The pioneering use of additive manufacturing techniques to create an unfolding metal cement retainer for a water shut off project in the UK Southern North Sea

SPE Paper #224080

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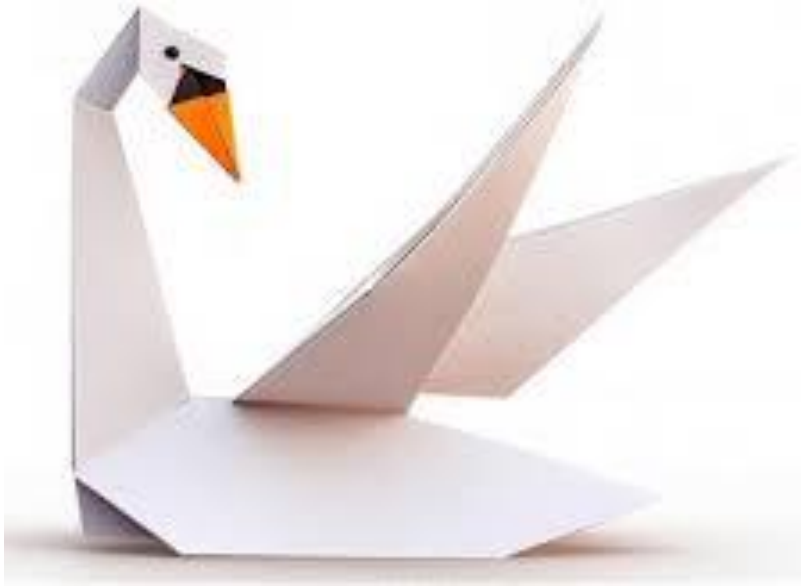
The Development

