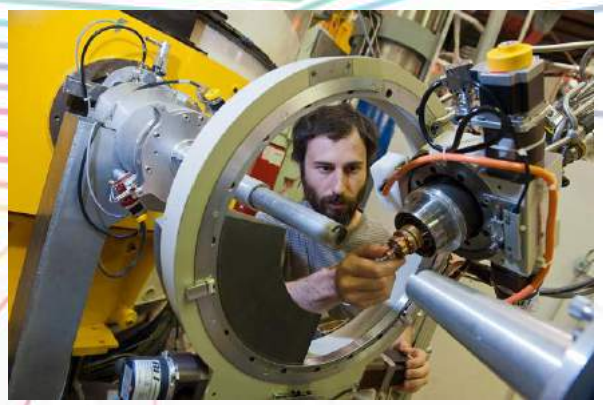
Institut Laue-Langevin

Neutrons for society

When neutrons and modelling improve aluminium casting process
Strain & stress mapping

Caroline Boudou, Industry Contact Officer

30/11/2021



www.ill.eu/industry

caroline.boudou@ill.eu

Institut Laue-Langevin (ILL)

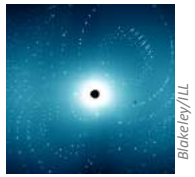
- 1 site (Grenoble)
- Managed by FR, DE, GB
- 11 member states
- Budget 2020: 102 MEUR
- 543 employees
- Since 1967

Source of neutrons to investigate materials, component and devices under real operational environment

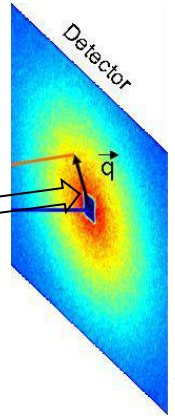
Magnetism, Biology and Health,
Material and engineering, Chemistry,
Crystallography, Soft matter
Particle and nuclear Physics
+ production of radio-isotopes

Neutron analytical techniques: probing the properties of materials

DIFFRACTION
Structure = arrangement of atoms
and / or magnetic domains



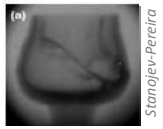
Small angle Scattering
Statistics on the
microstructure



source of neutrons or
synchrotron X-rays

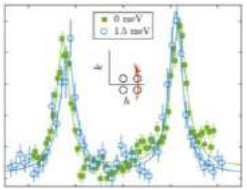
Beams of
neutrons

SAMPLE



IMAGING
Morphological and
Structural 3D info

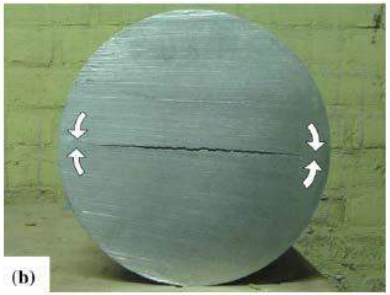
SPECTROSCOPY
Dynamics = movement of atoms,
Electronic structure



Instruments = **beam lines**
Measurement periods **= beam time**

ILL: being part of industrial engineering R&D

- Improving casting process (1/2)



The issue: **cold-cracking**
internal cracks in billets of self hardening Al-alloys for aeronautics applications

A 3 year study:
Combination of **modelling** and input **stress data on actual industrial products**
=> non-destructive neutron diffraction based stress-determination

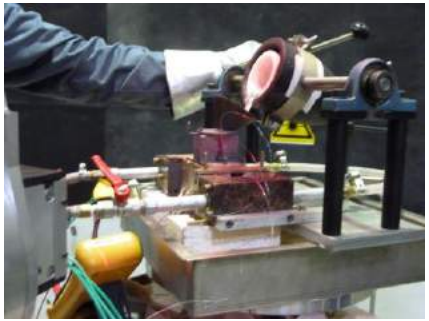
A 2 m Al billet being placed on the sample stage of an ILL instrument

ILL: being part of industrial engineering R&D

- Improving casting process (2/2)

