

Separation of simultaneous source blended data using radially and source similarity attributes

pp. 239-256

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Deblending

- Underdetermined problem

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$$d(t) = s_1(t) + s_2(t)$$

Constraints

- Requires constraints (regularization)

Constraints

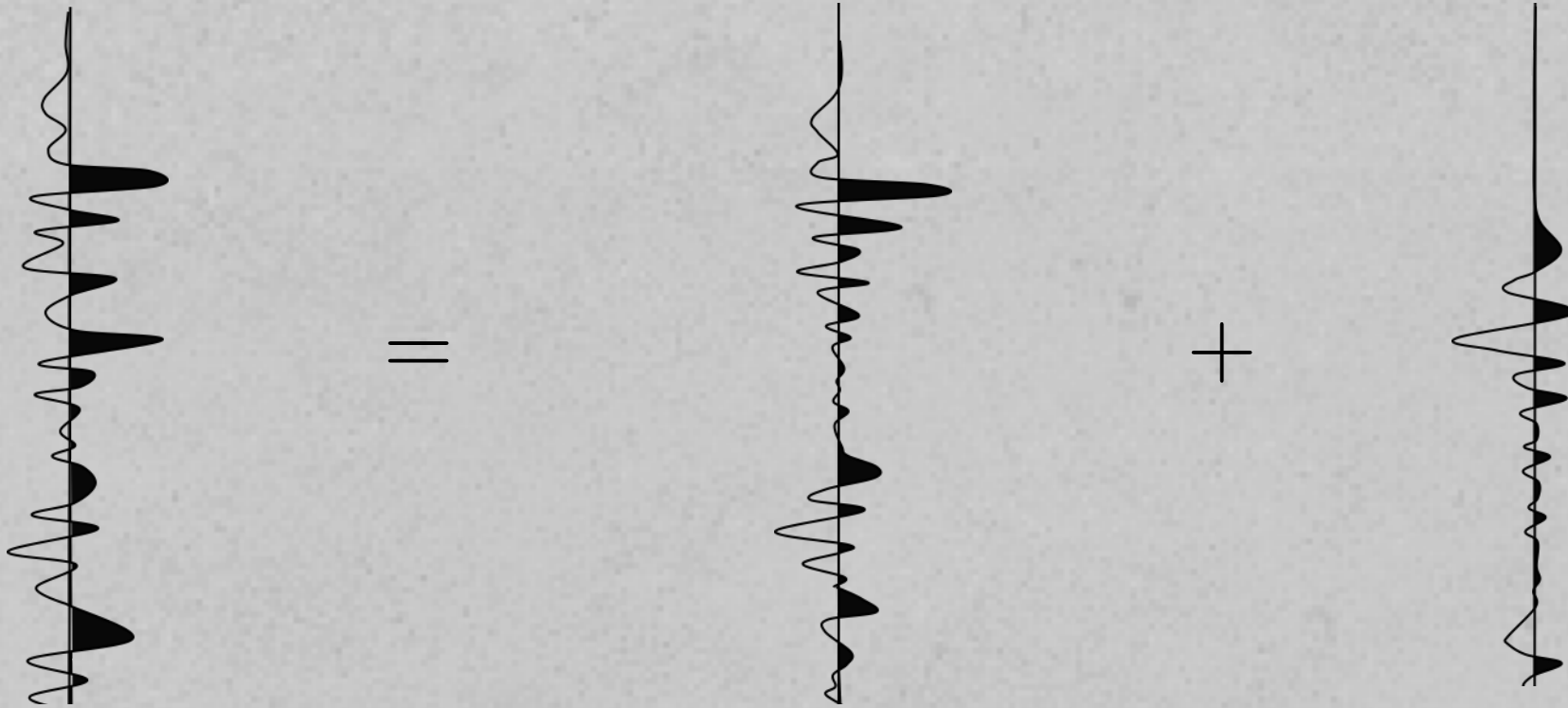
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 - Continuity in common receiver gathers (CRG)
 - Same reflectivity model

Constraints

- Requires constraints (regularization)
 - Continuity in common receiver gathers (CRG)
 - Same reflectivity model
 - **Relative probability of the presence of the dominant source at any time**

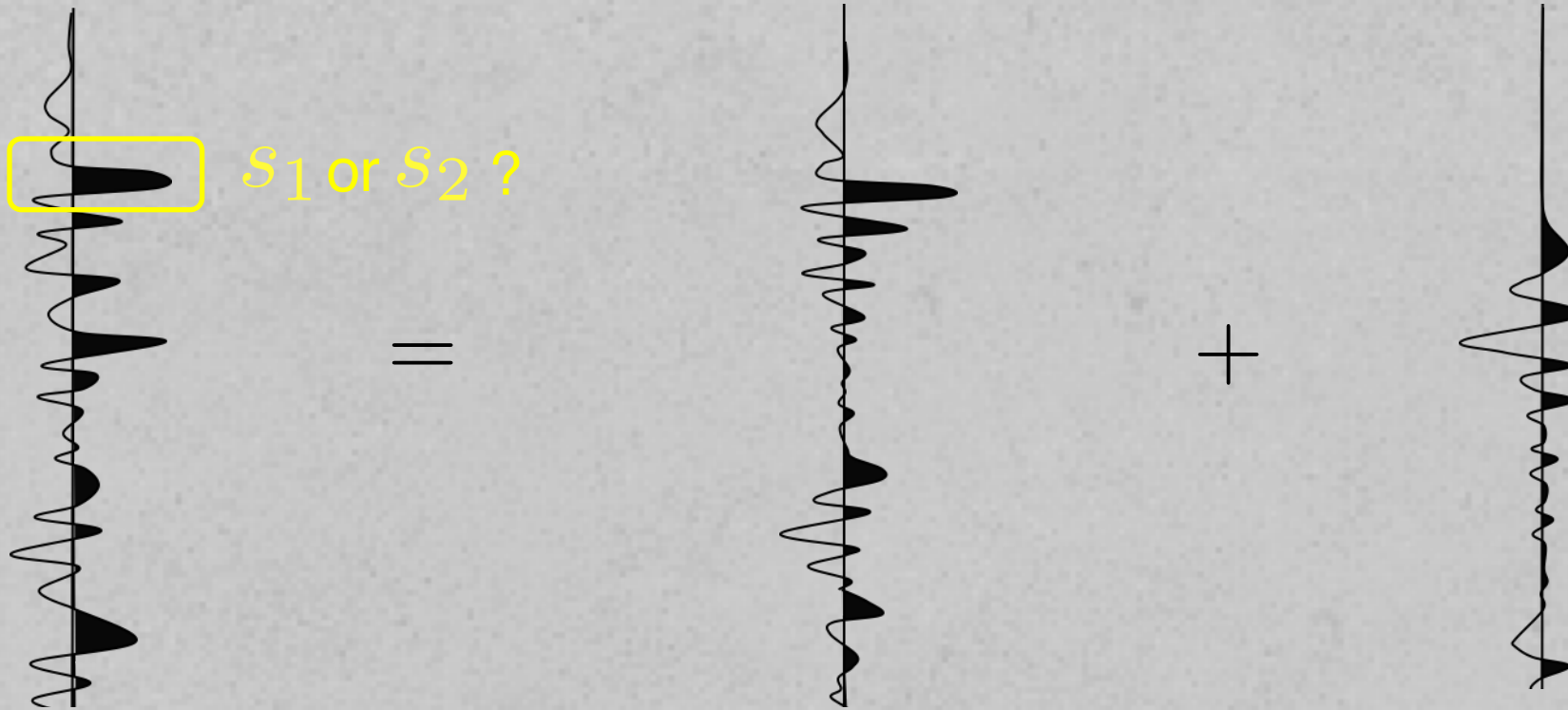
Dominant source

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Example

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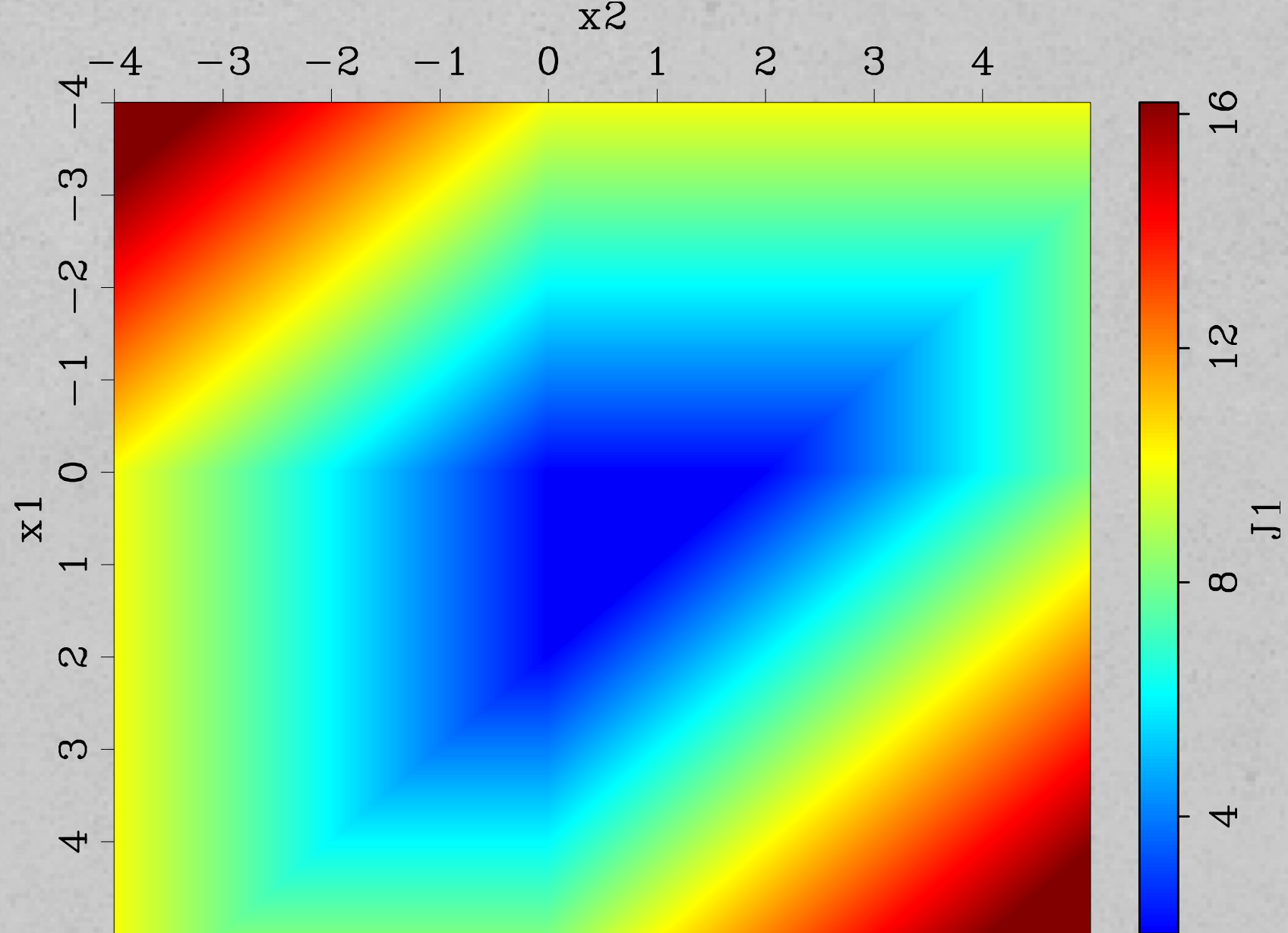
$$0 \approx x_1$$

$$0 \approx x_2$$

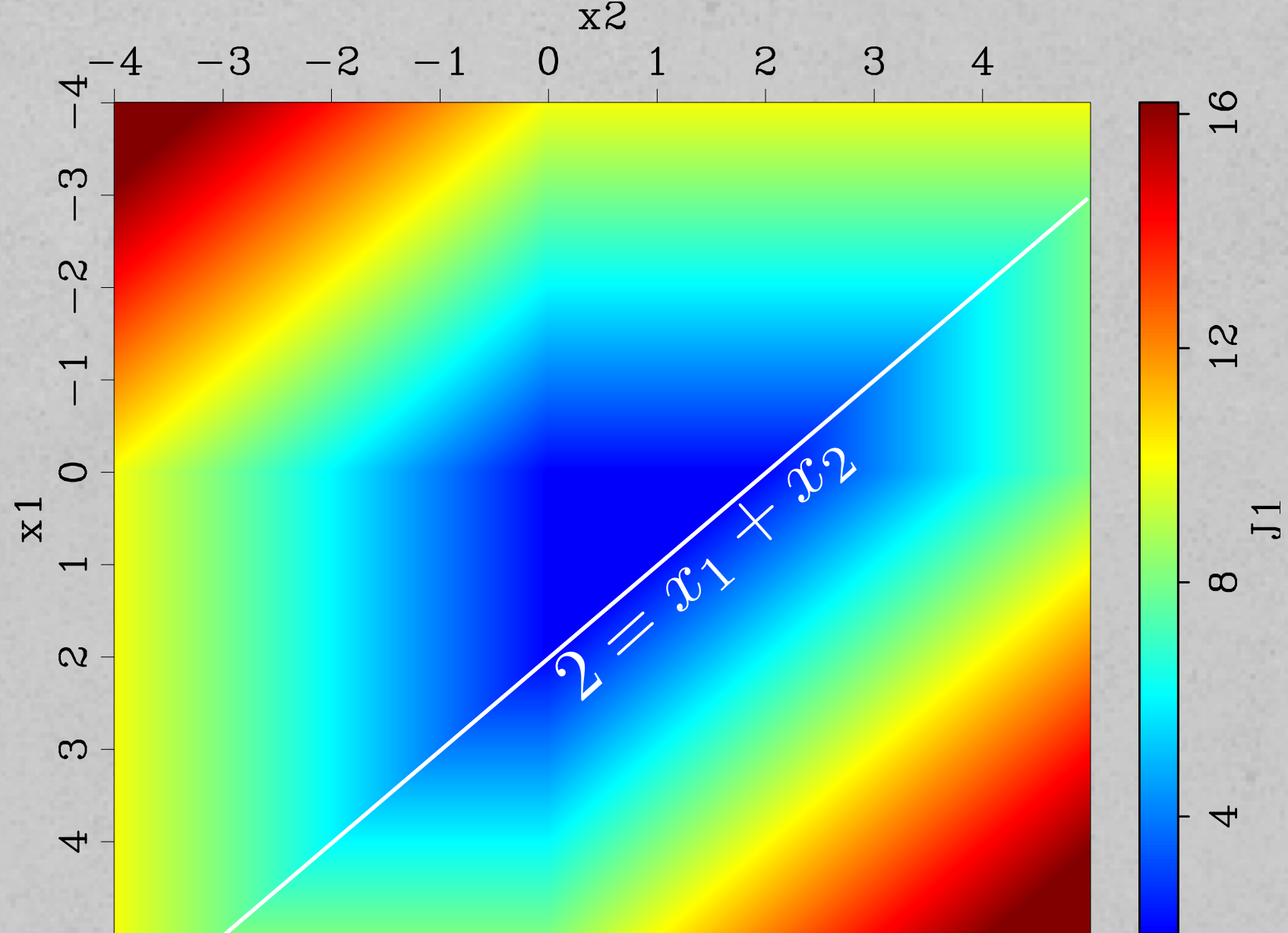
Minimize this objective function

$$J_1(x_1, x_2) = ||2 - (x_1 + x_2)||_1 + ||x_1||_1 + ||x_2||_1$$

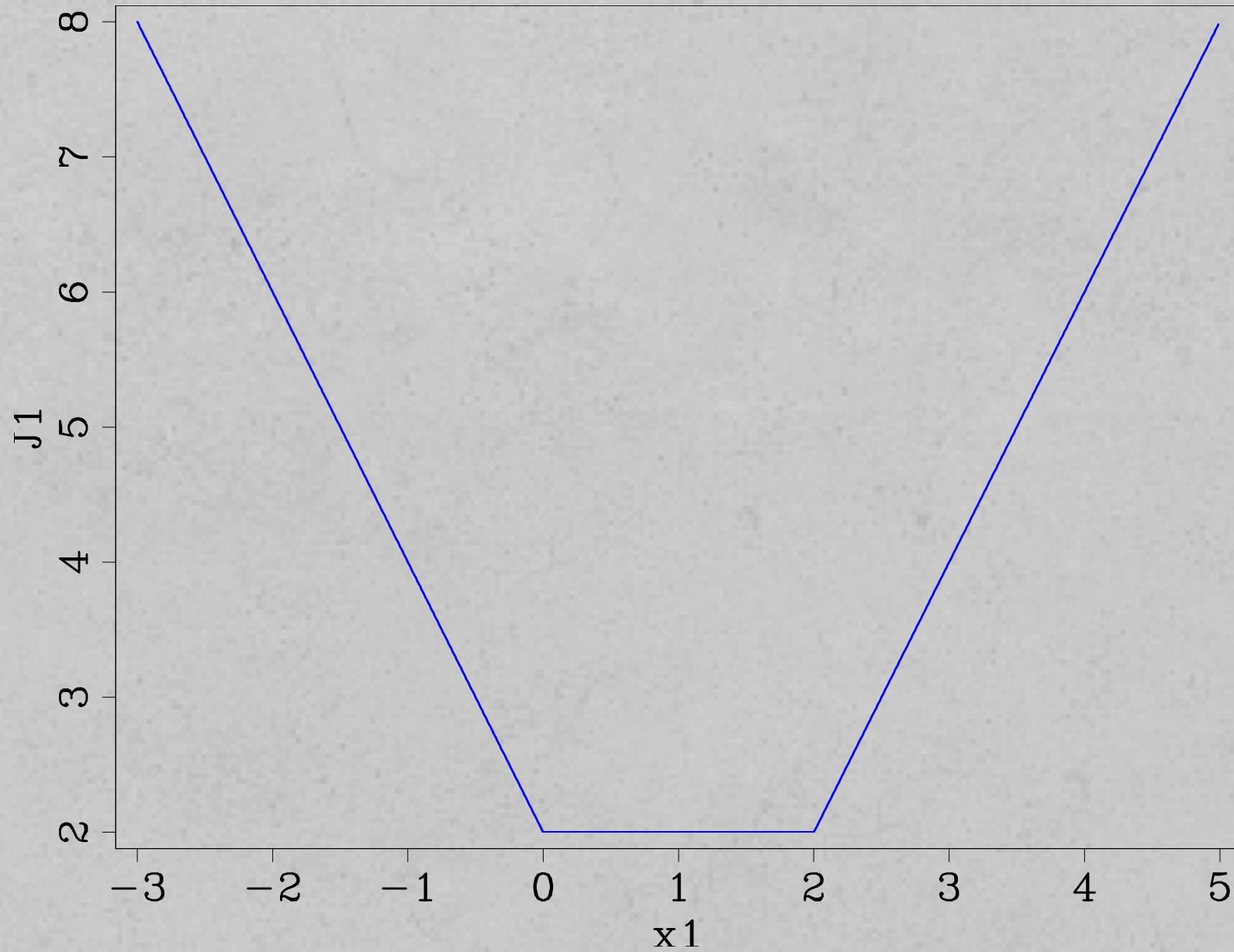
$$J_1(x_1, x_2)$$



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$$J_1(x_1)$$



Additional information

$$2 = x_1 + x_2$$

$p_2 \rightarrow$ the probability that $x_2 = 0$

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$p_2 \rightarrow$ the probability that $x_2 = 0$

