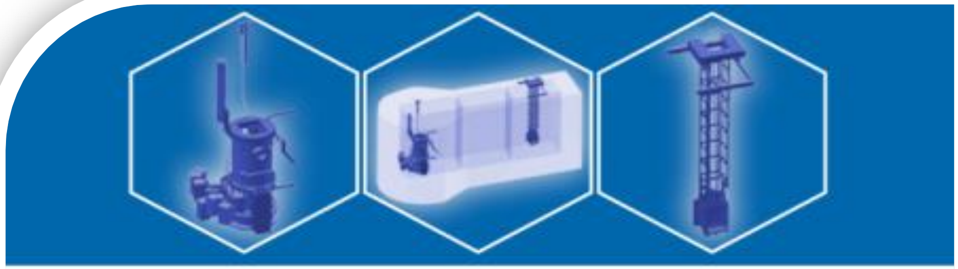
Workshop on

"Current and Emerging Methods for Optimising Safety and Efficiency in Nuclear Decommissioning"

Sarpsborg / Norway / 2017



SAFE DISMANTLING OF THE SVAFO RESEARCH REACTORS R2 & R2-0 IN SWEDEN

Dirk Schneider
<u>Hans-Uwe Arnold</u>

Back End Germany
Reactor D&D AREVA
Paul-Gossen-Str. 100
D - 91058 Erlangen

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SVAFO R2 Dismantling Content

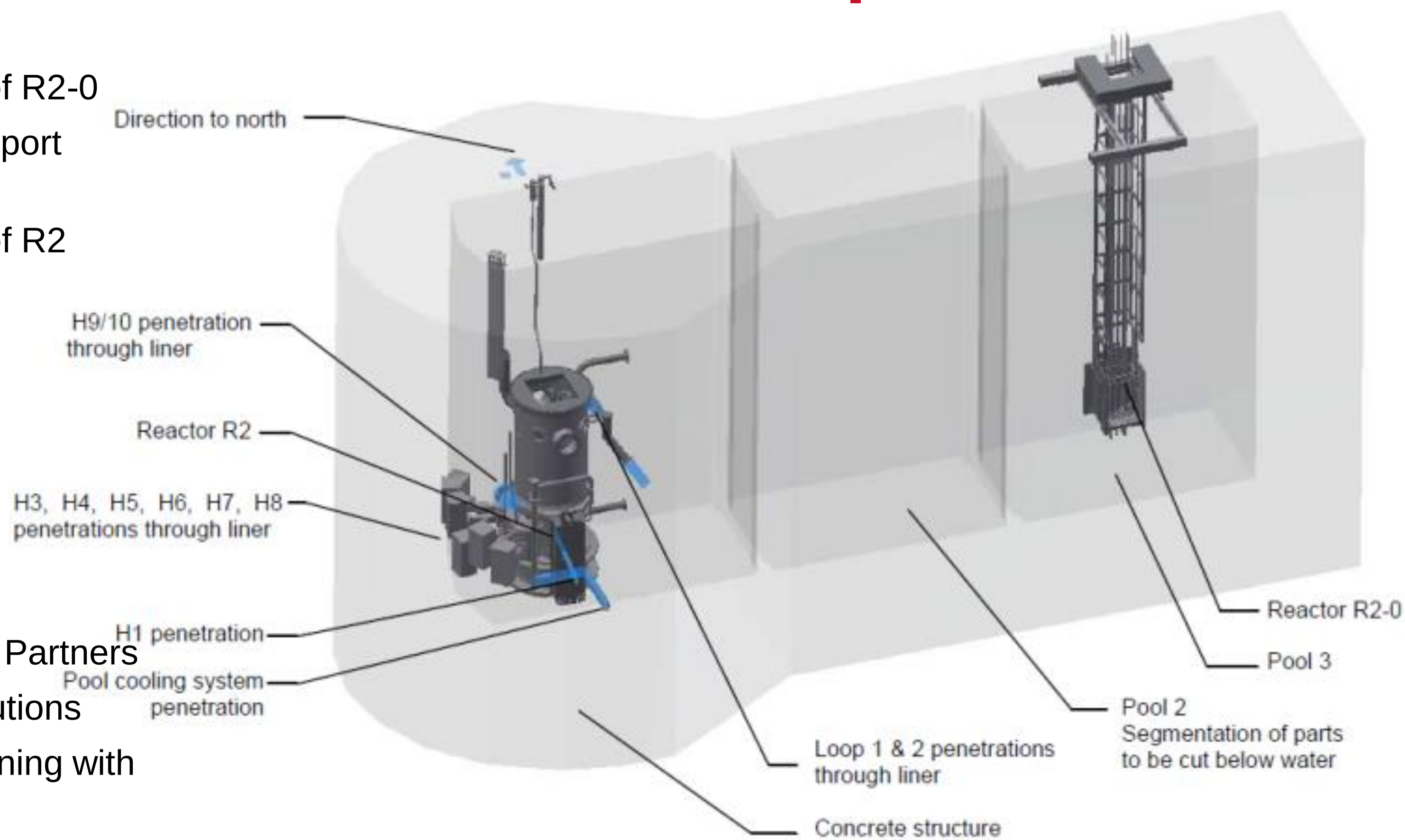
- Historical background
- Scope of Work
- Radiological Characterization
- Waste Routes
- Planned Sequence
- Safe Working Area
- Safe Dismantling
- (Un-) expected Challenges
- Preliminary vs. Final Packing Plan
- Results & Lessons Learned

SVAFO R2 Dismantling Historical background

- AB Atomenergi ordered the facility by Allis-Chalmers (USA)
- Time of operation:1960 to 2005
- Three sister facilities were built; whereof two facilities are still in operation: Safari (RSA) and Petten (NL)
- R2 and R2-0 reactors are in a three-part pond (150m³)
  - R2: 30MW, upgrade in 1969: 50MW
  - R2-0: 1MW
- Purpose: neutron experiments, material behavior
  - Test of fuel elements under BWR/PWR conditions
  - Isotope production for medical / industrial applications
  - BNCT radiotherapy
- 2010 Nuclear license transferred from Studsvik to SVAFO
- 2012 SVAFO R2 dismantling project started
- 2014 Decommissioning plan etc. approved by SSM
- 2014 Contract for dismantling and packing of the reactors (June)
- 2015 Completion. 3 pools were cleared from reactors R2-0, R2 and surroundings

SVAFO R2 Dismantling
Scope of work

- Phase 1
  - Dismantling / cutting of R2-0
  - Removal of all R2 support equipment
  - Dismantling / cutting of R2
  - Emptying of pools
  - Packaging, transport, documentation



- Project features
  - Experienced Swedish Partners
  - Reliable technical solutions
  - Combined FAT & Training with customer

Combining AREVA's expertise in D&D with the knowledge of the former operators and with experienced Swedish on-site team securing effective performance

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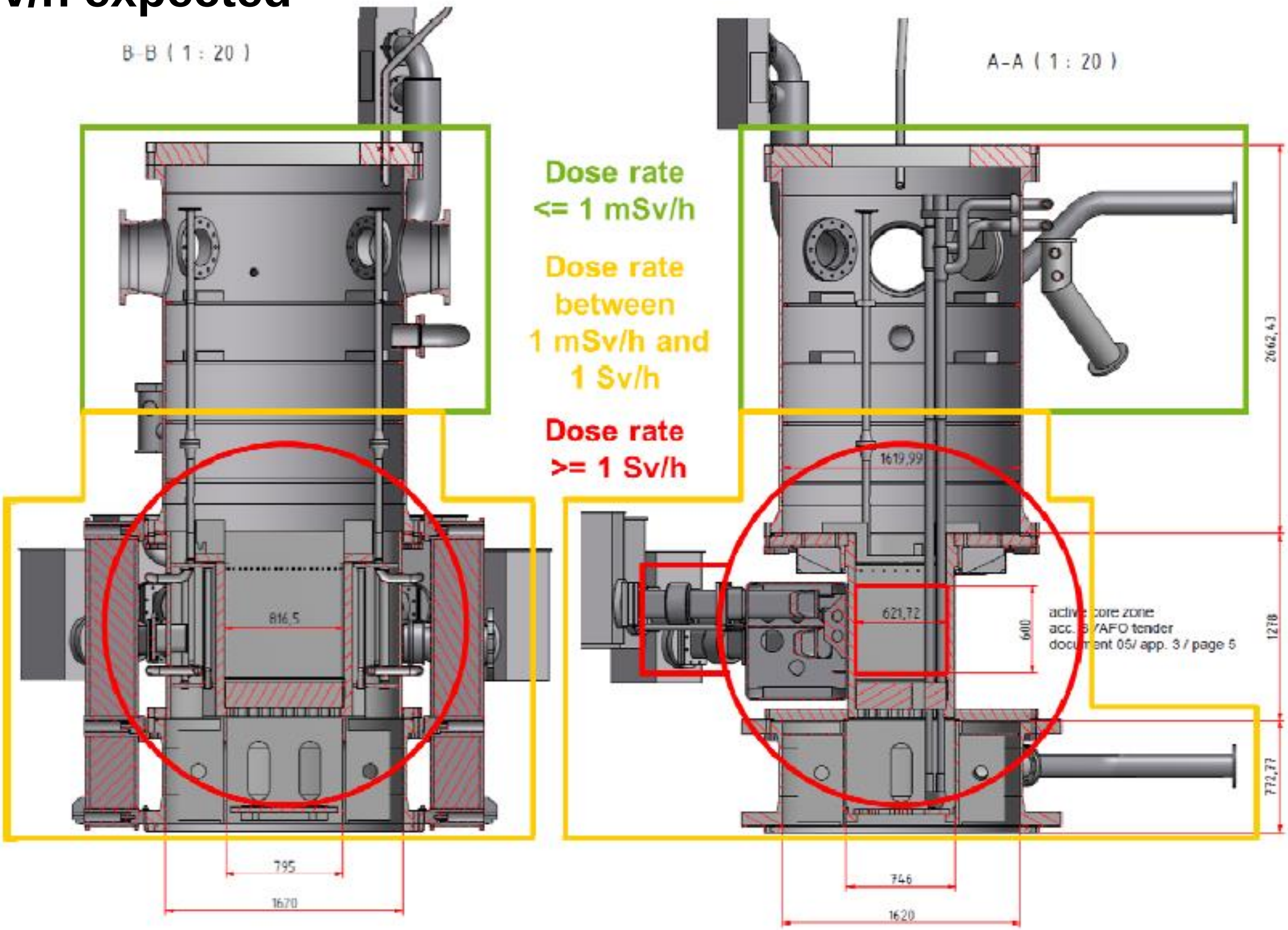
SVAFO R2 Dismantling Radiological Characterization

- up to 100Sv/h expected



SVAFO R2 Dismantling Waste Routes

▶ Waste Route 1

DR: > 2 Sv/h

Baskets for WR 1

- Size: Ø 160mm x 760mm
- Weight: max. 25kg load
- Loading of baskets under water

▶ 7 baskets, 87kg

▶ Waste Route 2

DR: 2 Sv/h … 2 mSv/h

Cassettes for WR 2

- Size: 810mm x 810mm x 800mm
- Weight: max. 3.400kg
- Loading of baskets under water

▶ 24 cassettes, 8.753kg

▶ Waste Route 3

DR: < 2 mSv/h

Handling according to WR 3

- Max. size: 2.5m x 1.0m x 1.0m
- Lifting, rinsing and packing in plastics

▶ 3.561kg

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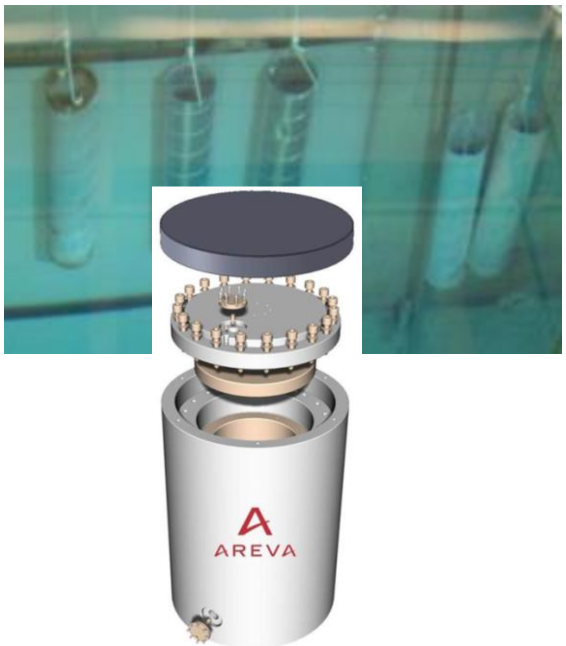
SVAFO R2 Dismantling
Example for optimized Packaging

