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PARTICLE PHYSICS AND ASTRONOMY RESEARCH COUNCIL

Progress report from UKIDSS

Memorandum by the UKIDSS Consortium Survey Scientist, Dr S J Warren

The present paper is somewhat longer than usual as it covers the important items of DR1, and the renewal documents.

1. First Data Release, 21 July 2006

The First Data Release, referred to as DR1, took place on 21 July 2006, and was announced on the ESO front page. The release date was just one week after the original target release date. The cause of the delay was the requirement to reprocess a fraction of the UDS frames where the sky subtraction was unsatisfactory. This issue is covered in Section 2, on progress rate. As with the EDR the release has gone well, with no major problems reported, and with heavy use of the archive.

DR1 is the first large release of survey quality data, and contains all the data from semesters 05A and 05B that passed quality control (QC). On the WSA DR1 appears as two databases. The DR1 database contains data where the filter set for that survey is complete for any detector. The DR1+ database includes fields with incomplete filter coverage. We can quantify the size of DR1 relative to the 7-year plan in terms of the summed integration time of data released for each survey relative to that required to complete the survey. The relevant figures for each survey in terms of both the 7-year and 2-year plans are provided in Table 1. Overall DR1 marks completion of 7% of the UKIDSS final goals. (The remaining columns in the table are explained later.)

DR1 represents an important milestone for UKIRT, marking the point where UKIDSS became the largest existing near-infrared survey. One may compare UKIDSS against 2MASS by asking how much of UKIDSS could 2MASS have completed if they had spent the same amount of time observing a smaller field in order to go deeper. Then the quantity to compare is the product $\Omega \times 10^{0.8m}$, where Ω is solid angle, and m is depth (apparent magnitude). Computed in this

Survey	1	2	3	4
LAS	0.06	0.16	0.24	507
GPS	0.07	0.22	0.41	140
GCS	0.13	0.31	0.37	86
DXS	0.11	0.35	0.49	65
UDS	0.04	0.21	0.21	272

Table 1: Proportion of each survey completed: 1. At DR1 (i.e. end of 05B) as proportion of 7-year plan, 2. At DR1 as proportion of 2-year plan, 3. At end of 06A as proportion of 2-year plan, 4. Allocation in hours to each survey for 06B.

way, summing over the entire contents of the DR1+ database (i.e. including fields where filter coverage is incomplete), DR1 is an order of magnitude larger than 2MASS. 2MASS, being a shallow survey, was of course optimal for surveying a large volume. Nevertheless DR1 is also a little larger than 2MASS in terms of volume surveyed.

The release was accompanied by a paper (Warren et al., 2006, MNRAS, in press, astro-ph/0610191) describing the contents for each survey, and changes since the EDR to the observing procedures, the pipeline, and the archive. The paper also included some interesting summary statistics on the distributions of seeing, airmass, and sky brightness over the dataset. The results confirm that, in terms of these global quantities, the observing protocols are working very satisfactorily. Regarding the seeing, the median value with 1σ range (i.e. the 16 and 84% quantiles) is $0.82^{+0.15}_{-0.13}$arcsec. This is really very satisfactory considering that the 05A data suffered from imperfect alignment of the optics, and that compensation for instrument flexure was not implemented until after completion of the 05B observations. The UKIRT seeing is of course much better than that for SDSS ($\sim$ 1.4arcsec) and for 2MASS ($\sim$ 2.6arcsec). The median airmass with 1σ range is $1.10^{+0.19}_{-0.06}$. There is a pronounced tail to large values, which is more a consequence of the declination of the fields, then any shortcoming in the observing protocols. Plots of the cumulative distribution of sky brightness for the ZYJHK bands were provided. There is a discrepancy between the Z-band measured values and the values published by SDSS, in the sense that the UKIDSS values are 0.4mag brighter, which remains to be understood.

A data release involves close interaction between UKIDSS and WFAU. We coordinate over the timetable, the exact content, and any enhancements to the archive functionality. The QC is done jointly and involves several weeks' work. WFAU have been unfailingly helpful throughout

the EDR and DR1, always willing to consider suggestions for additional functionality of the archive, and tireless in their efforts to meet the release schedule.

