Free Additive Manufacturing Enhancer (FAME)
Fredagsfika
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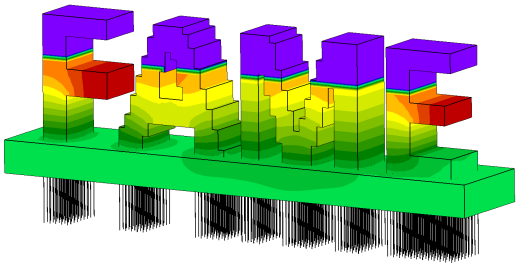
What is FAME?



- A tool for making geometrically better AM builds
- Production planning
- Free (GPL v3)
- Takes a desired geometry and outputs an adjusted geometry
    - , the engineering way!
- Very easy to use:

```
$ python3 FAME.py -i ~/path/to/file.stl -p ~/path/to/file.par
```

Why FAME?

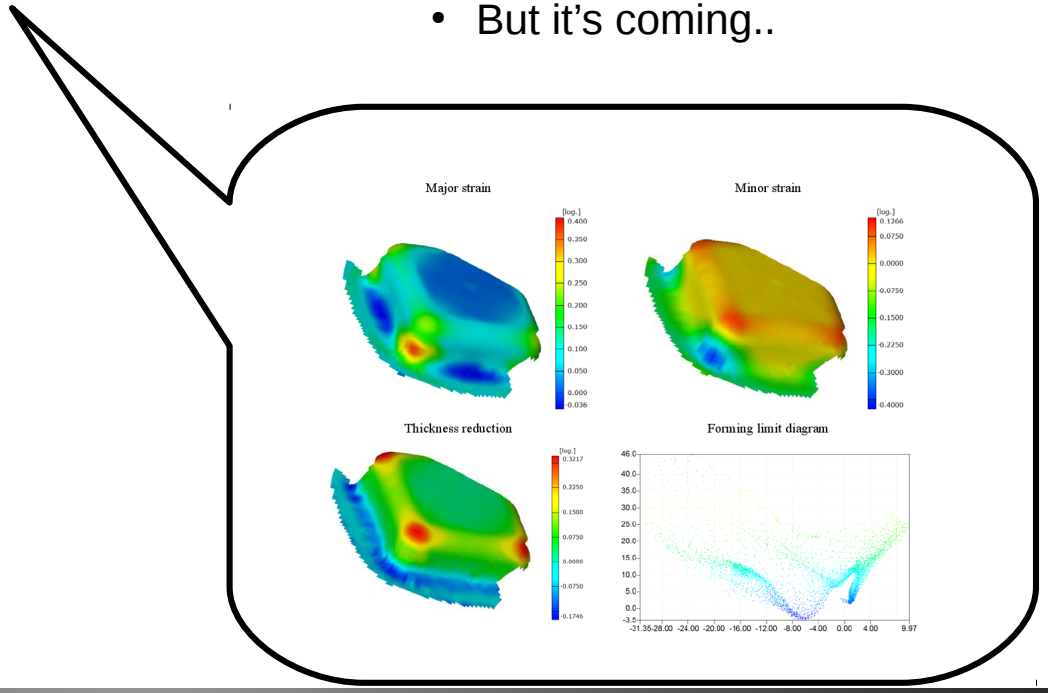
Numerical simulations are commonly used in production planning

For other processes:

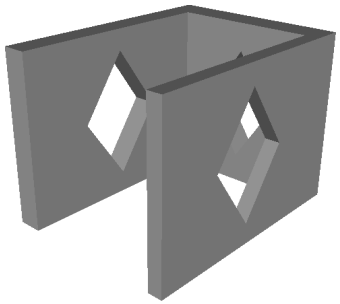
- **Sheet metal forming**
- Simulations for
  - Tool design
  - Spring back
  - Material failure
- **Welding**
- Simulations for
  - Spring back
  - Process parameters

For Additive Manufacturing:

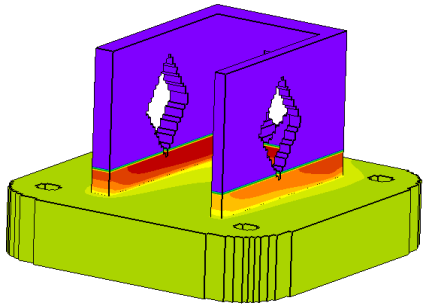
- Not much yet.
  - But it's coming..



