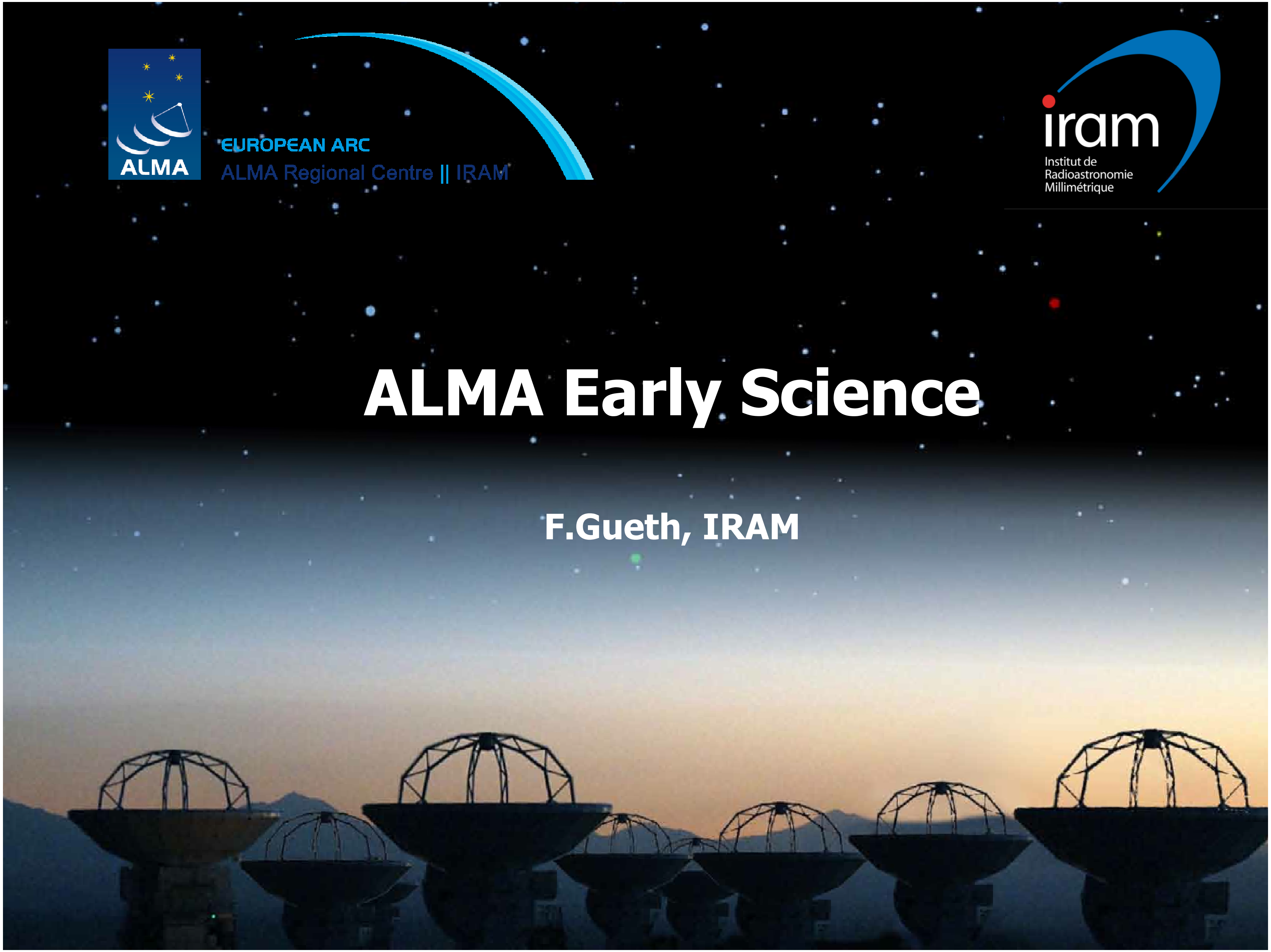


ALMA Early Science

F.Gueth, IRAM


ALMA
EUROPEAN ARC
ALMA Regional Centre || IRAM
iram
Institut de
Radioastronomie
Millimétrique
ALMA Operations

ALMA Operations

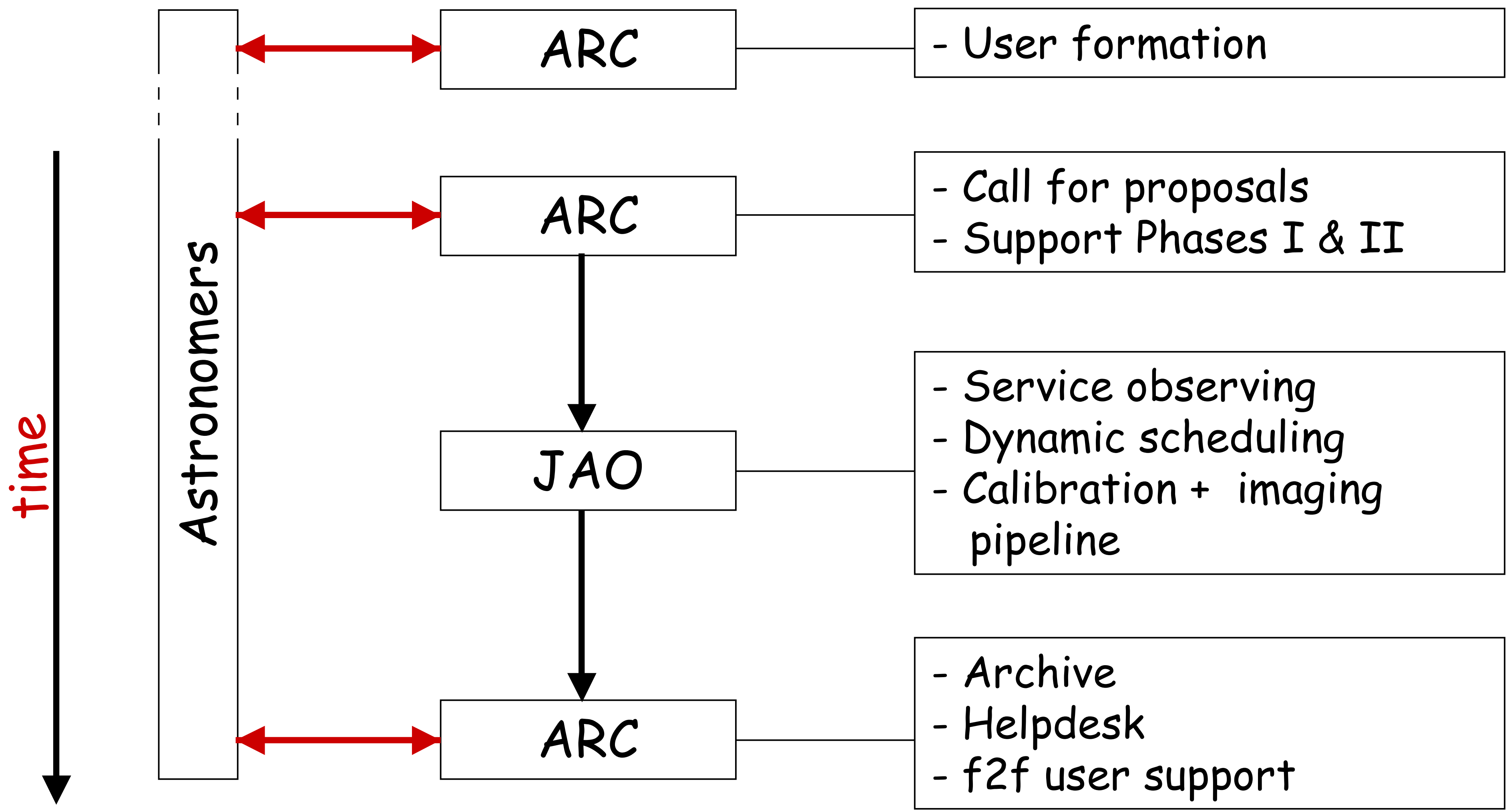
- **One call for Proposals per year (TBC)**
- **One single Time Allocation Committee for NA+EU+EA+Chile**
- **Service observing**
  - PI not involved in the observations
- **Dynamic scheduling**
  - Best project in the queue determined every SB (hour scale)
  - Depends on weather + configuration + priority + balance between partners

ALMA Operations

- **Calibration and imaging pipeline**
  - Final product = data cube
- **Archive**
  - Raw data + pipeline products
  - Public after 12 months
- **ALMA Regional Centers (ARC)**
  - Scientific operations & user support outside Chile
  - Contact point between users and ALMA
  - Three ARCs

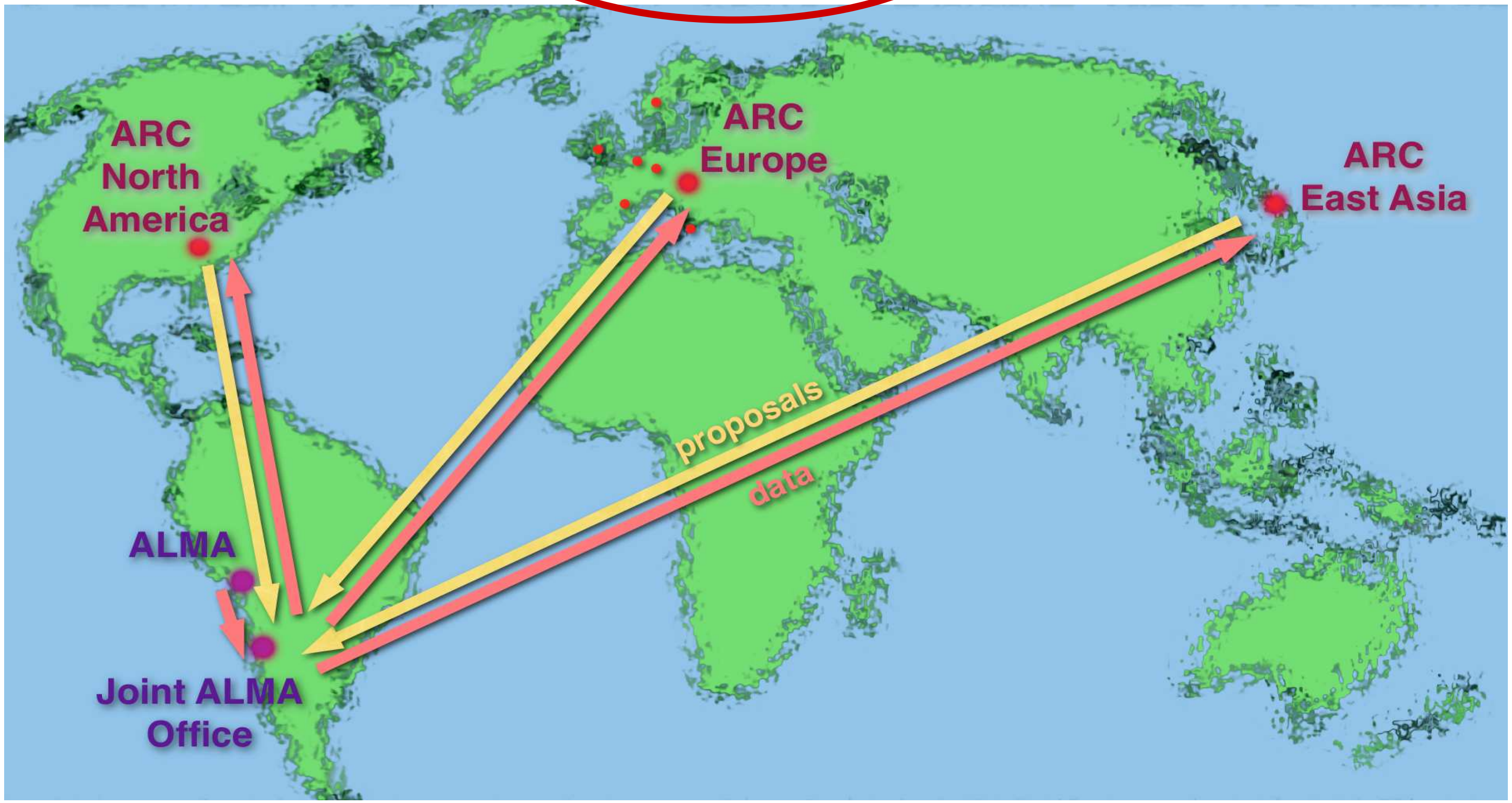
EUROPEAN ARC
ALMA Regional Centre

ALMA Regional Centers



almascience.nrao.edu | almascience.eso.org | almascience.nao.ac.jp

alma-help.nrao.edu | alma-help.eso.org | alma-help.nao.ac.jp



www.almascience.org

The ALMA User Portal

European ARC

Core tasks → ESO Garching

- Call for proposals, Phase I, Phase II
- Basic user support (helpdesk)
- Data product support = delivering data and software
- ALMA archive operations

