

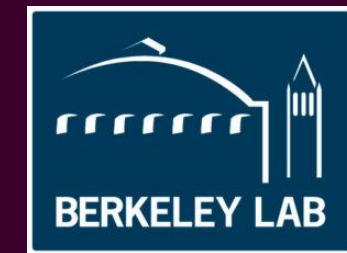


DEVELOPMENT OF THERMAL BREAKOUT TECHNOLOGY FOR DETERMINING IN SITU STRESS

DOE Award # DE-FE0031688

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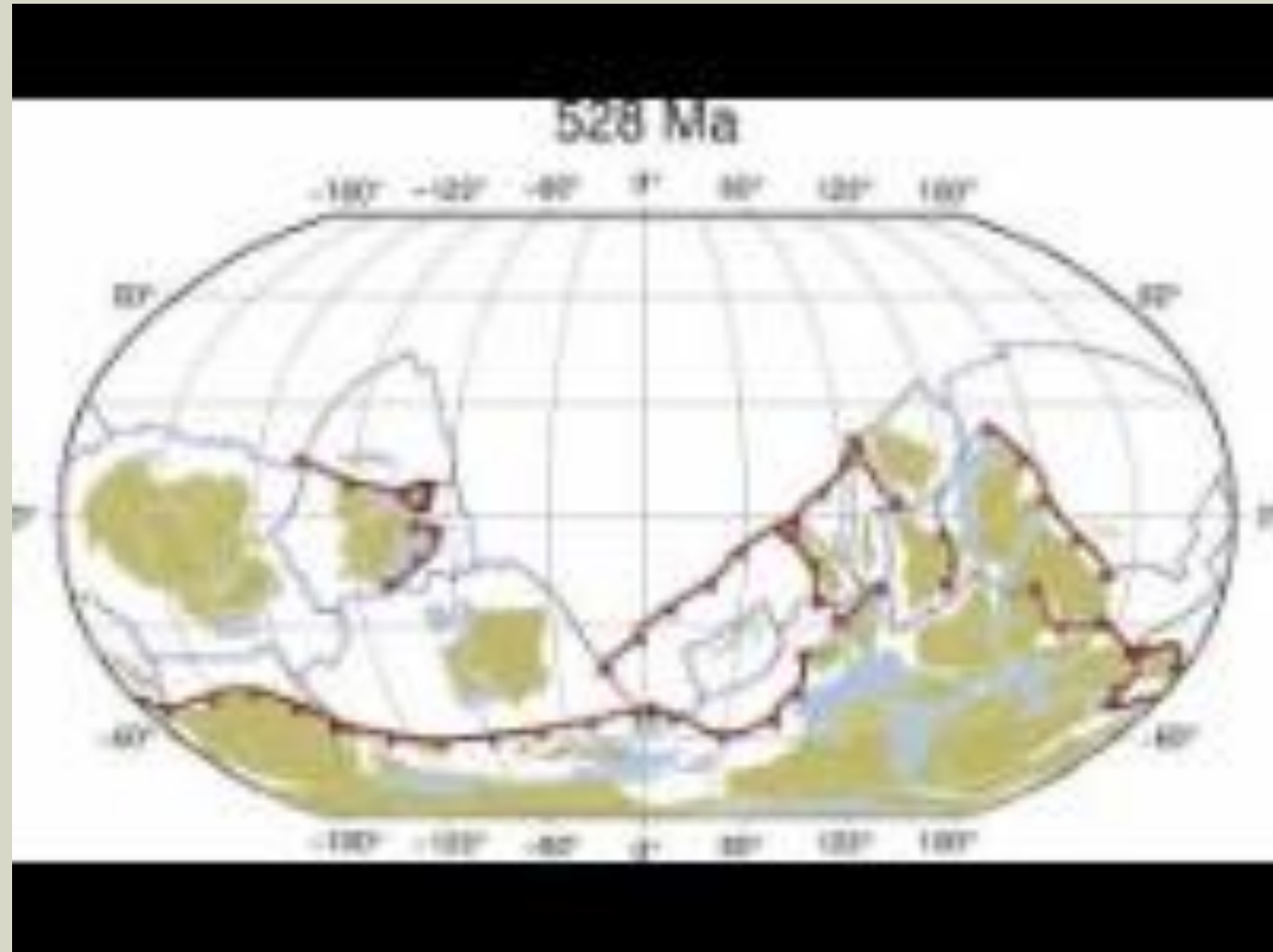


Thomas Doe
Daniel Moos



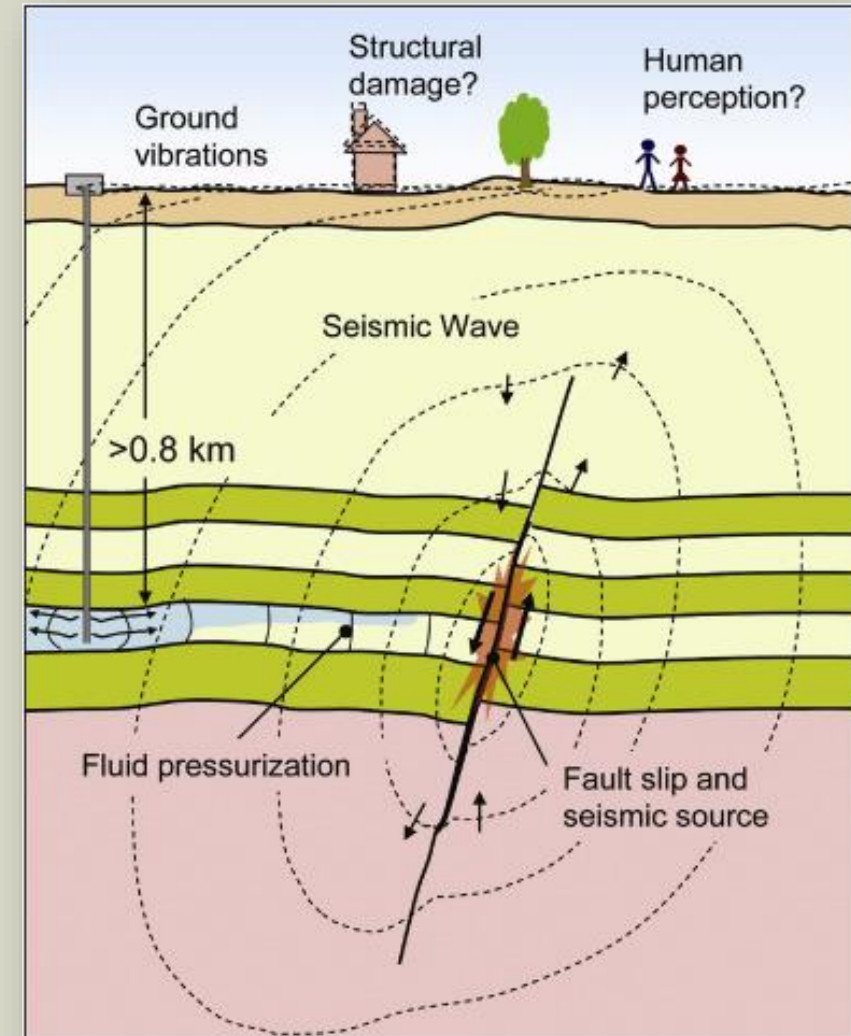
› What is “in situ stress”?

- / The tectonic stresses (forces) that naturally occur in the subsurface
- / Three principal stresses occur... vertical and two horizontals
- / The orientation and magnitude of these three stresses can be very complex