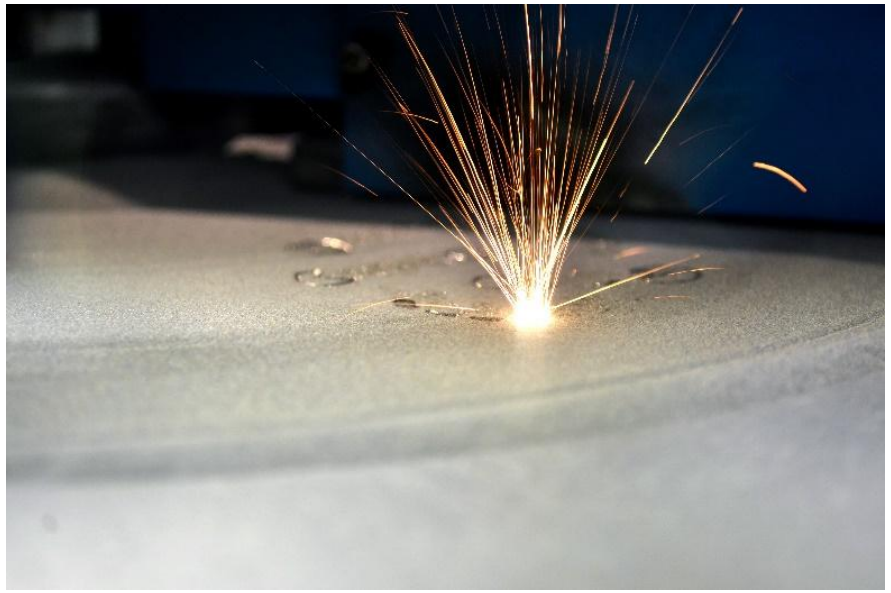
Origins – Folding Structures



Origami

Space Structures

Origins – Development of M-Bubble



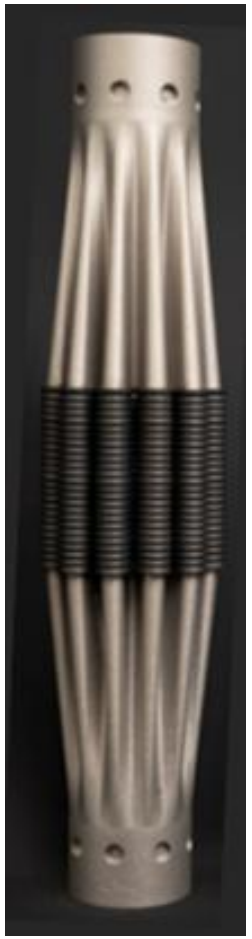
Additive Manufacturing

Direct Metal Laser Sintering (DMLS)
Inconel 625

