Brad Artman

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Spring Review 2005

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Passive Spy vs. Spy

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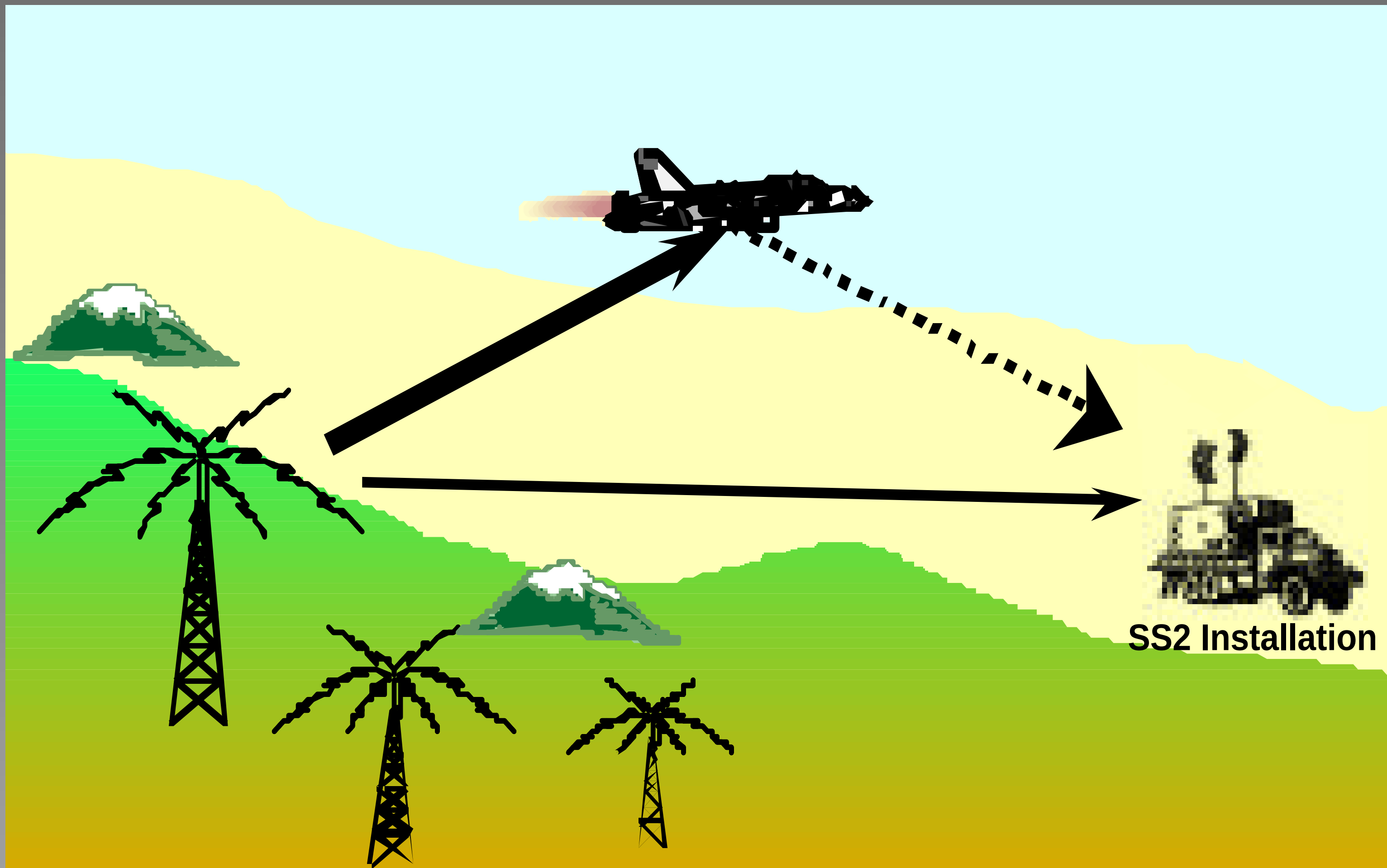


2004

- *Fourier domain imaging condition & migration aliasing*
- Fourier domain time windowing
- Gather convolution
- Foward-scattered angle gathers
- Valhall data
- 100% accurate $\omega - k$ propagator
- Combined Linear/Hyperbolic radon transforms

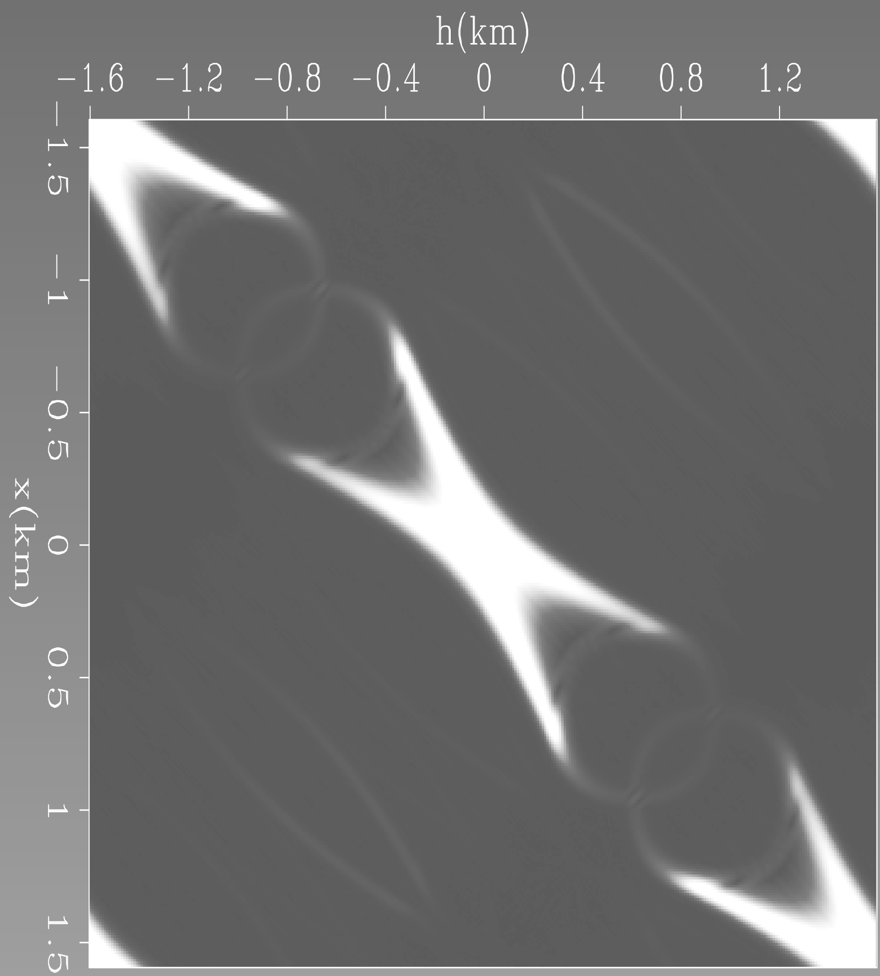
FDIC & aliasing

$$I(x,h)|_{\omega,z} = U(x+h)\, D^*(x-h)$$

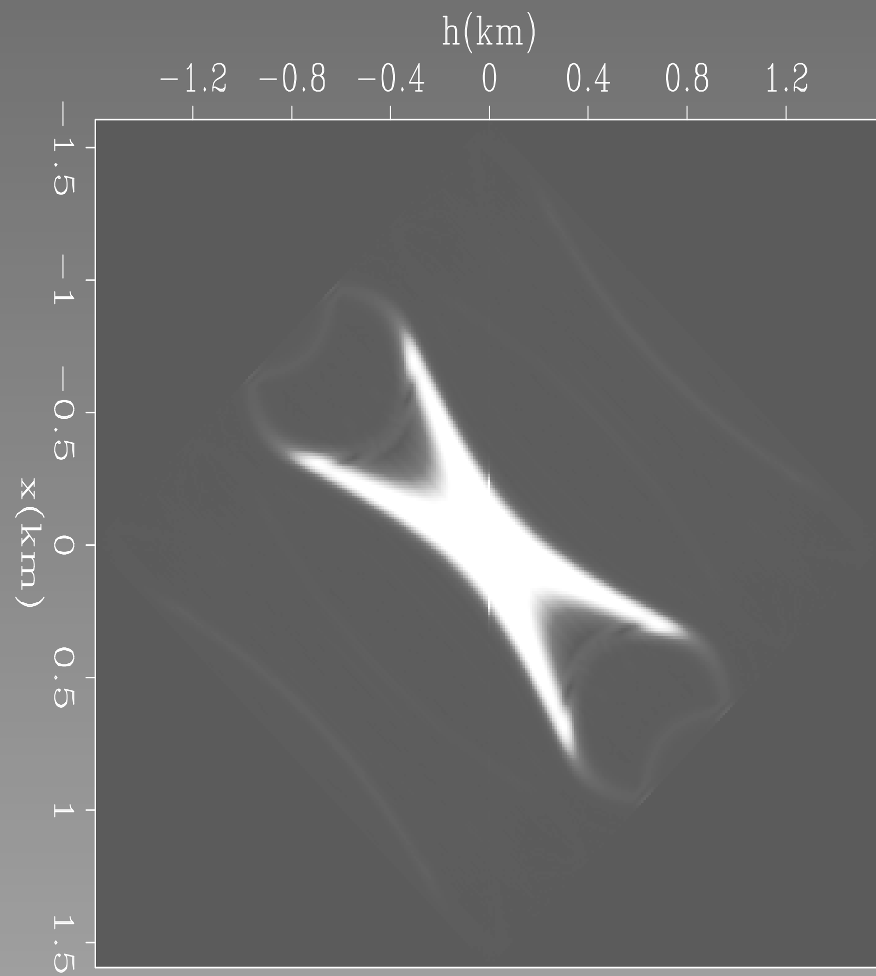
$$\widehat{I}(k_x,k_h)|_{\omega,z} = \frac{1}{2}\hat{U}\left(\frac{k_x+k_h}{2}\right)\,\hat{D}^*\left(\frac{k_x-k_h}{2}\right)$$

