

3.8 Simulation

3.8.1 General Simulation Requirements

Capability of simulating all ALMA modes of observation is needed for planning (with the Observing Tool), procedure and observing program checking (by staff), and comparison of data with models (in data reduction). Various levels of complexity and speed of execution will be necessary.

8.1–R1 Simulator input shall consist of:

1. a simple observing procedure, or a full observing program (set of scheduling blocks produced by the Observing Tool).
2. a user-supplied model source (for data simulation).

Priority:

8.1–R2 Relevant parts of the simulator (e.g. simple single field and mosaic dataset generation with thermal noise and pointing errors) should be available early in the software production cycle in order to use it to test other ALMA software components.

Priority:

8.1–R3 A primary use of the ALMA simulator is to provide guidance during the proposal and schedule preparation phases. As such, it is critical that the relevant parts of the simulation software be compatible with the Observing Tool, preferably integrated seamlessly into its interface.

Priority:

3.8.2 Procedure Checking

8.2–R1 For procedure checking the simulator output should have a validity assessment of the observing procedure or program.

Priority:

3.8.3 Sensitivity calculation

8.3–R1 It shall be possible to compute simple expected sensitivity levels and dynamic ranges, given the basic observing mode parameters (including integration time, configuration, mosaicing strategy, atmospheric quality limits), used for proposal and schedule preparation. Timescale for execution should be 0.1-5 minutes and should not require significant computational resources.

Priority:

8.3–R2 The sensitivity calculation shall be available to the users through the Observing Tool at Proposal Preparation stage.

Priority:

3.8.4 Data simulation

8.4–R1 It shall be possible to generate fake data given observing parameters and simple models of the instrument and atmosphere. These should include errors due to:

1. atmospheric emission,
Priority:
2. atmospheric phase fluctuations,
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3. antenna pointing (wind and thermal effects),
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4. antenna focus,
Priority:
5. antenna primary beam response (including polarization),
Priority:
6. antenna chromatism (standing wave effects),
Priority:
7. receiver thermal noise,
Priority:
8. receiver gain fluctuation,
Priority:
9. receiver passband shape and its time variations,
Priority:
10. antenna, optics, receiver, and correlator efficiencies.
Priority:

8.4–R2 The user shall be able to independently switch on and off the error terms.

Priority:

8.4–R3 All Baseline Correlator modes shall be supported in the simulation of both correlation and autocorrelation data. (*Priority:*). If an advanced correlator is constructed, appropriate simulation modes should be added (*Priority:*).

8.4–R4 Atmospheric emission data needed to calculate and calibrate the radiometric phase correction shall also be generated, using the same atmospheric model as used to generate atmospheric phase fluctuations.

Priority:

8.4–R5 Fake correlation data shall be averaged according to the integration time specified in the observing procedure; the phase correction will applied according to the rules required for real data taking.

Priority:

8.4–R6 All scanning and subreflector nutation modes shall be supported.

Priority:

8.4–R7 For a given input observing program/procedure, data simulation may (*will?*) be restricted by the user to either a broad-band channel, or one or a few narrow-band channels.

Priority:

8.4–R8 Fake data shall be produced in the standard ALMA data format, thus available to be used as input by the pipeline and offline data processing.

Priority:

8.4–R9 Timescale for execution shall be 1-30 minutes fo a single frequency channel and may require significant cpu and memory resources.

Priority:

8.4–R10 Data simulation shall be available to the general user at proposal preparation stage. In that case the array configuration will be simulated according to the needs of the observing program.

Priority:

8.4–R11 Data simulation shall be available to the general user at off-line data reduction stage. In that case the array configuration and observing procedures will be taken from the data headers.

Priority:

8.4–R12 Data simulation shall be preferably integrated with the off-line data reduction package to simplify its use for data quality and fidelity estimation during calibration and imaging,

Priority:

8.4–R13 Data simulation shall have the capability of incorporating real ALMA data sets taken previously, assuming the observer has been granted access to this data.

Priority: