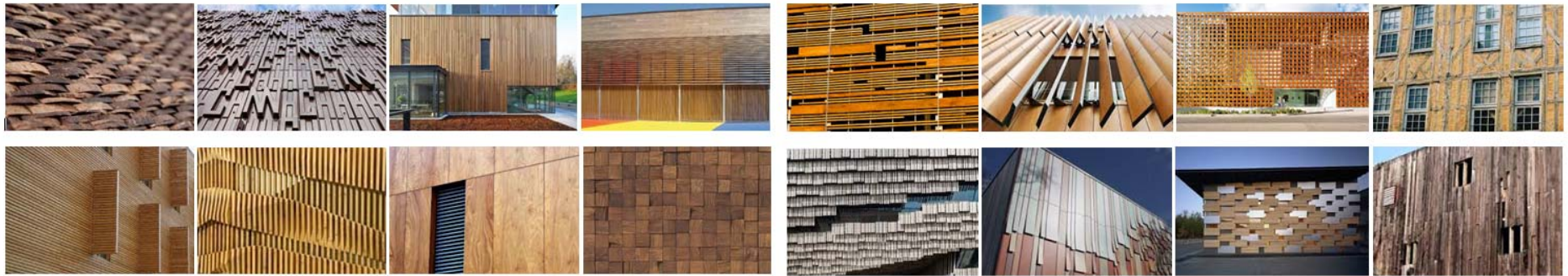


Bio-materials for building envelope - expected performance, life cycle costing & controlled degradation

Anna Sandak & Jakub Sandak



(RBSI14Y7Y4) within a call SIR funded by MIUR



Construction market

Is one of the major employment sectors across the EU
(496 billion € of value added).

The sector provides 20 million direct jobs and contributes to
about 10 % of the EU's GDP

Represents a large proportion
of the consumption of the
earth's non-renewable
resources in terms of:

- materials used for
construction
- energy consumption for
operation of buildings



Challenges that construction sector is facing currently



- **Stimulating demand:**
efficiency improvements in existing buildings and renovations



- **Training:**
improving specialized training and making the sector more research attractive



