



Band 2 Science Verification

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Plan

Prepared by M. Díaz Trigo, T. Mroczkowski and N. Phillips and presented to ESAC and STC in spring 2025

- Goals:
 - To perform an **end-to-end test** from observation specification in the ALMA OT, to execution of observations and data reduction. This will **ensure all tools are in place and working before offering Band 2 capability to users.**
 - To **demonstrate Band 2's scientific capabilities** and the potential of the new receivers. It will also foster an early scientific return for Band 2.
- Targets selected based on suggestions from ESAC, EU-IST and the EU ARC and ARC nodes



Targets

<https://almascience.eso.org/alma-data/science-verification/sciverinfo>

- **SPT 0027-50** (dusty star forming galaxy at $z = 3.444$):
 - Demonstrate unique redshift identification at via more than one CO transition (10 km/s spectral scan covering CO (4-3) and CO (3-2), plus HCN, HCO+, HNC and CI (1-0))
- **Arp 220** (ultraluminous infrared galaxy rich in line emission):
 - Demonstrate imaging capability and science capability of tracing CO (^{12}CO , ^{13}CO and C^{18}O) and dense gas tracers HCN, HCO+, HNC with the same band (10 km/s spectral scan)
- **G31.41+0.31** (chemically rich hot molecular core located outside the Galactic Center):
 - Demonstrate imaging capability for line forests and capability to detect COMs (1 km/s spectral scan)
- **HR 5907** (magnetic star with strong continuum circular polarization of $\sim 10\%$):
 - Demonstrate capability of detecting circular polarization and changes within the frequency range covered by Band 2 thanks to the increased fractional bandwidth



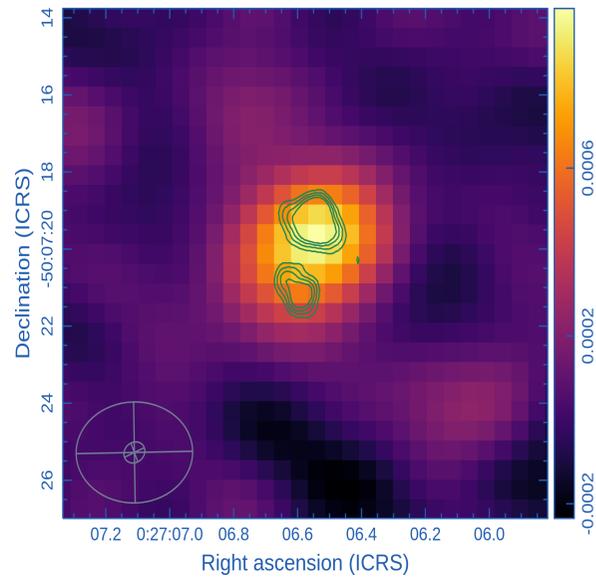
Observing campaign and data analysis

With the effort of a big team of people in JAO, ESO and the EU ARC nodes!

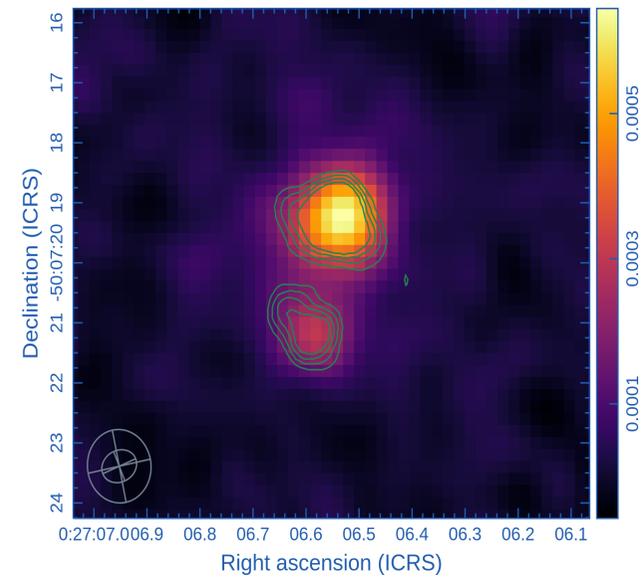
- Observations performed in the last 2 weeks of November 2025 with 24 antennas (observations prepared by N. Phillips and K. Immer, executions at JAO)
- Data reduction team met in Garching the first week of December 2025 (team led by the ARC and with contributions from ESO fellows and the ARC network)
- Data reduction team: G. Cosentino (IRAM), R. Paladino (Italian ARC node), D. Tafoya (Nordic node), T. Williams (UK ARC node), D. Walker (UK ARC node), M. Lewis (Allegro), K. Rygl (Italian ARC node), Y. Song (ESO fellow), F. Guglielmetti (ESO), L. Maud (ESO), M. de Simone (ESO)
- Coordination: G. Popping and M. de Simone (ESO)

