DECOMPOSITION THEOREMS

[S]

COHERENT DECOMPOSITION

E. KROGAGER (1990)

W.L. CAMERON (1990)

[K]

TARGET DICHOTOMY

J.R. HUYNEN (1970)

R.M. BARNES (1988)

[T] [C]

AZIMUTHAL SYMMETRY

EIGENVECTORS BASED DECOMPOSITION

MODEL BASED DECOMPOSITION

S.R. CLOUDE (1985)

W.A. HOLM (1988)

A.J. FREEMAN (1992)

EIGENVECTORS / EIGENVALUES ANALYSIS & MODEL BASED DECOMPOSITION

J.J. VAN ZYL (1992)

EIGENVECTORS / EIGENVALUES ANALYSIS ENTROPY / ANISOTROPY

S.R. CLOUDE - E. POTTIER (1996-1997)

COHERENT

TARGET DECOMPOSITION

→ ERNST KROGAGER (1990)

COHERENT DECOMPOSITION

ERNST KROGAGER

(1990)

DECOMPOSITION

$[S]$ → THREE COHERENT COMPONENTS

$$[S]=\begin{bmatrix} a+b & c \\ c & a-b \end{bmatrix}=e^{j\phi}\left\{k_S[S_S]+e^{j\phi_R}\left(k_D[S_D]+k_H[S_H]\right)\right\}$$

SINGLE BOUNCE SCATTERING

DOUBLE BOUNCE SCATTERING

HELICAL SCATTERING

COHERENT DECOMPOSITION

$$[S] = e^{j\phi}\left\{ k_S \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + e^{j\phi_R}\left(k_D \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} + \frac{k_H}{2} \begin{bmatrix} 1 & \pm j \\ \pm j & -1 \end{bmatrix} \right) \right\}$$

ROTATION AROUND THE RADAR LINE OF SIGHT

$$[U] = \begin{bmatrix} \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \cos(\theta) \end{bmatrix}$$

$$\begin{aligned} [S(\theta)] &= [U]^T [S][U] \\ &= e^{j\phi}\left\{ k_S \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + e^{j\phi_R}\left(k_D \begin{bmatrix} \cos(2\theta) & \sin(2\theta) \\ \sin(2\theta) & -\cos(2\theta) \end{bmatrix} \cdots \right.\right. \\ &\qquad \left.\left. \cdots + \frac{k_H e^{\mp j2\theta}}{2} \begin{bmatrix} 1 & \pm j \\ \pm j & -1 \end{bmatrix} \right) \right\} \end{aligned}$$

COHERENT DECOMPOSITION

$$[S] = e^{j\phi}\begin{bmatrix} k_S + e^{j\phi_R}\left\{k_D\cos(2\theta) + \frac{k_H}{2}\right\} & e^{j\phi_R}\left\{k_D\sin(2\theta) \pm j\frac{k_H}{2}\right\} \\ e^{j\phi_R}\left\{k_D\sin(2\theta) \pm j\frac{k_H}{2}\right\} & k_S - e^{j\phi_R}\left\{k_D\cos(2\theta) + \frac{k_H}{2}\right\} \end{bmatrix}$$

$$\underline{k} = \sqrt{2}e^{j\phi}\left[k_S \quad e^{j\phi_R}\left\{k_D\cos(2\theta) + \frac{k_H}{2}\right\} \quad e^{j\phi_R}\left\{k_D\sin(2\theta) \pm j\frac{k_H}{2}\right\}\right]^T$$

$$\underline{k} = \sqrt{2}k_S e^{j\phi}\begin{bmatrix}1\\0\\0\end{bmatrix} + k_H e^{j(\phi+\phi_R)}\frac{1}{\sqrt{2}}\begin{bmatrix}0\\1\\\pm j\end{bmatrix} + \sqrt{2}k_D e^{j(\phi+\phi_R)}\begin{bmatrix}0\\\cos(2\theta)\\\sin(2\theta)\end{bmatrix}$$

