Multi Swath Method: An Unconventional Yet Efficient Way to Acquire 3D Seismic Surveys

The application of 4D techniques to 3D acquisition

Emma McDonald, Technical Specialist

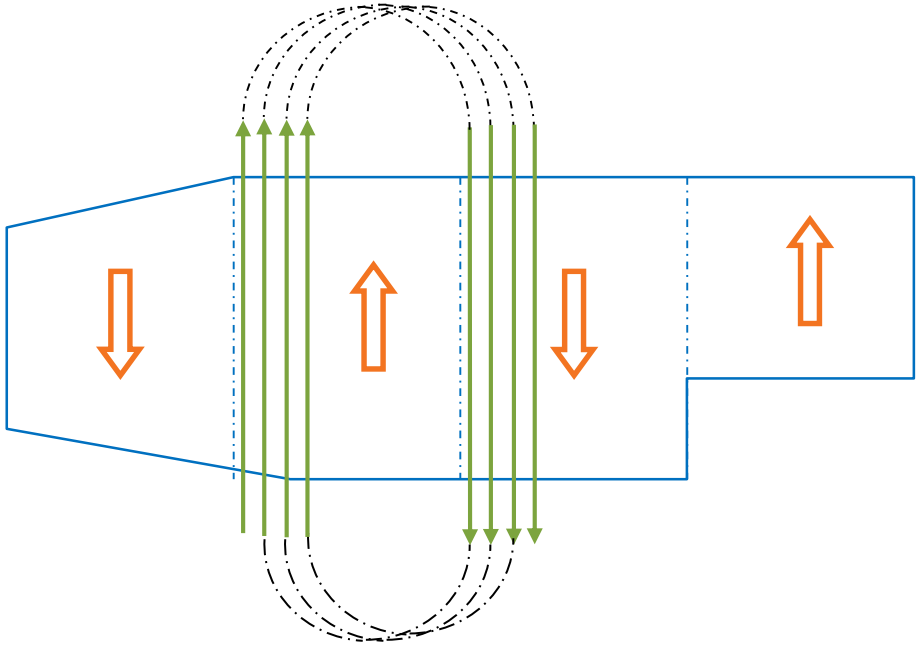
18th May 2021

Application of 4D Techniques to 3D

- ION have a long history of optimized planning on 4D surveys
- Recognition that some of the technology and techniques from 4D can improve 3D
  - Current monitoring, feather prediction and coverage modelling
- 3D case study from North Sea:
  - pre-survey modelling used to compare acquisition strategies
  - multi swath strategy applied infield

