

Design and Specification of luminaires using DIGITAL TWINS

An Innovative process applied in Generic Experiments

Vision

Predicting the behavior of a luminaire in harsh conditions (small volume of ceiling, installation on a facade receiving direct sun over the day) is a challenge. Precise indications on the lifetime and on the evolution of the performances of the product over time (such as color shifting) in specific operating environment are necessary for the design of lighting projects and for the development of dedicated luminaires. But the corresponding information are generally not available. This situation often leads to over-estimation of the size of the luminaire to be developed and to excessive energy consumption of the lighting installation. It can also induce unexpected failures.

Digital Twin process

Digital twin of luminaires can predict the evolution of the luminaire's performances and the remaining lifetime depending on the environment and on the **user profile**. For LED luminaires, a specific multidomain model is necessary in order to manage the optical, electrical, and thermal interactions at each moment.

The SMEs Ingélux (lighting design) and Eccelectro (lighting manufacturer) have been involved in different European research projects related to digitization of process leading to the below capacities :

- ❖ Design of luminaires based on Digital Twins : development of bespoke luminaires adapted to specific environments and optimized in terms of weight, electric power, number of LED sources, and reliability over time.
- ❖ Specification of lighting solutions through lighting Design using Digital Twin : selection of most suitable luminaires for selected application. Verification of consistency between expected performances and behavior during lifetime.

Both process are based on the CIE TC2-84 requirements for e-datasheet to be provided by LED manufacturers in order to create representative digital twin.

Benefits

The European lighting market will benefit from the digital twin concept by improving the quality of the products, and providing a new tool allowing all actors to simulate the behavior of the products.

Digital twin applied to lighting design by manufacturers have been shown to reduce the time of development of 25% and to save 30% in cost of development. It also leads to optimization of weight and performances of the luminaires, and therefore helps in reducing the cost of the final product.

Predictive maintenance is also permitted with Digital Twins.

