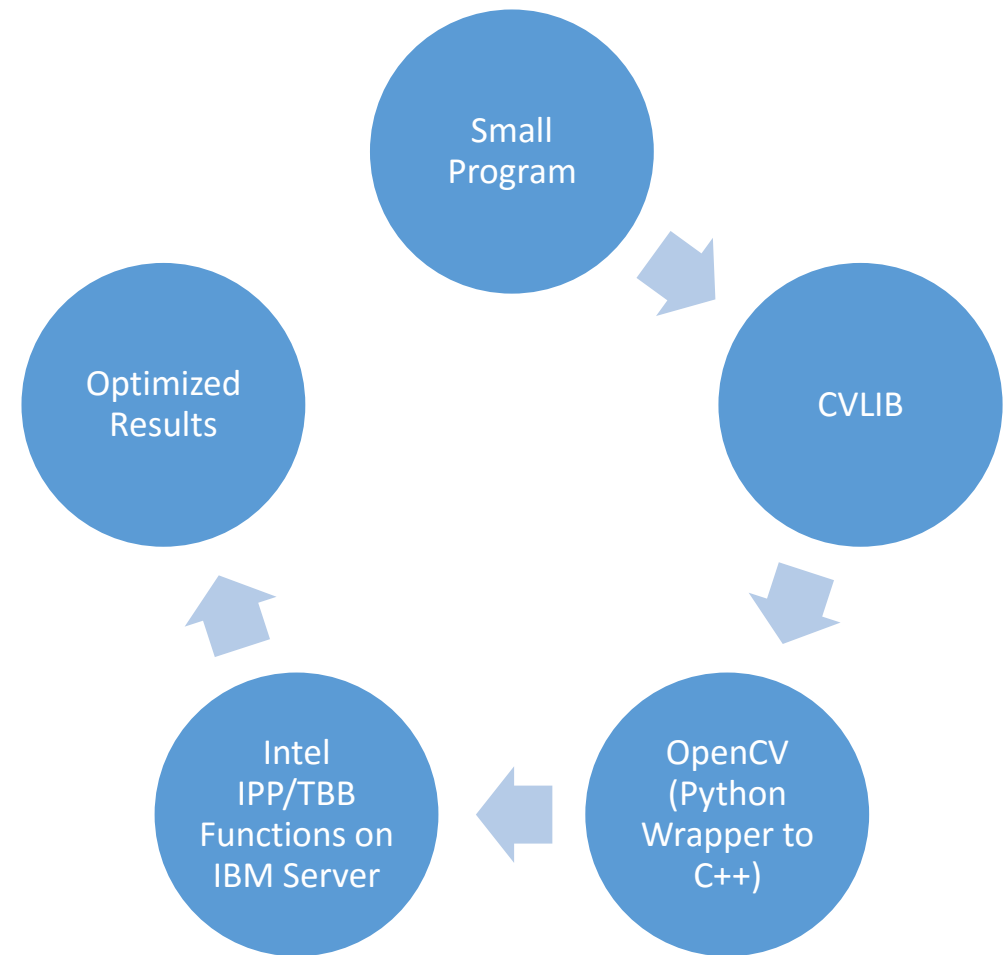


# Development of Computer Vision and Image Processing at NSLS-II

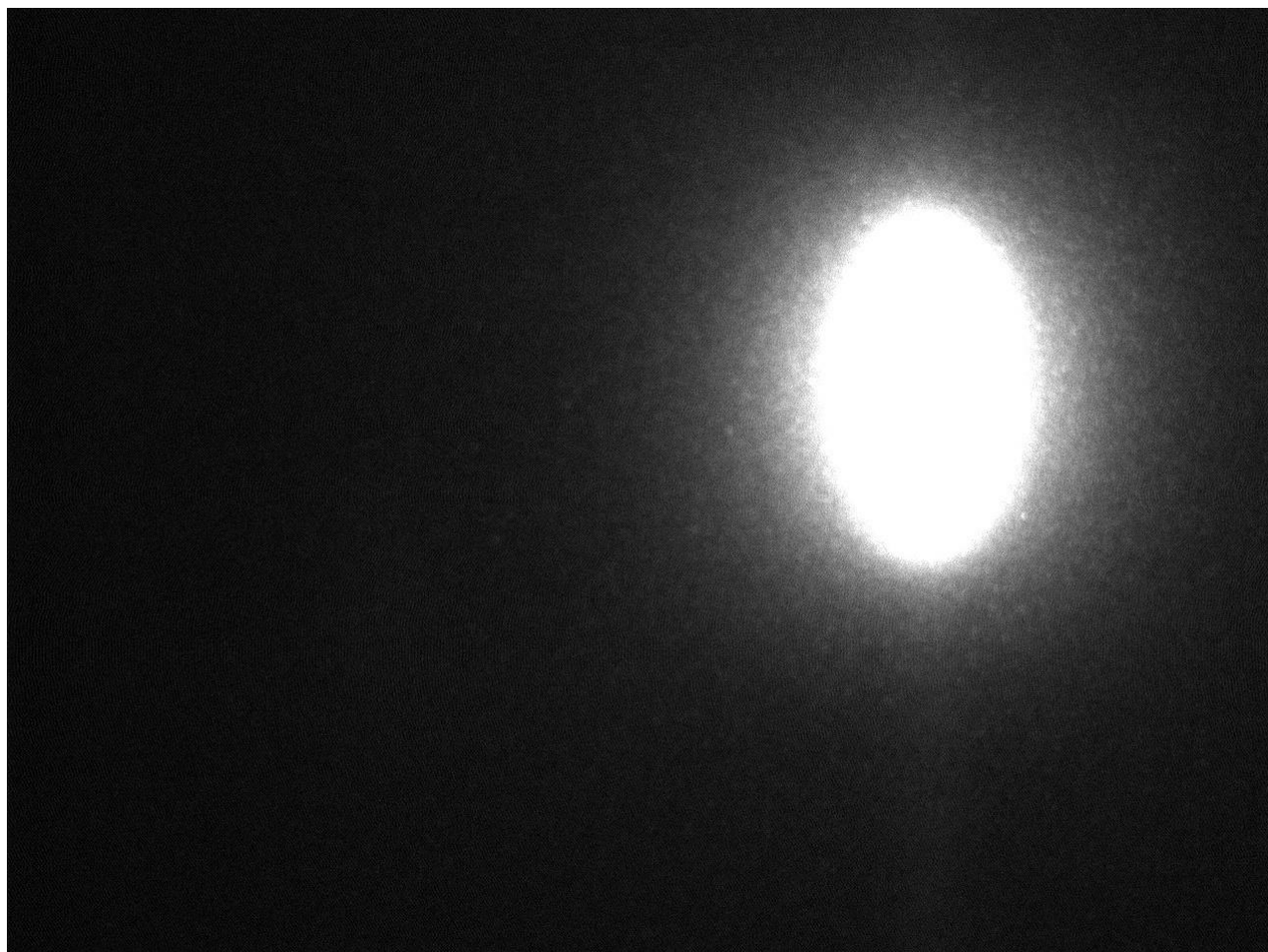
William Watson

# OpenCV and CVLIB

- Small Programs call upon functions in CVLIB
- CVLIB calls upon OpenCV, which has a Python Wrapper for C++
