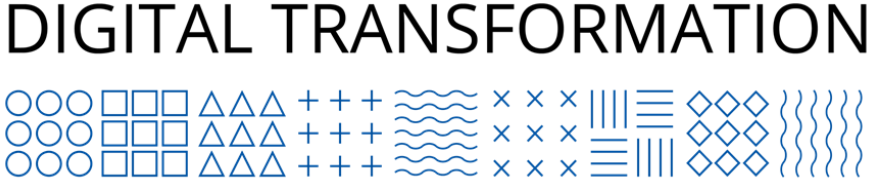


Rational Alloy Design
(ALLDESIGN)

Norwegian University of Science and Technology- Faculty of Natural Sciences- Department of Materials Science and Engineering

Arash Aria

Microstructure modelling of aluminium alloys

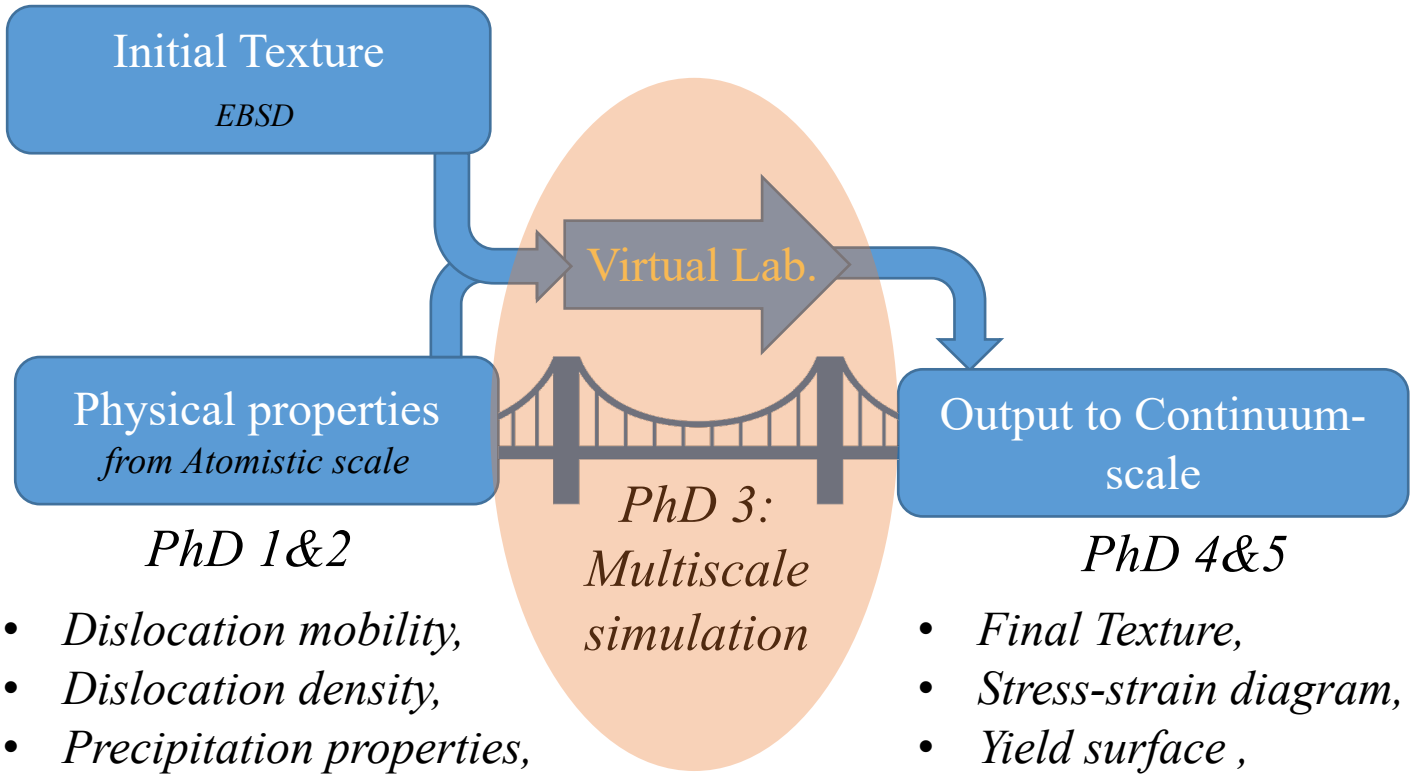
Main Supervisor: Prof. Knut Marthinsen
Co- Supervisors: Prof. Bjørn Holmedal, Dr. Tomas Manik

December 2022, Trondheim

NTNU

SINTEF

PhD3 in ALLDESIGN project, Multiscale simulation:



- *Dislocation mobility,*
- *Dislocation density,*
- *Precipitation properties,*
- *etc.*

