20th International Symposium of MASE
"RESILIENT STRUCTURES"
September, 28th – 29th , 2023, Skopje, N. Macedonia

ERIES
ENGINEERING RESEARCH INFRASTRUCTURES FOR EUROPEAN SYNERGIES

European Research Synergies Towards Loss and Risk-driven Mitigation Approaches

Presenter: Gerard J. O'Reilly[1]

1) Centre for Training and Research on Reduction of Seismic Risk (ROSE Centre)
Scuola Universitaria Superiore IUSS Pavia, Pavia, Italy

ROSE
Centre for Training and Research on Reduction of Seismic Risk

IUSS
Scuola Universitaria Superiore Pavia

PROJECT OVERVIEW

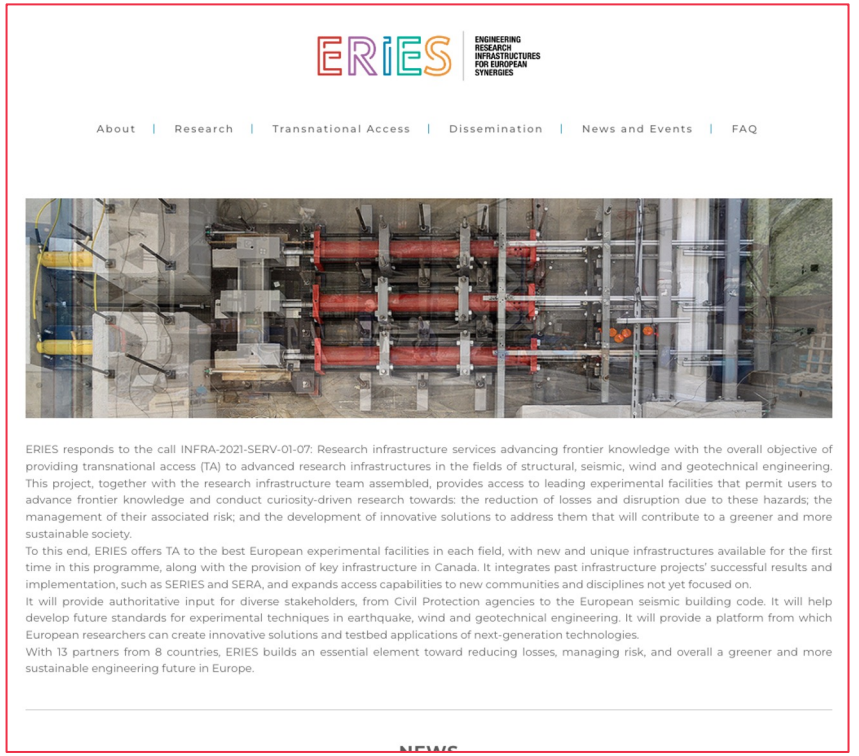
ERIES
ENGINEERING RESEARCH INFRASTRUCTURES FOR EUROPEAN SYNERGIES

- The objective of ERIES is to provide transnational access (TA) to research infrastructures to conduct research that will advance frontier knowledge related to seismic, wind and geotechnical hazards
- Funding: European Commission Horizon Europe

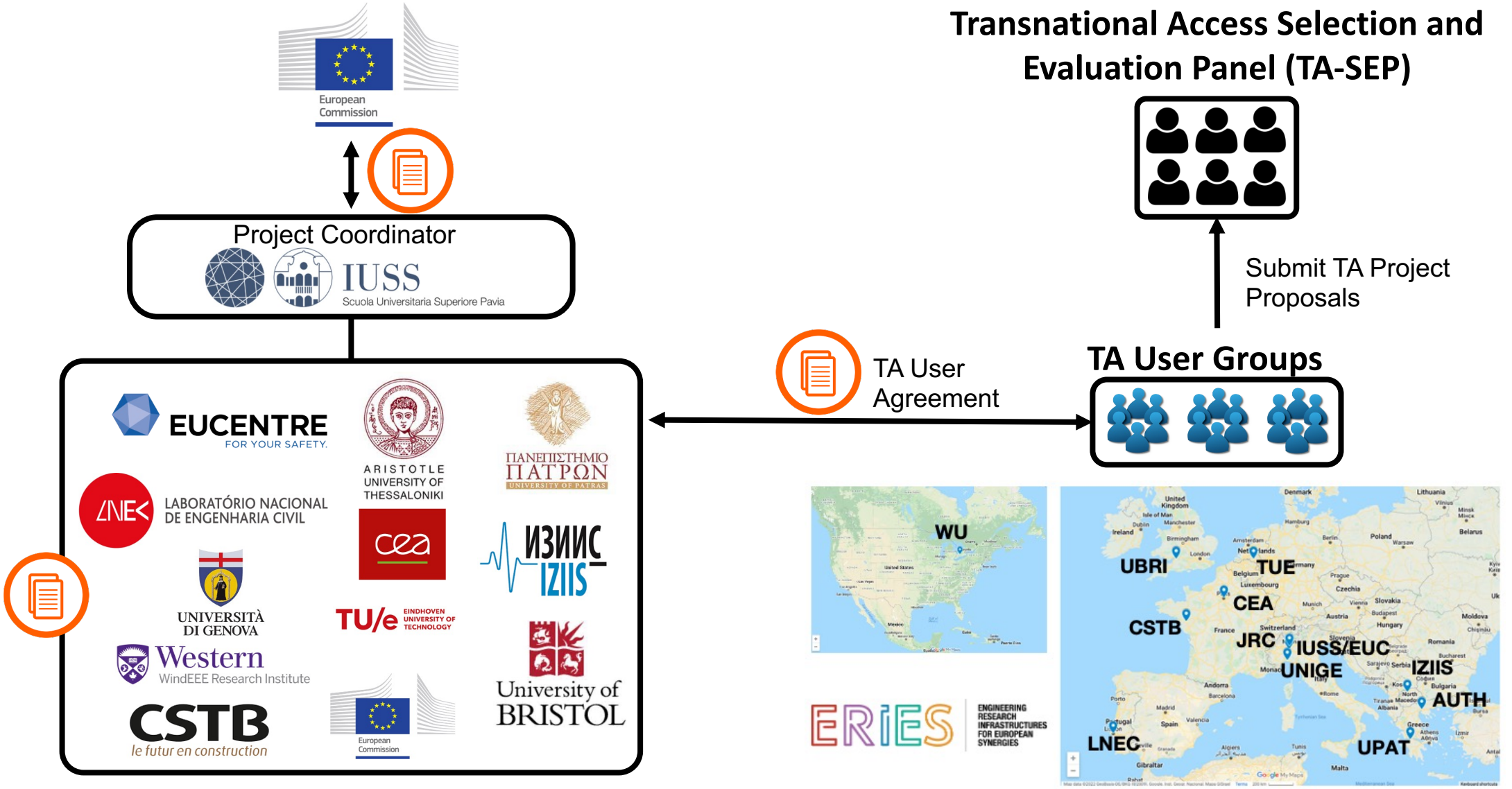
European Commission

Horizon Europe

- Total Budget: €11,616,118
  - €10,616,225 European Commission Contribution
  - €999,892 UKRI Contribution
- Duration: 4 years (01/06/2022 – 31/05/2026)



Website: www.eries.eu
Email: eries@iusspavia.it


European Commission
Project Coordinator
IUSS
Scuola Universitaria Superiore Pavia
EUCENTRE
FOR YOUR SAFETY.
ARISTOTLE UNIVERSITY OF THESSALONIKI
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ
UNIVERSITY OF PATRAS
LNEC
LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL
cea
ИЗИИС
IZIIS
UNIVERSITÀ DI GENOVA
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY
Western
WindEEE Research Institute
University of BRISTOL
CSTB
le futur en construction
European Commission
TA User Agreement
Transnational Access Selection and Evaluation Panel (TA-SEP)
Submit TA Project Proposals
TA User Groups
WU
UBRI
TUE
CEA
CSTB
JRC
IUSS/EUC
UNIGE
IZIIS
AUTH
LNEC
UPAT
ERIES
ENGINEERING RESEARCH INFRASTRUCTURES FOR EUROPEAN SYNERGIES

