



# BEAM ALIGNMENT AND DRIFT OF OPTICS

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# PURPOSE

- ◆ Aid initial alignment by providing a visual configuration for the operator, supplementary to WFS and dithering.
- ◆ Compare the image of the beam on the optics during data taking
  - Determine good position of beam from a good lock
  - Monitor beams on optics and beams on photodiodes
  - Determine drift of the beams on the optics

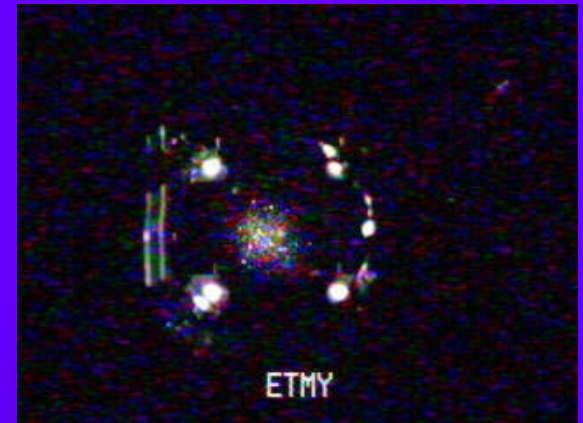
# Technique

## ◆ Image Acquisition

- Access channels (ETMX, ETMY, ITMX, ITMY, AS\_PD, AS\_Q, BS, and MC\_TRANS)
- Capture frames

## ◆ Image Processing

- Filtering
- Fourier transform
- Locate center of beam
- Calculate correlation coefficient
- Subtraction of images



single-arm lock



full lock



# Outline of Software

- ◆ Input reference image
- ◆ Grab frame
  - Access video card
  - Select input channel
- ◆ Run script
  - Process images
  - Fourier transforms
  - Difference image
  - Correlation coefficient
- ◆ Display difference image with correlation coefficient
- ◆ Clear workspace and repeat

# Cropping

- ◆ Have the option to disclude the OSEMs, but this sometimes clips the image of the beam
- ◆ Centering method solves problem of change in luminosity of OSEMs affecting the correlation coefficient



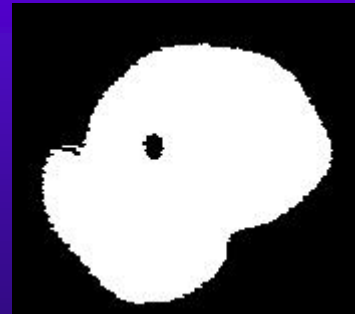
# Filtering

MC\_REFL

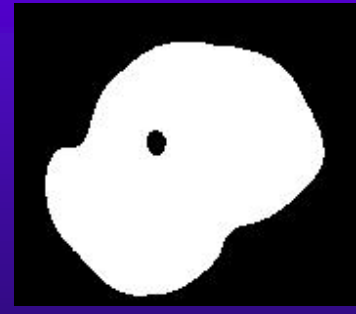
- ◆ Commands
  - **im2bw** converts colorscale to grayscale to binary
  - **medfilt2** eliminates “salt and pepper” noise
- ◆ Information is lost to filtering
- ◆ The purpose of filtering is to make viewing easier for the Operator



input image



im2bw

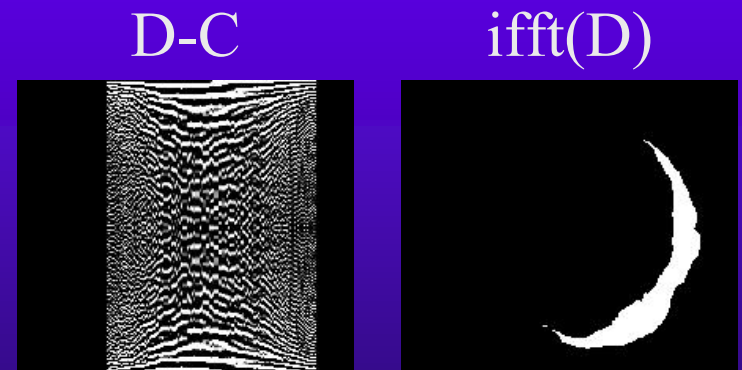
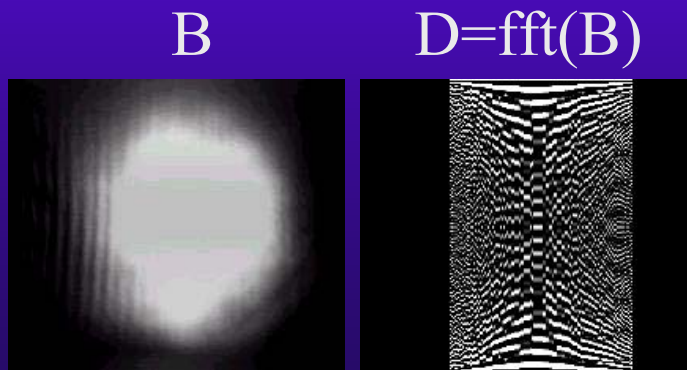
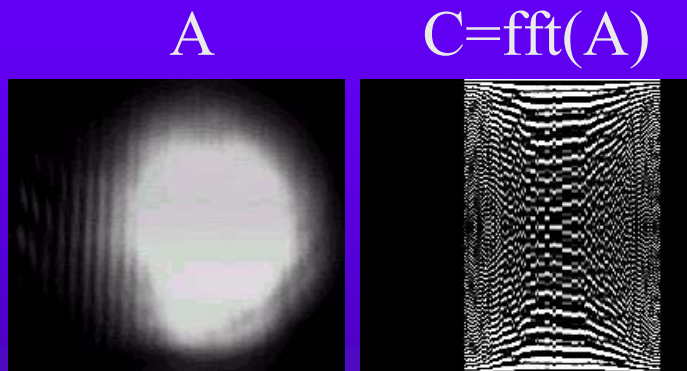


medfilt2

# Difference Image

IFO\_REFL

- ◆ Order of operations is important in accurately displaying which direction the beam needs to move