Stress determination in various Al billets

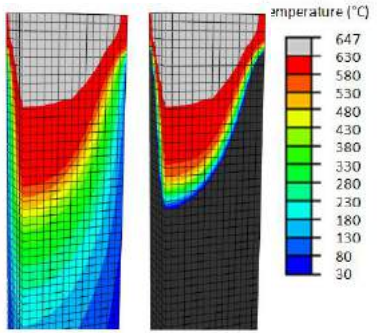
In-situ neutron experiments
determine solidification point and investigate building up of stress during cooling



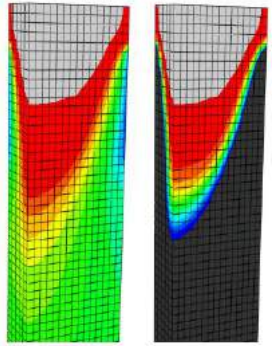
Simulation: use of neutron results as reliable input parameters
=> Strategy: modifying casting process

Verification:
Neutron stress-determination after modification of production process

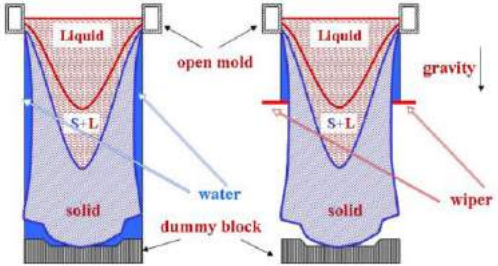
⇒**Reduction of tensile stresses by 30-50%**

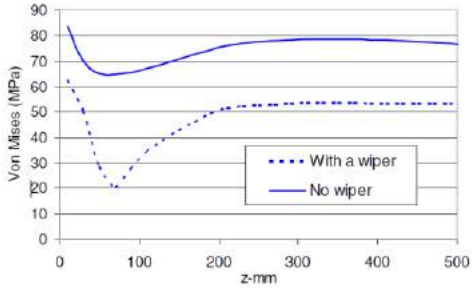


with wiper



no wiper





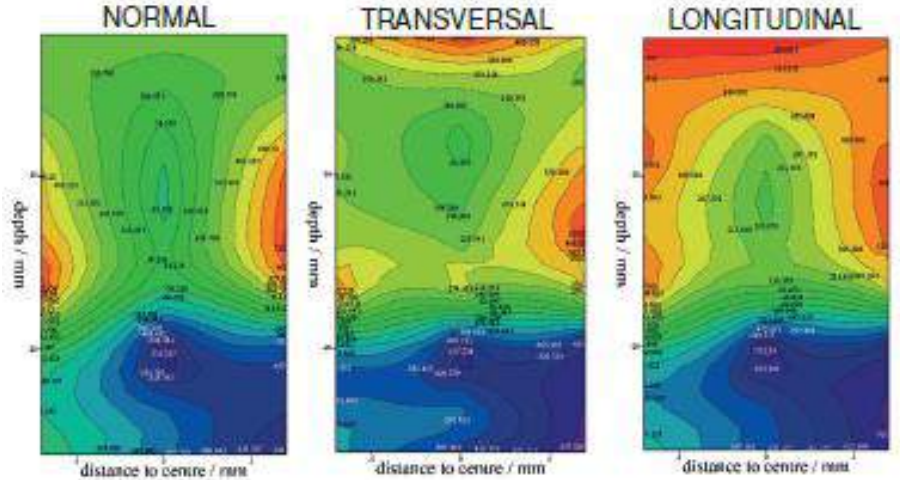
Influence of a wiper on residual stresses in {AA7050} rolling plate ingots, 2014, Drezet et al.

