NIF Imaging Session

NIF Beam Noise – Characterization and Simulation

Omar Hafiz and Walter Ferguson

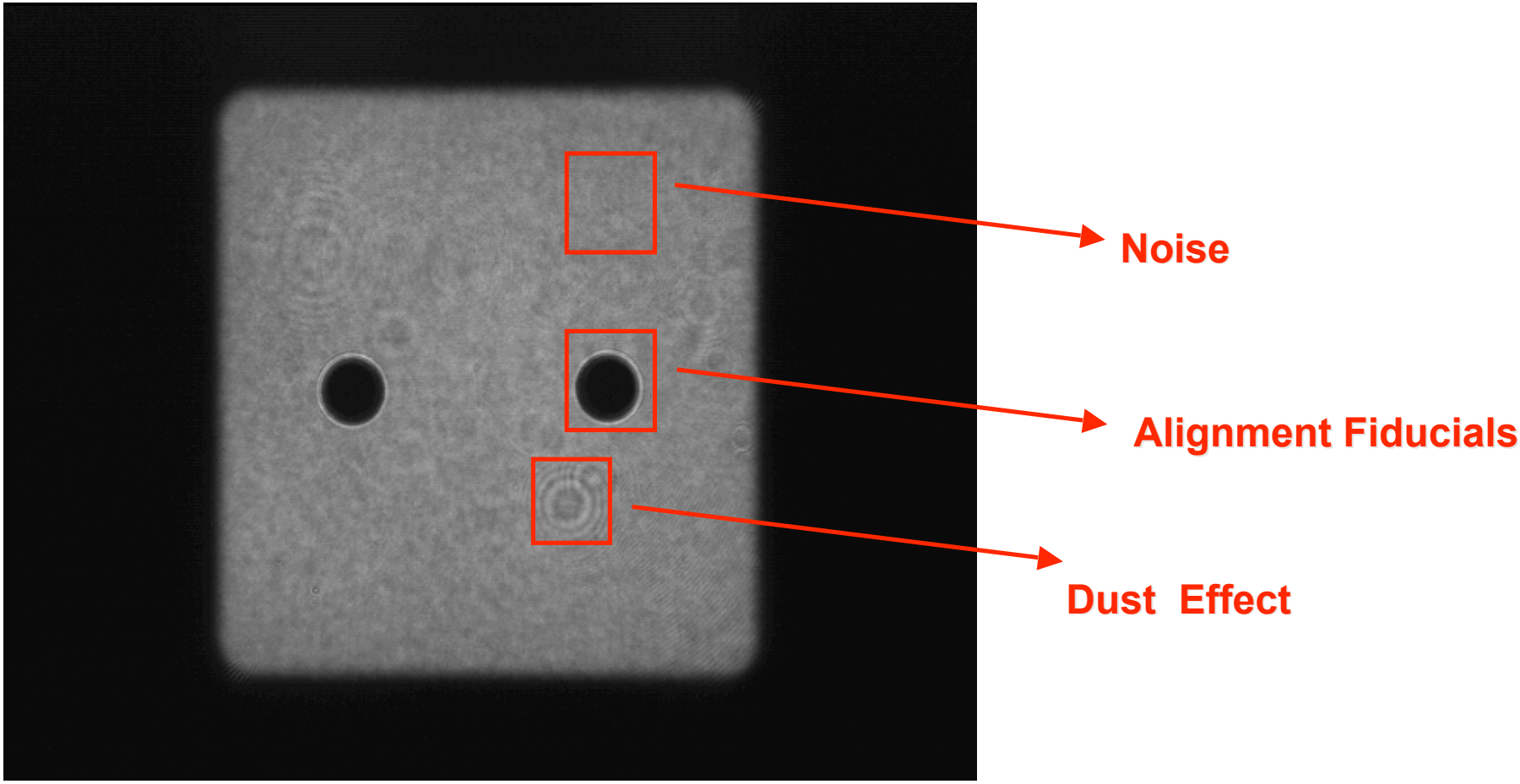
UCRL-PRES-208149

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Outline

- Historically NIF beams are simulated using white gaussian noise
- In real NIF beam, noise is visually different from white gaussian
- The project is to correctly model simulated NIF noise
- Noise Model (Amplitude Distribution)
- Noise Model (Frequency Distribution)
- NIF Beam Simulation
- Examples