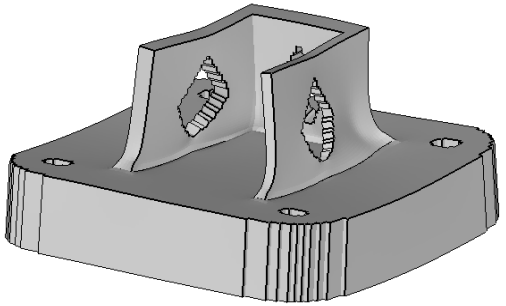
FAME – Free Additive Manufacturing Enhancer



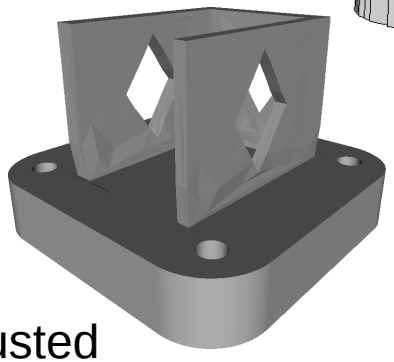
Desired geometry



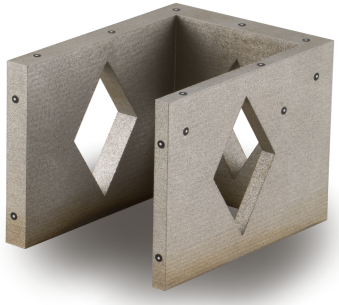
Build simulation



Sim. results



Adjusted geometry

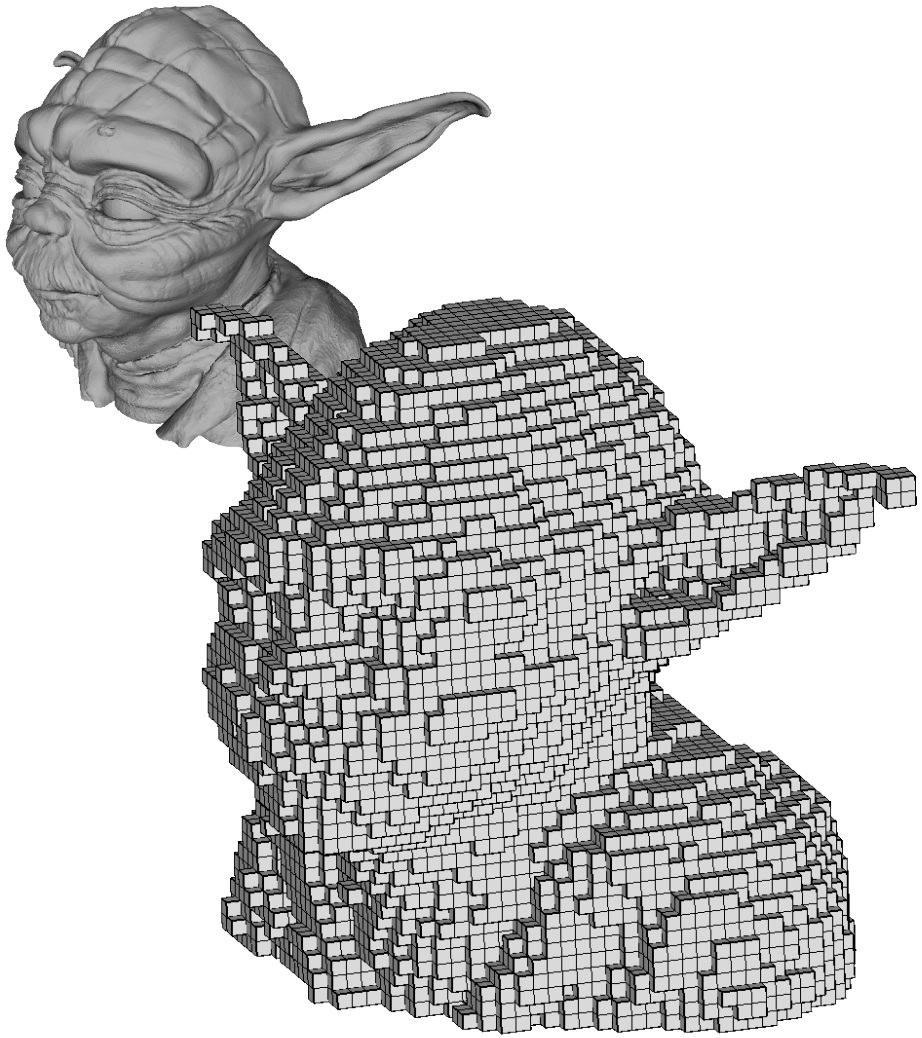


Actual build

