

# Multicomponent DAS prototype sensors - the pretzel and the croissant

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**NSERC  
CRSNG**



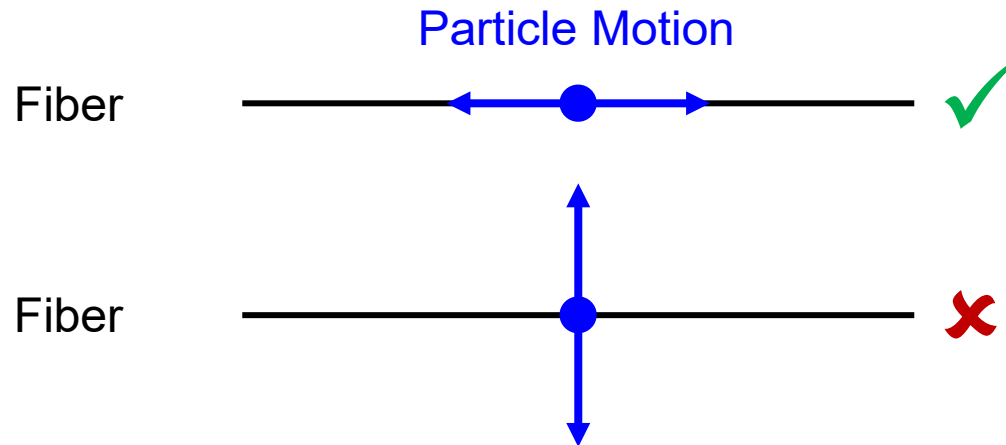
**UNIVERSITY OF CALGARY**  
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Fiber broadside insensitivity makes it a poor choice for multi-component seismic surveys:

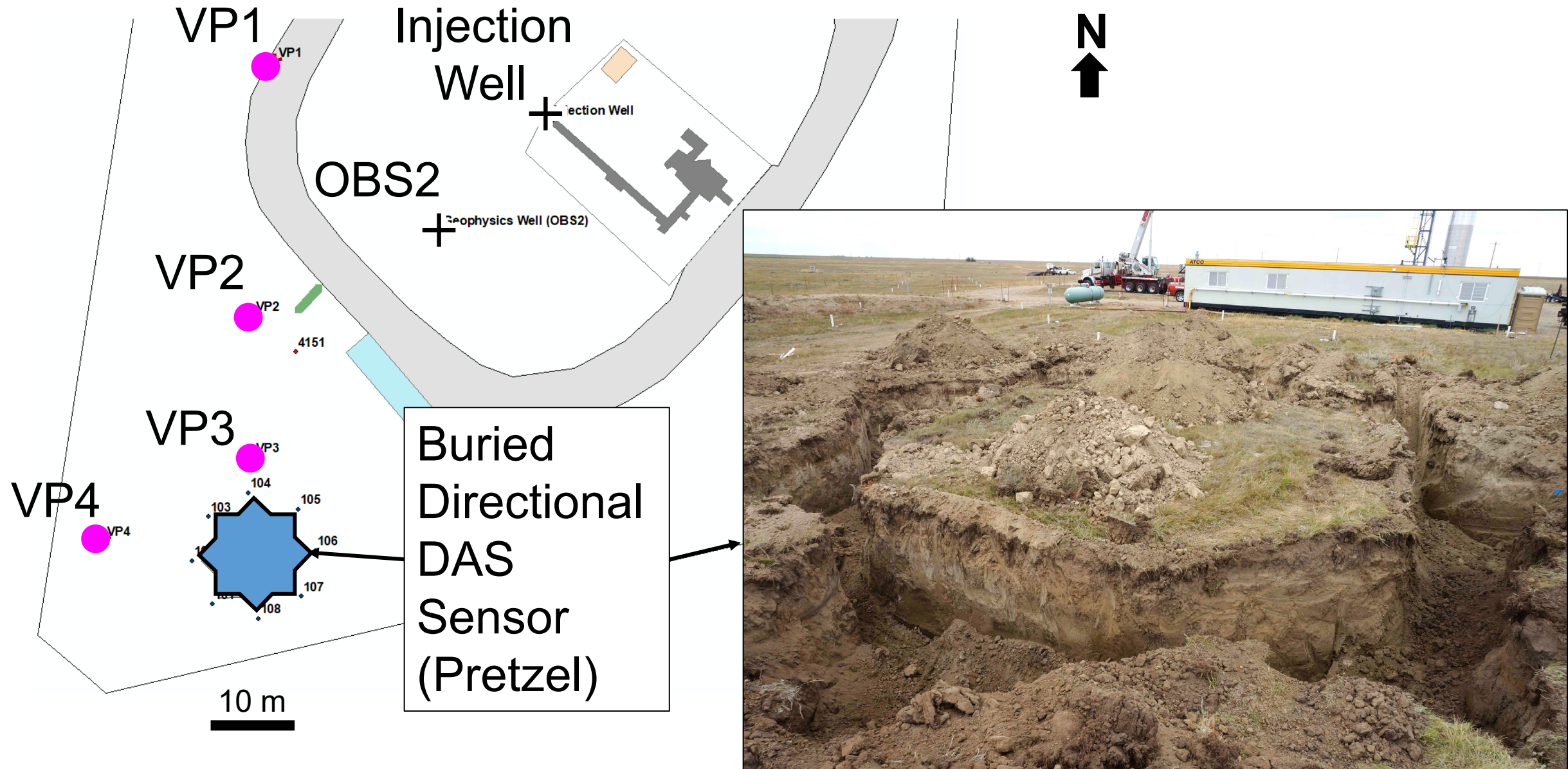


We are designing permanent directional fiber sensor that will be suitable for multi-component monitoring work

