Capabilities and Limitations of Piston Coring in the Academic Research Fleet

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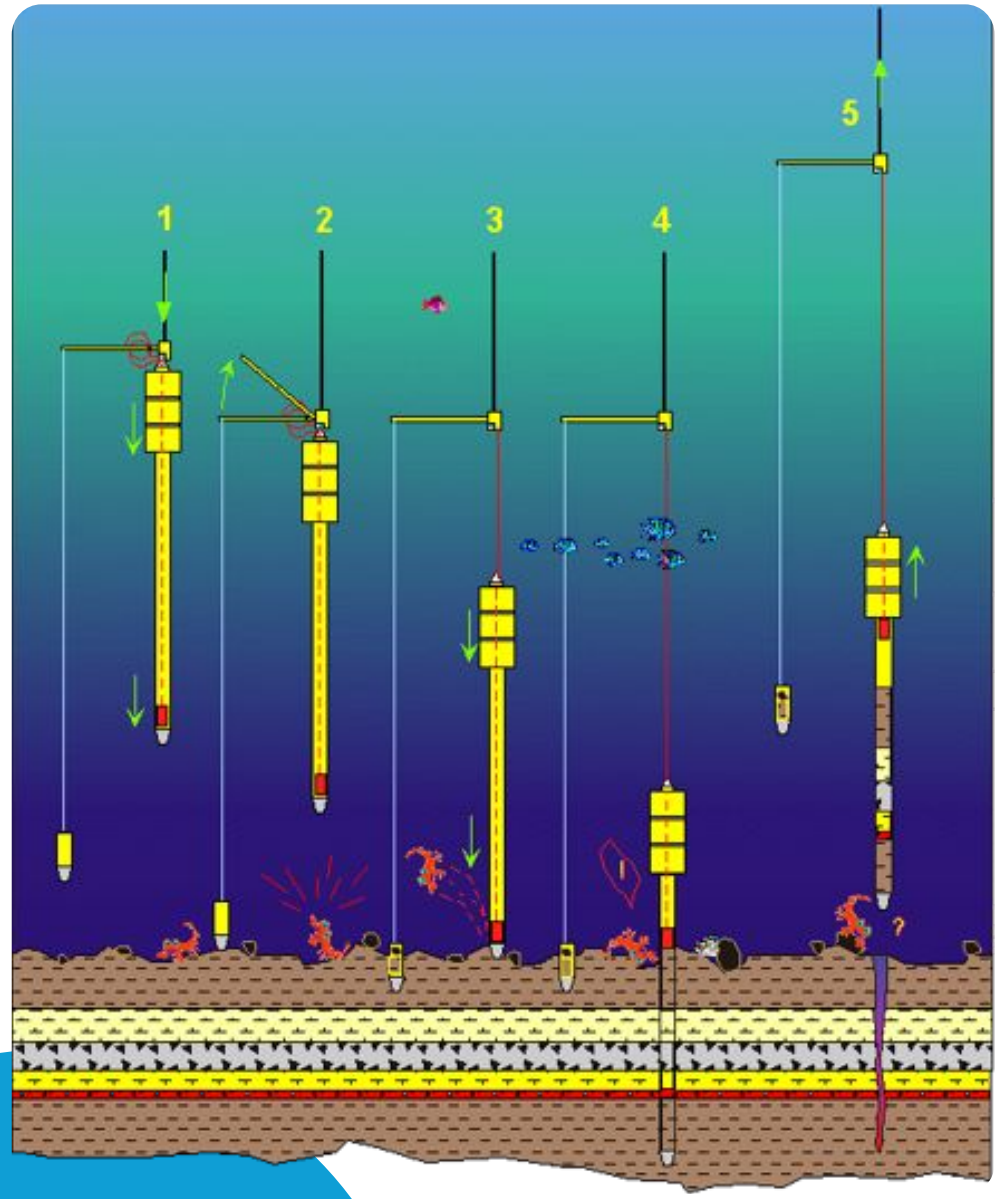
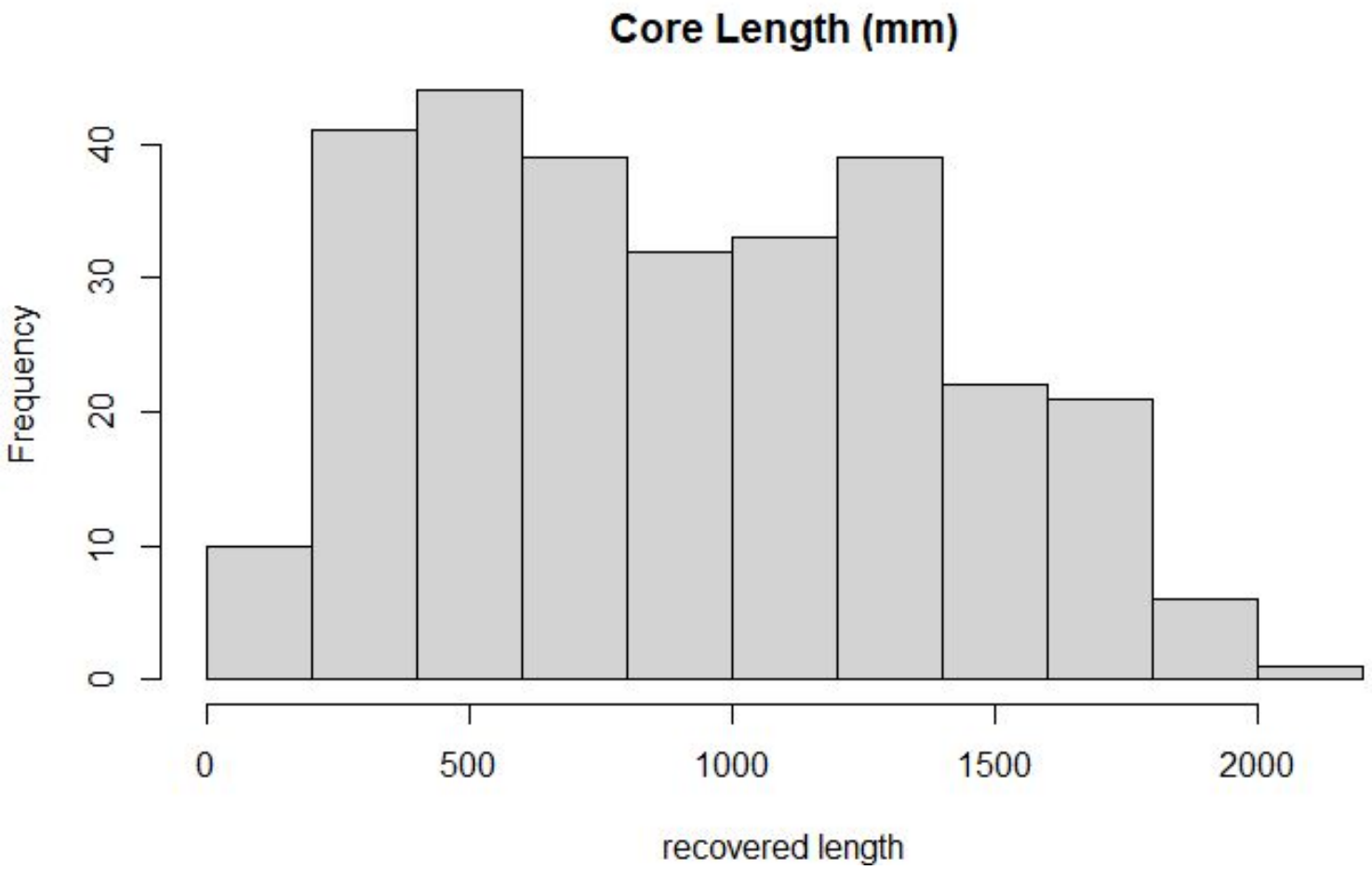


