
Multiple Sources
Blended Acquisition

Polarcus's Multiple-Source Initiative

- "blended acquisition" with multiple sources

$\Rightarrow$ novel acquisition designs, and
more data with the same quality

Blended Acquisition

- more rapidly firing of shots with overlapping shot records

⇒ novel acquisition designs, and
more data with the same quality

De-Blending

"blended" =
continuous
shot record

De-Blending

“blended” = continuous shot record

other domain

target shot aligned

De-Blending

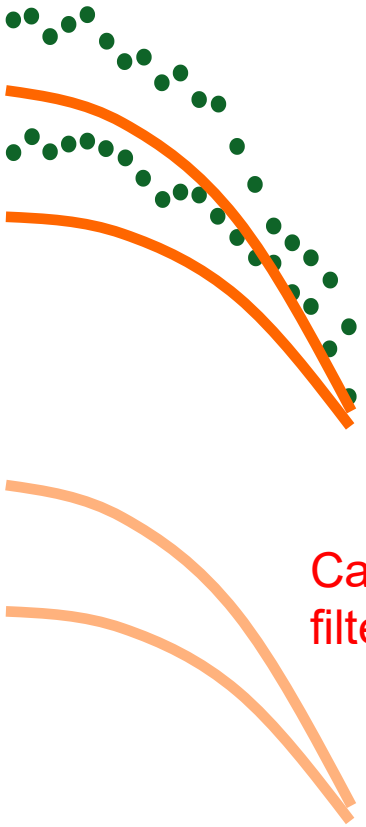
“blended” = continuous shot record

other domain

De-Blending

"blended" =
continuous
