CASA Pipelines

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Overview

- ALMA and VLA have CASA Pipelines
- Currently calibration only
  - Diagnostic calibrator images
  - ALMA science target imaging being commissioned
- The Pipelines use dedicated Pipeline tasks in CASA
- Execute using python scripts provided by the telescopes. Or self-build
- ALMA and VLA Pipelines common output: Pipeline WebLog

CASA Pipeline Versions

- CASA 4.2.2 and CASA 4.3.1 have special versions including the Pipeline
  - Obtain from http://casa.nrao.edu/casa_obtaining.shtml

- CASA 4.4 has no pipeline version

- Starting with CASA 4.5 (this month), one version

- Earliest CASA versions to be used with ALMA Cycle 3 data (manual or Pipeline) CASA 4.5

Pipeline Task Types

Prefix	Task type	Purpose
h_	Common	Interferometry and single-dish, ALMA & VLA
hif_	Interferometry	ALMA & VLA
hifa_	Interferometry	ALMA only
hifv_	Interferometry	VLA only
hsd_	Single-dish	ALMA single-dish

Pipeline Tasks vs CASA Tasks

Pipeline	CASA
hifa_importdata	importasdm
hifa_flagdata	flagdata
hifa_wvrgcalflag	wvrgcal
hifa_bandpass	bandpass
hifa_gfluxscale	fluxscale
hifa_timegaincal	gaincal
hif_applycal	applycal

Pipeline tasks use CASA tasks where possible

Pipeline tasks can also contain heuristics and may be multiple CASA tasks bundled together

Pipeline Mode

```
CASA <12>: inp hifa_importdata
---------> inp(hifa_importdata)
#  hifa_importdata :: Imports data into the interferometry pipeline
vis                 =       ['']        #  List of input visibility data
session             =       ['']        #  List of visibility data sessions
pipelinemode        = 'automatic'       #  The pipeline operating mode
async               =      False        #  If true the taskname must be started using hifa_importdata(...)
```

```
CASA <13>: pipelinemode='interactive'

CASA <14>: inp hifa_importdata
---------> inp(hifa_importdata)
#  hifa_importdata :: Imports data into the interferometry pipeline
vis                 =       ['']        #  List of input visibility data
session             =       ['']        #  List of visibility data sessions
pipelinemode        = 'interactive'     #  The pipeline operating mode
     asis           = 'Antenna Station Receiver CalAtmosphere' #  ASDM to convert as is
     process_caldevice =      False     #  Import the caldevice table from the ASDM
     overwrite      =      False        #  Overwrite existing files on import
     bdfflags       =      False        #  Apply BDF flags on import
     dryrun         =      False        #  Run the task (False) or display task command (True)
     acceptresults  =       True        #  Add the results into the pipeline context

async               =      False        #  If true the taskname must be started using hifa_importdata(...)

CASA <15>:
```

Pipeline Design

- Pipeline reduces data automatically by
  - Selecting the best processing strategies ⟶ **Heuristics**
  - Organizing the reduction environment / book-keeping ⟶ **Context**

- ALMA pipeline implements the two aspects using the "separation of concerns" design principle
  - Mix and match of steps is possible

Pipeline Implementation

- **Heuristics** and **Context** are implemented as Python Classes
- The variables for heuristics are “parameters”, the ones for context are “inputs”
- Pipeline runs handle the context automatically
- User interaction mainly via heuristics parameters
- However the context can be edited to insert own calibration tables

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```
__rethrow_casa_exceptions = True

h_init()

try:

    hifa_importdata(dbservice=False, vis=['uid___A002_X877e41_X452'],
session=['session_1'])

    hifa_flagdata(pipelinemode="automatic")

    hifa_fluxcalflag(pipelinemode="automatic")

    hif_rawflagchans(pipelinemode="automatic")

    hif_refant(pipelinemode="automatic")

    hifa_tsyscal(pipelinemode="automatic")

    hifa_tsysflag(pipelinemode="automatic")

    hifa_wvrgcalflag(pipelinemode="automatic")

    hif_lowgainflag(pipelinemode="automatic")

    hif_setjy(pipelinemode="automatic")

    hifa_bandpass(pipelinemode="automatic")

    hifa_spwphaseup(pipelinemode="automatic")

    hifa_gfluxscale(pipelinemode="automatic")

    hifa_timegaincal(pipelinemode="automatic")

    hif_applycal(pipelinemode="automatic")

    hif_makecleanlist(intent='PHASE,BANDPASS,CHECK')

    hif_cleanlist(pipelinemode="automatic")

    hif_exportdata(pipelinemode="automatic")

finally:

    h_save()
```

ALMA Pipeline Script

casapipescript.py

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```
__rethrow_casa_exceptions = True

h_init()

try:

    hifa_importdata(dbservice=False, vis=['uid___A002_X877e41_X452'],
session=['session_1'])

    hifa_flagdata(pipelinemode="automatic")

    hifa_fluxcalflag(pipelinemode="automatic")

    hif_rawflagchans(pipelinemode="automatic")

    hif_refant(pipelinemode="automatic")

    hifa_tsyscal(pipelinemode="automatic")

    hifa_tsysflag(pipelinemode="automatic")

    hifa_wvrgcalflag(pipelinemode="automatic")

    hif_lowgainflag(pipelinemode="automatic")

    hif_setjy(pipelinemode="automatic")

    hifa_bandpass(pipelinemode="automatic")

    hifa_spwphaseup(pipelinemode="automatic")

    hifa_gfluxscale(pipelinemode="automatic")

    hifa_timegaincal(pipelinemode="automatic")

    hif_applycal(pipelinemode="automatic")

    hif_makecleanlist(intent='PHASE,BANDPASS,CHECK')

    hif_cleanlist(pipelinemode="automatic")

    hif_exportdata(pipelinemode="automatic")

finally:

    h_save()
```

