SUSTAINABLE PLACES 2020
October 27-30, 2020
Digital Event

NEXT GENERATION TRANSPARENT SOLAR WINDOWS BASED ON CUSTOMISED INTEGRATED PHOTOVOLTAICS (SOLAR-WIN)

H2020-EIC-FTI-2018-2020-815083

Project Coordinator: Dr. Víctor Izquierdo-Roca (IREC)

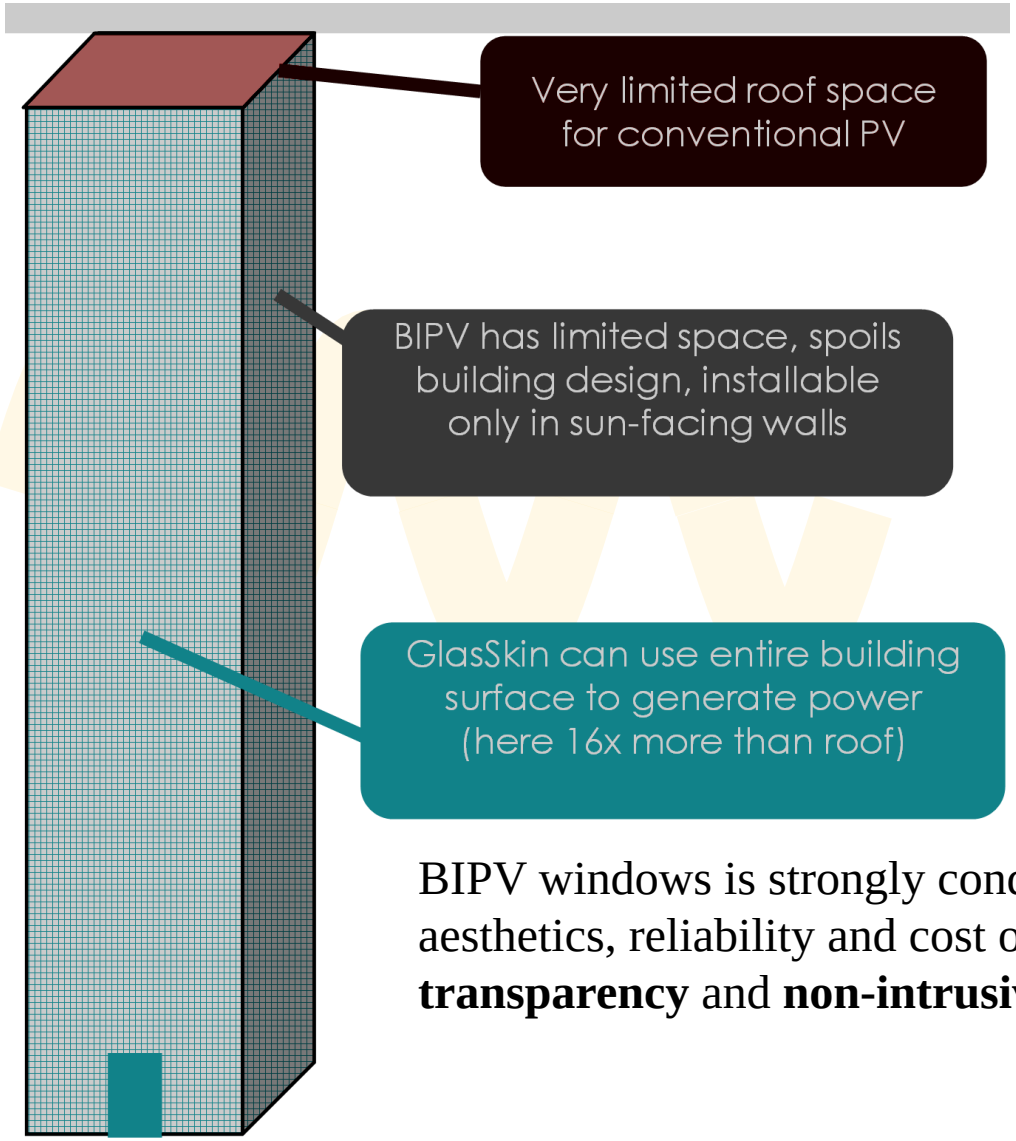
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815083

SOLAR-WIN PROJECT MOTIVATION

EU REGULATIONS (EPBD 2010/31/EU) are driving the building and architectural sector to the development of more energy efficient buildings, aiming to reach near-zero energy buildings (nZEBs) by 2020.

- nZEB sector will grow at a CAGR=30% over the next years
- and representing around one third of the total **Building Integrated Photovoltaic (BIPV)** market

