

A Sustainable Path to Automation

1 Introduction

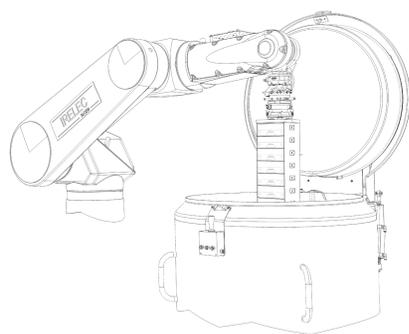
For 15 years, IRELEC has been designing and producing **robotic systems** intended for **structural biology** and **biomedical research** [1]. Advanced technologies have been continuously implemented so as to ensure safe, reliable and controlled storage and handling of biological samples (proteins, viruses, macro-bio-molecules, etc.).

IRELEC is the leading supplier worldwide for the automation of X-ray diffraction experiments on Synchrotron protein crystallography beamlines [2].

In the field of biobanking, IRELEC proposes INLANDYS®, a fully automated platform for sustainable bio-storage management at very low temperatures, that can be adapted to any **cryogenic biorepository** [3].

When considering the **cryopreservation** of biological samples in biobanks, the whole life cycle of the samples concerned has to be taken into account and each specific transfer from one piece of equipment to another is critical, as thermal cycling is involved.

That's why IRELEC considers that an **automated storage system** is only truly effective if all operations, from the time the samples have been cryoprotected until they are effectively used, are automated.



As reliability is the main feature required with automation, IRELEC has built INLANDYS® on reliable **field-proven robotic technologies** and existing commercially-available cryogenic tanks.

"When handling large numbers of biospecimens in the biobank setting, automation of sample handling and storage is often the method of choice to save labour and improve turnaround times and quality." **Loes Linsen**, Staff member at AC biobanking, University Hospitals Leuven. *Automated Sample Storage in Biobanking to Enhance Translational Research: The bumpy road to implementation - Original Research January 9, 2020*

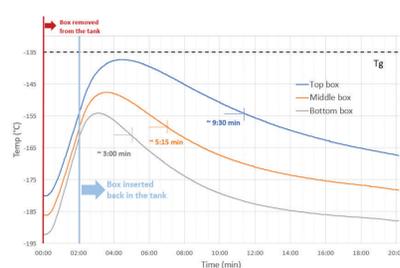
[1] Jacquamet et al. - Upgrade of the CATS sample changer on FIP-BM30A at the ESRF: towards a commercialized standard - J. Synchrotron Rad. (2009), 16, 14-21.
[2] Urby et al. - BioMAX, the first macromolecular crystallography beamline at MAX IV Laboratory - J. Synchrotron Rad. (2020), 27, 1415 - 1429.
[3] <https://www.staubli.com/en/robotics/solution-application/healthcare-life-sciences-robots/hospital-automation-robots/success-story-irelec/>

2 Sample Quality Management

When dealing with storage and the handling of biological samples in a Liquid Nitrogen environment, the question of **temperature monitoring** is often fundamental as most likely the integrity of the samples is concerned.

The secured long-term storage of various collections of samples in large volume cryogenic tanks is not trivial, as the temperature conditions inside the tank depend widely upon complex conduction and convection effects [5].

That's why the question of the max. temperature criterium should be considered with particular care. Research has determined that storage below -135°C is necessary for **long-term storage** of Human biospecimens, particularly tissues, in order to preserve a wider variety of biomarkers (including viability) [4].



Automation one enables to reliably track quality markers such as temperature and consequently to have a clear picture of each sample status history at any time.

