The SuperCOSMOS data processing guides: Introduction

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Contents

1 Introduction

This document is an introduction to the SuperCOSMOS data processing guides, which describe various aspects of the analysis of SuperCOSMOS data. Throughout, many example of use of the data and codes that manipulate the various image parameters are given. The intended final set of guides is as follows:

- Introduction (this document),
- Star/galaxy separation, or image classification,
- Pairing,
- Photometry,
- Astrometry,
- Plate stacking.

Note that it is expected that these documents and corresponding codes will evolve over time as user requirements become clearer, so please email `N.Hambly (nch); roe-dot-ac-dot-uk` with any questions, comments, suggestions, problems and/or bug reports. Also, be sure that you have the most up–to–date copies before processing your data (each guide is date stamped on the first page). Complete beginners should consult the Beginner's Guide before attempting to use their data (available via `http://www.roe.ac.uk/cosmos/begin_guide.html`)

The example programs listed in this document, and others, are available by anonymous ftp:

```
% mkdir code
% cd code
% mkdir recipes
% ftp ftp.roe.ac.uk
       .
       .
       .
Name (ftp.roe.ac.uk:xyz): anonymous
331 Guest login ok, send your complete email address as password
Password:
       .
       .
       .
ftp> ascii
ftp> cd pub/nch/code
ftp> mget *.f
ftp> lcd recipes
ftp> cd recipes
ftp> mget *.f
ftp> close
ftp> quit
%
```

In all cases, compilation information is given at the start of the source listings. Feel free to take these codes, examine them and adapt them for your own purposes. Note that for convenience, the codes use the Starlink PGPLOT, SLALIB (Wallace 1992) and NAG libraries (if you do not have access to these libraries at your site, then please email `N.Hambly (nch); roe-dot-ac-dot-uk` for help); some code from 'Numerical Recipes' (Press et al. 1989) is also used.

2 Global parameters of a plate measurement: the housekeeping file

A typical house–keeping file contains the following information:

```
HKFILE  <HOUSEKEEPING>

   JOB            <HEADER>         {structure}
      JOBNO          <_CHAR*16>       'UKJ247'
      DATE-MES       <_CHAR*12>       '1998:04:30'
      TIME           <_CHAR*8>        '12:49:15'
      INSTRUME       <_CHAR*13>       'SuperCOSMOS I'
      ORIGIN         <_CHAR*27>       'Royal Observatory Edinburgh'
      SOFTWARE       <_CHAR*18>       '/home/scosdev/v029'
      OPERATOR       <_CHAR*3>        'ebt'
      USER           <_CHAR*3>        'htm'
      USERREF        <_CHAR*1>        '1'
      UORIGIN        <_CHAR*3>        'ROE'
      UCOUNTRY       <_CHAR*2>        'uk'
      JOBDIR         <_CHAR*19>       '/scos1/scos/UKJ247/'
      COMMENT        <_CHAR*39>       'An object catalogue of the Southern Sky'
      IAM_OLD        <_CHAR*22>       '/scos1/scos/UKJ247/iam'
      IAM_FILE       <_CHAR*132>      'iam.srt'
```

These parameters are self–explanatory. A record of the operator and date/time of measurement can be useful. The final two filenames are used as intermediate stages in the co-ordinate transformation procedure: the pixel analyser outputs a file `iam`; this is then sorted to `iam.srt` and finally the celestial co-ordinate transformation software creates the file `iam.srtrd` with the first two parameters being the RA and DEC (see Section 3).

```
   PLATE          <HEADER>         {structure}
      TELESCOP       <_CHAR*4>        'UKST'
      TELTYPE        <_CHAR*4>        'SCHM'
      PLATE          <_CHAR*4>        '1929'
      MATERIAL       <_CHAR*9>        '3mm glass'
      EMULSION       <_CHAR*5>        'IIIaJ'
      FILTER         <_CHAR*5>        'GG395'
      PSCALE         <_REAL>          67.14
      FIELD          <_INTEGER>       247
      RA_PNT         <_REAL>          2.8
      DEC_PNT        <_REAL>          -45
      RADECSYS       <_CHAR*4>        'FK4'
      EQUINOX        <_REAL>          1950
```

```
      TIMESYS        <_CHAR*12>      'BESSELIAN'
      UTDATE         <_CHAR*6>       '761127'
      LST            <_CHAR*4>       '0229'
      EXPOSURE       <_DOUBLE>       60
      EPOCH          <_REAL>         1975.908
      TELLAT         <_DOUBLE>       -0.54584105765654
      TELLONG        <_DOUBLE>       2.6017661944583
      TELHT          <_DOUBLE>       1145
      TEMP           <_DOUBLE>       273.155
      ATMOSP         <_DOUBLE>       1013.25
      HUMID          <_DOUBLE>       0.5
      WAVE           <_DOUBLE>       4500
      TROPL          <_DOUBLE>       0.0065
      MJD            <_DOUBLE>       43108.528147532
```