shot record

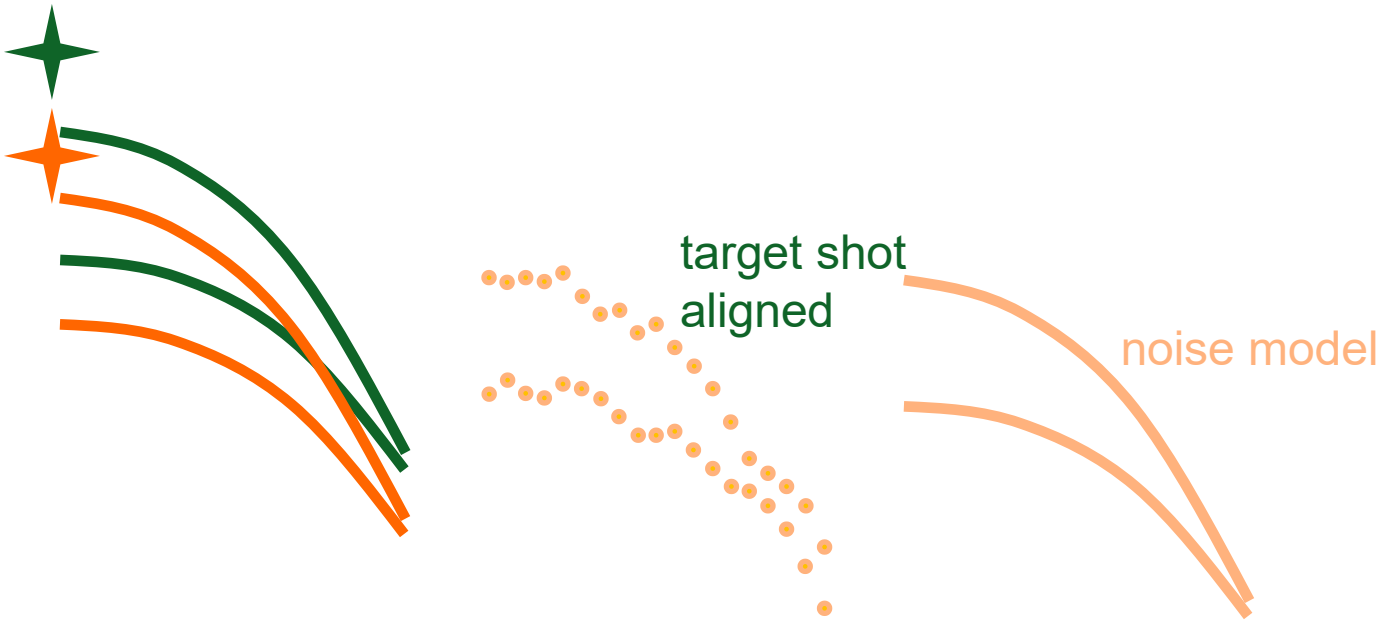
other domain



De-Blending

"blended" = continuous shot record

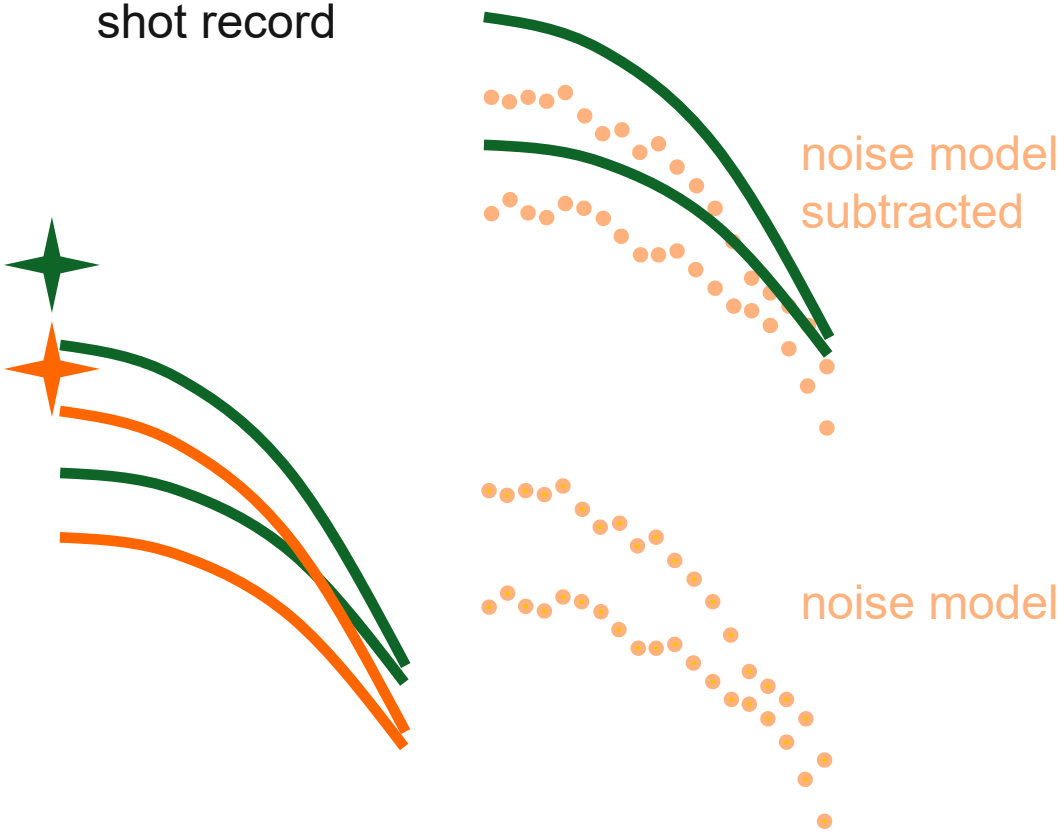
other domain



De-Blending

"blended" = continuous shot record

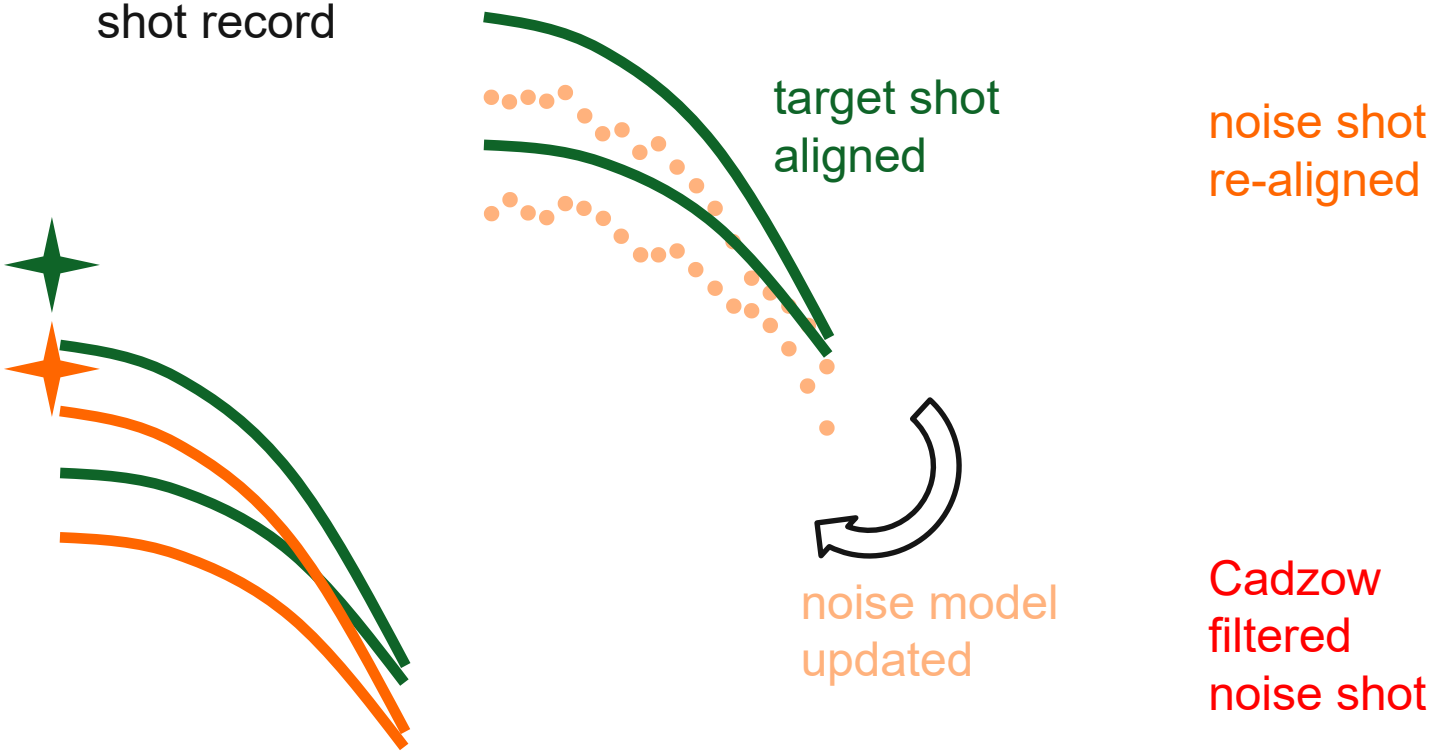
other domain



De-Blending

"blended" = continuous shot record

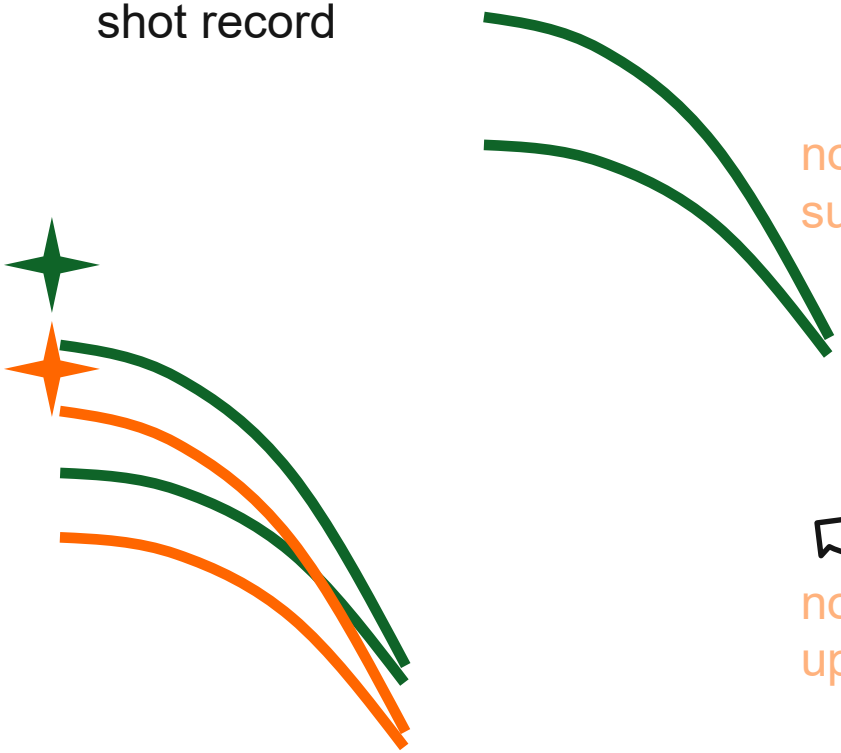
other domain



De-Blending

"blended" = continuous shot record

other domain



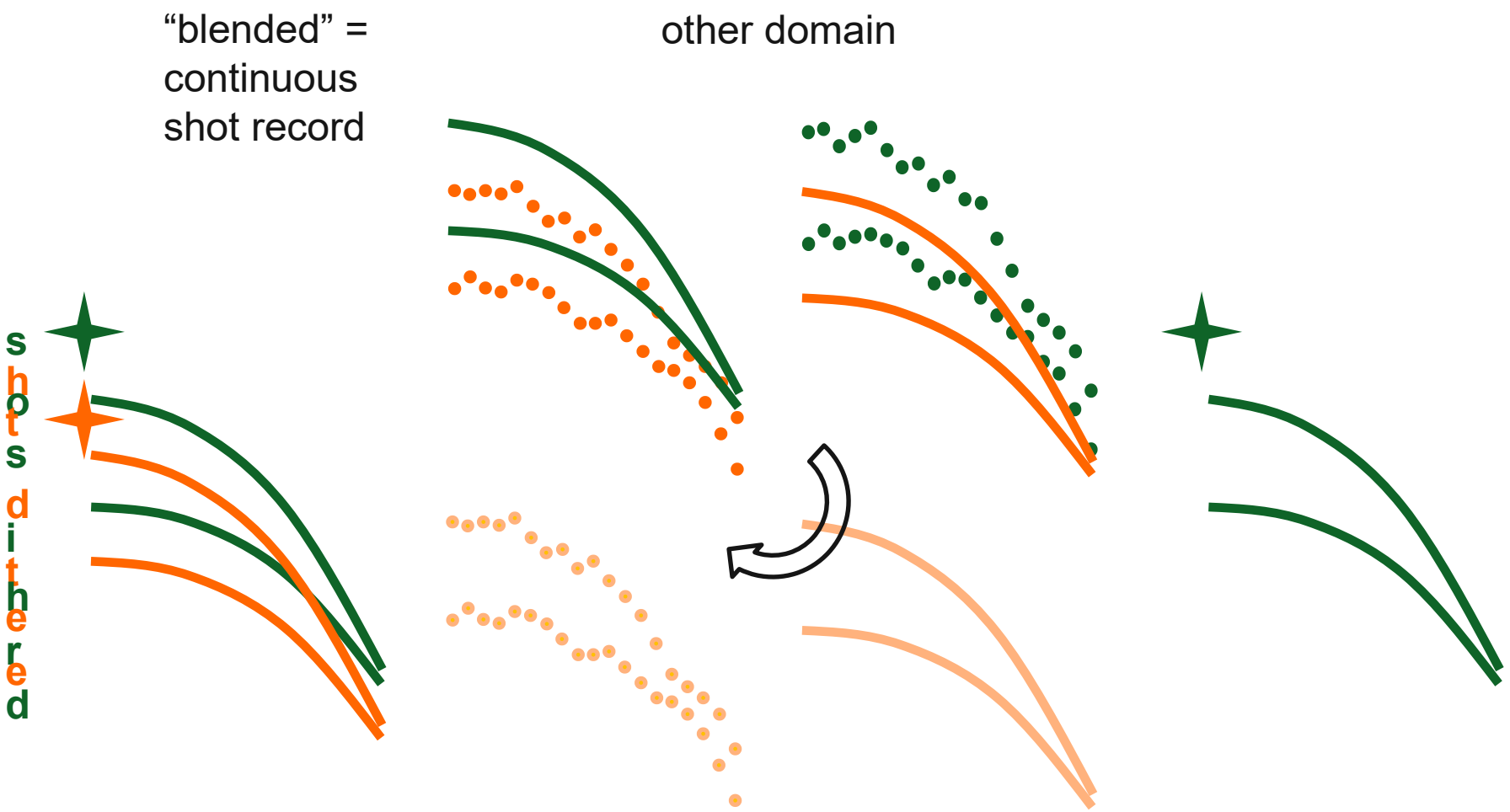
noise model subtracted

noise shot re-aligned

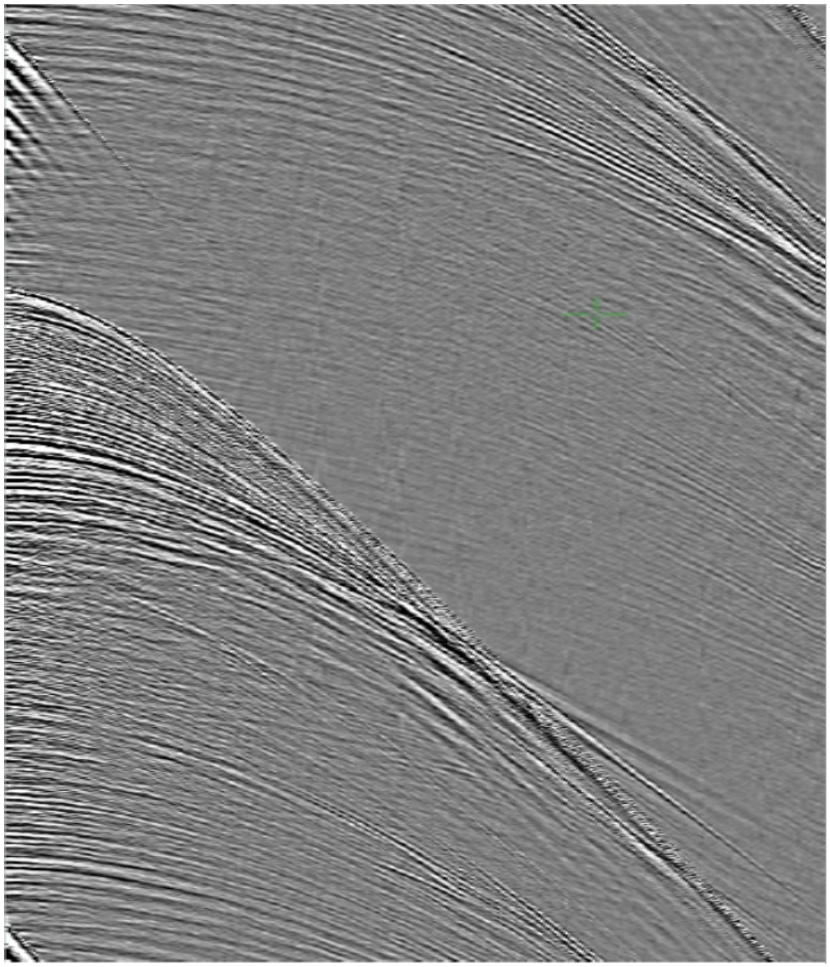
noise model updated

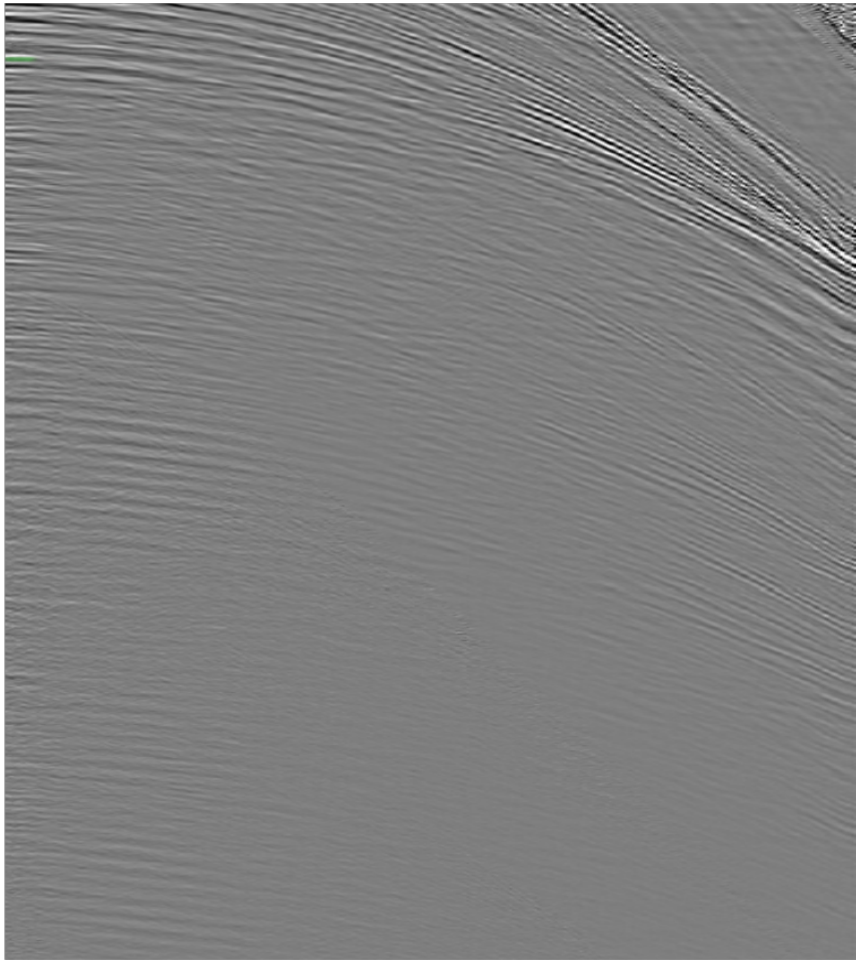