- OpenCV 3.0 supports optimization via Intel's IPP Low Level Functions, Intel TBB
- Computation is done on a dedicated IBM Server



# BPM-1 X-Ray Analysis

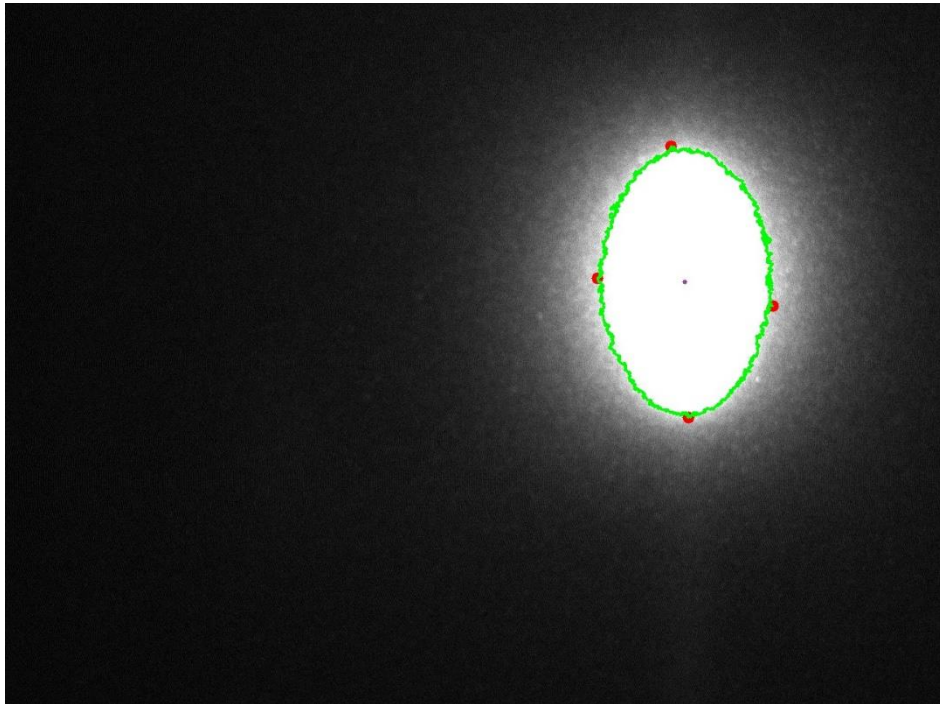


# BPM-1 Image Results

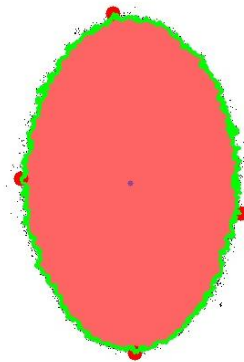
Process:

- Threshold
- Find Contours
- Interpret Contour Data (Plot, Draw, and Print)

