# oogmsh Octave package, User's Guide*

version 0.2.2

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February 17, 2020

**Abstract**

This Octave package make it possible to generate mesh files from *.geo* files by using `gmsh`. It's also possible with the ooGmsh2 and ooGmsh4 classes to read the mesh file (respectively for MSH file format version `2.2` and version `4.x`).This package must be regarded as a very simple interface between gmsh files and Octave. So you are free to create any data structures or objects you want from an ooGmsh2 object or an ooGmsh4 object.

## 0 Contents



*LaTeX manual, revision 0.2.2, compiled with Octave 5.2.0, and packages `fc-oogmsh`[0.2.2], `fc-tools`[0.0.30], `fc-bench`[0.1.2], `fc-amat`[0.1.2], `fc-meshtools`[0.1.3], `fc-graphics4mesh`[0.1.1], and using `gmsh` 4.5.1

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This work was supported by the ANR project DEDALES under grant ANR-14-CE23-0005.

# 1 Introduction

The fc oogmsh Octave package is closely related to **gmsh**, see [2] or [3], which is a three-dimensional finite element mesh generator with built-in pre- and post-processing facilities. **gmsh** can also build two-dimensional meshes and three-dimensional surface meshes. This package was initialy created to make it possible from Octave to rapidly

- generate mesh file from .geo file by using **gmsh**
- efficiently read this mesh file and store its contents in ooGmsh Octave object easy to manipulate.

The ooGmsh Octave object can be used to create, from a .msh file, any data structures or objects needed by your project. For example, the fc-simesh Octave package uses this package to create the siMesh object containing all the simplices elements of the mesh.

This package was tested on various OS with **gmsh** (versions 4.5.2, 4.4.1, 4.3.0, 4.2.3, 4.1.5, 4.0.7, 3.0.6 and 2.16.0) and Octave releases:

| **Operating system** | **4.4.0** | **4.4.1** | **5.1.0** | **5.2.0** |
|---|---|---|---|---|
| CentOS 7.7.1908 | ✓ | ✓ | ✓ | ✓ |
| Debian 9.11 | ✓ | ✓ | ✓ | ✓ |
| Fedora 29 | ✓ | ✓ | ✓ | ✓ |
| OpenSUSE Leap 15.0 | ✓ | ✓ | ✓ | ✓ |
| Ubuntu 18.04.3 LTS | ✓ | ✓ | ✓ | ✓ |
| MacOS High Sierra 10.13.6 | | ✓ | ✓ | ✓ |
| MacOS Mojave 10.14.4 | | ✓ | ✓ | ✓ |
| MacOS Catalina 10.15.2 | | ✓ | ✓ | ✓ |
| Windows 10 (1909) | ✓ | ✓ | ✓ | ✓ |

It is not compatible with Octave releases prior to 4.2.0. Here are the links used to install the Octave releases tested:

- **Linux :** sources from `https://www.gnu.org/software/octave/`;
- **MacOS :** release 4.4.1 installed with dmg file from `http://octave-app.org/Download.html`, releases 5.1.0 and 5.2.0 installed with Homebrew;
- **Windows :** binaries from `https://www.gnu.org/software/octave/`.

Firstly, we explain how to configure the fc oogmsh package for using `gmsh`. Thereafter, we describe the fc oogmsh 's functions which use `gmsh` to create mesh files.

# 2 Installation

## 2.1 Installation automatic, all in one (recommanded)

For automatic installation, one has to get/download the install file

ofc_oogmsh_install.m

or get it on the dedicated web page. Thereafter, one run it under Octave. This command download, extract and configure the *fc-oogmsh* toolbox and the required packages *fc-tools*, *fc-meshtools* and *fc-graphics4mesh*, in the current directory.

By default, the gmsh binary is supposed to be located in

- `<USERDIR>/bin/gmsh` under linux,
- `<USERDIR>/GMSH/Gmsh.app/Contents/MacOS/gmsh` under Mac OS X,
- `<USERDIR>/Softwares/GMSH/gmsh.exe` under Windows 10

It can be directly given by using the `'gmsh_bin'` option of the install command:

```
>> ofc_oogmsh_install('gmsh_bin', GMSH)
```

where `GMSH` is the gmsh binary with path as a string. It's also possible, after installation, to change the gmsh binary by using the Octave command

```
>> fc_oogmsh.configure('gmsh_bin','~/gmsh-4.2.2/bin/gmsh')
```

For example, to install this package in `~/Octave` directory, one have to copy the file ofc_oogmsh_install.m in the `~/Octave` directory. Then in a Octave terminal run the following commands

```
>> cd ~/Octave
>> ofc_oogmsh_install
```

There is the output of the `ofc_oogmsh_install` command:

```
Parts of the <fc-oogmsh> Octave package.
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1- Downloading and extracting the packages
2- Setting the <fc-oogmsh> package
Write in ~/Octave/fc-oogmsh-full/fc_oogmsh-0.2.2/configure_loc.m ...
3- Using packages :
   ->             fc-tools : 0.0.30
   ->             fc-bench : 0.1.2
   ->              fc-amat : 0.1.2
   ->         fc-meshtools : 0.1.3
   ->     fc-graphics4mesh : 0.1.1
 with            fc-oogmsh : 0.2.2
*** Using instructions
   To use the <fc-oogmsh> package:
   addpath('~/Octave/fc-oogmsh-full/fc_oogmsh-0.2.2')
   fc_oogmsh.init()

   See ~/Octave/ofc_oogmsh_set.m
```

The complete toolbox (i.e. with all the other needed packages) is stored in the directory

`~/Octave/fc-oogmsh-full`

and, for each Octave session, one has to set the package by:

```
>> addpath('~/Octave/fc-oogmsh-full/fc-oogmsh-0.2.2')
>> fc_oogmsh.init()
```

If it's the first time the `fc_oogmsh.init()` function is used, then its output is

```
Try to use default parameters!
 Use fc_tools.configure to configure.
Write in ~/Octave/fc-oogmsh-full/fc_tools-0.0.30/configure_loc.m ...
Try to use default parameters!
 Use fc_bench.configure to configure.
Write in ~/Octave/fc-oogmsh-full/fc_bench-0.1.2/configure_loc.m ...
Try to use default parameters!
 Use fc_amat.configure to configure.
Write in ~/Octave/fc-oogmsh-full/fc_amat-0.1.2/configure_loc.m ...
Try to use default parameters!
 Use fc_meshtools.configure to configure.
Write in ~/Octave/fc-oogmsh-full/fc_meshtools-0.1.3/configure_loc.m ...
Try to use default parameters!
 Use fc_graphics4mesh.configure to configure.
Write in ~/Octave/fc-oogmsh-full/fc_graphics4mesh-0.1.1/configure_loc.m ...
Using fc_oogmsh[0.2.2] with fc_tools[0.0.30], fc_bench[0.1.2], fc_amat[0.1.2], ...
    fc_meshtools[0.1.3], fc_graphics4mesh[0.1.1].
Configured to use gmsh 4.5.1 with default MSH file format version 4.1
```

Otherwise, the output of the `fc_oogmsh.init()` function is

```
Using fc_oogmsh[0.2.2] with fc_tools[0.0.30], fc_bench[0.1.2], fc_amat[0.1.2], ...
    fc_meshtools[0.1.3], fc_graphics4mesh[0.1.1].
Configured to use gmsh 4.5.1 with default MSH file format version 4.1
```

For **uninstalling**, one just has to delete directory:

`~/Octave/fc-oogmsh-full`

# 3 gmsh interface

All functions provided in this section use `gmsh` to create a mesh file from a `gmsh` geometry script file (extension *.geo*).

## 3.1 function `fc_oogmsh.gmsh.buildmesh2d`

This function uses `gmsh` and a *.geo* file (describing a 2D-geometry) to generate a 2D-mesh.

### Syntaxe

```
meshfile=fc_oogmsh.gmsh.buildmesh2d(geofile,N)

meshfile=fc_oogmsh.gmsh.buildmesh2d(geofile,N,Name,Value)
```

### Description

`meshfile=fc_oogmsh.gmsh.buildmesh2d(geofile,N)` create a 2D-mesh using `gmsh` and the *geo* file `geofile` (without path). The integer `N` has two functions : numbering the name of the generated mesh as <geofile without extension and path> + <-N.msh> and passing this number to `gmsh` via the option "-setnumber N <N>". Usually we used this parameter in `gmsh` to set the prescribed mesh element size at the points. (see given *geo* files)
As output return a file name (with full path) corresponding to the mesh generated by `gmsh`.

`meshfile=fc_oogmsh.gmsh.buildmesh2d(geofile,N,Name,Value, ...)` specifies function options using one or more `Name`,`Value` pair arguments. The `Name` options can be

- 'geodir' : to specify the directory of the *geo* file geofile,
- 'meshdir' : to specify the directory where the mesh file will be written,
- 'meshfile' : to specify the name of the mesh file (with path and .msh extension),
- 'check' : to perform various consistency checks on mesh with gmsh, if Value is true. (default : false)
- 'force' : to force meshing even if the mesh file already exists if Value is true (default : false)
- 'verbose' : to specify the degree of verbosity ( 0, silence; 2, default; ...)
- 'strings' : cells array of strings corresponding to gmsh options given with -string "..." (default empty) (see gmsh documentation). For example, Value could be:

  {'Mesh.Algorithm=1;', 'Mesh.ScalingFactor=2;'}

- 'MshFileVersion' : to specify the MSH file format version. Value could be
  - '2.2' if gmsh version $\geqslant$ 2.16.0,
  - '4.0' if gmsh version $\geqslant$ 4.0.0,
  - '4.1' if gmsh version $\geqslant$ 4.1.0.

**Examples** All the following examples use the *.geo* file condenser11.geo which is in the directory geodir of the package.