COHERENT DECOMPOSITION

SINGLE SCATTERING CONTRIBUTION

$$k_S = \sqrt{A_0} \qquad [S_S] = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

DOUBLE SCATTERING CONTRIBUTION

$$k_D = \sqrt{B_0 - |F|} \qquad [S_D] = \begin{bmatrix} \cos(2\theta) & \sin(2\theta) \\ \sin(2\theta) & -\cos(2\theta) \end{bmatrix}$$

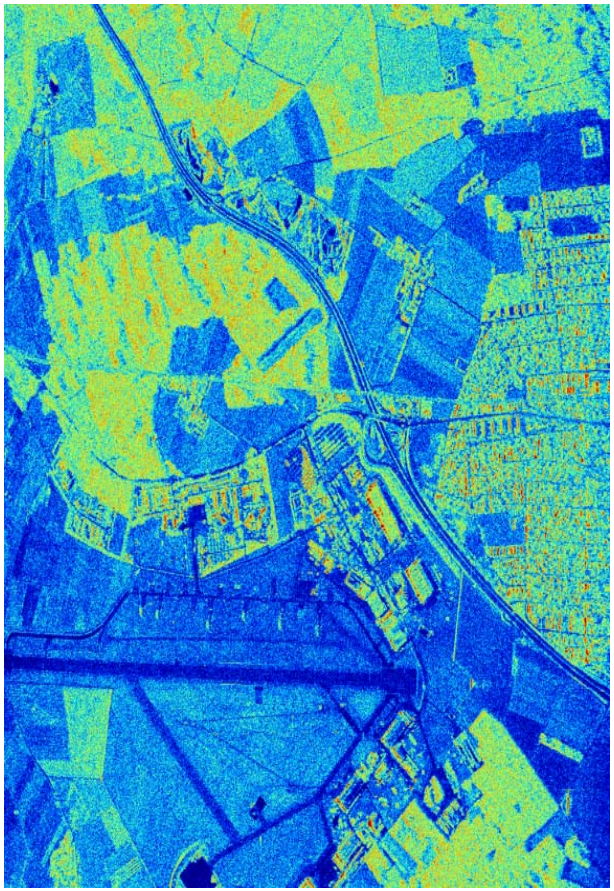
$$\tan(4\theta) = \frac{E}{B}$$

DIPLANE ORIENTATION ANGLE
INSIDE THE TARGET

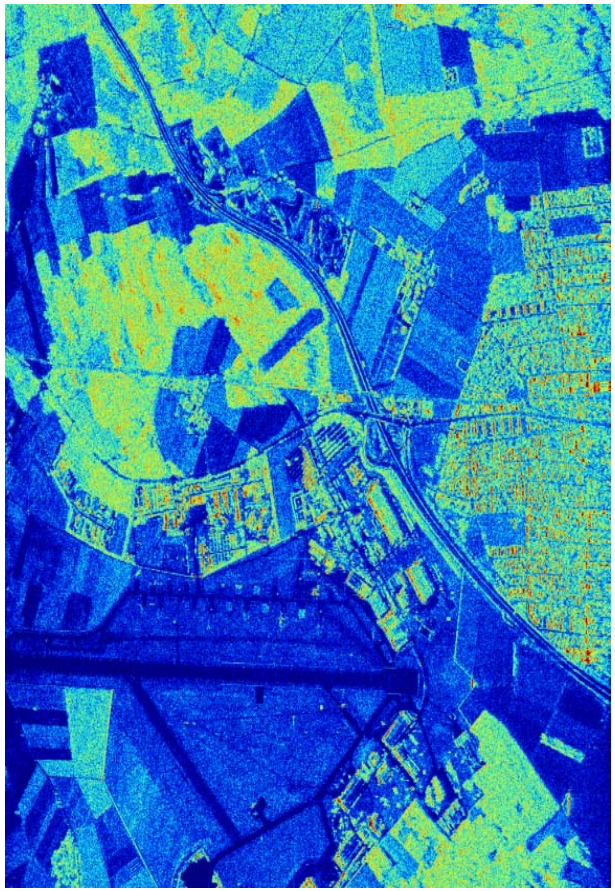
HELICAL SCATTERING CONTRIBUTION

$$k_H = \sqrt{B_0 + |F|} - \sqrt{B_0 - |F|} \qquad [S_H] = \frac{1}{2}\begin{bmatrix} 1 & \pm j \\ \pm j & -1 \end{bmatrix}$$

