

Exercise 3: Pixel Tracking with Sarproz in a toy example

Sarproz processing tutorial series

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Pixel Tracking with Sarproz

2018-Mar-27: In this tutorial, we demo a toy example showing how to do pixel tracking with Sarproz. **Please note that:**

1. A more functional pixel tracking module is currently under development. While waiting for its release, hereafter we show that we can already do some preliminary analysis;
2. This example has been processed with Sentinel-1 data. Sentinel orbits are precise enough to allow connecting the estimated images shifts to movement. If you want to use other data, you have to correct for orbital shifts.

Downloading Sample Data

- S1A_IW_SLC__1SDH_20170126T094350_20170126T094417_015001_0187FF_0006
- S1A_IW_SLC__1SDH_20170207T094350_20170207T094417_015176_018D60_1115
- S1B_IW_SLC__1SSH_20170213T094308_20170213T094335_004280_0076CC_8792

Part 1:

Tune coregistration parameters

MATLAB R2016a

HOME PLOTS APPS

Search Documentation

/ home yuxiao Documents pcodes

No new images to update!!!

3 images selected with HH polarization

2 SENTINEL-1A, 1 SENTINEL-1B
Mixed Multiple Polarizations

leggi_srtm: Warning! file /data3/P/TEST/./SRTM/N69W050.hgt is all zeros!!

Chosen Master: 20170207
Polarization: DUAL, HH HV

You cannot modify the area in Update Mode

leggi_srtm: Warning! file /data3/P/TEST/./SRTM/N69W050.hgt is all zeros!!

Run Google Earth manually

File /data3/P/TEST/EXT/20170126/20170126*HH.slc not found

File /data3/P/TEST/EXT/20170213/20170213*HH.slc not found

Processing the SLC data Preparation

Using 8 workers

Extracting Slave Images

SLC data extraction

Extract Slave from a different look: date 20170126...Done.

Extract Slave from a different look: date 20170213...Done.

The Processing concluded successfully, here a specific message:

Workspace

Δt

$\Delta t \exp$

$K(t_1 -$

SLC DATA Processing

SLC Data List

Get Contents ☒ Untar 2 SENTINEL-1A, 1 SENTINEL-1B
☒ Del tar Mixed Multiple Polarizations

Channel Selection

Polarization HH Subswath 3 Go

Data Selection

Single Image

☒ All ☐ Update Get Weather

☒ Ext. Orb. Set Orbits View Footprints View Parameters

☒ Deskewed

Master Selection

20170207
No rain/snow during the day

Area Selection

Latitude	Longitude	Radius [km]	Max Area
69.15	-49.55	20	<input type="checkbox"/>

	Samples	Lines	Rg OVS	Az OVS
Size	6440	3050	1	1
Final	6440	3050	View	

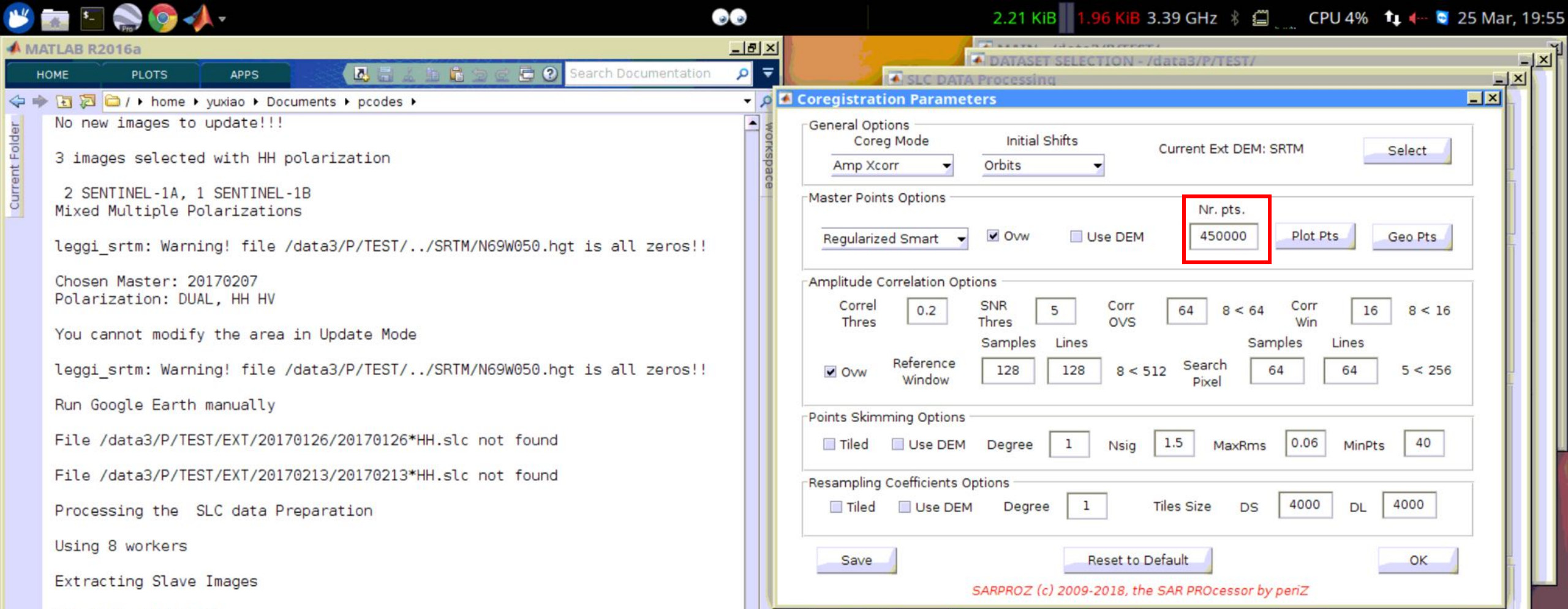
Data Processing

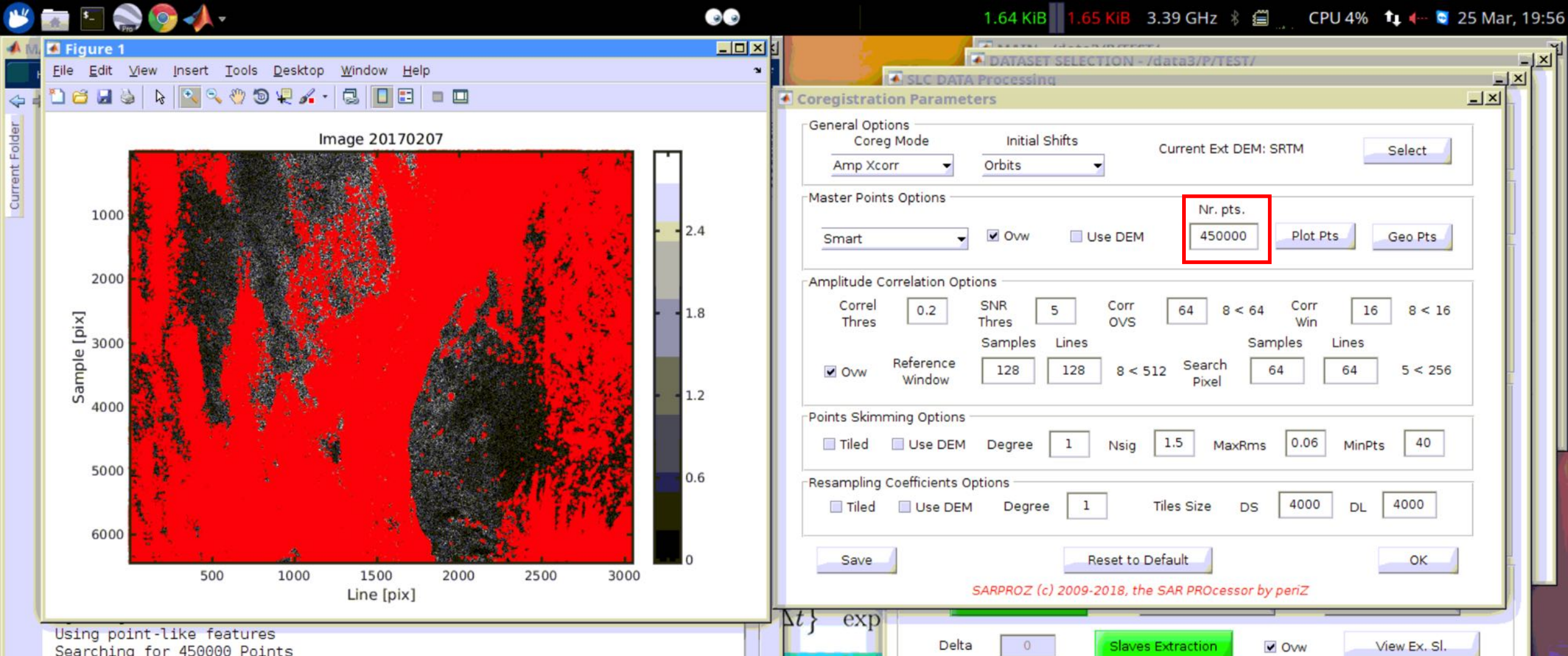
Master Extraction View Master Stop [single img]

Delta 0 Slaves Extraction ☒ Ovw View Ex. Sl.