ERIES Research Infrastructures

1. IUSS-EUC – Pavia, Italy
2. UPAT – Patras, Greece
3. UBRI – Bristol, UK
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5. LNEC – Lisbon, Portugal
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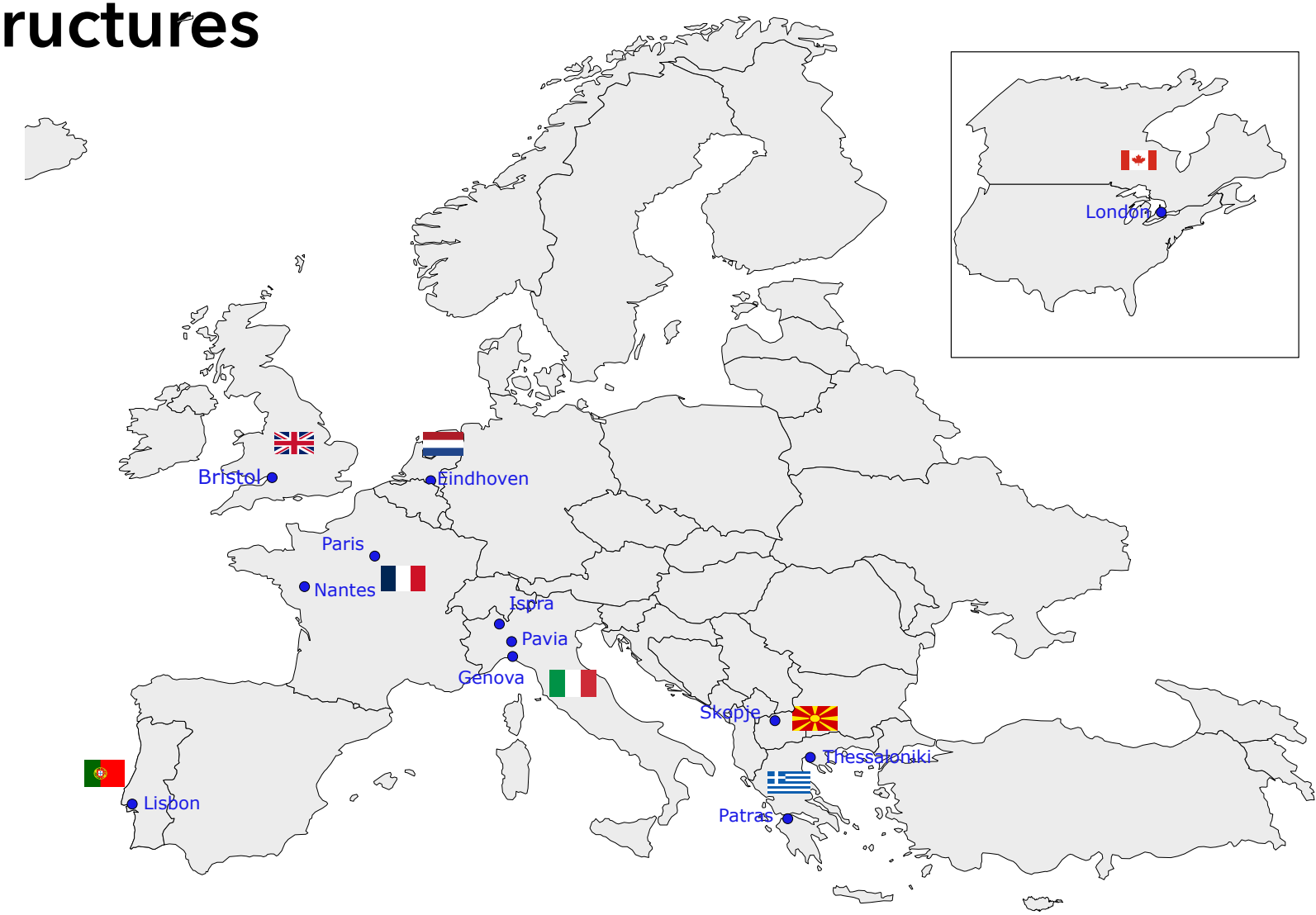
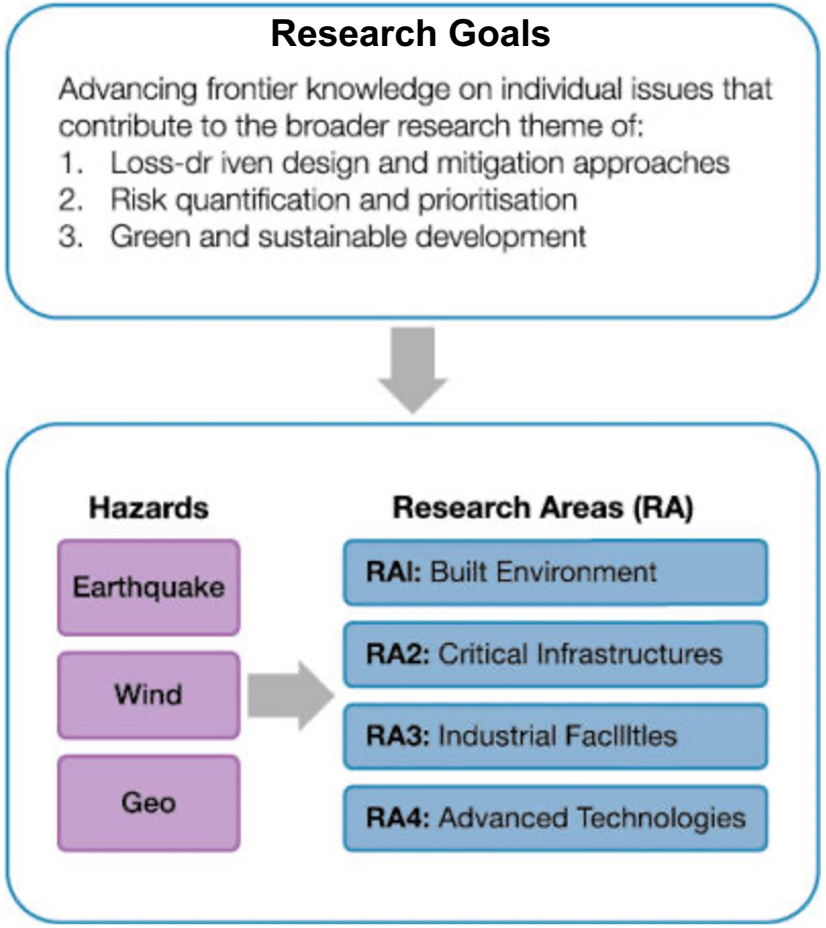
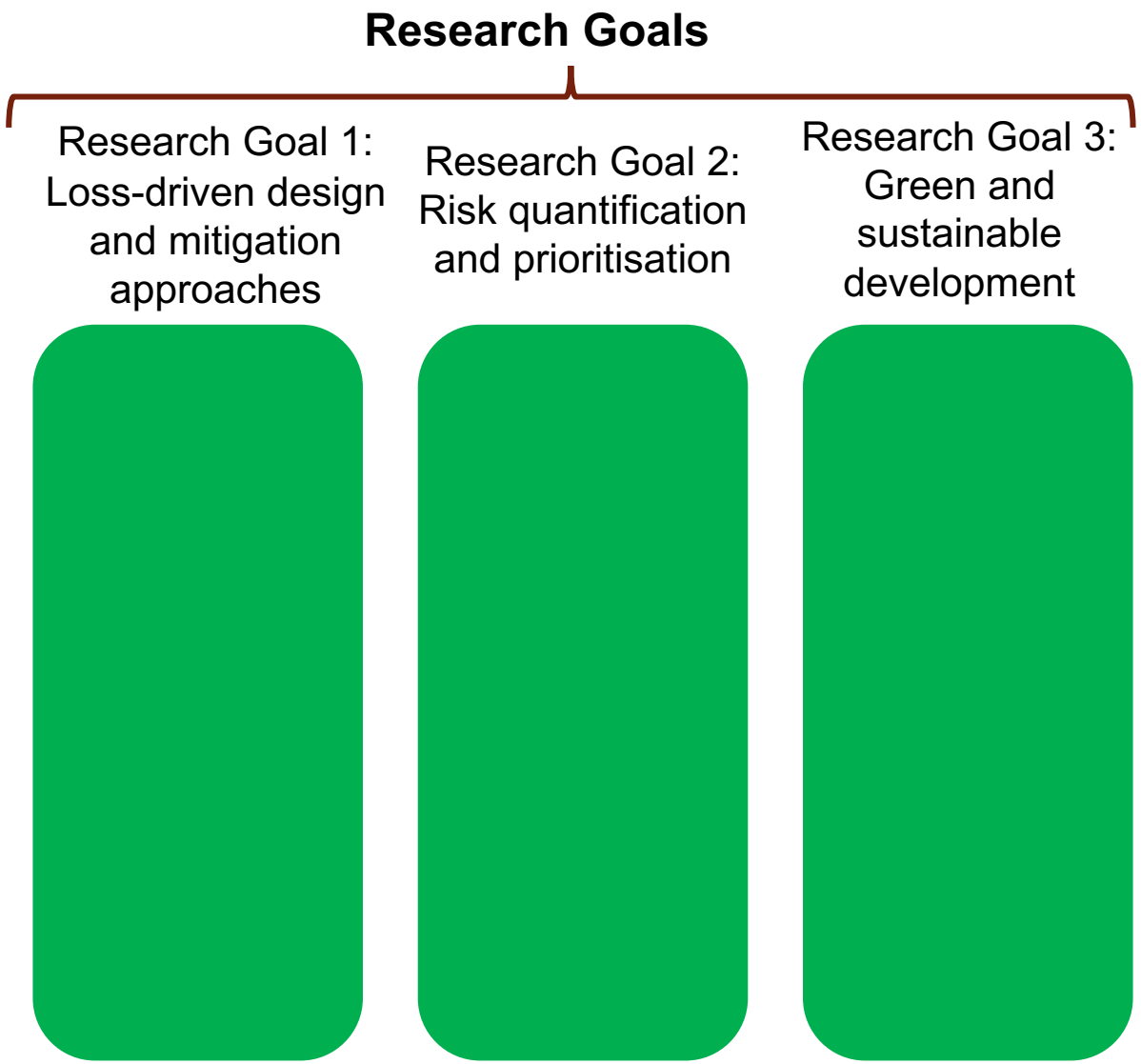
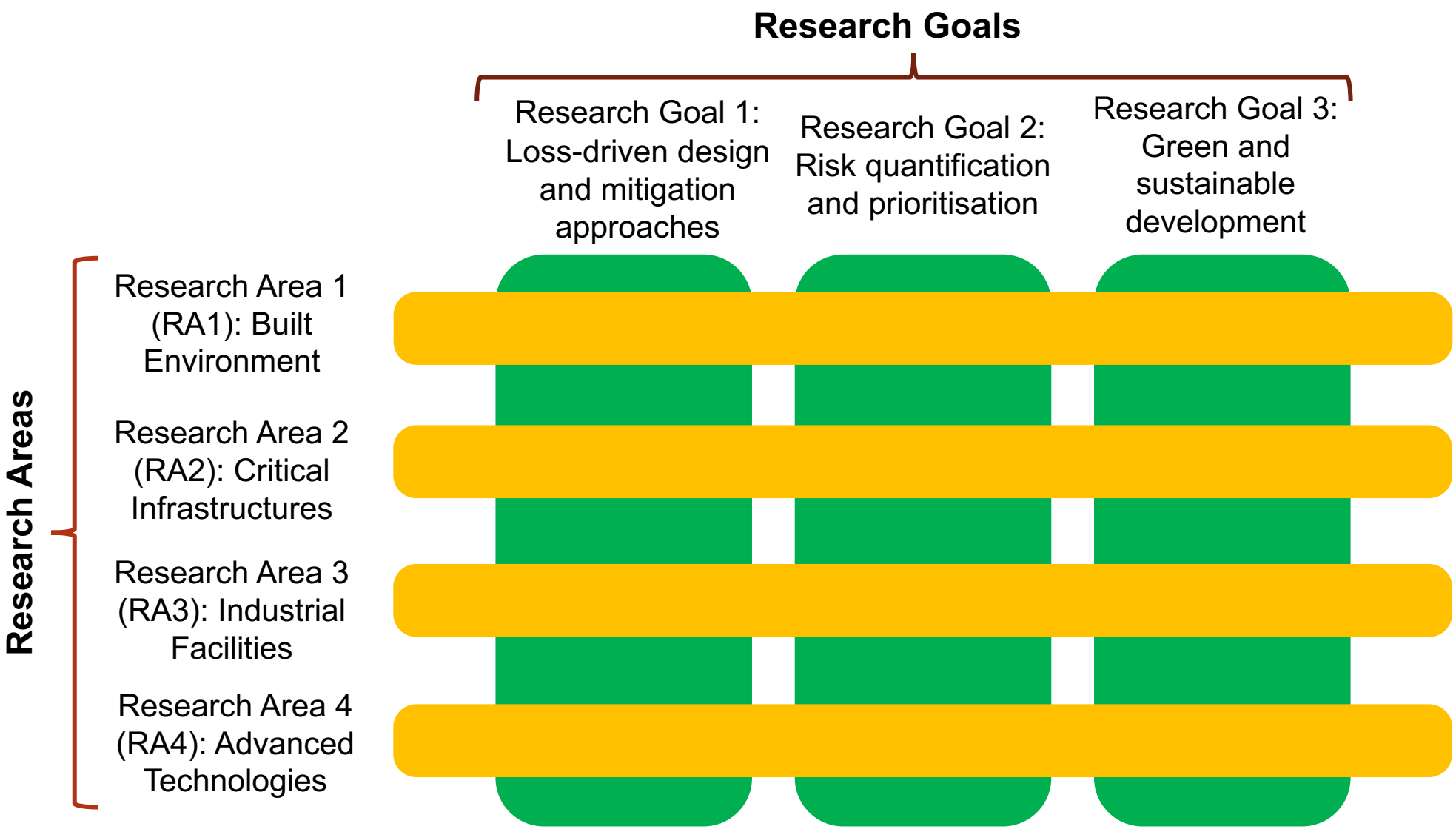


RESEARCH GOALS

- It comprises three main research goals shown which TA user projects shall strive to address
- ERIES will advance frontier knowledge related to seismic, wind, and geotechnical hazards
- Research will be carried out with respect to these three hazards and in one of the four research areas listed




