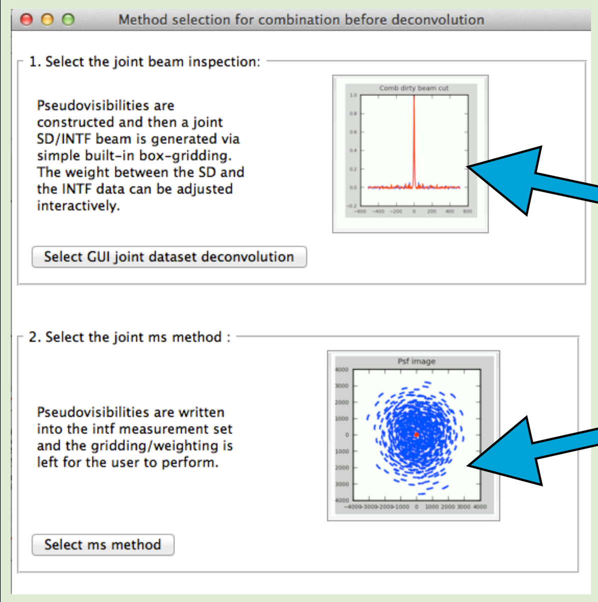
Data Combination GUI

Sandra Burkutean

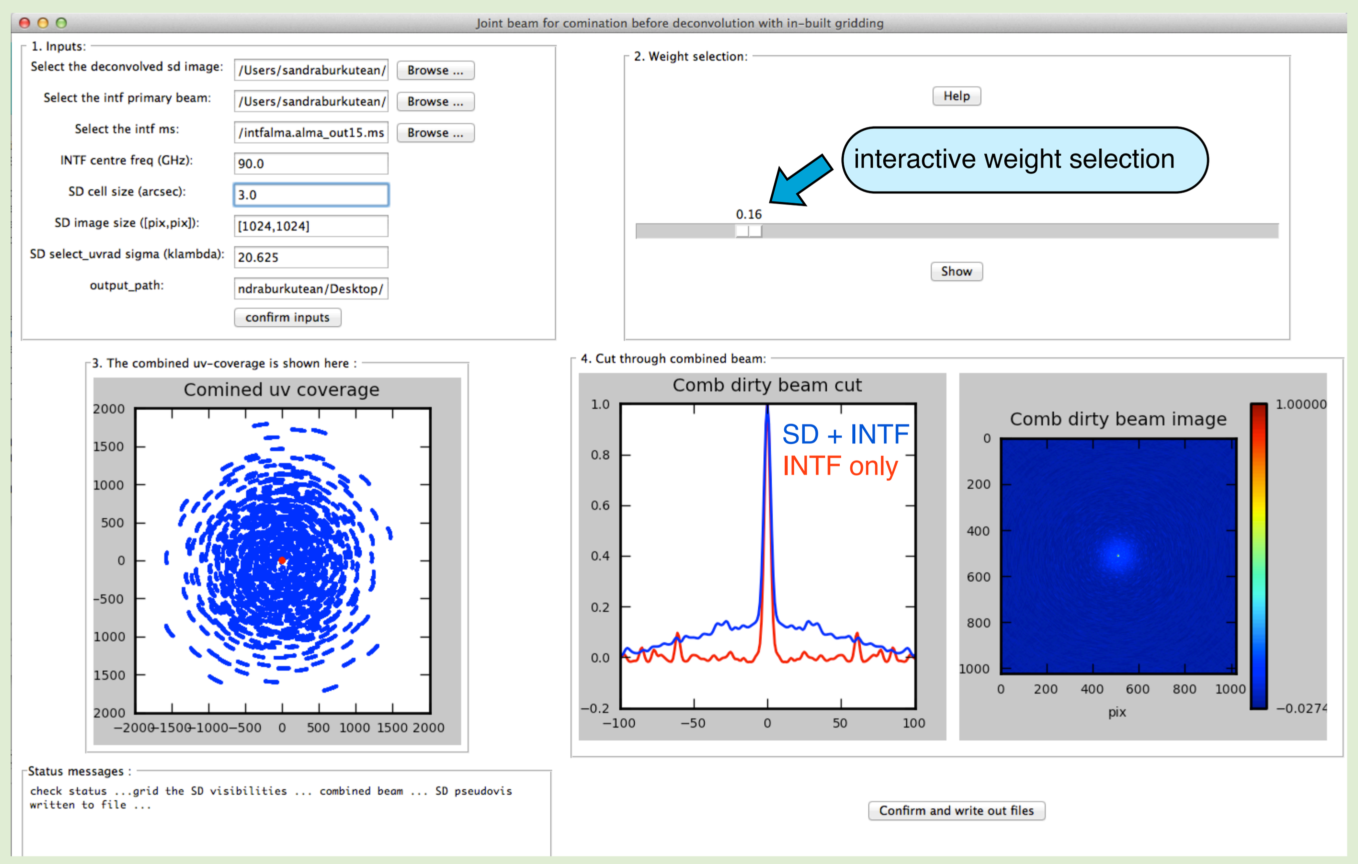
INAF, Istituto di Radioastronomia, Bologna, Italy; Argelander-Institute for Astronomy, University of Bonn, Bonn, Germany