- *Final Texture,*
- *Stress-strain diagram,*
- *Yield surface ,*
- *etc.*

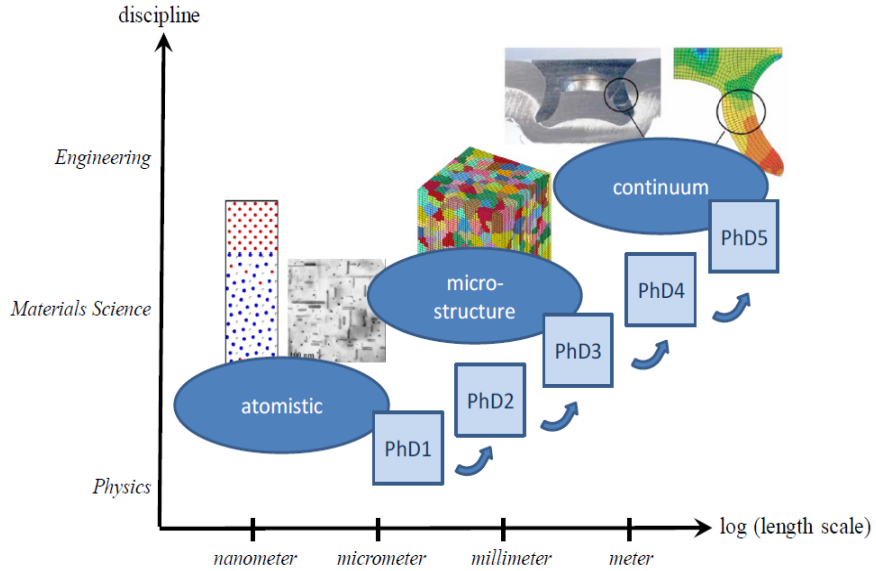


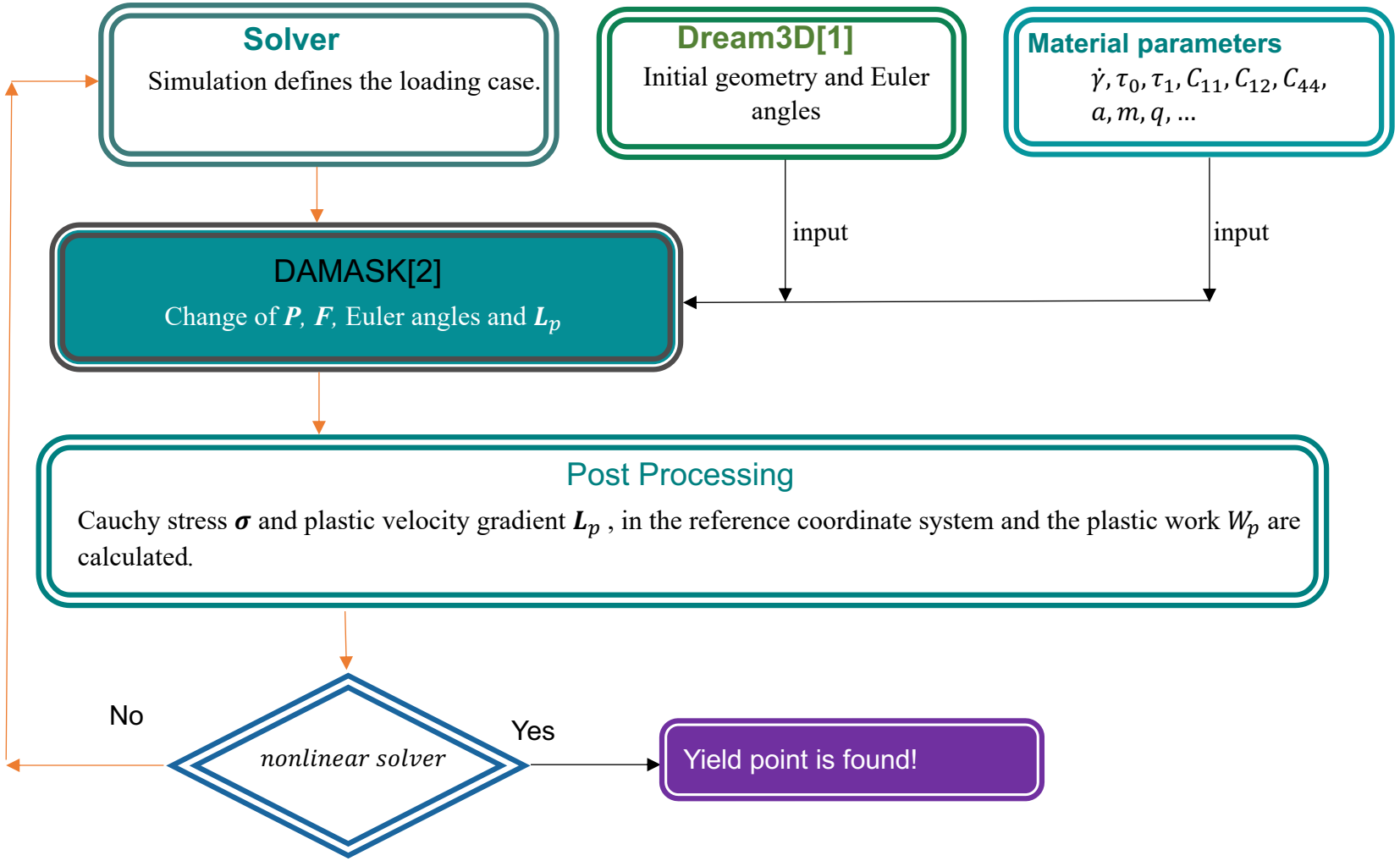
Figure 2. *Multiscale approach in AllDesign*[6].

