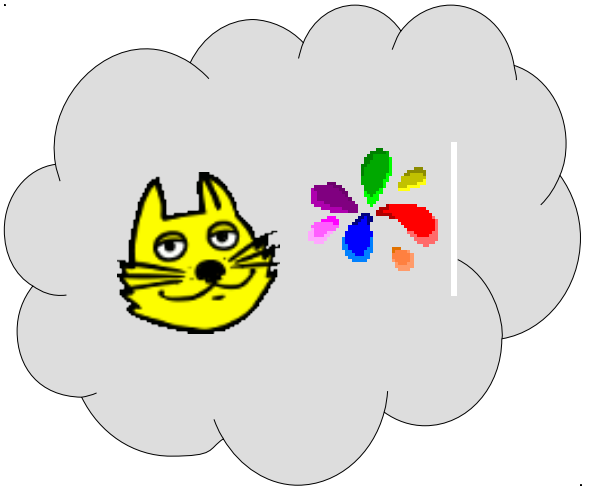
JCMT data reduction

pipelines, recipes and parameters

Overview

- Introduction to Starlink.
- JCMT pipelines.
- Reduction recipes.
- Parameters:
  - recipe parameters.
  - makemap configuration parameters.
- Interactive tutorial.

Starlink
Software Collection



Classic applications:

- SMURF
- KAPPA
- CUPID
- GAIA

Pipelines:

- ORAC-DR
- PICARD
- Wesley

StarJava:

- TOPCAT
- SPLAT

Setting up Starlink

Unpack downloaded package and set up:

```
~ % tar -zxf Downloads/starlink-2023A-macOS-Intel_beta.tar.gz
~ % sudo xattr -dr com.apple.quarantine star-2023A

~ % export STARLINK_DIR=~/star-2023A
~ % source $STARLINK_DIR/etc/profile
```

Optional:

add an alias to your environment (e.g. .zprofile)

```
alias starlink='export STARLINK_DIR=$HOME/star-2023A; source $STARLINK_DIR/etc/profile'
```

Starlink help

Cookbook “SC”:

- SC/20 Heterodyne DR
- SC/21 SCUBA-2 DR
- SC/22 POL-2 DR

Full documentation “SUN”:

- SUN/95 KAPPA
- SUN/258 SMURF
- SUN/260 Heterodyne pipeline
- SUN/264 SCUBA-2 pipeline

Open a document from the terminal:

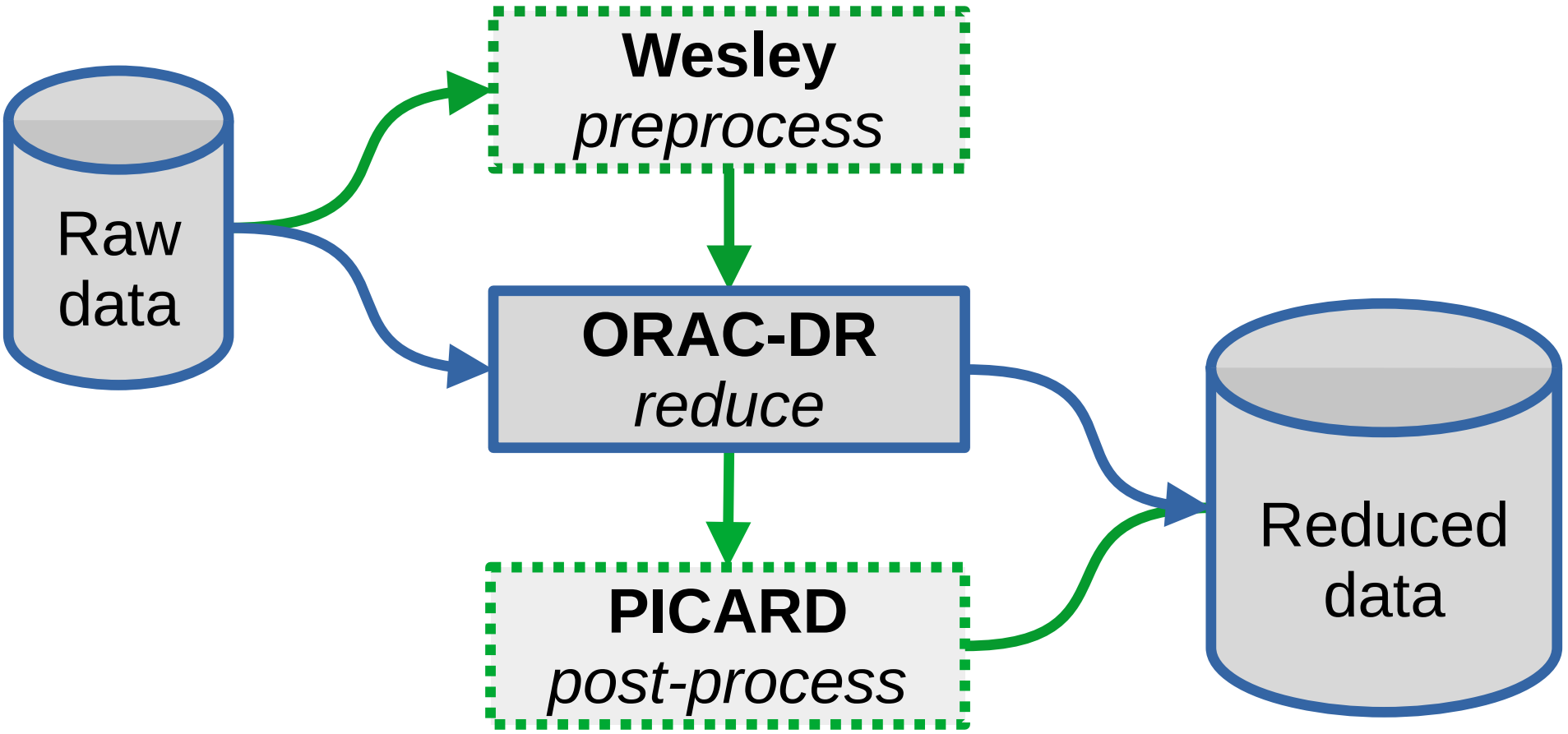
```
% showme sc21
```

Or search for a document:

```
% findme smurf
```

pipelines

Pipelines


Wesley
preprocess
Raw
data
ORAC-DR
reduce
PICARD
post-process
Reduced
data

Setting up ORAC-DR

Initialize the pipeline:

```
% oracdr_acsis --cwd
% oracdr_scuba2_850 --cwd
% oracdr_scuba2_450 --cwd
```

Environment variables:

- **ORAC_DATA_IN**
  - where to find raw data (may not be required)
- **ORAC_DATA_OUT**
  - where to run and write output data
  - set to current directory with `--cwd` option

Running Wesley

```
% oracdr_acsis --cwd 20191213

% wesley --log sf --nodisp --files raw.lis FIX_HEADER_IFFREQ


REDUCING: a20191213_00080_02_0001

Using recipe FIX_HEADER_IFFREQ specified on command-line

Setting headers in file a20191213_00080_02_0001_hdr

    IFFREQ = 6.000030517578

Writing preprocessed file list to preproc_2249.lis
```

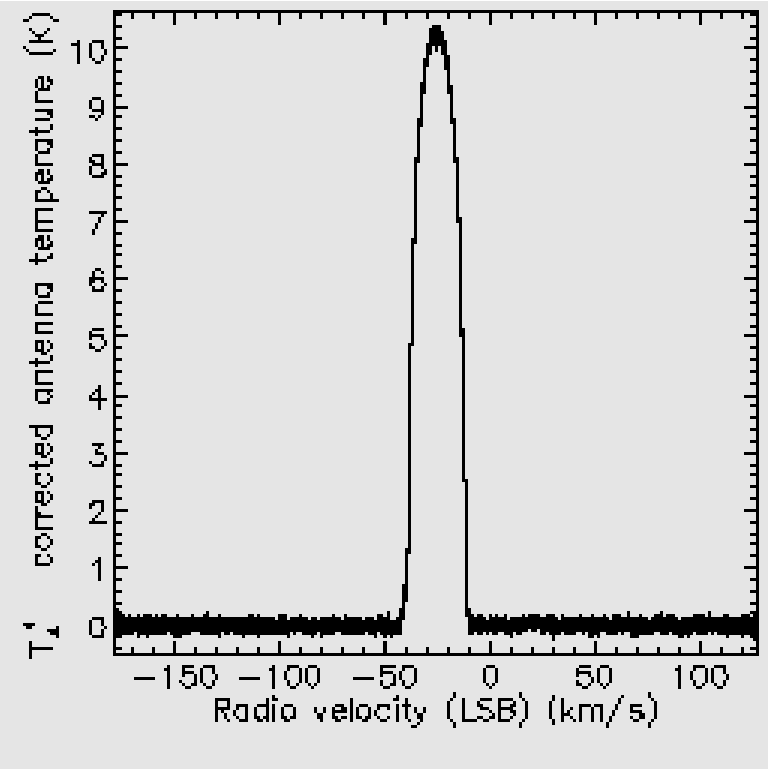
Running ORAC-DR

```
% oracdr --log sf --nodisp --files preproc_2249.lis
```