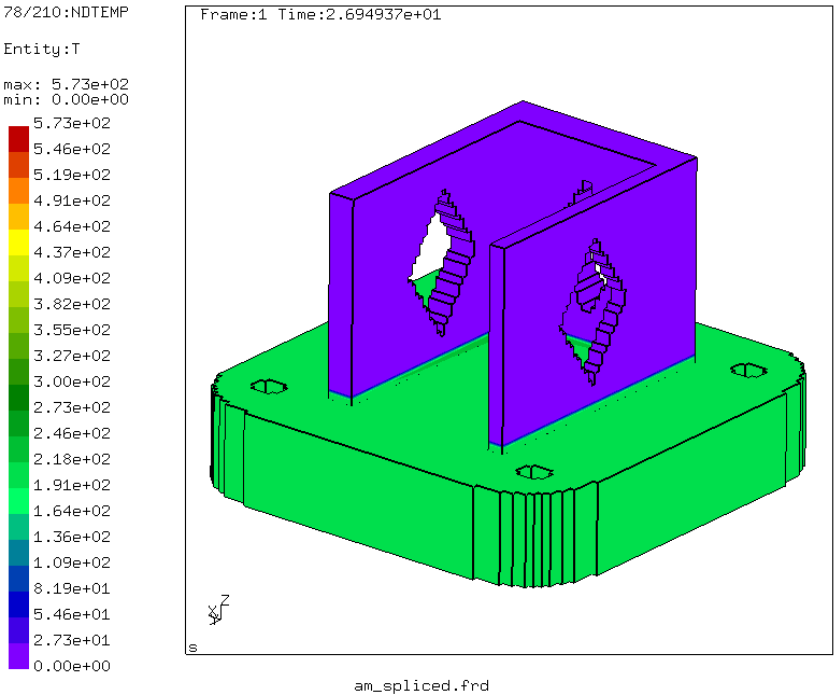
Creating FEA mesh

Stl geom. to voxel mesh

- Robust
- Easy to slice
- Derived from stltovoxel by Christian Pedersen



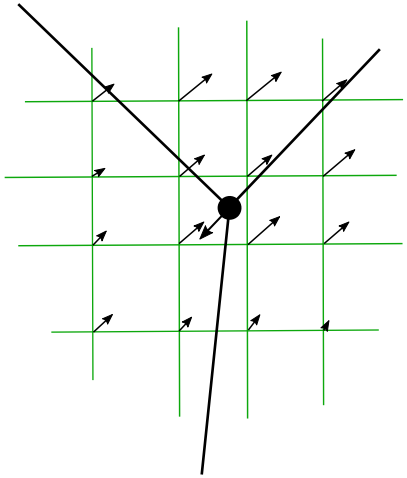
FEA Simulation



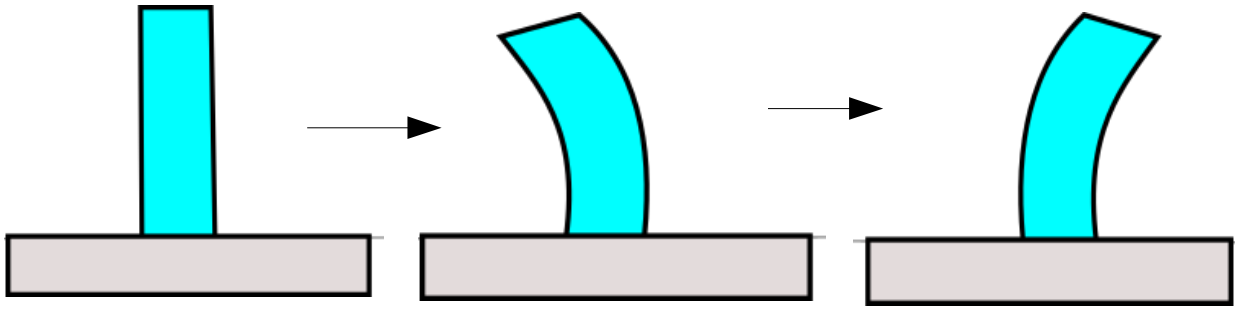
- Layer by layer
- A complete layer at elevated temperature is introduced at once.