http://www.eso.org/sci/facilities/alma/arc/

Same services are provided at Charlottesville (NAASC) and Tokyo

European ARC

Additional tasks → ARC nodes

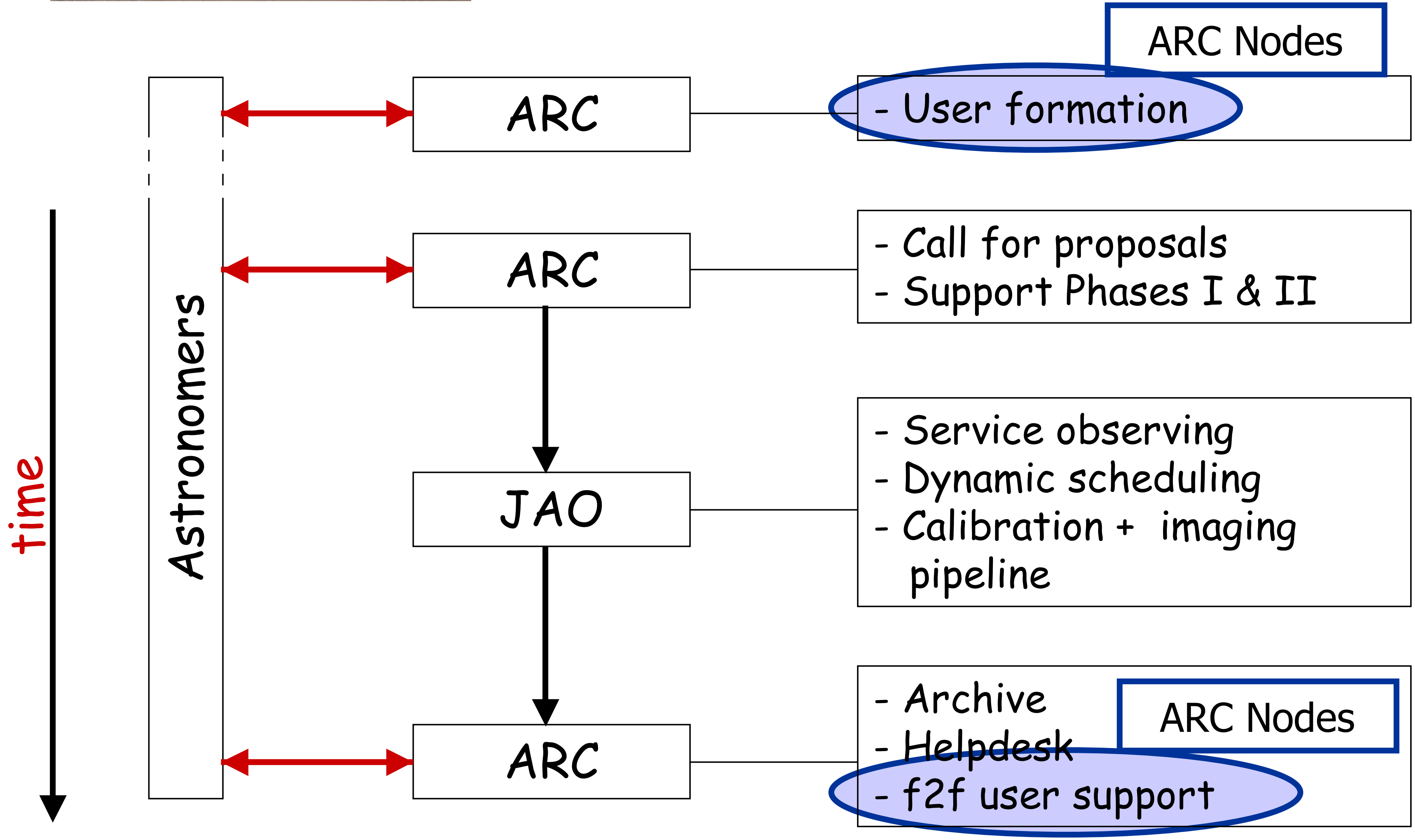
- User formation & community development
- Face-to-face support (core task)
- Special projects (extended archive & data reduction support)
- New developments

Seven ARC nodes in Europe

- INAF Bologna (I)
- Univ. Bonn (D)
- IRAM (F,D,E)
- Leiden Obs. (NL)
- Manchester Obs. (UK)
- Onsala Obs. (S,DK,SF)
- Prague (CZ)

- All nodes open to all European scientists but target own community
- IRAM → French, German, and Spanish communities

ALMA Regional Center



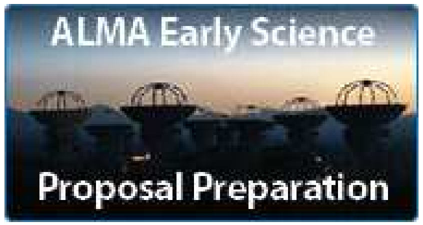
IRAM ARC node

www.iram-institute.org

arc@iram.fr

- New service provided by IRAM to French/German/Spanish community
- Based on PdBI user support + involvement in ALMA construction

User support



f2f support

Expertise center

Software dev.

Commissioning

D.Broguiere, A.Castro –Carrizo

M.Krips, V.Pietu

IRAM ARC Node

Contact: arc@iram.fr

EUROPEAN ARC
ALMA Regional Centre || IRAM

IRAM ARC node

- About the IRAM ARC node
- IRAM involvement in the ALMA construction
- Schools & Workshops
- Visiting program
- Staff
- Contact

ALMA Cycle 0
Full ALMA
ALMA tools
f2f support
Developments
Wiki (internal)

Welcome to the IRAM ARC Node

IRAM has established an **ALMA user support center**, which forms a node of the European ALMA Regional Center (ARC). The ARC nodes are providing support to the community in the preparation of ALMA observing proposals and in the data processing and analysis.

The ARC node is a new service provided by IRAM, open to all interested scientists with special emphasis on the German, French, and Spanish communities. More about the IRAM ARC node.

ALMA Early Science: Cycle 0

The first Call for Proposals for ALMA Early Science has been issued on March 30th 2011. Deadline is **June 30th**

IRAM ARC Node

Contact: arc@iram.fr

EUROPEAN ARC
ALMA Regional Centre || IRAM

IRAM ARC node
ALMA Cycle 0

- Workshop Dec. 2010
- Workshop May 2011
- How to use ALMA

Full ALMA
ALMA tools
f2f support
Developments
Wiki (internal)

ALMA Early Science: Cycle 0

The first Call for Proposals for ALMA Early Science has been issued on March 30th 2011. Deadline is **June 30th 2011 15h UT**. The Call can be found on the **ALMA Science Portal** (click on the Call for Proposals tab).

The Early Science ALMA will consist of 16 antennas, equipped with bands 3, 6, 7 and 9. Two configurations, with baselines up to 400 m will be available. The observations will be performed on a **best-effort basis** only.

- Project timeline: check the How to use ALMA pages *(checked & updated May 17th 2011)*
- Correlator modes during Cycle 0.

Observing with ALMA : Early Science

Time Allocation Committee

- **One single TAC for NA +EU +EA + Chile**
- Chair: N.Evans (Texas)

- Panels (ARP = ALMA Review Panels):
  - Cosmology and high redshift universe
  - Galaxies and galactic nuclei
  - ISM, star formation/protoplanetary disks and their astrochemistry, exoplanets
  - Stellar evolution, (the Sun) and the solar system

- ≥ 1 panel per science category
- 8 members per panel; list (probably) not public

Time Allocation Committee

- **Step 1** : ARPs meetings
- **Step 2**: APRC (ALMA Proporal Review Committee)
  - Chair: Neal Evans (not an ARP member)
  - Members: ARP chairs and deputy chairs
  - Merge outputs of individual ARPs into a single ranked list
  - With the aim to ensure that each region gets its share of ALMA time
  - **Time charged on PI affiliation**
- **Step 3**: Directors Council – final decision

Time Allocation Committee

Each proposal will be assigned a grade

- **A: highest priority proposals** < 20% of the available time
- **B: high priority proposals**
  - to be scheduled at lower priority than grade A proposals
  - A+B proposals account for 100% of the available time
- **C**: scientifically fruitful proposals to be observed only as **fillers**
  - to be observed only if no higher grade proposal for current conditions
  - ~50% oversubscription of available time
- **D**: proposals rejected

ALMA observing time

- No guaranteed time
- One single TAC for NA+EU+EA+Chile
- A world-wide collaboration
  - EU 33.75%, NA 33.75%, EA 22.5%, Chile 10%
  - In ESO: D~21%, F~16%, E~9%
  - In ALMA: D~7%, F~5.5%, E~3%

IRAM community ~ 15%

- Cycle 0: plan to accept ~100 projects
- ALMA received 601 notice of intend in April…

- Expect **huge competition**


EUROPEAN ARC
ALMA Regional Centre || IRAM
ALMA
iram
Institut de
Radioastronomie
Millimétrique
Cycle 0

ALMA Cycle 0

Cycle 0 call for proposals - timeline

- Issued March 30th 2011
- Archive open June 1st
- **Deadline June 30th 2011 15h UT**
- ARP, APRC meetings August 2011
- September 2011: outcome of the proposal review process
- **30 September 2011: start of Cycle 0 science observations**

- March/April 2012: expected deadline for Cycle 1 proposal submission
- 30 June 2012: end of Cycle 0

ALMA Cycle 0

Cycle 0 call for proposals - policies

- Will allocate max. 500-700 hours observing time, in blocks of 8-12 hours
- O*K*: normal projects (<100h), Target of Opportunities
- NO: large projects (>100h)
- **Typical project duration = 5-7 hours**
- **Expect ~100 projects to be accepted**

- Open sky policy
- Basic quality checks done by JAO/ARC
- **12 months proprietary period** after dataset ready for delivery

ALMA Cycle 0

Cycle 0 call for proposals – best effort

- **Top priority is construction & commissioning of ALMA**
- Do not guarantee observations of all accepted projects
- Projects are not carried over to Cycle 1 if not observed
- Basic data quality check only
- PIs should invest own time and expertise in data reduction

Notice of intents

- ALMA asked for Notice of Intent April 29th
- Not mandatory, no commitments
- ALMA received **601 NoI**
  - Somewhat flat distribution as a function of configurations, receiver bands, scientific categories
- Expect a huge competition!

Cycle 0 array

ALMA	IRAM	GHz
B3	B1	84-116
B6	B3	211-275
B7	B4	275-373
B9	--	602-720

ALMA Cycle 0

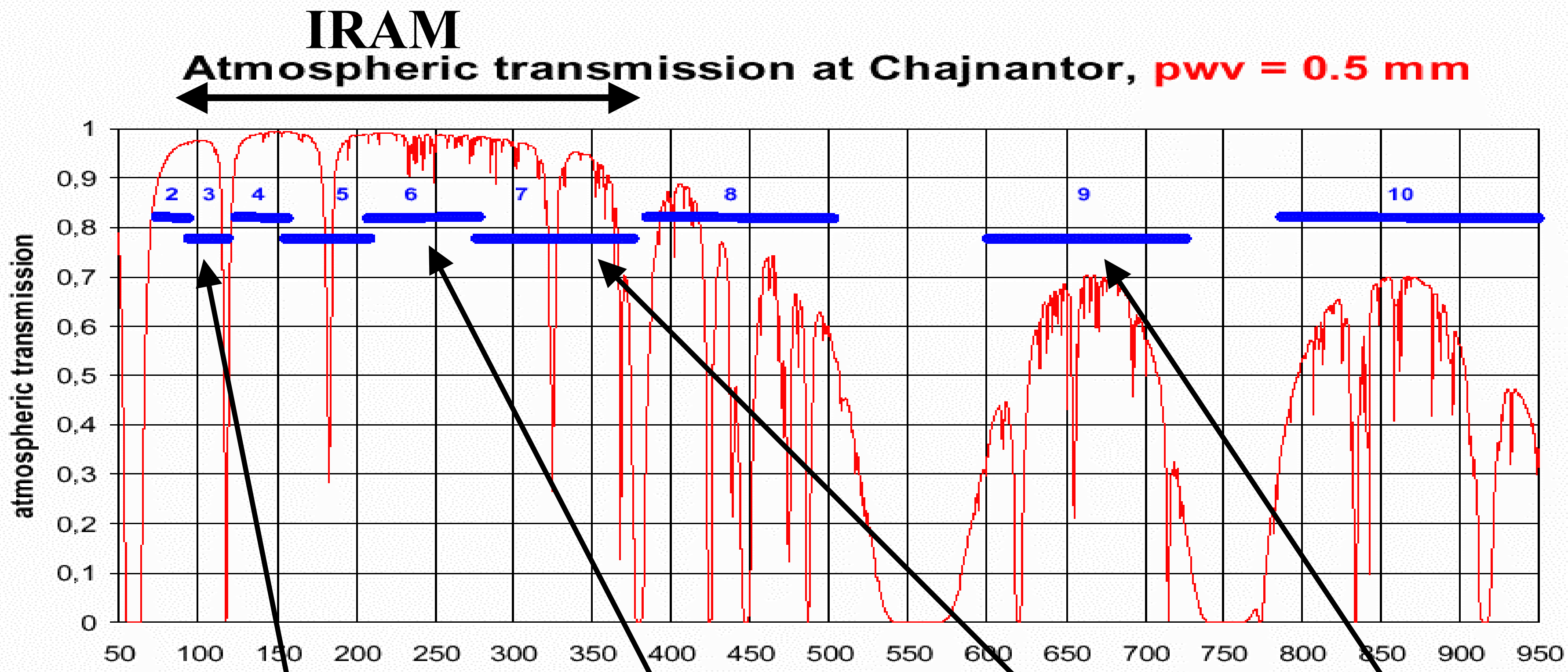
- 16 antennas
- 4 bands : B3, B6, B7, B9
- Baselines up to 400 m
- Mosaics up to 50 fields
- Calibration accuracy "as good as current arrays"

Limitations

- Only ~30% observing time → **limited number of projects**
- No ACA, no short-spacings
- No pipeline, no polarimetry
- Restrictions in terms of observing modes (correlator modes)