- **Innovation:**
more active uptake of new technologies

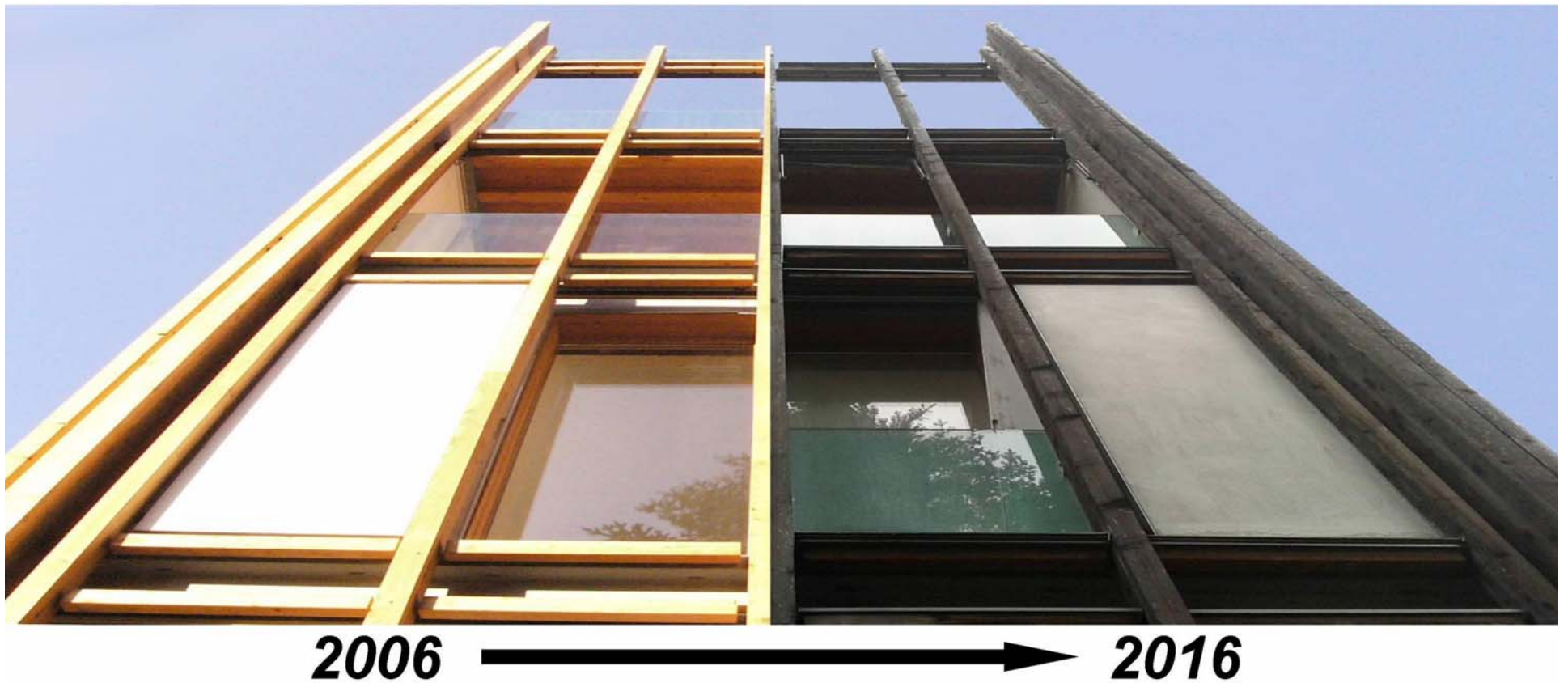
IVALSA experiences



Wood performance



Appearance change of the unprotected wooden structure in time: are we aware of that?



Bio4ever goals



Promote innovative bio-materials with minimal environmental impact

Establish original construction strategies by reducing gaps between expectations of designers, developers and consumers



Integrate science and experiences for understanding functional and aesthetical performance of bio-materials during service life

Improve sustainability of bio-materials by controlling its transformation at the end of use



Create new business opportunities for the construction industry by using validated material solutions and design tools



Research focus

- design and management of buildings and constructed assets
- proper choice of materials
- efficient energy use
- the physical, functional and aesthetical performances of building materials
- interaction with the urban and economic development and management

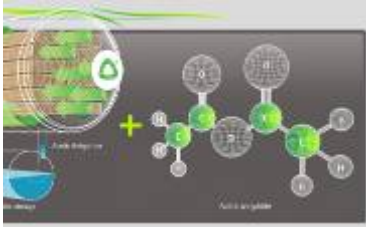
Aesthetical aspects of service life, specific consumer demands and preferences, as well as the functionality of building assemblies are the central focus of research 9

