USNS Maury (T-AGS 66)
Moon Pool Launch & Recovery System (MLARS)

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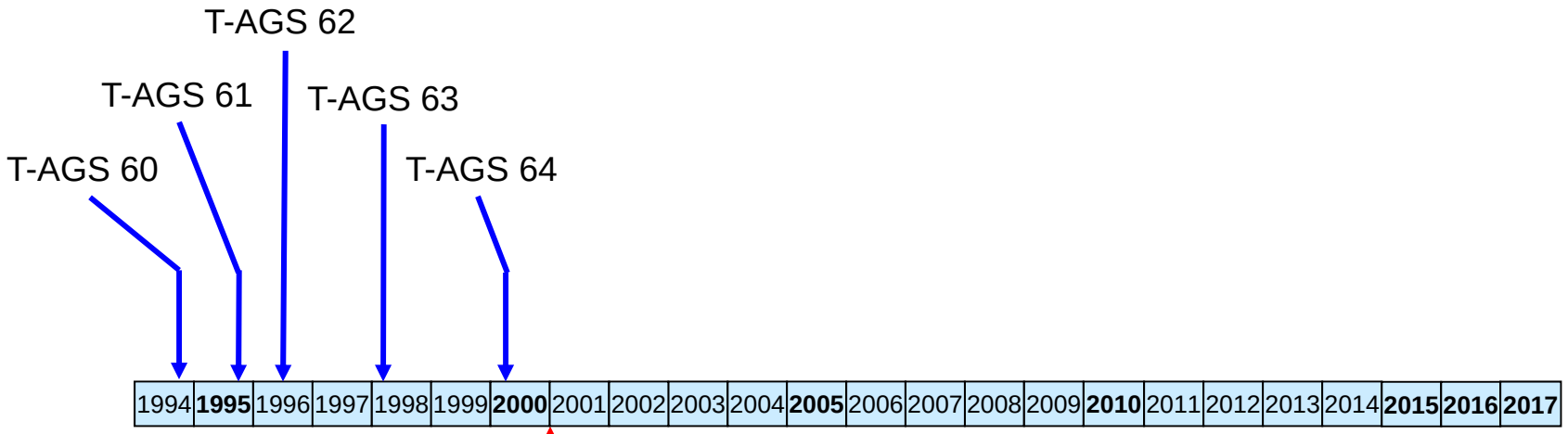
T-AGS 66 Oceanographic Survey Ship

Operating Capabilities:

- Deep ocean and coastal surveys
- Oceanographic sampling and data collections of surface, midwater and ocean floor parameters
- Shipboard oceanographic data processing and sample analysis
- Operation of autonomous underwater vehicles (AUVs) and hydrographic survey launches (HSLs)

Builder:	**VT Halter Marine (Per J&A approved 04/08)**	
Quantity:	**One (1) ship**	
Characteristics:	**LOA**	**353 FT**
	Draft (at delivery)	**19 FT**
	Displacement (Full Load)	**5,552 LT**
	Speed	**15 Kts**
	Accommodations	**67**
	- Crew	**28**
	- Surveyors/Force Protection	**39**

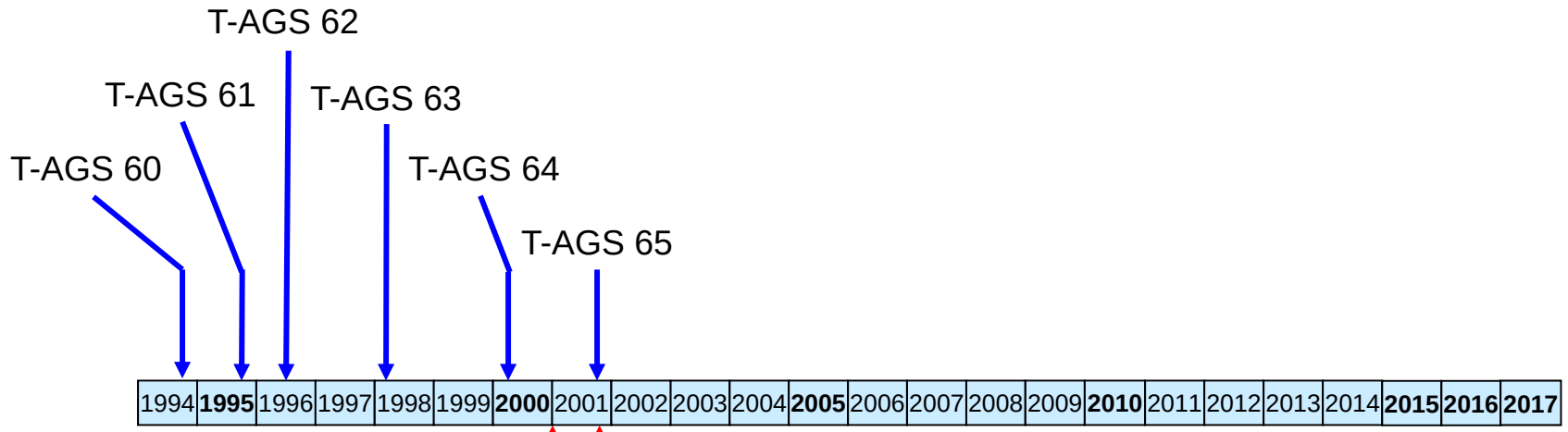
T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



OPNAV ltr
NAVAL SURVEY SHIPS
28 December 2000

"The next class of ships…should …exploit new and emerging… technologies." To include being "…center well (moon pool) capable."

T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



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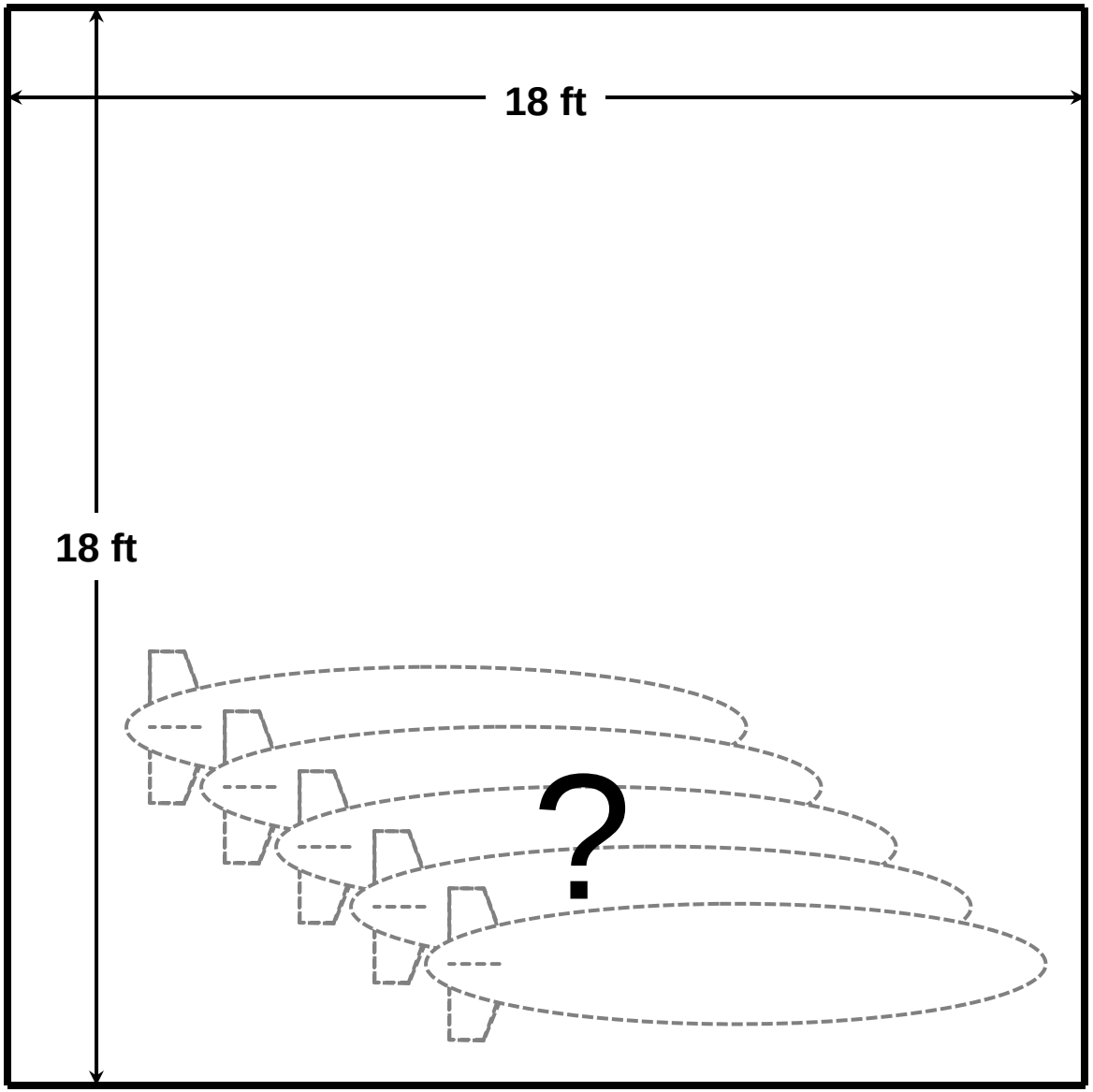
NAVAL SURVEY SHIPS
28 December 2000

T-AGS 65 Moon-Pool Variant
Modified Repeat Feasibility Study
24 October 2001

"An 18 x 18 ft moon-pool … can be incorporated within a ship-length increase of 24 ft..."