Waste Route 1	Waste Route 2	Waste Route 3
DR: > 2 Sv/h	DR: 2 Sv/h … 2 mSv/h	DR: < 2 mSv/h



- 1 TN® MW cask

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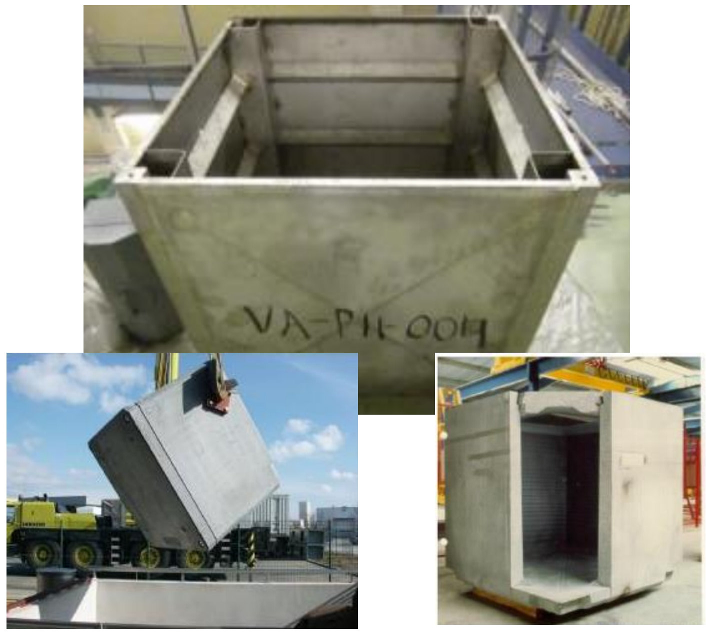
« All in One Solution »



- 6 CBF-KB pack units

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Handling according to WR 3

- Max. size: 2.5m x 1.0m x 1.0m
- Lifting, rinsing and packing in plastics

- 3.561kg

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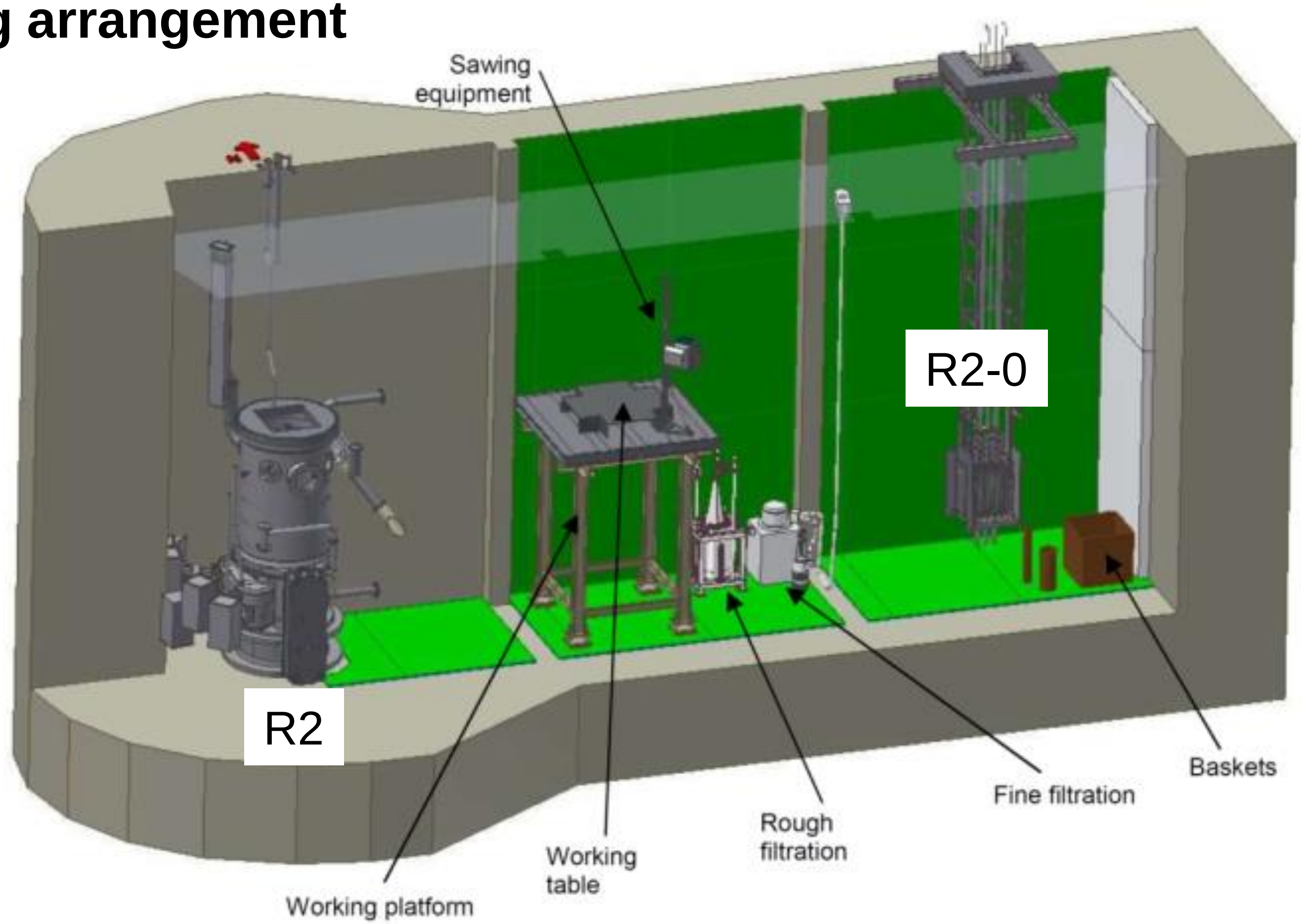
SVAFO R2 Dismantling Planned Sequence

- Create a safe working arrangement
  - Wall protection
  - Bottom protection
  - Working table
- Dismantling of R2-0
- Dismantling of R2



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SVAFO R2 Dismantling Planned Sequence