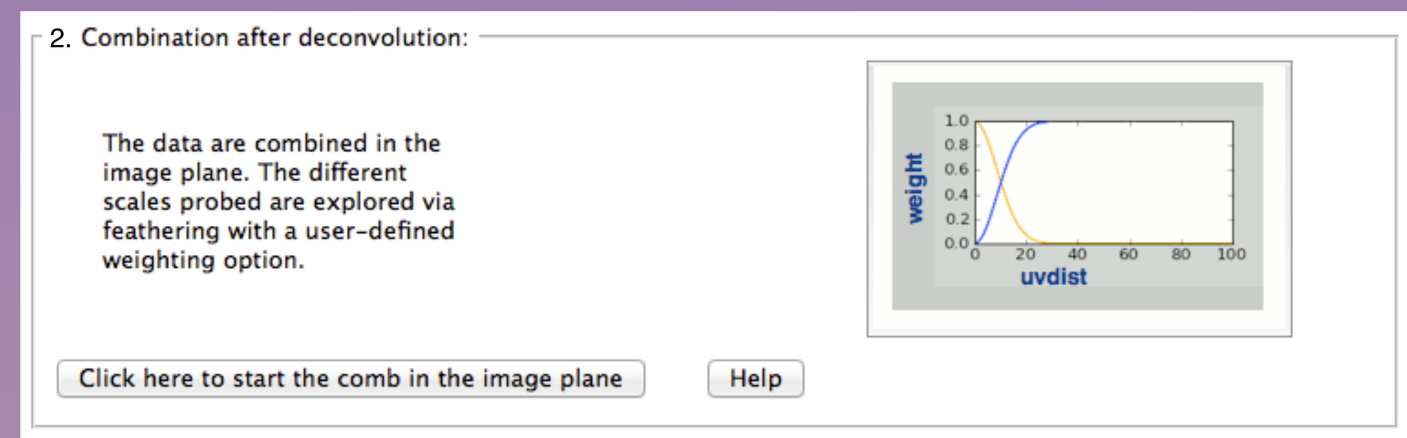
Motivation: Interferometers lack large-scale information and are subject to sparse spatial sampling. Single-dish (SD) data are naturally limited in spatial resolution but provide “zero-spacing” information, making a combination of interferometric and single-dish data highly desirable. Techniques for combining these datasets differ in the stage of combination during the data reduction process. Combination before deconvolution involves joining interferometric and single-dish data in the visibility domain, followed by a deconvolution with a beam computed from the combined interferometric uv and SD-pseudovisibility data. Combination after cleaning the interferometric data separately effectively feathers the SD and interferometric data with respective weights. During deconvolution of the interferometric data, the SD image can be given as a model image to guide the cleaning process. The developed GUI interface, whose first beta-release was tested in January 2016, combines these methods in a single task, allowing the users to explore different combination methods. It has undergone testing with simulated data and is currently being prepared for the second beta-testing stage including its application to real data.

Combination before deconvolution relies on the production of so-called single-dish pseudovisibilities. These are produced by first deconvolving the single-dish data and then transforming the result to the Fourier Transform plane. The weight between the interferometer and single-dish data can then be adjusted, giving rise to a joint uv-distribution and thus to a combined dirty beam.

