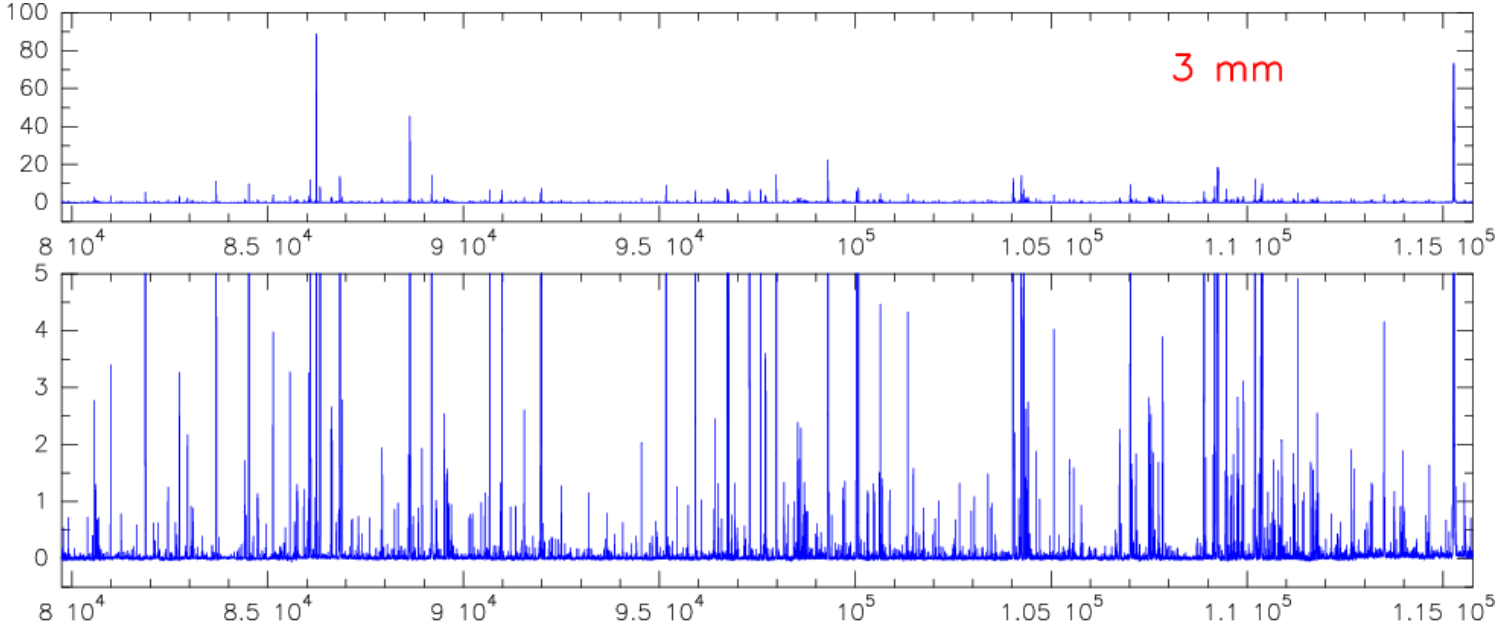
# Can we detect spectral lines?

When sensitivity can be a problem  
... entering the ALMA era



# Can we detect spectral lines?

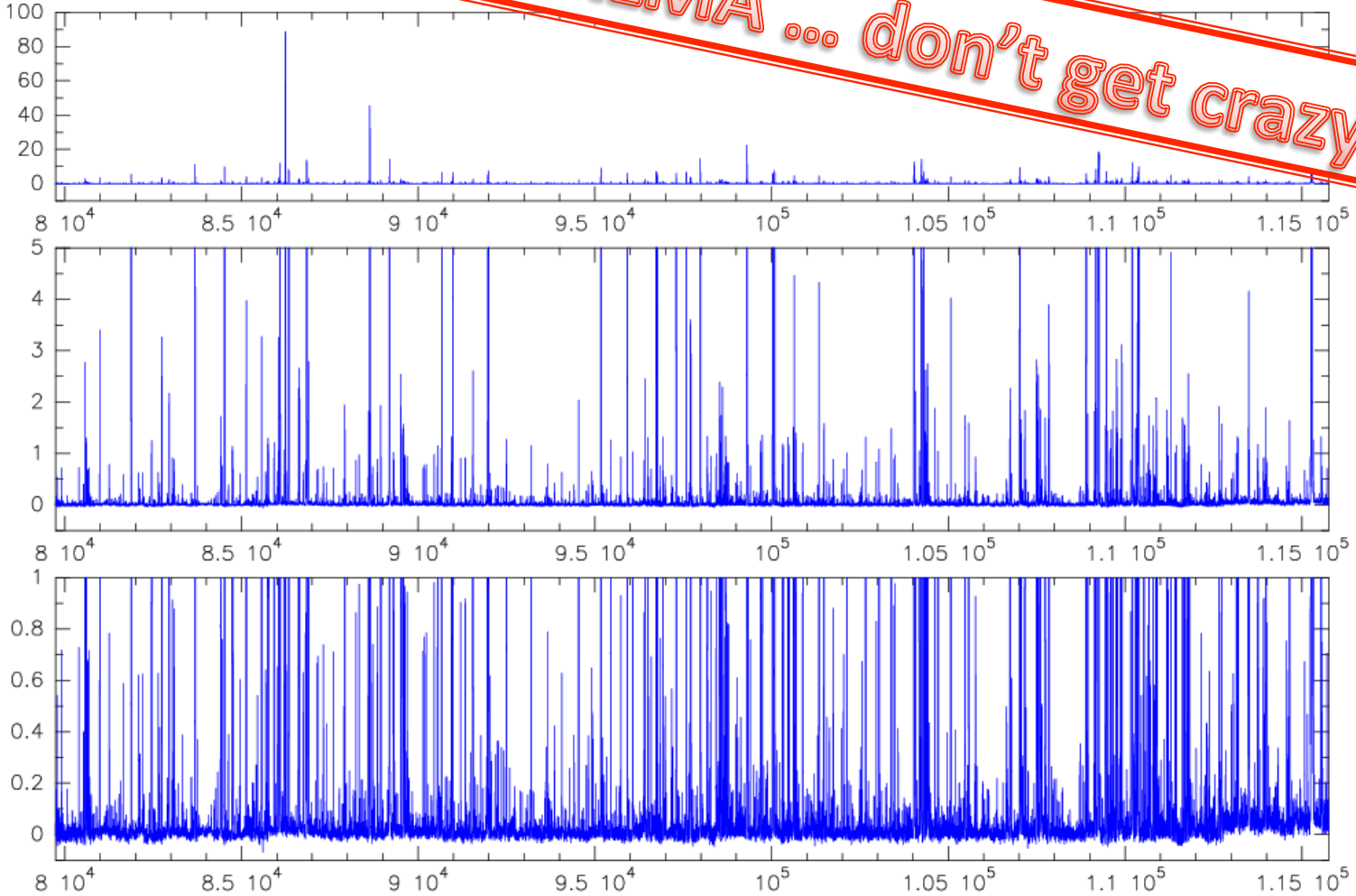
When sensitivity can be a problem  
... entering the ALMA era



# Can we detect spectral lines?

*With ALMA ... don't get crazy!*

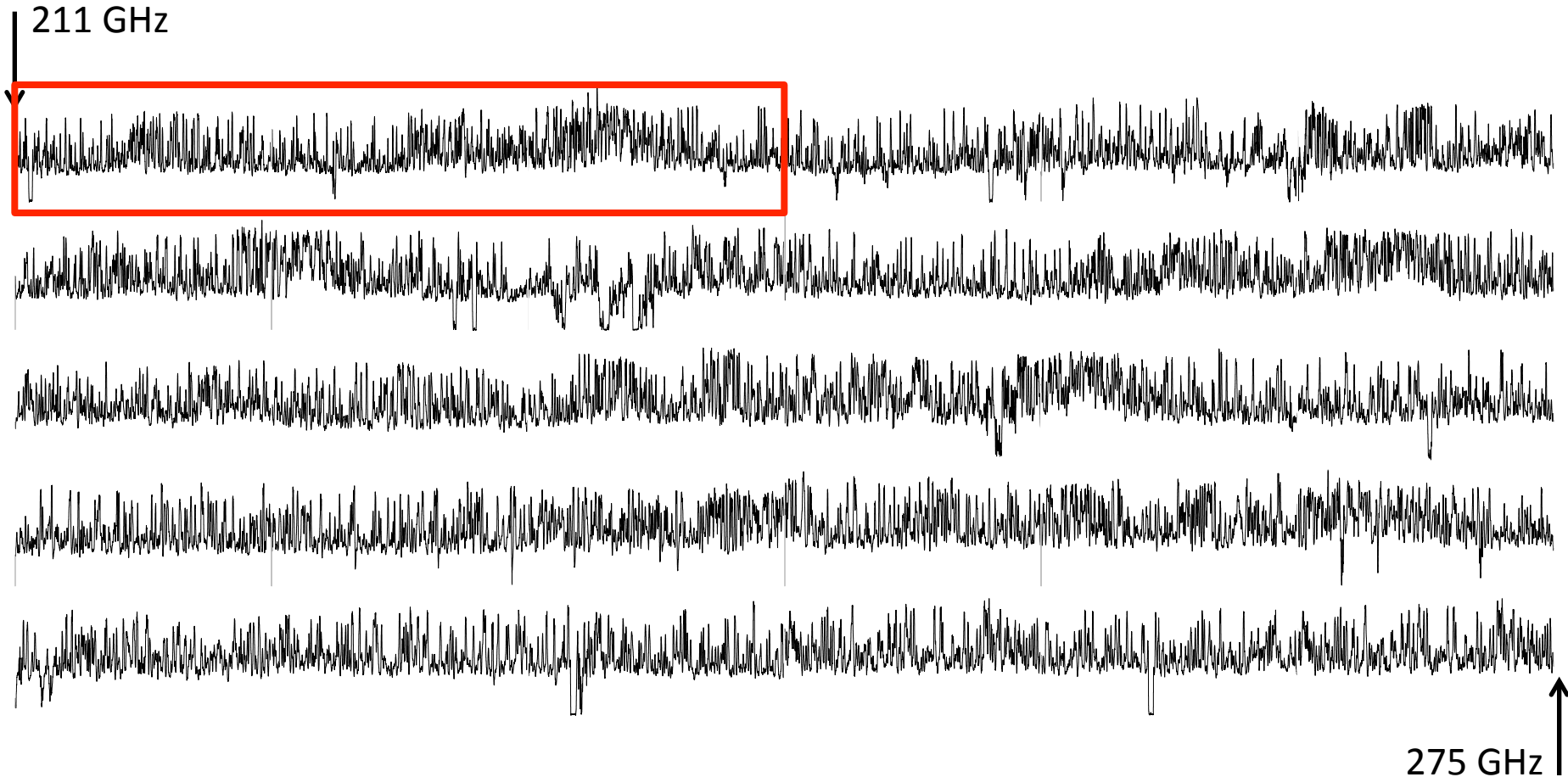
When sensitivity can be a problem  
... entering the ALMA era





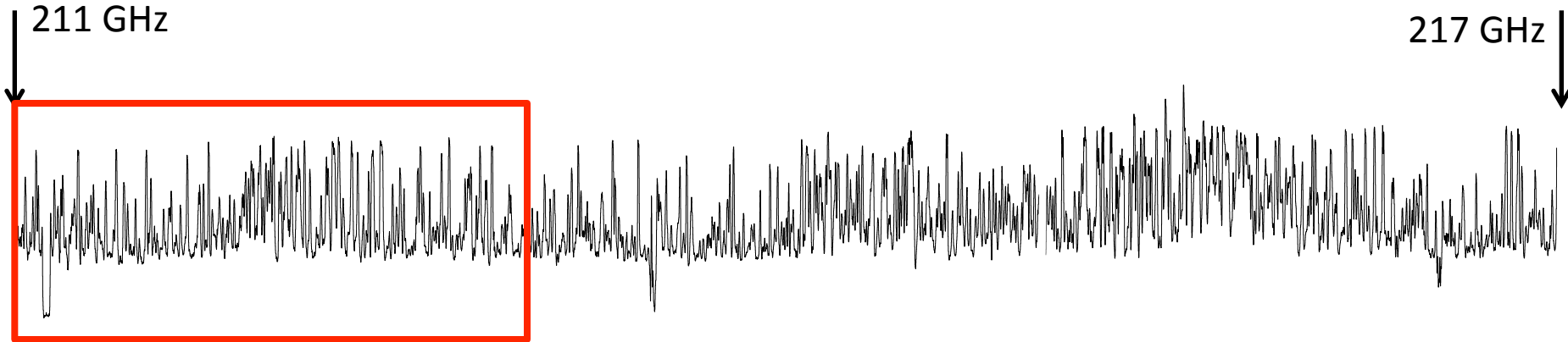
# Can we detect spectral lines?

Spectrum (211-275 GHz) towards 1 single pixel



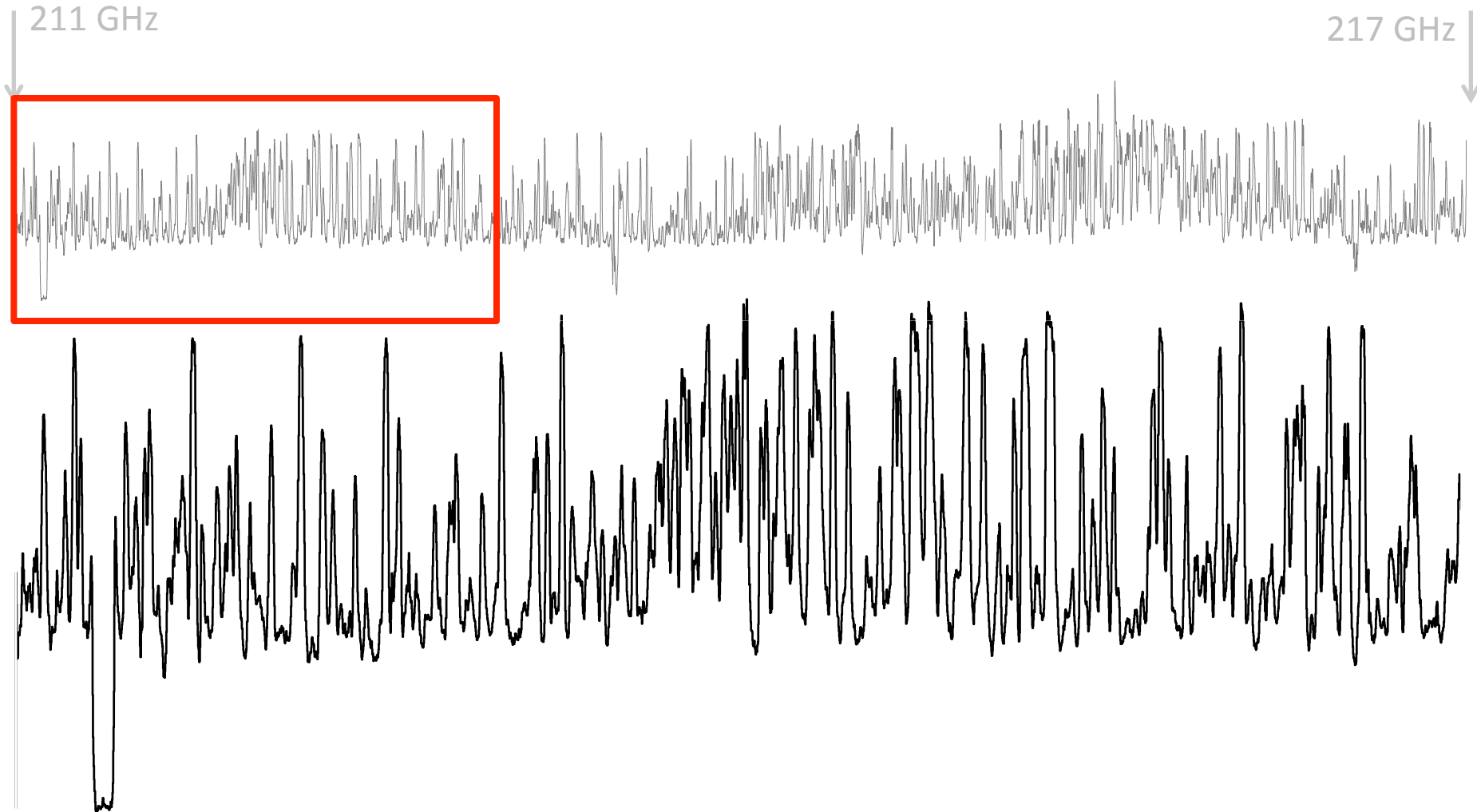
# Can we detect spectral lines?

Spectrum (211-275 GHz) towards 1 single pixel

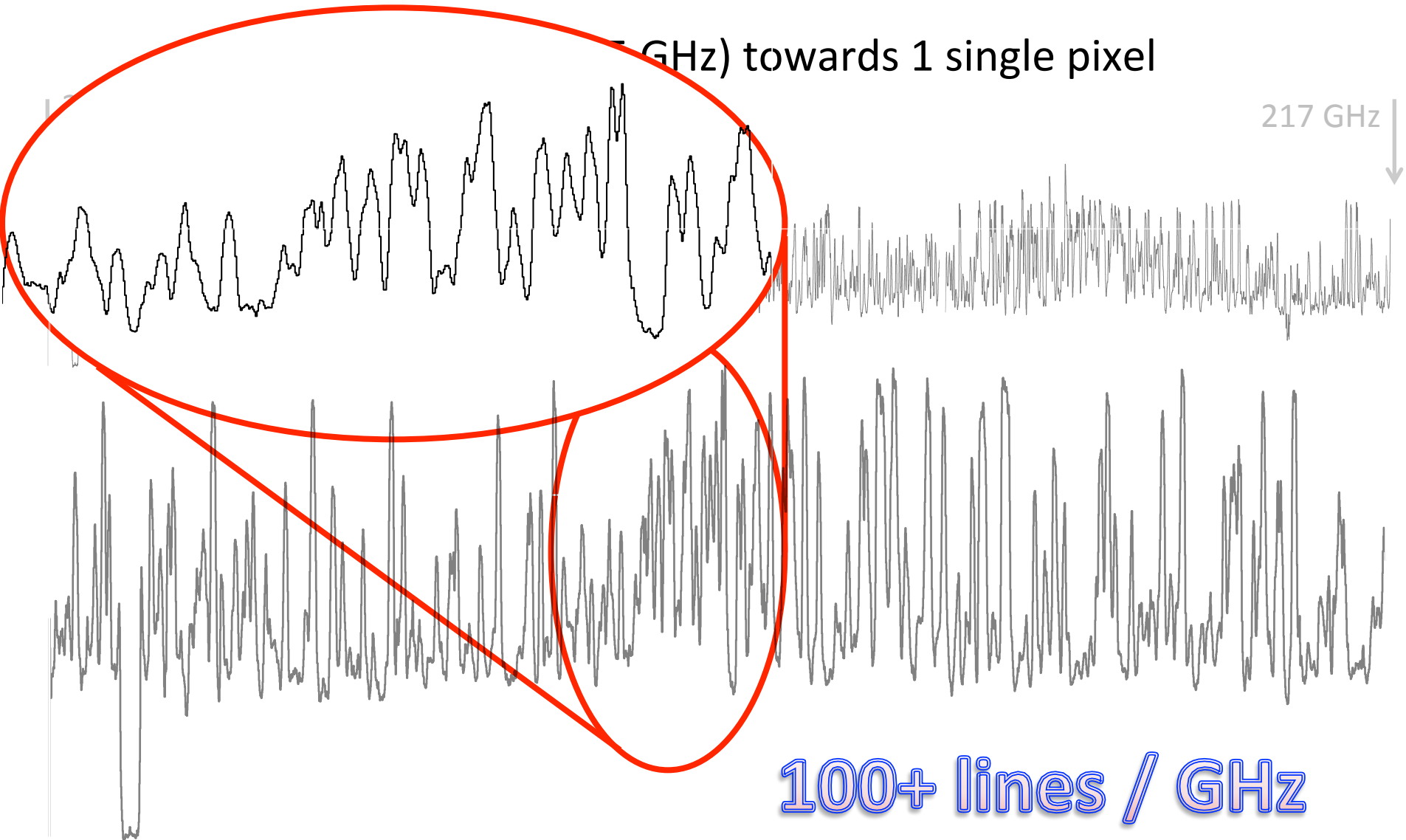


# Can we detect spectral lines?

Spectrum (211-275 GHz) towards 1 single pixel



# Can we detect spectral lines?



# What do you want to observe?

continuum emission

line emission

both (continuum and line)

# What do you want to observe?

## continuum emission

which frequency/wavelength (**band**)

intensity of the source (**rms**) [see next Section]

spatial distribution (**beam, LAS**) [see previous Section]

## line emission

## both (continuum and line)

# What do you want to observe?

## continuum emission

which frequency/wavelength (**band**)

intensity of the source (**rms**) [see next Section]

spatial distribution (**beam, LAS**) [see previous Section]

## line emission

which line (**frequency, band**)

intensity of the source (**rms**) [see next Section]

spatial distribution (**beam, LAS**) [see previous Section]

line shape (**bandwidth, spectral resolution**)

## both (continuum and line)

# What do we need to know?

- continuum or line (both?)
- **frequency of the lines to observe**
- velocity / redshift of the source
- bandwidth / velocity coverage
- spectral resolution
- polarization products
- ...