These parameters are set up according to the plate being scanned. Note that `RADECSYS`, `EQUINOX` and `TIMESYS` are relevant to `RA_PNT` and `DEC_PNT` (the nominal plate centre), *not* the co-ordinates output to the IAM file. The parameters `LST` through `MJD` are used in the calculation of atmospheric refraction for the astrometric solution (see Davenhall 1998); note however that currently `TEMP`, `ATMOSP` and `HUMID` default to the values listed above for all plates.

```
   FOCUS          <HEADER>        {structure}
      NX             <_INTEGER>      6
      NY             <_INTEGER>      6
      FOCUSMAP       <MAP>           {structure}
         ORIENTAT       <_CHAR*4>       'news'
         EMULPOS        <_CHAR*4>       'UP'
         SCANFILT       <_INTEGER>      14
         SOSP           <_INTEGER>      552
         STEPSIZE       <_INTEGER>      10
         SCANLEN        <_INTEGER>      1152
         A-XMIN         <_INTEGER>      1622000
         A-YMIN         <_INTEGER>      1622000
         A-XMAX         <_INTEGER>      33878000
         A-YMAX         <_INTEGER>      33878000
```

The focus parameters for the job are stored here. Plates are held horizontally when scanned, and sag under gravity. SuperCOSMOS measures the focus position of the emulsion by maximising the pixel–to–pixel noise over a range of focus positions at each of an `NX`,`NY` grid of points prior to the plate scan. A surface fit to those points then defines the focus position at any part of the scan. The other paramaters have the same meaning as in the `MEASUREMENT` structure below.

```
   CALIBRATION    <HEADER>        {structure}
      CALTYPE        <_CHAR*16>      'SPLINE'
      STEPWEDG       <_CHAR*16>      'KPNO'
      NSTEPS         <_INTEGER>      8
```

The transmission to intensity calibration parameters listed above describe the measured calibration fit type, the step wedge and the number of steps in the wedge. Although a calibration is measured and fitted for each plate scanned (assuming a measurable wedge is present on the emulsion), currently a straight line $\log \mathrm{I} - \log \mathrm{T}$ relationship is used with an assumed 'gamma' (see the photometry guide for more details).

```
MEASUREMENT    <MAP>          {structure}
   ORIENTAT       <_CHAR*4>      'news'
   EMULPOS        <_CHAR*4>      'UP'
   SCANFILT       <_INTEGER>     14
   SOSP           <_INTEGER>     552
   STEPSIZE       <_INTEGER>     10
   SCANLEN        <_INTEGER>     1152
   A-XMIN         <_INTEGER>     1622000
   A-YMIN         <_INTEGER>     1622000
   A-XMAX         <_INTEGER>     33878000
   A-YMAX         <_INTEGER>     33878000
   X_PNT          <_INTEGER>     17750000
   Y_PNT          <_INTEGER>     17750000
```

The area of measurement is defined above, in units of 0.01μm. Also given are the plate orientation in the machine, the emulsion position, the neutral density filter position at which the scan was made and the scan step (normally 10μm). The parameters `SOSP` and `SCANLEN` relate to the portion of the CCD used: the device is 2048 pixels long, but because of flat–field and geometric distortion problems off–axis in the imaging optics, currently only 1152 pixels starting at pixel 552 are used to scan the plate.

```
ANALYSIS       <PARAMS>       {structure}
   NPARAMS        <_INTEGER>     32
   PARAMS(32)     <_CHAR*12>     'RA','DEC','XMIN','XMAX','YMIN','YMAX',
                                 'QUALITY','COSMAGCAL','CORMAGCAL'
   AREACUT        <_INTEGER>     8
   AP-PARAM       <_REAL>        1.07
DEBLEND        <PARAMS>       {structure}
   DB-PARAM       <_REAL>        1.05
   DB-AMIN        <_INTEGER>     16
   DB-AMAX        <_INTEGER>     100000
   DB-ACUT        <_INTEGER>     8
   DB-LEVEL       <_INTEGER>     16
   SELECT         <_CHAR*16>     'PARENT+CHILD'
```

