

Making ALMA observations of MHD simulations

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The ALMA Simulator in GILDAS

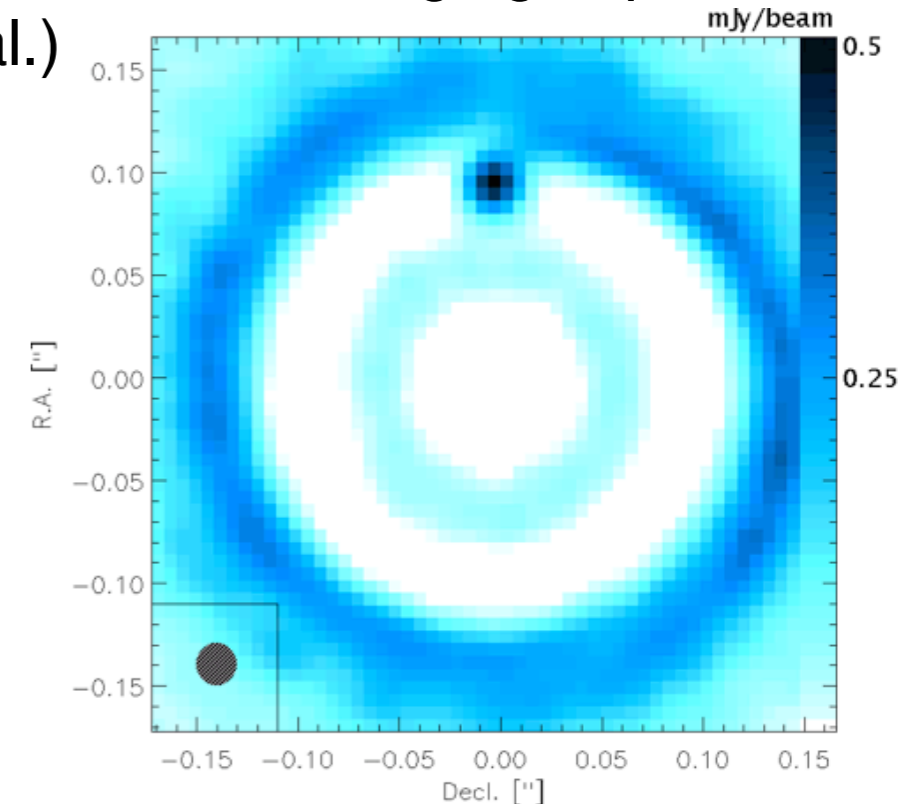
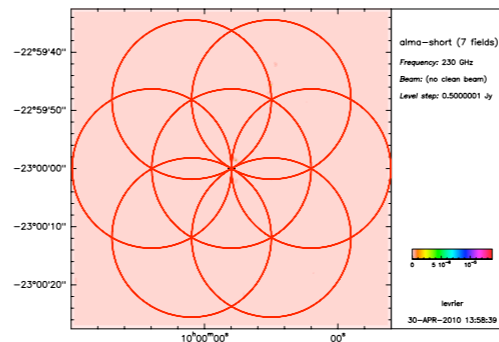
An **ALMA / ALMA Compact Array (ACA) / Single Dish** imaging simulator

- Detailed description in ALMA memo 398 (Pety, Gueth, Guilloteau)
- Developed for studying the impact of ACA on wide-field imaging capabilities
- Scientific preparation of ALMA (e.g. Wolf et al.)
- Included in GILDAS' MAPPING software

<http://www.iram.fr/IRAMFR/GILDAS/>

1. Inputs

- Source position and size : mosaicing
- Model brightness distribution
- Array configuration
- Frequency (**only continuum**)
- Type of observation (ALMA + ACA + Single Dish)



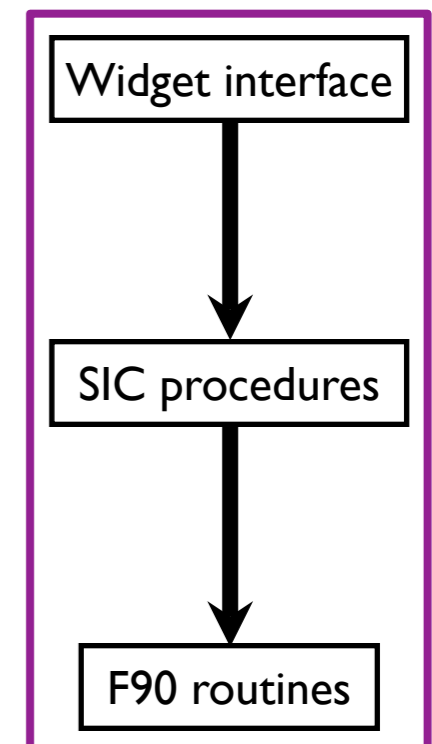
2. Visibilities

$$\text{Visibilities} = \text{Cover} \times \text{FT}[\text{Beam} \times \text{Model}]$$

- Cover from source position, array configuration and time range
- Beam from antenna size
- Source-calibrator loop
- Possibility to add pointing errors, atmospheric phase noise, calibration errors

3. Imaging

- Calibration (standard, fast switching, water vapor radiometry)
- Deconvolution (Standard CLEAN based methods)
- Input and output comparison



Graphical User Interface

MAPPING>@alma

Main window

ALMA+ACA Simulation (email: gildas@iram.fr)

