

```
# Step 1: Install the necessary libraries
!pip install scikit-image
!pip install lxml
!pip install pillow
!pip install opencv-python-headless

→ Requirement already satisfied: scikit-image in /usr/local/lib/python3.10/dist-packages (0.24.0)
Requirement already satisfied: numpy>=1.23 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (1.26.4)
Requirement already satisfied: scipy>=1.9 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (1.13.1)
Requirement already satisfied: networkx>=2.8 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (3.3)
Requirement already satisfied: pillow>=9.1 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (10.4.0)
Requirement already satisfied: imageio>=2.33 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (2.35.1)
Requirement already satisfied: tifffile>=2022.8.12 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (2024.9.20)
Requirement already satisfied: packaging>=21 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (24.1)
Requirement already satisfied: lazy-loader>=0.4 in /usr/local/lib/python3.10/dist-packages (from scikit-image) (0.4)
Requirement already satisfied: lxml in /usr/local/lib/python3.10/dist-packages (4.9.4)
Requirement already satisfied: pillow in /usr/local/lib/python3.10/dist-packages (10.4.0)
Requirement already satisfied: opencv-python-headless in /usr/local/lib/python3.10/dist-packages (4.10.0.84)
Requirement already satisfied: numpy>=1.21.2 in /usr/local/lib/python3.10/dist-packages (from opencv-python-headless) (1.26.4)
```

```
# Step 2: Mount Google Drive
from google.colab import drive
drive.mount('/content/drive')
```

→ Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force\_remount=True).

```
import os
import xml.etree.ElementTree as ET
from PIL import Image
from pathlib import Path

# Define the paths for images and annotations in Google Drive
image_base_dir = '/content/drive/MyDrive/Images 3'
annotation_base_dir = '/content/drive/MyDrive/Annotation'

# Use your actual folder names here:
classes = ['n02093859-Kerry_blue_terrier', 'n02097209-standard_schnauzer',
           'n02099849-Chesapeake_Bay_retriever', 'n02110185-Siberian_husky']

# Create an output directory for processed images
output_dir = 'Processed_Images'
Path(output_dir).mkdir(parents=True, exist_ok=True)

for dog_class in classes:
    Path(f"{output_dir}/{dog_class}").mkdir(parents=True, exist_ok=True)
```

```
# Step 6: Function to get bounding box coordinates from the XML annotation files
def get_bounding_boxes(annotation_file):
    tree = ET.parse(annotation_file)
    root = tree.getroot()
    bbox_list = []

    for obj in root.findall('object'):
        bndbox = obj.find('bndbox')
        xmin = int(bndbox.find('xmin').text)
        ymin = int(bndbox.find('ymin').text)
        xmax = int(bndbox.find('xmax').text)
        ymax = int(bndbox.find('ymax').text)
        bbox_list.append((xmin, ymin, xmax, ymax))

    return bbox_list
```

```
# Step 7: Function to crop and resize images based on bounding box coordinates
def crop_and_resize_image(image_path, annotation_path, output_path):
    img = Image.open(image_path)
    bboxes = get_bounding_boxes(annotation_path)

    for idx, bbox in enumerate(bboxes):
        cropped_img = img.crop(bbox)
        resized_img = cropped_img.resize((128, 128))
        resized_img.save(os.path.join(output_path, f"cropped_{idx}.jpg"))
```

```
# Step 8: Iterate through the four classes, process the images and save cropped and resized versions
for dog_class in classes:
```

```
image_dir = f"{image_base_dir}/{dog_class}"
annotation_dir = f"{annotation_base_dir}/{dog_class}"
output_class_dir = f"{output_dir}/{dog_class}"

for image_file in os.listdir(image_dir):
    if image_file.endswith(".jpg"):
        image_path = os.path.join(image_dir, image_file)
        annotation_path = os.path.join(annotation_dir, image_file.replace(".jpg", ""))

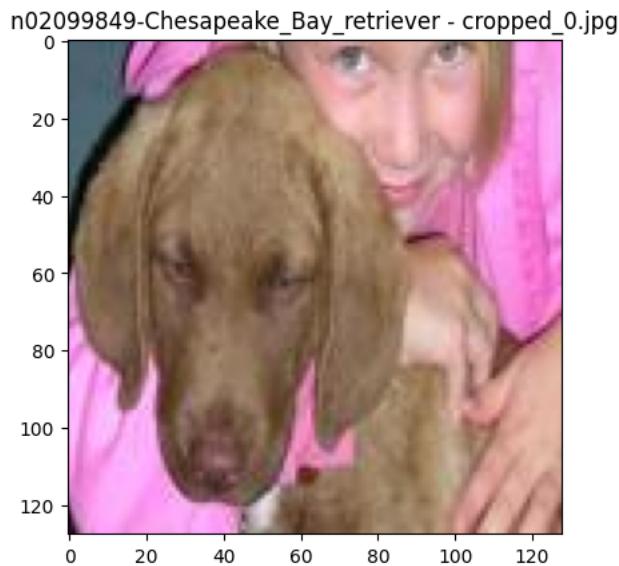
        if os.path.exists(annotation_path):
            crop_and_resize_image(image_path, annotation_path, output_class_dir)
```

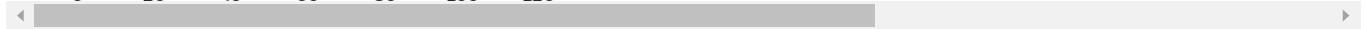
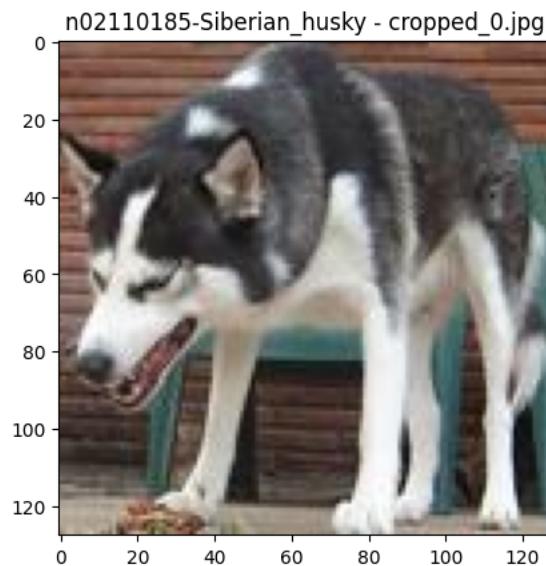
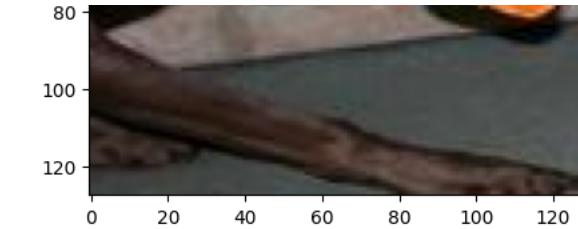
(a)

```
import numpy as np

import matplotlib.pyplot as plt
# Display some of the processed images
for dog_class in classes:
    image_dir = f"{output_dir}/{dog_class}"
    image_files = os.listdir(image_dir)

    # Show first 2 images from each class
    for i, image_file in enumerate(image_files[:2]):
        img = Image.open(os.path.join(image_dir, image_file))
        plt.imshow(img)
        plt.title(f"{dog_class} - {image_file}")
        plt.show()
```





(b)

```
import os
import numpy as np
from skimage import filters, exposure, io, color
import matplotlib.pyplot as plt

# Function to compute edge angles and histogram
def compute_edge_histogram(image_path):
    img = io.imread(image_path)
    gray_img = color.rgb2gray(img)

    sobel_h = filters.sobel_h(gray_img)
    sobel_v = filters.sobel_v(gray_img)
    angles = np.mod(np.arctan2(sobel_v, sobel_h), np.pi)

    hist, hist_centers = exposure.histogram(angles, nbins=36)

    return hist, hist_centers

# Function to plot edge histogram
def plot_histogram(image_path):
    hist, hist_centers = compute_edge_histogram(image_path)
    plt.bar(hist_centers, hist, width=0.05)
    plt.xlabel('Bins')
    plt.ylabel('Pixel Count')
    plt.title(f'Edge Histogram for {os.path.basename(image_path)}')
    plt.show()

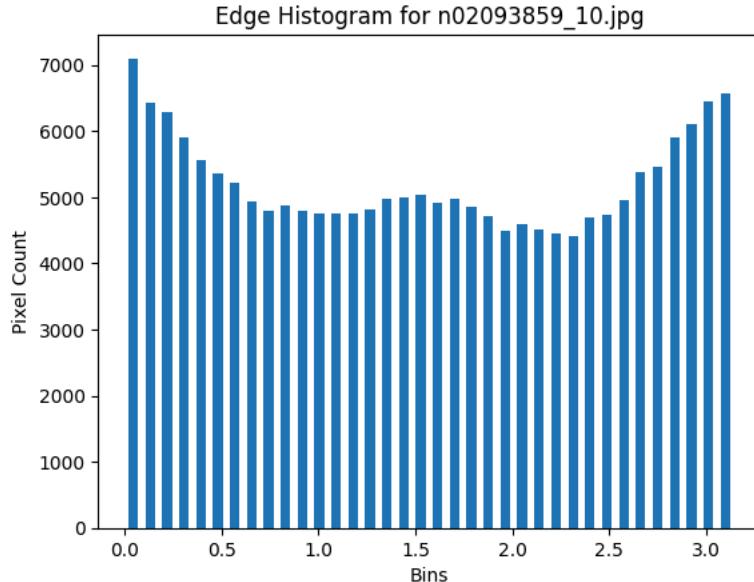
# Function to process all images in a folder
def process_images_in_folder(folder_path):
    images = [os.path.join(folder_path, img) for img in os.listdir(folder_path) if img.endswith(".jpg")]

    for image_path in images:
        print(f"Processing image: {image_path}")
        plot_histogram(image_path)

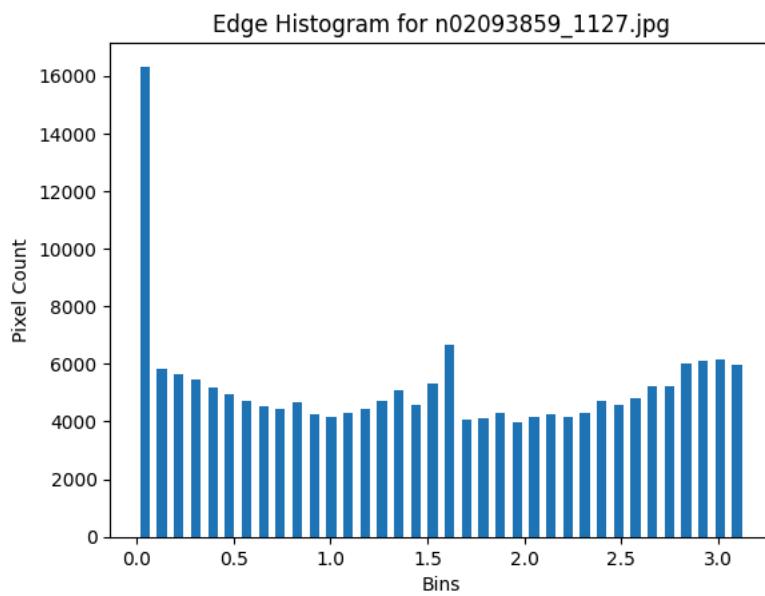
# Loop through each of the 4 folders and process images
base_folder = "content/drive/MyDrive/Images 3"
subfolders = ['/content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier', '/content/drive/MyDrive/Images 3/n02097209-standard_schnauzer']

for subfolder in subfolders:
    folder_path = os.path.join(base_folder, subfolder)
    process_images_in_folder(folder_path)
```

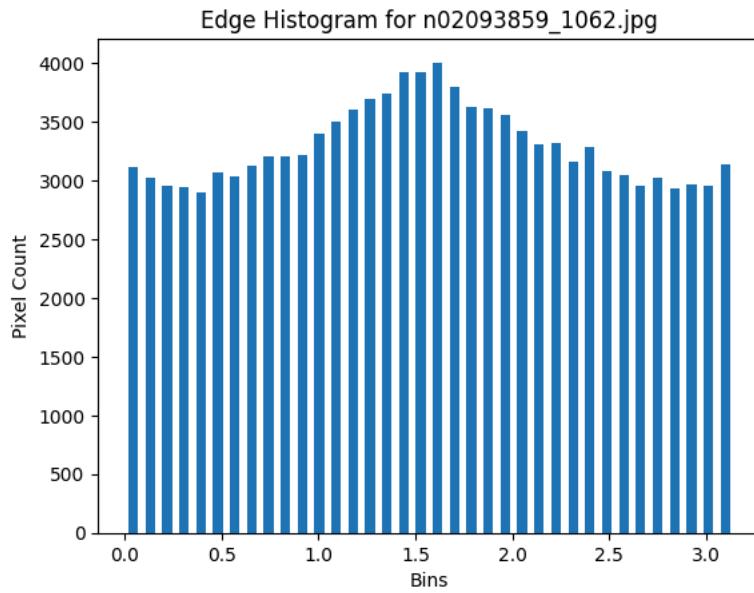
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_10.jpg



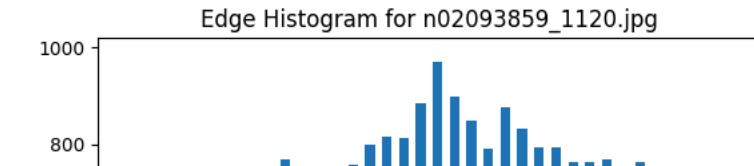
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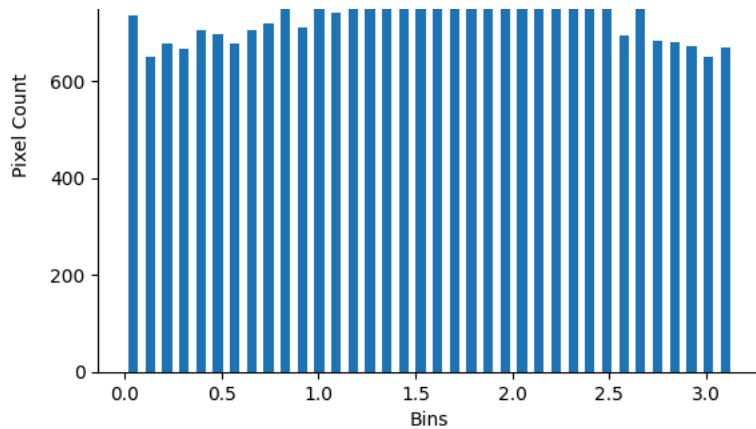


Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1062.jpg



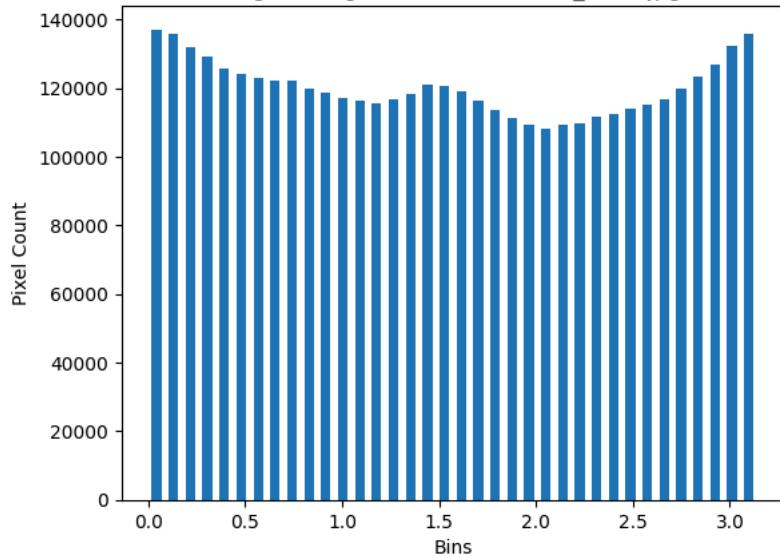
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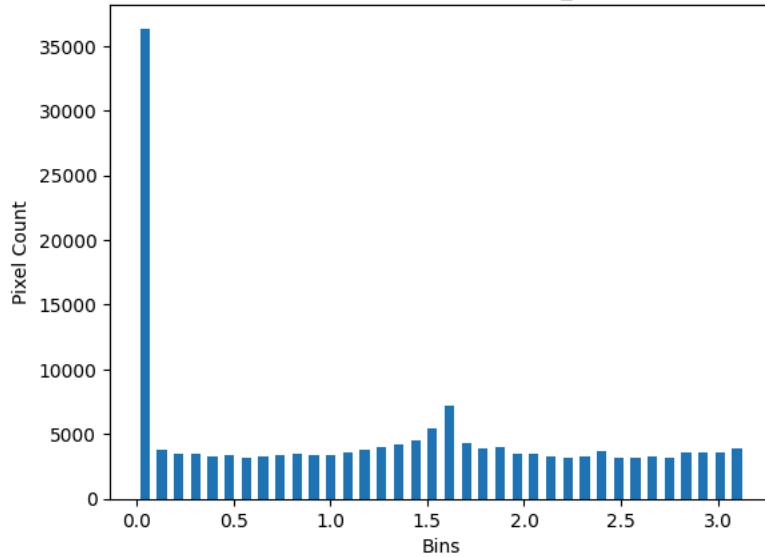
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Edge Histogram for n02093859\_1003.jpg



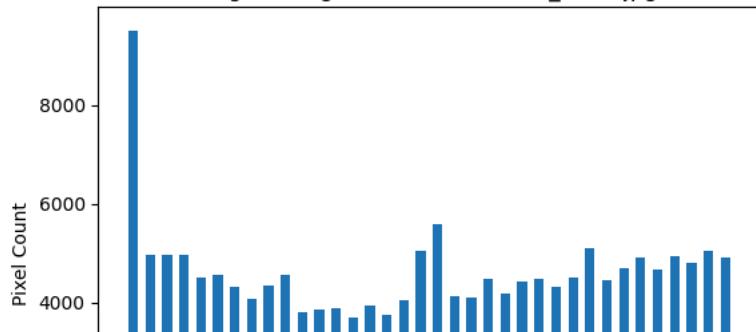
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1213.jpg

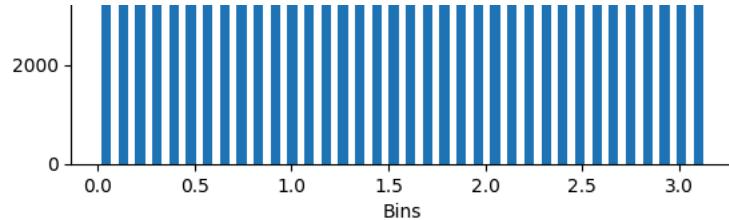
Edge Histogram for n02093859\_1213.jpg



Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1239.jpg

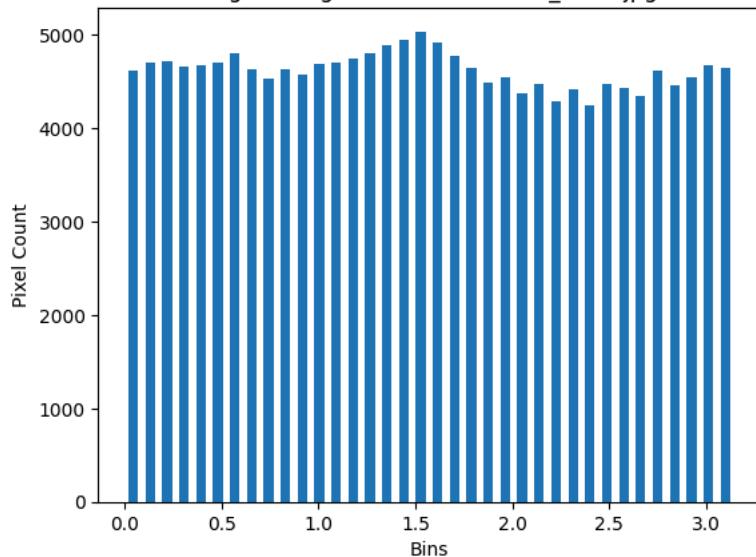
Edge Histogram for n02093859\_1239.jpg





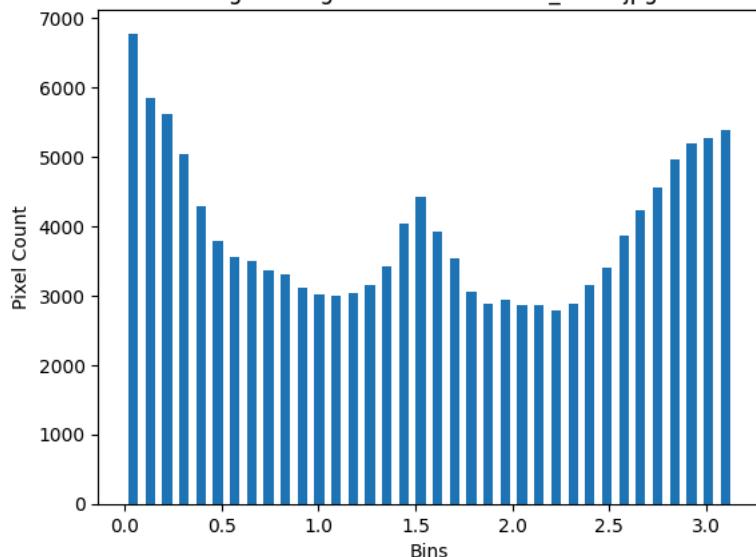
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Edge Histogram for n02093859\_1154.jpg



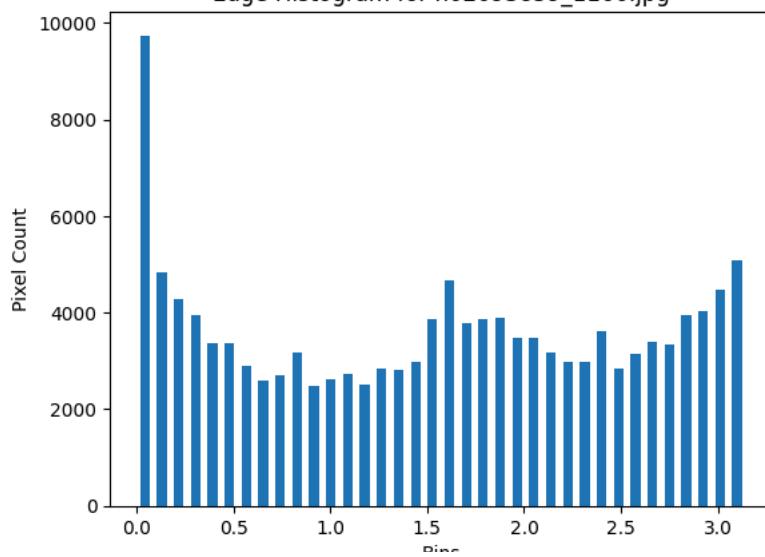
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Edge Histogram for n02093859\_1194.jpg

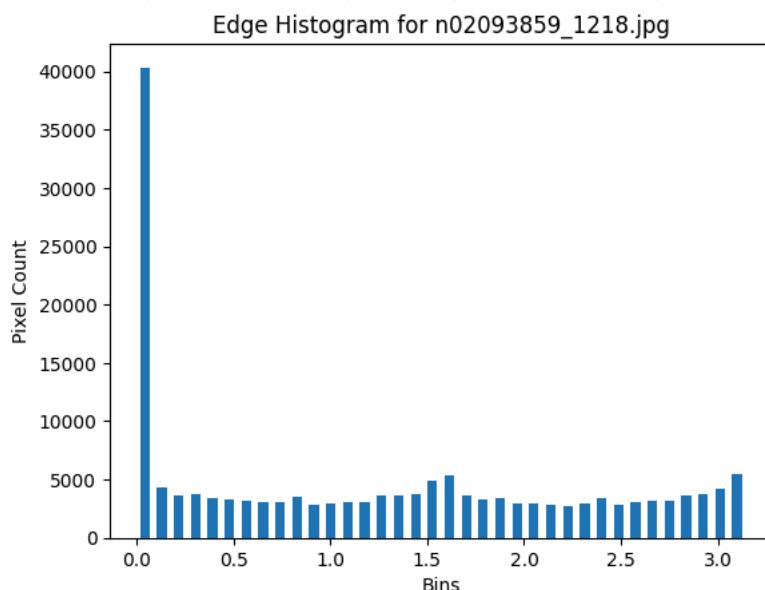


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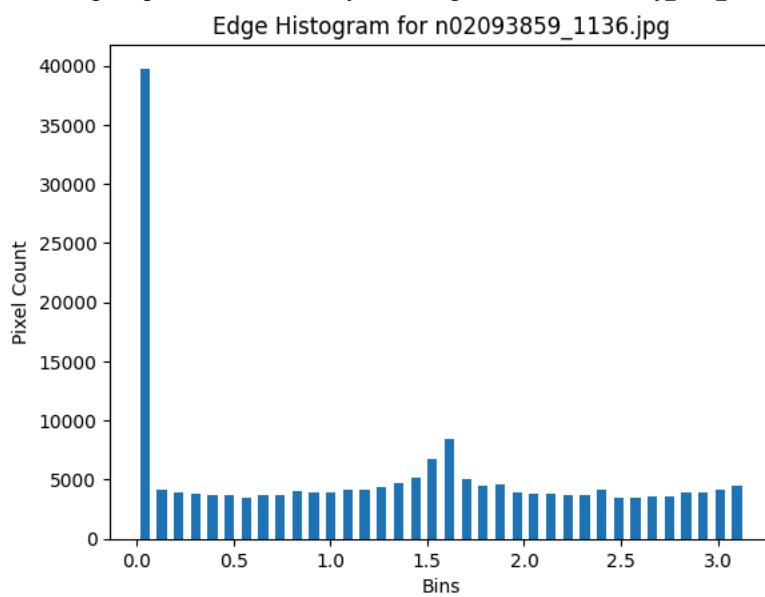
Edge Histogram for n02093859\_1166.jpg



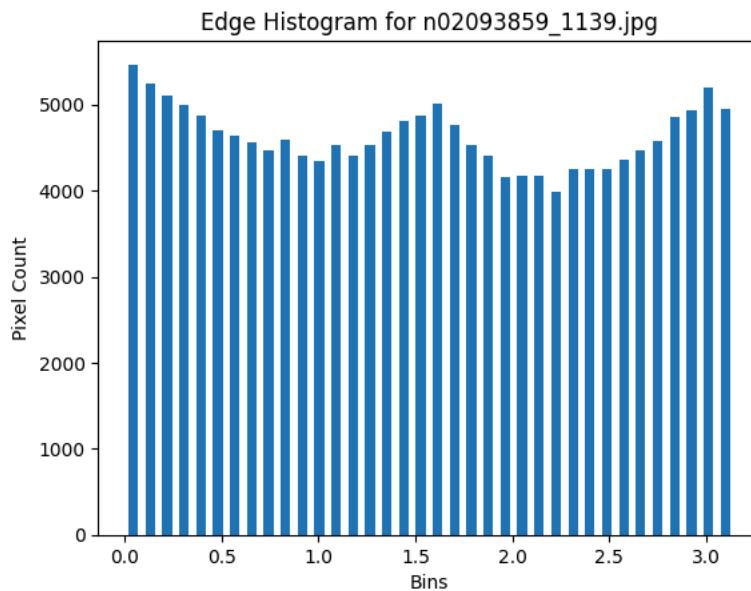
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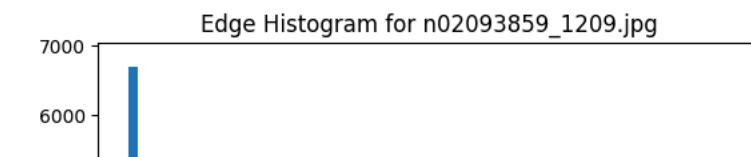
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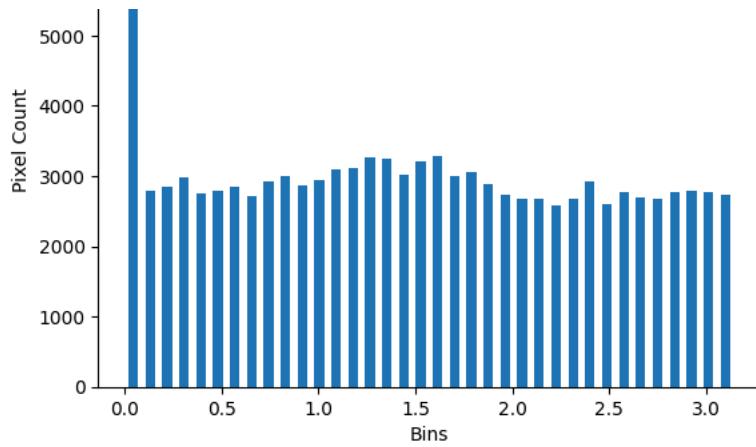


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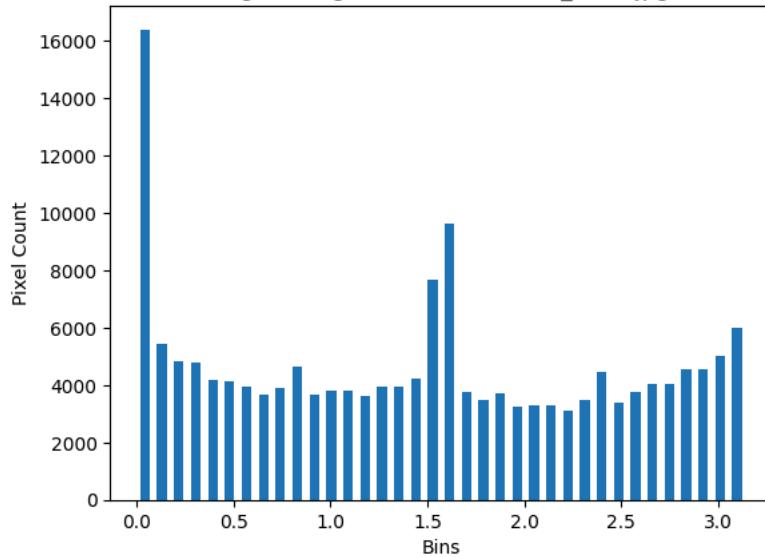
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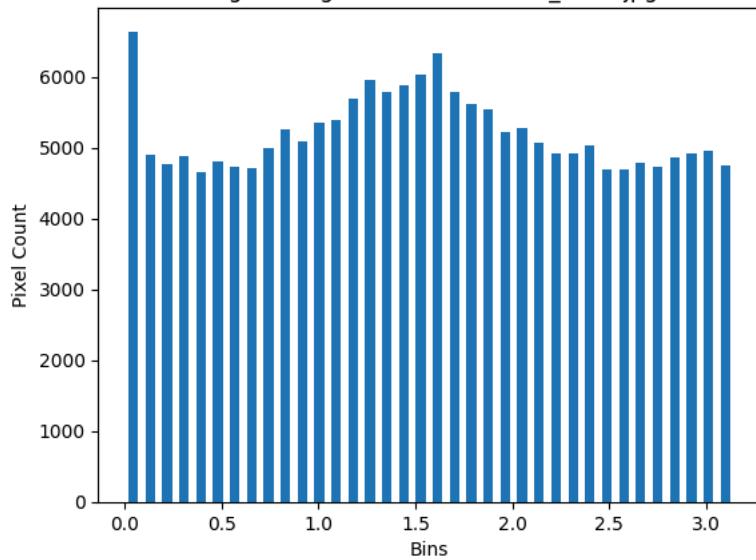
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Edge Histogram for n02093859\_1169.jpg



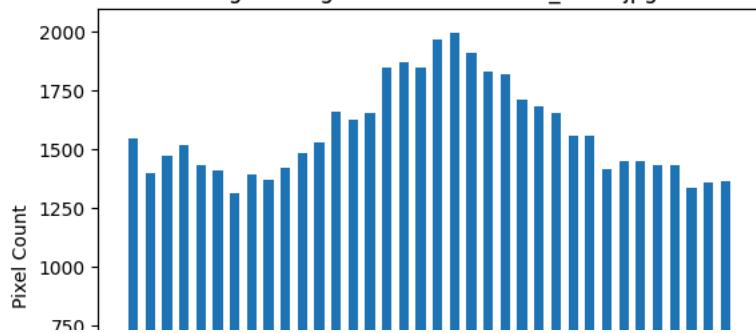
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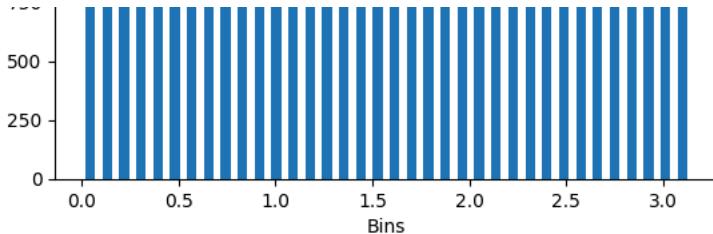
Edge Histogram for n02093859\_1251.jpg



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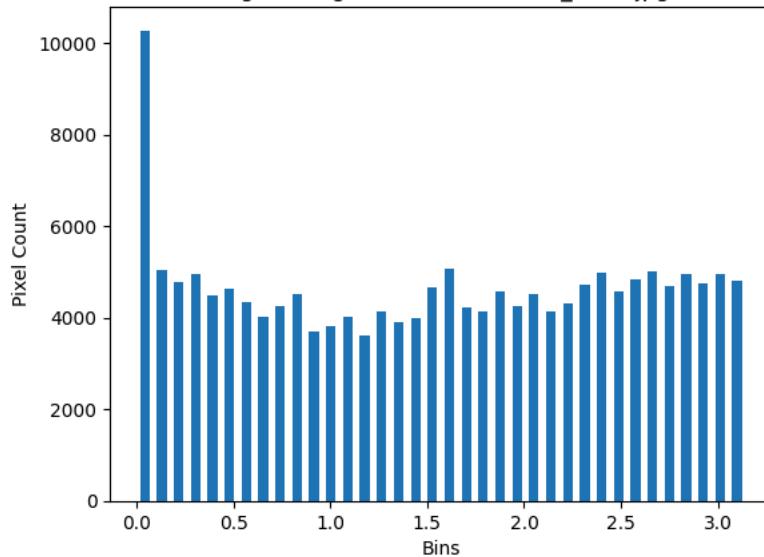
Edge Histogram for n02093859\_1279.jpg





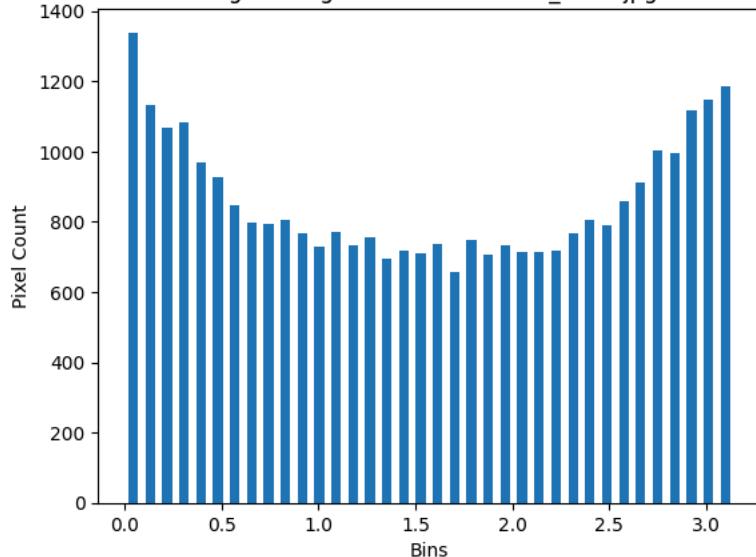
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Edge Histogram for n02093859\_1397.jpg



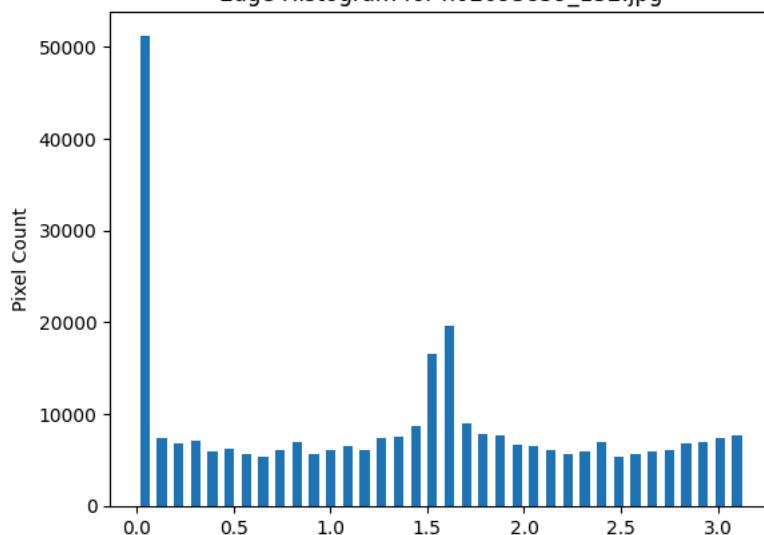
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Edge Histogram for n02093859\_1456.jpg

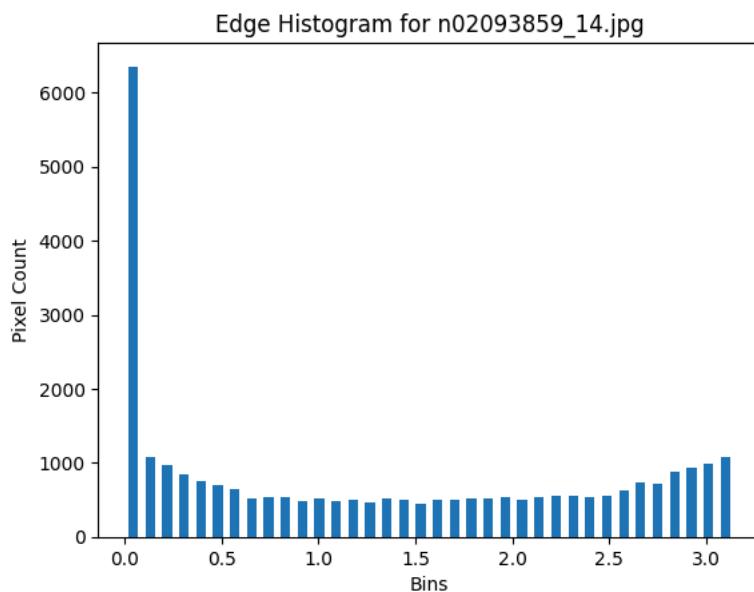


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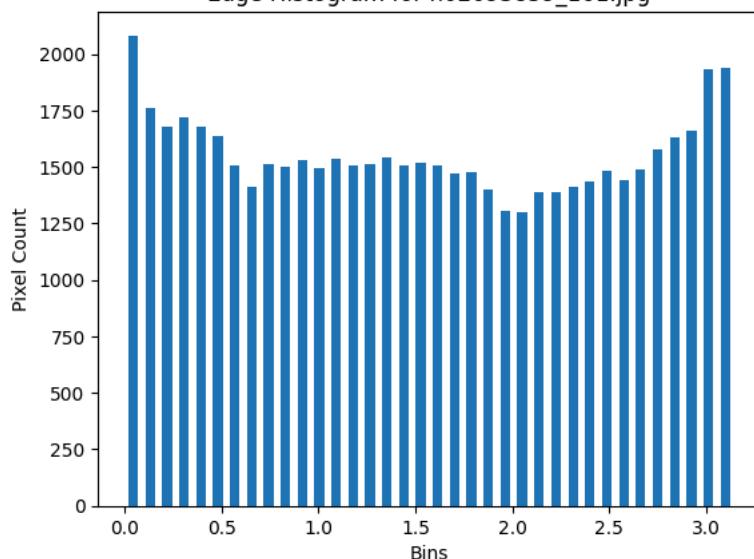
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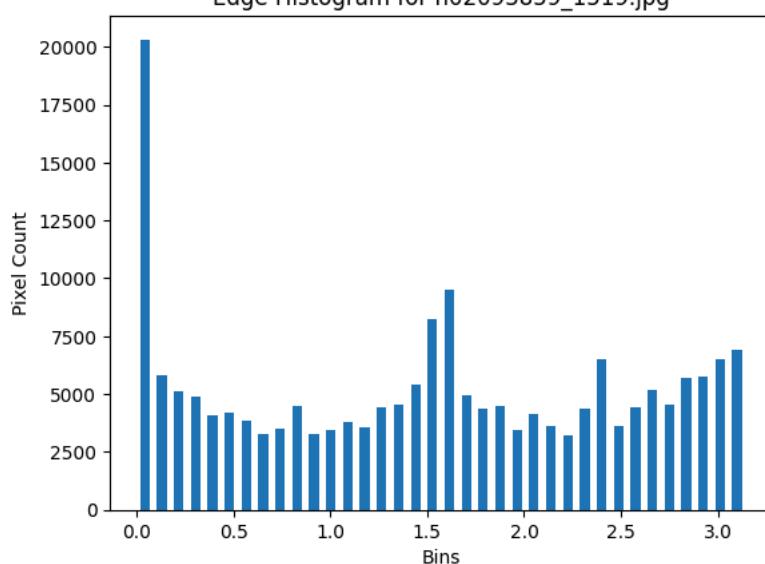
Bins  
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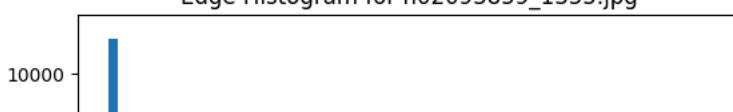
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Edge Histogram for n02093859\_161.jpg

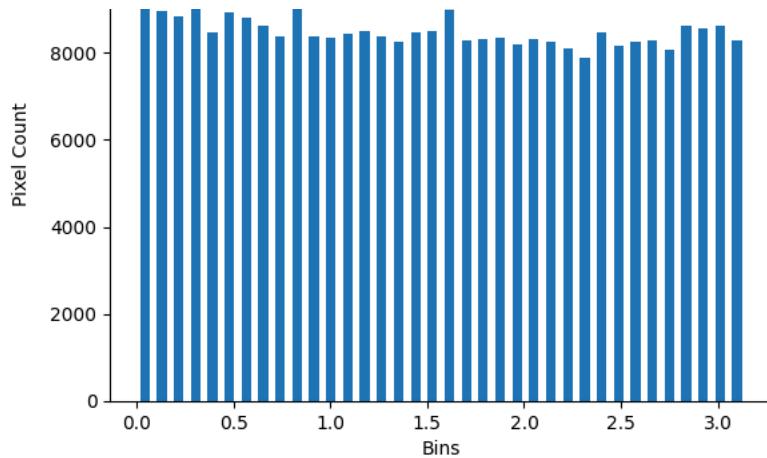


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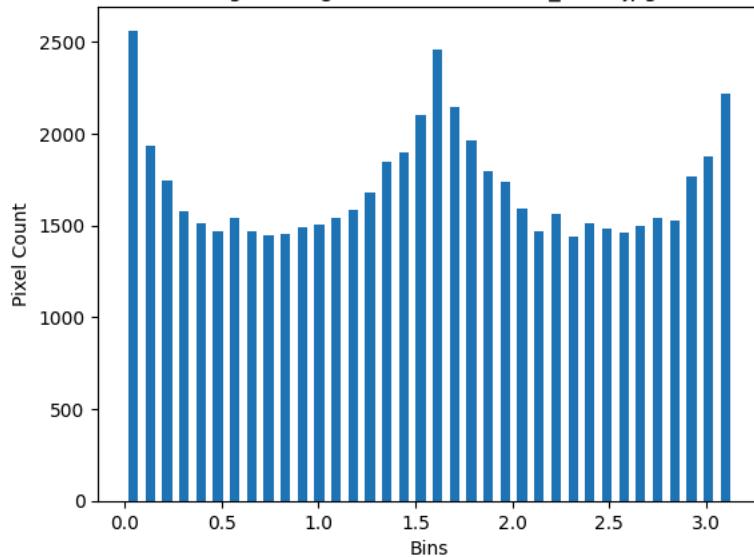
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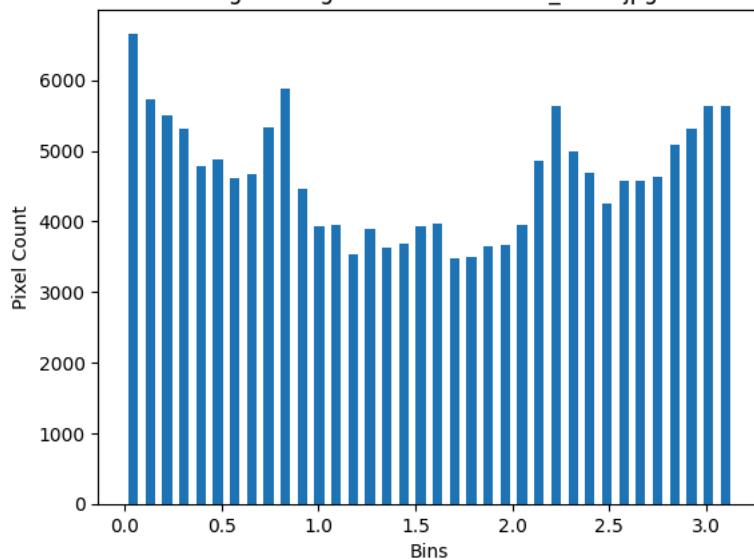
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Edge Histogram for n02093859\_1464.jpg



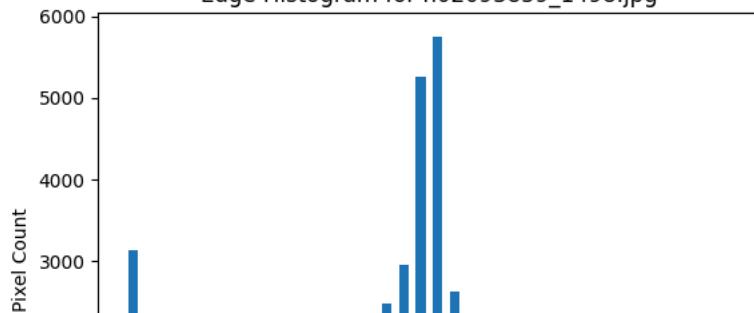
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1628.jpg

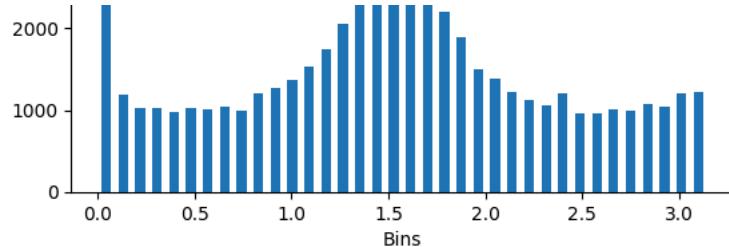
Edge Histogram for n02093859\_1628.jpg



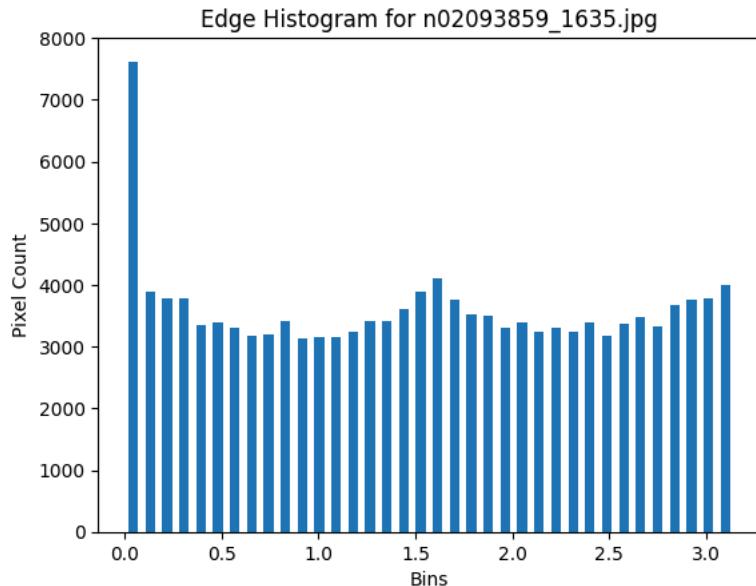
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1498.jpg

Edge Histogram for n02093859\_1498.jpg

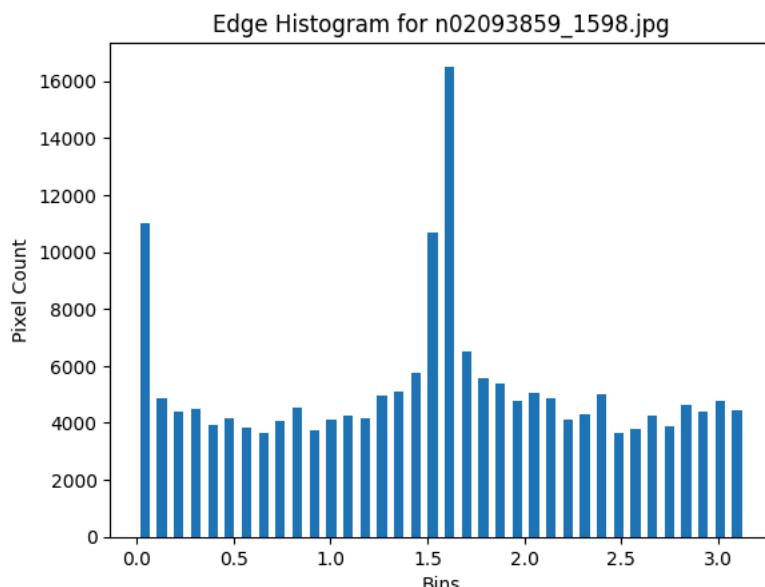




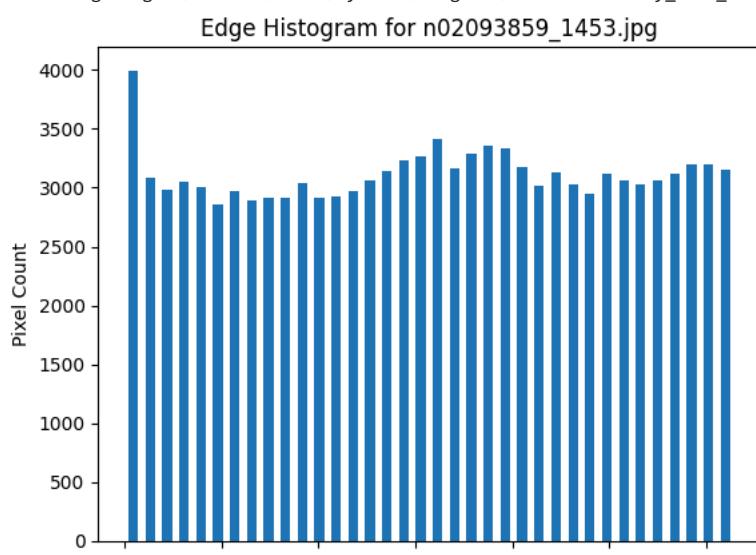
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Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1598.jpg



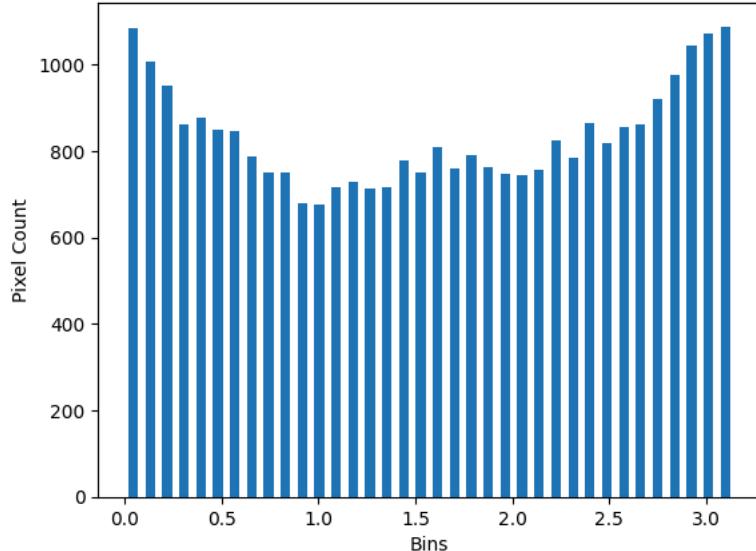
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1453.jpg



0.0 0.5 1.0 1.5 2.0 2.5 3.0  
Bins

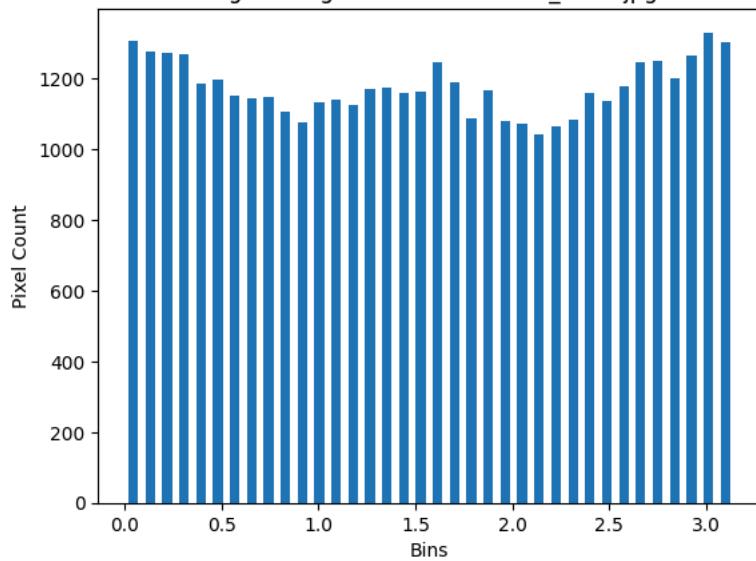
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Edge Histogram for n02093859\_1587.jpg



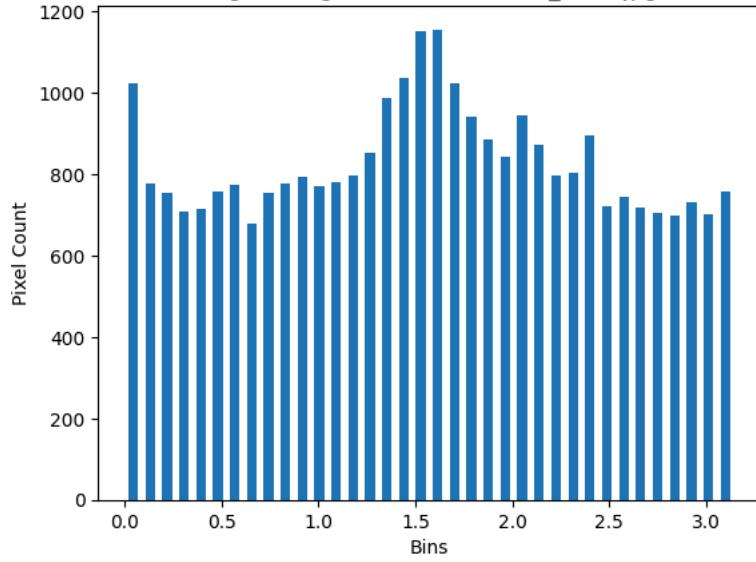
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Edge Histogram for n02093859\_1571.jpg



Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1813.jpg

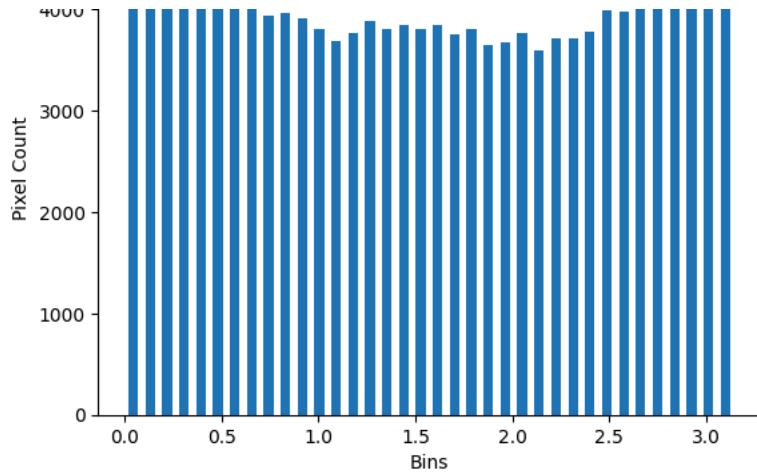
Edge Histogram for n02093859\_1813.jpg



Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1697.jpg

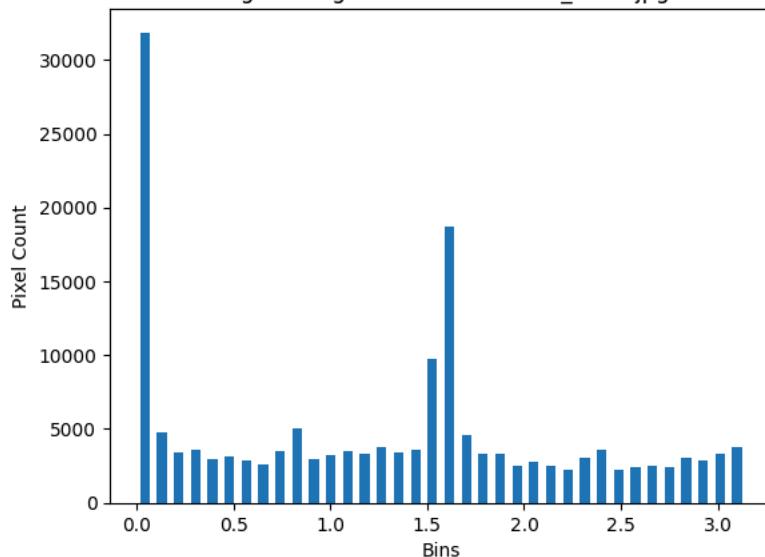
Edge Histogram for n02093859\_1697.jpg





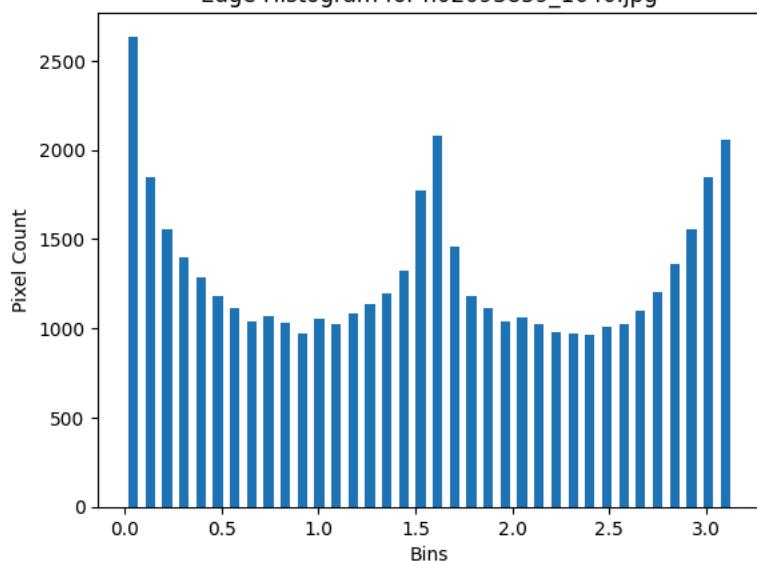
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Edge Histogram for n02093859\_1655.jpg



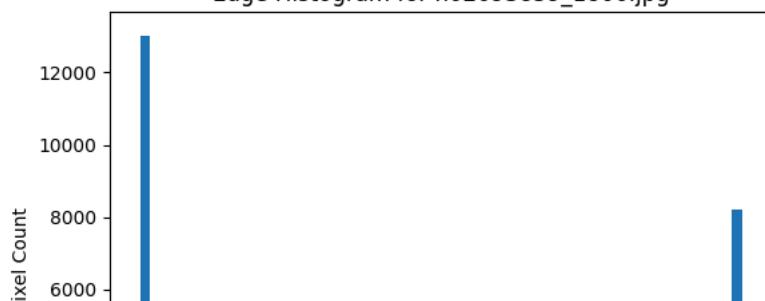
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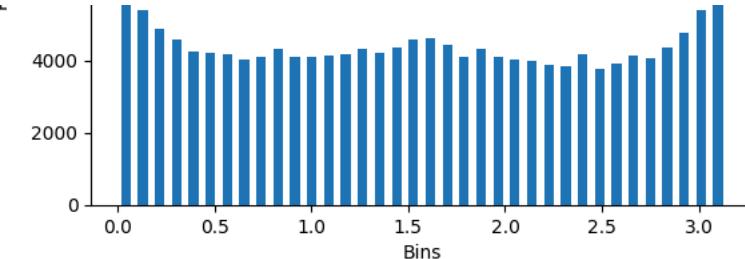
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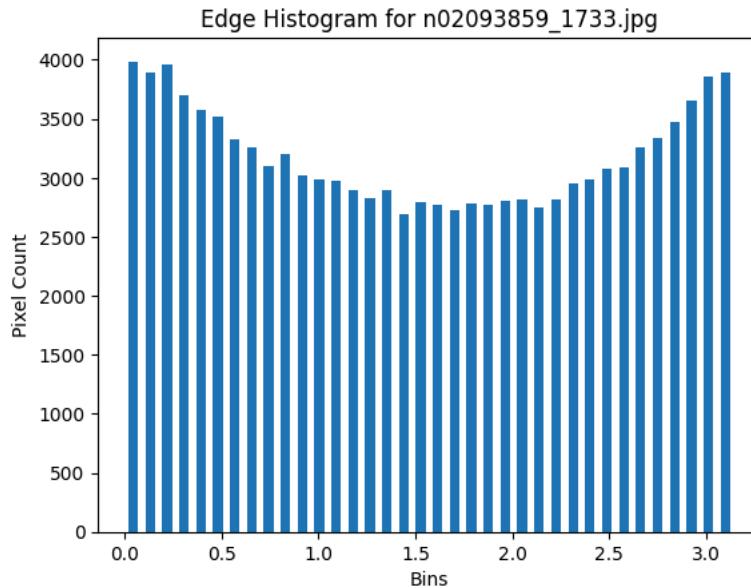
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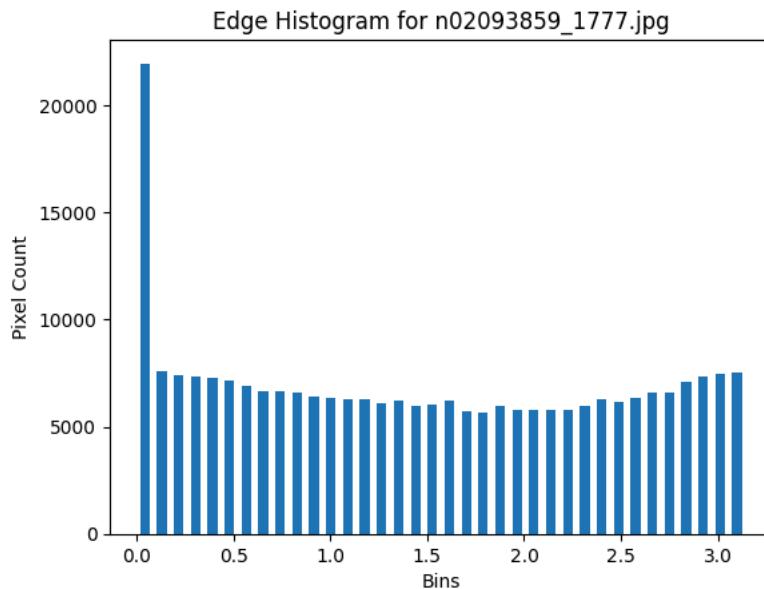




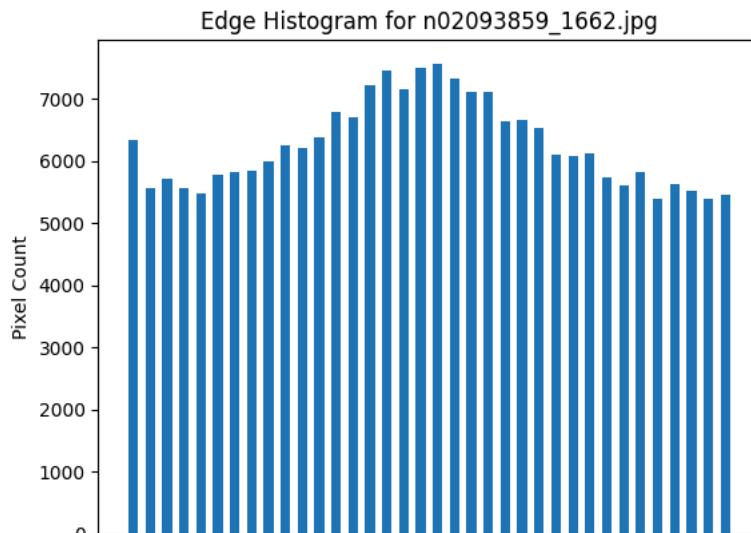
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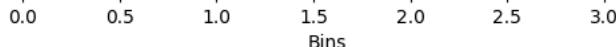


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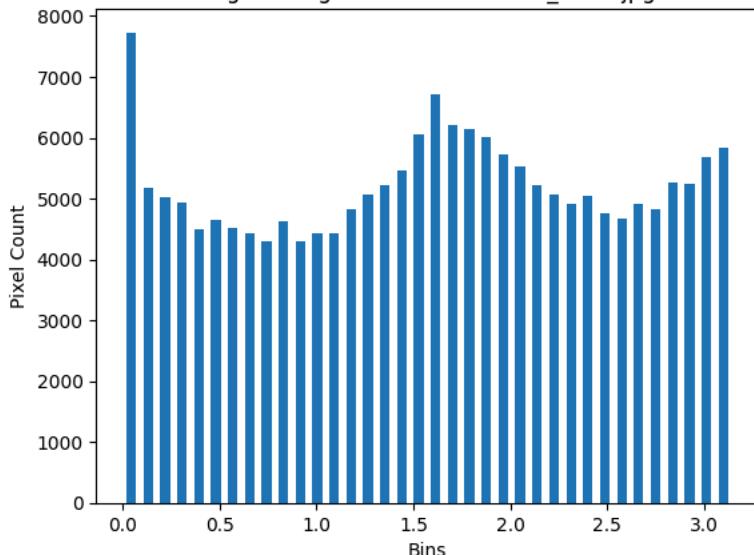
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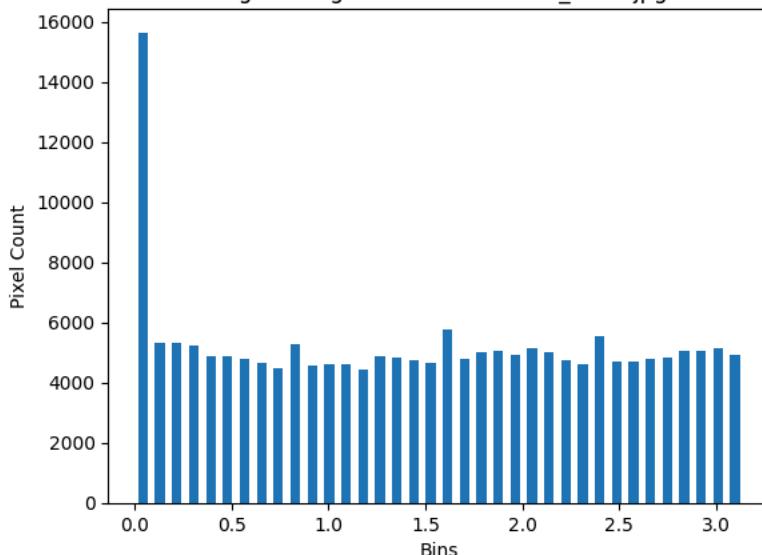
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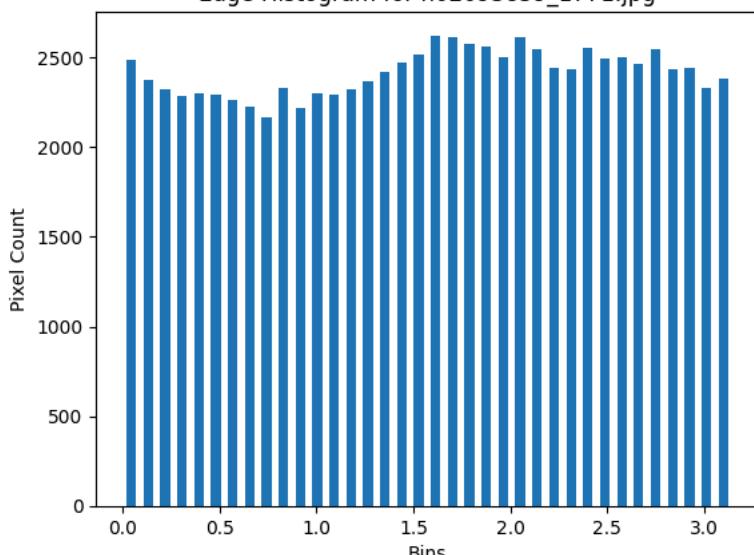
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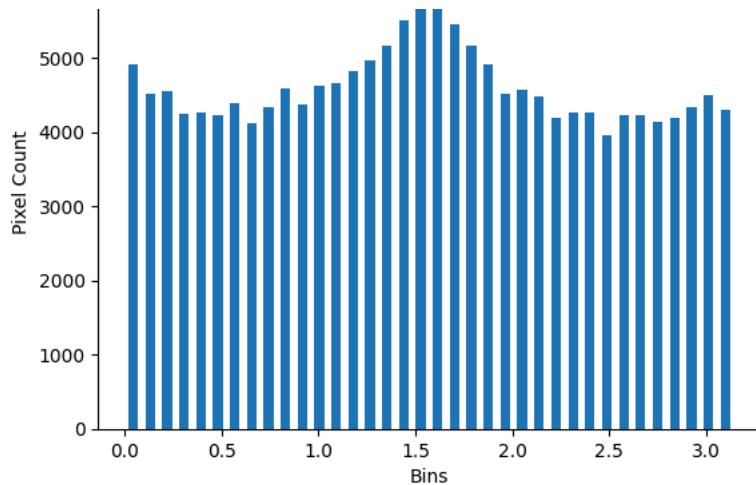
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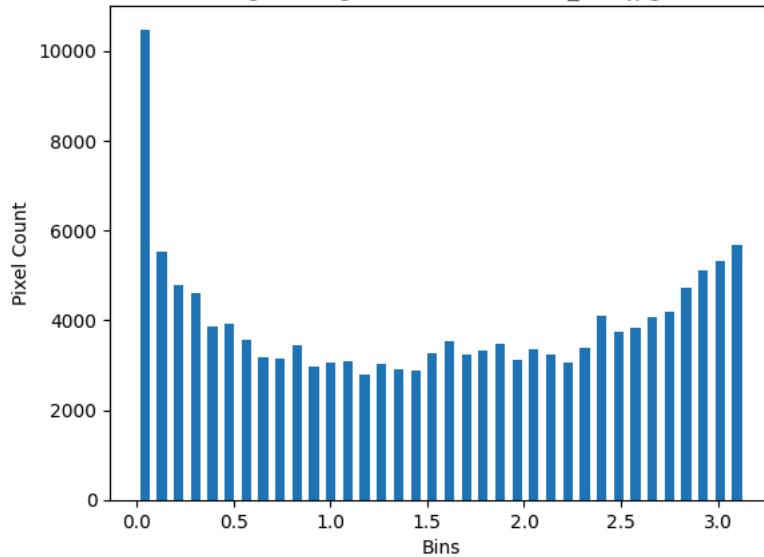
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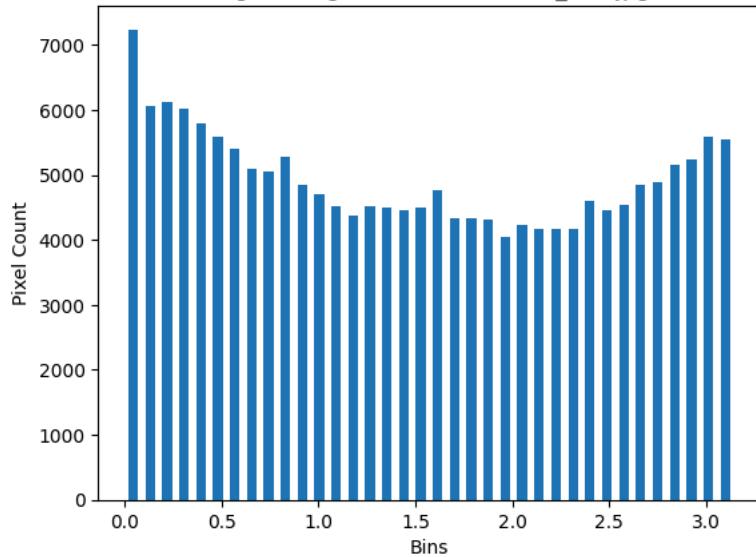
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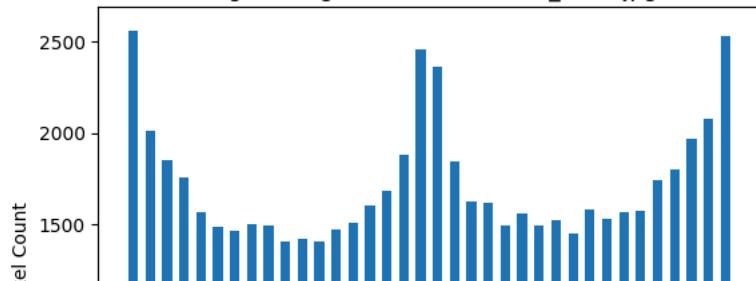
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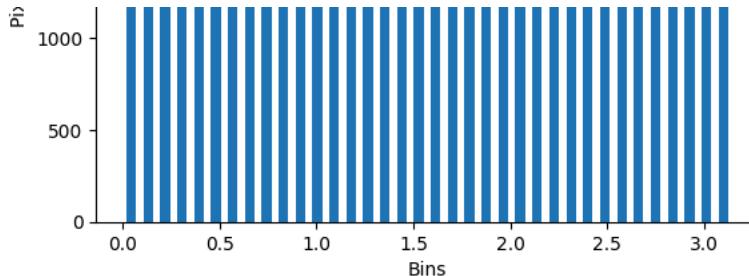
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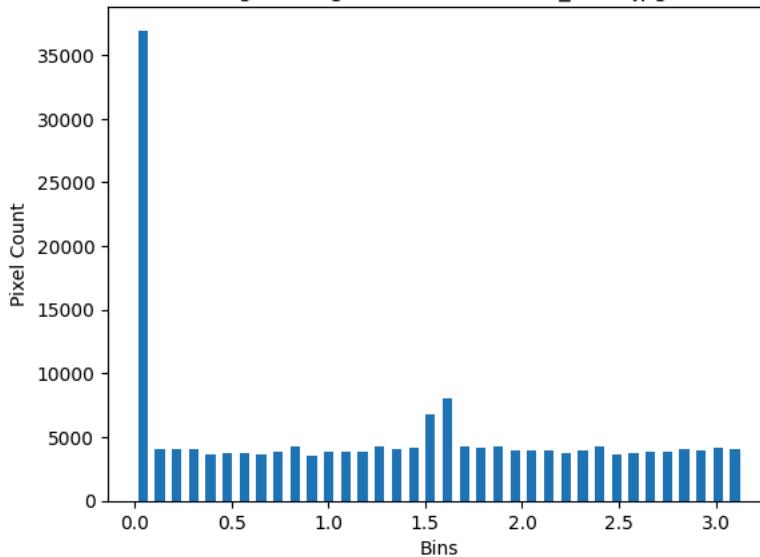
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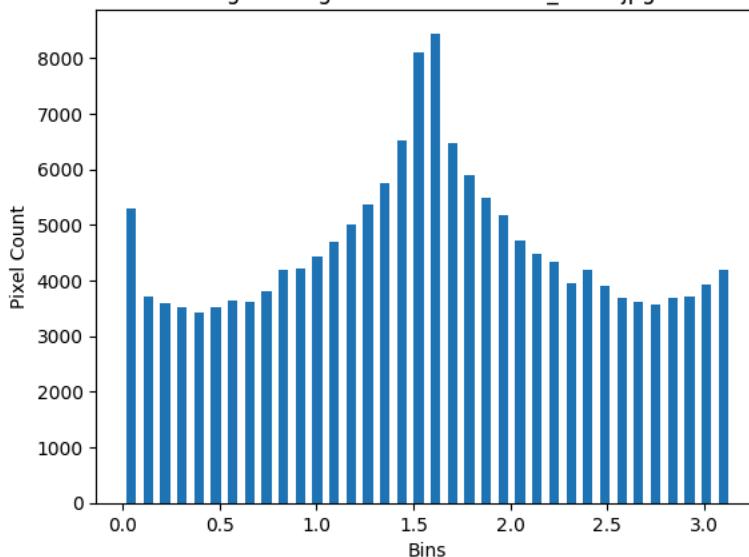
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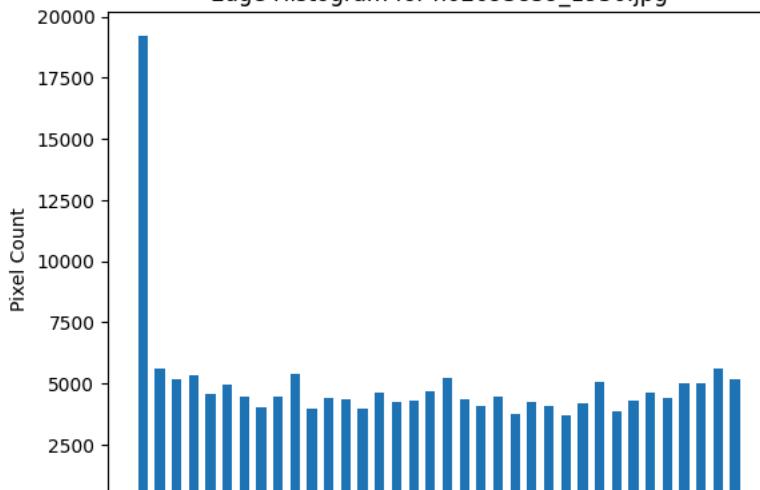
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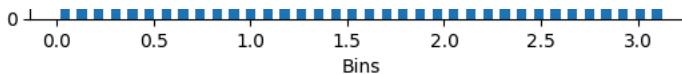
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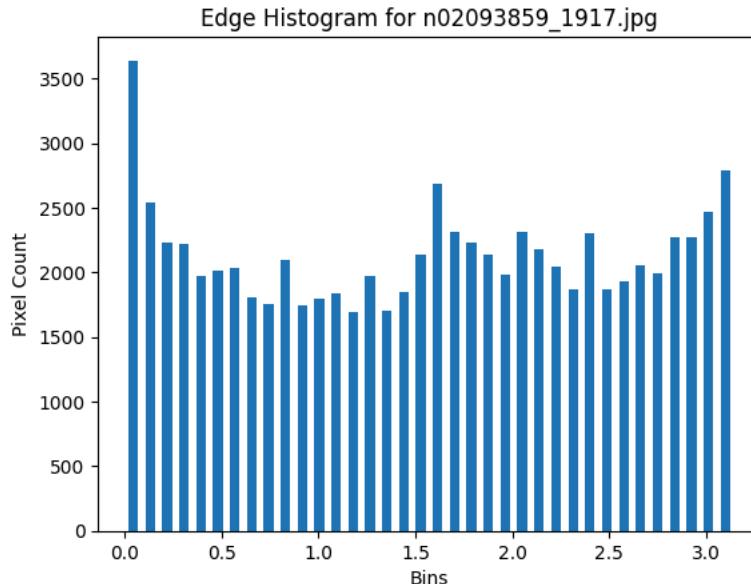
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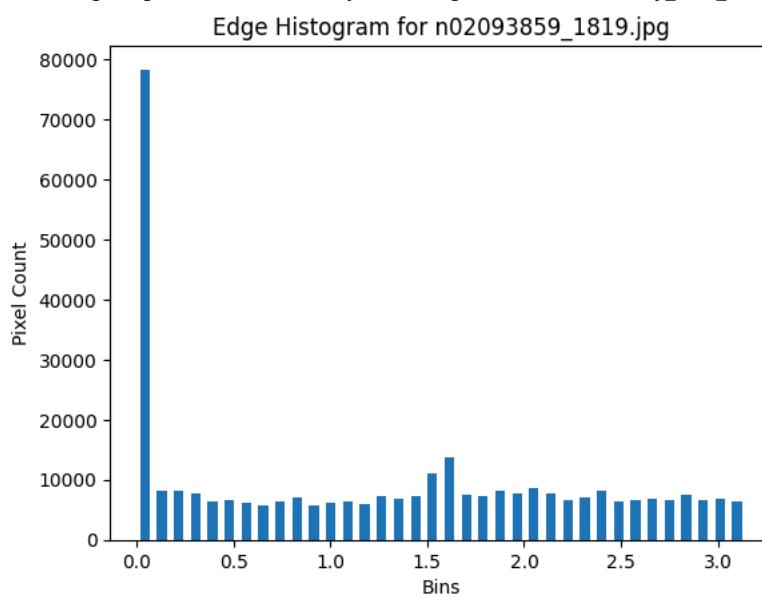




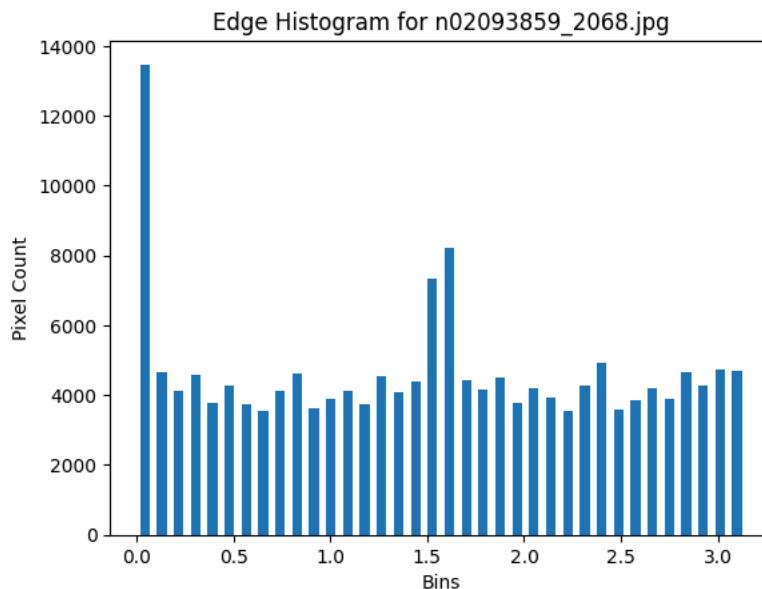
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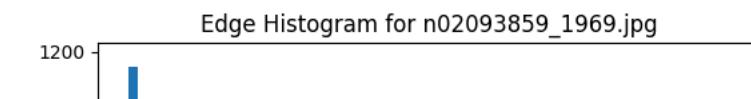
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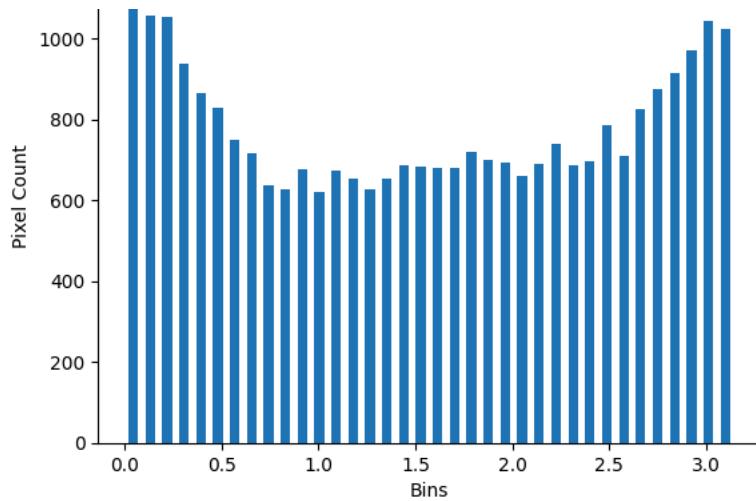


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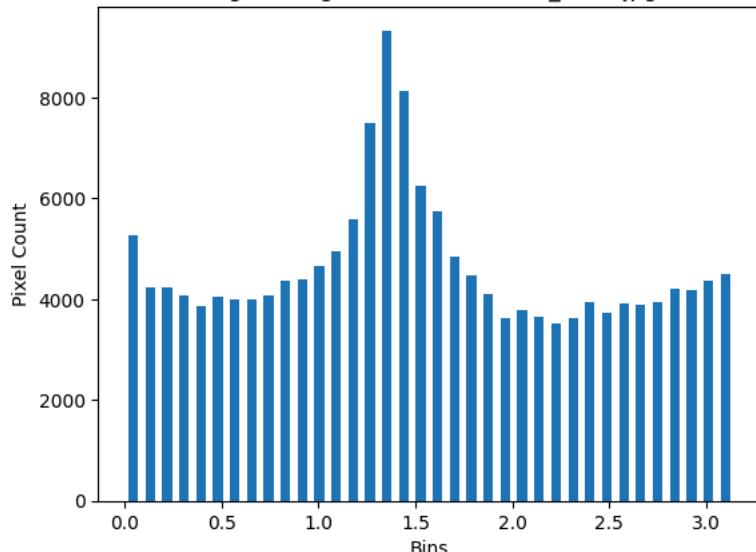
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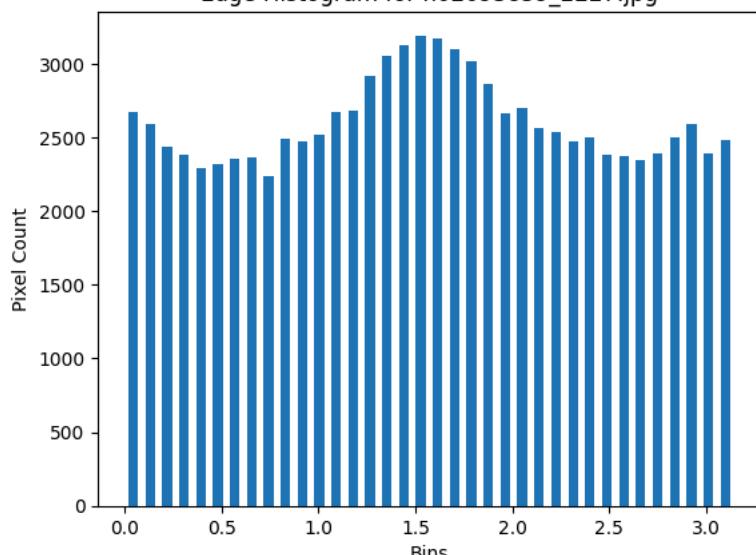
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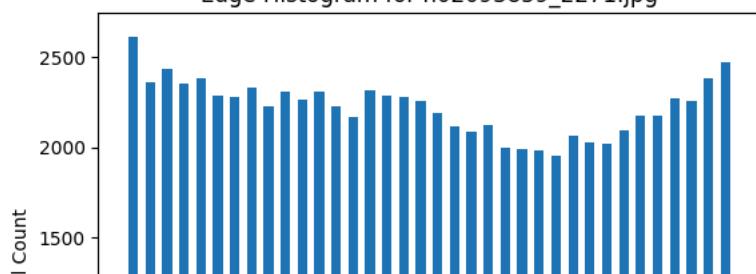
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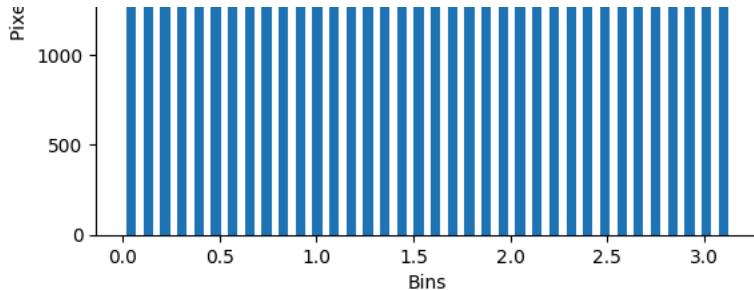
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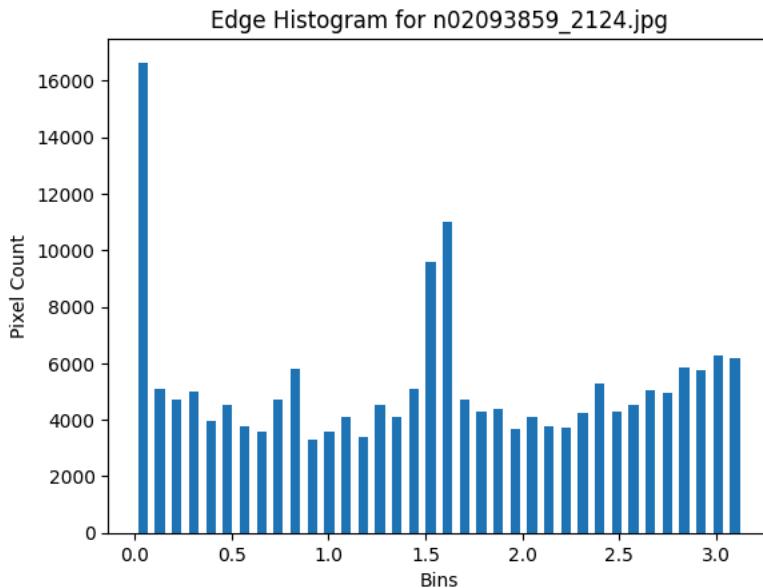
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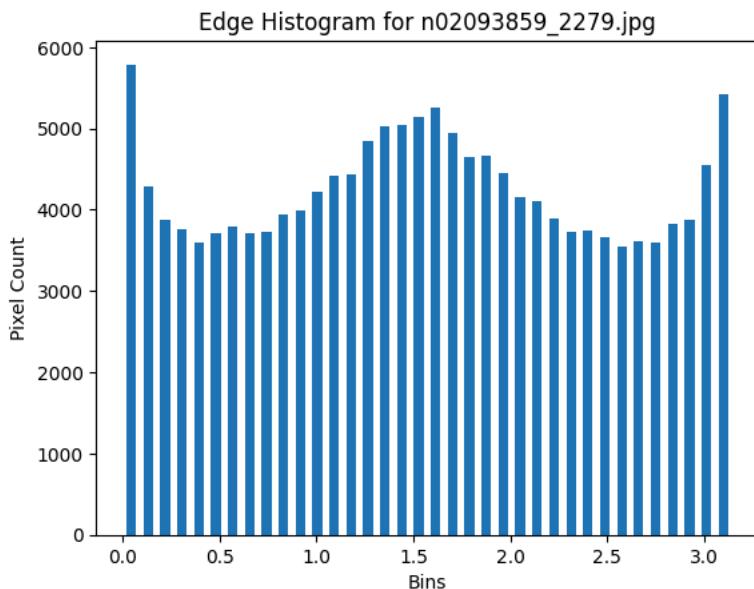




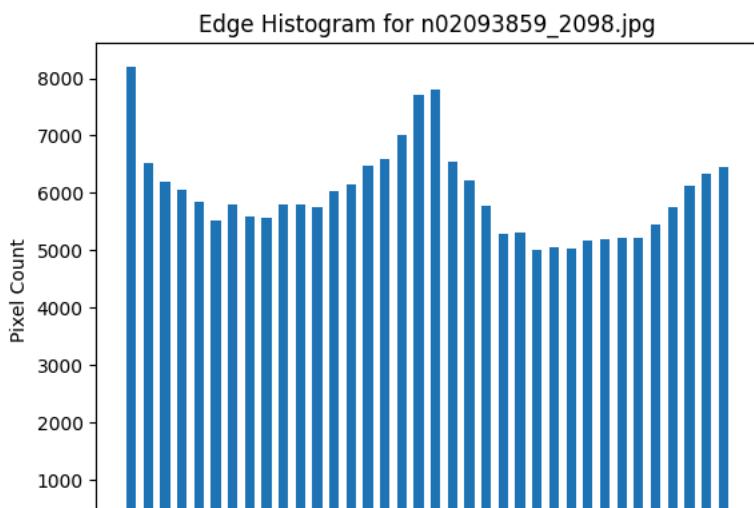
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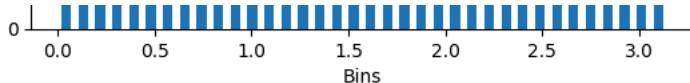


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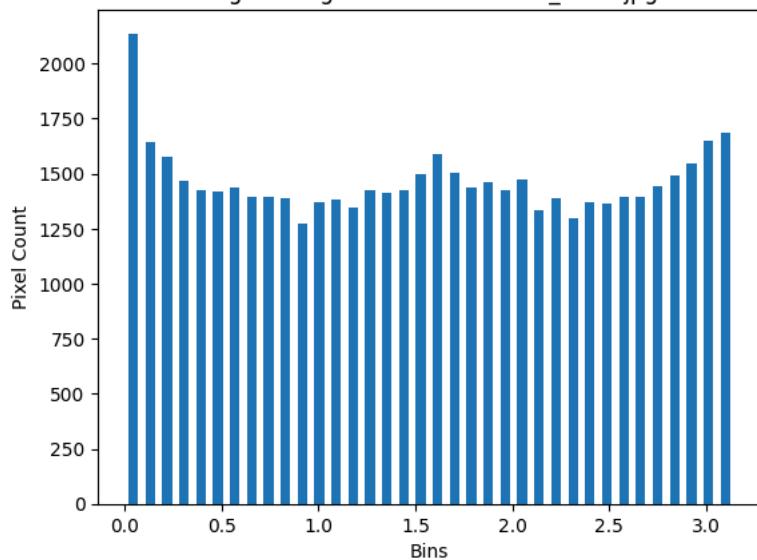
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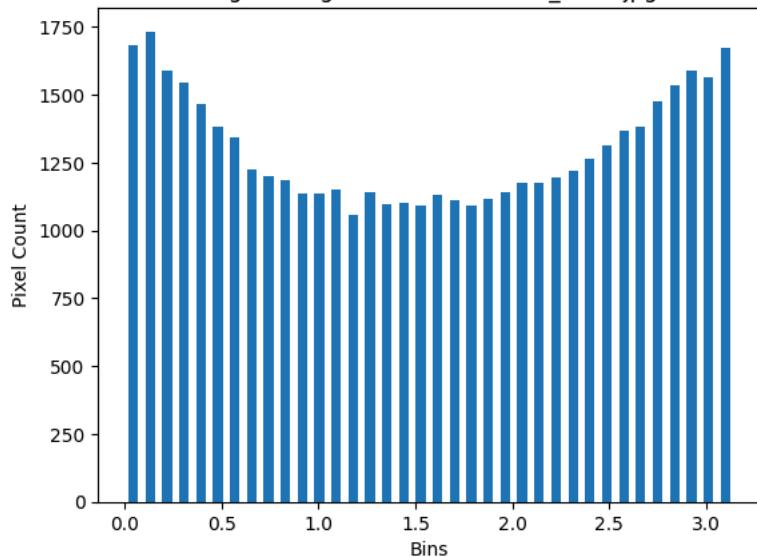
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Edge Histogram for n02093859\_2223.jpg



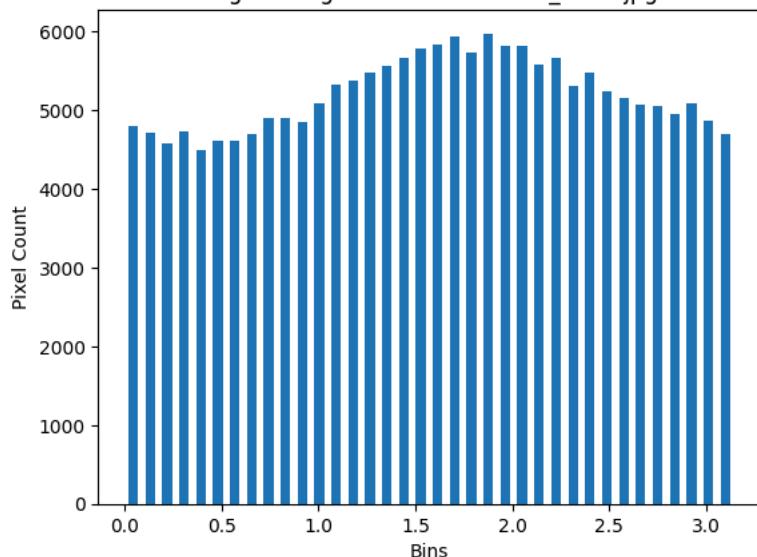
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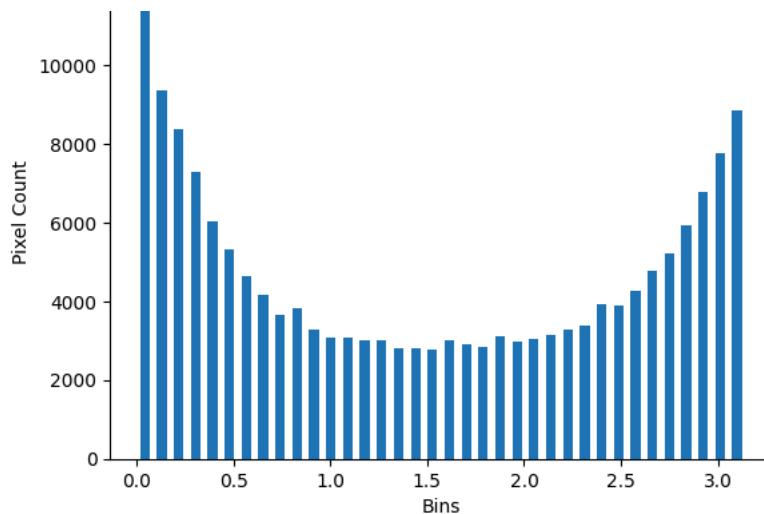
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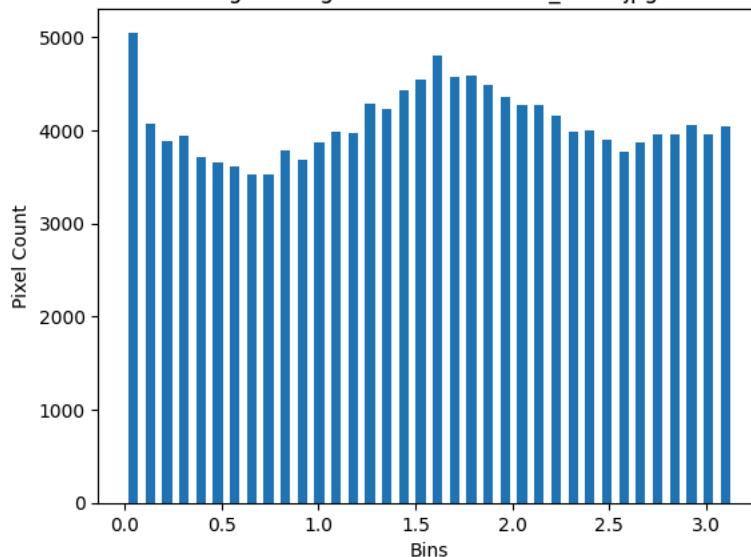
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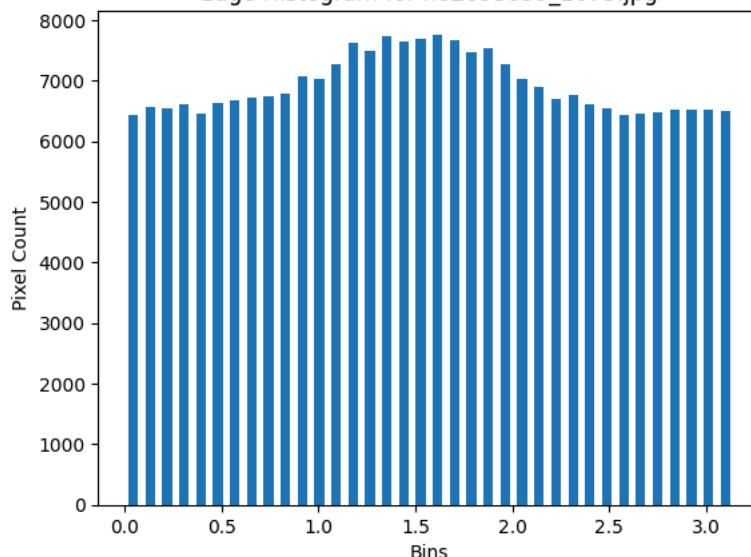
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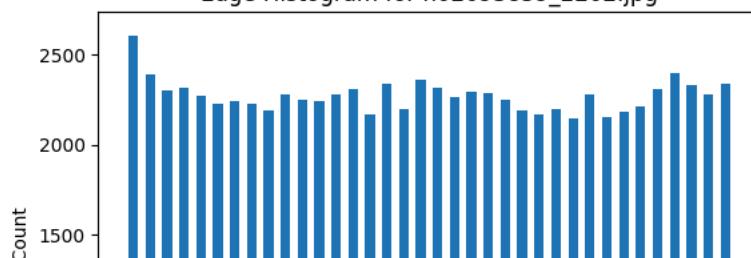
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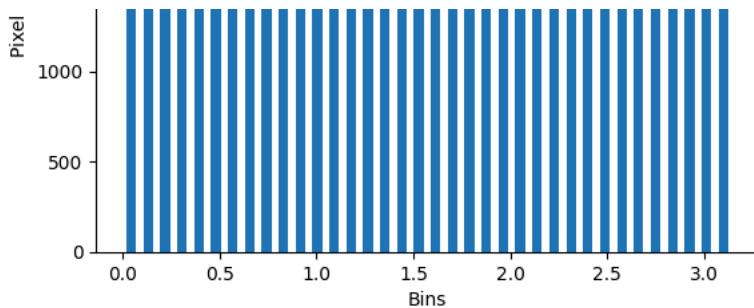
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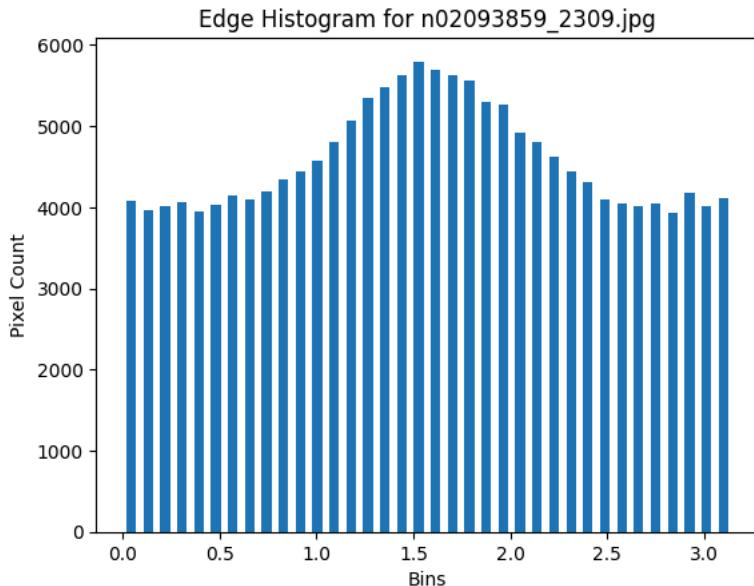
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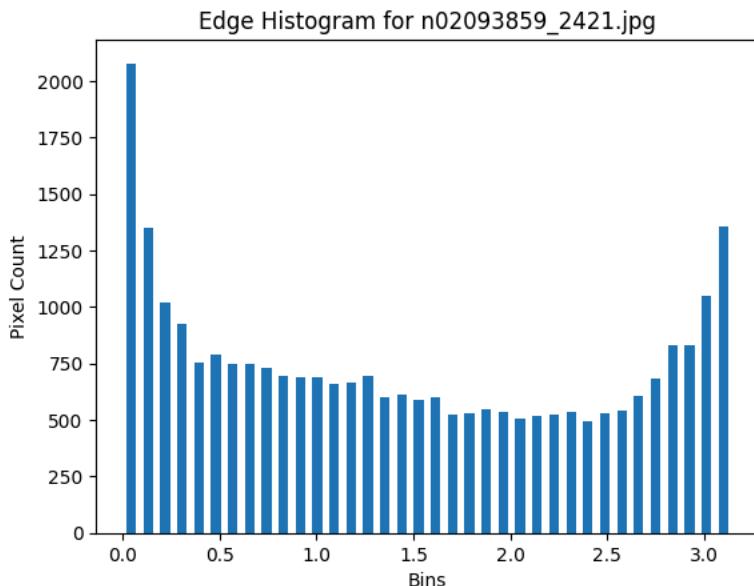




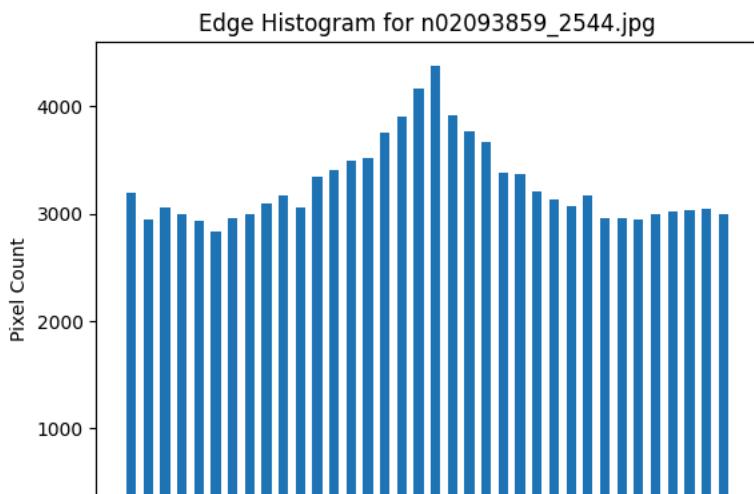
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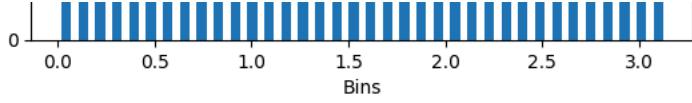


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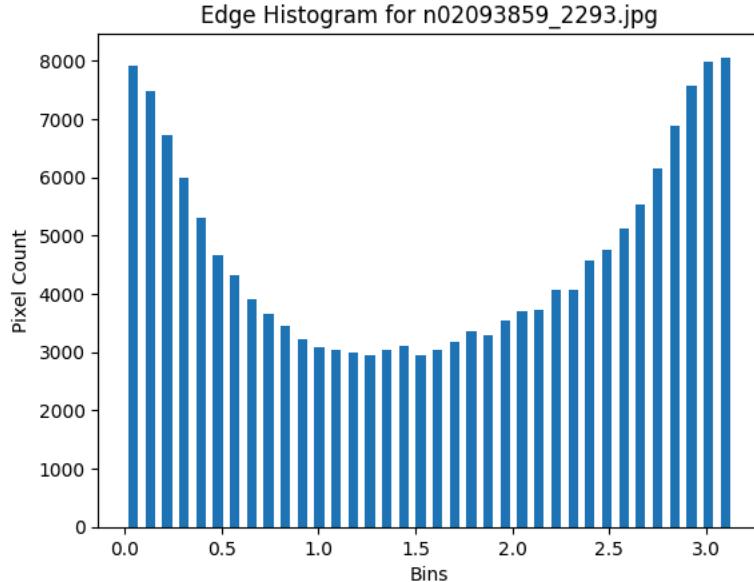


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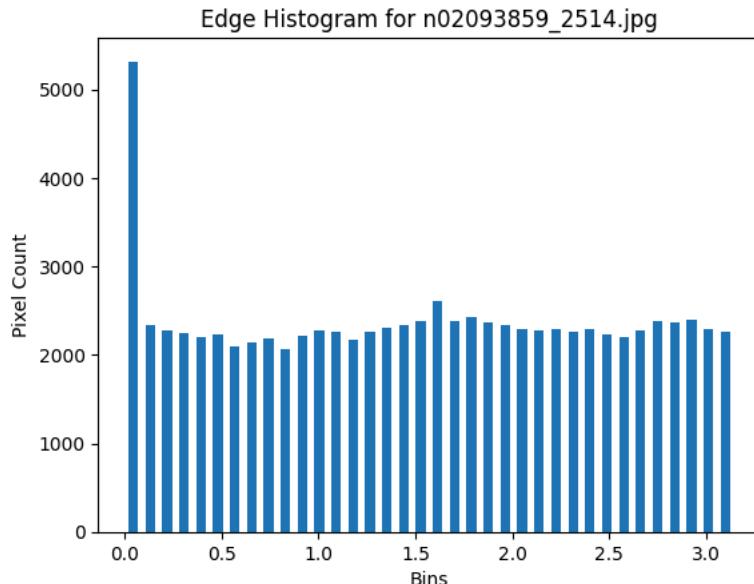




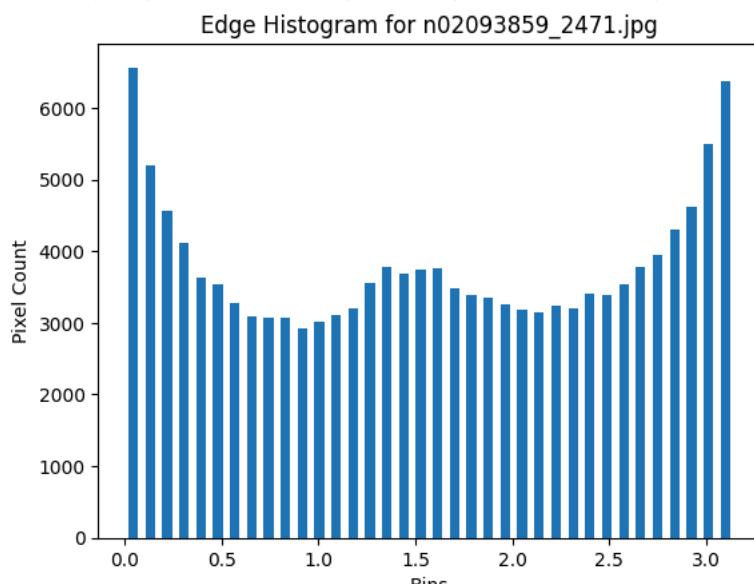
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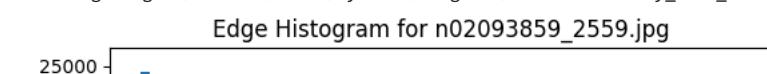
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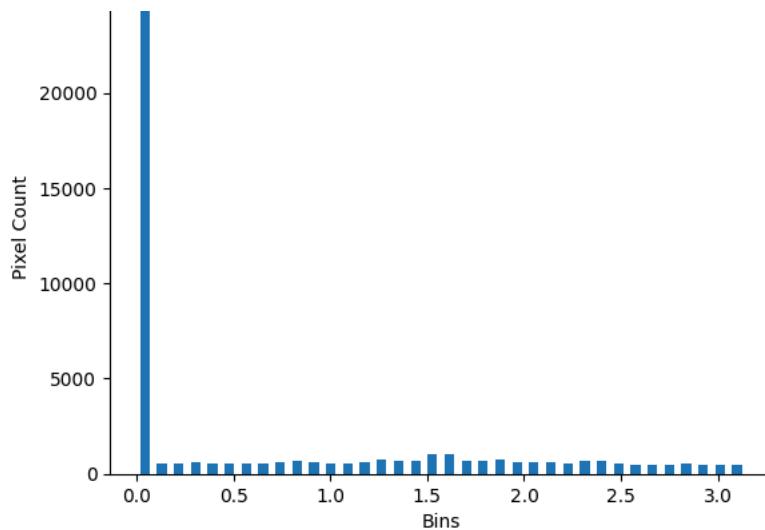