For these reasons, IRELEC decided to build a storage platform that:

- Takes full benefit of automation features: "The more standardized and reproducible your workflows are, the better the quality of your specimen"
- Guarantees the storage conditions for all samples, considering that -135°C is a maximum target value.
- Tracks the risks of samples abnormally over-heating, whatever the threshold applicable to the samples collection

[4] Allison Hubel, Ralf Spindler, and Amy P. N. Skubitz. Storage of Human Biospecimens: Selection of the Optimal Storage Temperature. BIOPRESERVATION AND BIOBANKING Volume 12, Number 3, 2014.
[5] IRELEC white paper Cryogenic Bio-Storage Management: <https://www.irelec-alcen.com/en/biobanking/biobanking-inlandys-automated-platform-integrates-existing-tanks-and-lims-any-size>

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Integrating automation to cryogenic biobanks



INLANDYS

IRELEC

Features

Storage	Vapor or liquid phase cryogenic storage
Safety	Physical barrier with PLC Oxygen detector interfaced with safety PLC Interfaces for GN2 extraction
Cold chain management	Sample temperature maintained below -135°C Sample transfer station cooled down with LN2
Traceability	100% controlled
Human Machine interface	Access drawer for sample deposit and retrieval (in shuttle box) Local HMI with touchscreen Connection with LIMS via FTP and/or remote access via web application
Regulations	Compliant with European Directives
IP	IRELEC Patented technologies
INLANDYS® Compact	On-the-shelf standalone platform Up to 4 tanks
INLANDYS® Extended	Custom adapted platform Unlimited number of tanks

3 Integrating Automation to Cryogenic Biobank

When envisioning the implementation of automation at a biobank facility, some obstacles seem difficult to overcome:

- Compatibility with existing storage devices
- Compatibility with existing practices
- Compatibility with existing infrastructure
- Automated biobank as a "Black box" that cannot be used manually anymore
- Need of having a back-up system in case of automation failure
- Investment costs

IRELEC has addressed all these concerns with the INLANDYS® platform, providing efficient and sustainable process automation.

- It maintains a **standard storage architecture**: racks, boxes and cryotubes
- INLANDYS® is adapted to each specific environment and particular constraints, according to the users' expectations
- The automation process can simply be disconnected for punctual manual operation or maintenance purposes
- It offers a straightforward **interface with existing LIMS**
- It is built on **field-proven technologies**, as the most important feature for automated biobanks is reliability.

Capital budget: INLANDYS® is designed so as to accompany biobanks with evolving needs and/or in a phase of growth, and consequently to optimize financial expenses throughout the life of the biobank. It operates with commonly used **commercially-available tanks**. In addition, the platform is modular, which enables you to further limit expenses when increasing the storage capacity while at the same time maintaining a single and unique interface for the user.

Planning for automation: The IRELEC team accompanies the biobank staff during all major steps of automation: **process mapping out**, interfacing with IT staff and civil engineering, commissioning and expert training, service support. IRELEC automation experts are attuned to biobank team members, who are the only experts on your collection and a key resource for a successful implementation of your process automation.

4 Summary: from Manual to Automated



Personal Safety	Highly improved as all strenuous manual operations are avoided. And staff is protected from the risk of anoxia linked to liquid nitrogen exposure and the risk of musculoskeletal disorders due to the handling of racks weighing several kilos with outstretched arms.
Sample Traceability	Fully managed by the automaton Each sample should have a unique identification number properly labelled (1D or 2D barcodes for instance)
Sample Integrity	All sample history is recorded. Uncontrolled thermal cycling is avoided, as transfer time at room temperature can be shortened and monitored.
Efficiency & Ergonomics	Time-consuming and strenuous operations are performed by the automated system (day and night). Automation enhances quality control and technicians can concentrate on their high-value activities. Easy and rapid access to any biological material inside the biobank that strengthens the innovation role of the biobank, which is a key factor in translational research [6]
Financial Sustainability	If apprehended as a whole integrated solution, automation can generate substantial economies of scale. And the development of the biobank can be done without a significant increase in manpower and equipment. Depending on the biobank activity, it can also offer the opportunity to attract third-party companies and generate service-based incomes.

Automation solutions offer many advantages that clearly outweigh the existing disadvantages, e.g. costs vs. benefits only, if they are well planned and fit the need of the intended use.

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Automation in biobanking from a
laboratory medicine perspective -
J Lab Med 2019; 43(6): 329-338

[6] Vandenberg, O., Martiny, D., Rochas, O. et al. Considerations for diagnostic COVID-19 tests. Nat Rev Microbiol (2020).