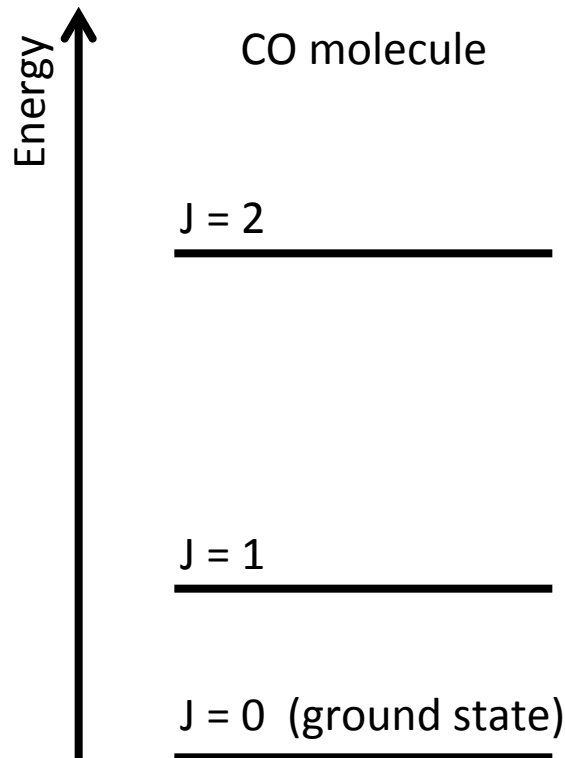
# Basic concepts of spectral line observations

Rest frequency

# Basic concepts of spectral line observations

## Rest frequency

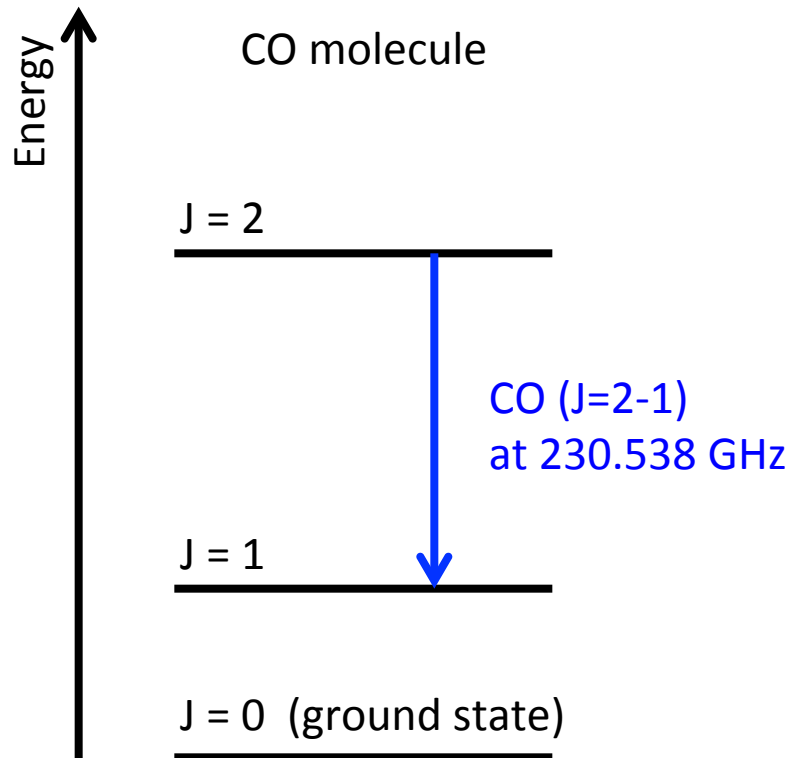
spectral line: transition between two different energy levels of a molecule, atom or ion



# Basic concepts of spectral line observations

## Rest frequency

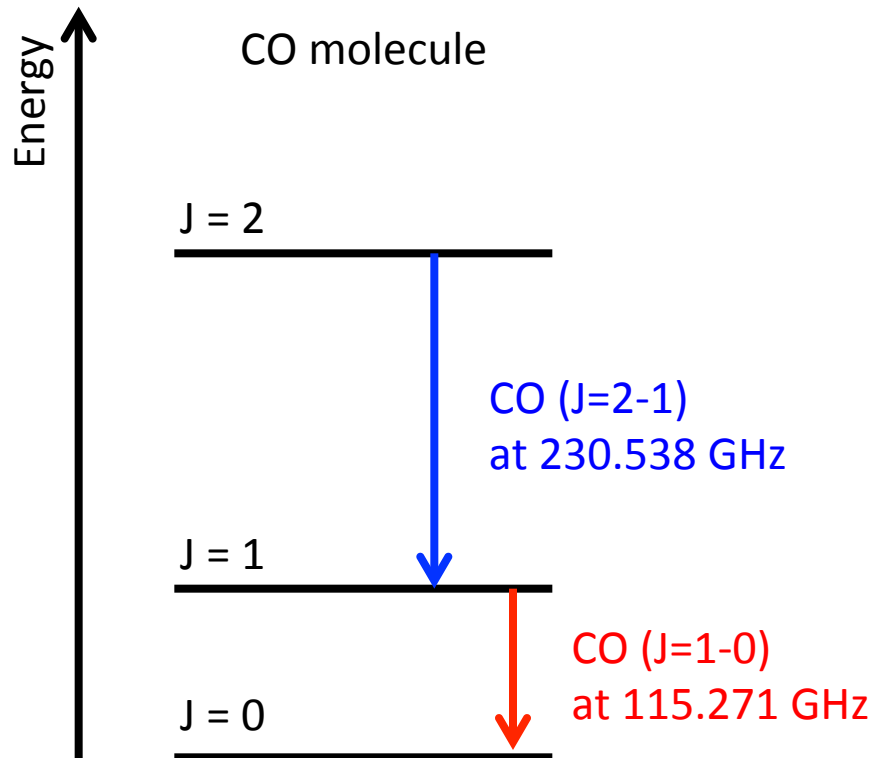
spectral line: transition between two different energy levels of a molecule, atom or ion



# Basic concepts of spectral line observations

## Rest frequency

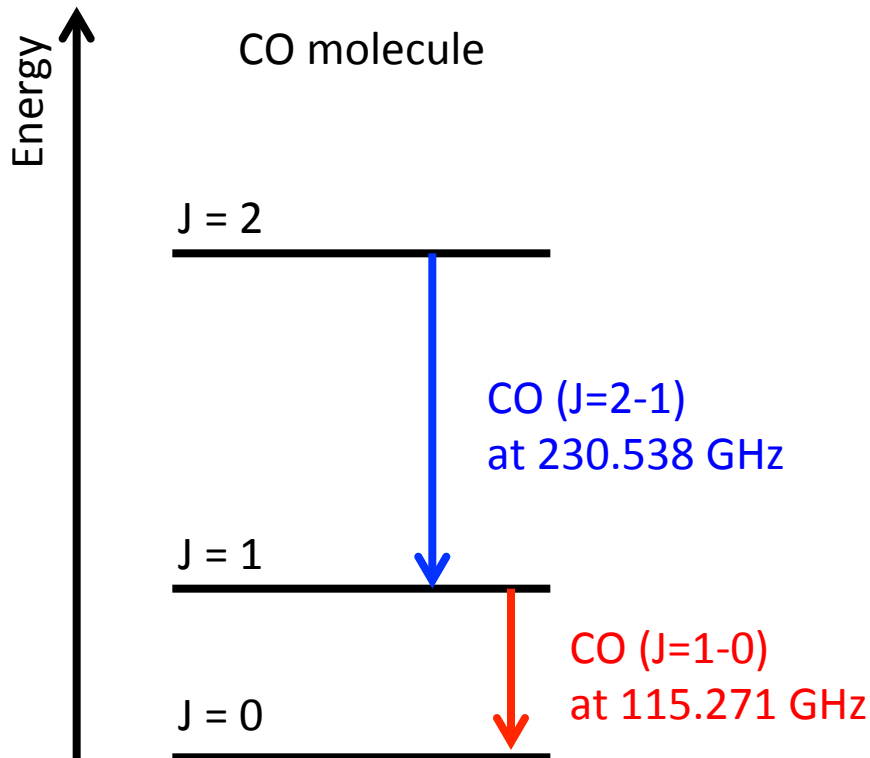
spectral line: transition between two different energy levels of a molecule, atom or ion



# Basic concepts of spectral line observations

## Rest frequency

spectral line: transition between two different energy levels of a molecule, atom or ion



**Rest frequencies** can be found in molecular databases:

CDMS

[www.astro.uni-koeln.de/cdms](http://www.astro.uni-koeln.de/cdms)

JPL

[spec.jpl.nasa.gov](http://spec.jpl.nasa.gov)

Splatalogue

[www.splatalogue.net](http://www.splatalogue.net)

# What do we need to know?

- continuum or line (both?)
- frequency of the lines to observe
- **velocity / redshift of the source**
- bandwidth / velocity coverage
- spectral resolution
- polarization products
- ...



# Basic concepts of spectral line observations

Velocity ( $V_{lsr}$ ) / redshift ( $z$ )

# Basic concepts of spectral line observations

Velocity ( $V_{lsr}$ ) / redshift ( $z$ )

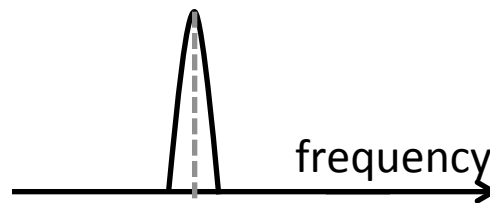
... from rest to sky frequencies ("**doppler effect**")



# Basic concepts of spectral line observations

Velocity ( $V_{lsr}$ ) / redshift ( $z$ )

... from rest to sky frequencies ("**doppler effect**")



230.538 GHz  
Band 6



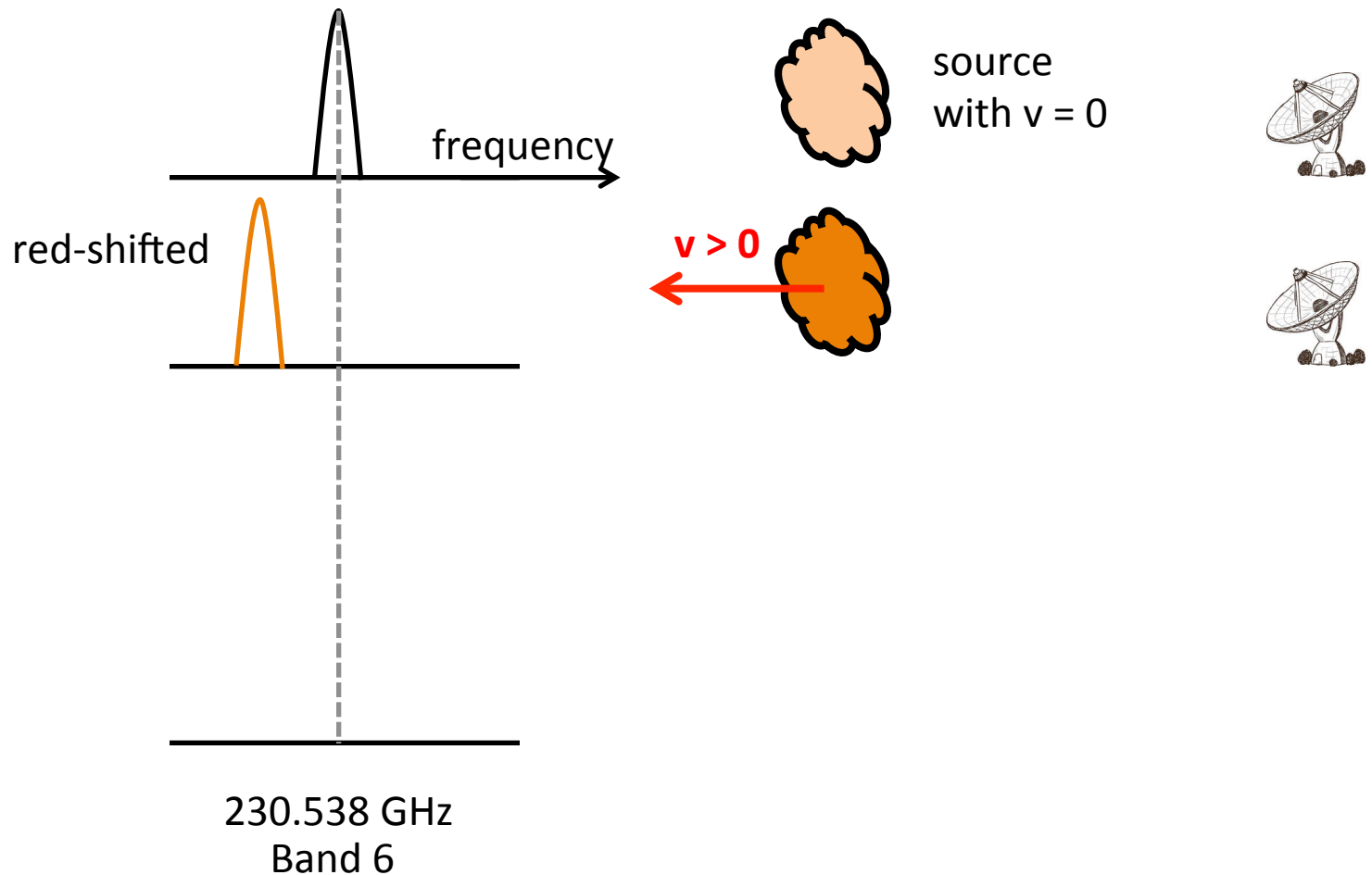
source  
with  $v = 0$



# Basic concepts of spectral line observations

Velocity ( $V_{lsr}$ ) / redshift ( $z$ )

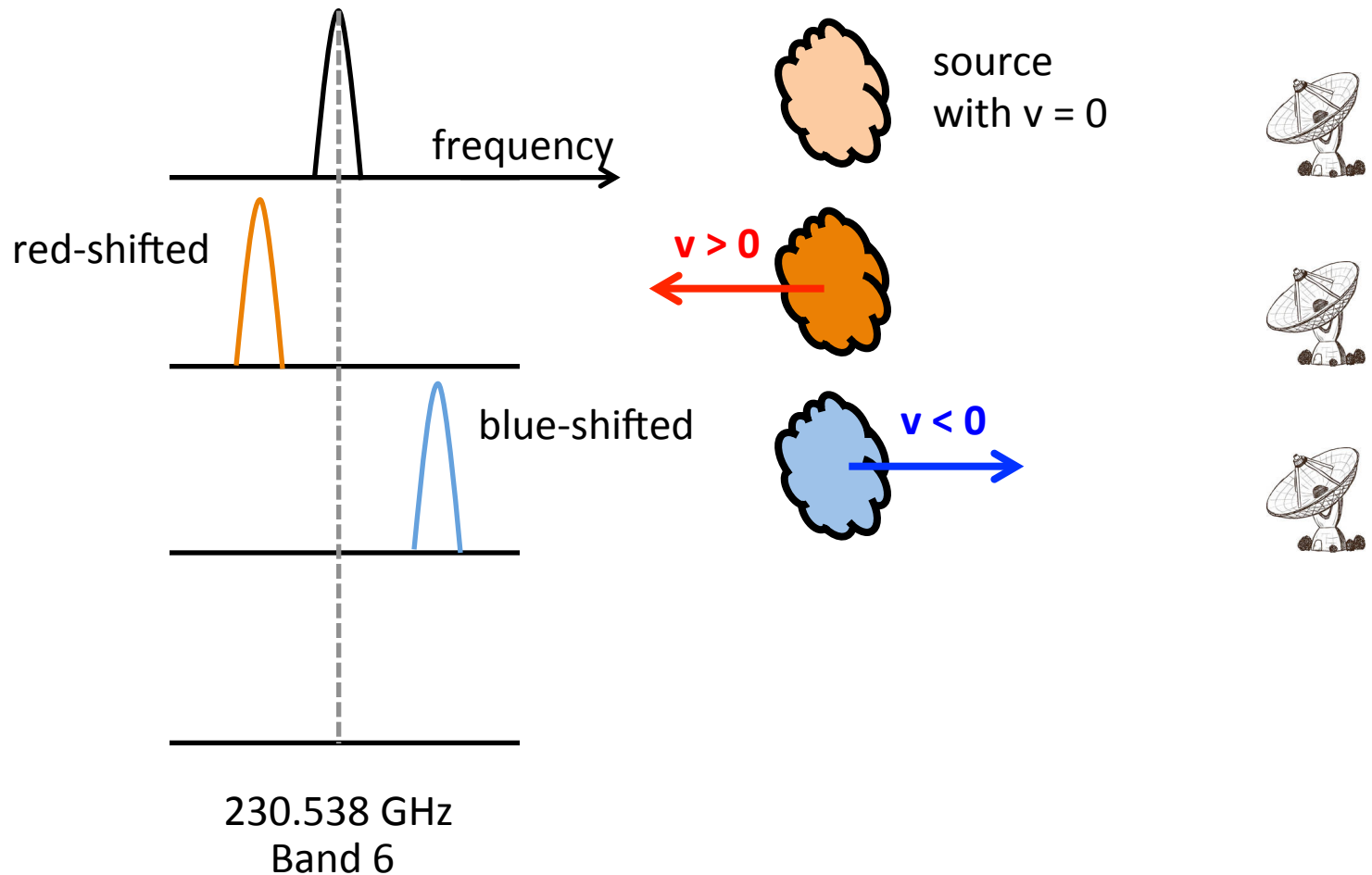
... from rest to sky frequencies (“**doppler effect**”)



# Basic concepts of spectral line observations

Velocity ( $V_{lsr}$ ) / redshift ( $z$ )

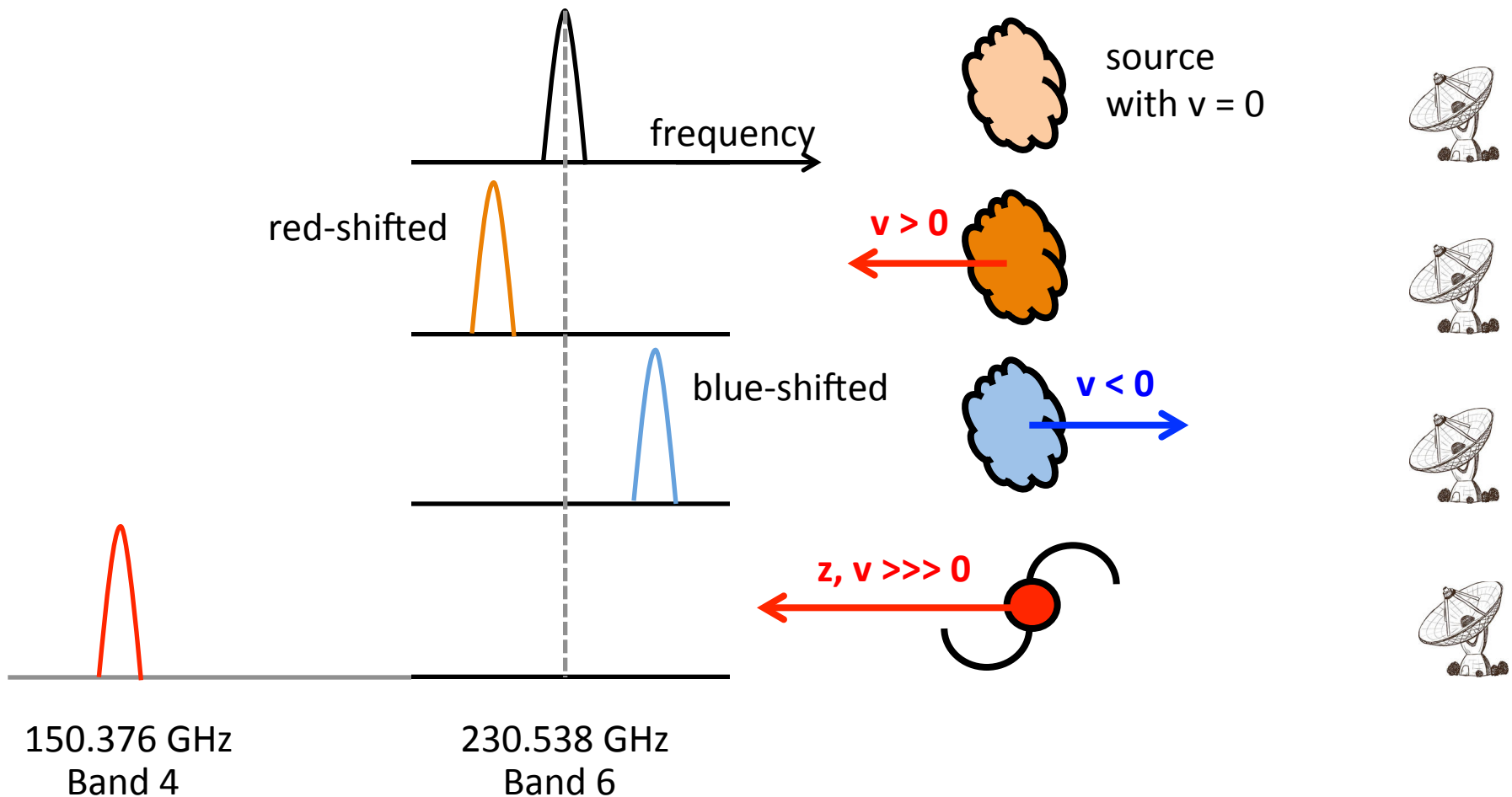
... from rest to sky frequencies (“**doppler effect**”)



# Basic concepts of spectral line observations

Velocity ( $V_{lsr}$ ) / redshift ( $z$ )

... from rest to sky frequencies (“**doppler effect**”)



# What do we need to know?

- continuum or line (both?)
- frequency of the lines to observe
- velocity /redshift of the source
- **bandwidth / velocity coverage**
- spectral resolution
- polarization products
- ...