Octave code with output

```
disp('**** fc_oogmsh.gmsh.buildmesh2d : 1st call')
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',25,'force',true);
disp('**** fc_oogmsh.gmsh.buildmesh2d : 2nd call')
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',25);
```

```
**** fc_oogmsh.gmsh.buildmesh2d : 1st call
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/2d/condenser11.geo
[fc-oogmsh] Starting building mesh <fc-oogmsh>/meshes/condenser11-25.msh with gmsh 4.5.1
[fc-oogmsh] Using command : gmsh -2 -setnumber N 25 -string "Mesh.MshFileVersion=4.1;" <fc-oogmsh>/geodir/2d/condenser11.geo -o ...
        <fc-oogmsh>/meshes/condenser11-25.msh
 Be patient...
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser11-25.msh
**** fc_oogmsh.gmsh.buildmesh2d : 2nd call
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/2d/condenser11.geo
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/condenser11-25.msh [version 4.1] already exists.
  -> Use "force" flag to rebuild if needed.
```

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',25,'force',true, ...
    'verbose',4, 'strings',{'Mesh.Algorithm=1;', 'Mesh.ScalingFactor=2;'});
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/2d/condenser11.geo
[fc-oogmsh] Overwritting mesh file <fc-oogmsh>/meshes/condenser11-25.msh
[fc-oogmsh] Starting building mesh <fc-oogmsh>/meshes/condenser11-25.msh with gmsh 4.5.1
[fc-oogmsh] Using command : gmsh -2 -setnumber N 25 -string "Mesh.Algorithm=1;Mesh.ScalingFactor=2;Mesh.MshFileVersion=4.1;" ...
       <fc-oogmsh>/geodir/2d/condenser11.geo -o <fc-oogmsh>/meshes/condenser11-25.msh
 Be patient...
[fc-oogmsh] gmsh output :
Info    : Running '/fcopt/GMSH/64bit/4.5.1/bin/gmsh -2 -setnumber N 25 -string Mesh.Algorithm=1;Mesh.ScalingFactor=2;Mesh.MshFileVersion=4.1; ...
       <fc-oogmsh>/geodir/2d/condenser11.geo -o <fc-oogmsh>/meshes/condenser11-25.msh' [Gmsh 4.5.1, 1 node, max. 1 thread]
Info    : Started on Mon Feb 17 17:52:31 2020
Info    : Reading '<fc-oogmsh>/geodir/2d/condenser11.geo'...
Info    : Reading '<fc-oogmsh>/geodir/2d/options01_data.geo'...
Info    : Done reading '<fc-oogmsh>/geodir/2d/options01_data.geo'
Info    : Reading '<fc-oogmsh>/geodir/2d/shape_functions.geo'...
Info    : Done reading '<fc-oogmsh>/geodir/2d/shape_functions.geo'
Info    : Removing duplicate mesh nodes...
Info    : Found 0 duplicate nodes
Info    : No duplicate nodes found
Info    : Done reading '<fc-oogmsh>/geodir/2d/condenser11.geo'
Info    : Meshing 1D...
Info    : [  0 %] Meshing curve 101 (Line)
Info    : [ 10 %] Meshing curve 102 (Line)
Info    : [ 10 %] Meshing curve 103 (Line)
Info    : [ 10 %] Meshing curve 104 (Line)
Info    : [ 10 %] Meshing curve 106 (Circle)
Info    : [ 20 %] Meshing curve 107 (Circle)
Info    : [ 20 %] Meshing curve 108 (Circle)
Info    : [ 20 %] Meshing curve 109 (Circle)
Info    : [ 20 %] Meshing curve 111 (Circle)
Info    : [ 30 %] Meshing curve 112 (Circle)
Info    : [ 30 %] Meshing curve 113 (Circle)
Info    : [ 30 %] Meshing curve 114 (Circle)
Info    : [ 30 %] Meshing curve 116 (Circle)
Info    : [ 40 %] Meshing curve 117 (Circle)
Info    : [ 40 %] Meshing curve 118 (Circle)
Info    : [ 40 %] Meshing curve 119 (Circle)
Info    : [ 40 %] Meshing curve 121 (Circle)
Info    : [ 50 %] Meshing curve 122 (Circle)
Info    : [ 50 %] Meshing curve 123 (Circle)
Info    : [ 50 %] Meshing curve 124 (Circle)
Info    : [ 50 %] Meshing curve 126 (Circle)
Info    : [ 60 %] Meshing curve 127 (Circle)
Info    : [ 60 %] Meshing curve 128 (Circle)
Info    : [ 60 %] Meshing curve 129 (Circle)
Info    : [ 60 %] Meshing curve 131 (Circle)
Info    : [ 70 %] Meshing curve 132 (Circle)
Info    : [ 70 %] Meshing curve 133 (Circle)
Info    : [ 70 %] Meshing curve 134 (Circle)
Info    : [ 70 %] Meshing curve 136 (Circle)
Info    : [ 80 %] Meshing curve 137 (Circle)
Info    : [ 80 %] Meshing curve 138 (Circle)
Info    : [ 80 %] Meshing curve 139 (Circle)
Info    : [ 80 %] Meshing curve 141 (Circle)
Info    : [ 90 %] Meshing curve 142 (Circle)
Info    : [ 90 %] Meshing curve 143 (Circle)
Info    : [ 90 %] Meshing curve 144 (Circle)
Info    : [ 90 %] Meshing curve 146 (Circle)
Info    : [100 %] Meshing curve 147 (Circle)
Info    : [100 %] Meshing curve 148 (Circle)
Info    : [100 %] Meshing curve 149 (Circle)
Info    : Done meshing 1D (0.011347 s)
Info    : Meshing 2D...
Info    : [  0 %] Meshing surface 105 (Plane, MeshAdapt)
Info    : [ 20 %] Meshing surface 110 (Plane, MeshAdapt)
Info    : [ 40 %] Meshing surface 120 (Plane, MeshAdapt)
Info    : [ 50 %] Meshing surface 130 (Plane, MeshAdapt)
Info    : [ 70 %] Meshing surface 140 (Plane, MeshAdapt)
Info    : [ 90 %] Meshing surface 150 (Plane, MeshAdapt)
Info    : Done meshing 2D (1.54093 s)
Info    : 2895 nodes 5923 elements
Info    : Writing '<fc-oogmsh>/meshes/condenser11-25.msh'...
Info    : Done writing '<fc-oogmsh>/meshes/condenser11-25.msh'
Info    : Stopped on Mon Feb 17 17:52:32 2020

[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser11-25.msh
```

## 3.2 function fc_oogmsh.gmsh.buildmesh3d

This function uses `gmsh` and a *.geo* file (describing a 3D-geometry) to generate a 3D-mesh. See function `gmsh.buildmesh2d` for usage and options (section 3.1).

## 3.3 function fc_oogmsh.gmsh.buildmesh3ds

This function uses `gmsh` and a *.geo* file (describing a 3D surface geometry or a 3D-geometry) to generate a 3D surface mesh. See function `gmsh.buildmesh2d` for usage and options (section 3.1).

## 3.4 function fc_oogmsh.gmsh.buildpartmesh2d

This function uses `gmsh` and a *.msh* file (containing a 2D-mesh) to generate a 2D partioned mesh.

### Syntaxe

```
partmeshfile=fc_oogmsh.gmsh.buildpartmesh2d(meshfile,np)

partmeshfile=fc_oogmsh.gmsh.buildpartmesh2d(meshfile,np,Name,Value)
```

### Description

`partmeshfile=fc_oogmsh.gmsh.buildpartmesh2d(meshfile,np)` create a 2D partitioned mesh using **gmsh** and the *msh* file `meshfile` (with path). The integer `np` is the number of partitions.
As output return a file name (with full path) corresponding to the partitioned mesh generated by **gmsh**. The output file name is construct as following : <meshfile without extension>-part<np>.msh

`partmeshfile=fc_oogmsh.gmsh.buildpartmesh2d(meshfile,np,Name,Value, ...)` specifies function options using one or more `Name`,`Value` pair arguments. The `Name` options can be

- `'savedir'` : to specify the directory where the partitioned mesh file will be written,
- `'check'` : to perform various consistency checks on mesh with **gmsh**, if `Value` is `true`. (default : `false`)
- `'force'` : to force meshing even if the mesh file already exists if `Value` is `true` (default : `false`)
- `'verbose'` : to specify the degree of verbosity ( 0, silence; 2, default; ...)
- `'strings'` : cells array of strings corresponding to **gmsh** options given with `-string "..."` (default empty) (see **gmsh** documentation)
- `'MshFileVersion'` : to specify the MSH file format version. `Value` could be
  - `'2.2'` if gmsh version $\geqslant$ 2.16.0,
  - `'4.0'` if gmsh version $\geqslant$ 4.0.0,
  - `'4.1'` if gmsh version $\geqslant$ 4.1.0.

### Examples

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',25,'verbose',0);
pmfile=fc_oogmsh.gmsh.buildpartmesh2d(meshfile,5,'force',true);
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/meshes/condenser11-25.msh
[fc-oogmsh] Starting building mesh <fc-oogmsh>/meshes/condenser11-25-part5.msh with gmsh 4.5.1
[fc-oogmsh] Using command : gmsh -2 -part 5 -string "Mesh.MshFileVersion=4.1;" -saveall <fc-oogmsh>/meshes/condenser11-25.msh -o ...
      <fc-oogmsh>/meshes/condenser11-25-part5.msh
 Be patient...
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser11-25-part5.msh
```