Neutron diffraction: stress determination

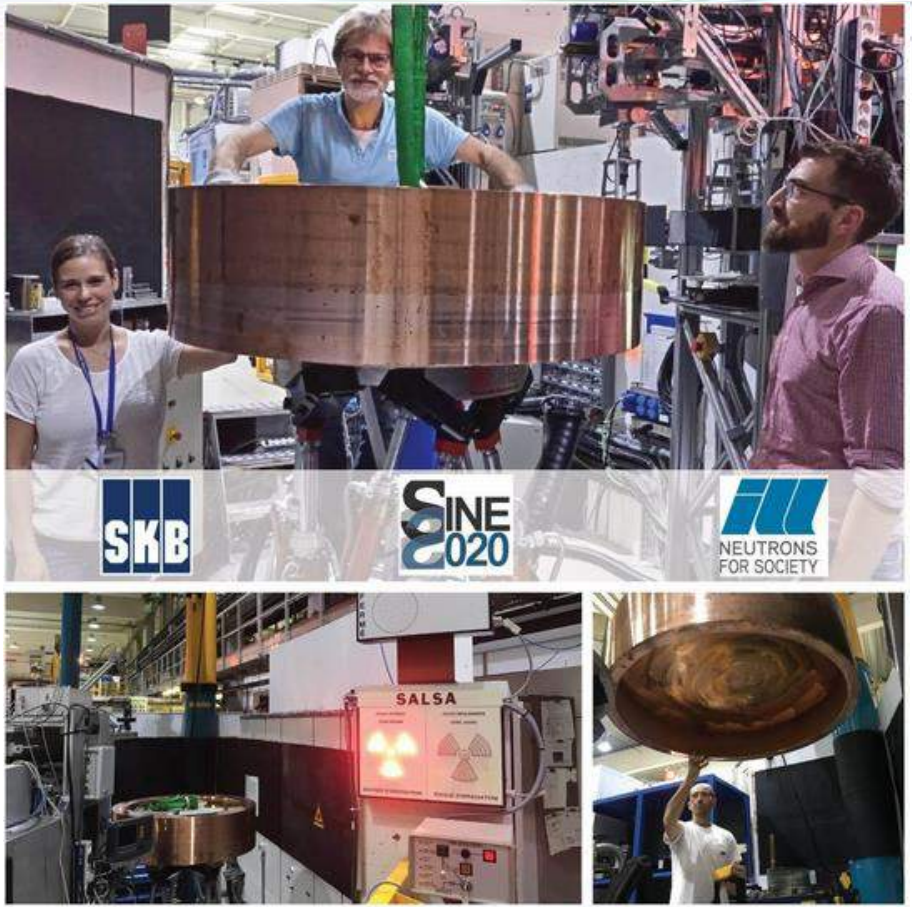
Investigation of residual stress in the thickness (4 cm) of the welded region (FSW)

- SKB, Sweden
- a 850 kg piece made of copper

Stress maps for the three principal components of the stress tensor



(values in MPa, maps not built from the SKB measurements)

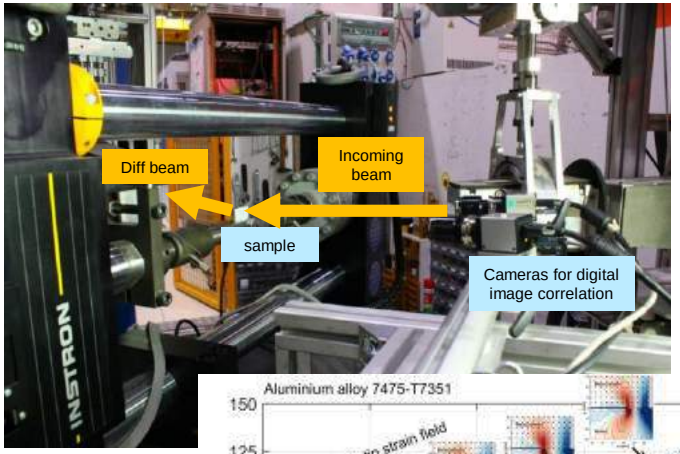


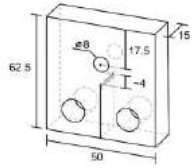
SINE2020 project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654000.