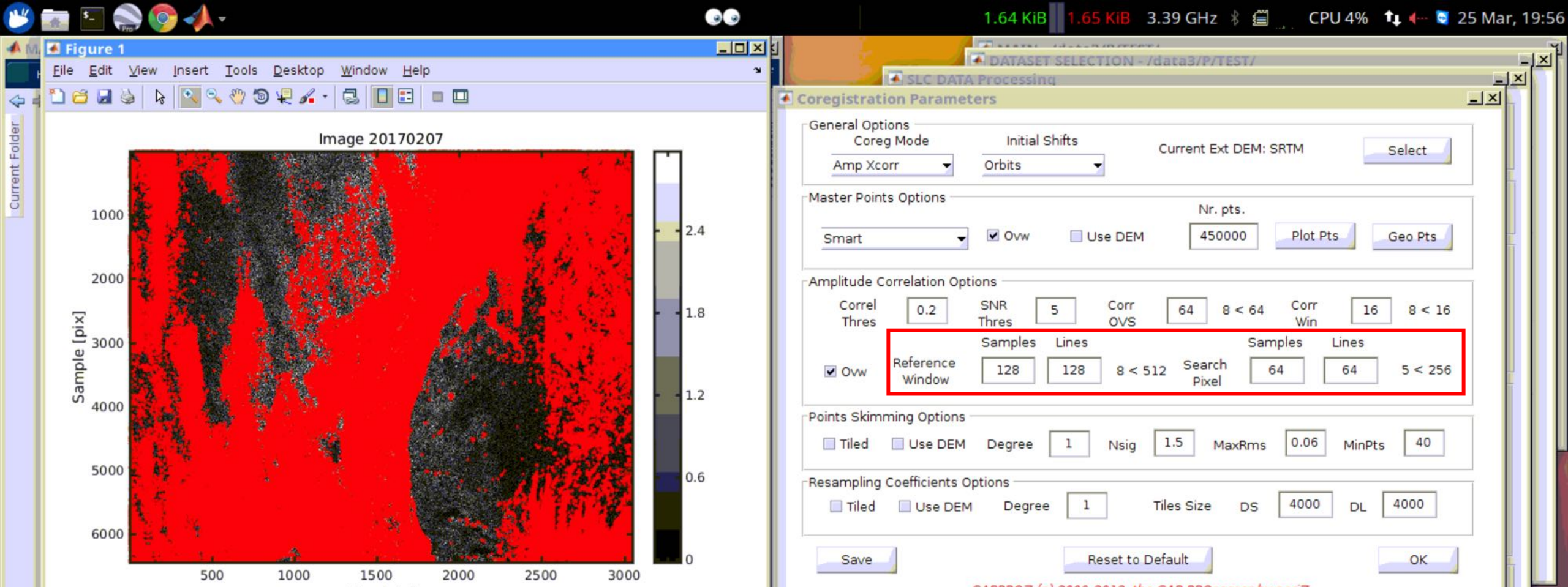
Co-reg. param. Co-registration View Co-reg. Sl.

1. If you use the SLC data given in the previous slide, then select the subswath, master and area according to the values given on this page. Extract master and slave.

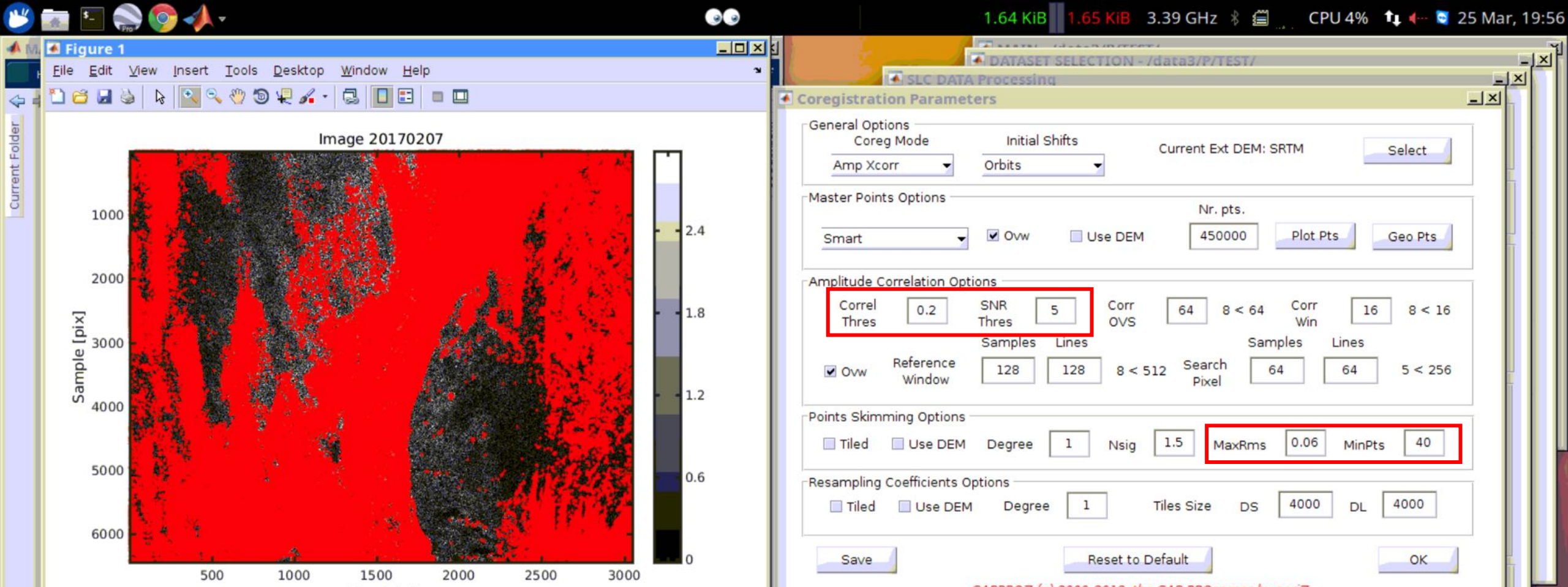




3. After selected the master chosen option and number of points, click “Save” and then click “Plot Pts” to see the points you selected for pixel tracking purpose. If you need to try different options for several times, check “Ovw (overwrite)”.



4. It is suggested to get a basic understanding of the movement magnitude of your AOI. If your area have very strong movement (e.g., ice sheet flow), it is suggested to increase the size of both reference window and search pixel. This will increase the success rate of coregistration. Areas with large pixel offset also requires larger window size (that is at least as large as the pixel offset value).



5. In cases where coregistration fail despite of an increasing window size, try relax the following restrictions: correlation threshold(Correl Thres), SNR threshold(SNR Thres), maximum RMS(MaxRms) and minimum points(MinPts). You might need to try a few different parameters for coregistration to succeed, especially for areas with large pixel offset.