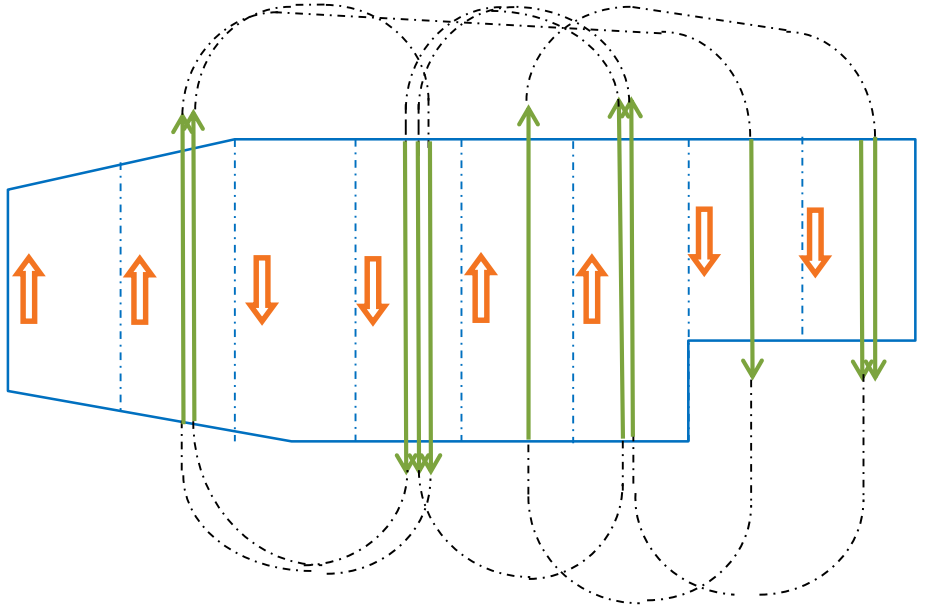
Acquisition Techniques

Racetrack Acquisition



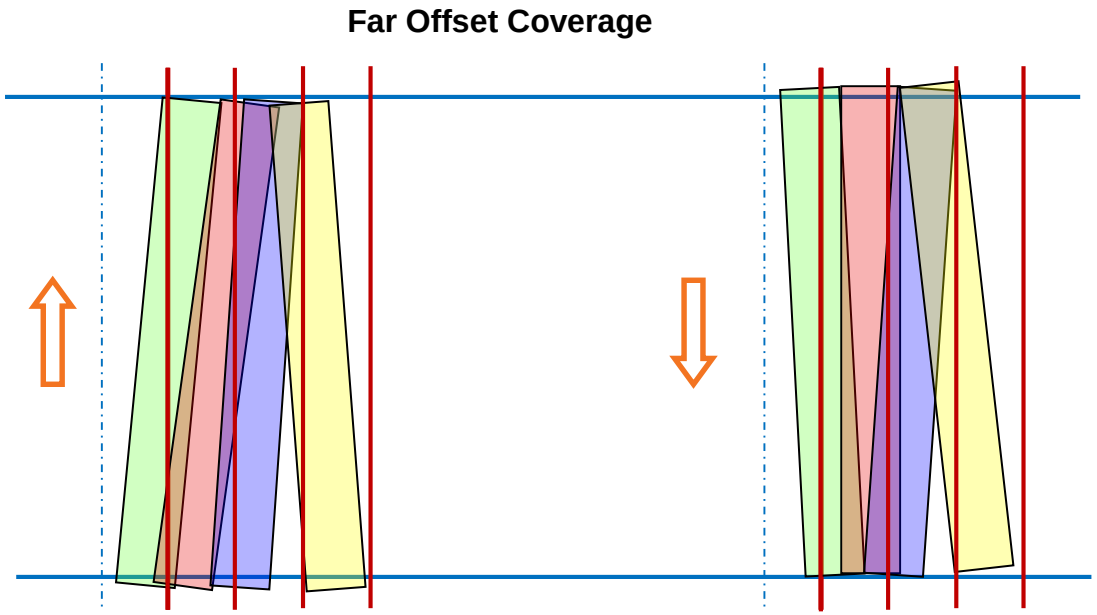
- Alternating swath azimuth
- Swath width determined by quickest turn time
- Turn diameter dependant on the configuration
- Coverage moving out from swath edge
- Vessel steers to minimize coverage gaps

Swath Matched Acquisition



- Acquires multiple sub-swaths
- Current prediction used to model coverage
- With turn time, this informs optimal line selection
- Coverage moves out from swath centres
- Vessel steers a straight line

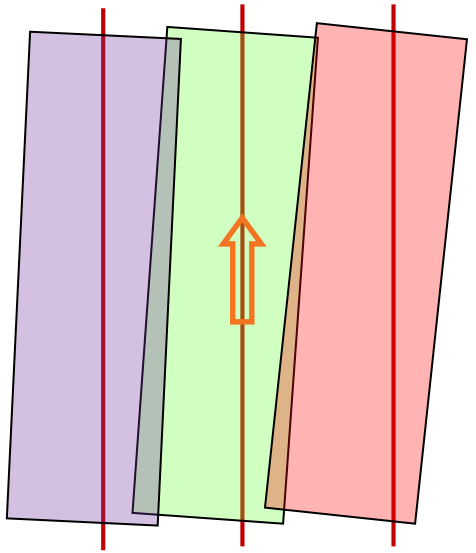
Racetrack Acquisition



- Inconsistent current dynamics on adjacent lines
- Sudden changes in current may leave gaps
- Steering to prevent gaps may cause overbinning
- Each pass adds more overbinned coverage
- Build-up of overbinning creates a mismatch between acquired coverage and preplot
- Full infill pass is required to remedy mismatch

