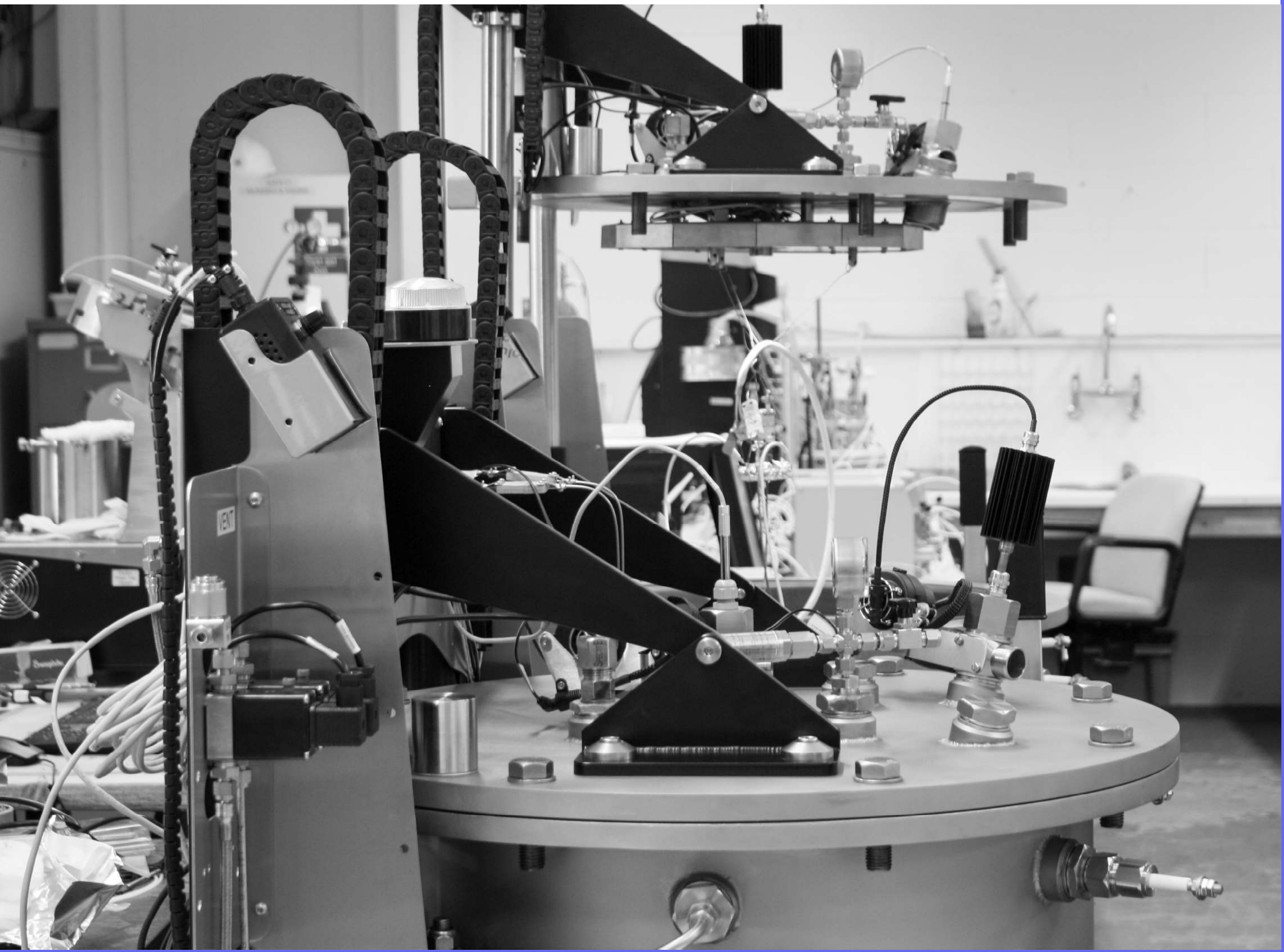
h.e.l

New Product for 2022!

