

ALMA Correlator *setup*

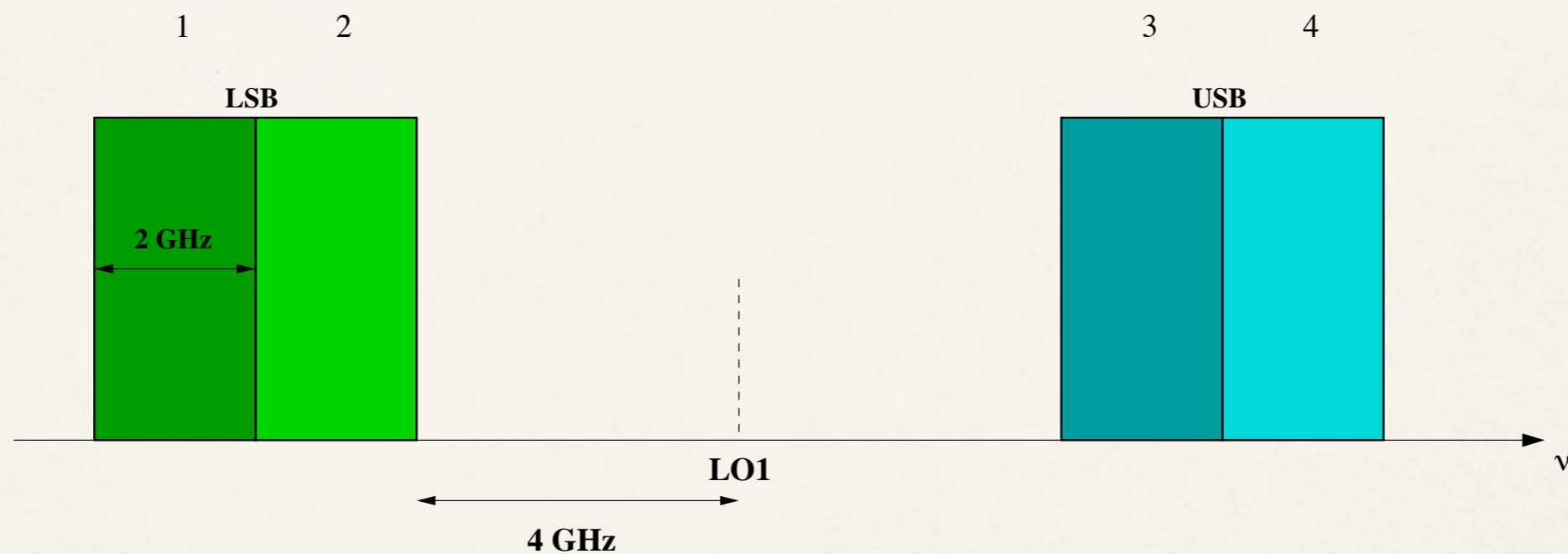
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Early Science (ES)

- ❖ Only one part of ALMA's full resources will be available for the ES phase. With the time, more antennas, receivers and observing modes will be available to users.

Basic concepts



The Lower Sideband (LSB) and Upper Sideband (USB) are the spectral parts in which the receivers of ALMA are tuned during observations. Each sideband may contain several basebands.

Each baseband is 2 GHz wide, and in this example, 2 of them are contained in each sideband.

Two phases of ALMA

	Early Science	Inauguration of ALMA
Antennas	16 (12m)	> 50 (12m & 7m)
Bands	3, 6, 7, 9	3, 6, 7, 9 + 4, 8, & 10
Correlator configurations	≥ 5	71
Maximum angular resolution	0.02'' [$\lambda/1\text{mm}$] [10 km/ max baseline]	
Maximum baseline	≥ 250 m (maybe 1 km)	15.3 km
Continuum sensitivity (60 sec, bands 3 - 9)	$\sim 0.2 - 4.2$ mJy	$\sim 0.05 - 1$ mJy
Spectral line sensitivity (60 sec, 1 km/s, bands 3 - 9)	$\sim 30 - 250$ mJy	$\sim 7 - 62$ mJy