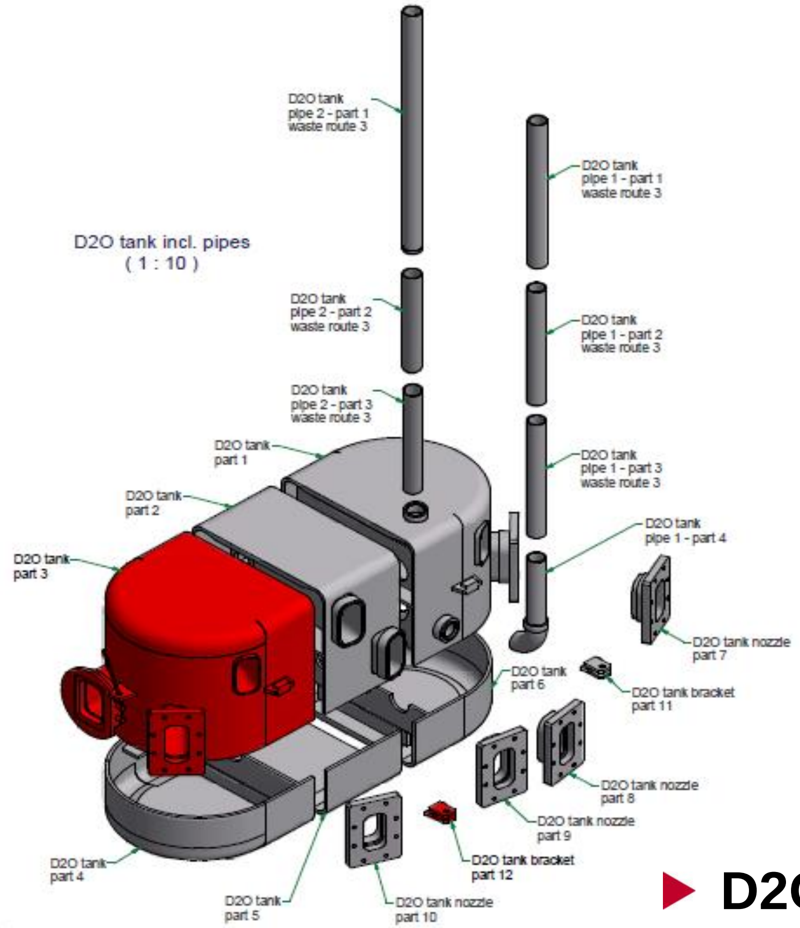
- **Dismantling of R2**

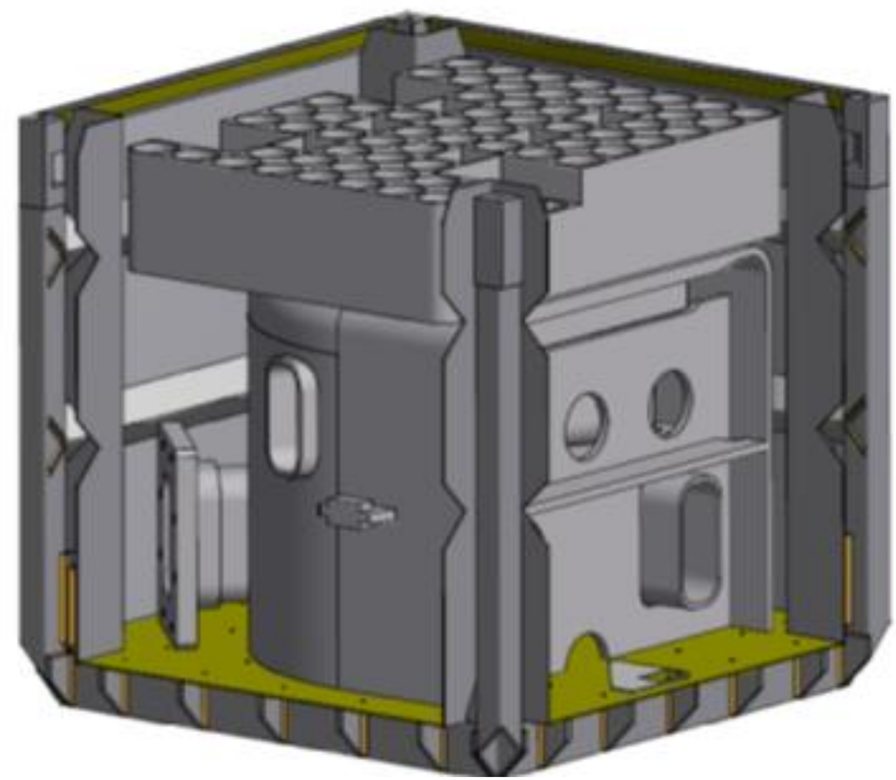
SVAFO R2 Dismantling
Planned Sequence

- **Dismantling of R2**

SVAFO R2 Dismantling
Planned Sequence

▶ Dismantling of R2

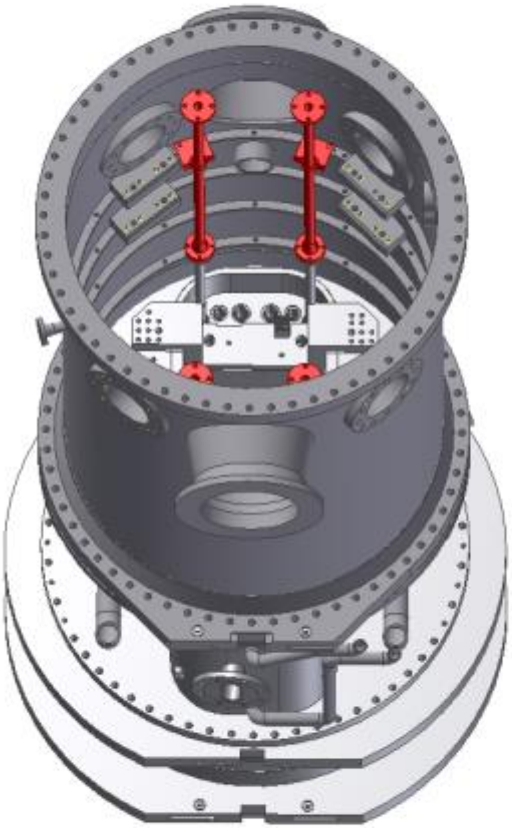


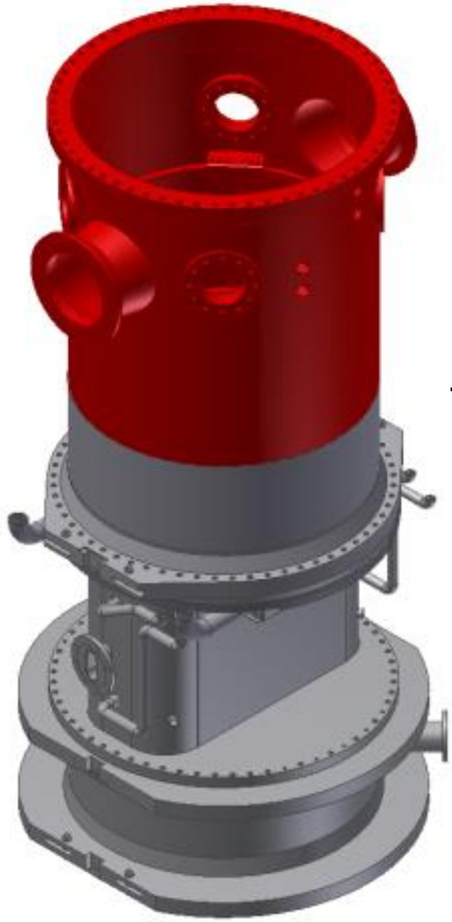


▶ D2O tank

SVAFO R2 Dismantling Planned Sequence

- **Dismantling of R2**

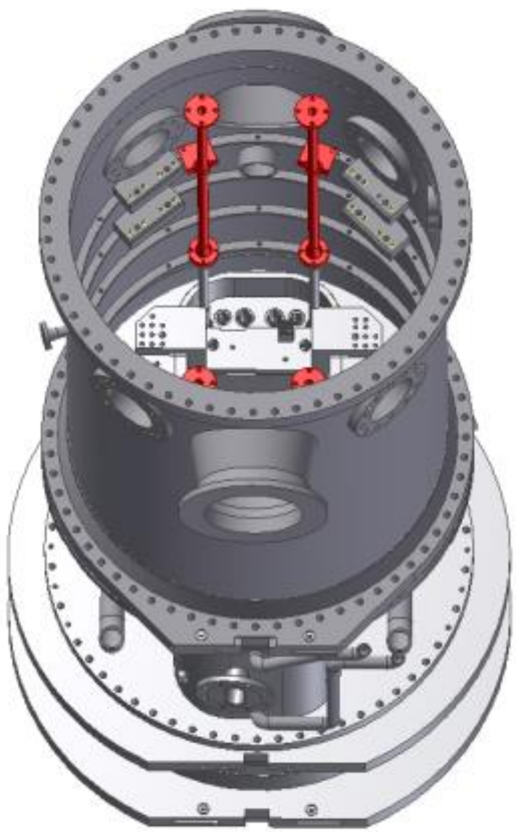


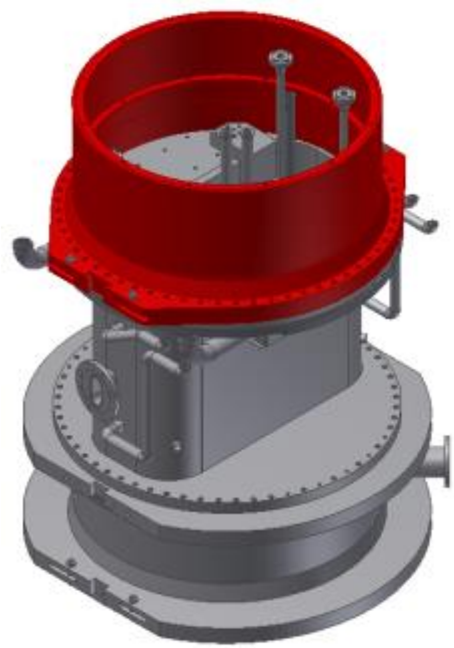


Transition area

SVAFO R2 Dismantling Planned Sequence

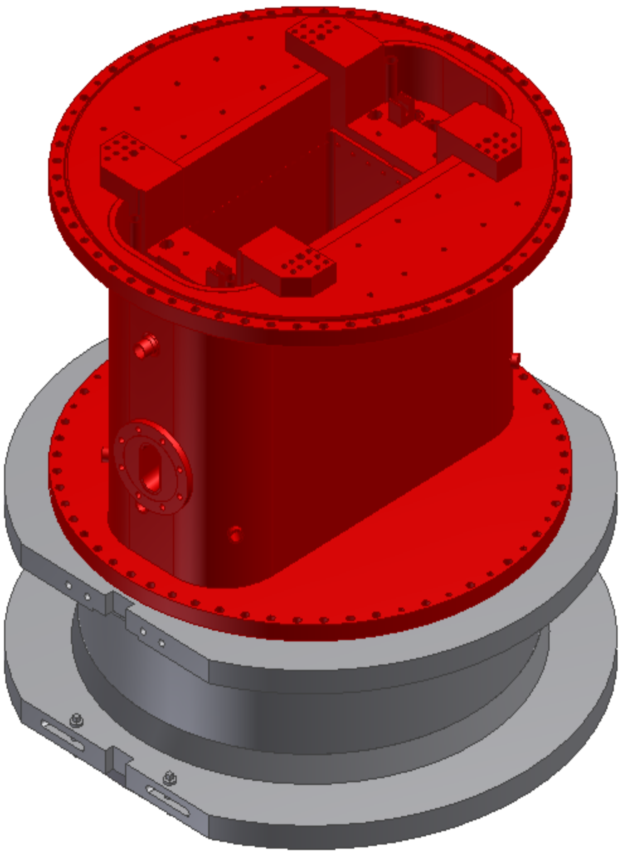
- **Dismantling of R2**





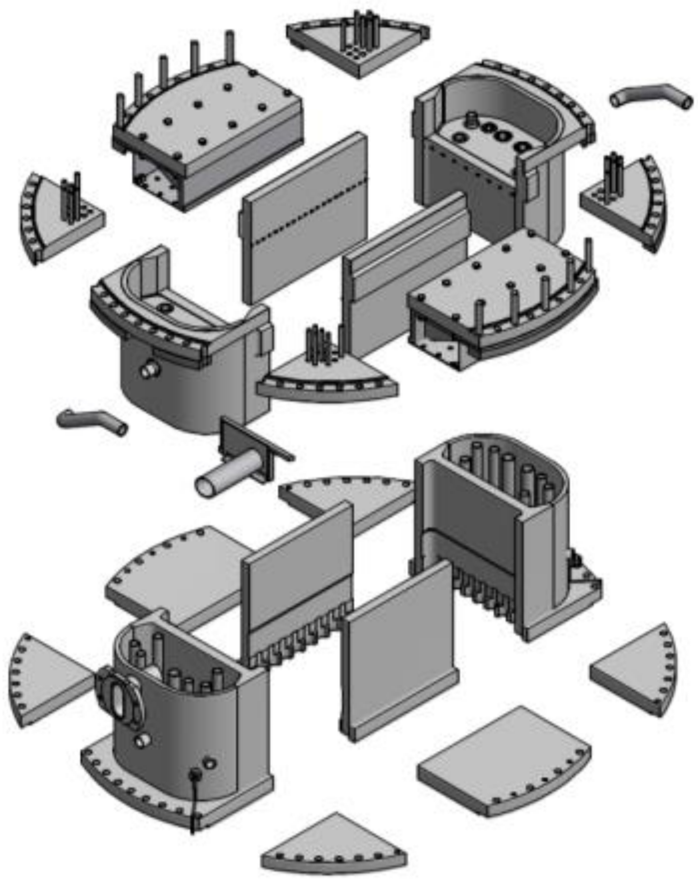
SVAFO R2 Dismantling