- Thermal → Linear Elastic → Norton creep
- Heat exits through plate
- Solved with Calculix

Adjustment

The original stl-mesh is adjusted in the opposite direction that of the simulation.



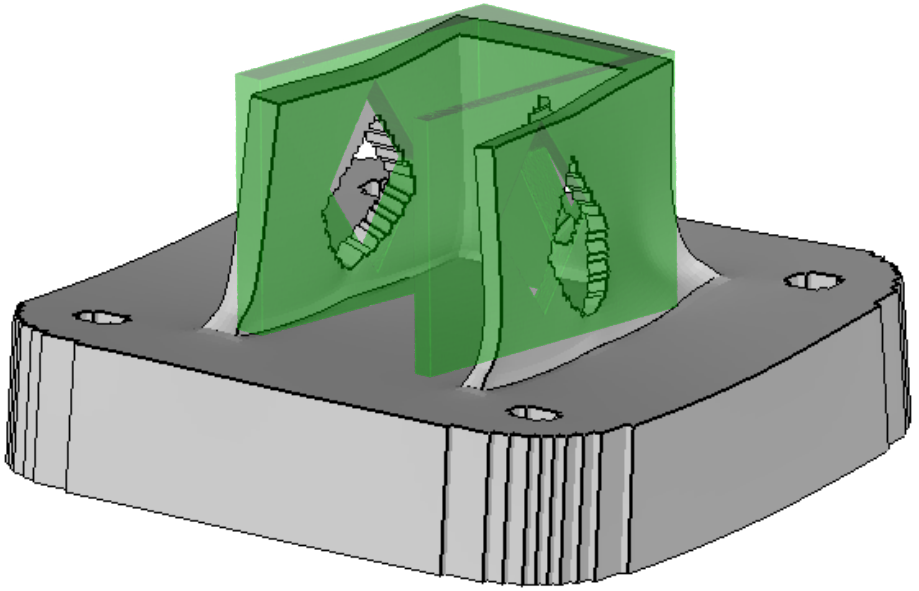
Every stl-node (black) is adjusted according to the nearby FEA nodes (green).



