

FE-analyses of welding. Single- and multi-pass welds

.Single pass welds

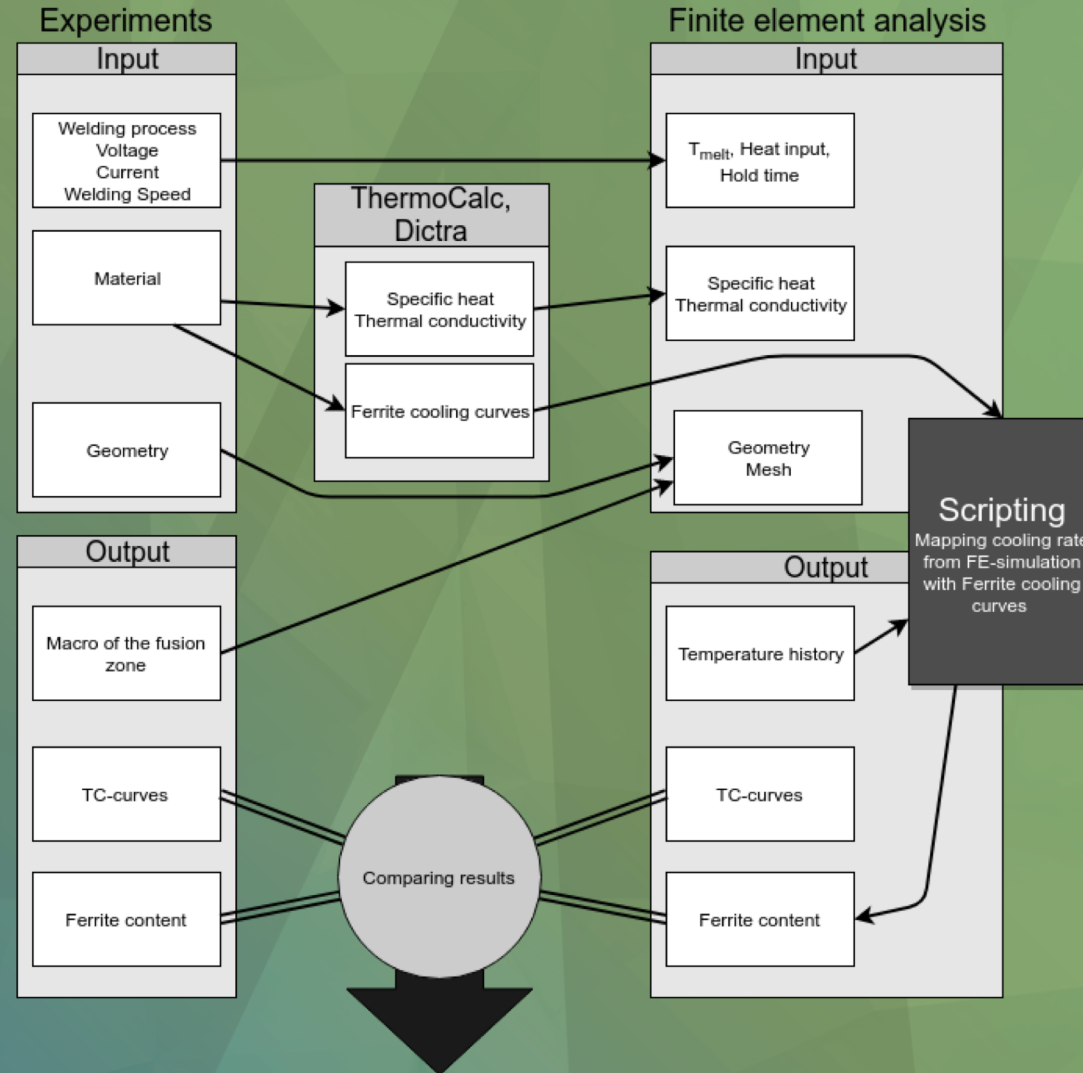
- .Starting point for the project
- .T-joint
- .Several materials

.Multi-pass welds

- .Final part of project
- .Butt-joint
- .2507 with 2509 filler

Single pass The Work flow

- Experiments give Geometry
- FEA gives Temp history
- Dictra gives ferrite change based on cooling rate and temperature

