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Title: Container Surface Evaluation by Function Estimation

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Container Surface Evaluation by Function Estimation

James Wendelberger

CCS-6

28 July 2017

Briefing

Abstract

Container images are analyzed for specific surface features, such as, pits, cracks, and corrosion. The detection of these features is confounded with complicating features. These complication features include: shape/curvature, welds, edges, scratches, foreign objects among others. A method is provided to discriminate between the various features. The method consists of estimating the image background, determining a residual image and post processing to determine the features present. The methodology is not finalized but demonstrates the feasibility of a method to determine the kind and size of the features present.

Outline

1. Background
2. Overview of the Methodology
   i. Import Depth Image by Pixel
   ii. Estimate the Image Background
   iii. Estimate the Image with Background
   iv. Difference the Estimates – Residual Surface
   v. Evaluate Surface Features of the Residual Surface
   vi. Report Image Statistics
3. 9 Examples on Actual Images
4. Lessons Learned
5. Future work

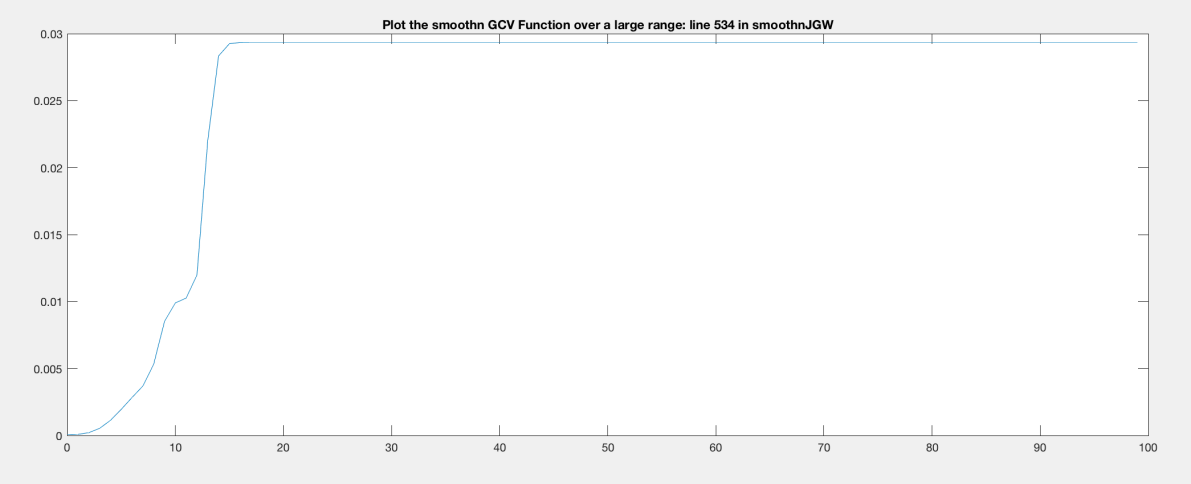
Background

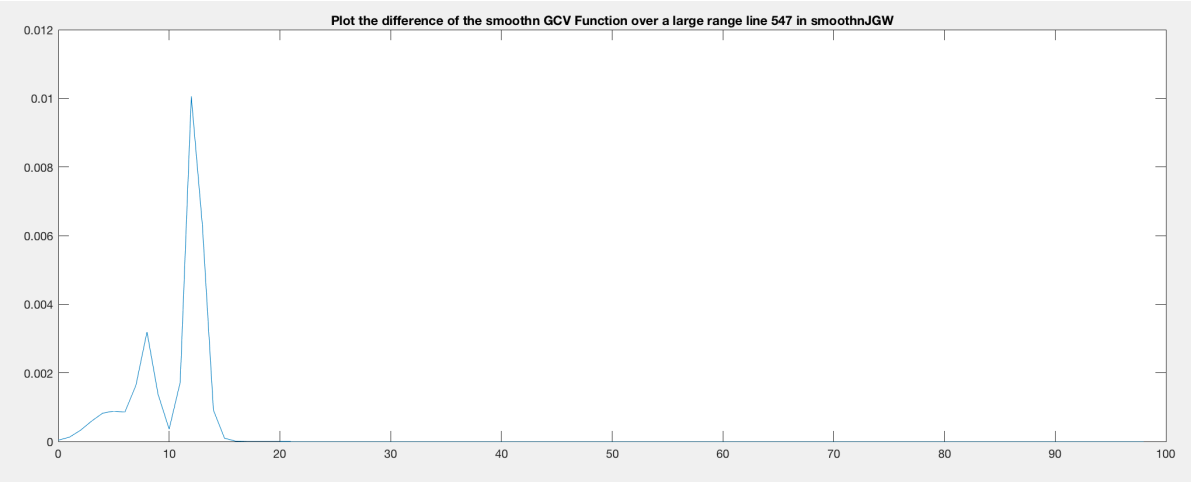
1. Image Data Collected – Visible and Depth
   i. Redundancies?
2. Detection of Relevant Features
   i. Size – Depth, Area and Volume
3. Non detection/Exclusion of Irrelevant Features
   i. Sample Edges, Sample Shape/Curvature
4. Automatic or Manual/Human Intervention
5. Stitching Required or Helpful?
6. Is a Solution to this Problem Feasible?

Methodological Overview

1. Import Depth Image by Pixel
2. Estimate the Image “Background” (Low Frequency)
3. Remove Background from Image – Residual Surface
4. Evaluate Surface Features of the Residual Surface
5. Report Image Statistics of the Residual Surface

Generalized Cross Validation





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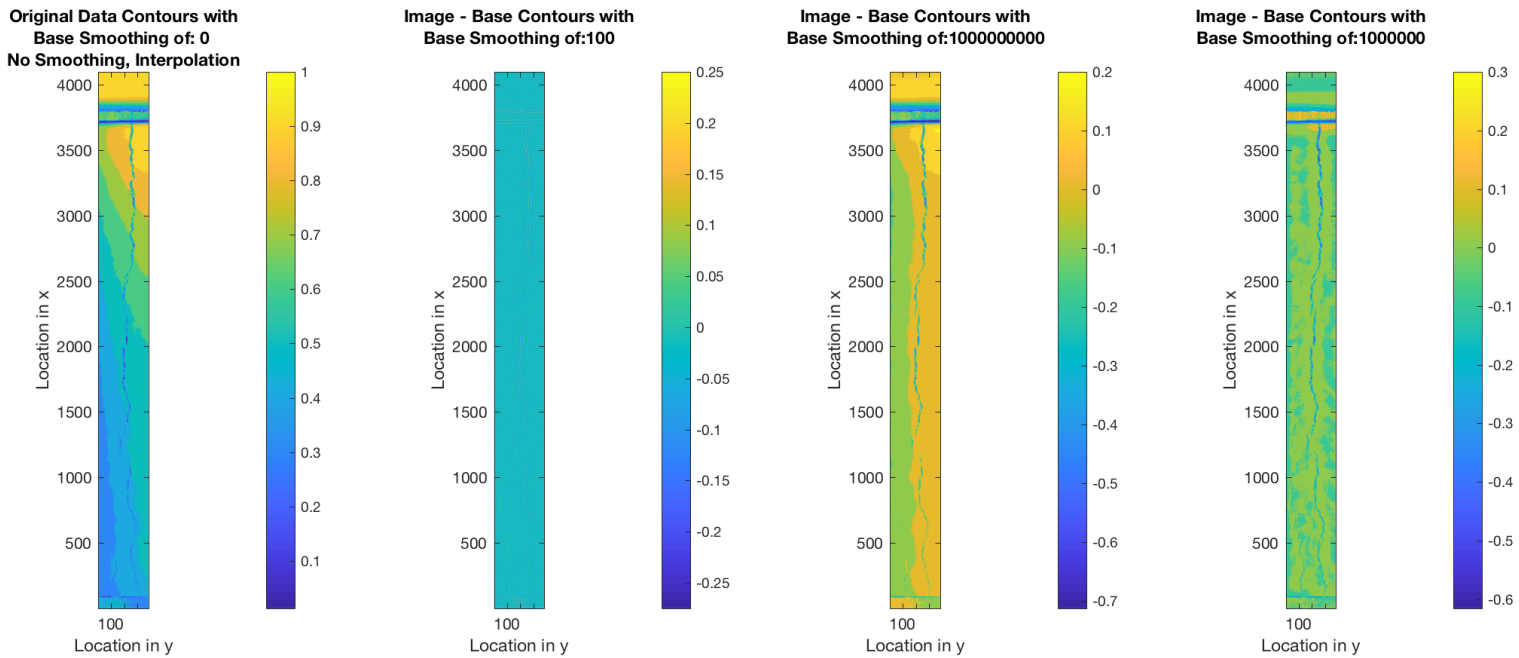
Nine Examples of Actual Images

Crack_HCL_Pol_no_O2_Sec1_noheader	12.6 MB
HCLO_SeC3_Stich_noheader	13.5 MB
HCLO_UnPol_no_O2...c4_Y1_X1_noheader	5.5 MB
MgCl2_Inside__Y1_X6_noheader	5.6 MB
MgCl2_Inside__Y15_X18_noheader	5.5 MB
MgCl2_Inside_noheader	16.4 MB
Pit_noheader	5.5 MB
S1_20X_6300X2500_noheader	5.5 MB
S19_5_3d_noheader	5.5 MB

Crack_HCL_Pol_no_O2_Sec1

1. 2571 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 4096
4. Height 384
5. Stitched Images of a Crack in Section 1 of HCl Polished with No Oxygen

Crack_HCL_Pol_no_O2_Sec1



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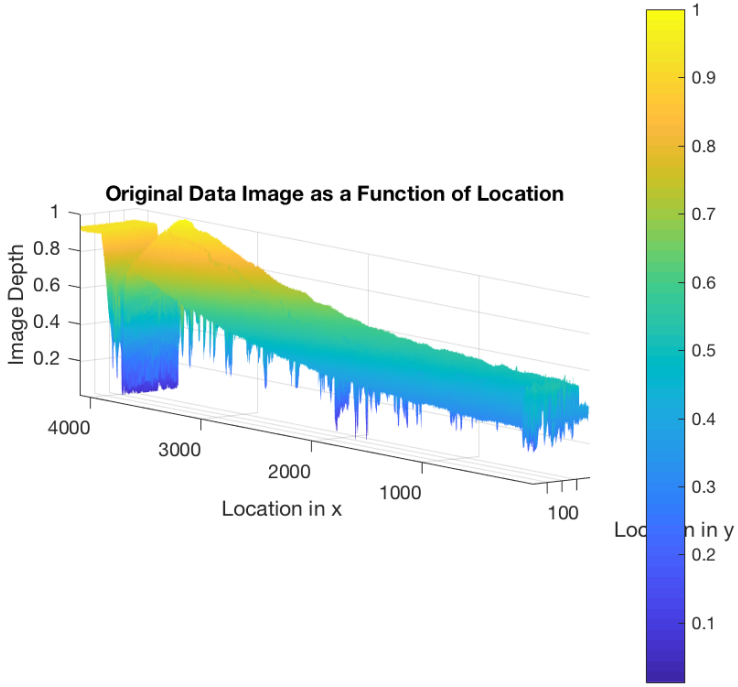
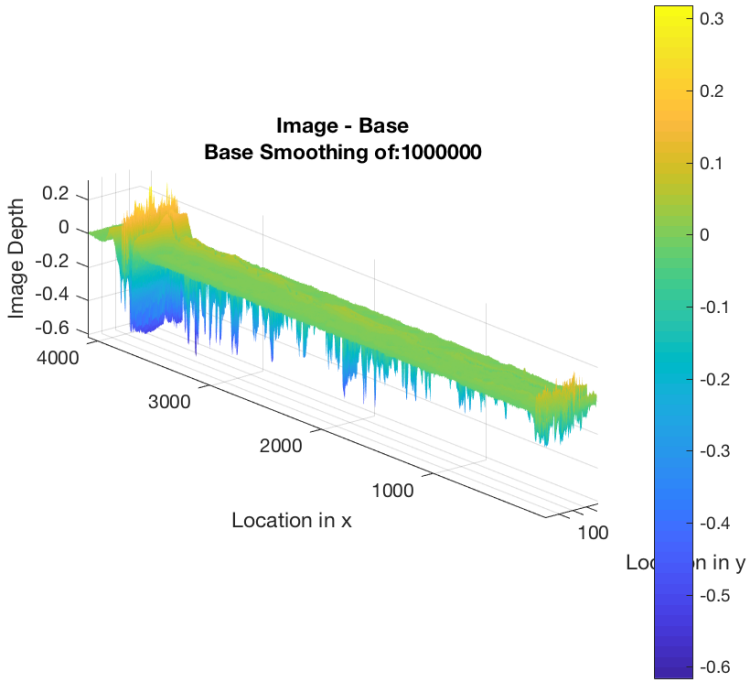
Crack_HCL_Pol_no_O2_Sec1





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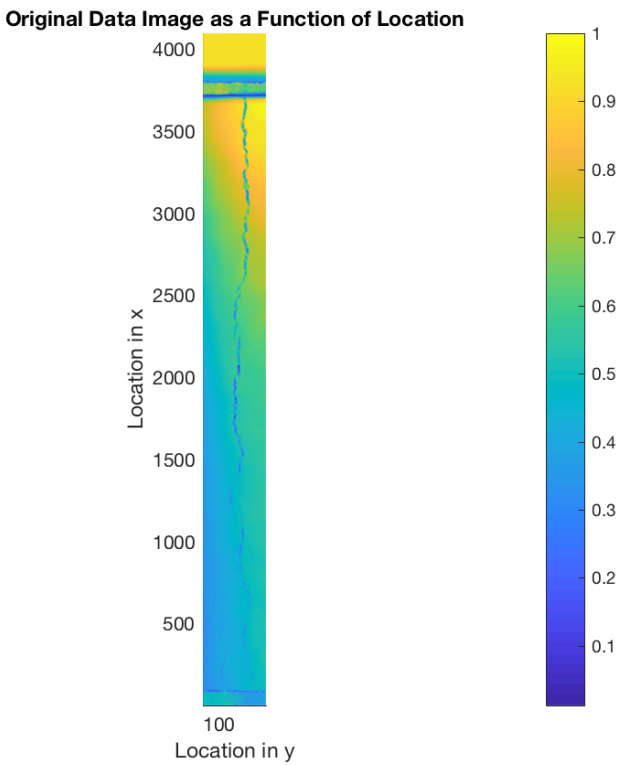

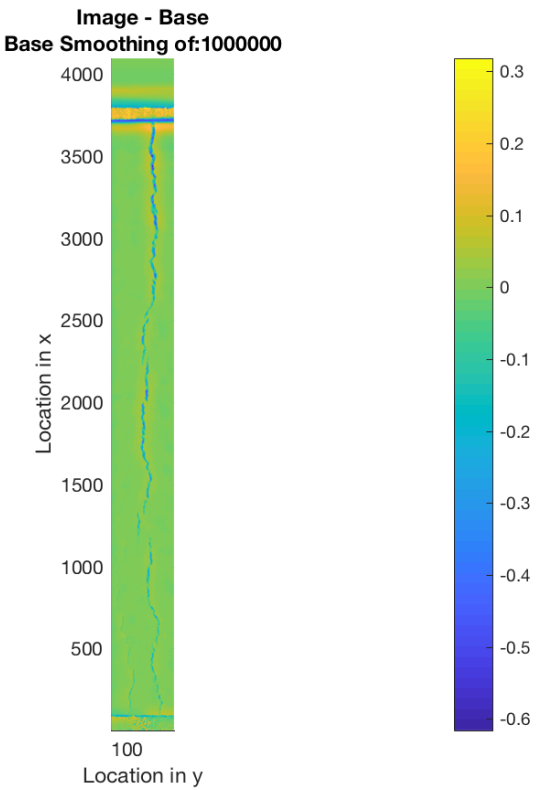

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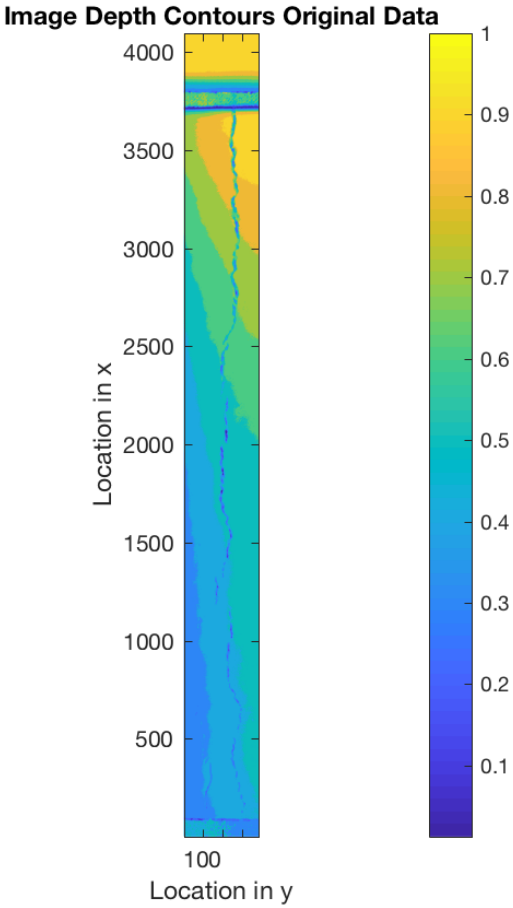

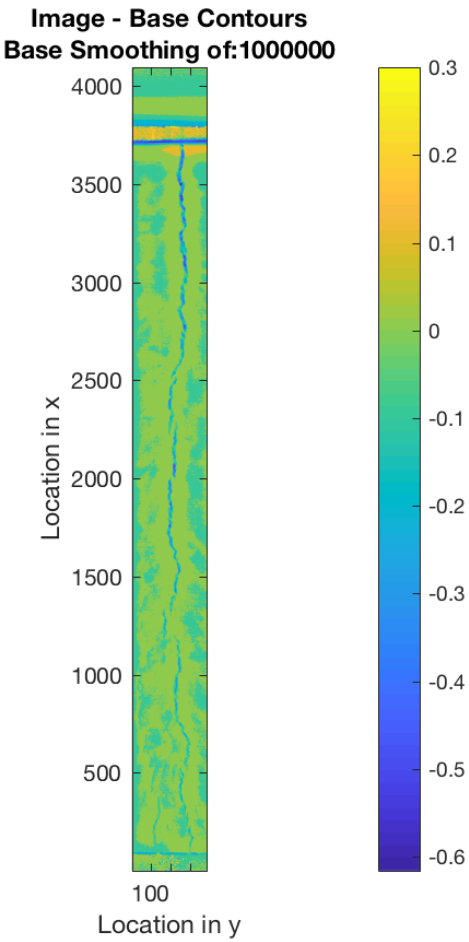

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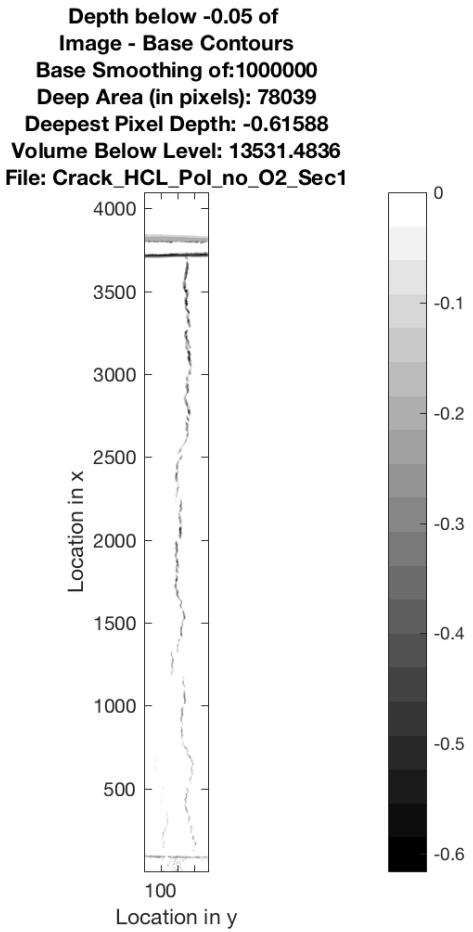
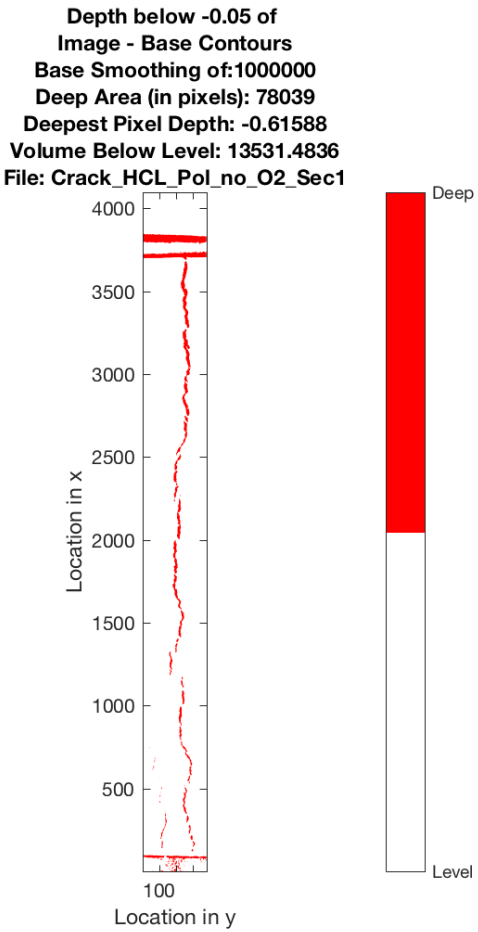
Crack_HCL_Pol_no_O2_Sec1





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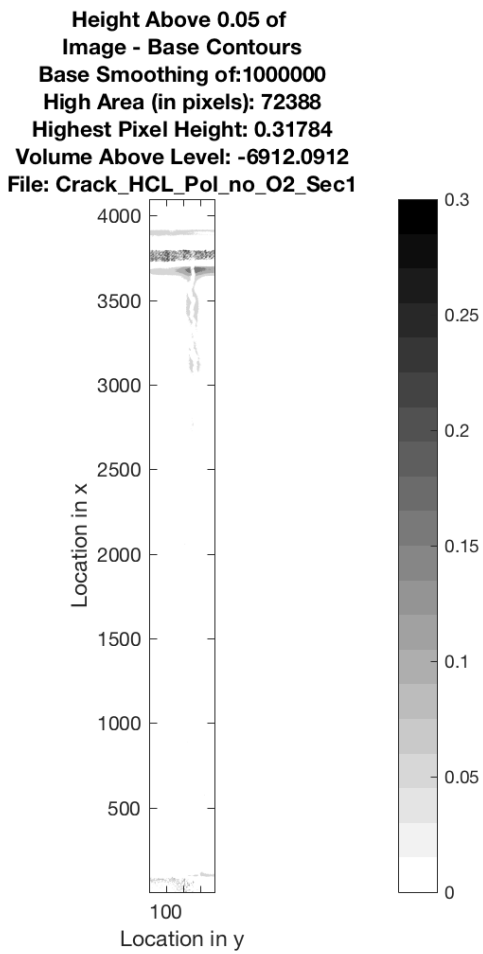
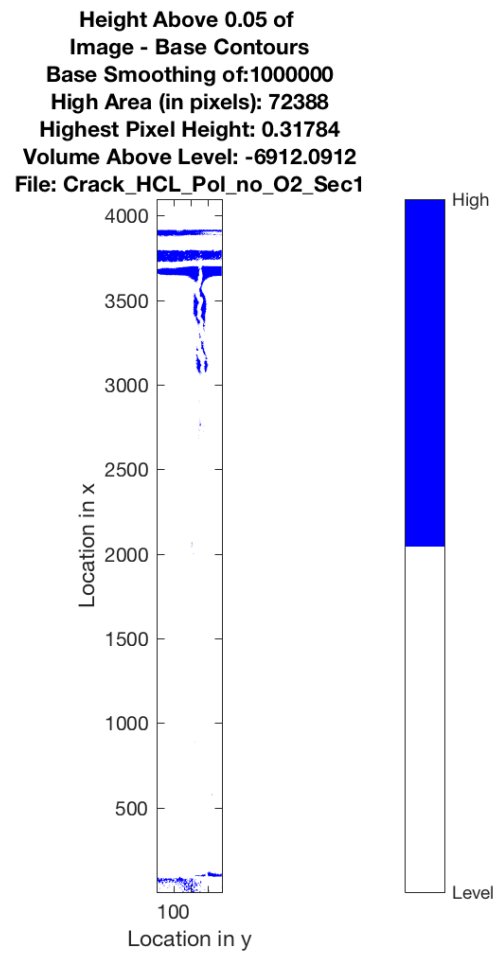
Crack_HCL_Pol_no_O2_Sec1





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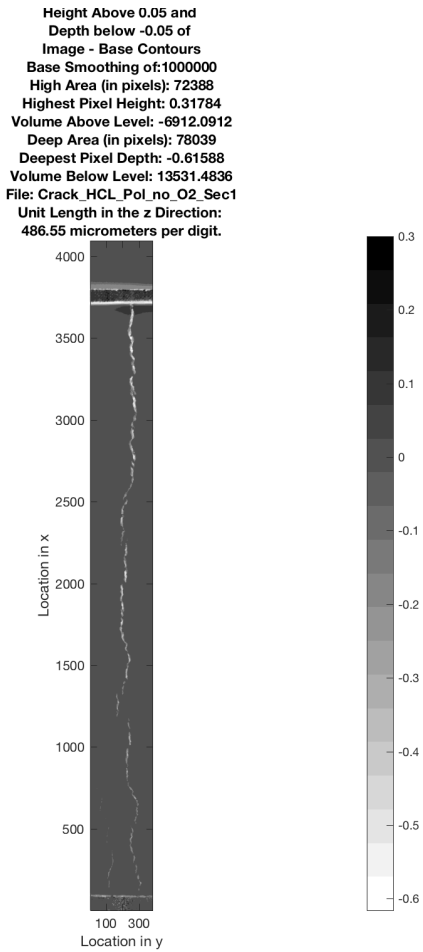

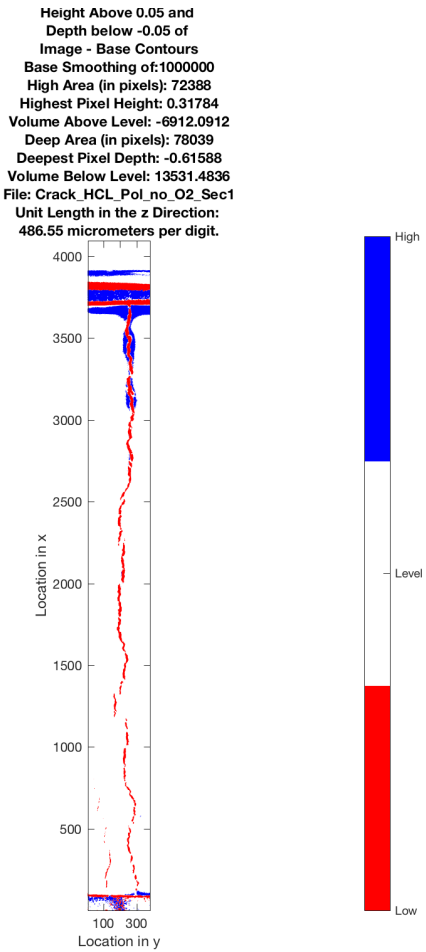

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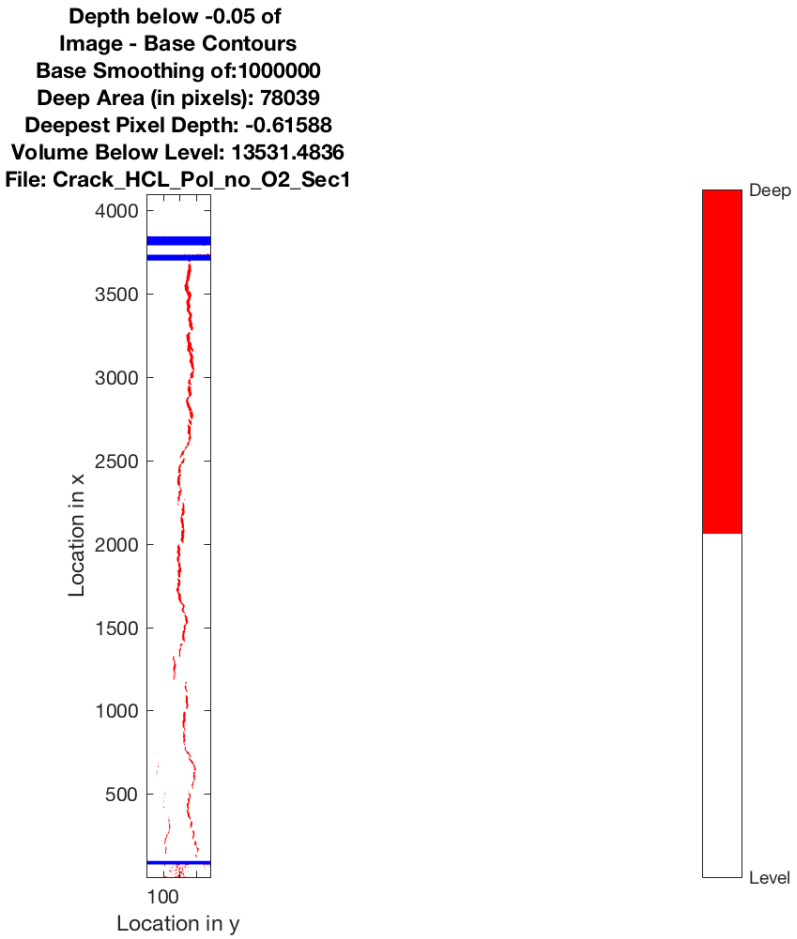

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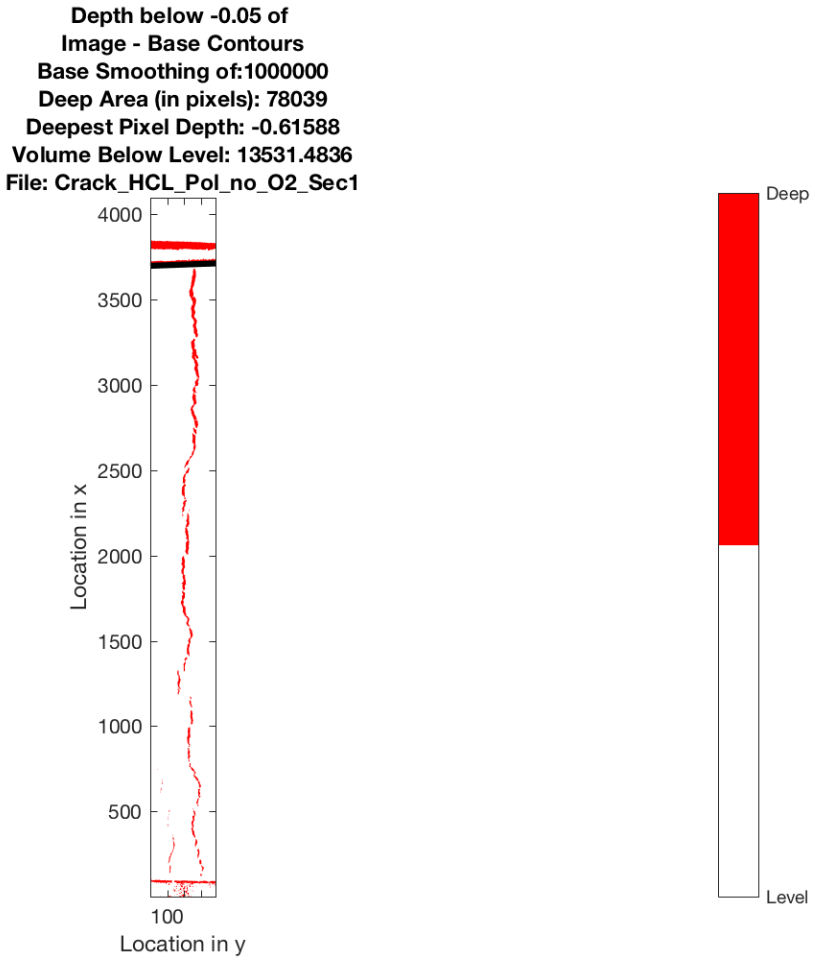
Crack_HCL_Pol_no_O2_Sec1



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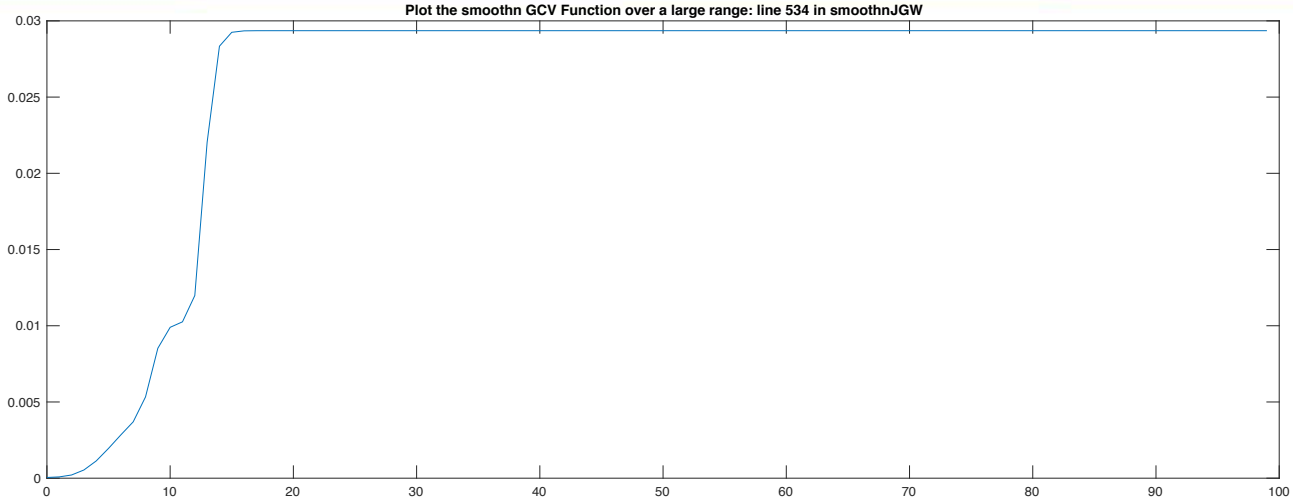
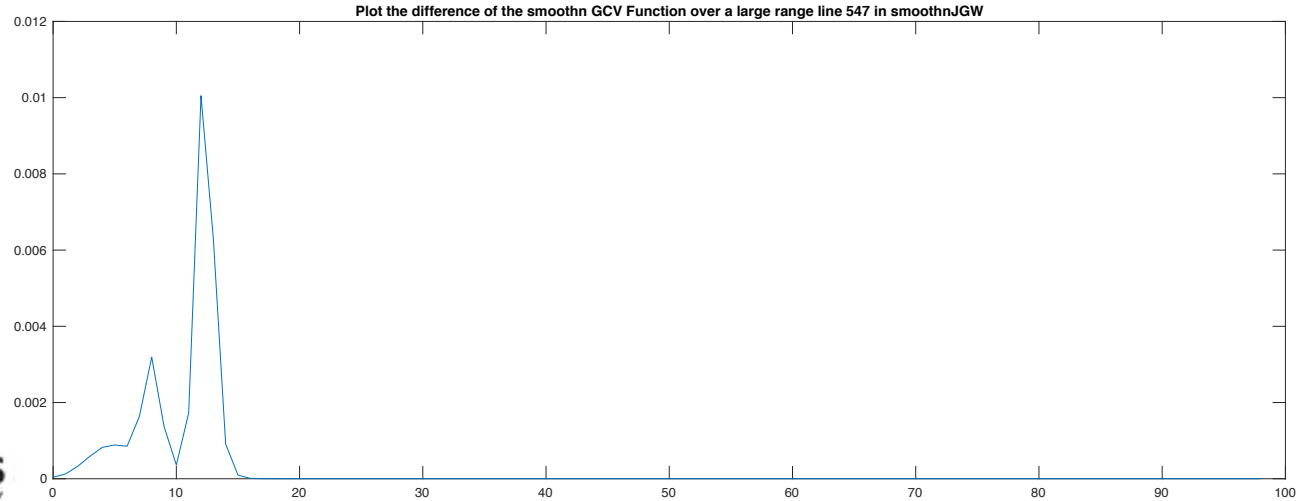
Crack_HCL_Pol_no_O2_Sec1