Figure 1

File Edit View Insert Tools Desktop Window Help

Image 20170207

Sample [pix] 1000 2000 3000 4000 5000 6000

Line [pix] 500 1000 1500 2000 2500 3000

Using point-like features
Searching for 450000 Points

get_master_pts: 240236 points selected

The Processing concluded successfully, here a specific message:

Get Master Points: job ended
Elapsed Time: 2 seconds
25-Mar-2018 19:56:00

SLC DATA Processing

Coregistration Parameters

General Options
Coreg Mode: Amp Xcorr Initial Shifts: Orbits Current Ext DEM: SRTM Select

Master Points Options
Smart Ovw Use DEM Nr. pts. 450000 Plot Pts Geo Pts

Amplitude Correlation Options
Correl Thres 0.2 SNR Thres 5 Corr OVS 64 8 < 64 Corr Win 16 8 < 16
Ovw Reference Window Samples 128 Lines 128 8 < 512 Search Pixel 64 64 5 < 256

Points Skimming Options
Tiled Use DEM Degree 1 Nsig 1.5 MaxRms 0.06 MinPts 40

Resampling Coefficients Options
Tiled Use DEM Degree 1 Tiles Size DS 4000 DL 4000

Save Reset to Default OK

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Slaves Extraction Ovw View Ex. Sl.

Co-reg. param. Co-registration View Co-reg. Sl.

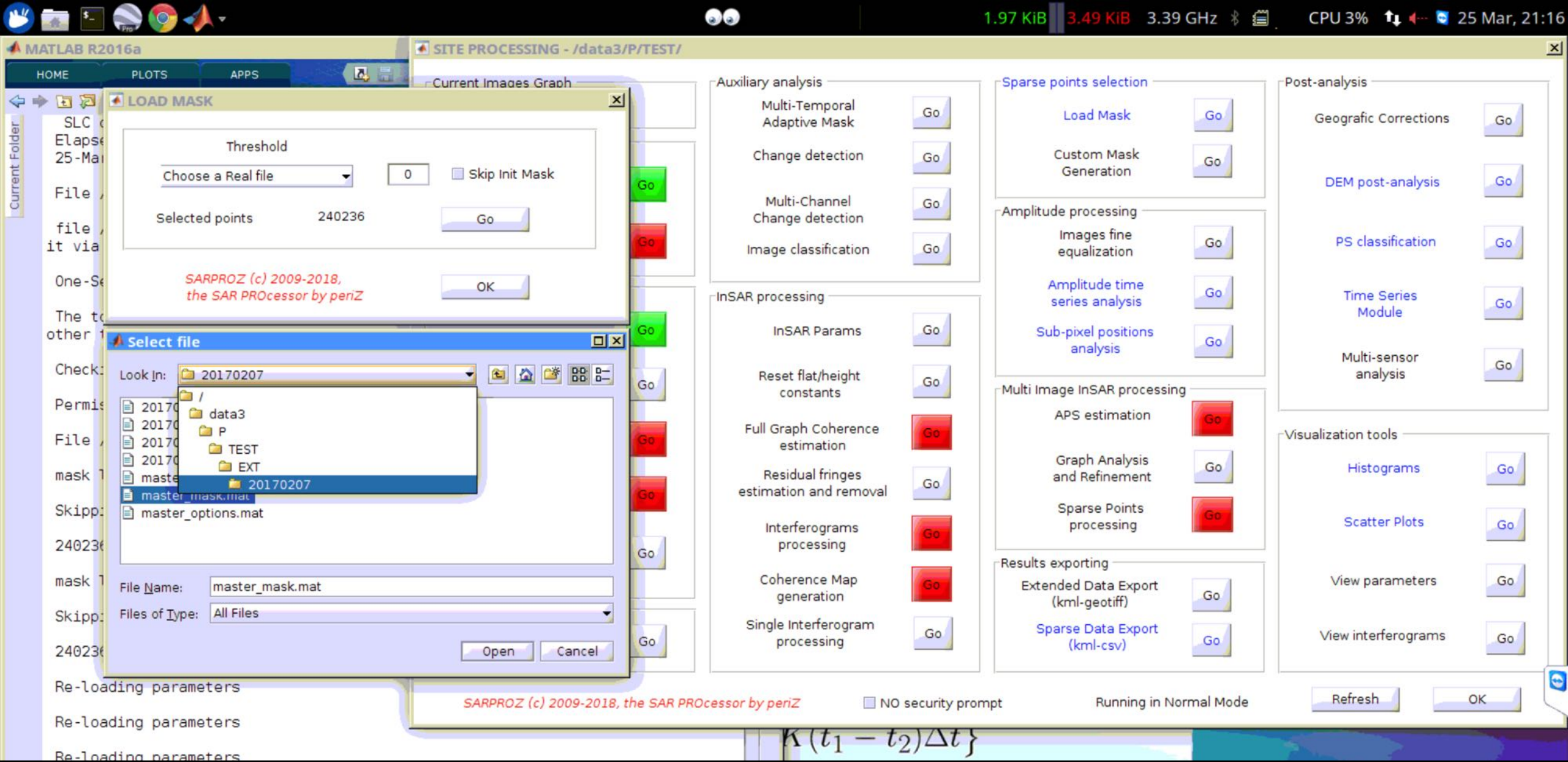
Refresh OK

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6. After you changed the parameters, click “save”. Then click “co-registration”.

Part 2:

Check pixel offsets



1. When SLC data are coregistered, go to “Load Mask” -> “Choose a Real File” -> “EXT/master-date/master_mask.mat”. This is the points you selected in page 6.