T-AGS 66 Oceanographic Survey Ship
Moon Pool Design - 2001



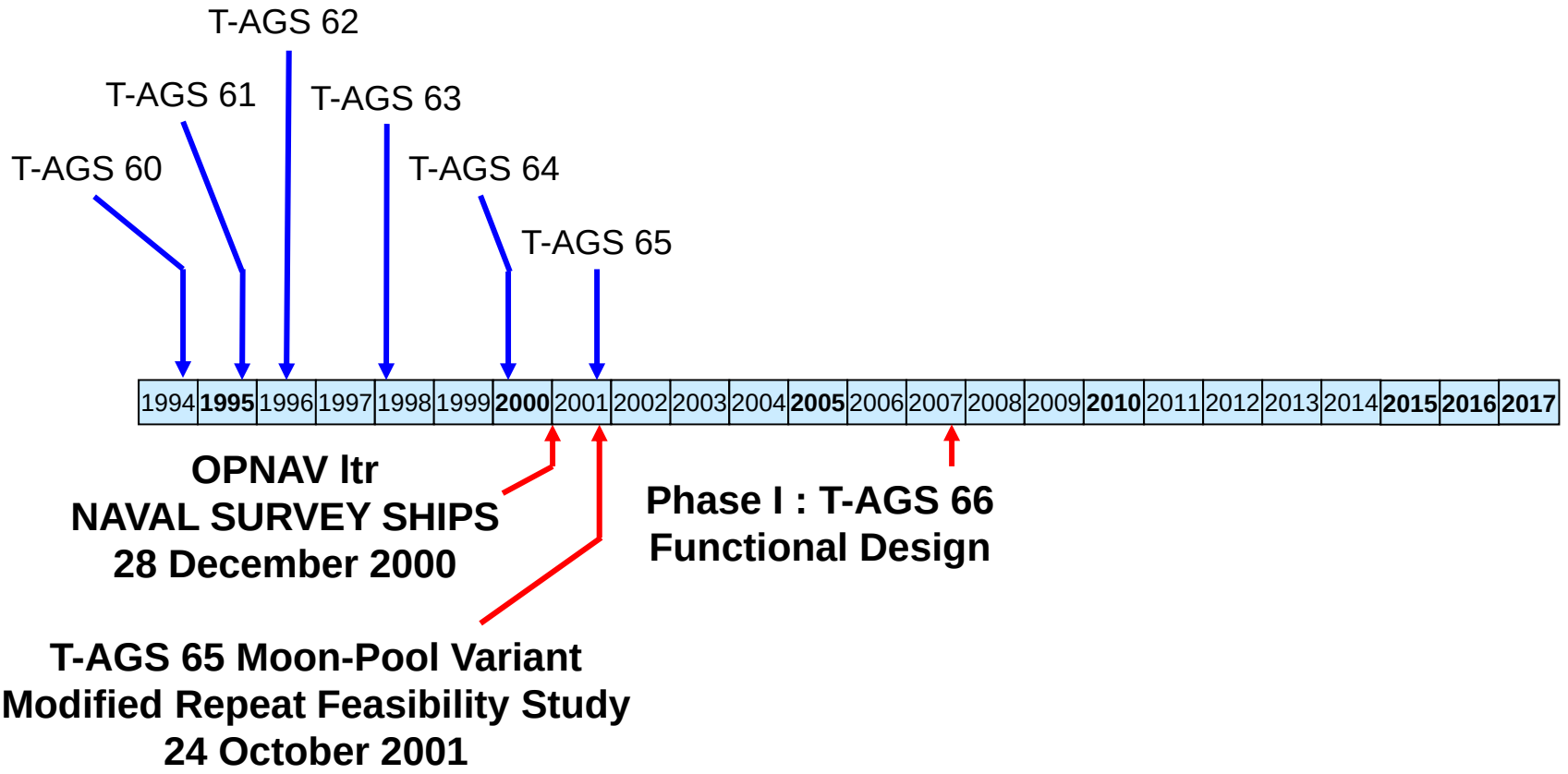
Moon Pool:

- "The Addition of an enclosed **18 x 18 ft** moon-pool … to a lengthened T-AGS 63 design, is technically feasible in all respects."
- "The existing midship scantlings will be sufficient up to a moon-pool length of **24 ft** …"

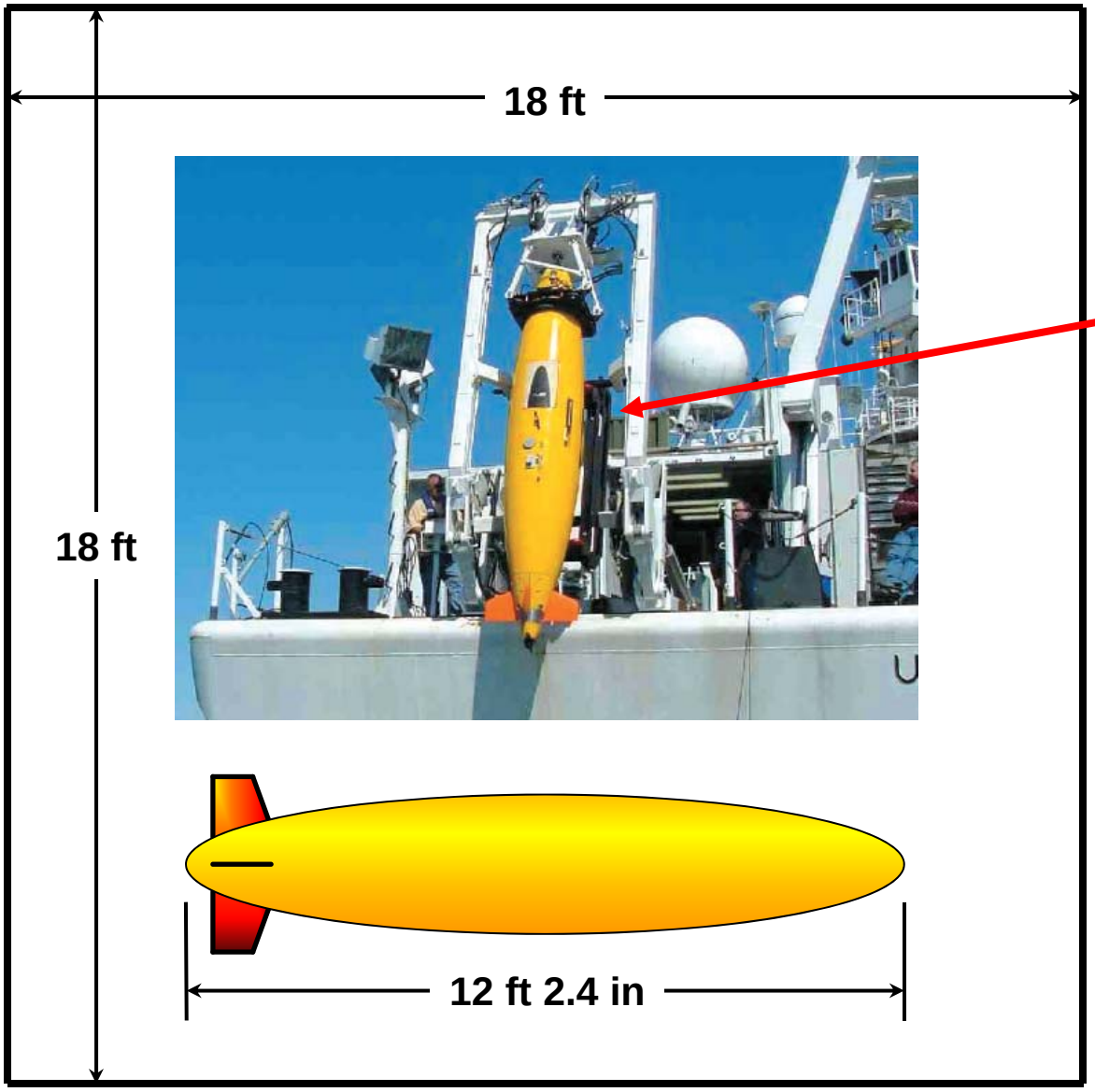
AUV:

- "Specific AUV-system requirements (size, weight, support requirements, number of vehicles, and **launch and recovery** system limits) are not yet final."

T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



T-AGS 66 Oceanographic Survey Ship
Moon Pool Design - 2007



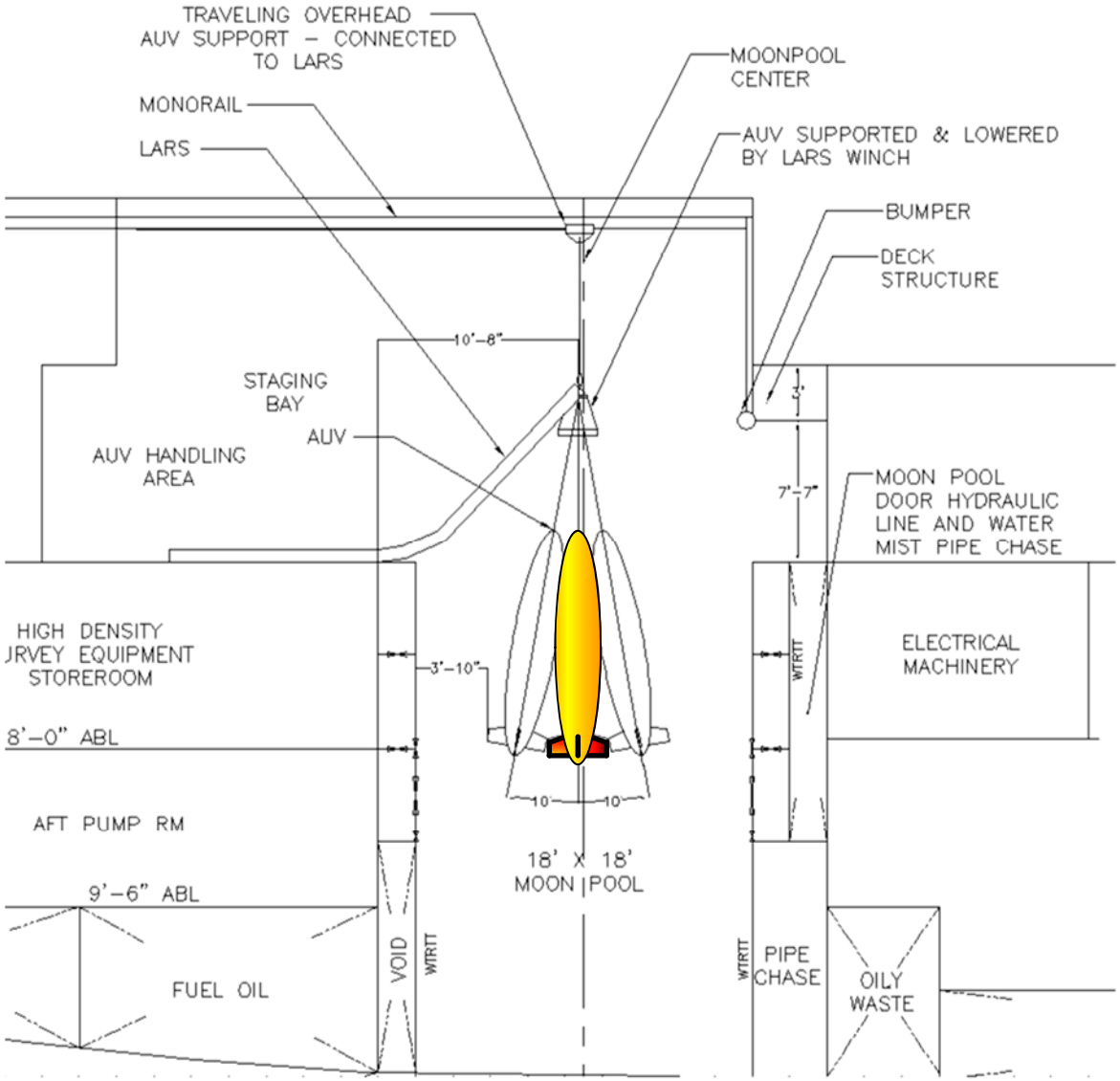
DI-12 Autonomous Underwater Vehicle (AUV) Handling Study

- "For the purposes of this study, the SAMS* AUV will be used to develop a handling system and interface requirements."
- "Since the AUV is recovered from the surface, the recovery of AUVs will remain at the stern."