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',25,'verbose',0);
pmfile=fc_oogmsh.gmsh.buildpartmesh2d(meshfile,5,'force',true, ...
    'verbose',4, 'strings',{'Mesh.MetisAlgorithm=3;'});
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/meshes/condenser11-25.msh
[fc-oogmsh] Overwritting mesh file <fc-oogmsh>/meshes/condenser11-25-part5.msh
[fc-oogmsh] Starting building mesh <fc-oogmsh>/meshes/condenser11-25-part5.msh with gmsh 4.5.1
[fc-oogmsh] Using command : gmsh -2 -part 5 -string "Mesh.MetisAlgorithm=3;Mesh.MshFileVersion=4.1;" -saveall <fc-oogmsh>/meshes/condenser11-25.msh -o ...
       <fc-oogmsh>/meshes/condenser11-25-part5.msh
 Be patient...
[fc-oogmsh] gmsh output :
Info    : Running '/fcopt/GMSH/64bit/4.5.1/bin/gmsh -2 -part 5 -string Mesh.MetisAlgorithm=3;Mesh.MshFileVersion=4.1; -saveall ...
       <fc-oogmsh>/meshes/condenser11-25.msh -o <fc-oogmsh>/meshes/condenser11-25-part5.msh' [Gmsh 4.5.1, 1 node, max. 1 thread]
Info    : Started on Mon Feb 17 17:52:36 2020
Info    : Reading '<fc-oogmsh>/meshes/condenser11-25.msh'...
Info    : 2886 nodes
Info    : 5874 elements
Info    : Done reading '<fc-oogmsh>/meshes/condenser11-25.msh'
Info    : Meshing 1D...
Info    : Done meshing 1D (9.3e-05 s)
Info    : Meshing 2D...
Info    : Done meshing 2D (8.5e-05 s)
Info    : 2895 nodes 5923 elements
Info    : Partitioning mesh...
Info    : Running METIS with ptype:rb, ufactor:default, ctype:shem, rtype:greedy, objtype:cut, minconn:default
Info    : 5 partitions, 148 total edge-cuts
Info    : Done partitioning mesh (0.050197 s)
Info    :  - Repartition of 49 points: 5(min) 18(max) 9.8(avg)
Info    :  - Repartition of 360 lines: 66(min) 86(max) 72(avg)
Info    :  - Repartition of 5514 triangles: 1102(min) 1103(max) 1102.8(avg)
Info    : Creating partition topology...
Info    :  - Creating partition curves
Info    :  - Creating partition points
Info    : Done creating partition topology (0.009243 s)
Info    : Writing '<fc-oogmsh>/meshes/condenser11-25-part5.msh'...
Info    : Done writing '<fc-oogmsh>/meshes/condenser11-25-part5.msh'
Info    : Stopped on Mon Feb 17 17:52:36 2020

[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser11-25-part5.msh
```

## 3.5 function fc_oogmsh.gmsh.buildpartmesh3d

This function uses **gmsh** and a *.msh* file (containing of a 3D-mesh) to generate a 3D partioned mesh. See function **gmsh.buildpartmesh2d** for usage and options (section 3.4).

## 3.6 function fc_oogmsh.gmsh.buildpartmesh3ds

This function uses **gmsh** and a *.msh* file (containing of a 3D surface mesh) to generate a 3D partioned surface mesh. See function **gmsh.buildpartmesh2d** for usage and options (section 3.4).

## 3.7 function fc_oogmsh.gmsh.buildPartRectangle

This function uses **gmsh** and the *geodir/rectanglepart.geo* file to generate a 2D regular partioned mesh of the rectangle $[0, \texttt{Lx}] \times [0, \texttt{Ly}]$ with `Nx` × `Ny` partitions.

### Syntaxe

```
meshfile=fc_oogmsh.gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N)

meshfile=fc_oogmsh.gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N, Name,Value)
```

### Description

`meshfile=fc_oogmsh.gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N)` create a 2D regular partitioned mesh using **gmsh** of the rectangle $[0, \texttt{Lx}] \times [0, \texttt{Ly}]$ with `Nx` × `Ny` partitions. The `N` parameter is passed to **gmsh** to set the prescribed mesh element size at the points
As output return a file name (with full path) corresponding to the partitioned mesh generated by **gmsh**. The default output file name is construct as following :

```
sprintf('rectanglepart-Lx%.3f-Ly%.3f-Nx%d-Ny%d-N%d.msh',Lx,Ly,Nx,Ny,N)
```

`meshfile=fc_oogmsh.gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N,Name,Value, ...)` specifies function options using one or more `Name`,`Value` pair arguments (see the `fc_oogmsh.gmsh.buildmesh2d`, section 3.1).

**Examples** All the following examples ...

Octave code with output

```
pmfile=fc_oogmsh.gmsh.buildpartrectangle(1,1,3,2,100,'force',true);
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/2d/rectanglepart.geo
[fc-oogmsh] Starting building mesh <fc-oogmsh>/meshes/rectanglepart-Lx1.000-Ly1.000-Nx3-Ny2-N100.msh with gmsh 4.5.1
[fc-oogmsh] Using command : gmsh -2 -string "Mesh.MshFileVersion=4.1;" -setnumber N 100 -setnumber NX 3 -setnumber NY 2 -setnumber LX 1 -setnumber LY 1 ...
       <fc-oogmsh>/geodir/2d/rectanglepart.geo -o <fc-oogmsh>/meshes/rectanglepart-Lx1.000-Ly1.000-Nx3-Ny2-N100.msh
 Be patient...
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/rectanglepart-Lx1.000-Ly1.000-Nx3-Ny2-N100.msh
```

Octave code with output

```
pmfile=fc_oogmsh.gmsh.buildpartrectangle(1,1,3,2,100,'verbose',4, ...
    'force',true,'meshfile','./toto.msh');;
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/2d/rectanglepart.geo
[fc-oogmsh] Starting building mesh ./toto.msh with gmsh 4.5.1
[fc-oogmsh] Using command : gmsh -2 -string "Mesh.MshFileVersion=4.1;" -setnumber N 100 -setnumber NX 3 -setnumber NY 2 -setnumber LX 1 -setnumber LY 1 ...
       <fc-oogmsh>/geodir/2d/rectanglepart.geo -o ./toto.msh
 Be patient...
[fc-oogmsh] gmsh output :
Info    : Running '/fcopt/GMSH/64bit/4.5.1/bin/gmsh -2 -string Mesh.MshFileVersion=4.1; -setnumber N 100 -setnumber NX 3 -setnumber NY 2 -setnumber LX 1 ...
       -setnumber LY 1 <fc-oogmsh>/geodir/2d/rectanglepart.geo -o ./toto.msh' [Gmsh 4.5.1, 1 node, max. 1 thread]
Info    : Started on Mon Feb 17 17:52:39 2020
Info    : Reading '<fc-oogmsh>/geodir/2d/rectanglepart.geo'...
Info    : Reading '<fc-oogmsh>/geodir/2d/partitions01_data.geo'...
Info    : Done reading '<fc-oogmsh>/geodir/2d/partitions01_data.geo'
Info    : Reading '<fc-oogmsh>/geodir/2d/partitions_shape.geo'...
Info    : Done reading '<fc-oogmsh>/geodir/2d/partitions_shape.geo'
Info    : Done reading '<fc-oogmsh>/geodir/2d/rectanglepart.geo'
Info    : Meshing 1D...
Info    : [  0 %] Meshing curve 1 (Line)
Info    : [ 10 %] Meshing curve 2 (Line)
Info    : [ 20 %] Meshing curve 3 (Line)
Info    : [ 20 %] Meshing curve 4 (Line)
Info    : [ 30 %] Meshing curve 5 (Line)
Info    : [ 30 %] Meshing curve 6 (Line)
Info    : [ 40 %] Meshing curve 7 (Line)
Info    : [ 50 %] Meshing curve 8 (Line)
Info    : [ 50 %] Meshing curve 9 (Line)
Info    : [ 60 %] Meshing curve 10 (Line)
Info    : [ 60 %] Meshing curve 11 (Line)
Info    : [ 70 %] Meshing curve 12 (Line)
Info    : [ 80 %] Meshing curve 13 (Line)
Info    : [ 80 %] Meshing curve 14 (Line)
Info    : [ 90 %] Meshing curve 15 (Line)
Info    : [ 90 %] Meshing curve 16 (Line)
Info    : [100 %] Meshing curve 17 (Line)
Info    : Done meshing 1D (0.007738 s)
Info    : Meshing 2D...
Info    : [  0 %] Meshing surface 19 (Plane, Frontal)
Info    : [ 20 %] Meshing surface 21 (Plane, Frontal)
Info    : [ 40 %] Meshing surface 23 (Plane, Frontal)
Info    : [ 50 %] Meshing surface 25 (Plane, Frontal)
Info    : [ 70 %] Meshing surface 27 (Plane, Frontal)
Info    : [ 90 %] Meshing surface 29 (Plane, Frontal)
Info    : Done meshing 2D (0.528333 s)
Info    : 12092 nodes 24496 elements
Info    : Writing './toto.msh'...
Info    : Done writing './toto.msh'
Info    : Stopped on Mon Feb 17 17:52:39 2020

[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in ./toto.msh
```

# 4 ooGmsh4 class (version 4.x)

The ooGmsh4 class can be used to read `gmsh` mesh files with the MSH ASCII file format version `4.1` since `gmsh 4.1.0` ([4], section 9.1) or version `4.0` since `gmsh 4.0.0`.

The `gmsh`'s native `"MSH"` file format (version 4.x) is used to store meshes and associated post-processing datasets either save as an ASCII file or a binary file with extension `.msh`. The focus of the ooGmsh4 class is to read only meshes contained in an ASCII file. Currently, it is not planned to read post-processing datasets.

As described in [4], section 9.1: *the MSH file format version 4 (current revision: version 4.1) contains one mandatory section giving information about the file (*`$MeshFormat`*), followed by several optional sections defining the physical group names (*`$PhysicalName`*), the elementary geometrical entities (*`$Entities`*), the partitioned entities (*`$PartitionedEntities`*), the nodes* `$Nodes`*), the elements (*`$Elements`*), the periodicity relations (*`$Periodic`*), the ghost* elements (`$GhostElements`) and the post-processing datasets (`$NodeData`, `$ElementData`, `$ElementNodeData`).

For each section, the ooGmsh4 class has a property with corresponding name. The properties of this class are:

**Properties of ooGmsh4 class**

| | | |
|---|---|---|
| dim | : | space dimension (2 or 3) |
| nq | : | number of nodes/vertices. |
| q | : | nodes/vertices array with dimension dim-by-nq. |
| toGlobal | : | ... |
| MeshFormat | : | structure |
| PhysicalNames | : | (optional), array of PhysicalName structure |
| Entities | : | structure |
| PartitionedEntities | : | (optional) structure |
| Nodes | : | structure |
| Elements | : | structure |
| PeriodicLinks | : | (optional), array of PeriodicLink structure |

The structures MeshFormat, PhysicalNames, Entities, PartitionedEntities, Nodes, Elements and PeriodicLinks are described in section 4.2. In the following subsections, Gh is an ooGmsh4 object.

## 4.1 Methods

### 4.1.1 ooGms4 constructor

The ooGmsh4 class have only one constructor :