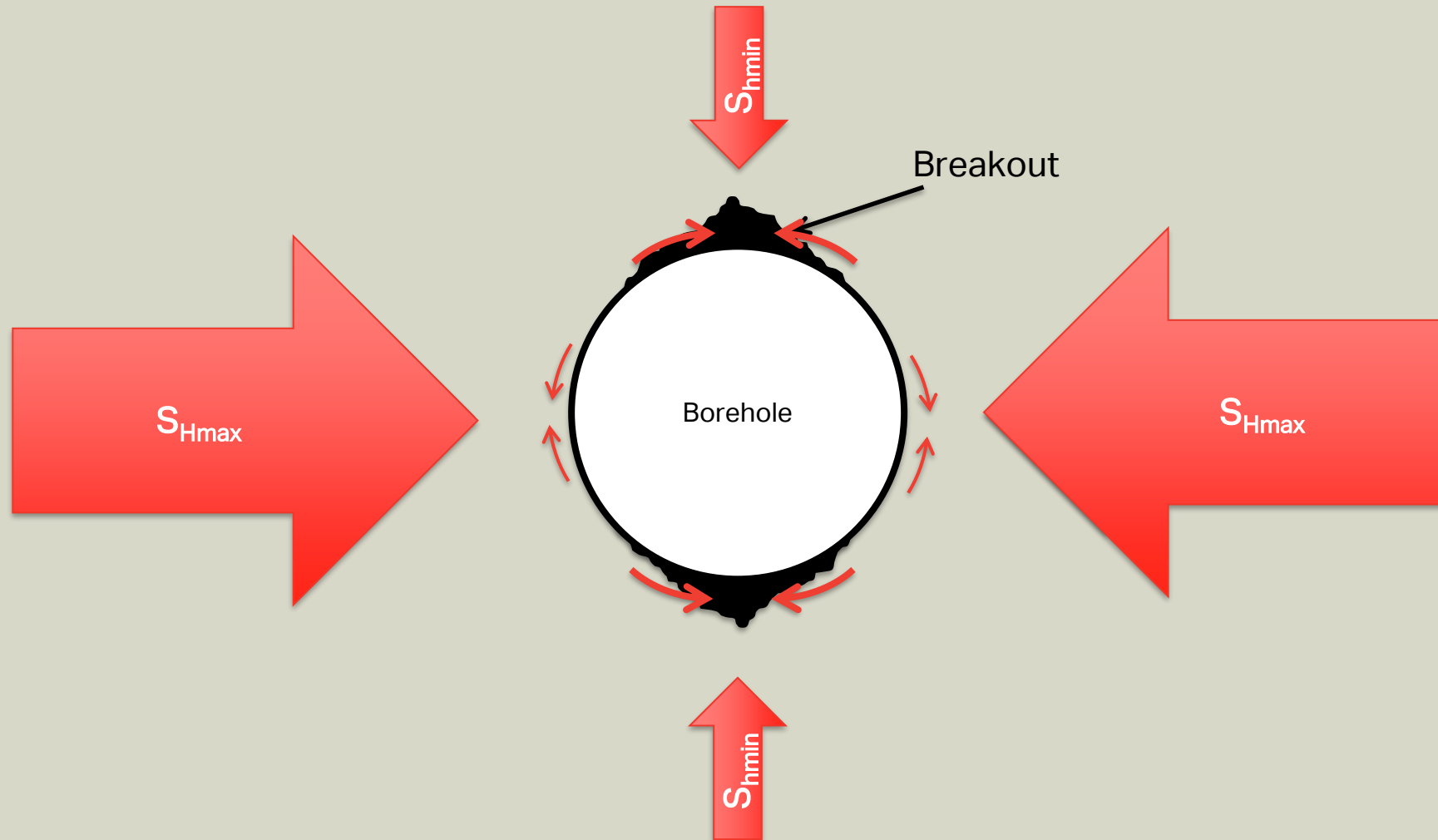


<https://www.nytimes.com/2021/02/06/science/tectonic-plates-continental-drift.html>

Why do we need to measure the in situ stress?

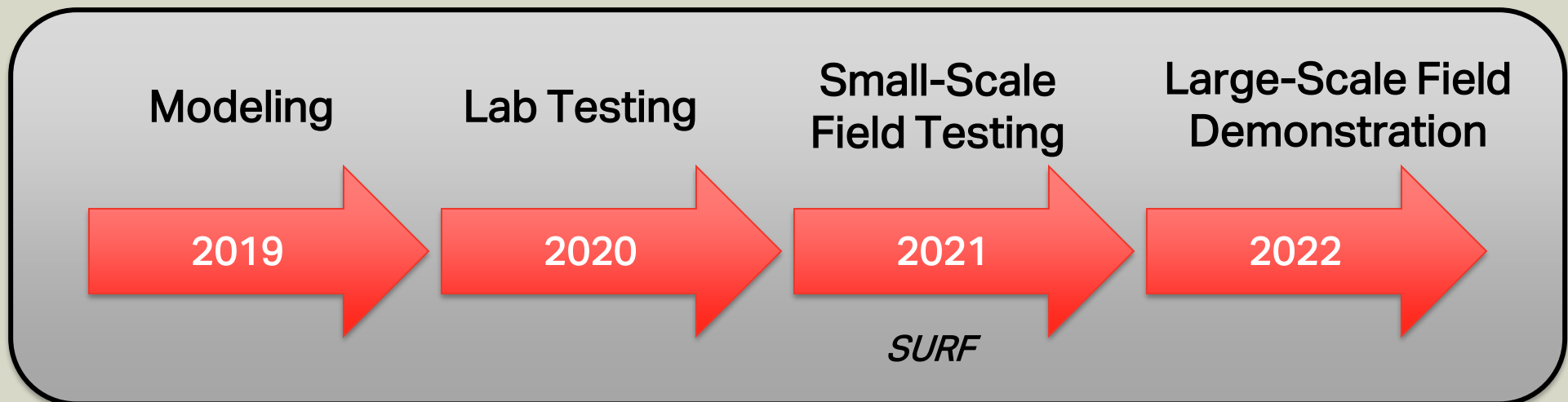


BACKGROUND



BACKGROUND

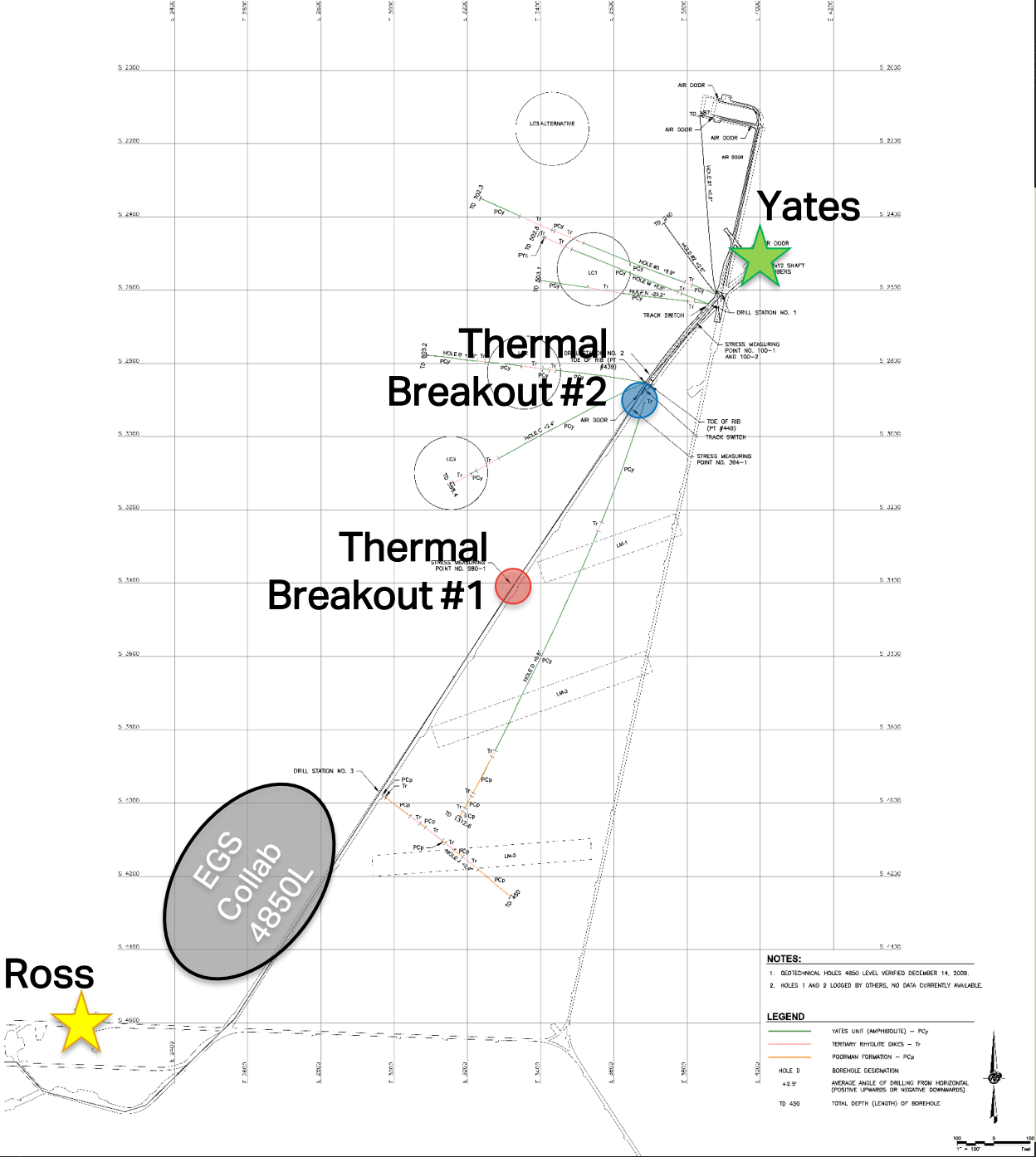
- › Use well-established, existing technology to improve the standard methods of in situ stress measurements by including thermally induced borehole breakout technology
- › Borehole breakouts are a proven indicator of the maximum horizontal in situ stress magnitude
- › The thermal breakout technology is intended to reliably create breakouts by inducing thermal compressive stress