ALMA Pipeline Script

Main Steps

Data Import

Data Flagging

Generate Tsys table & flag

Generate WVR table

Set the absolute fluxscale

Generate bandpass table

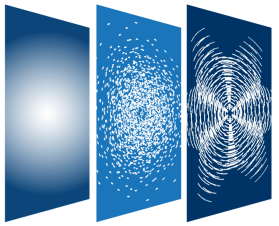
Determine fluxes of 2o cals

Generate gain tables

Apply calibration

Image calibrators

Pipeline CASA Commands Log

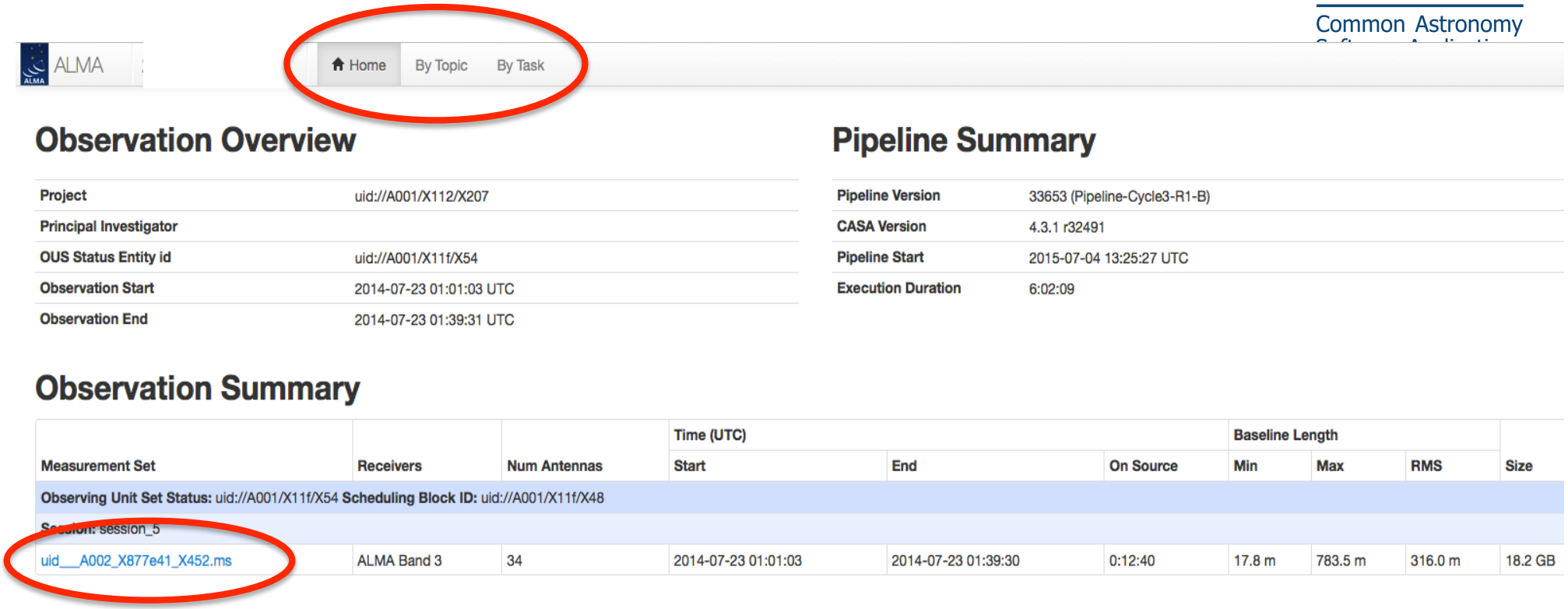


 # hifa_bandpass(pipelinemode="automatic")
#
 # The spectral response of each antenna is calibrated. A short-solint phase
 # gain is calculated to remove decorrelation of the bandpass calibrator before
 # the bandpass is calculated.
#

gaincal(field='0', minblperant=4, antenna='0~36', solint='4.502099s',
caltable='uid___A002_Xa43a0e_X115e.ms.hifa_bandpass.s11_3.spw9_11_13_15.solint4_502s.gpcal.tbl',
interp=['linear,linear', 'nearest'], minsnr=3.0,
gaintable=['uid___A002_Xa43a0e_X115e.ms.hifa_tsyscal.s6_1.tsyscal.tbl',
'uid___A002_Xa43a0e_X115e.ms.hifa_wvrgcalflag.s8_4.sm2_016s.wvrcal.tbl'],
spw='9,11,13,15', vis='uid___A002_Xa43a0e_X115e.ms', calmode='p',
gaintype='G', spwmap=[[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 9, 11, 11, 13, 13,
15, 15, 9, 11, 13, 15], []], intent='*BANDPASS*', solnorm=False,
refant='DA49,DA59,DV08,DA57,PM02,DV18,DV19,PM03,DV04,DA41,PM01,DA61,DA63,DA53,DV01,etc',
gainfield=['nearest', ''])

bandpass(field='0', bandtype='B', antenna='0~36', solint='inf,164.524257MHz',
caltable='uid___A002_Xa43a0e_X115e.ms.hifa_bandpass.s11_3.spw9_11_13_15.channel.solintinf.bcal.tbl',
interp=['linear,linear', 'nearest', 'linear,linear'], minsnr=3.0,
gaintable=['uid___A002_Xa43a0e_X115e.ms.hifa_tsyscal.s6_1.tsyscal.tbl',
'uid___A002_Xa43a0e_X115e.ms.hifa_wvrgcalflag.s8_4.sm2_016s.wvrcal.tbl',
'uid___A002_Xa43a0e_X115e.ms.hifa_bandpass.s11_3.spw9_11_13_15.solint4_502s.gpcal.tbl'],
spw='9', vis='uid___A002_Xa43a0e_X115e.ms', combine='scan', spwmap=[[0,
1, 2, 3, 4, 5, 6, 7, 8, 9, 9, 11, 11, 13, 13, 15, 15, 9, 11, 13, 15],
[], []], intent='*BANDPASS*', solnorm=True,
refant='DA49,DA59,DV08,DA57,PM02,DV18,DV19,PM03,DV04,DA41,PM01,DA61,DA63,DA53,DV01,etc',
gainfield=['nearest', '', 'nearest'], minblperant=4)