SPT 0027-50

Comparison to archival data



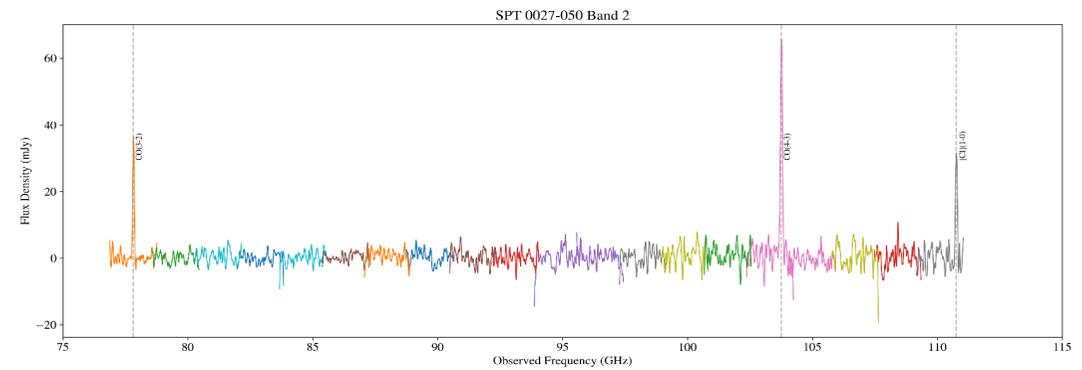
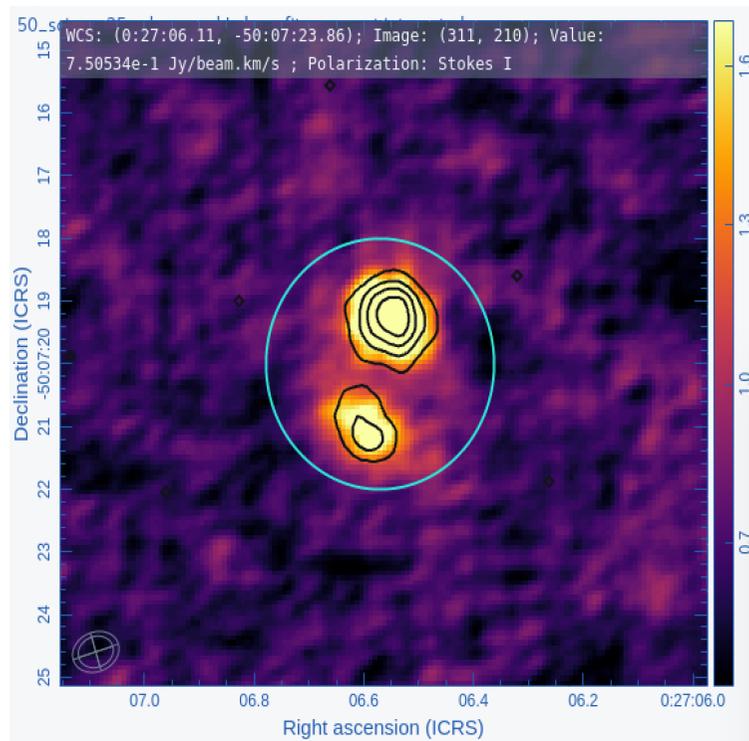
2015.1.00504, at 91 GHz



