

ASKAPsoft tutorial

ASKAPsoft Imaging Tutorial

- Courtesy of (and many thanks to) Wasim Raja
- Wasim has prepared four scripts to:
 - Generate input slurm scripts, parsets and associated files
 - Launch jobs on Galaxy
- The scripts are:
 1. bandpass calibration: **do_cal_1934.sh**
 2. prepare science data: **do_pre_process_ras.sh**
 3. image/selfcal science data (continuum only): **do_selfcal_ras.sh**
 4. form linear mosaic: **do_linmos_ras.sh**
- Also:
 - a script to set up galaxy modules: **setup_modules_on_nodes.sh**
 - a file to configure various parameters: **process_ASKAPdata.config**

setup_modules_on_nodes.sh

```
module use /group/askap/modulefiles  
module unload askapsoft  
module load askapsoft/0.22.1
```

```
module unload askapdata  
module load askapdata
```

```
module unload askappipeline  
module load askappipeline  
#module load askapcli
```

```
export PMI_NO_PREINITIALIZE=1  
export PMI_NO_FORK=1  
export PMI_DEBUG=1
```

```
module unload askap-cray  
module load askap-cray
```

```
module unload slurm  
module load slurm
```

process_ASKAPdata.config

```
export TRIAL=0 # set to 1 to generate files but not run them

export SPLIT_CHAN=1 # split out a subset of frequency channels
export BCHAN_SPLIT=8192
export ECHAN_SPLIT=8407 #9271

export MY_SBID_BPCAL=5181 # scheduling block for band-pass calibration (i.e. the id of the BP calibration
                          # observation)
export MY_SBID_TARGET=5177 # scheduling block for science data (i.e. the id of the science observation)
export MY_FIELD_NAME=COSMOLOGY_T15-2 # name of the science field
export PATH_TO_SETUP_FILE=$PWD # change me if running from a different directory
export MY_OUTPATH=ras_data_processing_${this_user}/
mkdir -p ${MY_OUTPATH}msdata/${MY_SBID_TARGET} ${MY_OUTPATH}bpcal_solutions/${MY_SBID_BPCAL}

# Decide which beams you wish to process. Do bandpass calibration for all 36 beams, but restrict imaging and selfcal to 1 or a few
export BBEAM_BPCAL=0 # Must be 0 with the current structure of bptables
export EBEAM_BPCAL=35 # Can be less than maxBeams
export BBEAM=0 # image / selfcal beams 0 to 1
export EBEAM=1

# Some imaging parameters:
export ROBUST=-0.5
export BLOOP_SELFCAL=0
export ELOOP_SELFCAL=1
```

Tutorial — Yesterday

```
$ mkdir askap_tutorial
```

```
$ cd askap_tutorial
```

```
$ cp -r /group/askap/dmitchell/askap_tutorial/* .
```

- “Source” some setup files:

```
$ . setup_modules_on_nodes.sh
```

```
$ . process_ASKAPdata.config
```

- process_ASKAPdata.config will set up things like a directory for output and input of scripts: `$MY_OUTPATH` (set to `ras_data_processing_username`) and various calibration and imaging parameters

Tutorial — Yesterday

- Generate solutions yourselves:

```
$ ./do_cal_1934.sh
```

- mssplit — select a subset of channels (to limit the amount of processing)
- cflag — look for radio frequency interference and set flags
- cbpcalibrator — run the calibrator for each frequency channel

- Or just copy the solution table that I generated:

```
$ . process_ASKAPdata.config
```

```
$ mv cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab \  
$MY_OUTPATH/bpcal_solutions/5181/
```

Tutorial — Yesterday

Plot some bandpass calibration solutions. Make sure you have logged in with X11 forwarding:

```
$ ssh -X username@galaxy.pawsey.org.au
```

- or:

```
$ ssh -Y username@galaxy.pawsey.org.au
```

For the help menu:

```
$ plot_bandpass.py -h
```

optional arguments:

| | |
|-----------------------------|--|
| -t BP_TAB, --t BP_TAB | Input Bandpass table (with path) |
| -ib BEAM_NUM, --ib BEAM_NUM | The beam number you wish to process |
| -ia ANTE_NUM, --ia ANTE_NUM | The antenna number you wish to process |

```
$ plot_bandpass.py -t cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab -ia 1
```

```
Successful readonly open of default-locked table cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab: 3 columns, 1 rows  
Plotting bandpass solutions for Input table: cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab  
For:
```

```
    Beam Num:  0
```

```
    Ante Num:  1
```

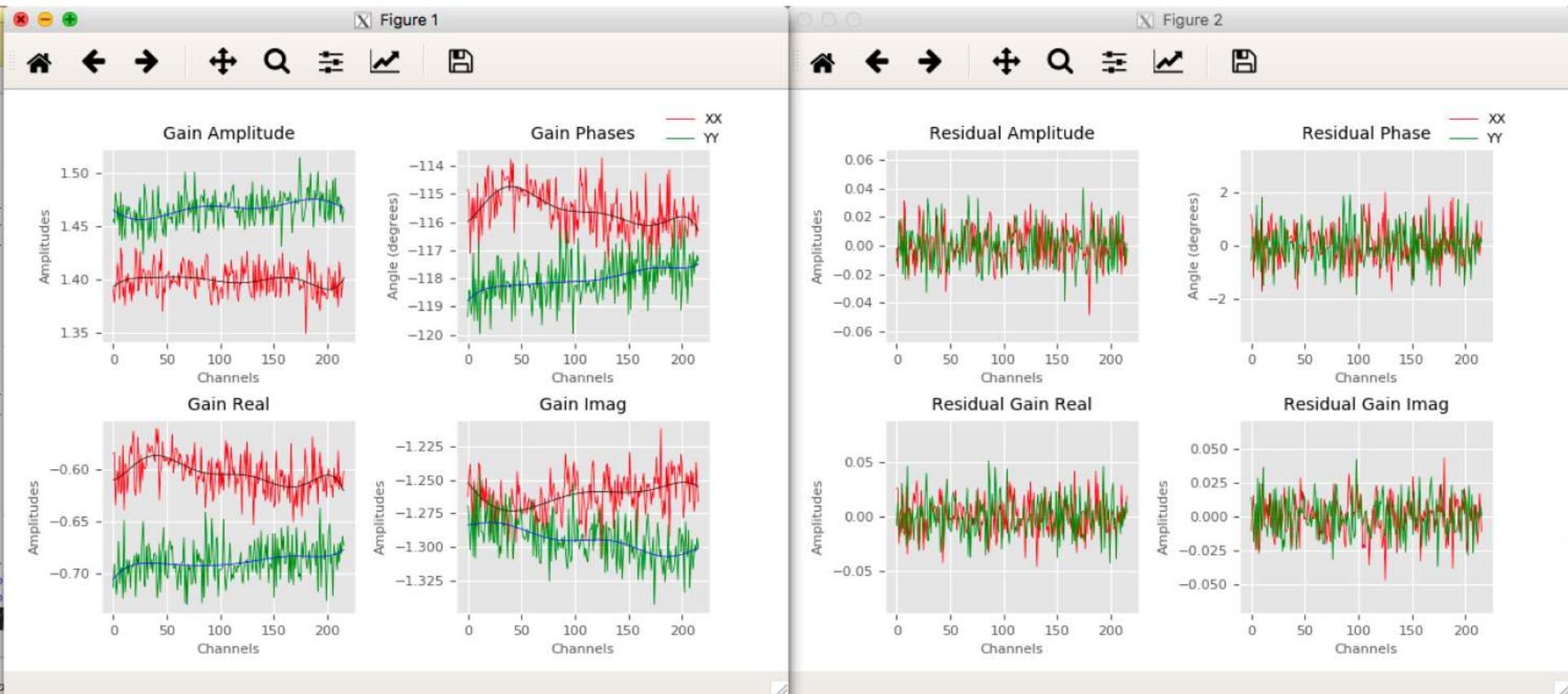
```
Smooth fits will be derived using:
```

```
    Poly Order:  2
```

```
    Harm Order:  3
```

Tutorial — Yesterday

plot_bandpass.py -t cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab



Tutorial — Today

- Look at visibilities
 - Make images
 - Look at images
 - Mosaic image
 - Look at mosaics
-
- Two options for looking at results:
 - Download (scp) to your local machine and look with casa tools.
 - Use remotevis.pawsey.org.au to use casa remotely on the Zeus cluster.

