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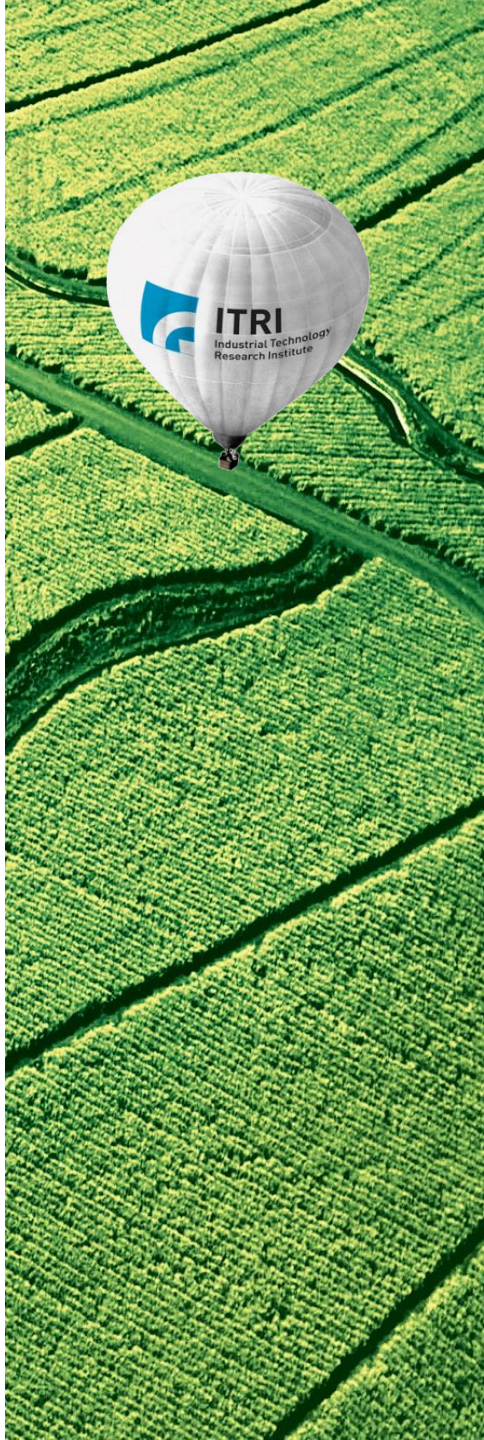

A Part-scale Process Simulation App for Laser Powder Bed Fusion

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Laser Powder Bed Fusion Process Workflow

Trial & Error Loops

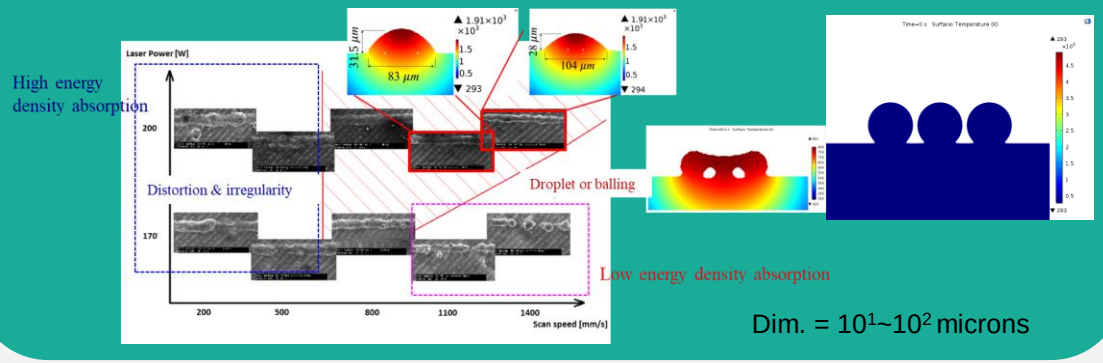
3D CAD Design → Build Orientation Laser Parameters Support Structure Design, etc. → Selective Laser Melting (SLM) → Part Inspection