GO ABORT HELP

LOAD COMPUTE COMPARE DISPLAY EXPERT

Input model file /levrier/Simulator/sandbox/s.gdf File

Output directory name File

Simulation kind ALMA+SD Choices

Observation Setup SHOW SOURCE Parameters Help

Configuration Setup SHOW CONF Parameters Help

Pointing Errors SHOW POINT Parameters Help

Amplitude conditions SHOW AMP Parameters Help

Phase conditions SHOW PHASE Parameters Help

Deconvolution setup COMPUTE Parameters Help

Display results DISPLAY Parameters Help

Expert setup EXPERT Parameters Help

File location SETUP Parameters Help

Observation

Parameters

Source

Change Declination ? Yes

New declination -23

Change image size ? Yes

New image size 15 15

Mosaic definition

Mosaic size (arcsec) 0

Mosaic orientation (deg) 0 Choices

Circular or rectangular shape ? No

SD sampling parameters

Number of points per beam 3

Grid position Centered Choices

Frequency

Observing frequency (GHz) 230

Bandwidth (MHz) 800

Observing time

ALMA hour angle range -0.5 0.5

ACA hour angle range -0.6 0.6

SD (on+off) integration time (hour) 1.2

Go Dismiss Help

Configuration

Parameters

ALMA array setup

Diameter (fixed) 12

Array name zoom

Configuration name c

ACA array setup

Diameter (m) 7

Array name aca

Configuration name 7

Single Dish

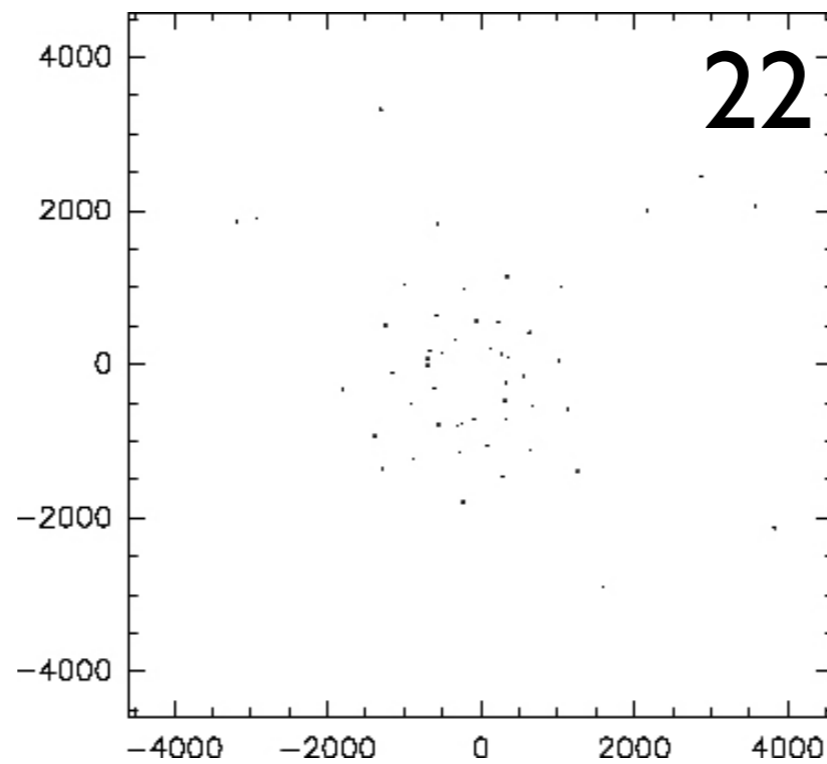
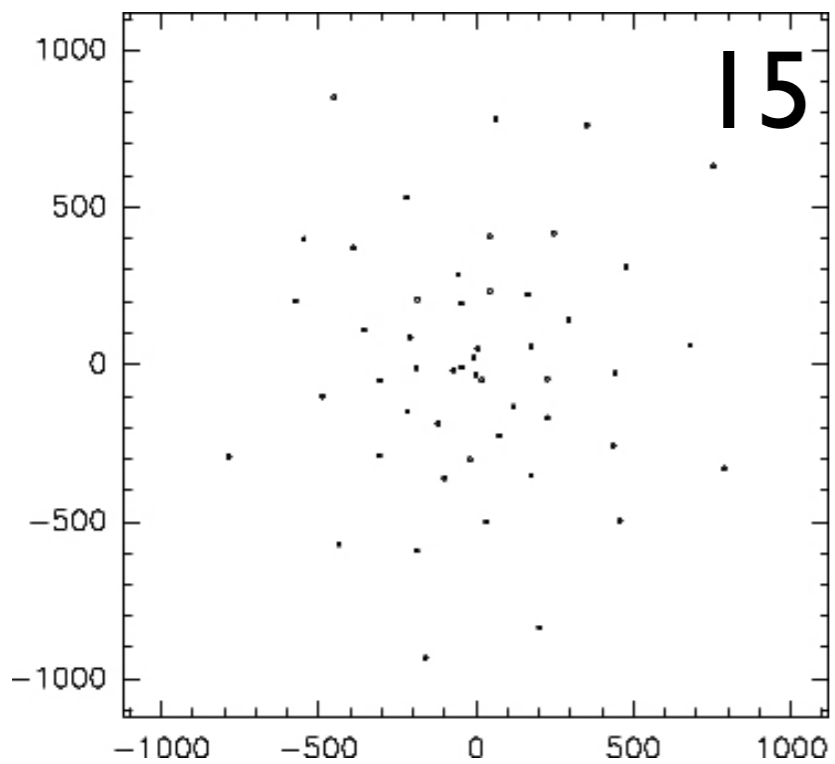
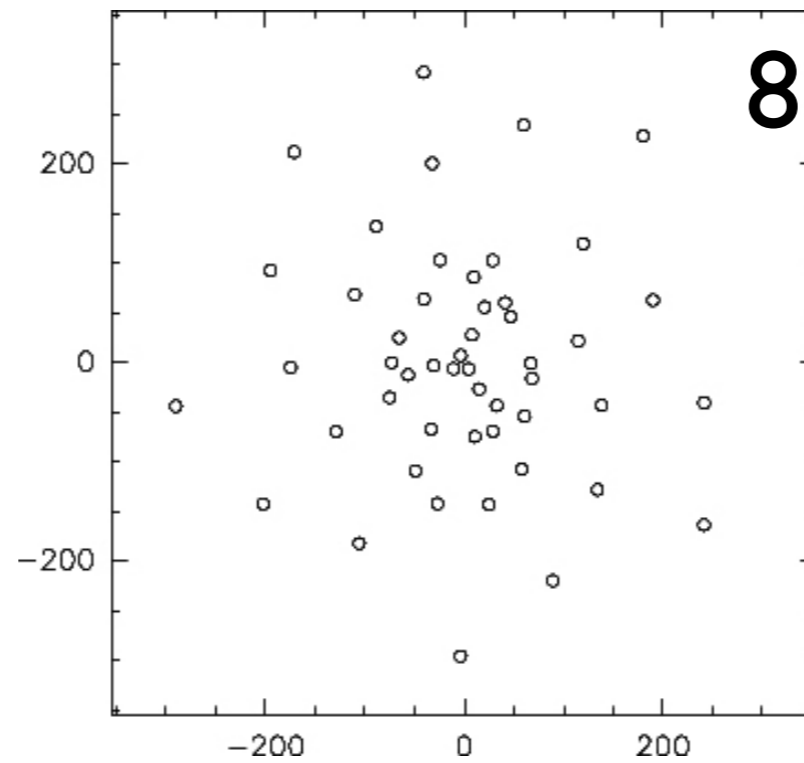
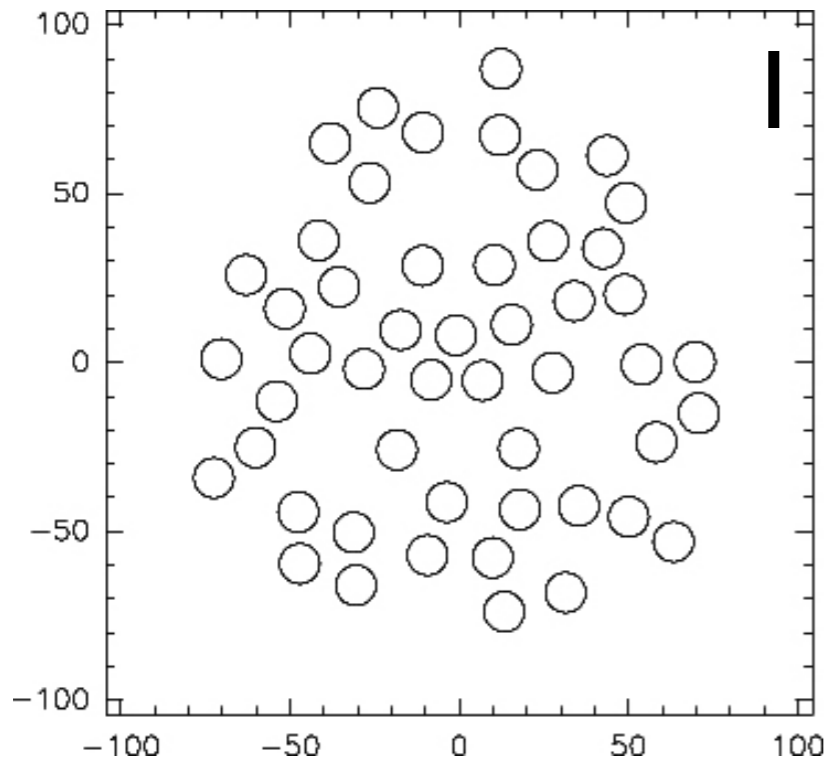
Diameter (m) 12