Research Goals
Research Goal 1: Loss-driven design and mitigation approaches
Research Goal 2: Risk quantification and prioritisation
Research Goal 3: Green and sustainable development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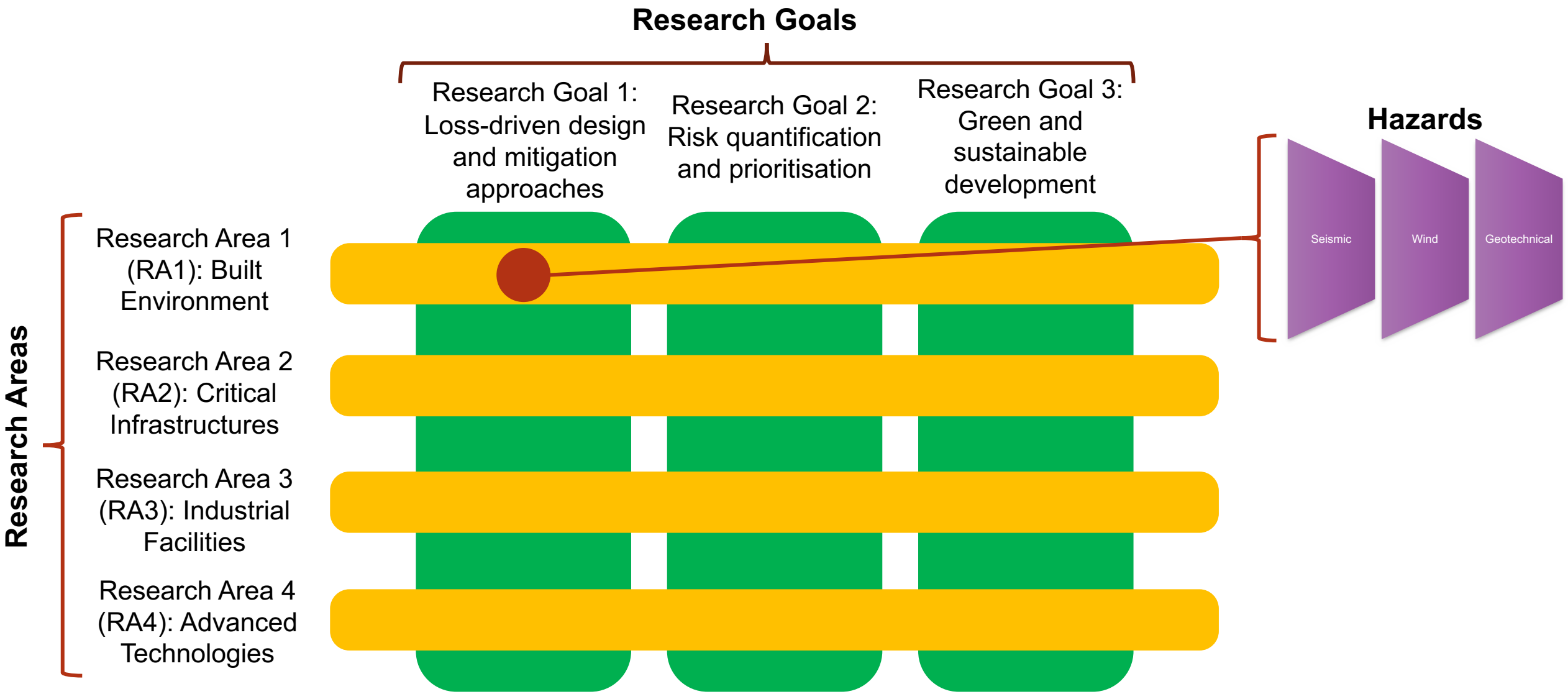
Research Areas
Research Area 1 (RA1): Built Environment
Research Area 2 (RA2): Critical Infrastructures
Research Area 3 (RA3): Industrial Facilities
Research Area 4 (RA4): Advanced Technologies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Hazards
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Wind
Geotechnical
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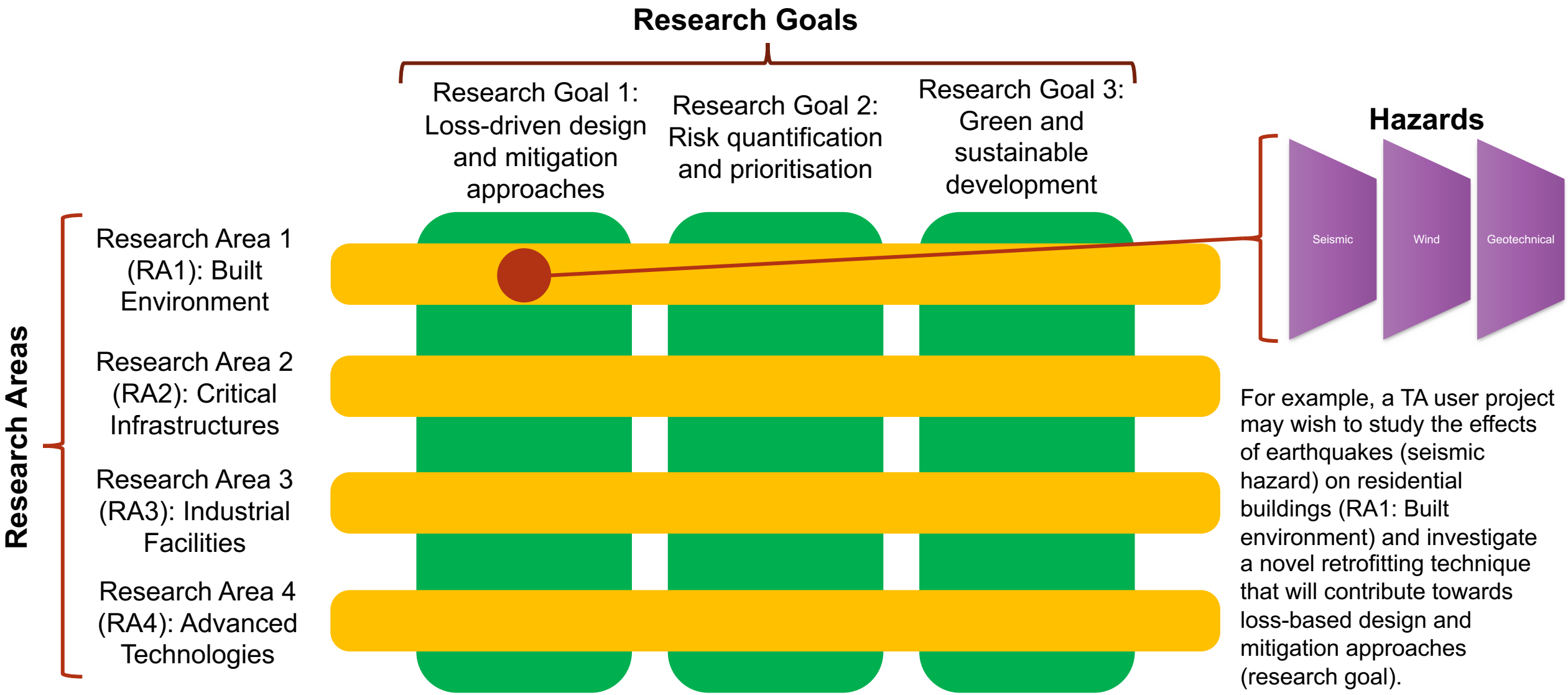
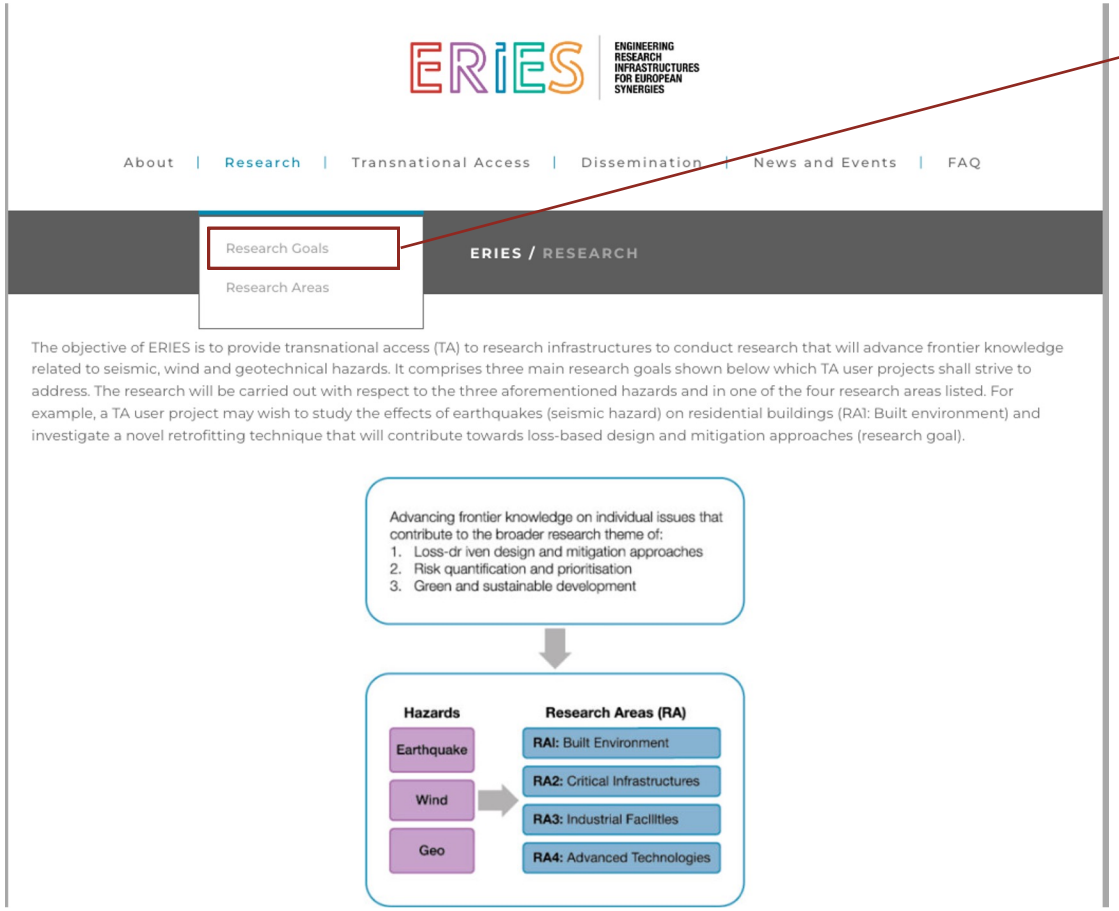


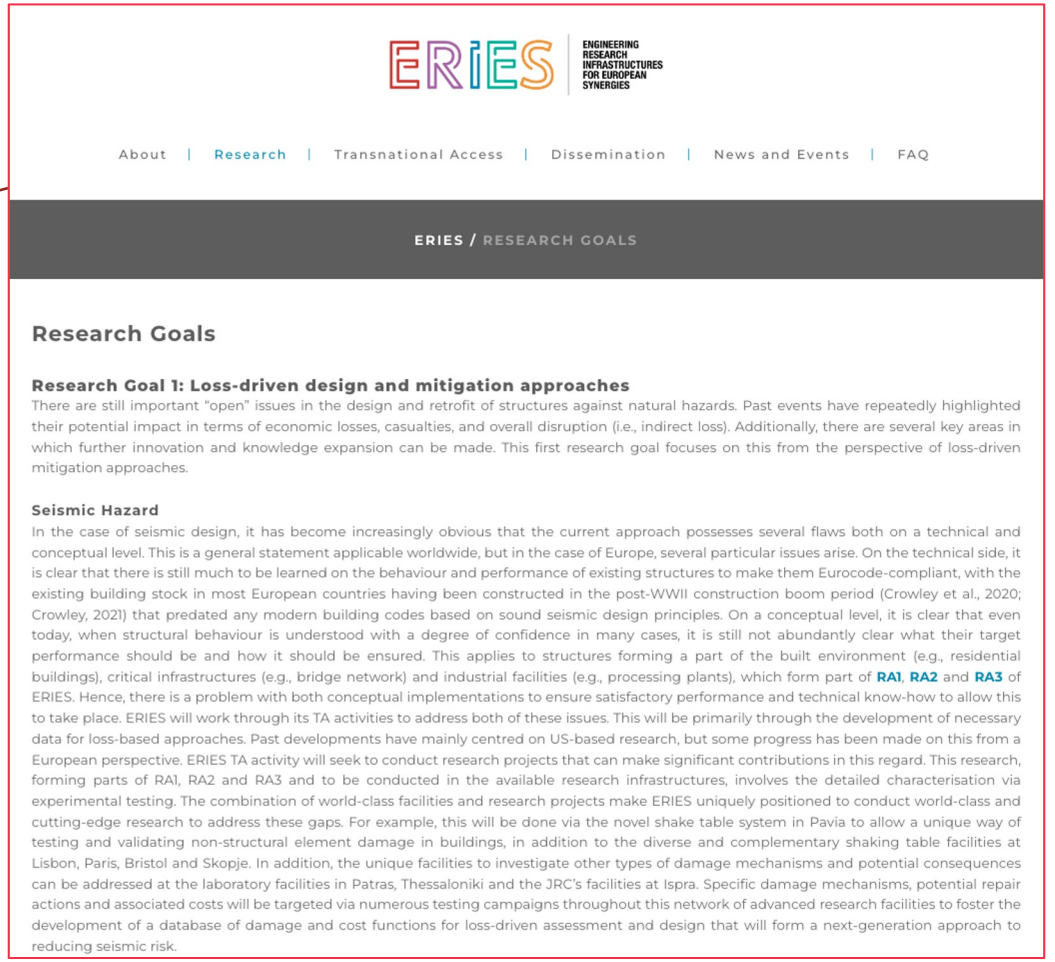
For example, a TA user project may wish to study the effects of earthquakes (seismic hazard) on residential buildings (RA1: Built environment) and investigate a novel retrofitting technique that will contribute towards loss-based design and mitigation approaches (research goal).

RESEARCH GOALS

https://eries.eu/

- Specific details can be found on the project website





RESEARCH AREAS

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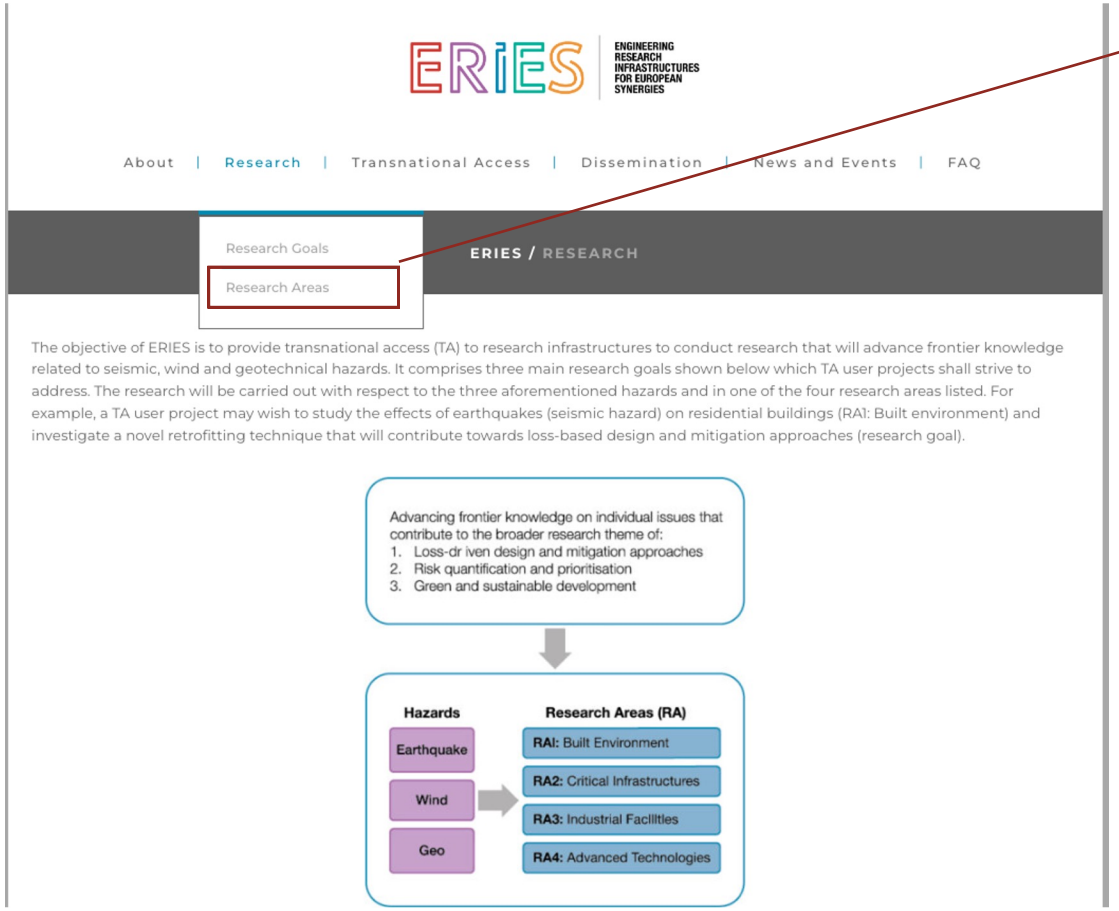