FIELD TESTING — SURF 4850L



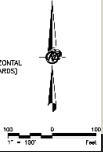
FIELD TESTING — 4850L



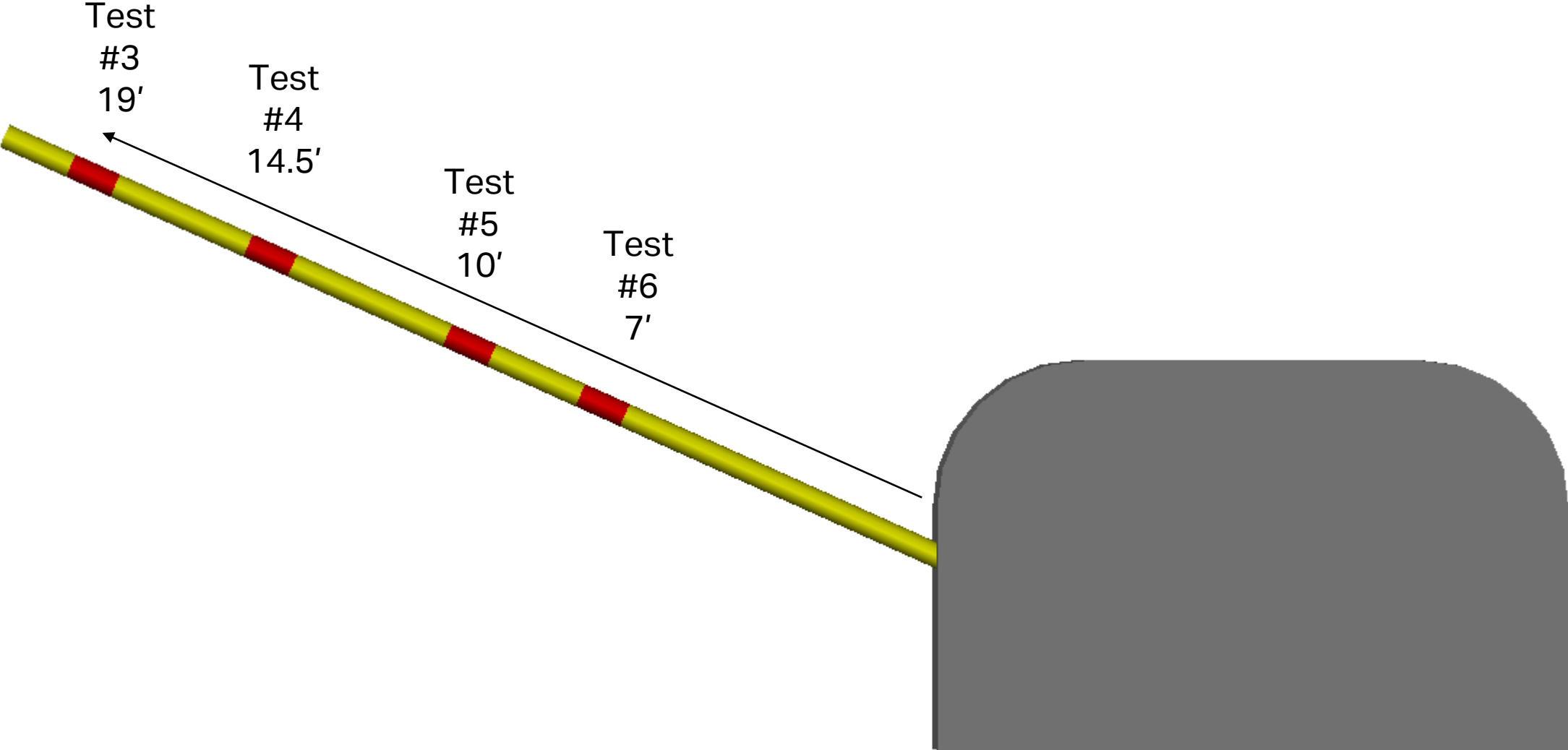
NOTES:
 1. GEOTECHNICAL HOLES 4850 LEVEL VERIFIED DECEMBER 14, 2009.
 2. HOLES 1 AND 2 LOGGED BY OTHERS, NO DATA CURRENTLY AVAILABLE.

LEGEND

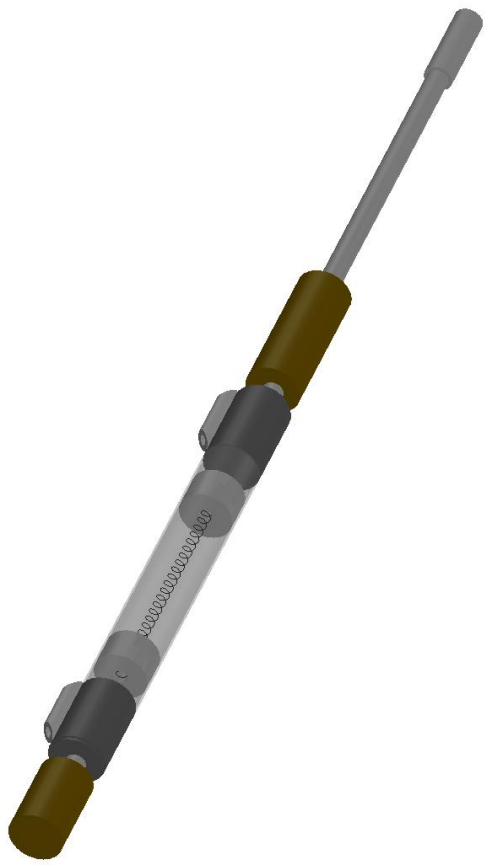
- YATES UNIT (AMPHIBOLITE) — PCy
- TERRIWAY RHYOLITE DIKES — Tr
- POORMAN FORMATION — PCp
- HOLE D BOREHOLE DESIGNATION
- +3.9' AVERAGE ANGLE OF DRILLING FROM HORIZONTAL (POSITIVE UPWARDS OR NEGATIVE DOWNWARDS)
- TD 450 TOTAL DEPTH (LENGTH) OF BOREHOLE.



