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The ALMA Re-imaging Project Study

Felix Stoehr,[1] Marcella Massardi,[2] Anita Richards,[3] Andrea Gianetti,[2] Elisabetta Liuzzo,[2] Sandra Burkutean,[2] Kazi Rygl,[2] and Matteo Bonato[2]

[1]*ESO, Garching, Germany;* `fstoehr@eso.org`

[2]*Istituto di Astrofisica Spaziale e Fisica Cosmica, Bologna, Italy*

[3]*Jodrell Bank Centre for Astrophysics, Manchester, United Kingdom*

Abstract. In the first 6 years of ALMA operations, data for more than 1700 projects have been calibrated and manually imaged for quality assessment purposes before being delivered to the PI and being added to the ALMA Science Archive. However, imaging is a time-consuming process and therefore the data-reducers have only created image products for a small fraction of the original data for quality control purposes. We study the feasibility and cost of a potential ALMA Re-Imaging project which would use the newly developed ALMA imaging pipeline to create image products for all the existing data. We here report about the concept and the currrent state of this study.

1. Introduction

ALMA delivers fully quality controlled science-grade data to Principal Investigators (PI) and archival researchers. During the Early Science operation of ALMA the calibration, the science products and the quality control itself were done manually. The ALMA Pipeline has taken more and more over that process over time, first the calibration part and recently also the imaging part. While the Pipeline will essentially create products making use of the entire raw data, manual quality control concentrated on a few sources, spectral windows and lines, as indeed manual imaging can be a very time-consuming process. We have estimated that during manual imaging roughly 10% of the raw data were converted into science products and indeed, the Archive is not complete as far as imaging products are concerned.

A (more) complete set of imaging products, however, would be of great benefit for the users, especially for archival research. Firstly archival research would be sped up by huge factors if products would not have to be created by the researchers which for some projects can mean many months of processing (Oteo et al. 2016a,b, 2017). Secondly more sophisticated archive services could be constructed on top of the products. Previews of the products giving the user a very quick overview of the content of the data before having to download more often than not several hundred GB are an essential tool to have. This includes previews in the modern HiPS format (Fernique et al. 2017) for display in tools like AladinLite (Boch & Fernique 2014). Moreover post-analysis can be run on the products which identifies sources and lines. The ALMA Data Mining Toolkit (ADMIT) (Teuben et al. 2015) has already been created to this effect. The metadata obtained from such a post-analysis (number of sources, identi-

fied lines, line-density, maximum line-strength, ...) could not only be directly offered from the interface, but, ideally even made search-able in case these metadata are of high-enough quality and completeness. Finally, the products can then be also offered through VO services like ObsCore or SIAPv2 and be sent to visualization solutions like CARTA (Rosolowsky et al. 2015).

2. The ALMA Re-Imaging project study

In 2016 the ALMA Re-Imaging (ARI) development study was submitted to the Call For Proposals of the ALMA development program of ESO to evaluate the feasibility and effort of using the now existing ALMA Imaging Pipeline to image the already existing calibrated science data of Cycle 0, 1, 2, 3 and maybe 4 as well as to ingest the resulting products into the official ALMA Science Archive. Indeed, with it's 5.x version, the ALMA Pipeline (Muders et al. 2014) has reached a status of maturity that makes processing a relatively large fraction of all ALMA data (of the order of 60-80% possible. Observing modes that currently can not be processed by the ALMA Pipeline will be added over time which is also true for more advanced capabilities like self-calibration or the combination of data from the ALMA 12m, the 7m and the TotalPower antennas.

The final deliverable of this study will be a report detailing feasibility, cost, total product size and timescales which can then be the basis of an ALMA development project to indeed create a relatively complete set of image products for ALMA.

3. Examples

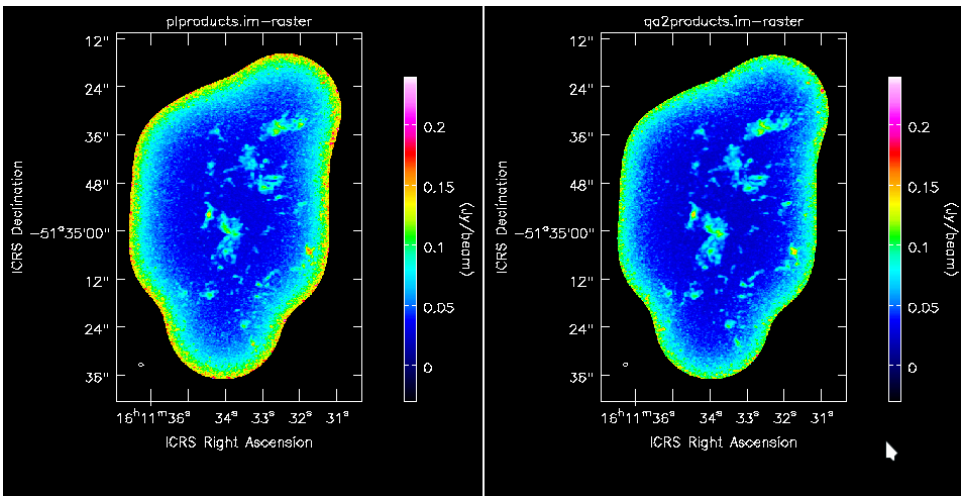

Figure 1. G331.372-00.116 (HCO+)