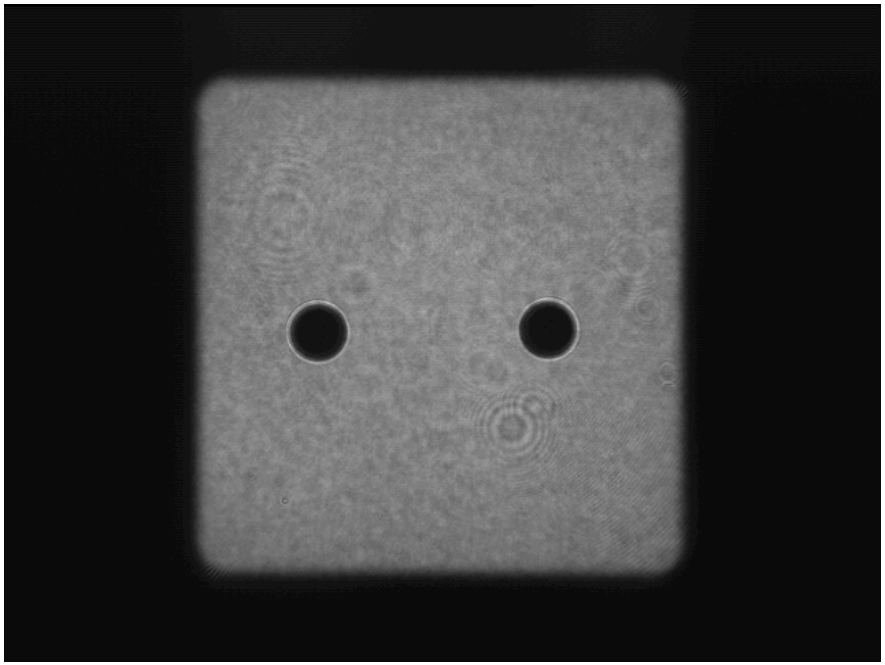
Real NIF Beams



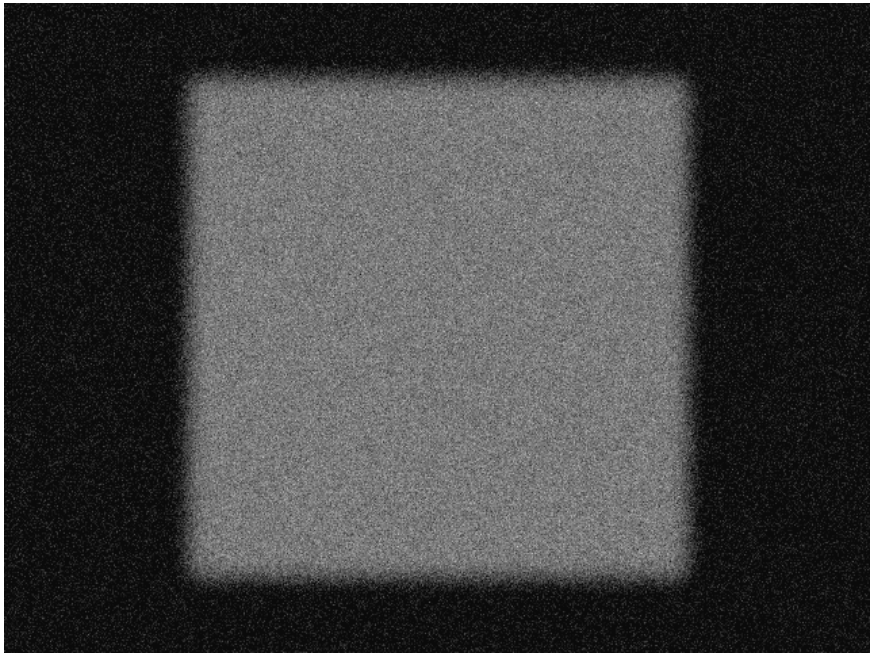
- Beam Shaper (Real Image)