```
Gh=fc_oogmsh.ooGmsh4(meshfile)
Gh=fc_oogmsh.ooGmsh4(meshfile, 'verbosity', Value)
```

where meshfile is the name of ... a mesh file. The 'verbosity' Key/Value option can be used to print some informations, when reading the file meshfile, if Value is true. Default is false

Octave code with output

```
fprintf('1) Building the mesh\n')
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser',10, ...
    'verbose',0,'force',true);
fprintf('2) Reading the mesh\n');
Gh = fc_oogmsh.ooGmsh4(meshfile,'verbose',true);
fprintf('-> Gh is an ooGmsh4 object containing a MSH file version ...
    %s\n',Gh.MeshFormat.version)
fprintf('3) Displaying Gh\n');
Gh
```

```
1) Building the mesh
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser-10.msh
2) Reading the mesh
Optional string "$PhysicalNames" not found
Reading $Entities section seem OK
Optional string "$PartitionedEntities" not found
Reading $Nodes section seem OK
Reading $Elements section seem OK
Optional string "$Periodic" not found
-> Gh is an ooGmsh4 object containing a MSH file version 4.1
3) Displaying Gh
Gh =

  fc_oogmsh.ooGmsh4 with properties:
            Elements: (1x1 struct)
            Entities: (1x1 struct)
                Info: (1x1 struct)
          MeshFormat: (1x1 struct)
               Nodes: (1x1 struct)
   PartitionedEntities: []
       PeriodicLinks: []
       PhysicalNames: []
                   d: 2 double
                 dim: 2 double
            meshfile: (1x110 char)
                  nq: 8151 double
              orders: 1 double
     partitionnedfile: 0 logical
                   q: (2x8151 double)
           toGlobal: (1x8151 double)
```

### 4.1.2 info method

```
info(Gh)
Gh.info()
Gh.info(Key, Value, ...)
```

### Description

`Gh.info()`
print informations on class fields with 3 levels of recursivity (i.e. field of field of field).

`Gh.info(Key, Value, ...)`
specifies function options using one or more `Key`,`Value` pair arguments. The `Key` options can be

- `'maxlevel'` : level of recursivity, default is 3.
- `'tab'` : number of space characters between two levels of recursivity, default is 4.

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser',6, ...
    'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile);
Gh.info('maxlevel',2);
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser-6.msh
  fc_oogmsh.ooGmsh4 with properties:
    [1] Elements : [1 1] struct
        [2] numEntityBlocks : [1 1] double
        [2] numElements : [1 1] double
        [2] minElementTag : [1 1] double
        [2] maxElementTag : [1 1] double
        [2] EntityBlocks : [1 19] struct
        [2] ElementTypes : [1 19] double
    [1] Entities : [1 1] struct
        [2] numPoints : [1 1] double
        [2] Points : [1 11] struct
        [2] numCurves : [1 1] double
        [2] Curves : [1 10] struct
        [2] numSurfaces : [1 1] double
        [2] Surfaces : [1 1] struct
        [2] numVolumes : [1 1] double
        [2] Volumes : [1 0] struct
    [1] Info : [1 1] struct
        [2] meshfile : [1 109] char
    [1] MeshFormat : [1 1] struct
        [2] version : [1 3] char
        [2] file_type : [1 1] double
        [2] data_size : [1 1] double
    [1] Nodes : [1 1] struct
        [2] numEntityBlocks : [1 1] double
        [2] numNodes : [1 1] double
        [2] minNodeTag : [1 1] double
        [2] maxNodeTag : [1 1] double
        [2] EntityBlocks : [1 21] struct
    [1] PartitionedEntities : [0 0] double
    [1] PeriodicLinks : [0 0] double
    [1] PhysicalNames : [0 0] double
    [1] d : [1 1] double
    [1] dim : [1 1] double
    [1] meshfile : [1 109] char
    [1] nq : [1 1] double
    [1] orders : [1 1] double
    [1] partitionnedfile : [1 1] logical
    [1] q : [2 3041] double
    [1] toGlobal : [1 3041] double
```

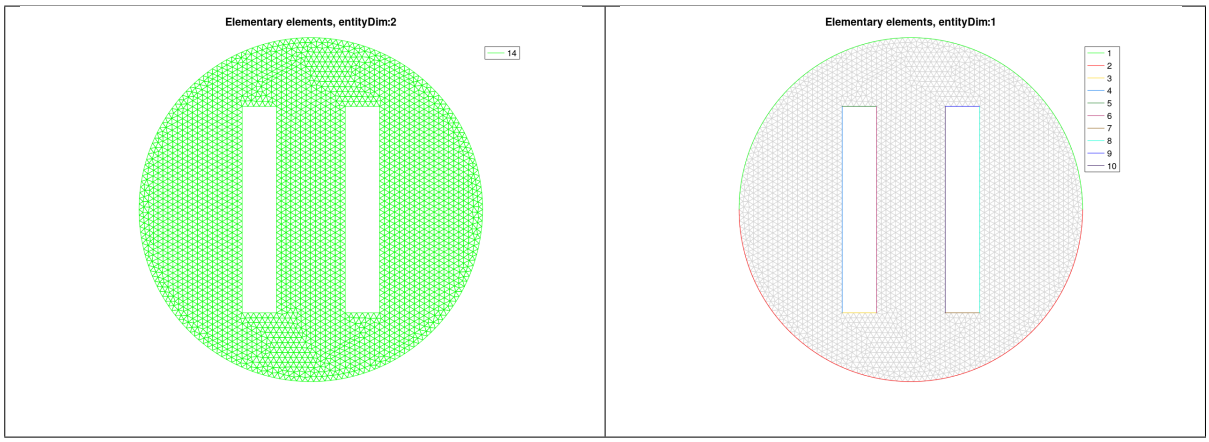



Figure 1: *Elementary Tag* elements of the *geofile* `condenser.geo`

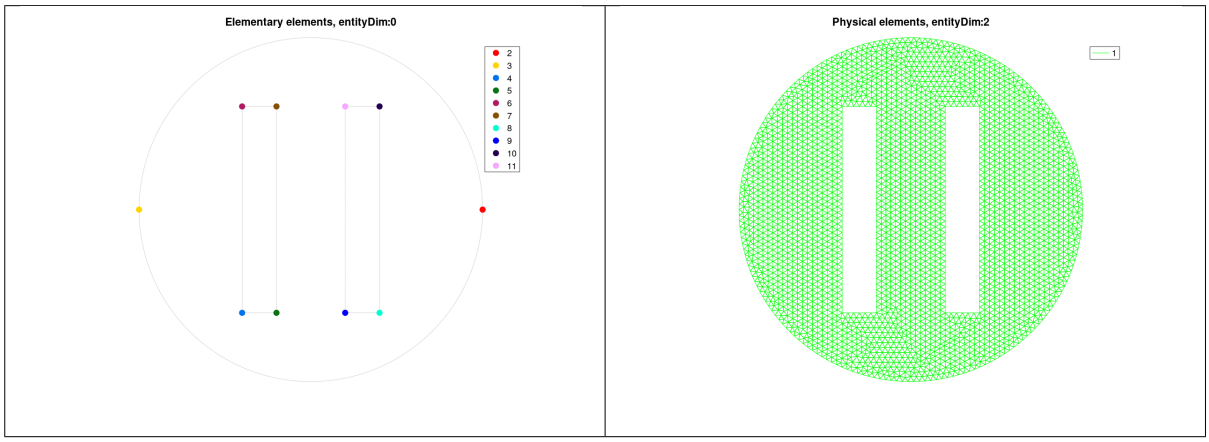



Figure 2: *Physical Tag* elements of the *geofile* `condenser.geo`

In the *geofile* `condenser.geo` the *Physical Tags* are created from the *Elementary Tags* as follow

```
...
Physical Line(1) = {1, 2};
Physical Line(98) = {5, 6, 3, 4};
Physical Line(99) = {9, 8, 7, 10};
Physical Surface(1) = {14};
```

### 4.1.3 `get_ElementaryTags` method

```
eltags=get_ElementaryTags(Gh,EltType)
eltags=Gh.get_ElementaryTags(EltType)
```

#### Description

`eltags=Gh.get_ElementaryTags(EltType)`

returns all the elementary tags associated with elements of type `EltType` as an array with unique elements. `EltType` is described in section **??**. For example, `EltType` is 1 for `2-nodes line` (i.e 1-simplex of order 1), `EltType` is 2 for `3-nodes triangle` (i.e 2-simplex of order 1) and `EltType` is 4 for `4-nodes tetrahedron` (i.e 3-simplex of order 1).

Octave code with output

```
eltags1=Gh.get_ElementaryTags(1)
eltags2=Gh.get_ElementaryTags(2)
```

```
eltags1 =

   1   2   3   4   5   6   7   8   9  10

eltags2 = 14
```

### 4.1.4 `get_PhysicalTags` method

```
phtags=get_PhysicalTags(Gh,EltType)
phtags=Gh.get_PhysicalTags(EltType)
```

#### Description

`phtags=Gh.get_PhysicalTags(EltType)`

returns all the elementary tags associated with elements of type `EltType` as an array with unique elements.

