



biobanking reimaged – arctic XC modular storage network

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introduction

- As biobanks strive to adopt best practice in sample curation, sample logistics remains a weak link in the chain.
- Process inconsistencies include: variable length of time between sample post processing to storage and variable freezing profiles of samples stored in racks depending on where each tube is in the rack.
- Addressing such inconsistencies, then maintaining process consistency as biobank collections grow is challenging, however, automation provides a solution.
- Implementing automated storage, however, can be a slow and costly process. For some solutions, significant changes to infrastructure are required to provide long term (up to 10 yr) capacity requirements upfront.
- The launch of TTP Labtech's arctic XC represents a significant step in tackling the inconsistencies of sample logistics whilst providing a cost and time effective solution to the challenges of scalability.

1. sample logistics and integrity

- Samples such as plasma and serum should be transferred to -80°C storage as quickly as possible.
- The batching and collating of samples post processing, results in variable times to reach storage, risking sample degradation and inconsistent data in future research.
- Almost 20 years ago, TTP Labtech introduced pneumatic sample transfer systems for small molecule sample management.
- This proven system has now been developed for use within biobanking. Pneumatic pipes connect laboratories to the biobank enabling samples to be stored at -80°C immediately after processing.



Fig 1. Remote delivery from sample processing laboratory on 1st floor to 3 arctic modular storage units.



Fig 2. 3 interconnected arctic systems in different locations connected to a common access point

2. storing in racks – the penguin effect

- As demonstrated by penguins in Antarctica, we hypothesised that samples stored at the edge of racks freeze much faster than those in the centre due to an insulation effect.
- We conducted experiments to measure the significance of the penguin effect using a standard SBS format rack containing 96 x 1.4mL vials, each filled with 0.97mL of bovine serum.
- Several vials were adapted to incorporate a thermocouple in the liquid. Temperatures were recorded as the samples cooled to -80°C (Fig 3.).

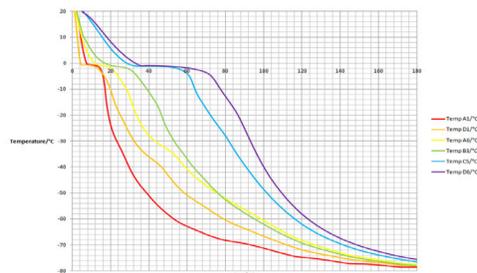


Fig 3. Freezing profiles for different positions in an SBS rack

- Our results confirmed that edge vials freeze faster than centre vials. Greater than 60 mins difference was observed between samples reaching sub-zero temperatures and 70 mins difference reaching -40°C.
- To avoid rack-based penguin effects the arctic system does not store vials in racks. Instead vials are stacked on each other in aluminium pipes, ensuring consistent freezing profiles.

3. comparing the economics of automated storage solutions

Consider a biobank storing 100,000 samples per year for 10 years

Option 1 install a large automated storage system with a 1M sample capacity.

- Cost per samples includes purchase cost, ongoing service costs and electricity costs, but not infrastructure changes which could be considerable.



Fig 5. Cost per sample illustration for a large automated store

- Fig 5. indicates that cost/sample ranges from ~€15 initially to €3.2 once the store is full.
- After 10 years the store may reach the end of its working life, requiring new funding to replace and/or expand.
- As a large upfront investment, this solution is inflexible to unforeseen changes.

Option 2 start with a single arctic automated storage system. Expand into an integrated arctic XC system over time.

- Cost/sample includes: purchase, service and electricity. Its compact module size means infrastructure changes are not generally required.

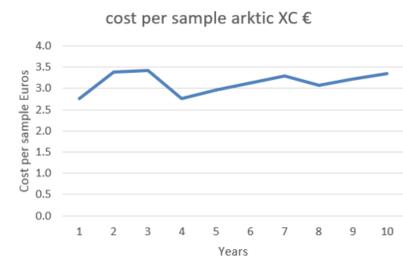


Fig 6. Cost per sample illustration for arctic XC store

- Fig 6. indicates cost/sample ranges between €3.4 to €2.8, fluctuating a little with the addition of integrated modules as required.
- This solution is highly adaptable to future changes, offering limitless expansion possibilities.

Depreciation of assets

- Considering the residual asset values over the 10 year period is also quite revealing.



Fig 7. Comparison of residual € values of large store (red) vs arctic XC (blue) when storing 100,000 samples per year over 10 years

- The arctic XC approach enables a rolling, programme of module replacement versus replacement of the entire system (see Fig 7.)

conclusions

- Planning the long term curation of samples is challenging and requires consistent, reliable and scalable processes.
- Introducing automated storage has generally required significant up-front investment, major infrastructure changes, lengthy implementation and slow return on investment.
- TTP Labtech's arctic XC system approach addresses these key factors providing:-
 - Standard "off the shelf" storage systems
 - Rapid install in standard laboratory spaces
 - Options to connect laboratories directly with storage
 - Improved sample handling and reduced time to store enhancing sample integrity
 - Flexibility to manage budgets effectively by scaling capacity only when needed
 - Adaptable systems that fit into existing and future infrastructure.