Pipeline WebLog: Home



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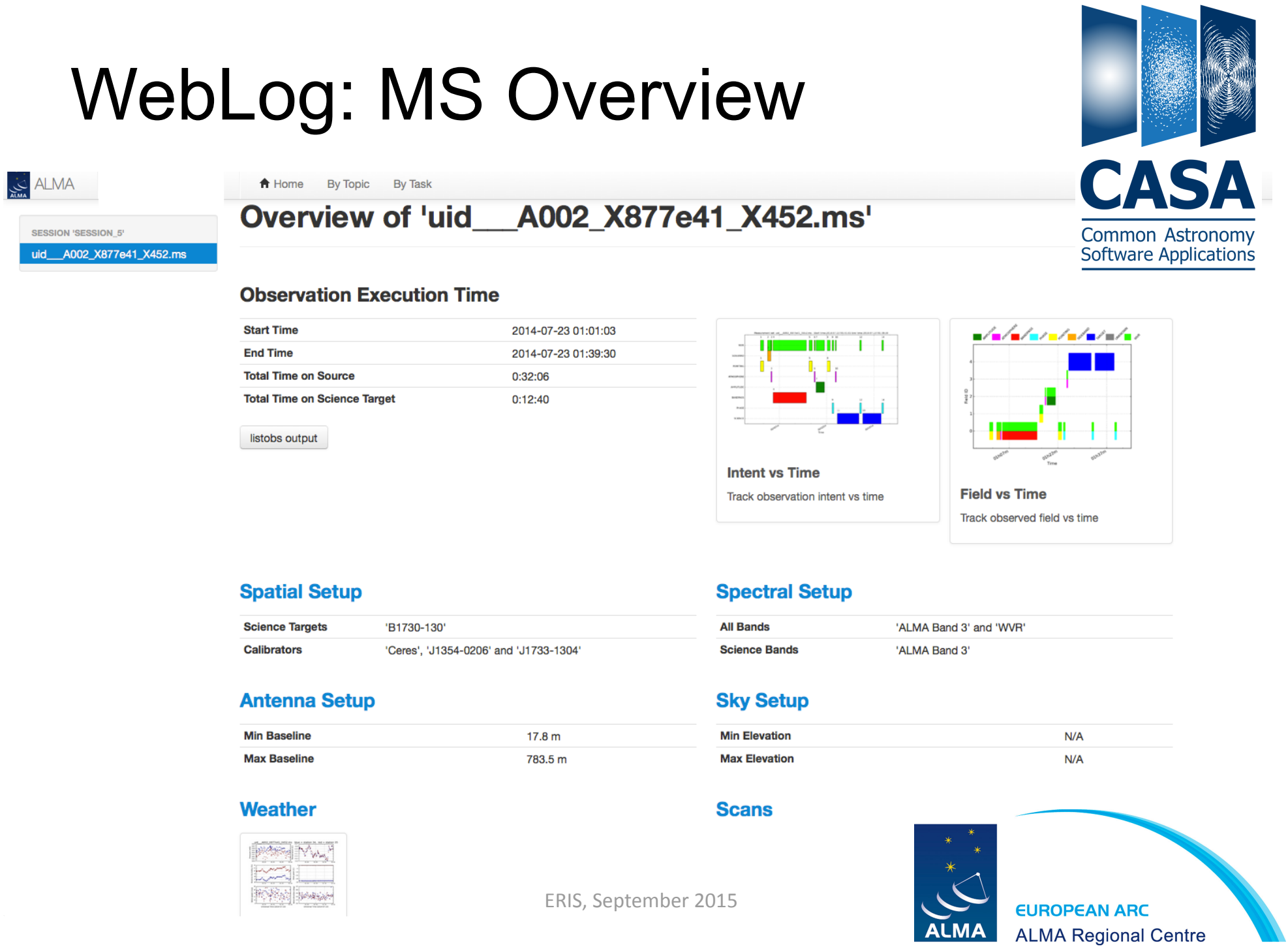
WebLog: MS Overview



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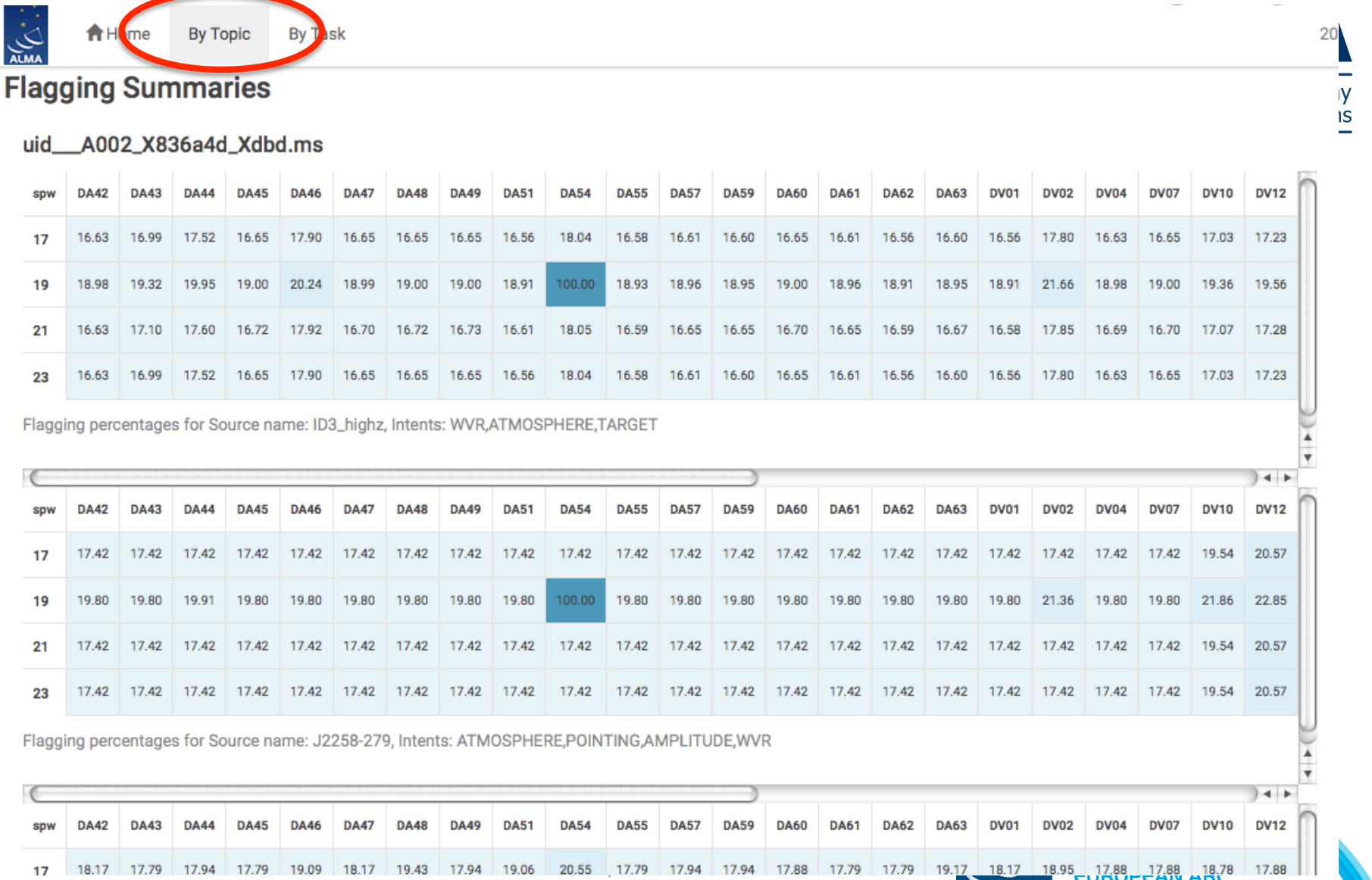
WebLog: By Topic



