



# MAKING NEUTRON CHARACTERIZATION TOOLS AVAILABLE TO INDUSTRY

ILL/ESS user meeting, 06.10.2022

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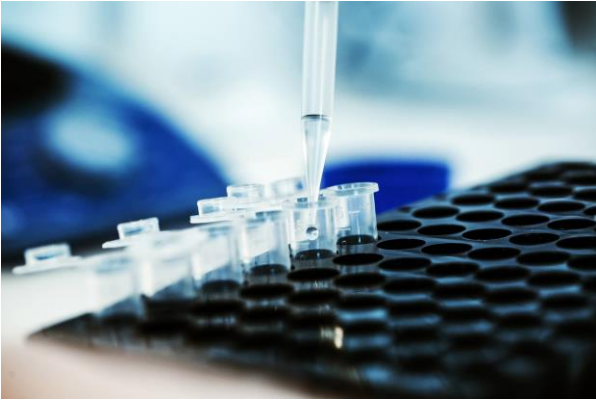
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 953219.





**DANISH  
TECHNOLOGICAL  
INSTITUTE**

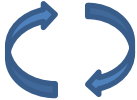
# DANISH TECHNOLOGICAL INSTITUTE, DTI



Industry needing  
test/analysis/insight

DTI answers  
the need

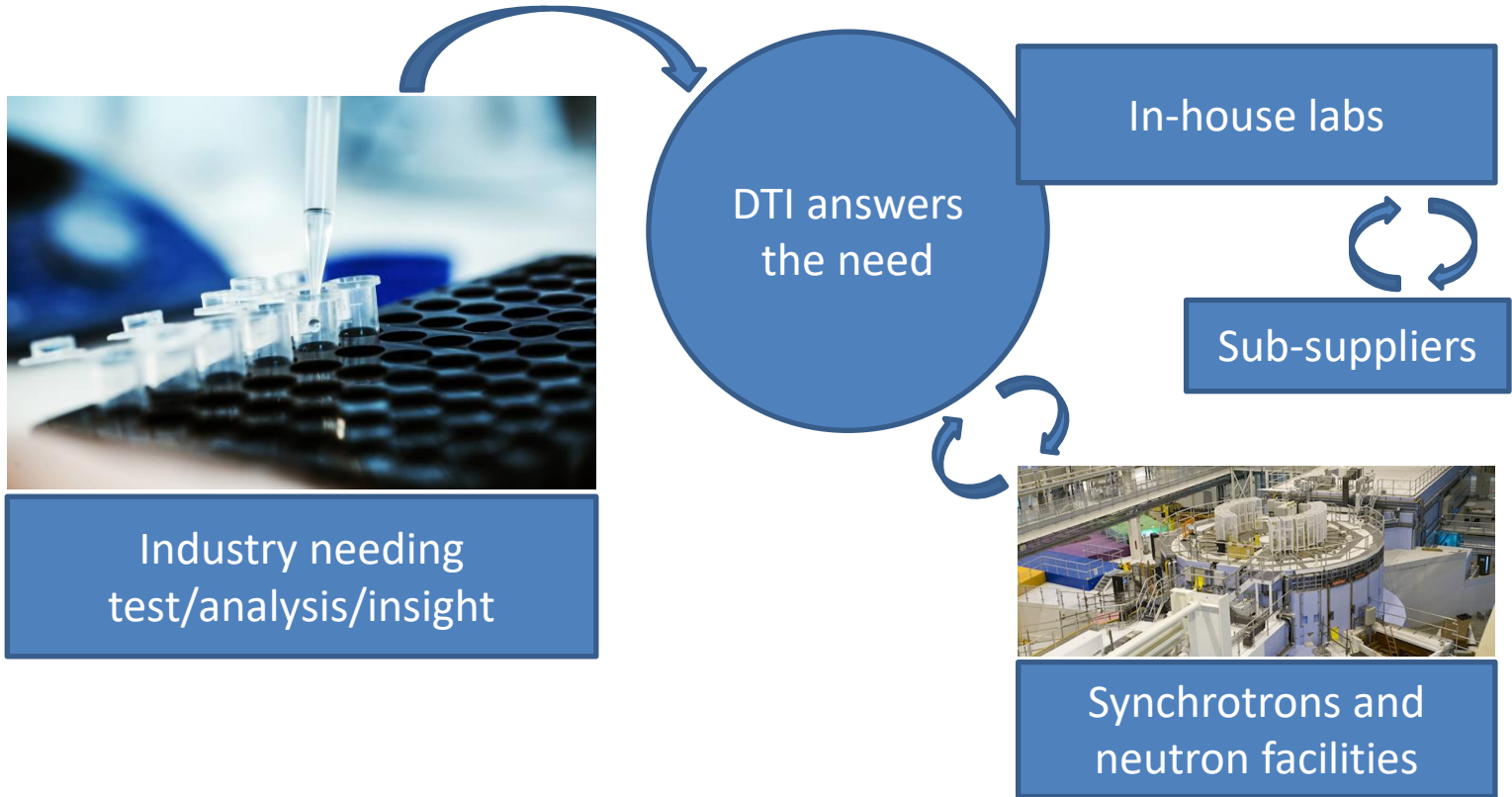
In-house labs



Sub-suppliers



# DTI AS MEDIATOR FOR ANALYSIS AT LARGE SCALE FACILITIES



# RESIDUAL STRESSES IN METALS

Residual stresses arise and develop during manufacturing and during operation.

Residual stresses influence many properties of a component, such as e.g.

- strength,
- fatigue behavior,
- corrosion resistance.

Considered in the design process by large safety factors.