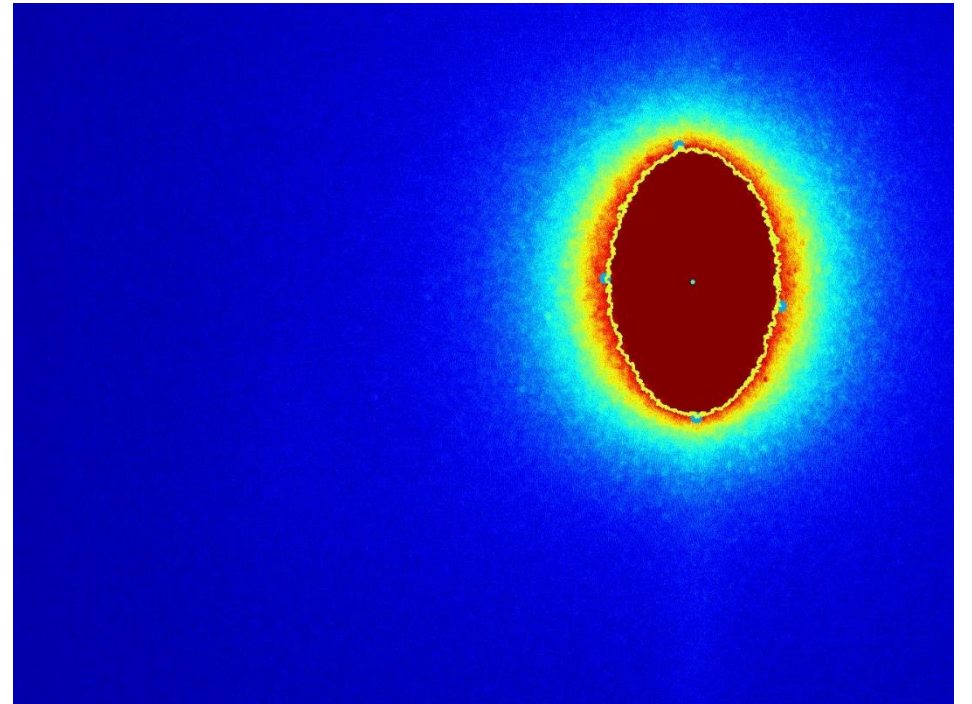
Result Superimposed on Original



Thresholding Result



Jet Color Map

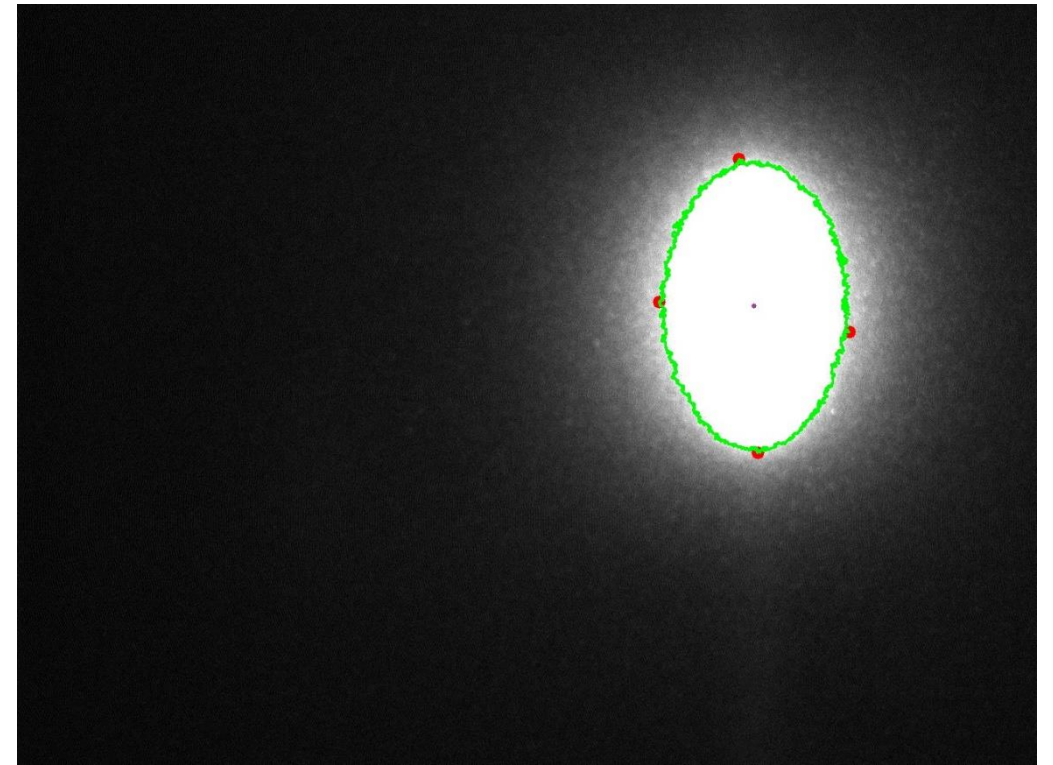


# BPM-1 Data Results

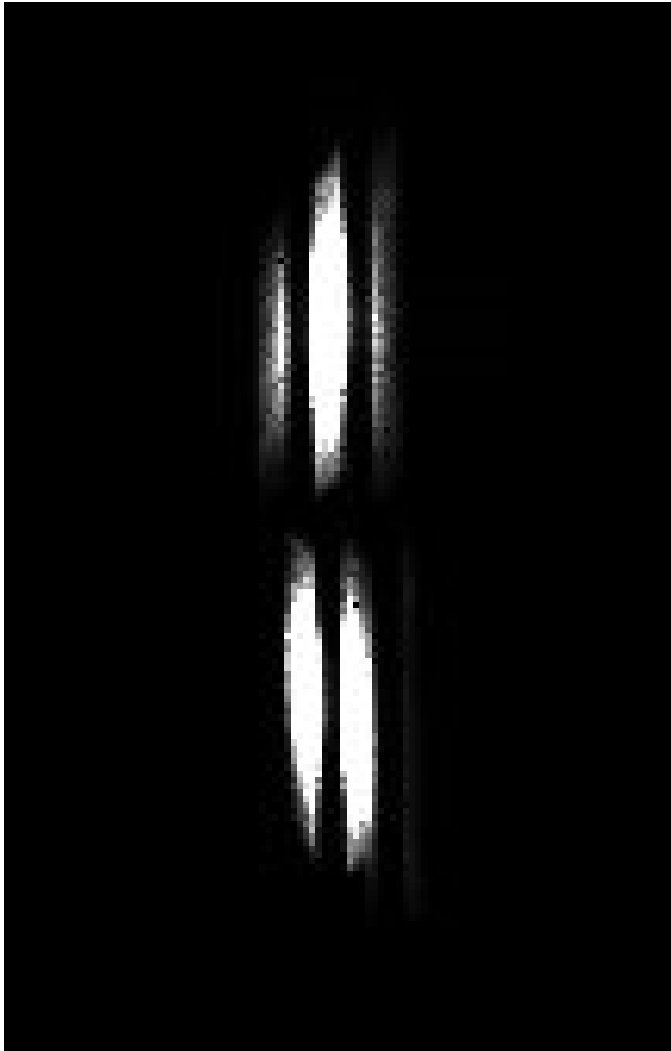
## Console Output:

### Object Details:

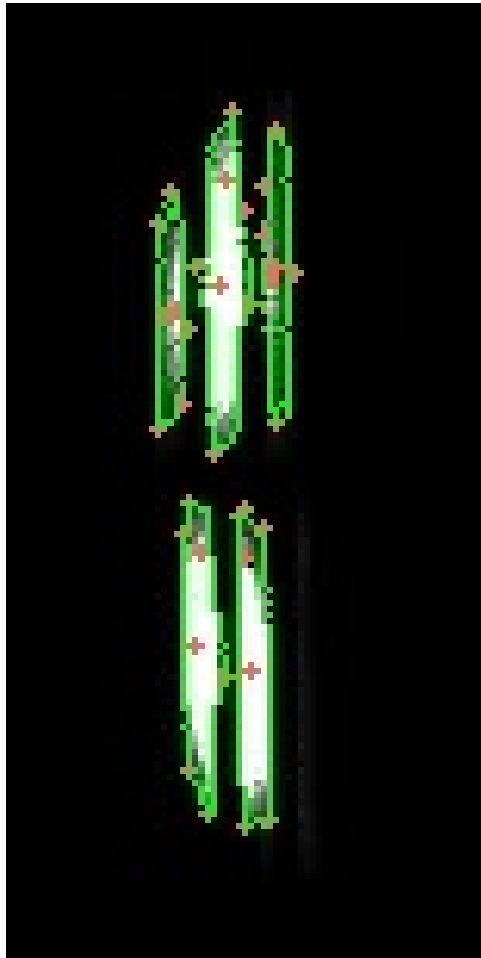
```
perimeter: 2356.99022925
orientation: 179.838363647
max: (925, 198)
solidity: 0.942924641105
height: 372
extent: 0.720742029114
extrema: {'B': (938, 568), 'R': (1054, 415), 'L': (813, 377), 'T': (914, 196)}
aspect ratio: 0.648793565684
area: 65058.5
min: (1047, 564)
sum intensity: 20426526
width: 241
centroid: (933, 382)
equivalent diameter: 287.810797089
mean intensity: 227.842390577
```



# Merlin Analysis

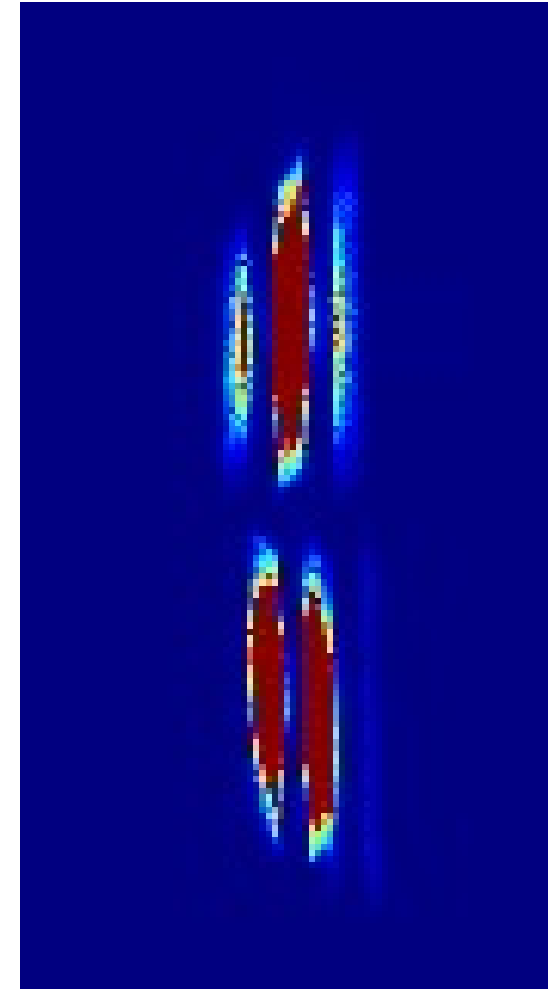


# Merlin Image Results



Process:

- Convert to Grayscale
- Threshold Image
- Find and filter contours by size
- For each object:
  - Print Object's Data
  - Plot Points of Interest
- Draw Contours
- Apply JET



# Merlin Data Results for First Object (Largest)

## Console Output:

Object 1:

perimeter: 125.840619564

orientation: 179.981033325

max: (131, 78)

solidity: 0.771754636234

height: 55

extent: 0.483035714286

extrema: {'B': (129, 122), 'R': (135, 98), 'L': (126, 92), 'T': (132, 67)}

aspect ratio: 0.178571428571

area: 270.5

min: (134, 83)

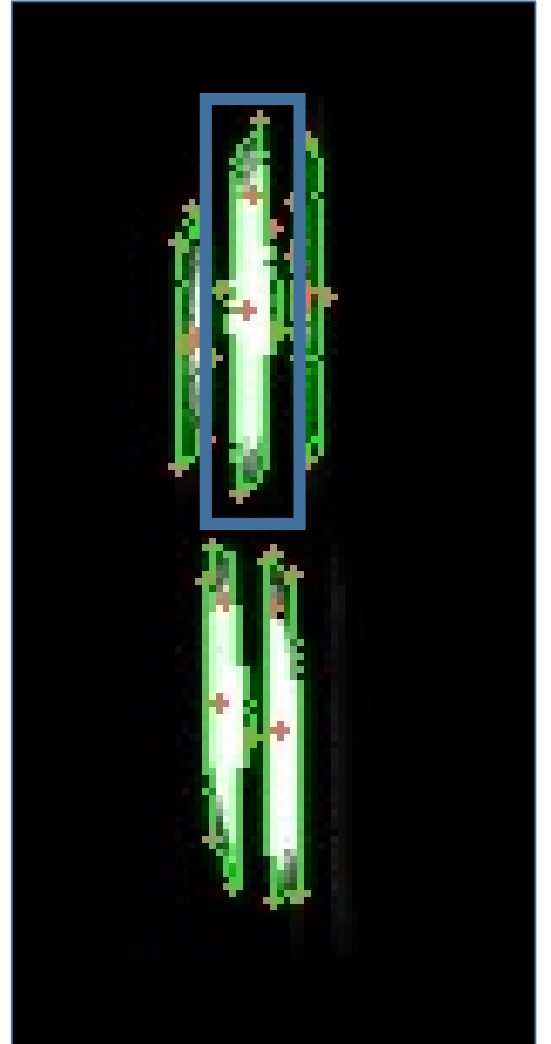
sum intensity: 62689

width: 9

centroid: (130, 95)