THE CHALLENGE OF GENERATING SOLAR POWER FROM BUILDING

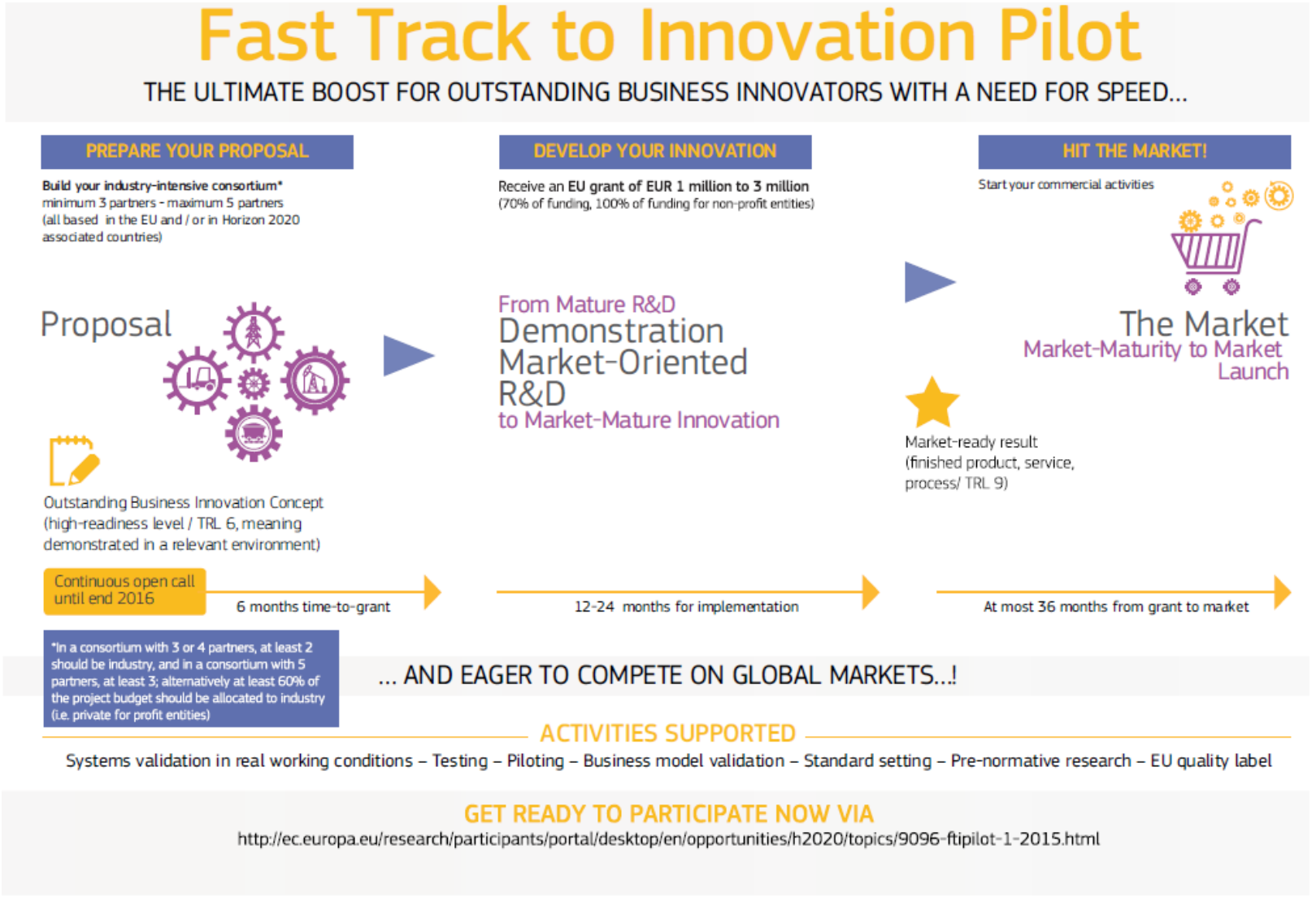


BIPV windows is strongly conditioned by the performance, aesthetics, reliability and cost of the solution. In particular, **transparency** and **non-intrusiveness**.

SOLAR WIN

H2020 Framework

The Fast Track to Innovation (FTI) program is a fully-bottom-up innovation support programme promoting close-to-the-market innovation activities open to industry-driven consortia that can be composed of all types of participants.



Solar-Win Objectives

The main goal of **Solar-Win** is to bring to the pre-commercial stage (TRL8) a patented solution to produce **colourless** and **truly non-intrusive transparent BIPV windows in 2 years**.

The **Solar-Win** solution will revolutionize the BIPV and the architectural sectors by providing a transparent BIPV window solution suitable for virtually any architectural application, and offering major advantages with respect to state-of-the-art BIPV windows in terms of **easiness of integration**, **reliability**, **efficiency** and **cost**

Truly transparent and visually non-intrusive (ATV up to 75%)

Efficient generation of photovoltaic electricity (up to 30W/m^2)

Transparent IR blocking coating to lower cooling costs and needs

Short payback times (below 4 years)

Easy integration into existing and new buildings

Lifetime equivalent to a standard window (>20 years)