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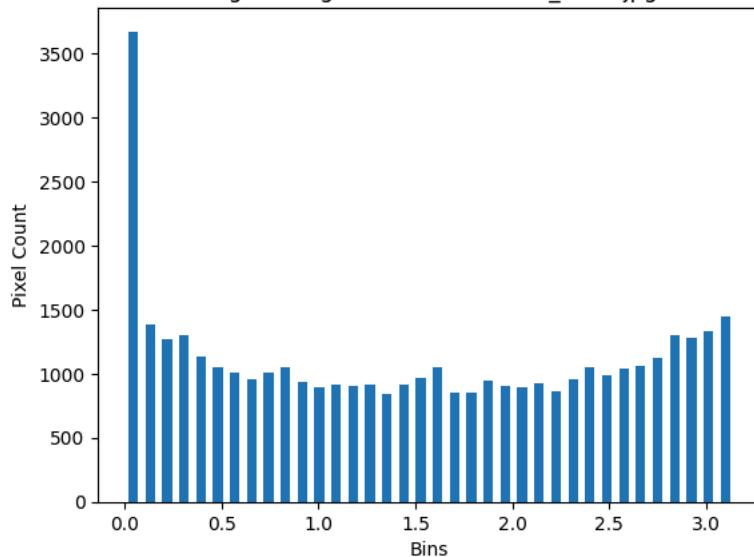
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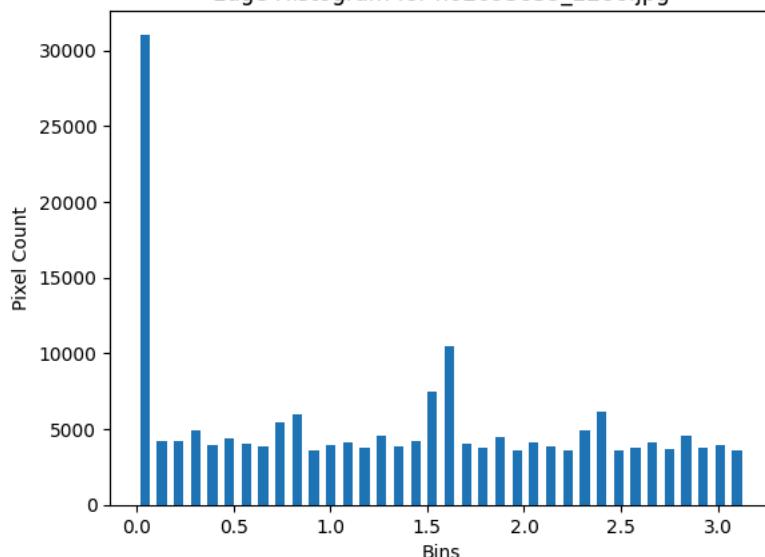
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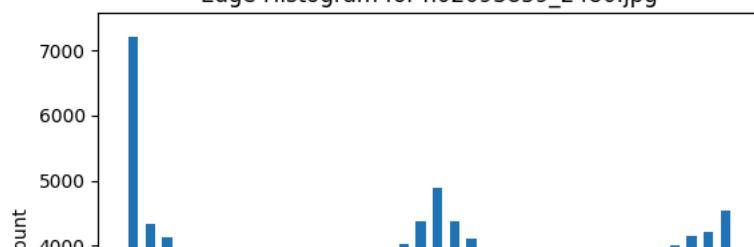
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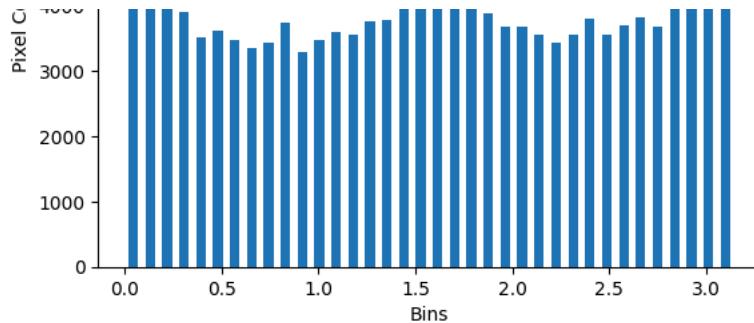
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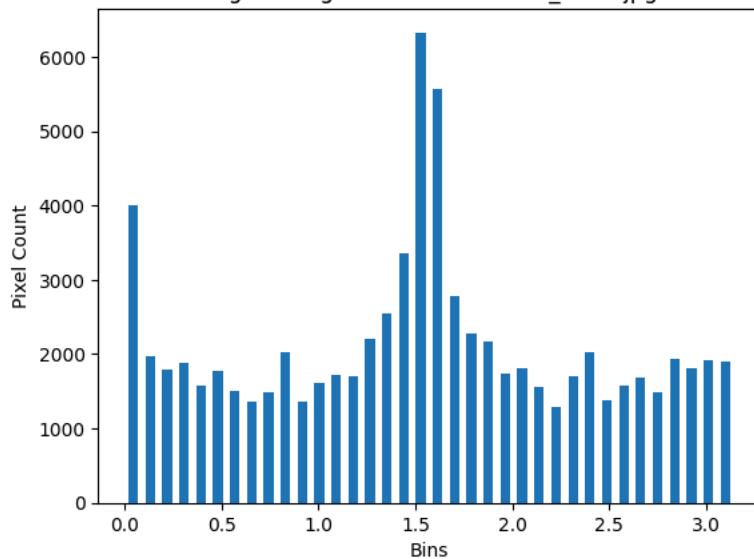
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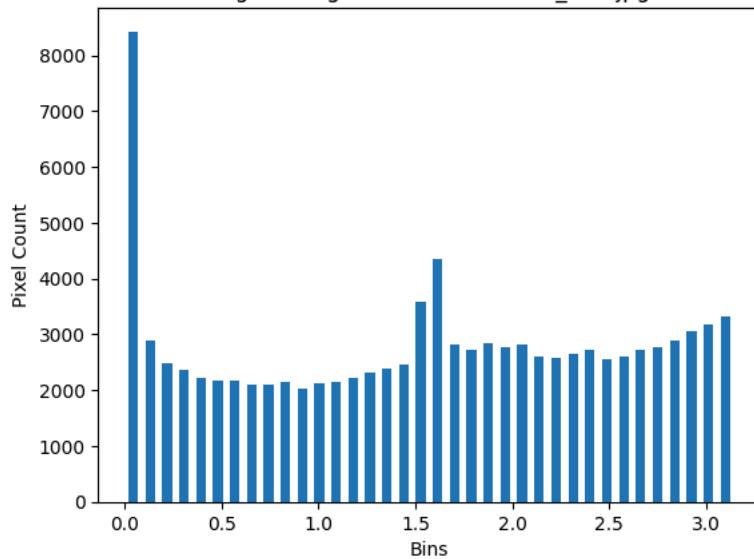
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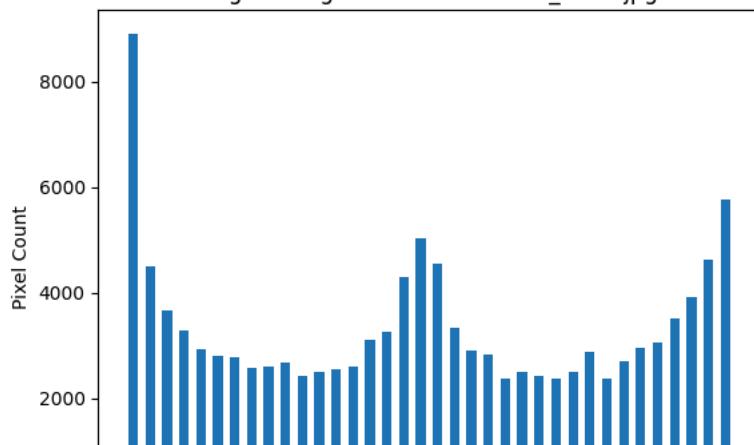
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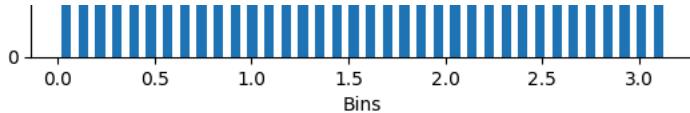
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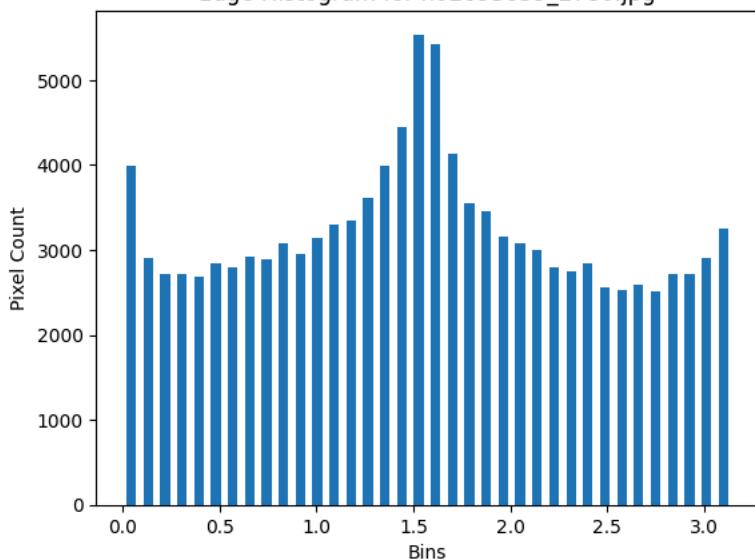
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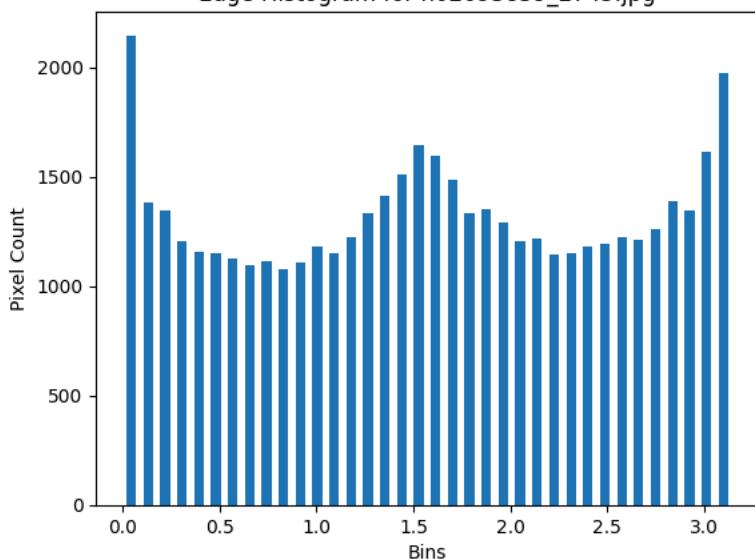
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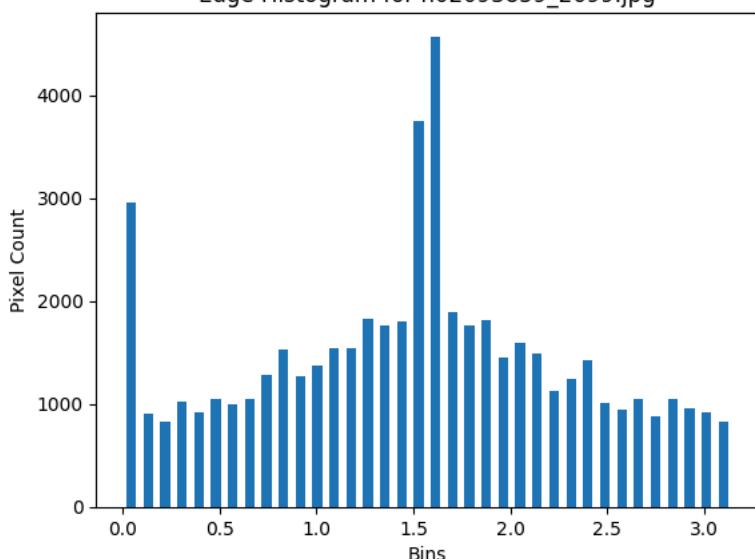
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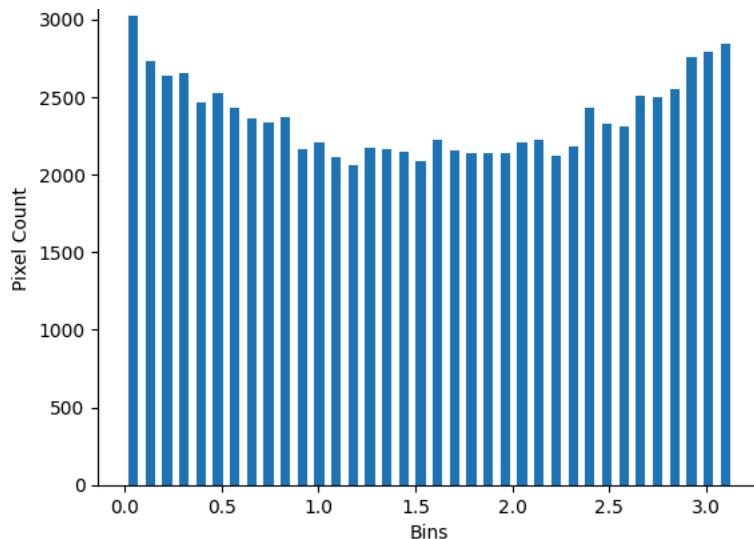
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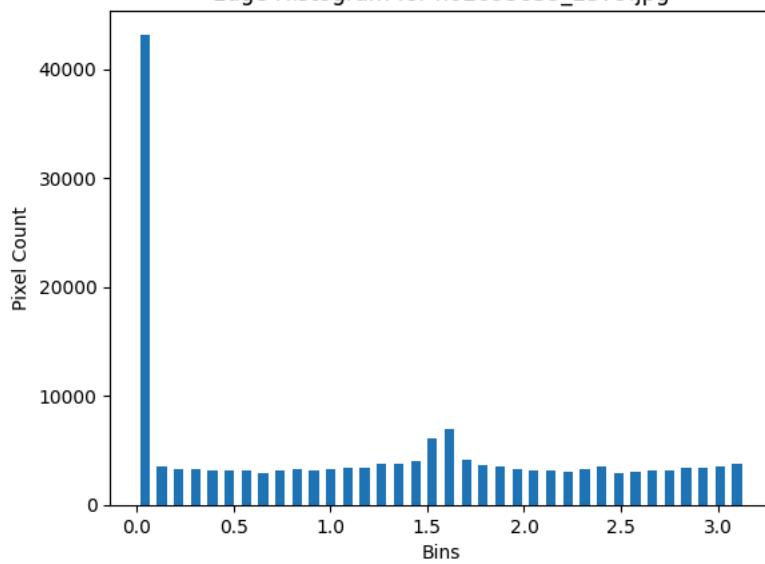
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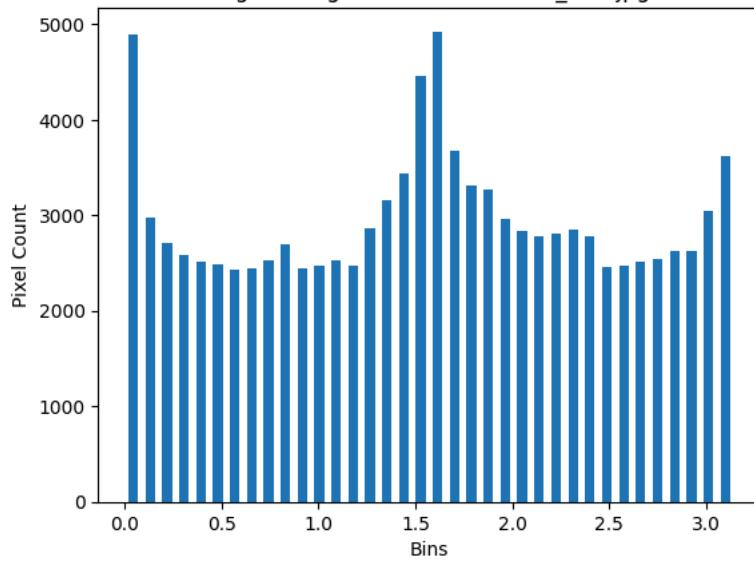
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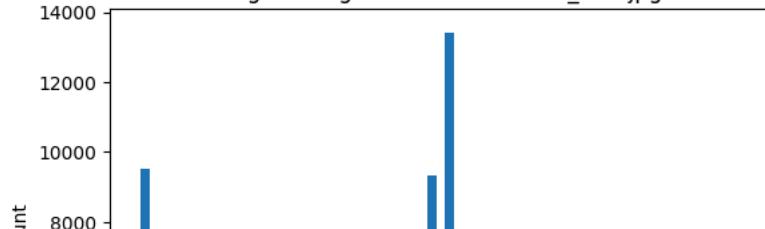
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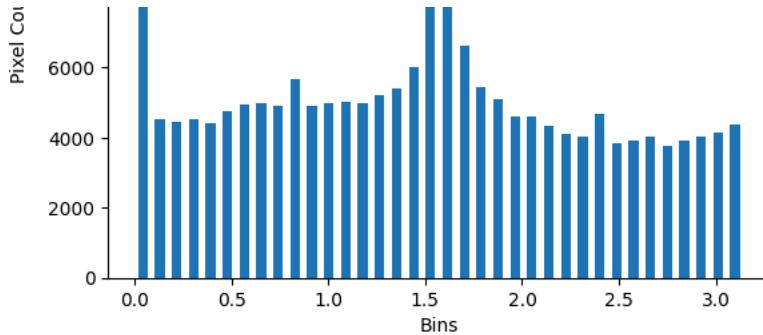
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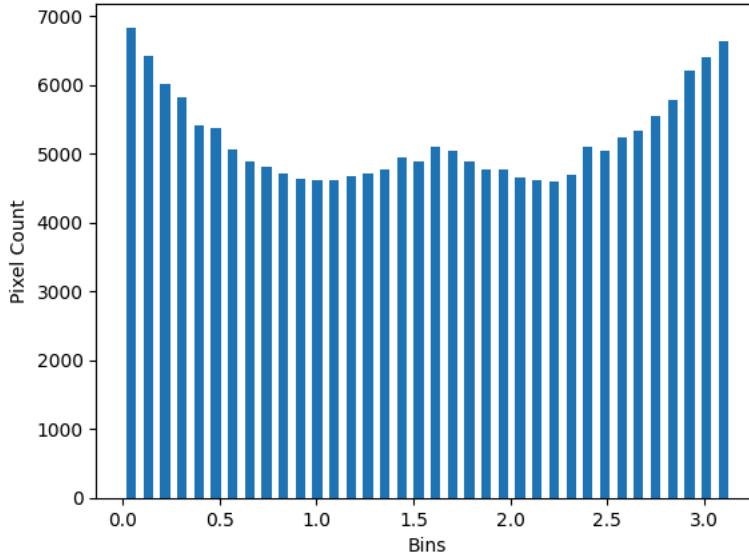
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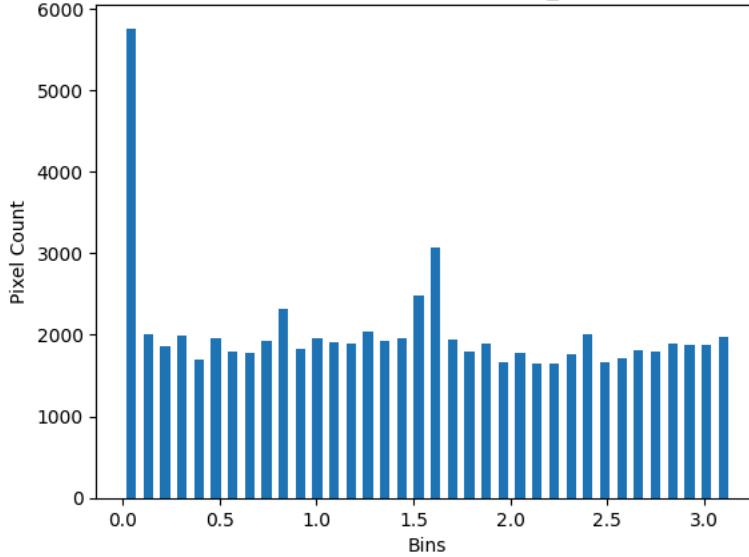
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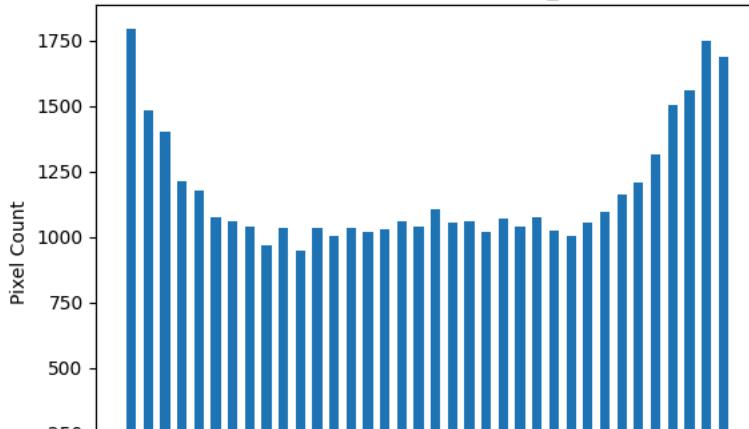
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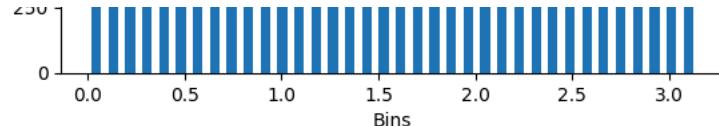
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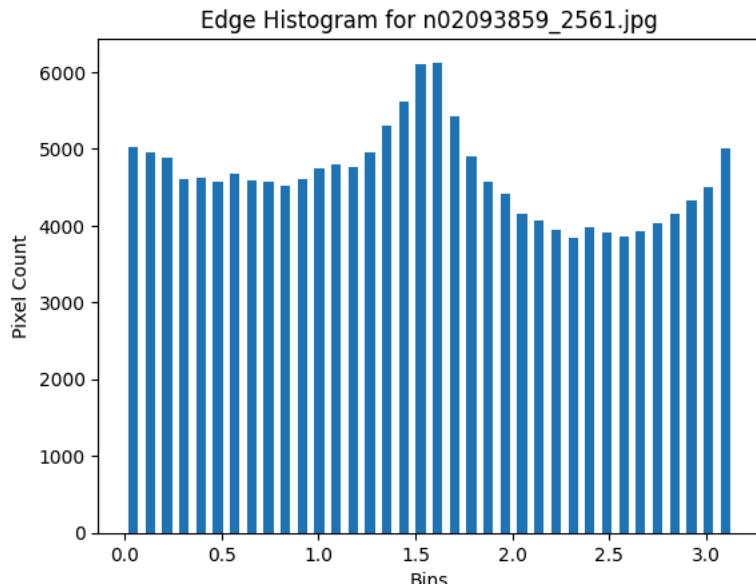
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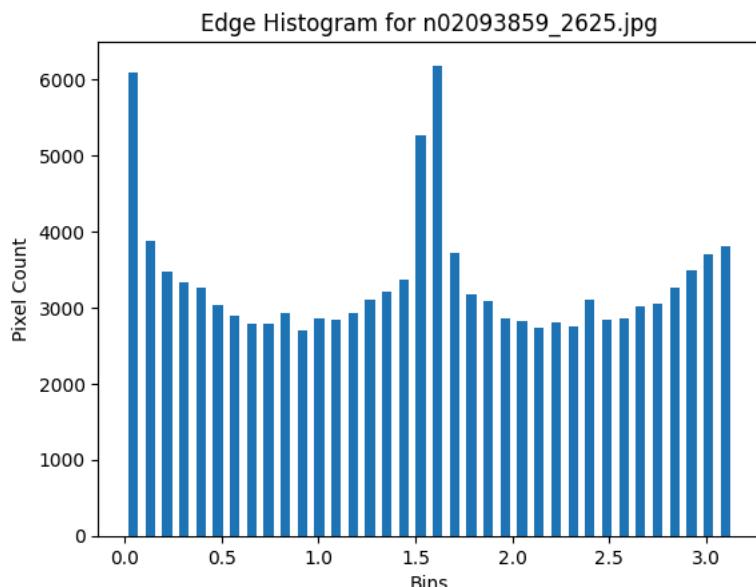




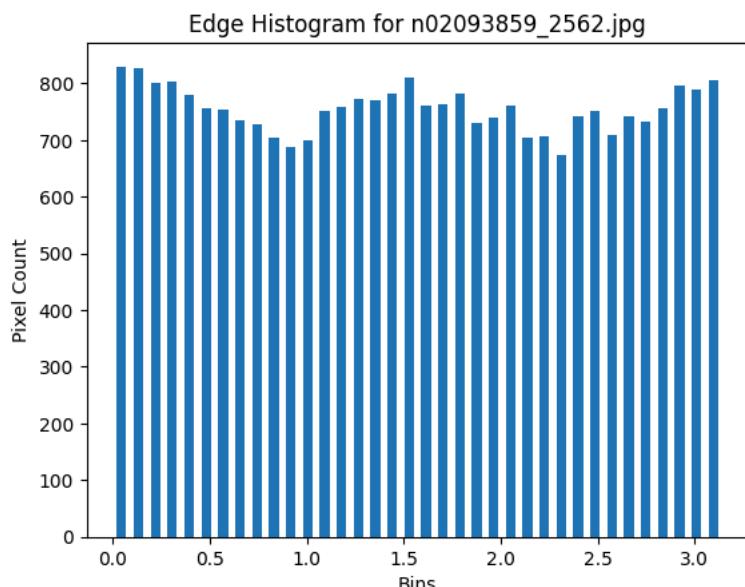
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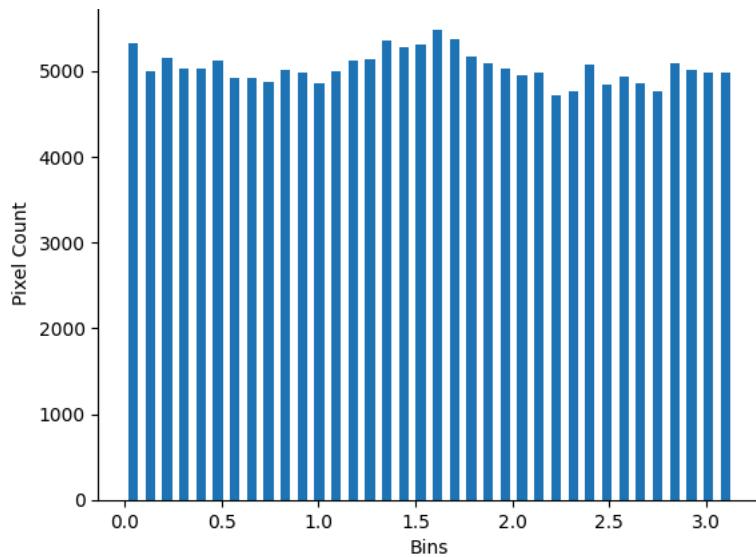


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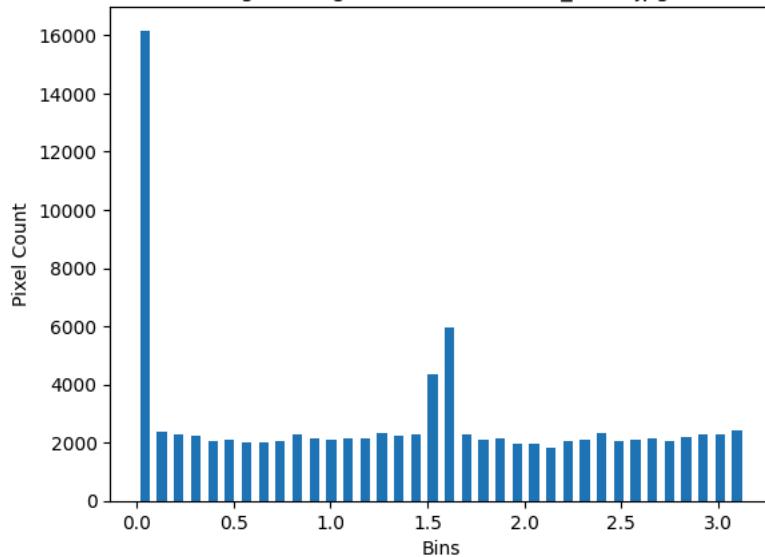
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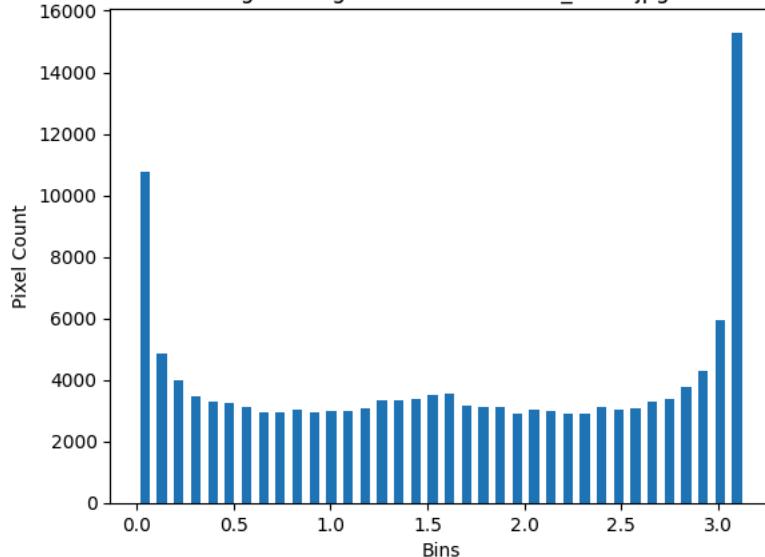
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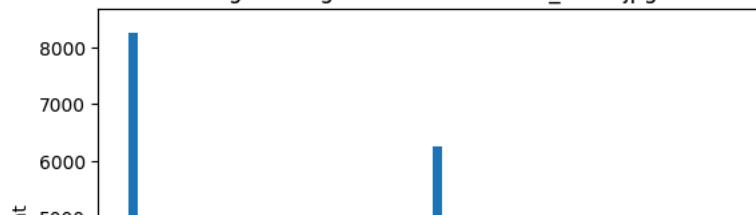
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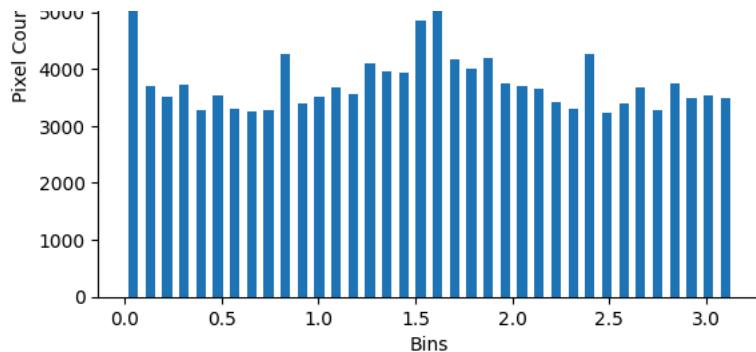
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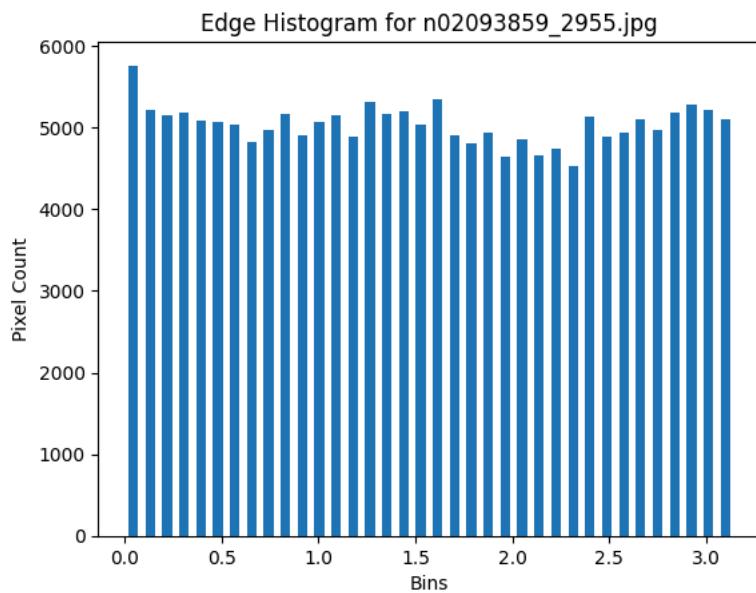
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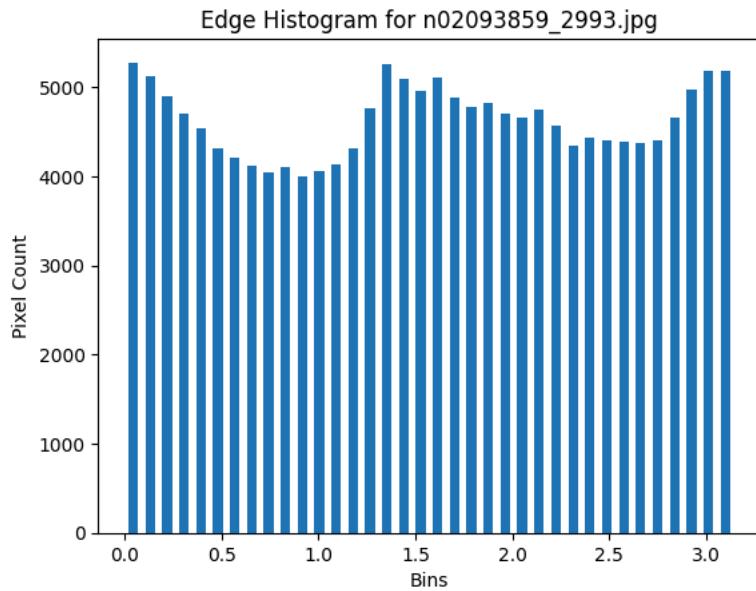




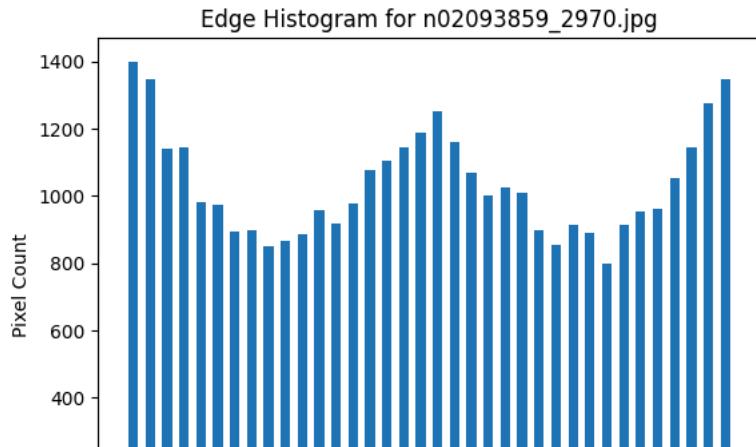
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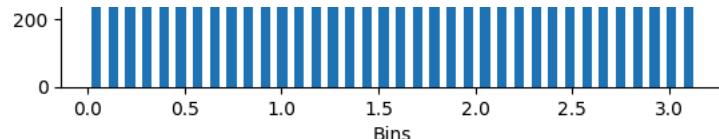


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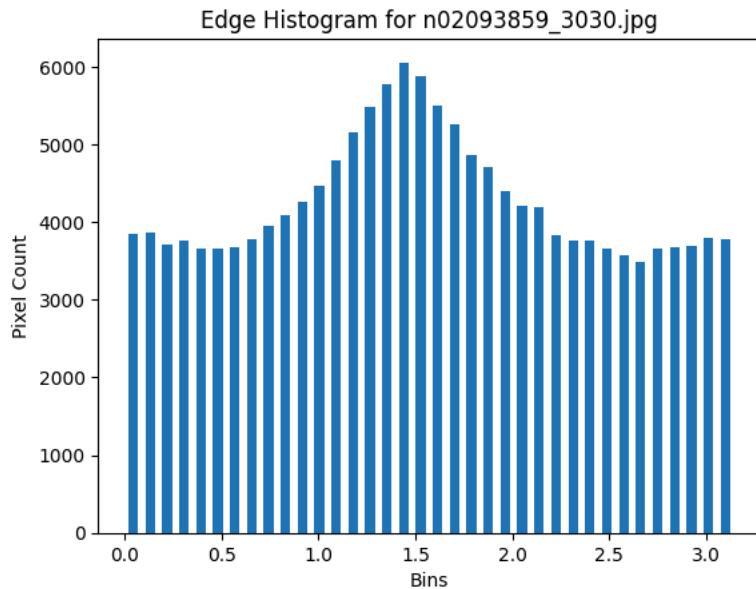


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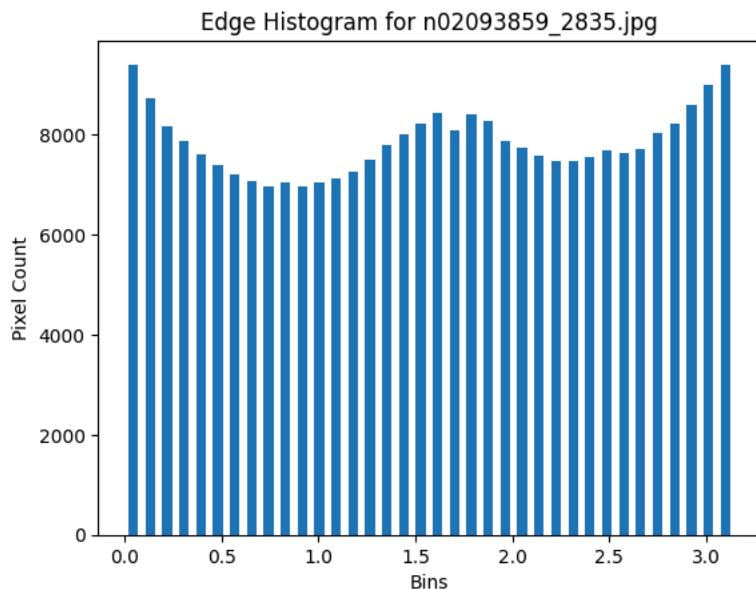




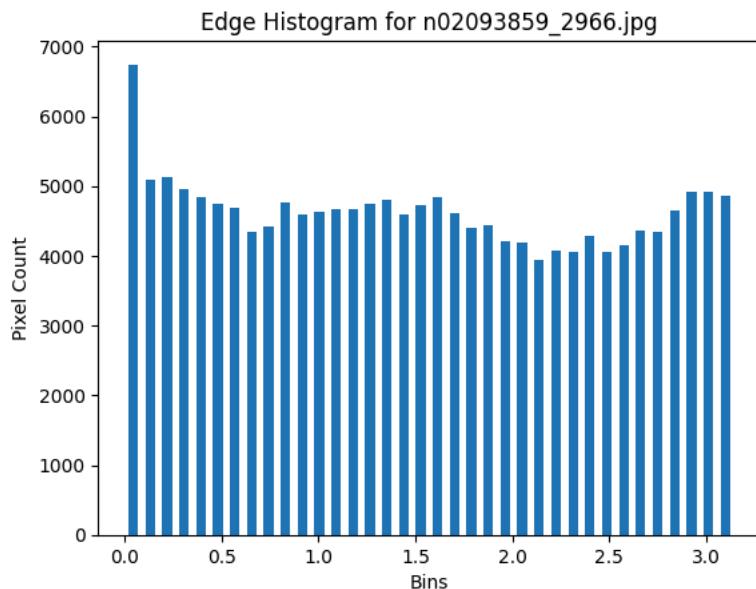
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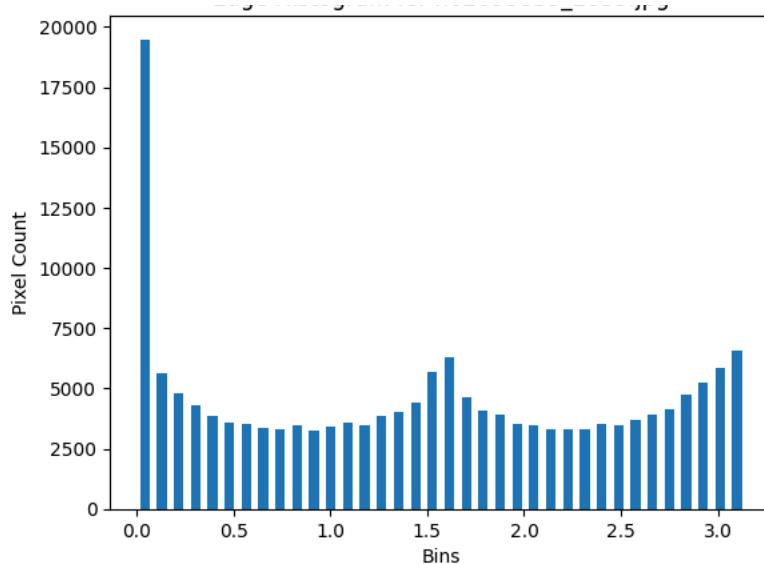


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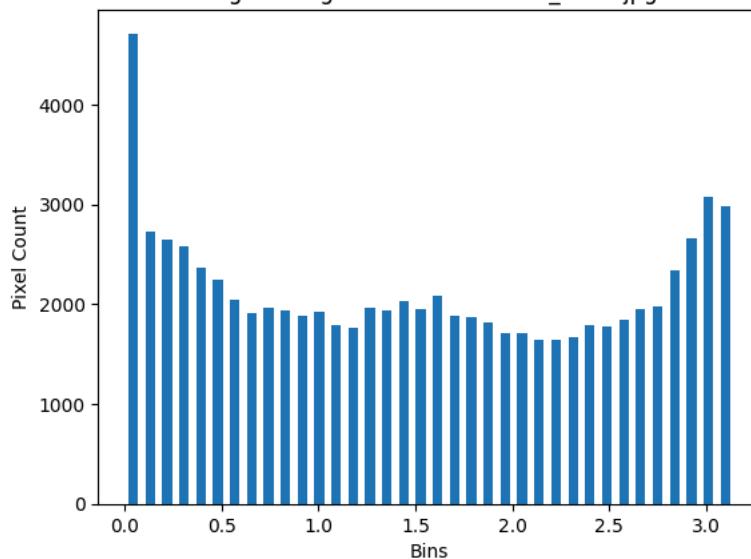
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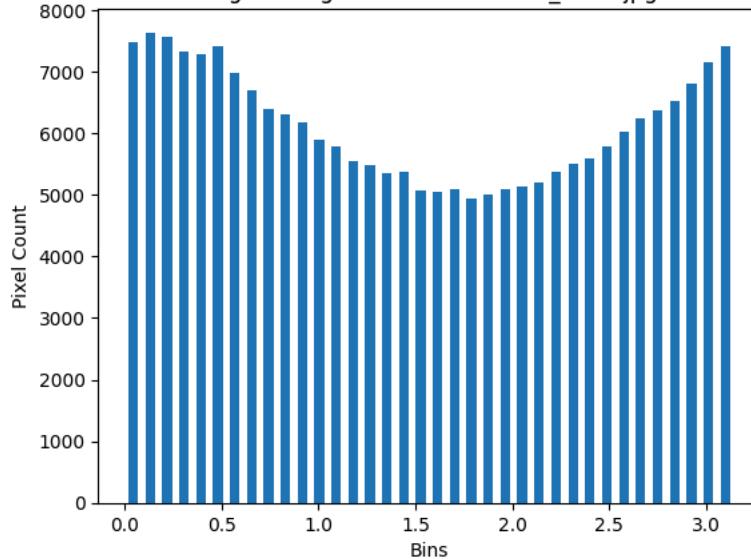
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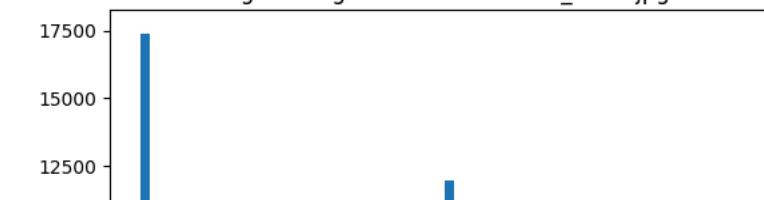
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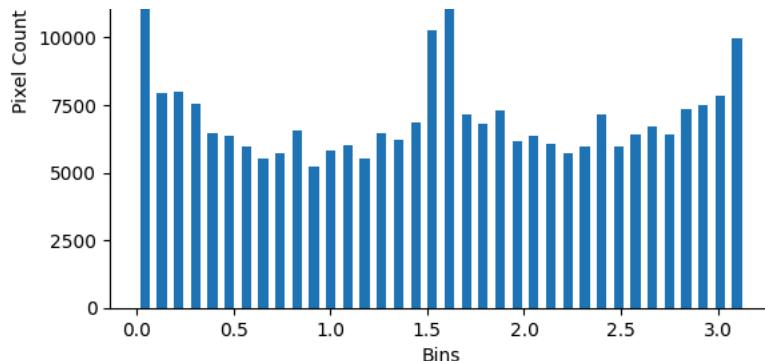
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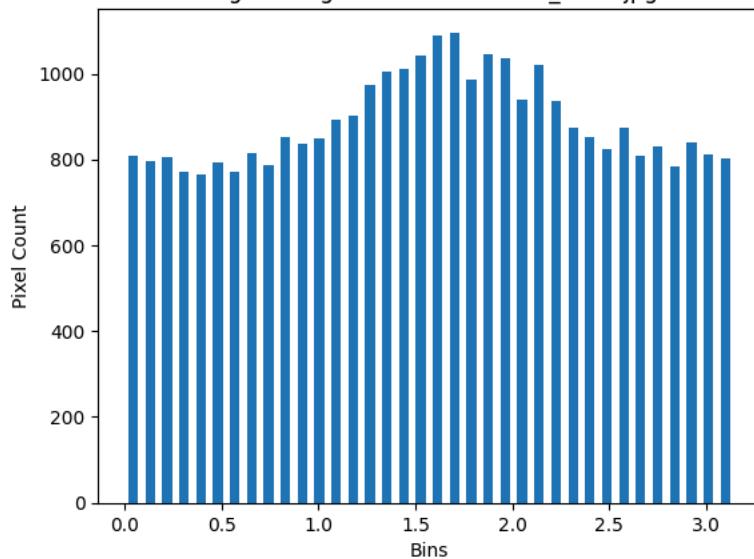
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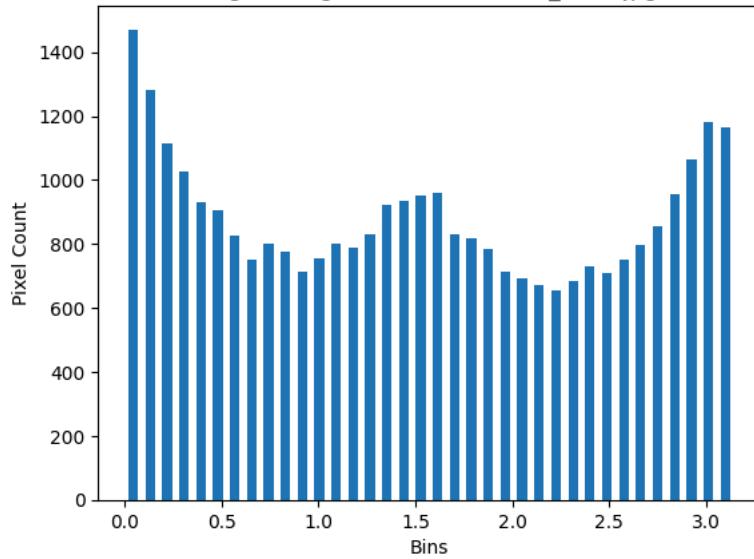
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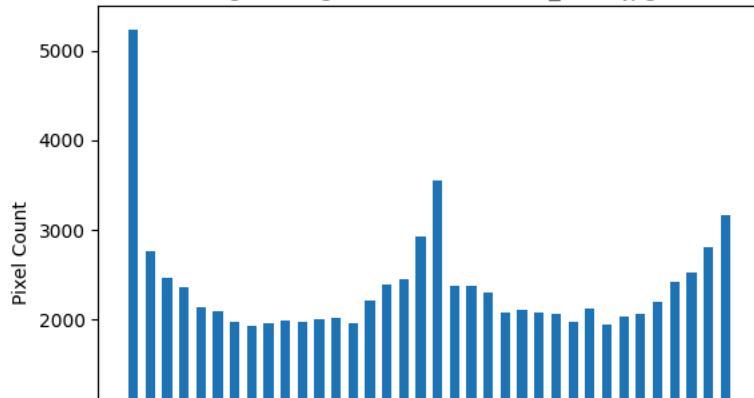
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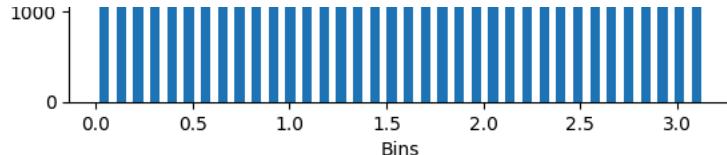
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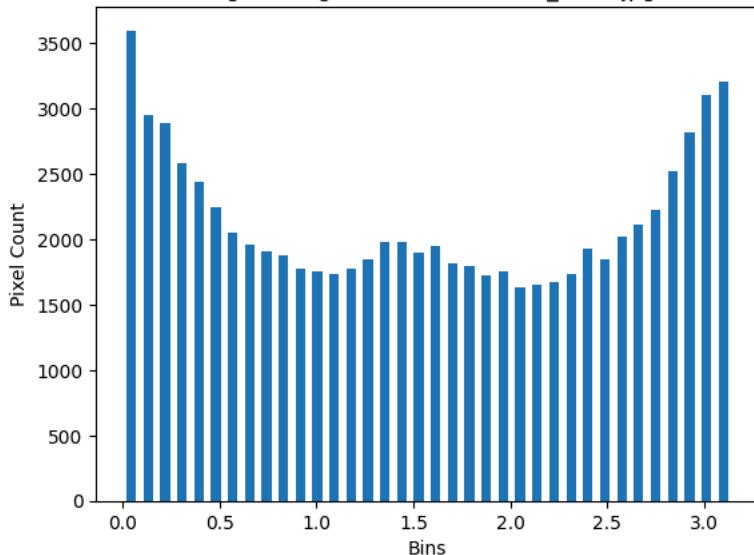
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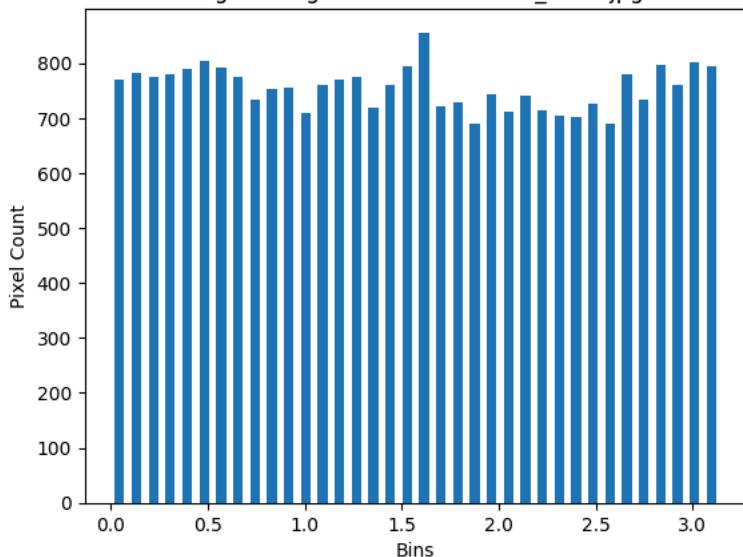
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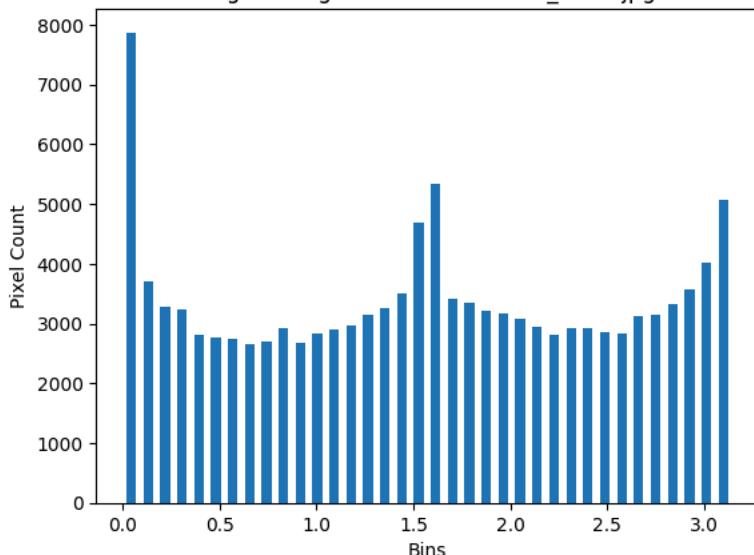
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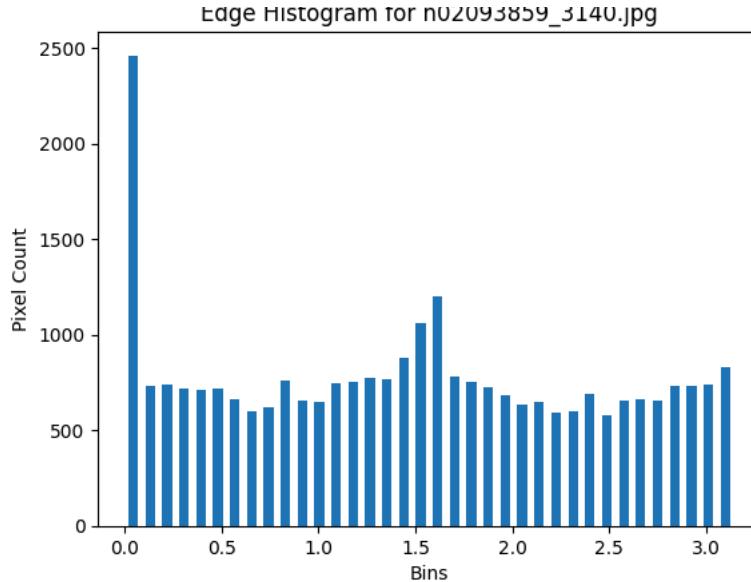


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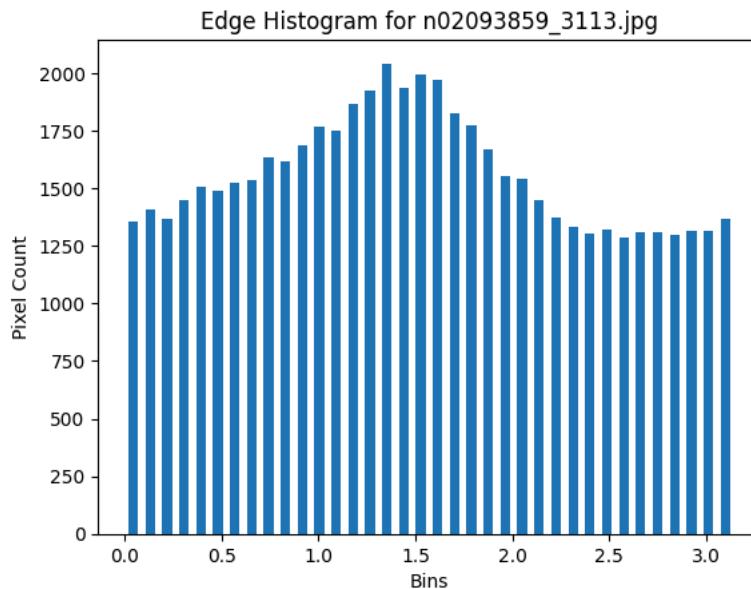
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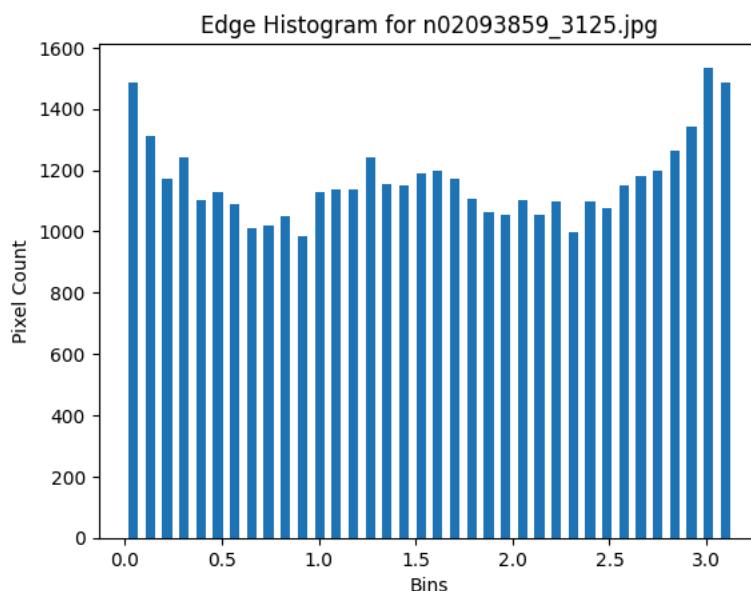
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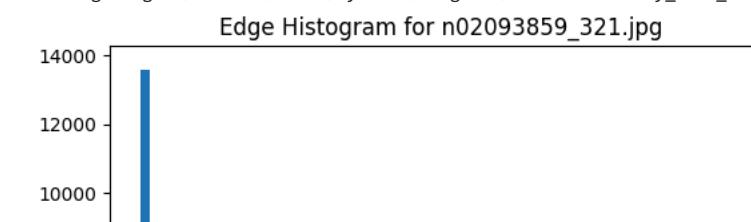
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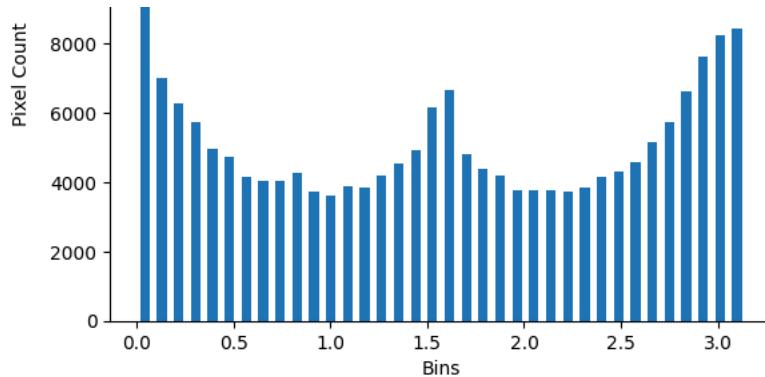


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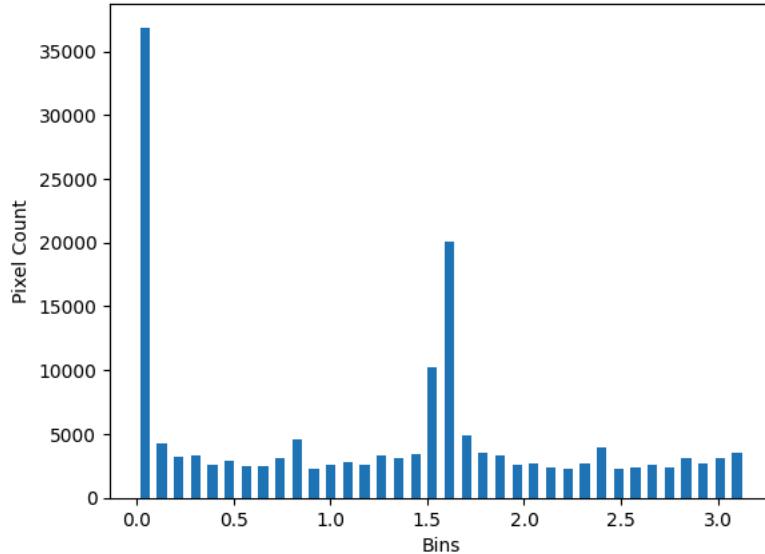
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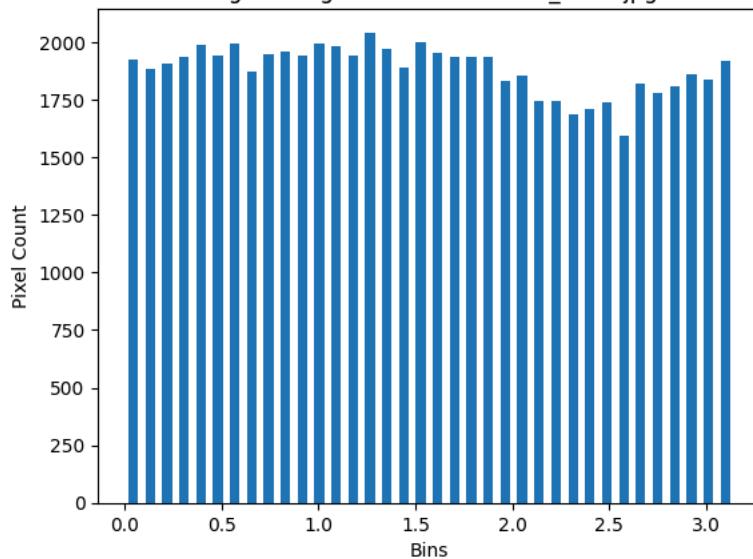
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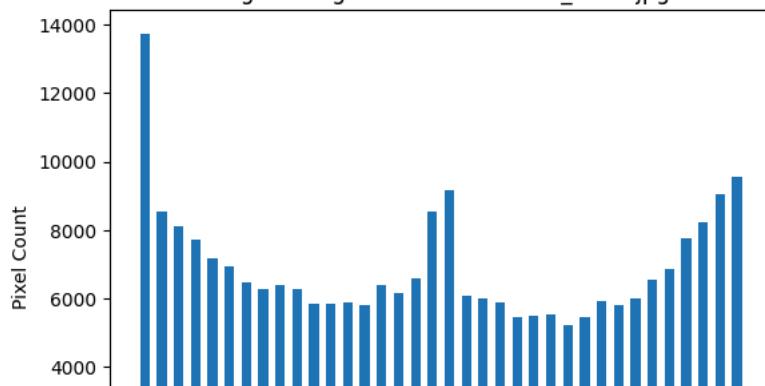
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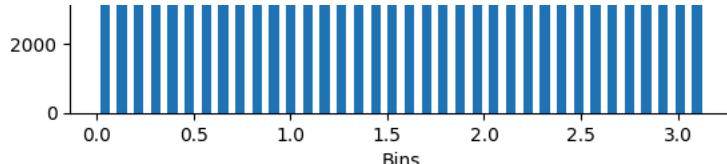
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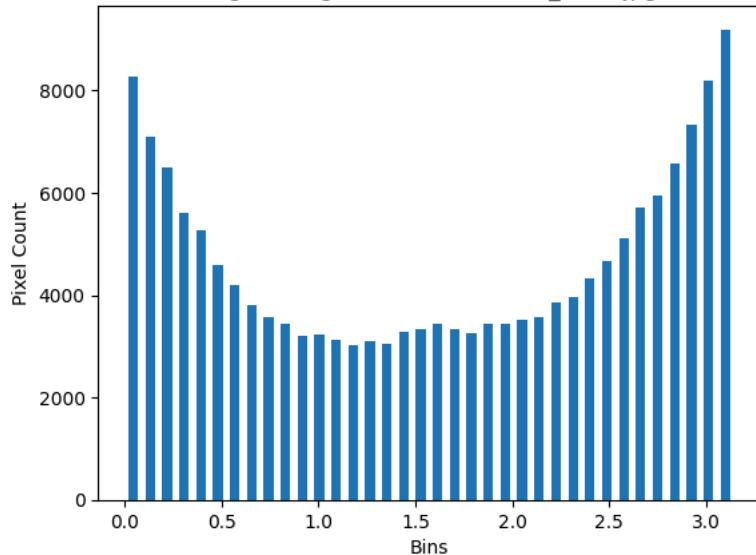
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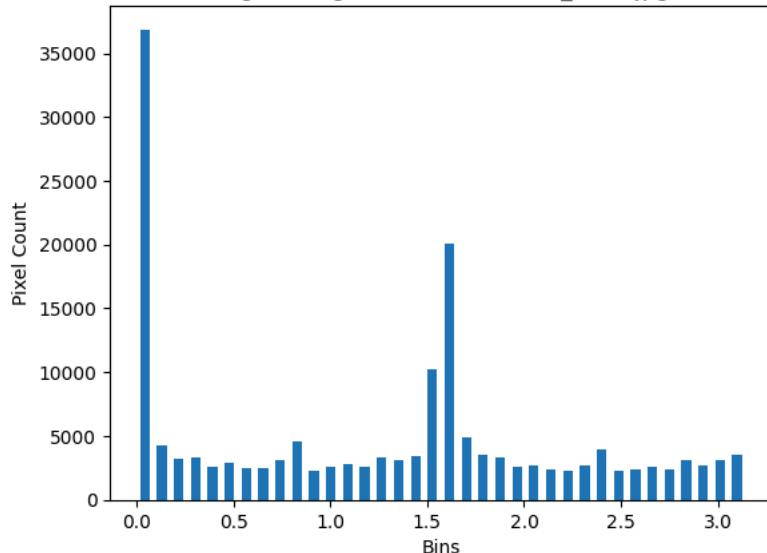
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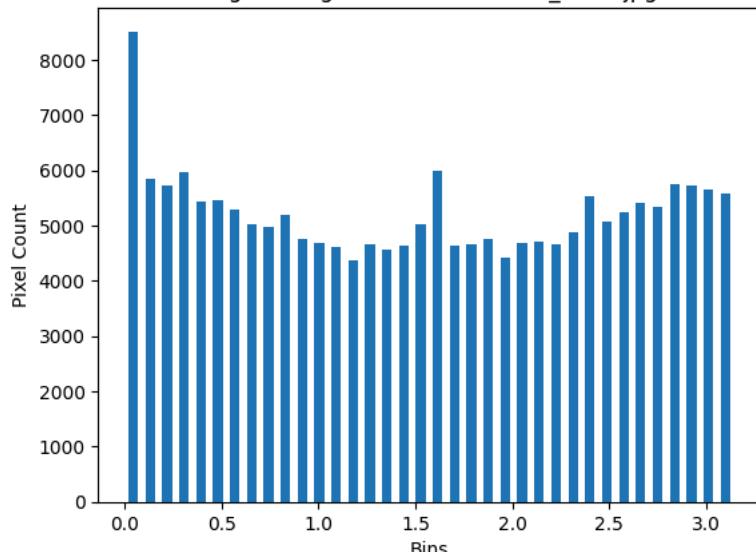
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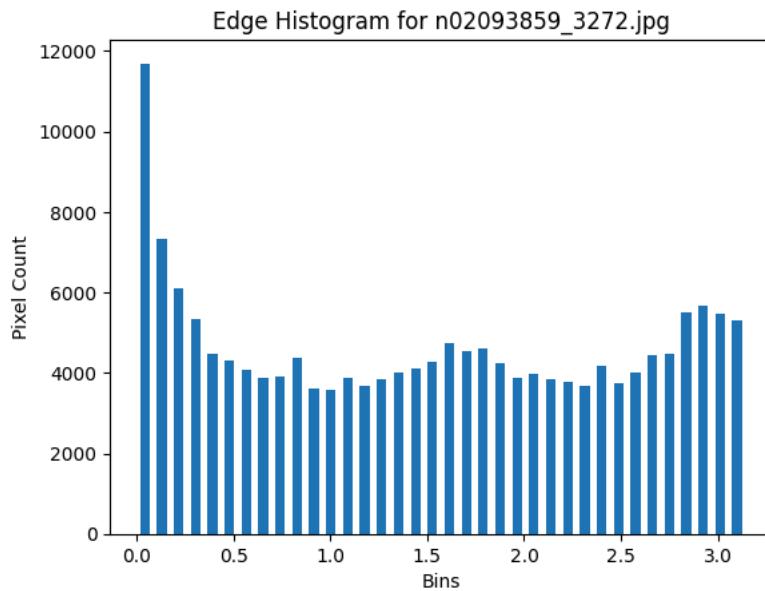


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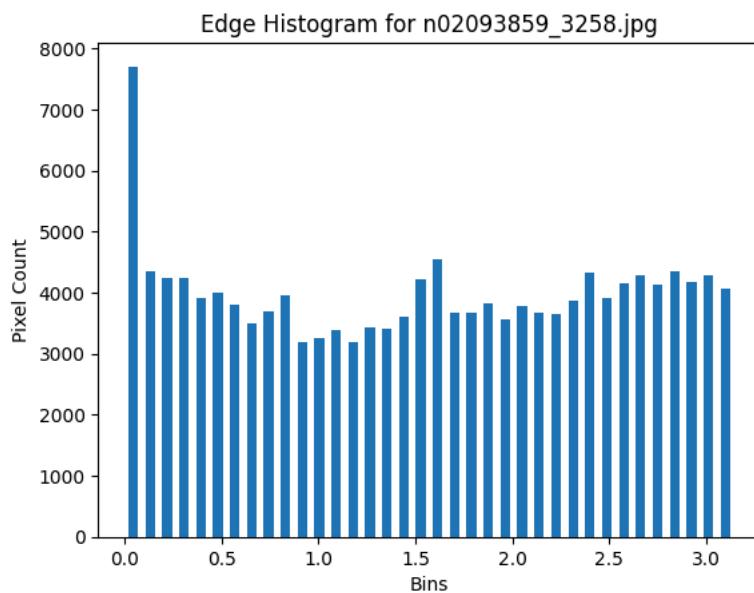
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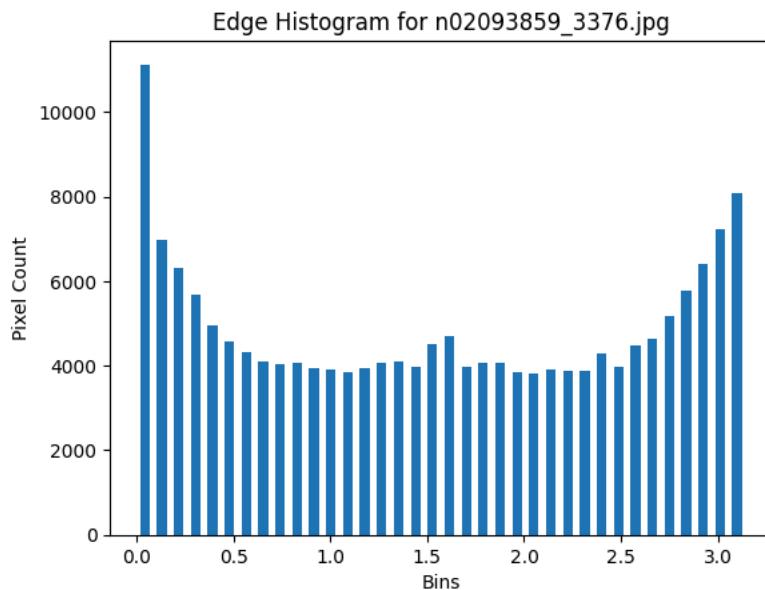
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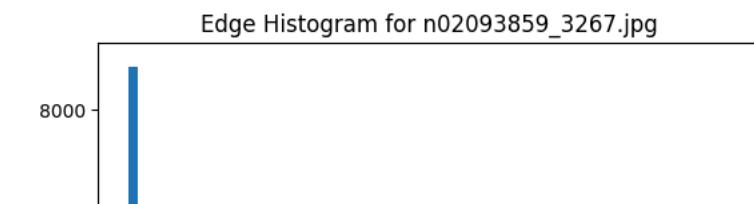
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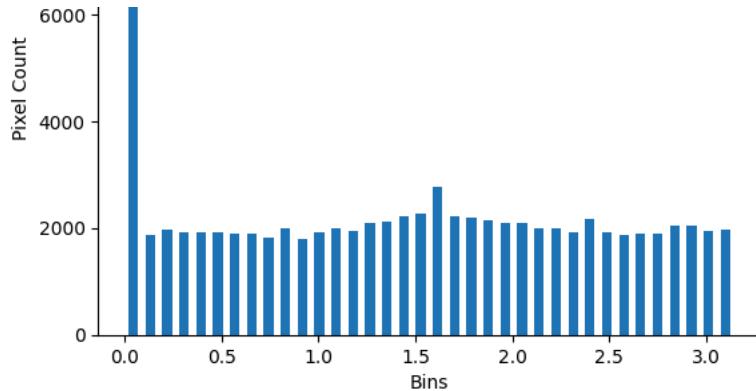


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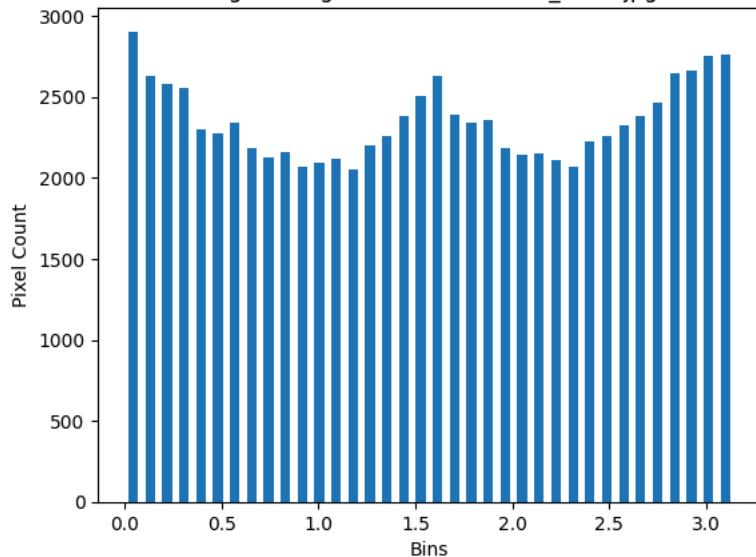
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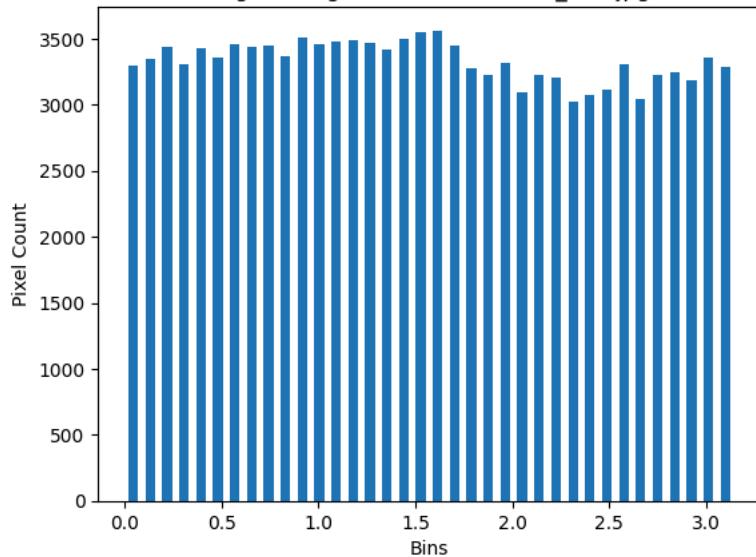
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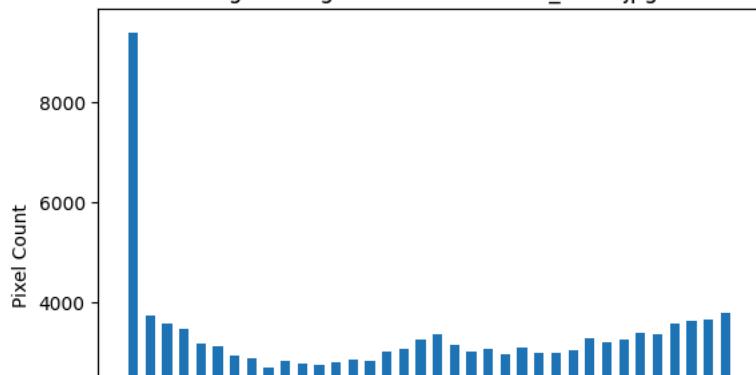
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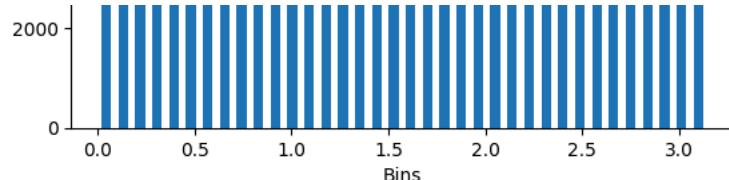
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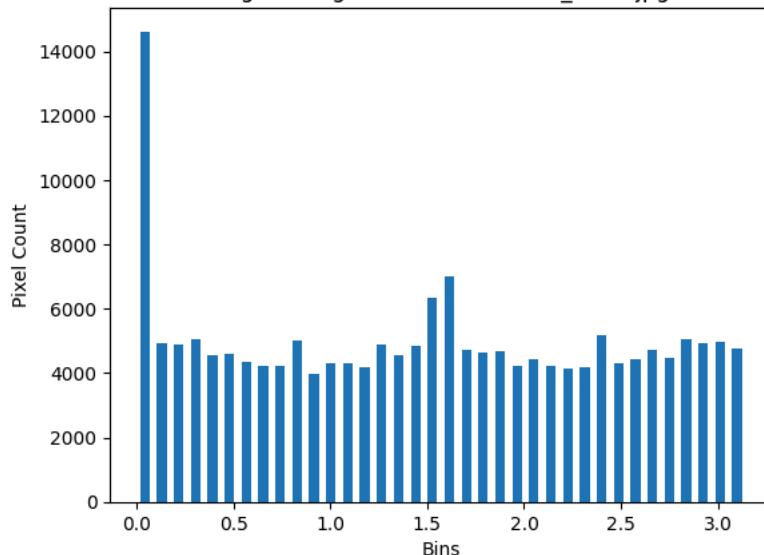
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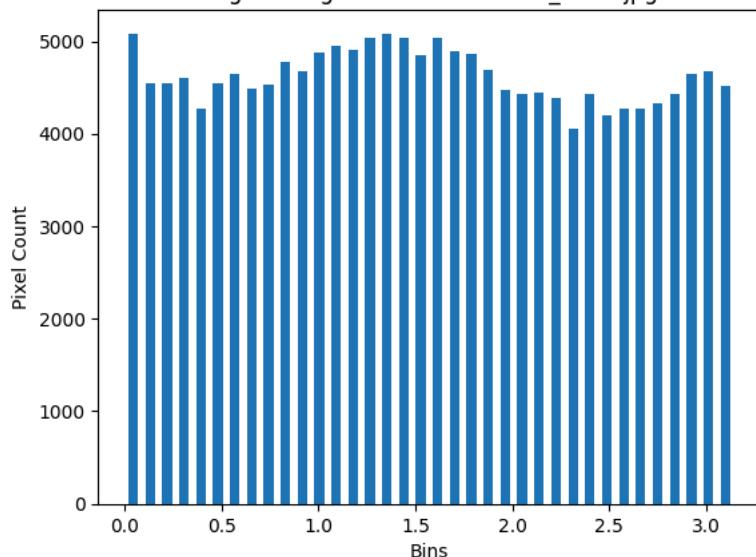
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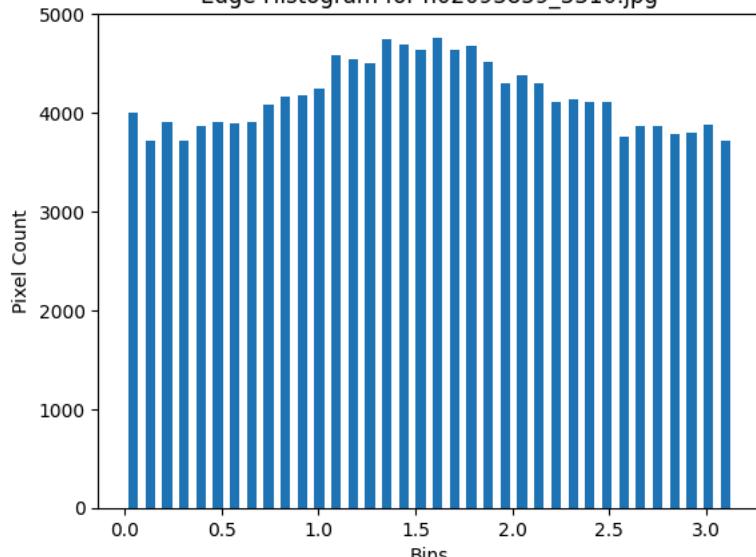
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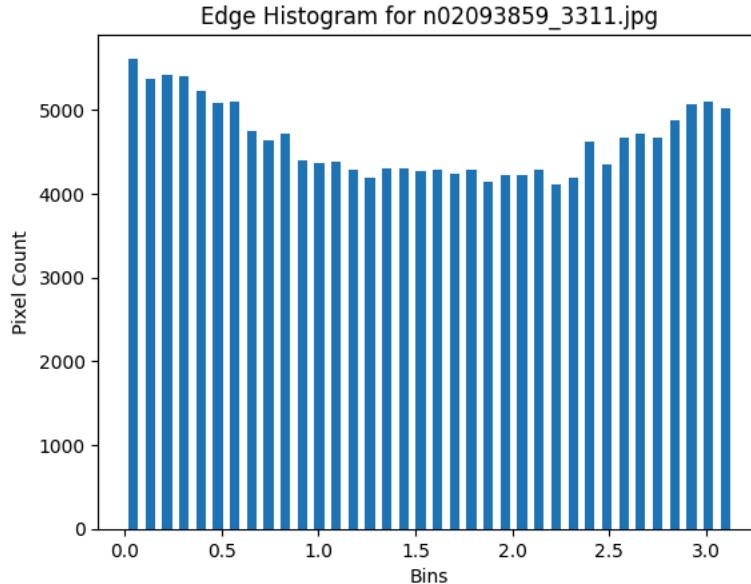
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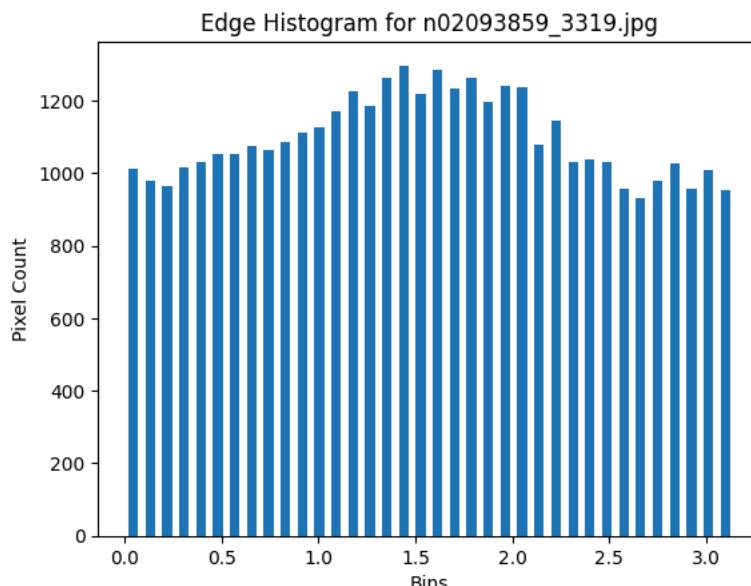
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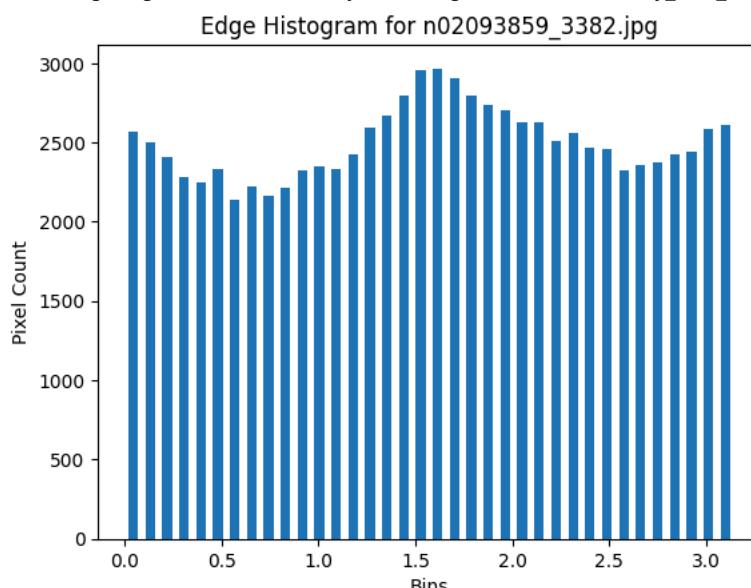
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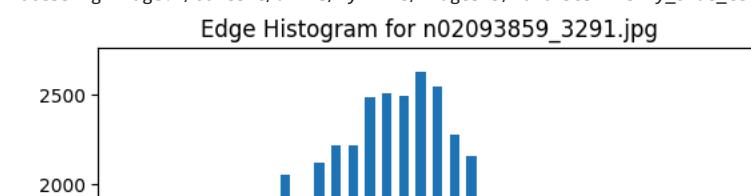
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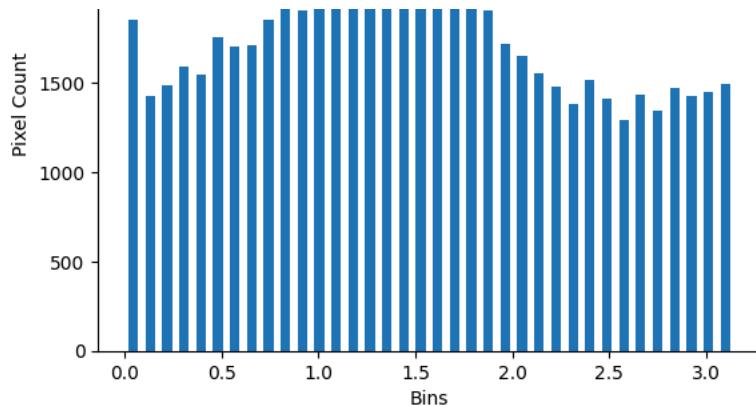


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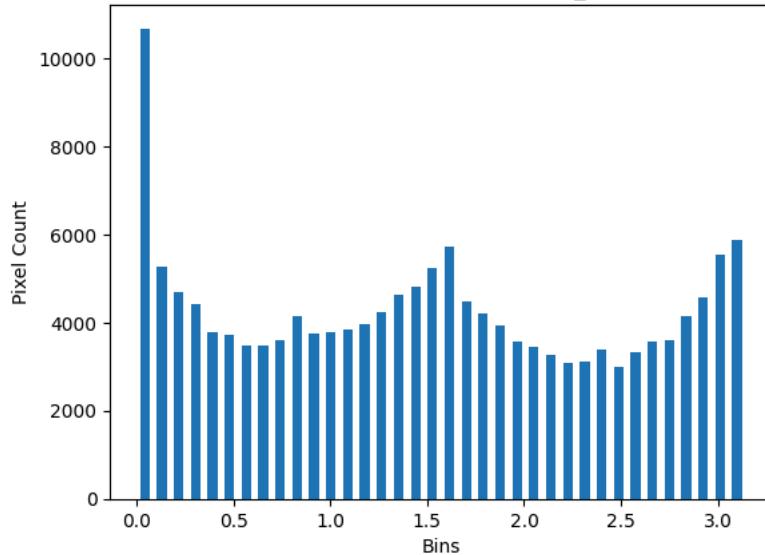
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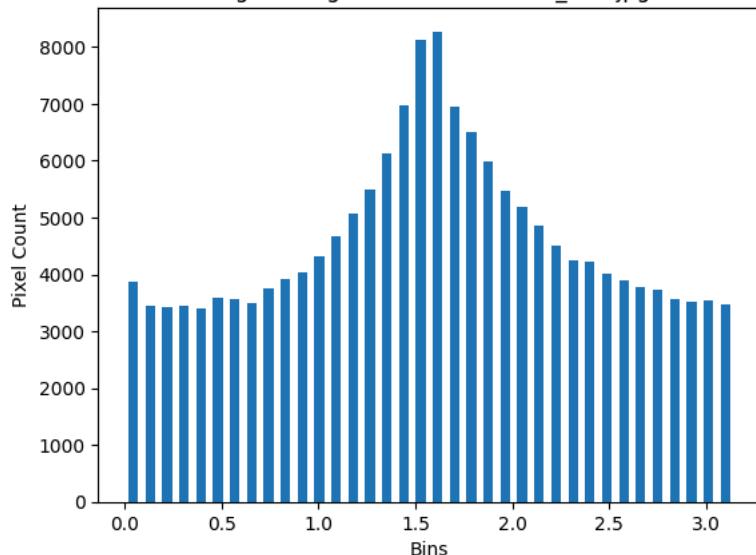
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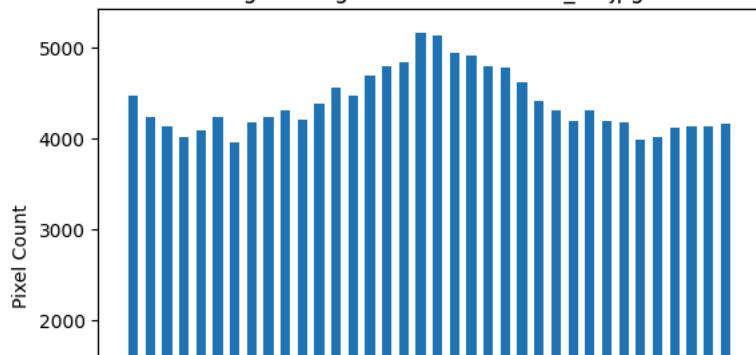
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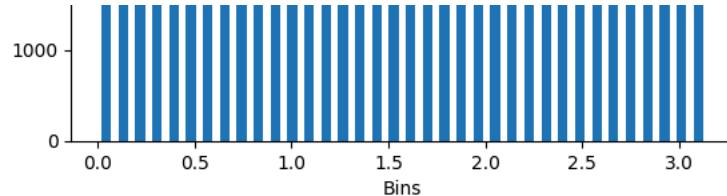
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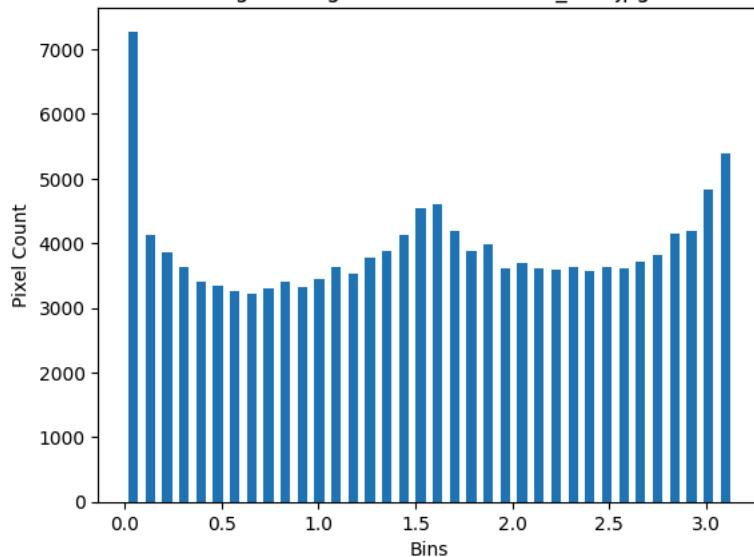
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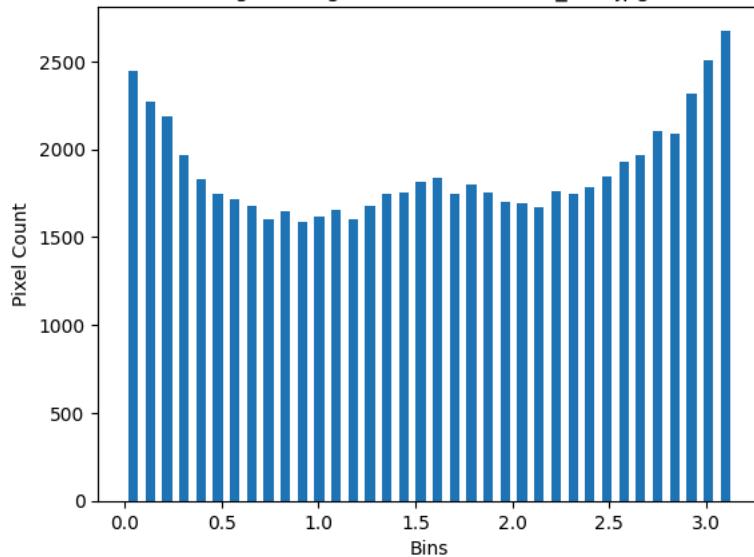
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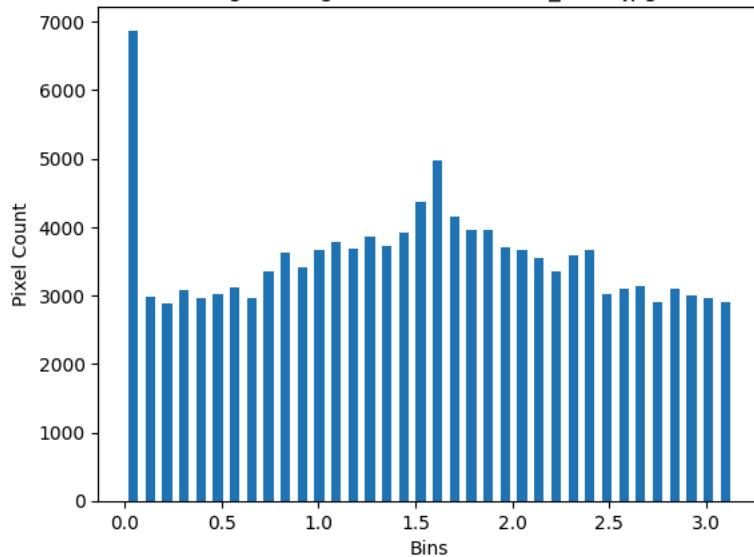
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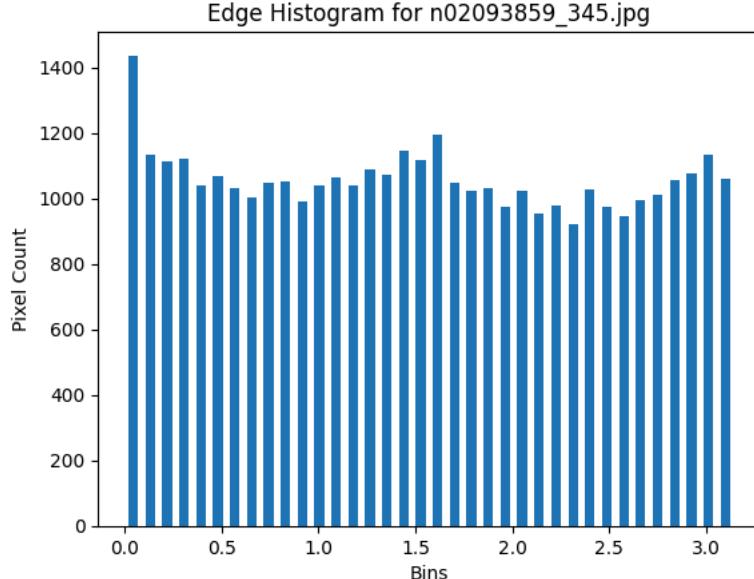


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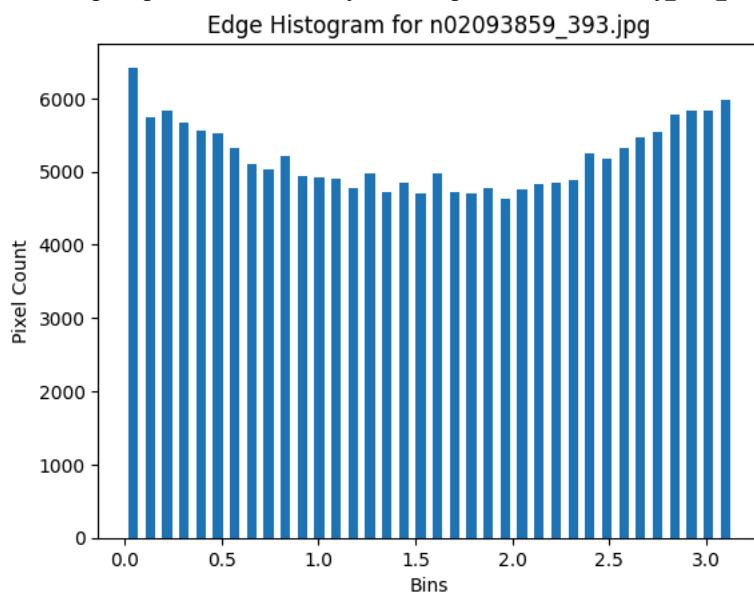
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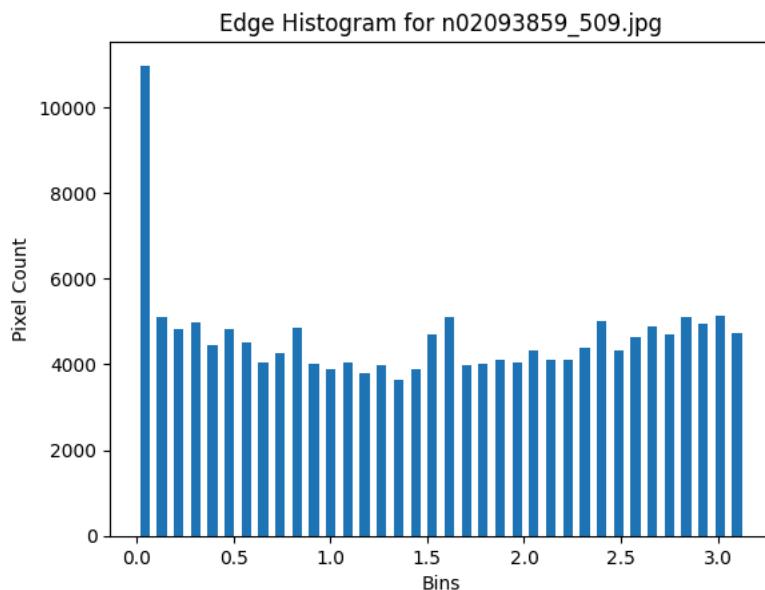
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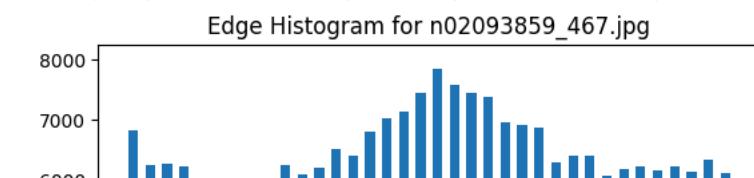
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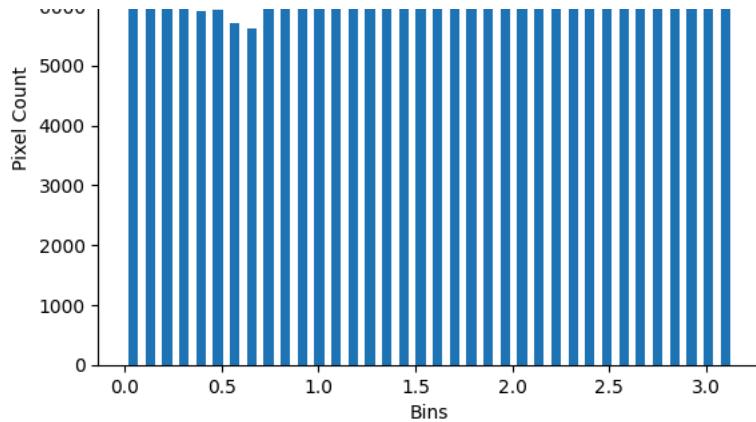


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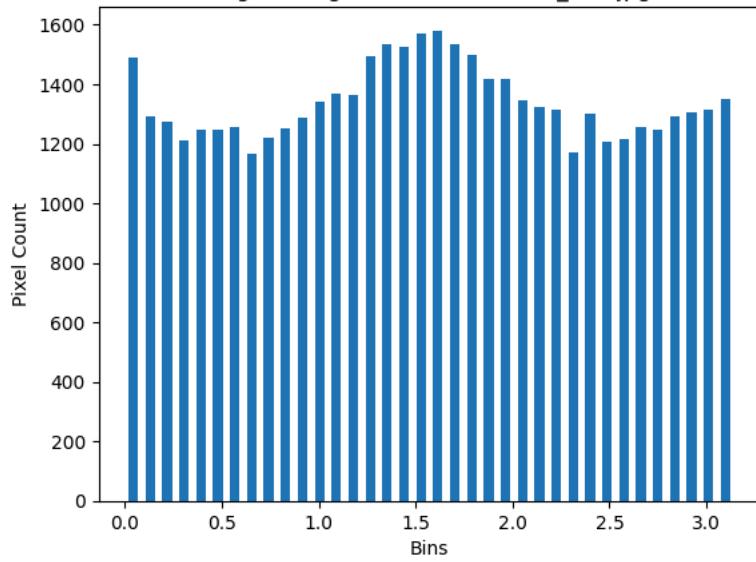
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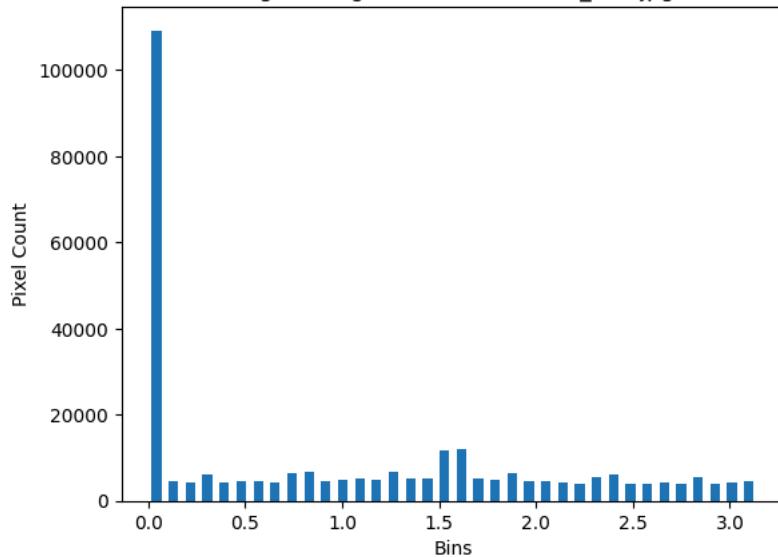
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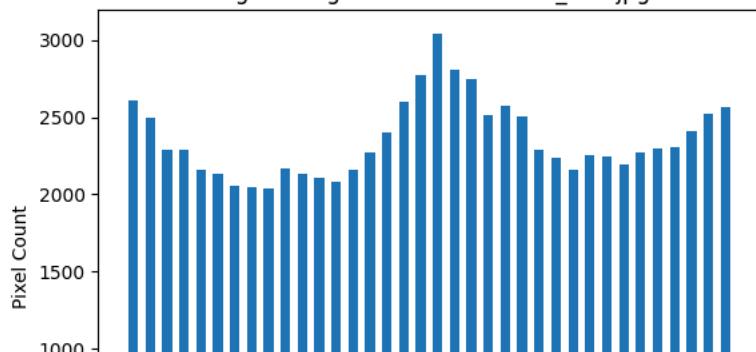
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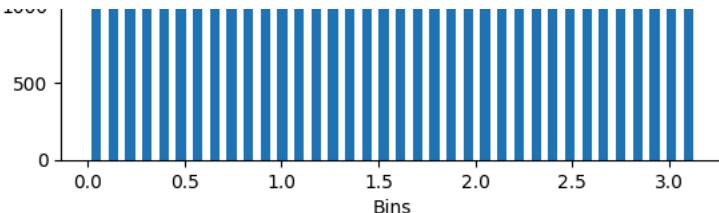
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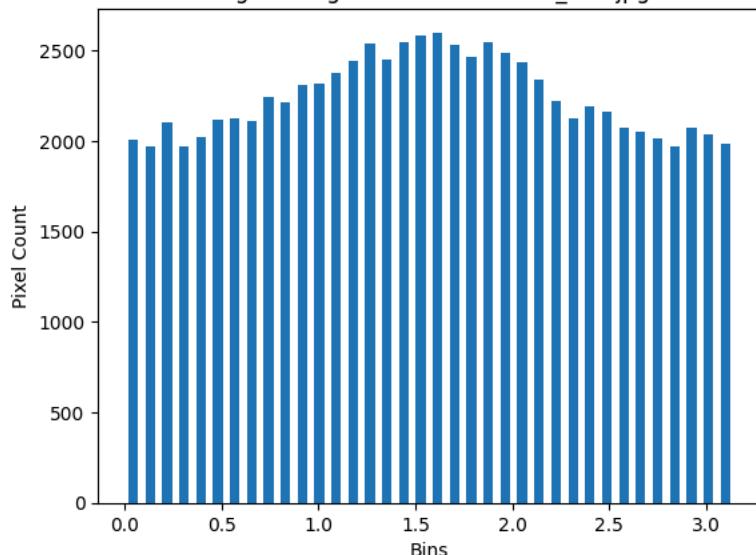
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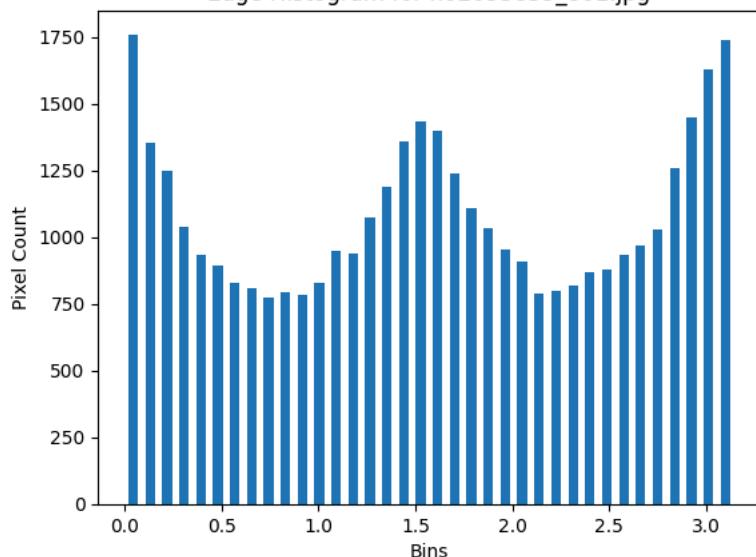
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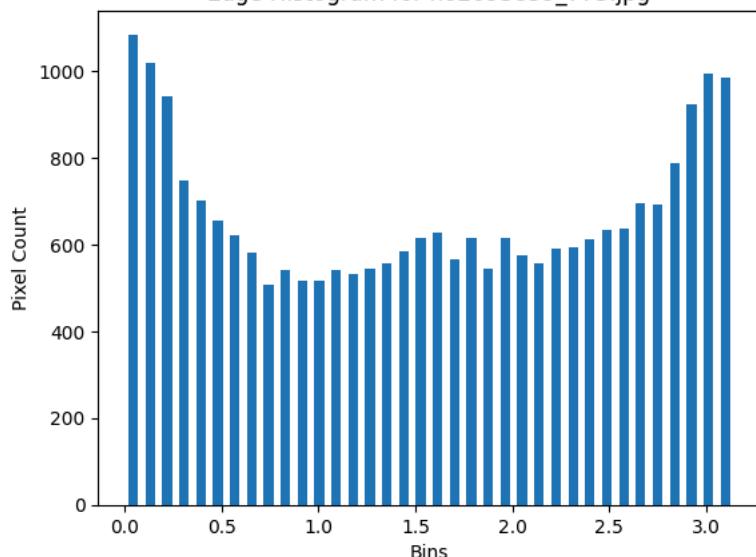
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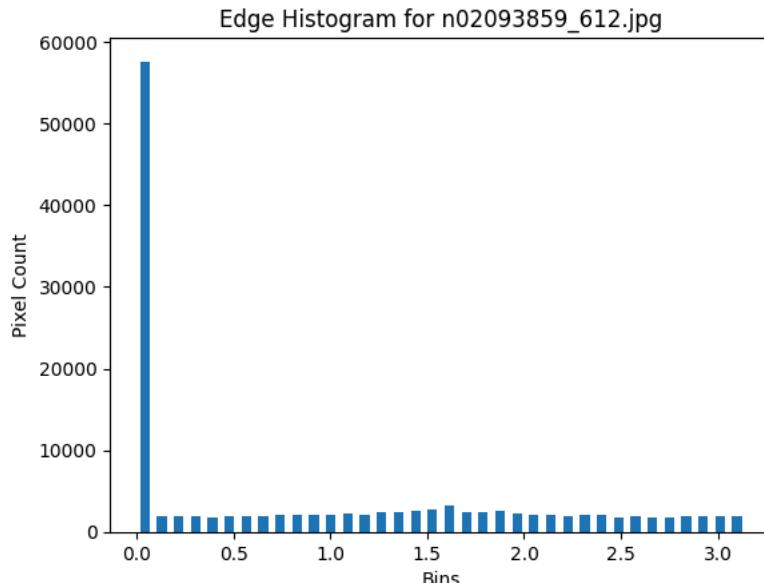


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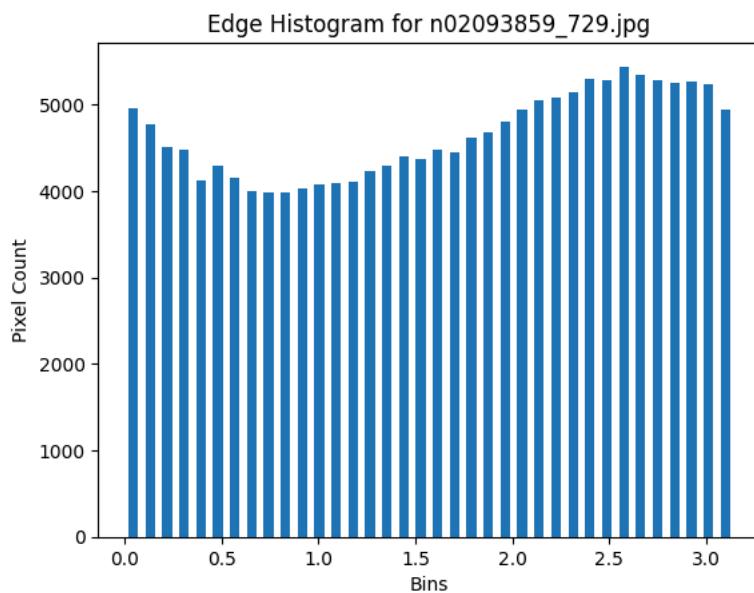
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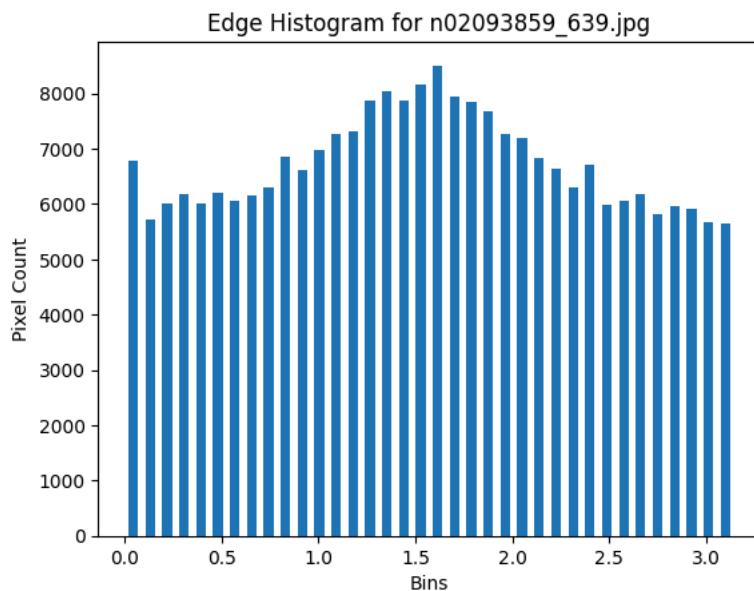
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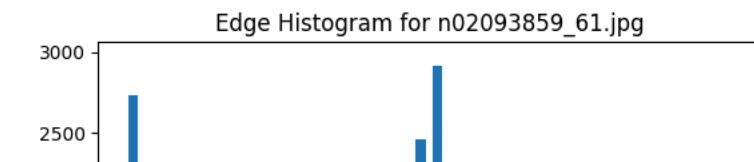
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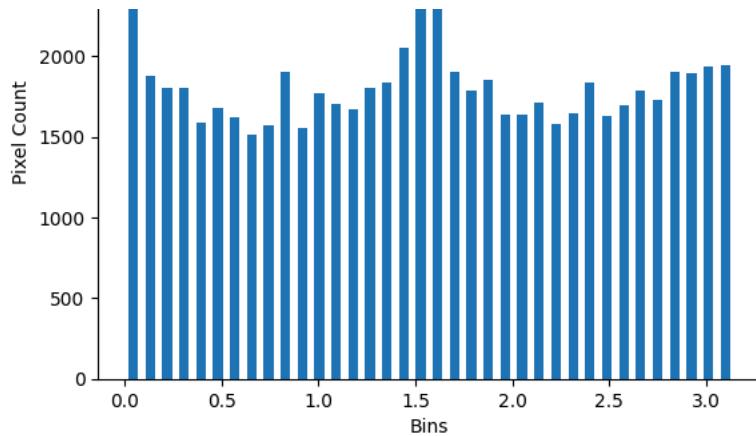


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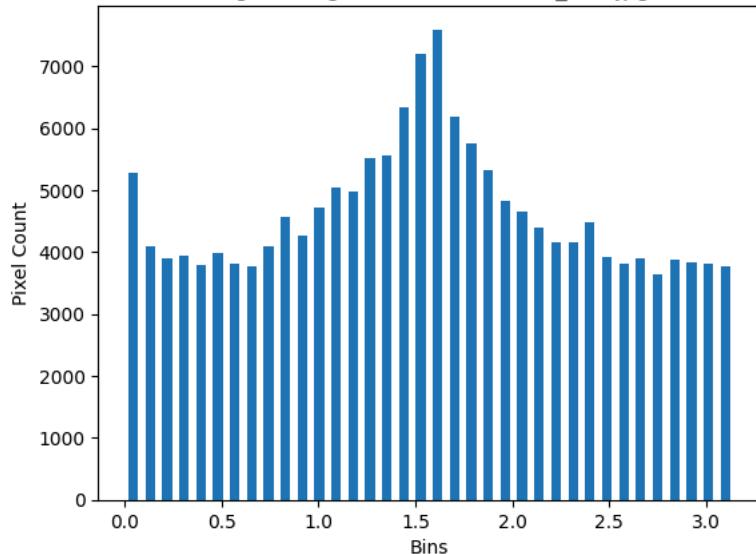
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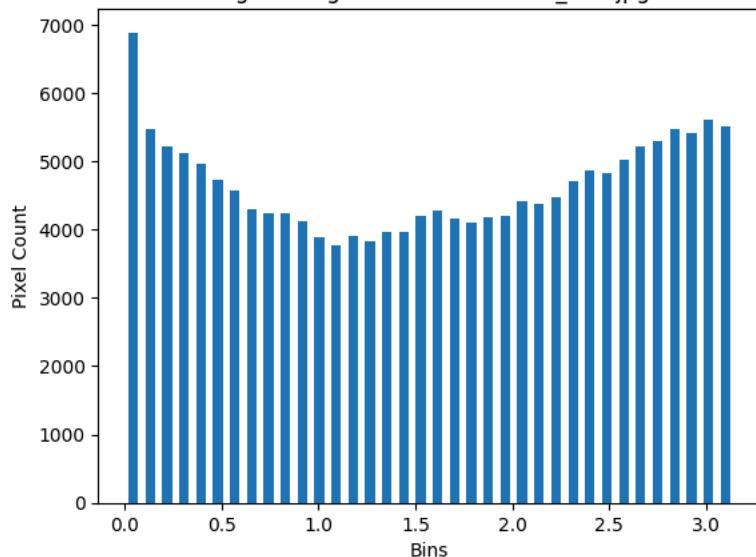
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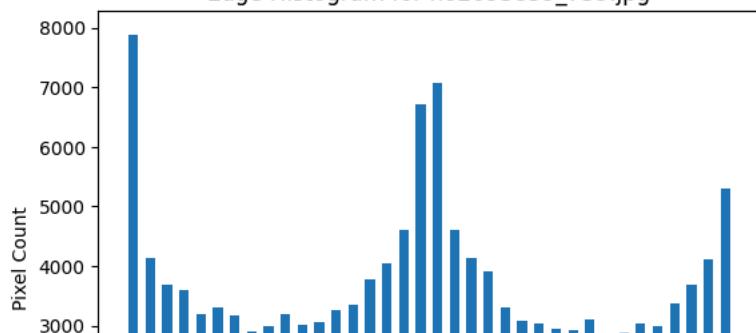
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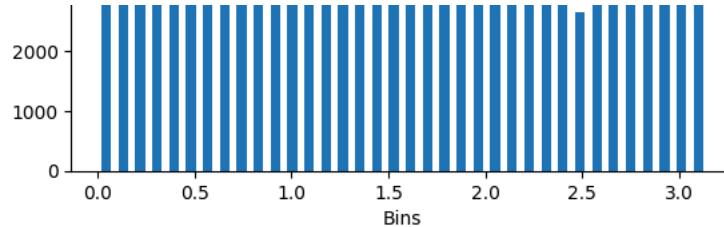
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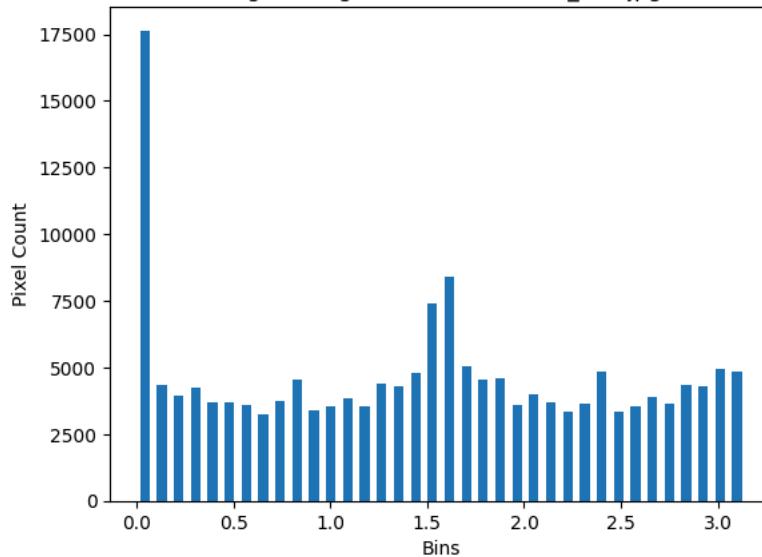
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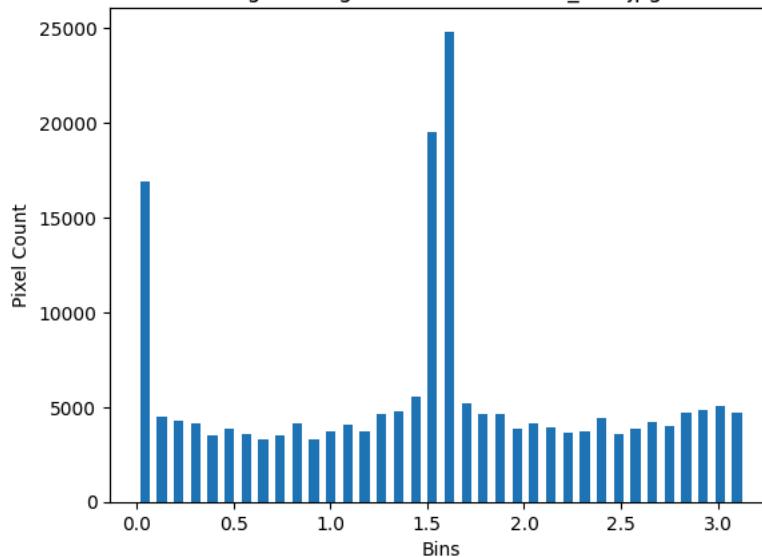
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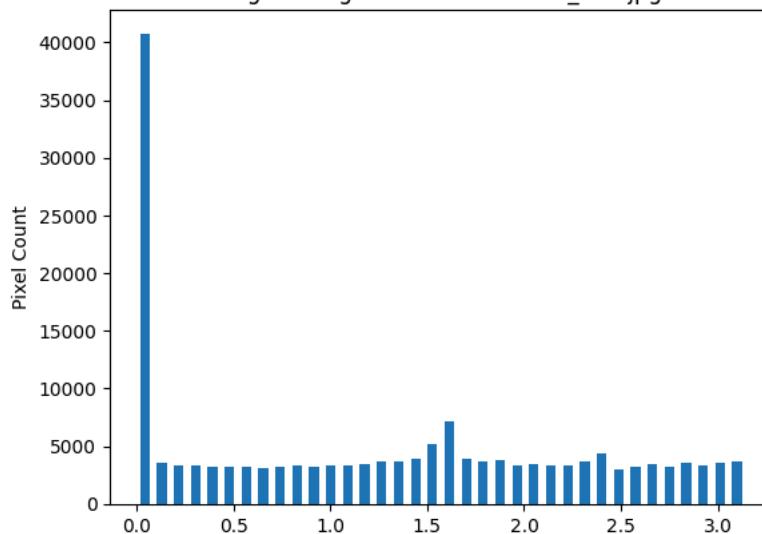
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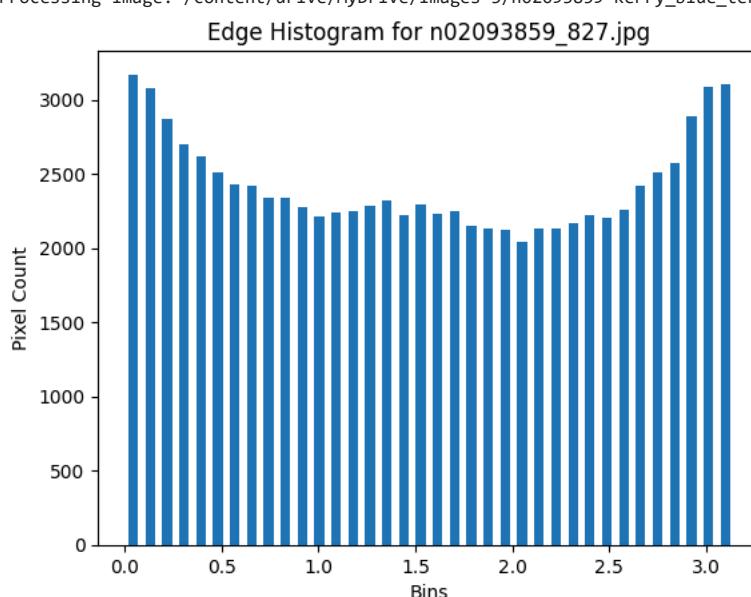


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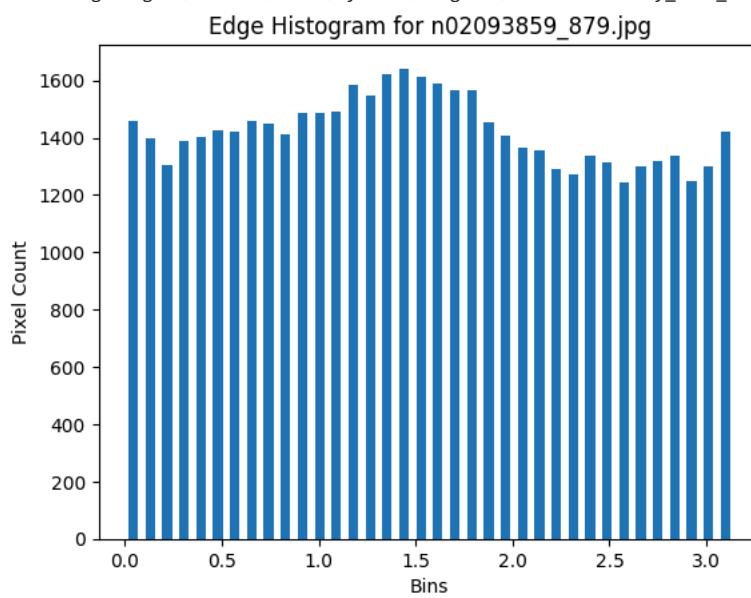
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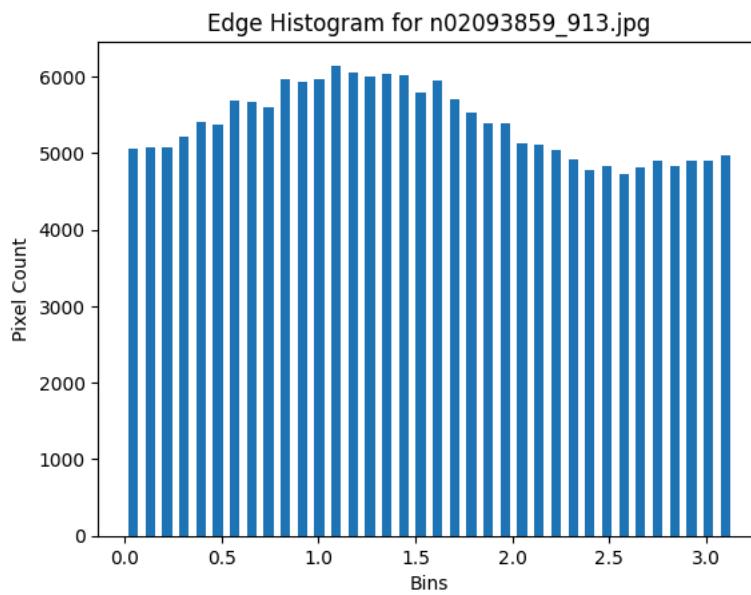
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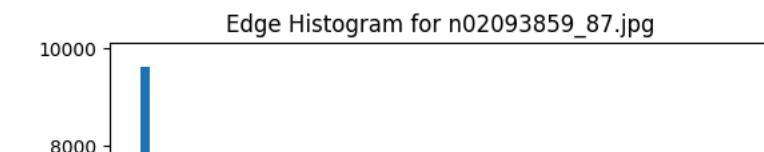
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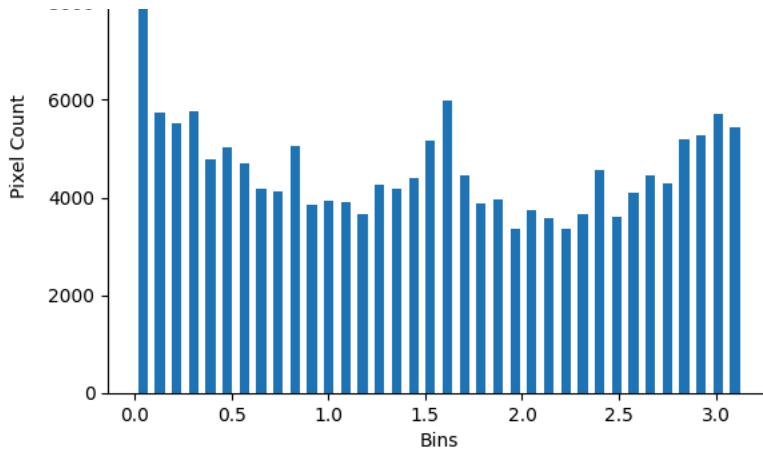


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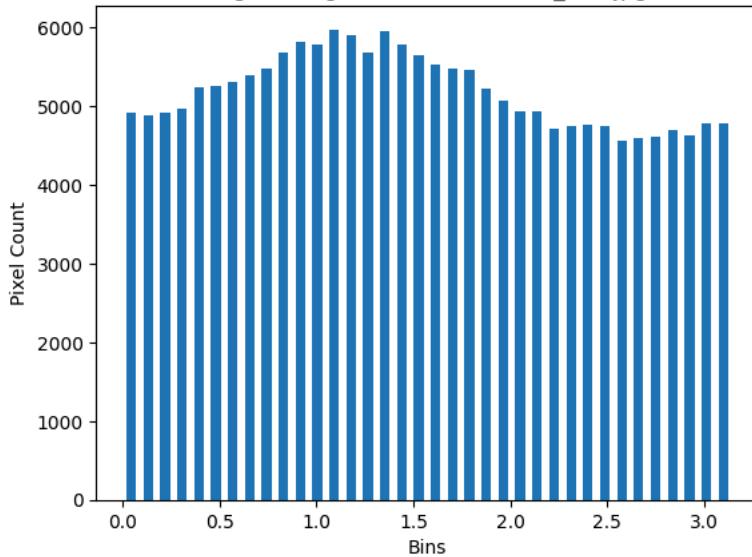
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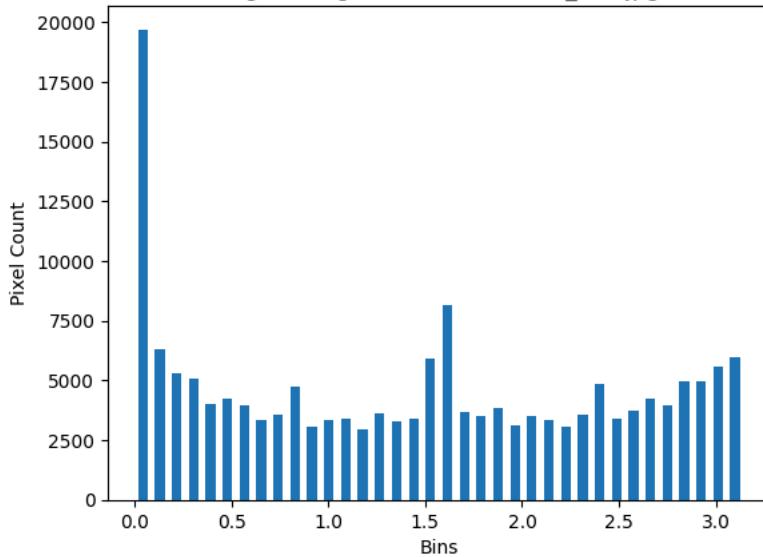
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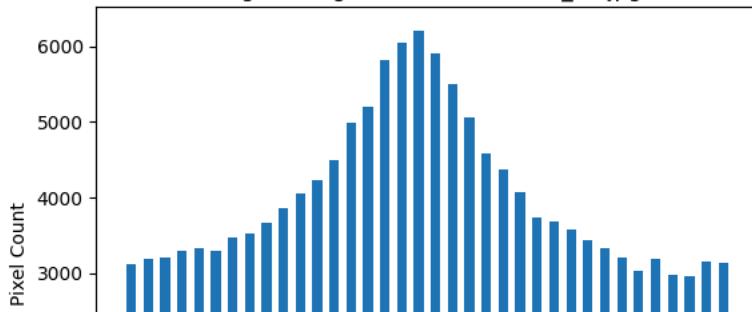
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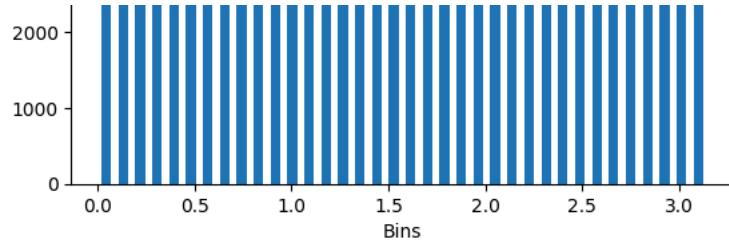
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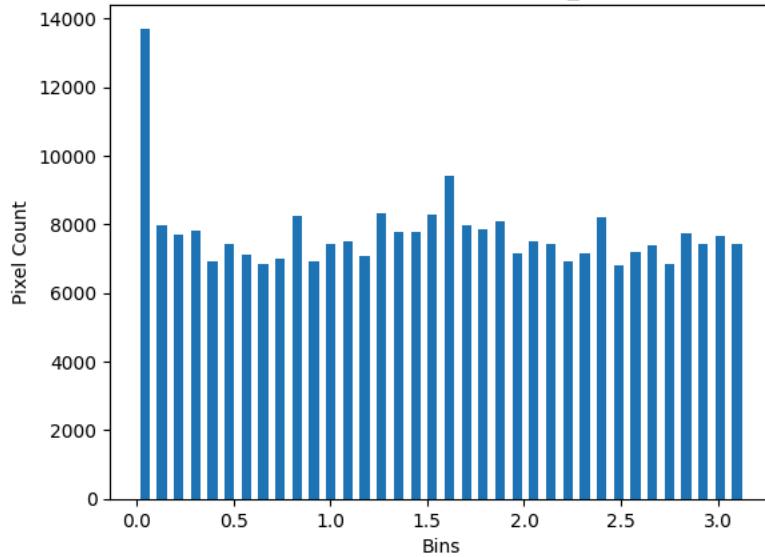
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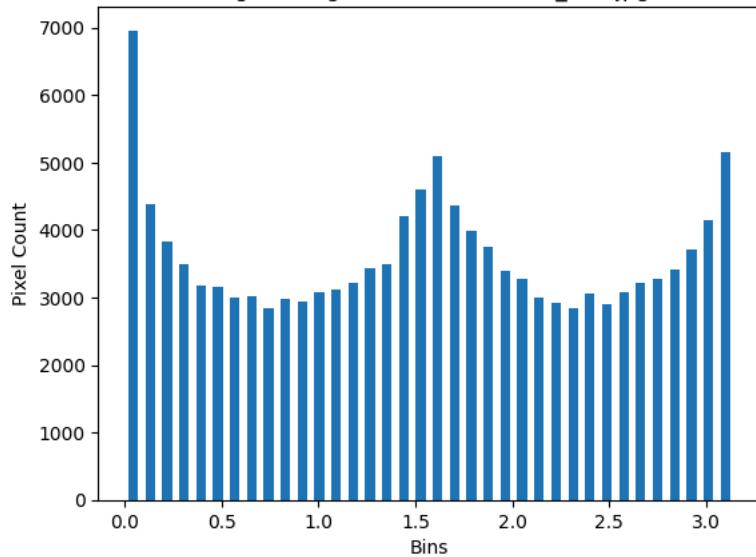
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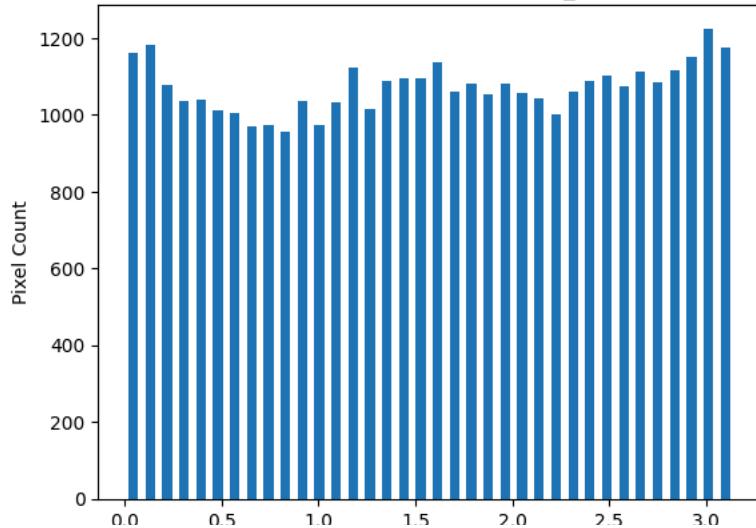
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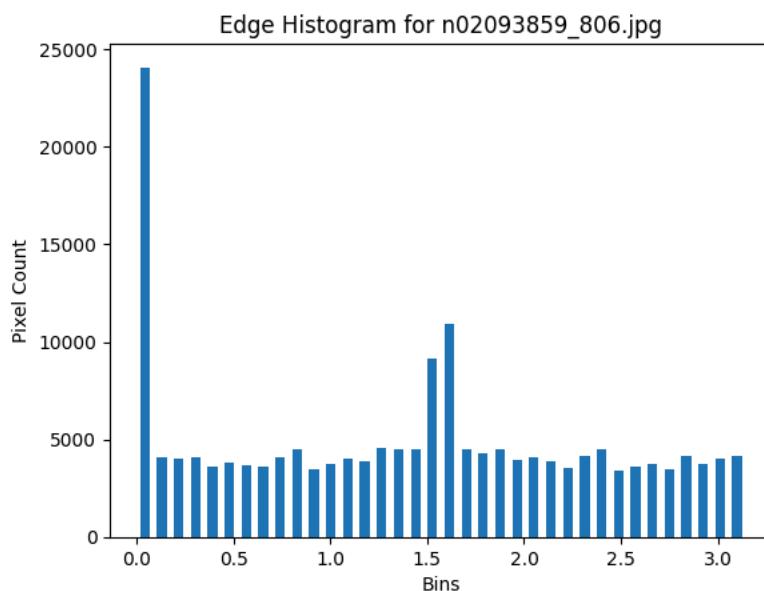