http://www.dierk-raabe.com/

NTNU

SINTEF

Virtual laboratory for probing yield surfaces



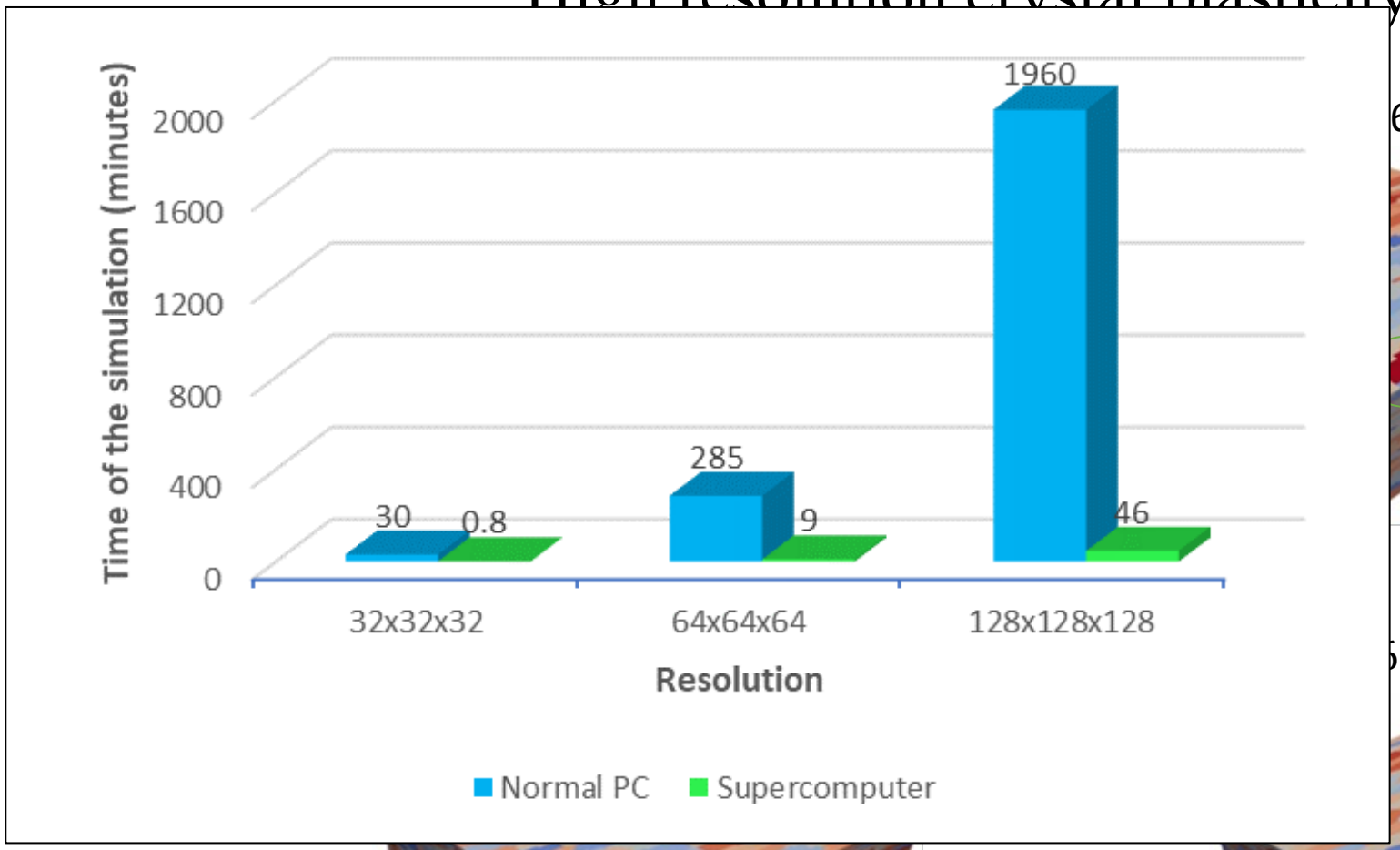
[1] http://dream3d.bluequartz.net/

[2] "DAMASK–The Düsseldorf Advanced Material Simulation Kit for modeling multi-physics crystal plasticity, thermal, and damage phenomena from the single crystal up to the component scale.

NTNU

SINTEF

High resolution crystal plasticity modelling



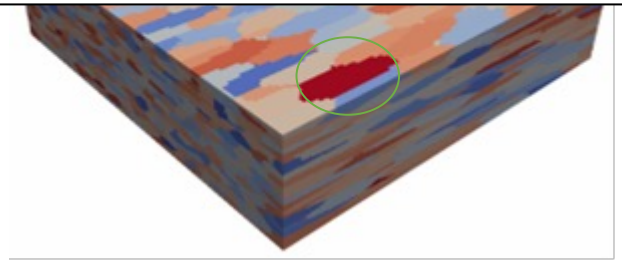
62144

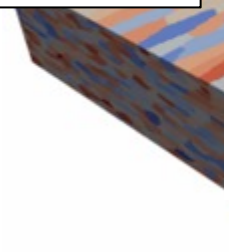
DAMASK on supercomputers?!