Home | By Topic | By Task

Flagging Summaries

uid___A002_X836a4d_Xdbd.ms

spw	DA42	DA43	DA44	DA45	DA46	DA47	DA48	DA49	DA51	DA54	DA55	DA57	DA59	DA60	DA61	DA62	DA63	DV01	DV02	DV04	DV07	DV10	DV12
17	16.63	16.99	17.52	16.65	17.90	16.65	16.65	16.65	16.56	18.04	16.58	16.61	16.60	16.65	16.61	16.56	16.60	16.56	17.80	16.63	16.65	17.03	17.23
19	18.98	19.32	19.95	19.00	20.24	18.99	19.00	19.00	18.91	100.00	18.93	18.96	18.95	19.00	18.96	18.91	18.95	18.91	21.66	18.98	19.00	19.36	19.56
21	16.63	17.10	17.60	16.72	17.92	16.70	16.72	16.73	16.61	18.05	16.59	16.65	16.65	16.70	16.65	16.59	16.67	16.58	17.85	16.69	16.70	17.07	17.28
23	16.63	16.99	17.52	16.65	17.90	16.65	16.65	16.65	16.56	18.04	16.58	16.61	16.60	16.65	16.61	16.56	16.60	16.56	17.80	16.63	16.65	17.03	17.23

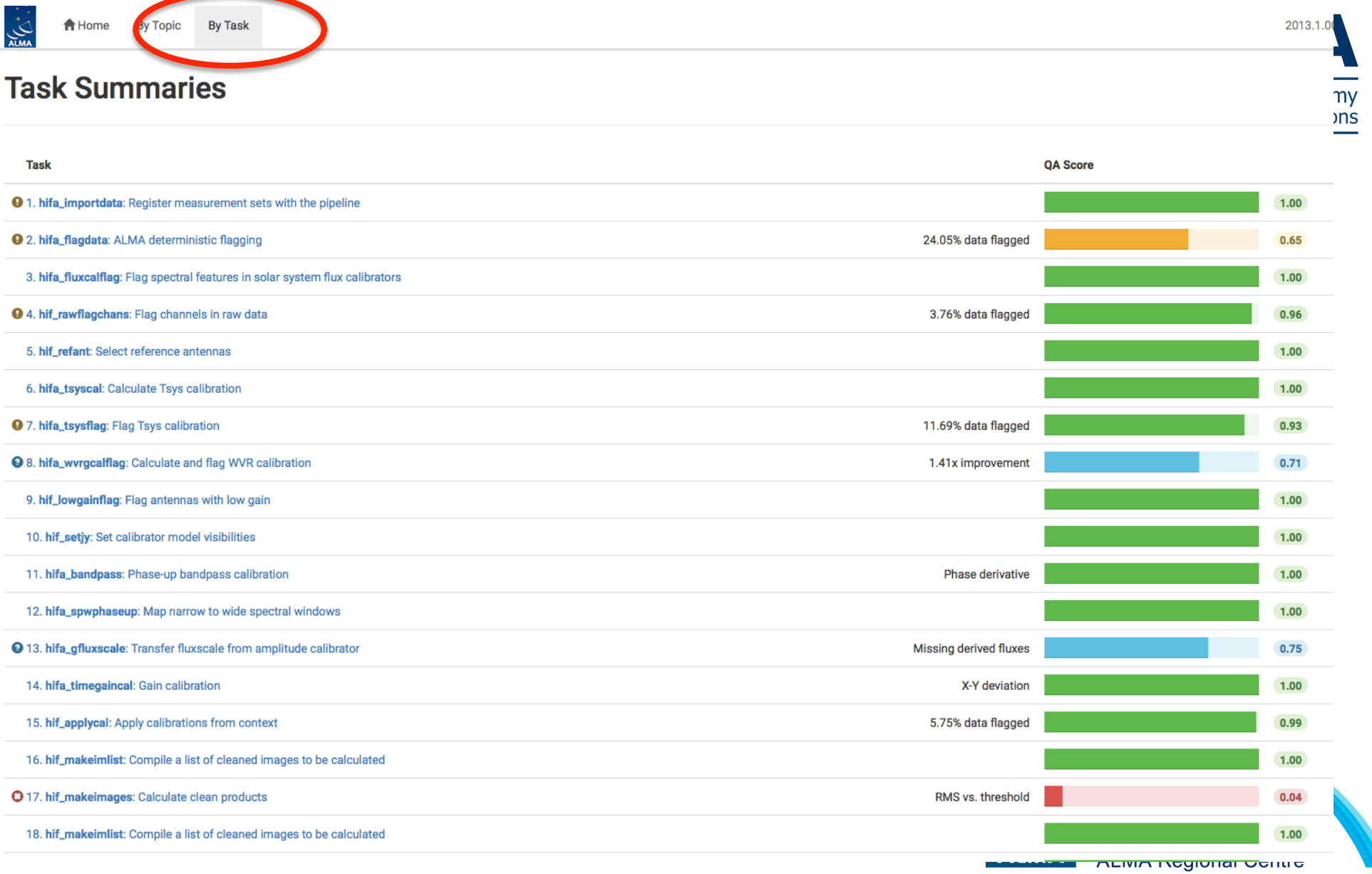
Flagging percentages for Source name: ID3_highz, Intents: WVR,ATMOSPHERE,TARGET

spw	DA42	DA43	DA44	DA45	DA46	DA47	DA48	DA49	DA51	DA54	DA55	DA57	DA59	DA60	DA61	DA62	DA63	DV01	DV02	DV04	DV07	DV10	DV12
17	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	19.54	20.57
19	19.80	19.80	19.91	19.80	19.80	19.80	19.80	19.80	19.80	100.00	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	21.36	19.80	19.80	21.86	22.85
21	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	19.54	20.57
23	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	17.42	19.54	20.57

