OptiPuls

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Project page: Simulation Based Optimization of the Time-Dependent Pulse Power for Laser Beam Welding of Aluminum Alloys in Order to Avoid Hot Cracks

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INTRODUCTION

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OPTIPULS IN DOCKER

The `optipuls` python package is based on the free and open-source FEniCS computing platform for solving partial differential equations (PDEs). The officially recommended way to run FEniCS is by using their official docker images.

In view of this, the `optipuls` python package comes in a bundle with the official optipuls docker images available at https://hub.docker.com/r/optipulsproject/.

2.1 References

- Docker Overview
- Getting Started with Docker
- Install Docker Engine

CHAPTER

THREE

EXTRAS

3.1 Advanced Mesh Generator

A helper script is provided for generation of advanced problem specific 2d (XZ) and 3d meshes for both the single-spot and the double-spot (multi-spot) problems. Notice that while Gmsh (an open source 3D finite element mesh generator) and `pygmsh` python package are not required for running `optipuls` these have to be installed for generation of an advanced custom mesh.

3.1.1 Generating mesh

Listing 1: Mesh generation options.

```
$ python3 mesh_generate.py --help
usage: mesh_generate.py [-h] [-Z Z] [-R R] [-r R] [--overlap OVERLAP] [--dim {2,3}] [--
↪lcar_min LCAR_MIN]
                        [--lcar_max LCAR_MAX] [-o OUTPUT] [-v] [--singlespot]

options:
  -h, --help            show this help message and exit
  -Z Z                  height of the problem domain
  -R R                  radius of the problem domain
  -r R                  radius of the laser beam
  --overlap OVERLAP     overlap of the welding spots for double-spot problem, float in␣
↪[0, 1]
  --dim {2,3}           dimension of the mesh
  --lcar_min LCAR_MIN   minimal resolution of the mesh
  --lcar_max LCAR_MAX   maxinal resolution of the mesh
  -o OUTPUT, --output OUTPUT
  -v, --verbose
  --singlespot          use this option for single-spot problems (sets overlap to 1)
```

Examples:

```
$ python3 mesh_generate.py --singlespot --dim 3 --output singlespot_XYZ.msh
$ python3 mesh_generate.py --overlap=.5 --dim 3 --output doublespot_0.5_XYZ.msh
$ python3 mesh_generate.py --singlespot --dim 2 --output singlespot_XZ.msh
```

The generated files can be viewed in Gmsh.