Stellate cross-sectional pattern

Origins – Development of M-Bubble

DEVELOPMENT

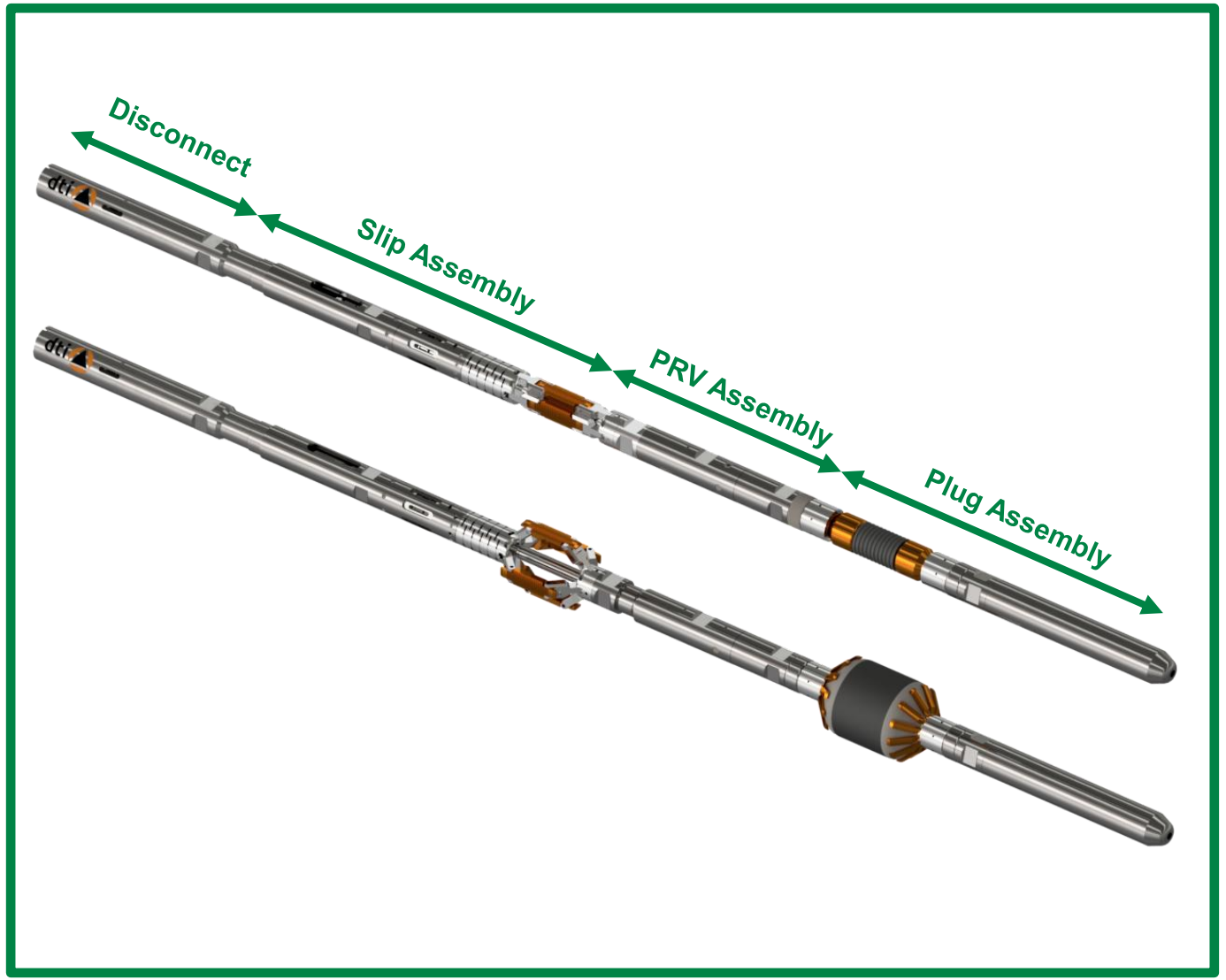


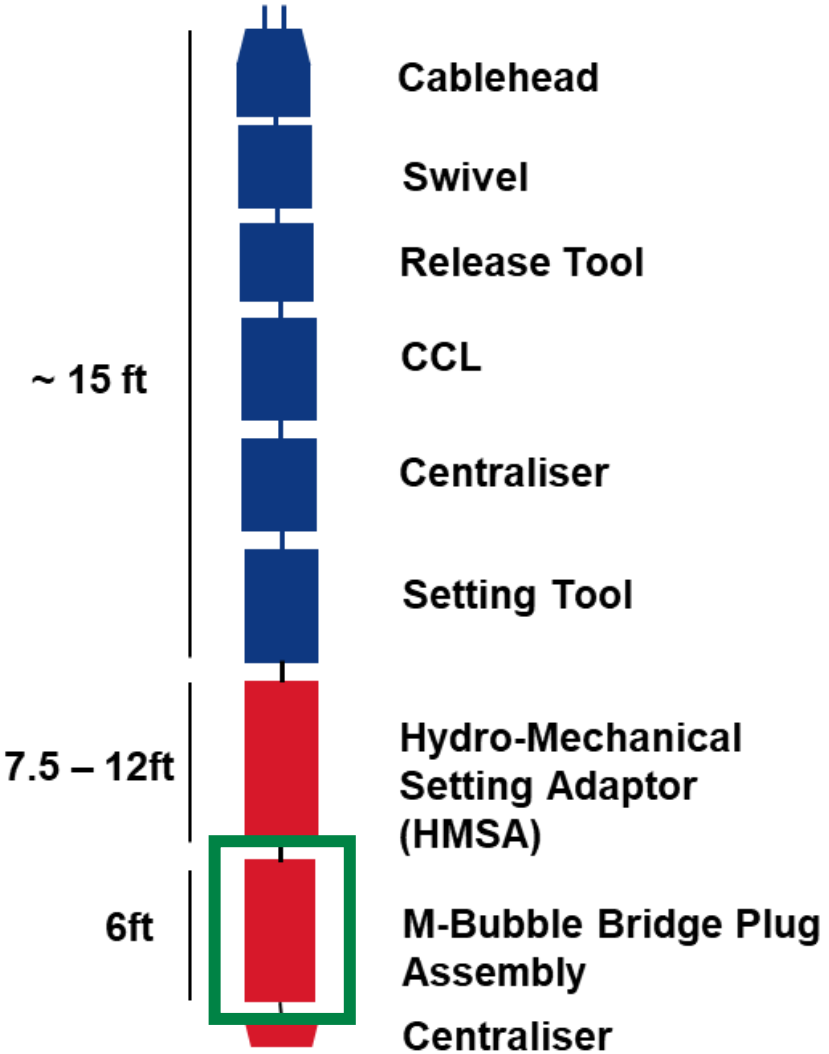
Stellate cross-sectional pattern

The seal

High Delta ID Unfolding Metal Element ‘M-Bubble’