MATLAB R2016a

SITE PROCESSING - /data3/P/TEST/

HOME PLOTS APPS

Current Images Graph

LOAD MASK

Threshold

master_mask 0 ☒ Skip Init Mask

Selected points 240236 Go

OK

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mask loading

Skipping initial Mask: loading all point 240236 points with master_mask > 0.00

mask loading

Skipping initial Mask: loading all point 240236 points with master_mask > 0.00

Re-loading parameters

Re-loading parameters

Re-loading parameters

Re-loading parameters

mask loading

Skipping initial Mask: loading all point 240236 points with master_mask > 0.00

Re-loading parameters

Auxiliary analysis

Multi-Temporal Adaptive Mask Go

Change detection Go

Multi-Channel Change detection Go

Image classification Go

InSAR processing

InSAR Params Go

Reset flat/height constants Go

Full Graph Coherence estimation Go

Residual fringes estimation and removal Go

Interferograms processing Go

Coherence Map generation Go

Single Interferogram processing Go

Sparse points selection

Load Mask Go

Custom Mask Generation Go

Amplitude processing

Images fine equalization Go

Amplitude time series analysis Go

Sub-pixel positions analysis Go

Multi Image InSAR processing

APS estimation Go

Graph Analysis and Refinement Go

Sparse Points processing Go

Results exporting

Extended Data Export (kml-geotiff) Go

Sparse Data Export (kml-csv) Go

Post-analysis

Geographic Corrections Go

DEM post-analysis Go

PS classification Go

Time Series Module Go

Multi-sensor analysis Go

Visualization tools

Histograms Go

Scatter Plots Go

View parameters Go

View interferograms Go

Current: SRTM Go

DEM visualization Go

GCP selection Go

External DEM and synthetic amplitude in SAR coordinates Go

Coregistration Refinement (optional) Go

Sub-dataset extraction

Selection and extraction Go

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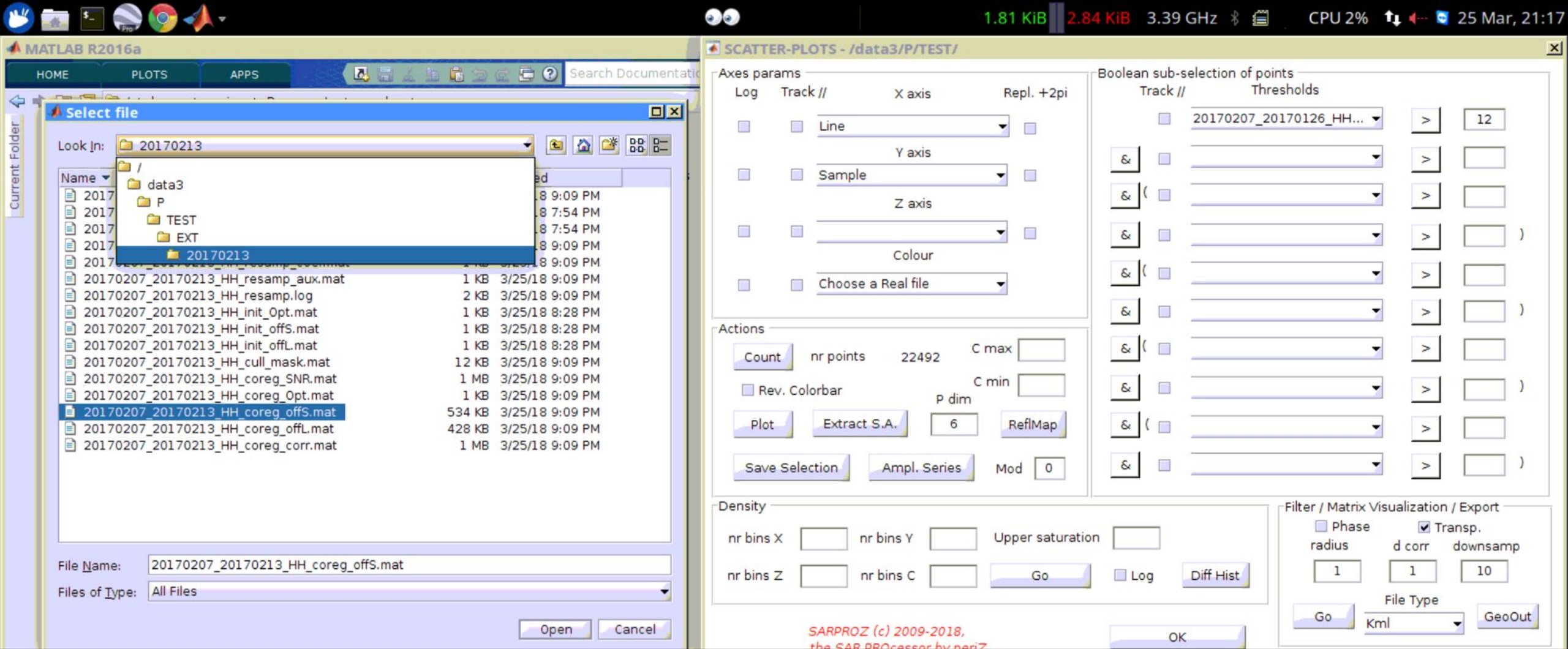
NO security prompt

Running in Normal Mode

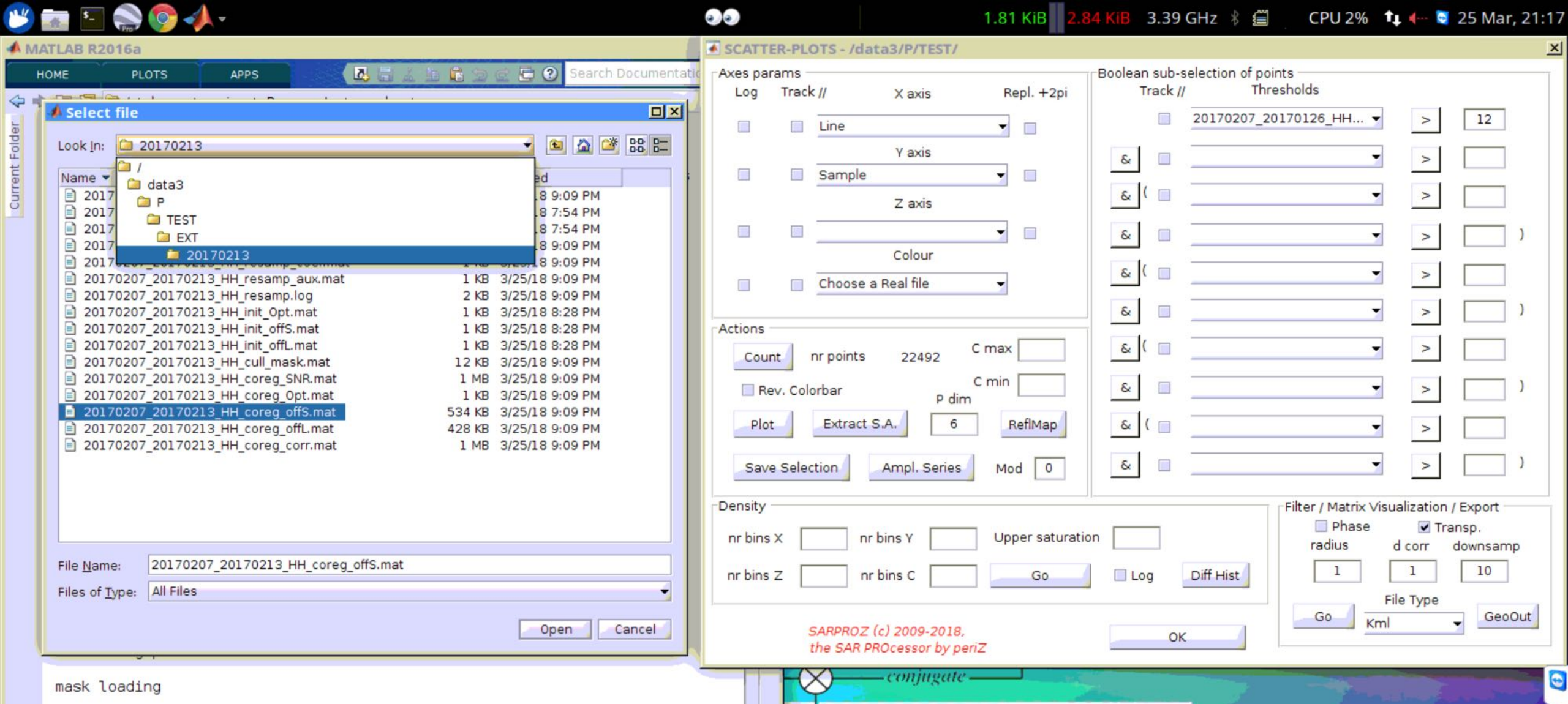
Refresh OK

$K(t_1 - t_2)\Delta t\}$

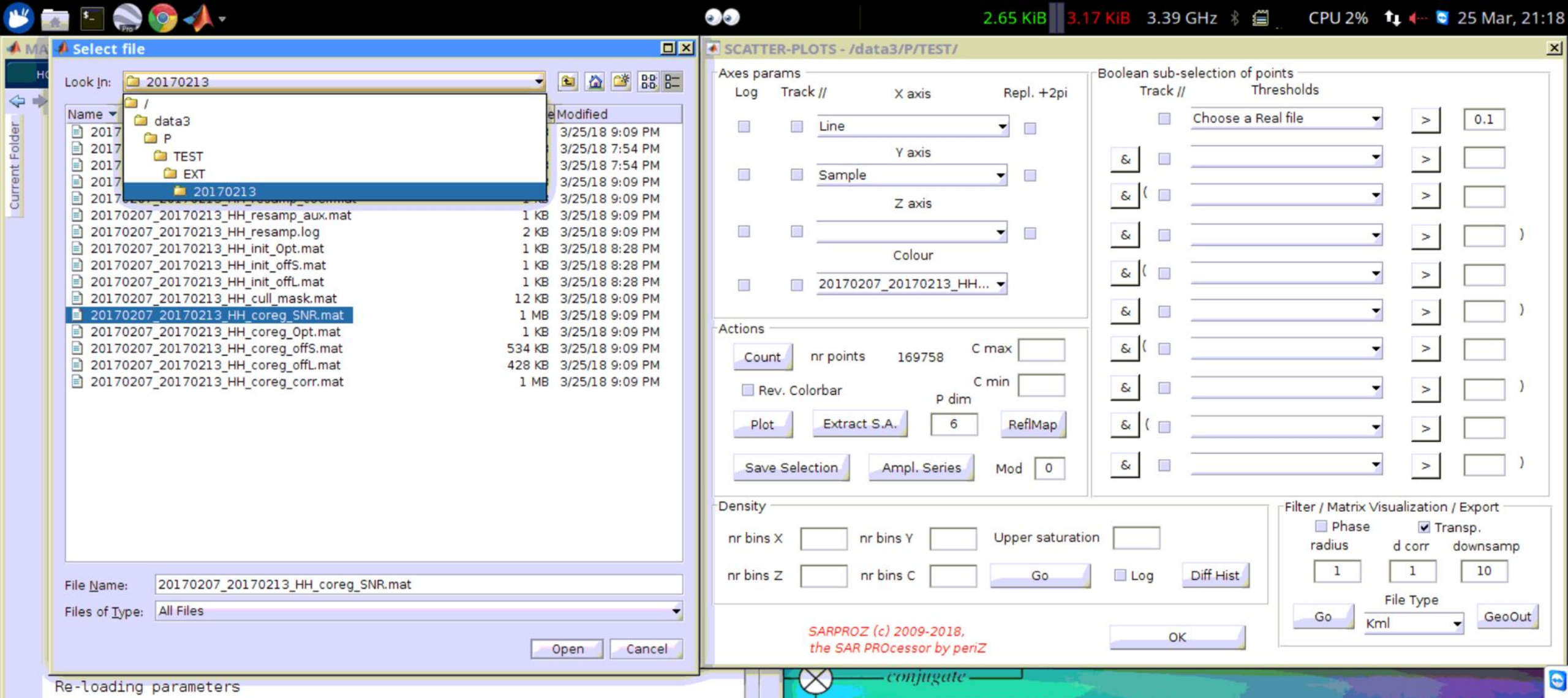
2. Check “skip init Mask” and click “Go”.