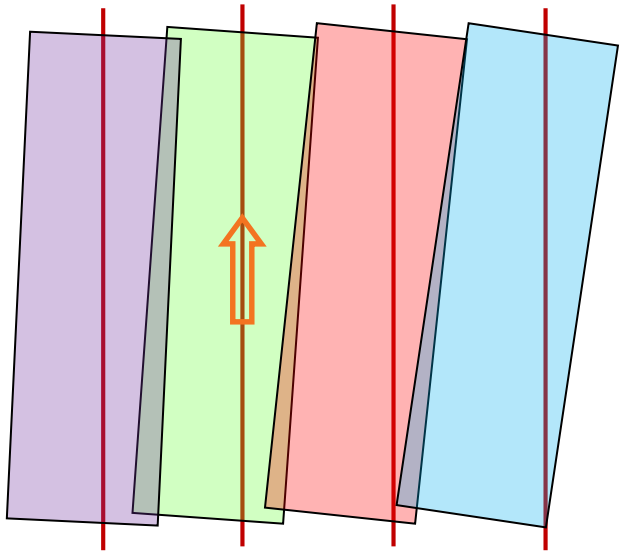
Swath Matched Acquisition

- Aim to acquire contiguous coverage with as little overlap as possible
- When feather is lower than previously, acquisition switches sides



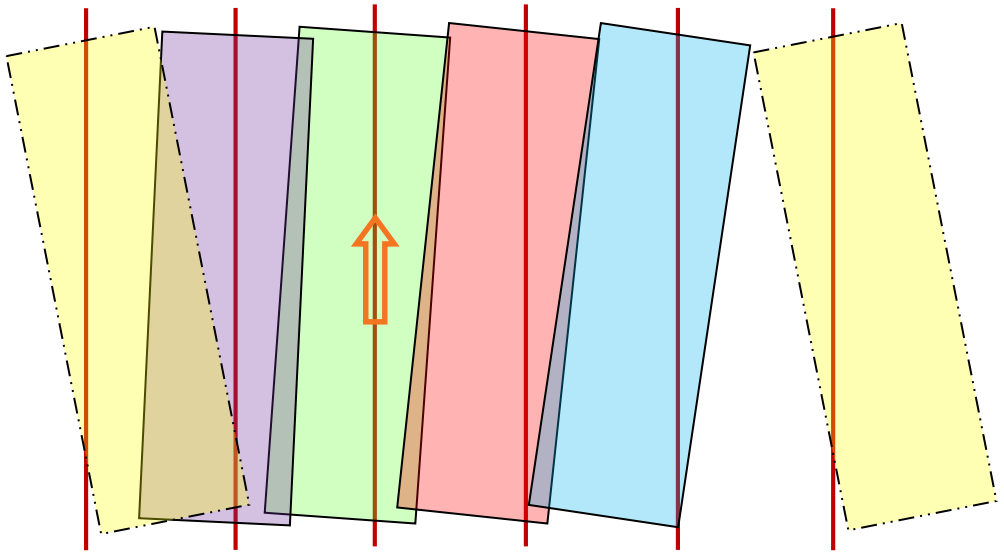
Swath Matched Acquisition

- Aim to acquire contiguous coverage with as little overlap as possible
- When feather is lower than previously, acquisition switches sides
- If the feather is slightly higher, acquisition returns to original side



