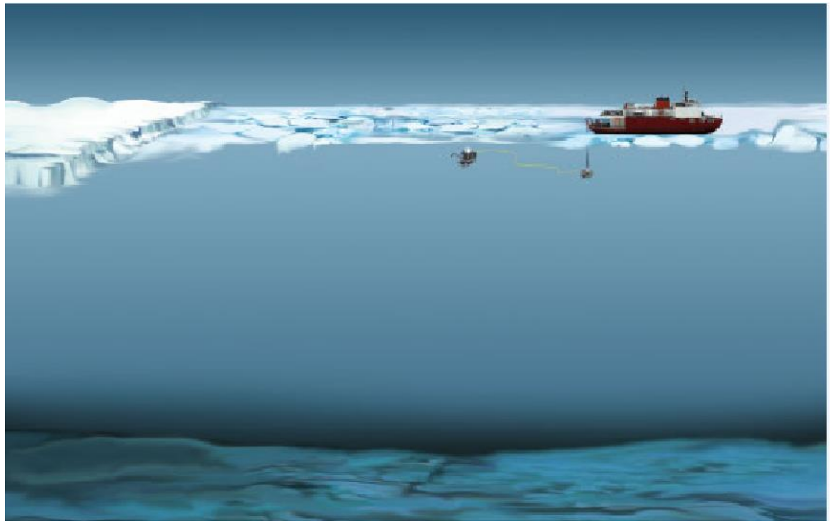
Accessing ice covered water for science operations

Ross Hein
ARV Science Mission Coordinator

What makes ARV different from current USAP vessels

Advanced Ice Management is the Key to providing Scientific Access in the dynamic conditions of the Southern Ocean



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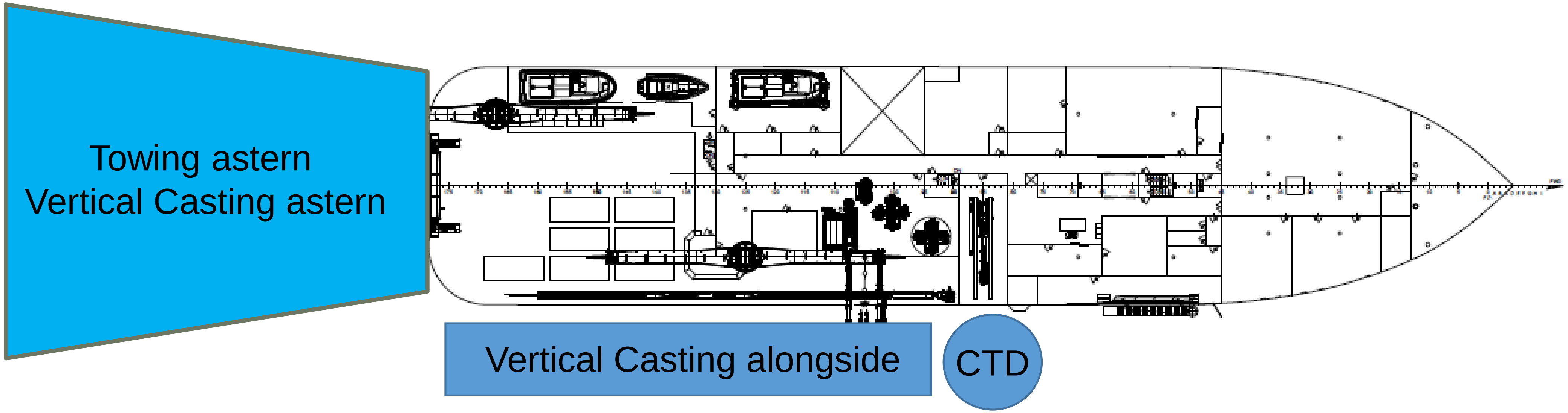
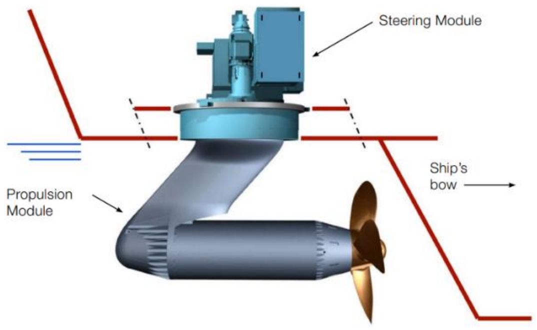
Overboard Handling Areas on ARV