Number of antennas 4

Go Dismiss Help

Up-to-date ALMA configurations

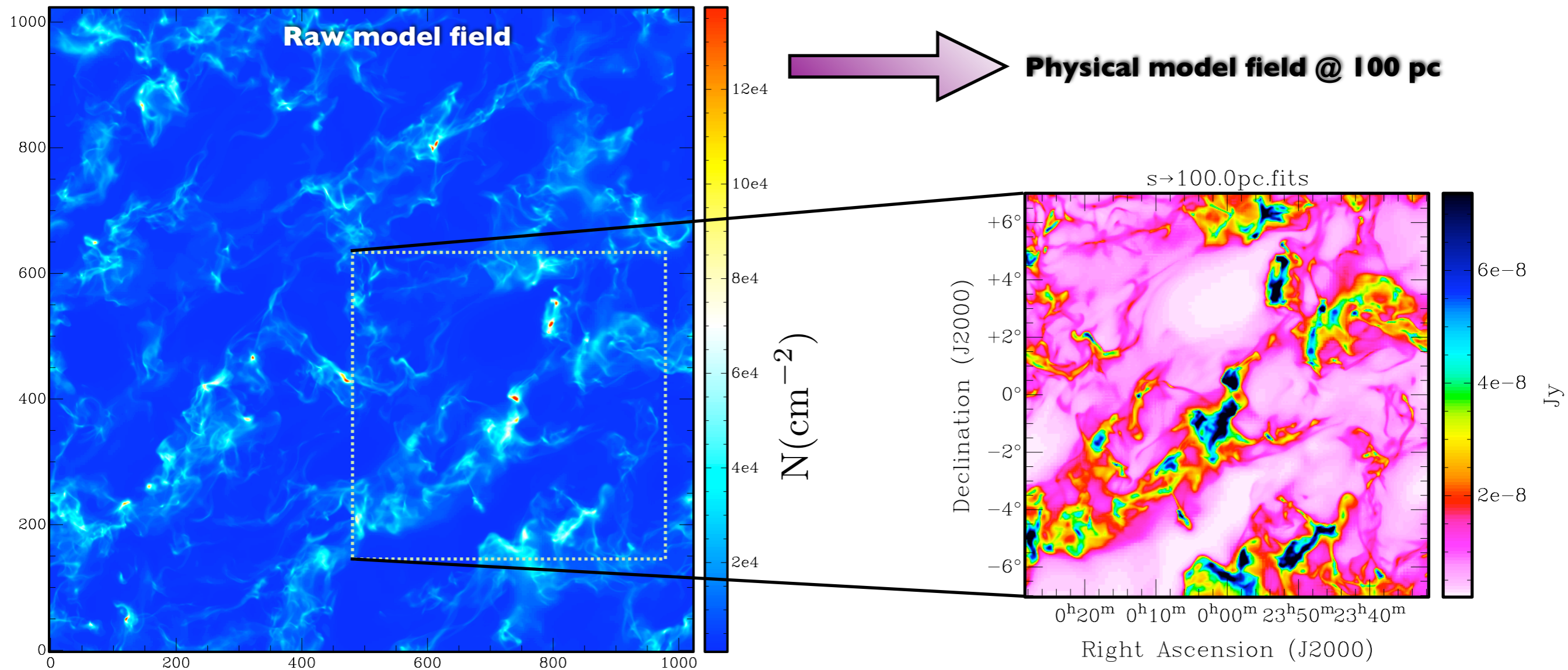
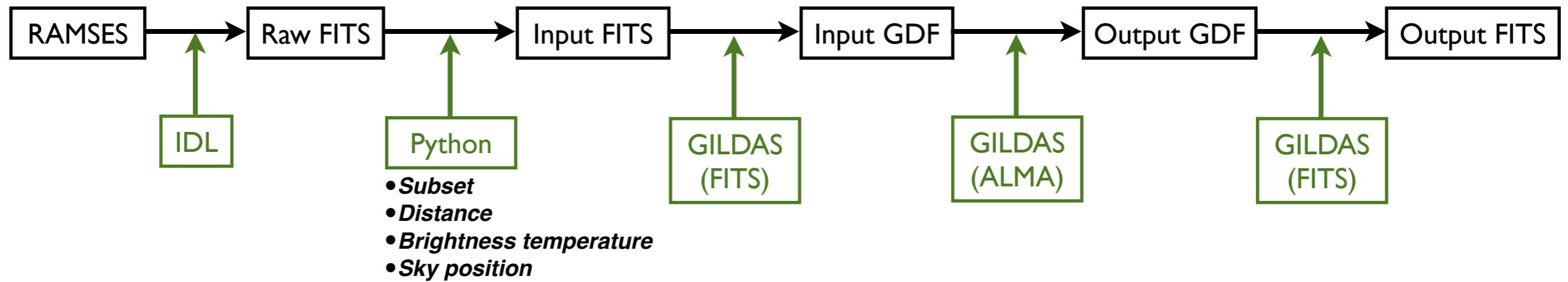
Antenna positions on the ground for 8 configurations



- **28 configurations**
- **From 90 m to 9.5 km radius**
- **CASA to GILDAS format conversion**