Cadzow filtered noise shot

De-Blending

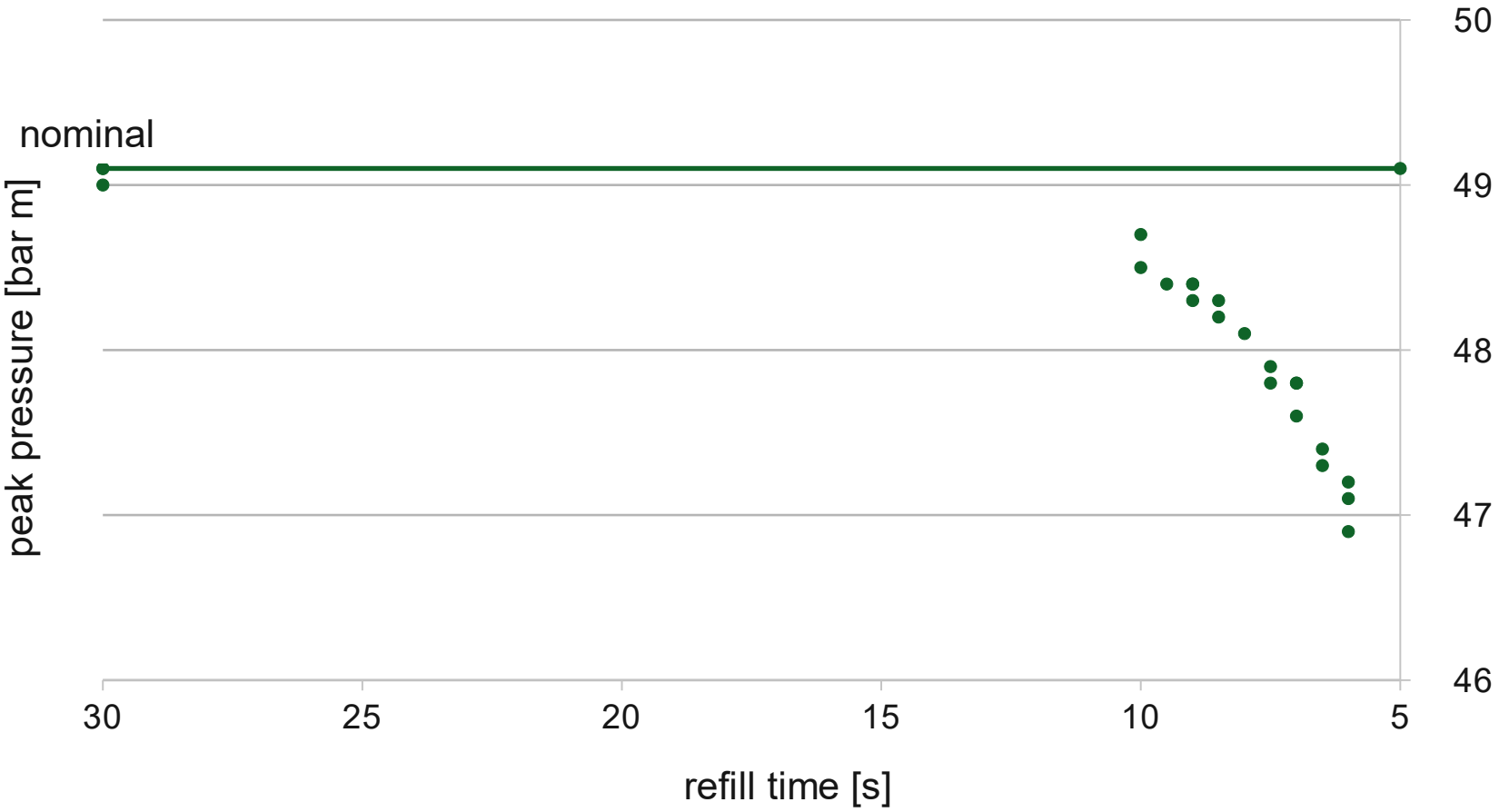

“blended” = continuous shot record
other domain
shots dithered

De-Blending

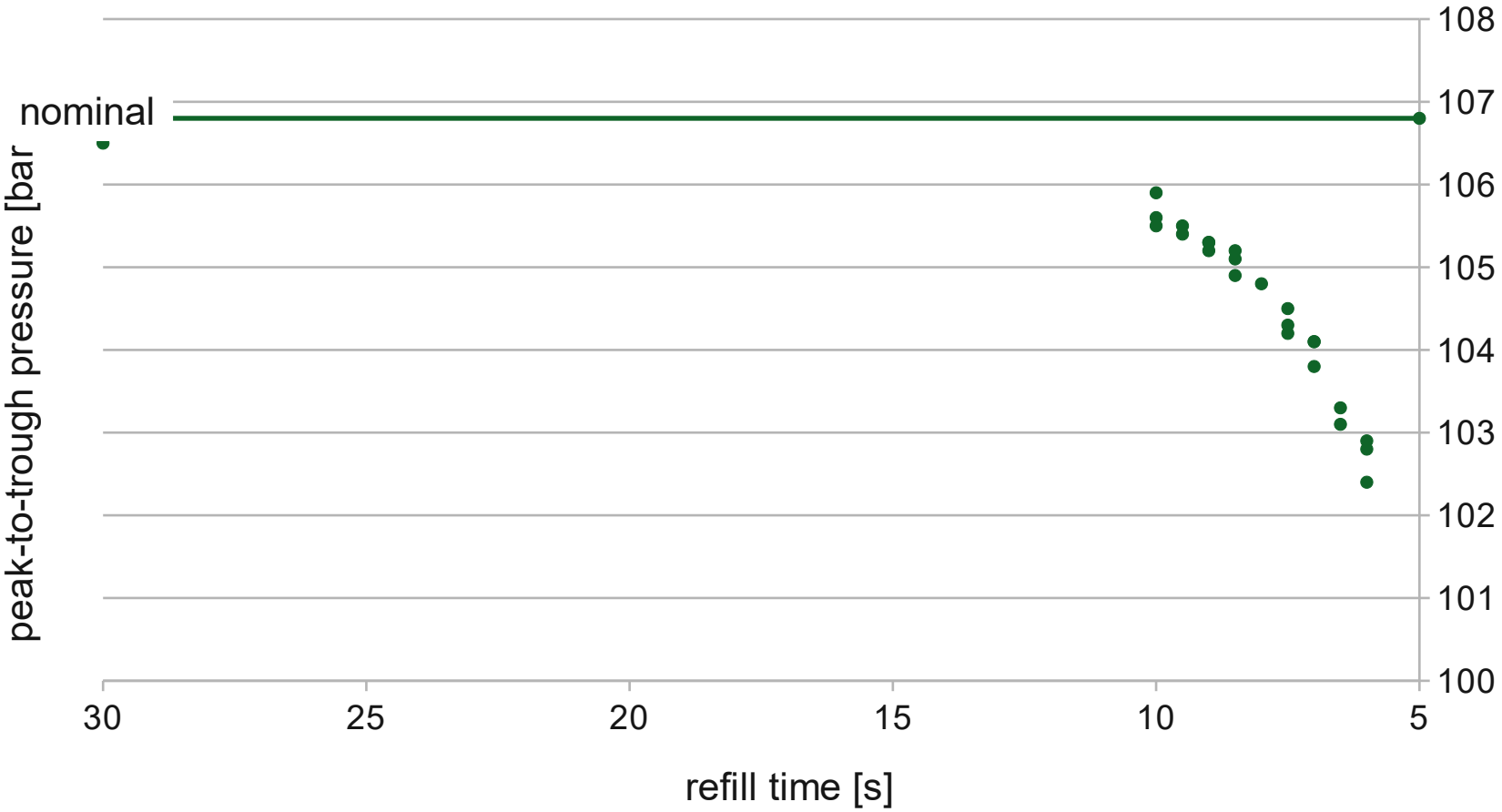




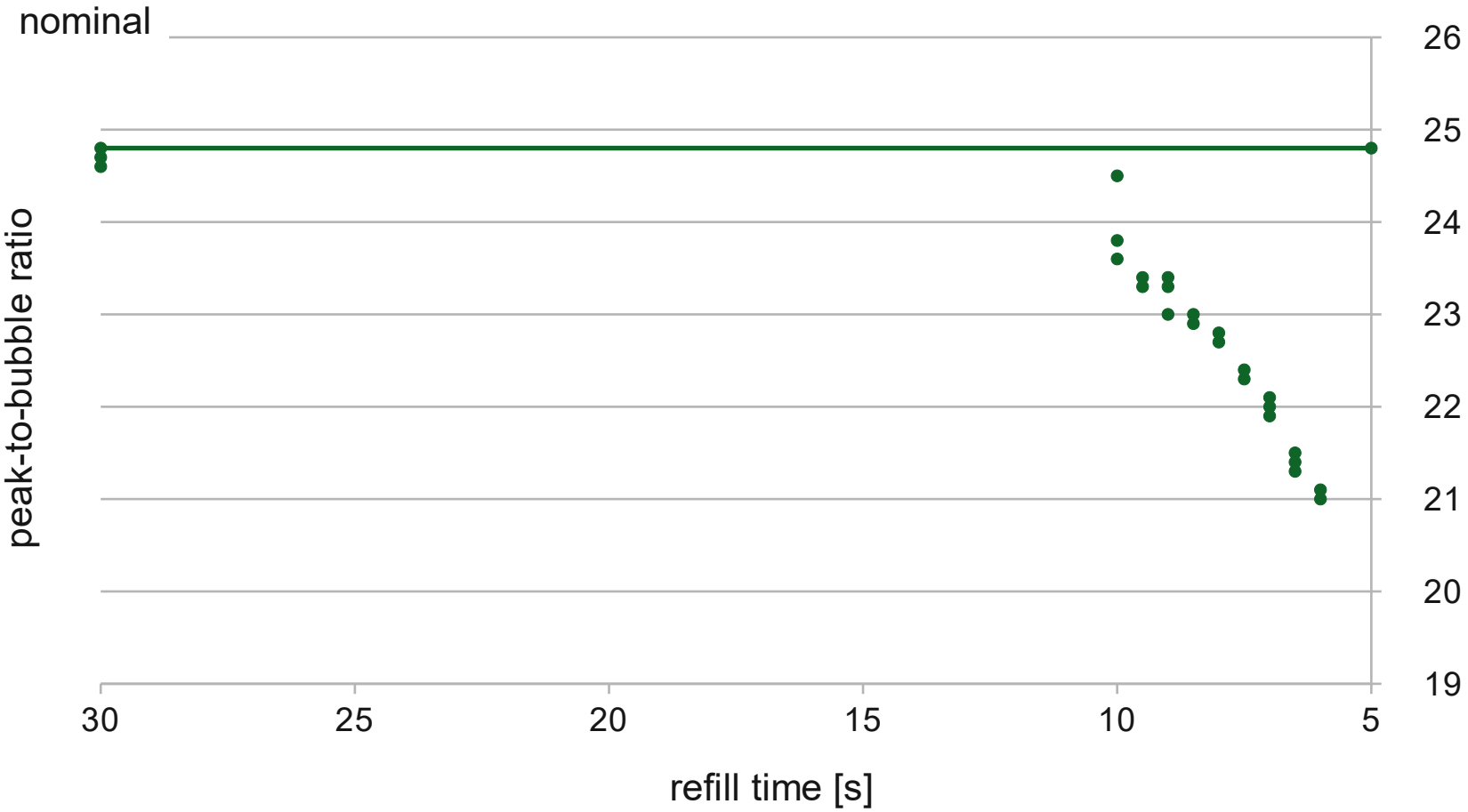
Fieldtest:
Peak Pressure



Fieldtest:
Peak-to-Trough Pressure



Fieldtest:
Peak-to-Bubble Ratio



Blended Acquisition
De-Blending in Processing

- too rapid a succession of shot firing

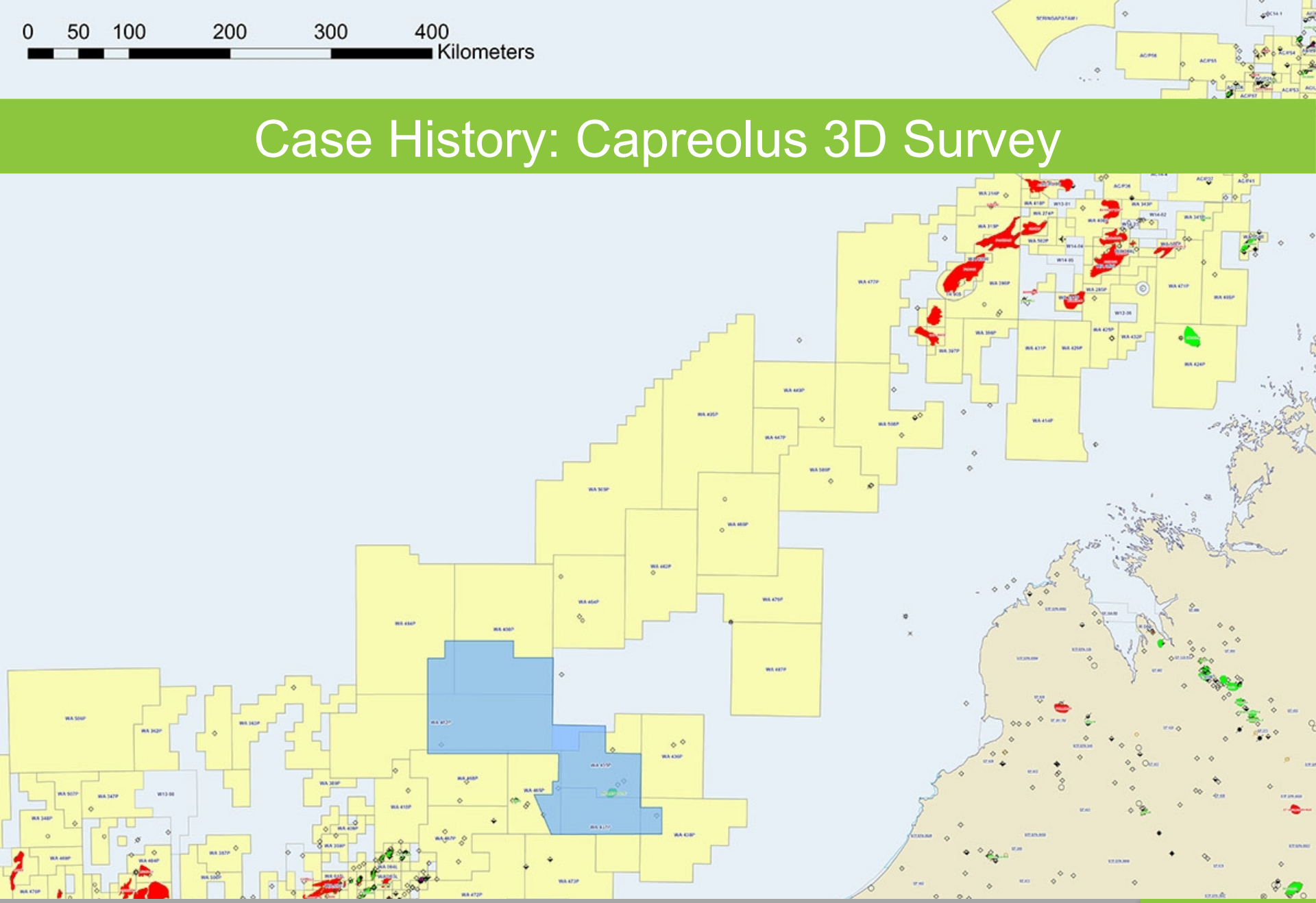
$\Rightarrow$ more data

to be demonstrated

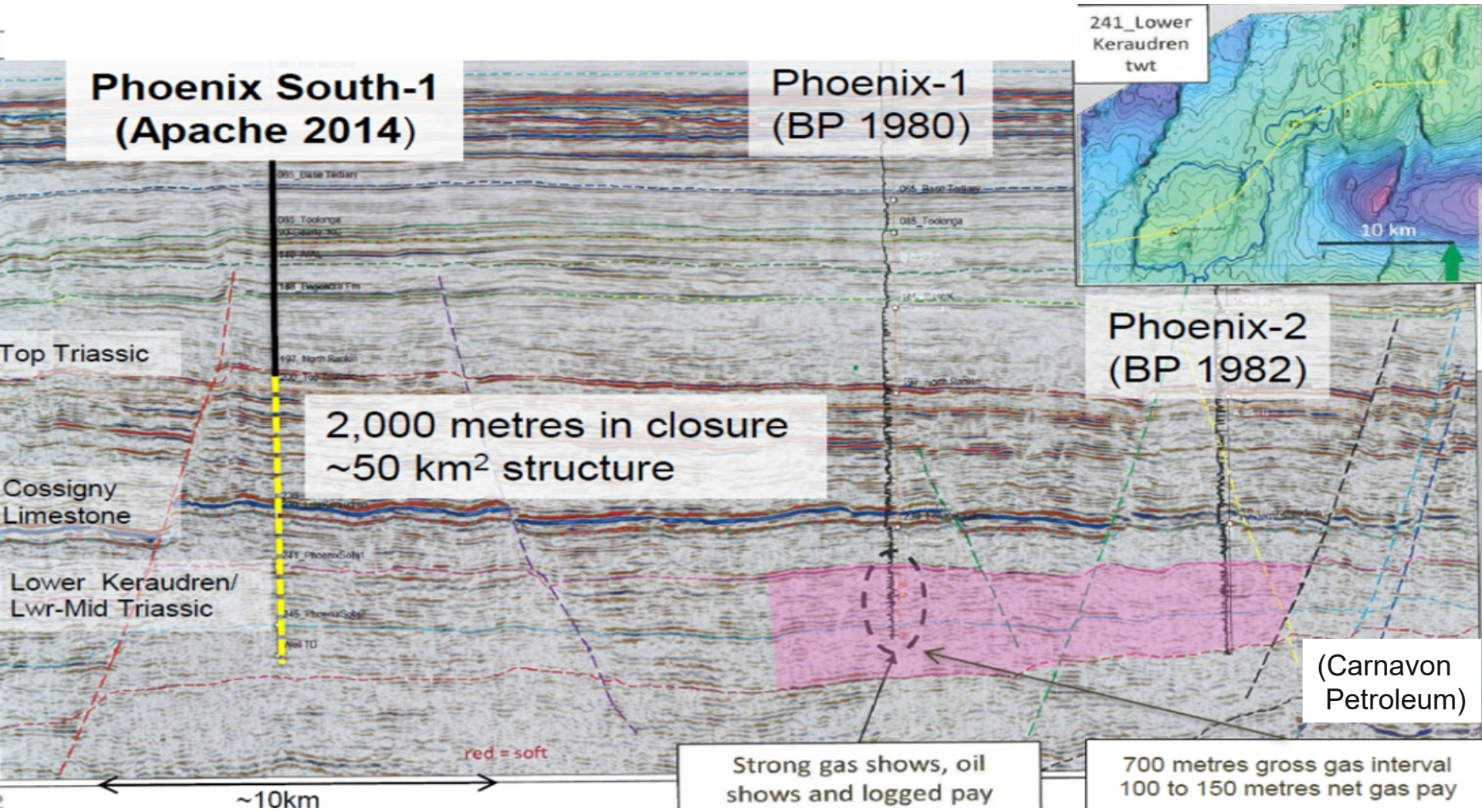
$\Rightarrow$ novel source/streamer layouts