Bio-based construction materials

Bio-based products



Modified wood



23 companies & research units from
16 countries

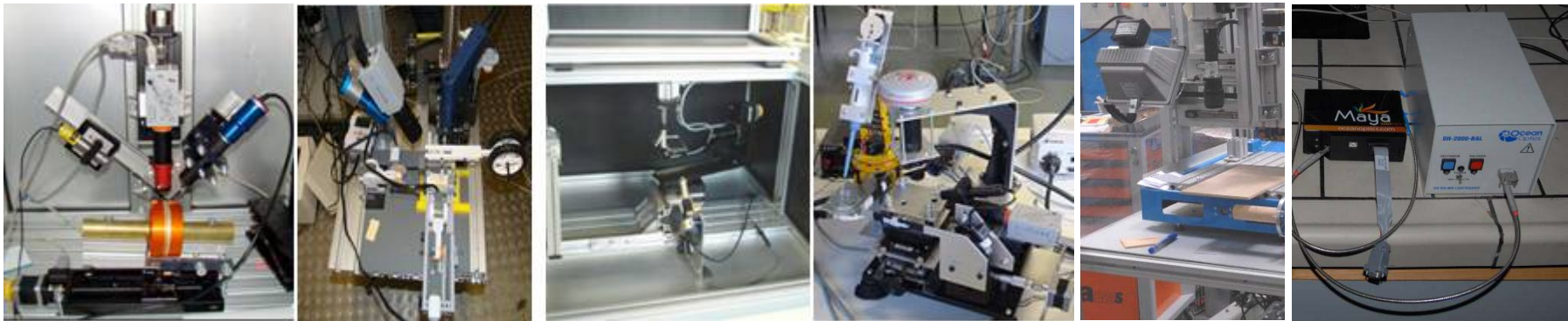
Experimental samples types

- Different wood species
- Modified wood: thermally, chemically
- Composites pannels
- Silicone and silicate based coatings
- Nano coatings
- Melamine treated wood
- Copper treated wood
- Bamboo cladding
- Reconstituted slate made with bio-resin
- Painted wood
- Waxed wood
- Shou-sugi-ban

**Totally around 100 different bio-materials
to be evaluated**

Multi-scale & multi-sensors characterization

An integrated set of prototype and ordinary instruments for determination of bio-materials properties at different scales (from nano to macro) at the **Lab. of Surface Characterization**



color CIE Lab + VIS + NIR + MIR + HI + gloss + XRF + microscopy + roughness + X-ray + wettability + surface pattern/texture + image analysis + aesthetics & customer preferences

Service life performance: living lab

natural weathering of bio-materials on the structure designed by Renzo Piano and installed at CNR-IVALSA (San Michele All'Adige)