Part Design

Expensive Production

Quality Control

Laser-Powder Interaction ➔ Working Process Window



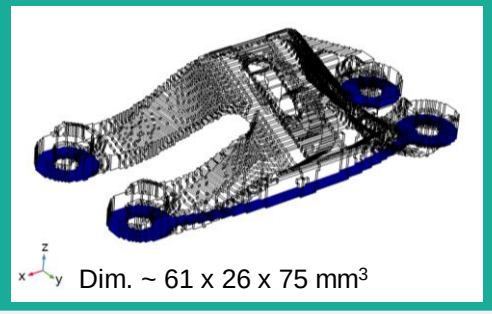
Dim. = 10^1~10^2 microns

Virtual Manufacturing

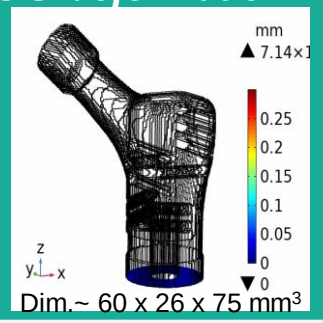
Micro-Scale Simulation: Laser-Powder Interaction

Macro-Scale Process Simulation

Part-Scale Simulation→ Residual Stress & deformation



Dim. ~ 61 x 26 x 75 mm^3



Dim.~ 60 x 26 x 75 mm^3

- Cost-effective Virtual Printing
- Boost up the ROI

Part-Scale Process Simulation

Simulation Approach:

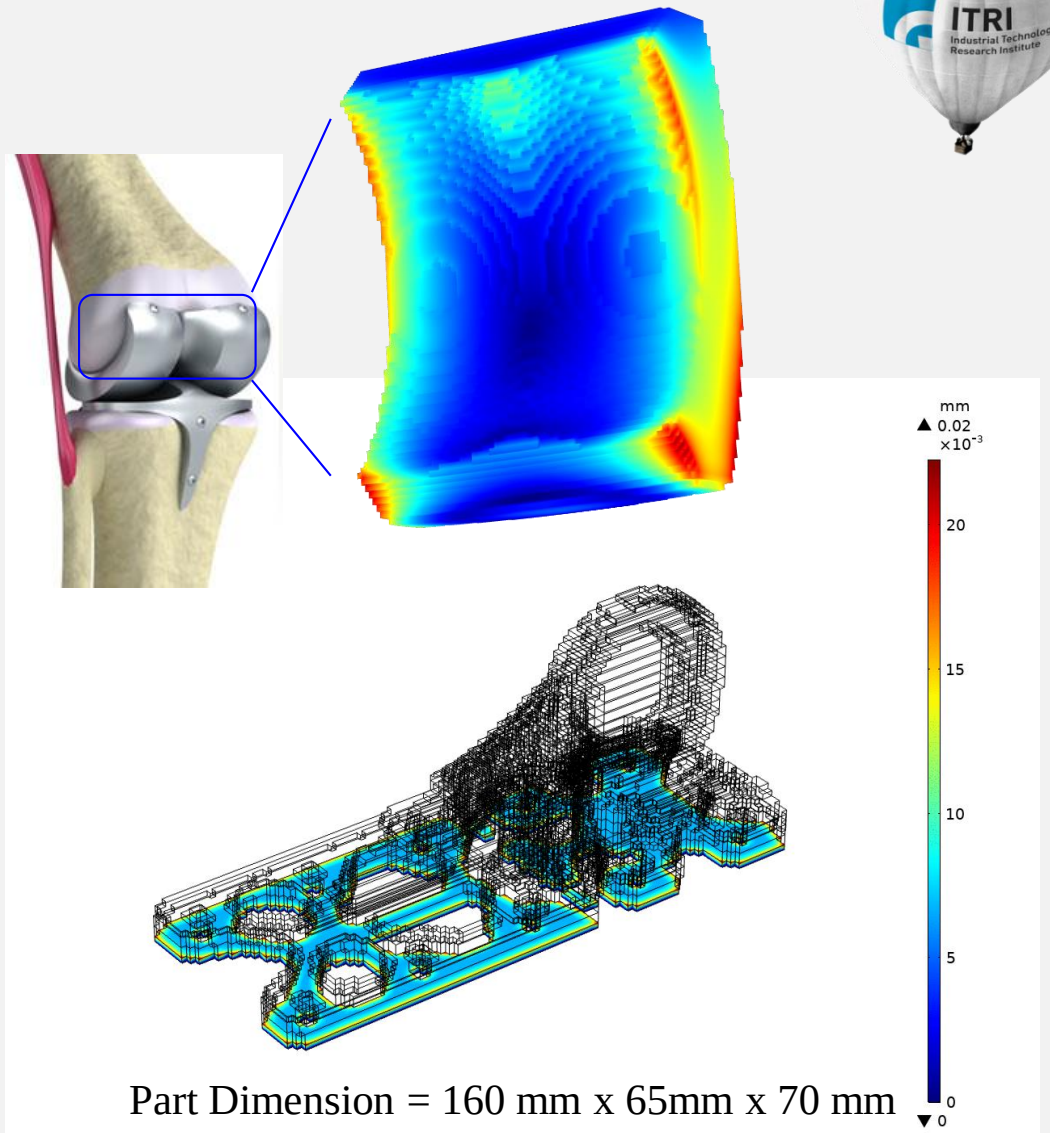
- ✓ FEM simulation
- ✓ Inherent Strain Approach
- ✓ Layer-by-layer activation