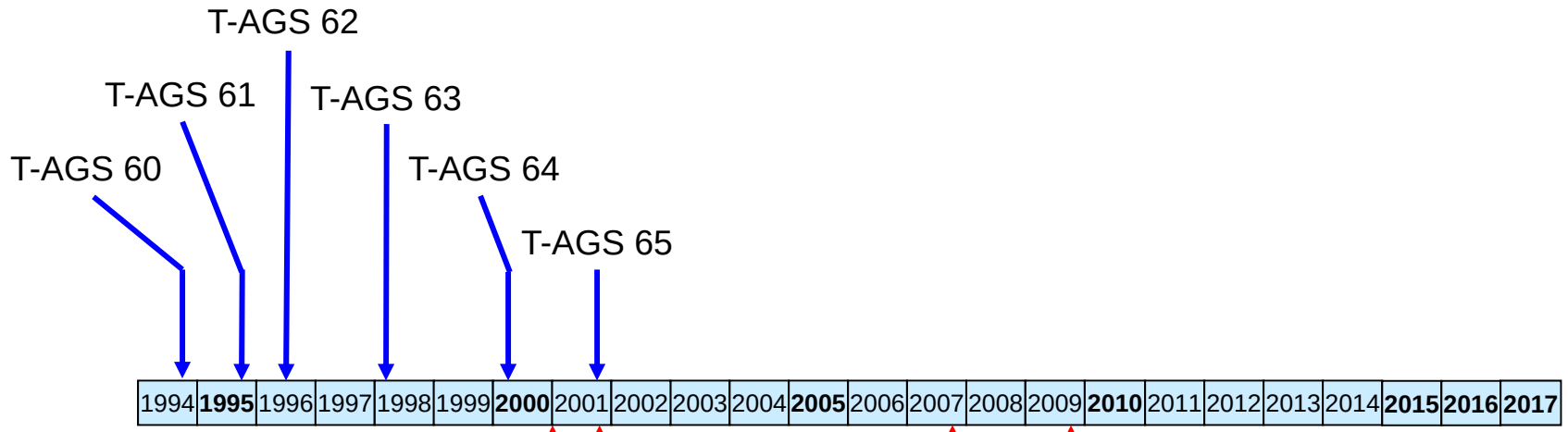
LAUNCH ONLY!

* Subsurface Autonomous Mapping System

T-AGS 66 Oceanographic Survey Ship
Moon Pool Design - 2007



T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



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T-AGS 65 Moon-Pool Variant
Modified Repeat Feasibility Study
24 October 2001

Phase I : T-AGS 66
Functional Design

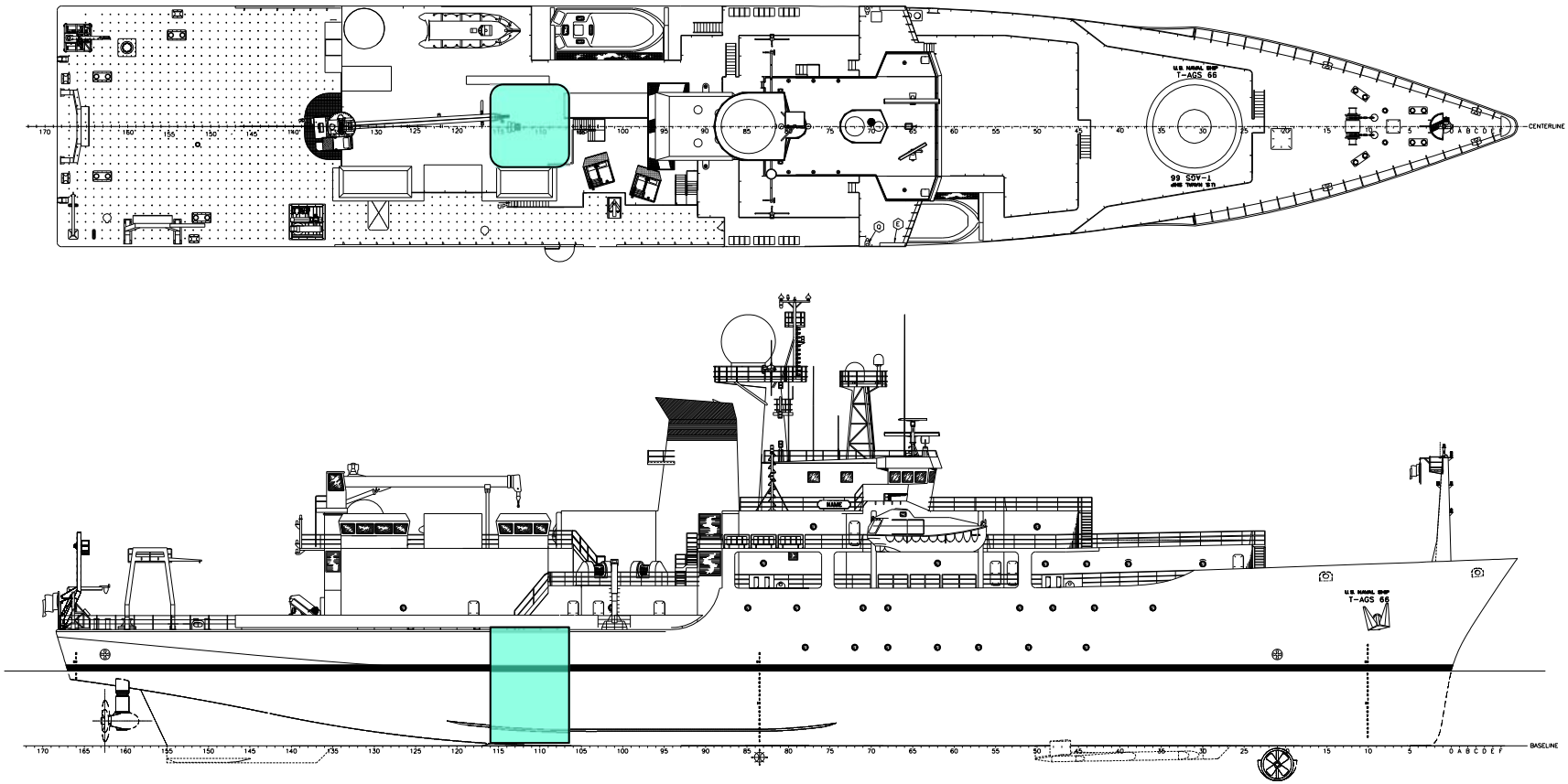
Phase II : T-AGS 66
Detail Design
& Construction

"A suitable means for … deployment of an AUV shall be provided…"

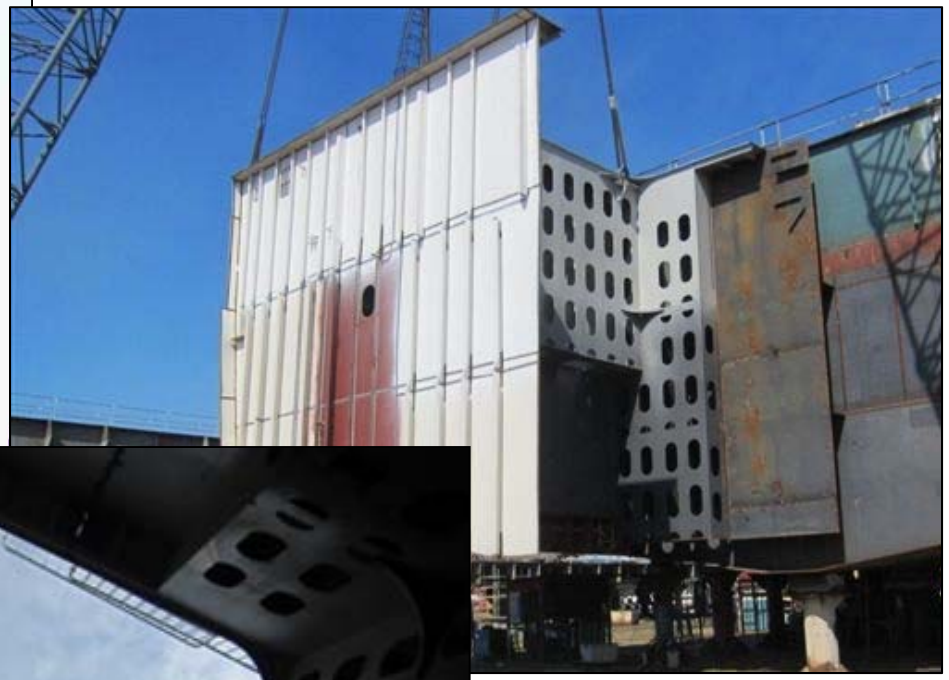
"…shall be capable of handling an item as large as 12 feet long by 5 feet wide by 5 feet high…"