2022.1.00526 - 98 GHz

SPT 0027-50

Image and spectral scan



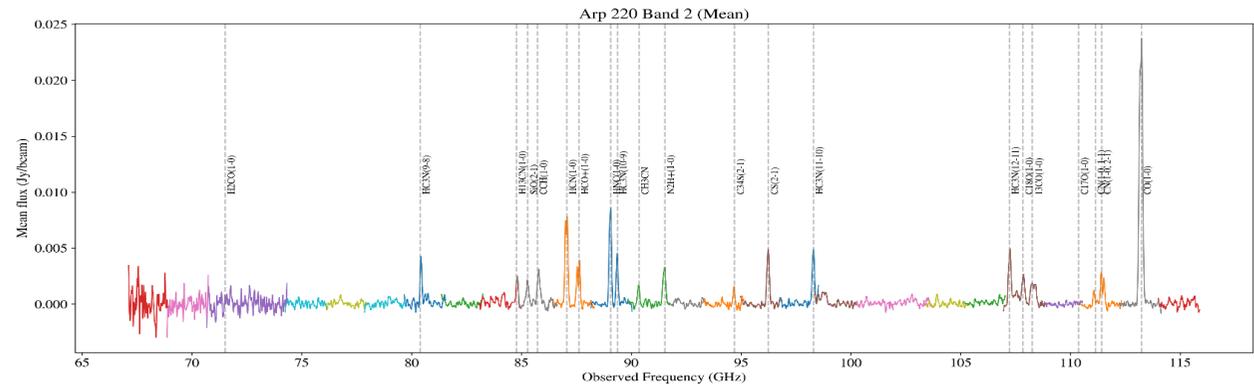
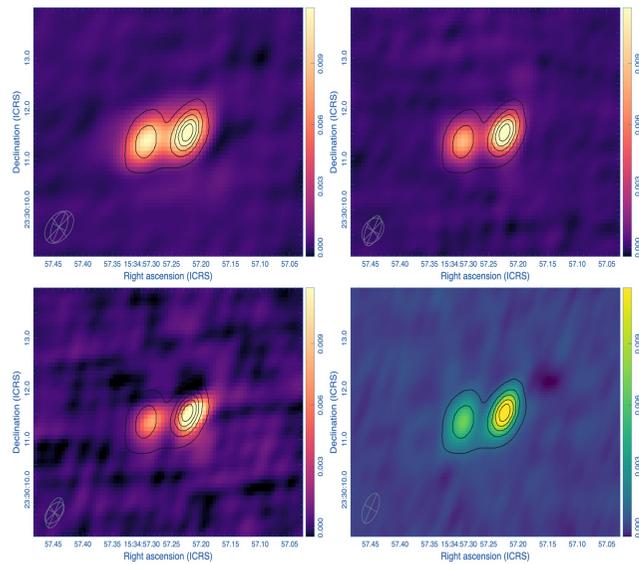
Line	SPW	Rest freq. (GHz)	Redshift freq. (GHz; $z=3.444$)	Measured freq. (GHz)	Calculated z
CO(3-2)	25	345.796	77.812	77.812	3.443
CO(4-3)	91	461.041	103.745	103.756	3.444
[C]I(1-0)	111	492.161	110.747	110.759	3.444

- CO (3-2) map with CO (4-3) contours overlaid (black)