UCRL-PRES-208149

Compare Real vs. Simulated



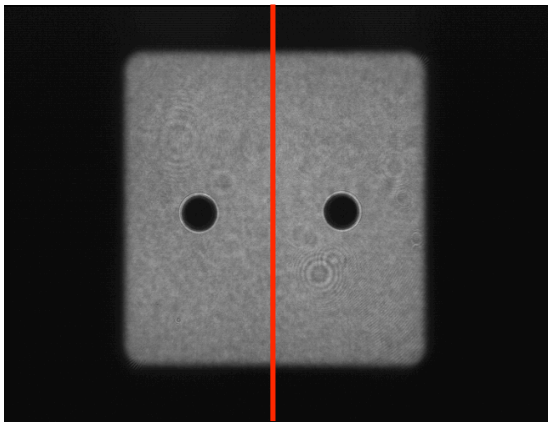
Real NIF Beam with Noise



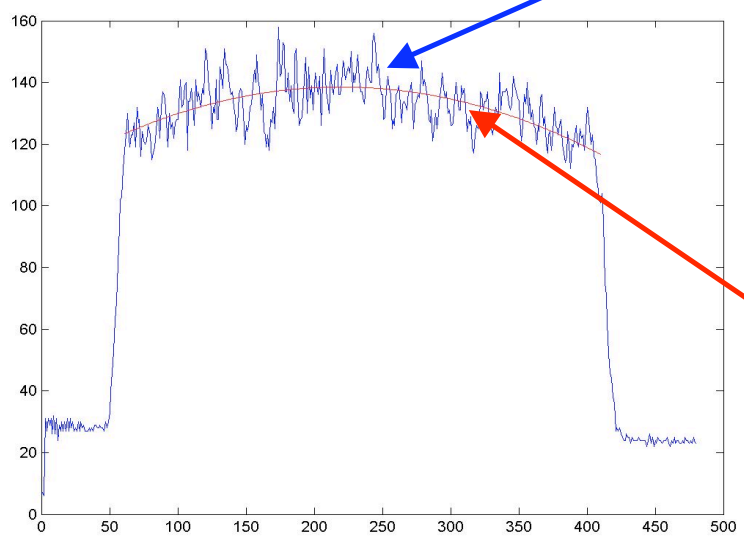
Simulated NIF Beam with Gaussian White Noise