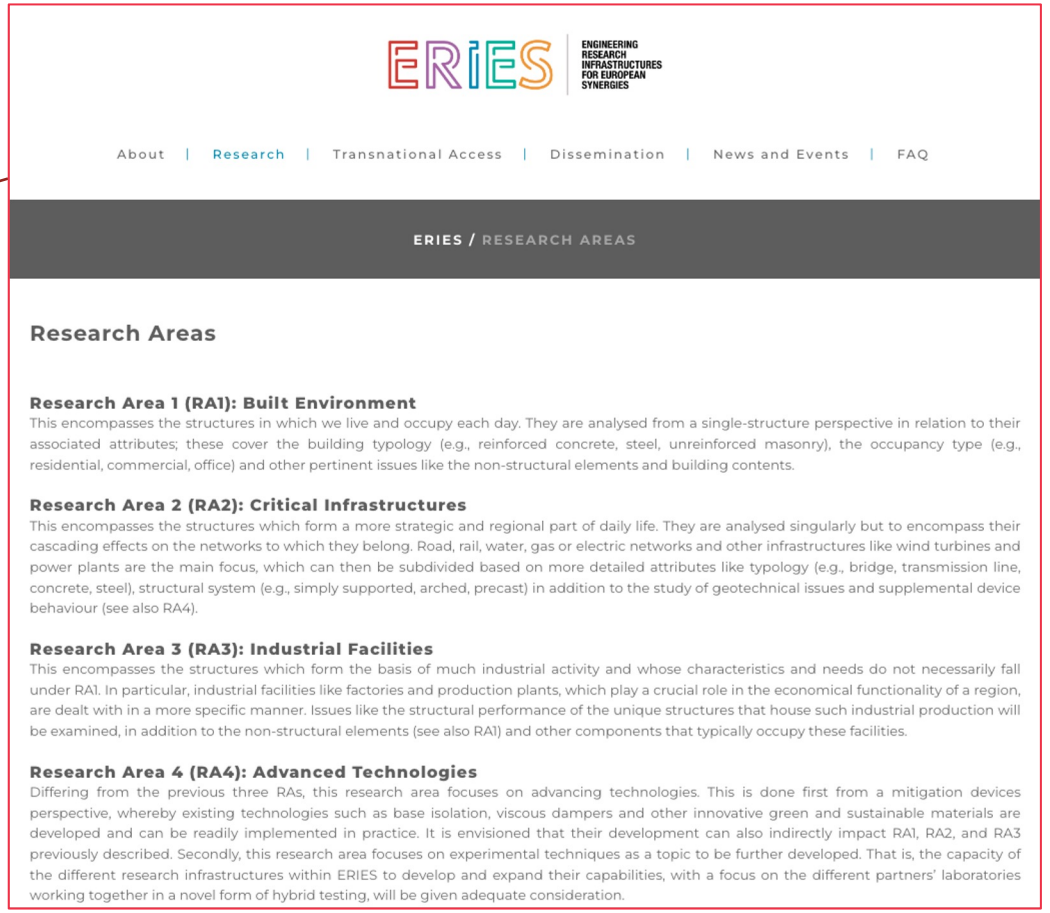

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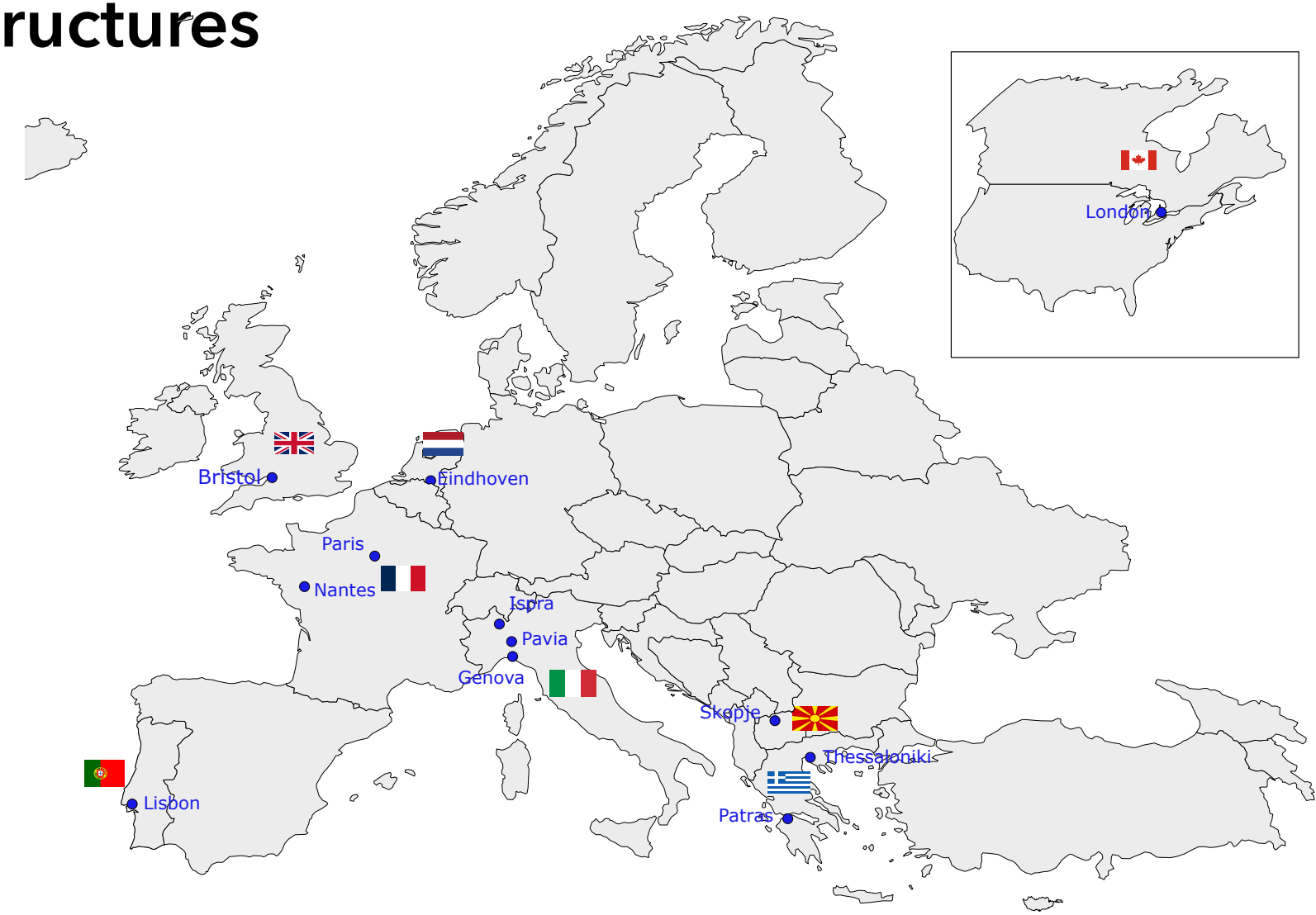
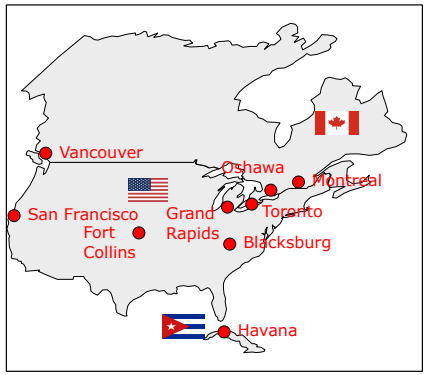


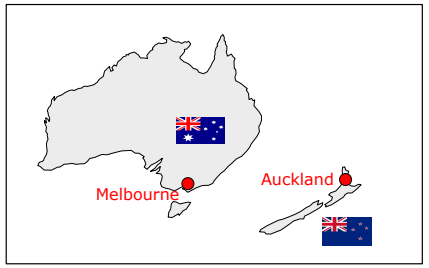
User Group Distribution (1st and 2nd Call)

- Geographical diversity

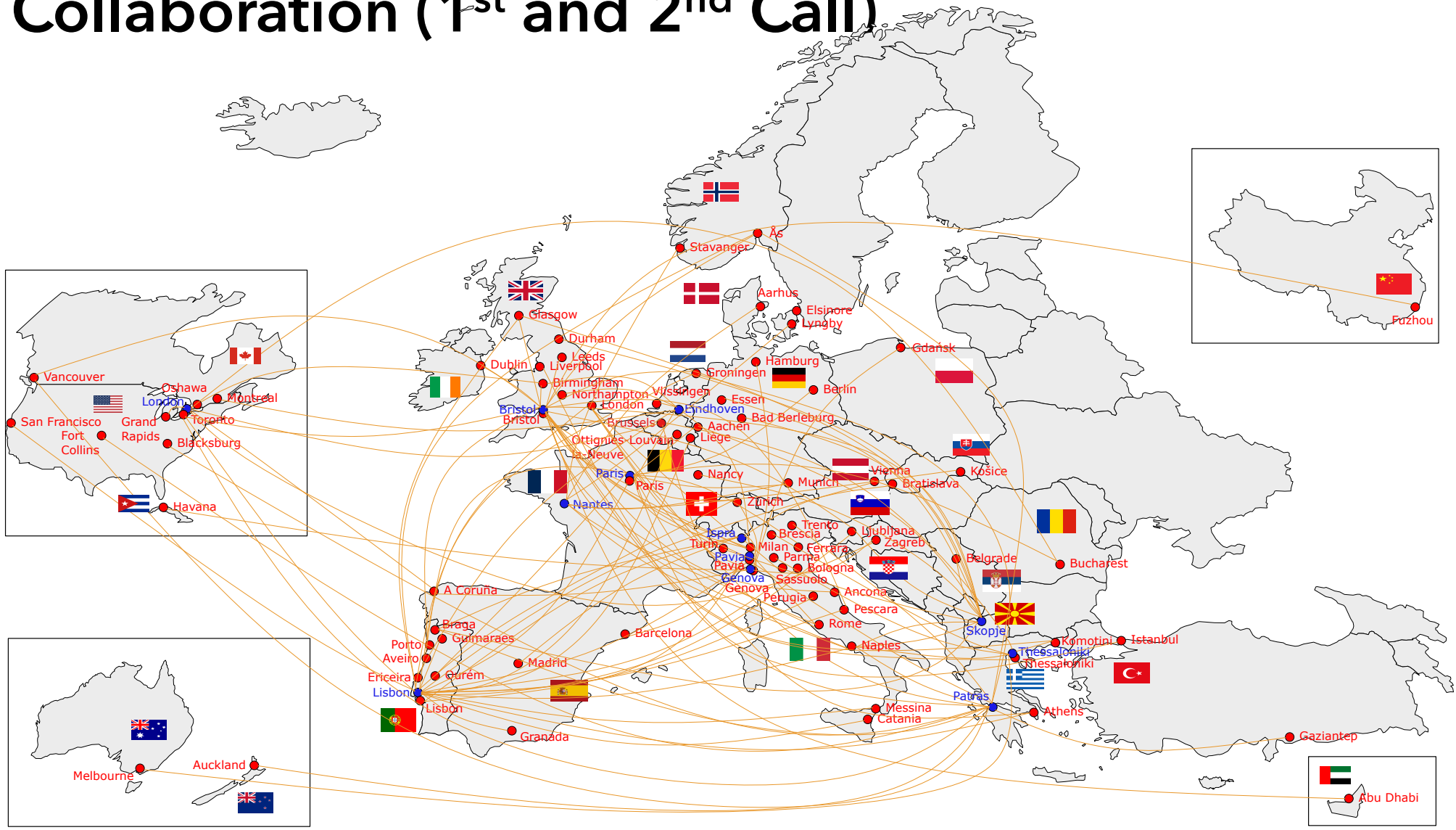
Users from:

- Europe
- North America
- Oceania
- Asia



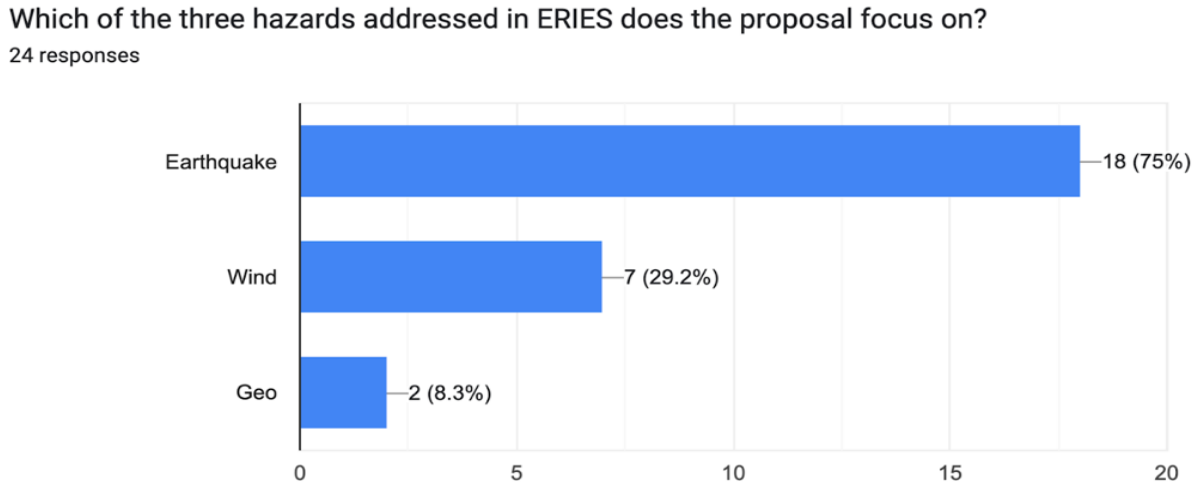


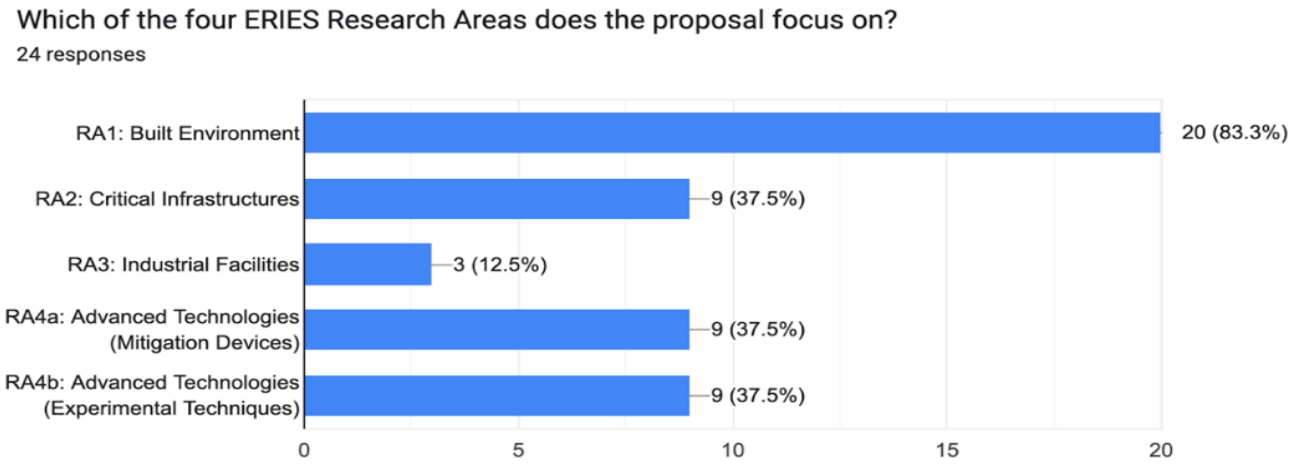
User Group Collaboration (1st and 2nd Call)



Transactional Access - 1st call

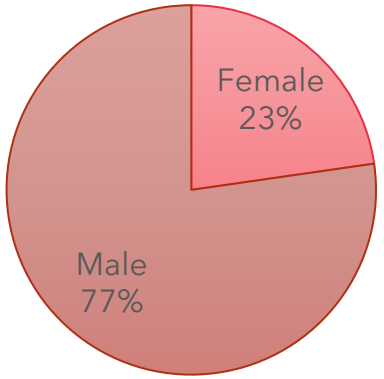
- 24 applications from 10 different countries around Europe
- Transactional access (TA) to infrastructures in the fields of structural, seismic, wind, and geotechnical engineering
- Majority of proposals focus on earthquake related research areas
- 5 research areas where the proposal focuses on with the majority related to Built Environment

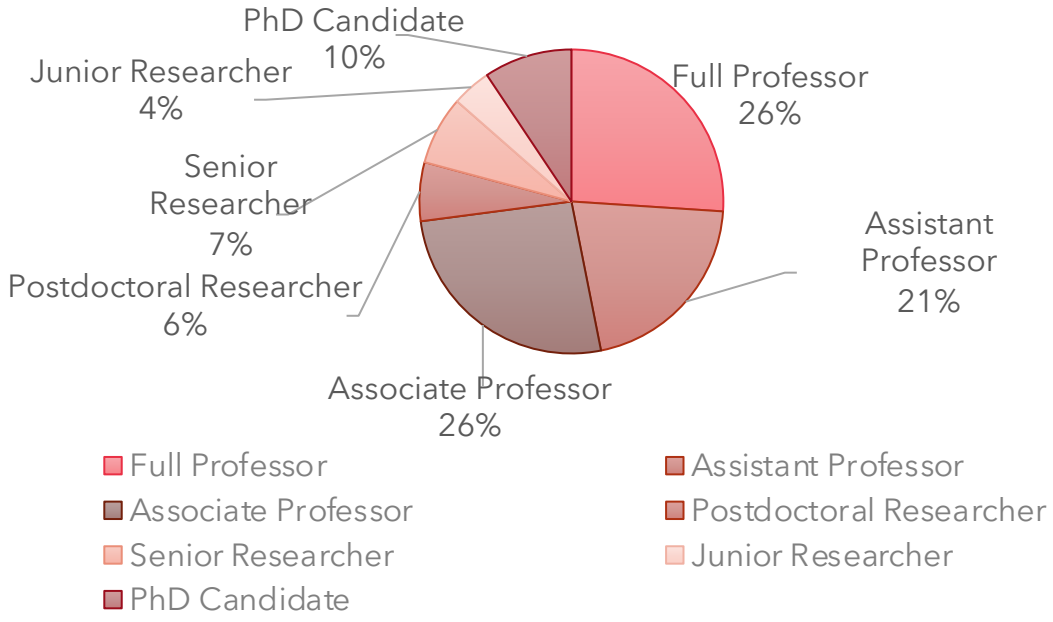


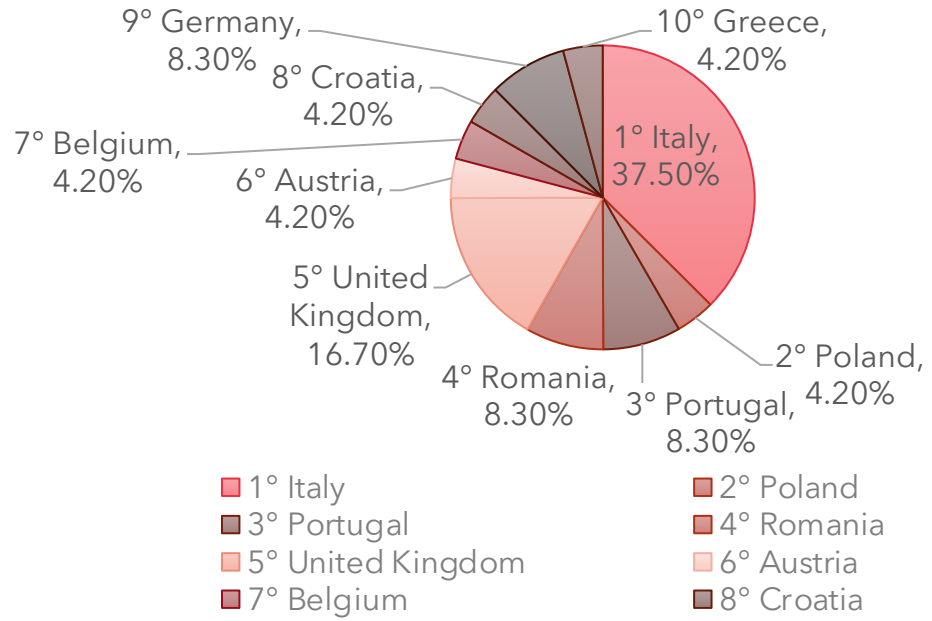


User groups - 1st call

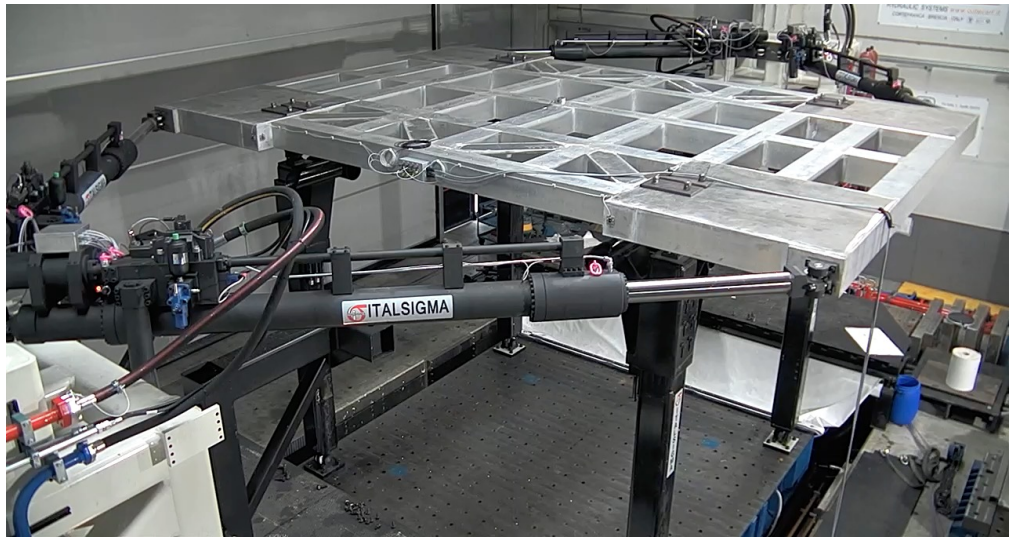
- Diverse group of people of different profiles representing universities, research institutions and different countries
- Highest number of applications received from Italy, followed by United Kingdom and Portugal
- 10 different countries