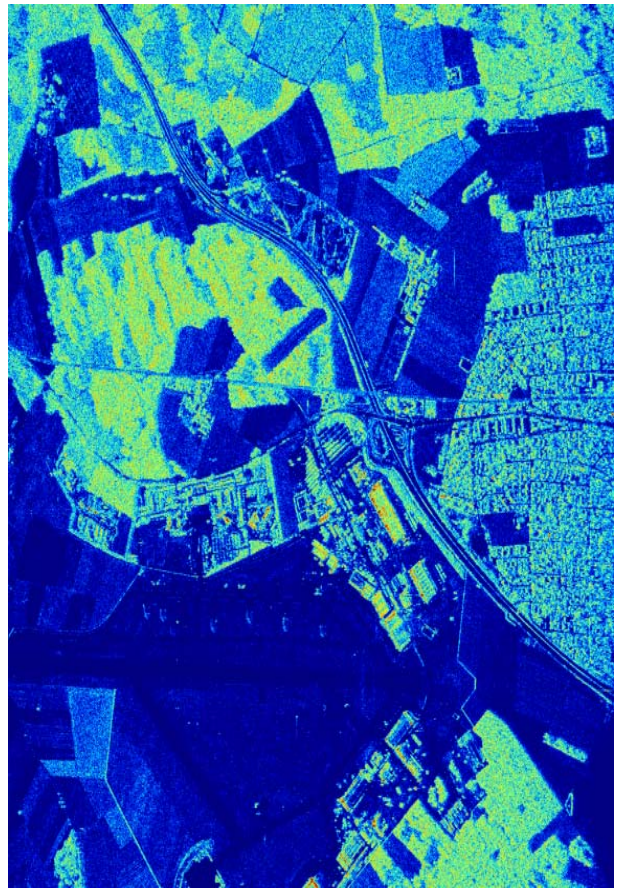
COHERENT DECOMPOSITION



$(2A_0)_{dB}$

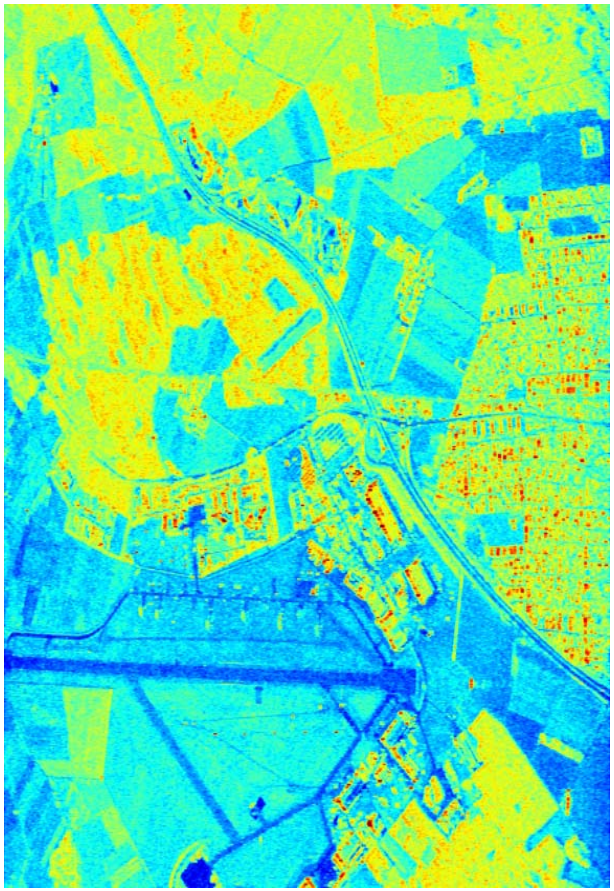


$(B_0 + B)_{dB}$

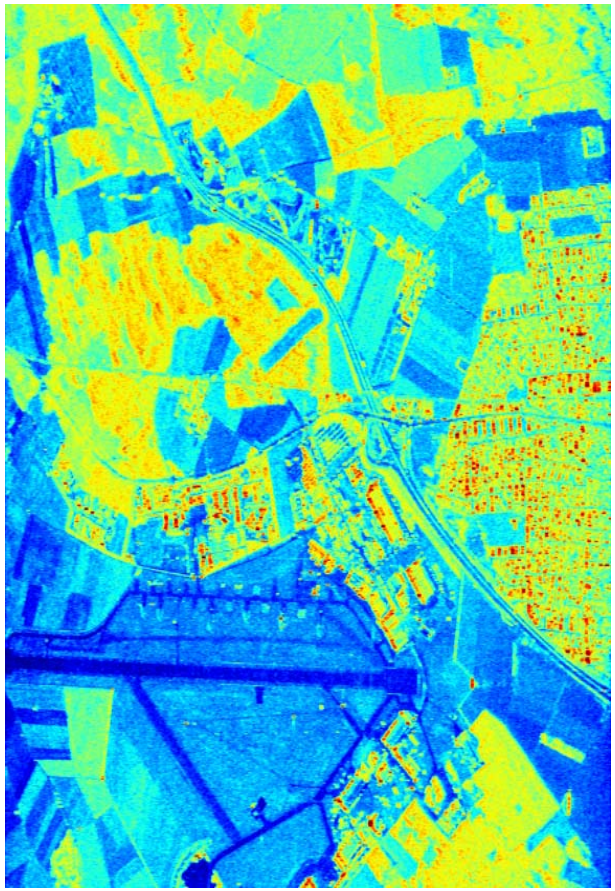


$(B_0 - B)_{dB}$

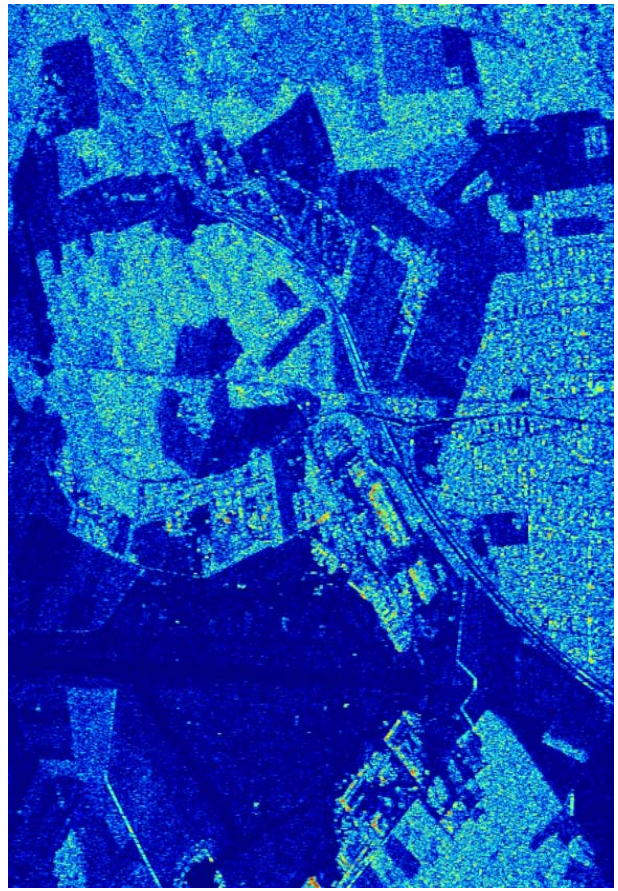