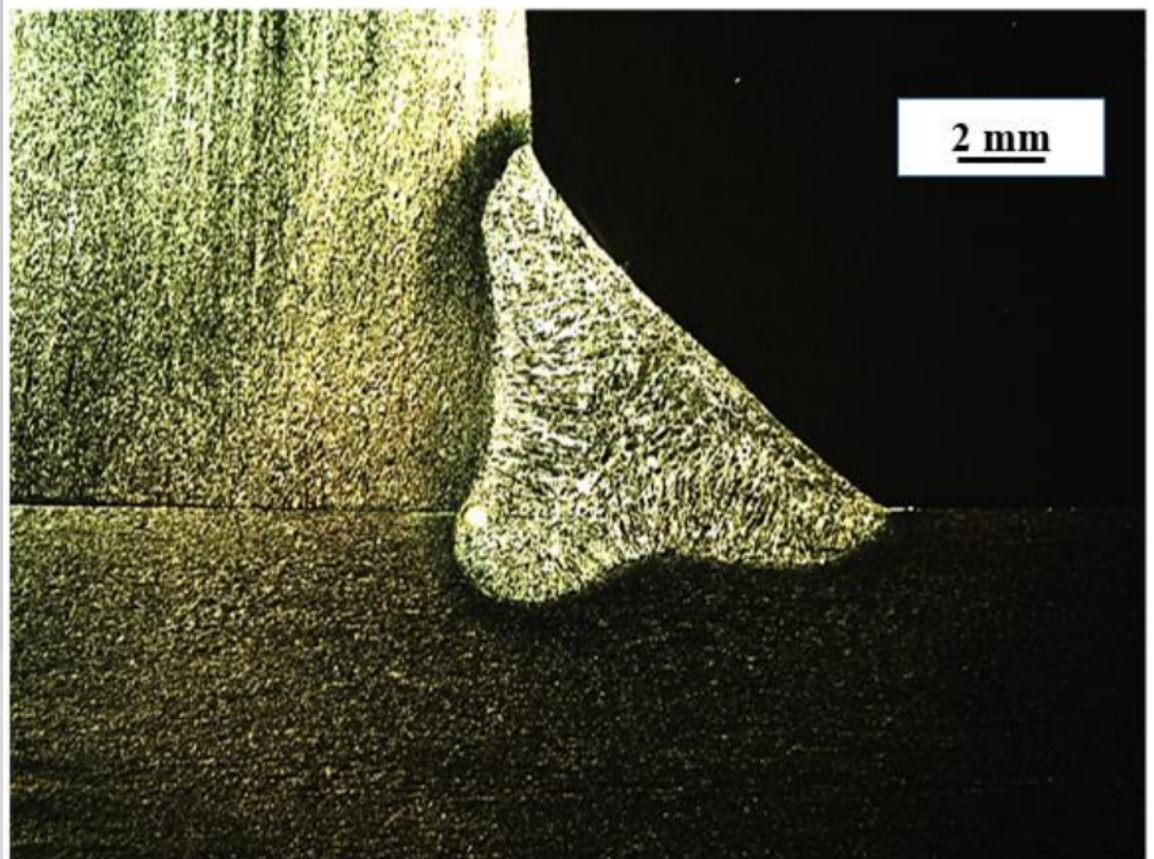


How its done: a typical single pass T-joint

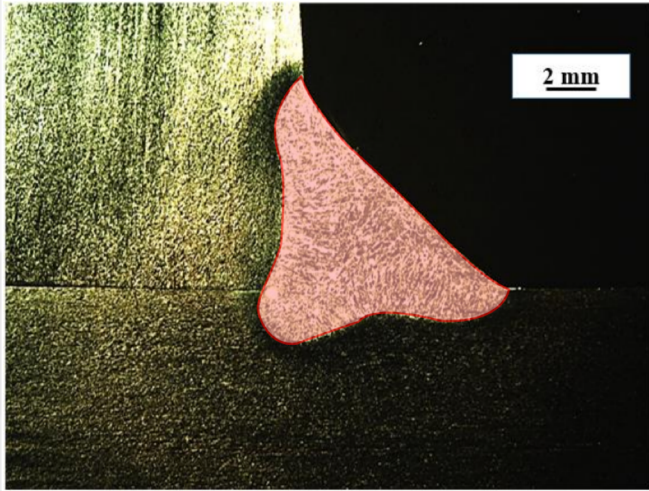
•Experiments feed the
analysis

-Weld parameters

-Weld geometry

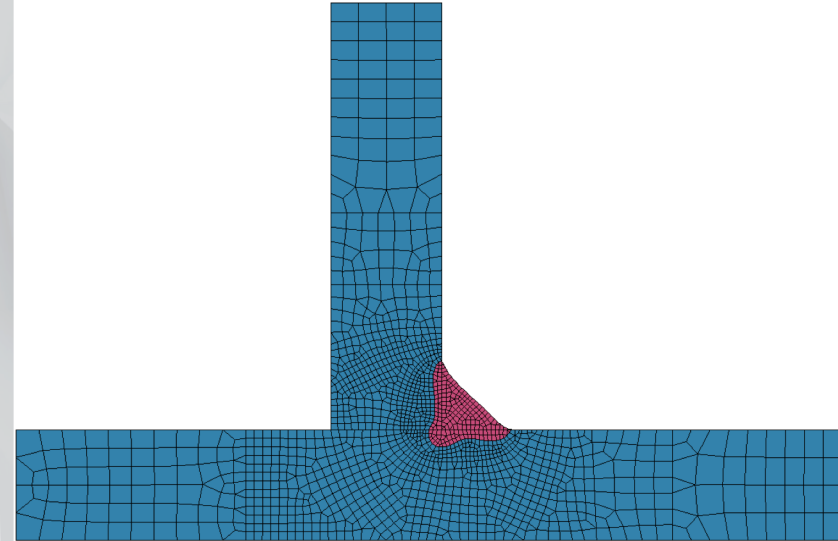
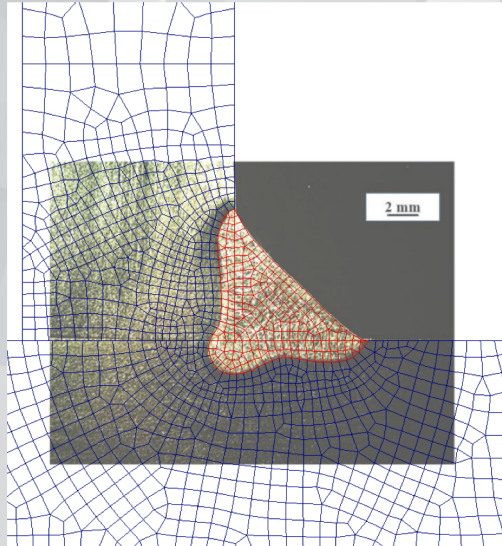


The geometry is processed



The weld is isolated

The area is meshed



The final mesh

Heat is added (weld parameters)

Using a Goldak heat source in a 3d model gives the time dependent temperature profile in a 2d model of the cross section.