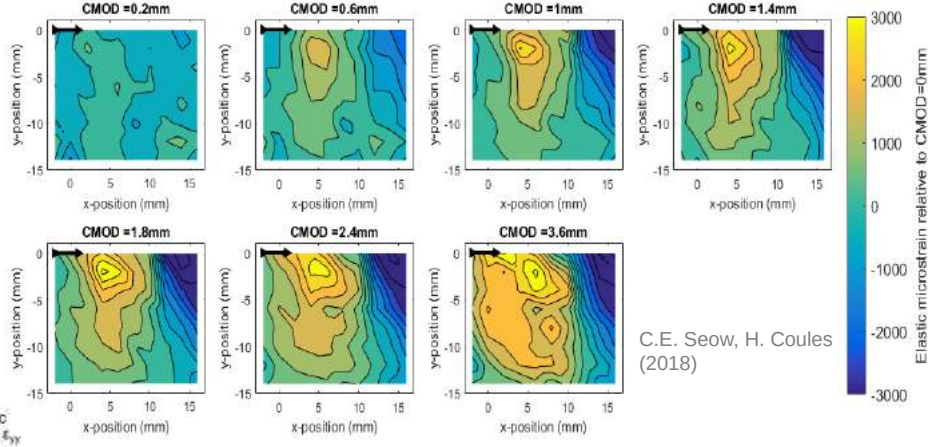
Additive manufacturing: In-situ characterization

In-situ crack growth in WAAM Ni-superalloy IN-625

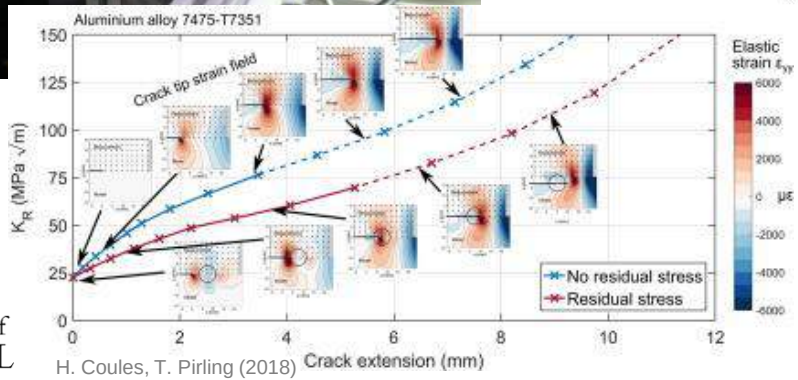
- Load Rig (50KN)
- Surface (DIC) and bulk (ND) strain field around crack during loading.
- Effect of crack orientation: elastic strain distribution is anisotropic







C.E. Seow, H. Coules (2018)



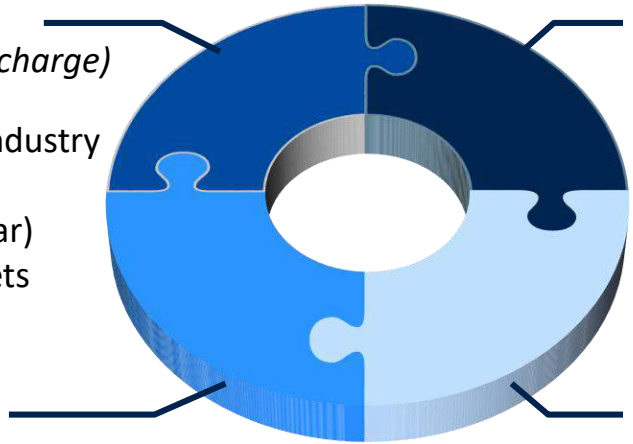
H. Coules, T. Pirling (2018)

How to work with the ILL?

Public Access

Results must be published (free of charge)

- Universities with Industry or Industry on its own
- Competitive access (2 calls/year)
- Innovation-led long term projets



Proprietary Access

- Rapid access
- Full IP rights to client
- paid for services

Technology Transfer

- Licencing technologies
- In-house manufacturing
- Consultancy

Collaboration and Grants

- Industry sponsored staff (PhD, post-doc, trainees...)
- Horizon Europe, French PIA, IRT, UK CASE, etc.

BIG-MAP brightness² NANOELEC EASI-STRESS SINE2020 InnovaXN TEESMAT

Thank you for your attention!

caroline.boudou@ill.eu
+33 476 207 209

industry@ill.eu