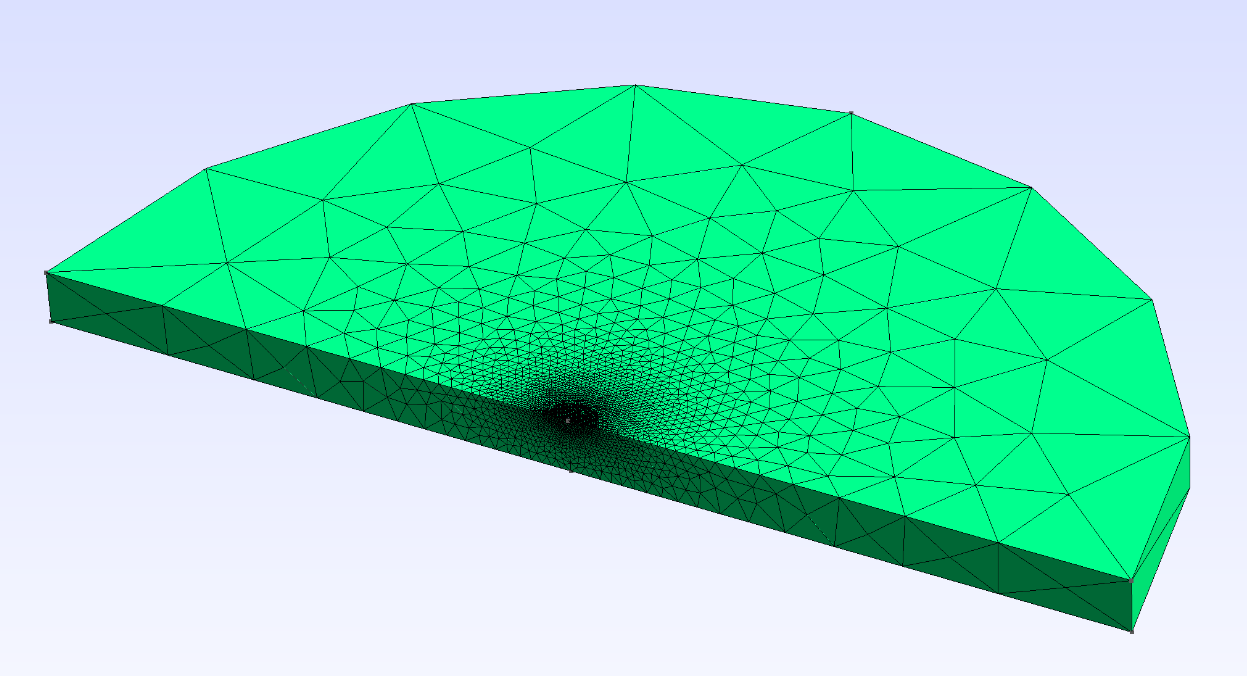

Fig. 1: Inspect generated mesh in Gmsh.a

3.1.2 Converting mesh

In order to be used by FEniCS the mesh should be converted to `.XDMF` format.

Listing 2: Mesh convertion options.

```
$ python3 mesh_convert.py --help
usage: mesh_convert.py [-h] [-i INPUT] [-o OUTPUT] [--dim {2,3}]

options:
  -h, --help            show this help message and exit
  -i INPUT, --input INPUT
  -o OUTPUT, --output OUTPUT
  --dim {2,3}           dimension of the mesh
```

Examples:

```
$ python3 mesh_convert.py --dim 3 --output singlespot_XYZ.xdmf
$ python3 mesh_convert.py --dim 2 --output singlespot_XZ.xdmf
```

3.2 ParaView Helpers

ParaView is an open-source, multi-platform data analysis and visualization application. In OptiPuls it is used to inspect the output of the numerical simulation of the laser welding.

3.2.1 ParaView State Files

In order to make the visualization more convenient, a set of preconfigured ParaView state files is provided.

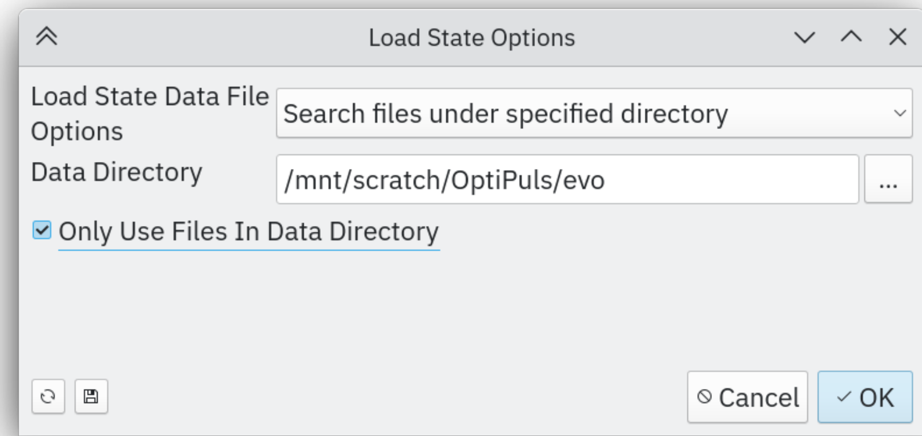

Fig. 2: Load state file and specify the simulation output directory.

3.2.2 Render Animation

A helper script `paraview_save_animation.py` is provided in order to generate an animation for a given state file. Its output is a set of `.PNG` files. These files can be converted to a video using `ffmpeg`.

Example:

```
ffmpeg -r 60 -f image2 -s 3840x2160 -i /tmp/paraview/ani.%04d.png -vcodec libx264 -pix_
↪fmt yuv420p -crf 17 output.mp4
```