In order to validate the blind data-processing we identify the corresponding manually created data-products to the PL products and then change the resolution, size and frequency-range of the latter so that they exactly match the specifications of the manually created products. Then we compute the same statistics on both (rms, dynamic

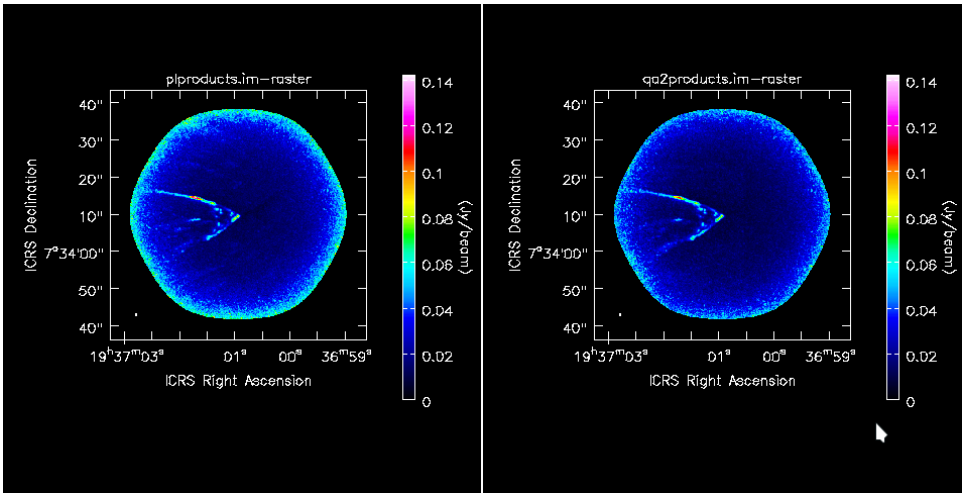

Figure 2. B335 (CO 2-1)

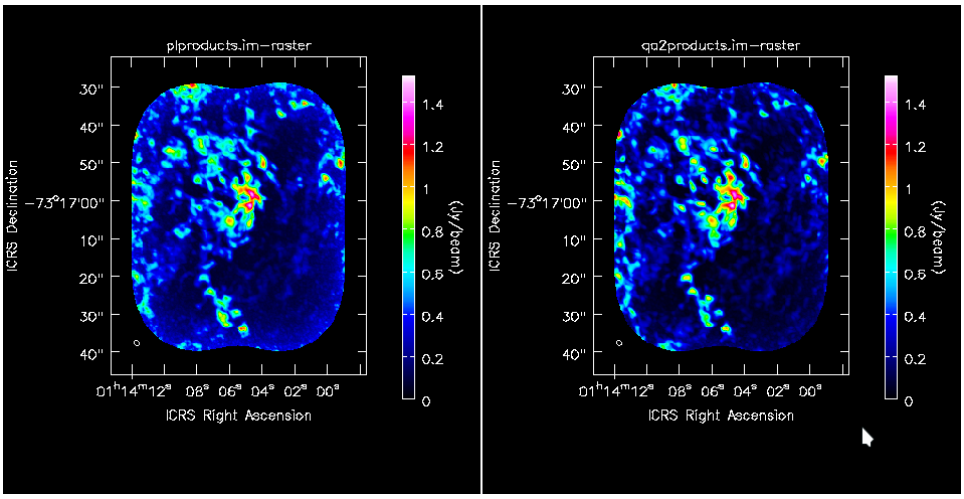

Figure 3. N83C (CO)

range, flux values). The three figures 1, 2 and 3 show visual comparisons between the manually created data products (right) and the corresponding ARI CASA/Imaging Pipeline runs (left).

4. Status

The ARI study has been approved by ESO and is underway. ARI software to launch the ALMA Imaging Pipeline has been written and some 1200 datasets from 617 projects, i.e. about 20% of the full holdings have been processed. This includes data from all Cycles, 2011.0, 2012.1, 2013.1, 2015.1 and 2016.1. The current work is focused on

the validation of the blind processing against the manually reduced products, on the resolution of errors and on the estimation of cost and feasibility.

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