Battery Performance and Safety Testing

Hazard screening, safety testing and performance characterization solutions



www.helgroup.com

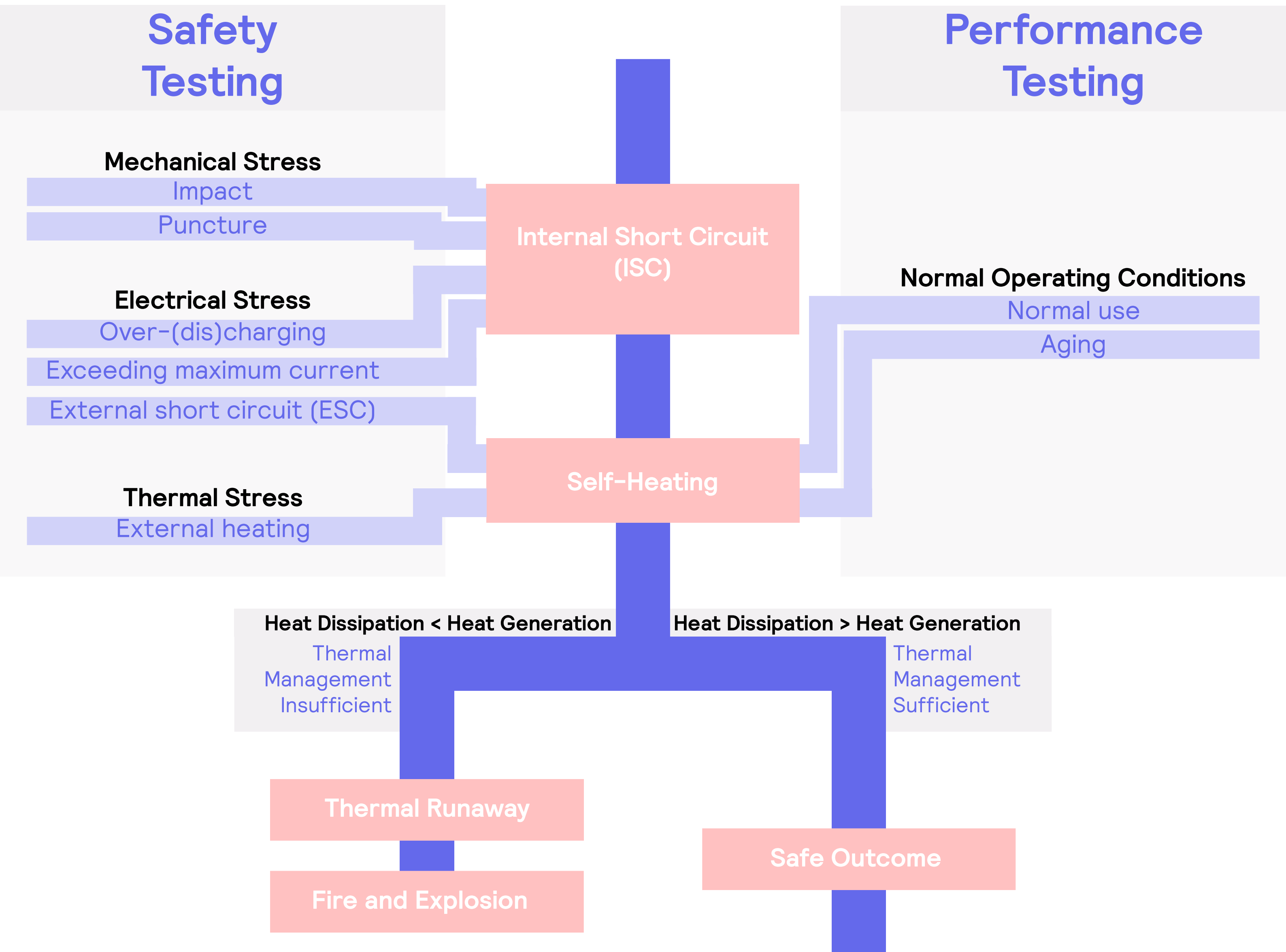
Solutions in Battery Safety Testing and Development

With the need for higher energy densities, quicker charging times, and longer lifetimes, safety is a crucial consideration in developing more powerful batteries.

High-energy batteries contain highly reactive and potentially hazardous chemicals. These batteries will operate under, and be subjected to, a range of conditions. Therefore, understanding battery thermal behavior is critical to controlling cell self-heating and mitigating thermal runaway risk. Self-heating can arise from normal usage, or as a consequence of being subjected to a stress condition. These stresses can be broadly categorized as mechanical, electrical, or thermal stresses.

Understanding battery thermal behavior is also a critical consideration in the development of higher performance cells. Here, the relationship of thermal behavior with electrical performance, and its characterization, is essential.