Main Features:

- ✓ Full-scale simulation
- ✓ Calibration according to scanning strategies
- ✓ Extremely **fast computations**
- ✓ Dependence of individual 3D printing systems

Results:

- ✓ **Residual stresses**
- ✓ **Part distortion** after removing from the baseplate
- ✓ Manufacturing process failure prediction

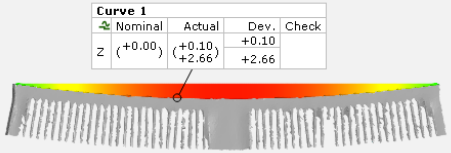


Part Dimension = 160 mm x 65mm x 70 mm
Max. Error ~ 1.5 mm
Calculation Time: 30 mins

Simulation Workflow

Pre-processing for Simulation

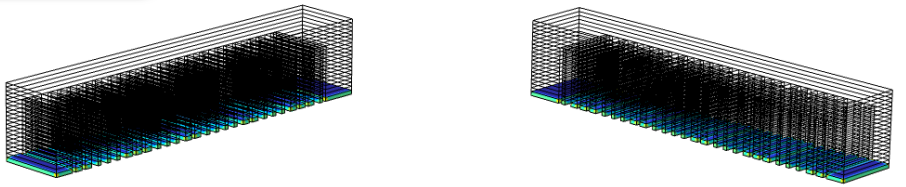
Calibration Experiment Bending Displacement Measurement



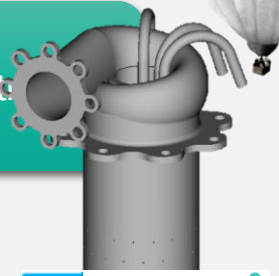
Reproducing Residual Displacement by Simulation

Inherent Strain Extraction for Certain Material and Scanning Strategy

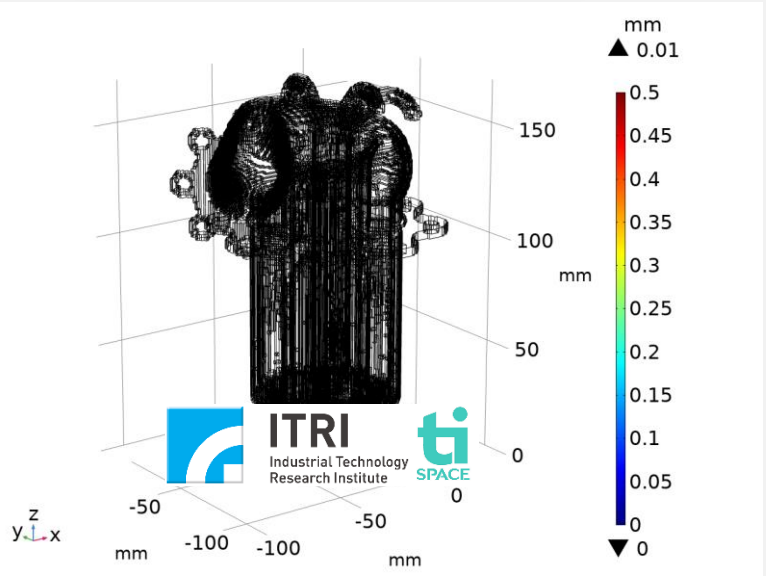
- Least-square optimization for parameter estimation



