Atacama
Large
Millimeter /
submillimeter
Array

Preliminary Progress Report on the High Frequency Single-Dish Sideband Separation

ALMA Technical Note Number: 12

Status: FINAL

Prepared by:	**Organization:**	**Date:**
James Chibueze (NAOJ)	ALMA	12 August 2014

Report on the High Frequency Single-Dish Sideband Separation

Prepared by James Chibueze (NAOJ) v2014/8/12

Contents

Reference JIRA tickets: CSV-2365, CSV-1526

Observation details:

BAND 9:
Total number of executions: 6 (4 taken with 4 antennas, 2 taken with 3 antenna)

Software build ALMA-10_6_0-B-2014-05-28-01-00-00, 4 antennas (DA61, DA64, PM03, PM04), PWV = 0.65 mm

Project "SBsep-test_v2" (Version 2.1, code 0000.0.00085.CSV)

SB "IRAS16293-offset_-204"
Start/End: 2014-06-03T05:19:26 - 05:48:43
ExecBlock: uid://A002/X833c94/X1cb
SB "IRAS16293-offset_-178"
Start/End: 06:58:31 - 07:28:09
ExecBlock: uid://A002/X833c94/X662
SB "IRAS16293-offset_-125"
Start/End: 07:33:15 - 08:02:25
ExecBlock: uid://A002/X833c94/X976
SB "IRAS16293-offset_-17"
Start/End: 08:03:45 - 08:32:51
ExecBlock: uid://A002/X833c94/Xccf

##################################

1 hour

ALMA Build ALMA-10_6_0-B-2014-06-17-01-00-00
Antennas (3) DA61, PM03, PM04

PWV~0.7mm

SBsep-test_v2 (Version 2.1)

Project Code 0000.0.00085.CSV
PI skomugi

* 1st execution:
SchedBlock IRAS16293-offset_0
ExecBlock uid://A002/X8505d8/X15c4

* 2nd execution:
SchedBlock IRAS16293-offset_+204
ExecBlock uid://A002/X8505d8/X196f

BAND 10

Total number of executions: 6 (all taken with 2 antennas; PM03 and PM04)

2 hours

SBsep-test_v2 (Version 2.1)
Project Code 0000.0.00085.CSV
PI skomugi

ALMA Build ALMA-10_6_0-B-2014-07-09-01-00-00
Antenna used: PM03 and PM04
PWV~0.6mm

Start/End 03:11:14 - 03:46:10
SchedBlock B10_IRAS16293-offset_-204
ExecBlock uid://A002/X881d57/X59

Start/End 03:46:38 - 04:20:57
SchedBlock B10_IRAS16293-offset_0
ExecBlock uid://A002/X881d57/X1e3

Start/End 04:21:24 - 04:52:23
SchedBlock B10_IRAS16293-offset_-17
ExecBlock uid://A002/X881d57/X5ef

1 hour

ALMA Build ALMA-10_6_0-B-2014-07-30-01-00-00
Antenna used: PM03 and PM04
PWV=0.51mm

SBsep-test_v2 (Version 2.1)
Project Code 0000.0.00085.CSV

SchedBlock B10_IRAS16293-offset_-204
Start/End 03:30:49 - 04:05:20
ExecBlock uid://A002/X8867ff/X103

SchedBlock B10_IRAS16293-offset_-178
Start/End 04:05:56 - 04:40:15
ExecBlock uid://A002/X8867ff/X3f5

30 minutes

ALMA Build ALMA-10_6_0-B-2014-07-30-01-00-00
PWV=0.86mm

SBsep-test_v2 (Version 2.1)
Start/End 03:44:40 - 04:19:03
Project Code 0000.0.00085.CSV
SchedBlock B10_IRAS16293-offset_-125
ExecBlock uid://A002/X8886e3/X270

Note that the data was obtained under the not very good weather condition for B10. Please check the data quality, and let us know if we need additional data.

Known Issues:

The data were affected by ICT-3082: the first subscan in each scan was done on-source. Hence the first raster row in each scan should be flagged prior to imaging.
SysCal.xml needs to be regenerated using offline TelCal, excluding the scans which contain subscanIntent=REFERENCE. Otherwise the script generator fails. The command is tc_atmosphere(asdm='hoge', dataorigin='specauto', scans='3 6 9').
Negative Trx in Band 6 (PRTSPR-5770) was seen.
Some of the datasets especially the band 10 data were taken under bad weather conditions.

Data Calibration:
* based on the generated script
- no additional flagging was done