Tutorial — Today

On local machine (replace \$MY_OUTPATH with full directory path):

```
$ scp -r username@hpc-data.pawsey.org.au:$MY_OUTPATH/msdata/5181/FLAGGED_DYNAMIC/1934_bm-0_scan-0.ms .
```

Have a look at the contents of the measurement set

```
$ casabrowser 1934_bm-0_scan-0.ms
```

Table Browser

1934_bm-0_scan-0.ms

| | UVW | FLAG | FLAG_CATEGORY | WEIGHT | SIGMA | ANTENNA1 | ANTENNA2 | ARRAY_ID | DATA_DESC_ID | EXPOSURE | FEED1 | FEED2 | FIELD_ID | FLAG_ROW | INTERVAL | OBSERVATION |
|----|---------------------------|------------------|-------------------|--------------|--------------|----------|----------|----------|--------------|----------|-------|-------|----------|----------|----------|-------------|
| 0 | [0, 0, 0] | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 0 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 1 | 9.95328 | 0 |
| 1 | [1.08631, -19.4913, -2... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 1 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 2 | [11.6401, -33.6758, -8... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 2 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 3 | [12.5459, -2.9094, 33... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 3 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 4 | [-4.9695, 54.5705, 58... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 4 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 5 | [80.243, -152.169, 37... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 5 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 6 | [95.213, -1.2759, 280... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 6 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 7 | [212.605, -425.366, 58... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 7 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 8 | [-205.4, 159.651, -38... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 8 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 9 | [-1.64016, 440.97, 586... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 9 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |
| 10 | [100.194, 772.702, 660... | [4, 216] Boolean | [0, 0, 0] Boolean | [1, 1, 1, 1] | [1, 1, 1, 1] | 0 | 10 | 0 | 0 | 9.95328 | 0 | 0 | 0 | 0 | 9.95328 | 0 |

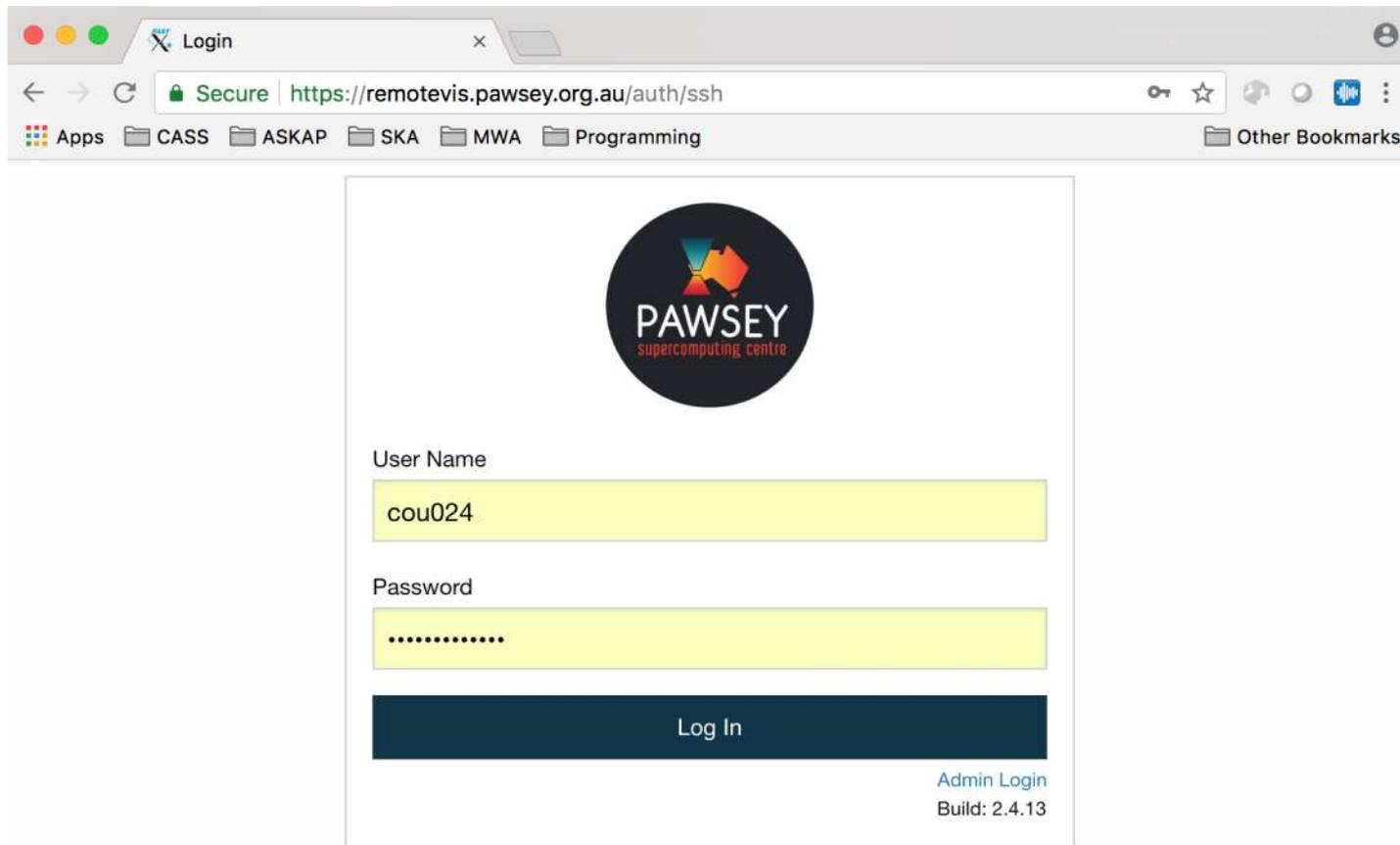
Restore Columns Resize Headers

PAGE NAVIGATION First << [1 / 9] >> Last 1 Go Loading 1000 rows.

Opened saved view.