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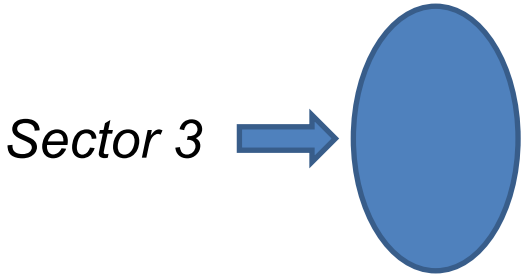
HCLO_SeC3_Stich

1. 2759 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 3392
4. Height 512
5. Stitched Images of Sector 3 of HClO Teardrop



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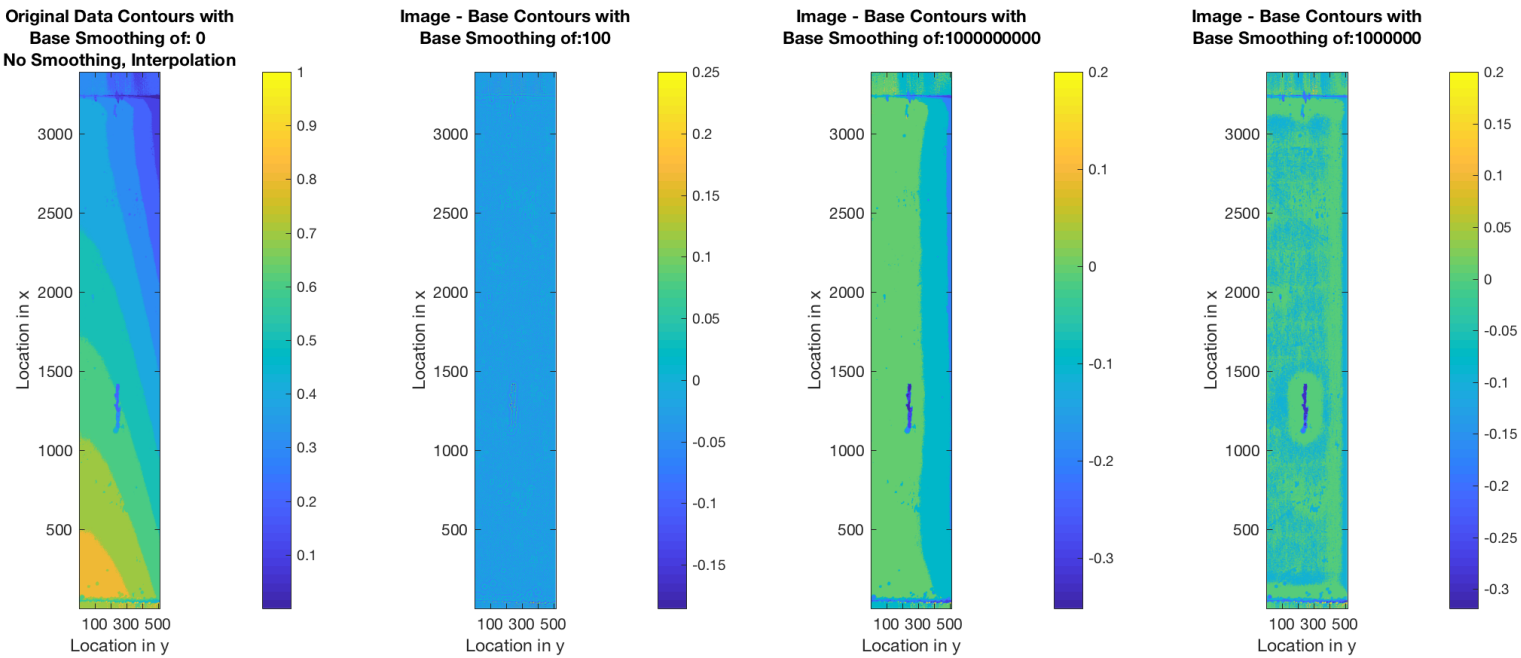

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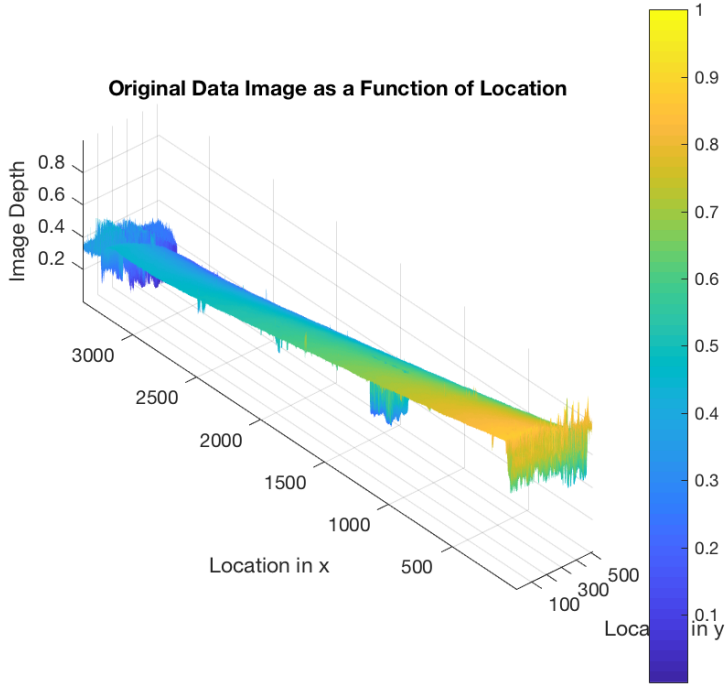
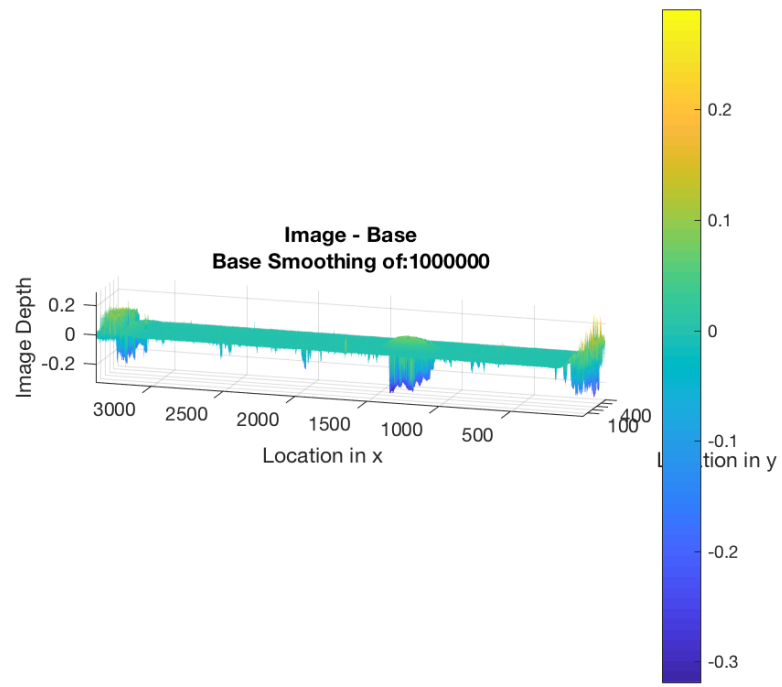
HCLO_SeC3_Stich





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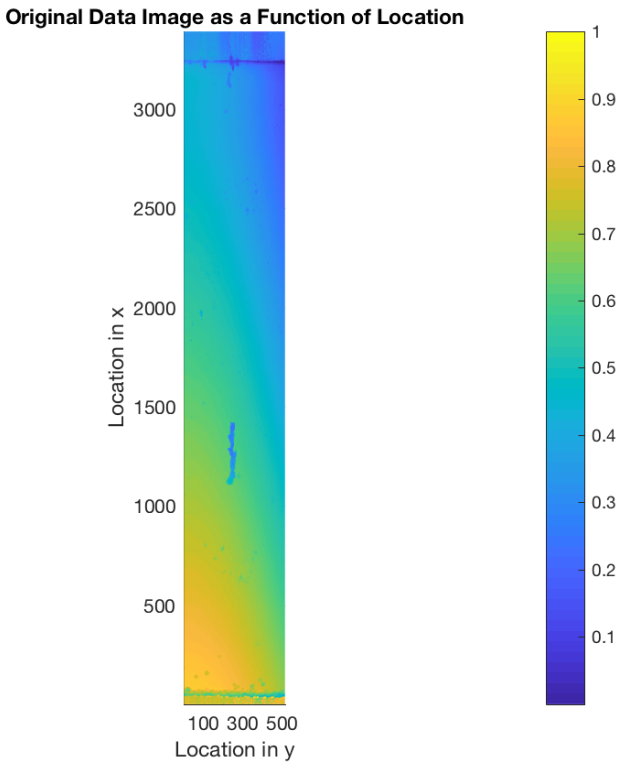

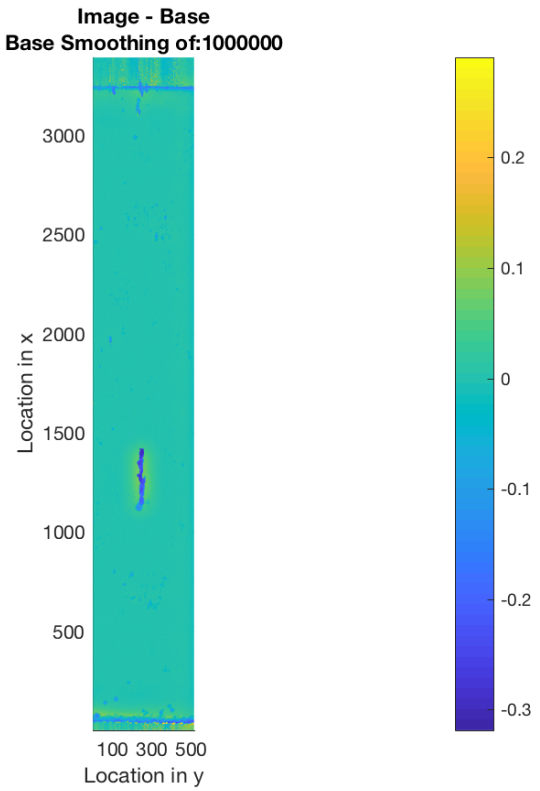

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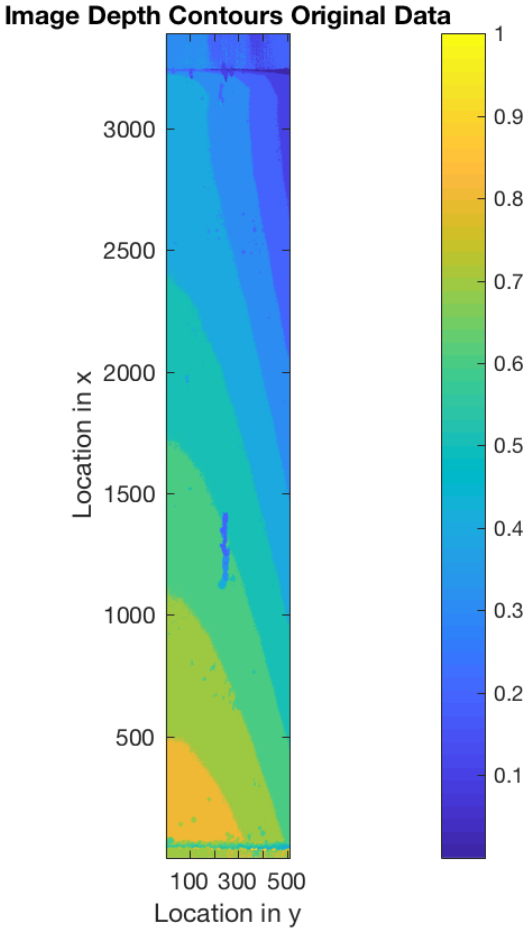

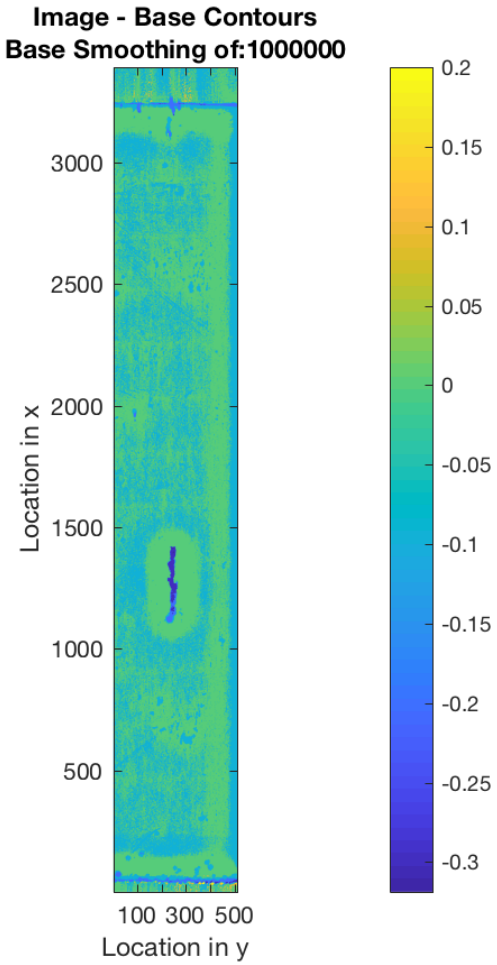

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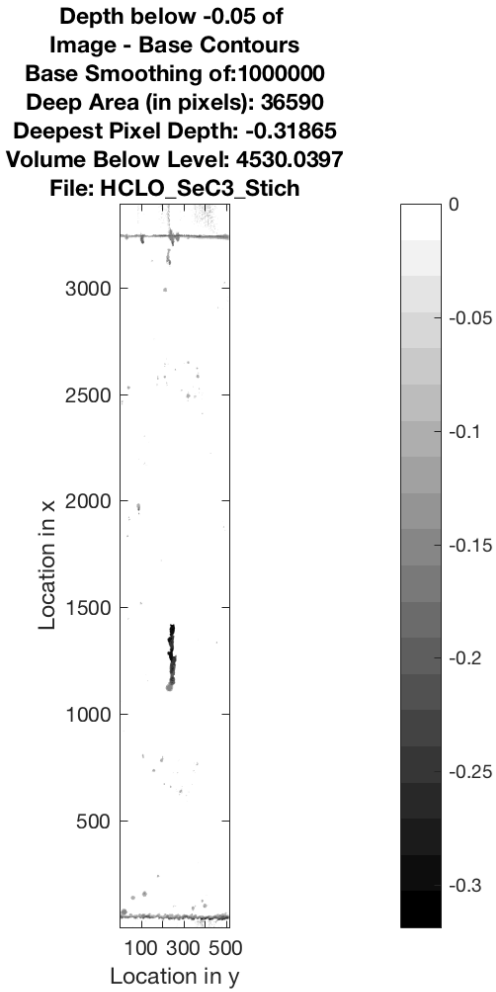

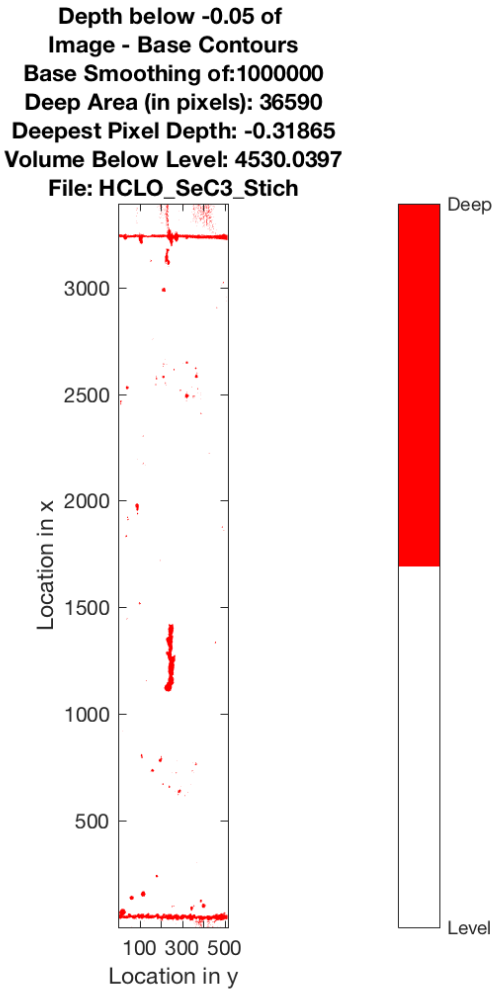

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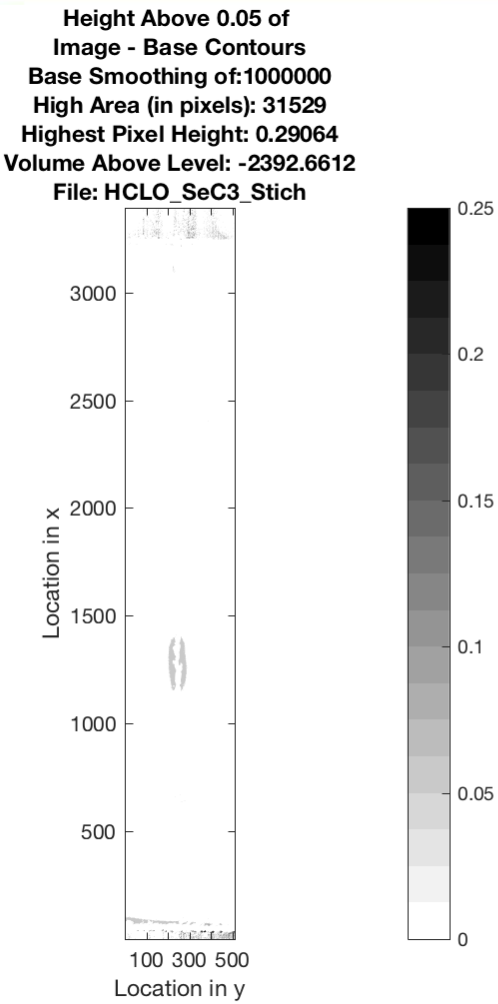

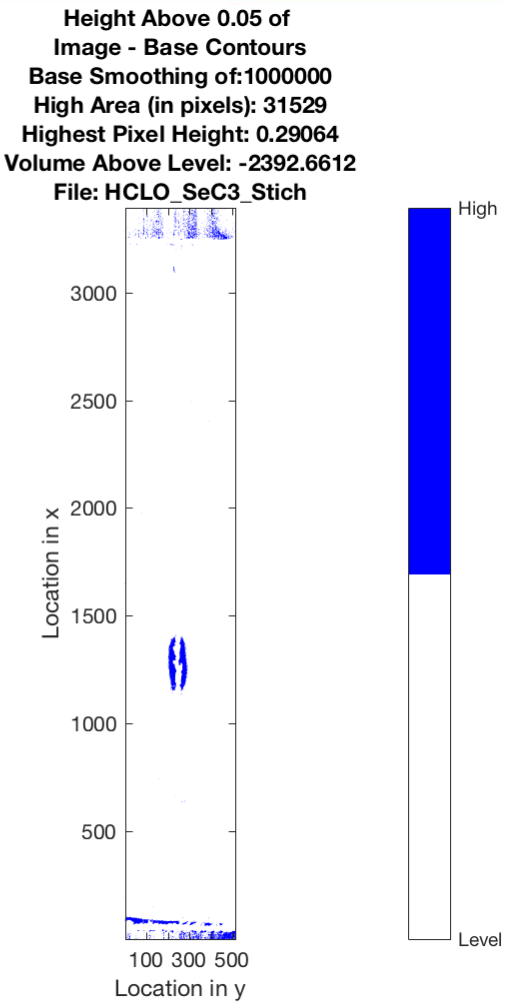

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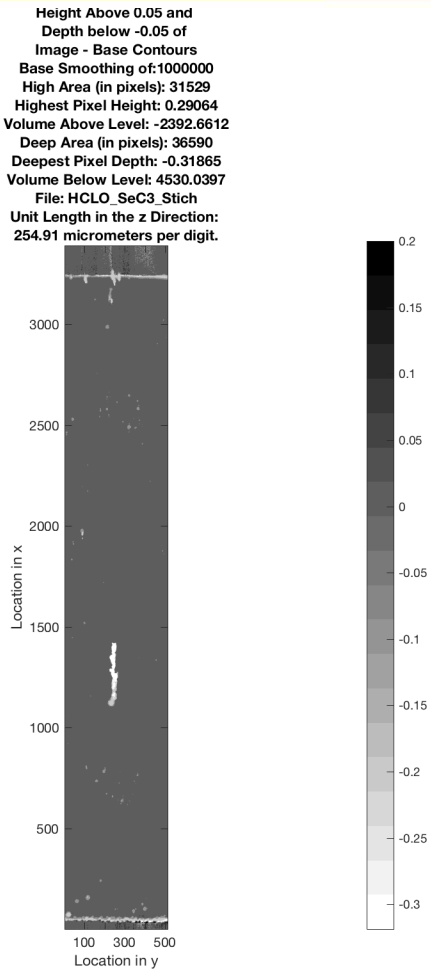
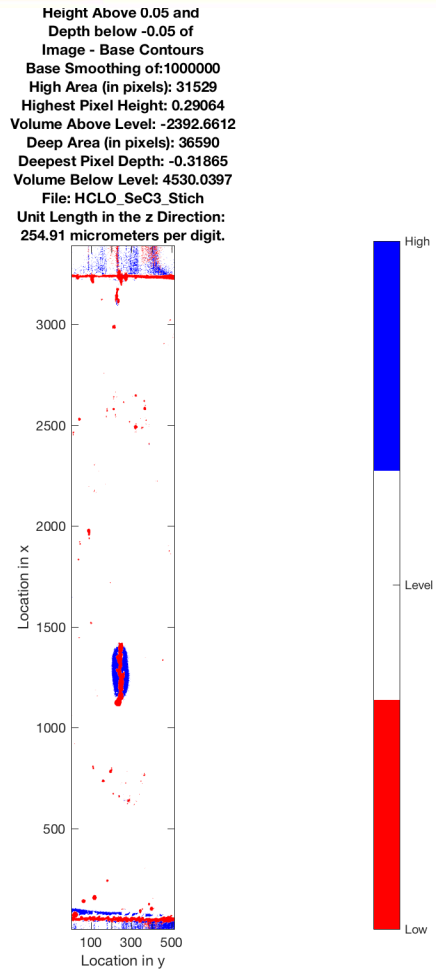
HCLO_SeC3_Stich





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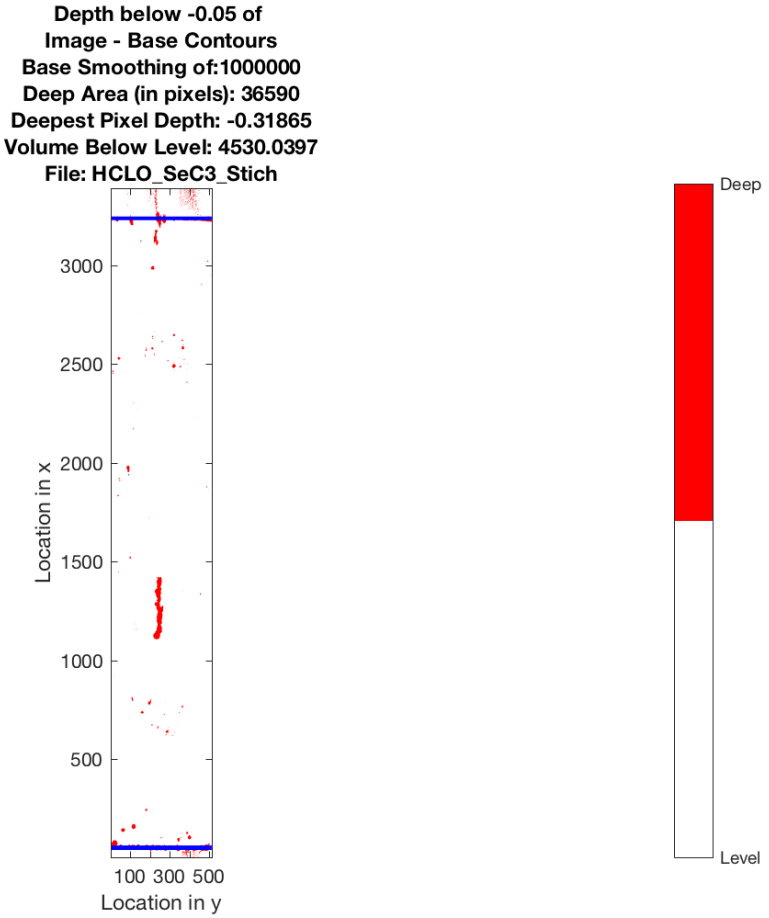

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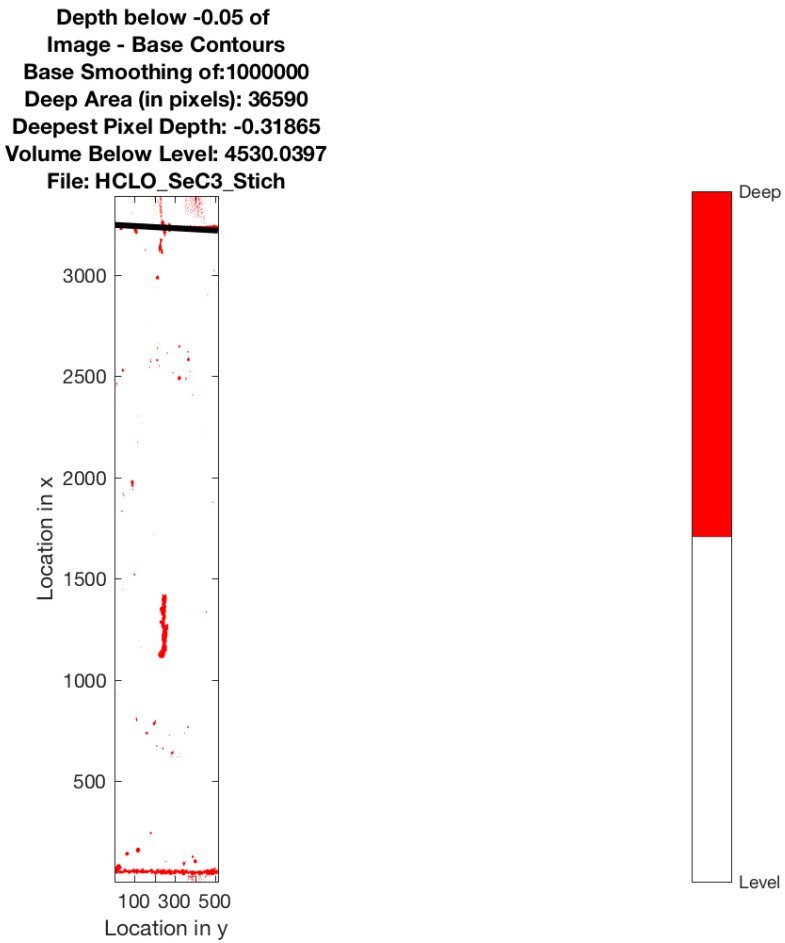
HCLO_SeC3_Stich



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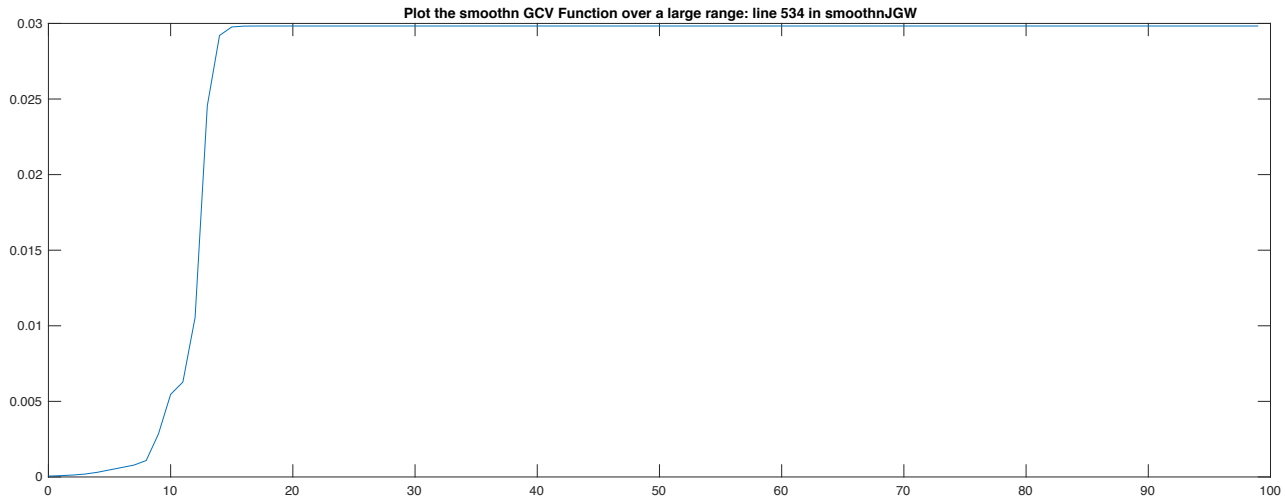

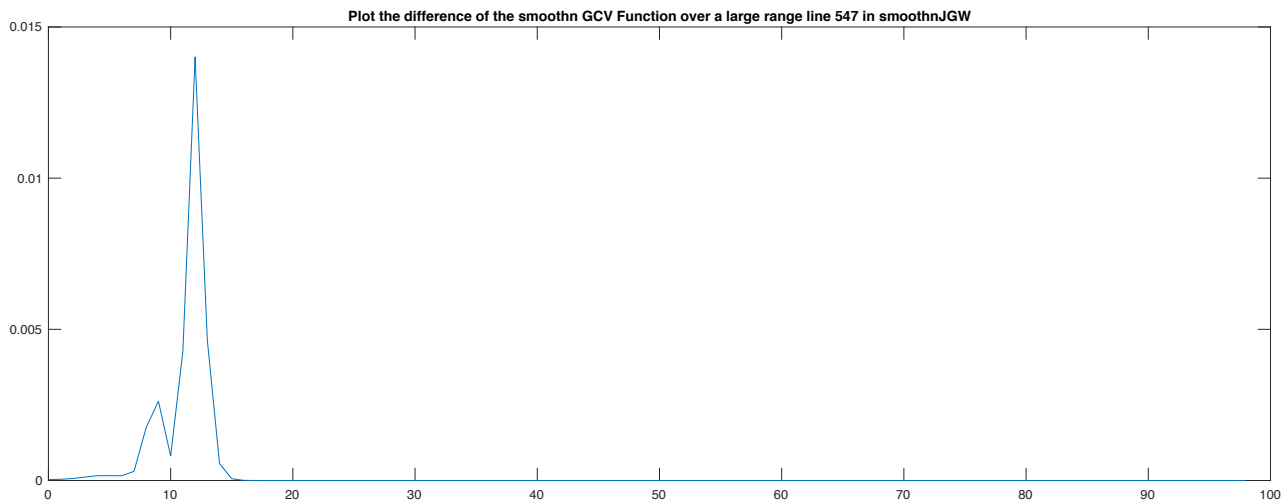

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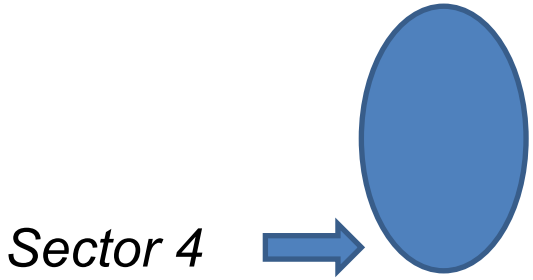
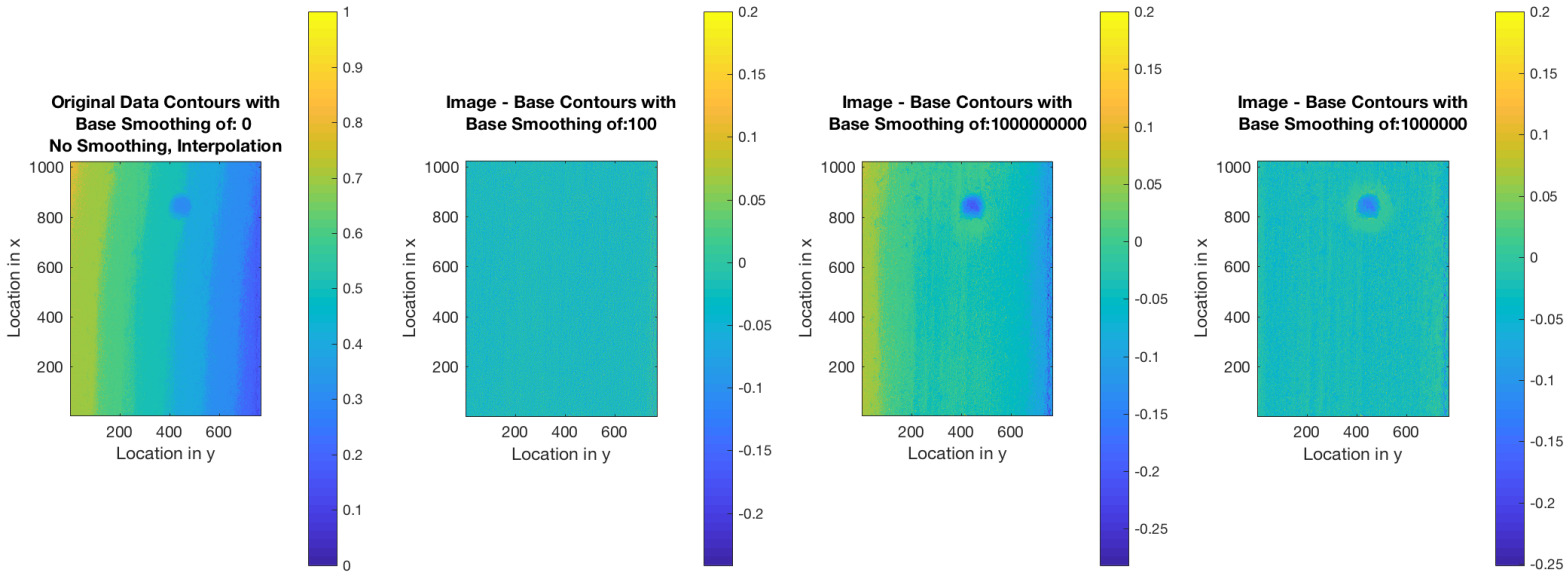
HCLO_UnPol_no_O2_Sec4_Y1_X1

1. 690 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 1024
4. Height 768
5. Stitched Images of Sector 4 of HClO Unpolished No Oxygen In Location Y1, X1 of a Teardrop



HCLO_UnPol_no_O2_Sec4_Y1_X1



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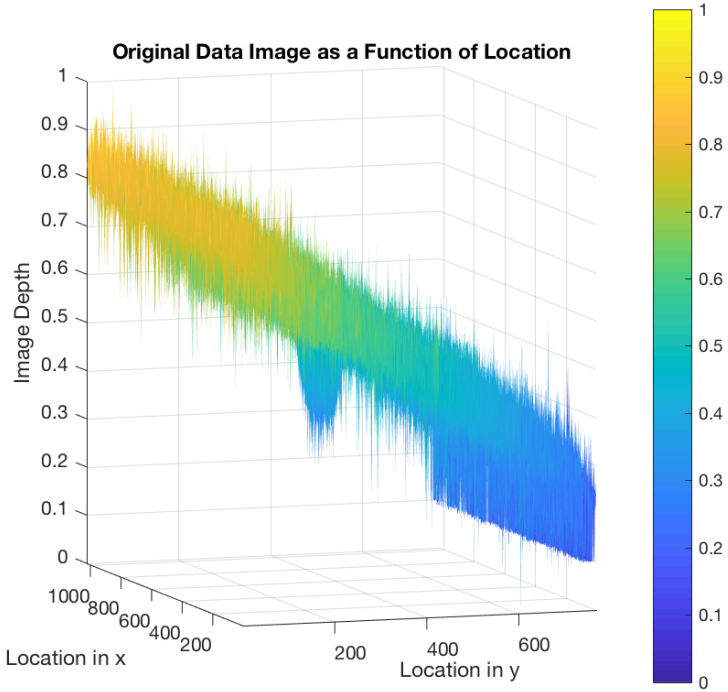
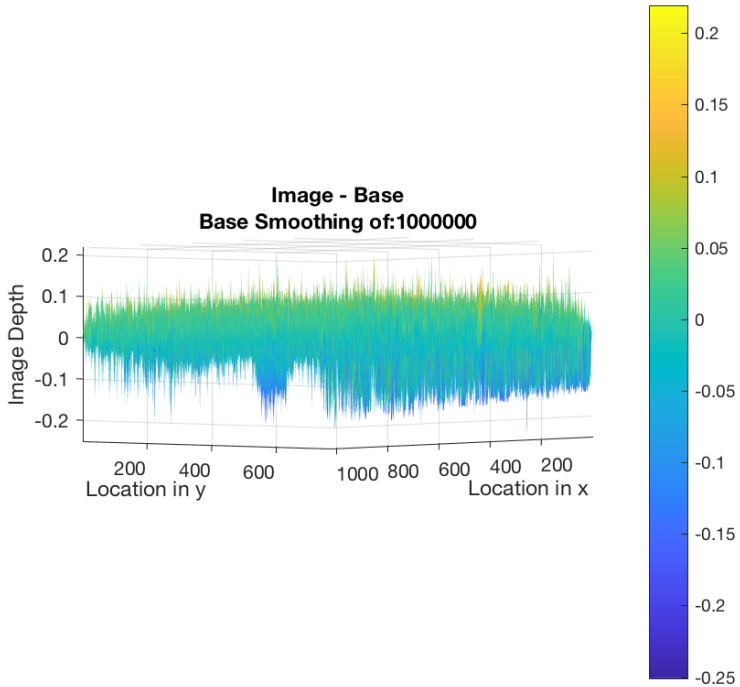
HCLO_UnPol_no_O2_Sec4_Y1_X1