Pixel analysis parameters are specified above. The number and names of the image parameters output to the IAM file are given, along with the 'area cut', *ie.* the minimum number of connected pixels constituting an image, and the areal and deblend profile parameters (these are described in detail in Section 3). The minimum area for an image before deblending is attempted is given by `DB-AMIN`; the maximum area that can be deblended by `DB-AMAX`; the minimum area of a deblended componenet that is retained is `DB-ACUT` and the number of deblend levels is given by `DB-LEVEL` (16 is the default and is unlikely to change). Finally, the `SELECT` parameter indicates which images are retained in the final sorted IAM file. In general, both the parent images of a blend, and all the components into which it splits when deblended, are retained. It is therefore important to allow for this when reading through an IAM file. In the codes described in these documents, parent images are generally ignored if present.

```
SKY             <PARAMS>        {structure}
   SKYSQUAR        <_INTEGER>      128
   SKYDEFN         <_CHAR*16>      'MEDIAN'
   SKYFILTR        <_CHAR*16>      'bdkjunk'
   F-THRESH        <_INTEGER>      8
   F-SCLEN         <_REAL>         4
```

A filtered sky background map is produced from the entire pixel map before the pixel analyser is run. These parameters remain the same for most plate scans. The parameter `SKYSQUAR` gives the box size, in pixels, of the area used to initially estimate the sky background over the entire pixel map using the method given by `SKYDEFN`. Further details of the sky estimation and filtering procedures can be found in MacGillivray & Stobie (1984) and Beard, MacGillivray & Thanisch (1990).

```
THRESHOLDING    <PARAMS>        {structure}
   PCUT            <_REAL>         9.000004
   PCUT-O          <_REAL>         9
```

Once a sky background map has been determined, the pixel analyser runs on the data. The threshold value for a pixel to be considered as part of an object is set as a percentage if the local sky background intensity:

$$\mathrm{I_{THRESH}} = \frac{\mathrm{I_{SKY}} \times (100 + \mathrm{PCUT})}{100}$$

The original value set at plate scan time is copied into `PCUT-O` as a record (in case the data are subsequently rethresholded at a different level).

```
XYTORADEC       <HEADER>        {structure}
   STARCAT         <_CHAR*80>      '/sdata/scos/refcats/act.FIT'
   BRIGHTLIM       <_REAL>         9
   R-EQUIN         <_REAL>         2000
   R-TSYS          <_CHAR*12>      'JULIAN'
   MAXITER         <_INTEGER>      500
   RCRITINI        <_DOUBLE>       500000
   RCRITABS        <_DOUBLE>       40000
   RCRITREL        <_DOUBLE>       1
   RCRITFIN        <_DOUBLE>       2.5
   DISTYPE         <_CHAR*80>      'R/TAN(R)'
   HARDCOPY        <_CHAR*80>      '/scos1/scos/UKJ247/UKJ247.ps'
   REFSMULT        <_REAL>         5
   RESDMULT        <_REAL>         1000
   HISTBINS        <_INTEGER>      25
   RACOL           <_CHAR*16>      'RA'
   DECOL           <_CHAR*16>      'DEC'
   RAPMCOL         <_CHAR*16>      'PMRA'
   DECPMCOL        <_CHAR*16>      'PMDE'
   PLXCOL          <_CHAR*16>      'NONE'
   RVCOL           <_CHAR*16>      'NONE'
```

```
      MAGCOL          <_CHAR*16>       'VT'
      C-EQUIN         <_REAL>          2000
      C-EQTSYS        <_CHAR*16>       'JULIAN'
      C-EPOCH         <_REAL>          2000
      C-EPTSYS        <_CHAR*16>       'JULIAN'
      STARSI          <_INTEGER>       424
      STARSC          <_INTEGER>       605
      STARSU          <_INTEGER>       371
      COEFFS_1        <_DOUBLE>        17.4888931379
      COEFFS_2        <_DOUBLE>        -307.28493478247
      COEFFS_3        <_DOUBLE>        -1.294695455447
      COEFFS_4        <_DOUBLE>        17.737746562642
      COEFFS_5        <_DOUBLE>        -1.2945412417776
      COEFFS_6        <_DOUBLE>        307.28327174024
      DISTR           <_DOUBLE>        -0.33333333333333
      RA_PNT          <_DOUBLE>        0.74004115282982
      DEC_PNT         <_DOUBLE>        -0.7839308623139
      SHIFT_PNT       <_DOUBLE>        0.0019307822865124
```