Best-effort basis only

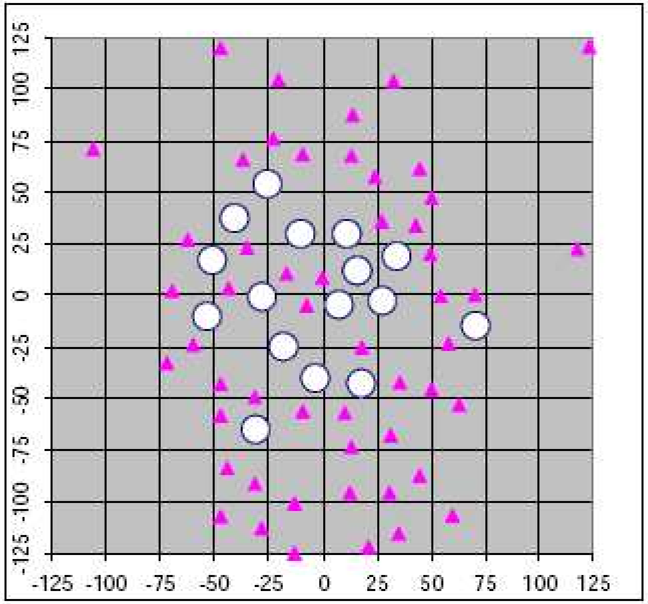
Receivers bands

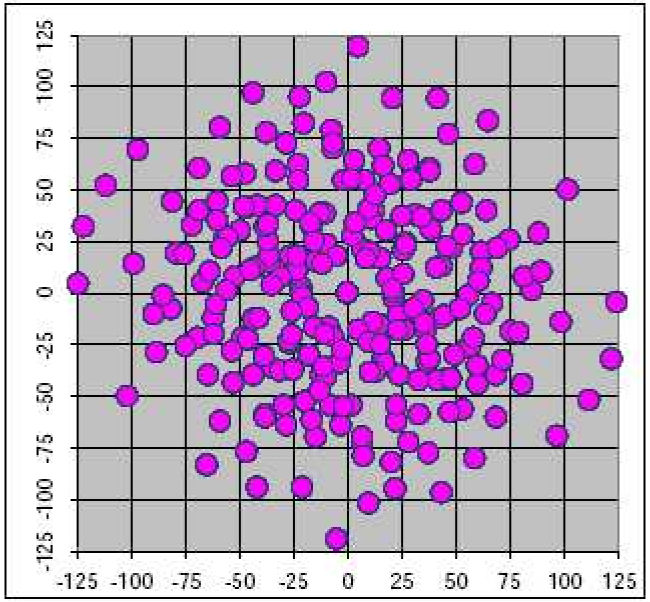


Band 3	Band 6	Band 7	Band 9
3mm window	1.3mm window	850 μm window	450 μm window
84-116 GHz	211-275 GHz	275-376 GHz	602-720 GHz
~ B1 IRAM	~ B3 IRAM	~ B4 IRAM	