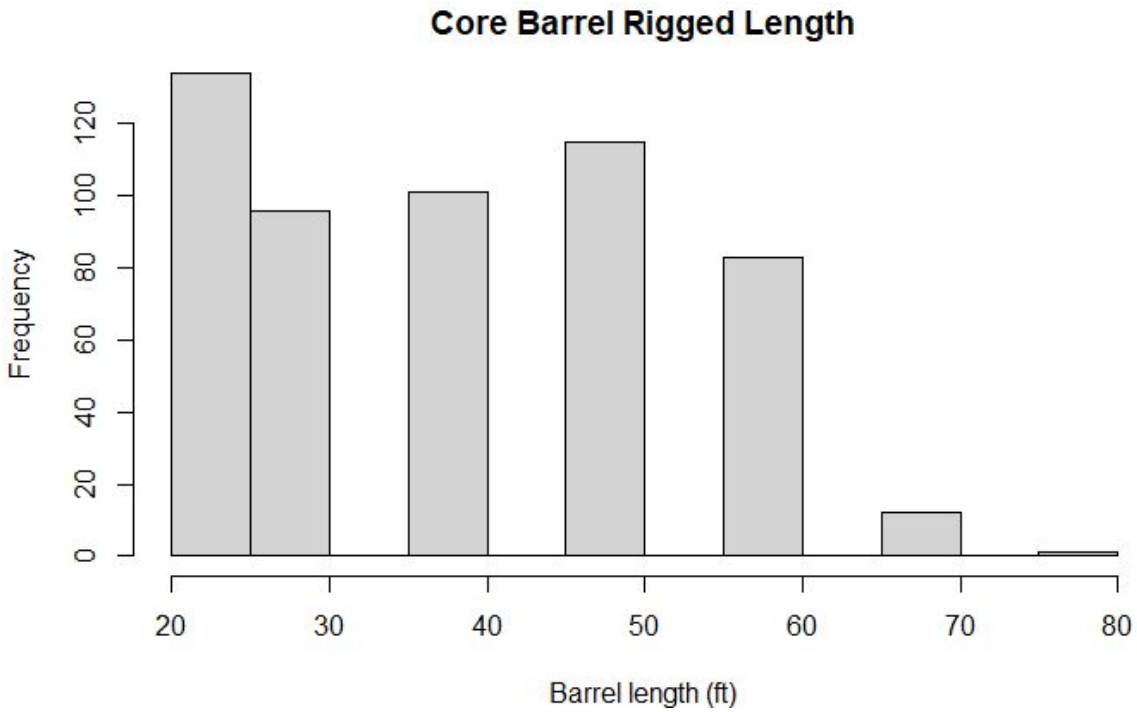
•Why Focus on Piston Coring?

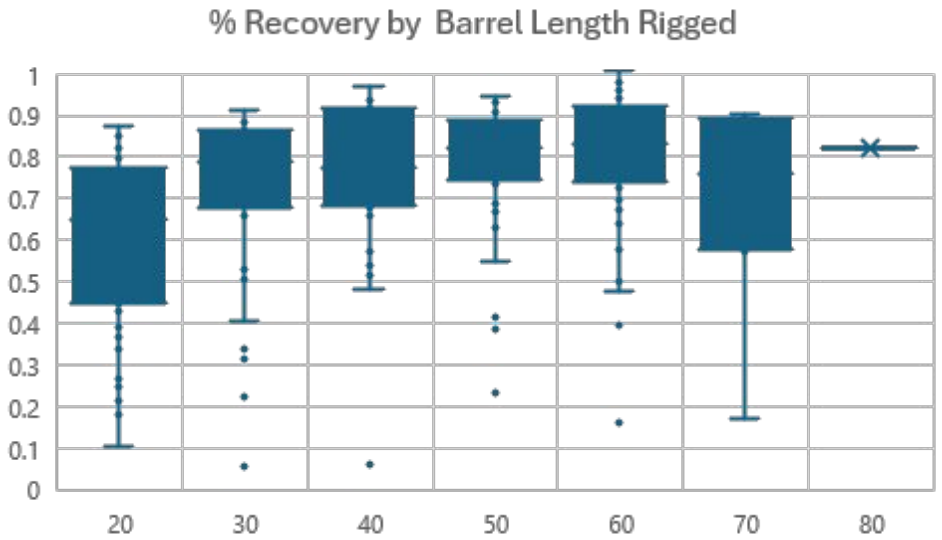
- Provides longest samples possible in the research fleet
- Is the sampling type limited by current ship capabilities (compared to gravity coring, surface coring etc.)

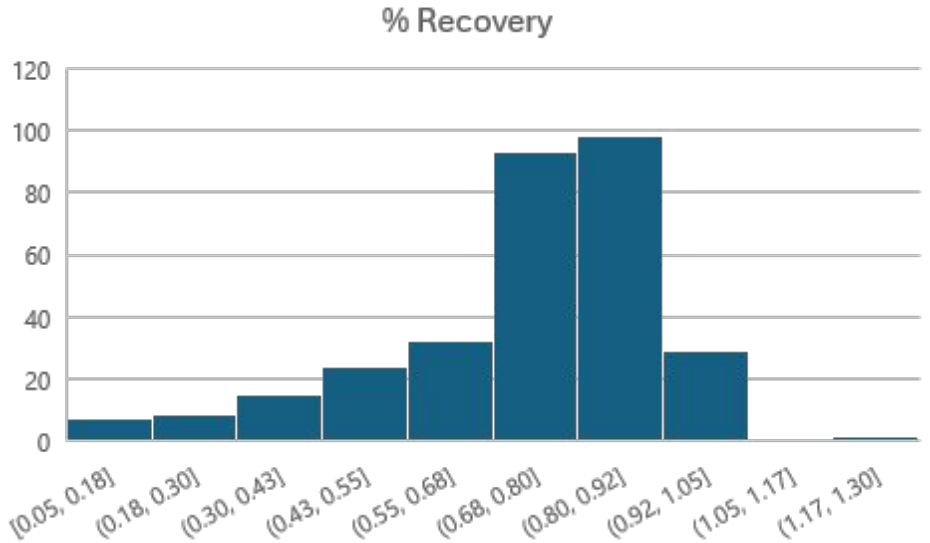
- What are our capabilities?
- Let's look at historical core recovery



**Data from OSU Marine Geological Repository Coring Data Sheets, not inclusive of all UNOLS piston cores. N = 323







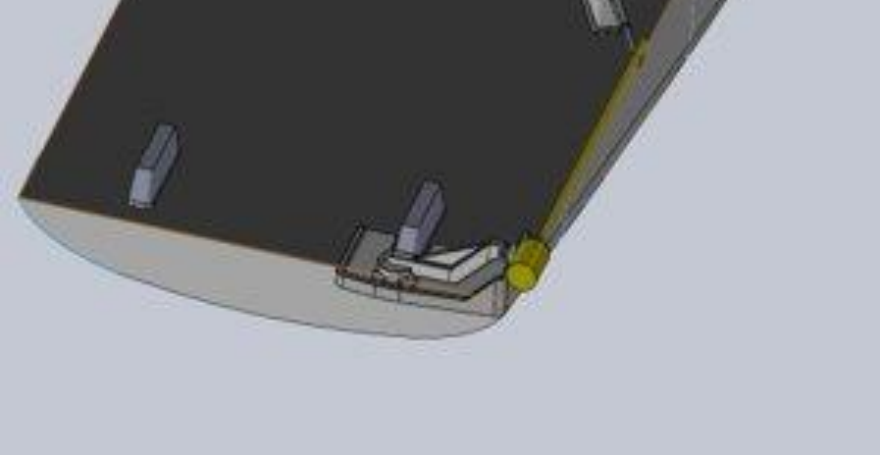
Data from Coring Data Sheets in OSU MGR database

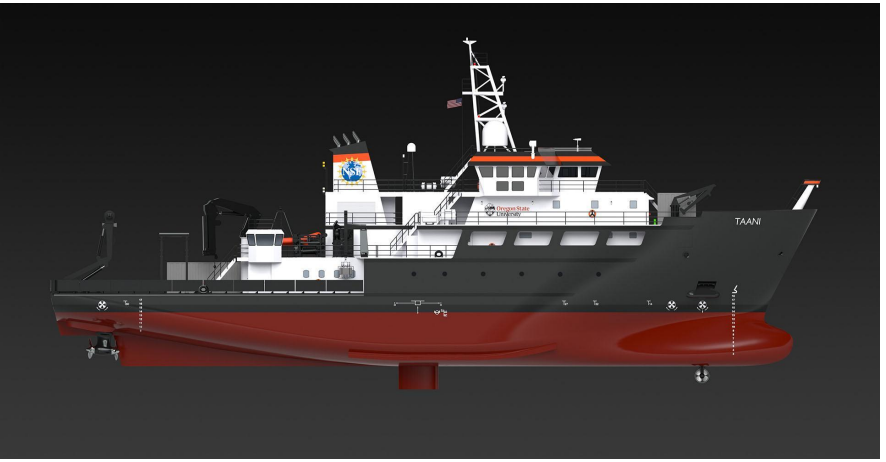
•What Determines Core Length?