Planned Sequence

▶ **Dismantling of R2**



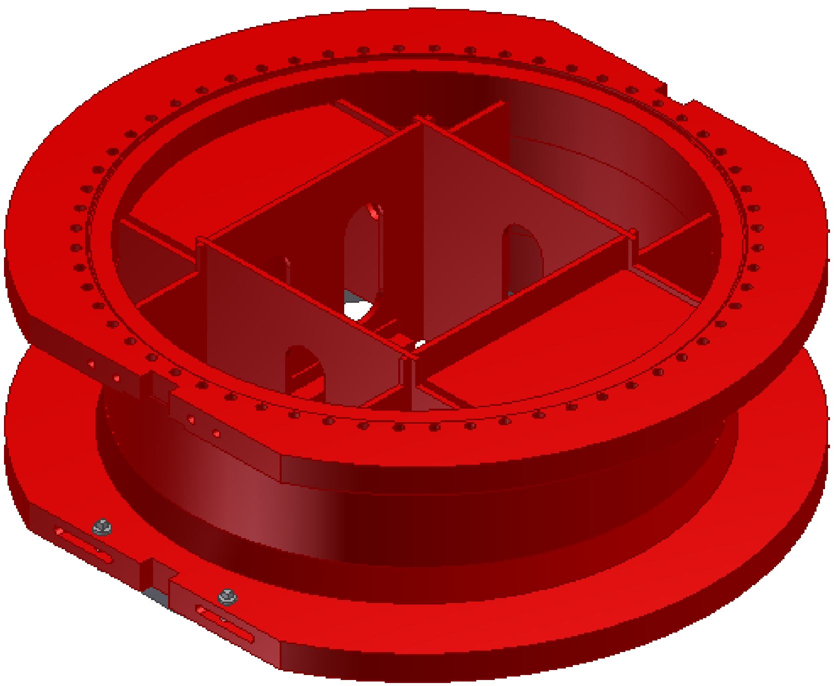
Core box

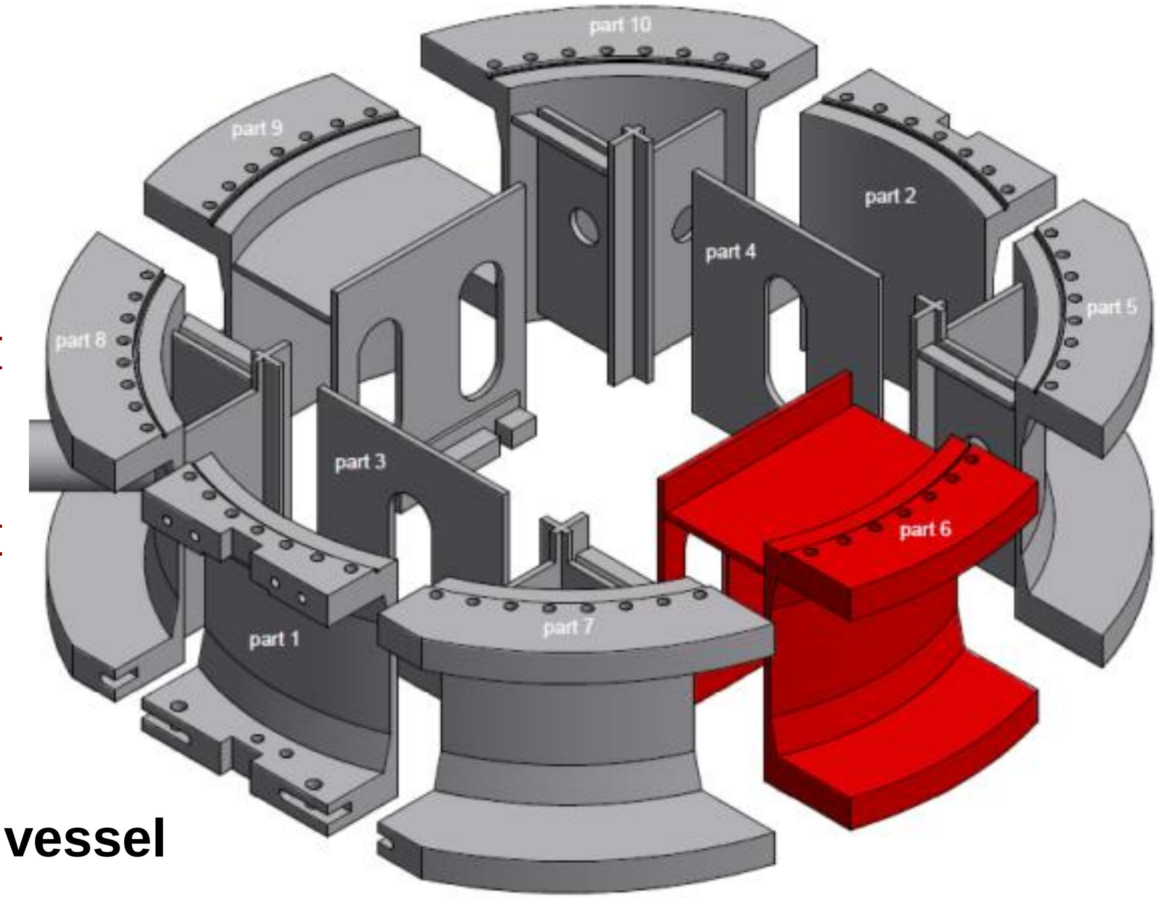
Lower vessel



SVAFO R2 Dismantling Planned Sequence

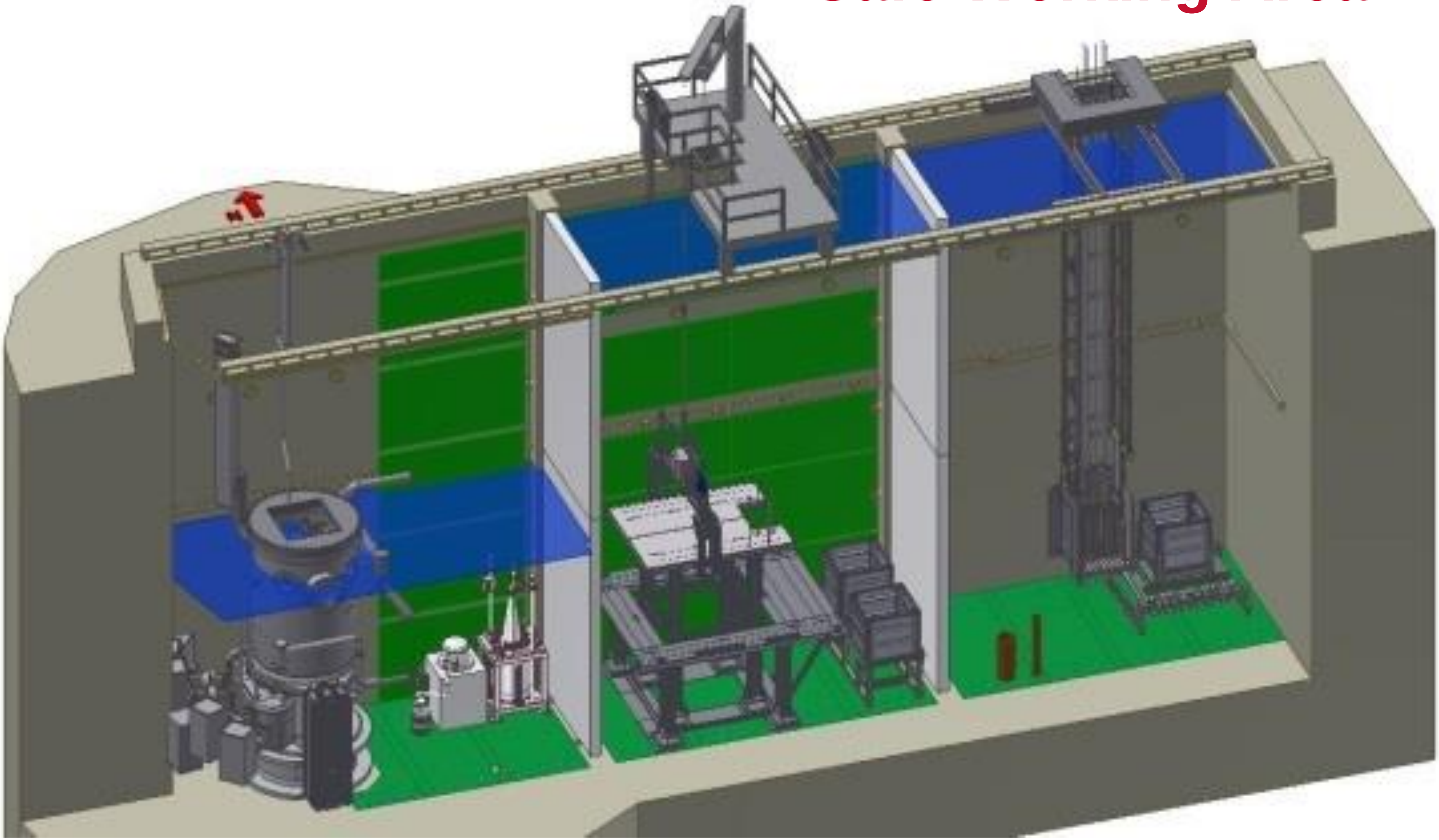
- **Dismantling of R2**





Lower vessel

SVAFO R2 Dismantling
Safe Working Area



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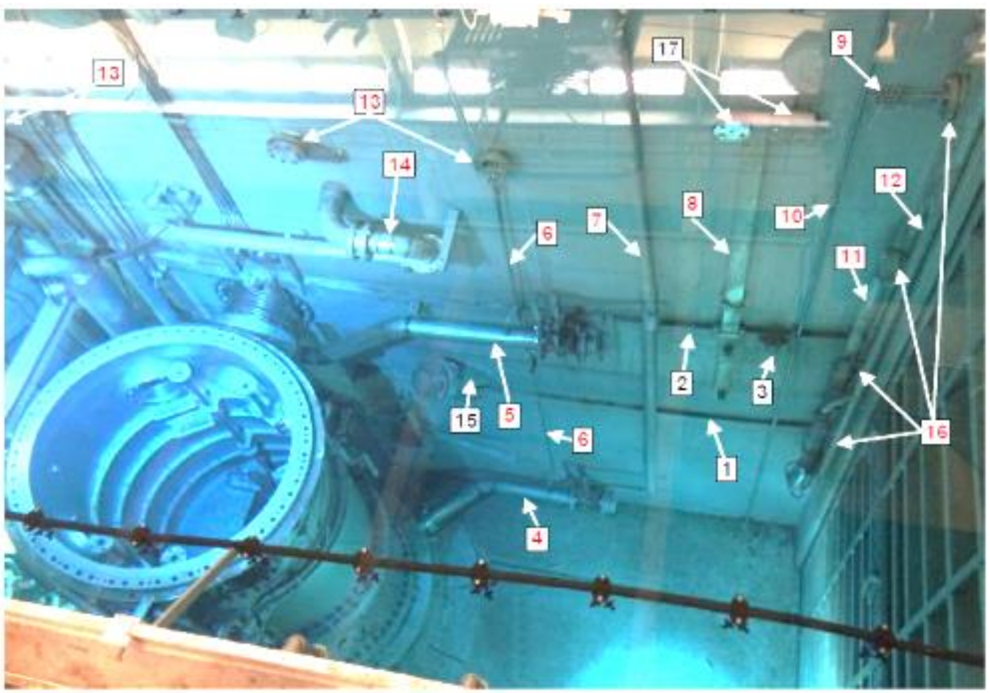
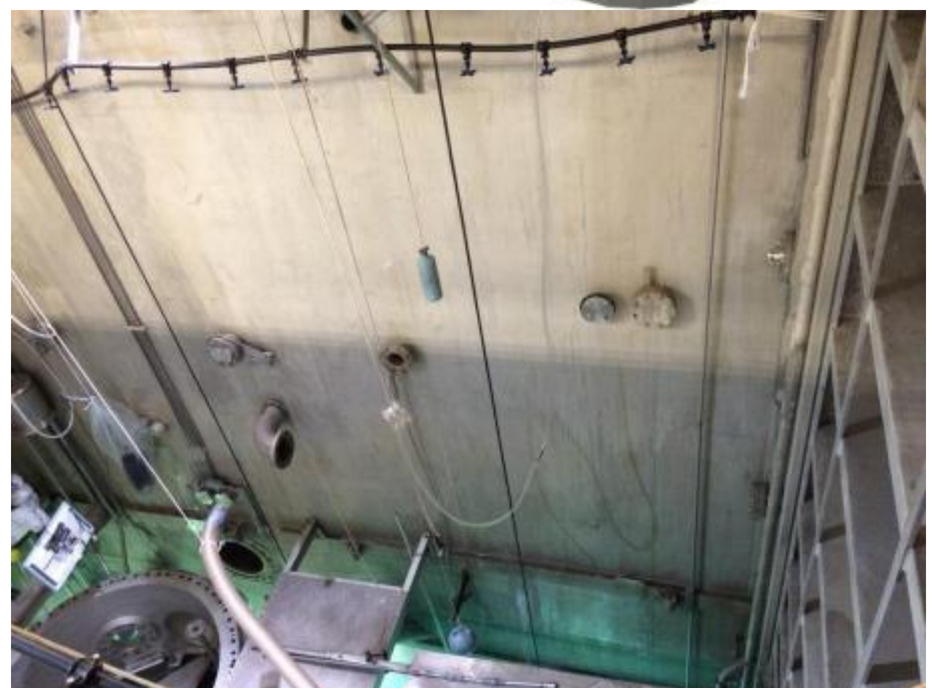
SVAFO R2 Dismantling
Safe Working Area

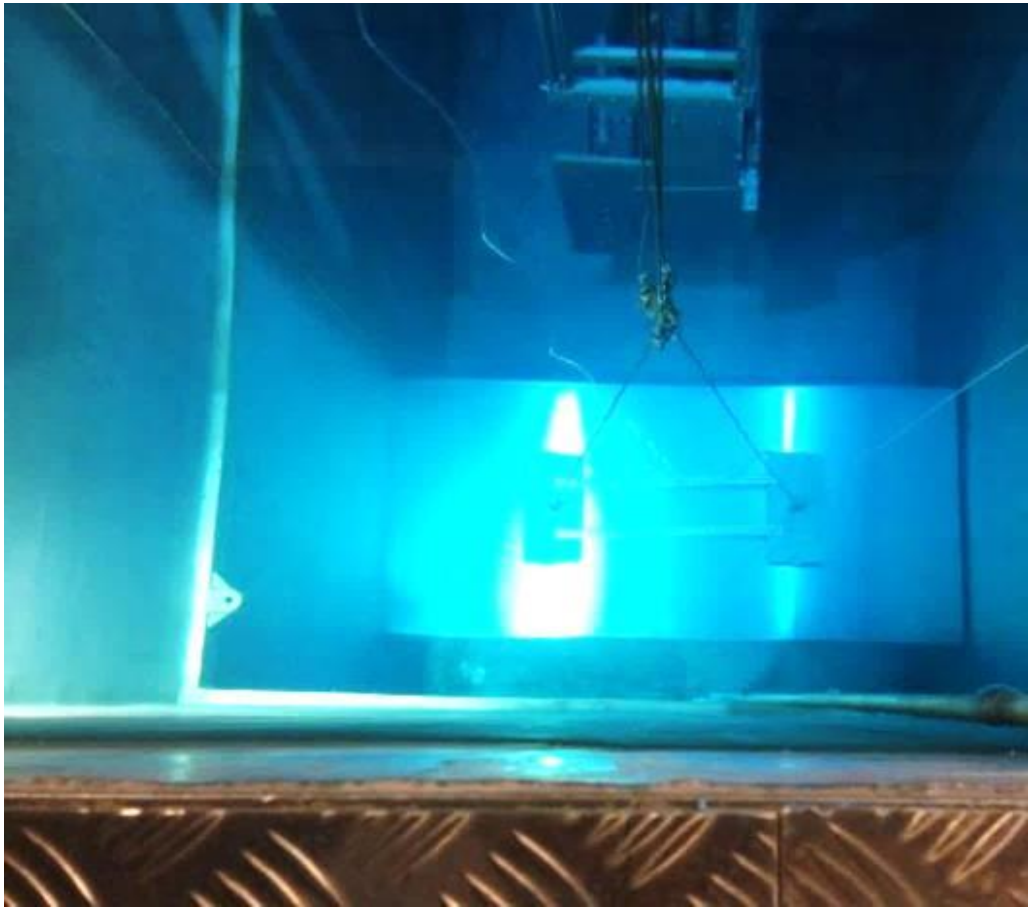
- **Removal of R2 reactor connections to the bioshield, close wall penetrations, unbolt flange connections in Pool 1**