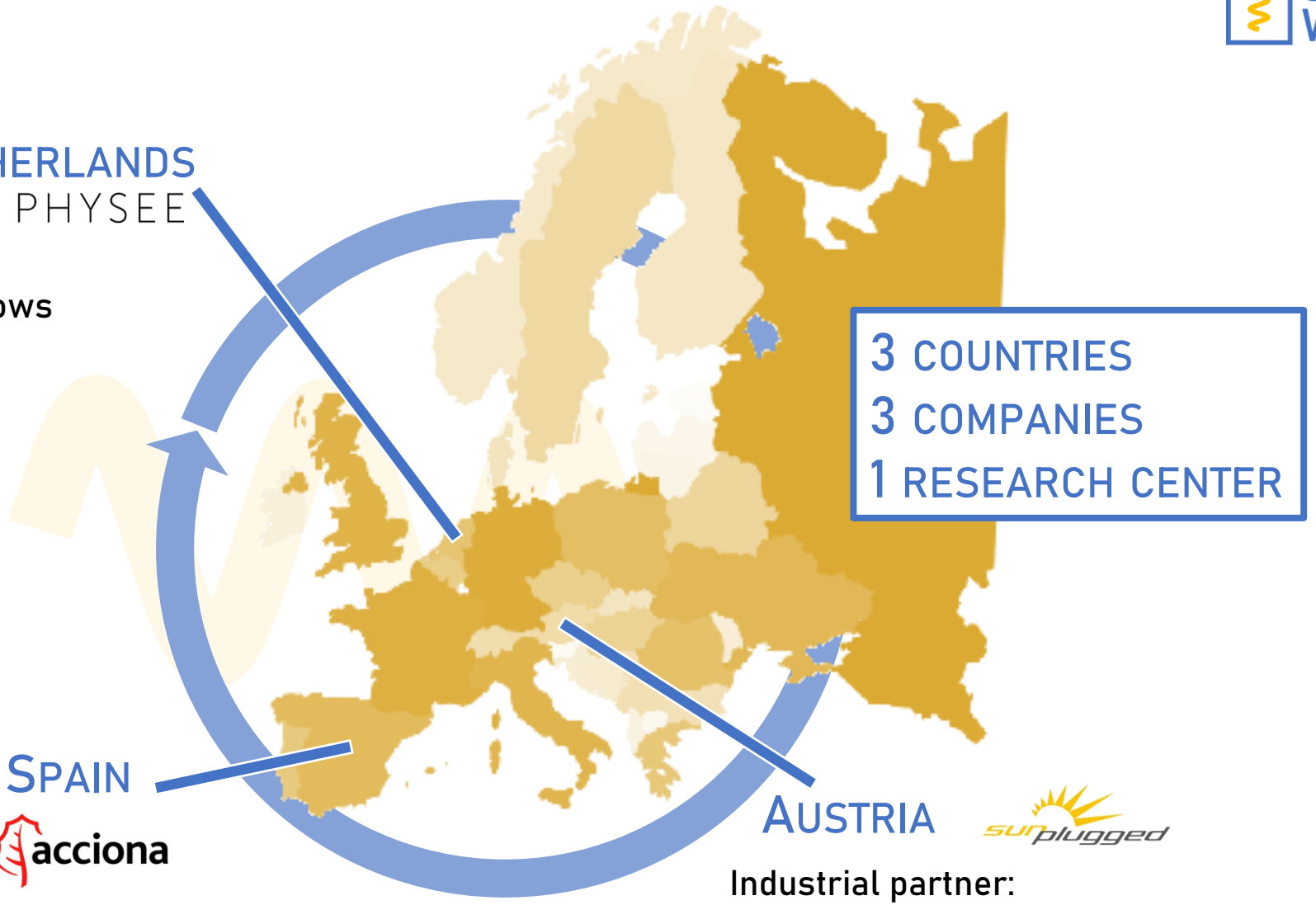
THE CONSORTIUM

SOLAR WIN

NETHERLANDS

PHYSEE

Industrial Partner:
- Expertise in smart windows
- https://physee.eu



SPAIN

acciona

Industrial Partner:
- Leader construction company
- https://www.acciona-construccion.com/innovation/

AUSTRIA

sunplugged

Industrial partner:
- Expertise in customized photovoltaics solutions
- https://Sunplugged.at

IREC 10 YEARS
Shaping Energy for a Sustainable Future

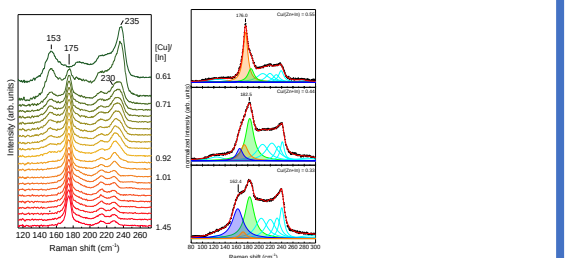
Research partner:
- Coordinator & technology transfer of process monitoring
- https://www.irec.cat

THE CONSORTIUM: IREC HTTP://WWW.IREC.CAT

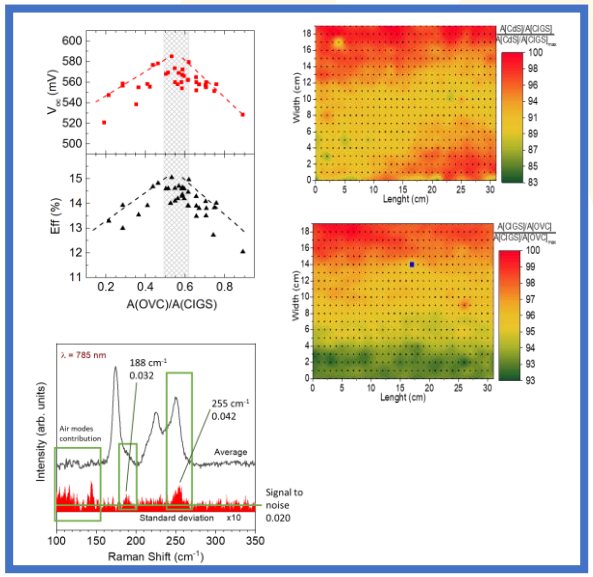
IREC POSSESSES A RECOGNIZED EXPERTISE IN NON-DESTRUCTIVE ADVANCED CHARACTERIZATION OF PV-RELATED MATERIALS AS WELL AS A STRONG BACKGROUND IN THE DESIGN OF METHODOLOGIES AND FABRICATION OF TOOLS FOR PROCESS MONITORING (RESEARCH→INDUSTRY TRANSFERENCE)