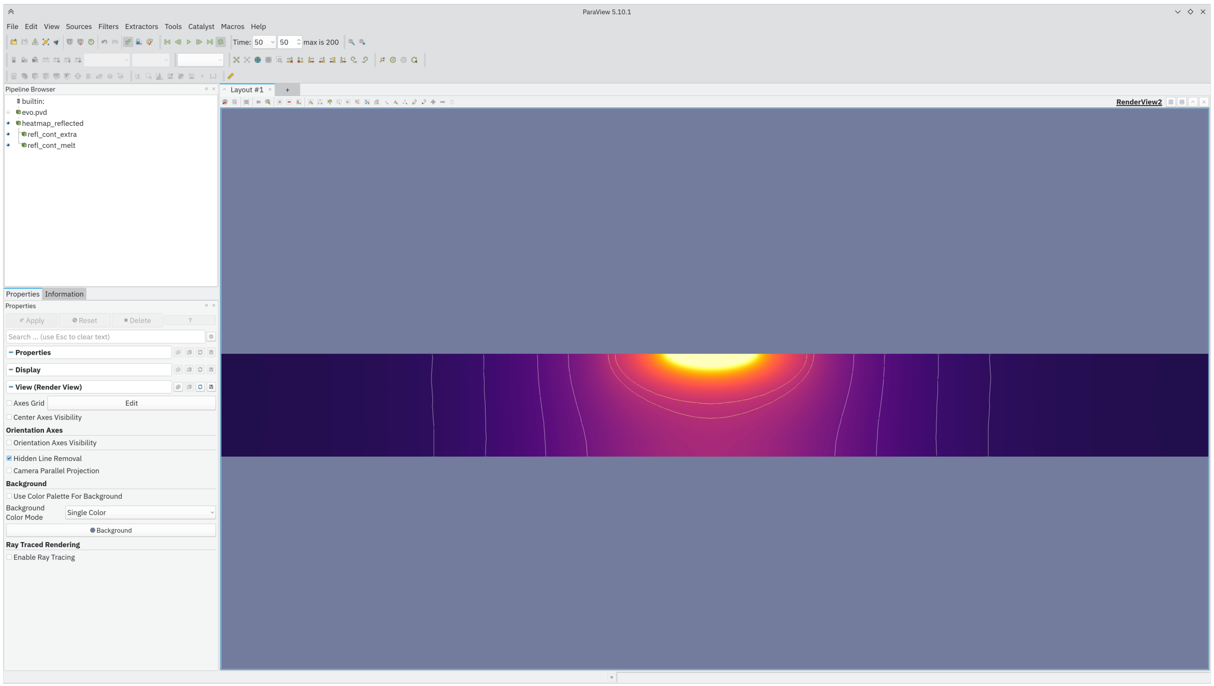

Fig. 3: Sectional view for a 2d problem.

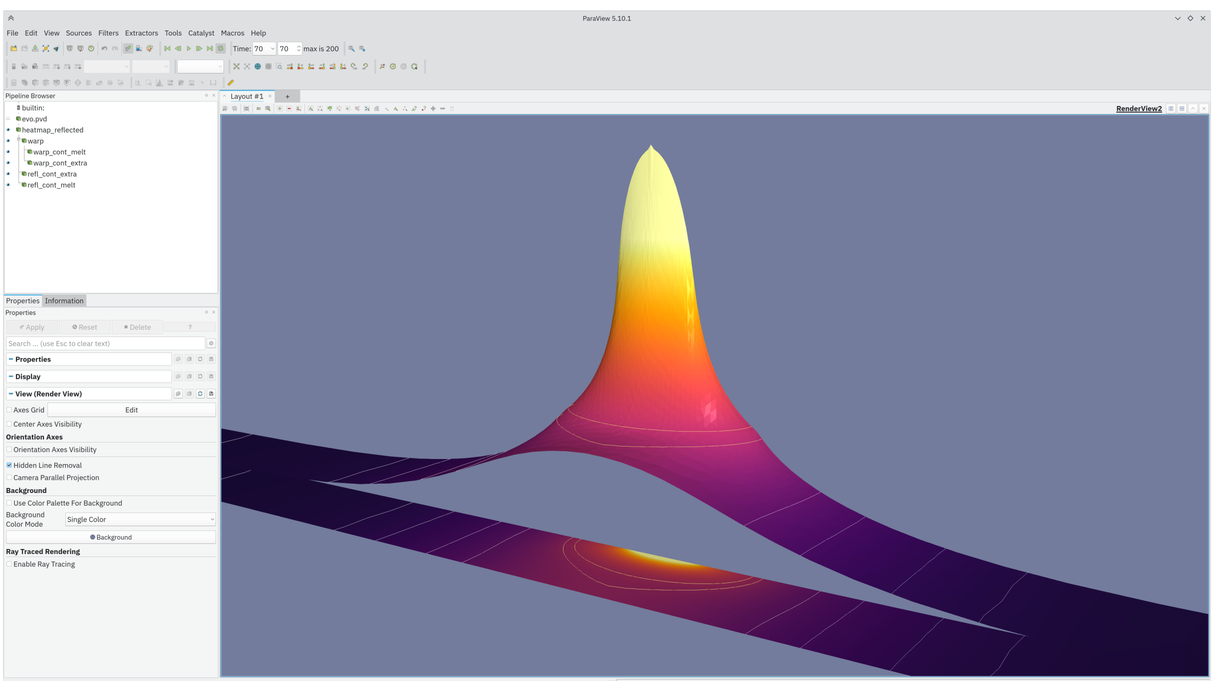

Fig. 4: Warp view for a 2d problem.