2. Progress rate

Completion of DR1 allowed us to undertake an in-depth analysis of survey progress, and to compare the the actual survey rate achieved to the survey-rate model used in the original UKIDSS proposal. The results are fairly uniform across the surveys, and therefore easy to summarise.

In the original proposal we assumed that the amount of time spent integrating divided by the total amount of time spent observing was 0.65 for the shallow surveys and 0.85 for the deep surveys. Averaged over 05A and 05B, over the 5 surveys, the actual observing efficiency compared to expectation is 0.78 (we will refer to this as the 'relative observing efficiency' later). The main cause of the reduced efficiency is the overhead associated with the readout, principally writing the data to disk.

The second factor which affects progress is the amount of data deprecated at the QC stage. Again this is fairly uniform over the surveys, amounting to a factor 0.79 surviving quality control (referred to later as the 'quality control factor'). Taken together over 05A and 05B the surveys progressed at an overall rate $0.78 \times 0.79 = 0.62$ of that originally expected (this is similar to the figure provided in my report to the last Board meeting, where I gave the rough estimate of 'a factor of about 1.5' slower).

Some reductions to the readout overhead have been achieved in both 06A and 06B. Similarly we anticipate that we will measure an improvement to the quality control factor over 06A (this cannot be measured until DR2 is prepared), and further improvements can be expected over 06B. The rather large fraction lost in QC is a serious concern. Therefore, with the aim of reducing the proportion lost, on completion of DR1 we undertook a study in depth of the different contributions. We now report the findings in detail. The broad summary is as follows: *a.)* 7% of frames were duplicated, because the observations were abandoned (principally because the seeing deteriorated), and were later repeated; *b.)* 8% of frames were rejected because the sky subtraction was unsatisfactory, or bright moon ghosts were present; *c.)* 4% of frames were rejected because the seeing exceeded the required limits, or the images were elongated; *d.)* 2% of frames were rejected for a variety of causes, including, for example, bad channel-bias offsets, plus a tiny fraction of pipeline errors (wrong choice of repeated frames).

In category *(a.)* a significant contribution here comes from the GPS and occurred at the time

when the pipeline was not keeping up with the data (because cataloguing the myriad stars in the plane). This had the consequence that on occasion the observer was only able to reject the MSB after it was completed, whereas it should have been rejected nearer the start at the time the seeing deteriorated. This problem has since been fixed.

In category *(b.)* about half this fraction is due to moon ghosts. We understand that the baffle installed at the beginning of 06B has been very successful. The remaining 4% are examples of poor sky subtraction. This was a relatively serious issue for DR1 and led to considerable discussion between UKIDSS and CASU. The wide variety of exposure times, filters, observing protocols, moon distances etc experienced over a single night present a considerable challenge in the development of a comprehensive sky-subtraction algorithm. Some judgment must be exercised in the choice of observations from different times of the night to combine, to produce a sky frame. In a number of cases, particularly for the deep surveys, the choices made led to a visually poor result, and the frames were rejected in QC on inspection of the images. CASU reprocessed a number of nights of data on request from the UDS working group, and the results were satisfactory.

As a result of these concerns, it was agreed to trial a new algorithm for sky subtraction, before proceeding with DR2 wholesale. The 05A (*sic*) data were reprocessed and the images made available to the survey heads over October and November. No adverse comments on the quality of the sky subtraction were recorded.

We consider that the figure of 6%, rejected in categories (c.) and (d.), is an acceptable figure, broadly speaking. Recall that our observing strategy aims to tailor the MSB to the conditions, so as to be able to observe even through thin cirrus, and whenever the seeing is better than 1.3arcsec. Because we are trying to squeeze as much useful time out of the nights awarded, it is inevitable that a small fraction of the observations exceed the requested limits on e.g. seeing or sky brightness.