# Basic concepts of spectral line observations

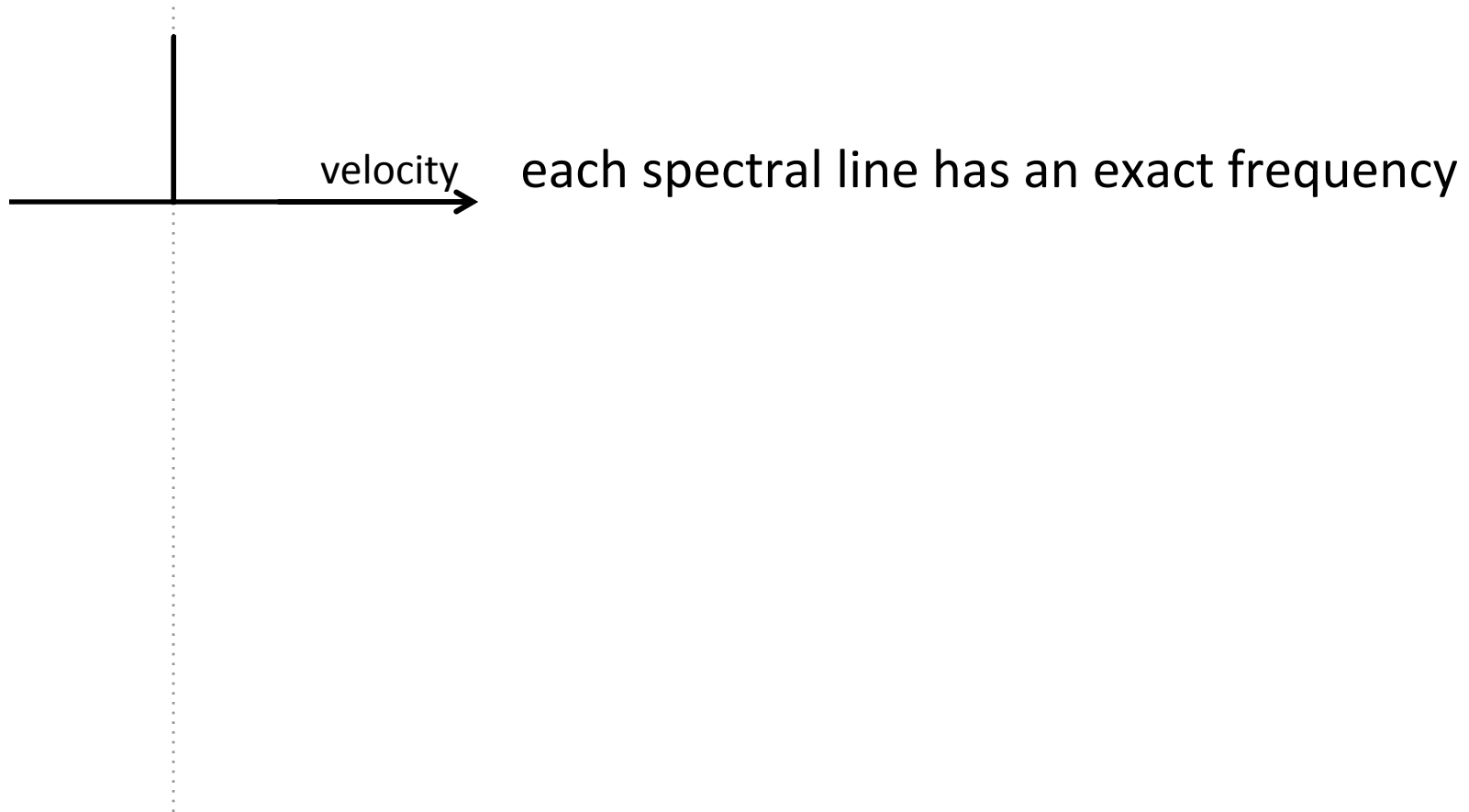
## Linewidth ( $\Delta\nu$ )

the spectral line will have a width that depends on the properties of the object you are studying

# Basic concepts of spectral line observations

## Linewidth ( $\Delta v$ )

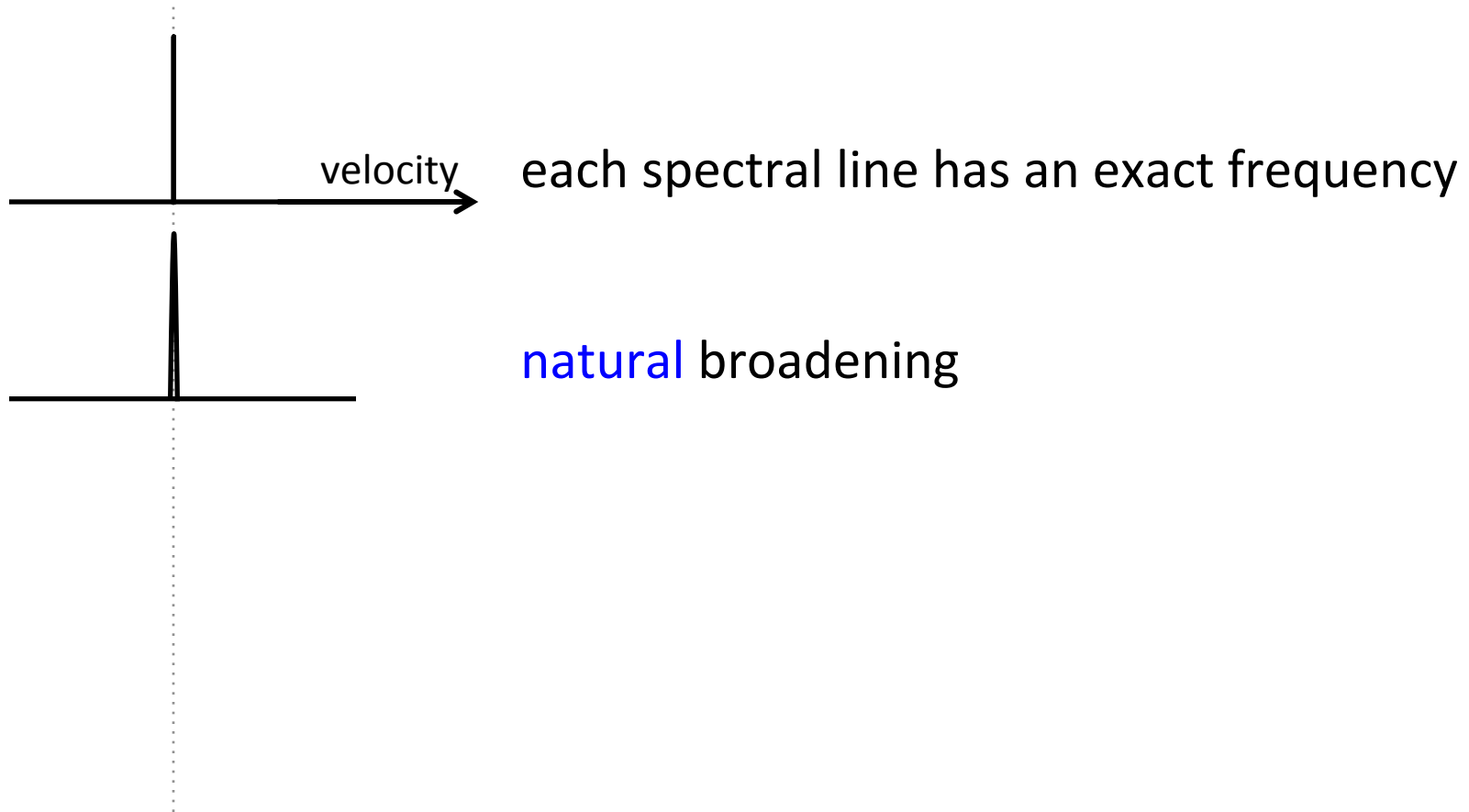
the spectral line will have a width that depends on the properties of the object you are studying



# Basic concepts of spectral line observations

## Linewidth ( $\Delta v$ )

the spectral line will have a width that depends on the properties of the object you are studying

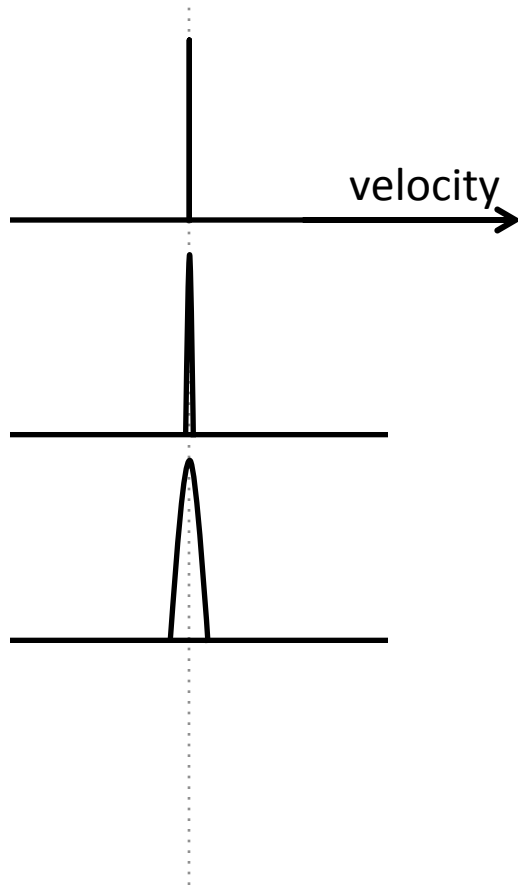




# Basic concepts of spectral line observations

## Linewidth ( $\Delta v$ )

the spectral line will have a width that depends on the properties of the object you are studying



each spectral line has an exact frequency

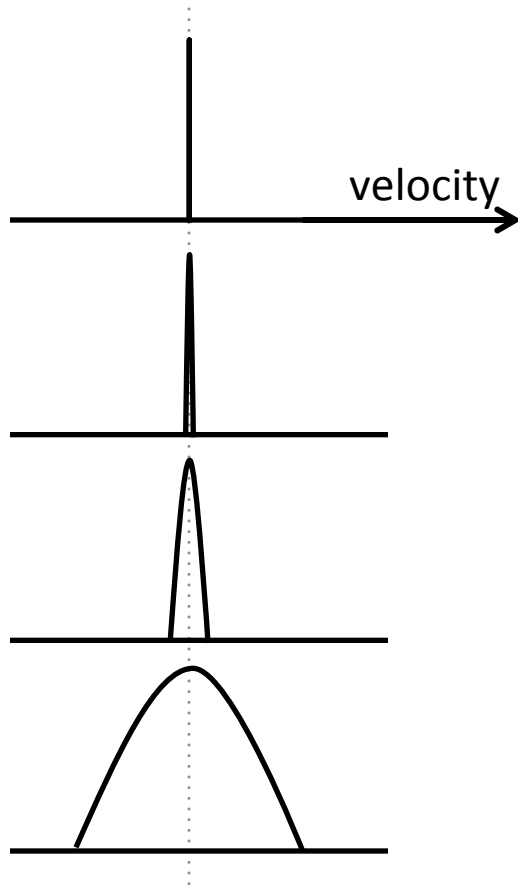
natural broadening

thermal, microturbulent, pressure broadening

# Basic concepts of spectral line observations

## Linewidth ( $\Delta v$ )

the spectral line will have a width that depends on the properties of the object you are studying



each spectral line has an exact frequency

natural broadening

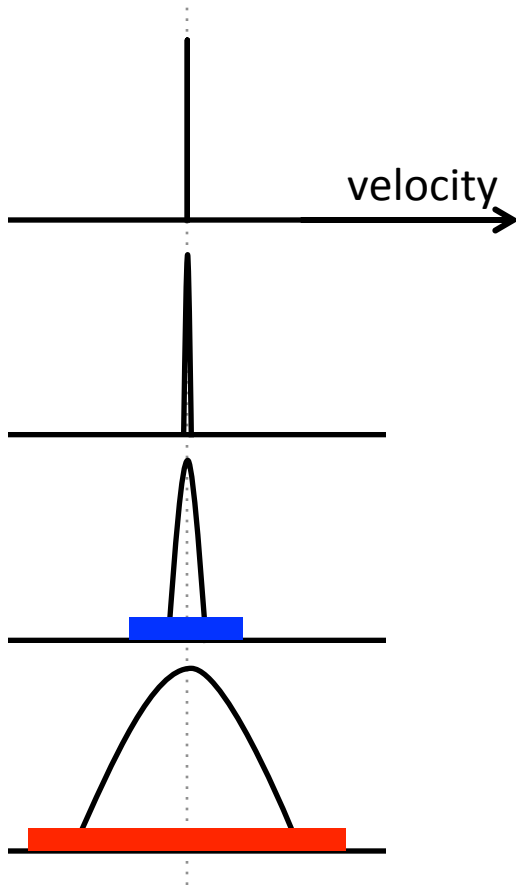
thermal, microturbulent, pressure broadening

large-scale motions broadening

# Basic concepts of spectral line observations

## Linewidth ( $\Delta v$ )

the spectral line will have a width that depends on the properties of the object you are studying

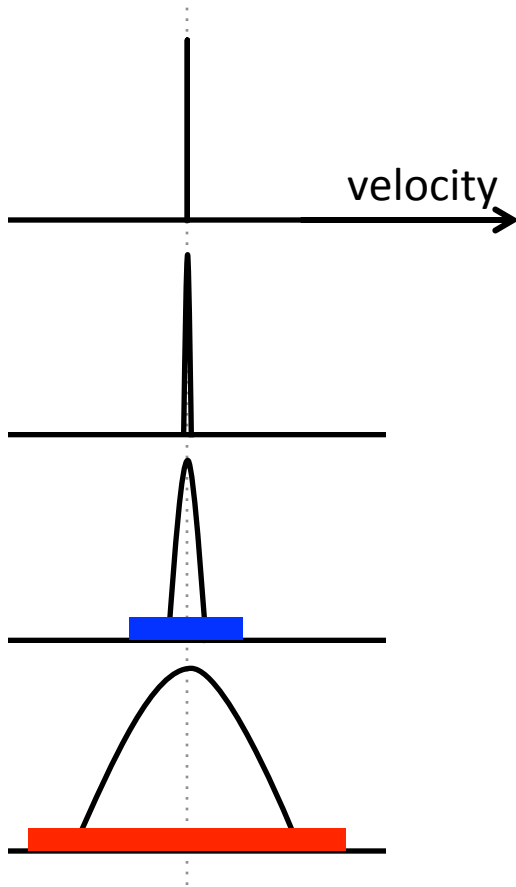


Depending on the linewidth of the line,  
you will cover a **narrower/broader**  
frequency (velocity) range

# Basic concepts of spectral line observations

## Linewidth ( $\Delta v$ )

the spectral line will have a width that depends on the properties of the object you are studying



velocity  
linewidth  
(km/s)

frequency  
linewidth  
(Hz)

$$\Delta V = -\Delta \nu \frac{c}{\nu_0}$$

Depending on the linewidth of the line,  
you will cover a **narrower/broader**  
**frequency (velocity) range**

# Spectral setup in the almaOT

ALMA Observing Tool (Cycle5)

ALMA Observing Tool (Cycle5) - Project

File Edit View Tool Search Help

Project Structure

Proposal Program

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observing
      - ScienceGoal (Science Goal)
        - General
        - Field Setup
        - Spectral Setup
        - Calibration Setup
        - Control and Performance
        - Technical Justification

Editors

Spectral Spatial Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

**Continuum or line ?**

Spectral Line  
 Single Continuum  
 Spectral Scan

Spectral Type

**Polarization products ?**

Produce image sidebands (Bands 9 and 10 only)

Polarization products desired  
 XX  DUAL  FULL

Spectral Setup Errors

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

Spectral Line

Baseband	Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Repre Wi
Baseband-1							
Baseband-2							

Add spectral window centred on a spectral line Add spectral window manually Delete  Show image spectral window

**Rest frequency ?**

**Bandwidth, spectral resolution ?**

# What do we need to know?

- continuum or line (both?)
- frequency of the lines to observe
- velocity / redshift of the source
- bandwidth / velocity coverage
- spectral resolution
- polarization products
- ...

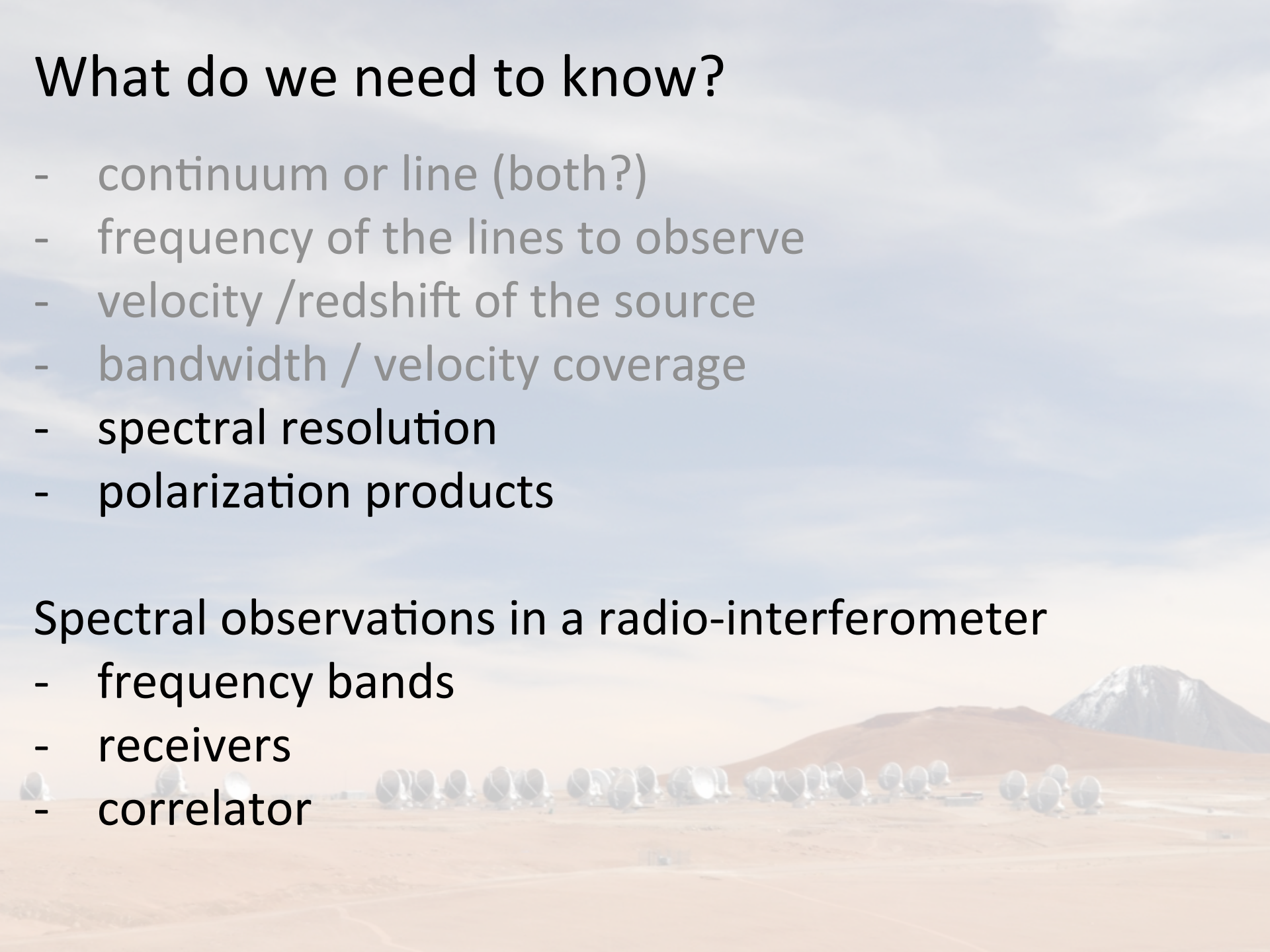


# What do we need to know?

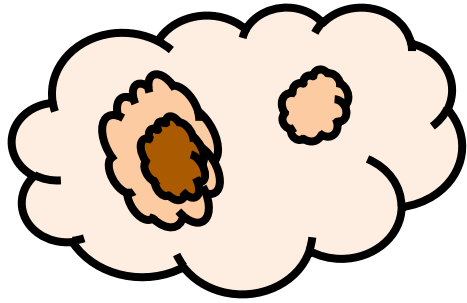
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- spectral resolution
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## Spectral observations in a radio-interferometer