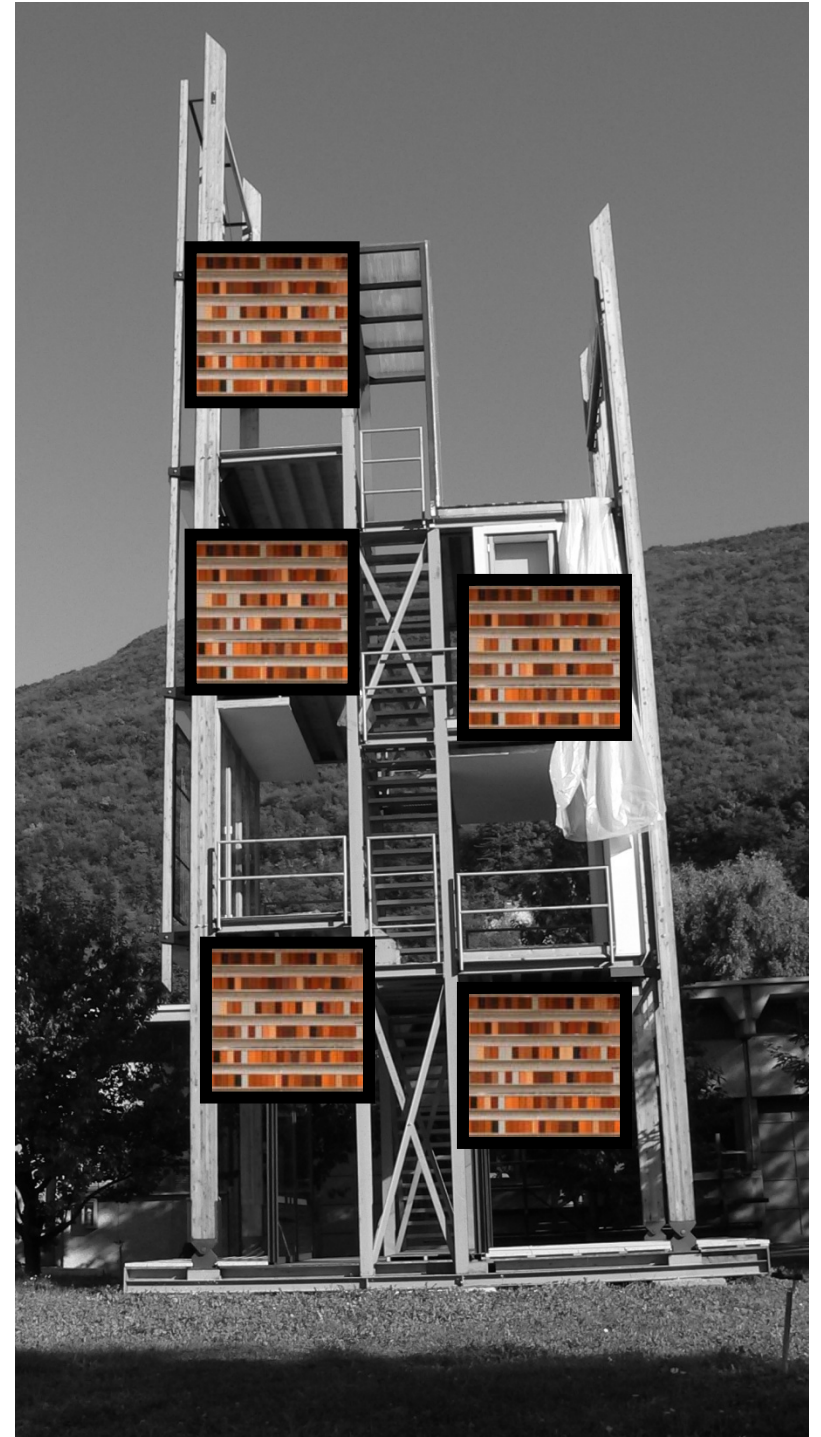


30 months in total according to the schedule

test start	3 months	6 months	9 months	12 months	18 months	24 months	30 months
april 2016	july 2016	october 2016	january 2017	april 2016	july 2017	january 2018	july 2018
	1	8					
	2		9				
	3			10			
	4				11		
	5					12	
	6						13
	7						