#SDcalibLine script

```
# ALMA Data Reduction Script

# Calibration

thesteps = []
step_title = {0: 'listobs',
              1: 'Split by antenna',
              2: 'sdlist',
              3: 'Filling the Tsys solutions in the dataset',
              4: 'Do initial flagging',
```

```
            5: 'Calibration of the data into Kelvins',
            6: 'Subtracting the baseline',
            7: 'Converting ASAP -> MS',
            8: 'Split and concatenation'}

if 'applyonly' not in globals(): applyonly = False
try:
  print 'List of steps to be executed ...', mysteps
  thesteps = mysteps
except:
  print 'global variable mysteps not set.'
if (thesteps==[]):
  thesteps = range(0,len(step_title))
  print 'Executing all steps: ', thesteps

# The Python variable 'mysteps' will control which steps
# are executed when you start the script using
#   execfile('scriptForCalibration.py')
# e.g. setting
#   mysteps = [2,3,4]# before starting the script will make the script execute
# only steps 2, 3, and 4
# Setting mysteps = [] will make it execute all steps.

import re

import filltsys

es = aU.stuffForScienceDataReduction()

if re.search('^4.2.1', casadef.casa_version) == None:
 sys.exit('ERROR: PLEASE USE THE SAME VERSION OF CASA THAT YOU USED FOR
GENERATING THE SCRIPT: 4.2.1')


# CALIBRATE_AMPLI:
# CALIBRATE_ATMOSPHERE: IRAS16293-2422,J1626-2951
# CALIBRATE_BANDPASS:
# CALIBRATE_FLUX:
# CALIBRATE_FOCUS: J1626-2951
# CALIBRATE_PHASE:
# CALIBRATE_POINTING: J1626-2951
# OBSERVE_TARGET: IRAS16293-2422
# listobs
mystep = 0
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -rf uid___A002_X8886e3_X270.ms.listobs')
```

```
  listobs(vis = 'uid___A002_X8886e3_X270.ms',
    listfile = 'uid___A002_X8886e3_X270.ms.listobs')

  aU.getTPSampling(vis = 'uid___A002_X8886e3_X270.ms', showplot = True, plotfile =
'uid___A002_X8886e3_X270.ms.sampling.png')

# Split by antenna
mystep = 1
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  for i in ['PM03', 'PM04']:
    os.system('rm -Rf uid___A002_X8886e3_X270.ms.'+i+'*')

  sd.splitant(filename = 'uid___A002_X8886e3_X270.ms',
    outprefix = 'uid___A002_X8886e3_X270.ms',
    overwrite = True)



# sdlist
mystep = 2
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM03.asap.sdlist')
  sdlist(infile = 'uid___A002_X8886e3_X270.ms.PM03.asap',
    outfile = 'uid___A002_X8886e3_X270.ms.PM03.asap.sdlist')

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM04.asap.sdlist')
  sdlist(infile = 'uid___A002_X8886e3_X270.ms.PM04.asap',
    outfile = 'uid___A002_X8886e3_X270.ms.PM04.asap.sdlist')



# Filling the Tsys solutions in the dataset
mystep = 3
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.tsys')

  gencal(vis = 'uid___A002_X8886e3_X270.ms',
    caltable = 'uid___A002_X8886e3_X270.ms.tsys',
    caltype = 'tsys')
```

```
  from recipes.almahelpers import tsysspwmap
  tsysmap = tsysspwmap(vis = 'uid___A002_X8886e3_X270.ms', tsystable =
'uid___A002_X8886e3_X270.ms.tsys')

  for i in [42]:
    filltsys.fillTsys('uid___A002_X8886e3_X270.ms.PM03.asap',
      specif = i,
      tsysif = tsysmap[i],
      mode = 'linear',
      extrap = True)

  for i in [42]:
    filltsys.fillTsys('uid___A002_X8886e3_X270.ms.PM04.asap',
      specif = i,
      tsysif = tsysmap[i],
      mode = 'linear',
      extrap = True)

  plotbandpass(caltable='uid___A002_X8886e3_X270.ms.tsys', overlay='time',
    xaxis='freq', yaxis='amp', subplot=22, buildpdf=False, interactive=False,
    showatm=True,pwv='auto',chanrange='5~123',showfdm=True,
    field='',
figfile='uid___A002_X8886e3_X270.ms.tsys.plots.overlayTime/uid___A002_X8886e3_X270.ms.tsy
s')

  es.checkCalTable('uid___A002_X8886e3_X270.ms.tsys',
msName='uid___A002_X8886e3_X270.ms', interactive=False)


# Do initial flagging
mystep = 4
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  sdflag2(infile = 'uid___A002_X8886e3_X270.ms.PM03.asap',
    specunit = 'channel',
    mode = 'manual',
    ifs = [42],
    maskflag = [[0, 119], [3960, 4079]],
    overwrite = True)

  sdflag2(infile = 'uid___A002_X8886e3_X270.ms.PM04.asap',
    specunit = 'channel',
    mode = 'manual',
    ifs = [42],
    maskflag = [[0, 119], [3960, 4079]],
    overwrite = True)
```

```
# Calibration of the data into Kelvins
mystep = 5
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM03.asap.cal')

  sdcal(infile = 'uid___A002_X8886e3_X270.ms.PM03.asap',
    calmode = 'ps',
    iflist = [42],
    scanaverage = False,
    timeaverage = False,
    polaverage = False,
    outfile = 'uid___A002_X8886e3_X270.ms.PM03.asap.cal',
    overwrite = True)

  es.SDcheckSpectra('uid___A002_X8886e3_X270.ms.PM03.asap.cal', spwIds='42',
interactive=False)

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM04.asap.cal')

  sdcal(infile = 'uid___A002_X8886e3_X270.ms.PM04.asap',
    calmode = 'ps',
    iflist = [42],
    scanaverage = False,
    timeaverage = False,
    polaverage = False,
    outfile = 'uid___A002_X8886e3_X270.ms.PM04.asap.cal',
    overwrite = True)

  es.SDcheckSpectra('uid___A002_X8886e3_X270.ms.PM04.asap.cal', spwIds='42',
interactive=False)



# Subtracting the baseline
mystep = 6
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl')

  sdbaseline(infile = 'uid___A002_X8886e3_X270.ms.PM03.asap.cal',
    iflist = [42],
    maskmode = 'auto',
```

```
    thresh = 5.0,
    avg_limit = 4,
    blfunc = 'poly',
    order = 1,
    outfile = 'uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl',
    overwrite = True)

  es.SDcheckSpectra('uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl', spwIds='42',
interactive=False)

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl')

  sdbaseline(infile = 'uid___A002_X8886e3_X270.ms.PM04.asap.cal',
    iflist = [42],
    maskmode = 'auto',
    thresh = 5.0,
    avg_limit = 4,
    blfunc = 'poly',
    order = 1,
    outfile = 'uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl',
    overwrite = True)

  es.SDcheckSpectra('uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl', spwIds='42',
interactive=False)



# Converting ASAP -> MS
mystep = 7
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl.ms')

  sdsave(infile = 'uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl',
    outfile = 'uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl.ms',
    outform = 'MS2')

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl.ms')

  sdsave(infile = 'uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl',
    outfile = 'uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl.ms',
    outform = 'MS2')



# Split and concatenation
mystep = 8
```

```
if(mystep in thesteps):
  casalog.post('Step '+str(mystep)+' '+step_title[mystep],'INFO')
  print 'Step ', mystep, step_title[mystep]

  os.system('rm -Rf uid___A002_X8886e3_X270.ms.cal')

  concat(vis = [ \
     'uid___A002_X8886e3_X270.ms.PM03.asap.cal.bl.ms', \
     'uid___A002_X8886e3_X270.ms.PM04.asap.cal.bl.ms' ], \
   concatvis = 'uid___A002_X8886e3_X270.ms.cal')
```