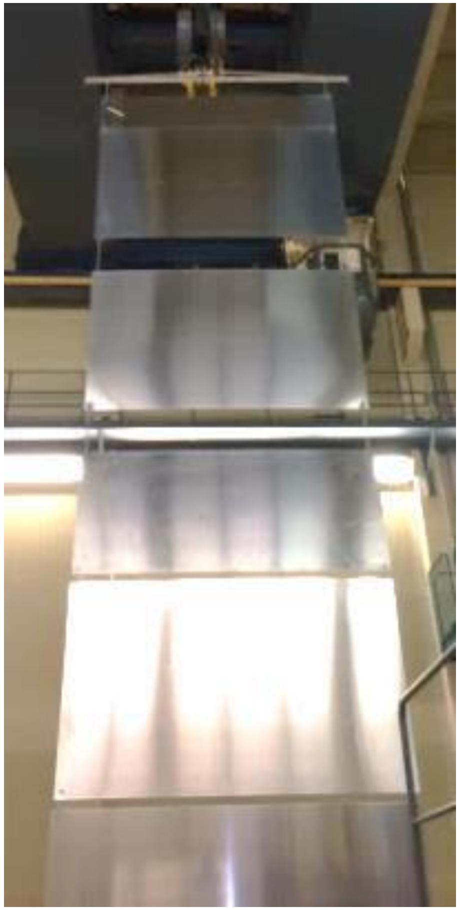




SVAFO R2 Dismantling
Safe Working Area

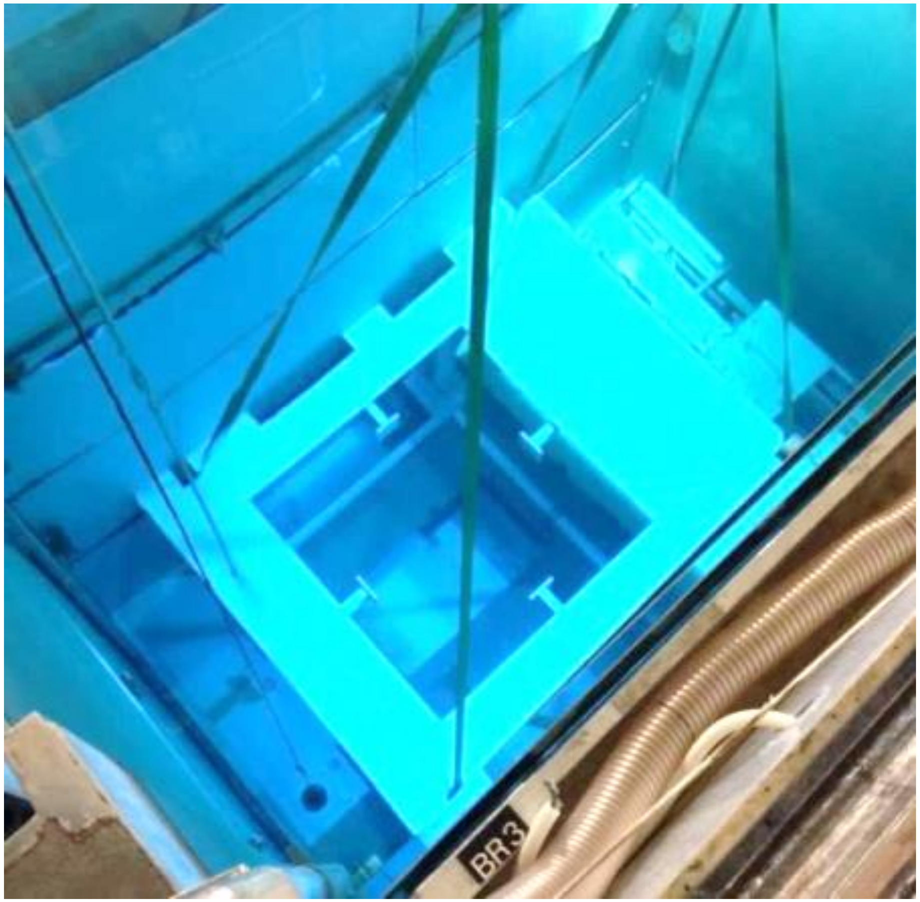
- **Protection of pool bottom & walls avoids leakages**

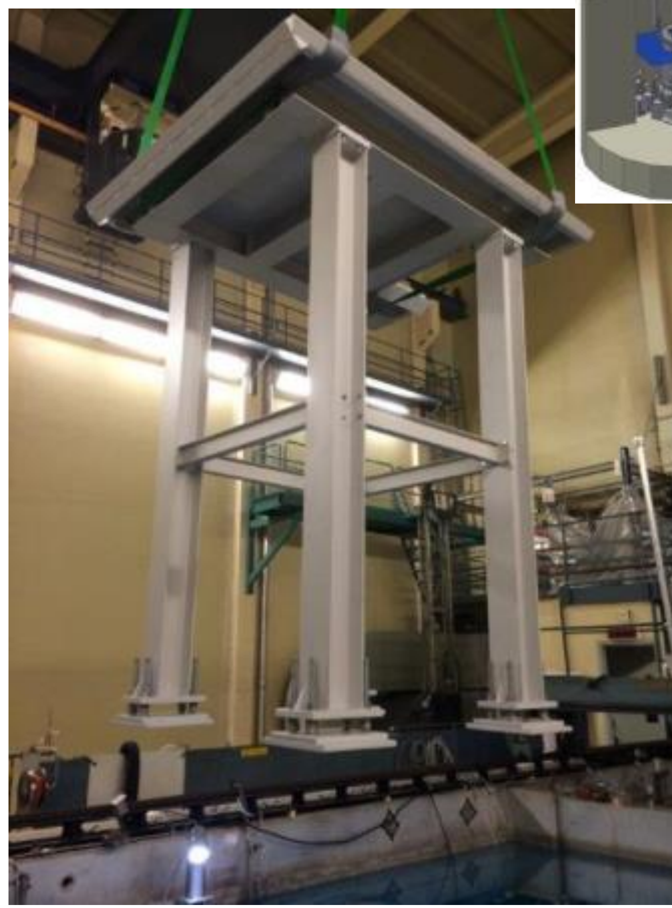




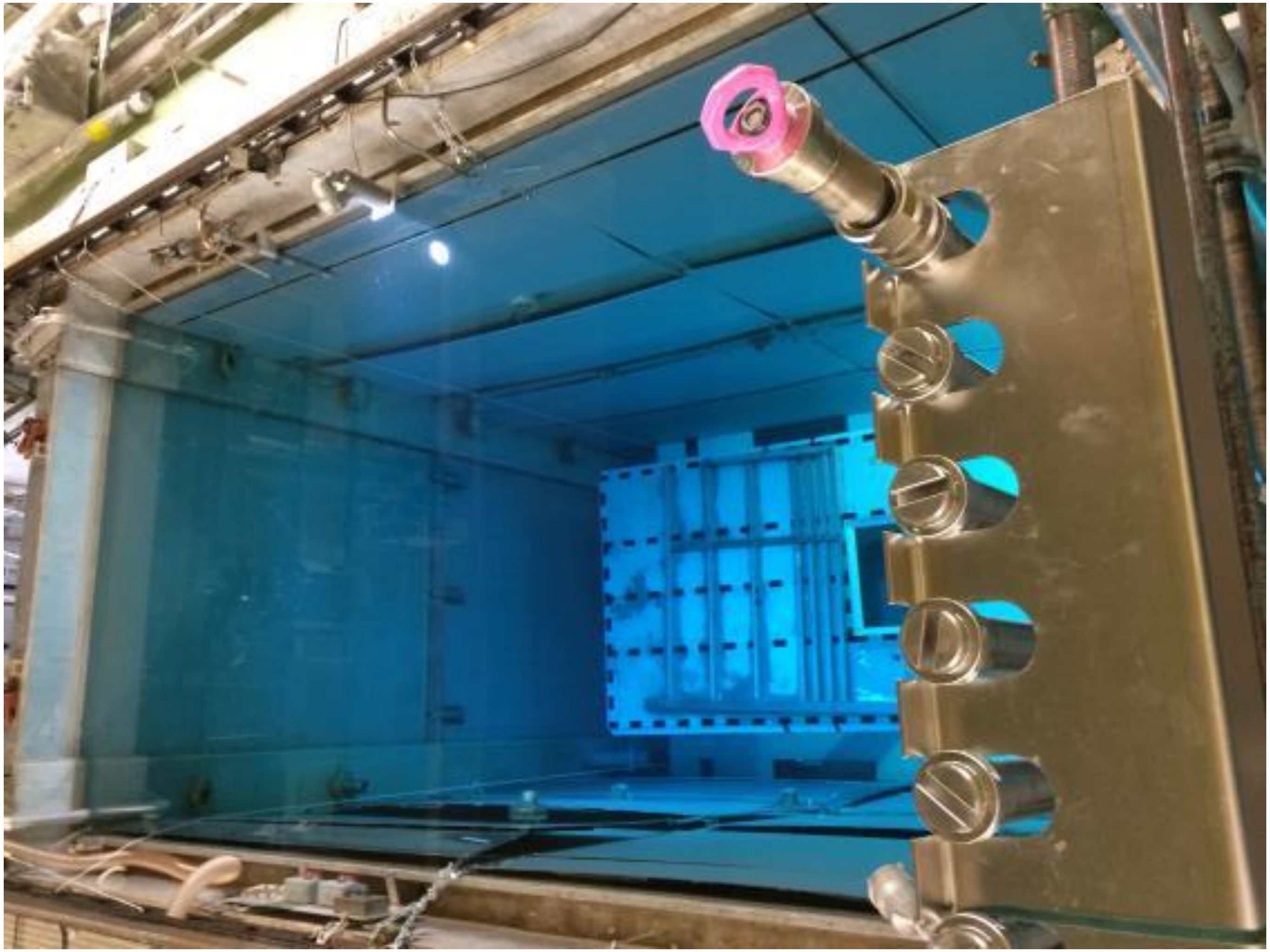
SVAFO R2 Dismantling
Safe Working Area

- **Safe working distance = table inside platform**





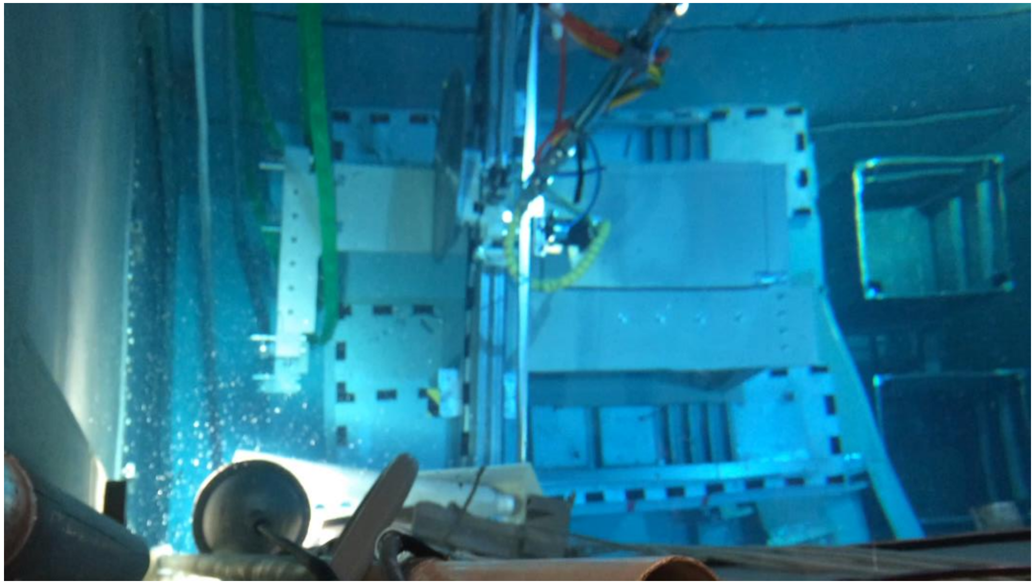
SVAFO R2 Dismantling
Safe Working Area

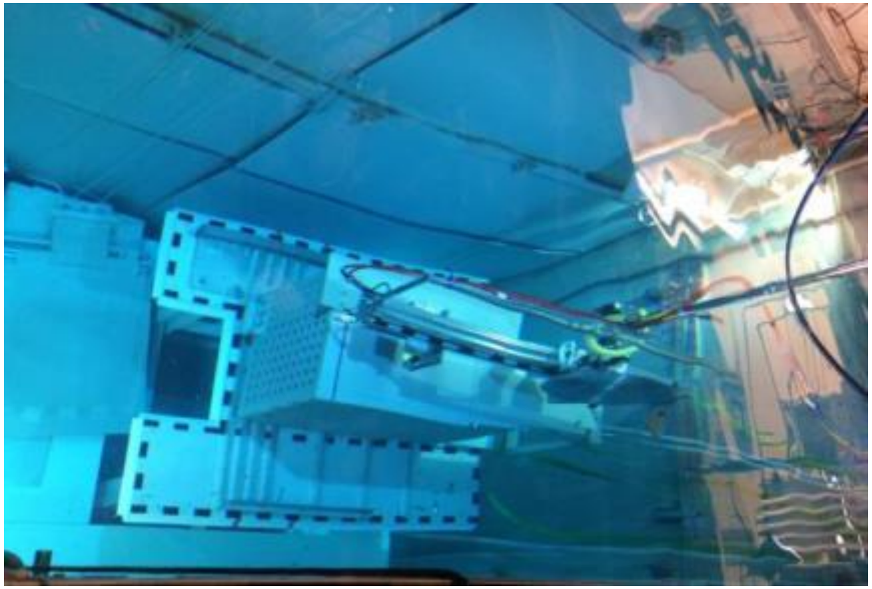


- **Platform and working table in Pool 2**
  - **Handling rods**
  - **Rack for safe storage**