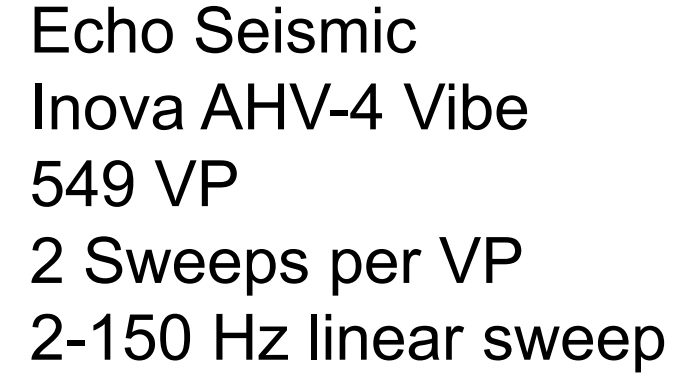
This talk shows results from:

- Hall, K. W., Innanen, K. A., and Lawton, D. C., 2022, Multi-azimuth and offset directional strain tensor results recorded on an experimental directional sensor.: CREWES Research Report, 34, 18, 8.
- Hall, K. W., Innanen, K. A., and Lawton, D. C., 2022, The croissant: a smaller, fluffier, flakier pretzel: CREWES Research Report, 34, 19, 9.