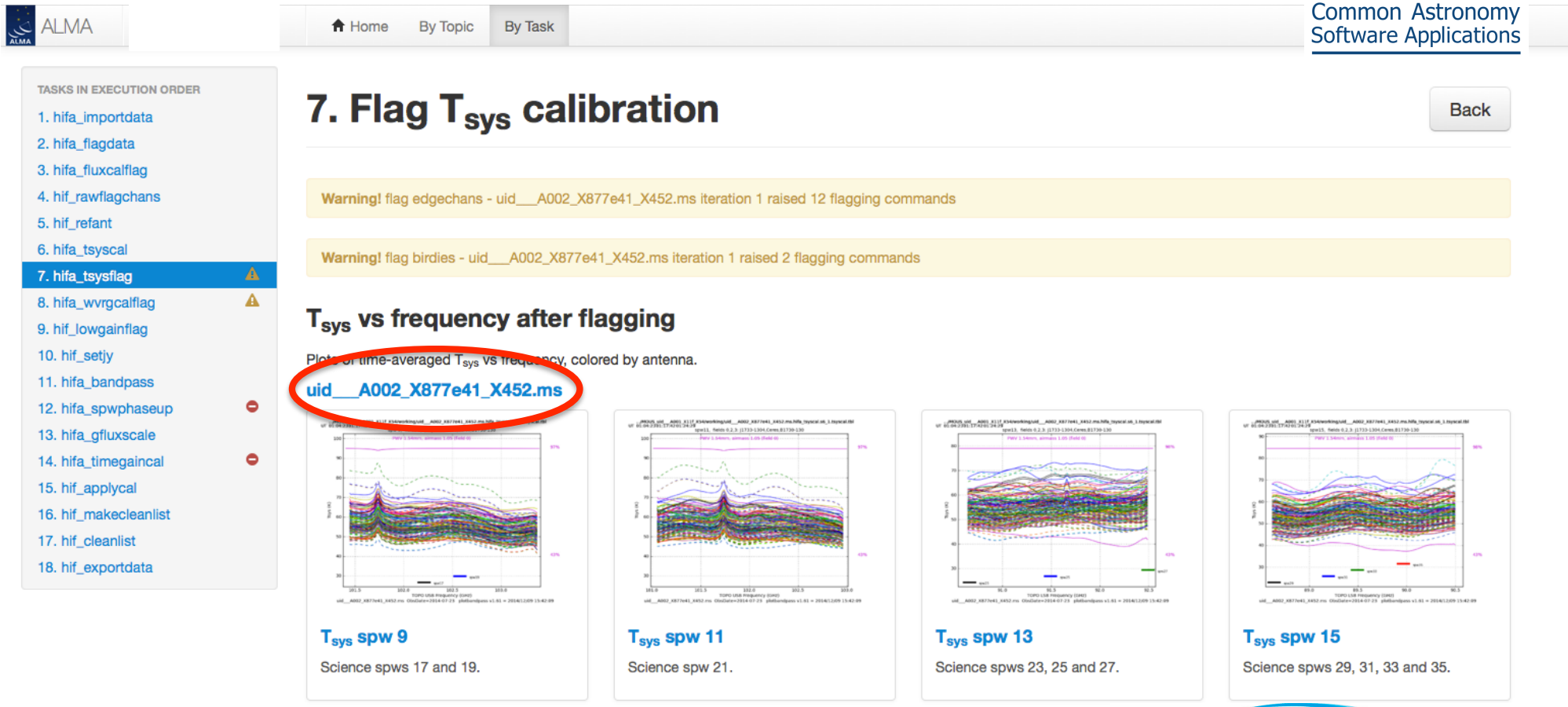
Flagging percentages for Source name: J2258-279, Intents: ATMOSPHERE,POINTING,AMPLITUDE,WVR

spw	DA42	DA43	DA44	DA45	DA46	DA47	DA48	DA49	DA51	DA54	DA55	DA57	DA59	DA60	DA61	DA62	DA63	DV01	DV02	DV04	DV07	DV10	DV12
17	18.17	17.79	17.94	17.79	19.09	18.17	19.43	17.94	19.06	20.55	17.79	17.94	17.94	17.88	17.79	17.79	19.17	18.17	18.95	17.88	17.88	18.78	17.88