$\Rightarrow$ better image quality

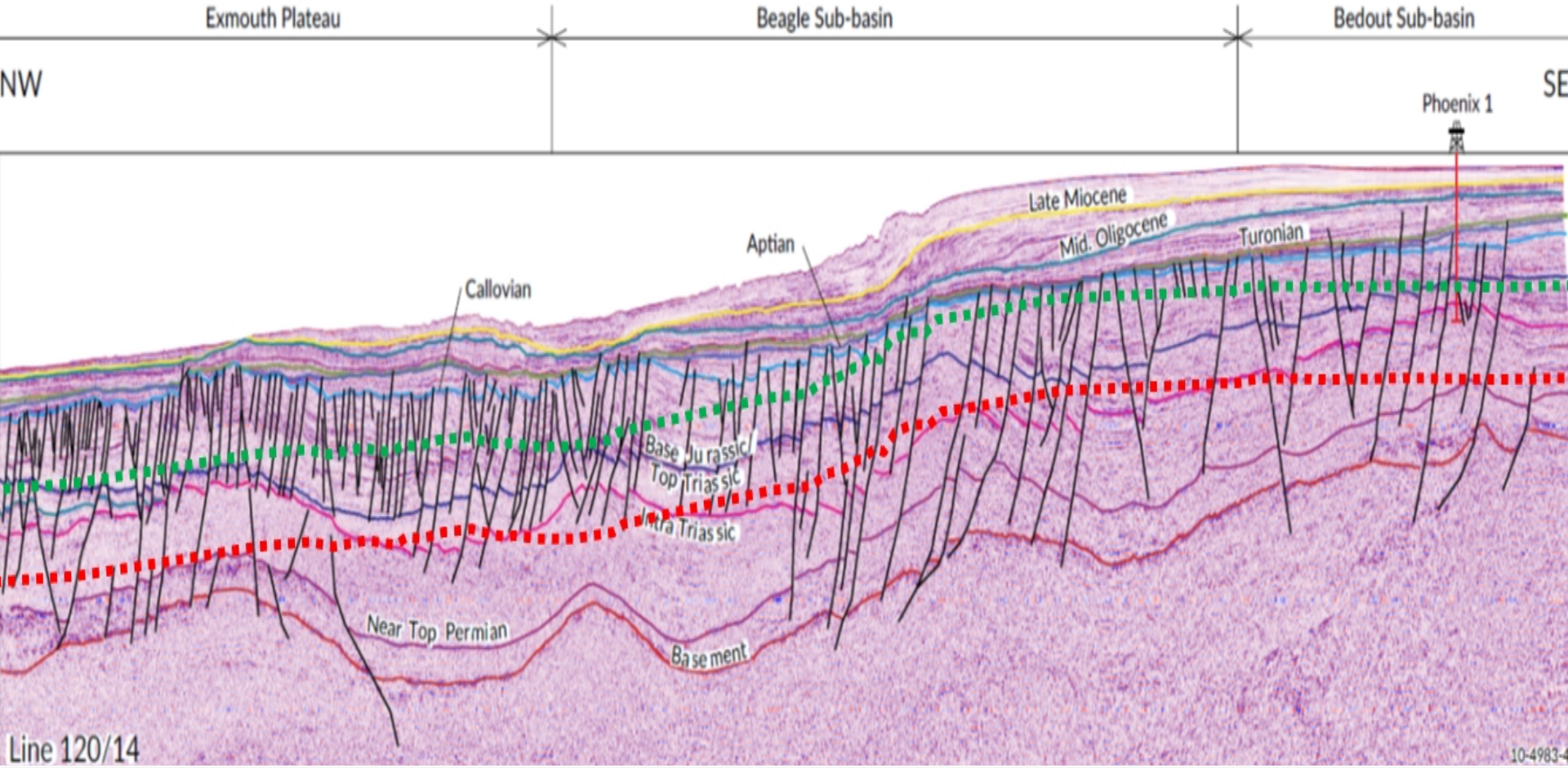
Case History: Capreolus 3D Survey



Gas until Drilled



AGSO Regional Line



Acquisition parameters

- **VESSELS** **POLARCUS** **ASIMA / AMANI / NAILA**

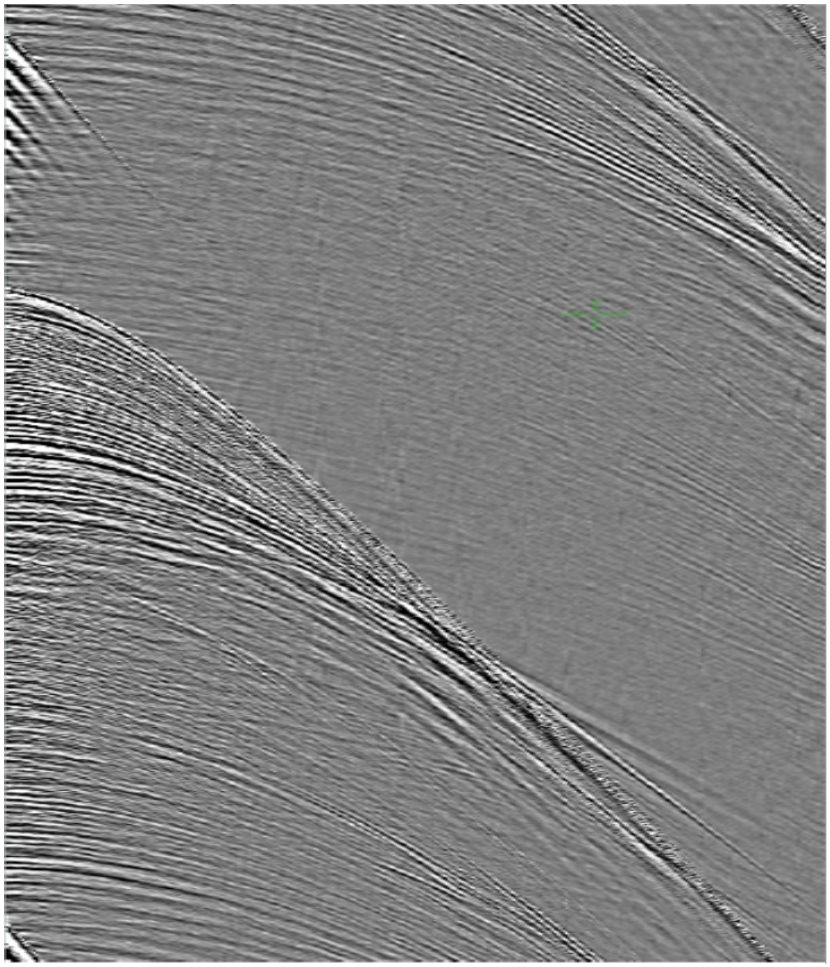
- **SOURCE** Bolt 1500-LL/1900-LLXT dual sources
- Volume 3480-in³
- Array/Sub-Array Seps. 50m / 7.0m
- Depth 7m (+/-0.5m)
- Operating Pressure 2000 psi
- Shot interval 12.5m flip/flop

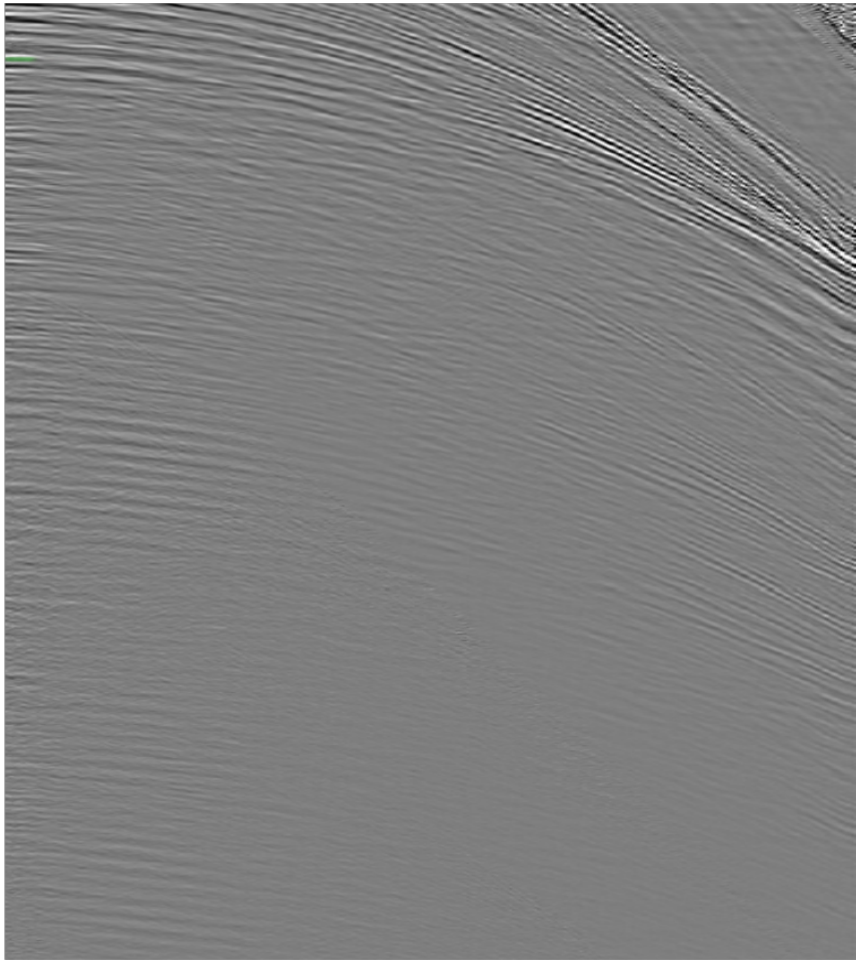
- **STREAMERS** Sercel Sentinel Solid
- Number x Length of Str. 12 x 8100m (Phoenix area) 12 x 9000m (Beagle/Exmouth area)
- Streamer Spacing 100m
- Number of Groups per Str. 648/720
- Depth of Streamer 17.5m (+/- 1m)

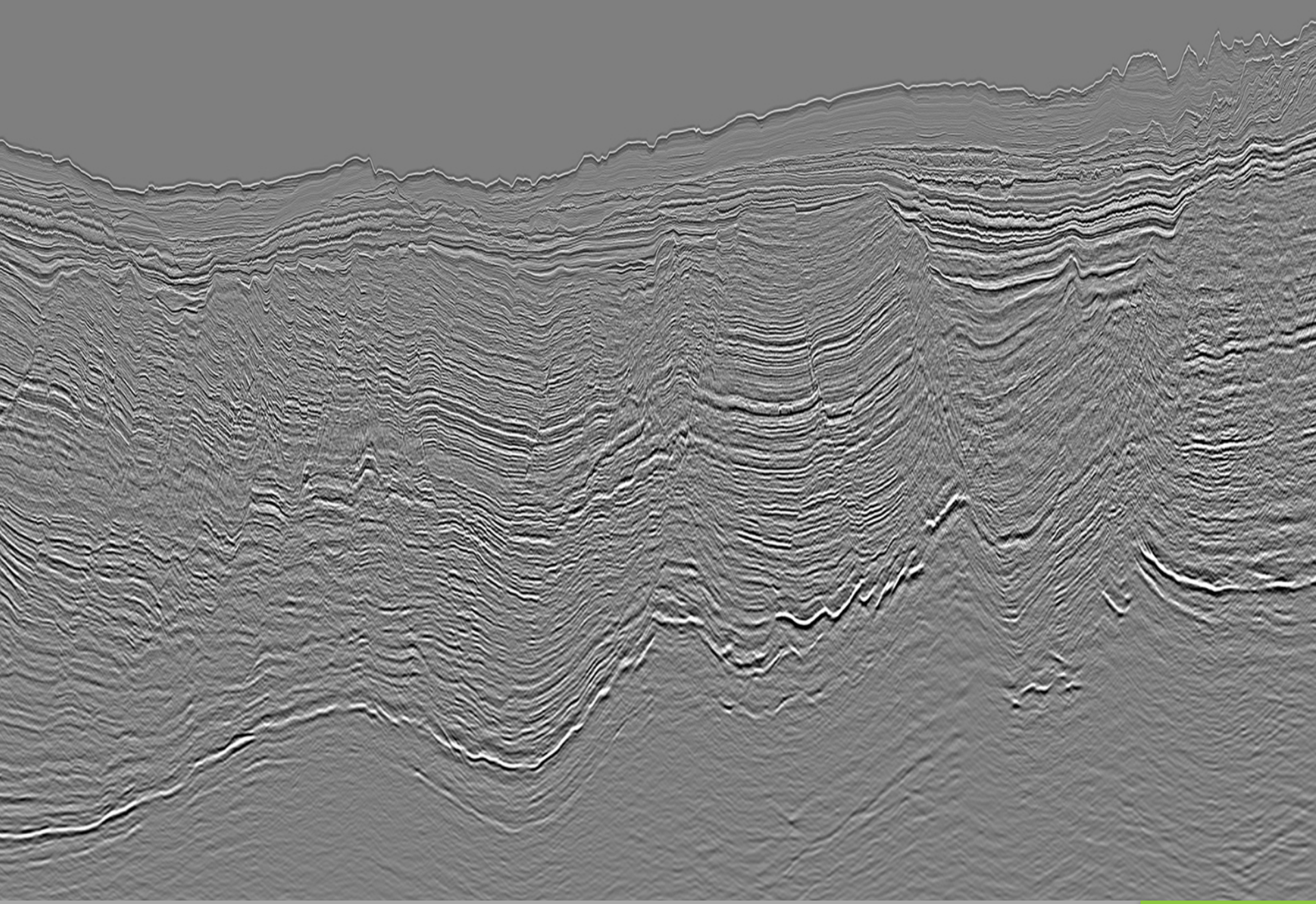
- **RECORDING SYSTEM** SERCEL SEAL 2,000 channels + 48 aux
- Sample Rate 2 ms
- Lo Cut Analog 2 Hz + Digital 2 Hz(12dB)
- Recording Mode Continuous
- Record Length* 12.0 sec
- Format SEG-D, 8058
- Media 3592 Cartridge

- **GRAVITY & MAGNETIC DATA (WA-480P & WA-484P)**
- Contractor EDCON-PRJ
- Gravity meter LaCoste & Romberg Model S with AirSea System II computer controller
- Magnetometer SeaSpy by Marine Magnetics
- Deliverables Processed digital data (CD-ROM), Maps, Final report