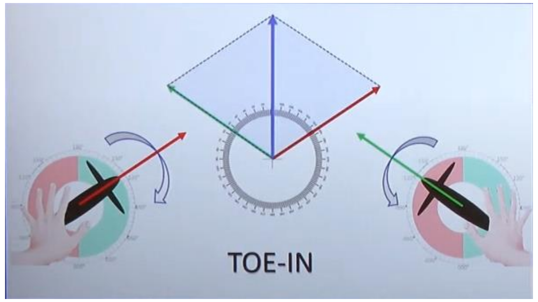
Azimuth propulsion and vectored thrust in ice

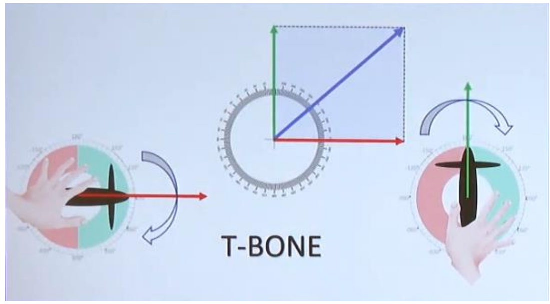
Strategic use of directed thrust delivers unique and advanced maneuvering and ice management solutions to ARV

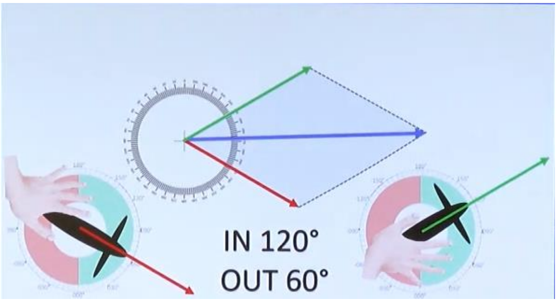


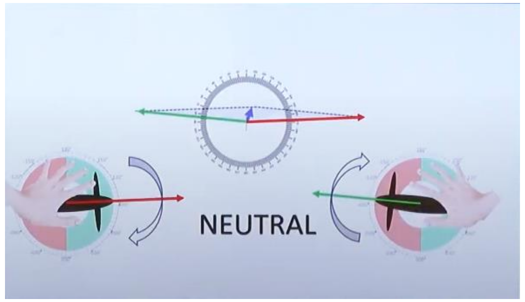
360° Independent Rotation

Variable and Independent RPMs









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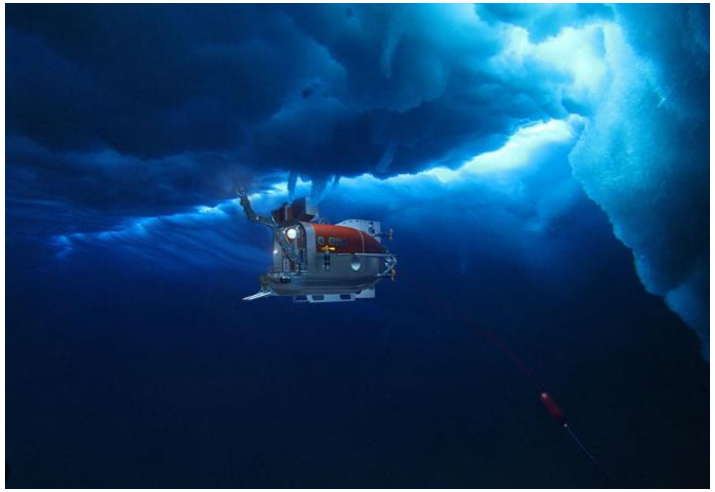
ARV Capability

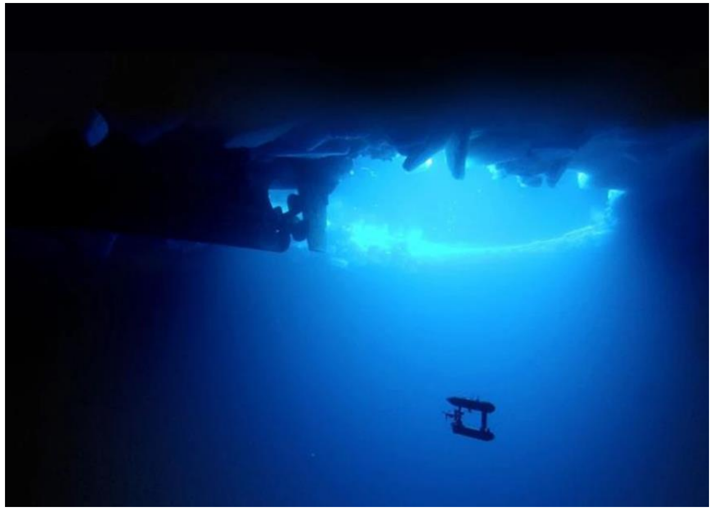
Heavy/Multi-year Ice Conditions

- ARV can lay alongside to port and use directed thrust, turbulent flow and heeling to open and maintain ice free water to starboard (polynia) to maintain CTD access.