derivation

FDIC & aliasing

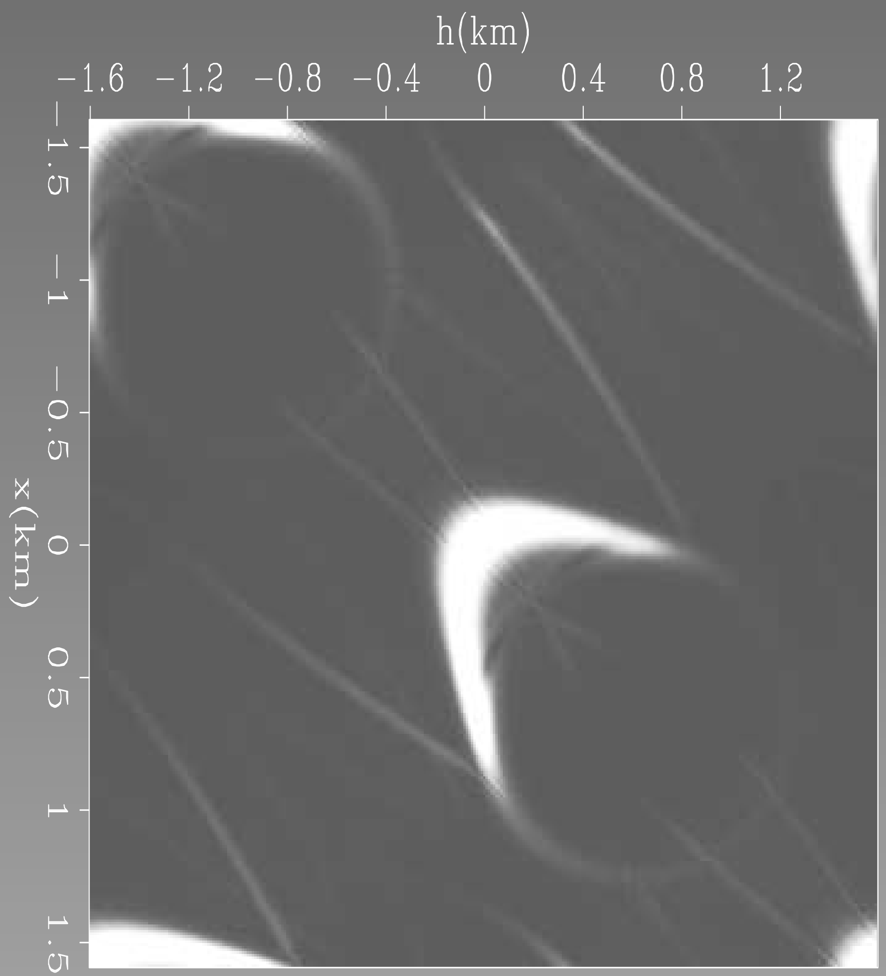


Fourier domain

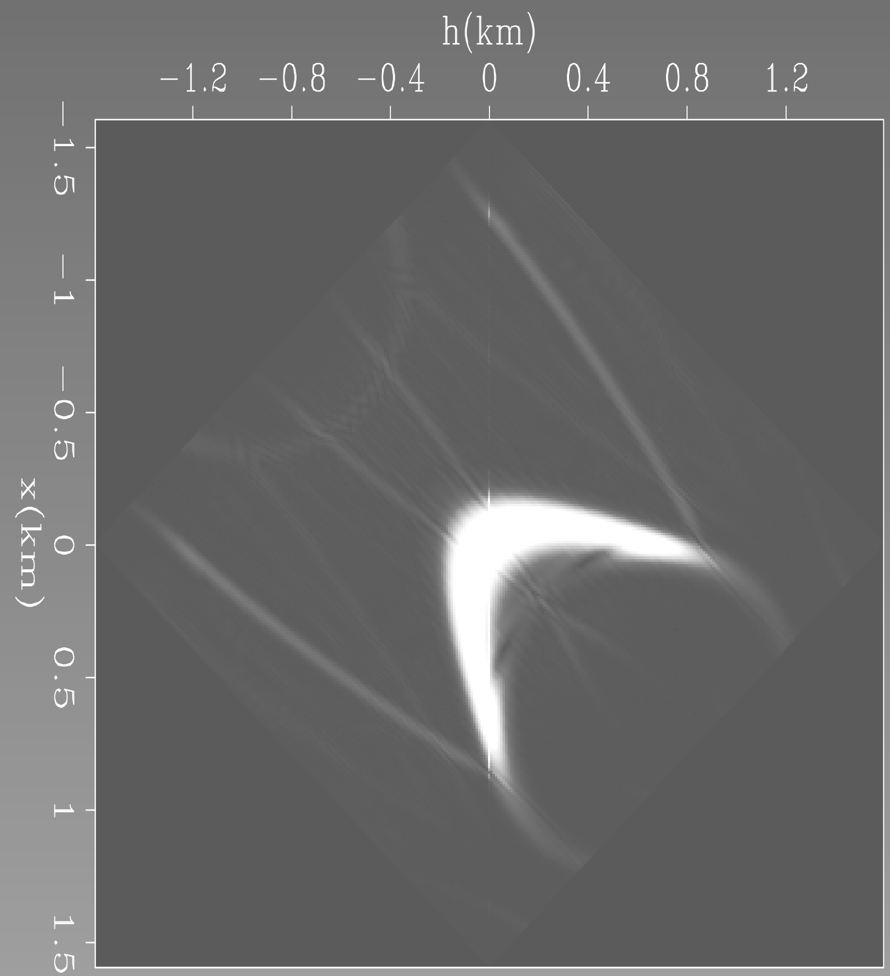


Space domain

FDIC & aliasing

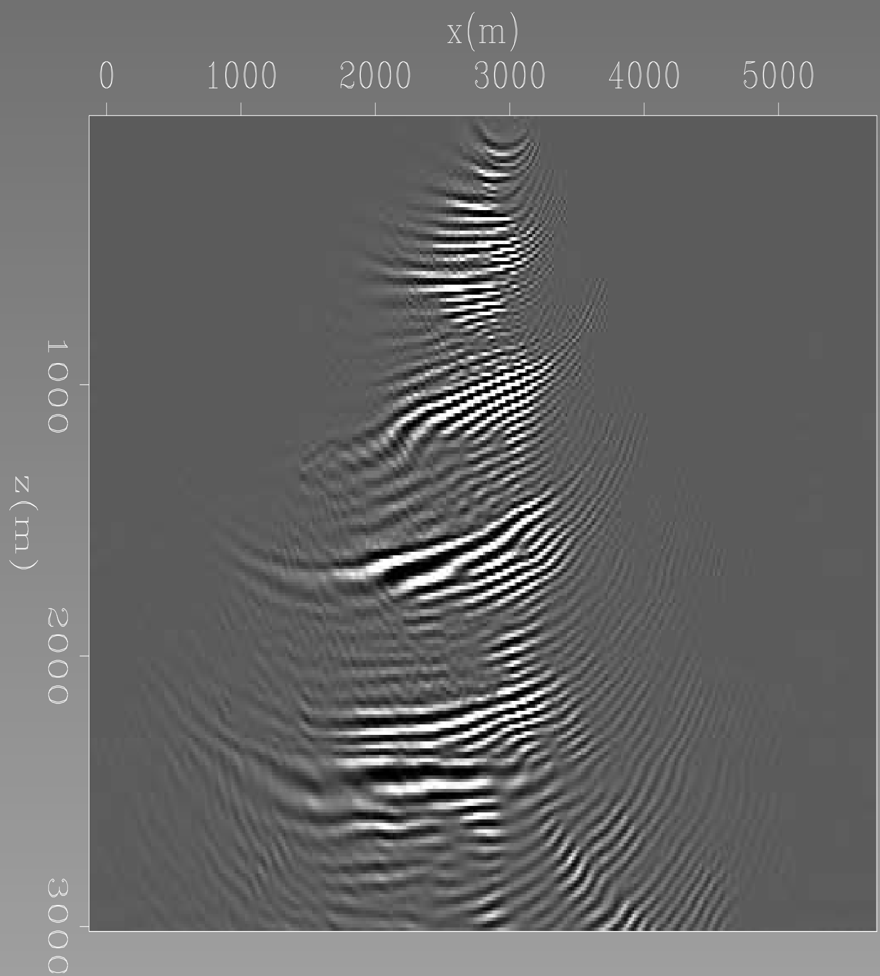


Fourier domain

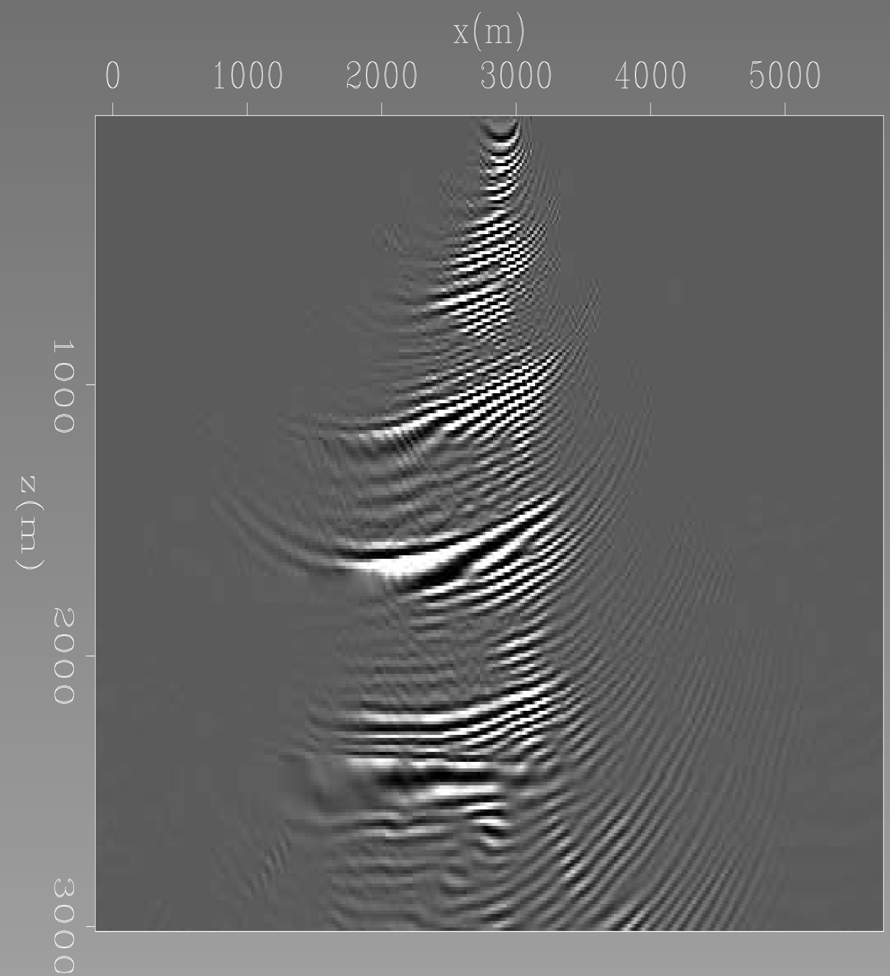


Space domain

FDIC & aliasing

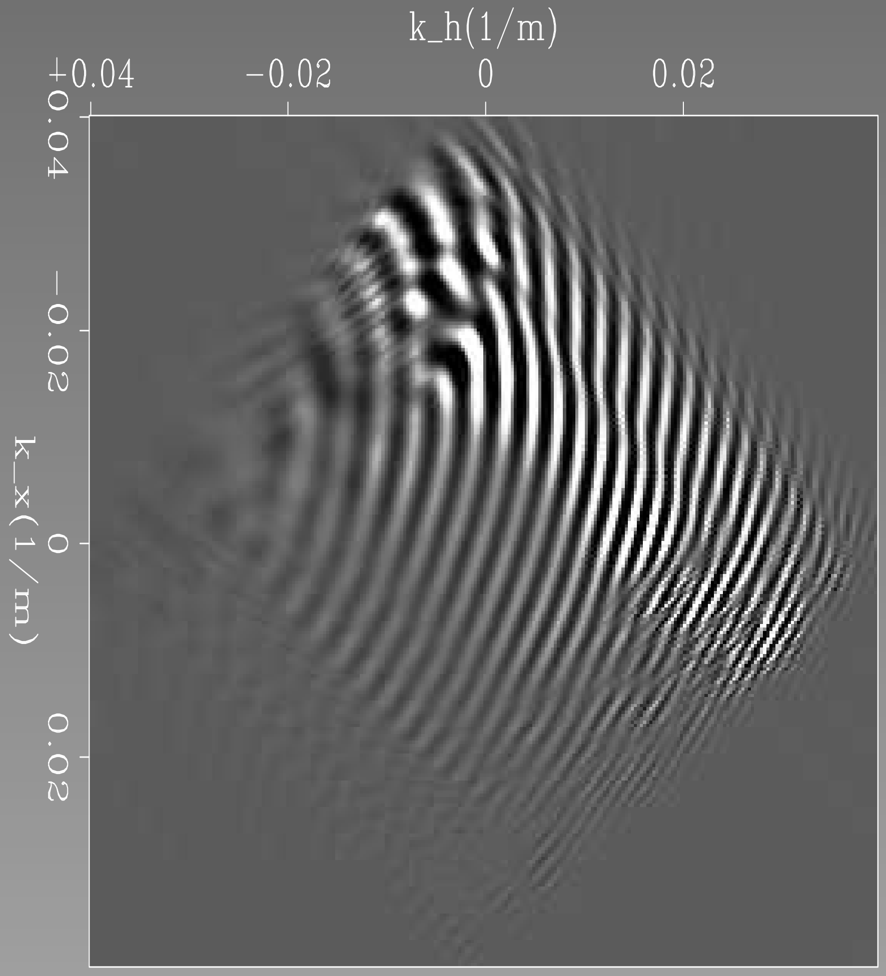


Fourier domain

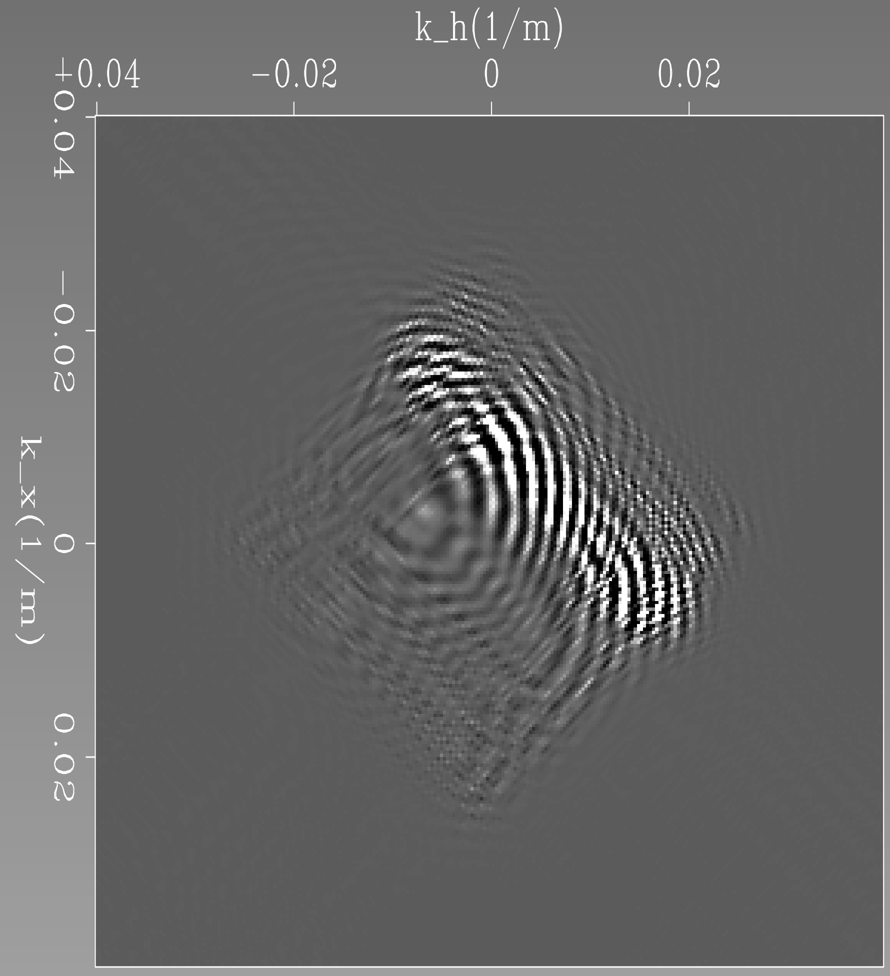


Space domain