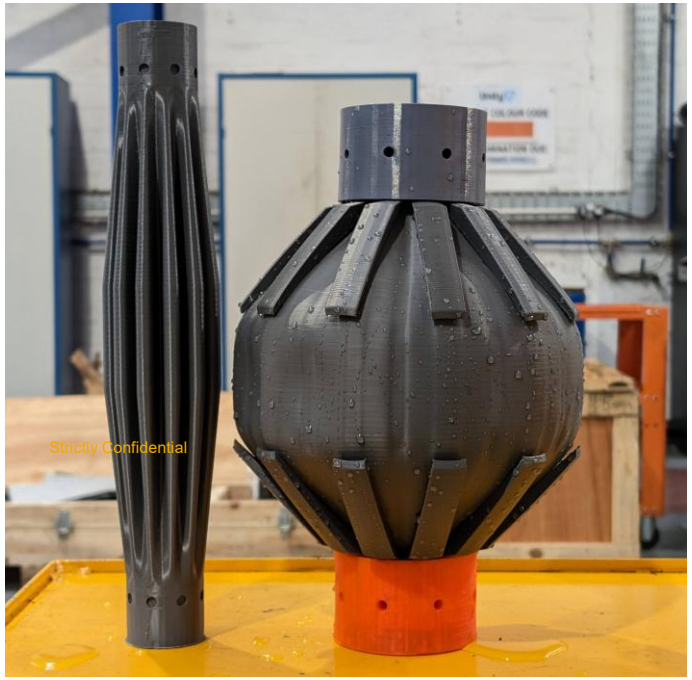
Standard Plug and Setting Assembly

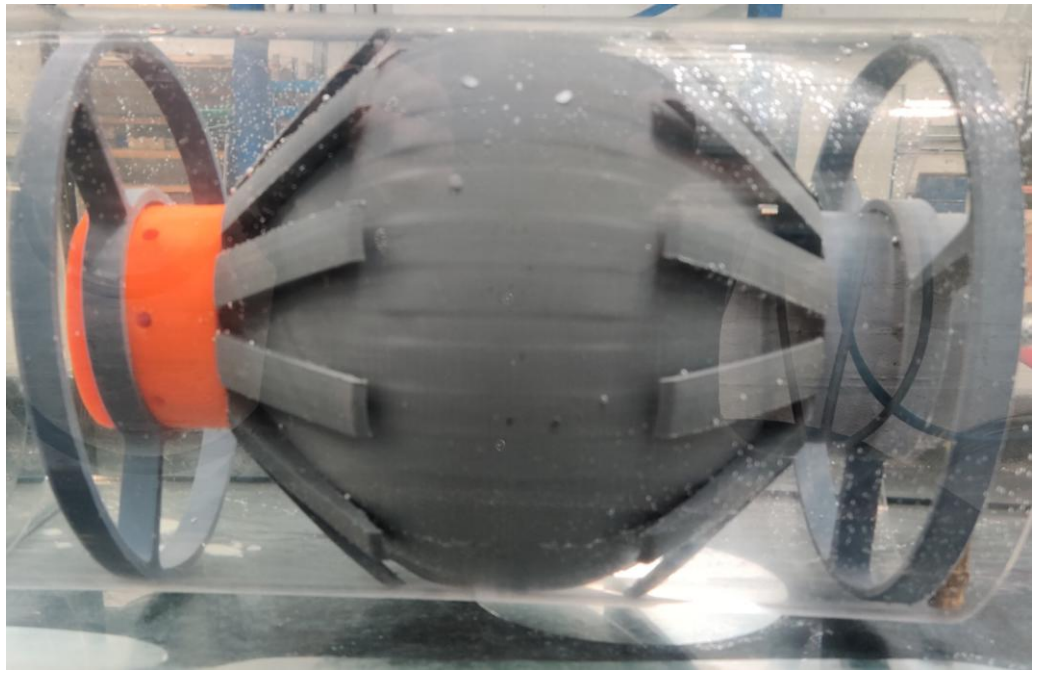




Prototype Testing – Development of new M-Bubble sizes

- Fused Deposition Modelling (FDM) in Polylactic Acid (PLA) print used for concept testing.
- Proved to be analogous to DMLS in Inconel 625.
- Enables quick iteration of designs with << wastage of Inconel.