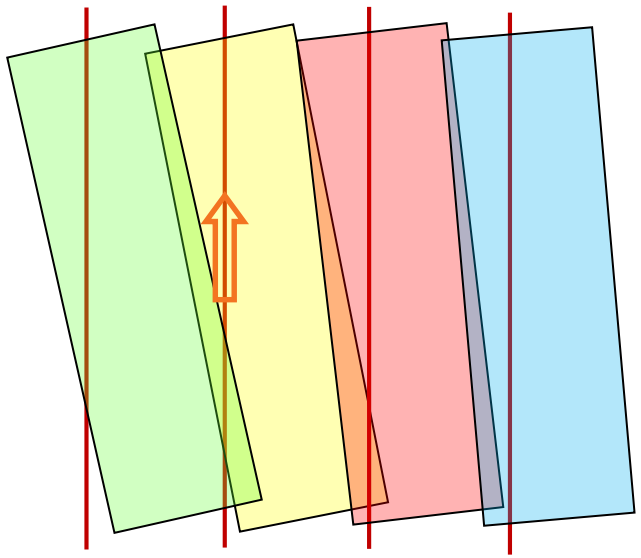
Swath Matched Acquisition

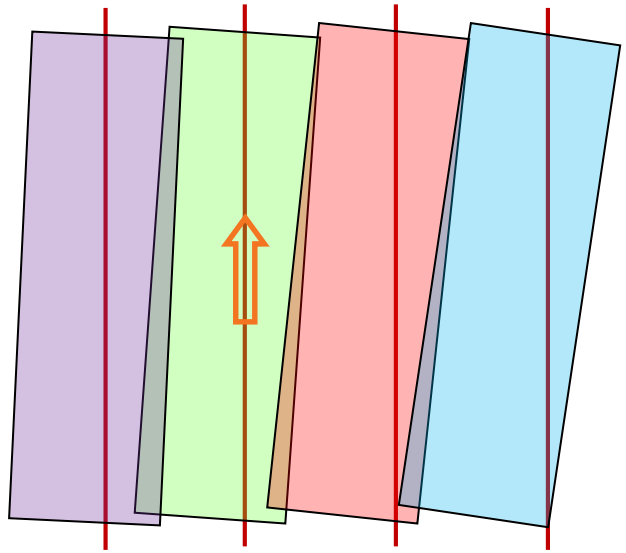
- Aim to acquire contiguous coverage with as little overlap as possible
- When feather is lower than previously, acquisition switches sides
- If the feather is slightly higher, acquisition returns to original side
- Currents can change significantly, potentially leaving a gap ... or a significant overlap.



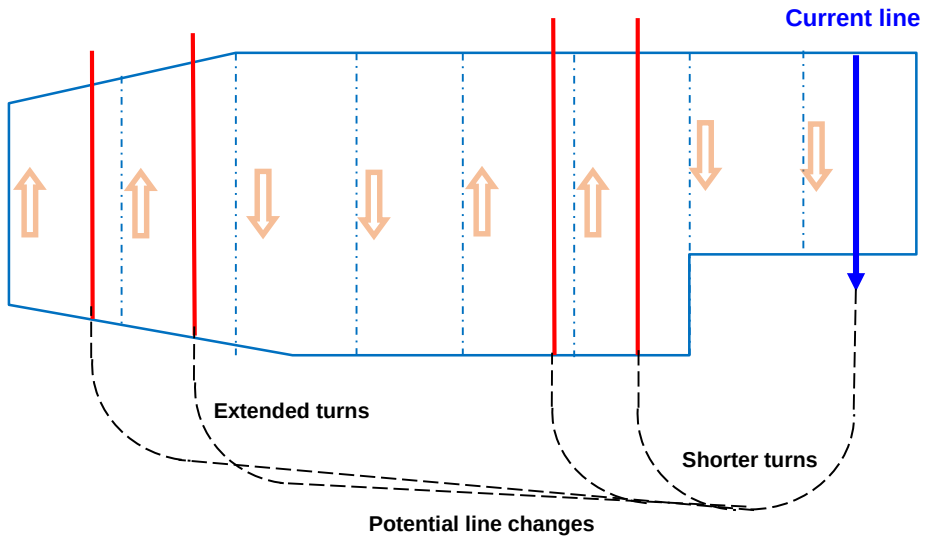
Swath Matched Acquisition

- Aim to acquire contiguous coverage with as little overlap as possible
- When feather is lower than previously, acquisition switches sides
- If the feather is slightly higher, acquisition returns to original side
- Currents can change significantly – a new sub-swath is started



