

Synthesis Imaging

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Synthesis Imaging

- Angular resolution of collector = $\frac{1.22\lambda}{D}$

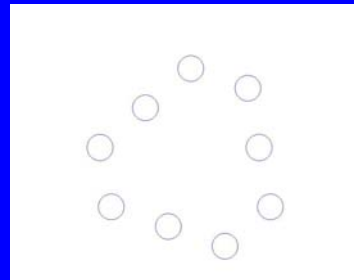


COAST

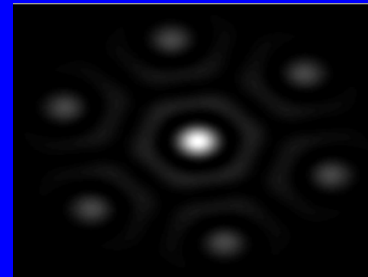
- SBD spatial freq sampling by VCZ
- PSF \otimes SBD = Image (Incoherent)



AV platform



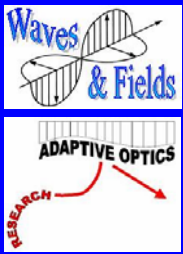
9 Aperture array



PSF



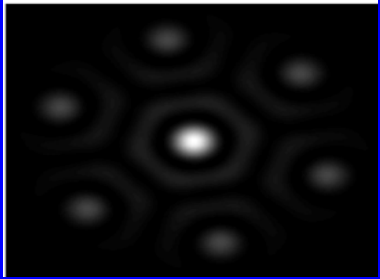
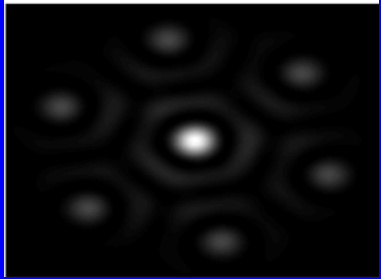
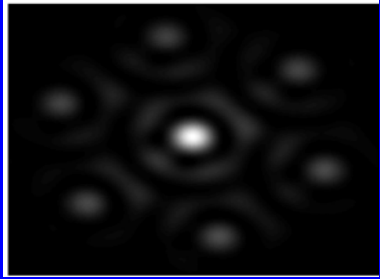
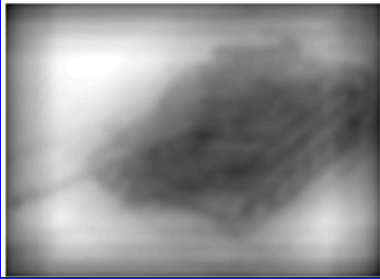
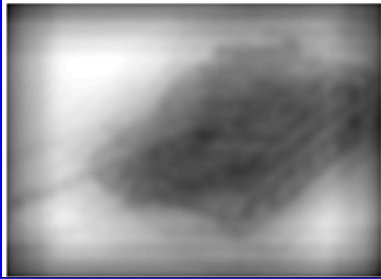
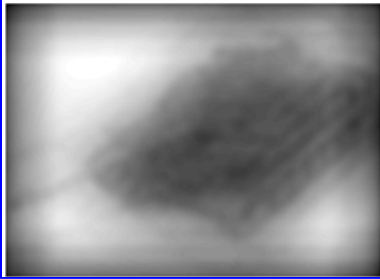
SBD



Reconstruction Simulations without Phase Calibration

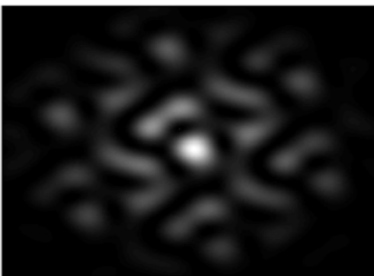
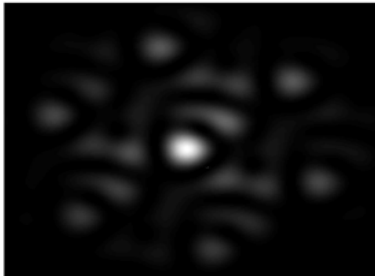