Improved Reliability

- Azipods have a proven track record to be highly resistant to ice damage.
- Zero broken propellers to date versus shaft line ice breakers due to reversing process and tip loading.

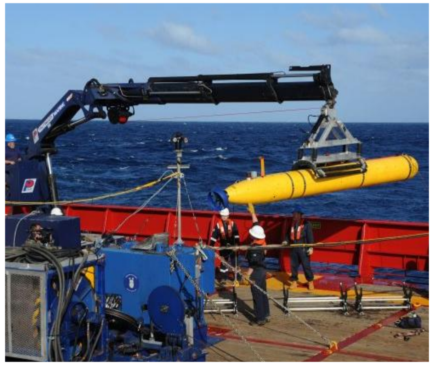


Over-the-Side Ice Operation types

Towing Astern	Vertical Casting Astern	Vertical Casting Alongside
• Bottom Trawls • Midwater Net Tows • Dredging • Seismic Survey • Towed Profilers • Tow body	• Light Coring • Gravity Coring (rails) • Vertical mooring deployment • Geotechnical Drill • Large AUV Ops	• CTD (traditional/TMC) • Vertical Profilers • Light Coring • Piston Coring • ROV Ops • AUV Ops

Large Science Packages requiring Ice Management

Hydroid



HUGIN 3000

AutoSub 3

Jaguar

Jason

HUGIN1000

Over-the-Side Ice Operating Requirements

Towing Astern

- Tow speed 1.5 - 6 knots
- 2’ or less level first year ice
- 100+ yards of ice free water astern

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Over-the-Side Ice Operating Requirements

Vertical Casting Astern

- 2’+ level first year ice
- 100+ yards ice free water astern
- Thrust to hold position and manage ice

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GeoTechnical Drilling from ARV

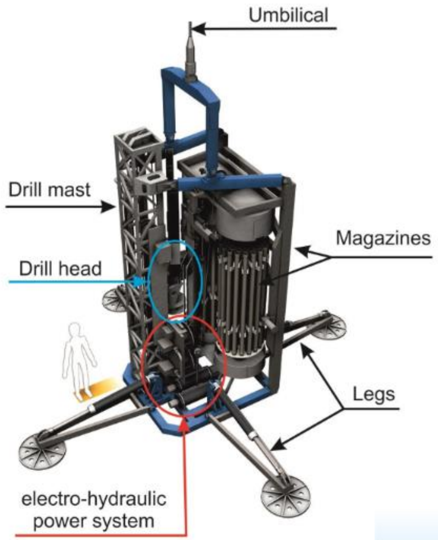
MeBo200 Case Study

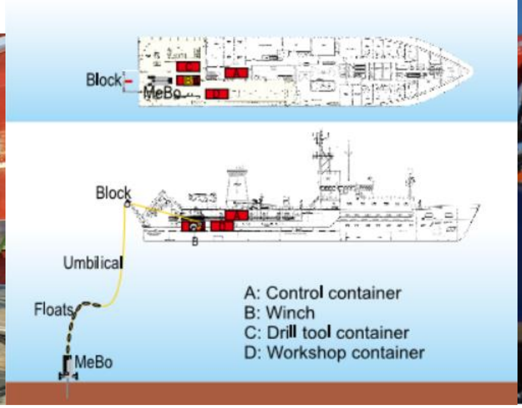
Capability

- max water depth 2,700 m
- max core length 200 m

Support Requirements

- 30 tonne A-Frame
- 400V, 50Hz, 500A Power
- 8x14 m footprint + 4ea 20' Containers





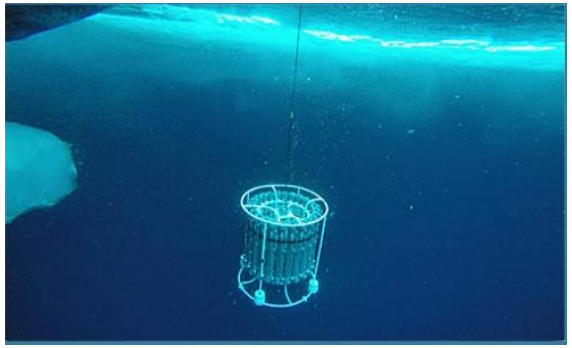
ARV support operations

- Ice Management, Vertical Casting Astern
- Station keeping ~30m watch circle

Over-the-Side Ice Operating Requirements

Vertical Casting Alongside

- 2'+ level first year ice
- 100 yards ice free water on starboard side
- Able to provide sufficient open water in heavy and multi-year ice to maintain vertical casting access