Tutorial — Today

remotely on the Zeus cluster using `remotevis.pawsey.org.au`

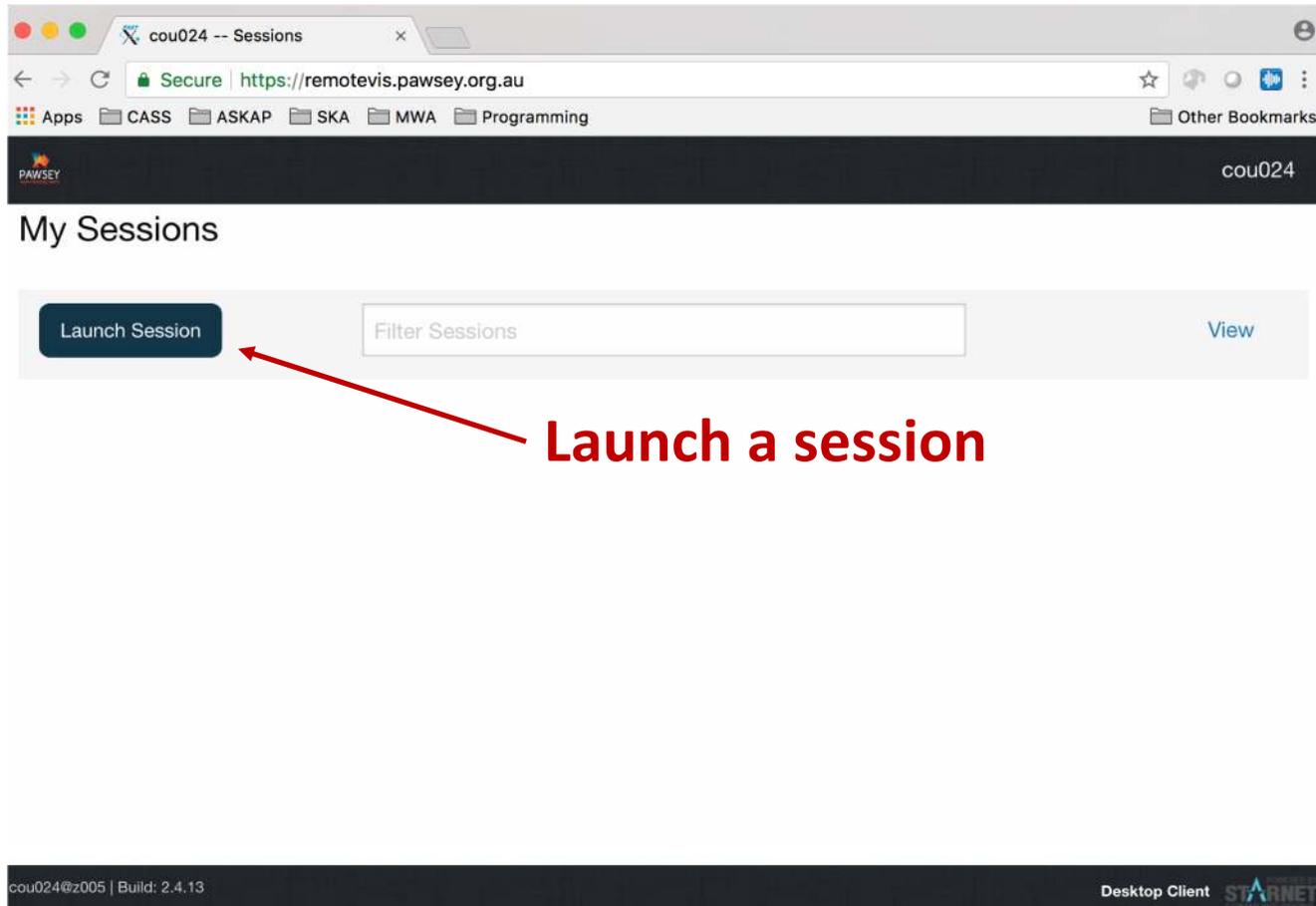


The screenshot shows a web browser window with the following details:

- Browser tab: Login
- Address bar: [Secure | https://remotevis.pawsey.org.au/auth/ssh](https://remotevis.pawsey.org.au/auth/ssh)
- Bookmarks: Apps, CASS, ASKAP, SKA, MWA, Programming, Other Bookmarks
- Page Content:
 - PAWSEY supercomputing centre logo
 - User Name: cou024
 - Password:
 - Log In button
 - Admin Login (link)
 - Build: 2.4.13

Tutorial — Today

remotely on the Zeus cluster using remotevis.pawsey.org.au



The screenshot shows a web browser window with the URL <https://remotevis.pawsey.org.au>. The page title is "My Sessions" and the user is logged in as "cou024". The interface includes a "Launch Session" button, a "Filter Sessions" input field, and a "View" button. A red arrow points to the "Launch Session" button with the text "Launch a session" written in red. The bottom of the page shows the text "cou024@z005 | Build: 2.4.13" and "Desktop Client" with the STARNET logo.

Tutorial — Today

remotely on the Zeus cluster using remotevis.pawsey.org.au

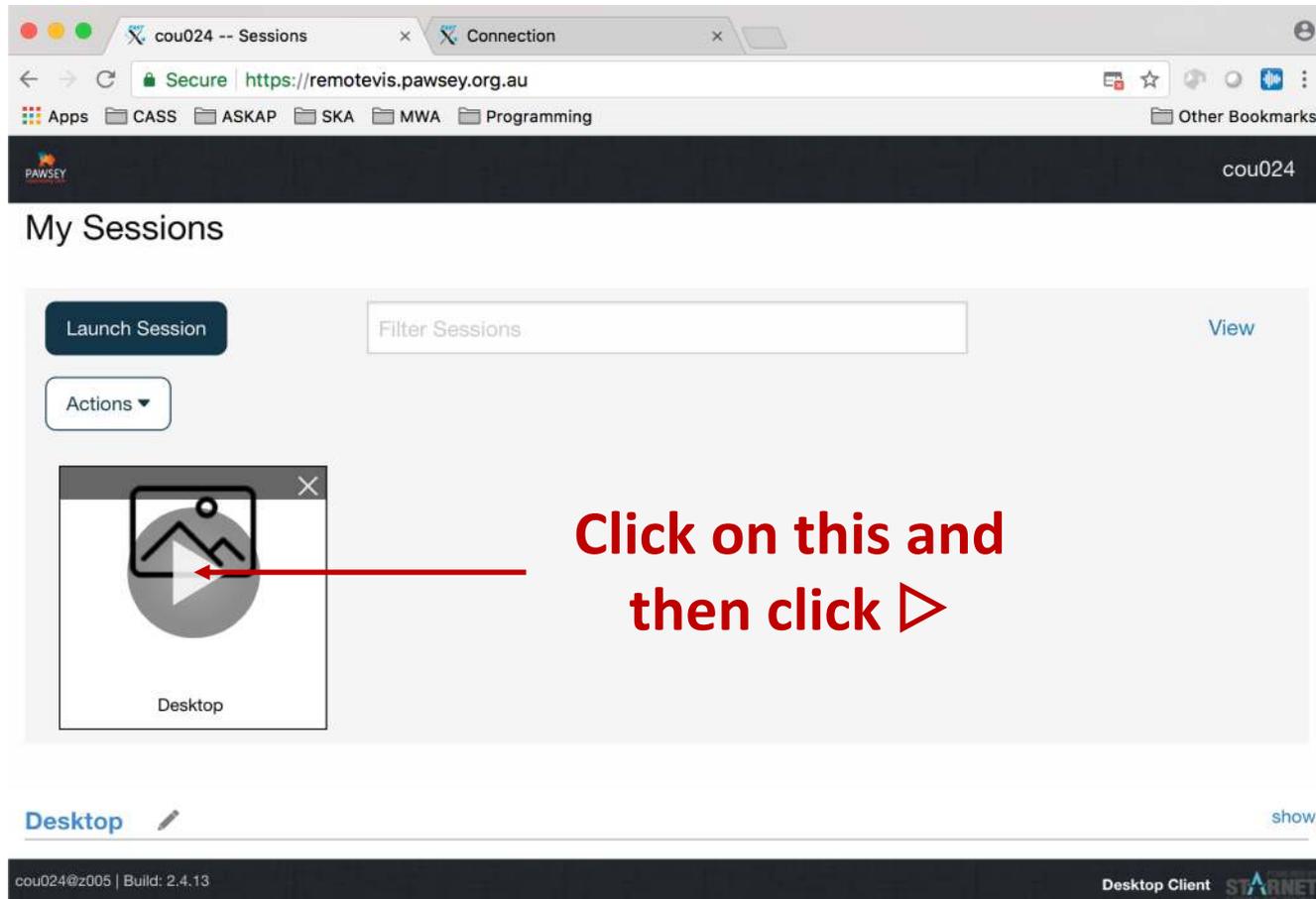
The screenshot shows a web browser window with the URL <https://remotevis.pawsey.org.au>. The page title is "My Sessions" and the user is logged in as "cou024". The main content area displays four session options: "Desktop" (with a penguin icon), "FaceView" (with a multi-colored bar icon), "Visit" (with the "visit" logo), and "xterm" (with a terminal icon). A red arrow points from the text "Select 'desktop'" to the "Desktop" option. Below the options is a "Launch" button and a "Cancel" button. A red arrow points from the text "Then launch it" to the "Launch" button. The bottom of the page shows the user's email "cou024@z005" and the build version "Build: 2.4.13".