- frequency bands
- receivers
- correlator



Scientific target

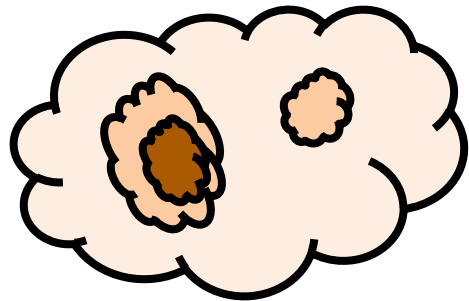


Telescopes

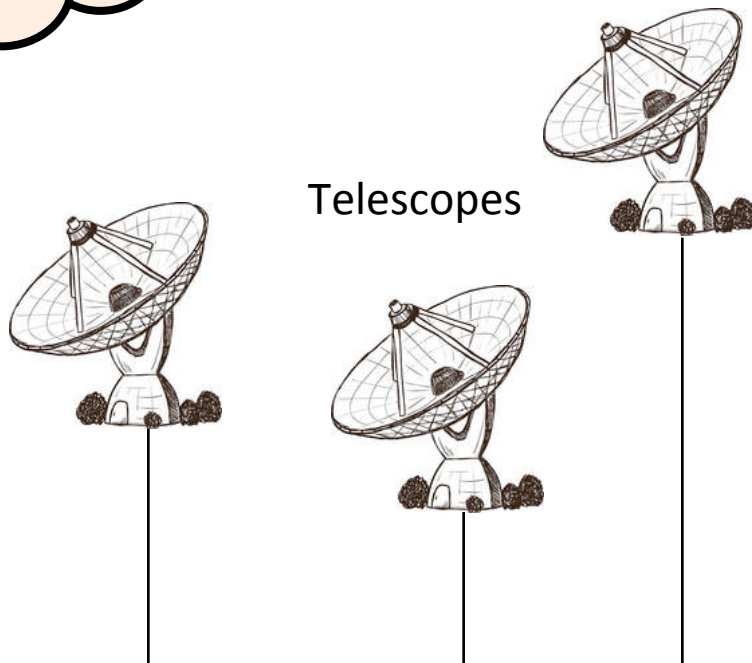




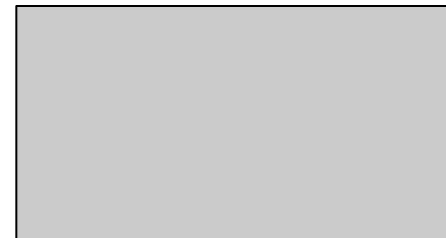
Scientific target



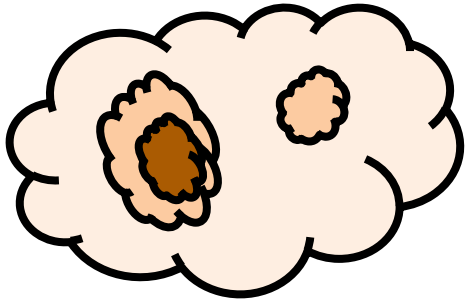
Telescopes



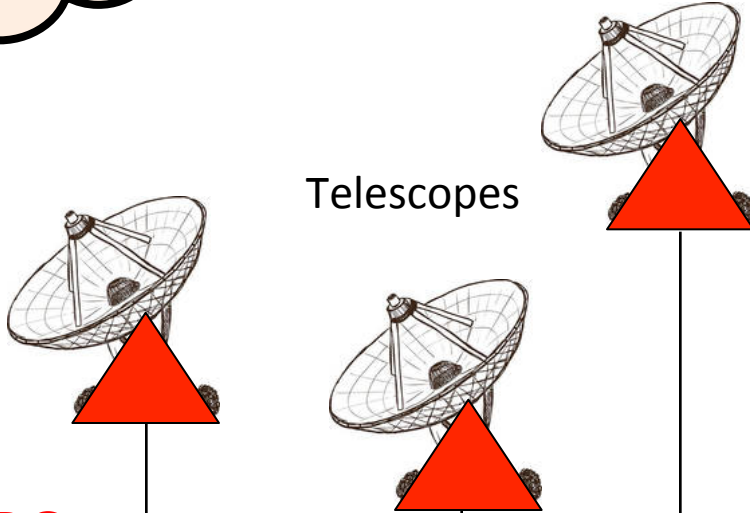
Control room



Scientific target



Telescopes



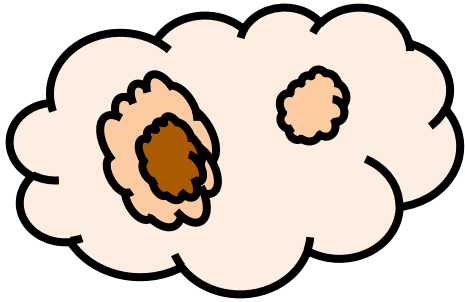
Control room



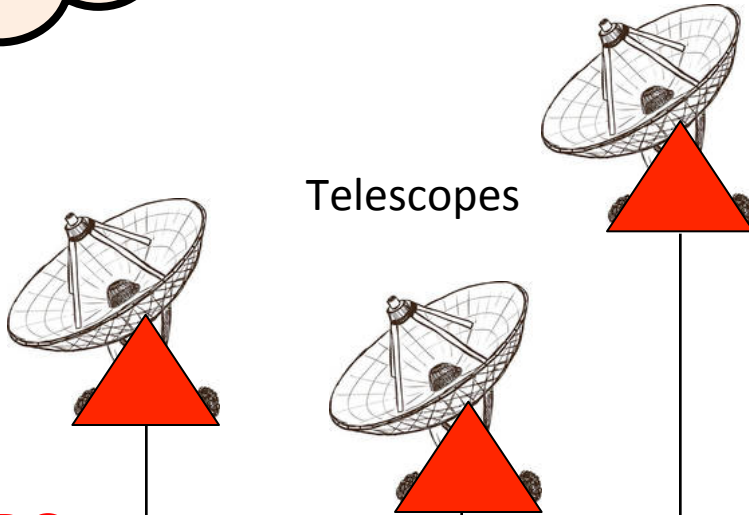
**RECEIVERS**

front-ends, bands

Scientific target

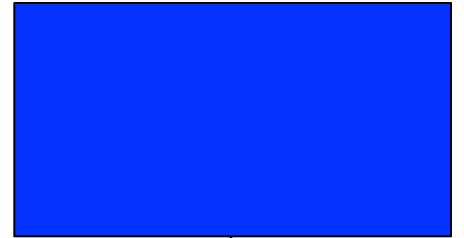


Telescopes



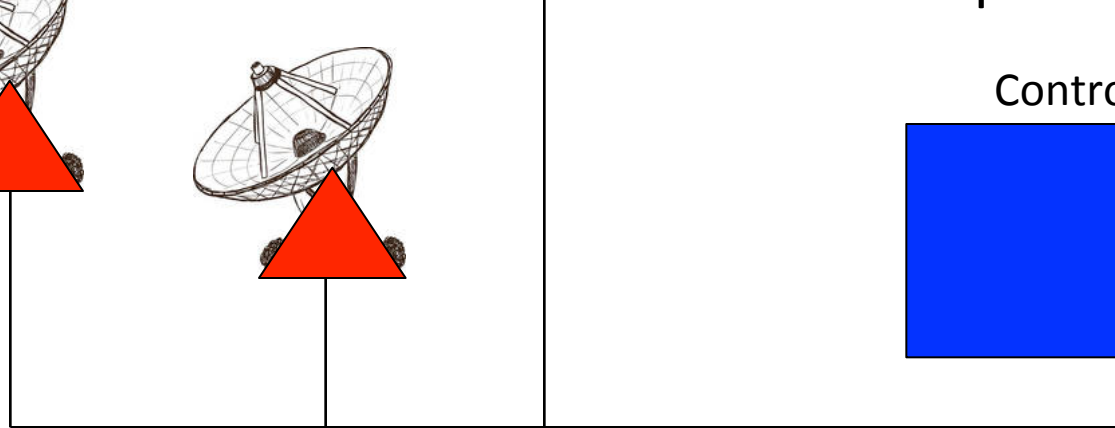
**CORRELATOR**  
super-computer

Control room

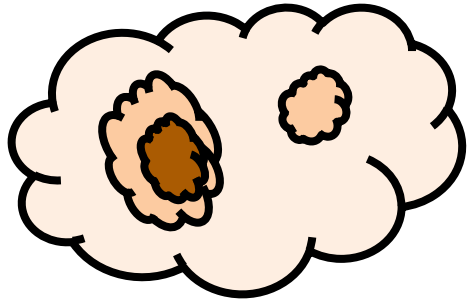


**RECEIVERS**

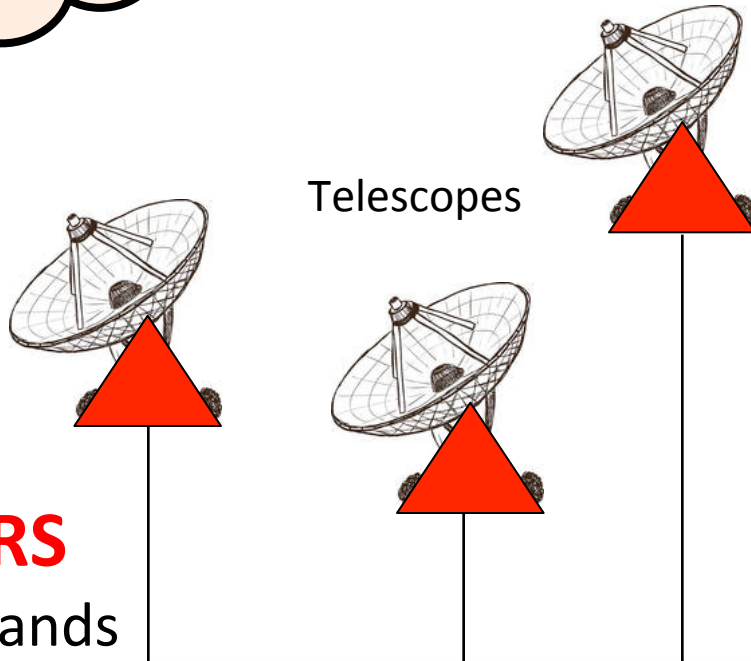
front-ends, bands



Scientific target

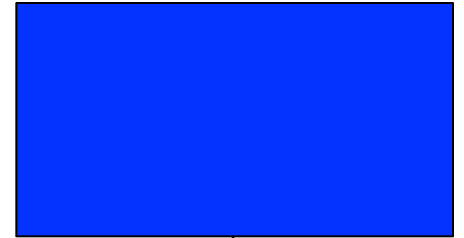


Telescopes



**CORRELATOR**  
super-computer

Control room



**RECEIVERS**

front-ends, bands

**WHAT** frequencies do/can we observe?

**HOW** do/can we observe those frequencies?

# What do we need to know?

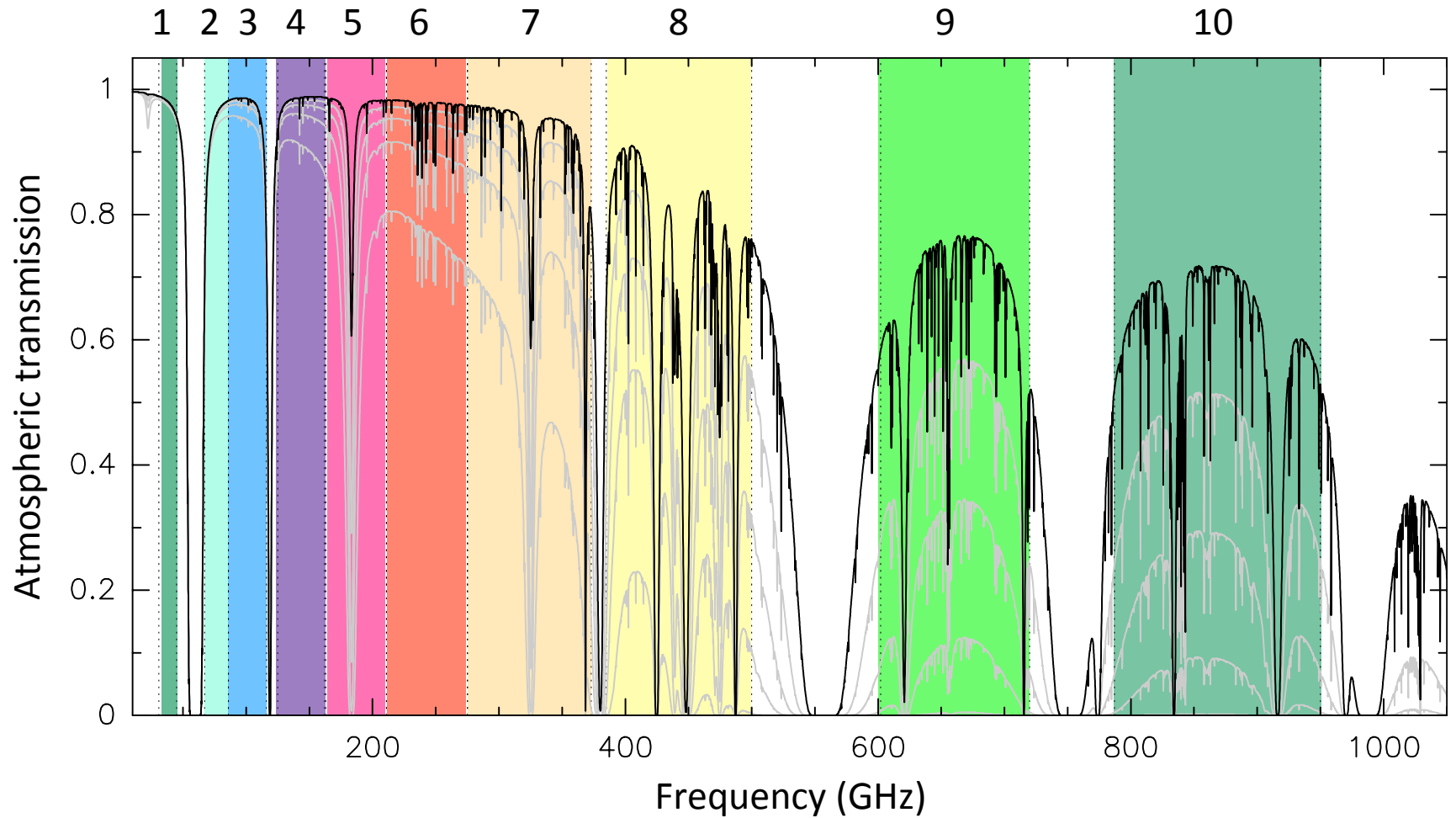
- continuum or line (both?)
- frequency of the lines to observe
- velocity / redshift of the source
- bandwidth / velocity coverage
- spectral resolution
- polarization products

## Spectral observations in a radio-interferometer

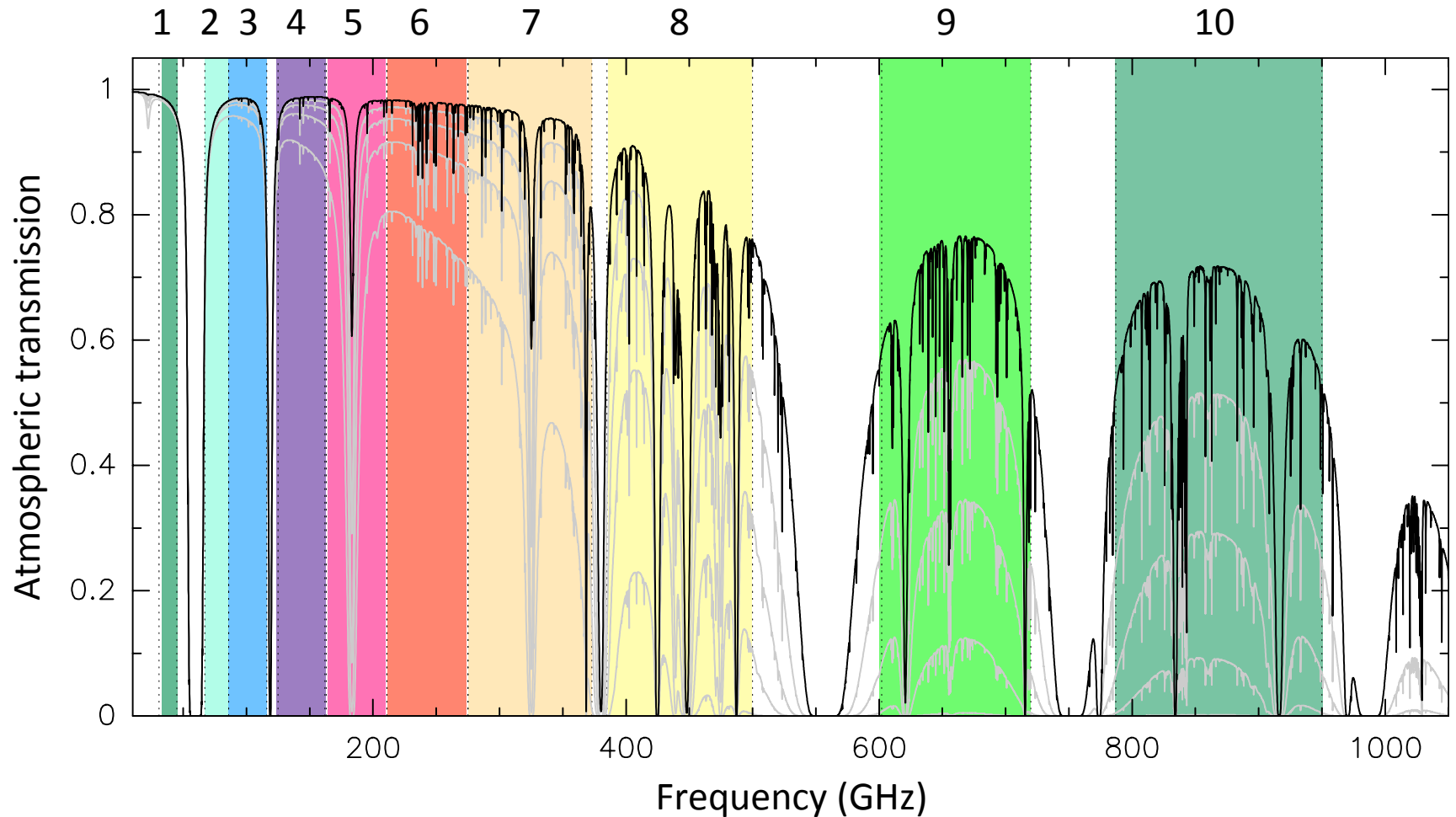
- **frequency bands**
- receivers
- correlator



# ALMA frequency bands



# ALMA frequency bands



**Band 3:** 84 – 116 GHz

**Band 4:** 125 – 163 GHz

**Band 5:** 159 – 211 GHz

**Band 6:** 211 – 275 GHz

**Band 7/8:** 275 – 373 GHz / 385 – 500 GHz

**Band 9/10:** 602 – 720 GHz / 787 – 950 GHz

# What do we need to know?

- continuum or line (both?)
- frequency of the lines to observe
- velocity / redshift of the source
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- spectral resolution
- polarization products

## Spectral observations in a radio-interferometer

- frequency bands
- **receivers**
- correlator

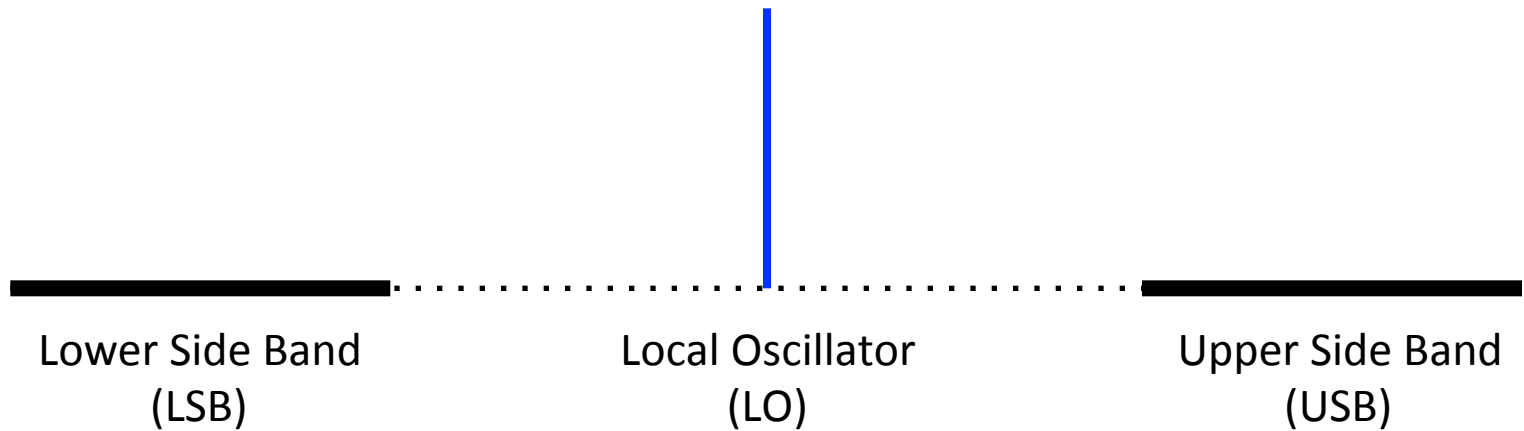




# ALMA receivers

**Heterodyne** receivers

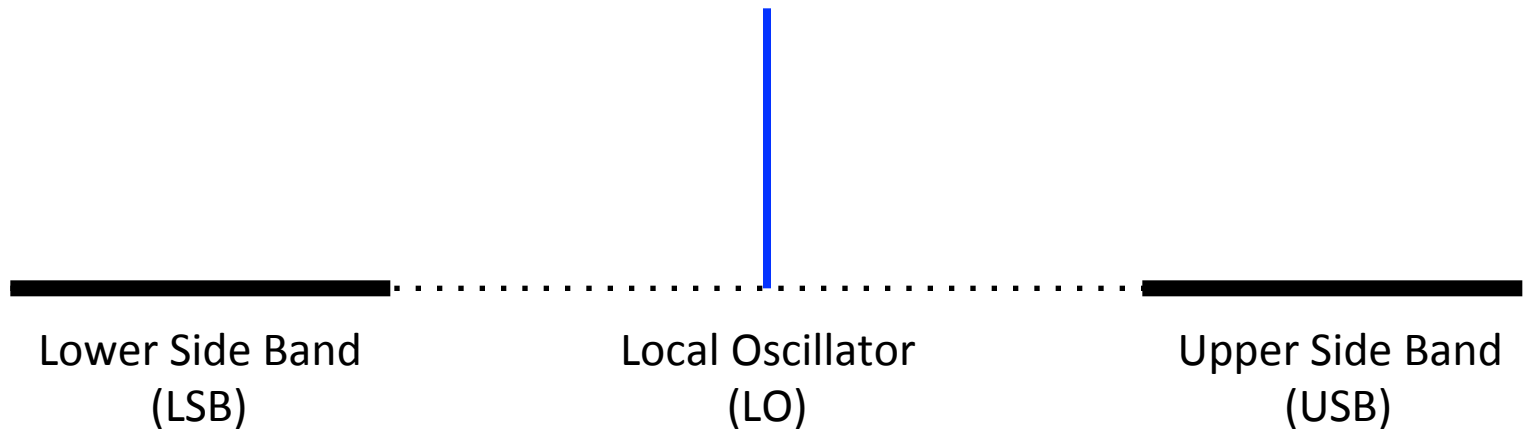
are sensitive to Lower Side Band (LSB) and Upper Side Band (USB)



# ALMA receivers

## Heterodyne receivers

are sensitive to Lower Side Band (LSB) and Upper Side Band (USB)



Heterodyne receivers can be:

**SSB** (single) outputs **LSB or USB**

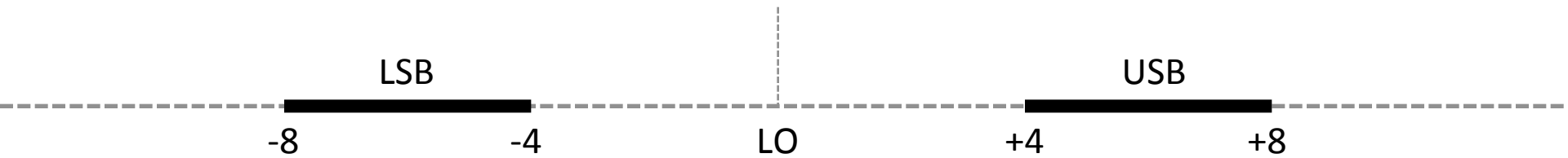
**DSB** (double) outputs the sum **LSB+USB** (separated in correlator)

