The ALMA Observing Tool

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The ALMA Observing Tool

- The OT is used for
  - preparation of ALMA **proposals**
  - the resultant observing **programs** (not covered in this talk)
- Two design goals
  - Detailed knowledge of radio/submm interferometry should not be necessary to apply for ALMA time
  - Expert users and observatory staff should be able to create any kind of observing program
- Solution
  - Scientific requirements are captured in Science Goals (SGs)
  - Technical information contained in Scheduling Blocks (SBs)
  - OT automatically converts Science Goals into Scheduling Blocks

Installation

- The OT is a Java-based application
  - Must be downloaded to one's computer
  - User must have at least Java 7 installed
- Java Web Start is recommended
  - One-click installation (from Science Portal)
  - Updates automatically
  - Tarball also available (inc. Linux version with own Java)
- Troubleshooting guide available in Science Portal
- Detailed documentation including video tutorials also available
- Help function within the OT

http://www.java.com

Proposal Creation

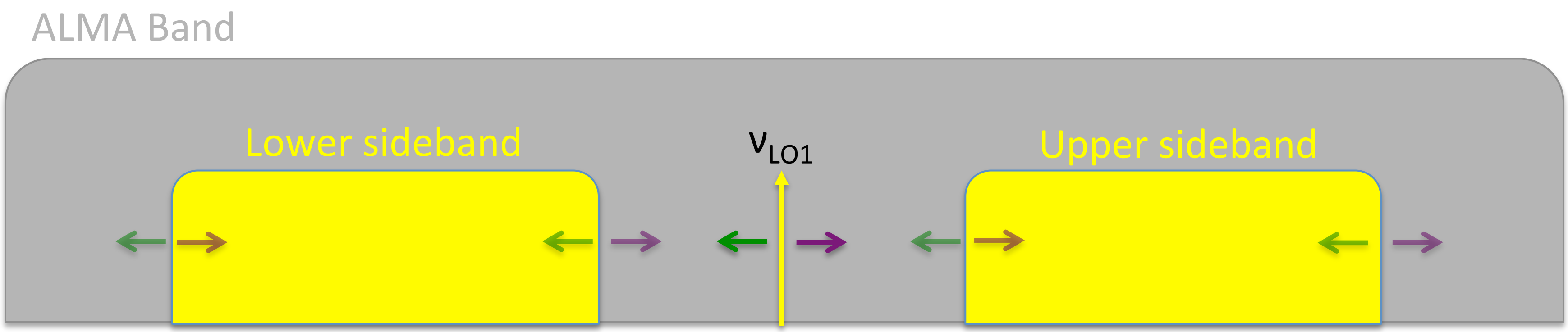
- Proposal preparation and submission is referred to as Phase 1
- Include usual proposal details
  - PI and co-I names, abstract, scientific category, keywords, ...
  - Attach scientific justification as PDF
- **Science Goals** describe the scientific requirements
  - Angular resolution, largest angular scale -> required configurations
  - Desired sensitivity, frequency, bandwidth -> required time
- No limit on number of SGs per proposal

Spectral Concepts: Bands

ALMA Band

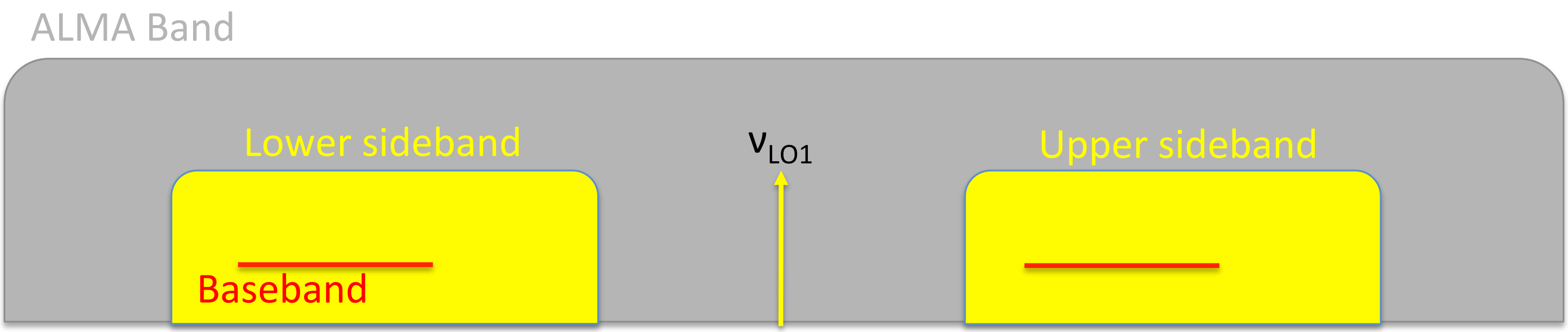
- Each receiver can potentially detect a fixed range of frequencies
  - Band 3: 84-116 GHz
  - Band 9: 602-720 GHz