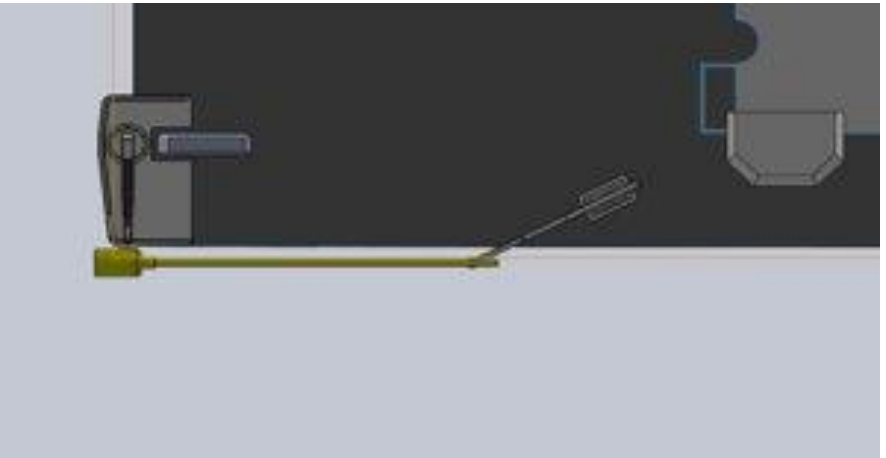
- Space to assemble coring device
  - Usable deck space
  - Deployment considerations
- Ability to handle tensions related to coring device
  - Varies by sediment type
  - Ultimate determinant is vessel stability

Limitation/Capability 1

Building the Core



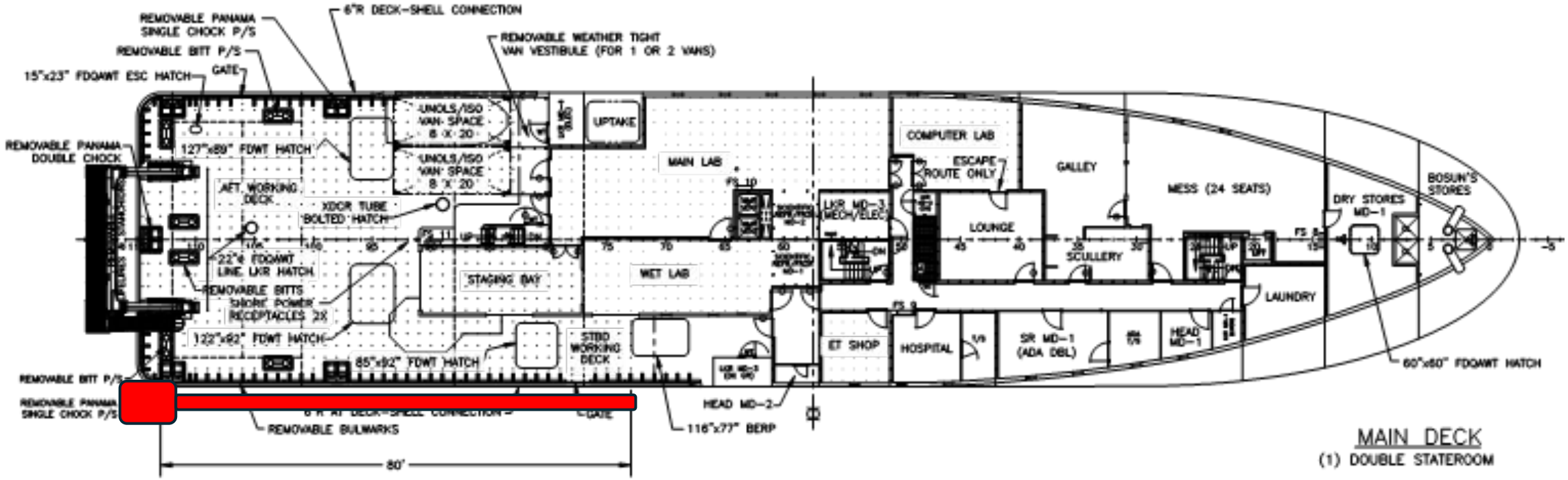




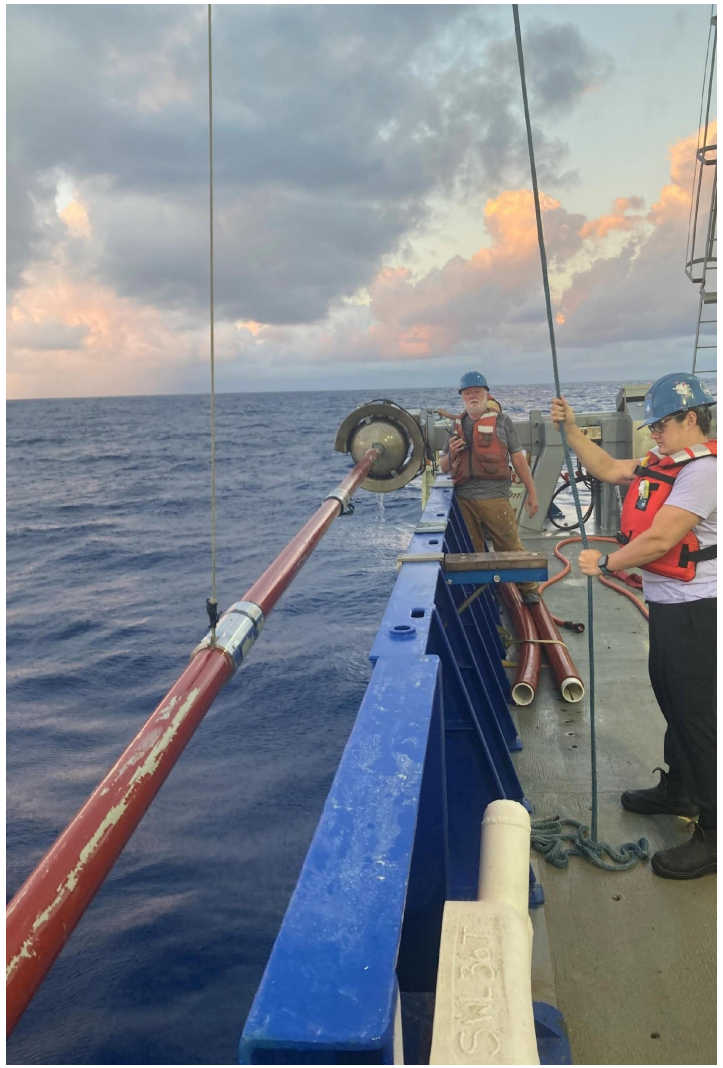
RCRV

•Rail limited to 50 ft barrel (15m). Will require PCDRM hydraulic arm to reposition barrel to A-frame for deployment

OCRV – Armstrong and Ride

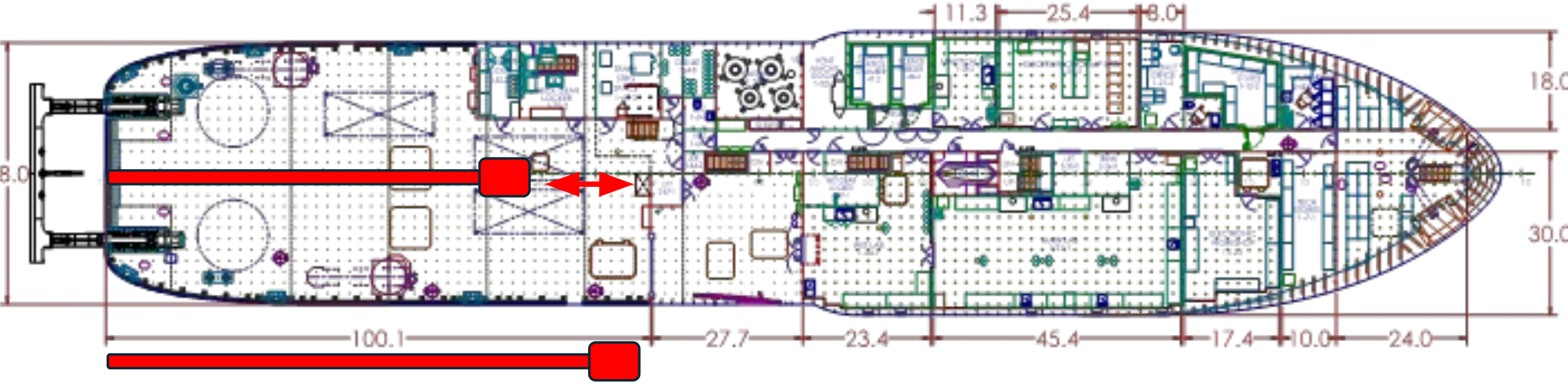


- 80’ – 90’ (24 – 27 m) Core Barrel possible to rig
- No Rail deployment option, requires using crane on 02 deck to move coring device from stbd side to A frame, increases deployment time and reduces workable sea states