Nominal Simulated Adjusted

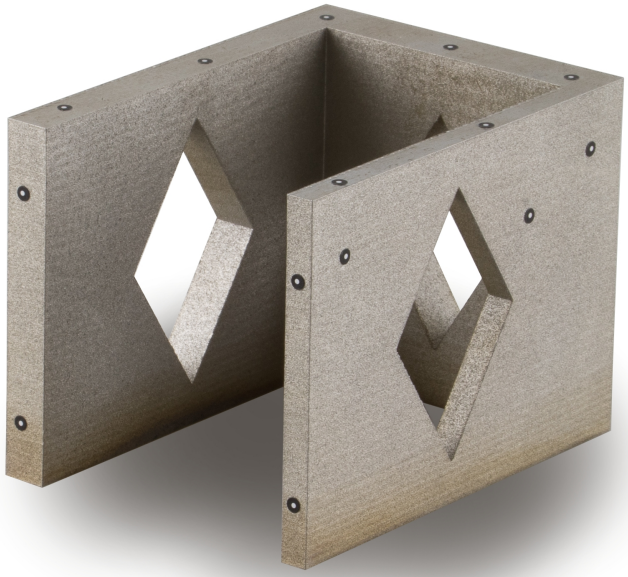
Parameters

speed=0.00089999998
elasticHotBuild=136000.0
resolution=40
solidify=500.0
elasticHotPlate=136000.0
conductivityPlate=133.71335
creepmcold=0
sinkTemp=-1.6653345e-14
sinkCond=0.0049999999
creepAcold=8.316954e-32
specHeat=5e+08
nu=0.30000001
thermExpHotBuild=1.8999999e-05
thermExpHotPlate=1.8999999e-05
creepmmiddle=9.7311897
thermExpColdBuild=1.6e-05
conductivityPowder=9.9999997e-05
densityPlate=7.9899998e-09
powderTemp=20
thermExpColdPlate=1.6e-05
heating=1.9856188
elasticMiddleBuild=173000.0
elasticColdPlate=210000.0
creepAmiddle=7.7941649e-20
elasticColdBuild=210000.0
creepnmiddle=55.584732
creepncold=4.4015315e-16
creepmhot=6.3048687
conductivityBuild=16
coolDown=72000000.0
elasticMiddlePlate=173000.0
creepnhot=6.9441938
buildDensity=7.5904998e-09
creepAhot=1.5369383e-20



Parameters fitted so that simulation deformations corresponds to an actual SLM build.