Thanks to J. Pety and A. Wooten

ALMA simulator on MHD simulations



Examples of simulated observations

ALMA only

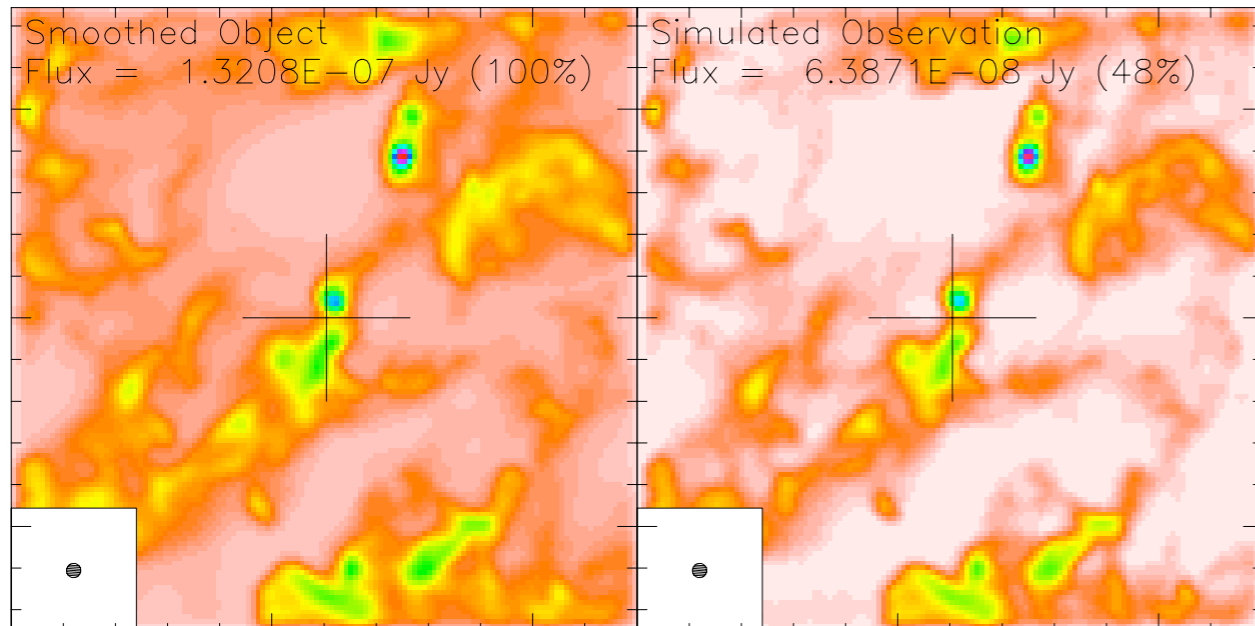
Flux recovered : 48%