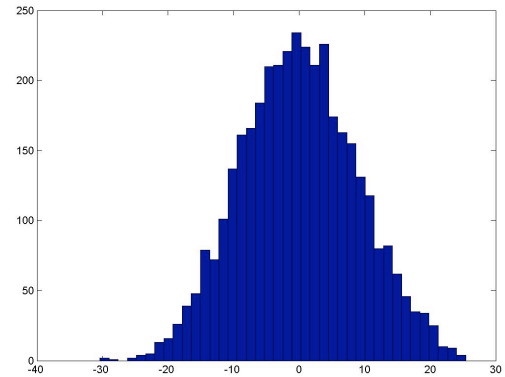
UCRL-PRES-208149

Real NIF Beams Have Gaussian Noise



Line out



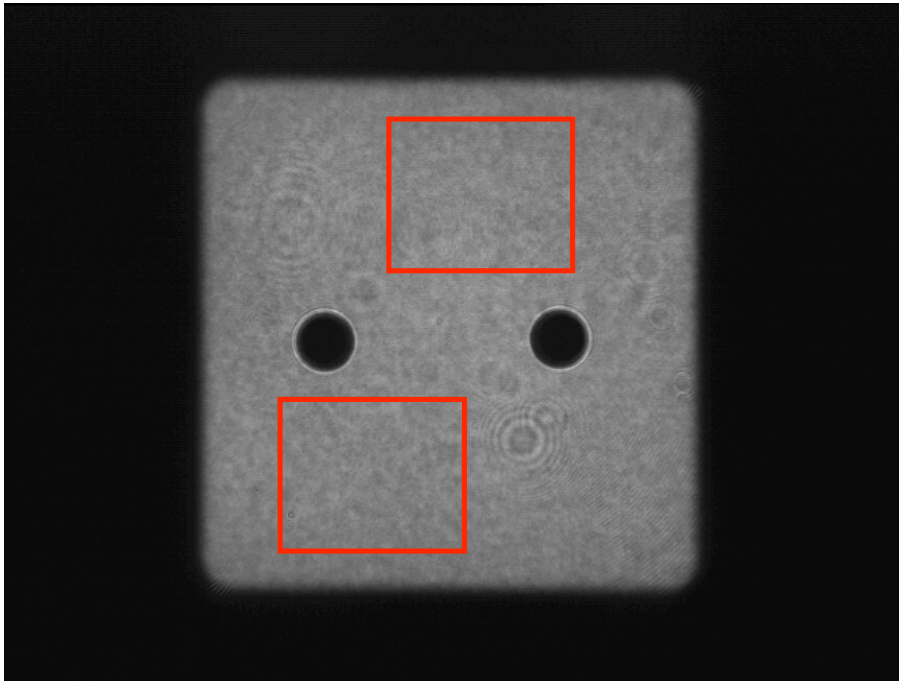


Noise:
STD = 10
Mean = 0

Trend :
Approximated as a polynomial function.
For 2-D, fit a surface!

NIF Beam Noise Analysis

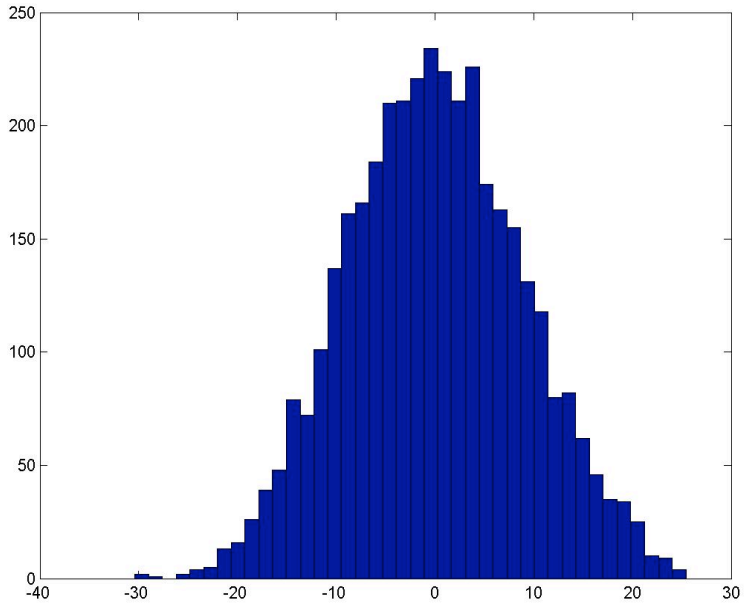
Analyzed 20 Sub-Images for Amplitude and Frequency Distribution



- Avoid two circles
- Fit 2D surface
- Avoid dust effect

Noise Model (Spatial domain)