COHERENT DECOMPOSITION



$(k_S)_{dB}$



$(k_D)_{dB}$



$(k_H)_{dB}$

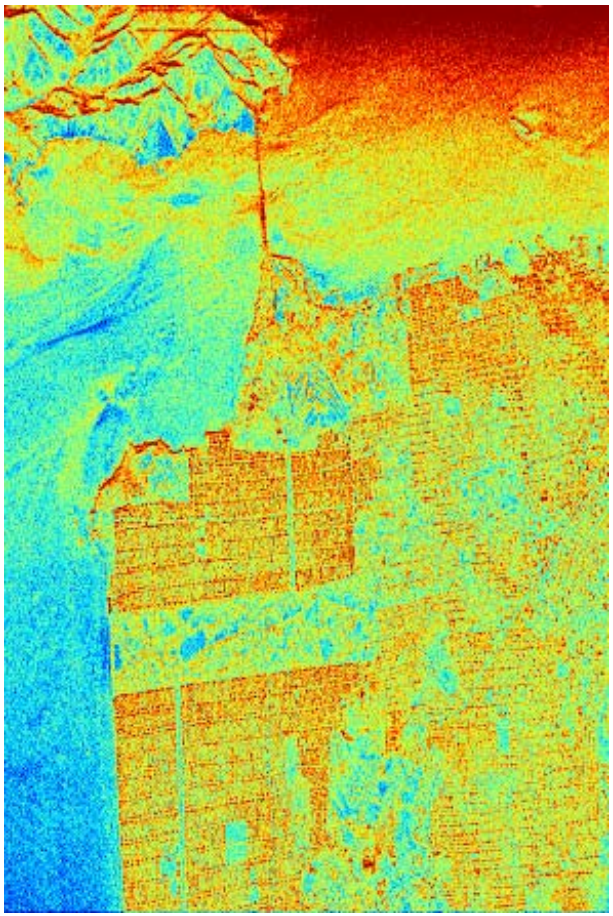
-10dB 5dB 20dB

COHERENT DECOMPOSITION

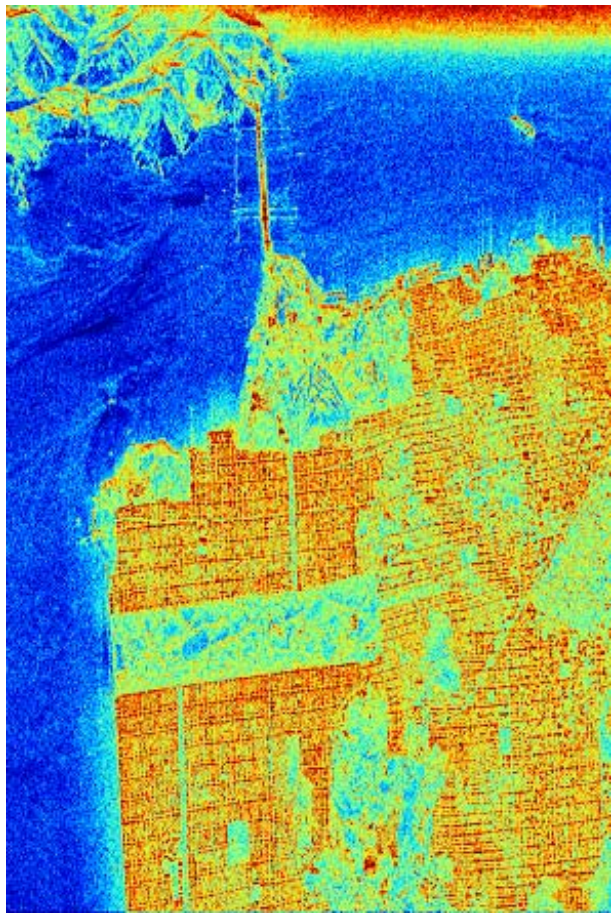
$2A_0$ $B_0 + B$ $B_0 - B$