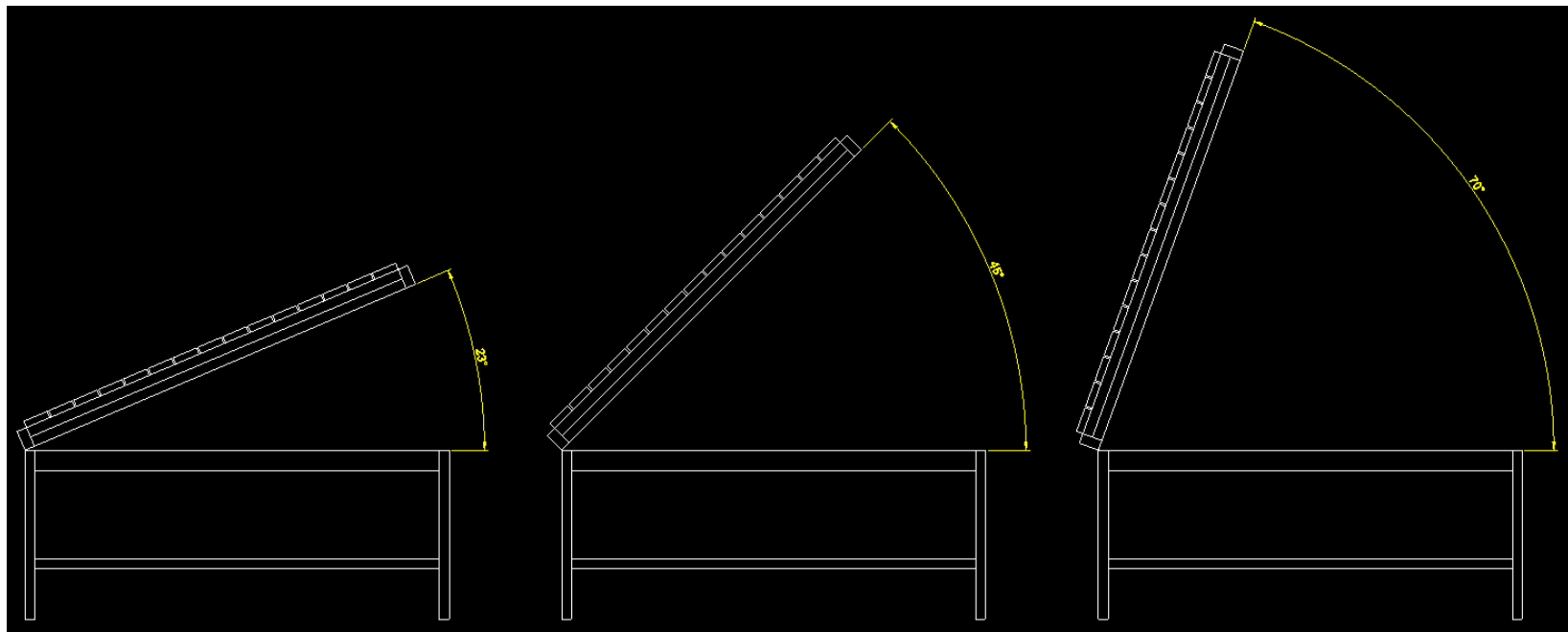
Measurement in the laboratory

- samples will be exposed for different weathering doses (periods) and characterized in the laboratory with color CIE Lab + VIS + NIR + MIR + HI + gloss + XRF + microscopy + roughness + X-ray + wettability + surface pattern/texture + image analysis
- 2 replicates/biomaterial/cycle



Service life performance: natural weathering

- robotized stand, (South exposure, variable inclination 23° , 45° and 70°)