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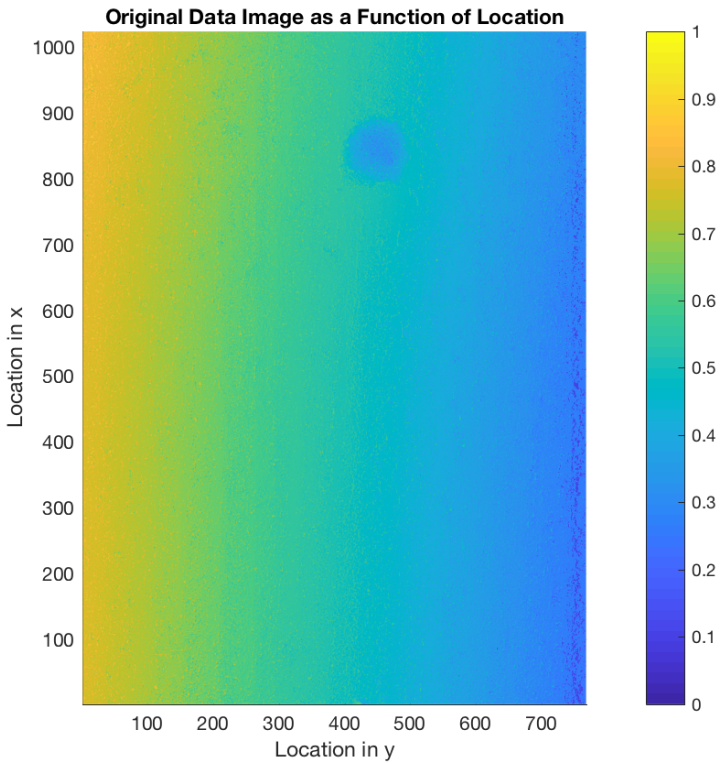
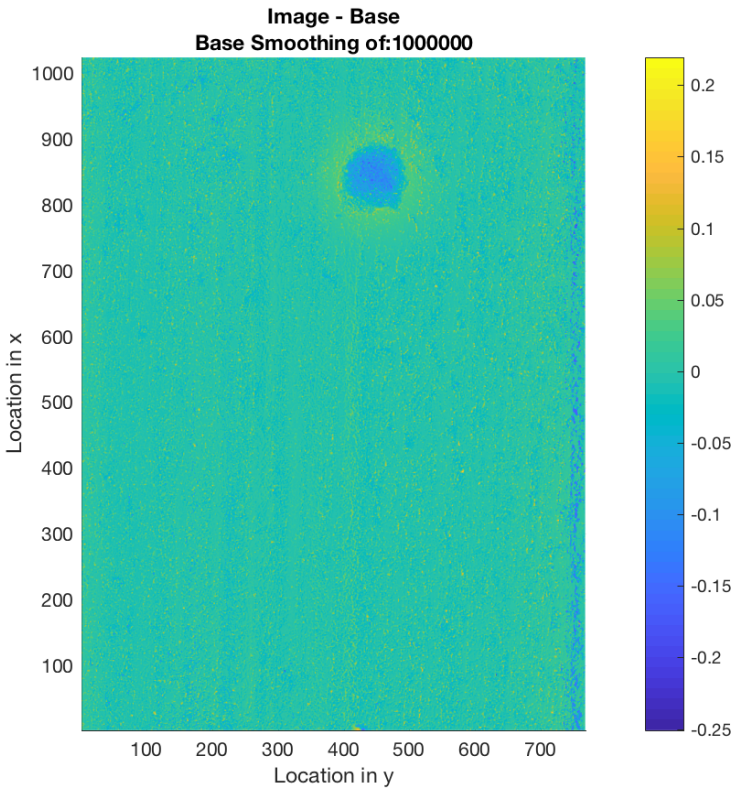
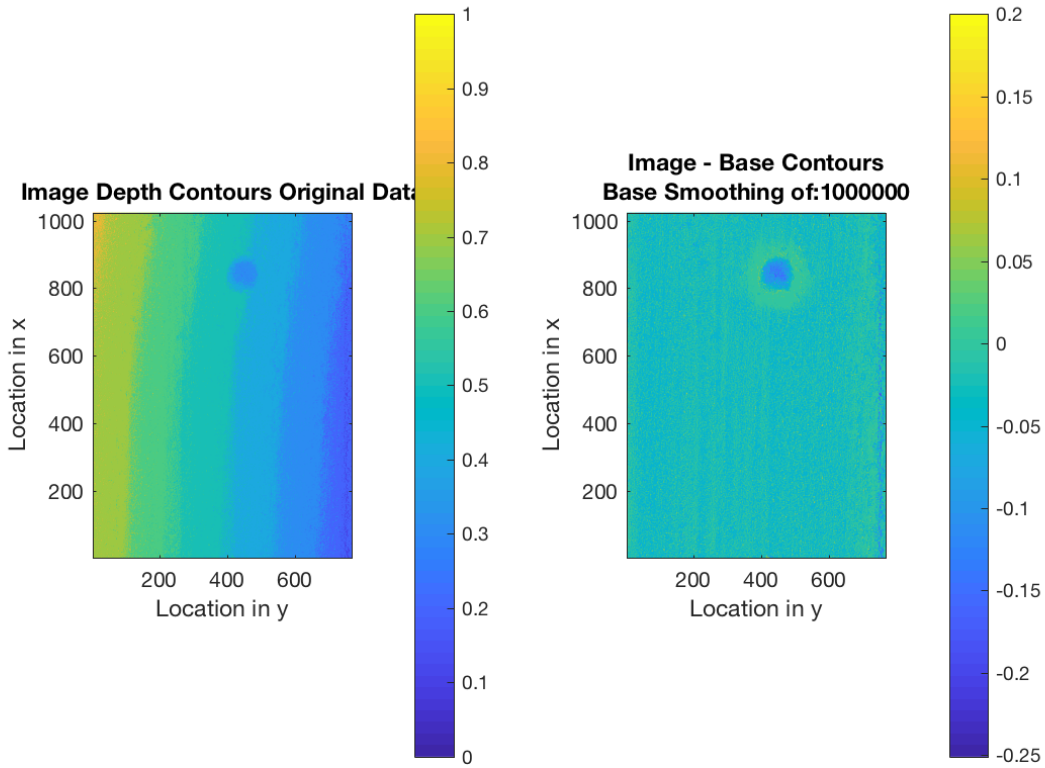
HCLO_UnPol_no_O2_Sec4_Y1_X1





HCLO_UnPol_no_O2_Sec4_Y1_X1



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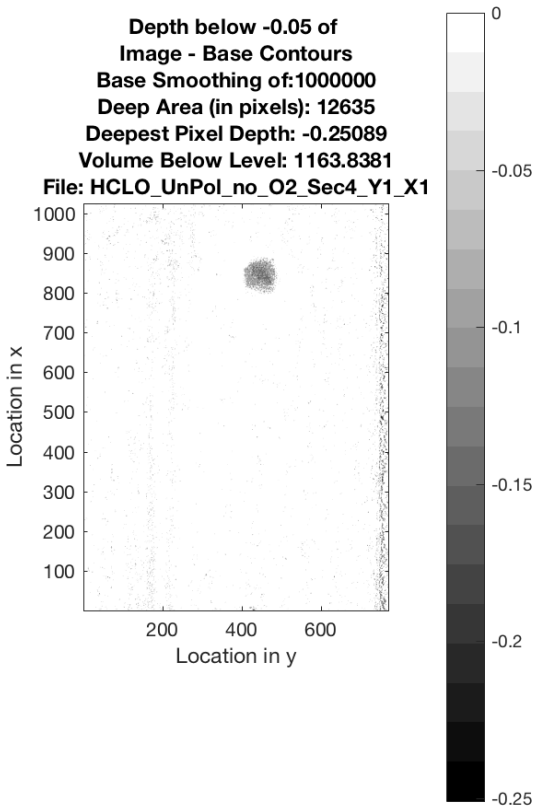
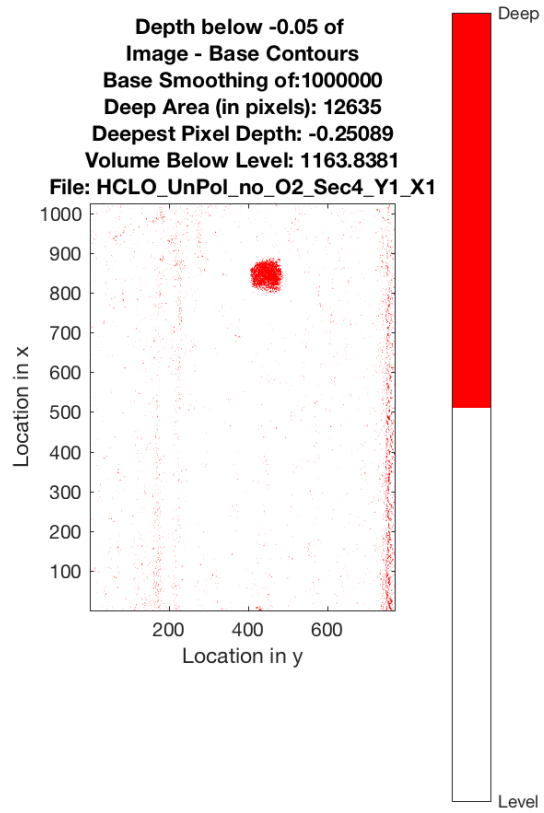
HCLO_UnPol_no_O2_Sec4_Y1_X1





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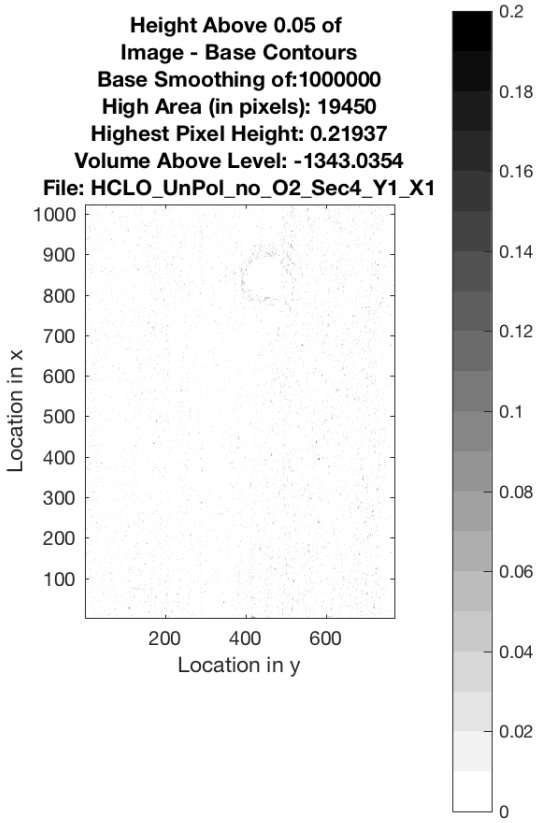
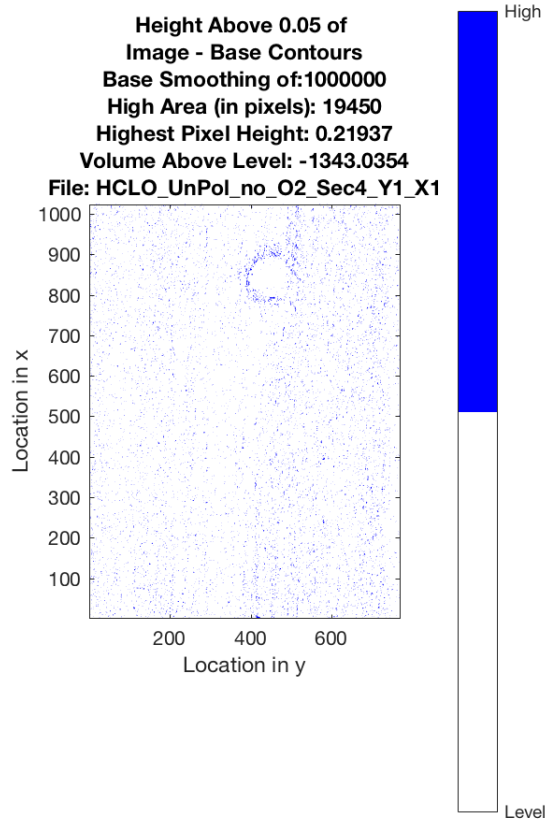
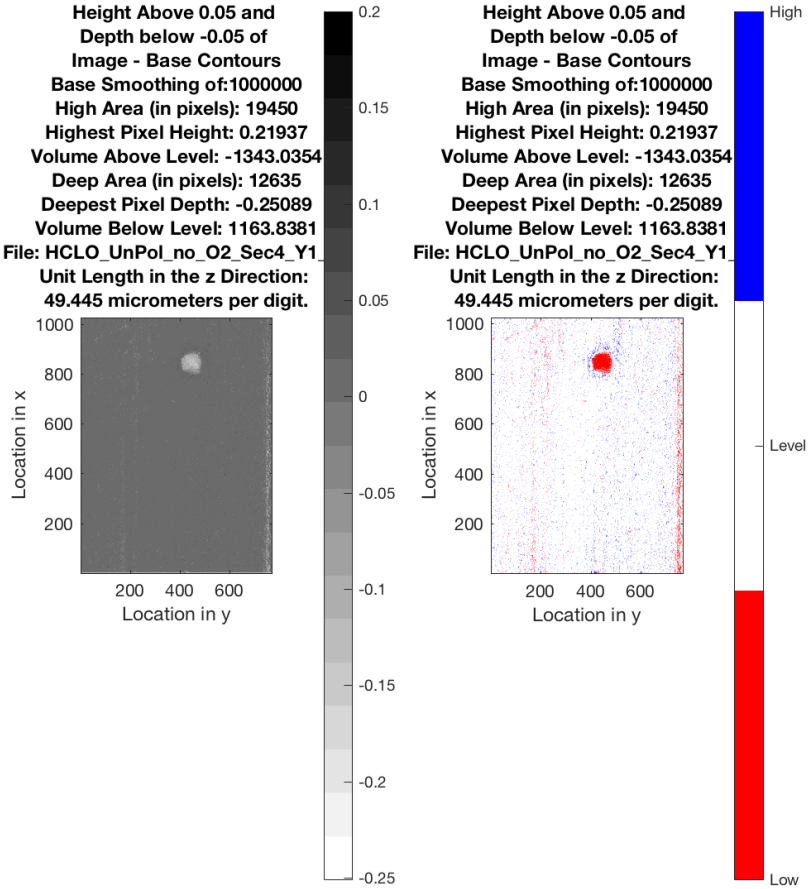
HCLO_UnPol_no_O2_Sec4_Y1_X1





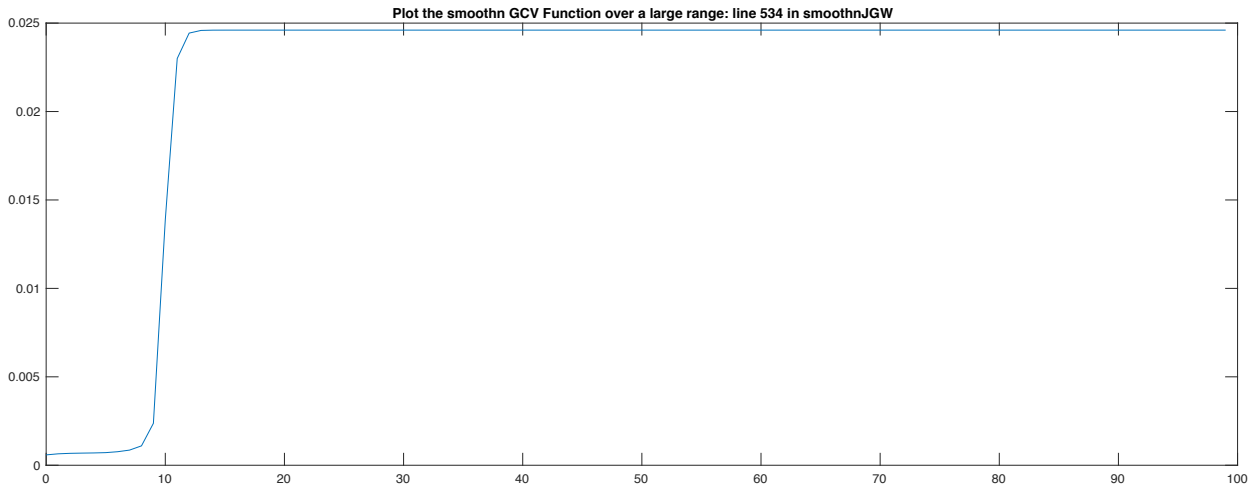
Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

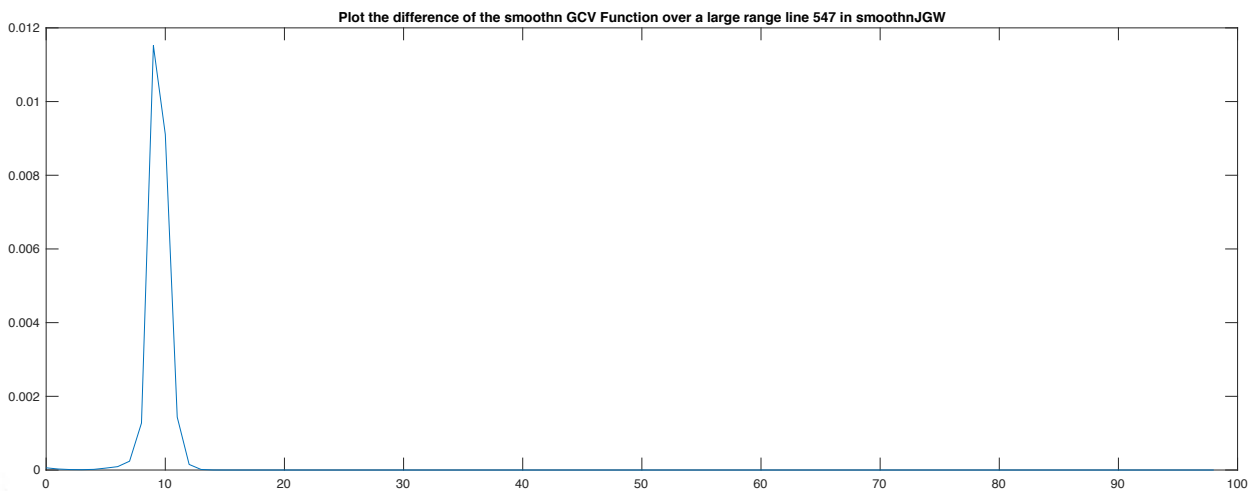
HCLO_UnPol_no_O2_Sec4_Y1_X1



Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

HCLO_UnPol_no_O2_Sec4_Y1_X1



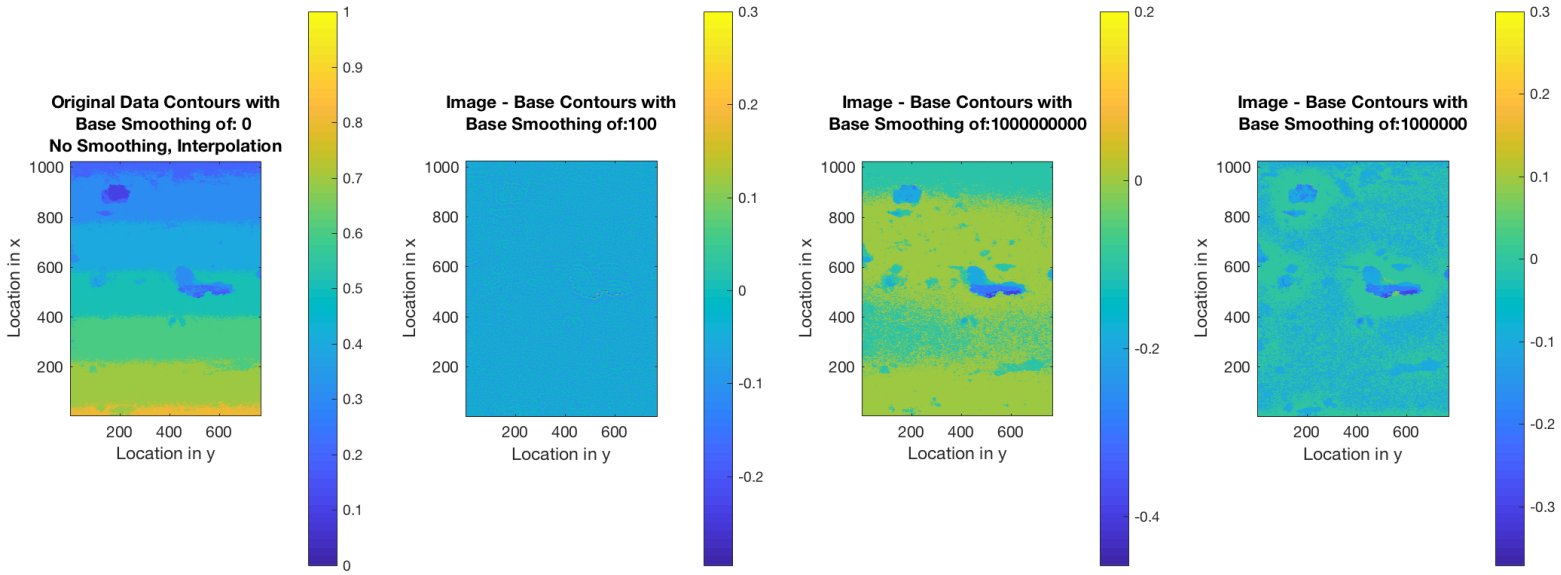


Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

MgCl2_Inside__Y1_X6

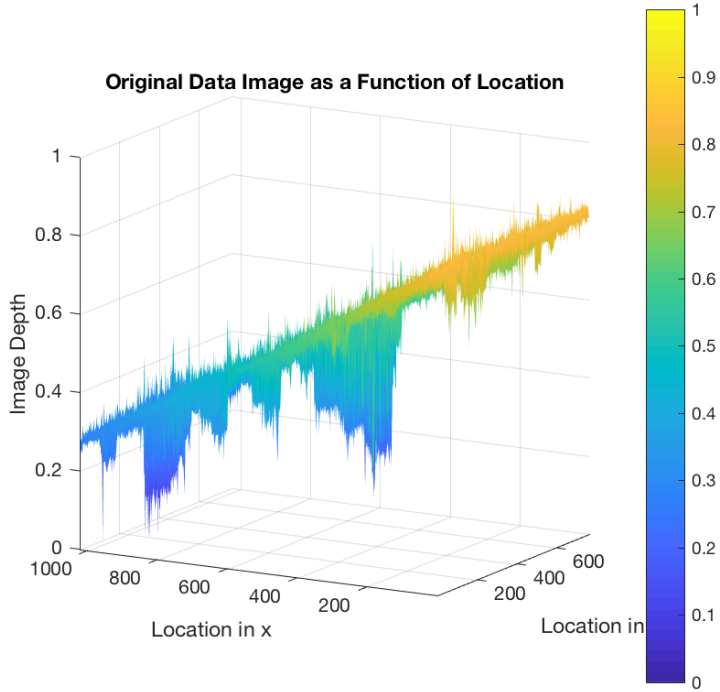
1. 690 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 1024
4. Height 768
5. Magnesium Chloride In Location Y1, X6 Inside Can at 20x Magnification

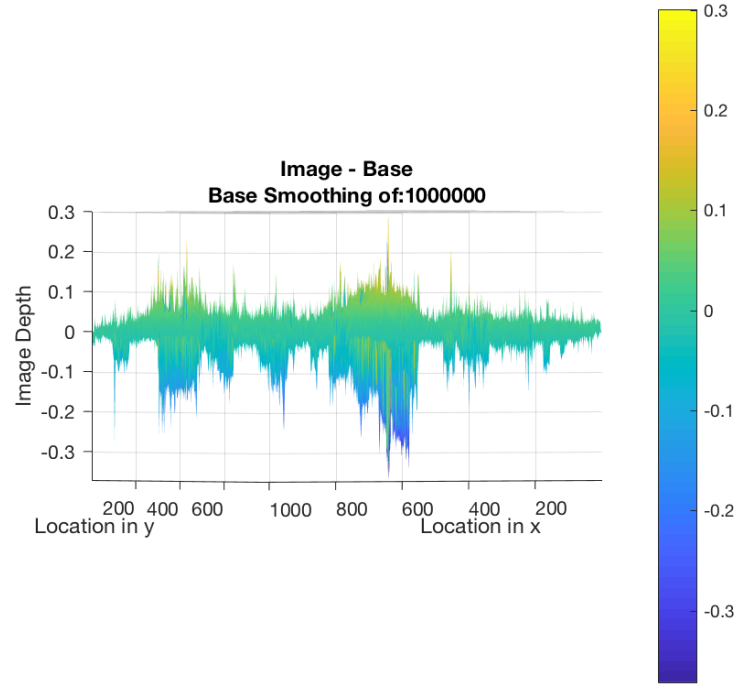
MgCl2_Inside__Y1_X6



Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

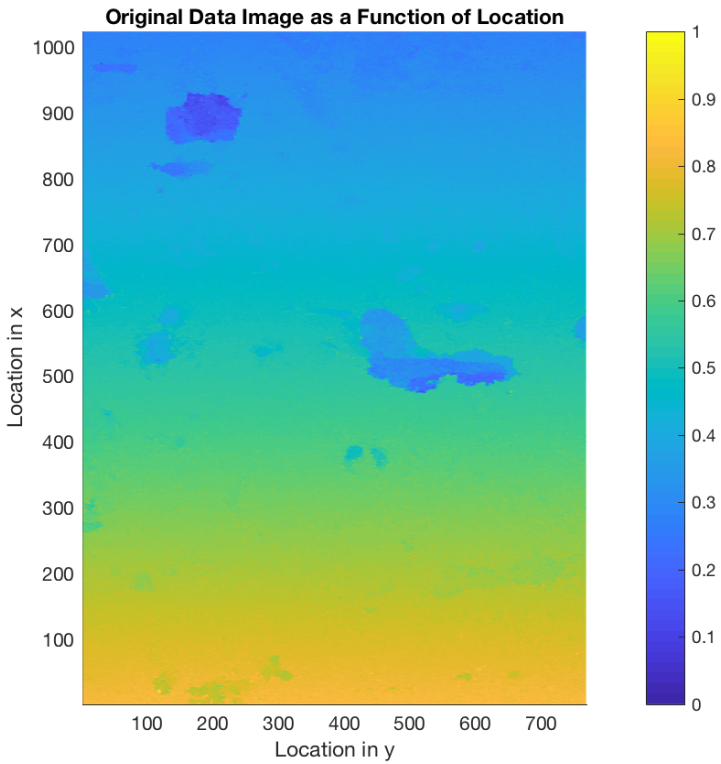
MgCl2_Inside__Y1_X6

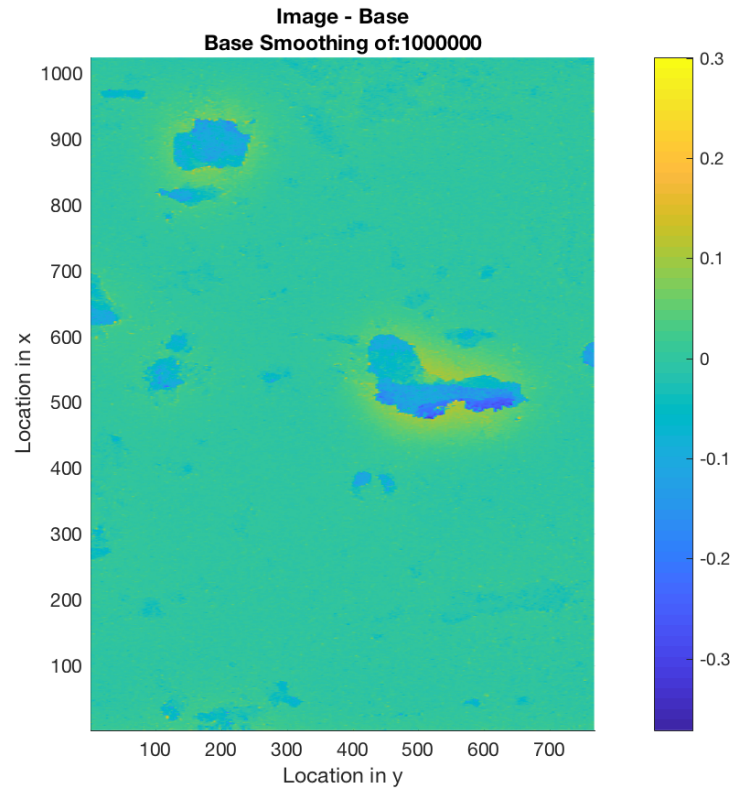




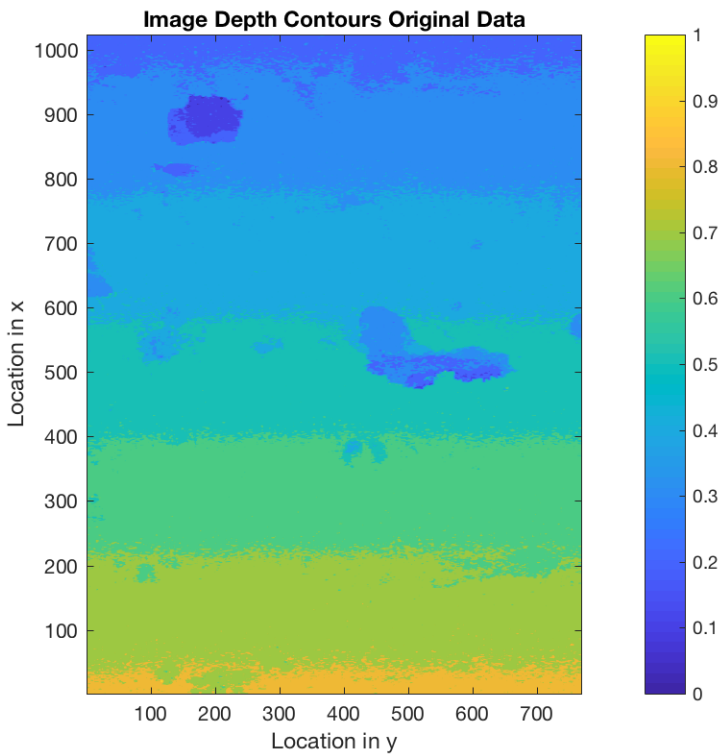
Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