- For the 20 sub-images, Noise has a Gaussian distribution with a

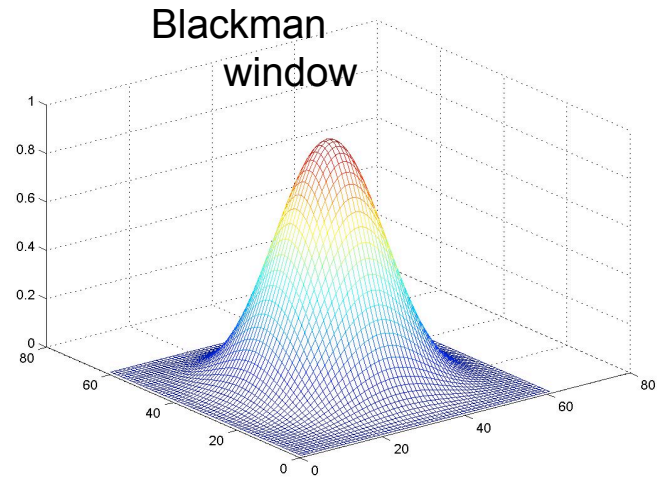


Noise Histogram

Noise:
STD = 10
Mean = 0

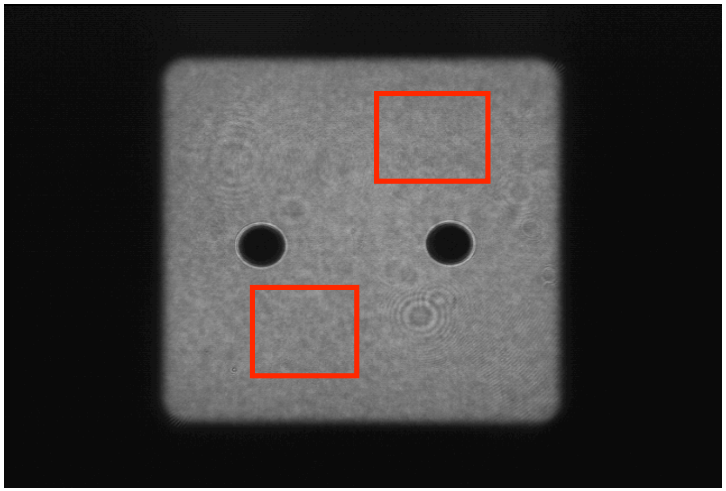
Noise Model (frequency domain)

- We multiply each sub-image with blackman window

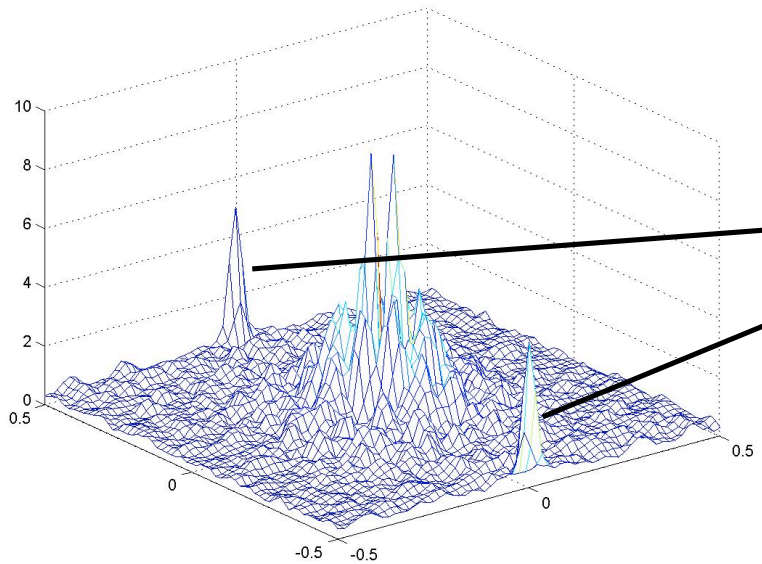


- The magnitude of the noise :