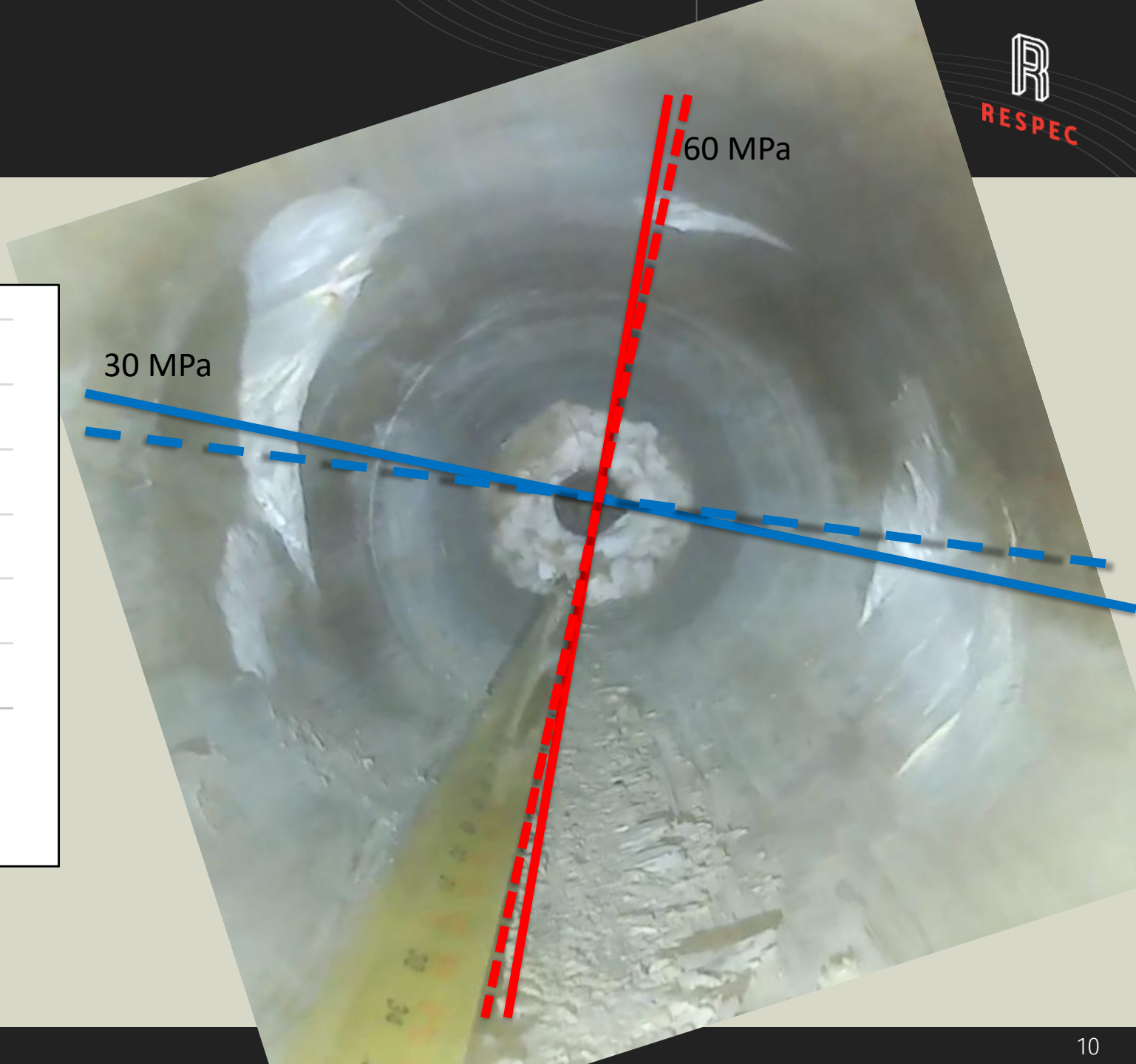
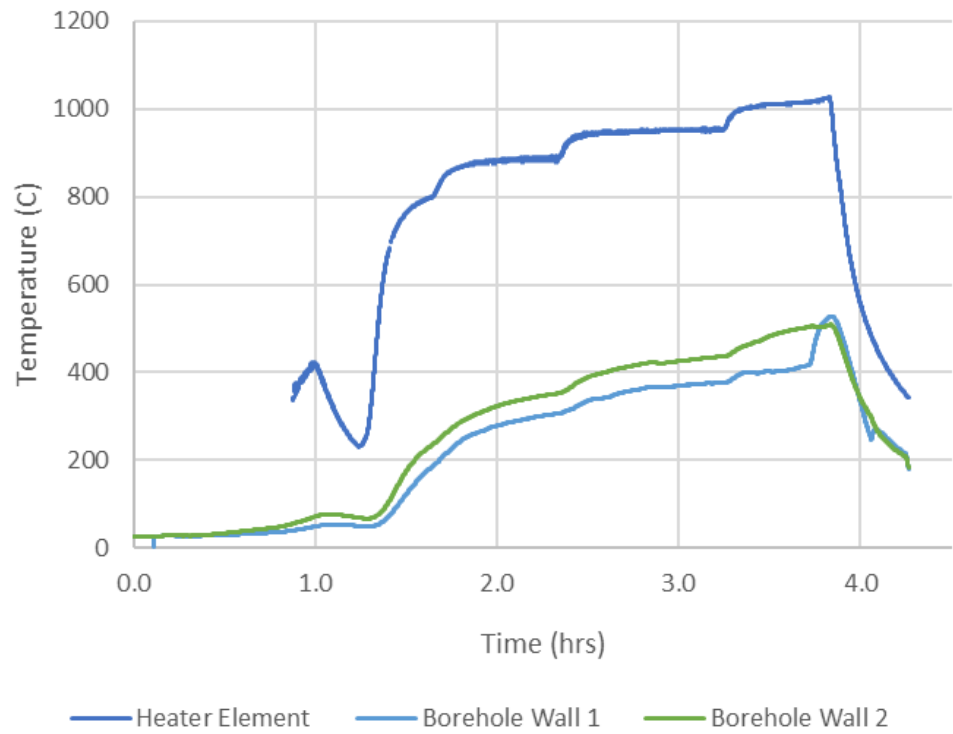
FIELD TESTING – 4850L