Octave code with output

```
phtags1=Gh.get_PhysicalTags(1)
phtags2=Gh.get_PhysicalTags(2)
```

```
phtags1 =

   1   98   99

phtags2 = 1
```

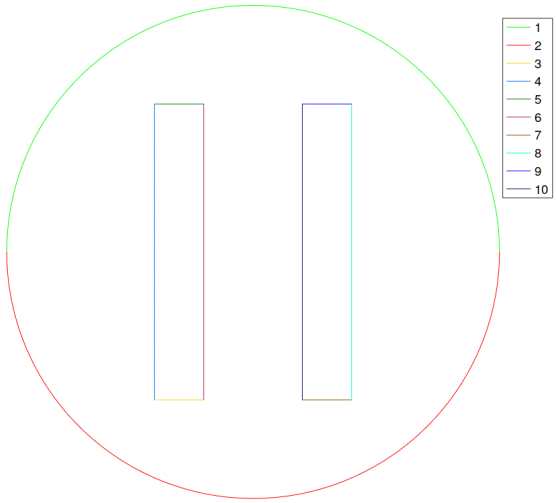
### 4.1.5 get_me_ElementaryTag method

```
me=get_me_ElementaryTag(Gh,EltType,EltTag)
me=Gh.get_me_ElementaryTag(EltType,EltTag)
```

**Description**

`me=Gh.get_me_ElementaryTag(EltType,EltTag)`

returns `me` the connectivity array of mesh elements of type and *elementary tag* given respectively by `EltType` and `EltTag`. This array is associated with the `Gh.q` nodes/vertices array.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser',6, 'verbose',0);
Gh = fc_oogmsh.ooGmsh4(meshfile);
eltags1=Gh.get_ElementaryTags(1);
n1=length(eltags1);
colors = fc_tools.graphics.selectColors(length(eltags1));
figure(1)
hold on
for i=1:n1
  me=Gh.get_me_ElementaryTag(1,eltags1(i));
  h(i)=fc_graphics4mesh.plotmesh(Gh.q,me,'color',colors(i,:));
  clegend{i}=num2str(eltags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh4_get_me_ElementaryTags', SaveOptions{:})
```

Listing 1: Plot curves mesh elements by using `get_me_ElementaryTags` function

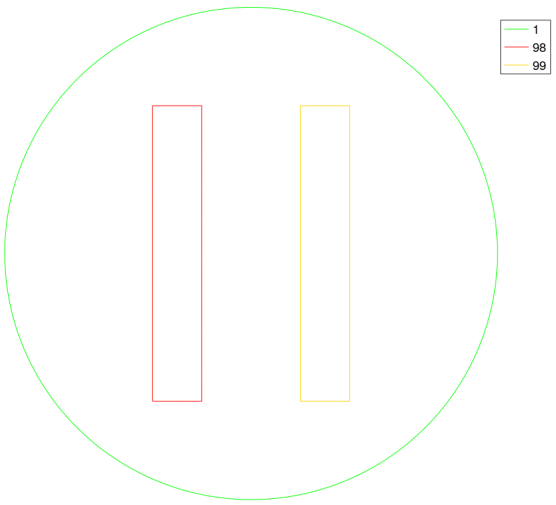
### 4.1.6 get_me_PhysicalTag method

```
me=get_me_PhysicalTag(Gh,EltType,PhyTag)
me=Gh.get_me_PhysicalTag(EltType,PhyTag)
```

### Description

`get_me_PhysicalTag(Gh,EltType,PhyTag)`

returns `me` the connectivity array of mesh elements of type and *physical tag* given respectively by `EltType` and `PhyTag`. This array is associated with the `Gh.q` nodes/vertices array.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser',6, 'verbose',0);
Gh = fc_oogmsh.ooGmsh4(meshfile);
phtags1=Gh.get_PhysicalTags(1);
n1=length(phtags1);
colors = fc_tools.graphics.selectColors(length(phtags1));
figure(1)
hold on
for i=1:n1
  me=Gh.get_me_PhysicalTag(1,phtags1(i));
  h(i)=fc_graphics4mesh.plotmesh(Gh.q,me,'color',colors(i,:));
  clegend{i}=num2str(phtags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh4_get_me_PhysicalTags', SaveOptions{:})
```

Listing 2: Plot curves mesh elements by using `get_me_PhysicalTags` function

#### 4.1.7 `get_localmesh_ElementaryTag` method

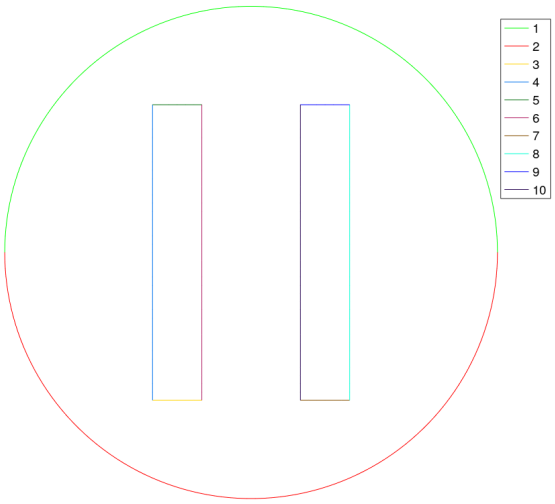
```
[q,me]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)
[q,me,toGlobal]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)
```

`[q,me]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)`

returns the *local* nodes/vertices array `q` and the *local* connectivity array `me` of the element of type `EltType` and with *elementary tag* given by `EltTag`.

`[q,me,toGlobal]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)`

Also returns the *global* tags array `toGlobal` such that `Gh.q(:,toGlobal)` is equal to `q`.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser',6, 'verbose',0);
Gh = fc_oogmsh.ooGmsh4(meshfile);
eltags1=Gh.get_ElementaryTags(1); % 1: 2-nodes line
n1=length(eltags1);
colors = fc_tools.graphics.selectColors(length(eltags1));
figure(1)
hold on
for i=1:n1
  [q,me]=Gh.get_localmesh_ElementaryTag(1,eltags1(i));
  h(i)=fc_graphics4mesh.plotmesh(q,me,'color',colors(i,:));
  clegend{i}=num2str(eltags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh4_get_localmesh_ElementaryTag', SaveOptions{:})
```

Listing 3: Plot *2-nodes line* mesh elements by using `get_localmesh_ElementaryTag` function

### 4.1.8 `get_localmesh_PhysicalTag` method

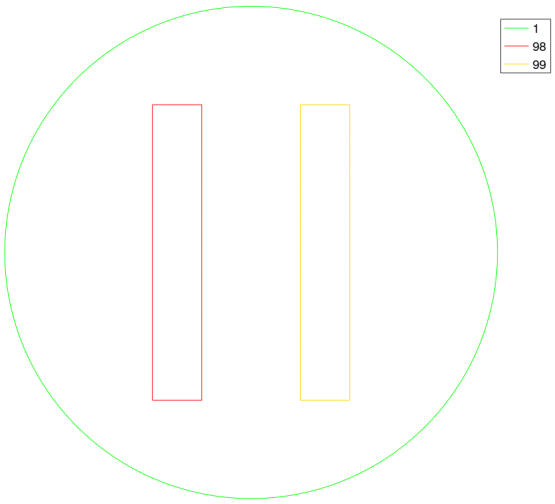
```
[q,me]=Gh.get_localmesh_PhysicalTag(EltType,PhyTag)
[q,me,toGlobal]=Gh.get_localmesh_PhysicalTag(EltType,PhysicalTag)
```

`[q,me]=Gh.get_localmesh_PhysicalTag(EltType,PhyTag)`

returns the *local* nodes/vertices array `q` and the *local* connectivity array `me` of the elements of type `EltType` and with *PhyTag* given by `PhysicalTag`.

`[q,me,toGlobal]=Gh.get_localmesh_PhysicalTag(EltType,PhyTag)`

Also returns the *global* tags array `toGlobal` such that `Gh.q(:,toGlobal)` is equal to `q`.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser',6, 'verbose',0);
Gh = fc_oogmsh.ooGmsh4(meshfile);
phtags1=Gh.get_PhysicalTags(1); % 1: 2-nodes line
n1=length(phtags1);
colors = fc_tools.graphics.selectColors(length(phtags1));
figure(1)
hold on
for i=1:n1
  [q,me]=Gh.get_localmesh_PhysicalTag(1,phtags1(i));
  h(i)=fc_graphics4mesh.plotmesh(q,me,'color',colors(i,:));
  clegend{i}=num2str(phtags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh4_get_localmesh_PhysicalTag', SaveOptions{:})
```

Listing 4: Plot *2-nodes line* mesh elements by using `get_localmesh_PhysicalTag` function

## 4.2 Description of properties

### Fields of `MeshFormat` structure

| | | |
|---|---|---|
| `version` | : | string, version of the mesh file format. |
| `file_type` | : | integer, 0 for ASCII mode, 1 for binary mode. |
| `data_size` | : | integer, `sizeof(size_t)` |

### Fields of the (optional) `PhysicalName` structure

| | | |
|---|---|---|
| `dimension` | : | integer. |
| `physicalTag` | : | integer. |
| `name` | : | string |

### Fields of the `Entities` structure

| | | |
|---|---|---|
| `numPoints` | : | integer. |
| `Points` | : | array of `Point` structure. |
| `numCurves` | : | integer. |
| `Curves` | : | array of `Curve` structure. |
| `numSurfaces` | : | integer. |
| `Surfaces` | : | array of `Surface` structure. |
| `numVolumes` | : | integer. |
| `Volumes` | : | array of `Volume` structure. |

### Fields of (optional) `PartitionedEntities` structure

| | | |
|---|---|---|
| `numPartitions` | : | integer. |
| `numGhostEntities` | : | integer. |
| `GhostEntities` | : | array of structure. |
| `numPoints` | : | integer |
| `Points` | : | array of structure. |
| `numCurves` | : | integer |
| `Curves` | : | array of structure. |
| `numSurfaces` | : | integer |
| `Surfaces` | : | array of structure. |
| `numVolumes` | : | integer. |
| `Volumes` | : | array of structure. |

### Fields of `Nodes` structure

| | | |
|---|---|---|
| `numEntityBlocks` | : | integer. |
| `numNodes` | : | integer. |
| `minNodeTag` | : | integer. |
| `maxNodeTag` | : | integer |
| `EntityBlocks` | : | array of `EntityBlock` structure. |

### Fields of `EntityBlocks` structure of `Nodes`

| | | |
|---|---|---|
| `entityDim` | : | integer. |
| `entityTag` | : | integer. |
| `parametric` | : | integer. |
| `numNodes` | : | integer. |
| `nodeTags` | : | 1-by-`numNodes` array of integer. |
| `Nodes` | : | 3-by-`numNodes` array of double. |

### Fields of `Elements` structure

| | | |
|---|---|---|
| `numEntityBlocks` | : | integer. |
| `numElements` | : | integer. |
| `minElementTag` | : | integer. |
| `maxElementTag` | : | integer |
| `EntityBlocks` | : | array of `EntityBlock` structure. |
| `ElementTypes` | : | array of . |

**Fields of `EntityBlocks` structure of `Elements`**

| | | |
|---|---|---|
| `entityDim` | : | integer. |
| `entityTag` | : | integer. |
| `elementType` | : | integer. |
| `elementDesc` | : | structure returned by function `gmsh.elm_type_desc(elementType)`. |
| `numElementsBlock` | : | integer. |
| `nodeTags` | : | $n$-by-`numElementsBlock` array. $n$ depends of `elementType`: $n$ = `elementDesc.nb_nodes` |
| `elementTags` | : | 1-by-`numElementsBlock` array |

**Fields of `PeriodicLink`**

| | | |
|---|---|---|
| `entityDim` | : | integer. |
| `entityTag` | : | integer. |
| `entityTagMaster` | : | integer. |
| `numAffine` | : | |
| `values` | : | . |
| `numCorrespondingNodes` | : | . |
| `nodeTags` | : | |
| `nodeTagMasters` | : | |

## 4.3 Sample 1

The 2d .geo file *condenser.geo* is used to create a .msh file : `condenser-25.msh`. This `.msh` file contains only 1 (2-node line) and 2 (3-node triangle) *elm-type*.