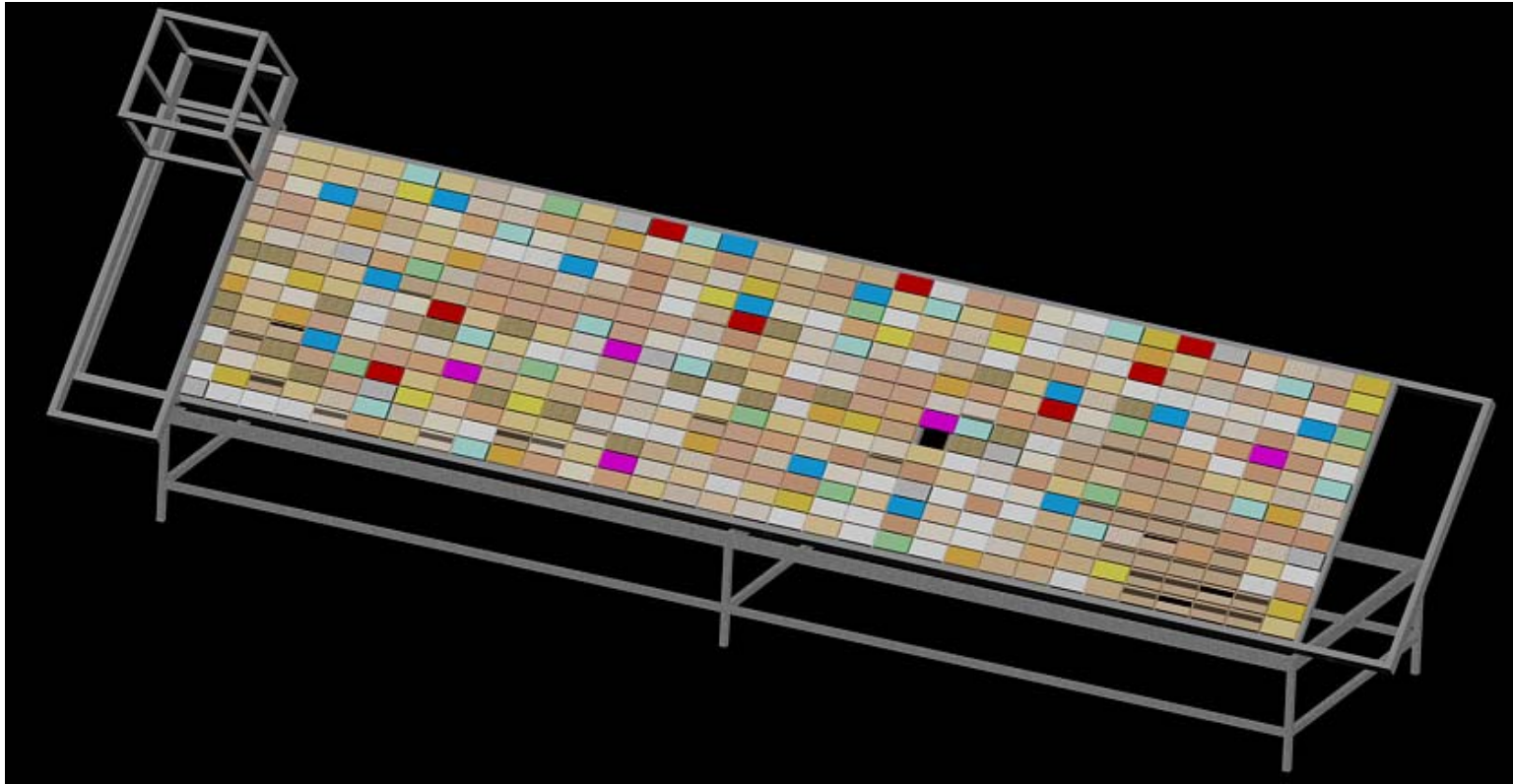


30 months continuously

spring 2016

July 2018

Robotized scanner



- samples will be automatically characterized (weekly) with a multi sensor scanner (MicroNIR + image + hamamatsu VIS + gloss) installed on the stand in-field
- 3 replicates/bio-material