Sideband Separation Results

Catepory A:

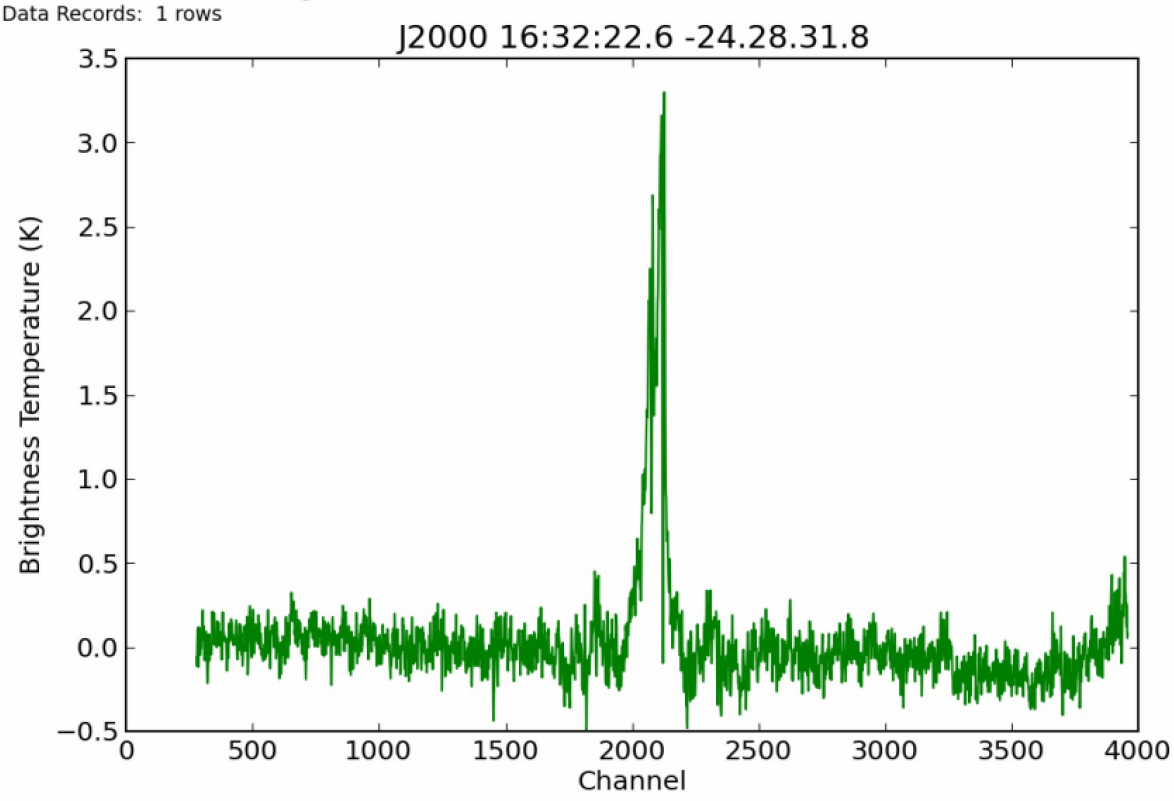
Performed with scantables from the same antenna but with different offsets.

Parameters:

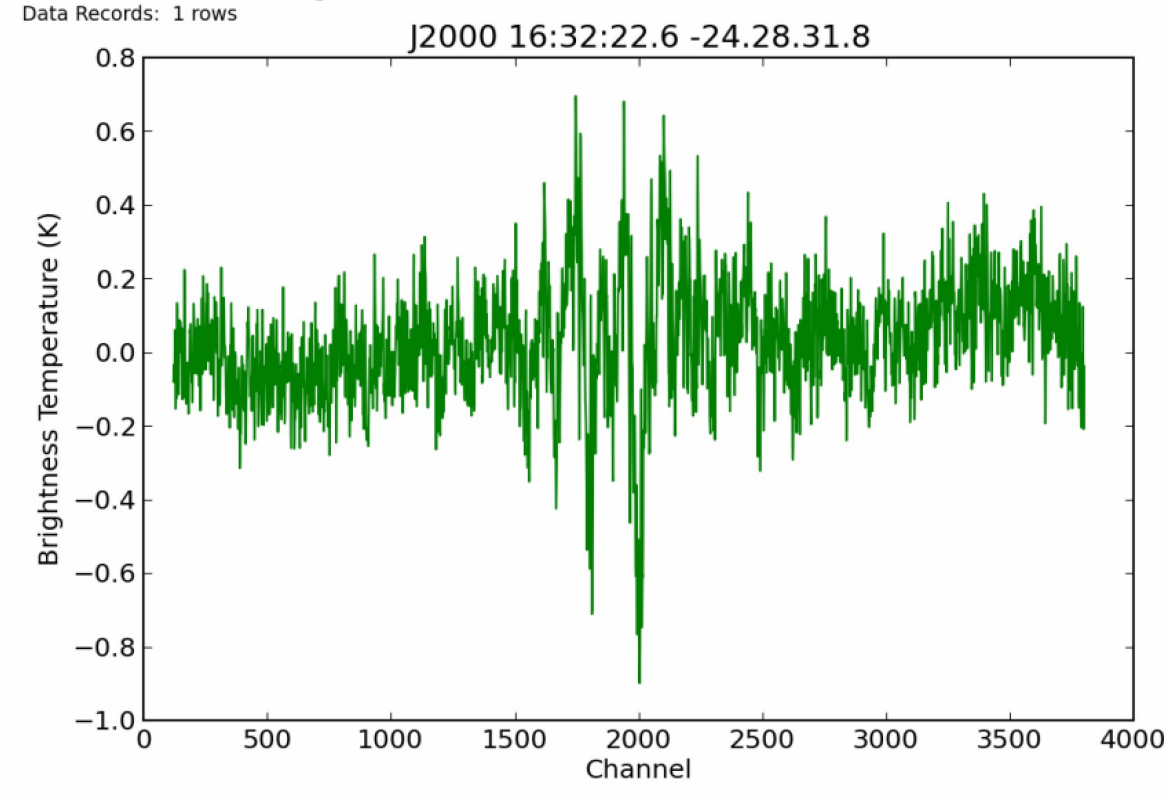
```
infiles=['uid___A002_X833c94_X1cb.ms.DA61.asap.cal.bl',
'uid___A002_X833c94_X662.ms.DA61.asap.cal.bl','uid___A002_X833c94_X976.ms.DA61.asap.c
al.bl','uid___A002_X833c94_Xccf.ms.DA61.asap.cal.bl','uid___A002_X8505d8_X15c4.ms.DA61.
asap.cal.bl','uid___A002_X8505d8_X196f.ms.DA61.asap.cal.bl']
sep = sd.sbseparator(infiles)
sep.set_frequency(42, 500, frame='TOPO')
sep.set_dirtol(dirtol=['2arcsec', '2arcsec'])
sep.set_limit(0.2)
sep.set_both(True)
sep.separate('DA_paramset_1.asap')
# profile maps
sdplot('DA_paramset_1.asap.imageband', plottype='grid', subplot=66,
outfile='DA_paramset_1.asap.imageband.png')
sdplot('DA_paramset_1.asap.signalband', plottype='grid', subplot=66,
outfile='DA_paramset_1.asap.signalband.png')
```

A number of variations of the sdplot were also carried out and compared.

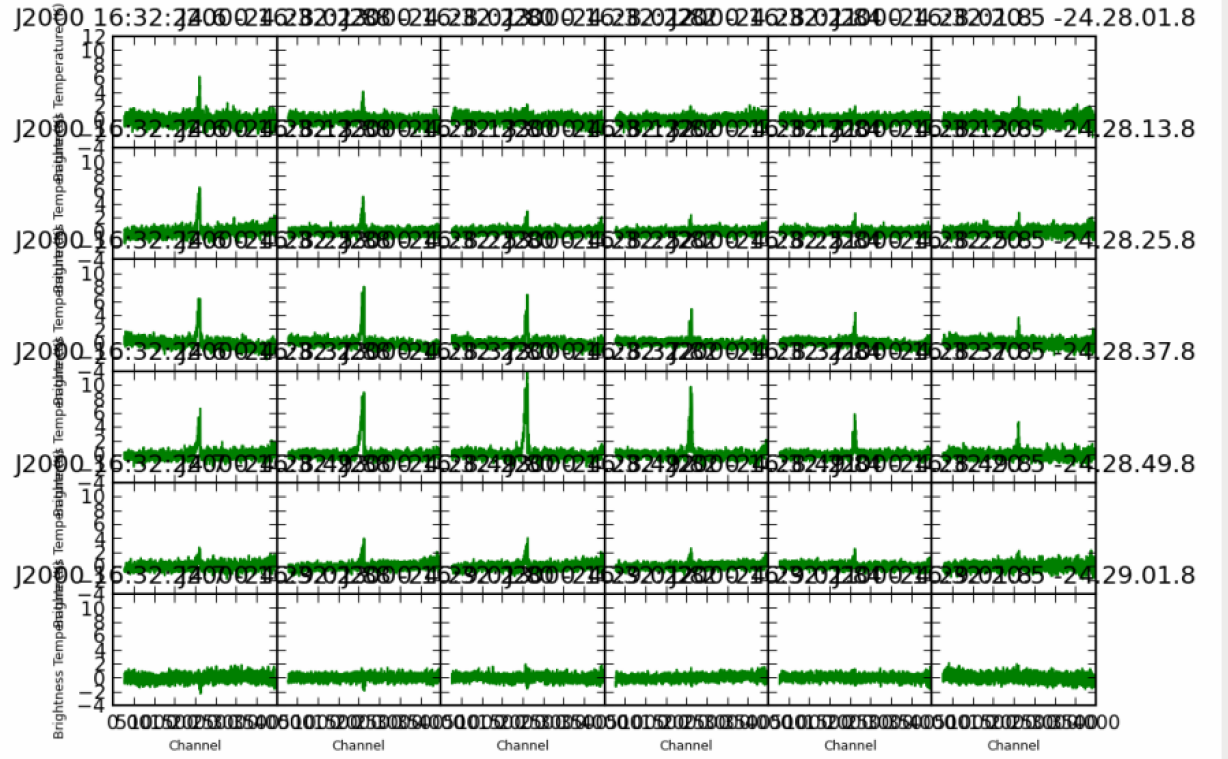
Data File: DA_paramset_1.asap.signalband(gridded)
Project: uid://A002/X5d9e5c/X72
Obs Date: 2014/06/03/05:19:27
Observer: skomugi
Antenna Name: ALMA//DA61@A075
Data Records: 1 rows
Obs.Type: CALIBRATE_POINTING#ON_SOURCE,CALIBRATE_WVR#ON_SOURCE
Beams: 1
IFs: 44
Polarisations: 1 (linear)
Channels: 4080
IFNO: [42]
BEAMNO: [0]
POLNO: [0]Sort Order: ['IFNO', 'POLNO']