NTNU

High Performance Computing Group

Idun





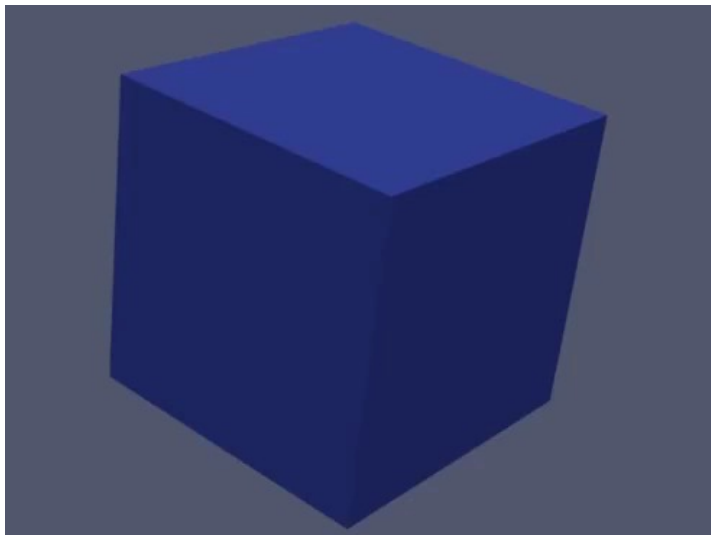
NTNU

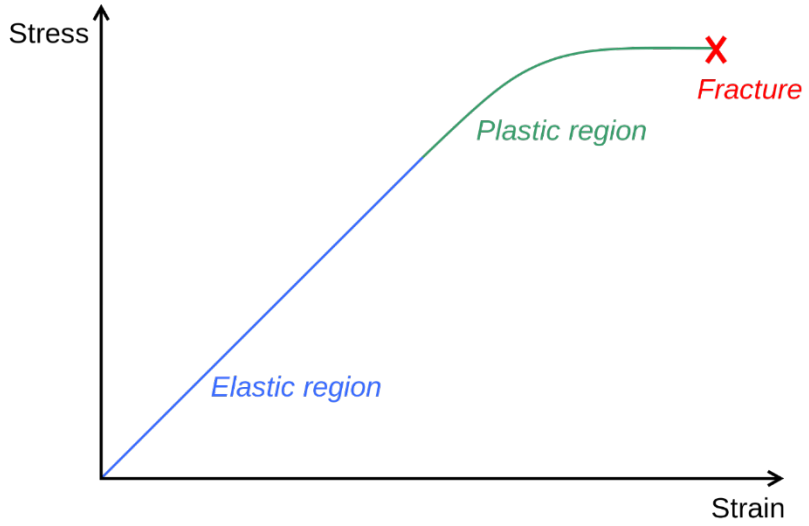
Applications - Part 1: Yield surface

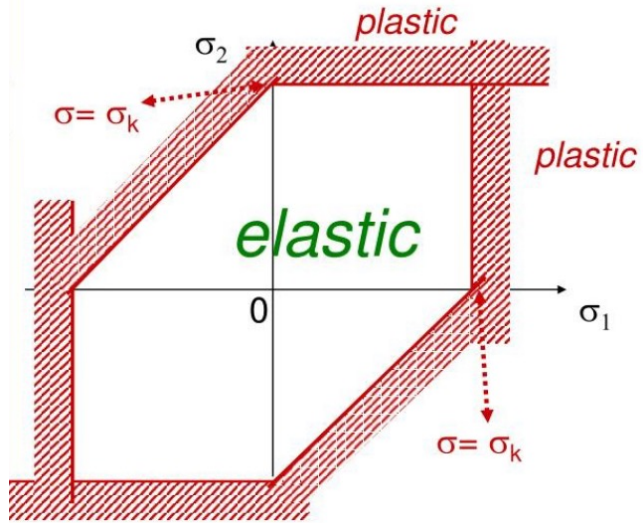
SINTEF

What is a yield surface?

A yield surface is a generalized form of the yield strength, at which materials start to undergo inelastic deformation (also, more correctly, referred to as elastic-plastic deformation).







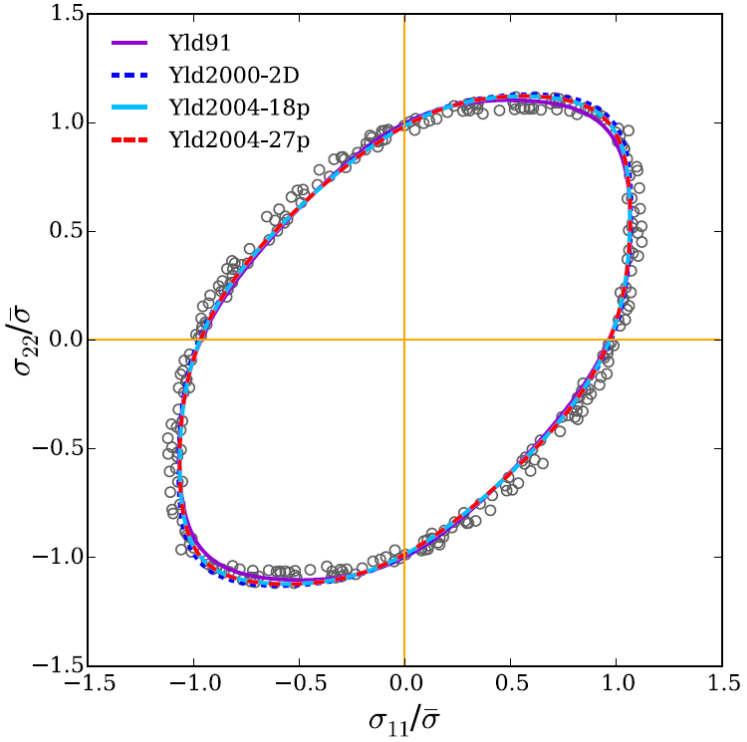
NTNU

Applications - Part 1: Yield surface

SINTEF

Present virtual lab.

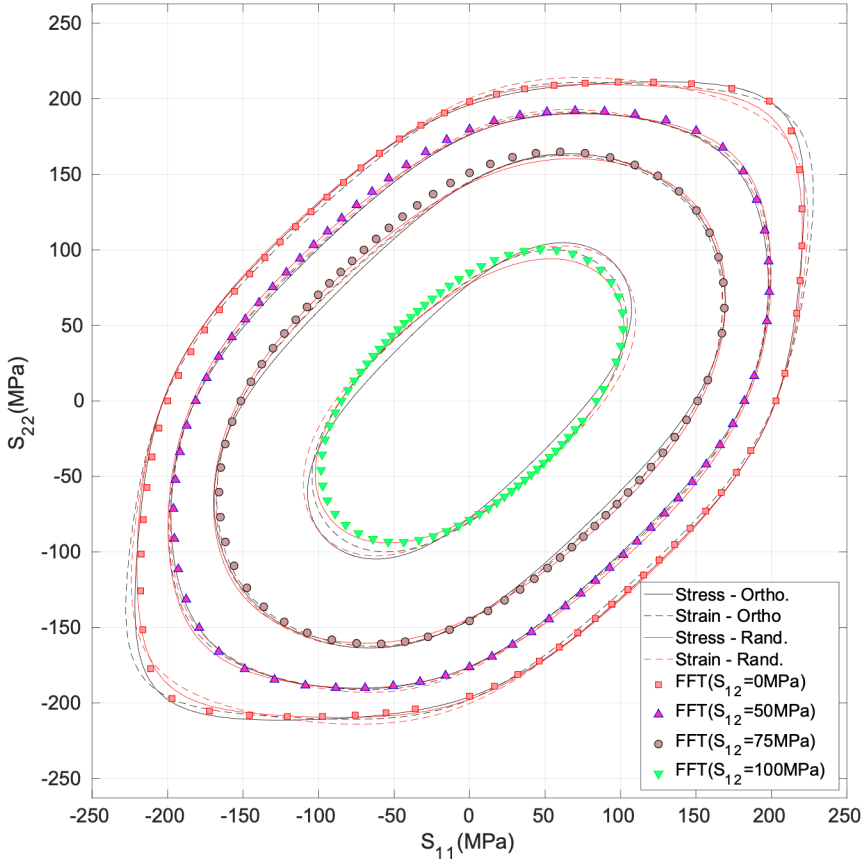
Literature



Zhang, H., Diehl, M., Roters, F. and Raabe, D., 2016. A virtual laboratory using high resolution crystal plasticity simulations to determine the initial yield surface for sheet metal forming operations. International Journal of Plasticity, 80, pp.111-138.