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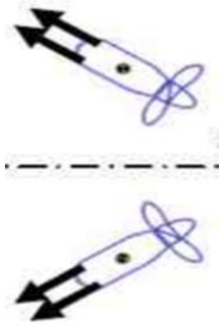
Ice Management for Towing

Hull form and directed thrust work together to open a clear channel

<u>Risks</u>

- ➢Ice damage to equipment at surface
- ➢Ice interaction with tow wire



<u>Management Strategy</u>

- ✓ Adjust propulsor toe-in for operational speed requirements and ice conditions
- ✓ Articulate A-Frame to bring tow wire close to transom
- ✓ Active depth management of shallow tows
- ✓ Directed thrust = Channel wider than beam

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Ice Management for Vertical Casting Astern

Bow held in ice with directed thrust maintaining open water

Risks

- ➢ Ice damage to equipment at surface
- ➢ Ice interaction with vertical wire

Management Strategy

- ✓ Approach position into the wind
- ✓ Adjust propulsor toe-in for ice conditions
- ✓ Adjust thrust to hold the bow in ice once in position
- ✓ Direct/Adjust Thrust to maintain ice free water astern

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Ice Management for Vertical Casting Alongside

Hull creates a lee and managed thrust directs broken ice

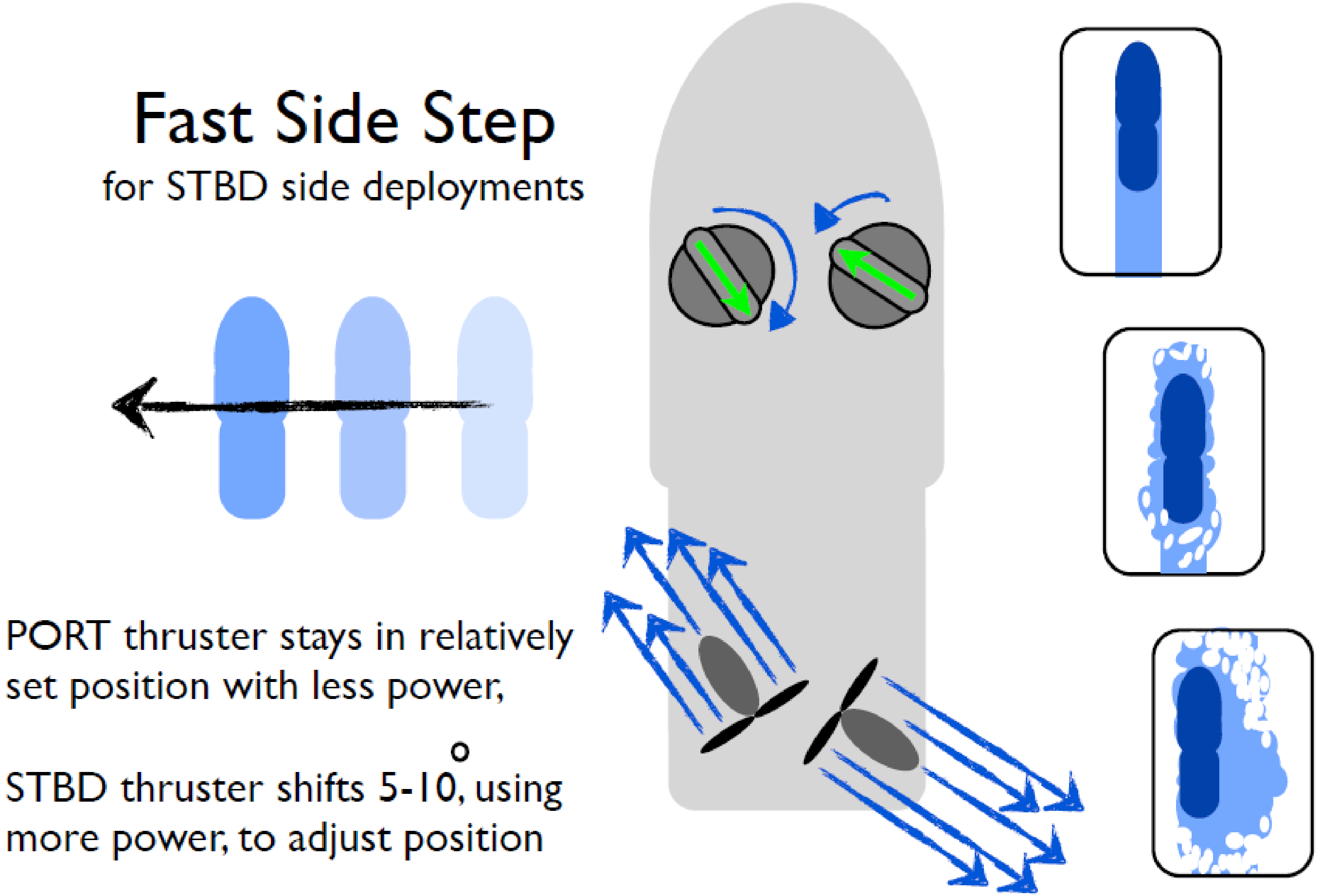
Risks

- ➢Ice damage to equipment at surface
- ➢Ice interaction with vertical wire

Management Strategy

- ✓ Orient hull for working side lee
- ✓ Direct thrust to break ice
- ✓ Direct Thrust to maintain ice free water
- ✓ Consider mechanical protection
- ✓ Heavy ice polynia creation

How Do you Do It?



A. Stop one ship length forward of the Station, wind slightly on STB bow
B. Toe-in thrusters and open pocket around stern
C. Back into opened space
D. Fast Side Step on PORT and lay alongside channel wall
E. Shift thrusts to maintain pocket

Green arrow head indicates propeller location in tractor mode