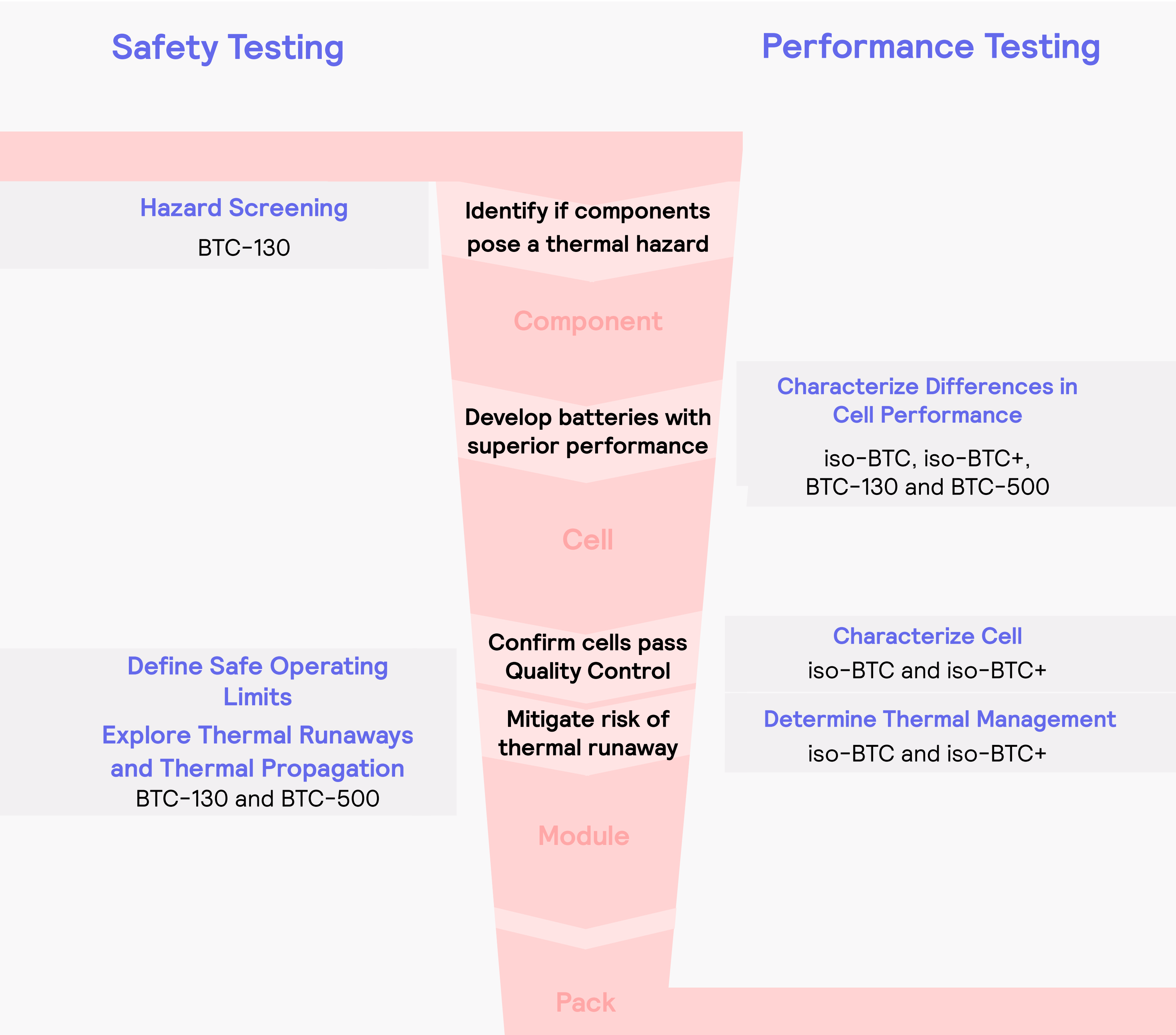
Considerations for mitigating cell failure



Broadly, testing can be divided into safety and performance. Safety testing considers the component, cell, module, or pack response to stress conditions. It typically allows worst-case scenarios to be assessed, informing appropriate mitigation.

In contrast, performance testing focuses on characterizing the cell's thermal behavior and electrical performance under a range of operating conditions. Performance testing is particularly valuable in cell development, quality control, and it can guide thermal management strategies.

Your Problem and Our Solution



Safety Testing

BTC-130 and BTC-500

Safety testing involves subjecting cell components, cells, modules, and battery packs to stress conditions to characterize their response.