ALMA + Single Dish

Flux recovered : 73%

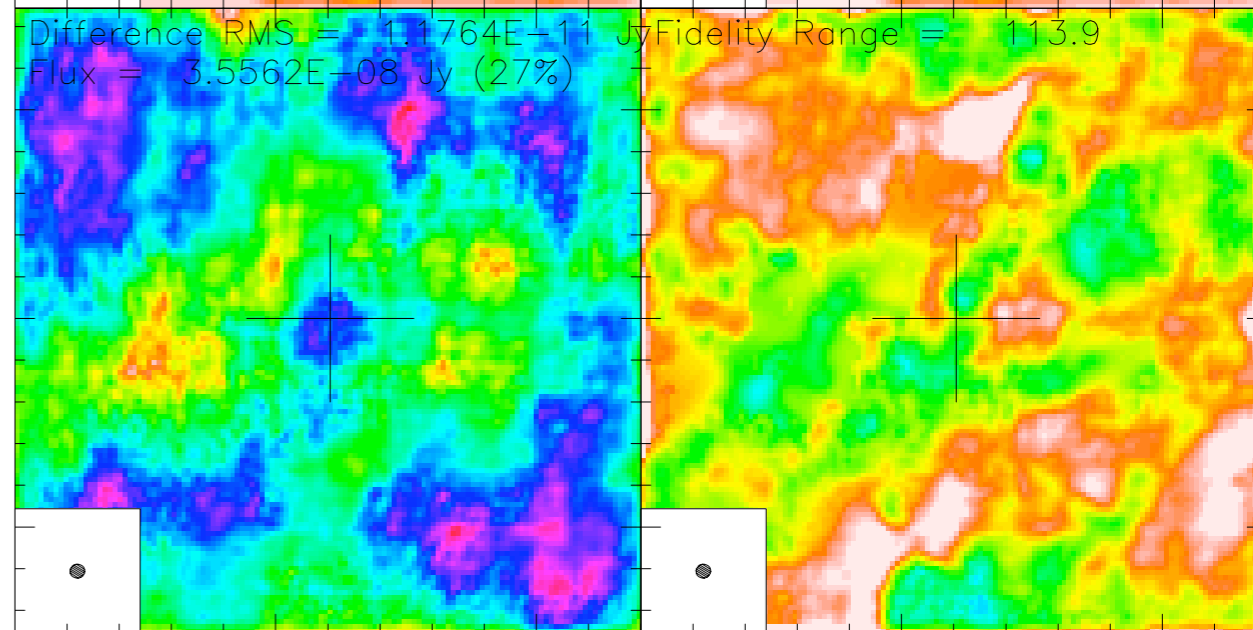
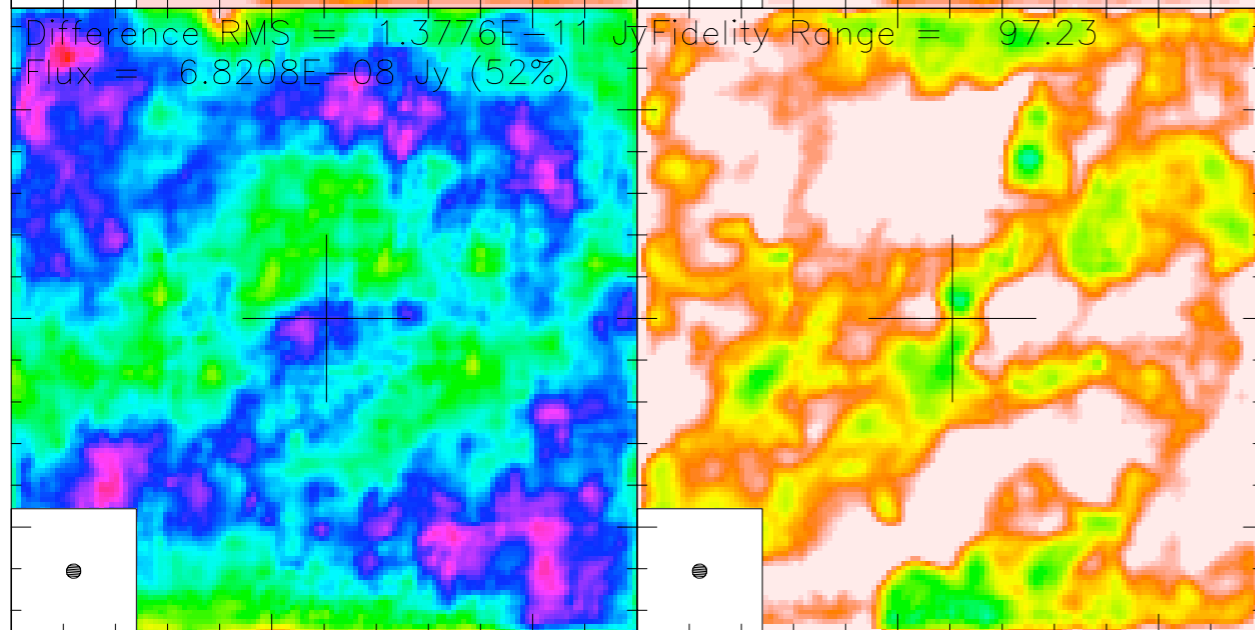
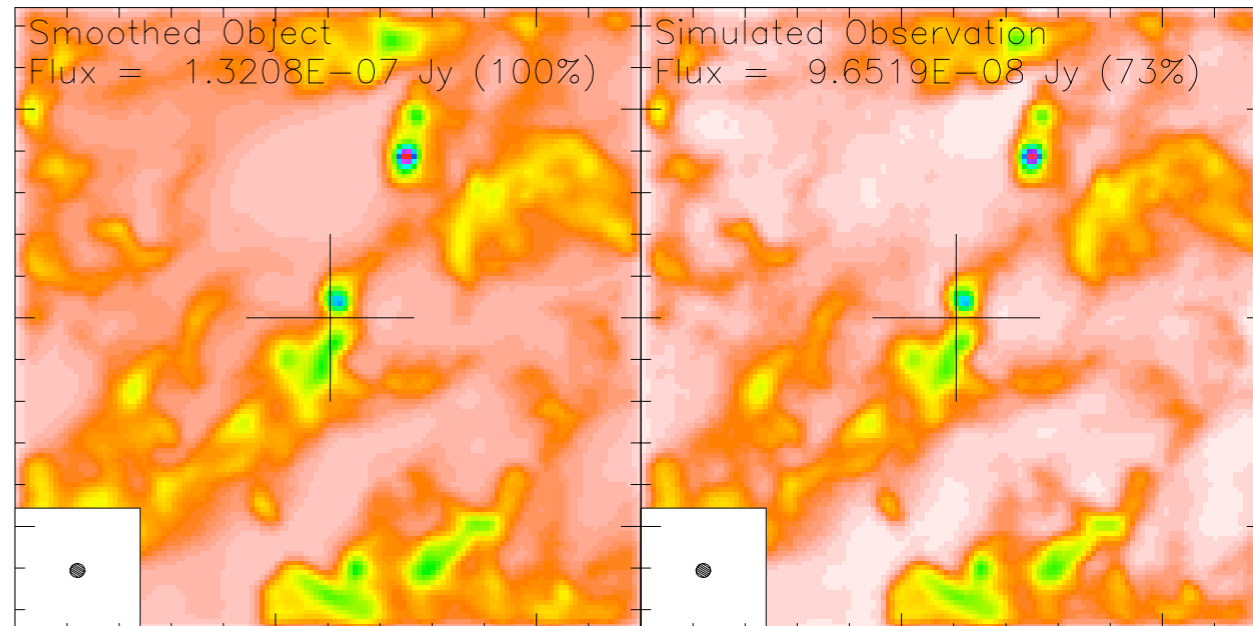
Smoothed input