T-AGS 66 Oceanographic Survey Ship
Moon Pool Construction

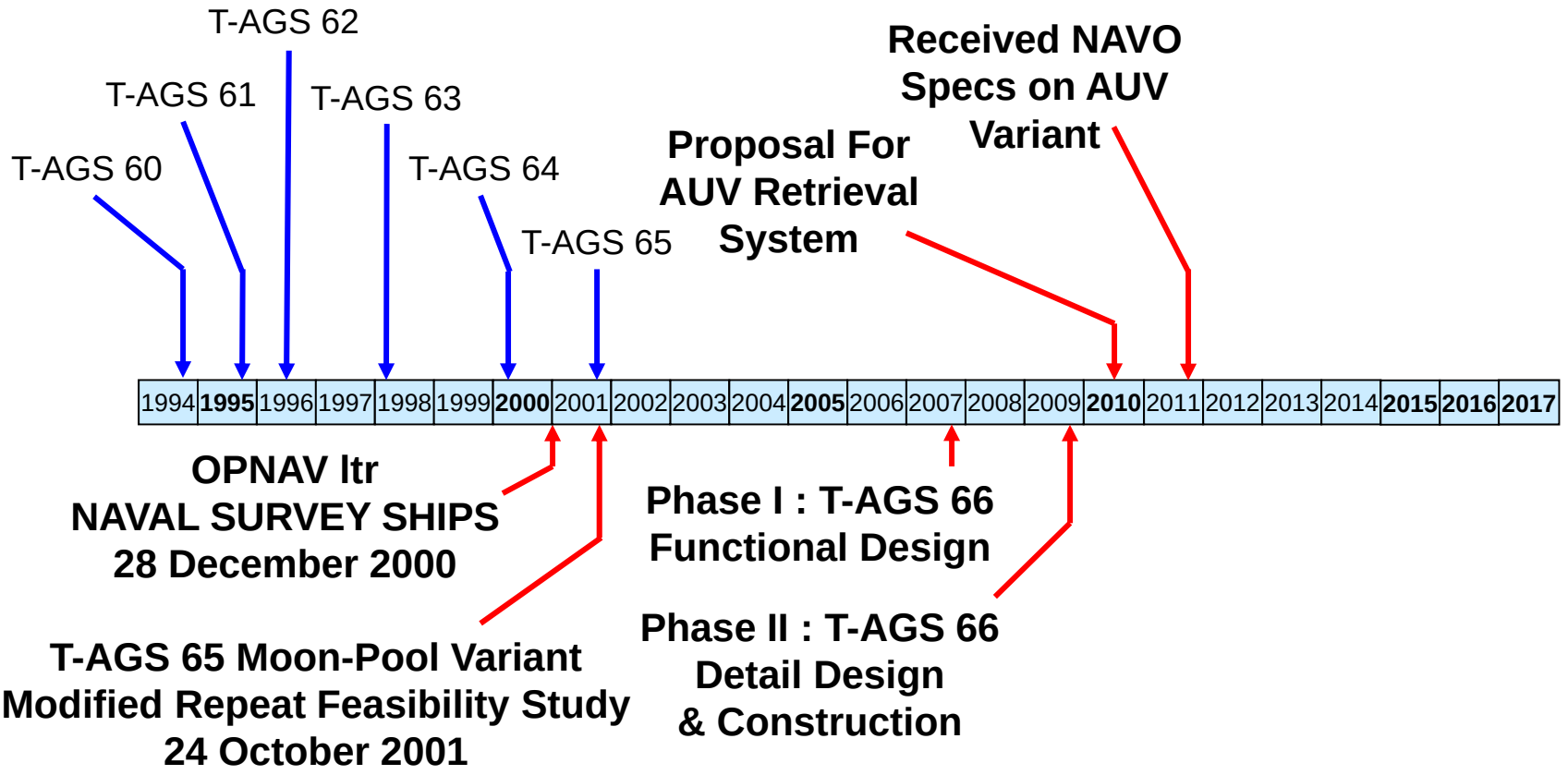
- Moon pool located at approximately the longitudinal center of flotation (aka the center of pitch)



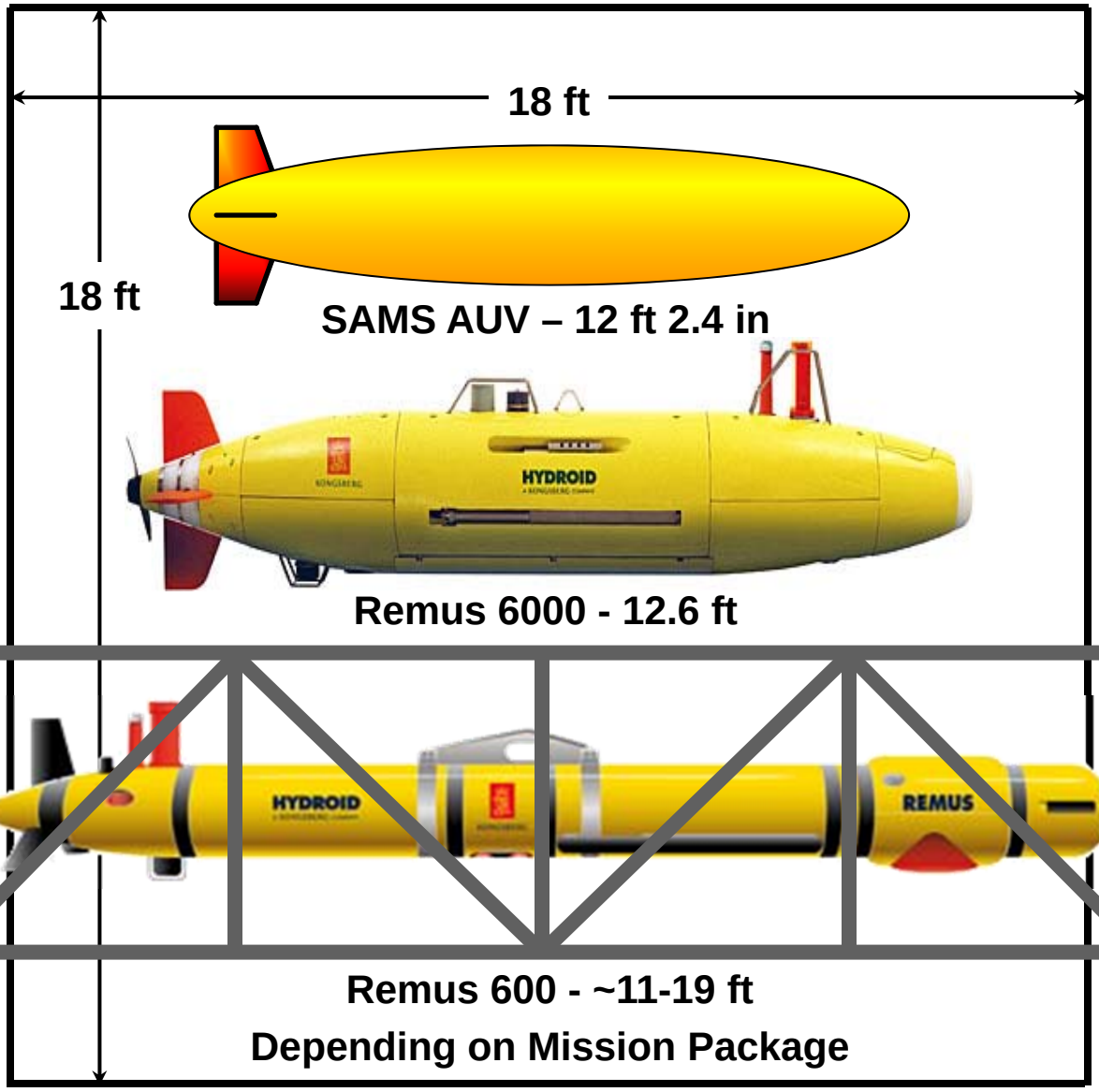
T-AGS 66 Oceanographic Survey Ship
Moon Pool Construction



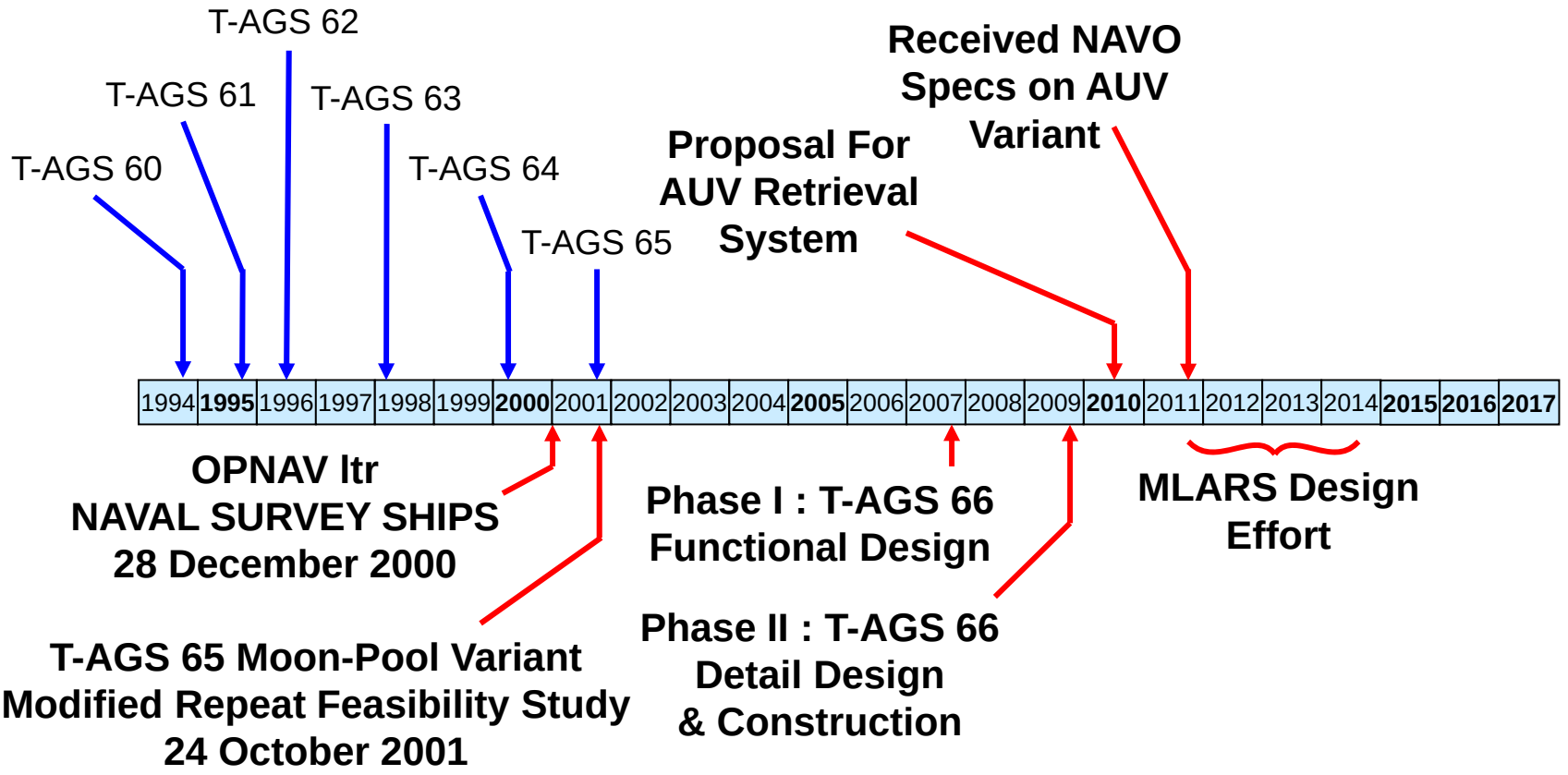
T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