$$p_2 = 0.6$$

$$p_1 = 1 - p_2$$

$$0 \leq p_1 \leq 1$$

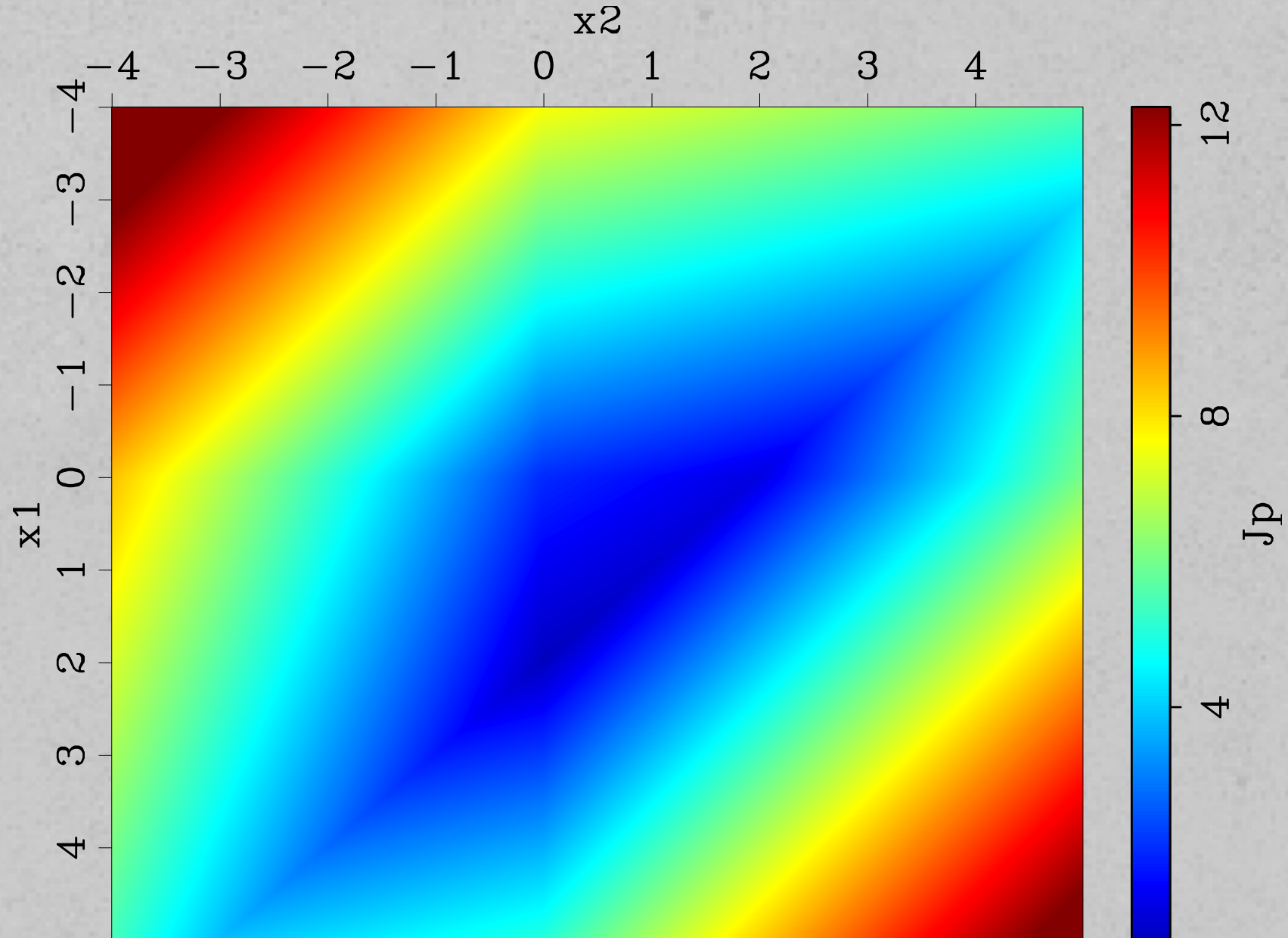
$$0 \leq p_2 \leq 1$$

Probability penalty

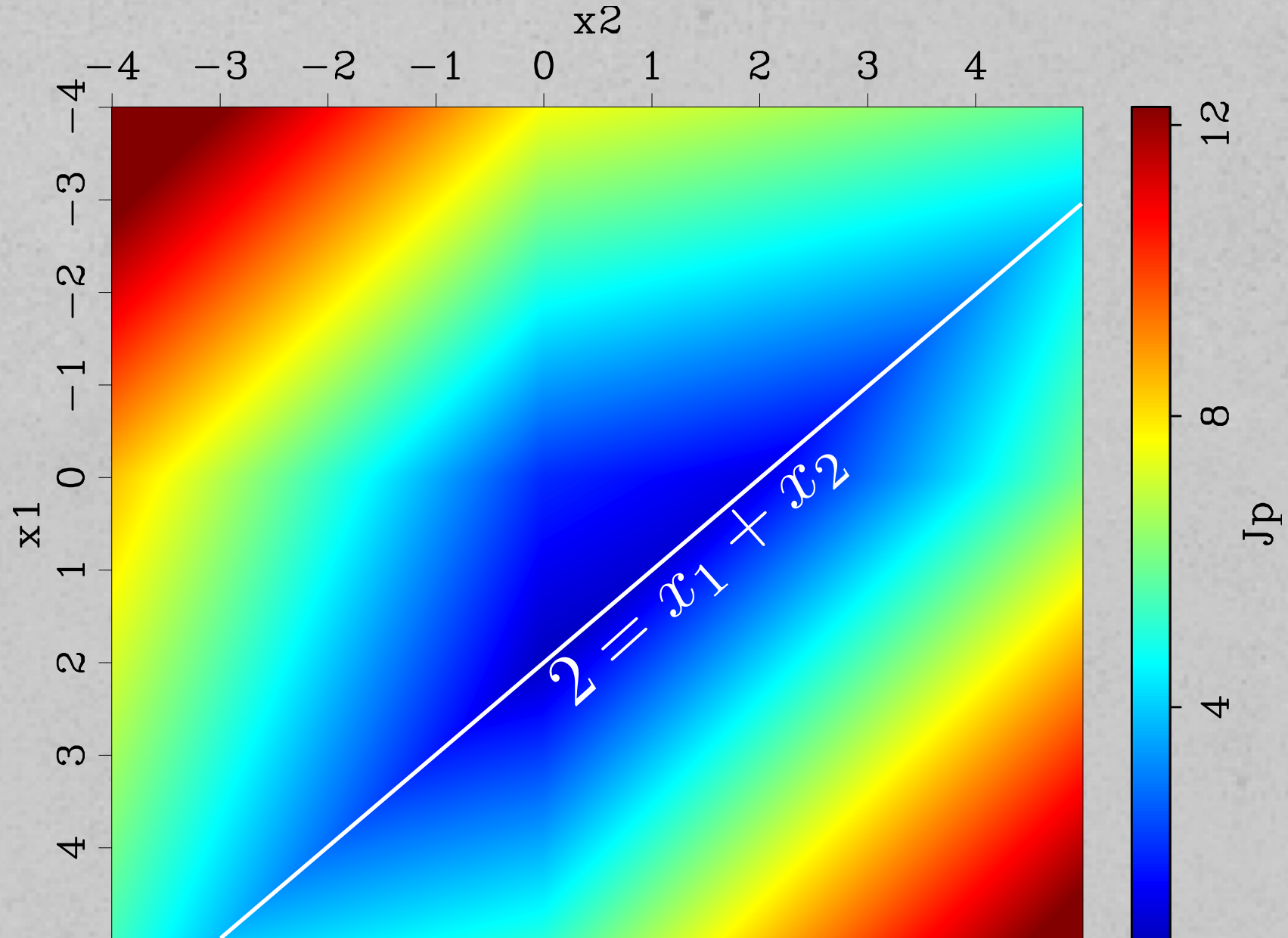
$$J_p(x_1, x_2) = ||2 - (x_1 + x_2)||_1 + ||p_1 x_1||_1 + ||p_2 x_2||_1$$

$$p_1 = 0.4, p_2 = 0.6$$

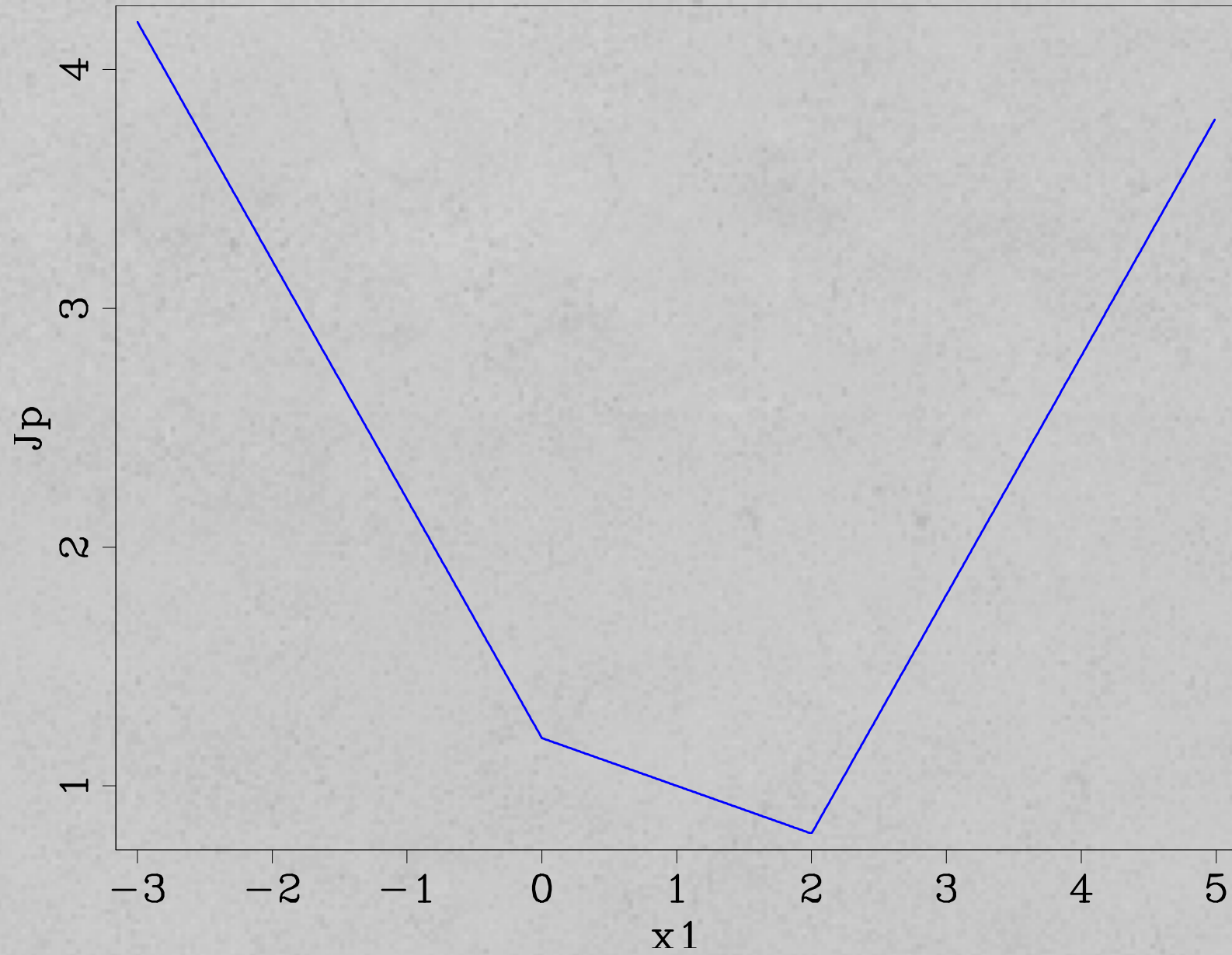
$$J_p(x_1, x_2)$$



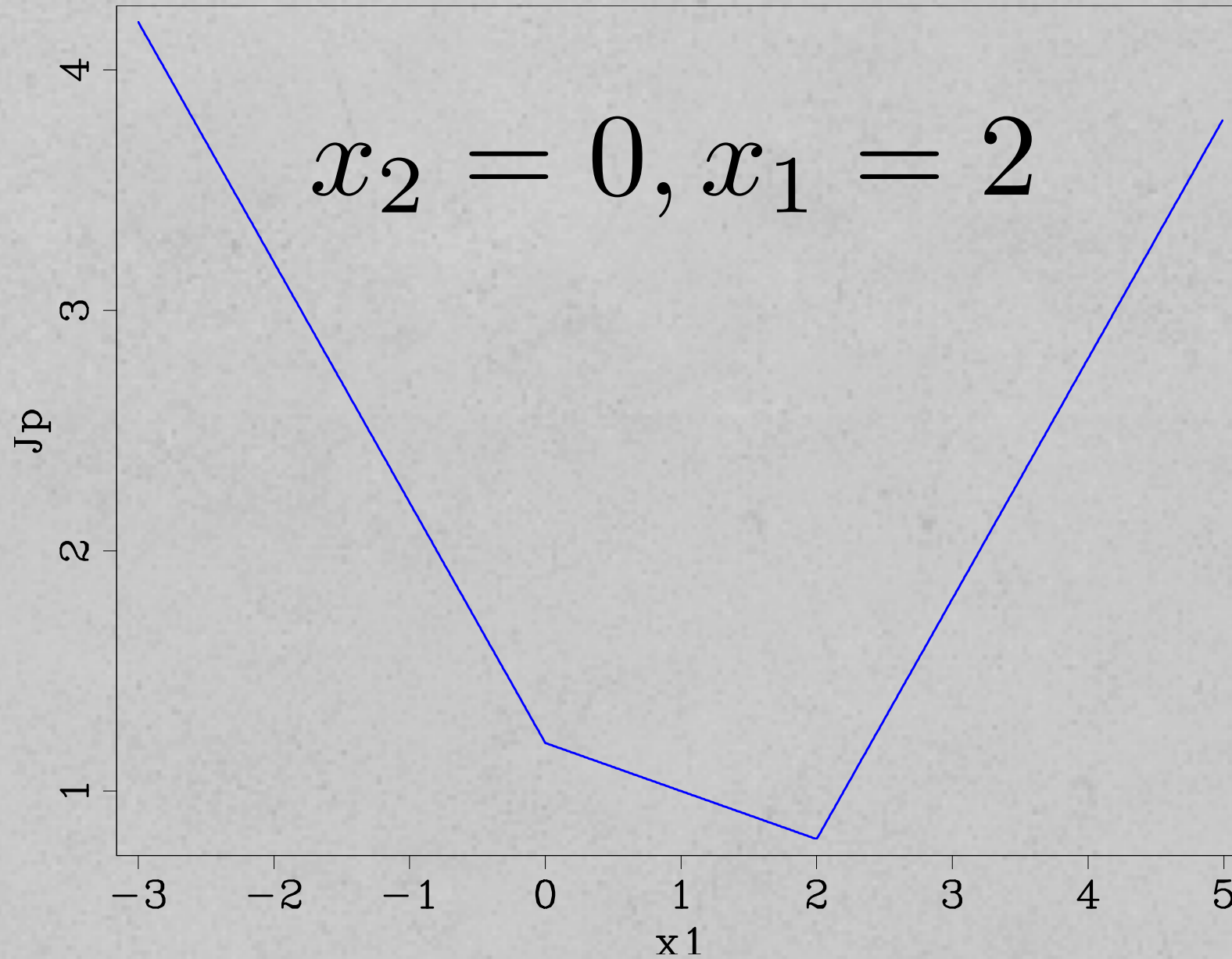
$$J_p(x_1, x_2)$$



$$J_p(x_1)$$

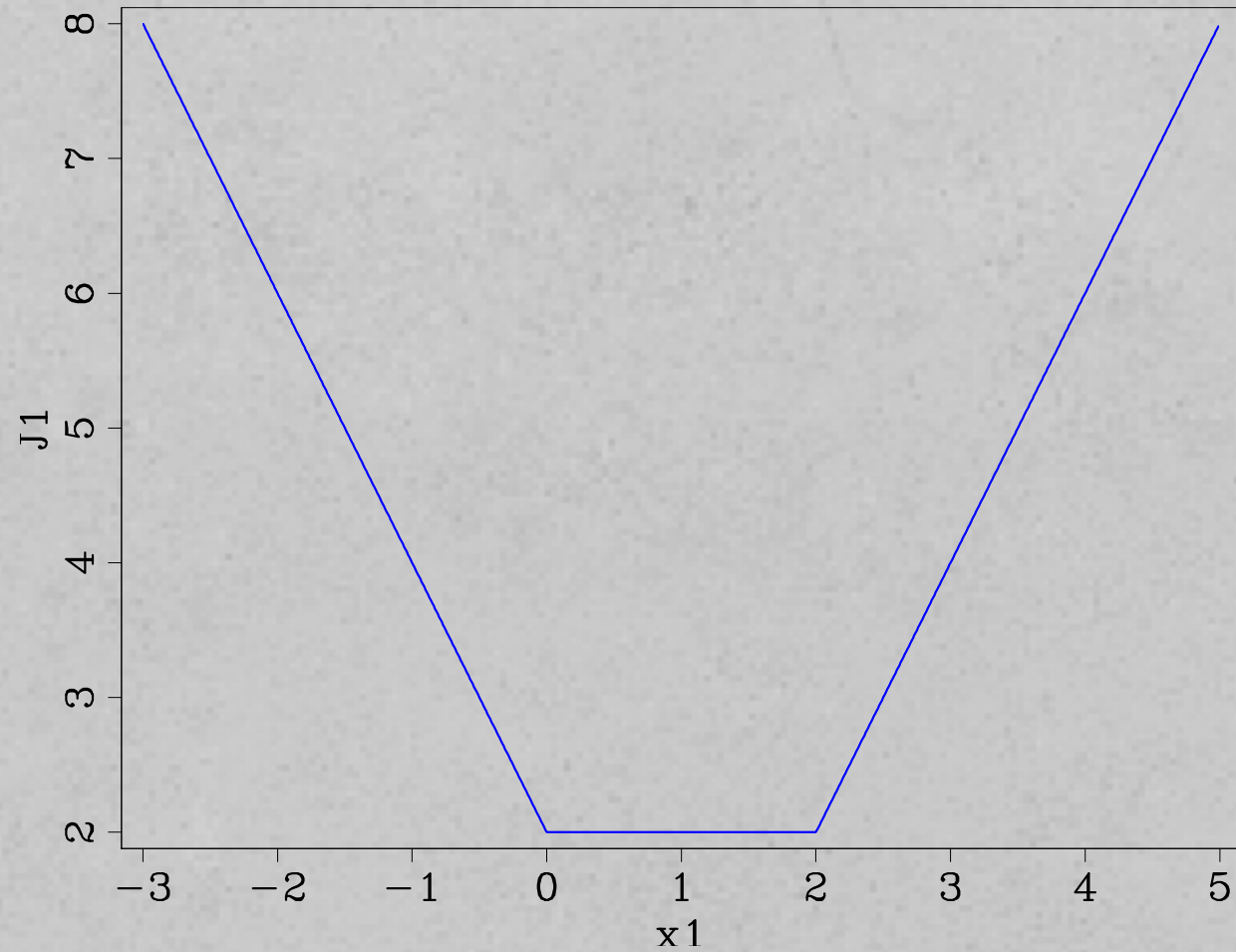


$$J_p(x_1)$$

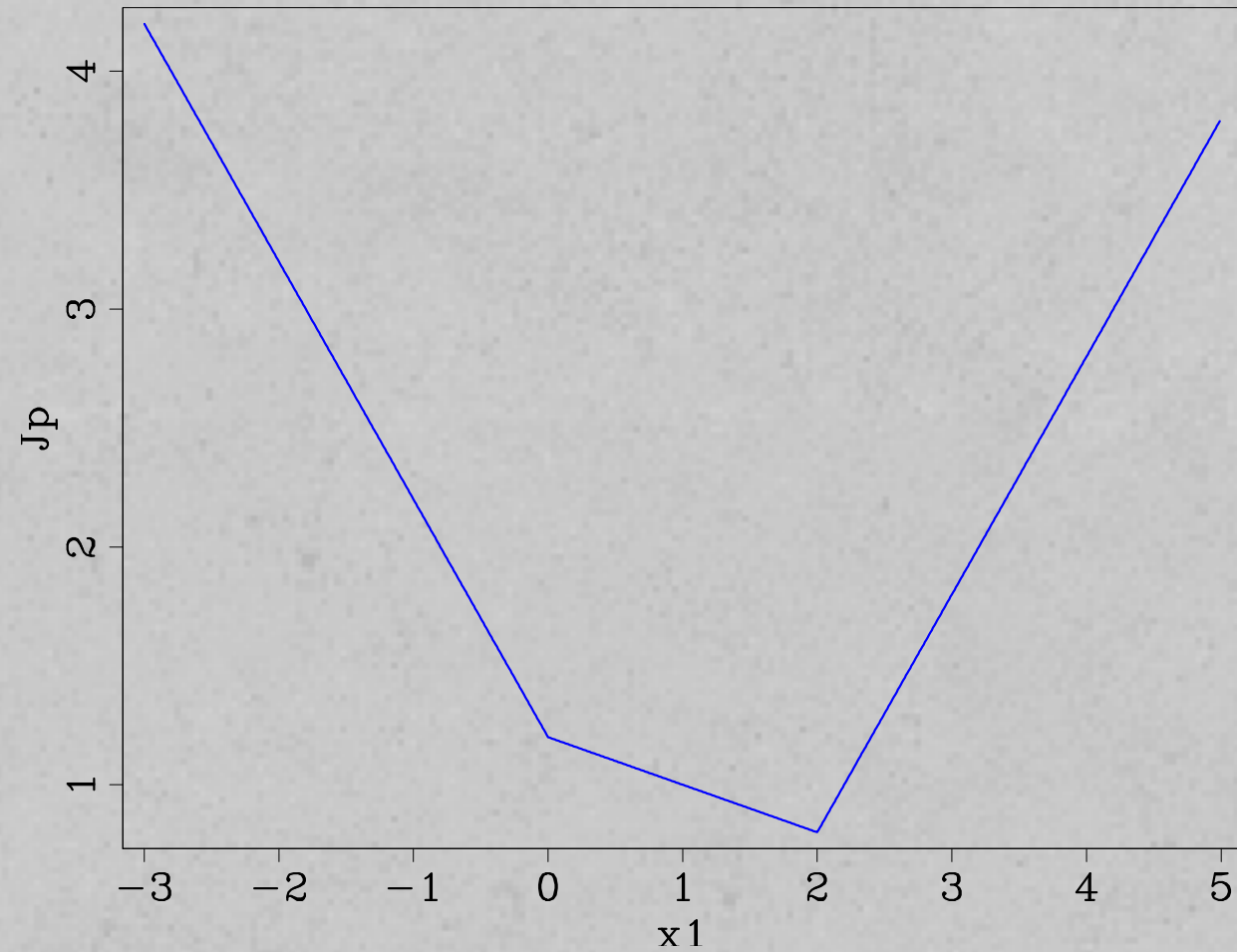


Comparison

$$J_1(x_1)$$



$$J_p(x_1)$$



Obtaining p_1 and p_2

How can we get p_1 and p_2 ?

Let's look at two attributes:

- Radiality – multicomponent data/source position
- Similarity – changes in source signature

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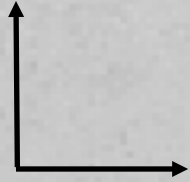
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Experiment

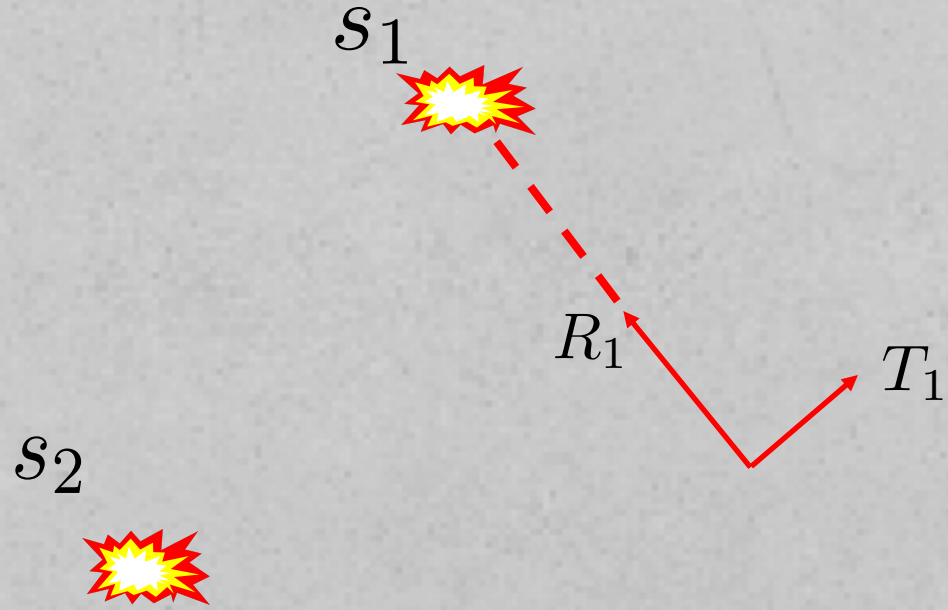
s_1

A small, stylized explosion icon with a bright yellow center and a jagged red and orange border.