De-Blending

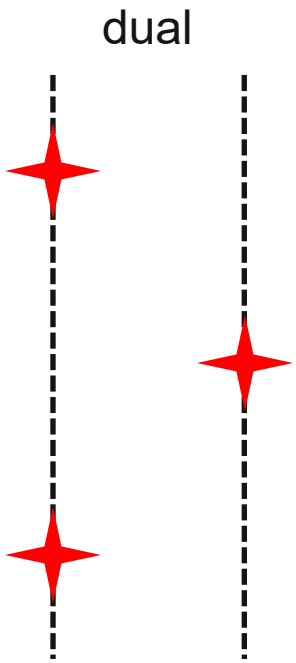






Triple Sources

State-of-Art: Dual Source in Flip-Flop Mode

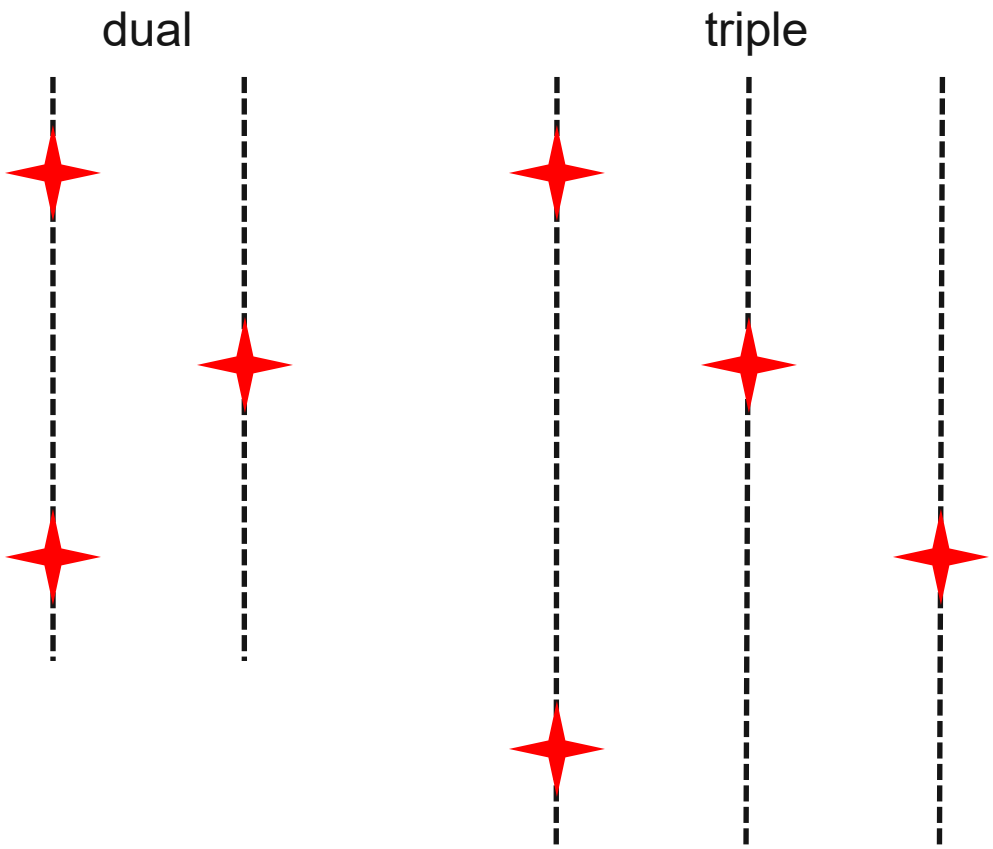


Dual versus Triple Source

- shot-point interval increases

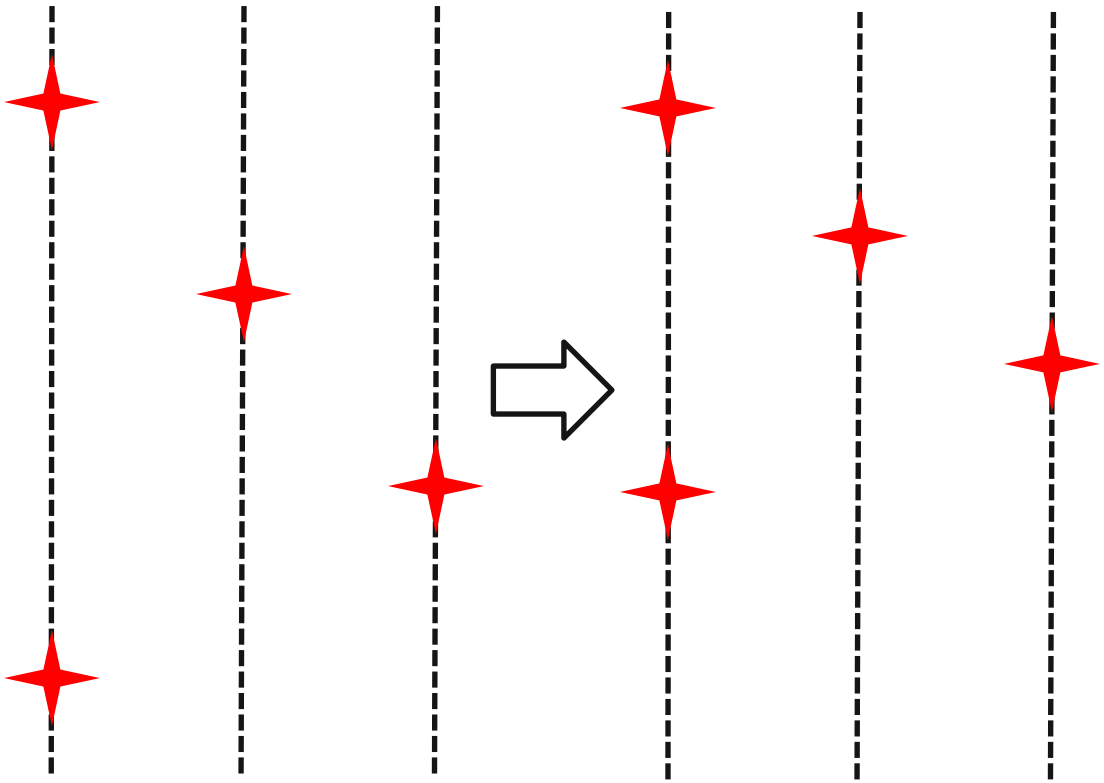
⇒ fold decreases

! bad idea
  - too much noise
  - reduced speed uneconomical

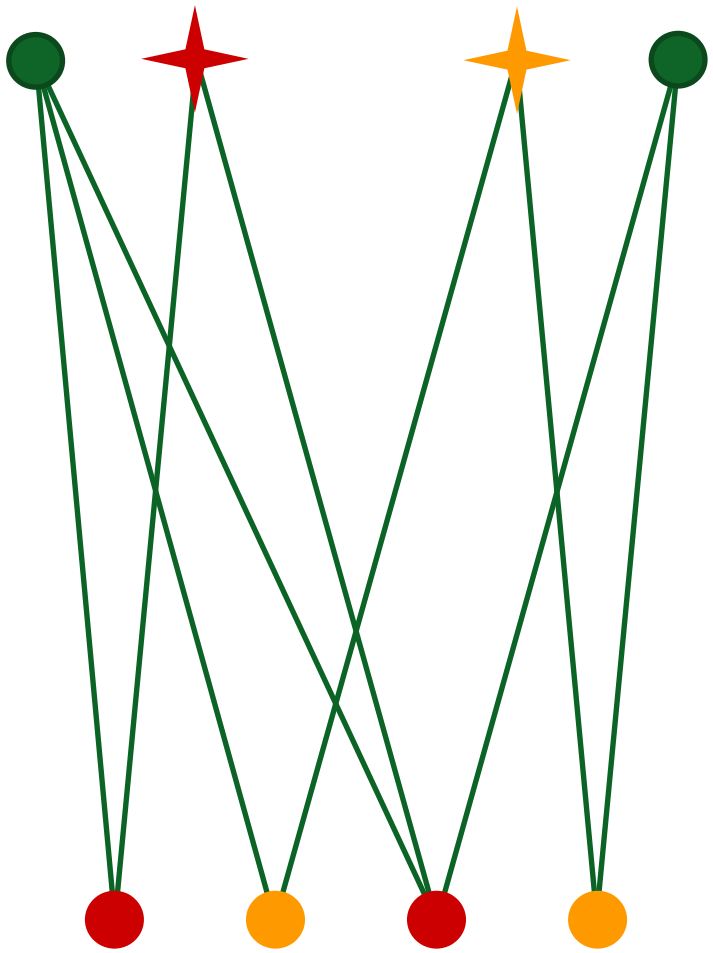


Enabling Triple Source

- blended acquisition
  - ! shot-point interval not constrained

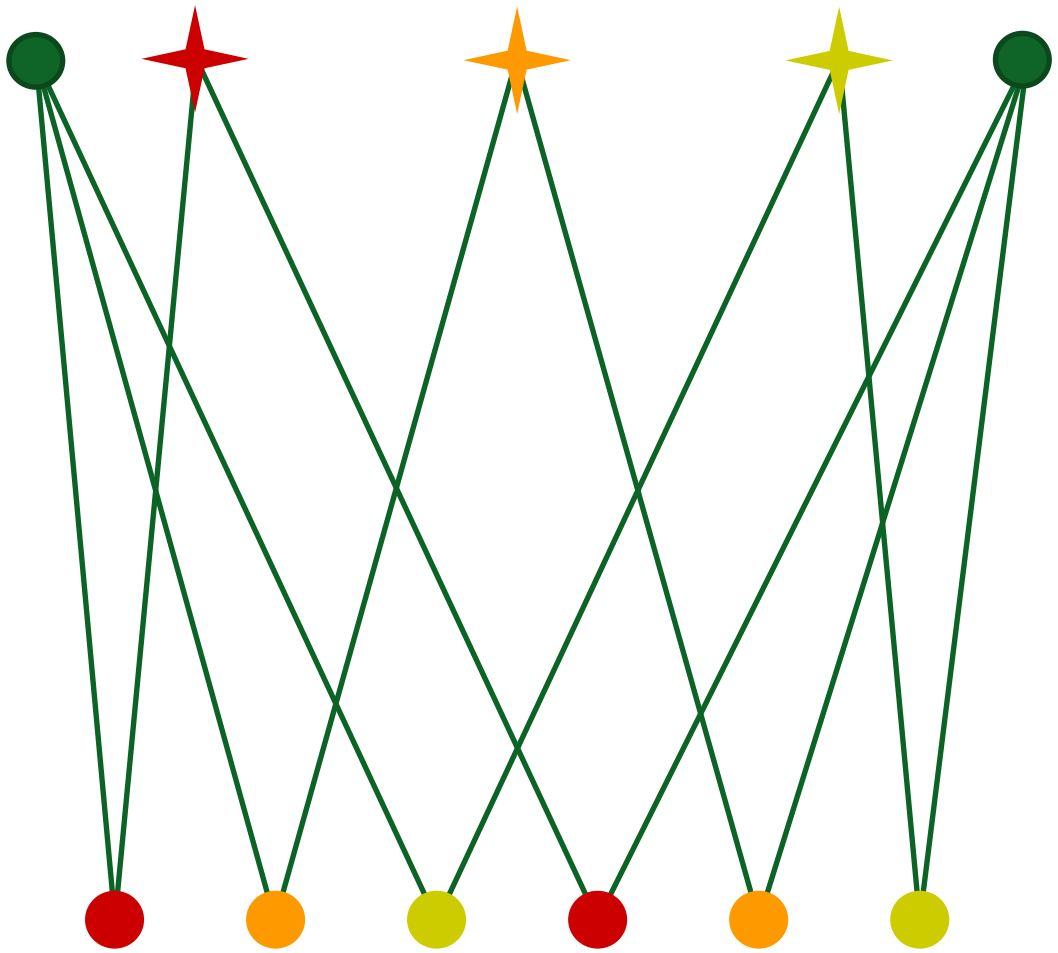


Dual Source



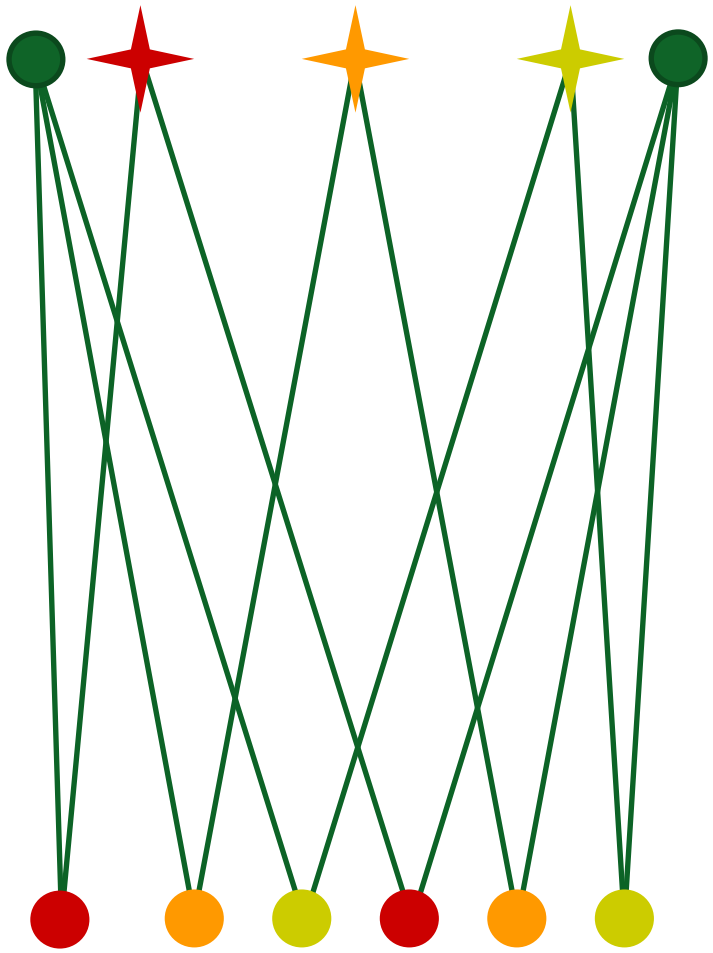
1/4 streamer separation

Wide Triple Source



+1/2 more streamer spread

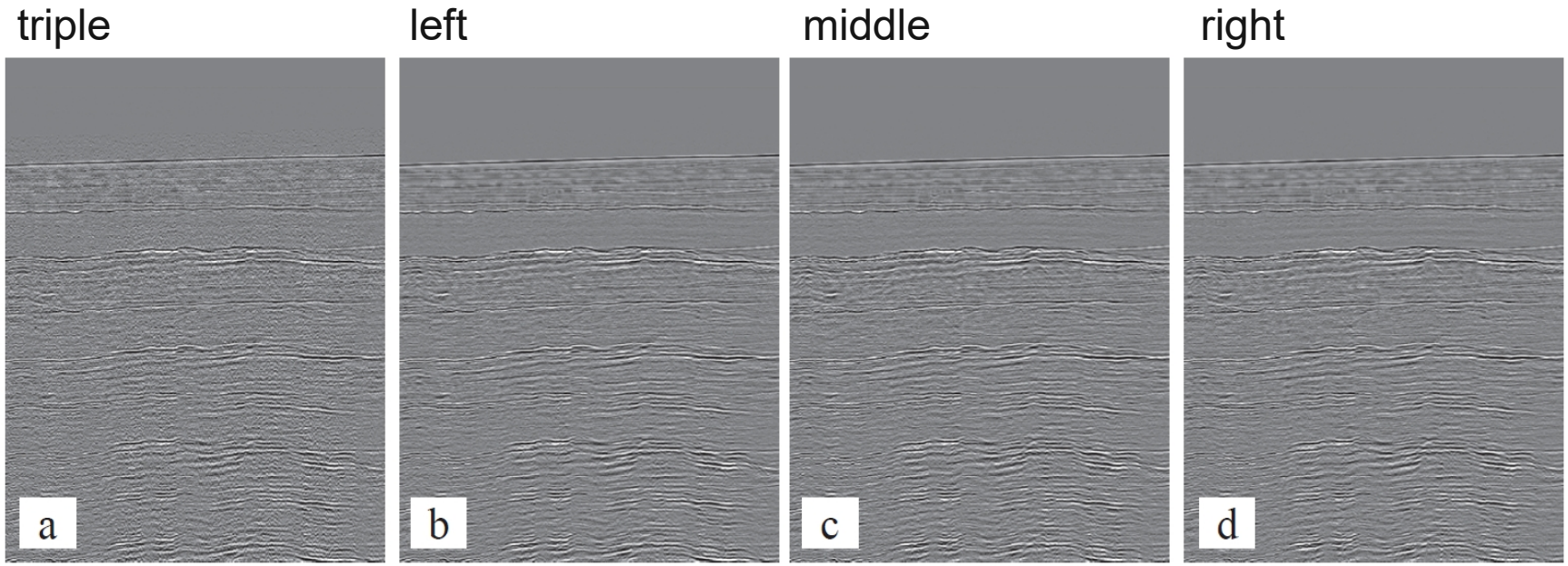
Narrow Triple Source



1/6 streamer separation

Concept Proven

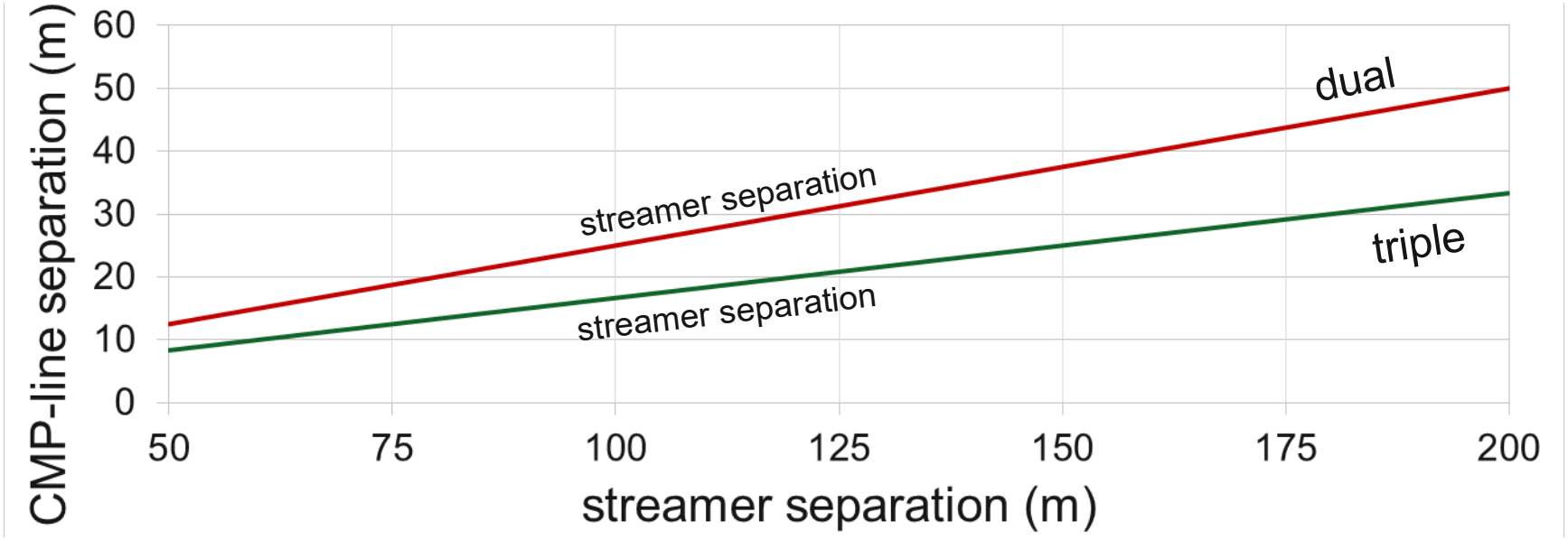
- TGS West-of-Shetland triple 12.5 > 12.5 simultaneous ± 300ms dither
  TGS Europa triple 12.5 > 37.5 sequential overlapping