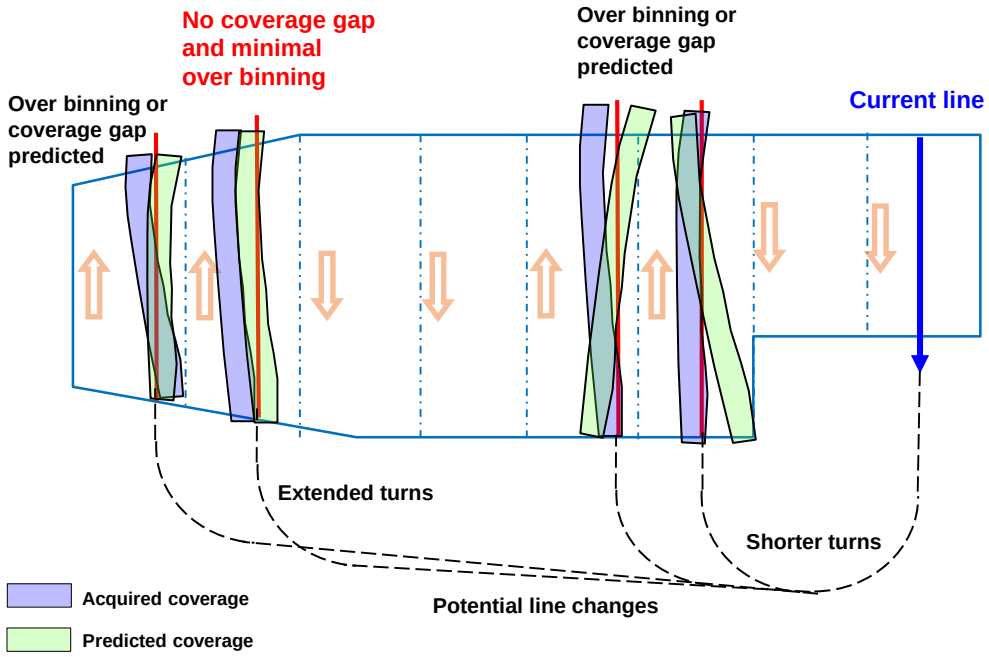


Planning Process



- Infield planning identifies each available swath edge
- Time for line change and acquisition are calculated