New STL Geomet

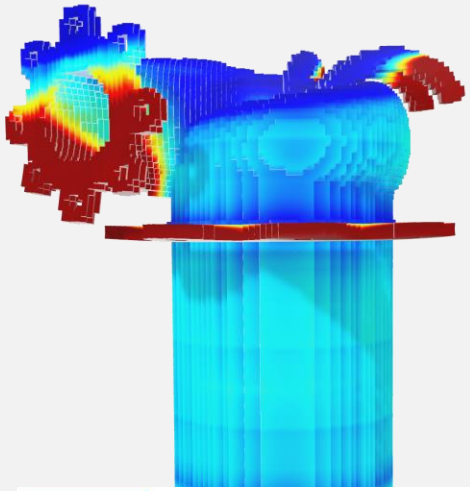


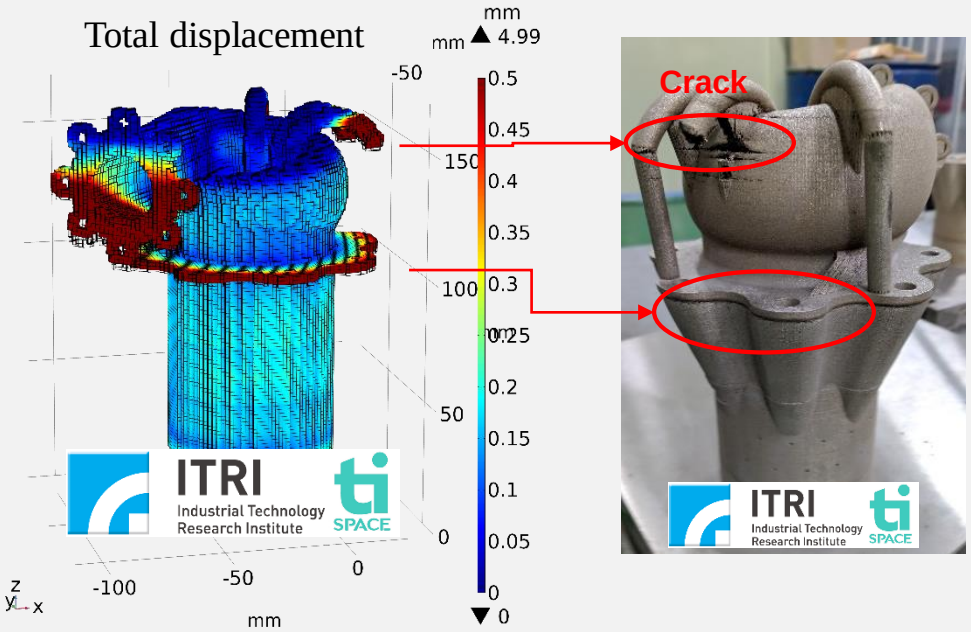
AMSIM APP Process Simulation

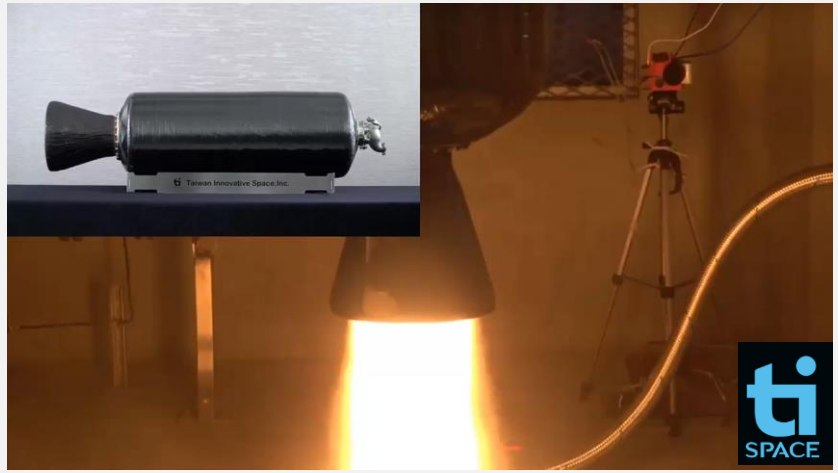


Case study- 3DP Injector

- 3DP Injector for rocket propulsion designed by TISPACE
- Material: 316L
- Dimension : 110 mm x 110 mm x 170 mm
- Printing Time : 4 days
- Simulation Time : 40 mins
- Simulation assisted to predict the failure locations during printing
- Reducing manufacturing cost and time > 70%