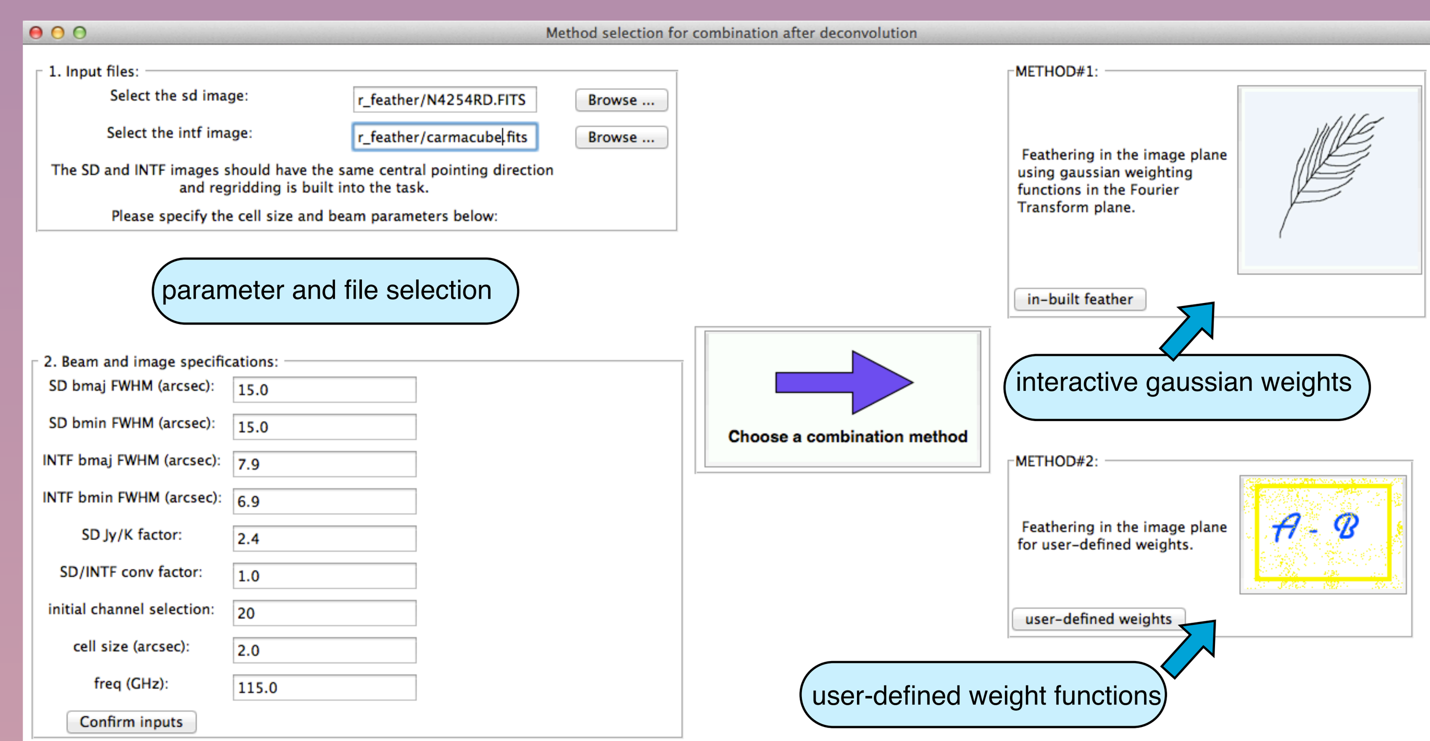


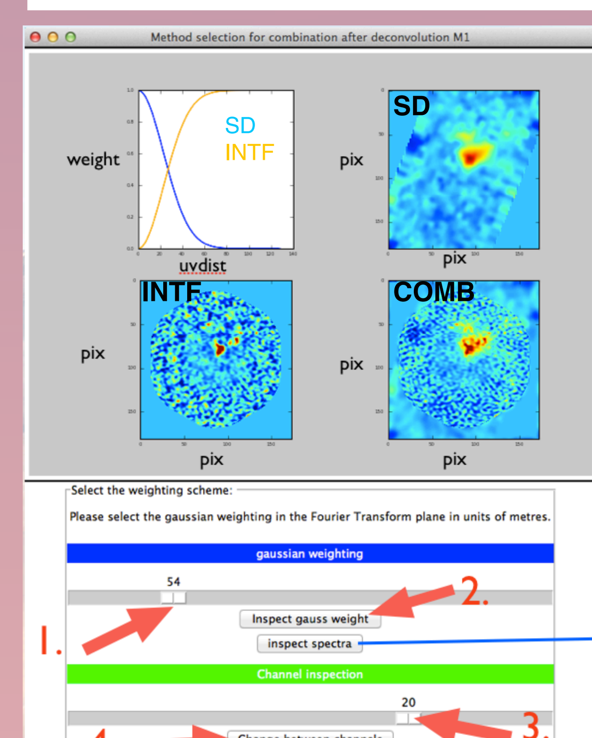
The GUI offers two methods for generating single-dish pseudovisibilities.
The first method allows the user to interactively explore the relative weight between the single-dish and interferometer data and to explore the resultant combined dirty beam, the weights being assigned in such a way as to favor a gaussian visibility distribution in the Fourier Transform domain.
The second method assumes equal weighting between both datasets in terms of visibility counts, allowing the user to adjust the weights outside of the GUI while taking into account the respective visibility noise levels.



