

## VIRERO

### Virtual REMote RObotized System for handling dangerous material

Framatome's modular and customizable VIRERO system allows for various assisted modes of safe, remote and cost-effective waste manipulation.

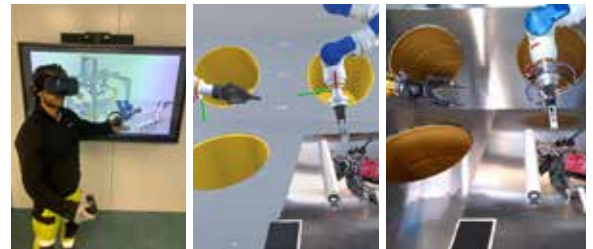
#### Challenge

Manipulation and storage of dangerous material can be costly and labor intensive. The tasks are very demanding, potentially exposing operators to contamination as well as possible harm from cutting tools, high-speed debris, high-pressure jets, caustic agents and more. If the list of processed material content is incomplete, risk assessment can be very complex. Waste that is not sorted by size, materials and potential danger can be inefficiently stored at a higher price than needed.

#### Solution

Framatome's VIRERO system offers a full range of effective, customizable and reliable technologies for safe and cost-efficient manipulation of dangerous material. The system is based on robotic manipulators optimized to accommodate various handling processes (scanning, drying, cutting, brushing, drilling, wiping, etc.) with high dexterity. Thanks to advanced control algorithms, the VIRERO system can be operated in three different modes: fully autonomous; assisted manipulation (point and click); or fully manual virtual reality teleoperation.

Designed to fit inside a 20-foot container, the system is transportable, can be used on-site and is customizable to your process requirements. An ideal solution for scanning, handling, processing and sorting dangerous material, the VIRERO system can be operated remotely, improving user safety, optimizing storage space and reducing lead time and costs.

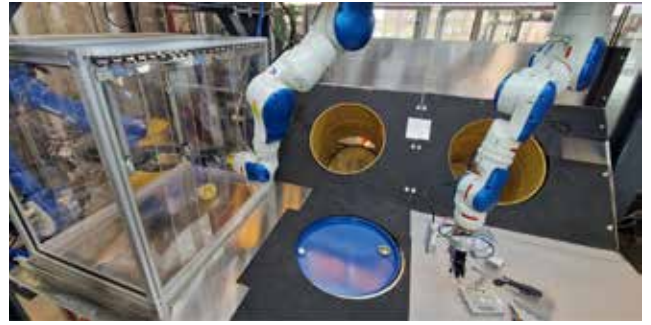


Example of the scene reconstruction with virtual reality technology, augmented view in the control room and an actual picture inside the station.

#### Customer benefits

- Overall **cost optimization** through:
  - **Reduction of storage** space
  - **Reclassification** of previously stored waste
  - **Reduction of risk** to manpower
- Spatial and radiological characterization of waste enabling sorting as well as **documentation and archiving**
- Teleoperation system allows operators to perform tasks at distance from the risk area — from a few meters to thousands of kilometers away, **improving workforce flexibility**
- Transportable, modular and scalable design enabling use in different scenarios, conditions and locations. One VIRERO system can be utilized multiple times at different sites and for various uses

## Example of VIRERO System Use



VIRERO technologies integrated into a 210L waste drum sorting station enabled waste drum opening, drum content archiving and resorting of drum content into low-level and very low-level waste categories, reducing final storage costs.

### Picking:

Extraction of random items from barrels, including entangled or complex shapes

### Scanning:

Separation of waste items on sorting table and application of radioactivity reconstruction (heatmap)

### Operating:

Cutting, processing, dismantling, wiping, sampling

### Documenting:

Documentation and Archiving of waste characteristics

### Final Sorting:

Placement of items in suitable drums, optimizing space

## Technical information

### Key Technologies available:

- Multiple radiation detectors with multiple focal lengths to enable partially resolved assessment of nuclide-specific activity reconstruction
  - Energy-compensated Geiger-Müller detector for use with high-level radioactive waste
  - Modern scintillation detectors for use with intermediate-level radioactive waste
  - High-resolution HPGe detectors for use with low-level radioactive waste
- Unknown, random and unordered object grasping based on reinforcement learning technologies
- Real-time 3D scene reconstruction with ability to add augmented information (weight, size, heatmap, etc.)
- Virtual Reality or screen-based remote teleoperation with ability to dynamically move camera within operation field
- Material processing abilities with automatic tool changers (cutting, untangling, brushing, wiping, etc.)
- On-the-fly robot replacement system and passive radiation hardening through predictive maintenance

## Features

- VIRERO is compatible with manipulators from a wide range of robotics manufacturers (e.g., Yaskawa, Stäubli, Walischmuller, La Calhène, and others)
- Highly modular and customizable system allows for additional processes such as shredding, cleaning, drying or compressing
- Arm control algorithms allow operator to manipulate waste in various assisted modes and abstraction levels
- Gripper mimics operator hand movements for fully manual control
- Operator-assisted point-and-click control generates pick-and-place order
- Fully autonomous manipulation



Example of measuring table for spatially resolving radiological emissions

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is our everyday commitment**