ARV Model Testing for Ice Management

Clearing of a pool with thrusters in the HSVA Test Basin (Side Step)

Ice Management Astern in the HSVA Test Basin (30° toe-in angle)

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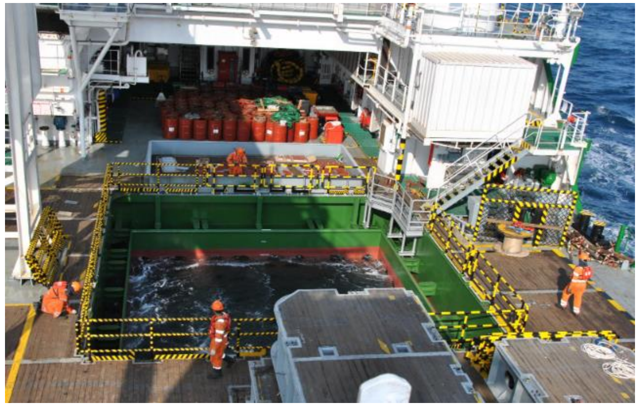
What about a Moon Pool?

What is it?

Opening in the hull bottom originally developed for Drill Platforms and Diving and Offshore Support Vessels

What it is used for?

Lowering equipment through the hull often from an interior or sheltered space



- **Pros**
  - Working in an interior space
  - Ice free access below the ship
  - Limits sea state action
  - Equipment protection from ice interaction
- **Cons**
  - Impact to overall ship design
  - Loss of usable volume
  - Size limitations for equipment
  - Damage potential during deploy/recovery
  - Capture/Closure system maintenance
  - De-icing challenges
  - Seal/Pressure challenges

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Moon Pool Uses

Interior Moon Pool Science Applications

- CTD (most common)
- Small ROV
- Limited vertical casting (size dependent)

Open Deck Moon Pool (often w/o bottom closure)

- Larger science payloads
- Small Drilling (if tower provided)

Not Moon Pool compatible

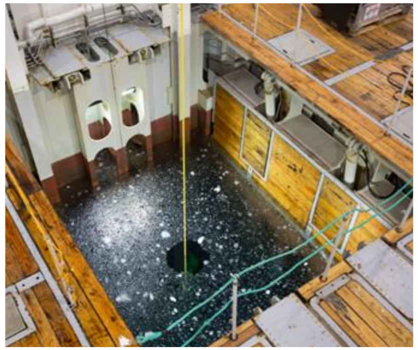
- Ø Long Coring Systems (OSIL, WHOI long core)
- Ø Large Drilling Systems (tower drills, MeBo200)
- Ø Large ROV Systems (JASON, ROPOS)
- Ø Large AUV Systems (HUGIN, AutoSub LR)

Open Deck Moon Pool

CTD Handling System

Handling System Engaged

Handling System Deployed



Conclusion

The current ARV configuration utilizes Advanced Ice Management techniques to provide access in support of all of these operations in ice with out sacrificing the internal volume required for a Moon Pool