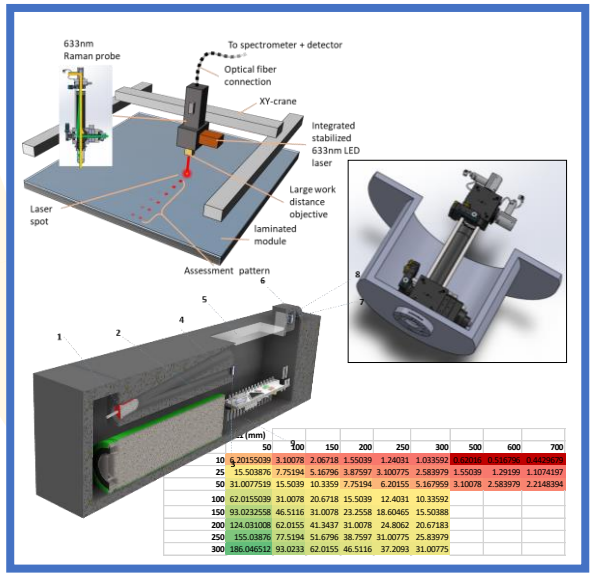
RESEARCH LEVEL

FUNDAMENTAL RESEARCH: NON-DESTRUCTIVE CHARACTERIZATION



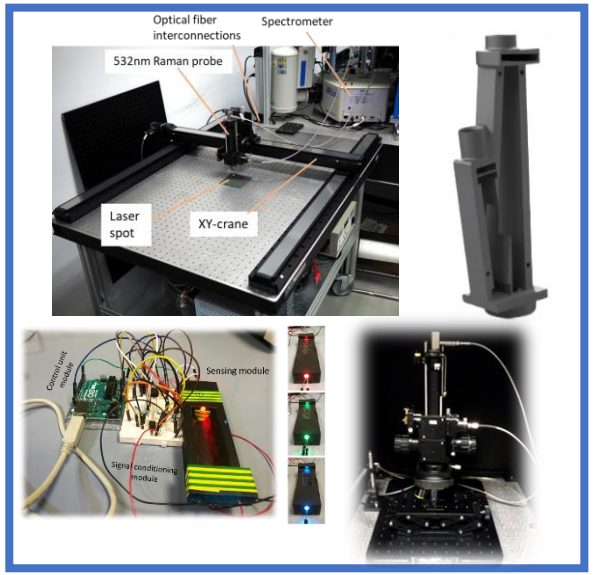
DEVELOPMENT OF PROCESS MONITORING METHODOLOGIES





	50	100	150	200	250	300	500	600	700
10	6.20155039	3.10078	2.06718	1.55039	1.24031	1.033592	0.620156	0.516796	0.44296568
25	15.503876	7.75194	5.16796	3.87597	3.100775	2.583979	1.55039	1.29199	1.1074197
50	31.0077519	15.5039	10.3359	7.75194	6.20155	5.167959	3.10078	2.583979	2.2148394
100	62.0155039	31.0078	20.6718	15.5039	12.4031	10.33592			
150	93.0232558	46.5116	31.0078	23.2558	18.60465	15.50388			
200	124.031008	62.0155	41.3437	31.0078	24.8062	20.67183			
250	155.03876	77.5194	51.6796	38.7597	31.00775	25.83979			
300	186.046512	93.0233	62.0155	46.5116	37.2093	31.00775			

DESIGN OF OPTIMIZED OPTICAL SYSTEMS FOR INSPECTION TOOLS



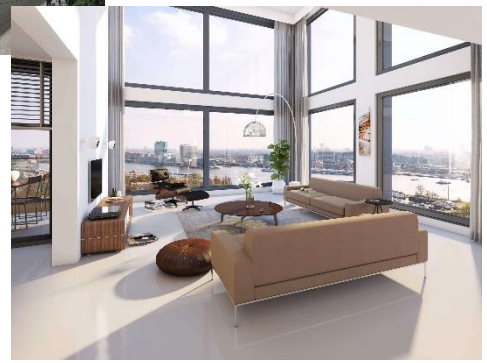
IMPLEMENTATION OF FUNCTIONAL PROTOTYPES COMPATIBLE WITH PROCESS MONITORING APPLICATIONS

INDUSTRY LEVEL

THE CONSORTIUM: PHYSEE HTTPS://WWW.PHYSEE.EU

PHYSEE SMARTSKIN IS A FAÇADE PLATFORM THAT USES 4.0 TECHNOLOGIES FOR SUSTAINABLE IMPACT INSIDE BUILDINGS.

PHYSEE



SMARTwindow

Window frames with integrated PV generators and internal/external environment sensors

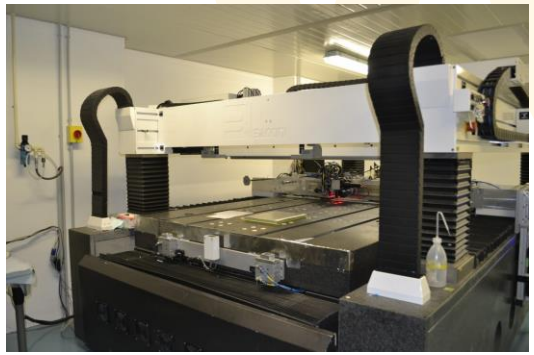
- Local power storage
- Sensor connectivity: sensor data is analysed to assess comfort and energy performance.
- Interconnection with existing 3rd party technologies (such as shading systems, air ventilation or lighting) for smart building management
- Visually non-intrusive solution

MANUFACTURING OF CIGS TECHNOLOGY COMPATIBLE WITH INTEGRATED/UBIQUITOUS PV APPLICATIONS

SUNPLUGGED: *CUSTOMIZED R2R-CIGSE PV MODULES*

SUNPLUGGED TECHNOLOGY IS BASED IN PV MANUFACTURING OF HIGHLY CUSTOMIZABLE FLEXIBLE CIGSE SOLAR CELLS ON STAINLESS STEEL SUBSTRATES THAT ADAPT TO THE REQUIREMENTS OF ITS APPLICATION USING AN INNOVATIVE PRINTED INTERCONNECTION CONCEPT