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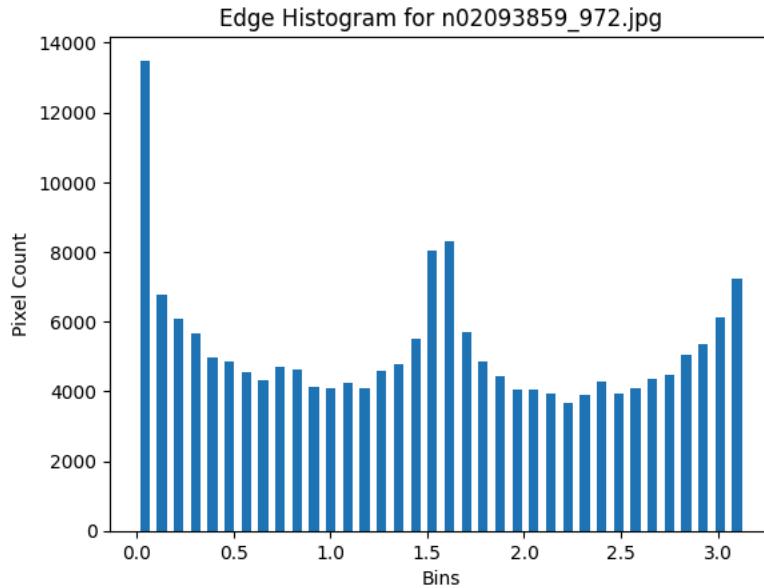
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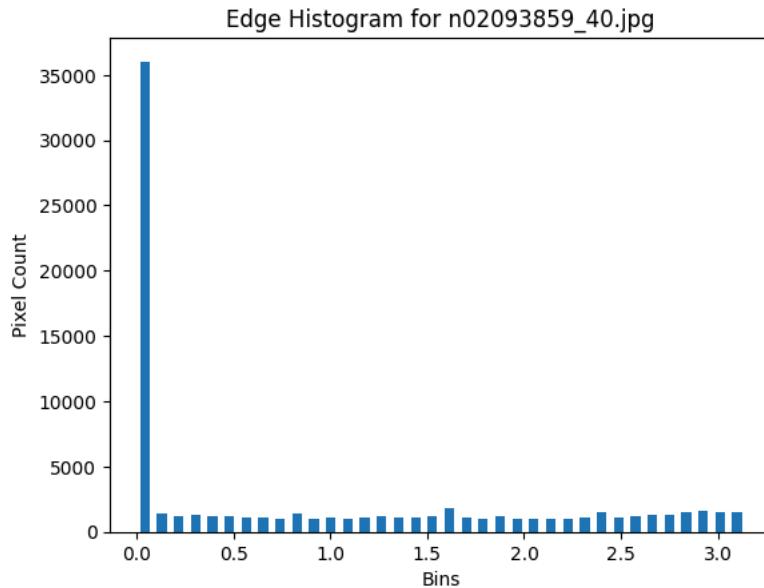
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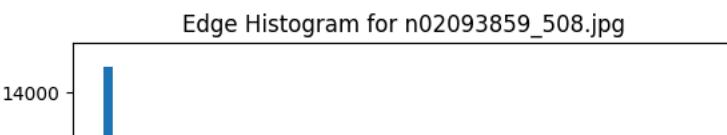
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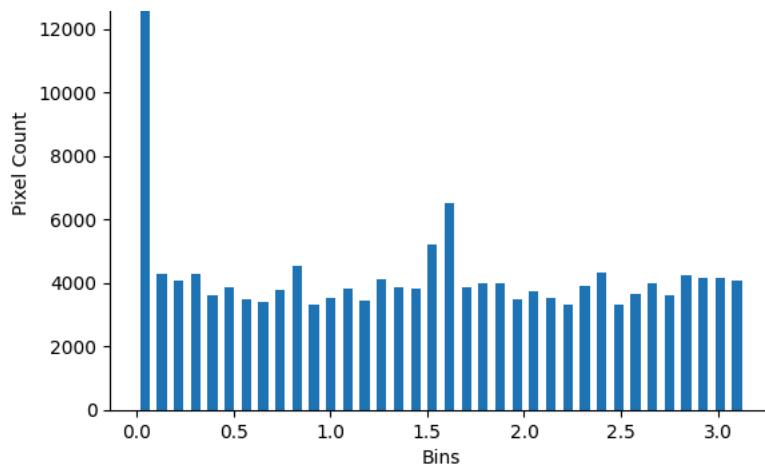


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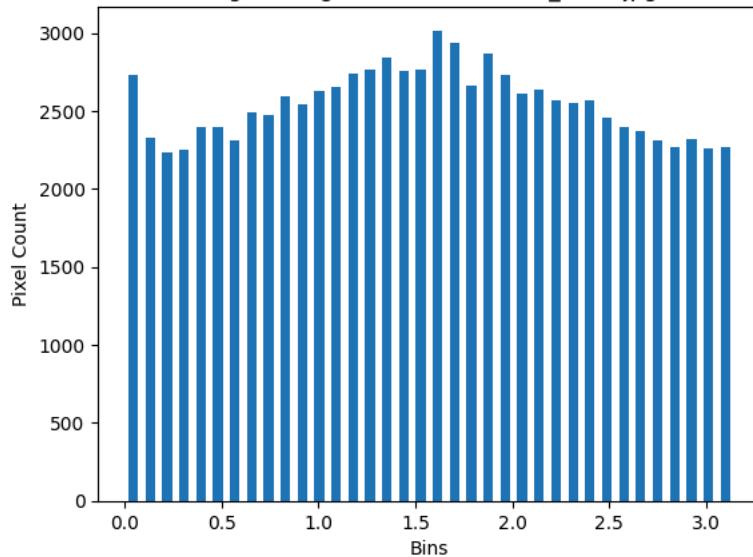
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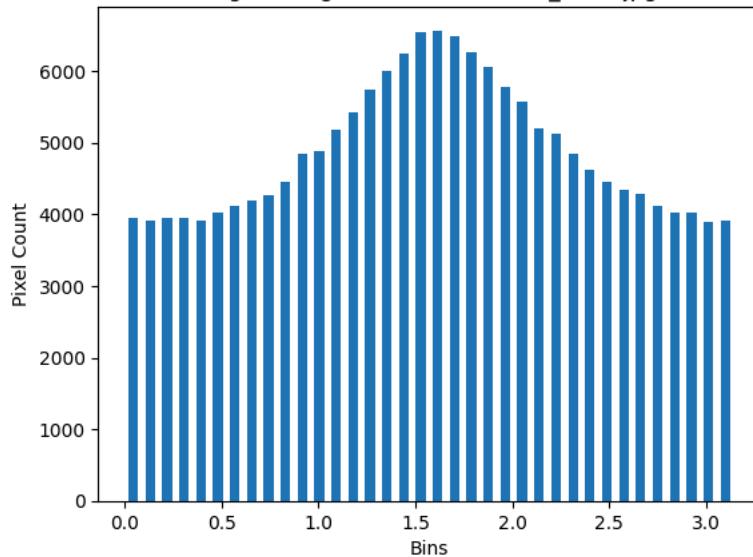
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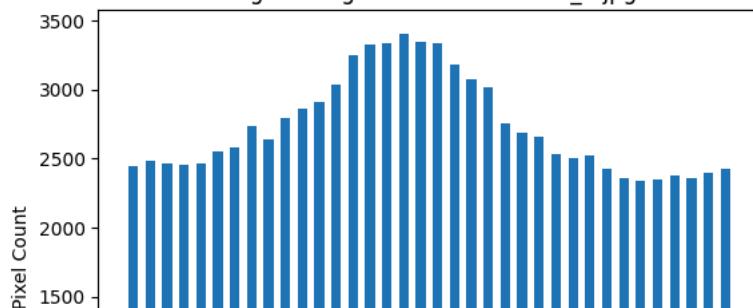
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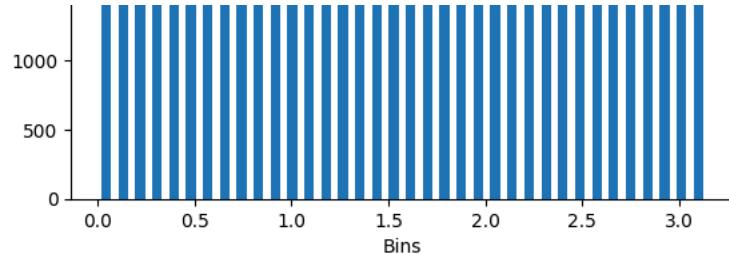
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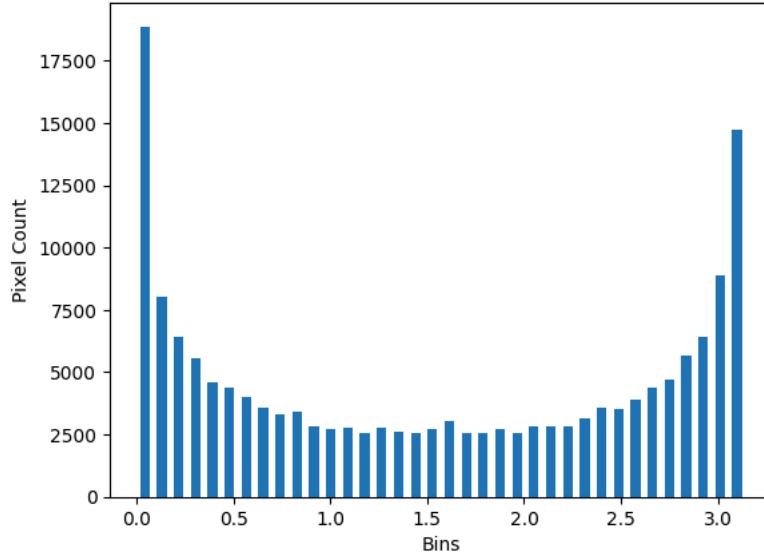
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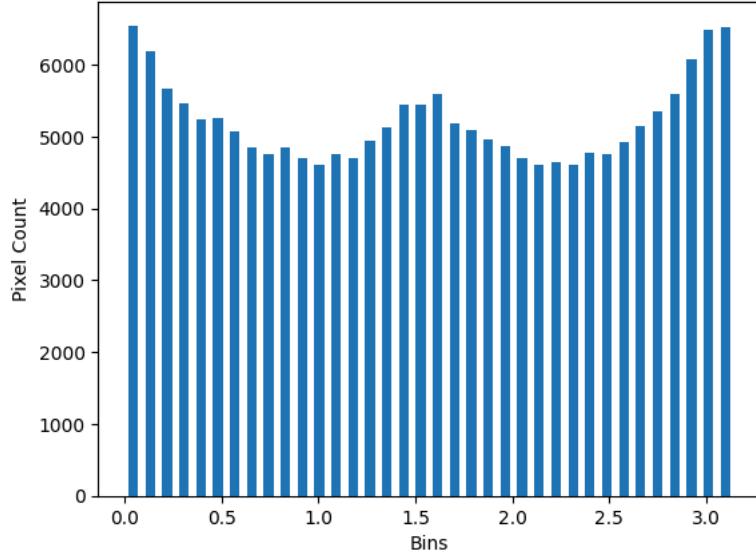
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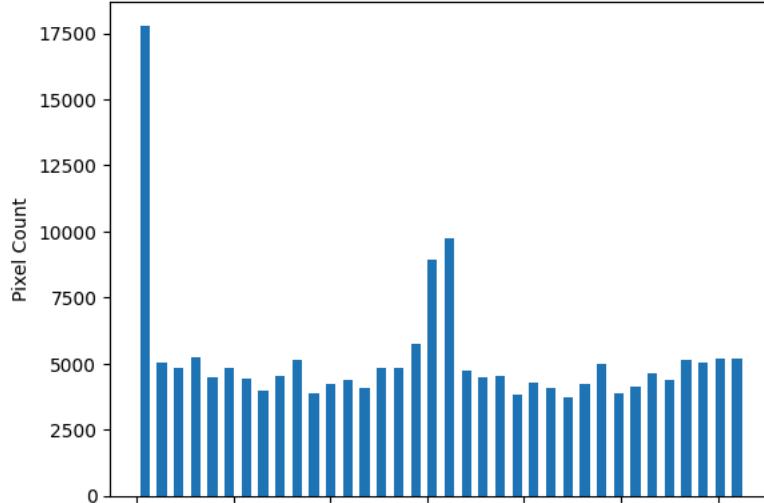
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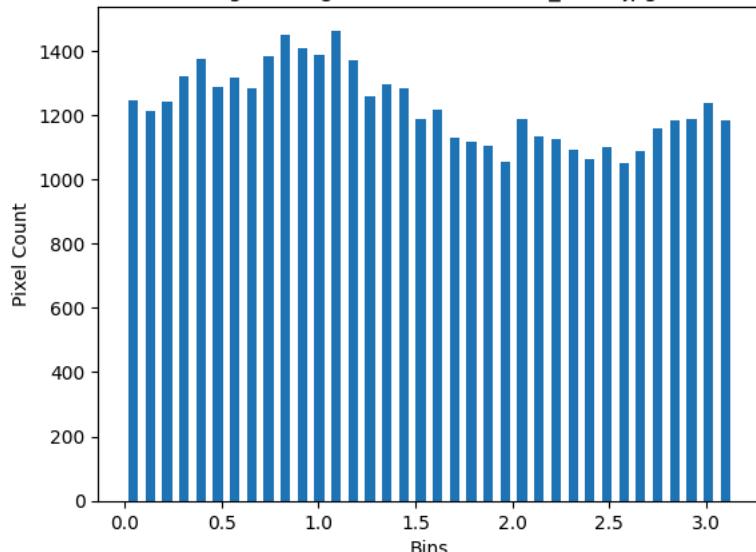
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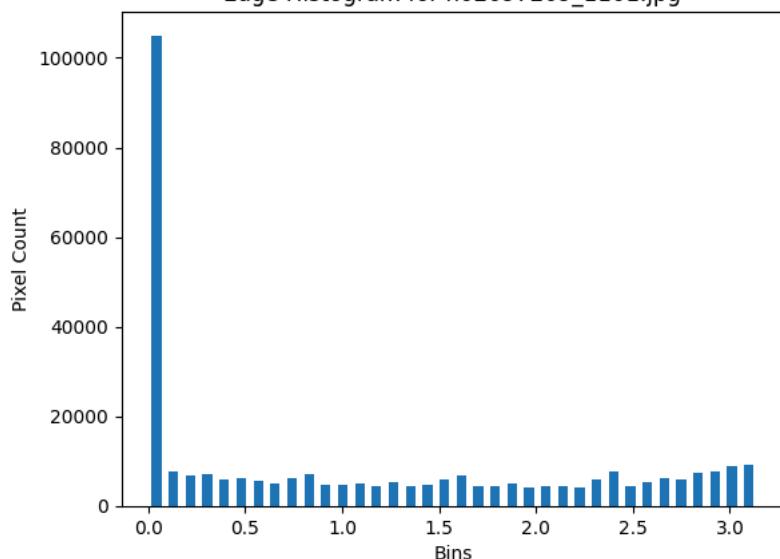
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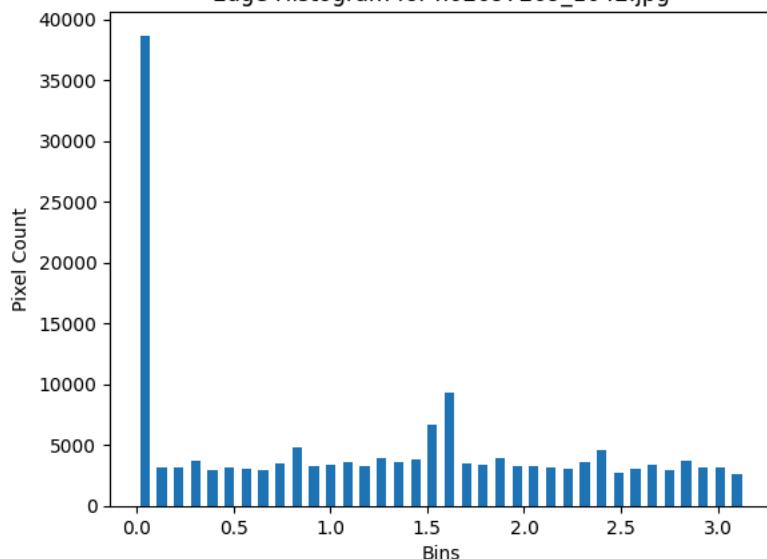
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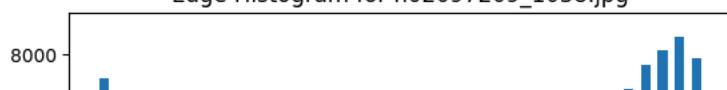
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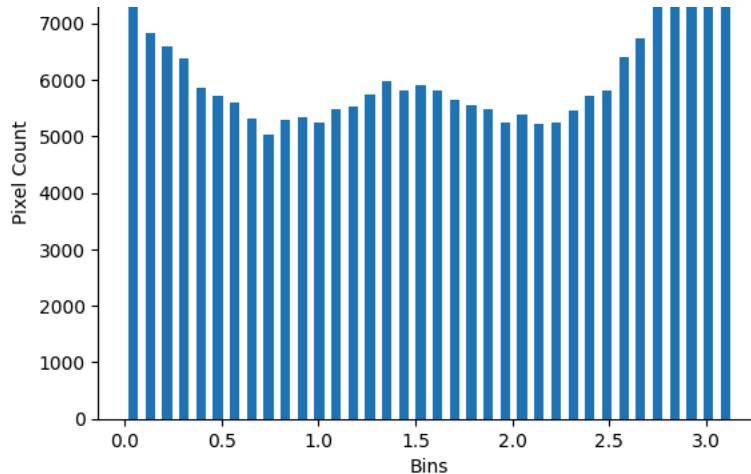
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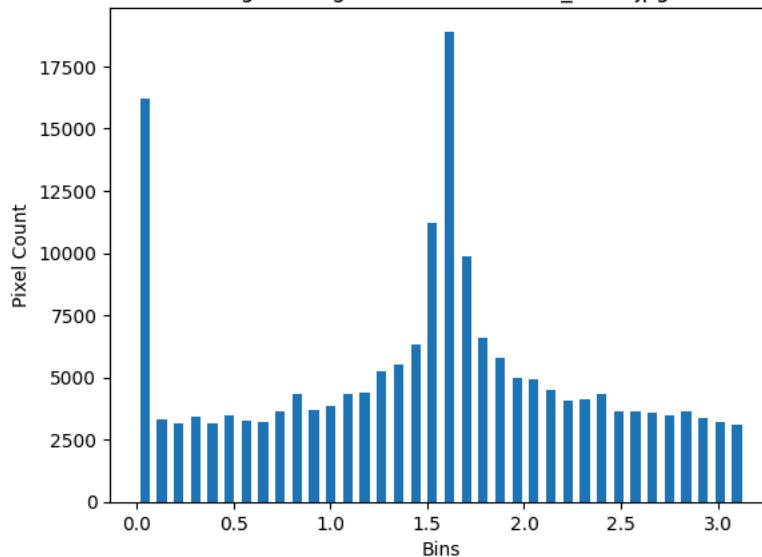
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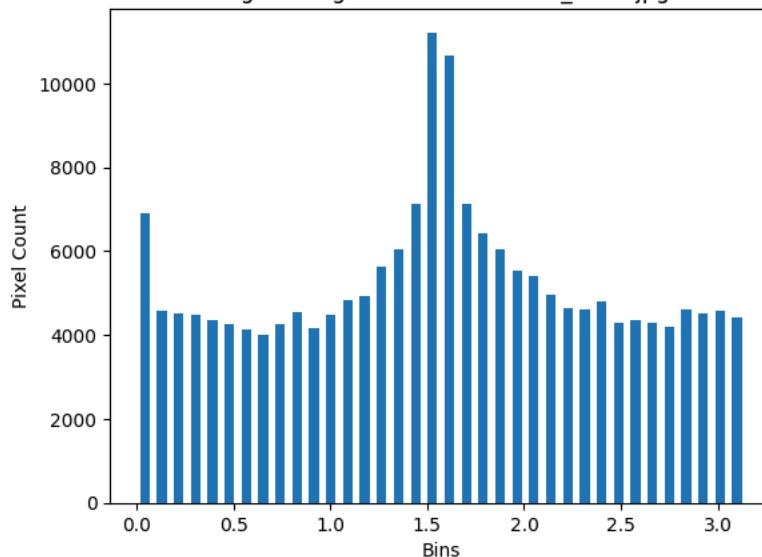
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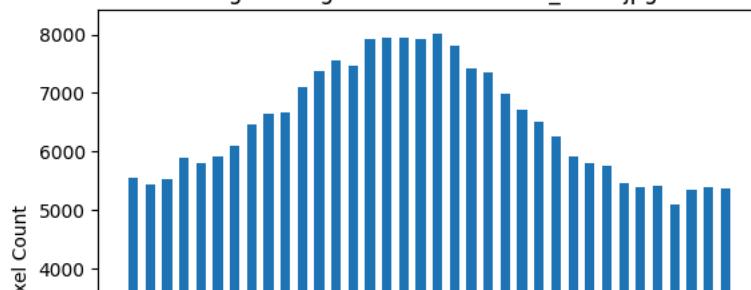
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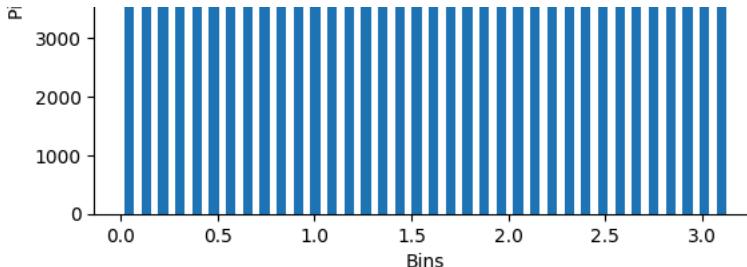
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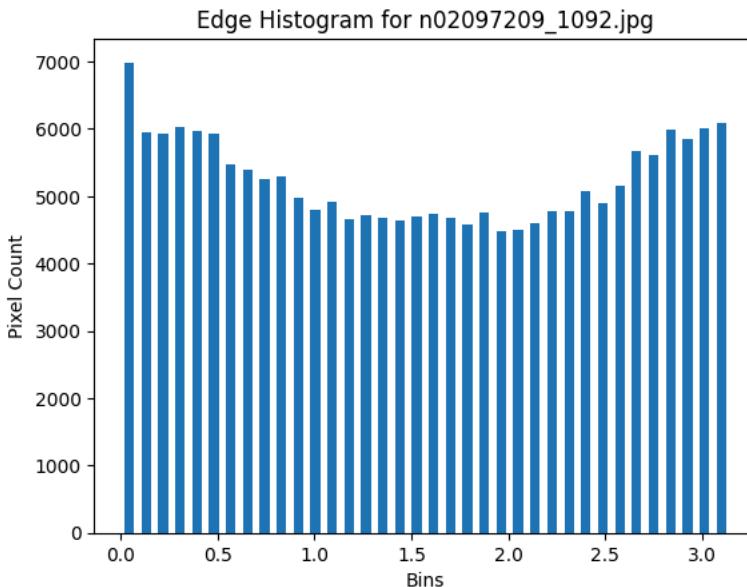
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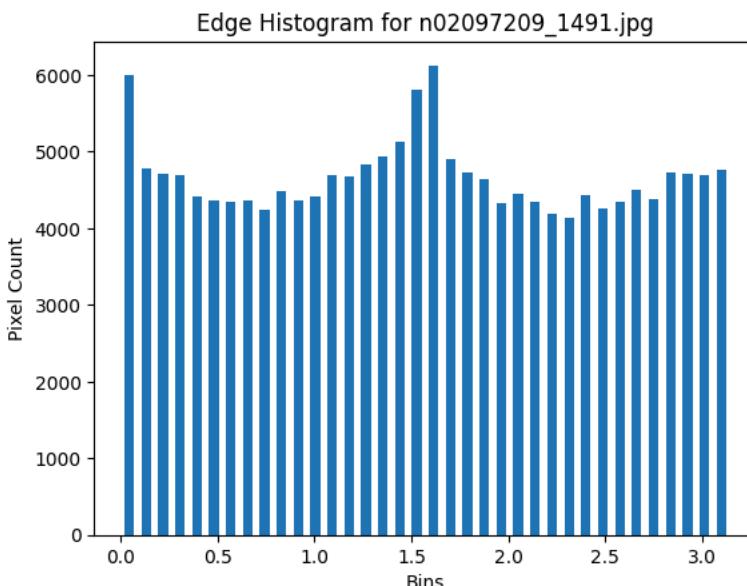




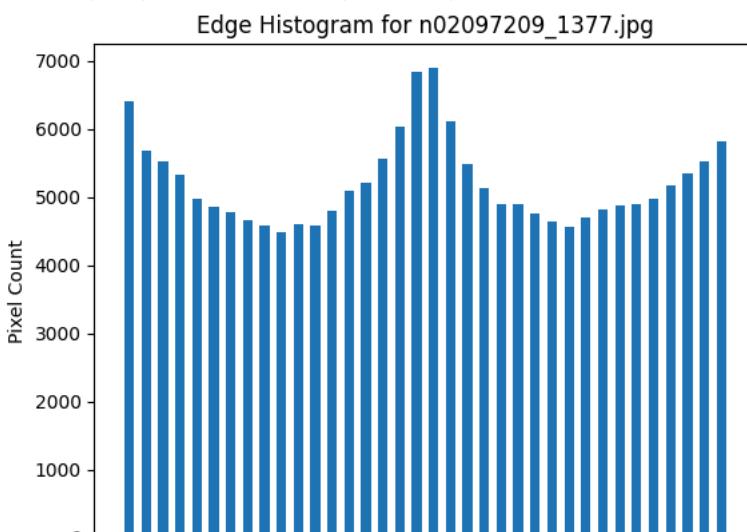
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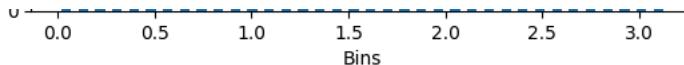


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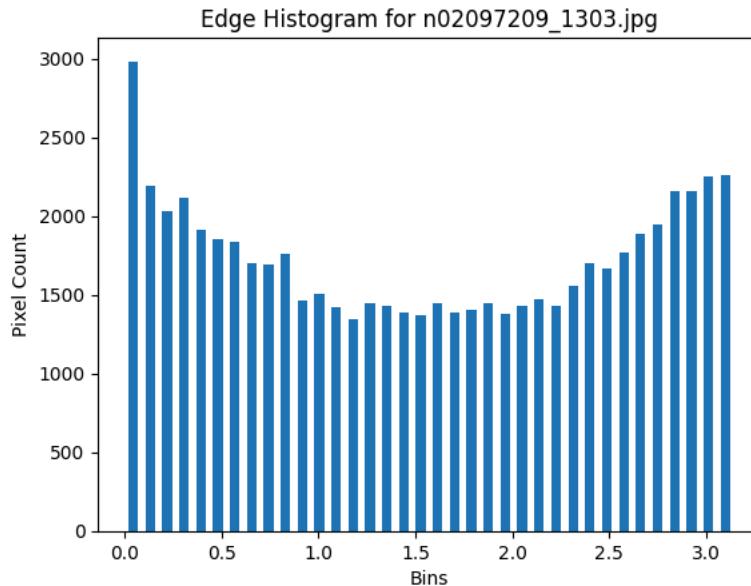


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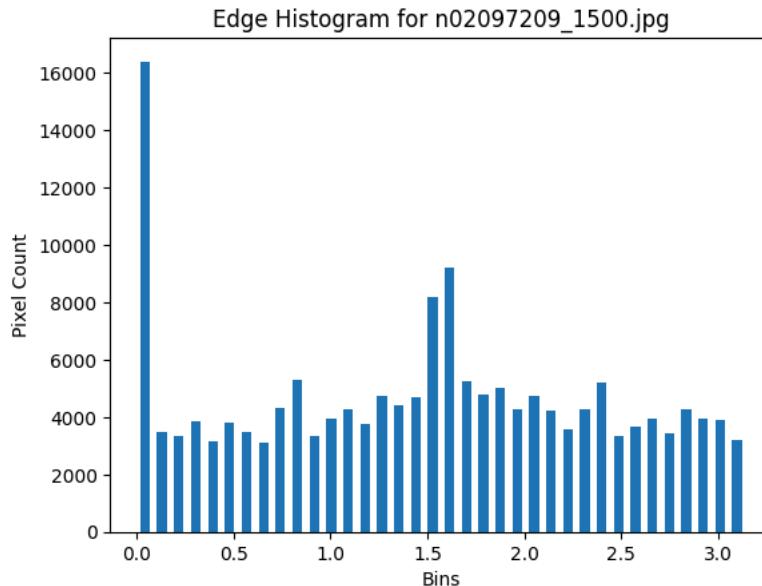




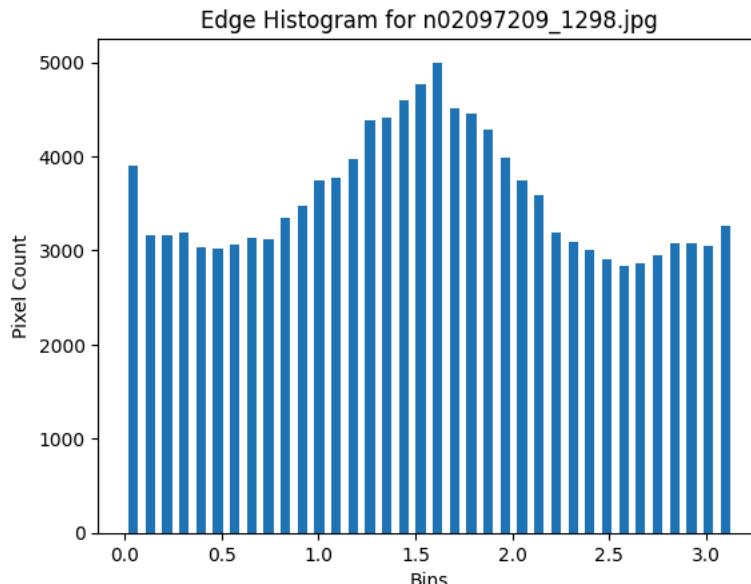
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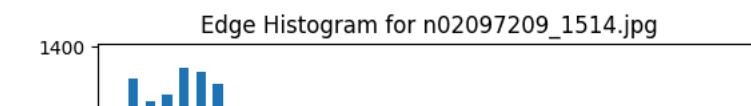
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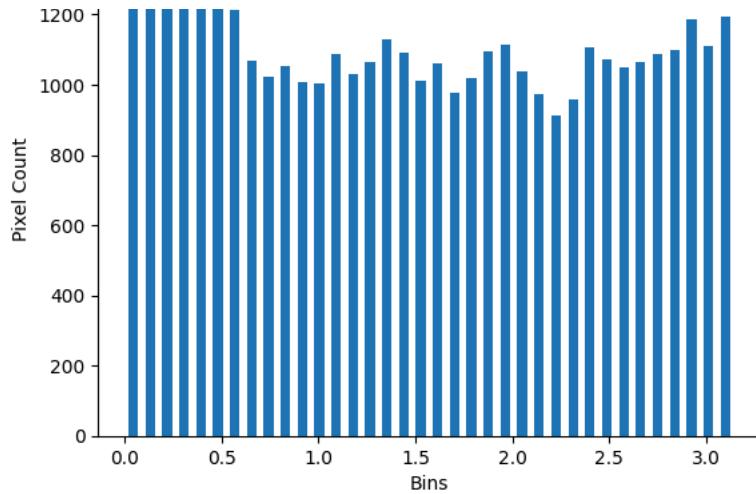


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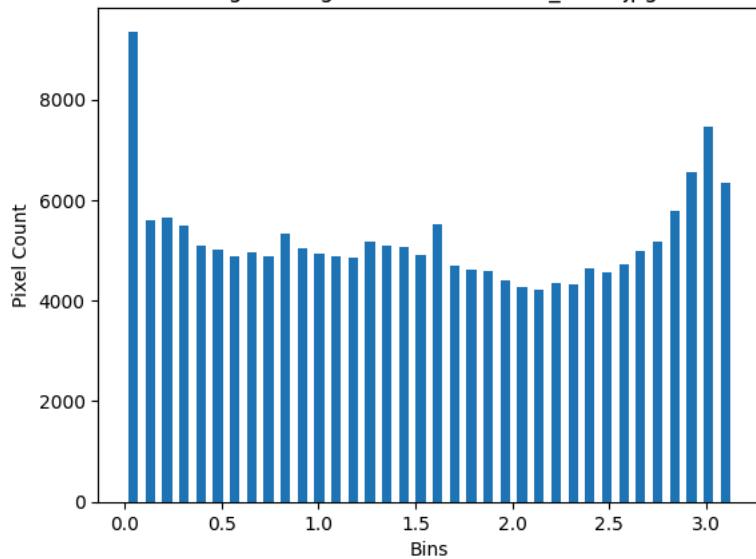
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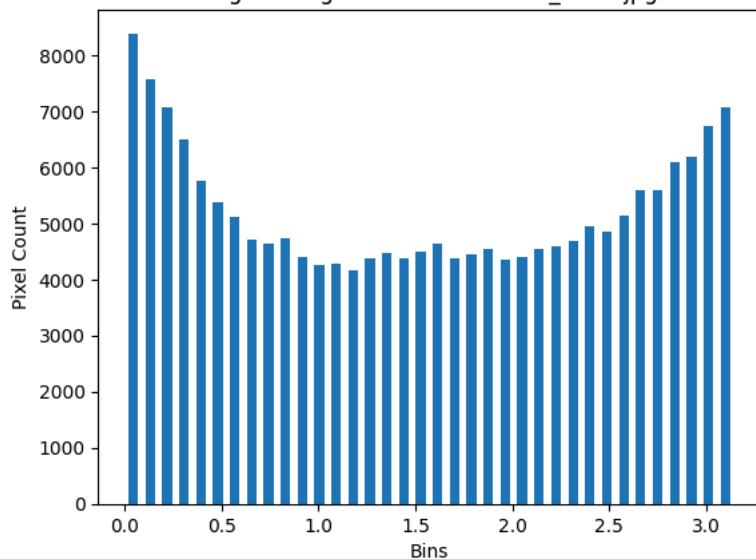
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Edge Histogram for n02097209\_1363.jpg



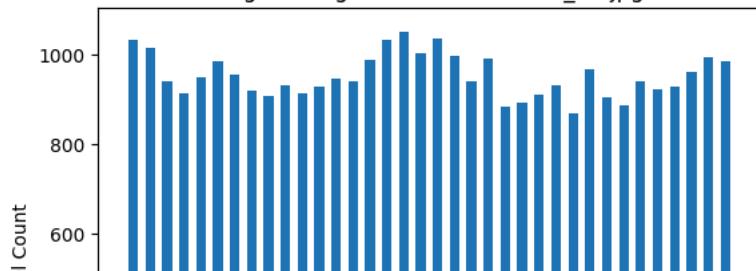
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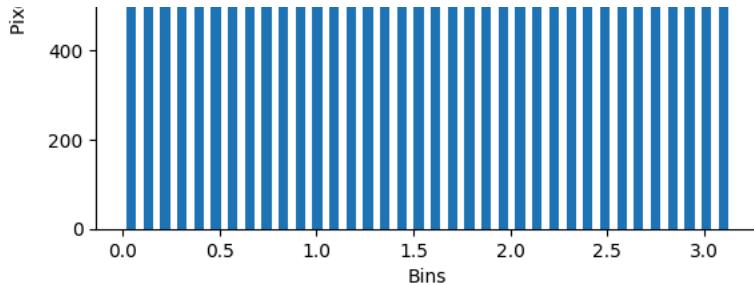
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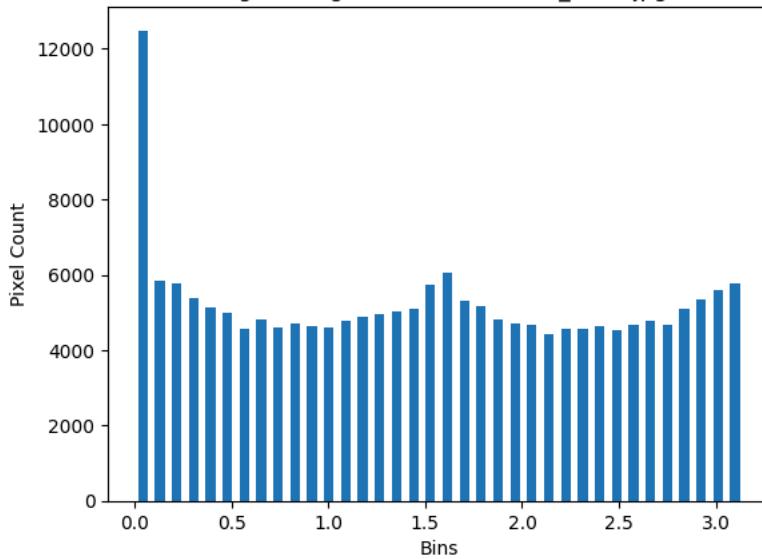
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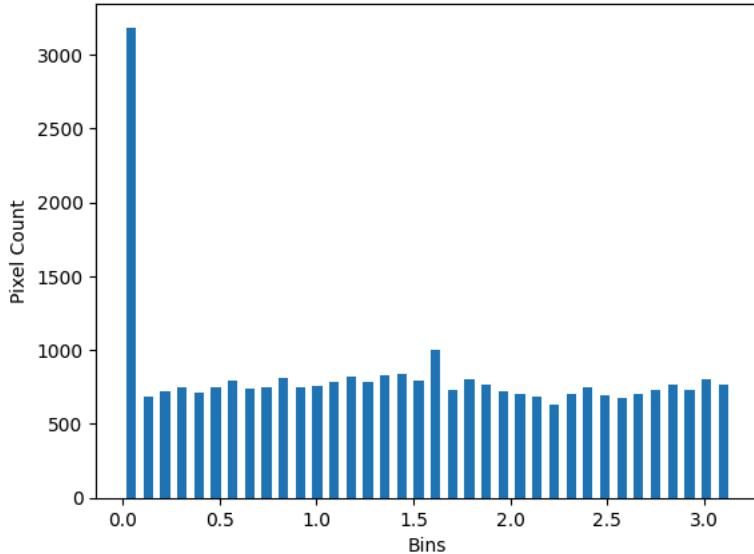
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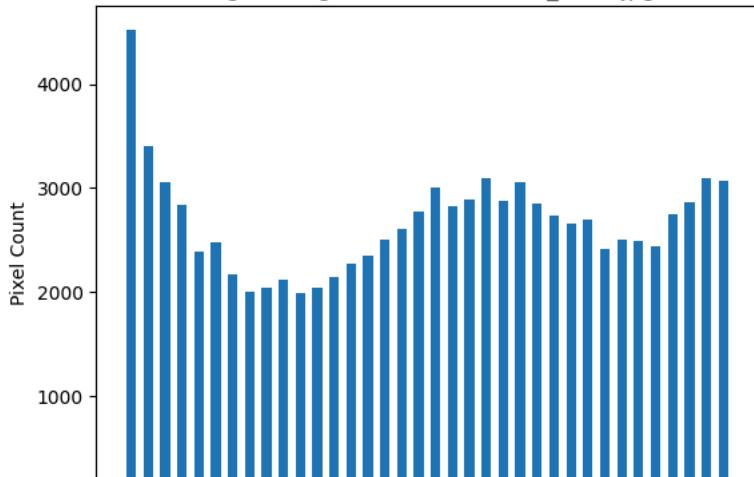
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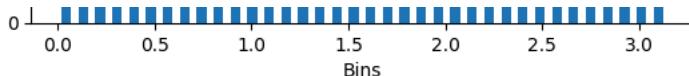
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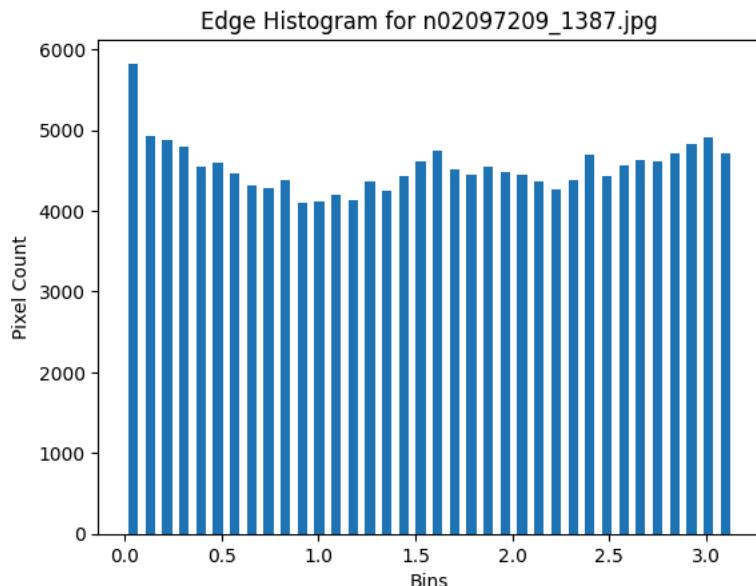
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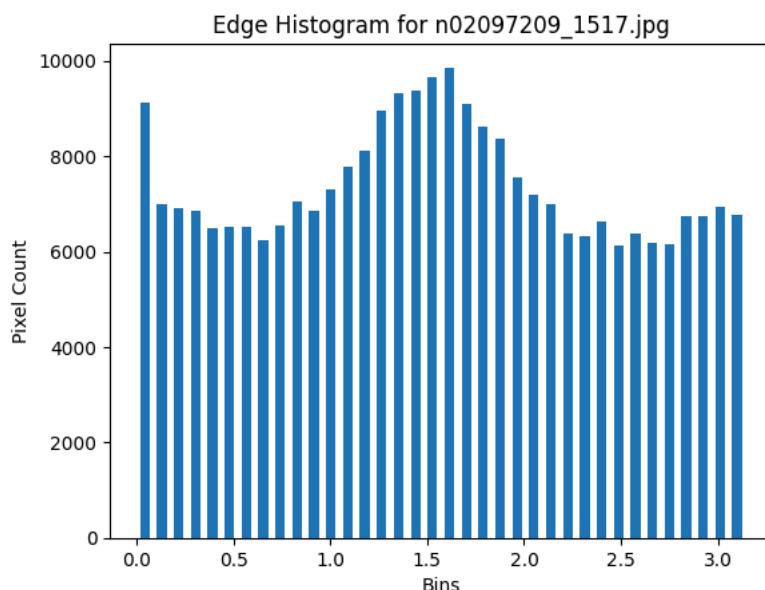




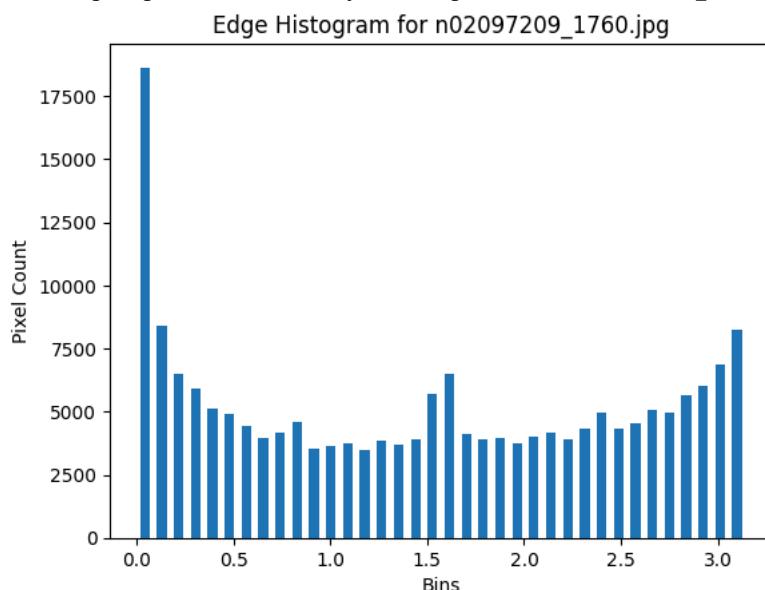
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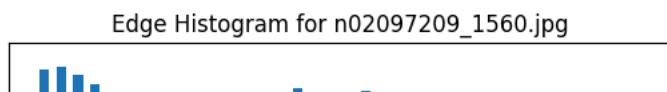
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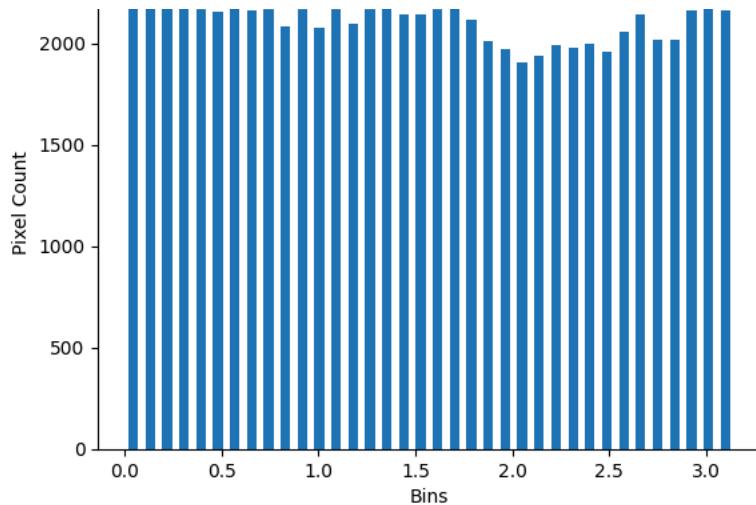


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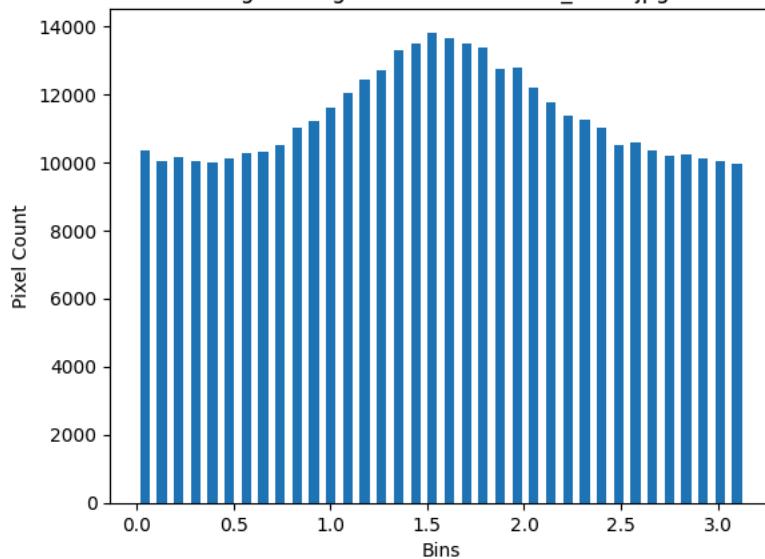
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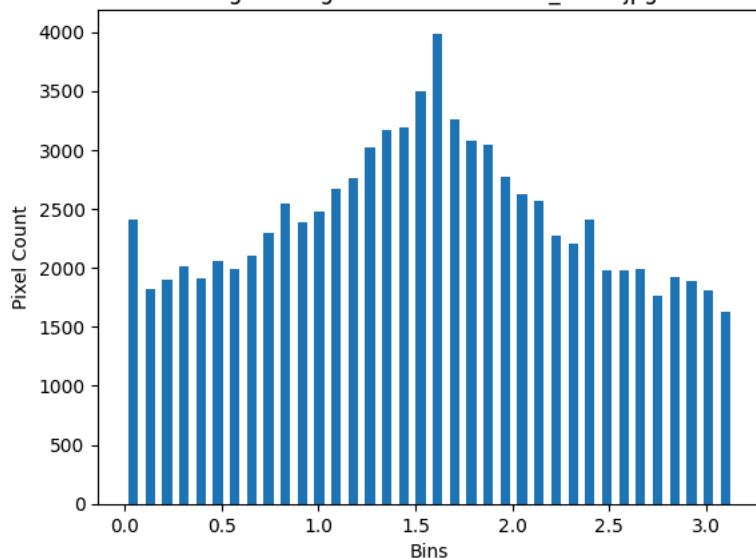
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Edge Histogram for n02097209\_1807.jpg



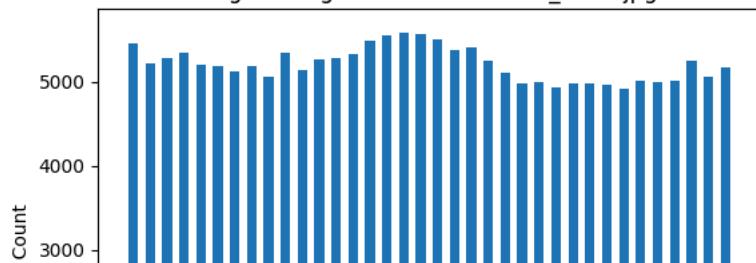
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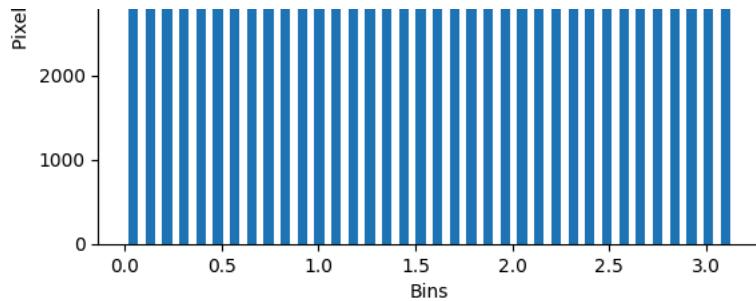
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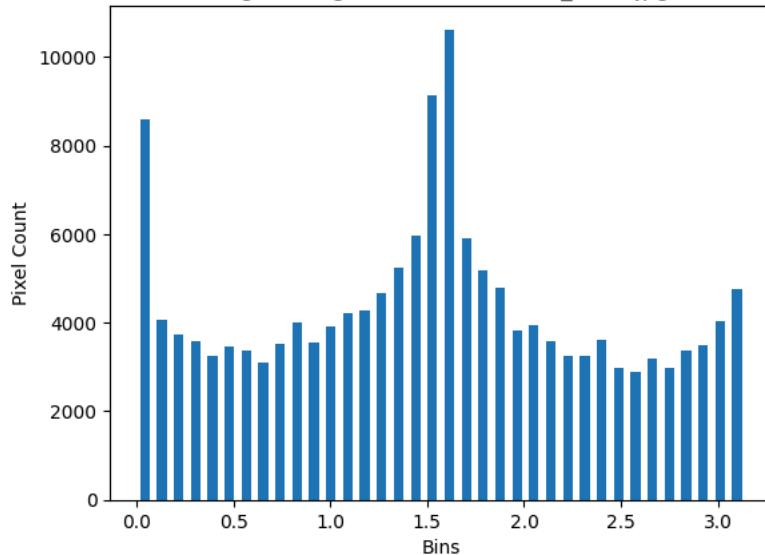
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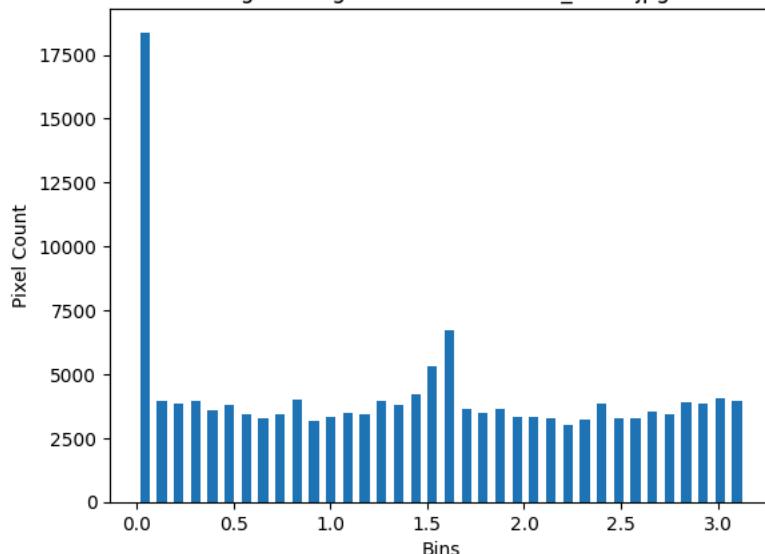
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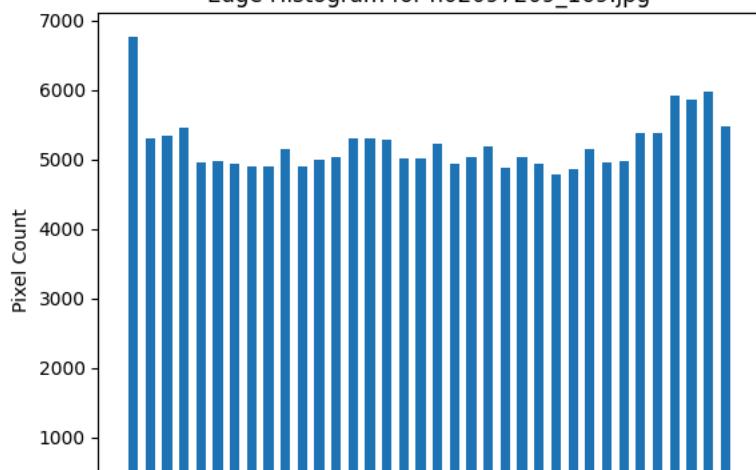
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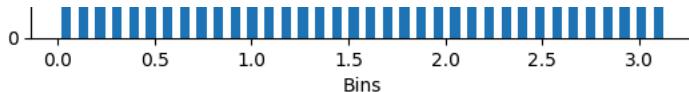
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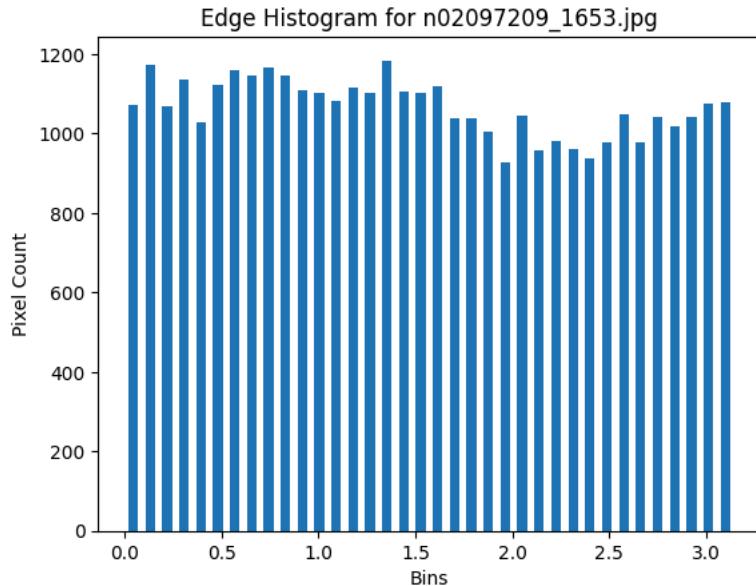
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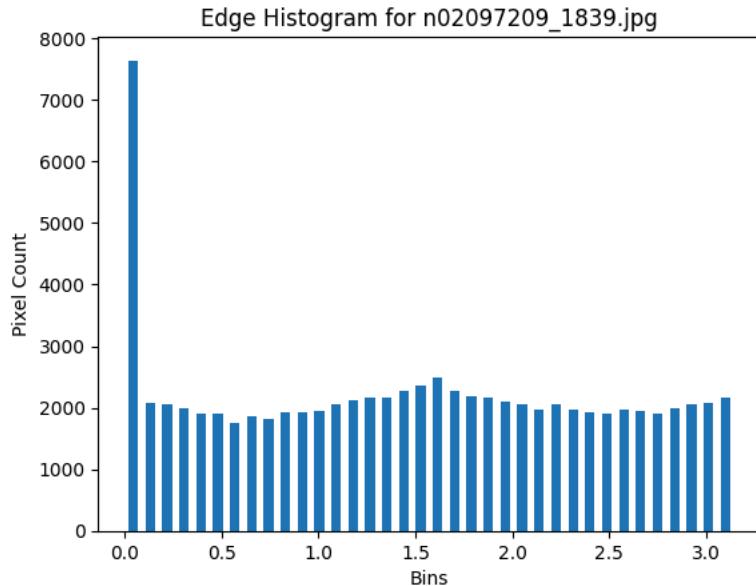




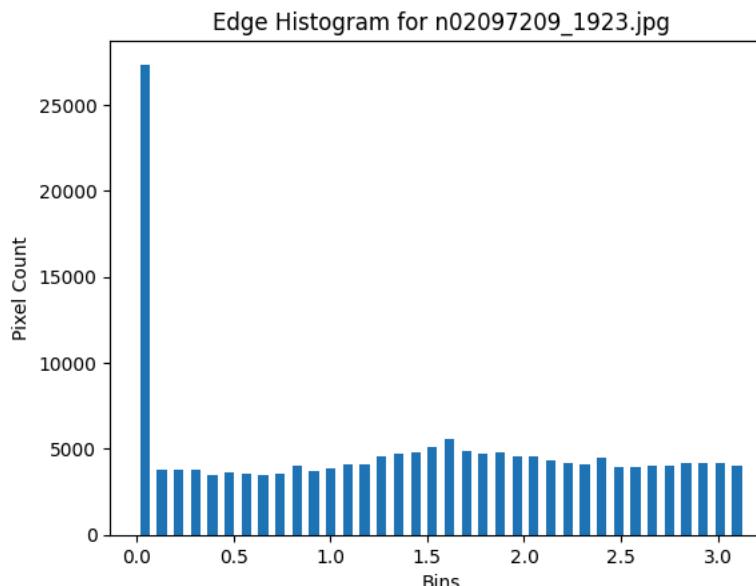
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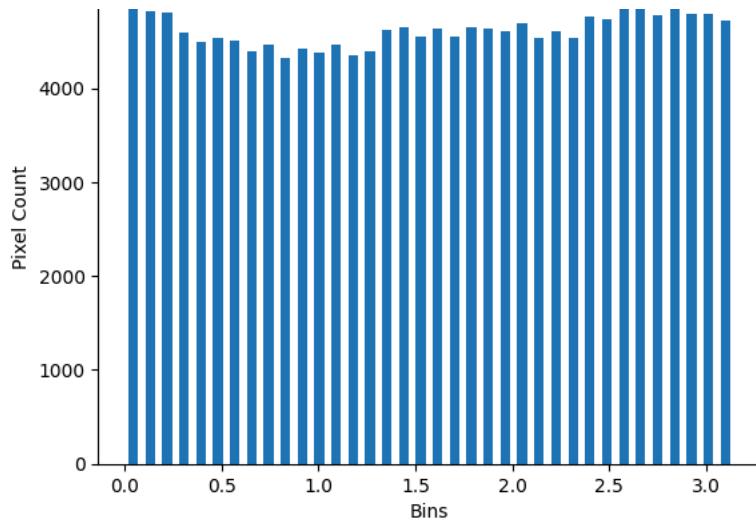


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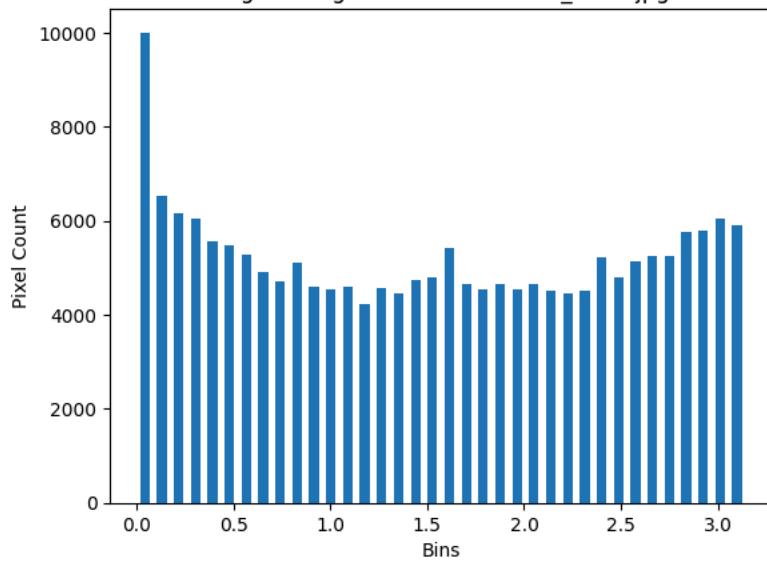
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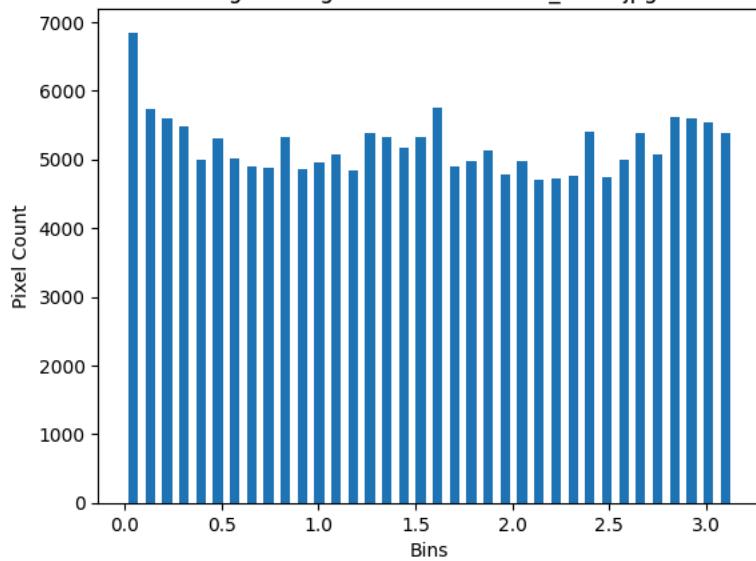
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Edge Histogram for n02097209\_2205.jpg



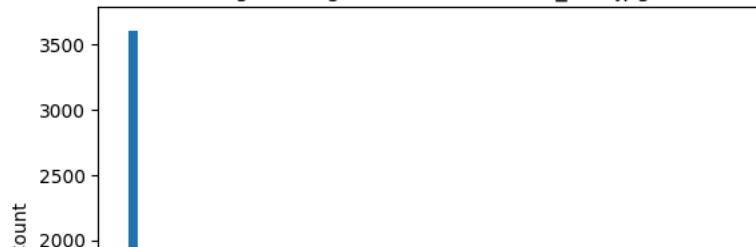
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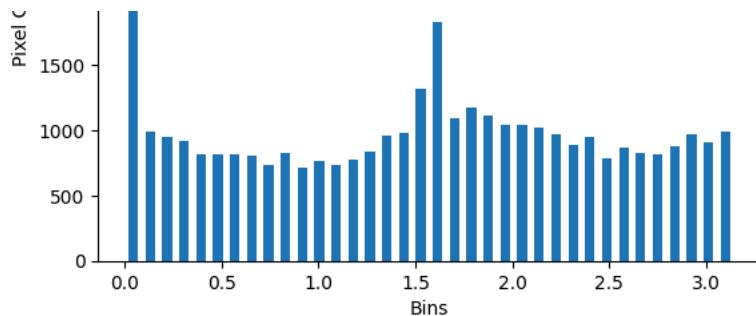
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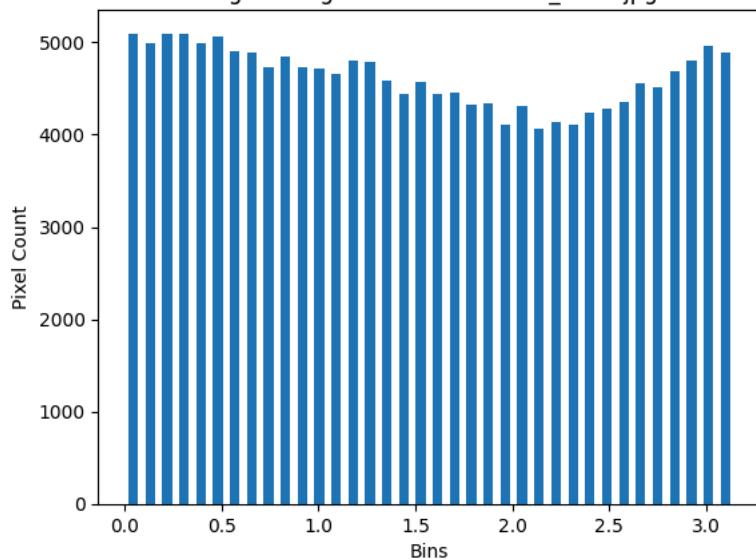
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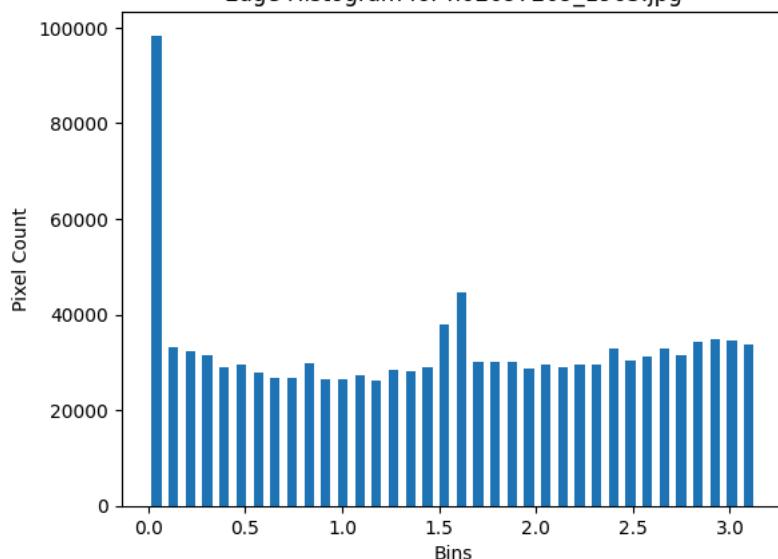
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Edge Histogram for n02097209\_2027.jpg



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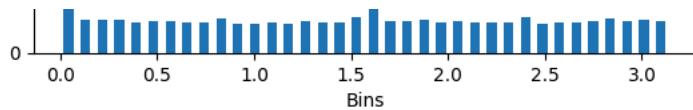
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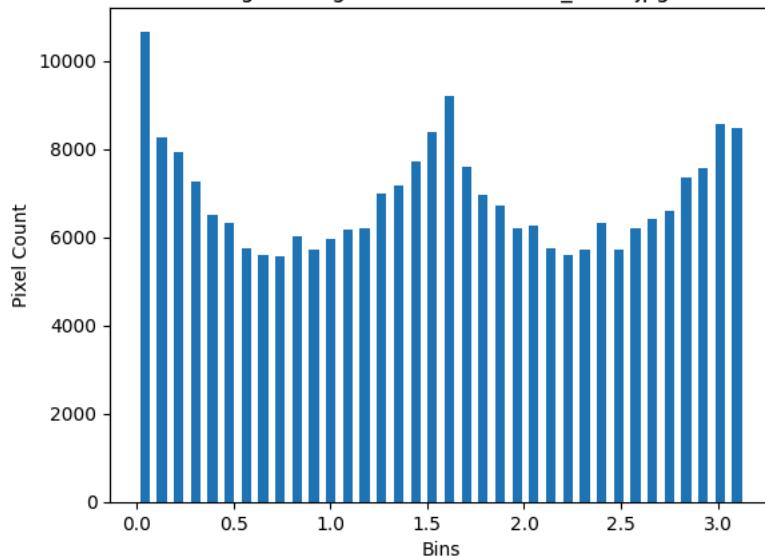
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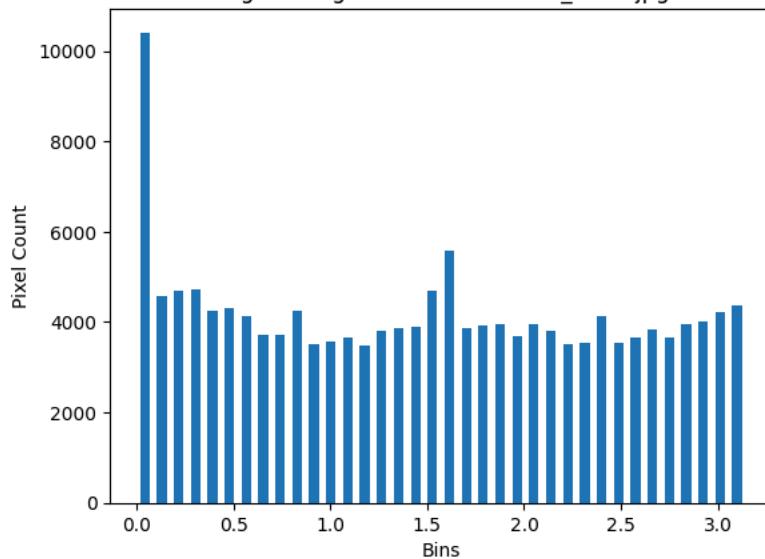
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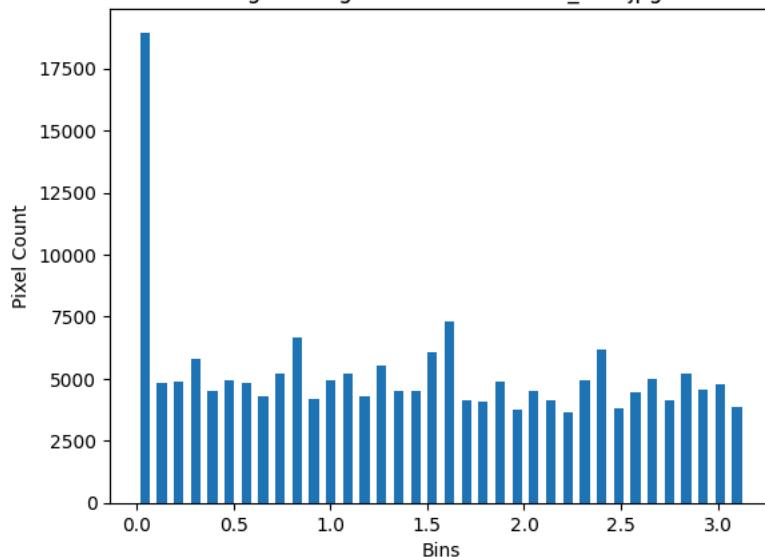
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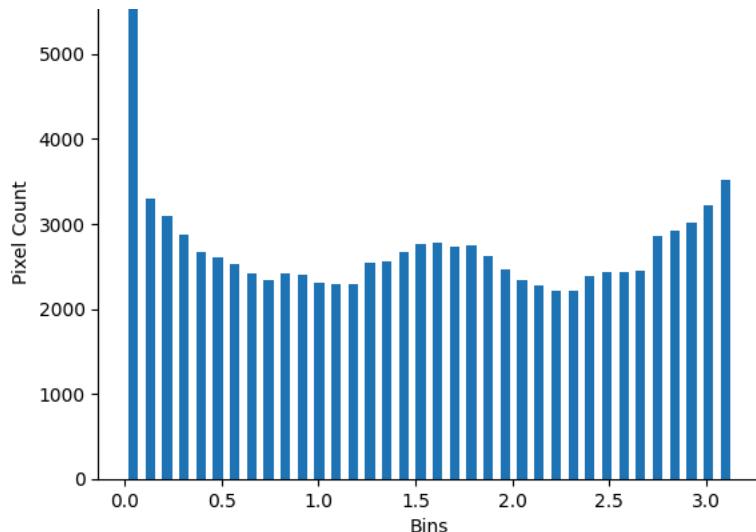
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Edge Histogram for n02097209\_213.jpg



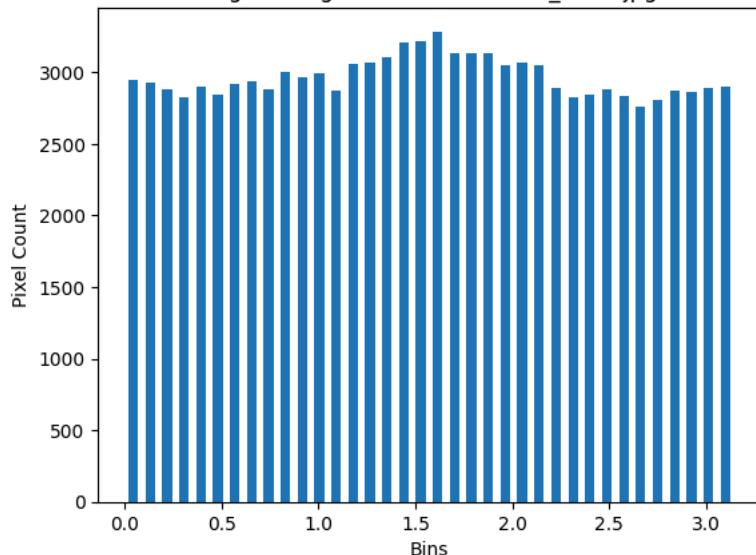
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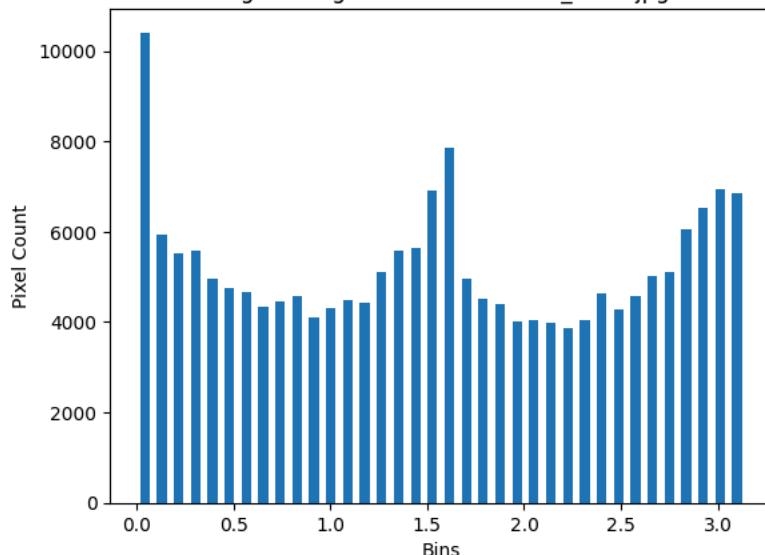
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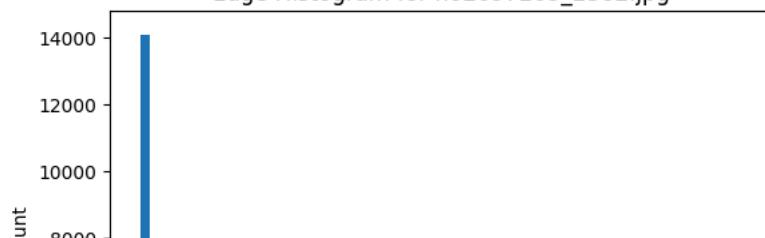
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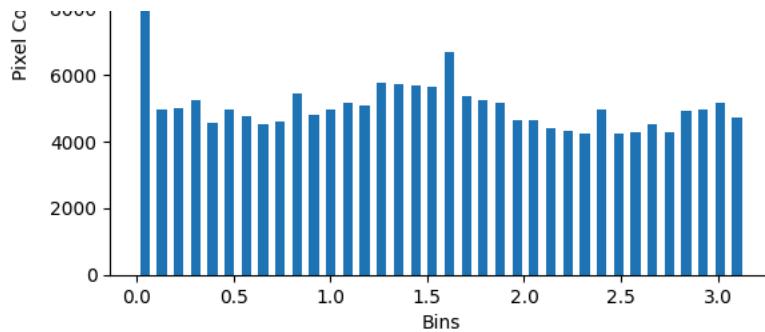
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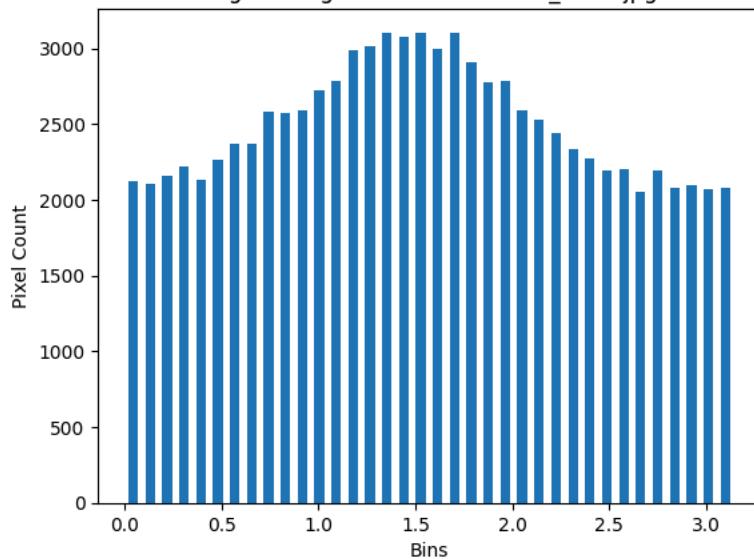
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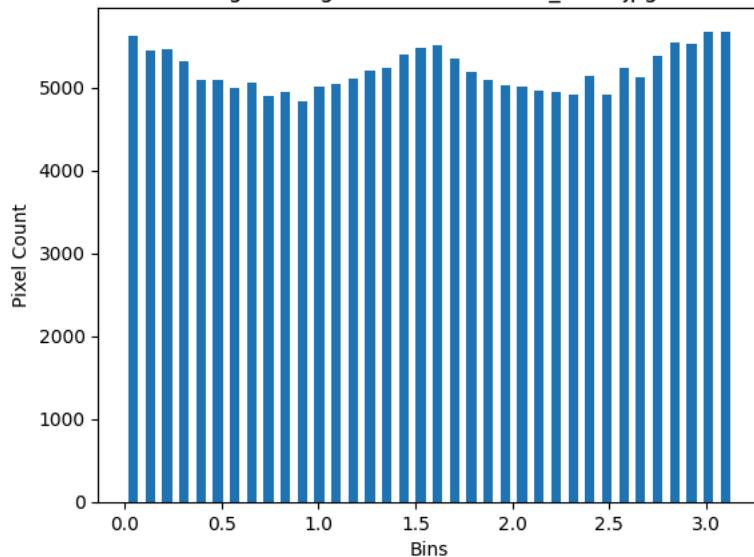
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Edge Histogram for n02097209\_2468.jpg



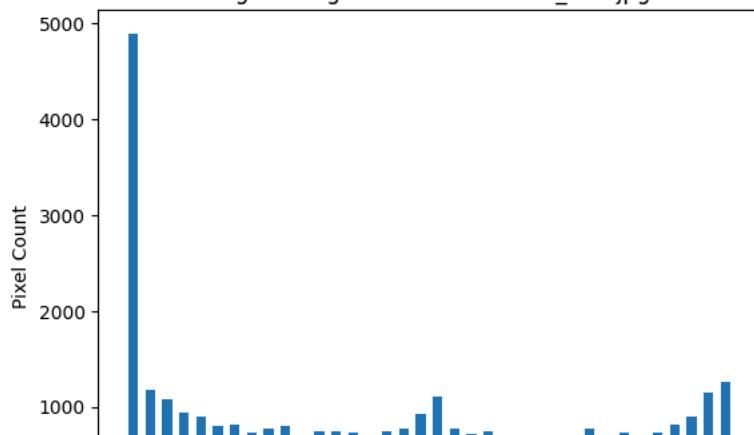
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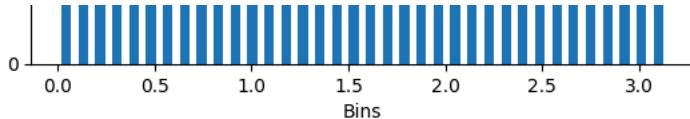
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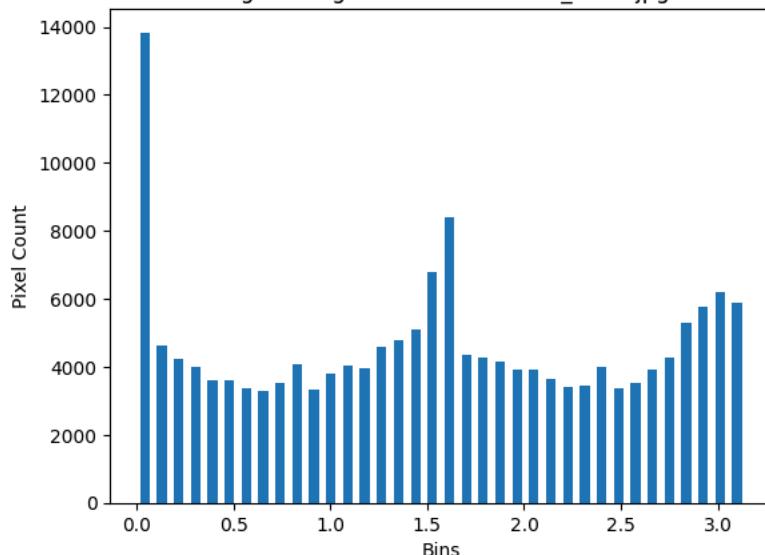
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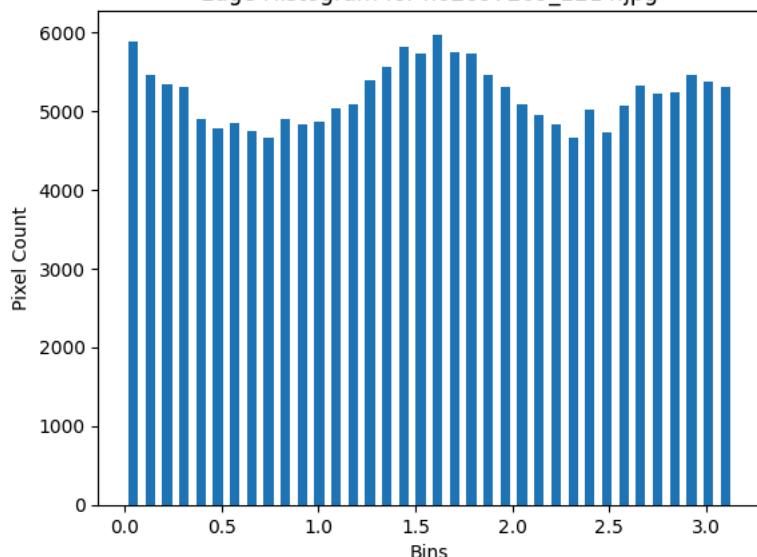
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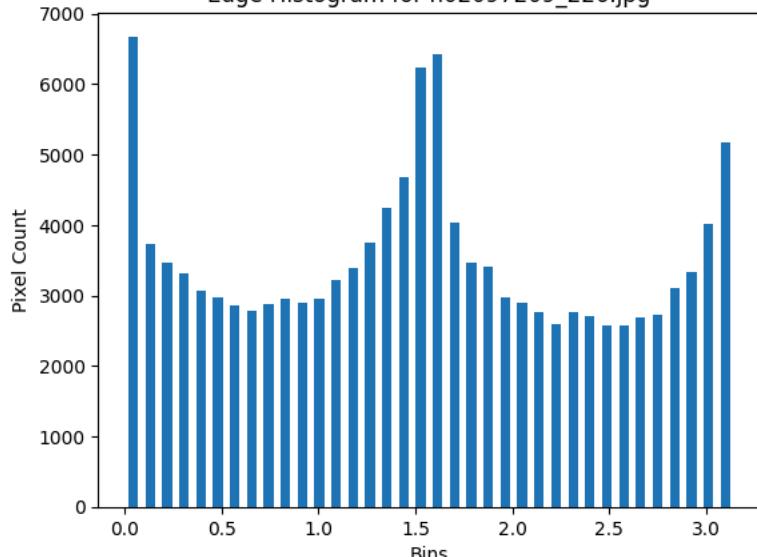
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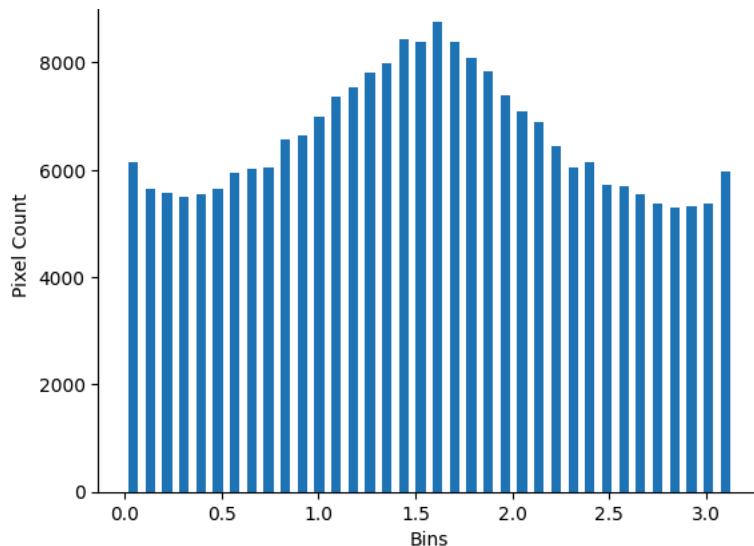
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Edge Histogram for n02097209\_226.jpg

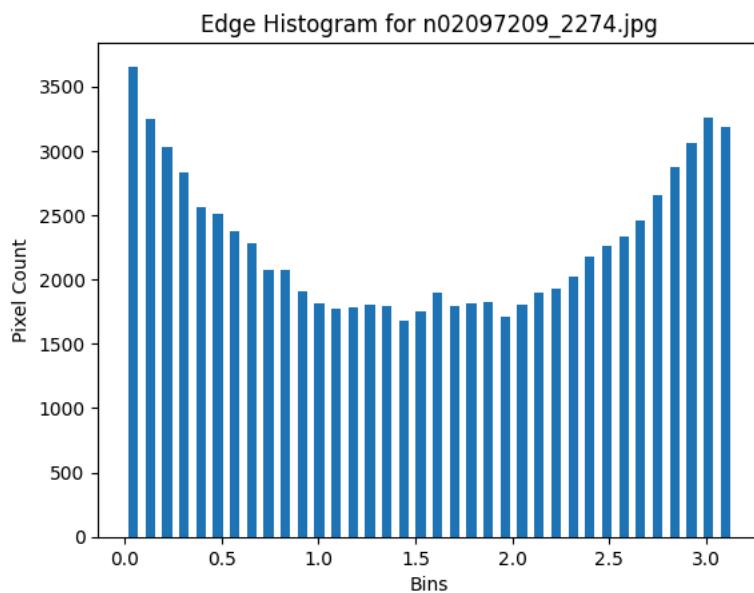


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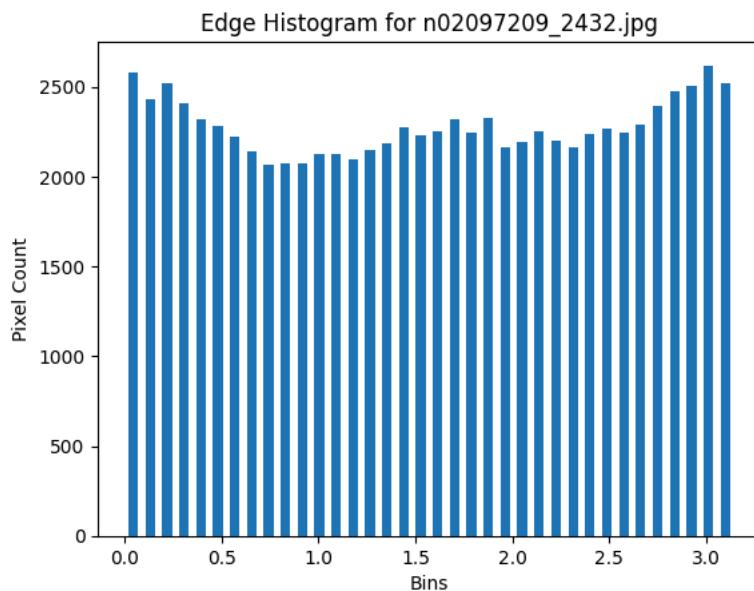
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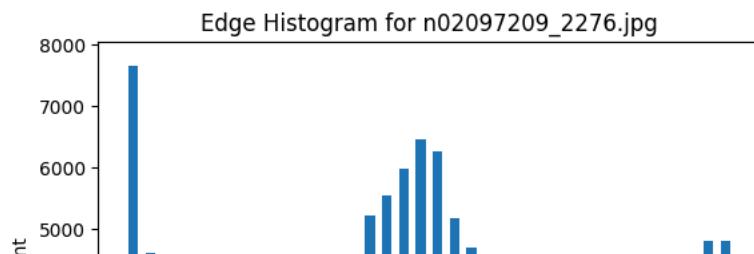
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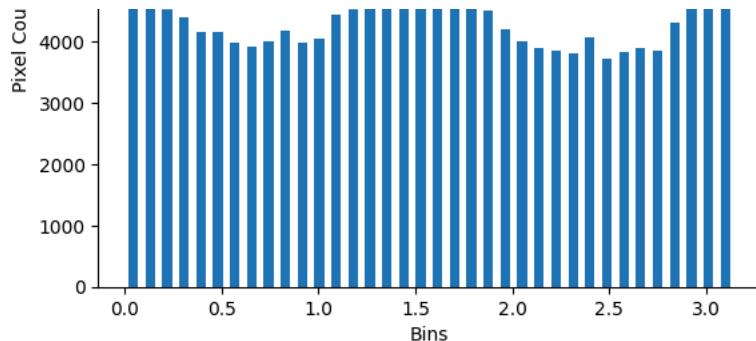


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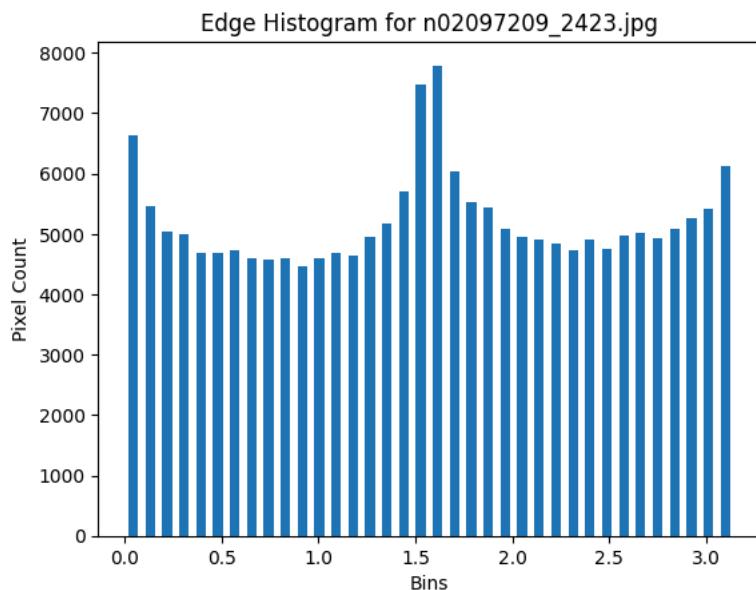


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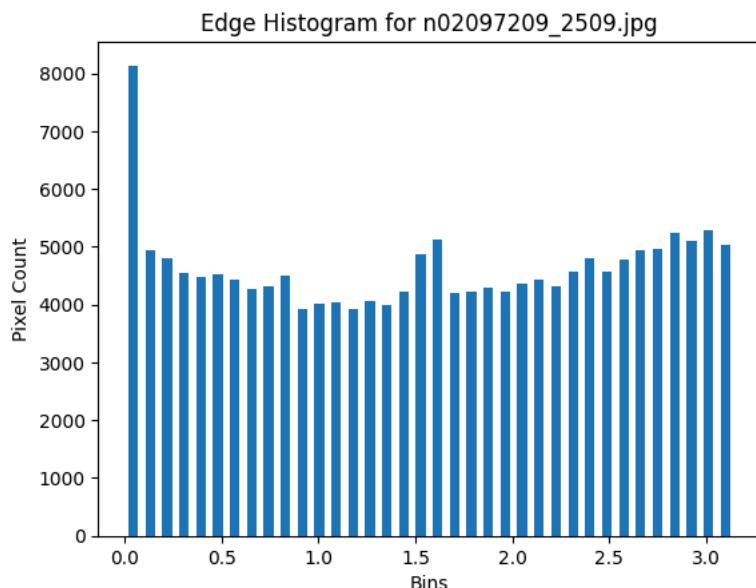




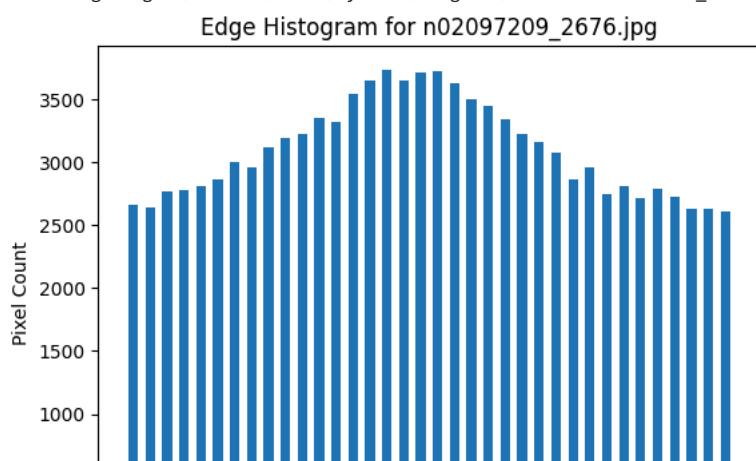
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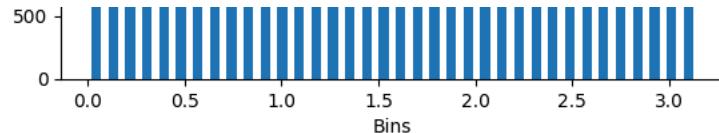


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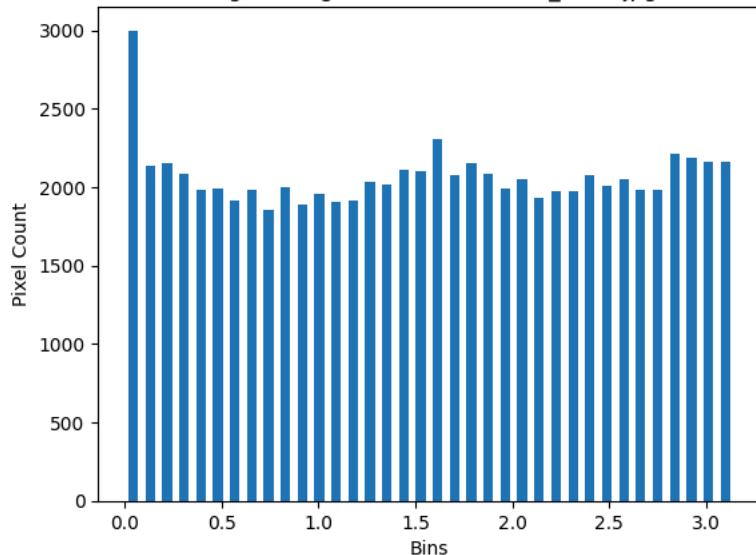
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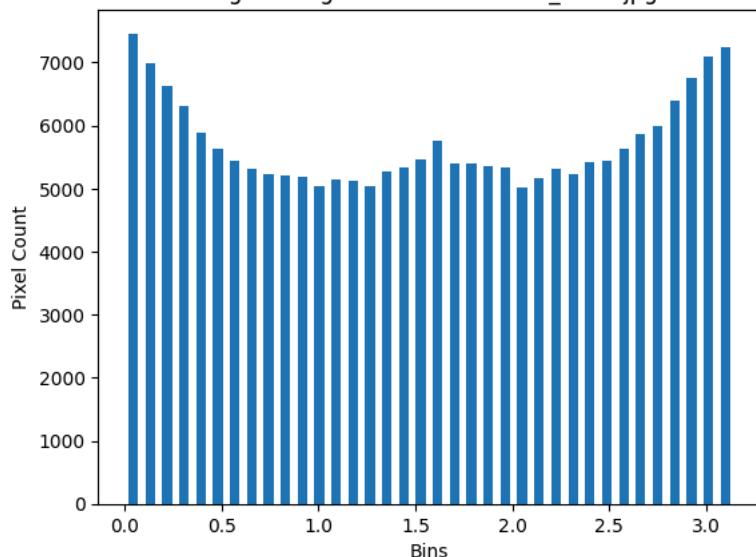
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Edge Histogram for n02097209\_2555.jpg



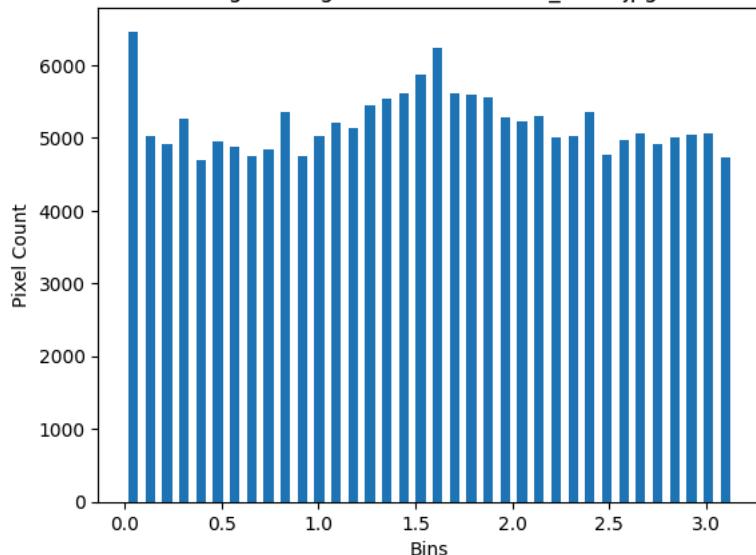
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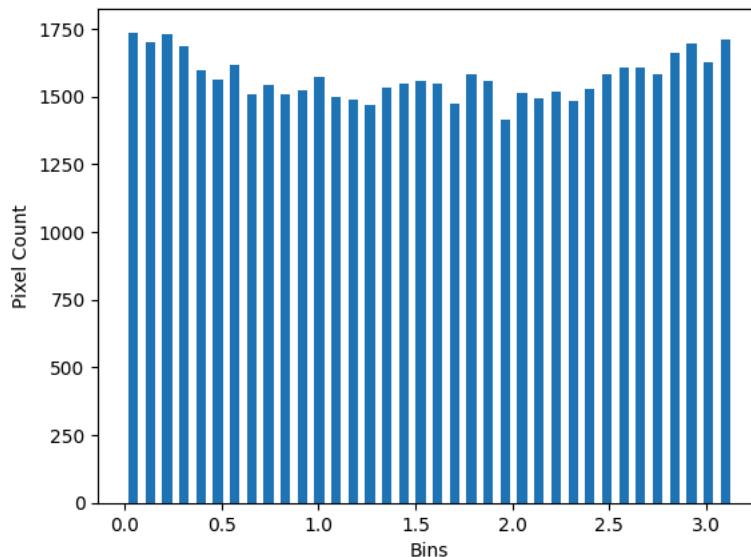
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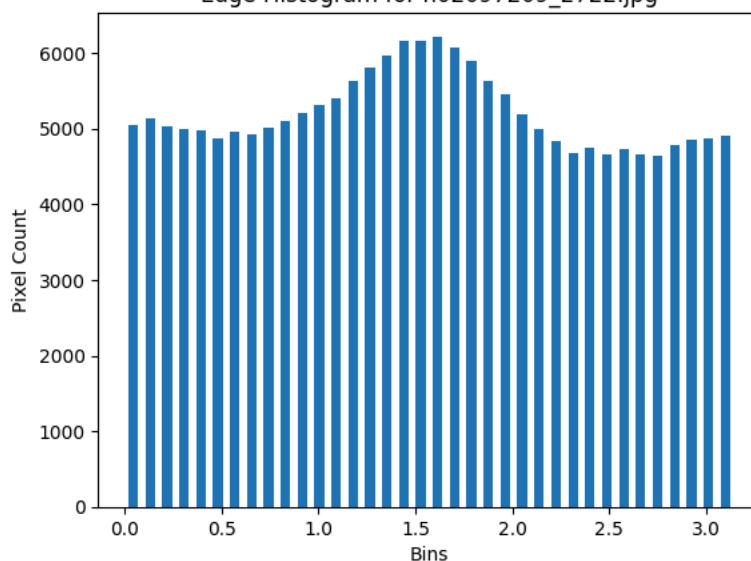
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Edge Histogram for n02097209\_2505.jpg



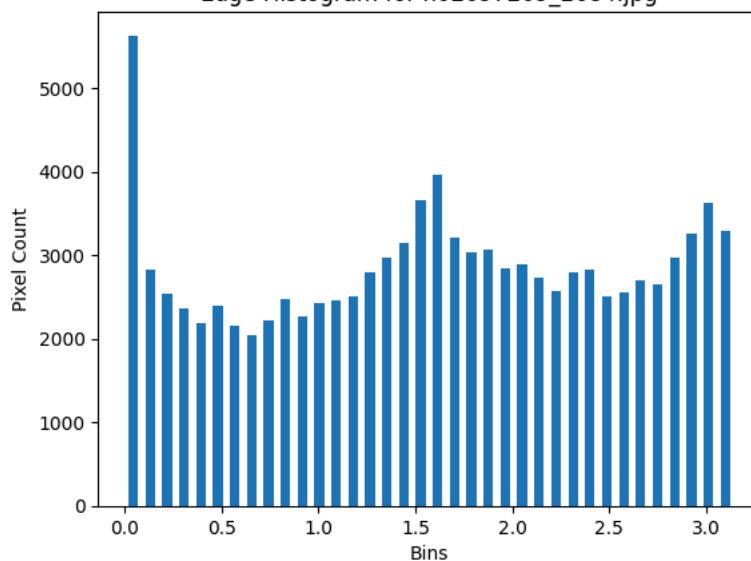
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Edge Histogram for n02097209\_2722.jpg



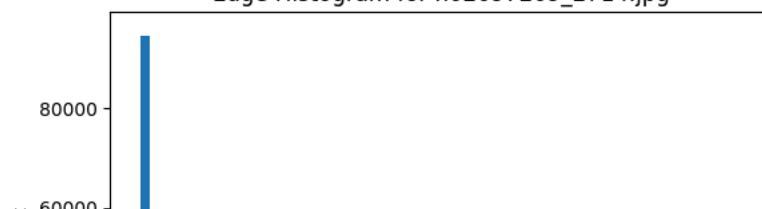
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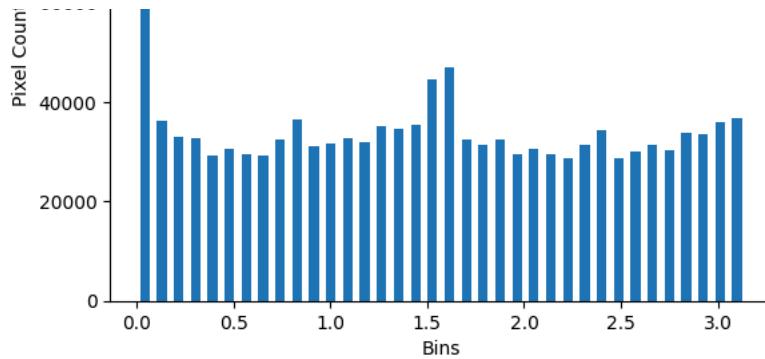
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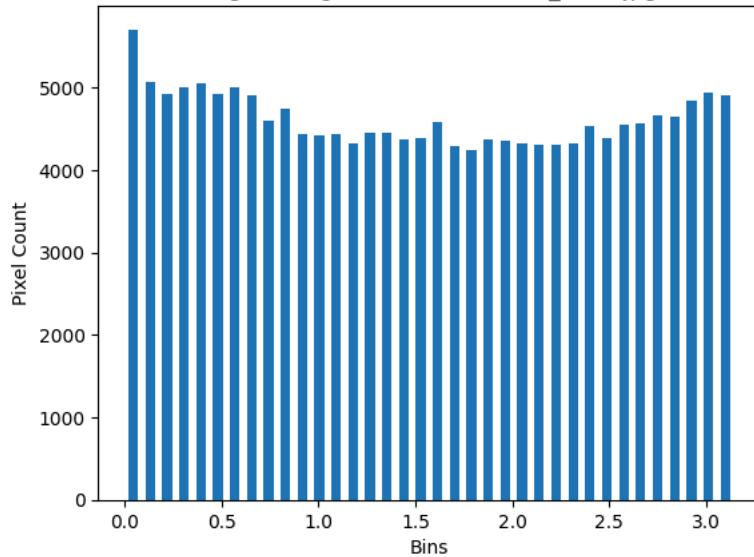
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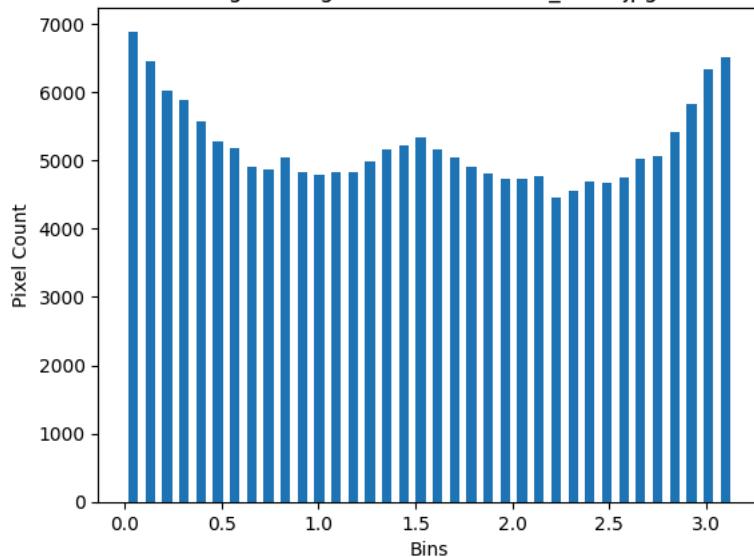
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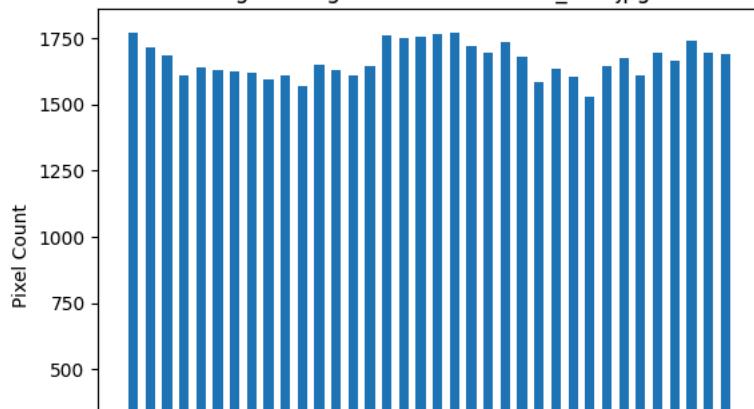
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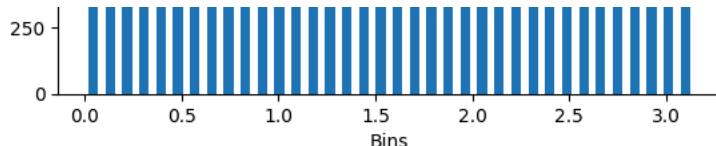
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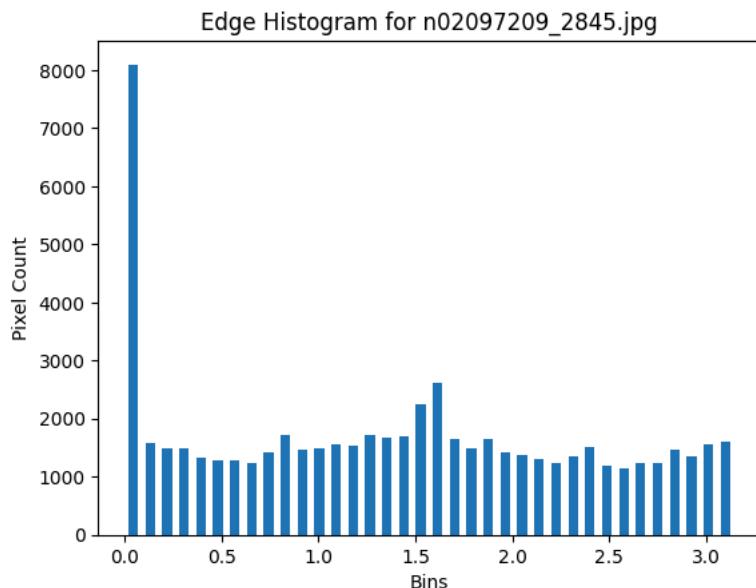
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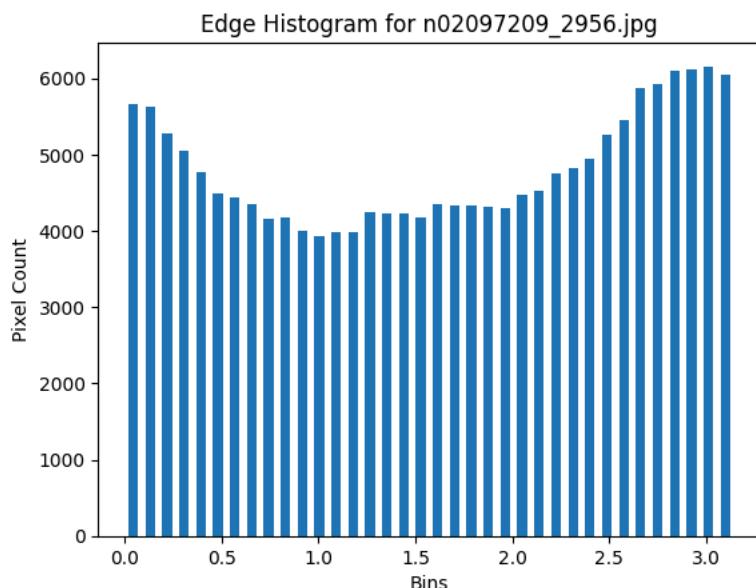




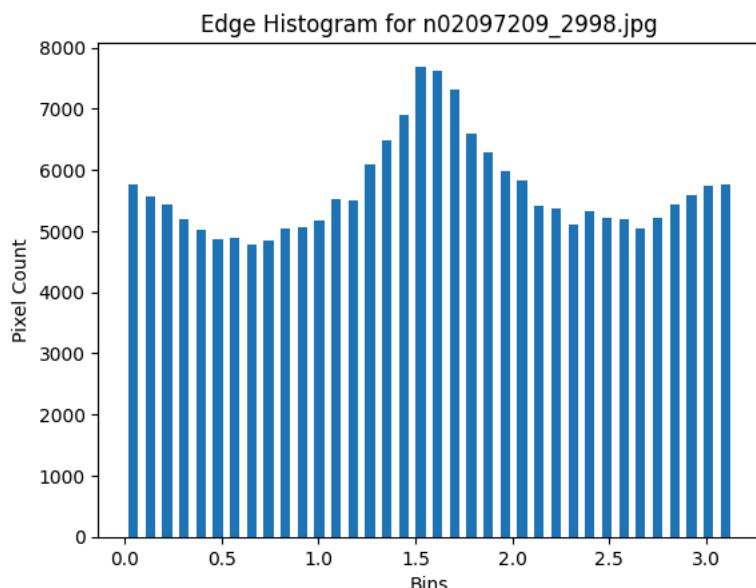
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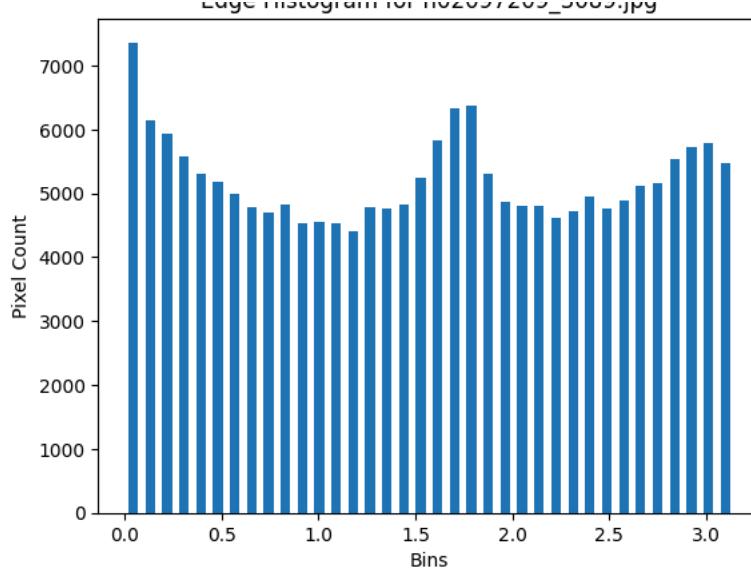


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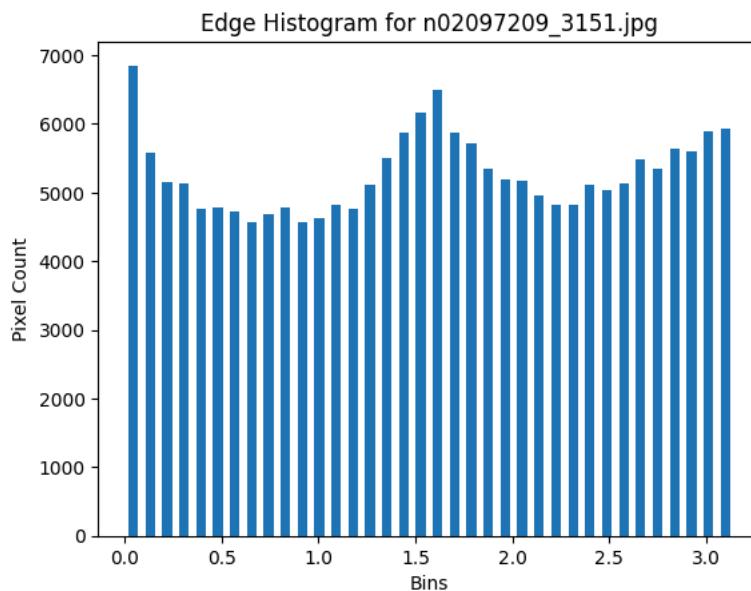


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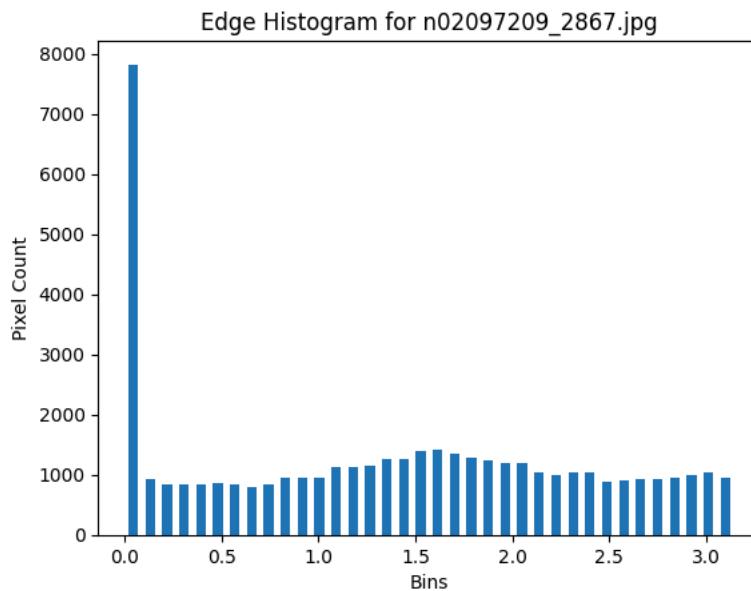
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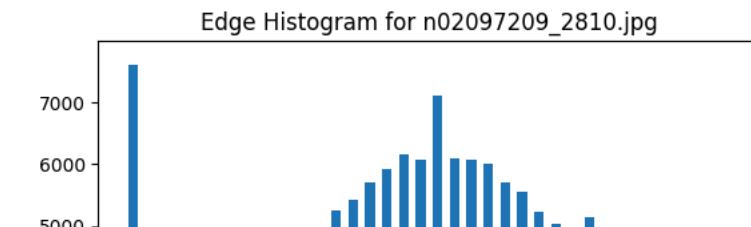
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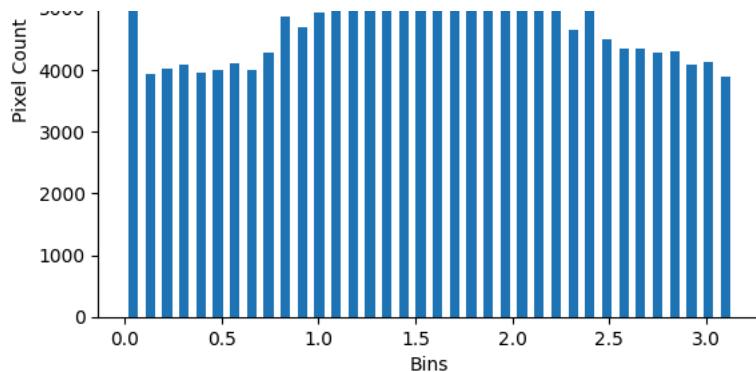


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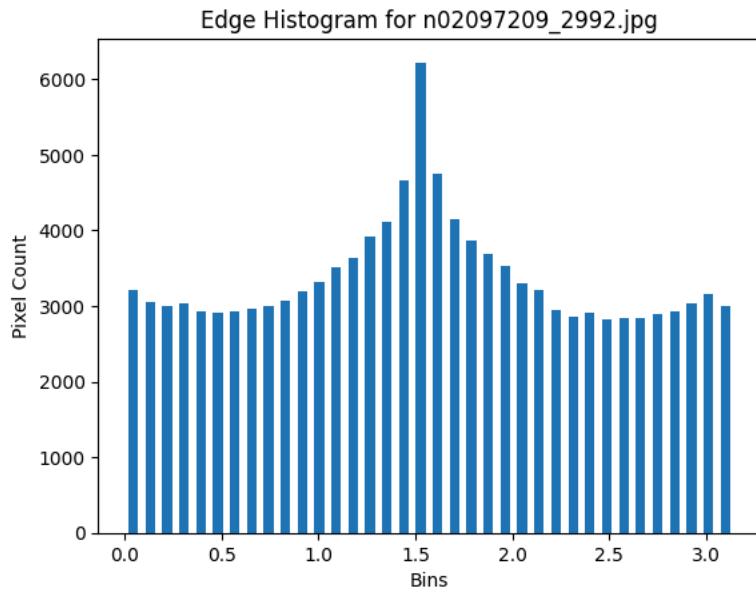