equivalent diameter: 18.5583214987

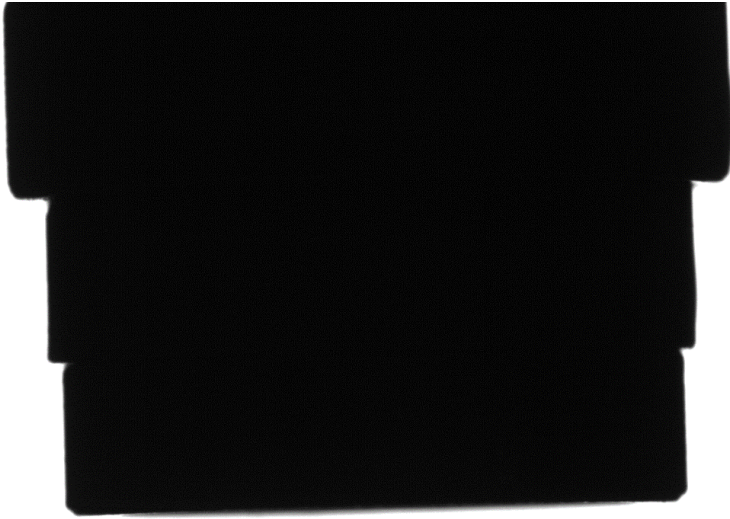
mean intensity: 126.644444444



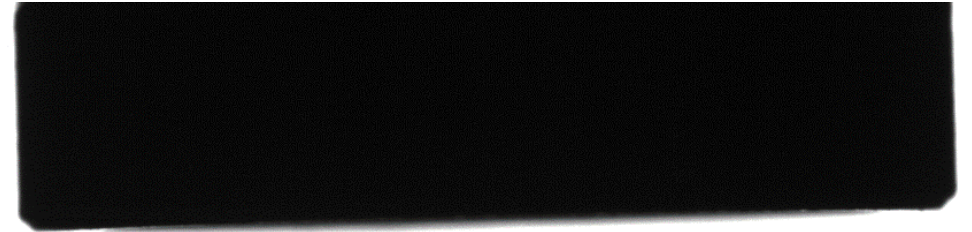


# Match Game – Template Images

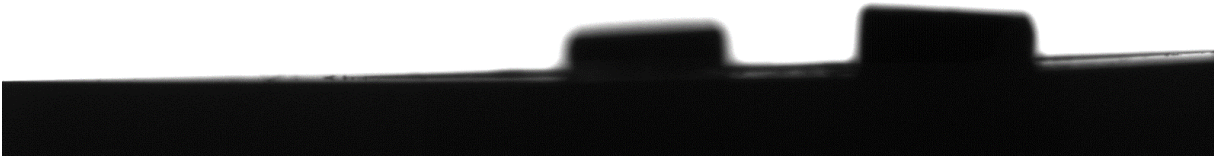
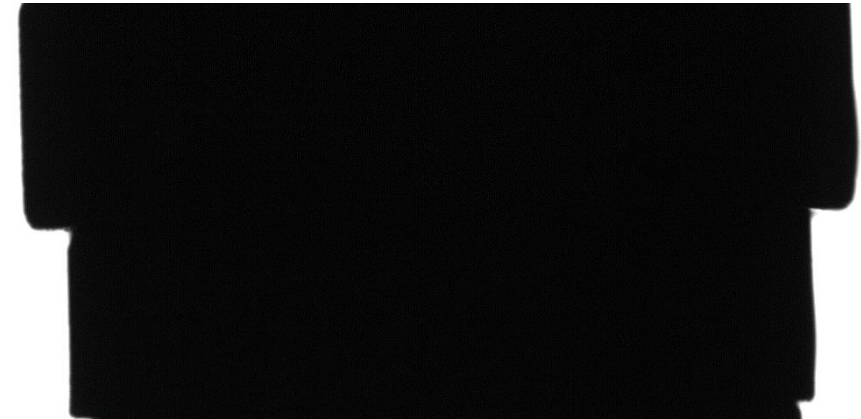
Pin and Gripper 'Perfect' Image



Pin Template Image



Gripper Template Image



# Match Game – ‘Perfect’ vs Actual

‘Perfect’