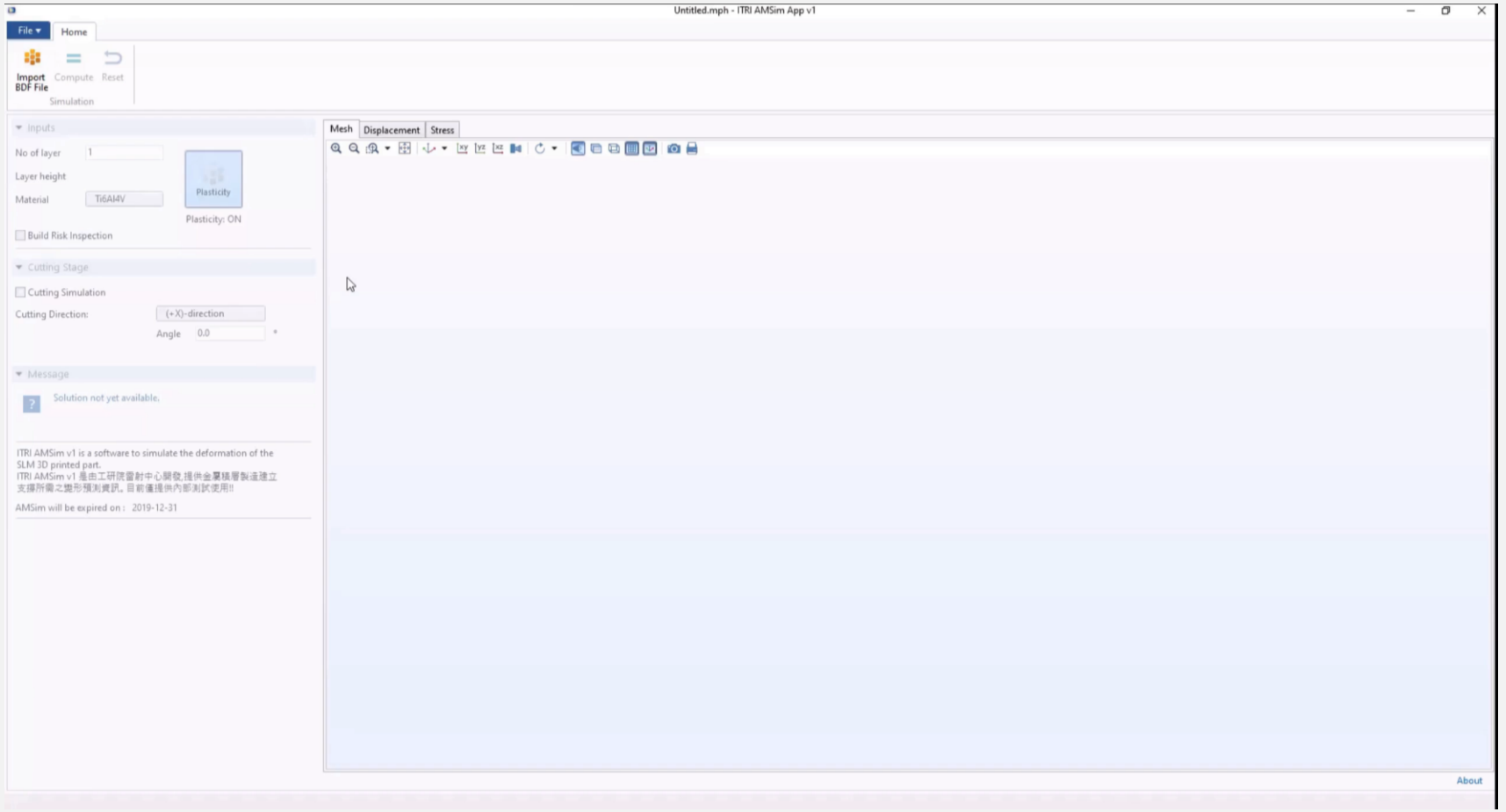






Source:
https://www.youtube.com/watch?v=exXVuppC0Qc;
https://www.youtube.com/watch?v=y26ZIdxVI3E

ITRI AMSim App



Inputs:
- STL
- Elastic / Elastoplastic
- Enable/ Disable Cutting Process

Available Materials:
- Ti 6Al-4V, a titanium alloy;
- MP1, a CoCrMo alloy;
- PH1, a stainless steel;
- 316L, a stainless steel;
- AlSi10Mg, an aluminum alloy.

Outputs:
- Total Displacement
- Residual stress (Von Mises Stress)

Thank you