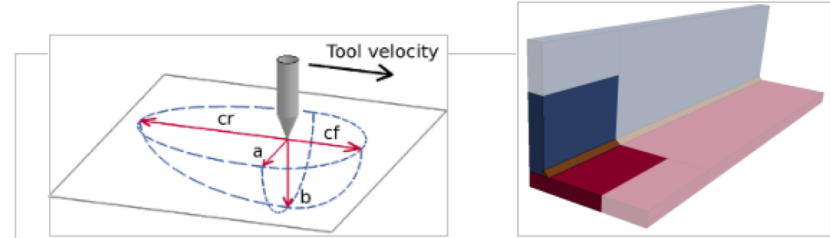
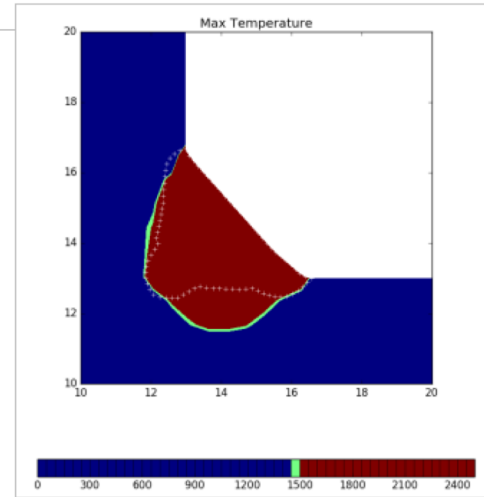
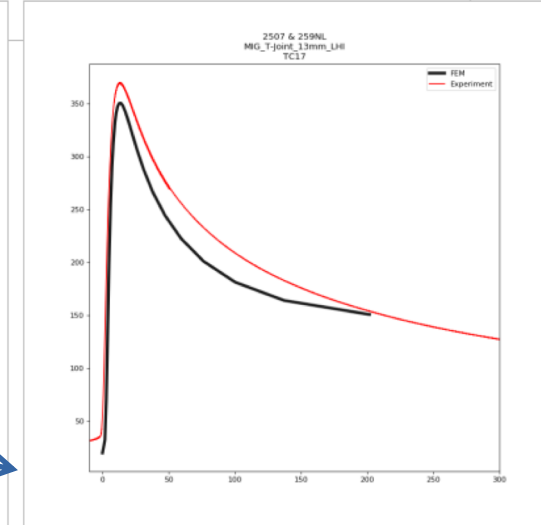
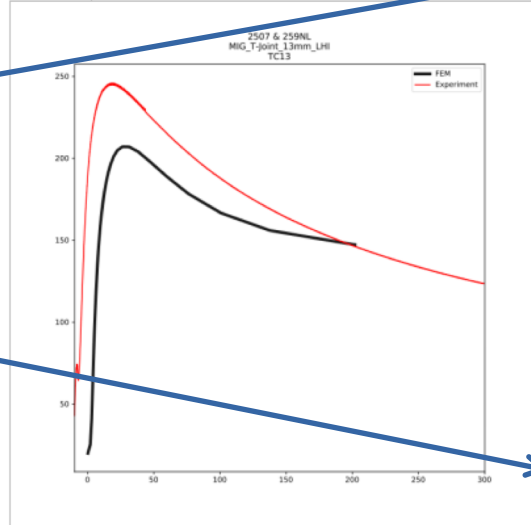
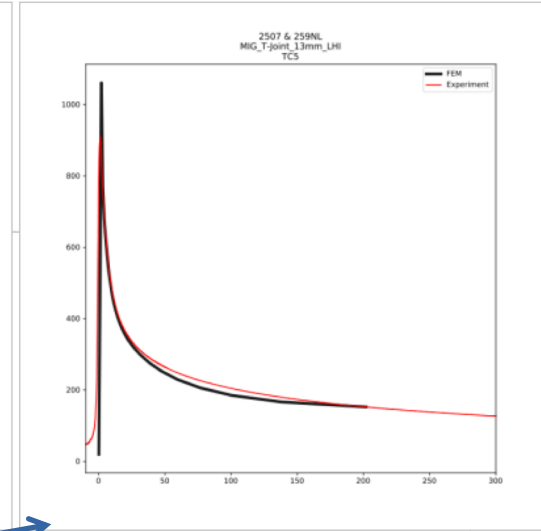
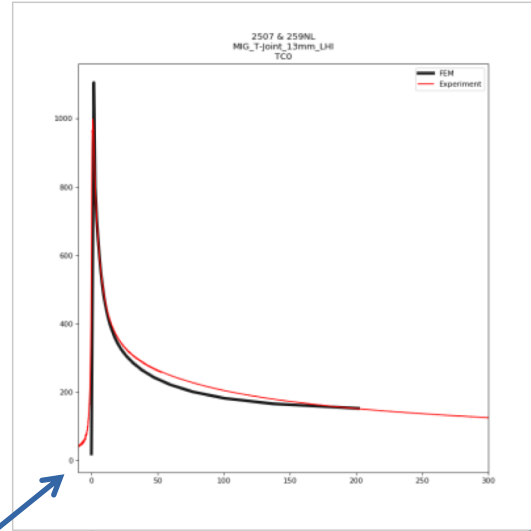
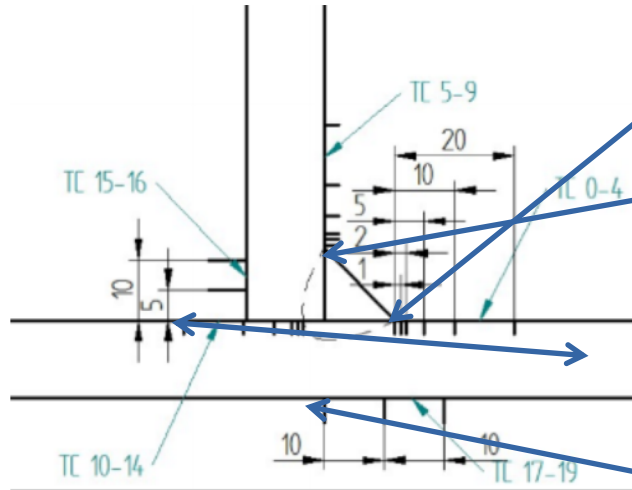