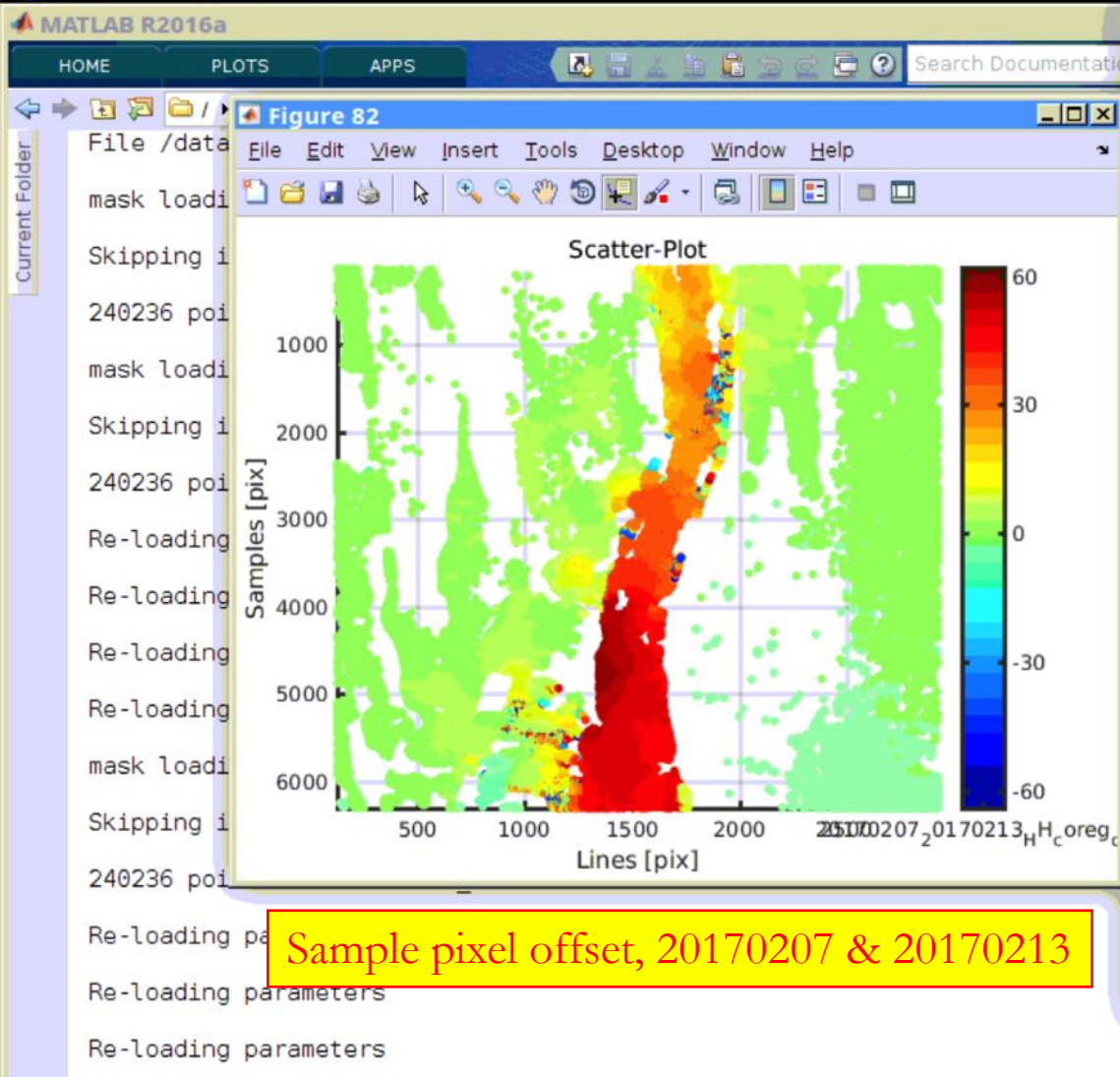
3. The pixel offset for each slave dates (w.r.t master) is saved in /EXT/slave-date. The line offset is slave_master_POL_coreg_offL.mat. The sample offset is slave_master_POL_coreg_offS.mat. One can check the pixel offset with “Scatter Plots”.



4. Click “Scatter Plots”. Choose “Line” as X axis and “Sample” as Y axis. In “Colour”, choose “Choose a real file...” Firstly choose `slave_master_Pol_coreg_offS.mat` for checking the sample offset.



5. Use the signal to noise ratio (SNR) of each points to filter out the noisy points. To do so, in “Thresholds”, click “choose a real file” and select /EXT/slave/slave_master_POL_coreg_SNR.mat.



Sample pixel offset, 20170207 & 20170213

SCATTER-PLOTS - /data3/P/TEST/

Axes params

Log	Track //	X axis	Repl. +2pi
<input type="checkbox"/>	<input type="checkbox"/>	Line	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Y axis	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Sample	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Z axis	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Colour	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	20170207_20170213_HH...	<input type="checkbox"/>

Boolean sub-selection of points

Track //	Thresholds
<input type="checkbox"/>	20170207_20170213_HH... > 5
<input type="checkbox"/>	& <input type="checkbox"/> >
<input type="checkbox"/>	& (<input type="checkbox"/> >)
<input type="checkbox"/>	& <input type="checkbox"/> >
<input type="checkbox"/>	& (<input type="checkbox"/> >)
<input type="checkbox"/>	& <input type="checkbox"/> >
<input type="checkbox"/>	& (<input type="checkbox"/> >)
<input type="checkbox"/>	& <input type="checkbox"/> >
<input type="checkbox"/>	& (<input type="checkbox"/> >)
<input type="checkbox"/>	& <input type="checkbox"/> >
<input type="checkbox"/>	& (<input type="checkbox"/> >)

Actions

Count nr points 130325 C max

☐ Rev. Colorbar C min

Plot Extract S.A. P dim 6 RefMap

Save Selection Ampl. Series Mod 0

Density

nr bins X nr bins Y Upper saturation

nr bins Z nr bins C Go ☐ Log ☐ Diff Hist

Filter / Matrix Visualization / Export

☐ Phase ☒ Transp.