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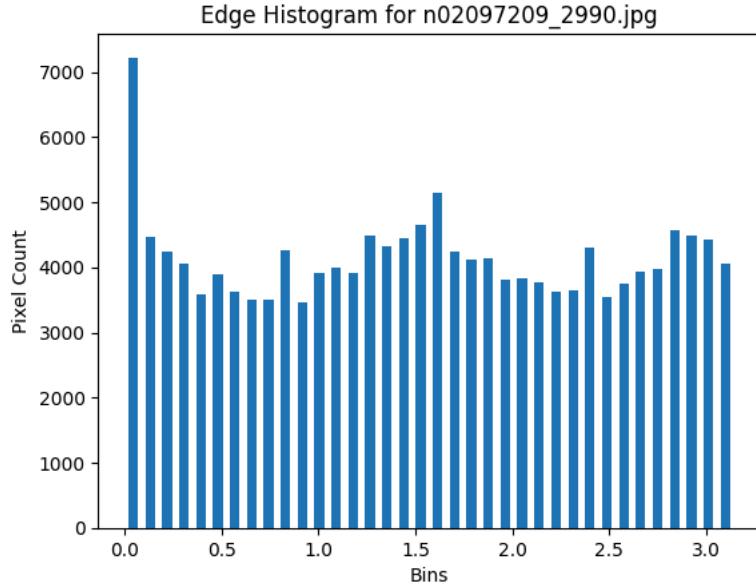




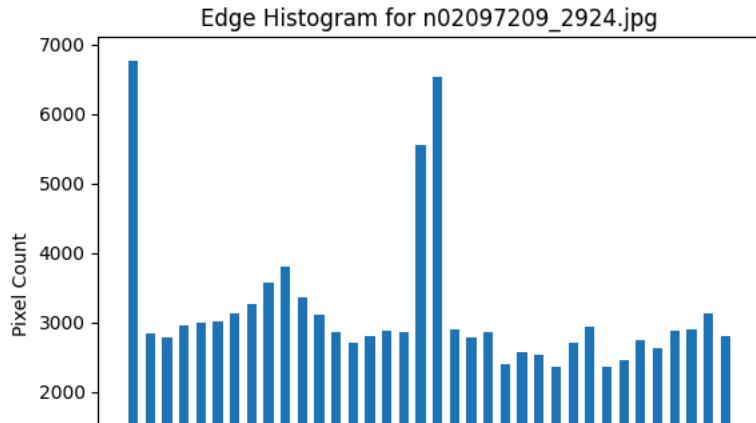
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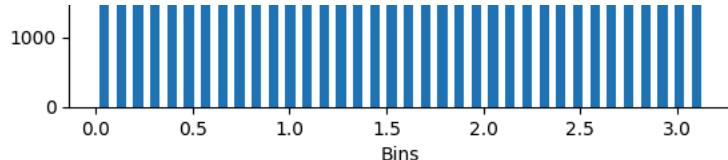


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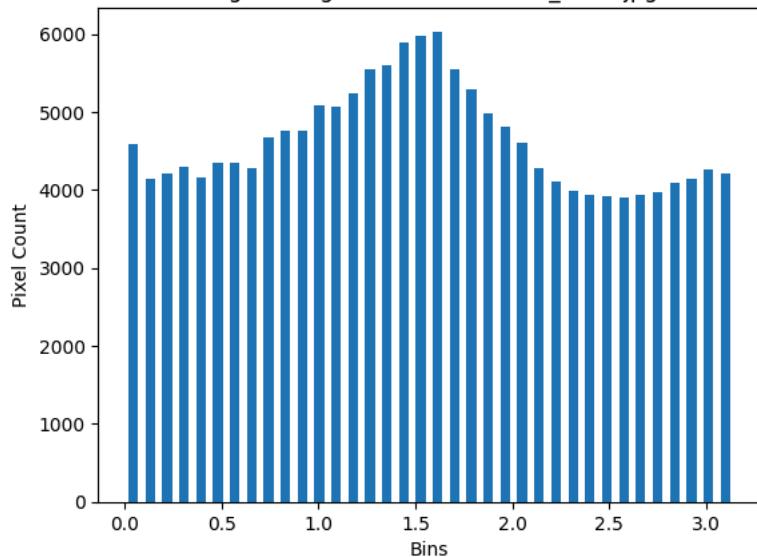
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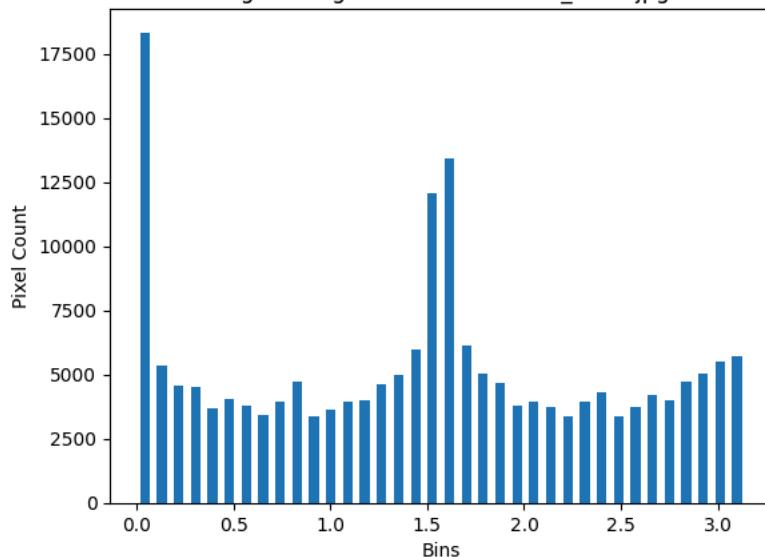
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Edge Histogram for n02097209\_2813.jpg



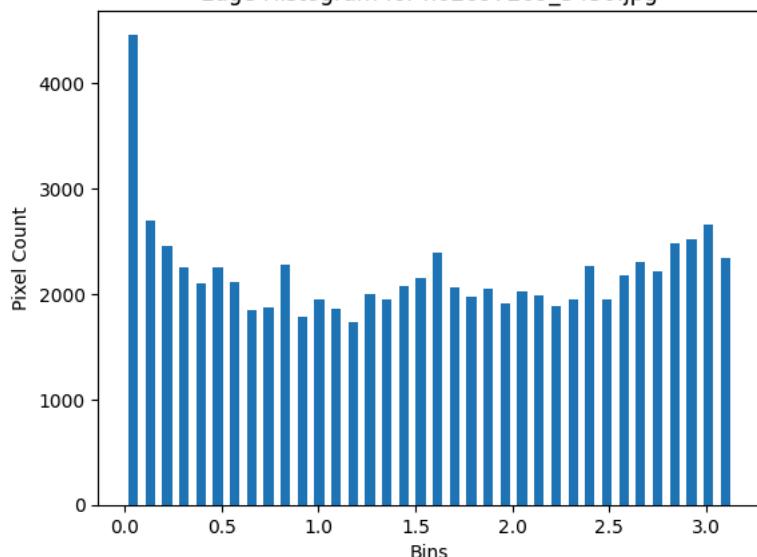
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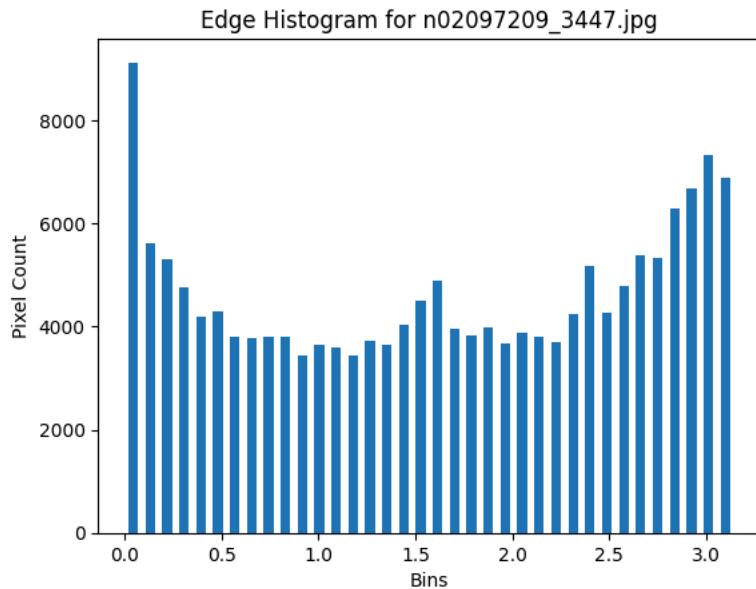


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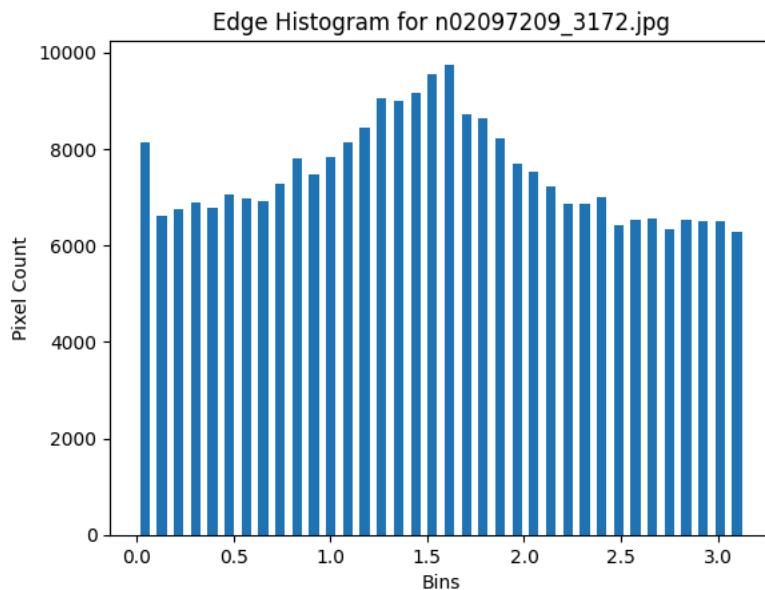
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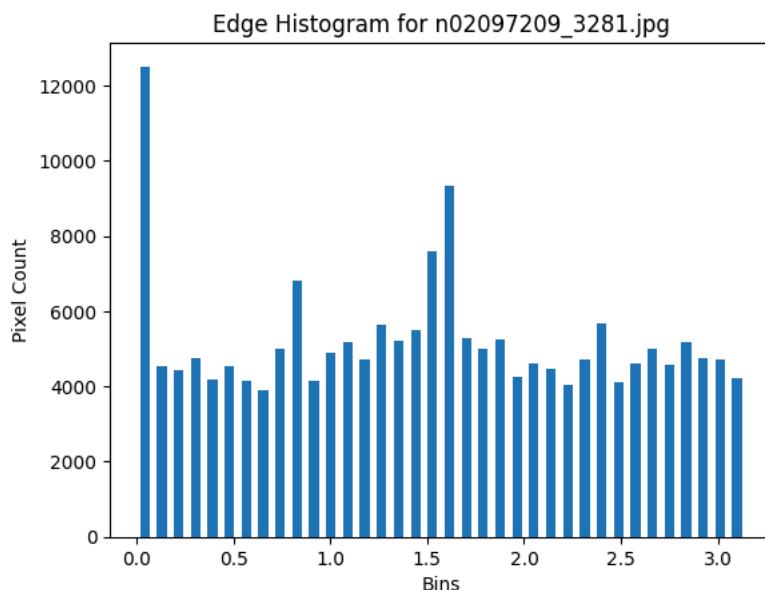
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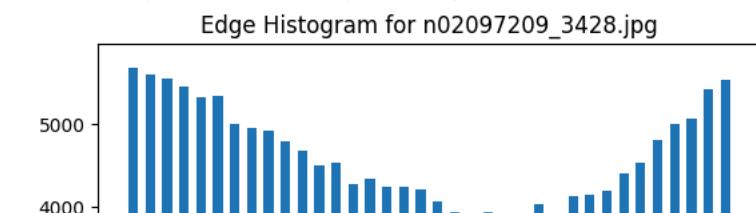
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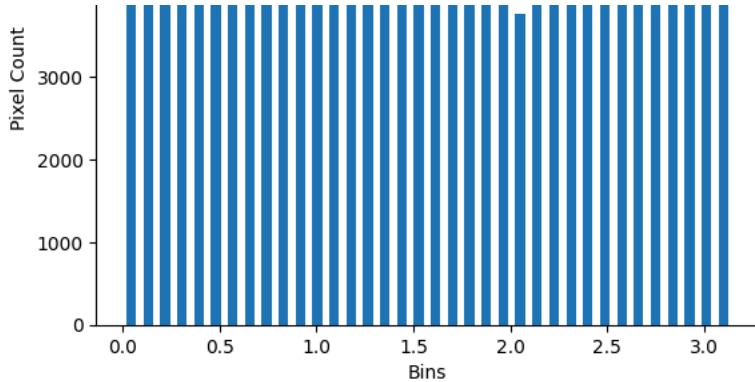


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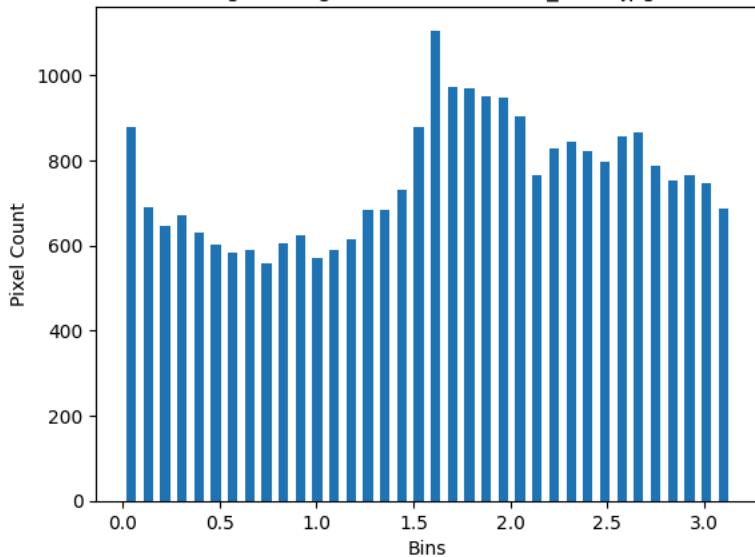
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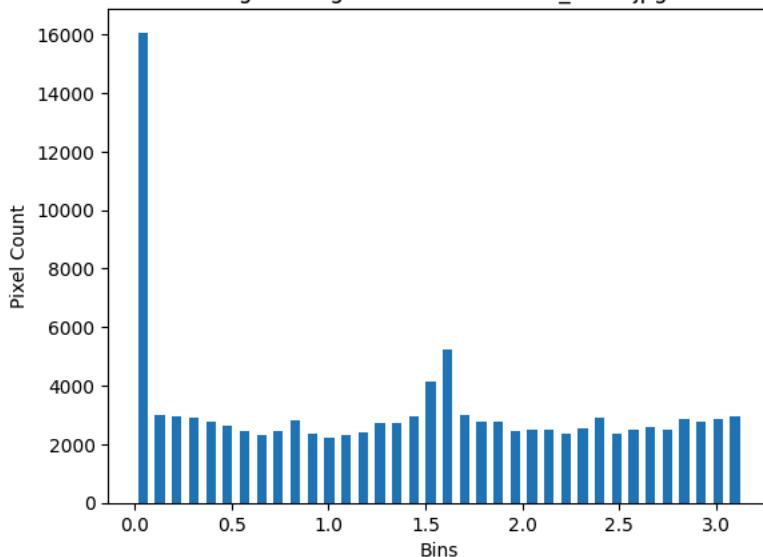
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Edge Histogram for n02097209\_3202.jpg



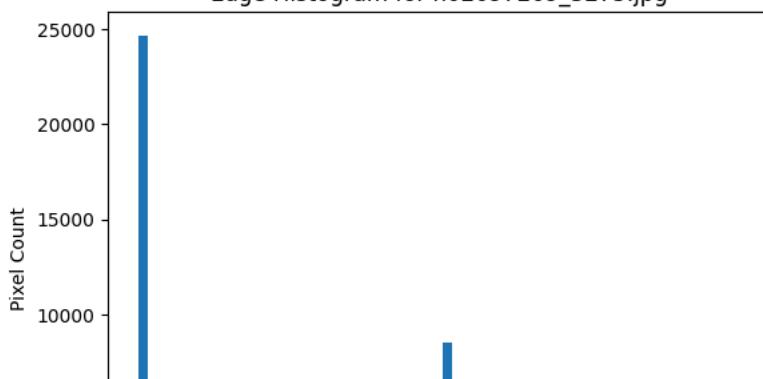
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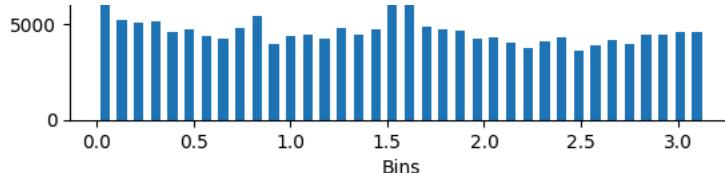
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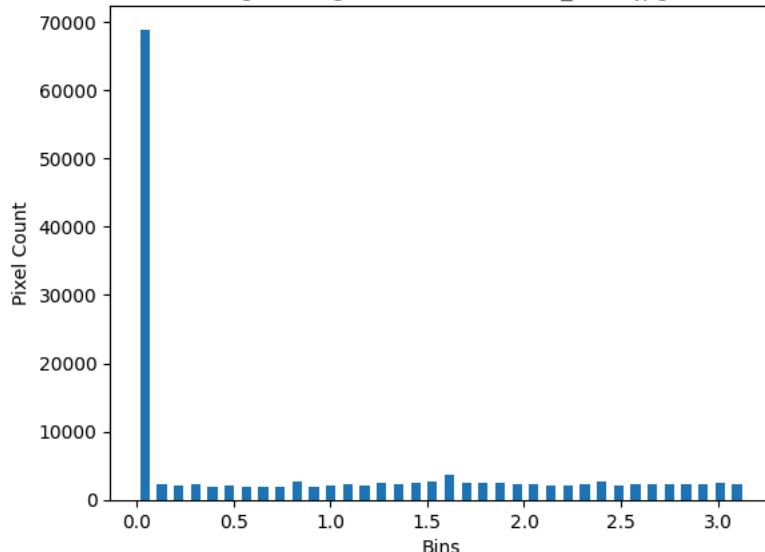
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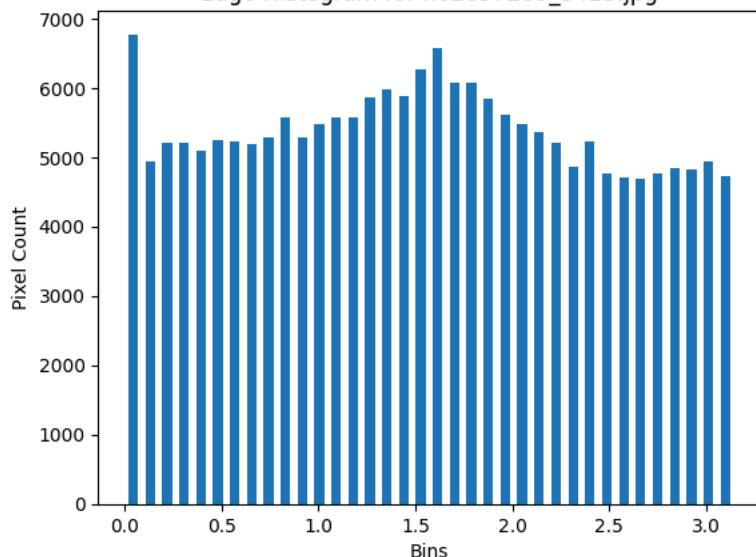
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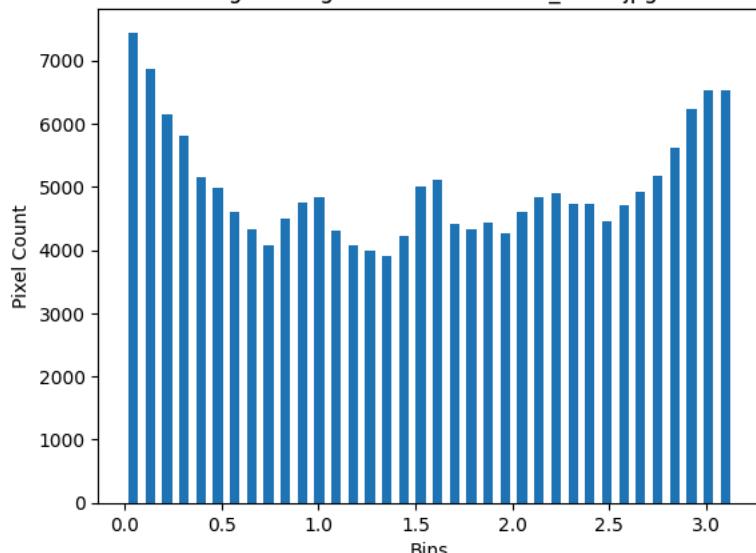
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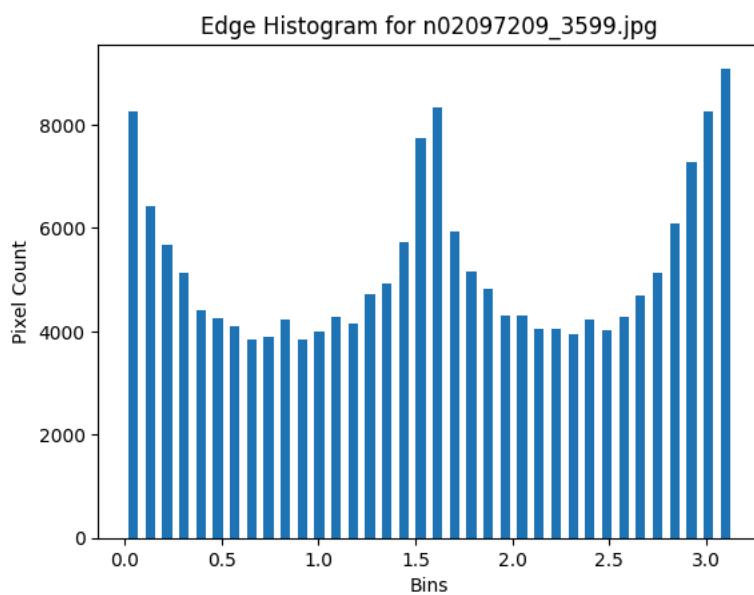
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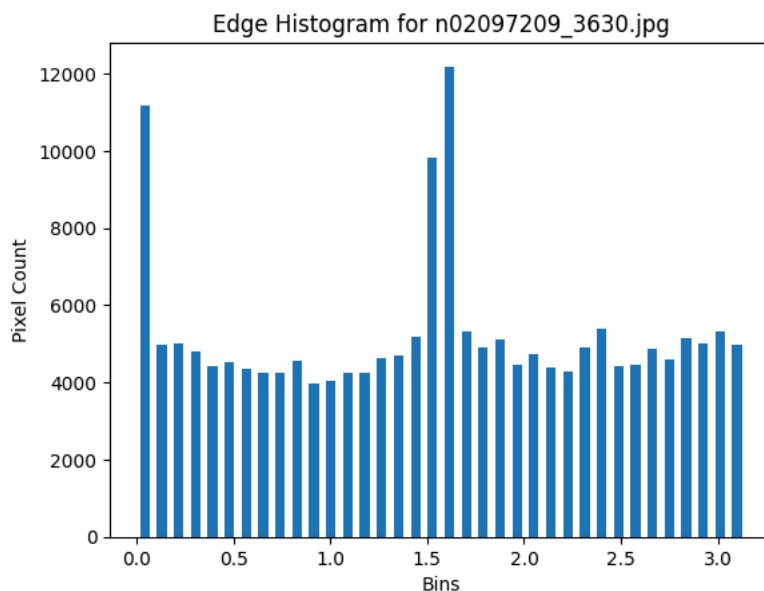


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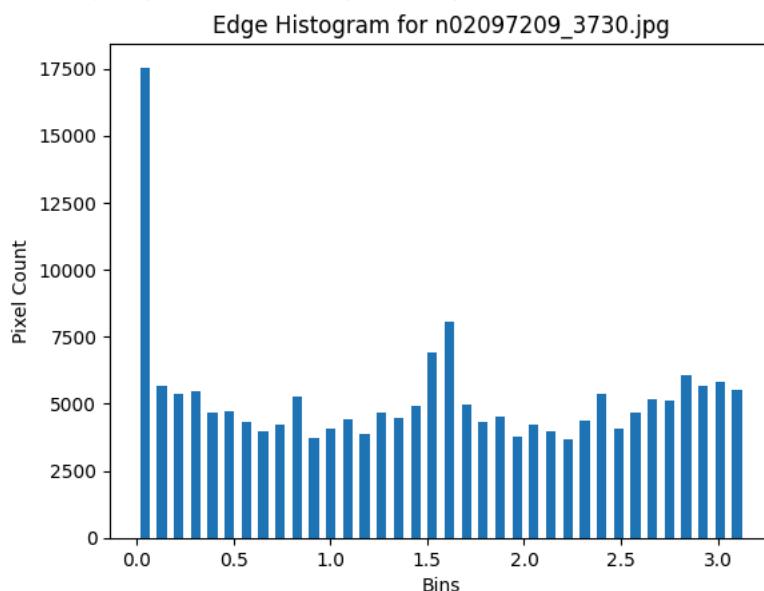
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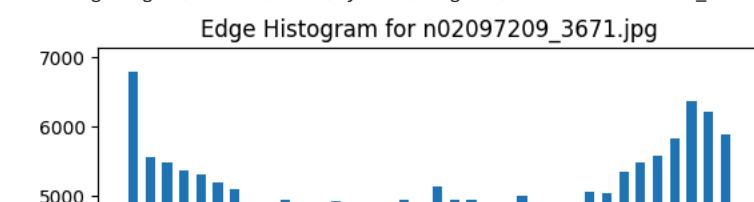
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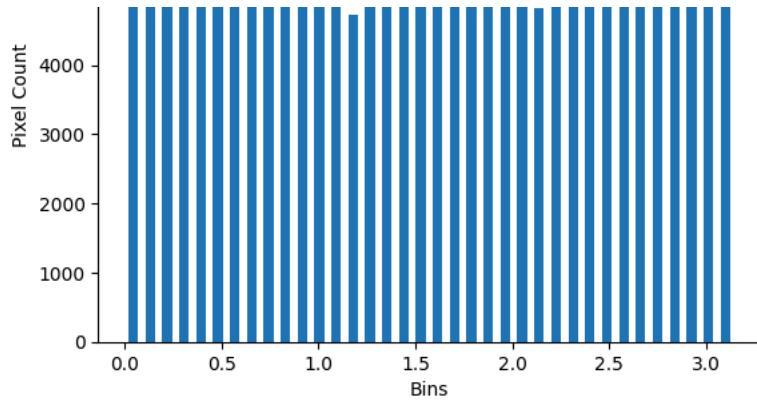


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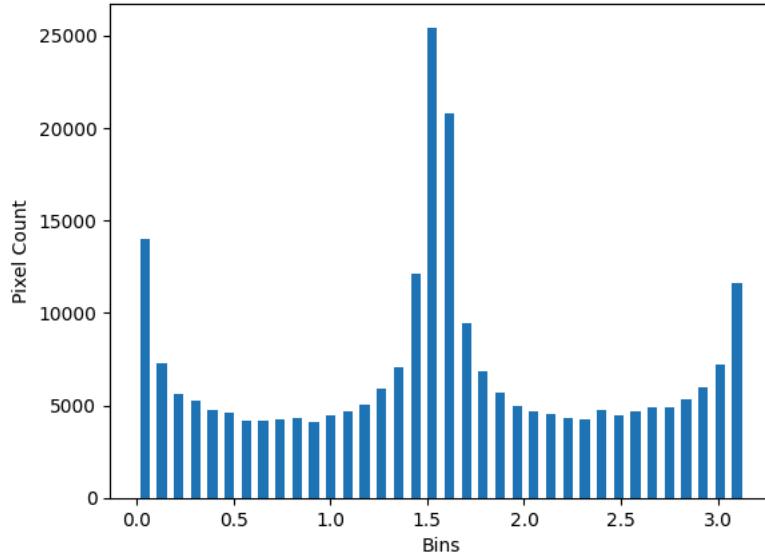
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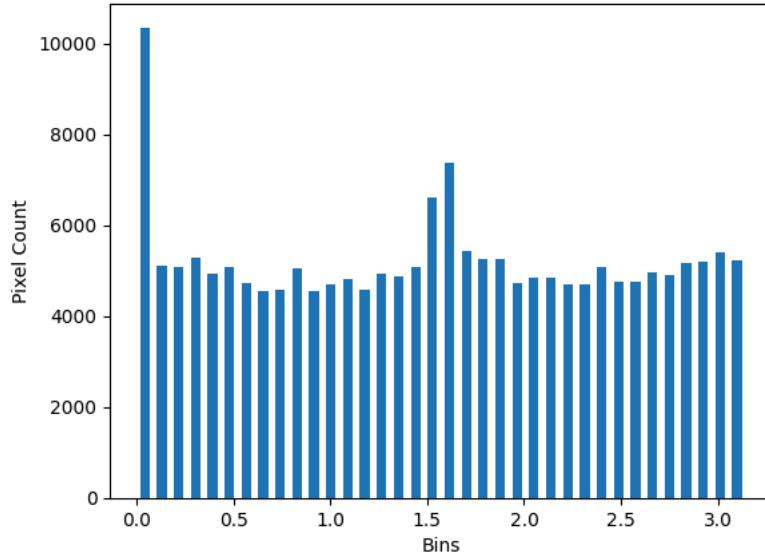
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Edge Histogram for n02097209\_367.jpg



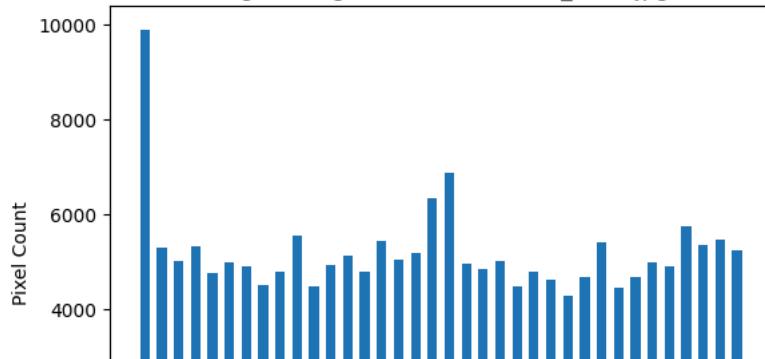
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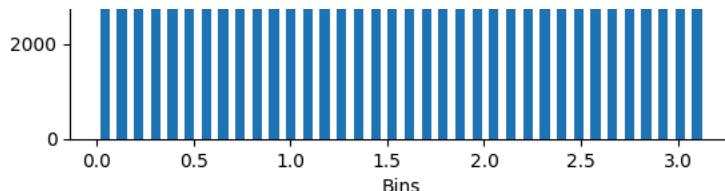
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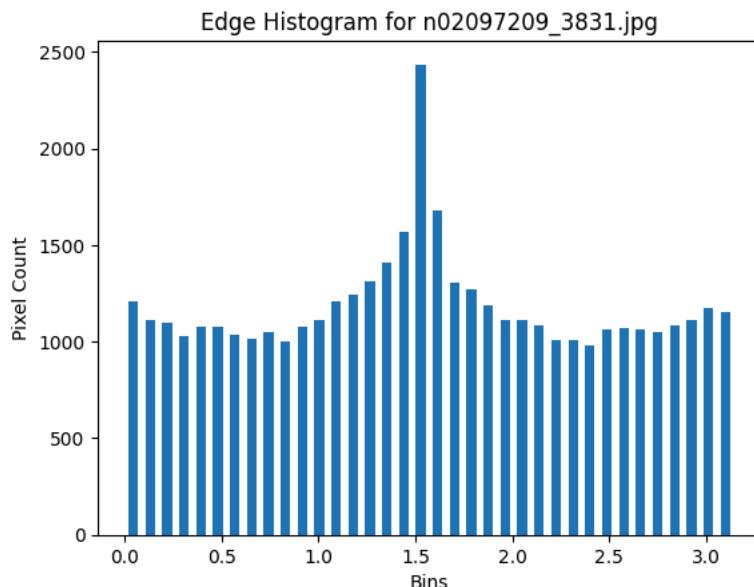
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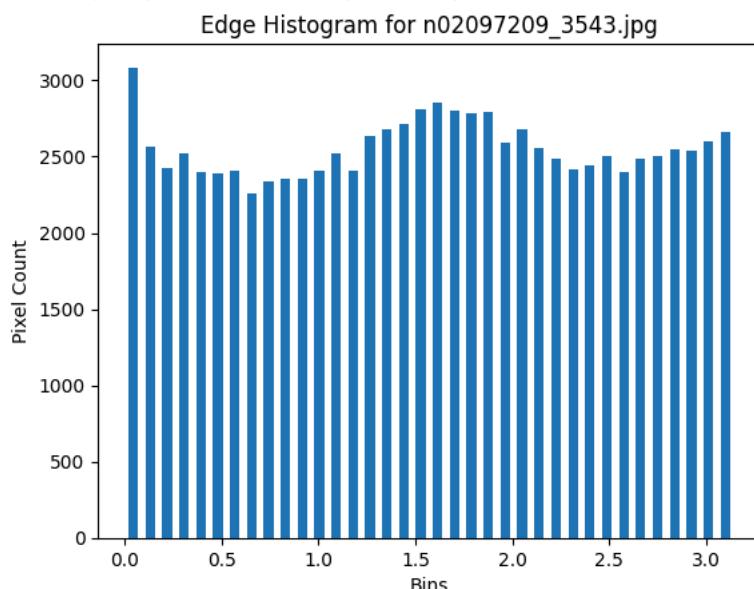




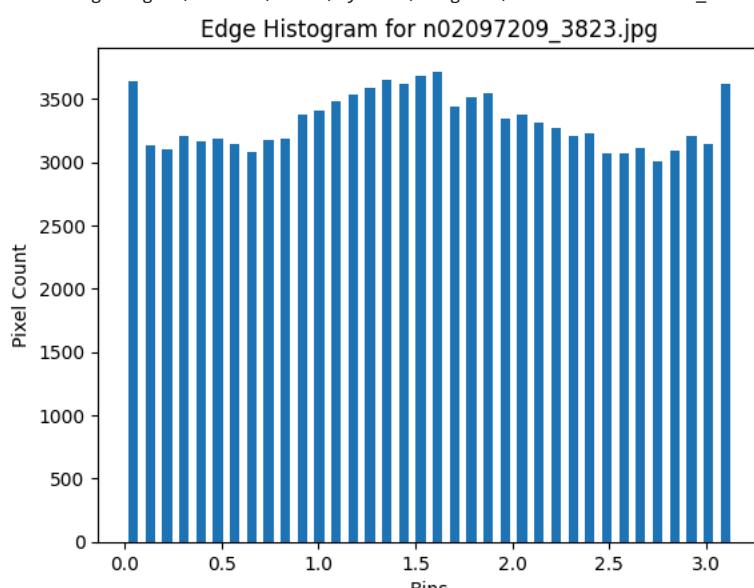
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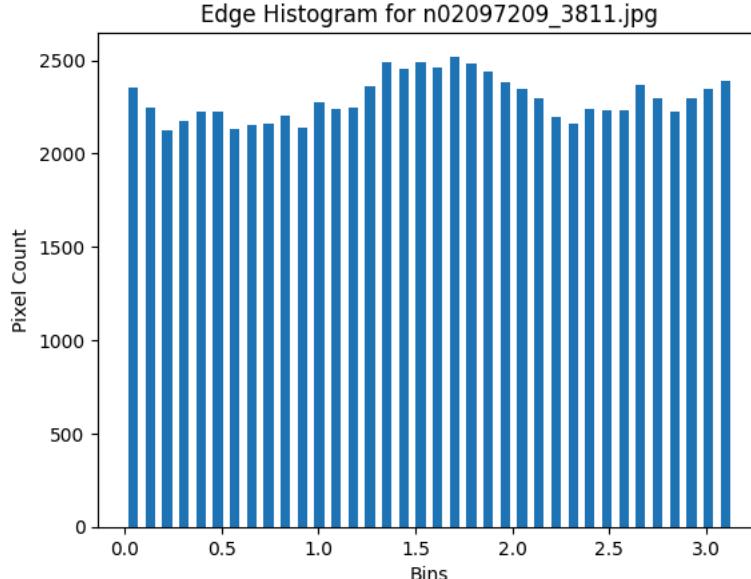
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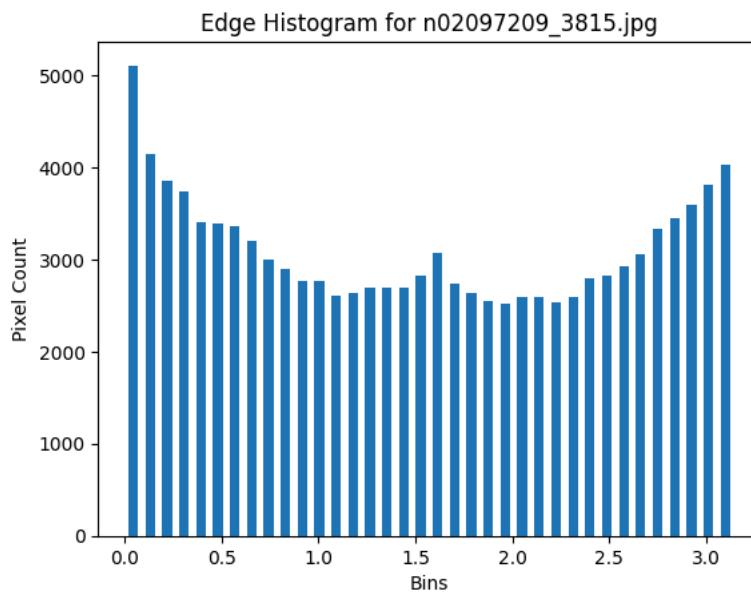
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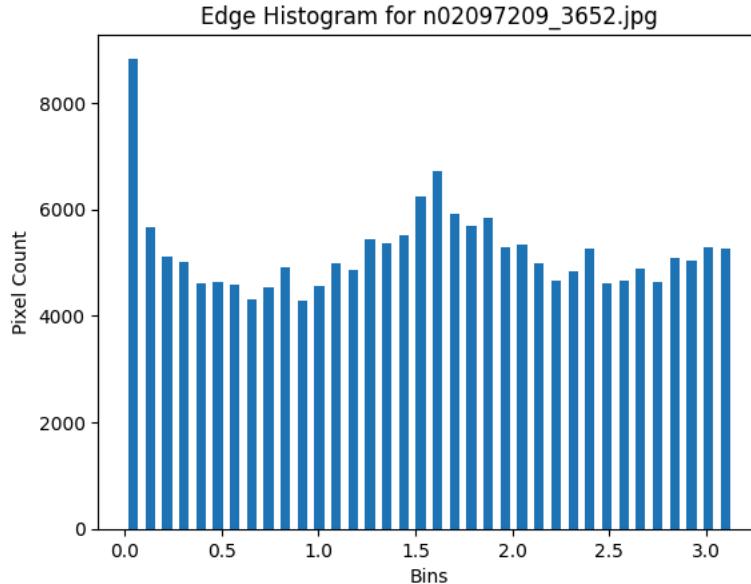
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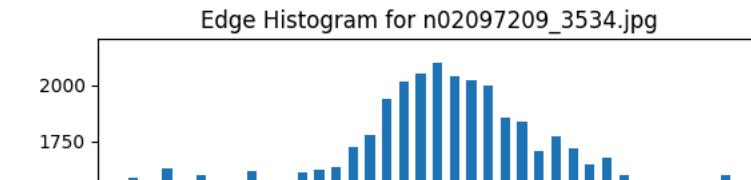
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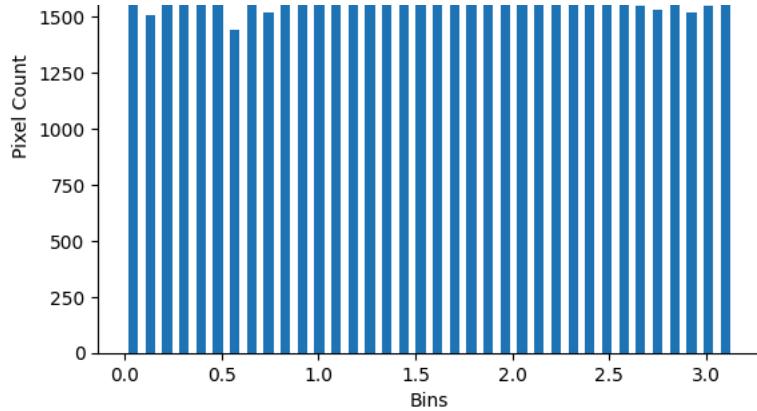


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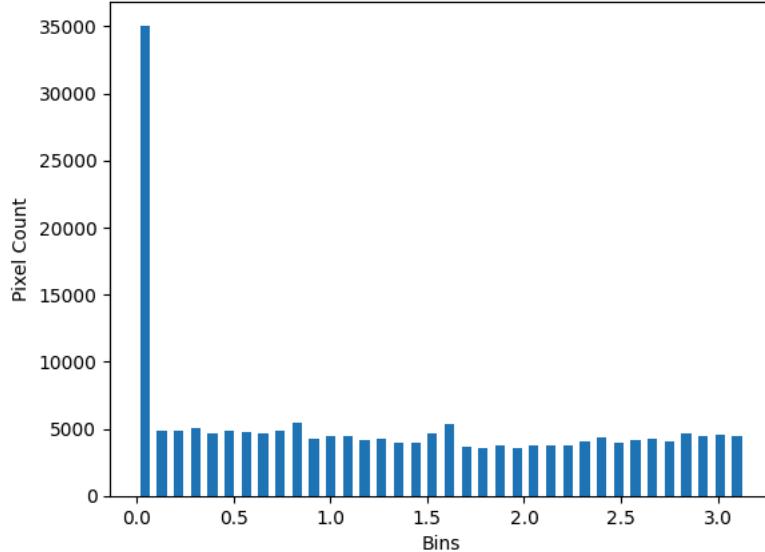
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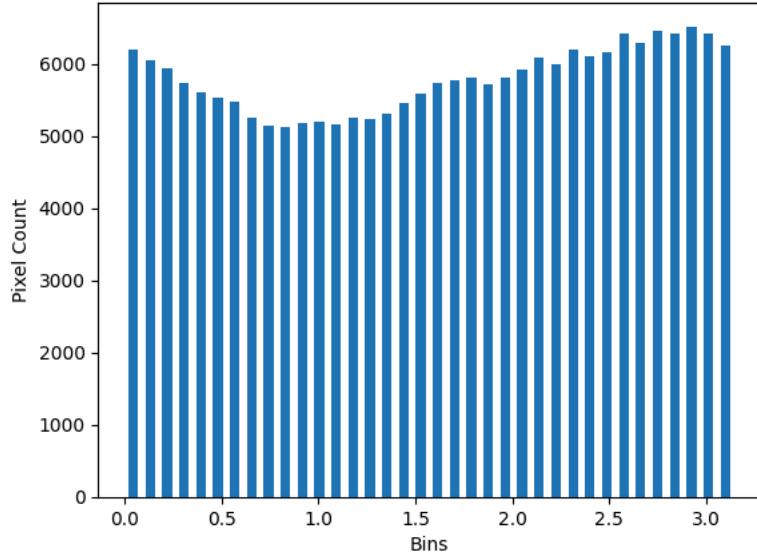
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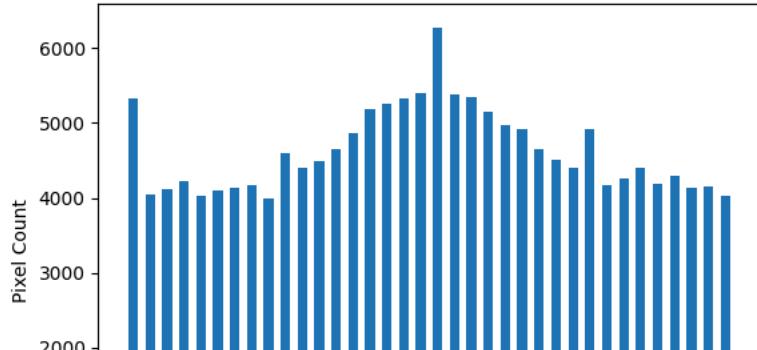
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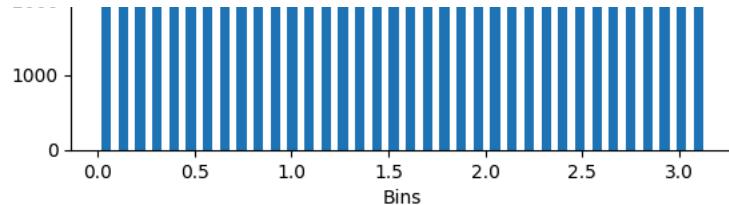
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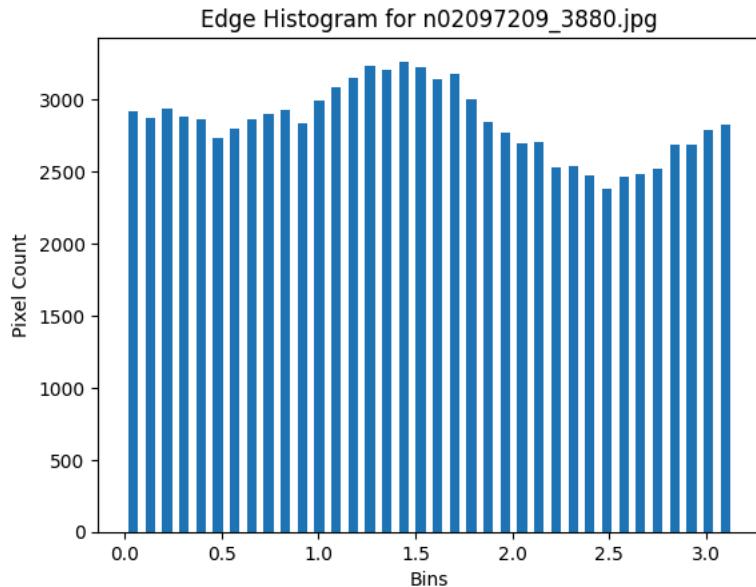
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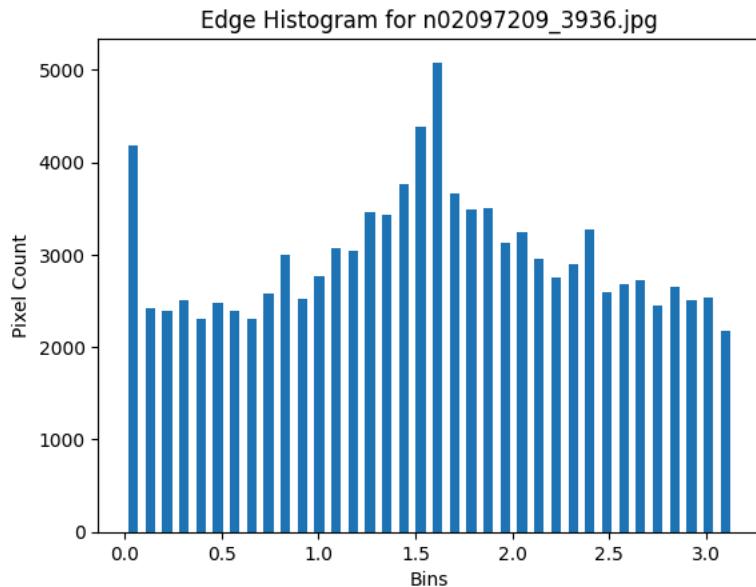




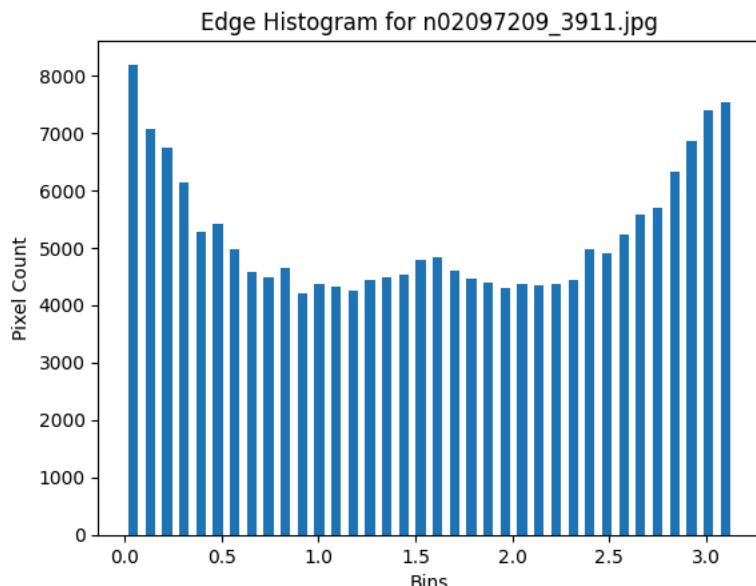
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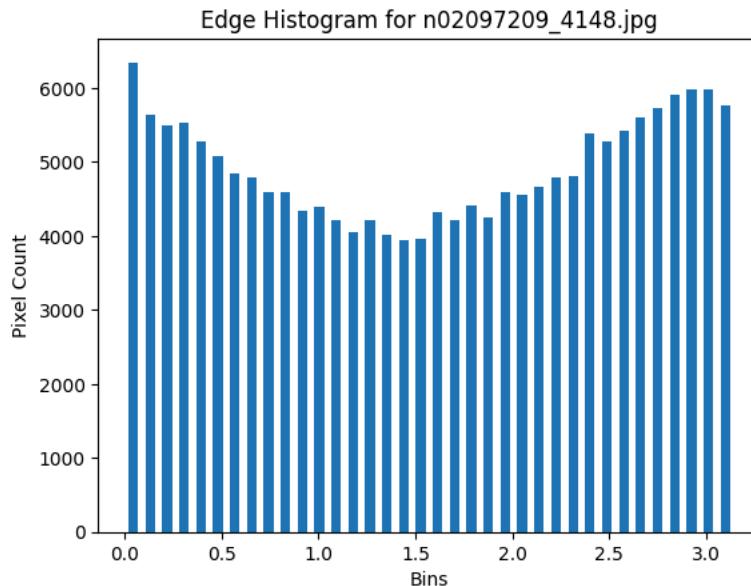
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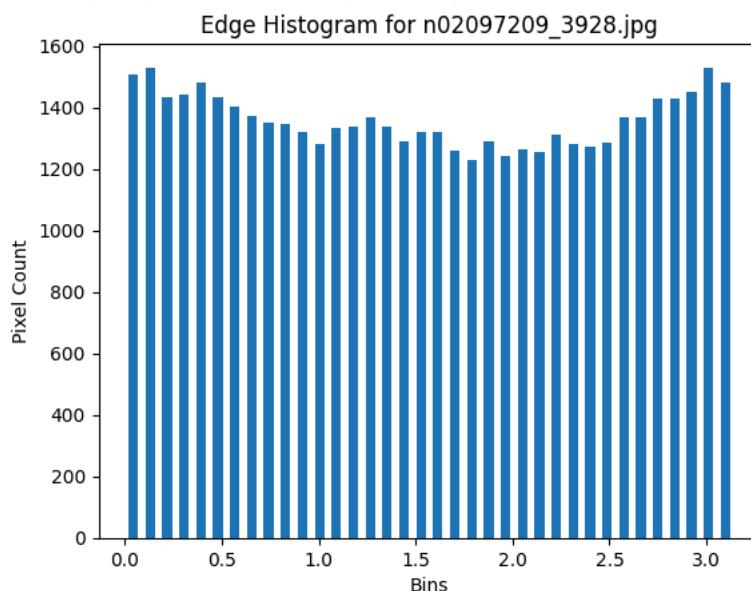
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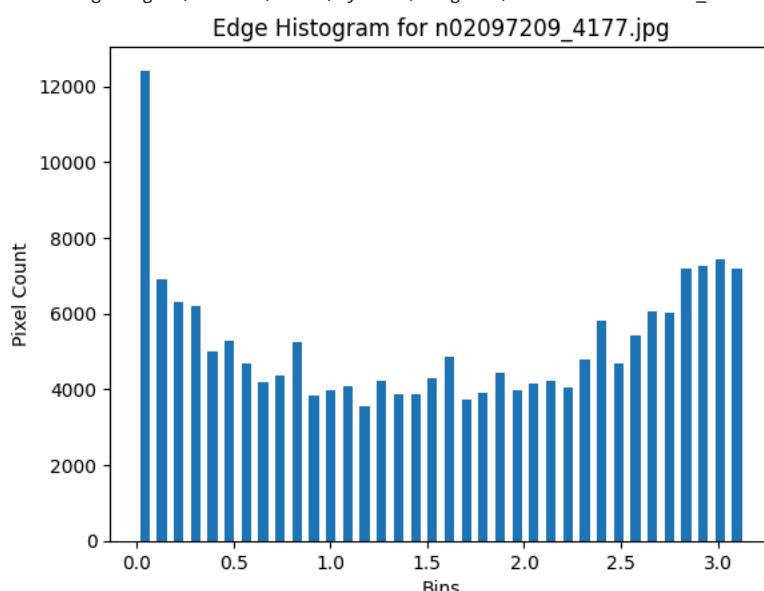
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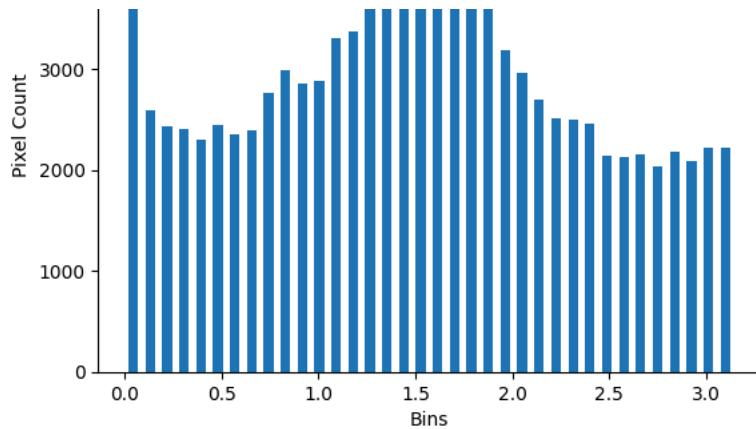


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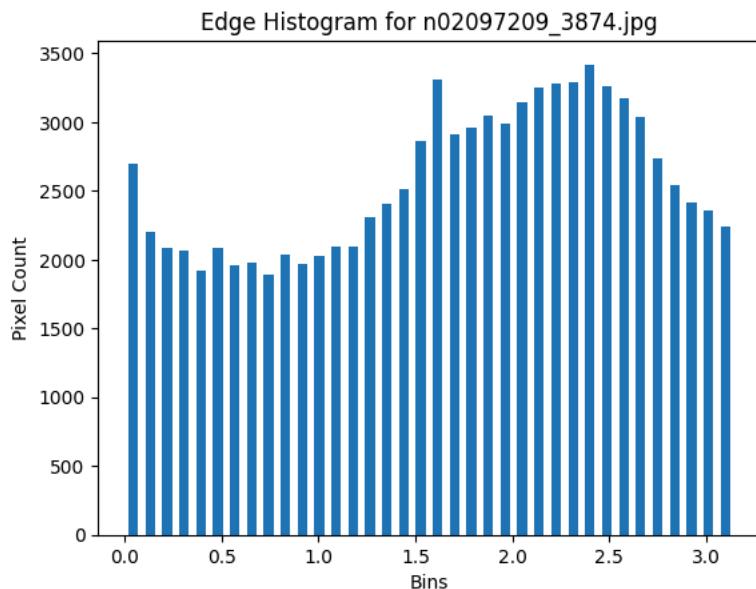


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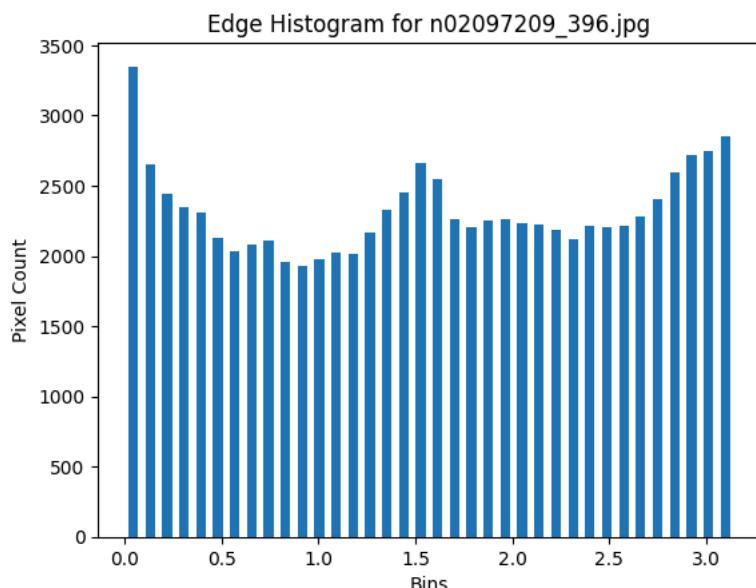




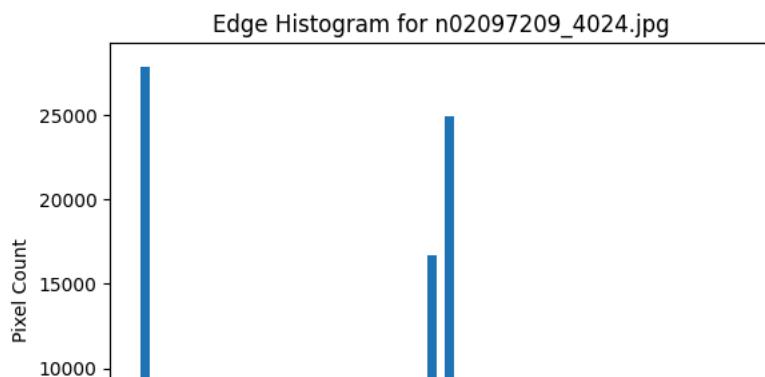
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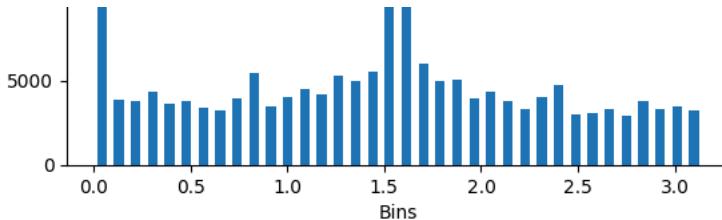


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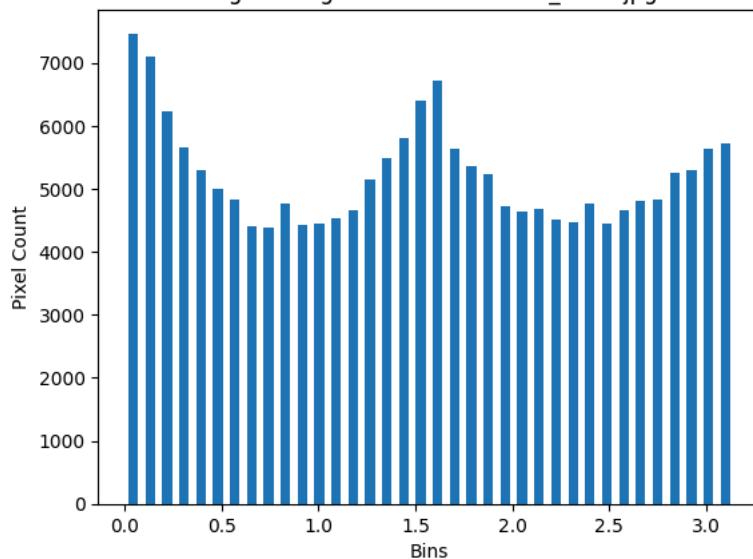
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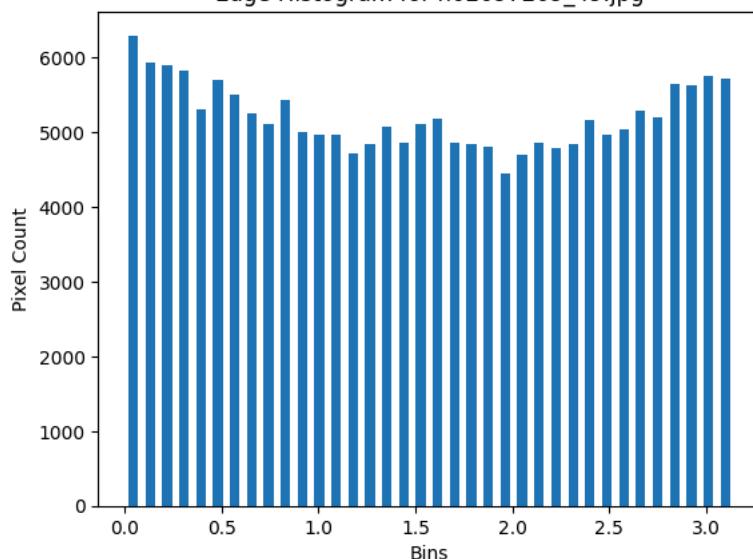
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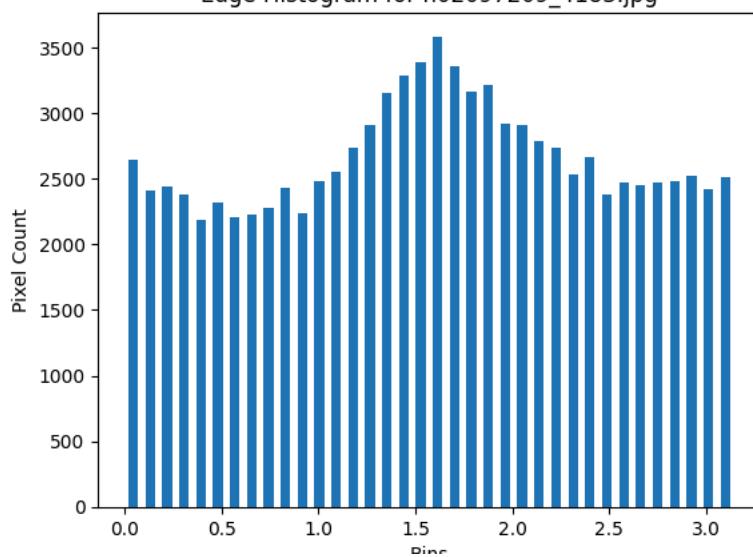
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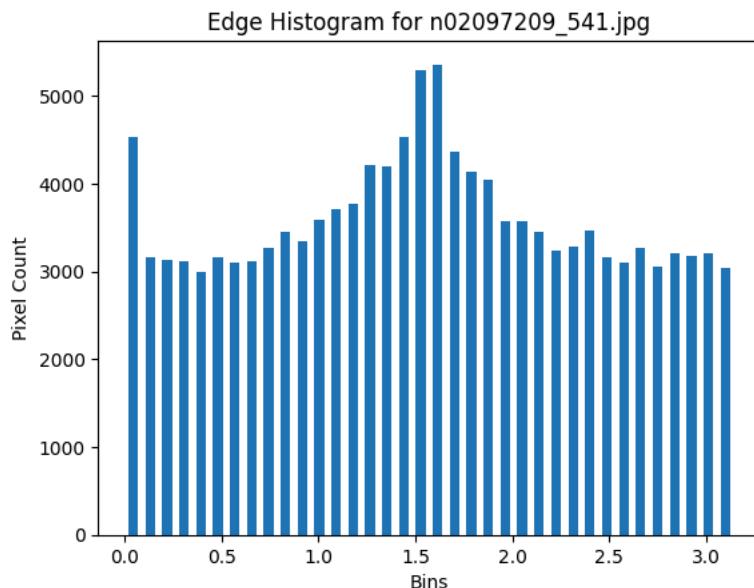


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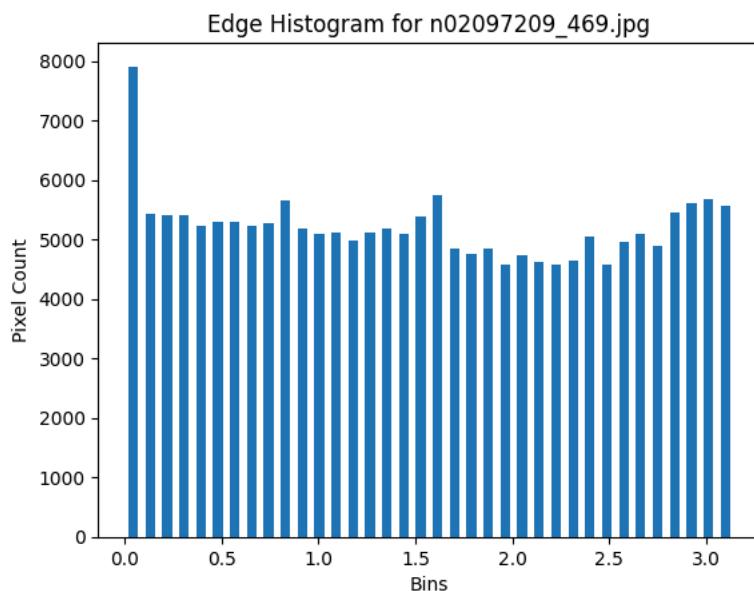
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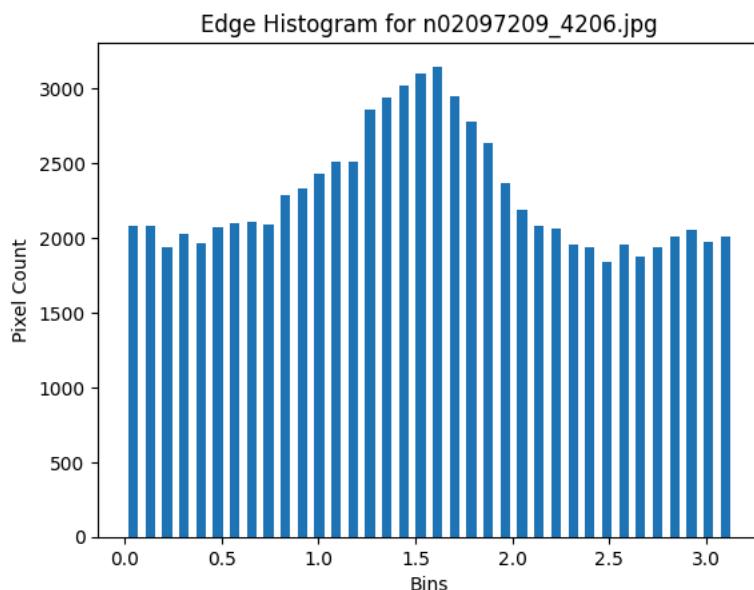
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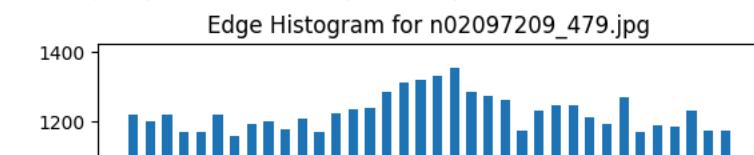
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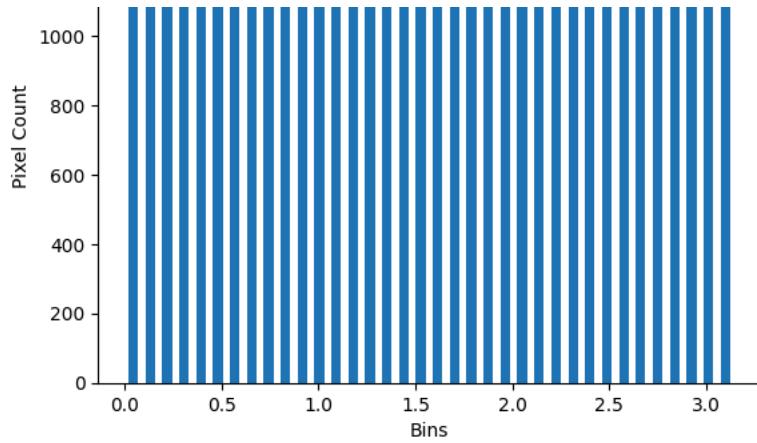


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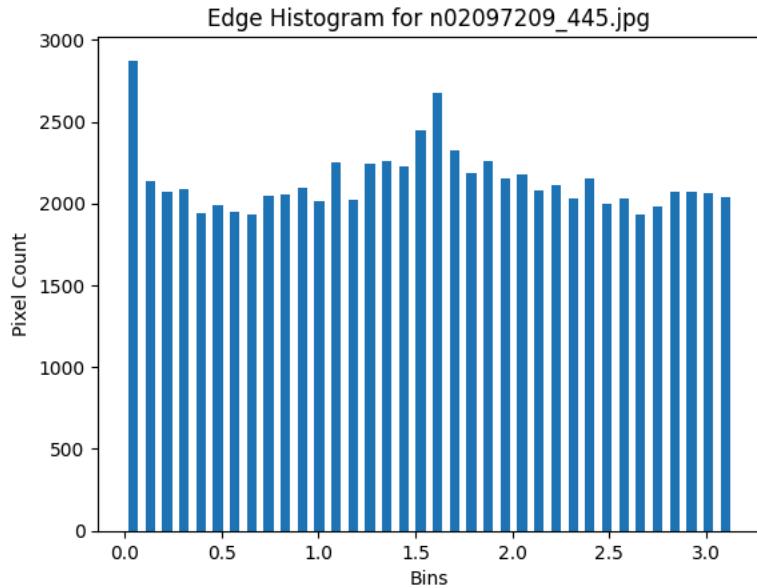


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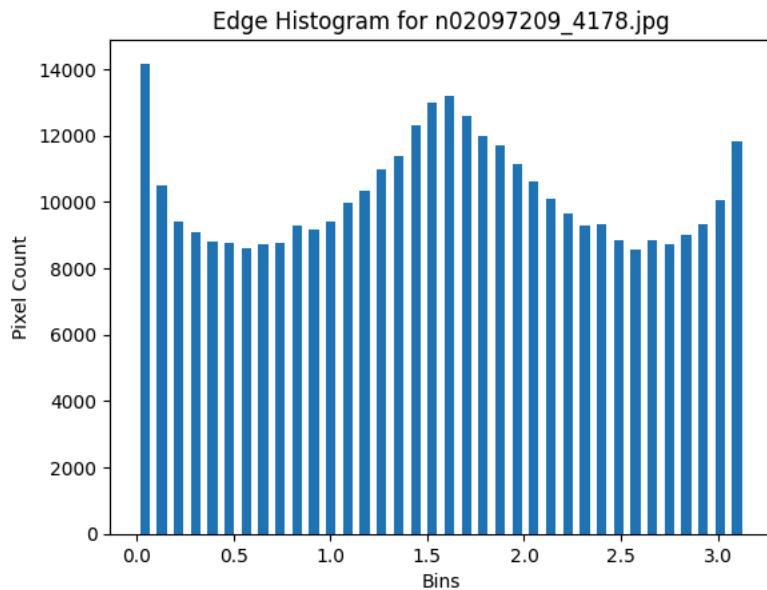




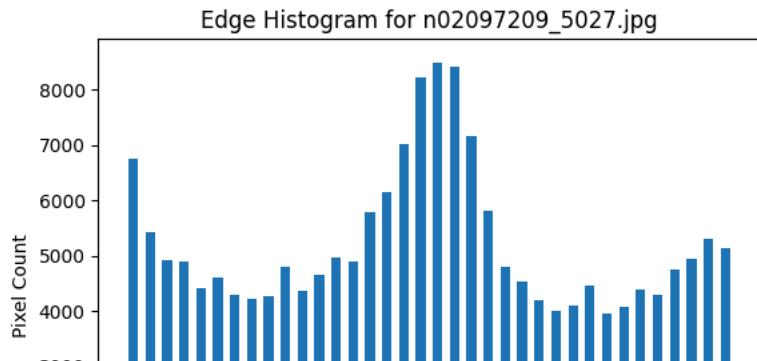
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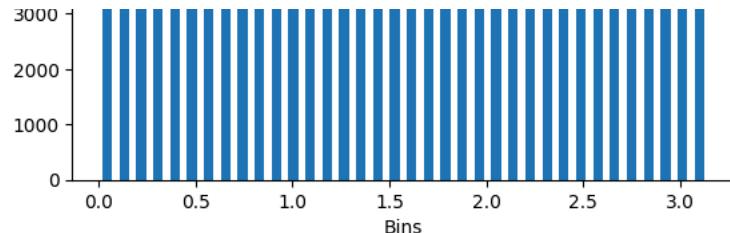


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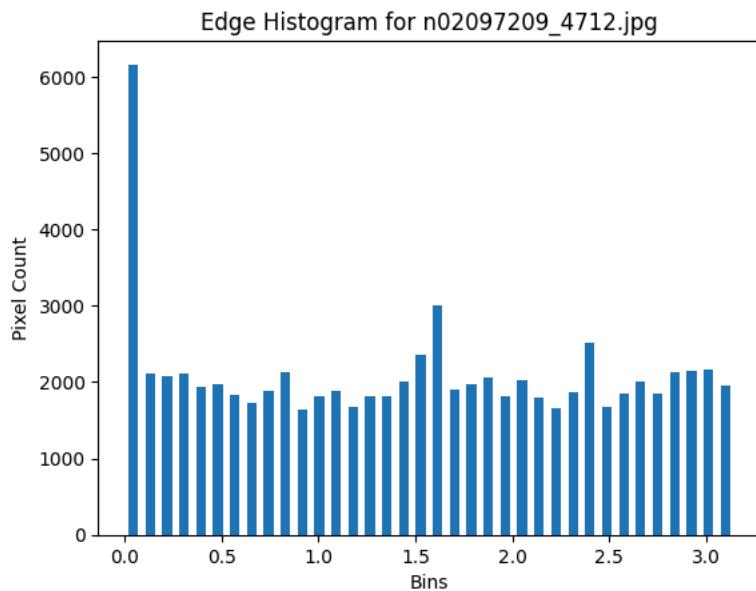


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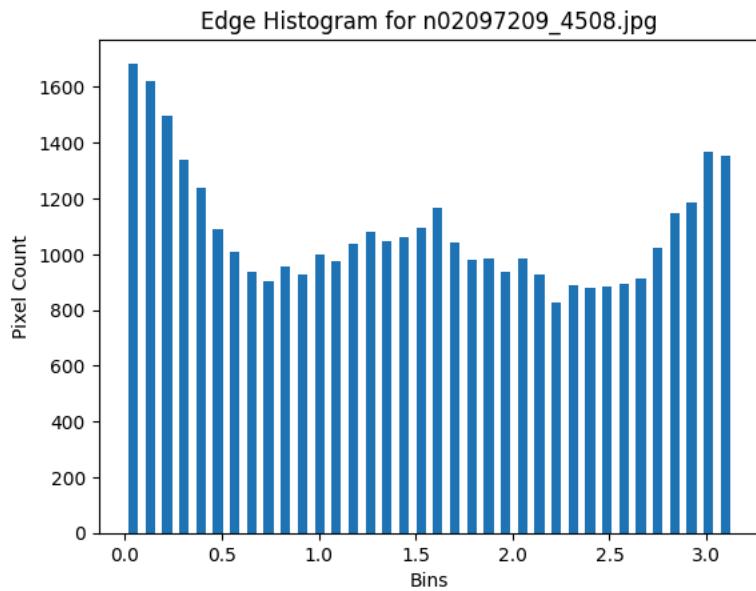




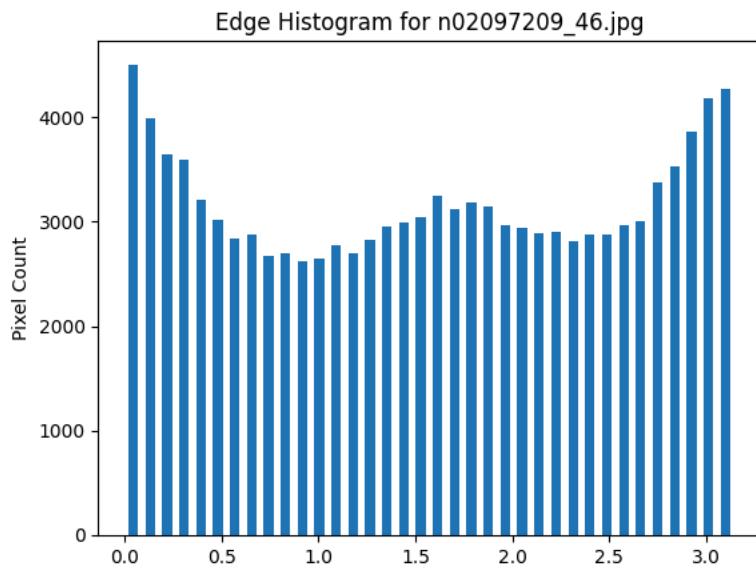
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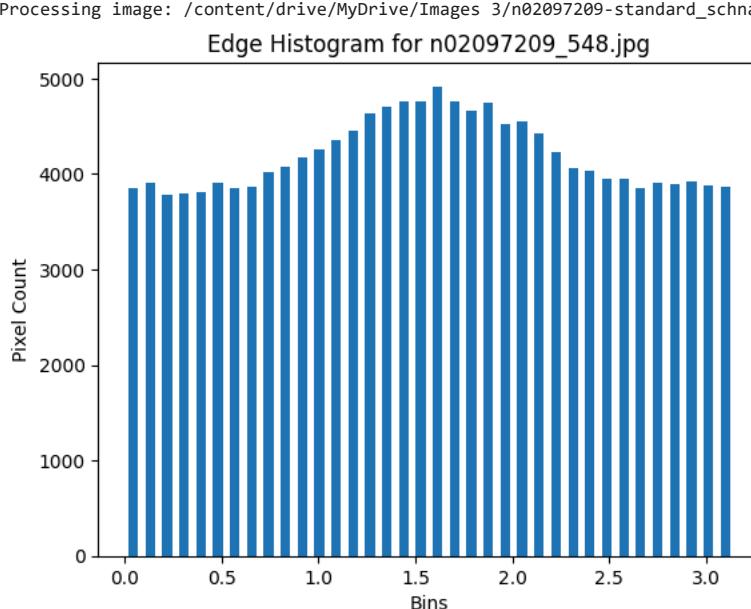
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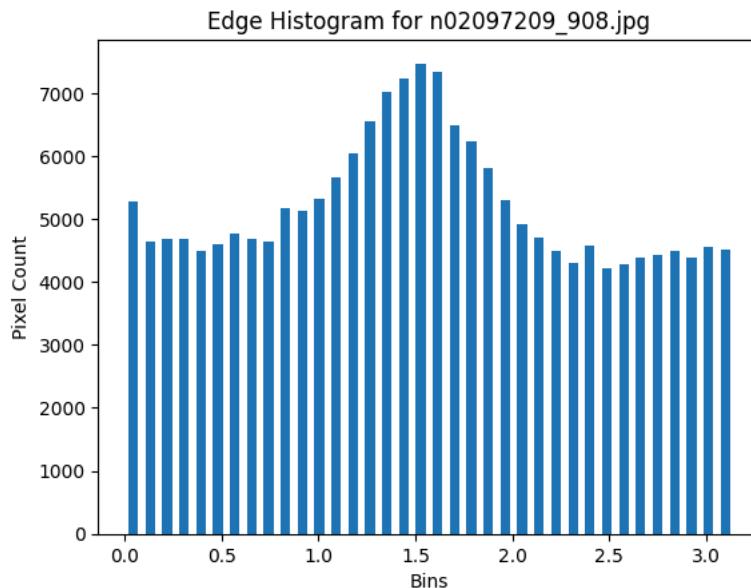
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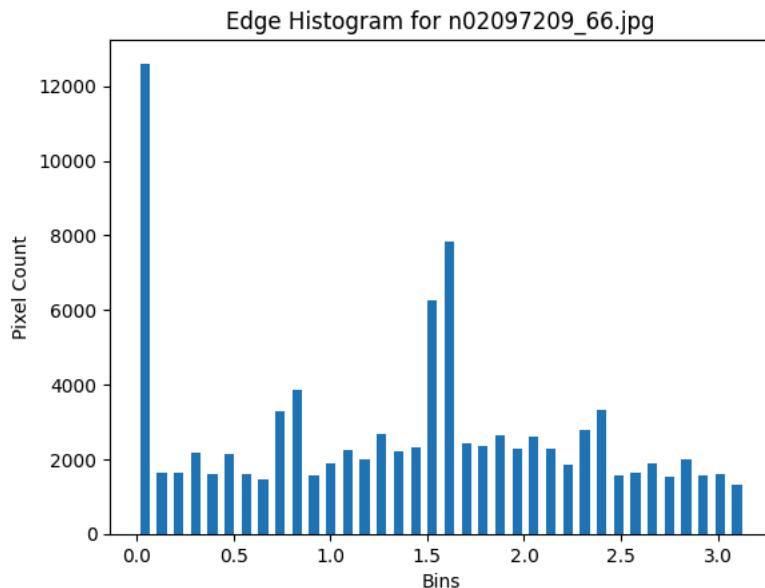
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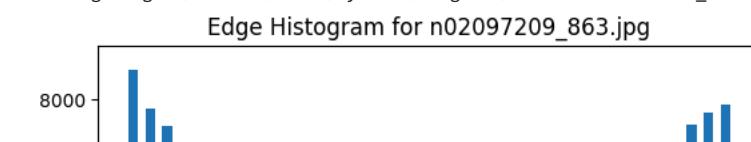
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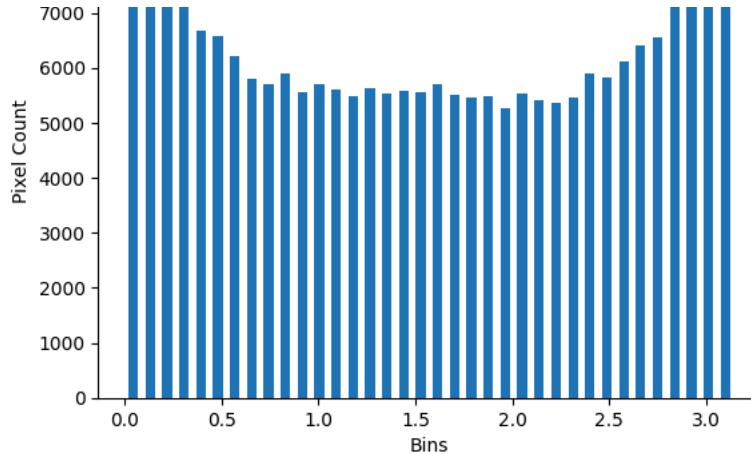


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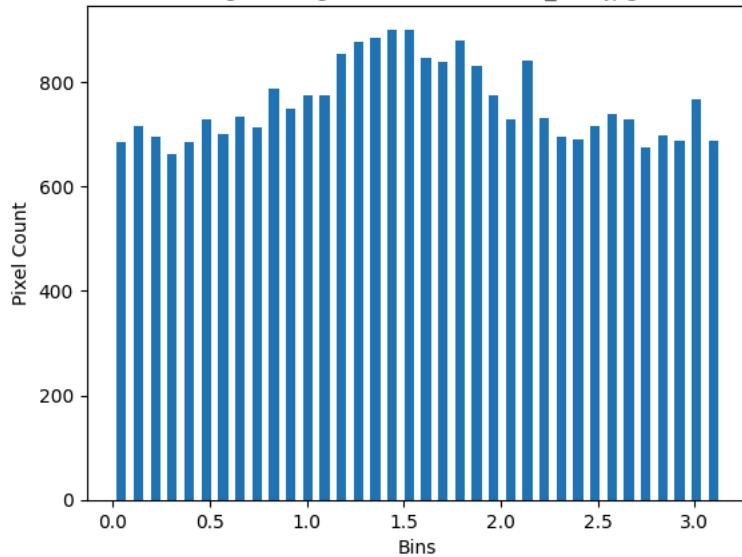
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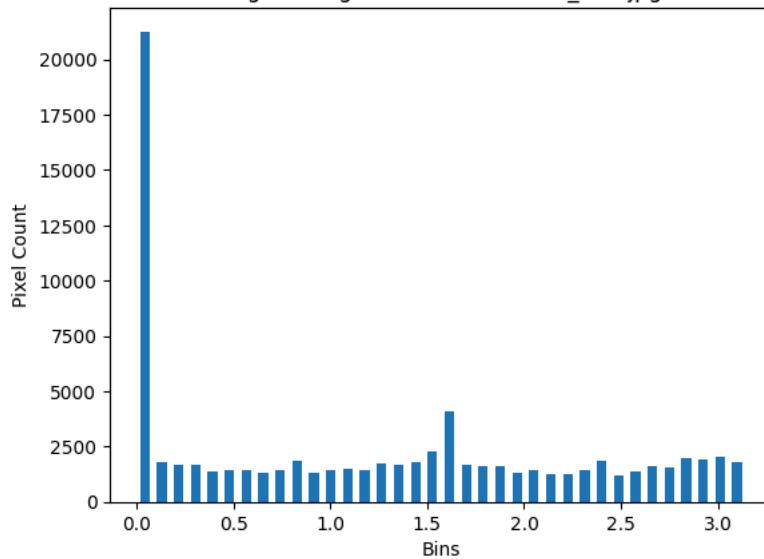
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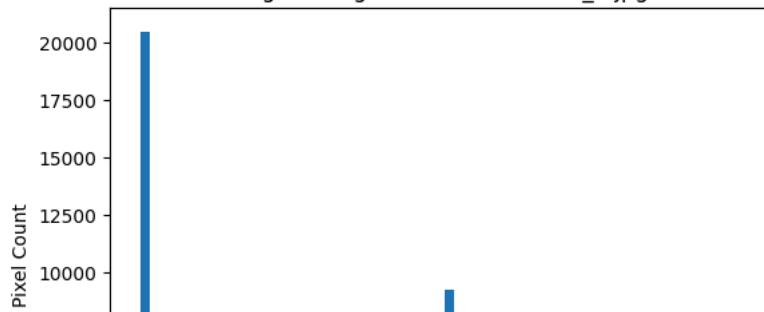
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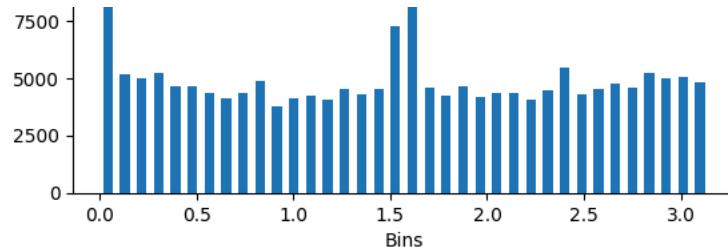
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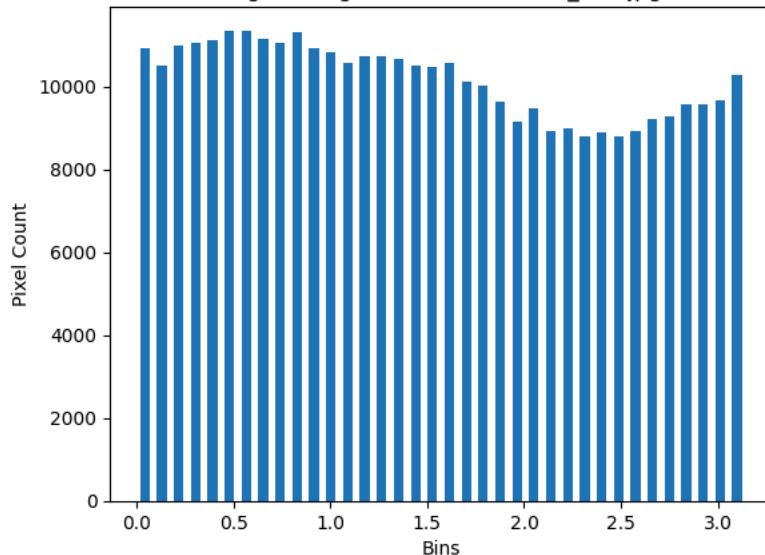
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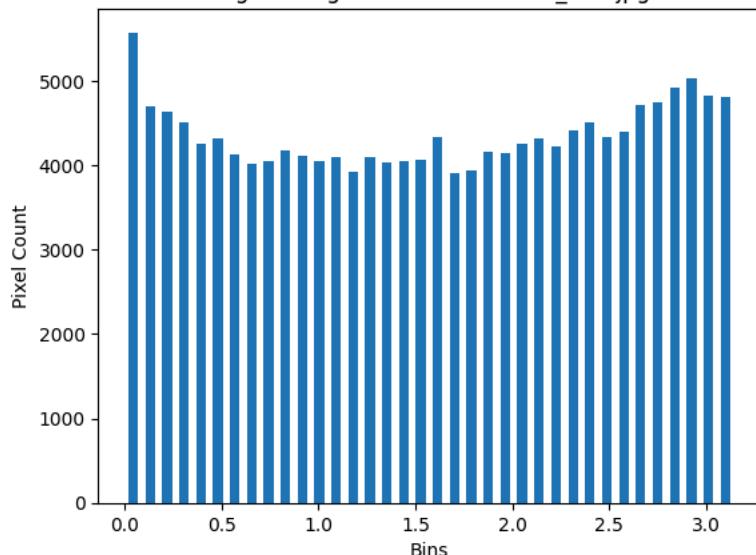
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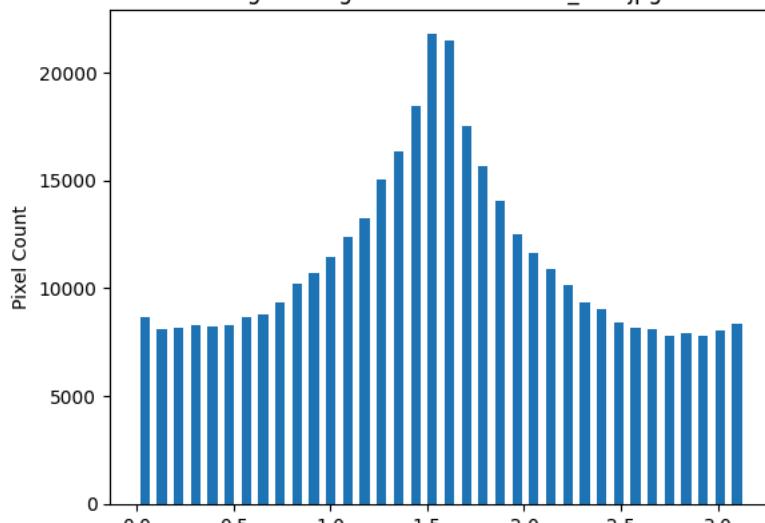
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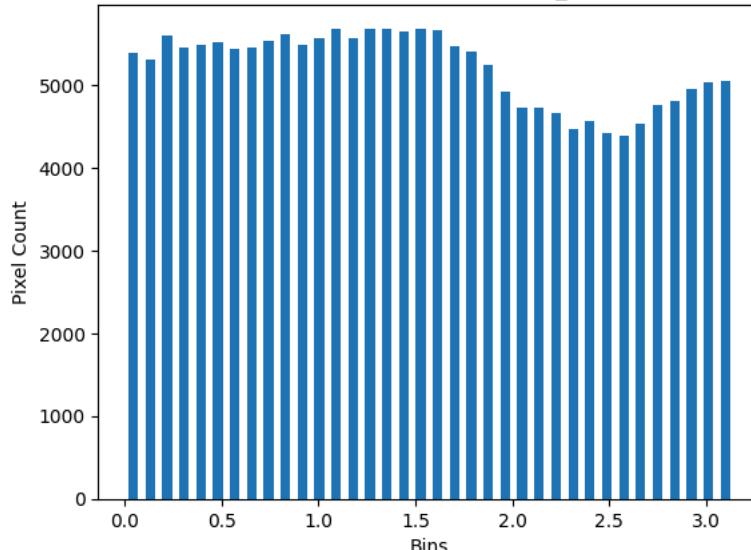
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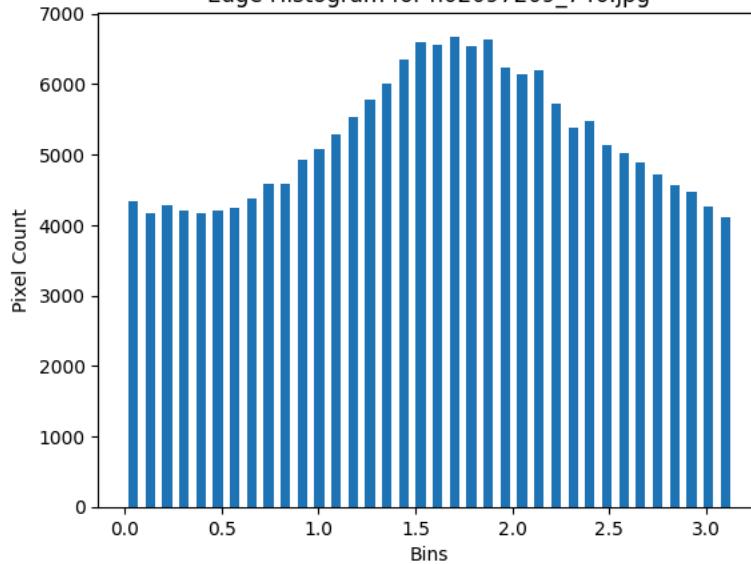
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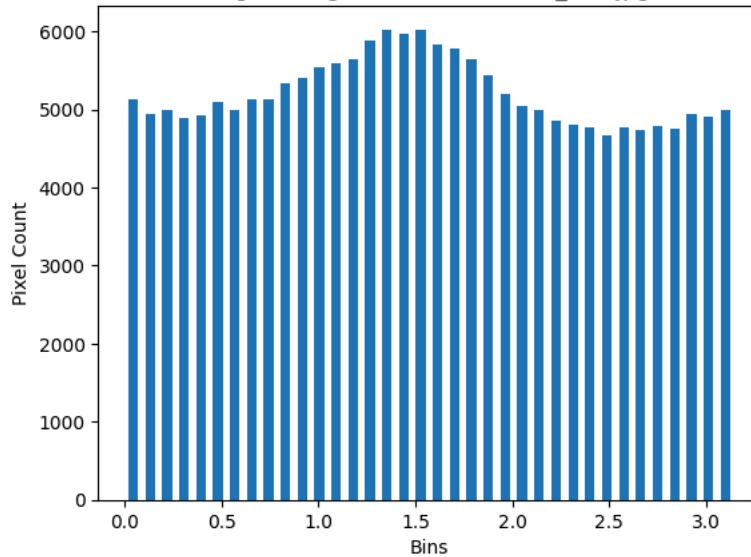
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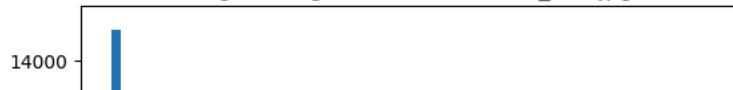
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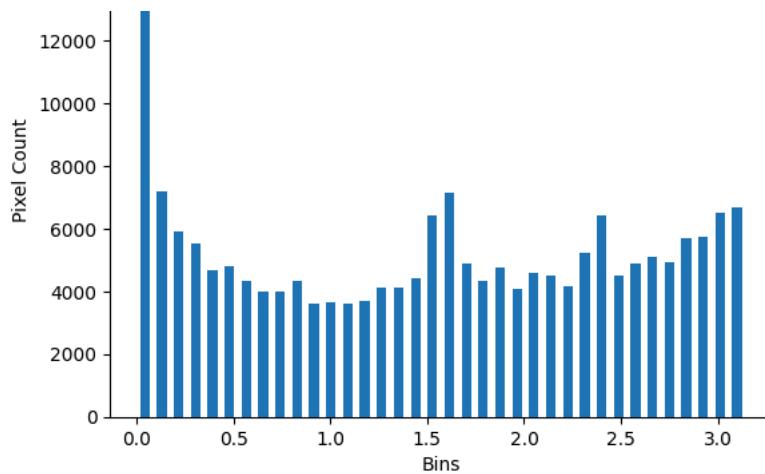
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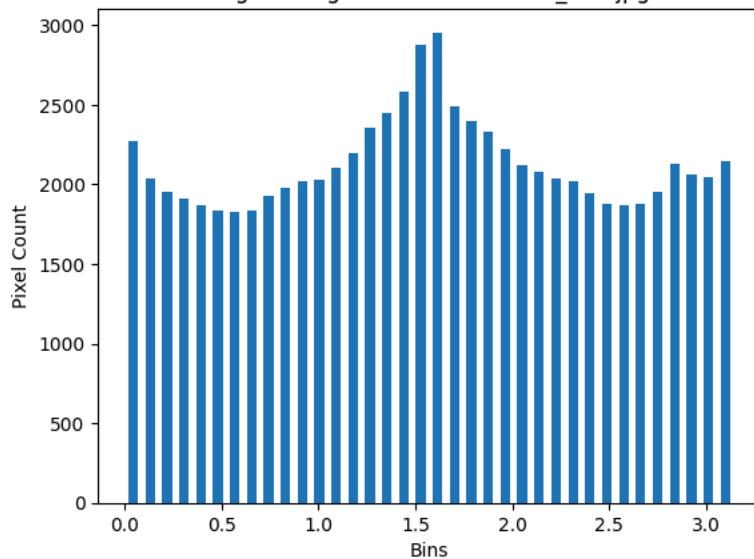
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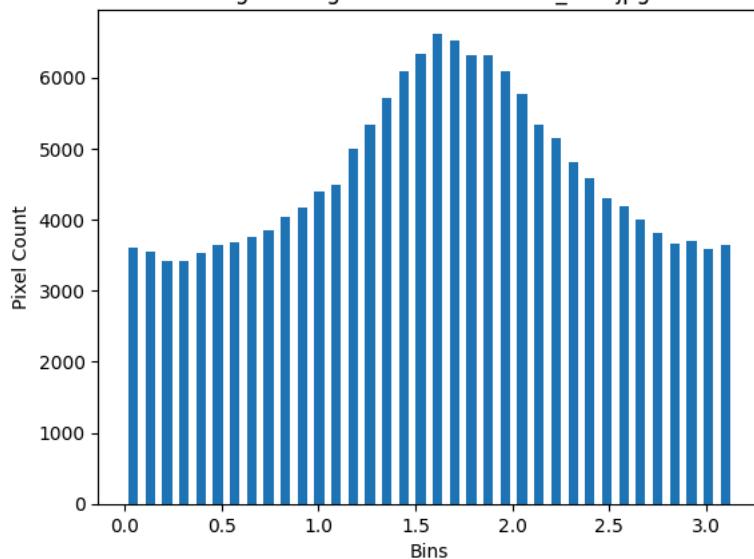
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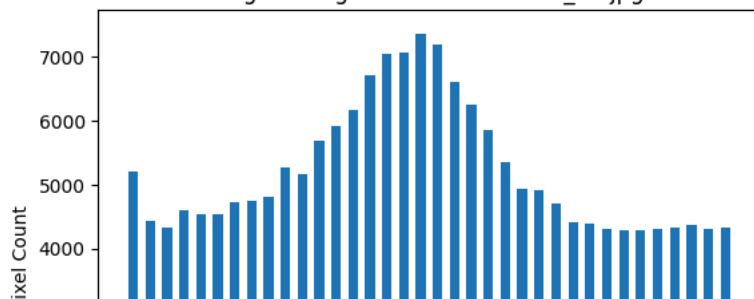
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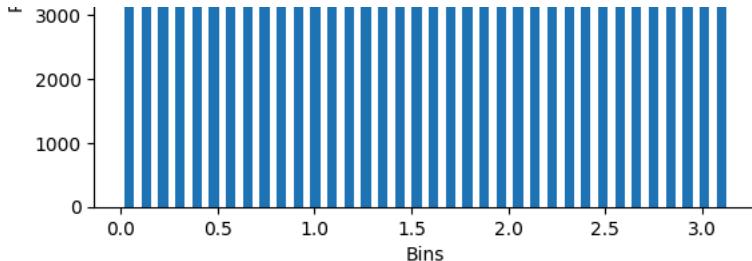
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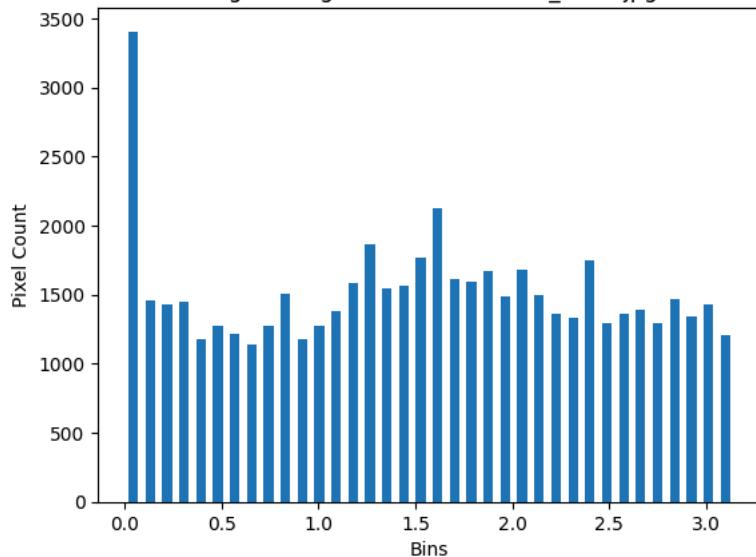
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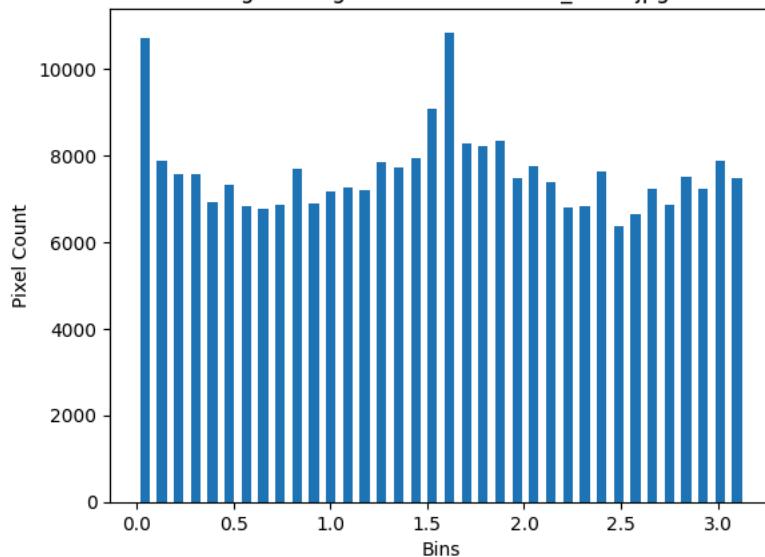
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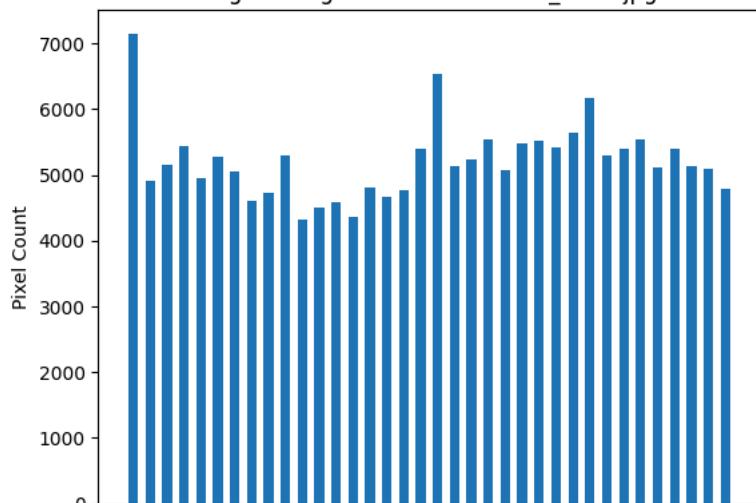
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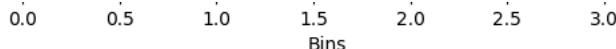
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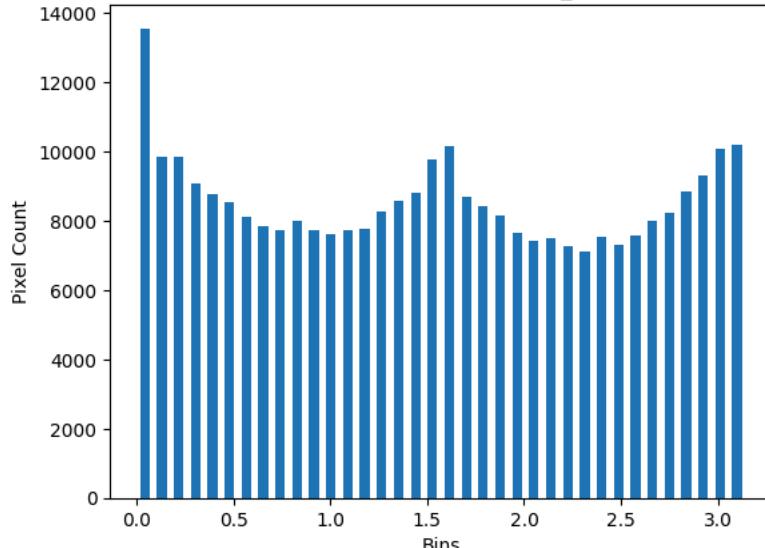
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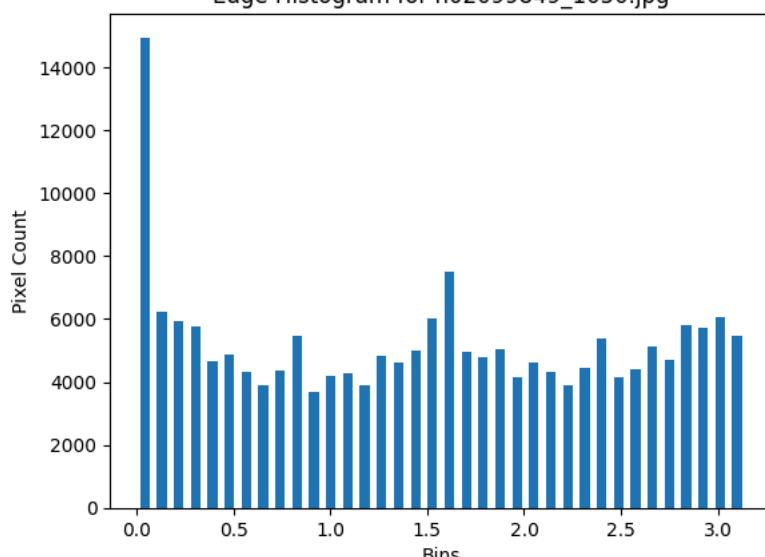
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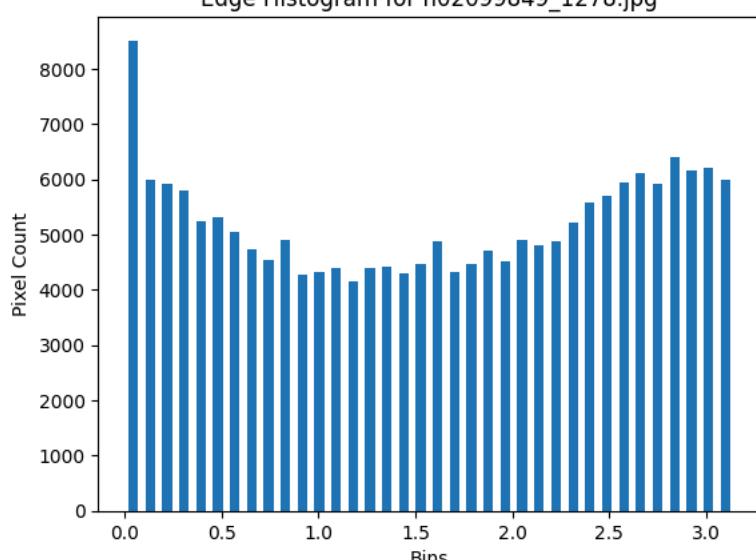
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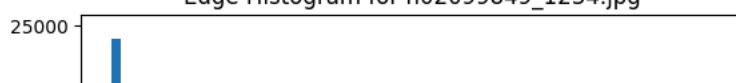
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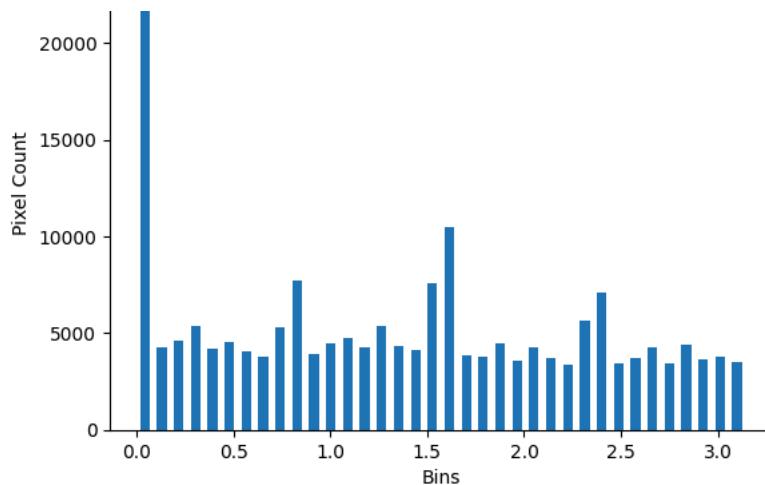
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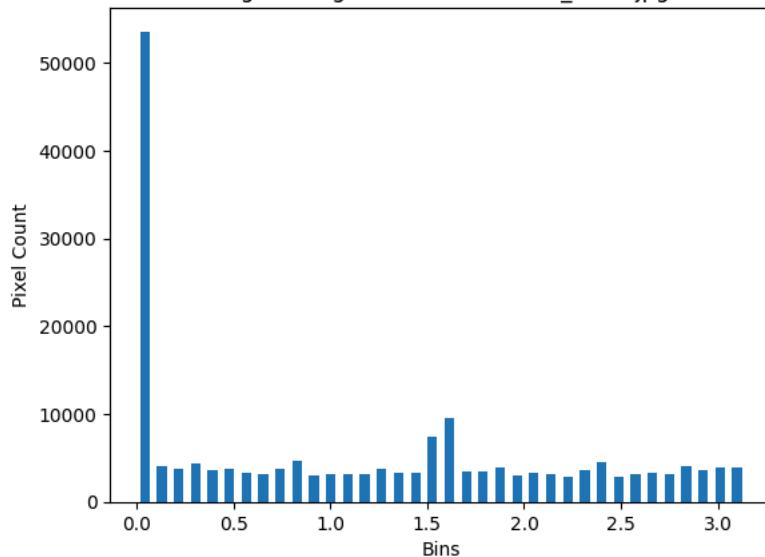
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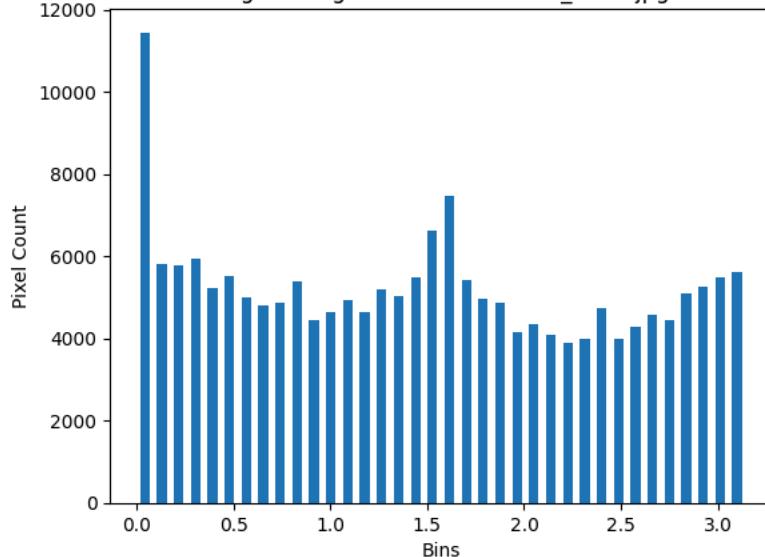
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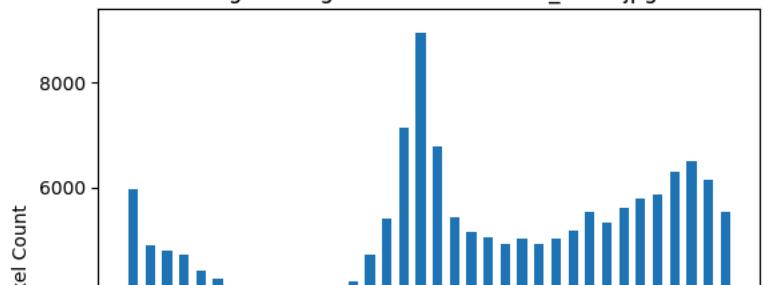
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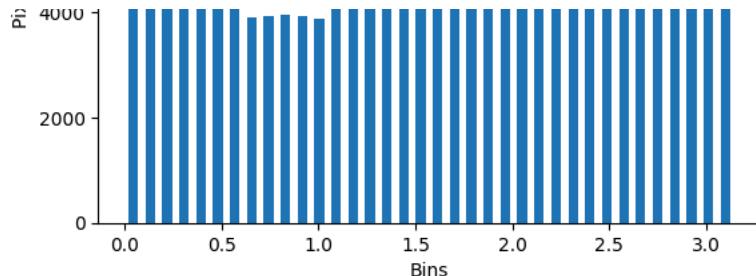
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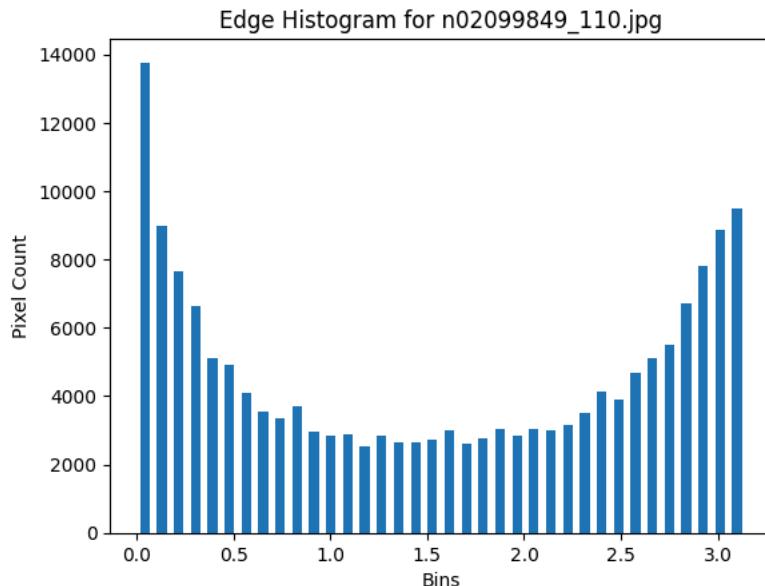
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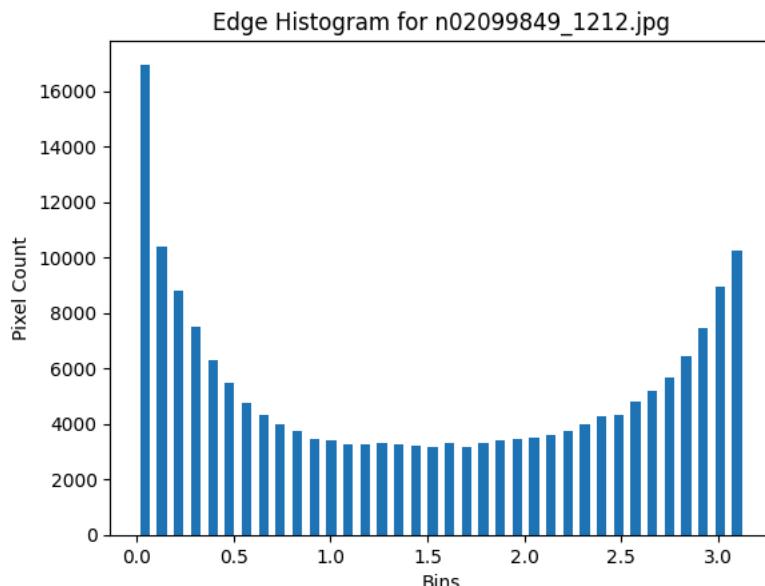




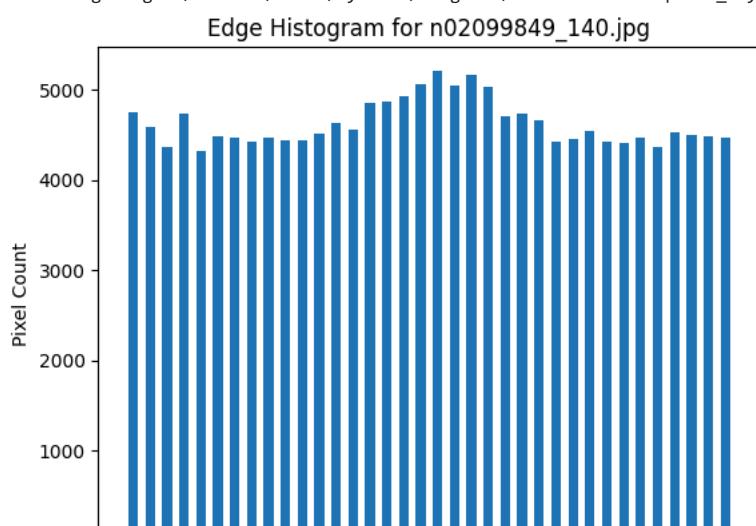
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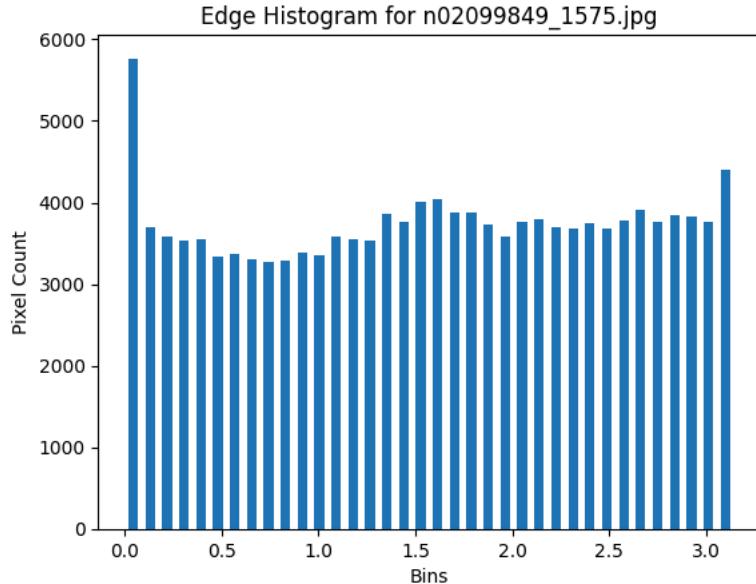


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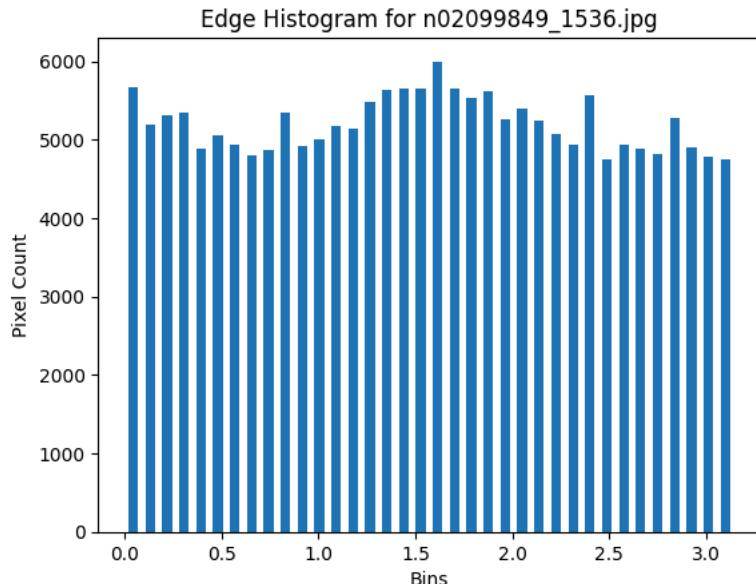




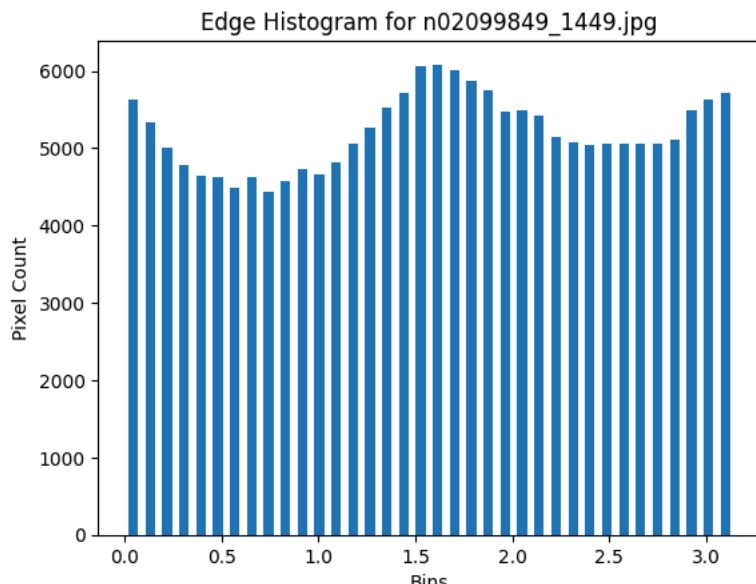
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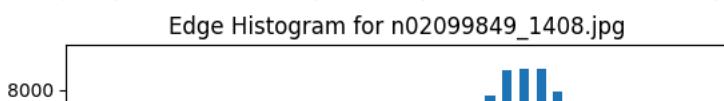
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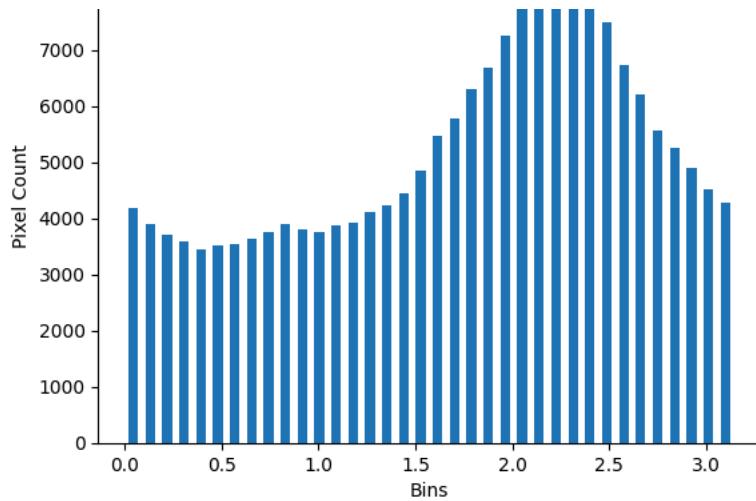