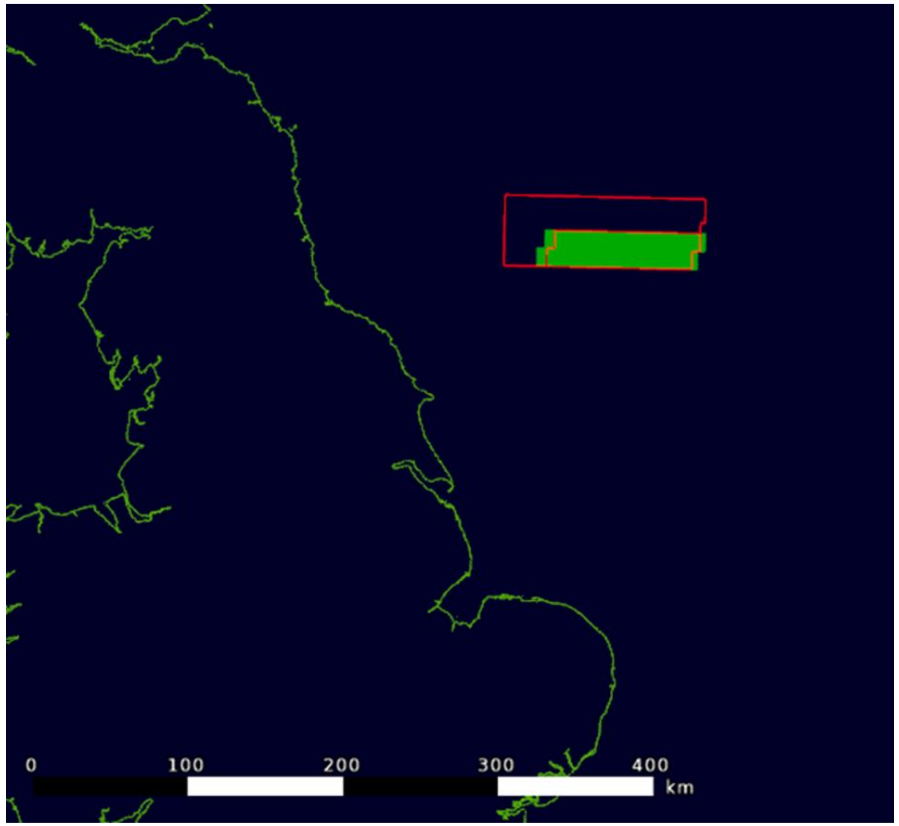
Planning Process



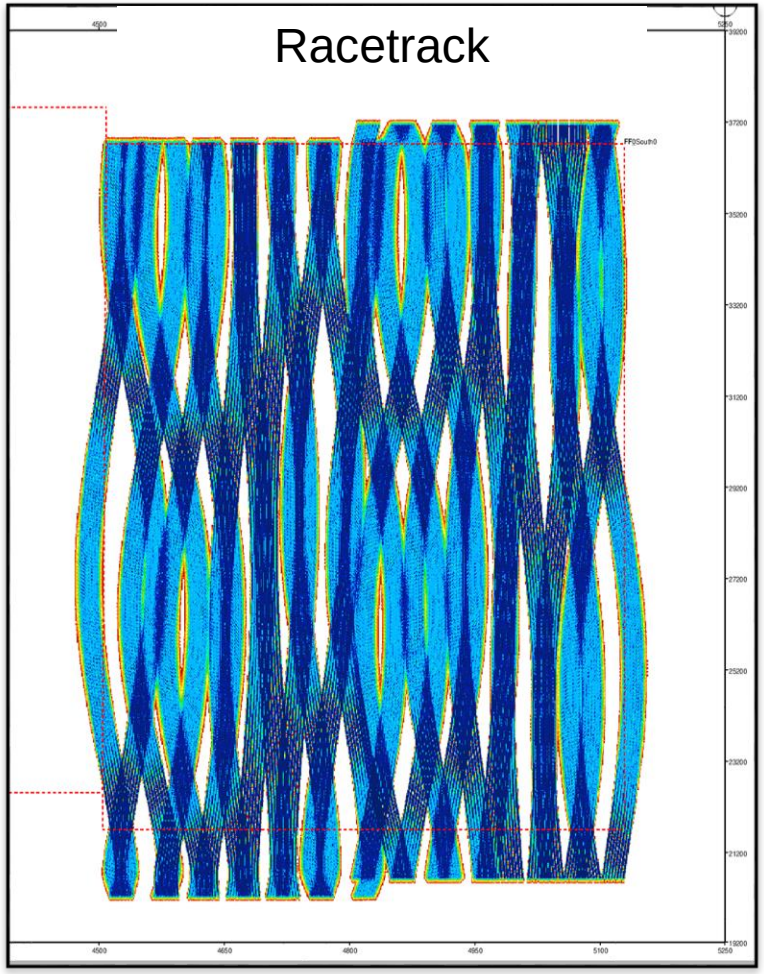
- Infield planning identifies each available swath edge
- Time for line change and acquisition are calculated
- **Coverage Footprint** is predicted - number of unique (new) bins are calculated
  - **Unique Bins Per Hour** (UBPH) measures the efficiency of the line choice

Case Study – Mid North Sea High 3D

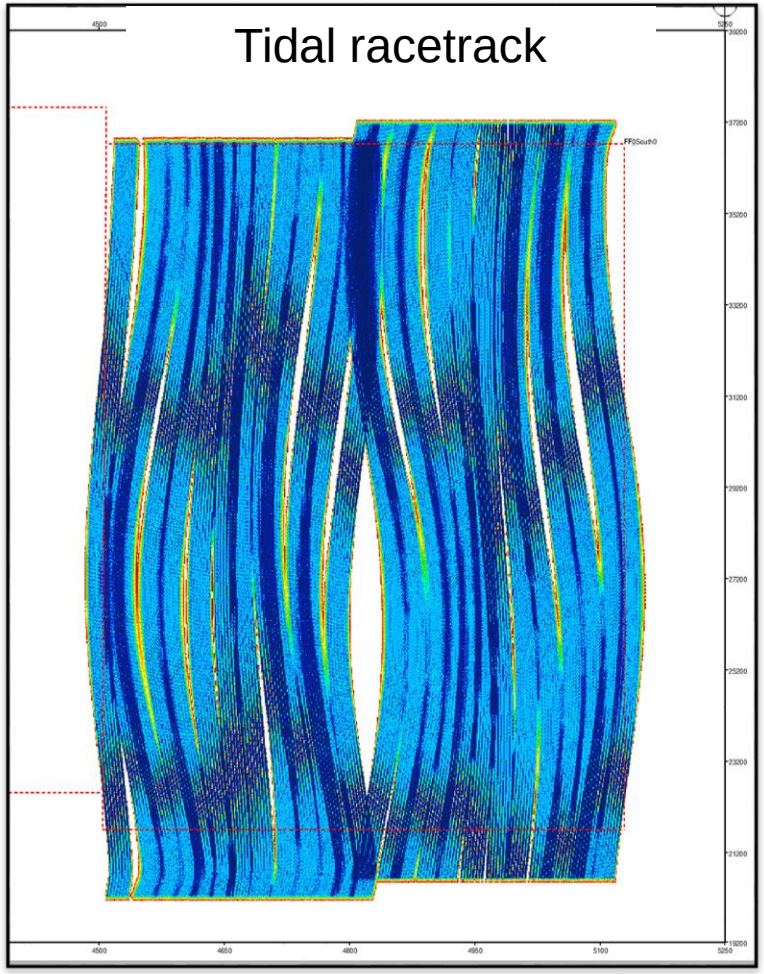
- Multiclient survey was acquired over the Dogger Bank in the mid North Sea, starting Q3 2020.
- Line length (c.100km) did not allow synchronisation with tidal cycle within standard racetrack
- Pre-survey analysis indicated feathers up to +/-10°
  - High potential for large feather mismatches between passes
  - Long streamers (7.2 km) would intensify the effect of feather differences
- Opportunity to utilize multi swath acquisition
- Pre-survey modelling compared 3 acquisition scenarios:
  1. **Standard 3D type Racetrack with normal turn radius**
  2. **Tidal Racetrack (extending line changes to wait on the tide)**
  3. **Swath Matched acquisition using 4 separate sub-swaths**