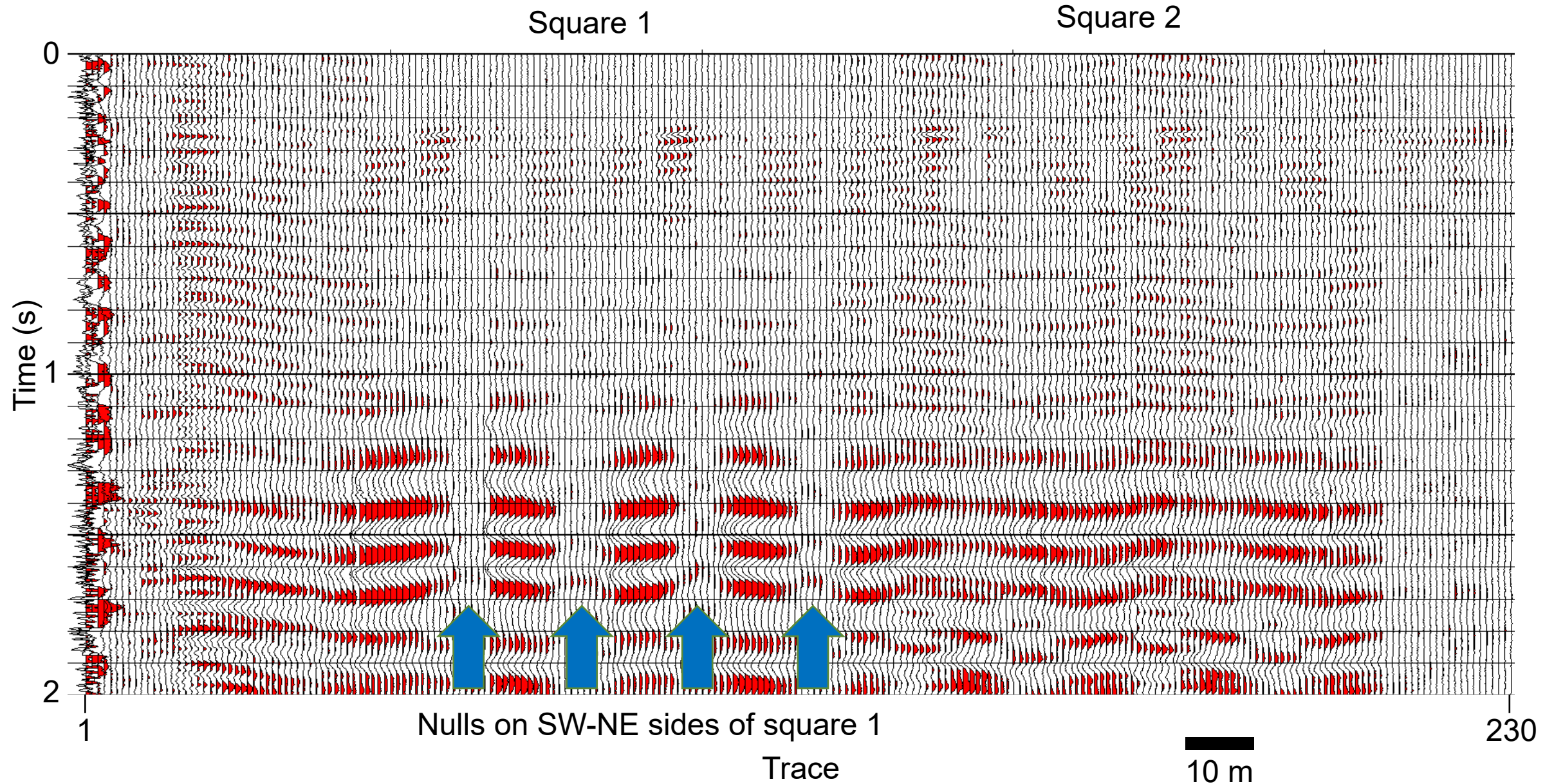






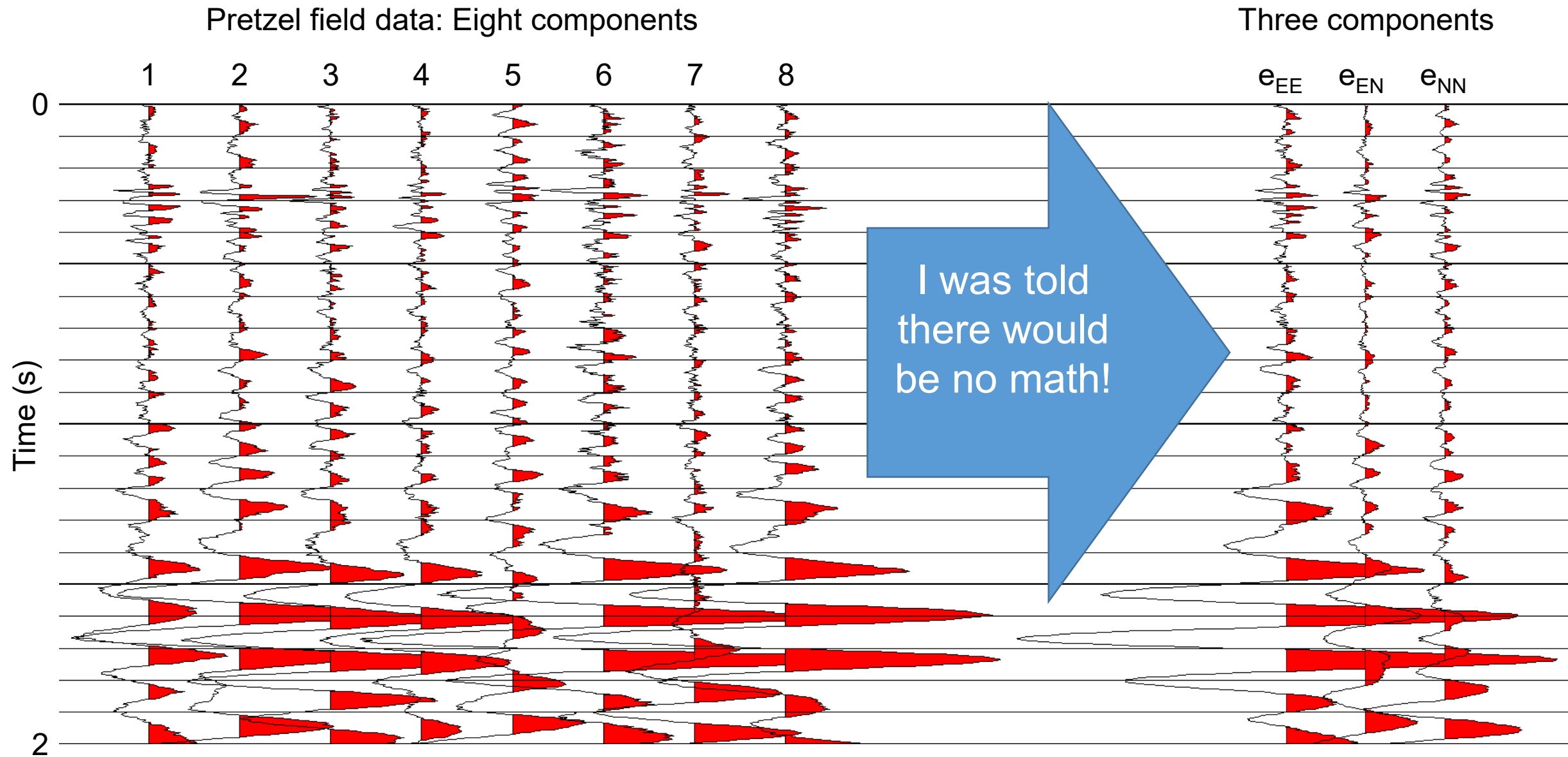


# Pretzel 2022: VP 10101, 470 m from Pretzel, straight fiber cable





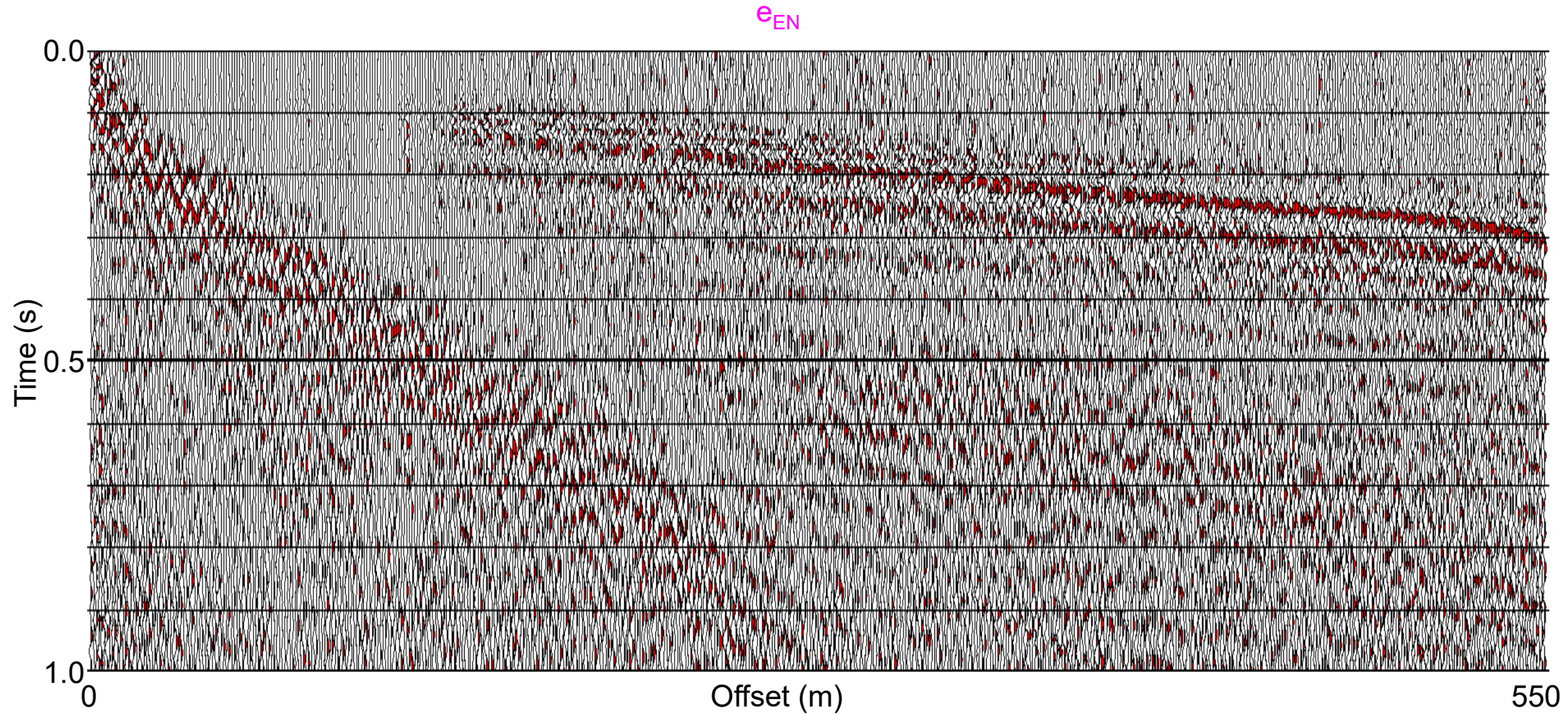
# Pretzel 2022: VP 1101 Tensor Estimation







# Pretzel 2022: All VP, $e_{EN}$ component







Logistically: We need a smaller sensor to better approximate a point receiver, and for ease of burial. We also need vertical component data.