WebLog: By Task



WebLog: Task Main Pages



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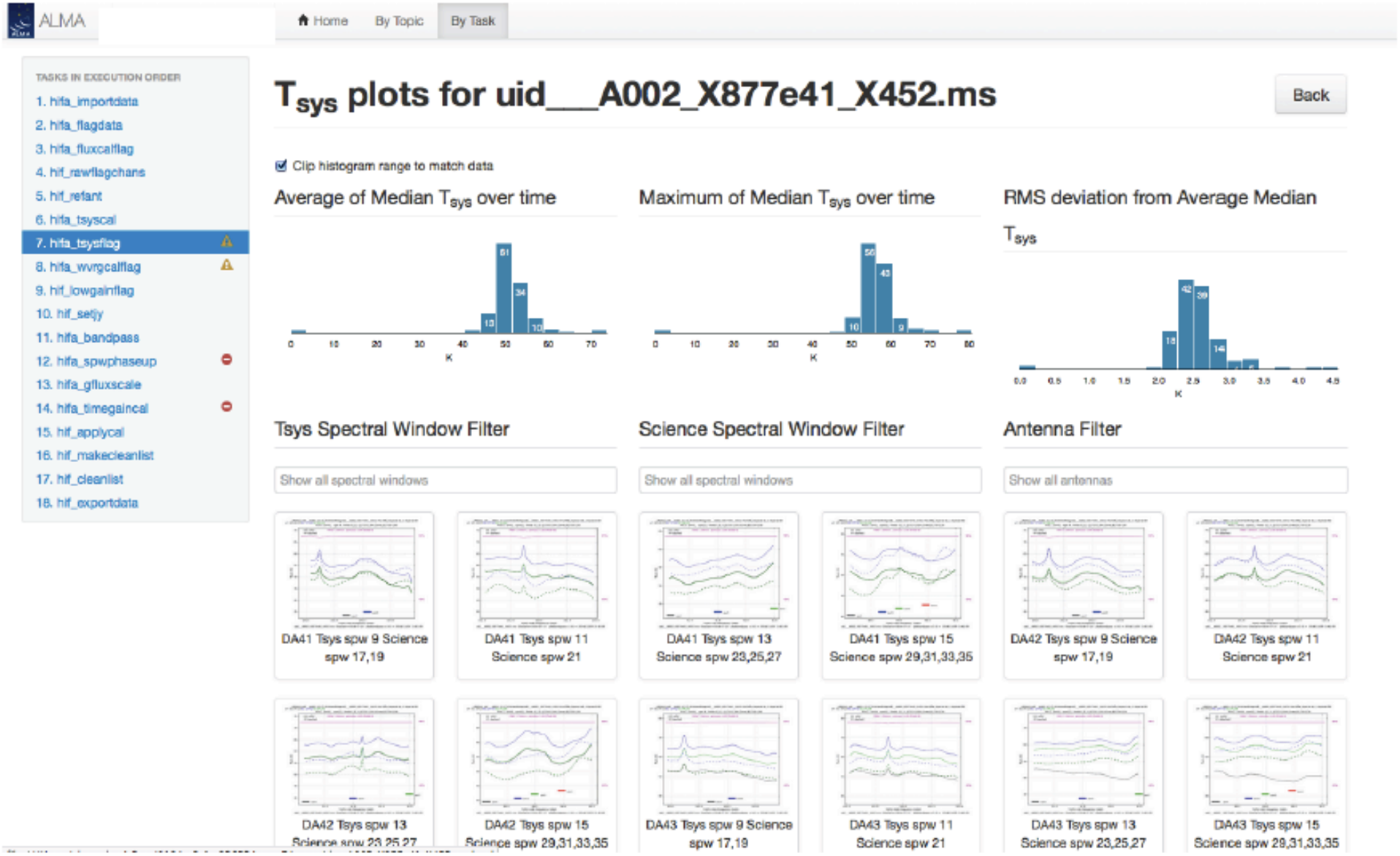