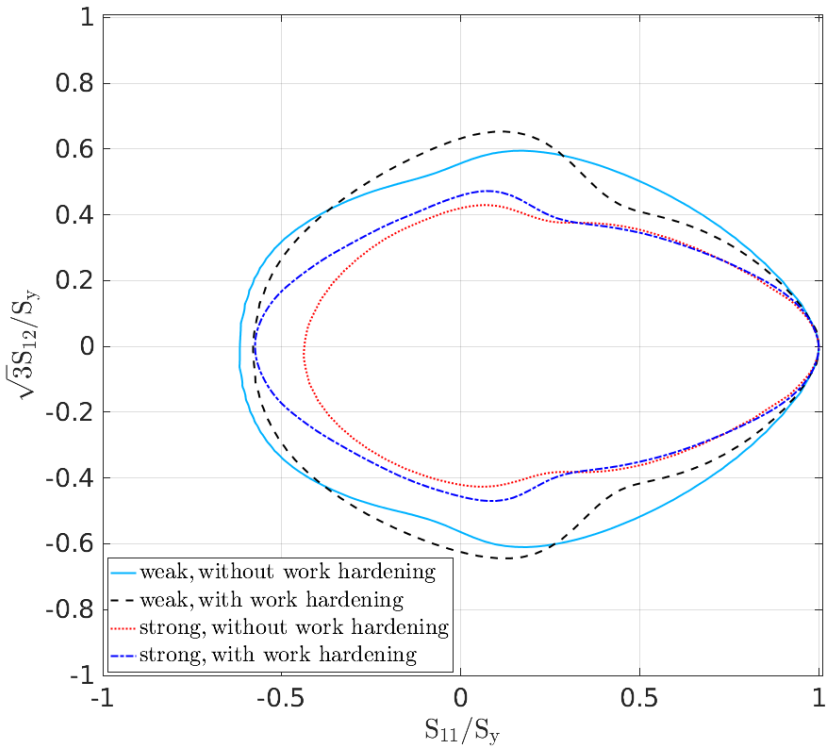
Present virtual lab.

Cold rolled 3103H18 alloy

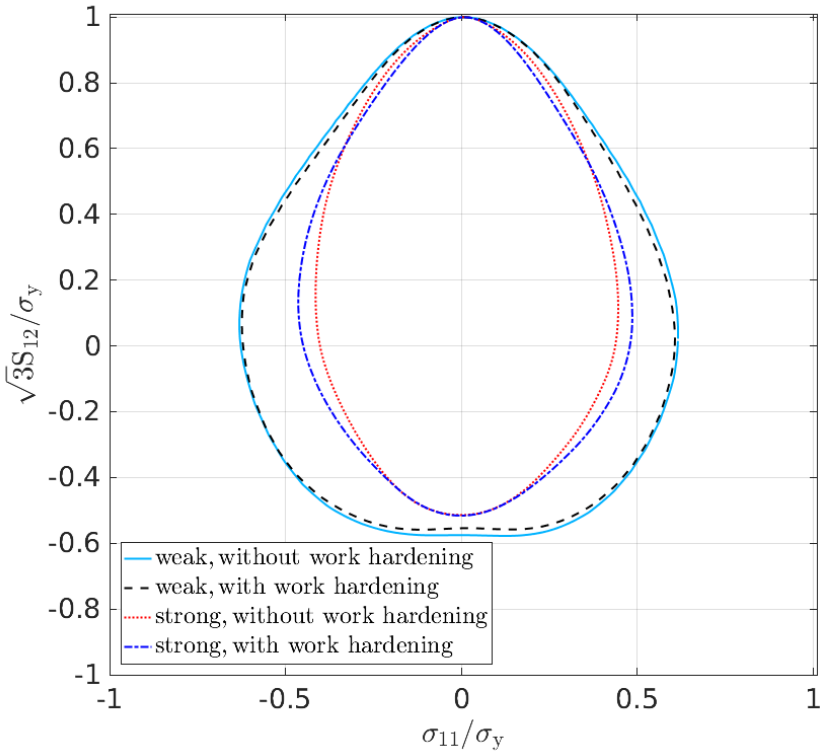


Part 2: Loading- unloading – elastoplastic transition.

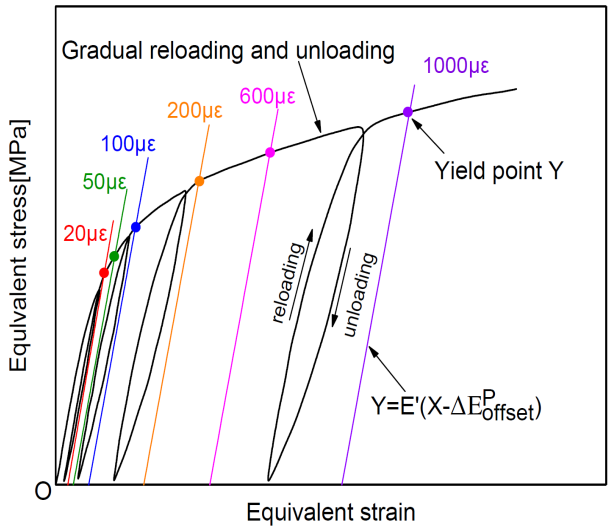
Pre-deformation in tensile dir.