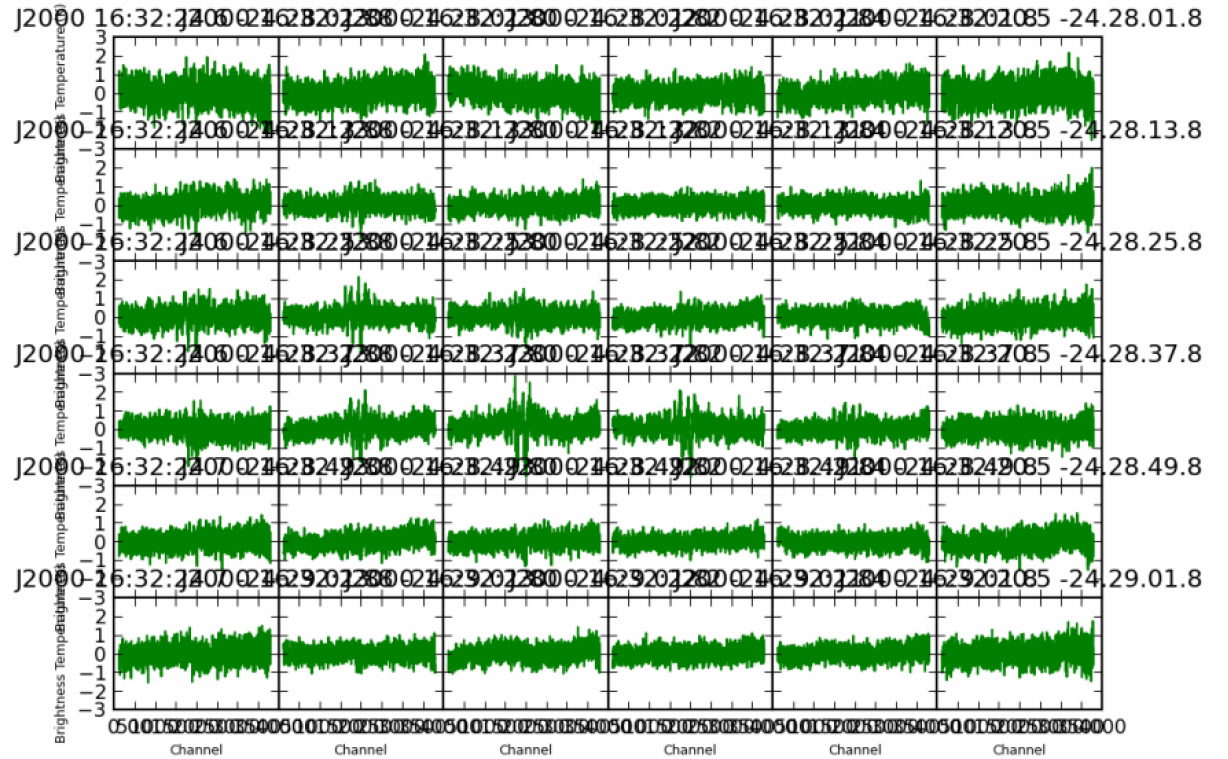
Data File: DA_paramset_1.asap.imageband(gridded)
Project: uid://A002/X5d9e5c/X72
Obs Date: 2014/06/03/05:19:27
Observer: skomugi
Antenna Name: ALMA//DA61@A075
Data Records: 1 rows
Obs.Type: CALIBRATE_POINTING#ON_SOURCE,CALIBRATE_WVR#ON_SOURCE
Beams: 1
IFs: 44
Polarisations: 1 (linear)
Channels: 4080
IFNO: [42]
BEAMNO: [0]
POLNO: [0]Sort Order: ['IFNO', 'POLNO']