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh('condenser',25,'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/condenser-25.msh
Gh =

  fc_oogmsh.ooGmsh4 with properties:
            Elements: (1x1 struct)
            Entities: (1x1 struct)
                Info: (1x1 struct)
          MeshFormat: (1x1 struct)
               Nodes: (1x1 struct)
   PartitionedEntities: []
       PeriodicLinks: []
       PhysicalNames: []
                   d: 2 double
                 dim: 2 double
            meshfile: (1x110 char)
                  nq: 49238 double
              orders: 1 double
     partitionnedfile: 0 logical
                   q: (2x49238 double)
           toGlobal: (1x49238 double)
```

## 4.4 Sample 2

The 3d .geo file *cylinderkey.geo* is used to create a .msh file : `cylinderkey-10.msh`. This `.msh` file contains 1 (2-node line), 2 (3-node triangle) and 4 (4-node tetrahedron) *elm-type*.

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinderkey',10, ...
    'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/cylinderkey-10.msh
Gh =

  fc_oogmsh.ooGmsh4 with properties:
            Elements: (1x1 struct)
            Entities: (1x1 struct)
                Info: (1x1 struct)
          MeshFormat: (1x1 struct)
               Nodes: (1x1 struct)
   PartitionedEntities: []
        PeriodicLinks: []
        PhysicalNames: []
                    d: 3 double
                  dim: 3 double
             meshfile: (1x112 char)
                   nq: 5834 double
               orders: 1 double
      partitionnedfile: 0 logical
                    q: (3x5834 double)
             toGlobal: (1x5834 double)
```

## 4.5 Sample 3

The 3d .geo file *ball8.geo* is used to create a 3d surface .msh file : `ball8-50.msh`. This `.msh` file contains 1 (2-node line), 2 (3-node triangle) and 15 (1-node point) *elm-type*.

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh3ds('ball8',50, 'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 4.1 in <fc-oogmsh>/meshes/ball8-50.msh
Gh =

  fc_oogmsh.ooGmsh4 with properties:
            Elements: (1x1 struct)
            Entities: (1x1 struct)
                Info: (1x1 struct)
          MeshFormat: (1x1 struct)
               Nodes: (1x1 struct)
   PartitionedEntities: []
        PeriodicLinks: []
        PhysicalNames: []
                    d: 3 double
                  dim: 3 double
             meshfile: (1x106 char)
                   nq: 37801 double
               orders: 1 double
      partitionnedfile: 0 logical
                    q: (3x37801 double)
             toGlobal: (1x37801 double)
```

# 5 ooGmsh2 class (version 2.2)

The ooGmsh2 class can be used to read `gmsh` mesh files with the MSH ASCII file format (version 2.2) described for example in [3], section 9.1. A MSH file can contain various mesh elements which are identified by an *elm-type* integer given in Appendix A. One can also refer to the `fc_oogmsh.gmsh.elm_type_desc` function, described in Appendix B.1, to obtain information on a given *elm-type*.

When reading a MSH file (format 2.2) generated by `gmsh`, we split the mesh elements by *elm-type* and generate an array of `Elmt` structure. The dimension of this array is the number of differents *elm-type* founds on the .msh file.

The `Elmt` structure is given by

**Fields of `Elmt` structure**

| | | |
|---|---|---|
| `type` | : | integer, refers to the type of the element : 1 for 2-node line, 2 for 3-node triangle, ... See the *elm-type* description of [3], section 9.1. Informations on a given `type` can be obtained by using `elt=fc_oogmsh.gmsh.elm_type_desc(type)`. |
| `geo` | : | string, contains the kind of geometry: 'line', 'triangle', 'tetrahedron', ... |
| `d` | : | integer, space dimension or `d`-simplex. |
| `order` | : | integer, order of the element. |
| `nme` | : | integer, number of mesh elements. |
| `me` | : | array of `nb_nodes`-by-`nme` integers, connectivity array. `nb_nodes` is equal to `elt.nb_nodes` where `elt=fc_oogmsh.gmsh.elm_type_desc(type)`. |
| `phys_lab` | : | array of `nme`-by-... integers, physical labels of the elements. |
| `geo_lab` | : | array of `nme`-by-... integers, geometrical labels of the elements. |
| `nb_parts` | : | array of `nme`-by-1 integers, number of mesh partitions to which the element belongs. |
| `part_lab` | : | array of `nme`-by-max(`nb_parts`) integers, `part_lab`$(i, 1 :$ `nb_parts`$(i))$ contains all the partitions index to which the $i$-th element belongs. |

The ooGmsh2 class was created to store a maximum of(all the) information(s) contained in the .msh file. The properties of this class are:

**Properties of ooGmsh class**

| | | |
|---|---|---|
| dim | : | integer<br>space dimension |
| $n_q$ | : | integer<br>number of vertices/nodes |
| q | : | dim-by-$n_q$ array of reals<br>array of vertex coordinates |
| `types` | : | array of integers<br>List of the element types found in the mesh file. |
| `orders` | : | array of integers<br>List of the orders of the element types found in the mesh file. |
| `sElts` | : | array of `Elmt` structure<br>One `Elmt` structure by element type, such that `sElts`$(i)$ contains all the elements of type `types`$(i)$ and order `orders`$(i)$. |

## 5.1 Methods

### 5.1.1 `ooGmsh2` constructor

The `ooGmsh2` class have only one constructor :

```
Gh=fc_oogmsh.ooGmsh2(meshfile)
```

where meshfile is the name of ... a mesh file

Octave code with output

```
fprintf('1) Building the mesh\n')
meshfile=fc_oogmsh.gmsh.buildmesh2d('disk3holes',15, ...
    'verbose',0,'force',true,'MshFileVersion','2.2');
fprintf('2) Reading the mesh\n');
Gh = fc_oogmsh.ooGmsh2(meshfile);
fprintf('-> Gh is an ooGmsh2 object containing a MSH file version ...
    %s\n',Gh.MeshFormat.version)
fprintf('3) Displaying Gh\n');
Gh
```

```
1) Building the mesh
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/disk3holes-15.msh
2) Reading the mesh
-> Gh is an ooGmsh2 object containing a MSH file version 2.2
3) Displaying Gh
Gh =

  fc_oogmsh.ooGmsh2 with properties:
             Info: (1x1 struct)
       MeshFormat: (1x1 struct)
                d: 2 double
            debug: (1x1 struct)
              dim: 2 double
         meshfile: (1x111 char)
               nq: 910 double
           orders: 1 double
   partitionnedfile: 0 logical
                q: (2x910 double)
             sElts: (2x1 struct)
         toGlobal: (1x910 double)
            types: [ 1 2 ] (1x2 double)
```

### 5.1.2 `info` method

```
info(Gh)
Gh.info()
Gh.info(Key, Value, ...)
```

#### Description

`Gh.info()`

print informations on class fields with 3 levels of recursivity (i.e. field of field of field).

`Gh.info(Key, Value, ...)`

specifies function options using one or more `Key`,`Value` pair arguments. The `Key` options can be

- `'maxlevel'` : level of recursivity, default is 3.
- `'tab'` : number of space characters between two levels of recursivity, default is 4.

Octave code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh2d('disk3holes',15, ...
    'verbose',0,'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile);
Gh.info('maxlevel',2);
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/disk3holes-15.msh
 fc_oogmsh.ooGmsh2 with properties:
   [1] Info : [1 1] struct
       [2] meshfile : [1 111] char
   [1] MeshFormat : [1 1] struct
       [2] version : [1 3] char
       [2] file_type : [1 1] double
       [2] data_size : [1 1] double
   [1] d : [1 1] double
   [1] debug : [1 1] struct
       [2] Mt : [1824  55] double
   [1] dim : [1 1] double
   [1] meshfile : [1 111] char
   [1] nq : [1 1] double
   [1] orders : [1 1] double
   [1] partitionnedfile : [1 1] logical
   [1] q : [2 910] double
   [1] sElts : [2 1] struct
       [2] type : [1 1] double
       [2] geo : [1 4] char
       [2] d : [1 1] double
       [2] order : [1 1] double
       [2] me : [2 146] double
       [2] nme : [1 1] double
       [2] phys_lab : [146  1] double
       [2] geo_lab : [146  1] double
       [2] part_lab : [0 0] double
       [2] nb_parts : [146  1] double
   [1] toGlobal : [1 910] double
   [1] types : [1 2] double
```