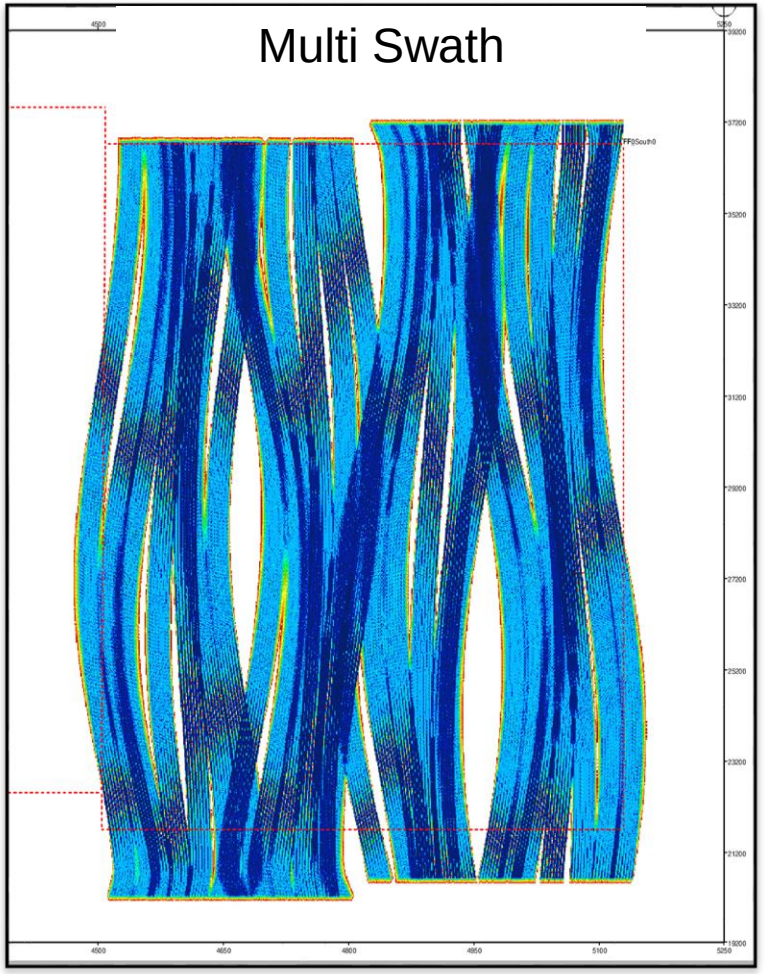
Modelled Far Offset Coverage



Time to acquire prime : 428 hrs
Empty bins = 149.0 km2
Infill passes = 13

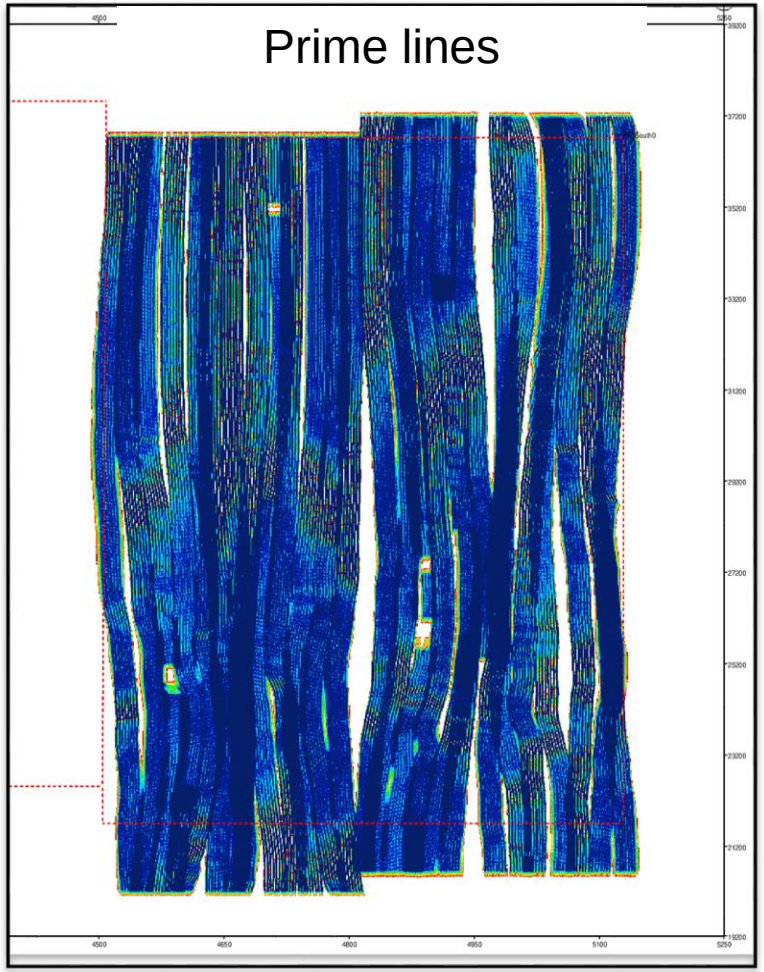


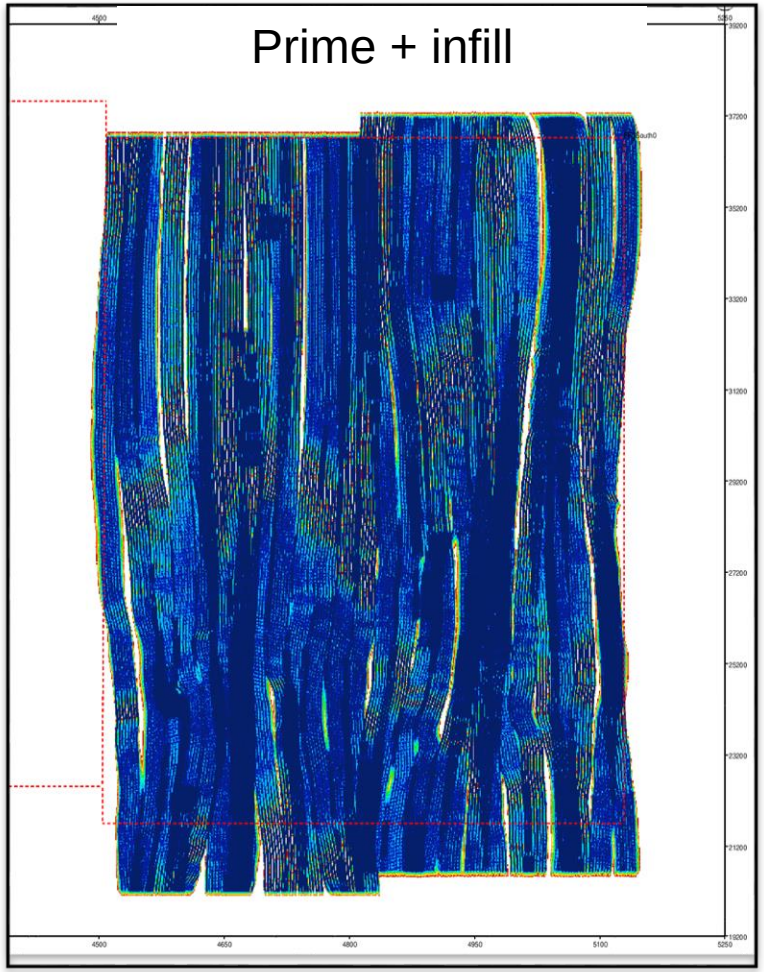
Time to acquire prime : 502 hrs
Empty bins = 66.5 km2
Infill passes = 2



Time to acquire prime : 427 hrs
Empty bins = 120.4 km2
Infill passes = 3

Acquired MNSH 3D Far Offset Coverage





- Duration slightly shorter than modelled
- Slightly more infill passes than modelled coverage

Time to acquire prime = 412 hrs
Empty bins = 72.3 km2
Actual infill passes = 5

Summary of Multi Swath Benefits

- Swath Matching assists with:
    1. **Reduced infill, survey costs and exposure**
    2. **Using the natural current reduces active streamer steering and associated noise**
    3. **Improved and more regular spatial sampling that allow migration processes to work better**
    4. **Fewer coverage gaps, so reduced interpolation**
    5. **Straighter source tracks that would benefit future 4D**
- Using current predictions, both racetrack and swath matched plans can be modelled simultaneously
    - This has lead Multi Swath to be successfully applied both in tidal areas and in areas where spatial currents are dominant, such as West Africa

Powering data-driven decisions