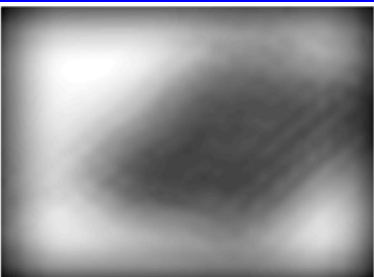
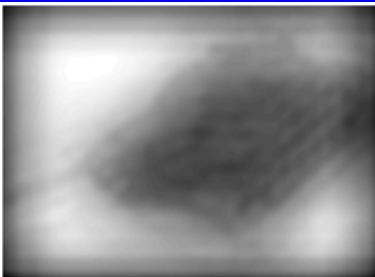
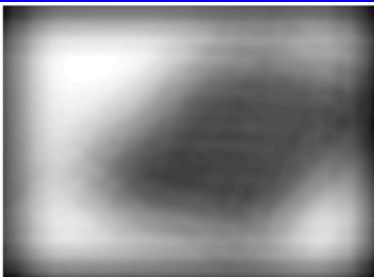


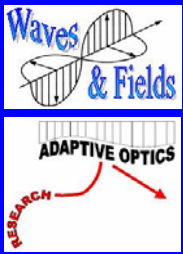
- 9 aperture array

Phase variance	0 waves	0.1	0.25
PSF			
Reconstructed Image			

Reconstruction Simulations

- 9 aperture array (cont)

Phase variance	0.5 waves	0.75	1
PSF			
Reconstructed Image			

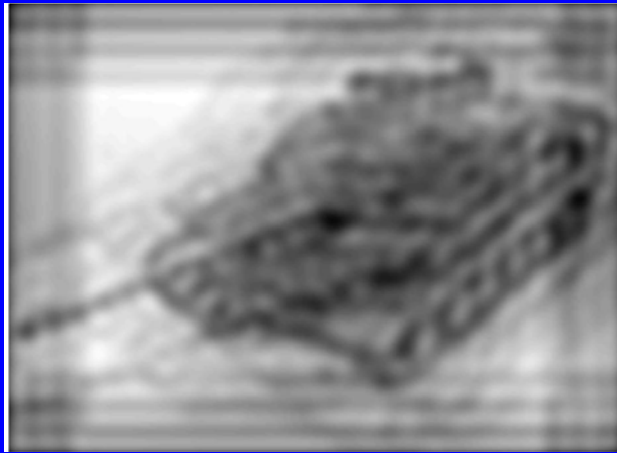


Lucky Imaging

- Depending on atmosphere statistics a certain proportion of snapshots will be of better than average quality
- Computer selection of lucky snapshot
 - MTF does not change for non-redundant arrays

Reconstruction Simulations

- Deconvolution of redundancy bias
 - Images above for zero phase variance are considerably improved as excess frequency components removed
 - Practicalities of the deconvolution process may render it unavailable for real-time imaging



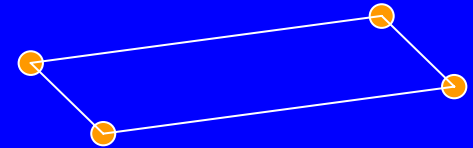
9 aperture array



21 aperture array

Calibration

- Redundant Spacings Calibration (RSC)
 - Sampling same frequency should yield identical answer, any difference is due to phase errors.