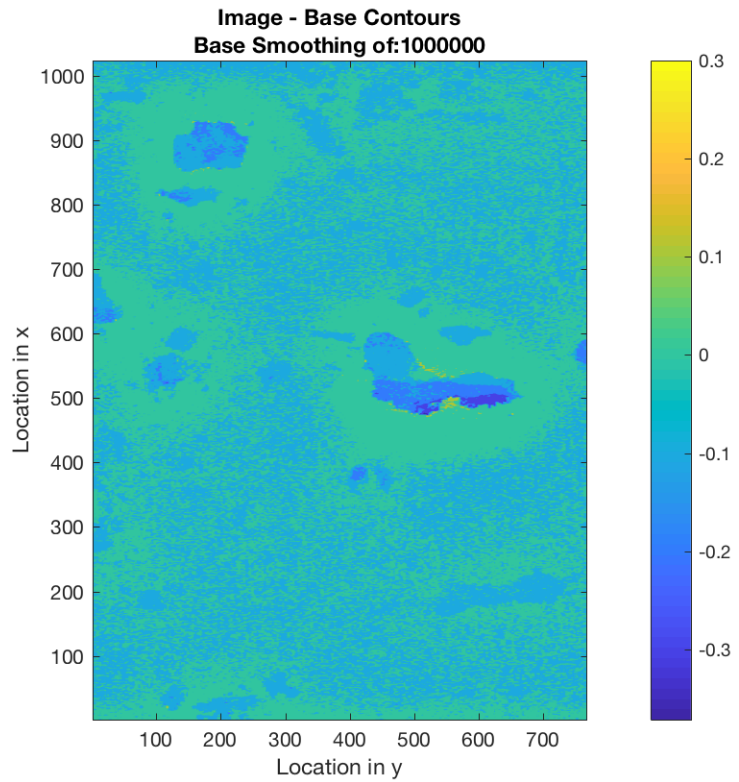
MgCl2_Inside__Y1_X6



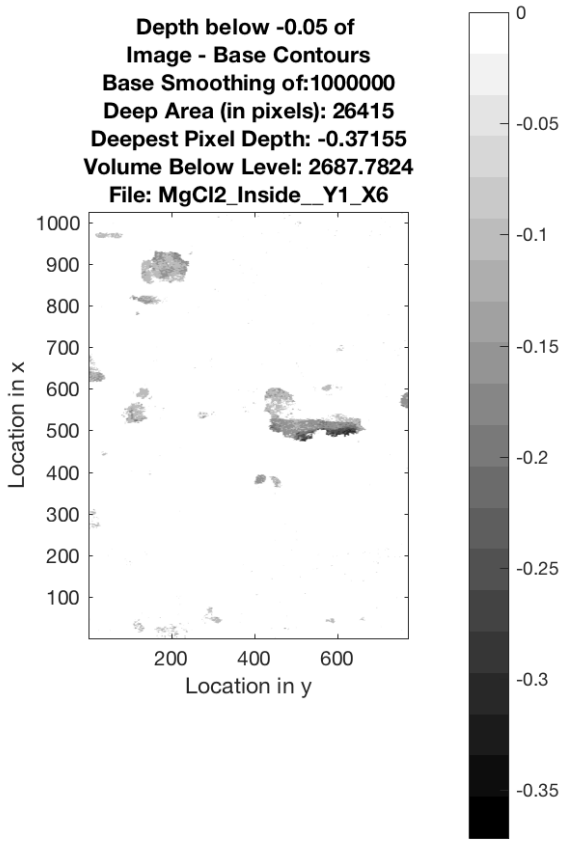


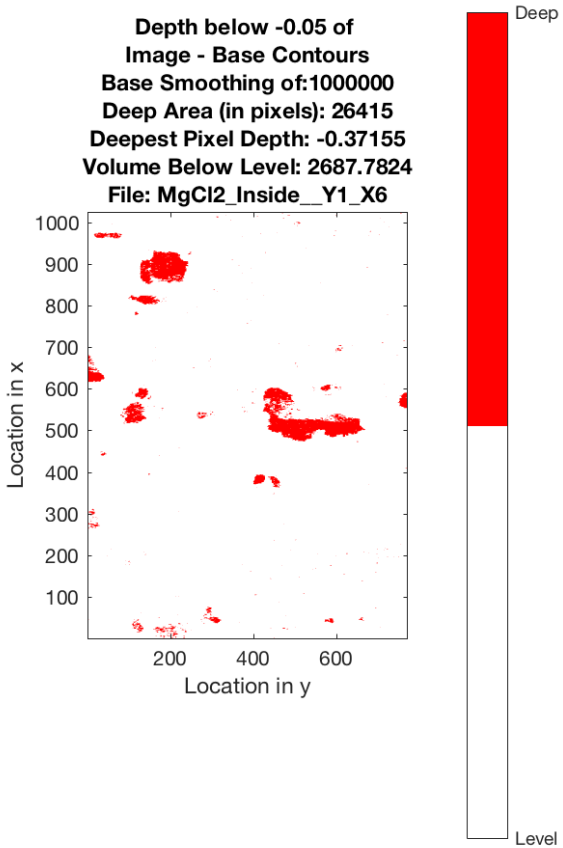
MgCl2_Inside__Y1_X6





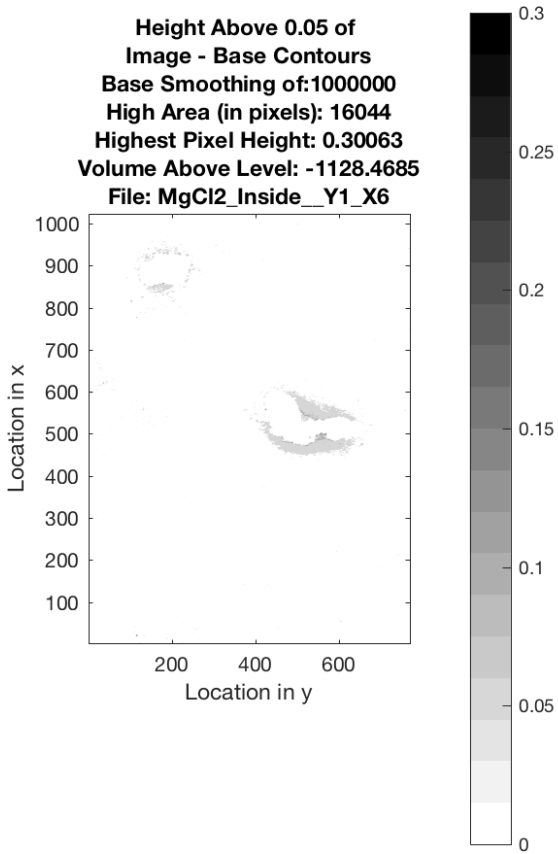
MgCl2_Inside__Y1_X6

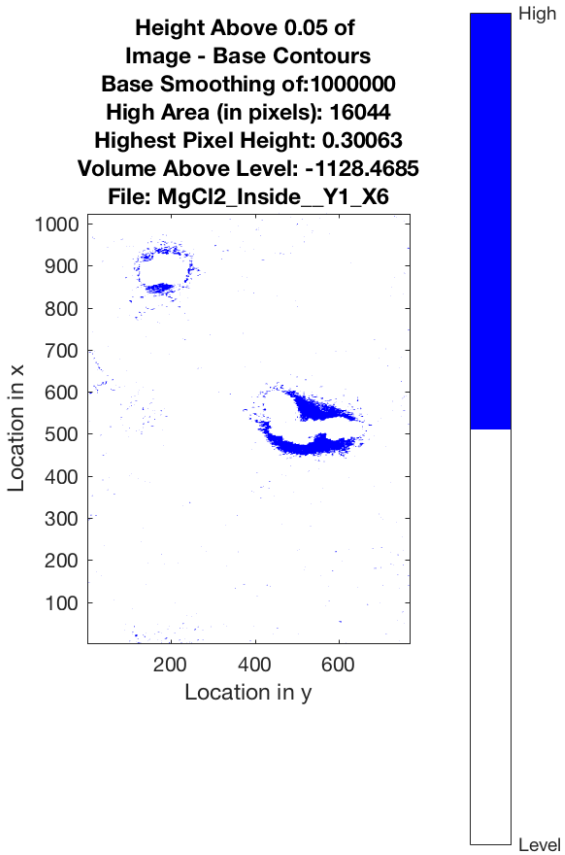




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

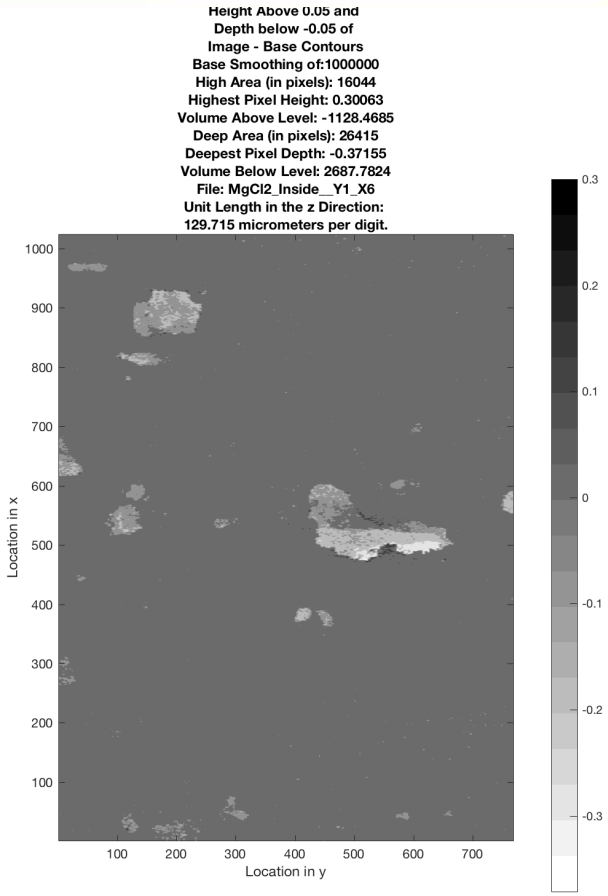
MgCl2_Inside__Y1_X6

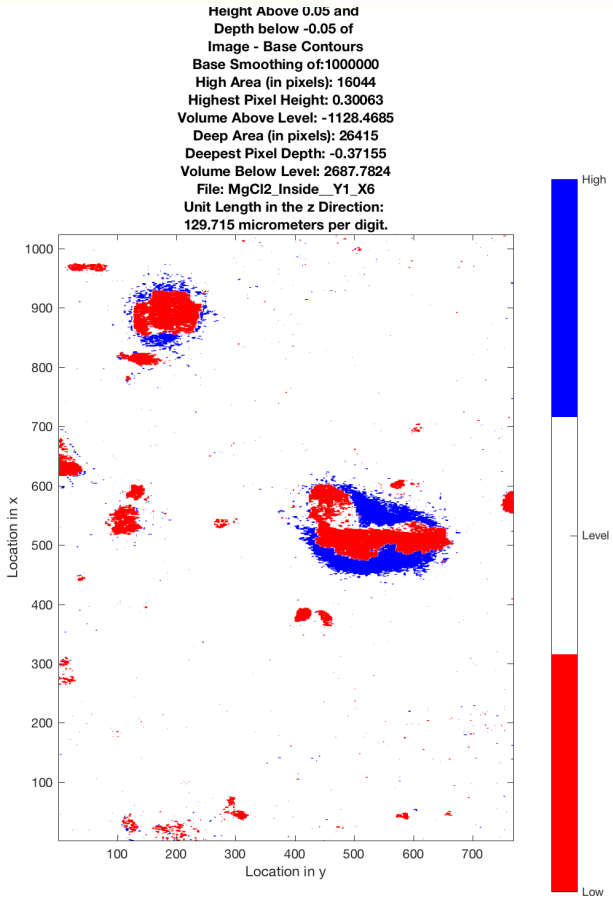




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

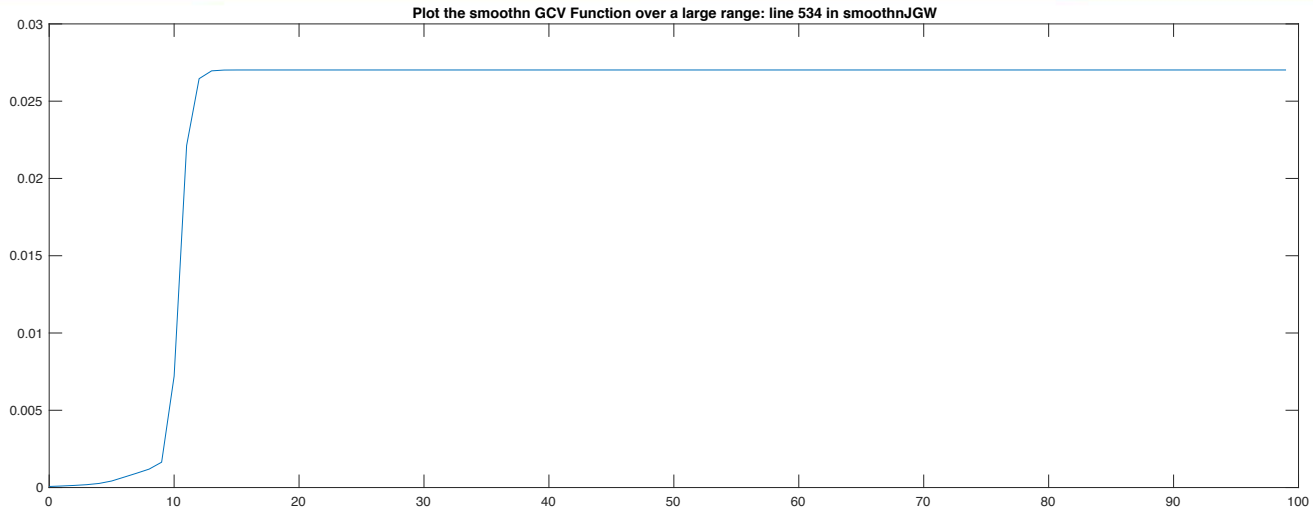
MgCl2_Inside__Y1_X6

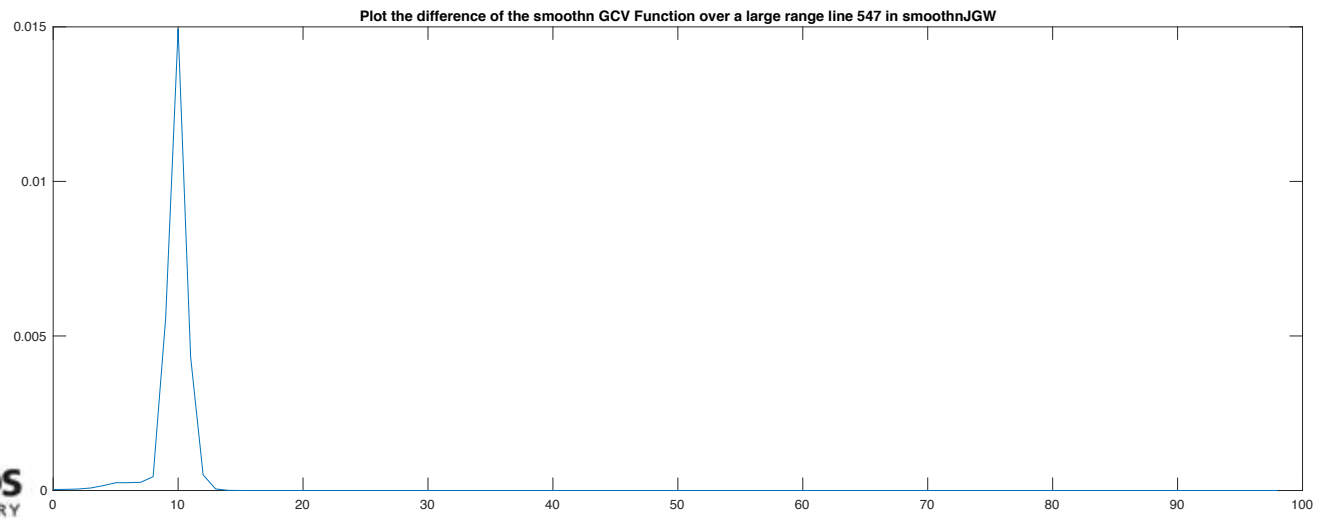




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

MgCl2_Inside__Y1_X6



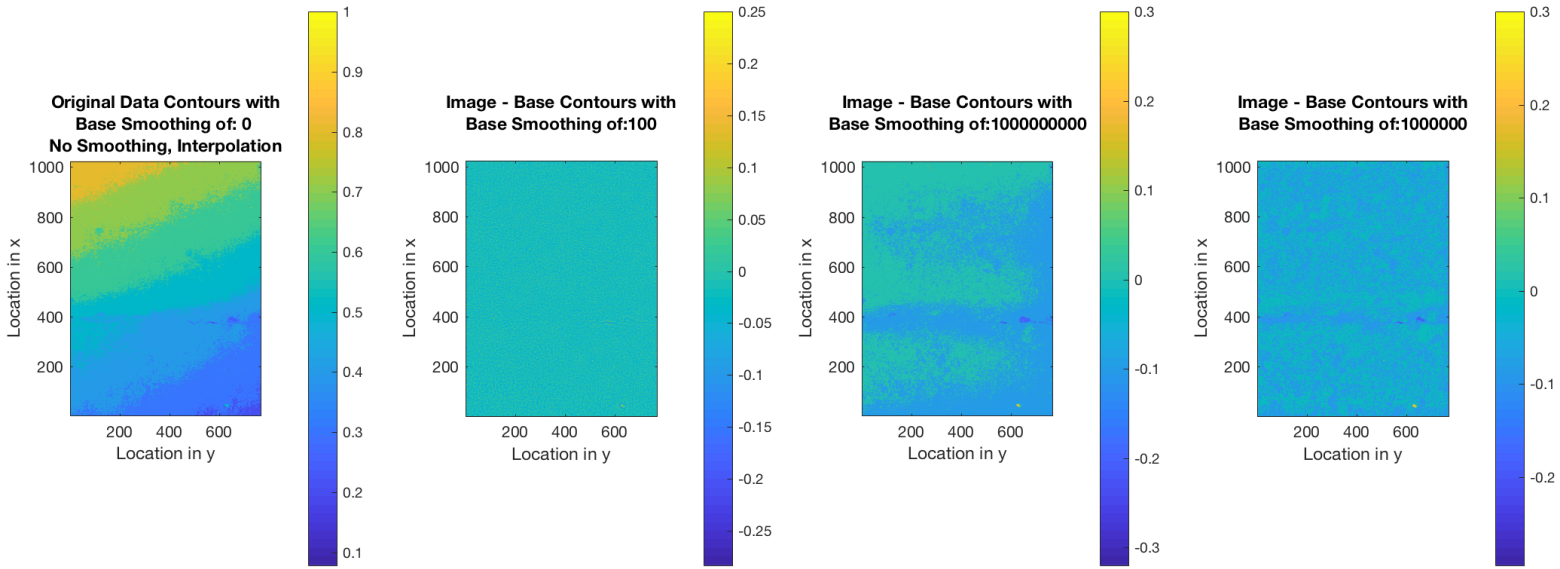


Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

MgCl2_Inside__Y15_X18

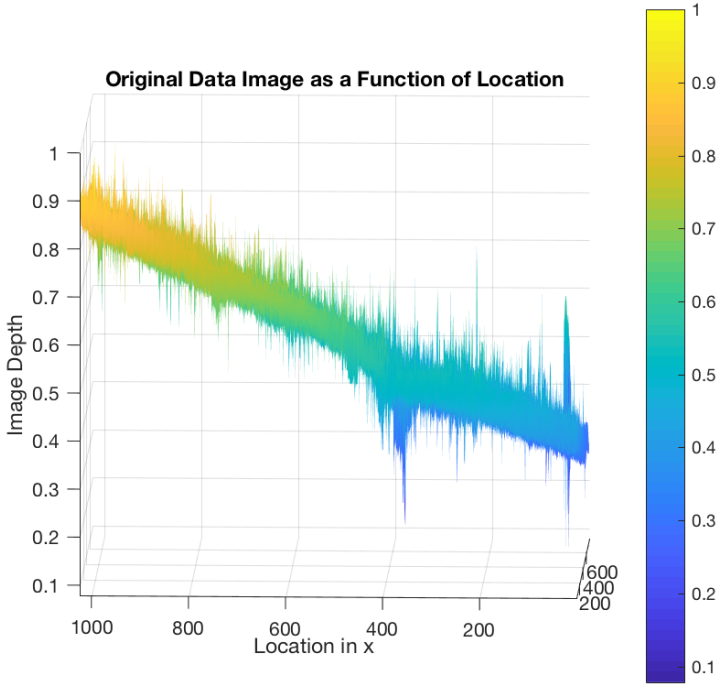
1. 690 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 1024
4. Height 768
5. Magnesium Chloride In Location Y15, X18 Inside Can at 20x Magnification

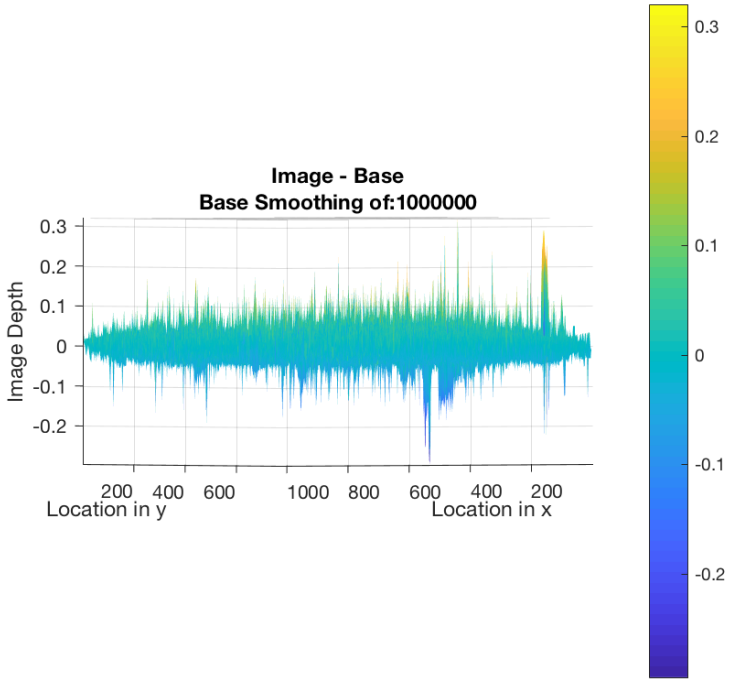
MgCl2_Inside__Y15_X18



Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

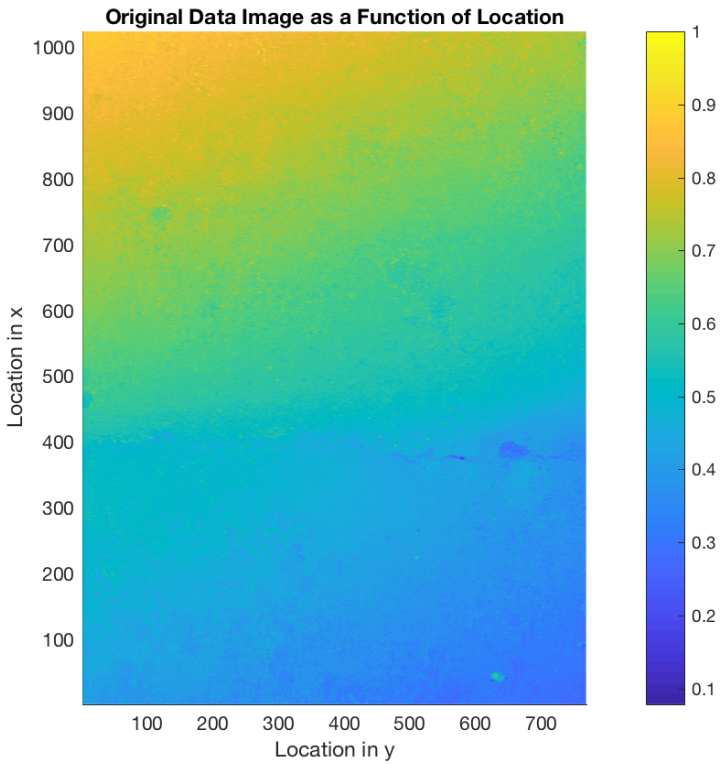
MgCl2_Inside__Y15_X18

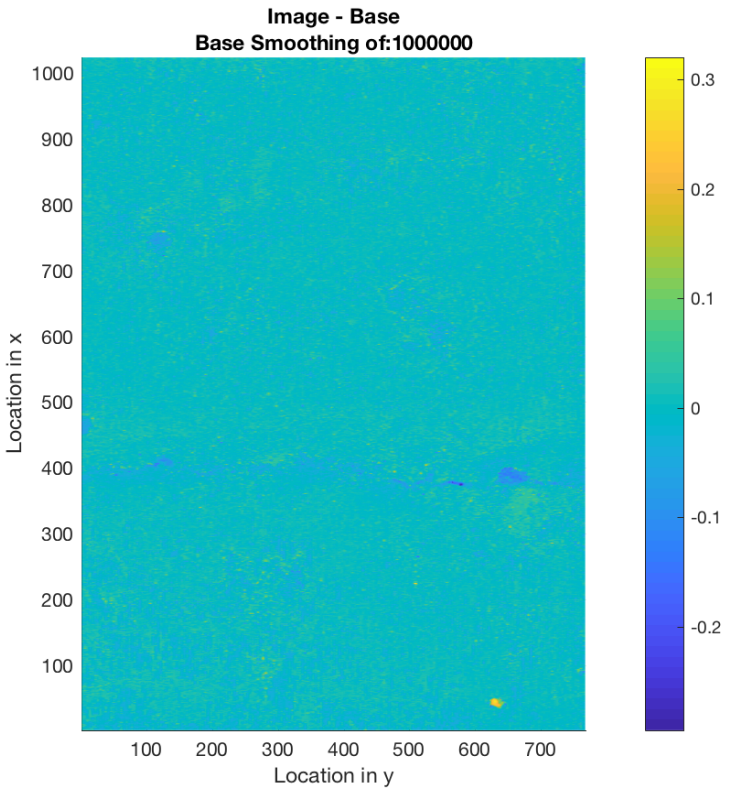




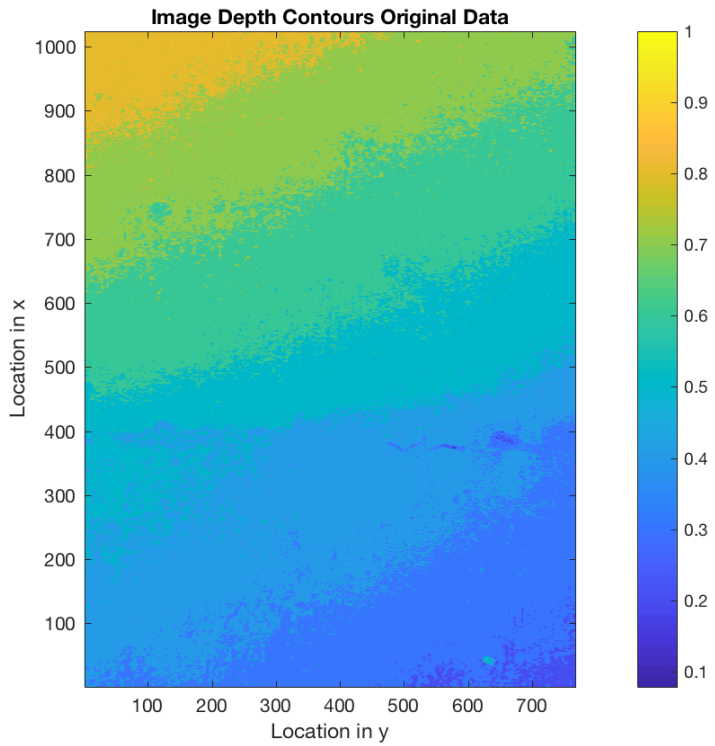
Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

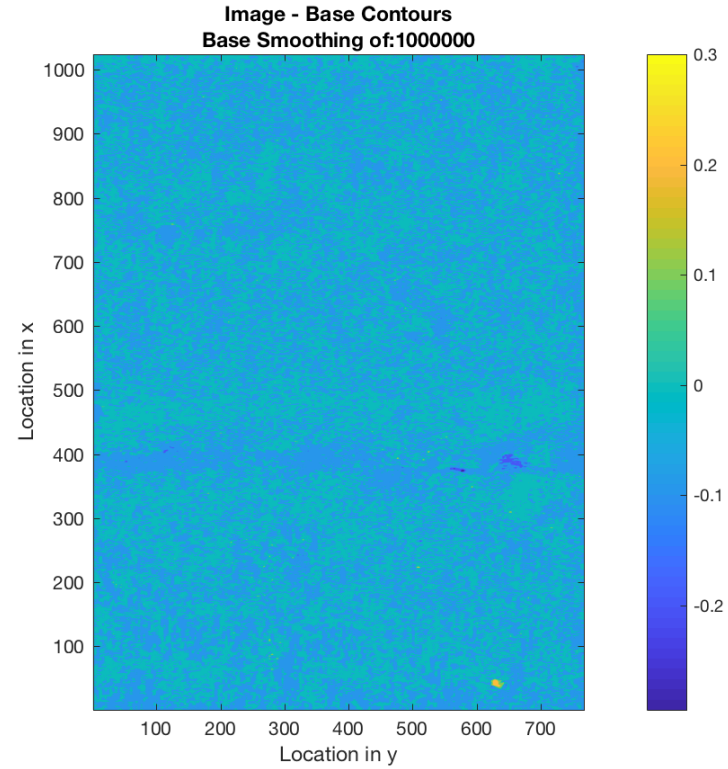
MgCl2_Inside__Y15_X18



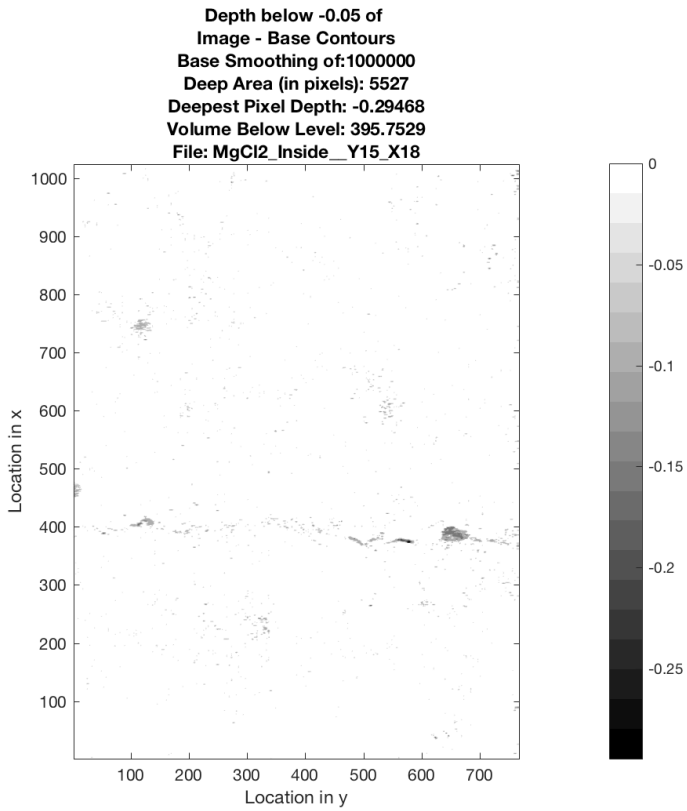


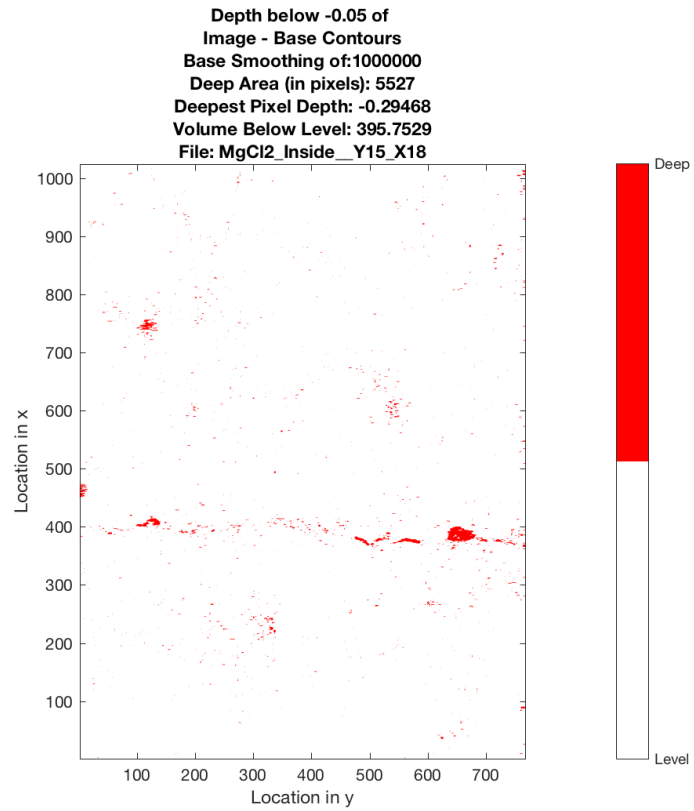
MgCl2_Inside__Y15_X18





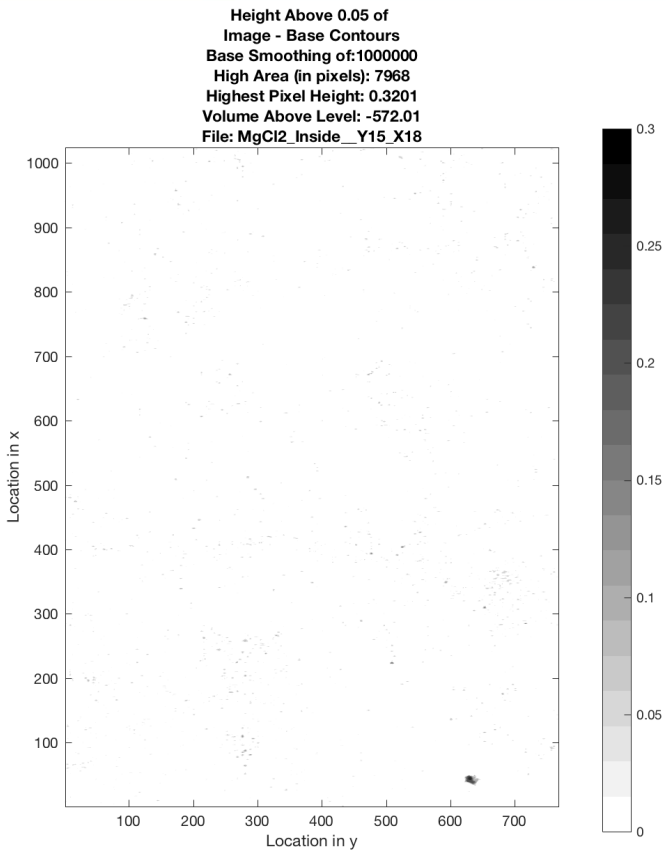
MgCl2_Inside__Y15_X18

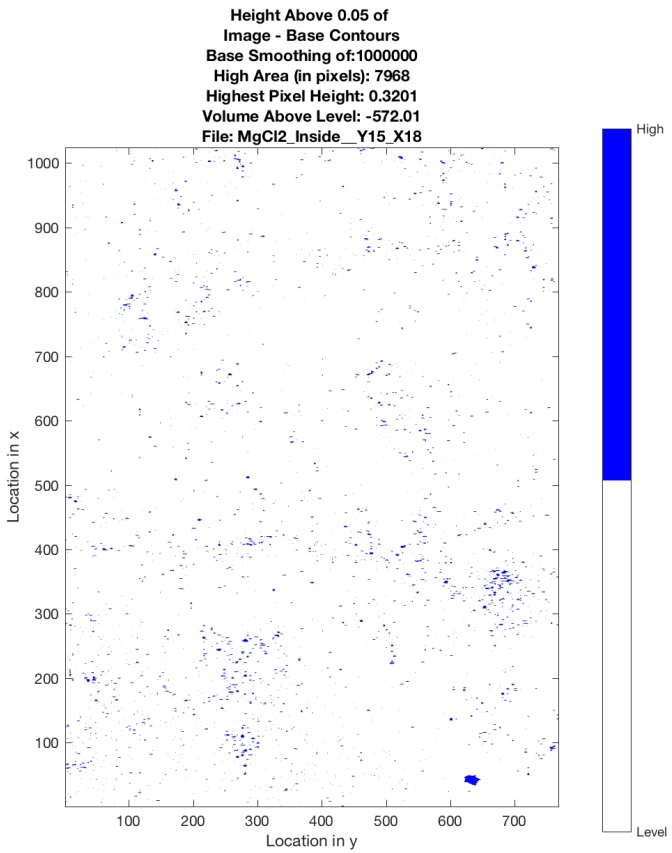




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

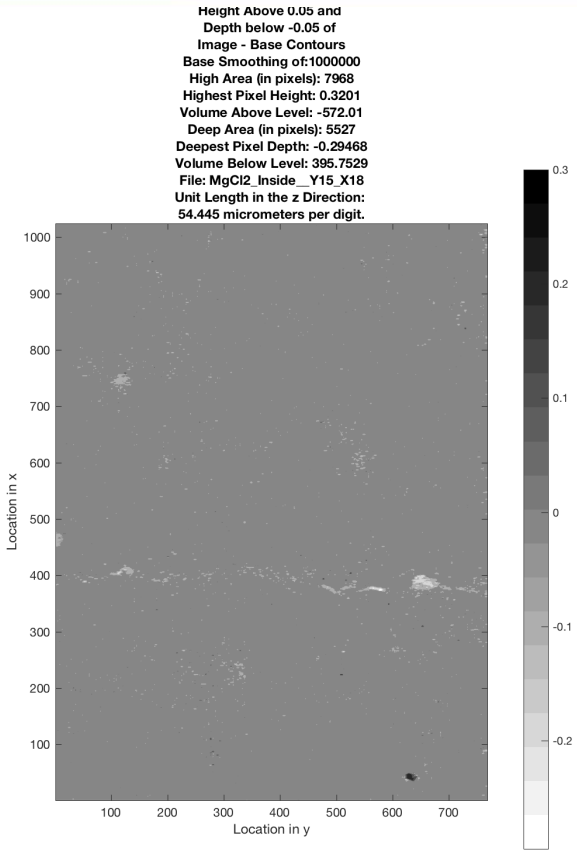
MgCl2_Inside__Y15_X18

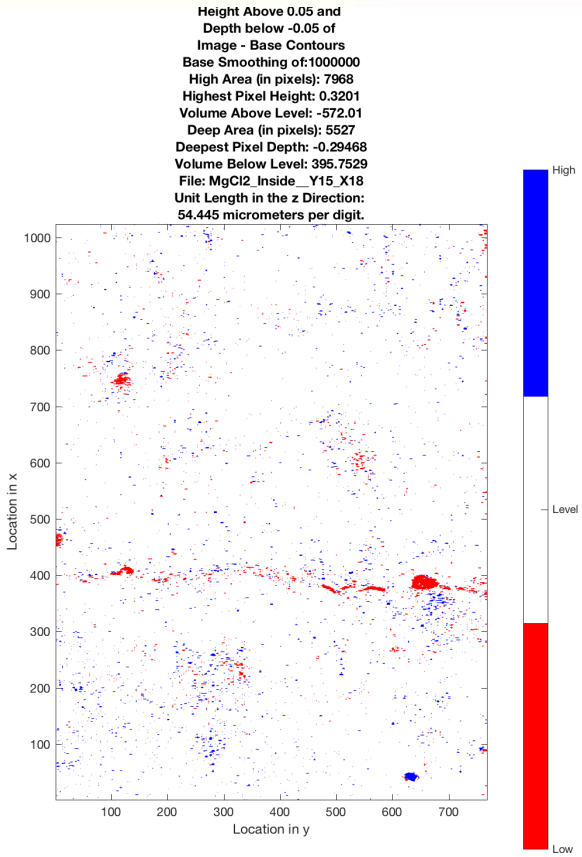




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

MgCl2_Inside__Y15_X18





Los Alamos NATIONAL LABORATORY EST. 1943
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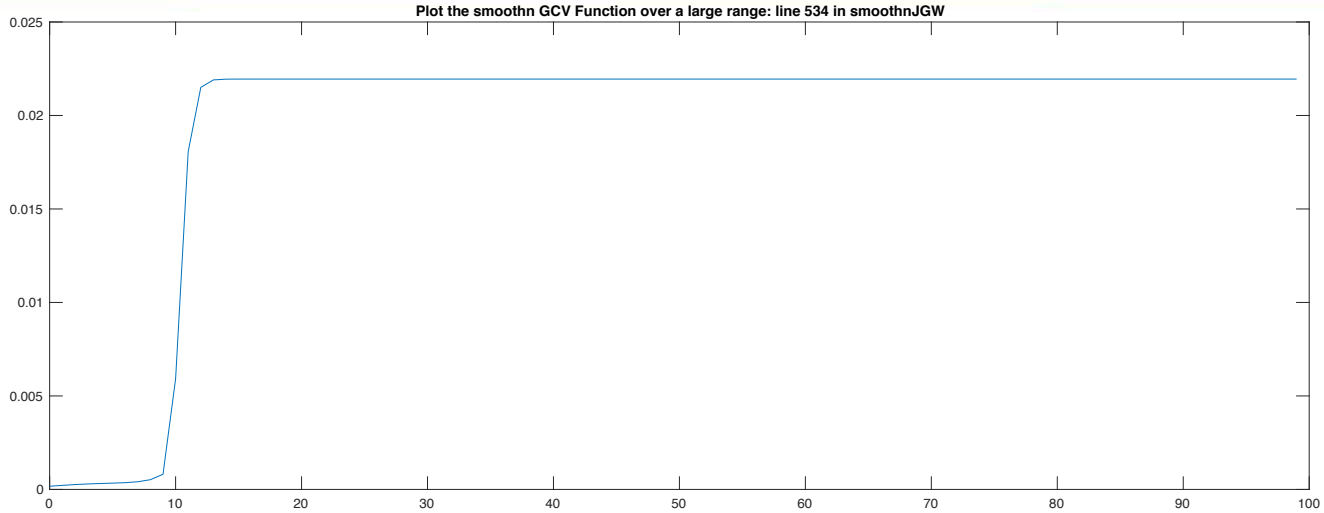
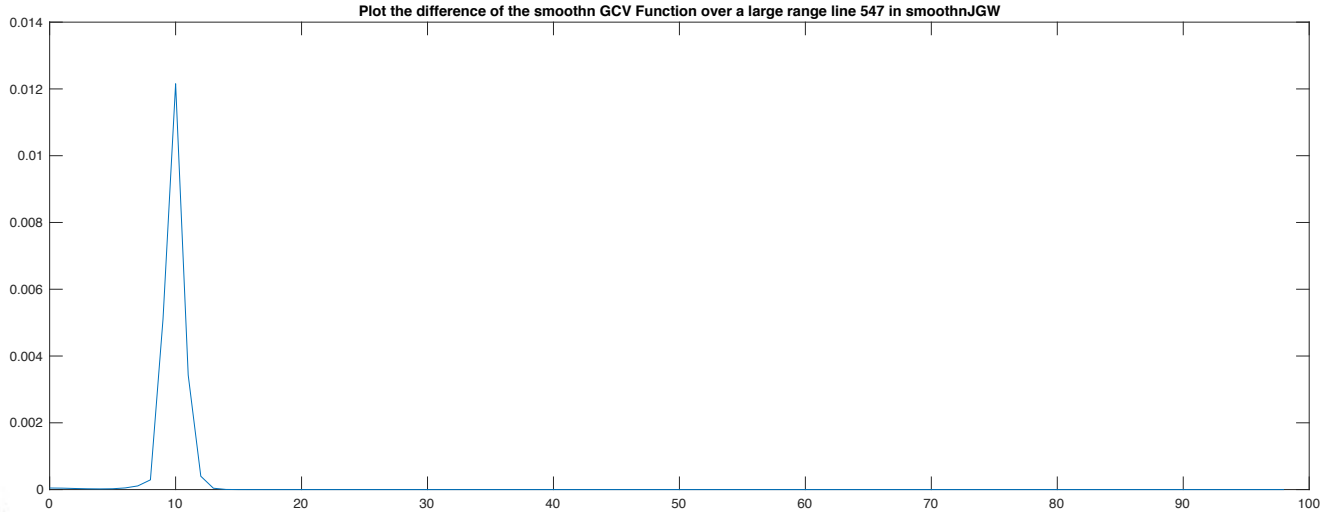
MgCl2_Inside__Y15_X18