Image 1



Image 2

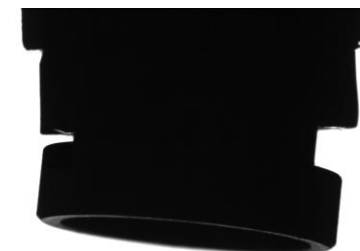


Image 3

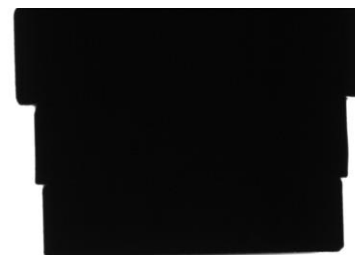


Image 4



# Match Game - Results

## Console Output:

Template: 0.0 Disim

Image-1: 1.36311088973 Disim

Image-2: 0.0286209618648 Disim

Image-3: 0.0045508842333 Disim

Image-4: 0.190357587177 Disim

Image 2

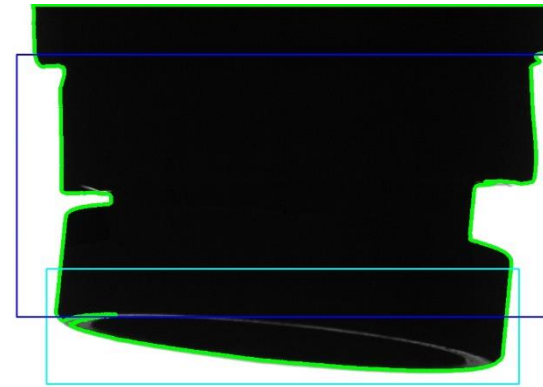


Image 3

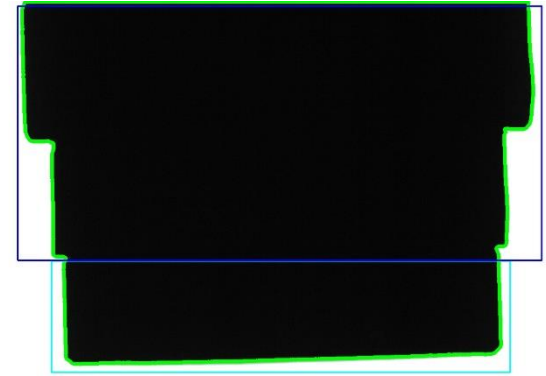
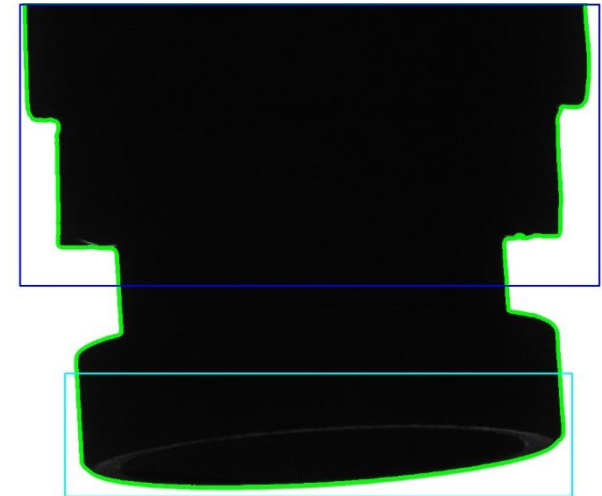


Image 4



'Perfect'



Image 1



# Pin/Gripper – ‘Perfect’ vs Actual

‘Perfect’



Image 1



Image 2



Image 3



Image 4



# Pin/Gripper Image Analysis – Results – Image 1

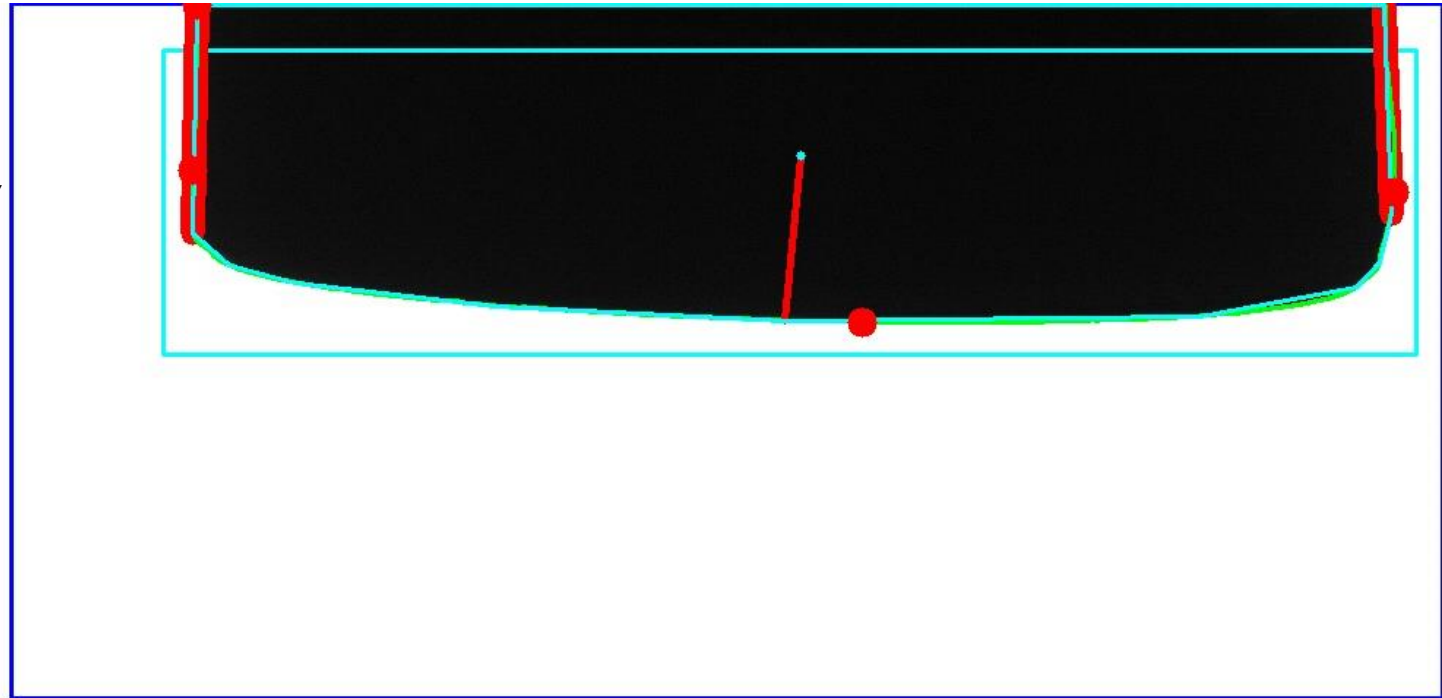
## Console Output on Image 1:

### Image 1:

```
perimeter: 2017.74725473
orientation: 91.0750732422
max: (745, 1)
solidity: 0.996730365951
height: 217
extent: 0.940458938544
extrema: {'B': (1203, 218), 'R': (1567, 129),
          'L': (745, 114), 'T': (748, 1)}
aspect ratio: 3.7752293578
area: 168731.5
min: (793, 1)
sum intensity: 4280971
width: 822
centroid: (1161, 104)
equivalent diameter: 463.503633473
mean intensity: 23.999971969
```

## Error Results:

```
Image Dissimilarity: 1.36080901012
ERROR: Mount Centroid: Too High: 104
ERROR: Missing Component / Gripper Not Aligned
```