$$N(N-1)/2 + N$$

Unknowns

$$N(N-1)/2$$

Measurements

3

Disposable parameters define a plane

$$N - 3$$

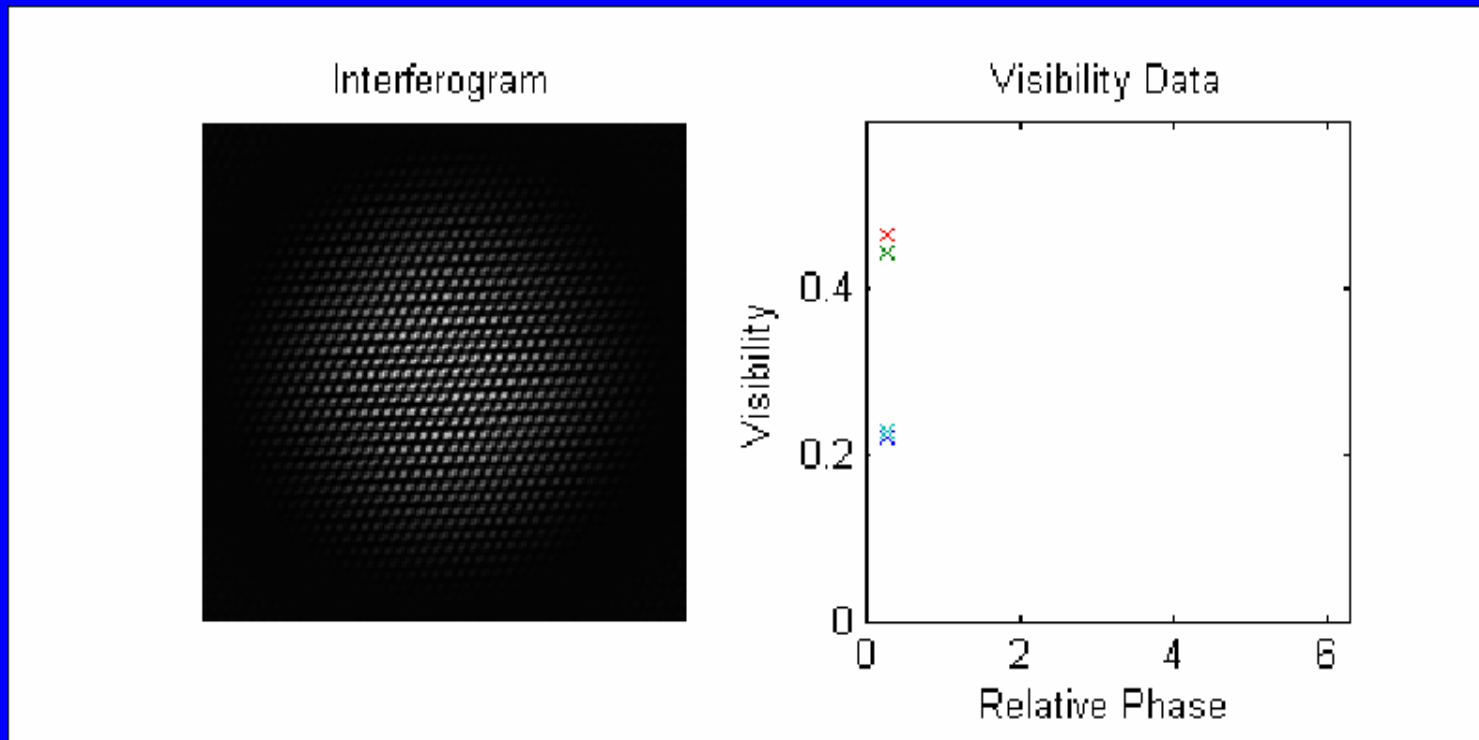
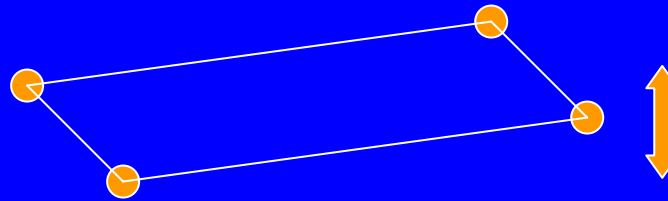
Redundant baseline measurements

$$\psi'_{a,b} = \psi_{a,b} + k\xi_{a,b} \cdot \beta$$

1	0	0	0	0	0	1	-1	0	0	$\psi'_{1,2}$	$\phi_{1,2}$
0	1	0	0	0	0	1	0	-1	0	$\psi'_{1,3}$	$\phi_{1,3}$
0	0	1	0	0	0	1	0	0	-1	$\psi'_{1,4}$	$\phi_{1,4}$
0	0	0	1	0	0	0	1	-1	0	$\psi'_{2,3}$	$\phi_{2,3}$
0	0	0	0	1	0	0	1	0	-1	$\psi'_{2,4}$	$\phi_{2,4}$
0	0	0	0	0	1	0	0	1	-1	$\psi'_{3,4}$	$\phi_{3,4}$
1	0	0	0	0	0	0	0	0	0	kl_1	0
0	1	0	0	0	0	0	0	0	0	kl_2	0
0	0	0	0	0	0	0	1	0	0	kl_3	0
1	0	0	0	0	-1	0	0	0	0	kl_4	0