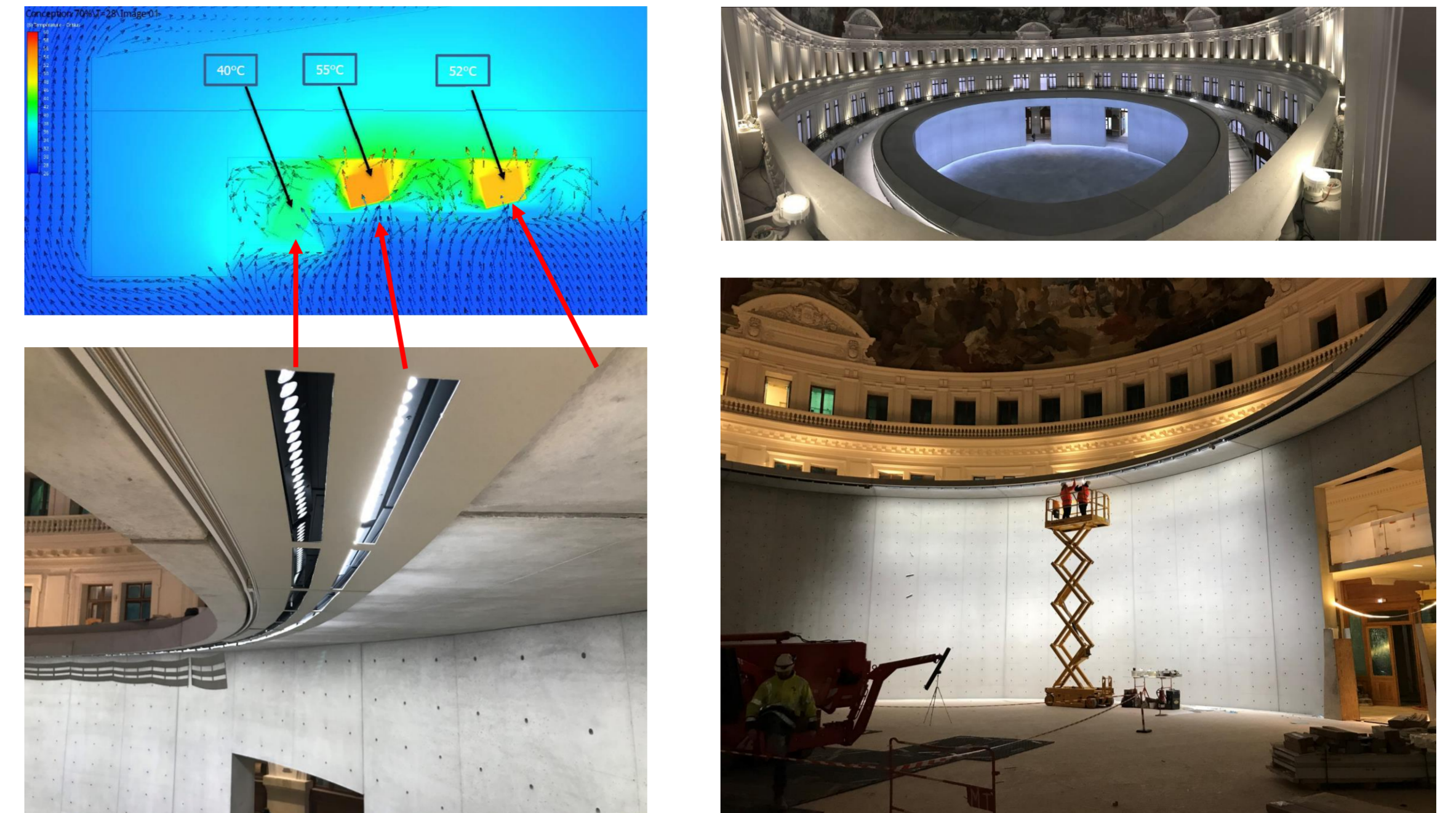
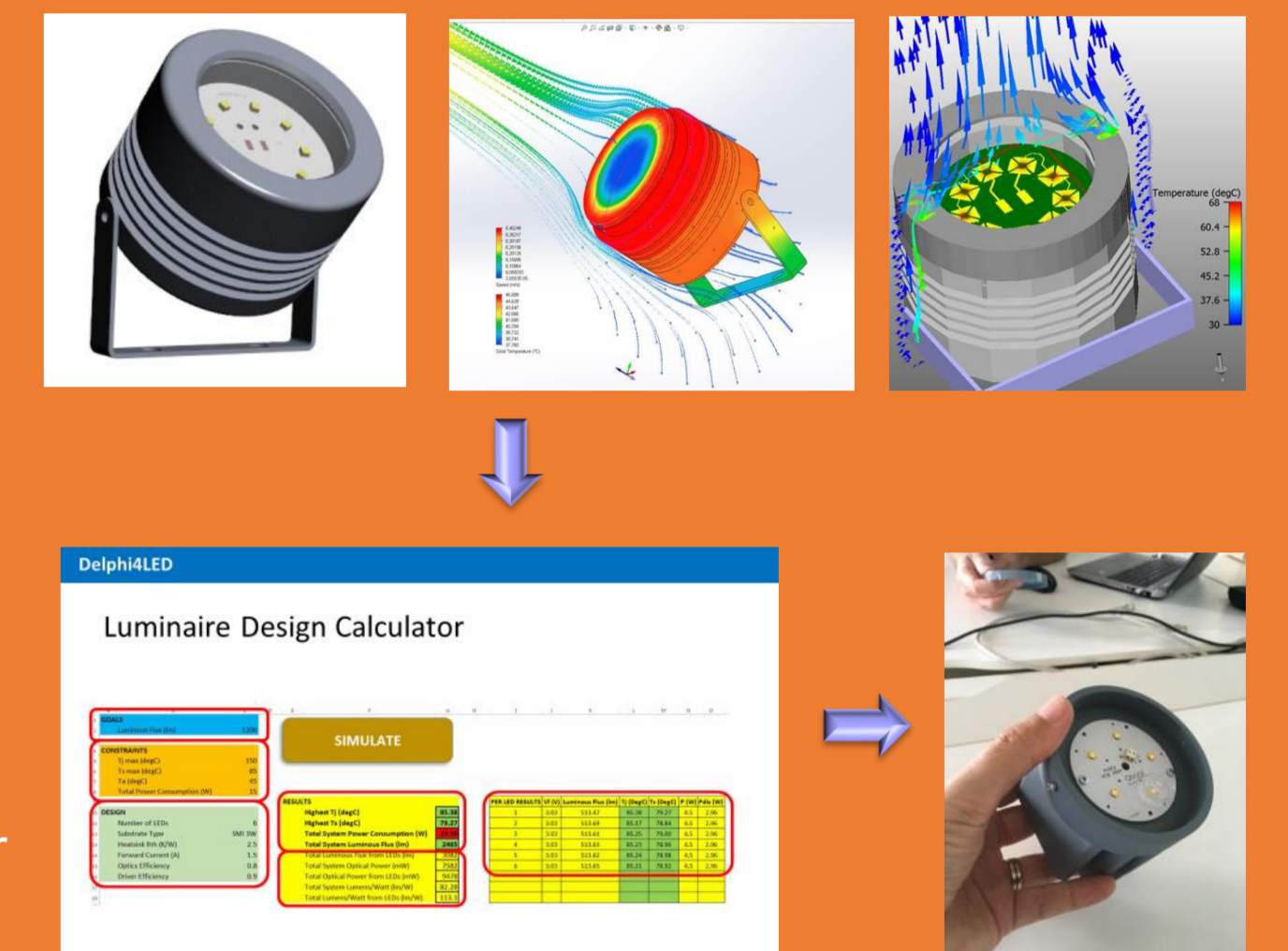


Figure 1. On-site luminaires specified by Ingélux for a museum, requiring specific thermal and optical simulations due to installation in small volume.

Design with a digital twin:



A e-datasheet (complying with CIE TC2-84 report) of the LEDs is used and coupled to a thermal model of the luminaire.

A compact model of the luminaire is created allowing different changes in the parameters (number of LEDs, type of heat sink, etc.).