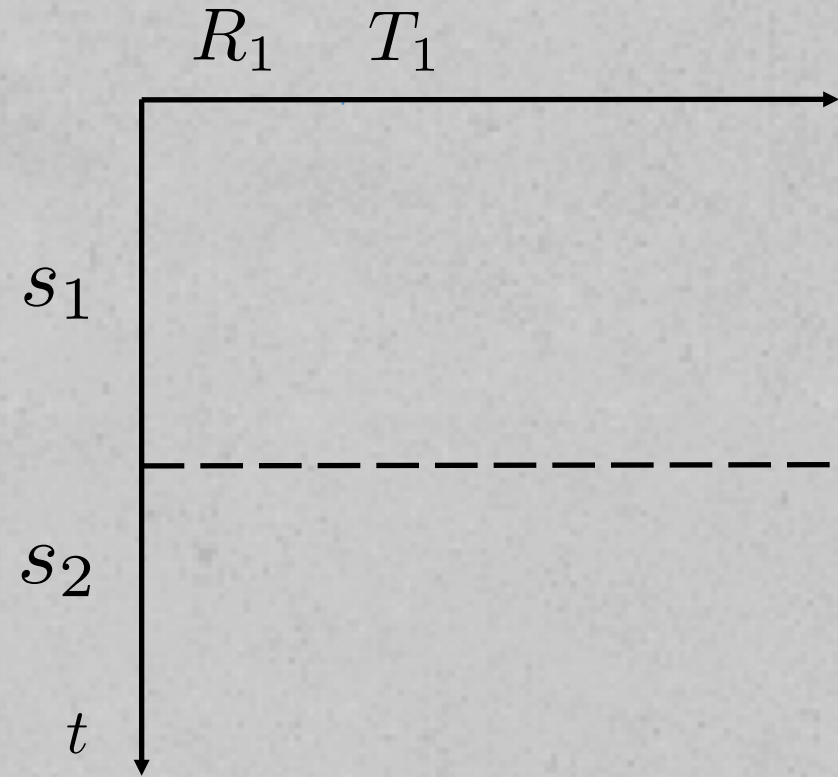
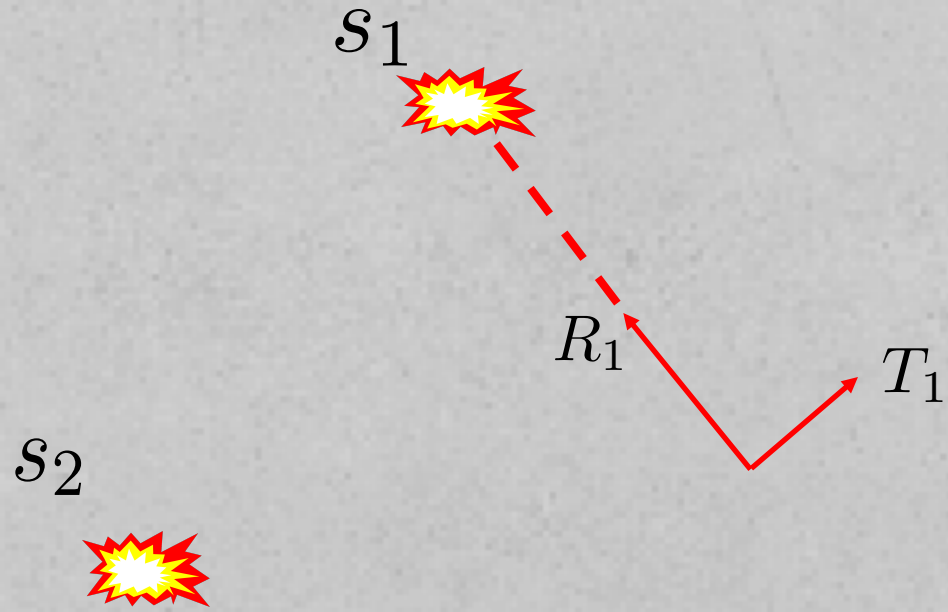
s_2



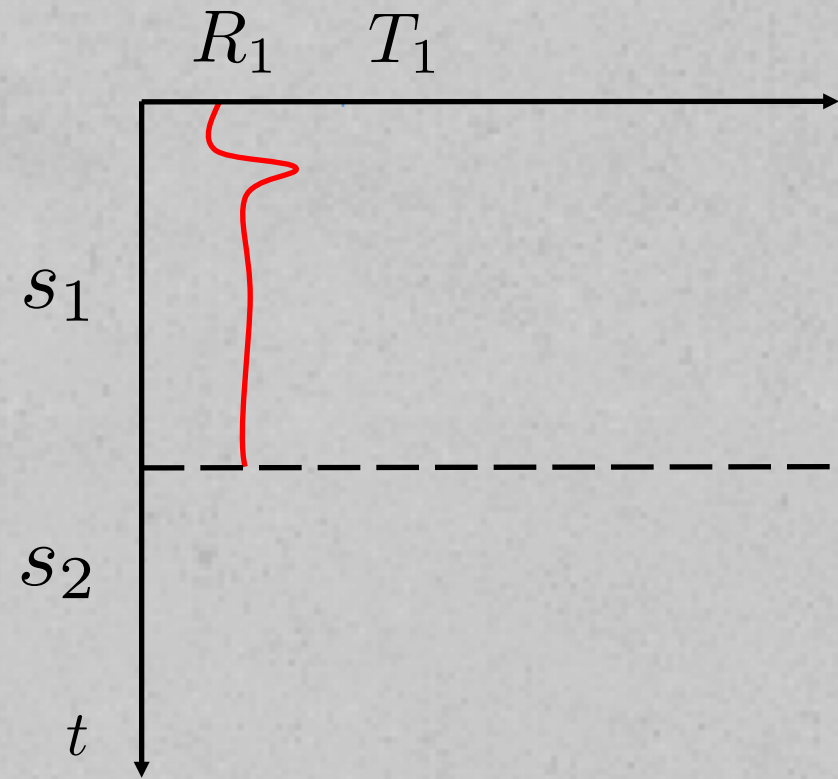
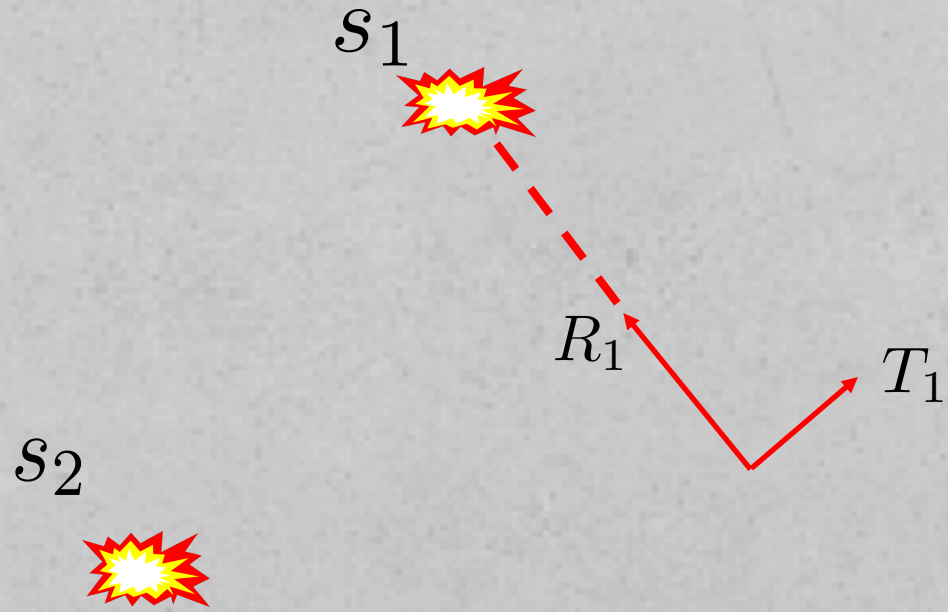
Experiment



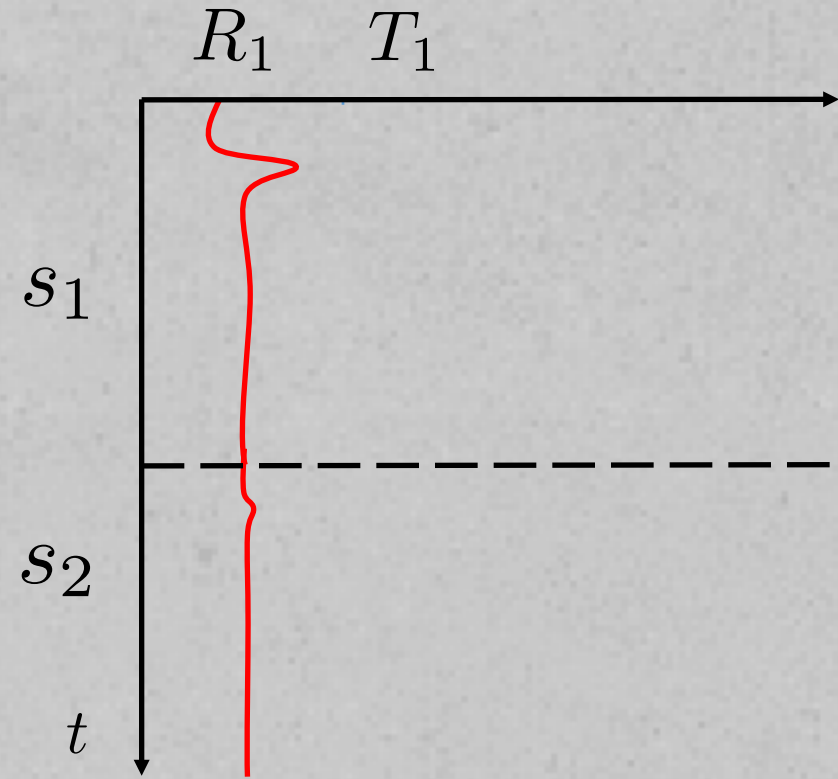
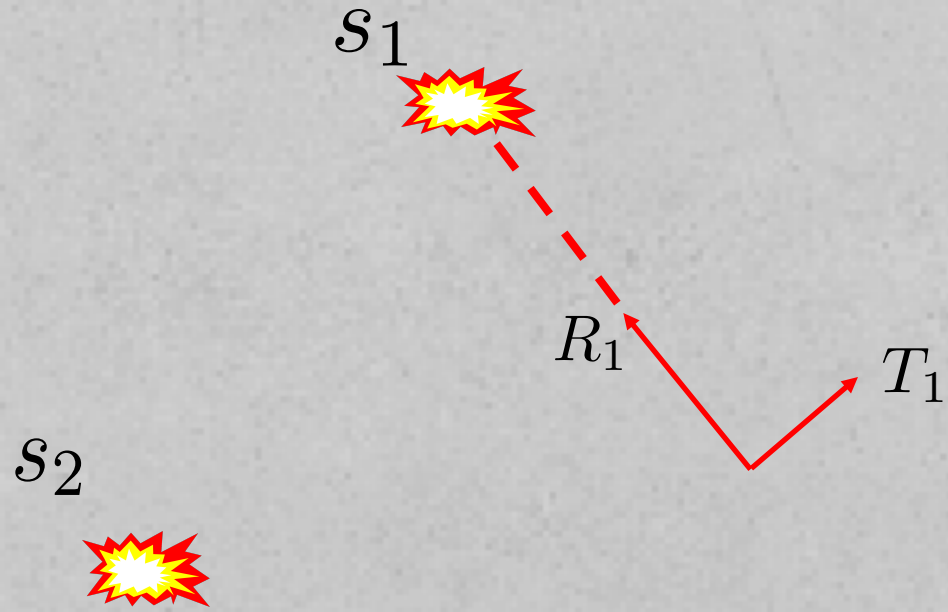
Experiment



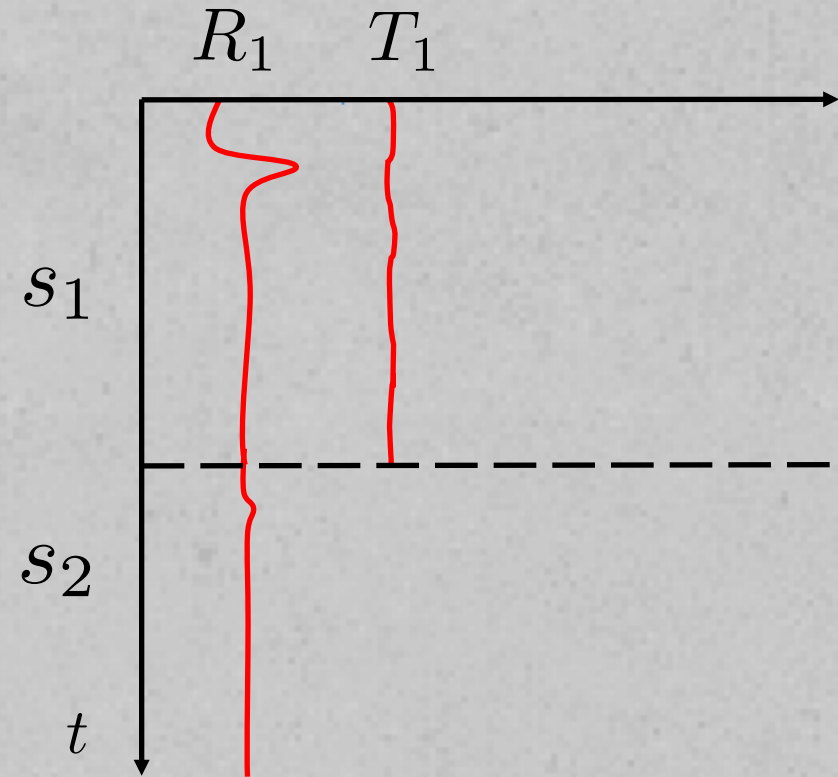
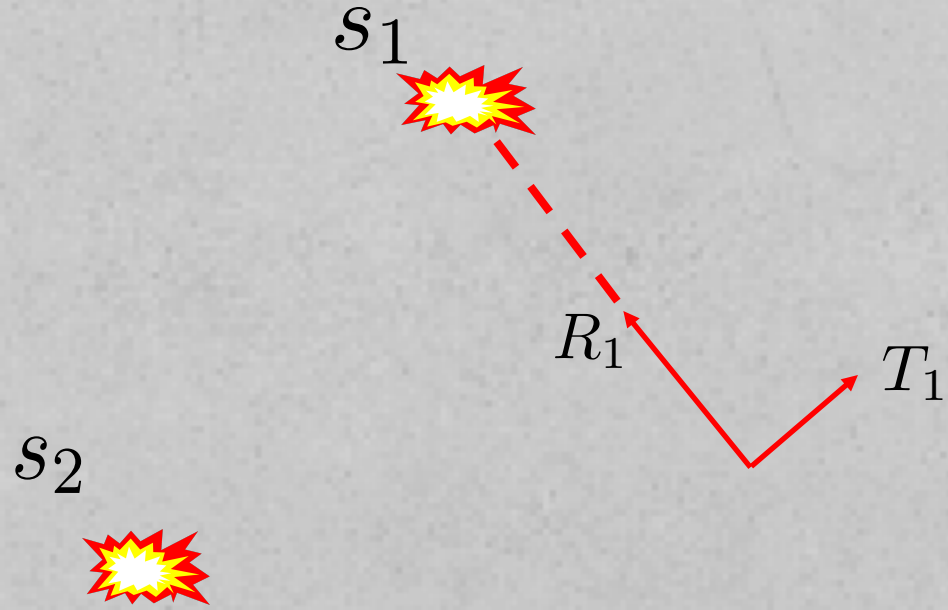
Experiment



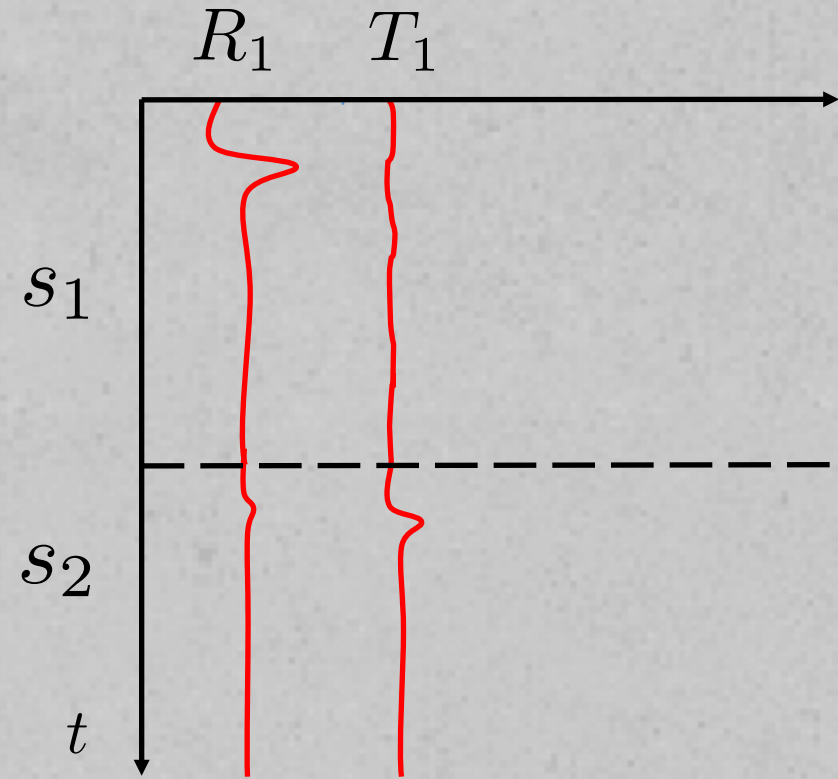
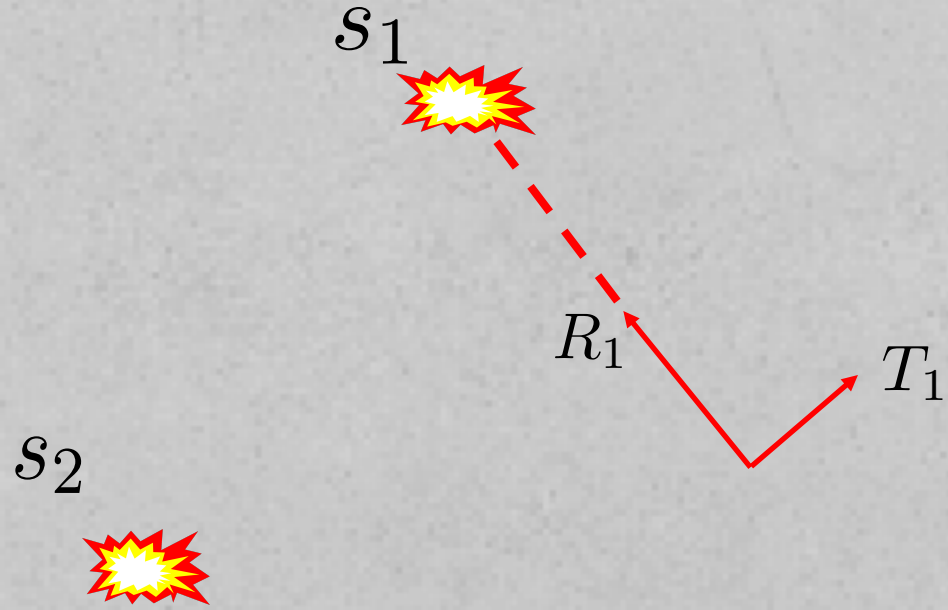
Experiment



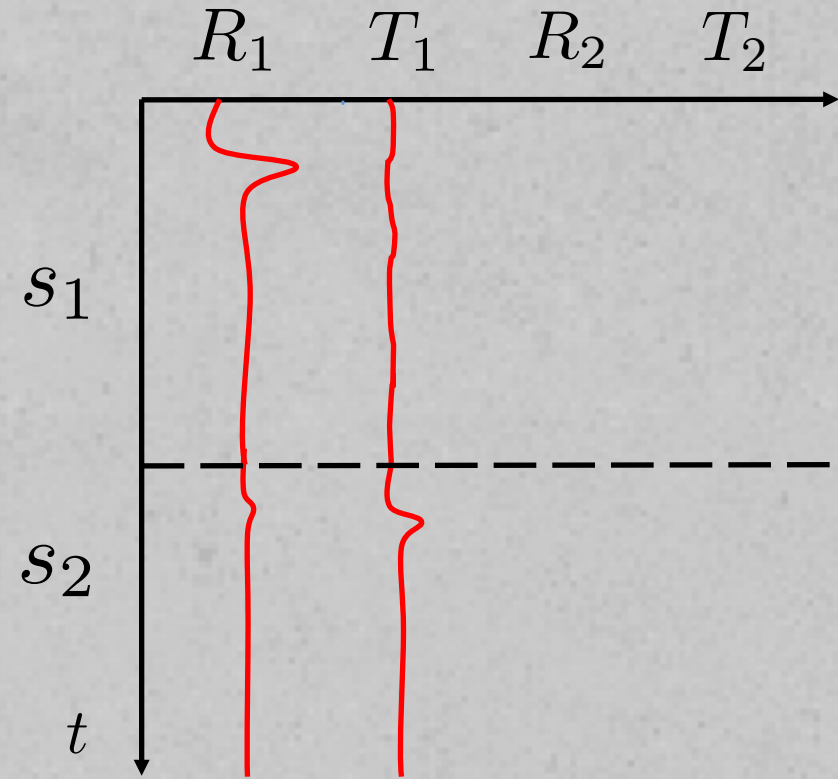
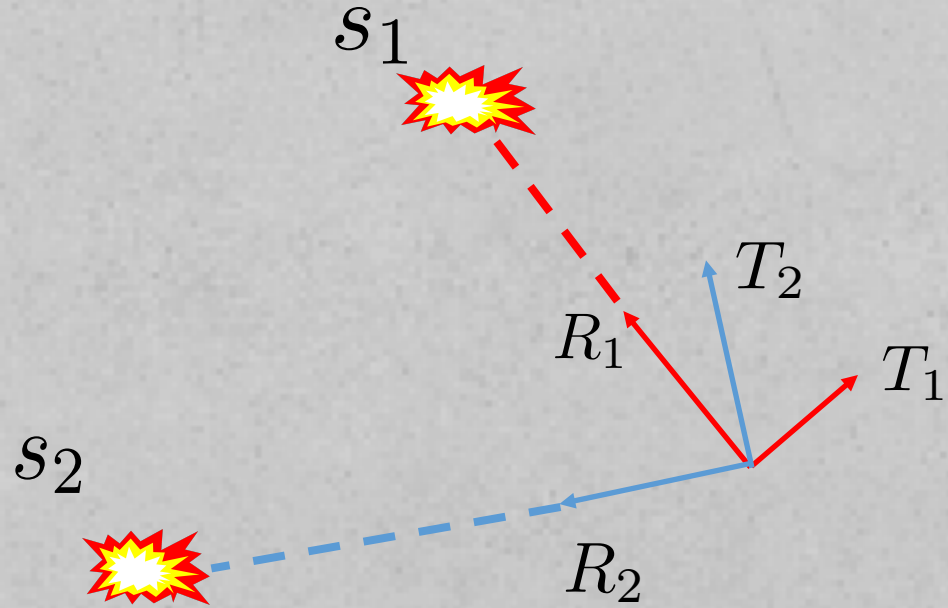
Experiment