Observing modes for ES

At least these 5 highest-priority observing modes will be available for ES

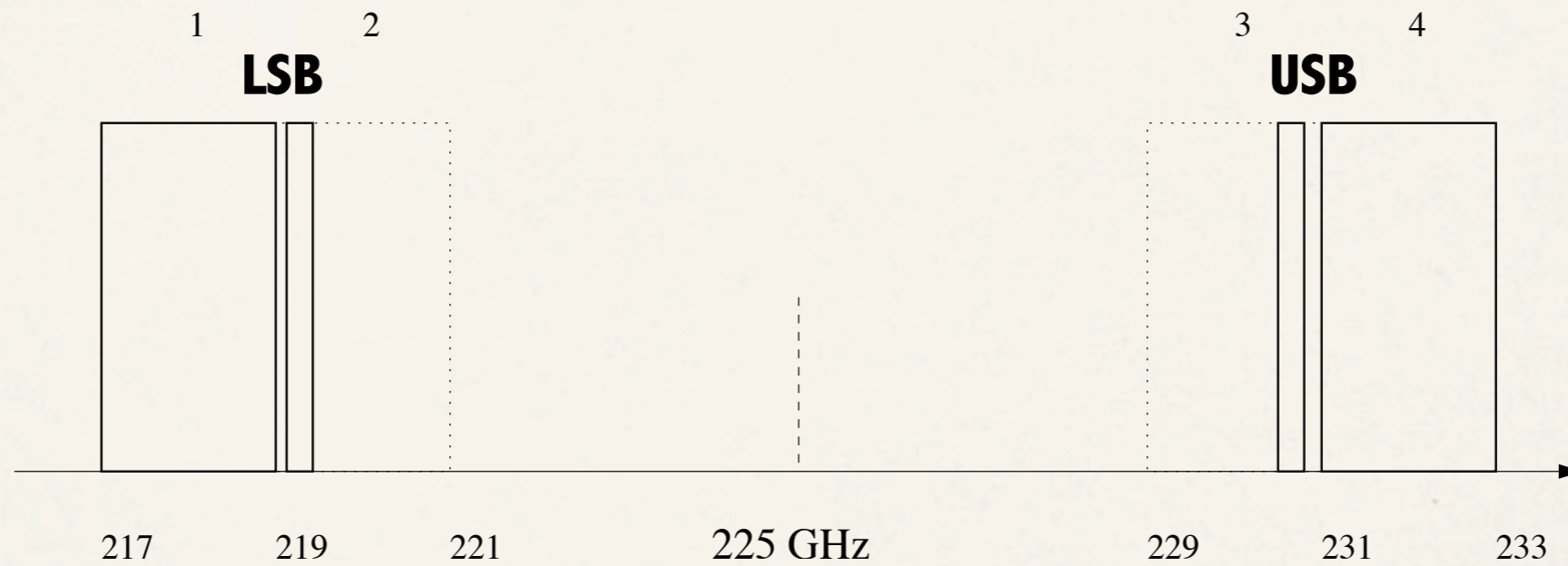
Mode	Total bandwidth	Eff bandwidth	Spectral points	Spectral resolution	Polarization products	B6 211-275 (km/s)
70	2 GHz	2 GHz	64	31.25 MHz	Full	~ 39
7	2 GHz	1.875 GHz	3840	488 kHz	Dual	~ 0.6
9	500 MHz	469 MHz	3840	122 kHz	Dual	~ 0.15
12	62.5 MHz	58.6 MHz	3840	15 kHz	Dual	~ 0.02
18	62.5 MHz	58.6 MHz	1920	30 kHz	Full	~ 0.04

Last column shows the velocity resolution at the center of the band 6.

Comments on observing modes

- ❖ **Bands 3** (84-116 GHz), **6** (211-275 GHz), **7** (275-373 GHz), **9** (602-720 GHz).
- ❖ One quadrant of the correlator will process all 4 baseband pairs for the 16 antennas.
- ❖ **Each baseband will have ONE spectral window (one spectral mode).**
- ❖ **Each baseband's spectral window must have identical characteristics.**