radius d corr downsamp

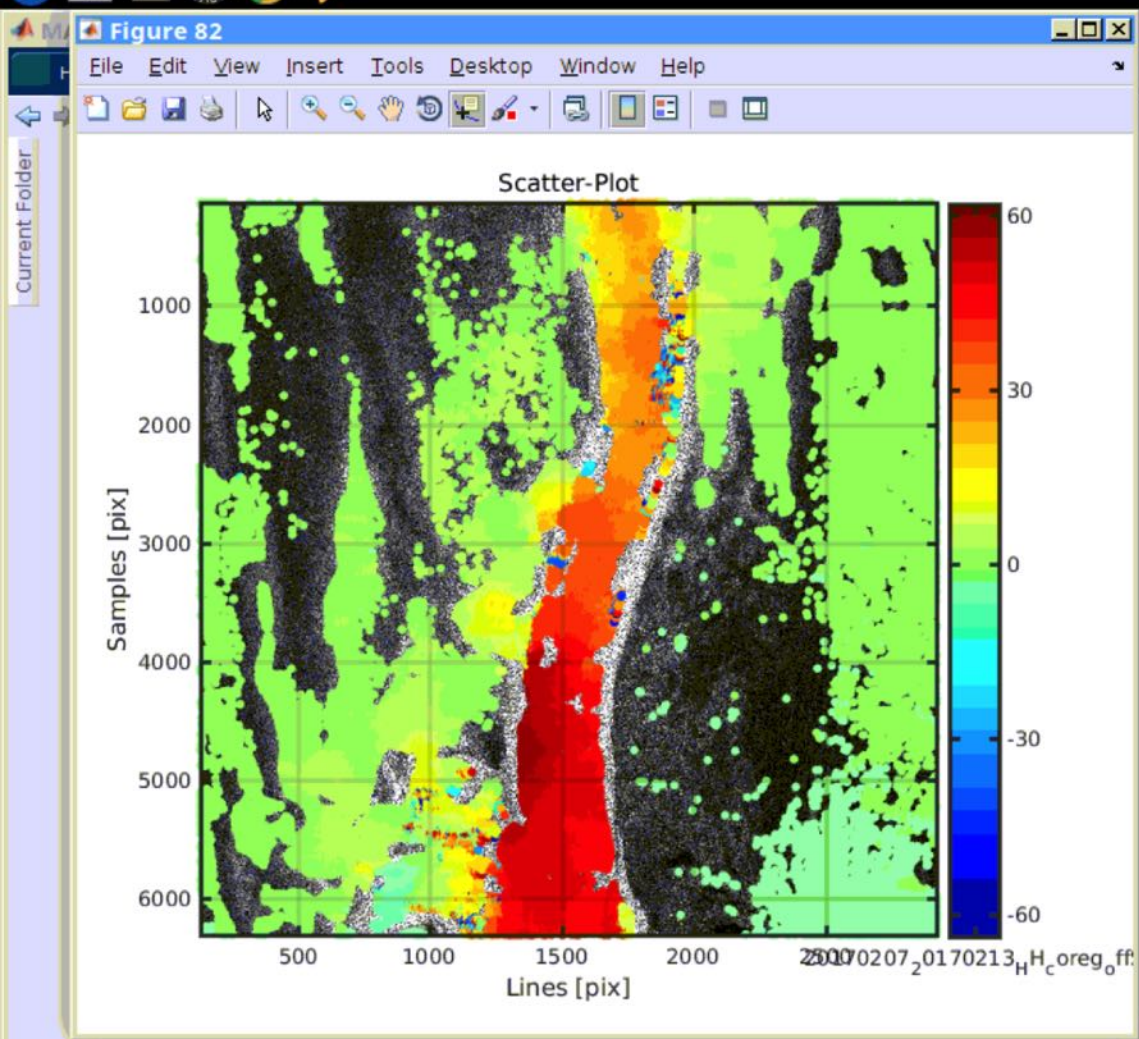
1 1 10

Go File Type Kml GeoOut

OK

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6. Select the threshold (try a few different values). Then click “Count” to reflect the effects of threshold. Then click “Plot” to see your pixel offset map. The unit (shown in colorbar) is pixel.



SCATTER-PLOTS - /data3/P/TEST/

Axes params

Log ☐ Track // X axis Repl. +2pi

☐ Line

Y axis

☐ Sample

Z axis

Colour

☐ 20170207_20170213_HH...

Boolean sub-selection of points

Track // Thresholds

☐ 20170207_20170213_HH... > 5

& ☐ >

& (☐ >

& ☐ >

& (☐ >

& ☐ >

& (☐ >

& ☐ >

& (☐ >

& ☐ >

Actions

Count nr points 130325 C max

Rev. Colorbar

Plot Extract S.A. 6 ReflMap

Save Selection Ampl. Series Mod 0

Density

nr bins X nr bins Y Upper saturation

nr bins Z nr bins C Go Log Diff Hist

Filter / Matrix Visualization / Export

☐ Phase ☒ Transp.

radius d corr downsamp

1 1 10

File Type

Go Kml GeoOut

OK

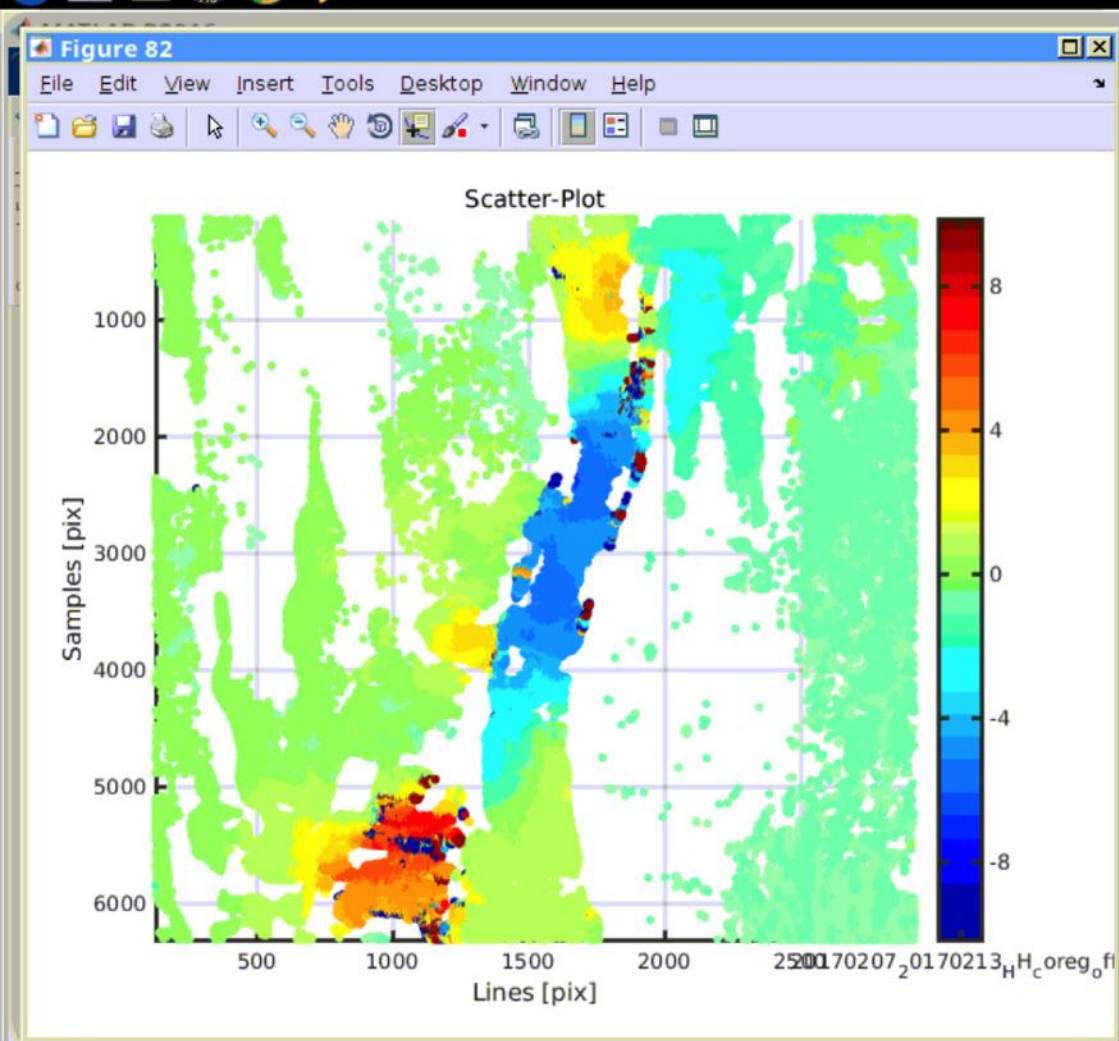
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Sample pixel offset, 20170207 & 20170213

conjugate

$$K(t_1 - t_2)\Delta t\}$$

7. You can also click “Reflmap (reflectivity map)” and then click “plots” to see the pixel offset overlay to the reflectivity map to understand the area with pixel offsets.