to minimize edge effects that results in spectral leakage

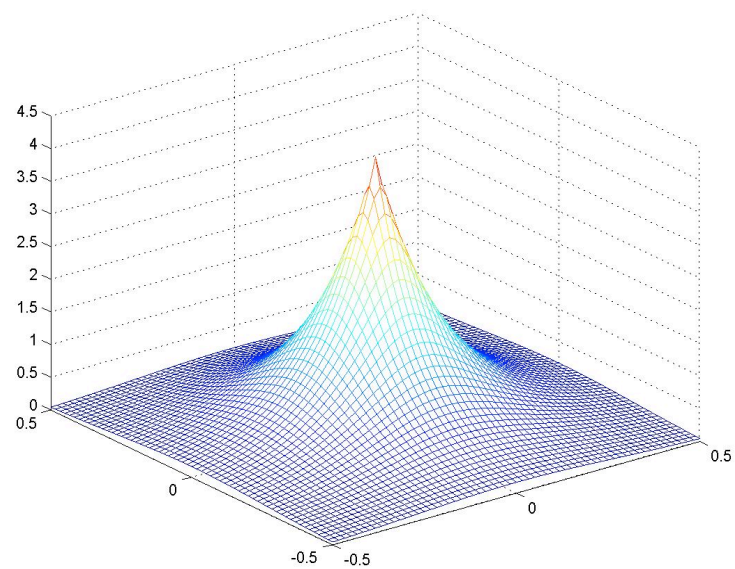


Noise Model (frequency domain)