FDIC & aliasing

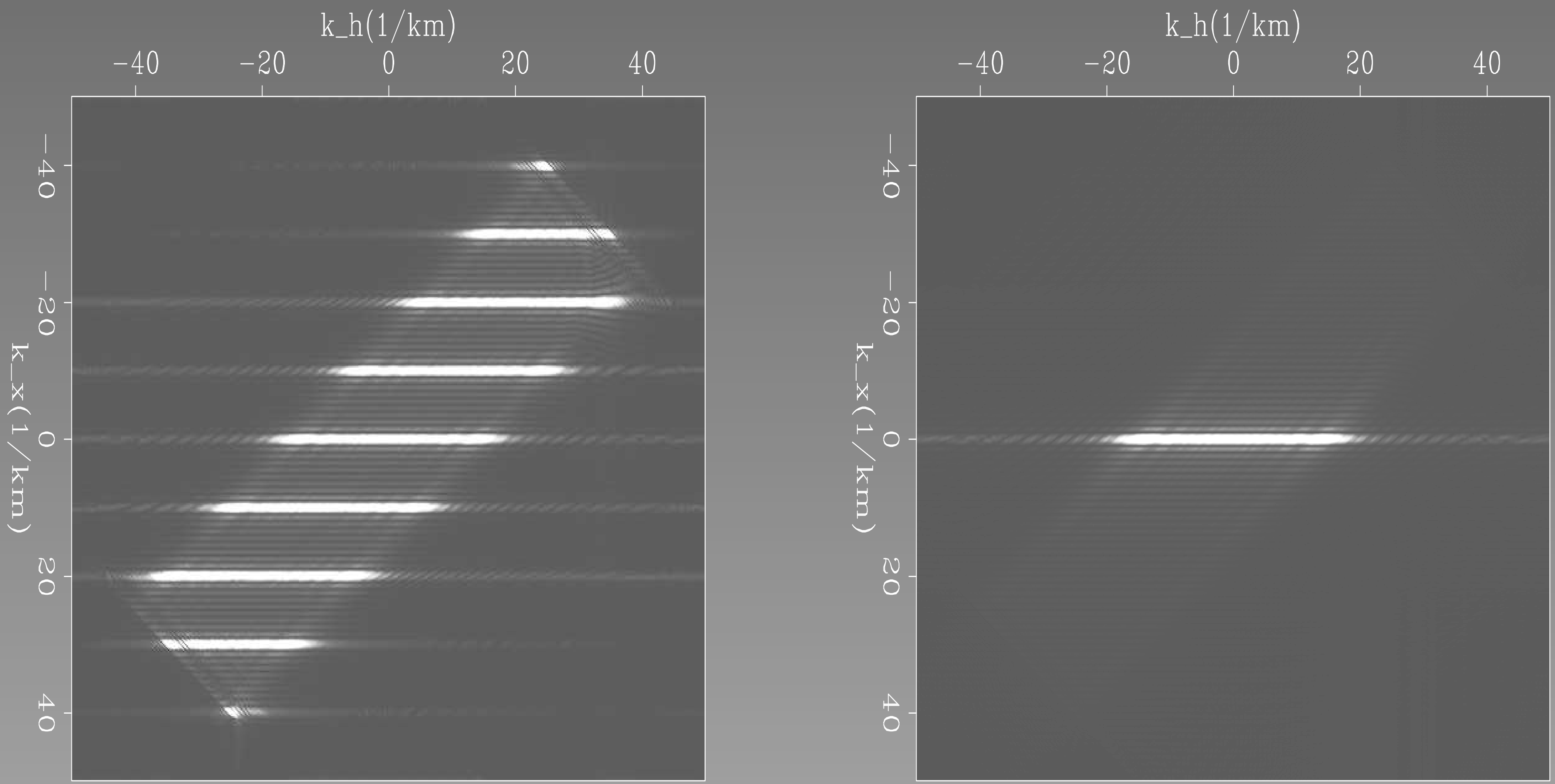


shallow



deep

FDIC & aliasing



every 10^{th} shot

all shots

FDIC & aliasing

$$\widehat{I}(k_x, k_h) = \frac{1}{2}\hat{U}\left(\frac{k_x + k_h}{2}\right)\hat{D}^*\left(\frac{k_x - k_h}{2}\right)$$

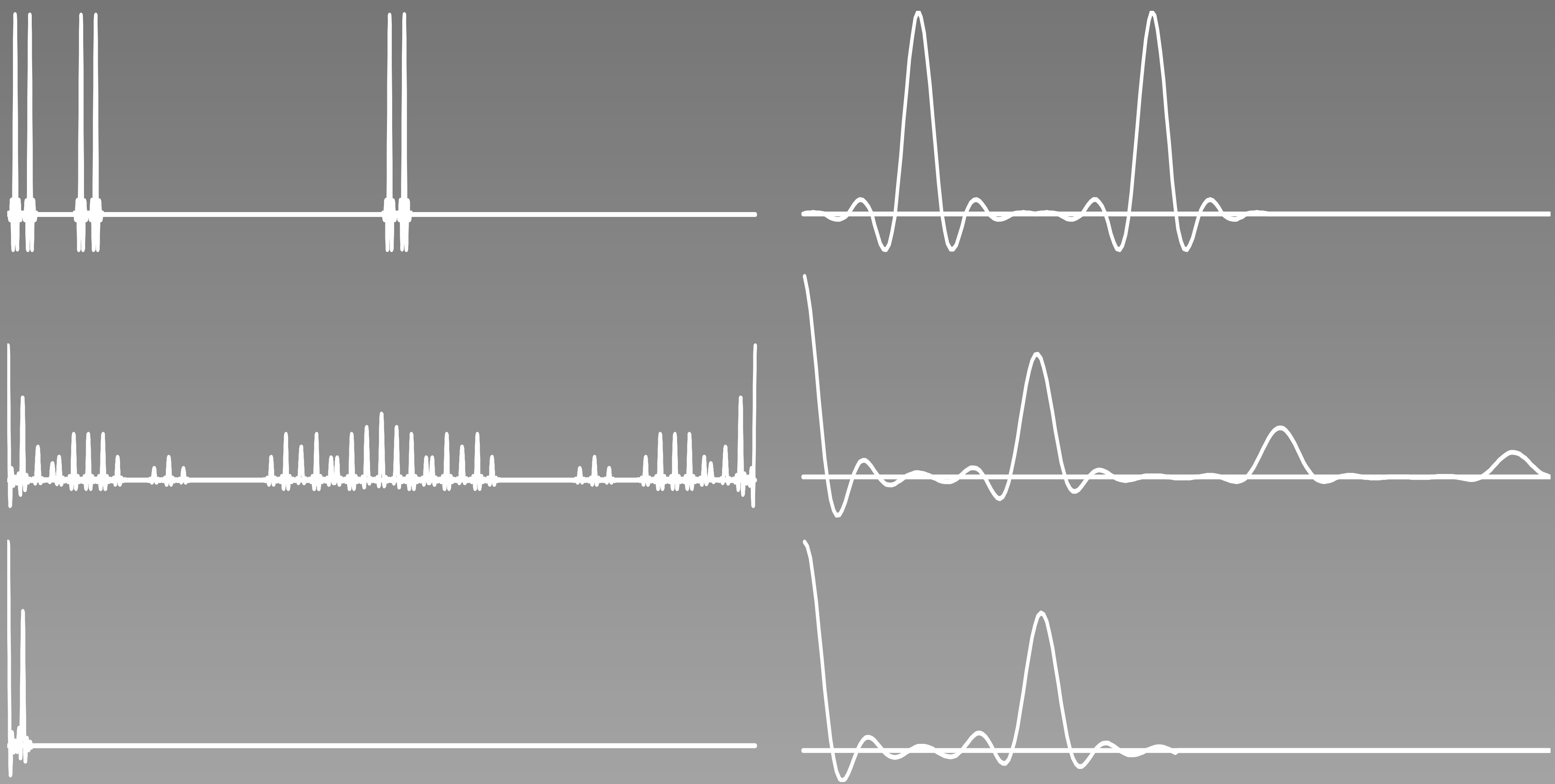
k_h

		-1	0	1
	-1	$\hat{U}(\frac{-2}{2})\hat{D}^*(0)$	$\hat{U}(\frac{-1}{2})\hat{D}^*(\frac{-1}{2})$	$\hat{U}(0)\hat{D}^*(\frac{-2}{2})$
k_x	0	$\hat{U}(\frac{-1}{2})\hat{D}^*(\frac{1}{2})$	$\hat{U}(0)\hat{D}^*(0)$	$\hat{U}(\frac{1}{2})\hat{D}^*(\frac{-1}{2})$
	1	$\hat{U}(0)\hat{D}^*(\frac{2}{2})$	$\hat{U}(\frac{1}{2})\hat{D}^*(\frac{1}{2})$	$\hat{U}(\frac{2}{2})\hat{D}^*(0)$
	2	$\hat{U}(\frac{1}{2})\hat{D}^*(\frac{3}{2})$	$\hat{U}(\frac{2}{2})\hat{D}^*(\frac{2}{2})$	$\hat{U}(\frac{3}{2})\hat{D}^*(\frac{1}{2})$