SCATTER-PLOTS - /data3/P/TEST/

Axes params

Log	Track //	X axis	Repl. +2pi
<input type="checkbox"/>	<input type="checkbox"/>	Line	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Sample	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Z axis	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Colour	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	20170207_20170213_HH...	<input type="checkbox"/>

Boolean sub-selection of points

Track //	Thresholds
<input type="checkbox"/> 20170207_20170213_HH...	> 5
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>
<input type="checkbox"/>	>

Actions

<input type="button" value="Count"/>	nr points	130325	C max	10
<input type="checkbox"/> Rev. Colorbar			C min	-10
<input type="button" value="Plot"/>	<input type="button" value="Extract S.A."/>	P dim	<input type="button" value="ReflMap"/>	
<input type="button" value="Save Selection"/>	<input type="button" value="Ampl. Series"/>	Mod	<input type="button" value="0"/>	

Density

nr bins X	<input type="text"/>	nr bins Y	<input type="text"/>	Upper saturation	<input type="text"/>
nr bins Z	<input type="text"/>	nr bins C	<input type="text"/>	<input type="button" value="Go"/>	<input type="checkbox"/> Log <input type="button" value="Diff Hist"/>

Filter / Matrix Visualization / Export

<input type="checkbox"/> Phase	<input checked="" type="checkbox"/> Transp.
radius	d corr
<input type="text" value="1"/>	<input type="text" value="1"/>
downsamp	<input type="text" value="10"/>
<input type="button" value="Go"/>	<input type="button" value="GeoOut"/>

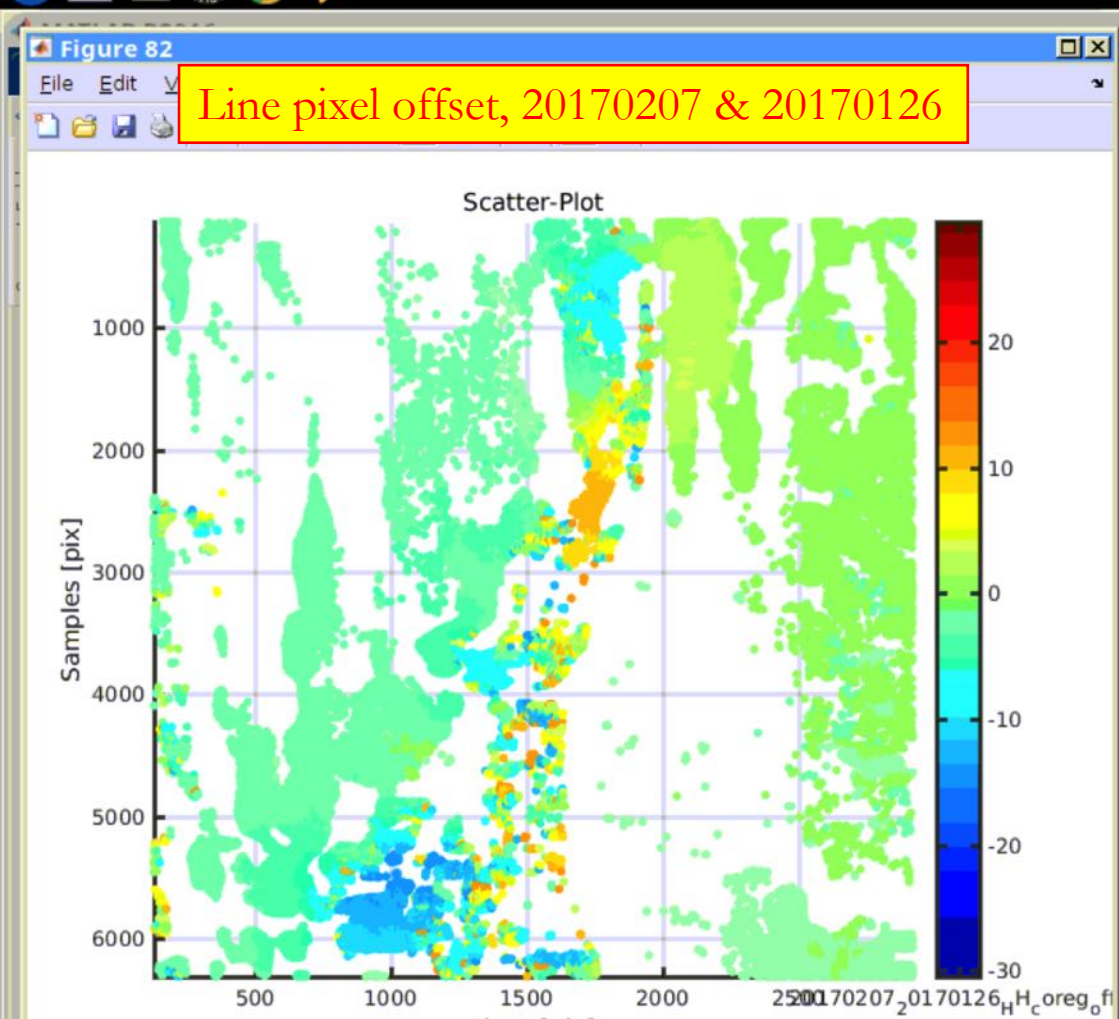
OK

Line pixel offset, 20170207 & 20170213

conjugate

$$K(t_1 - t_2)\Delta t\}$$

8. Check also the offsets in line direction. One can use the same threshold (SNR) for points selection. Note that the plus/minus sign in offset value indicates the direction.



SCATTER-PLOTS - /data3/P/TEST/

Axes params

Log ☐ Track // ☐ X axis ☐ Repl. +2pi ☐

☐ ☐ Line ☐

☐ ☐ Sample ☐

☐ ☐ Z axis ☐

☐ ☐ Colour ☐

☐ ☐ Choose a Real file ☐

Boolean sub-selection of points

Track // Thresholds

☐ 20170207_20170126_HH... > .05

& ☐ 20170207_20170126_HH... > 5

& (☐ 20170207_20170126_HH... < 15

& ☐ 20170207_20170126_HH... > -15)

& (☐ >

& ☐ >

& (☐ >

& ☐ >

Actions

Count nr points 83728 C max 30

☐ Rev. Colorbar C min -30

Plot Extract S.A. 6 ReflMap

Save Selection Ampl. Series Mod 0

Density

nr bins X nr bins Y Upper saturation

nr bins Z nr bins C Go ☐ Log ☐ Diff Hist

Filter / Matrix Visualization / Export

☐ Phase ☒ Transp.