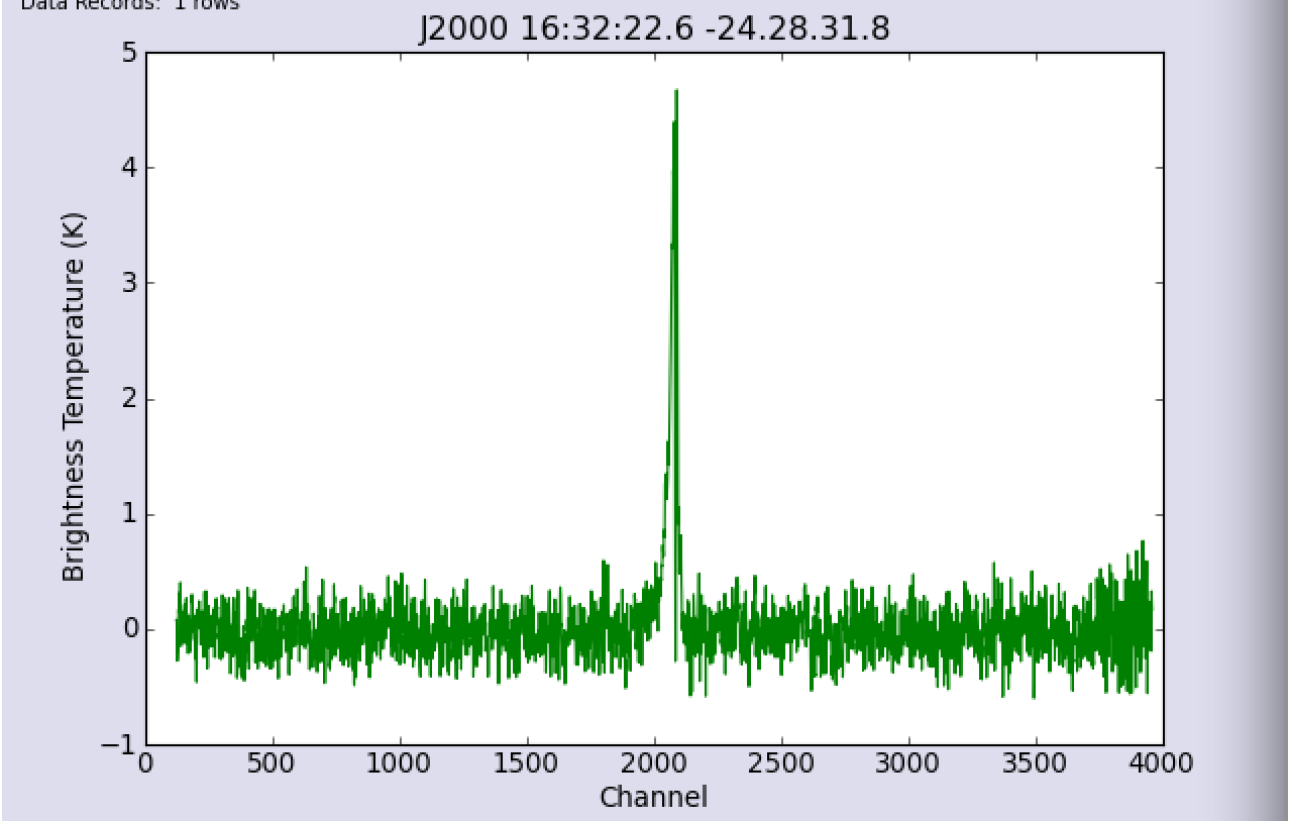
Data File: PM03_paramset_1.asap.signalband.sdfits Obs Type: CALIBRATE_POINTING#ON_SOURCE,CALIBRATE_WVR#ON_SOURCE
Project: uid://A002/X5d9e5c/X72 Beams: 1 IFNO: [42]
Obs Date: 2014/06/03/05:19:27 IFs: 44 BEAMNO: [0]
Observer: skomugi Polarisations: 1 (linear) POLNO: [0]Sort Order: ['IFNO', 'POLNO']
Antenna Name: ALMA//PM03@T701 Channels: 4080
Data Records: 36 rows



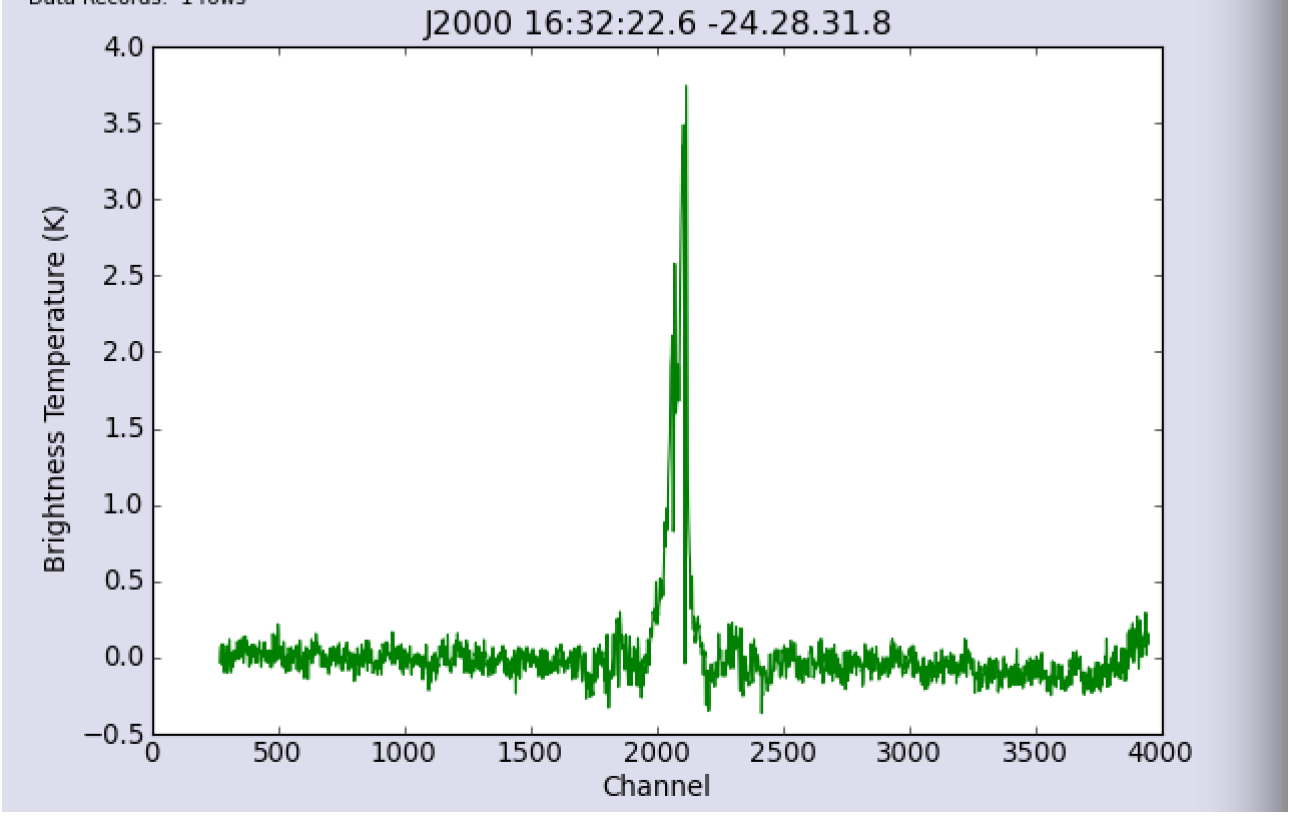
Data File: DA_paramset_1.asap.imageband.sdfits Obs Type: CALIBRATE_POINTING#ON_SOURCE,CALIBRATE_WVR#ON_SOURCE
Project: uid://A002/X5d9e5c/X72 Beams: 1 IFNO: [42]
Obs Date: 2014/06/03/05:19:27 IFs: 44 BEAMNO: [0]
Observer: skomugi Polarisations: 1 (linear) POLNO: [0]Sort Order: ['SCANNO', 'POLI
Antenna Name: ALMA//DA61@A075 Channels: 4080
Data Records: 36 rows