T-AGS 66 Oceanographic Survey Ship
Moon Pool Design - 2011



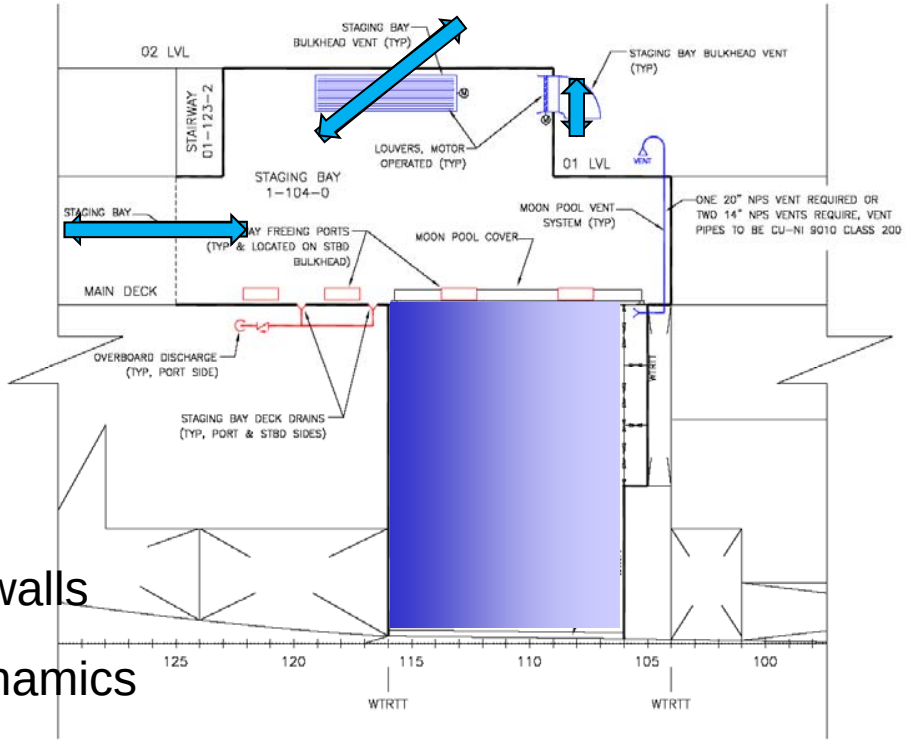
T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



T-AGS 66 Oceanographic Survey Ship
MLARS Technical Approach

Design out as many likely failure modes as possible including:

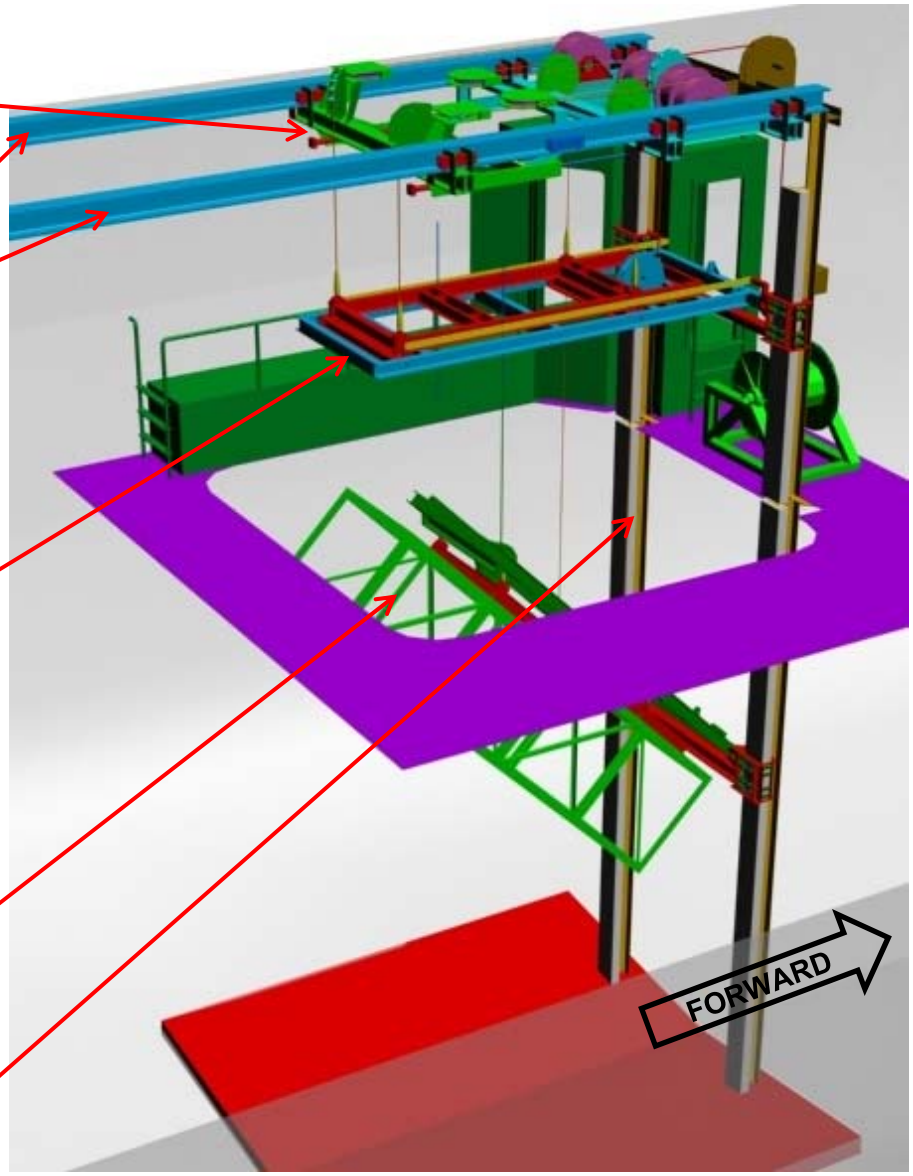
- Corrosion
- Biofouling of underwater equipment
- Slack cable problems
- Cable corrosion from the inside out
- Excessive Pendulation due to ship motions
- Water heave in the moon pool
- Payload impact with moon pool opening or walls
- Utilize 3D solid modeling & include hydrodynamics



- Use Lebus Shells with matching level winds on lift winches to control cable reeling
- Use Nylatron Sheaves to control corrosion issues
- Use keeper rollers to prevent the cable from jumping out of the groove
- Any Hydraulic cylinders are normally closed to minimize corrosion and seal wear

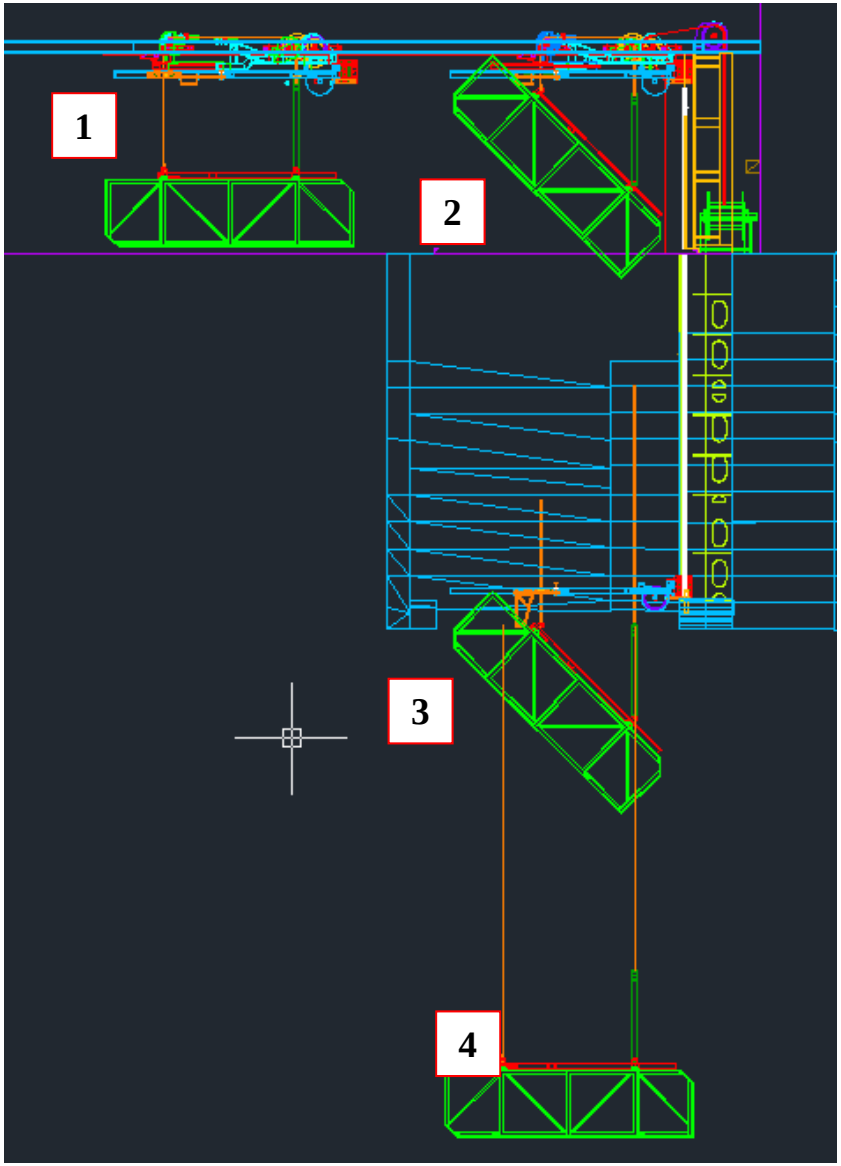
T-AGS 66 Oceanographic Survey Ship
MLARS Technical Approach

- L&R System must be able to:
- Launch & Recover 20 ft long. 5 ft wide. 5 ft high. cage through 18 ft long moon pool.
- Maneuver the cage around the mission bay aboard ship while level and with minimal pendulation.
- Be adaptable to a range of different L&R Operations for ROVs, AUVs, Buoy Moorings, and other TBD packages up to 6000 pounds.
- Lower the cage through the moon pool while preventing pendulation and not binding or wracking.
- Be capable of lowering the payload to as far as 75 meters below the hull.