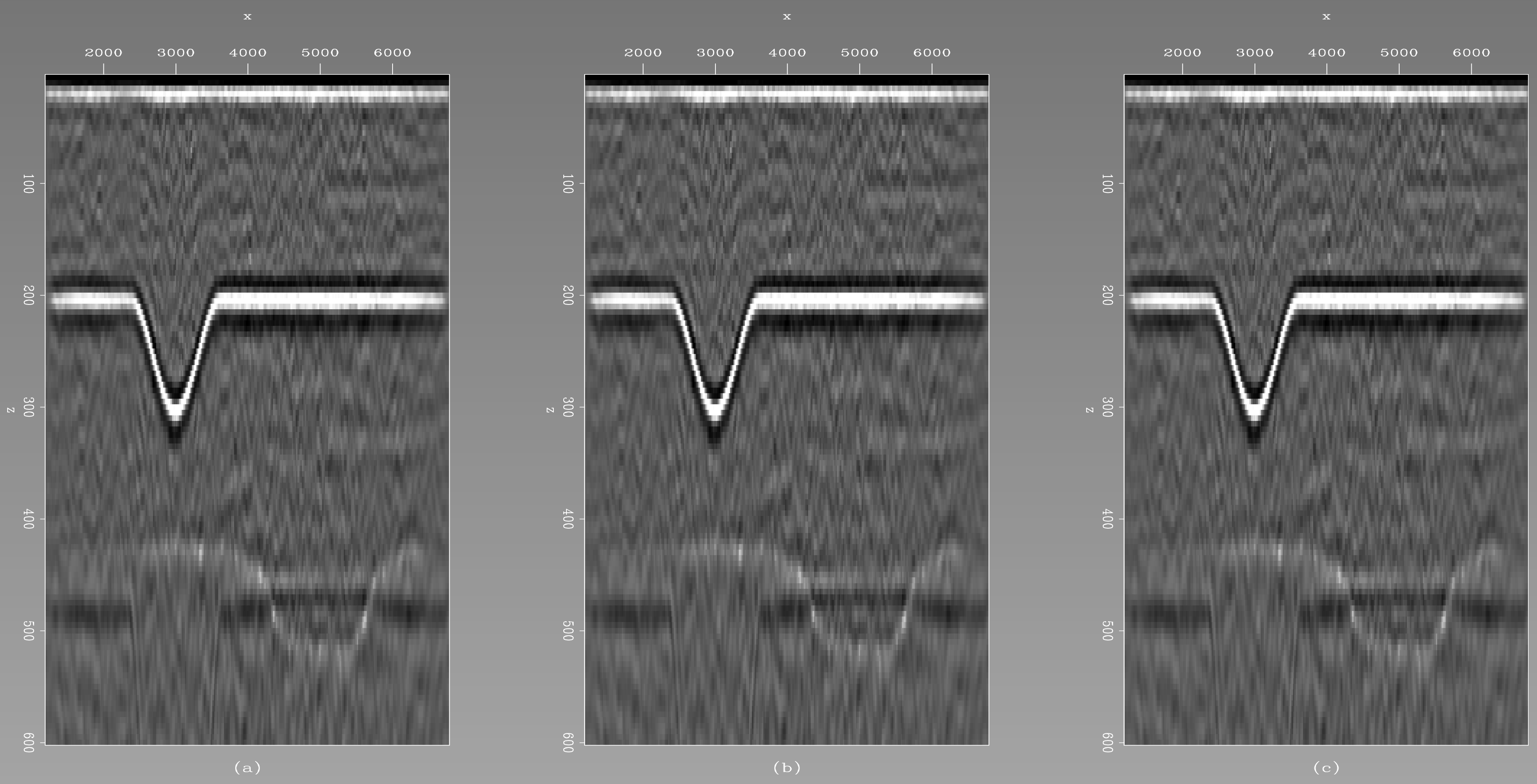
2004

- Fourier domain imaging condition & migration aliasing
- *Fourier domain time windowing*
- Gather convolution
- Foward-scattered angle gathers
- Valhall data

Fourier domain time windowing



Fourier domain time windowing



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Gather correlation

shot-profile	survey sinking	passive imaging

$$
\begin{array}{ccccccccc}
U_{z=0}(\mathbf{x_r},\mathbf{x_s},\omega) & \otimes & D_{z=0}(\mathbf{x_r},\mathbf{x_s},\omega) & \rightarrow & R_{z=0}(\mathbf{x_r},\mathbf{x_s},\omega) & \leftarrow & T_{z=0}(\mathbf{x_r},\omega) & \otimes & T_{z=0}(\mathbf{x_r},\omega) \\
| & & | & & | & & | & & | \\
\mathrm{SSR}^{-1} & & \mathrm{SSR}^{+1} & & \mathrm{DSR} & & \mathrm{SSR}^{-1} & & \mathrm{SSR}^{+1} \\
\downarrow & & \downarrow & & \downarrow & & \downarrow & & \downarrow \\
U_{z=1}(\mathbf{x_r},\mathbf{x_s},\omega) & \otimes & D_{z=1}(\mathbf{x_r},\mathbf{x_s},\omega) & \rightarrow & R_{z=1}(\mathbf{x_r},\mathbf{x_s},\omega) & \leftarrow & T^{-}_{z=1}(\mathbf{x_r},\omega) & \otimes & T^{+}_{z=1}(\mathbf{x_r},\omega)
\end{array}
$$

Gather correlation

Shot-profile=Source-receiver migration

$$
\begin{aligned}
R_{z+1} &= \mathrm{DSR}\; R_z = \mathrm{DSR}\; U_z D_z^* = \\
&= \mathrm{SSR}\; U_z\; \mathrm{SSR}\; D_z^* = \\
&= \mathrm{SSR}\; U_z\; (\mathrm{SSR}^{-1}\; D_z)^* = U_{z+1} D_{z+1}^* \;.
\end{aligned}
\tag{1}
$$

Gather convolution

Image space SRME:

$$
\begin{aligned}
M_{z+1} &= \mathrm{DSR}\, M_z = \mathrm{DSR}\, U_z U_z^* = \\
&= \mathrm{SSR}\, U_z \, \mathrm{SSR}\, U_z^* = \\
&= \mathrm{SSR}\, U_z \, (\mathrm{SSR}^{-1}\, U_z)^* = U_{z+1} U_{z+1}^* \, .
\end{aligned} \tag{2}
$$