Reactive sputtering process



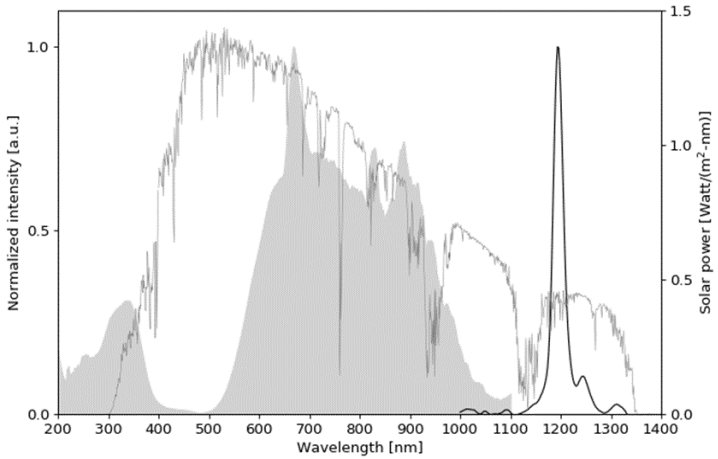
Modular interconnection

ACCIONA: *TECHNOLOGY VALIDATION AND IMPLEMENTATION*

ACCIONA IS A LEADING EUROPEAN CONSTRUCTION COMPANY DESIGNING, CONSTRUCTING AND MANAGING BUILDINGS AND CIVIL INFRASTRUCTURES UNDER SUSTAINABILITY PRINCIPLES. IT POSSESS STATE-OF-THE-ART FACILITIES FOR VALIDATING AND TESTING ADVANCED CONSTRUCTION MATERIALS AS WELL AS AND INNOVATIVE BUILDING CONCEPTS AND PRODUCTS PLAYING AN ACTIVE ROLE IN PUSHING FORWARD DISRUPTIVE CONSTRUCTION TECHNOLOGIES

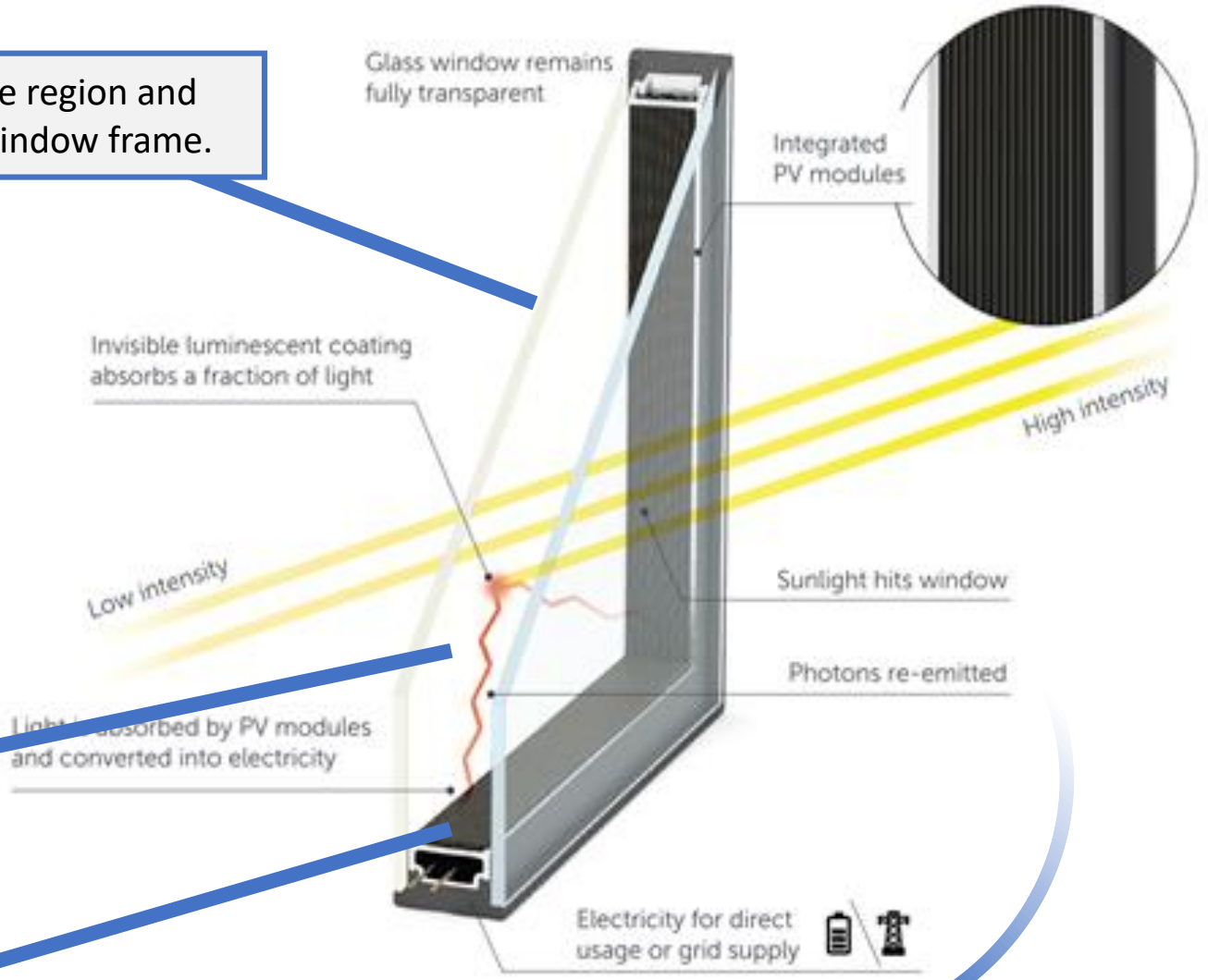
Technology Principles

Luminescent layer absorbing in the visible region and emitting in the NIR region towards the window frame.



Laminated glass configuration provide a light concentration effect in the windows frame

Integrate an array of interconnected solar cells optimized to NIR light to convert light into electricity in the window frame



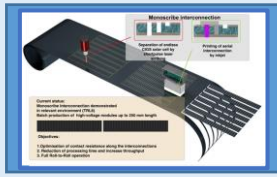
Window design fully compatible with existing window manufacturing techniques.