Los Alamos NATIONAL LABORATORY EST. 1943
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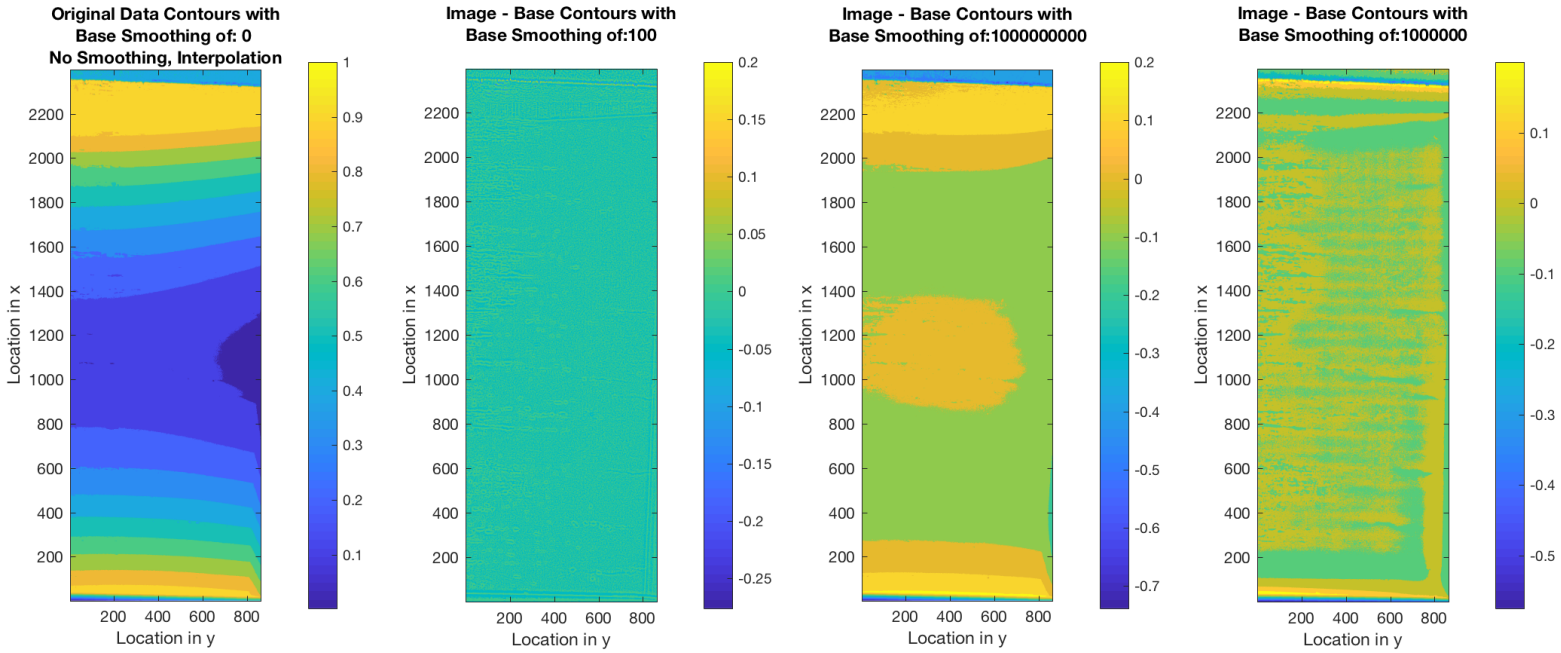
MgCl2_Inside_

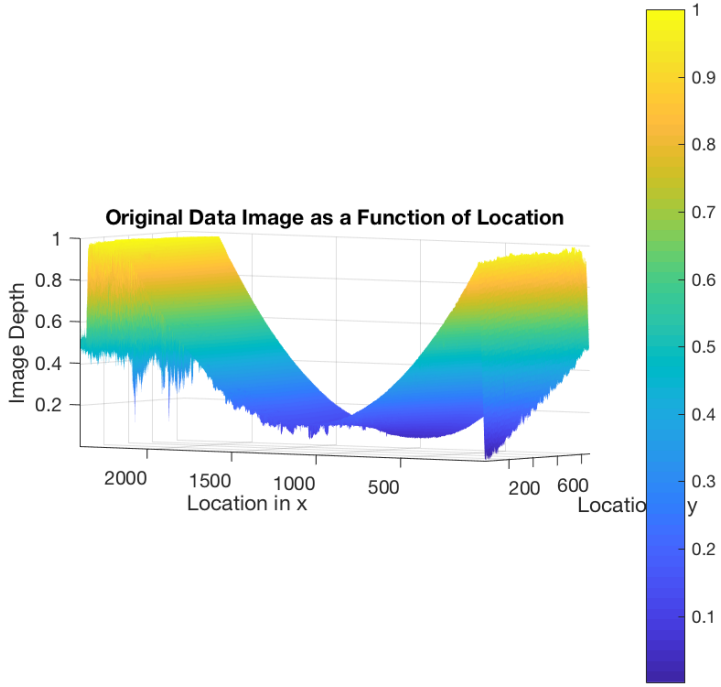
1. 8276 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 2399
4. Height 863
5. Magnesium Chloride Stitched Image Inside Can

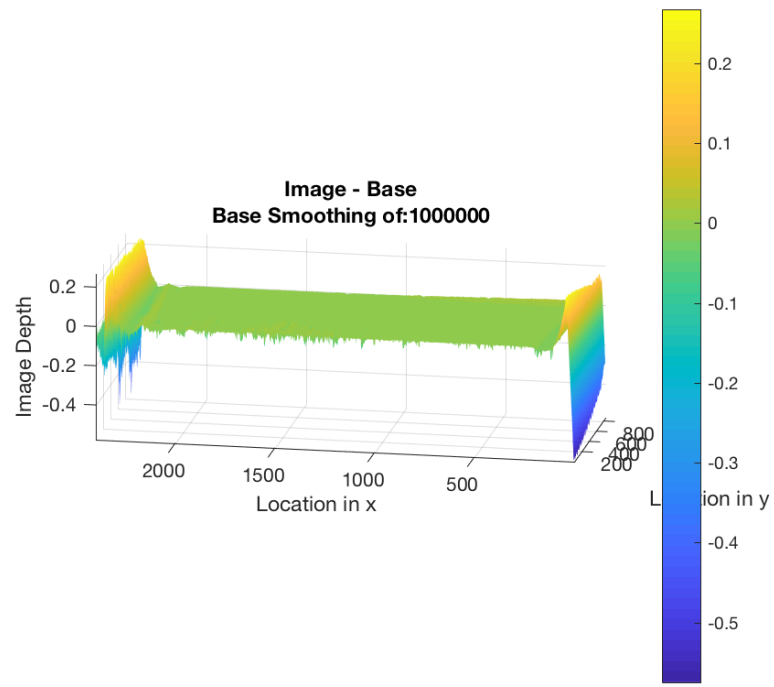
MgCl2_Inside_



Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

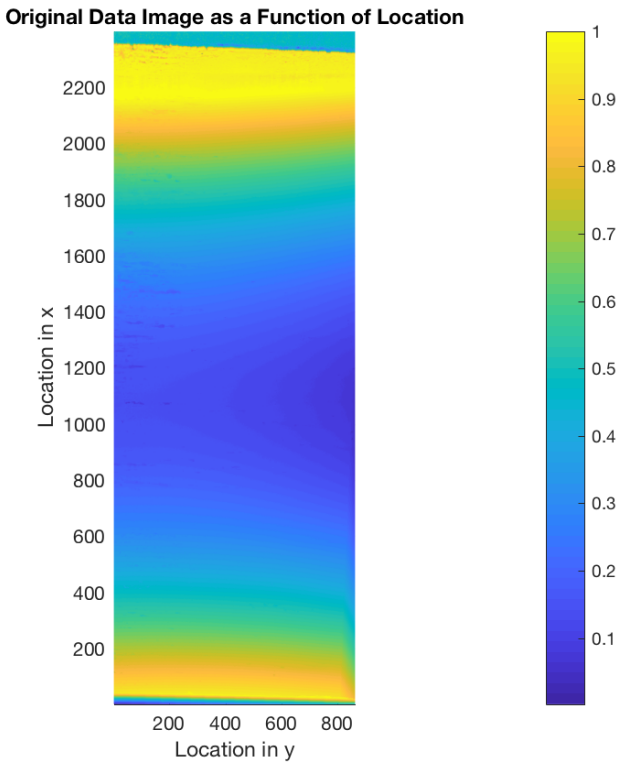
MgCl2_Inside_

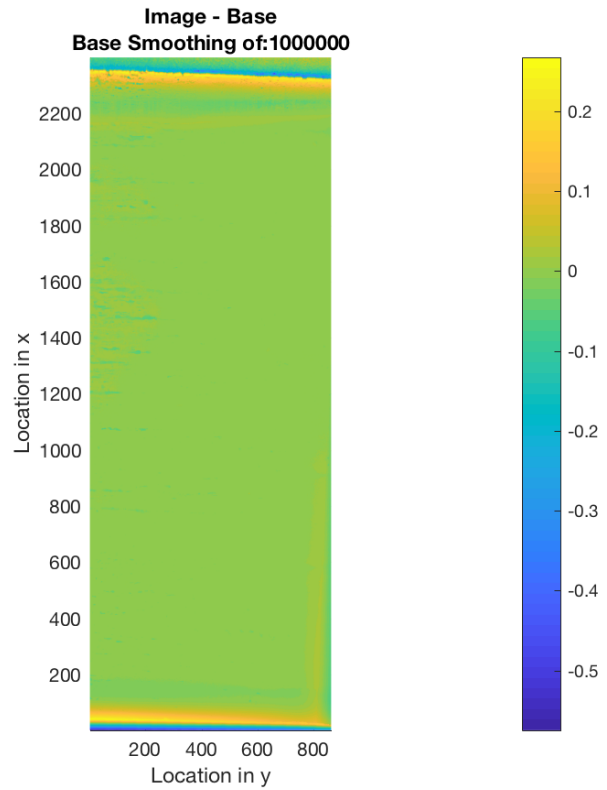




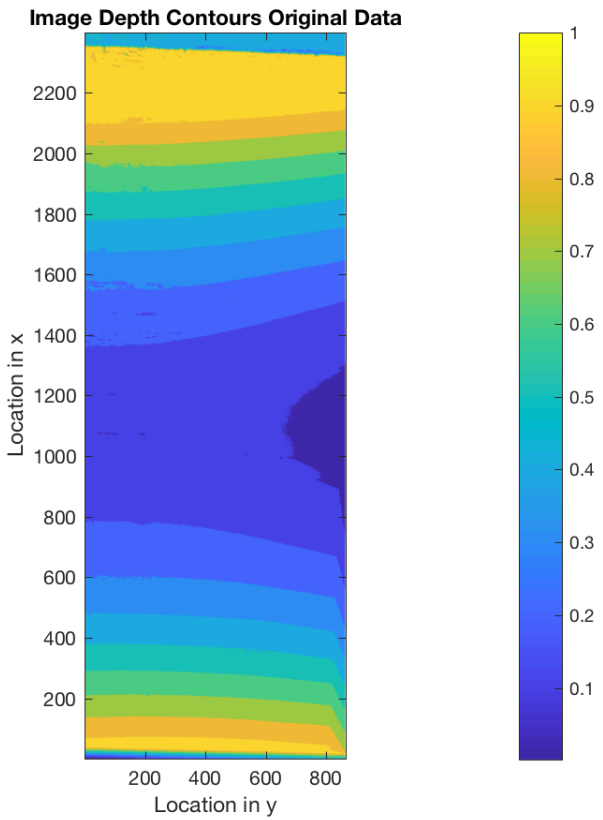
Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

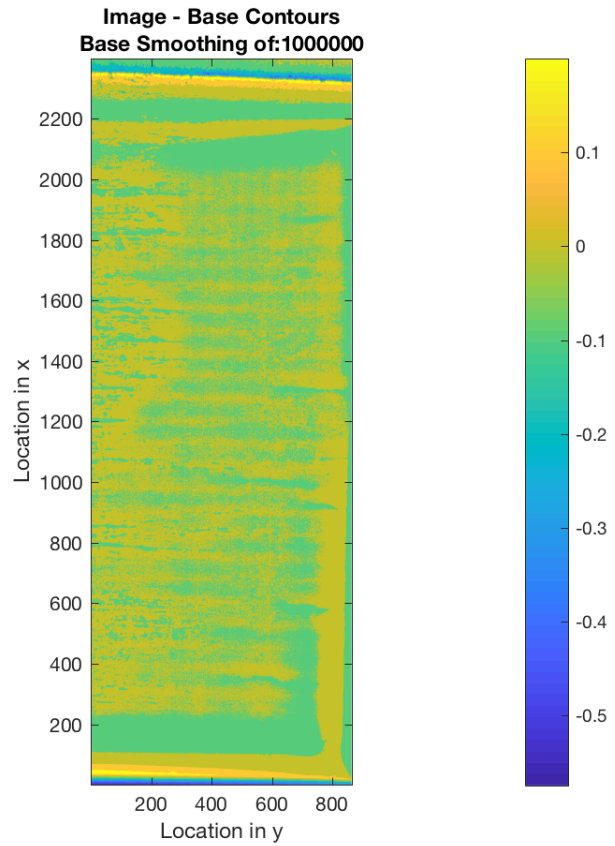
MgCl2_Inside_



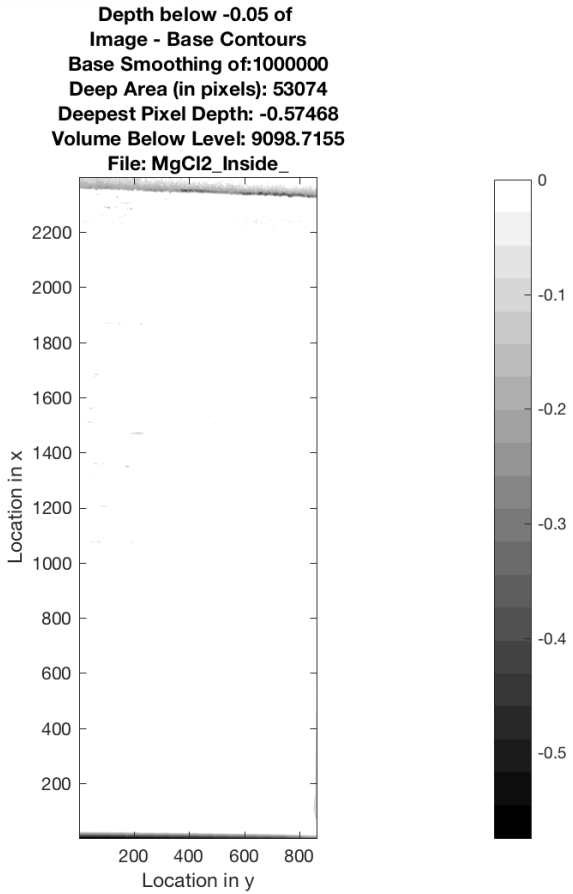


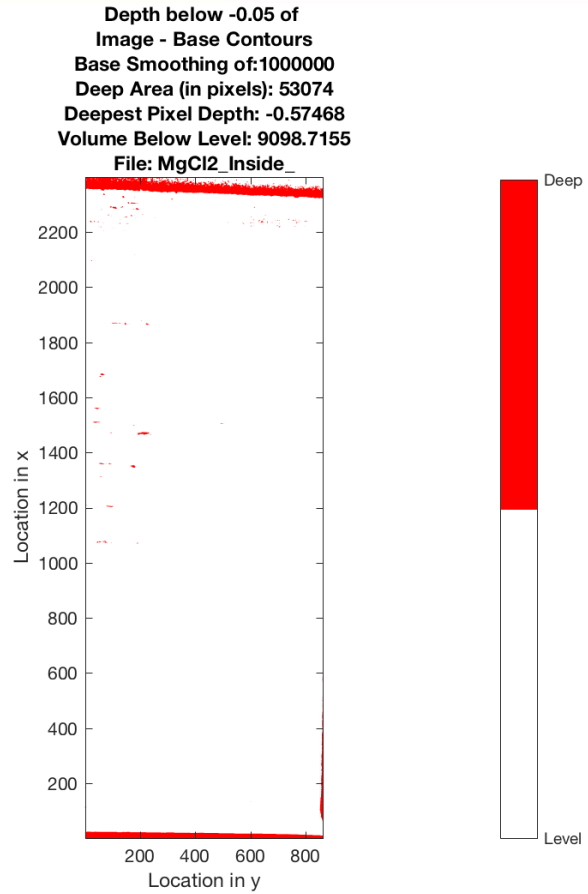
MgCl2_Inside_





MgCl2_Inside_





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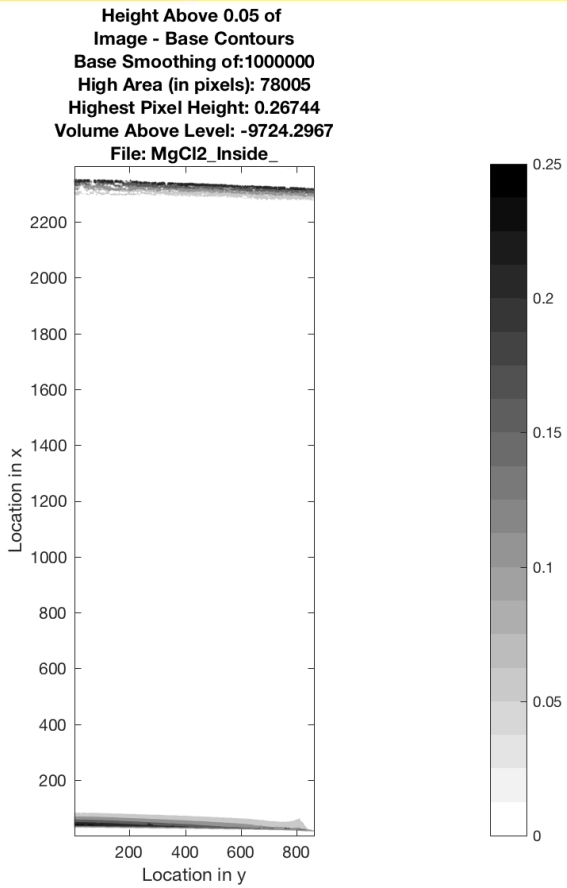
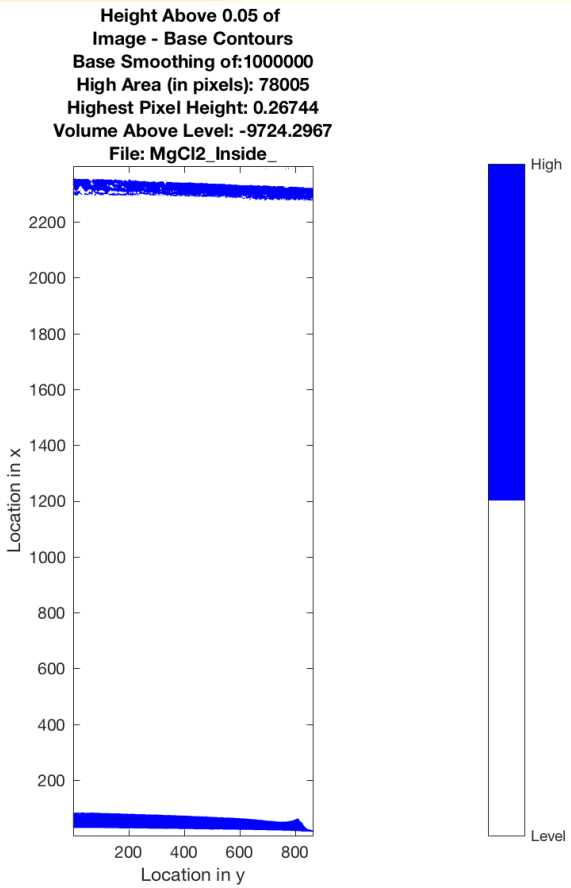
MgCl2_Inside_





Los Alamos NATIONAL LABORATORY EST. 1943
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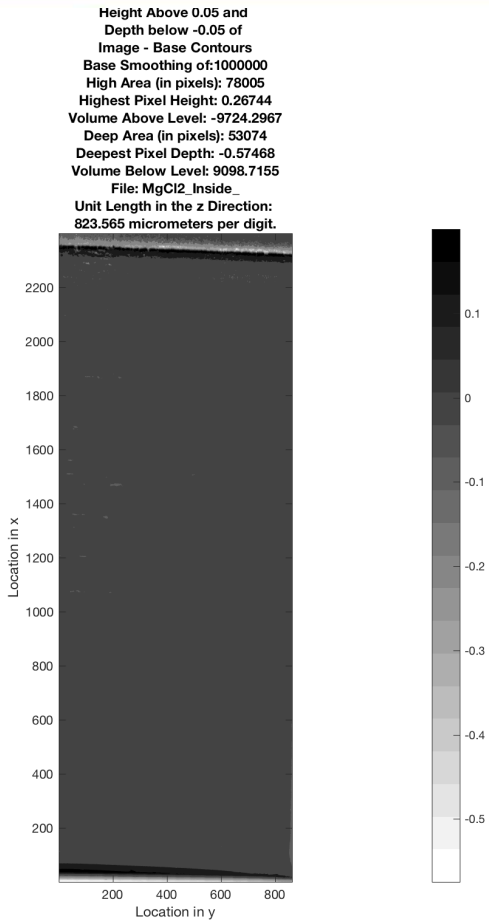
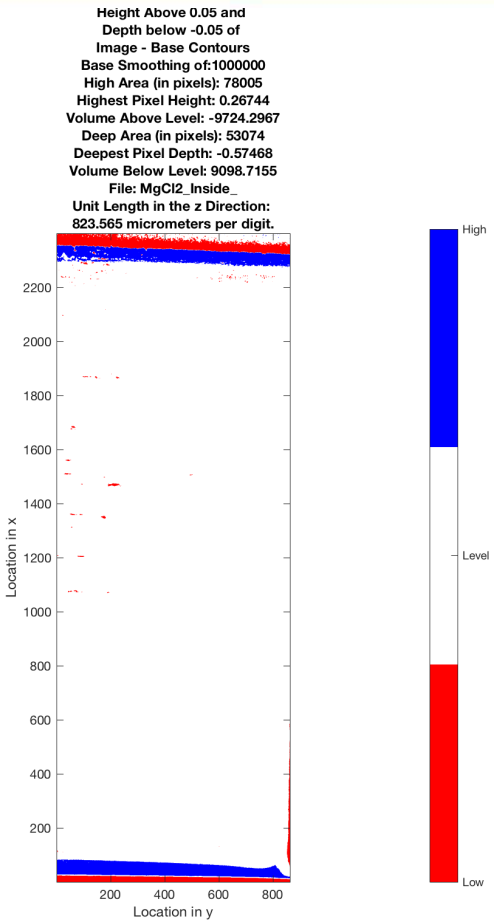
MgCl2_Inside_





Los Alamos NATIONAL LABORATORY EST. 1943
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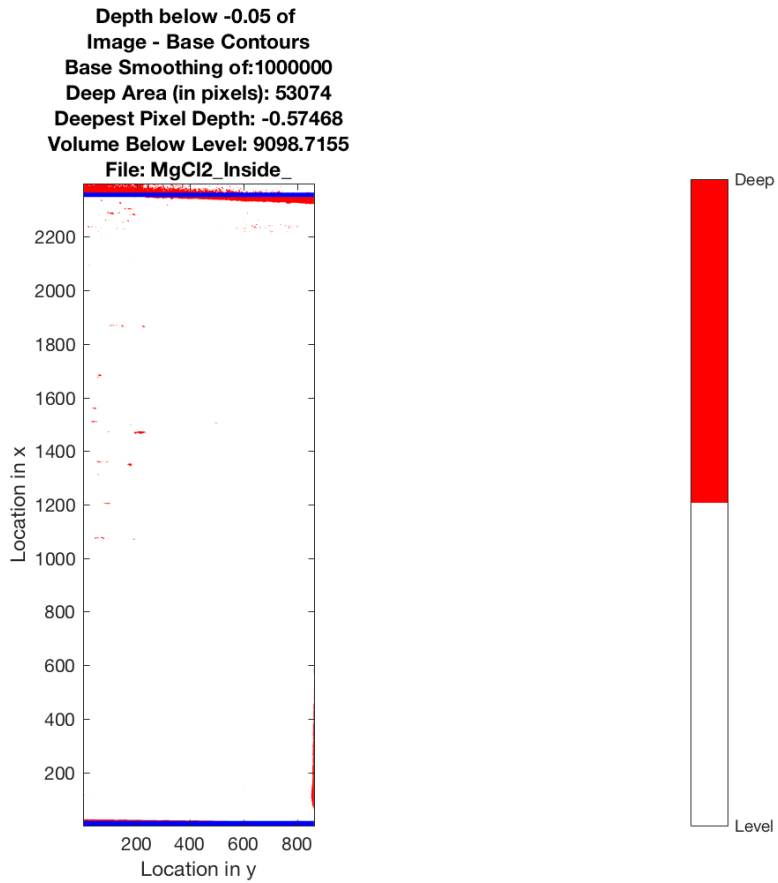
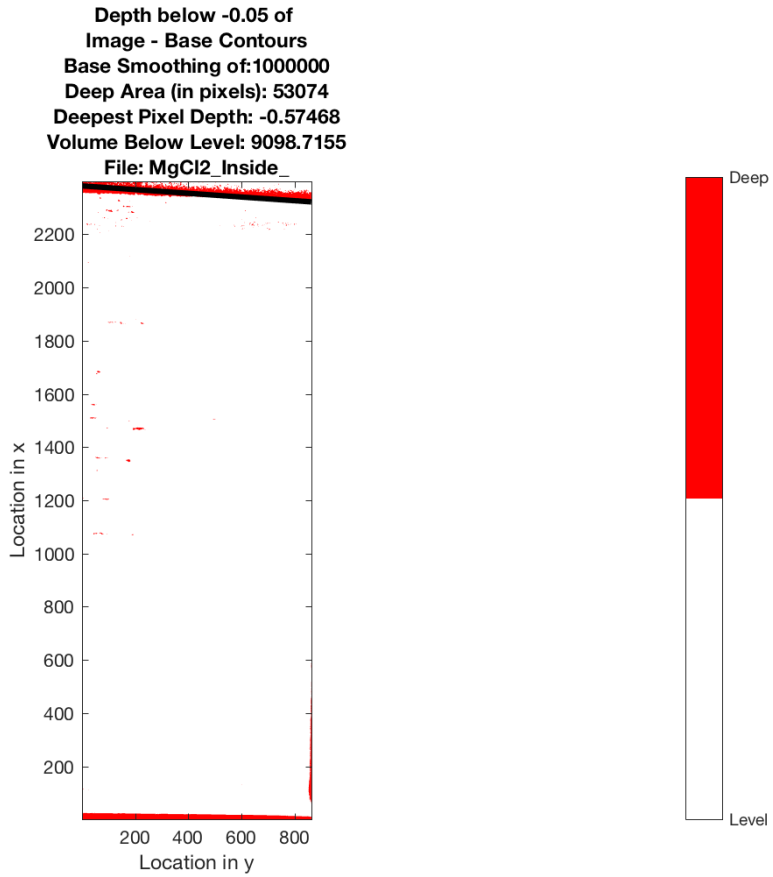
MgCl2_Inside_



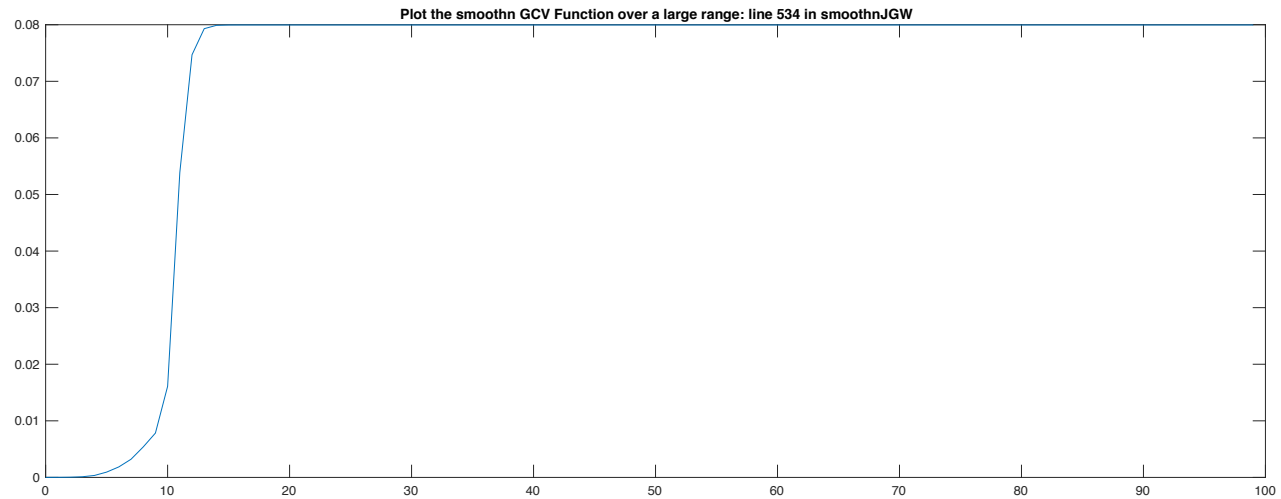
Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

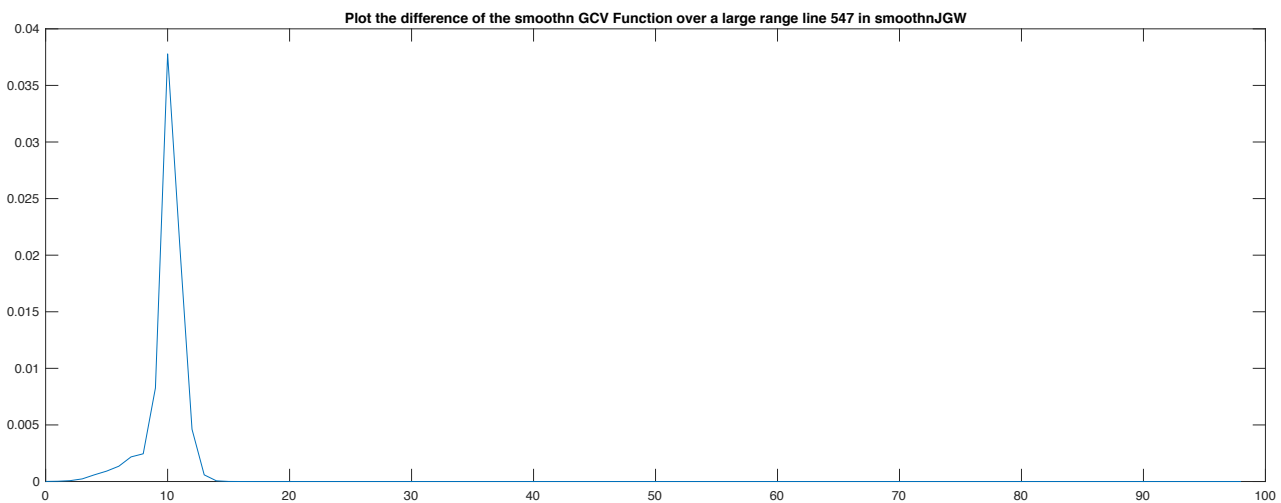
MgCl2_Inside_



Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

MgCl2_Inside_





Los Alamos NATIONAL LABORATORY EST. 1943
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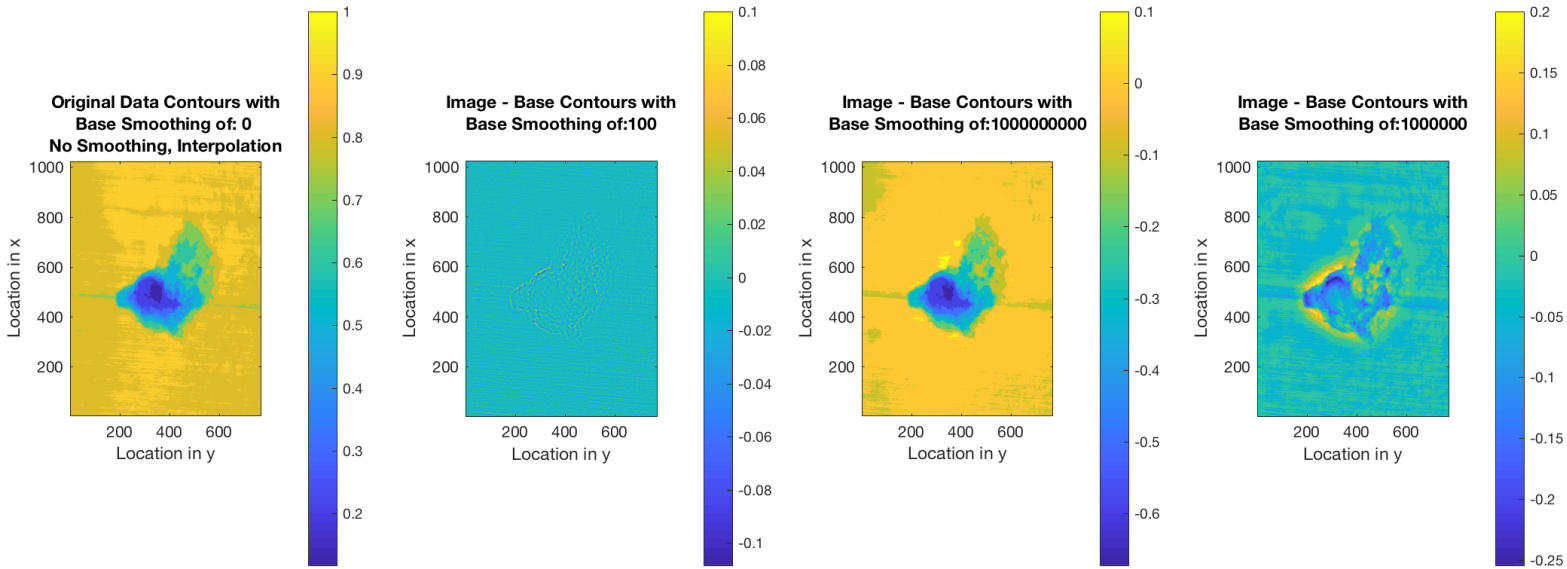
Pit