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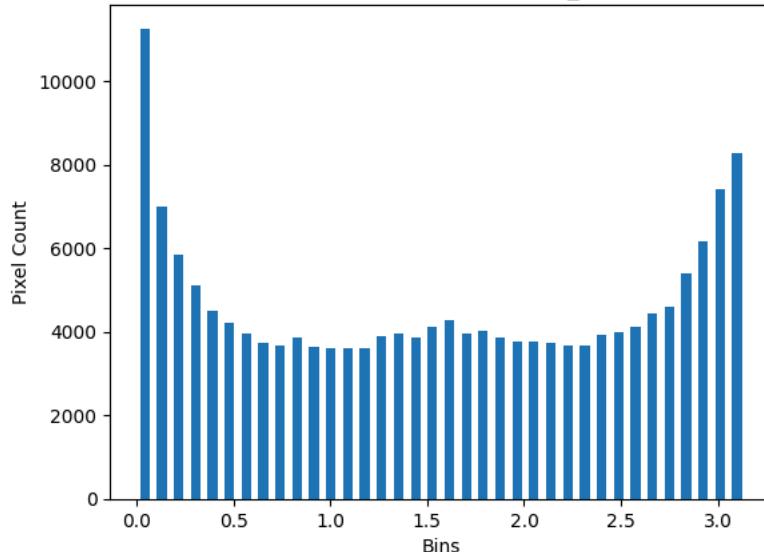
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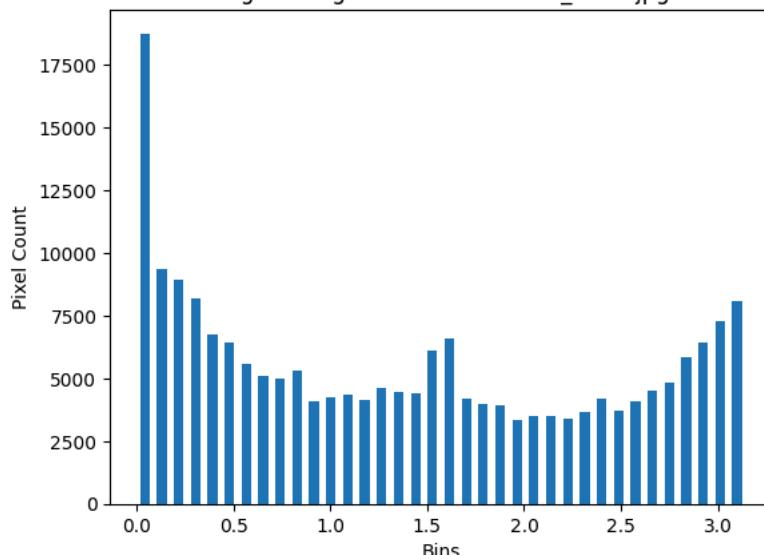
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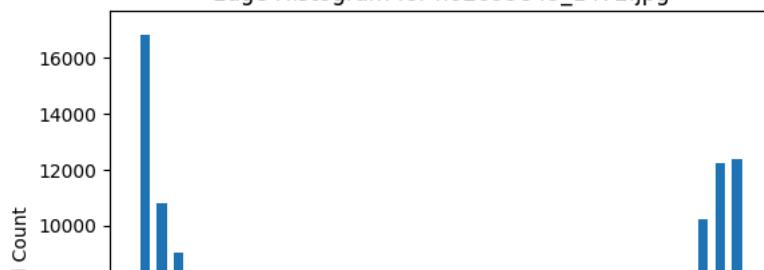
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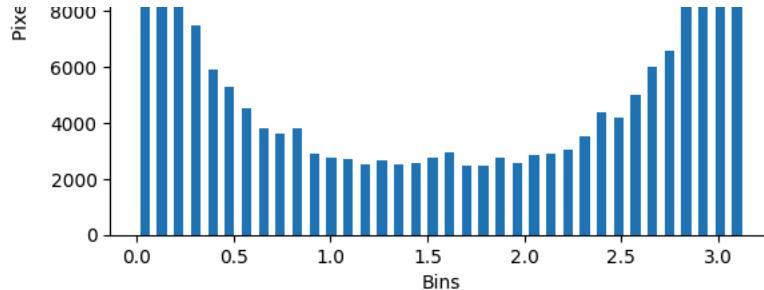
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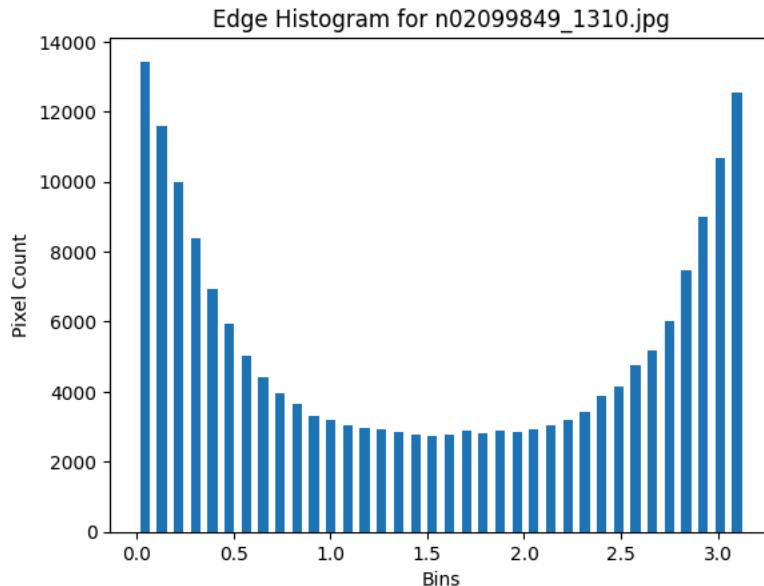
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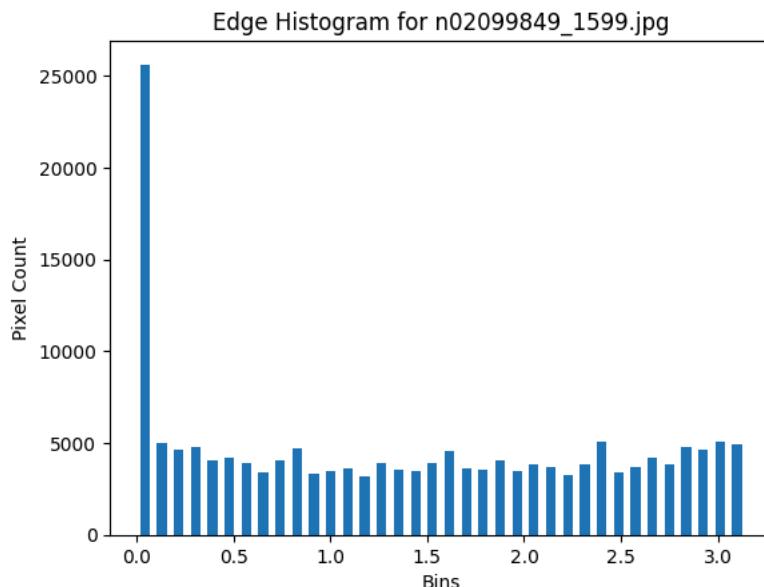




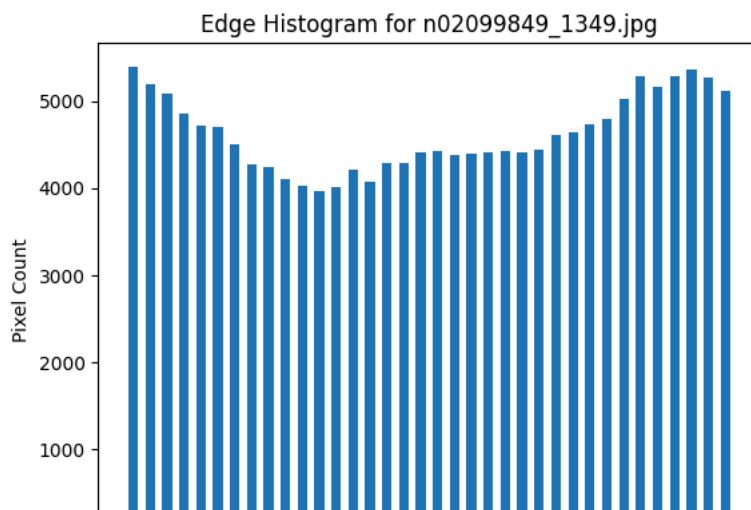
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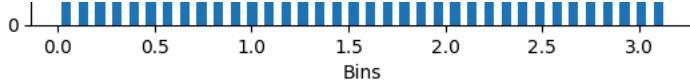


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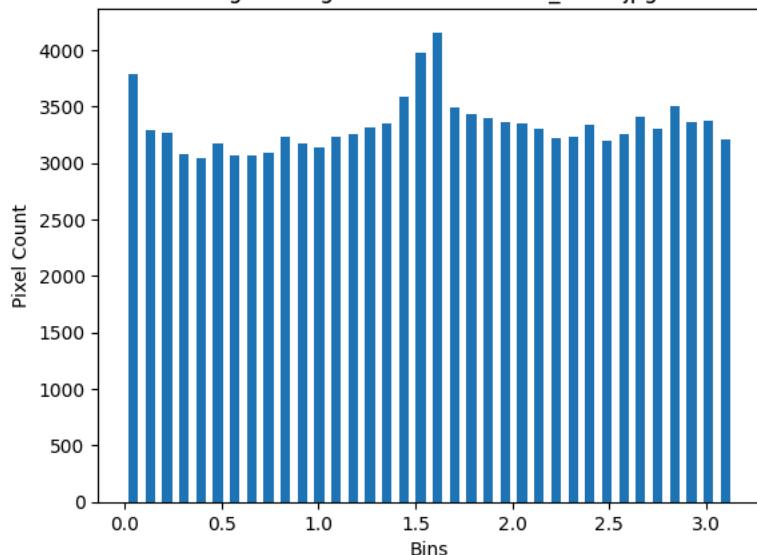
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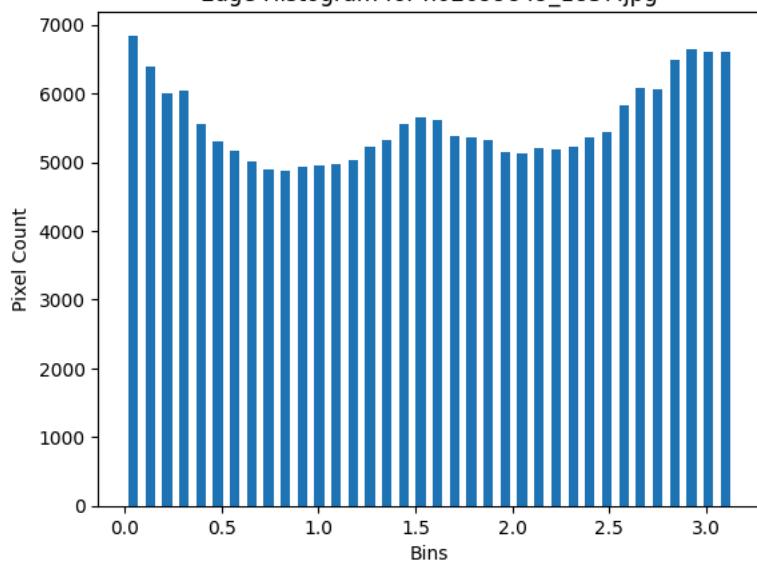
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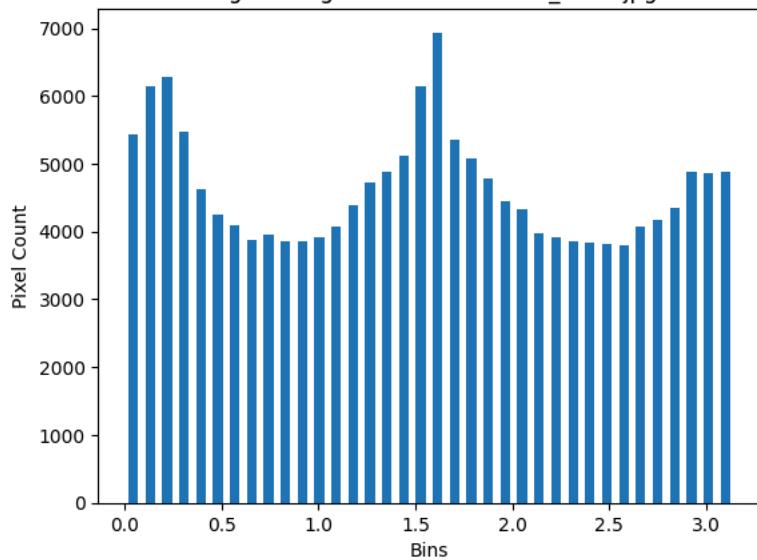
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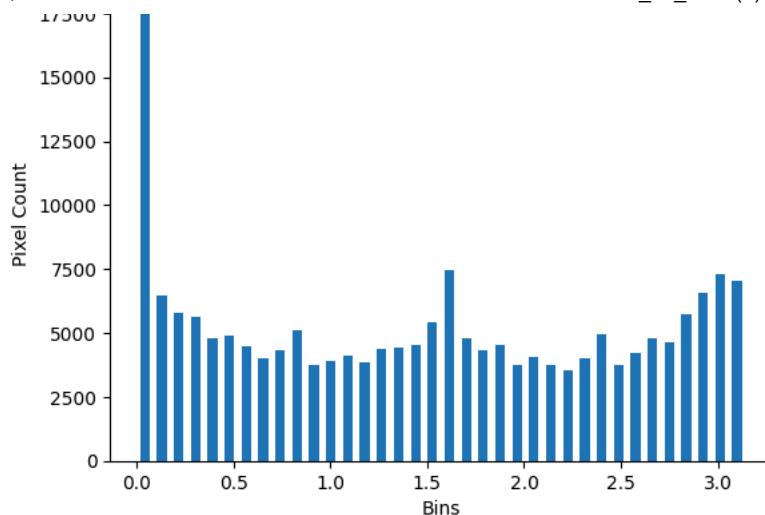
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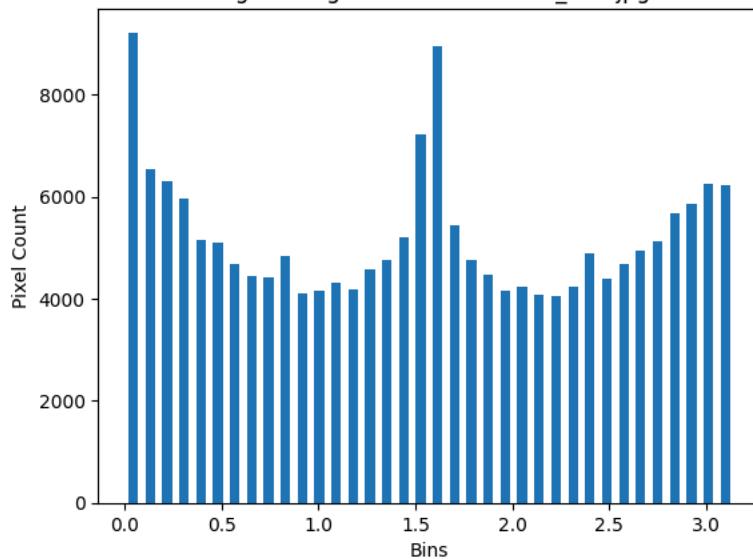
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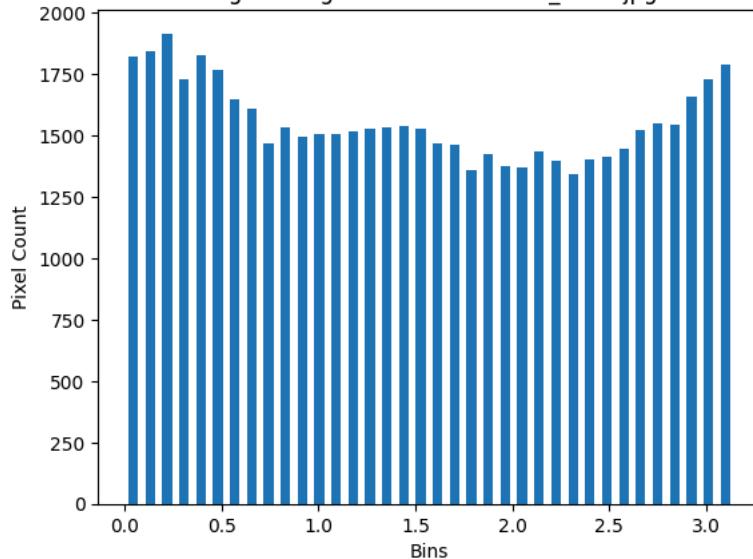
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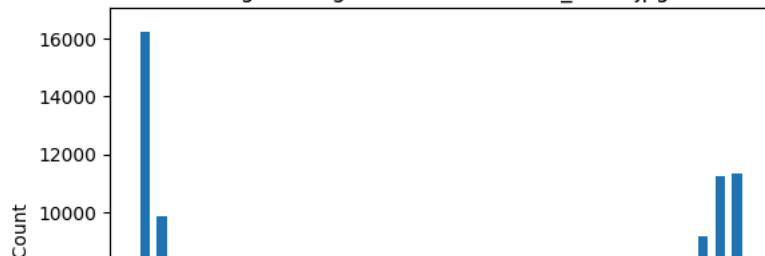
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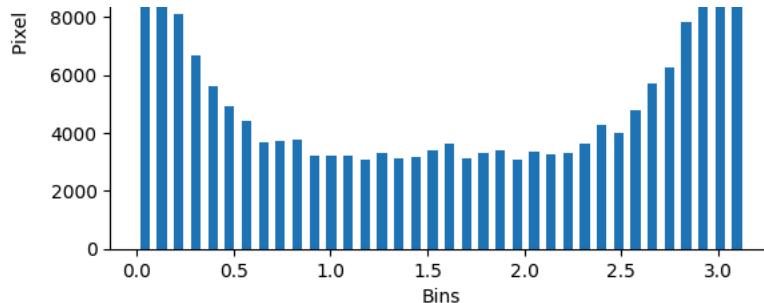
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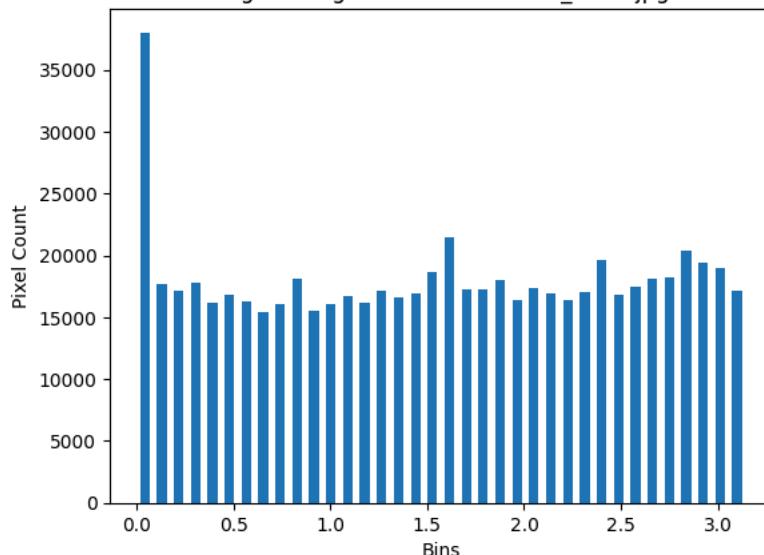
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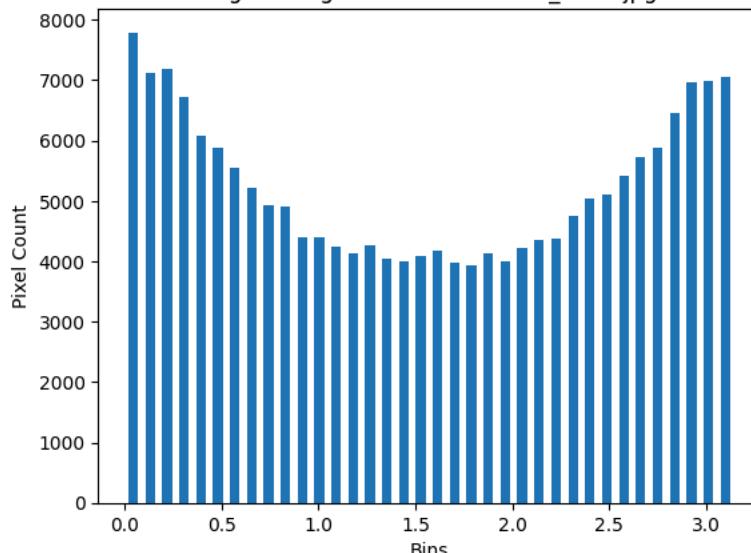
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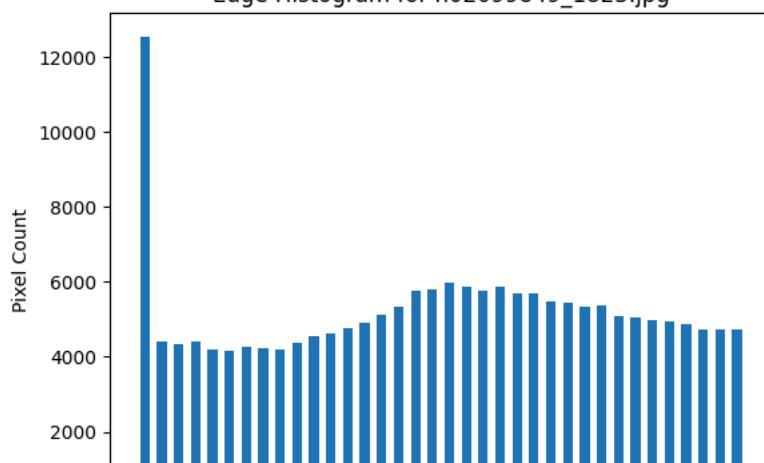
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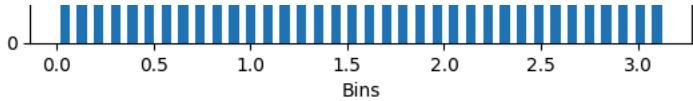
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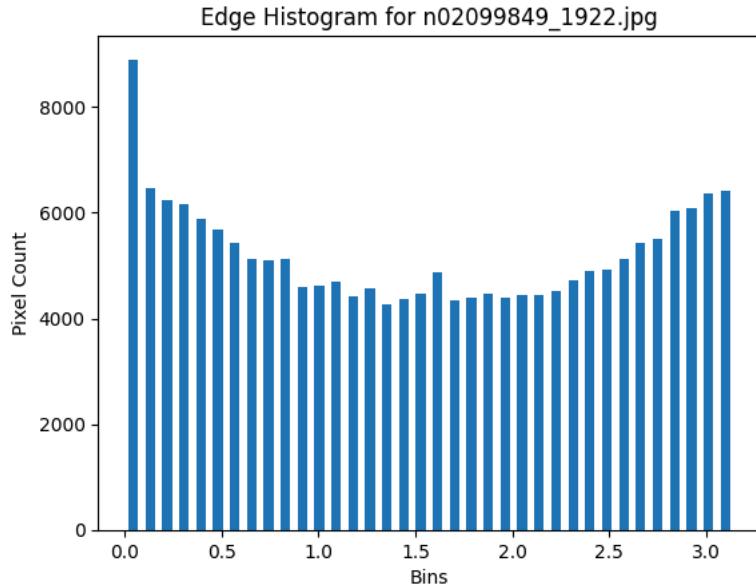
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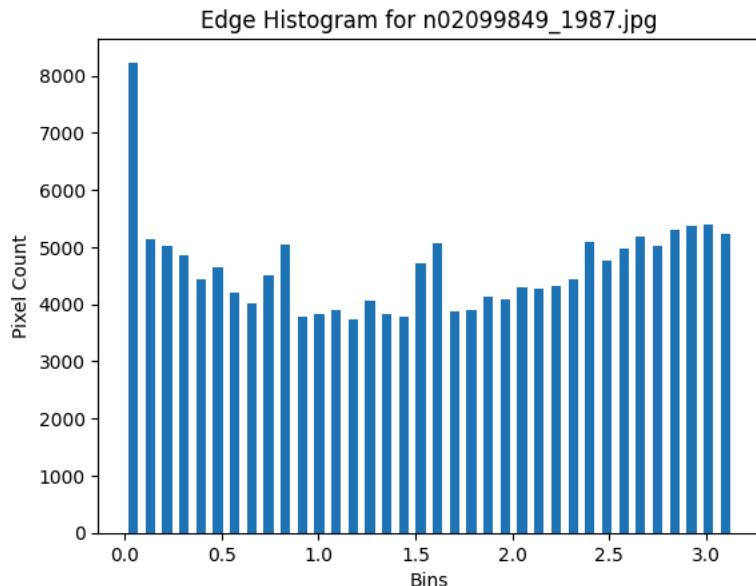




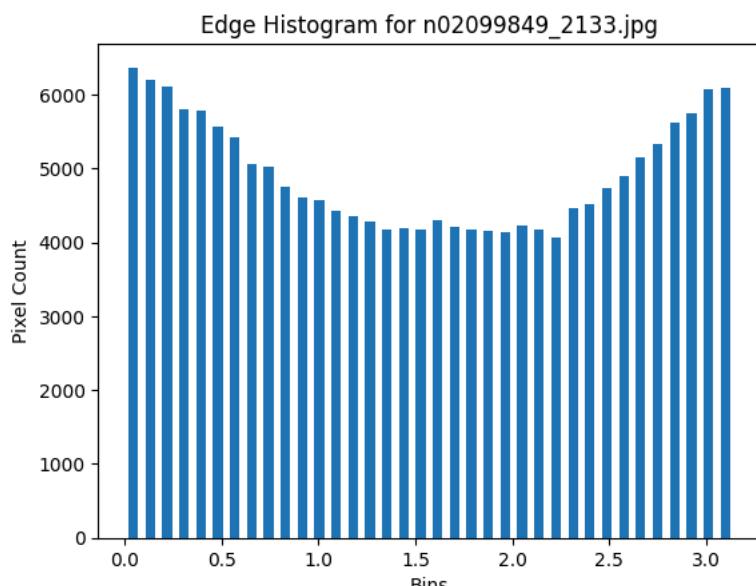
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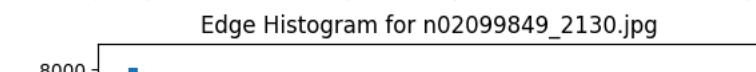
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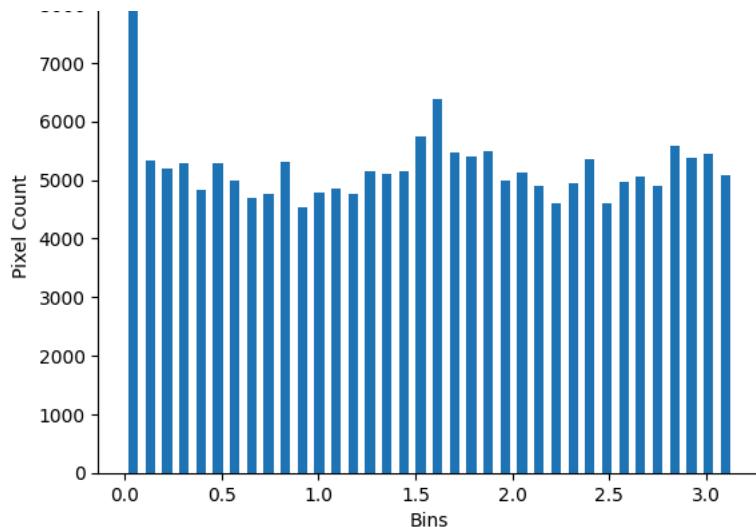


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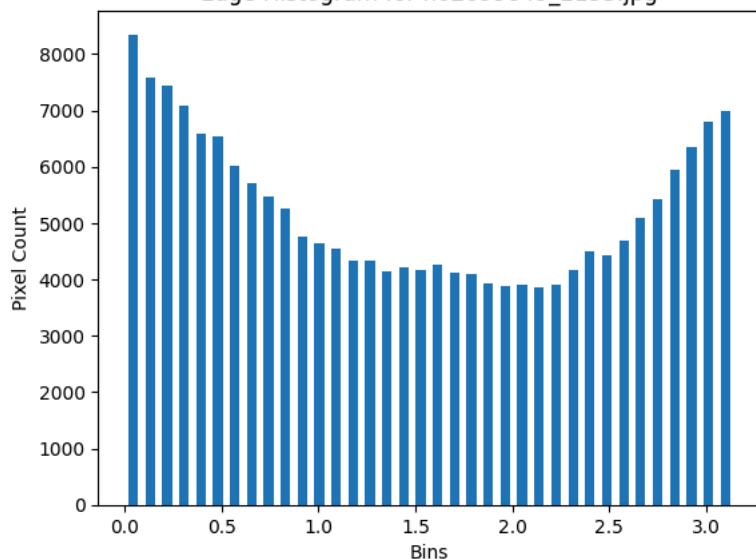
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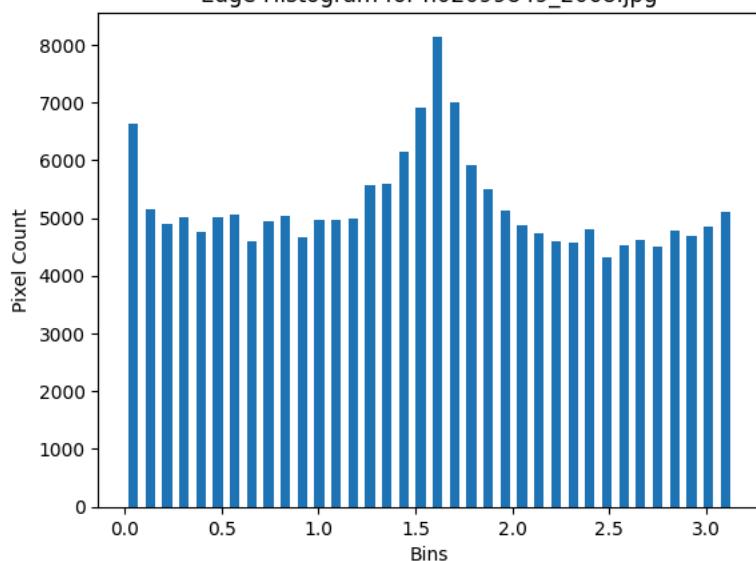
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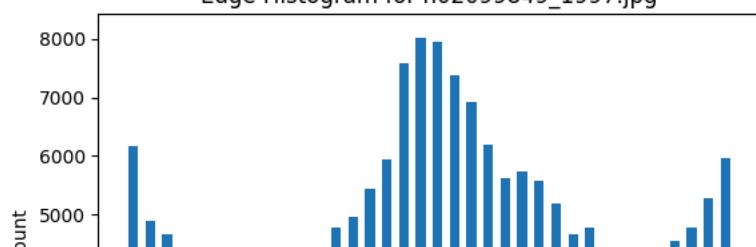
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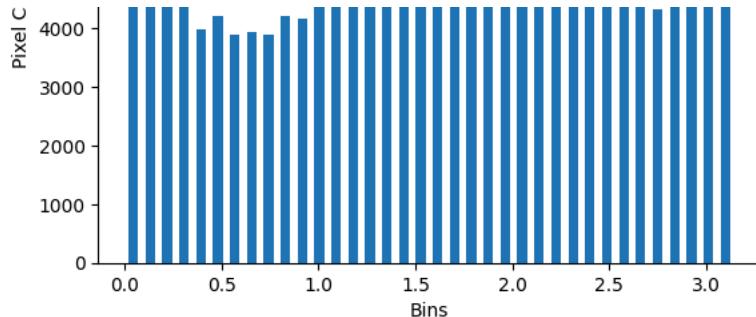
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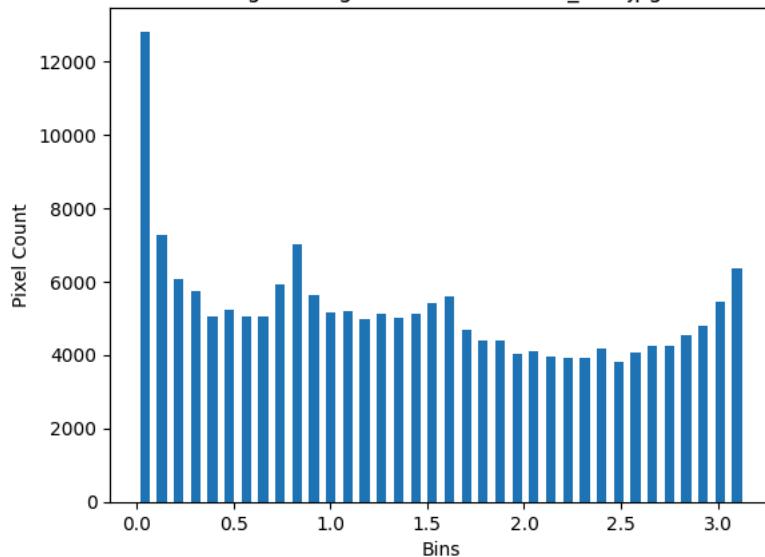
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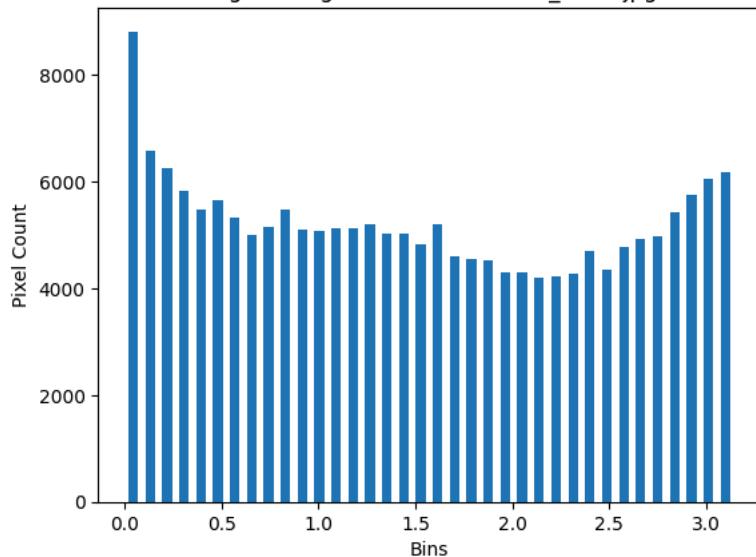
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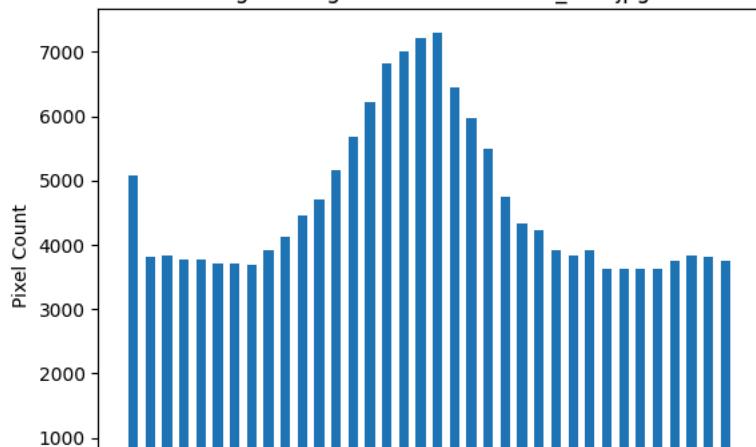
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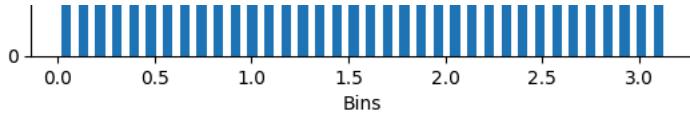
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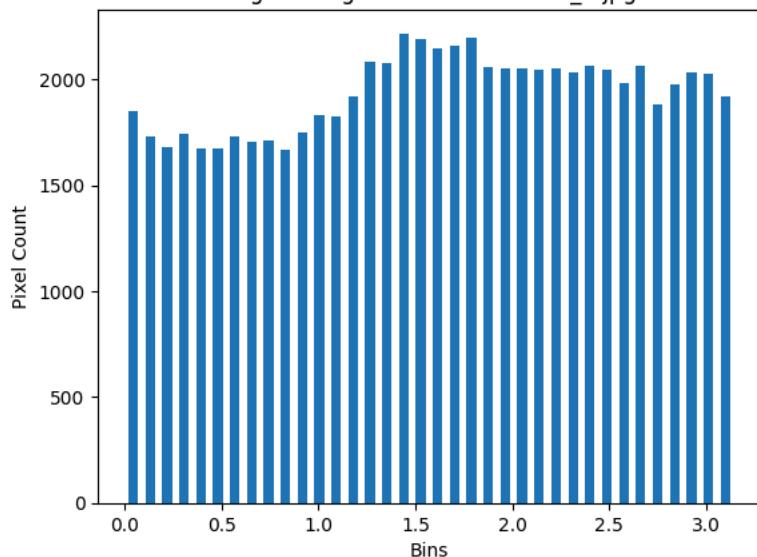
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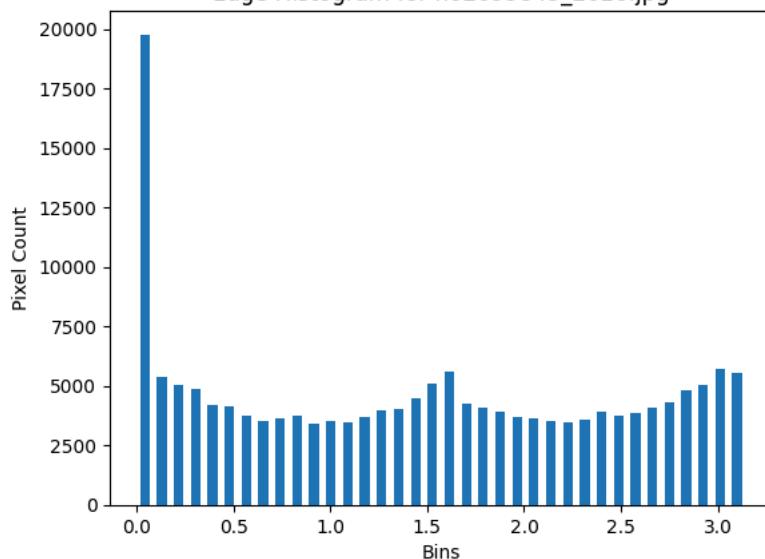
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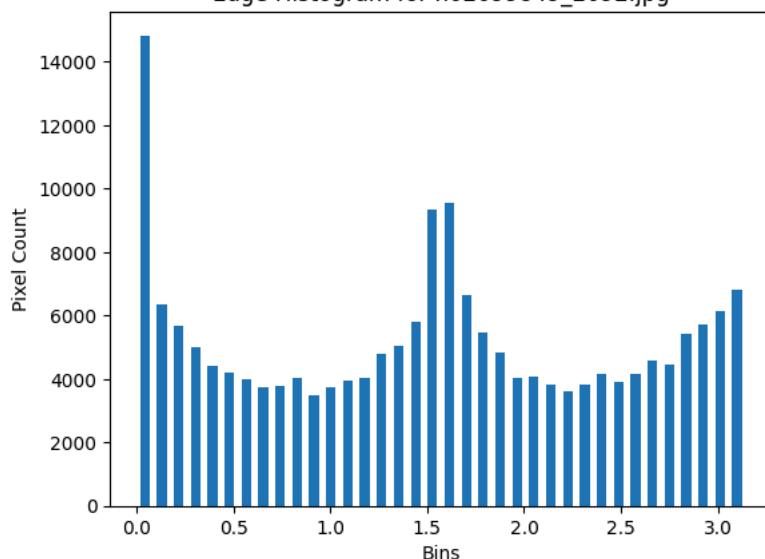
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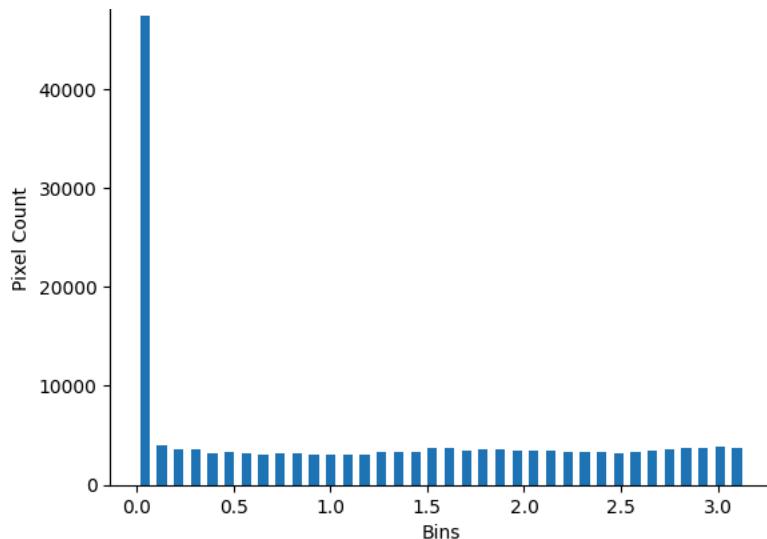
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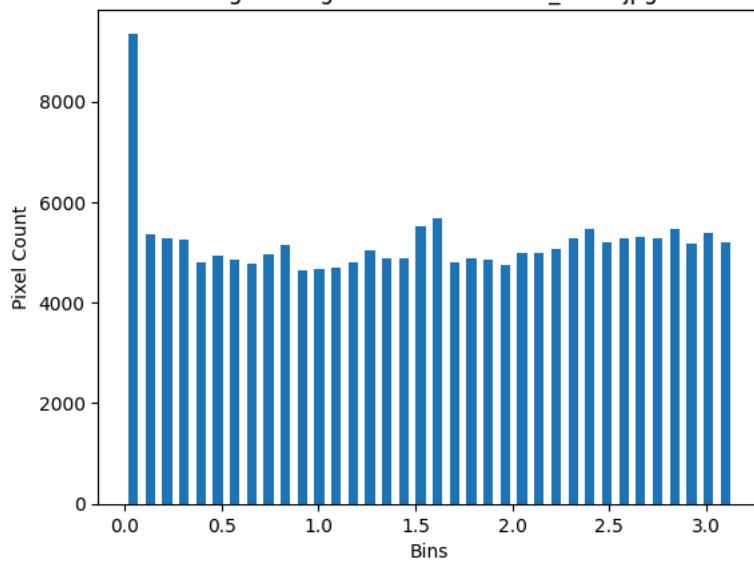
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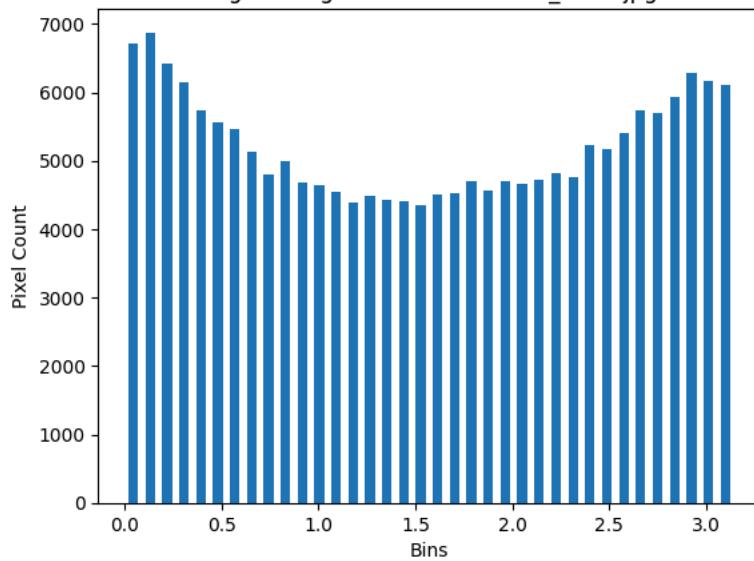
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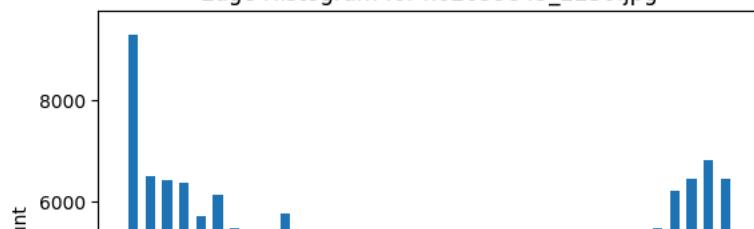
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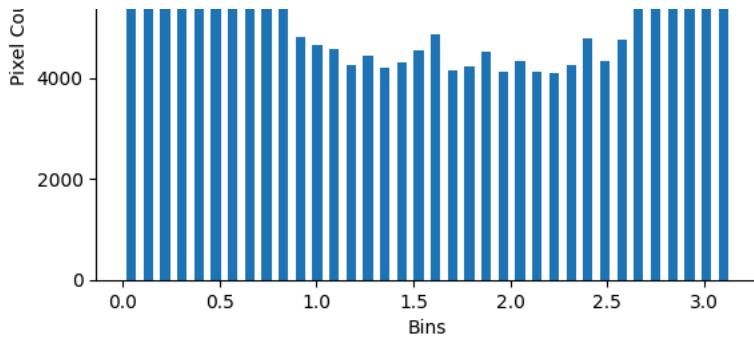
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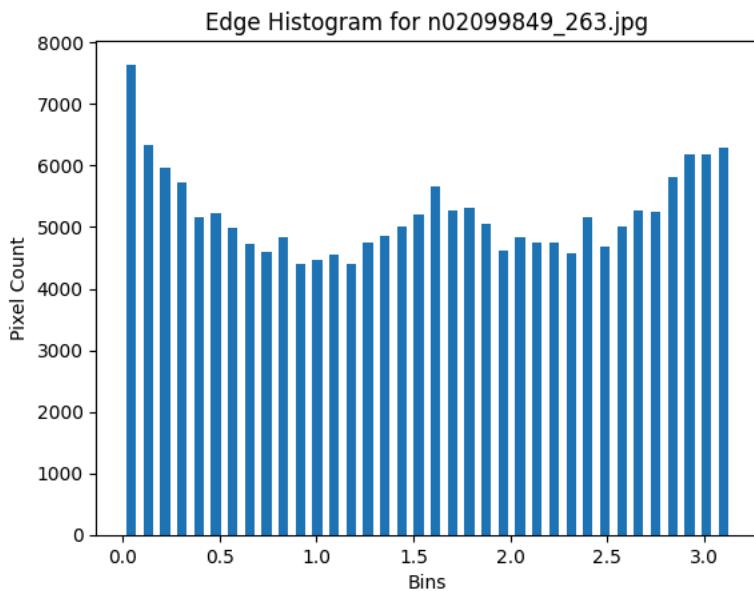
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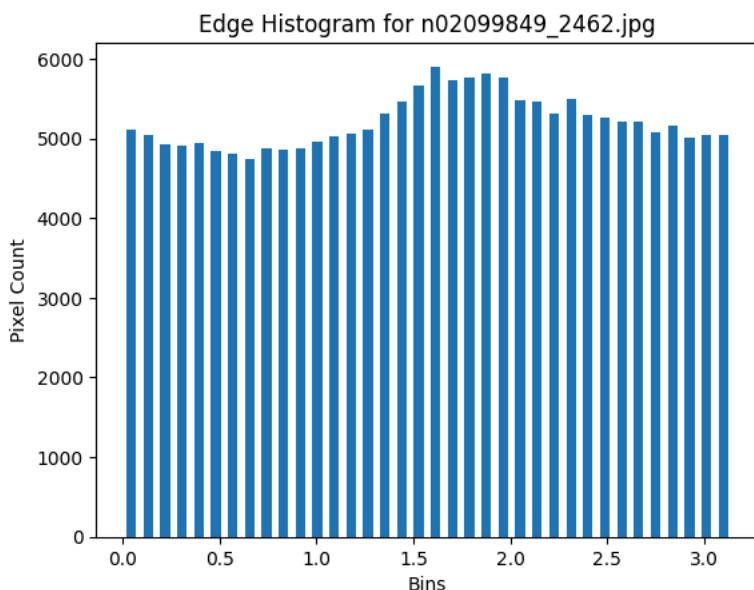




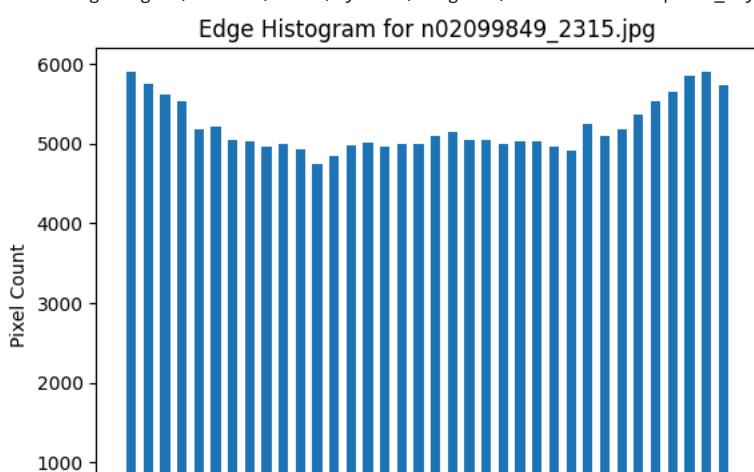
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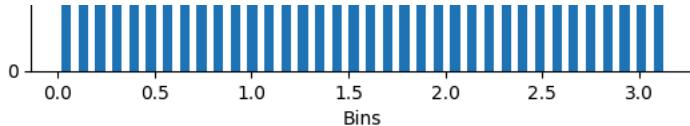


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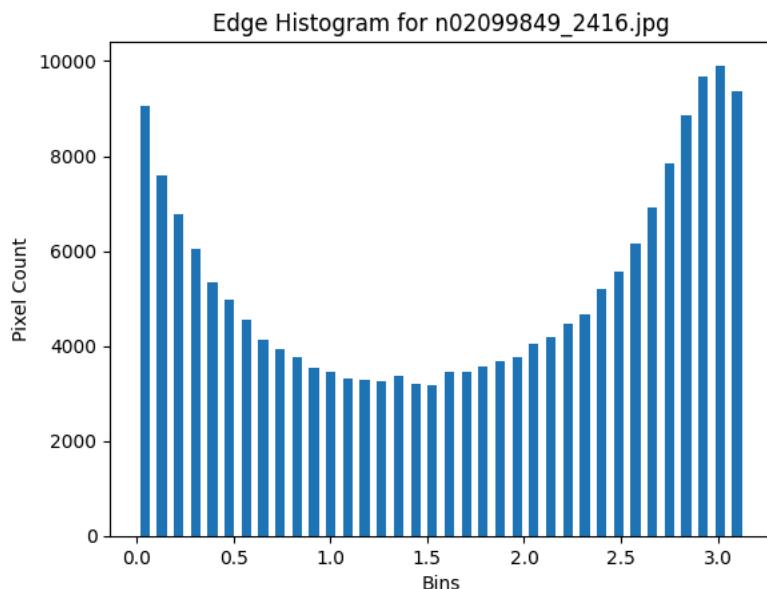


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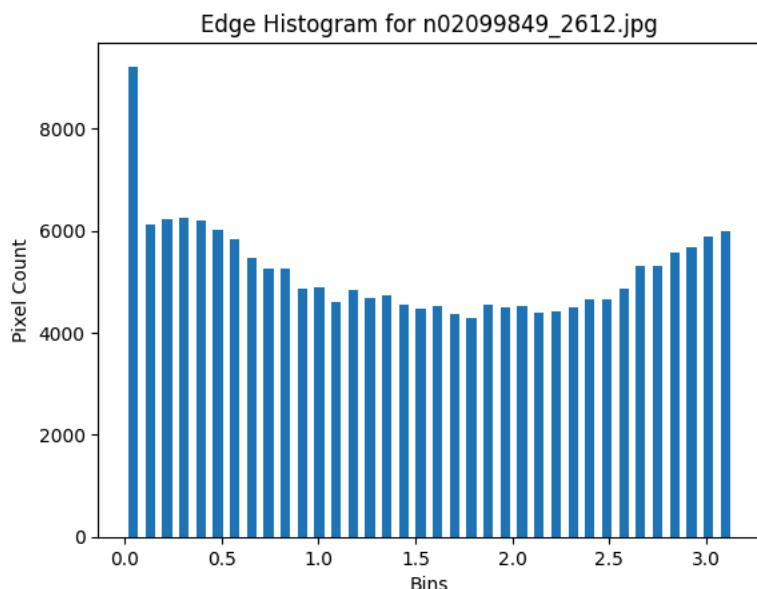




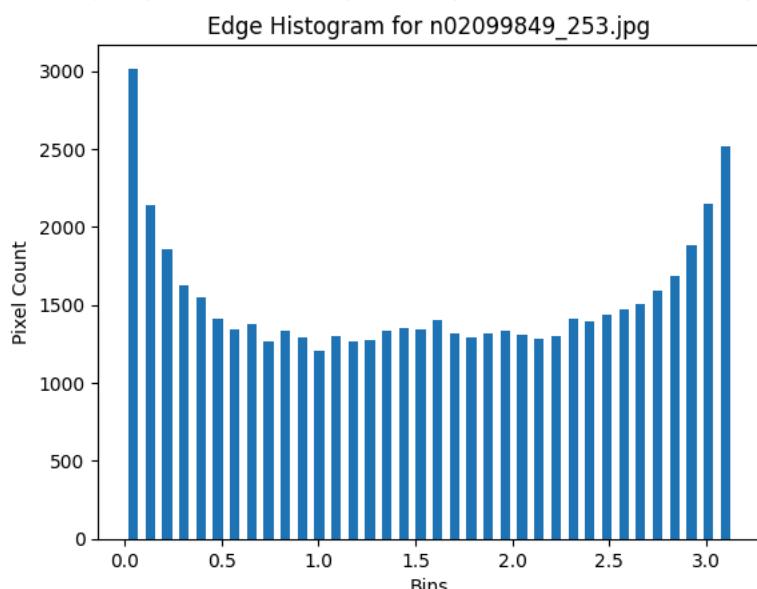
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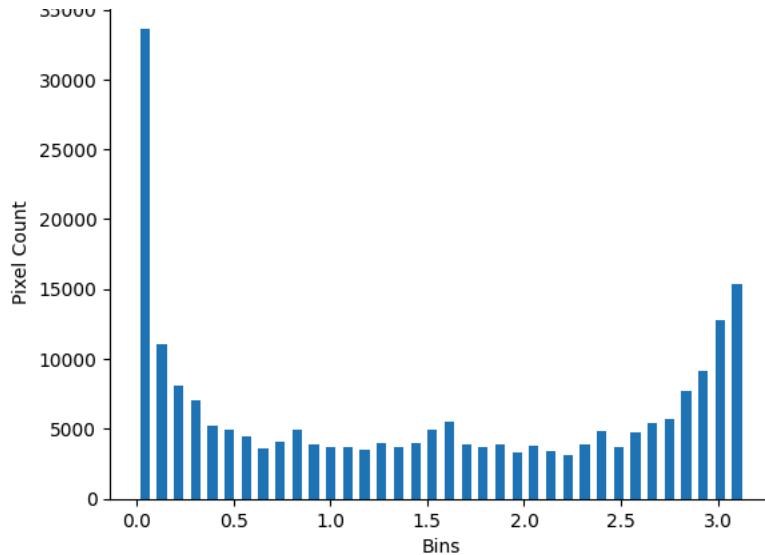


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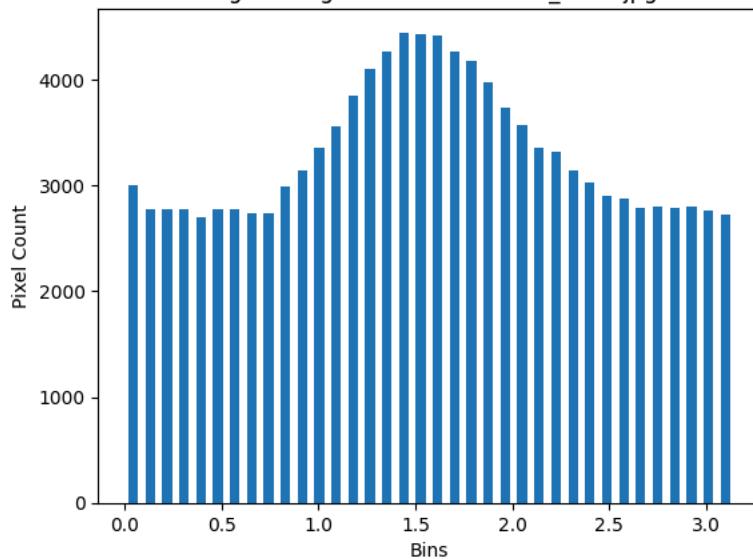
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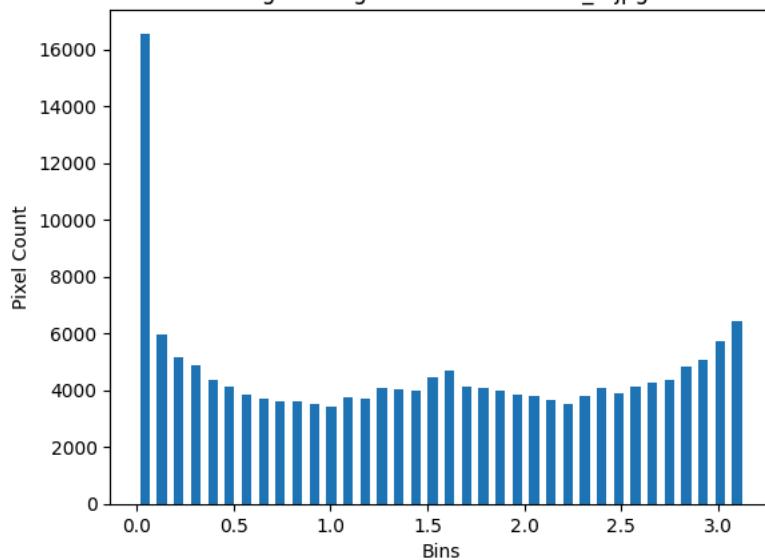
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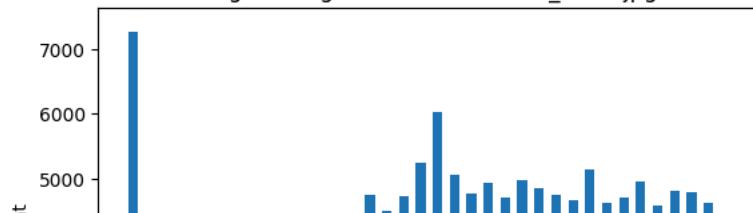
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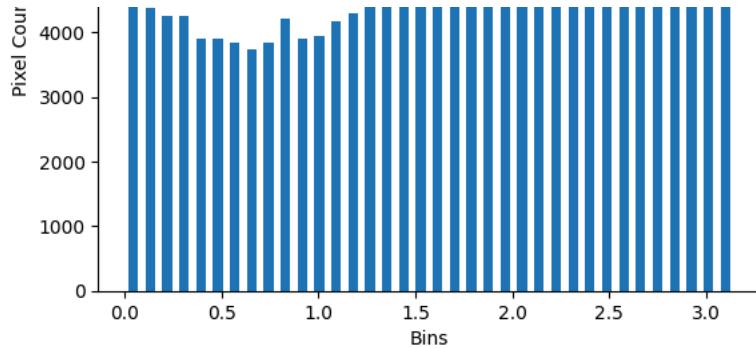
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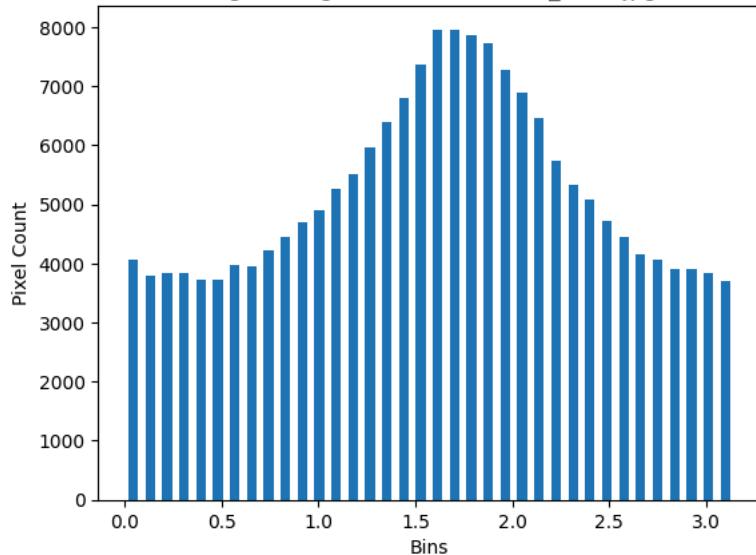
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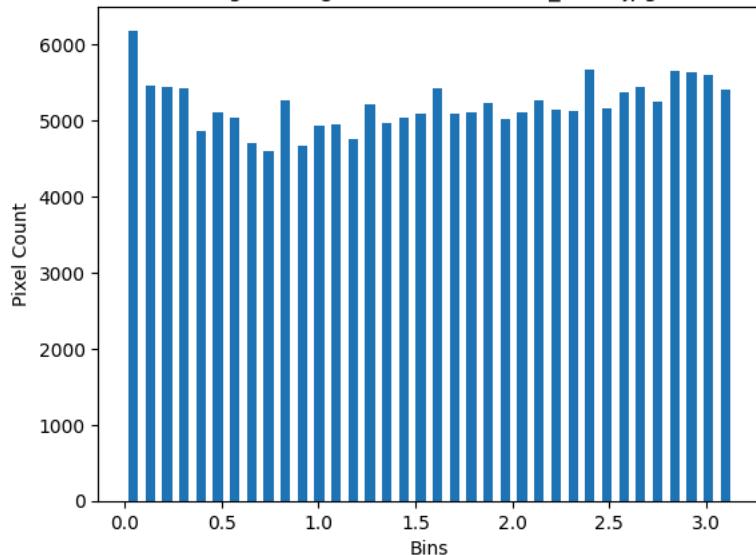
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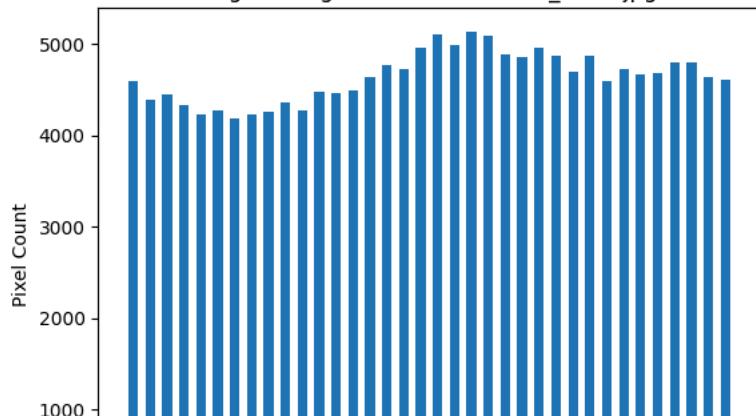
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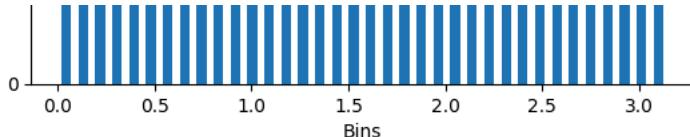
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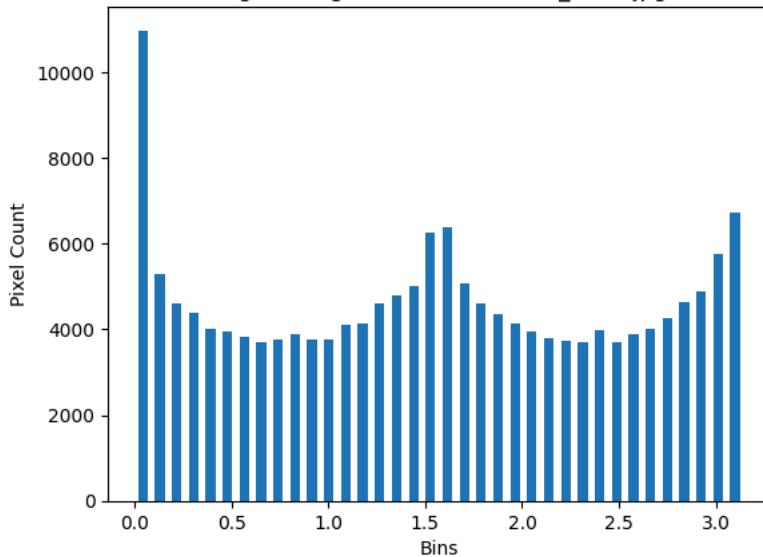
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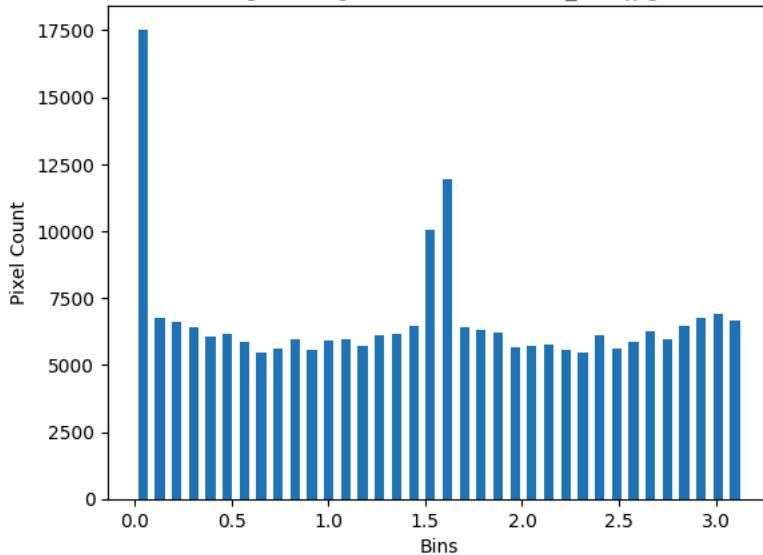
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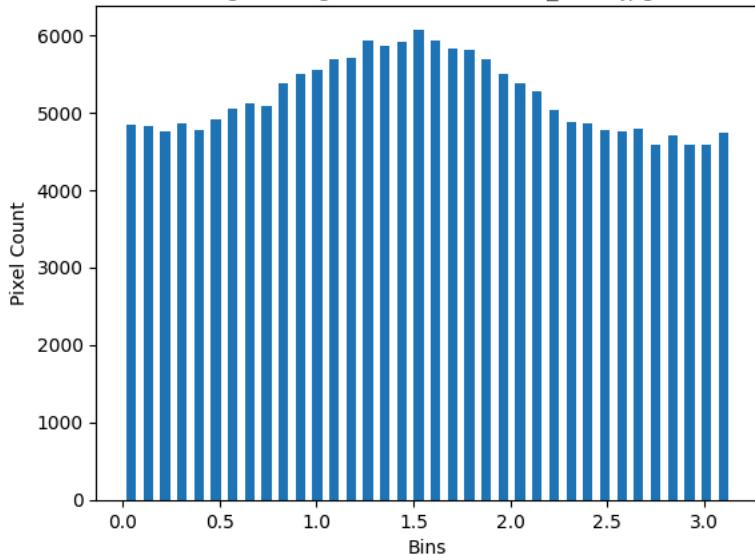
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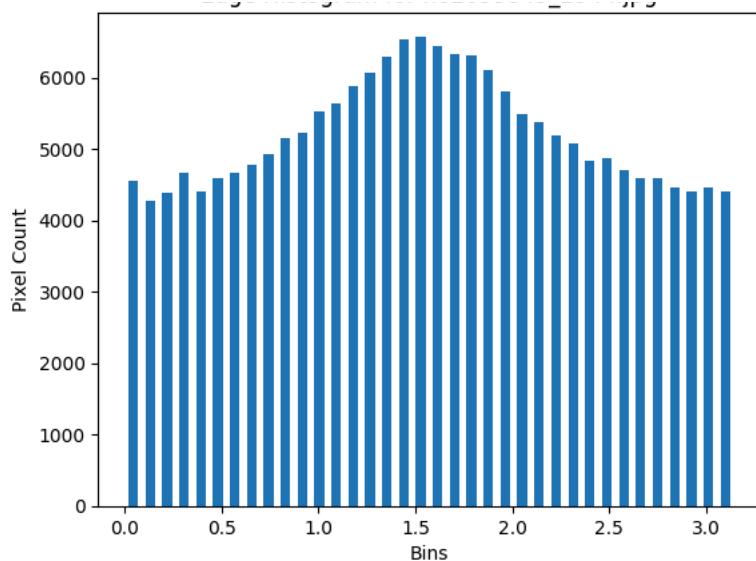
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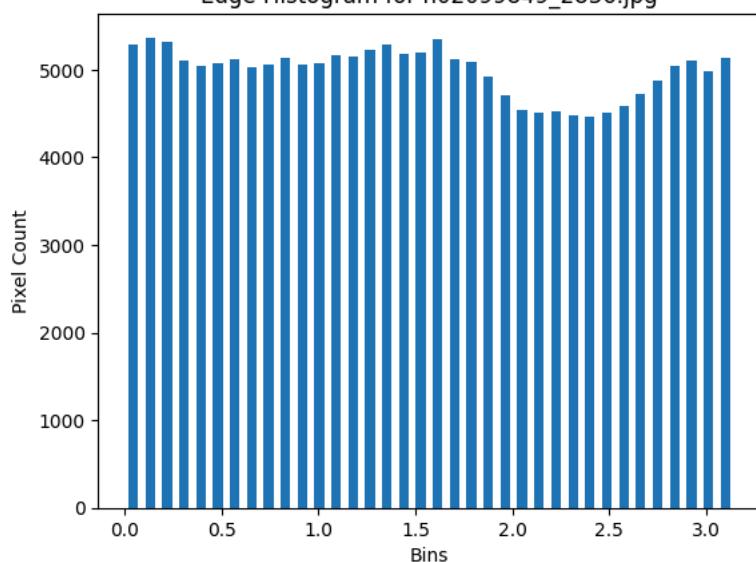
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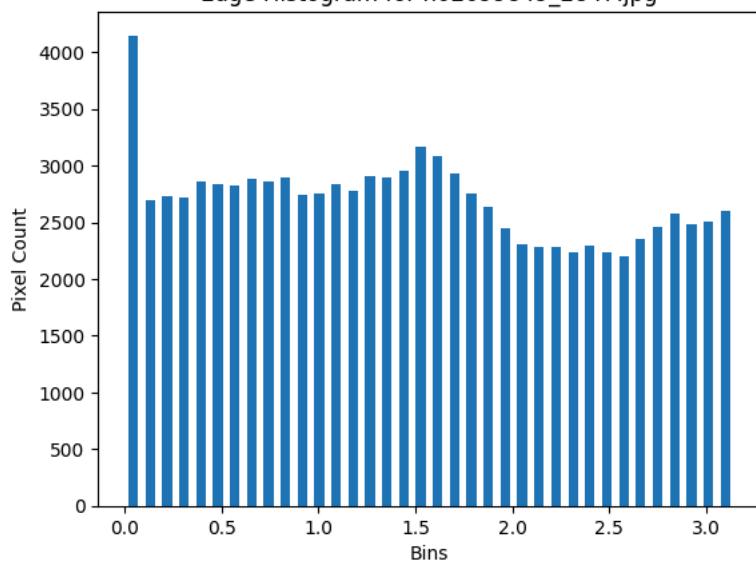
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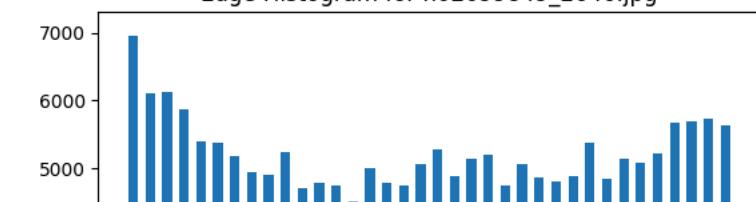
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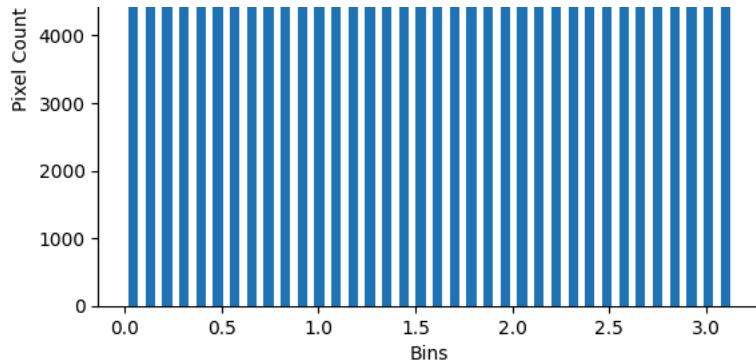
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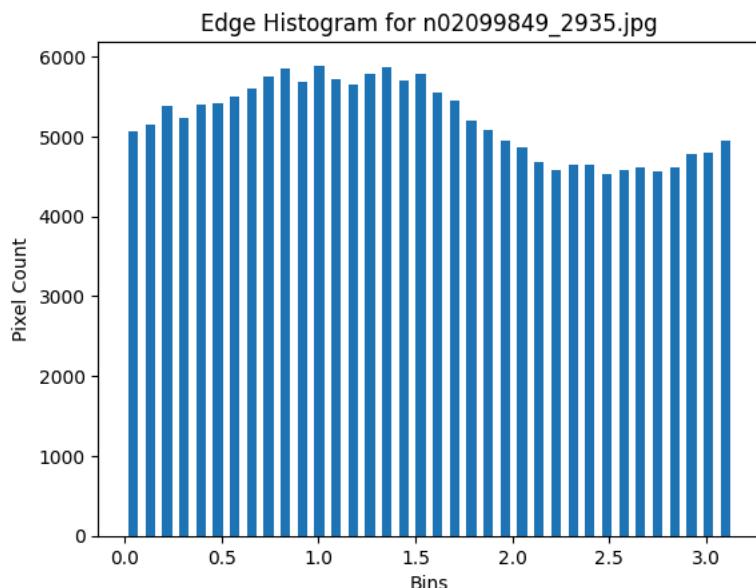
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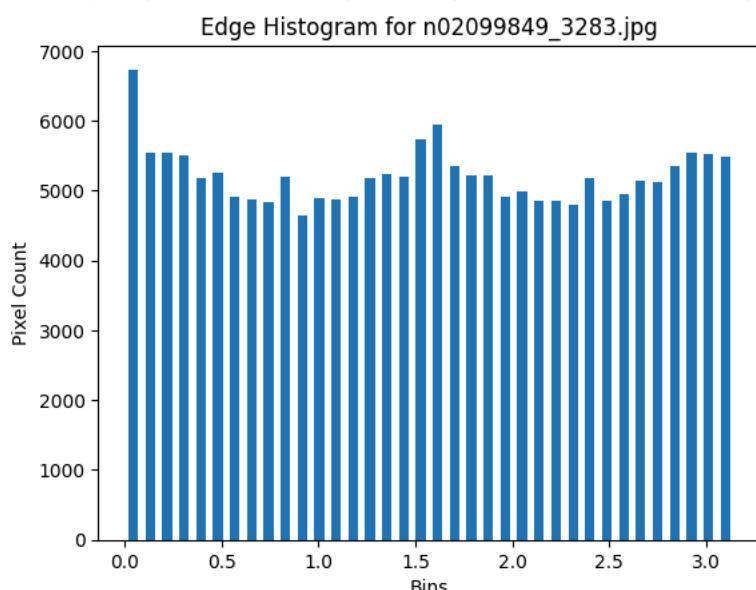




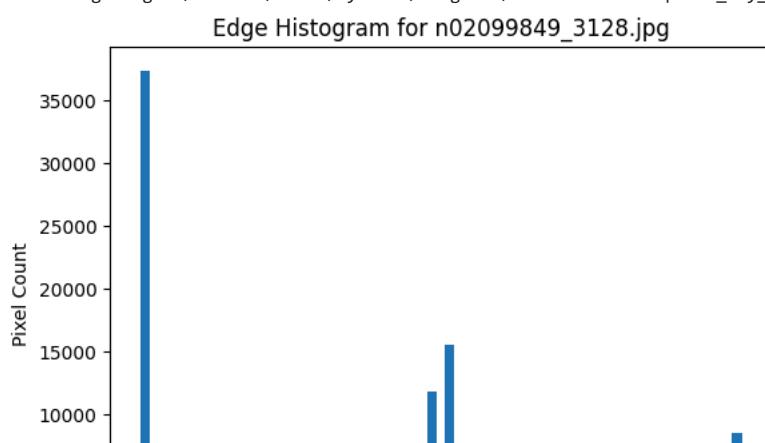
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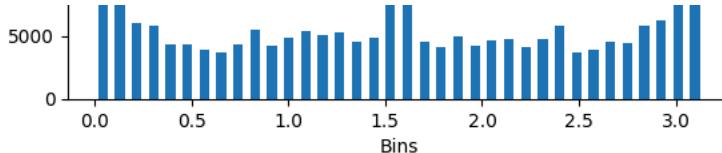


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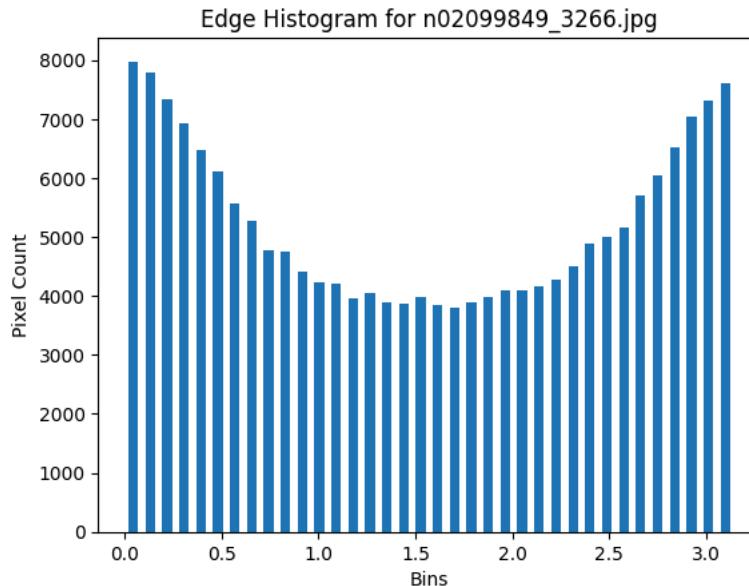


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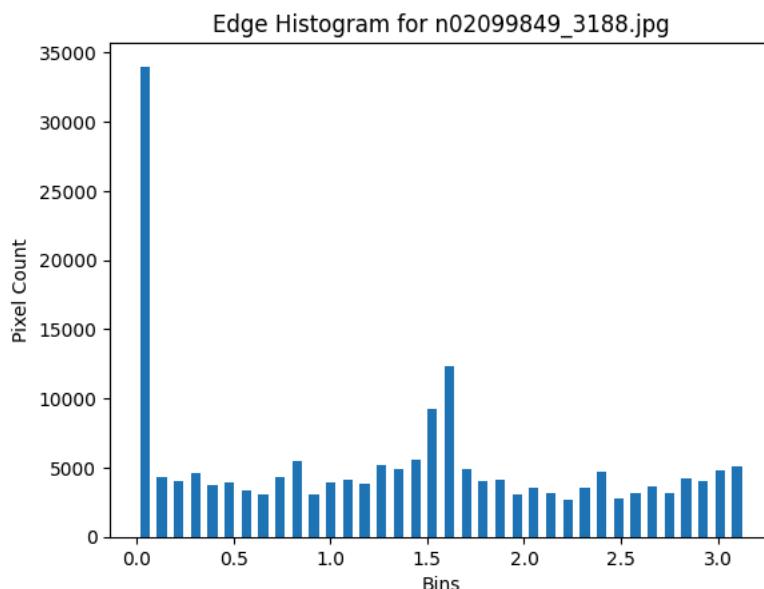




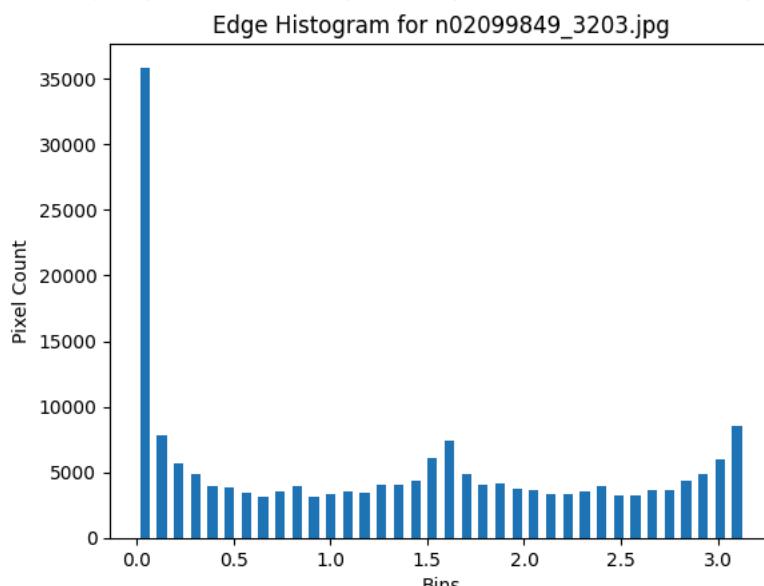
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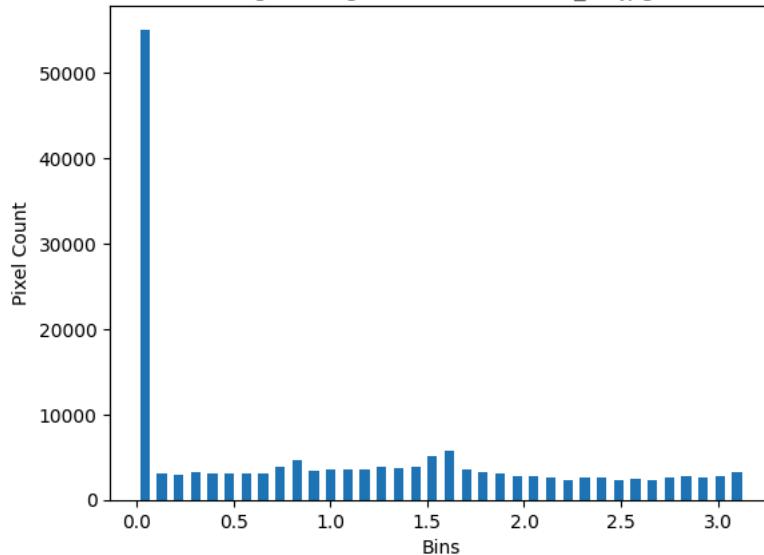


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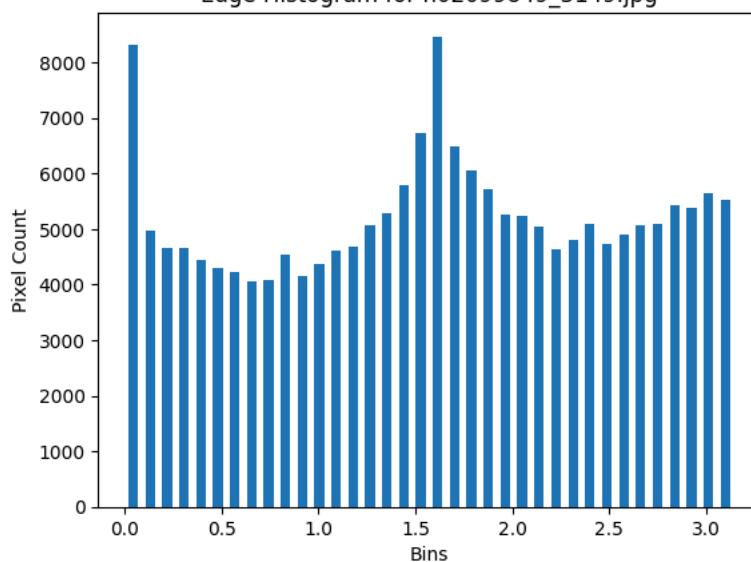
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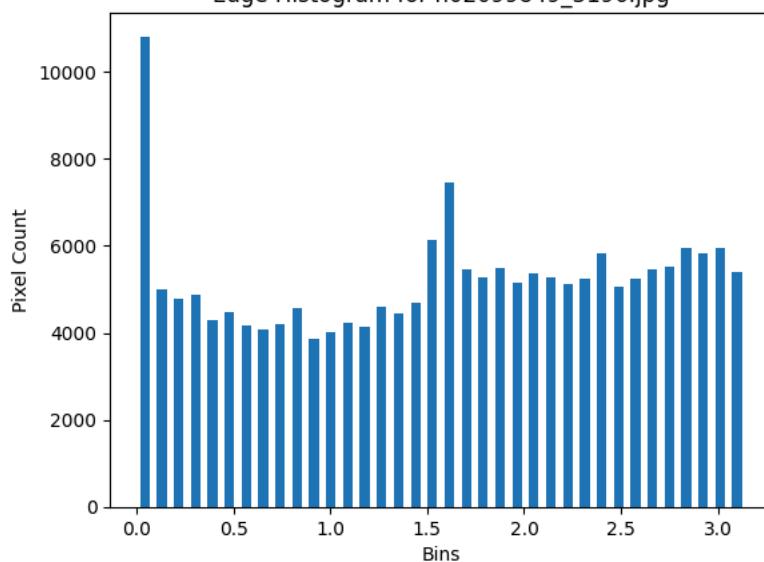
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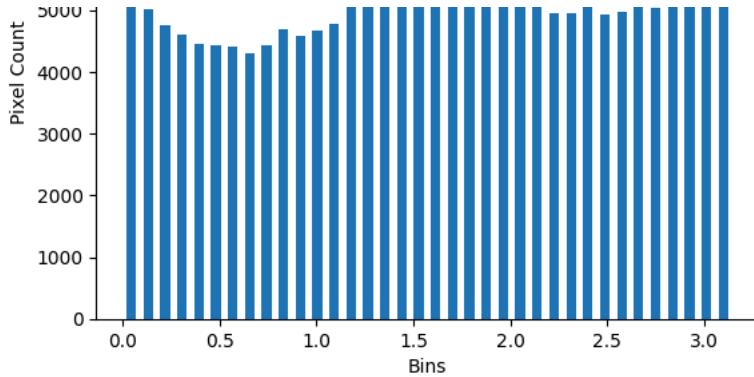
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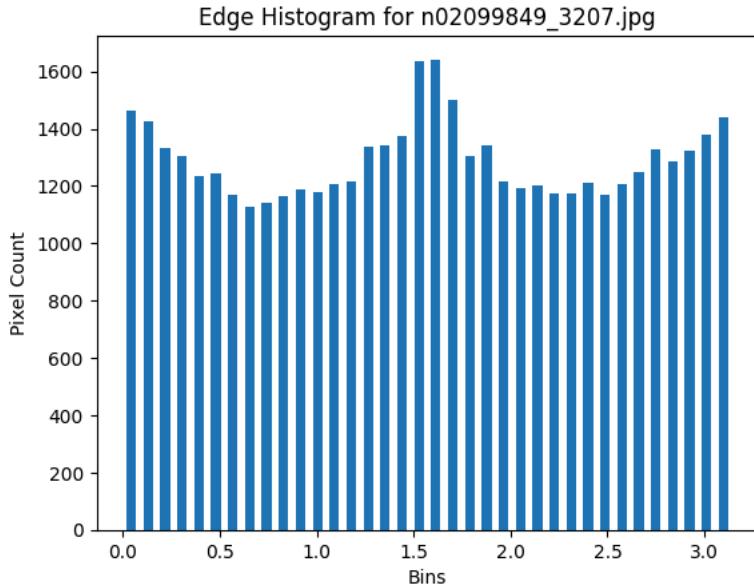
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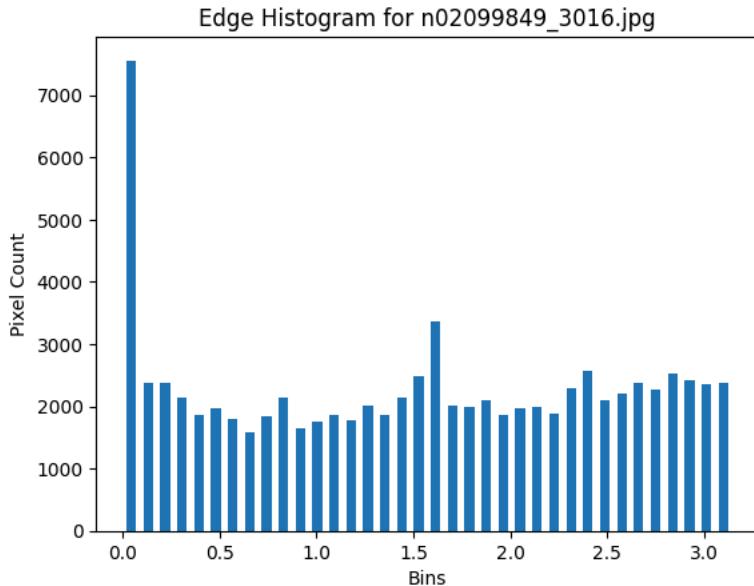




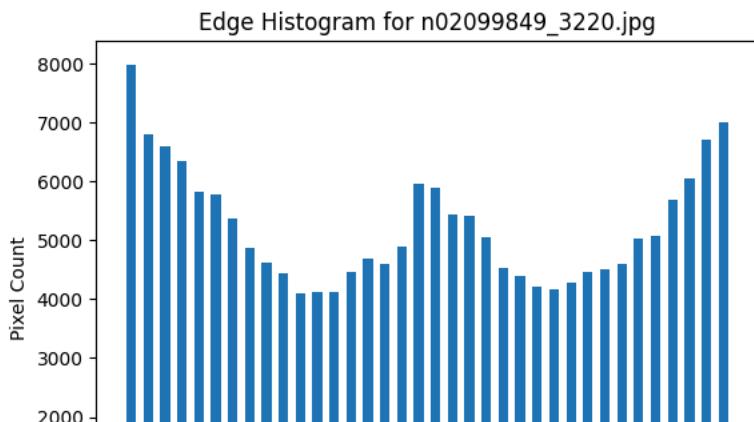
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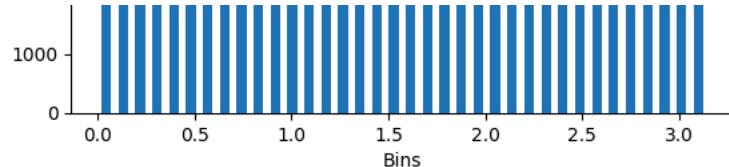


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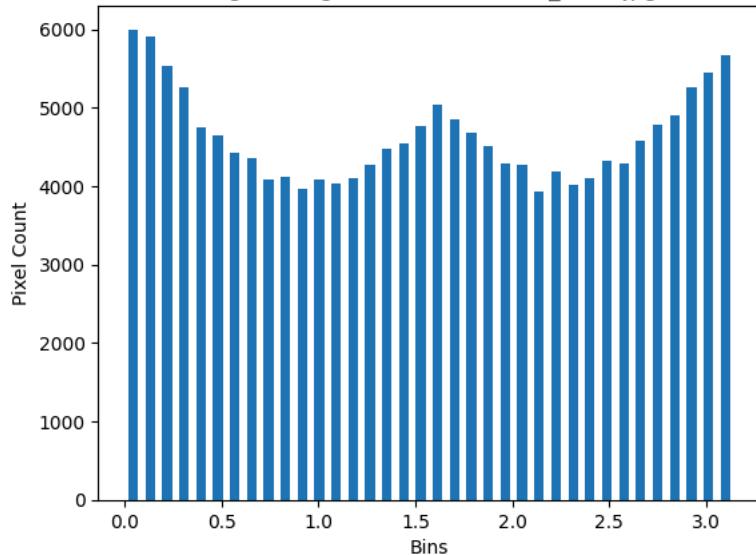
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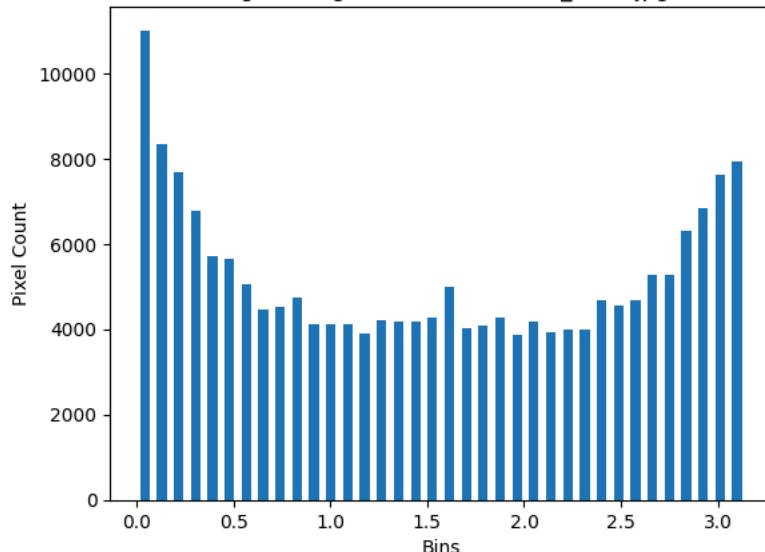
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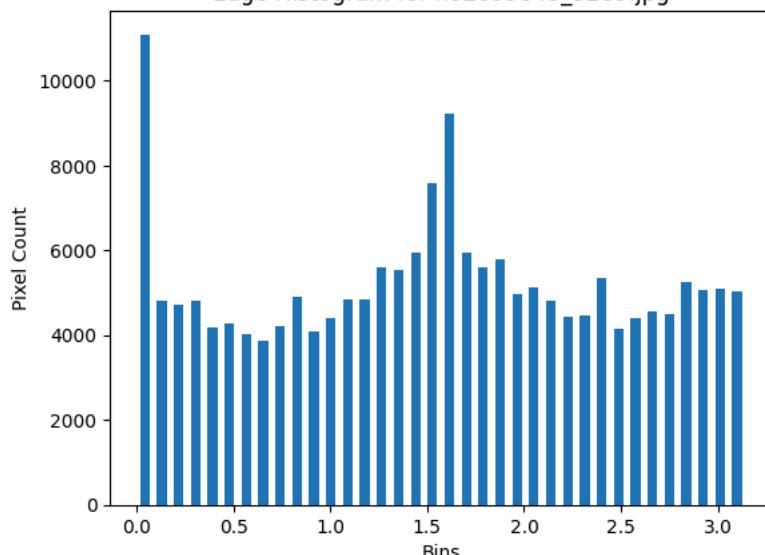
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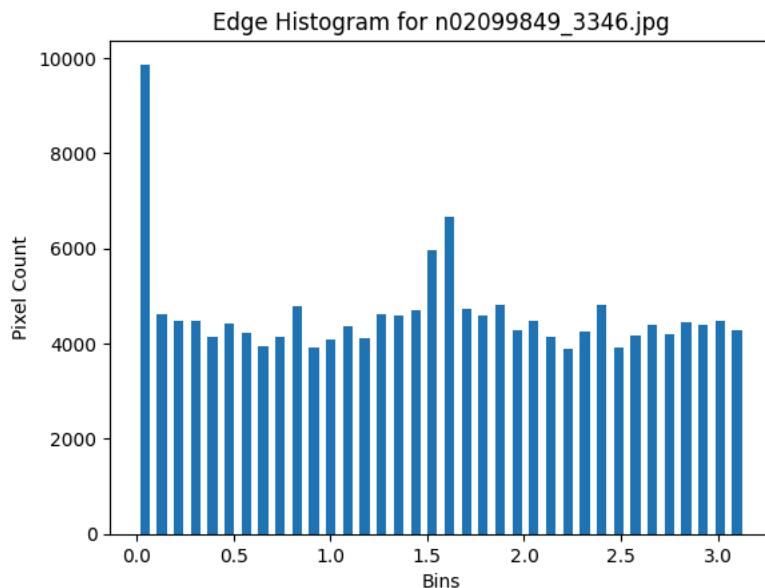


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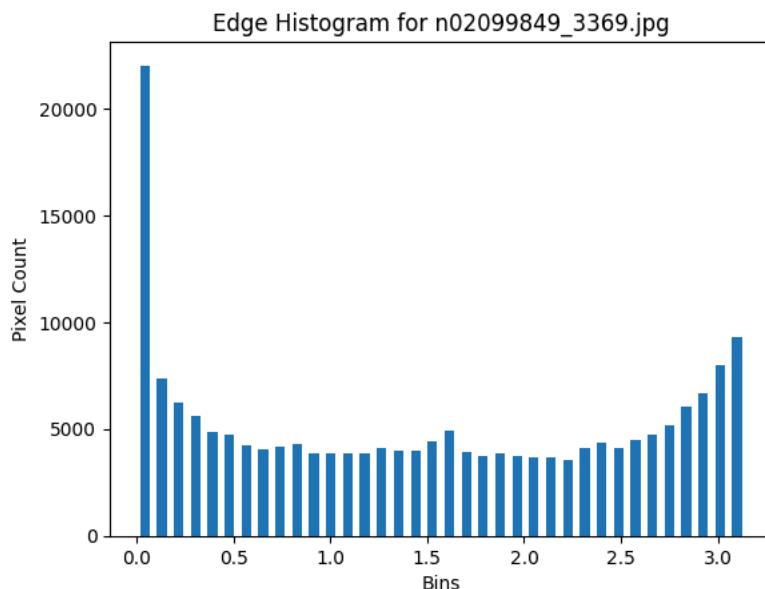
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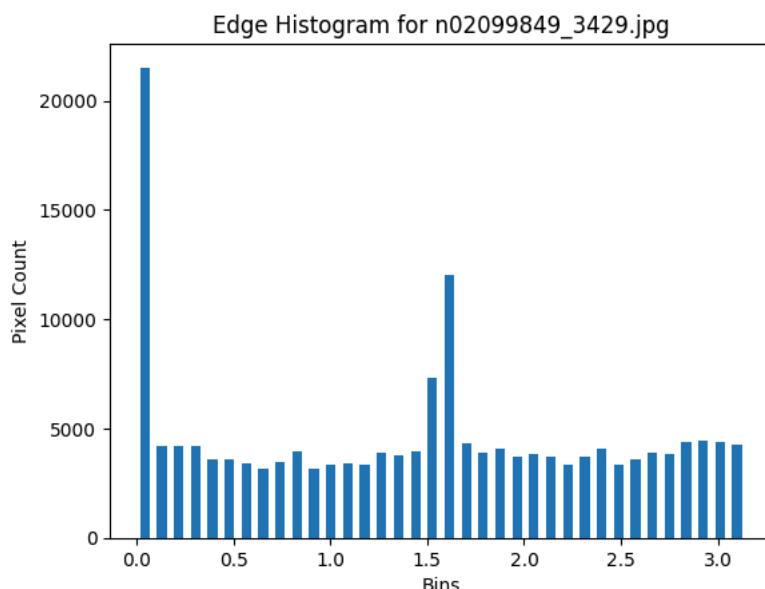
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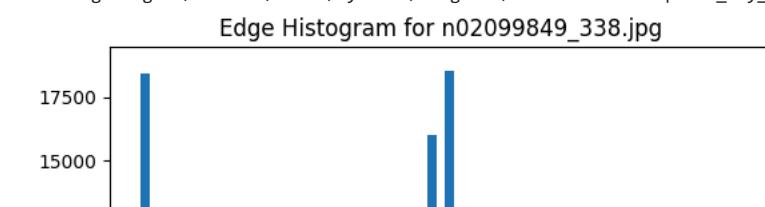
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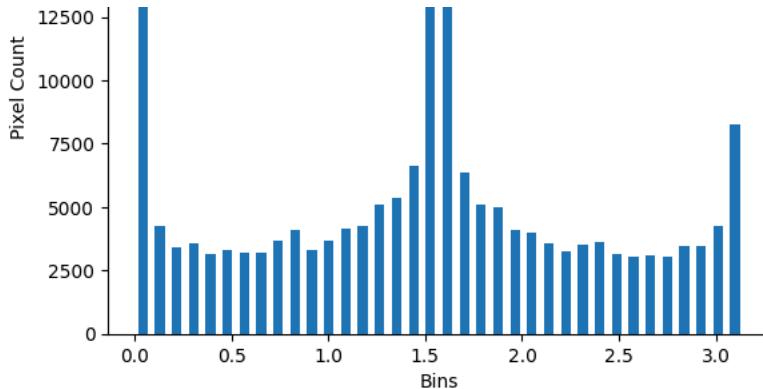


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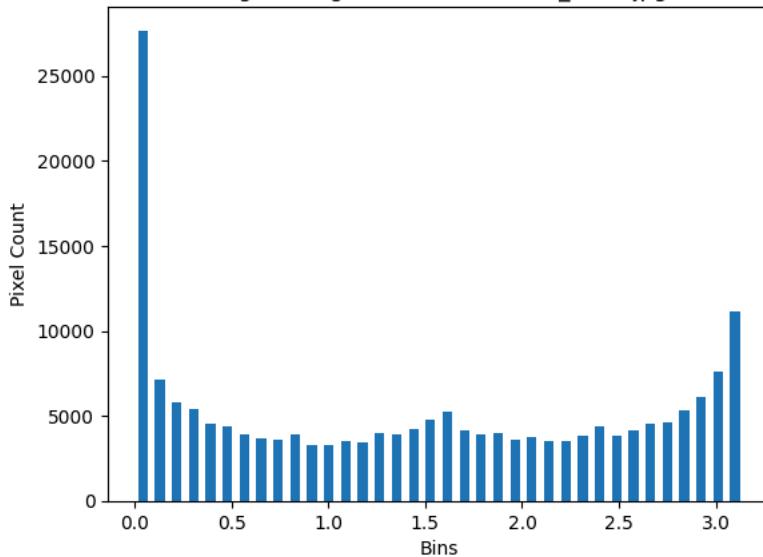
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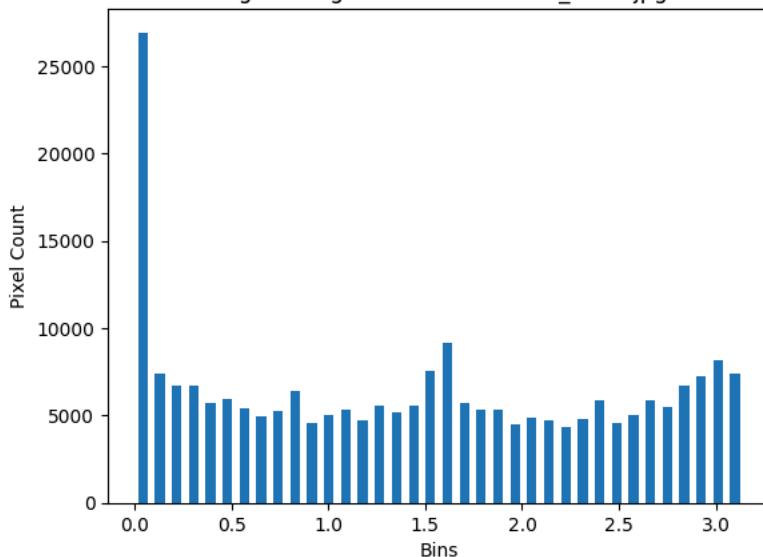
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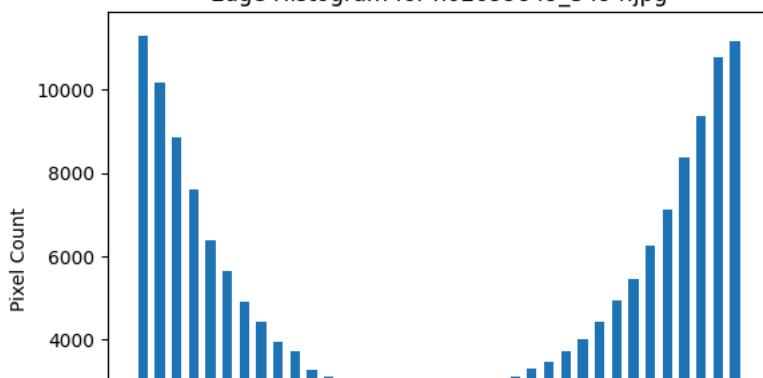
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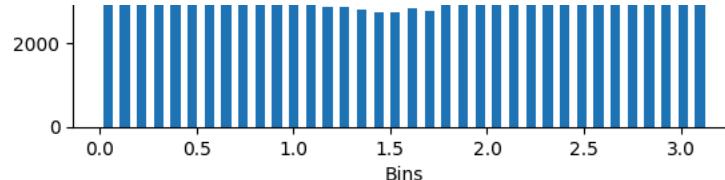
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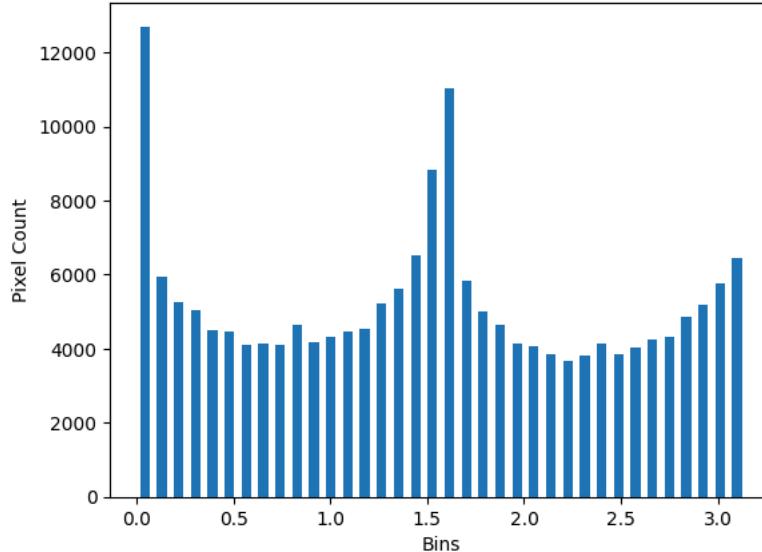
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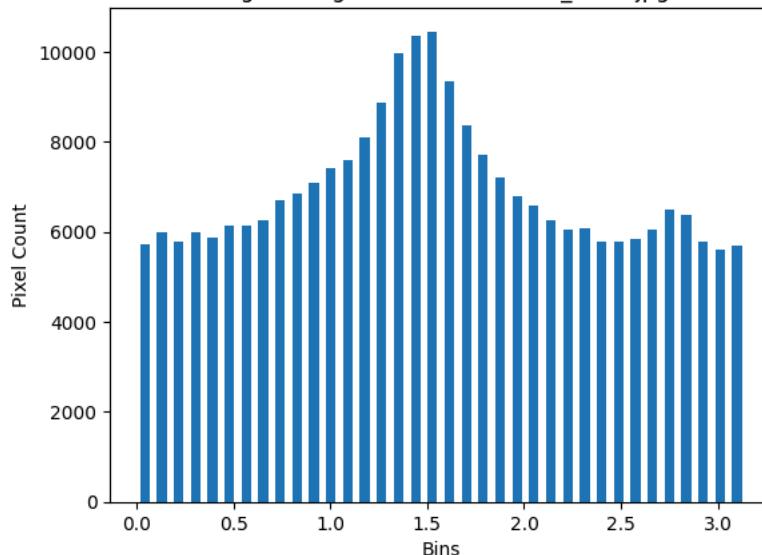
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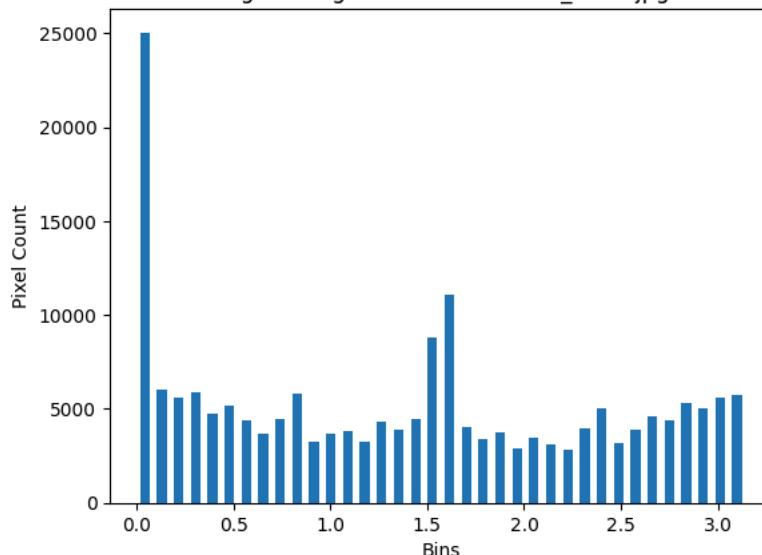
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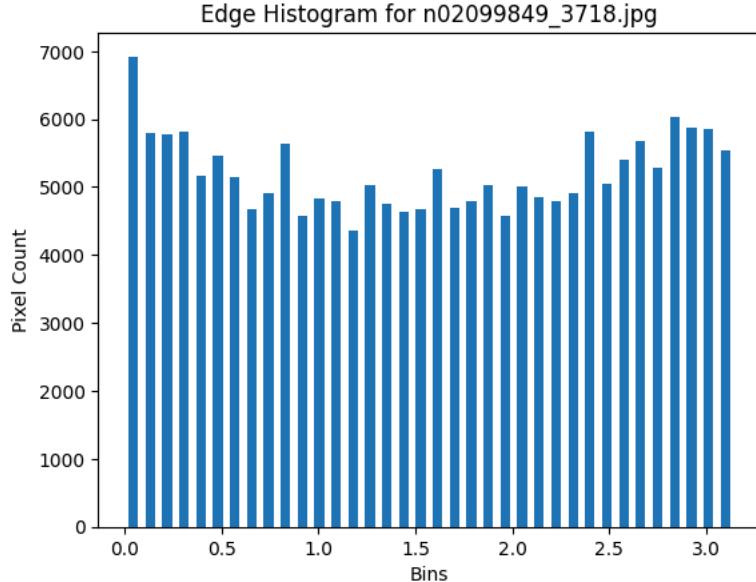
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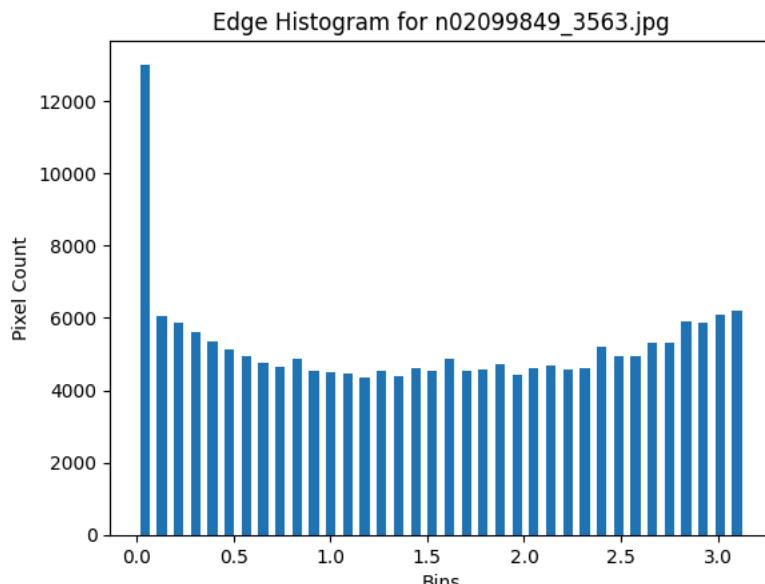
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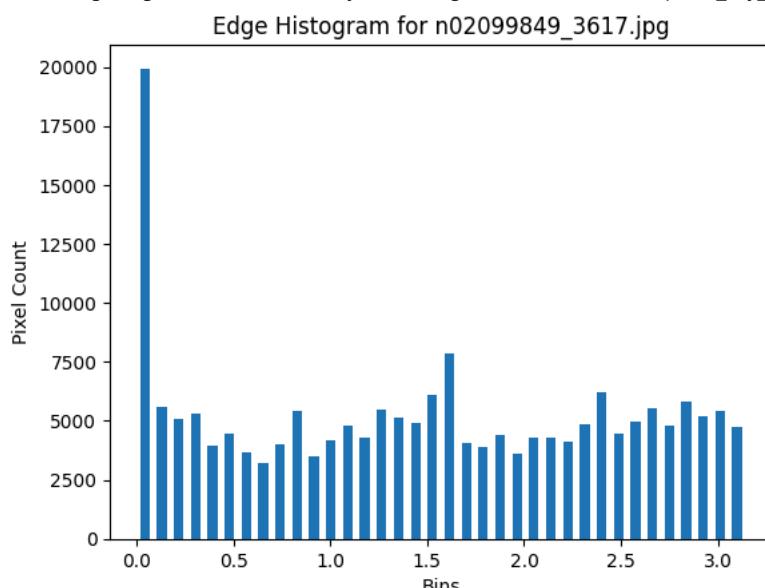
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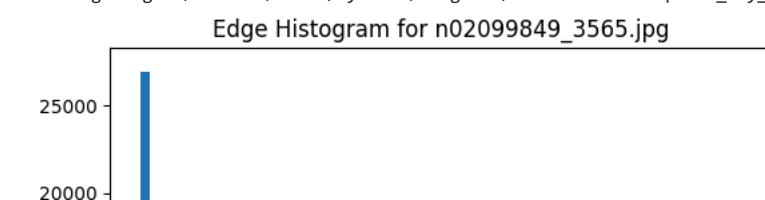
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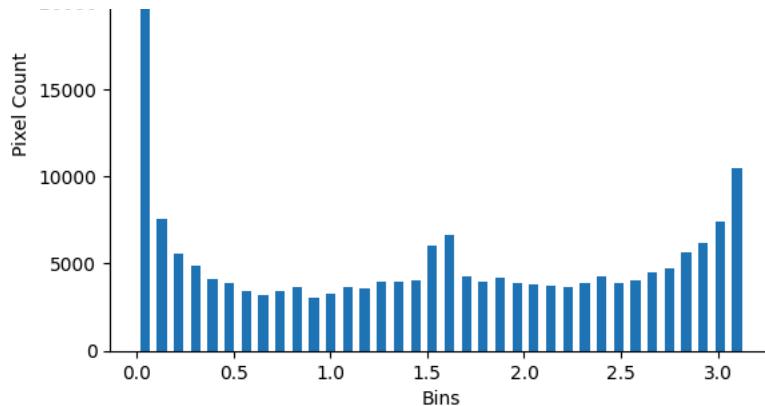


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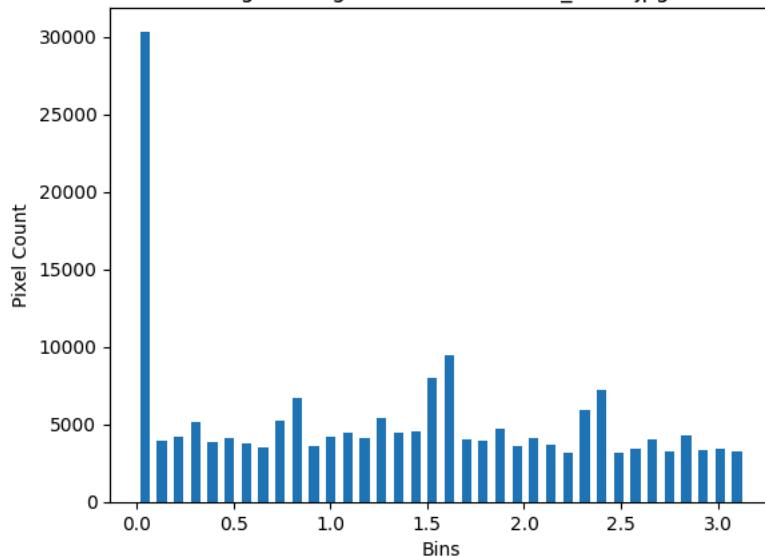
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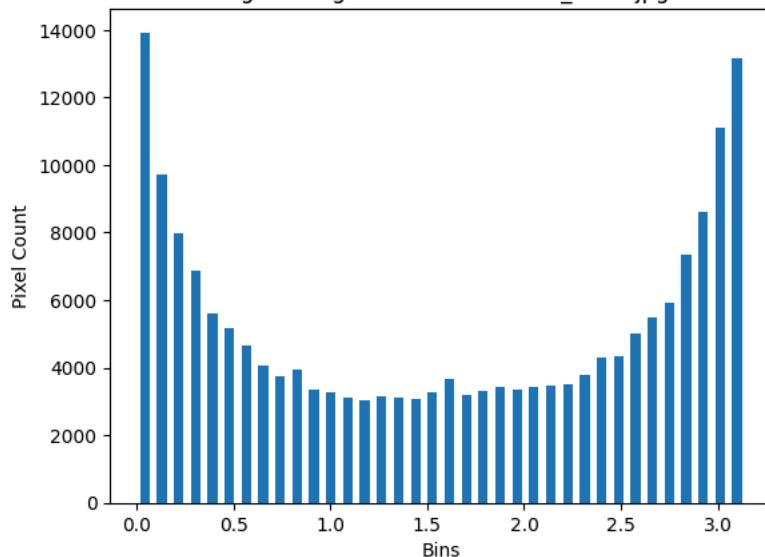
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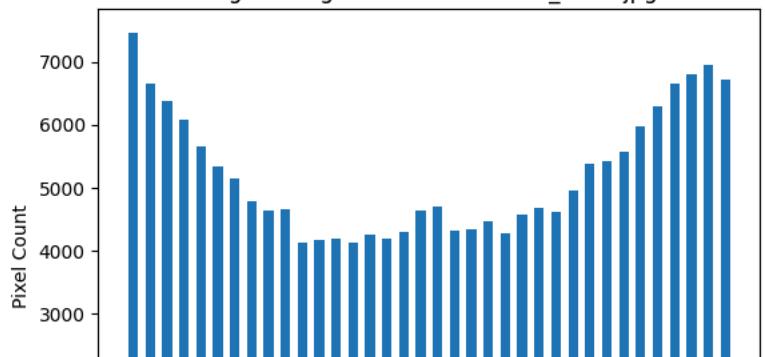
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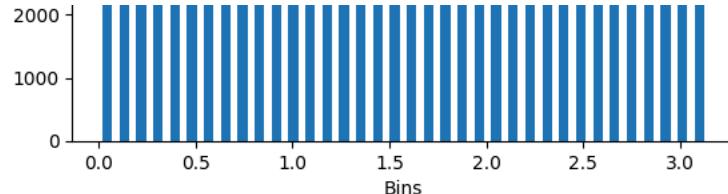
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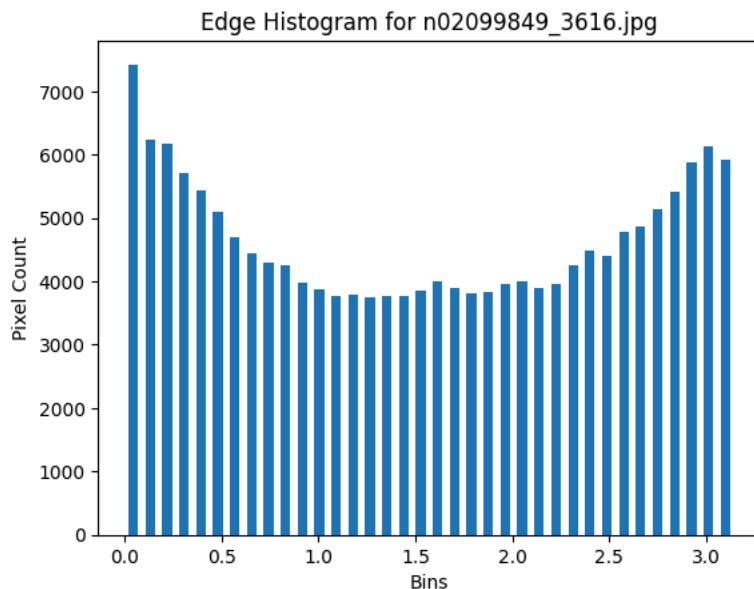
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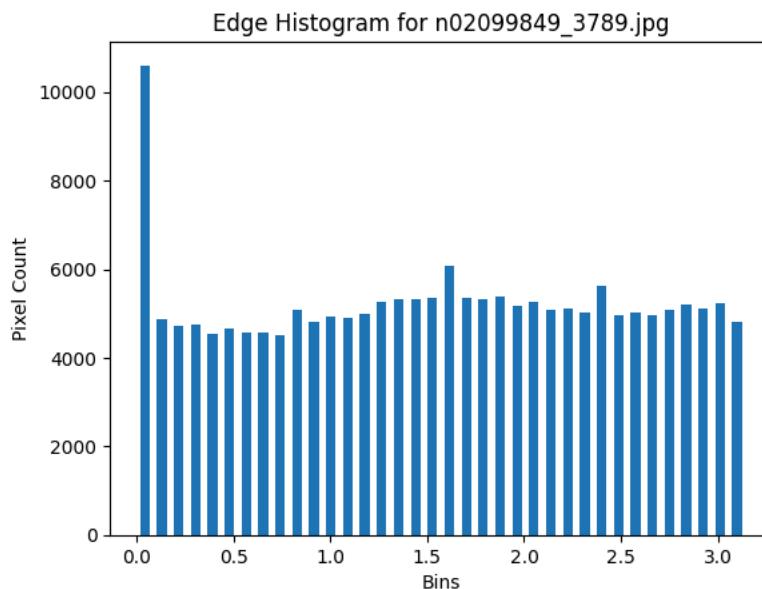