COMPACT

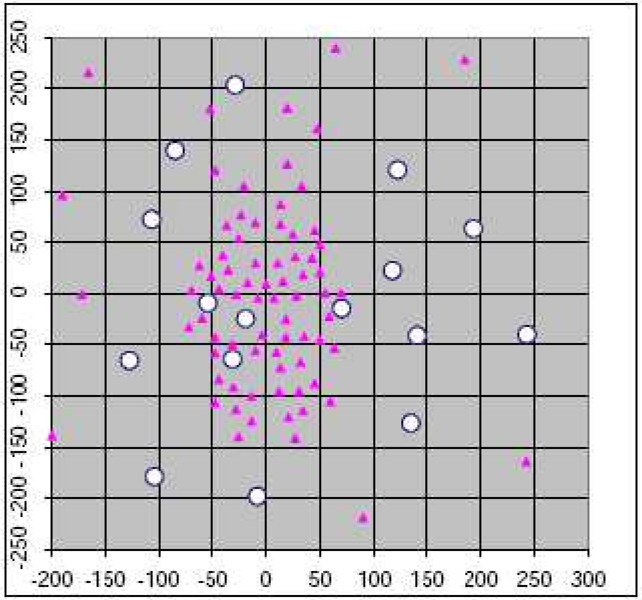
Up to 125 m

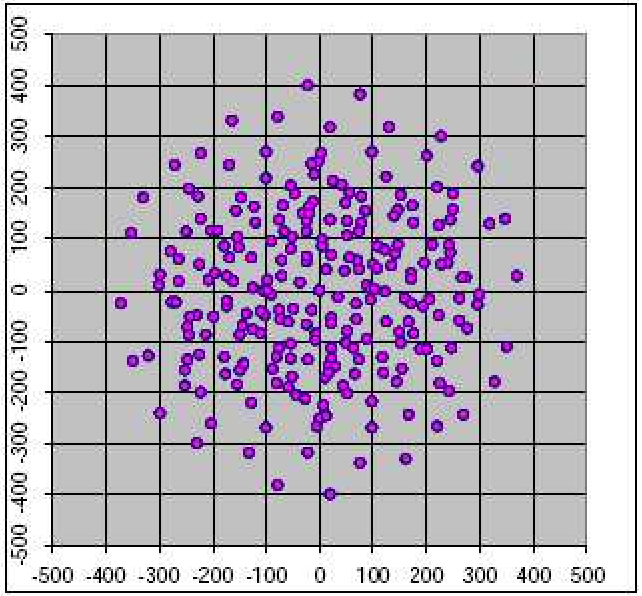




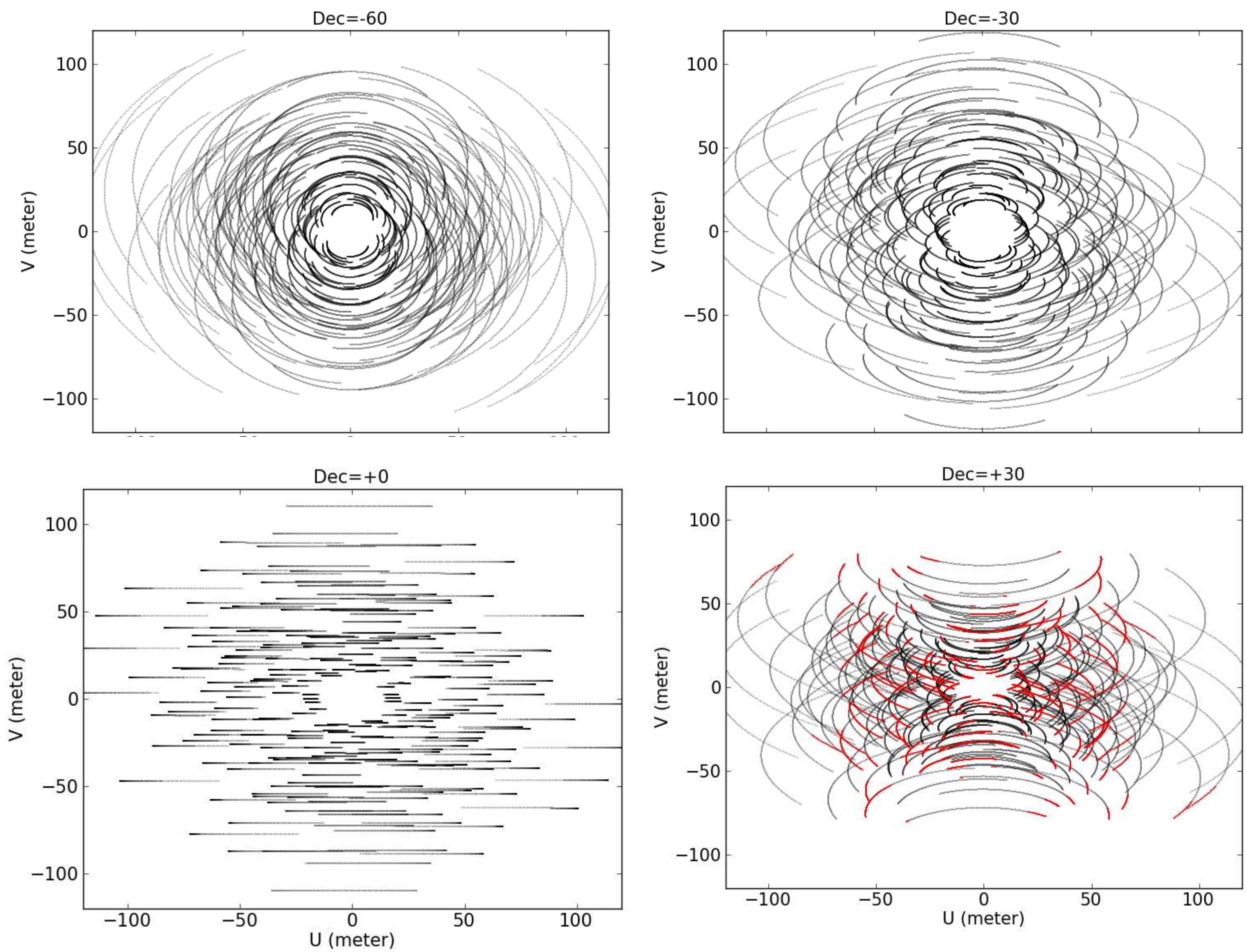
EXTENDED

Up to 400m

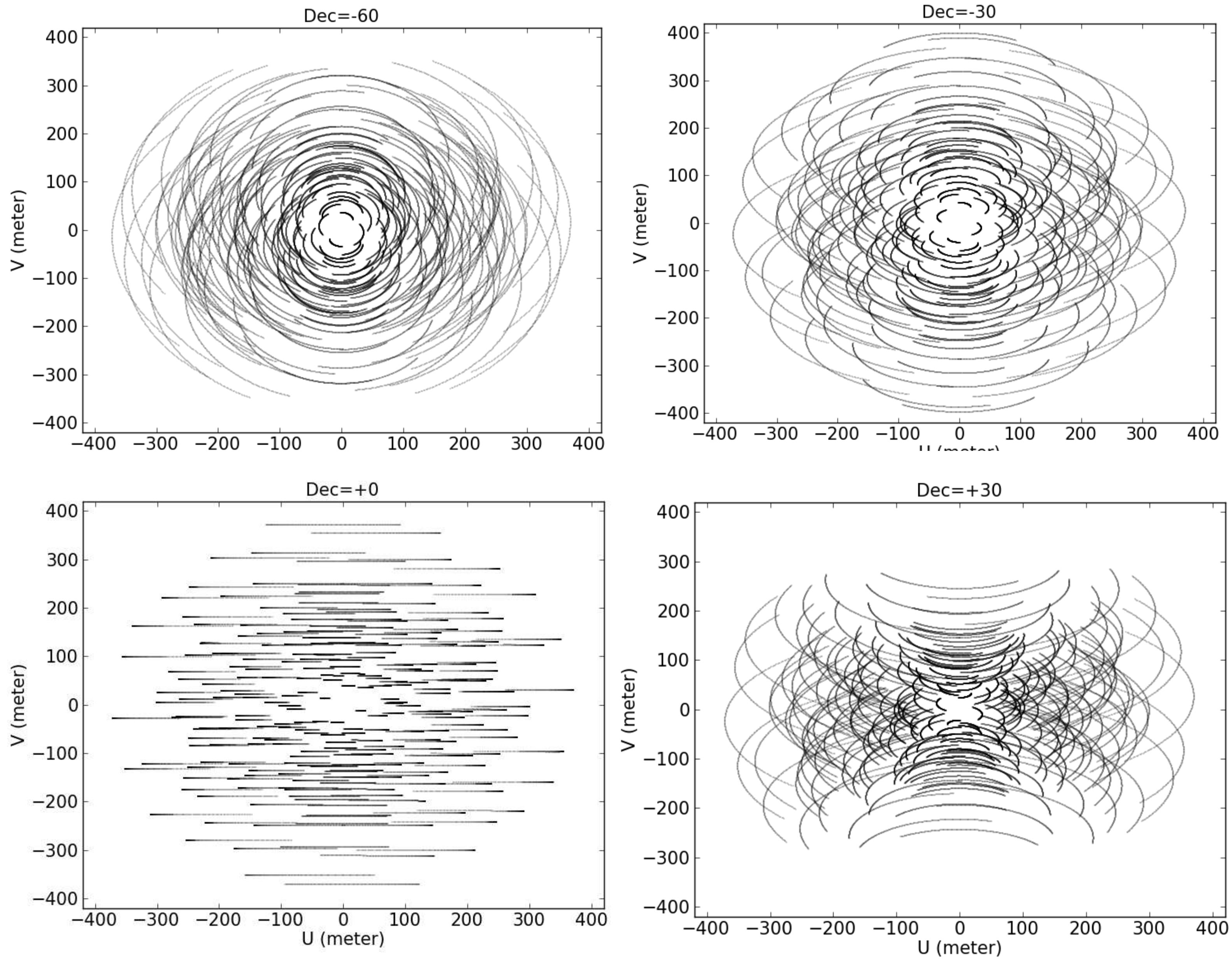


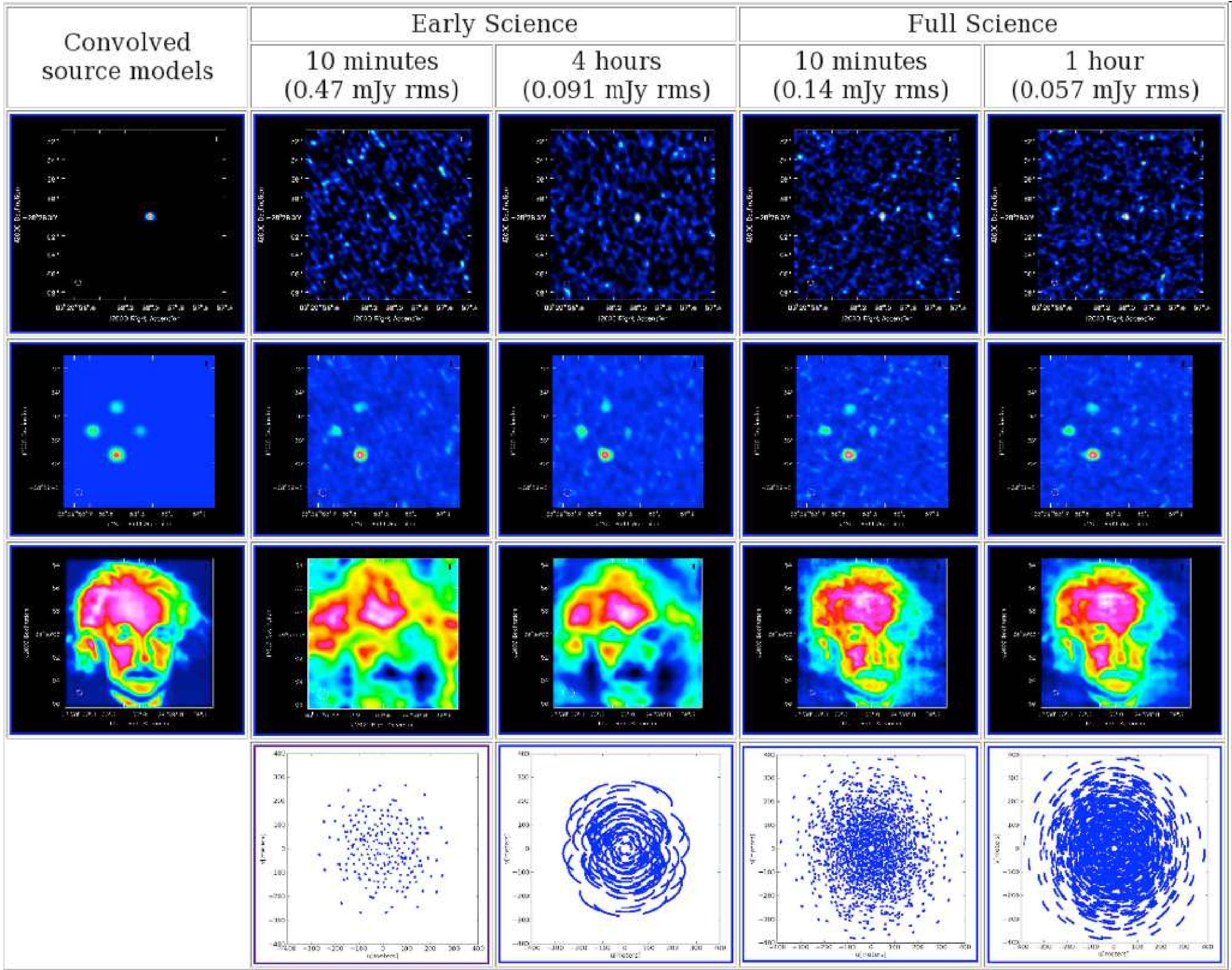


COMPACT CONFIGURATION



EXTENDED CONFIGURATION




Convolved source models
Early Science
Full Science
10 minutes (0.47 mJy rms)
4 hours (0.091 mJy rms)
10 minutes (0.14 mJy rms)
1 hour (0.057 mJy rms)

Angular resolution

Dec -30	Band 3		Band 6		Band 7		Band 9	
	Maj.	Min.	Maj.	Min.	Maj.	Min.	Maj.	Min.
Compact	5.5	4.8	2.4	2.1	1.6	1.4	0.8	0.7
Extended	1.5	1.4	0.6	0.6	0.4	0.4	0.2	0.2

PdBI (800m) 0.8 0.3 0.2

Schedule

- **EXTENDED** October-November RA ~ 21h to 09h
- **COMPACT** December-January RA ~ 01h to 13h
- Shutdown February
- **COMPACT** March-April RA ~ 07h to 19h
- **EXTENDED** May-June RA ~ 11h to 23h

EXTENDED CONFIGURATION

shortest baseline = 36 m

lack of short spacings

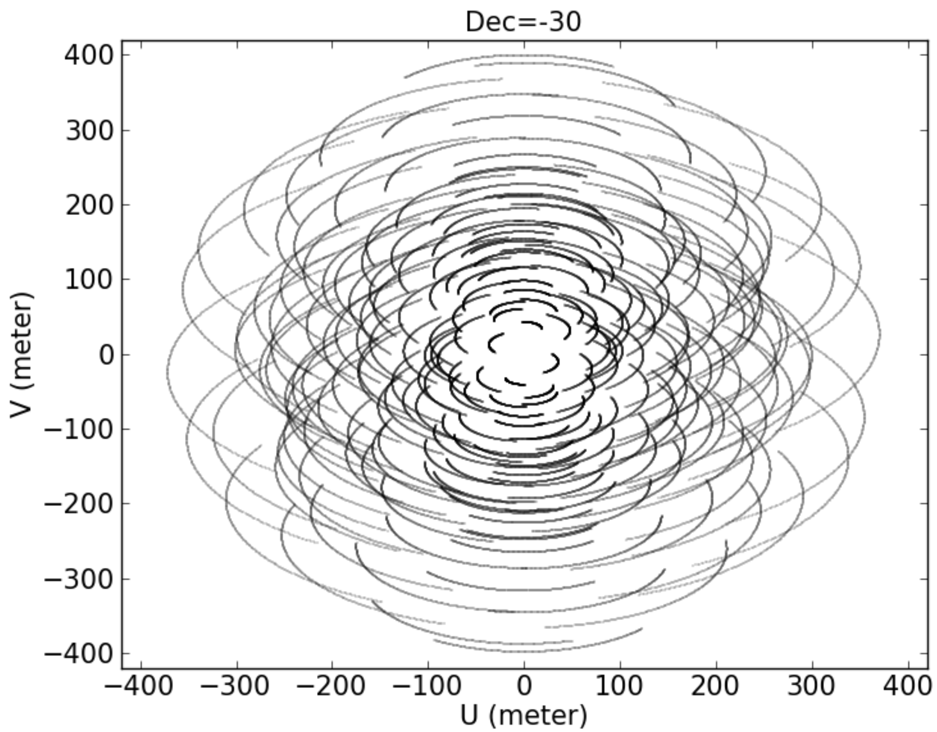


Table 6. Maximum Scale (arcsec) for a source at Dec = -30 degrees

Configuration	Compact	Extended
B_{min} (meter)	15	30
Band 3 (“)	21.0	10.5
Band 6 (“)	9.0	4.5
Band 7 (“)	6.0	3.0
Band 9 (“)	3.0	1.5

Sensitivities

- **16 antennas**: 2304 m2 = 1.7 (PdBI 1350 m2)

ALMA Band	Central Frequency	IRAM Band	Sensitivity gain
B3	100 GHz	B1	~1.8
B6	230 GHz	B3	~2.5
B7	345 GHz	B4	~3.5
B9	675 GHz	--	--

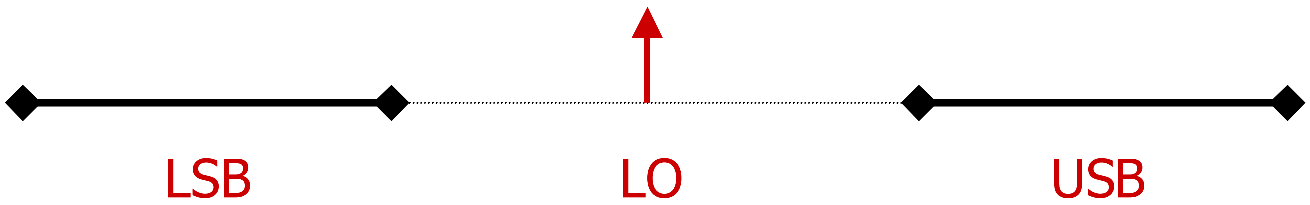
NB: ALMA sensitivity estimator somewhat optimistic

- All receivers with 8 GHz bandwidth x two polarizations
  (PdBI: 4 GHZ x two polarizations; 30m: up to 16 GHz x two pol.)

- **Time Estimator available on the User Portal or within the Observing Tool**

Receiver bandwidth

Heterodyne receivers are sensitive to Lower Side Band and Upper Side Band



Receivers can be

- **DSB** outputs the sum LSB + DSB → separated in the correlator
- **SSB** outputs LSB **or** DSB
- **2SB** outputs LSB and DSB separately

IRAM receivers

PdBI SSB receivers 4-8 GH*z* (4 GH*z* bandwidth LSB or USB)

EMIR090 2SB receivers 4-12 GH*z* (16 GH*z* bandwidth)

EMIR150 and EMIR230 SSB receiver 4-8 GH*z*

EMIR330 2SB receivers 4-8 GH*z* (8 GH*z* bandwidth)

Receivers have 4 to 16 GHz bandwidth

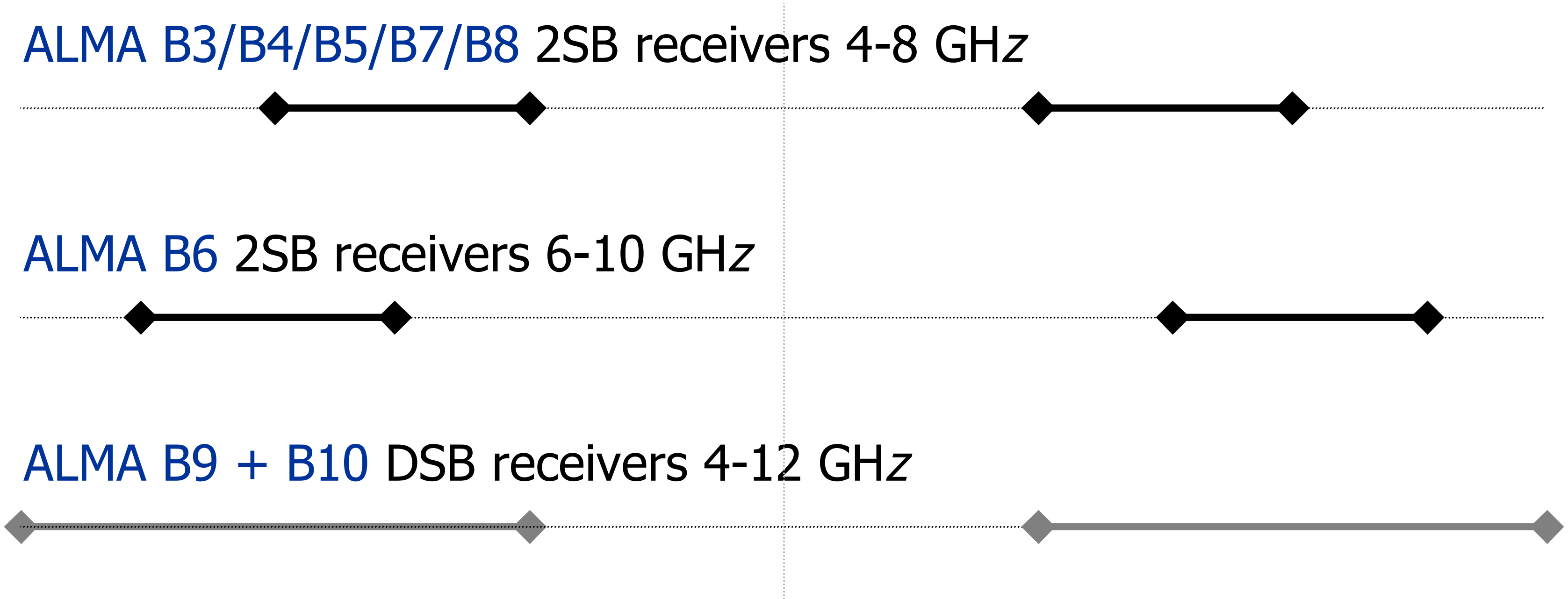
x 2 polarizations

ALMA receivers

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

ALMA B6 2SB receivers 6-10 GHz

ALMA B9 + B10 DSB receivers 4-12 GHz



All ALMA receivers bands have 8 GHz bandwidth

x 2 polarizations

ALMA correlator

- ALMA correlator = **4 basebands**
- Each baseband processes
  - 64 antennas (2016 baselines)
  - 2 polarizations
  - **2 GHz input**