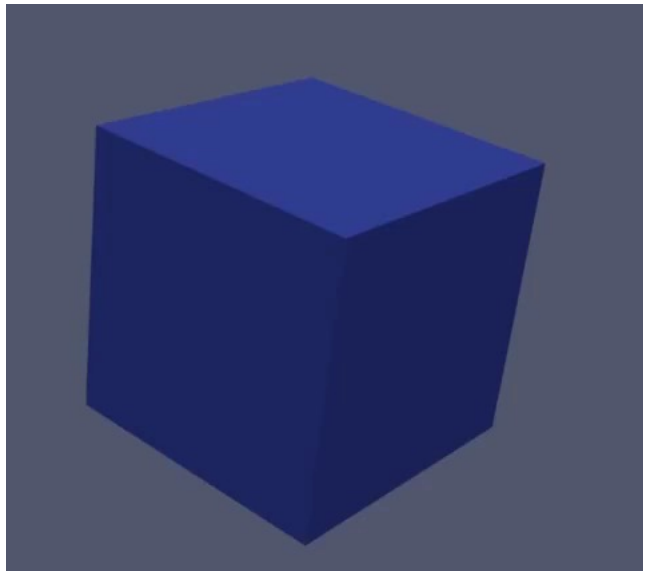


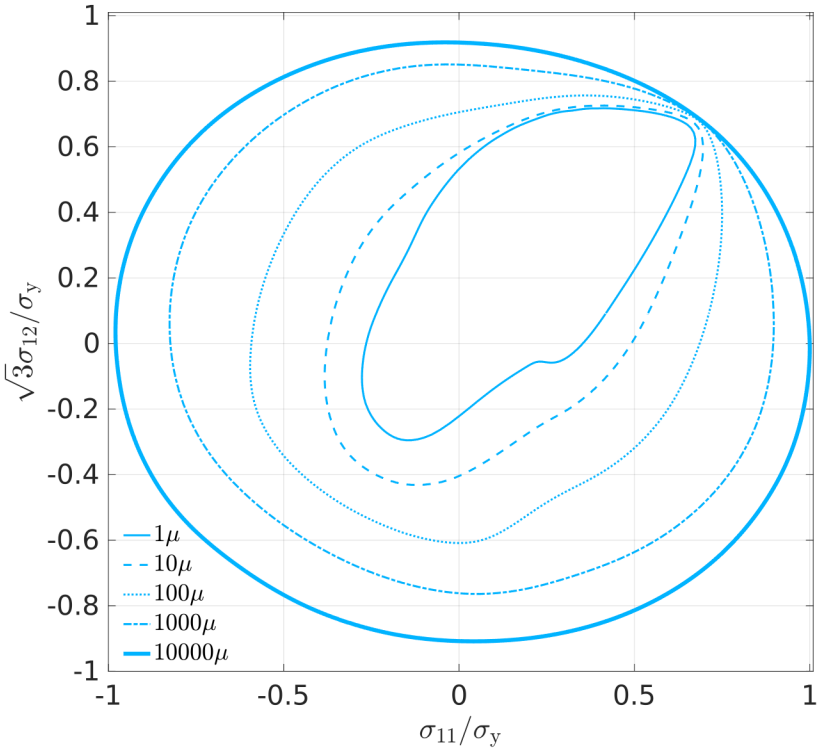
Pre-deformation in shear dir.

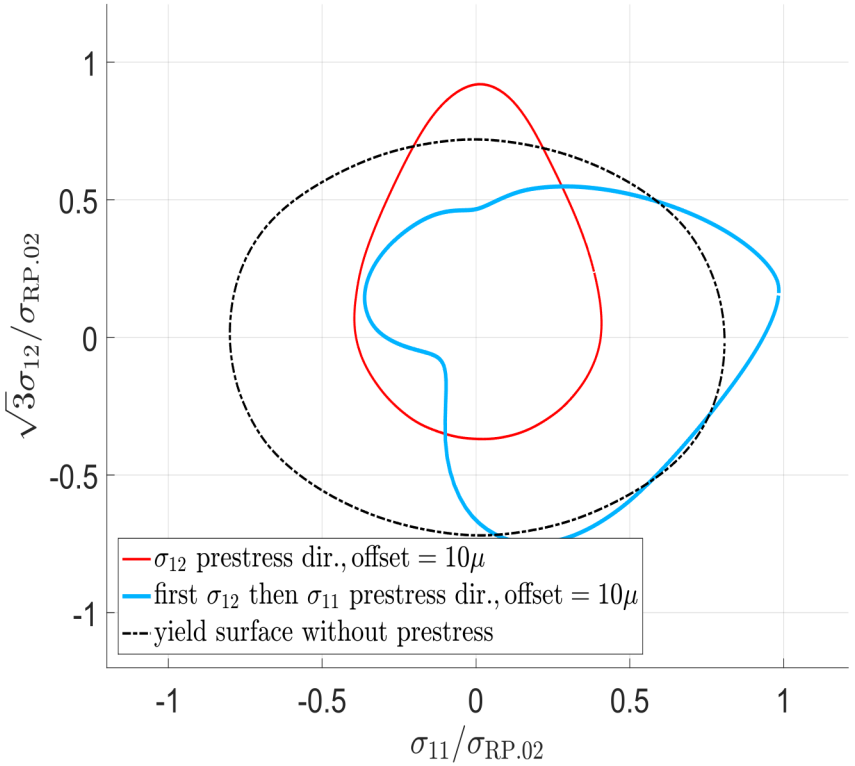


Part 2: Loading- unloading - Subsequent yield surface.