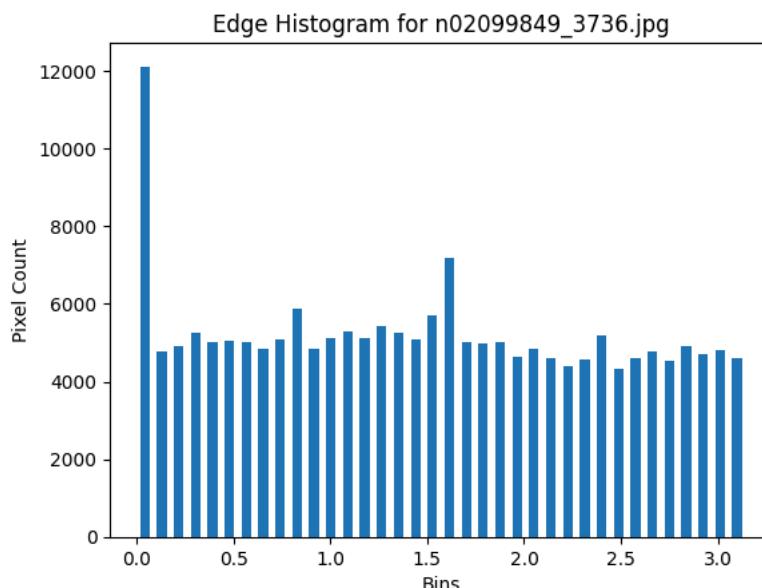
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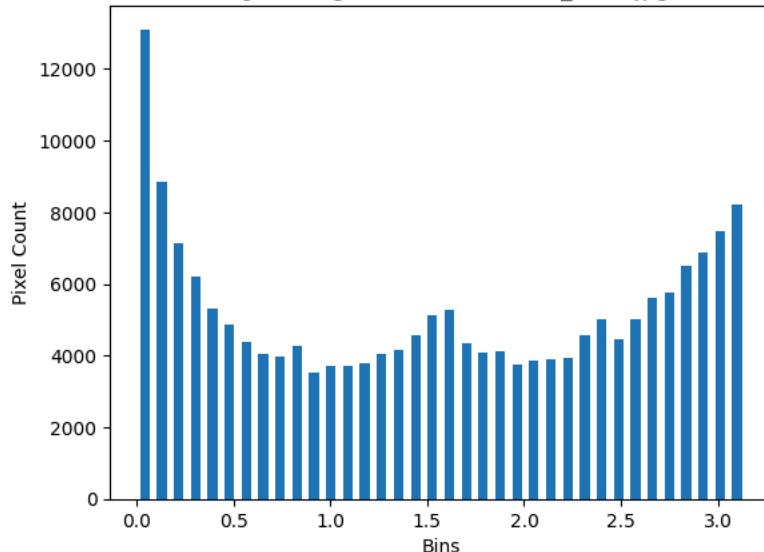


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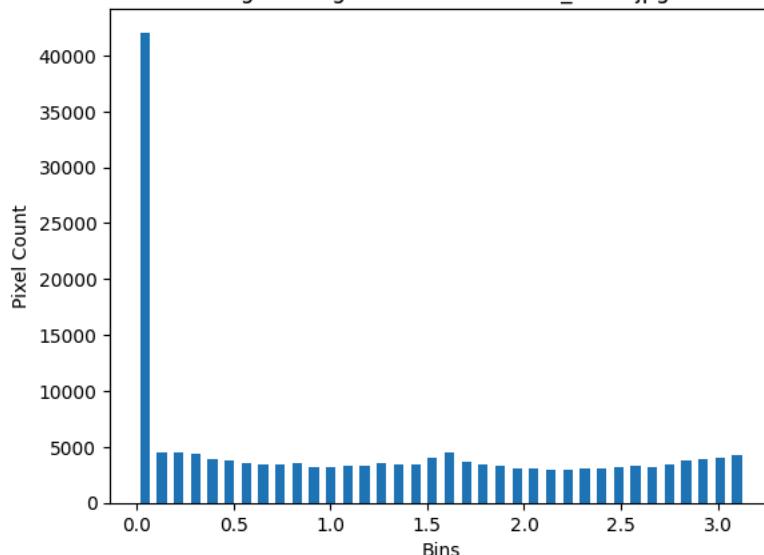
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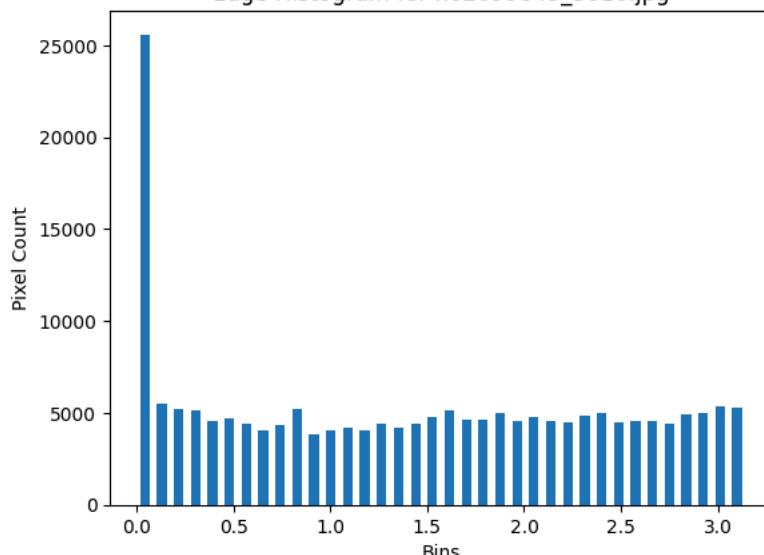
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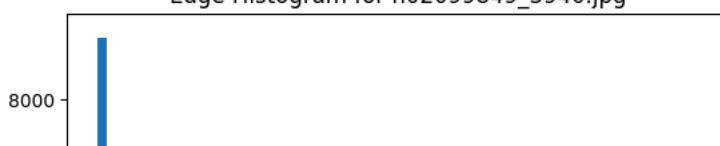
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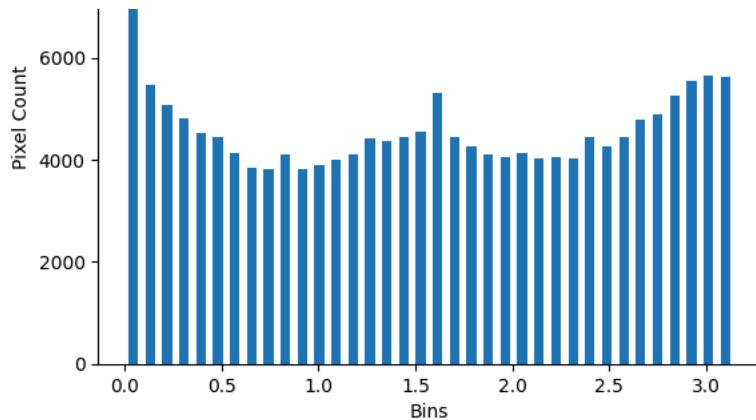
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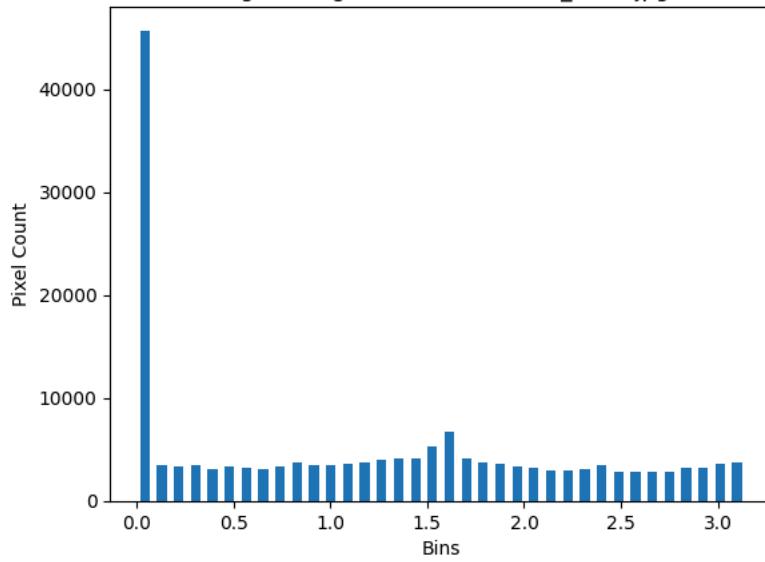
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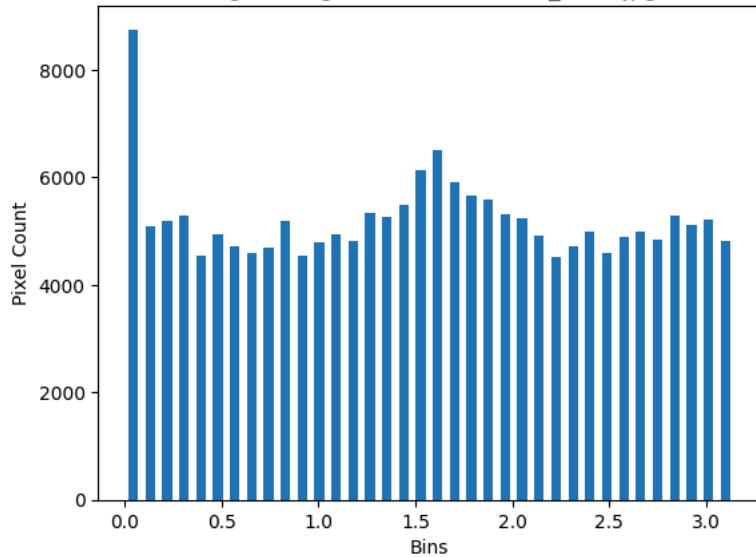
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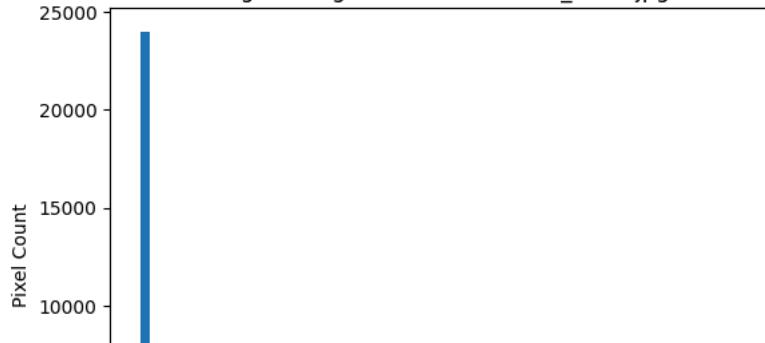
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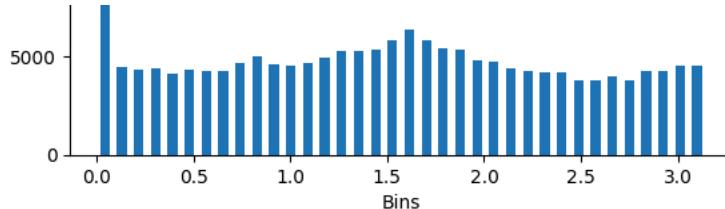
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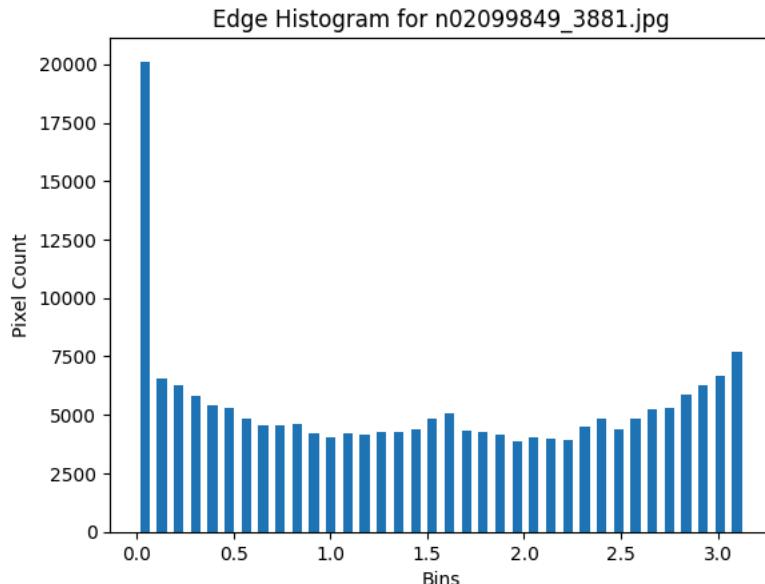
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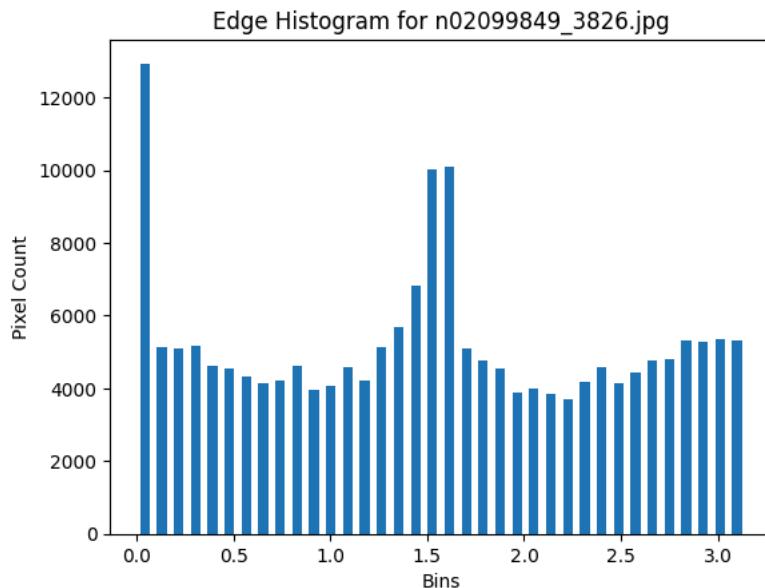




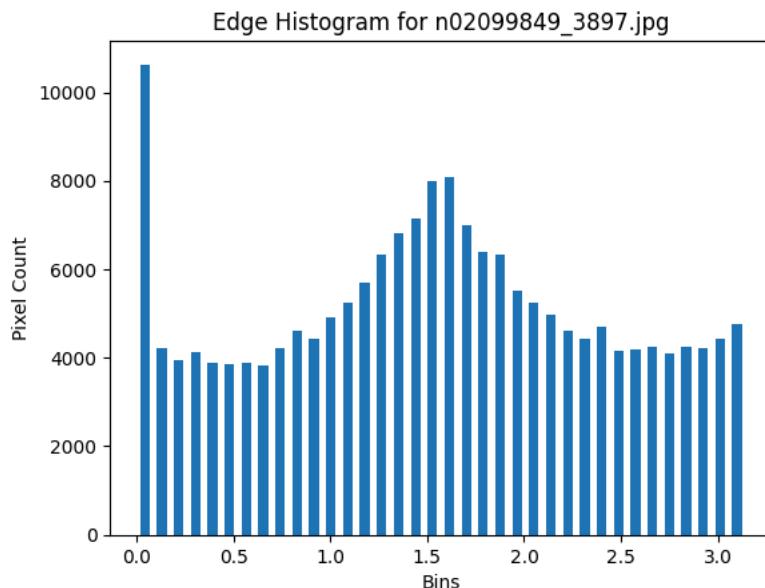
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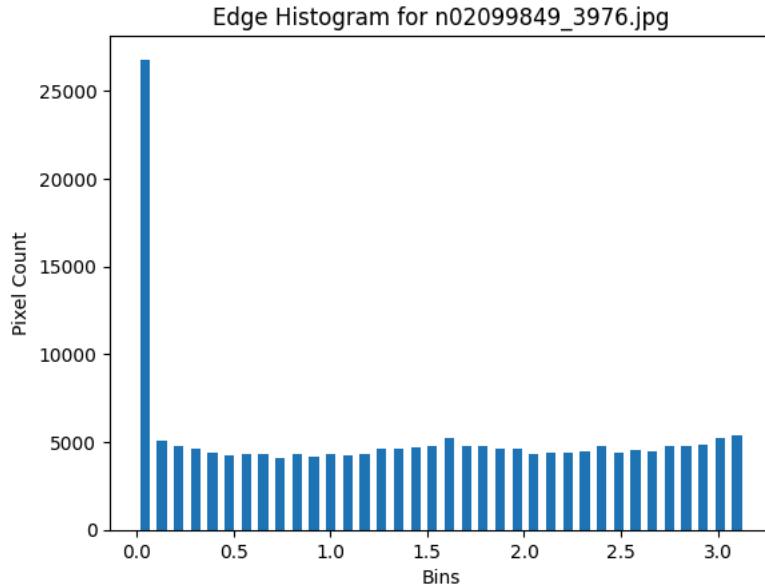
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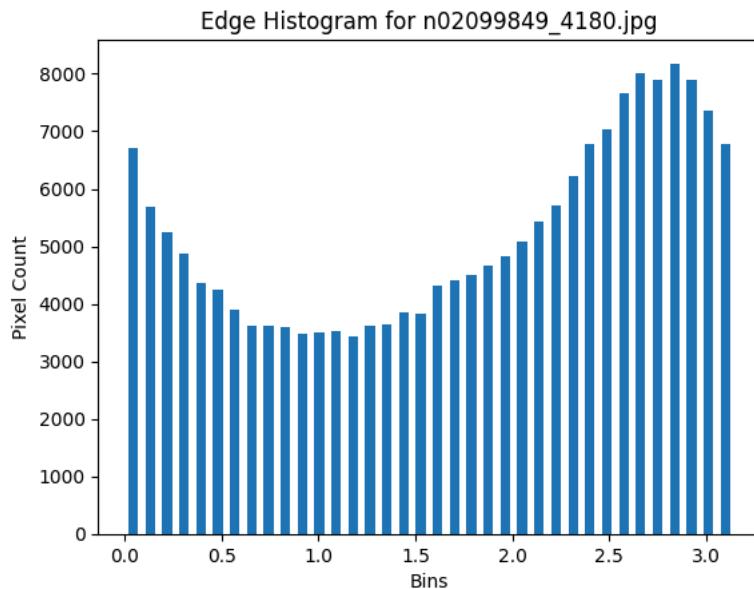
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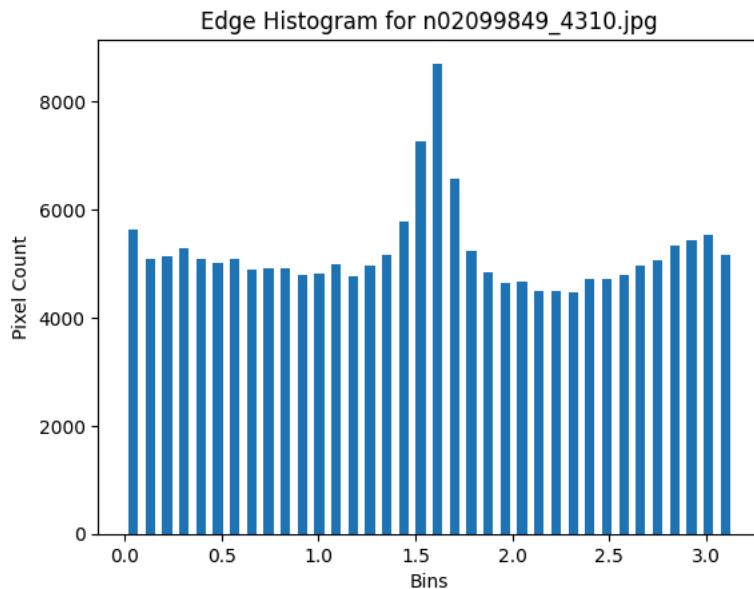
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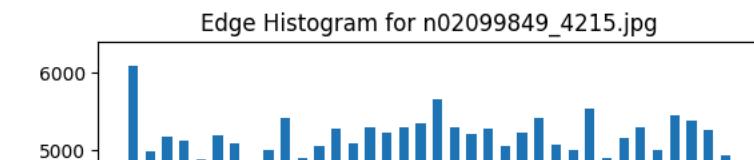
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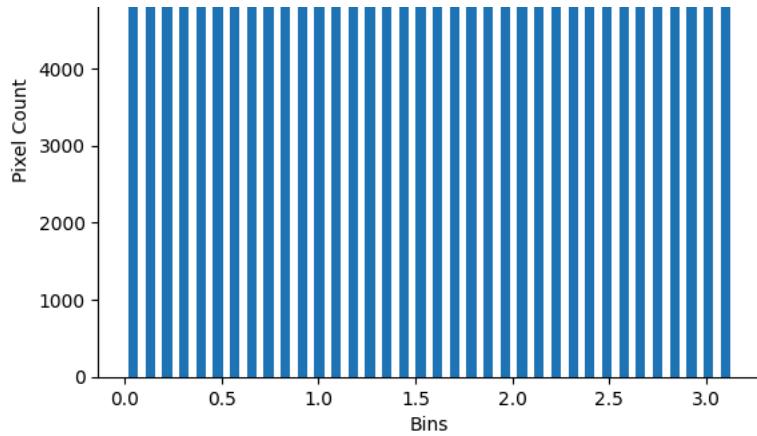


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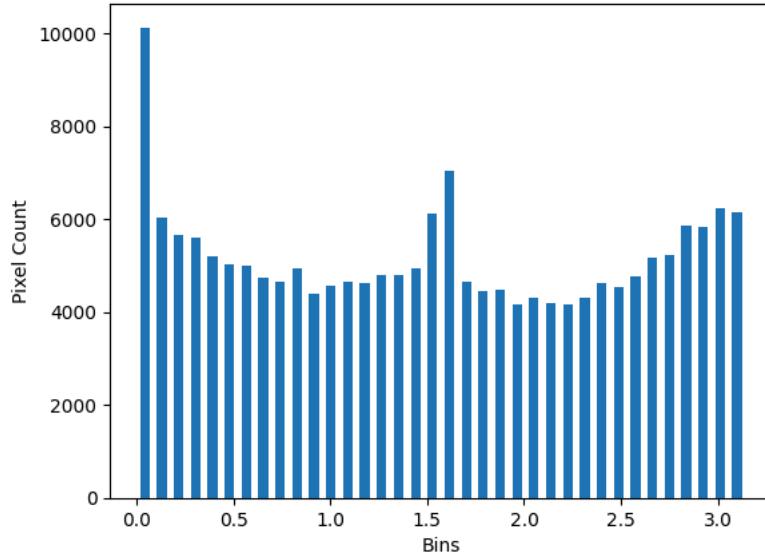
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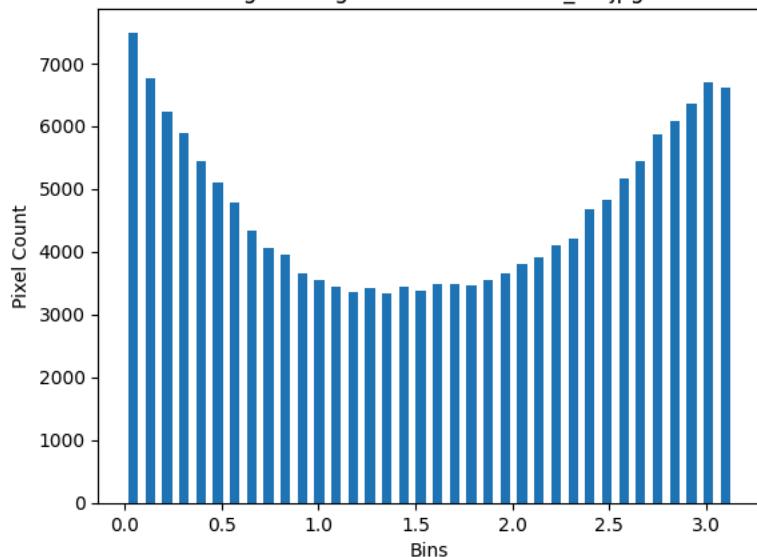
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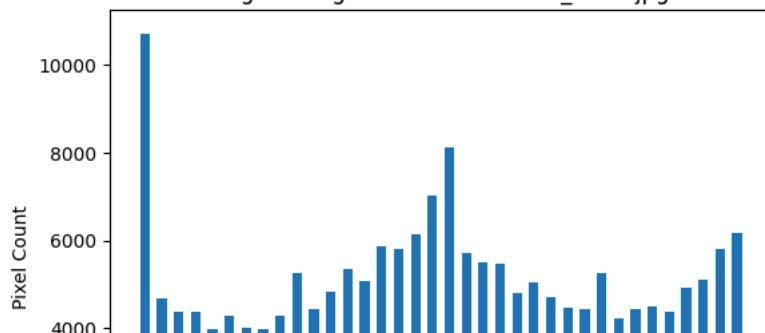
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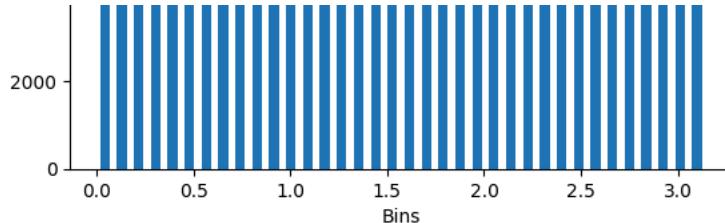
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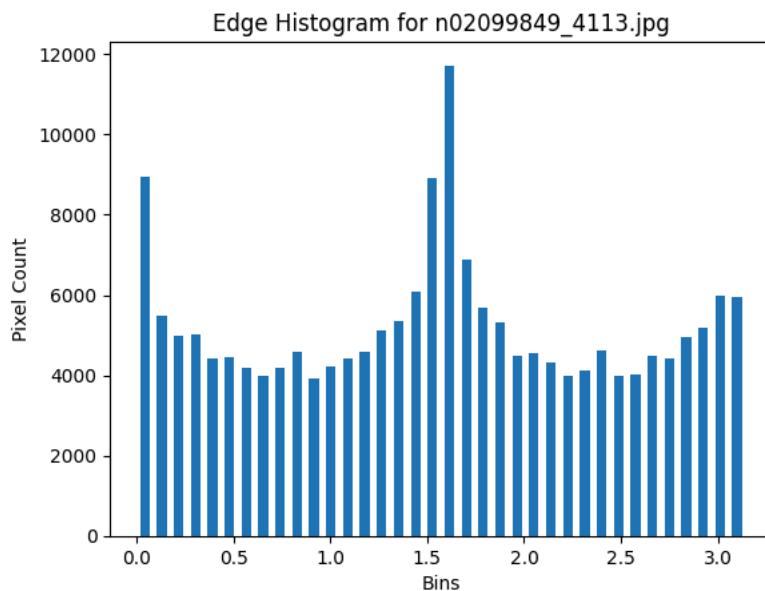
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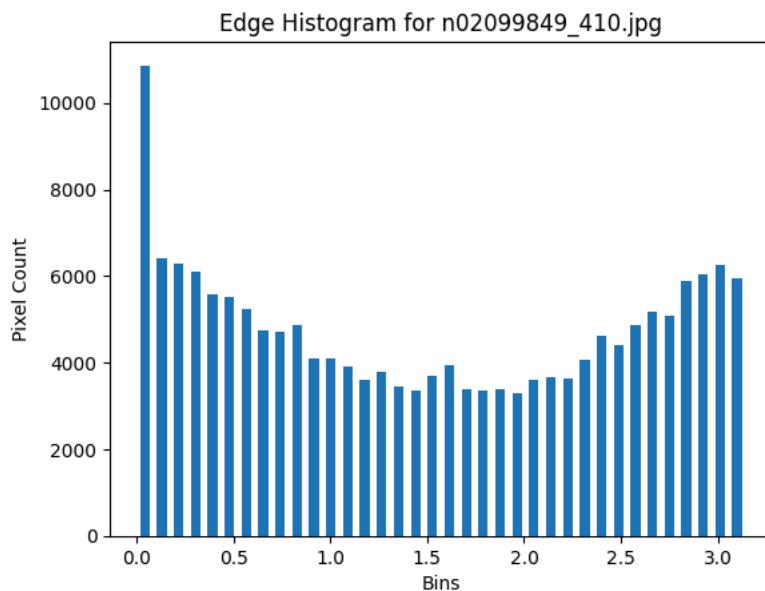




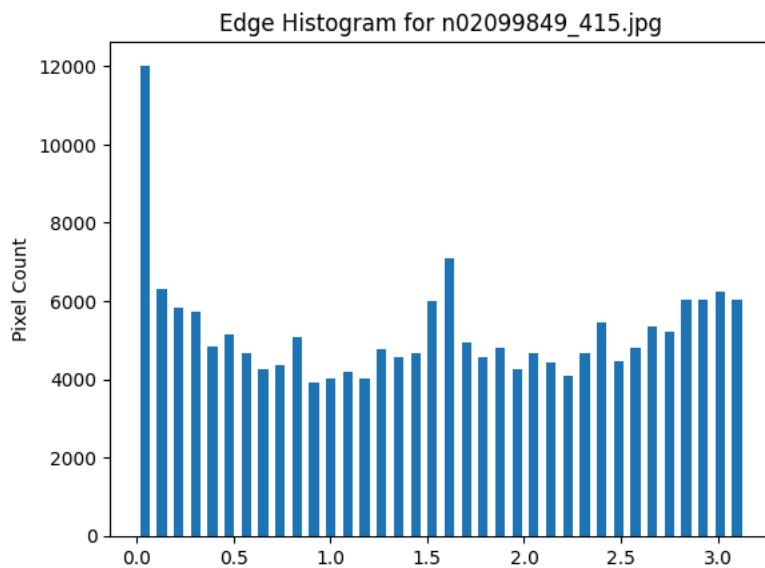
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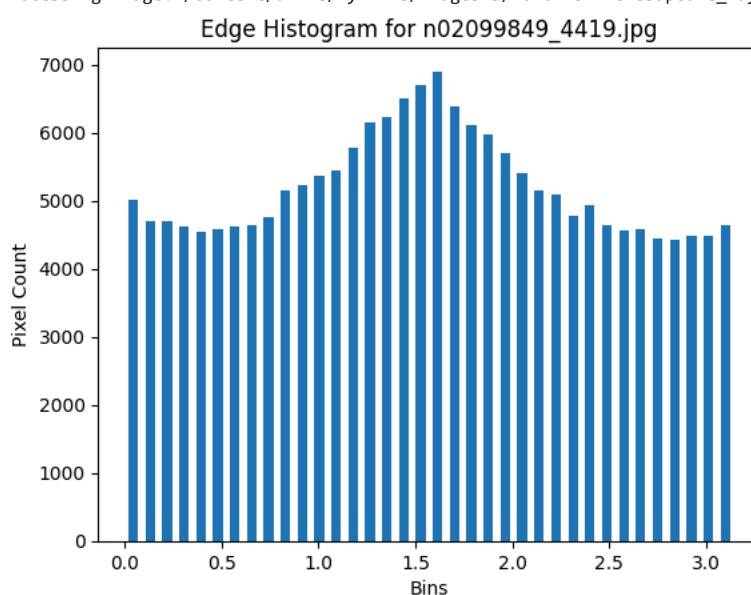
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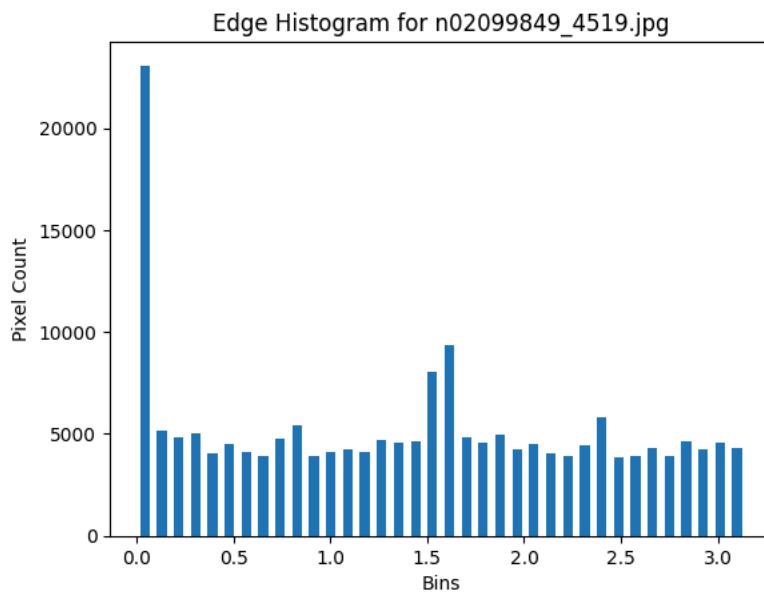
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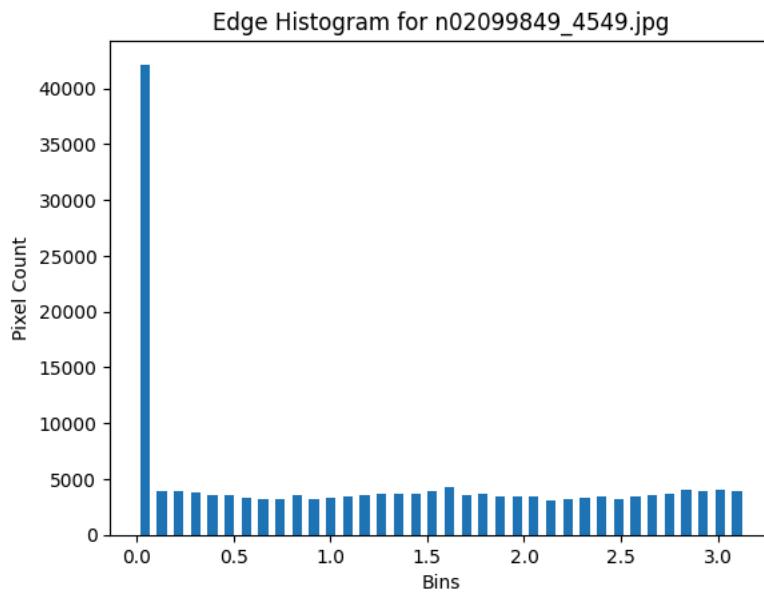
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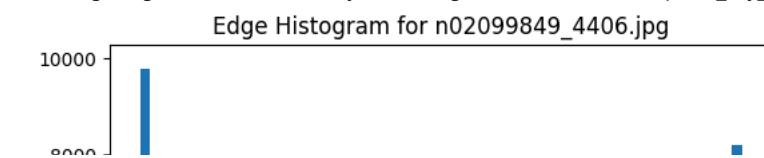
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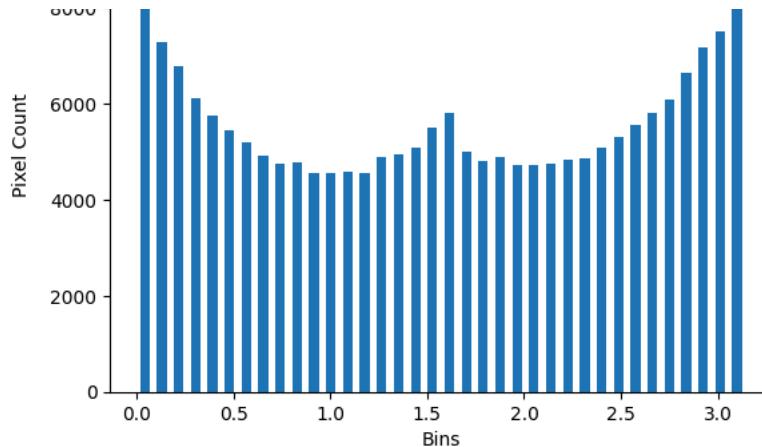


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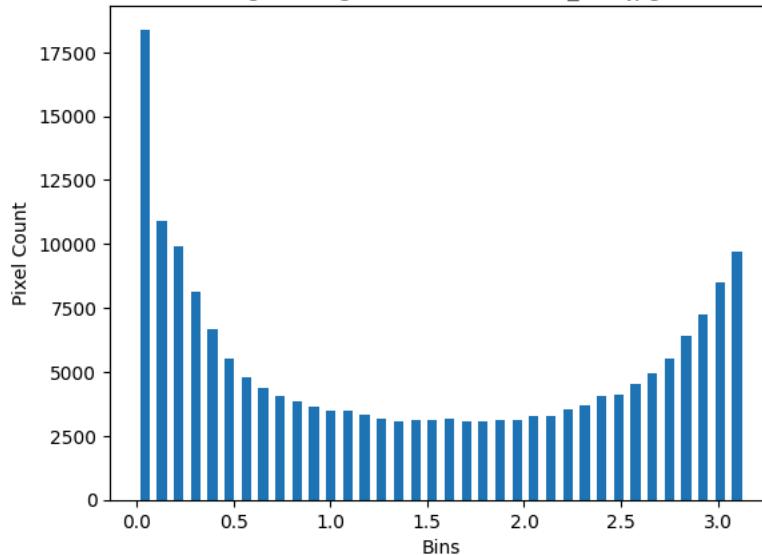
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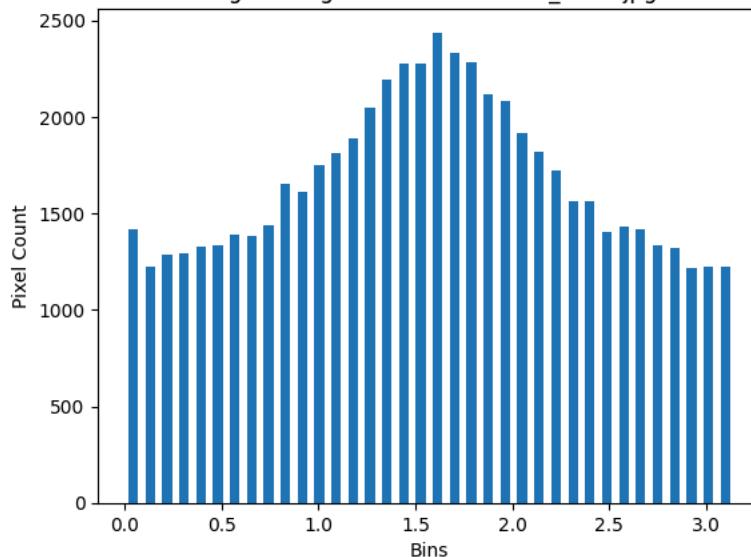
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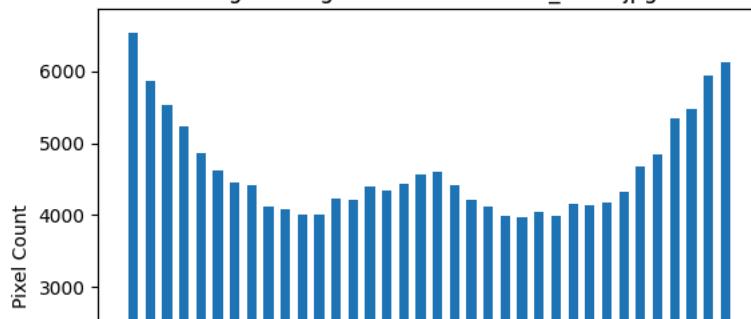
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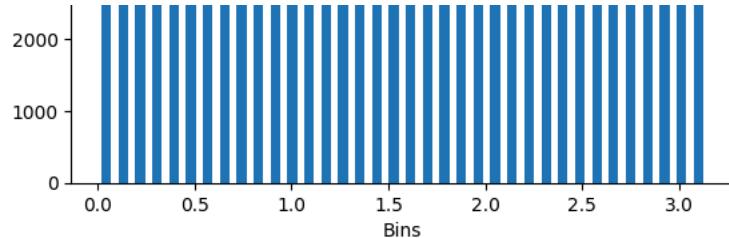
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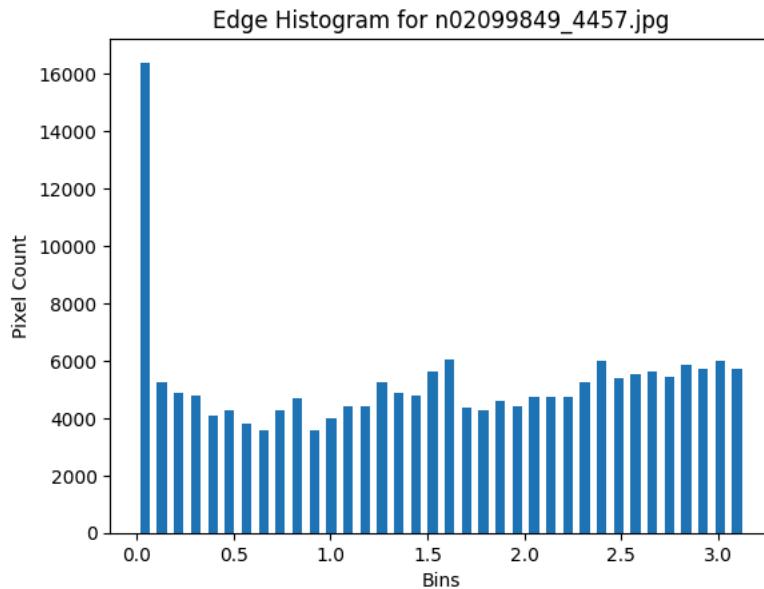
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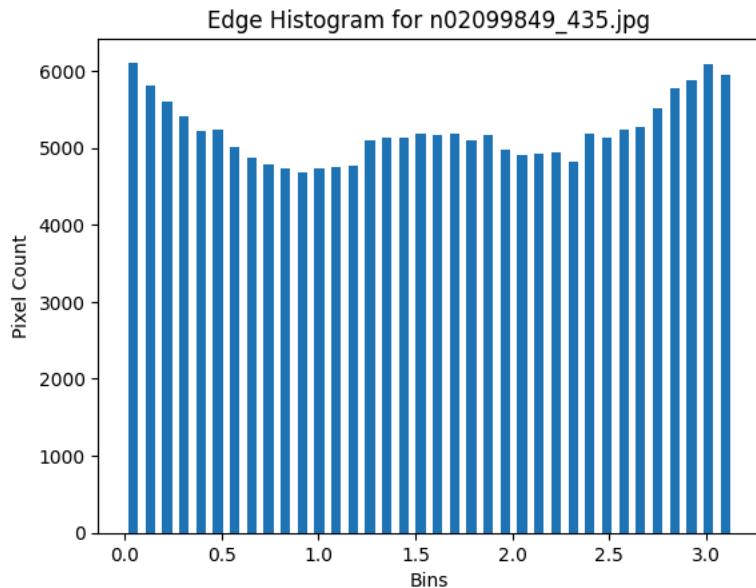




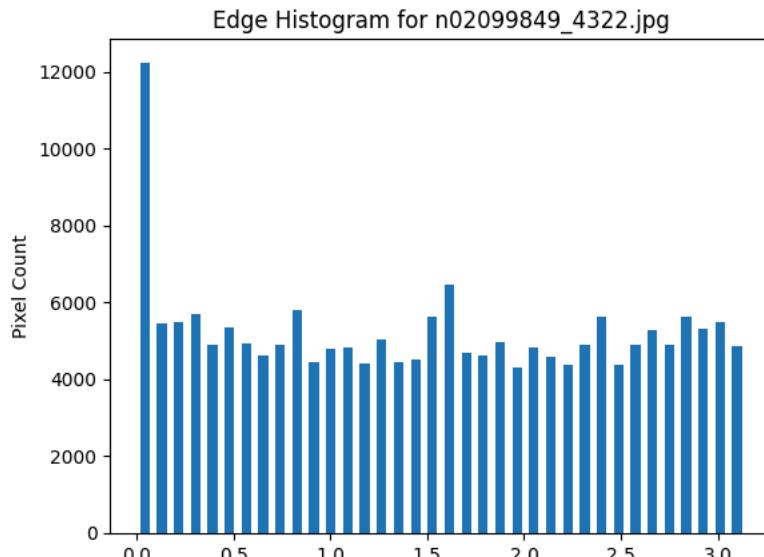
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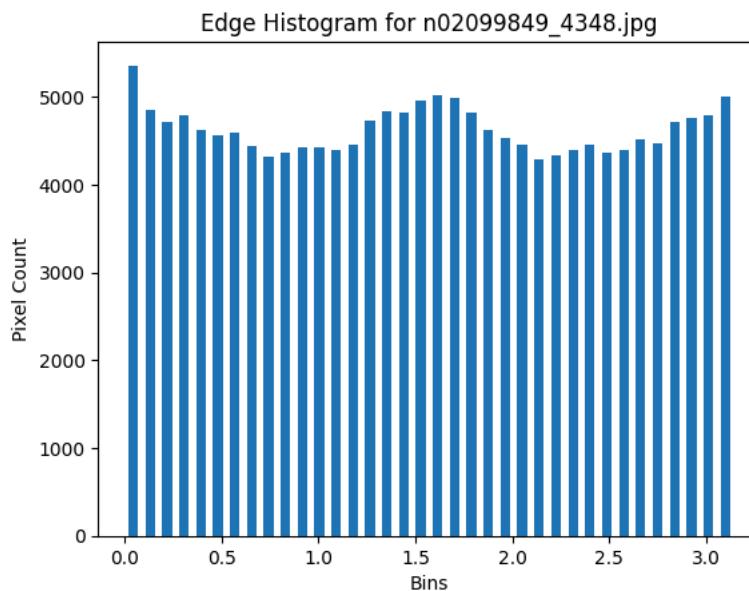
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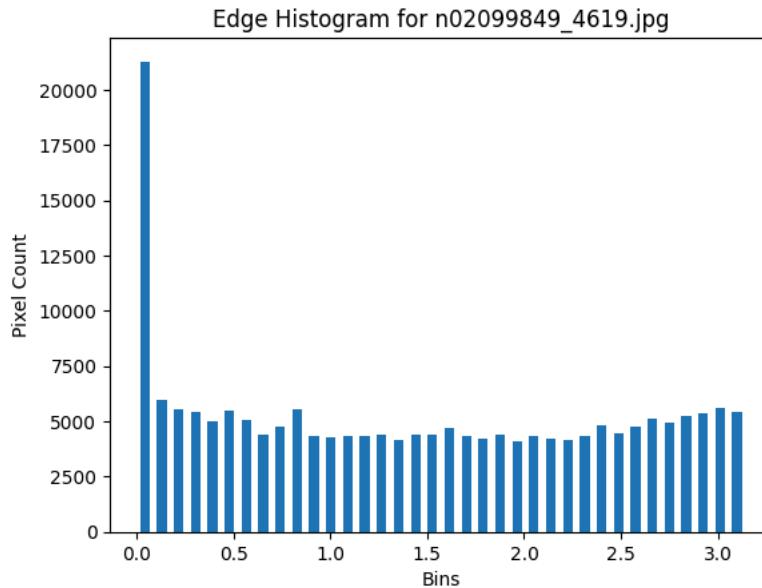
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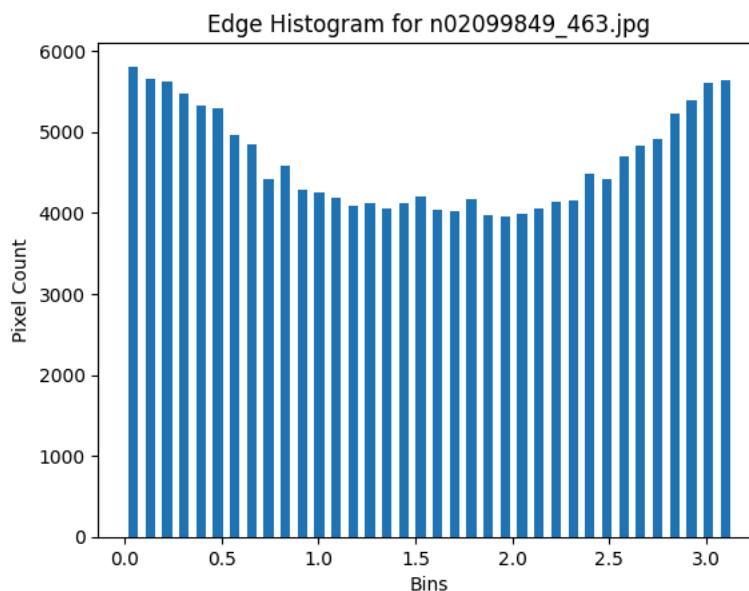
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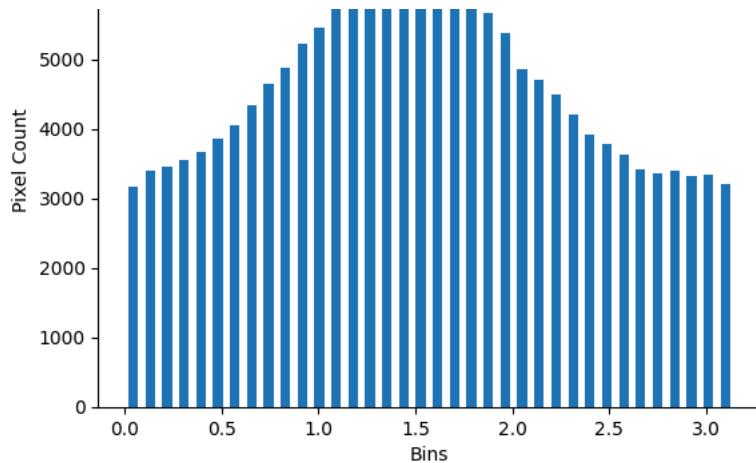


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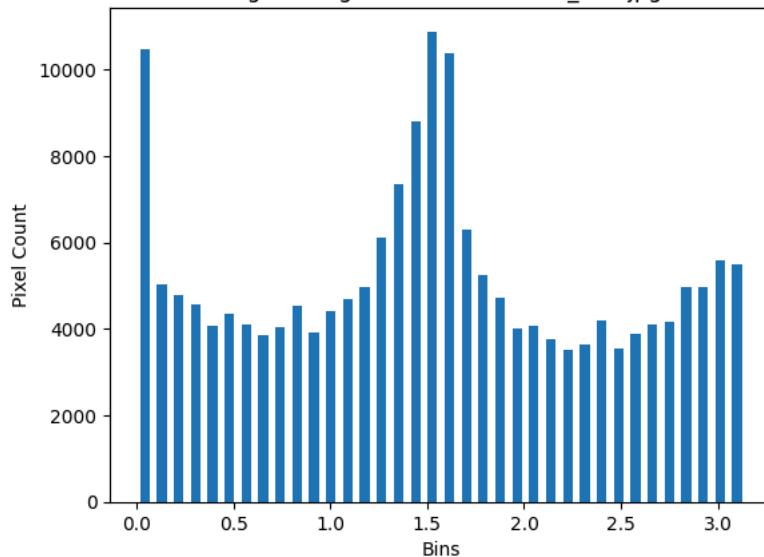
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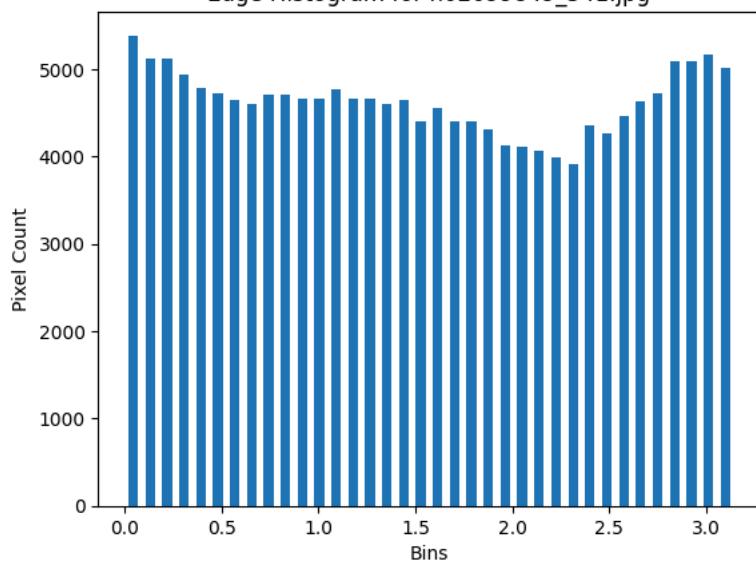
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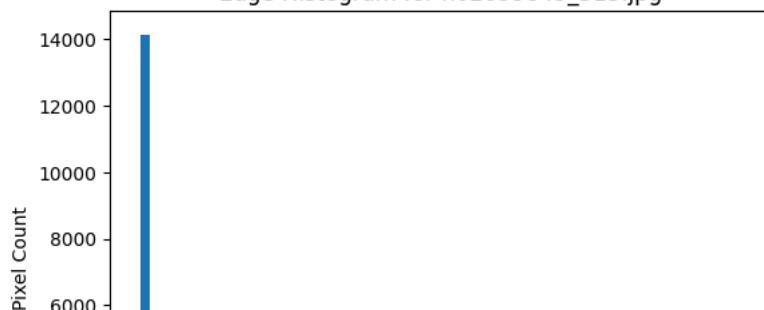
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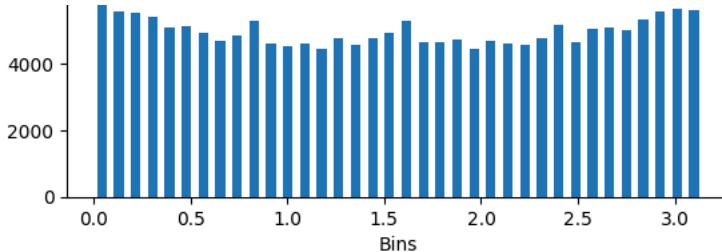
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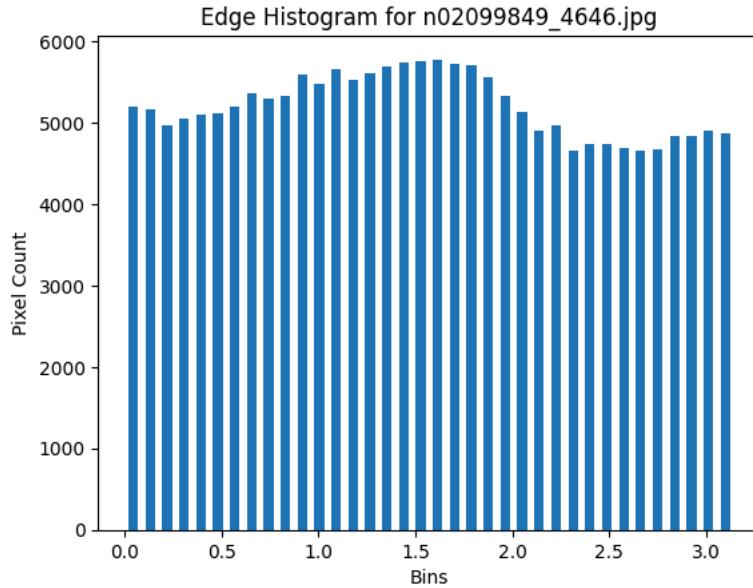
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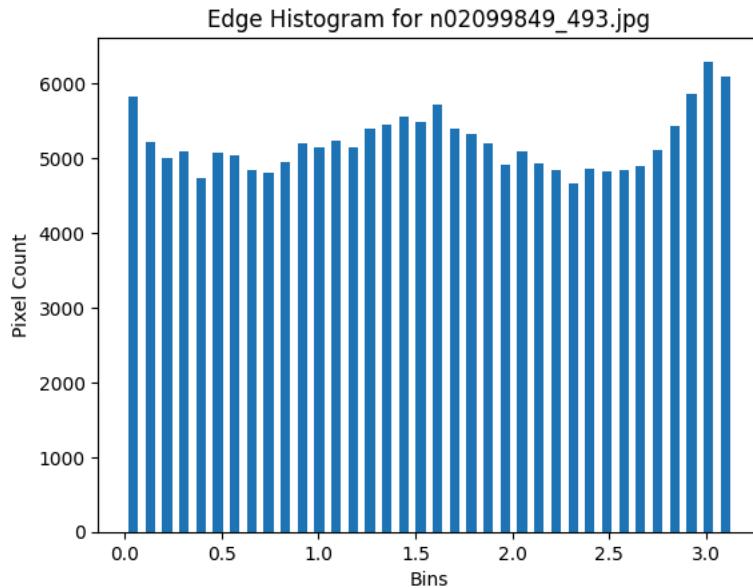




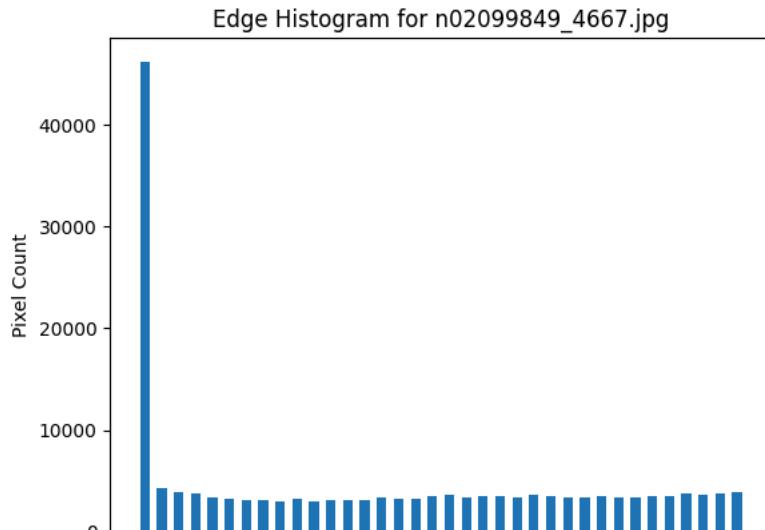
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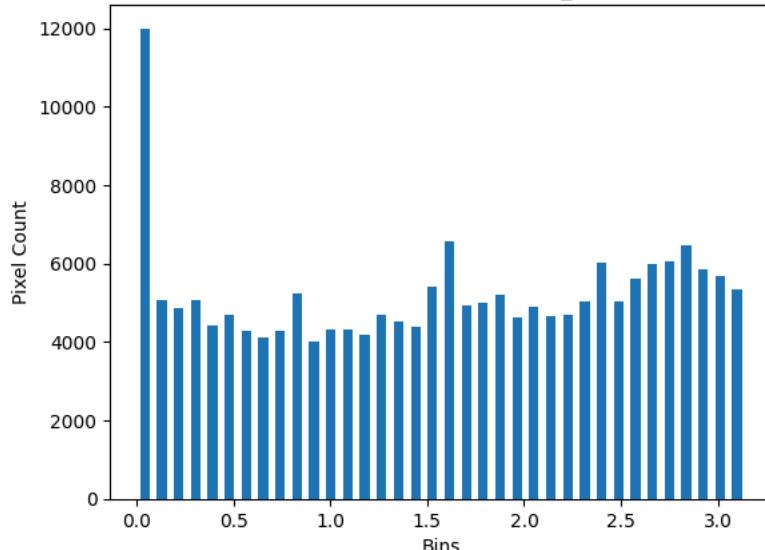
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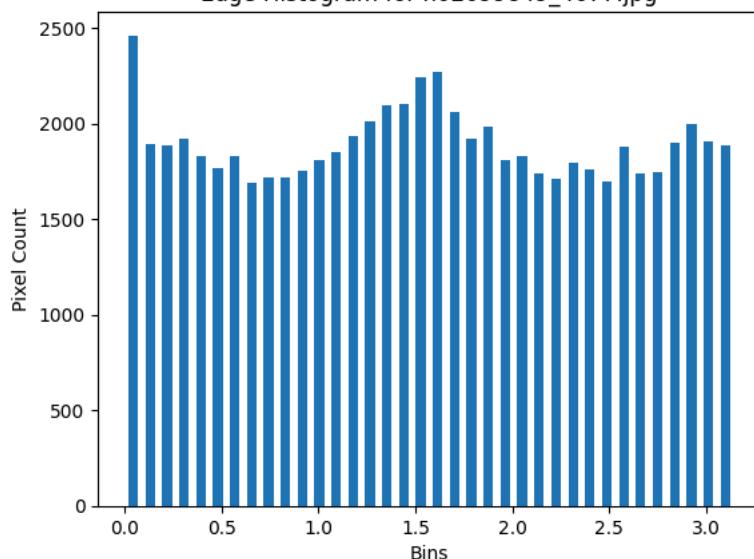
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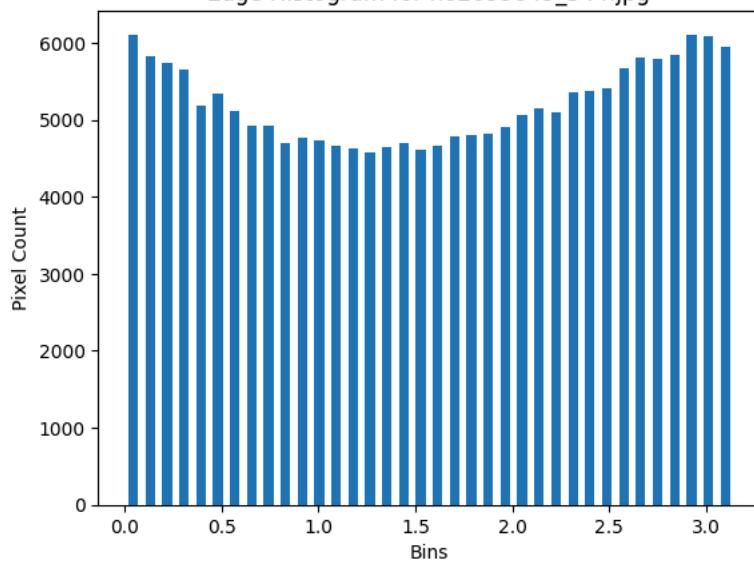
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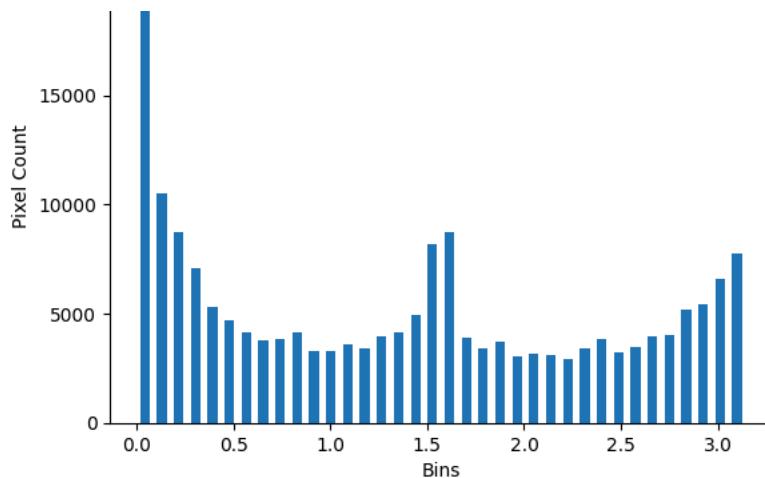
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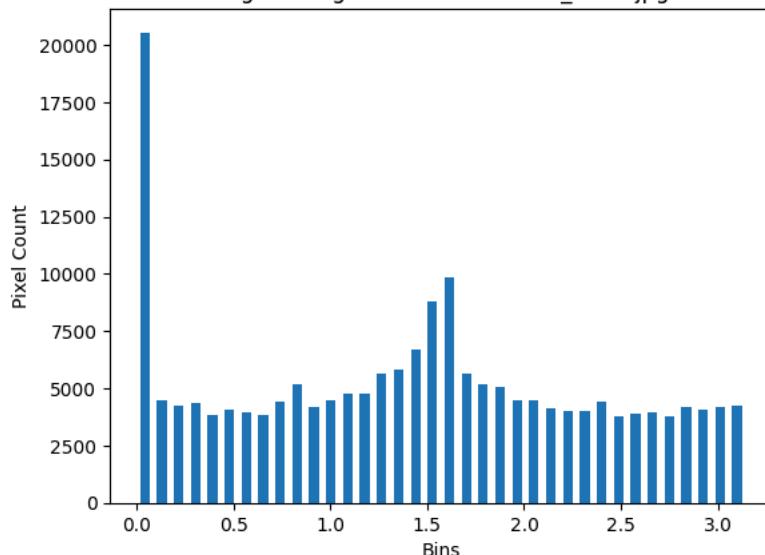
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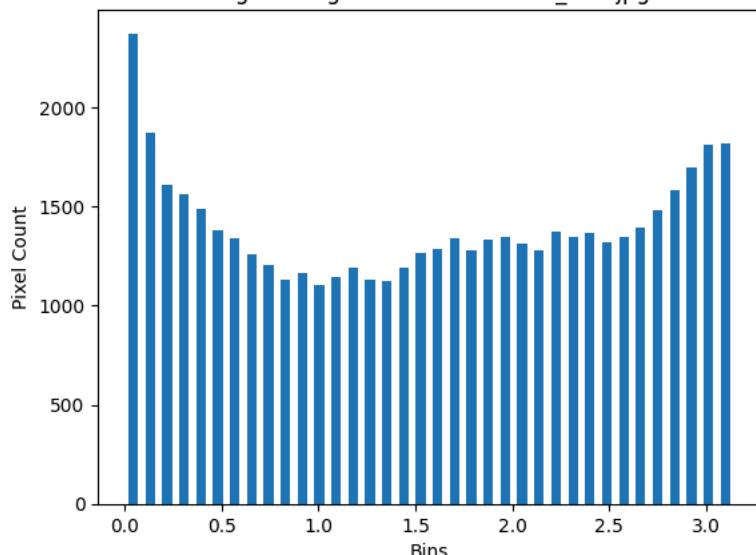
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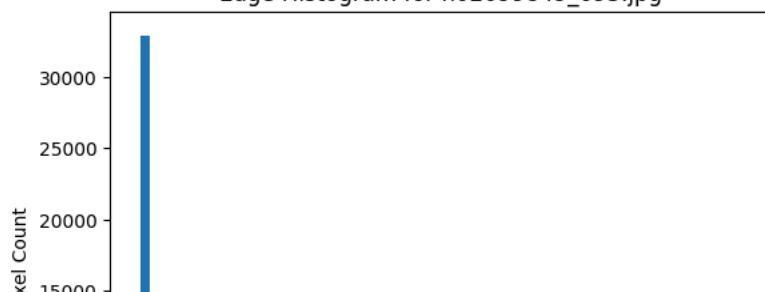
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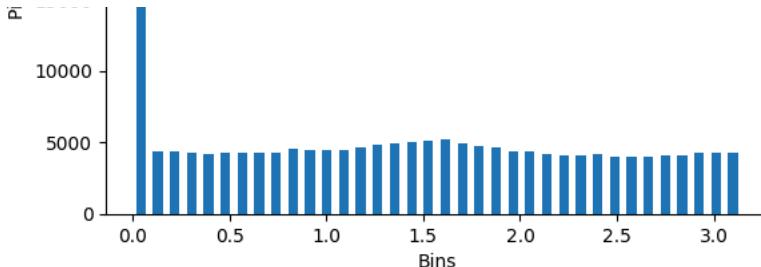
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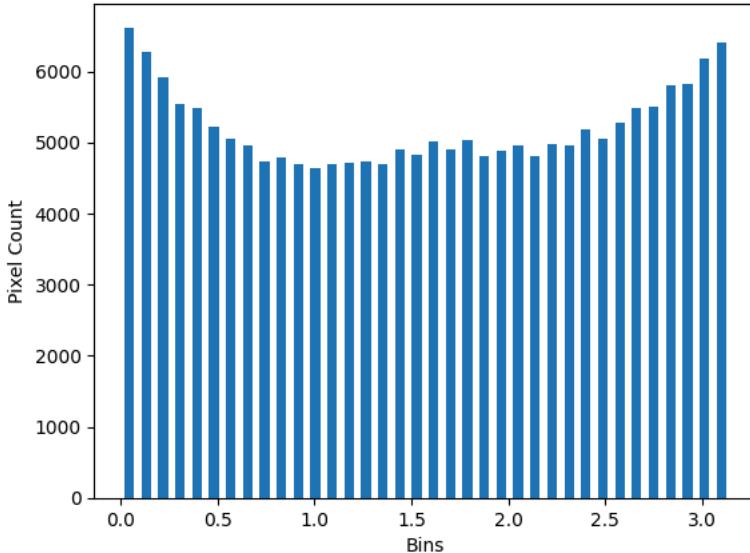
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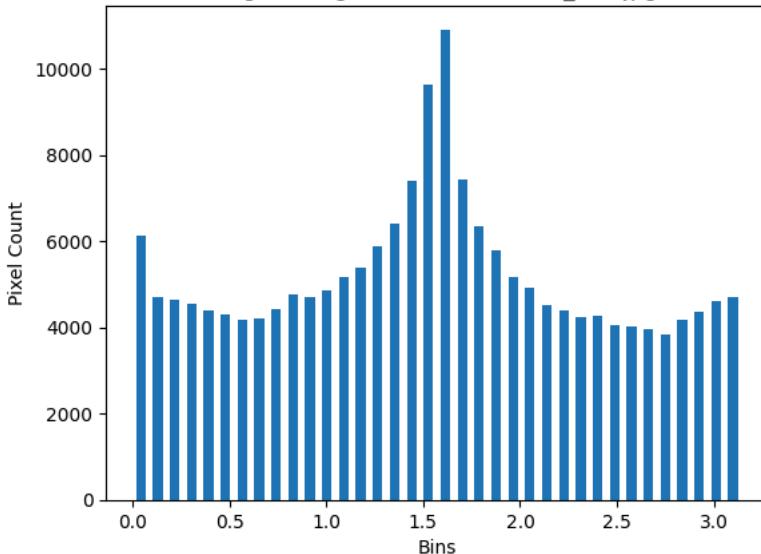
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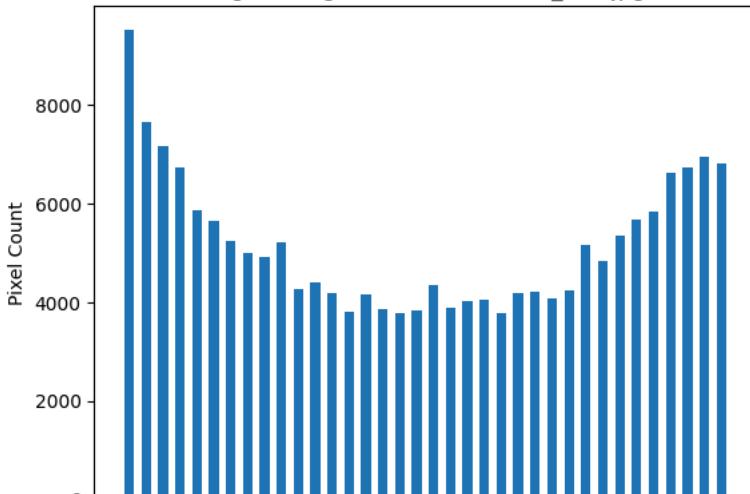
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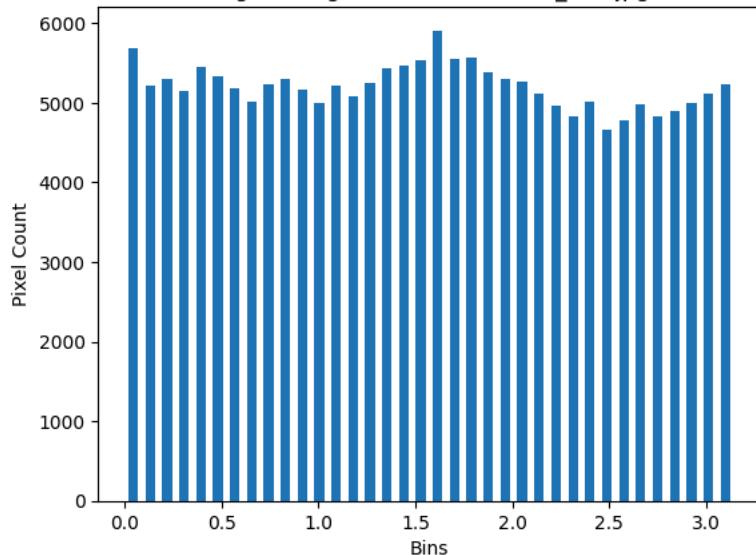
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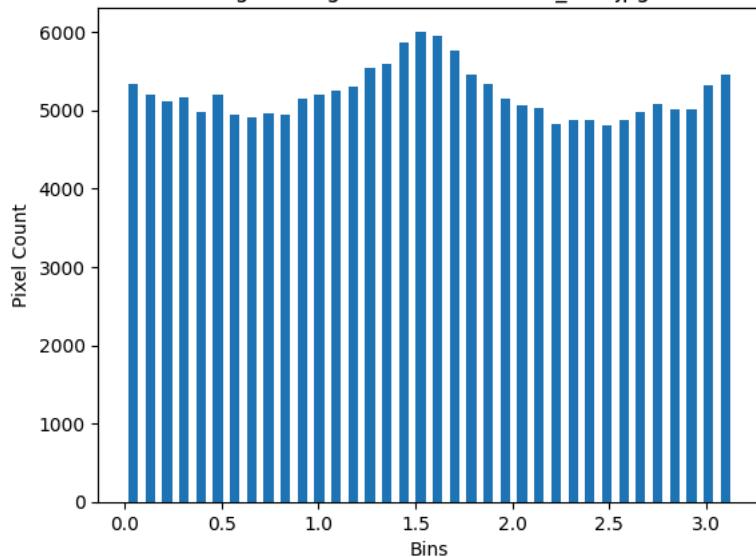
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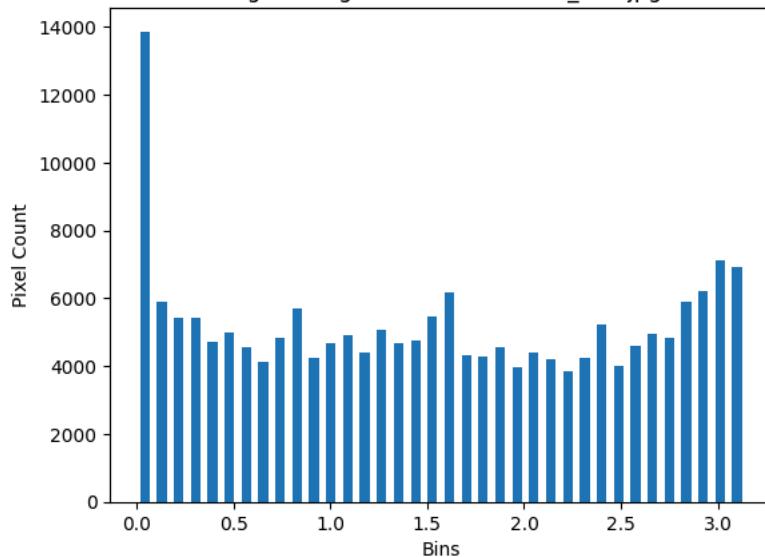
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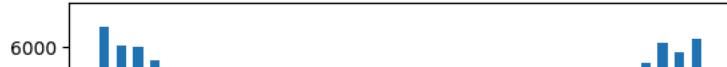
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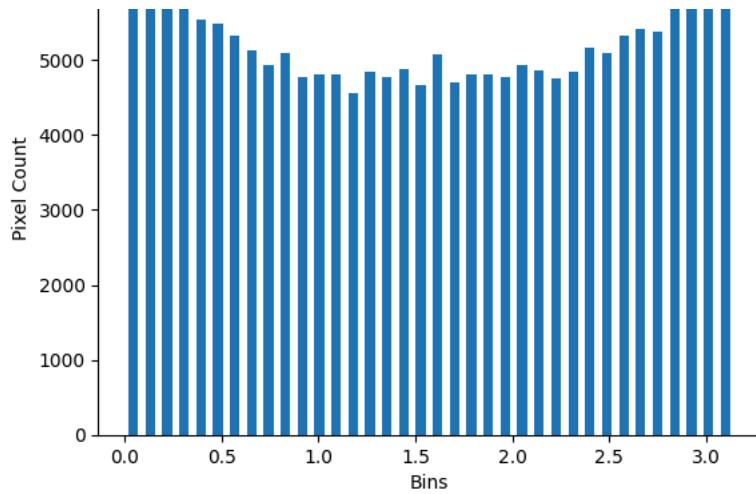
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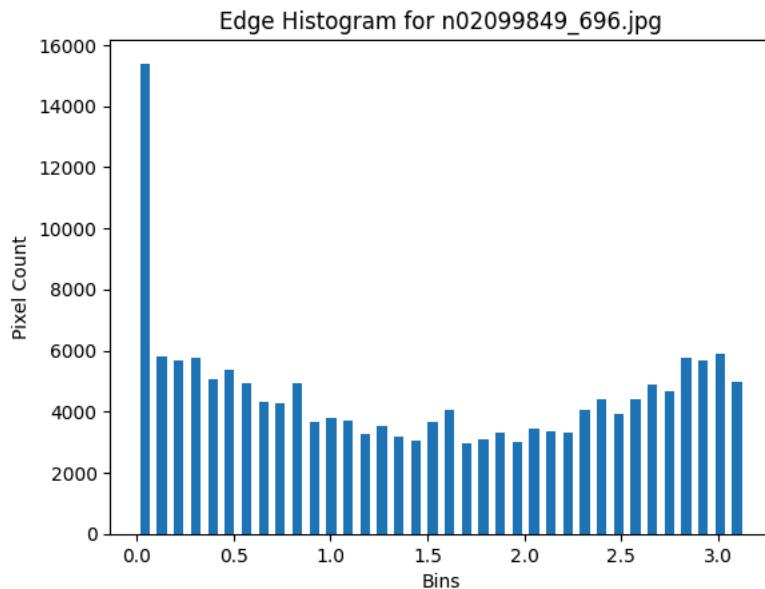
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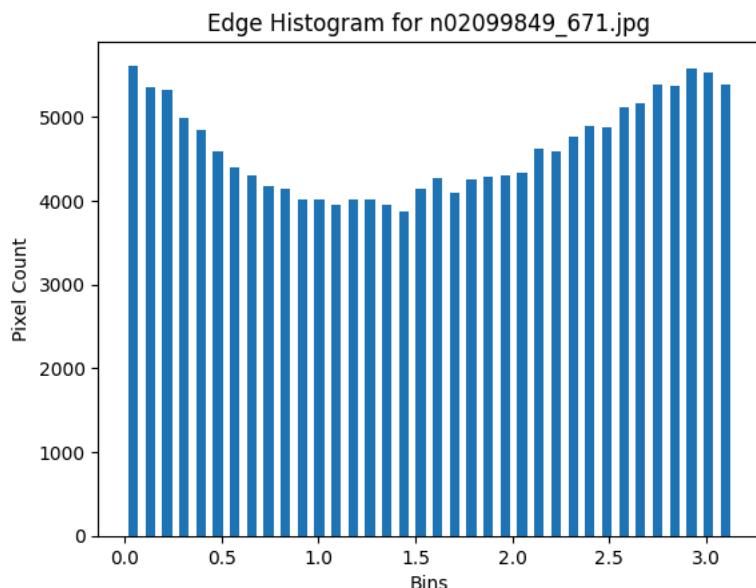




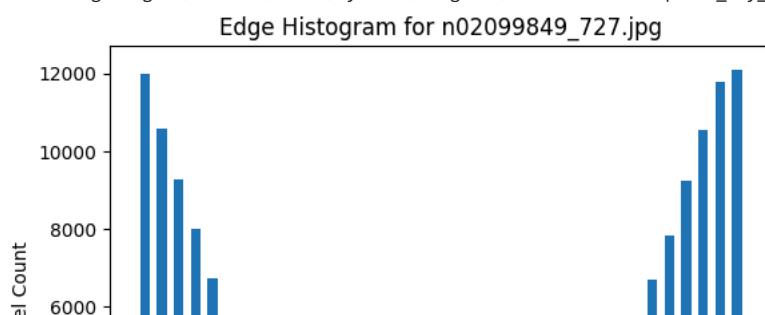
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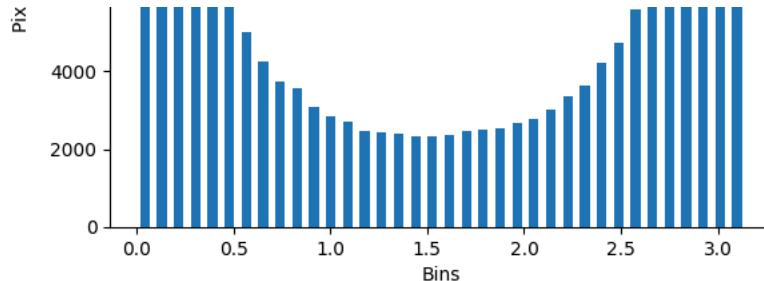


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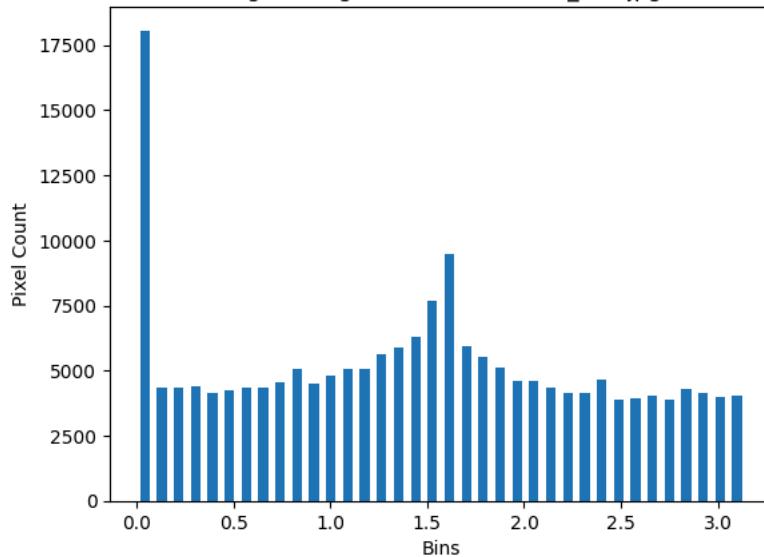
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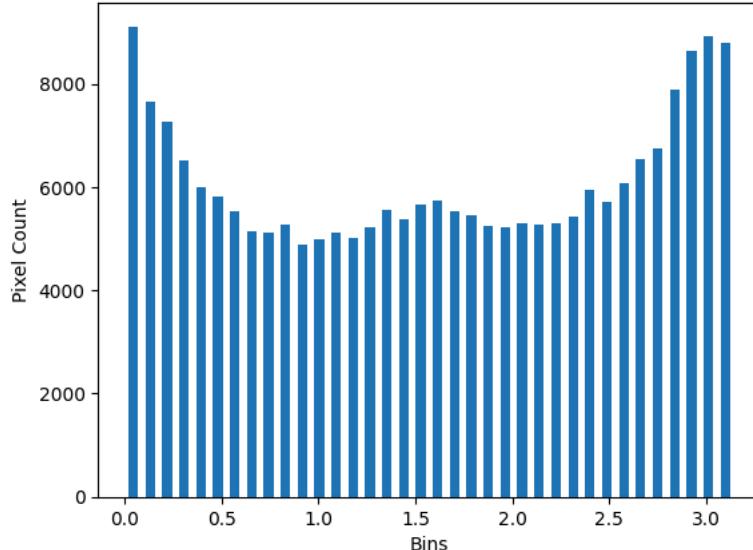
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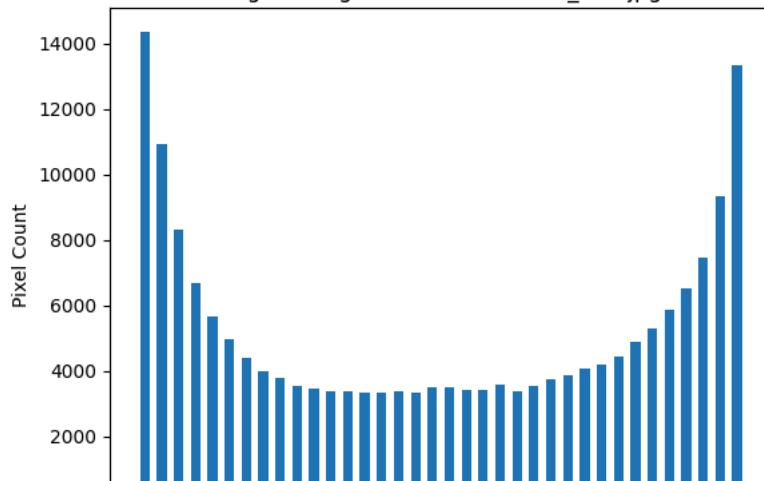
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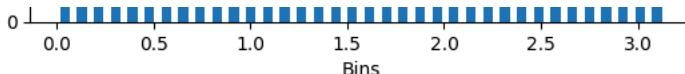
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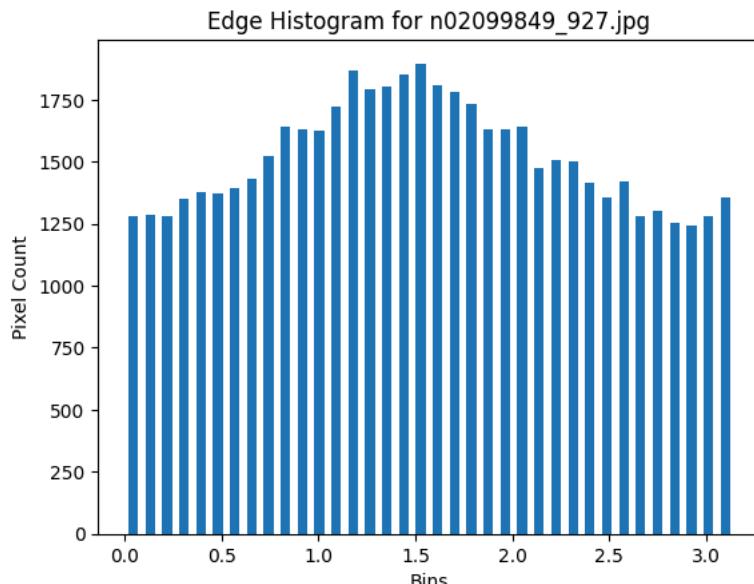
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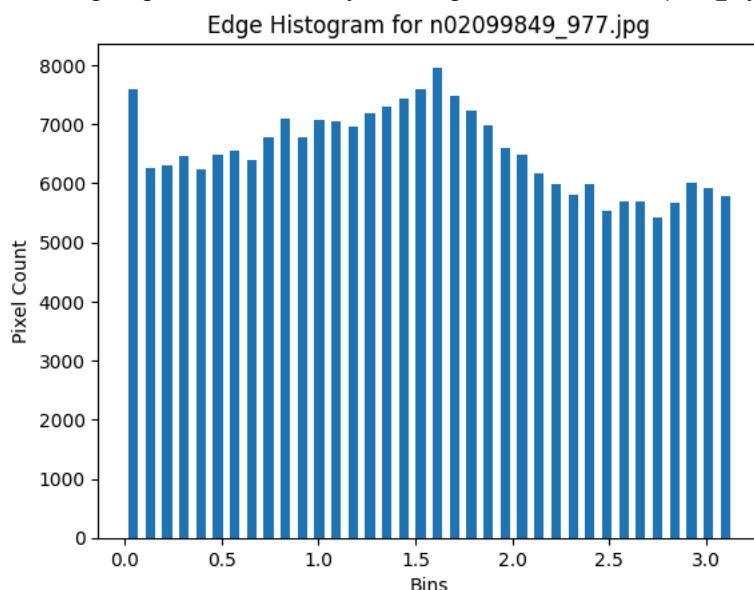




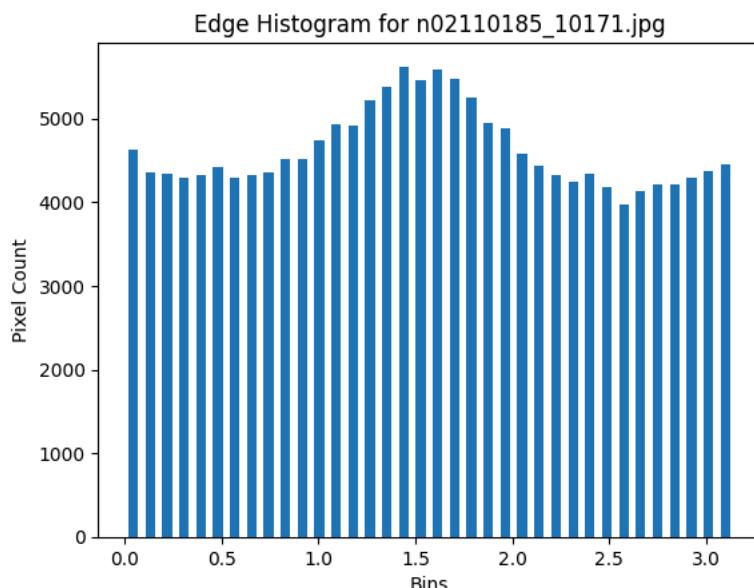
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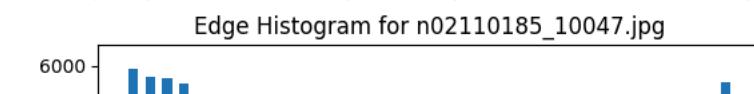
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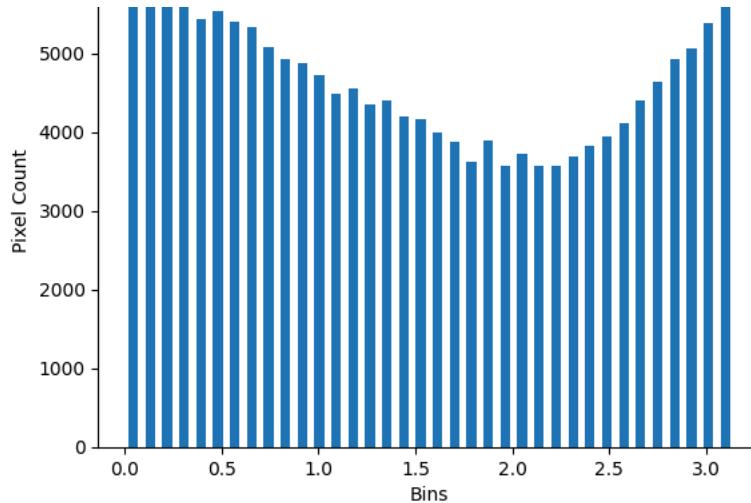


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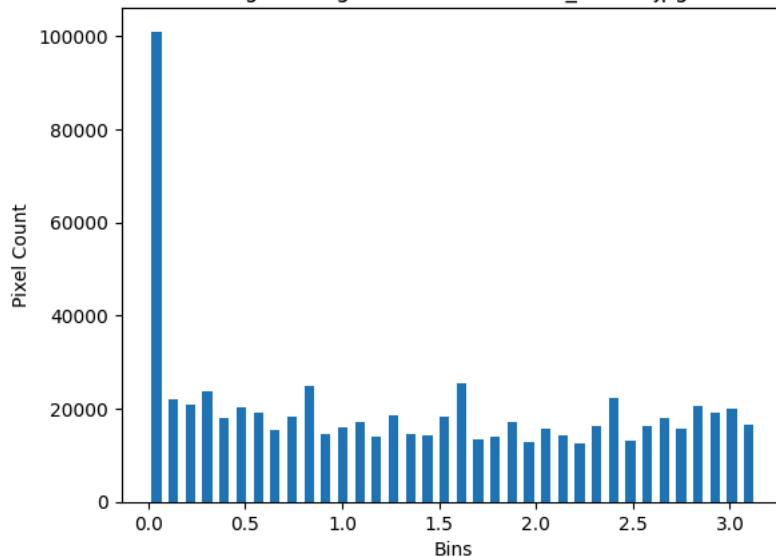
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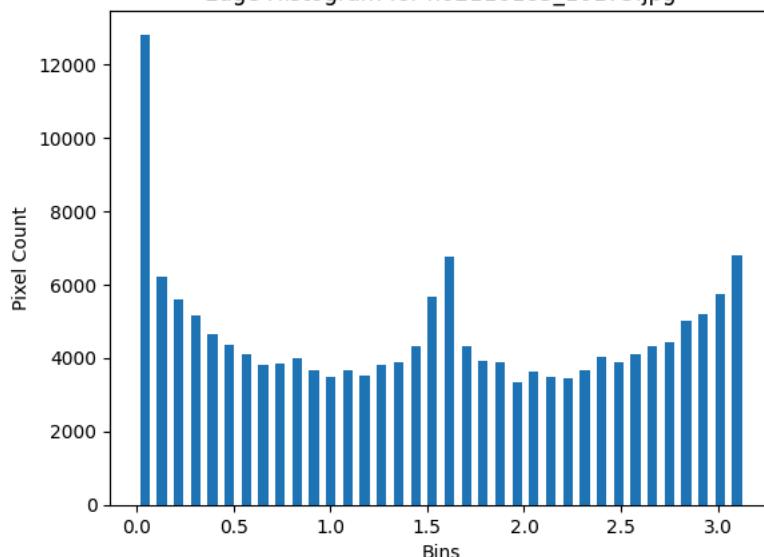
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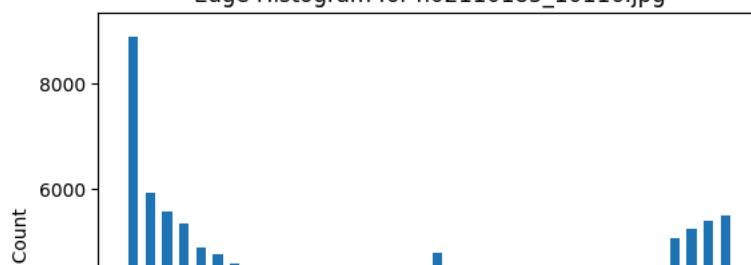
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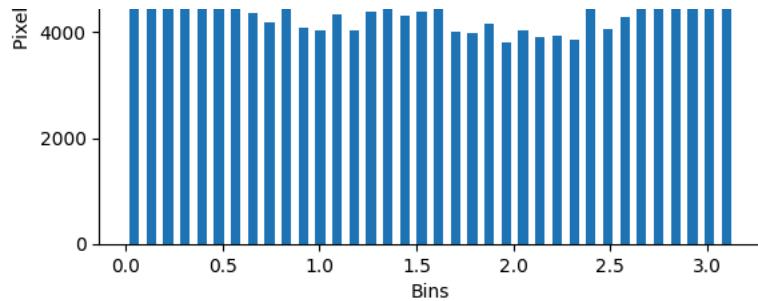
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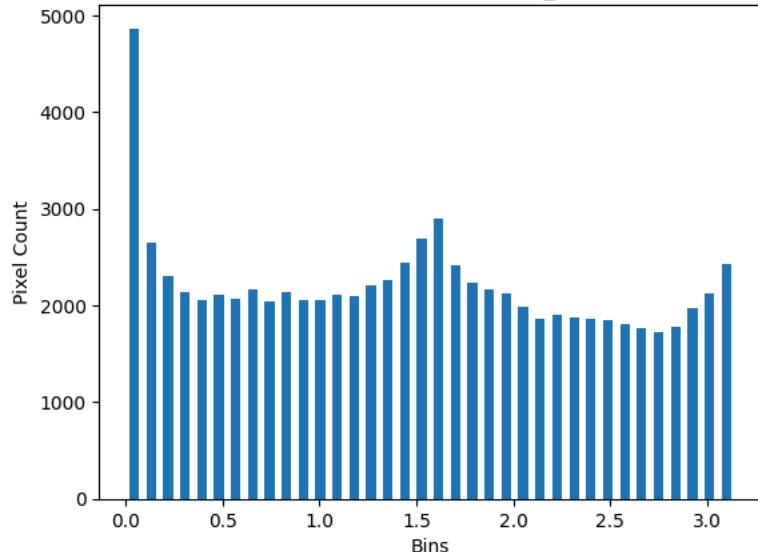
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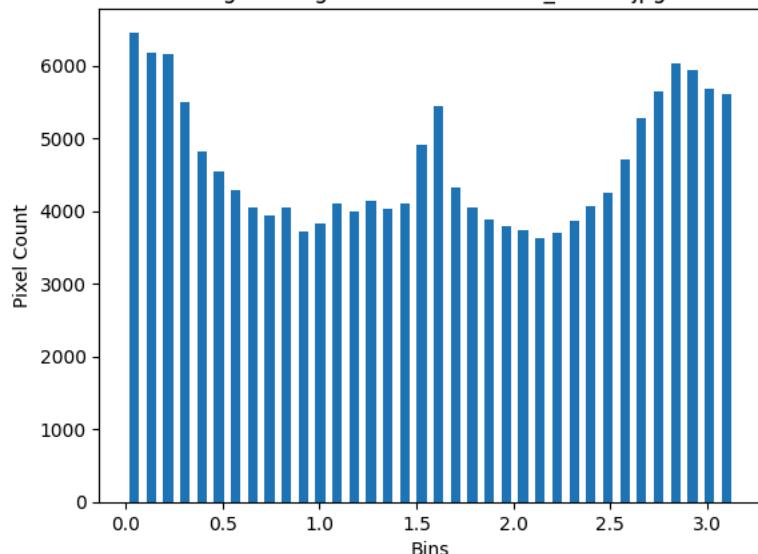
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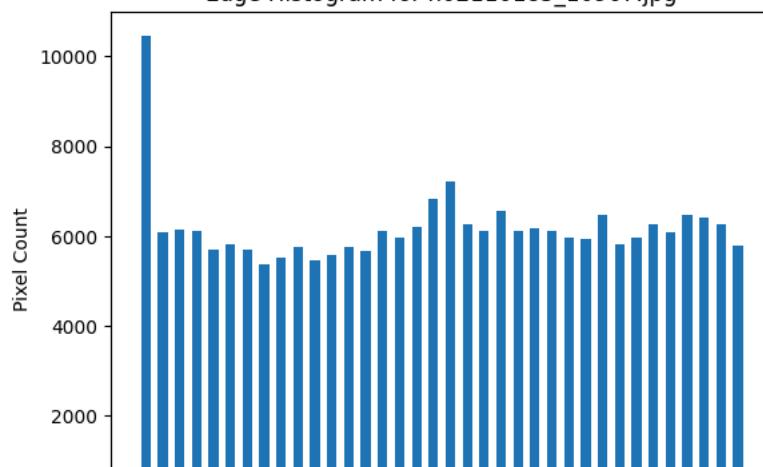
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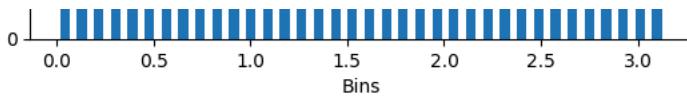
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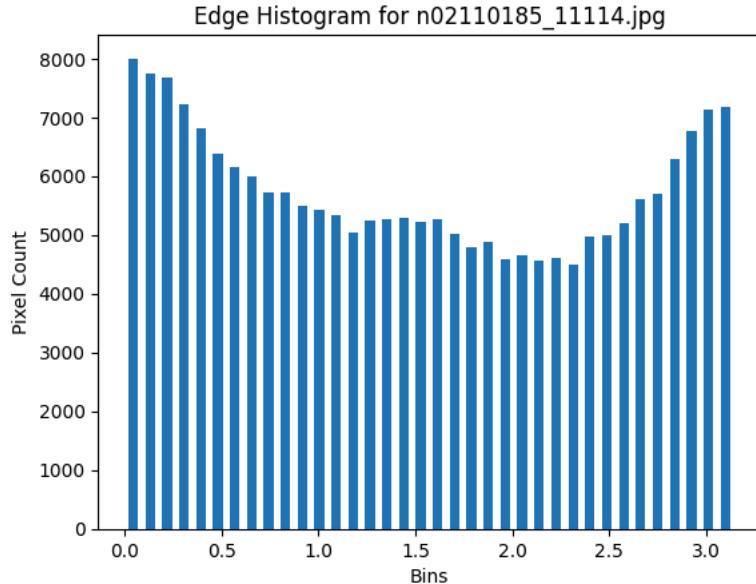
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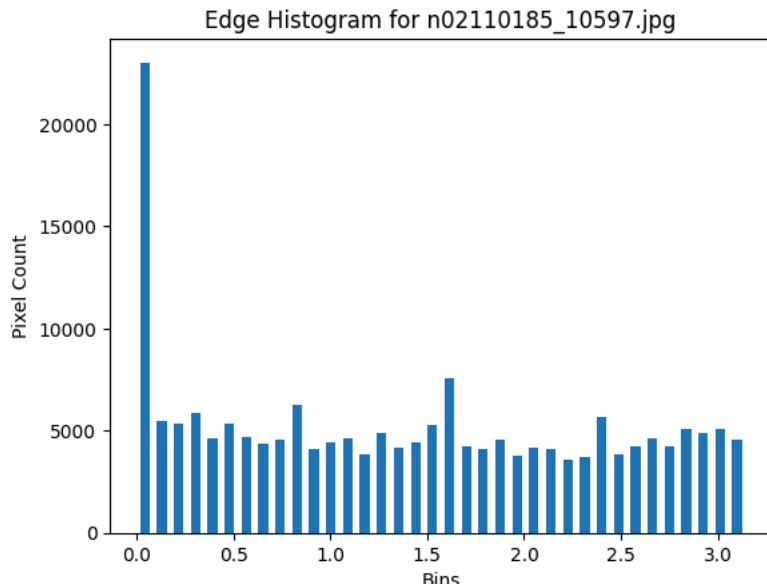




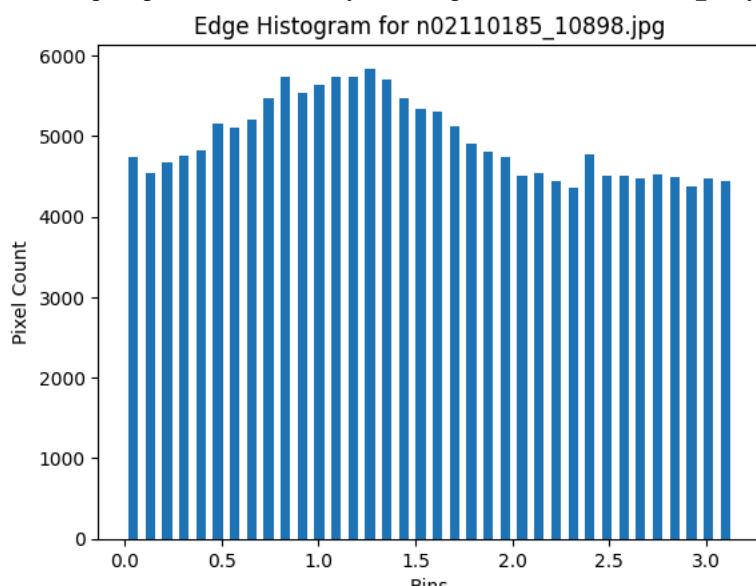
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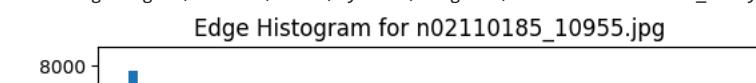
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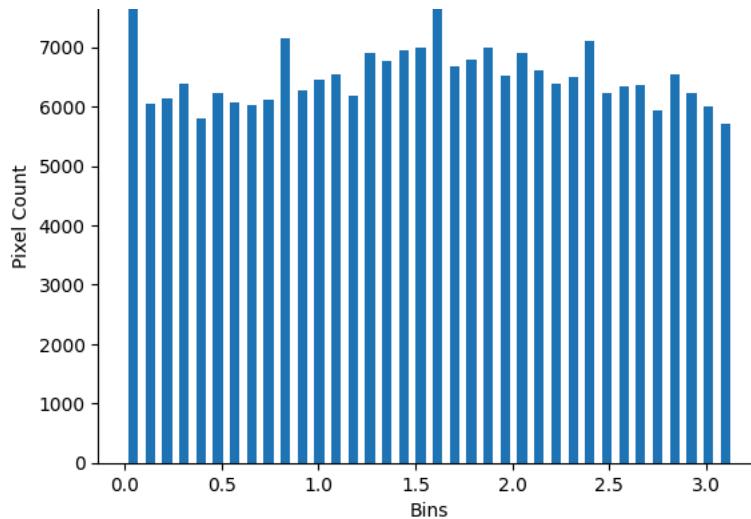


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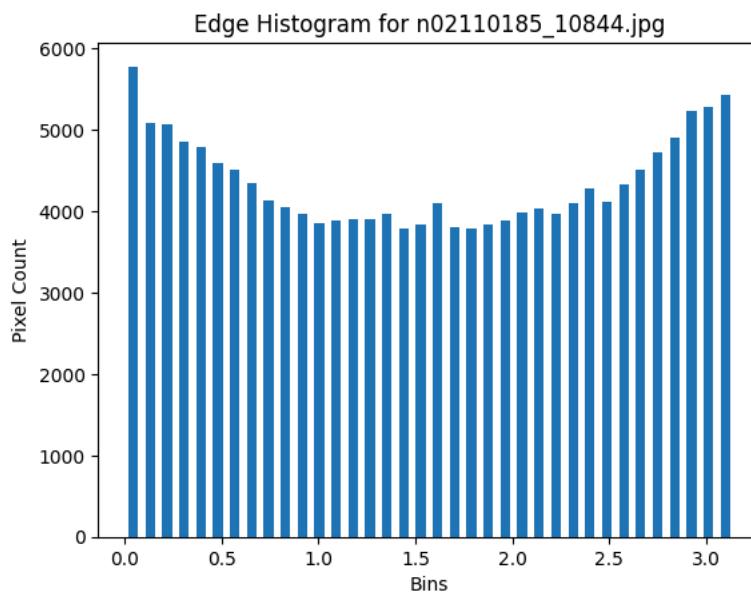


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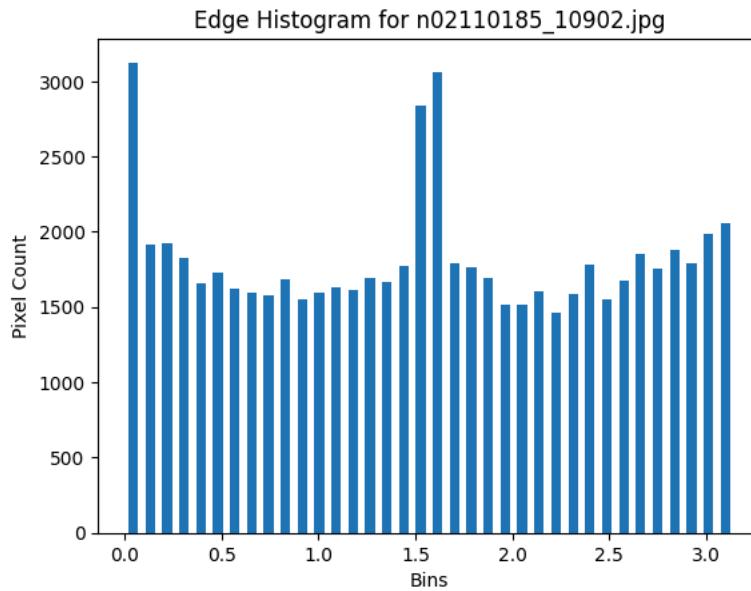




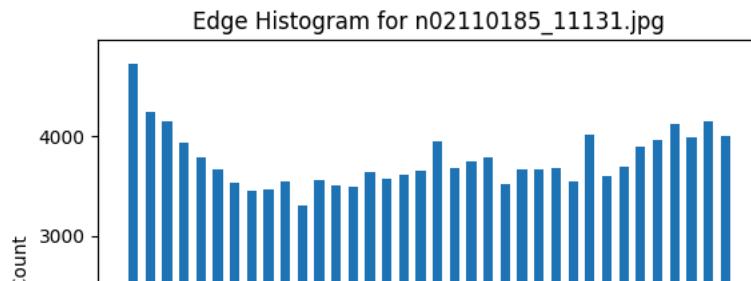
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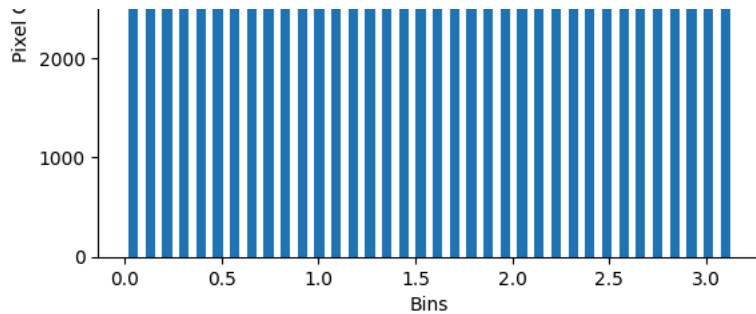


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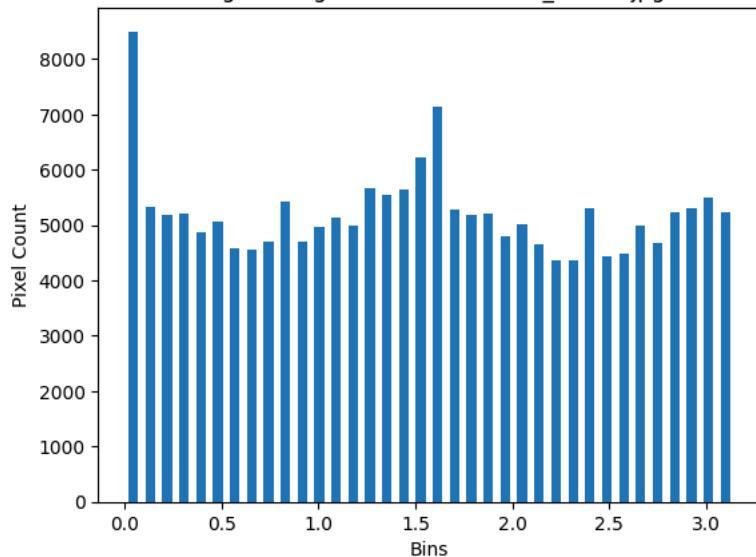
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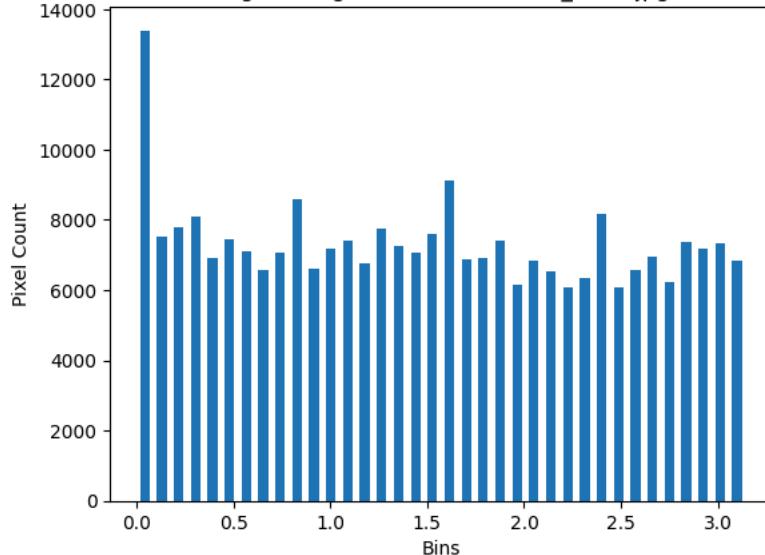
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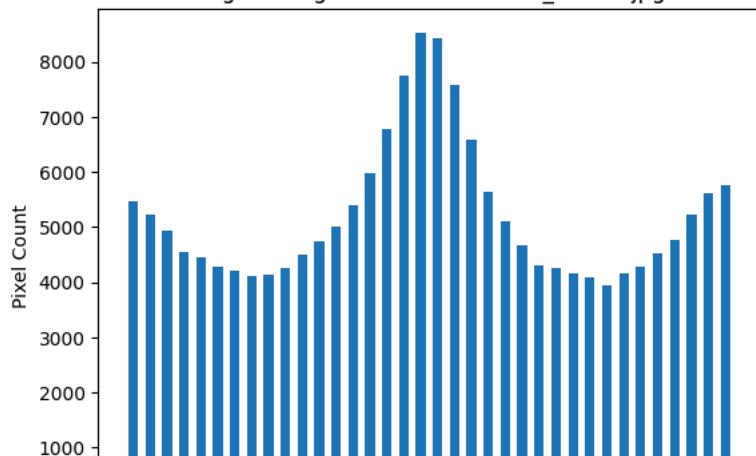
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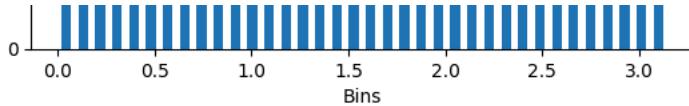
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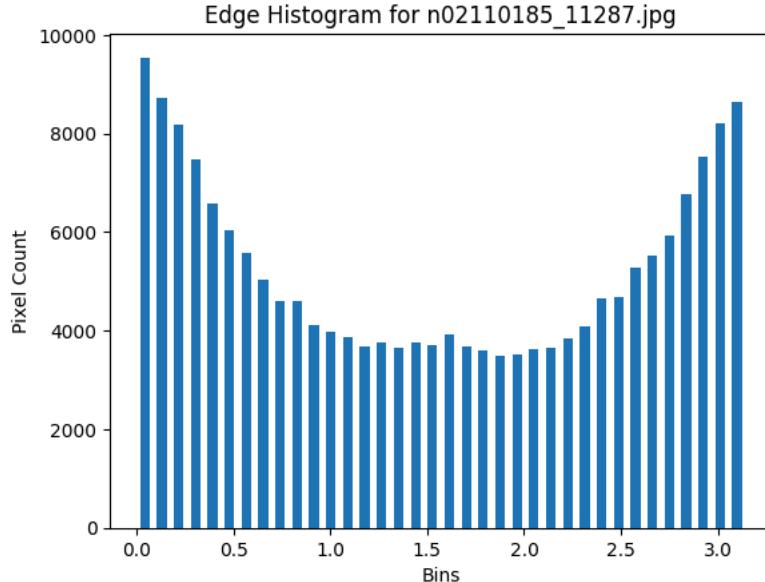
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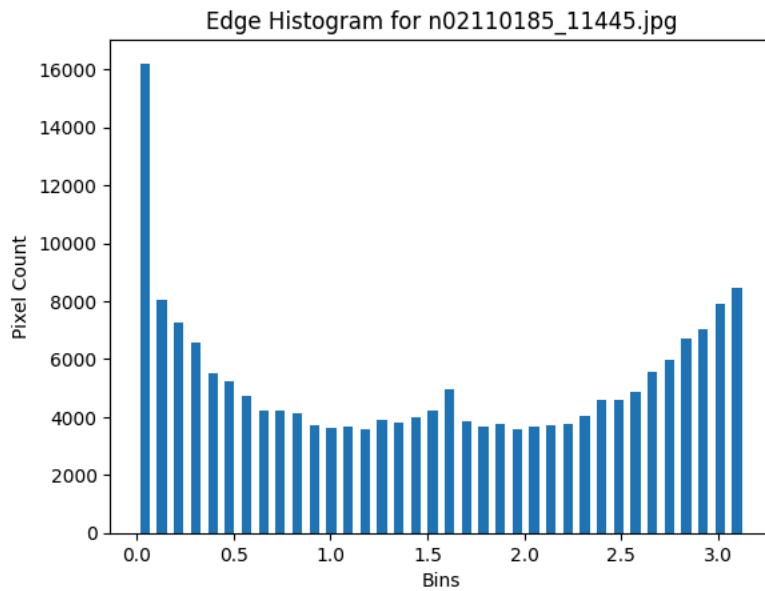




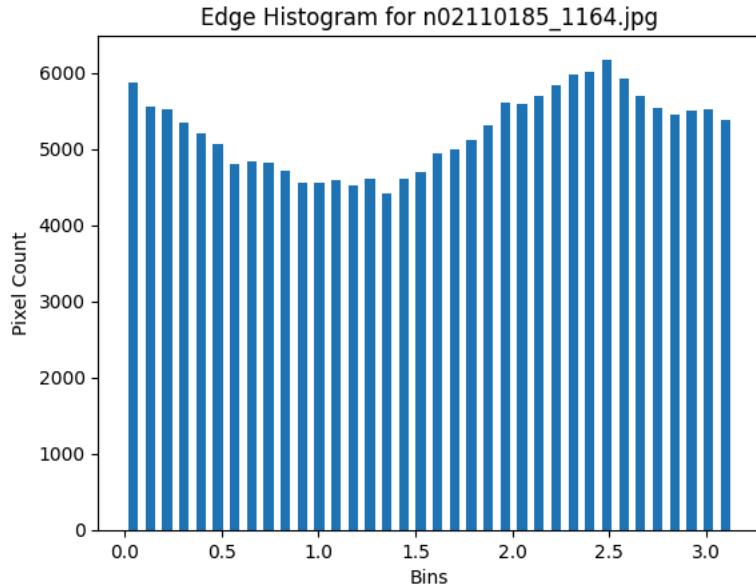
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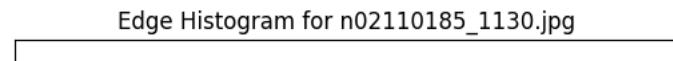
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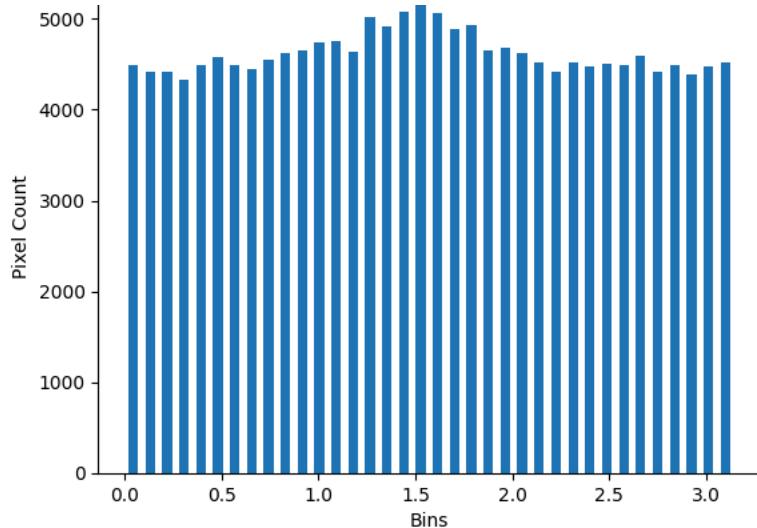