Select "desktop"

Then launch it

Tutorial — Today

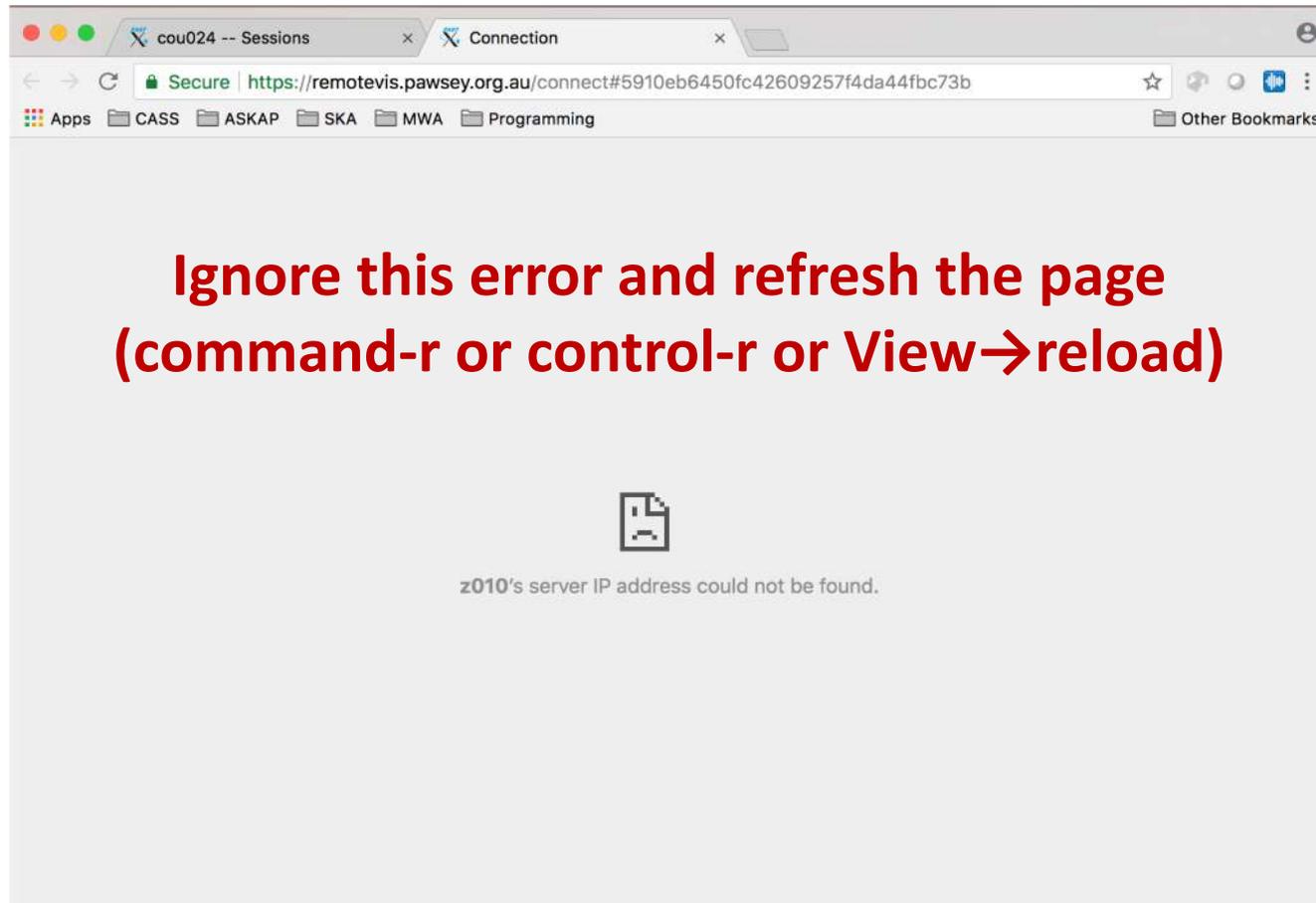
remotely on the Zeus cluster using remotevis.pawsey.org.au