Data File: uid__A002_X833c94_X976.ms.PM03.type.asap.calibrated
Project: uid://A002/X5d9e5c/X72
Obs Date: 2014/06/03/07:33:16
Observer: skomugi
Antenna Name: ALMA//PM03@T701
Data Records: 1 rows
Beams: 1
IFs: 44
Polarisations: 1 (linear)
Channels: 4080
IFNO: [42]
BEAMNO: [0]
POLNO: [0]Sort Order: ['IFNO', 'POLNO']



Data File: all_ant_paramset_1.asap.signal
Project: uid://A002/X5d9e5c/X72
Obs Date: 2014/06/03/06:58:32
Observer: skomugi
Antenna Name: ALMA//DA61@A075
Data Records: 1 rows
Beams: 1
IFs: 44
Polarisations: 1 (linear)
Channels: 4080
IFNO: [42]
BEAMNO: [0]
POLNO: [0]Sort Order: ['IFNO', 'POLNO']



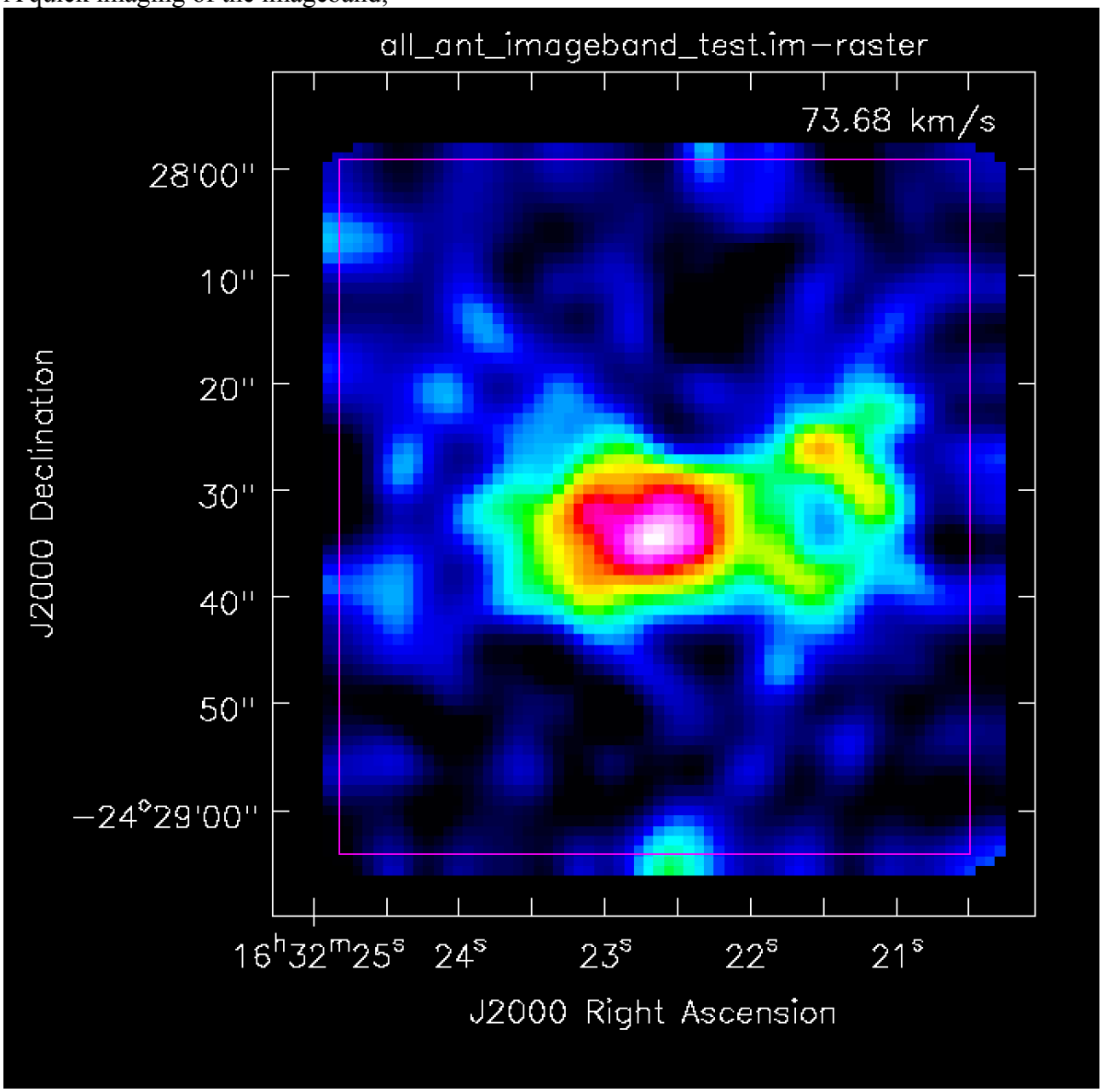
The ratio of signalband peak to imageband peak, S/I, is 5.3.