PROJECT ROADMAP

NOW
10/2020

10/2019

12/2021



PV MODULES OPTIMIZATION

PV MODULES FABRICATION

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PROCESS MONITORING DEVELOPMENT

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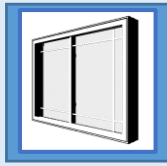

WINDOWS DESIGN

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Validation

PROTOTYPE IMPLEMENTATION

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TESTING & CERTIFICATIONS

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Optimization and technologies coupling

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Prototyping

WINDOWS FABRICATION

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PROJECT PROGRESS

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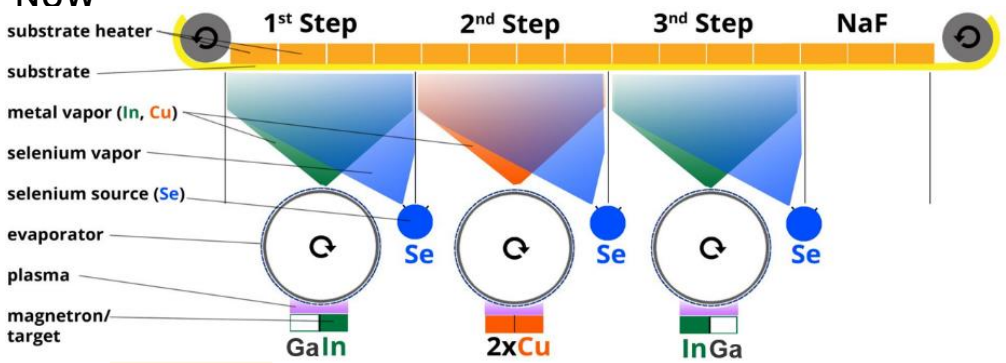
PV MODULE OPTIMIZATION

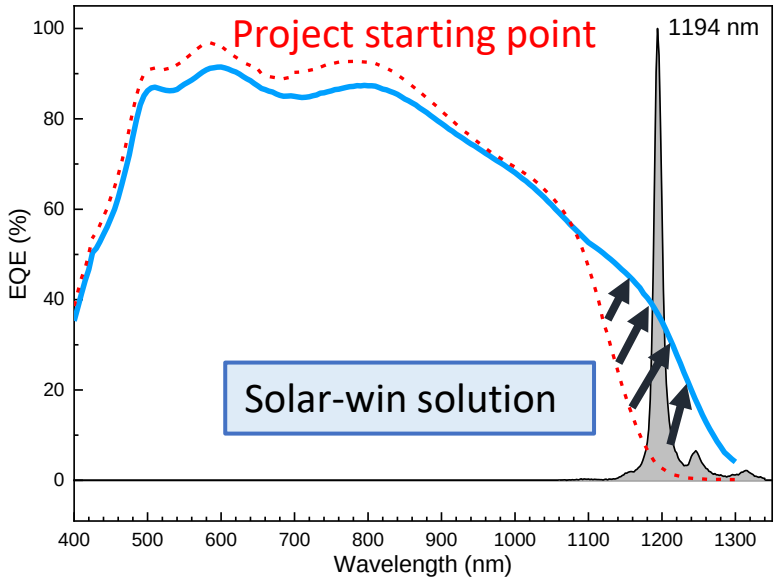
PROCESS MONITORING DEVELOPMENT

WINDOW DESIGN

PROTOTYPE IMPLEMENTATION

PROTOTYPE TESTING





R2R CIGSe fabrication process optimization for increasing IR-response

Identification of IR photoconversion loss mechanisms

Fabrication of prototypes with >50% IQE in luminescent emission region

PROJECT PROGRESS

10/2019 — 10/2020 — 12/2021

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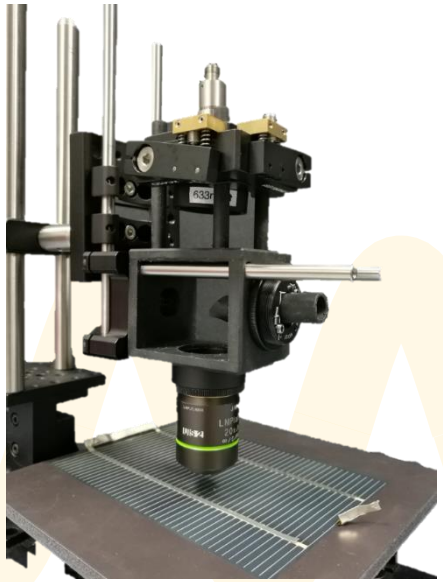
PV MODULE OPTIMIZATION

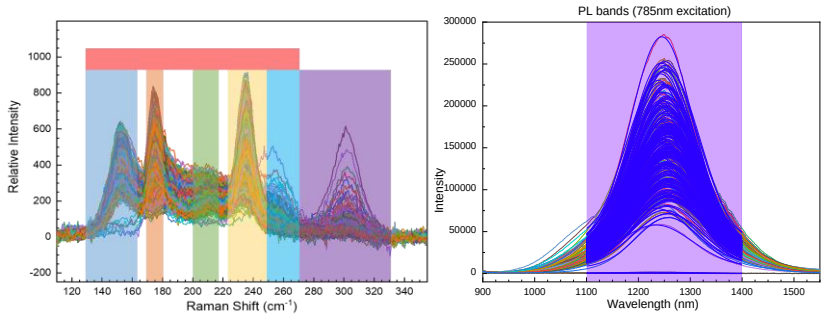
PROCESS MONITORING DEVELOPMENT

WINDOW DESIGN

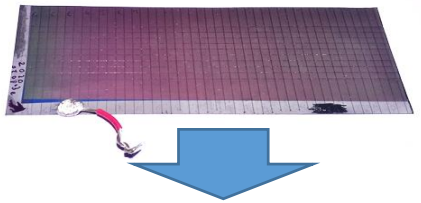
PROTOTYPE IMPLEMENTATION

PROTOTYPE TESTING





Advanced characterization

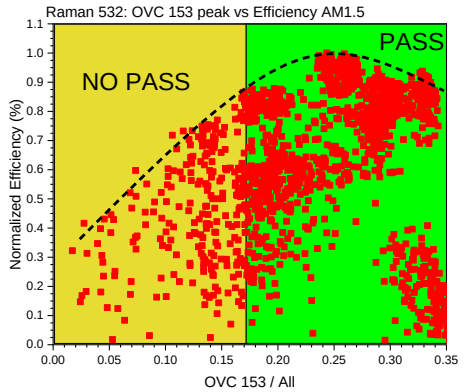


Large area analysis

Identification of CIGS device quality control indicators

Development of process monitoring metrologies with Integration time <10s

Design of optical components for a process monitoring inspection tool with resolution for detection 10% deviations