Can process the incoming 8 GHz x 2 polarizations

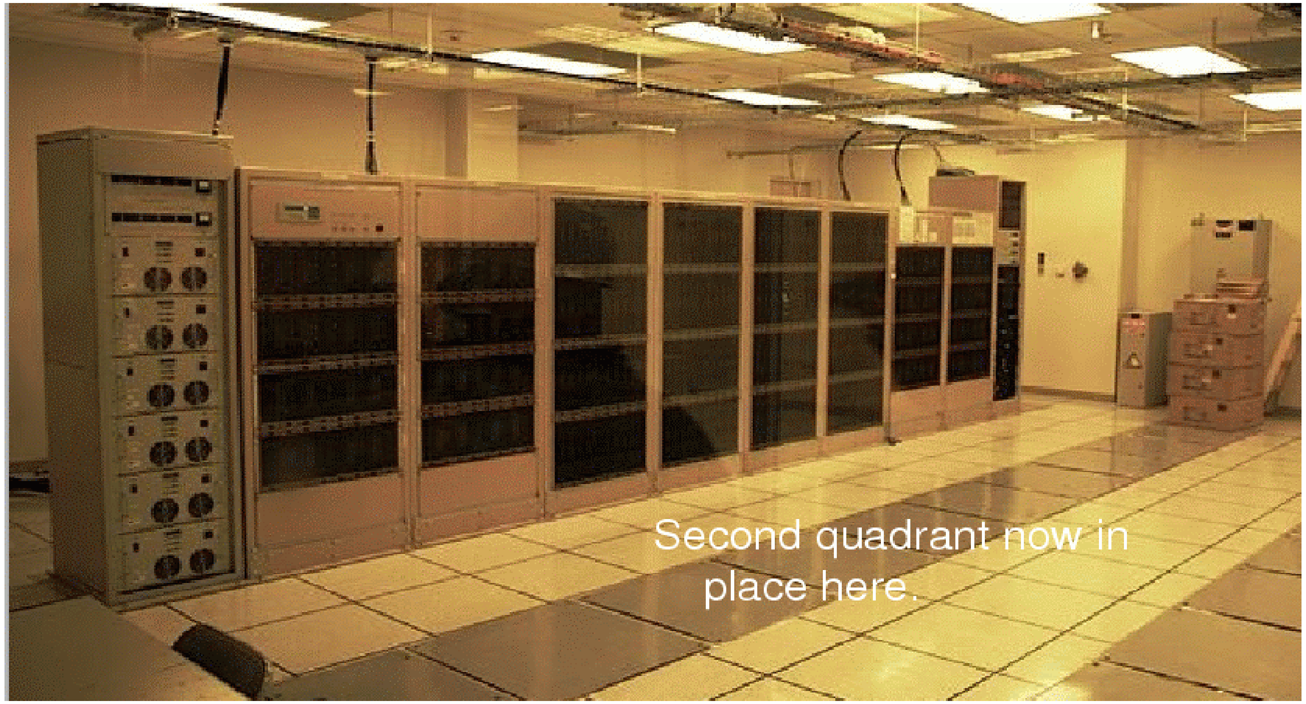
- Each baseband can be centered anywhere* in the incoming 8 GHz
- All four basebands can be setup independently : gain on resolution / loss on bandwidth

(* Minor limitations because of LOs finite step)

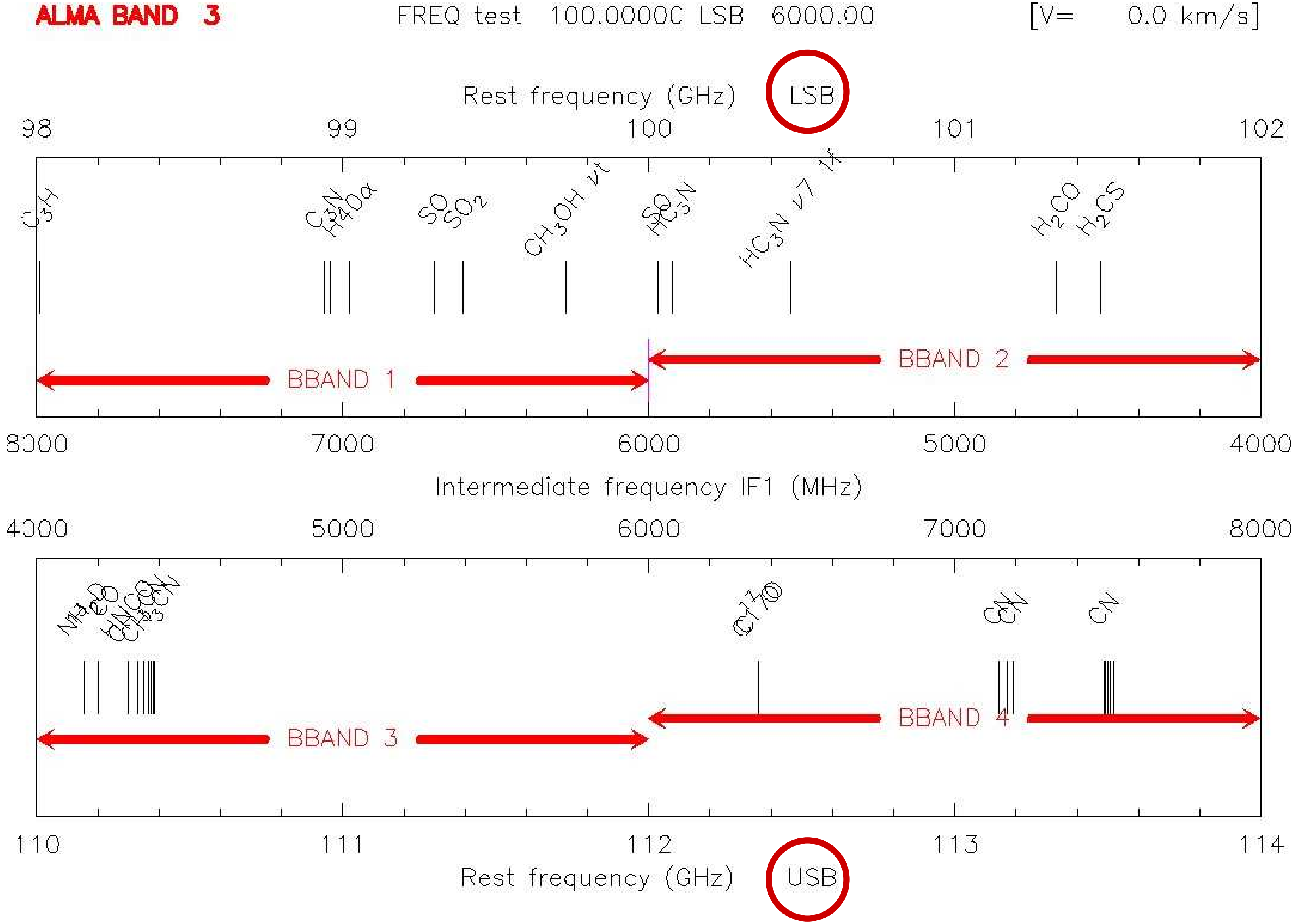
Higher spectral resolution but not on the full 8 GHz

ALMA correlator

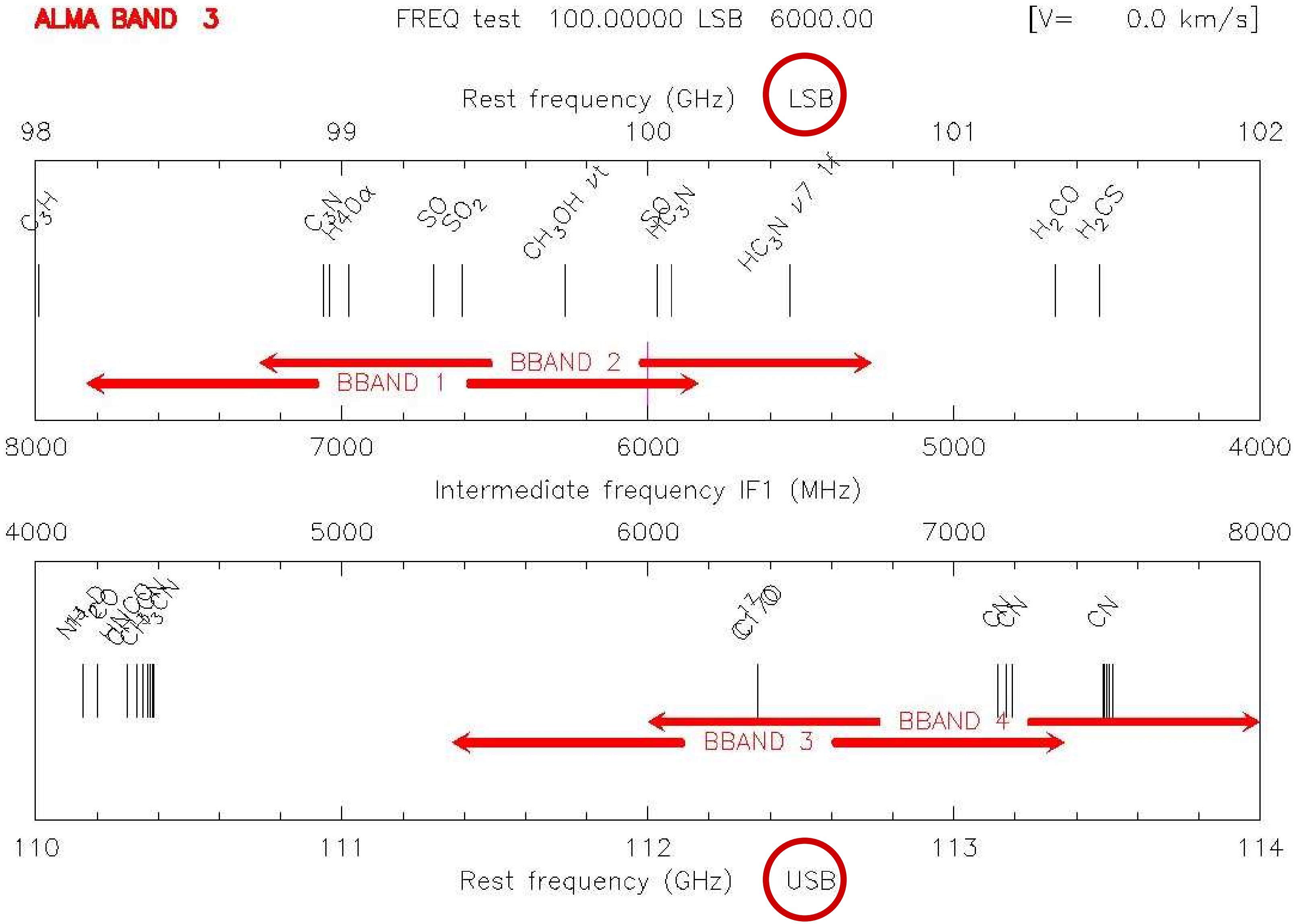
- Physically: correlator = 4 quadrants
- **Full ALMA: 1 quadrant = 1 baseband**
- **<16 antennas : 1 quadrant = 4 basebands**