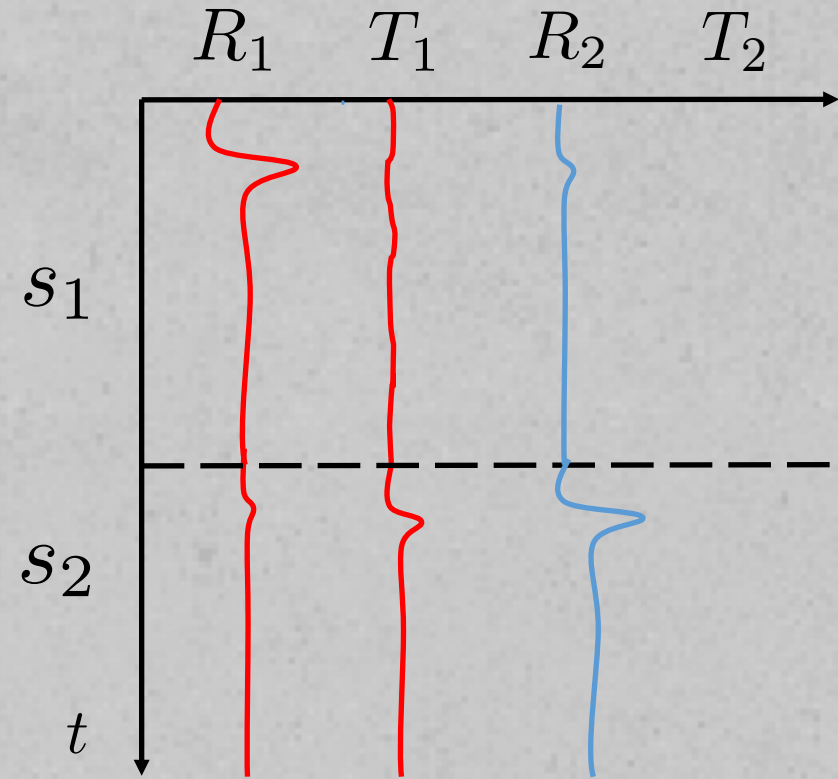
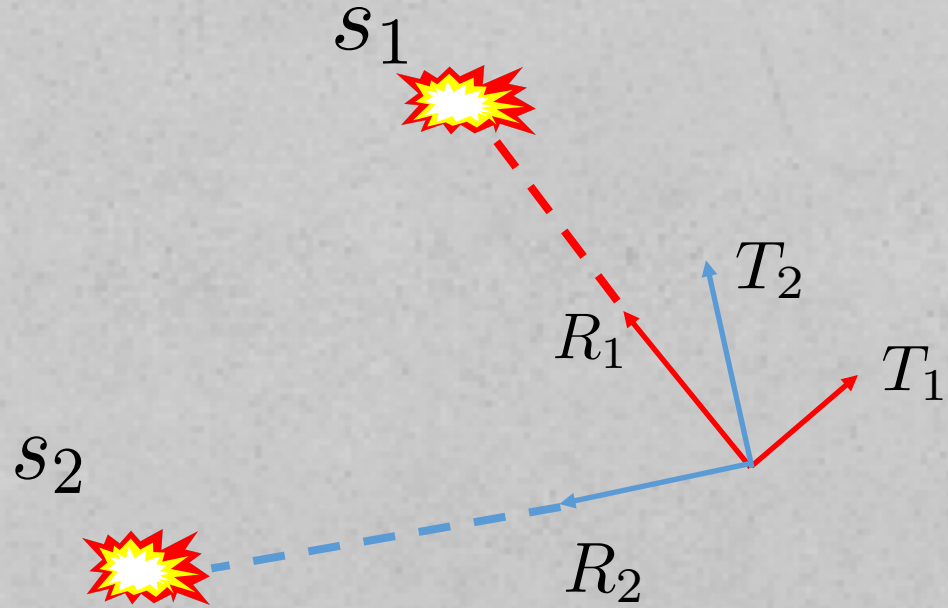
Experiment



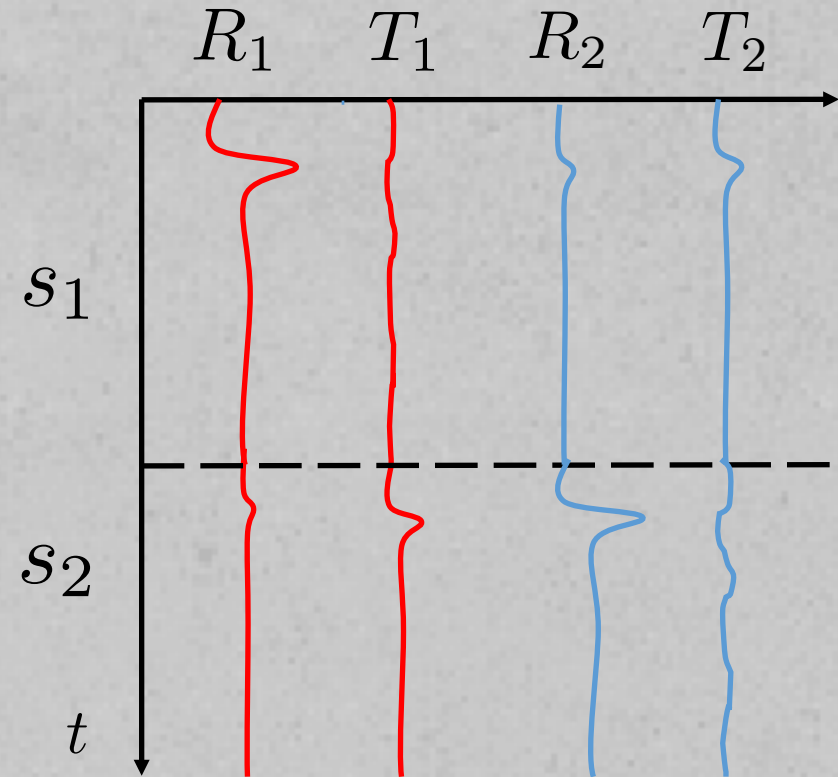
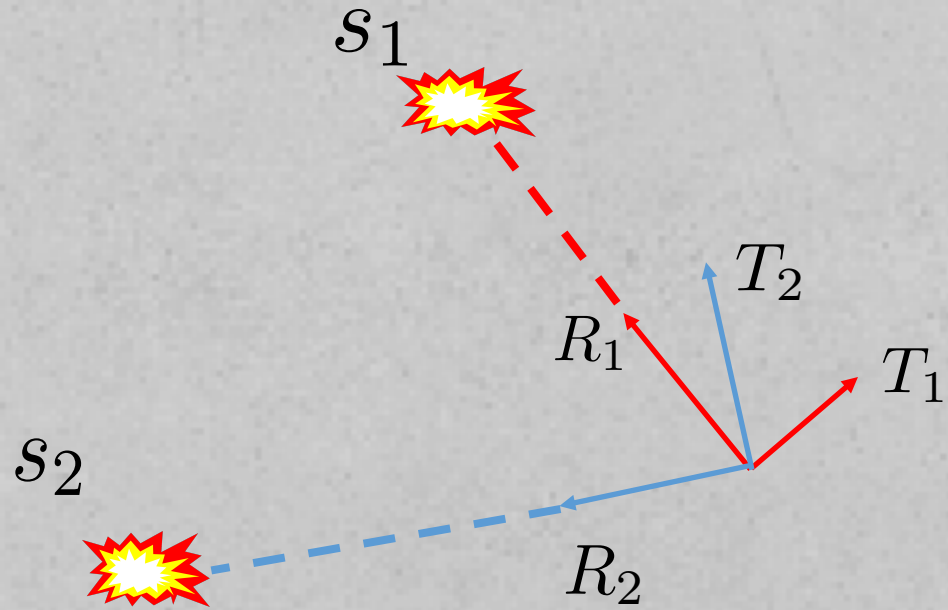
Experiment



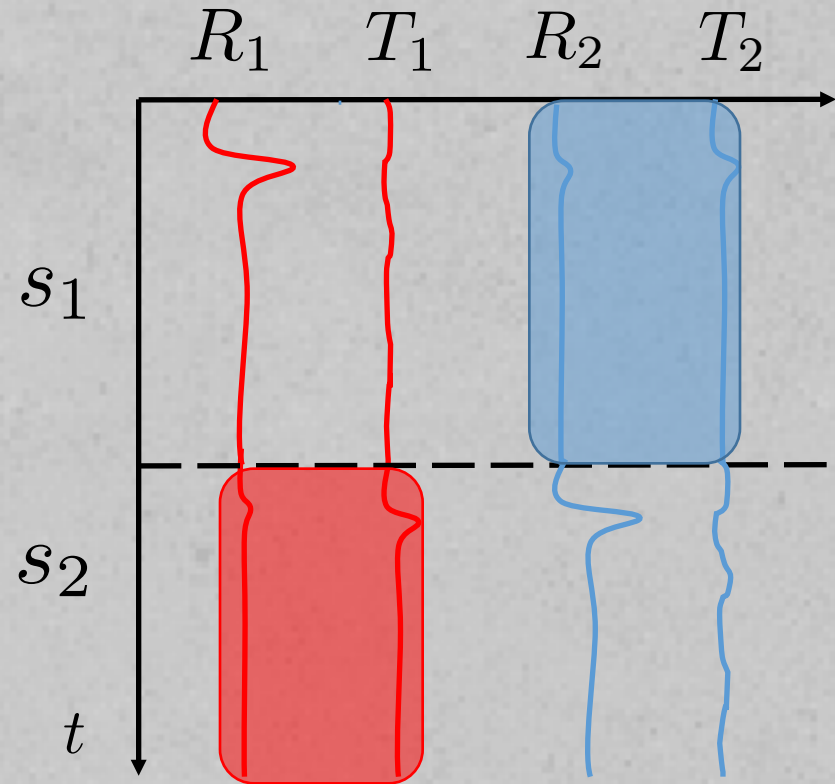
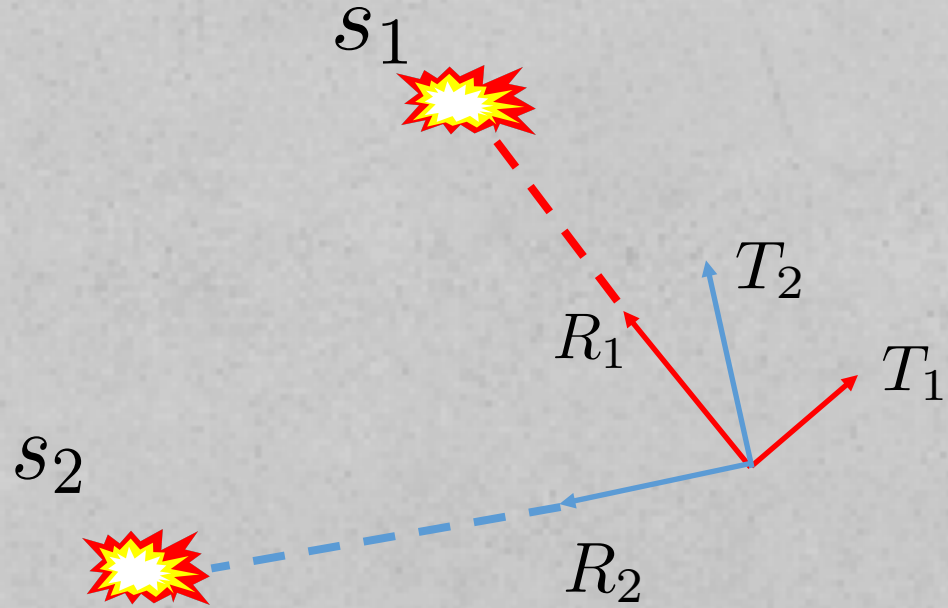
Experiment



Experiment



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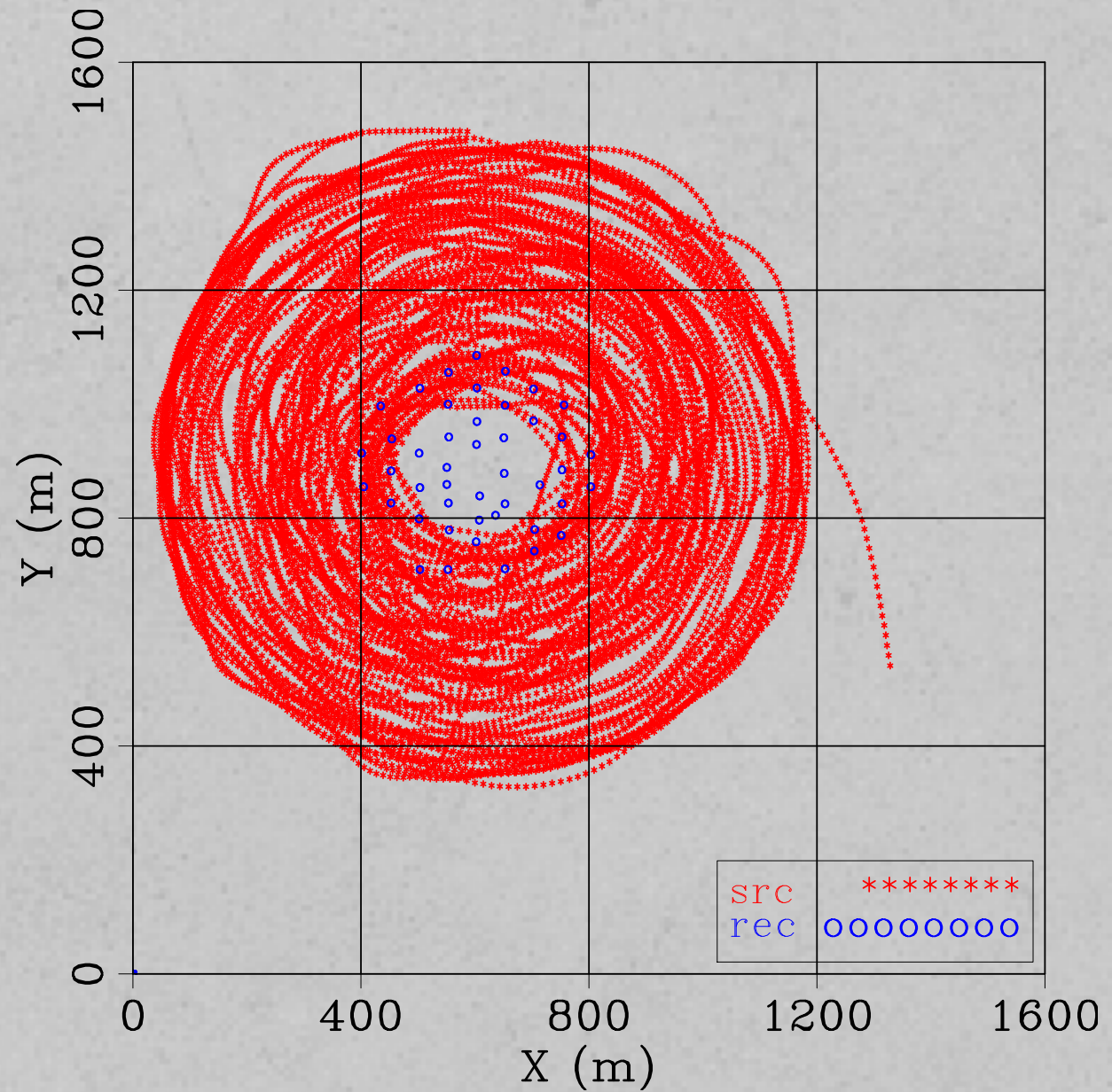


Radiality

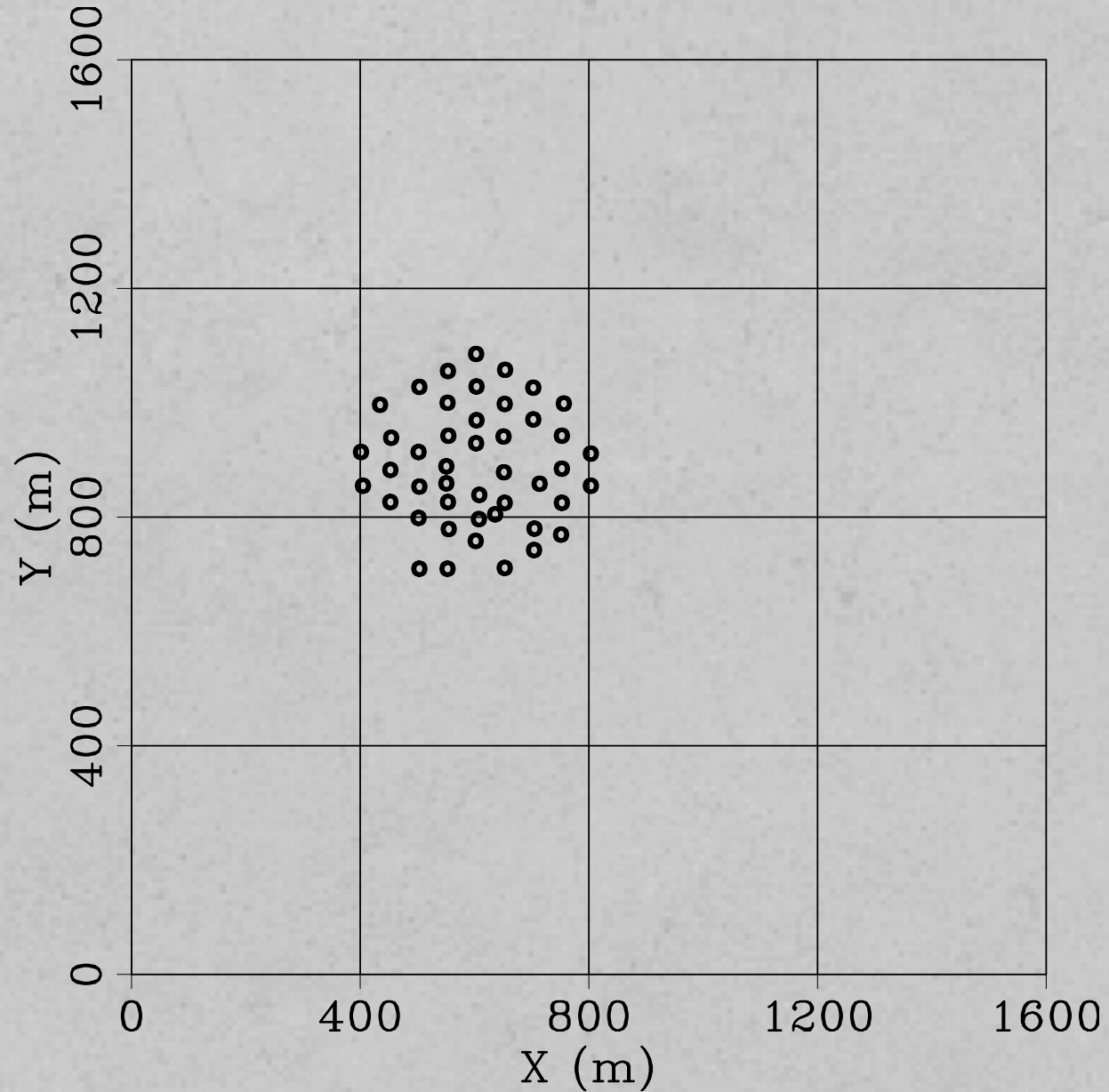
$$\text{Radiality} = \frac{E_{\text{radial}}}{E_{\text{transverse}}}$$