# MEASURING RESIDUAL STRESSES IN METALS

## Choosing the right method

### Destructive or non-destructive?

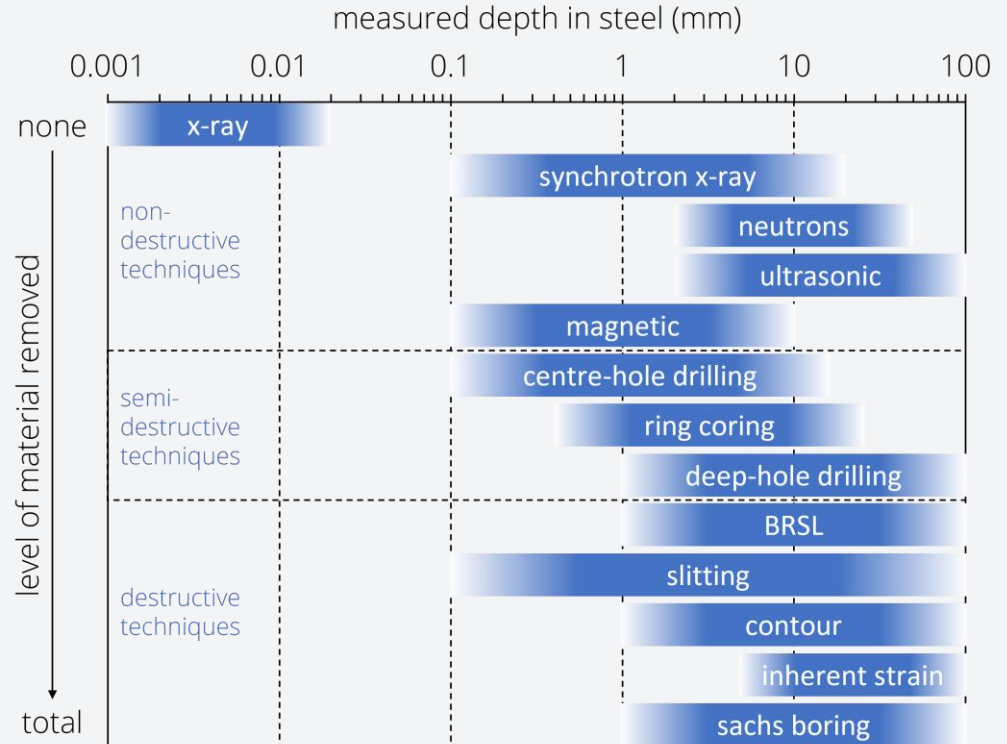
- Diffraction
- Mechanical

### Relevant geometry?

- Resolution
- Gauge depth
- Number of stress orientations

### Delivery?

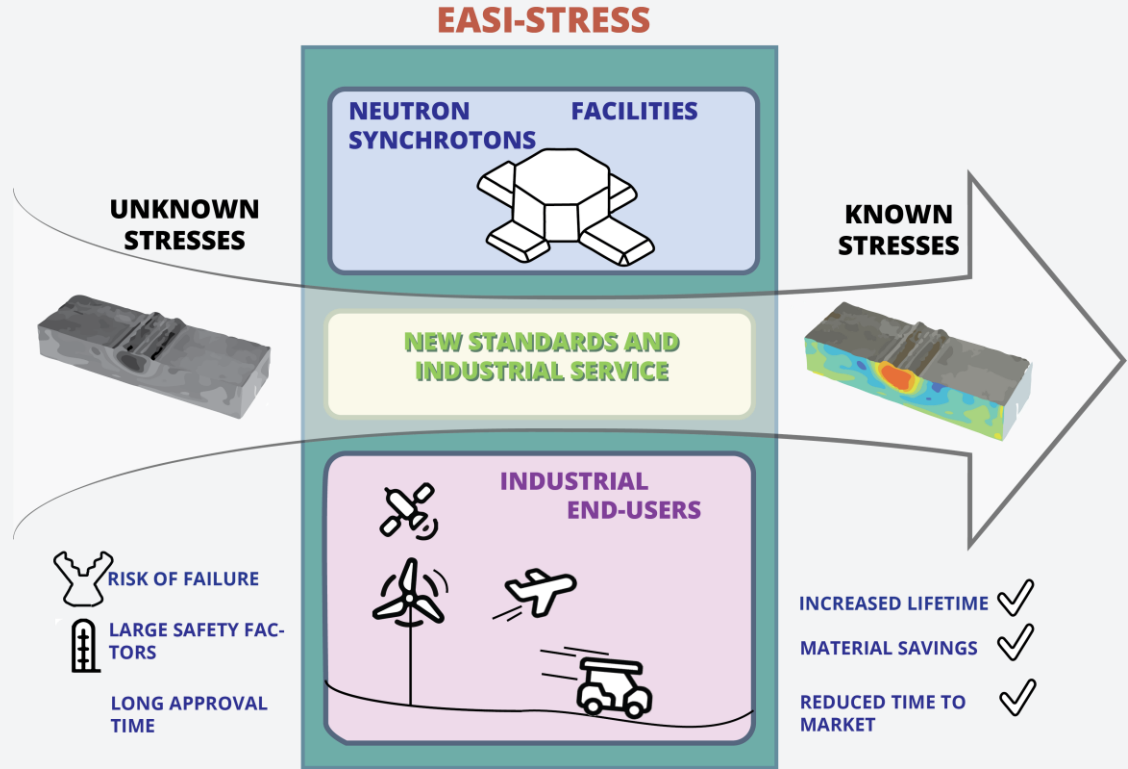
- Measurement time
- Cost
- Expertise/consultancy
- Material handling





# EASI-STRESS: PROJECT GOALS

- Start date: Jan 1st, 2021
- Duration: 36 months
- Budget: EUR 4.5 million



# EASI-STRESS: CONSORTIUM

RTOs and  
Universities



**DANISH  
TECHNOLOGICAL  