**2SB** (two) outputs **LSB and USB** (separately)

# ALMA receivers

ALMA B3 / B4 / B5 / B7 / B8

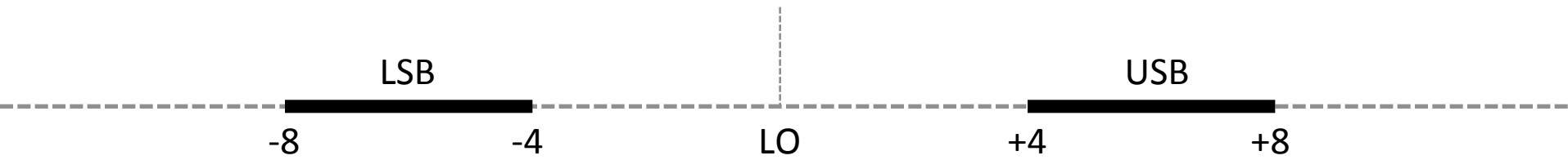
2SB receivers 4-8 GHz



# ALMA receivers

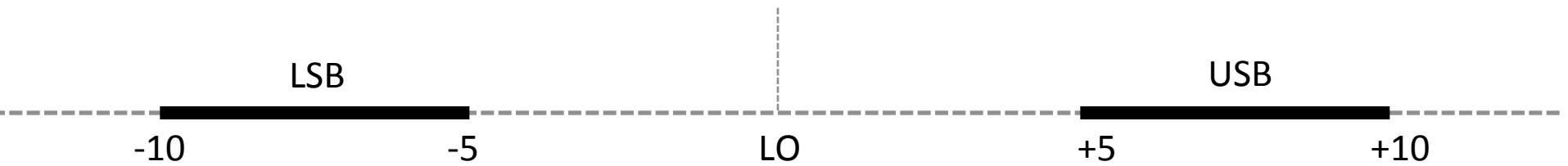
ALMA B3 / B4 / B5 / B7 / B8

2SB receivers 4-8 GHz



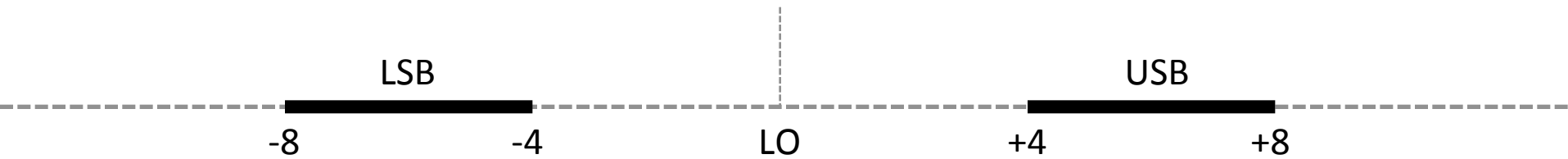
ALMA B6

2SB receivers 5-10 GHz

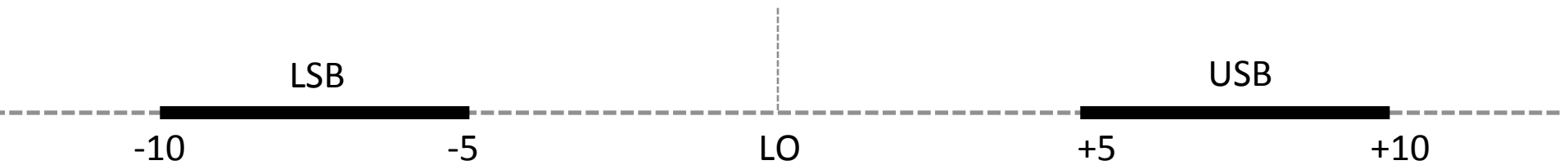


# ALMA receivers

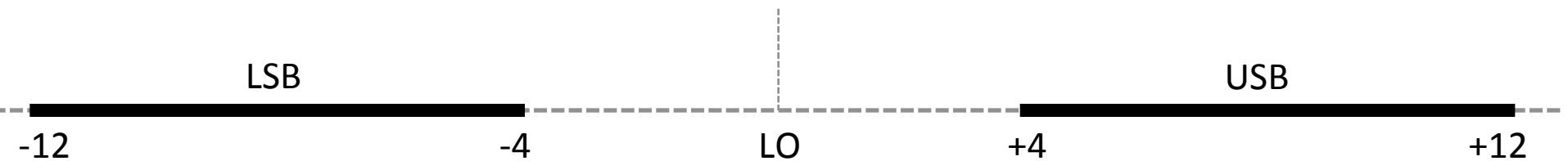
ALMA B3 / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



ALMA B6 2SB receivers 5-10 GHz



ALMA B9 / B10 DSB receivers 4-12 GHz



# ALMA frequency bands & receivers

Band 3: 84 – 116 GHz

Band 4: 125 – 163 GHz

Band 6: 211 – 275 GHz

Band 7: 275 – 373 GHz

Band 8: 385 – 500 GHz

Band 9/10: 602 – 720 GHz / 787 – 950 GHz

# ALMA frequency bands & receivers

**Band 3:** 84 – 116 GHz

Band 4: 125 – 163 GHz

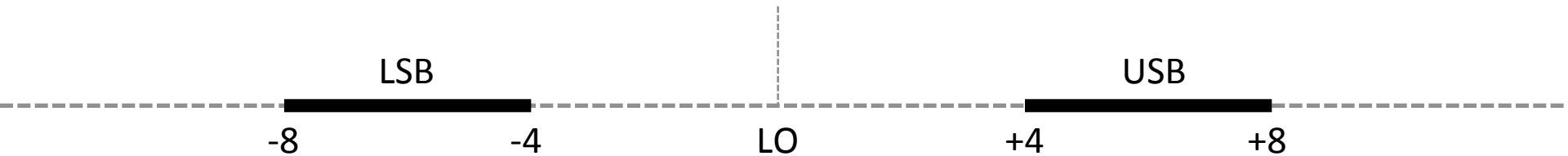
Band 6: 211 – 275 GHz

Band 7: 275 – 373 GHz

Band 8: 385 – 500 GHz

Band 9/10: 602 – 720 GHz / 787 – 950 GHz

**ALMA B3** / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



# ALMA frequency bands & receivers

**Band 3:** 84 – 116 GHz

Band 4: 125 – 163 GHz

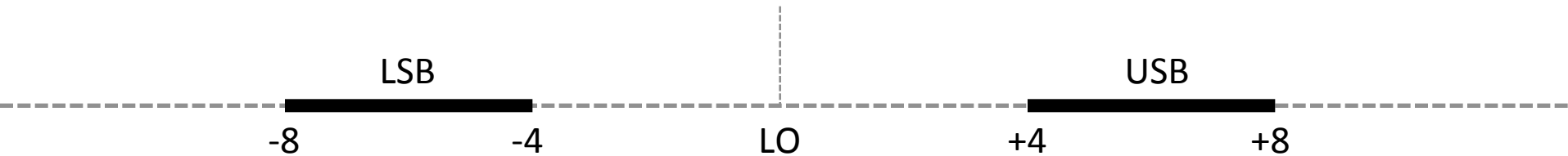
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**ALMA B3** / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



Band 3





# ALMA frequency bands & receivers

**Band 3:** 84 – 116 GHz

Band 4: 125 – 163 GHz

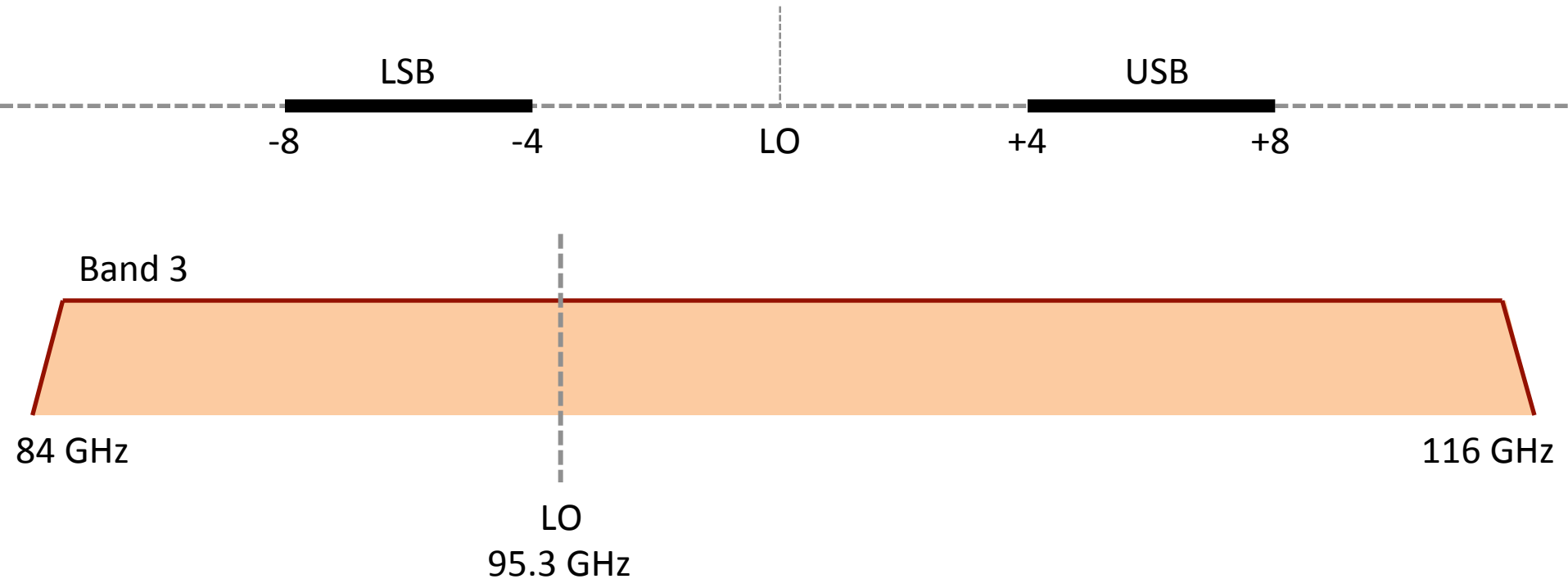
Band 6: 211 – 275 GHz

Band 7: 275 – 373 GHz

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**ALMA B3** / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



# ALMA frequency bands & receivers

**Band 3:** 84 – 116 GHz

Band 4: 125 – 163 GHz

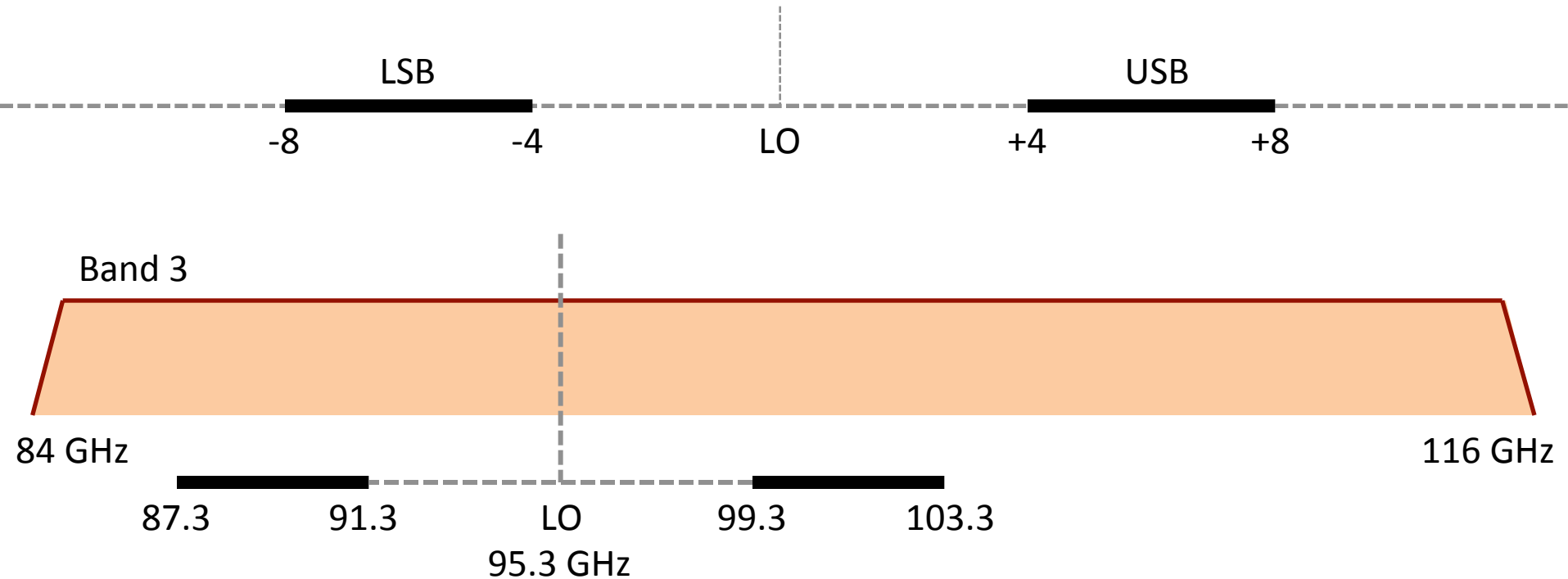
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**ALMA B3** / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



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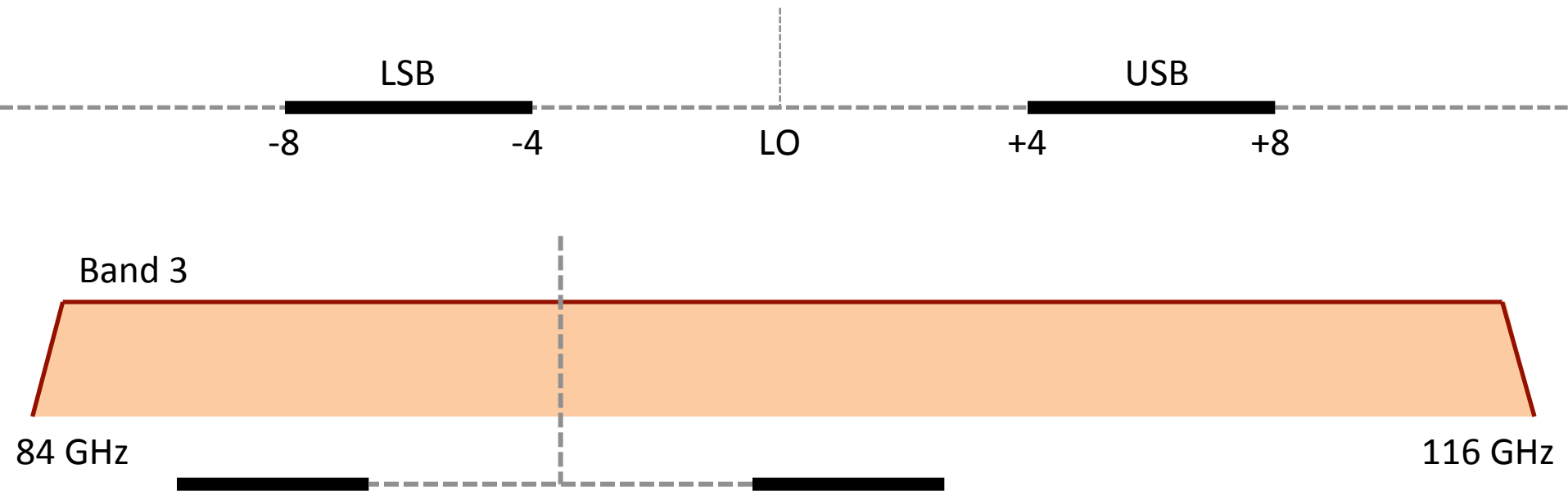
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**ALMA B3** / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



# ALMA frequency bands & receivers

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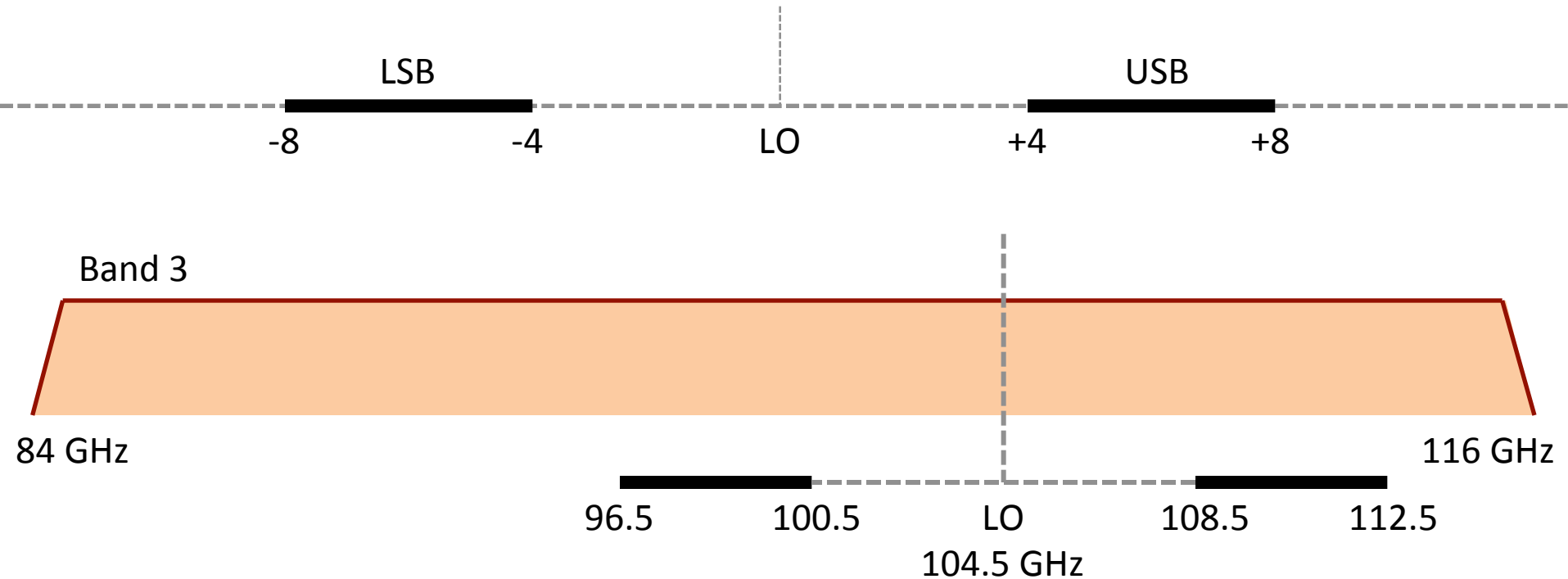
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**ALMA B3** / B4 / B5 / B7 / B8 2SB receivers 4-8 GHz



# What do we need to know?

- continuum or line (both?)
- frequency of the lines to observe
- velocity / redshift of the source
- bandwidth / velocity coverage
- spectral resolution
- polarization products

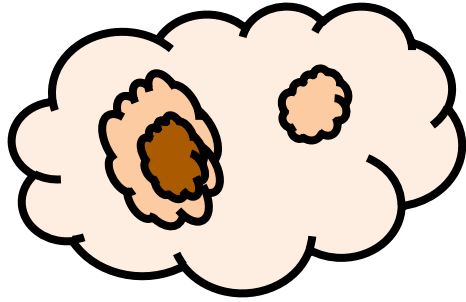
## Spectral observations in a radio-interferometer

- frequency bands
- receivers
- **correlator**

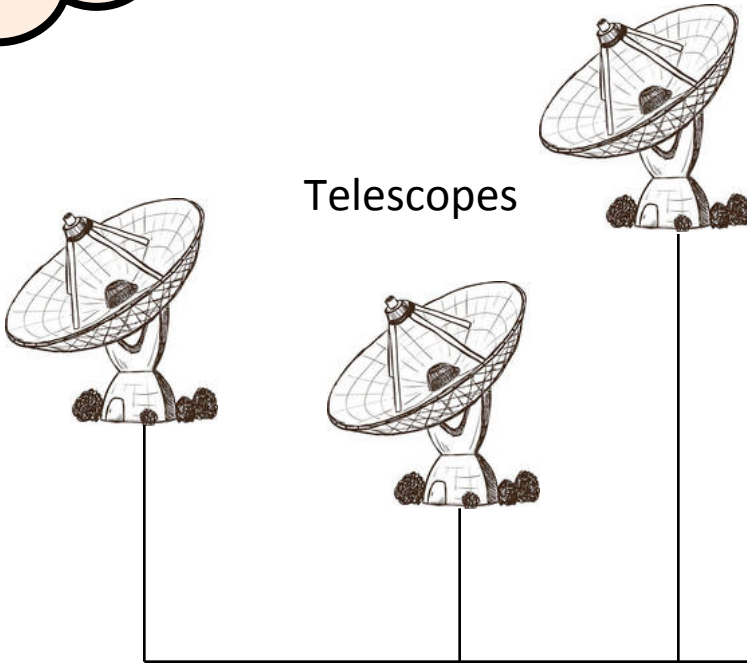


# ALMA correlator

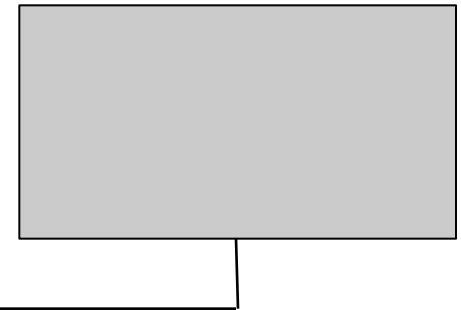
Scientific target



Telescopes

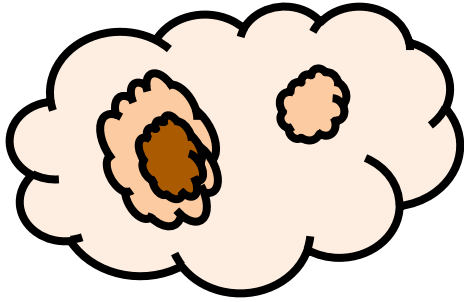


Control room

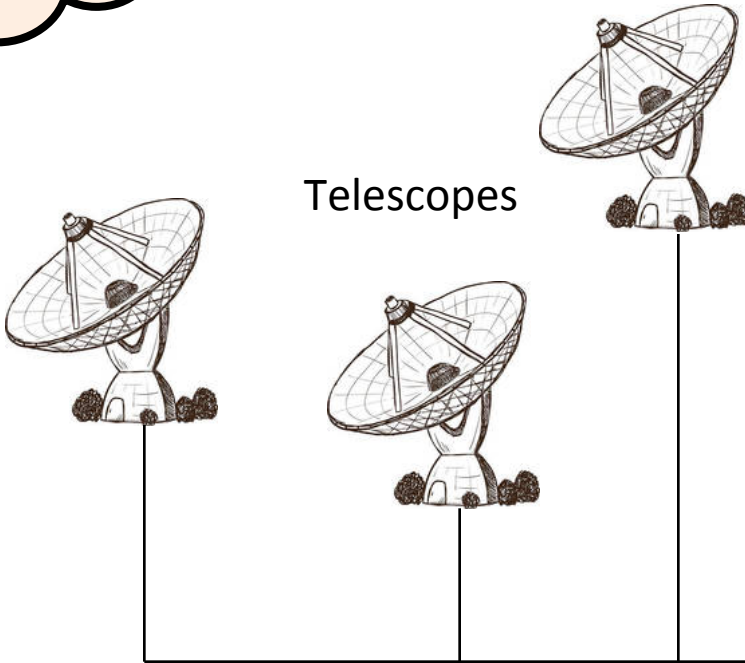


# ALMA correlator

Scientific target



Telescopes



CORRELATOR:

**Super-computer** that accepts signals from element antennas, calculates **cross-correlation** of them, and produces **complex visibilities** that are used to synthesize images.