The **BTC-130** and **BTC-500** are Battery Testing Calorimeters, which enable mechanical, electrical, and thermal stress tests to be safely carried out under adiabatic conditions on small and large batteries, respectively.

- **Mechanical stress:** the **BTC-500** can be equipped to perform a range of puncture tests
- **Electrical stress:** the **BTC-130** and **BTC-500** can be fully integrated with charge-discharge units to support electrical stress tests. An external short circuit (ESC) option can also be provided
- **Thermal stress:** the **BTC-130** and **BTC-500** maintain adiabatic conditions to help assess the component's thermal stability. Thermal events that occur as a result of other stresses can be similarly characterized

The use of adiabatic conditions, where heat generated is retained within the system, enables the hazard assessment to be conducted under worst-case scenarios.

Component

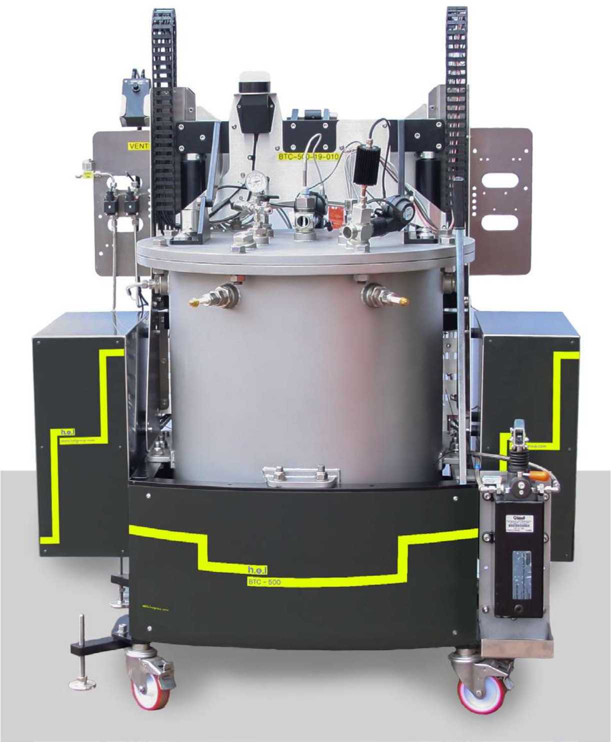
BTC-130

Component hazard screening

Batteries are used in a wide variety of environmental conditions and undergo internal heating and cooling from both normal use and stress conditions. Therefore, it is vital to understand how individual cell components will behave under a range of temperatures early on in development. If a new cell component has a low temperature of self-heating, it could pose a thermal runaway risk. Similarly, if a rapid increase in pressure accompanies a thermal event, or if toxic gases are produced, this may indicate the use of the component should be reassessed.

The **BTC-130** facilitates the use of small volume test cells in addition to supporting the testing of small battery cells. This enables the thermal stability of individual cell components to be assessed under adiabatic conditions and informed decisions on how to proceed with cell development to be made.

Cell to Module


BTC-500

Define safe operating limits

It is essential to identify the safe operating limits of battery cells, modules, and packs in order to avert the risk of thermal runaway, and the potentially catastrophic consequences to which it could lead. Therefore, batteries need to be subjected to mechanical, electrical, and thermal stresses in order to define their safe operating limits.

- Thermal stability data from thermal stress tests can help define the **safe working temperature of the battery**
- The evaluation of over-charging and discharging rates allows the **maximum safe voltage** and **maximum safe current** to be determined
- The consequences of mechanical stresses and external short circuits (ESC) can be evaluated

Exploring thermal runaways and thermal propagation

In general, most extreme conditions can result in thermal stress on the battery cell, which can lead to a thermal runaway. Therefore, for the development of safe batteries, it is essential to understand the mechanism of the thermal runaway in a cell, and how it propagates within a module or pack so that appropriate mitigation strategies can be implemented.

The data obtained from the stress tests performed in the **BTC-130** and the **BTC-500** can be used to model a cell's predicted thermal behavior. Successive onset temperatures of decomposition of components within the cell can be detected, and the resultant heat released determined. This can help to facilitate a mechanistic understanding of the thermal runaway within the cell. Further insight can also be derived from the external analysis of the composition of any evolved gases collected.