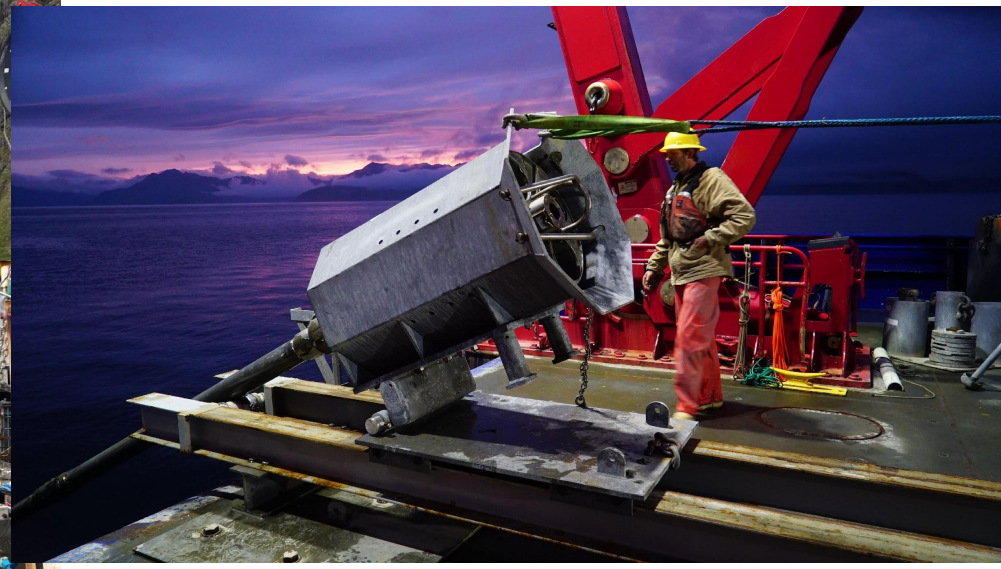


Coring on r/v Armstrong – 2022

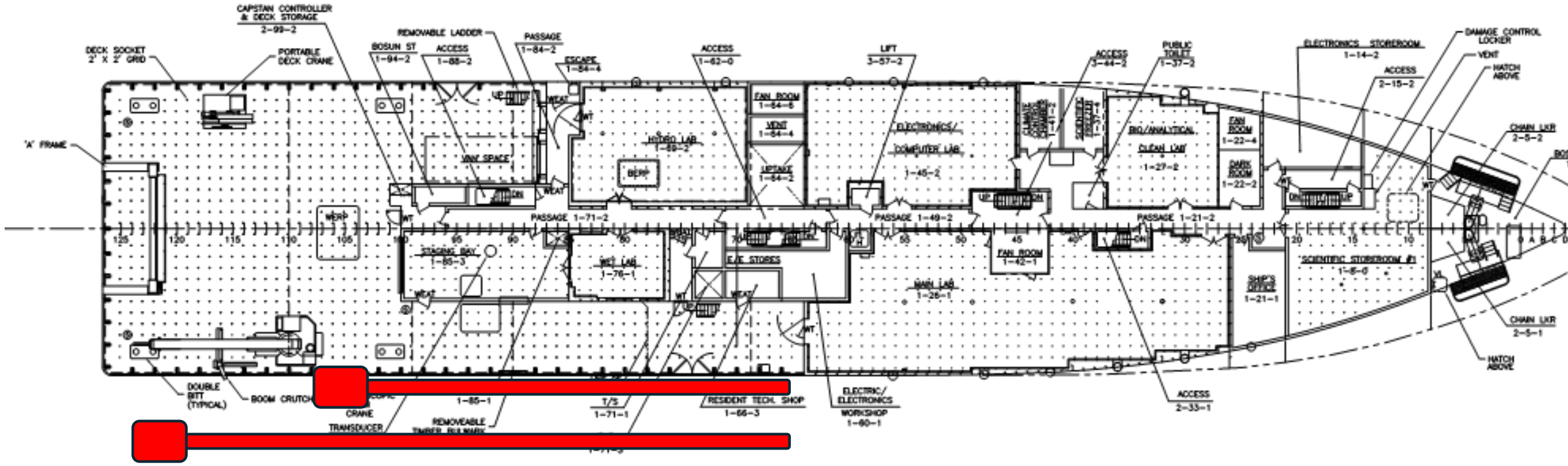
R/V Sikuliaq



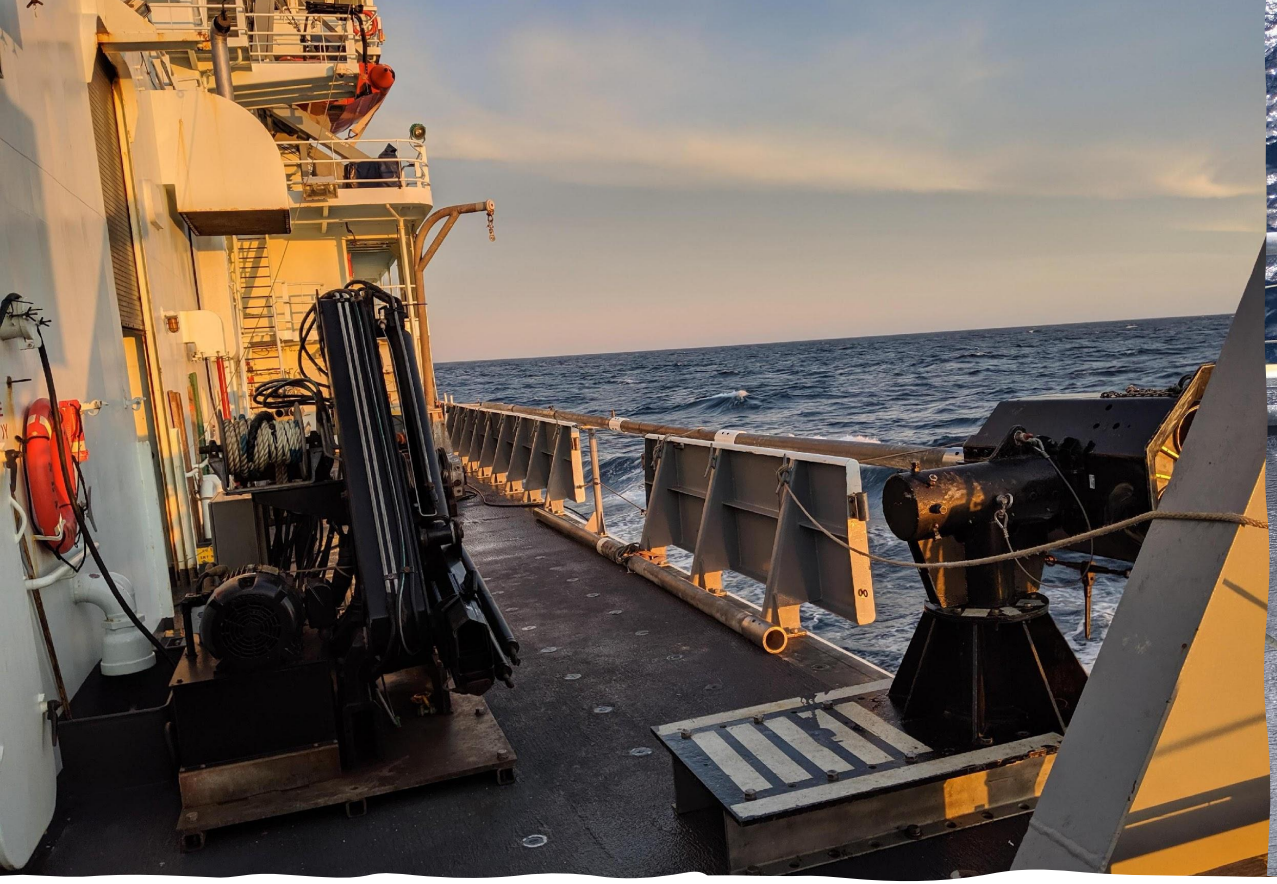
- Currently uses “Railroad Track” deployment – limits barrel to 60’ (18 m) due to strain on barrel during recovery
- There are probably exists some creative solution to utilize full deck length, allowing for 90’ (27 m) barrel construction



Globals – Thompson, Revelle, Atlantis



- STBD Crane Deployment
- Could rig up to 90’ (27m) core barrel
- Can be more convenient to set up to rig max possible 60’ core