FIELD TESTING – 4850L



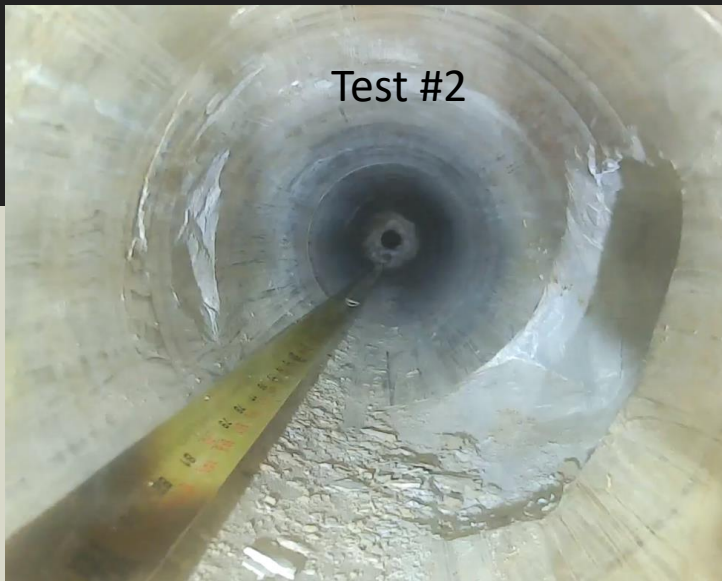
FIELD TESTING – 4850L



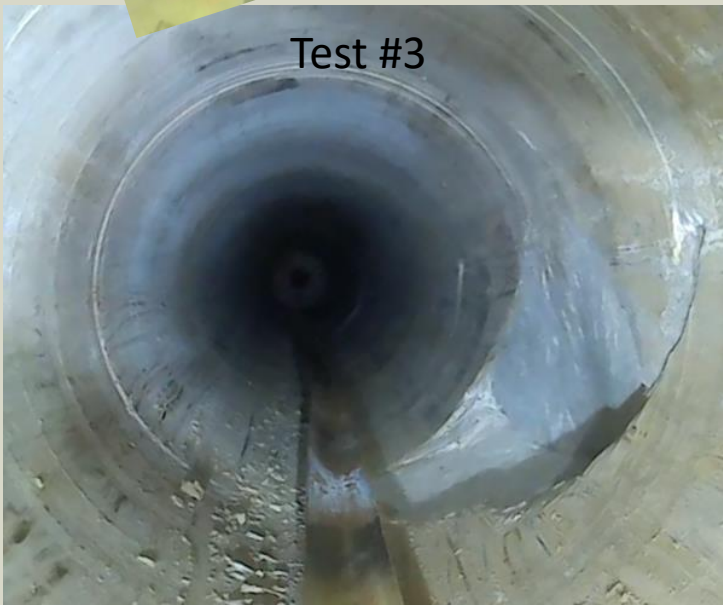
Test #1



Test #2



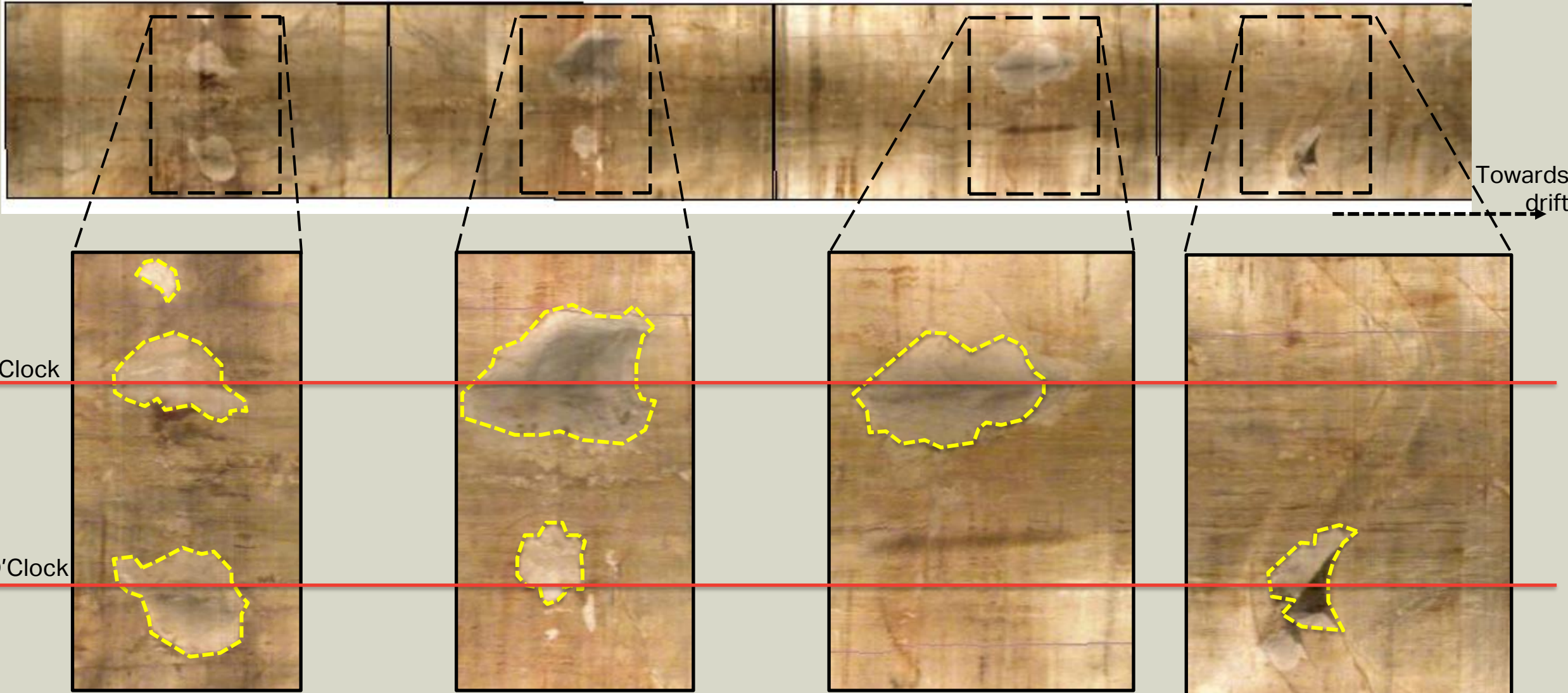
Test #3



Test #4



FIELD TESTING



Amphibolite Test #1



Amphibolite Test #2

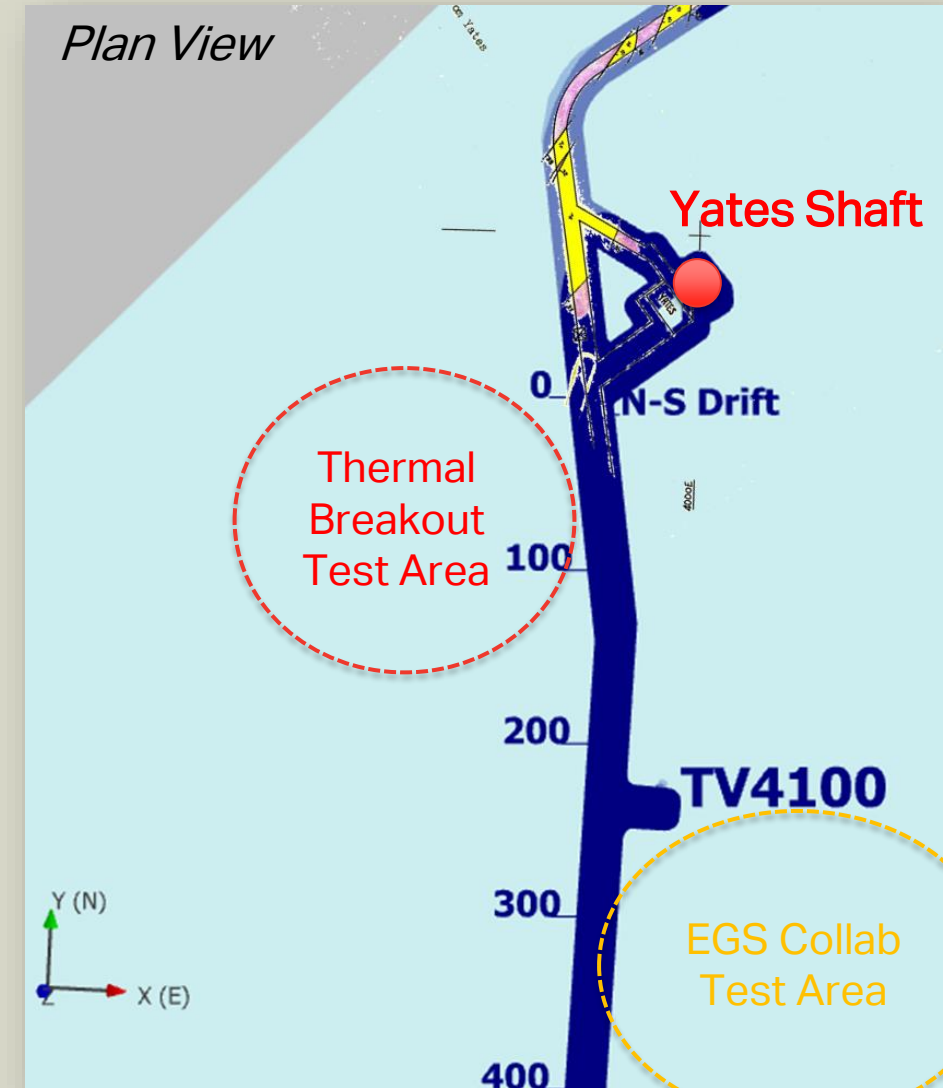


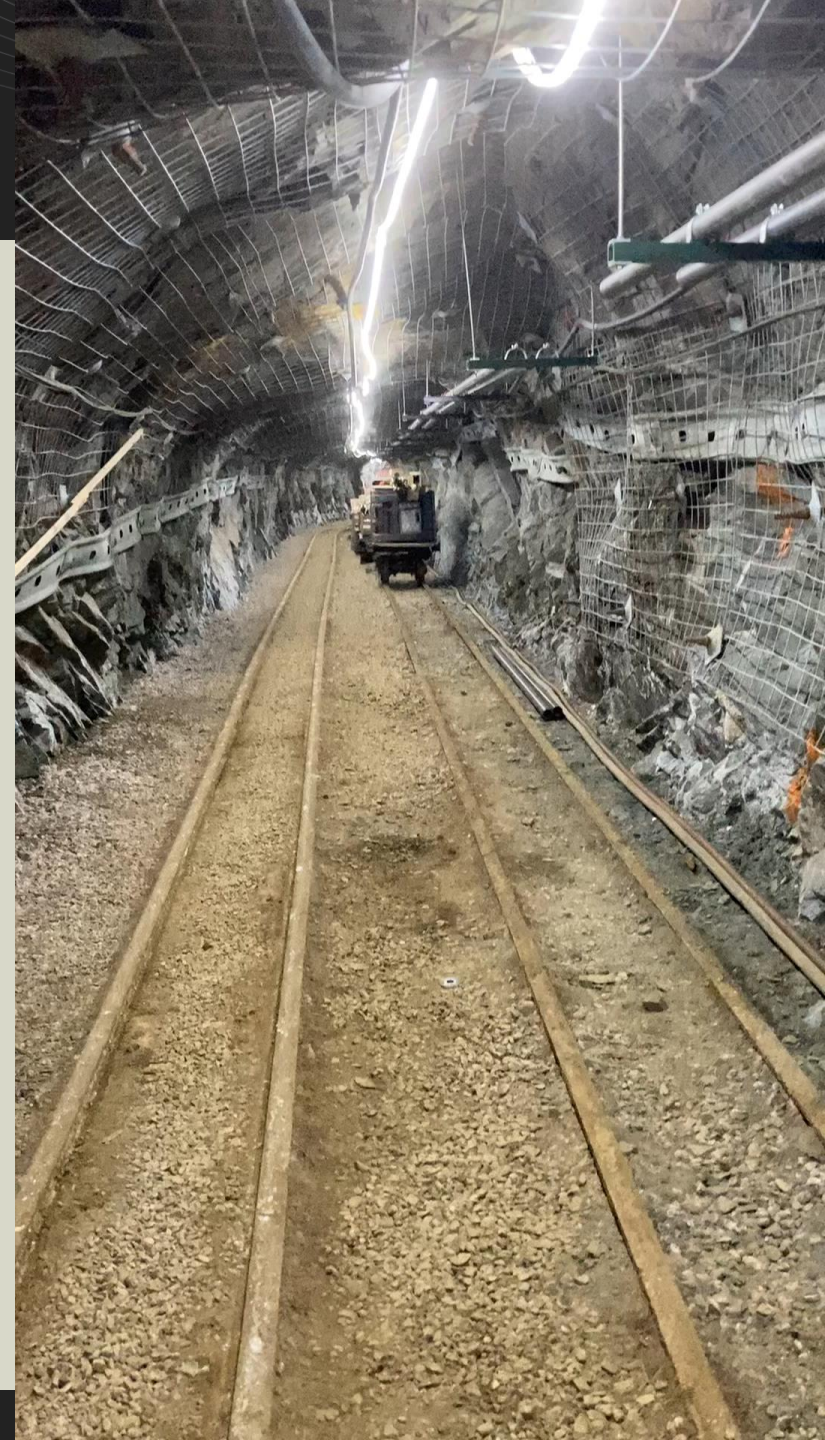
FIELD TESTING — SURF 4100L



FIELD TESTING – 4100L

- › We had previously been testing on the 4850L.
- › Lost access to 4850L in 2020 because of LBNF construction
- › We moved to a new test site on the 4100L
- › Our experiments are next door to another project that is investigating geothermal fracture stimulation (EGS-Collab)





