VLA data reduction – part 1:

Post-observing, pre-calibration

Loránt Sjouwerman, NRAO

Outline

- After the observations:
  - Obtaining your data from the archive
    - Which CPU processes the data? (Home or NRAO)
  - Examine your data
    - Structure and potential issues: all expected data present, RFI, calibrators, reference antenna…
  - Prepare for calibration steps
    - Use examination to flag bad data upfront

Better preparation eases the process!

Outline – interactive elements

- After the observations:
  - Obtaining your data from the archive
    - Finding data sets in the (new) archive
  - Examine your data
    - Antenna locations (potential reference antenna)
    - Listing of the observations; scans, sources, setup
  - Prepare for calibration steps
    - Some bad data editing using plotms

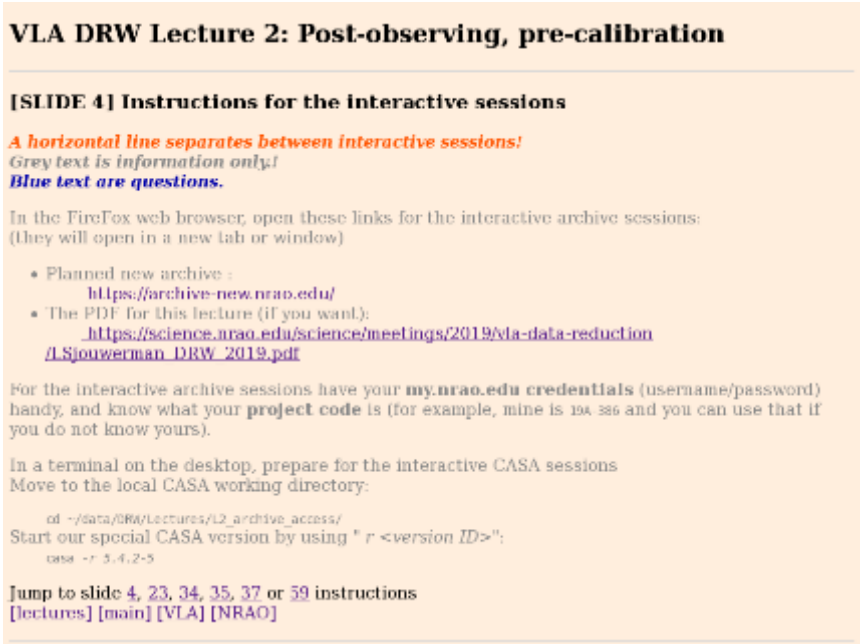
Better preparation eases the process!

INTERACTIVE

Interactive information with this talk

- Browse to http://go.nrao.edu/vla-drw-local
  - Select Lecture 2

    (each opens in a new tab)
    - Archive web-access pages
      - Planned new archive
    - These lecture slides (pdf)



VLA DRW Lecture 2: Post-observing, pre-calibration

[SLIDE 4] Instructions for the interactive sessions

A horizontal line separates between interactive sessions!
Grey text is information only.!
Blue text are questions.

In the FireFox web browser, open these links for the interactive archive sessions:
(they will open in a new tab or window)

- Planned new archive :
  https://archive-new.nrao.edu/
- The PDF for this lecture (if you want):
  https://science.nrao.edu/science/meetings/2019/vla-data-reduction/LSjouwerman_DRW_2019.pdf

For the interactive archive sessions have your **my.nrao.edu credentials** (username/password) handy, and know what your **project code** is (for example, mine is 19A-386 and you can use that if you do not know yours).

In a terminal on the desktop, prepare for the interactive CASA sessions
Move to the local CASA working directory:

```
cd ~/data/DRW/Lectures/L2_archive_access/
```

Start our special CASA version by using "*-r <version ID>*":

```
casa -r 5.4.2-5
```

Jump to slide 4, 23, 34, 35, 37 or 59 instructions
[lectures] [main] [VLA] [NRAO]

- In a terminal (for CASA typing)
  - Start CASA (version for this workshop)
    - casa –r 5.4.2-5

Assumptions (for all these lectures)

This presentation assumes that you are familiar with **the basics of**:

- radio interferometry
- flux density calibration, *antenna-based* calibration (complex gain, bandpass), and self-calibration
- imaging and deconvolution

For references on the above, please check:

- The lectures of the 2014-2018 synthesis imaging workshops:
  https://science.nrao.edu/science/meetings/2014/14th-synthesis-imaging-workshop/
  https://science.nrao.edu/science/meetings/2016/15th-synthesis-imaging-workshop/
  https://science.nrao.edu/science/meetings/2018/16th-synthesis-imaging-workshop/
- Synthesis Imaging for Radio Astronomy II
  (eds. Taylor, Carilli, and Perley).
- Interferometry and Synthesis in Radio Astronomy
  (by Thompson, Moran, and Swenson).

NRAO versus Local/home computing

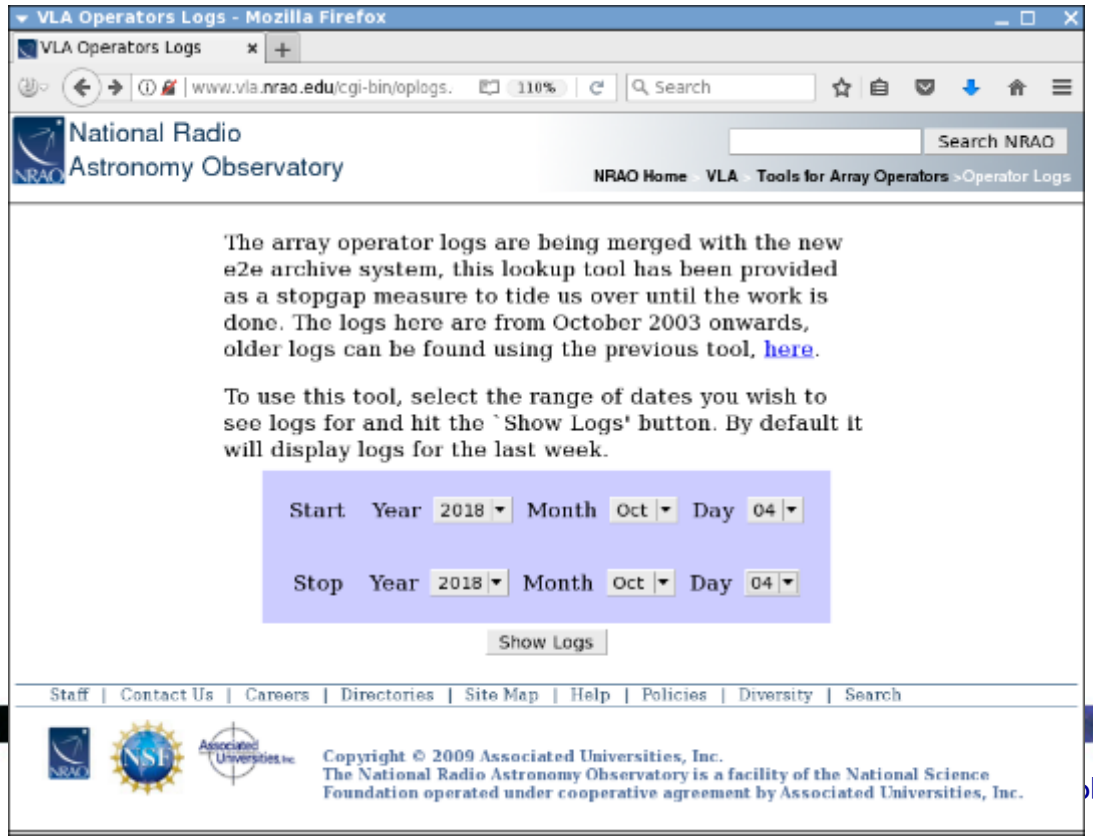
- Note that NRAO offers computing facilities for ***demanding*** projects upon request
  - Registered user (portal https://my.nrao.edu)
  - Limited capacity, compete with others, no guarantee
  - See computing policy page https://info.nrao.edu/computing/guide/cluster-processing/

- Here assume **processing at home institute**
  - Data transfer over internet (up to couple of 100 GB)
  - Data shipped on disk (purchase, up to 1.8 TB/disk)

Observing operator logs are available

Sent by email to proposers directly after observation
Stored on web servers:

http://www.vla.nrao.edu/cgi-bin/oplogs.cgi



Date	Time	Code	File
2018-10-04	13:57	SOFTWARE	pdf
2018-10-04	13:21	18A-498	pdf
2018-10-04	12:03	18A-342	pdf
2018-10-04	09:32	18A-131	pdf
2018-10-04	08:32	18A-389	pdf
2018-10-04	05:41	TDRW0001	pdf
2018-10-04	04:59	18A-146	pdf
2018-10-04	03:41	18A-342	pdf
2018-10-04	03:12	STARTUP	pdf
2018-10-04	02:12	18A-354	pdf

Observing operator logs are available

Sent by email to proposers directly after observation
Stored on web servers:

http://www.vla.nrao.edu/cgi-bin/oplogs.cgi

VLA OBSERVING LOG **2018-10-04_0541_TDRW0001**

Observing Date:	04-Oct-2018	Project:	TDRW0001	# Subarrays: 1	Observation Type: Test
Configuration:	D	Observer(PI):	Dr Emmanuel Momjian		Band(s) Used: C S
Decommissioned:	27	SBID(s):	35624494		
		Source File(s):	TDRW0001_sb35624494_1_1		
		Observer E-mail:	emomjian@nrao.edu		
		Operator(s):	Kenneth Gibson		

Adobe PDF version of this log is located at: http://www.vla.nrao.edu/operators/logs/
Visibility data is updated each day at IAT/UT midnight and is available from the online archive at: https://archive.nrao.edu

Time (UTC)	Dew Point (C)	Temp. (C)	Wind Speed & Direction (avg)	Bar. Pressure (mbars)	API RMS Phase (degs)	Remarks
04Oct 5:44:10	6.2	17.2	SW at 6.7 m/s	789.7	4.3	Sky cover 20%. Cumuliform clouds.
04Oct 6:46:31	7.0	14.3	SW at 4.7 m/s	789.4	4.7	Sky cover 10%. Stratiform clouds.

Number of antennas used: 27

Start Time	End Time	Comments/Outages	Form #	# Ants	Down Time (in minutes)
04Oct 5:41:30		Starting project: TDRW0001.			
04Oct 5:41:30		The band(s) used is(are): C S.			
04Oct 5:44:06		On source 0137+331=3C48 with all available antennas.			
04Oct 5:41:30		To access your data from the NRAO archive, visit:			
		https://science.nrao.edu/facilities/vla/archive.			
		All VLA science data are processed through the VLA calibration pipeline. Details			
		are at: https://science.nrao.edu/facilities/vla/data-processing/pipeline.			
		For further questions please use the NRAO helpdesk at:			
		https://science.nrao.edu/observing/helpdesk.			
04Oct 5:41:30		Note: To support our ongoing RFI monitoring efforts, any feedback from your			
		program on RFI can be sent to: nrao-rfi@nrao.edu.			
		The key information to provide is:			
		- Observation/project code			
		- Frequency and Time of the observations			
		- The characteristics of the RFI signal, in particular if it is continuous or			

VLA OBSERVING LOG **2018-10-04_0541_TDRW0001**

Observing Date: 04-Oct-2018 | Project: TDRW0001 | # Subarrays: 1 | Observation Type: Test
Configuration: D | Observer(PI): Dr Emmanuel Momjian | Band(s) Used: C S
Decommissioned: 27 | SBID(s): 35624494
Source File(s): TDRW0001_sb35624494_1_1
Observer E-mail: emomjian@nrao.edu
Operator(s): Kenneth Gibson

Adobe PDF version of this log is located at: http://www.vla.nrao.edu/operators/logs/
Visibility data is updated each day at IAT/UT midnight and is available from the online archive at: https://archive.nrao.edu

Time (UTC)	Dew Point (C)	Temp. (C)	Wind Speed & Direction (avg)	Bar. Pressure (mbars)	API RMS Phase (degs)	Remarks
04Oct 5:44:10	6.2	17.2	SW at 6.7 m/s	789.7	4.3	Sky cover 20%. Cumuliform clouds.
04Oct 6:46:31	7.0	14.3	SW at 4.7 m/s	789.4	4.7	Sky cover 10%. Stratiform clouds.

Number of antennas used: 27

Start Time	End Time	Comments/Outages	Form #	# Ants	Down Time (in minutes)
04Oct 5:41:30		Starting project: TDRW0001.			
04Oct 5:41:30		The band(s) used is(are): C S.			
04Oct 5:44:06		On source 0137+331=3C48 with all available antennas.			
04Oct 5:41:30		To access your data from the NRAO archive, visit:			
		https://science.nrao.edu/facilities/vla/archive.			
		All VLA science data are processed through the VLA calibration pipeline. Details			
		are at: https://science.nrao.edu/facilities/vla/data-processing/pipeline.			
		For further questions please use the NRAO helpdesk at:			
		https://science.nrao.edu/observing/helpdesk.			
04Oct 5:41:30		Note: To support our ongoing RFI monitoring efforts, any feedback from your			
		program on RFI can be sent to: nrao-rfi@nrao.edu.			
		The key information to provide is:			
		- Observation/project code			
		- Frequency and Time of the observations			
		- The characteristics of the RFI signal, in particular if it is continuous or			

Antenna 5 (&12) potential issues

Obtaining data from the NRAO archive

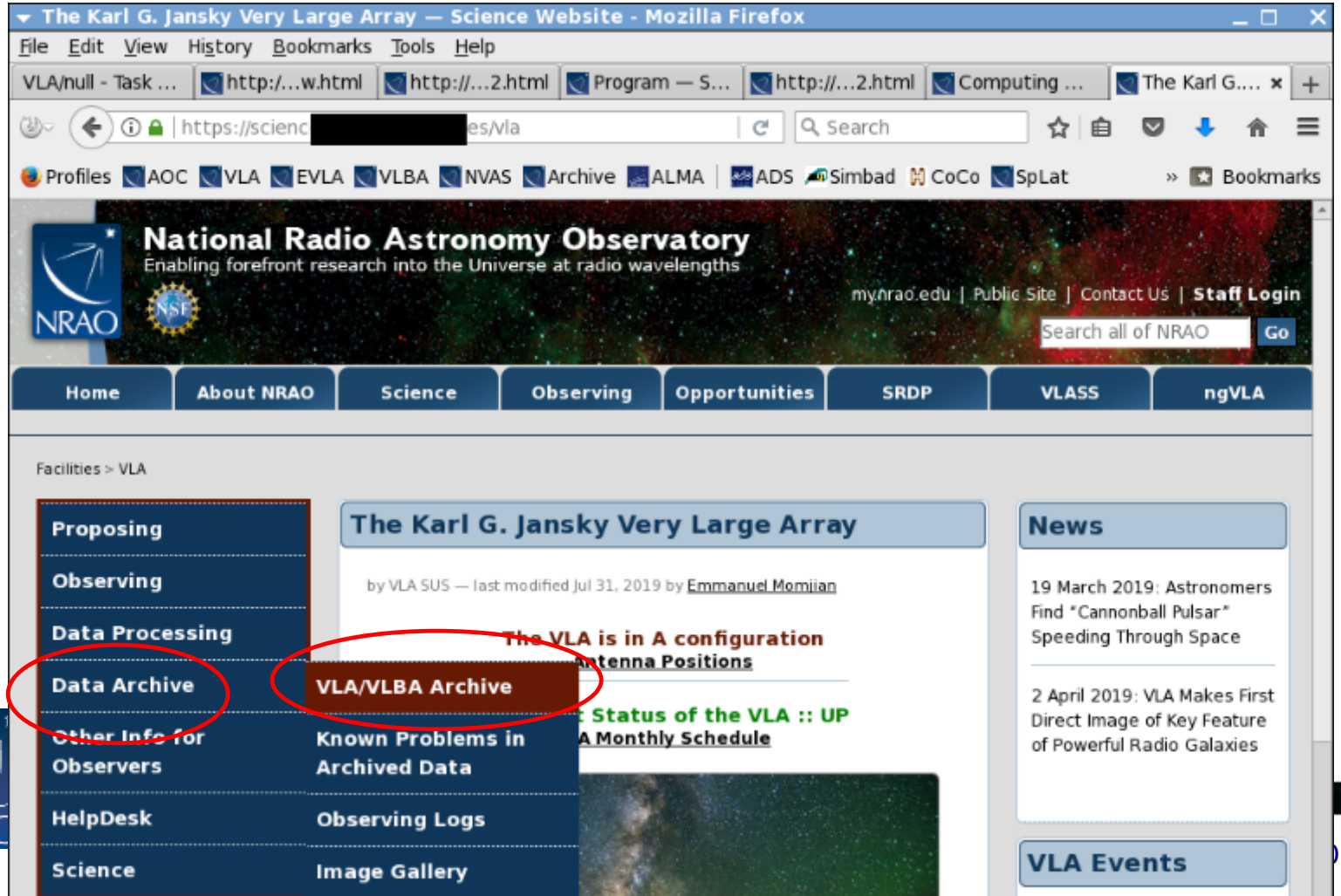
The *current* archive tool and the *new* archive tool