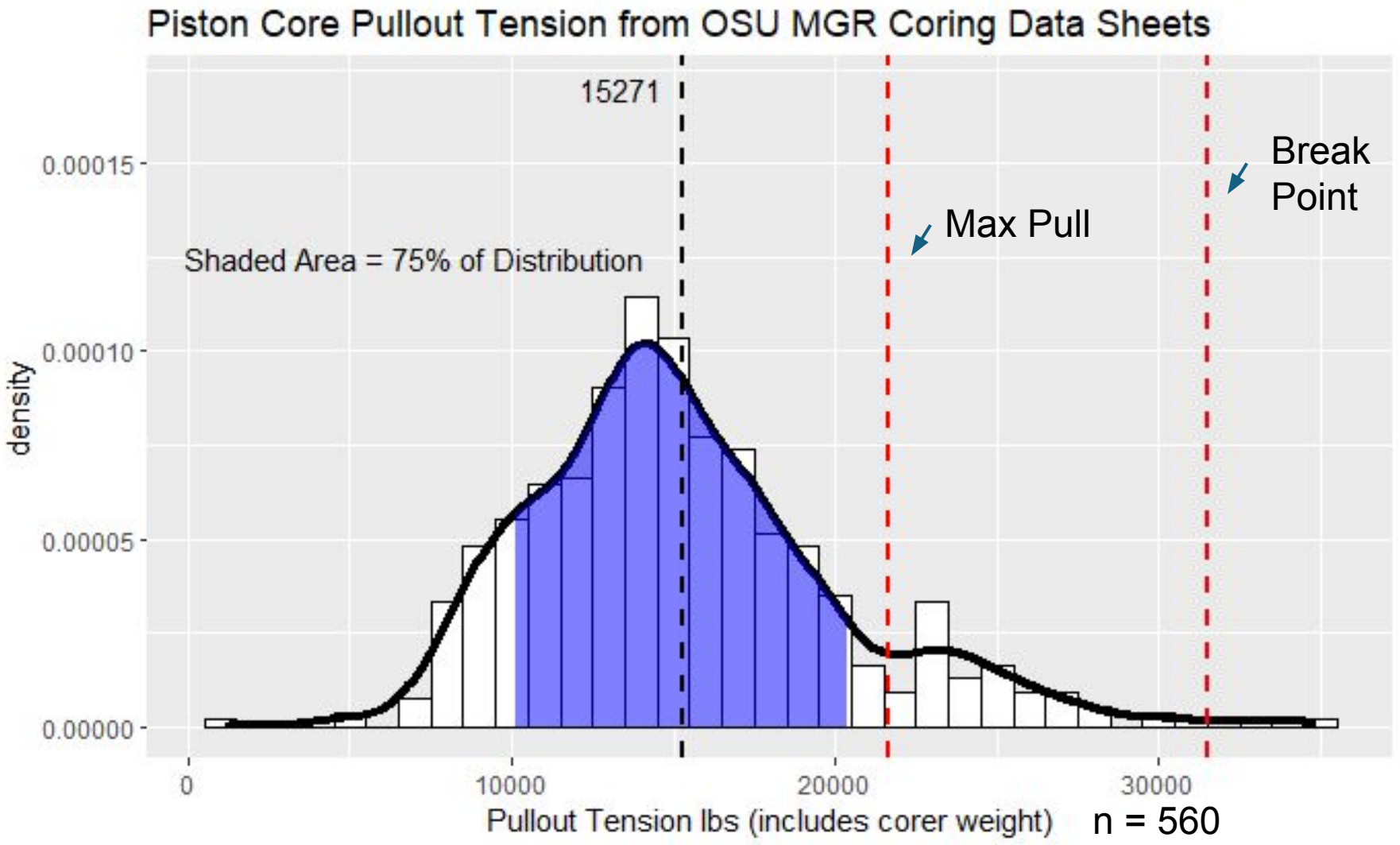
- Piston Coring r/v Thompson
- Note that core is deployed stbd side from built position

Limitation/Capability 2

Getting the core into and out of the mud

Strength Member Limitations

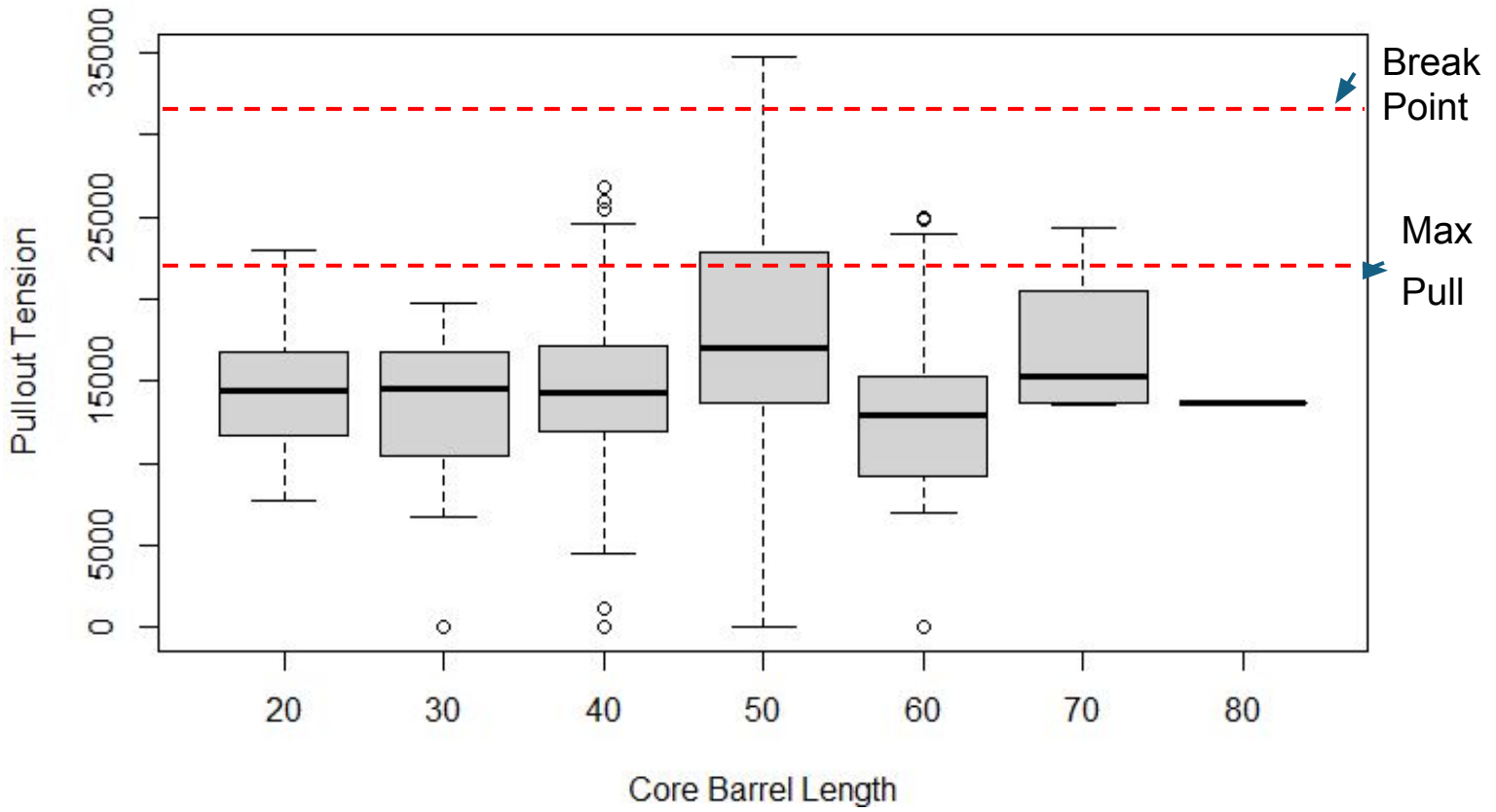
- Corer Weight Determines Pullout Tension
- UNOLS RVSS allows maximum 21,667 lbs on 9/16” Trawl Wire which has theoretical break at 31,500 lbs
- Current Piston Coring Approaches these limits



Current JPC Weights from 3500 lbs – 5700 lbs

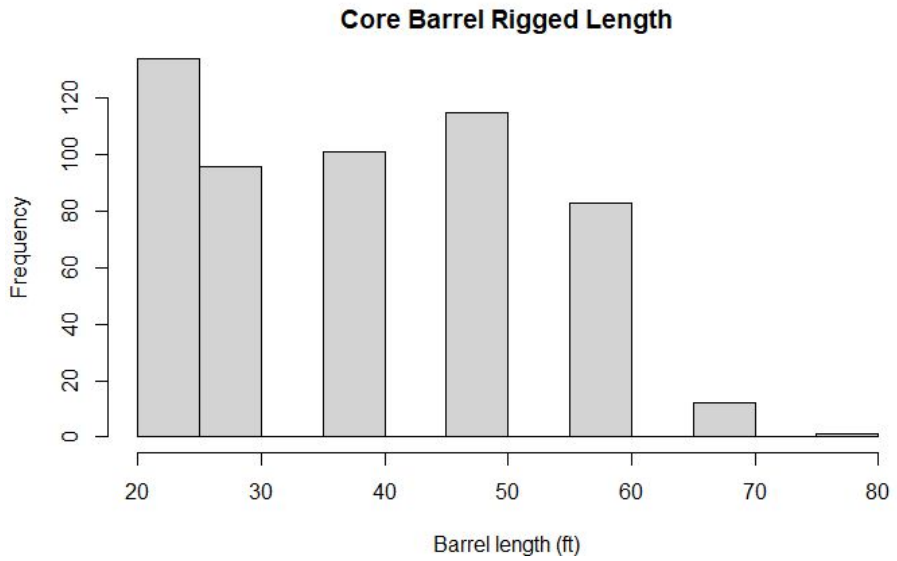
75% of Pullout Tensions between 10,000 – 20,000 lbs

- Pullout Tension dependent on Corer Weight
- High Variability by Sediment
- Necessitates conservative approach, gradually increase barrel length in certain sediment type
- PI rarely want to repeat core single location to maximize recovery



- Does this represent the limitation of what current corer weights can achieve or is it the limitation of what we attempt?