The XYTORADEC parameters pertain to the astrometric solution for the plate; the parameters are all described in detail in Davenhall (1988). The most important parameters from the user point of view are the results equinox R-EQUIN and the results time system R-TSYS. The default for SuperCOSMOS celestial co-ordinates is J2000.0; the epoch is of course the date of exposure of the plate and is recorded in PLATE.EPOCH (see above).

```
   IAMQC           <PARAMS>         {structure}
      AREAMIN         <_INTEGER>       8
      AREAMAX         <_INTEGER>       980009
      MINMAG          <_REAL>          -33453
      MAXMAG          <_REAL>          -17715
      MINELL          <_REAL>          0.0002151728
      MAXELL          <_REAL>          1
      MODELL          <_REAL>          0.04
      MODOR           <_REAL>          79
      MIDELL          <_REAL>          0.27
      MIDOR           <_REAL>          85
      MEANELL         <_REAL>          0.2897227
      MEANOR          <_REAL>          86.44309
      NUMOBJ          <_INTEGER>       288538
      PARENTS         <_INTEGER>       267066
      RANGING         <_LOGICAL>       TRUE
      LANE_1          <_INTEGER>       7585
      LANE_2          <_INTEGER>       16034
      LANE_3          <_INTEGER>       26081
      LANE_4          <_INTEGER>       36116
                         .
                         .
                         .
```

Finally, some quality control information is written into the housekeeping file once pixel analysis is complete. A running total of images is produced as the data are sorted in lane order.

3 Detailed description of the 32 IAM image parameters

The following is taken from Kelly (1995):

No.	Name	Type	Description	Units
1	RA	INTEGER	Celestial Right Ascension	10^{-8} radians
2	DEC	INTEGER	Celestial Declination (Note: the usual celestial co-ordinate equinox is J2000.0)	10^{-8} radians
3	XMIN	INTEGER	Left extent	0.01 micron
4	XMAX	INTEGER	Right extent	0.01 micron
5	YMIN	INTEGER	Bottom extent	0.01 micron
6	YMAX	INTEGER	Top extent	0.01 micron
7	AREA	INTEGER	Total area	Pixels
8	IPEAK	INTEGER	Brightest intensity above sky	
9	COSMAG	INTEGER	1000×COSMOS magnitude ($-2.5\log\sum_i$)	
10	ISKY	INTEGER	Sky intensity at (XCEN_I,YCEN_I)	
11	XCEN_I	INTEGER	Intensity weighted X centroid	0.01 micron
12	YCEN_I	INTEGER	Intensity weighted Y centroid	0.01 micron
13	A_U	INTEGER	Unweighted semi-major axis	0.01 micron
14	B_U	INTEGER	Unweighted semi-minor axis	0.01 micron
15	THETA_U	INTEGER	Unweighted orientation	Degrees
16	A_I	INTEGER	Weighted semi-major axis	0.01 micron
17	B_I	INTEGER	Weighted semi-minor axis	0.01 micron
18	THETA_I	INTEGER	Weighted orientation	Degrees
19	CLASS	INTEGER	Classification flag (0=none, 1=galaxy, 2=star, 3=faint, 4=junk 5,6=subcondensations)	
20	P_A	INTEGER	Celestial position angle	Degrees
21	AP(1)	INTEGER	Area above areal profile level 1	Pixels
22	AP(2)	INTEGER	Area above areal profile level 2	Pixels
23	AP(3)	INTEGER	Area above areal profile level 3	Pixels
24	AP(4)	INTEGER	Area above areal profile level 4	Pixels
25	AP(5)	INTEGER	Area above areal profile level 5	Pixels
26	AP(6)	INTEGER	Area above areal profile level 6	Pixels
27	AP(7)	INTEGER	Area above areal profile level 7	Pixels
28	AP(8)	INTEGER	Area above areal profile level 8	Pixels
29	BLEND	INTEGER	Deblending flag (0 if not deblended)	
30	QUALITY	INTEGER	Quality flag	
31	COSMAGCAL	INTEGER	1000 × COSMOS magnitude converted into surface brightness	Mag arcsec^{-2}
32	SPARE	INTEGER	Currently unused.	