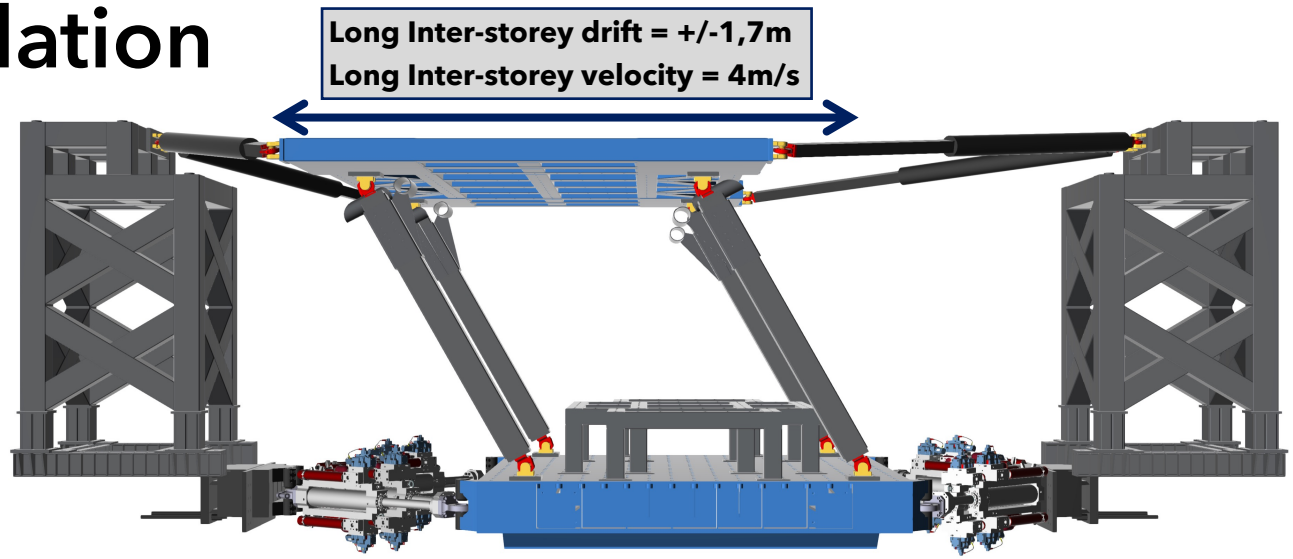


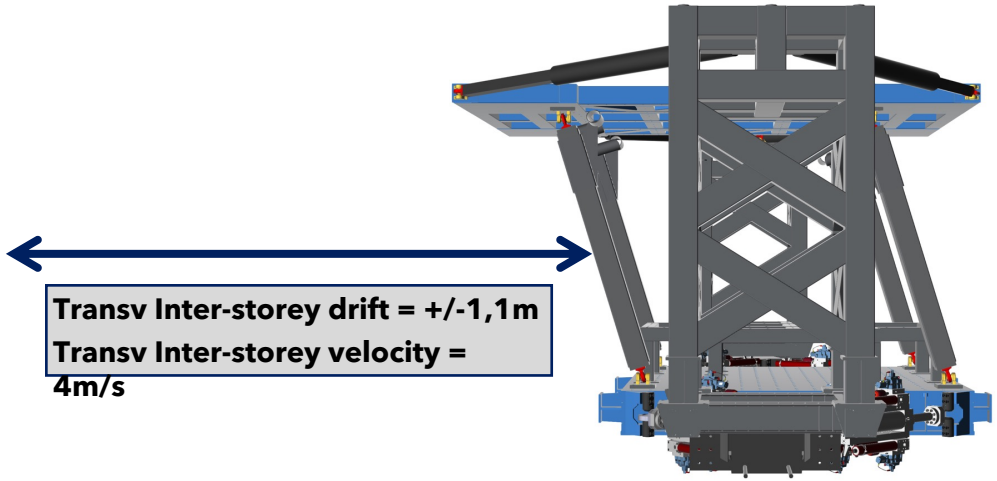


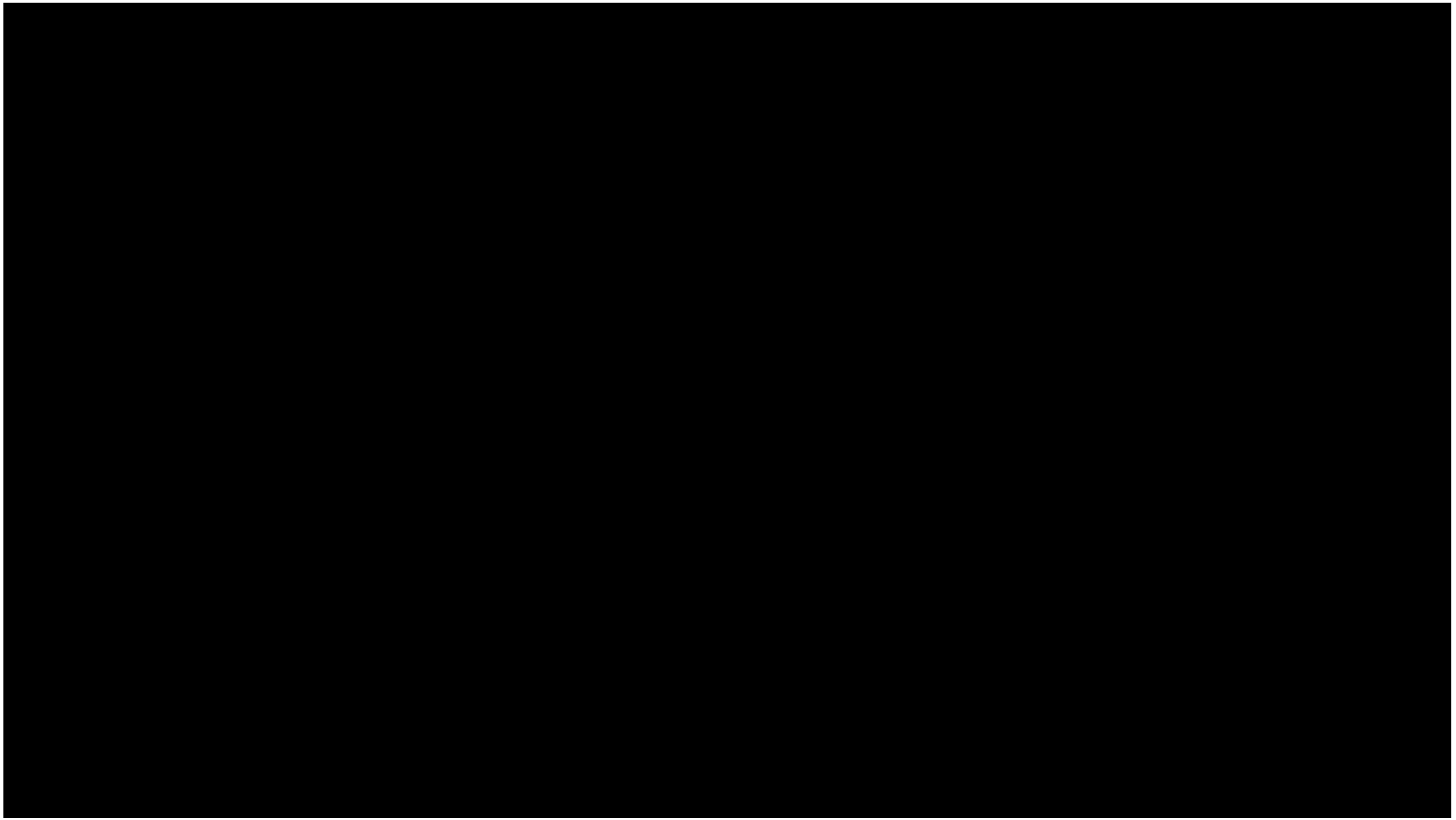


9DLAB at EUCENTRE Foundation



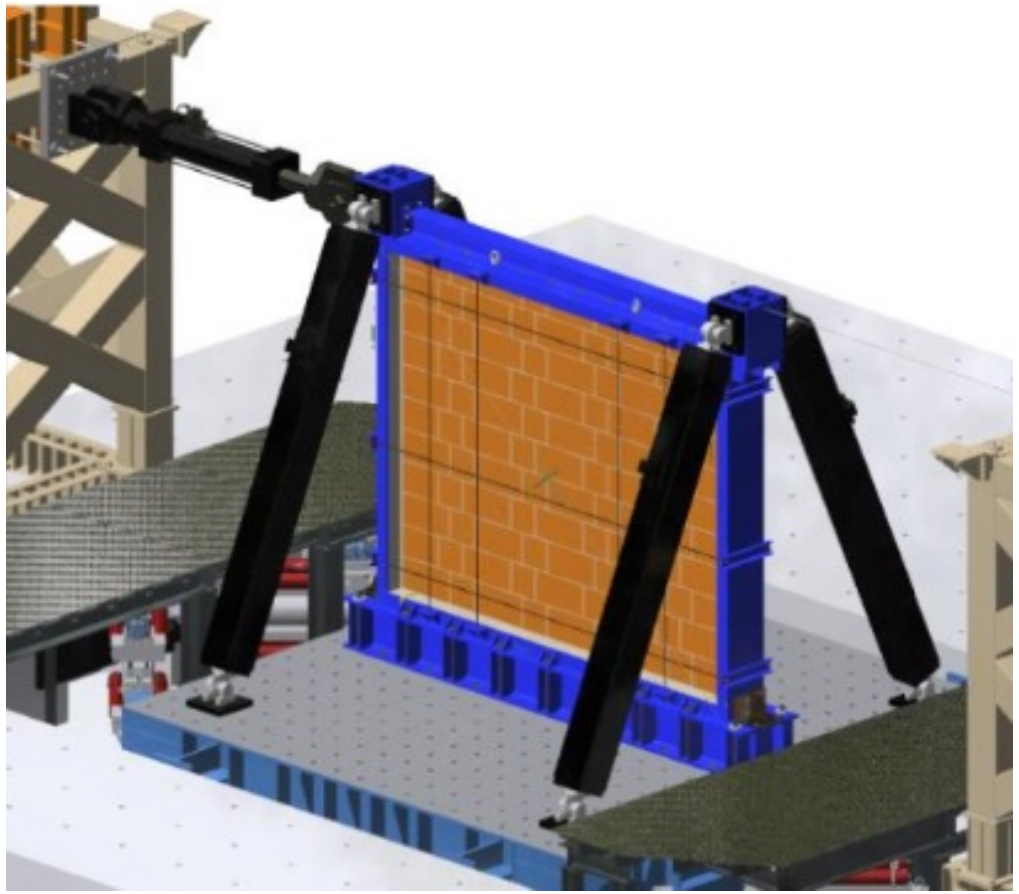






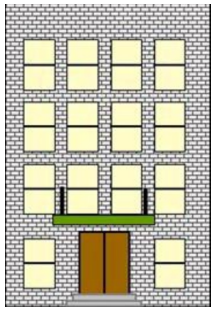
Case-Study Project: ENFRAG

- A case study example is described to illustrate the types of projects and how they address the research goals and areas outlined previously
- The project is ENFRAG (ENhancing state-dependent FRAGility through experimentally validated Energy-Based Approaches)
- It is led by the University College London, UK alongside Sapienza, Rome and is accessing the 9DLAB facilities at the Eucentre Foundation in Pavia, Italy

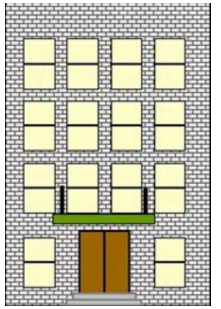


Background

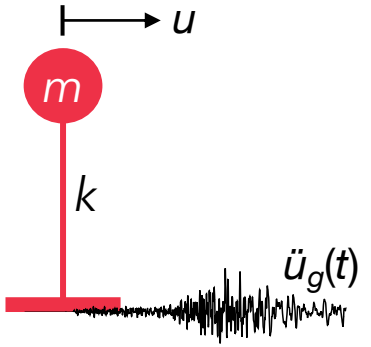
- The aim is to investigate the impact of energy dissipation in buildings on the seismic response and damage estimation
- If we test two identical structures (A and B) with the same earthquake scaled to PGA_A=0.2g and PGA_B=0.5g



Structure A



Structure B



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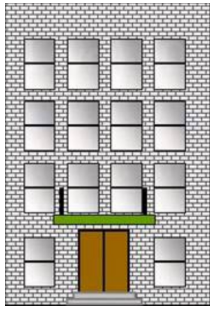
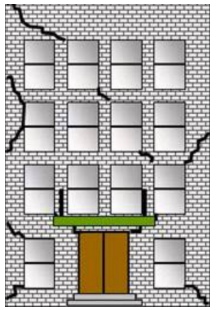


Structure A



Structure B

Structure B is damaged more

Background

- If we run a second earthquake on them at PGA=1g, specimen B will be more damaged than A
- This is because of the damage it suffered accumulated previously
- Most numerical modelling and seismic fragility models used in risk assessment don't account for this

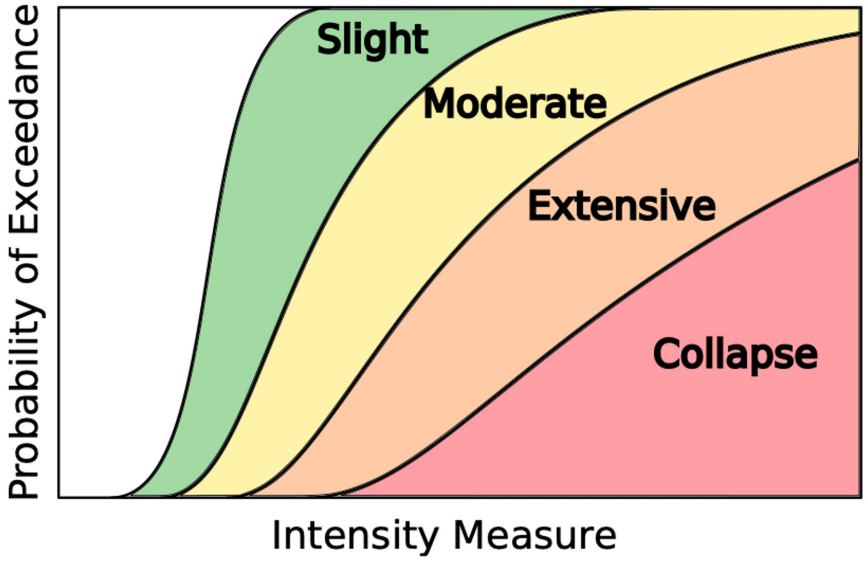
Structure A

Structure B

Background

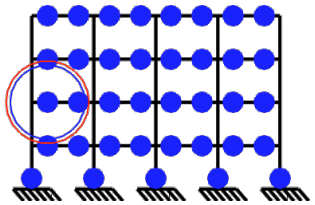
- If we run a second earthquake on them at PGA=1g, specimen B will be more damaged than A
- This is because of the damage it suffered previously
- State-independent fragility functions would say they have the same damage state
- We know this is not the case
- Most numerical modelling and seismic fragility models used in risk assessment don't account for this