k_S k_D k_H

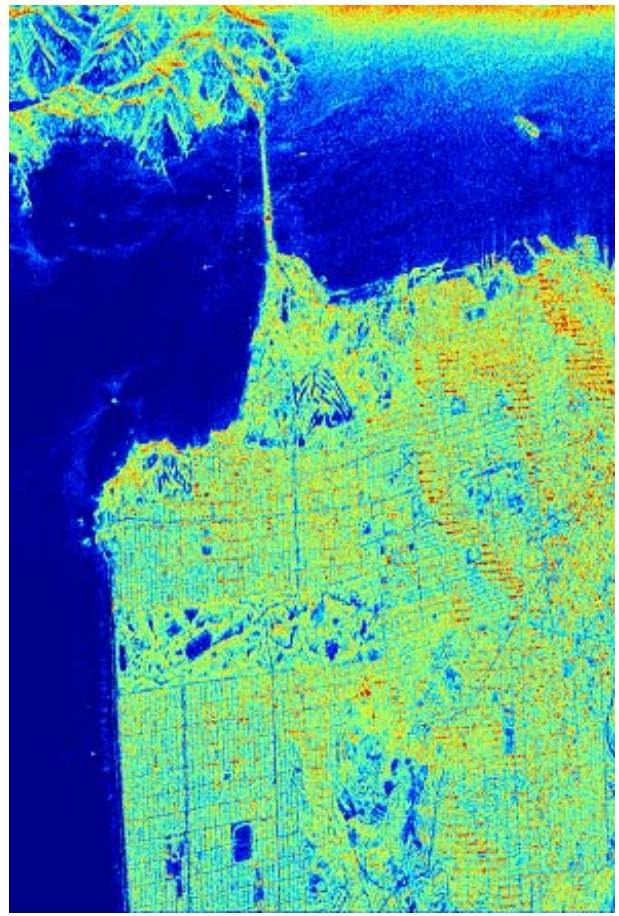
COHERENT DECOMPOSITION



$(2A_0)_{dB}$



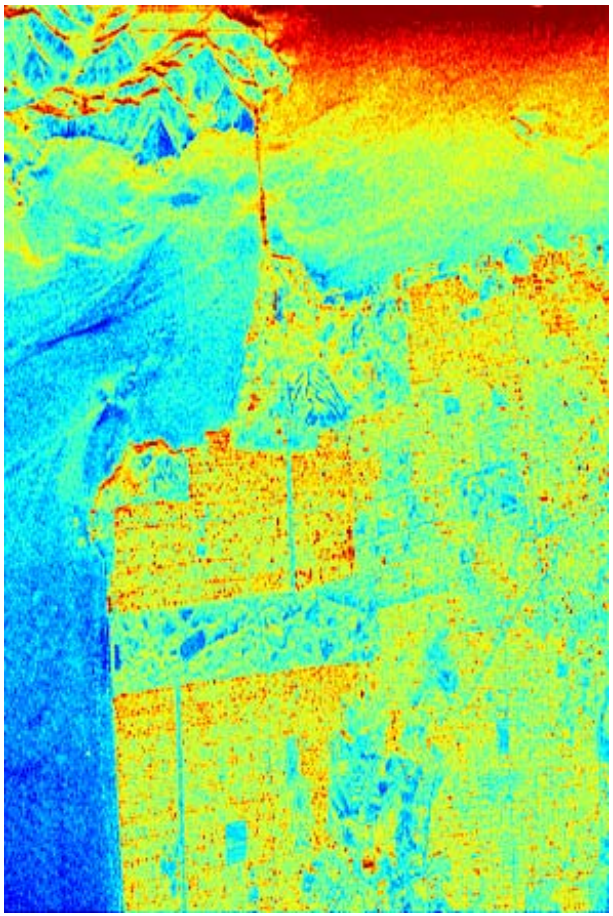
$(B_0 + B)_{dB}$



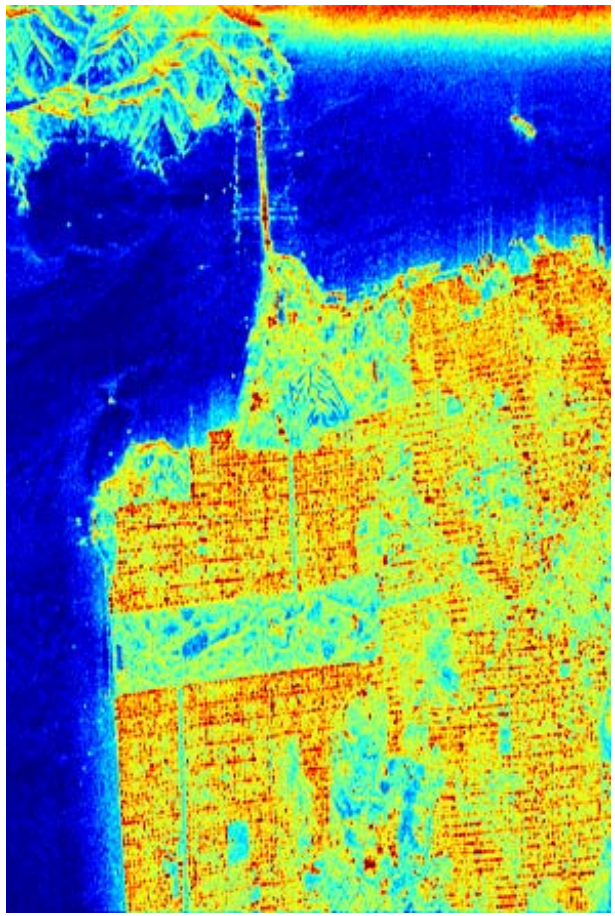
$(B_0 - B)_{dB}$