Migration

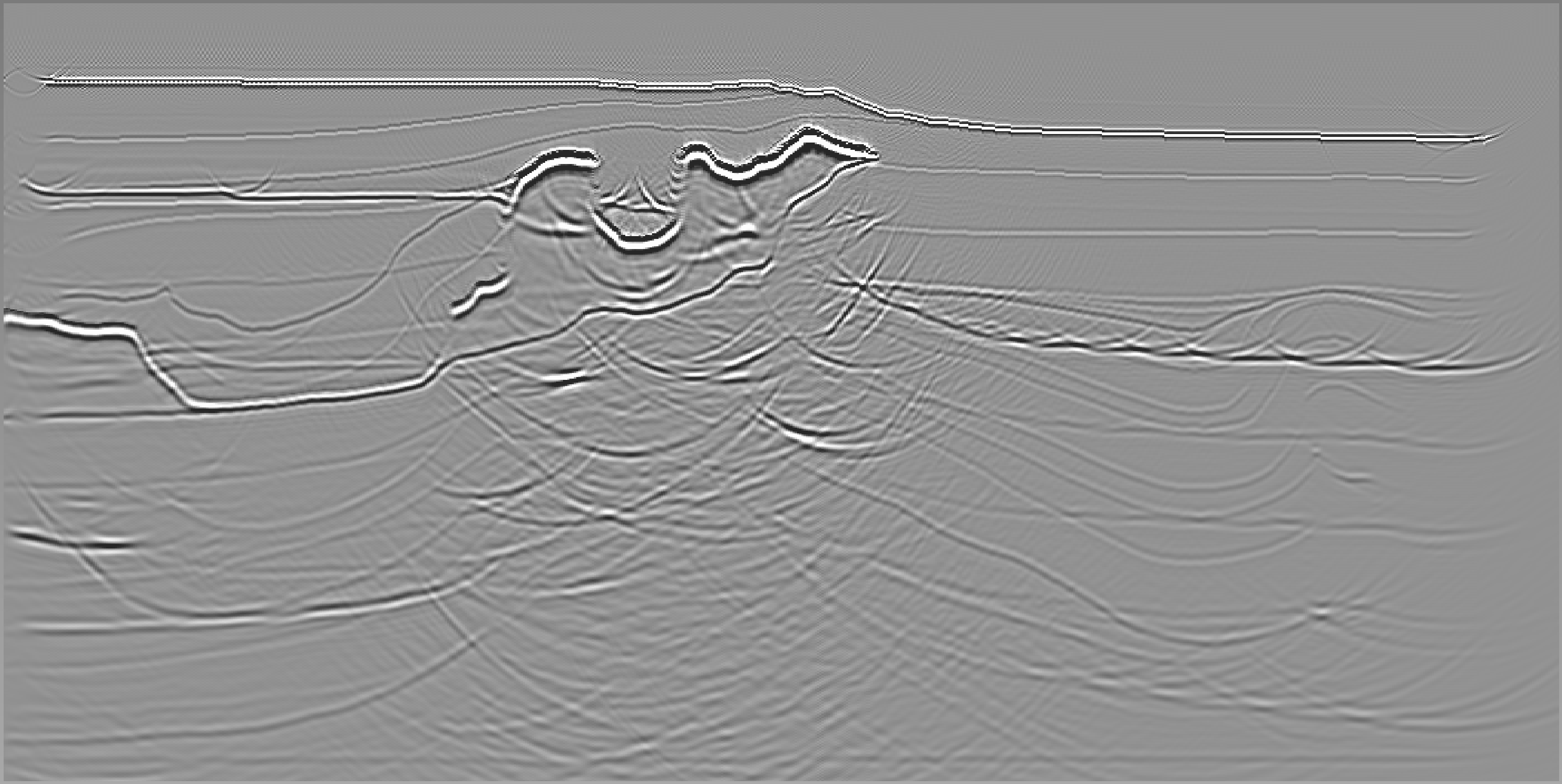
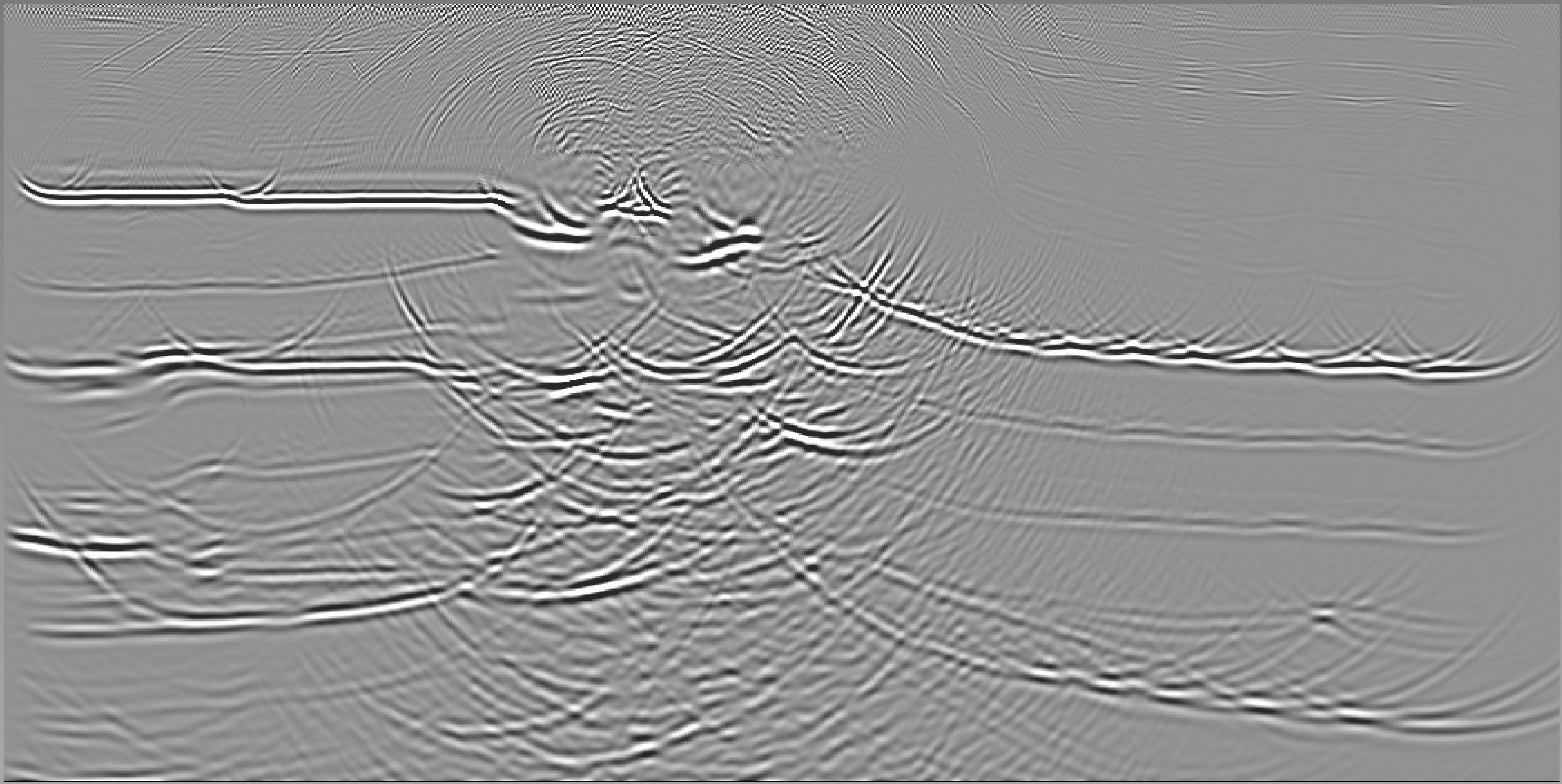
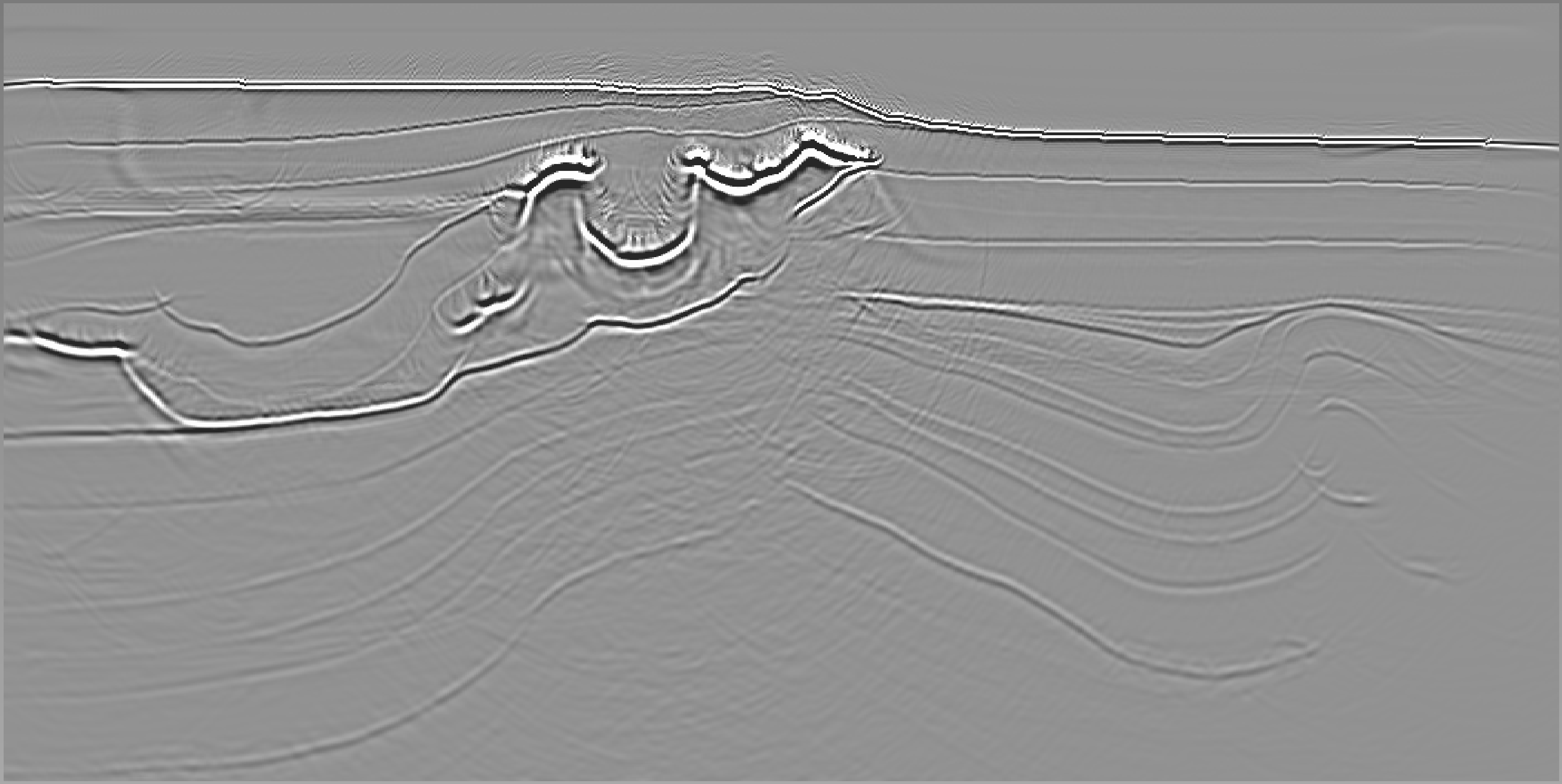