In more detail:

1	RA	INTEGER	Celestial Right Ascension	10^{-8} radians
2	DEC	INTEGER	Celestial Declination	10^{-8} radians

Every image in the IAM file has its (X,Y) position translated into celestial co-ordinates. The astrometric solution is currently based on the Tycho–ACT catalogue, and typically yields accuracies of order ~ 0.2" in either co-ordinate. More detail concerning absolute and relative astrometry will be given in the astrometry guide; Davenhall (1998) details the astrometric solution procedure.

3	XMIN	INTEGER	Left extent	0.01 micron
4	XMAX	INTEGER	Right extent	0.01 micron
5	YMIN	INTEGER	Bottom extent	0.01 micron
6	YMAX	INTEGER	Top extent	0.01 micron
7	AREA	INTEGER	Total area	Pixels

These five parameters simply give the extent of the image and it's area. The pixel size is given in `MEASUREMENT.STEPSIZE` in the house–keeping file (see Section 2), and is normally 10μm.

8	IPEAK	INTEGER	Brightest intensity above sky
9	COSMAG	INTEGER	1000×COSMOS magnitude ($-2.5 \log \sum_i$)
10	ISKY	INTEGER	Sky intensity at (XCEN_I,YCEN_I)

These photometric parameters are described in detail in the photometry guide. The parameter IPEAK is the intensity of the brightest pixel in an object, while ISKY is the interpolated value of the sky (from the filtered sky background map) at the image centroid.

11	XCEN_I	INTEGER	Intensity weighted X centroid	0.01 micron
12	YCEN_I	INTEGER	Intensity weighted Y centroid	0.01 micron

The intensity weighted centroid of each image is available in these two image parameters. The RA and DEC (parameters 1 and 2) are obtained by applying an astrometric solution to these co-ordinates.

13	A_U	INTEGER	Unweighted semi-major axis	0.01 micron
14	B_U	INTEGER	Unweighted semi-minor axis	0.01 micron
15	THETA_U	INTEGER	Unweighted orientation	Degrees
16	A_I	INTEGER	Weighted semi-major axis	0.01 micron
17	B_I	INTEGER	Weighted semi-minor axis	0.01 micron
18	THETA_I	INTEGER	Weighted orientation	Degrees

For a set of connected pixels, the pixel analyser fits an ellipse to parameterise the shape of each detected image. Both unweighted and intensity weighted ellipse fit parameters are available for each image (note that the unweighted centroid is not available as the RA and DEC overwrite these). The orientation of the ellipse is measured as positive anticlockwise from the X–axis of the measurement.

19	CLASS	INTEGER	Classification flag (0=none, 1=galaxy, 2=star, 3=faint, 4=junk 5,6=subcondensations)

The star/galaxy separation applied to a plate scan is described in detail in the image classification guide. If the data have not been run through image classification software, then this parameter will be zero for every image.

20	P_A	INTEGER	Celestial position angle	Degrees

This parameter is the unweighted orientation of the ellipse fit expressed as a celestial position angle on the sky, measured positive East of North. The relationship of this to the orientations above depends on the position of the image on the plate and the declination of the plate centre.