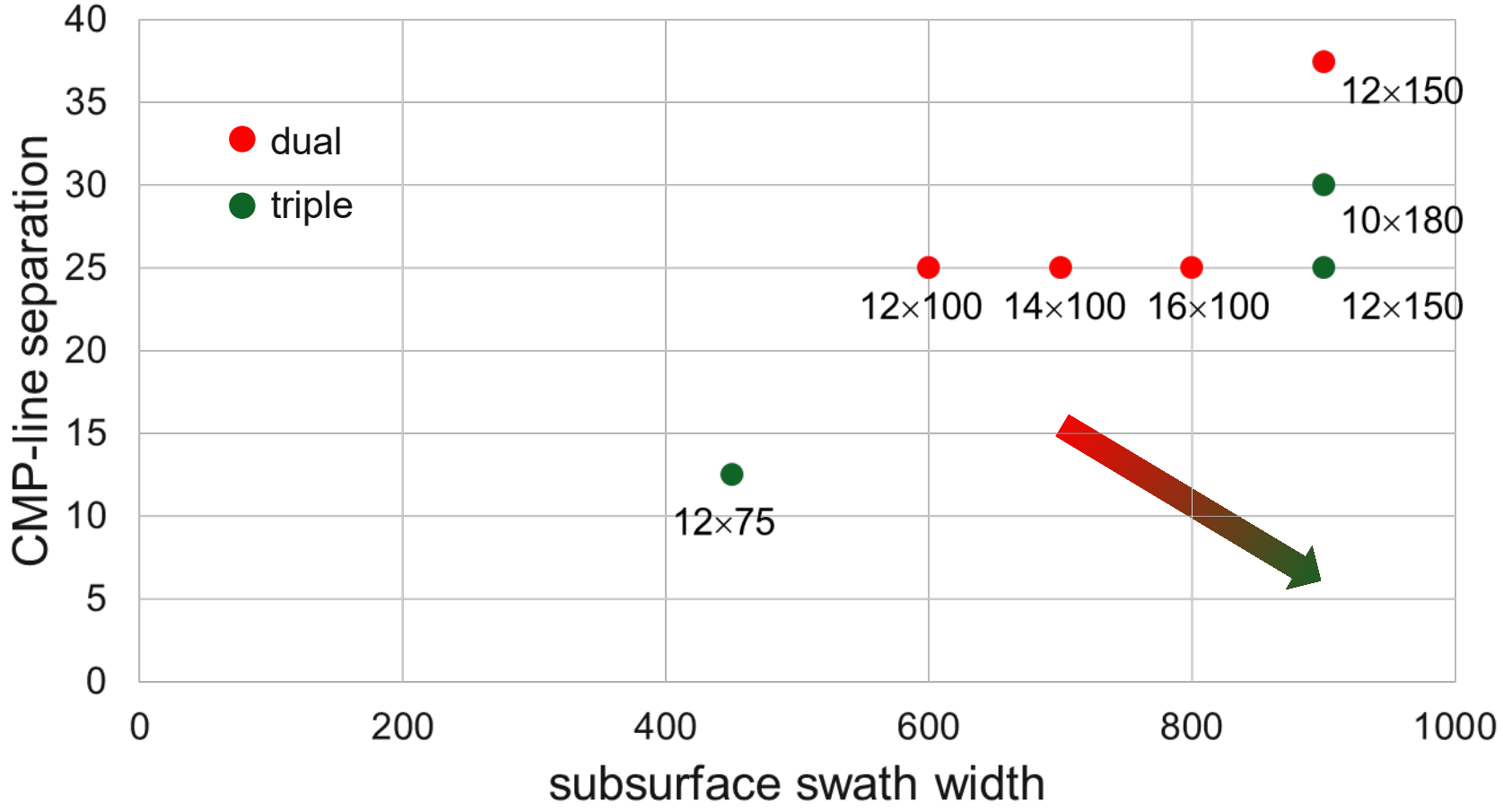
TGS, West-of-Shetland survey

(Liu et al., 2015)

CMP-Line Separation versus Streamer Separation



CMP-Line Separation versus Subsurface Swath Width

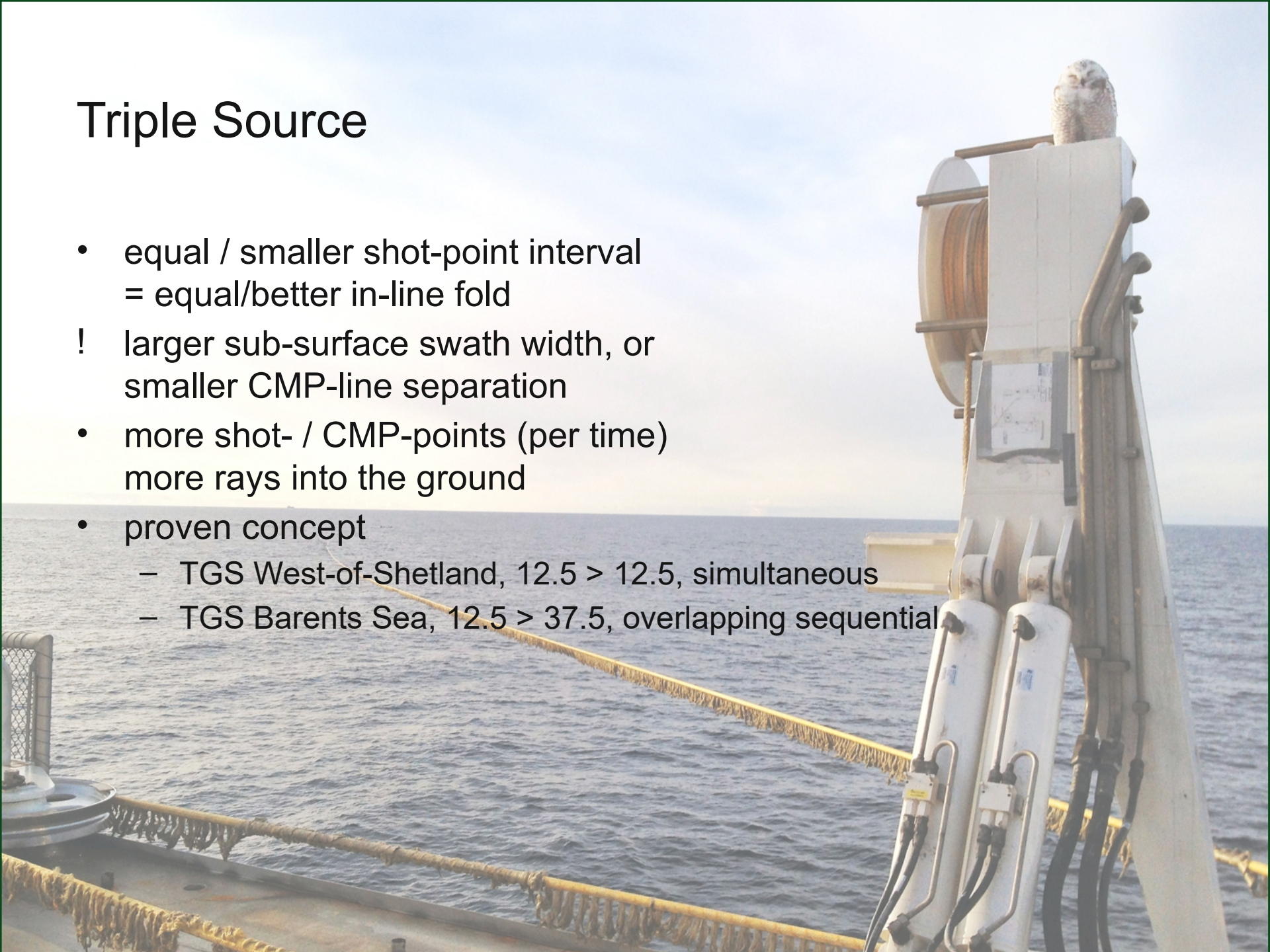


Recommendation

- Deep-water survey
  - $10 \times 180 \times 10{,}000$ with ΔCMP=30m and long offsets
  - $12 \times 150 \times 8{,}100$ with ΔCMP=25m
- Shallow-water survey
  - $12 \times 75 \times 8{,}100$ with ΔCMP=12.5m
- High-density survey
  - $12 \times 75 \times 8{,}100$ with ΔCMP=12.5m

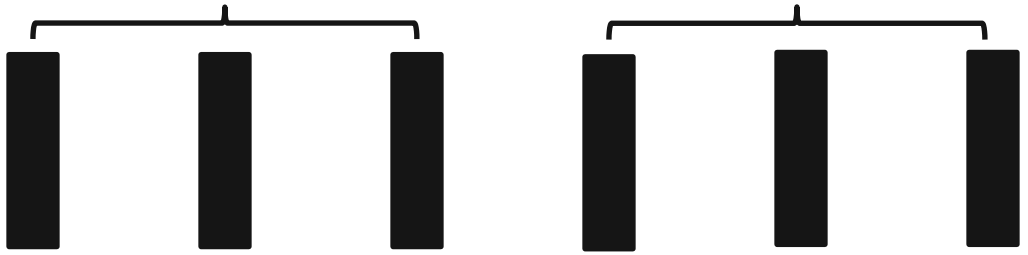
Triple Source

- equal / smaller shot-point interval
  = equal/better in-line fold
- ! larger sub-surface swath width, or
  smaller CMP-line separation
- more shot- / CMP-points (per time)
  more rays into the ground
- proven concept
  - TGS West-of-Shetland, 12.5 > 12.5, simultaneous
  - TGS Barents Sea, 12.5 > 37.5, overlapping sequential