T-AGS 66 Oceanographic Survey Ship
MLARS Concept Video

T-AGS 66 Oceanographic Survey Ship
MLARS Overview



L&R Sequence
(System shown in 4 positions)

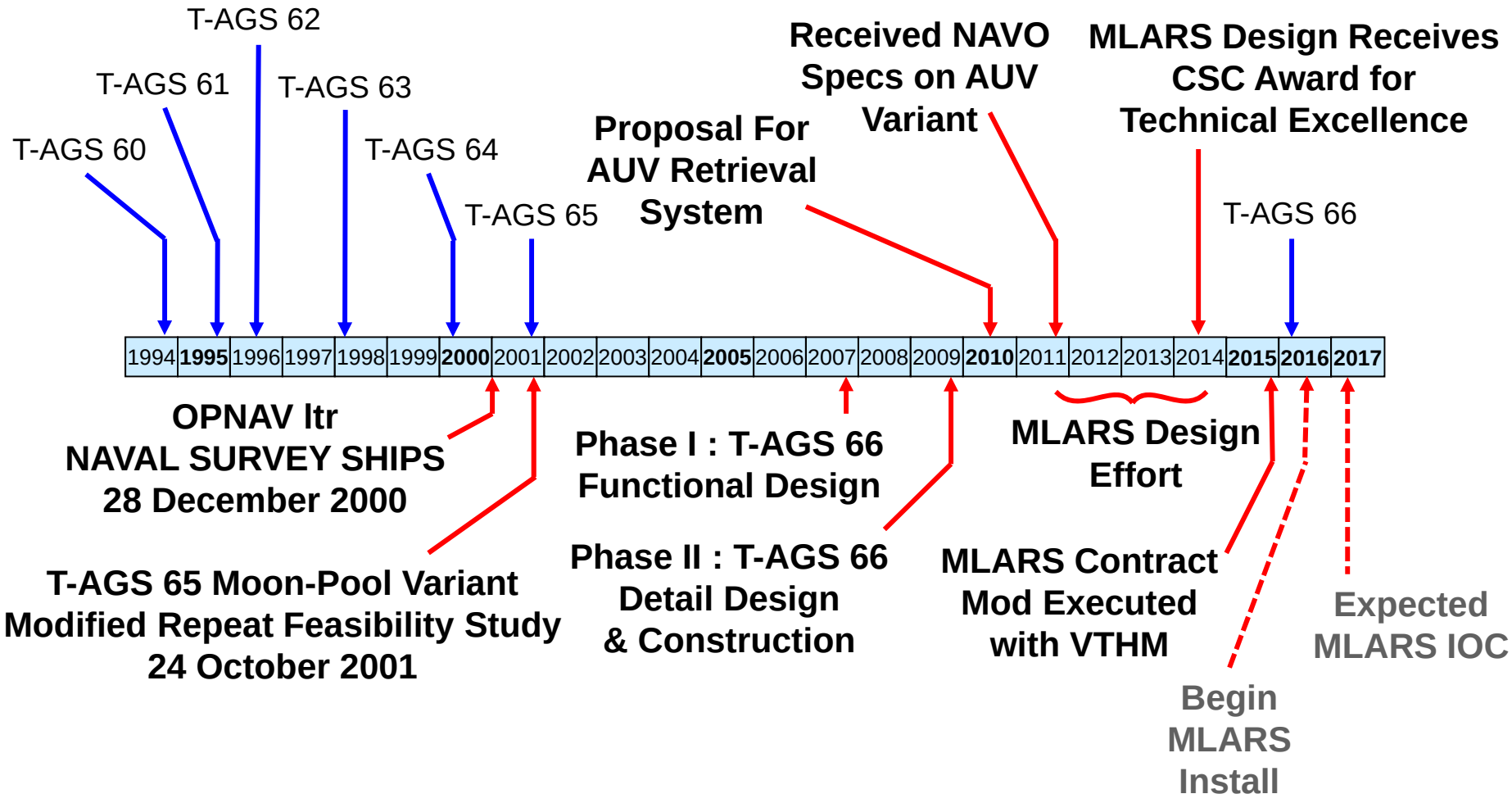
1. System over deck in Mission bay, note not much clearance below, but clears the door track. Overhead trolley is fully extended.

2. Tilt up over moon pool, note that aft end of cage goes between the aft end of cursor legs. Overhead trolley is retracted to a shorter length to keep lift lines vertical. OH Trolley aligns cursor with vertical rails.

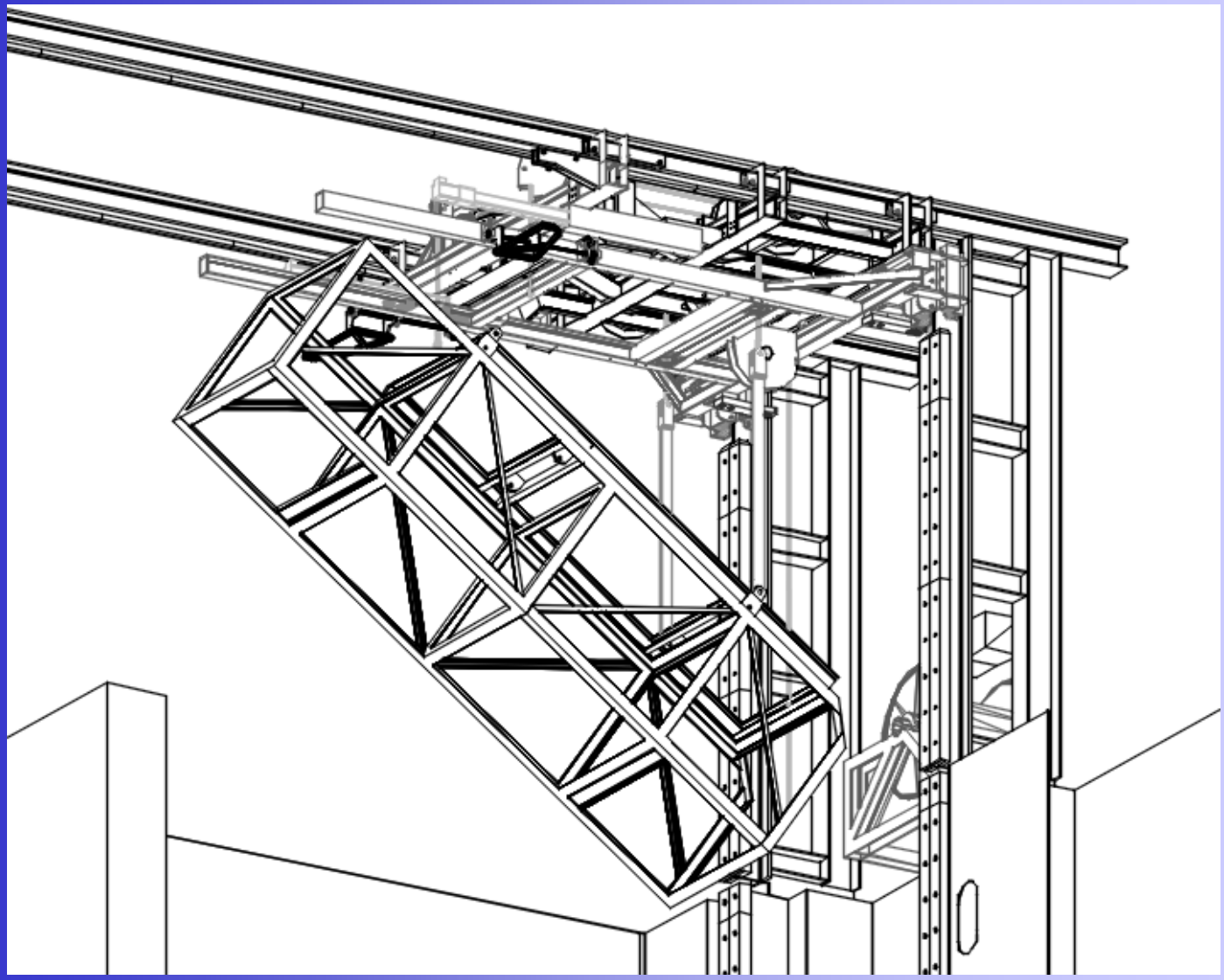
3. Cursor is docked to the bottom of the moon pool, forward end loops drop over two sturdy towing pins which takes the load off the cursor skate rollers.

4. AUV cage is lowered back to Horizontal and overhead Trolley is expanded back to full length to keep the lift lines vertical between the overhead and the cursor. The forward lift lines do not move. The aft lift lines can slide a skate in the cursor fore and aft.