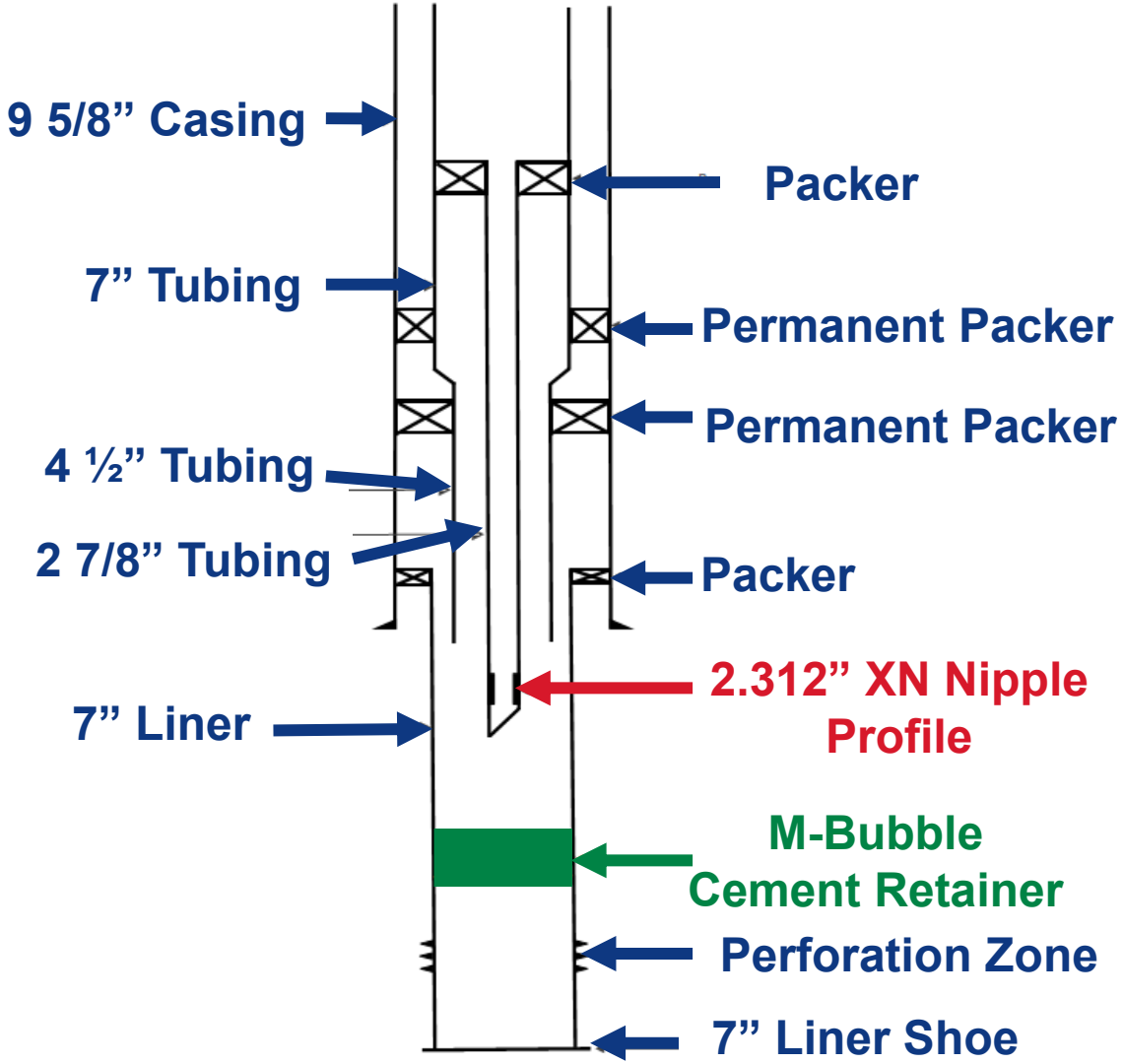




Example – Concept development of 9 5/8” M-Bubble plug

The Challenge

The Well

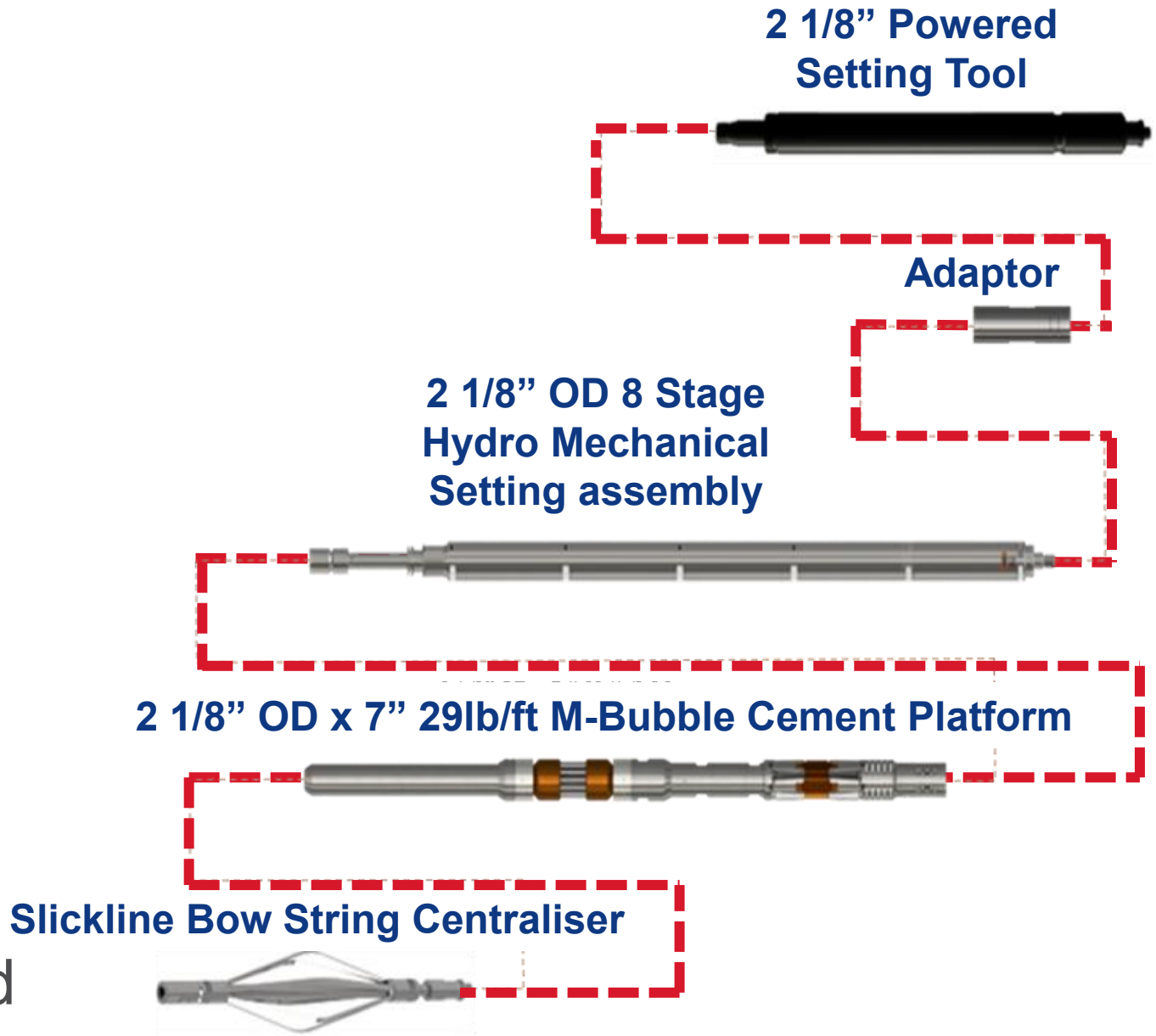


- Villages Gas Fields – UKNS
- Water coning at start up
- Well restriction – **2.205" No Go**
- Liner 7" (6.184" ID, 29 lb/ft)
- Cement platform required for WSO cement plug
- Set at 14,000ft + and 63deg inclination