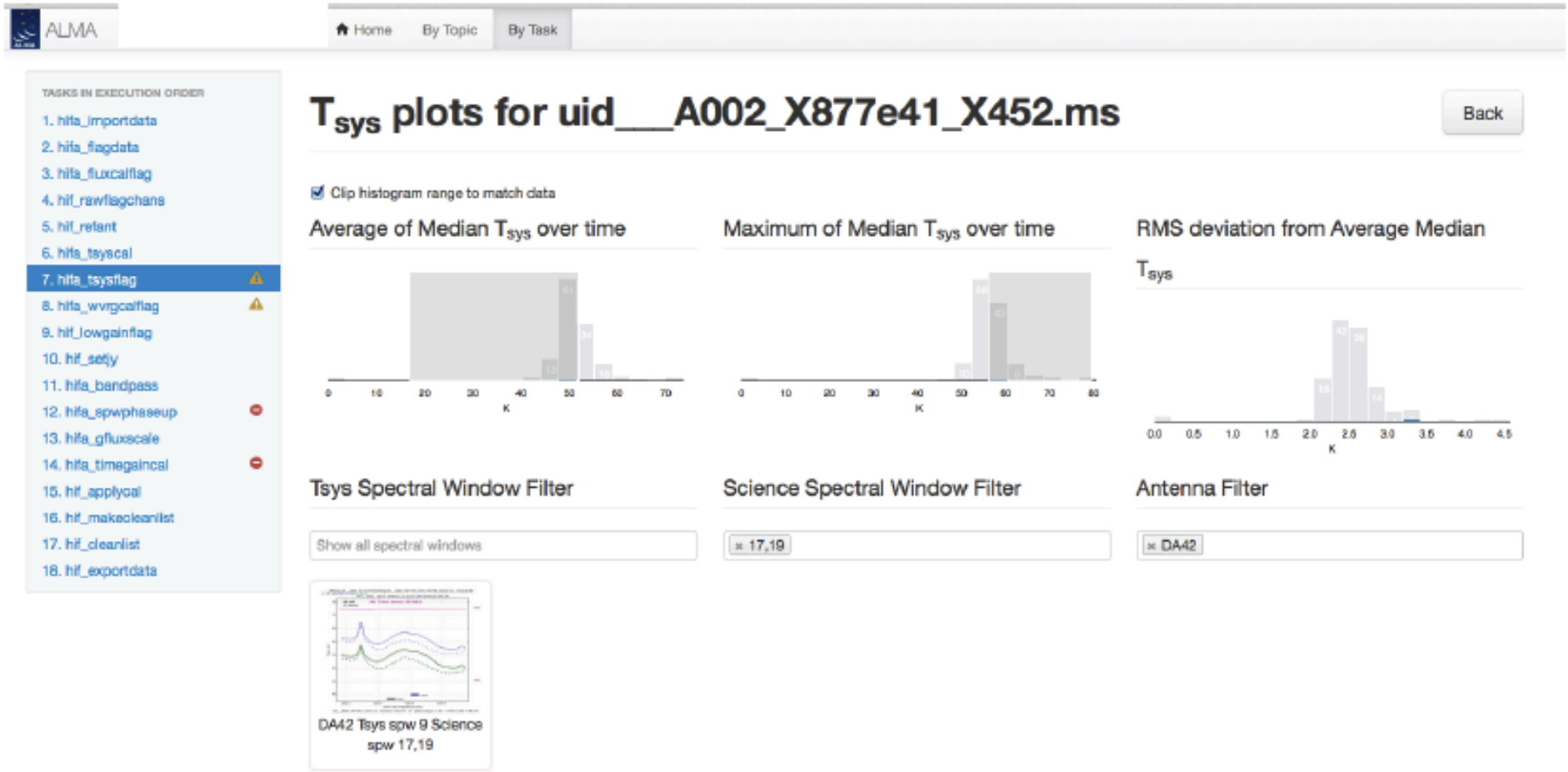
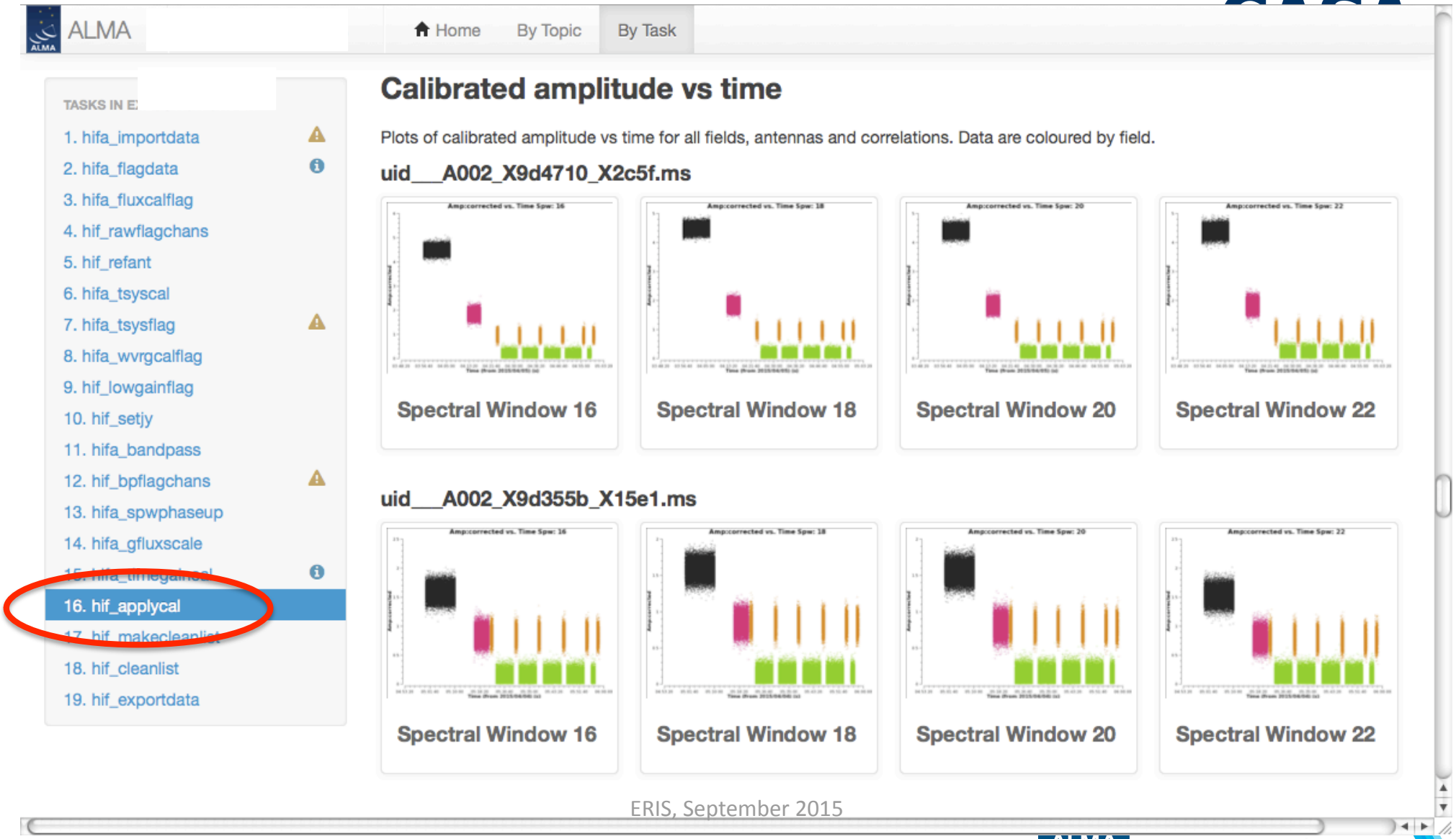
WebLog: Task Details Pages