Simulated observation



Smoothed input

Simulated observation



Difference

Fidelity

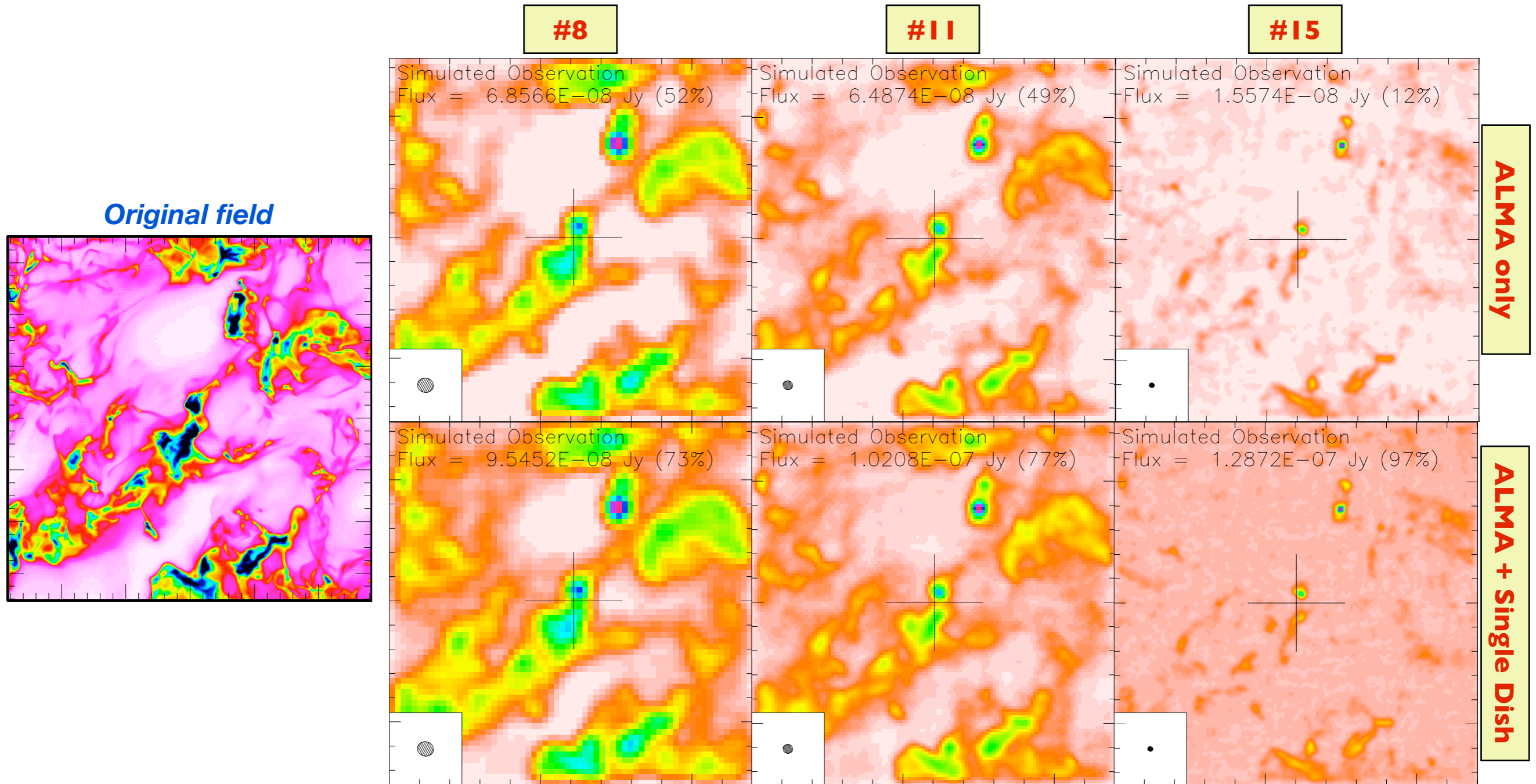
Difference

Fidelity

Fidelity image = input model / difference

- Inverse of relative error
- In practice, lowest values of difference are truncated

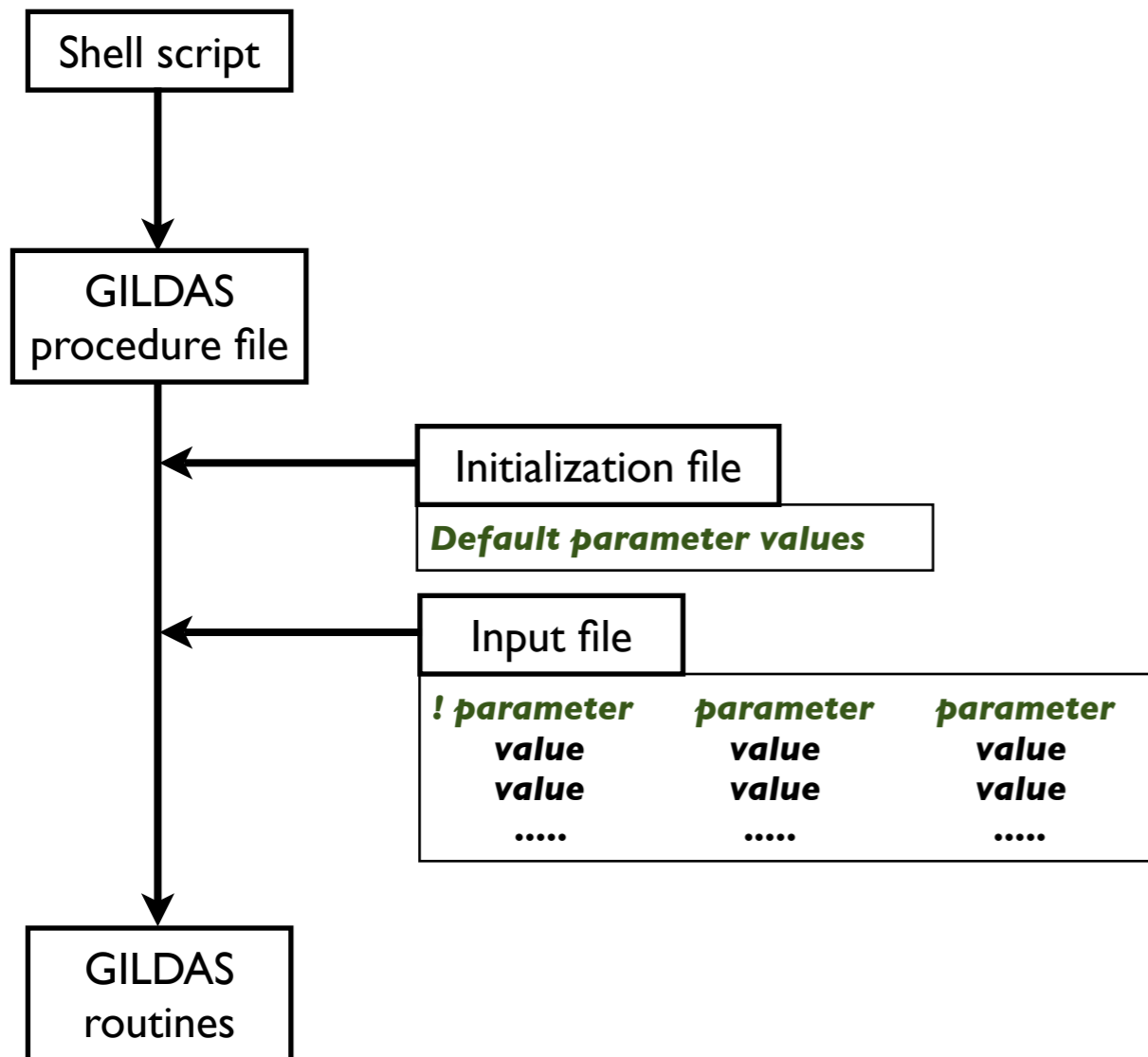
Simulations for different configurations