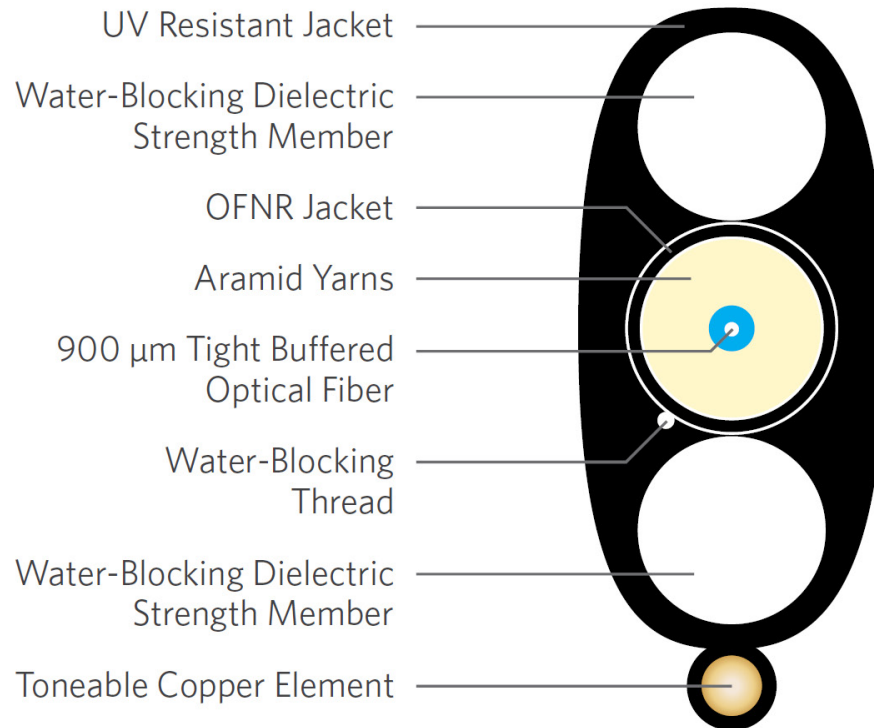
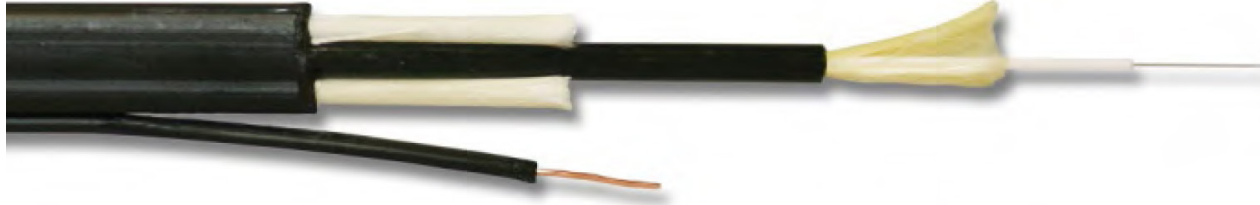
Questions:

1. What happens if the length of each side of the fiber loops is smaller than the gauge length?
  - Directionality effects observable in the data?
  - Confirm no polarity reversals
2. How many wraps are required in each fiber loop?
  - Guessing: two gauge lengths minimum



# Croissant: Fiber Cable

Toneable FTTP Tight Buffered Indoor/Outdoor Drop Series W7T



<https://SuperiorEssex.com>

Single-mode fiber cable that can be buried and can be bent around small radius corners with minimal signal loss