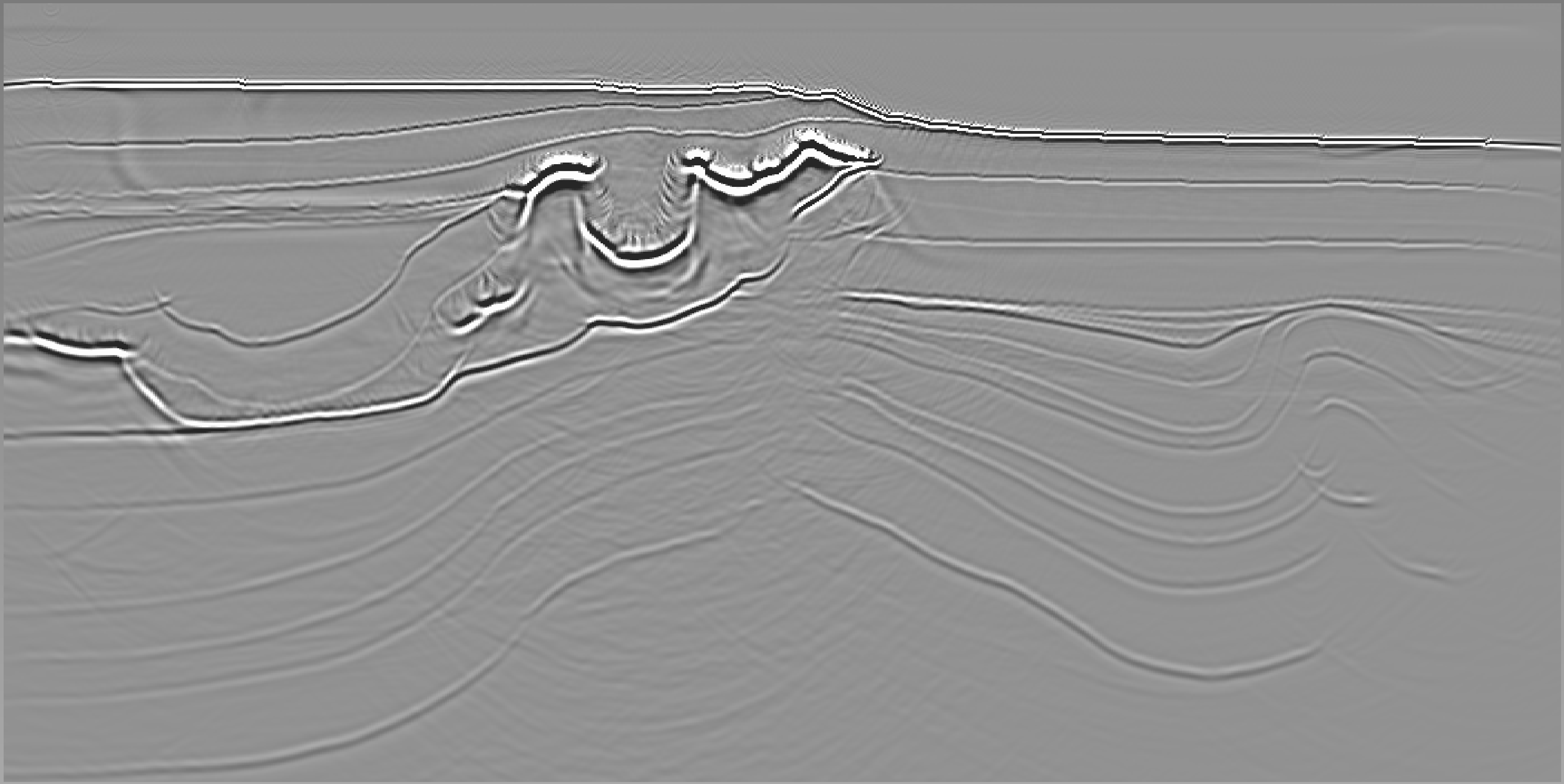
Image-space multiple model



Migration, subtraction



Subtraction, migration



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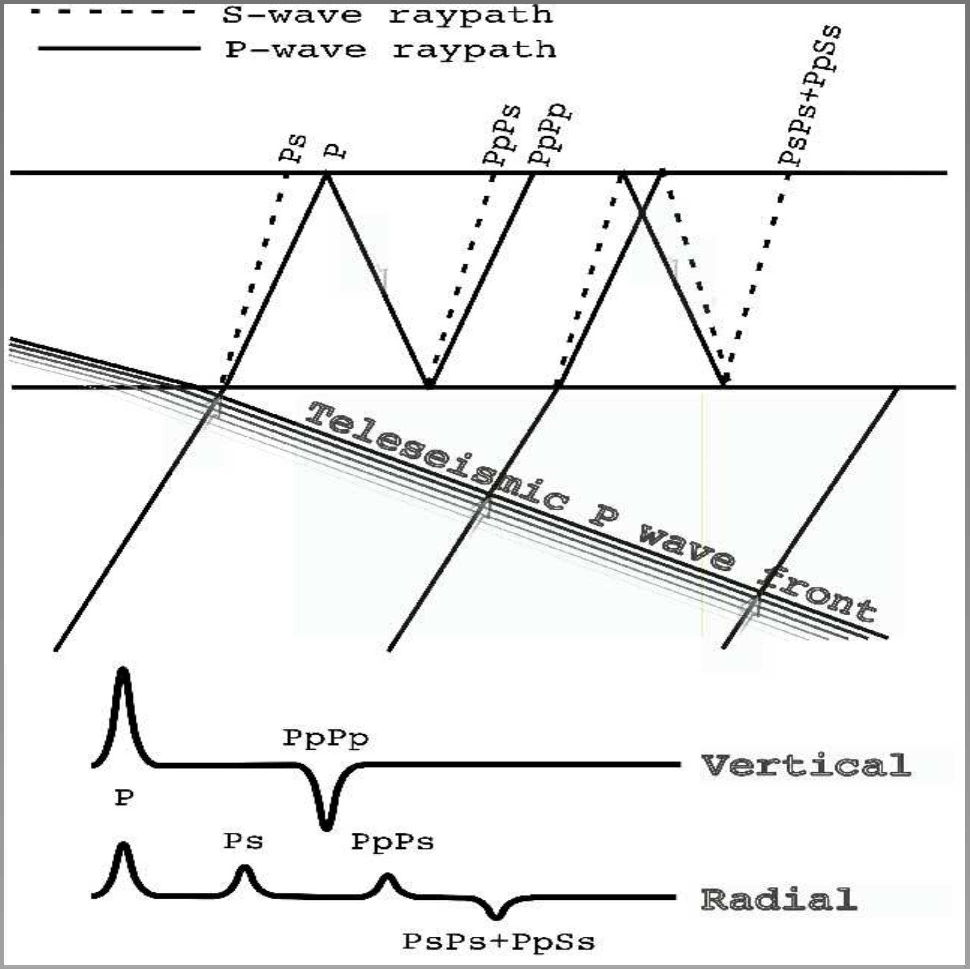
Forward-scattered angle gathers



Forward-scattered angle gathers

$$x\,(p_r + p_s) + z\,(q_r + q_s) - h_x\,(p_r - p_s) - h_z\,(q_r - q_s) = 0,$$

$$\frac{\partial z}{\partial h_x} = -\tan\ \gamma \qquad \text{and} \qquad \frac{\partial z}{\partial x} = -\tan\ \alpha.$$

$$x\,(p_r - p_s) + z\,(q_r - q_s) - h_x\,(p_r + p_s) - h_z\,(q_r + q_s) = 0,$$

$$\frac{\partial z}{\partial h_x} = -\cot\ \gamma_a \qquad \text{and} \qquad \frac{\partial z}{\partial x} = -\cot\ \alpha_a.$$