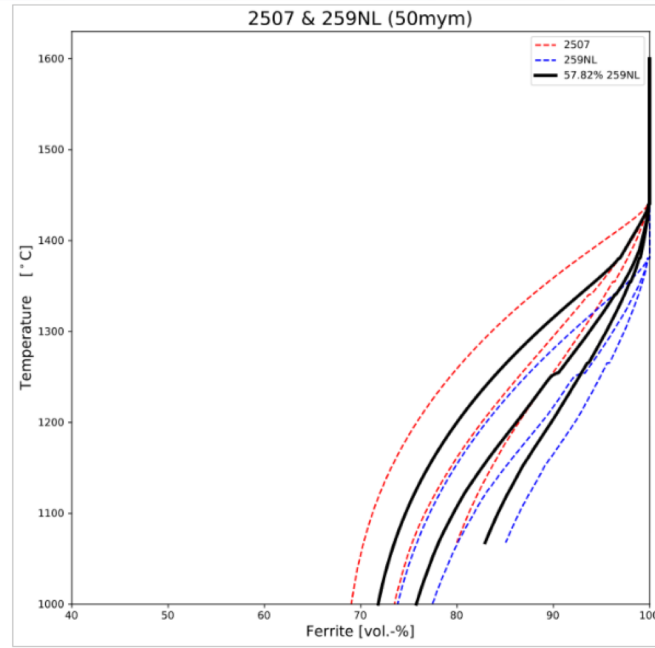
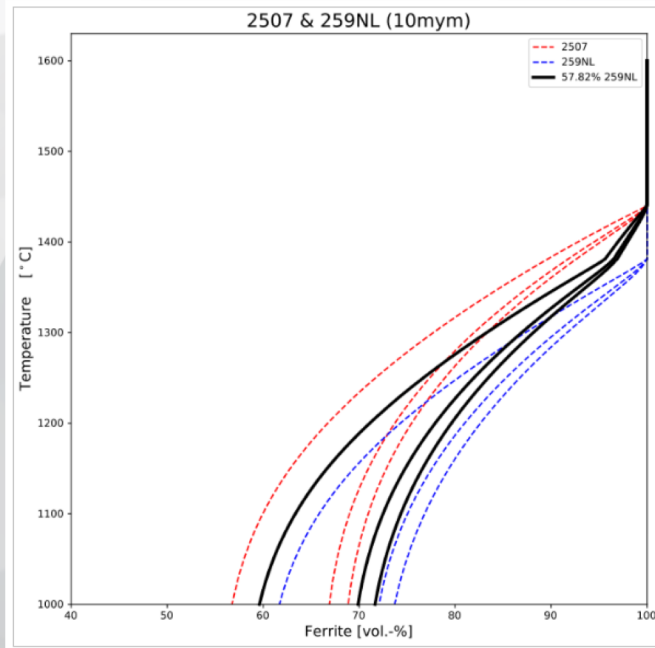
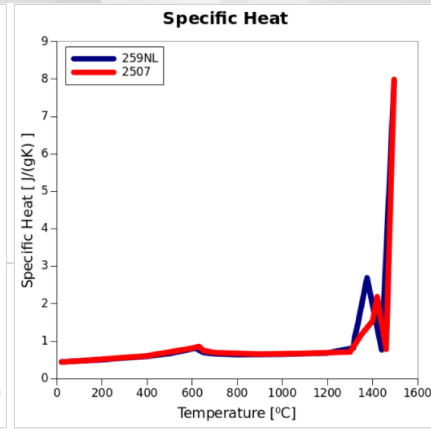
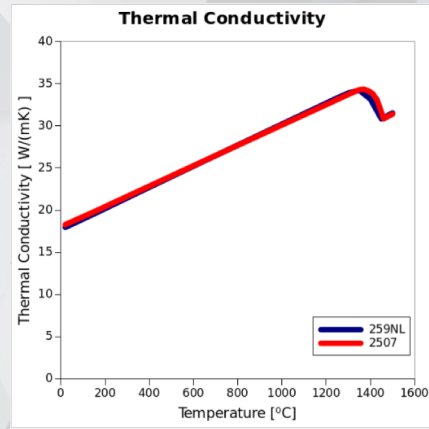
Figure 6 Right: Goldak double ellipsoid. Left: 3D-model.