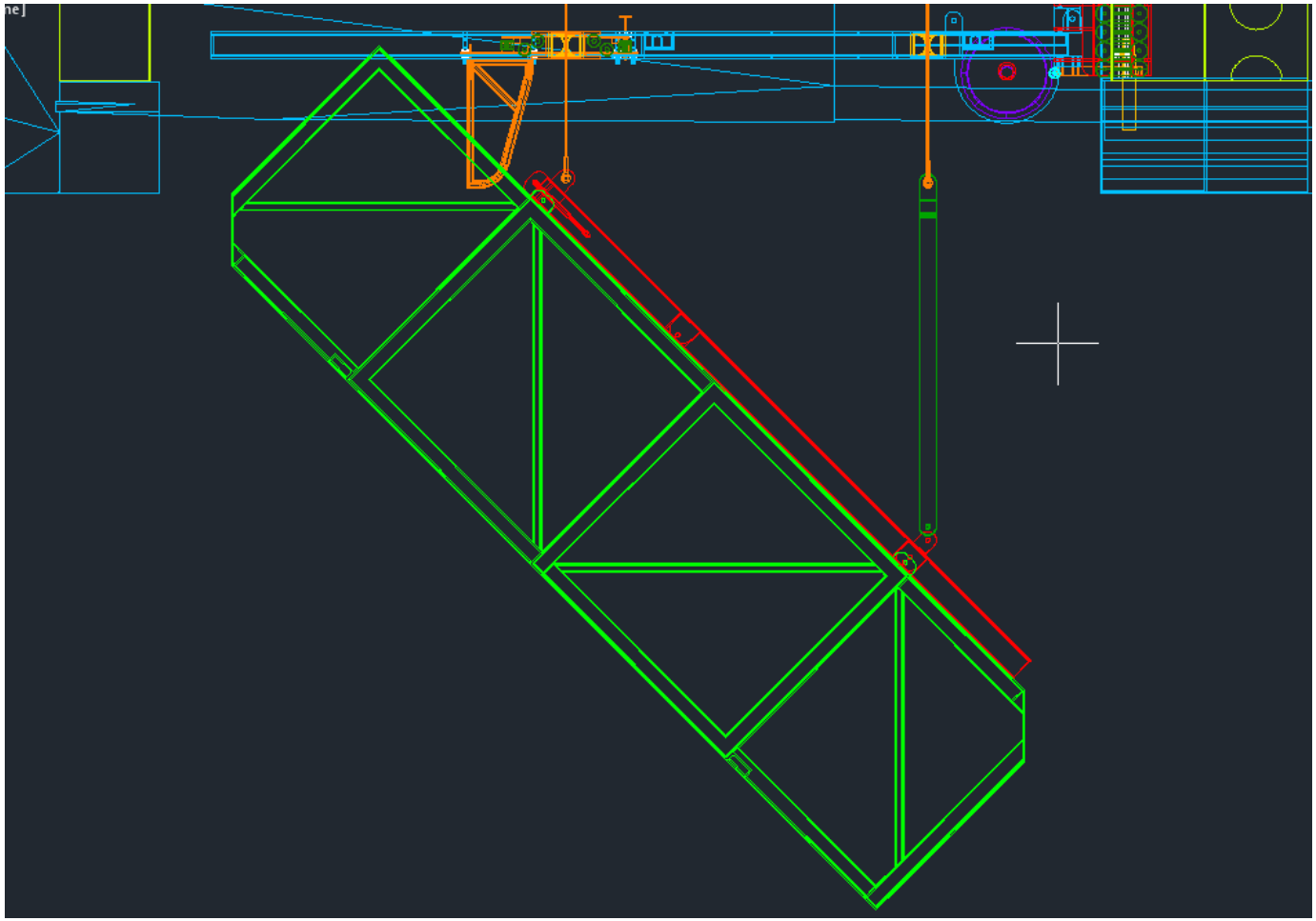
T-AGS 66 Oceanographic Survey Ship
AUV & MLARS Timeline



QUESTIONS?

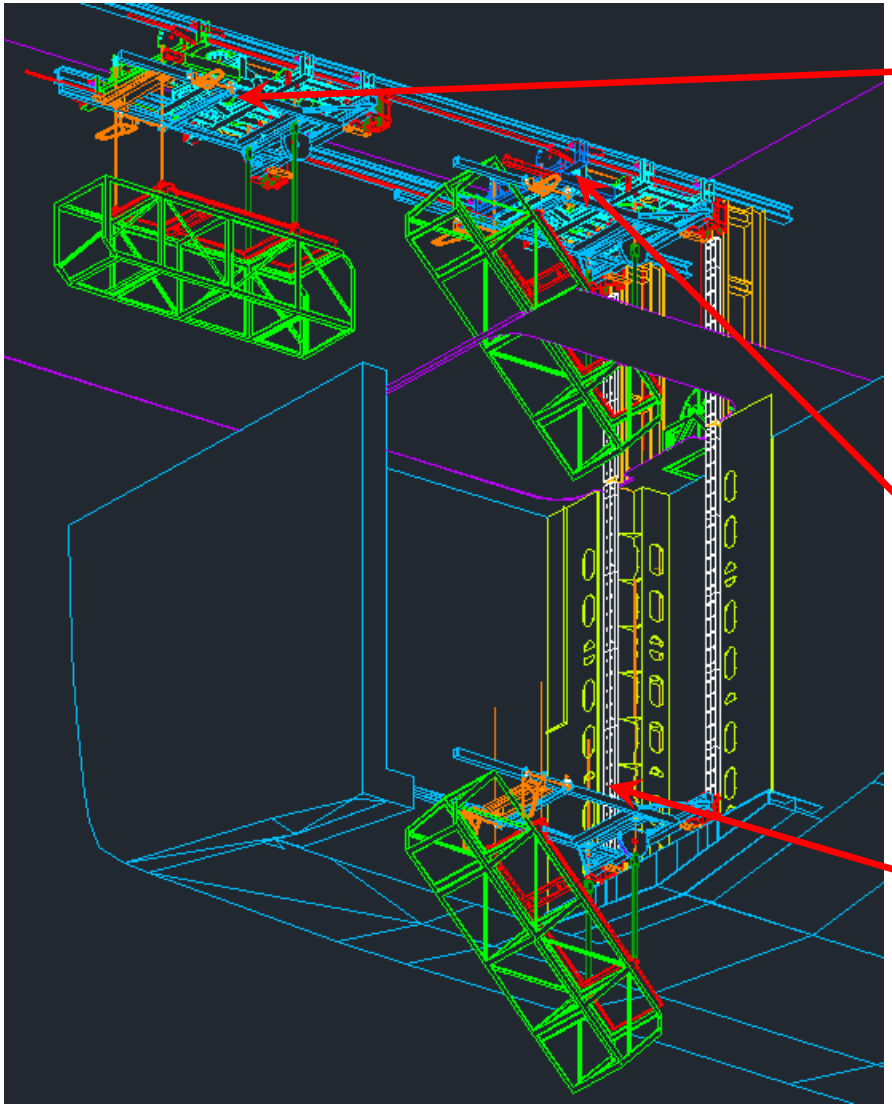


T-AGS 66 Oceanographic Survey Ship
AUV Cage Details



122 inch cage with 12 by 12 corner snipes gives 16.6 inch clearance on the hull on both ends

T-AGS 66 Oceanographic Survey Ship
MLARS Overview



Cage level over mission bay deck

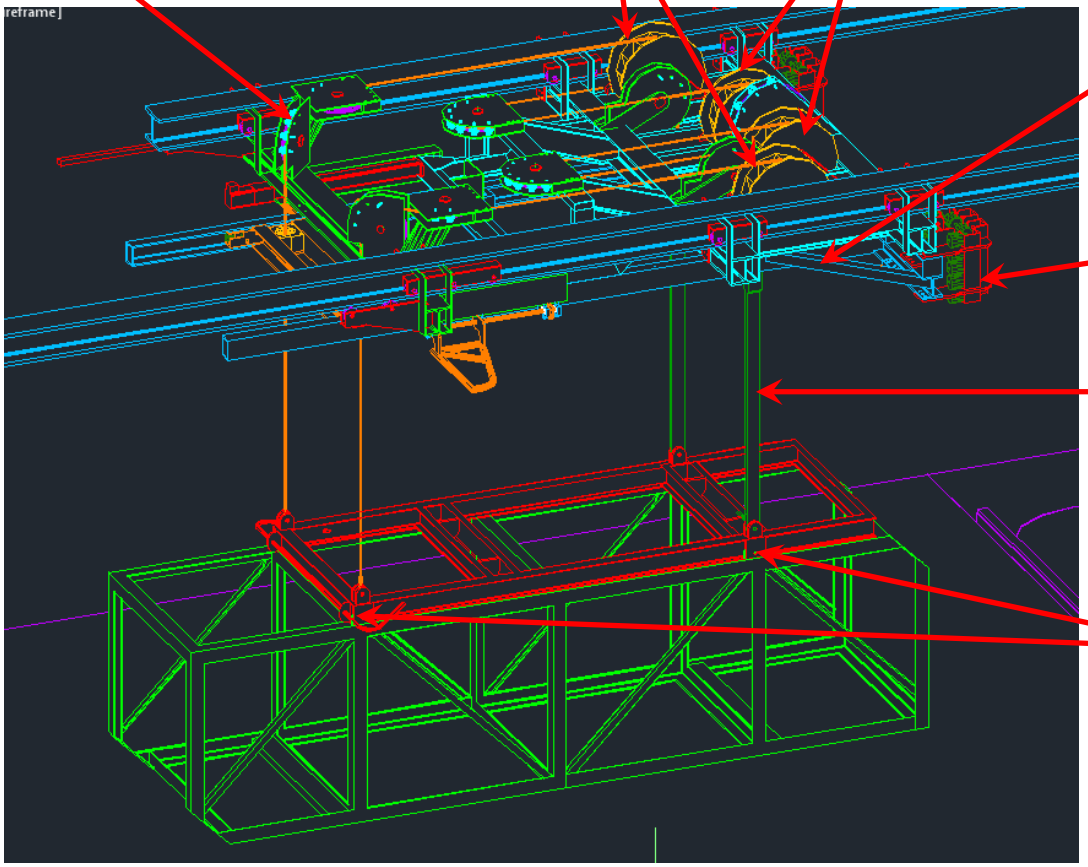
Cage over moon pool tilted up to begin L&R sequence, vertical cursor skates engage vertical rails to prevent pendulation as the load is raised or lowered.

Cage at bottom of ship, anti-pendulation devices are deployed.