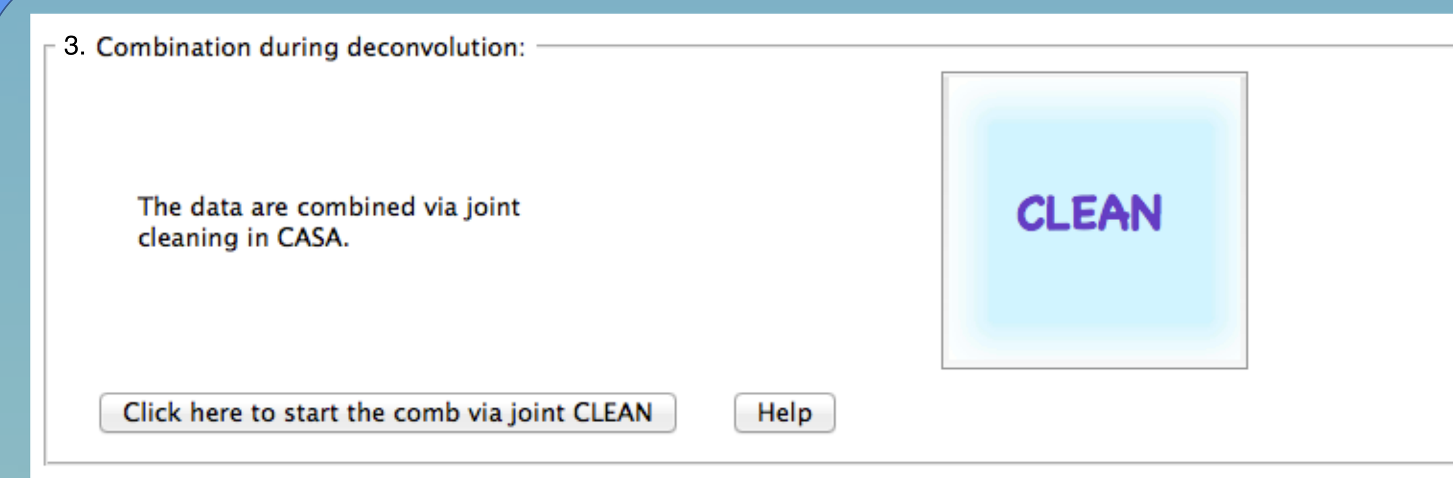


Combination after deconvolution enables the linear combination of the cleaned interferometric data cube with the single-dish data using an appropriate weighting function. Please note that the overall data combination is intrinsically non-linear as the cleaning itself introduces non-linearity into the solution. A similar method is currently implemented into CASA as the feather task but the GUI interface allows for an interactive examination of the image cubes to ease the inspection of different weighting effects. In addition a further section allowing for user-defined weighting functions increases the flexibility in weight choice.