$E \rightarrow$ Envelope of a seismic trace

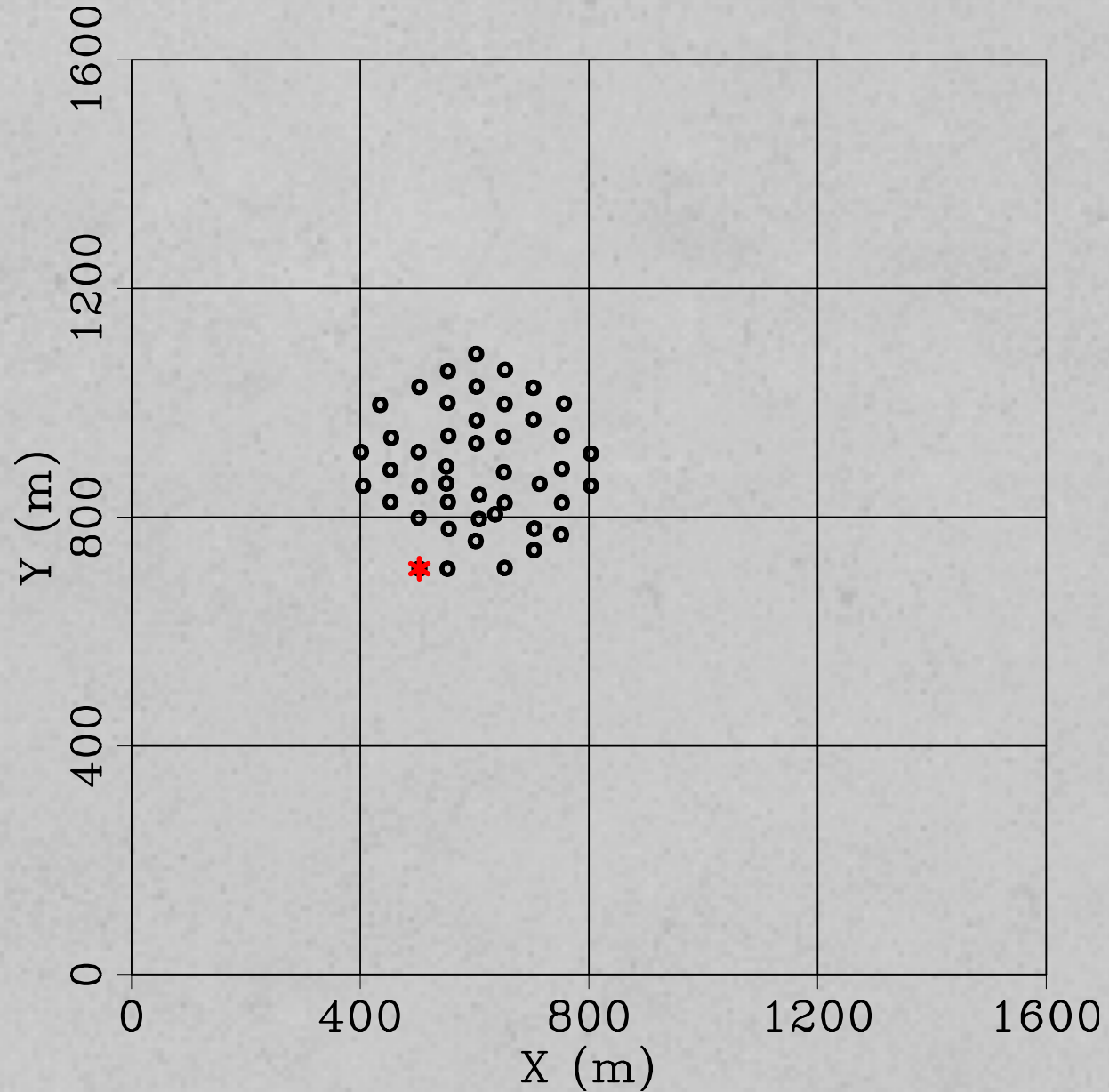
Shot-Recv Map: Delta Platform



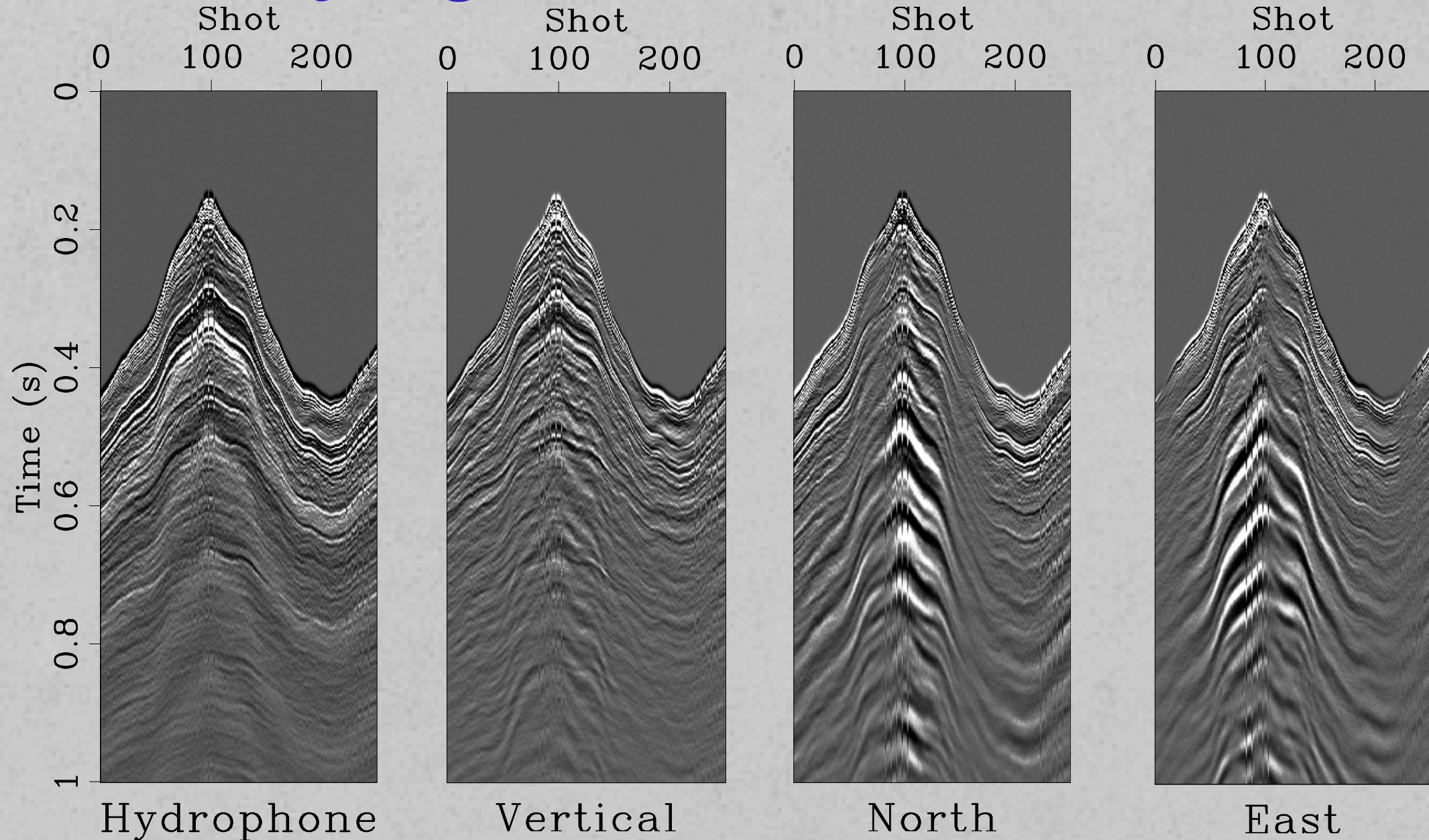
Receiver Map: Delta Platform



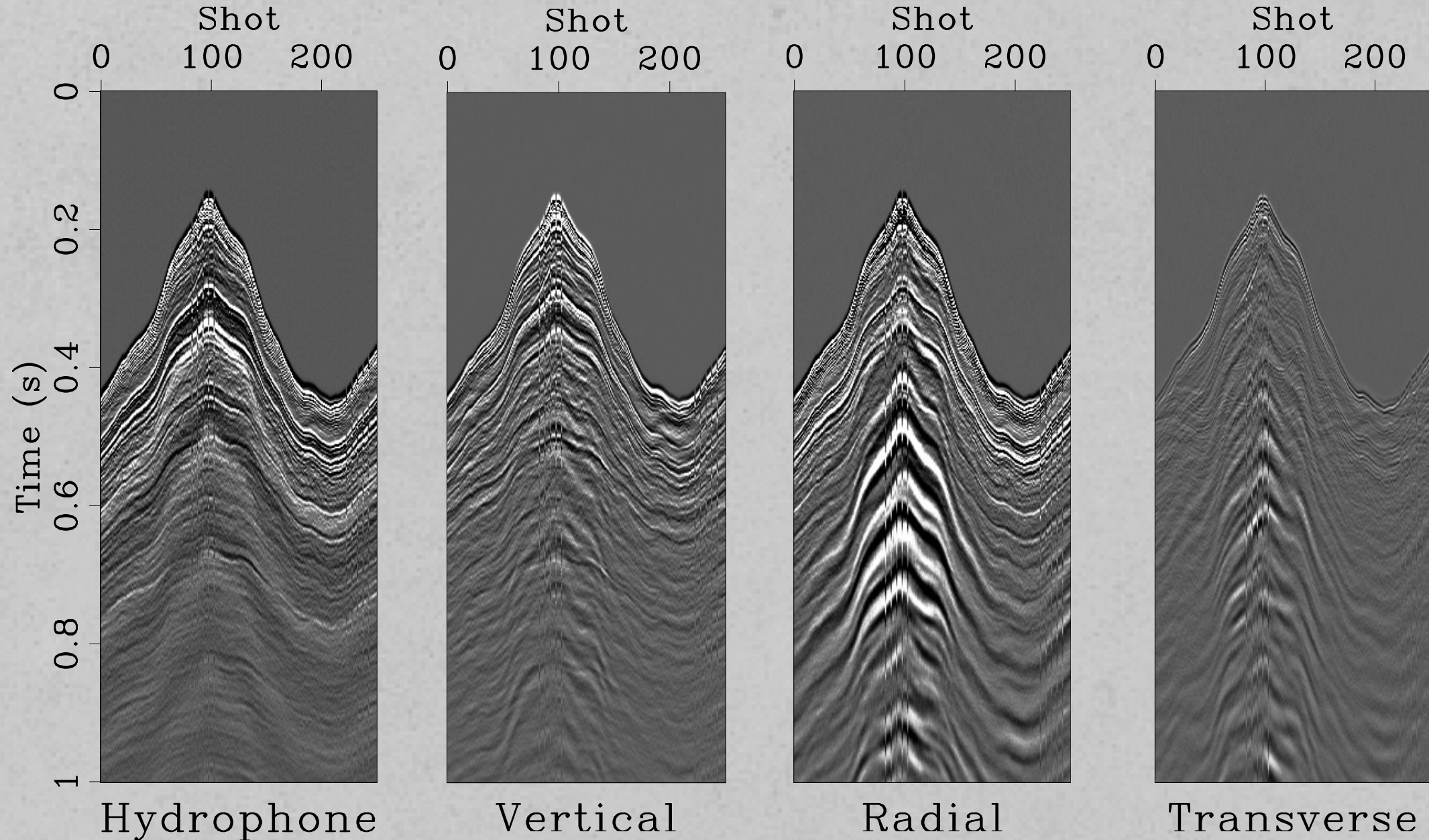
Receiver Map: Delta Platform



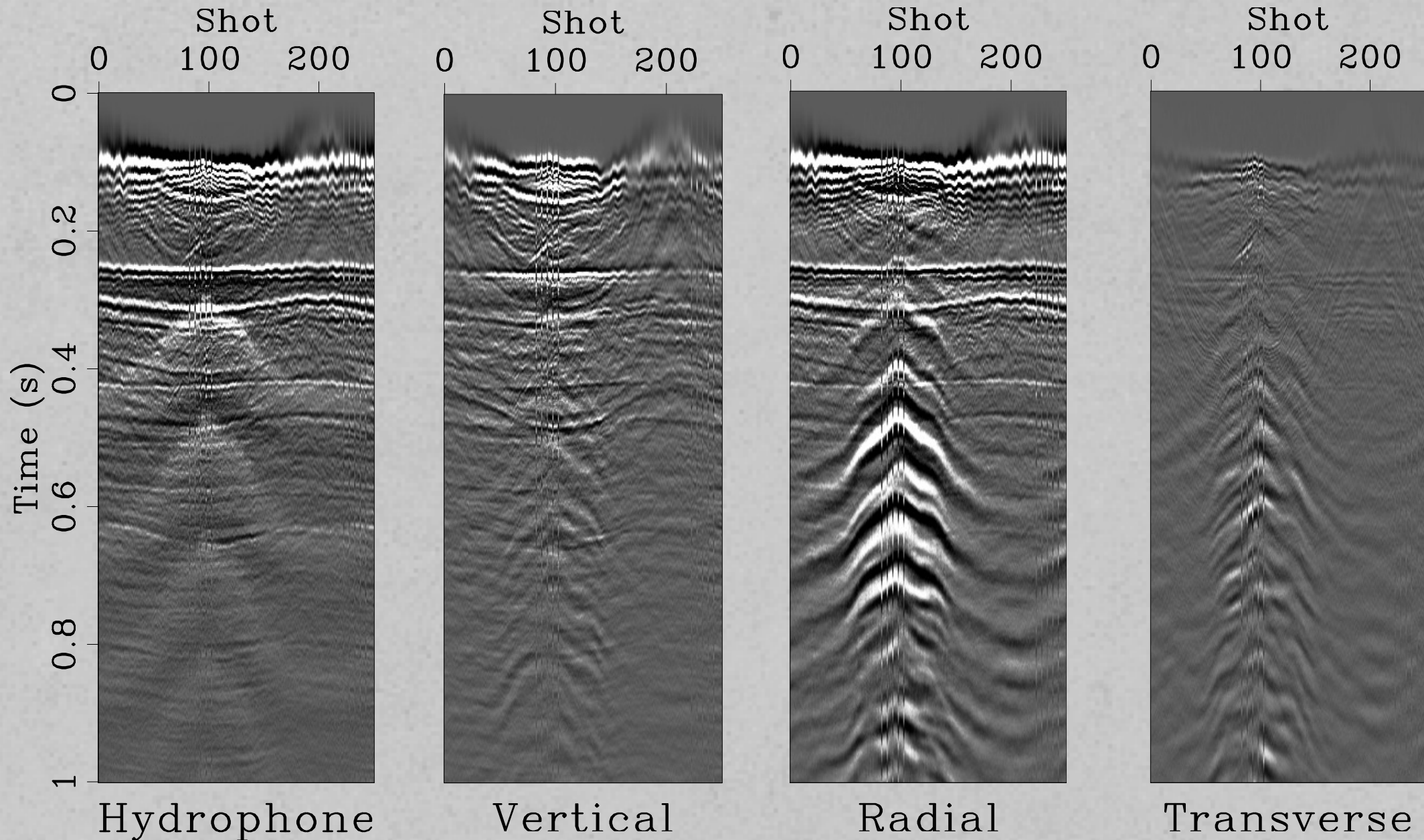
Varying distance from node



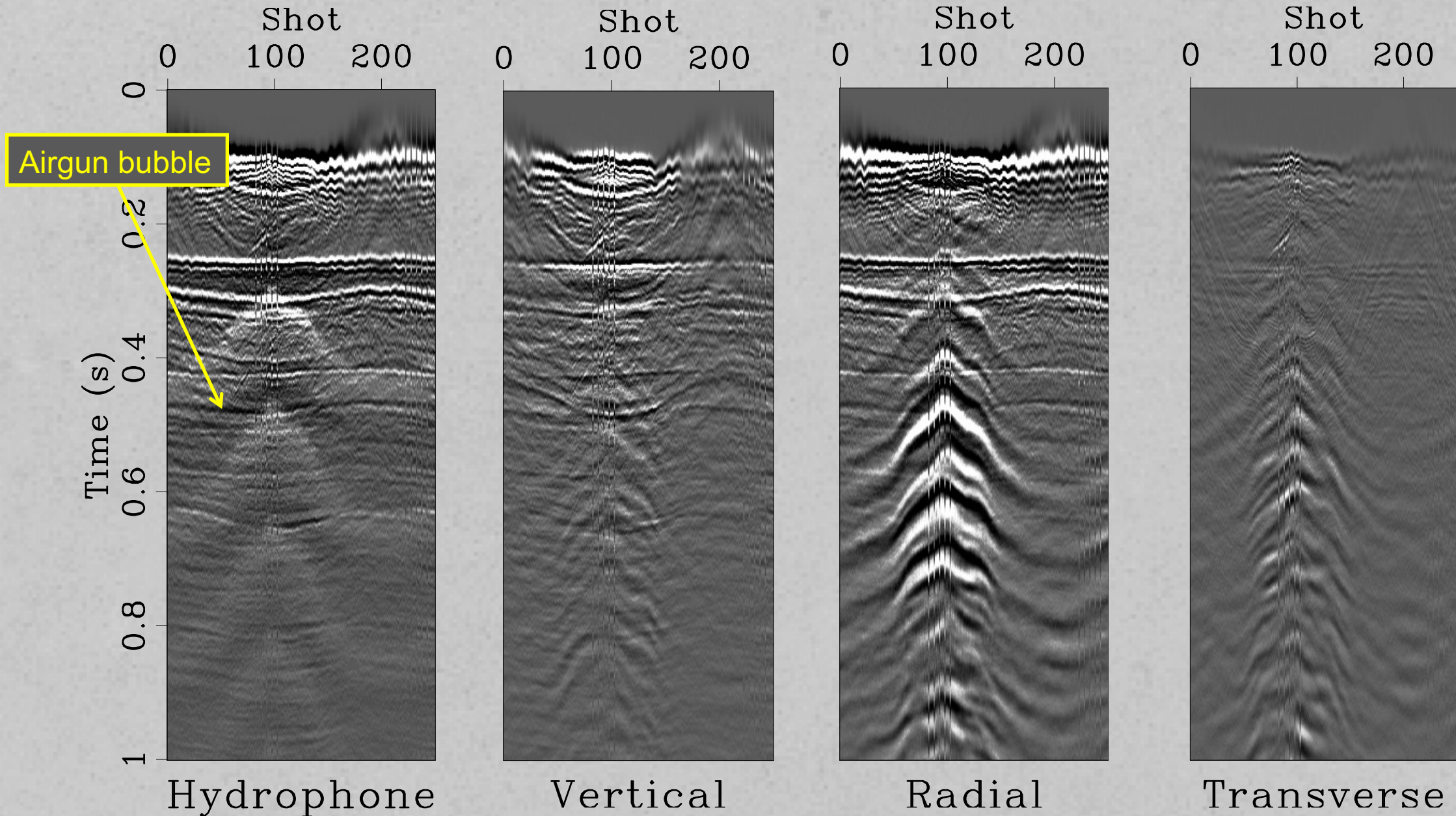
Rotated toward source



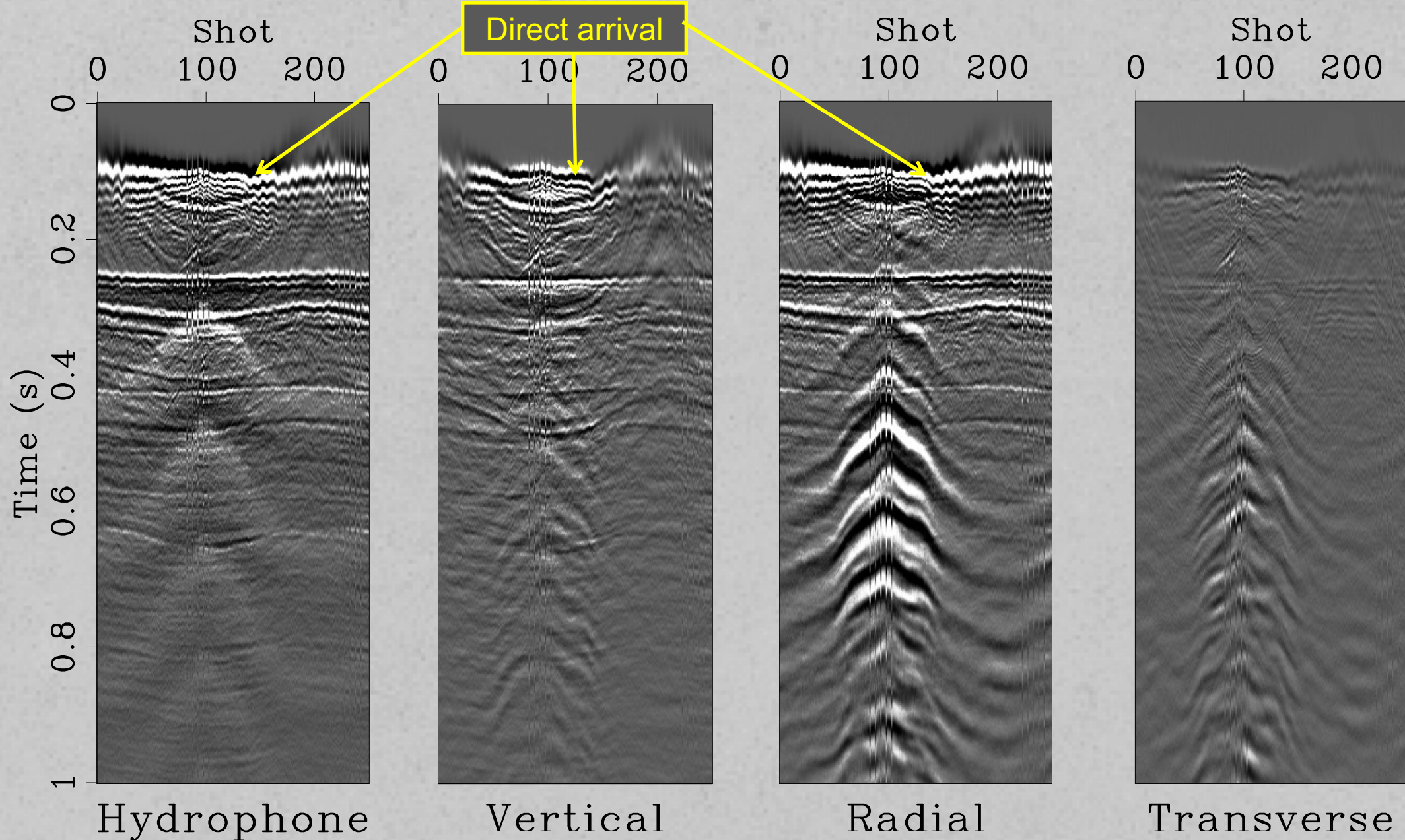
CRG after NMO



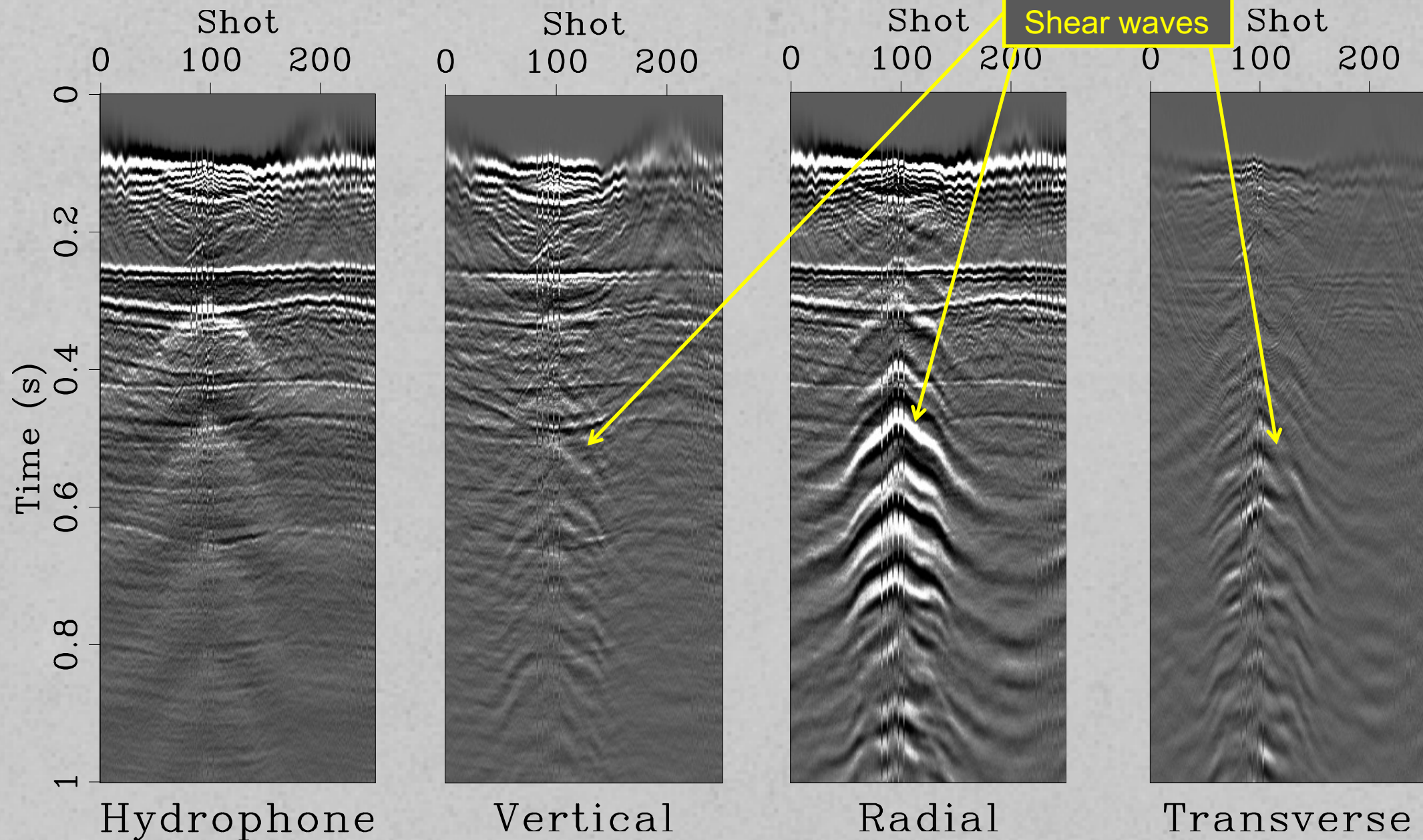
CRG after NMO