(still a work in progress)

The NRAO Data Archive Tool

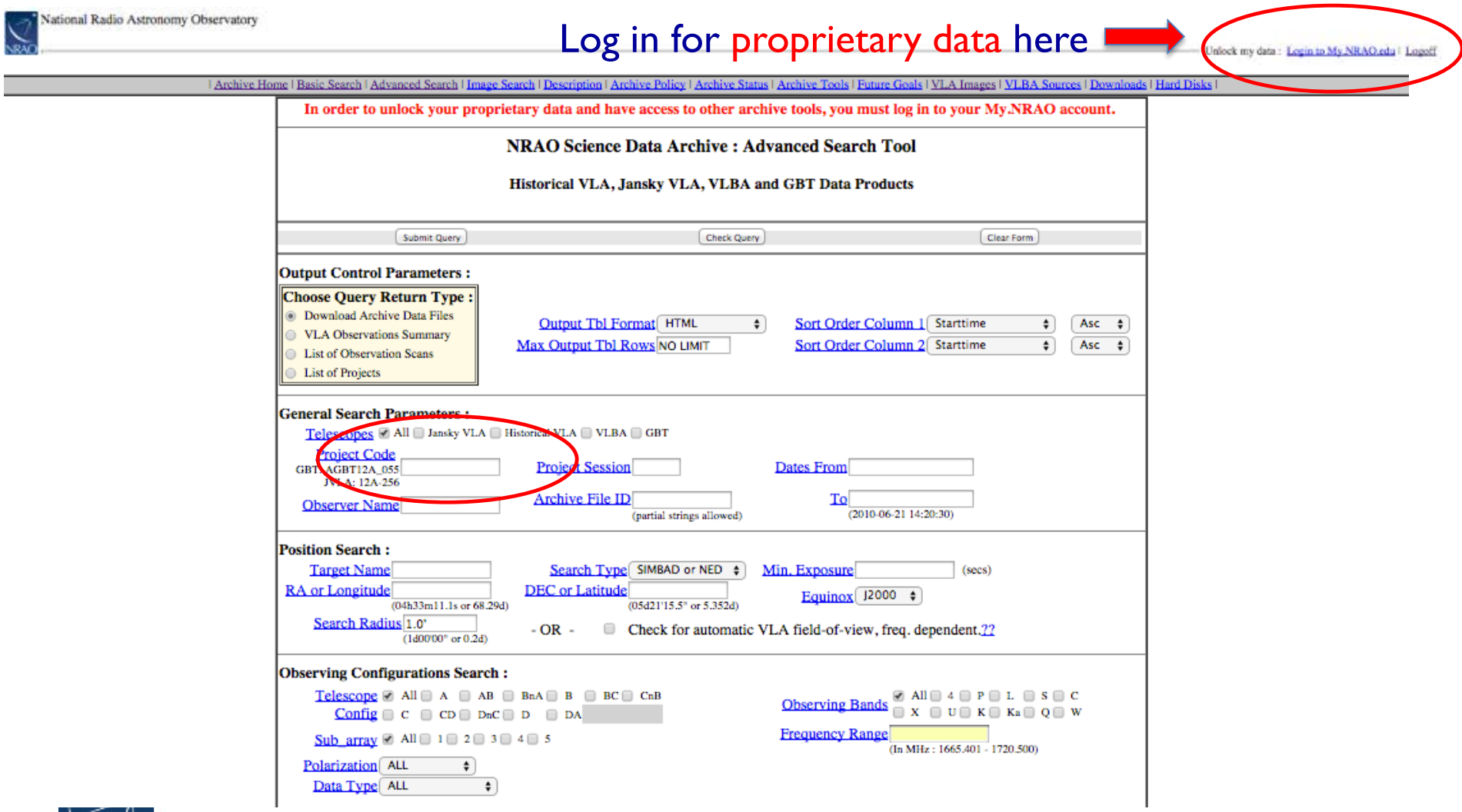
https://science.nrao.edu/facilities/vla/

→ Data Archive (left menu), VLA/VLBA Archive



The Archive Tool

Also https://archive.nrao.edu/



Query return

- For each match, the archive query return presents per observation (i.e. per row):
  - The observing run identifier (i.e., the SB name)
  - Any data quality issues (highlighted in yellow/red)
  - The SDM-BDF set (content of the SDM directory)
  - The individual scans with their details
  - The operator log (usually, also sent by email)

Archive File	Status	Project	Seg	Obs. Data Starts	Obs. Data Stops	File Size	Telescope: config:sub"	Bands	Format	Type	Data Qual	View Scans	Logs etc.
11A-291.sb4911125.eb4924302.55782.00136674769	public	11A-291	x	11-Aug-09 00:02:01	11-Aug-09 01:01:45	42.46GB	VLA:A:0	L	SDMset	raw	OK	Scans	Logs
11A-291.sb4911125.eb4944094.55784.99251239583	public	11A-291	x	11-Aug-11 23:50:07	11-Aug-13 02:14:44	30.29GB	VLA:A:0	L	SDMset	raw	OK	Scans	Logs
11A-291.sb4910900.eb4947827.55787.6933925	public	11A-291	x	11-Aug-14 16:39:27	11-Aug-14 18:39:07	78.96GB	VLA:A:0	L	SDMset	raw	info	Scans	Logs
11A-291_sb4911125_2.55795.922649976856	public	11A-291	x	11-Aug-22 22:08:44	11-Aug-22 23:08:30	36.44GB	VLA:A:0	L	SDMset	raw	OK	Scans	Logs
11A-291_sb4911125_3_000.55804.894766516205	public	11A-291	x	11-Aug-31 21:28:29	11-Aug-31 22:28:18	39.47GB	VLA:A:0	L	SDMset	raw	OK	Scans	Logs

Scan listing:

Scan details (source, date, setup, etc)

Project	Scan :sub	Source	Cal Code	Start Time	Stop Time	Sys	TOS (sec)	Intrvl (sec)	Scan Intent	Spect Win	Obs_Freq (MHz)	Bandw (MHz)	Polar	Spect chans	Corr Mode	Tele:config :sub:nants	RA(J2000)	DEC(J2000)	Archive File
11A-291	1:1	J1120+1420		11-Aug-09 00:02:01	11-Aug-09 00:02:54	UTC	53.5	1	OBS	CD_0:SW_0	958.000000	64.000	RR,LL	128	WIDR	EVLA:A:1:27	11h20m27.807s	+14d20'54.99"	11A-291.sb4911125.eb4924302.55782.00136674769 uid___evla_bdf_1312848123251.bdf
										CD_0:SW_1	1062.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_2	1126.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_3	1190.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_4	1254.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_5	1318.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_6	1382.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_7	1446.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_8	1506.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_9	1570.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_10	1634.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_11	1698.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_12	1762.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_13	1826.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_14	1890.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_15	1954.000000	64.000	RR,LL	128	WIDR				
11A-291	2:1	J1120+1420		11-Aug-09 00:02:54	11-Aug-09 00:03:54	UTC	59.8	1	CAL	CD_0:SW_0	958.000000	64.000	RR,LL	128	WIDR	EVLA:A:1:27	11h20m27.807s	+14d20'54.99"	11A-291.sb4911125.eb4924302.55782.00136674769 uid___evla_bdf_1312848123257.bdf
										CD_0:SW_1	1062.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_2	1126.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_3	1190.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_4	1254.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_5	1318.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_6	1382.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_7	1446.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_8	1506.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_9	1570.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_10	1634.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_11	1698.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_12	1762.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_13	1826.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_14	1890.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_15	1954.000000	64.000	RR,LL	128	WIDR				
11A-291	3:1	J1120+1420		11-Aug-09 00:03:54	11-Aug-09 00:05:24	UTC	89.8	1	CAL	CD_0:SW_0	958.000000	64.000	RR,LL	128	WIDR	EVLA:A:1:27	11h20m27.807s	+14d20'54.99"	11A-291.sb4911125.eb4924302.55782.00136674769 uid___evla_bdf_1312848174961.bdf
										CD_0:SW_1	1062.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_2	1126.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_3	1190.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_4	1254.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_5	1318.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_6	1382.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_7	1446.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_8	1506.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_9	1570.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_10	1634.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_11	1698.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_12	1762.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_13	1826.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_14	1890.000000	64.000	RR,LL	128	WIDR				
										CD_0:SW_15	1954.000000	64.000	RR,LL	128	WIDR				

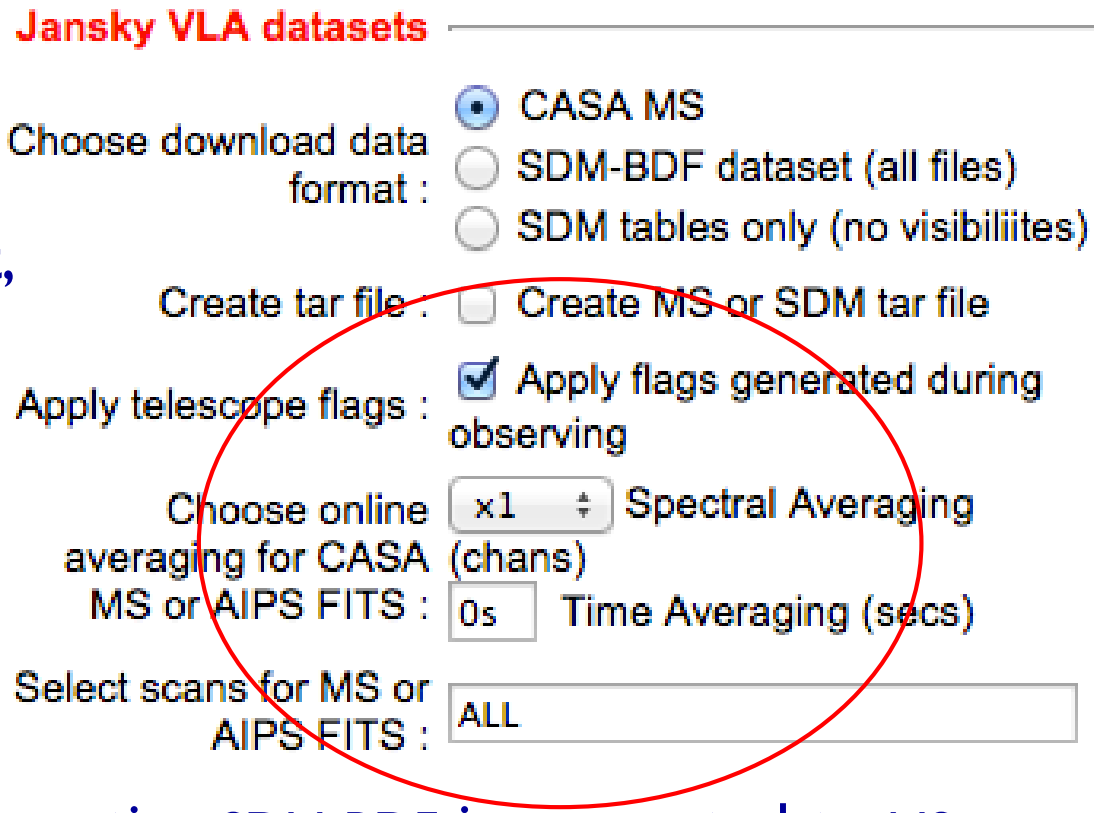
Scan listing

FYI: reference pointing and OTF have subscans

11A-258	42:1	0542+498=3C147		11-Jun-01 01:26:47	11-Jun-01 01:27:07	UTC	19.4	1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891607524.bdf
11A-258	42:2	0542+498=3C147		11-Jun-01 01:27:07	11-Jun-01 01:27:27	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891608043.bdf
11A-258	42:3	0542+498=3C147		11-Jun-01 01:27:27	11-Jun-01 01:27:47	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891627503.bdf
11A-258	42:4	0542+498=3C147		11-Jun-01 01:27:47	11-Jun-01 01:28:07	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891647507.bdf
11A-258	42:5	0542+498=3C147		11-Jun-01 01:28:07	11-Jun-01 01:28:27	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891667503.bdf
11A-258	42:6	0542+498=3C147		11-Jun-01 01:28:27	11-Jun-01 01:28:47	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891687511.bdf
11A-258	42:7	0542+498=3C147		11-Jun-01 01:28:47	11-Jun-01 01:29:07	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891707505.bdf
11A-258	42:8	0542+498=3C147		11-Jun-01 01:29:07	11-Jun-01 01:29:27	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891727505.bdf
11A-258	42:9	0542+498=3C147		11-Jun-01 01:29:27	11-Jun-01 01:29:47	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891747507.bdf
11A-258	42:10	0542+498=3C147		11-Jun-01 01:29:47	11-Jun-01 01:30:07	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891767505.bdf
11A-258	42:11	0542+498=3C147		11-Jun-01 01:30:07	11-Jun-01 01:30:27	UTC	20	1.1	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891787507.bdf
11A-258	42:12	0542+498=3C147		11-Jun-01 01:30:27	11-Jun-01 01:30:42	UTC	15.4	1.2	POINT	CD_1:SW_16 CD_1:SW_17	8332.000000 8460.000000	128.000 128.000	RR,RL,LR,LL RR,RL,LR,LL	64 64	WIDR WIDR	EVLA:BnA->A:1:25	05h42m36.138s	+49d51'07.23"	11A-258.sb4139176.eb4258095.55713.0339549537 uid___evla_bdf_1306891807506.bdf

Download options: data format

- Data formats:
  - SDM-BDF ⟸ raw, best
  - CASA measurement set, i.e., CASA MS (default)
  - SDM tables only
- Flagging and averaging options only apply to CASA MS format