**Keeps coherence** in the complex visibilities, by providing delay and phase tracking to adjust wavefronts of received signals before correlation.

CORRELATOR



# ALMA correlator



ALMA CORRELATOR:  
one of the four 'quadrants' of the ALMA correlator

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CORRELATOR





# ALMA correlator



ALMA CORRELATOR:  
one of the four 'quadrants' of the ALMA correlator

Physically:

- 1 correlator = 4 quadrants
- 1 quadrant = 1 baseband
- **ALMA correlator = 4 basebands**
- **Each baseband** processes
  - 64 antennas (2016 baselines)
  - 2 polarizations
  - **2 GHz** input
- Each baseband can be centered anywhere in the incoming 8 GHz

# ALMA correlator / 4 basebands

## basebands

information from 64 antennas

2 GHz input

up to 8192 channels

2 polarizations Horizontal / Vertical

up to 4 polarization products (HH, VV, HV, VH)

# ALMA correlator / 4 basebands

## basebands

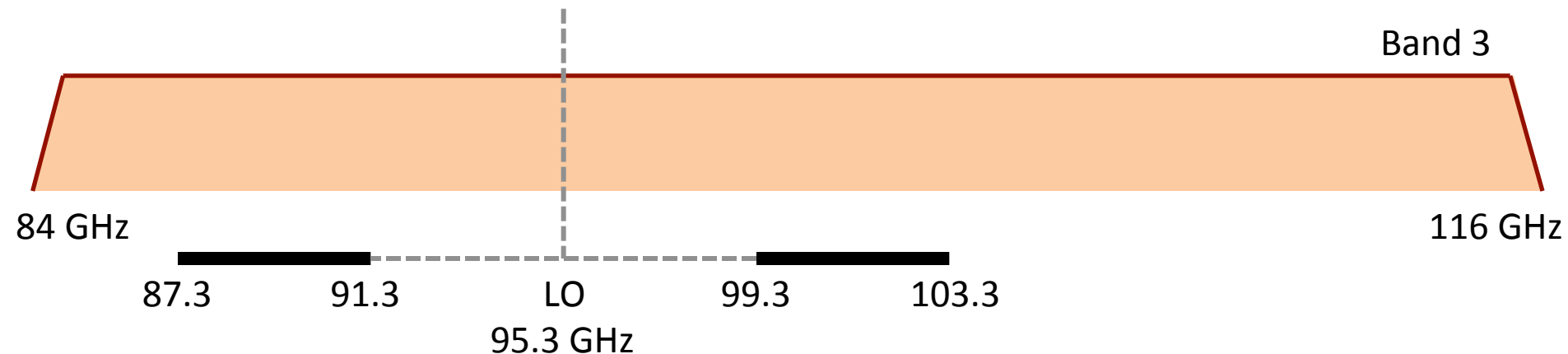
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## basebands

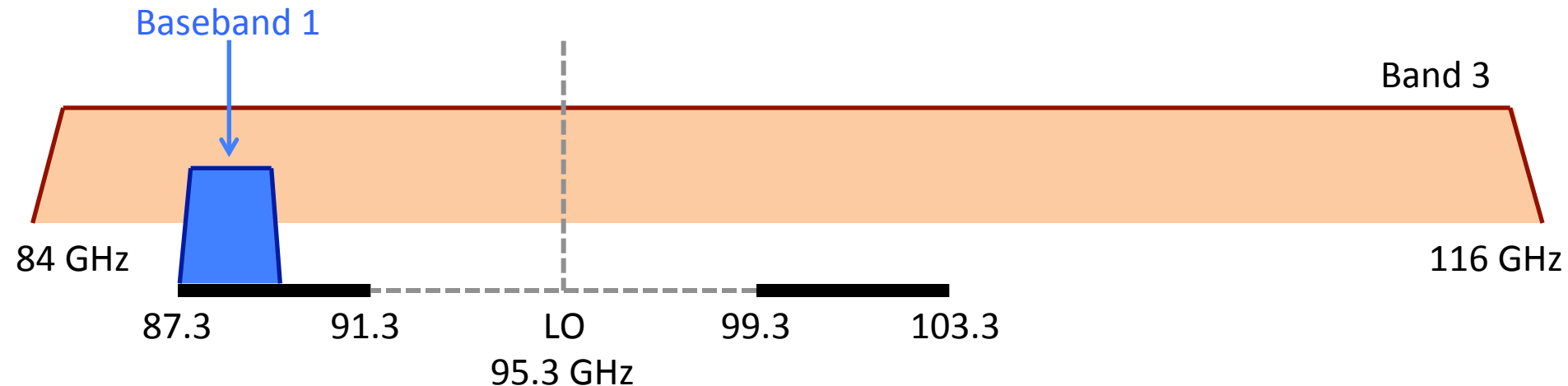
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# ALMA correlator / **4 basebands**

## basebands

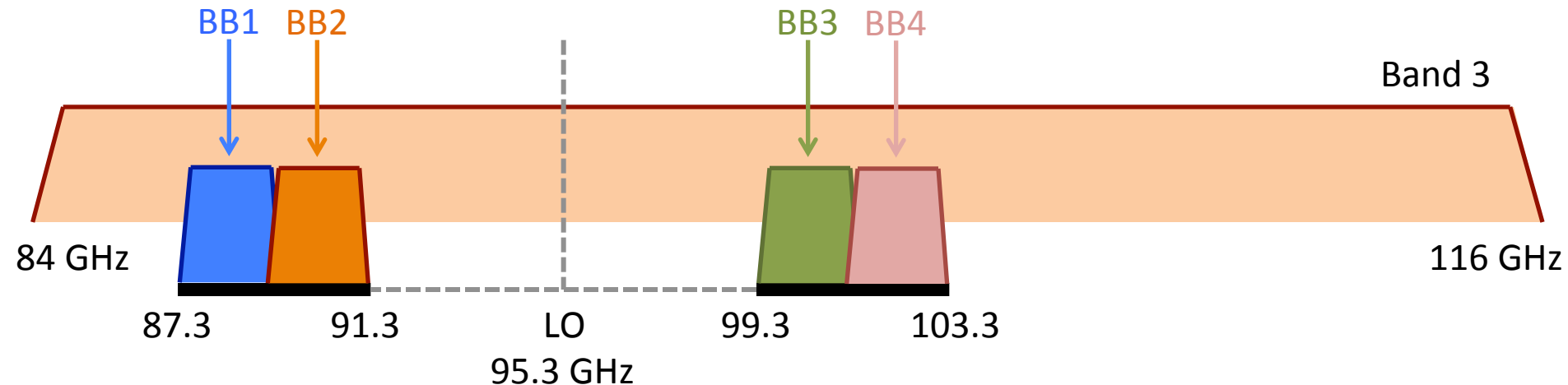
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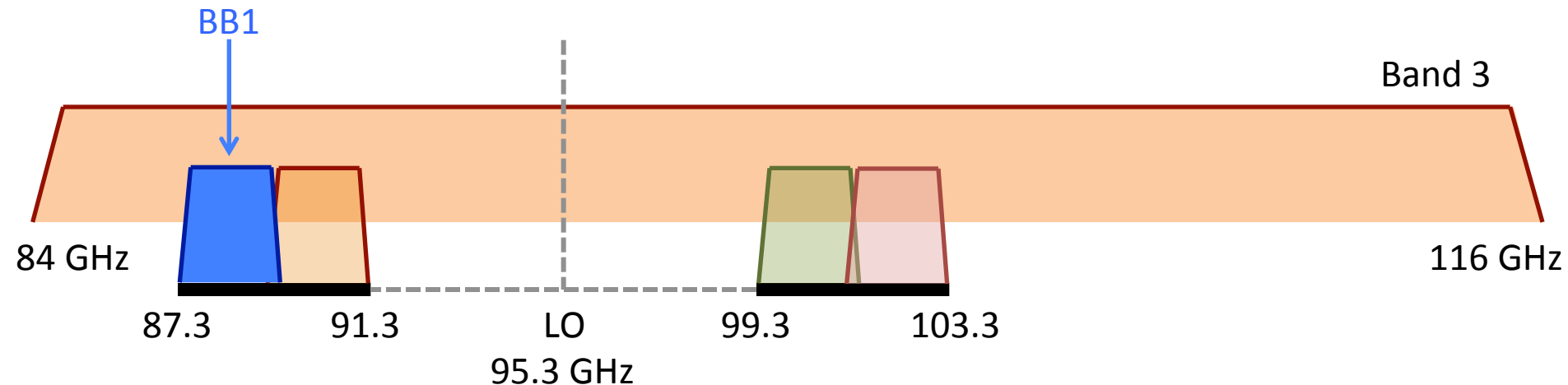
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# ALMA correlator / **4 basebands**

## basebands

information from 64 antennas

**2 GHz** input

up to 8192 channels

2 polarizations Horizontal / Vertical

up to 4 polarization products (HH, VV, HV, VH)

Baseband 1



87.3 GHz

89.3 GHz

# ALMA correlator / **4 basebands**

## basebands

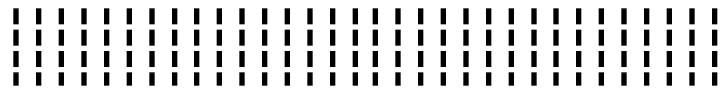
information from 64 antennas

**2 GHz** input

up to **8192 channels**

2 polarizations Horizontal / Vertical

up to 4 polarization products (HH, VV, HV, VH)



Baseband 1

87.3 GHz

89.3 GHz



# ALMA correlator / **4 basebands**

## basebands

information from 64 antennas

**2 GHz** input

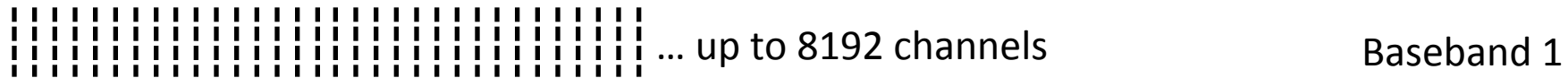
up to **8192 channels**

2 polarizations Horizontal / Vertical

up to 4 polarization products (HH, VV, HV, VH)

channel width (**spectral resolution**):

$$2 \text{ GHz} / 8192 = 244 \text{ kHz}$$



87.3 GHz

89.3 GHz

# ALMA correlator / **4 basebands**

## basebands

information from 64 antennas

**2 GHz** input

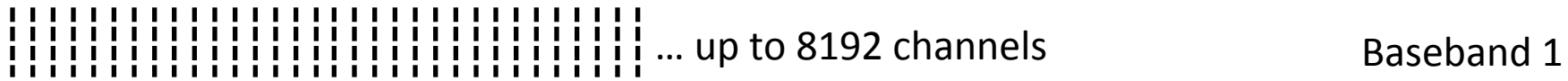
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up to 4 polarization products (HH, VV, HV, VH)

channel width (**spectral resolution**):

$$2 \text{ GHz} / 8192 = 244 \text{ kHz}$$



87.3 GHz

89.3 GHz

bandwidth = 2 GHz / resolution = 244 kHz ... **not fixed!**

# ALMA correlator

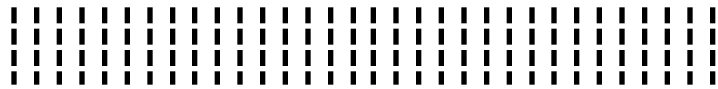
## Bandwidth – Spectral resolution

BW	2 GHz	8192 channels x 1 polz	244 kHz resol.
BW	1 GHz	8192 channels x 1 polz	122 kHz resol.
BW	500 MHz	8192 channels x 1 polz	61 kHz resol.
BW	250 MHz	8192 channels x 1 polz	30 kHz resol.
BW	125 MHz	8192 channels x 1 polz	15 kHz resol.
BW	64 MHz	8192 channels x 1 polz	7.5 kHz resol.
BW	32 MHz	8192 channels x 1 polz	3.8 kHz resol.
continuum mode		256 channels x 1 polz	7.5 MHz resol.

# ALMA correlator

## Bandwidth – Spectral resolution

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... up to 8192 channels

Baseband 1



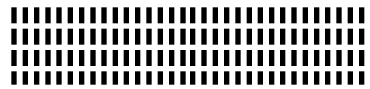
87.3 GHz

89.3 GHz

# ALMA correlator

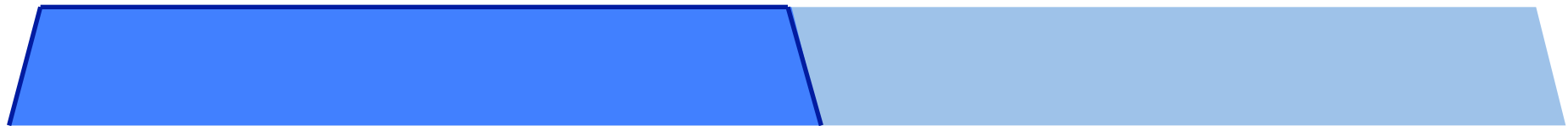
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BW	64 MHz	8192 channels x 1 polz	7.5 kHz resol.
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continuum mode		256 channels x 1 polz	7.5 MHz resol.



... up to 8192 channels

Baseband 1



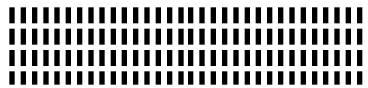
87.3 GHz

88.3 GHz

# ALMA correlator

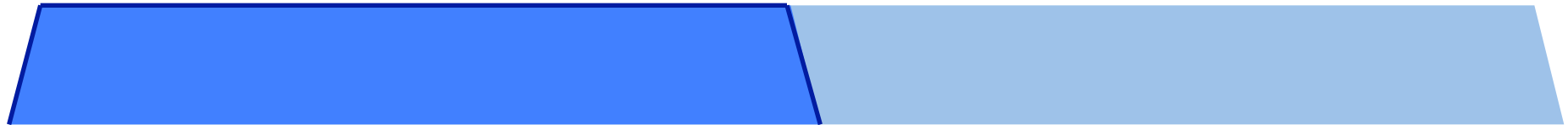
## Bandwidth – Spectral resolution **1 polz (H or V)**

BW	2 GHz	8192 channels x 1 polz	244 kHz resol.
BW	1 GHz	8192 channels x 1 polz	122 kHz resol.
BW	500 MHz	8192 channels x 1 polz	61 kHz resol.
BW	250 MHz	8192 channels x 1 polz	30 kHz resol.
BW	125 MHz	8192 channels x 1 polz	15 kHz resol.
BW	64 MHz	8192 channels x 1 polz	7.5 kHz resol.
BW	32 MHz	8192 channels x 1 polz	3.8 kHz resol.
continuum mode		256 channels x 1 polz	7.5 MHz resol.



... up to 8192 channels

Baseband 1



87.3 GHz

88.3 GHz

# ALMA correlator

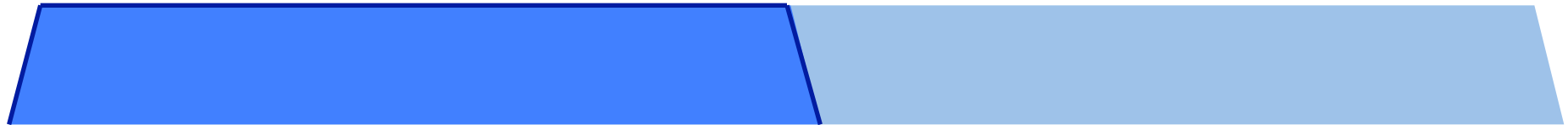
## Bandwidth – Spectral resolution **2 polz (H and V)**

BW	2 GHz	4096 channels x 2 polz	488 kHz resol.
BW	1 GHz	4096 channels x 2 polz	244 kHz resol.
BW	500 MHz	4096 channels x 2 polz	122 kHz resol.
BW	250 MHz	4096 channels x 2 polz	61 kHz resol.
BW	125 MHz	4096 channels x 2 polz	30 kHz resol.
BW	64 MHz	4096 channels x 2 polz	15 kHz resol.
BW	32 MHz	4096 channels x 2 polz	7.5 kHz resol.
continuum mode		128 channels x 2 polz	15 MHz resol.



... up to **4096 channels**

Baseband 1



87.3 GHz

88.3 GHz

# ALMA correlator

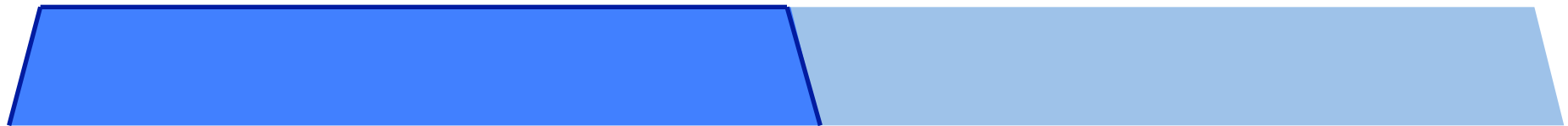
## Bandwidth – Spectral resolution **4 polz (HH, VV, HV, VH)**

BW	2 GHz	2048 channels x 4 polz	976 kHz resol.
BW	1 GHz	2048 channels x 4 polz	488 kHz resol.
BW	500 MHz	2048 channels x 4 polz	244 kHz resol.
BW	250 MHz	2048 channels x 4 polz	122 kHz resol.
BW	125 MHz	2048 channels x 4 polz	61 kHz resol.
BW	64 MHz	2048 channels x 4 polz	30 kHz resol.
BW	32 MHz	2048 channels x 4 polz	15 kHz resol.
continuum mode		64 channels x 4 polz	31 MHz resol.