INSTITUTE**  
(Coordinator)



The University of Manchester



Advanced Research Facilities



Centre for  
Energy Research

Standardisation  
Body



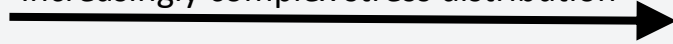
Industry



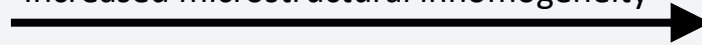


# BENCHMARK AND VALIDATION AGAINST LAB. TECHNIQUES

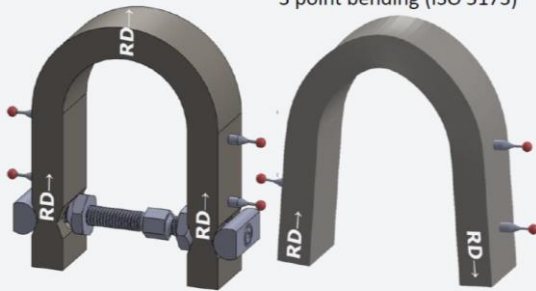
Increasingly complex stress distribution



Increased microstructural inhomogeneity



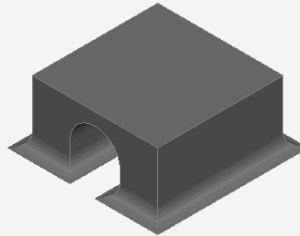
3 point bending (ISO 5173)



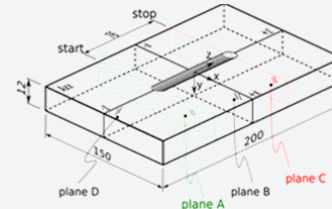
Flexure (tension)