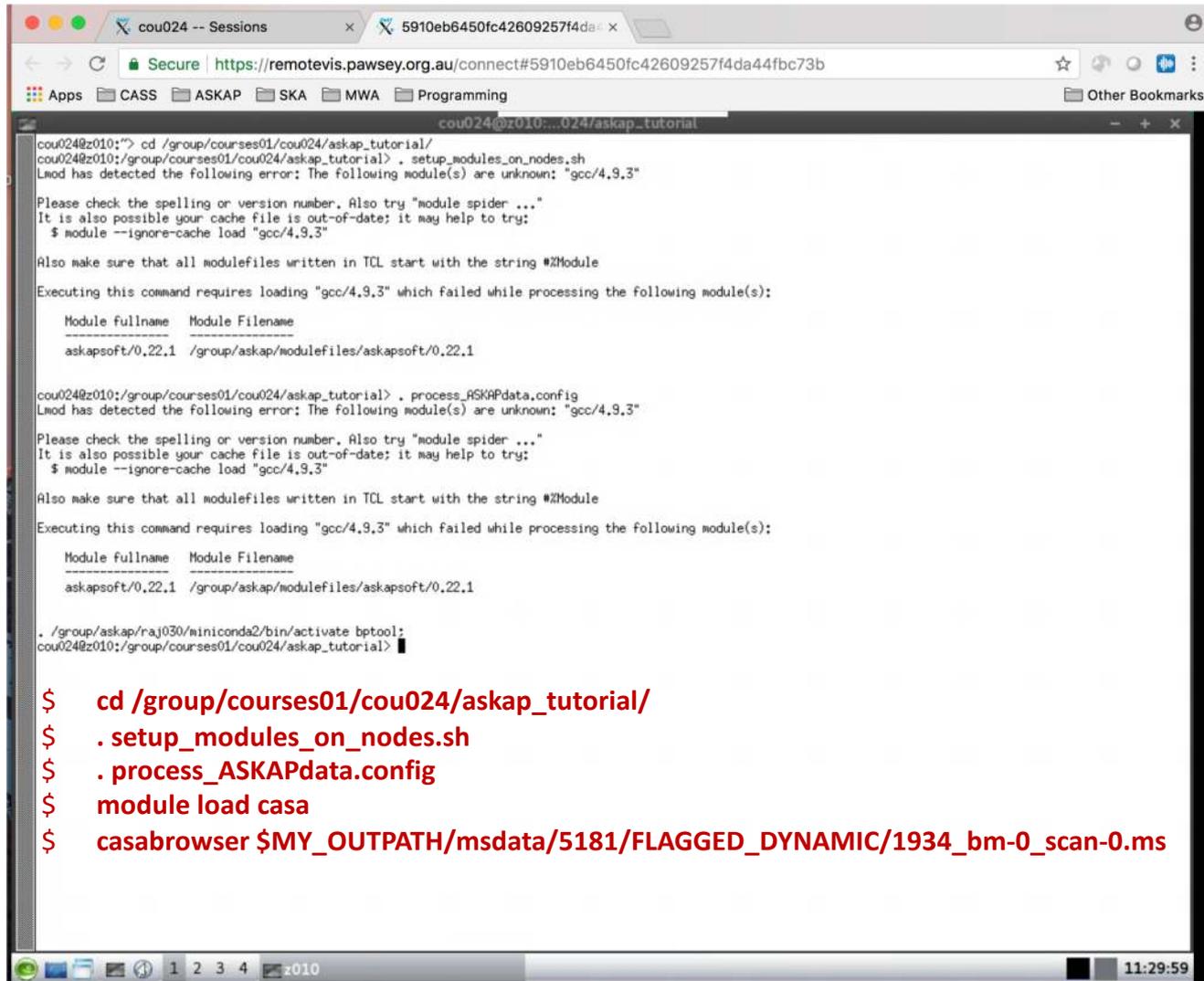
The screenshot shows a web browser window with two tabs: 'cou024 -- Sessions' and 'Connection'. The address bar shows 'Secure https://remotevis.pawsey.org.au'. The page title is 'My Sessions'. There is a 'Launch Session' button, a 'Filter Sessions' input field, and a 'View' link. Below these is an 'Actions' dropdown menu. A session card is visible with a play button icon and the label 'Desktop'. A red arrow points to the play button icon, and red text next to it says 'Click on this and then click ▶'. At the bottom of the page, there is a 'Desktop' label with a pencil icon and a 'show' link. The footer contains 'cou024@z005 | Build: 2.4.13' and 'Desktop Client STARNET'.

Tutorial — Today

remotely on the Zeus cluster using remotevis.pawsey.org.au



Tutorial — Today



```
cou024@z010:~$ cd /group/courses01/cou024/askap_tutorial/
cou024@z010:/group/courses01/cou024/askap_tutorial$ . setup_modules_on_nodes.sh
Load has detected the following error: The following module(s) are unknown: "gcc/4.9.3"

Please check the spelling or version number. Also try "module spider ..."
It is also possible your cache file is out-of-date; it may help to try:
$ module --ignore-cache load "gcc/4.9.3"

Also make sure that all modulefiles written in TCL start with the string #Module

Executing this command requires loading "gcc/4.9.3" which failed while processing the following module(s):

  Module fullname  Module Filename
  -----
askapsoft/0.22.1  /group/askap/modulefiles/askapsoft/0.22.1

cou024@z010:/group/courses01/cou024/askap_tutorial$ . process_ASKAPdata.config
Load has detected the following error: The following module(s) are unknown: "gcc/4.9.3"

Please check the spelling or version number. Also try "module spider ..."
It is also possible your cache file is out-of-date; it may help to try:
$ module --ignore-cache load "gcc/4.9.3"

Also make sure that all modulefiles written in TCL start with the string #Module

Executing this command requires loading "gcc/4.9.3" which failed while processing the following module(s):

  Module fullname  Module Filename
  -----
askapsoft/0.22.1  /group/askap/modulefiles/askapsoft/0.22.1

./group/askap/raj030/miniconda2/bin/activate bptool:
cou024@z010:/group/courses01/cou024/askap_tutorial$
```

\$ cd /group/courses01/cou024/askap_tutorial/

\$. setup_modules_on_nodes.sh

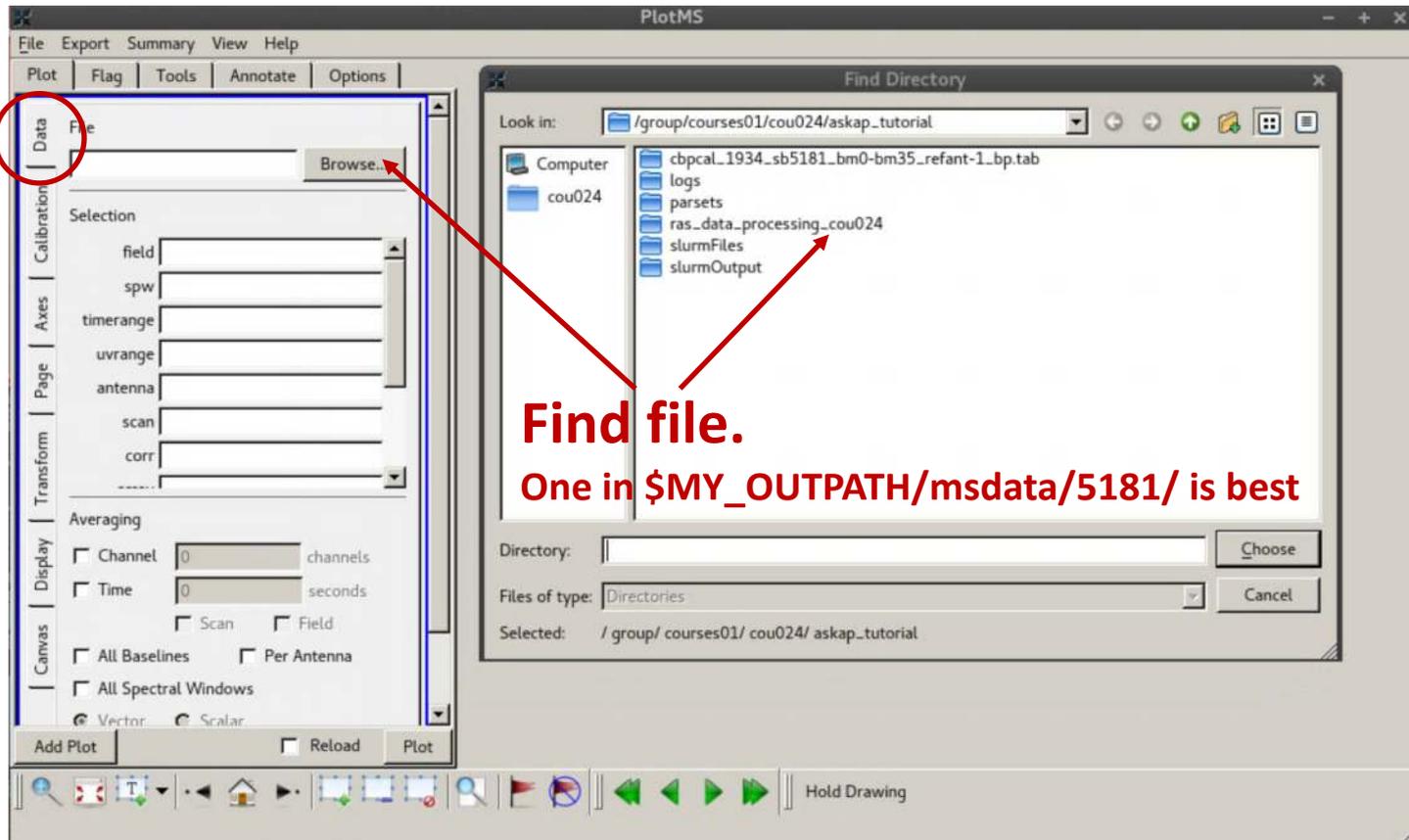
\$. process_ASKAPdata.config

\$ module load casa

\$ casabrowser \$MY_OUTPATH/msdata/5181/FLAGGED_DYNAMIC/1934_bm-0_scan-0.ms

Tutorial — Today

On local machine or remotevis.pawsey.org.au, plot data in the measurement set:



Tutorial — Today

On local machine or remotervis.pawsey.org.au, plot data in the measurement set:

\$ `casaplotms`

The image shows three sequential screenshots of the Casaplotms software interface, illustrating the steps to configure a plot. Red arrows and text annotations provide guidance:

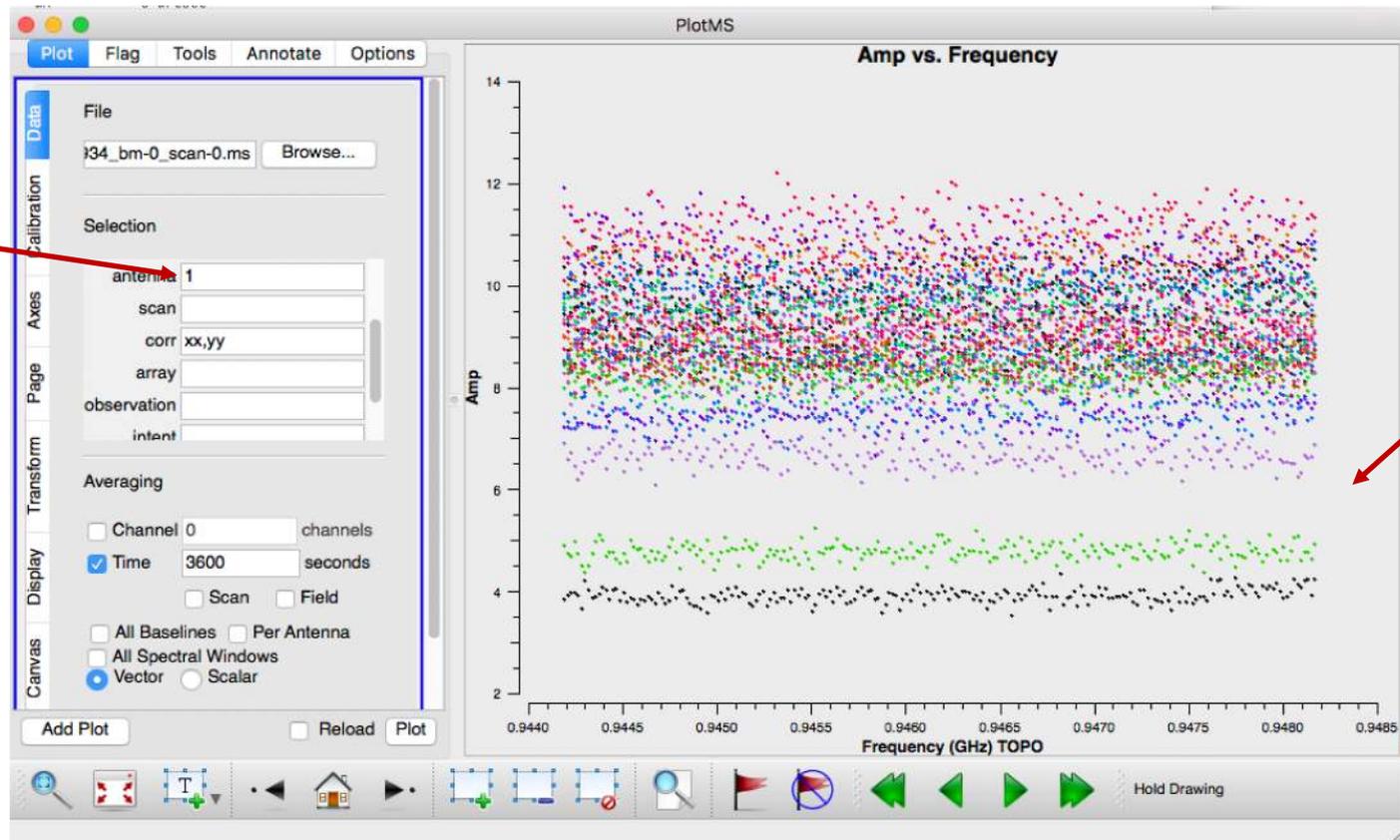
- First Screenshot:** The **Data** tab is selected. The file `134_bm-0_scan-0.ms` is loaded. The **Averaging** section shows **Time** averaging set to 3600 seconds. The **Display** section has **Vector** selected. A red circle highlights the **Data** tab, and red arrows point to the **Time** and **Vector** options with the text: "Choose a few polarisations and average in time".
- Second Screenshot:** The **Axes** tab is selected. The **X Axis** is set to **Frequency**. The **Data** is set to **Amp** and the **Data Column** is **data**. The **Attach** option is set to **Left**. A red circle highlights the **Axes** tab, and red arrows point to the **X Axis** and **Attach** options with the text: "Choose x and y axes".
- Third Screenshot:** The **Display** tab is selected. The **Colorize** option is checked and set to **Baseline**. The **Unflagged Points Symbol** is set to **Default** and the **Flagged Points Symbol** is set to **None**. A red circle highlights the **Colorize** dropdown, and a red arrow points to it with the text: "Choose a colour scheme".

At the bottom of the third screenshot, a red arrow points to the **Plot** button with the text: "And plot!".

And plot!

Tutorial — Today

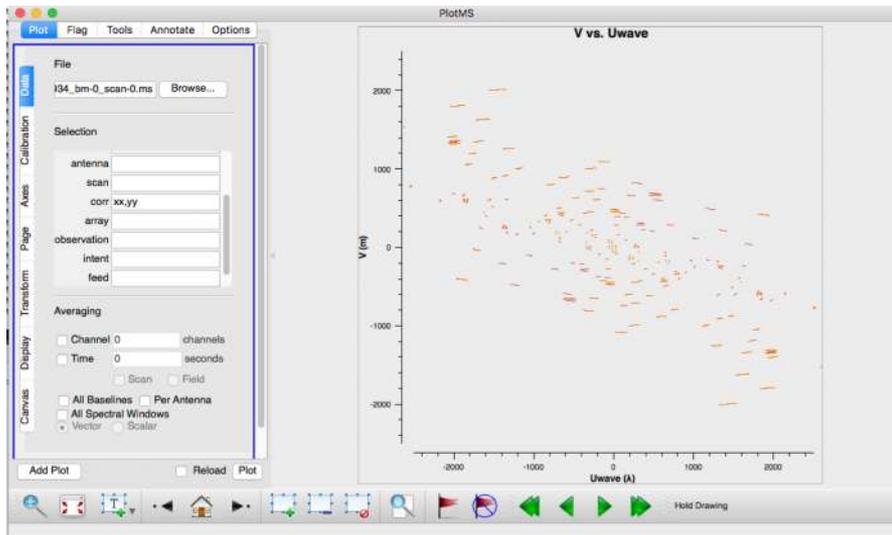
On local machine or remotervis.pawsey.org.au, plot data in the measurement set:
\$ casaplotms