1. 689 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 1024
4. Height 768
5. Large Pit from the Baseline Surface with 20x magnification

Pit



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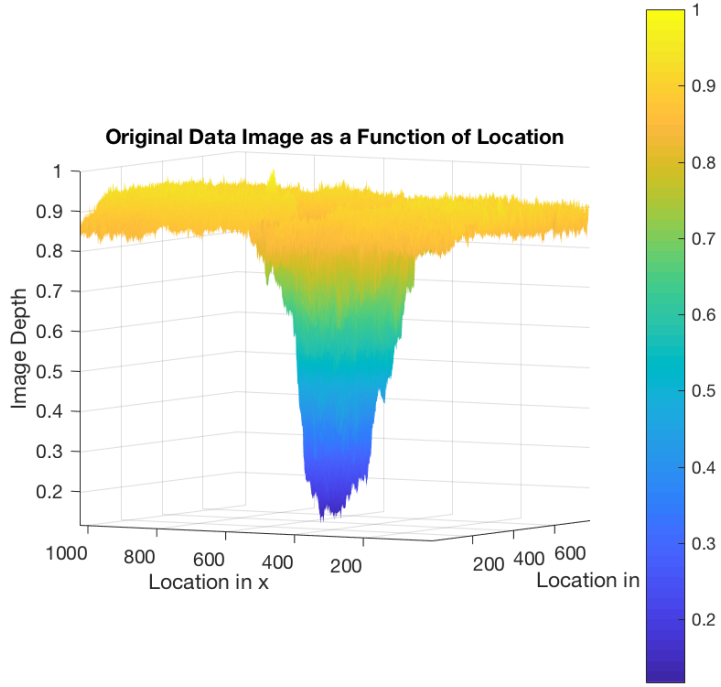
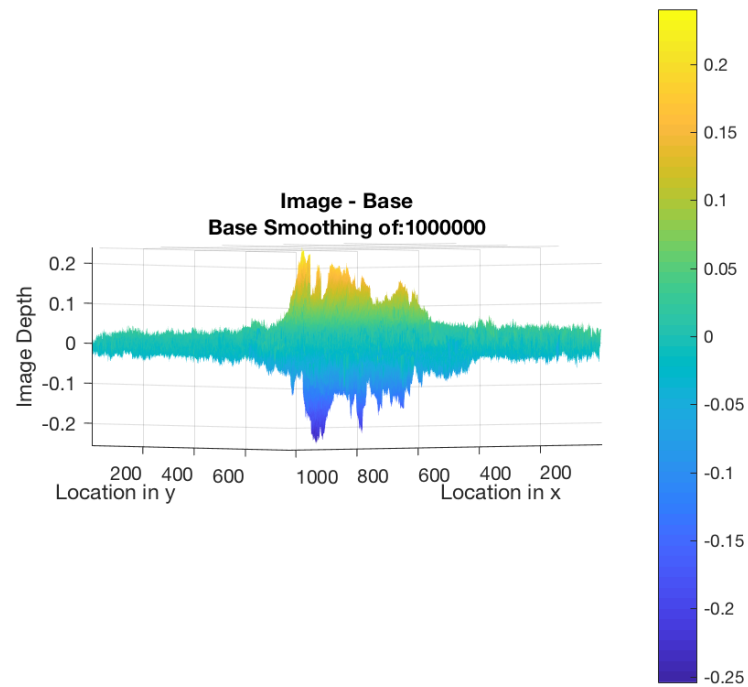
Operated by Los Alamos National Security, LLC for NNSA

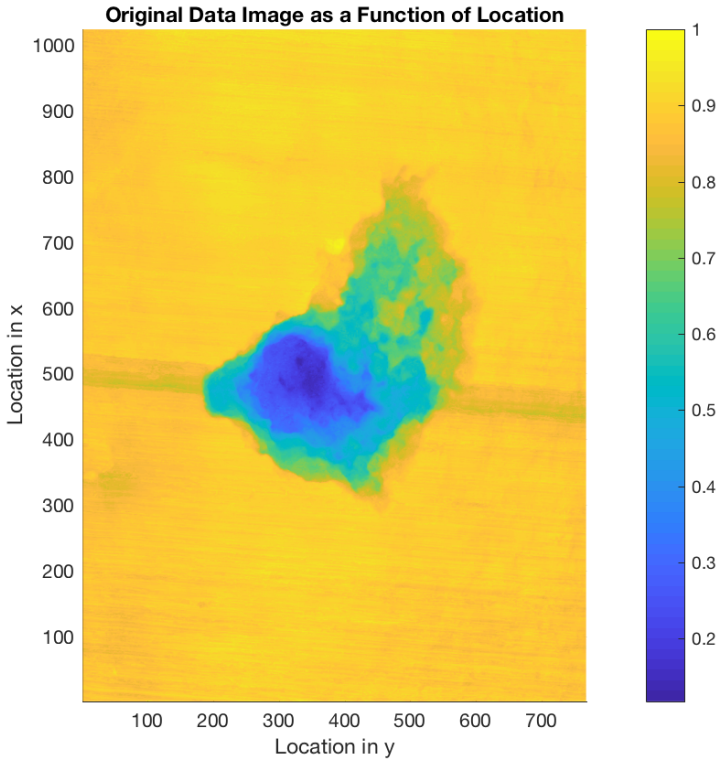
Pit





Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

Pit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Location in y
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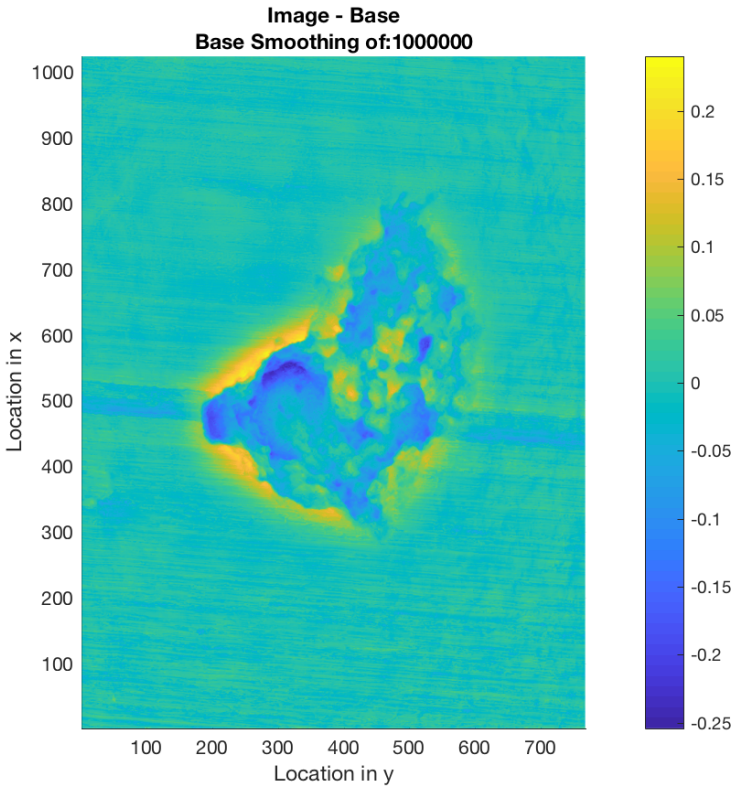
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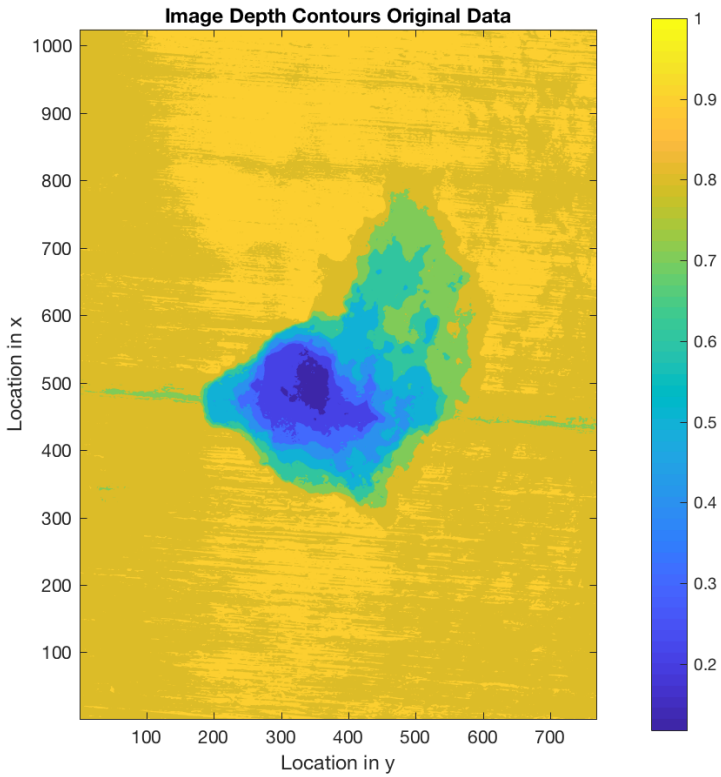
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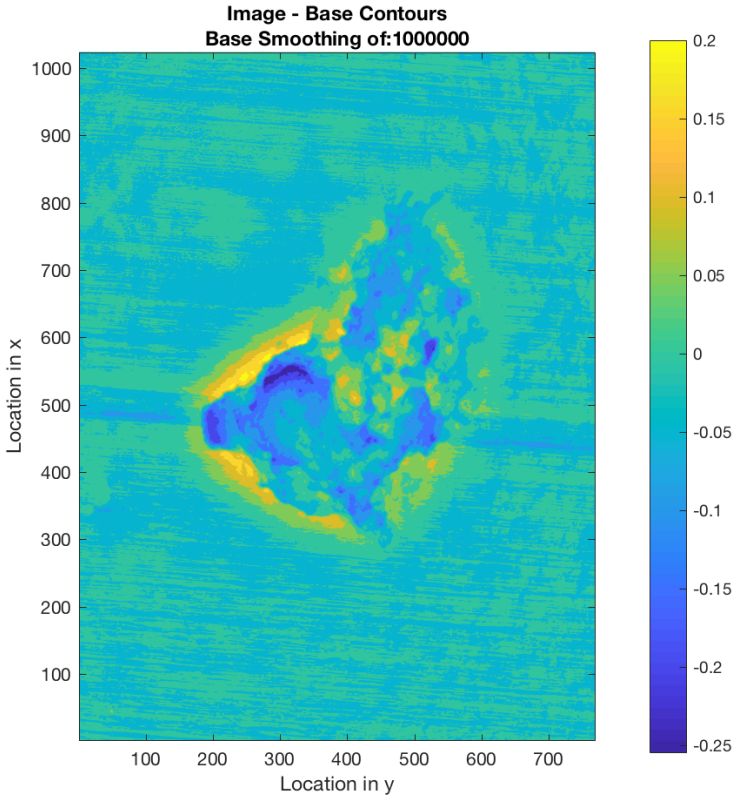
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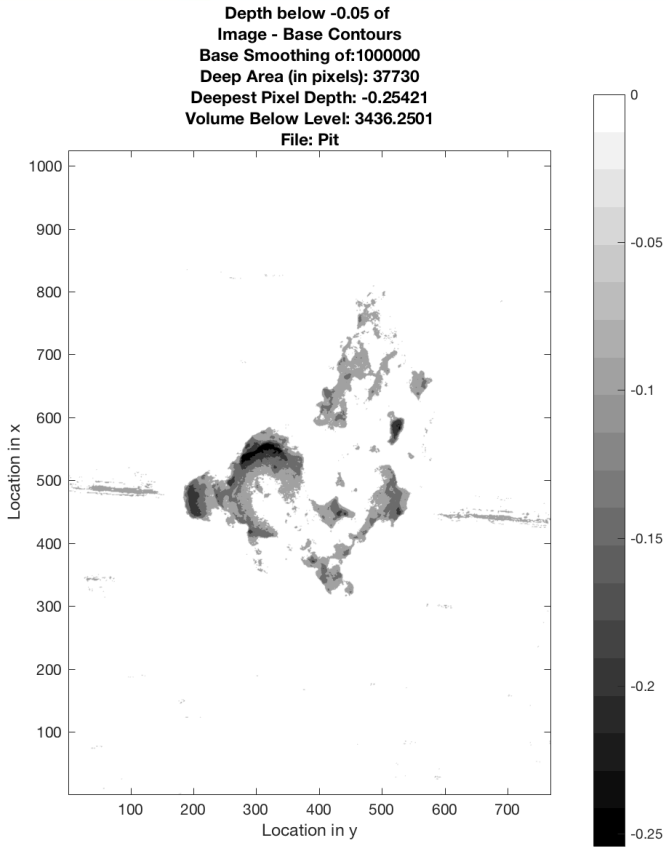

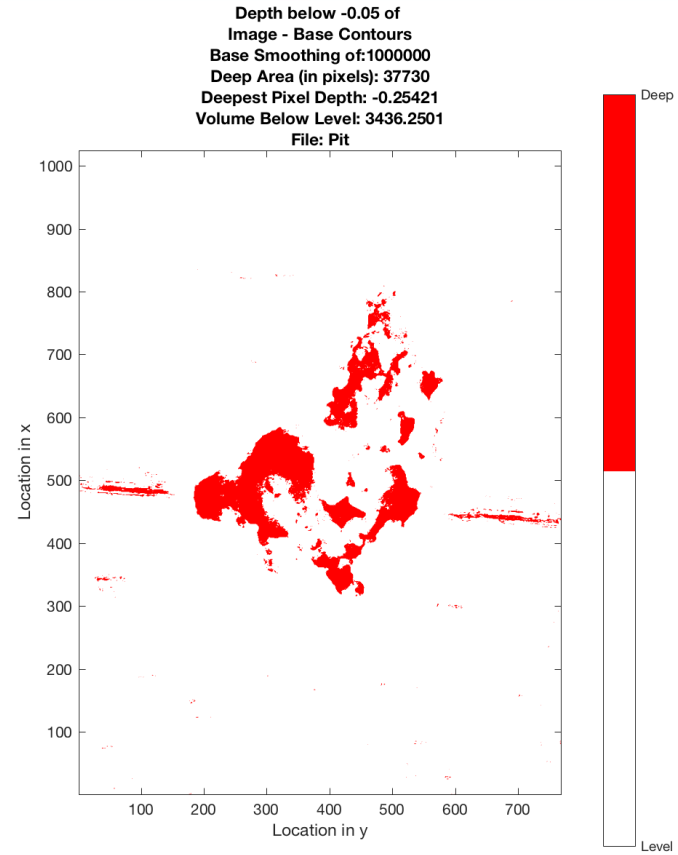

Los Alamos NATIONAL LABORATORY EST. 1943
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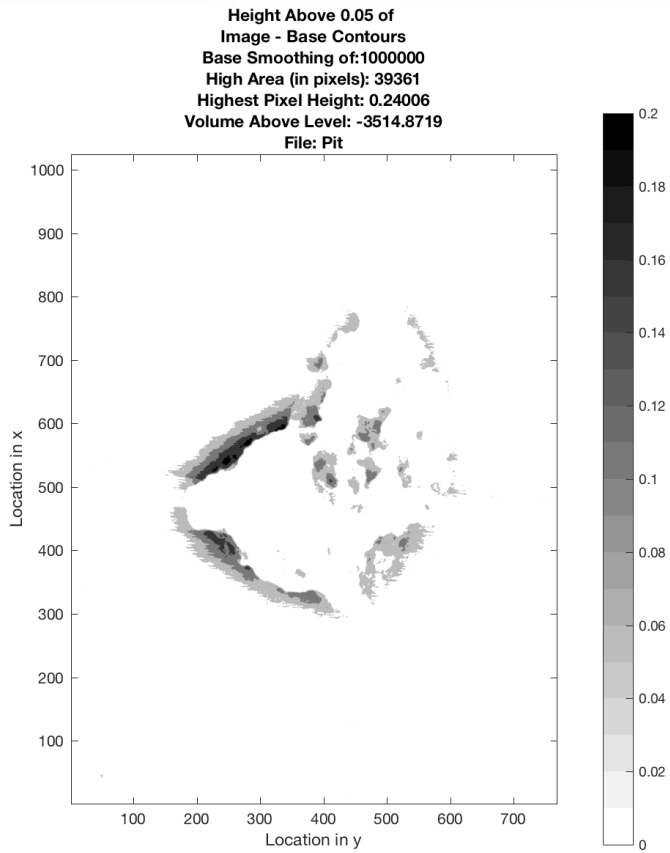
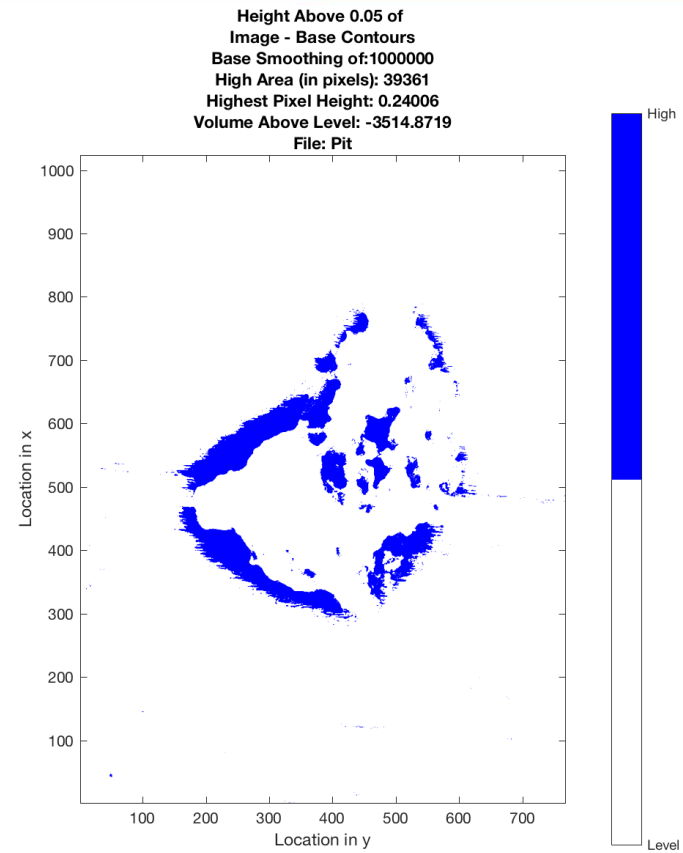
Pit





Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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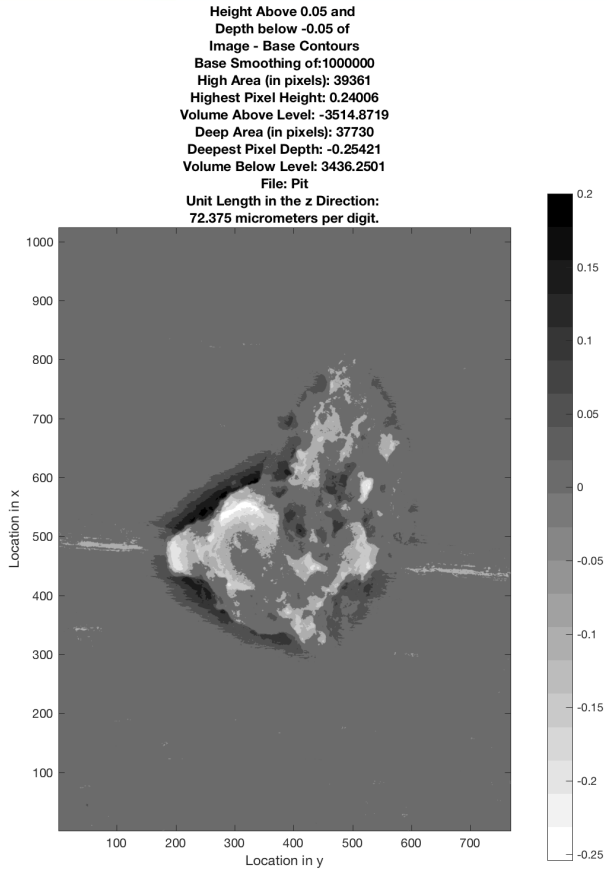

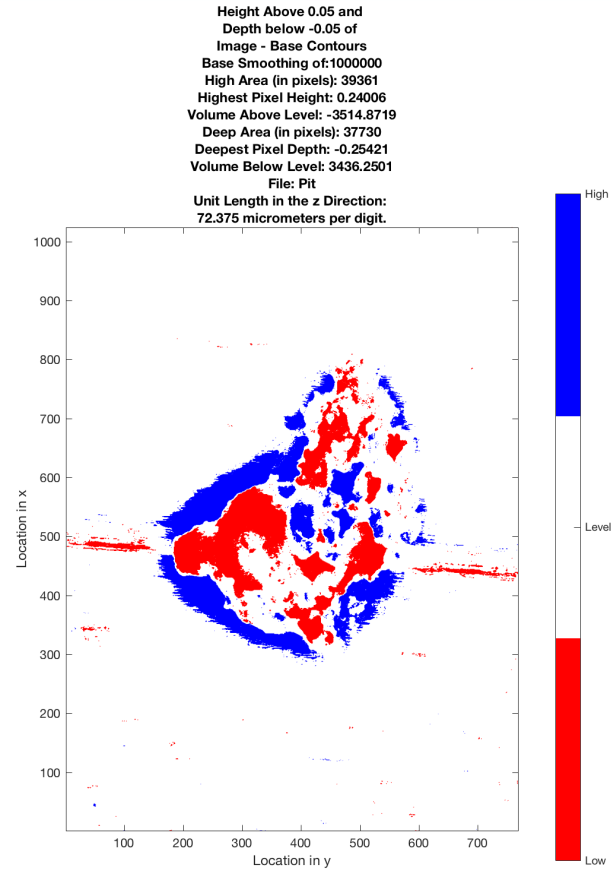

Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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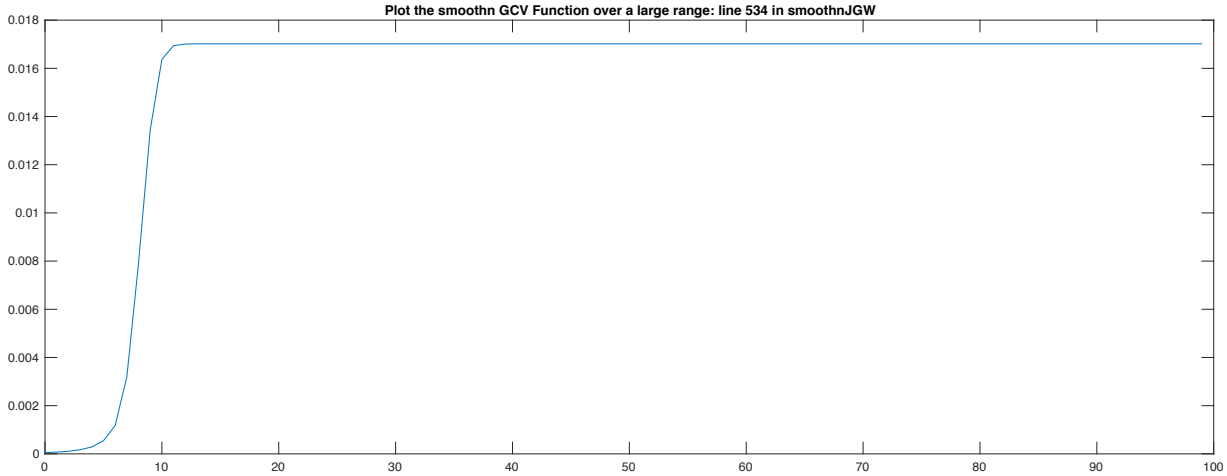
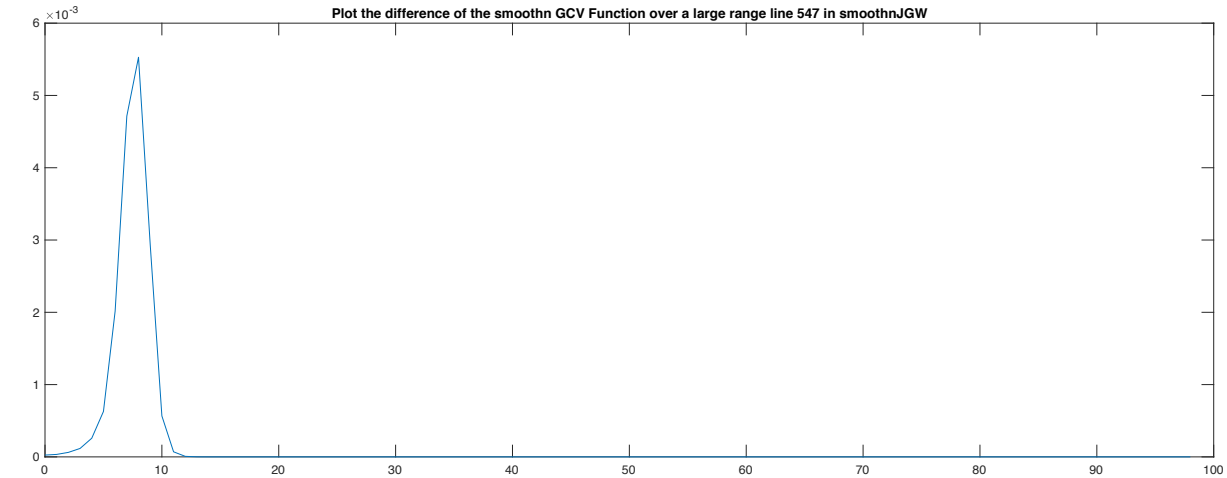
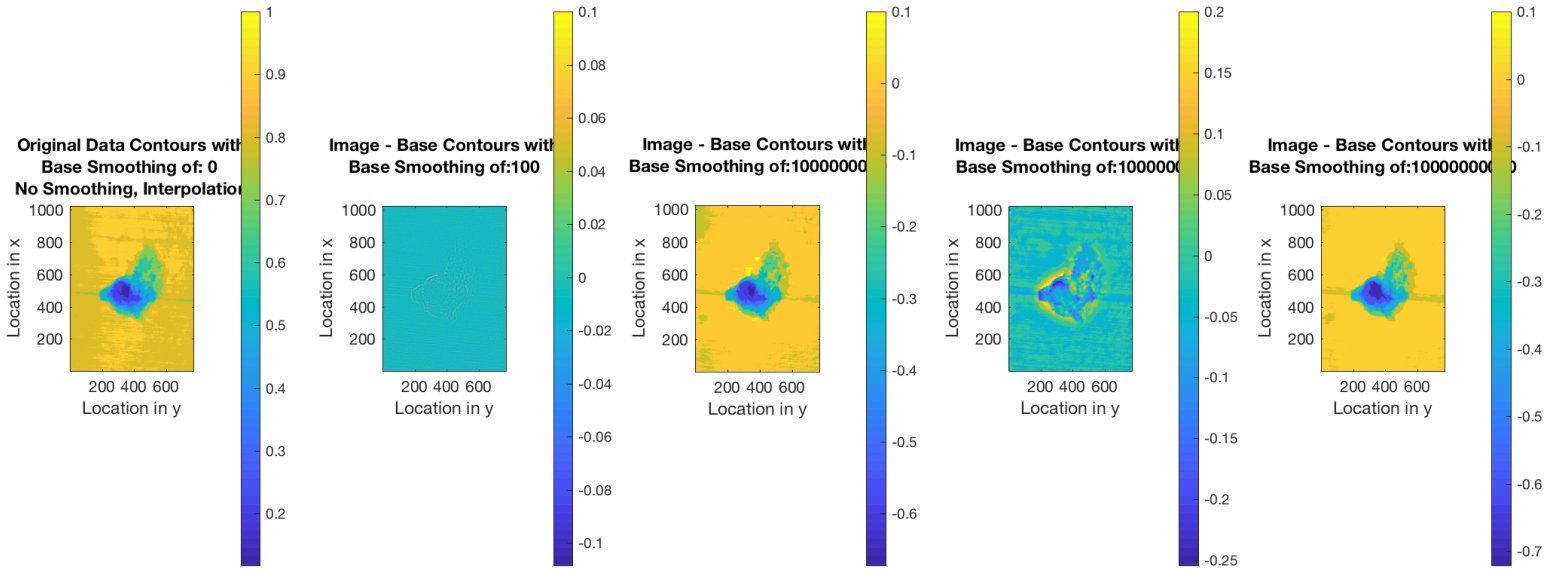




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

Pit



Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

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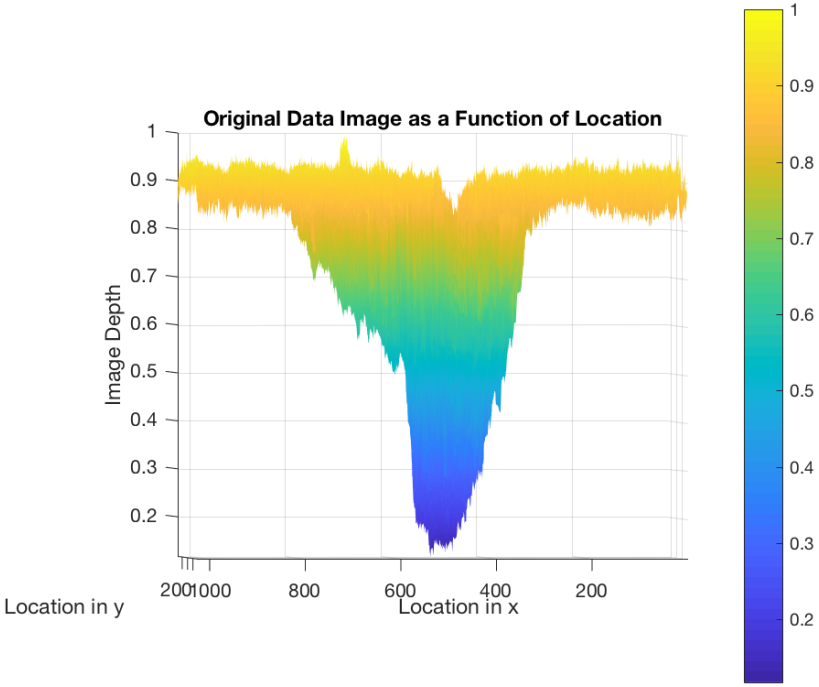

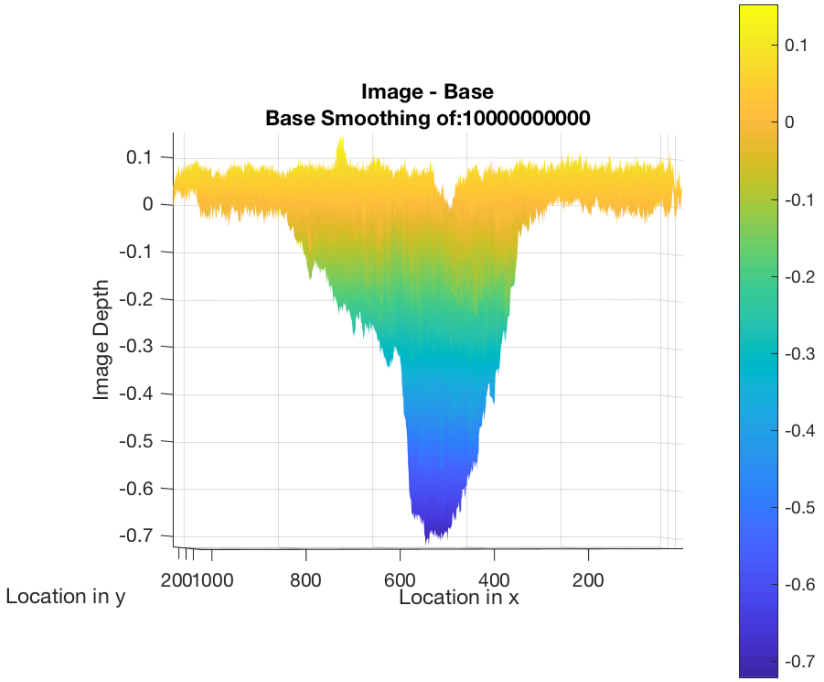

Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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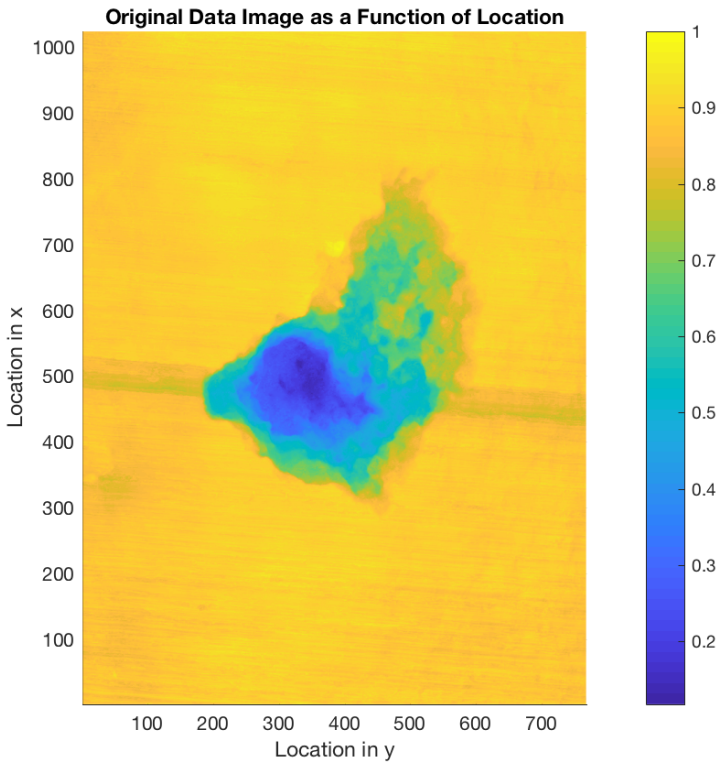