Deformed

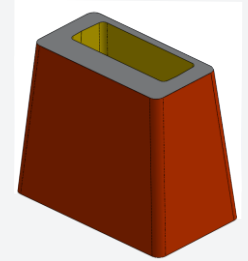
U-flexures/U-bends  
(S355 stainless steel)



AM arches  
(316 steel)



Inconel gas tungsten  
arc **welded** (GTAW)  
three pass welded  
plates  
([NeT-network.eu/tg6](http://NeT-network.eu/tg6))



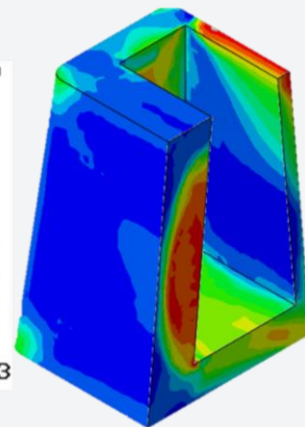
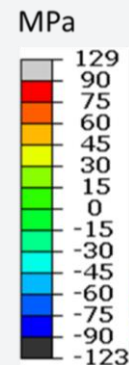
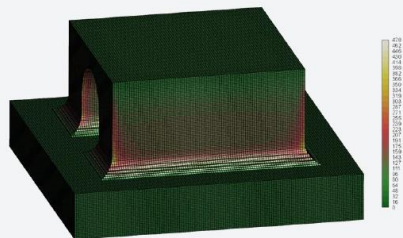
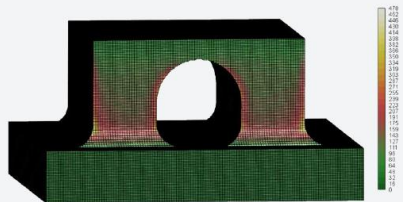
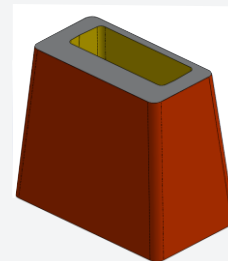
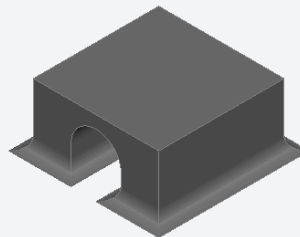
Cast and quenched  
aluminium  
wedge



# BENCHMARK AND VALIDATION AGAINST LAB. TECHNIQUES

Comparison of

- Neutron diffraction
- Synchrotron x-ray diffraction
- Laboratory x-ray diffraction
- Holdedrilling
- Contour mapping
- ... and compared with modelling data