- Spatial frequency filtering
- Flux loss
- Importance of single-dish measurements

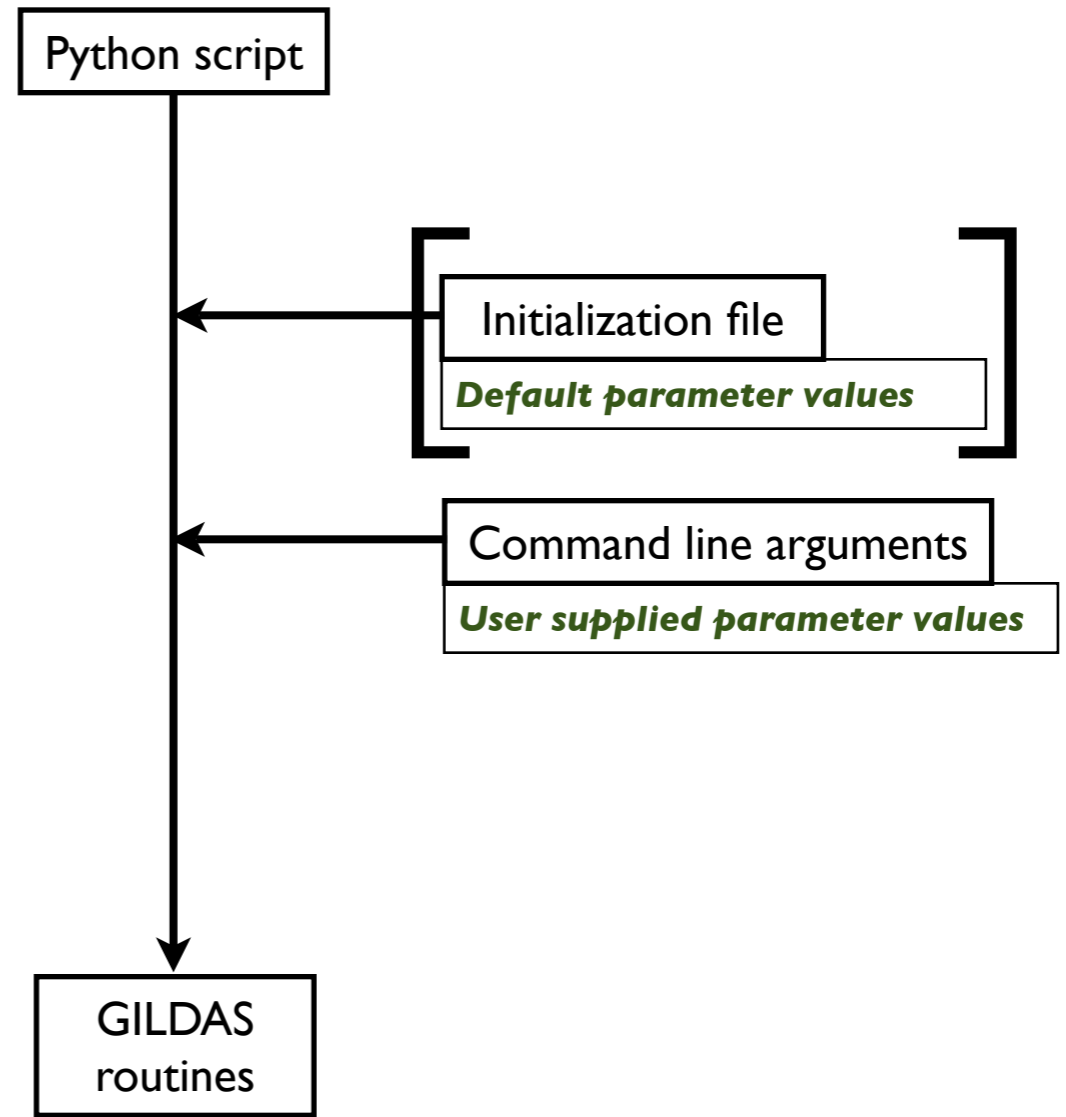
ALMA simulator for STARFORMAT

Current status of batch mode



Runs one "mapping @alma" per line in the input file

Proposed evolution



Runs single "mapping @alma"

- **Suppresses extra layer**
- **Simplifies development of web service**
- **Possible mutualization with CASA simulator @ESO (Ian Heywood)**

Example batch simulation : line mapping