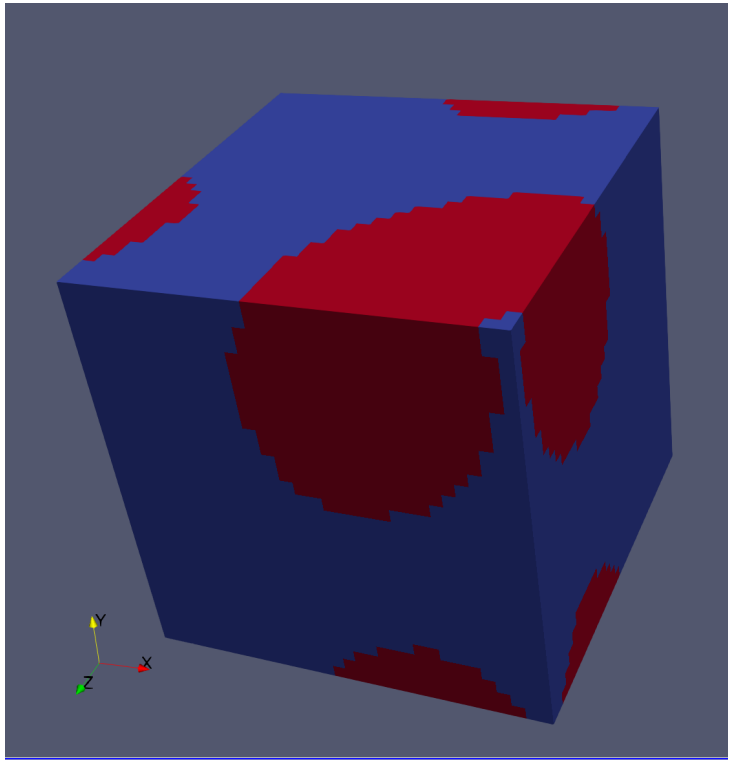


NTNU

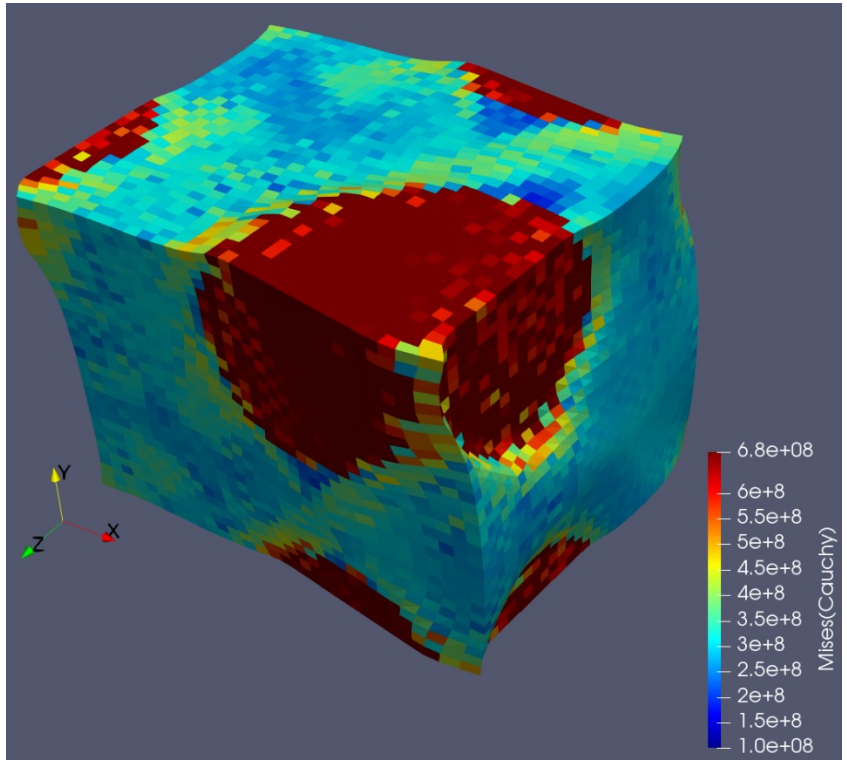
SINTEF

Part 3: Aluminum matrix with hard particles.

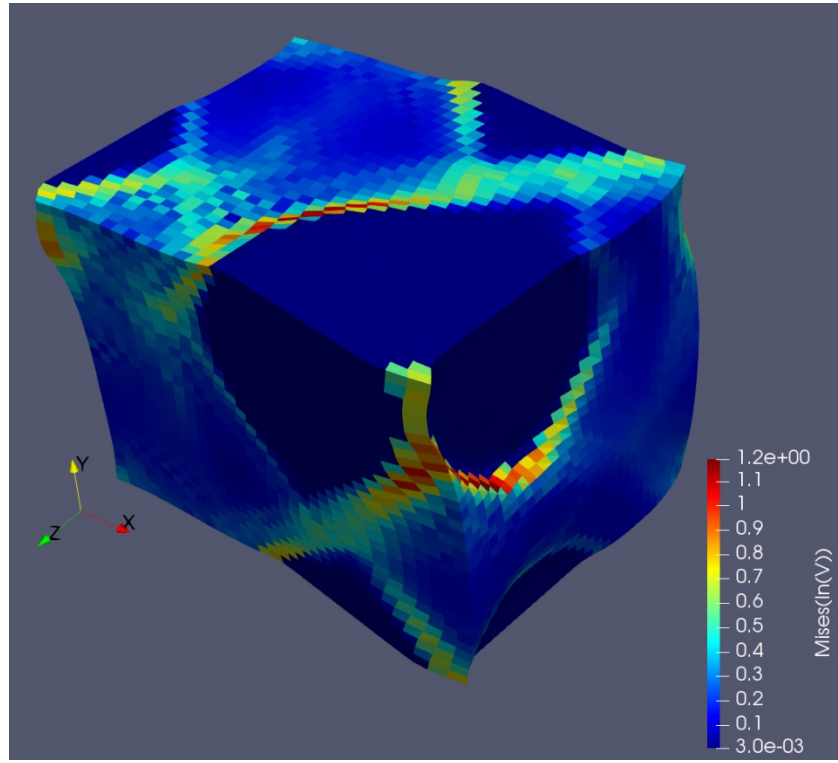
Blue: aluminium
Red: Particle



Stress distribution(Pa)