FIELD TESTING – 4100L

Testing in TH4100

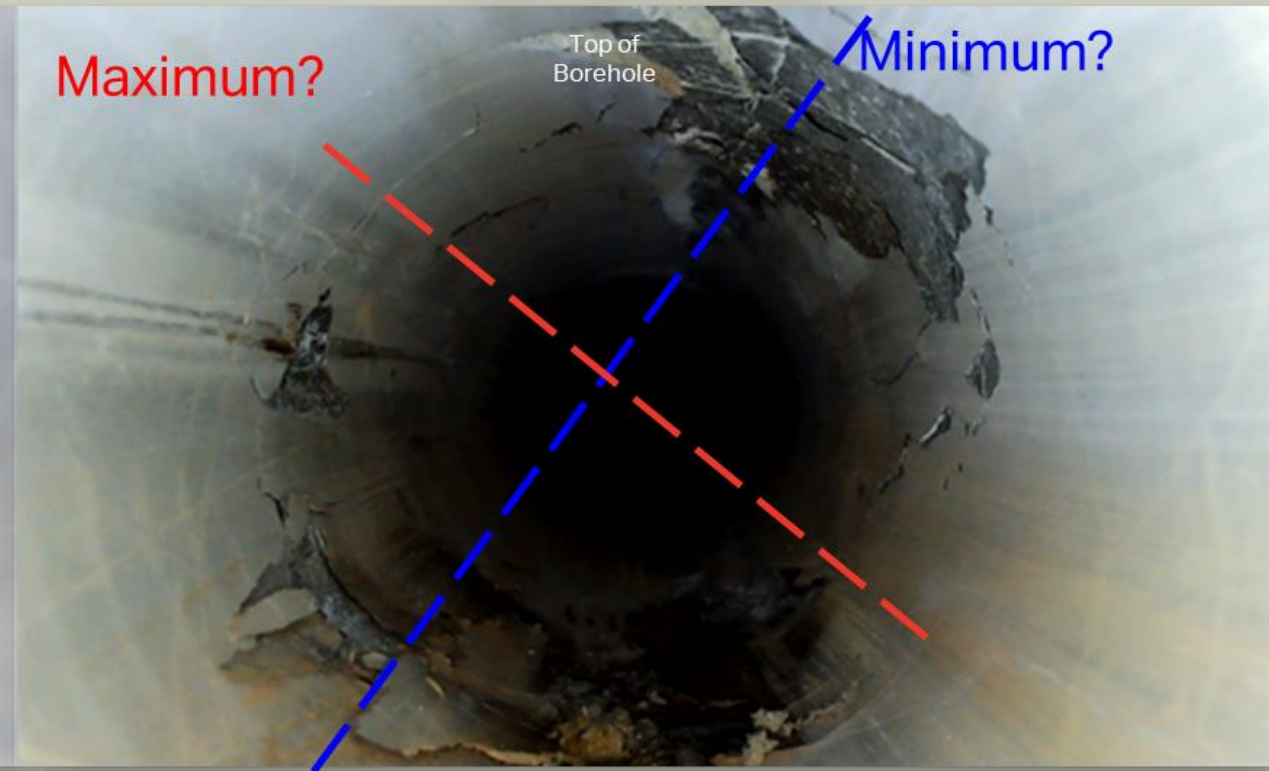


FIELD TESTING – 4100L

Test Zone Before



Test Zone After



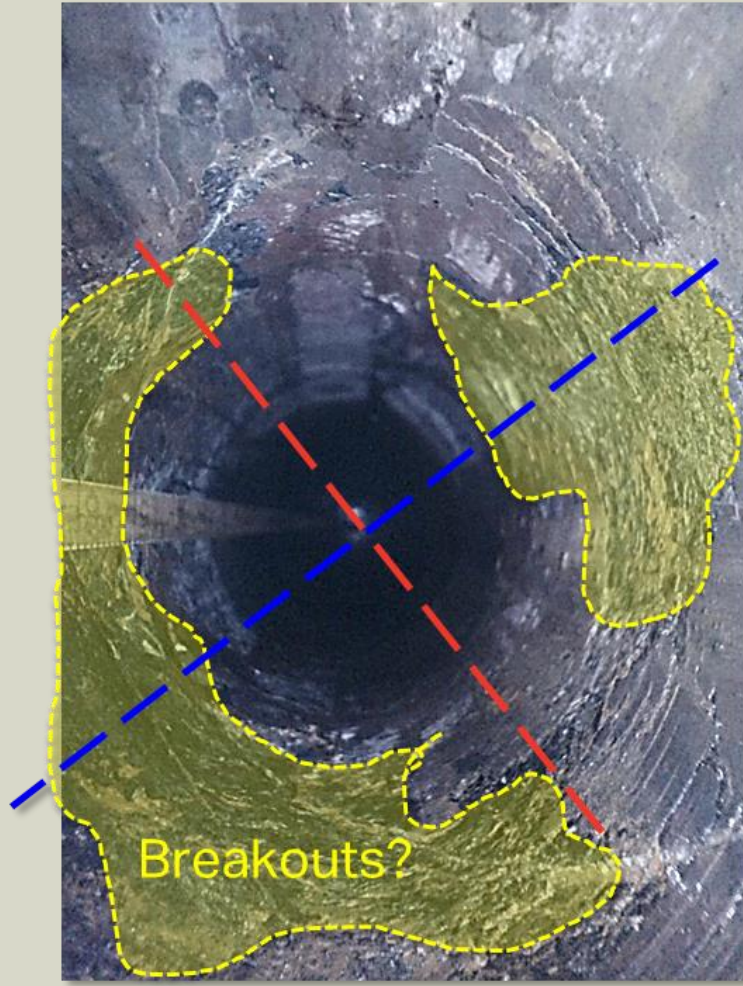
FIELD TESTING – 4100L



FIELD TESTING – 4100L

Test Zone After

Test Zone After



FIELD TESTING – 4100L ONGOING

- › Currently drilling two experimental boreholes on the 4100L
 - / Each borehole is ~75 feet long
 - / Fully cored 6-inch boreholes
 - » Help identify natural fractures, mineralogy, etc...
 - » Might perform limited lab testing to define rock properties
 - / Log the boreholes for baseline measurements (before testing)

- › Testing planned to start in December 2021 when the prototype tool is finished