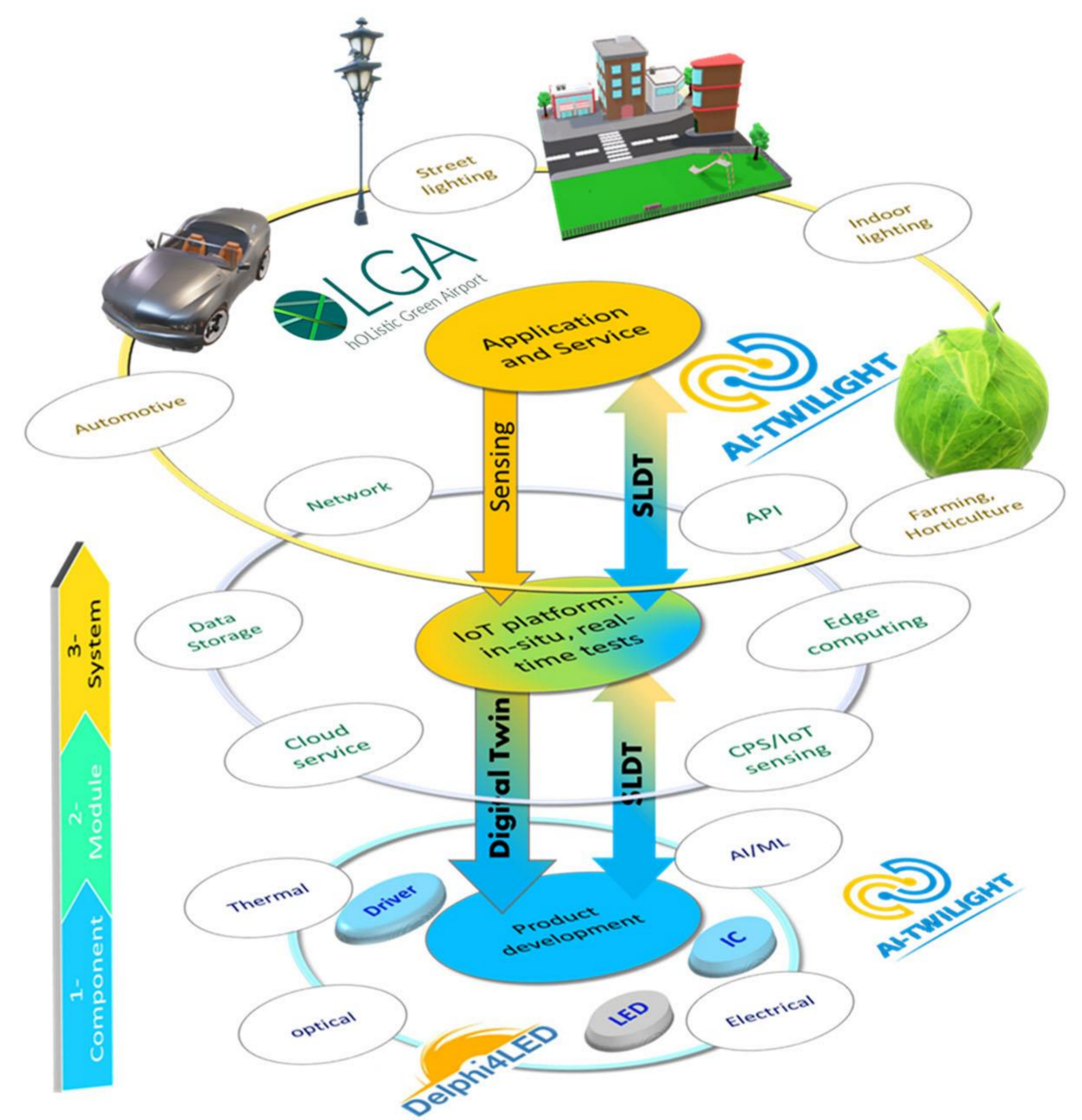


Figure 2. Concept of the Self Learning Digital Twin of luminaire, with applications

	<p>Development of a standardized method to create multi-domain (thermal-optical-electrical) LED based design and simulation tools for the solid-state lighting industry. Consortium : 15 partners from 7 countries. Academics, industrials, software, lighting designers. Project closed in 2019.</p>
	<p>AI powered Digital twin for lighting infrastructure in the context of front-end Industry 4.0. Consortium : 24 partners from 8 countries. of which ~30% academia, ~31% SMEs and ~40% large companies. Ongoing project, 2021-2024</p>
	<p>Innovative and sustainable solutions to reduce CO2 emissions, optimise energy efficiency, preserve biodiversity, and improve air quality and waste management while involving the entire aviation value chain. Consortium : 41 partners and 17 third parties. Ongoing project, 2021-2026</p>

Use Case in Lyon :

Six luminaires are being installed in a corridor in the Lumen building Lyon, together with measurement devices.

The luminaires were designed by Eccelectro under the prescription of Ingélux, using LED Chips characterized in different European Labs.

A Digital Twin of the luminaire is under development. The real user profile will be applied to it and the behavior compared to reality.