# Fourier Transform vs. Simple Math

## Simple Subtraction of Images

- ◆ Ignores intensity dependence
- ◆ Reduces number of steps in image processing
- ◆ Does not expedite script

## Fourier Transform

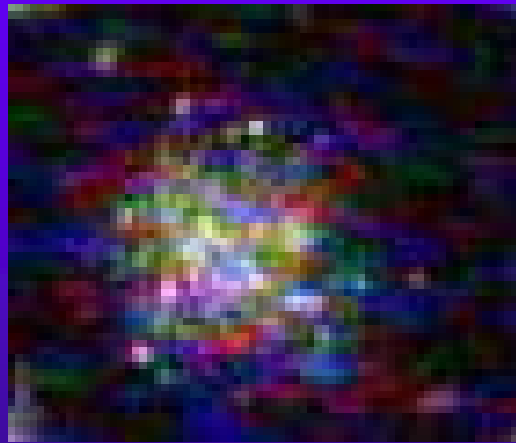
- ◆ Prevents having to calibrate the intensity
- ◆ Produces sharper image



For Example

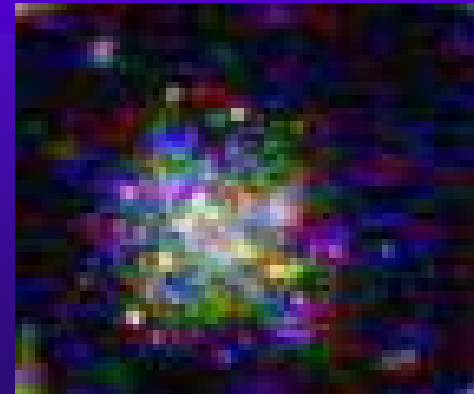
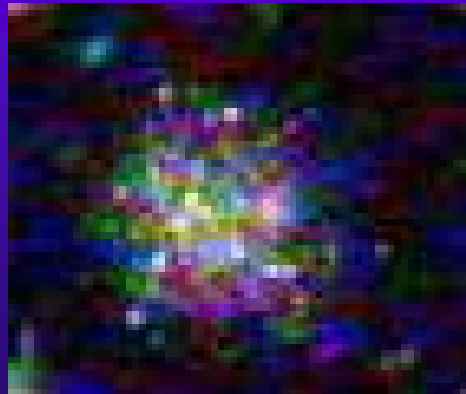
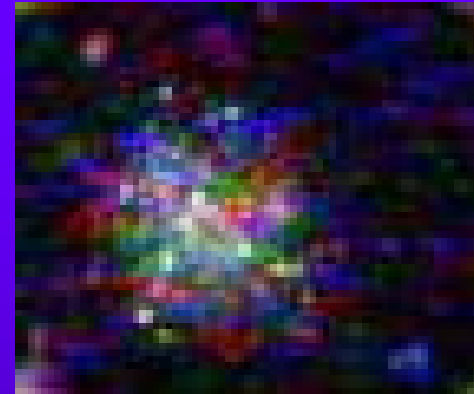
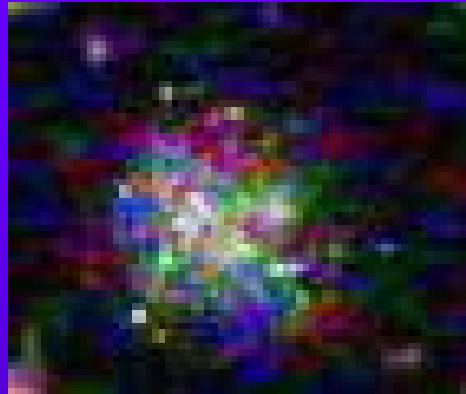
ETMY (single arm)

◆ Reference Image



# Cont. Example

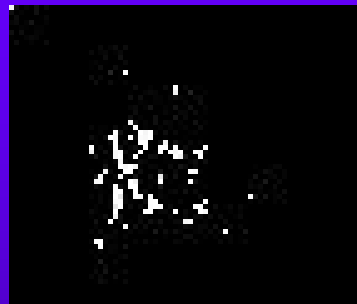
ETMY (single arm)



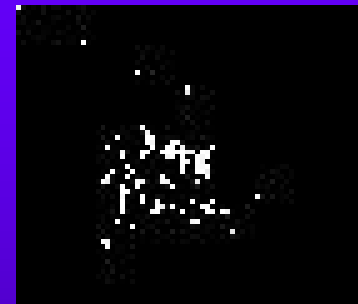
# Quantitative and Qualitative Representations of Misalignment



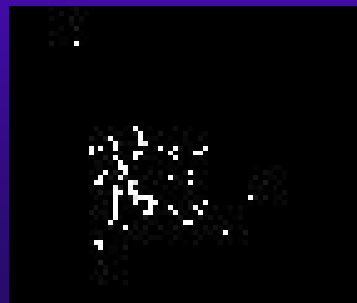
CORRELATION=79.62



CORRELATION=83.46



CORRELATION=85.17



CORRELATION=86.5



# CONCLUSION

- ◆ Fourier transform method successfully displays misalignment of beam relative to reference image during initial alignment
- ◆ Develop beam center method that will be useful in monitoring drift of beam on optics
- ◆ Data collected during S3 will determine extent if any to which beams on optics drift
- ◆ Study correlations of beam position on AS\_PD with data quality

