Toward Sub-wavelength Spatial Resolution in VISAR Interferogram Analysis

Image Sciences (CASIS) Workshop 2017 *David J. Erskine* LLNL

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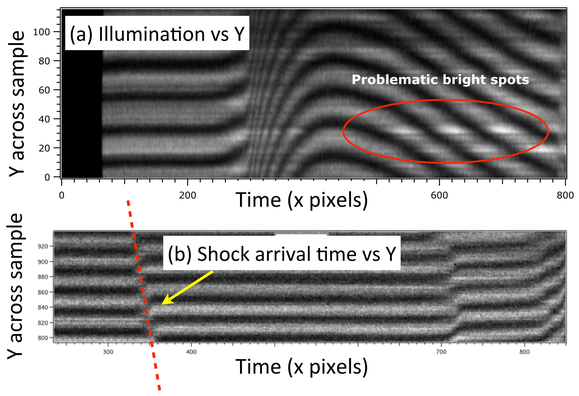
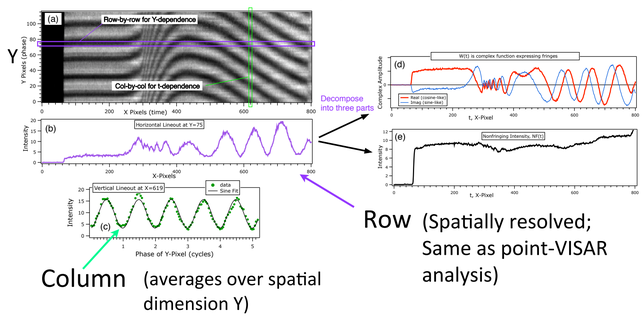
INTRODUCTION

Spatial resolution along slit needed to more accurately measure Y-dependent shock behaviors, including target granularity, nonplanar shock loading, irregular illumination



Two styles of analysis, by columns, or by rows

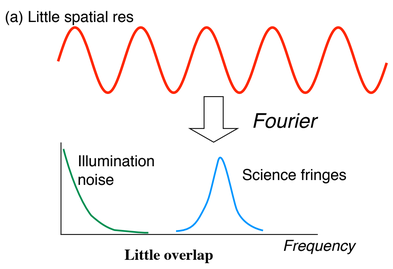


(Spatially resolved; Same as point-VISAR analysis)

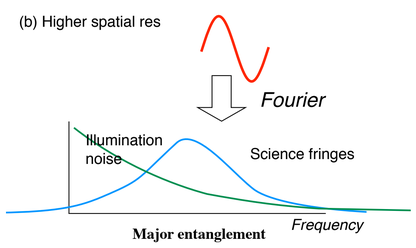
(averages over spatial dimension Y)

Traditional col-by-col Fourier method ill-suited for high spatial resolution, due to uncertainty principle and use of fringes deliberately splayed along Y

Fourier not well-suited for localization



Uncertainty principle broadens peaks, entanglement with illum noise increased



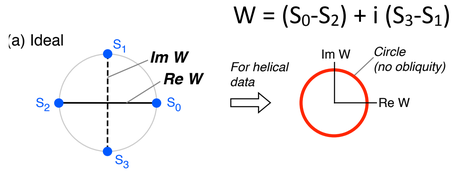
We optimize a row-by-row method toward achieving a spatial resolution FINER than one fringe along Y. We achieve good results with real data and synthetic data.

METHOD

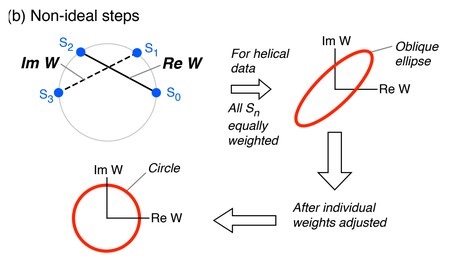
New: "**sub-wave**" analysis produces better spatial resolution than usual "full-wave"

$W = (S_0 - S_2) + i\,(S_3 - S_1)$

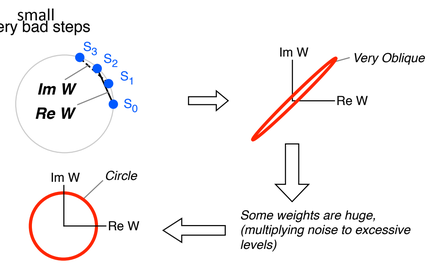
Full-wave
(90 degree spacing)



Sub-wave
uses < 90 degree



very-Subwave



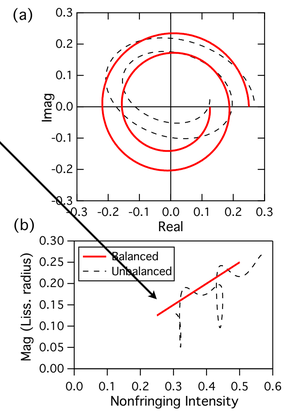
Spatial resolution improved,
but pixel noise expected to increase