The **BTC-500** also enables the triggering of a cell at a specific position within a module to undergo a thermal runaway with a mechanical- or electrical-induced short circuit, while the integrated camera will visually capture the event unfolding. The induced thermal runaway allows the risk of thermal propagation to be evaluated, the magnitude of the thermal event to be characterized, and appropriate mitigation measures to be implemented within the module design to ensure heat dissipation is greater than heat generation.

Performance Testing

iso-BTC, iso-BTC+, BTC-130 and **BTC-500**

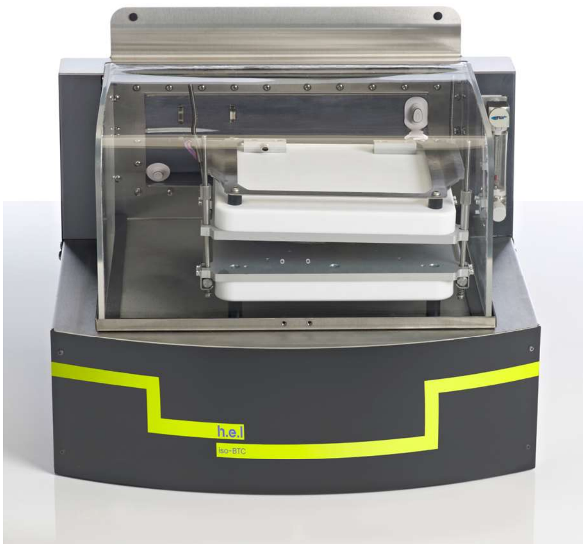
Performance testing focuses on characterizing the thermal behavior and electrical performance of the cell under a range of operating conditions.

The **iso-BTC** and the adiabatic **BTC-130** and **BTC-500** all support the full integration of a charge-discharge unit. This enables the automation of repeated cycling of battery cells under a range of operating conditions, while concurrently recording both the battery's electrical performance and the heat evolved.

The **iso-BTC** and **iso-BTC+** are isothermal calorimeters and enable cells to be characterized under normal or abnormal usage conditions. They also support a range of adaptors which allows batteries and packs of different sizes and shapes to be tested.

In contrast, the **BTC-130** and **BTC-500** are adiabatic calorimeters, facilitating the assessment of cell performance under extreme conditions.

Cell



iso-BTC

Characterize differences in cell performance

Battery chemistry, electrode composition, type of battery cell, and battery age all influence battery performance. The **iso-BTC** and **iso-BTC+** enable the impact of these factors to be investigated during the development of new cells. The data generated on how battery efficiency, (dis) charging capacity, and heat evolved vary with temperature, and (dis)charging rate can be used to model battery performance and enhance understanding of battery behavior for cell development.

The **BTC-130** and **BTC-500** can be used to characterize the cell performance under more extreme operating conditions. The absolute limit of safe, repeated use can be assessed with the automated cycling of the battery cell until the heat generated by its discharge causes the onset of self-heating. Similarly, puncture tests provide an indication of the structural stability of the cell. The resulting thermal event can also be captured on camera on the **BTC-500**. These tests enable the safety performance of the cells to be compared.

Cell to Module

iso-BTC+

Characterize cell for Quality Control

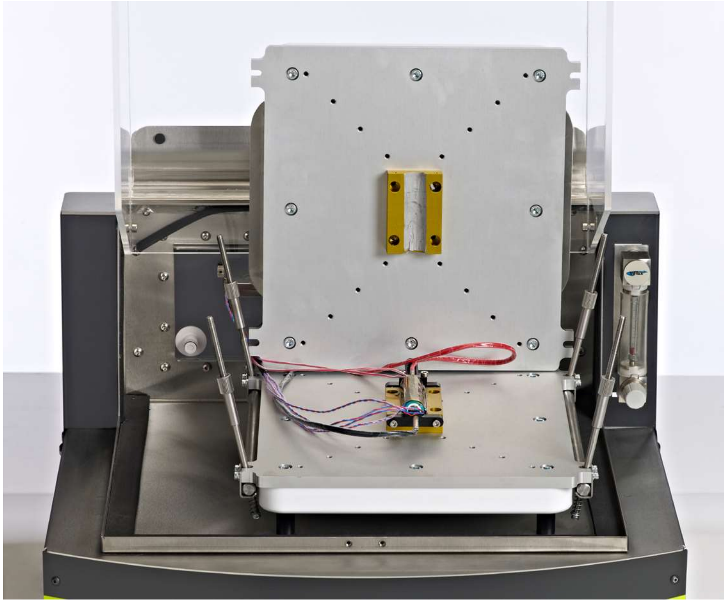
Battery attributes, such as battery efficiency and heat evolved, at specified temperatures and C-rates, can be used to characterize the battery performance. These defined characteristics can be used in Quality Control for both cell manufacturers to demonstrate a stated performance, and for battery integrators to check cell performance downstream. The data from the **iso-BTC** and **iso-BTC+** can enable these characteristics to be determined.