-30dB -15dB 0dB

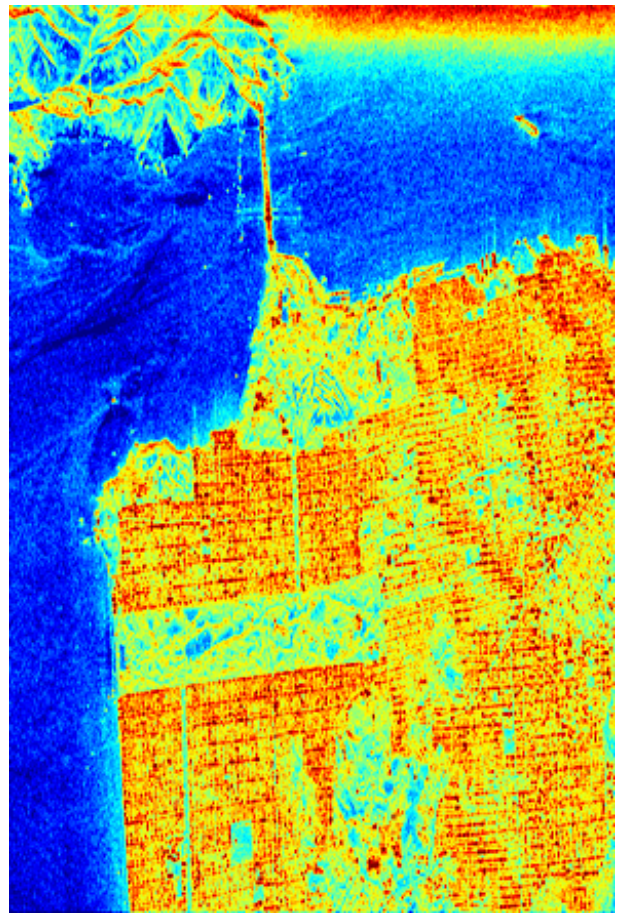
COHERENT DECOMPOSITION



$(k_S)_{dB}$



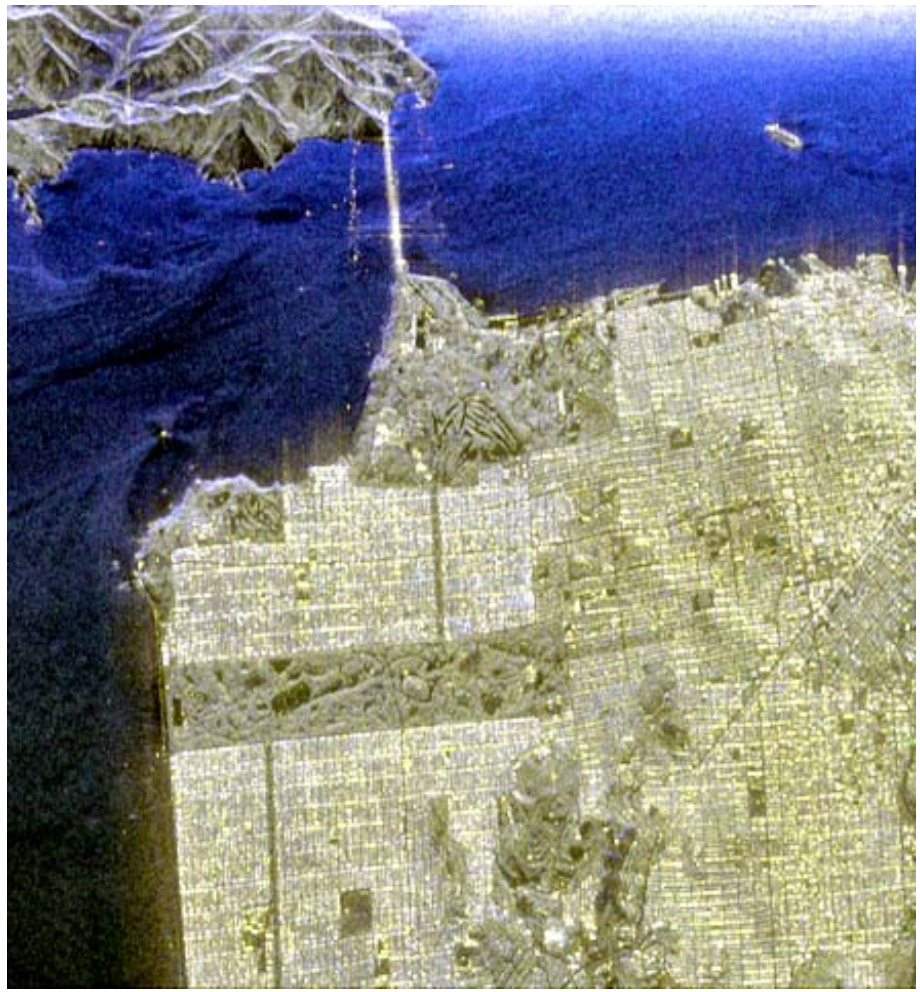
$(k_D)_{dB}$



$(k_H)_{dB}$

-30dB -15dB 0dB

COHERENT DECOMPOSITION



$2A_0$ $B_0 + B$ $B_0 - B$ k_S k_D k_H

COHERENT DECOMPOSITION

$$\underline{k} = \sqrt{2}k_S e^{j\phi}\begin{bmatrix}1\\0\\0\end{bmatrix} + k_H e^{j(\phi+\phi_R)}\frac{1}{\sqrt{2}}\begin{bmatrix}0\\1\\\varepsilon j\end{bmatrix} + \sqrt{2}k_D e^{j(\phi+\phi_R)}\begin{bmatrix}0\\\cos(2\theta)\\\sin(2\theta)\end{bmatrix}$$

EIGENVECTORS OF $[U_{3R}(\phi)]$ (ROLL INVARIANCE)

➡ NO ORTHOGONALITY OF THE TARGETS COMPONENTS

➡ COHERENT DECOMPOSITION and SPECKLE FILTERING ?