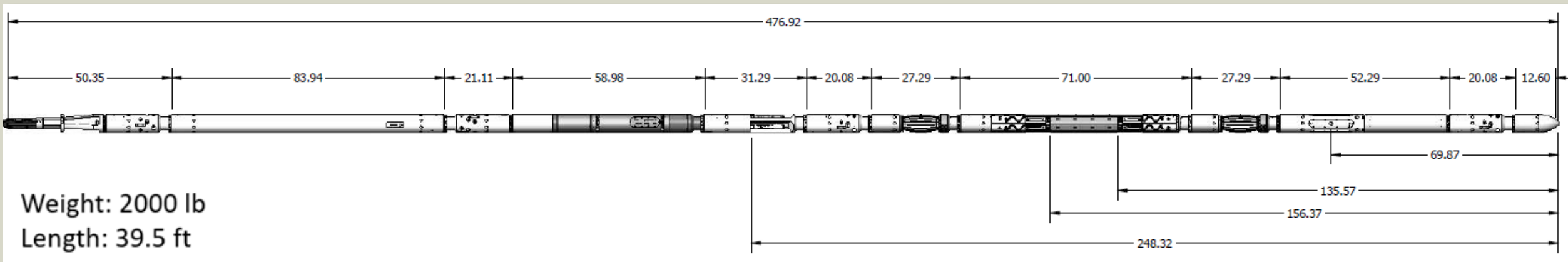


TOOL CONSTRUCTION



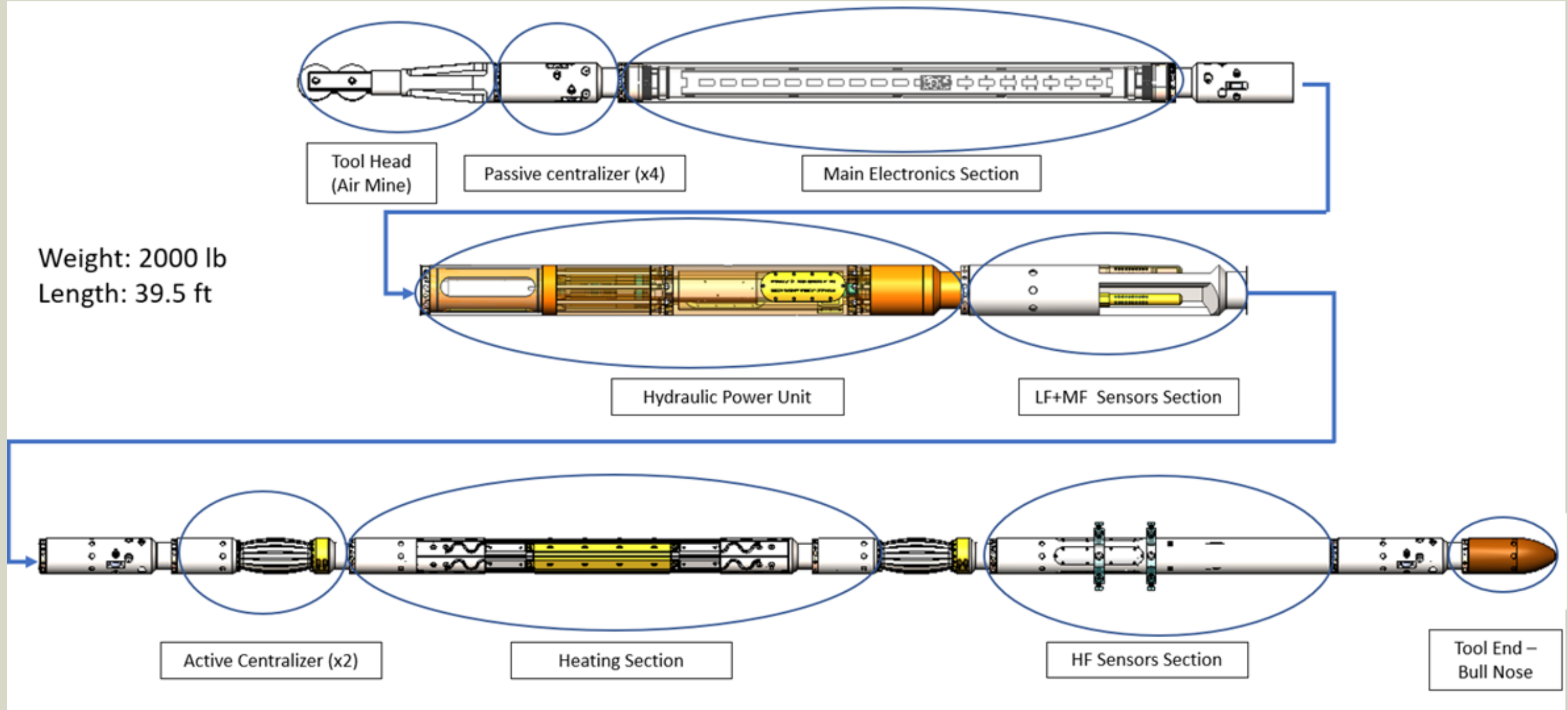
TOOL CONSTRUCTION

- › The prototype tool is currently being constructed

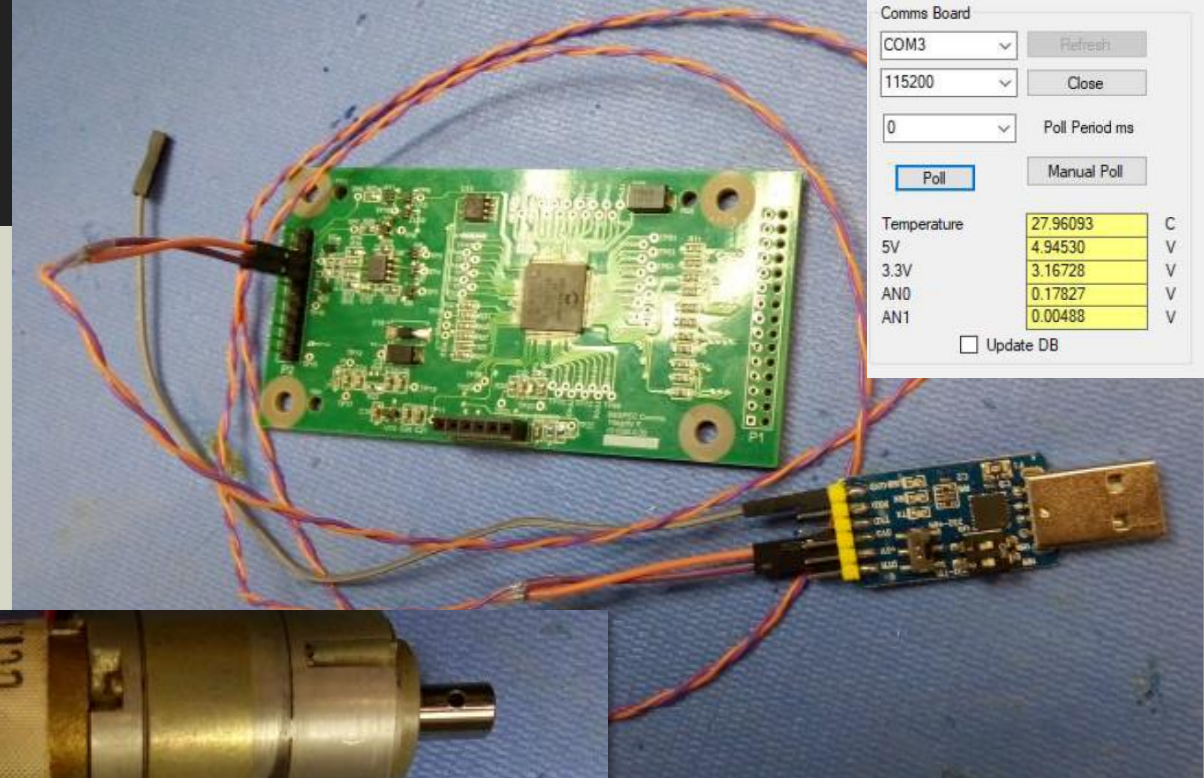
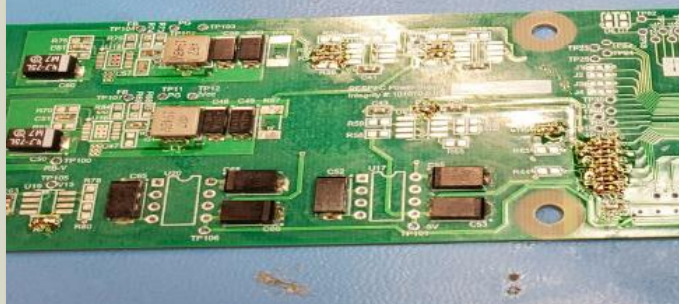
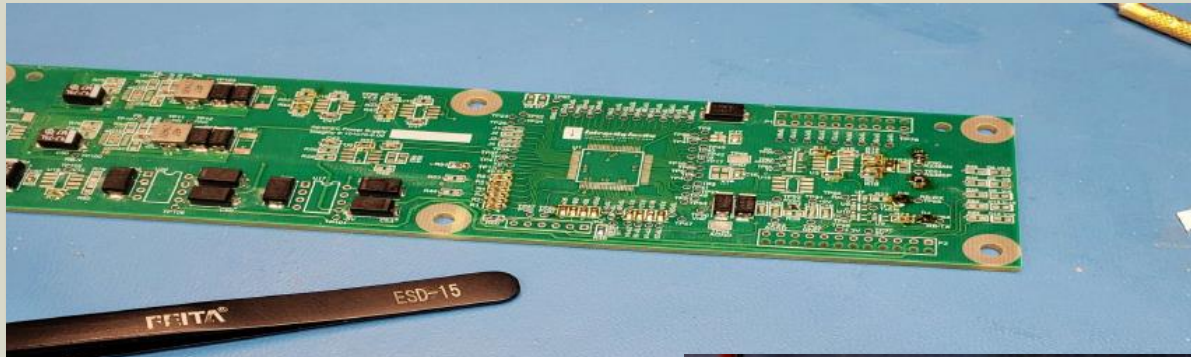