- Output:
  - a20191213_00080_02_**reduced**001.sdf
  - a20191213_00080_02_**rsp**.sdf
  - (a20191213_00080_02_**rimg**.sdf)
- Group products:
  - ga20191213_80_2_**reduced**001.sdf
  - ga20191213_80_2_**rsp**.sdf
  - (ga20191213_80_2_**rimg**.sdf)

Running PICARD

```
% picard --log sf --nodisp CREATE_PNG a20191213_00080_02_rsp.sdf
```



recipes

Common ORAC-DR recipes

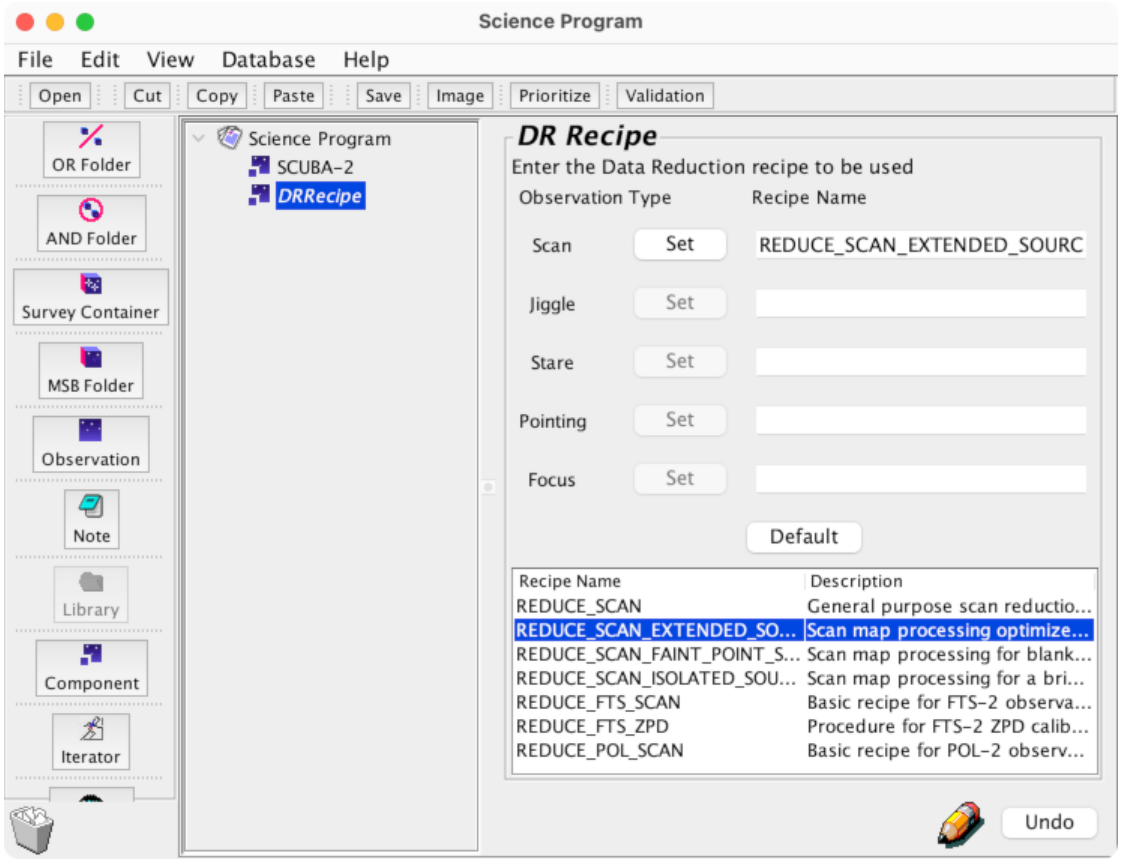
ACSIS:

- REDUCE_SCIENCE_BROADLINE
- REDUCE_SCIENCE_GRADIENT
- REDUCE_SCIENCE_LINEFOREST
- REDUCE_SCIENCE_NARROWLINE

SCUBA-2

- REDUCE_SCAN
- REDUCE_SCAN_EXTENDED_SOURCES
- REDUCE_SCAN_FAINT_POINT_SOURCES
- REDUCE_SCAN_ISOLATED_SOURCE

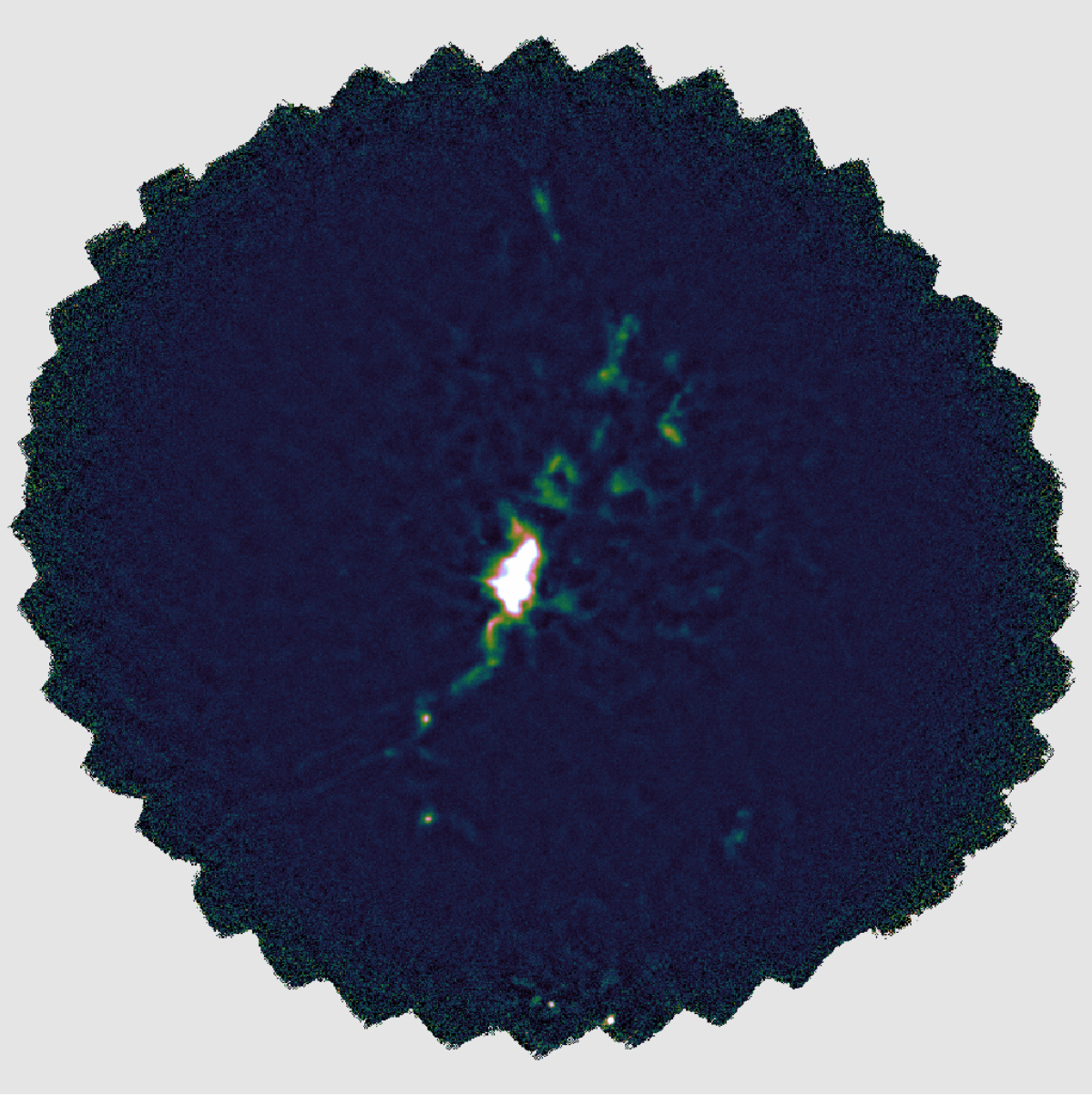
Recipe selection



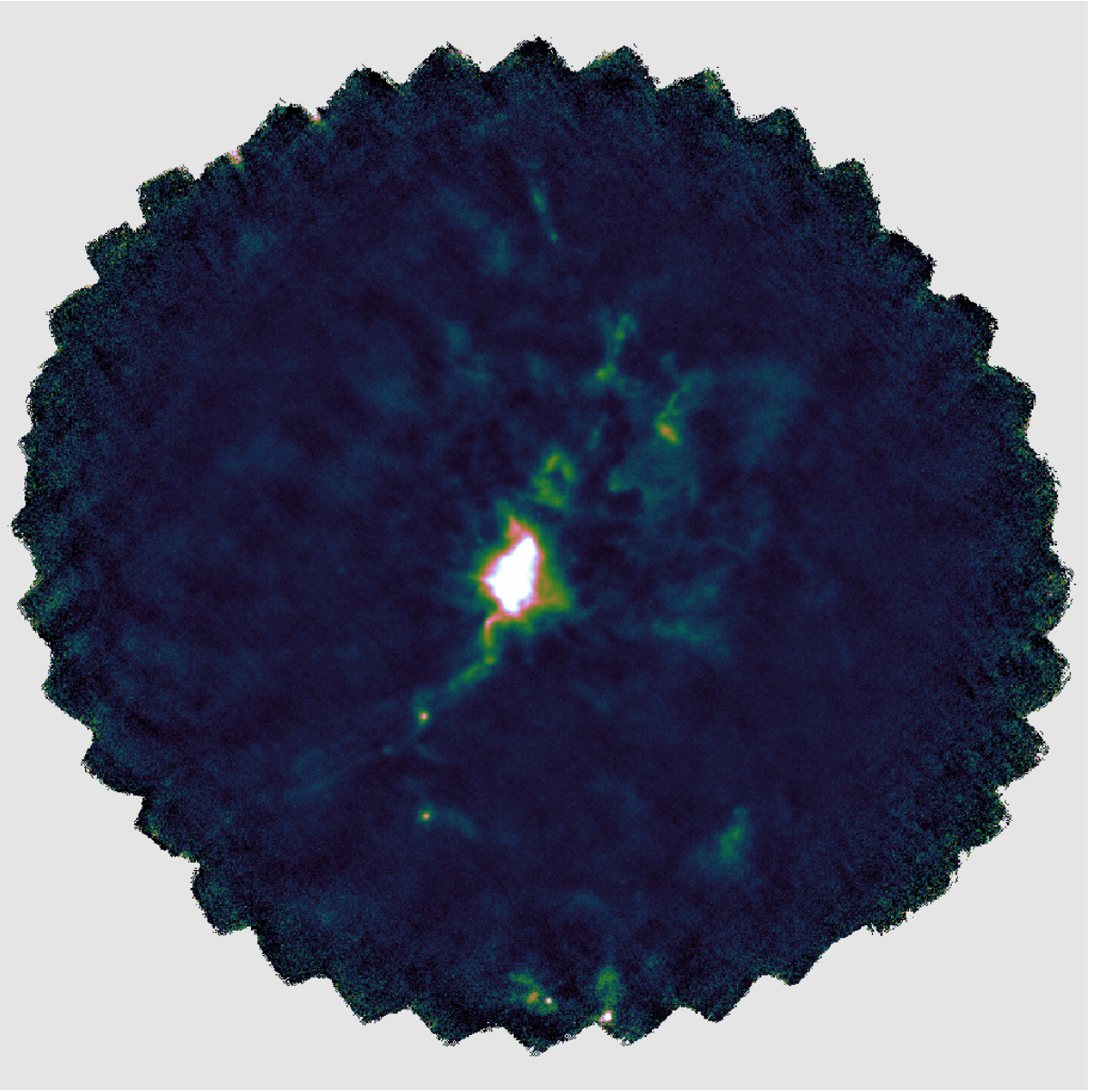
Or:

```
% oracdr --files raw.lis REDUCE_SCAN
```