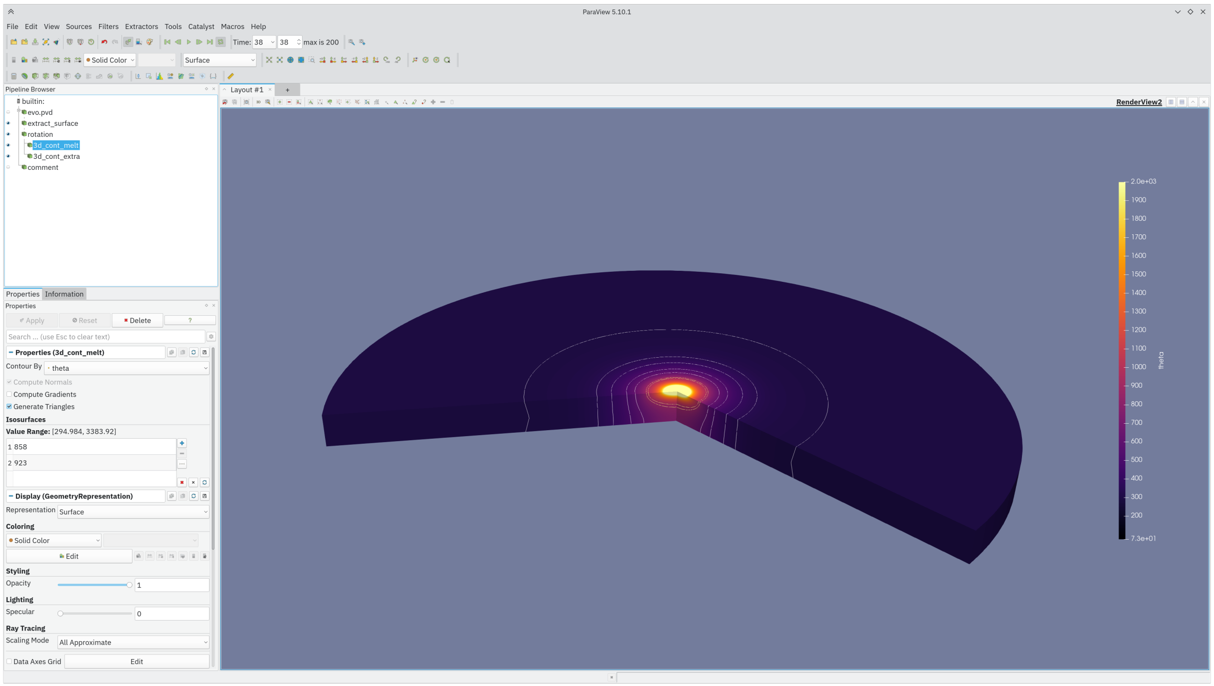

Fig. 5: 3d (rotated) view for a 2d problem.