We bought a 500 m spool

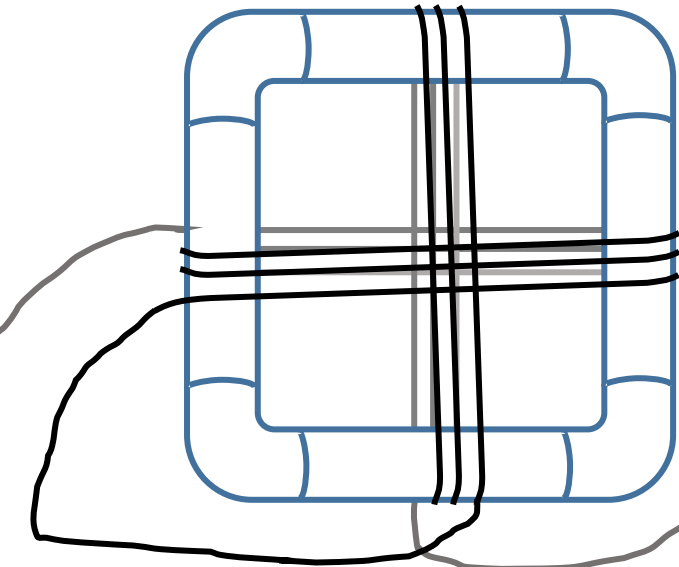




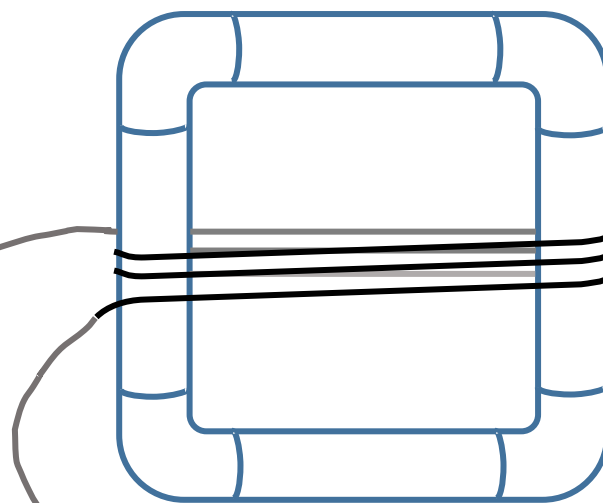
## 3C design

- 2 1x1 m frames constructed with 4" (10 cm) diameter ABS pipe
- Fiber wrapped around the frames in three orientations.
- Frames buried in two vertical orientations
  - Needs two trenches instead of one pit

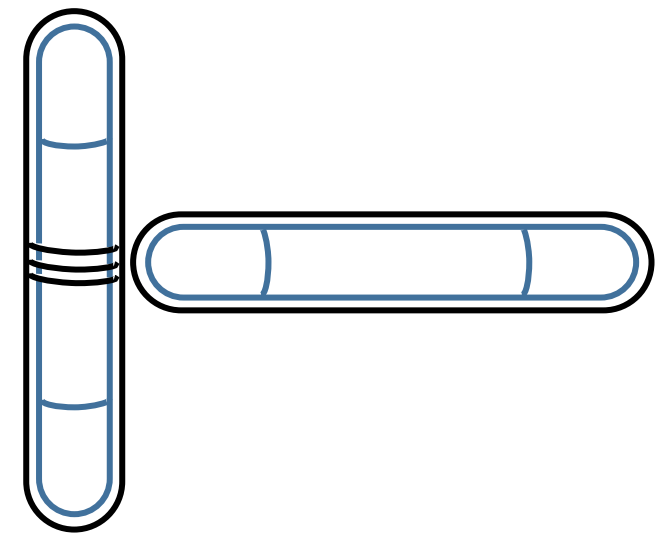
Side view  
Vertical and Horizontal 1



Side view  
Horizontal 2



Top view  
Vertical, Horizontal 1 and 2



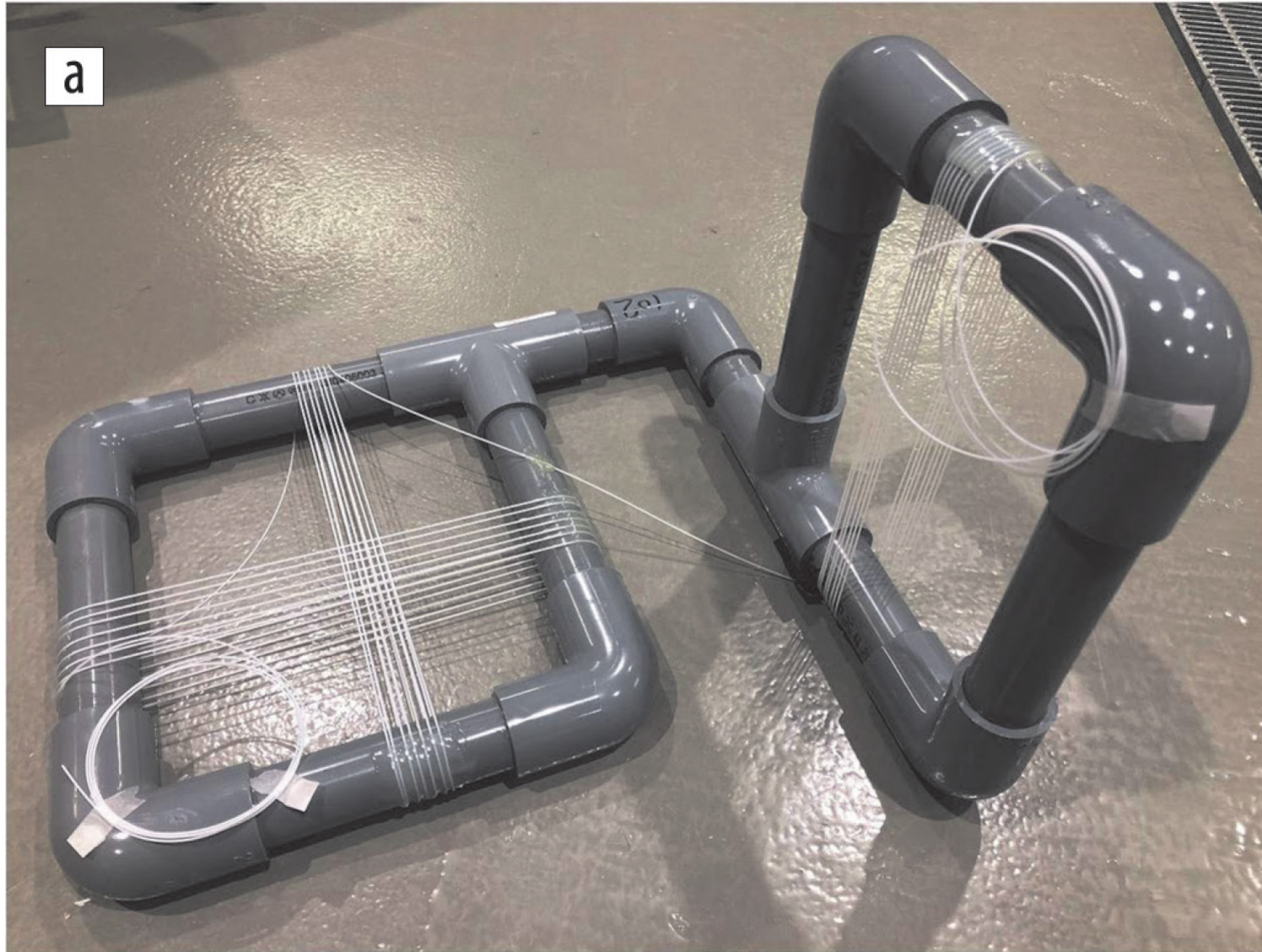


Figure 1a

Takekawa, J., Mikada, H., Xu, S., Uno, M., Kamei, S., Kishida, K., Azuma, D., Aoyanagi, M., Tanaka, N., and Ichikawa, H., 2022, A new DAS sensor prototype for multicomponent seismic data, *The Leading Edge*, **41**, 338–346