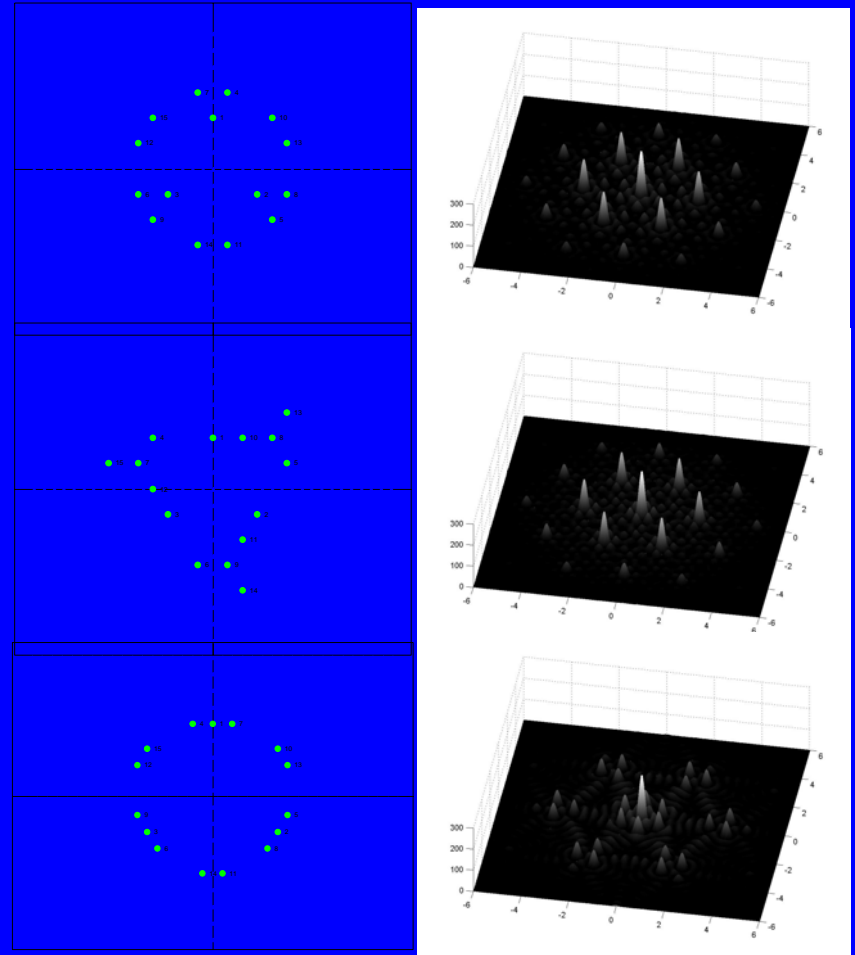
Solve for object phases by robust matrix inversion

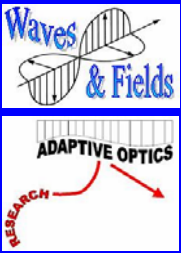
Calibration



Array Design

- Array design
 - Self-calibrating RSC
 - Full Rank array
 - Efficient u-v sampling
 - 2-Metric of binned area coverage against general MTF of scene
 - Suppression of grating responses
 - Steering of PSF envelope null





Passive vs Active Imaging

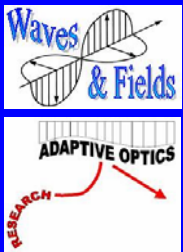
- Active Imaging
 - Flux for object recognition achievable

$$p \square \frac{-4hcN^2 R^2}{q\lambda ad^2 \ln(S) |O(\xi)|^2}$$

- Telescopy possible

$$\int o(r) e^{-ikr.\xi} dr \Rightarrow \int o(r) (\cos(kr.\xi) - i \sin(kr.\xi)) dr$$

- Passive Imaging
 - Flux low



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