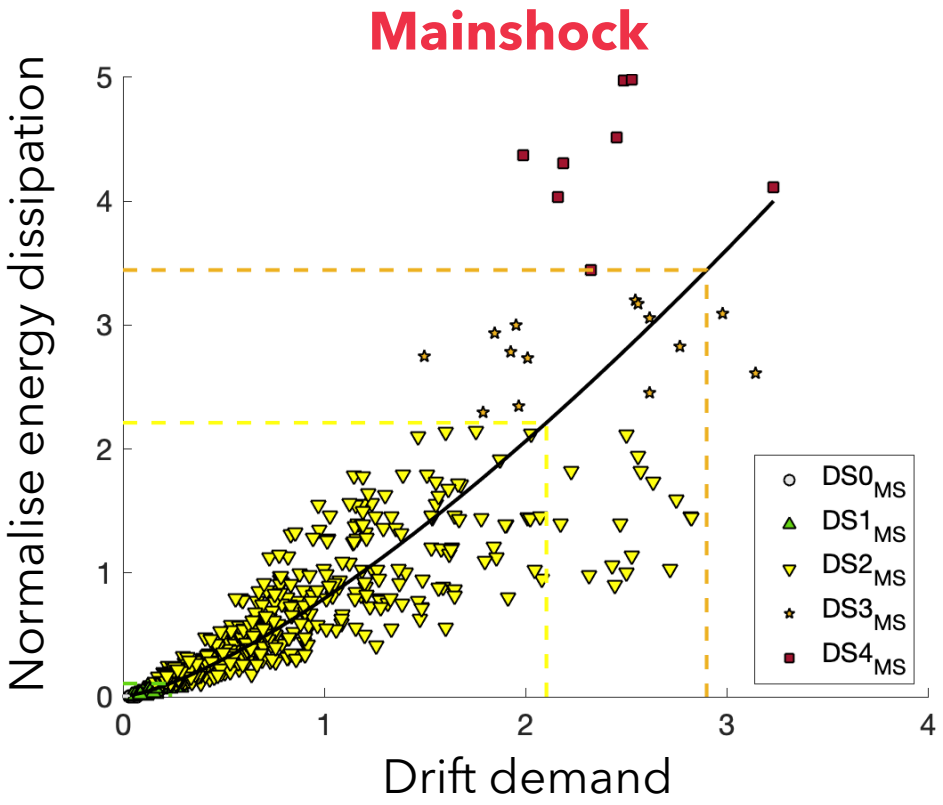
Structure A Structure B



Objectives

Aim to perform experimental research on peak drift vs. hysteretic energy

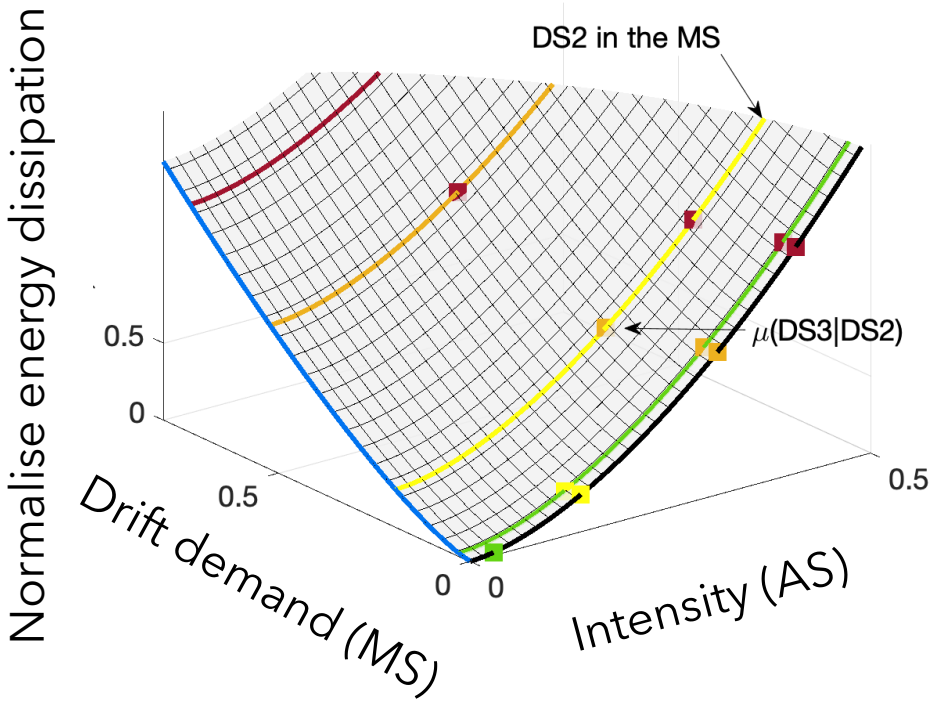


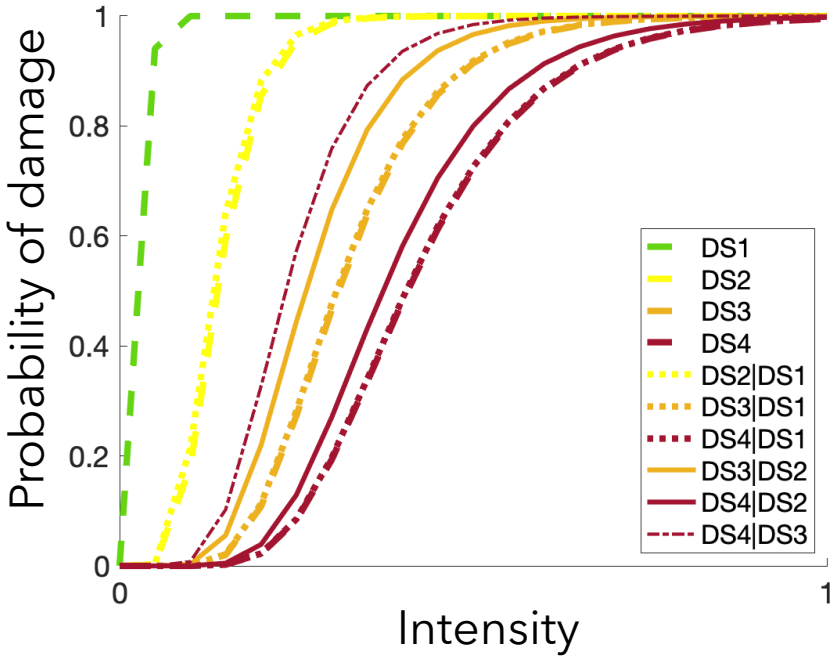


Gentile R, Galasso C. (2020) Hysteretic energy-based state-dependent fragility for ground motion sequences. *EESD*. https://doi.org/10.1002/eqe.3387

Objectives

Energy-based state-dependent fragility curves

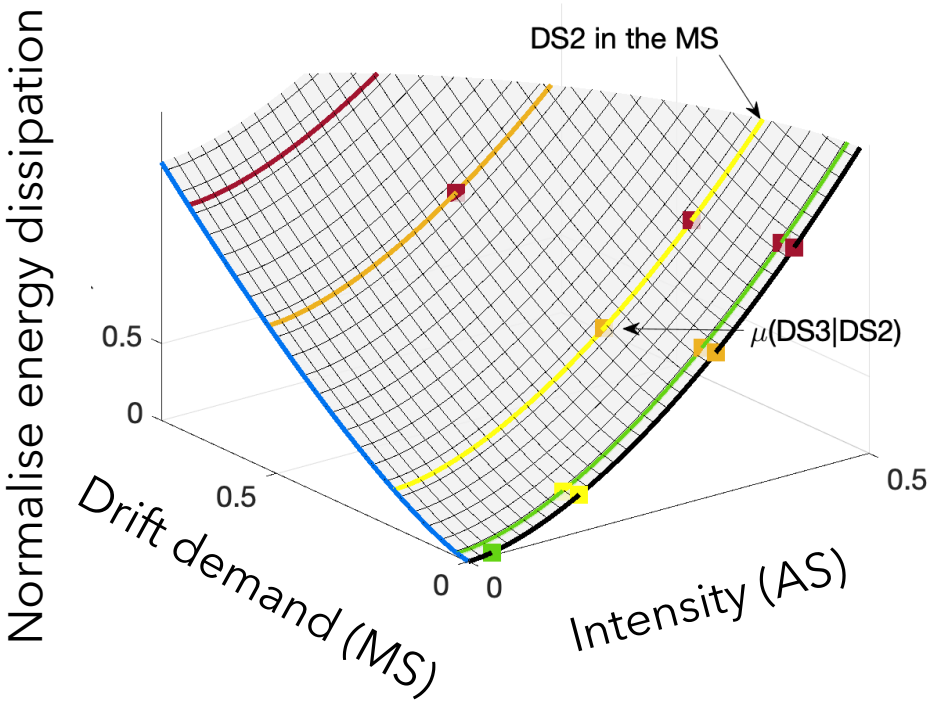




Line colour represents DS(AS)
Line type represents DS(MS)

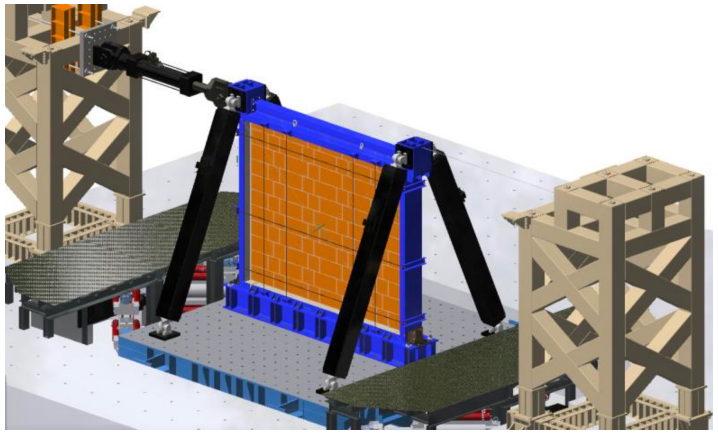
Gentile R, Galasso C. (2020) Hysteretic energy-based state-dependent fragility for ground motion sequences. *EESD*. https://doi.org/10.1002/eqe.3387

Experimental test programme

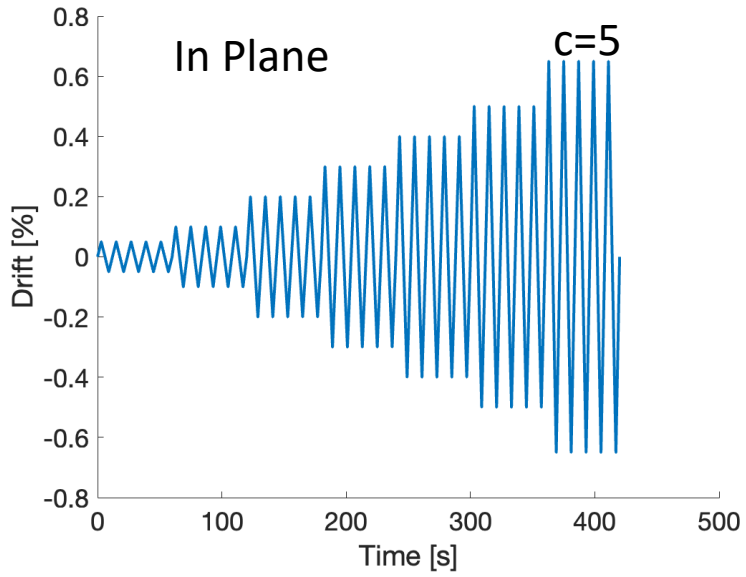


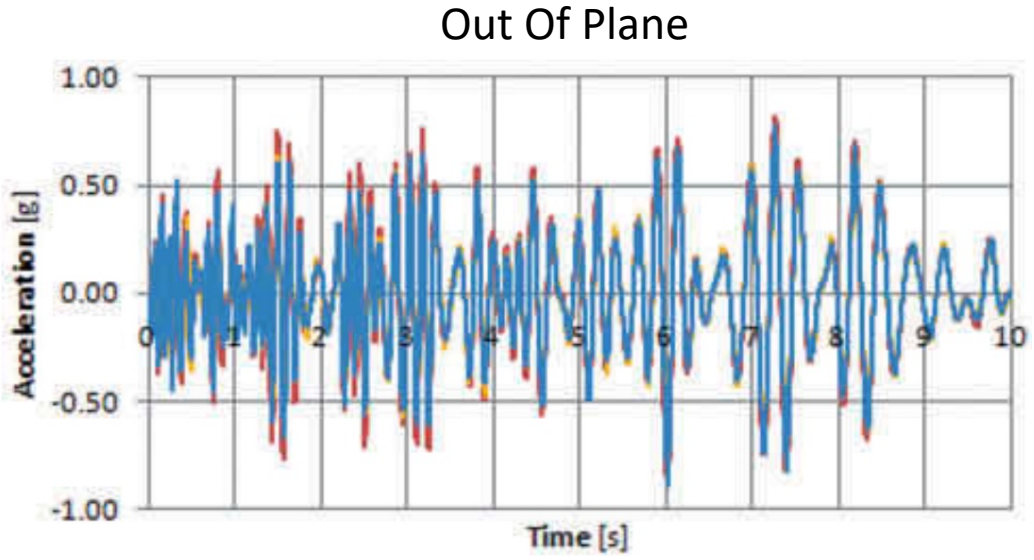
- Four nominally-identical masonry infill walls:
  - quasi-static cyclic displacement-controlled IP tests
  - and sequential shaking-table dynamic OOP tests
- Those are tested with different load protocols
- This will induce the same values of peak-based EDPs while modulating the energy-based demand conditional to the above peak quantities ($Eh|EDP_{IP}$ and $Eh|EDP_{OOP}$)