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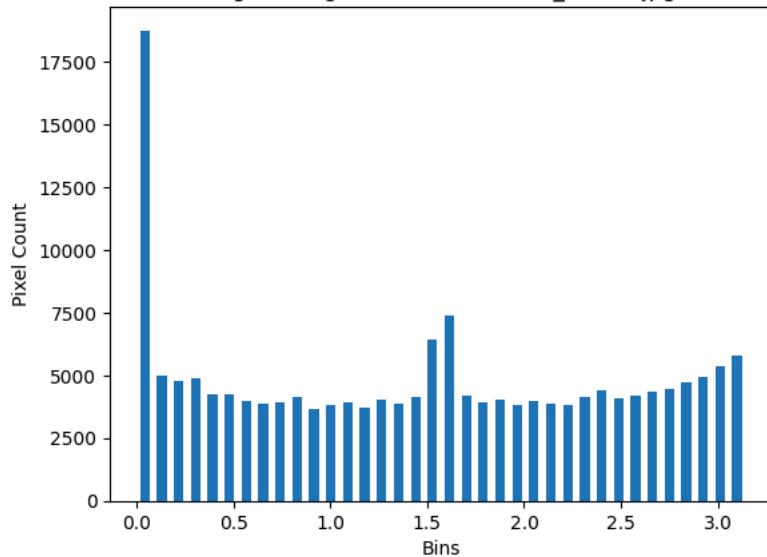
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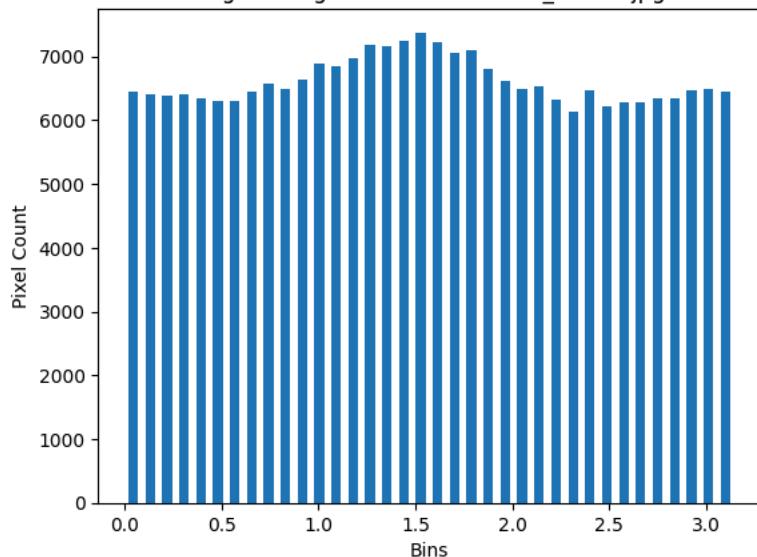
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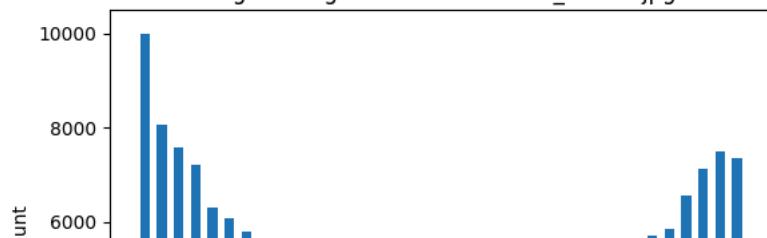
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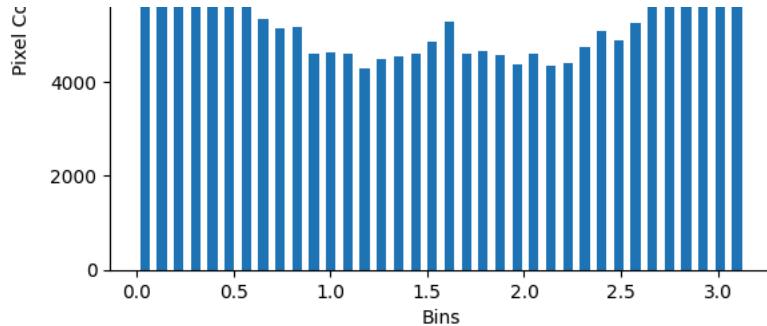
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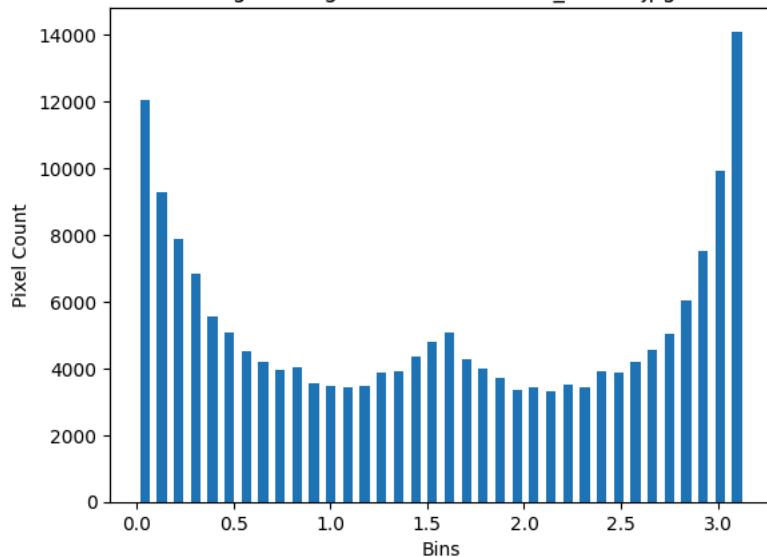
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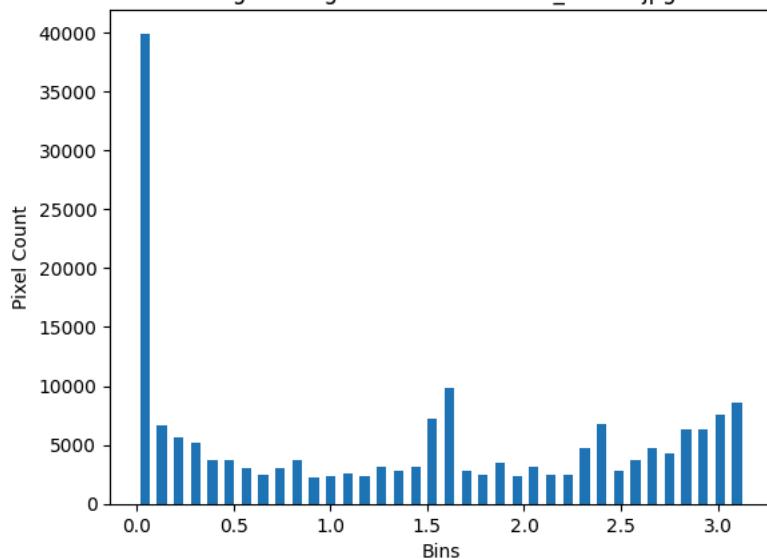
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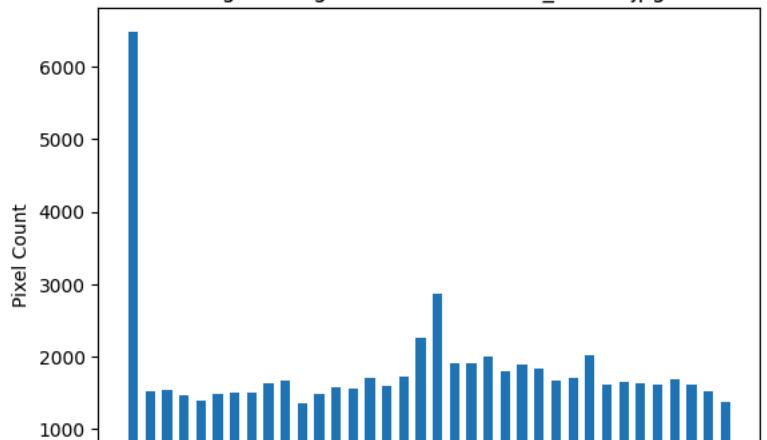
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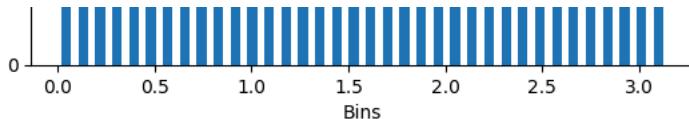
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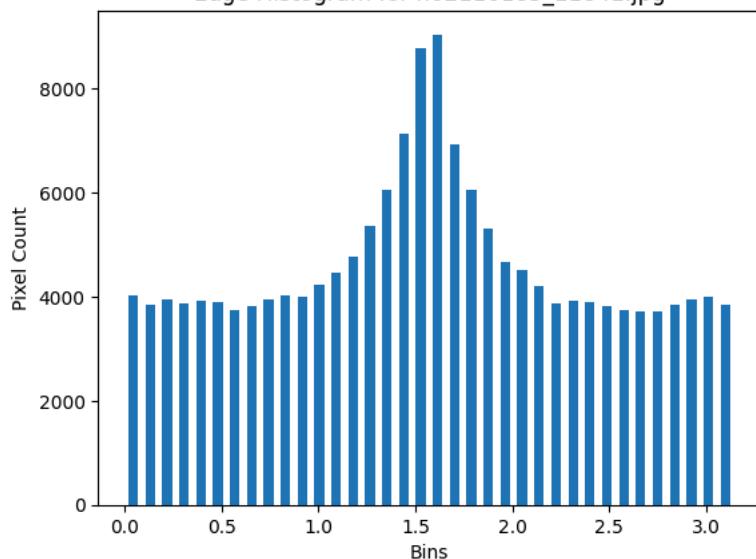
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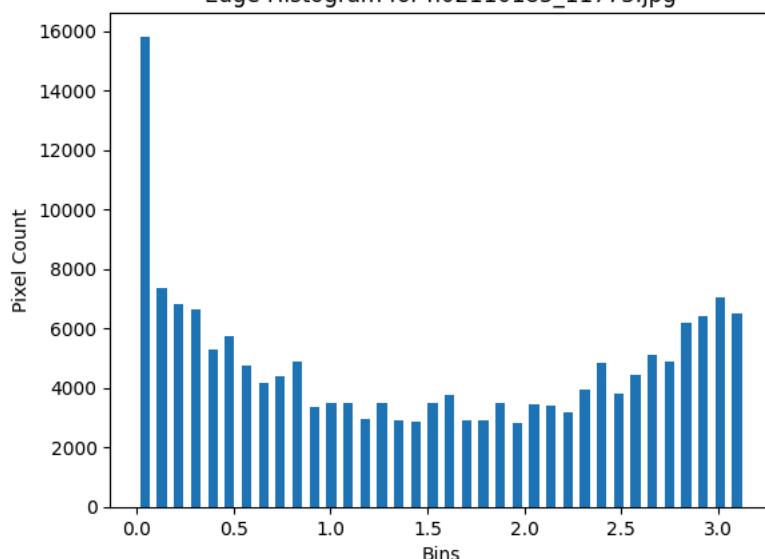
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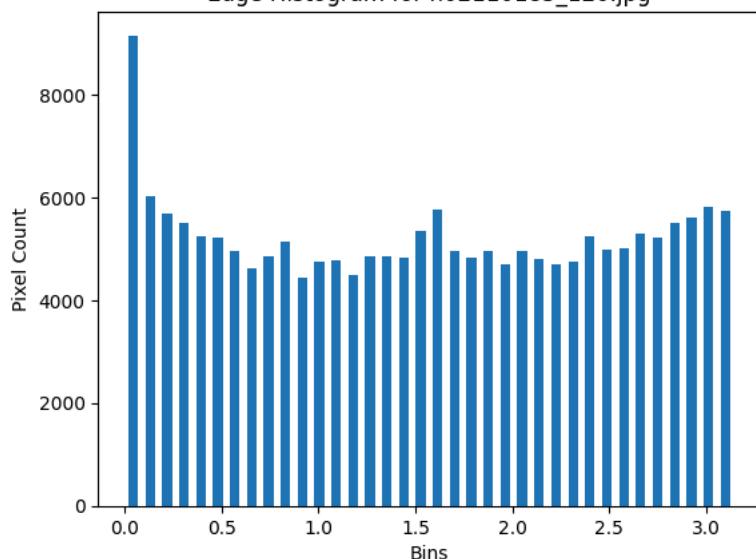
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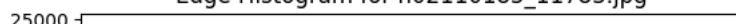
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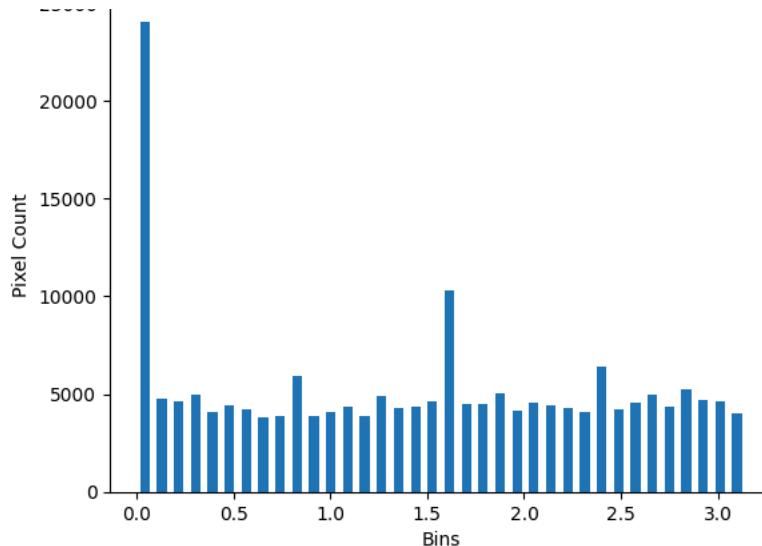
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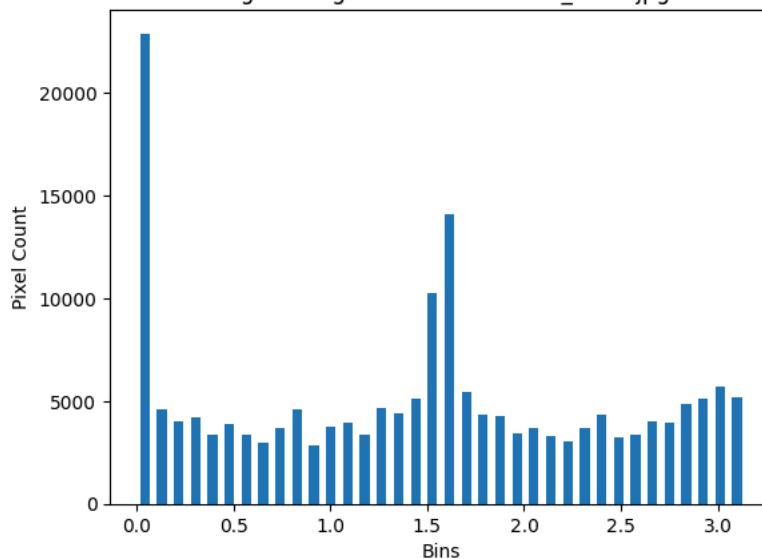
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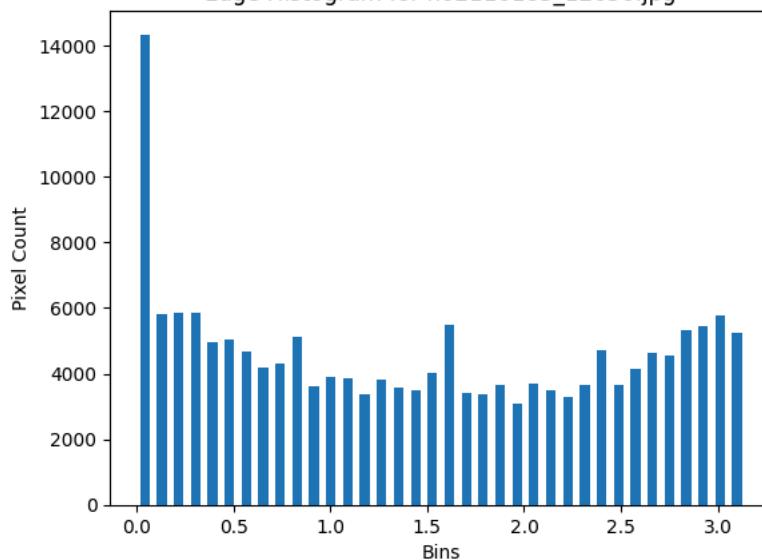
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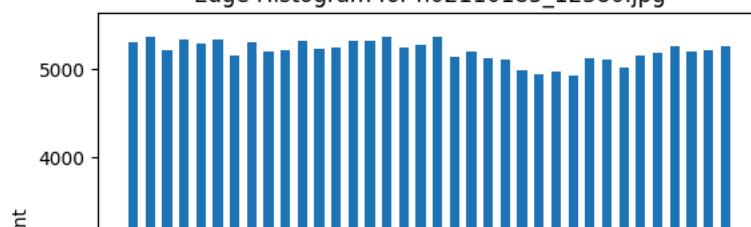
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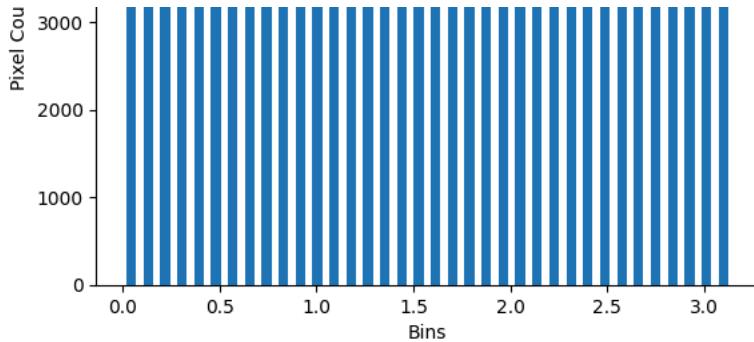
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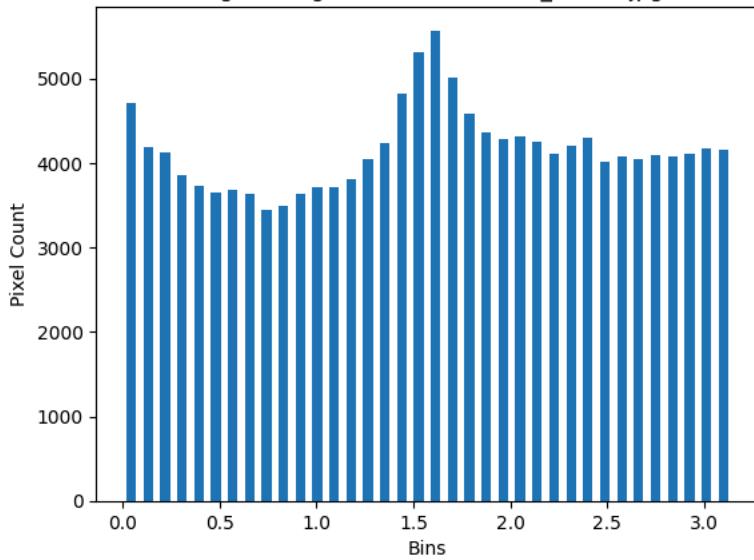
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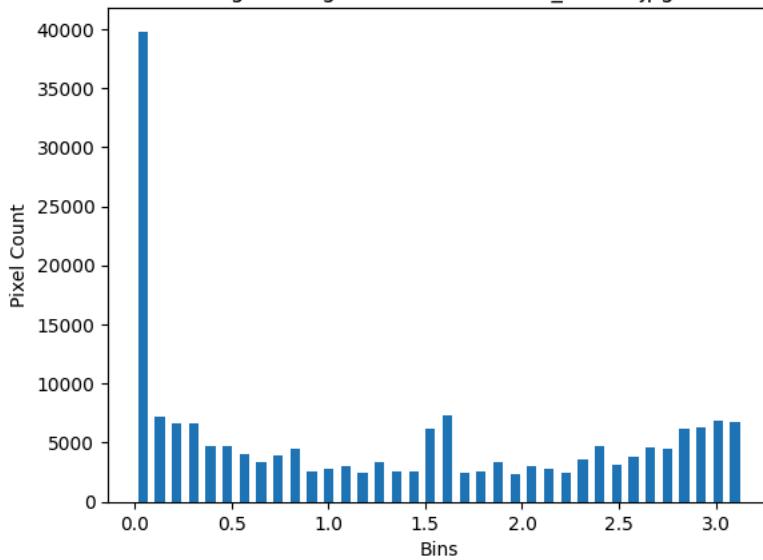
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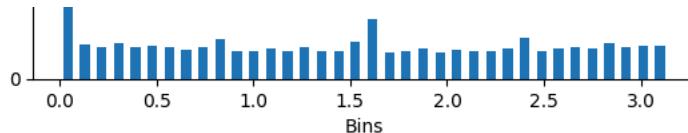
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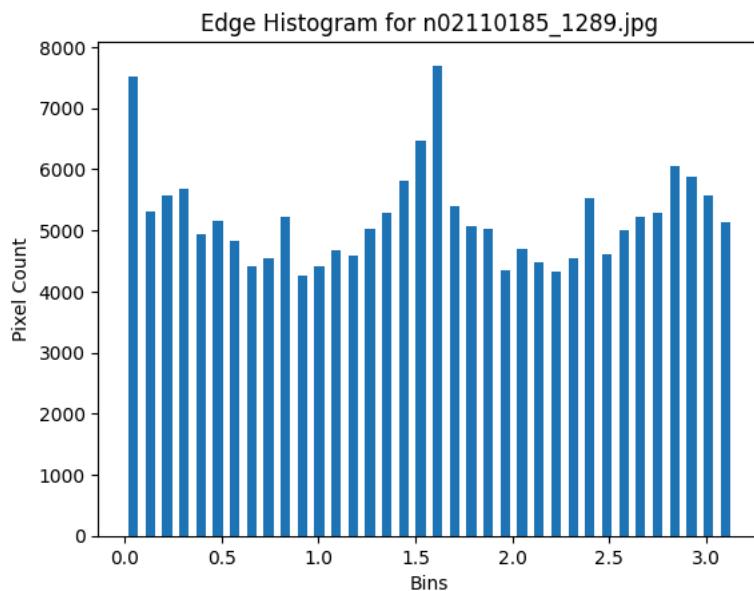
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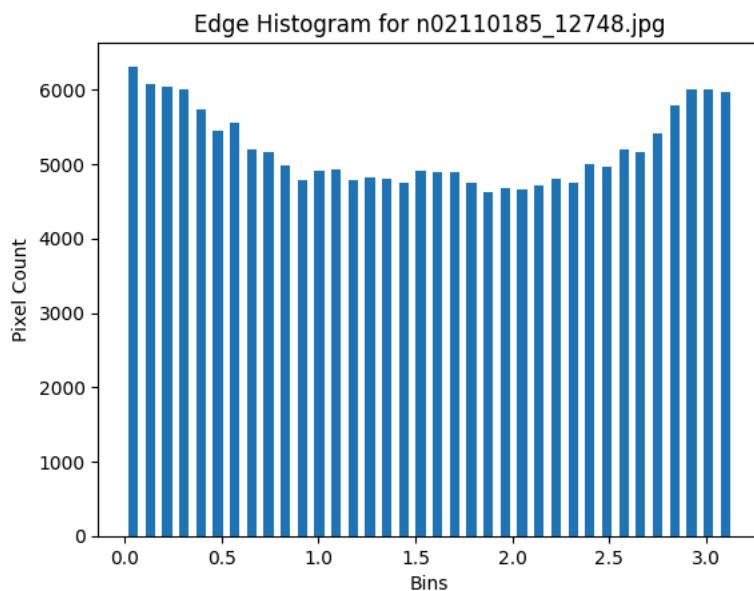




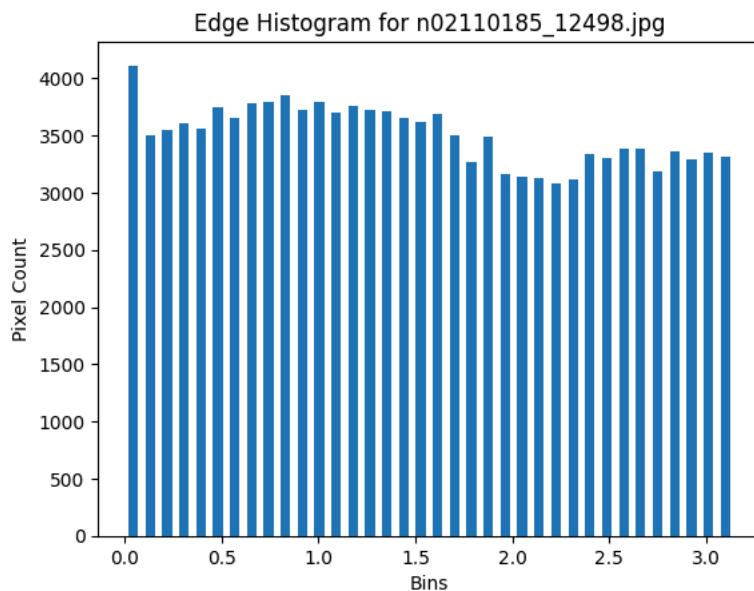
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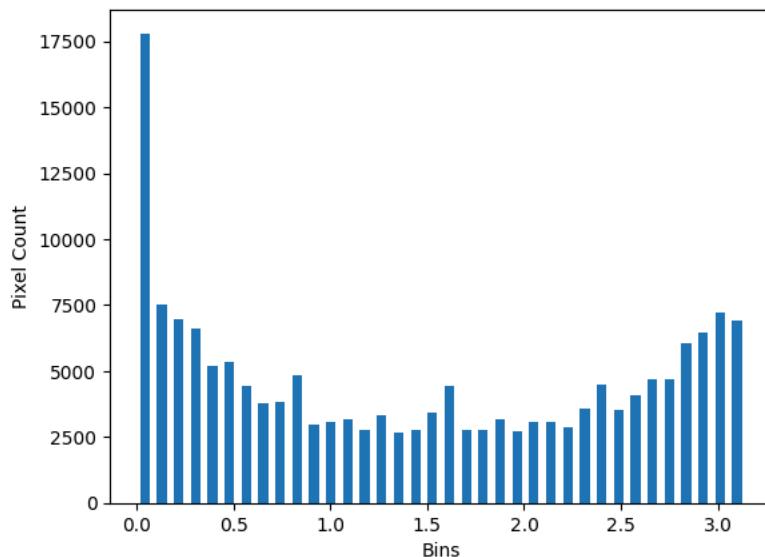


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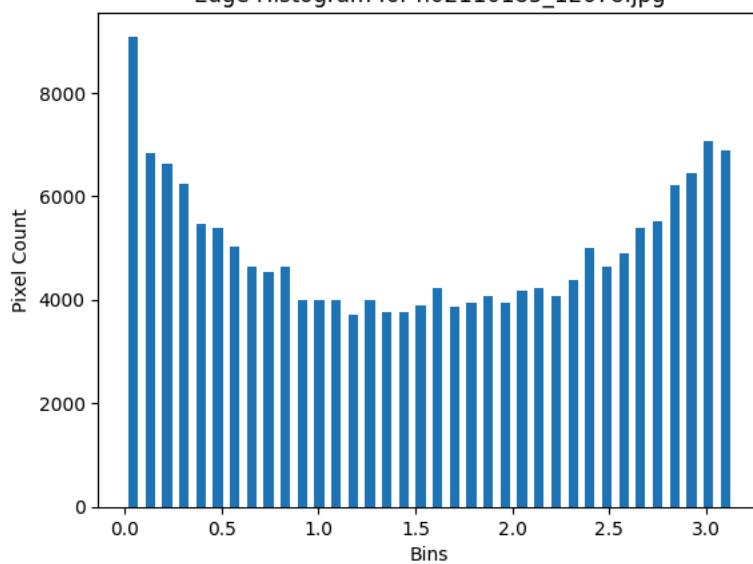
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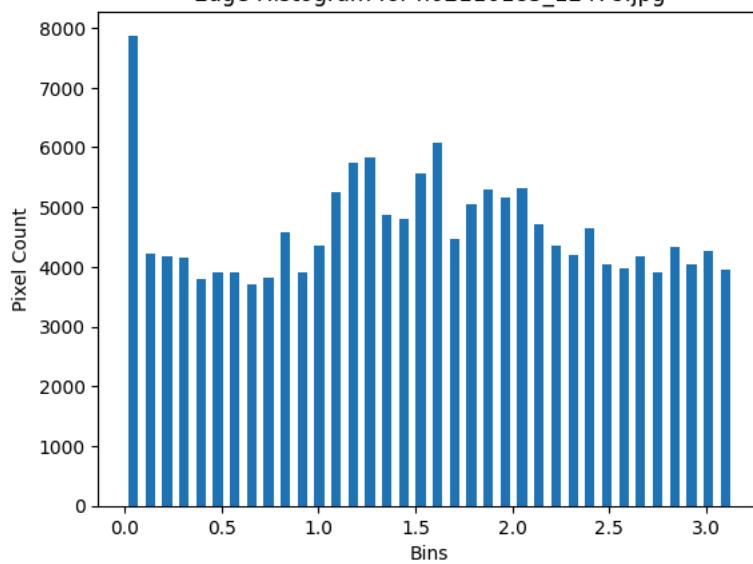
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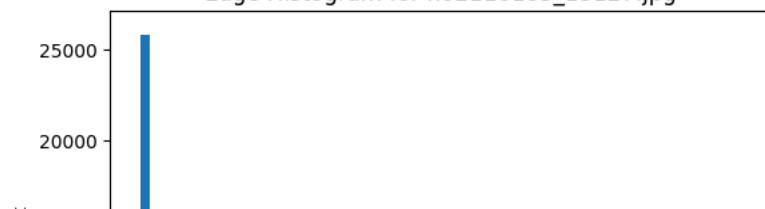
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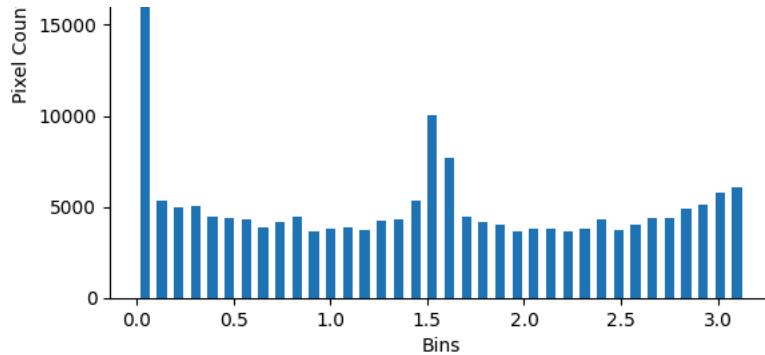
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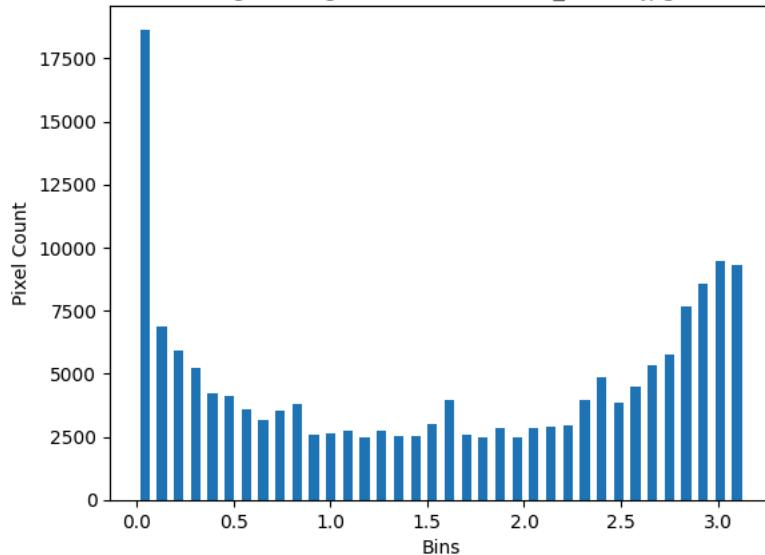
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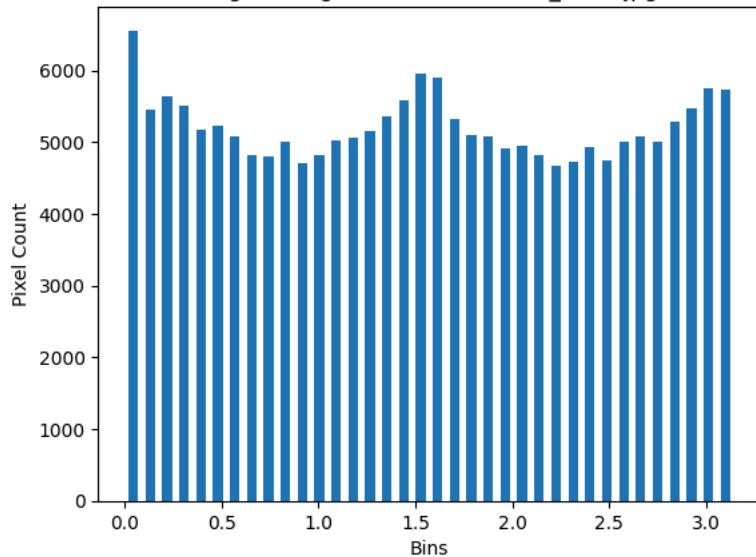
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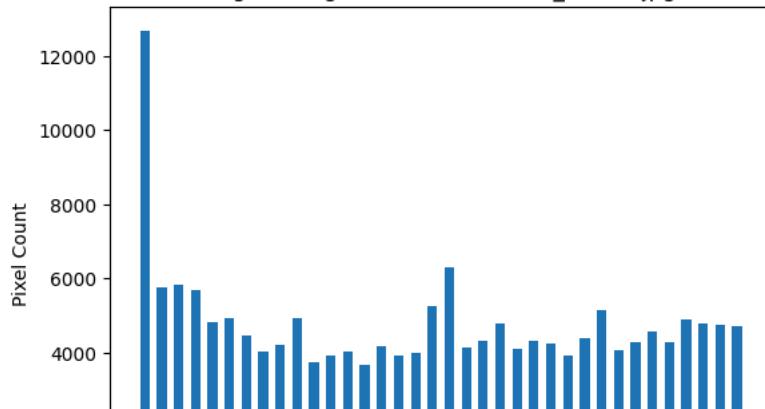
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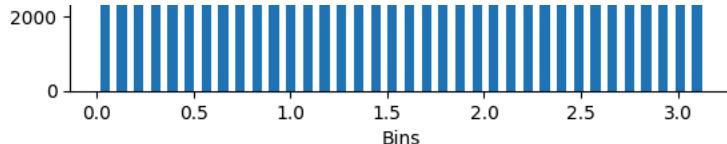
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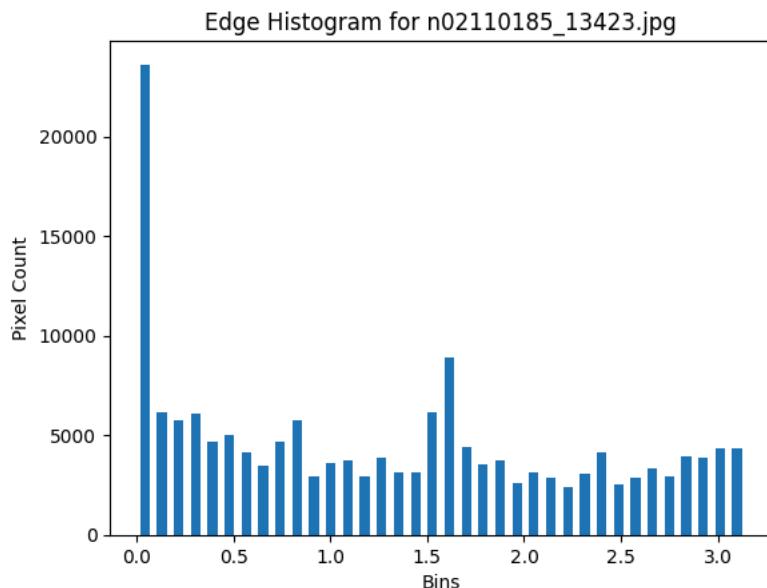
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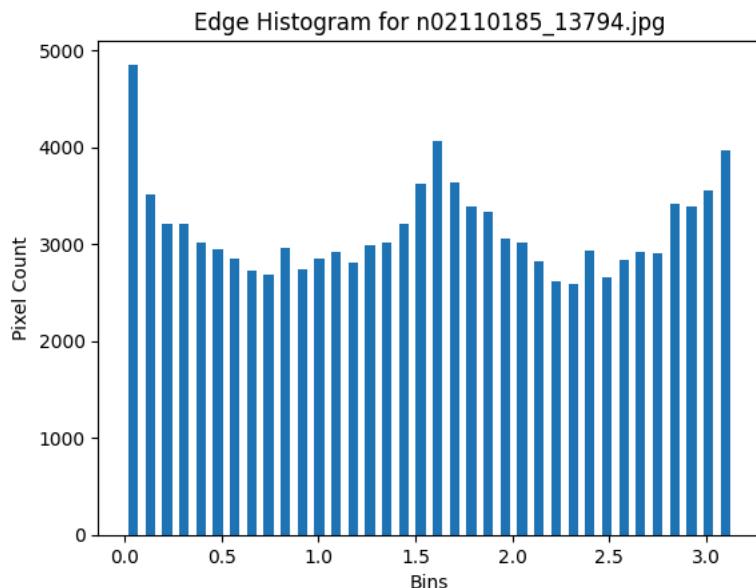




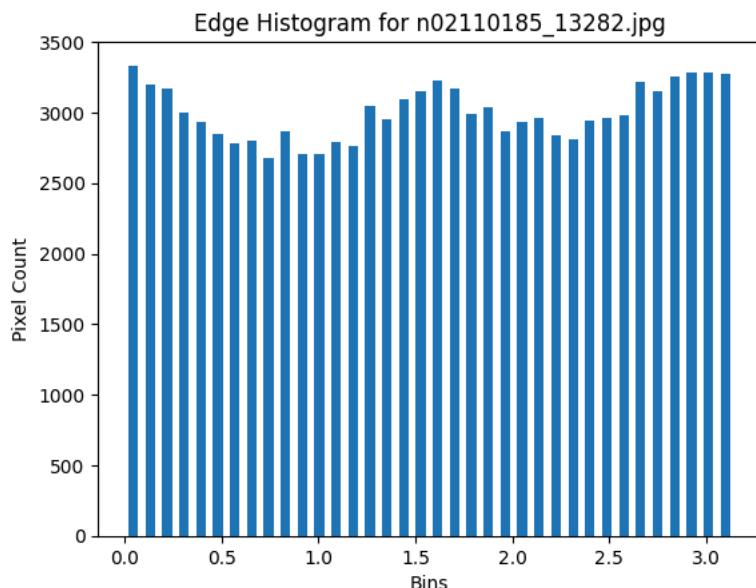
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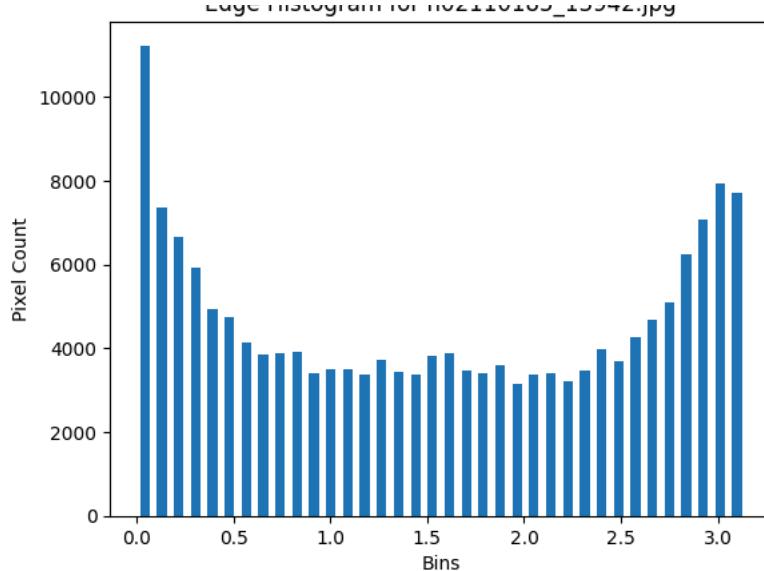


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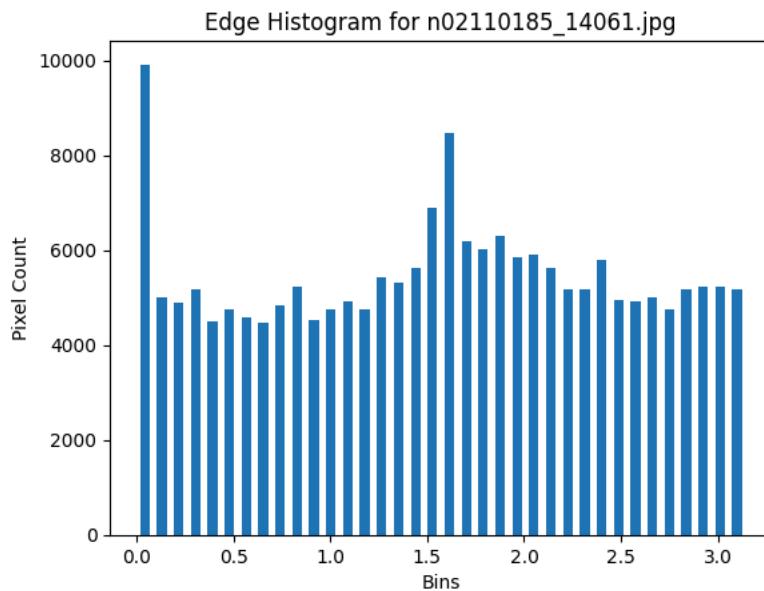


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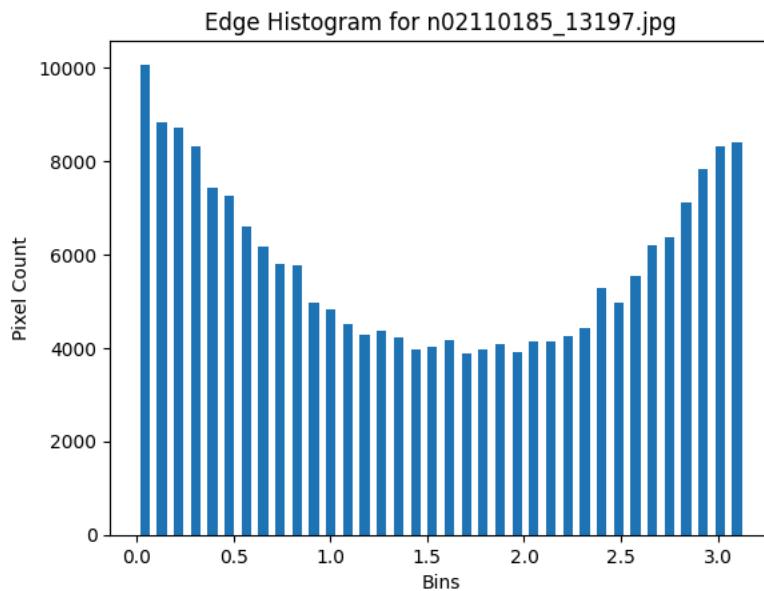
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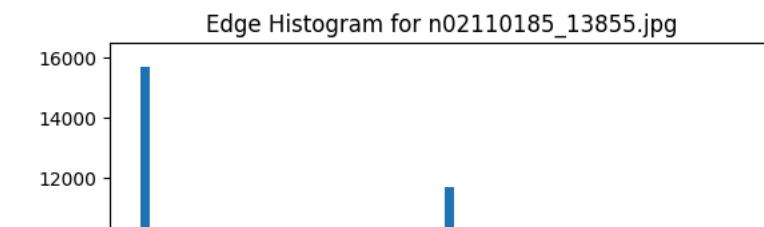
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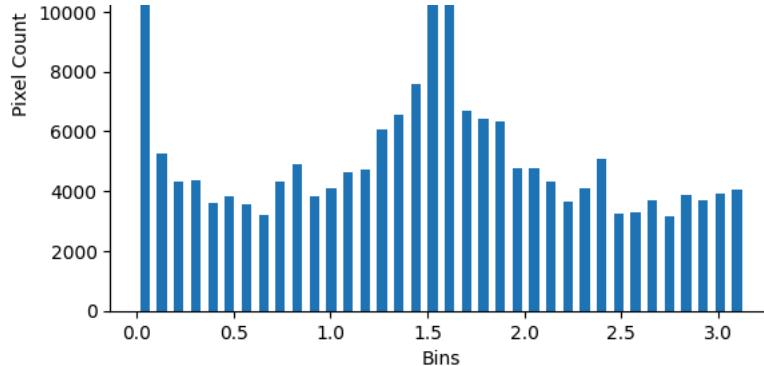


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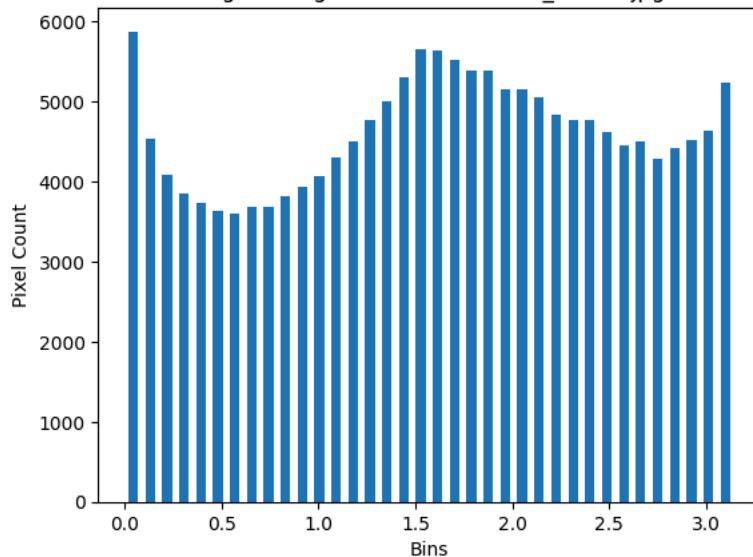
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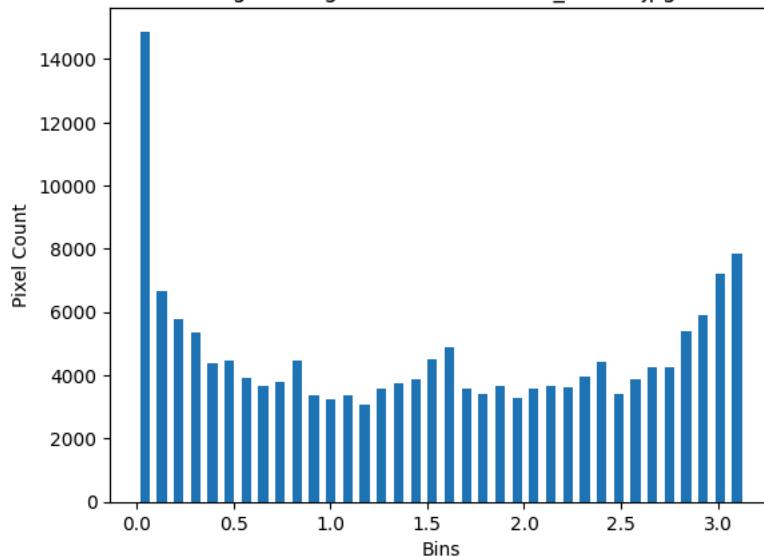
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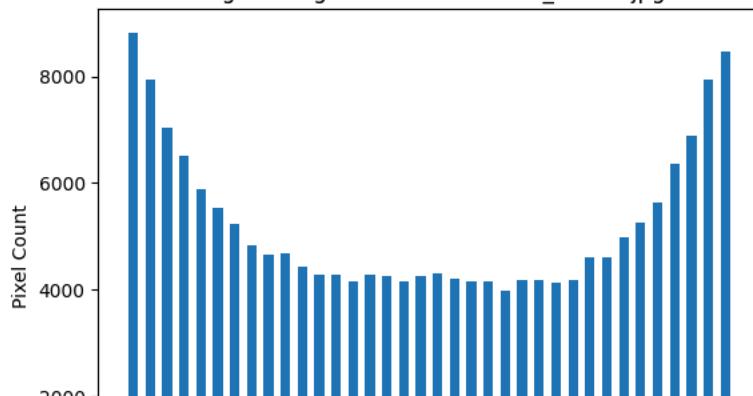
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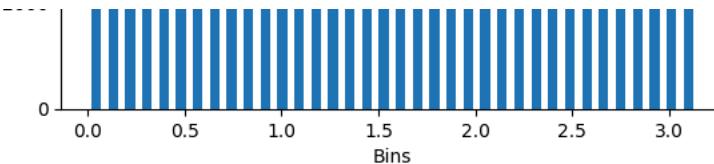
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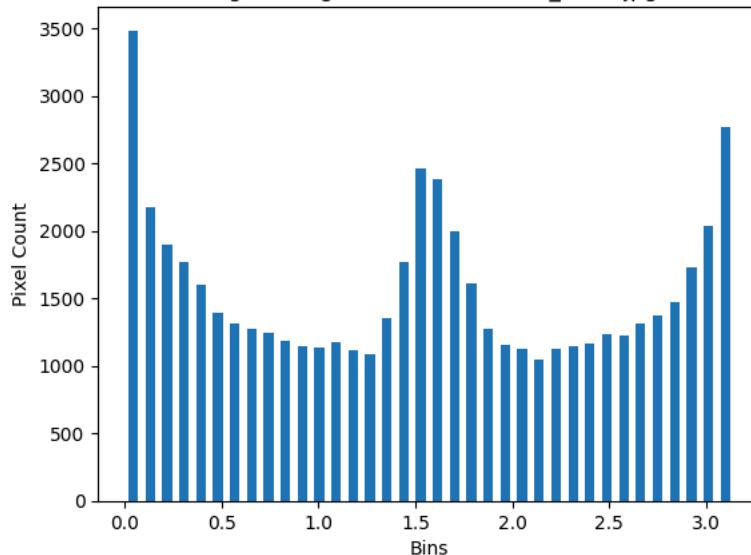
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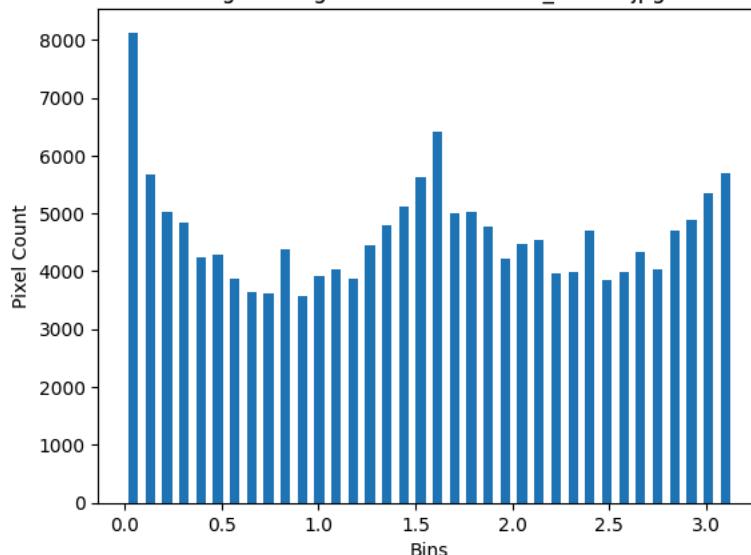
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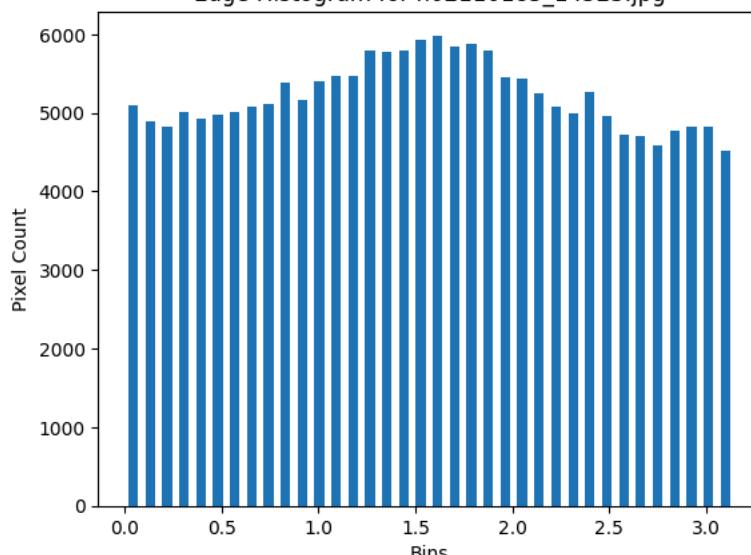
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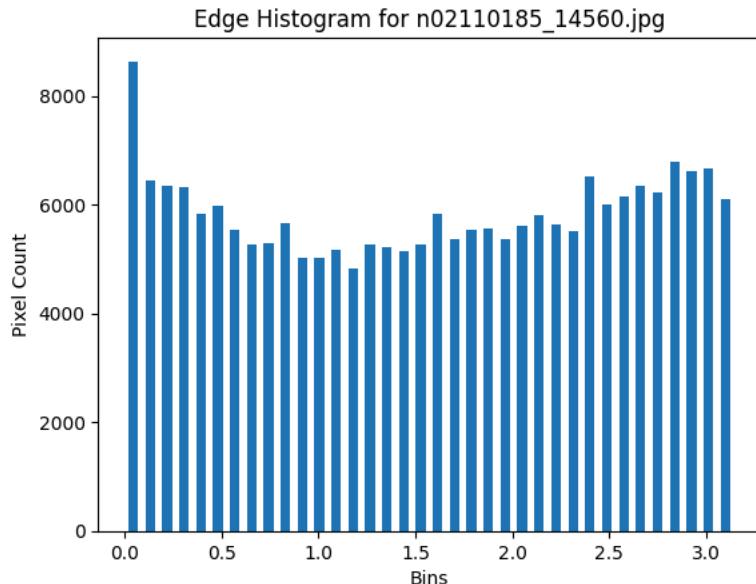


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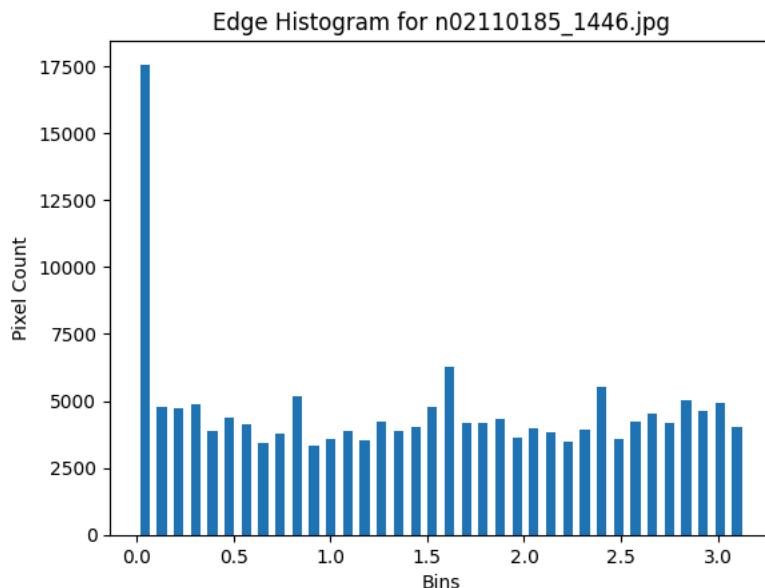
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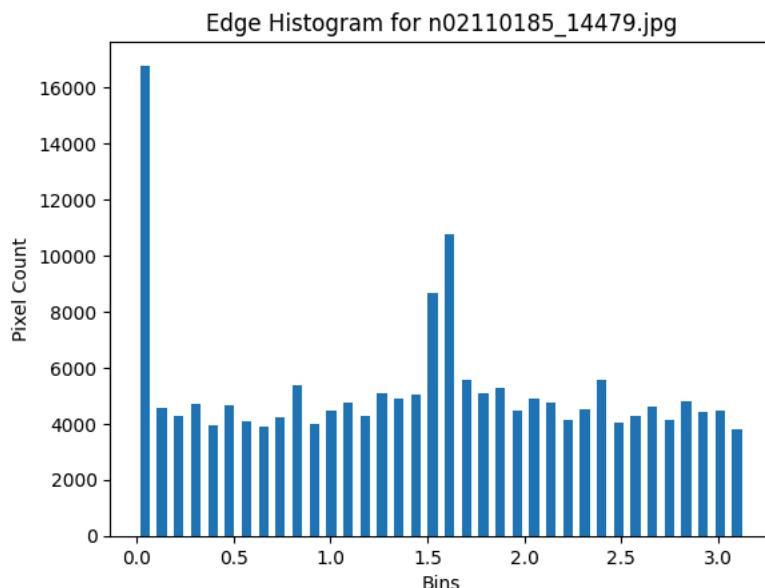
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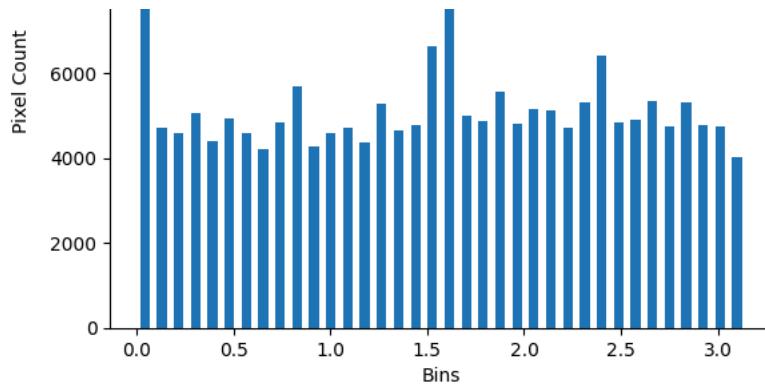


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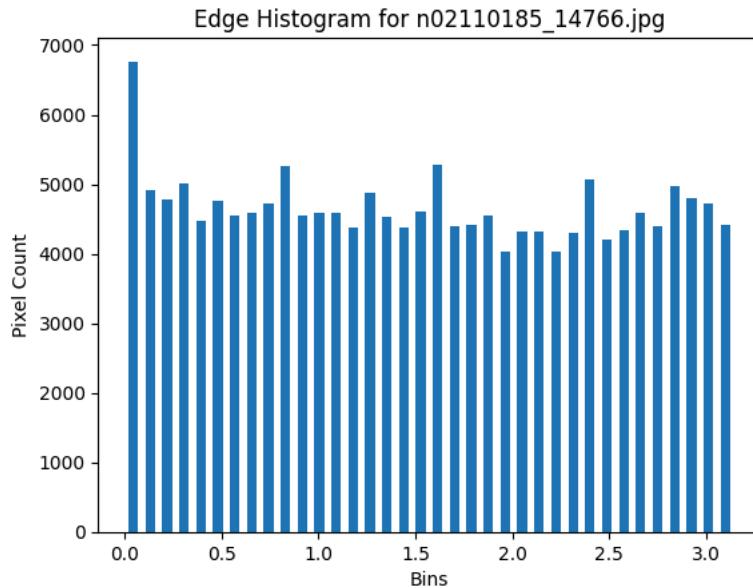


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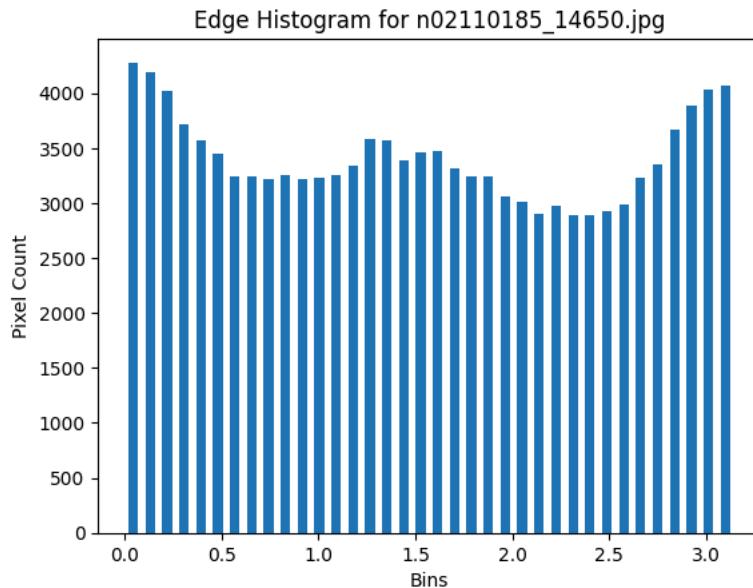




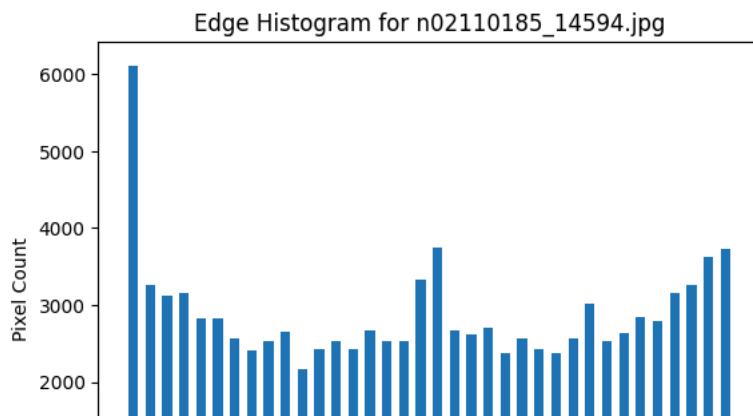
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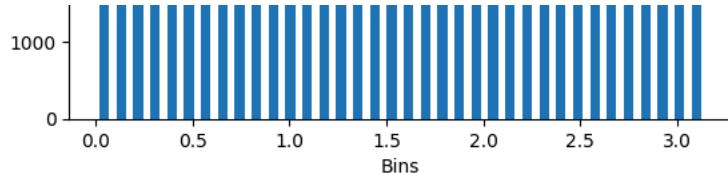


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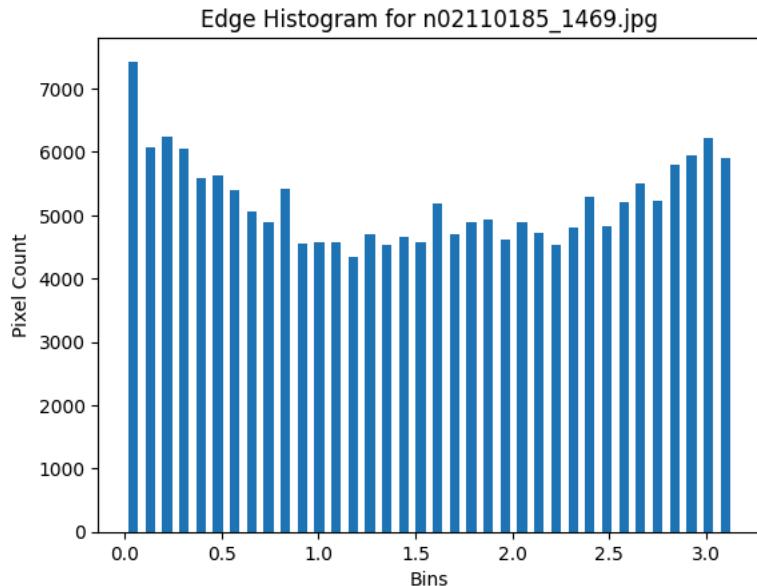


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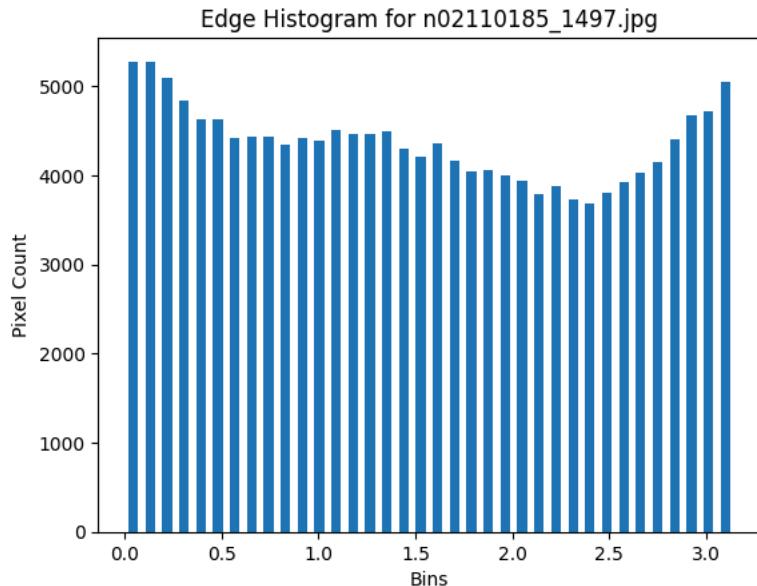




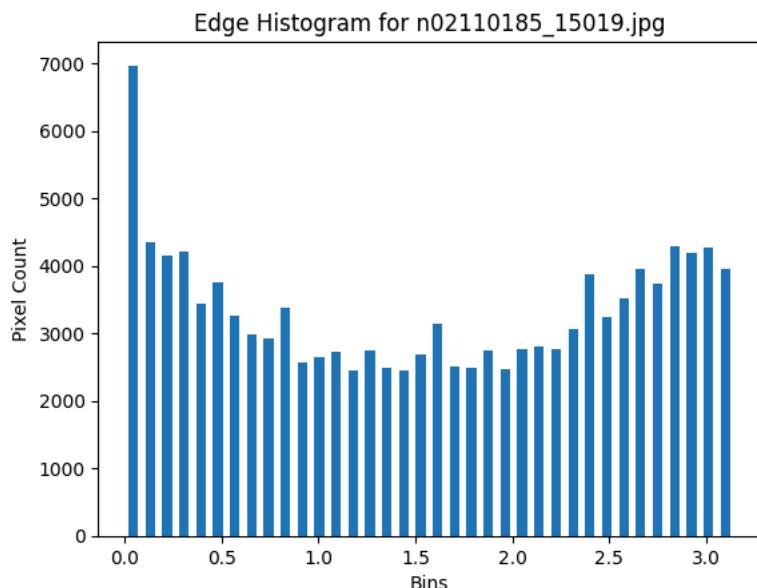
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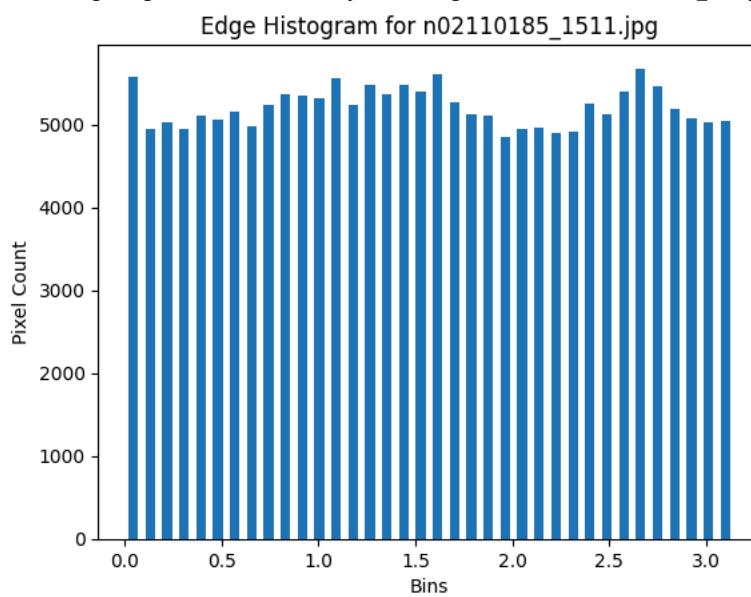
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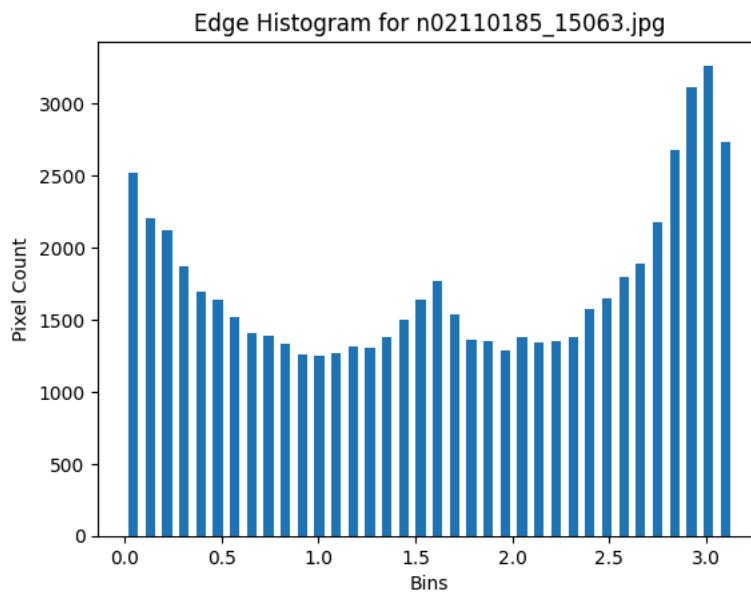
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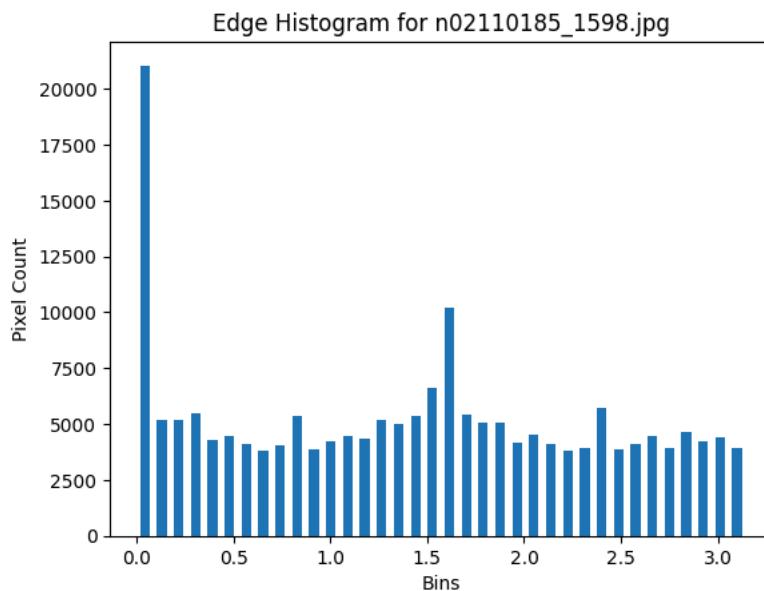
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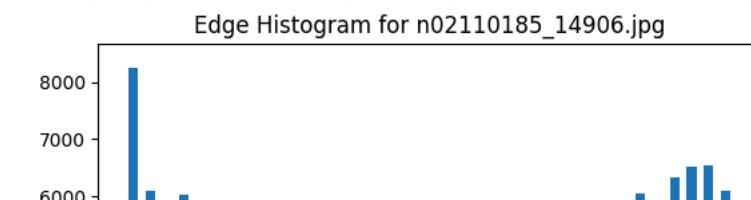
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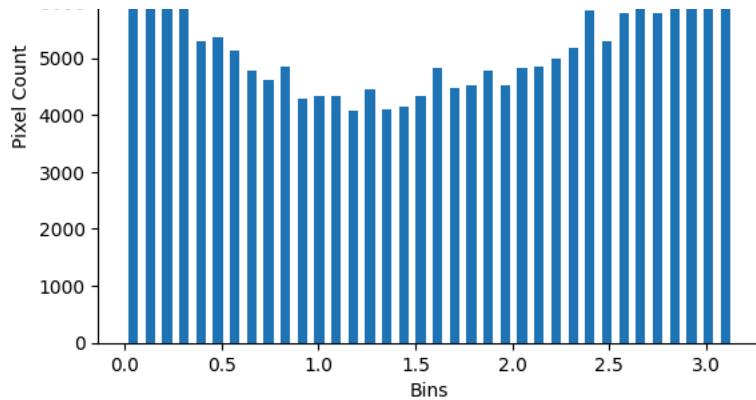


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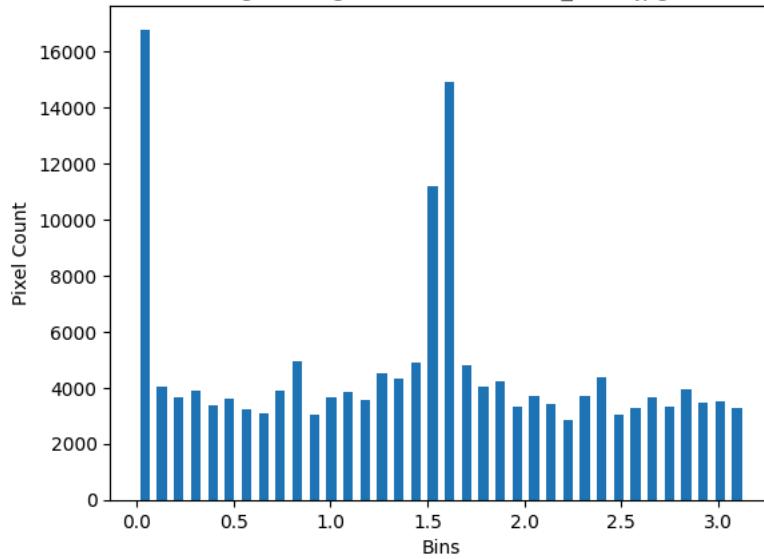
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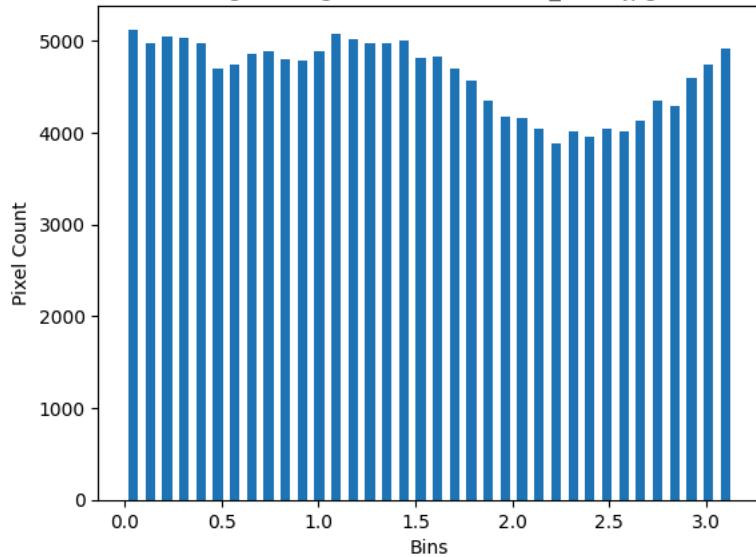
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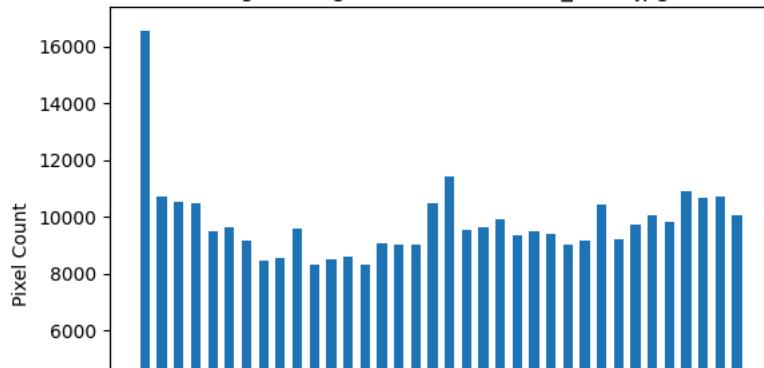
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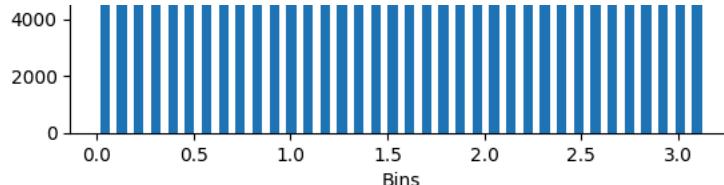
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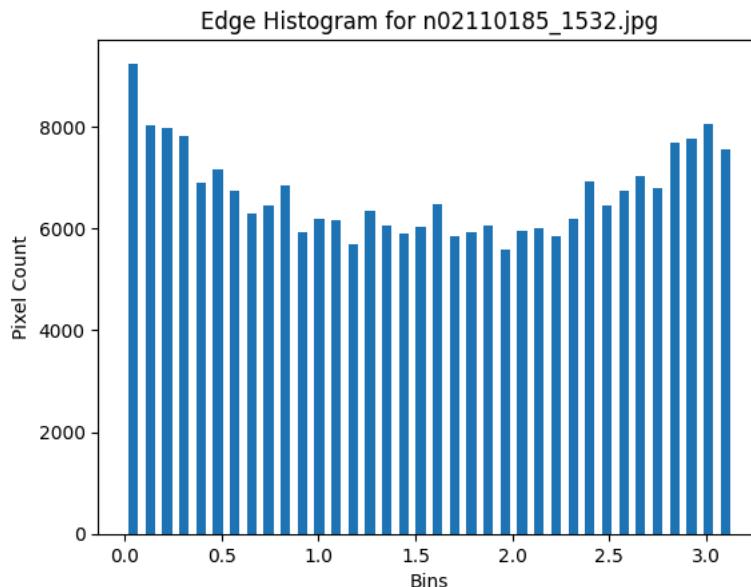
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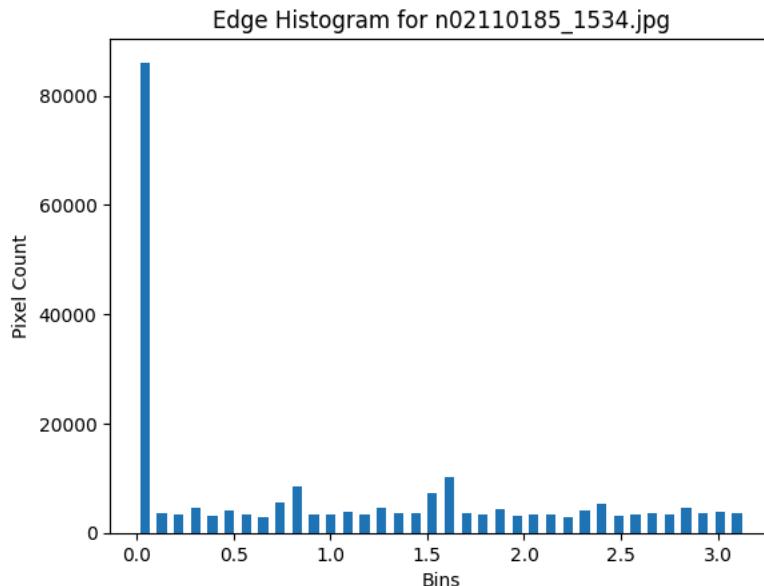




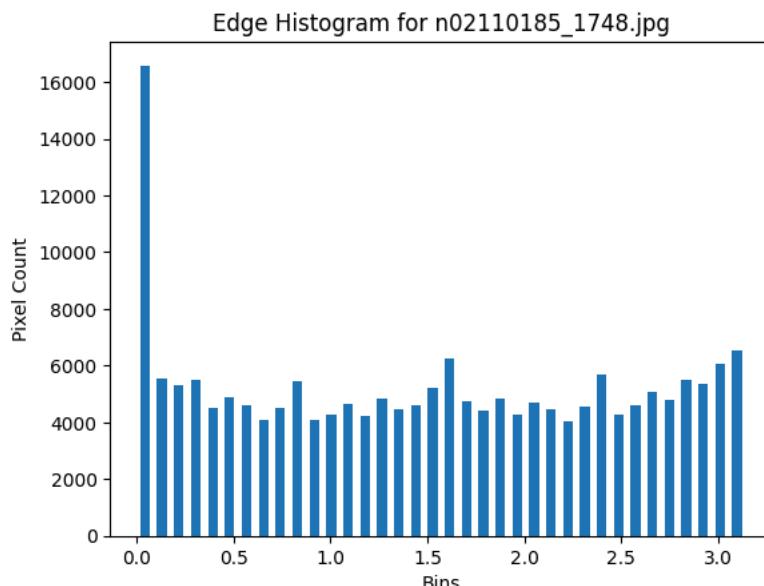
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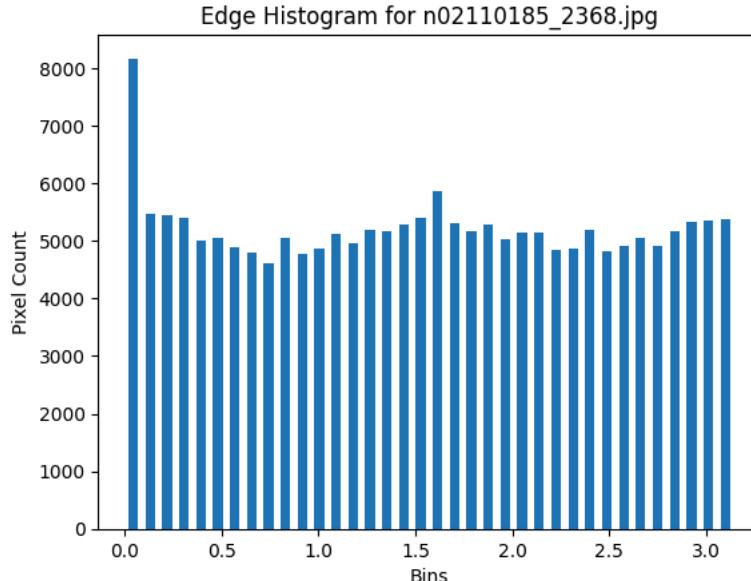
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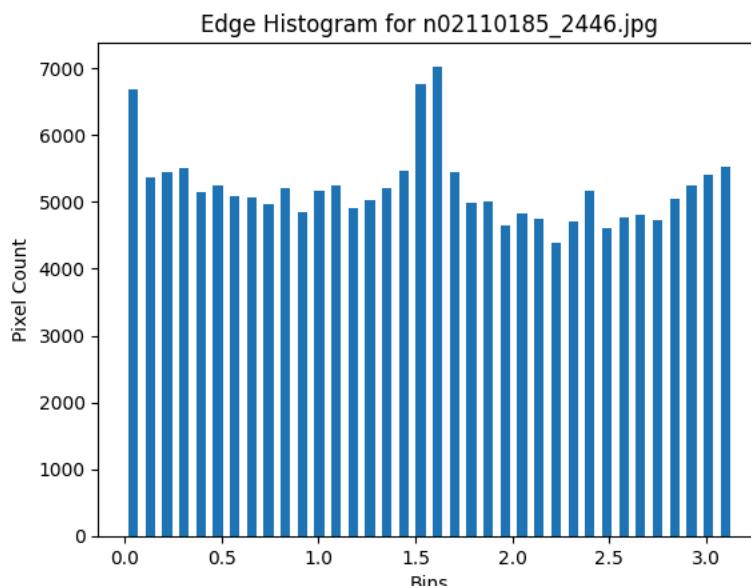
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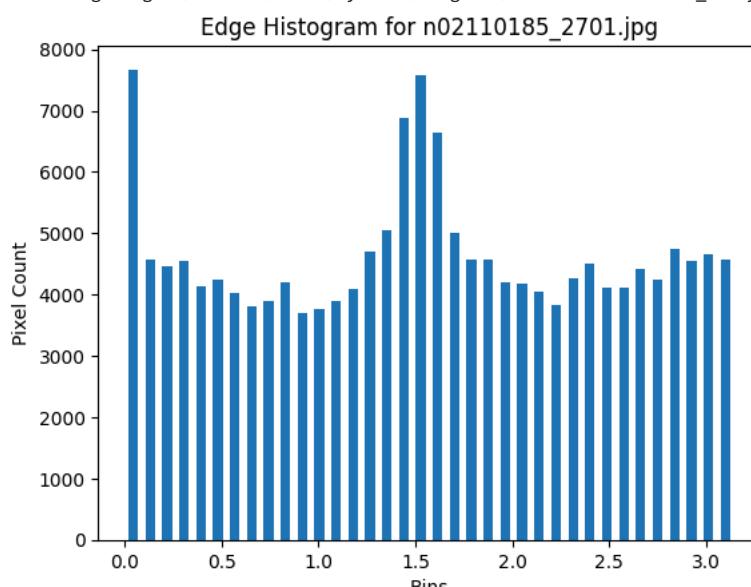
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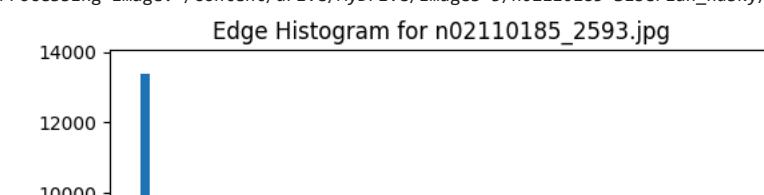
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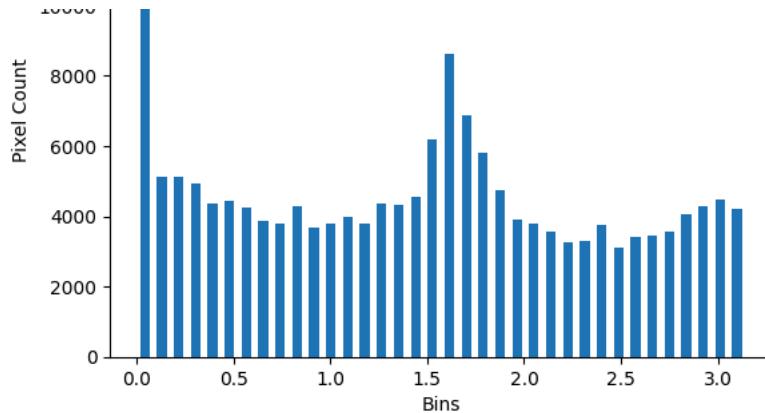


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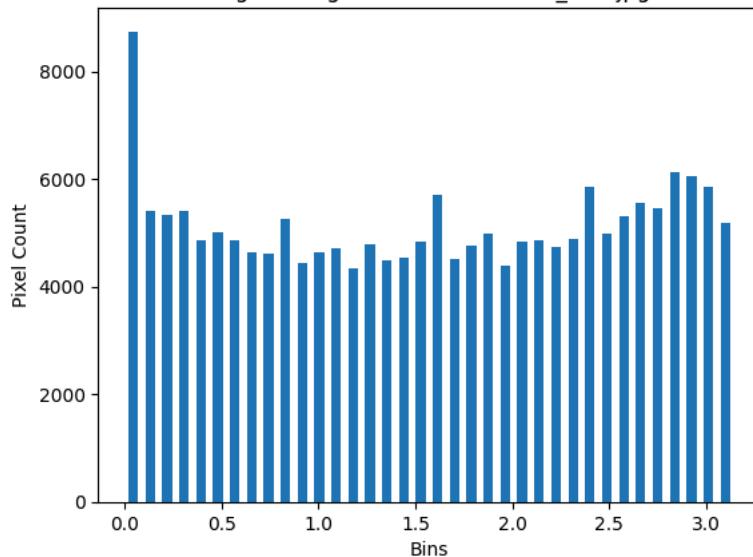
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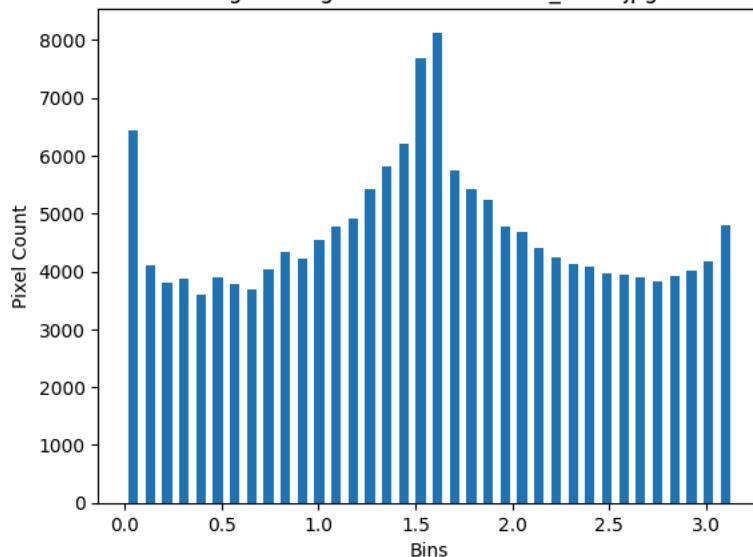
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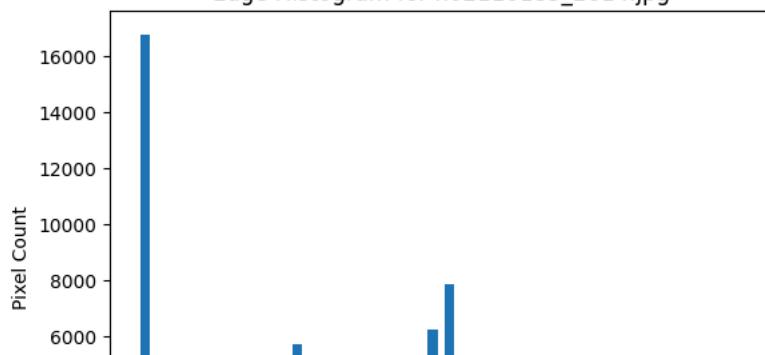
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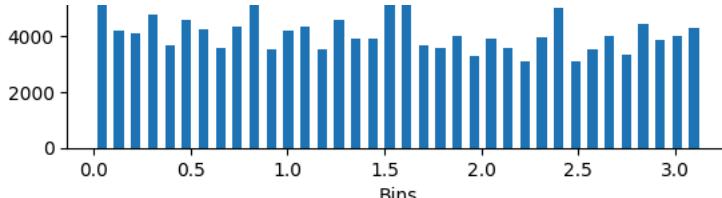
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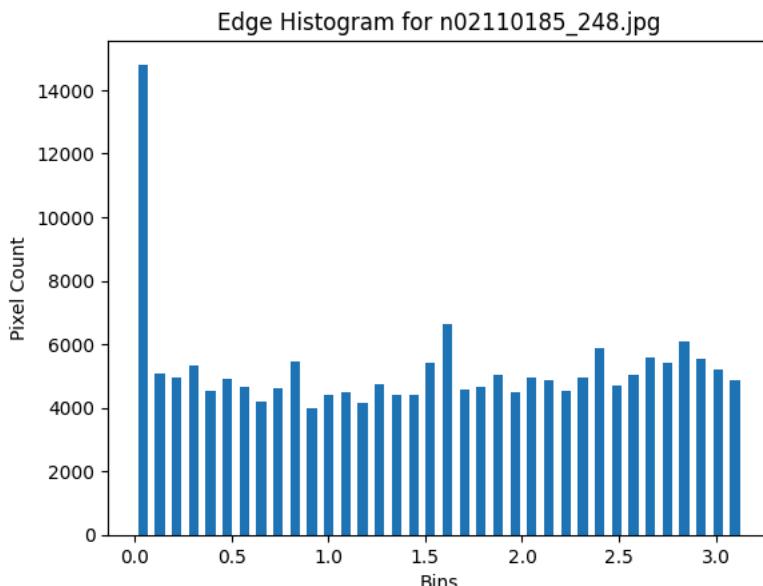
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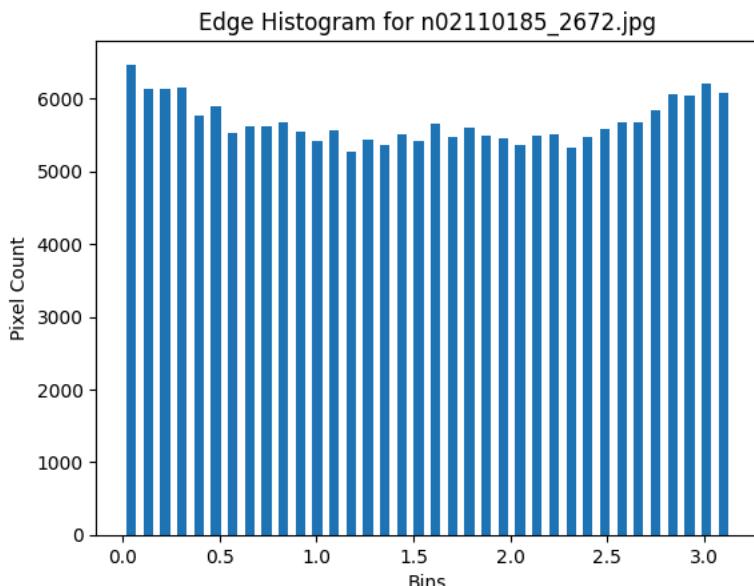




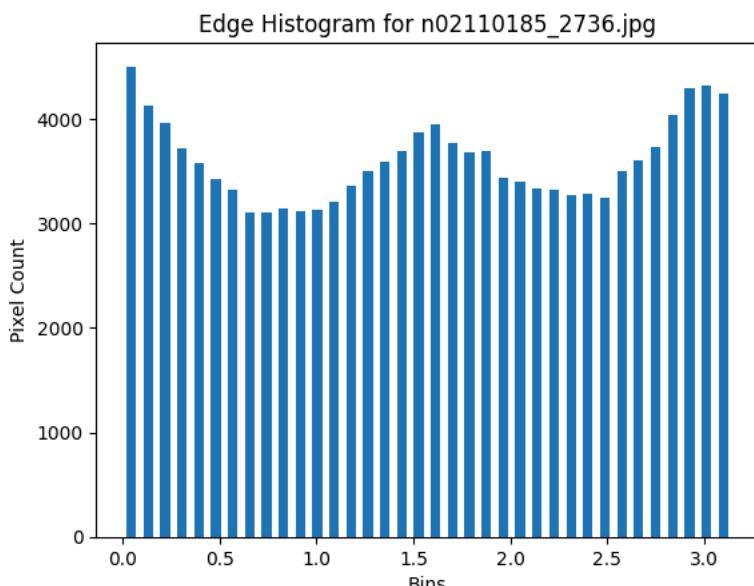
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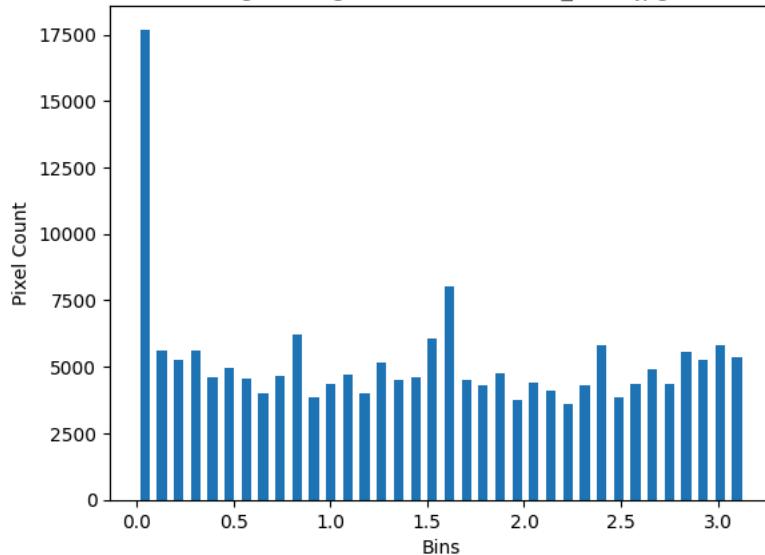


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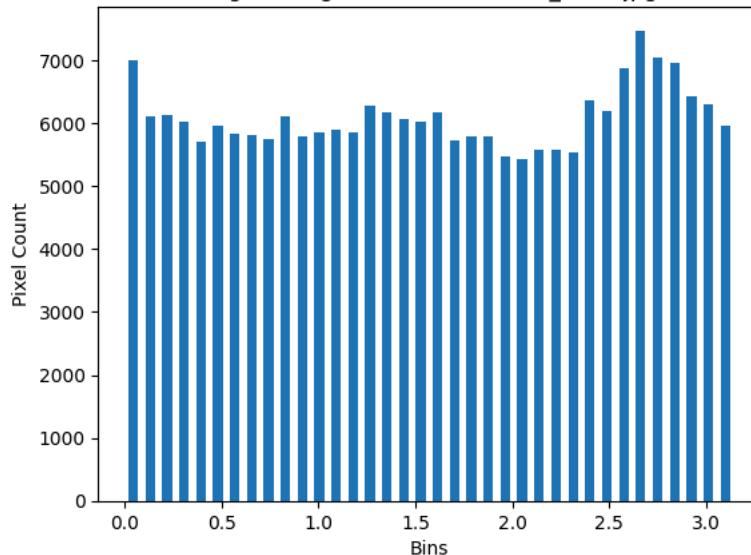
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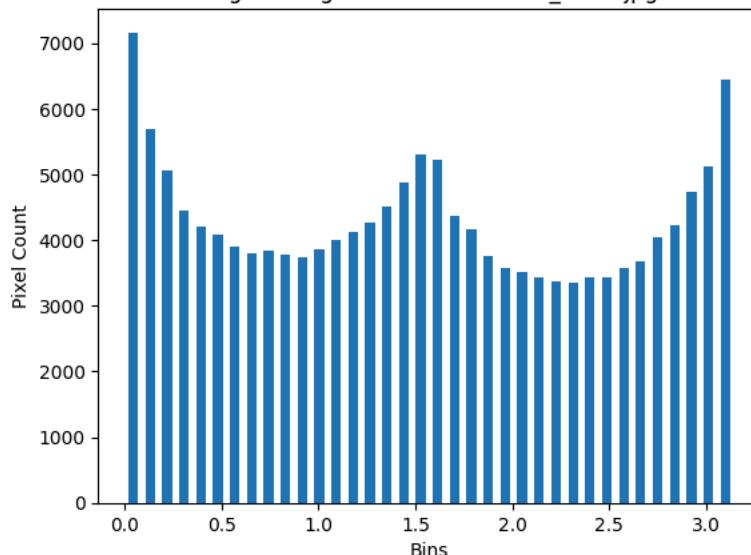
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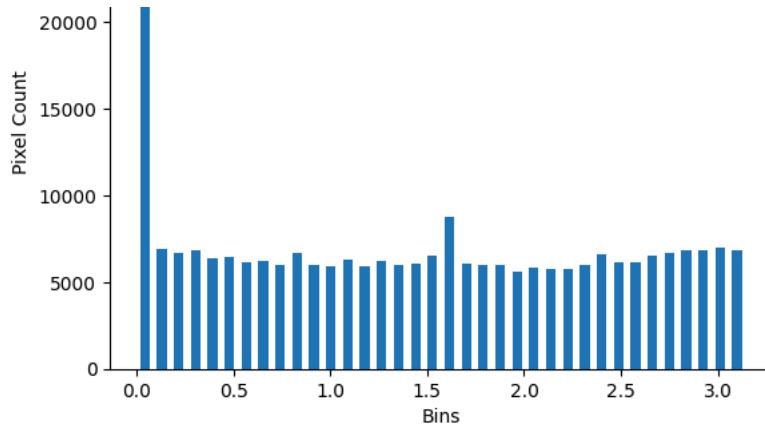
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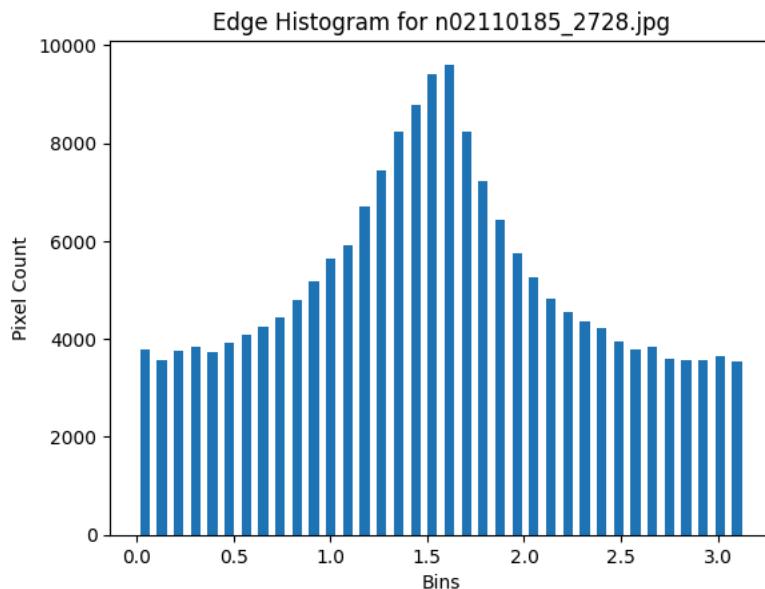
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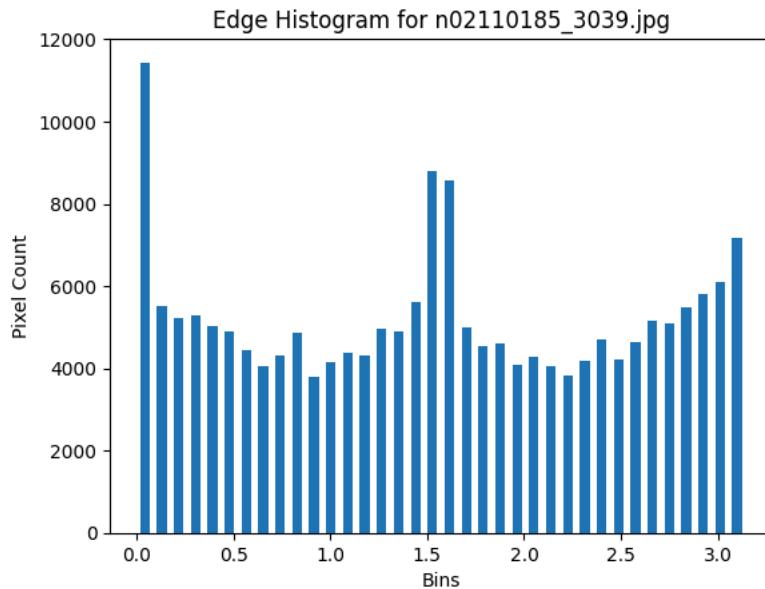




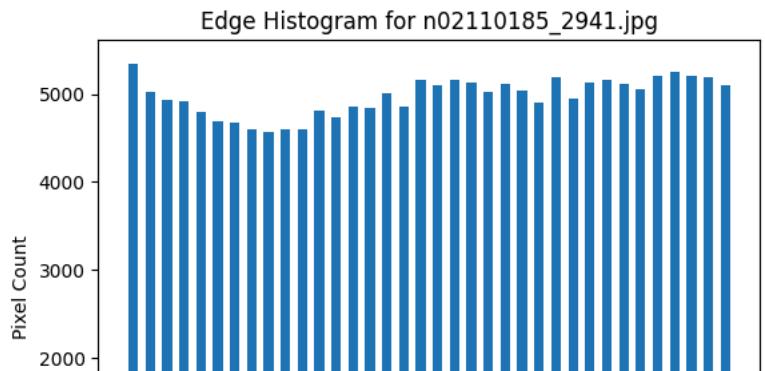
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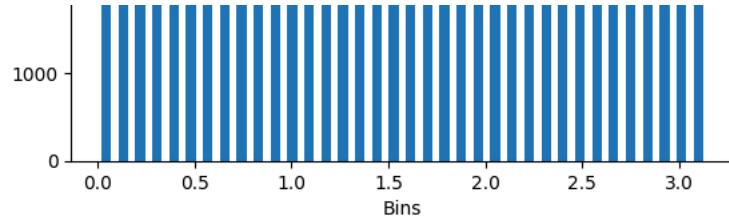


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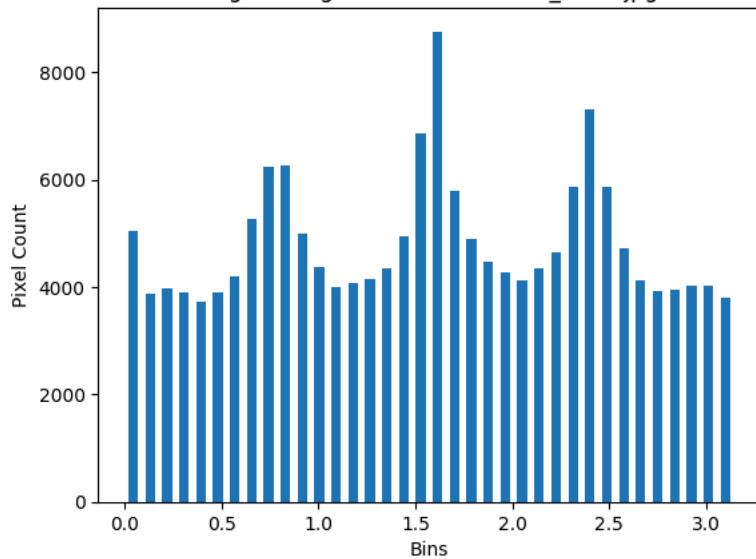
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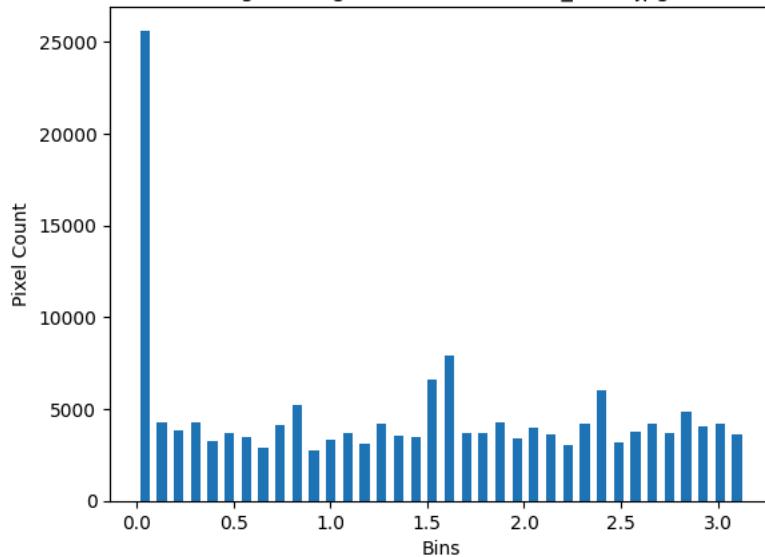
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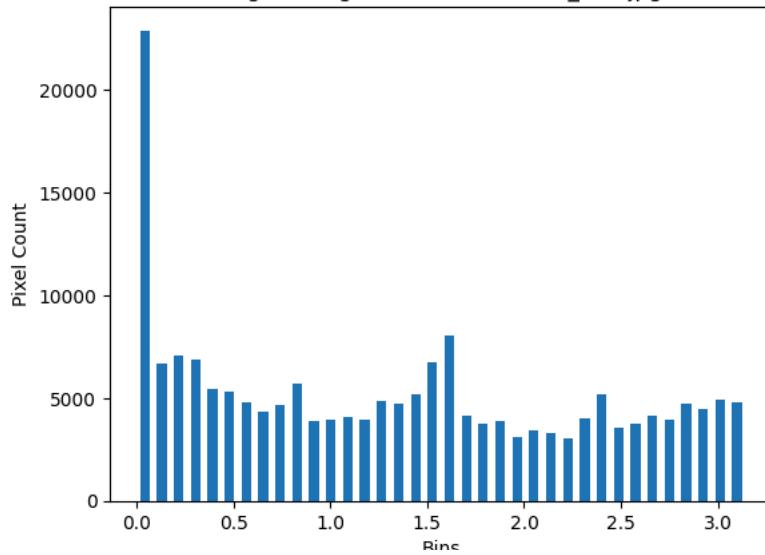
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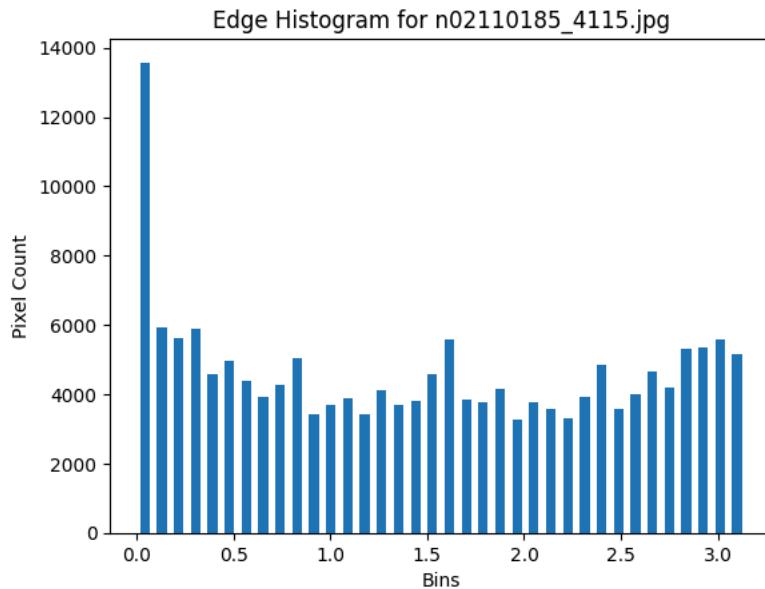


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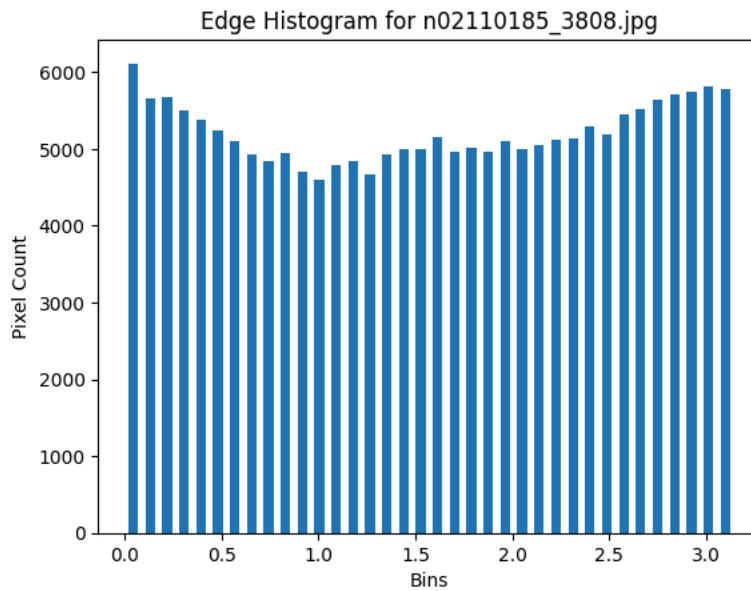
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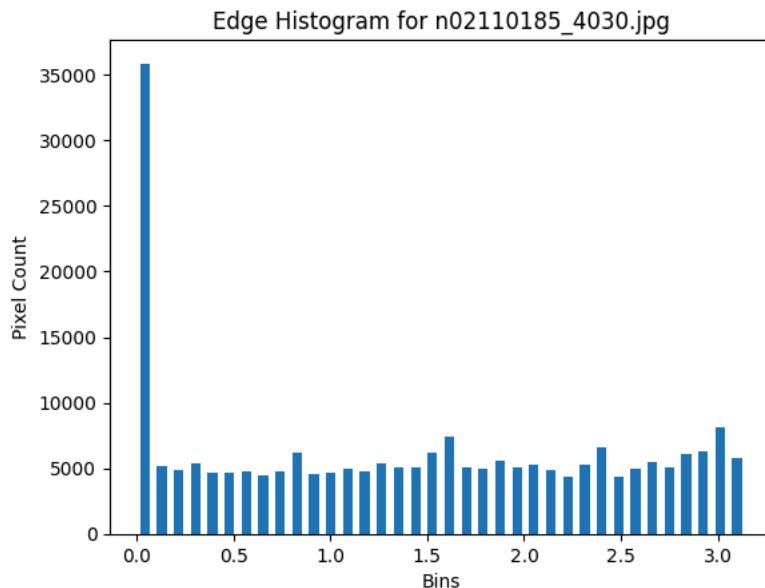
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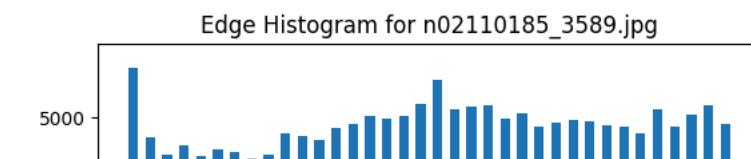
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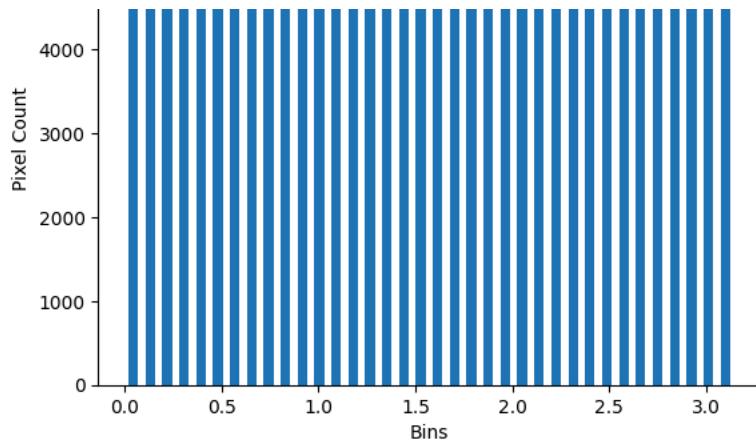


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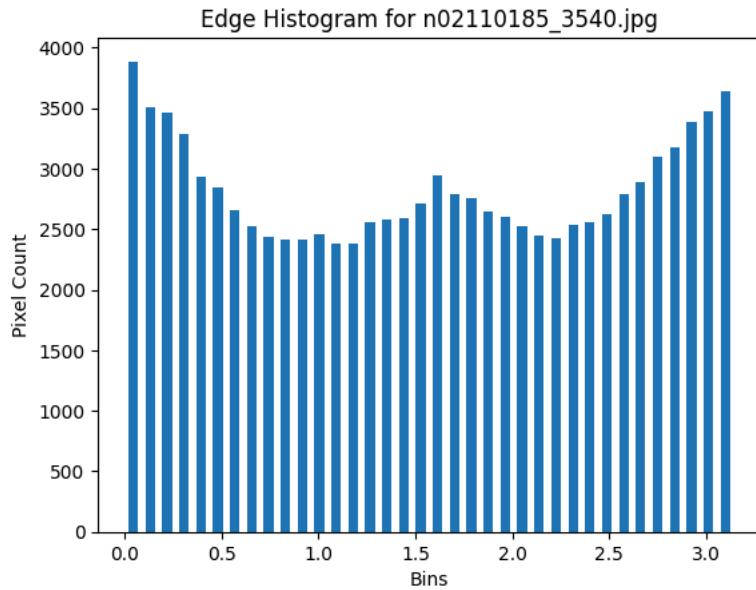


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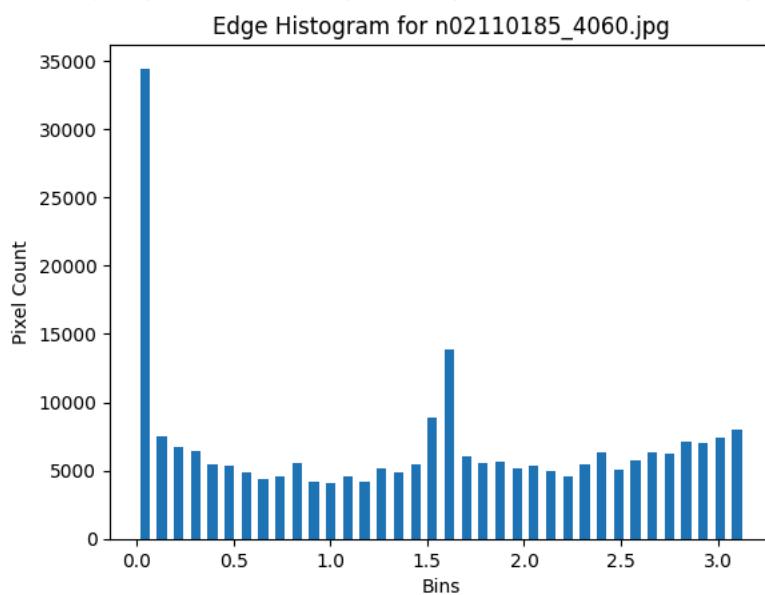




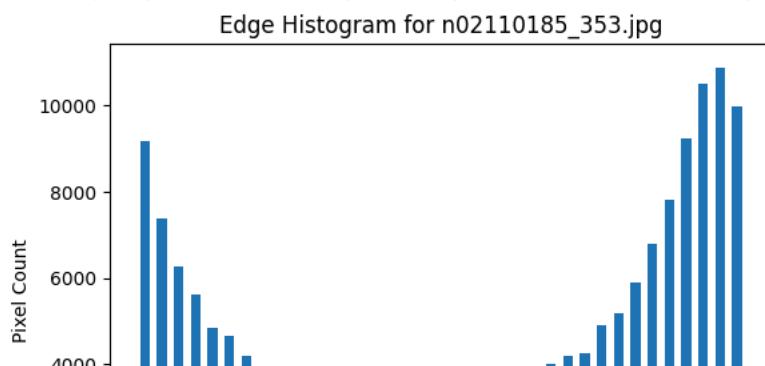
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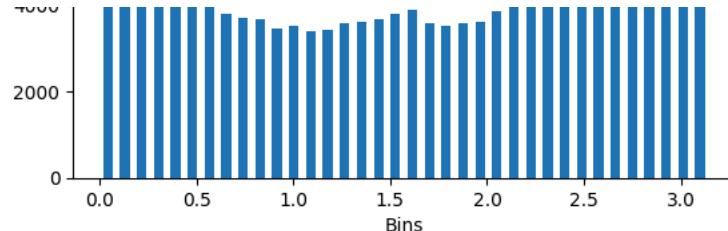


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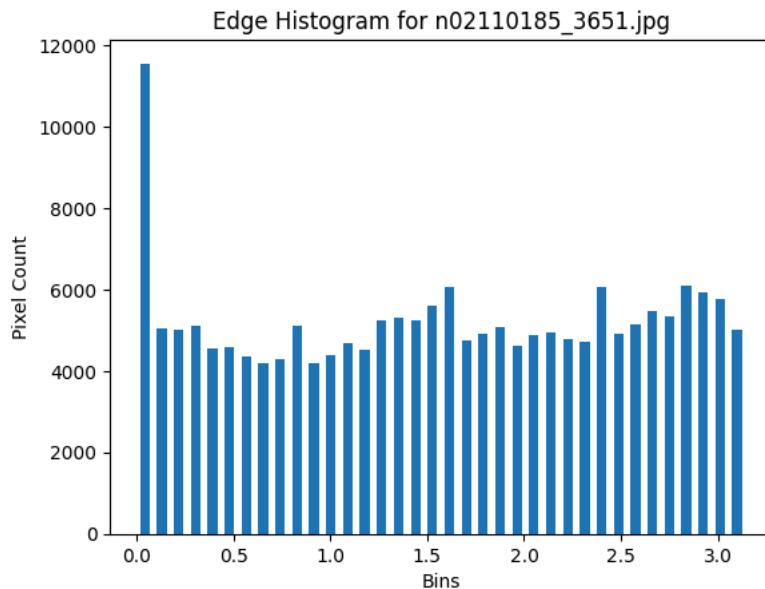


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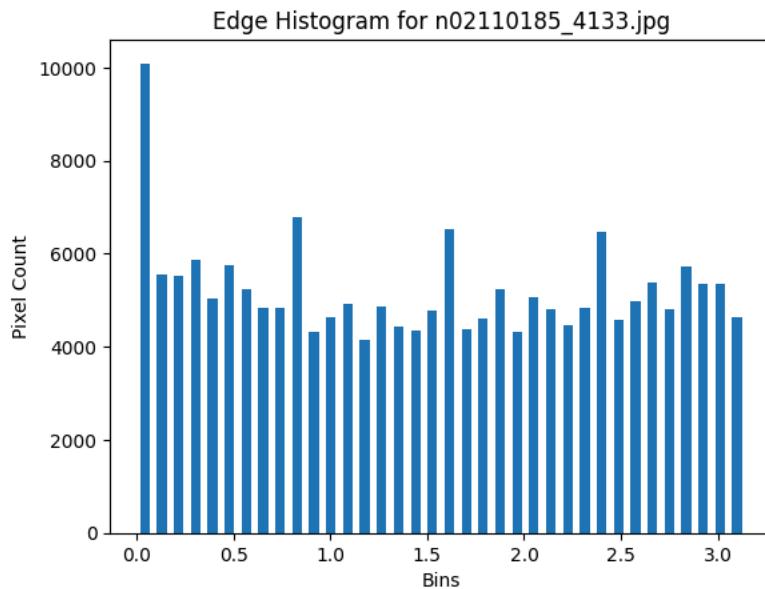




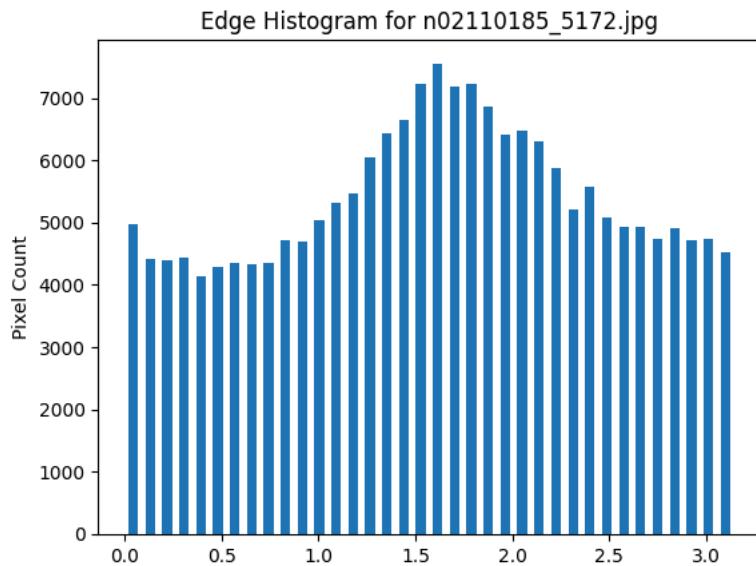
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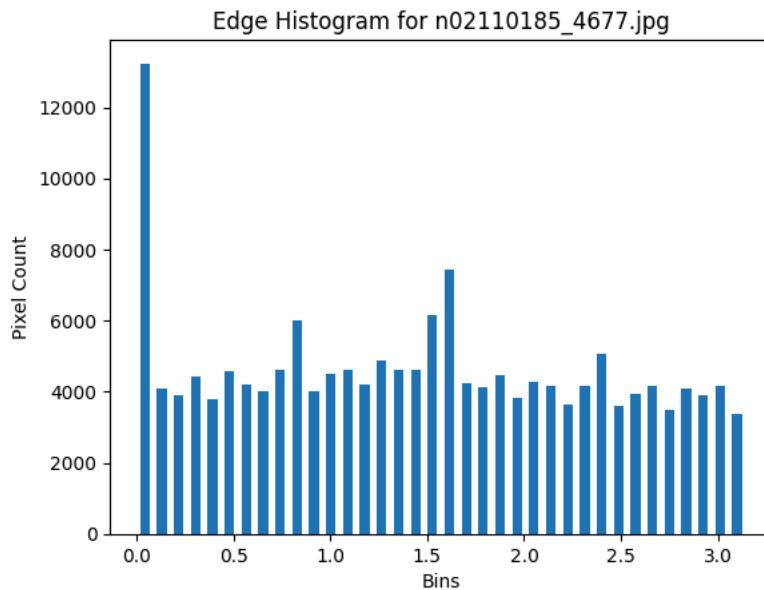
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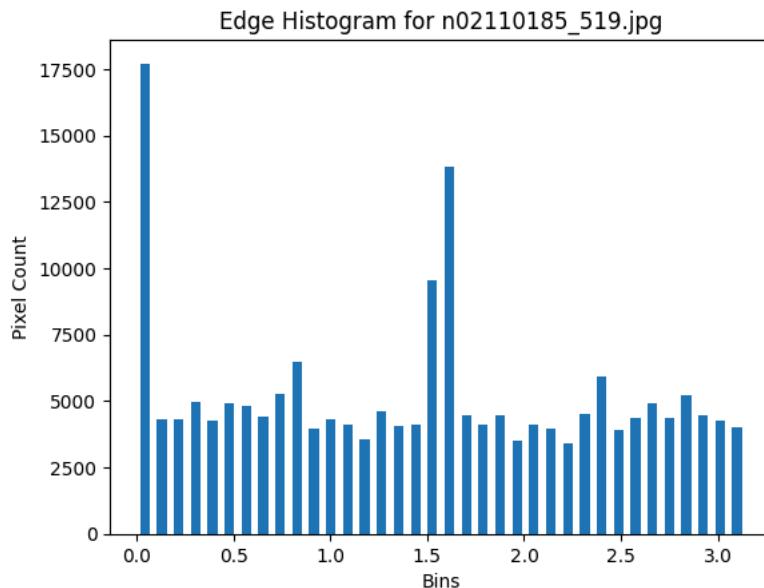
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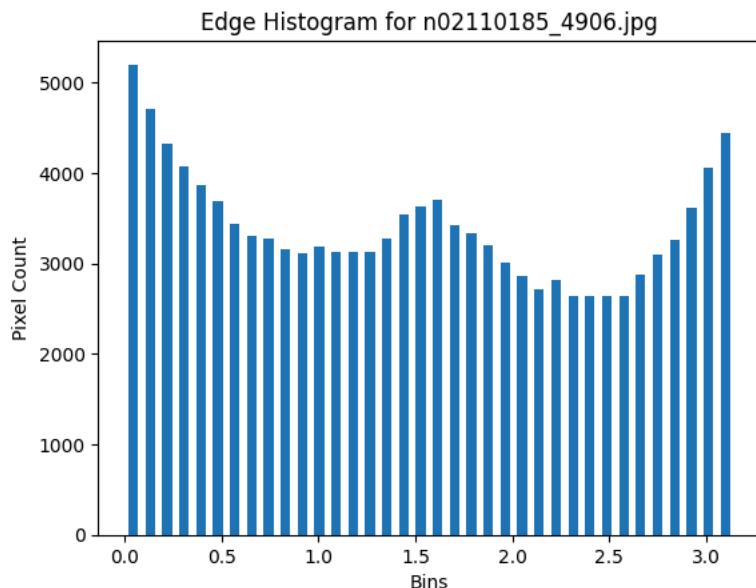
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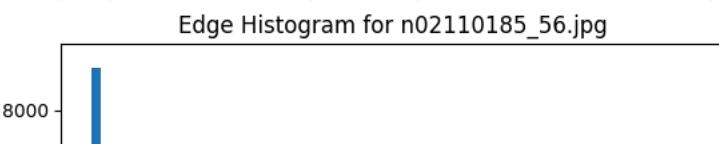
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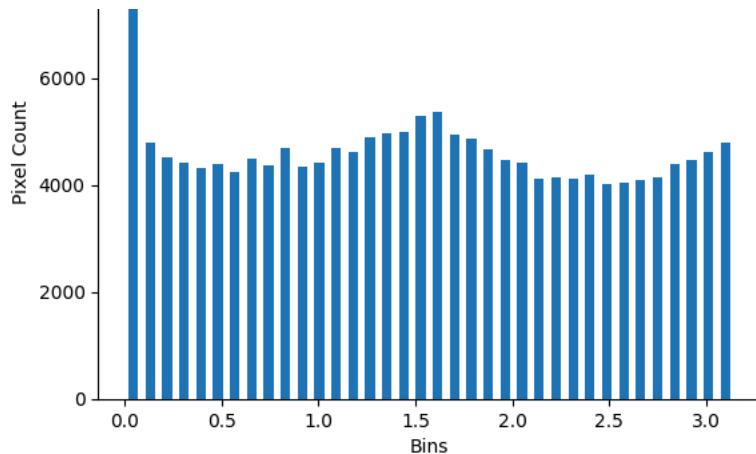