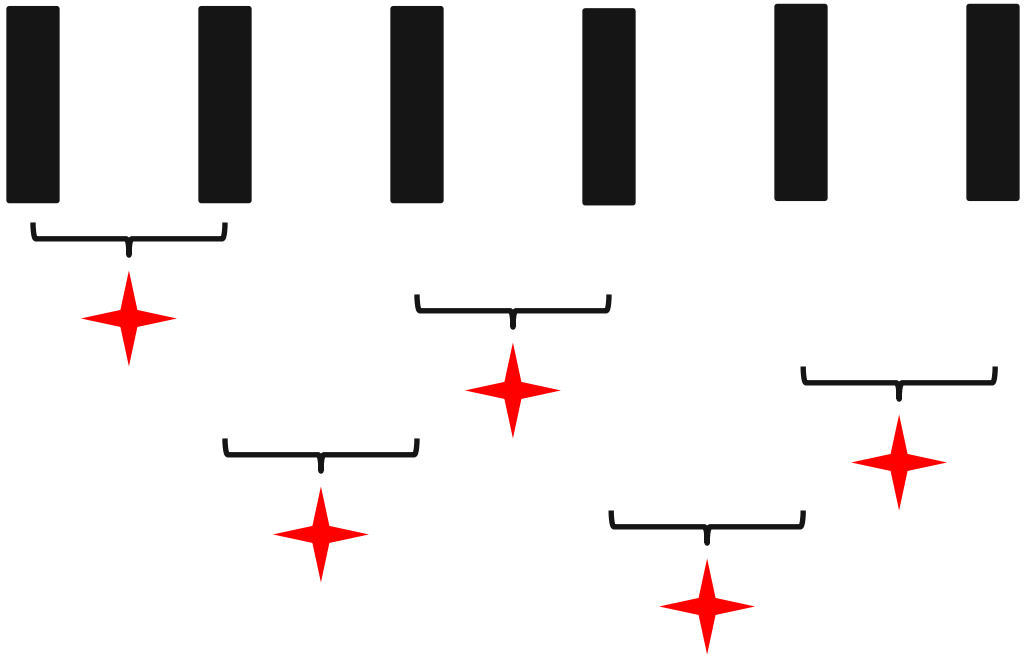
Penta Sources

Dual Source = 6 Airgun Strings



6 Airgun Strings Re-Configured

- 2 strings to 1 source
- firing sequence



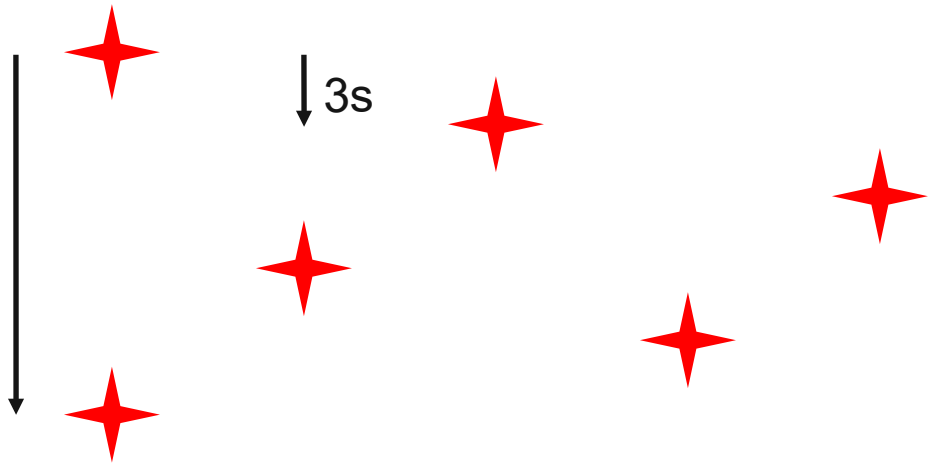
Shotpoint Interval

- 3s shot-time interval

! over 37.5m
5×6.945m penta versus
3×12.5m or 2×18.75m flip-flop dual

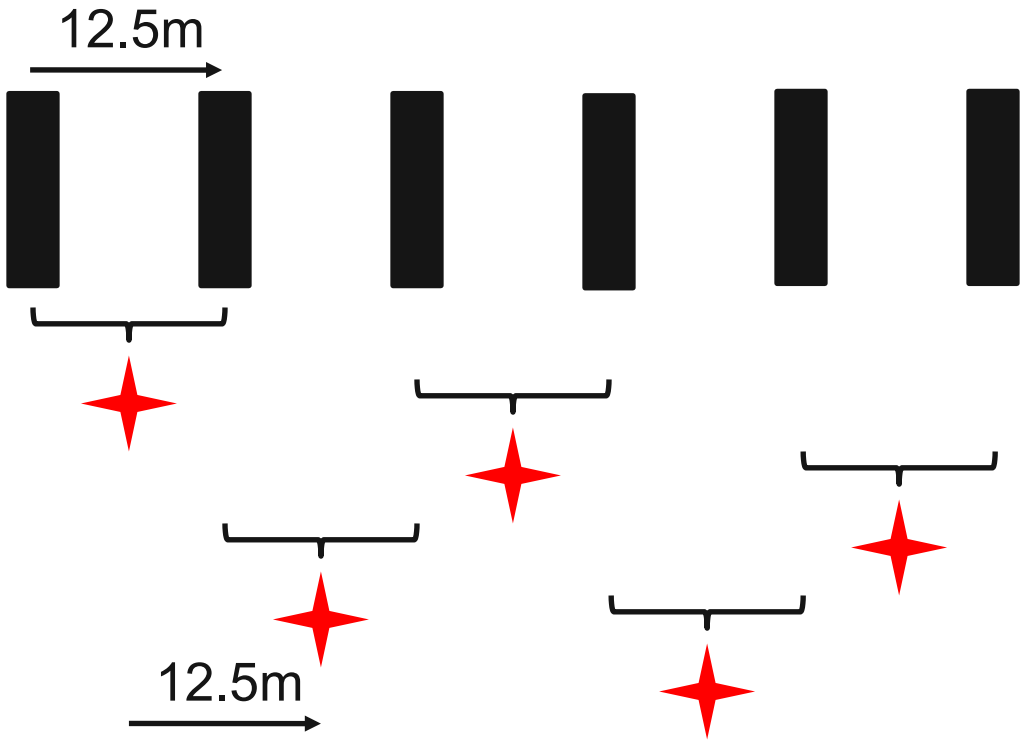
! unlimited shot records

⇒ less source-generated noise

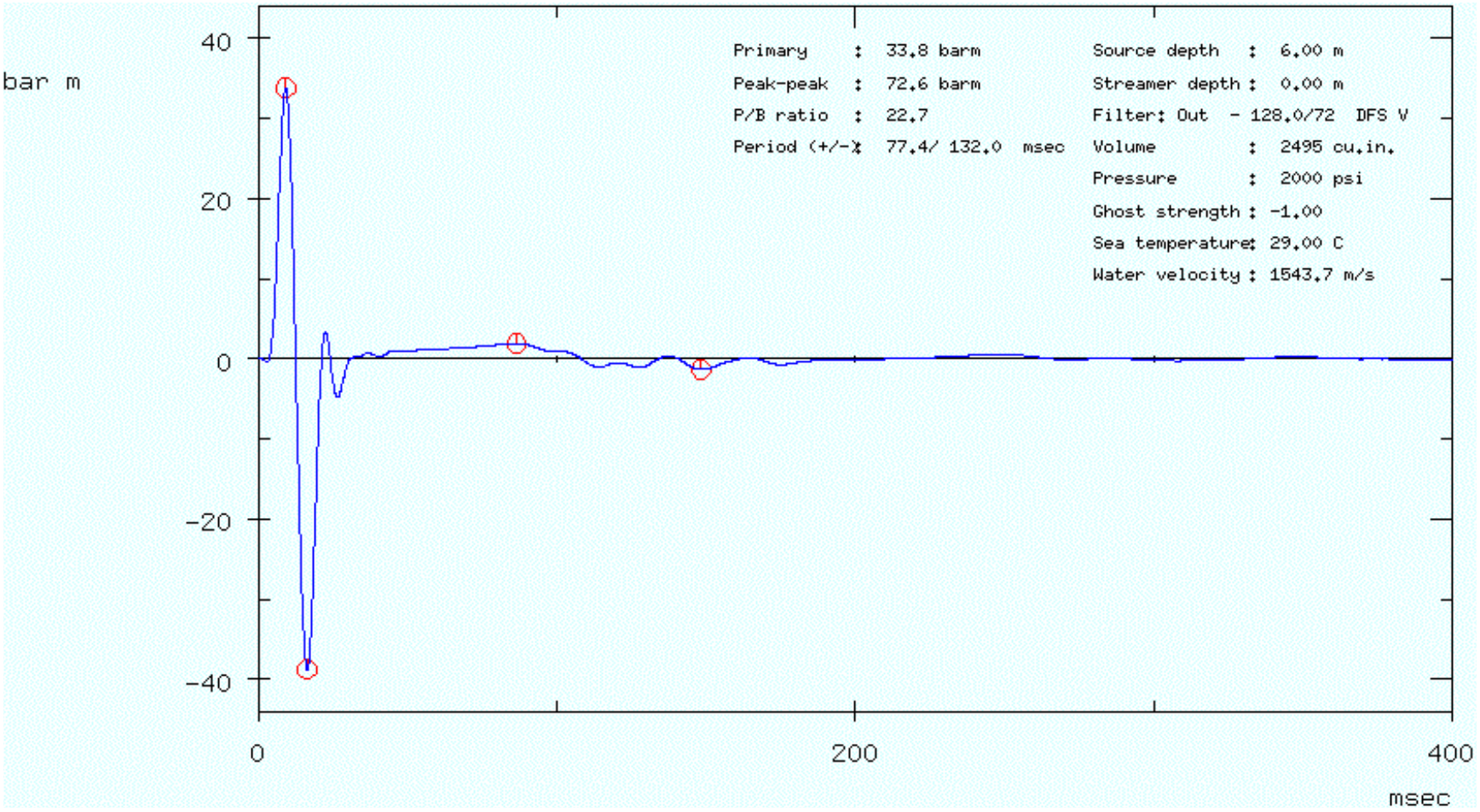


6 Airgun Strings Re-Configured

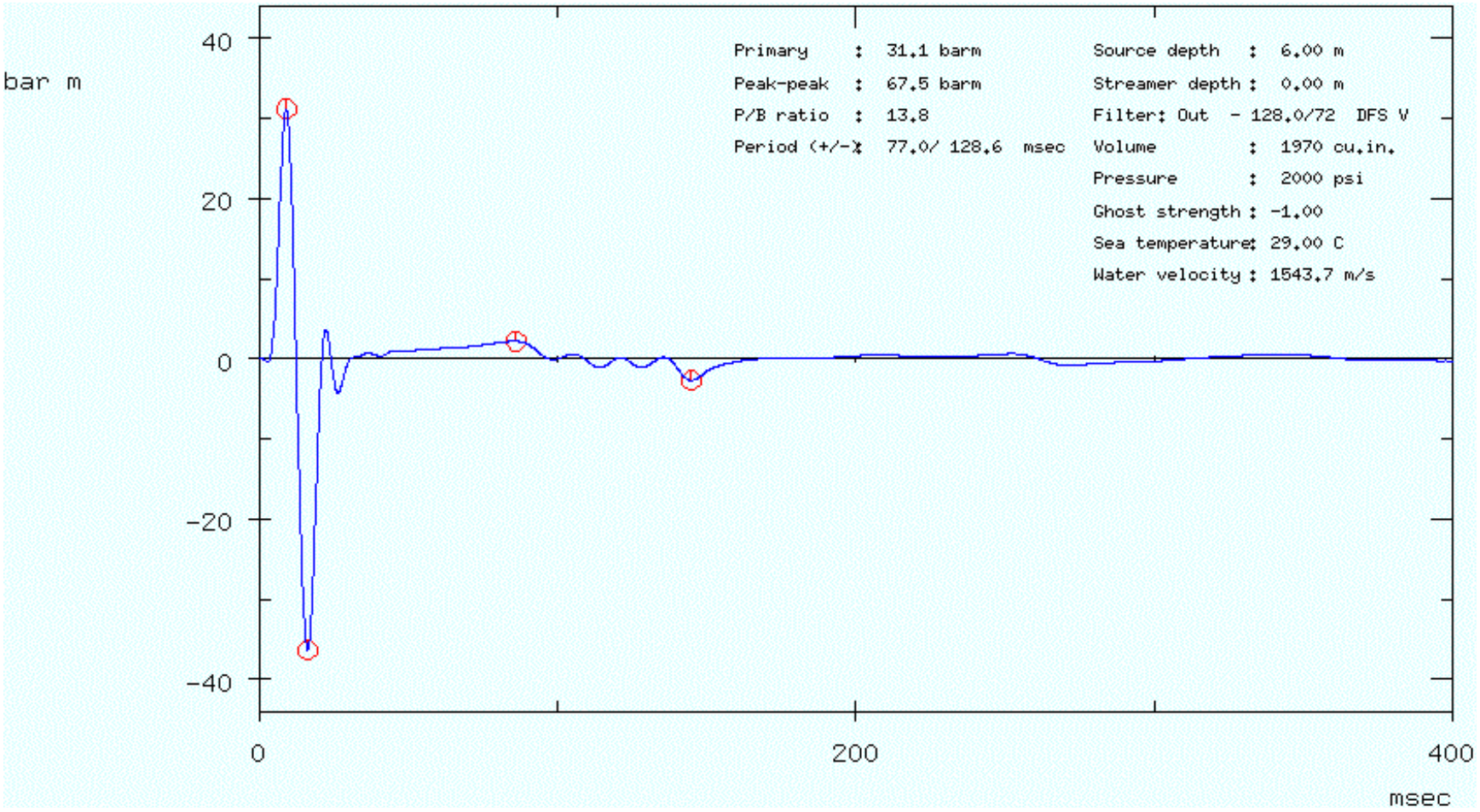
- 12.5m shot-line separation



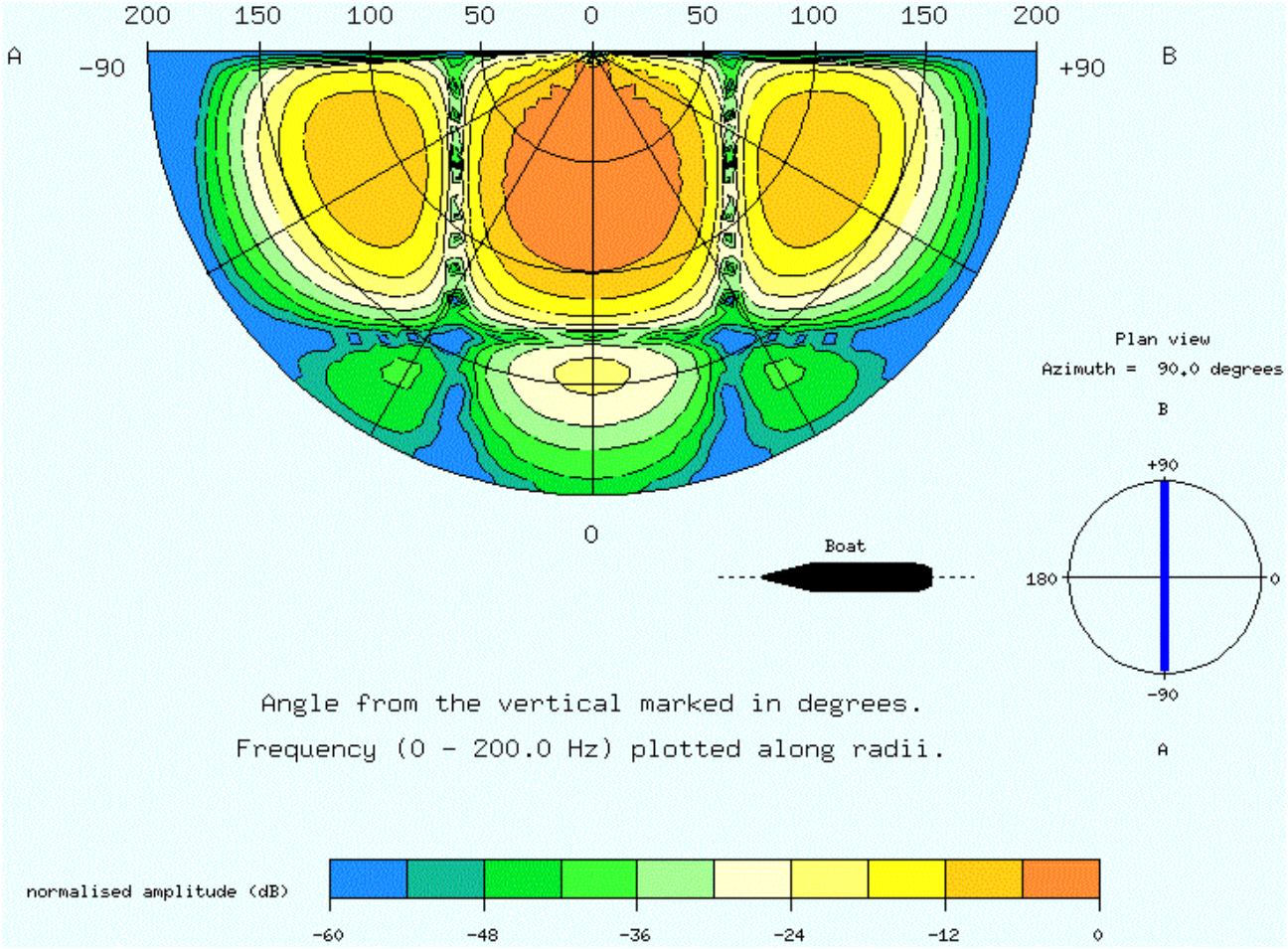
Far-Field Signal
Inside Left+Right



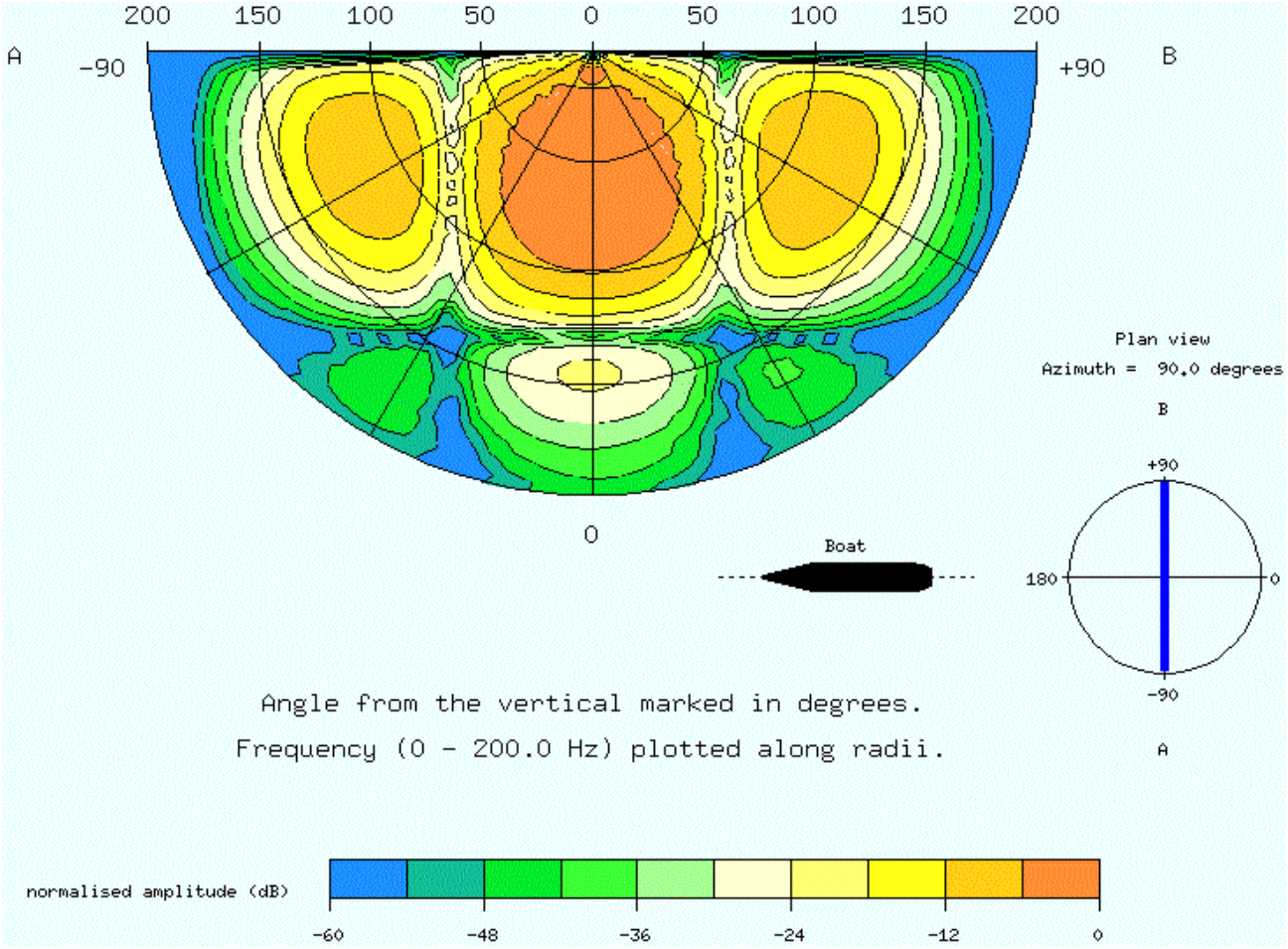
Far-Field Signal
Left Outside+Center



Source Directivity: Cross-Line Inside Left+Right