Quality control parameter

PROJECT PROGRESS

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PV MODULE OPTIMIZATION

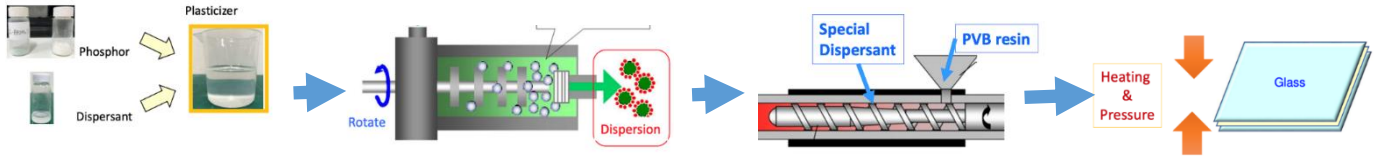
PROCESS MONITORING DEVELOPMENT

WINDOW DESIGN

PROTOTYPE IMPLEMENTATION

PROTOTYPE TESTING

LUMINESCENT COATING OPTIMIZATION



Formulation of new coating

Deposition of luminescent coating on 100x100 cm^2 glass with good transmittance and without color effects.

- ***Light concentration effect >x10***
- ***Transmittance 60% colorless (|a|<0.1 |b|<0.1)***

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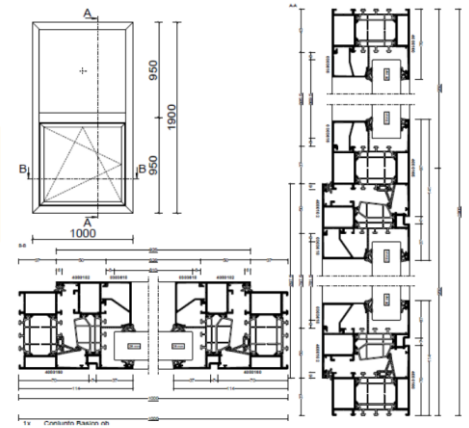
WINDOW STRUCTURAL AND ELECTRIC DESIGN



Development of smart frame where PV modules and electronics elements are integrated

PROJECT PROGRESS

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PV MODULE OPTIMIZATION

PROCESS MONITORING DEVELOPMENT

WINDOW DESIGN

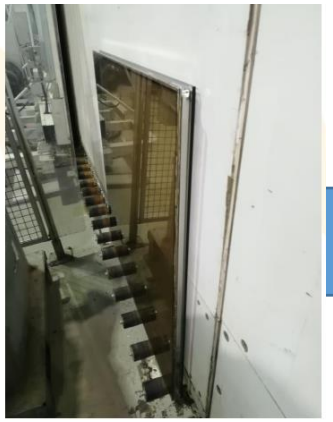
PROTOTYPE IMPLEMENTATION

PROTOTYPE TESTING

Customized solar module stripe fabrication

NIR-Module P_{out}=2.8W/m²
without concentration

Solar module coupling to laminate



IGU manufacturing

Electronic connections

- Light concentration effect >x10
- Transmittance 60% colorless (|a|<0.1 |b|<0.1)

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Integration on first functional prototyped

Under testing: preliminary results P_{out}=1.1W/m²

Identification of power loss mechanisms in light guiding and glass/PV module coupling

PROJECT PROGRESS

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PV MODULE OPTIMIZATION

PROCESS MONITORING DEVELOPMENT

WINDOW DESIGN

PROTOTYPE IMPLEMENTATION

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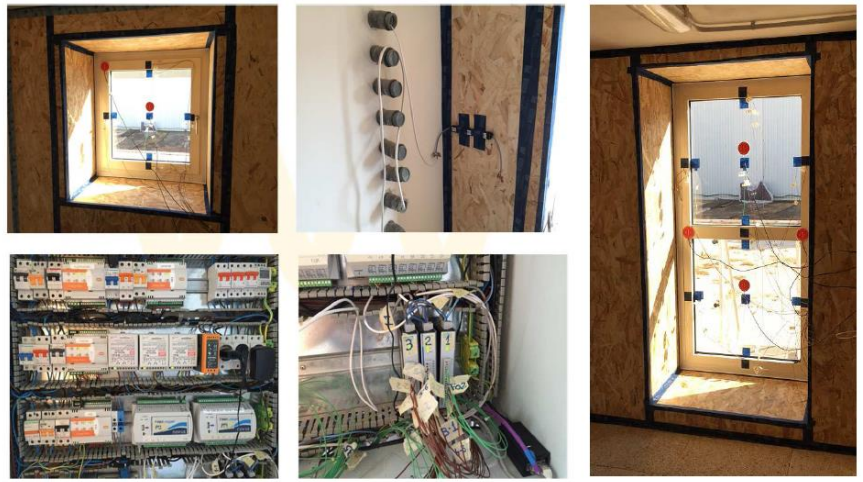

Different prototypes installed in ACCIONA's test cell in Sevilla for structural, climatic and photovoltaic assessment