Spectral Concepts: Sidebands



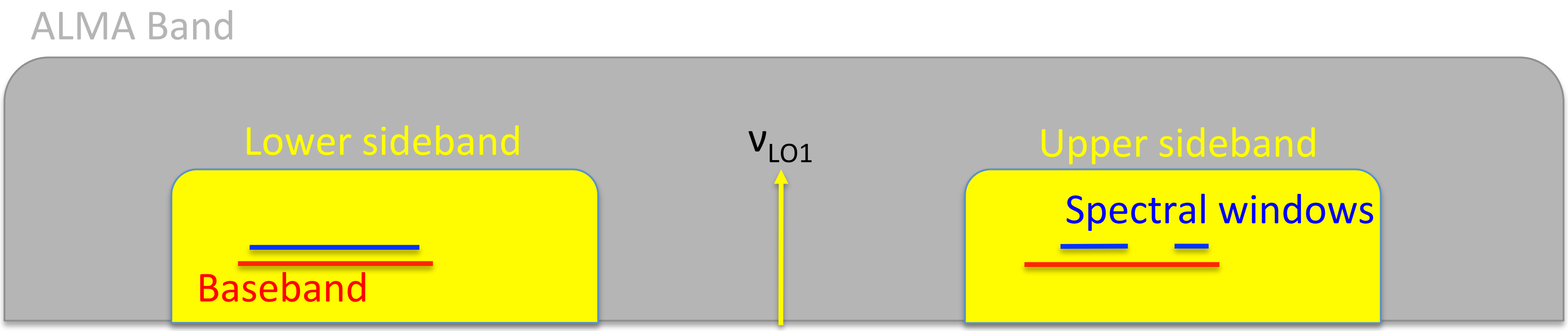
- At any one time, a receiver can only detect a fraction of a band
- The available frequency space is restricted to two **sidebands**
- Their location within the band is set using ν_{LO1}
  - ν_{LO1} = first local oscillator frequency
- Sideband widths and separations depend on band
  - Band 3: width = 4 GHz, separation = 8 GHz
  - Band 9: width = 8 GHz, separation = 8 GHz

Spectral concepts: Basebands



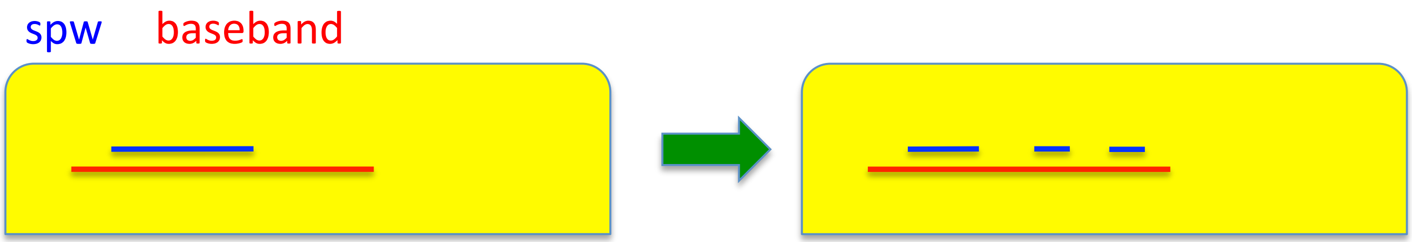
- **Basebands** then select a desired fraction of a sideband
- Up to four basebands are available
- Each baseband
  - has a fixed width of 2 GHz (max bandwidth = 8 GHz)
  - can be placed anywhere within a sideband (must fit completely)
  - can overlap
- Baseband signals are fed into the correlator