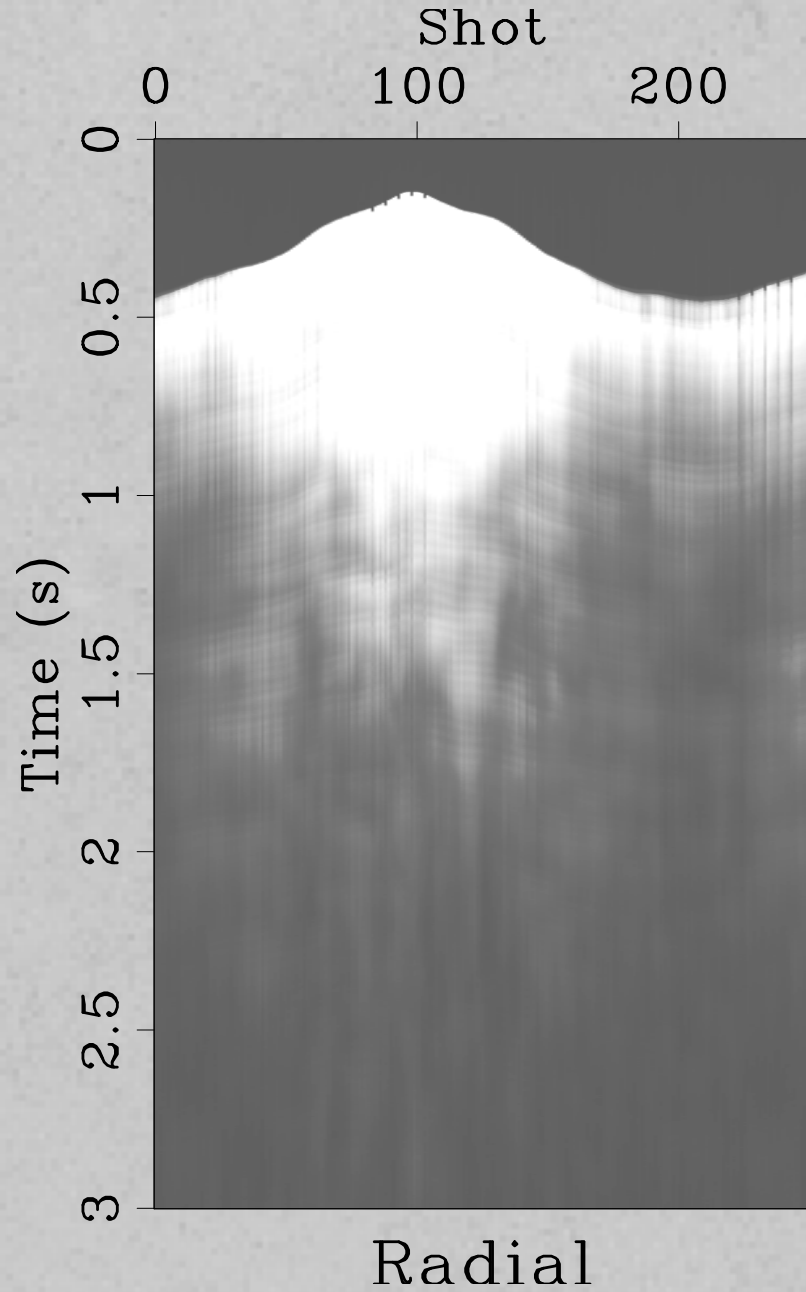
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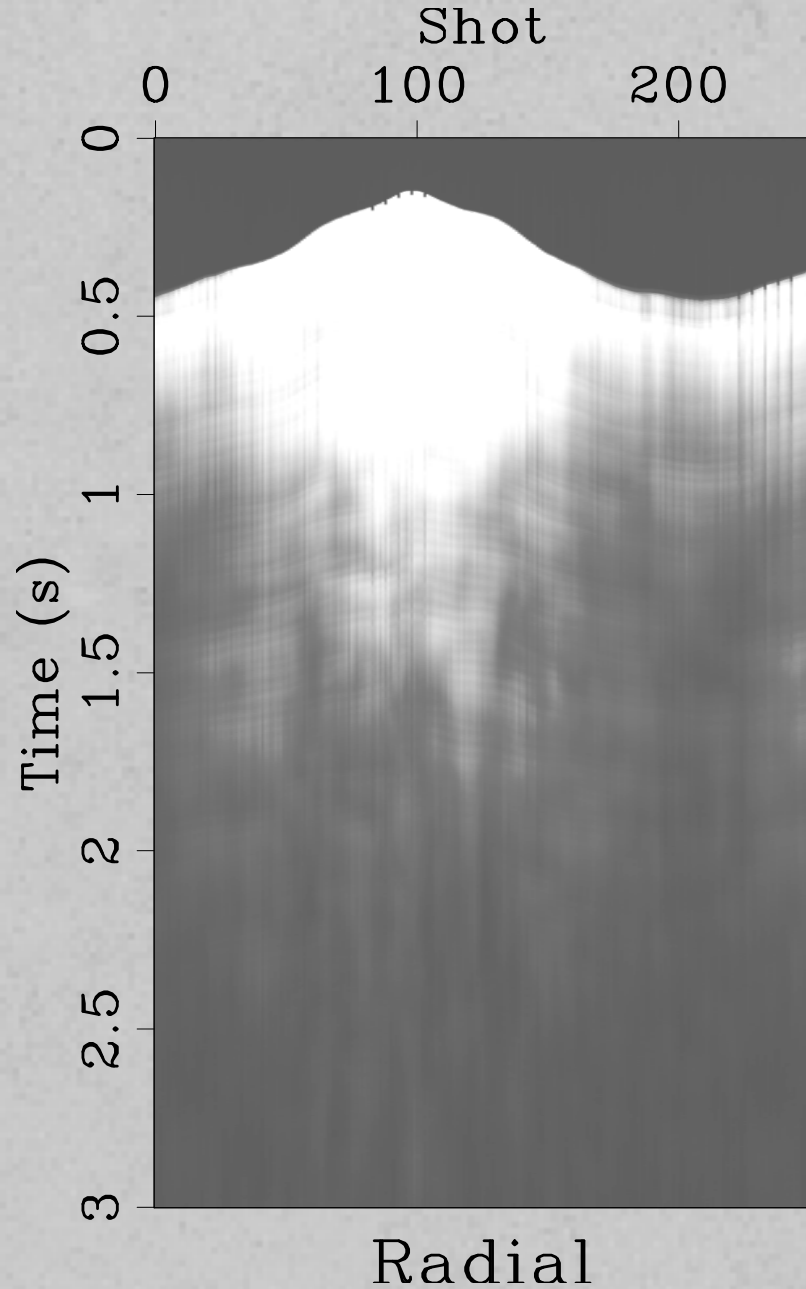
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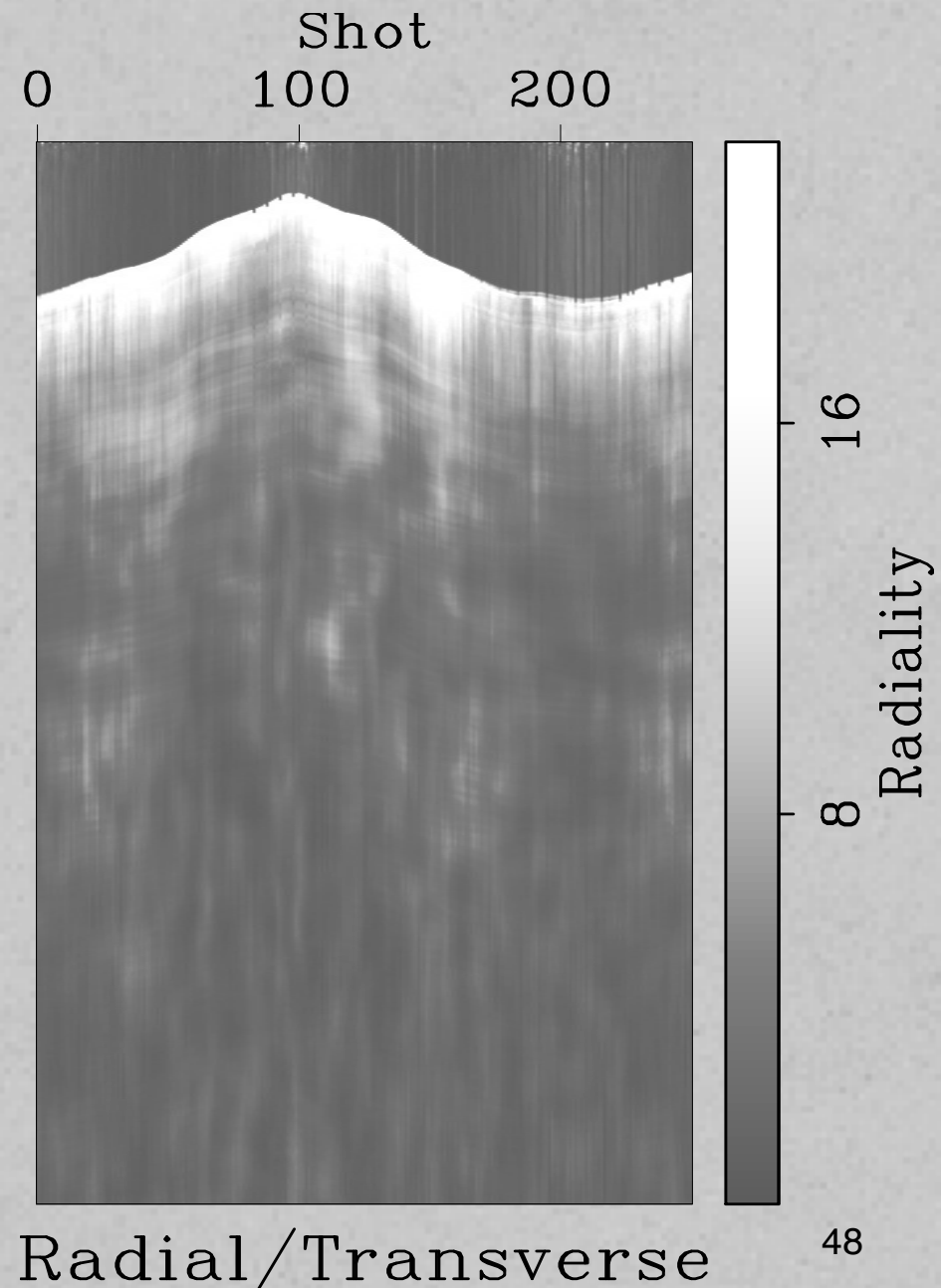
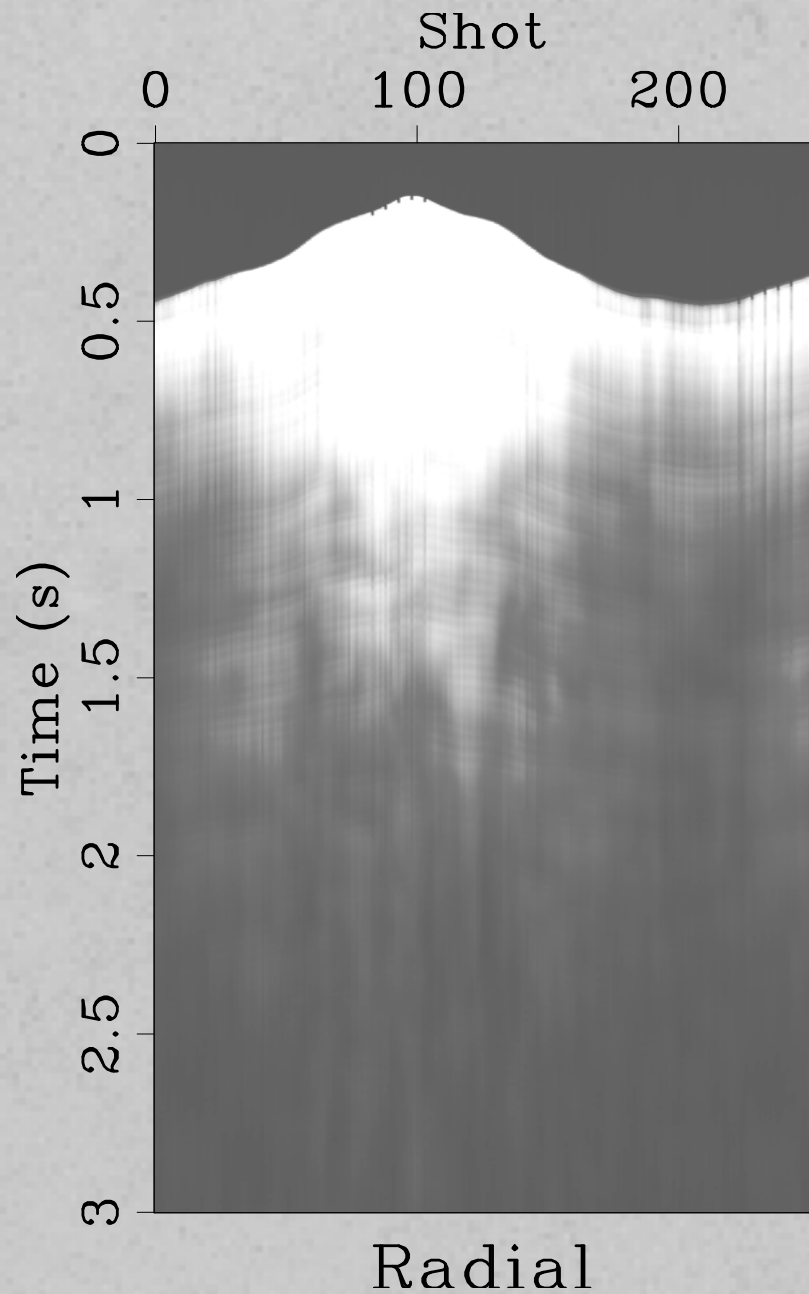
Radiality



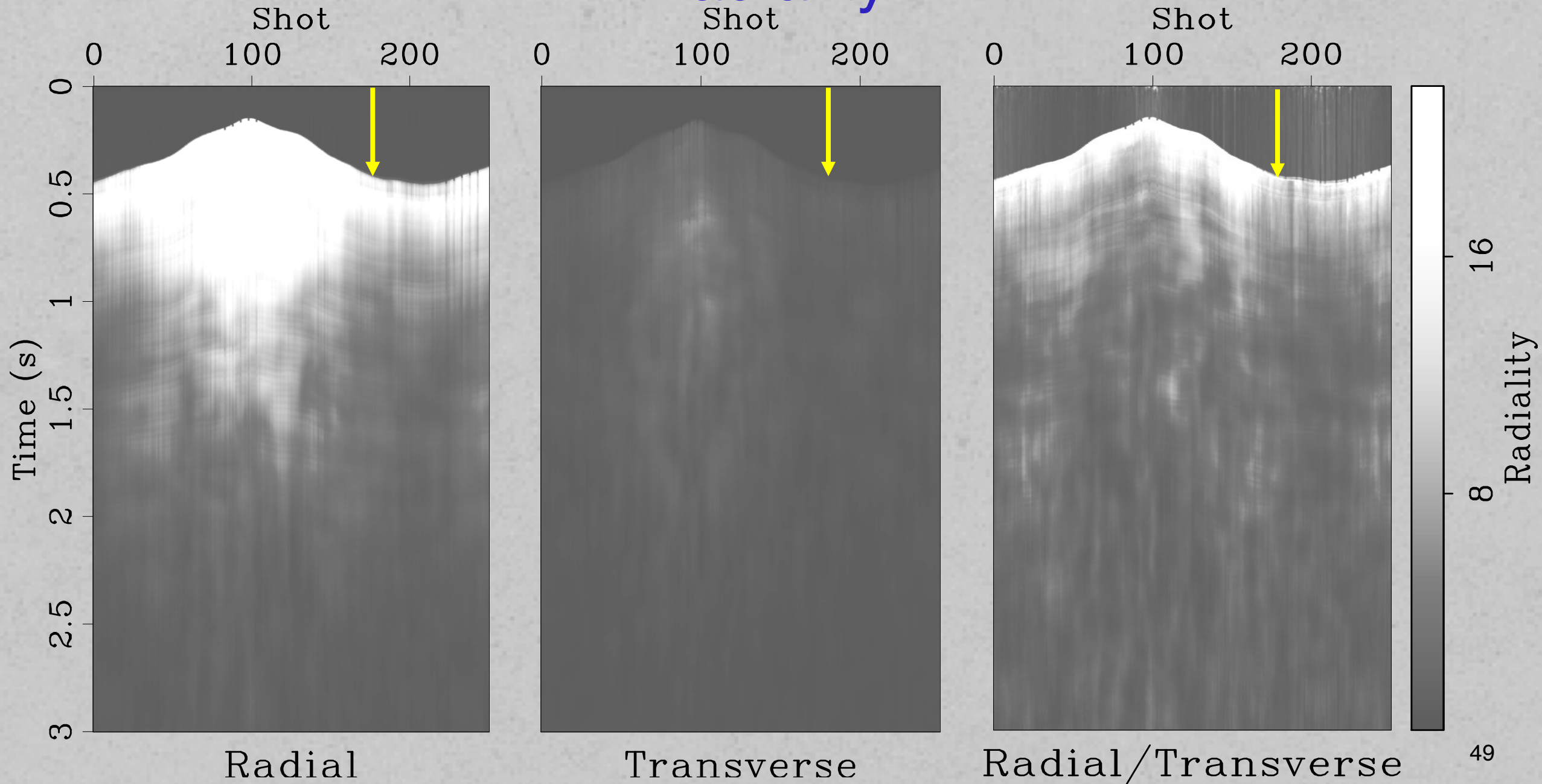
Radiality



Radiality



Radiality



Radiality

Radial



Transverse



Radial/Transverse



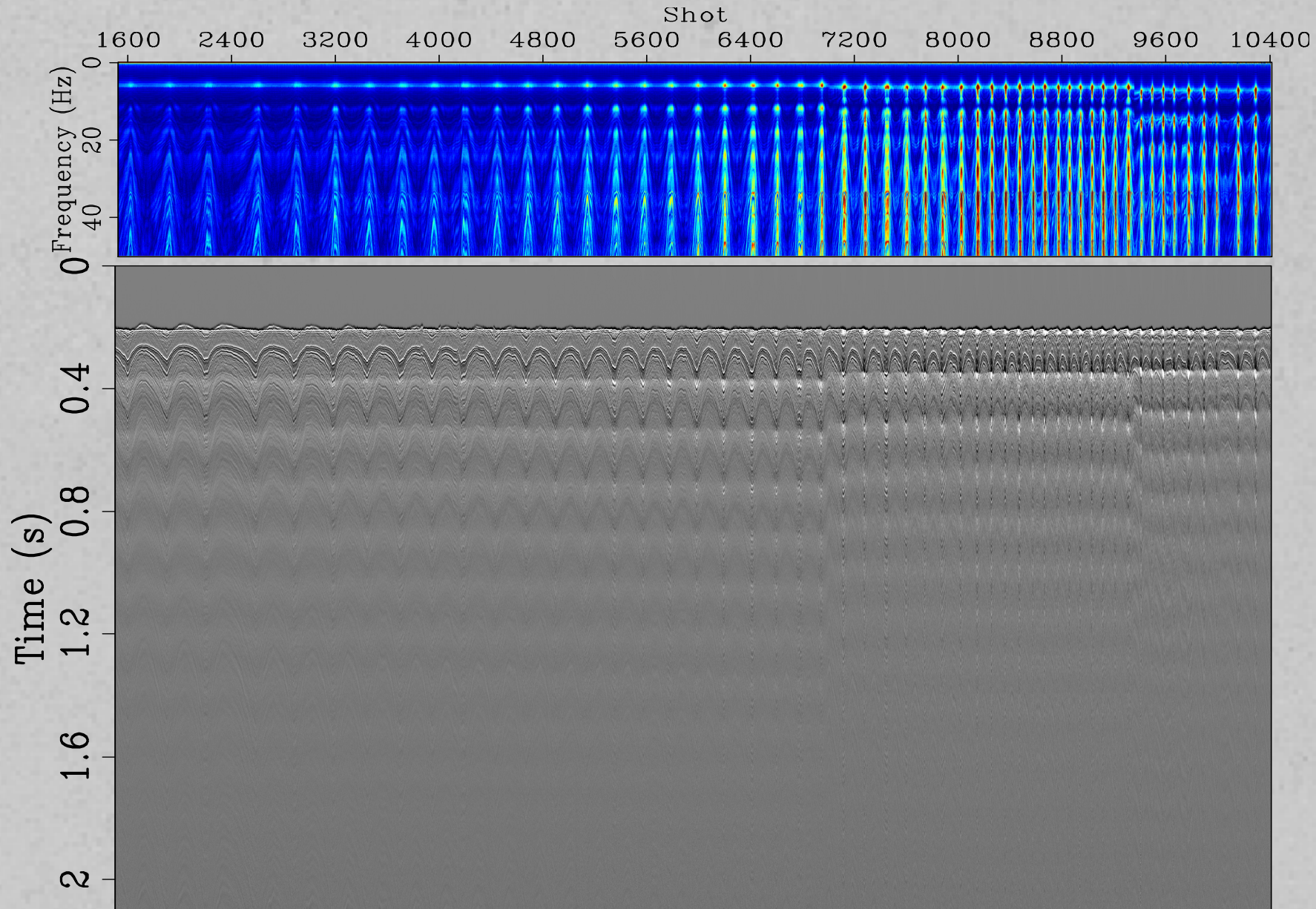
Similarity

How can we get p_1 and p_2 ?