PROTOTYPE TESTING

6 MONTH TESTING ➔ Provide information of PV efficiency and windows performance (thermal isolation and light transmittance

PROJECT ROADMAP

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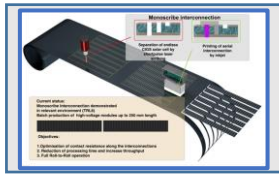

PV MODULES OPTIMIZATION

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PROCESS MONITORING DEVELOPMENT

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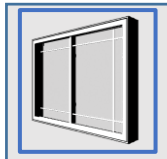

WINDOWS DESIGN

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PROTOTYPE IMPLEMENTATION

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TESTING & CERTIFICATIONS

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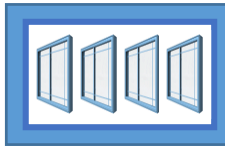

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PROJECT ROADMAP

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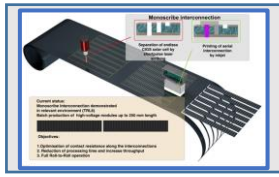

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PROCESS MONITORING

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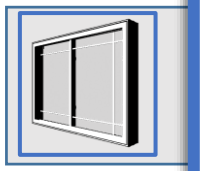

Implementation of new NIR–PV concepts in pilot line

Production of modules for windows manufacturing

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Implementation of new set of prototype optimizing the light coupling and optimized PV modules

Increase of 1.1W/m² to 30W/m²

PROTOTYPE IMPLEMENTATION

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TESTING & CERTIFICATIONS

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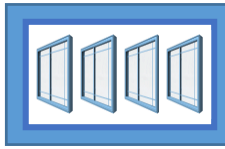

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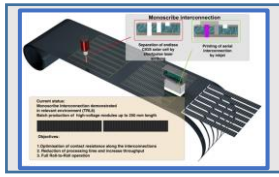

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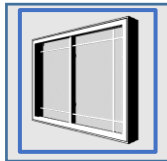

WINDOWS DESIGN

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Testing in controlled conditions (TESTCELL, ACCIONA) and certification of the windows

TESTING & CERTIFICATIONS

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WINDOWS FABRICATION

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PROJECT ROADMAP

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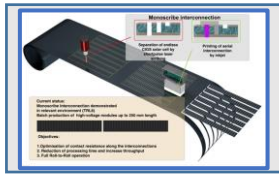

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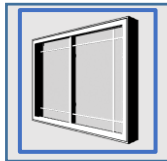

WINDOWS DESIGN

PHYSEE

Manufacturing 16 2m² windows for testing and the electronics for its evaluation in real conditions

TESTING & CERTIFICATIONS

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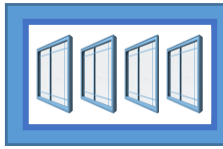

WINDOWS FABRICATION

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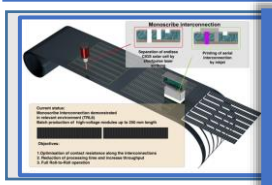
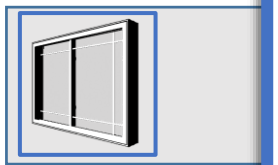
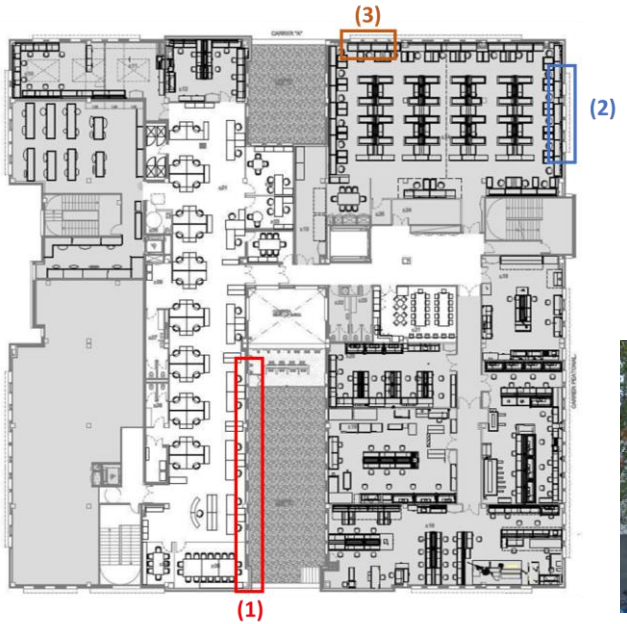
10/2019 — NOW 10/2020 — 12/2021

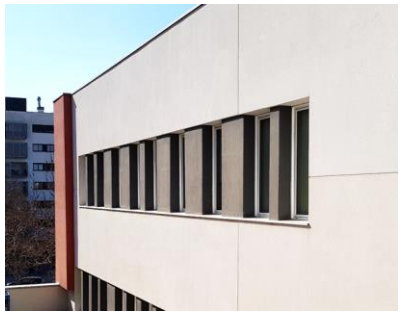




Finally testing the windows in real building

Installation of 32m^2 of windows in different light illumination conditions





June 2021

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- The intermediate steps required for the implementation of first functional prototypes have been successfully achieved
  - Development of first generation of PV modules optimized for the NIR range (1eV) and implementation of industrial process monitoring technology
  - Implementation of functional coating for light down-conversion without colour impact
  - Development of a structural and electrical integration window architecture compatible with standard windows

- First functional prototypes have been implemented and the main power loss mechanisms have been identified

Perspectives: After optimization of the PV modules, luminescent coating and NIR light-guiding coupling for final implementation in real building demo-site, the P_{out} is expected to rise up to 30W/m^2, enough for sensorica and autonomous IoT-based technologies for smart buildings.

THANK YOU FOR YOUR ATENTION

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