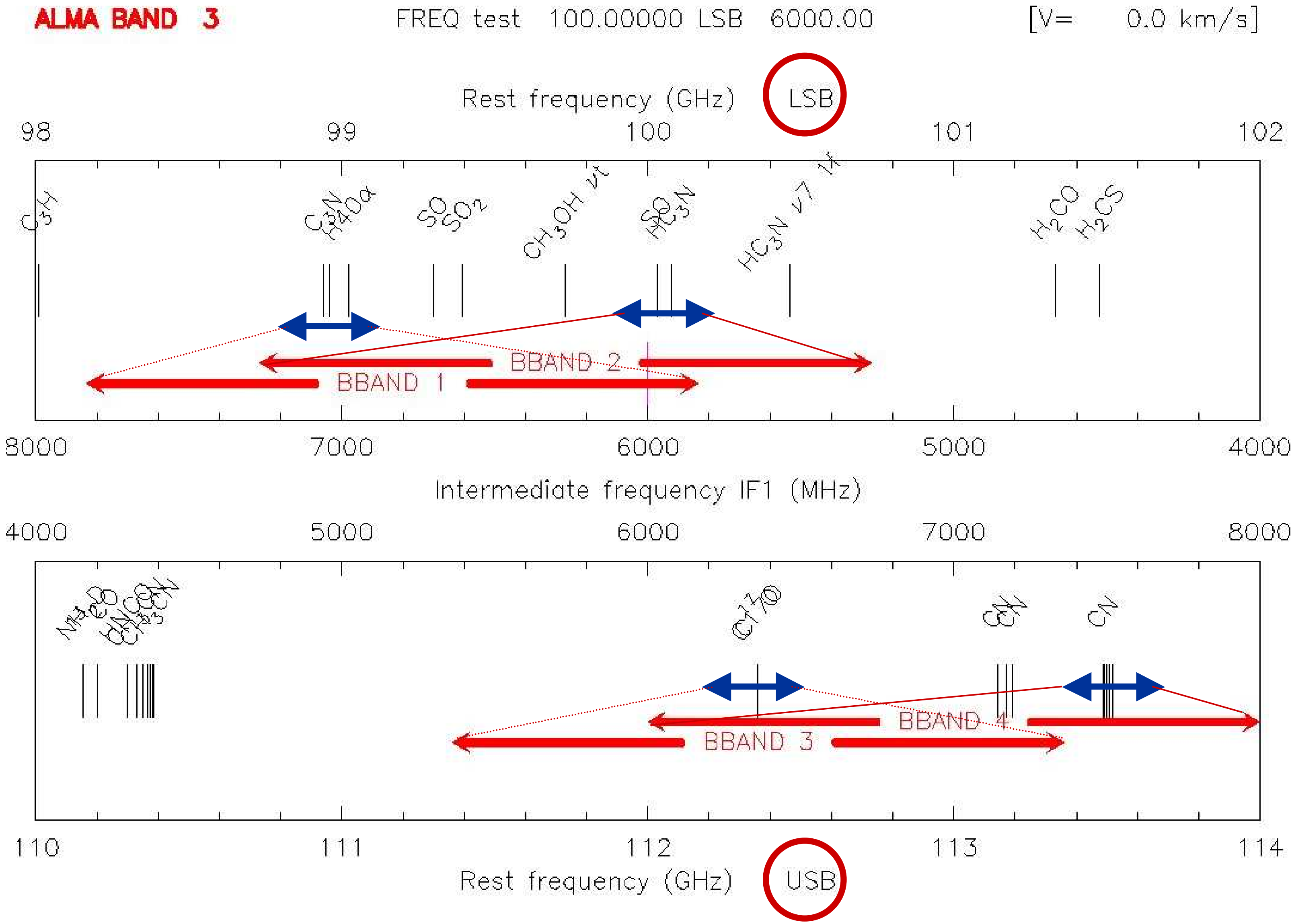
ALMA : basebands



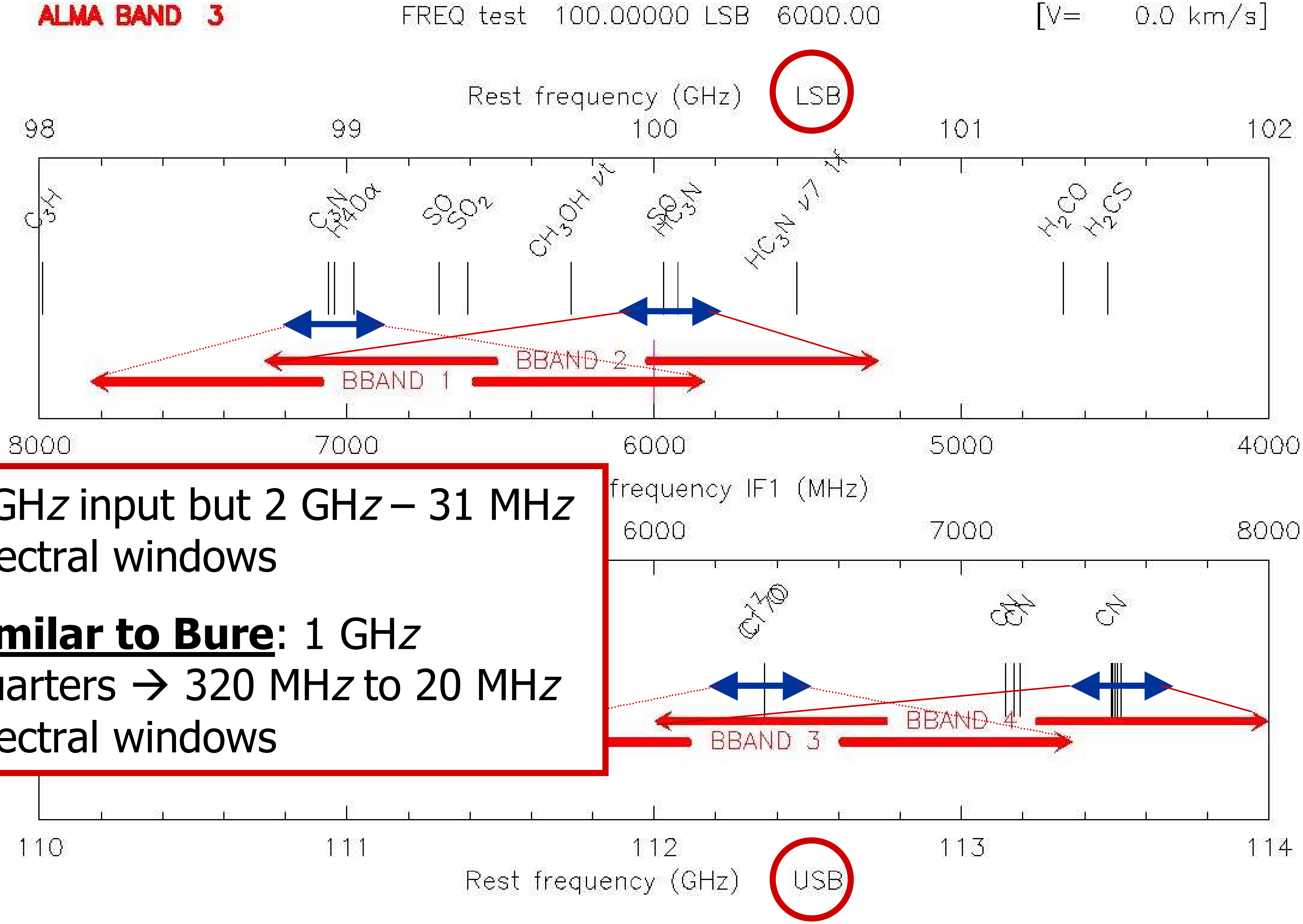
ALMA : basebands



ALMA : basebands



ALMA : basebands



2 GHz input but 2 GHz – 31 MHz spectral windows

<u>Similar to Bure</u>: 1 GHz Quarters → 320 MHz to 20 MHz spectral windows

Basebands modes

1 polarization output (H or *V*)

- 2 GHz 8192 channels x 1 Pol = 244 kHz resol.
- 1 GHz 8192 channels x 1 Pol = 122 kHz resol.
- 500 MHz 8192 channels x 1 Pol = 61 kHz resol.
- 250 MHz 8192 channels x 1 Pol = 30 kHz resol.
- 125 MHz 8192 channels x 1 Pol = 15 kHz resol.
- 64 MHz 8192 channels x 1 Pol = 7.6 kHz resol.
- 31.25 MHz 8192 channels x 1 Pol = 3.8 kHz resol.
- Continuum mode 256 ch. x 1 Pol = 7.8 MHz resol.

Basebands modes

1 polarization output (H or V)

- 2 GHz 8192 channels x 1 Pol = 244 kHz resol.
- 1 GHz 8192 channels x 1 Pol = 122 kHz resol.
- 500 MHz 8192 channels x 1 Pol = 61 kHz resol.
- 250 MHz 8192 channels x 1 Pol = 30 kHz resol.
- 125 MHz 8192 channels x 1 Pol = 15 kHz resol.
- 64 MHz 8192 channels x 1 Pol = 7.5 kHz resol.
- 31.25 MHz 8192 channels x 1 Pol = 3.8 kHz resol.

FDM

- Continuum mode 256 ch. x 1 Pol = 7.5 MHz resol. **TDM**

Frequency/Time division modes

Basebands modes

2 polarization outputs (H and V)

- 2 GHz 4096 channels x 2 Pol = 488 kHz resol.
- 1 GHz 4096 channels x 2 Pol = 244 kHz resol.
- 500 MHz 4096 channels x 2 Pol = 122 kHz resol.
- 250 MHz 4096 channels x 2 Pol = 61 kHz resol.
- 125 MHz 4096 channels x 2 Pol = 30 kHz resol.
- 64 MHz 4096 channels x 2 Pol = 15 kHz resol.
- 31.25 MHz 4096 channels x 2 Pol = 7.6 kHz resol.
- Continuum mode 128 ch. x 2 Pol = 15.6 MHz resol.

Baseband = 8192 channels

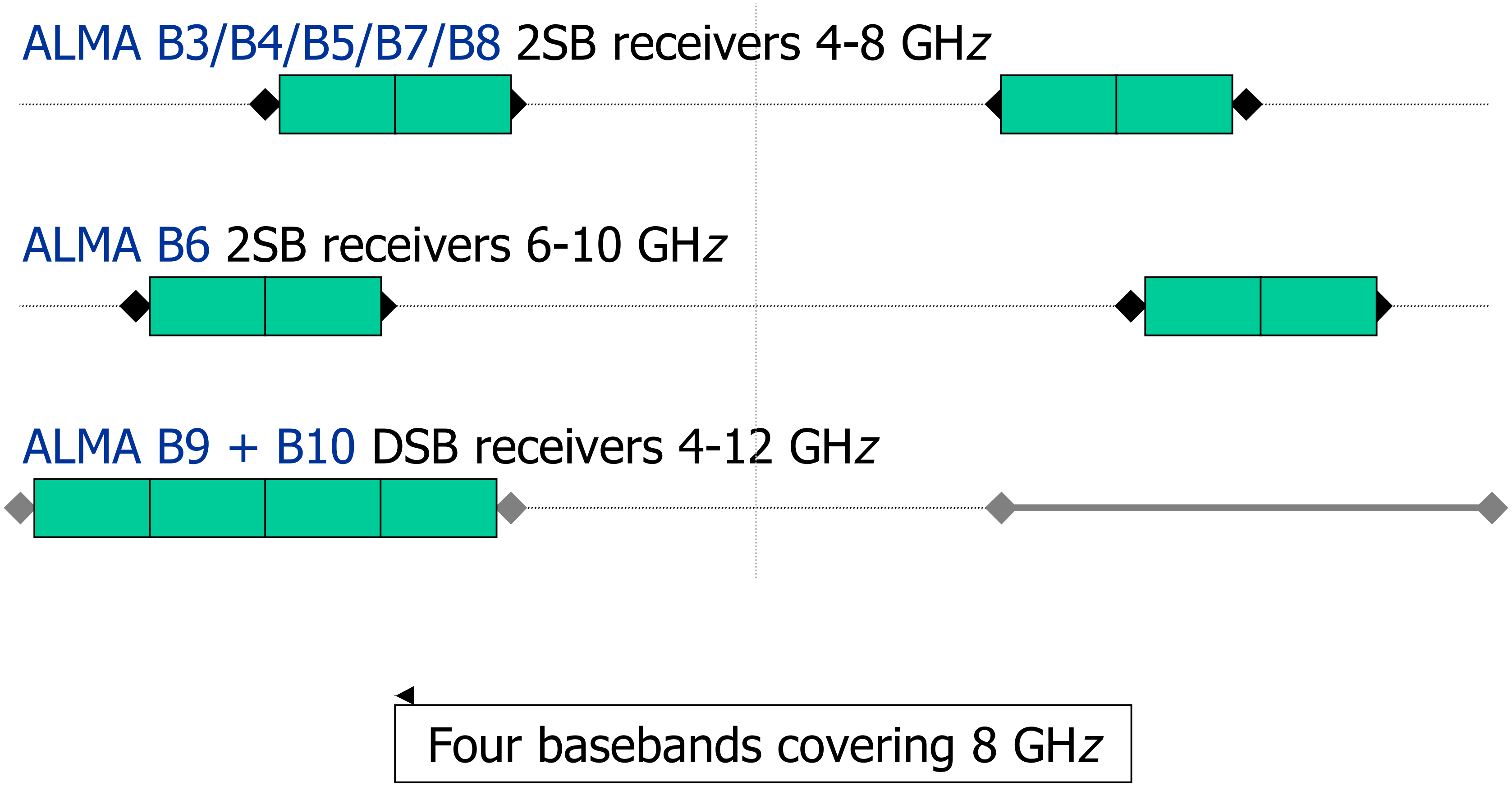
Basebands modes

4 polarization outputs (HH, VV, HV, VH)

- 2 GHz 2048 channels x 4 Pol = 976 kHz resol.
- 1 GHz 2048 channels x 4 Pol = 488 kHz resol.
- 500 MHz 2048 channels x 4 Pol = 244 kHz resol.
- 250 MHz 2048 channels x 4 Pol = 122 kHz resol.
- 125 MHz 2048 channels x 4 Pol = 61 kHz resol.
- 64 MHz 2048 channels x 4 Pol = 30 kHz resol.
- 31.25 MHz 2048 channels x 4 Pol = 15 kHz resol.
- Continuum mode 64 ch. x 4 Pol = 31 MHz resol.

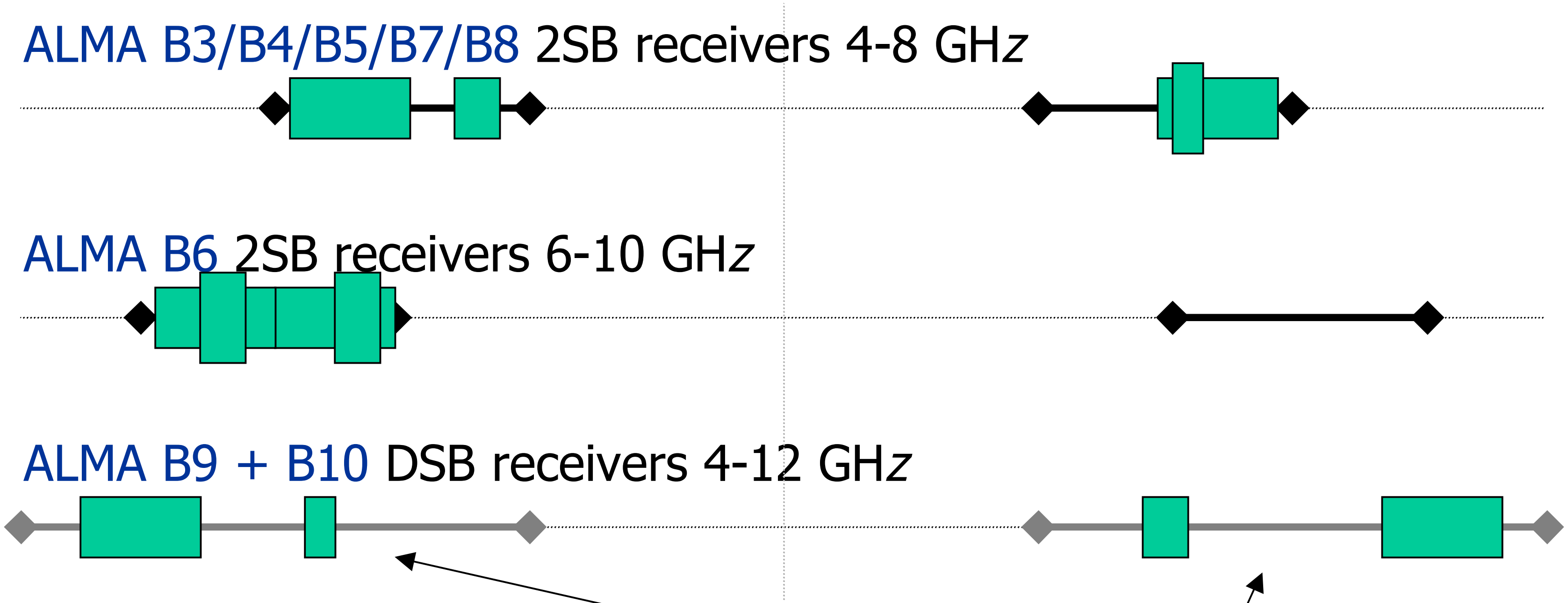
Baseband = 8192 channels

Examples



ALMA B3/B4/B5/B7/B8 2SB receivers 4-8 GHz
ALMA B6 2SB receivers 6-10 GHz
ALMA B9 + B10 DSB receivers 4-12 GHz
Four basebands covering 8 GHz