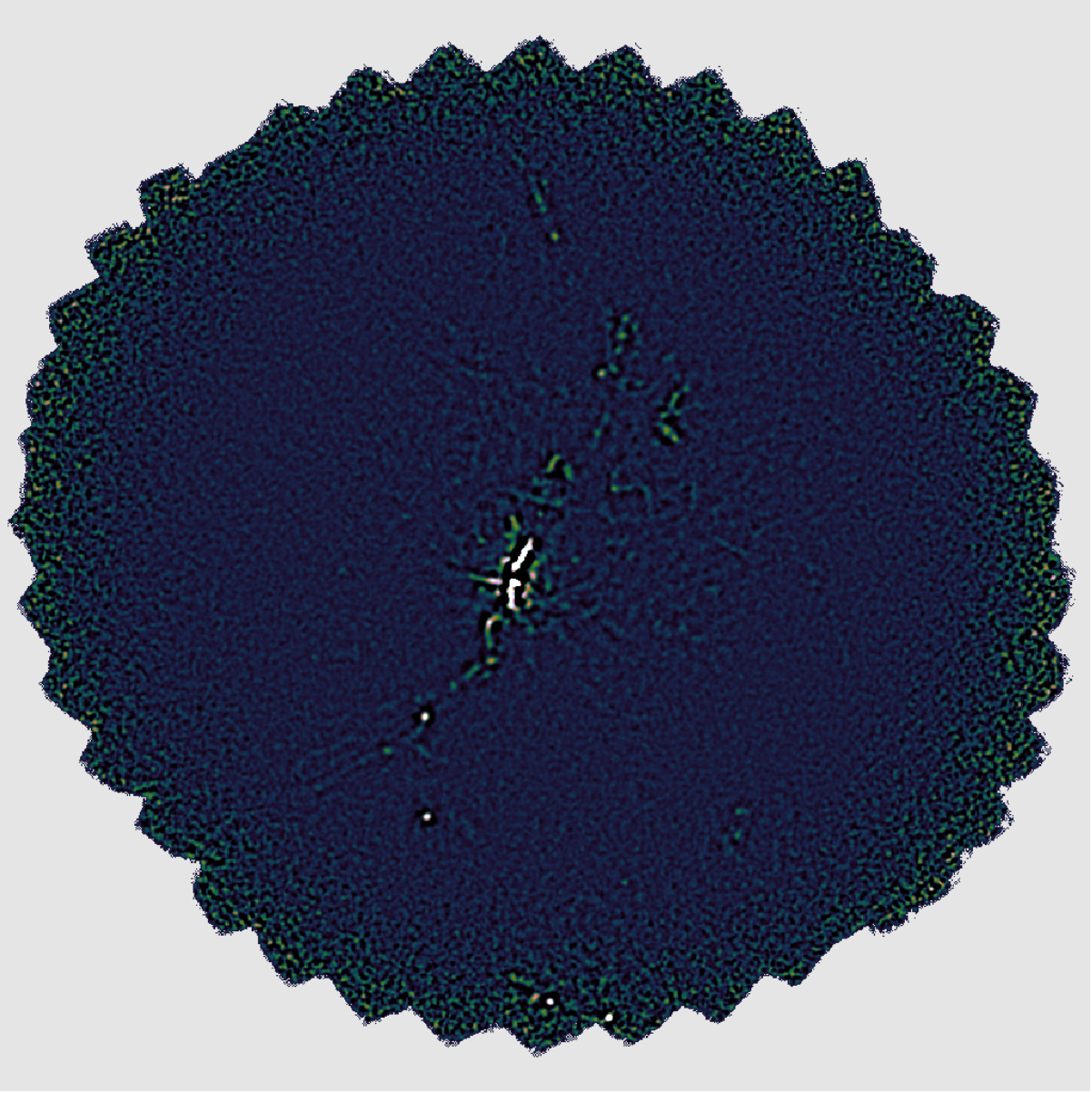
REDUCE_SCAN



REDUCE_SCAN_ EXTENDED_SOURCES



REDUCE_SCAN_ FAINT_POINT_SOURCES



parameters

recipe parameters

Directly-specified

Single parameter:

```
% oracdr --log sf --nodisp \
      --recpars CALUNITS=ARCSEC \
      --files raw.lis
```