- Hard to say without trying.



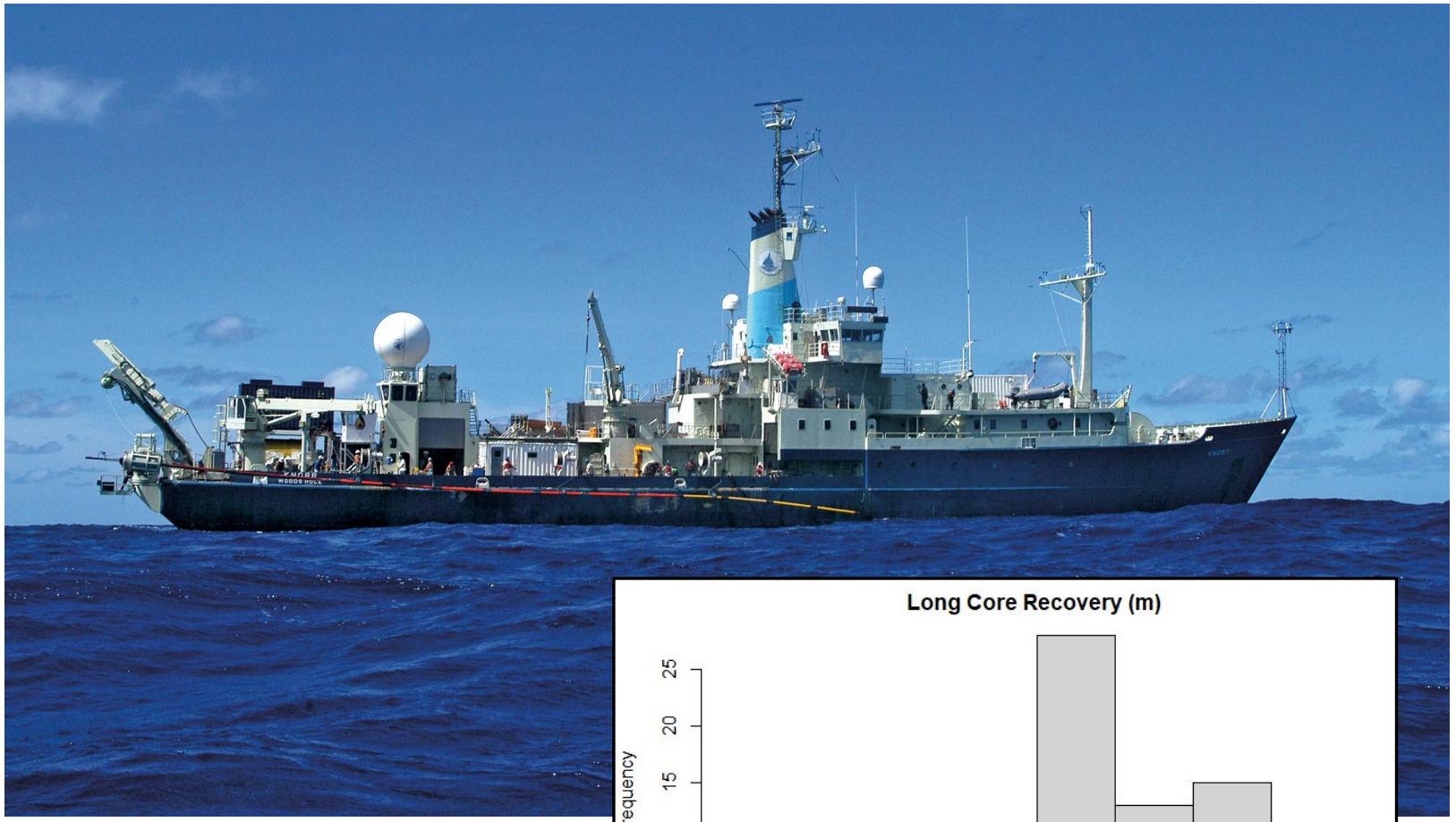
"…the maximum penetration for current UNOLS piston cores cannot be expected to exceed 20 m except in sediments with the lowest observed shear strengths. Core weights of at least 10,000 would be needed to increase routine penetration and recovery to 20 m."
Long Coring on UNOLS Vessels: A Feasibility Study and Workshop Report; Curry, Pisias 2001

What does it look like to move past these limitations?

How Do You Get Longer Cores? More Weight – creates a cascade of engineering challenges

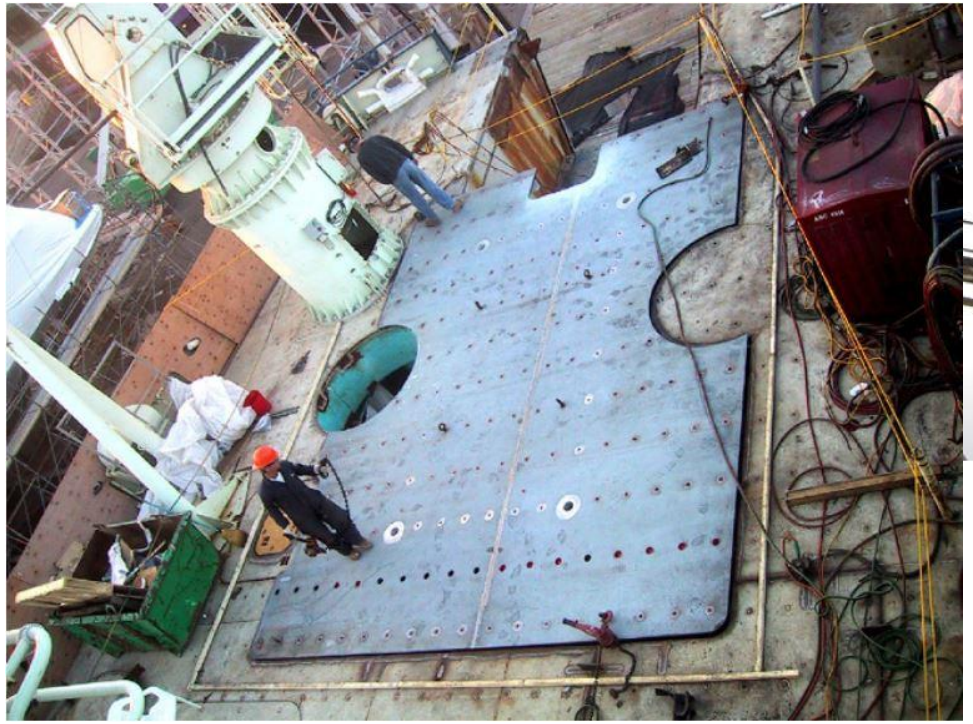
Knorr Long Core System – (2007 - 2014)

- Capable of **45 m** cores
- Used up to **27,500** lb core weight
- Utilized Synthetic Strength member with **355,000 lbs** Break strength
- Engineered for pullouts of **90,000 lbs**
- **Ship Stability Necessitated Stern Deployment. System represents the upper limit of coring capacity on vessel of this size and type**
- Required specialized winch, a frame, core-handling grapple and hydraulic power unit and Significant, permanent Shipyard modifications to the vessel to interface with equipment



Structural Modifications to Knorr for Long Core

https://www2.whoi.edu/site/longcore/long-core-operations/refitting-the-ship/



“Three candidate vessels; Thompson, Revelle, and Sikuliaq, can be modified to support direct integration of a reduced length Long Core system by incorporating modifications similar in scope to those on the Knorr, but integration of full length (45 meter) coring capability would require modifications that impact the current mission capability (Main Lab space) of each vessel” - *White Paper UNOLS Fleet Support Capability for Long Core System; Edgar, Suchy, Broda, 2010*