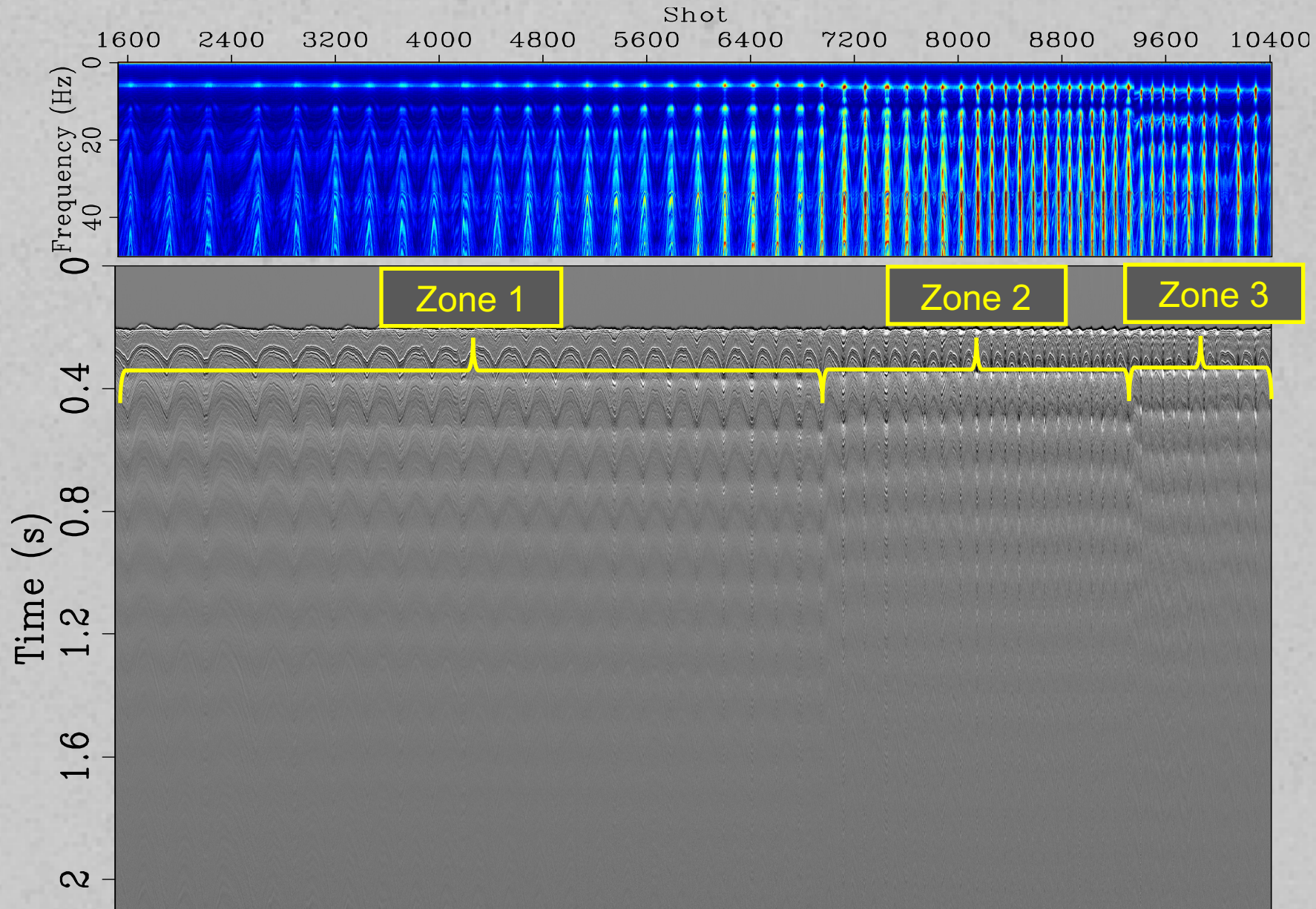
Let's look at two attributes:

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- Similarity – changes in source signature

CRG and spectrum after flattening direct



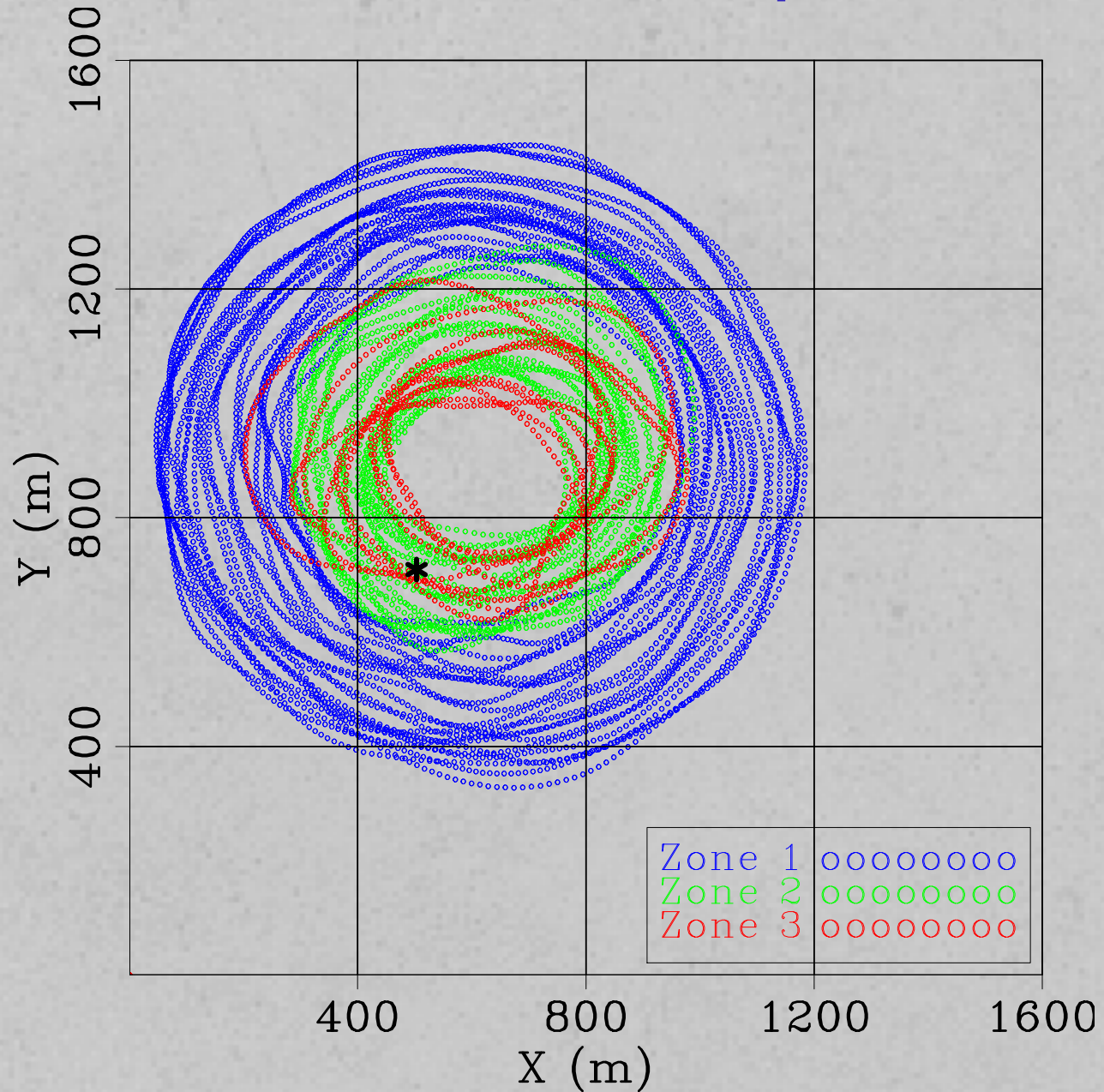
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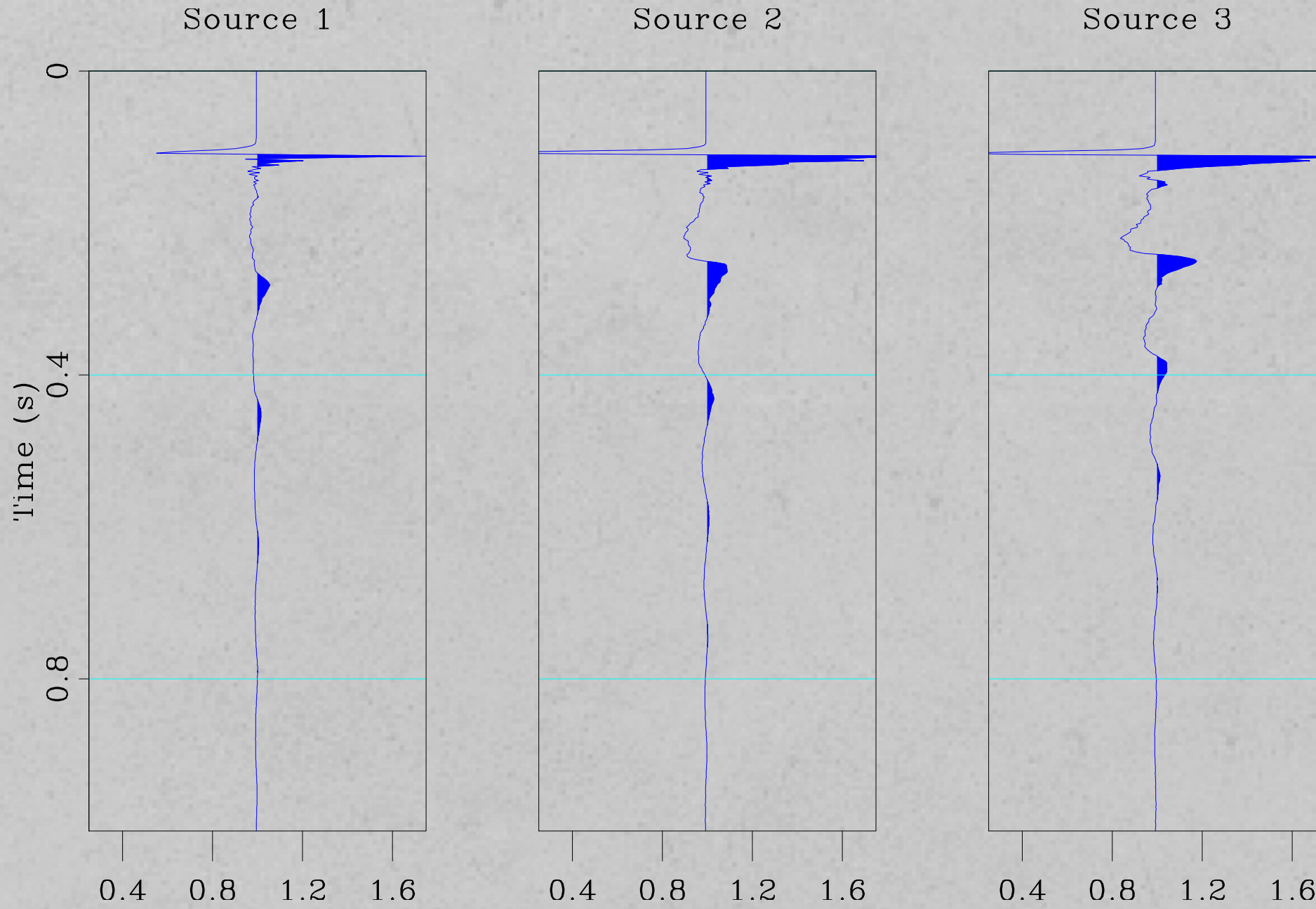
Airgun failure



Zone map



Extracted sources



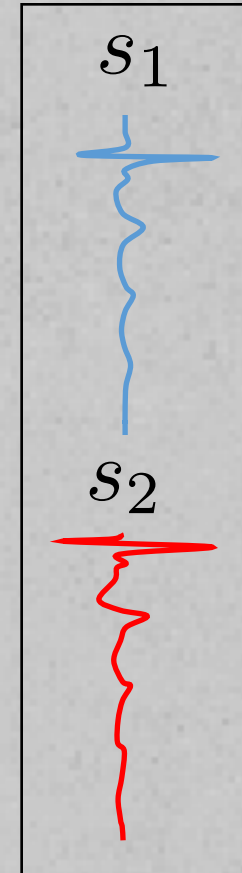
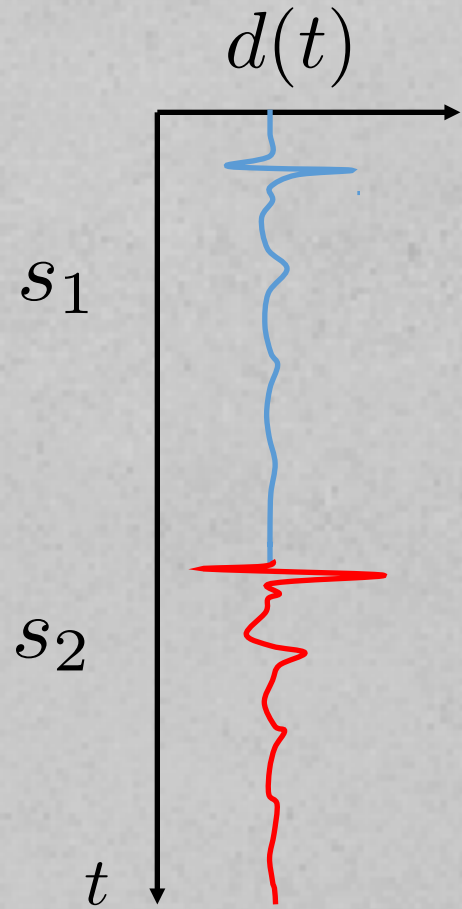
Similarity

$$S_{12} = \frac{\max_t(d_1 \star d_2)}{\sqrt{\max_t(d_1 \star d_1)\max_t(d_2 \star d_2)}}$$