Service life performance: artificial weathering

- SUN-test, QUV
- 3 replicates/bio-material/test

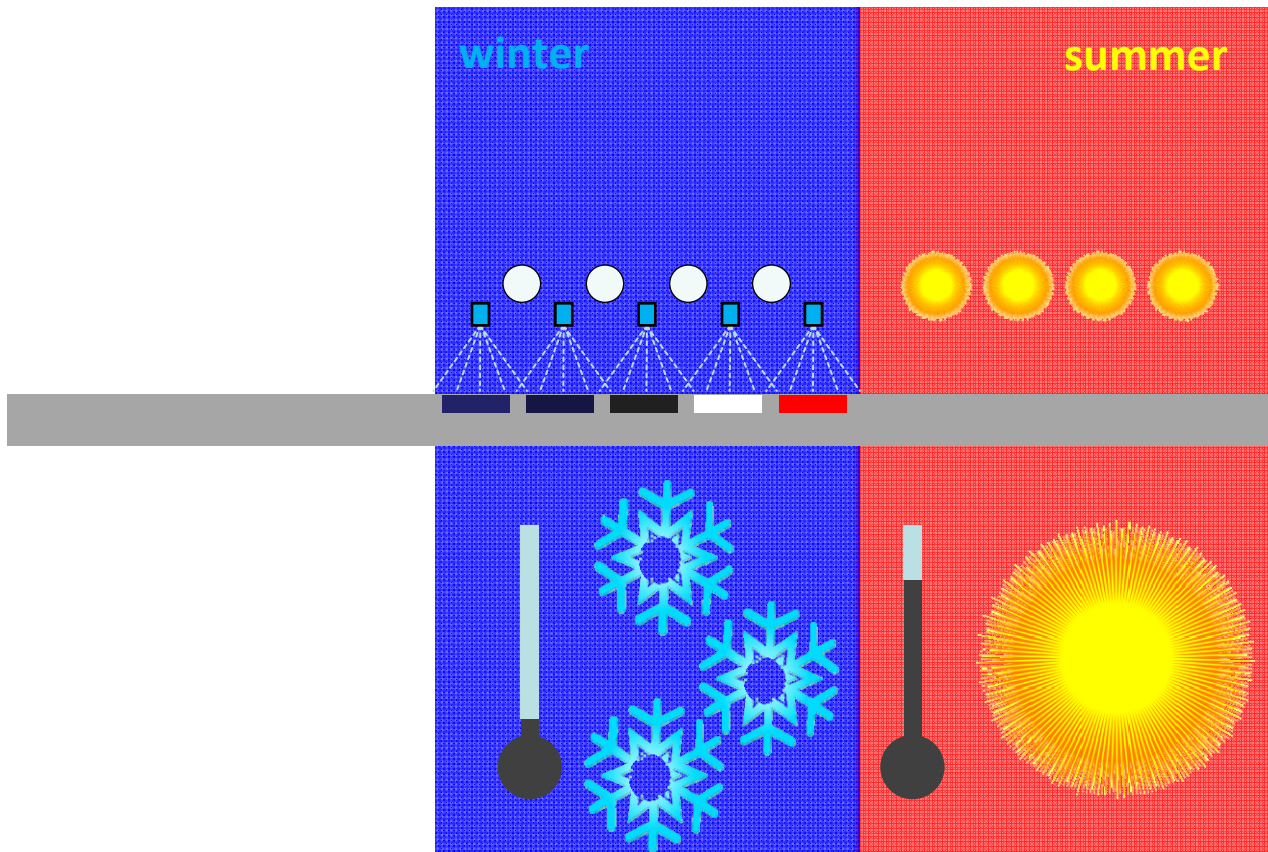


according to standard UNI EN 927-6

April 2016

July 2018

Service life performance: custom weathering machine



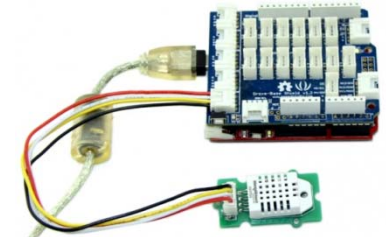
Service life performance: model house

- Natural weathering of bio-materials on the model structure in order to investigate influence of architectonic details on degradation rate



digital camera

weather station



Arduino moisture & temperature

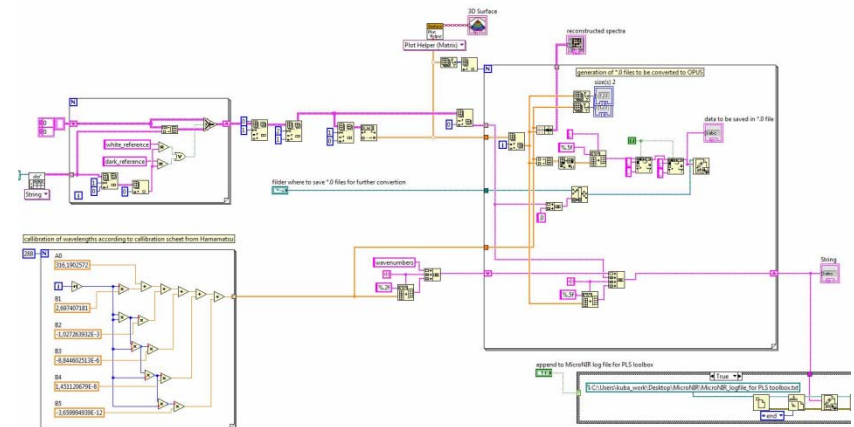
30 months continuously

spring 2016

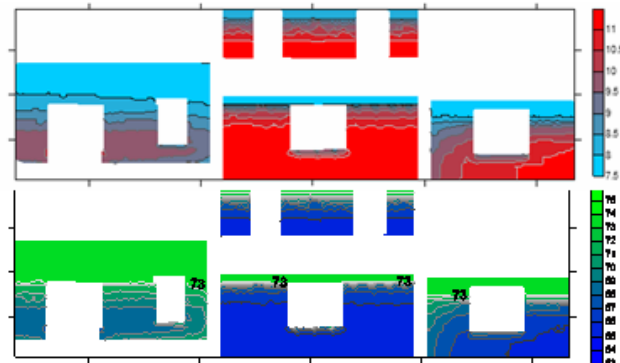
July 2018

Multi-scale modeling and simulation of material deterioration

- Selection of the most suitable data pre- and post- processing
- “Data Fusion” for the integration of experimental data
- Multivariate classification of bio-materials quality/functionality - special focus on aesthetical aspect



Design of dose-response model for material deterioration at different scales



Validation of models and tools within field trials



International network:

COST Action FP 1006 Bringing new functions to wood through surface modification

COST Action FP 1101 Assessment, Reinforcement and Monitoring of Timber Structures

COST Action FP 1303 Performance of bio-based building materials

COST Action FP 1407 Understanding wood modification through an integrated scientific and environmental impact approach (ModWoodLife)