radius d corr downsamp

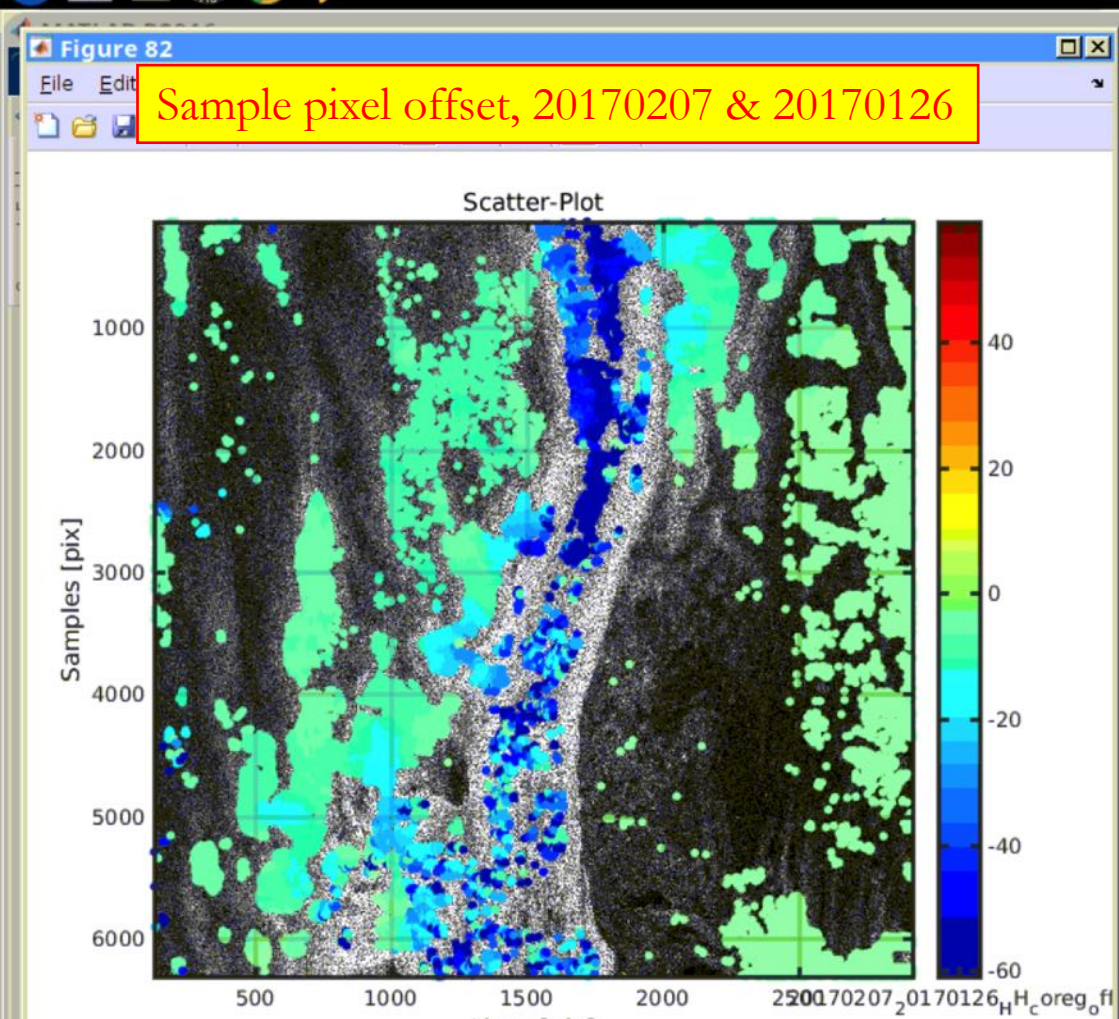
1 1 10

Go File Type Kml GeoOut

OK

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9. If the data is noisy, one can also select more threshold to filter out noisy points. For example, you can choose thresholds both in SNR and in correlation (slave_master_pol_coreg_corr.mat). One can also filter out points with very large pixel offset values. It requires tuning the parameters a bit to get a reasonable outcome.



SCATTER-PLOTS - /data3/P/TEST/

Axes params

Log	Track //	X axis	Repl. +2pi
<input type="checkbox"/>	<input type="checkbox"/>	Line	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Sample	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Z axis	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Colour	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	20170207_20170126_HH...	<input type="checkbox"/>

Boolean sub-selection of points

Track //	Thresholds
<input type="checkbox"/>	20170207_20170126_HH... > 0.05
<input type="checkbox"/>	20170207_20170126_HH... > 7
<input type="checkbox"/>	20170207_20170126_HH... < 0
<input type="checkbox"/>	20170207_20170126_HH... > -100
<input type="checkbox"/>	
<input type="checkbox"/>	
<input type="checkbox"/>	
<input type="checkbox"/>	
<input type="checkbox"/>	

Actions

Count nr points 53232 C max 60

Rev. Colorbar C min -60

Plot Extract S.A. 6 ReflMap

Save Selection Ampl. Series Mod 0

Density

nr bins X nr bins Y Upper saturation

nr bins Z nr bins C Go Log Diff Hist

Filter / Matrix Visualization / Export

Phase ☐ Transp. ☒

radius d corr downsamp

1 1 10

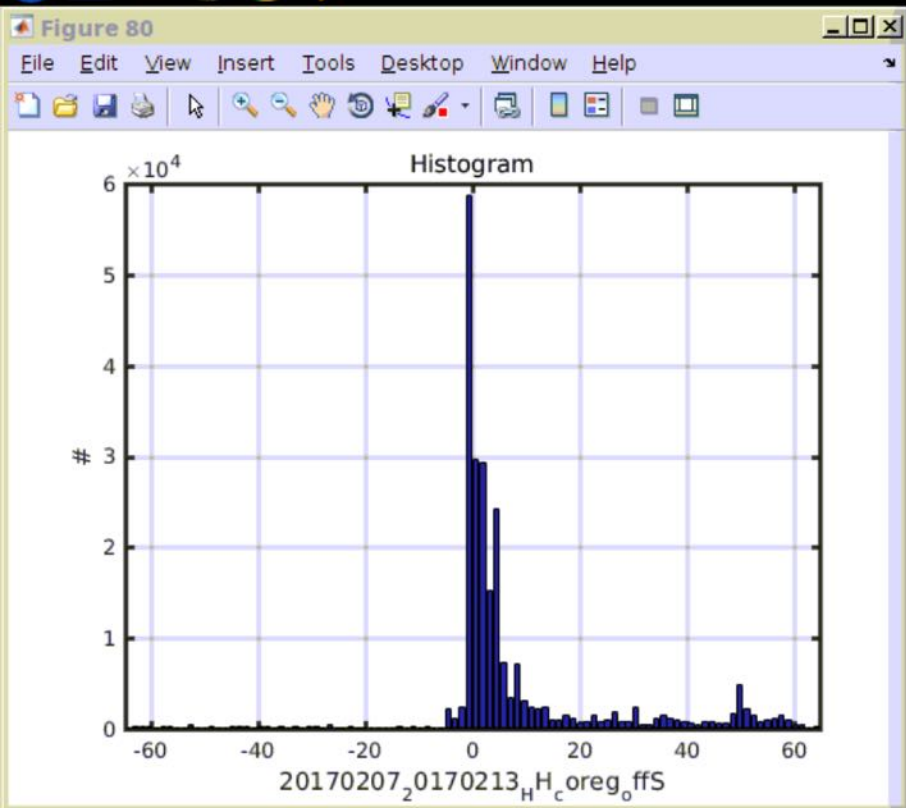
File Type

Go Kml GeoOut

OK

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9. If the data is noisy, one can also select more threshold to filter out noisy points. For example, you can choose thresholds both in SNR and in correlation (slave_master_pol_coreg_corr.mat). One can also filter out points with very large pixel offset values. It requires tuning the parameters a bit to get a reasonable outcome.



HISTOGRAMS - /data3/P/TEST/

Track //	Histogram Parameter	Track //	Thresholds
<input type="checkbox"/>	20170207_20170213_HH...	<input type="checkbox"/>	
<input type="checkbox"/>	Amp. Stab. Index 1-Sigma/N	<input type="checkbox"/>	>
<input type="checkbox"/>	Synt. Coher.	<input type="checkbox"/>	>
<input type="checkbox"/>	Spatial Coher.	<input type="checkbox"/>	>
<input type="checkbox"/>	Ext. DEM Height	<input type="checkbox"/>	>
<input type="checkbox"/>	Synthetic Amplitude	<input type="checkbox"/>	>
<input type="checkbox"/>	Eff. Bn	<input type="checkbox"/>	>
<input type="checkbox"/>	Eff. Bt	<input type="checkbox"/>	>
<input type="checkbox"/>	Amp. Stab. Mu/Sigma	<input type="checkbox"/>	>
<input type="checkbox"/>	Atmo. Coherence	<input type="checkbox"/>	>
<input type="checkbox"/>	Life Time	<input type="checkbox"/>	>
<input type="checkbox"/>	Cumulative Displacement	<input type="checkbox"/>	>
<input type="checkbox"/>	Amp. Stab. Ind plus Sp. Coh	<input type="checkbox"/>	>
<input type="checkbox"/>	MT Adapt Mask Cluter Nr	<input type="checkbox"/>	>
<input type="checkbox"/>	MT Adapt Mask Cluter Size	<input type="checkbox"/>	>
<input type="checkbox"/>	Choose a Real file	<input type="checkbox"/>	>
<input type="checkbox"/>	Choose Interf. Coher.	<input type="checkbox"/>	>
<input type="checkbox"/>	Choose Interf. Phase	<input type="checkbox"/>	>
<input type="checkbox"/>	Choose Image Amplitude	<input type="checkbox"/>	>
<input type="checkbox"/>	Choose Image Phase	<input type="checkbox"/>	>
<input type="checkbox"/>	20170207_20170213_HH_c	<input type="checkbox"/>	>

Bins Nr 100 Count Points Nr 240236

Histogram Wrapped Hist.

H(sel) / H(whole) Amplitude Series

OK

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Analysis

Geographic Corrections Go

DEM post-analysis Go

PS classification Go

Time Series Module Go

Multi-sensor analysis Go

Visualization tools

Histograms Go

Scatter Plots Go

View parameters Go

View interferograms Go

Refresh OK

10. At last, you can also check the histogram statistics by click “Histograms” and check the histogram of sample/line pixel offsets.

Bye