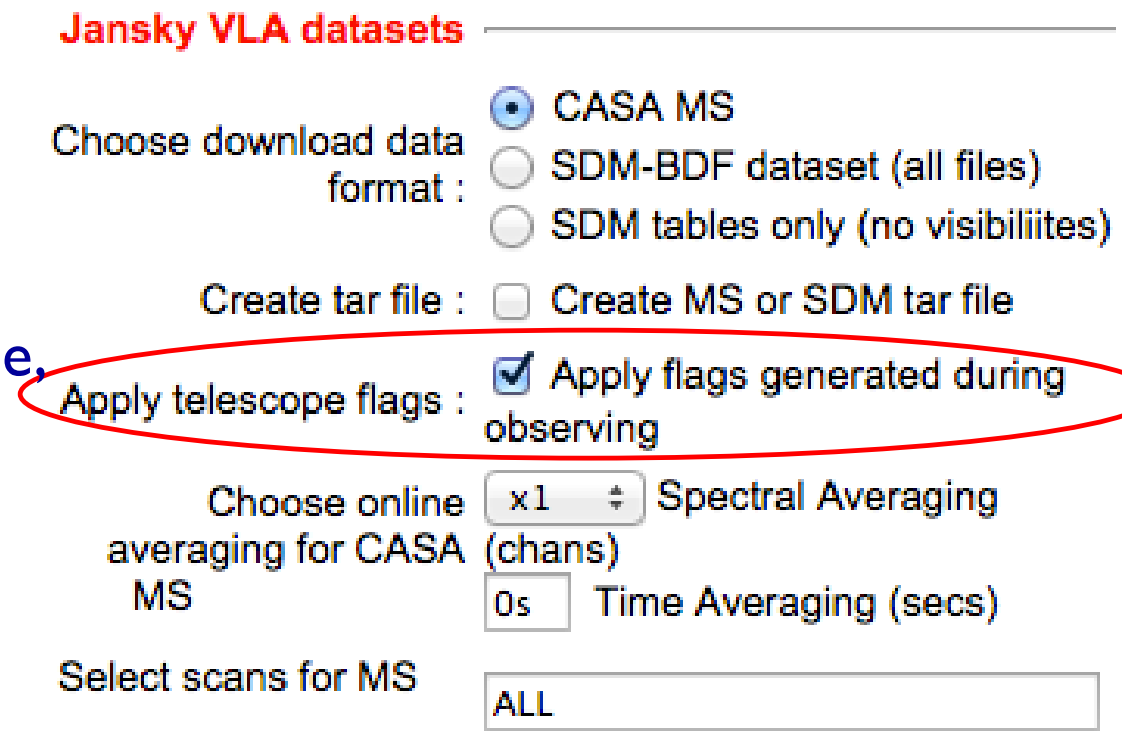


- If CASA MS is requested, the native SDM-BDF is converted to MS using (old) *import**evla*** task (casa 4.7 - allows flagging, averaging)

Download options: flagging

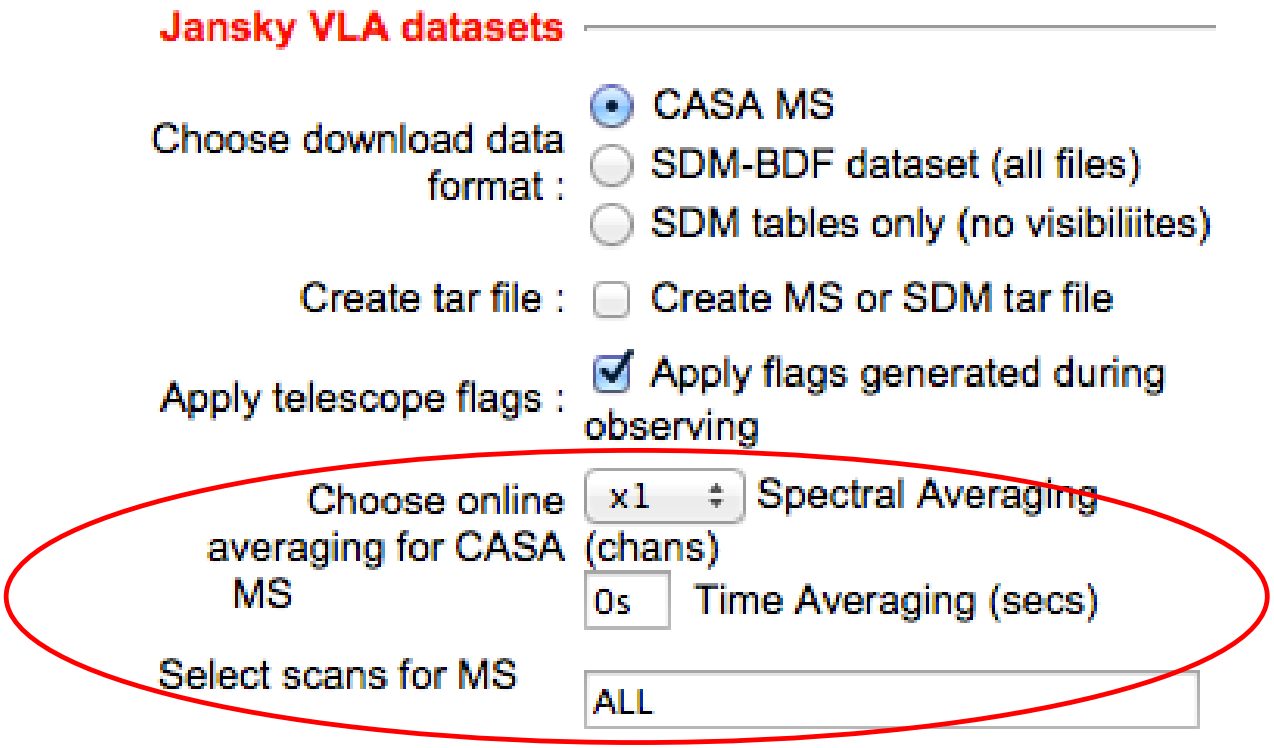
'Telescope flags'

- Online flags, e.g., antenna not on source, sub-reflector error
- Shadowing flags, and
- Zero flags (pure zero's)



- If the "apply flags" option is not checked, the flags are written to a FLAG_CMD MS table. They can later be applied by using the CASA task *flagcmd*
- If checked, flags are applied to the data in the MS conversion

Download options: averaging



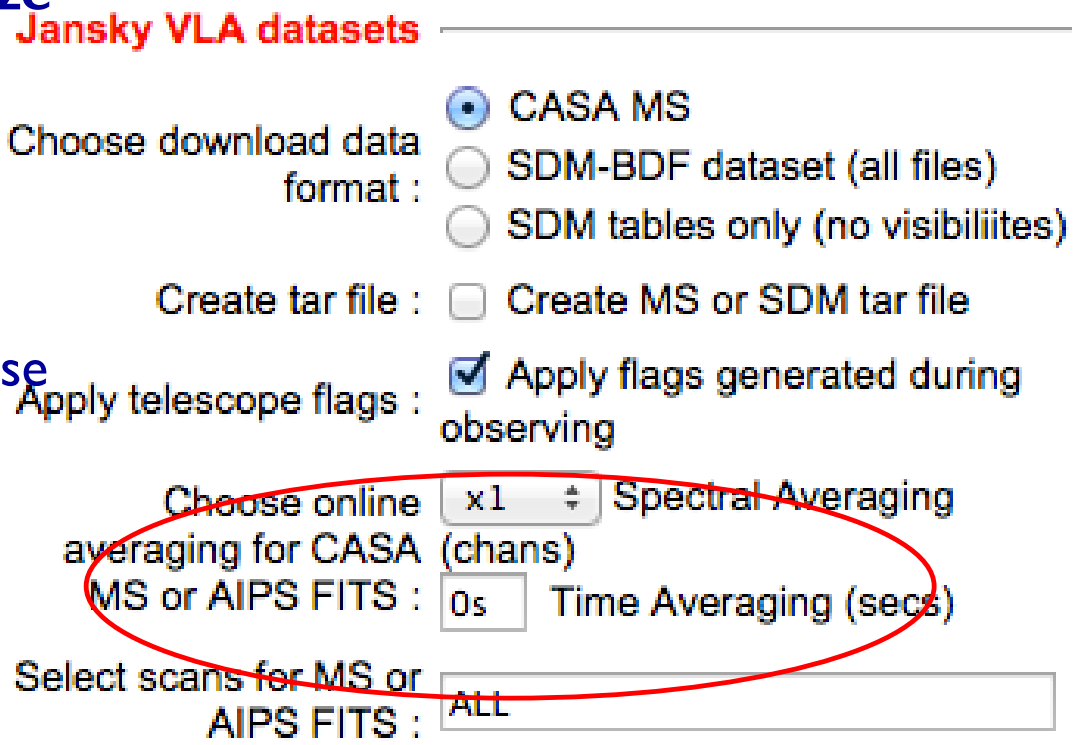
- Possible to average MS data in time and/or in frequency
- Selection of scan numbers (use scan listing mentioned before)
- For these, the archive tool uses the CASA task *split*

Notes on averaging

Averaging decreases data size
which helps in the transfer and data reduction speed

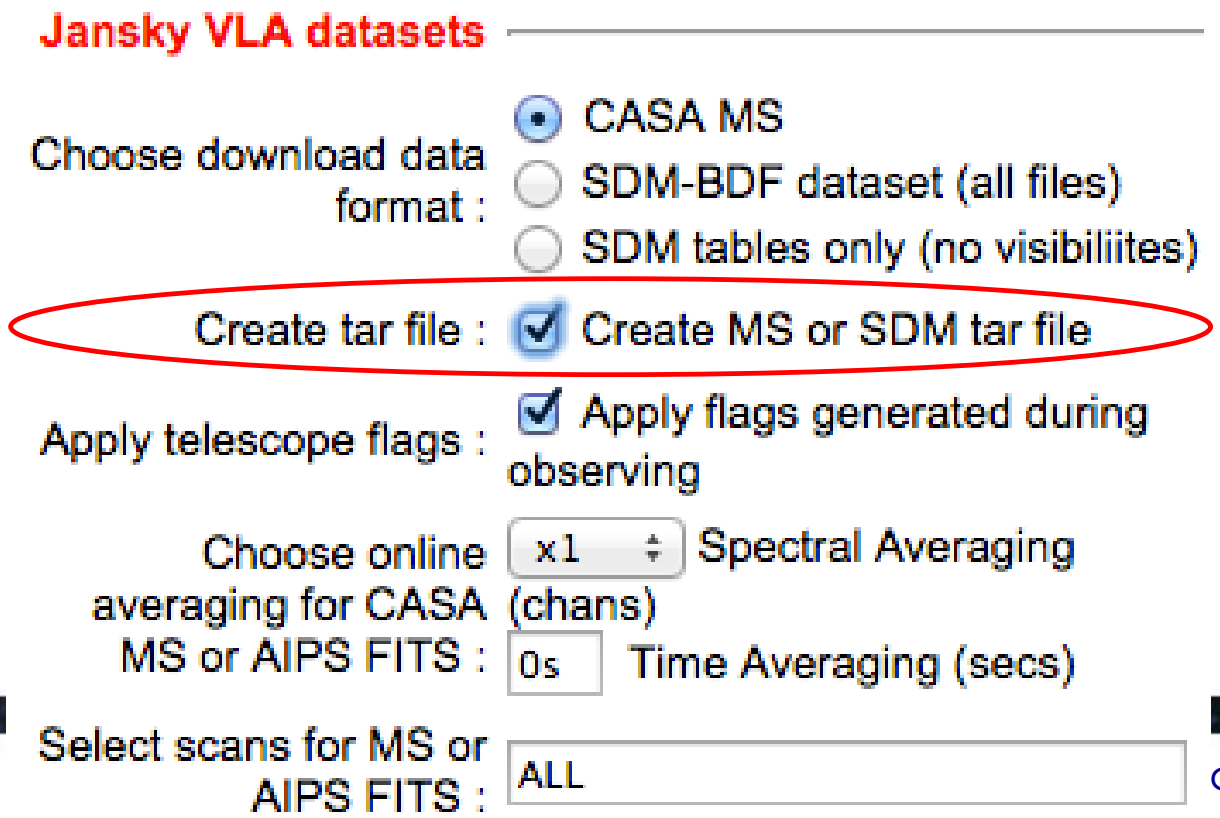
When averaging:

- Apply the flags!
- Frequency averaging may cause coherence loss
  Check that delays are small before frequency averaging
- Amount of allowable time averaging depends on the science goal
  The VLA Observational Status Summary discusses amplitude loss due to time averaging.

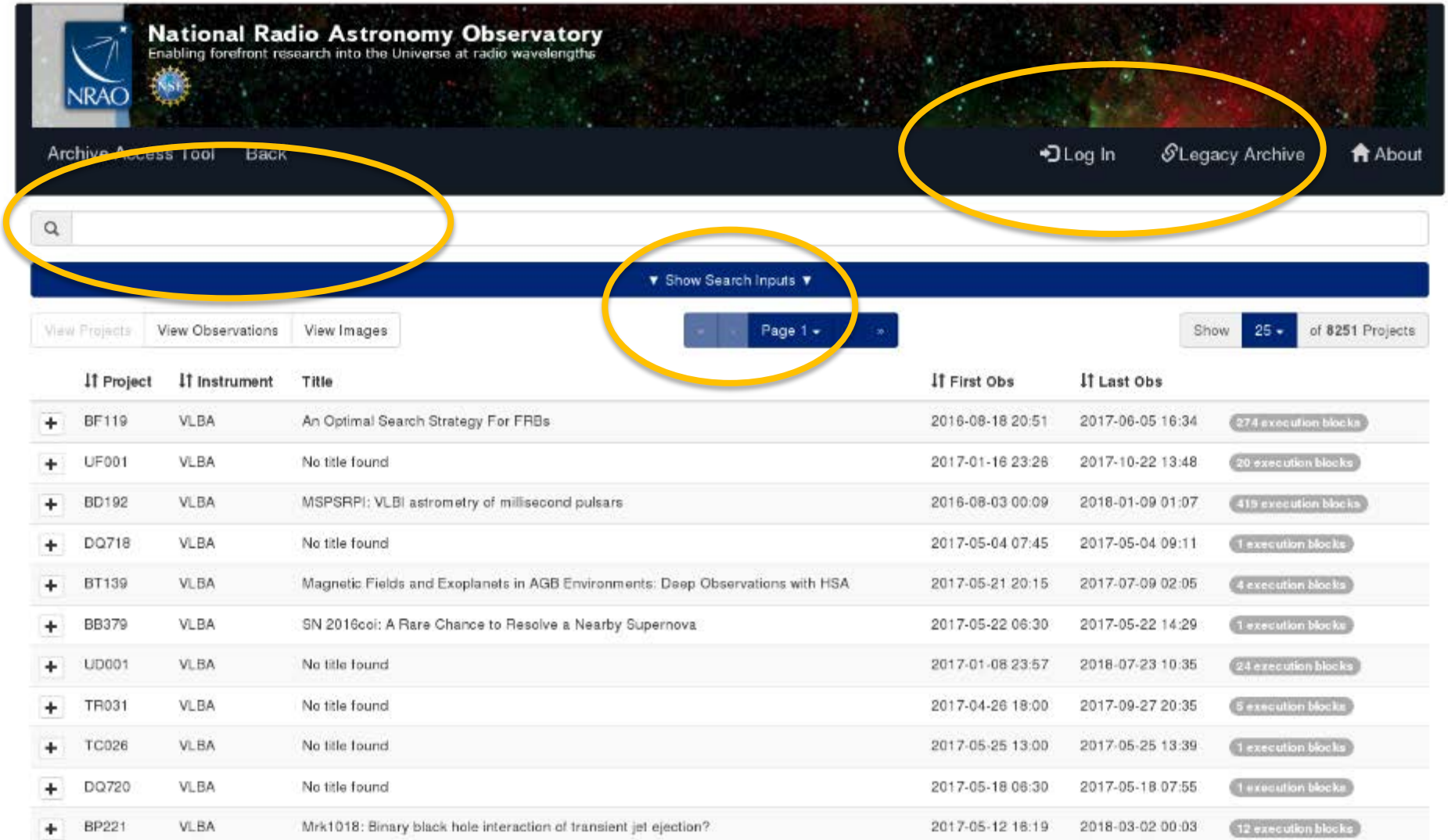


Transfer of SDM and MS directories:

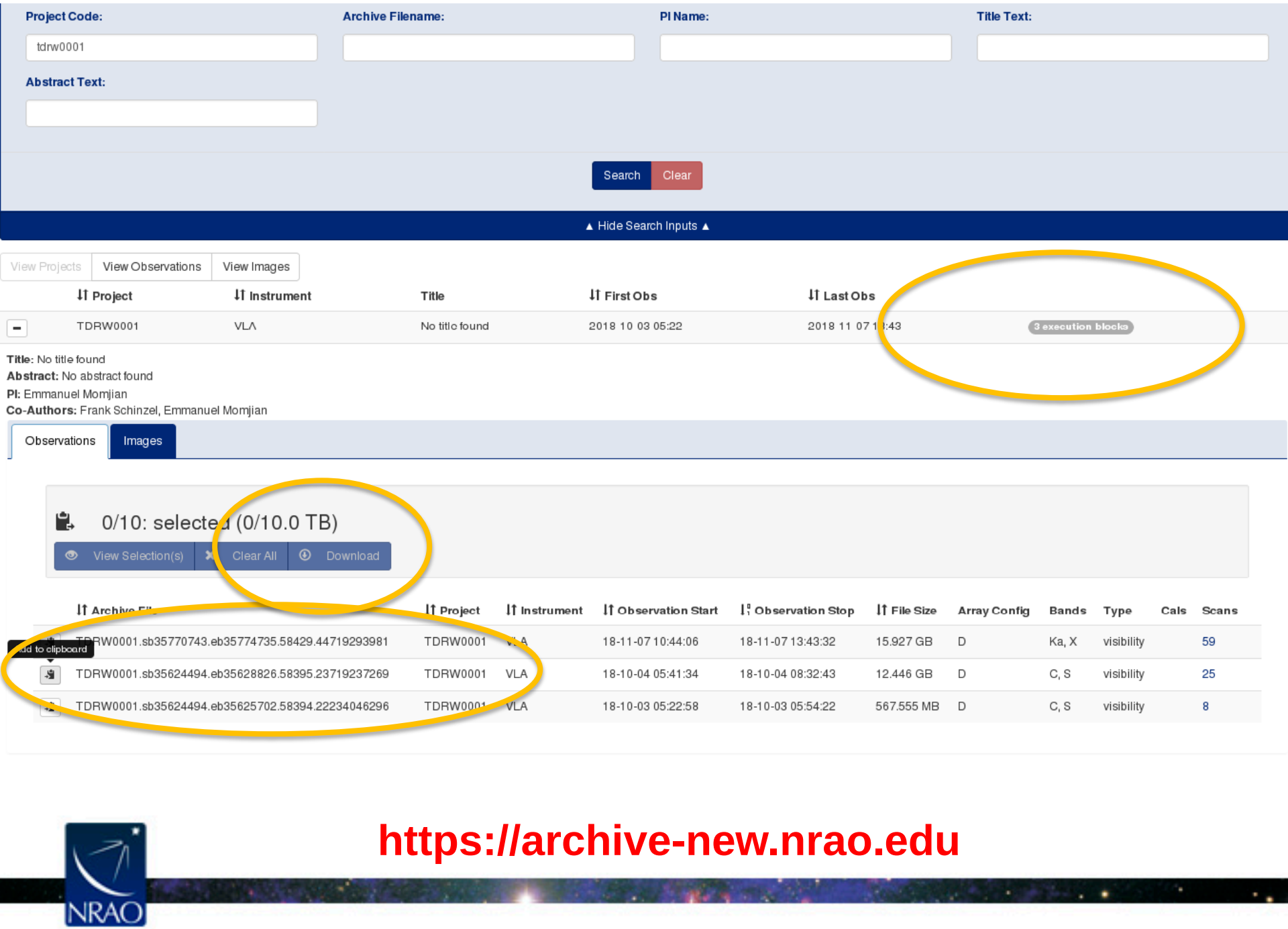
- The SDM-BDF and MS are data directories!
  - For downloading over internet, "tar" is recommended
    (but requires twice the disk space)
  - Alternatively, use "wget"



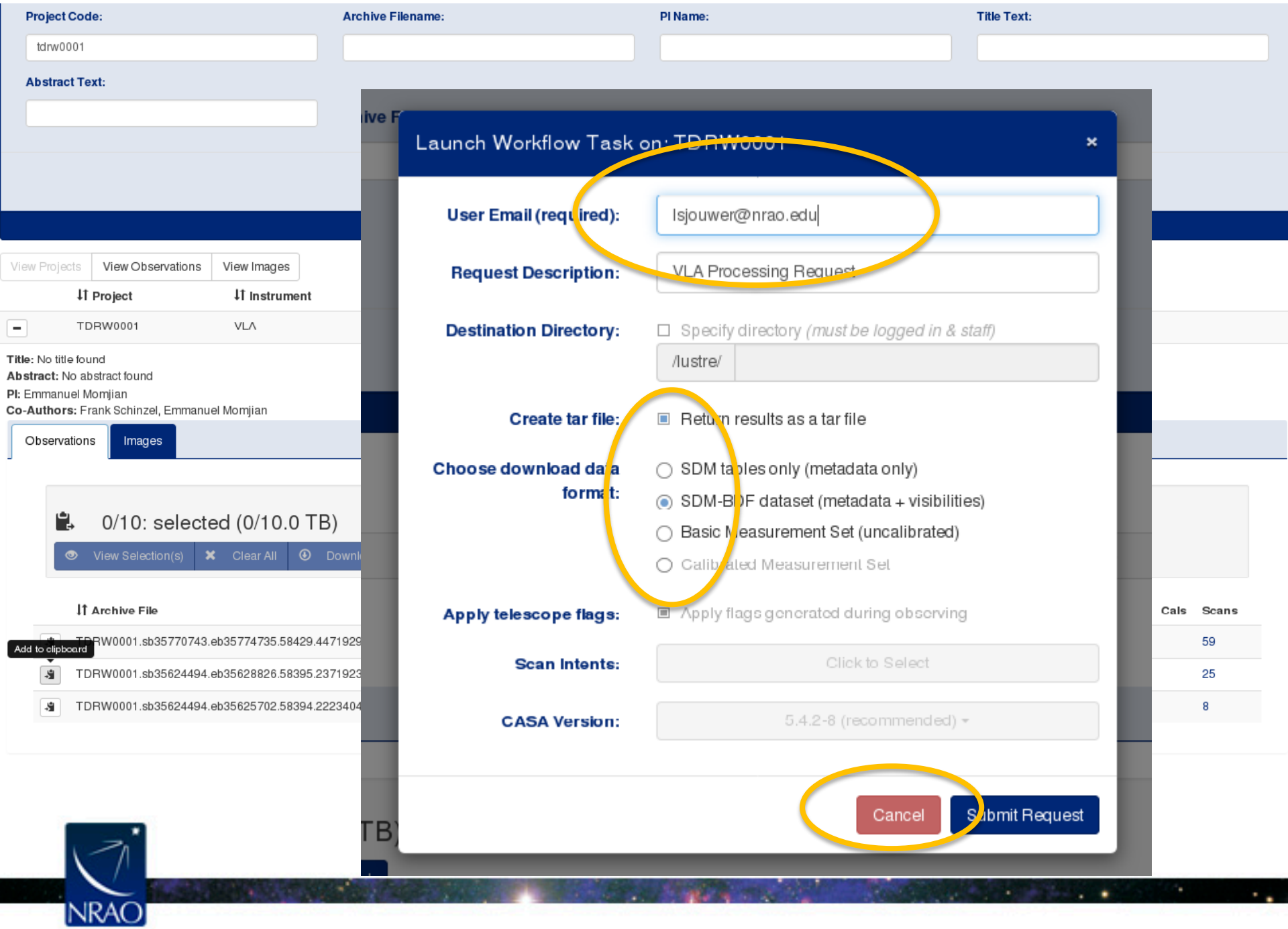
This Archive Access Tool serves Jansky-VLA, ALMA Cycle 1+ and VLBA data only.



https://archive-new.nrao.edu



https://archive-new.nrao.edu


Project Code:
tdrw0001
Archive Filename:
PI Name:
Title Text:
Abstract Text:
View Projects
View Observations
View Images
Project
Instrument
TDRW0001
VLA
Title: No title found
Abstract: No abstract found
PI: Emmanuel Momjian
Co-Authors: Frank Schinzel, Emmanuel Momjian
Observations
Images
0/10: selected (0/10.0 TB)
View Selection(s)
Clear All
Archive File
Add to clipboard
TDRW0001.sb35770743.eb35774735.58429.4471929
TDRW0001.sb35624494.eb35628826.58395.2371923
TDRW0001.sb35624494.eb35625702.58394.2223404
Cals
Scans
59
25
8
Launch Workflow Task on: TDRW0001
User Email (required):
lsjouwer@nrao.edu
Request Description:
VLA Processing Request
Destination Directory:
Specify directory (must be logged in & staff)
/lustre/
Create tar file:
Return results as a tar file
Choose download data format:
SDM tables only (metadata only)
SDM-BDF dataset (metadata + visibilities)
Basic Measurement Set (uncalibrated)
Calibrated Measurement Set
Apply telescope flags:
Apply flags generated during observing
Scan Intents:
Click to Select
CASA Version:
5.4.2-8 (recommended)
Cancel
Submit Request

Finding data in the "new" archive tool

- **Interactive archive:**
- Browse to/find tab http://archive-new.nrao.edu/
  - Open search parameter dialog (or use magnifying glass)
  - In project code type "tdrw0001" and "search"/return
  - Hide inputs or scroll down to click the "+"-sign
  - Add second data set to clipboard and click "download"
  - Enter your email and select a download product
  - *Please don't download!* - press **"cancel"**
- Find your own project
  - A padlock in front of the data set?
  - What if you log in and do the same?

Some final archive notes

- The native SDM-BDF data is always good:
  - May take a while to convert to MS at home
  - Should be usable for any CASA version available
  - Can also be used for AIPS
- Archive processed (averaged/flagged MS) data may need the same CASA version to proceed; currently uses 4.7! [ask SDM]
  - Version used should be listed in a file in the download directory in *__asdm2MS.log or *__casalog.log
- Pipeline processed (MS) data and/or products must use the same CASA version to proceed
  - Calibration tables specific to CASA version

Requesting data on a hard disk

- NRAO can ship data on hard disks upon request, e.g.:
  - when the size of the data is large (over a few 100 GB)
  - when the internet connection cannot handle the request

- This disk-ordering process is done through the archive tool.
- Data is shipped on a 2 TB disk (which holds1.8 TB of data)
- Cost: USD **125** per disk, potentially plus shipping cost

- Disk shipment information and policies are posted at
  https://science.nrao.edu/facilities/vla/archive/shipment

Getting CASA Pipeline Calibrated Data

- Upcoming VLA CASA pipeline talks…

- Note that VLA CASA calibration pipeline products are not yet available through the current archive

  (work is in progress using the new archive tool)

- Request pipelined data products through the *VLA Pipeline department* of the NRAO help desk (https://help.nrao.edu/)

  Download through the internet or ask for a hard disk (purchase)

Loading data into AIPS

- Conversion from the native SDM into UV FITS format is no longer supported through the archive

- Download the native SDM-BDF from the archive.
- Use OBIT to load into AIPS using task '*bdf2aips*'.
  http://www.cv.nrao.edu/~bcotton/Obit.html
- For more details on the VLA data archive, see
  https://science.nrao.edu/facilities/vla/archive/index

Examine the visibility data (in CASA)

CASA

- See previous lecture..
- Documentation is available at
  http://casa.nrao.edu/ → 'Using CASA'
- Training material is available at
  http://casaguides.nrao.edu
- For help, use the NRAO help desk at:
  http://help.nrao.edu

CASA 5.4.2-5 will be used at this workshop

Loading The Data: *importasdm*

If one chooses to download the SDM-BDF (not CASA MS)

- Task *import**asdm*** converts the SDM-BDF to MS
- *importasdm* only understands VLA online flags:
  - It converts the data into a MS while applying flags.

```
> default importasdm
> inp
> asdm              =  'archive_sdm_directory_name'
> vis               =  'output MS name'
> ocorr_mode        =  'co'    (or load ca, ao)
> applyflags        =   True
> inp
> go
```

Loading The Data: *flagdata*

Additional flags for VLA data:

- Note that if `applyflags = False` (the default in *importasdm*), the flags are written to a FLAG_CMD MS table. They can be examined (listed, plotted) and applied by using the task *flagcmd*

- VLA data needs additional flags for shadowing and pure zero data; these flags are applied using the *flagdata* task:

```
> default flagdata
> mode              =       'shadow'
> inp
> go
> mode              =       'clip'
> correlation       =       'ABS_ALL'
> clipzeros         =       True
> inp
> go
```

Refreshing The Data: *mstransform (split)*

For these workshop lectures we use modified data sets:

- In this lecture, after *importasdm*, additional flags for shadowing and pure zero data were added, and removed from the drw-temp measurement set using *mstransform* (a front-end to *split*), retaining only the scientific interesting spw and scans:

```
> default mstransform
> vis                 =     'drw-temp.ms'
> outputvis           =     'drw.ms'
> spw                 =     '2~9:3~60'
> scan                =     '5~25'
> datacolumn          =     'data'
> keepflags           =     False
> hanning             =     True
> go
```

Examining Your Data

- Operator observing log (email, posted on web)
- Plotting the antenna positions: *plotants*

  (potential reference antennas)
- Observing summary: *listobs*

  (sources, scans, spectral windows, antennas, etc…)
- Plotting/displaying/editing data: *plotms*

Examine your data carefully before flagging:

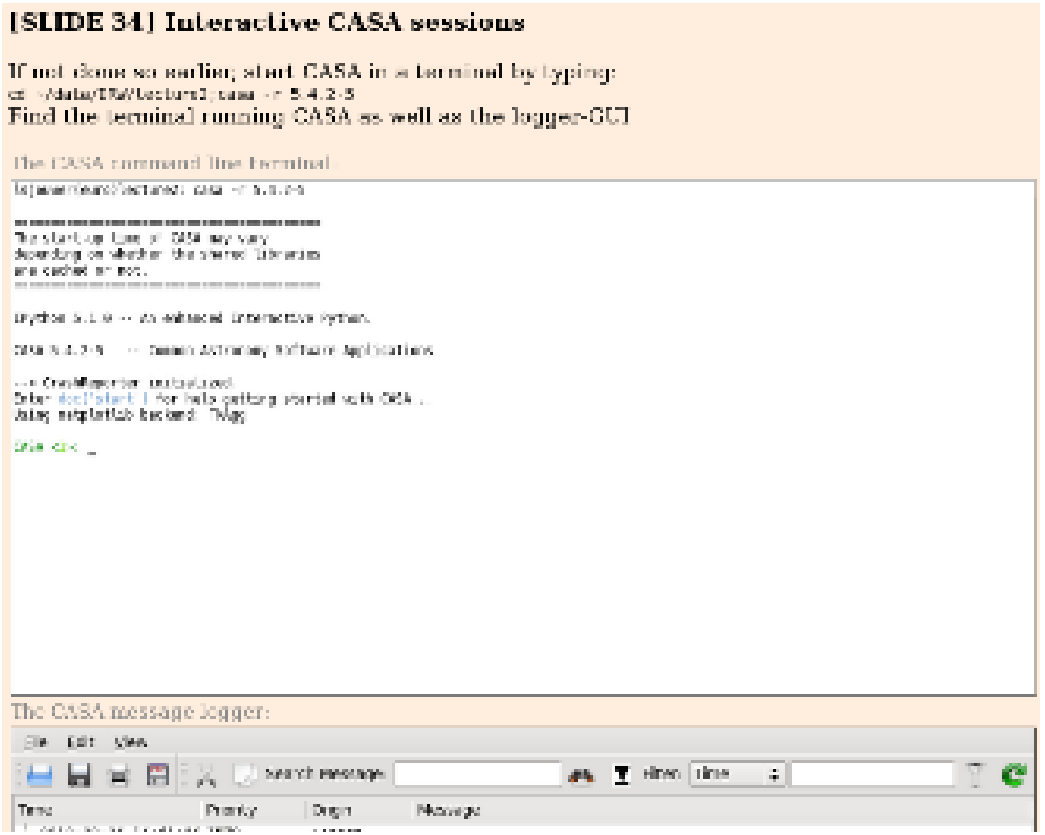
That is, know your data content

Plotting the antennas: *plotants*

INTERACTIVE

- **Interactive CASA:**
  - Move to the terminal with CASA running and type the commands as shown in the web page for Lecture 2:

```
> default plotants
> inp
> ...
> vis = 'drw-temp.ms'
> antindex = true
> inp
> ..
```