Camera Artifact – charge dispersion when reading pairs of lines

Approximate it as an exp function

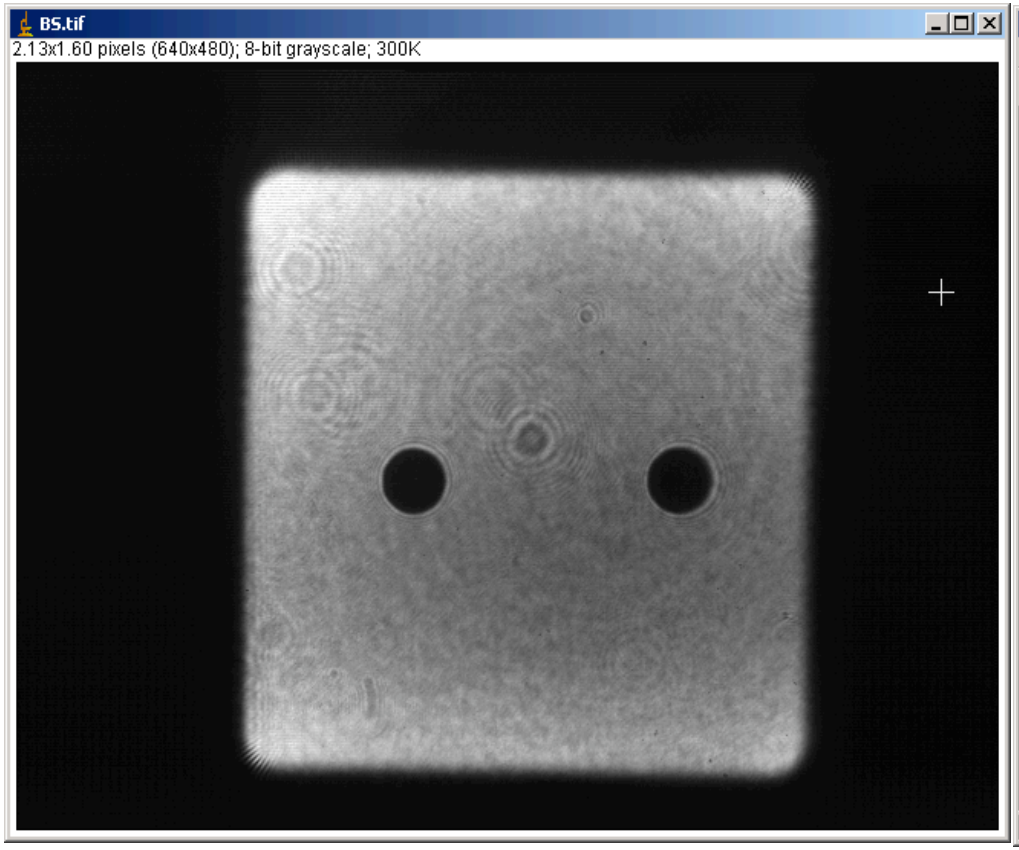


Simulation Summary

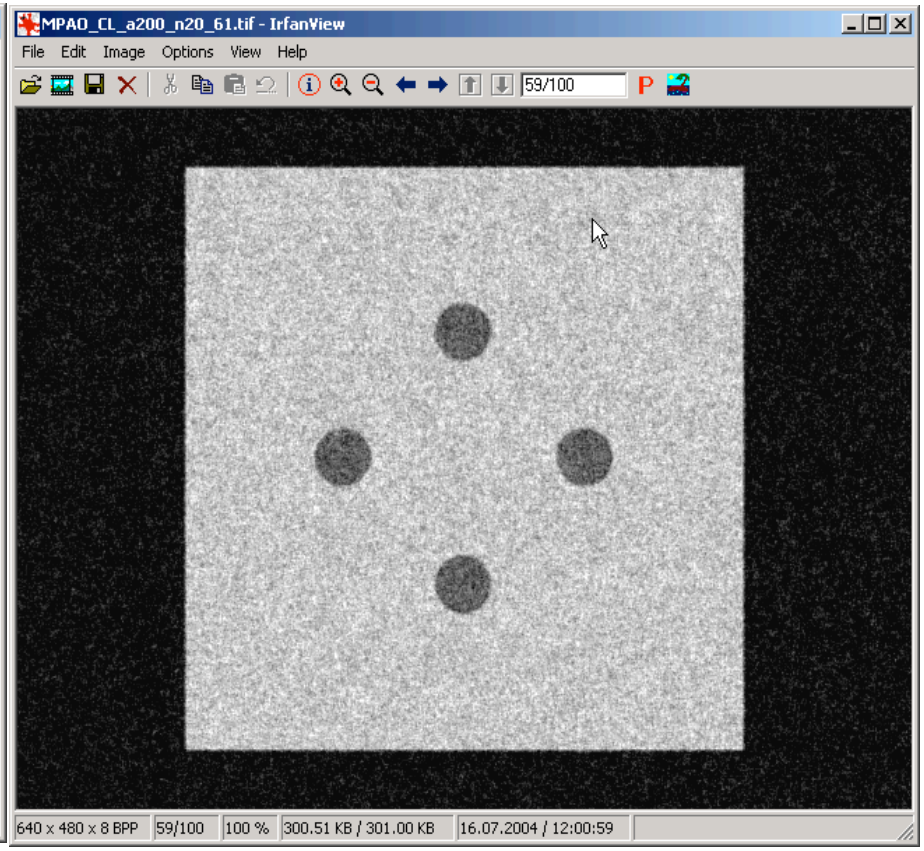
- Generate White Gaussian Noise using Matlab function randn with desired STD and Mean=0
- Get the 2D Fourier transform of your generated white gaussian noise
- Multiply it with the band limited gaussian filter
- Use inverse Fourier transform to regenerate the noise