# Pin/Gripper Image Analysis – Results – Image 2

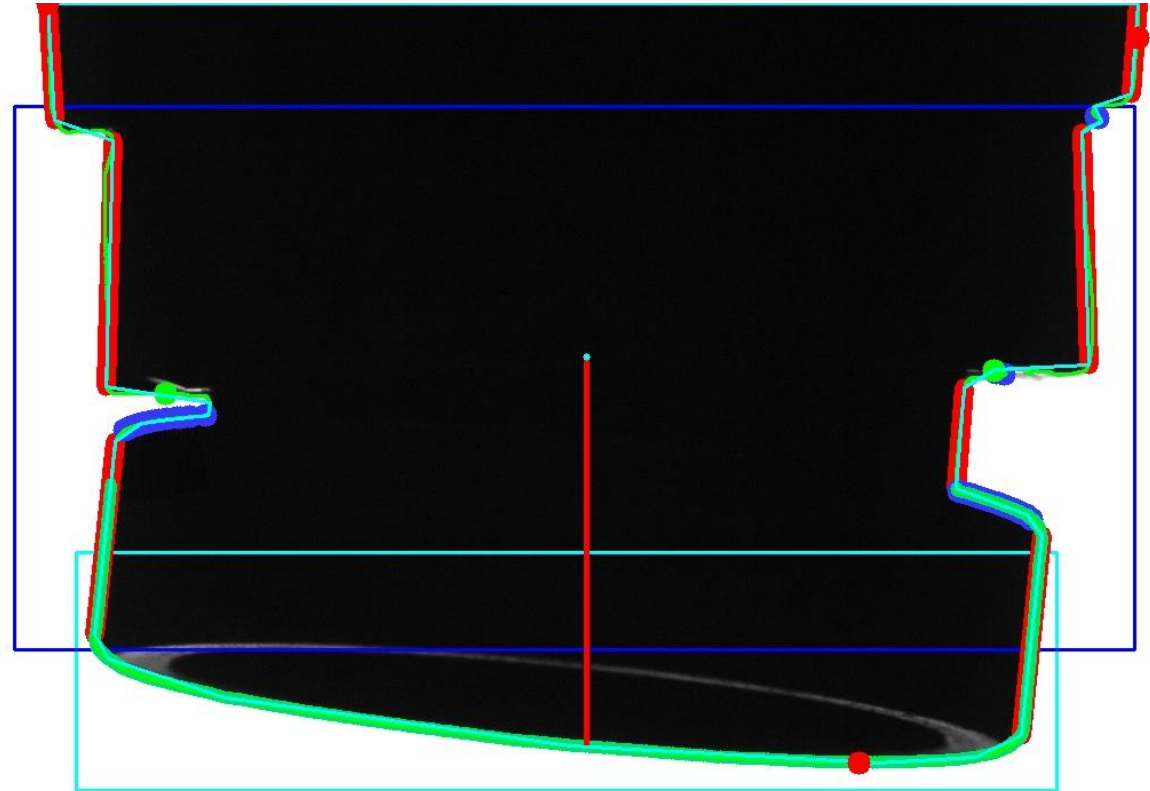
## Console Output:

### Image 2:

perimeter: 3512.21232665  
orientation: 0.774656236172  
max: (497, 66)  
solidity: 0.941137856546  
height: 664  
extent: 0.839552497596  
extrema: {'B': (1206, 665), 'R': (1450, 31)  
          'L': (497, 1), 'T': (497, 1)}  
aspect ratio: 1.43458646617  
area: 532620.5  
min: (515, 1)  
sum intensity: 30095708  
width: 953  
centroid: (968, 310)  
equivalent diameter: 823.500748595  
mean intensity: 47.5601903943

## Error Results:

Image Dissimilarity: 0.0274253192917  
ERROR: Possible Kinks Detected  
ERROR: 41 Possible Kink Points Detected: Adjust Gripper  
ERROR: Possible Kink Distance on R: 115.004347744  
ERROR: Possible Kink Distance on L: 27.3130005675  
ERROR: Pin Not Mounted Correctly: Distance: 329



# Pin/Gripper Image Analysis – Results – Image 3

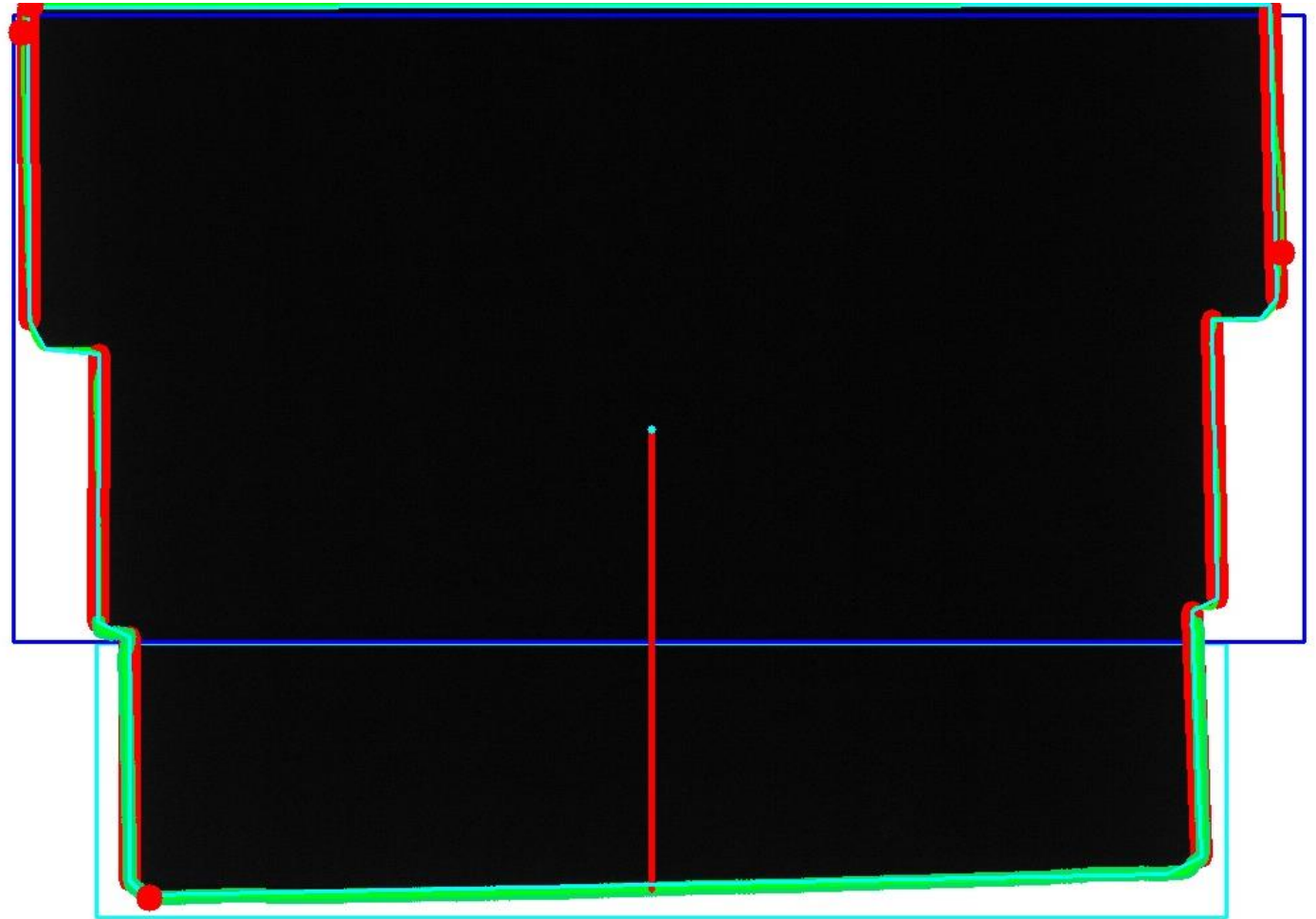
## Console Output:

### Image 3:

```
perimeter: 3272.13917053
orientation: 160.072814941
max: (496, 1)
solidity: 0.967876787861
height: 677
extent: 0.902237973263
extrema: {'B': (593, 678), 'R': (1452, 189),
          'L': (496, 22), 'T': (503, 1)}
aspect ratio: 1.41150442478
area: 585413.5
min: (525, 1)
sum intensity: 20199272
width: 956
centroid: (974, 323)
equivalent diameter: 863.349070899
mean intensity: 31.2096685476
```

## Error Results:

Image Dissimilarity: 0.00487836456791





# Pin/Gripper Image Analysis – Results – Image 4

## Console Output:

Image 4:

perimeter: 3790.45496655

orientation: 177.796310425

max: (1443, 1)

solidity: 0.925888779152

height: 821

extent: 0.845230278227

extrema: {'B': (828, 822), 'R': (1447, 125),  
          'L': (492, 1), 'T': (492, 1)}

aspect ratio: 1.16301703163

area: 664209.0

min: (503, 1)

sum intensity: 35452804

width: 955

centroid: (974, 387)

equivalent diameter: 919.617945002

mean intensity: 45.2172411374

## Error Results:

Image Dissimilarity: 0.190836638543

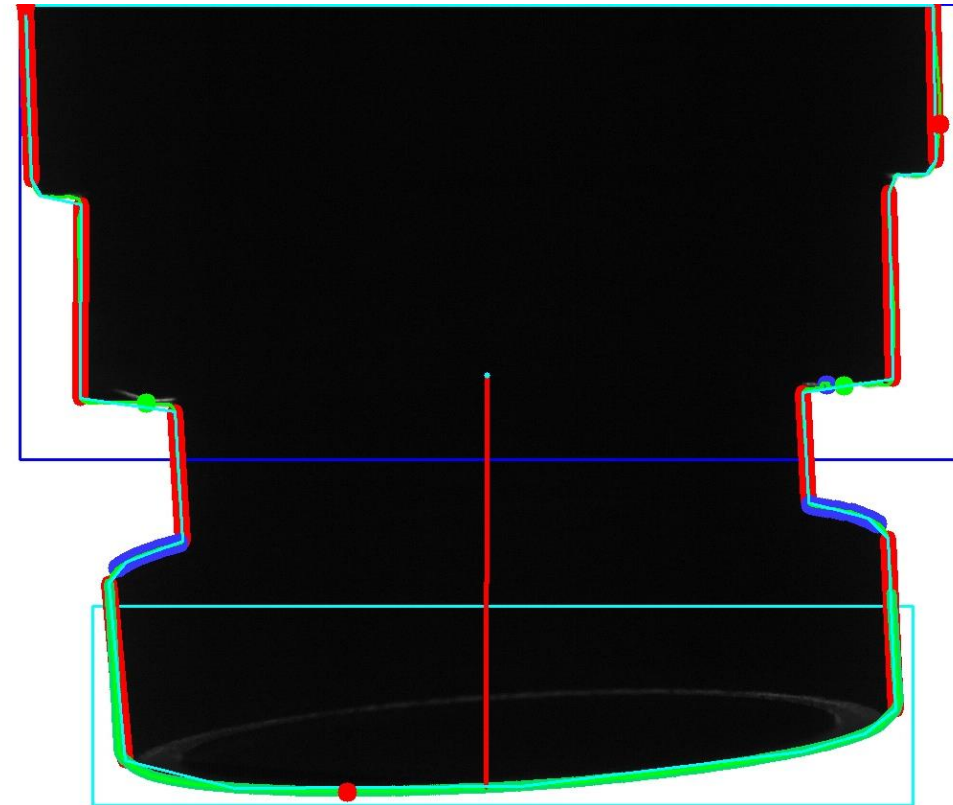
ERROR: Possible Kinks Detected

ERROR: 44 Possible Kink Points Detected: Adjust Gripper

ERROR: Possible Kink Distance on R: 125.015998976

ERROR: Possible Kink Distance on L: 157.003184681

ERROR: Pin Not Mounted Correctly: Distance: 411





# Time Analysis – No Display or Drawing on Img

## BPM-1:

Real	0m0.488s
User	0m0.460s
Sys	0m0.044s

## Merlin:

Real	0m0.321s
User	0m0.284s
Sys	0m0.036s

## Match Game (All Img):

Real	0m1.057s
User	0m1.088s
Sys	0m0.064s

## Pin/Gripper (All Img):

Real	0m2.710s
User	0m2.772s
Sys	0m0.100s

## Match Game (Single):

Real	0m0.525s
User	0m0.500s
Sys	0m0.056s

## Pin/Gripper (Single):

Real	0m0.661s
User	0m0.596s
Sys	0m0.096s