Arp 220

Position and size comparison

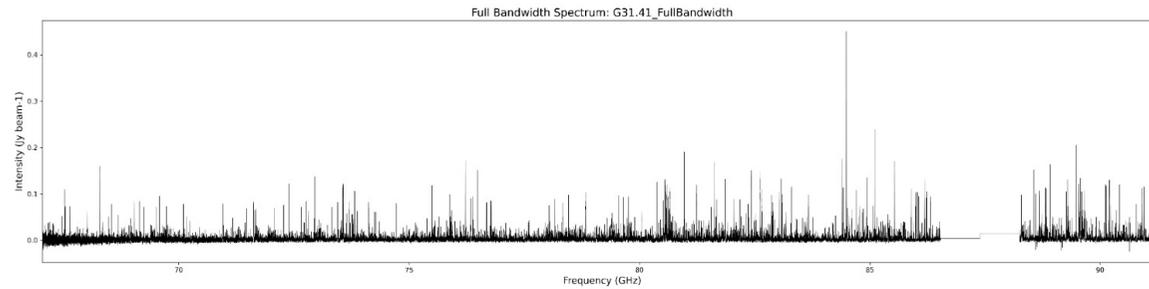
- 24 antennas, 0.4" resolution



Mean spectra from all SPWs extracted from a region encompassing both nuclei, with bright lines identified.

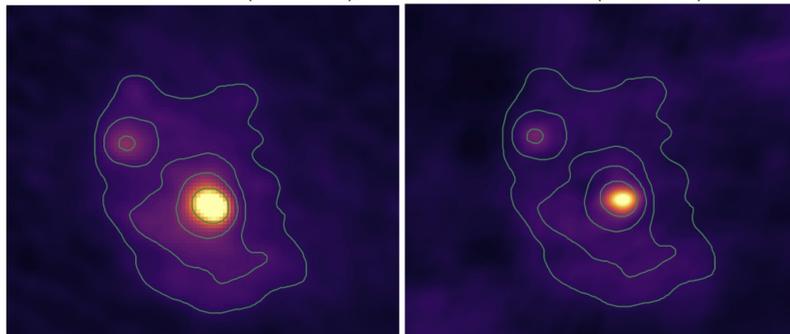
Scoville (2015.1.00113.S, bottom right and contours) and Zhang (2019.1.01641.S)

G31.41+031

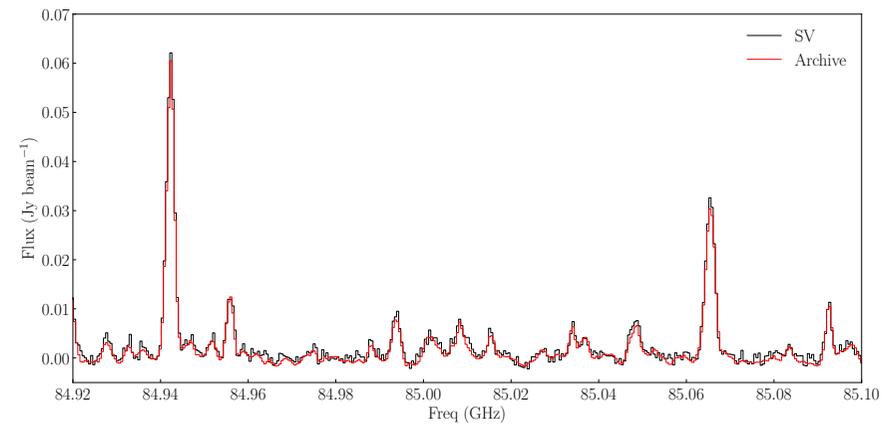


Archival continuum (~ 86 GHz)

B2 continuum (~ 79 GHz)



Scales matched. Contours from archival data.
Common envelope not well recovered + artifacts on large scales. Likely need to improve continuum selection and cleaning.