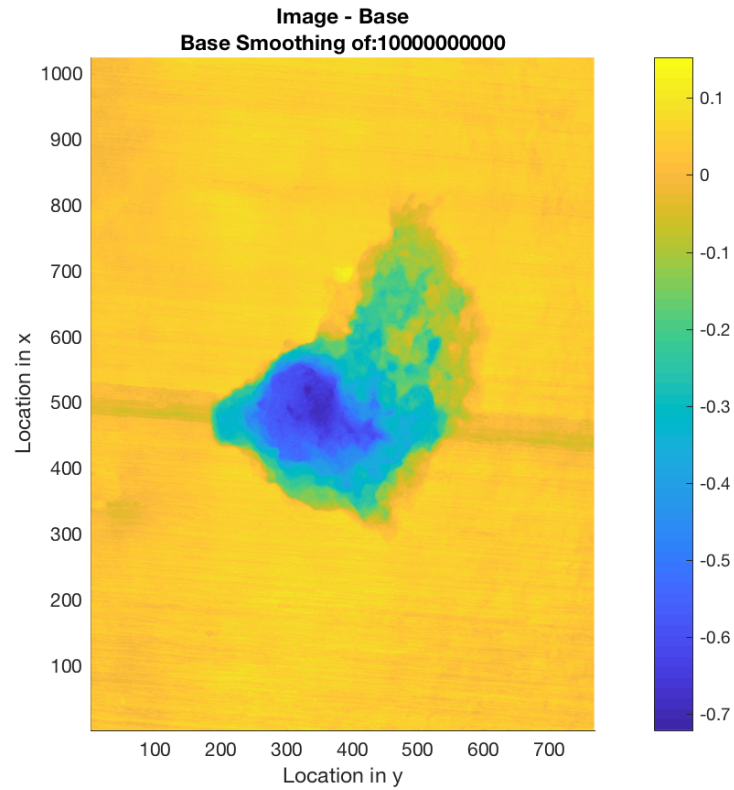

Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

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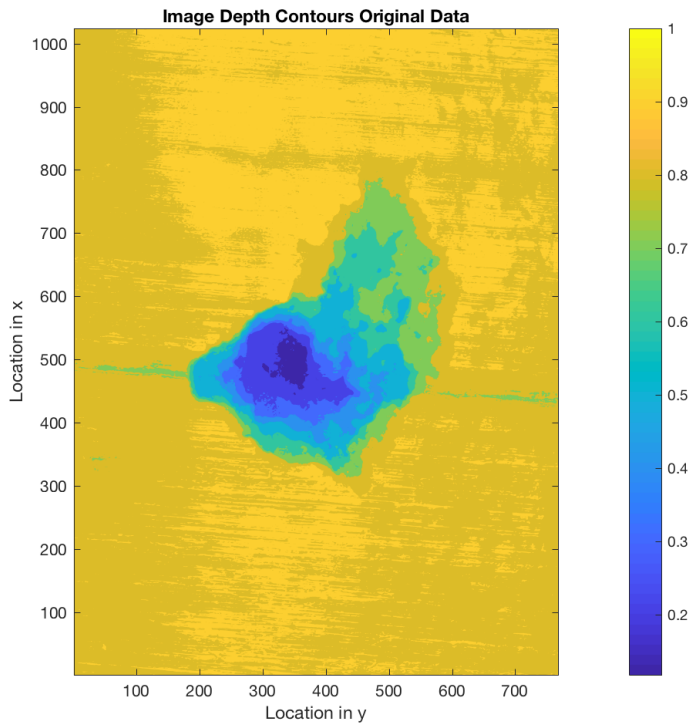
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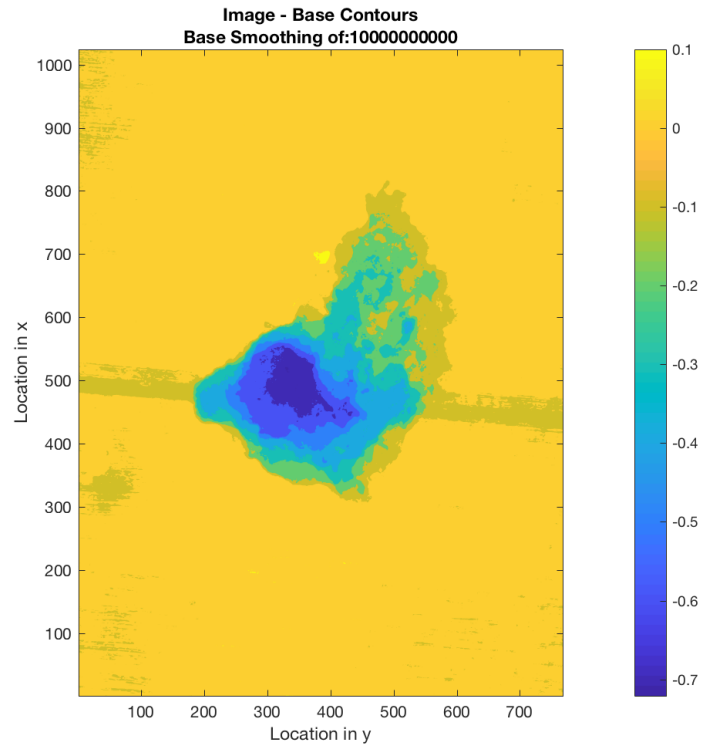
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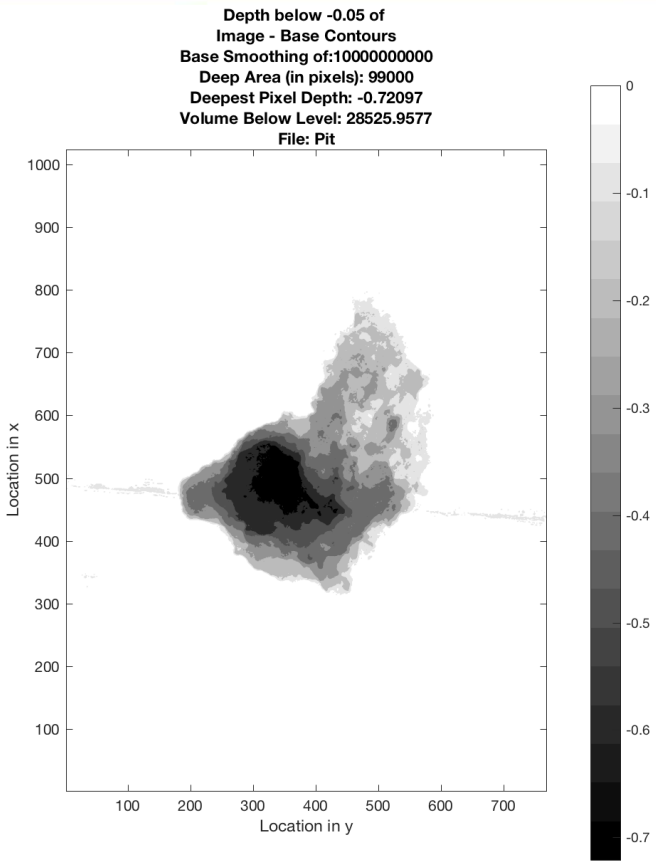
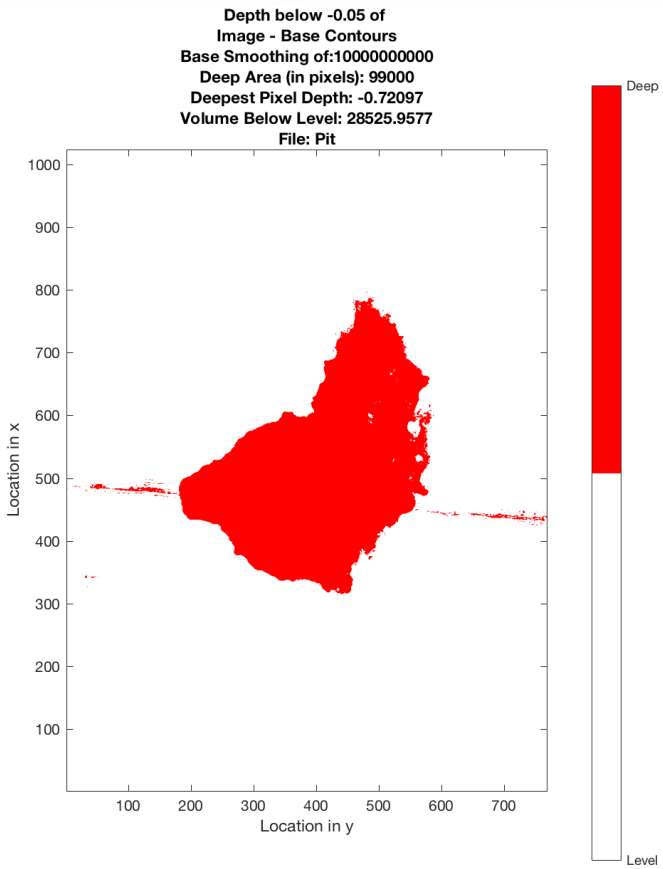
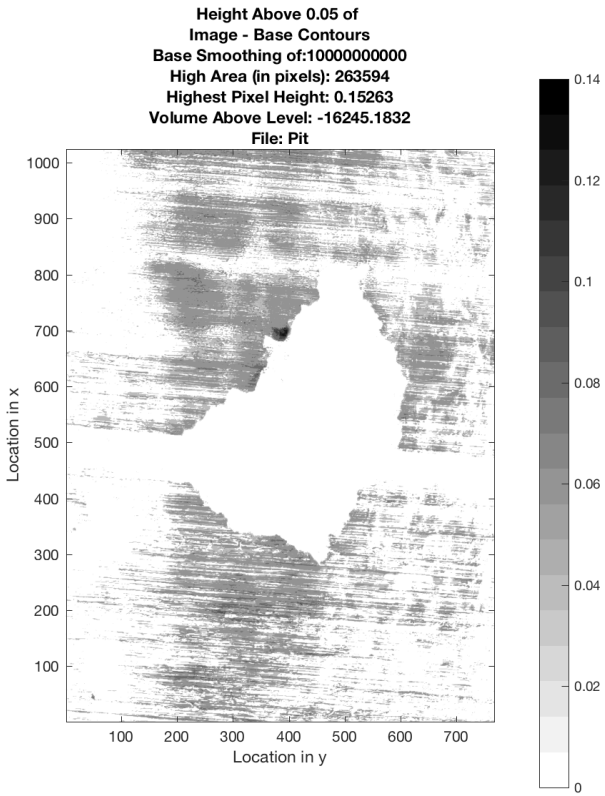
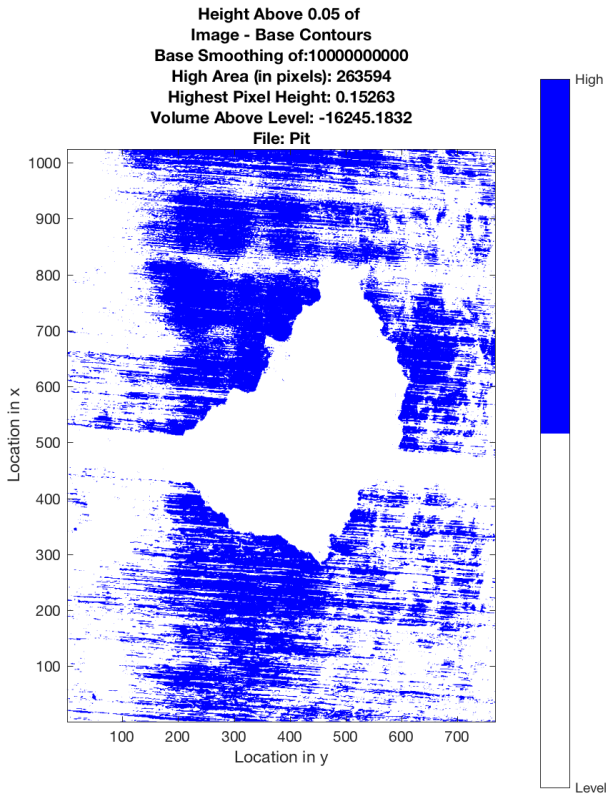




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

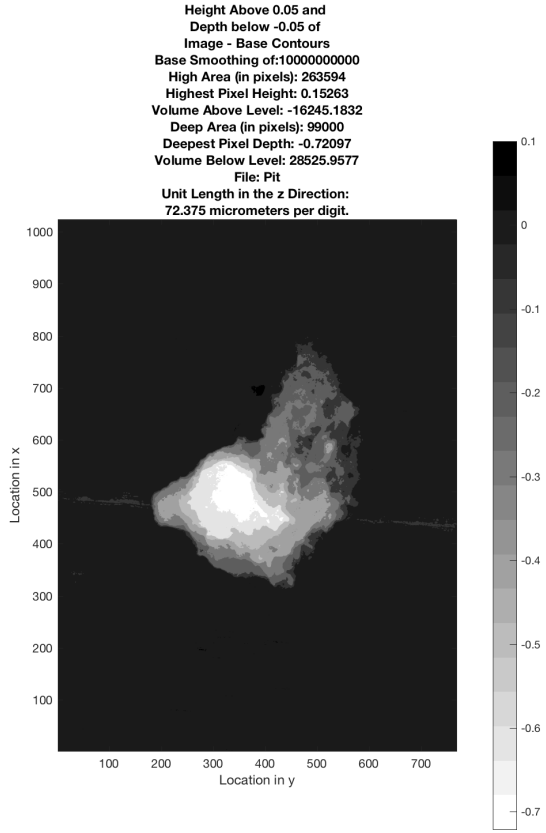
Pit

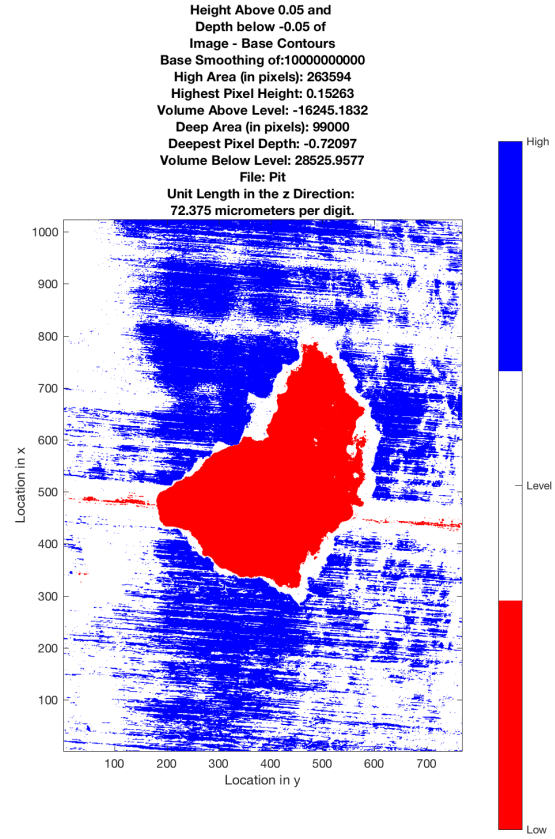




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

Pit





Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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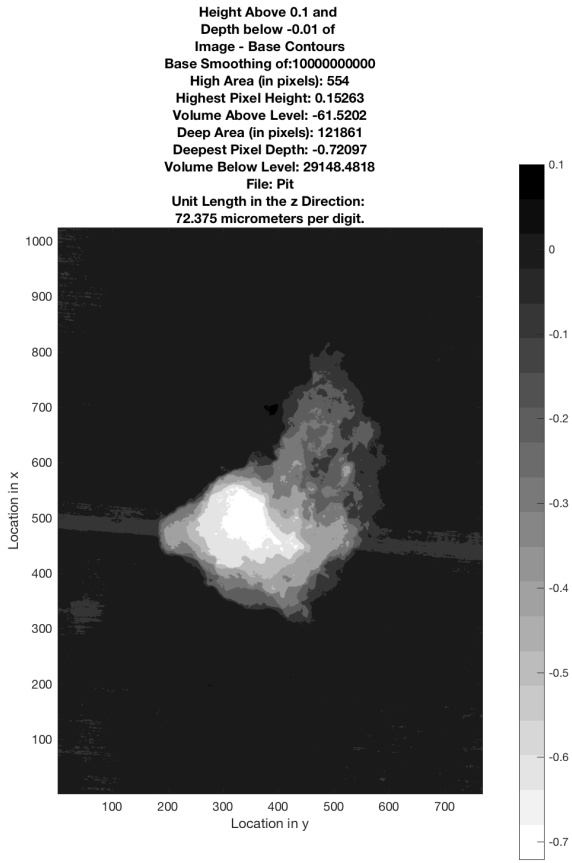
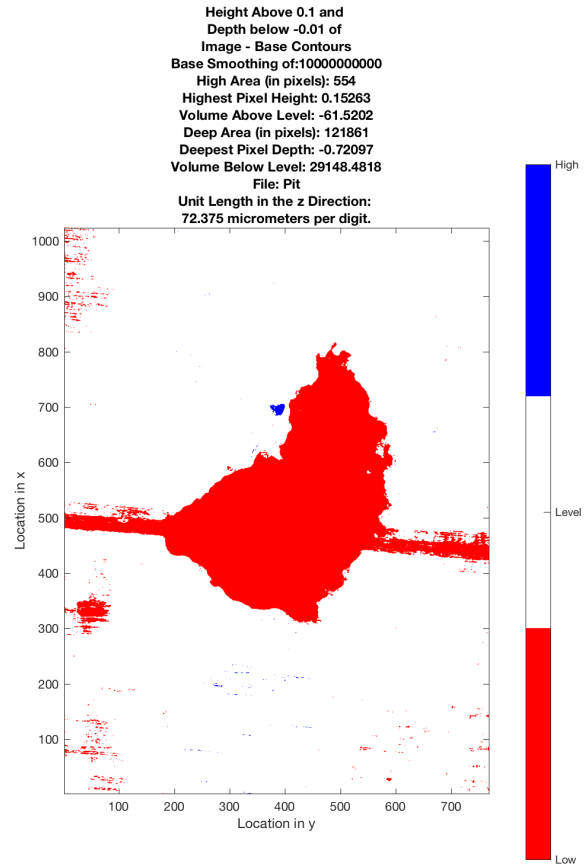




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

Pit

Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

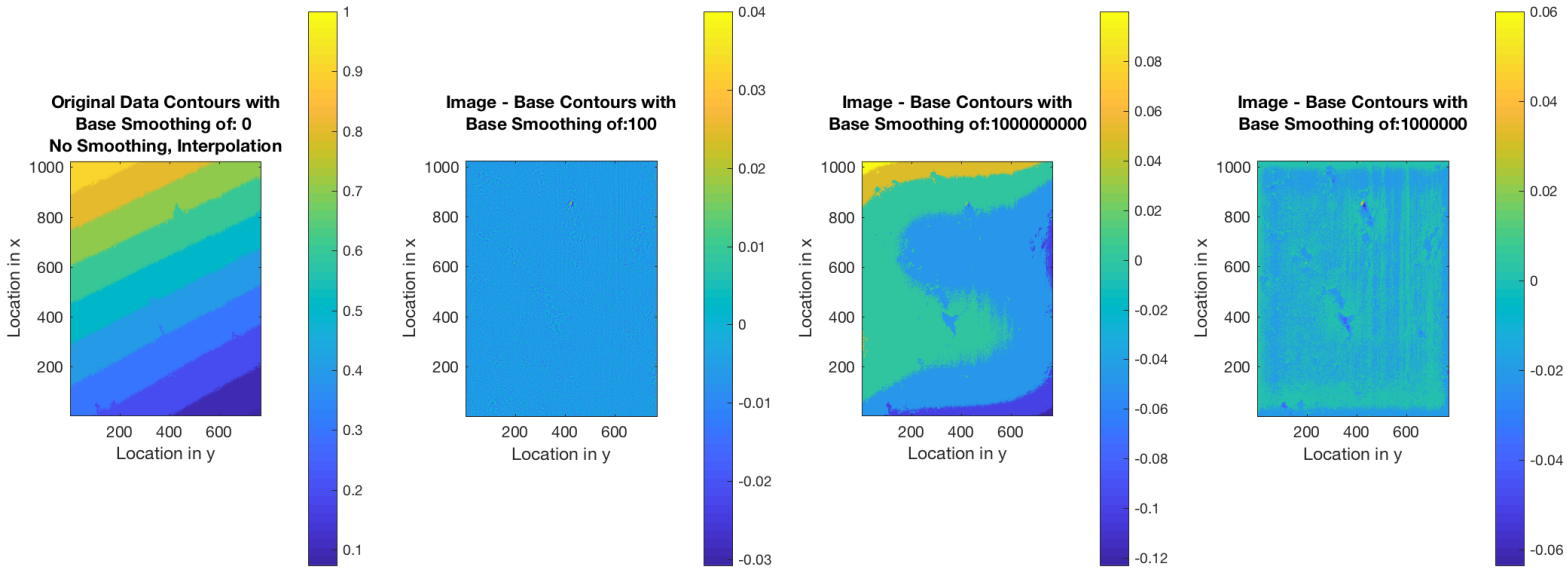
Pit

Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

S1_20X_6300X2500

1. 690 nm/pixel
2. Z Calibration .1 nm per digit
3. Width 1024
4. Height 768
5. Sample 1 of Baseline Data with 20x magnification at Location 6300 by 2500

S1_20X_6300X2500



Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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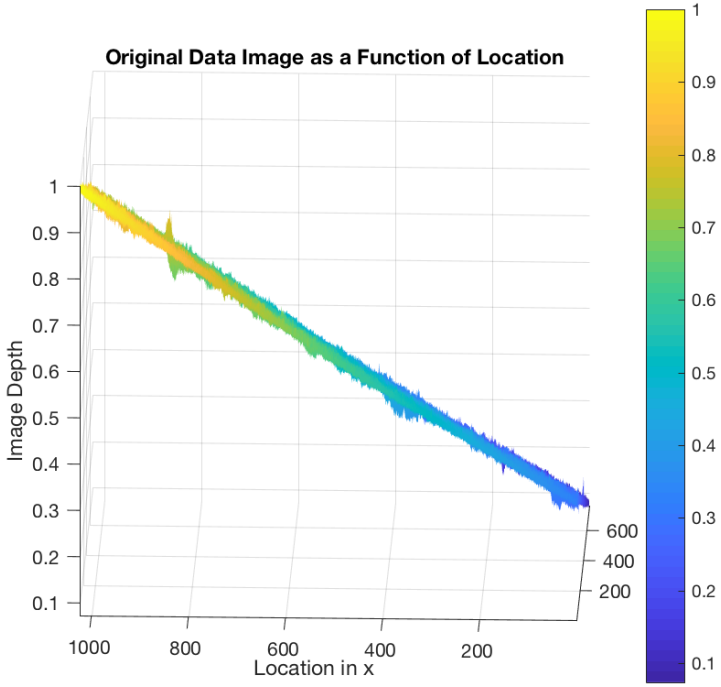

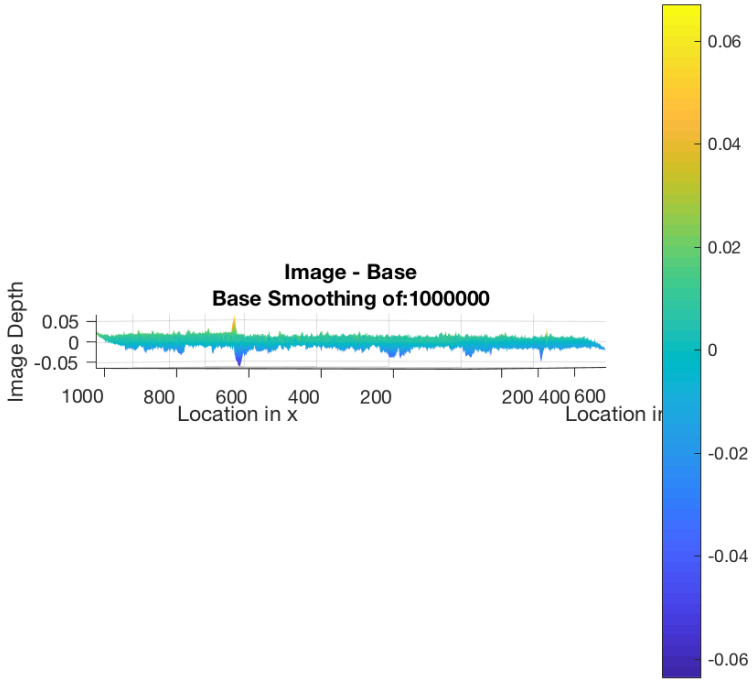

Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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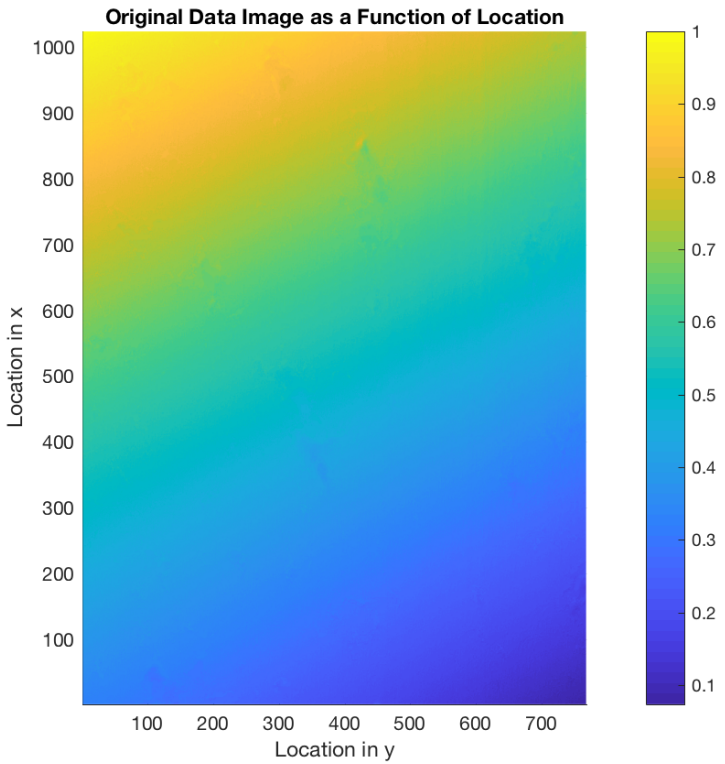

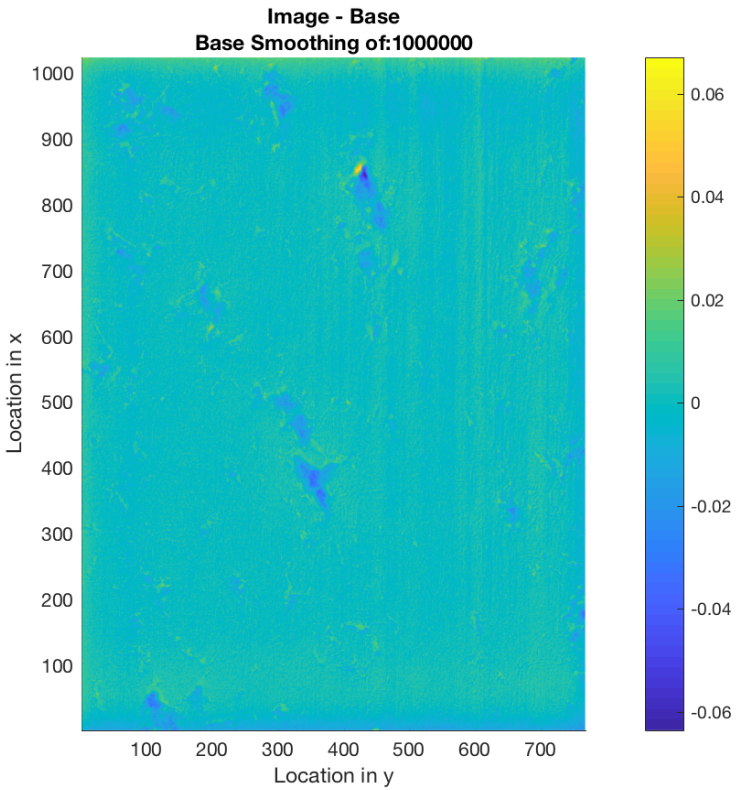

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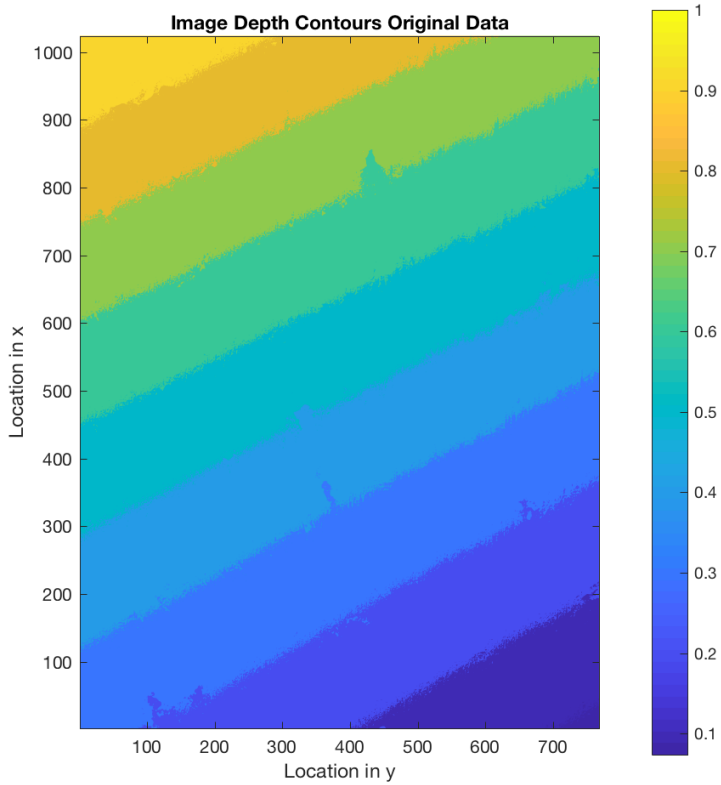

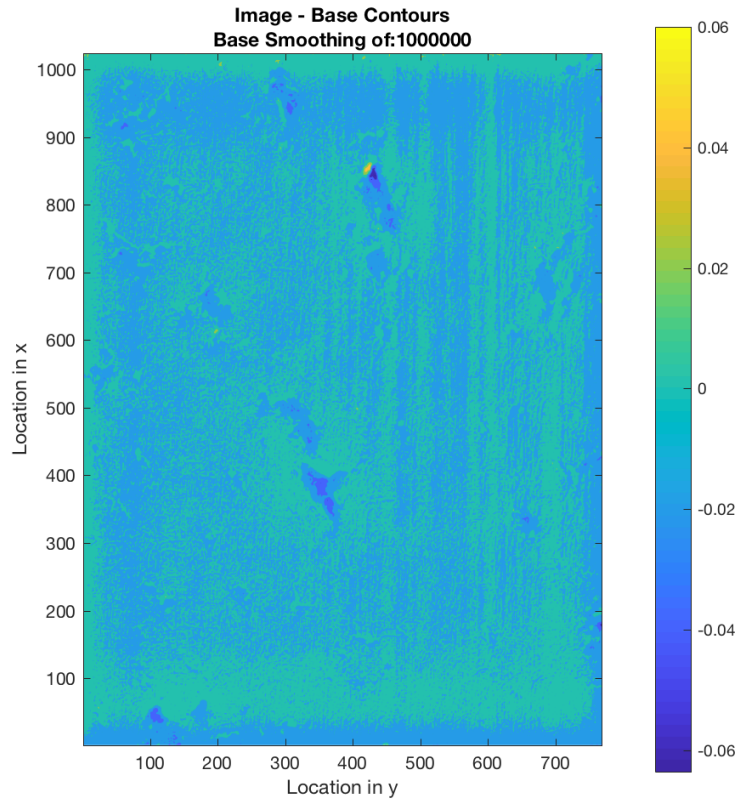

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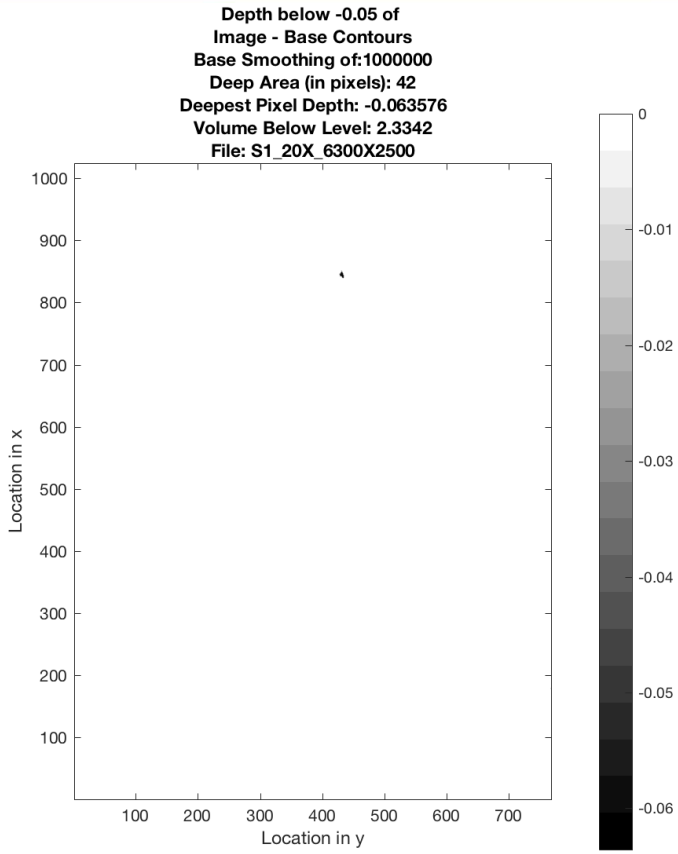

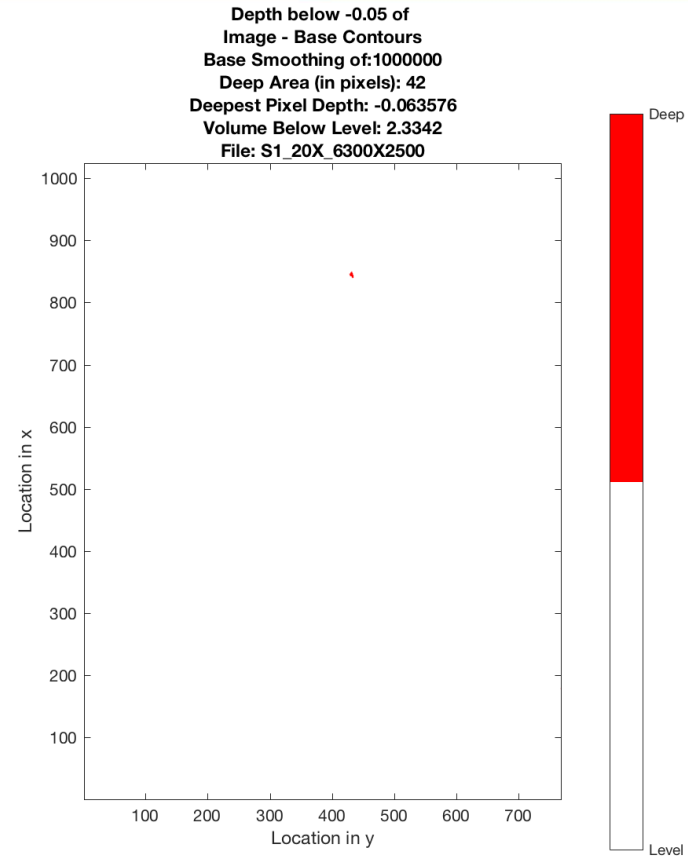

Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

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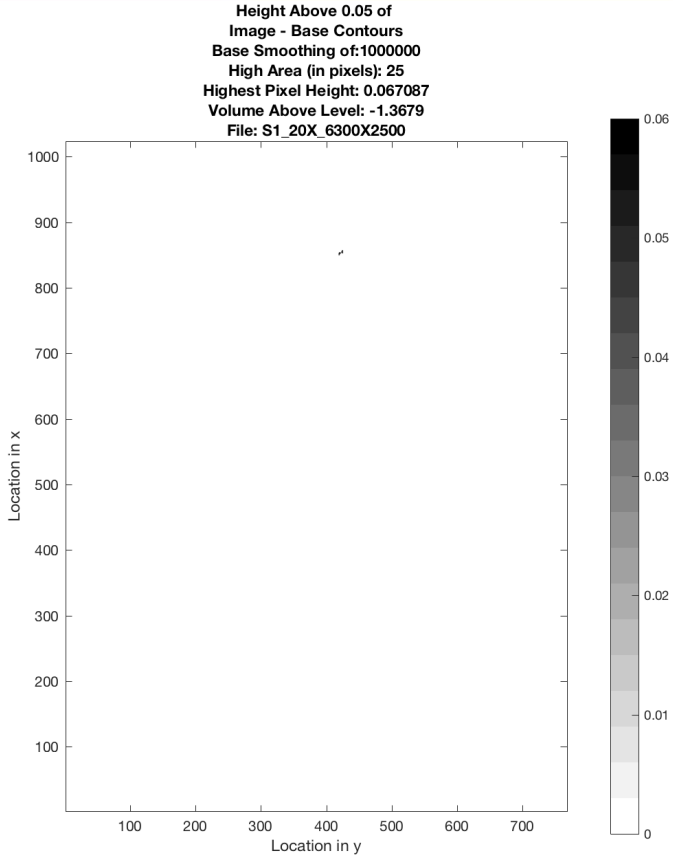
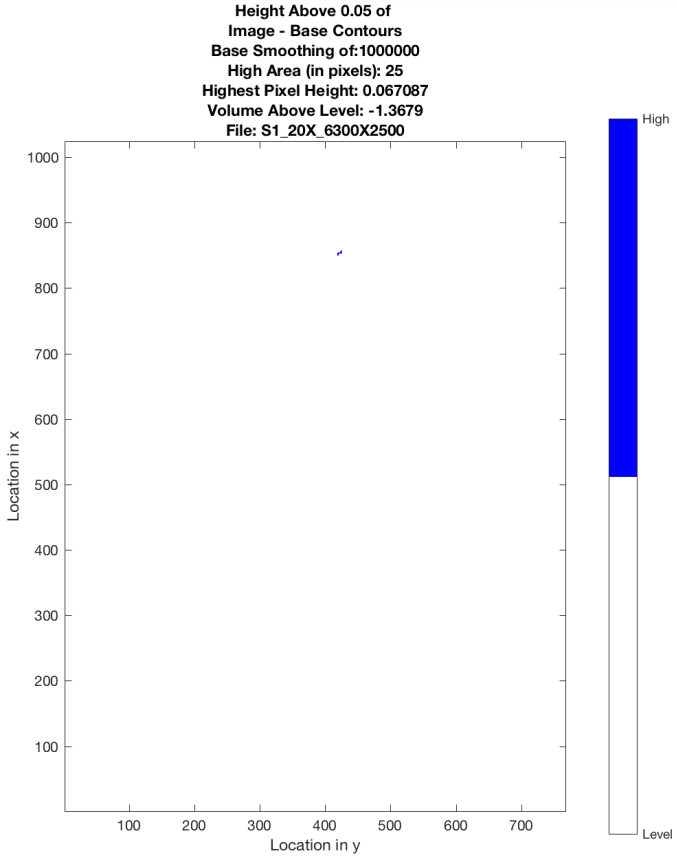
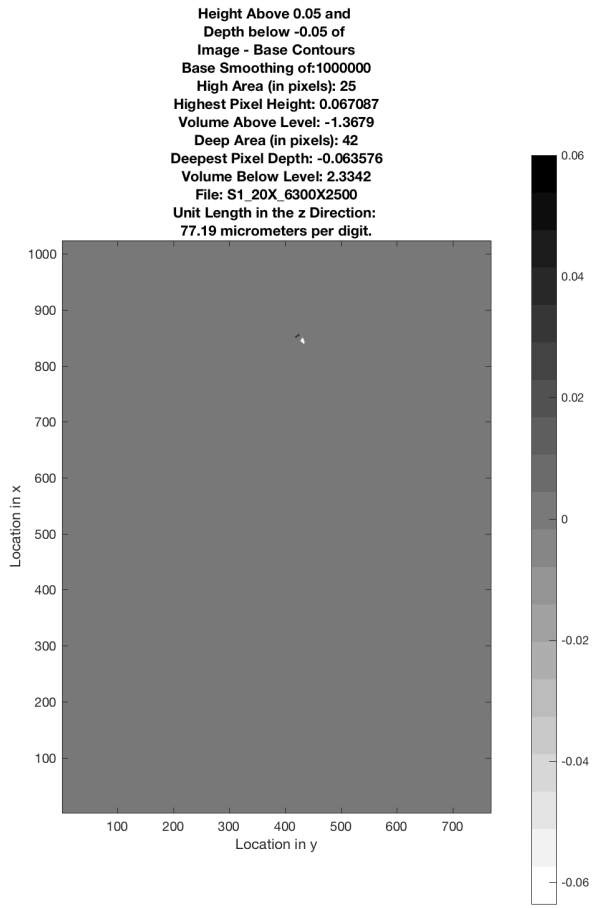
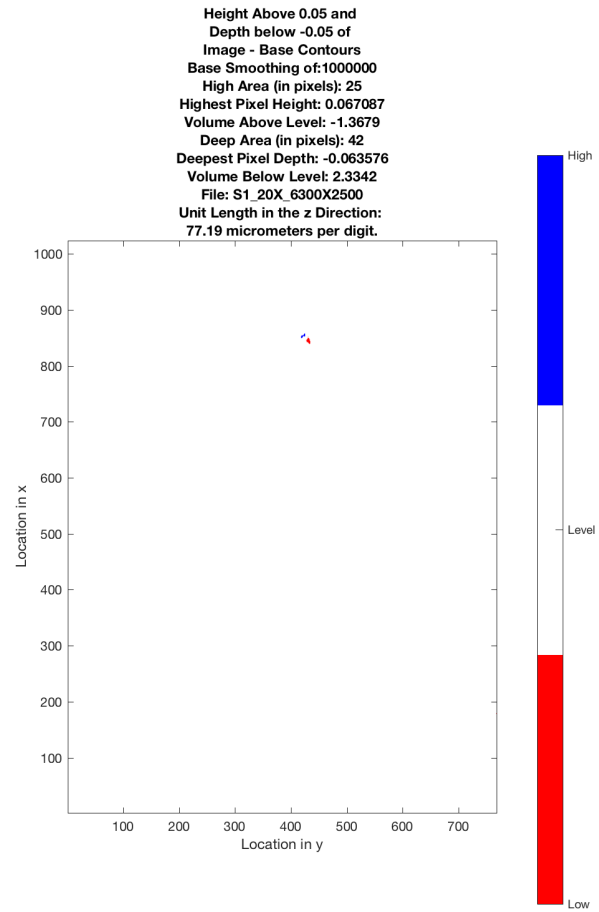