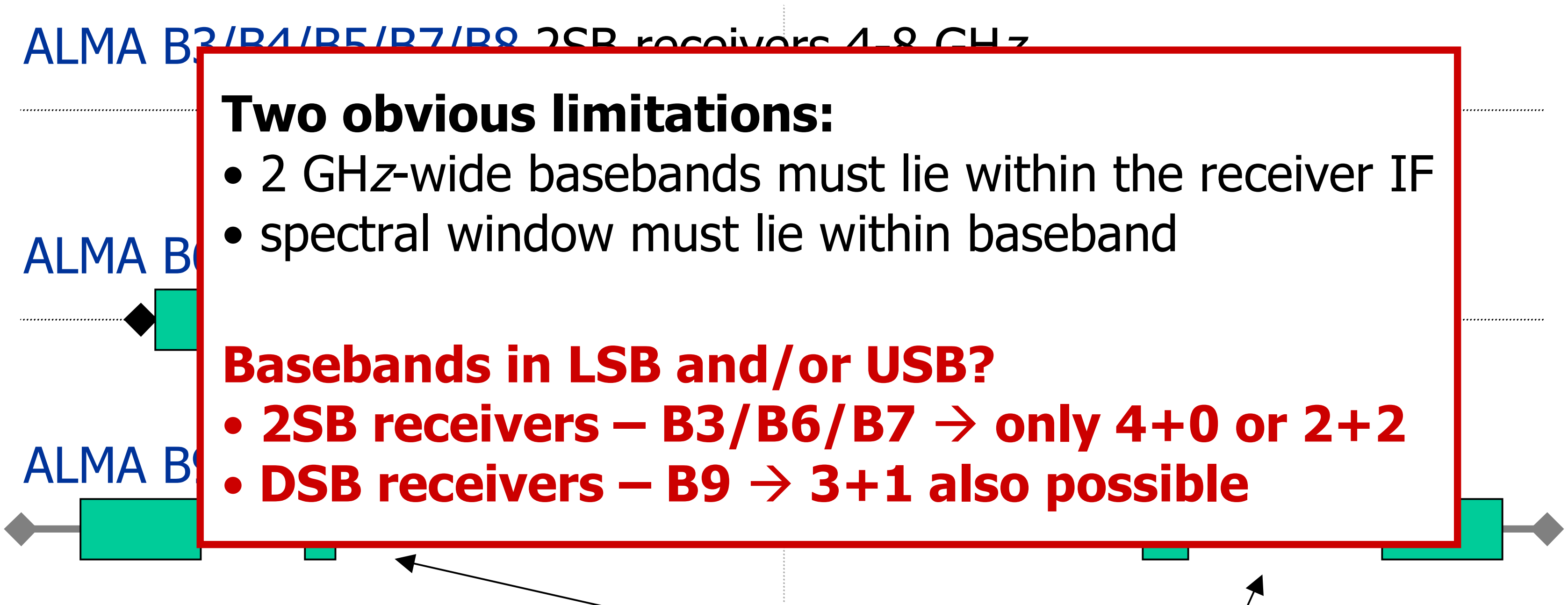
Examples



Four basebands with different width/resolution

B9 + B10: choice of LSB vs USB done <u>for each baseband</u>

Examples



Two obvious limitations:
- 2 GHz-wide basebands must lie within the receiver IF
- spectral window must lie within baseband

Basebands in LSB and/or USB?
- **2SB receivers – B3/B6/B7 → only 4+0 or 2+2**
- **DSB receivers – B9 → 3+1 also possible**

Four basebands with different width/resolution

B9 + B10: choice of LSB vs USB done <u>for each baseband</u>

Summary

- **4 independent spectral windows**
- **2 GHz to 31.25 MHz bandwidth**
  - **1, 2, or 4 polar. products**
  - **8192 channels**
- ***OR* 2 GHz continuum**

<u>real bandwidths are smaller</u>

- 1875 instead of 2000 MHz
- 938 instead of 1000 MHz
- 469 instead of 512 MHz
- 234 instead of 256 MHz
- 117 instead of 128 MHz
- 58.6 instead of 64 MHz

<u>real resolutions are higher</u>

1.2 to 2 times the channel spacing

<u>real number of channels</u>

7680 instead of 8192

Summary

- 4 independent spectral windows
- 2 GHz to 31.25 MHz bandwidth
  - 1, 2, or 4 polar. products
  - 8192 channels
- *OR* 2 GHz continuum

- Full-ALMA correlator is much more complex – can split the basebands in several/many windows
- Cycle 0 correlator is more simple – several limitations

Correlator Cycle 0

1 polarization output (H or *V*)

- 2 GHz 8192 channels x 1 Pol = 244 kH*z* resol.
- 1 GHz 8192 channels x 1 Pol = 122 kH*z* resol.
- 500 MHz 8192 channels x 1 Pol = 61 kH*z* resol.
- 250 MHz 8192 channels x 1 Pol = 30 kH*z* resol.
- 125 MHz 8192 channels x 1 Pol = 15 kH*z* resol.
- 64 MHz 8192 channels x 1 Pol = 7.6 kH*z* resol.

FDM

- Continuum mode 256 ch. x 1 Pol = 7.8 MH*z* resol. **TDM**

Correlator Cycle 0

Proposers guide p.36

1 polarization output (H or *V*) – actual channels numbers

- 1875MHz 7680 channels x 1 Pol = 244 kHz resol.
- 938 MHz 7680 channels x 1 Pol = 122 kHz resol.
- 469 MHz 7680 channels x 1 Pol = 61 kHz resol.
- 234 MHz 7680 channels x 1 Pol = 30 kHz resol.
- 117 MHz 7680 channels x 1 Pol = 15 kHz resol.
- 58.6 MHz 7680 channels x 1 Pol = 7.6 kHz resol.
- Continuum mode 256 ch. x 1 Pol = 7.8 MHz resol.

FDM

TDM

Correlator Cycle 0

Proposers guide p.36

2 polarization outputs (H and *V*) – actual channels numbers

- 1875MH*z* 7680 channels x 2 Pol = 488 kH*z* resol.
- 938 MH*z* 7680 channels x 2 Pol = 244 kH*z* resol.
- 469 MH*z* 7680 channels x 2 Pol = 122 kH*z* resol.
- 234 MH*z* 7680 channels x 2 Pol = 61 kH*z* resol.
- 117 MH*z* 7680 channels x 2 Pol = 30 kH*z* resol.
- 58.6 MH*z* 7680 channels x 2 Pol = 15 kH*z* resol.
- Continuum mode 256 ch. x 2 Pol = 15.6 MH*z* resol.

FDM

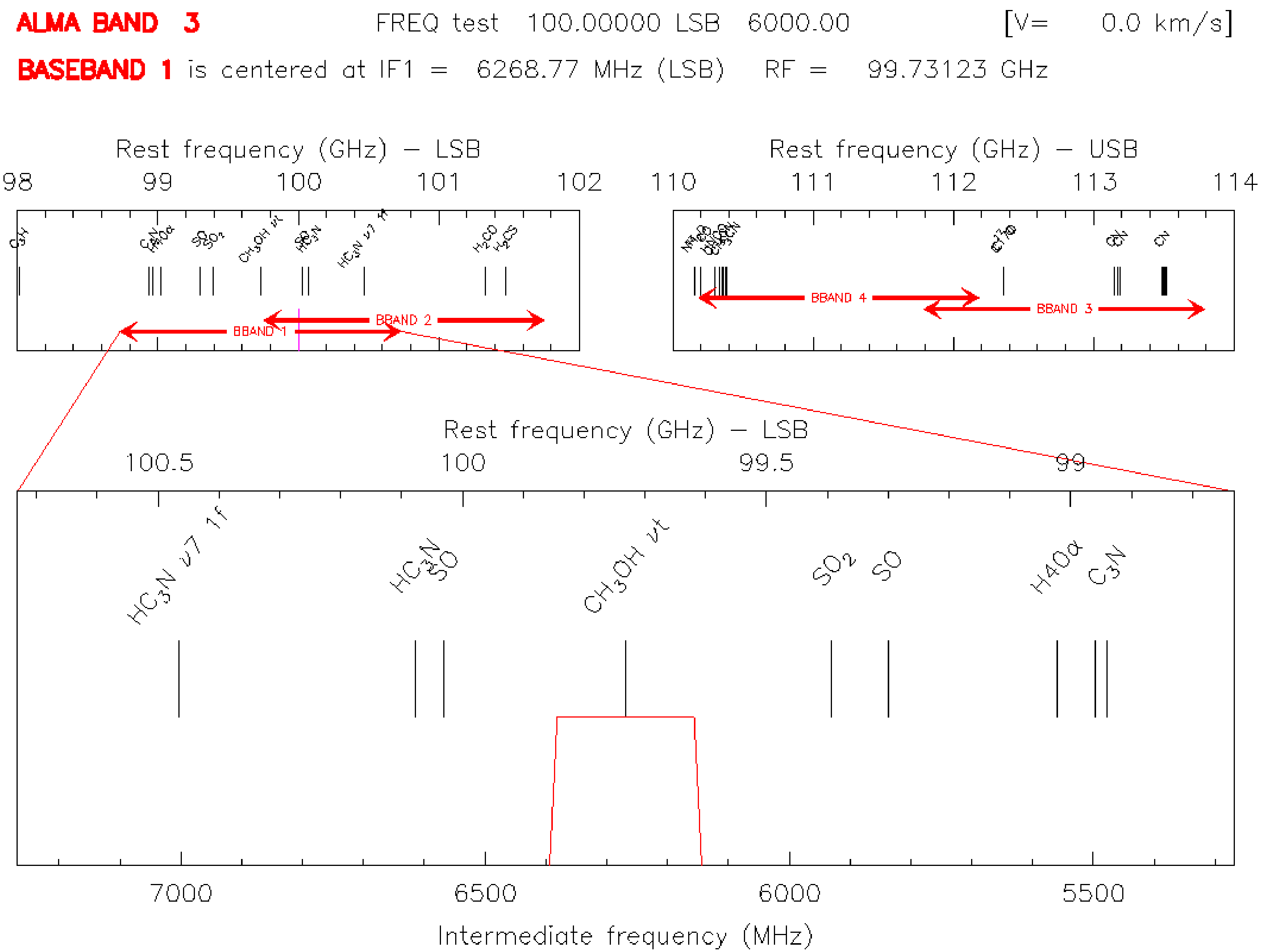
TDM

4 polarization outputs – not offered in Cycle 0

Correlator Cycle 0

All four spectral windows must share the same mode

- Same resolution/bandwidth for the four spectral windows
  - Continuum & line? Must compromise!
- Same number of polar. products
- Same position within the baseband
  - Making multi-line setups may be tricky, better prepare it asap



The four spectral windows will be 250 MHz/1 Polar

Limitation Cycle 0

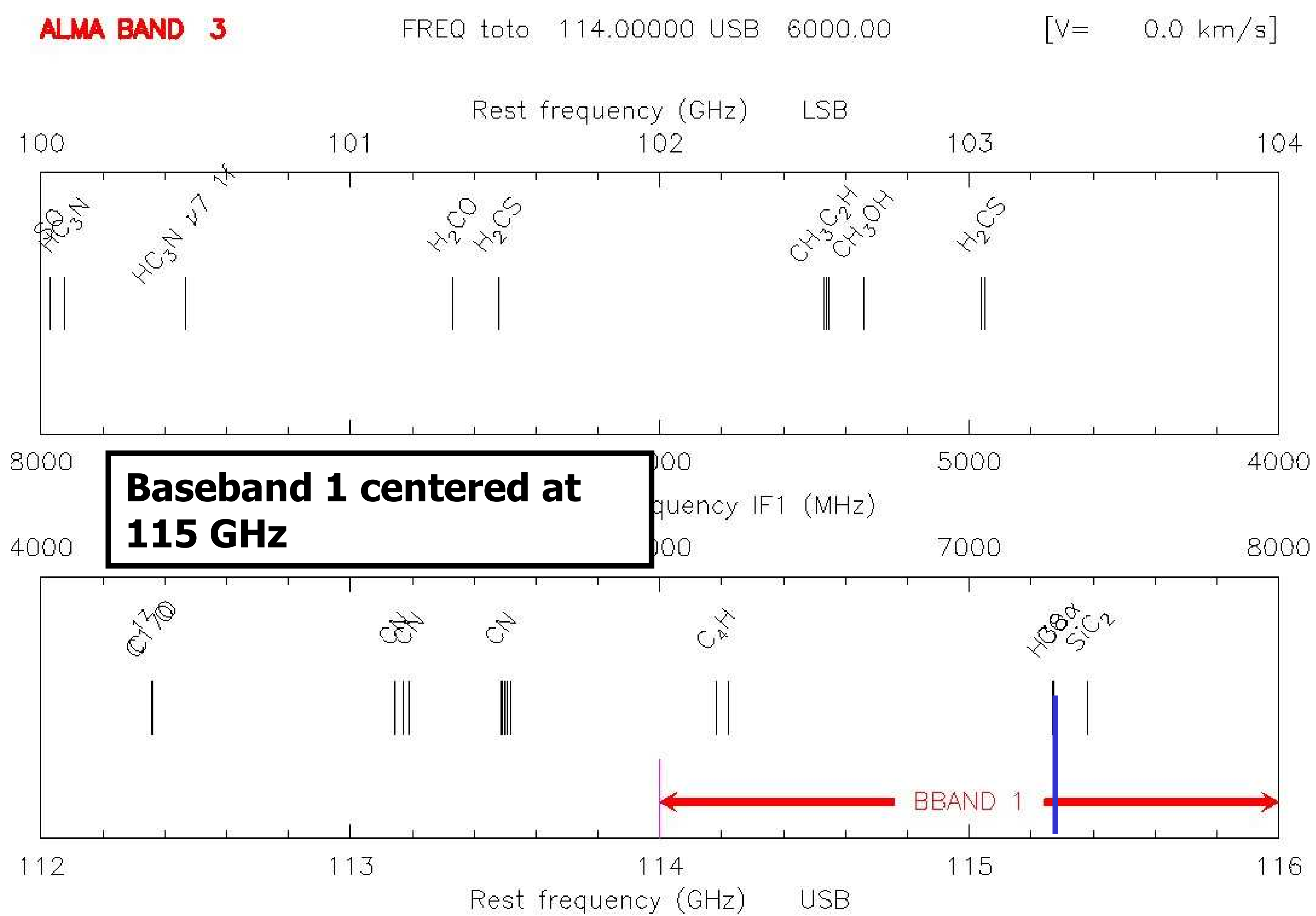
The four spectral window share the same position within the baseband – is that a serious limitation?