COST Action TU1403 Adaptive Facades Network

IUFRO

SISNIR Italia

IRGWP

Integration of models with software tools for architects

BI@4ever &



time series
of pictures



interactive
visualization

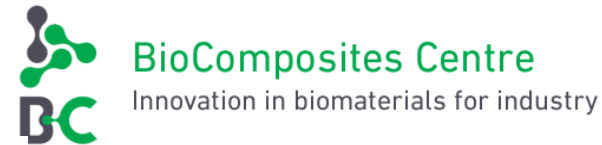


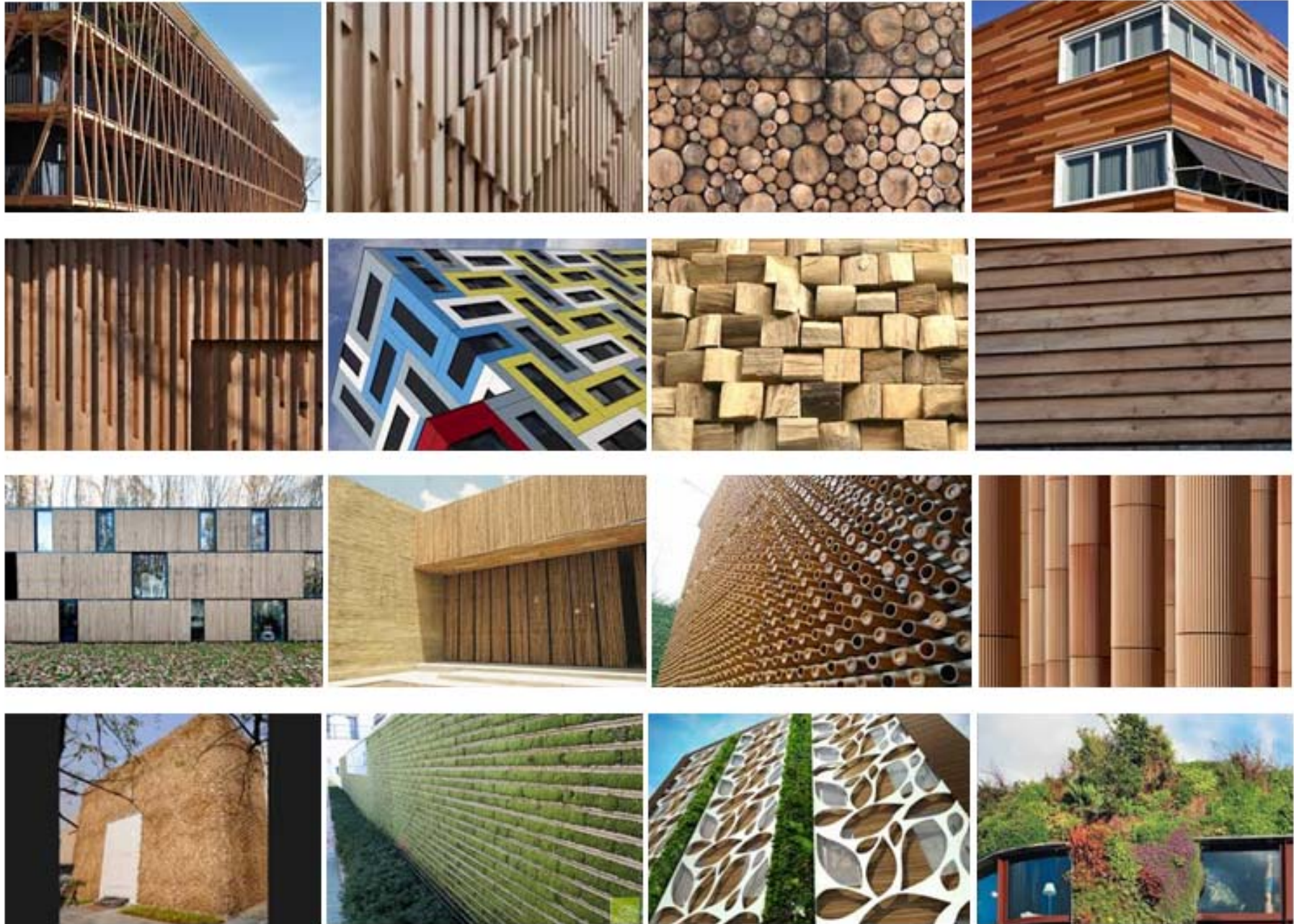
Enhancing the way we perceive bio-materials

BIO4ever project partners



Univerza v Ljubljani





www.bio4everproject.com



BI**4ever**