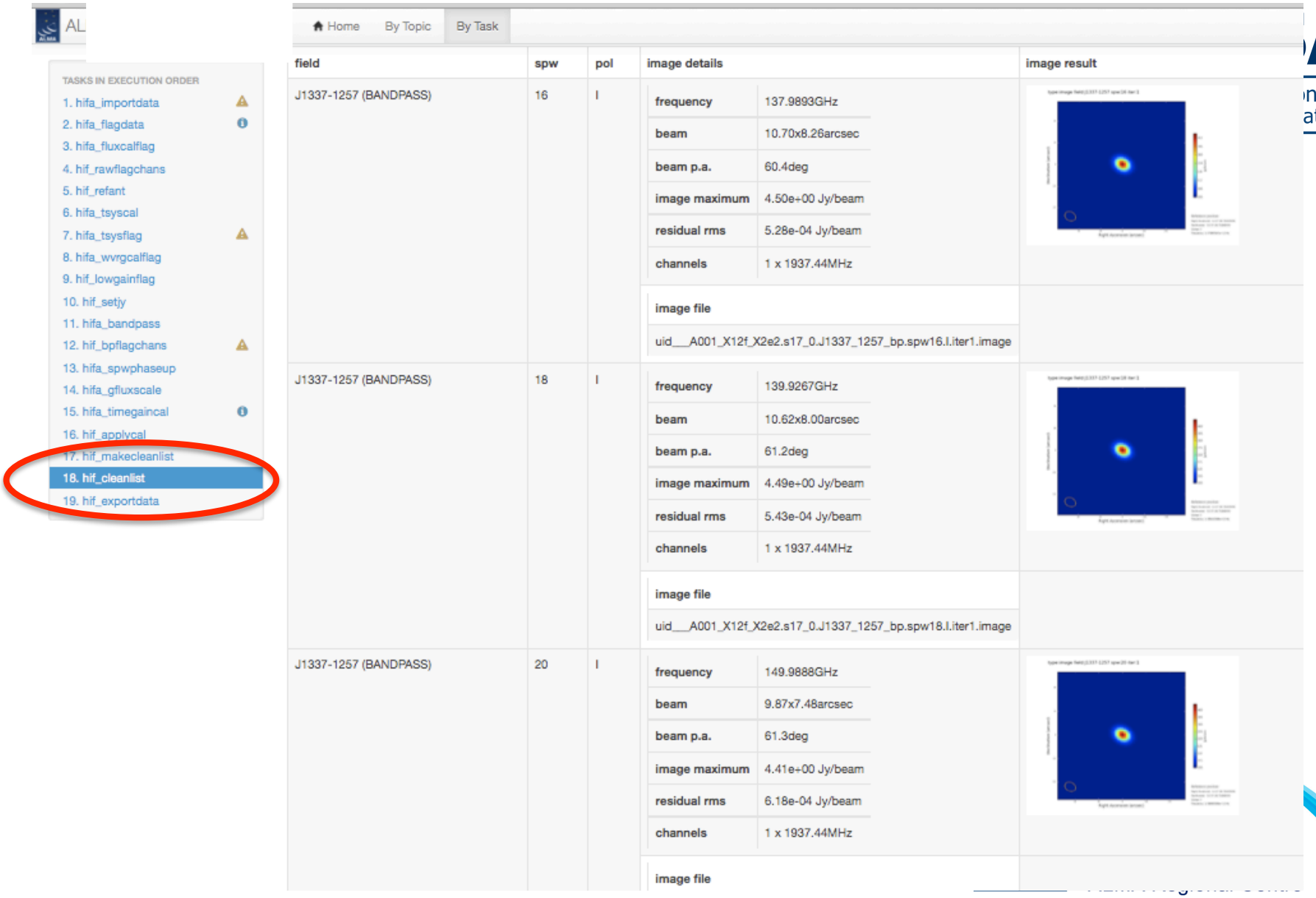
WebLog: Filtering



WebLog: Calibrated Data



WebLog: Calibrator Images



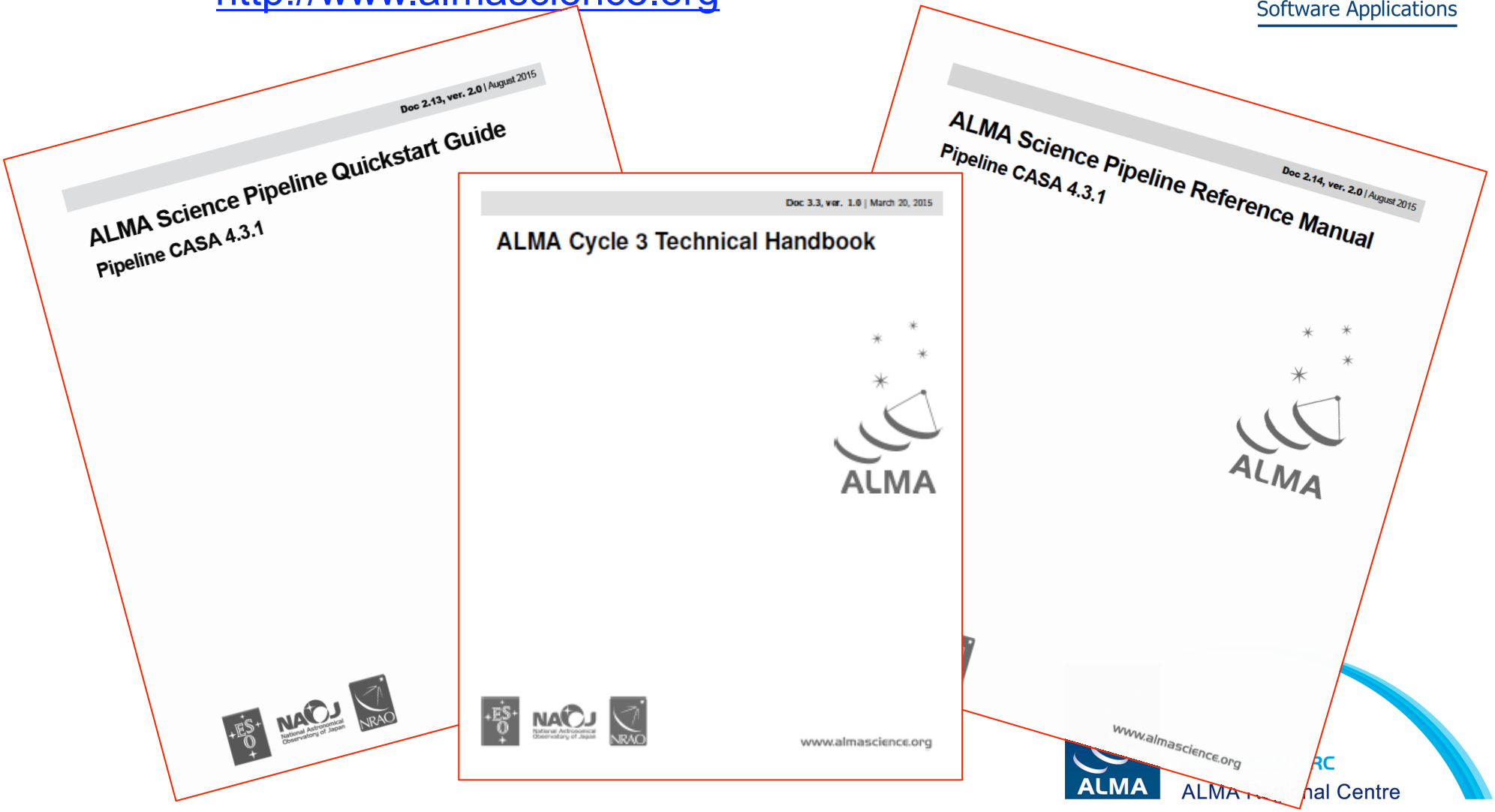
ALMA Pipeline

- Pipeline CASA 4.5 commissioned for at least:
  - 12m array calibration (<= Band 7)
  - 7m array calibration (<= Band 7)
  - Single-dish end-to-end processing

- ALMA Data Deliveries
  - (1) Keep the same calibration as Observatory
    - Use scriptForPI.py to apply calibration tables (Faster and recommended!)
  - (2) Alter the calibration
    - Use casapipescript.py (Slower)

ALMA Pipeline Information

- Available from the ALMA Science Portal
  - http://www.almascience.org



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VLA Pipeline Information

- Available from
  - https://science.nrao.edu/facilities/vla/data-processing/pipeline
  - https://science.nrao.edu/science/meetings/2014/vla-data-reduction/Pipeline_DRwkshp.pdf

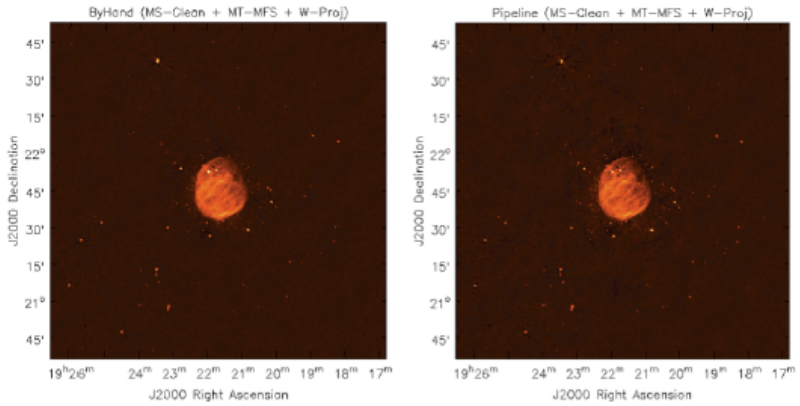
The VLA Calibration Pipeline

Data Reduction Workshop, October 2014

Claire Chandler

Atacama Large Millimeter/submil
Expanded Ver
Robert C. Byrd Green Ba
Very Long Baseline Array

Imaging comparison



Left: L-band image of G55.7+3.4 produced from data flagged and calibrated by hand; the rms noise is 11.5 μJy/beam. Right: an image made from data flagged and calibrated by the VLA calibration pipeline; the rms noise is 12.2 μJy/beam. Differences in the source structure and/or source flux density are dominated by the uncertainty in the deconvolution process, not the calibration and flagging (images provided by Urvashi Rao).

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