Spectral concepts: Spectral windows



- Finally…
- The correlator samples each baseband using **spectral windows**
- Each spectral window (spw)
  - has a variable width (59 MHz – 2 GHz)
  - has a fixed number of channels (trade bandwidth / spectral resolution)
  - can be placed anywhere within a baseband (must fit completely)
  - can overlap (wouldn't normally do this)
  - can be split into multiple regions

Multi-region modes

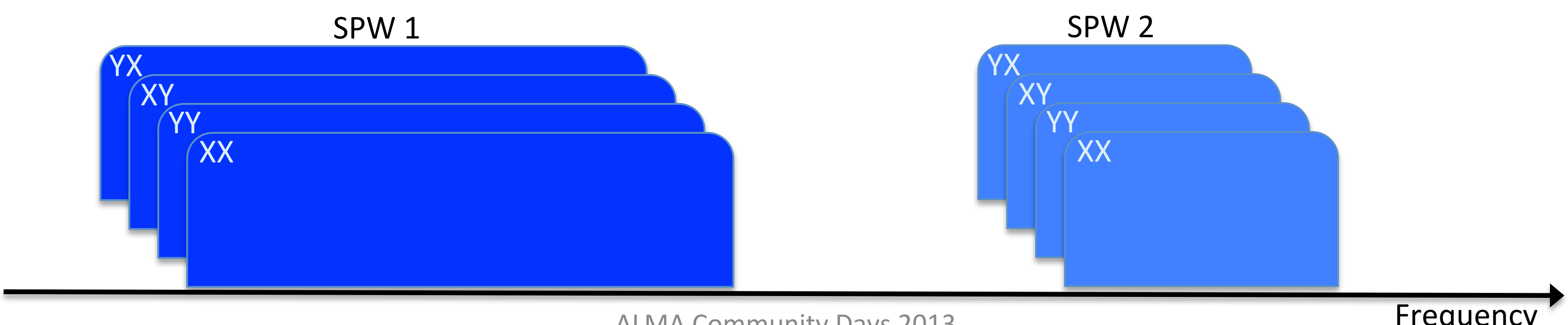


- Each Baseband can use a single correlator mode
  - For example: 937.5 MHz / 244.141 kHz (4096 channels)
- Each mode can be split into up to 4 spws
  - Each must have the same spectral resolution
  - Must set the "Fraction" parameter for each
  - For example:
    - 1 x 468.75 MHz / 244.141 kHz / fraction=½ (2048 channels)
    - 2 x 234.375 MHz / 244.141 kHz / fraction=¼ (1024 channels)
- Usually only need to use these when >5 spws are required