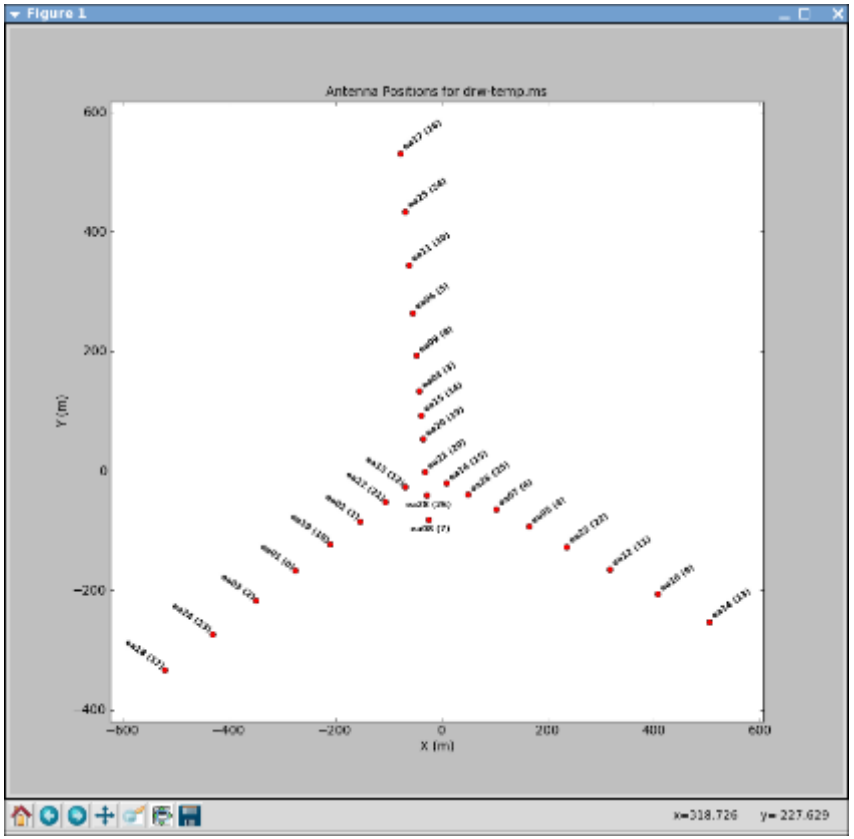
Plotting the antennas: *plotants*

INTERACTIVE

- **Interactive CASA:**
  - On "inp" you will see the parameters set for the task:
    - Black: default value
    - Blue: changed (non-default)
    - Red: invalid value!
      - Typo
      - Does not exist

```
> antindex = True
> inp
> ..
> go
```

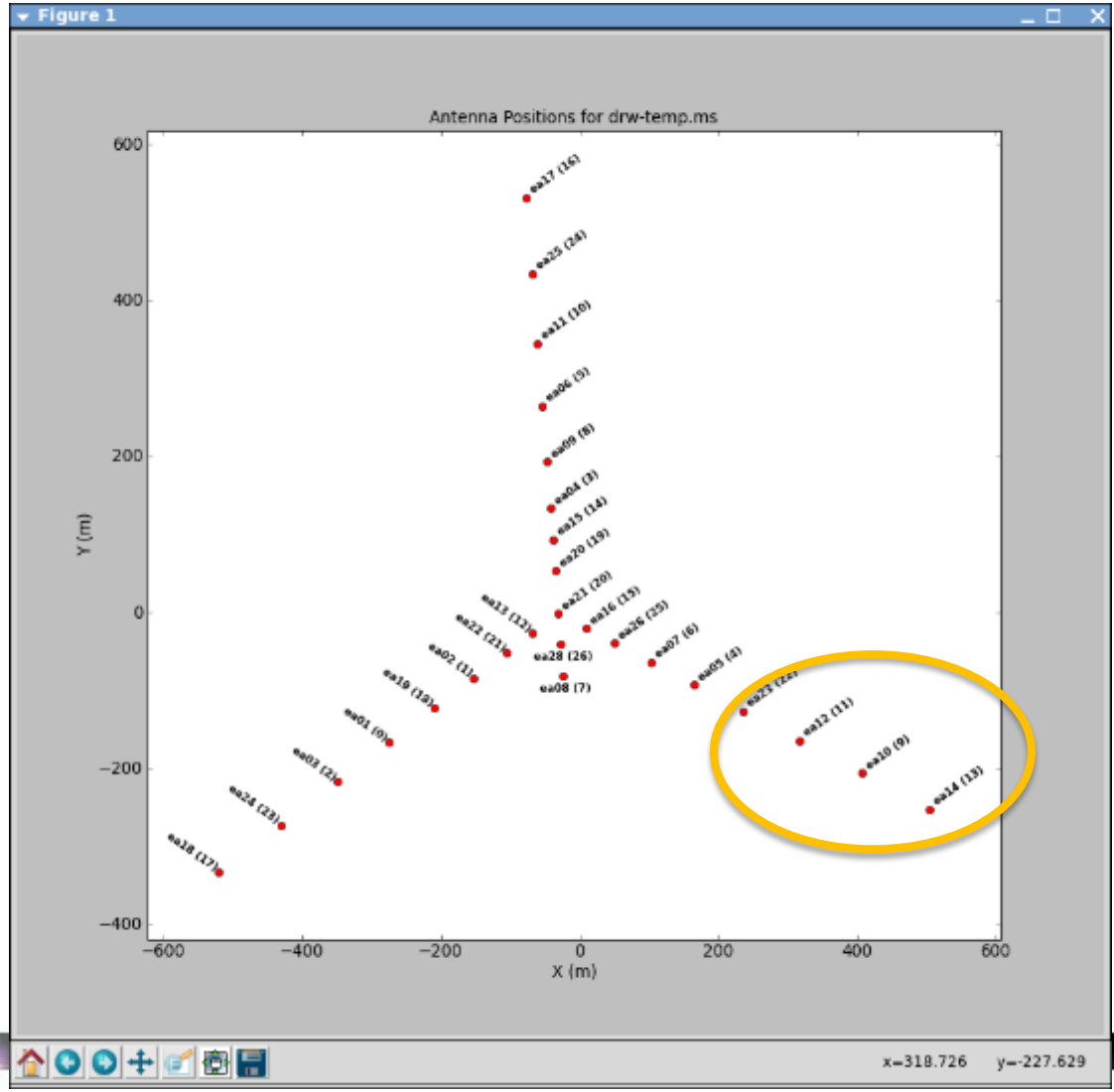
  - On "go" this plot will show up on your screen



Choosing the reference antenna

Hints:

- Must have good data on **all calibrator** sources (target scans irrelevant)
  - No antenna “issues”
  - Clean from RFI
- Baselines not too long
  - **Near** center of array
    (use *listobs/vishead*)
  - e.g. 08-pad [WNE]
    A: inner antennas
    D: no shadowing
    Also don’t move..
- Here: **ea10**
    (D array, E08, #=9)

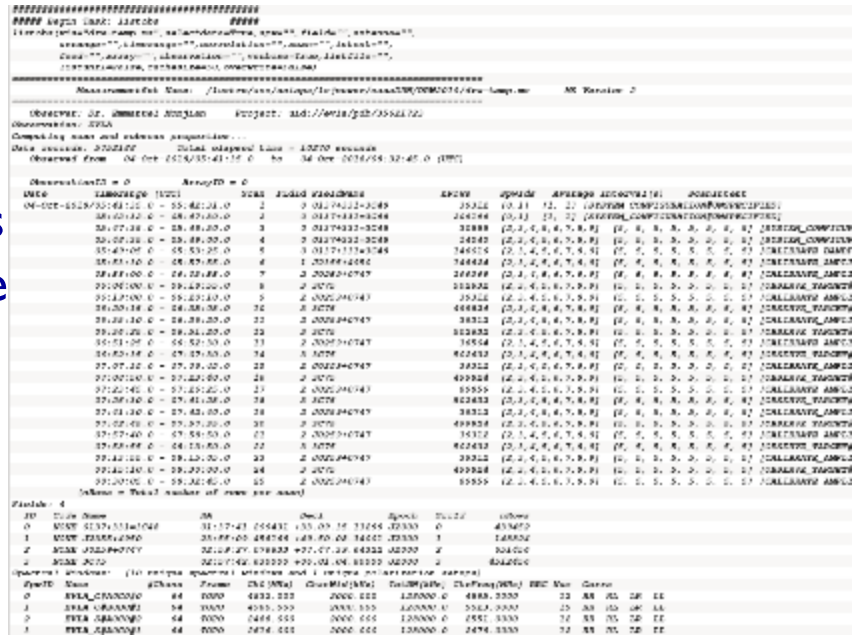


Observing summary: *listobs*

INTERACTIVE

- **Interactive CASA:**
  - Move to the terminal with CASA running and type the commands as shown in the web page for Lecture
  - On "go" this listing will show up in the logger

```
> default listobs
> vis = 'drw-temp.ms'
> inp
> ..
> go
```



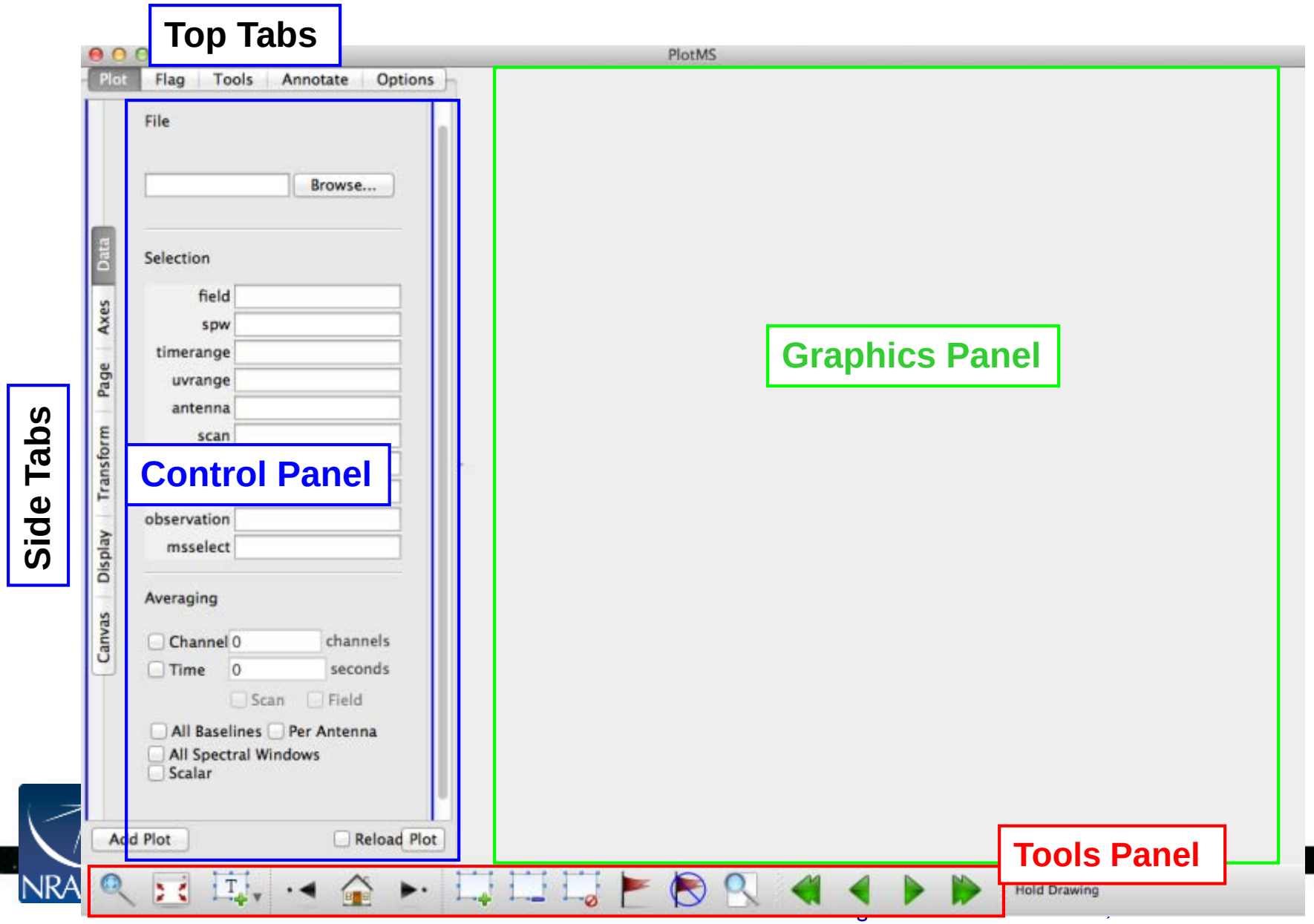
  - More on the web page; stop after "vishead"

Observing summary: *listobs*

Summary:

- Four sources:
  - 0137+331=3C48
    - 5 scans of which 4 are setup, i.e. 1 scan on Flux calibrator
  - J2355+4950, 1 scan, some calibrator
  - J0259+0747, 10 scans, Gain/phase calibrator
  - **3C75**, 9 scans, source with the most time on source, has the most visibilities so this would be the **target source**
- 8 spectral windows (spw), full polarization products (RR,RL,LR,LL)
  - Ranging 2488 to (3384+128=) 3512 MHz, centered at 3000 MHz
  - 64 channels per spw/pol, each 2 MHz wide
- Using 27 antennas (ea27 is not used)
  - Highest numbered antenna pad is E09/N09/W09: D-array
  - Here, use ea10 on pad E08 with ID number 9 as reference

Data Review: *plotms*



Data Review: *plotms*

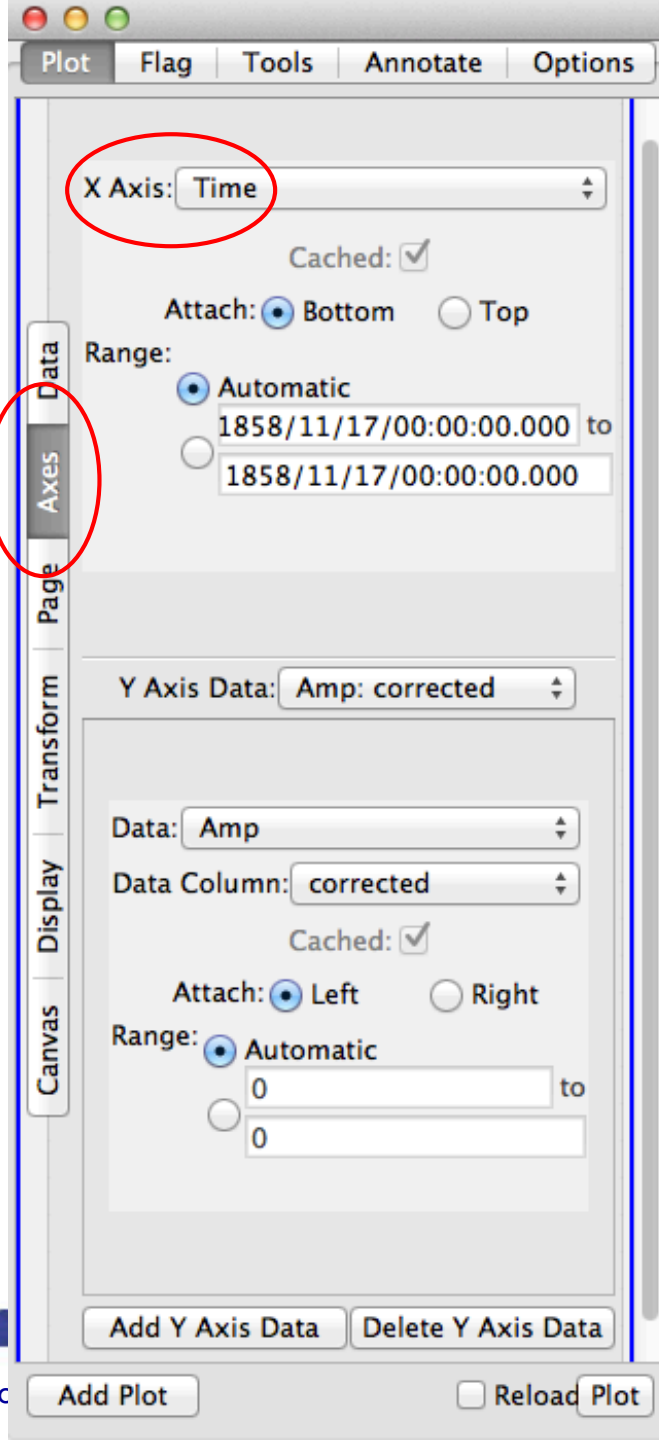
MS Ids and other meta info:

'scan' (number)
'field' (index)
'time',
'interval'='timeint'='timeinterval'='time_interval'
'spw' (index)
'chan'='channel' (index)
'freq'='frequency' (GHz)
'vel'='velocity' (km/s)
'corr'='correlation' (index)
'ant1'='antenna1' (index)
'ant2'='antenna2' (index)
'baseline' (a baseline index)
'row' (absoute row Id from the MS)

Axes

Visibility values, flags:

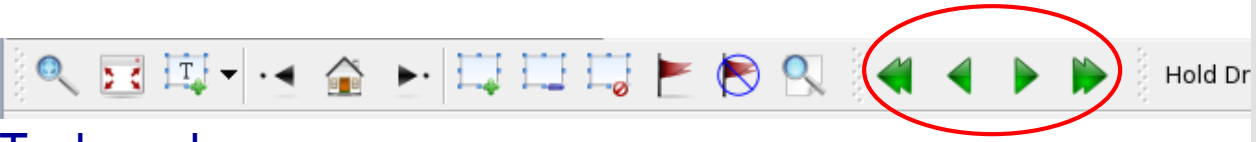
'amp'='amplitude'
'phase' (deg)
'real'
'imag'='imaginary'
'wt'='weight'
'flag'
'flagrow'



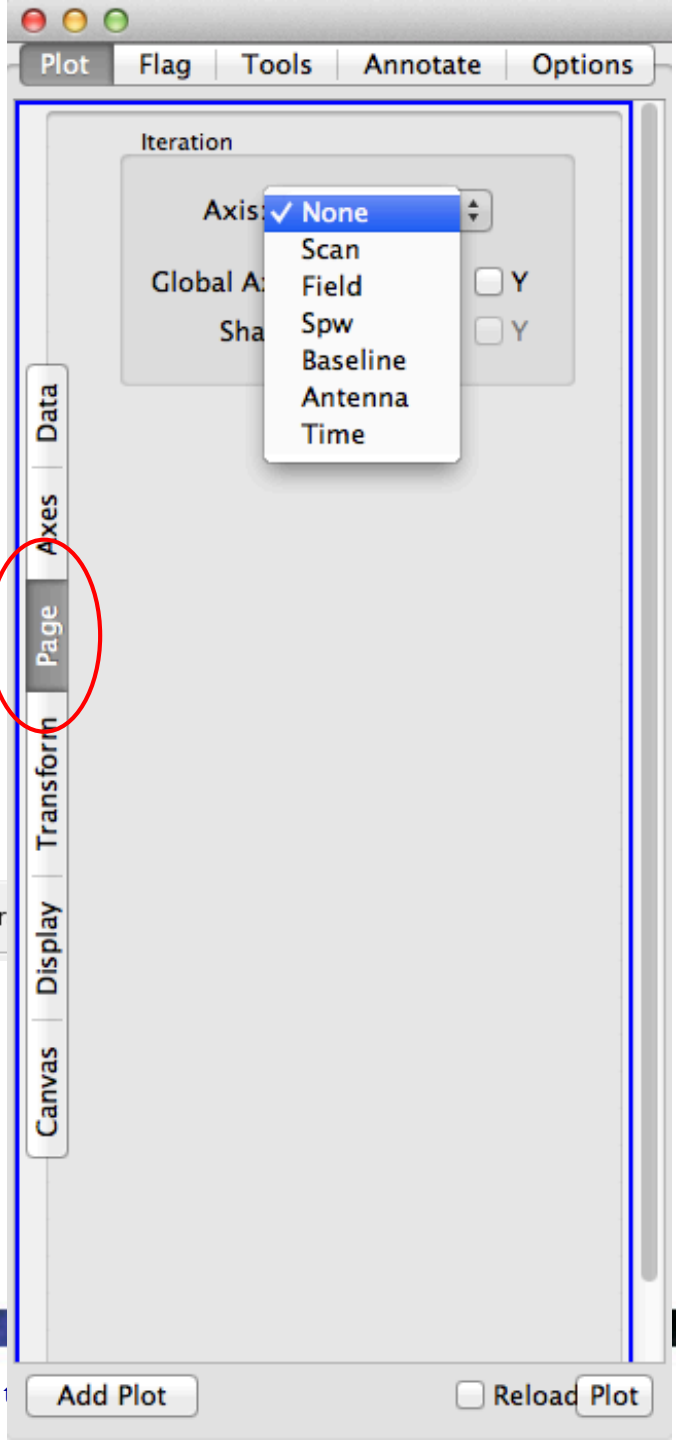
Data Review: *plotms*

Multi-page, cycling through/iterate

Scan
Field
Spw
Baseline
Antenna
Time



Tool panel

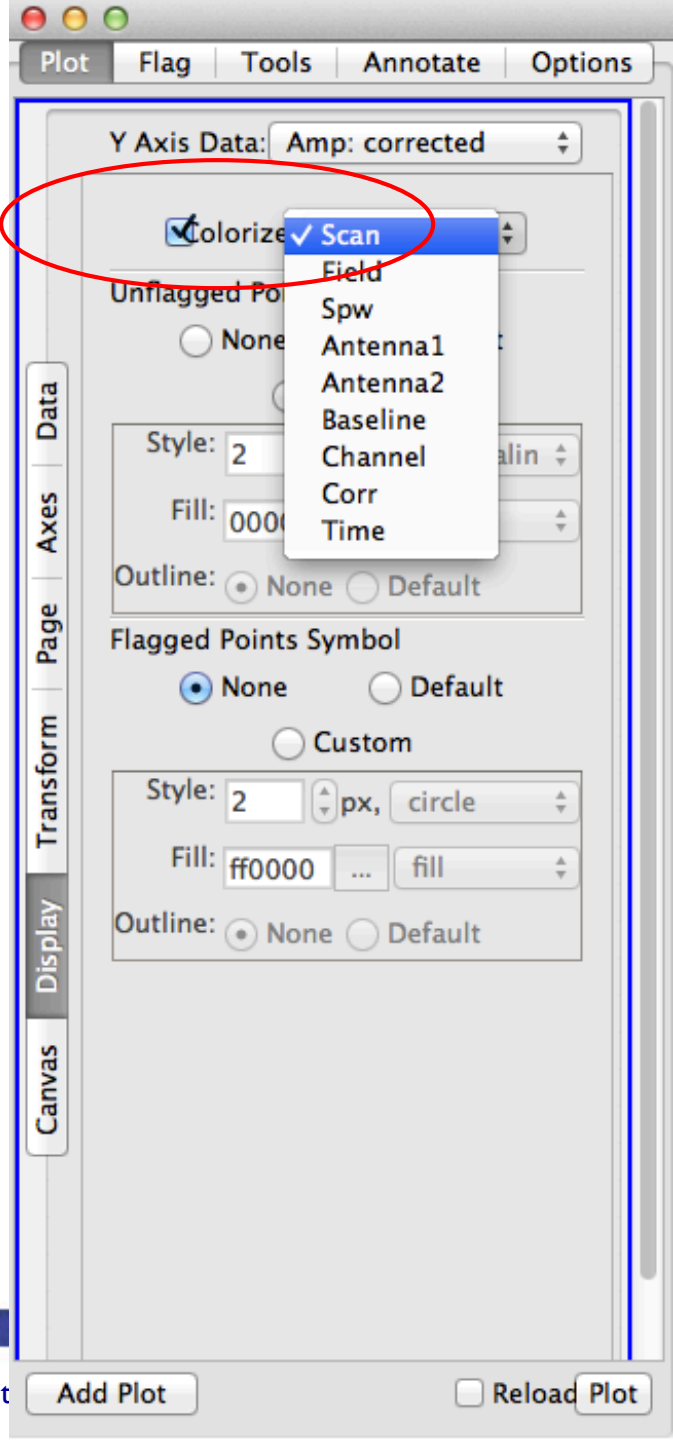


Data Review: *plotms*

Display

Colorize by:

- Scan
- Field
- Spw
- Antenna1
- Antenna2
- Baseline
- Channel
- Correlation
- Time



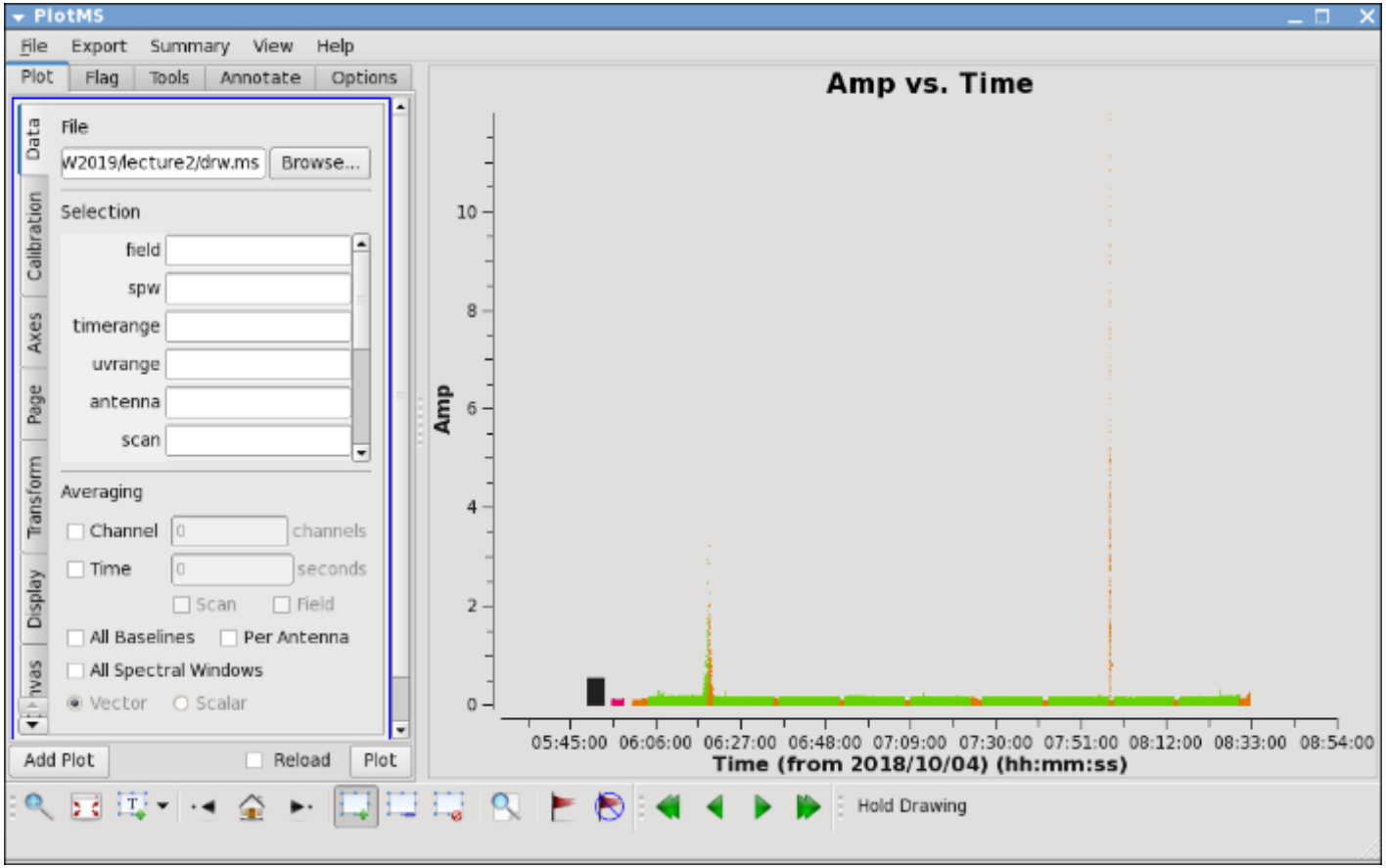
What are we looking for?

- A feel of the overall structure of the data
  (see also the OPT schedule):
  - Calibrators and target visibilities, frequency setup
  - Observing conditions, instrumental response

- Where to expect bad data
  - Specific ill-performing antennas/baseline(boards)
  - In time
    - Start of scans
    - Bad weather/pointing (observing conditions)
  - In frequency
    - Bandpass, subband edges
    - RFI – not your line!

Data Review: *plotms*

Example: xaxis='time', yaxis='amp,' coloraxis='field'



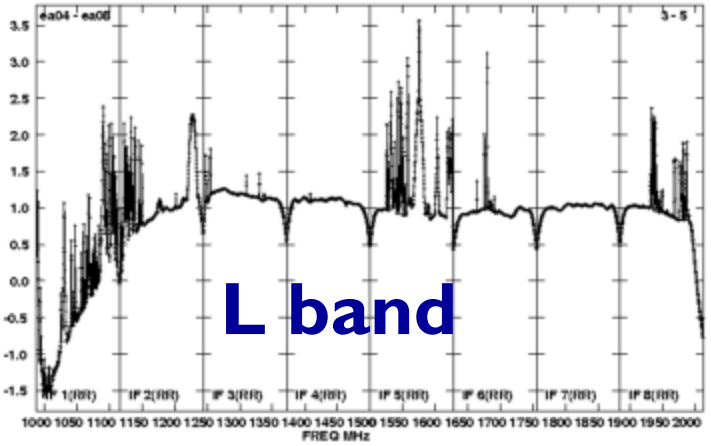
Radio Frequency Interference (RFI)

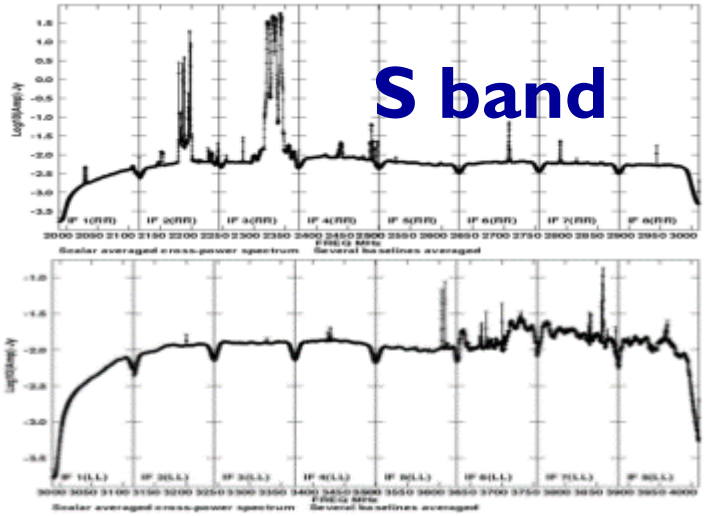
1. VLA observations, particularly at the lower frequency bands, will be severely affected by RFI.
2. VLA RFI information is available at:

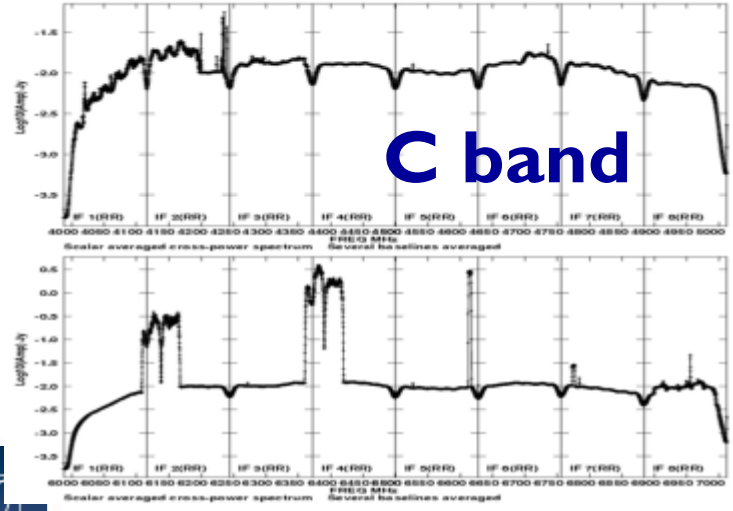
   https://science.nrao.edu/facilities/vla/ → Observing → VLA Observing Guide → #5: Radio Frequency Interference

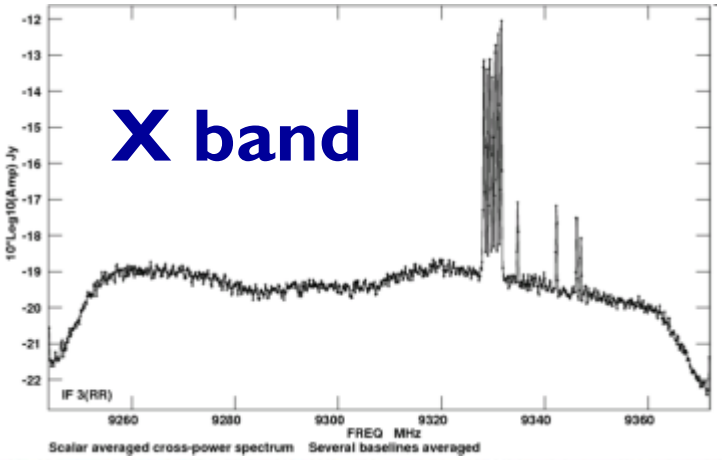
   - RFI listings per frequency band.
   - Spectra of various RFI sweeps between 1-50 GHz.

RFI is present at lower frequency bands



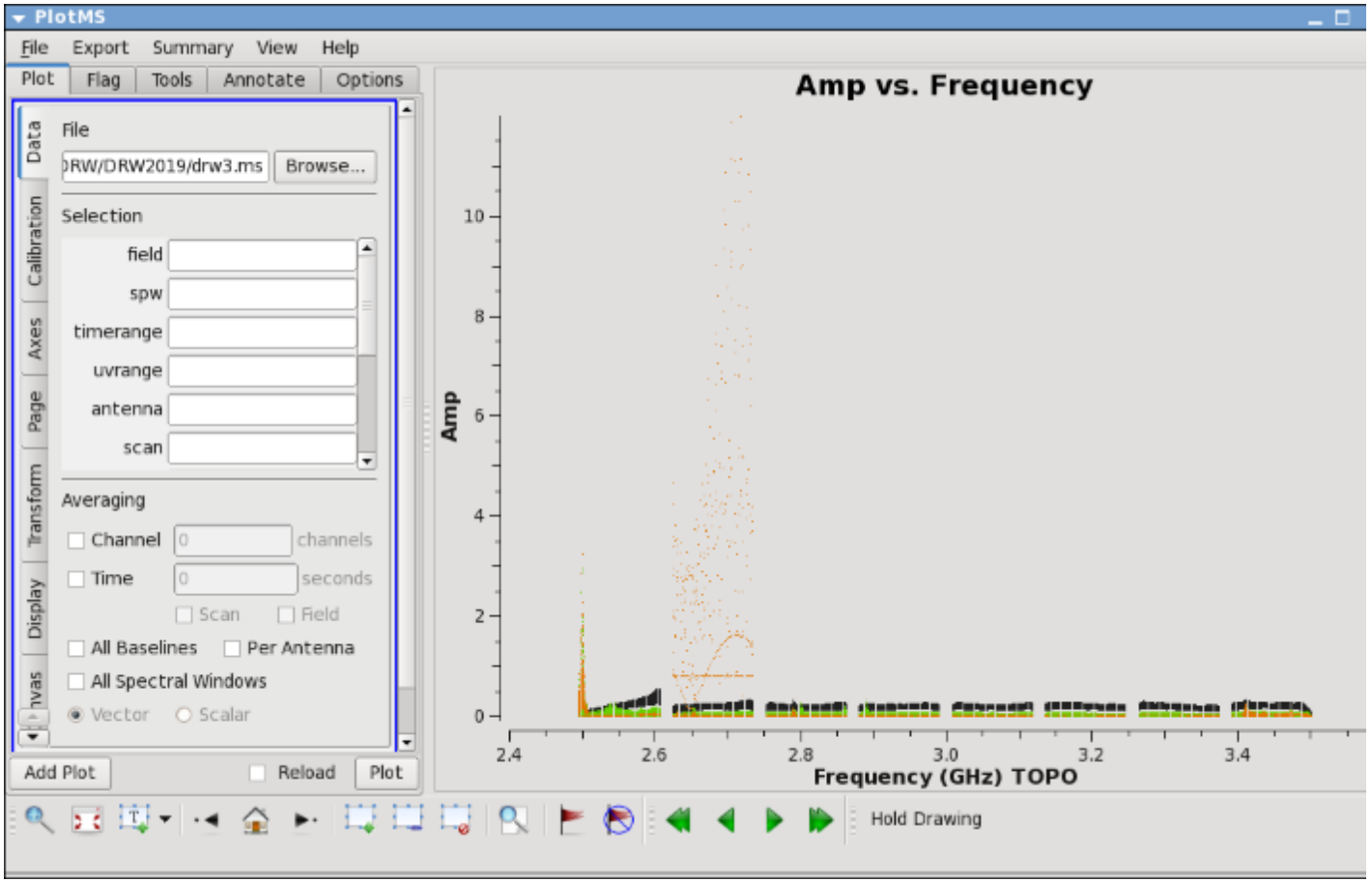






Data Review: *plotms*

Example: xaxis='frequency', yaxis='amp',coloraxis='field'



Preparing for calibration: editing

Editing/Flagging (or unflagging) Data

1. *flagdata:* All purpose flagging task based on selection.
   - Includes RFI flagging capabilities (RFLAG, TFCROP).
2. *flagcmd:* All purpose flagging task based on commands (alternative to *flagdata* for certain types of flagging).
3. *plotms:* Interactive flagging

Review the VLA operator's log carefully.
Certain issues (e.g., antennas without receivers), do not end up in the online flags, and may need to be flagged manually.

Editing/Flagging (or unflagging) Data
A few important notes

- Data in CASA are either flagged or not flagged.
  - Every MS has a flag column.
  - Every bit of data has its own flag (set either to True or False).
  - Applying flags means setting the flag column entries of the selected bits of data to True.
  - Unflagging sets it to Flase, *regardless* it's immediate previous setting
- ***Most*** flagging tasks have the option to create a flag backup.
  - In particular *plotms* does not have this option!
- A flag backup is an MS table and contains the state of the flags before running the flagging task.
- With *flagmanager* flag back-ups can be restored (and made)

Editing Data: *flagdata* - Modes

- *list* = apply a list of flagging commands
- *manual* = flagging based on specific selection parameters
- *clip* = clip data according to values
- *quack* = remove/keep specific time range at scan beginning/end
- *shadow* = remove antenna-shadowed data
- *elevation* = remove data below/above given elevations
- *tfcrop* = auto identification of outliers on the time-freq plane
- *rflag* = auto detection of outliers based on sliding-window RMS filters
- *extend* = extend and/or grow flags
- Also *summary* (per antenna, correlation, field, scan, total), and *unflag*.
- Can also flag calibration tables.

Editing Data: *flagcmd*

- It allows listing, plotting, saving, applying, or un-applying flags.
- Flagging modes (`inpmode`) are:
  - *table*: uses the FLAG_CMD MS table (created by *importasdm*)
  - *list*: uses an ASCII file that contains a set of flagging commands.
  - *xml*: uses the online flags from Flag.xml in the MS.
- It allows the user to save the flag records in the FLAG_CMD MS table or a file.

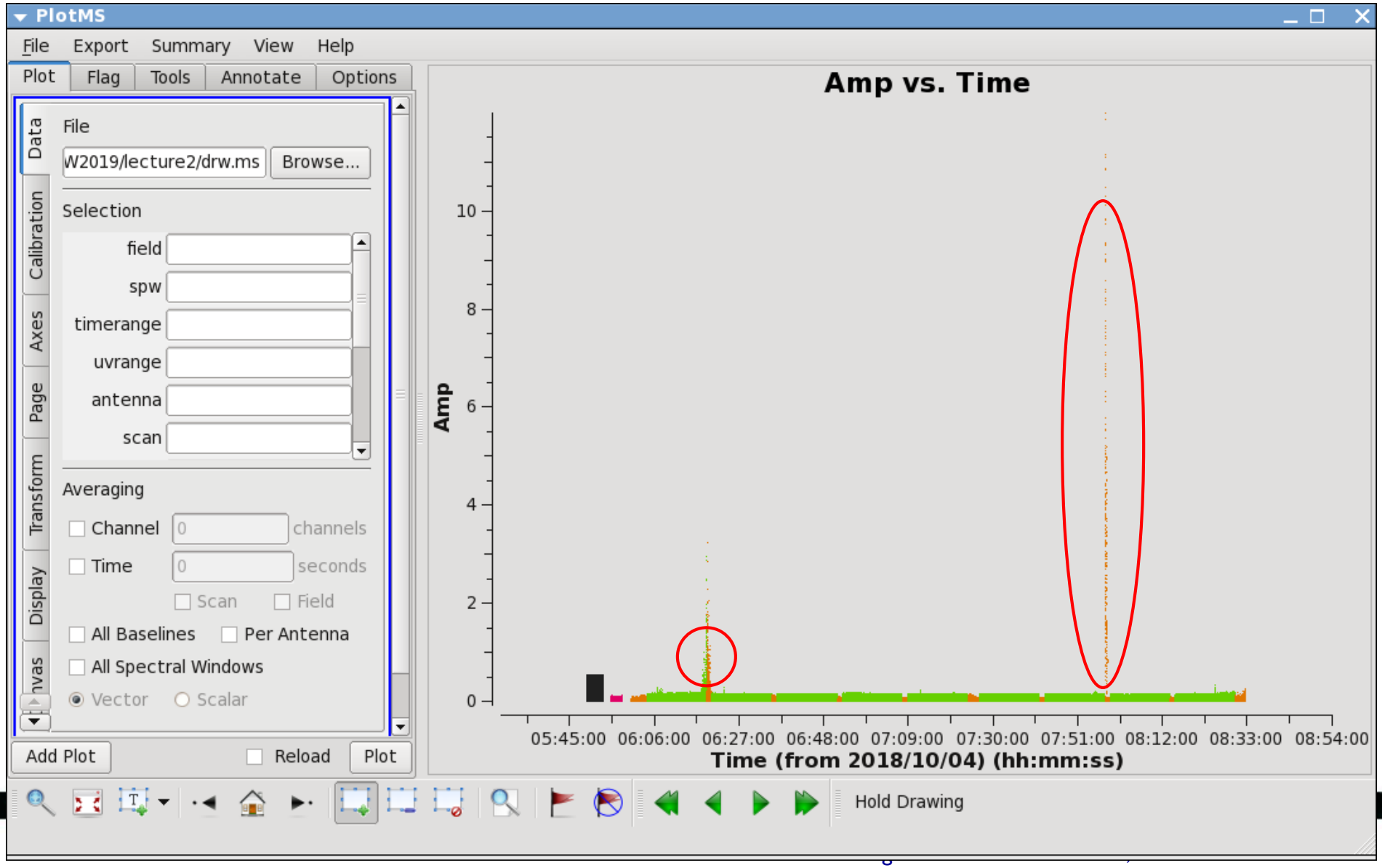
Editing Data: *flagdata vs. flagcmd*

- Complementary flagging tasks.
- Have several common features.
- Some of the important differences:

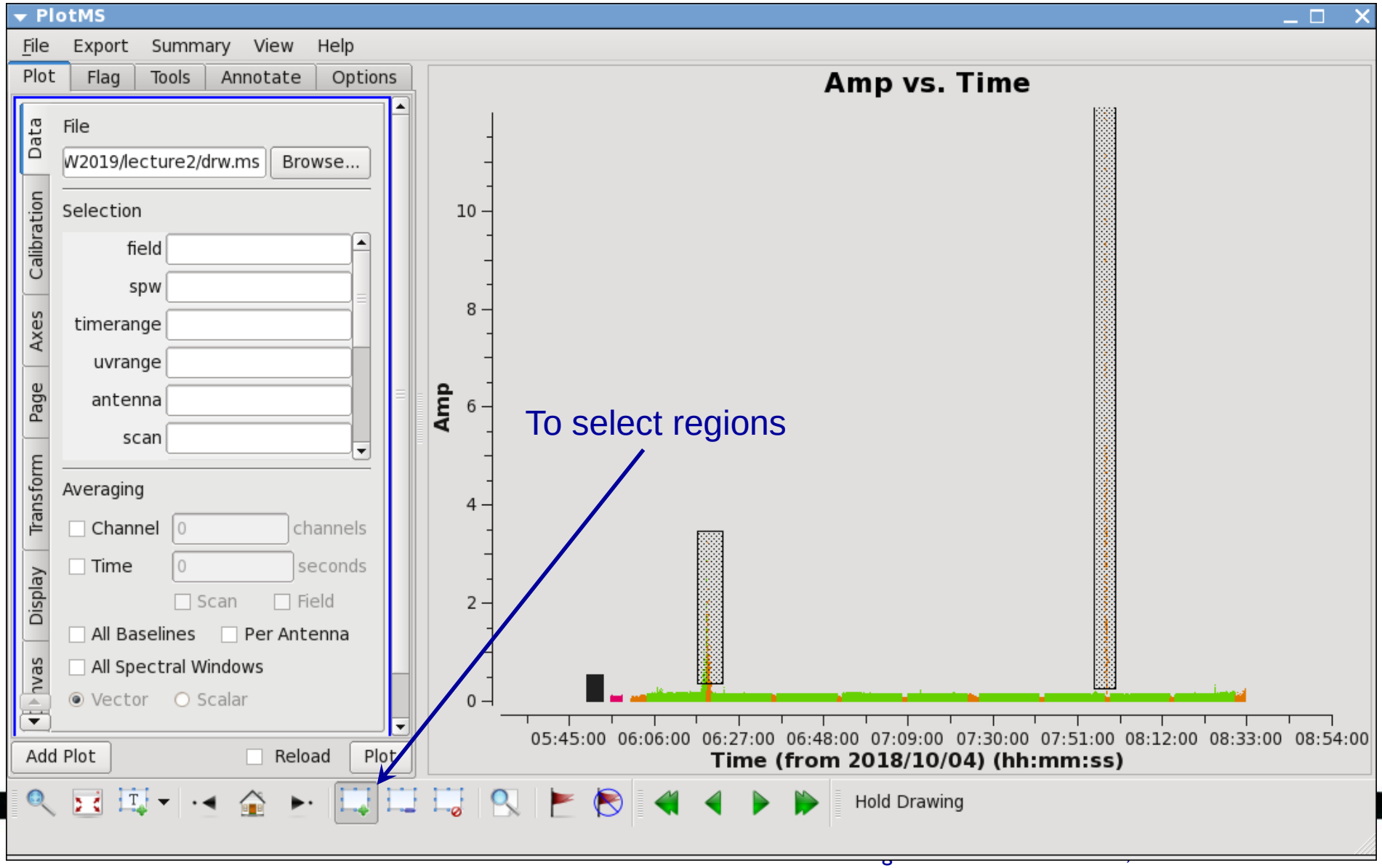
Flagdata	Flagcmd
RFI flagging (tfcrop, rflag)*	Access to the Flag.xml
Runtime displays* (before and after flagging)	Apply the online (and other) flags in FLAG_CMD MS table
	Plot Flags