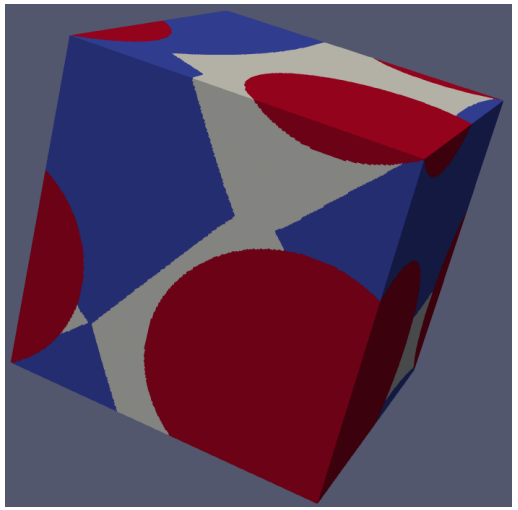
Strain distribution



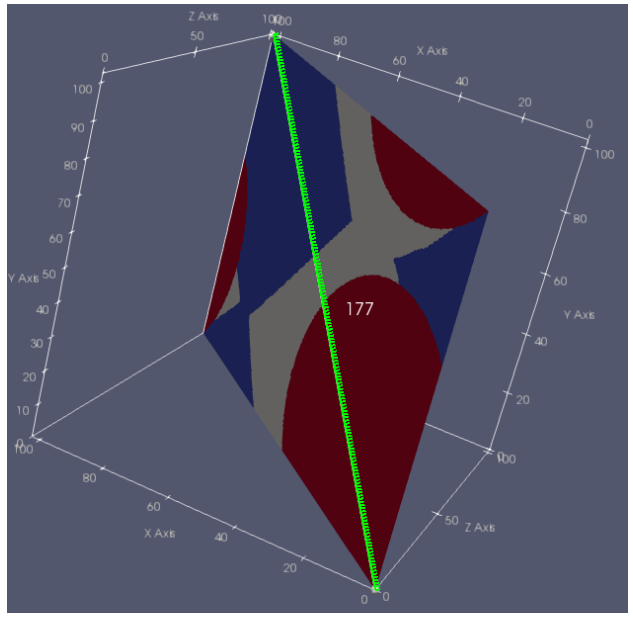
NTNU

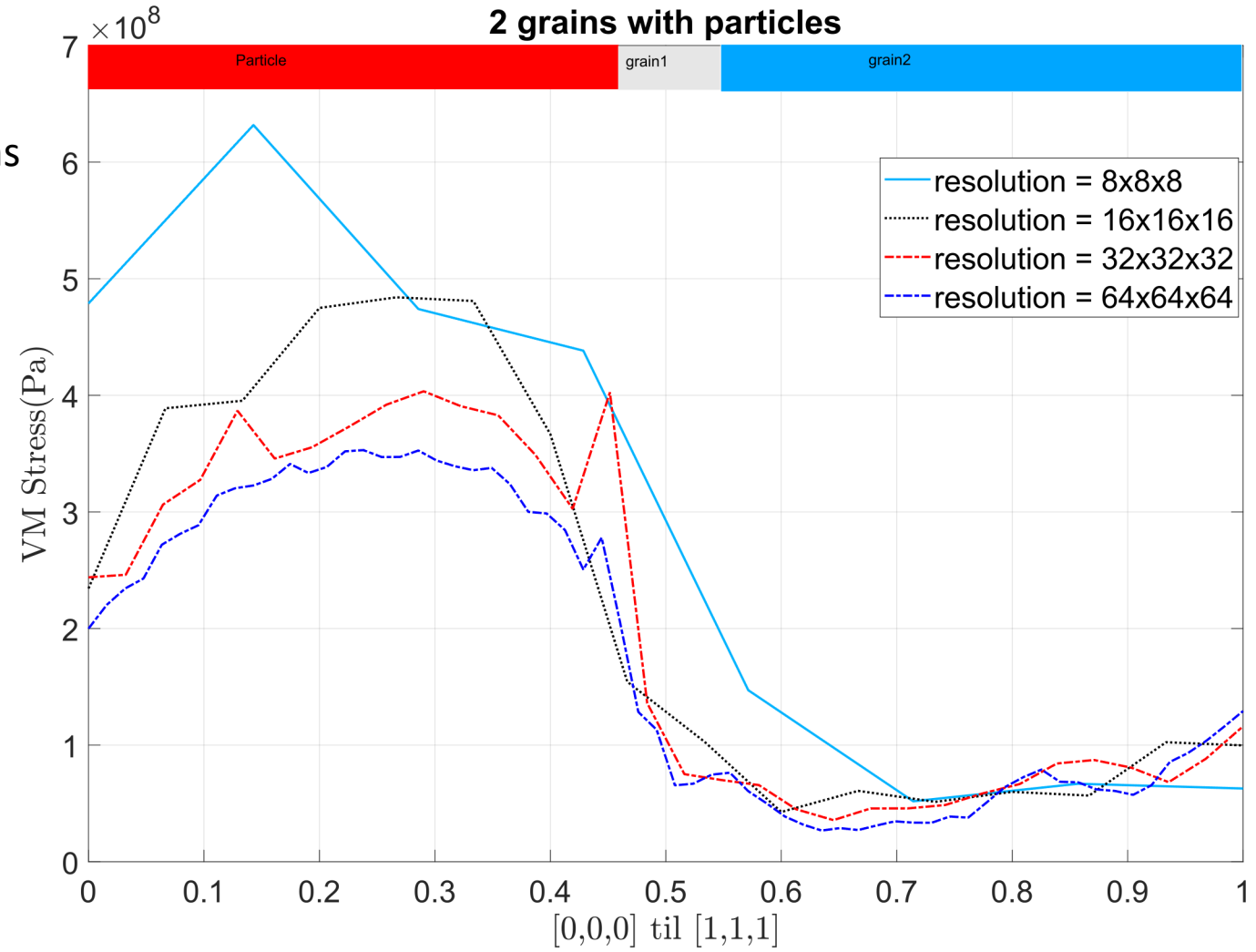
SINTEF

Part 3: Aluminium matrix with hard particles.



Red: particle
Gray & blue: Aluminium grains





NTNU

SINTEF

Summary & publications:

- Part 1: *A crystal plasticity virtual laboratory - high resolution spectral solver with uniformly distributed stress directions.*

- Part 2: *The evolution of subsequent yield surfaces with plastic deformation along proportional and non-proportional loading paths using spectral solved based virtual laboratory.*

- Part 3: *Hard particles inside polycrystals and how they influence the strength and anisotropy of the aluminium alloys.*