... up to **2048 channels**

Baseband 1



87.3 GHz

88.3 GHz



# ALMA correlator

Polarization products (HH, VV, HV, VH)

the four are necessary for polarization studies

# ALMA correlator

## Polarization products (HH, VV, HV, VH)

the four are necessary for polarization studies

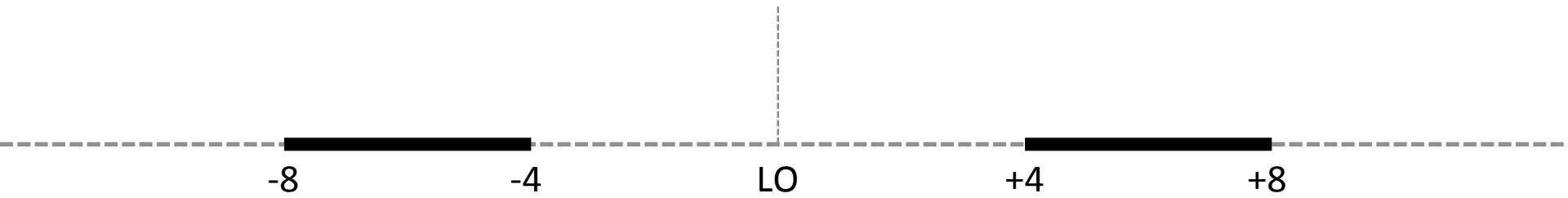
message to take home ...

	polarization	sensitivity	spectral resolution
1 polz product (HH <b>or</b> VV)	gray	red	green
2 polz products (HH <b>and</b> VV)	gray	green	orange
4 polz products (HH, VV, HV, VH)	green	green	red

# ALMA correlator (examples)

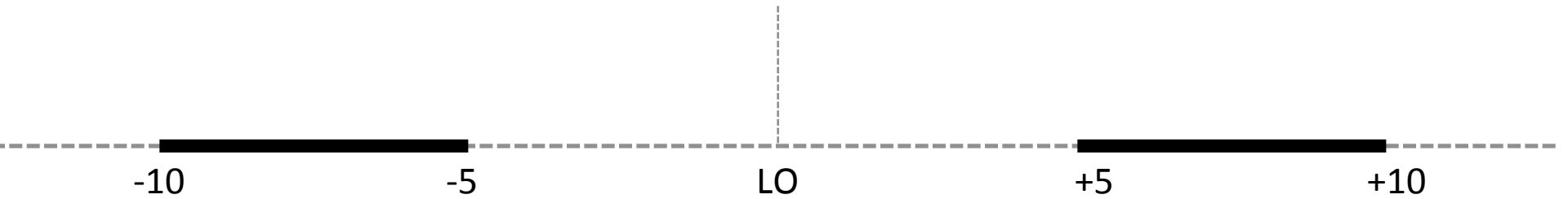
ALMA B3 / B4 / B5 / B7 / B8

2SB receivers 4-8 GHz



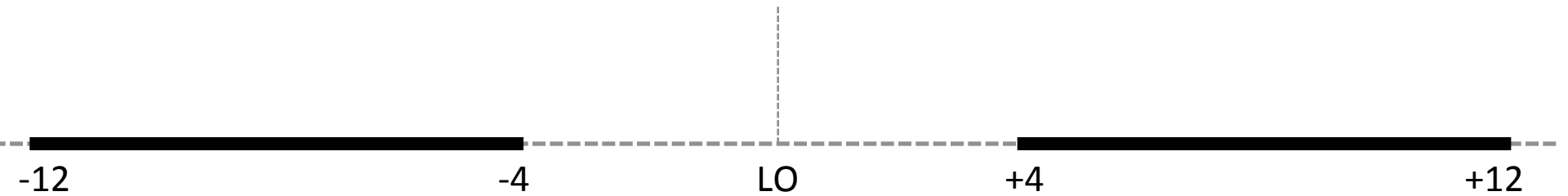
ALMA B6

2SB receivers 5-10 GHz



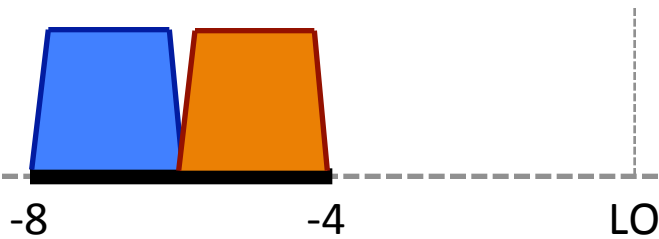
ALMA B9 / B10

DSB receivers 4-12 GHz

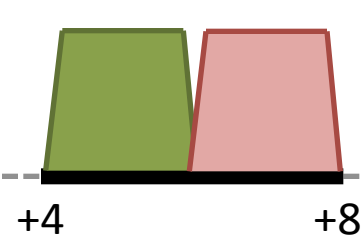


# ALMA correlator (examples)

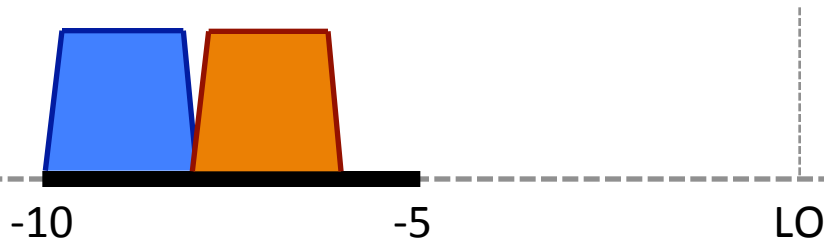
ALMA B3 / B4 / B5 / B7 / B8



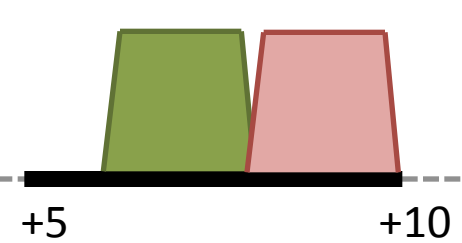
2SB receivers 4-8 GHz



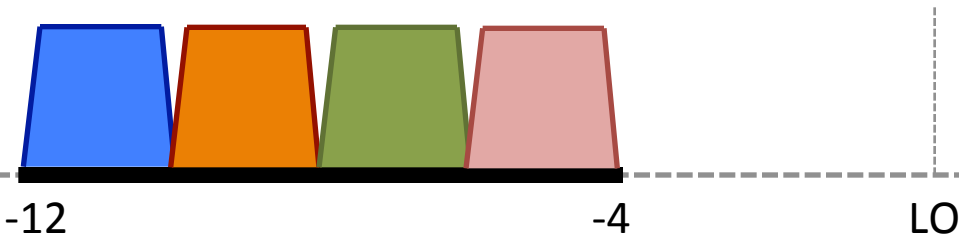
ALMA B6



2SB receivers 5-10 GHz



ALMA B9 / B10

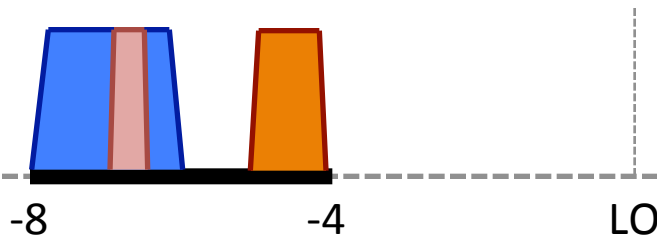


DSB receivers 4-12 GHz

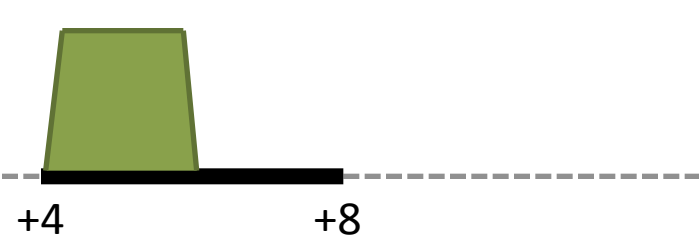


# ALMA correlator (examples)

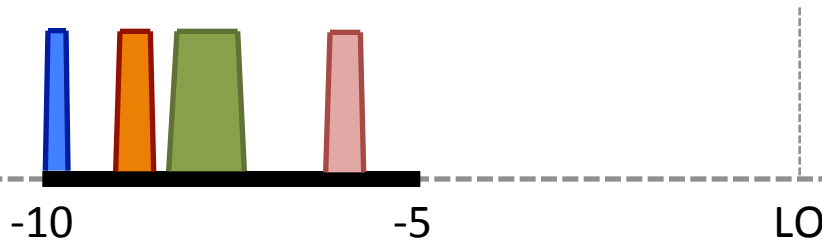
ALMA B3 / B4 / B5 / B7 / B8



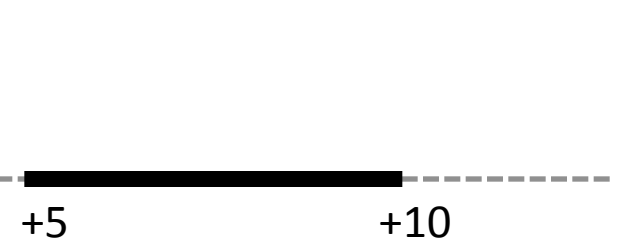
2SB receivers 4-8 GHz



ALMA B6



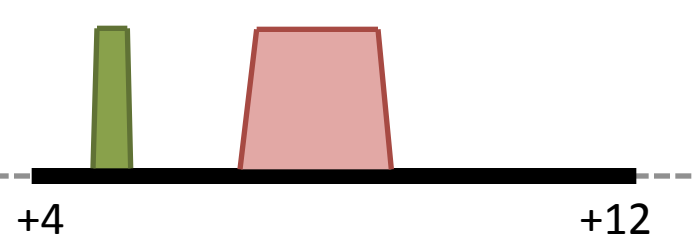
2SB receivers 5-10 GHz



ALMA B9 / B10



DSB receivers 4-12 GHz



# Spectral setup in the almaOT

ALMA Observing Tool (Cycle5)

ALMA Observing Tool (Cycle5) - Project

File Edit View Tool Search Help

Project Structure

Proposal Program

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observing
      - ScienceGoal (Science Goal)
        - General
        - Field Setup
        - Spectral Setup
        - Calibration Setup
        - Control and Performance
        - Technical Justification

Editors

Spectral Spatial Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

**Continuum or line ?**

Spectral Line  
 Single Continuum  
 Spectral Scan

Spectral Type

**Polarization products ?**

Produce image sidebands (Bands 9 and 10 only)

Polarization products desired  
 XX  DUAL  FULL

Spectral Setup Errors

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

Spectral Line

Baseband	Fraction	Centre Freq (rest,lsrk)	Centre Freq (sky,bar)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg	Repre Wi
Baseband-1							
Baseband-2							

Add spectral window centred on a spectral line Add spectral window manually Delete  Show image spectral window

Add spectral window centred on a spectral line Add spectral window manually Delete  Show image spectral window

**Rest frequency ?**

**Bandwidth, spectral resolution ?**

# Spectral setup in the almaOT (EXAMPLE)

We want to observe three lines in our target:

HCN(1-0), HCO<sup>+</sup>(1-0) and H<sup>13</sup>CO<sup>+</sup>(1-0)

# Spectral setup in the almaOT (EXAMPLE)

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From previous observations we know the approximate linewidth:

HCN(1-0)       $\rightarrow \Delta v = 7 \text{ km/s}$

HCO<sup>+</sup>(1-0)     $\rightarrow \Delta v = 10 \text{ km/s}$

H<sup>13</sup>CO<sup>+</sup>(1-0)  $\rightarrow \Delta v = 3 \text{ km/s}$



# Spectral setup in the almaOT (EXAMPLE)

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From previous observations we know the approximate linewidth:

HCN(1-0) →  $\Delta v = 7$  km/s

HCO<sup>+</sup>(1-0) →  $\Delta v = 10$  km/s

H<sup>13</sup>CO<sup>+</sup>(1-0) →  $\Delta v = 3$  km/s

For our ALMA observations we would need:

**Bandwidth** > 20 km/s to properly cover the extend of the lines

**Resolution** < 0.7 km/s for the HCN and HCO<sup>+</sup> lines

< 0.3 km/s for the H<sup>13</sup>CO<sup>+</sup> line

# Spectral setup in the almaOT (EXAMPLE)

The screenshot displays the ALMA Observing Tool (Cycle3) interface. The title bar shows "ALMA Observing Tool (Cycle3-Patchtests2) - Project" and the system tray includes the date "Sun Mar 22 14:16" and the user "Alvaro Sanchez". The menu bar contains "File", "Edit", "View", "Tool", "Search", and "Help". The toolbar includes icons for file operations and navigation.

The interface is divided into two main panes. The left pane, titled "Project Structure", shows a tree view of the project hierarchy: "Unsubmitted Proposal" > "Project" > "Proposal" > "Planned Observations" > "Science Goals" > "Spectral". The right pane, titled "Editors", has tabs for "Spectral", "Spatial", and "Spectral Setup". The "Spectral Setup" tab is active.

The "Spectral Setup" pane contains the following information:

- Text:** "In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other."
- Spectral Type:** A dropdown menu with a help icon (?) and a minus sign (-).
- Spectral Type:** Radio buttons for "Spectral Line" (selected), "Single Continuum", and "Spectral Scan".
- Polarization products desired:** Radio buttons for "XX", "DUAL" (selected), and "FULL".
- Spectral Setup Errors:** A red text message: "No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]".
- Spectral Line:** A dropdown menu with a help icon (?) and a minus sign (-).
- Baseband-1:** A table with columns: "Fraction", "Center Freq (Rest)", "Center Freq (Sky)", "Transition", "Bandwidth, Resolution (smoothed)", "Spec Avg.", and "Representative Window". Below the table are buttons: "Select Lines to Observe in Baseband-1...", "Add", and "Delete".
- Baseband-2:** A table with the same columns as Baseband-1. Below the table are buttons: "Select Lines to Observe in Baseband-2...", "Add", and "Delete".
- Baseband-3:** A table with the same columns as Baseband-1.

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure

Editors

Spectral Spatial Spectral Setup

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observations
      - Science Goals
        - General
        - Field Set
        - Spectral
        - Calibration
        - Control
        - Technical

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

Spectral Line

Single Continuum

Spectral Scan

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors

No spectral window in the list. No suitable receiver band for the range :[0.0 GHz, 0.0 GHz]

Spectral Line

Baseband-1

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window

Select Lines to Observe in Baseband-1... Add Delete

Baseband-2

Select Lines to Observe in Baseband-2... Add Delete

Baseband-3

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:18 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project  
Select Spectral Lines

**Transition Filter**

e.g. CO\*2-1\* or \*oxide\*

Include description

**Frequency Filters**

**ALMA Band**

1 2 3 4 5 6 7 8 9 10

**Sky Frequency (GHz)**

Min  Max

**Receiver/Back End Configuration**

Hide unobservable lines

Filtering unobservable lines

**Maximum Upper-state Energy (K)**

0 20 40 60 80 100 ∞

**Molecule Filter / Environment**

Show

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

**Transitions matching your filter settings:**  
(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions.)

Transition ^	Description	Rest Freq...	Sky Frequ...	Upper-state E...	Lovas Inte...	Sij μ <sup>2</sup>
I-C5H J=35/2-33/2, Ω=3/2, F=17-16, l=f	2,4-Pentadiynylidyne	84.108 GHz	84.108 G...	71.861 K	4.7	401.709
I-C5H J=35/2-33/2, Ω=3/2, F=18-17, l=f	2,4-Pentadiynylidyne	84.108 GHz	84.108 G...	71.861 K	4.7	425.314
I-C5H J=35/2-33/2, Ω=3/2, F=17-16, l=e	2,4-Pentadiynylidyne	84.11 GHz	84.11 GHz	71.862 K		401.692
I-C5H J=35/2-33/2, Ω=3/2, F=18-17, l=e	2,4-Pentadiynylidyne	84.11 GHz	84.11 GHz	71.862 K		425.395
C4H v7 = 1 J=17/2-15/2, Ω=1/2, l=f	1,3-Butadiynyl radical	84.123 GHz	84.123 G...	211.671 K	2.1	12.771 [
CH3OH v t=1 11(10,1)-11(11,0)	Methanol	84.159 GHz	84.159 G...	1066.119 K		1.459 D <sup>2</sup>
U-84163	UNIDENTIFIED	84.163 GHz	84.163 G...		0.06	
30SiO v=1 2-1	Silicon Monoxide	84.164 GHz	84.164 G...	1753.828 K		19.441 [
C-H13CCCH 2(1,2)-1(0,1)	Cyclopropenylidene	84.186 GHz	84.186 G...	6.331 K	0.13	17.24 D <sup>2</sup>
U-84215	UNIDENTIFIED	84.215 GHz	84.215 G...		0.08	
SO2 v=0 32(5,27)-31(6,26)	Sulfur dioxide	84.321 GHz	84.321 G...	549.36 K	0.1	13.463 [
U-84356	UNIDENTIFIED	84.356 GHz	84.356 G...		0.07	
U-84385	UNIDENTIFIED	84.385 GHz	84.385 G...		0.08	
34SO 2(2)-1(1)	Sulfur Monoxide	84.411 GHz	84.411 G...	19.233 K	0.03	3.534 D <sup>2</sup>
CH3OH v t=0 13(-3,11)-14(-2,13)	Methanol	84.424 GHz	84.424 G...	273.898 K		4.303 D <sup>2</sup>
13CH3OH v t=0 13(-3,11)-12(-4,9)	Methanol	84.444 GHz	84.444 G...	269.033 K		3.267 D <sup>2</sup>
U-84468	UNIDENTIFIED	84.468 GHz	84.468 G...		0.18	
U-84478	UNIDENTIFIED	84.478 GHz	84.478 G...		0.18	
U-84496	UNIDENTIFIED	84.496 GHz	84.496 G...		0.1	
CH3OH v t=0 5(-1,5)-4(0,4)	Methanol	84.521 GHz	84.521 G...	40.391 K		3.083 D <sup>2</sup>
CH3OH v t=1 12(10,2)-12(11,1)	Methanol	84.54 GHz	84.54 GHz	1093.861 K		2.786 D <sup>2</sup>
NH2CHO 4(0,4)-3(0,3)	Formamide	84.542 GHz	84.542 G...	10.158 K	0.21	52.272 [
C6H J=61/2-59/2, Ω=3/2, l=e	1,3,5-Hexatriynyl	84.55 GHz	84.55 GHz	63.662 K	0.04	1867.72
CH3OH v t=0 19(2,17)-18(-3,16)	Methanol	84.574 GHz	84.574 G...	463.489 K		0.424 D <sup>2</sup>
C6H l=61/2-59/2, Ω=3/2, l=f	1.3.5-Hexatriynyl	84.575 GHz	84.575 G...	63.675 K	0.03	1867.56

Add to Selected Transitions

---

**Selected transitions**

Transition ^	Description	Rest Frequency ^	Sky Frequency

Remove from Selected Transitions

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

Select Spectral Lines

Transition Filter  

 Include description

Frequency Filters  
 ALMA Band

Sky Frequency (GHz)  
 Min  Max

Receiver/Back End Configuration  
 Hide unobservable lines  
 Filtering unobservable lines

Maximum Upper-state Energy (K)

Molecule Filter / Environment  
 Show

Transitions matching your filter settings:  
 (double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions.)

Transition $\triangle$	Description	Rest Freq... $\triangle$	Sky Freq...	Upper-state E...	Lovas Inte...	Sij $\mu^2$
I-C5H J=35/2-33/2, $\Omega=3/2$ , F=17-16, l=f	2,4-Pentadiynylidyne	84.108 GHz	84.108 G...	71.861 K	4.7	401.709
I-C5H J=35/2-33/2, $\Omega=3/2$ , F=18-17, l=f	2,4-Pentadiynylidyne	84.108 GHz	84.108 G...	71.861 K	4.7	425.314
I-C5H J=35/2-33/2, $\Omega=3/2$ , F=17-16, l=e	2,4-Pentadiynylidyne	84.11 GHz	84.11 GHz	71.862 K		401.692
I-C5H J=35/2-33/2, $\Omega=3/2$ , F=18-17, l=e	2,4-Pentadiynylidyne	84.11 GHz	84.11 GHz	71.862 K		425.395
C4H v7 = 1 J=17/2-15/2, $\Omega=1/2$ , l=f	1,3-Butadiynyl radical	84.123 GHz	84.123 G...	211.671 K	2.1	12.771 [
CH3OH v t=1 11(10,1)-11(11,0)	Methanol	84.159 GHz	84.159 G...	1066.119 K		1.459 D <sup>2</sup>
U-84163	UNIDENTIFIED	84.163 GHz	84.163 G...		0.06	
CSO v=1 2-1	Silicon Monoxide	84.164 GHz	84.164 G...	1753.828 K		19.441 [
U-84165	Cyclopropenylidene	84.186 GHz	84.186 G...	6.331 K	0.13	17.24 D <sup>2</sup>
U-84165	UNIDENTIFIED	84.215 GHz	84.215 G...		0.08	
SO2 v=0 32(5,27)-31(6,26)	Sulfur dioxide	84.321 GHz	84.321 G...	549.36 K	0.1	13.463 [
U-84356	UNIDENTIFIED	84.356 GHz	84.356 G...		0.07	
U-84385	UNIDENTIFIED	84.385 GHz	84.385 G...		0.08	
34SO 2(2)-1(1)	Sulfur Monoxide	84.411 GHz	84.411 G...	19.233 K	0.03	3.534 D <sup>2</sup>
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U-84468	UNIDENTIFIED	84.468 GHz	84.468 G...		0.18	
U-84478	UNIDENTIFIED	84.478 GHz	84.478 G...		0.18	
U-84496	UNIDENTIFIED	84.496 GHz	84.496 G...		0.1	
CH3OH v t=0 5(-1,5)-4(0,4)	Methanol	84.521 GHz	84.521 G...	40.391 K		3.083 D <sup>2</sup>
CH3OH v t=1 12(10,2)-12(11,1)	Methanol	84.54 GHz	84.54 GHz	1093.861 K		2.786 D <sup>2</sup>
NH2CHO 4(0,4)-3(0,3)	Formamide	84.542 GHz	84.542 G...	10.158 K	0.21	52.272 [
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CH3OH v t=0 19(2,17)-18(-3,16)	Methanol	84.574 GHz	84.574 G...	463.489 K		0.424 D <sup>2</sup>
C6H l=61/2-59/2, $\Omega=3/2$ , l=f	1.3.5-Hexatriynyl	84.575 GHz	84.575 G...	63.675 K	0.03	1867.56

Add to Selected Transitions

Selected transitions

Transition $\triangle$	Description	Rest Frequency $\triangle$	Sky Frequency
Remove from Selected Transitions			

Cancel

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

Select Spectral Lines

Transition Filter: **HCN\***

Include description

Frequency Filters: Min 31.3, Max 950

Receiver/Back End Configuration:  Hide unobservable lines,  Filtering unobservable lines

Maximum Upper-state Energy (K): 0 to 100

Molecule Filter / Environment: Show all atoms and molecules

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Find More... Reset Filters

Transitions matching your filter settings:

(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions.)

Transition	Description	Rest Freq...	Sky Frequu...	Upper-state E...	Lovas Inte...	Sij
HCN v=0 J=1-0, F=1-1	Hydrogen Cyanide	88.63 GHz	88.63 GHz	4.254 K	9.6	2.967
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	8.911
HCN v=0 J=1-0, F=2-1	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	4.946
HCN v=0 J=1-0, F=0-1	Hydrogen Cyanide	88.634 GHz	88.634 G...	4.254 K	6.8	0.989
HCN v=0 J=3-2, F=3-3	Hydrogen Cyanide	265.885 GHz	265.885 ...	25.521 K		0.989
HCN v=0 J=3-2, F=2-1	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	5.347
HCN v=0 J=3-2	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	26.734
HCN v=0 J=3-2, F=3-2	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	7.913
HCN v=0 J=3-2, F=4-3	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	11.466
HCN v=0 J=3-2, F=2-2	Hydrogen Cyanide	265.889 GHz	265.889 ...	25.521 K		0.989
HCN v=0 J=4-3	Hydrogen Cyanide	354.505 GHz	354.505 ...	42.534 K	17.4	35.644
HCN v=0 J=5-4	Hydrogen Cyanide	443.116 GHz	443.116 ...	63.8 K		44.551
HCN v=0 J=7-6	Hydrogen Cyanide	620.304 GHz	620.304 ...	119.088 K		62.379
HCN v=0 J=8-7	Hydrogen Cyanide	708.877 GHz	708.877 ...	153.109 K	48.7	71.291
HCN v=0 J=9-8	Hydrogen Cyanide	797.433 GHz	797.433 ...	191.38 K	55	80.201
HCN v=0 J=10-9	Hydrogen Cyanide	885.971 GHz	885.971 ...	233.899 K	15	89.111

Add to Selected Transitions

Selected transitions

Transition	Description	Rest Frequency	Sky Frequency
------------	-------------	----------------	---------------

Remove from Selected Transitions

Cancel

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:18 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project  
Select Spectral Lines

File Edit

**Transition Filter**

HCN\*

Include description

**Frequency Filters**

**ALMA Band**

1 2 3 4 5 6 7 8 9 10

**Sky Frequency (GHz)**

Min 31.3 Max 950

**Receiver/Back End Configuration**

Hide unobservable lines

Filtering unobservable lines

**Maximum Upper-state Energy (K)**

0 20 40 60 80 100 ∞

**Molecule Filter / Environment**

Show all atoms and molecules

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Find More...

