POSSUM Report 23: Data Verification Plan

Lisa Harvey-Smith and the POSSUM Team

Introduction

This report describes the data verification process for the ASKAP POSSUM survey. This constitutes the design of a software verification pipeline, to be run on-the-fly as part of the ASKAP rotation measure pipeline, to test the individual and global properties of the data products destined for the POSSUM Polarization Catalogue (PPC). In this document it is assumed that the ASKAP pipeline has been sufficiently tested in the software commissioning stages. The verification steps described here will test the viability of the results against factors such as hardware errors, RFI, weather, etc. A list of the verified data products of the PPC is specified in POSSUM Report #22, which should be read in parallel with this report.

Individual tests on the data products written to the PPC

The POSSUM Polarization Catalogue (PPC) will be populated in real-time with the data products resulting from the calculation of polarization properties and Faraday rotation for every EMU source.

Table 1 describes the entries that will populate the PPC, along with the pipeline module, the report number and the person(s) responsible for delivery of that report. Report #22 has already outlined a draft for the flags r_1 and r_2 and this will be investigated further before the production of Report #56. For each pipeline module reports, the author in Table 1 will not only provide a detailed description of the process or algorithm leading to the data product, but will also include a description of any necessary verification calculation(s) for that catalogue entry, to the same level of detail. For example, POSSUM Report 61 will describe the algorithms to calculate (a) the values of $P(\lambda^2)$ for each source; (b) the uncertainties in $P(\lambda^2)$ and (c) the required data verification calculations for this data product. In this case one might expect to generate a flag if the polarized intensity changed

by more than a factor of two in adjacent spectral channels. A number of other examples that can guide the report authors were given in POSSUM Report # 3: Draft Data Format and Access. It is the role of WG5 Chair (Harvey-Smith) to actively liaise with the authors of the reports that describe the generation of PPC entries to ensure that robust verification of data quality is achieved. This process has already begun and will be continued through individual meetings and joint WG2/5/8 teleconferences.

Catalogue Entry[a]	Module[b]	Report[c]	Person[d]
emu_id	EMU catalogue	NA	NA
emu_comp	EMU catalogue	NA	NA
e^e	EMU catalogue	NA	NA
$\mathcal{I}, \mathcal{Q}, \mathcal{U}, \mathcal{V}$	2.1	51	Banfield
$\delta\mathcal{I}, \delta\mathcal{Q}, \delta\mathcal{U}, \delta\mathcal{V}$	2.1	51	Banfield
$P(\lambda^2)$, $\delta P(\lambda^2)$	2.6, 2.7	61	Sun
$F(\phi)$, $\delta F(\phi)$, $F_{ann}(\phi)$	2.6	52	Sun/Gaensler
RM_0, $\delta\mathrm{RM}_0$	2.6	52	Sun/Gaensler
θ_0, $\delta\theta_0$	2.6	52	Sun
P, δP	2.6, 2.7	61	Sun
P^+	2.3	55	Stil
V, δV	2.6, 2.7	61	Sun
V^+	2.3	55	Stil
f, δf	2.6, 2.7	61	Sun
f^+	2.3	55	Stil
s	2.4	58	Brown
r_1	2.6	56	Harvey-Smith/Purcell
r_2	2.7	56	Harvey-Smith/Purcell

Table 1: a) Symbol for the PPC entry, described in detail in POSSUM Report #7; b) The module where the entry will be calculated; c) The POSSUM Report number where the algorithm will be described; for #24, it will outline the time line and report numbers in which each of these algorithms will be provided; d) The primary person(s) responsible for leading the development of the algorithm; e) e is a flag from the EMU catalogue indicating whether a source is extended or not. The horizontal line delineates spectral quantities which are functions of channel or RM (above) from those that have a single band-averaged quantity (below).

On-the-fly data verification for images and the PPC

In addition to these verification processes for individual catalogue entries, the ASKAP pipeline will also automatically check images for quality as the survey progresses. These checks will be carried out under the auspices of the EMU survey, described in EMU Memo 14. These checks are as follows: For each EMU source, the pipeline will ensure that the polarization leakage, after calibration, remains within the POSSUM specifications. If it does not, a flag will be generated to alert the survey team of the possible need to re-observe the field. If the root-mean-square noise in an image is above a certain level (this level to be determined during the BETA phase) then a similar 're-observe' flag will be generated.

For each 30 square degree field, the POSSUM pipeline will generate a histogram of the polarization position angle in each pixel. As the survey progresses through each field-of-view, a script (written by POSSUM team members) will create a running sum of these histograms (following Battye et al. 2008) with the purpose of detecting any systematic effects which cause particular polarization position angles (or $n\pi$ multiples thereof) to be seen more frequently than others.

Comparison of ASKAP data with existing catalogues

POSSUM will be the deepest and most comprehensive survey of the rotation measure sky to date. Even so, it is possible to test the RM and polarization information gathered by POSSUM by comparing results with existing RM catalogues. Dedicated observations of two ASKAP 30 deg^2 fields have been carried out using the ATCA (Feain et al). Work has also been carried out by members of the POSSUM team (O'Sullivan et al.) to image 10 deg^2 of the ASKAP sky (yielding $\sim$100 polarized sources with a source density of 10 deg^{-2}) using the ATCA. Although these data will be useful in testing the RM pipeline during the ASKAP design study phase, it would be beneficial to extend this work before full ASKAP operations commence to ensure that every 30 deg^2 ASKAP field has at least one independently verified RM (a 'polarized verification source') for data verification purposes. Plans are afoot to compile a more comprehensive all-sky database of RMs, which may be available by commencement of BETA operations (Schnitzler et al. and Oppermann et al. 2012). Once commissioning of BETA is complete, the POSSUM team should compile a 'POSSUM Calibrator Catalogue' of all these known sources. POSSUM Reports #63 and #65 will shed more light on the degree of similarity between the results of the ATCA RM observations and ASKAP

BETA observations of the same sources.