T-AGS 66 Oceanographic Survey Ship
MLARS Trolley Details

Each Lift line uses a turning sheave to maintain fleet angle and an overboarding sheave

Four Independent lift winches



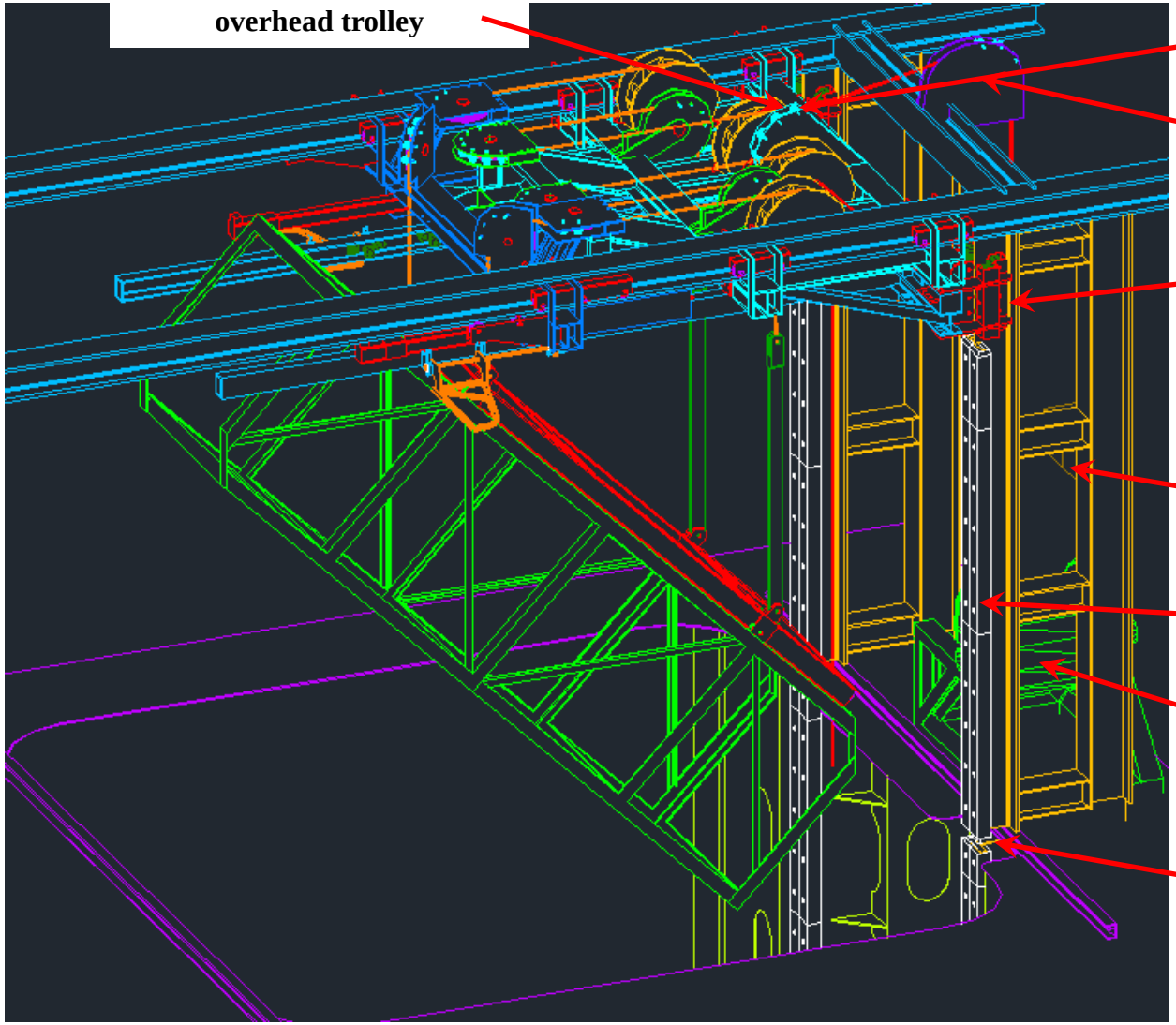
Cursor locked to overhead trolley by two remotely controlled ISO Corner twist locks, (not visible from this angle)

Trucks that ride the vertical rails and lift off the top.

Tilt legs unbolt and are stowed when shorter packages are used

Four sockets in strongback drop over four padeyes on AUV cage, pinned with ¾ or 1” bolts

T-AGS 66 Oceanographic Survey Ship
MLARS Overview



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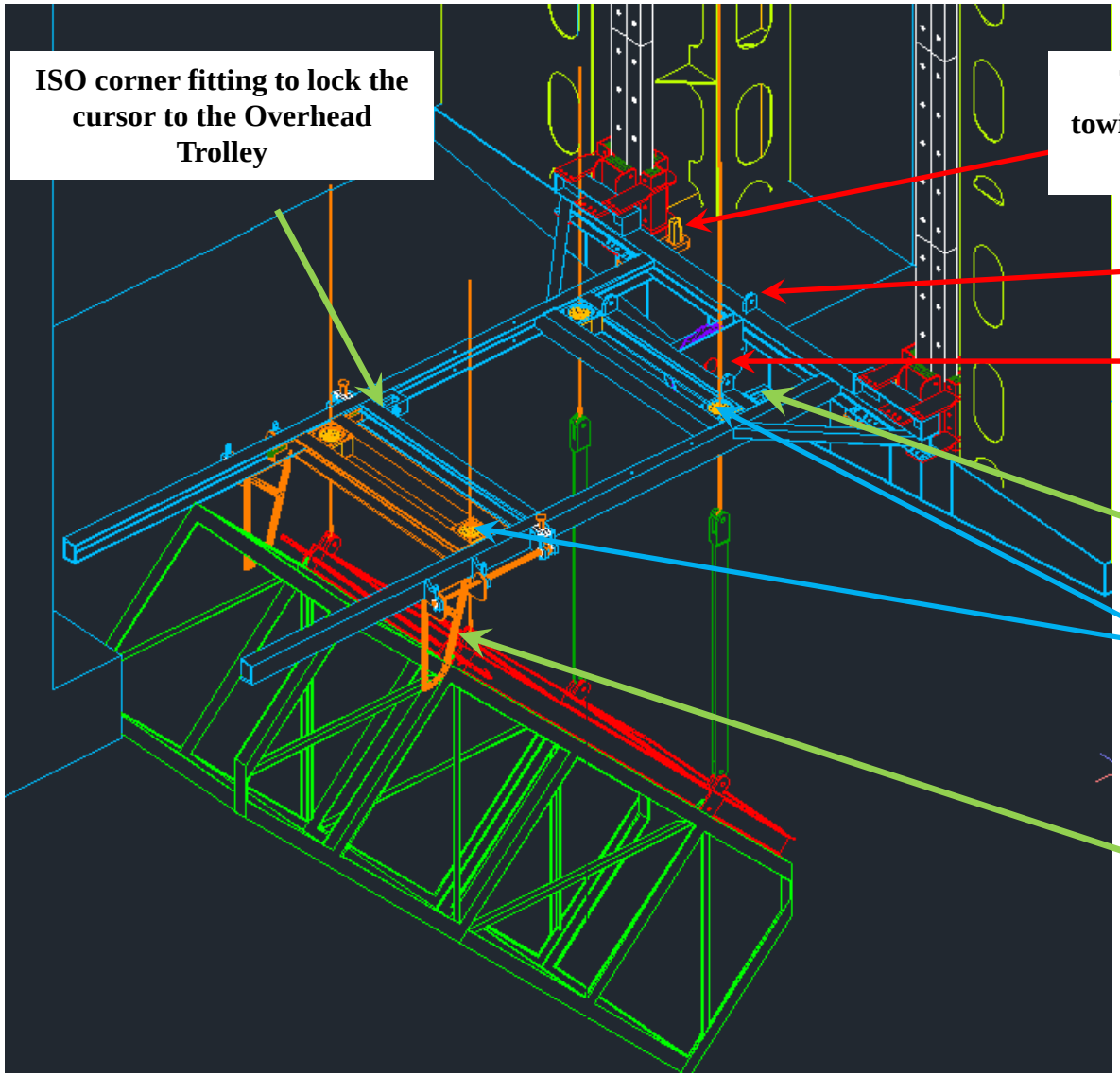
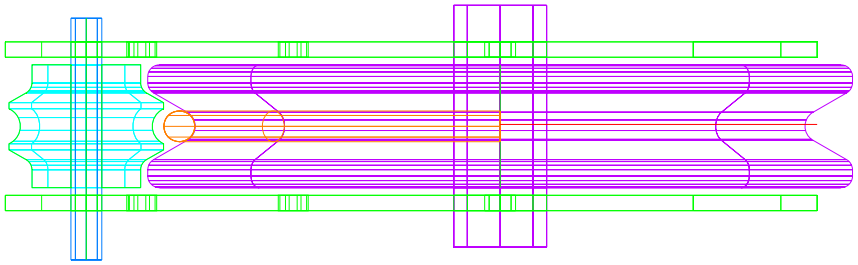


T-AGS 66 Oceanographic Survey Ship
MLARS Design Notes

- All Fasteners are type 316 stainless steel.
- Strongback and cursor are aluminum, open sections, 5000 series preferred.
- Vertical tracks covered with thick UHMW polyethylene to protect the paint on the steel from rubbing friction and to make it easy to remove any bio-fouling prior to beginning an L&R evolution.
- Overhead trolley is Aluminum: Starboard trucks are welded to the trolley, whereas port side trucks are bolted up. This allows the trolley to be hung in place while the connections are made.
- Lift winches hold 400 feet of ½ inch 38 by 7 Pyton Hoist, three layer, torque balanced, plastic filled, IWRC, EIPS wire rope.
- Lower ends of wire rope are terminated with Crosby Swage fittings.
- Each winch is to be equipped with a Lebus shell and matching level wind to ensure even winding on all 4 winches.
- Winch speeds are variable and computer controlled / synchronized. Inertial Navigation Sensor data is already on the ship's data buss. TBD software can be used to motion compensate the L&R system to extend the operating envelope to higher sea state conditions such as the top of sea state 4.
- Winch motors to be sized based upon maximum required motions from completed ship motions study.

T-AGS 66 Oceanographic Survey Ship
MLARS Keeper Rollers



12” sheave for ½” wire rope shown (typical)

- **Cheap Keeper rollers CNC machined out of UHMW or Delrin, prevent cables from getting out of the sheave groove, if the cable ever goes slack. Cables in the overhead and out over the moon pool can not be reached at sea to fix any problems. These prevent the most common ones from occurring at minimal cost. UHMW is it’s own bearing. Axel is a simple bolt with Nylock nut. Roller spacing should be smaller than natural slack bending radius of the cable or rope.**