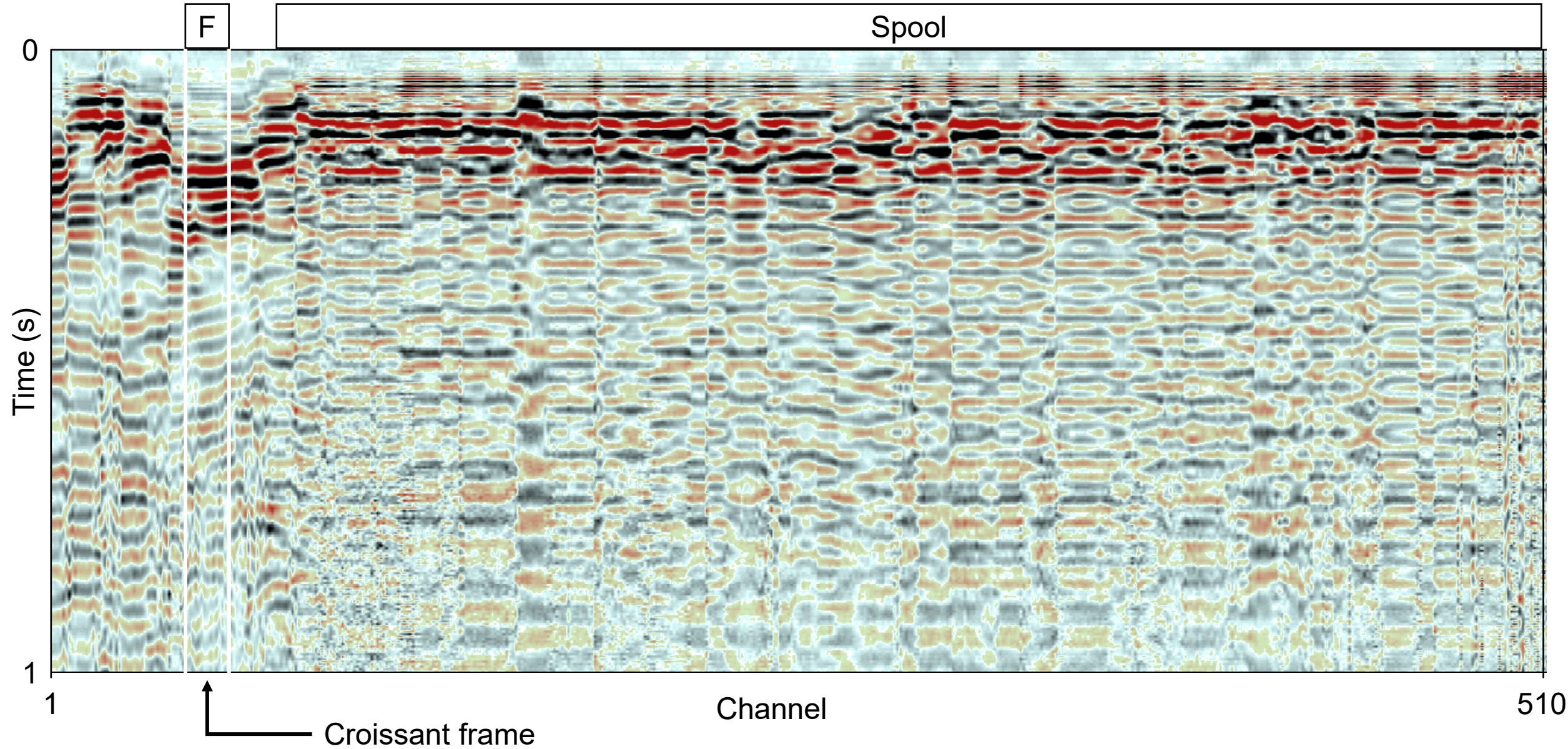
## Attempt 2







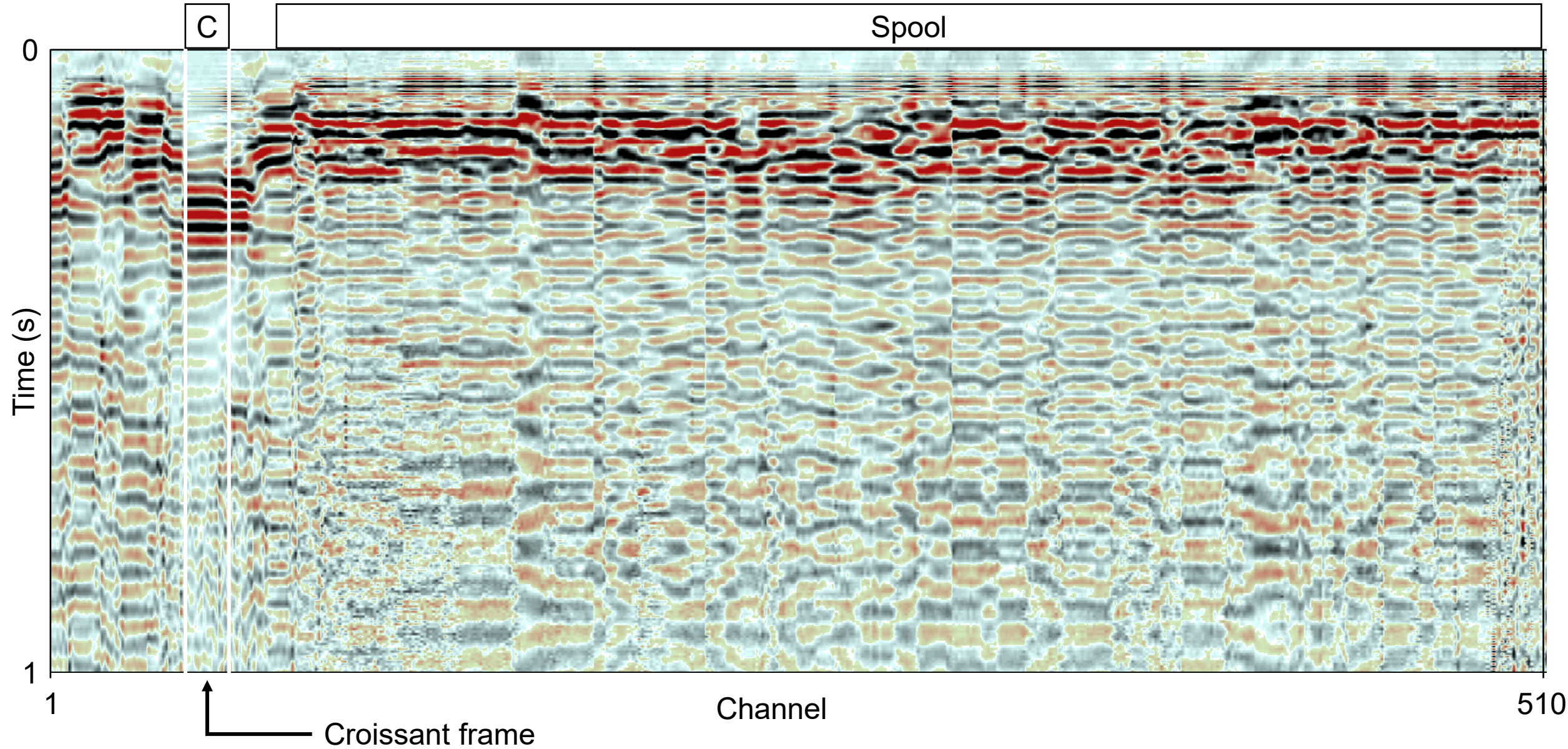
# Croissant: Test 2, Fiber loop in-line, Spool axis vertical