Tutorial — Today

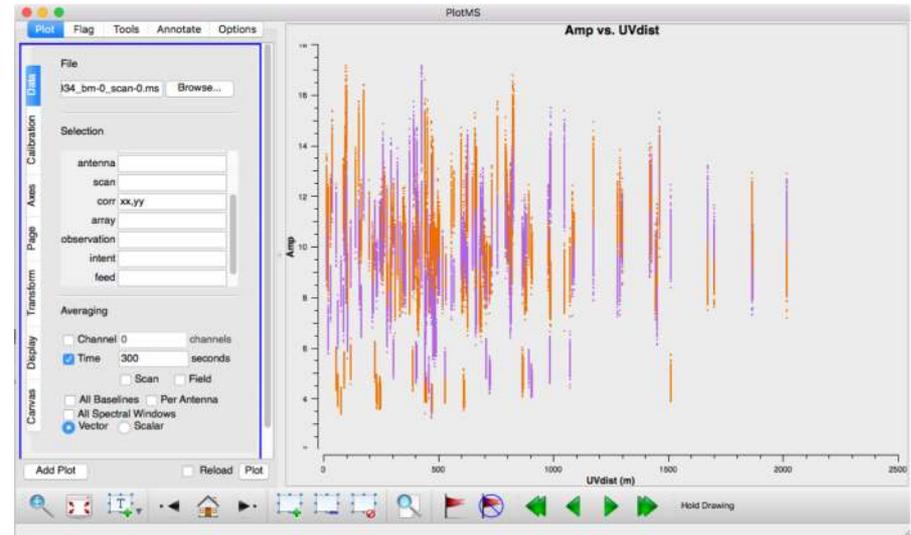
On local machine or remotevis.pawsey.org.au, plot data in the measurement set:
\$ casaplotms

Plot the uv coverage



Plot amplitude versus uvdist

$$\text{“uv distance”} = \sqrt{u^2 + v^2}$$



Calibrate the Calibrator!

- **Generate a new file apply_cal.in:**

```
Ccalapply.dataset = test_cal.ms
Ccalapply.calibaccess = table
Ccalapply.calibaccess.table.maxant = 16
Ccalapply.calibaccess.table.maxbeam = 36
Ccalapply.calibaccess.table.maxchan = 216
Ccalapply.calibaccess.table = cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab
```

- **Generate a new file apply_cal.sbatch:**

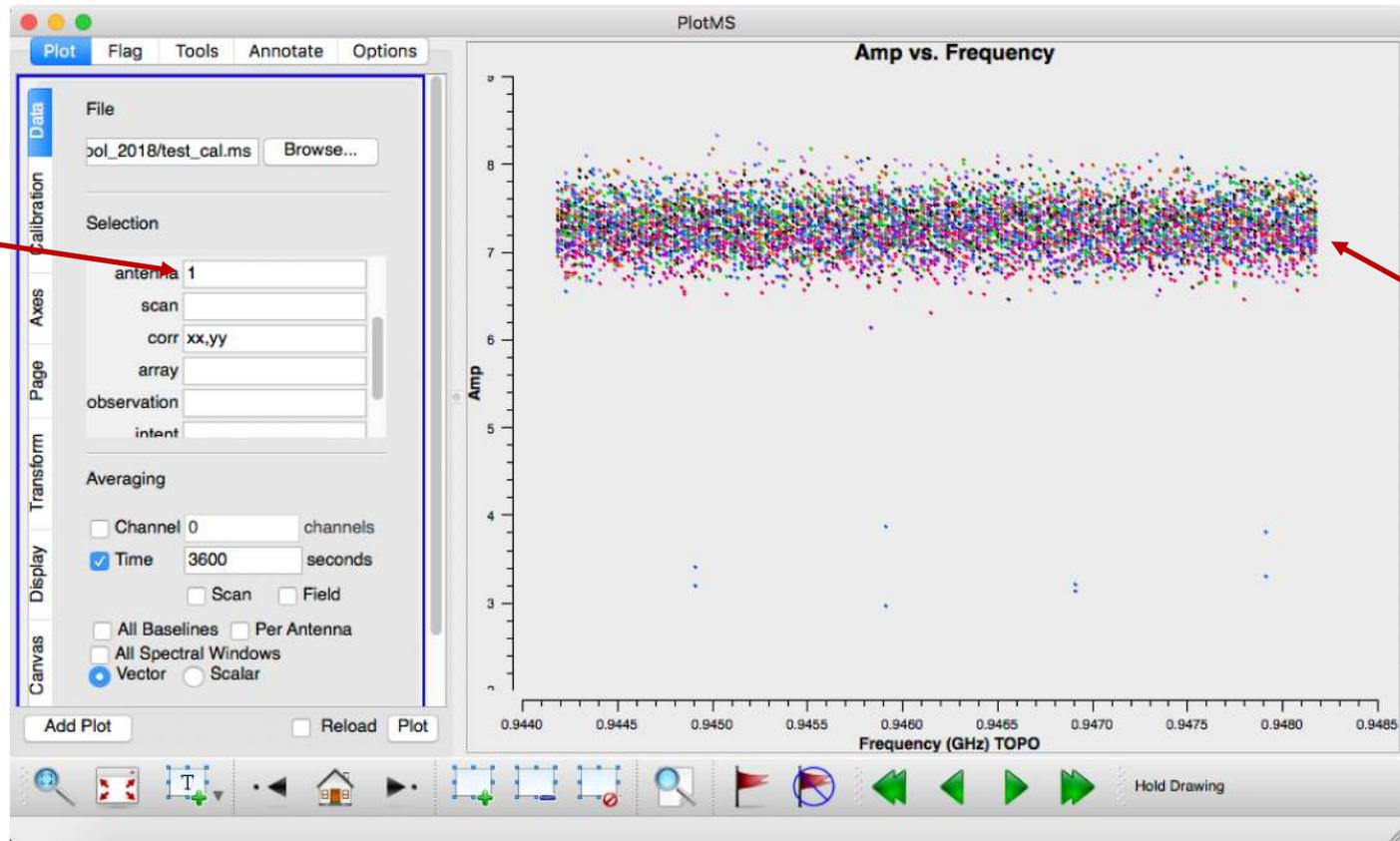
```
#!/usr/bin/env bash
#SBATCH --partition=workq
#SBATCH --time=00:05:00
#SBATCH --ntasks=20
#SBATCH --ntasks-per-node=20
#SBATCH --job-name=apply_cal
#SBATCH --account=courses01
#SBATCH --reservation=courseq
#SBATCH --export=ALL
srun --ntasks=19 --ntasks-per-node=19 ccalapply -c apply_cal.in > apply_cal.log
```

- **Run:**

```
cp -r $MY_OUTPATH/msdata/5181/1934_bm-0_scan-0.ms test_cal.ms
cp -r $MY_OUTPATH/bpcal_solutions/5181/cbpcal_1934_sb5181_bm0-bm35_refant-1_bp.tab .
sbatch apply_cal.sbatch
```