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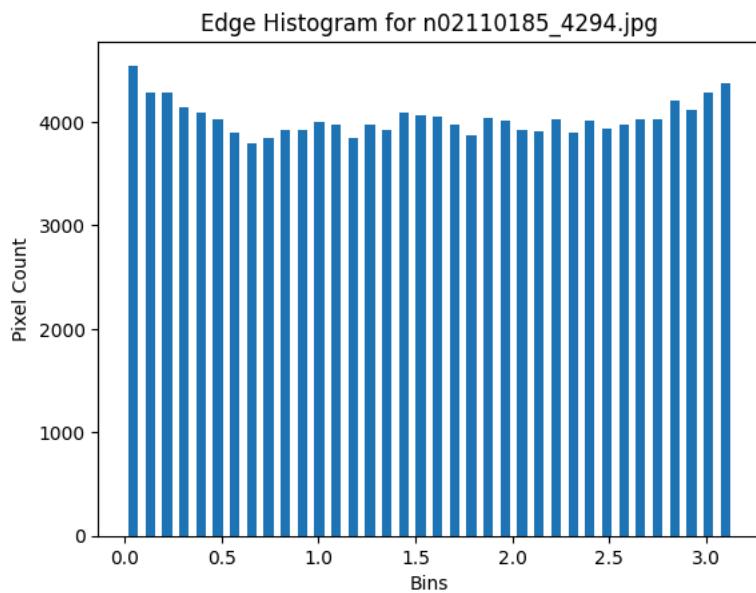


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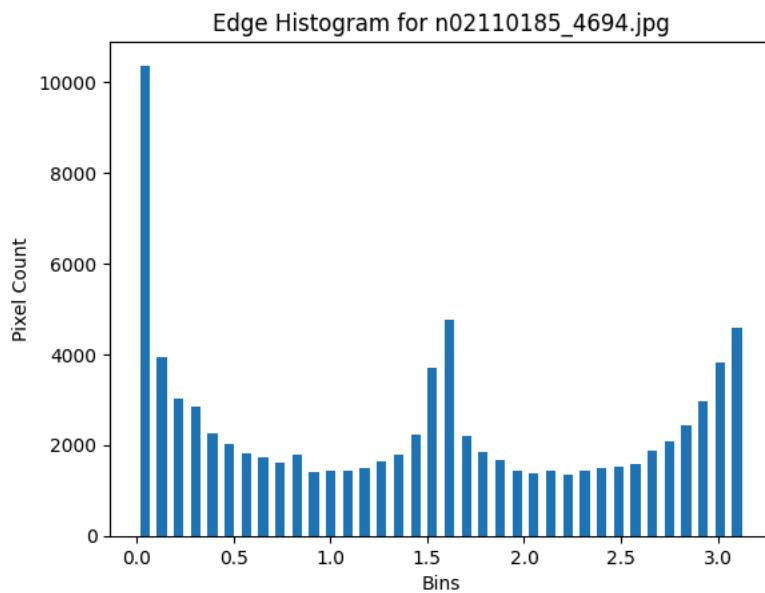




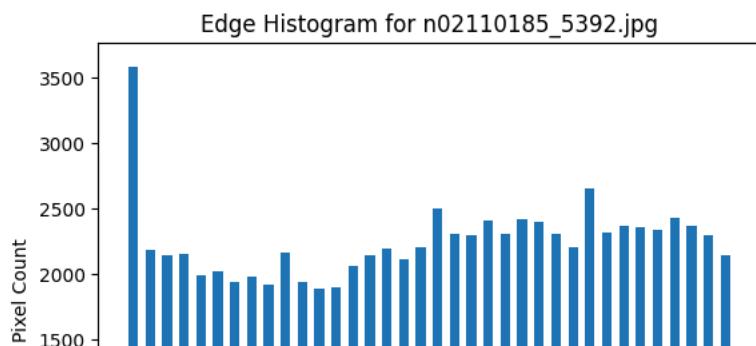
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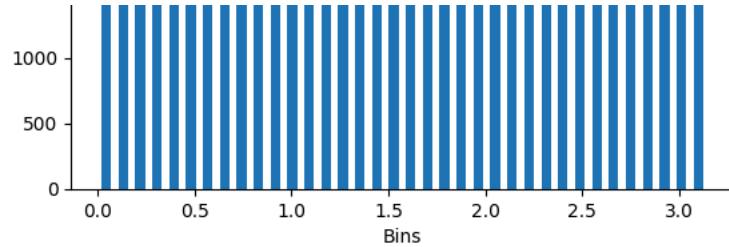


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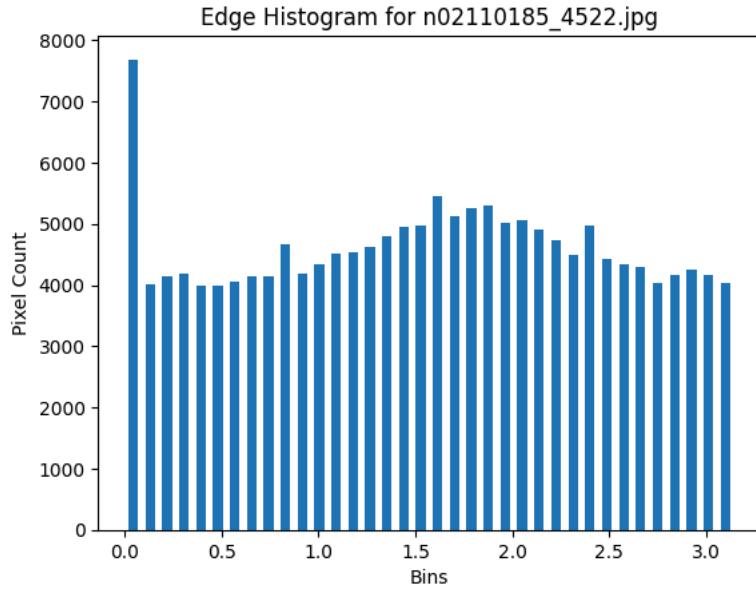


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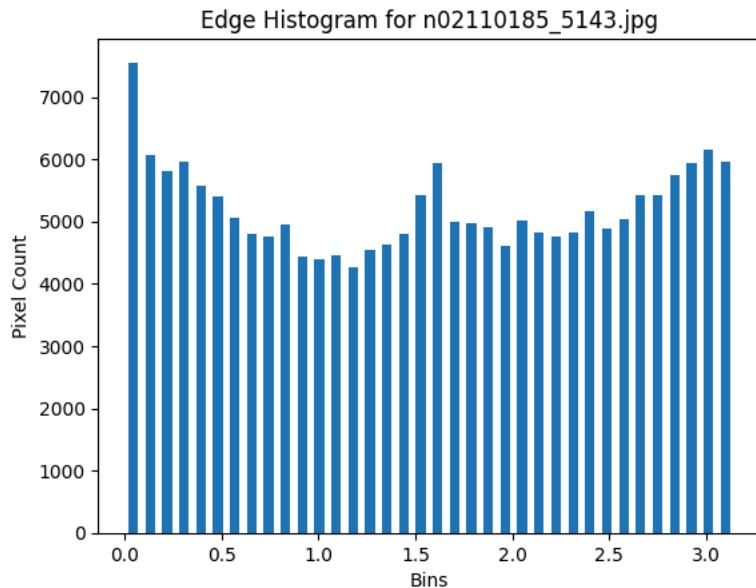




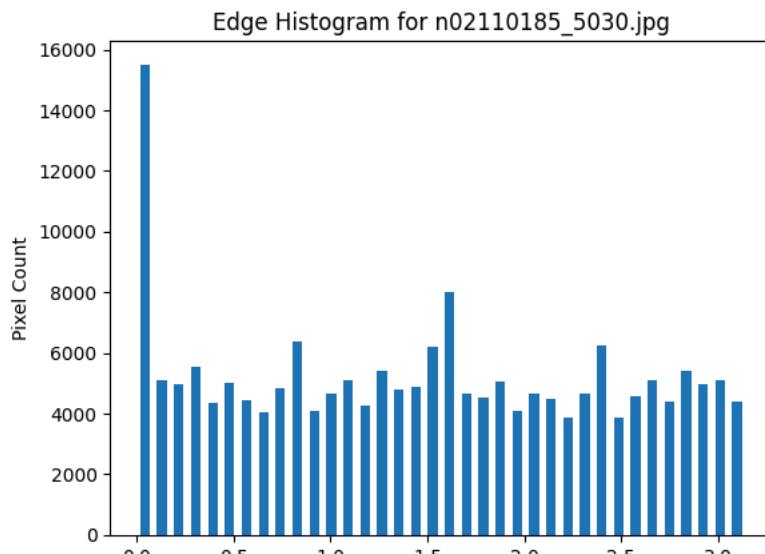
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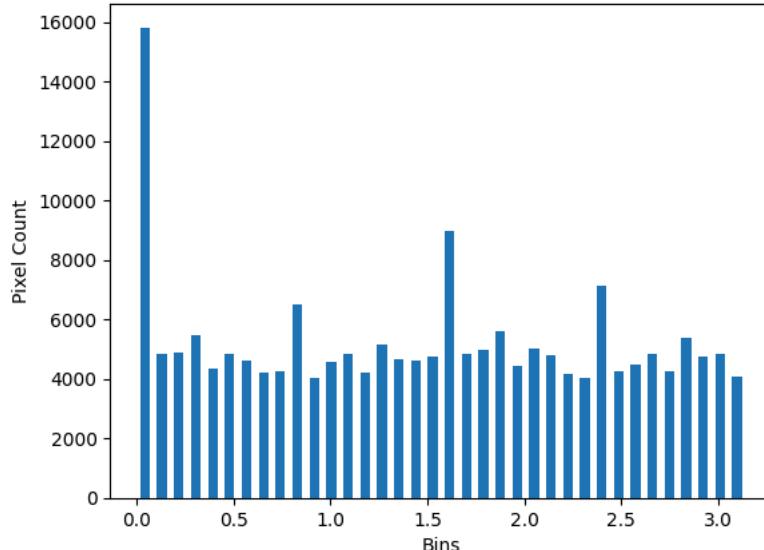
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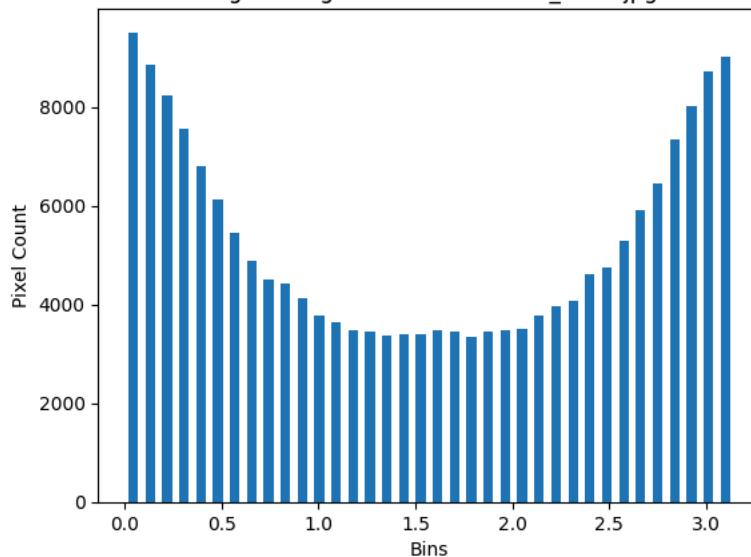
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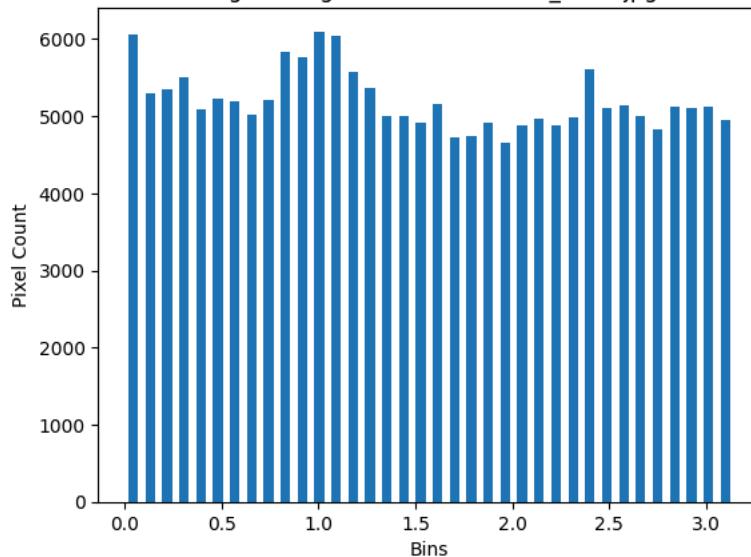
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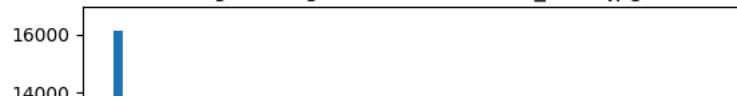
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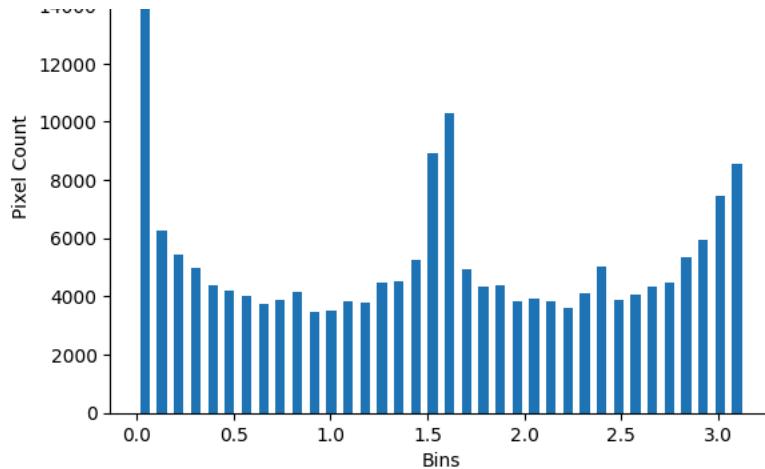
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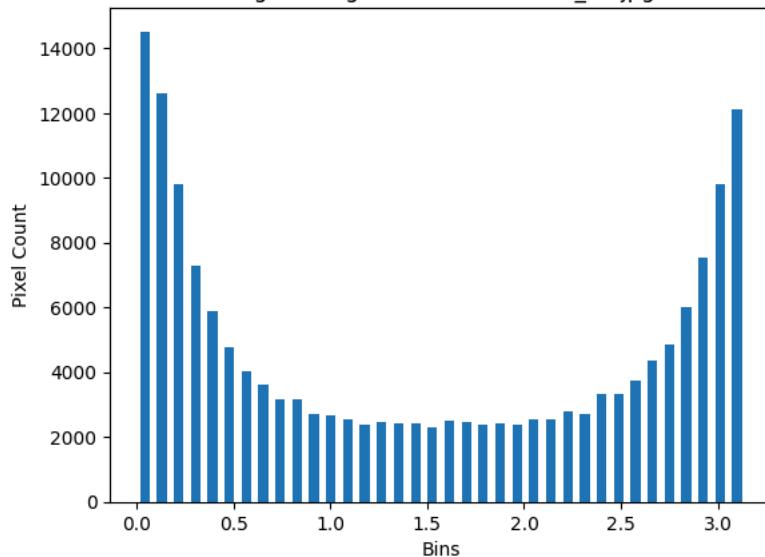
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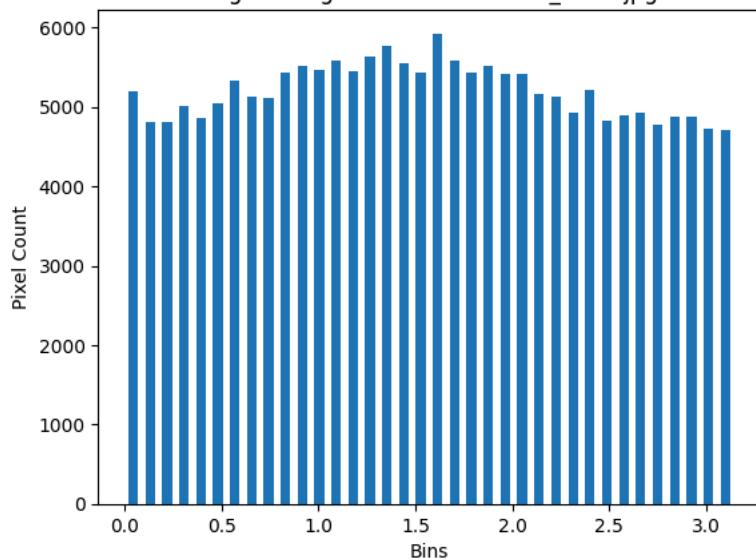
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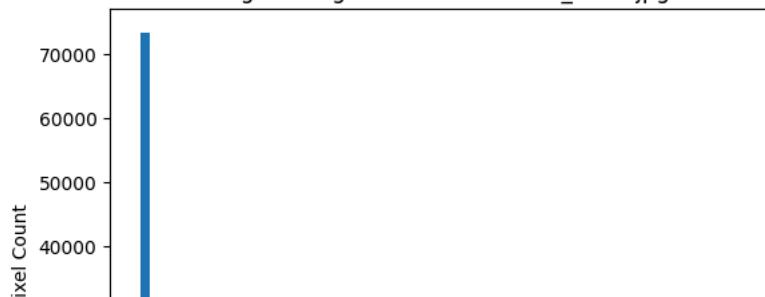
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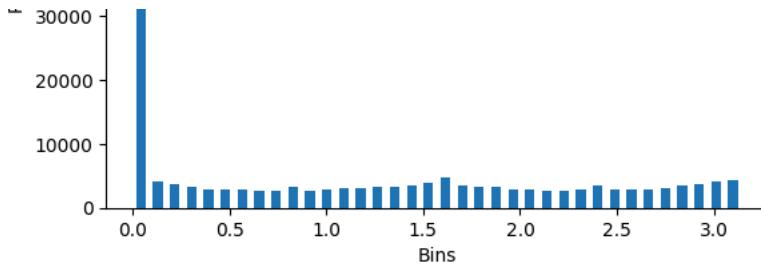
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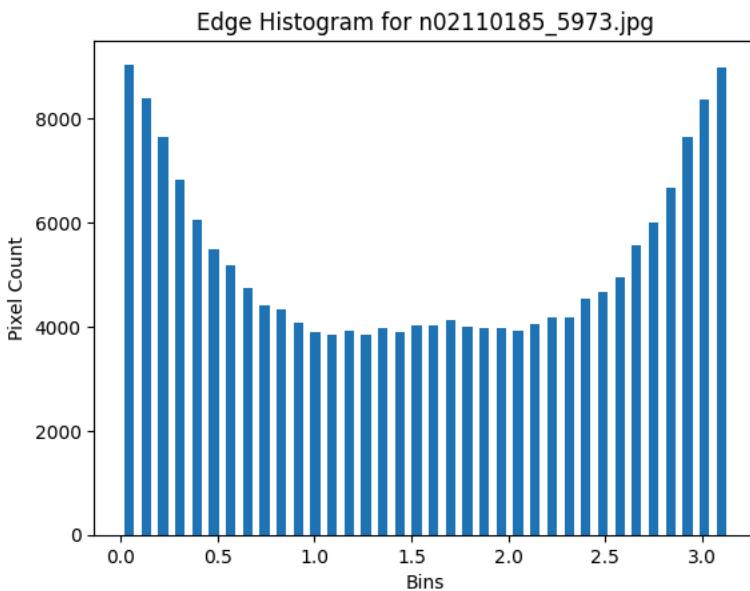
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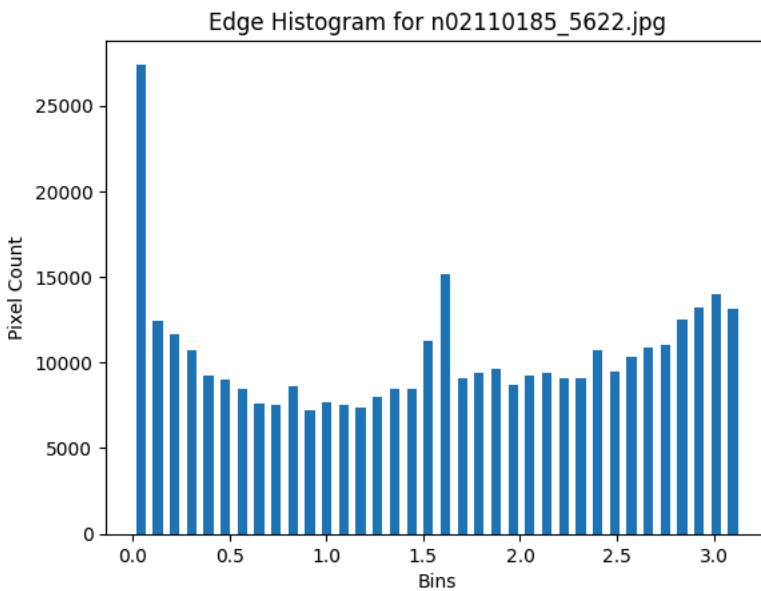




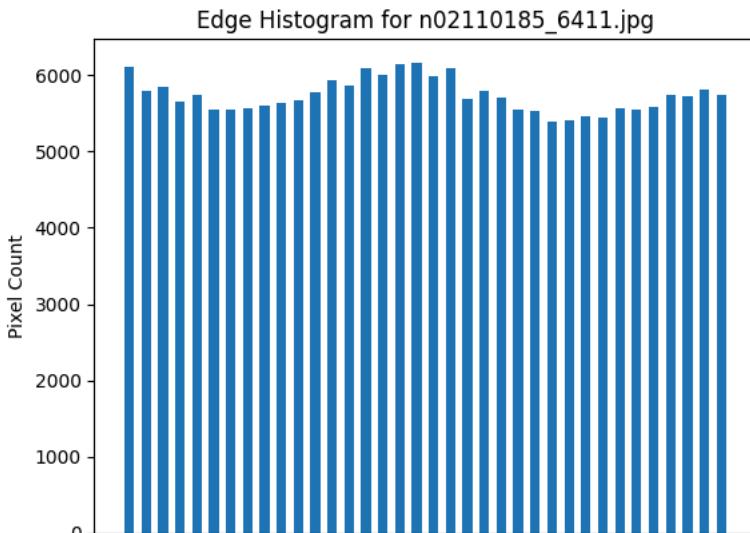
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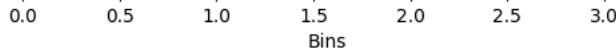


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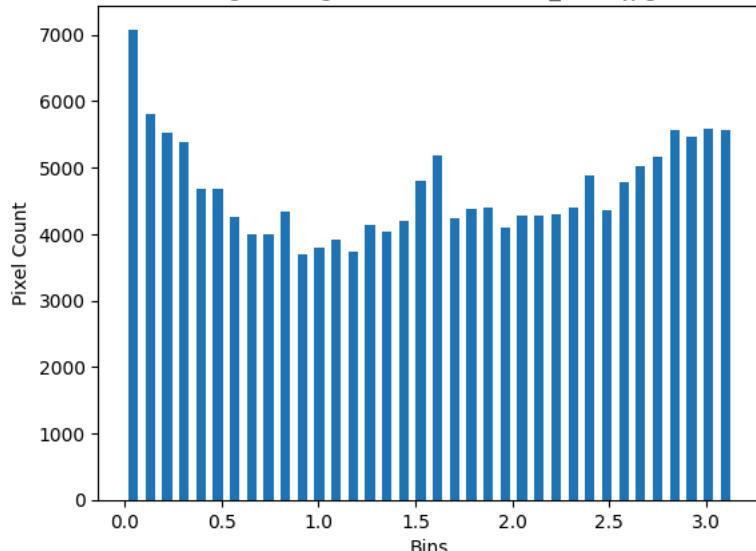
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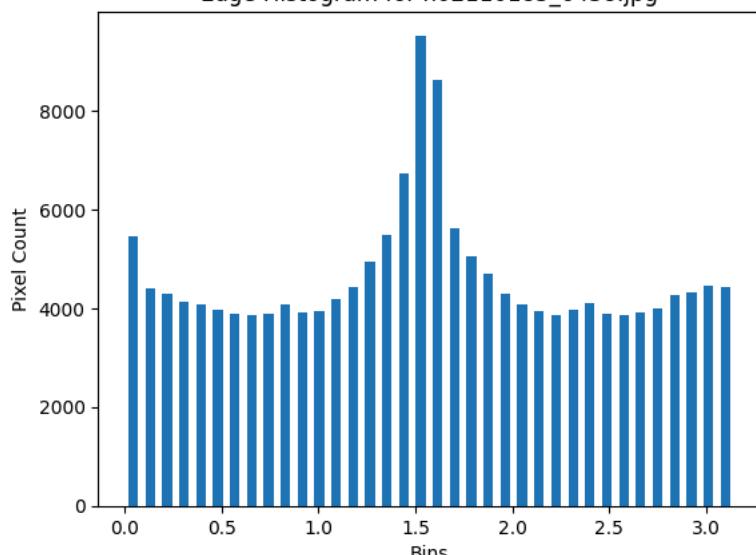
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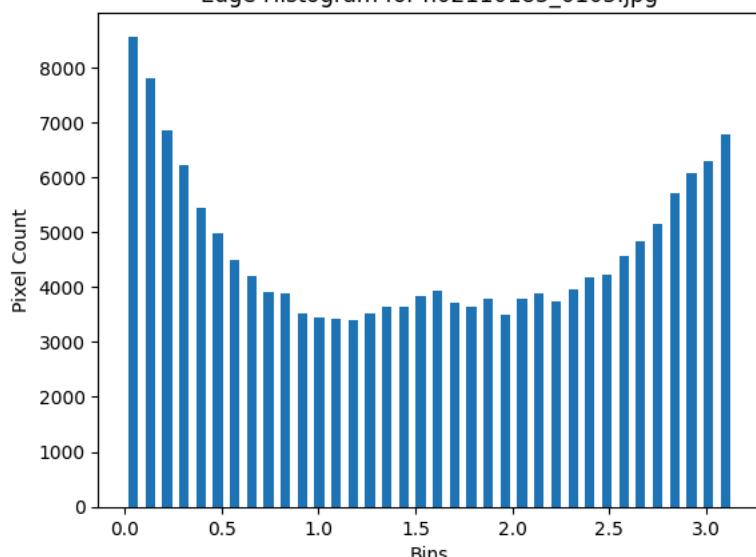
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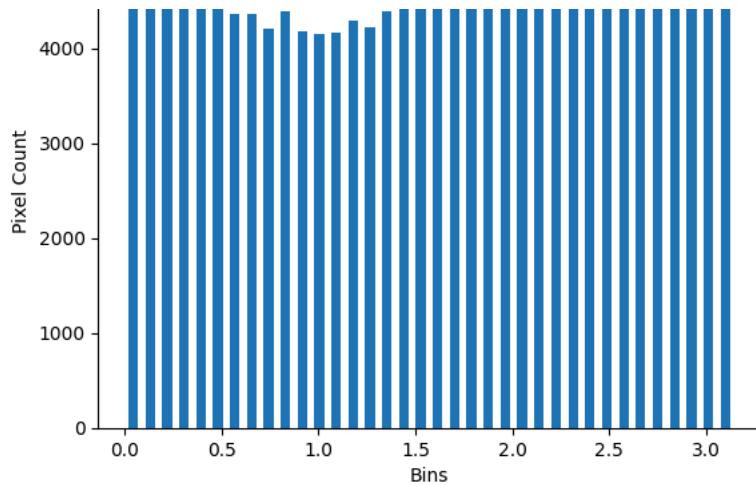
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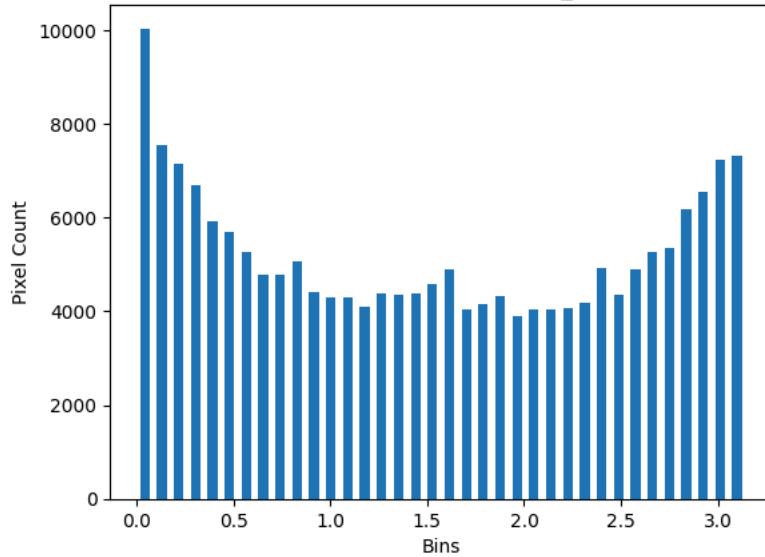
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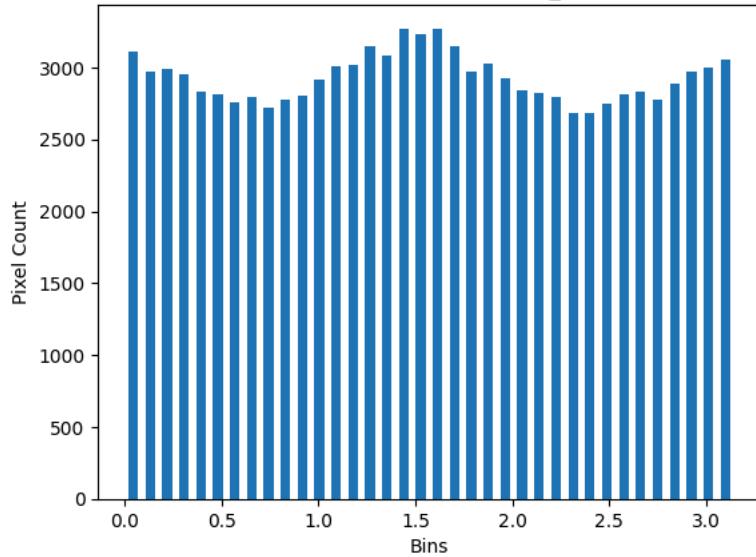
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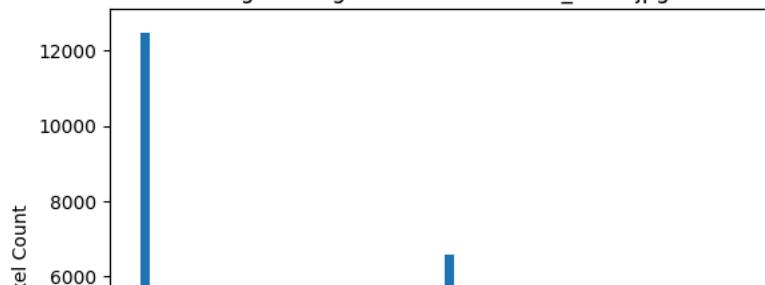
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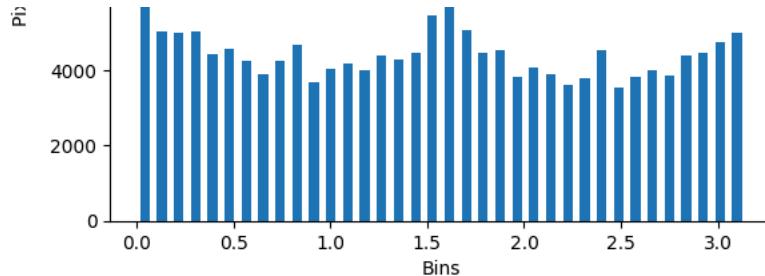
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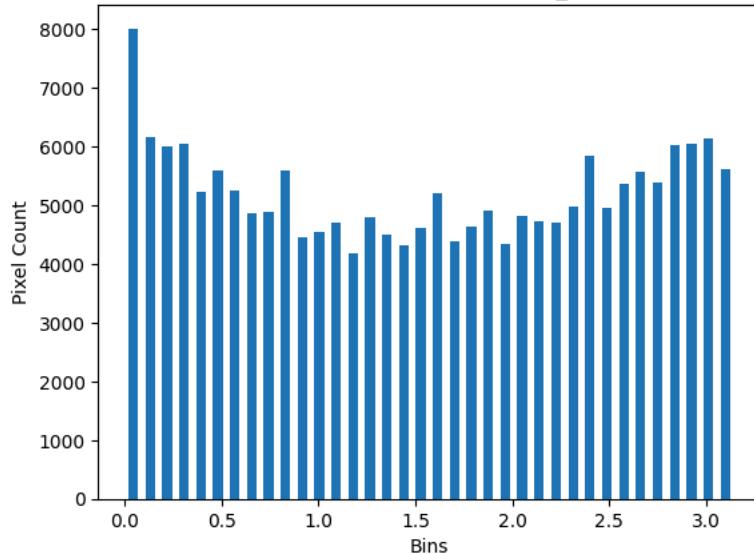
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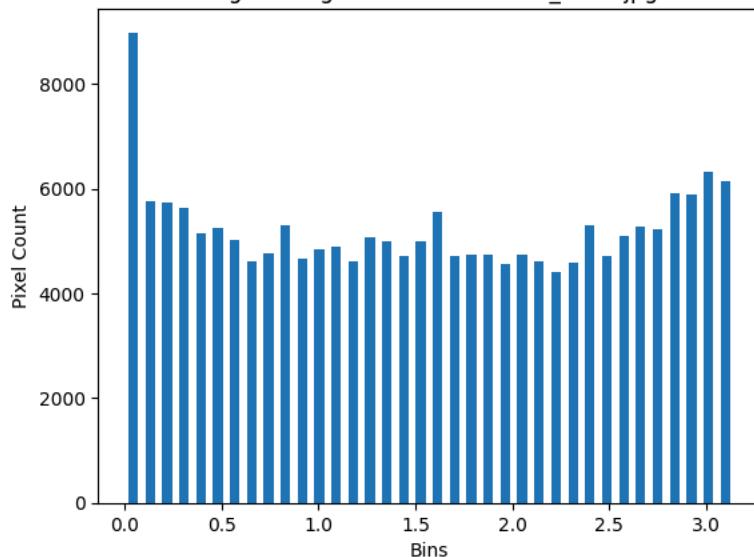
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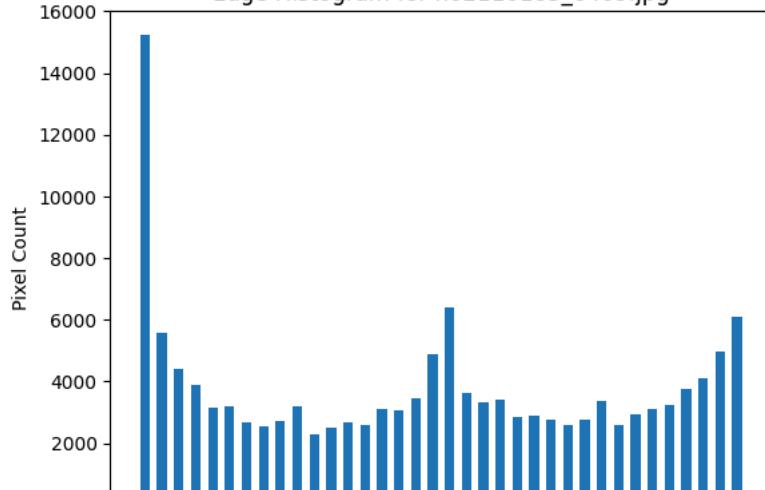
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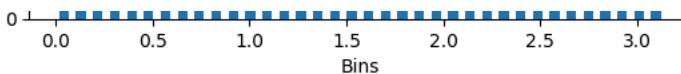
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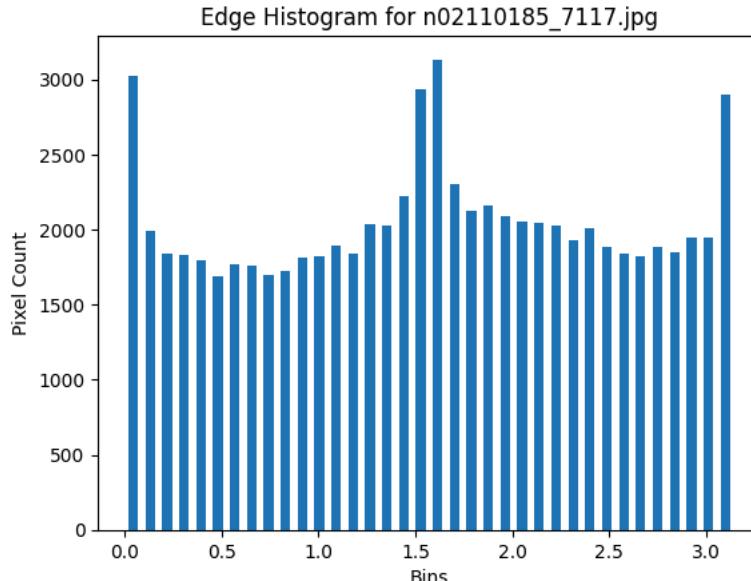
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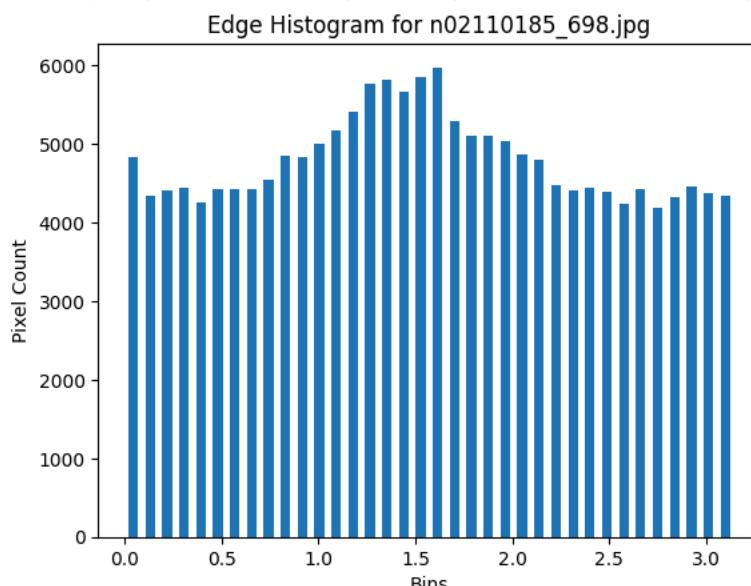




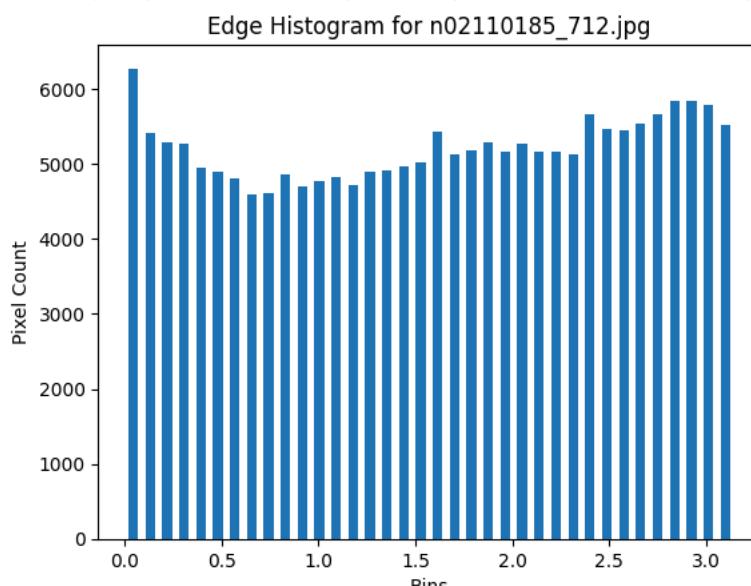
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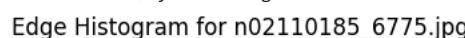
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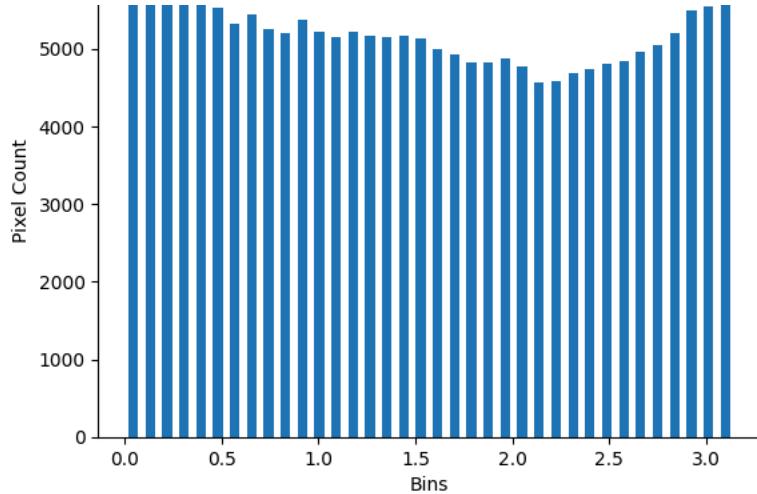


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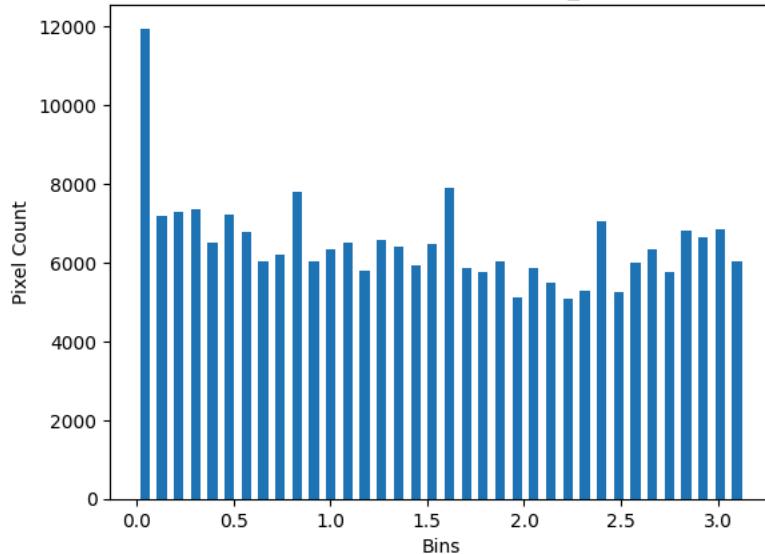
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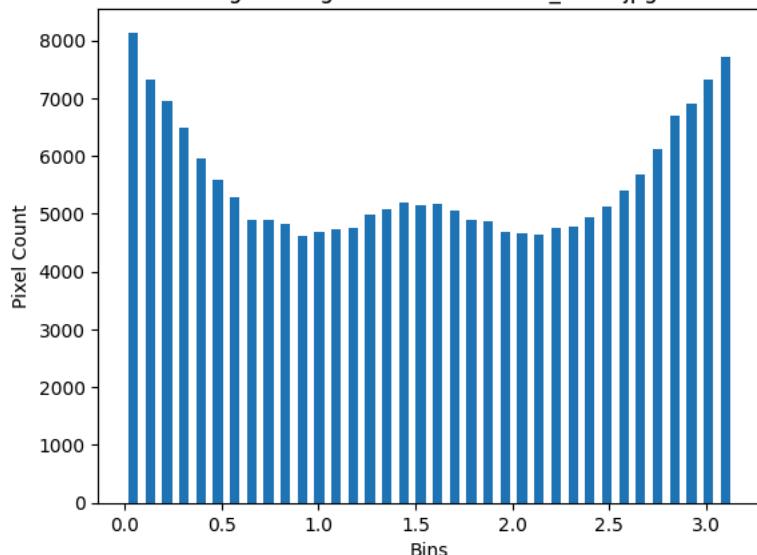
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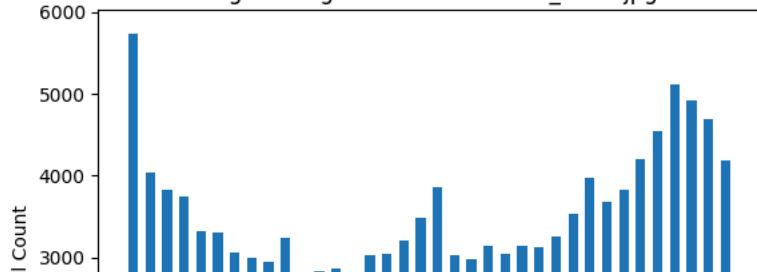
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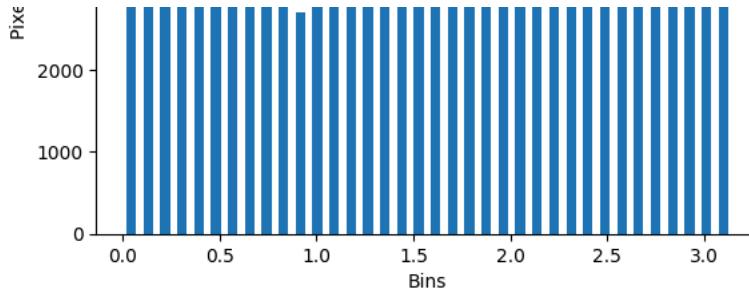
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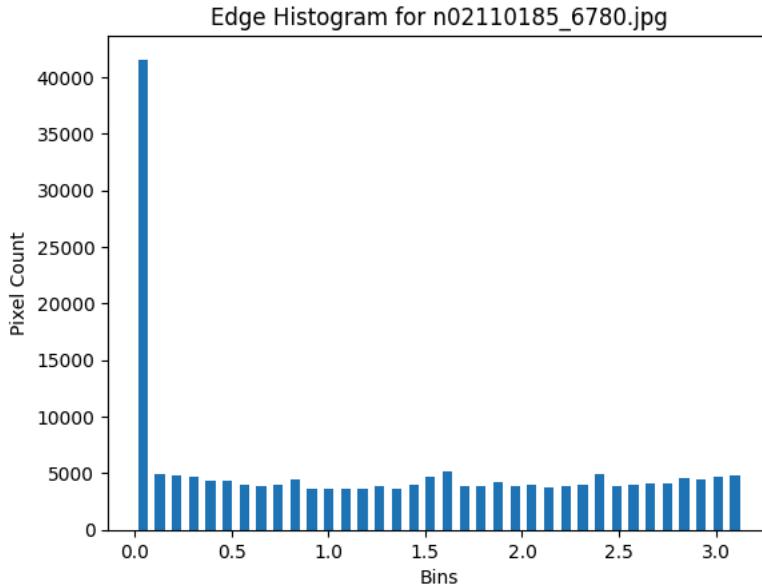
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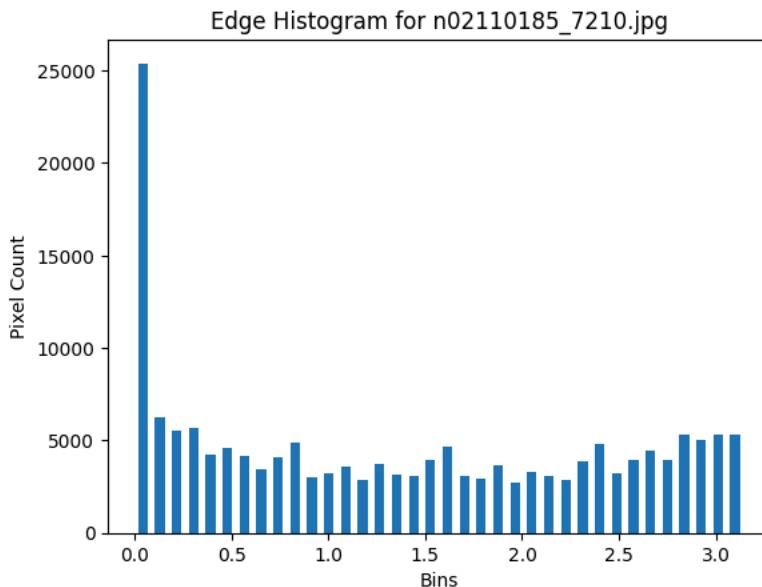




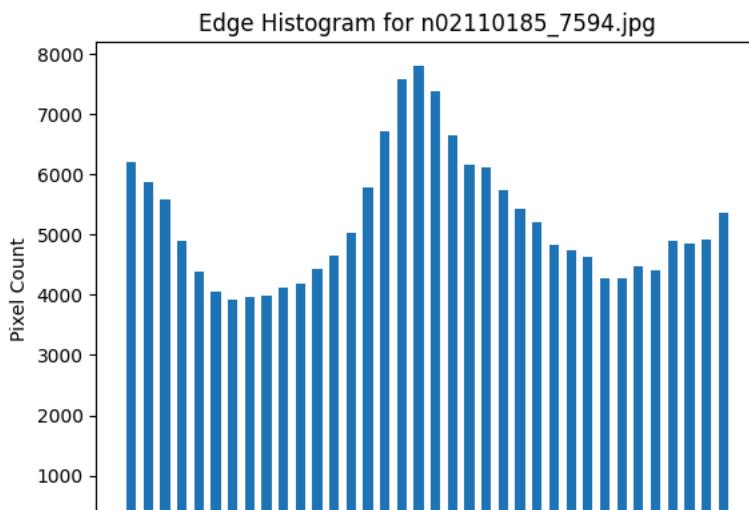
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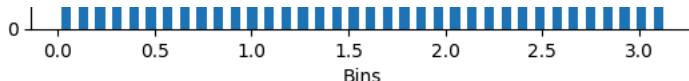


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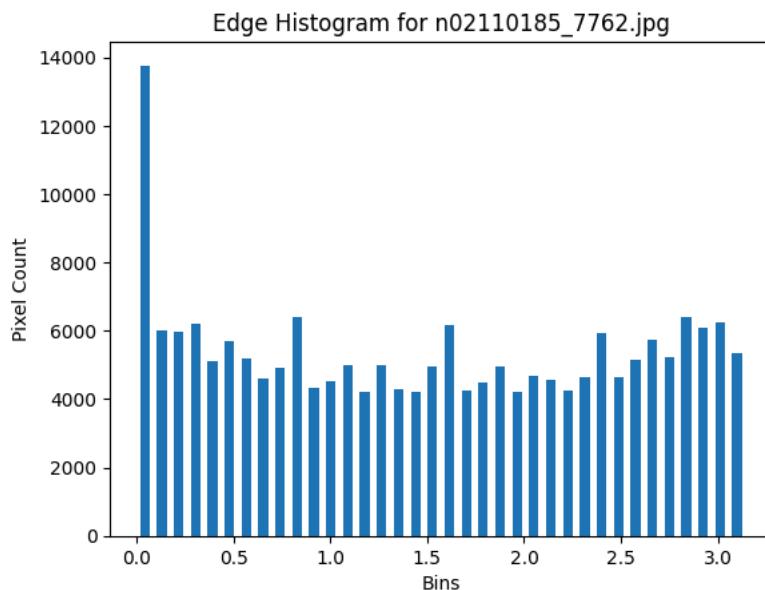


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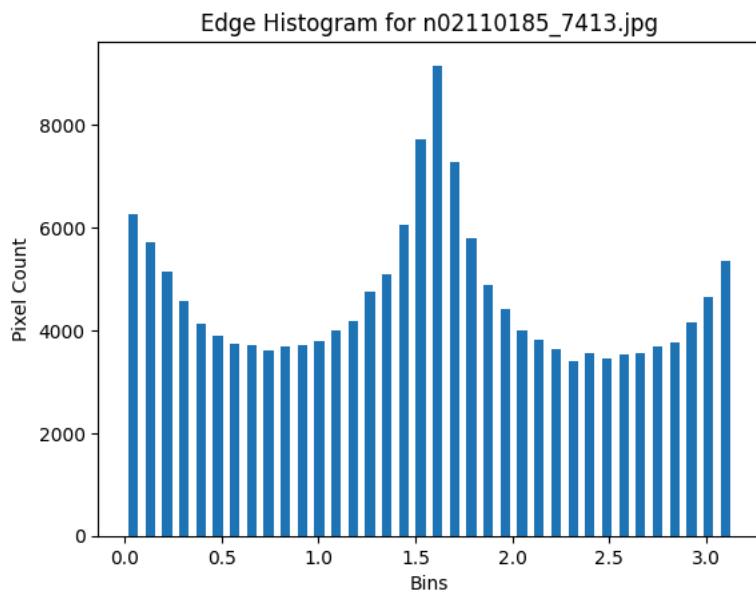




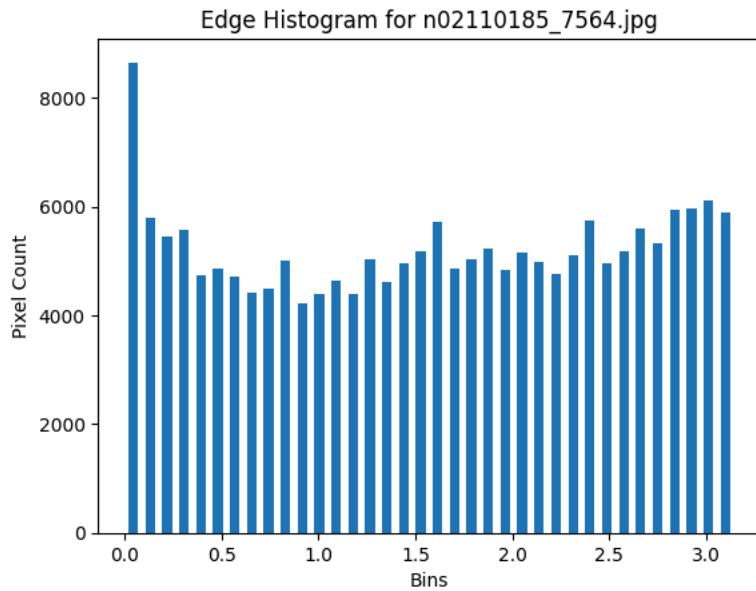
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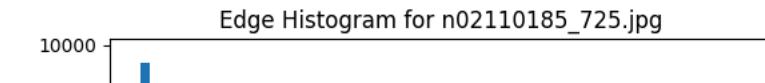
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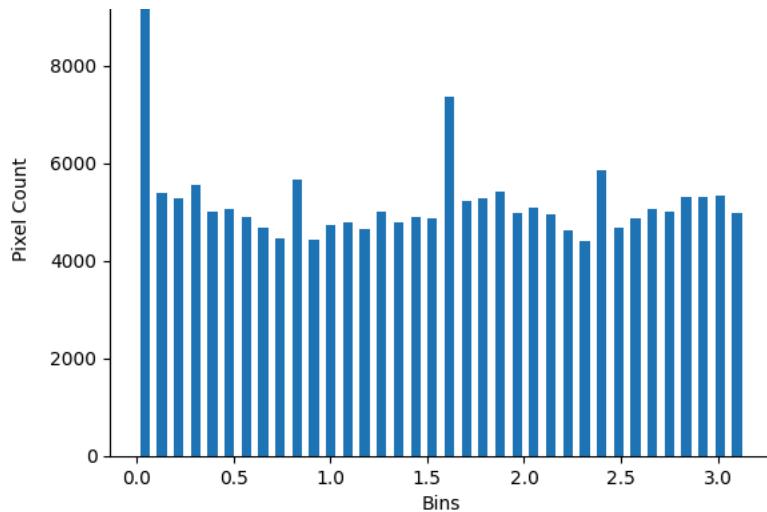


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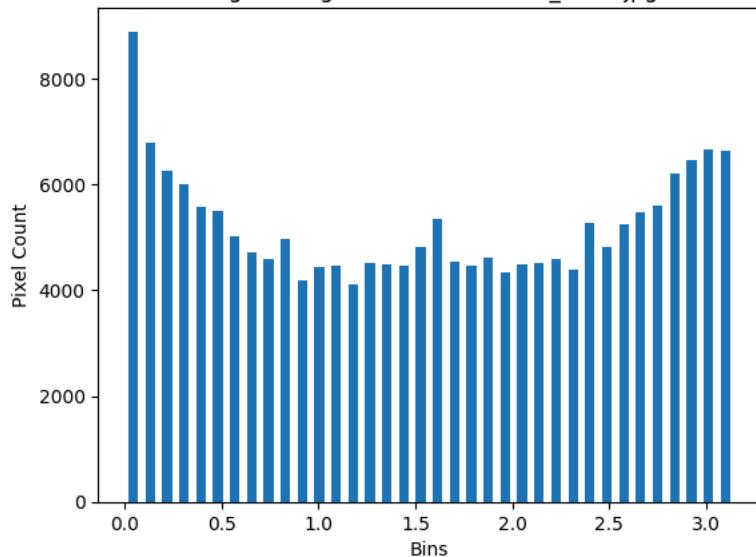
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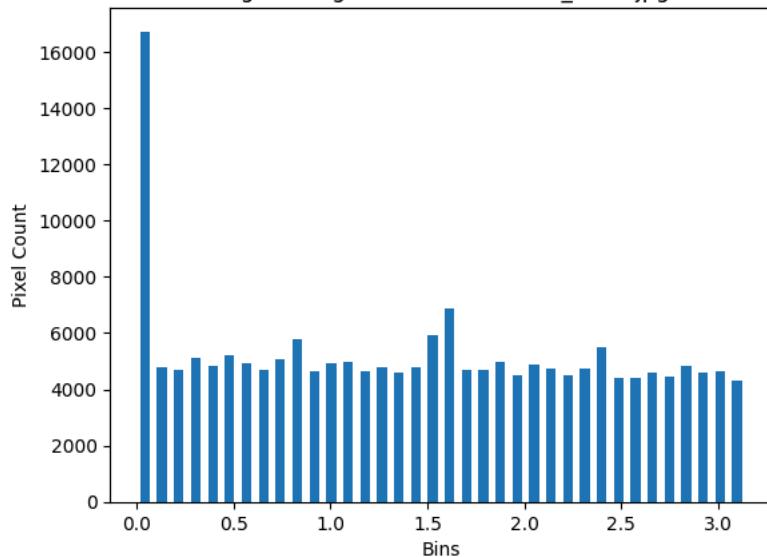
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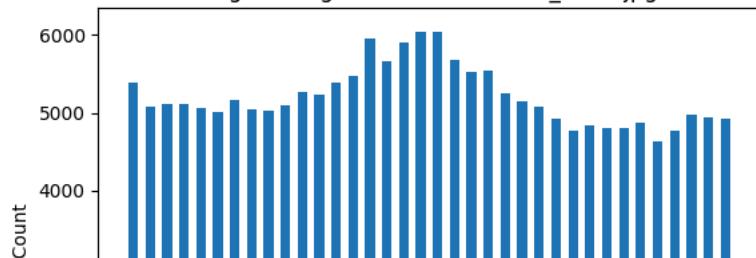
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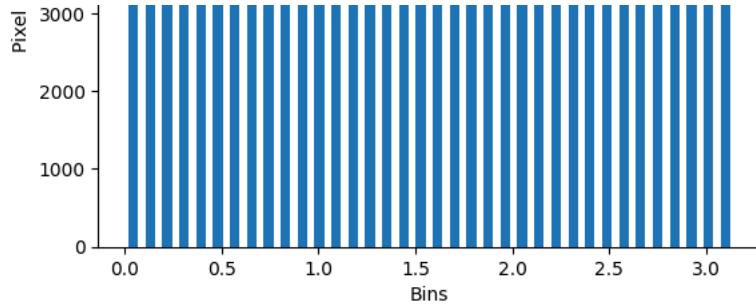
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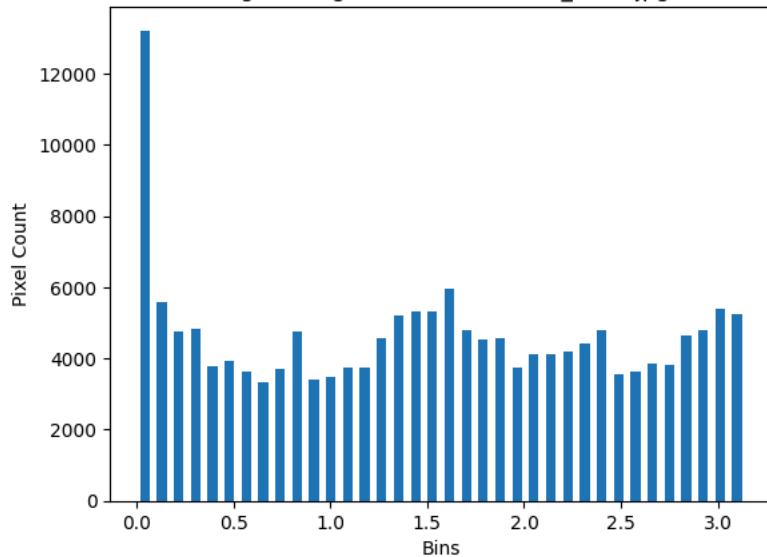
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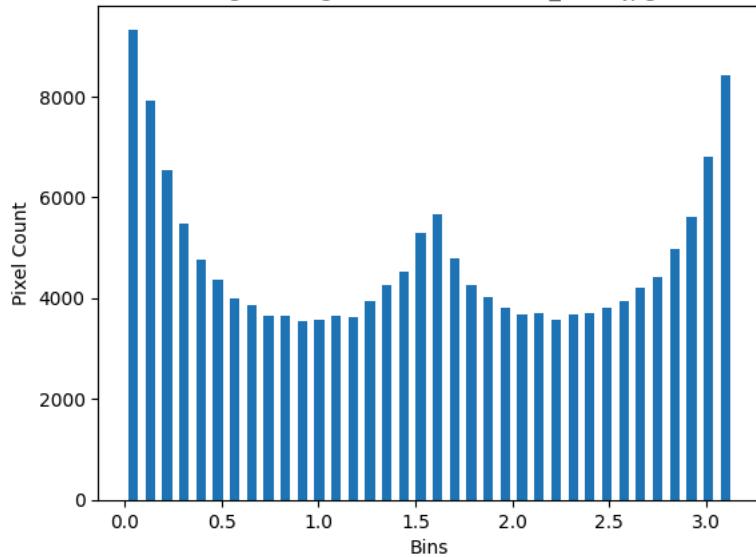
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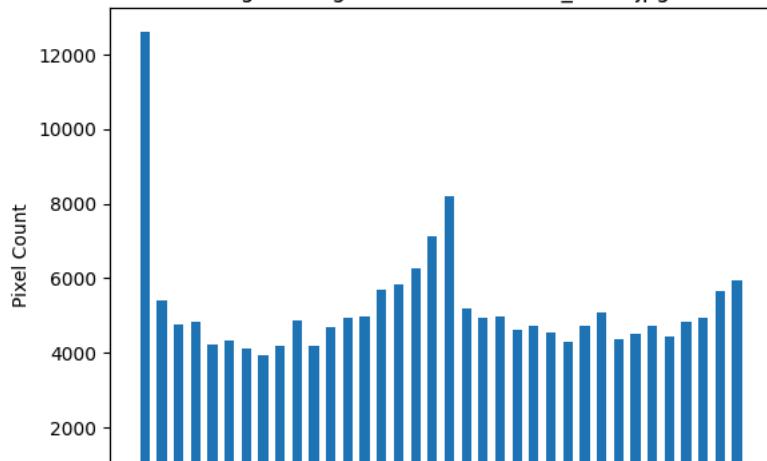
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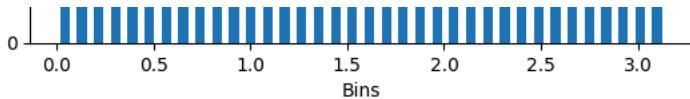
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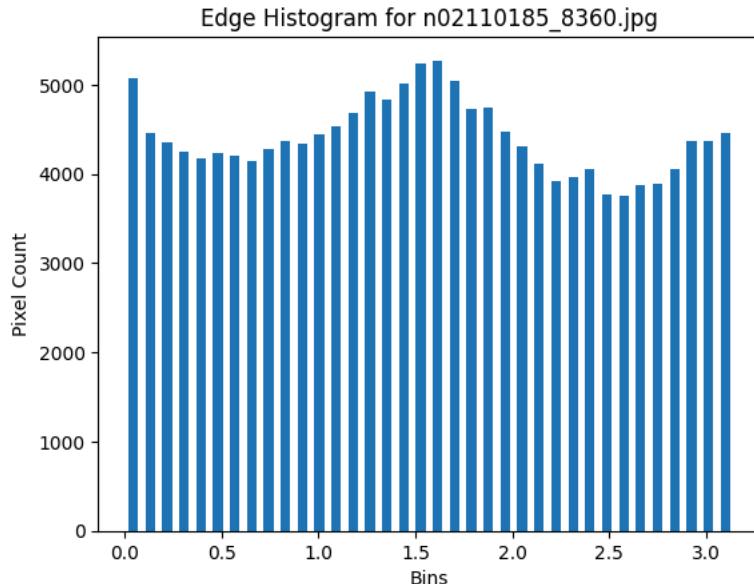
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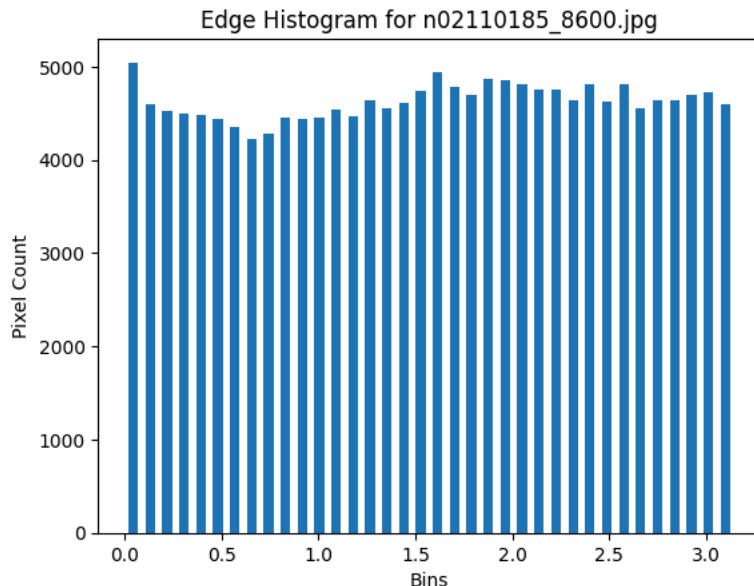




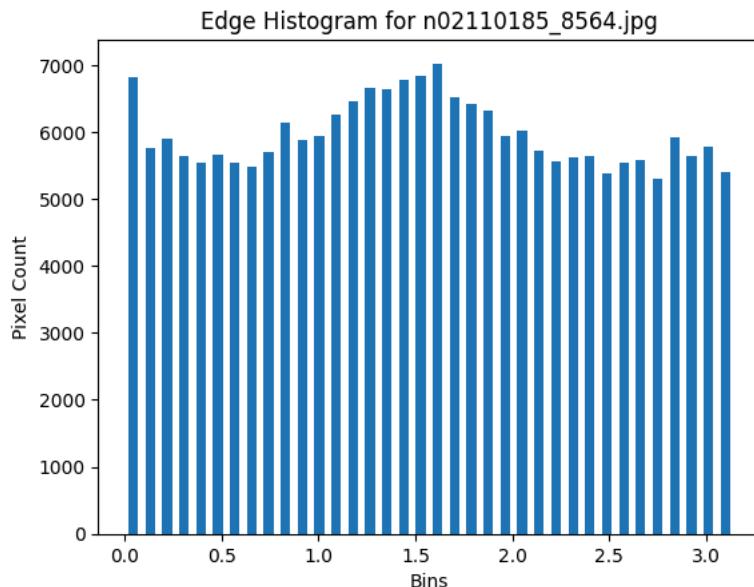
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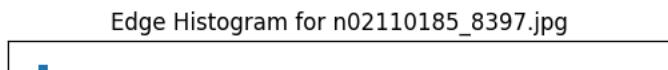
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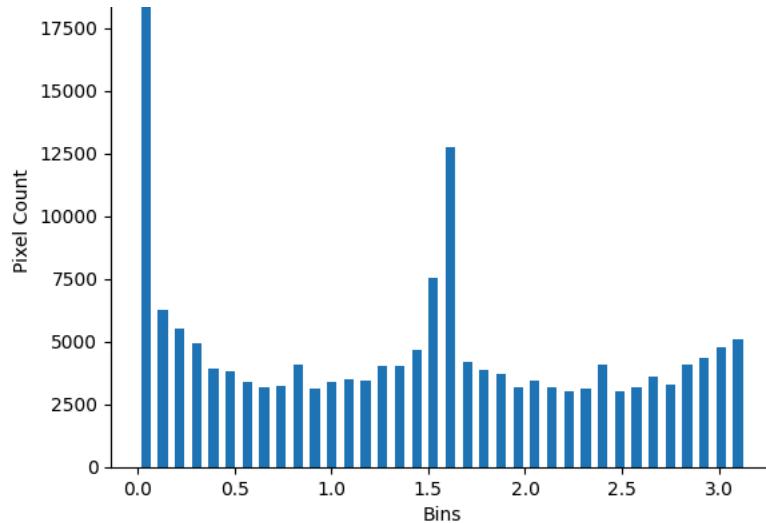


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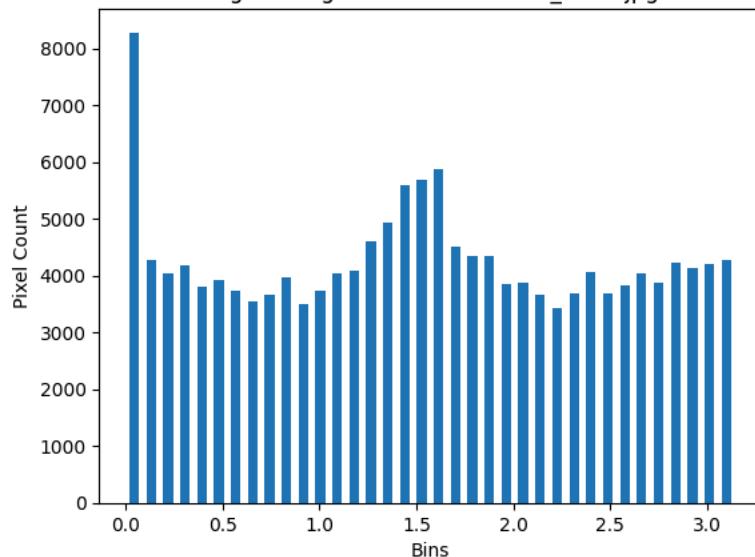
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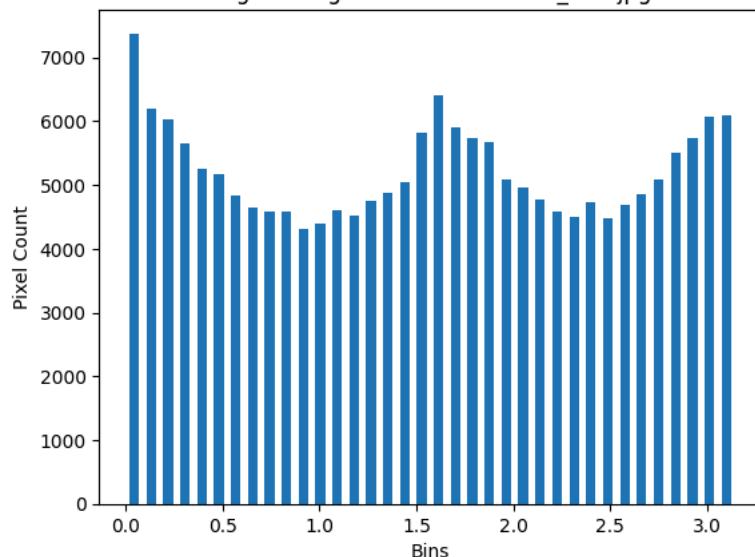
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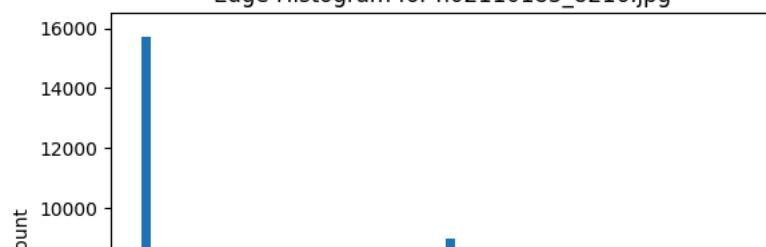
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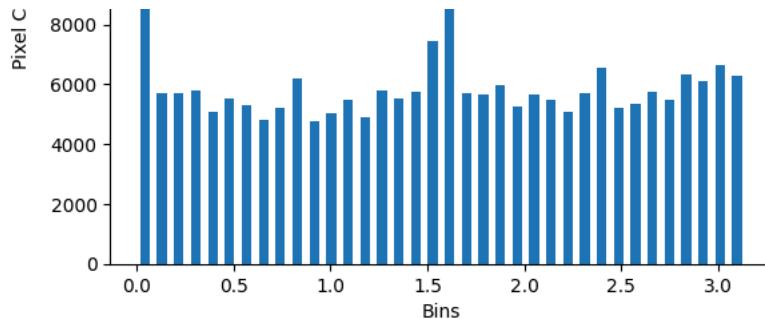
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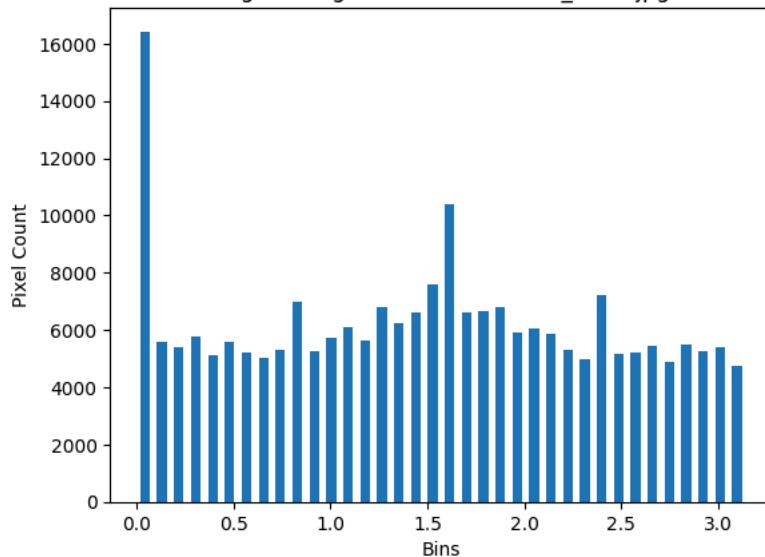
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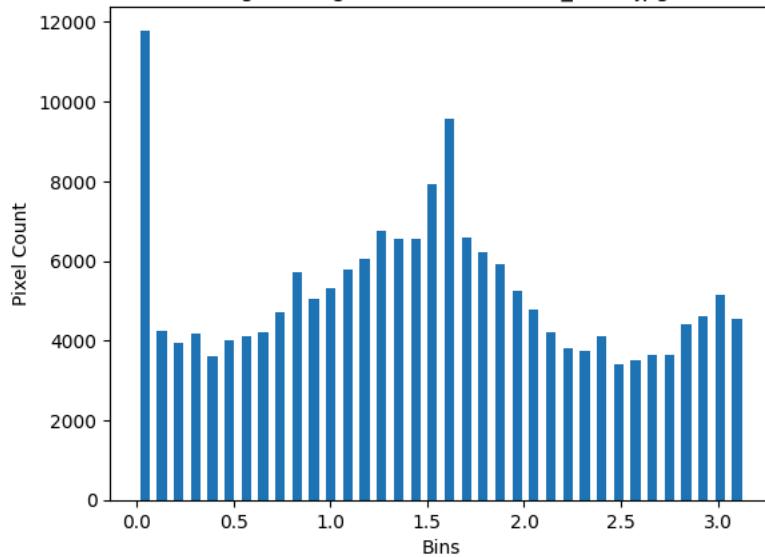
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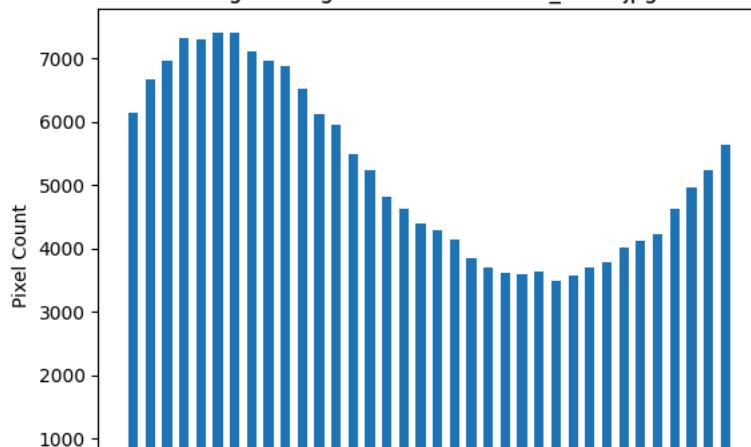
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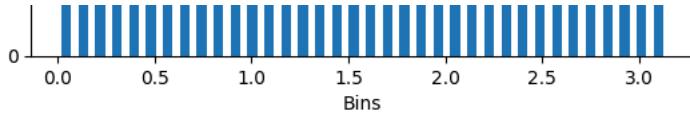
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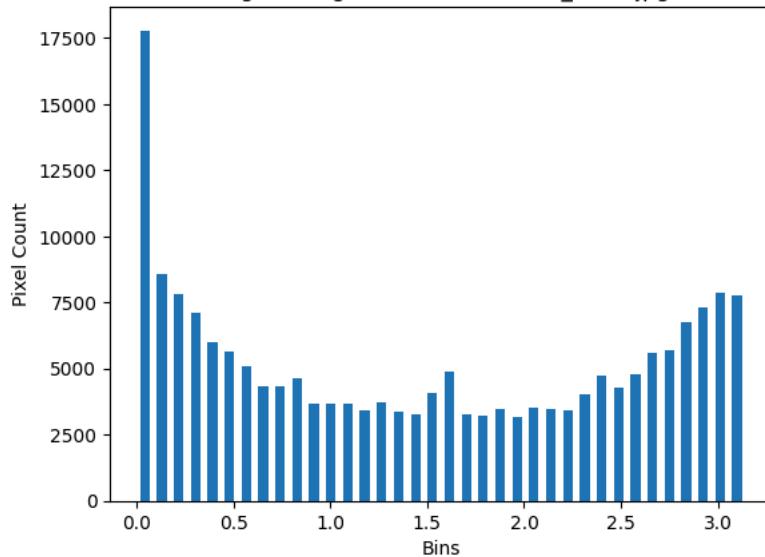
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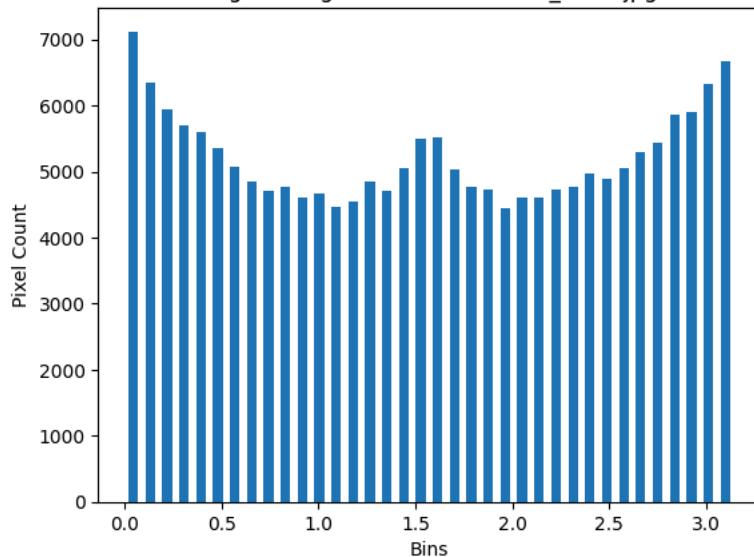
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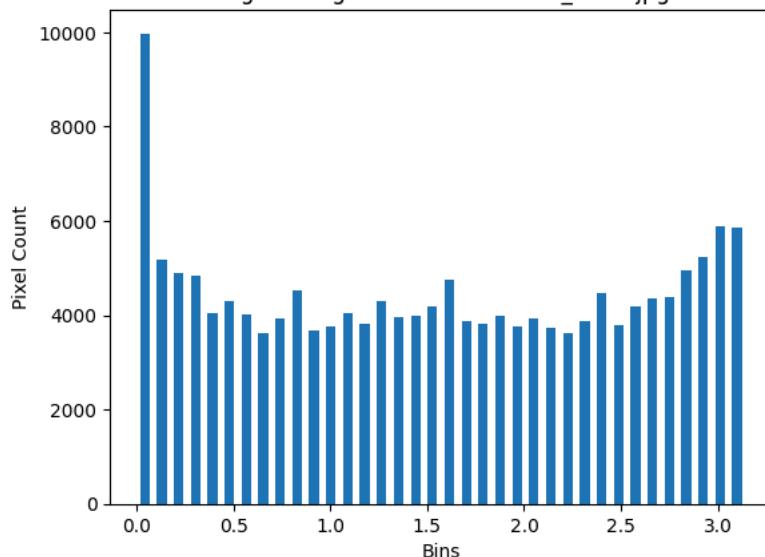
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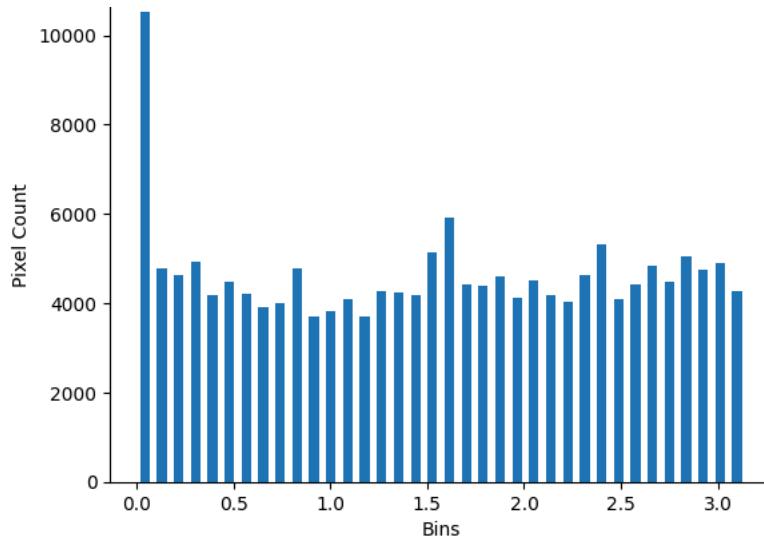
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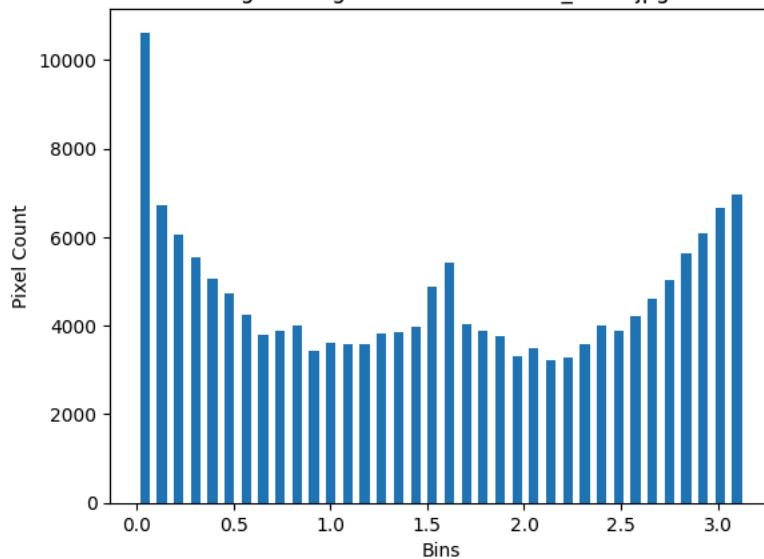
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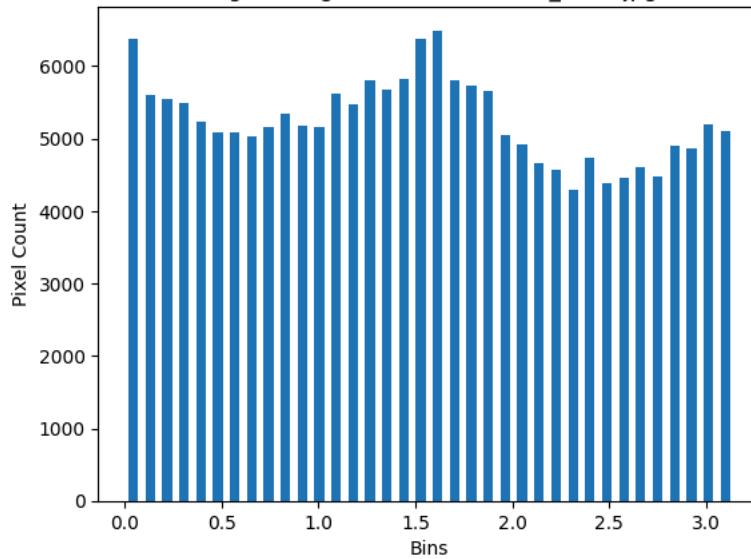
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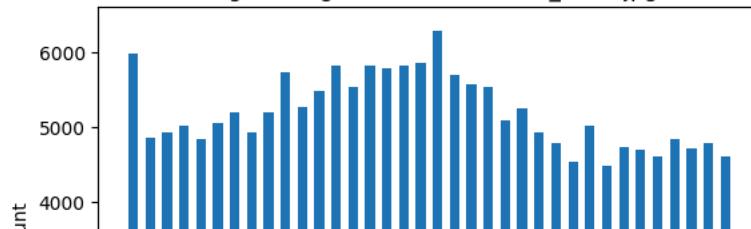
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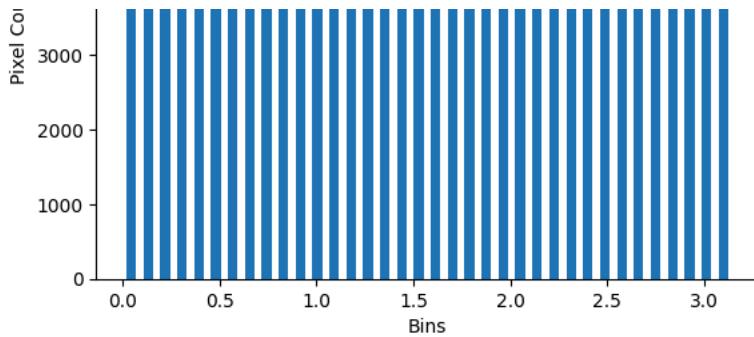
Edge Histogram for n02110185\_8748.jpg



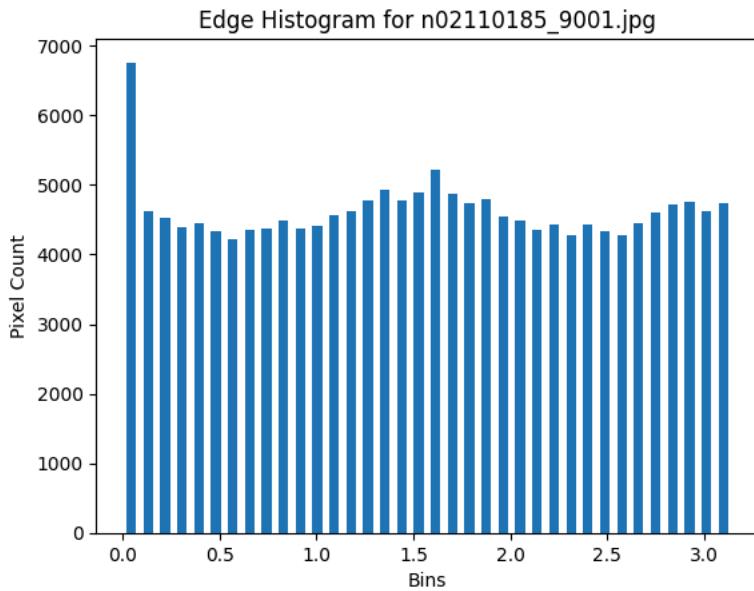
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_8923.jpg

Edge Histogram for n02110185\_8923.jpg

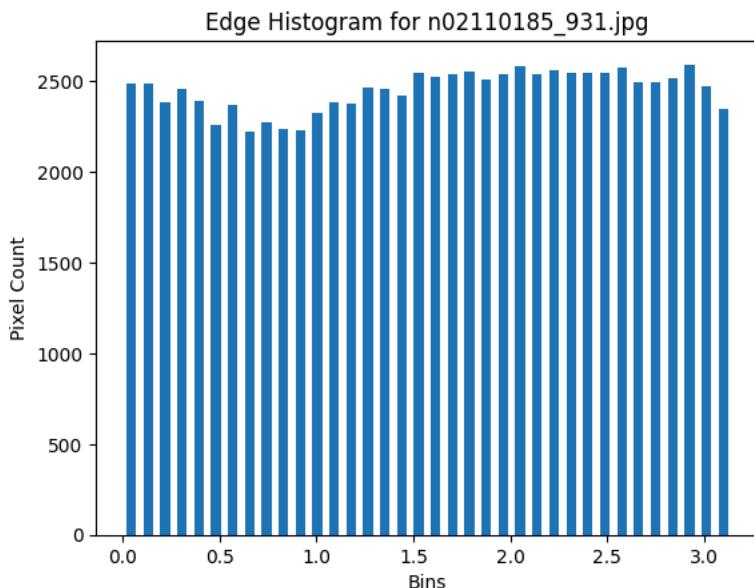




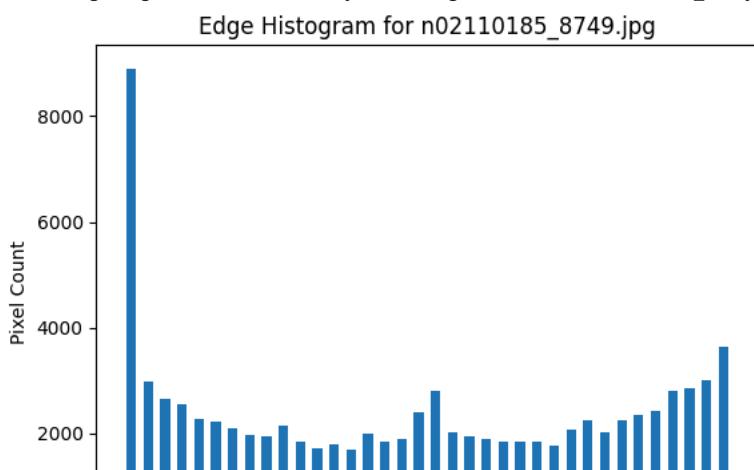
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9001.jpg

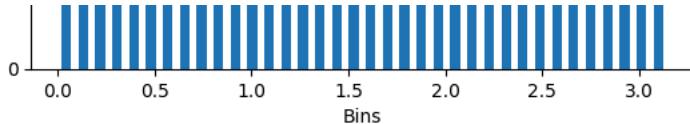


Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_931.jpg

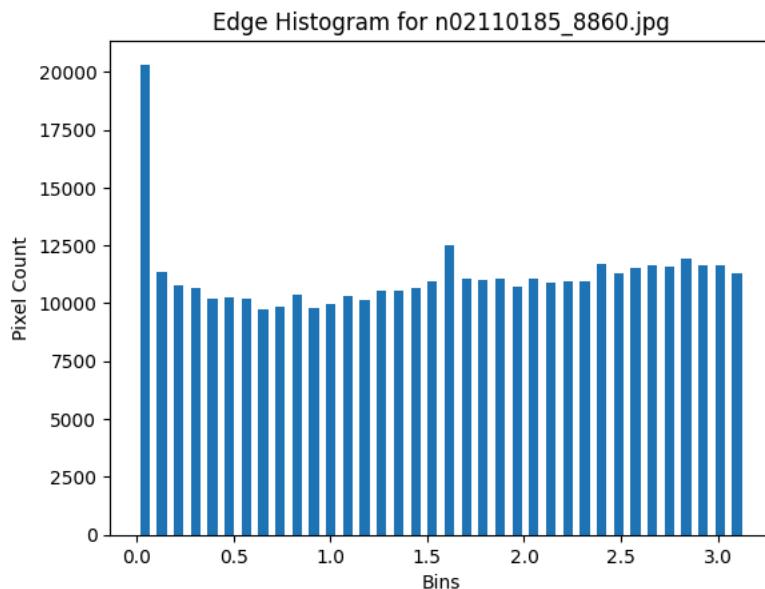


Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_8749.jpg

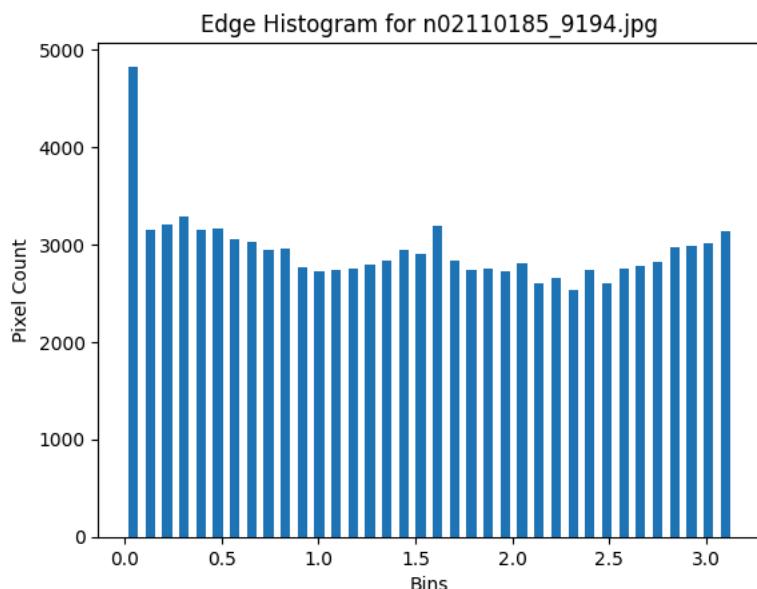




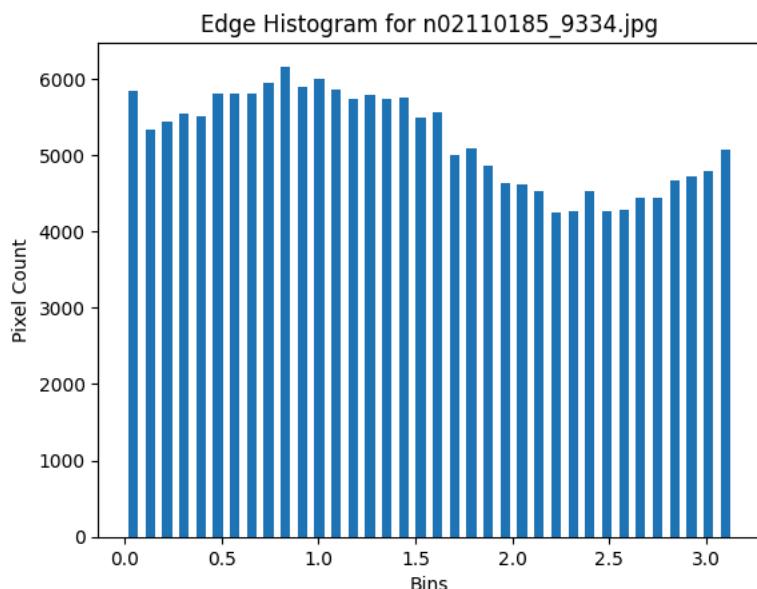
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_8860.jpg



Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9194.jpg

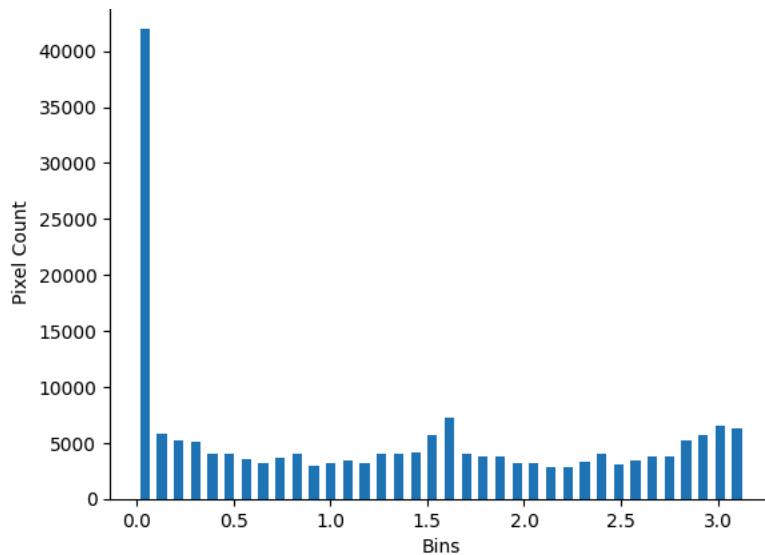


Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9334.jpg



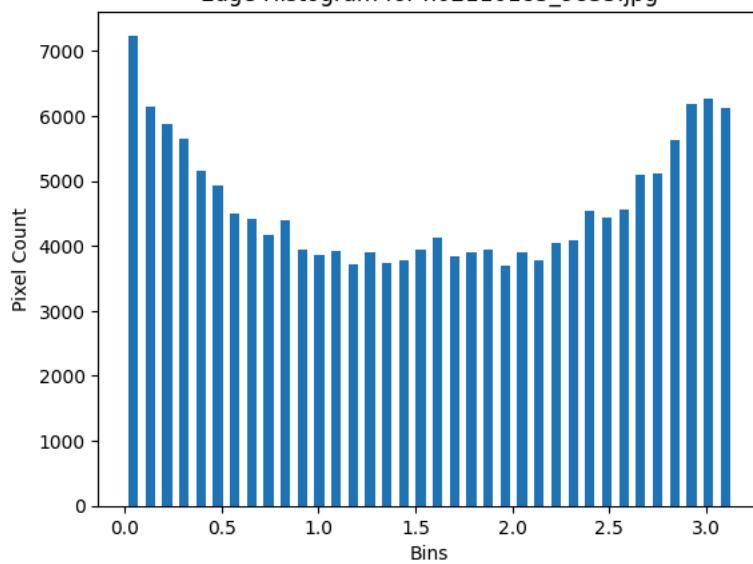
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9846.jpg

**Edge Histogram for n02110185\_9846.jpg**



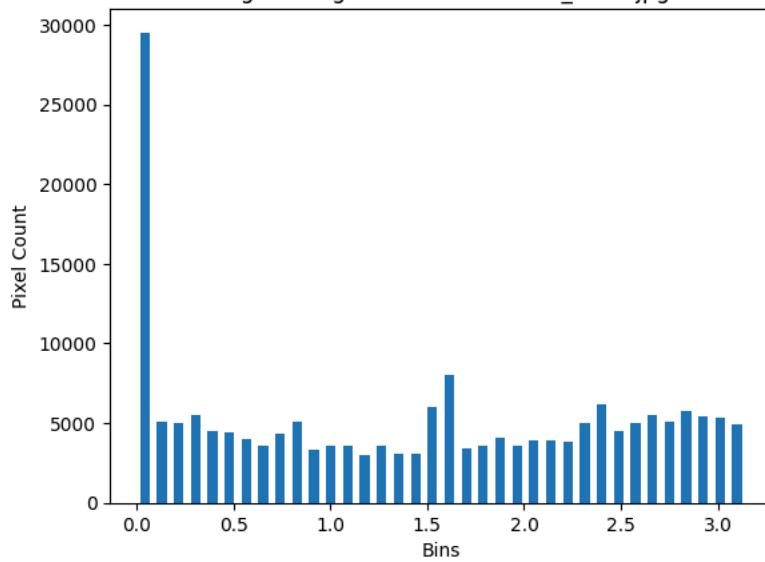
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9833.jpg

Edge Histogram for n02110185\_9833.jpg



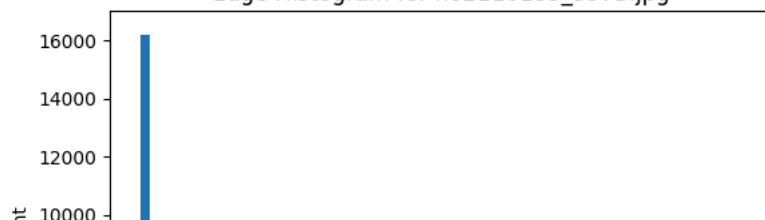
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9461.jpg

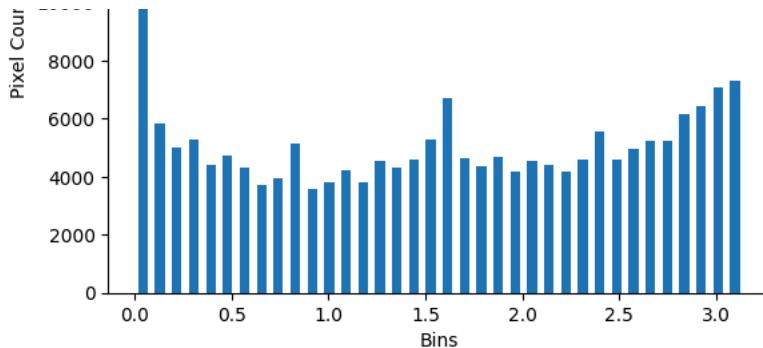
Edge Histogram for n02110185\_9461.jpg



Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9975.jpg

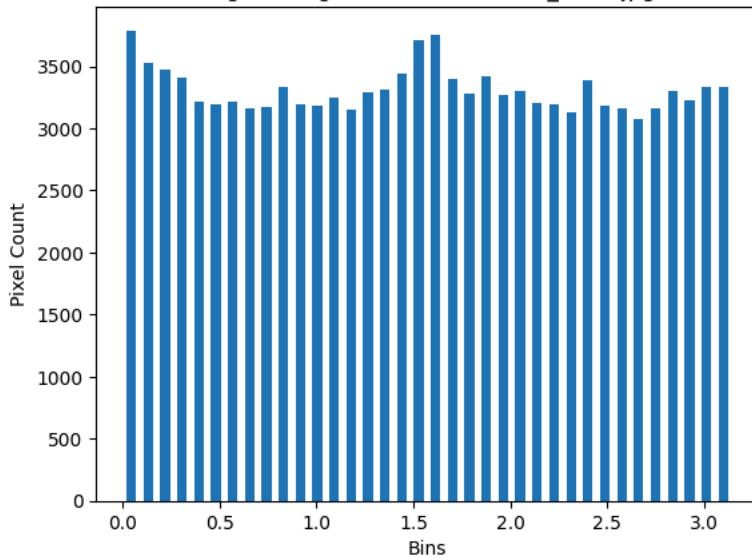
Edge Histogram for n02110185\_9975.jpg





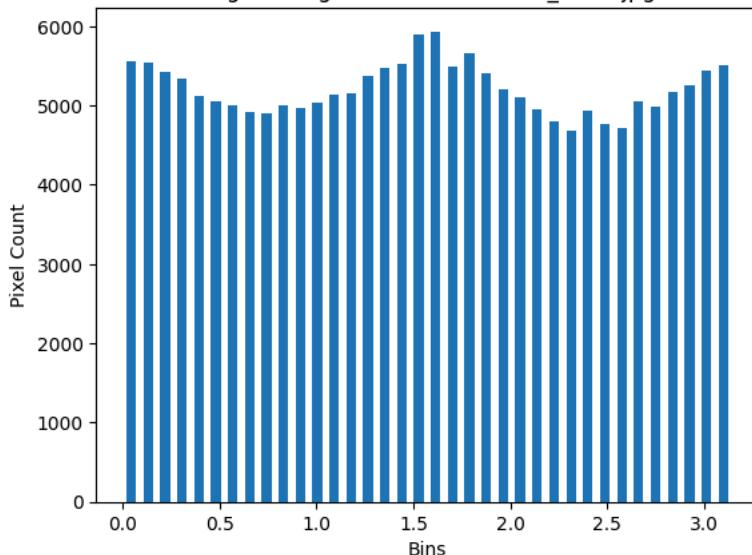
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9855.jpg

Edge Histogram for n02110185\_9855.jpg



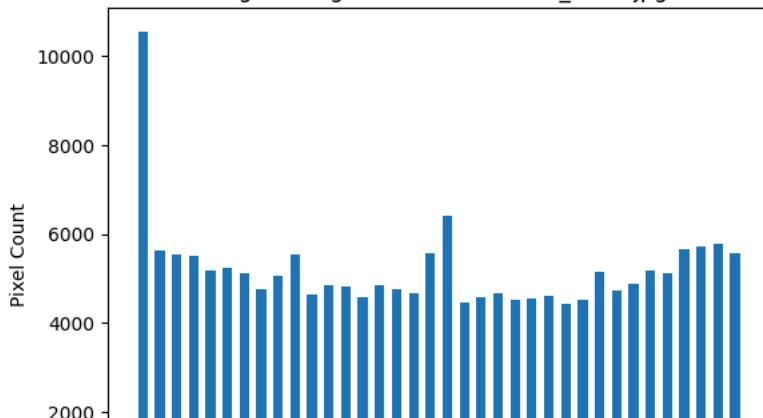
Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9396.jpg

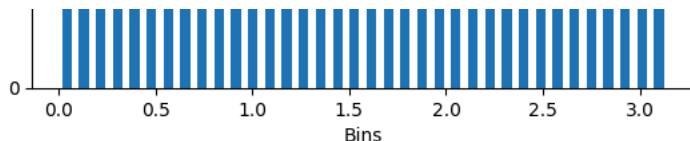
Edge Histogram for n02110185\_9396.jpg



Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9429.jpg

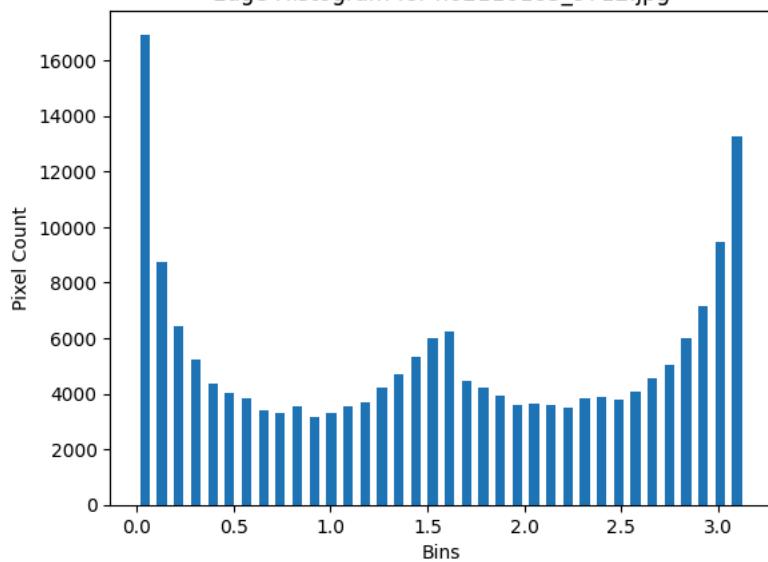
Edge Histogram for n02110185\_9429.jpg





Processing image: /content/drive/MyDrive/Images 3/n02110185-Siberian\_husky/n02110185\_9712.jpg

Edge Histogram for n02110185\_9712.jpg



## Compare histograms using distance metrics

```

import os
import numpy as np
from skimage import filters, exposure, io, color
from sklearn.metrics.pairwise import euclidean_distances, manhattan_distances, cosine_distances

def compute_edge_histogram(image_path):
    img = io.imread(image_path)
    gray_img = color.rgb2gray(img)

    sobel_h = filters.sobel_h(gray_img)
    sobel_v = filters.sobel_v(gray_img)
    angles = np.mod(np.arctan2(sobel_v, sobel_h), np.pi)

    hist, hist_centers = exposure.histogram(angles, nbins=36)

    return hist, hist_centers

def compare_histograms(hist1, hist2):
    euc_dist = euclidean_distances([hist1], [hist2])[0][0]
    man_dist = manhattan_distances([hist1], [hist2])[0][0]
    cos_dist = cosine_distances([hist1], [hist2])[0][0]

    return euc_dist, man_dist, cos_dist

def compare_images_in_folders(folder1, folder2):
    images1 = [os.path.join(folder1, img) for img in os.listdir(folder1) if img.endswith(".jpg")]
    images2 = [os.path.join(folder2, img) for img in os.listdir(folder2) if img.endswith(".jpg")]

    if not images1 or not images2:
        print(f"No images found in one of the folders: {folder1} or {folder2}")
        return

    for image_path1, image_path2 in zip(images1, images2):
        print(f"Comparing {os.path.basename(image_path1)} and {os.path.basename(image_path2)}")
        hist1, _ = compute_edge_histogram(image_path1)
        hist2, _ = compute_edge_histogram(image_path2)

        euc, man, cos = compare_histograms(hist1, hist2)
        print(f'Euclidean: {euc}, Manhattan: {man}, Cosine: {cos}')

base_folder = "content/drive/MyDrive/Images 3"
subfolders = ['/content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier', '/content/drive/MyDrive/Images 3/n02097209-standard_schnauzer']

compare_images_in_folders(os.path.join(base_folder, subfolders[0]), os.path.join(base_folder, subfolders[1]))

```

→ Comparing n02093859\_10.jpg and n02097209\_1.jpg  
 Euclidean: 15792.451994544735, Manhattan: 89100.0, Cosine: 0.023857563109222824  
 Comparing n02093859\_1127.jpg and n02097209\_1133.jpg  
 Euclidean: 12859.661815148951, Manhattan: 57720.0, Cosine: 0.07224501914901615  
 Comparing n02093859\_1062.jpg and n02097209\_1186.jpg  
 Euclidean: 12212.882542626863, Manhattan: 68700.0, Cosine: 0.012865728778892693  
 Comparing n02093859\_1120.jpg and n02097209\_1063.jpg  
 Euclidean: 30420.930787863806, Manhattan: 160300.0, Cosine: 0.09152166777902093  
 Comparing n02093859\_1003.jpg and n02097209\_1164.jpg  
 Euclidean: 714129.1971219213, Manhattan: 4275820.0, Cosine: 0.00443142491607329  
 Comparing n02093859\_1213.jpg and n02097209\_1181.jpg  
 Euclidean: 70279.59506144014, Manhattan: 141658.0, Cosine: 0.03338866608371216  
 Comparing n02093859\_1239.jpg and n02097209\_1042.jpg  
 Euclidean: 30256.560346476926, Manhattan: 69694.0, Cosine: 0.2525826792091319  
 Comparing n02093859\_1154.jpg and n02097209\_1038.jpg  
 Euclidean: 10287.823676560558, Manhattan: 51924.0, Cosine: 0.011784225290920602  
 Comparing n02093859\_1194.jpg and n02097209\_1004.jpg  
 Euclidean: 22141.150828265454, Manhattan: 83834.0, Cosine: 0.17070782799797624  
 Comparing n02093859\_1166.jpg and n02097209\_1240.jpg  
 Euclidean: 14357.905070030238, Manhattan: 67446.0, Cosine: 0.0669834423491833  
 Comparing n02093859\_1218.jpg and n02097209\_1170.jpg  
 Euclidean: 39720.40096726114, Manhattan: 141235.0, Cosine: 0.43101702319834034  
 Comparing n02093859\_1136.jpg and n02097209\_1092.jpg  
 Euclidean: 34065.59628129236, Manhattan: 79928.0, Cosine: 0.3059788072800216  
 Comparing n02093859\_1139.jpg and n02097209\_1491.jpg  
 Euclidean: 2111.49188963633, Manhattan: 9734.0, Cosine: 0.0027867482215474526  
 Comparing n02093859\_1209.jpg and n02097209\_1377.jpg  
 Euclidean: 13925.304772248253, Manhattan: 80609.0, Cosine: 0.018506307024857227  
 Comparing n02093859\_1169.jpg and n02097209\_1303.jpg  
 Euclidean: 21784.650697222576, Manhattan: 105292.0, Cosine: 0.07188404992878838  
 Comparing n02093859\_1251.jpg and n02097209\_1500.jpg  
 Euclidean: 12289.103872943706, Manhattan: 49544.0, Cosine: 0.07682037080274429  
 Comparing n02093859\_1279.jpg and n02097209\_1298.jpg  
 Euclidean: 12215.687209486006, Manhattan: 71442.0, Cosine: 0.0034960642252090945  
 Comparing n02093859\_1397.jpg and n02097209\_1514.jpg

```

Euclidean: 21956.351609500154, Manhattan: 126810.0, Cosine: 0.01935740872565017
Comparing n02093859_1456.jpg and n02097209_1363.jpg
Euclidean: 26557.965019933286, Manhattan: 156540.0, Cosine: 0.00649803973864016
Comparing n02093859_132.jpg and n02097209_1337.jpg
Euclidean: 48302.68787552096, Manhattan: 120486.0, Cosine: 0.21484539779309442
Comparing n02093859_14.jpg and n02097209_15.jpg
Euclidean: 5744.539494163131, Manhattan: 16736.0, Cosine: 0.35098202349917407
Comparing n02093859_161.jpg and n02097209_1247.jpg
Euclidean: 23073.24938104731, Manhattan: 131587.0, Cosine: 0.017574196149188648
Comparing n02093859_1519.jpg and n02097209_1353.jpg
Euclidean: 30421.978929714616, Manhattan: 157900.0, Cosine: 0.02109330422885025
Comparing n02093859_1355.jpg and n02097209_1364.jpg
Euclidean: 35299.19143549891, Manhattan: 211200.0, Cosine: 0.011621977267605943
Comparing n02093859_1464.jpg and n02097209_1387.jpg
Euclidean: 17090.18829621254, Manhattan: 102090.0, Cosine: 0.00940353967301022
Comparing n02093859_1628.jpg and n02097209_1517.jpg
Euclidean: 19305.40737720911, Manhattan: 99184.0, Cosine: 0.03810351307711146
Comparing n02093859_1498.jpg and n02097209_1760.jpg
Euclidean: 26307.854834630663, Manhattan: 127800.0, Cosine: 0.19803122996814293
Comparing n02093859_1635.jpg and n02097209_1560.jpg
Euclidean: 9772.916760108008, Manhattan: 53112.0, Cosine: 0.016902921596787968
Comparing n02093859_1598.jpg and n02097209_1807.jpg
Euclidean: 39169.28071844057, Manhattan: 228436.0, Cosine: 0.08002943515397543

```

## (c) Histogram of Oriented Gradients (HOG)

```

import os
import numpy as np
from skimage.feature import hog
from skimage import io, color
import matplotlib.pyplot as plt

# Function to compute and visualize HOG for a given image path
def compute_and_plot_hog(image_path):
    img = io.imread(image_path)
    gray_img = color.rgb2gray(img)

    hog_descriptor, hog_image = hog(gray_img, visualize=True, block_norm='L2-Hys')

    # Plotting the original image and the HOG descriptor
    plt.figure(figsize=(8, 4))

    plt.subplot(1, 2, 1)
    plt.imshow(gray_img, cmap='gray')
    plt.title('Original Image')

    plt.subplot(1, 2, 2)
    plt.imshow(hog_image, cmap='gray')
    plt.title('HOG Descriptor')

    plt.show()

# Function to process all images in a folder and compute HOG for each
def process_hog_in_folder(folder_path):
    images = [os.path.join(folder_path, img) for img in os.listdir(folder_path) if img.endswith(".jpg")]

    if not images:
        print(f"No images found in folder: {folder_path}")
        return

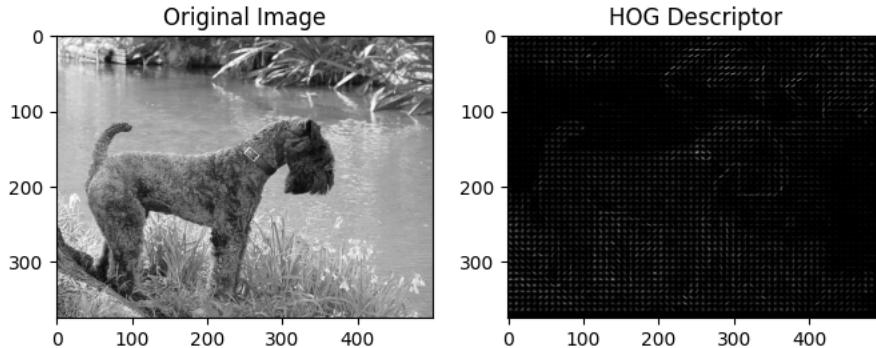
    for image_path in images:
        print(f"Processing image: {image_path}")
        compute_and_plot_hog(image_path)

    # Loop through each of the 4 folders and process images
    base_folder = "content/drive/MyDrive/Images 3"
    subfolders = ['/content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier', '/content/drive/MyDrive/Images 3/n02097209-standard_schnau']

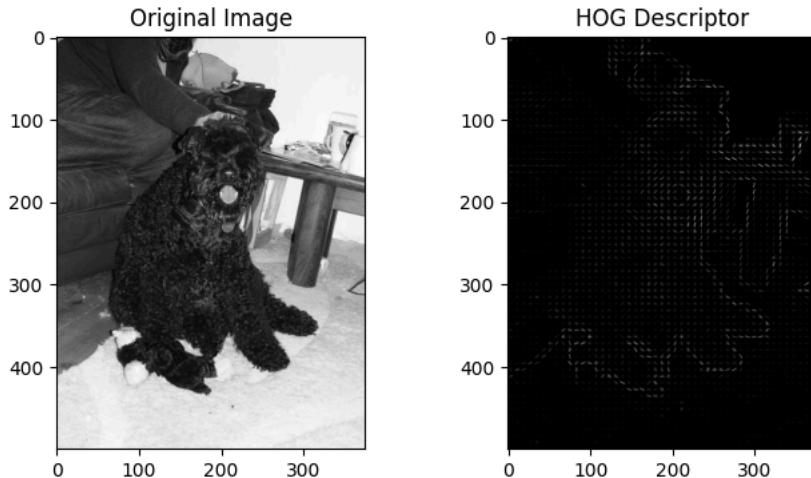
    for subfolder in subfolders:
        folder_path = os.path.join(base_folder, subfolder)
        print(f"Processing folder: {folder_path}") # Debugging print statement
        process_hog_in_folder(folder_path)

```

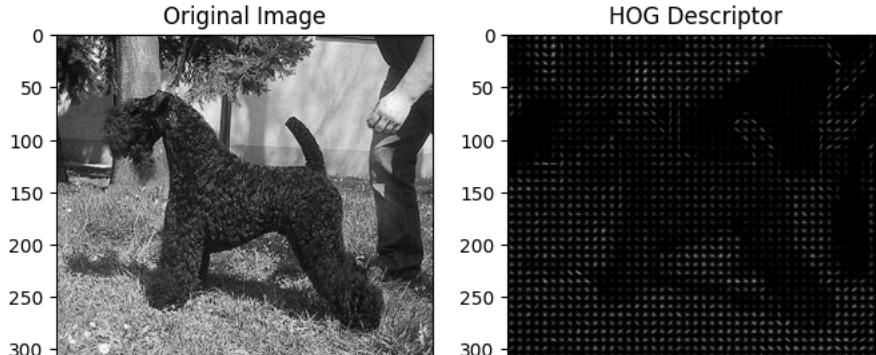
Processing folder: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier  
 Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_10.jpg



Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1127.jpg



Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry\_blue\_terrier/n02093859\_1062.jpg



(d) Dimensionality Reduction with PCA

```
import os
import numpy as np
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt

# Function to compute edge angles and histogram (same as before)
def compute_edge_histogram(image_path):
    img = io.imread(image_path)
    gray_img = color.rgb2gray(img)

    sobel_h = filters.sobel_h(gray_img)
    sobel_v = filters.sobel_v(gray_img)
    angles = np.mod(np.arctan2(sobel_v, sobel_h), np.pi)

    hist, hist_centers = exposure.histogram(angles, nbins=36)

    return hist

# Function to perform PCA
def perform_pca(histograms):
    pca = PCA(n_components=2)
    reduced_data = pca.fit_transform(histograms)

    return reduced_data

# Function to plot the PCA results
```

```
def plot_pca(reduced_data, labels):
    colors = ['r', 'g', 'b', 'c']
    for i, label in enumerate(set(labels)):
        plt.scatter(reduced_data[labels == label, 0], reduced_data[labels == label, 1], color=colors[i], label=f'Class {label}')
    plt.legend()
    plt.xlabel('PCA Component 1')
    plt.ylabel('PCA Component 2')
    plt.title('PCA of Edge Histograms')
    plt.show()

# Function to collect histograms from images in all subfolders
def collect_histograms_from_folders(base_folder, subfolders):
    histograms = []
    labels = []

    for class_idx, subfolder in enumerate(subfolders):
        folder_path = os.path.join(base_folder, subfolder)
        images = [os.path.join(folder_path, img) for img in os.listdir(folder_path) if img.endswith(".jpg")]

        for image_path in images:
            print(f"Processing image: {image_path}")
            hist = compute_edge_histogram(image_path)
            histograms.append(hist)
            labels.append(class_idx) # Use class index as label for the PCA plot

    return np.array(histograms), np.array(labels)

# Example usage
base_folder = "content/drive/MyDrive/Images 3"
subfolders = ['/content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier', '/content/drive/MyDrive/Images 3/n02097209-standard_schnauzer']

# Collect histograms and labels from the images
histograms, labels = collect_histograms_from_folders(base_folder, subfolders)

# Perform PCA on the histograms
reduced_data = perform_pca(histograms)

# Plot the PCA results
plot_pca(reduced_data, labels)

→ Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_10.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1127.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1062.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1120.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1003.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1213.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1239.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1154.jpg
Processing image: /content/drive/MyDrive/Images 3/n02093859-Kerry_blue_terrier/n02093859_1194.jpg
```