Multiple parameters:

```
% oracdr --log sf --nodisp \
      --recpars MAKEMAP_CONFIG=config.lis,MAKEMAP_PIXSIZE=12 \
      --files raw.lis
```

Recipe parameter files

```
% oracdr --log sf --nodisp \
      --recpars params.ini \
      --files raw.lis
```

Where params.ini contains:

```
[REDUCE_SCAN]
CALUNITS = ARCSEC
MAKEMAP_CONFIG = config.lis
MAKEMAP_PIXSIZE = 12
```

Example parameters

ACSIS:

- PIXEL_SCALE (arcseconds)
- BASELINE_ORDER
- Rebinning parameters:
  - SPREAD_METHOD
  - SPREAD_FWHM_OR_ZERO
  - SPREAD_WIDTH

SCUBA-2:

- MAKEMAP_CONFIG (file name)
- MAKEMAP_PIXSIZE (arcseconds)
- CALUNITS (BEAM, ARCSEC or PW)

Format of parameter files

- “ini” format.
- Sections match recipe names:

```
[REDUCE_SCAN_ISOLATED_SOURCE]
MAKEMAP_PIXSIZE = 3

[REDUCE_SCAN_EXTENDED_SOURCES]
MAKEMAP_PIXSIZE = 7
```

Matching by object

- We can also match by object name:

```
[REDUCE_SCAN:NGC1234]
CALUNITS = ARCSEC

[REDUCE_SCAN:NGC5678]
CALUNITS = PW
```

Matching by header values

- And we can match by other (translated) headers:

```
[REDUCE_SCAN#SCAN_PATTERN=CV_DAISY]
MAKEMAP_CONFIG = config_daisy.lis

[REDUCE_SCAN#SCAN_PATTERN=CURVY_PONG]
MAKEMAP_CONFIG = config_pong.lis
```

parameters

makemap configuration

Makemap config. files

- What is makemap?
  - Application used by ORAC-DR to grid raw SCUBA-2 data.
  - Part of the Starlink SMURF package.
- Various sample configurations:
  - `$STARLINK_DIR/share/smurf/`
- Default values:
  - `$STARLINK_DIR/bin/smurf/smurf_makemap.def`

Format of config. files

- Include other files with: **^**
- Add comments with: **#**

E.g. to modify a standard configuration to allow more iterations:

```
^$STARLINK_DIR/share/smurf/dimmconfig_jsa_generic.lis

# Increase maximum number of iterations.

numiter = -40
```

Using custom config. files

With ORAC-DR:

- Use MAKEMAP_CONFIG recipe parameter.

```
% oracdr --log sf --nodisp --files in.lis \
      --recpars MAKEMAP_CONFIG=config.lis
```

When running makemap manually:

- Give config parameter, using ^ to read from a file:

```
% makemap in=^in.lis out=map config=^config.lis
```

Some common parameters

- **`numiter`** — number of iterations to perform. If negative, stop earlier on convergence.
  - default -5, generic: -25, extended: -40
- **`maptol`** — normalized change between iterations required for convergence.
  - default 0.05, generic: 0.01
- **`com.perarray`** — process common mode separately for each sub-array.
- **`flt.filt_edge_largescale`** — spatial scale at which to filter data. (Converted to time in raw data based on scan speed.)
  - default 300″ (850μm) / 600″ (450μm)
  - generic: 200″, extended: 480″

tutorial

Tutorial

https://www.eaobservatory.org/JCMT/user-tutorials/dr-2023/

https://ftp.eao.hawaii.edu/jcmt/usersmeetings/2023-London/tutorial_prp.tar.gz

1) Wesley, ORAC-DR & PICARD.

2) SCUBA-2 recipes.

3) ACSIS recipe parameters.

A) Makemap configuration.

GAIA problems on macOS? Please try running with:

% gaia -unicoderadec 0