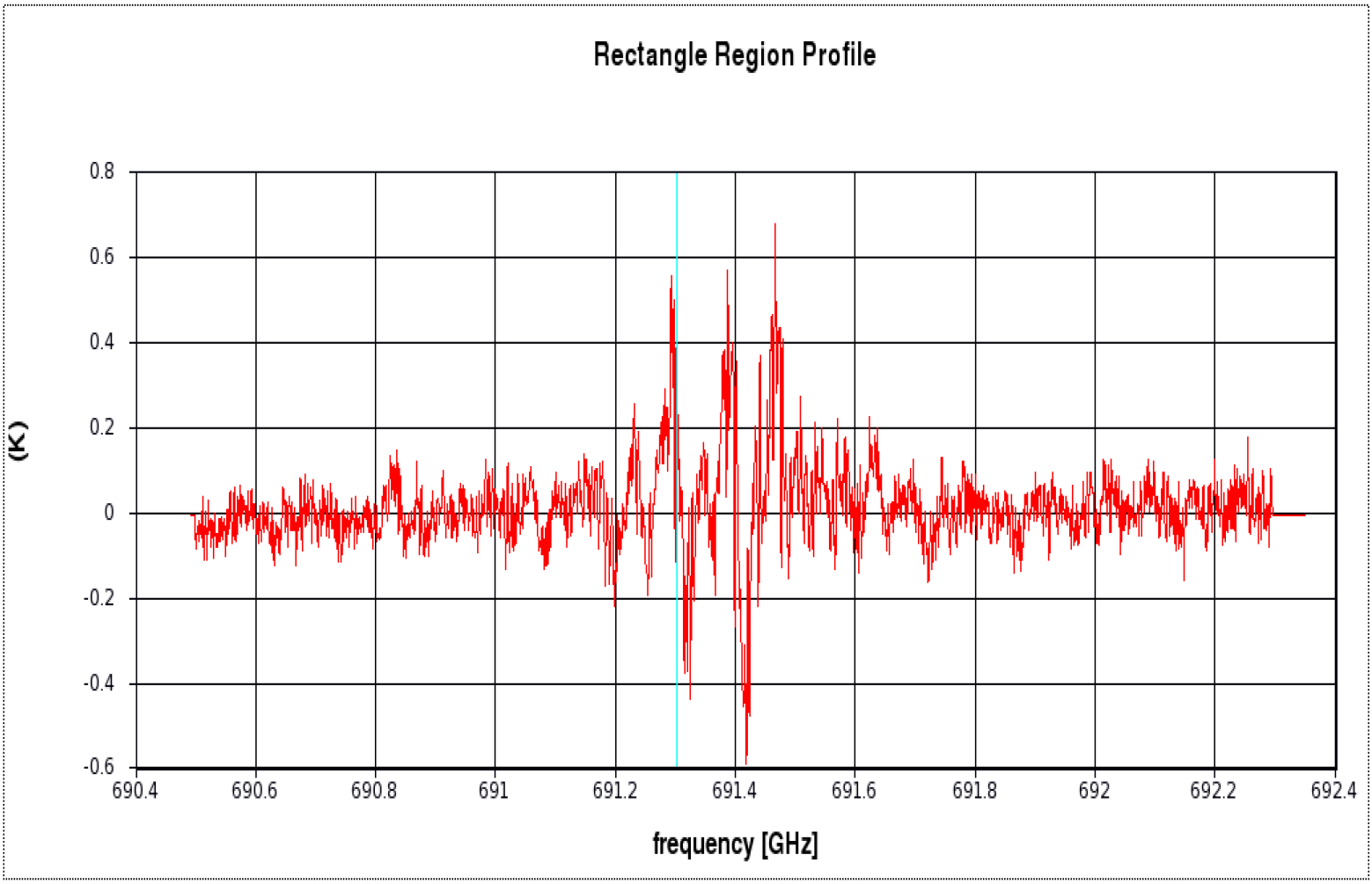
Increasing the rejection ratio by set_limit(0.4), S/I dropped to 4.1.

Recommended choice of set_limit is 0.2 or 0.1. Using 0.2 produces slightly better results compared to results when 0.1 was adopted. The imageband spactra looks noisier when 0.1 was adopted, but the signalband is similar to the case of 0.2.

The noise level decreased by a factor of 2, from ~0.5 K to ~0.2 K, after sideband separation.

A quick imaging of the imageband;





Band 10 SD separator task failed, I am inquiring of a work around and will update this report accordingly.