# HARMONIZED PROCEDURES AND STANDARDISATION

Different

- instruments
- techniques
- probes

Same workflow  
and principles in  
measurements



DESY, P61A



DESY, P07



ESRF, ID15A



ESRF, ID30



ESRF, ID22



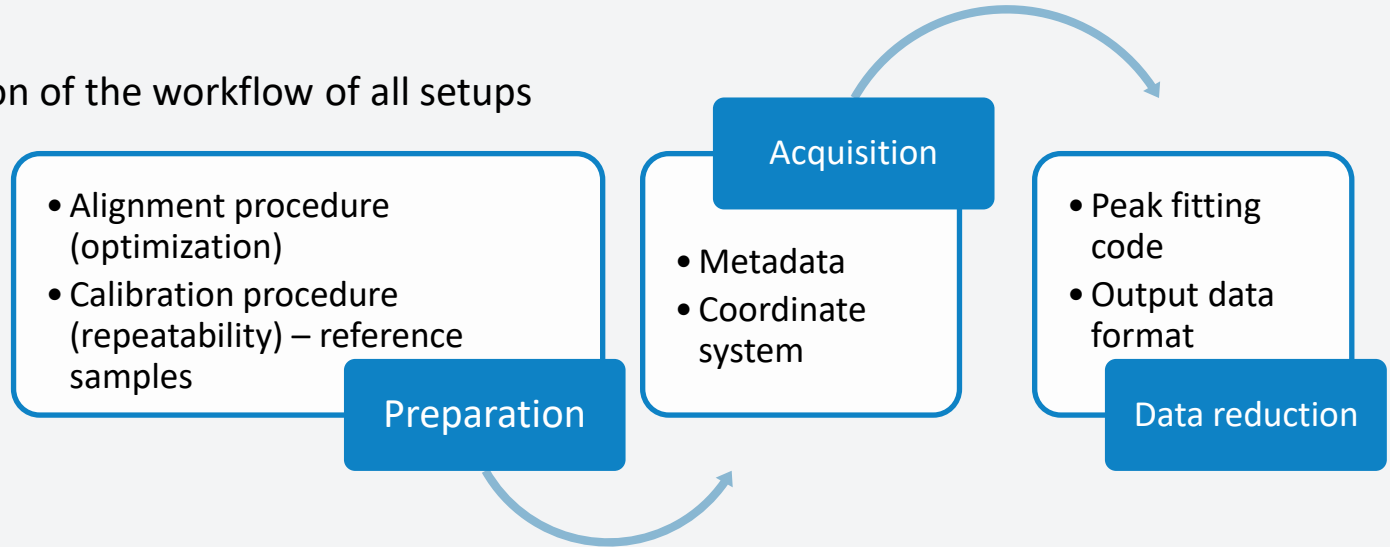
ILL, SALSA



BNC, ATHOS

# HARMONIZED PROCEDURES AND STANDARDISATION

Harmonization of the workflow of all setups

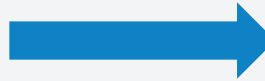


# SOFTWARE AND (META)DATA FORMATS FOR MODELLING

“The JPEG solution”  
No matter the source

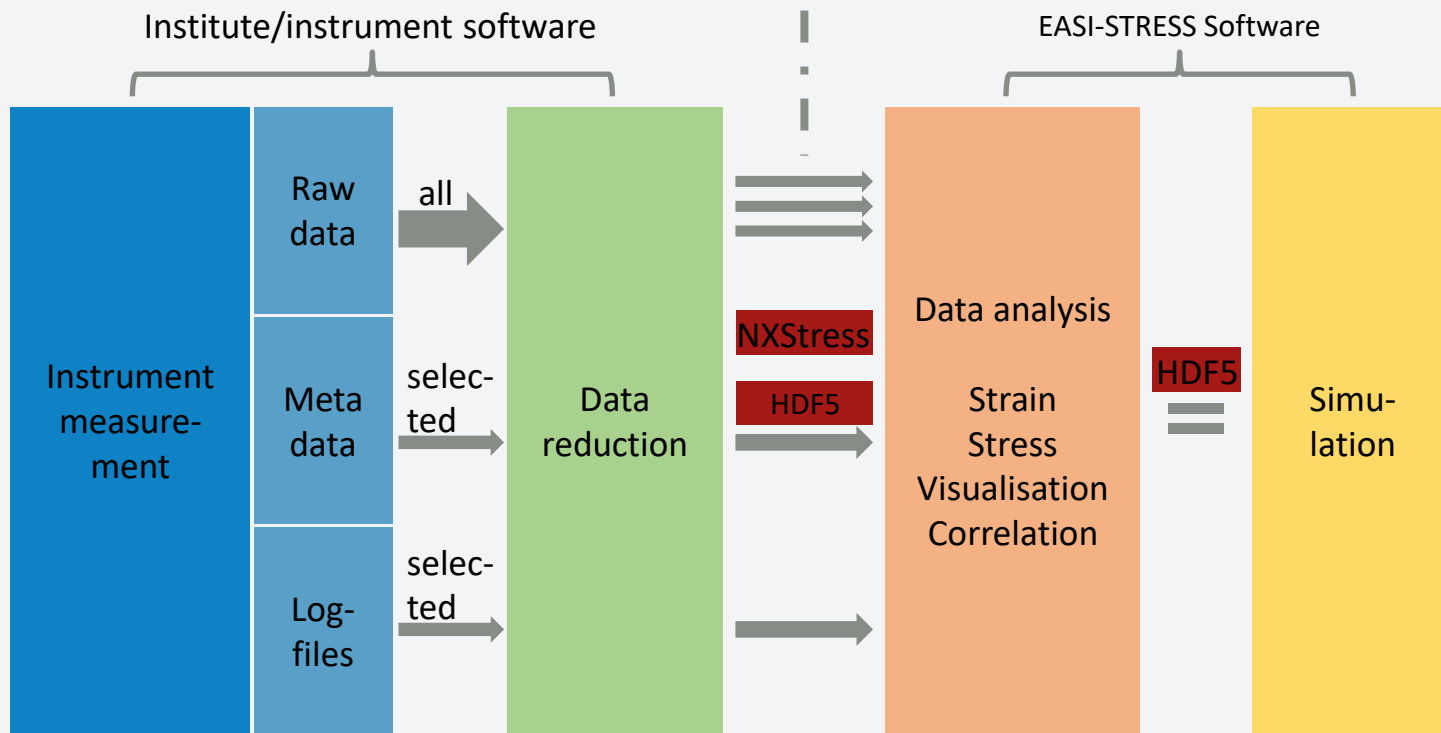


Standard data +  
metadata



“customers” (e.g. industry)  
can see the picture – and  
it’s traceable

# SOFTWARE AND (META)DATA FORMATS FOR MODELLING

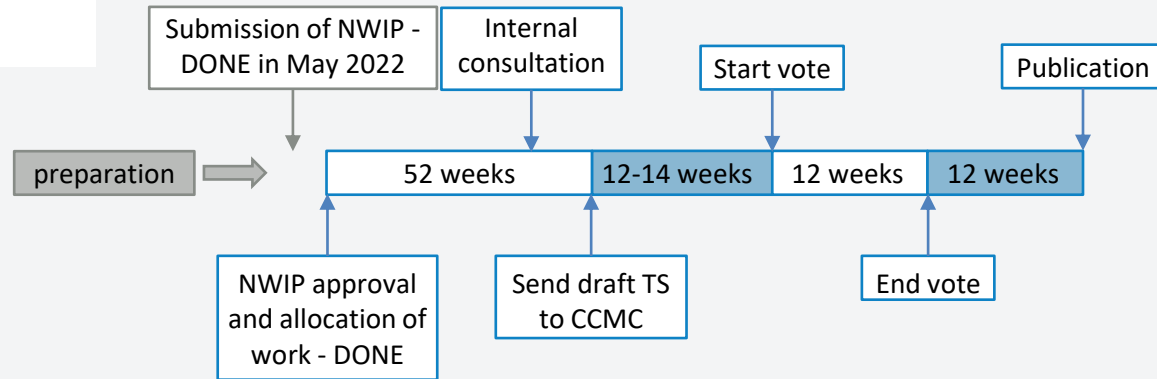




# HARMONIZED PROCEDURES AND STANDARDISATION



Standards are the language of industry



# INDUSTRIAL CASES AND TESTBED SERVICE

Software and  
procedures



Industrial case  
studies



Testbed service



# ENGAGING INDUSTRIAL STAKEHOLDERS

Ensure broad industrial adaptation of the new techniques AND recruit support for standardisation effort.



## EASI-STRESS

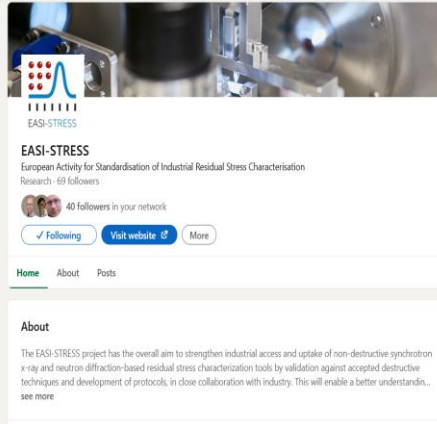
### European Activity for Standardisation of Industrial Residual Stress Characterisation

The EASI-STRESS project has the overall aim to strengthen industrial access and uptake of non-destructive synchrotron x-ray and neutron diffraction-based residual stress characterization tools by validation against accepted destructive techniques and development of protocols, in close collaboration with industry.

This will enable a better understanding of the formation and progression of residual stresses by direct comparison with and incorporation of the measured data into modelling tools. Incorporating this knowledge into the design process and lifetime assessment of metallic components will give more reliable products with increased lifetime and reduced material usage. Currently, conservative worst-case scenario safety factors, e.g. as defined by EUROCODE, are used when designing metallic components exposed to cyclic loads. In knowing the actual internal stress levels, the safety factors can be relaxed, resulting in an estimated expense cost saving of around 15%.



Homepage: [www.easi-stress.eu](http://www.easi-stress.eu)  
Form for registration of interest



LinkedIn Showcase



Public webinars to share technical insights



# THANK YOU!

Please contact us, if you would like to stay informed about the project activities and events.

[www.easi-stress.eu/about/contact](http://www.easi-stress.eu/about/contact)



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