Optimizing Blocker Usage on NIF using Image Analysis and Machine Learning

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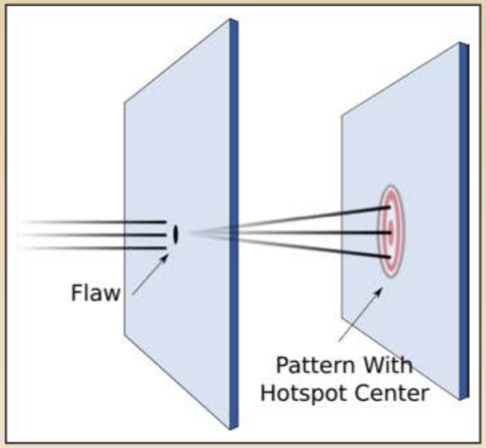
Image Analysis and Machine Learning identify hotspots of faraway flaws that require blocking

Diffraction ring "signature" imaged 8m from the camera confirms the presence of a flaw 17m from the camera



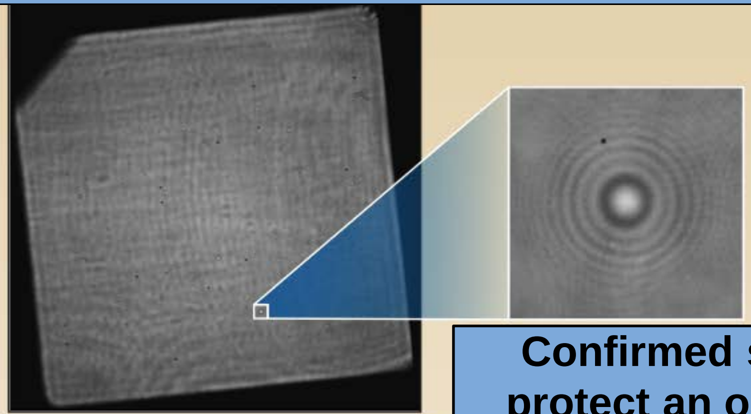
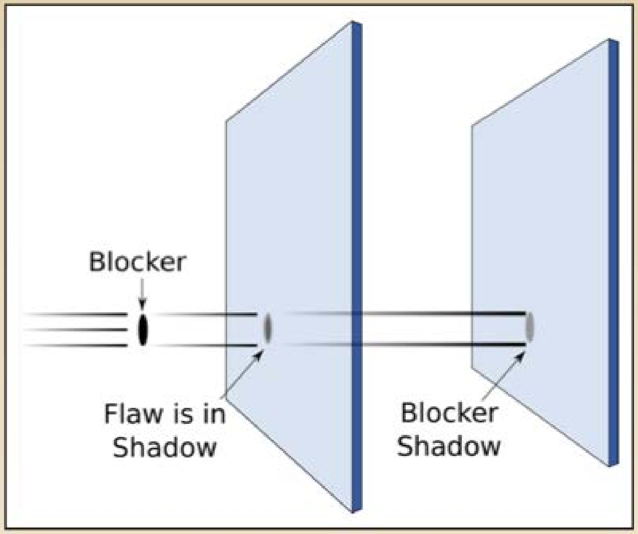


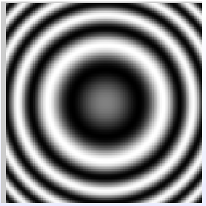
Image of a Wedge-Focus Lens (WFL), showing evidence of a flaw on an upstream optic

Confirmed sites can be blocked to protect an optic until it is repaired



This wave interaction equation predicts the "signature" ring pattern for relevant sites

$$I(r,R,z)=\frac{r^2+R\cdot J\left[1,\frac{2\pi rR}{\lambda\cdot z}\right]\left(R\cdot J\left[1,\frac{2\pi rR}{\lambda\cdot z}\right]-2r\sin\left[\frac{\pi r^2}{\lambda\cdot z}\right]\right)}{r^2}$$



z = distance from flaw to image plane (9.6 m)
r = distance of image pixel from pattern center (110 um/pixel)
R = defect radius (150 microns)
λ = light wavelength (1053 nm)
J[1,x] = Bessel equation of the first kind

The ideal template is used to find candidate locations for hotspots; candidates are measured and dozens of features extracted.

We used semi-supervised learning to create an ensemble of decision trees

10-fold cross validation: 99% false alarm rejection;
98% True Positive detection

Machine learning distinguishes sites of interest from false alarms so the most relevant sites for blocking are brought forward