SVAFO R2 Dismantling
Safe Dismantling

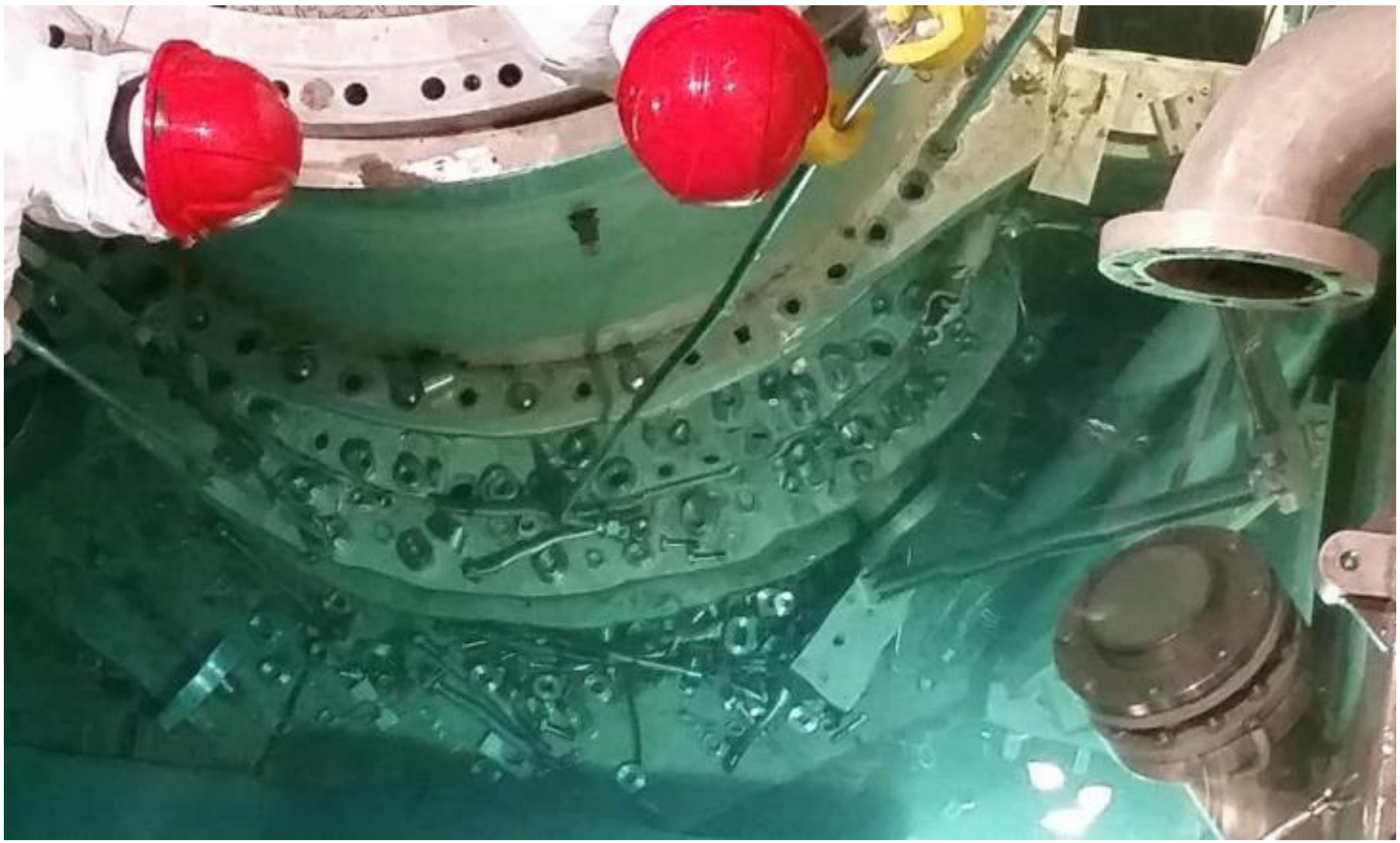
- **Cutting of R2-0 in Pool 2**

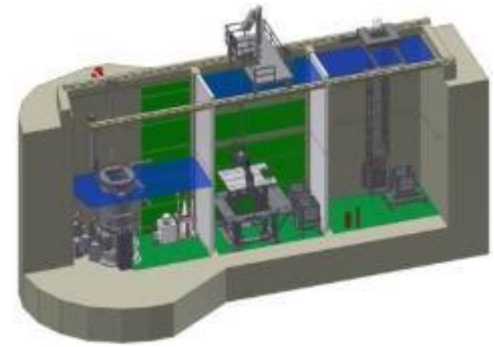




SVAFO R2 Dismantling
Safe Dismantling

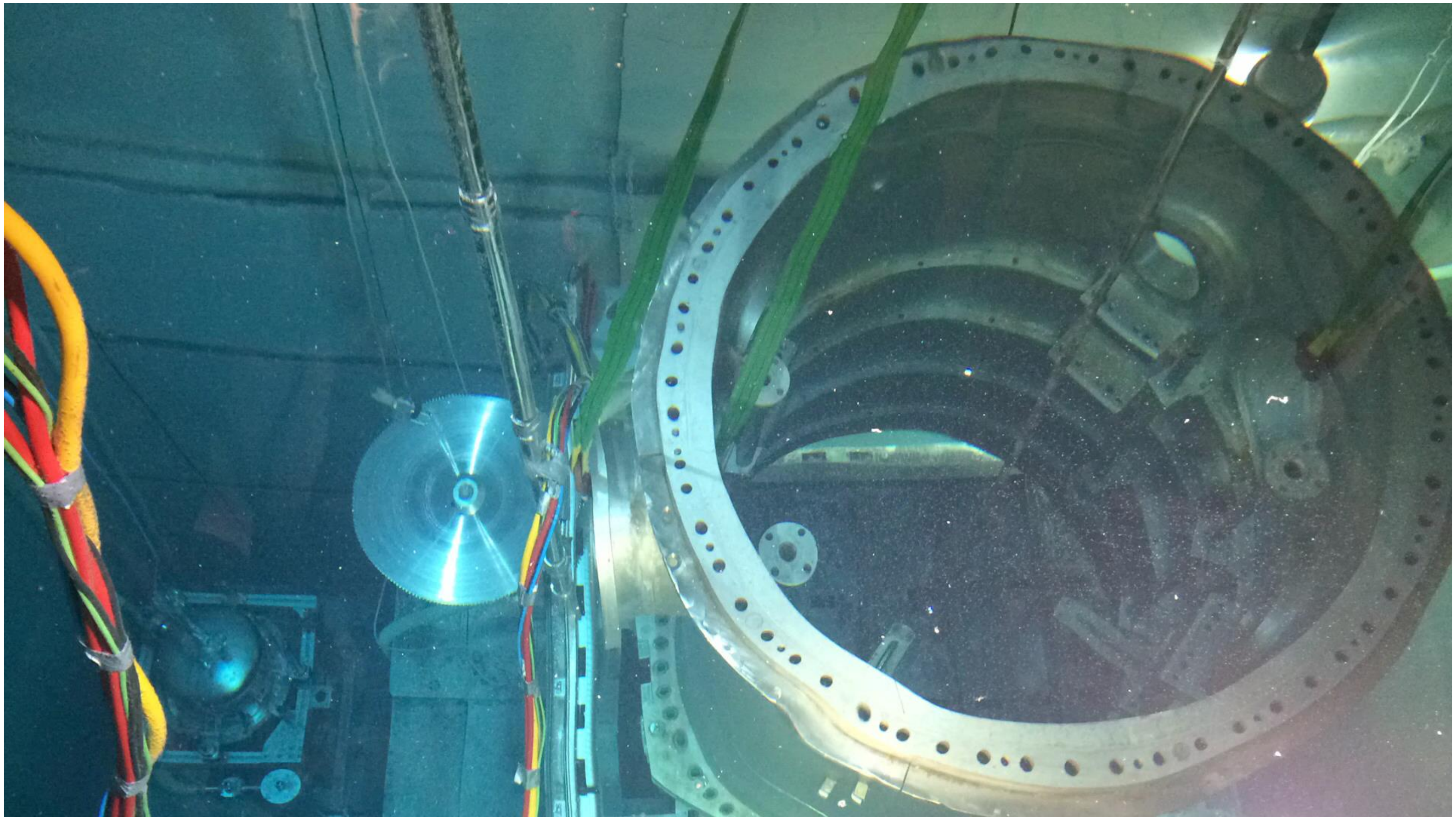
- **Dismounting work in Pool 1**



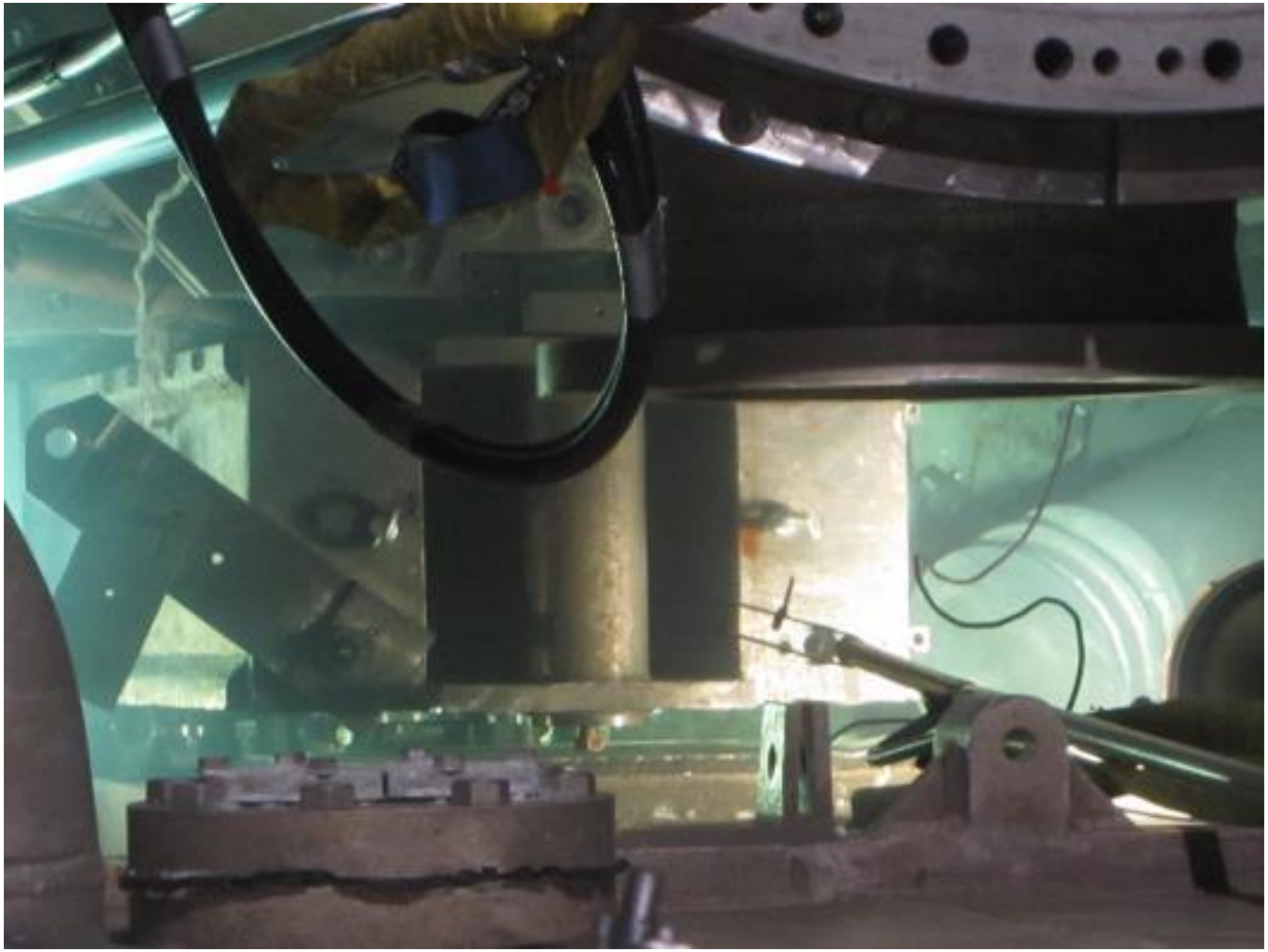


SVAFO R2 Dismantling
Safe Dismantling

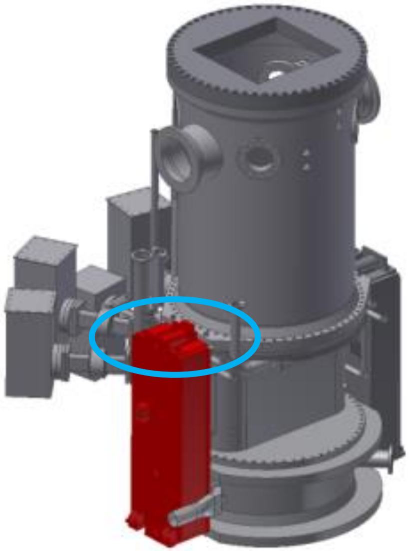
▶ Cutting of Upper Vessel



SVAFO R2 Dismantling Challenges



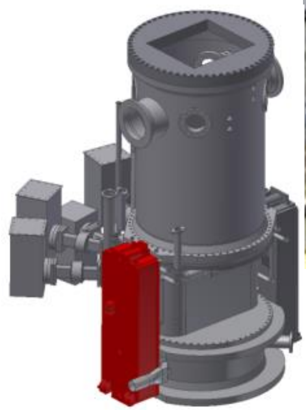
- Dismounting work in Pool 1
  - confined working conditions, 73mm “free” space
  - Sensitive handling essential (Al liner)