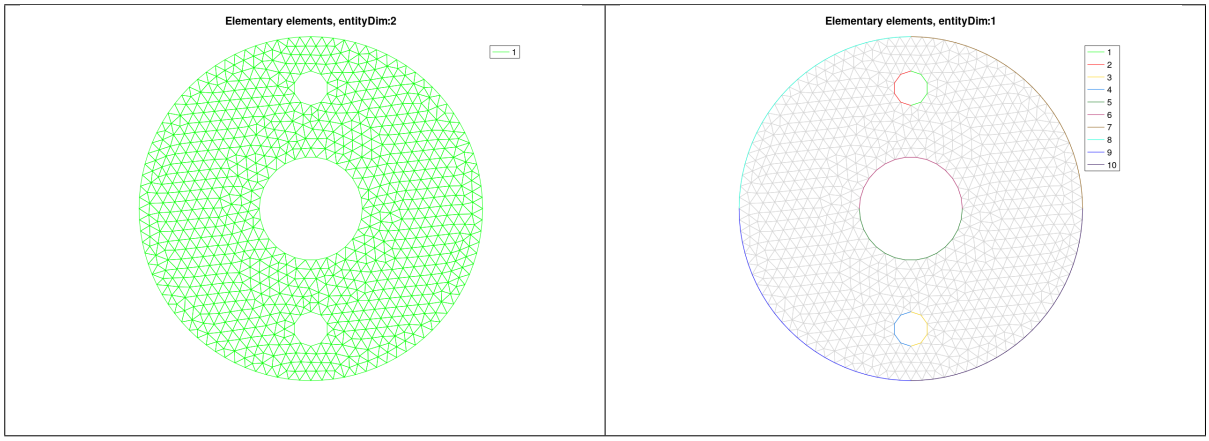



Figure 3: *Elementary Tag* elements of the *geofile* `disk3holes.geo`

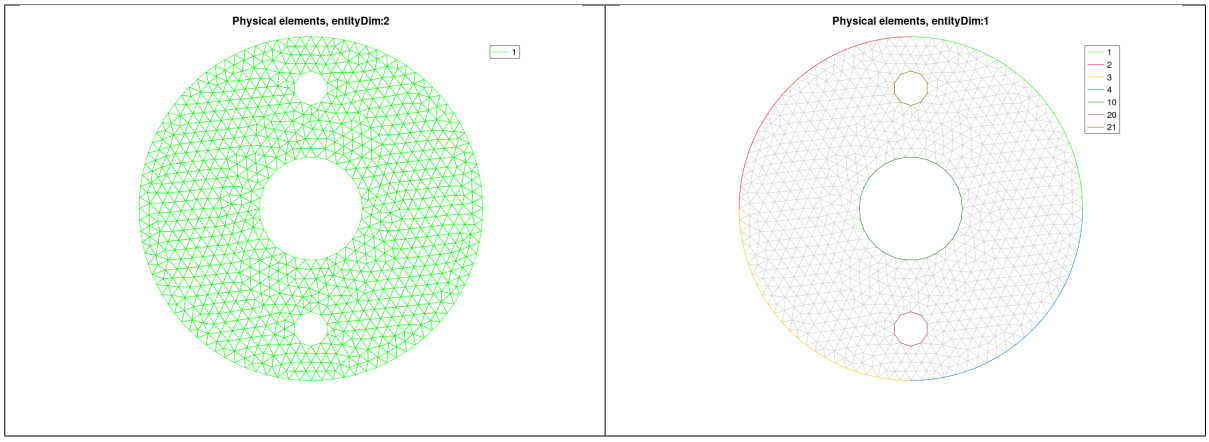



Figure 4: *Physical Tag* elements of the *geofile* `disk3holes.geo`

In the *geofile* `disk3holes.geo` the *Physical Tags* are created from the *Elementary Tags* as follow

```
...
Physical Line(10) = {6, 5};
Physical Line(21) = {2, 1};
Physical Line(20) = {4, 3};
Physical Line(1) = {7};
Physical Line(2) = {8};
Physical Line(3) = {9};
Physical Line(4) = {10};
Physical Surface(1) = {1};
```

### 5.1.3 get_ElementaryTags method

```
eltags=get_ElementaryTags(Gh,EltType)
eltags=Gh.get_ElementaryTags(EltType)
```

#### Description

`eltags=Gh.get_ElementaryTags(EltType)`

returns all the elementary tags associated with elements of type `EltType` as an array with unique elements. `EltType` is described in Section A. For example, `EltType` is 1 for `2-nodes line` (i.e 1-simplex of order 1), `EltType` is 2 for `3-nodes triangle` (i.e 2-simplex of order 1) and `EltType` is 4 for `4-nodes tetrahedron` (i.e 3-simplex of order 1).

Octave code with output

```
eltags1=Gh.get_ElementaryTags(1)
eltags2=Gh.get_ElementaryTags(2)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/disk3holes-15.msh
eltags1 =

   1   2   3   4   5   6   7   8   9  10

eltags2 = 1
```

### 5.1.4 get_PhysicalTags method

```
phtags=get_PhysicalTags(Gh,EltType)
phtags=Gh.get_PhysicalTags(EltType)
```

#### Description

`phtags=Gh.get_PhysicalTags(EltType)`

returns all the physical tags associated with elements of type `EltType` as an array with unique elements. `EltType` is described in Section A.

Octave code with output

```
phtags1=Gh.get_PhysicalTags(1)
phtags2=Gh.get_PhysicalTags(2)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/disk3holes-15.msh
phtags1 =

   1   2   3   4  10  20  21

phtags2 = 1
```

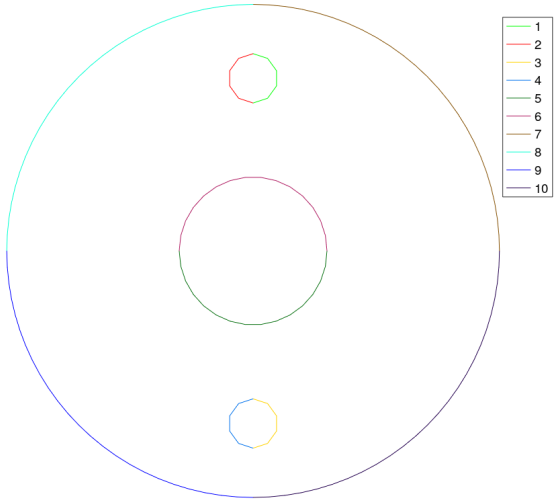
### 5.1.5 get_me_ElementaryTag method

```
me=get_me_ElementaryTag(Gh,EltType,EltTag)
me=Gh.get_me_ElementaryTag(EltType,EltTag)
```

### Description

`me=Gh.get_me_ElementaryTag(EltType,EltTag)`

returns `me` the connectivity array of mesh elements of type and *elementary tag* given respectively by `EltType` and `EltTag`. This array is associated with the `Gh.q` nodes/vertices array.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('disk3holes',15, 'verbose',0,'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile);
eltags1=Gh.get_ElementaryTags(1);
n1=length(eltags1);
colors = fc_tools.graphics.selectColors(length(eltags1));
figure(1)
hold on
for i=1:n1
  me=Gh.get_me_ElementaryTag(1,eltags1(i));
  h(i)=fc_graphics4mesh.plotmesh(Gh.q,me,'color',colors(i,:));
  clegend{i}=num2str(eltags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh2_get_me_ElementaryTags', SaveOptions{:})
```

Listing 5: Plot curves mesh elements by using `get_me_ElementaryTags` function

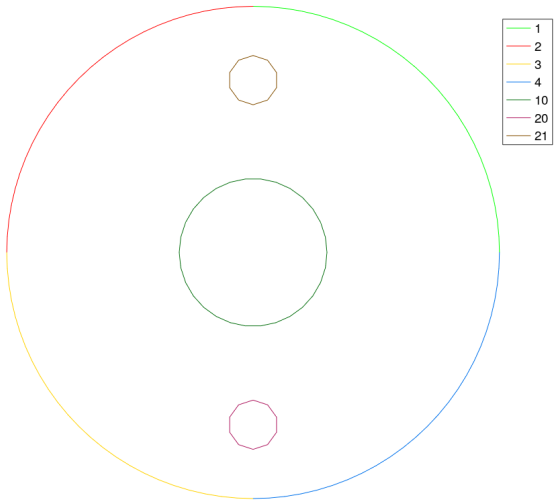
### 5.1.6 `get_me_PhysicalTag` method

```
me=get_me_PhysicalTag(Gh,EltType,PhysicalTag)
me=Gh.get_me_PhysicalTag(EltType,PhysicalTag)
```

### Description

`get_me_PhysicalTag(Gh,EltType,PhysicalTag)`

returns `me` the connectivity array of mesh elements of type and *physical tag* given respectively by `EltType` and `PhysicalTag`.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('disk3holes',15, 'verbose',0,'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile);
phtags1=Gh.get_PhysicalTags(1);
n1=length(phtags1);
colors = fc_tools.graphics.selectColors(length(phtags1));
figure(1)
hold on
for i=1:n1
  me=Gh.get_me_PhysicalTag(1,phtags1(i));
  h(i)=fc_graphics4mesh.plotmesh(Gh.q,me,'color',colors(i,:));
  clegend{i}=num2str(phtags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh2_get_me_PhysicalTags', SaveOptions{:})
```

Listing 6: Plot curves mesh elements by using `get_me_PhysicalTags` function

### 5.1.7 `get_localmesh_ElementaryTag` method

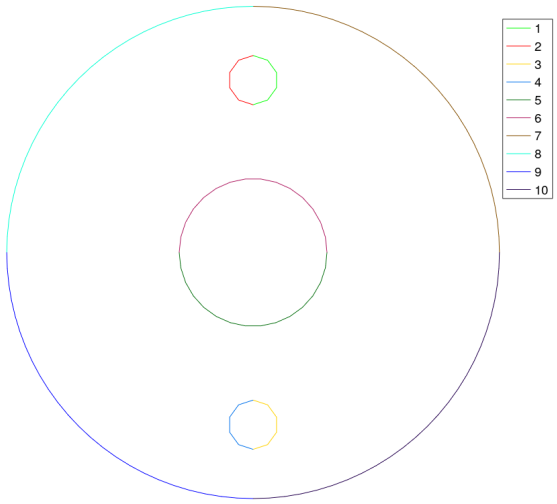
```
[q,me]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)
[q,me,toGlobal]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)
```

`[q,me]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)`

returns the *local* nodes/vertices array `q` and the *local* connectivity array `me` of the element of type `EltType` and with *elementary tag* given by `EltTag`.