Results: Temp-hist



The material

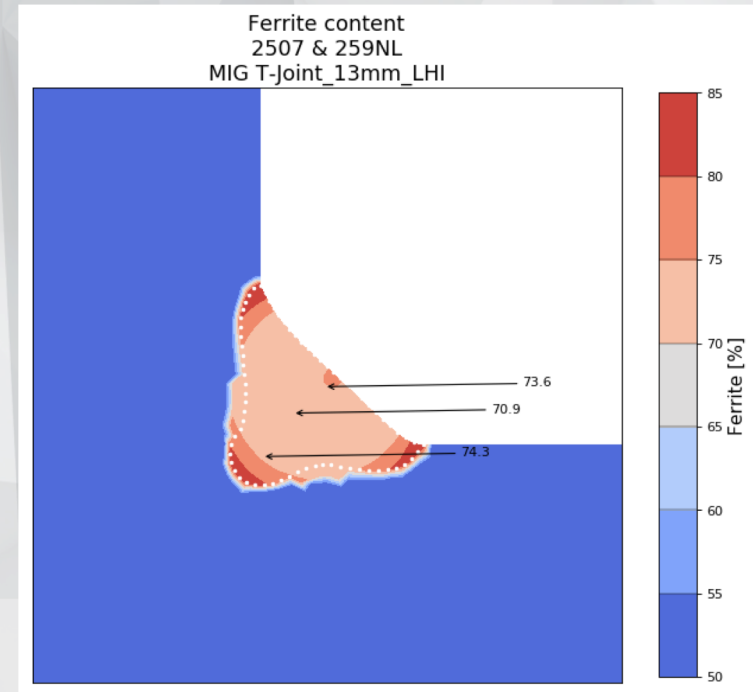


Calculated Fe-content for 3 different

Remapped to rate-based curves to be usable in FE-result post processing

Welding 50/50 duplex steels give a weld with varying ferrite content

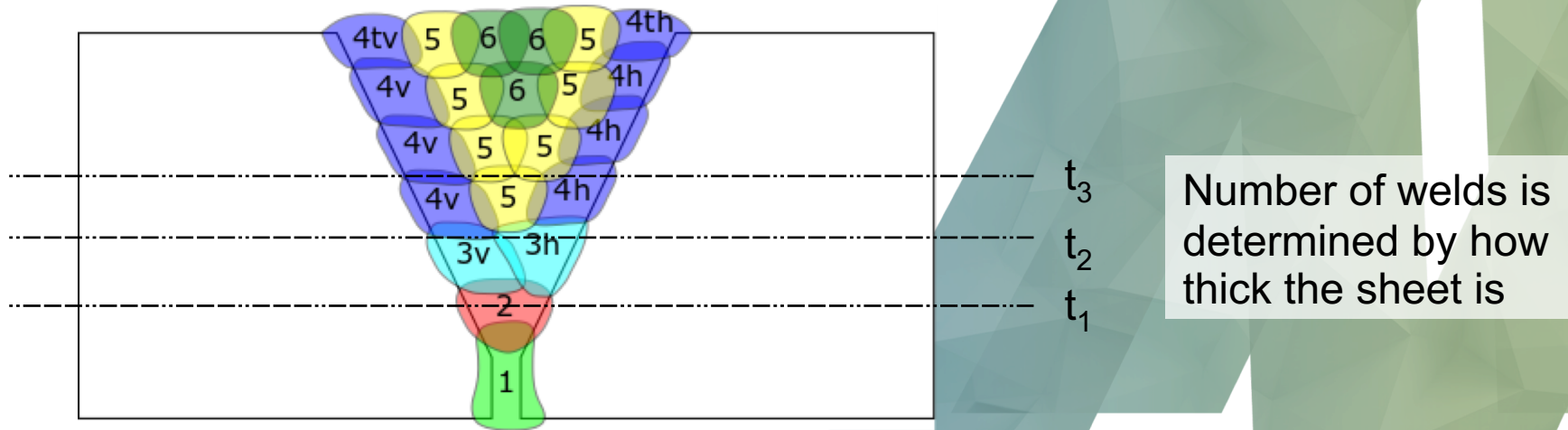
.The temperature history for every material point control the ferrite/austenite content