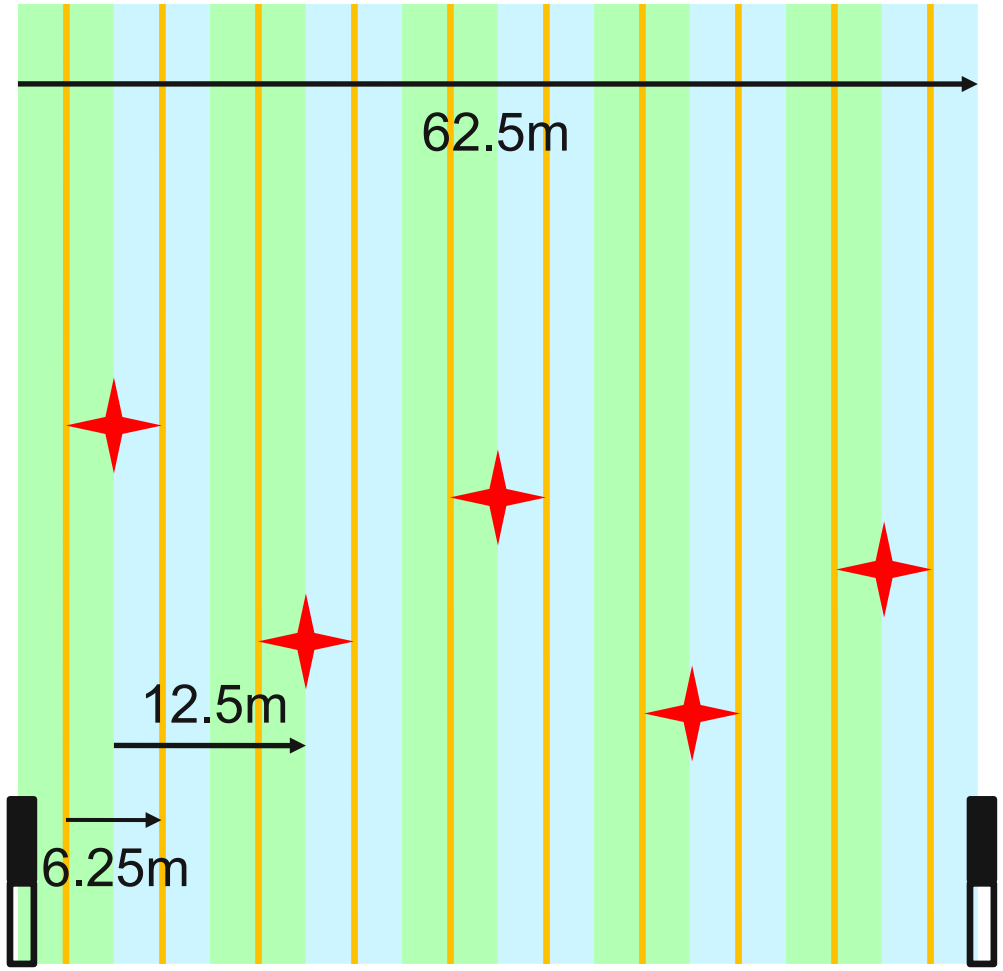


Source Directivity: Cross-Line
Left Outside+Center



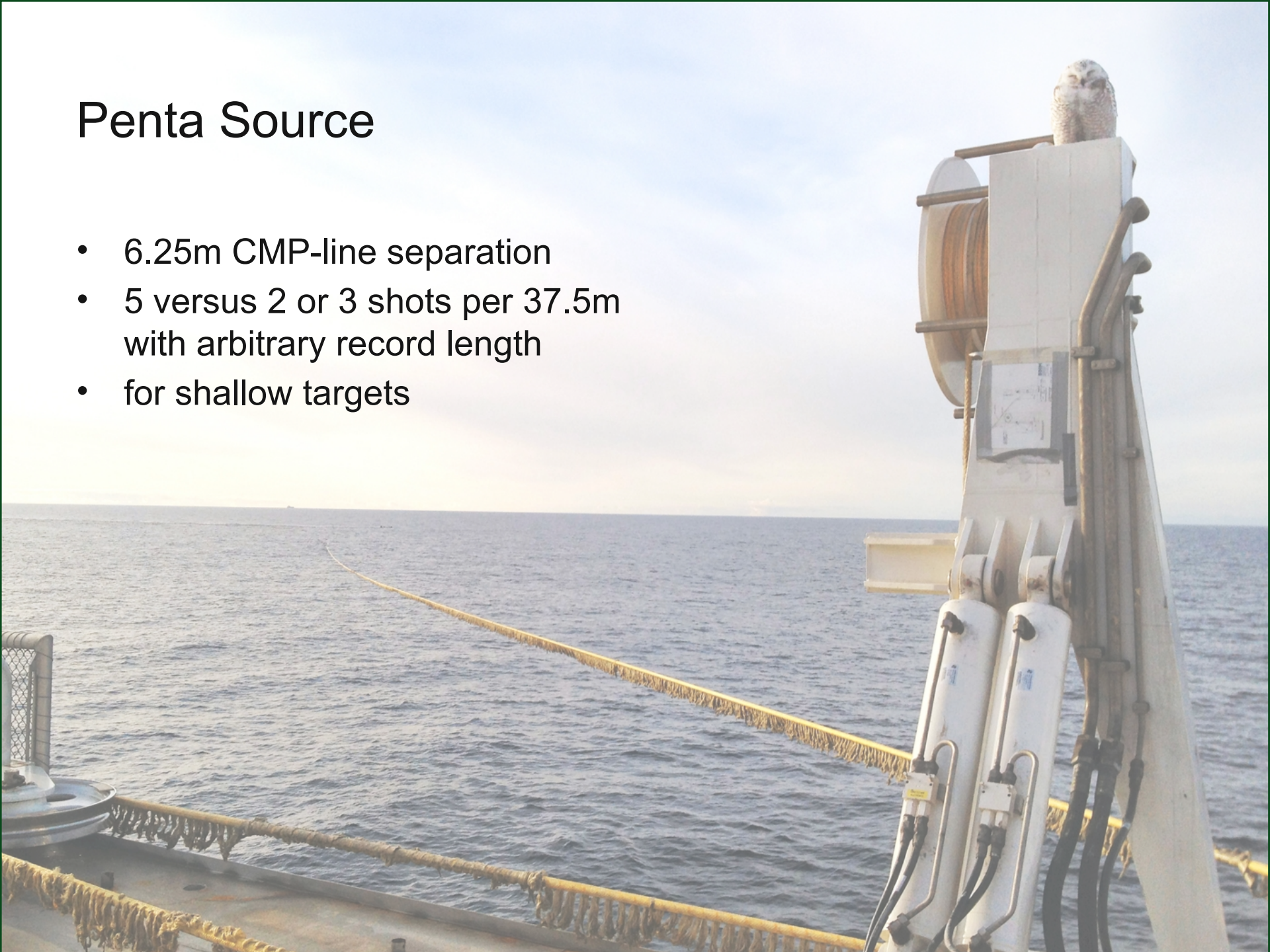
6 Airgun Strings Re-Configured

- 6.25m CMP-line separation
  - ⇒ true, not virtual data



Penta Source

- 6.25m CMP-line separation
- 5 versus 2 or 3 shots per 37.5m with arbitrary record length
- for shallow targets



Summary

- blended acquisition + de-blending in processing
  - more in-line shots / more source lines
  - larger sub-surface swath width
    smaller CMP-line separation
  - higher productivity $\Rightarrow$ faster turn-around
    more data $\Rightarrow$ better data quality

- proven concept
  - dual source: Capreolus
  - triple source: West-of-Shetland and Barents Sea; ongoing field test
  - penta source: awaiting award