SVAFO R2 Dismantling Challenges

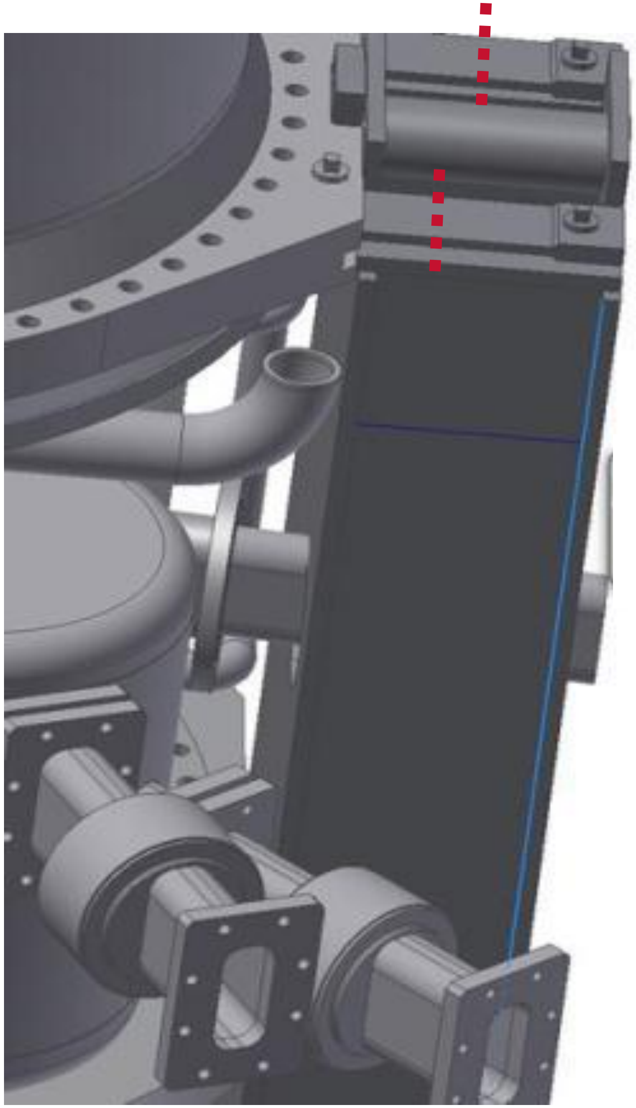
Safety Measure

- **Self-construction of a pneumatic balancer for sensitive lifting tasks**
- **Recognizes stuck or jammed load:**
  - no damages
- **Compensates the weight of the component:**
  - gives feeling while handling



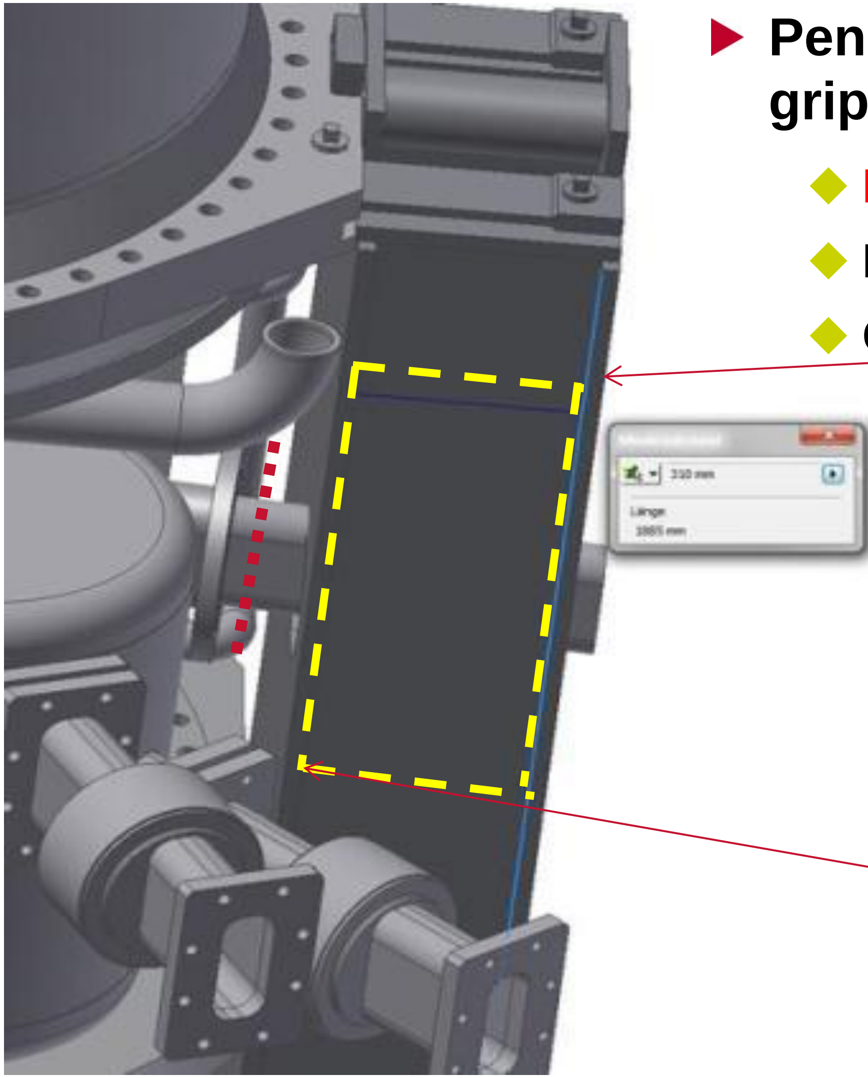
SVAFO R2 Dismantling Challenges

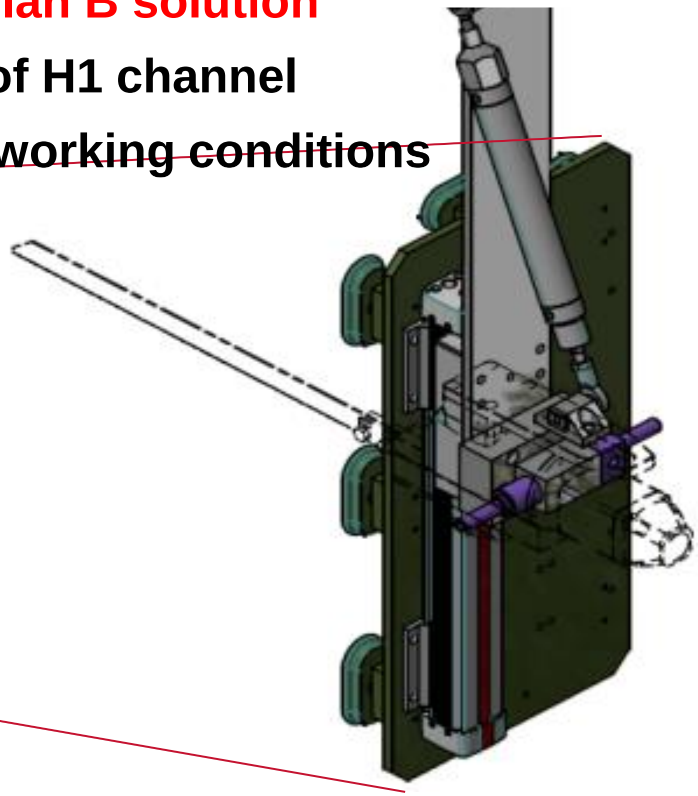
- **Pendular hacksaw combined with shear**
  - **Application of Plan B solution**
  - **Removal of stainless restraint structure**
  - **Components with mechanical stress**



SVAFO R2 Dismantling Challenges

- **Pendular hacksaw combined with vacuum gripper plate**
  - **Planned Plan B solution**
  - **Removal of H1 channel**
  - **Confined working conditions**

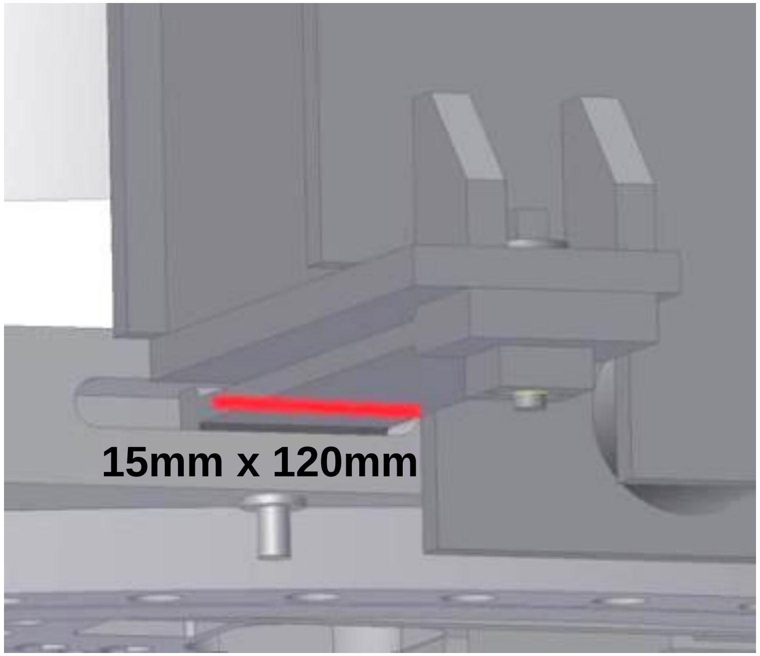


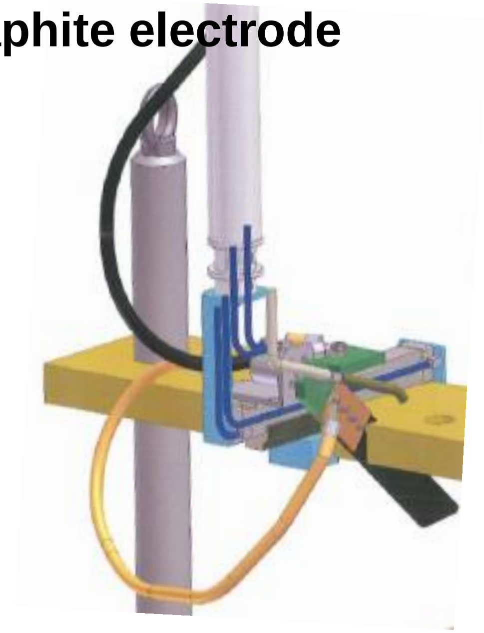


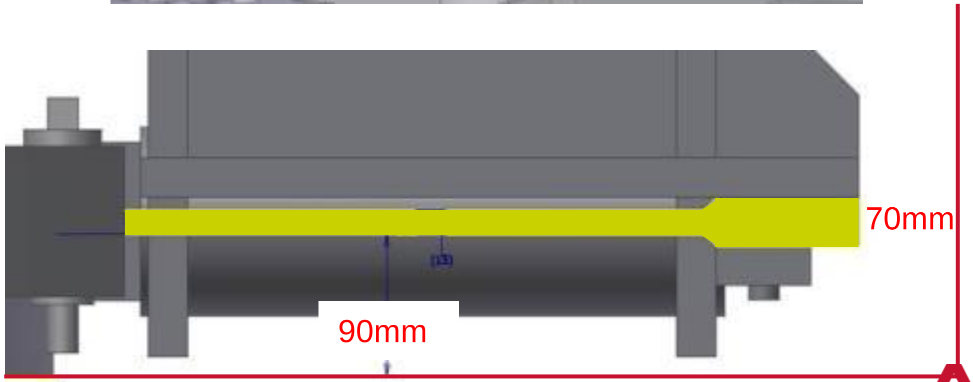
SVAFO R2 Dismantling Challenges

Intervention tool

- **Planned Plan C solution**
- **Contact Arc Metal Cutting (CAMC)**
- **Confined accessibility:90mm from bottom, 70mm from wall liner**
- **Only solution: cut through lamella with graphite electrode**