2004

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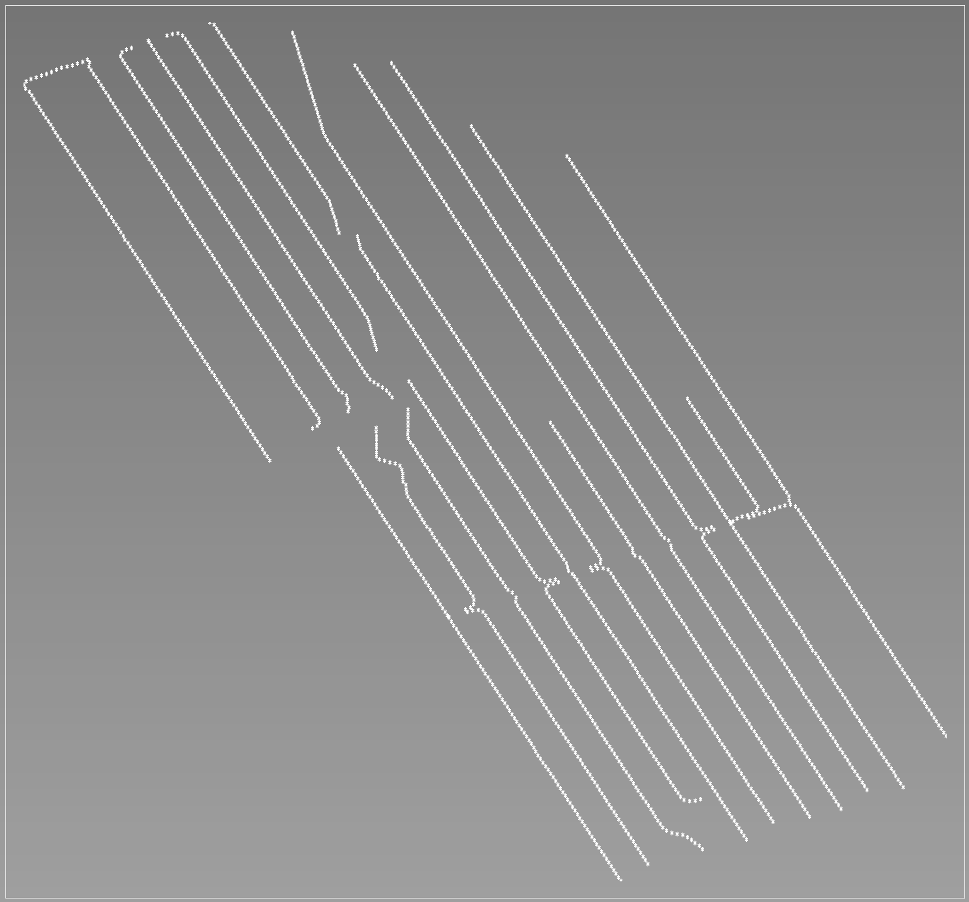
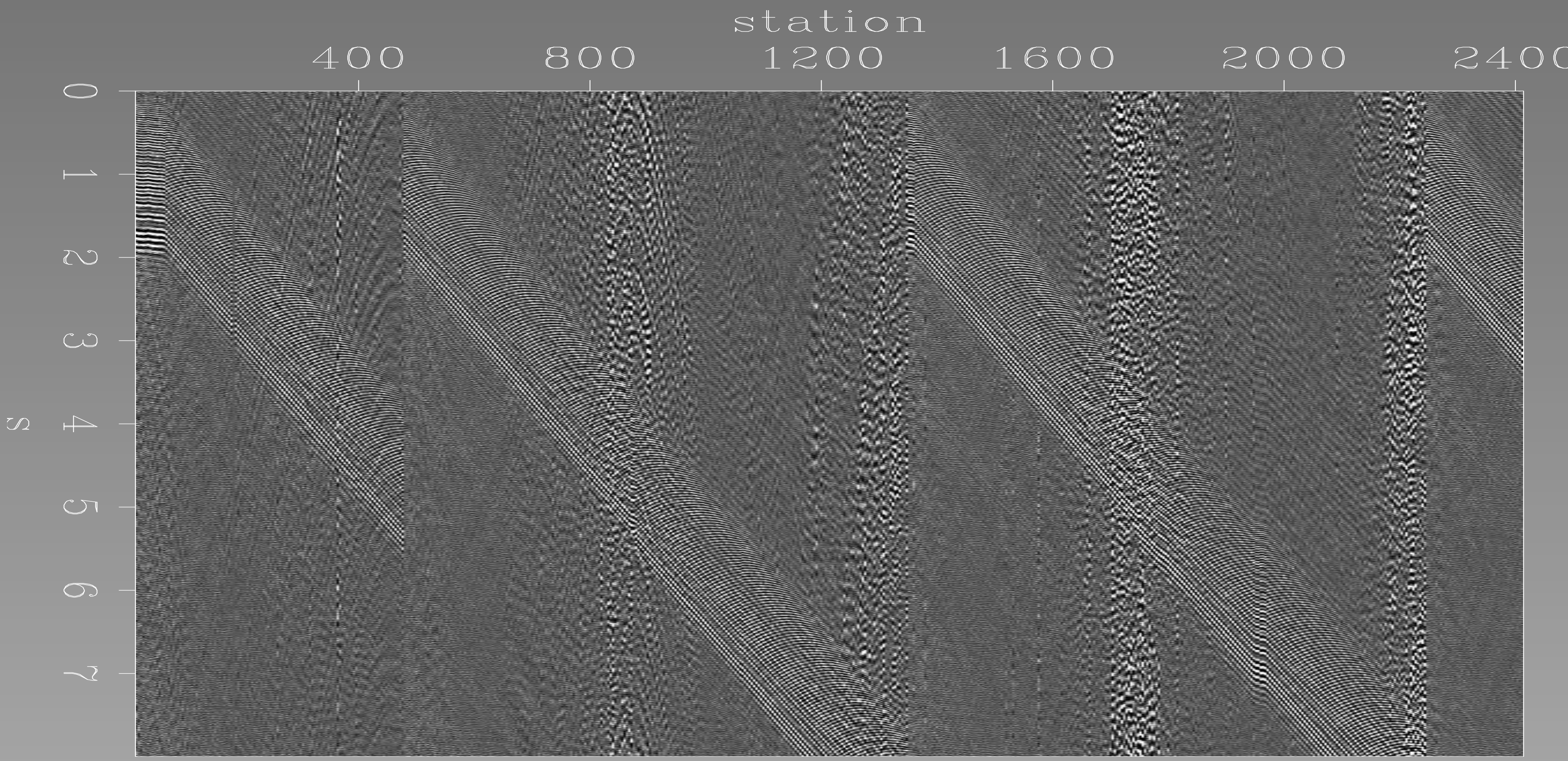
Valhall

receivers



Valhall



2005a

- Valhall passive data
- Plan-wave decomposition & spectral analysis
- migrate P,Z, & S components
  - ⋆ Back-scattered
  - ⋆ Forward-scattered
- P-Z summation as U D separation vs. correlation
- Compare to “best-case” image
- Search for earth tremor

2005b

- Finish aliasing paper
- Finish image-space multiple modeling paper
- Direct migration of Long Beach VSP data
- Submit multi-offset GPR migration paper

Thanks

contents

2004

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Derivation 1

$$I(x,h)|_{\omega,z} = U(x_r - h)D(x_s + h) \quad (1)$$

Fourier transform D to $\hat{D}$

$$\hat{I}(x,h) = U(x-h)\int \hat{D}(k_s)e^{ik_s(x+h)}dk_s \quad (2)$$

FT all the x's

$$\hat{I}(k_x,h) = \int U(x-h)\int \hat{D}(k_s)e^{ik_s(x+h)}dk_s e^{-ixk_x}dx \quad (3)$$

Derivation 2

Introduce (Sergey inspired) variable flip-flop/reorder

$$\hat{I}(k_x, h) = \int \hat{D}(k_s) e^{ik_s h} \int U(x-h) e^{-ix(k_x-k_s)} dx dk_s$$

$$\hat{I}(k_x, h) = \int \hat{D}(k_s) e^{ih(2k_s-k_x)} \int U(x-h) e^{-i(x-h)(k_x-k_s)} d(x-h) dk_s \quad (4)$$

Note salient details: Inner integral is FT of U,

$$\hat{I}(k_x, h) = \int \hat{U}(k_x - k_s) \hat{D}(k_s) e^{ih(2k_s-k_x)} dk_s \quad (5)$$

Derivation 3

knowing $k_h = 2k_s - k_x$,

$$\hat{I}(k_x, h) = \frac{1}{2} \int \hat{U}(\frac{k_x - k_h}{2}) \hat{D}(\frac{k_x + k_h}{2}) e^{-ihk_h} dk_h \qquad (6)$$

This we see is FT over offset, so the complete FT of the IC is

$$\widehat{I}(k_x, k_h) = \frac{1}{2} \hat{U}(\frac{k_x - k_h}{2}) \hat{D}(\frac{k_x + k_h}{2}). \qquad (7)$$

return