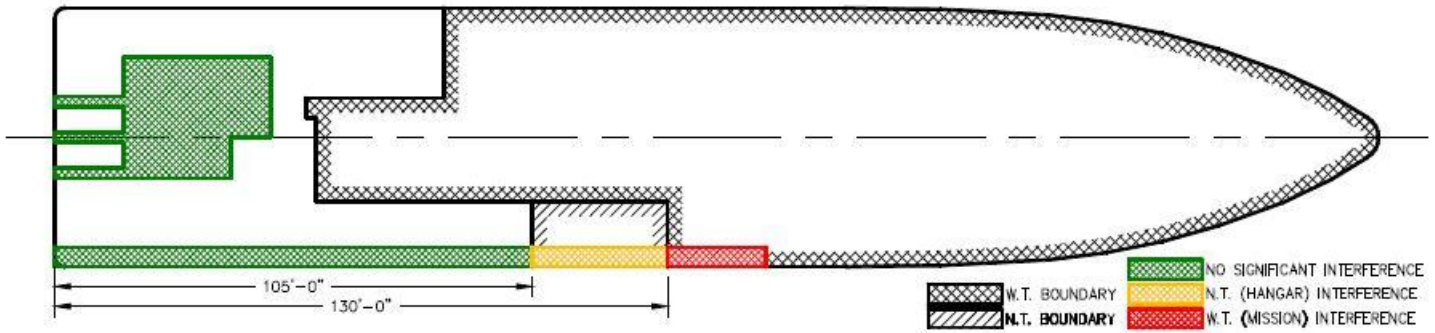


Figure 6 – Long Core Integration on R/V *Thompson* and R/V *Revelle*

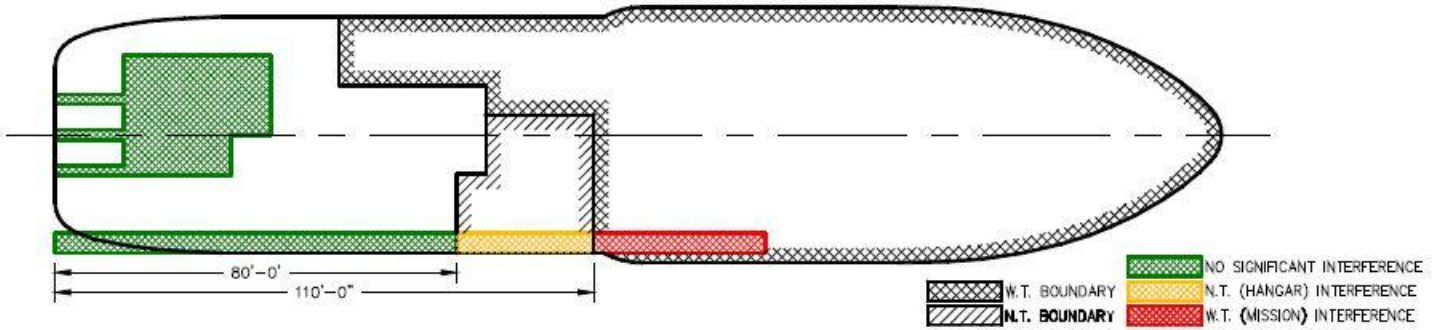
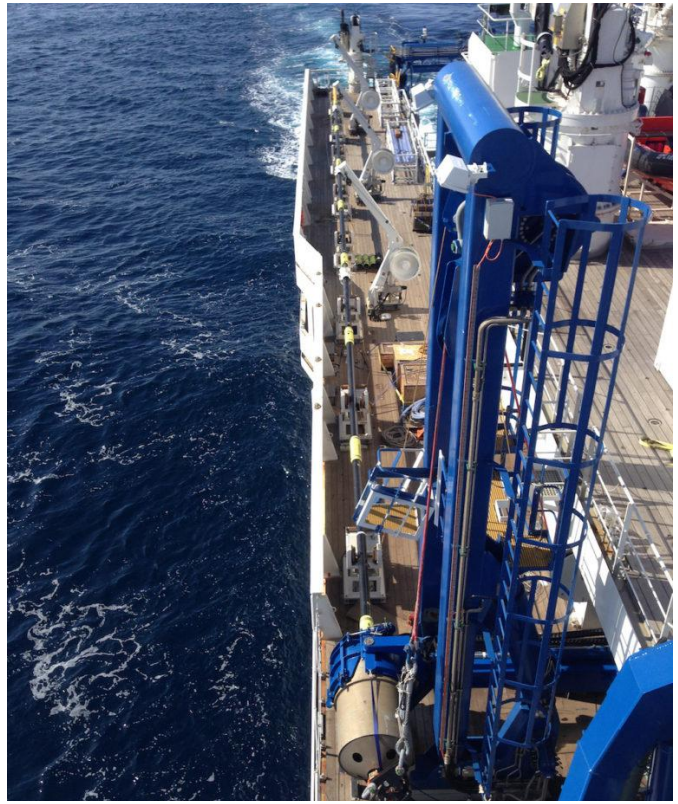


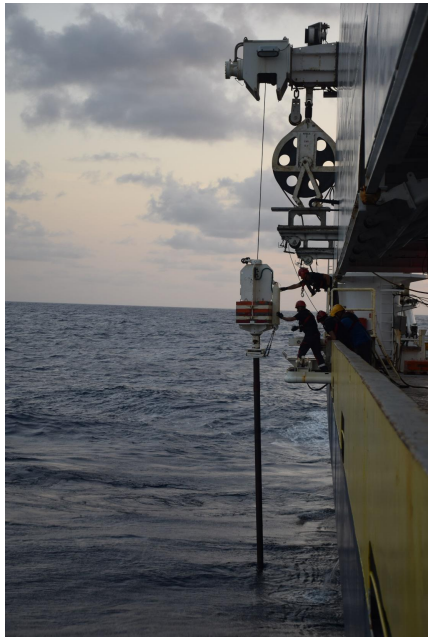
Figure 8 – Long Core Integration on R/V *Sikuliaq* (ARRV)

What else is going on out there?

- There are other vessels (OSIL has sold “over 15*”, also calypso corer and others) deploying Giant Piston Coring Systems (40 m). Typically use 28 mm – 32 mm Synthetic strength member with ~84T (168,000 lbs) Break Strength and 10-12 Ton Corer weight*
- 40 m Cores require around 36T (72000 lbs) pullout*
- 3 examples below – all vessels over 100 m



r/v Kaimei – recovered 37.74 m core from 8,023 m water depth in



Pourquoi pas?

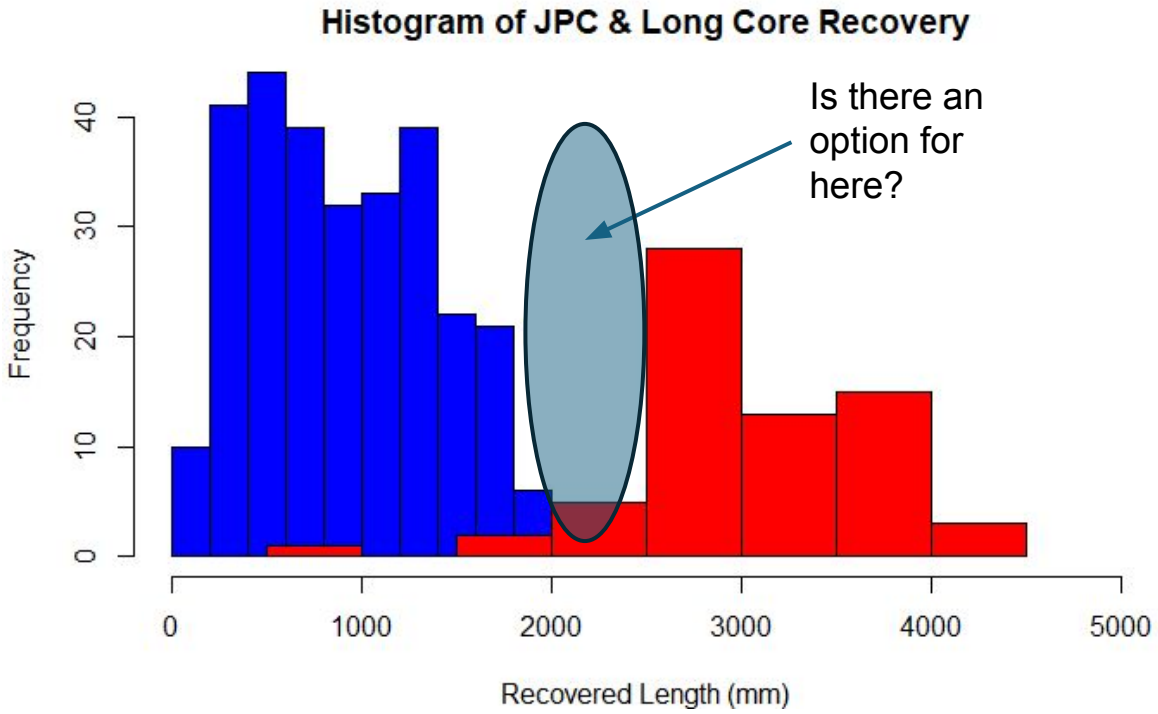
Marion Dufresne

*personal communication

How Could We Maximize Coring Capabilities on Existing Platforms?