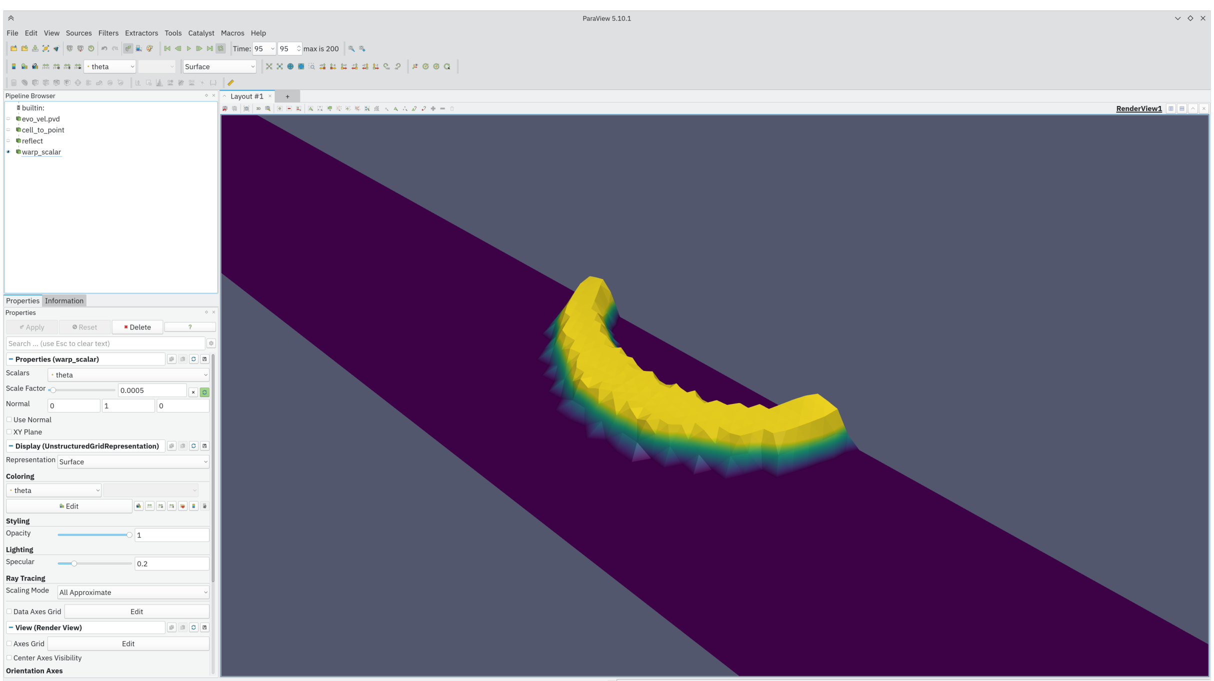

Fig. 6: Solidification front velocity warp view for a 2d problem.

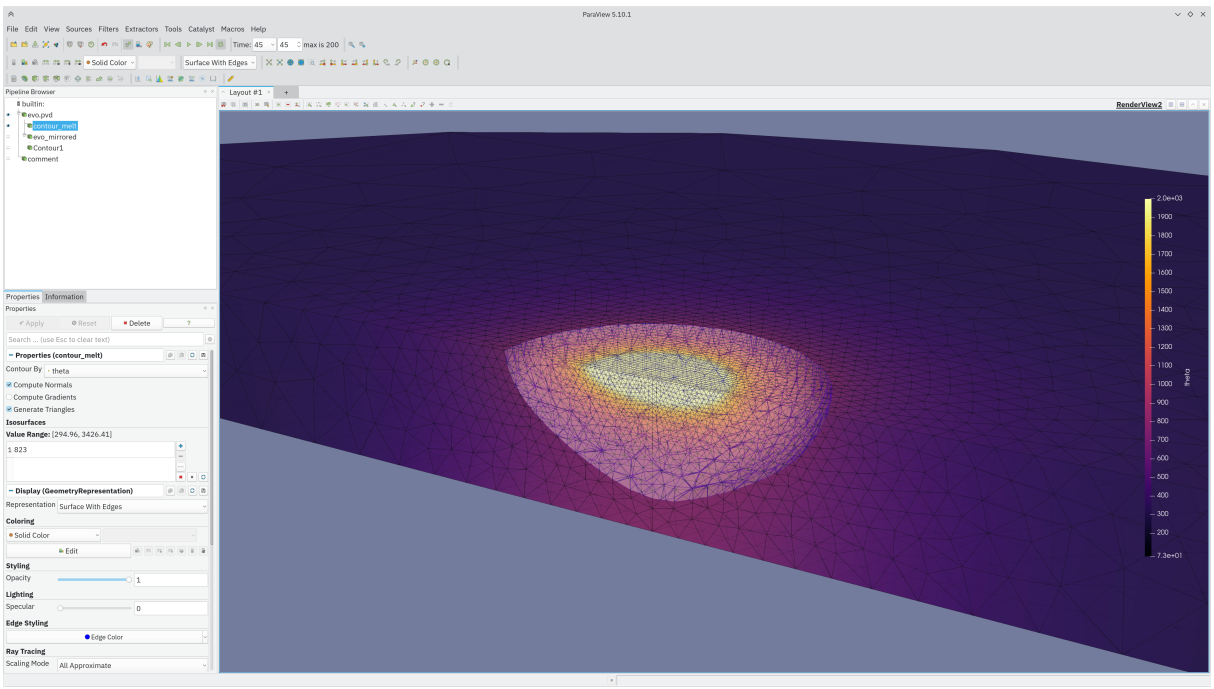

Fig. 7: Wireframe view for a true 3d problem.

CHAPTER

FOUR

INDICES AND TABLES

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