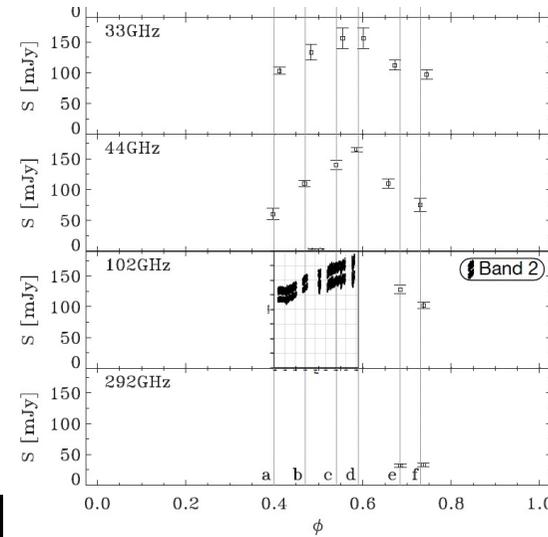
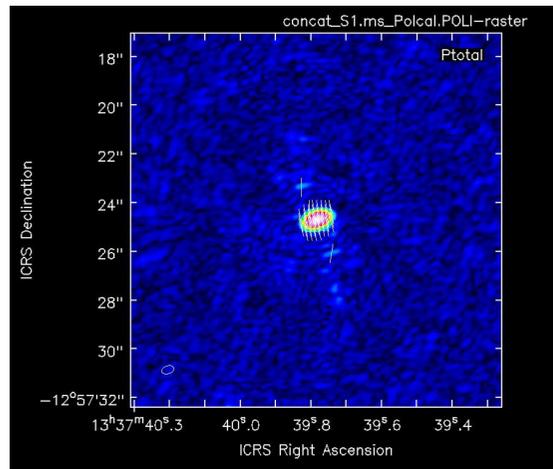


Integrated flux, position and source size consistent with archival data.

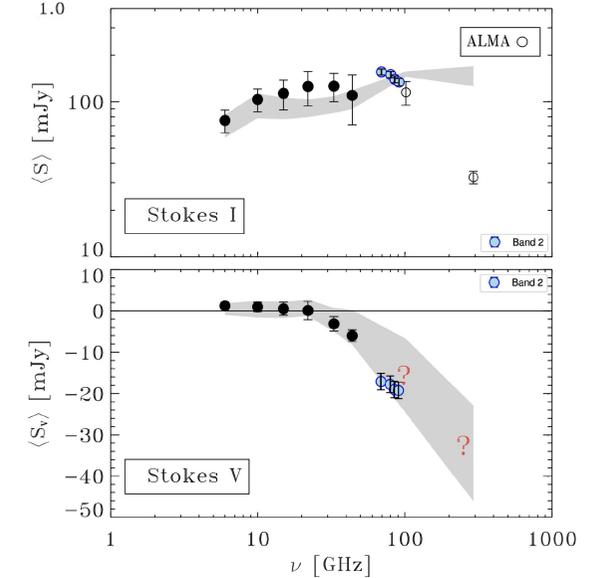
HR 5907

Brightest early-type star in the cm-mm band

- 23 antennas used, 15.3 m – 2.4 km baselines
- Manual calibration and by AMAPOLA consistent with each other



Adapted from Leto et al. 2018





Using the data

Things to watch out

- Data are of high quality
- No major issues have been identified and data nicely compare to previous Band 3 data
- Data have been run through calibration and imaging pipeline and results are included in the release packages
- BUT please check the README files:
 - Data have worse uv-coverage than for regular observations since they have been taken with 23-25 antennas and with short exposure times (watch out for image artifacts derived from this, manual imaging may improve image quality)
 - If you were to re-calibrate data, please use the recommended flux calibration

Data release

Happening next week!



 **Atacama Large Millimeter/submillimeter Array**
In search of our Cosmic Origins

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Announcement of Intent to Release Science Verification Data in Band 2

19 February 2026

A new release of Science Verification data is planned late February. The data release for Band 2 will consist of the following targets:

- G31.41+0.31: spectral scan in Band 2
- SPT 0027-50: spectral scan in Band 2
- HR 5907: full polarization in Band 2

Details of the targets will be listed on [the Science Verification web page](#). There will be a separate announcement once the data are released.

Data on Arp220, announced as candidate target [here](#), will be released at a later date and will be correspondingly announced when the data are ready for release.



Thank you!

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