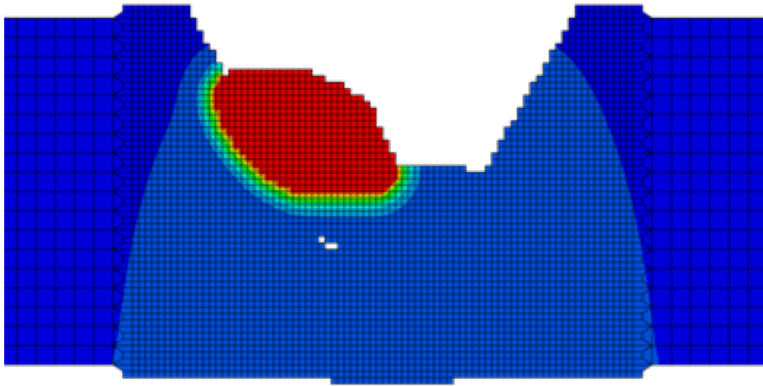
Multi pass welds

- .Predefined weld beads
- .shape and position determined numerically
- .4 weld techniques {mag, tig, mma, saw}
- .9 thicknesses
- .5 weld speeds, 5 heat inputs
- .total of 675 unique simulations

Predefined weld beads



Heat added in welds



- 1) Weld material is added
- 2) Heat is added in weld
- 3) Cooled because surrounding material
- 4) Next weld added

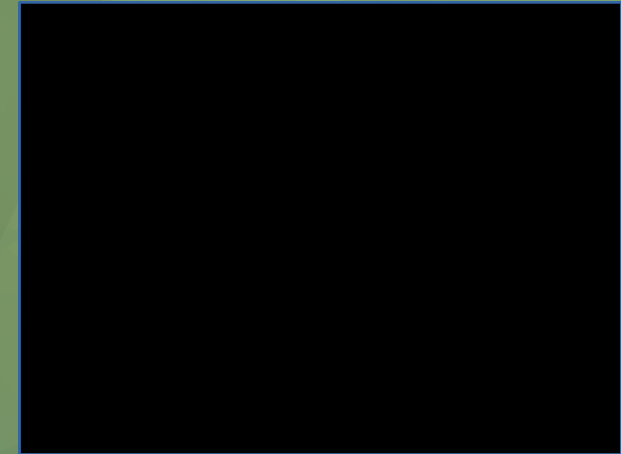
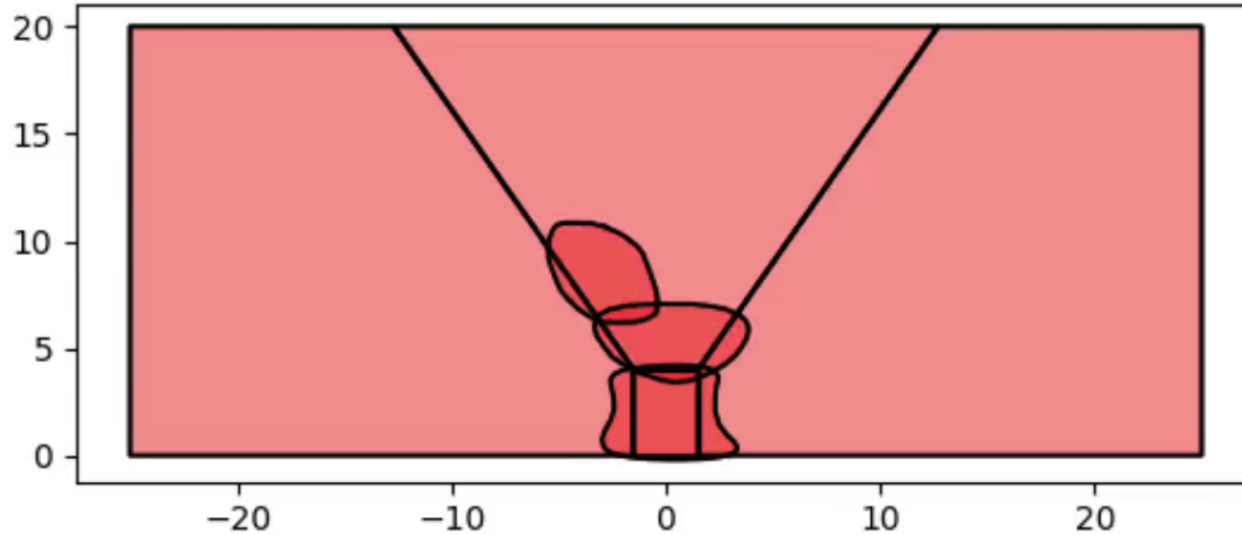
Temperature history in every node
(up to approx 45000 points)