The Operation

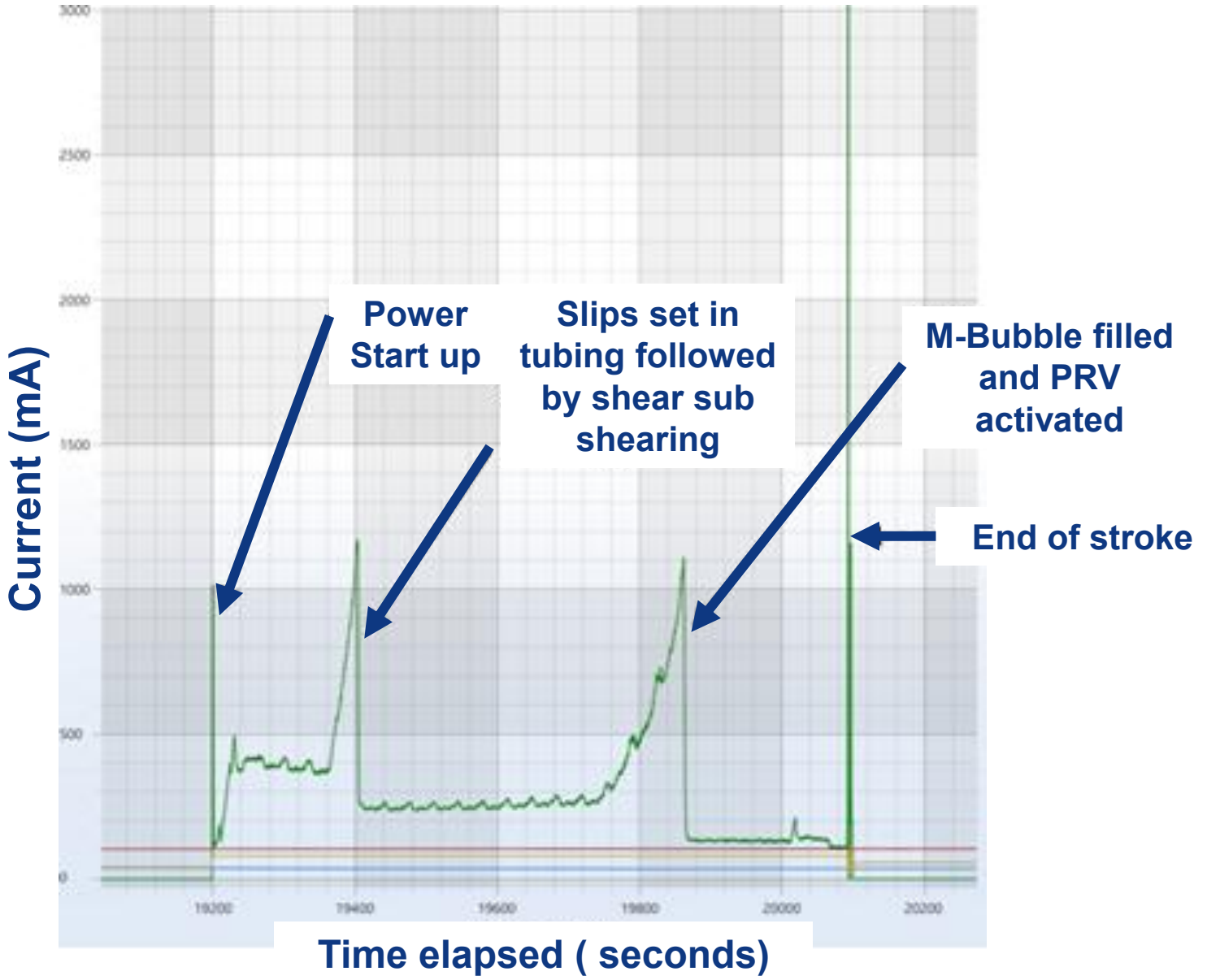
The Operation

- No seal due to 290% ID Delta
- Centralisers above and below the plug
- Setting tool on a timer
- Setting tool stroked the plug and slips
- Slips released first
- Once plug filled PRV activated