Experimental test programme



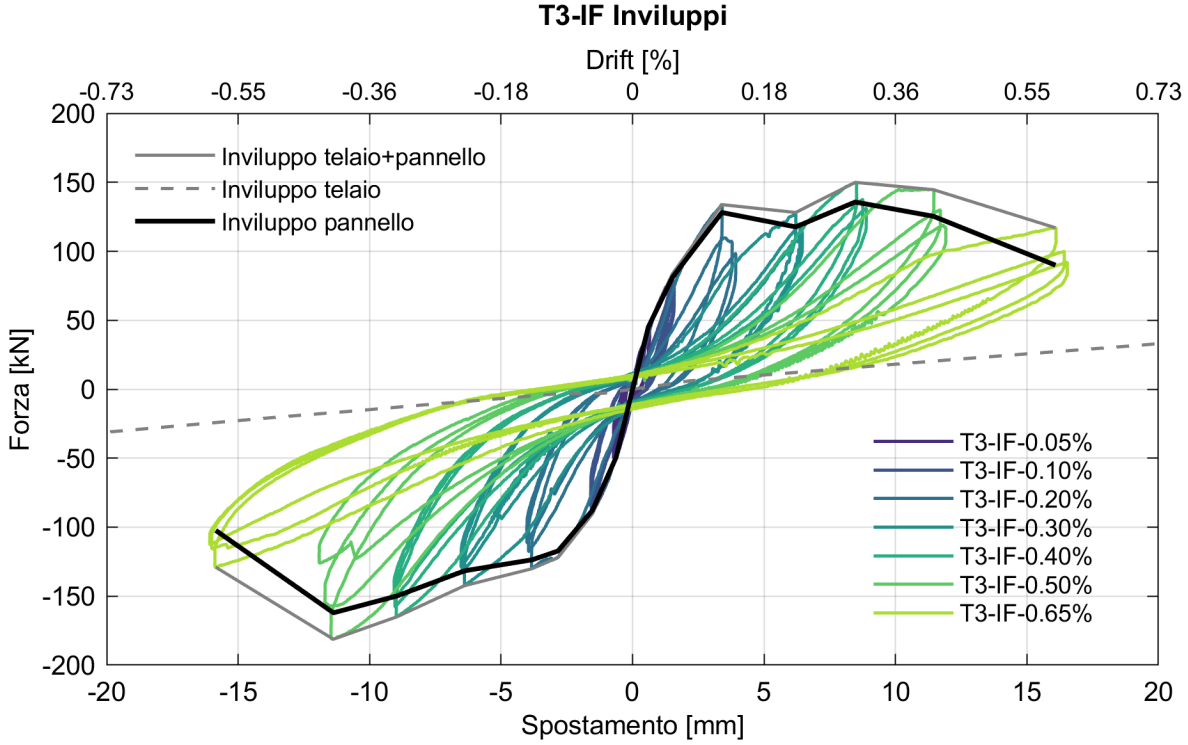
	θ_{max}	d	c	a(t)	ΔPFA	Notes
Test1	[0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.65]%	7	5	AC156	0.10g	more $E_h \vert EDP_{IP}$ increasing EDP_{IP} cycles
Test2	[0.05, 0.3, 0.65]%	3	3	AC156	0.10g	less $E_h \vert EDP_{IP}$ decreasing EDP_{IP} levels
Test3	[0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.65]%	7	3	AC156	0.05g	more $E_h \vert EDP_{OOP}$ with more PFA levels
Test4	[0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.65]%	7	3	AC156 w/ half duration	0.10g	less $E_h \vert EDP_{OOP}$ changing frequency content of PFA input



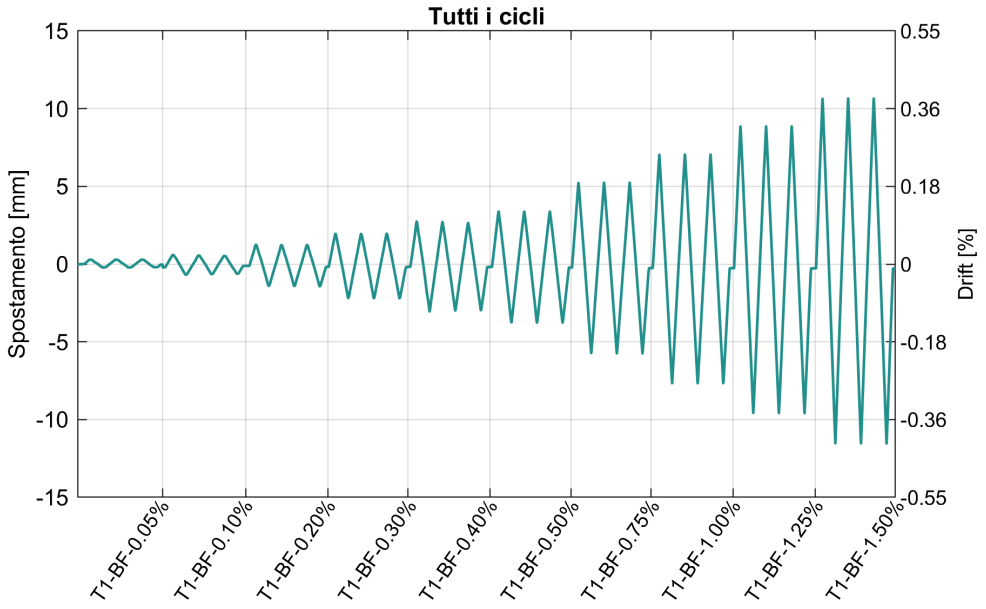


Experimental data elaboration

- Reference tests: Kurukulasuriya et al., 2022
- Specimens - infill panel surrounded by a steel frame (mimicking RC column stiffness)
- Load Protocol - IP quasi-static + OOP sequential IDA

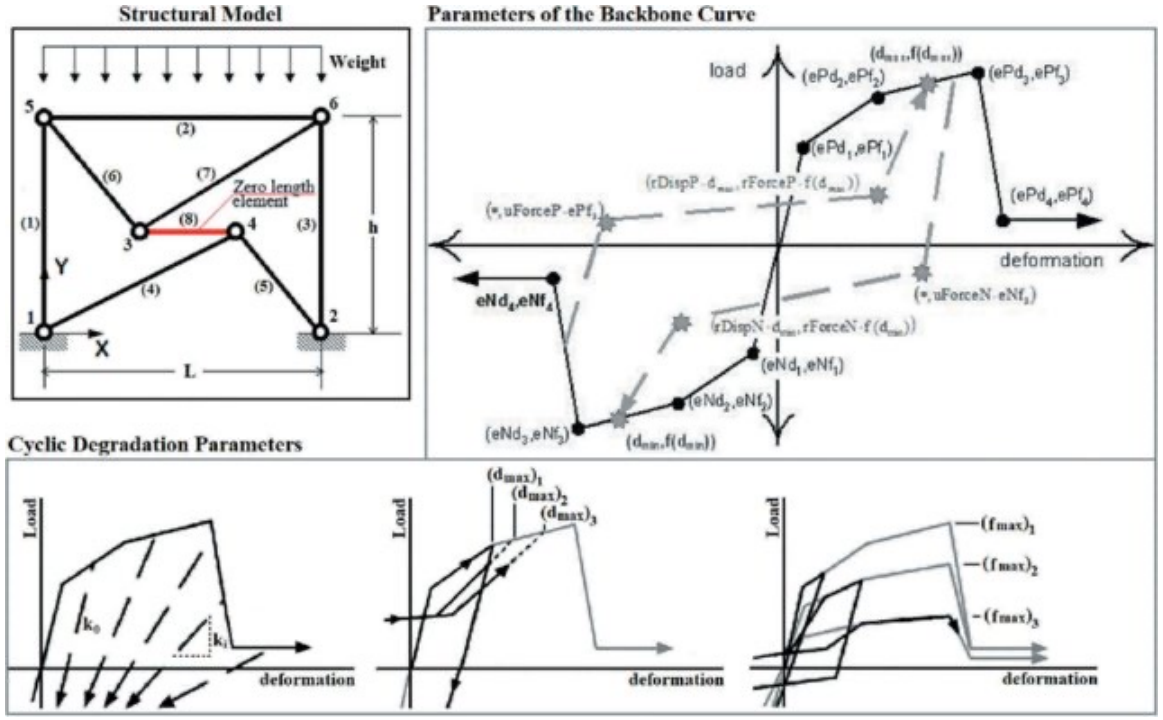


Kurukulasuriya et al., 2022



Potential impacts

- Understanding energy dissipation can be useful for:
  - Experimental test comparison
  - Numerical modelling calibration
- Tests carried out using different loading protocols cann be difficult to compare
- With these insights, it can pave the way to compare two different tests via the energy dissipated in both specimens
- Utilising the experimental test data collected for nominally identical specimens, we can calibrate hysteretic parameters for numerical models
- Use OpenSeesPy Hysteretic and Pinging4 models
- Use maximum likelihood method to estimate the most representative set of hysteretic parameters based on energy dissipated during experimental testing



Conclusions

- This presentation gave an overview of the research possibilities with the ERIES research project
- It showed how frontier research is targeted through experimental testing facilities around Europe and Canada
- Case study example project ENFRAG described the investigation of the impact of energy dissipation in damage estimation
- It is envisaged that similar research projects can have a lasting impact on earthquake engineering through the problems tackled and the experimental data produced

ERIES

ENGINEERING RESEARCH INFRASTRUCTURES FOR EUROPEAN SYNERGIES

RESEARCH GOALS

Advancing frontier knowledge on individual issues that contribute to the broader research theme of:

- Loss-driven design and mitigation approaches
- Risk quantification and prioritisation
- Green and sustainable development

The objective of ERIES is to provide transnational access (TA) to research infrastructures to advance frontier knowledge related to seismic, wind and geotechnical hazards

HAZARDS

- Earthquake
- Wind
- Geotech/SSI

RESEARCH AREAS (RA)

- RA1: Built Environment
- RA2: Critical Infrastructures
- RA3: Industrial Facilities
- RA4: Advanced Technologies

TA User Groups

Total Budget: €11,616,118
Duration: 4 years (01/06/2022 – 31/05/2026)

Project Coordinator

IUSS Scuola Universitaria Superiore Pavia

Research Infrastructures

EUCENTRE FOR YOUR SAFETY
ARISTOTLE UNIVERSITY OF THESSALONIKI
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ UNIVERSITY OF PATRAS
LNEC LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL
cea
ИЗИИС IZIIS
UNIVERSITÀ DI GENOVA
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY
Western WindEEE Research Institute
University of BRISTOL
CSTB le futur en construction
European Commission

Funded by the European Union

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Funded under the Horizon Europe Framework Programme
Ref: 101058684-HORIZON-INFRA-2021-SERV-01-07

TA User Groups

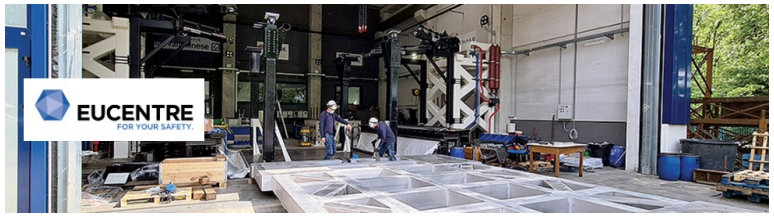
ERIES

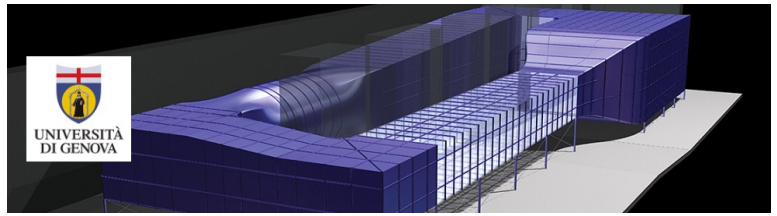
ENGINEERING RESEARCH INFRASTRUCTURES FOR EUROPEAN SYNERGIES

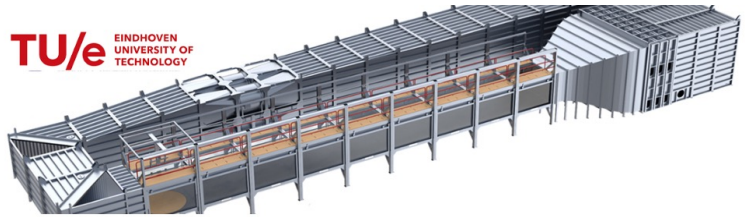
World-class experimental research infrastructures include:

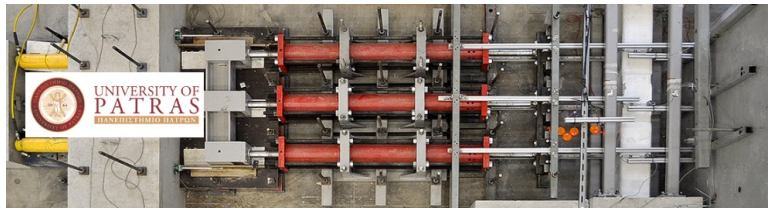
- Shaking Tables
- Reaction Walls
- Soil Pits
- Wind Tunnels
- Doppler Lidar Systems
- Hybrid-Simulation Capabilities (Multi-lab)

- External user groups prepare project proposals in line with the goals of ERIES
- They collaborate with ERIES research infrastructures via transnational access
- This means European* users travel to another country and use the research infrastructures made available as part of ERIES
- Cost of experimental testing in addition to travel and accommodation of user groups are covered









More information

www.eries.eu

Applications collected and evaluated at cut-off dates:

- 30th Sep 2022
- 8th Jan 2023
- 7th Jun 2023
- 3rd Nov 2023

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