SVAFO R2 Dismantling Challenges

- **Inspection of as-build situation**
  - **Rod handled camera (12m long)**
  - **Cardanic wrench socket prolongation joined TV controlled**

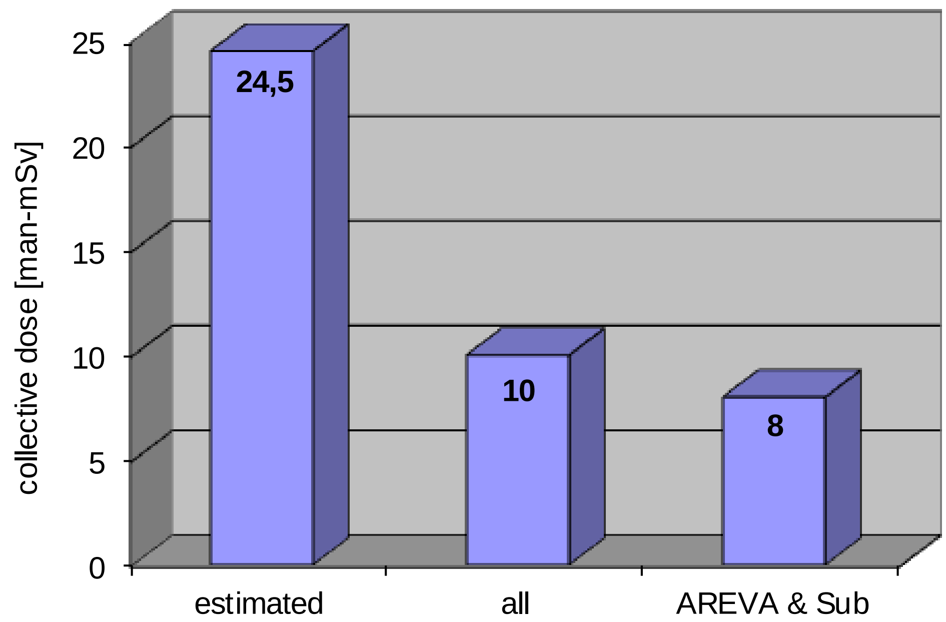
SVAFO R2 Dismantling Results

R2-0 & R2	masses
Aluminium	5.400kg
Stainless steel	6.000kg
Peripheral equipment	1.000kg
total	12.400kg

reactor	pieces
R2-0	88
R2	257
total	345

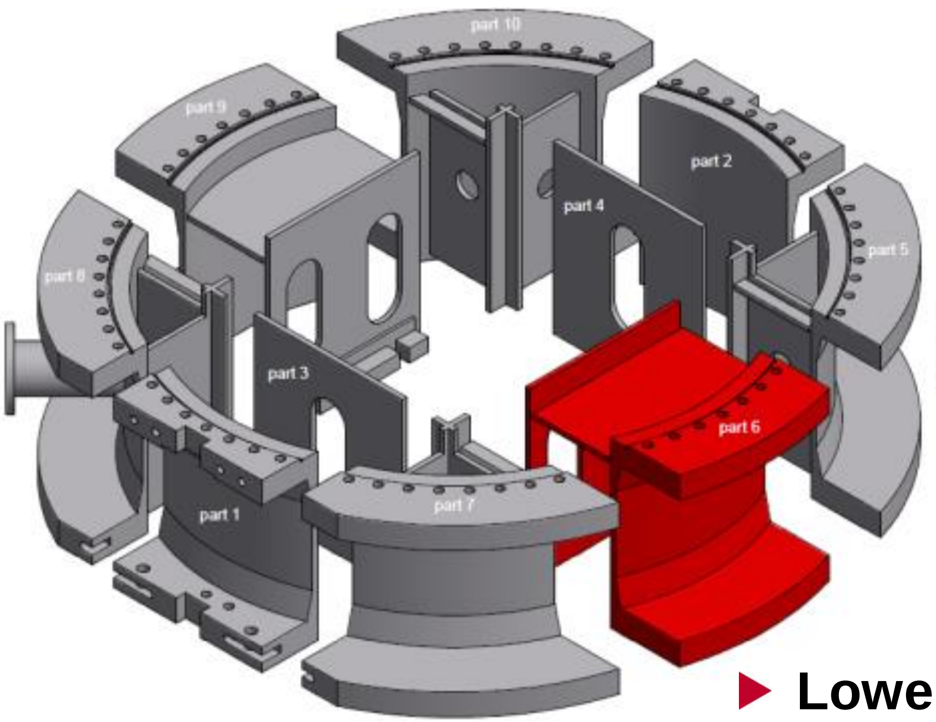
WR	→	WR	delta
WR1	→	WR2	270kg
WR2	→	WR3	808kg
WR2	→	WR1	47kg
		total	1.125kg

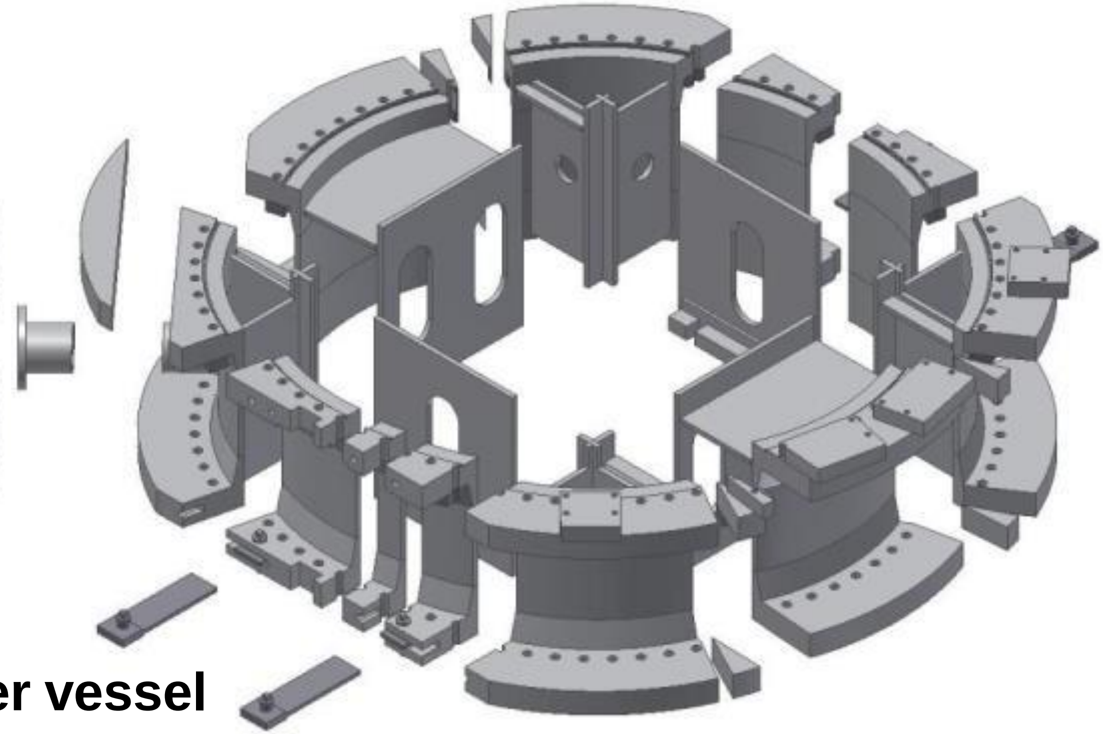
- **No accidents**
- **Personnel dose below estimation**
- **Huge amount of small pieces**
  - **Container with bigger volume**



SVAFO R2 Dismantling Results

- Originally planned layout (10pc.)
- Realized layout (28pc.)

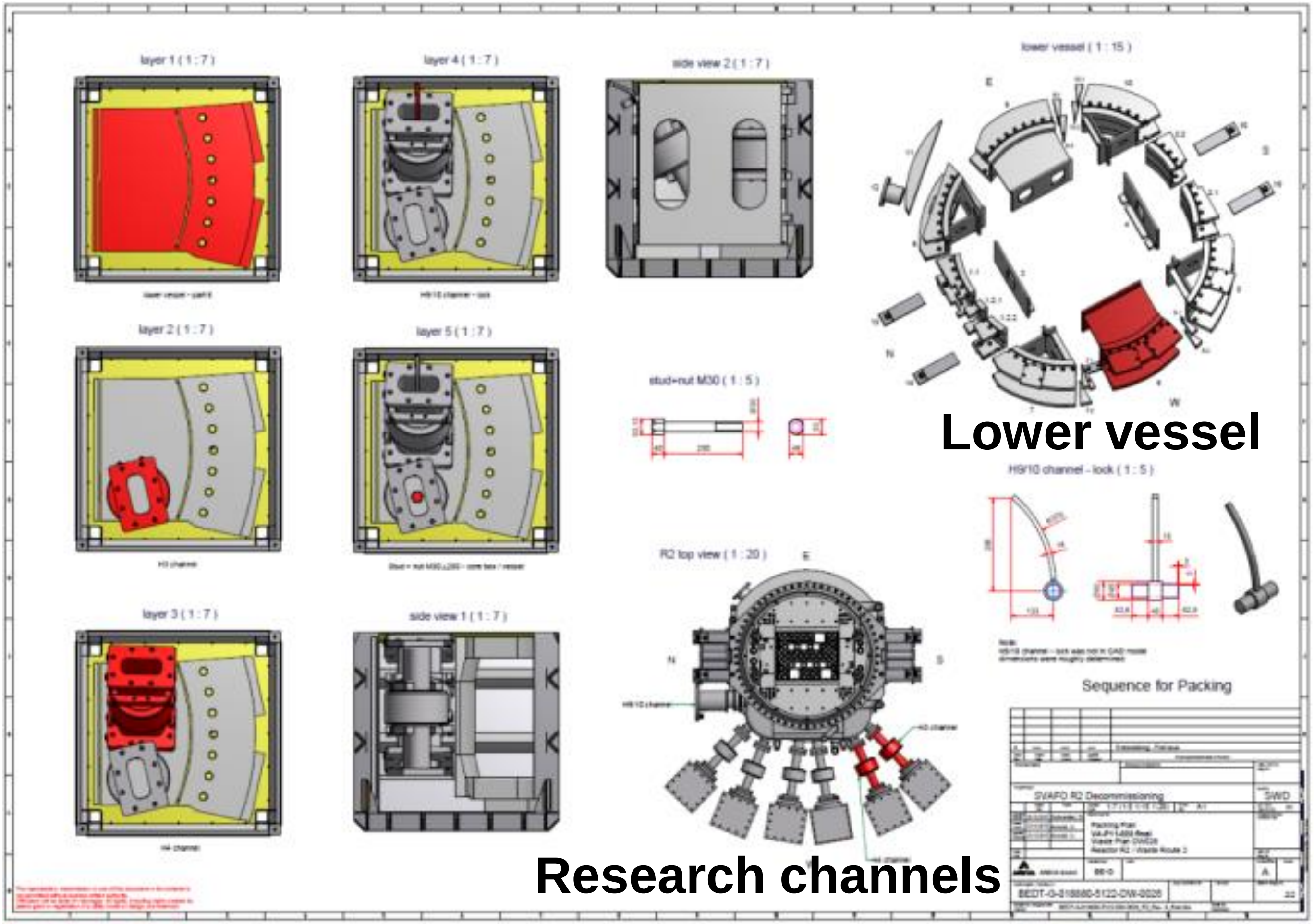




▶ Lower vessel

▶ **No detailed Preliminary Packing Plan necessary, one final only!**

SVAFO R2 Dismantling Results



- No detailed Preliminary Packing Plan necessary, one final only!

SVAFO R2 Dismantling Lessons Learned

- Build a “Decommissioning Team”
- Prepare a thorough “Radiological Characterization”
- Replace the legacy operation systems with new, flexible “Decommissioning Support Systems”
- Close communication to the Back Office
- Use the wide AREVA experiences from D&D of PWR and BWR, which are also valid for RTR.
- Use AREVA services all along the D&D project avoiding interferences in the chain:
  - scenario definition - characterization - sampling - cutting - sorting - conditioning - cask supply - logistic

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More information:

Hans-Uwe Arnold
Phone: +49 9131 900 91823
Mobile: +49 160 88 78 500
Mail: uwe.arnold@areva.com

AREVA GmbH
Back End Germany
Reactor D&D AREVA
Paul-Gossen-Str. 100
D - 91058 Erlangen

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