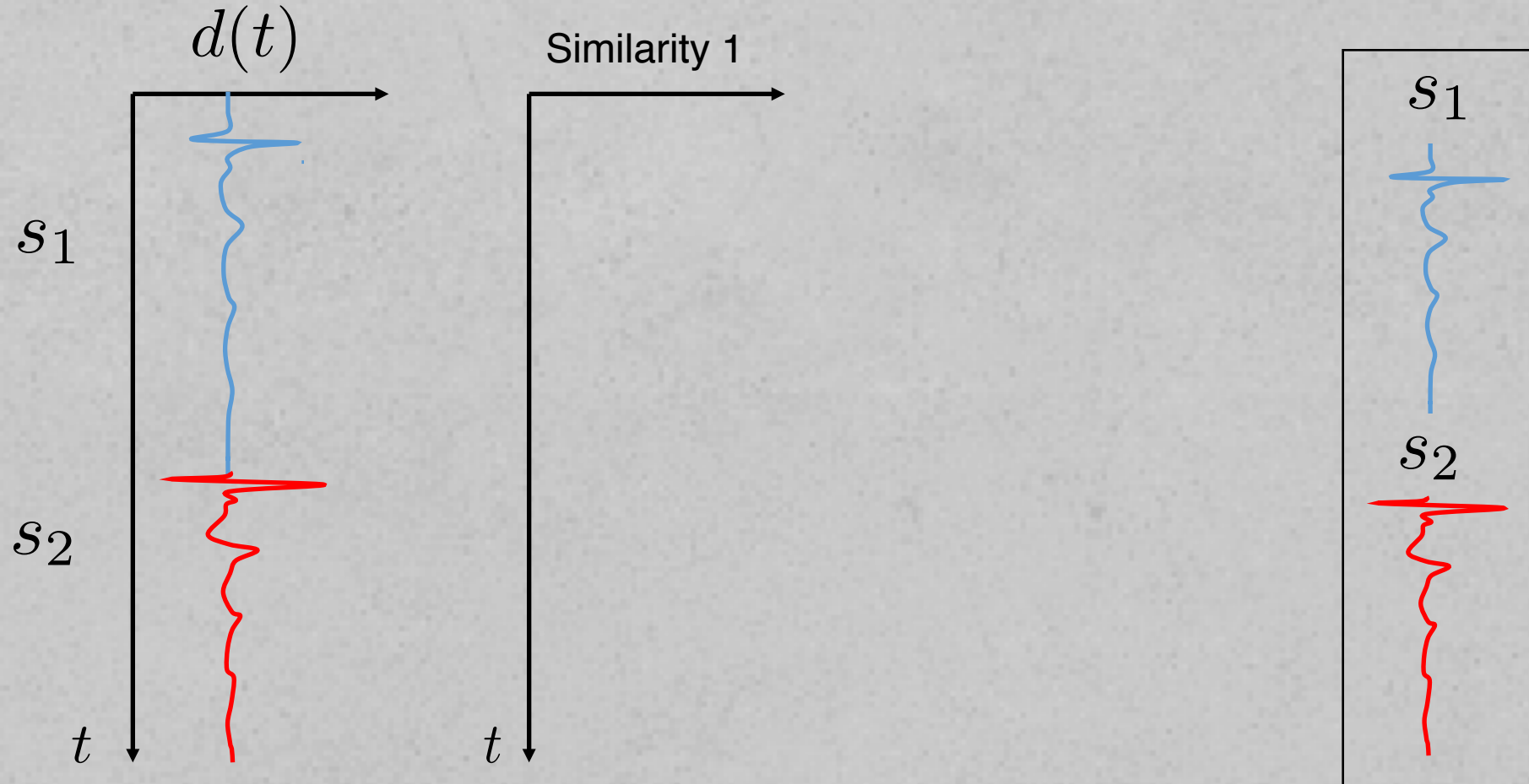
★ – cross-correlation

d – seismic trace

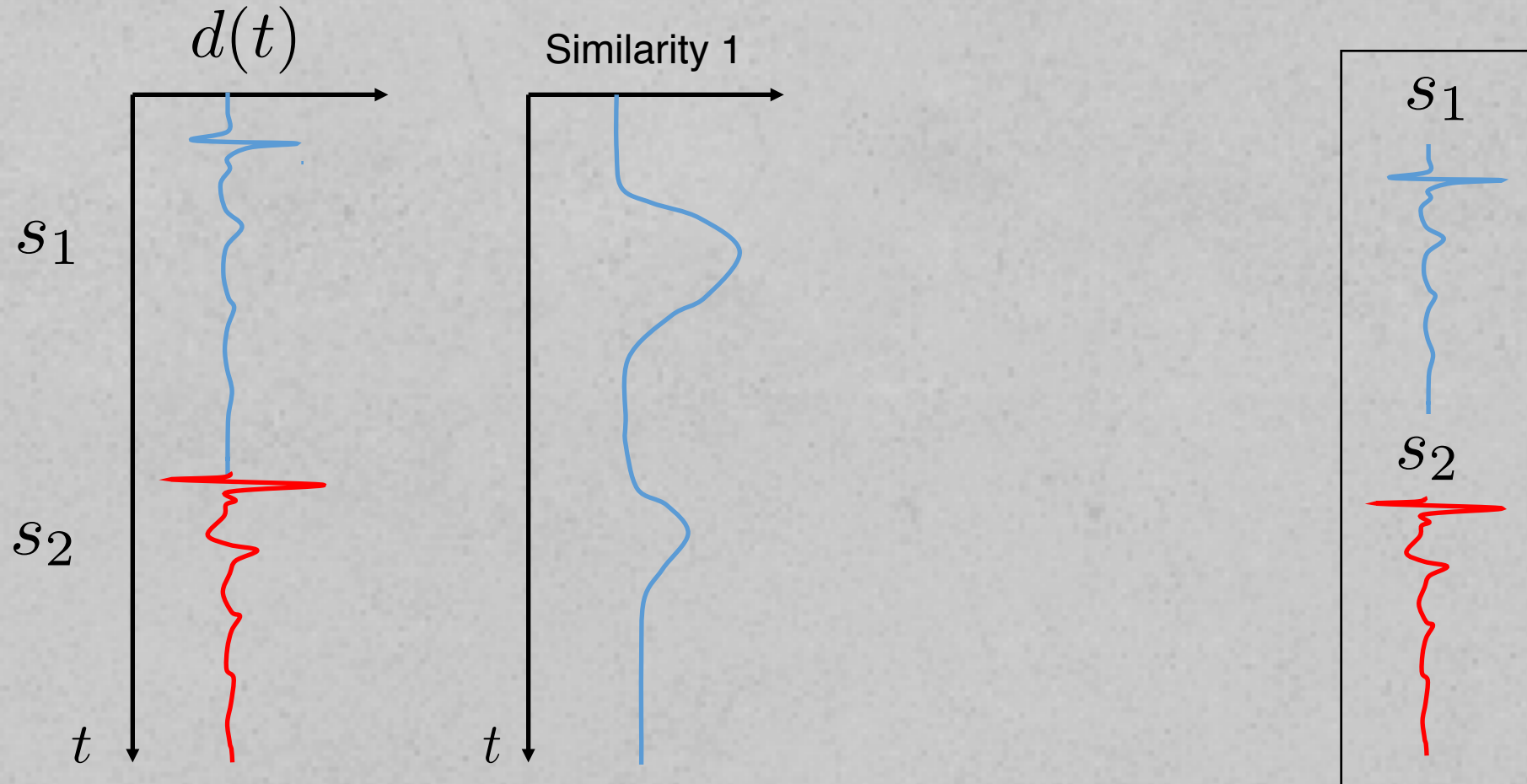
Similarity



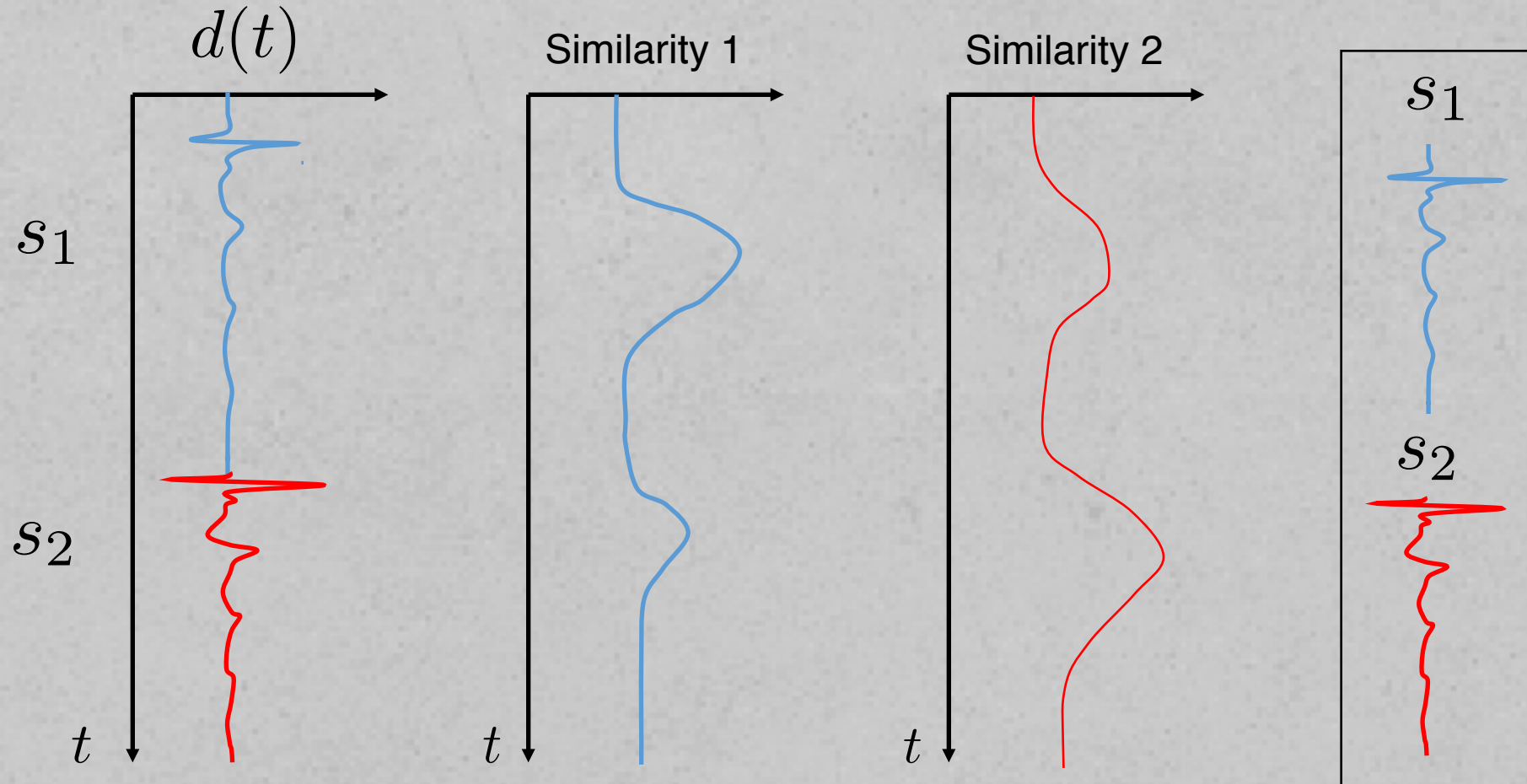
Similarity



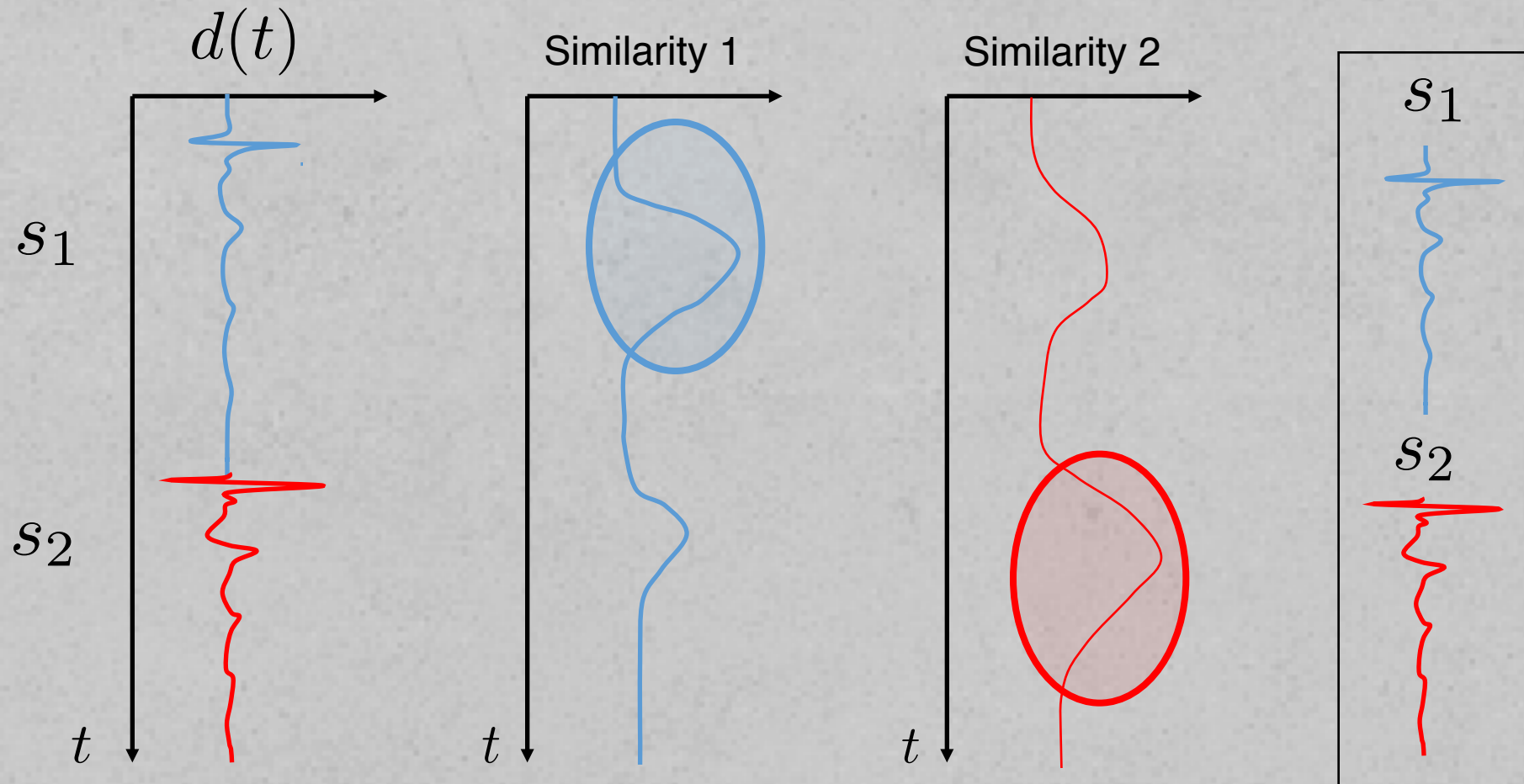
Similarity



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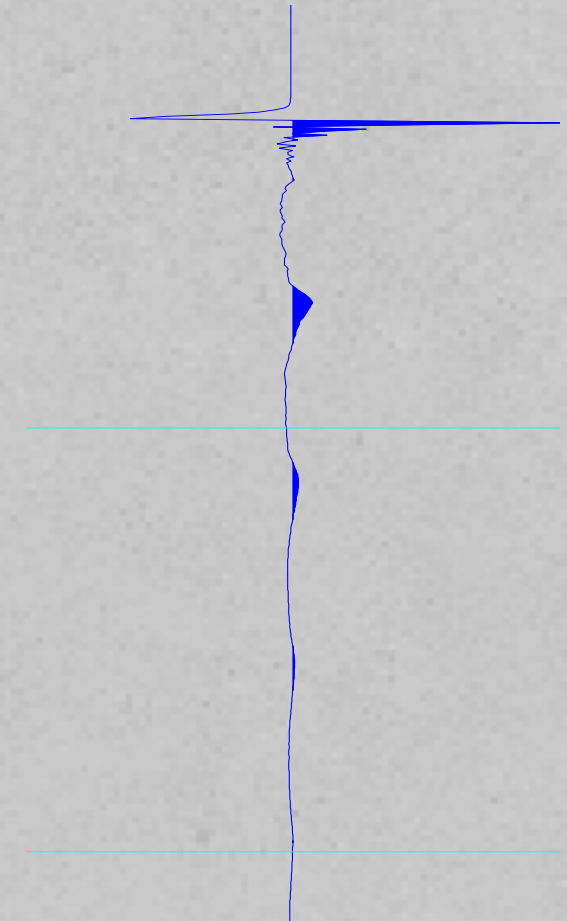


Similarity

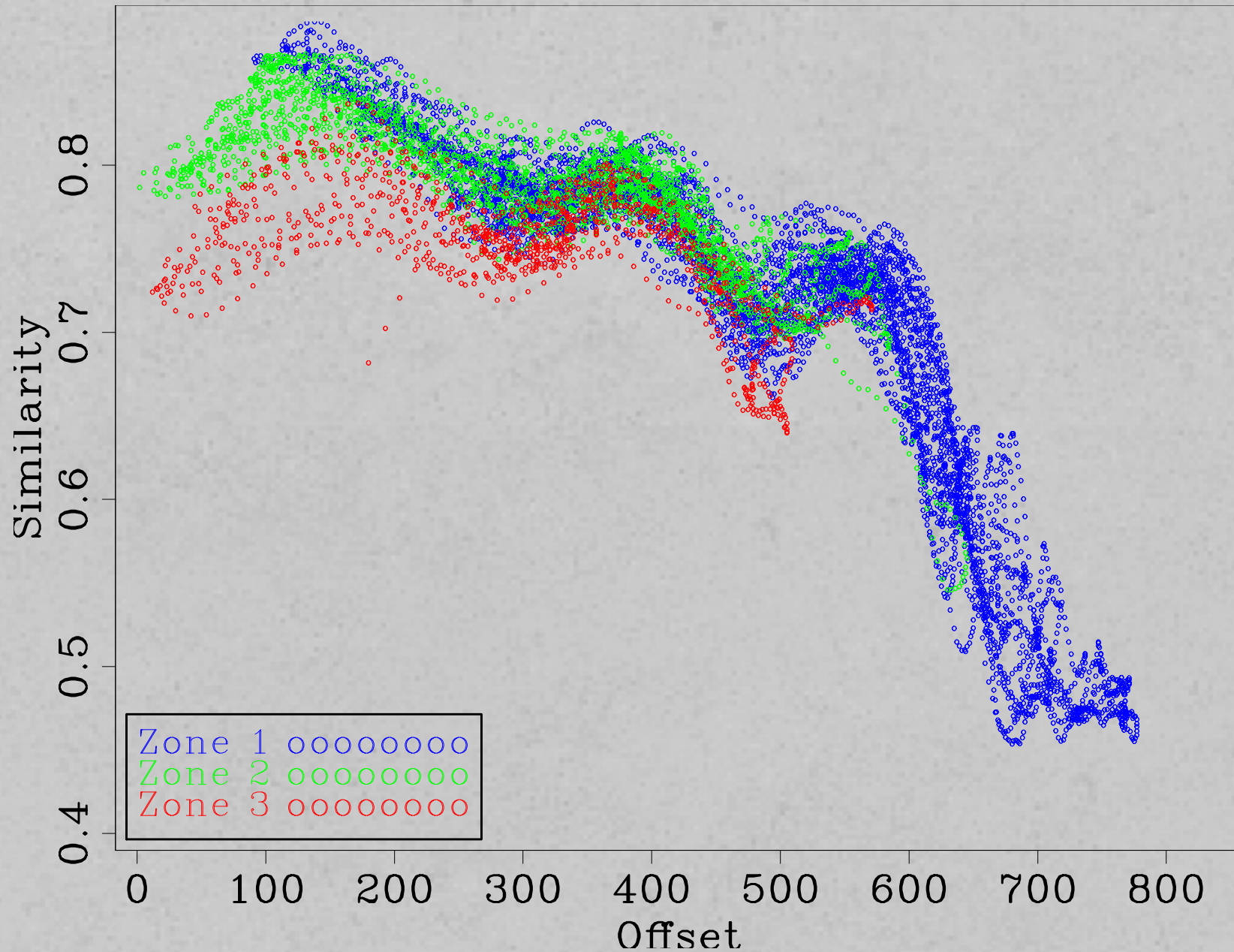


All traces correlated with source 1

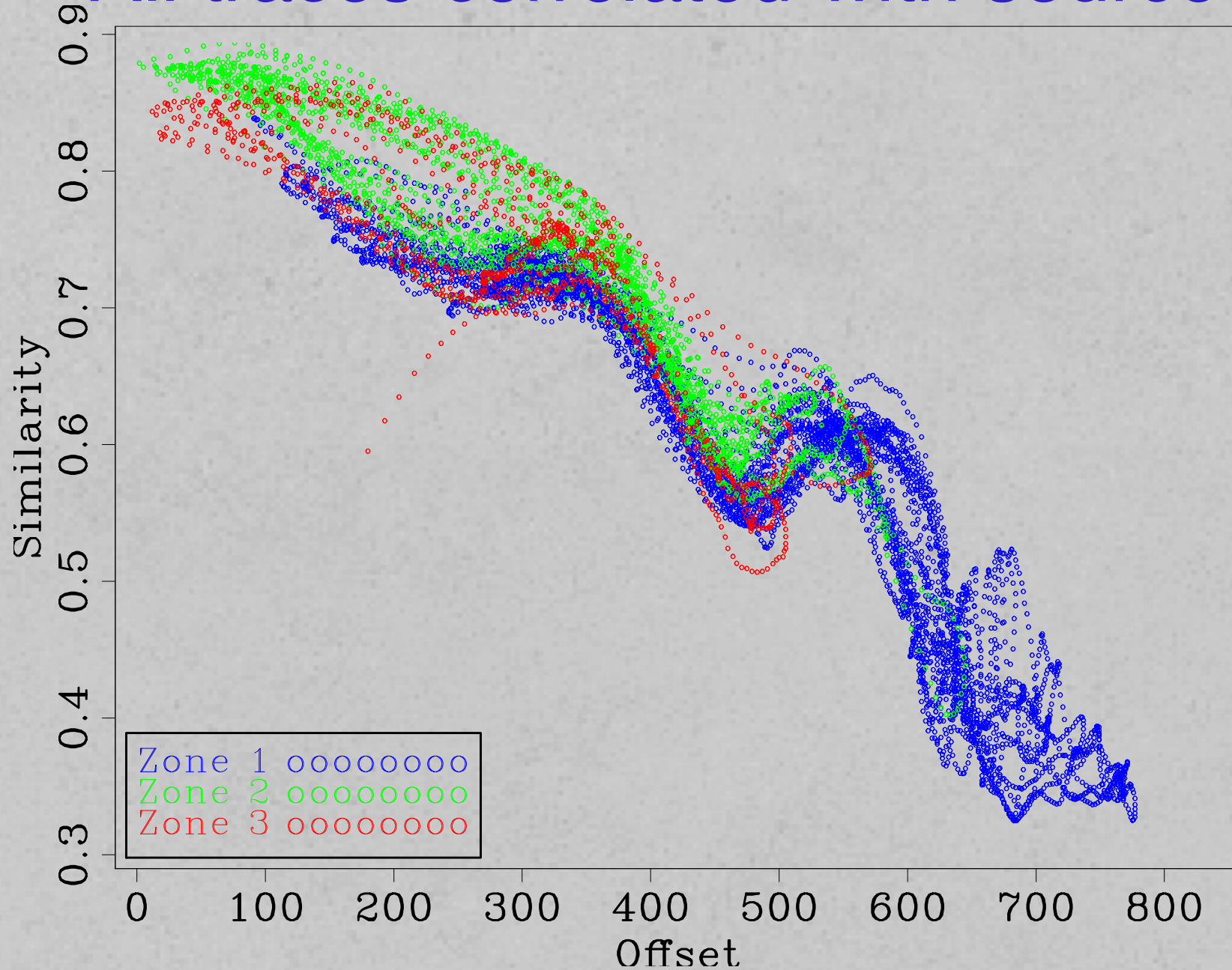
Source 1



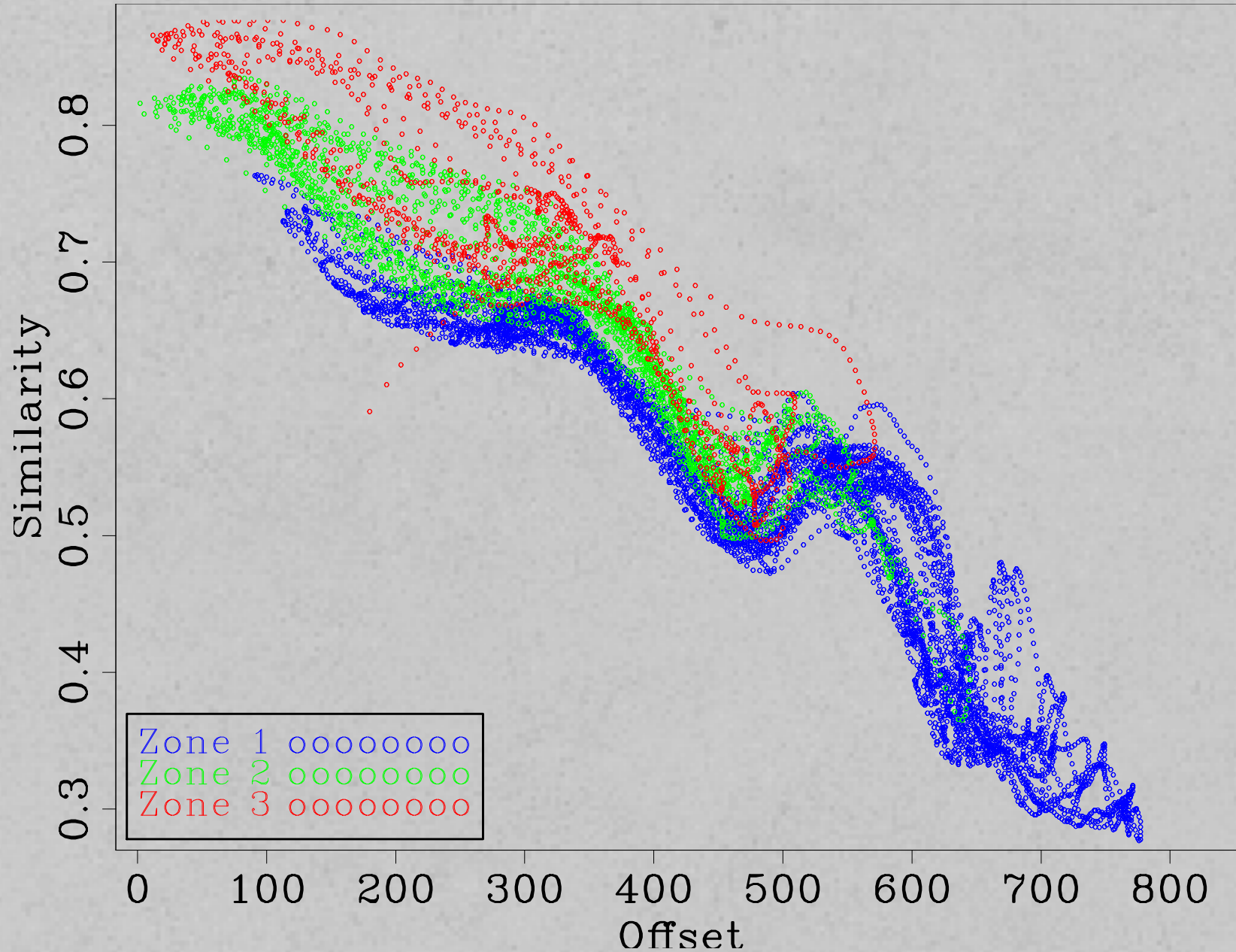
All traces correlated with source 1



All traces correlated with source 2



All traces correlated with source 3



Summary

What we have shown:

- Radiality and similarity attributes

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 - Mostly radial energy
 - Detect changing source signature

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What we plan to do:

1. Blend the data
2. Compute radiality and similarity
3. Incorporate into inversion schemes

Questions?