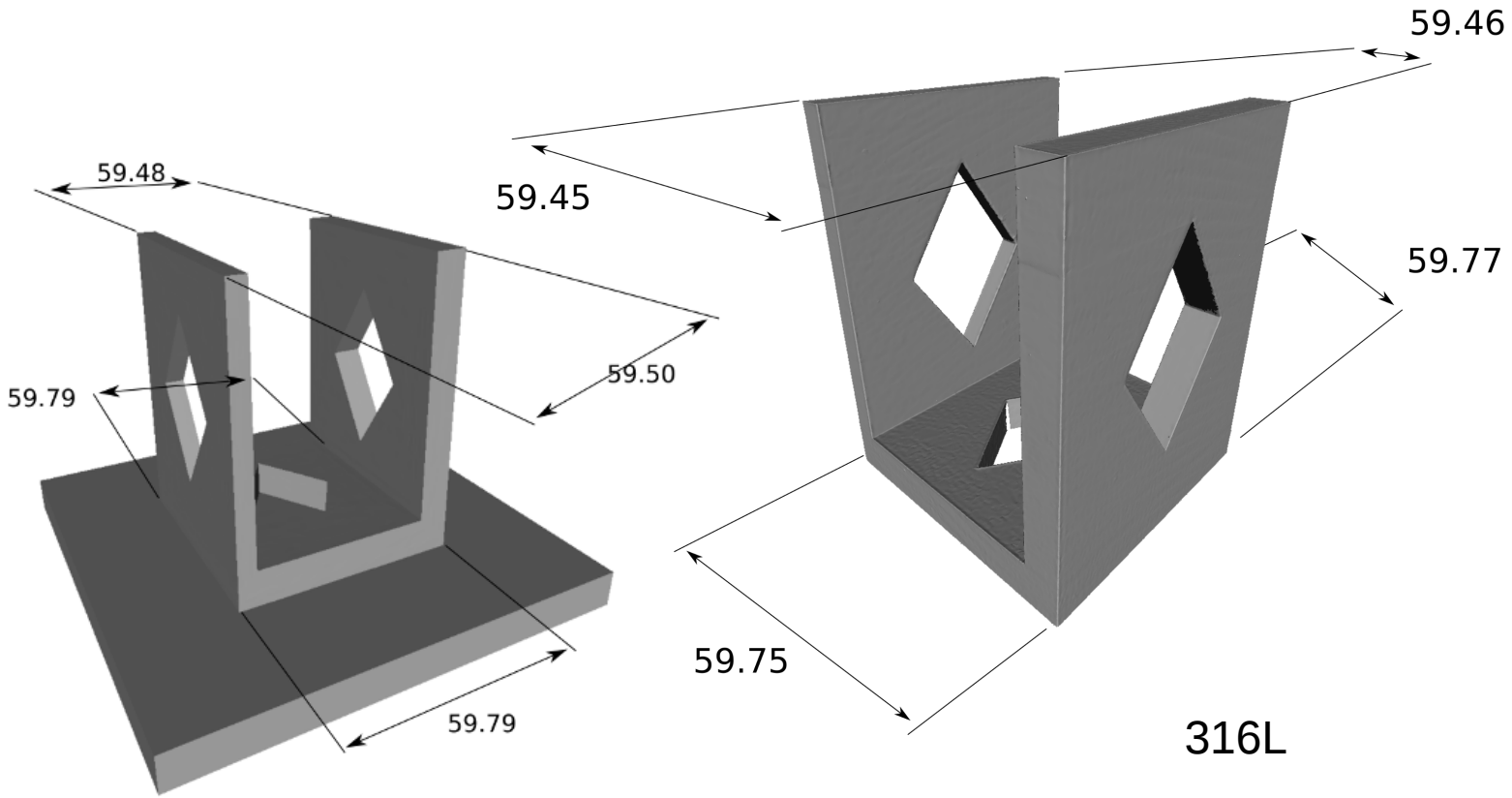
Test specimen



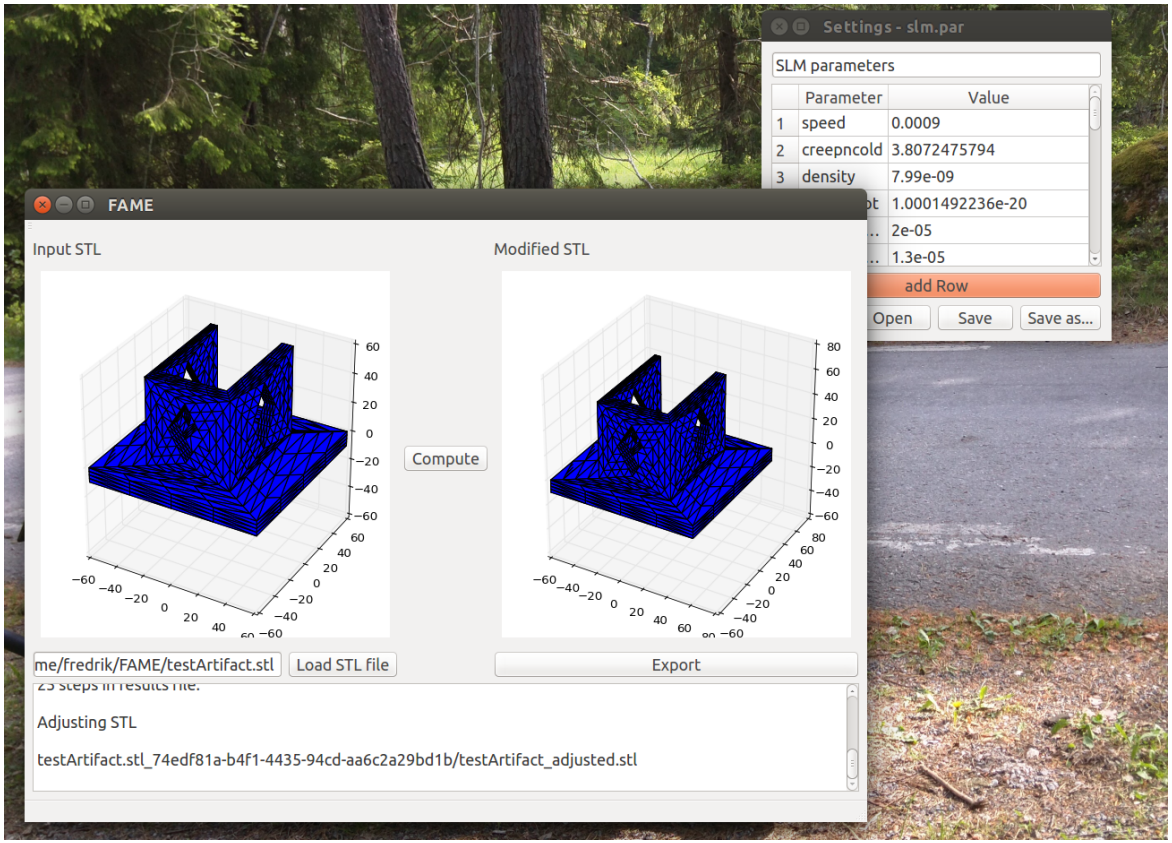
- Asymmetrical
- Well defined surfaces
- Easily measured
- No need for supports

Predicting something else: Simulation vs. build

Nominally 60 mm [mm]

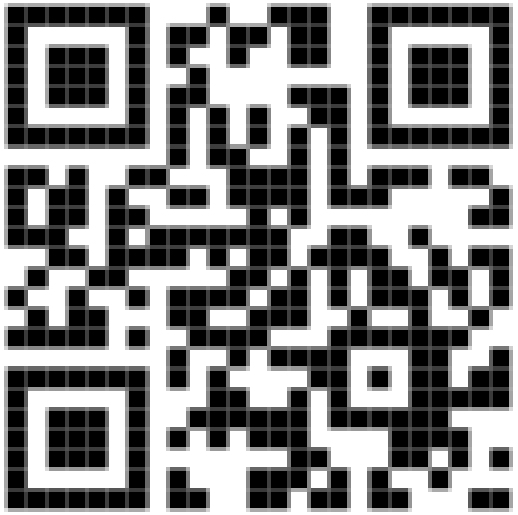


GUI


Settings - slm.par
SLM parameters
Parameter
Value
1 speed 0.0009
2 creepncold 3.8072475794
3 density 7.99e-09
1.0001492236e-20
2e-05
1.3e-05
add Row
Open
Save
Save as...
FAME
Input STL
Modified STL
Compute
me/fredrik/FAME/testArtifact.stl
Load STL file
Export
Adjusting STL
testArtifact.stl_74edf81a-b4f1-4435-94cd-aa6c2a29bd1b/testArtifact_adjusted.stl

FAME is Free!

- Get it from github.com/swerea/FAME
- Clone, test, fork or please contribute!



To do.. (wish list)

- Phase transformations
- Remeshing
- Better GUI
- Better support support

Conclusions

- FAME enables you to predict and compensate for shape distortions
- You’re better off with FAME than without.

Thanks to Åforsk foundation and Vinnova.