With regard to the last point, it is interesting to note that during UKIDSS nights up to the end of 06A, the fraction of useable time has been 85%, substantially higher than our standard assumption of 70% useable. A detailed analysis has not been undertaken, so it is not clear whether this is a consequence of better than average weather conditions. But it seems that it more likely reflects the fact that we are able to make use of conditions that would be unusable for many observers.

3. Plans for 06B

We have estimated the current status of the surveys at the end of 06A, starting from the known position at the end of 05B, factoring in the amount of data taken for each survey in 06A, and assuming a quality control factor of 0.85. Then the estimated status of the surveys as a proportion of the 2-year plan is provided in the third column of Table 1. This highlights a relatively serious issue, that the two largest surveys, the LAS, and UDS, are lagging well behind the other surveys. The 2-year plan was originally timetabled to be complete by the end of March. On the basis of the slower survey rate we agreed a revised plan of completion of a fraction of 2/3 of the 2-year plan by the end of 06B. Following detailed discussion with JAC, it became evident that it would be necessary to extend 06B through to mid May to achieve this. We requested 141 nights, and were awarded 126 nights. Under standard assumptions we expect usable conditions 70% of the time. The allocations for each survey (i.e. the number of MSB hours that may be uploaded) assume 10h nights, and cover the possibility of better weather conditions, by assuming 85% usable. These allocations are summarised in the last column of Table 1. If conditions are indeed this clear then we should be able to complete 2/3 of the 2-year plan by the end of 06B.

4. UKIDSS resubmission

The resubmission proposals of the five surveys were submitted on time on 3 Nov. An additional proposal for a sixth survey, the UKIDSS Hemisphere Survey, hereafter the UHS was also submitted. The UHS would be executed in two phases, referred to by I and II below. It is worth remarking that exploitation of UKIDSS is still in the very early stages. As noted above, the first large release, 7% of the whole, took place on 21 July, so that follow up in earnest was only really possible in the new semester, i.e. over September and October, for inclusion in the renewal proposals.

On the basis of the foregoing analysis of survey efficiency, to estimate the amount of time required, we adopted the assumptions of a relative survey efficiency of ~ 0.9, and a quality control factor ~ 0.9, and based our calculation on an overall efficiency of a factor 0.8 compared to the original proposal. This factor must be considered approximate until the completion of 06B, when we will conduct another detailed study of the overall efficiency. We note that this factor 0.8 refers only to the time that is clear, but we mistakenly applied it to the overall time estimate. That is, we assumed the amount of time needed would be a factor $1/0.8 = 1.25$ longer than originally anticipated. The correct figure should be $0.7/0.8 + 0.3 = 1.175$. Therefore our request should be scaled down by a factor $1.175/1.25 = 0.94$. In each survey we estimated the number of nights required after the end of 06B, assuming 2/3 completion of the 2-year plan at that stage. In Table 2 we list the requested number of nights for each survey, and the revised

Survey	1	2
LAS	240	226
GPS	191	180
GCS	68	64
DXS	125	118
UDS	310	291
UHS-I	400	376
UHS-II	400	376
Total	1734	1631

Table 2: Requested number of nights for completion of UKIDSS and its extension. 1. Number of nights requested beyond the end of 06B in proposal, 2. Revised request adjusted by factor 0.94.

figure, using the above correction factor.

5. Registration

So far 68 institutions have registered for access to UKIDSS data, of which 38 are from outside the UK.

We have received several requests for registration from Spanish institutions. Under instructions from the ESO DG these have been postponed until Spain is formally admitted to ESO. This was planned for 1 July, but has been delayed.

6. Publicity etc.

A press release accompanied DR1, focused on UDS results, and generated considerable interest.

We made substantial contributions to the UKIRT Newsletter No. 19. A four page article (appended) on early UKIDSS science results will appear in the Dec issue of The Messenger. We have been asked to submit an article for the PPARC magazine Frontiers by the end of Nov.

So far in 2006 12 journal papers with UKIDSS (in full or in acronym) in the title have appeared

on astro-ph, and we are aware of several in preparation.