Determine thermal management

Under normal use, heat is absorbed and evolved during the charging and discharging cycles of a battery cell. In addition to this, cells within a module may not exhibit uniform properties upon cycling. The potential imbalance this causes, may trigger a safety hazard and affect battery performance.

Without careful management, this self-heating can result in overheating and trigger a thermal runaway. The packing and physical arrangement of cells within a module or pack are essential in governing heat transfer. Therefore, it is important to characterize the thermal behavior of the cells, modules, and packs over a range of temperatures and (dis)charge rates, as the data generated can be used to inform effective thermal management.

The **iso-BTC** and **iso-BTC+** also support thermal mapping during testing to highlight regions of the battery, which generate greater thermal energy levels. This information can also be utilized in the implementation of targeted thermal management strategies.



labCONSOL®

Bringing effortless efficiency to your laboratory automation

Built around the next generation of the proven WinISO software engine and introduces new features that enable scientists to improve laboratory efficiency and boost productivity.

Designed around the user experience, labCONSOL® combines:

- **advanced real-time data display**
- **automated monitoring of experiment completion and failure states**
- **rapid data capture modes**

across single or multiple parallel reaction systems.

Enabling researchers to quickly and accurately track how an experiment is proceeding, focusing on the most critical aspects, avoiding unnecessary repeated lab work, which can be both costly and time-consuming.

Better user experience – increased productivity

- New intuitive design means less training time required
- Creating new plans/recipes is now simplified. labCONSOL® will also provide hints and tips along the way to prevent errors.
- New plans can be created while an existing experiment is running

Fully configurable workspace – improved efficiency by displaying the info you need

- No swapping between windows required; configure the workspace to suit you.

Improved data-logging and graphing functionality

- New SQL database for file management – no risk of data loss from any experiment
- Improved graphing performance – view entire experiment on a single graph

Invest for the future – benefit from additional features and functionality

- Free software upgrades during the warranty period of your equipment
- Can be extended with a Premium Agreement or Extended Warranty

Powerful software

- One piece of software to support the full range of H.E.L equipment
- Powerful and flexible code base combined with intuitive and user-friendly design

For more information, and how to request an upgrade,
visit https://helgroup.com/products/labconsol/
or speak to your local H.E.L representative

Upgrades, Support and Training

We understand that your needs can change over time and you may require:

- **A system upgrade**
- **Training for new team members**
- **Support on your processes**
- **To book some time with our service team**

Our dedicated service team and highly knowledgeable technical staff will work with you to find the right solution.

Customer Service Enquiries & Technical Support Requests

E: service@helgroup.com
T: +44 (0) 20 8736 0640

About H.E.L Group

H.E.L Group's mission is to work together with chemistry, safety and biotechnology experts to engineer and unleash the full potential of the scientific community. To this end, H.E.L develops and manufactures innovative scientific instruments and software designed to optimize the efficiency, safety and productivity of key processes in chemistry and biology applications.

The H.E.L team includes highly skilled process and software engineers, based at their extensive research and manufacturing facilities in the UK, as well as sales and support offices around the world.

H.E.L has a long history of solving complex challenges for customers. For more than 30 years the company has worked with businesses and laboratories globally, providing proprietary automated solutions for the pharma, biotechnology, chemical, battery and petrochemical sectors.
H.E.L is accredited with ISO 9001 : 2015 and ISO 14001 : 2015.

- With a strong focus on the customer, our **service and support** enables our customers to keep working efficiently
- Our **wide range of customizable products** put the customer at the heart of what we do, with solutions designed around their needs

H.E.L Group

UK - London	e: sales@helgroup.com	t: +44 208 7360 640
US - New Jersey	e: sales@helgroup.com	t: +1 609 912 1551
China - Beijing	e: info@helchina.com	t: +86 10 8210 1033
India - Mumbai	e: info@helindia.com	t: +44 208 7360 640

For a complete listing of all global contacts, visit www.helgroup.com/contact/

H.E.L Group HEL.Ltd hel_group