Individual row gains are adjusted. Data is corrected when Lissajous is circular, or more precisely, when Mag vs Inten plot is linear

Mag vs inten plot is key litmus test for centration

Gains adjusted to circularize the Lissajous

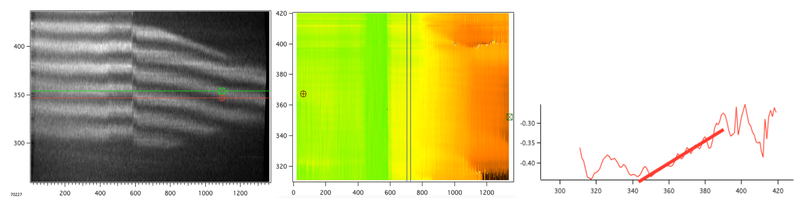
this linearizes the Mag vs Inten



Mag vs Inten is linear only when EVERY type of distortion (of at at least four modes) is zero. Hence it is a good litmus test.

RESULTS

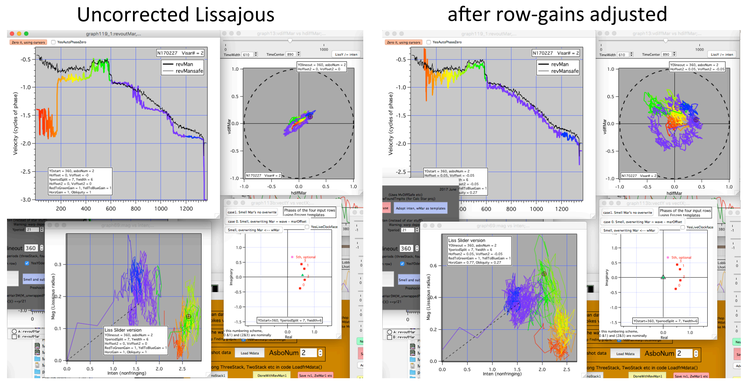
Test on NIF data (mild spatial dependence)



Example of (~1/3) sub-wave on NIF data

Uncorrected Lissajous

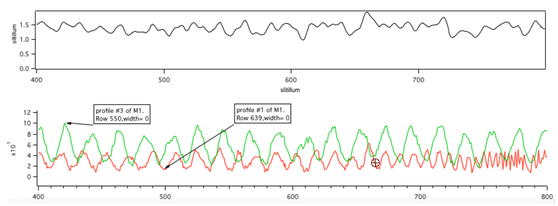
Lissajous more circular after row-gains adjusted



The rainbow (subwave) phase vs time curve parallels the black curve (fullwave) in right panel set, indicating success

Test on synth data (severe spatial dependence)

Synthetic data included "speckle noise" or variation in slit illumination

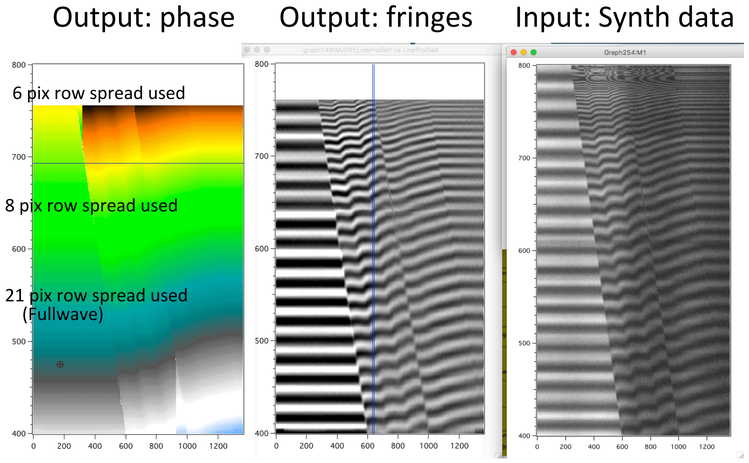


Slit illum noise freqs similar to science frequencies (can't simply filter it away)

Post-shock (red) has different apparent period than pre-shock (green) due to Y-dependent physics

Simulation result

Output: phase Output: fringes Input: Synth data



http://**spectralfringe.org/EDI/MyPubs4/SCCM2017proc.pdf**
Future 2017 SCCM Proceedings

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REFERENCES

D. Erskine, "Speckle-adaptive VISAR fringe analysis technique," in *19th Biennial APS Conference on Shock Compression of Condensed Matter*, *American Institute of Physics Conference Series* 1793, p. 160017, Jan. 2017.

D. Erskine, J. Eggert, P. Celliers, and D. Hicks, "Ghost fringe removal techniques using Lissajous data presentation," in *19th Biennial APS Conference on Shock Compression of Condensed Matter*, *American Institute of Physics Conference Series* 1793, p. 160016, Jan. 2017.