Different observing modes



NO DIFFERENT OBSERVING MODES AT THE SAME TIME

Call for proposals for ES

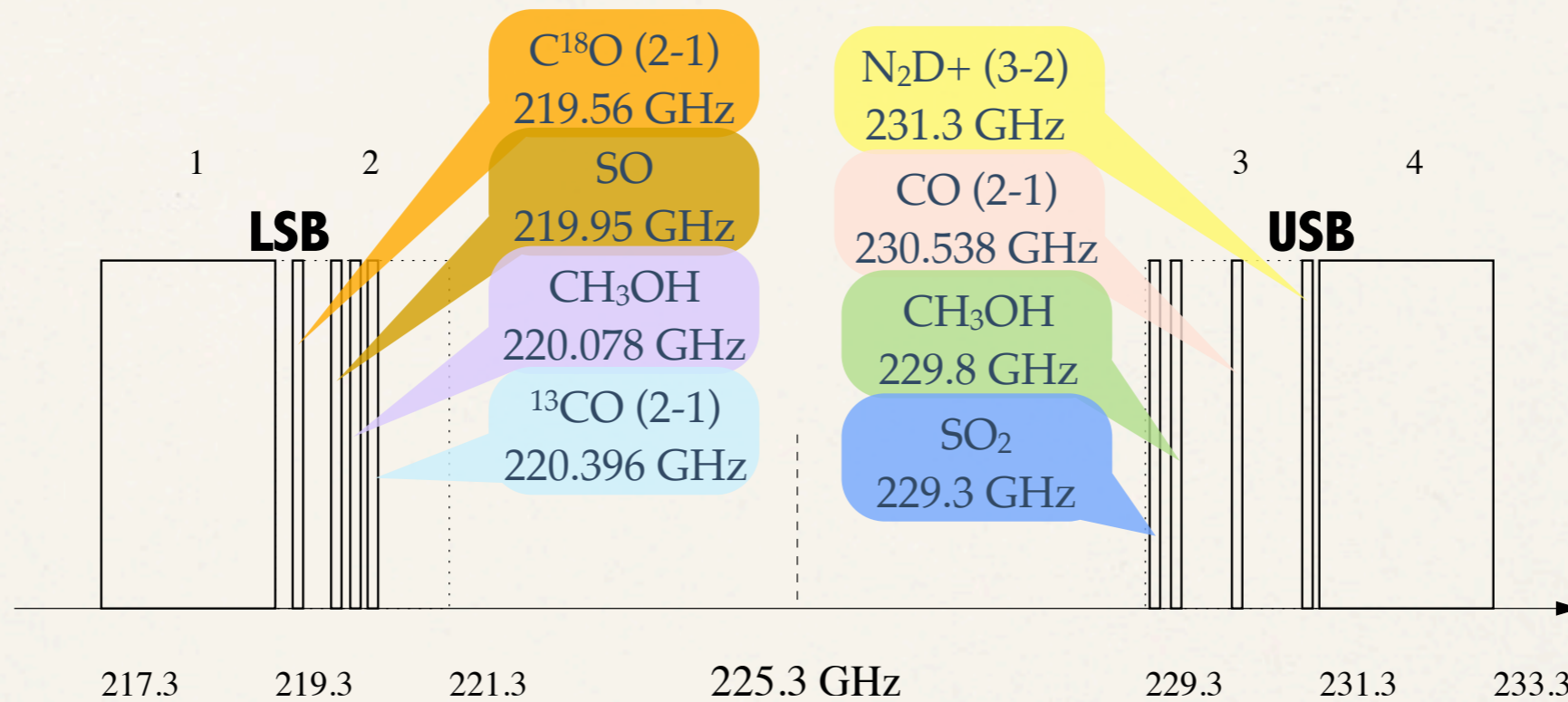
- ❖ To be issued at the end of March 2011.
- ❖ The deadline comes 2 months after.
- ❖ ES begins at the end of 2011.
- ❖ There might be more observing modes available for ES. The exact details will be announced with the call itself.

Correlator setup in OT

Science goals: when and how

- ❖ Inside OT, the basic elements to define the correlator setup are the SCIENCE GOALS.
- ❖ Tabs for description, field setup, calibration and spectral setup are inside each science goal.
- ❖ **Each science goal has ONE polarization setup and so ALL basebands inside inherit it.**
- ❖ Do not put different observing modes inside a single science goal.

Once ALMA is inaugurated...



Multiple spectral windows per baseband,
combined with different observing modes.

OT exercises

1. Continuum

The observation of continuum emission is very important in all radio astronomy. In this example the user is asked to use OT to observe the source NGC 1333, a star formation region. The goal is to observe continuum emission with 4 GHz of bandwidth per sideband (2 GHz per baseband).

The central frequency is 222 GHz.

In this way the correlator will observe four basebands, covering the frequencies

213 - 217 GHz

227 - 231 GHz

With an angular resolution of 1", how much time is needed to reach a sensitivity of 0.1 mJy/beam?

2. Spectral lines

In the star formation field, the observation of several spectral lines gives information about the physical structure of the source, density of the gas and the kinematics of outflows, among others. The user is asked to work on the spectral setup of the ALMA correlator to observe the next lines.

$\text{CH}_3\text{OH } 10_{2,9}-9_{3,6}$ 231.28115 GHz

$\text{SO } 5_6-4_5$ 219.94943 GHz

Each line of the above must have a velocity resolution of less than 0.2 km/s.

To obtain the desired velocity resolution, the user has to figure out which observing mode(s) are adequate. Wider spectral windows can cover additional molecular lines at similar frequencies.

Set the "Control and Performance Parameters" tab to get a sensitivity of 10 mJy/beam at 1" of angular resolution, and check how much time you would need to get it.

3. Spectral lines 2

The study of evolved stars also uses spectral lines to calculate chemical composition as ratios between isotopes of molecules, to estimate the evolutionary state of these sources. We want to observe spectral transitions for two CO isotopes, ^{12}CO and ^{13}CO . Work in OT to setup the correlator to observe the next spectral lines

CO 2-1 230.538 GHz	^{13}CO 2-1 220.398 GHz
CO 3-2 345.795 GHz	^{13}CO 3-2 330.587 GHz
CO 1-0 115.271 GHz	^{13}CO 1-0 110.201 GHz
CO 6-5 691.473 GHz	^{13}CO 6-5 661.067 GHz

Look at the OT messages for any errors while choosing the observing modes and the spectral lines. In particular, see how many science goals you need. Try to estimate the observing time to get a sensitivity of 10 mJy/beam (for each line) at a velocity resolution of about 1 km/s or less, using an angular resolution of 1". How much time do you need for each pair of lines? And the total time for the project?