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

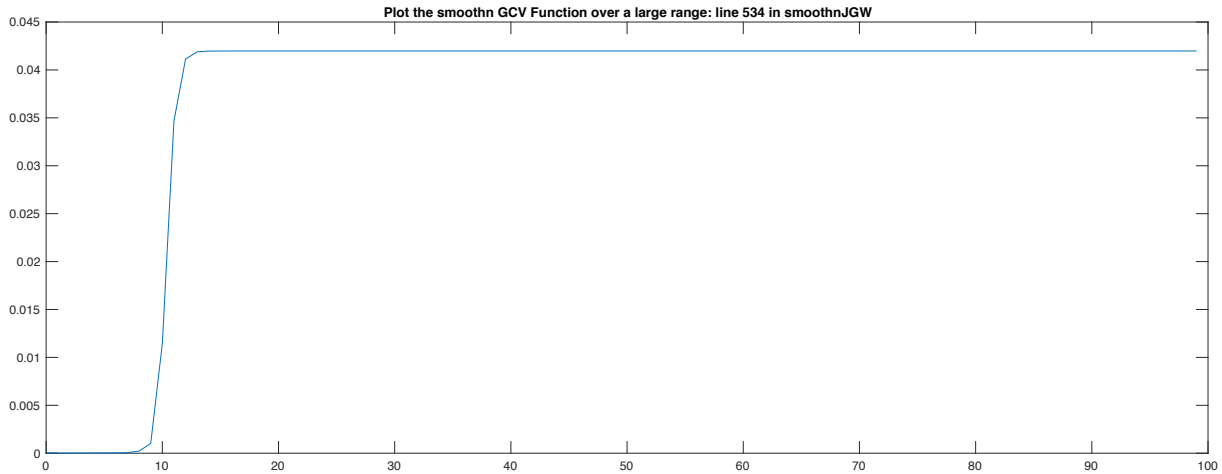
S1_20X_6300X2500

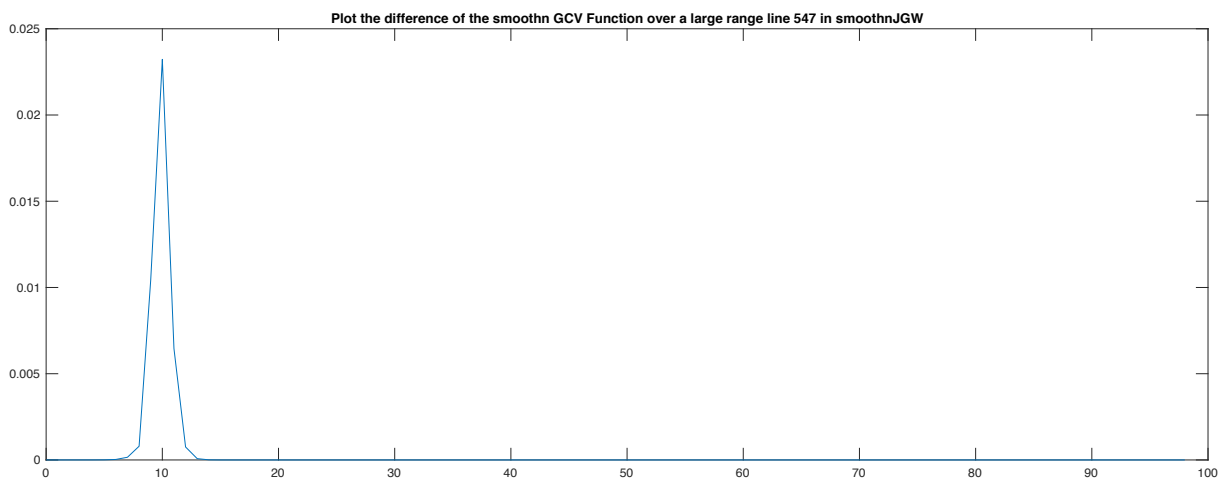




Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

S1_20X_6300X2500





Los Alamos NATIONAL LABORATORY EST. 1943
Operated by Los Alamos National Security, LLC for NNSA

S19_5_3d

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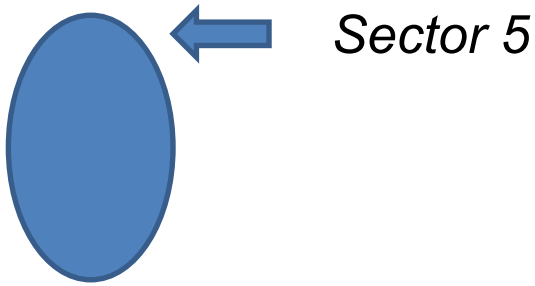

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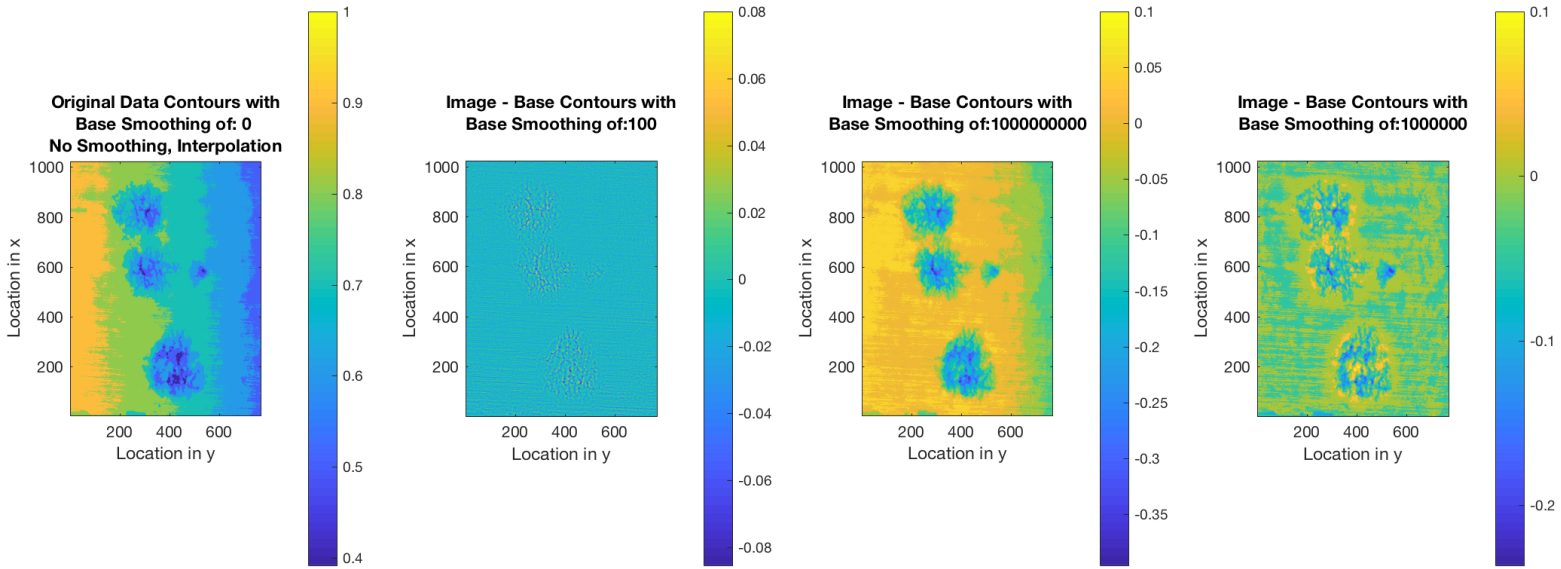
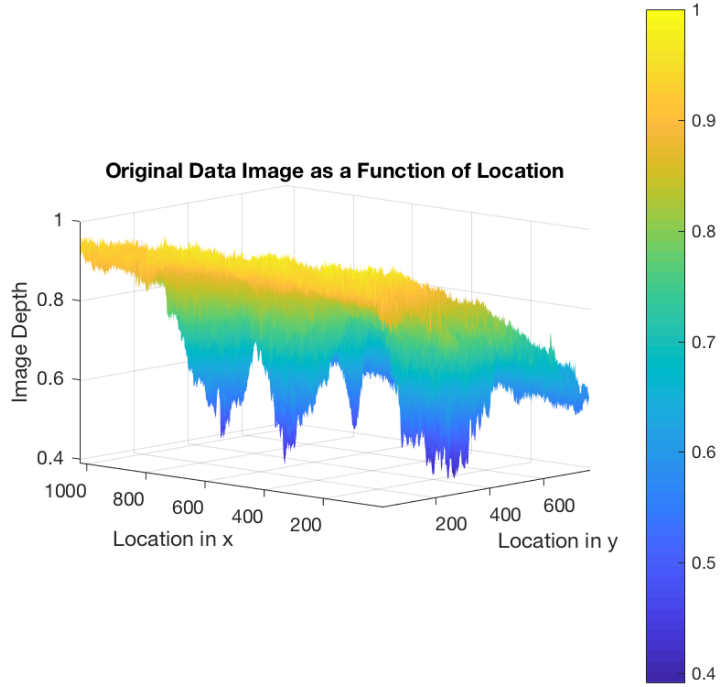
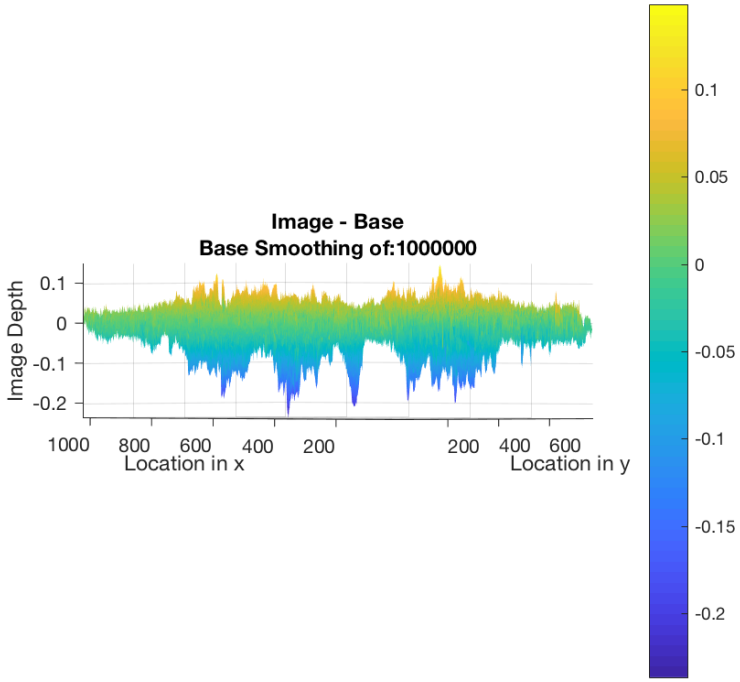


Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

S19_5_3d





Los Alamos NATIONAL LABORATORY EST.1943
Operated by Los Alamos National Security, LLC for NNSA

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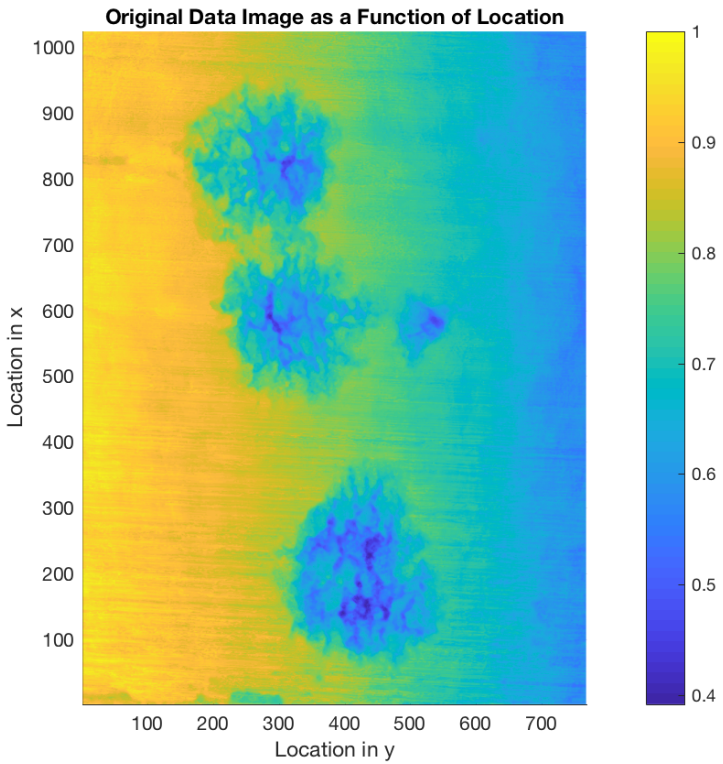

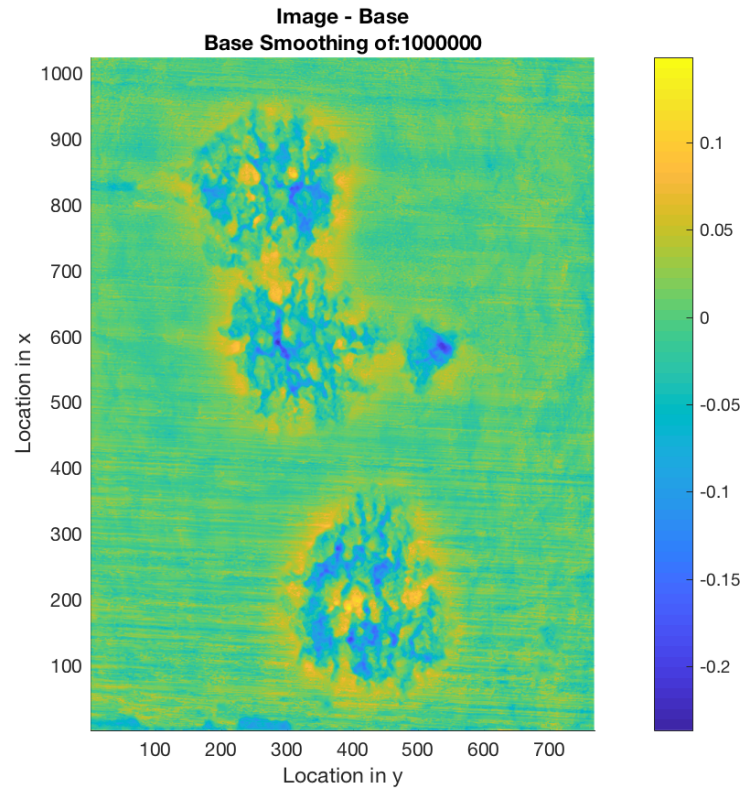

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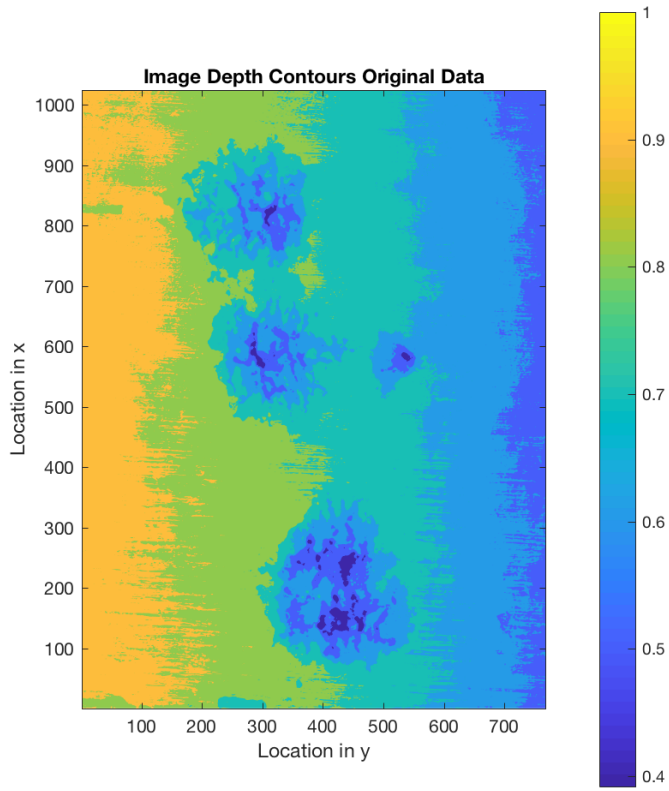

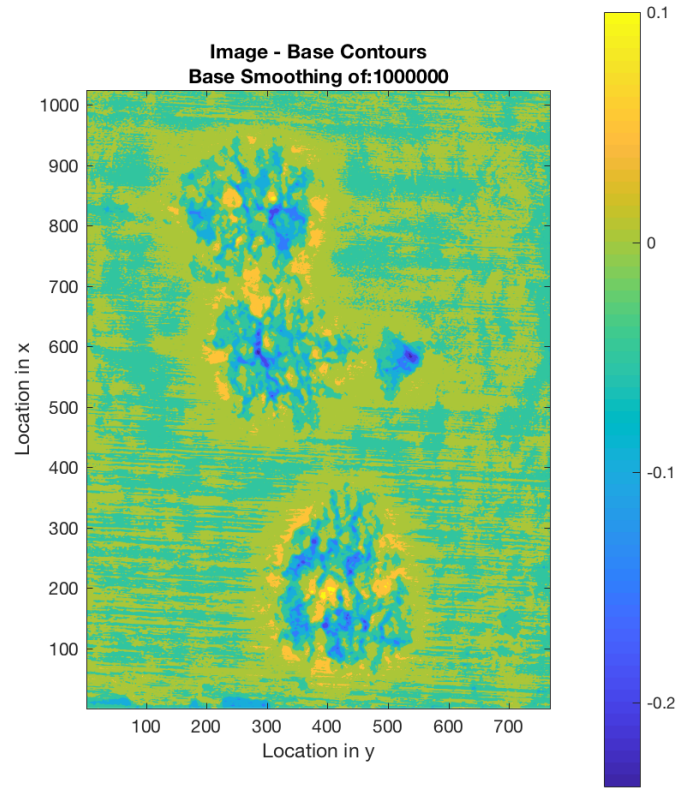

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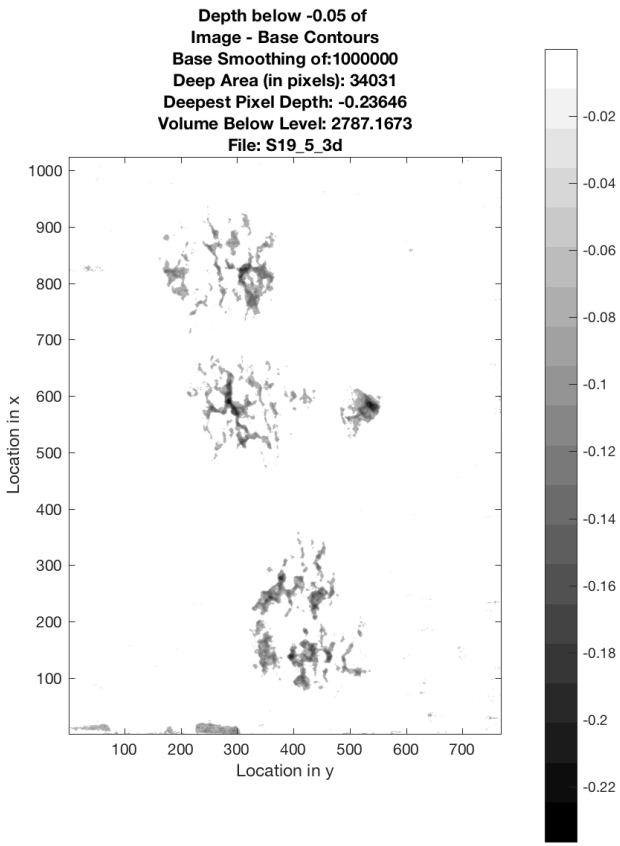

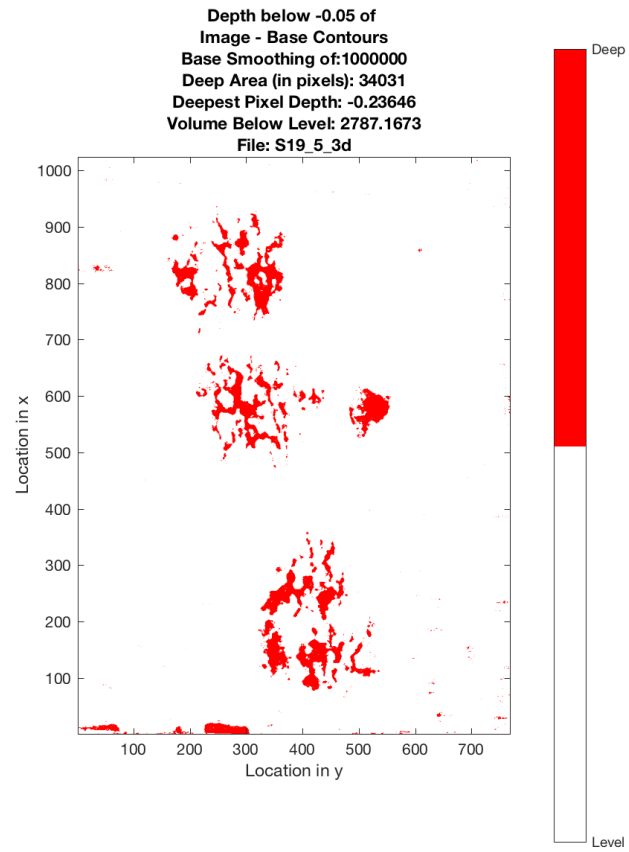

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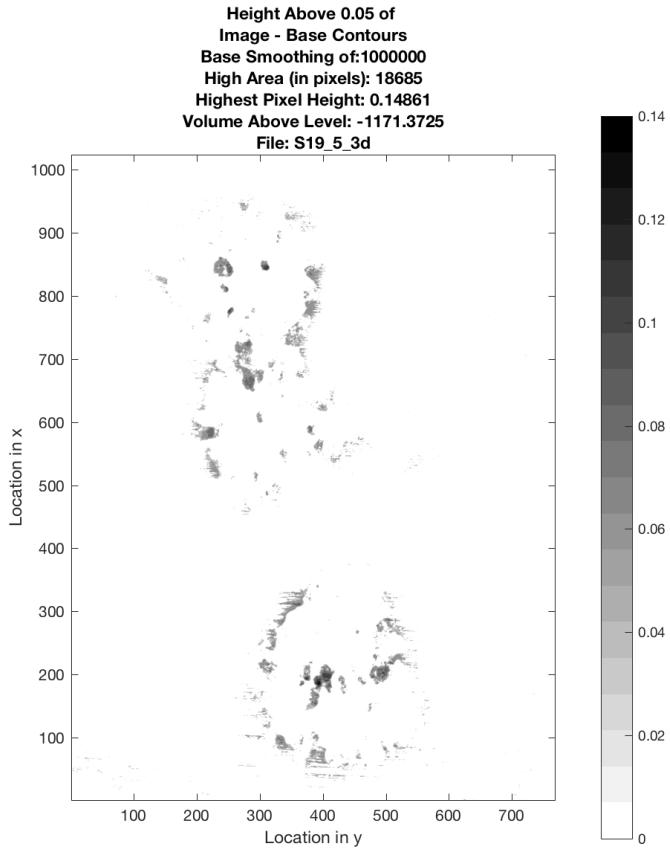

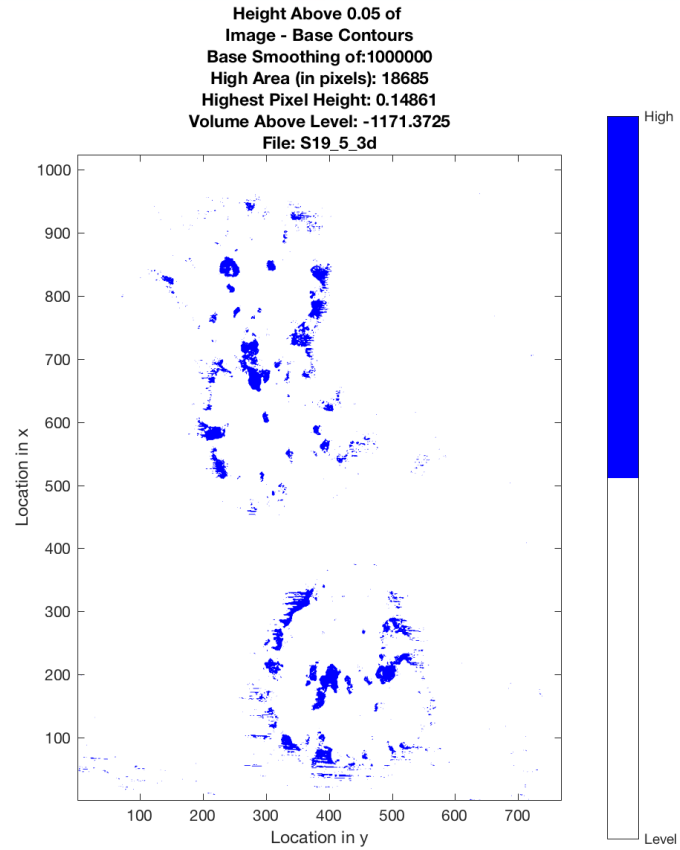

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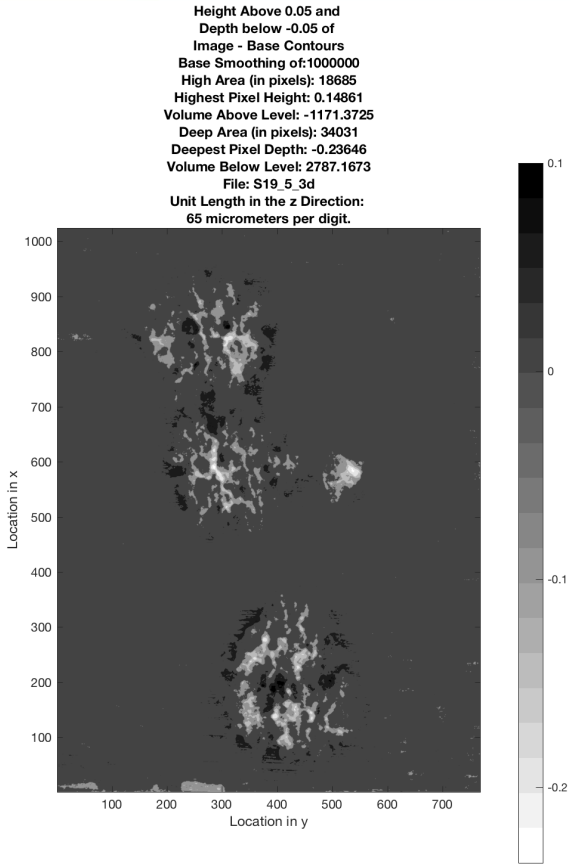

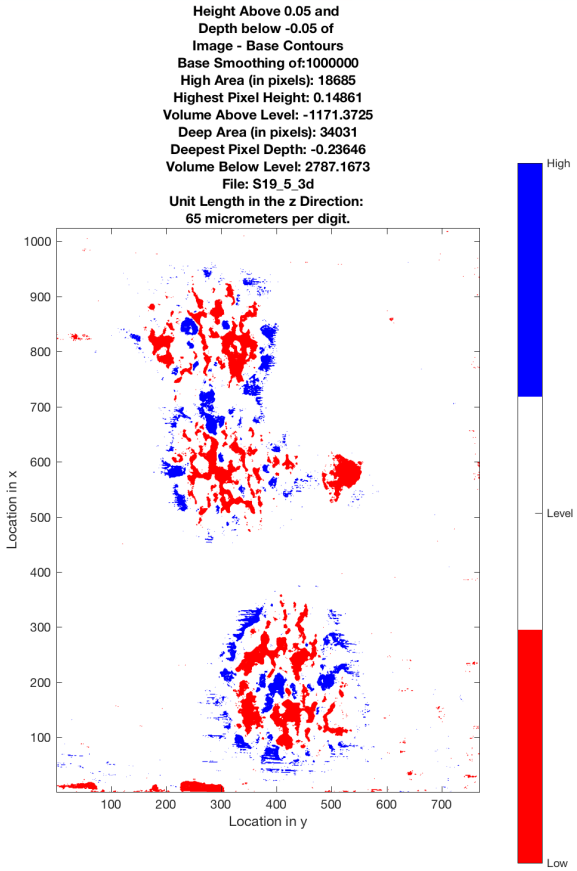

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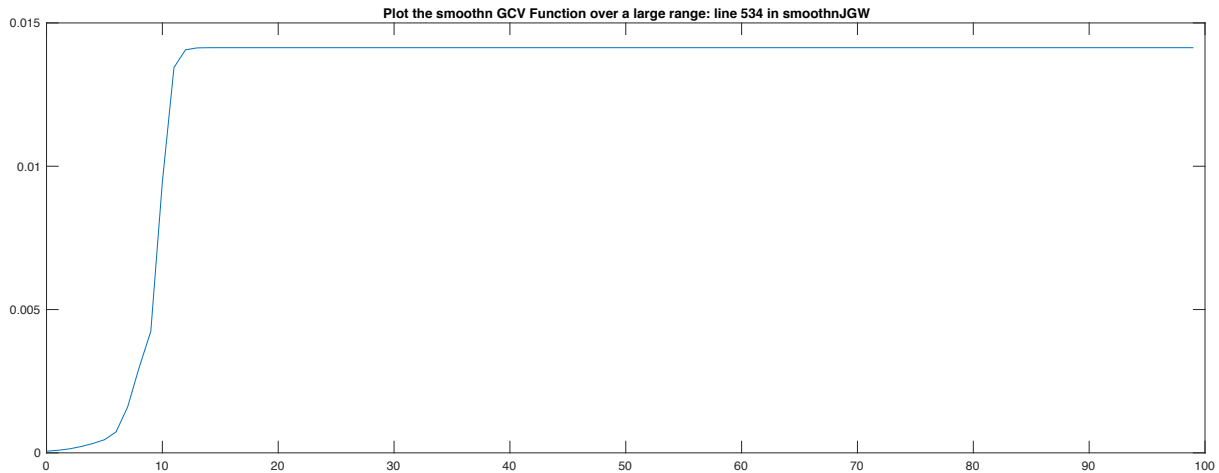

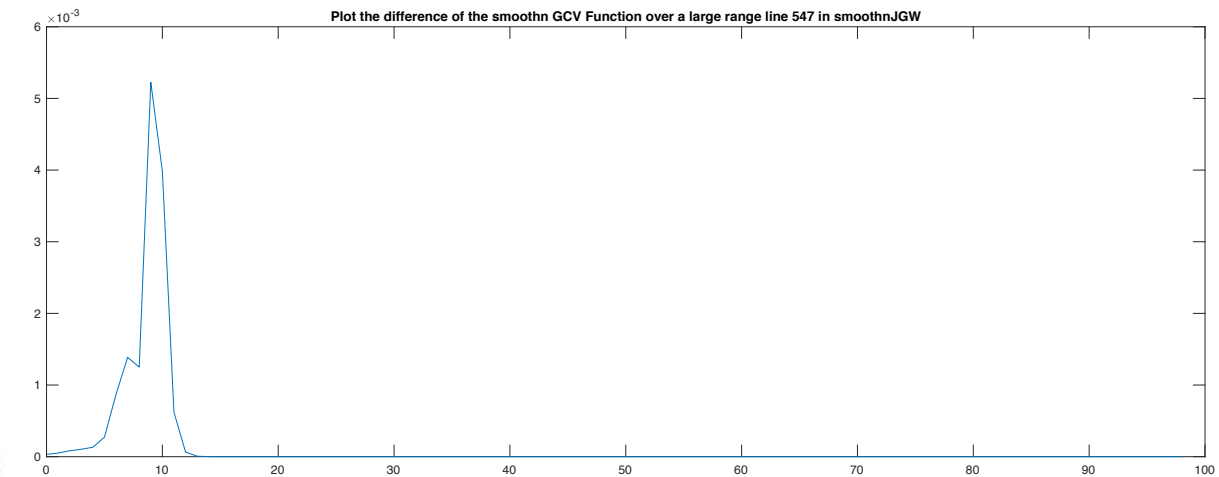

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Lessons Learned

1. One Smoothing Parameter Works Well to Estimate the Background - 9 Images
2. Generalized Cross Validation
3. Multiple Minima
4. Non Stitched and Stitched Images Are Different
5. Edges Detected and Removed from Analysis
6. Too Small a Feature Should Be Defined
7. Stitched Images Lose Sufficient Resolution
8. Stitched Images Introduced Artifacts
9. Image Post Processing Is Feasible

Future Work

1. Expand to Libraries of Images
   i. Read Header Information
   ii. Handle Many Images In One Run
2. Avoid Stitched Images
3. Best Background Estimation
   i. Edge Details (started working on this)
   ii. May Result in Non Rectangular Image
4. Individual Feature Definition and Discrimination
   i. Cracks, Scratches, Elongated Pits, Stitching, Edges
   ii. Pit Depth, Area, Volume
   iii. Corrosion Depth, area, Roughness
5. Subsurface Features by Incorporation of Cross Sectional Information/Data

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