Simple solution: spectral window all centered in baseband, move the basebands on the right position

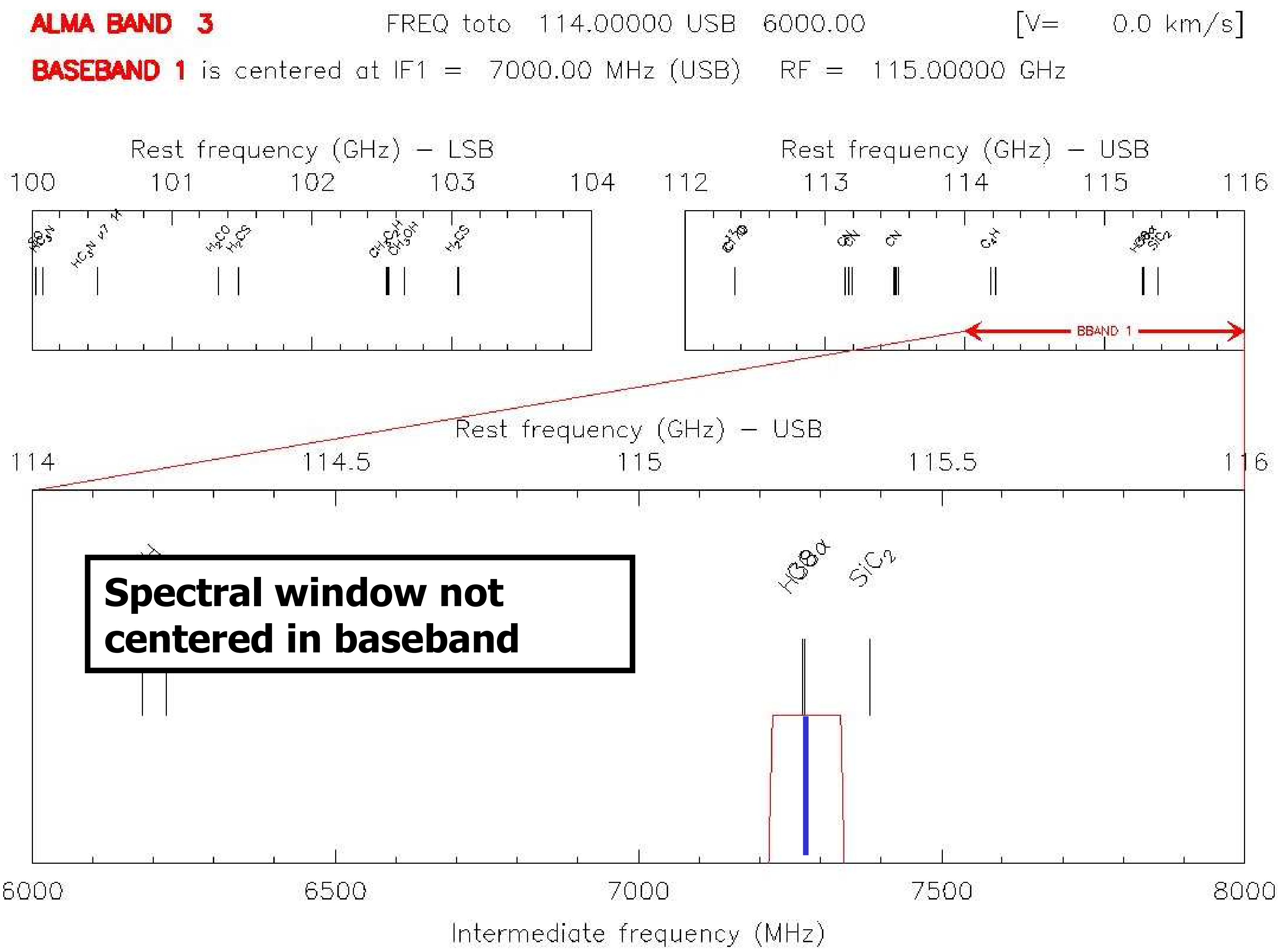
Problem if line to be observed is **near the edge of the RF bandpass** of the receiver

One famous example: CO(1-0) at 115.3 GH*z*

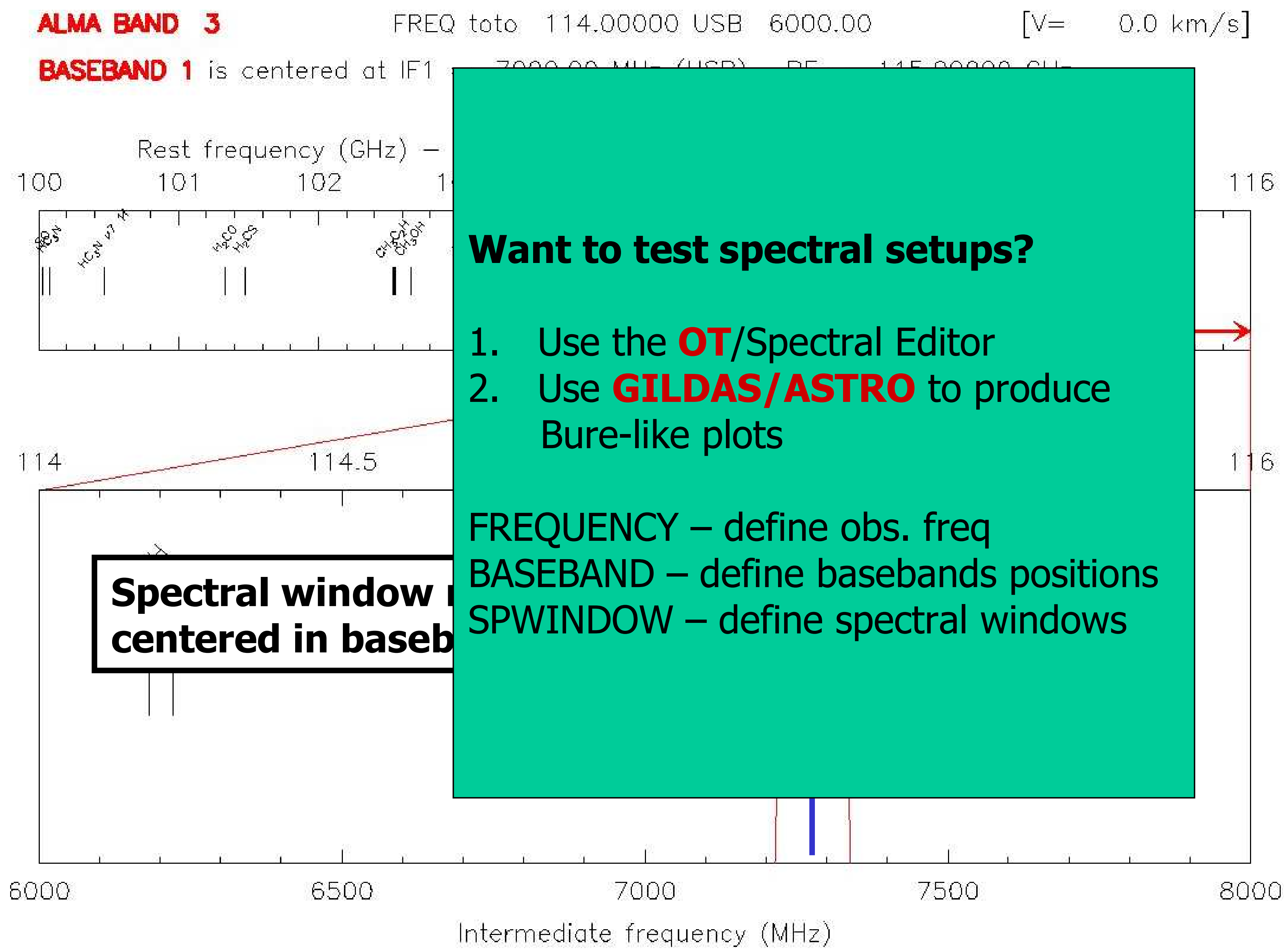
The OT does not force this restriction – caution with complex spectral setups!



Baseband 1 centered at 115 GHz



ALMA BAND 3
FREQ toto 114.00000 USB 6000.00
[V= 0.0 km/s]
BASEBAND 1 is centered at IF1 = 7000.00 MHz (USB) RF = 115.00000 GHz
Rest frequency (GHz) – LSB
100
101
102
103
104
Rest frequency (GHz) – USB
112
113
114
115
116
CN
C4H
BBAND 1
Rest frequency (GHz) – USB
114
114.5
115
115.5
116
H38α
SiC2
Spectral window not centered in baseband
6000
6500
7000
7500
8000
Intermediate frequency (MHz)

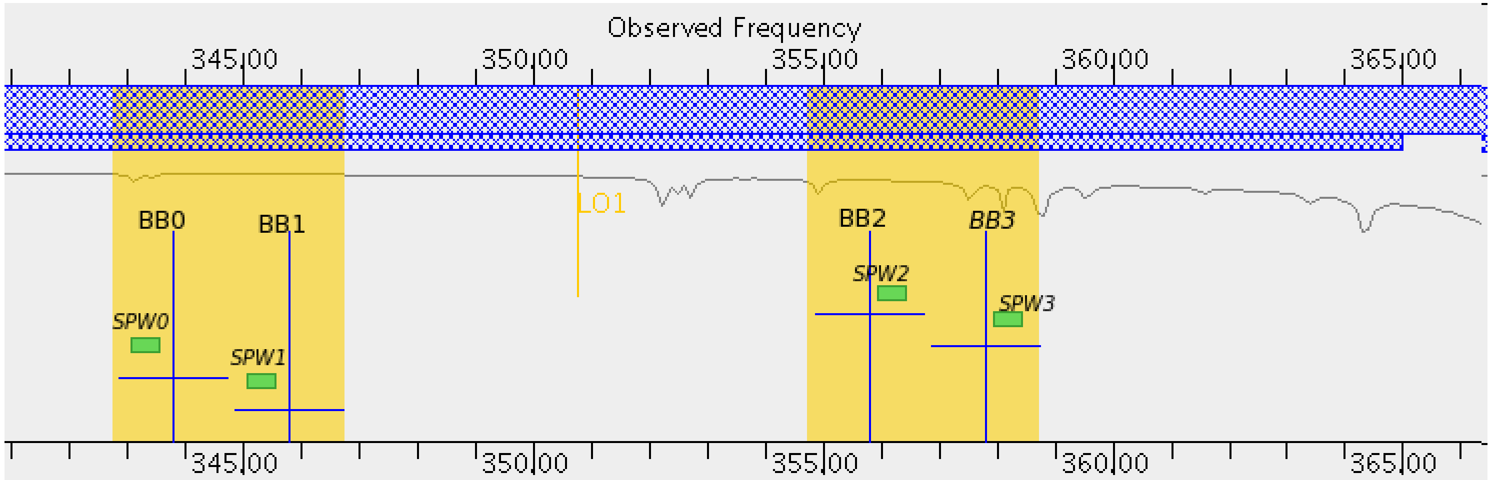


Want to test spectral setups?

1. Use the **OT**/Spectral Editor
2. Use **GILDAS/ASTRO** to produce Bure-like plots

FREQUENCY – define obs. freq
BASEBAND – define basebands positions
SPWINDOW – define spectral windows

Spectral setup in the OT



Yellow areas = LSB/USB (here Band 7)

BB0 to BB3 = 4 basebands, each 2 GHz wide

SPW0 to SPW3 = 4 spectral windows, each within a baseband

Note similar position of SPWs in each baseband

Cycle 0 proposals

- ALMA capabilities ramping up FAST
  - No interest in long integration/complex projects in Cycle 0
  - ALMA ES capabilities and constraints are best suited for limited scope projects (as opposed to large scale surveys)
- **Typical project for ES should be few hours (4-10) and deliver result!**
- ALMA will accept only ~100 proposals
- Cycle 0 done on a **best-effort basis**

Must read

- ALMA Cycle 0 Proposer's Guide
  Doc. 0.2 , *V*1.1, May 2011

- ALMA Cycle 0 Technical Handbook
  Doc. 0.3, *V*1.0, May 2011

- New versions of these documents have been published on-line **today**