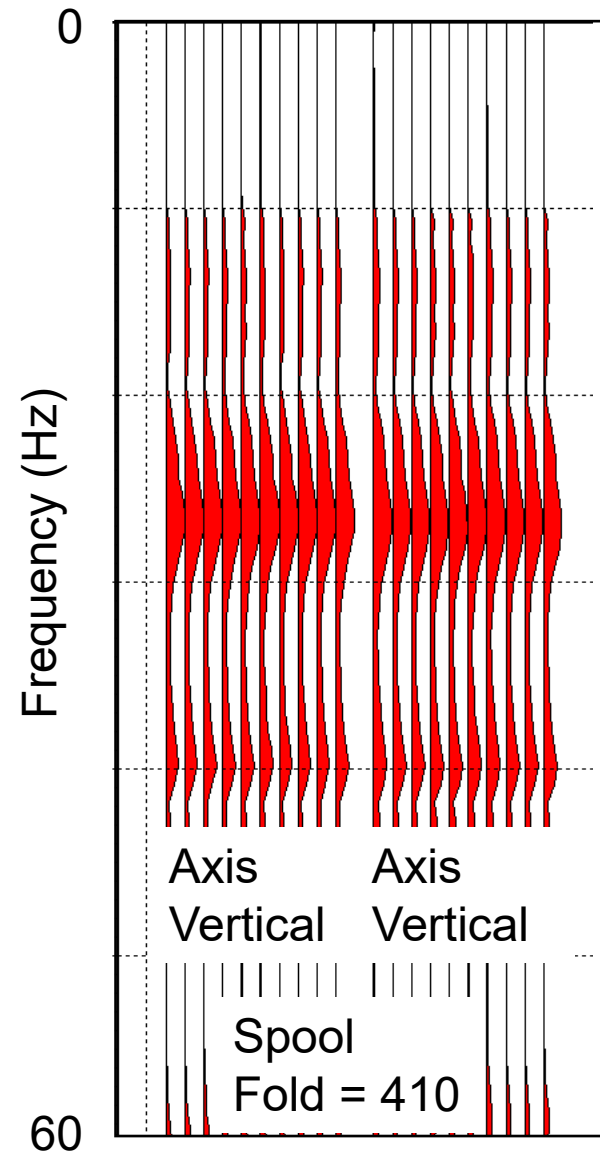
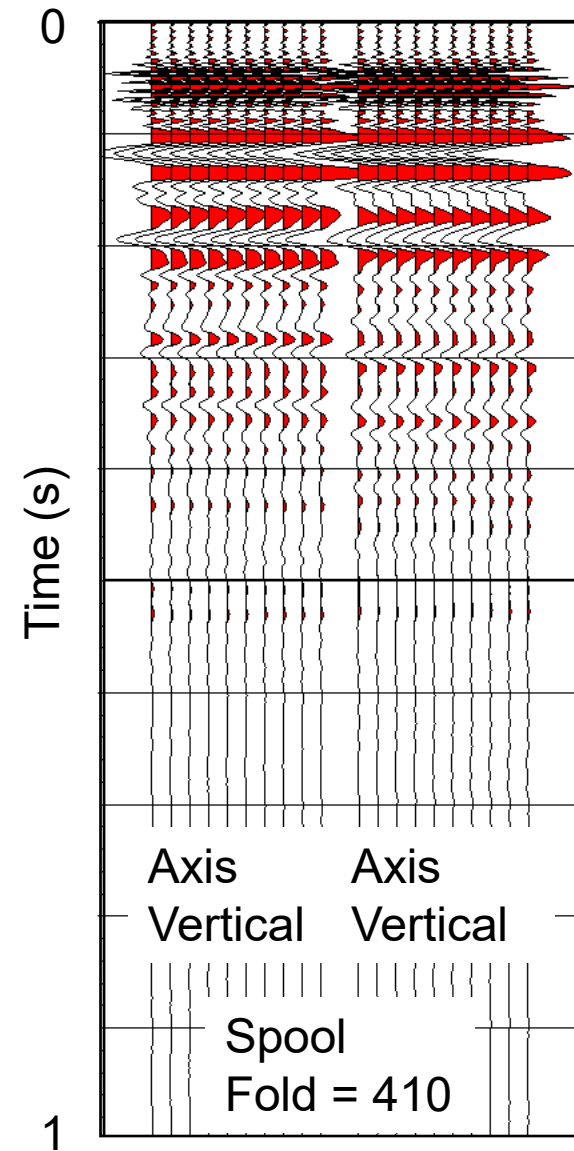
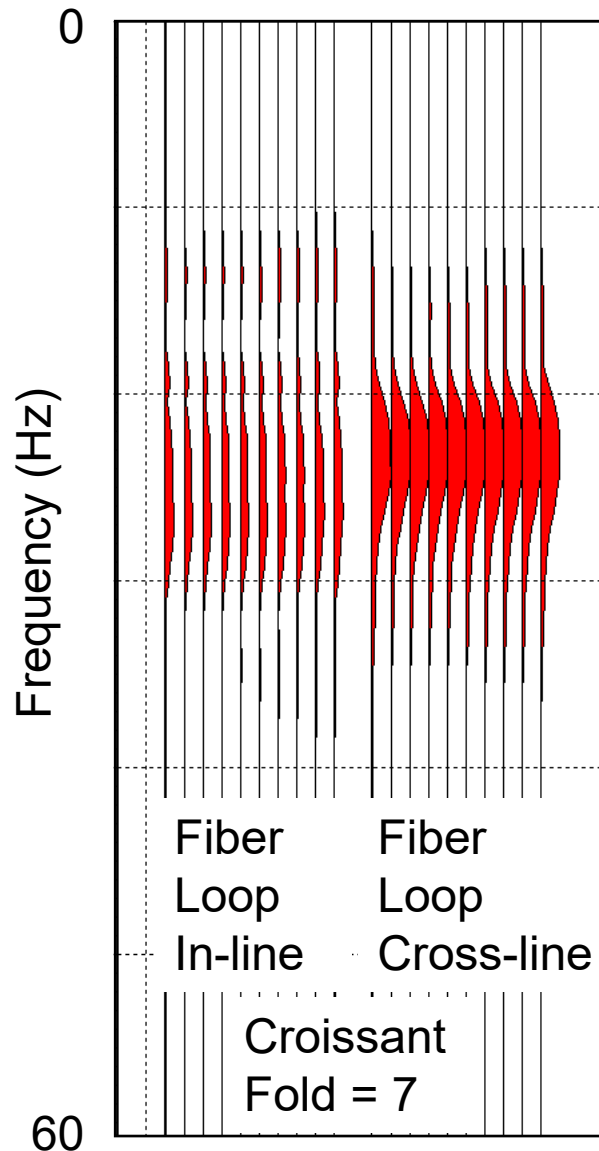
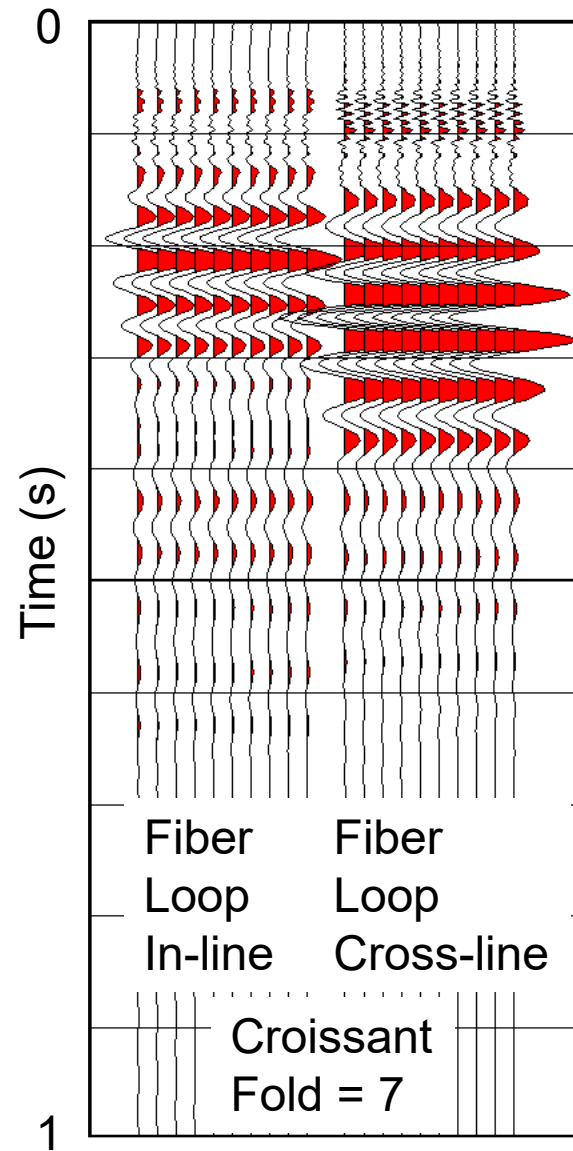


# Croissant: Test 2, Fiber loop cross-line, Spool axis vertical





# Stacked croissant and spool data, 10-150 Hz linear sweeps





## Pretzel

- Recorded 549 VP on eight horizontal components
- Estimated directional strain tensors to obtain three components
- Difficult to interpret receiver gather
- Can observe circular wavefronts in animated map view

## Croissant

- Smaller than the Pretzel, three component design
- Limited testing of two horizontal components shows:
  - Data changes attributable to orientation of fiber loop
  - No polarity reversals on fiber loop with sides smaller than G.L.
- 2023 plans
  - Further testing
  - Bury and acquire data on 3 sensors spaced 10 m apart.



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- Franki Race and Stu Philpott (CMC and CDN Controls Ltd.; Croissant fiber cable purchase)

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