TOOL CONSTRUCTION

Weight: 2000 lb
Length: 39.5 ft



TOOL CONSTRUCTION



Comms Board

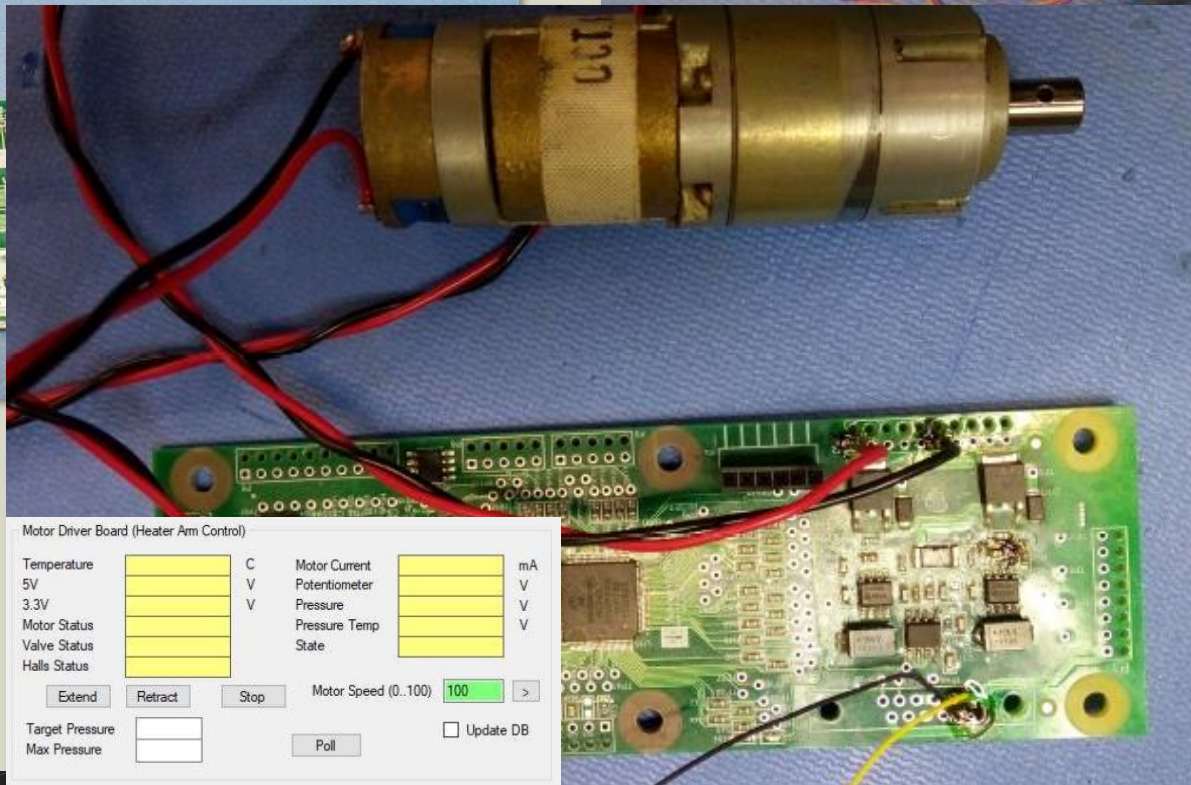
COM3

115200

0

Temperature	27.96093	C
5V	4.94530	V
3.3V	3.16728	V
AN0	0.17827	V
AN1	0.00488	V

Update DB



Motor Driver Board (Heater Arm Control)

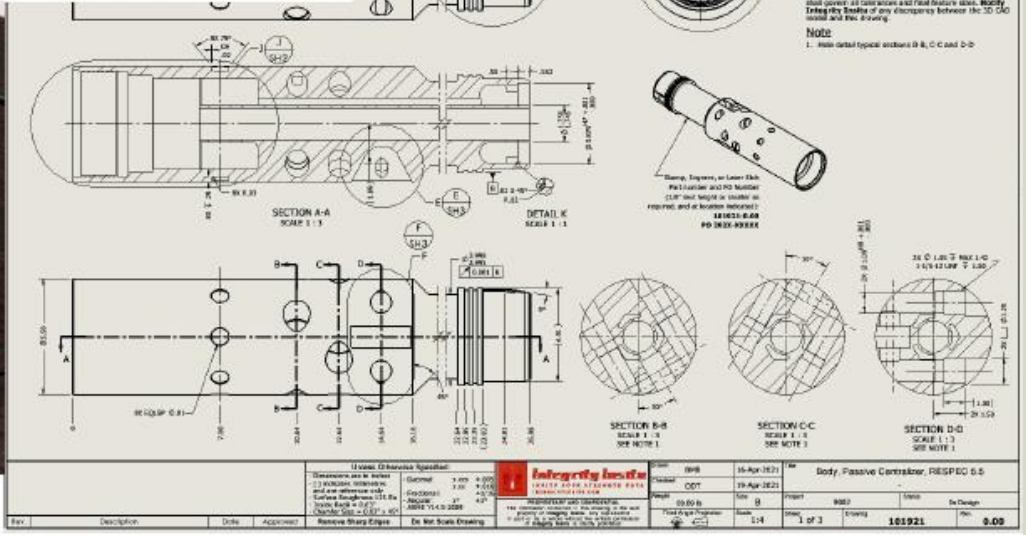
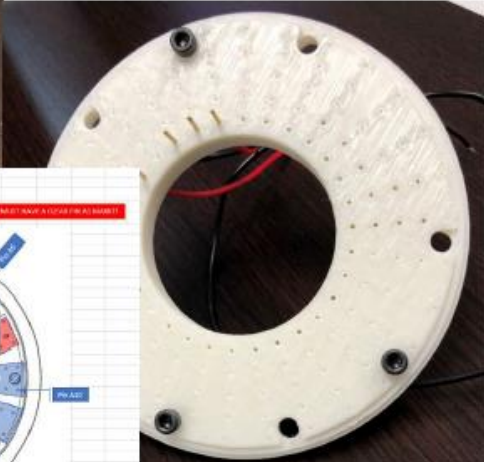
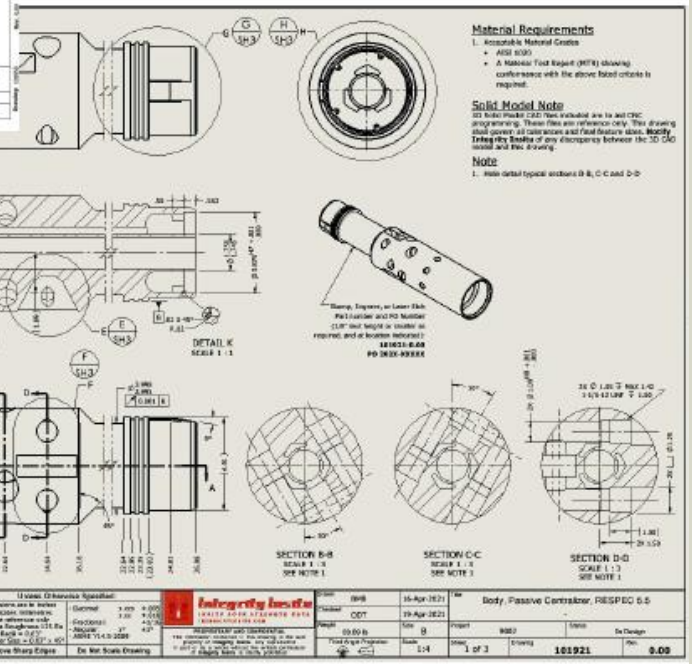
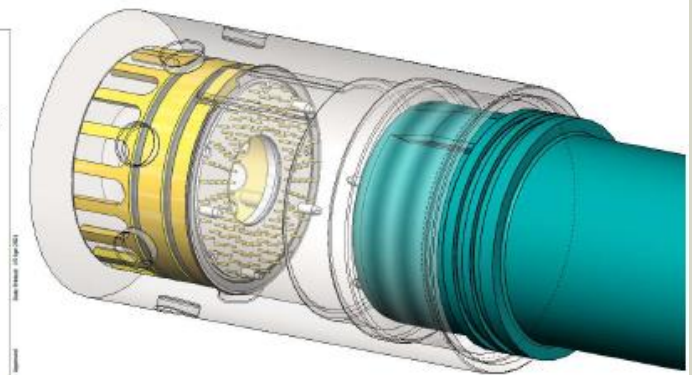
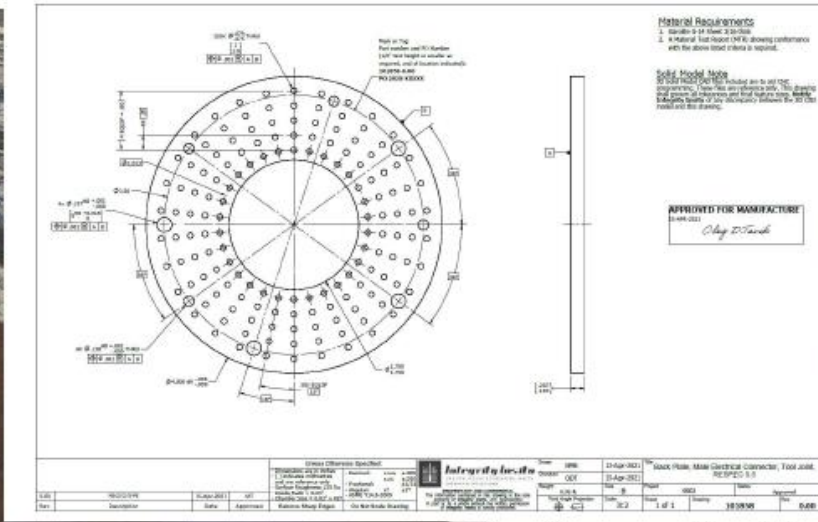
Temperature		C	Motor Current		mA
5V		V	Potentiometer		V
3.3V		V	Pressure		V
Motor Status			Pressure Temp		V
Valve Status			State		
Halls Status					

Motor Speed (0..100)

Target Pressure

Max Pressure Update DB

TOOL CONSTRUCTION





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