Calculation flow for multi pass welds

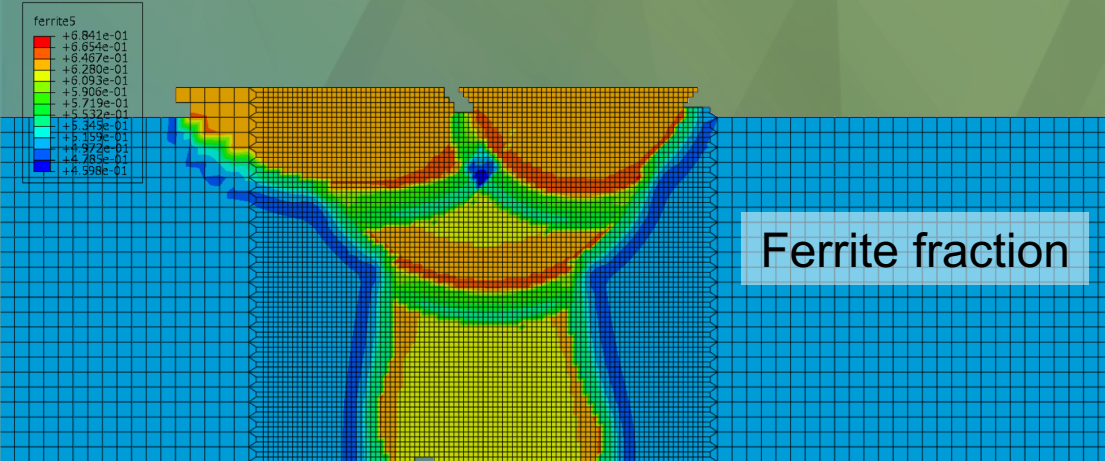
- .Define sheets
- .Place first weld
- .Place subsequent welds
- .if filled then stop
- .Run simulation with weld sequence
- .Calculate ferrite and sigma content with temp history and dictra results

- .Shape and place of bead is determined numerically
- .Weld technique determines bead size and dilution
- .A two step Calculation of position
 - Place bead as close as possible by guessing
 - optimisation loop to final position

Automatic positioning of subsequent welds

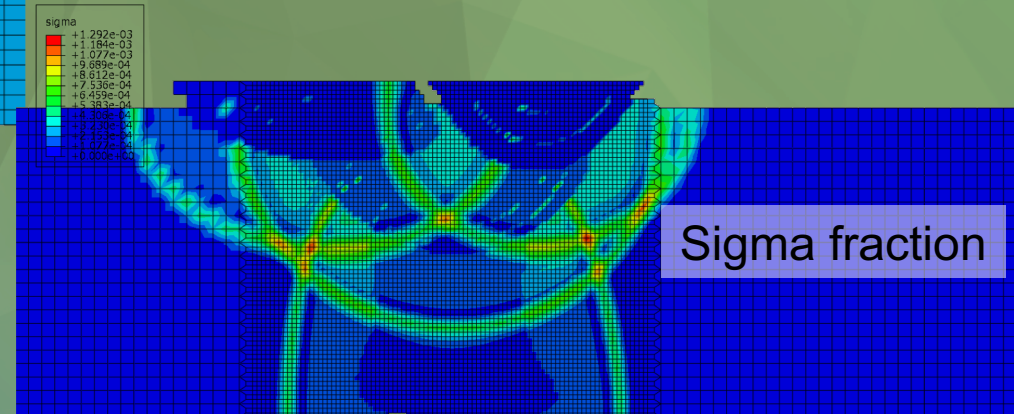


Typical Results



Y ODB: dtoolSim.odb Abaqus/Standard 3DEXPERIENCE R2019x Mon Feb 10 15:15:21 CET 2020

Step: coolStep4
 X Increment 38: Step Time = 400.0
 Primary Var: ferrite5



Y ODB: dtoolSim.odb Abaqus/Standard 3DEXPERIENCE R2019x Mon Feb 10 15:15:21 CET 2020

Step: coolStep4
 X Increment 38: Step Time = 400.0
 Primary Var: sigma
 Deformed Var: not set Deformation Scale Factor: not set