- Existing winches and overboarding systems are designed around 9/16” Trawl wire and .680/.681 Conducting wire. Some able to use 9/16” synthetic

- Increasing the lengths of routinely recovered cores requires heavier core weights which requires stronger strength members
- How much stronger is needed? How much stronger is possible?
  - Stability
  - A-frames/cranes/specialized deployment devices
  - Deck structure
  - All questions that require engineering analysis

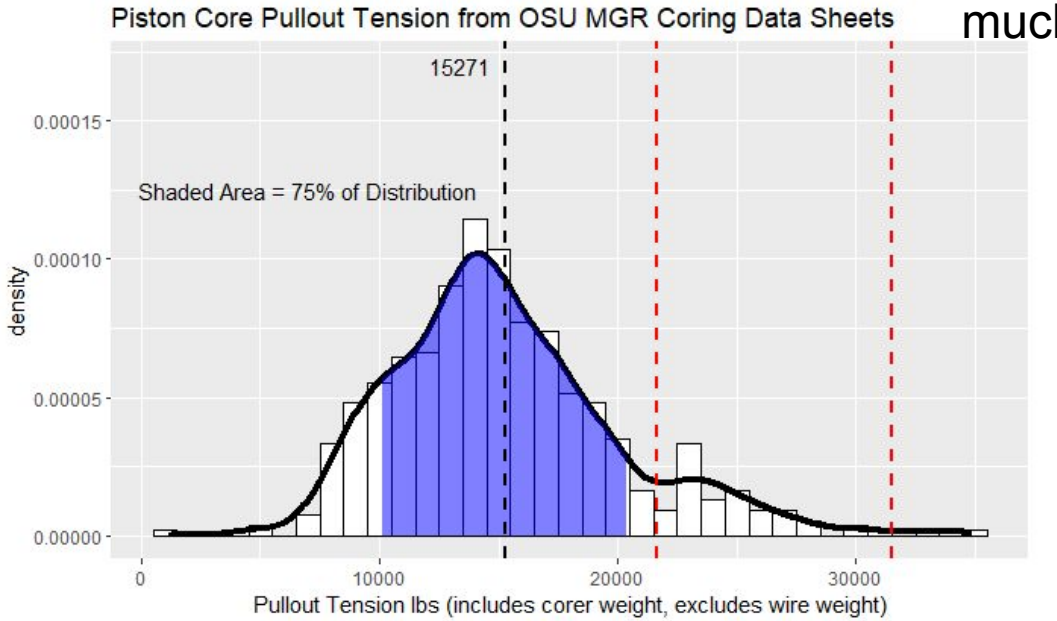


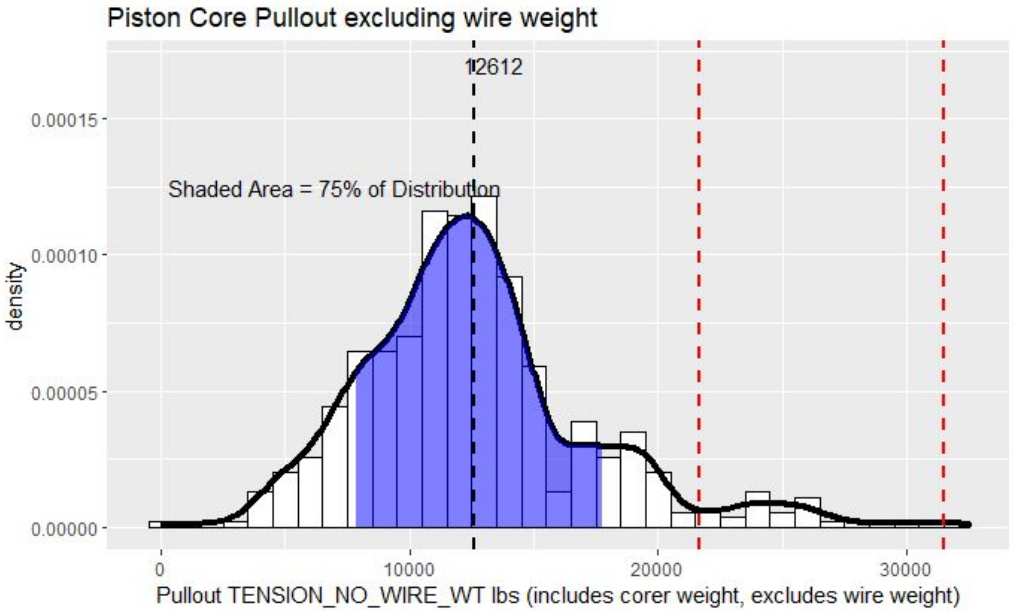
In Summary

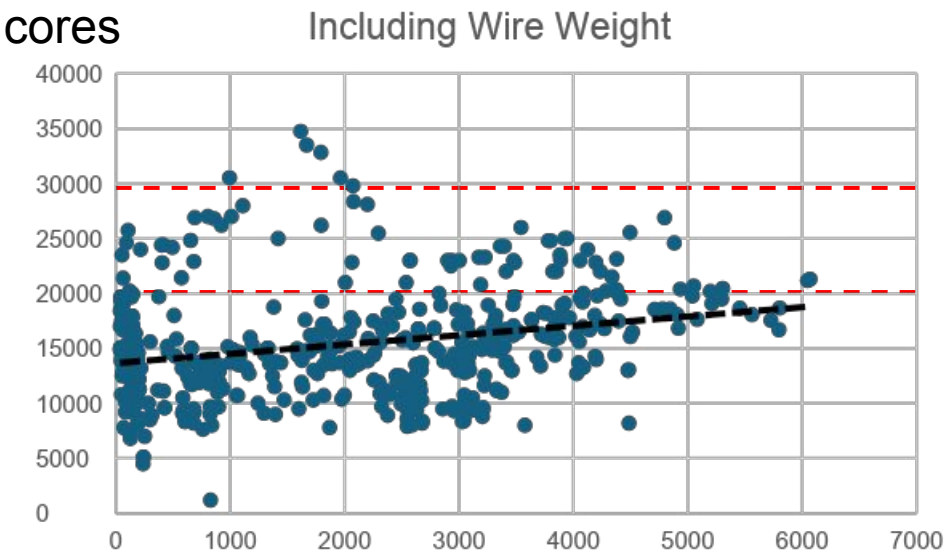
- Attempted JPCs rarely exceed 15-18 m
- Current jumbo piston coring capabilities on UNOLS vessels are limited by strength of deep sea strength members
- It is possible to build longer cores on deck than we routinely attempt
- Significantly longer (30m+) cores require larger vessels or significant structural modifications to existing ships
- Intermediate improvement (20m-30m) may be possible but requires creativity and engineering analysis

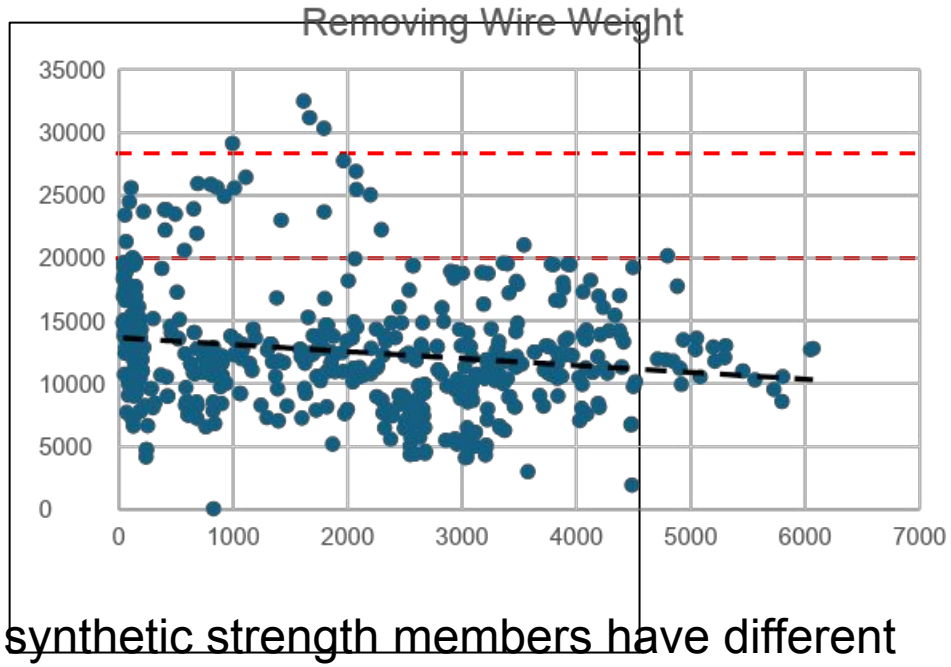
Impact of Removing Wire-Weight

Marginal Increase in pull, allows for deeper water depths but probably r
much longer cores









Note that synthetic strength members have different break loads and SWL considerations

Brief note on synthetic strength members (HMPE)

- Synthetic Strength Members have slightly larger strength compared to steel of similar diameter
- Other physical properties, namely elasticity and visco-elastic contraction are different, importantly so for piston coring
- Elastic Recoil is an important consideration for piston coring and is a function of corer weight/break load of rope
- Higher factors of safety reduce elastic recoil which is an added benefit to piston coring