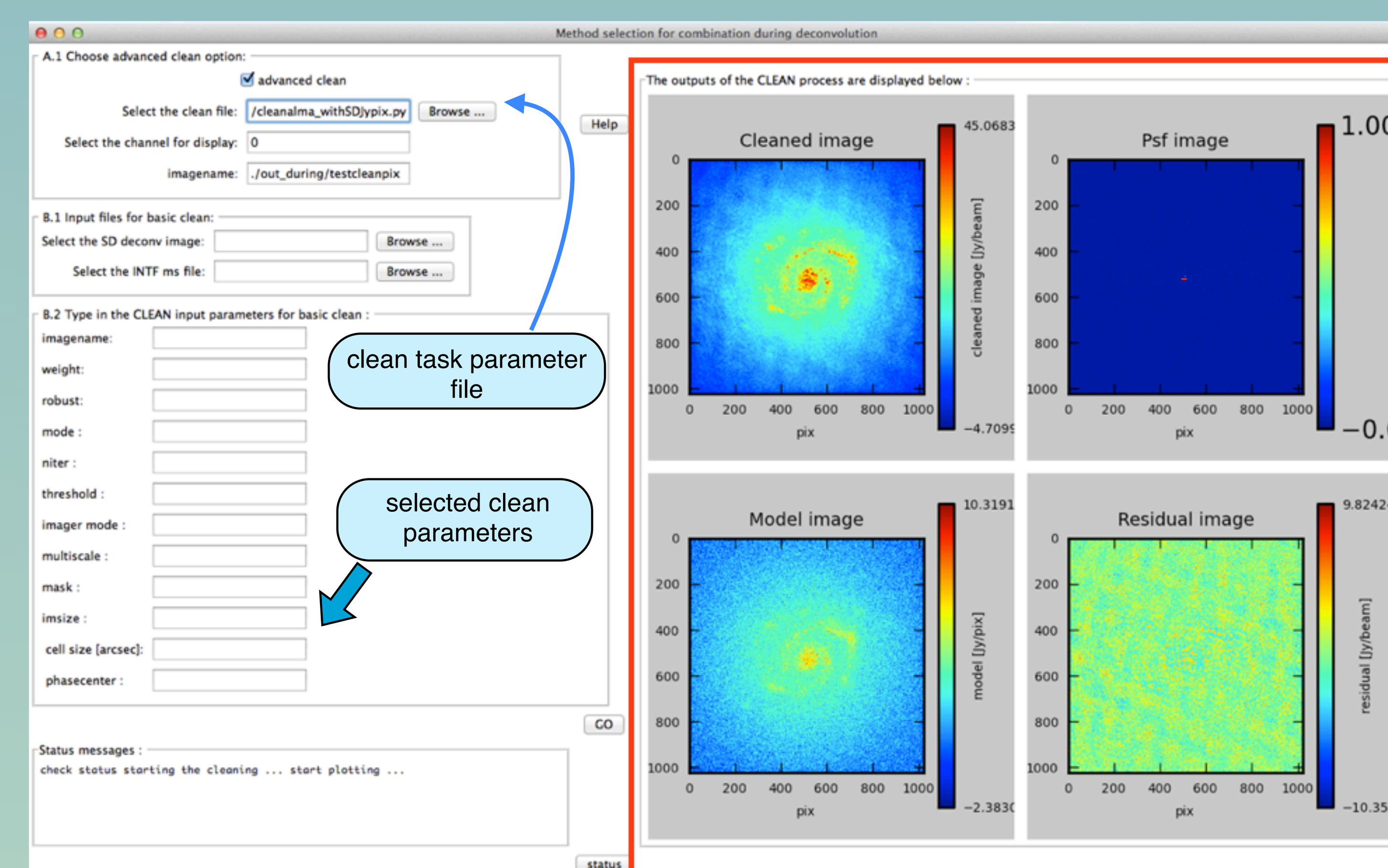




The first combination method allows respective gaussian weights between the cleaned interferometric data cube and the single-dish data to be chosen interactively (1,2). The interface enables the user to inspect all channels of the combined image cube (3) and thus allows for an optimization of the combination with respect to the relative weights. Once the user has chosen a weighting, the spectrum of the combined cube can also be examined (4). The second method facilitates the input of user-defined weighting functions that are then applied to the respective image data cubes to yield a combined INTF/SD image.



Combination during the deconvolution of the interferometric data relies on the fact that a clean model, in this case the single-dish image cube, helps to guide the clean task towards a solution that takes into account the zero-spacing information of the single-dish image. Please note that this layer of the combination GUI relies entirely on CASA's clean task. The same method can be employed for a Maximum Entropy Method approach, which has yet to be implemented into the GUI.



There are two options on how to use the in-built clean task. The first is to import an executable python file specifying the set clean parameters. The second method involves direct input of selected clean task parameters into the GUI interface. These tasks are entirely built on CASA's clean task. In the new beta-release, additional checks on the single-dish and interferometer headers will be implemented to ensure the smooth running of the clean process for a larger single-dish input file header format variety. Furthermore, this task is also going to be extended to provide joint cleaning of the combined single-dish pseudovisibility/interferometric data using the combined INTF/SD beam as this is necessary in the case of high SD weights.

Further developments: The 1.0 beta release is currently available for testing on a set of simulated data as well as a Nobeyama 45m + CARMA dataset. Currently, further extensions of the GUI to allow greater flexibility in parameter setting, input header testing and joint de-convolution are in development. Further testing is currently being done using ALMA + ALMA SD data and an extension to a Maximum Entropy Method combination is planned. In addition, an improved joint INTF/SD de-convolution method allowing for high single-dish weights using the generated combined beam is currently being investigated.

For more information, just ask or contact me via burkutean@ira.inaf.it