Tutorial — Today

On local machine or remotervis.pawsey.org.au, plot data in the measurement set:
\$ casaplotms



do_pre_process_ras.sh

```
$ ./do_pre_process_ras.sh
```

- mssplit — select the same subset of channels from the science dataset
- ccalapply — apply calibration solutions to the science data
- cflag — look for radio frequency interference and set flags
- mssplit — average in frequency
- cflag — a final round of flagging

do_selfcal_ras.sh

```
$ ./do_selfcal_ras.sh
```

- ccalibrator — run calibration using a model of this field
 - cimager — image and deconvolve the field with the new calibration solutions
 - selavy — run relatively shallow source finder on the restored image
 - cmodel — generate a model image from the selavy catalogue
-
- 1st run: set BLOOP_SELFICAL=0 & ELOOP_SELFICAL=0: imaging with no selfcal

```
$ squeue -u username
```

| JOBID | USER | ACCOUNT | NAME | EXEC_HOST | ST | REASON | START_TIME | END_TIME | TIME_LEFT | NODES | PRIORITY |
|---------|----------|---------|---------------|-----------|----|--------|------------|----------|-----------|-------|----------|
| 5055128 | dmitchel | askaprt | IMG-5177-0A.I | nid00217 | R | None | 08:36:54 | 14:36:54 | 5:56:54 | 1 | 10001 |
| 5055129 | dmitchel | askaprt | IMG-5177-1A.I | nid00299 | R | None | 08:36:54 | 14:36:54 | 5:56:54 | 1 | 10001 |

do_selfcal_ras.sh

```
$ ls -ld ${MY_OUTPATH}/image/5177/weight*
```

```
image/5177/weights.I.COSMOLOGY_T15-2A_bm-0_iter-0
```

```
image/5177/weights.I.COSMOLOGY_T15-2A_bm-1_iter-0
```

```
$ ls -ld ${MY_OUTPATH}/image/5177/image*restored
```

```
image/5177/image.I.COSMOLOGY_T15-2A_bm-0_iter-0.restored
```

```
image/5177/image.I.COSMOLOGY_T15-2A_bm-1_iter-0.restored
```

```
$ ls -ld ${MY_OUTPATH}/image/5177/image*restored.cmodel
```

```
image/5177/image.I.COSMOLOGY_T15-2A_bm-0_iter-0.restored.cmodel
```

```
image/5177/image.I.COSMOLOGY_T15-2A_bm-1_iter-0.restored.cmodel
```

```
$ ls -ld ${MY_OUTPATH}/image/5177/psf*
```

```
image/5177/psf.I.COSMOLOGY_T15-2A_bm-0_iter-0
```

```
image/5177/psf.I.COSMOLOGY_T15-2A_bm-1_iter-0
```

```
image/5177/psf.image.I.COSMOLOGY_T15-2A_bm-0_iter-0
```

```
image/5177/psf.image.I.COSMOLOGY_T15-2A_bm-1_iter-0
```

do_linmos_ras.sh

```
$ ./do_linmos_ras.sh
```

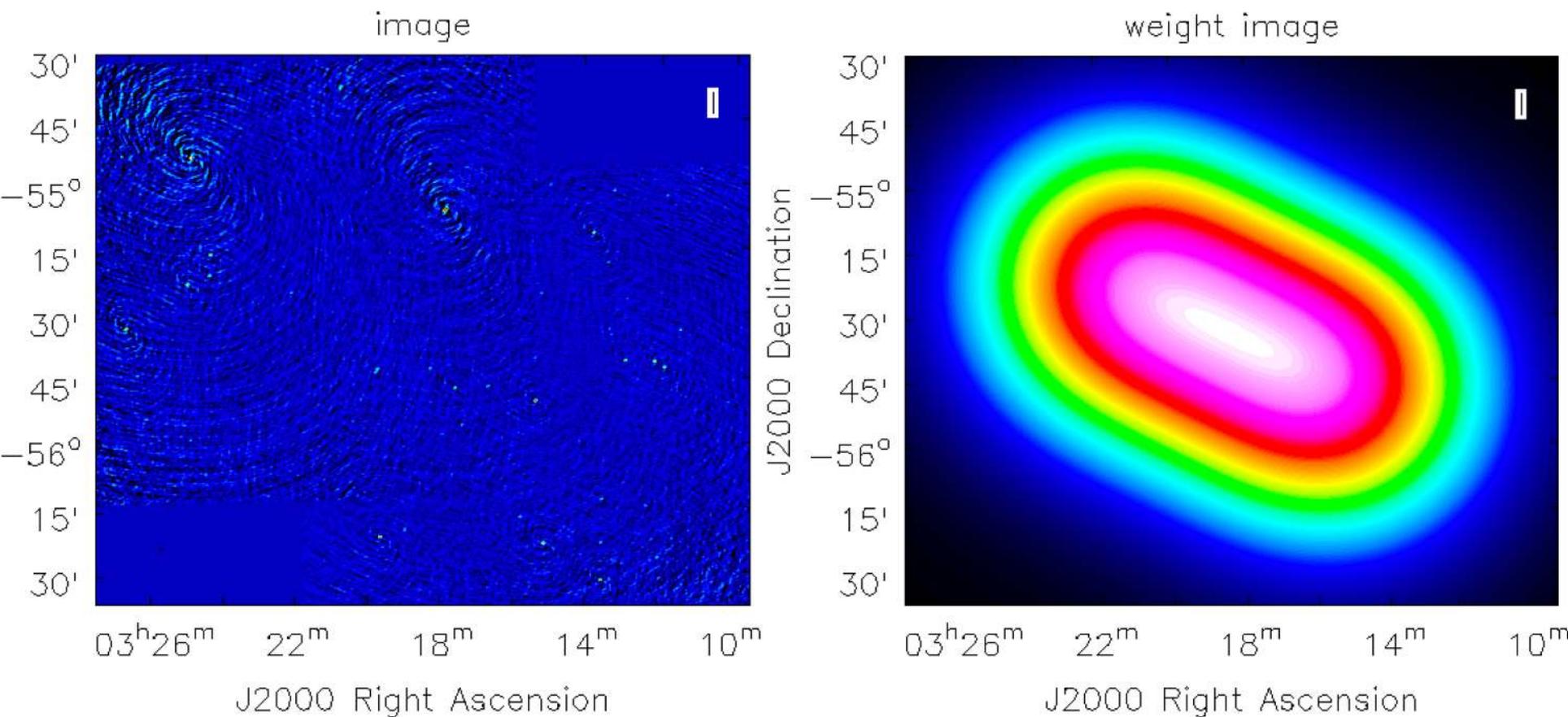
- linmos — form a linear mosaic of the final images

On local machine or remotevis.pawsey.org.au

```
$ casaviewer dir/image.I.COSMOLOGY_T15-2iter-0.linmosRAS_5177
```

- dir = \$MY_OUTPATH/image/5177

casaviewer image.I.COSMOLOGY_T15-2iter-0.linmosRAS_5177



One loop of self-cal

- 2nd run: set BLOOP_SELFCAL=1 & ELOOP_SELFCAL=1: imaging with a selfcal update

```
$ . process_ASKAPdata.config
```

```
$ ./do_selfcal_ras.sh
```

```
$ ./do_linmos_ras.sh
```

```
$ ls -l $MY_OUTPATH/linmos/5177/
```

```
$ scp -r username@hpc-data.pawsey.org.au:$MY_OUTPATH/linmos/5177/\*iter-1\* .
```

```
$ casaviewer image.I.COSMOLOGY_T15-2iter-1.linmosRAS_5177
```