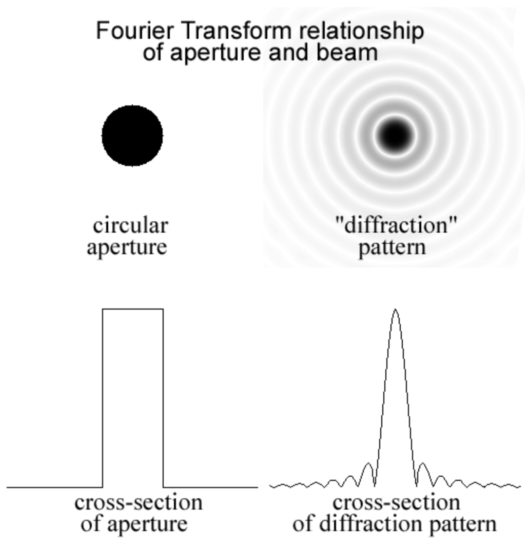
Polarization selection

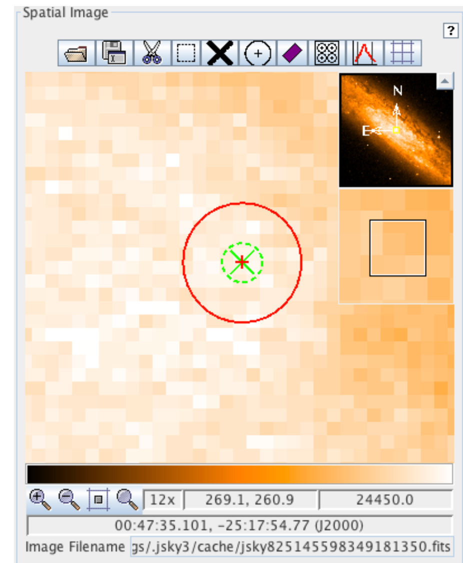
Polarization selection	Products	Spectral channels/pol. (FDM|TDM)
Single	XX	8192 | 256
Dual	XX, YY	4096 | 128
Full	XX, YY, XY, YX	2048 | 64

- Dual polarization is usually selected
  - Single: hardly ever required
  - Dual: maximum sensitivity (default)
  - Full: for detecting **linear** polarization
- The polarization selection applies to each spectral window



Antenna Beamsize / FOV





- Each antenna has an approximately Gaussian beam
  - OT assumes FWHM = 1.13 λ / *D* where *D* is dish diameter
    - ≈ 1 arcmin at Band 3, ≈10 arcsec at Band 9
  - Sets the field of view of the observation
  - Only achieve requested sensitivity at centre of pointing
    - Dashed circle on spatial visualizer shows 1/3 FWHM

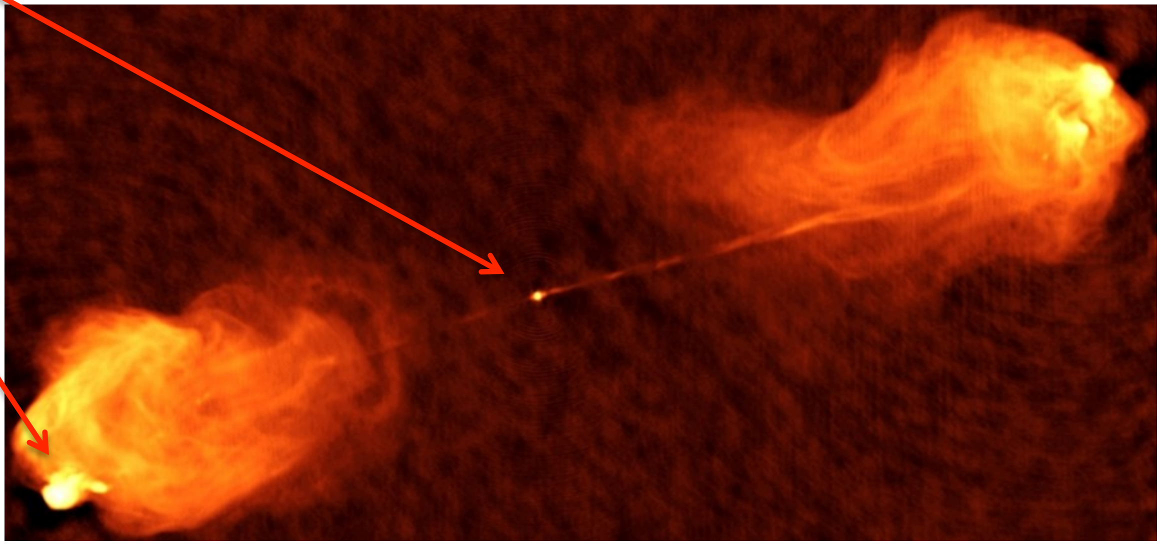
Control & Performance

- Interferometry array characteristics
  - Longest baseline (L_{max}) sets angular resolution
  - Shortest baseline (L_{min}) sets max recoverable scale
    - An object of this size can be reliably imaged
- Configurations are chosen such that
  - λ / L_{max} < requested angular resolution
  - λ / L_{min} > requested largest angular scale
- Up to 2 12-m configurations are possible
- If ACA is required, get 7-m and TP arrays
  - TP not available for Band 9, 10 or single continuum

Source angular scales

Hot spots and core are compact – “seen” by all baselines

VLA image of Cygnus A



Lobes are much larger – only shorter baselines see this emission

If the short baselines were missing, the lobes would be completely invisible!