Reset Filters

**Transitions matching your filter settings:**  
(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions.)

Transition ^	Description	Rest Freq...	Sky Freq...	Upper-state E...	Lovas Inte...	Sij
HCN v=0 J=1-0, F=1-1	Hydrogen Cyanide	88.63 GHz	88.63 GHz	4.254 K	9.6	2.967
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	8.911
HCN v=0 J=1-0, F=2-1	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	4.946
HCN v=0 J=1-0, F=0-1	Hydrogen Cyanide	88.634 GHz	88.634 G...	4.254 K	6.8	0.989
HCN v=0 J=3-2, F=3-3	Hydrogen Cyanide	265.885 GHz	265.885 ...	25.521 K		0.989
HCN v=0 J=3-2, F=2-1	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	5.347
HCN v=0 J=3-2	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	26.734
HCN v=0 J=3-2, F=3-2	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	7.913
HCN v=0 J=3-2, F=4-3	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	11.466
HCN v=0 J=3-2, F=2-2	Hydrogen Cyanide	265.889 GHz	265.889 ...	25.521 K		0.989
HCN v=0 J=4-3	Hydrogen Cyanide	354.505 GHz	354.505 ...	42.534 K	17.4	35.643
HCN v=0 J=5-4	Hydrogen Cyanide	443.116 GHz	443.116 ...	63.8 K		44.553
HCN v=0 J=7-6	Hydrogen Cyanide	620.304 GHz	620.304 ...	119.088 K		62.379
HCN v=0 J=8-7	Hydrogen Cyanide	708.877 GHz	708.877 ...	153.109 K	48.7	71.293
HCN v=0 J=9-8	Hydrogen Cyanide	797.433 GHz	797.433 ...	191.38 K	55	80.203
HCN v=0 J=10-9	Hydrogen Cyanide	885.971 GHz	885.971 ...	233.899 K	15	89.113

Add to Selected Transitions

**Selected transitions**

Transition ^	Description	Rest Frequency ^	Sky Frequency

Remove from Selected Transitions

Cancel

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

Select Spectral Lines

Transition Filter: HCN\*

Include description

Frequency Filters

ALMA Band: [Slider]

Sky Frequency (GHz): [Slider] Min: 31.3 Max: 950

Receiver/Back End Configuration

Hide unobservable lines

Filtering unobservable lines

Maximum Upper-state Energy (K): [Slider]

Molecule Filter / Environment

Show: all atoms and molecules

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Transitions matching your filter settings:

(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected)

Transition ^	Description	Rest Freq...	Sky Freq...	Upper-state E...	Lovas Inte...	Sij
HCN v=0 J=1-0, F=1-1	Hydrogen Cyanide	88.63 GHz	88.63 GHz	4.254 K	9.6	2.967
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	8.911
HCN v=0 J=1-0, F=2-1	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	4.946
HCN v=0 J=1-0, F=0-1	Hydrogen Cyanide	88.634 GHz	88.634 G...	4.254 K	6.8	0.989
HCN v=0 J=3-2, F=3-3	Hydrogen Cyanide	265.885 GHz	265.885 ...	25.521 K		0.989
HCN v=0 J=3-2, F=2-1	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	5.347
HCN v=0 J=3-2	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	26.734
HCN v=0 J=3-2, F=3-2	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	7.913
HCN v=0 J=3-2, F=4-3	Hydrogen Cyanide	265.886 GHz	265.886 ...	25.521 K	20	11.466
HCN v=0 J=3-2, F=2-2	Hydrogen Cyanide	265.889 GHz	265.889 ...	25.521 K		0.989
HCN v=0 J=4-3	Hydrogen Cyanide	354.505 GHz	354.505 ...	42.534 K	17.4	35.643
HCN v=0 J=5-4	Hydrogen Cyanide	443.116 GHz	443.116 ...	63.8 K		44.553
HCN v=0 J=7-6	Hydrogen Cyanide	620.304 GHz	620.304 ...	119.088 K		62.379
HCN v=0 J=8-7	Hydrogen Cyanide	708.877 GHz	708.877 ...	153.109 K	48.7	71.293
HCN v=0 J=9-8	Hydrogen Cyanide	797.433 GHz	797.433 ...	191.38 K	55	80.203
HCN v=0 J=10-9	Hydrogen Cyanide	885.971 GHz	885.971 ...	233.899 K	15	89.113

Selected transitions

Transition ^	Description	Rest Frequency ^	Sky Frequency
--------------	-------------	------------------	---------------



# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:18 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project  
Select Spectral Lines

File Edit

Transition Filter  
HCN\*

Include description

Frequency Filters  
ALMA Band

Sky Frequency (GHz)  
  
Min 31.3 Max 950

Receiver/Back End Configuration  
 Hide unobservable lines  
 Filtering unobservable lines

Maximum Upper-state Energy (K)

Molecule Filter / Environment  
Show all atoms and molecules


Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Transitions matching your filter settings:  
(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions)

Transition ^	Description	Rest Freq...	Sky Freq...	Upper-state E...	Lovas Inte...	Sij
HCN v=0 J=1-0, F=1-1	Hydrogen Cyanide	88.63 GHz	88.63 GHz	4.254 K	9.6	2.967
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	8.911
HCN v=0 J=1-0, F=2-1	Hydrogen Cyanide	88.632 GHz	88.632 G...	4.254 K	17.2	4.946
HCN v=0 J=1-0, F=0-1	Hydrogen Cyanide	88.634 GHz	88.634 G...	4.254 K	6.8	0.989

Selected transitions

Transition ^	Description	Rest Frequency ^	Sky Frequency
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 GHz



# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:18 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project  
Select Spectral Lines

Transition Filter: **HCO\***

Include description

Frequency Filters

Min: 31.3 Max: 950

Receiver/Back End Configuration

Hide unobservable lines

Filtering unobservable lines

Maximum Upper-state Energy (K)

Molecule Filter / Environment

Show: all atoms and molecules

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Find More...

Reset Filters

Transitions matching your filter settings:  
(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions.)

Transition ^	Description	Rest Freq...	Sky Freq...	Upper-state E...	Lovas Inte...	Sij
HCO 1(0,1)-0(0,0), J=3/2-1/2, F=1-0	Formyl Radical	86.708 GHz	86.708 G...	4.161 K	0.04	1.817
HCO 1(0,1)-0(0,0), J=1/2-1/2, F=1-1	Formyl Radical	86.777 GHz	86.777 G...	4.183 K	0.021	1.817
HCO 1(0,1)-0(0,0), J=1/2-1/2, F=0-1	Formyl Radical	86.806 GHz	86.806 G...	4.185 K	0.015	0.619
HCO+ v=0 1-0	Formylium	89.189 GHz	89.189 G...	4.28 K	10.8	15.21

Add to Selected Transitions

Selected transitions

Transition ^	Description	Rest Frequency ^	Sky Frequency
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 GHz

Remove from Selected Transitions

Cancel

**HCO\***

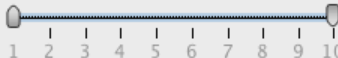

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:19 Alvaro Sanchez

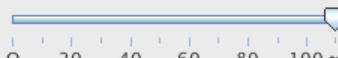
ALMA Observing Tool (Cycle3-Patchtests2) - Project  
Select Spectral Lines

File Edit

Transition Filter  
HCO<sup>+</sup>  
 Include description

Frequency Filters  
ALMA Band  
  
Sky Frequency (GHz)  
  
Min  Max

Receiver/Back End Configuration  
 Hide unobservable lines  
 Filtering unobservable lines

Maximum Upper-state Energy (K)  


Molecule Filter / Environment  
Show

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.

Transitions matching your filter settings:  
(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected transitions.)

Transition ^	Description	Rest Freq... ^	Sky Freq...	Upper-state E...	Lovas Inte...	Sij
HCO+ v=0 1-0	Formylium	89.189 GHz	89.189 G...	4.28 K	10.8	15.21

Selected transitions

Transition ^	Description	Rest Frequency ^	Sky Frequency
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 GHz
HCO+ v=0 1-0	Formylium	89.189 GHz	89.189 GHz

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:19 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project  
Select Spectral Lines

File Edit

Transition Filter  
HCO\*

Include description

Frequency Filters  
ALMA Band  
Sky Frequency (GHz)  
Min 31.3 Max 950

Receiver/Back End Configuration  
 Hide unobservable lines  
 Filtering unobservable lines

Maximum Upper-state Energy (K)  
0 20 40 60 80 100 ∞

Molecule Filter / Environment  
Show all atoms and molecules

Can't find the transition you're looking for in the offline pool? Find more in the online Splatalogue.  
Find More...  
Reset Filters

Transitions matching your filter settings:  
(double-click column header for primary sort, single-click subsequent columns for secondary sorting. Single clicks will reverse sort order of already selected columns)

Transition ^	Description	Rest Freq...	Sky Freq...	Upper-state E...	Lovas Inte...	Sij $\mu^2$	Cata.
HCO+ v=0 1-0	Formylium	89.189 GHz	89.189 G...	4.28 K	10.8	15.21 D <sup>2</sup>	Offline

Add to Selected Transitions

Selected transitions

Transition ^	Description	Rest Frequency ^	Sky Frequency
HCN v=0 J=1-0	Hydrogen Cyanide	88.632 GHz	88.632 GHz
HCO+ v=0 1-0	Formylium	89.189 GHz	89.189 GHz

Remove from Selected Transitions

Cancel Ok

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure

Editors

Spectral Spatial Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

Spectral Type

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors

Baseband-1 : Bandwidth and channel spacing must be set to all spectral windows.

Spectral Line

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window
1/2	88.63160 GHz	88.63160 GHz	HCN v=0 J=1...	Please select a correlator mode	1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz	HCO+ v=0 1-0	Please select a correlator mode	1	<input type="radio"/>

Select Lines to Observe in Baseband-1... Add Delete

Baseband-2

Select Lines to Observe in Baseband-2... Add Delete

Baseband-3

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:19 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project Perspective 1

File Edit View Tool Search Help

**Project Structure** | **Editors** | Spectral | Spatial | Spectral Setup

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observations
      - Science Goals
        - General
        - Field Set
        - Spectral
        - Calibration
        - Control
        - Technical

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type ? -

Spectral Line  
 Single Continuum  
 Spectral Scan

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors

**Baseband-1 : Bandwidth and channel spacing must be set to all spectral windows.**

Spectral Line ? -

Baseband-1 ? -

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window
1/2	88.63160 GHz	88.63160 GHz	HCN v=0 J=1...	58.594 MHz ( 198 km/s), 61.035 kHz ( 0.206 km/s)	1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz	HCO+ v=0 1-0	58.594 MHz ( 198 km/s), 61.035 kHz ( 0.206 km/s) 117.188 MHz ( 396 km/s), 122.070 kHz ( 0.413 km/s) 234.375 MHz ( 793 km/s), 244.141 kHz ( 0.826 km/s) 468.750 MHz ( 1586 km/s), 488.281 kHz ( 1.652 km/s) 937.500 MHz ( 3171 km/s), 976.563 kHz ( 3.303 km/s)	1	<input type="radio"/>

Select Lines to Observe in Baseband-1...

Baseband-2

Select Lines to Observe in Baseband-2...

Baseband-3

# Spectral setup in the almaOT (EXAMPLE)

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

Spectral Line  
 Single Continuum  
 Spectral Scan

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors  
Baseband-1 : Bandwidth and channel spacing must be set to all spectral windows.

Spectral Line

Baseband-1

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window
1/2	88.63160 GHz	88.63160 GHz	HCN v=0 J=1...	58.594 MHz ( 198 km/s), 61.035 kHz ( 0.206 km/s)	1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz	HCO+ v=0 1-0	58.594 MHz ( 198 km/s), 61.035 kHz ( 0.206 km/s) 117.188 MHz ( 396 km/s), 122.070 kHz ( 0.413 km/s) 234.375 MHz ( 793 km/s), 244.140 kHz ( 0.826 km/s) 468.750 MHz ( 1586 km/s), 488.280 kHz ( 1.652 km/s) 937.500 MHz ( 3171 km/s), 976.563 kHz ( 3.303 km/s)	1	<input type="radio"/>

Select Lines to Observe in Baseband-1... Add

Baseband-2

Select Lines to Observe in Baseband-2

Baseband-3

resolution

bandwidth

# Spectral setup in the almaOT (EXAMPLE)

The screenshot shows the ALMA Observing Tool (Cycle3) interface. The title bar indicates the application is running on a Mac, with the window title "ALMA Observing Tool (Cycle3-Patchtests2) - Project". The menu bar includes "File", "Edit", "View", "Tool", "Search", and "Help". The toolbar contains various icons for file operations and navigation. The main window is divided into several panes:

- Project Structure:** A tree view on the left showing the project hierarchy: "Unsubmitted Proposal" > "Project" > "Proposal" > "Planned Observations" > "Science Goals" > "General", "Field Set", "Spectral", "Calibration", "Control", and "Technical".
- Editors:** A tabbed interface with "Spectral", "Spatial", and "Spectral Setup" tabs. The "Spectral Setup" tab is active.
- Spectral Setup Panel:**
  - Text:** "In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other."
  - Spectral Type:** Radio buttons for "Spectral Line" (selected), "Single Continuum", and "Spectral Scan".
  - Polarization products desired:** Radio buttons for "XX", "DUAL" (selected), and "FULL".
  - Spectral Setup Errors:** A section for reporting errors.
  - Spectral Line:** A section for defining spectral lines, currently showing "Baseband-1".
- Baseband-1 Table:** A table with columns: "Fraction", "Center Freq (Rest)", "Center Freq (Sky)", "Transition", "Bandwidth, Resolution (smoothed)", "Spec Avg.", and "Representative Window".

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window
1/2	88.63160 GHz	88.63160 GHz	HCN v=0 J=1...	117.188 MHz( 396 km/s), 122.070 kHz( 0.413 km/s)	1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz	HCO+ v=0 1-0	117.188 MHz( 394 km/s), 122.070 kHz( 0.410 km/s)	1	<input type="radio"/>
- Buttons:** "Select Lines to Observe in Baseband-1...", "Add", and "Delete".
- Baseband-2 and Baseband-3:** Similar sections for other basebands, currently empty.



# Spectral setup in the almaOT (EXAMPLE)

The screenshot shows the ALMA Observing Tool (Cycle3) interface. The main window is titled "ALMA Observing Tool (Cycle3-Patchtests2) - Project". The "Editors" panel is active, showing the "Spectral Setup" tab. The interface includes a "Project Structure" tree on the left, a "Spectral Setup Errors" section, and a table for defining spectral windows. A red circle highlights the "Baseband-2" section, and a red box highlights the text "the same for H<sup>13</sup>CO<sup>+</sup>".

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

Spectral Line  
 Single Continuum  
 Spectral Scan

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors

Baseband	Fraction	Line	Resolution	Spec Avg.	Representative Window
1/2				1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz H13CO+ v=0 1-0	117.188 MHz( 394 km/s), 122.070 kHz( 0.410 km/s)	1	<input type="radio"/>

Select Lines to Observe in Baseband-1... Add Delete

Baseband-2

1(Full)	86.75429 GHz	86.75429 GHz H13CO+ 1-0	58.304 MHz( 207 km/s), 30.518 kHz( 0.105 km/s)	1	<input type="radio"/>
---------	--------------	-------------------------	--	---	-----------------------

Select Lines to Observe in Baseband-2... Add Delete

Baseband-3

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3) Sun Mar 22 14:20 Alvaro Sanchez

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure: Unsubmitted Proposal, Project, Proposal, Planned Observations, Science Goals, General, Field Set, Spectral, Calibration, Control, Technical

Editors: Spectral, Spatial, Spectral Setup

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type

Spectral Type:  Spectral Line,  Single Continuum,  Spectral Scan

Polarization products desired:  XX,  DUAL,  FULL

Spectral Setup Errors

Spectral Line

Baseband-1

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window
1/2	88.63160 GHz	88.63160 GHz	HCN v=0 J=1...	117.188 MHz( 396 km/s), 122.070 kHz( 0.413 km/s)	1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz	HCO+ v=0 1-0	117.188 MHz( 394 km/s), 122.070 kHz( 0.410 km/s)	1	<input type="radio"/>

Select Lines to Observe in Baseband-1... Add Delete

Baseband-2

1(Full)	86.75429 GHz	86.75429 GHz	H13CO+ 1-0	58.594 MHz( 207 km/s), 30.518 kHz( 0.105 km/s)	1	<input type="radio"/>
---------	--------------	--------------	------------	--	---	-----------------------

Select Lines to Observe in Baseband-2... Add Delete

Baseband-3

HCN  
HCO<sup>+</sup>

H<sup>13</sup>CO<sup>+</sup>

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure Editors

Proposal Program **Spectral** Spatial Spectral Setup

Unsubmitted Proposal

- Project
  - Proposal
    - Planned Observations
      - Science Goals
        - General
        - Field Set
        - Spectral
        - Calibration
        - Control
        - Technical

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Spectral Type [?]

Spectral Line  
 Single Continuum  
 Spectral Scan

Spectral Type

Polarization products desired  XX  DUAL  FULL

Spectral Setup Errors

Spectral Line [?]

Baseband-1

Fraction	Center Freq (Rest)	Center Freq (Sky)	Transition	Bandwidth, Resolution (smoothed)	Spec Avg.	Representative Window
1/2	88.63160 GHz	88.63160 GHz	HCN v=0 J=1...	117.188 MHz( 396 km/s), 122.070 kHz( 0.413 km/s)	1	<input checked="" type="radio"/>
1/2	89.18853 GHz	89.18853 GHz	HCO+ v=0 1-0	117.188 MHz( 394 km/s), 122.070 kHz( 0.410 km/s)	1	<input type="radio"/>

Select Lines to Observe in Baseband-1...

Baseband-2

1(Full)	86.75429 GHz	86.75429 GHz	H13CO+ 1-0	58.594 MHz( 707 km/s), 30.518 kHz( 0.105 km/s)	1	<input type="radio"/>
---------	--------------	--------------	------------	--	---	-----------------------

Select Lines to Observe in Baseband-2...

Baseband-3

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure

- Unsubmitted Proposal
  - Project
    - Proposal
      - Planned Observations
        - Science Goals
          - General
          - Field Setup
          - Spectral
          - Calibration
          - Control
          - Technical

Editors

Spectral Spatial Spectral Setup

Visualisation

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Left/right click to zoom in/out, grab sliding bar to pan  
Note: Moving LO1 here is for experimentation only - actual setup determined by the windows

Observed Frequency

Rest Frequency

Overlays:  Receiver Bands  Transmission  Overlay Lines  DSB Image [Select Lines to Overlay](#)

Water Vapour Column Density:  Automatic Choice  Manual Choice 5.186mm (7th Octile)

Viewport: [Pan to Line](#) [Zoom to Band](#) [Reset](#)

Spectral Type

Spectral Line  
 Single Continuum  
 Spectral Scan

Polarization products desired  XX  DUAL  FULL

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure

Editors

Spectral Spatial Spectral Setup

Visualisation

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

Left/right click to zoom in/out, grab sliding bar to pan  
Note: Moving LO1 here is for experimentation only - actual setup determined by the windows

Observed Frequency

Rest Frequency

Overlays:  Receiver Bands  Transmission  Overlay Lines  DSB Image [Select Lines to Overlay](#)

Water Vapour Column Density:  Automatic Choice  Manual Choice 5.186mm (7th Octile)

Viewport: [Pan to Line](#) [Zoom to Band](#) [Reset](#)

Spectral Type

Spectral Type  Spectral Line  Single Continuum  Spectral Scan

Polarization products desired  XX  DUAL  FULL

# Spectral setup in the almaOT (EXAMPLE)

ALMA Observing Tool (Cycle3)

ALMA Observing Tool (Cycle3-Patchtests2) - Project

File Edit View Tool Search Help

Project Structure

- Unsubmitted Proposal
  - Project
    - Proposal
      - Planned Observations
        - Science Goals
          - General
          - Field Set
          - Spectral
          - Calibration
          - Control
          - Technical

Editors

Spectral Spatial Spectral Setup

Visualisation

In the table below, it is possible to define up to 16 spectral windows, 4 per baseband as long as the total Fraction per baseband is no more than 1. Each baseband is 2GHz wide and can be separately configured i.e. each spectral window can have a different bandwidth and resolution. Note that for bands 3, 4, 6, 7 and 8, it is not possible to put 3 basebands in one sideband and the fourth one in the other.

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Observed Frequency

Rest Frequency

Overlays:  Receiver Bands  Transmission  Overlay Lines  DSB Image [Select Lines to Overlay](#)

Water Vapour Column Density:  Automatic Choice  Manual Choice 5.186mm (7th Octile)

Viewport: [Pan to Line](#) [Zoom to Band](#) [Reset](#)

Spectral Type

Spectral Type  Spectral Line  Single Continuum  Spectral Scan

Polarization products desired  XX  DUAL  FULL

# Break #2

German ARC: ALMA community days (March 2017)