Example

Beamshaper Noise

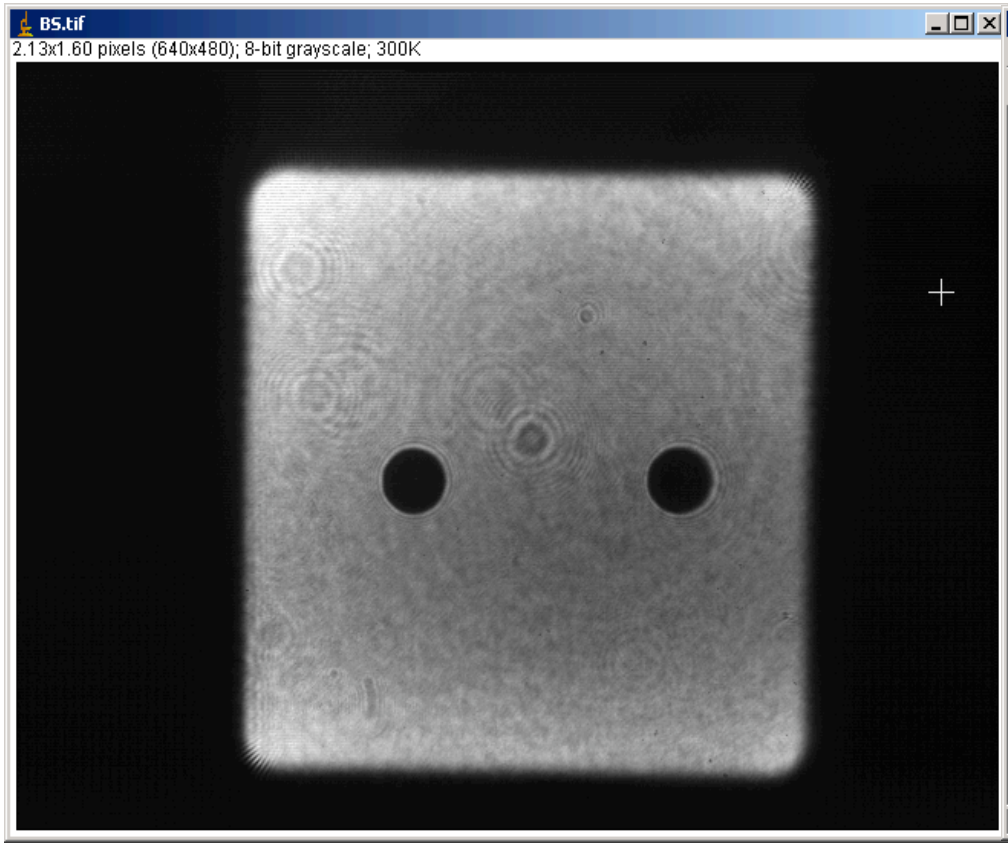
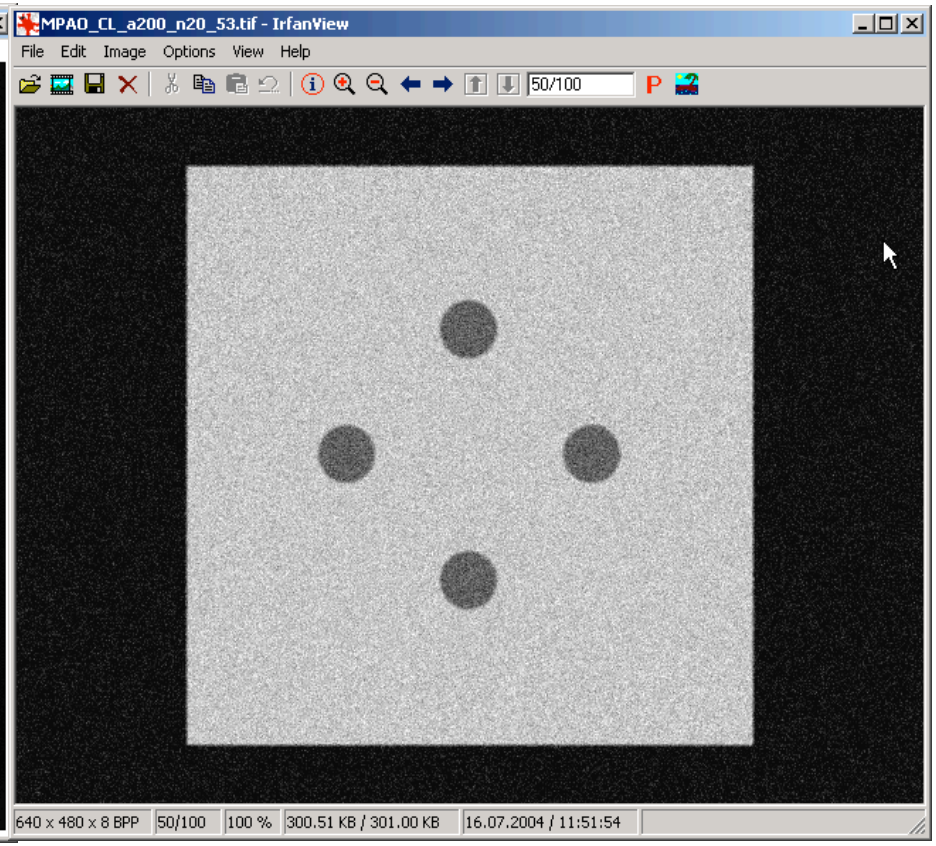


Gaussian_Band_Limited_Noise



Example

Beamshaper Noise



Gaussian_White_Noise