21	AP(1)	INTEGER	Area above areal profile level 1	Pixels
22	AP(2)	INTEGER	Area above areal profile level 2	Pixels
23	AP(3)	INTEGER	Area above areal profile level 3	Pixels
24	AP(4)	INTEGER	Area above areal profile level 4	Pixels
25	AP(5)	INTEGER	Area above areal profile level 5	Pixels
26	AP(6)	INTEGER	Area above areal profile level 6	Pixels
27	AP(7)	INTEGER	Area above areal profile level 7	Pixels
28	AP(8)	INTEGER	Area above areal profile level 8	Pixels

Each image is provided with an areal profile in 8 levels (there are effectively 9 areal profiles, because the total area can be used as part of the areal profile – see below). The areal profile is calculated by examining the number of pixels in each image which are brighter than a given set of intensity levels. These are defined as follows: the threshold intensity used for image detection is used as the zeroth intensity level for the areal profile calculations. This is found using the formula

$$\mathrm{thresh} = \mathrm{level}(0) = \mathrm{Isky}\times(100+\mathrm{PCUT})/100,$$

where PCUT is the 'percentage cut' used and Isky is the sky intensity at the image centroid (as stated above, PCUT will typically be $2.3\sigma_{\mathrm{I}} \times 100/\mathrm{I}_{\mathrm{sky}}$). A further 8 intensity levels are defined by

$$\mathrm{level}(1) = \mathrm{level}(0)\times\mathrm{AP\text{-}PARAM},$$
$$\mathrm{level}(n+1) = \mathrm{level}(n)\times\mathrm{AP\text{-}PARAM},$$

where AP-PARAM is known as the 'areal profile parameter'. Defining the levels in this way ensures they are separated logarithmically in intensity, which makes the profiles independent of emulsion sensitivity variations. The most useful value for AP-PARAM is the one which ensures the full dynamic range of the measuring machine is used with the caveat that the highest areal profile level should not be *at* the dynamic range limit — we require the highest areal profile level to yield useful profile information. Both the percentage cut (PCUT) and areal profile parameter (AP-PARAM) may be obtained from the house–keeping file (see Section 2).

The areal profile at level (n) is defined as the total number of pixels within the image whose intensity exceeds that of level(n).

29	BLEND	INTEGER	Deblending flag (0 if not deblended)

Each image is deblended by rethresholding it at each of sixteen levels defined in the same way as the areal profiles, but using a different parameter (DB-PARAM, which can also be found in the house–keeping file). At each level a record is kept of whether the image split into pieces, and which sets of faint pixels belong to which of the deblended fragments. If the rethresholding reveals that an image is multiple, each of the deblended components is pieced together, top level downwards, by aportioning the fainter pixels between the components. Images which have been deblended have this indicated in their deblending flag. This contains 0 if the image has not split into smaller images or if it is not a component of a split image; $-n$ means the image is a parent image which split into n components when deblended; n means the image is the n^{th} deblended component of a parent image. Normally, both parent images and children are included in the IAM data (indicated by 'DEBLEND.SELECT = PARENT+CHILD' in the house–keeping file). Note that many of the code examples described herein ignore images having negative deblending flags, *ie.* they operate only on unblended images or deblended components.

30 QUALITY INTEGER Quality flag

Each image is given a quality flag to indicate what happened while its parameters were being calculated. Individual events are indicated by a bit being set in the quality flag. This is equivalent to incrementing the flag by a power of 2. Most of the events flagged do not mean there is anything wrong with an image, and the image flag is only incremented by a small amount for these. For serious defects, the quality flag is incremented by a large amount. The nett result is that an image is perfectly acceptable if its quality flag is in the range 0 to 65535, but should not be relied upon if its quality flag exceeds 65535. The bits used and the events logged in the quality flag are as follows:

Event	Bit set	Equivalent increment	Severity	Comments
Orientation calculation failed	0	1	Information	Image perfectly round
Ellipticity calculation failed	1	2	Information	Image perfectly straight
Image too multiple for deblending	2	4	Information	Image split into too many fragments
Image too faint	3	8	Warning	Not used as yet
Image too bright	4	16	Warning	Has pixels brighter than the highest areal profile
Image too small	5	32	Warning	Not used as yet
Image too large	4	16	Warning	Has area greater than maximum specified for deblending
Image touches boundary	16	65536	Severe defect	Image may be partially missing
Areal profile failed	17	131072	Severe defect	Odd sky background or image has ALL pixels brighter than highest areal profile level
Bad sky	18	262144	Severe defect	Image has bad sky background
Flushed image	19	524288	Severe defect	Image was not properly tidied up by the IAM software
Bad image	20	1048576	Severe defect	General ‘bad image’ flag