* More details on Tuesday (RFI talk)

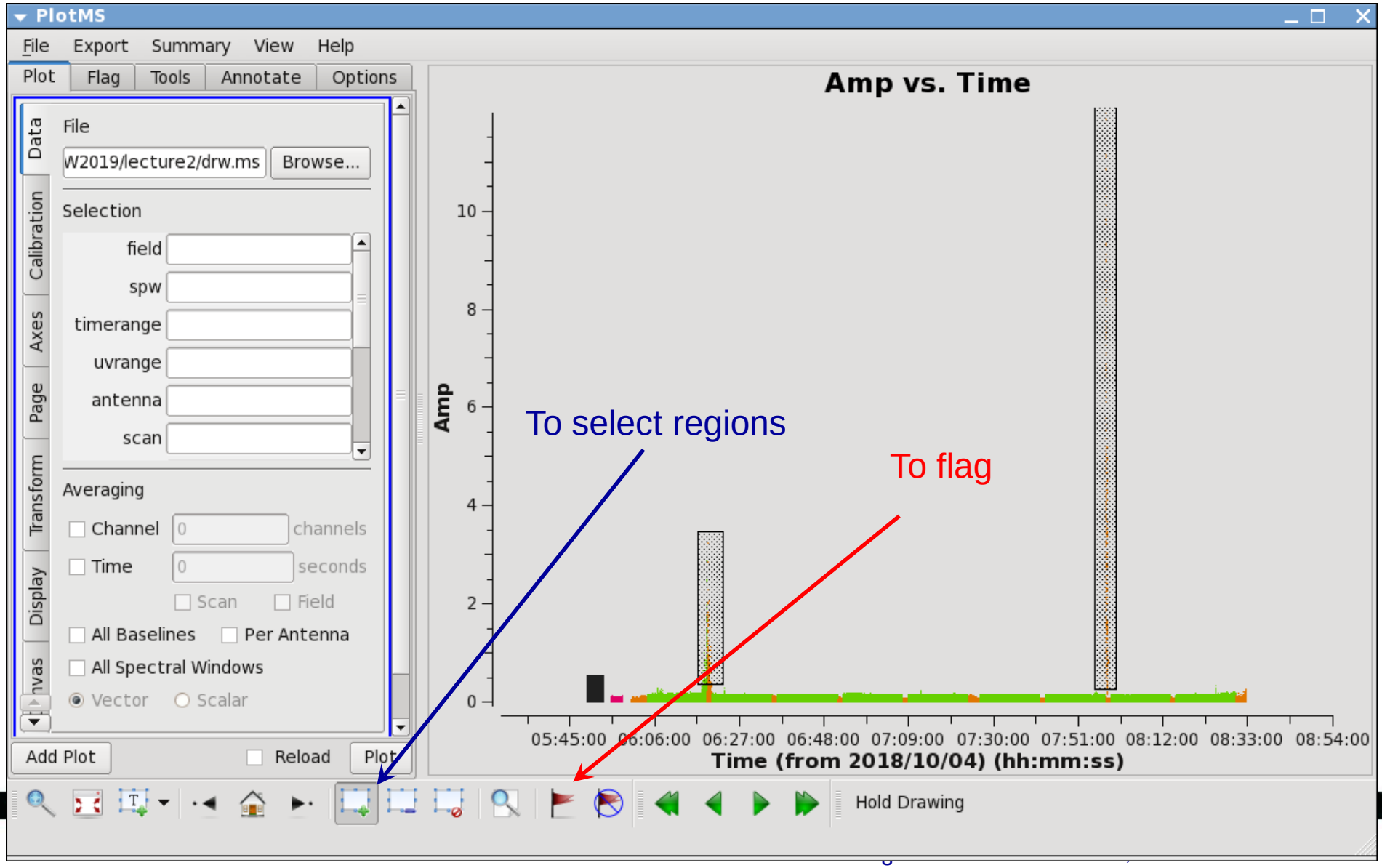
Editing Data: *plotms*



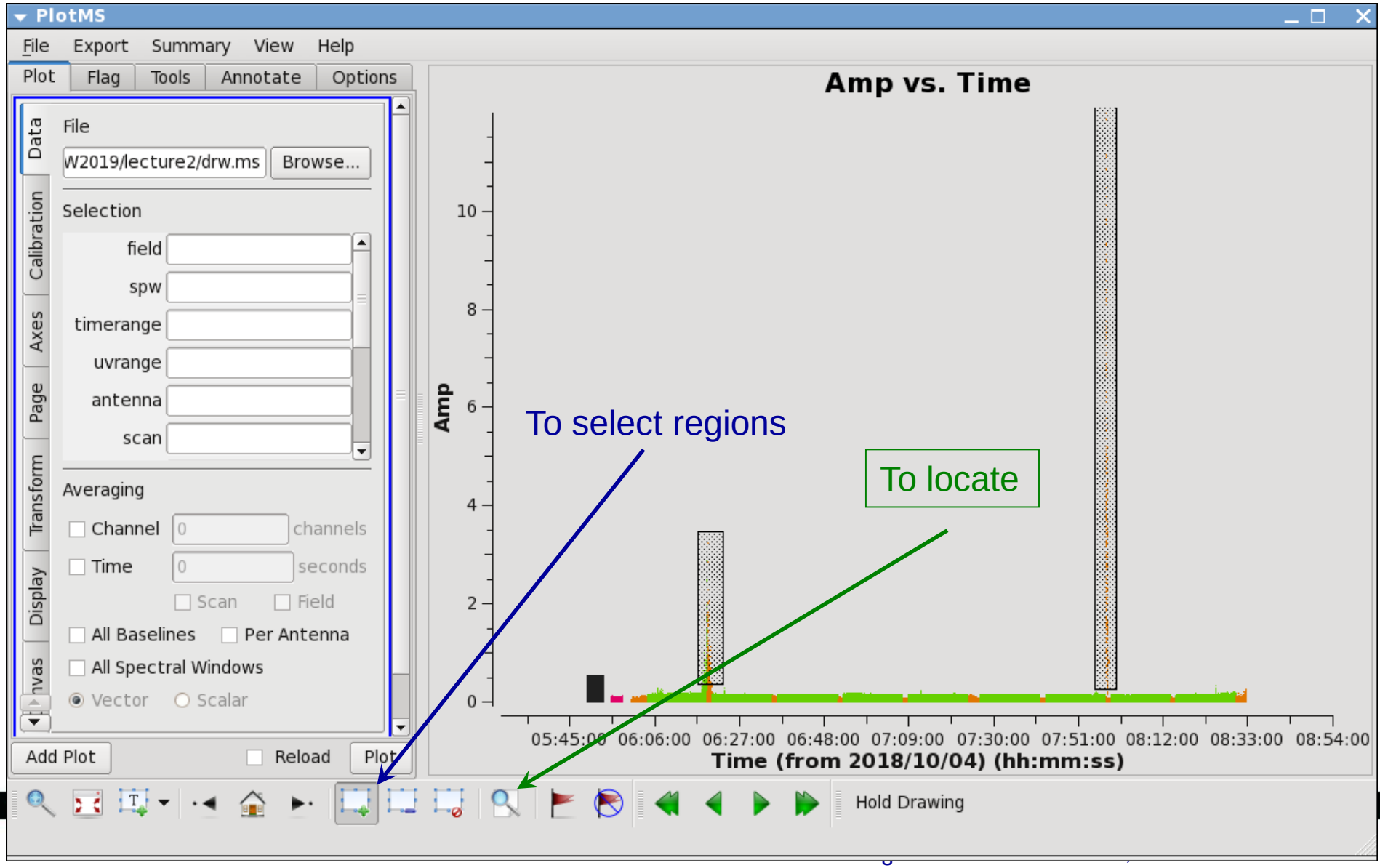
Editing Data: *plotms*



Editing Data: *plotms*

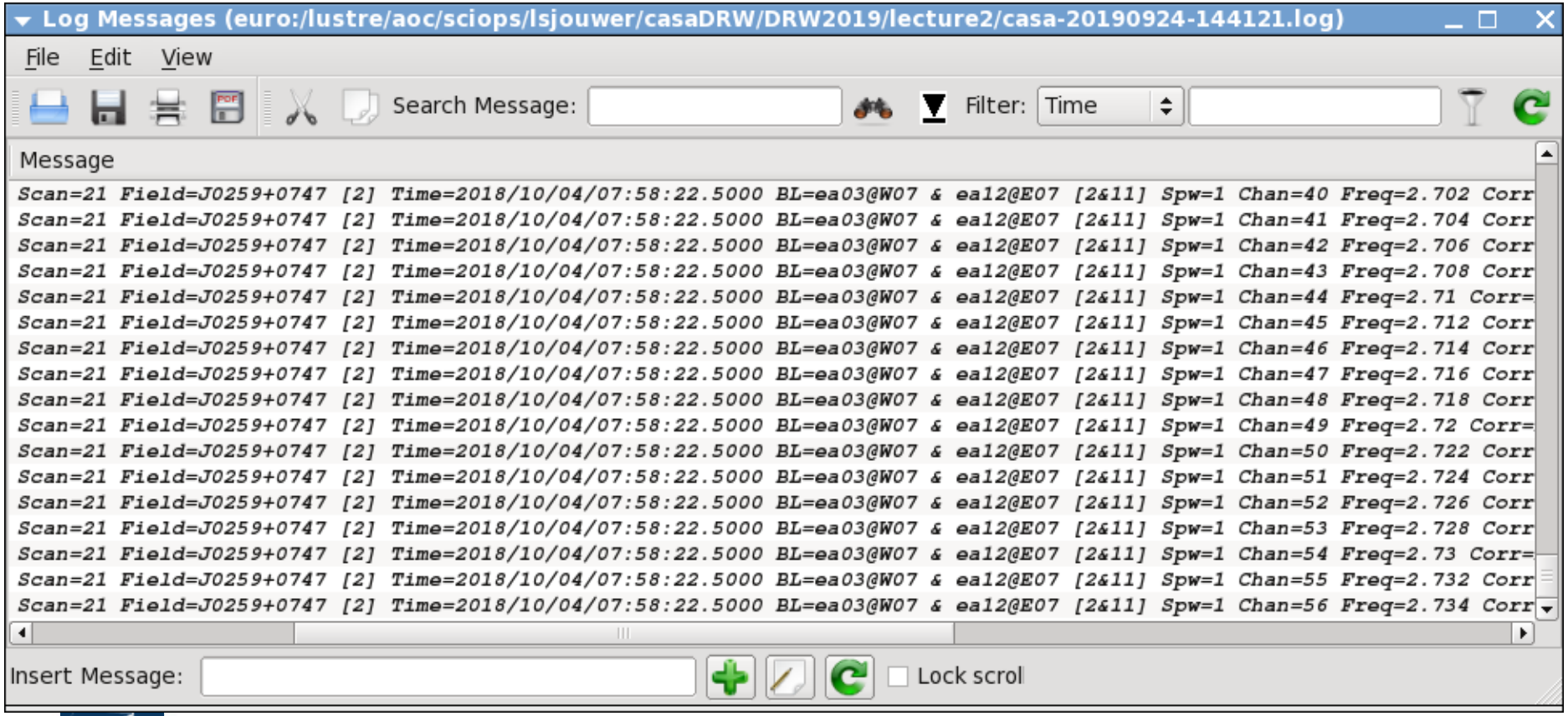


Editing Data: *plotms*



Editing Data: *plotms*

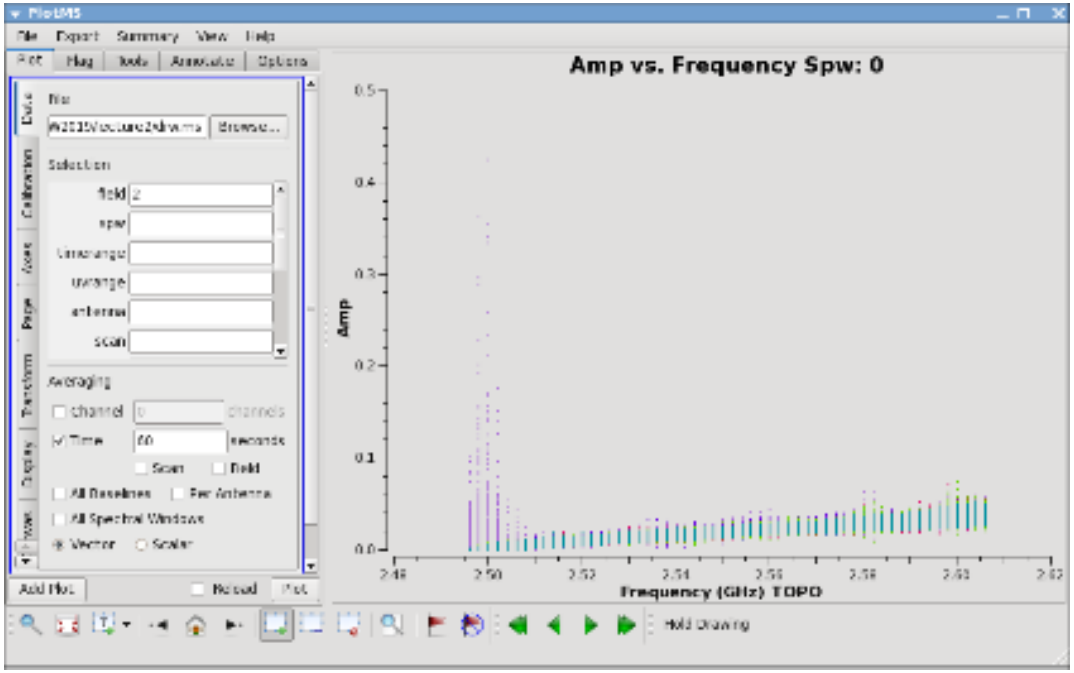
The output of “locate” in the logger – look for common lines



Editing data: *plotms*

- **Interactive CASA:**
  - Move to the web page for instructions

```
> default plotms
> vis = 'drw.ms'
> xaxis = 'frequency'
> yaxis = 'amp'
> field = '2'
> correlation = 'll,rr'
> avgtime = '60'
> iteraxis = 'spw'
> coloraxis = 'scan'
> inp
> ..
> go
```



  - Much more on the web page…

INTERACTIVE

Editing Data: *plotms*
A few important notes

- Use *plotms* carefully for editing data.
- Keep in mind that editing data with *plotms* often requires extending the flags (through the Flag tab).
- *plotms* does not produce a flag backup (*flagmanager* has to be used).
- Use *plotms* to identify bad data (through the locate option). Then flag the bad data using *flagcmd* or *flagdata*.

Ready to calibrate the data?

- ✓ The data structure is understood, reference antenna picked
- ✓ Calibrators (flux density, bandpass, gain) are identified
- ✓ Bad antennas and bad basebands are flagged
- ✓ RFI is removed (as much as possible), Hanning smooth?
- ✓ Bad individual visibilities/baselines/times are flagged

- Maybe inspect (some parts of) the data again to make sure

  Likely more flagging may need to be done during/after calibration steps

- **Ready to start with data calibration**

  Next lecture…

www.nrao.edu
science.nrao.edu
public.nrao.edu

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.