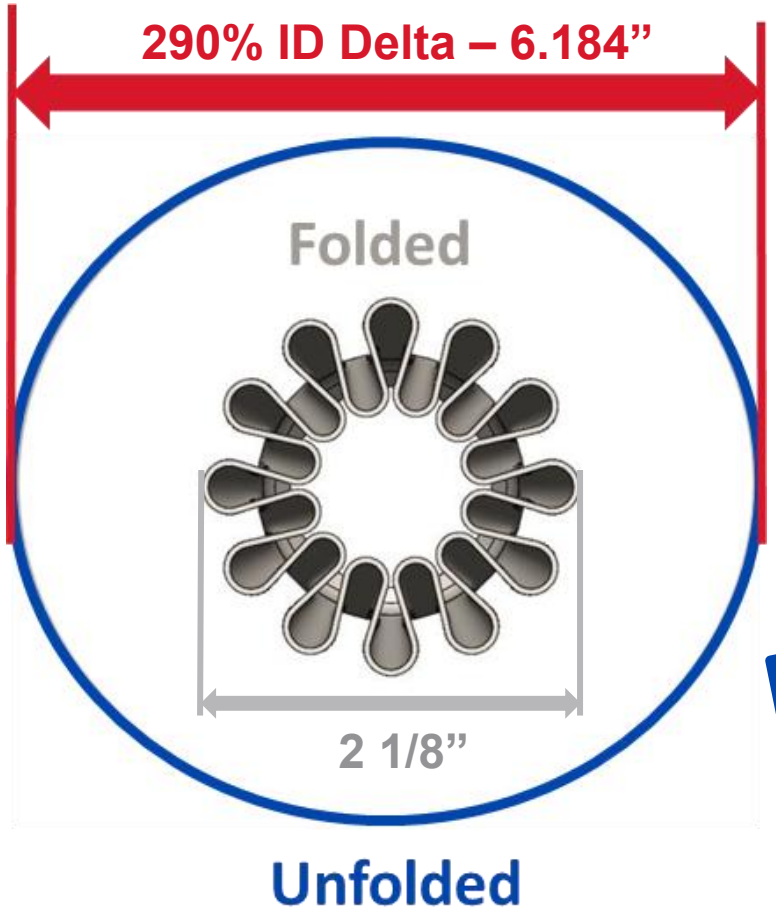
The Operation

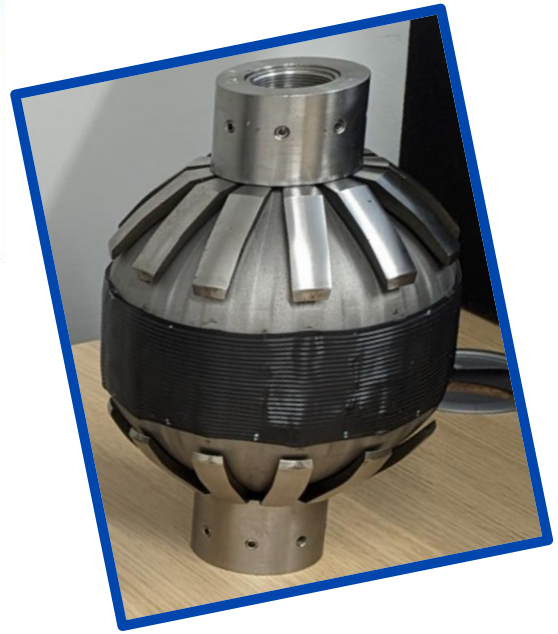
- Data downloaded from power setting tool
- Compared to ‘good’ run data sets
- ‘Good set’ confirmed
- Ceramic balls and cement deposited
- PLT used to check ‘good’ seal



The Summary

- Achieved a water shut of across a high ID delta
- Additive manufacturing and the concept of folding structures made this possible
- The application of forcing fluid at pressure to unfold the plug, combined with proppant and cement, gave an effective long term seal.





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Thank you!