4 Sun/Alpha byte order, byte swapping and compilation options

If you suspect that the byte order is wrong for the workstation on which you wish to analyse your data, then a quick check can be made using the 'octal dump' command `od`:

```
% od -t d4 -N 128 iam.srtrd
       .
       .
       .
%
```

(note that Unix command options can vary between different implementations of the operating system — for example, `-I` or `-S` can be substituted for `-t d4` on many machines. If in doubt, type `man od` and look for the option to display longwords in signed decimal). This will display the 32 parameters for the first image in lane 1 of the IAM file `iam.srtrd` (ignoring the octal pointer in the first output column). If parameters 15, 18 and 20 are all in the range 0 to 359, then the data are in the correct order; if these parameters have ridiculously large values, then the byte order is wrong. Alternatively, if the MM data are on line then look at the header file (see the Beginner's Guide). If you wish to use a Sun workstation, and `dtype` is `I2S`, fine; if an Alpha or a PC is used with `I2D`, fine.

It is easy to swap the bytes of a 2– or 4–byte integer with a little FORTRAN 77. If needed, you may choose to do this every time you read from a binary file, or you may do it once and make a swapped copy of the file. The former is probably preferable for the case of MM data where making a swapped copy of 2 Gbyte of data may be difficult and where only small amounts of data are likely to be read anyway; the latter is to be recommended for IAM data where speed will be increased if a swapped copy is available for many file reads.

The following two subroutines swap 2–byte and 4–byte words:

```
% cat swbyte2.f
      subroutine swbyte2(buff,n)
      implicit none
      integer*4 n,i,j
      integer*2 buff(n),in,out
      logical*1 lin(2),lout(2)
      equivalence (in,lin),(out,lout)

      do i=1,n
       in=buff(i)
       do j=1,2
        lout(j)=lin(3-j)
       enddo
       buff(i)=out
      enddo
      return
      end
% cat swbyte4.f
      subroutine swbyte4(buff,n)
      implicit none
```

```
      integer*4 n,i,j
      integer*4 buff(n),in,out
      logical*1 lin(4),lout(4)
      equivalence (in,lin),(out,lout)

      do i=1,n
       in=buff(i)
       do j=1,4
        lout(j)=lin(5-j)
       enddo
       buff(i)=out
      enddo
      return
      end
%
```

An example of the use of the latter is the following routine, which will make a swapped copy of an IAM file:

```
% cat swapiam.f
      program swapiam
c
c  Creates a byte-swapped copy of an IAM file.
c
c  To Compile: alpha% f77 swapiam.f -o swapiam
c                sun% f77 swapiam.f -o swapiam -xl
c
      implicit none
      integer buff(32),i
      character in*80,out*80

      write (*,*) 'Input file?'
      read (*,'(a)') in
      write (*,*) 'Output file?'
      read (*,'(a)') out

      open (unit=1,file=in,access='direct',
     :status='old',form='unformatted',recl=32,readonly)
      open (unit=2,file=out,access='direct',
     :status='new',form='unformatted',recl=32)

      i=0
10    i=i+1
      read (1,rec=i,err=20) buff
      call swbyte4(buff,32)
      write (2,rec=i) buff
      goto 10
20    close (1)
      close (2)
```

```
      write (*,*) 'No. of records transfered: ',i-1

      end

      include 'swbyte4.f'
```

Note that when reading direct access files, the record length is specified in 4–byte words on Alpha workstations (*i.e.* `recl=32` for IAM data; `recl=576` for MM data), even when using the `-vms` compilation option; whereas it is specified in bytes on Sun workstations **unless** compiling with the `-xl` option, in which case specify in 4–byte words. It is possible of course to make codes applicable in all cases by setting parameters at the start, and editing in appropriate values before compilation: this has been done in some of the code examples (*e.g.* program `ibrisel.f` in the Beginner's Guide).

Finally, a few hints on compilation: most STARLINK sites have the PGPLOT, SLALIB and NAG libraries set up with the compilation commands `` `pgplot_link` ``, `` `sla_link` `` (note the backward quotes) and `-lnag` linking those respective libraries. In some cases, an additional `-L/star/lib` maybe needed for one or all of these, and an `-lsocket` when linking PGPLOT is sometimes required. If you have any trouble compiling the codes (for example if your site does not have the STARLINK Software Collection installed) please email `N.Hambly (nch); roe-dot-ac-dot-uk` for assistance.

5 References

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