`[q,me,toGlobal]=Gh.get_localmesh_ElementaryTag(EltType,EltTag)`

Also returns the *global* tags array `toGlobal` such that `Gh.q(:,toGlobal)` is equal to `q`.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('disk3holes',15, 'verbose',0,'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile);
eltags1=Gh.get_ElementaryTags(1);
n1=length(eltags1);
colors = fc_tools.graphics.selectColors(length(eltags1));
figure(1)
hold on
for i=1:n1
  [q,me]=Gh.get_localmesh_ElementaryTag(1,eltags1(i));
  h(i)=fc_graphics4mesh.plotmesh(q,me,'color',colors(i,:));
  clegend{i}=num2str(eltags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh2_get_localmesh_ElementaryTag', SaveOptions{:})
```

Listing 7: Plot curves mesh elements by using `get_localmesh_ElementaryTag` function

### 5.1.8 `get_localmesh_PhysicalTag` method

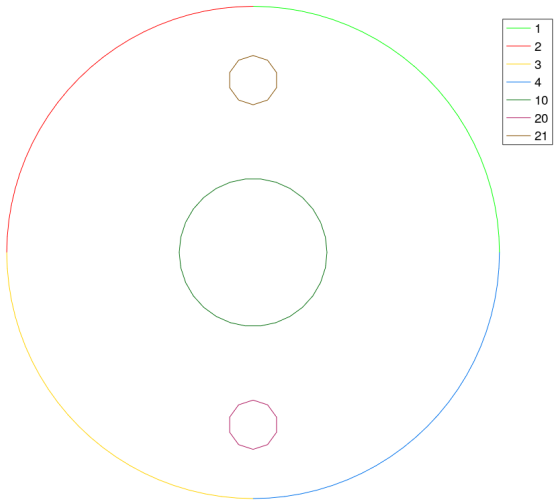
```
[q,me]=Gh.get_localmesh_PhysicalTag(EltType,PhysicalTag)
[q,me,toGlobal]=Gh.get_localmesh_PhysicalTag(EltType,PhysicalTag)
```

`[q,me]=Gh.get_localmesh_PhysicalTag(EltType,PhysicalTag)`

returns the *local* nodes/vertices array `q` and the *local* connectivity array `me` of the elements of type `EltType` and with *PhysicalTag* given by `PhysicalTag`.

`[q,me,toGlobal]=Gh.get_localmesh_PhysicalTag(EltType,PhysicalTag)`

Also returns the *global* tags array `toGlobal` such that `Gh.q(:,toGlobal)` is equal to `q`.




```
meshfile=fc_oogmsh.gmsh.buildmesh2d('disk3holes',15, 'verbose',0,'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile);
phtags1=Gh.get_PhysicalTags(1);
n1=length(phtags1);
colors = fc_tools.graphics.selectColors(length(phtags1));
figure(1)
hold on
for i=1:n1
  [q,me]=Gh.get_localmesh_PhysicalTag(1,phtags1(i));
  h(i)=fc_graphics4mesh.plotmesh(q,me,'color',colors(i,:));
  clegend{i}=num2str(phtags1(i));
end
legend(h,clegend,'Location','NorthEastOutside','AutoUpdate','off');
axis image;axis off
fc_tools.graphics.SaveAllFigsAsFiles('ooGmsh2_get_localmesh_PhysicalTag', SaveOptions{:})
```

Listing 8: Plot curves mesh elements by using `get_localmesh_PhysicalTag` function

## 5.2 Sample 1

The 2d .geo file *condenser.geo* is used to create a .msh file : `condenser-25.msh`. This `.msh` file contains only 1 (2-node line) and 2 (3-node triangle) *elm-type*.

Matlab code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh('condenser',25,'verbose',0, ...
    'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/condenser-25.msh
Gh =

  fc_oogmsh.ooGmsh2 with properties:
            Info: (1x1 struct)
       MeshFormat: (1x1 struct)
                d: 2 double
            debug: (1x1 struct)
              dim: 2 double
         meshfile: (1x110 char)
               nq: 49238 double
           orders: 1 double
   partitionnedfile: 0 logical
                q: (2x49238 double)
             sElts: (3x1 struct)
         toGlobal: (1x49238 double)
            types: [ 1 2 15 ] (1x3 double)
```

## 5.3 Sample 2

The 3d .geo file *cylinderkey.geo* is used to create a .msh file : `cylinderkey-10.msh`. This `.msh` file contains 1 (2-node line), 2 (3-node triangle) and 4 (4-node tetrahedron) *elm-type*.

Matlab code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinderkey',10,'verbose',0, ...
    'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/cylinderkey-10.msh
Gh =

  fc_oogmsh.ooGmsh2 with properties:
            Info: (1x1 struct)
       MeshFormat: (1x1 struct)
                d: 3 double
            debug: (1x1 struct)
              dim: 3 double
         meshfile: (1x112 char)
               nq: 5834 double
           orders: 1 double
   partitionnedfile: 0 logical
                q: (3x5834 double)
            sElts: (3x1 struct)
         toGlobal: (1x5834 double)
            types: [ 1 2 4 ] (1x3 double)
```

## 5.4 Sample 3

The 3d .geo file *ball8.geo* is used to create a 3d surface .msh file : `ball8-50.msh`. This `.msh` file contains 1 (2-node line), 2 (3-node triangle) and 15 (1-node point) *elm-type*.

Matlab code with output

```
meshfile=fc_oogmsh.gmsh.buildmesh3ds('ball8',50,'verbose',0, ...
    'force',true,'MshFileVersion','2.2');
Gh = fc_oogmsh.ooGmsh2(meshfile)
```

```
[fc-oogmsh] Using gmsh 4.5.1 to write MSH file format version 2.2 in <fc-oogmsh>/meshes/ball8-50.msh
Gh =

  fc_oogmsh.ooGmsh2 with properties:
            Info: (1x1 struct)
       MeshFormat: (1x1 struct)
                d: 2 double
            debug: (1x1 struct)
              dim: 3 double
         meshfile: (1x106 char)
               nq: 37801 double
           orders: 1 double
   partitionnedfile: 0 logical
                q: (3x37801 double)
            sElts: (3x1 struct)
         toGlobal: (1x37801 double)
            types: [ 1 2 15 ] (1x3 double)
```

# A Element type

In a .msh file the kind of mesh elements are identified by their *elm-type* integer values :

| *elm-type* | **description** |
|---|---|
| 1 | 2-node line |
| 2 | 3-node triangle |
| 3 | 4-node quadrangle |
| 4 | 4-node tetrahedron |
| 5 | 8-node hexahedron |
| 6 | 6-node prism |
| 7 | 5-node pyramid |
| 8 | 3-node second order line (2 nodes associated with the vertices and 1 with the edge) |
| 9 | 6-node second order triangle (3 nodes associated with the vertices and 3 with the edges) |
| 10 | 9-node second order quadrangle (4 nodes associated with the vertices, 4 with the edges and 1 with the face) |
| 11 | 10-node second order tetrahedron (4 nodes associated with the vertices and 6 with the edges) |

| | |
|---|---|
| 12 | 27-node second order hexahedron (8 nodes associated with the vertices, 12 with the edges, 6 with the faces and 1 with the volume) |
| 13 | 18-node second order prism (6 nodes associated with the vertices, 9 with the edges and 3 with the quadrangular faces) |
| 14 | 14-node second order pyramid (5 nodes associated with the vertices, 8 with the edges and 1 with the quadrangular face) |
| 15 | 1-node point |
| 16 | 8-node second order quadrangle (4 nodes associated with the vertices and 4 with the edges) |
| 17 | 20-node second order hexahedron (8 nodes associated with the vertices and 12 with the edges) |
| 18 | 15-node second order prism (6 nodes associated with the vertices and 9 with the edges) |
| 19 | 13-node second order pyramid (5 nodes associated with the vertices and 8 with the edges) |
| 20 | 9-node third order incomplete triangle (3 nodes associated with the vertices, 6 with the edges) |
| 21 | 10-node third order triangle (3 nodes associated with the vertices, 6 with the edges, 1 with the face) |
| 22 | 12-node fourth order incomplete triangle (3 nodes associated with the vertices, 9 with the edges) |
| 23 | 15-node fourth order triangle (3 nodes associated with the vertices, 9 with the edges, 3 with the face) |
| 24 | 15-node fifth order incomplete triangle (3 nodes associated with the vertices, 12 with the edges) |
| 25 | 21-node fifth order complete triangle (3 nodes associated with the vertices, 12 with the edges, 6 with the face) |
| 26 | 4-node third order edge (2 nodes associated with the vertices, 2 internal to the edge) |
| 27 | 5-node fourth order edge (2 nodes associated with the vertices, 3 internal to the edge) |
| 28 | 6-node fifth order edge (2 nodes associated with the vertices, 4 internal to the edge) |
| 29 | 20-node third order tetrahedron (4 nodes associated with the vertices, 12 with the edges, 4 with the faces) |
| 30 | 35-node fourth order tetrahedron (4 nodes associated with the vertices, 18 with the edges, 12 with the faces, 1 in the volume) |
| 31 | 56-node fifth order tetrahedron (4 nodes associated with the vertices, 24 with the edges, 24 with the faces, 4 in the volume) |
| 92 | 64-node third order hexahedron (8 nodes associated with the vertices, 24 with the edges, 24 with the faces, 8 in the volume) |
| 93 | 125-node fourth order hexahedron (8 nodes associated with the vertices, 36 with the edges, 54 with the faces, 27 in the volume) |

# B Other functions

## B.1 function fc_oogmsh.gmsh.elm_type_desc

This function returns a structure which contains some informations on a `gmsh` *elt-type* described in Appendix A.

**Syntaxe**

```
elt=fc_oogmsh.gmsh.elm_type_desc(type)
```

Octave code with output

```
elt2=fc_oogmsh.gmsh.elm_type_desc(2)
elt4=fc_oogmsh.gmsh.elm_type_desc(4)
elt11=fc_oogmsh.gmsh.elm_type_desc(11)
```

```
elt2 =

  scalar structure containing the fields:

    define = MSH_TRI_3
    elm_type = 2
    desc = 3-node triangle
    nb_nodes = 3
    order = 1
    incomplete = 0
    d =  2
    geo = triangle

elt4 =

  scalar structure containing the fields:

    define = MSH_TET_4
    elm_type = 4
    desc = 4-node tetrahedron
    nb_nodes = 4
    order = 1
    incomplete = 0
    d =  3
    geo = tetrahedron

elt11 =

  scalar structure containing the fields:

    define = MSH_TET_10
    elm_type = 11
    desc = 10-node second order tetrahedron (4 nodes associated with the vertices and 6 with the edges)
    nb_nodes = 10
    order = 2
    incomplete = 0
    d =  3
    geo = tetrahedron
```

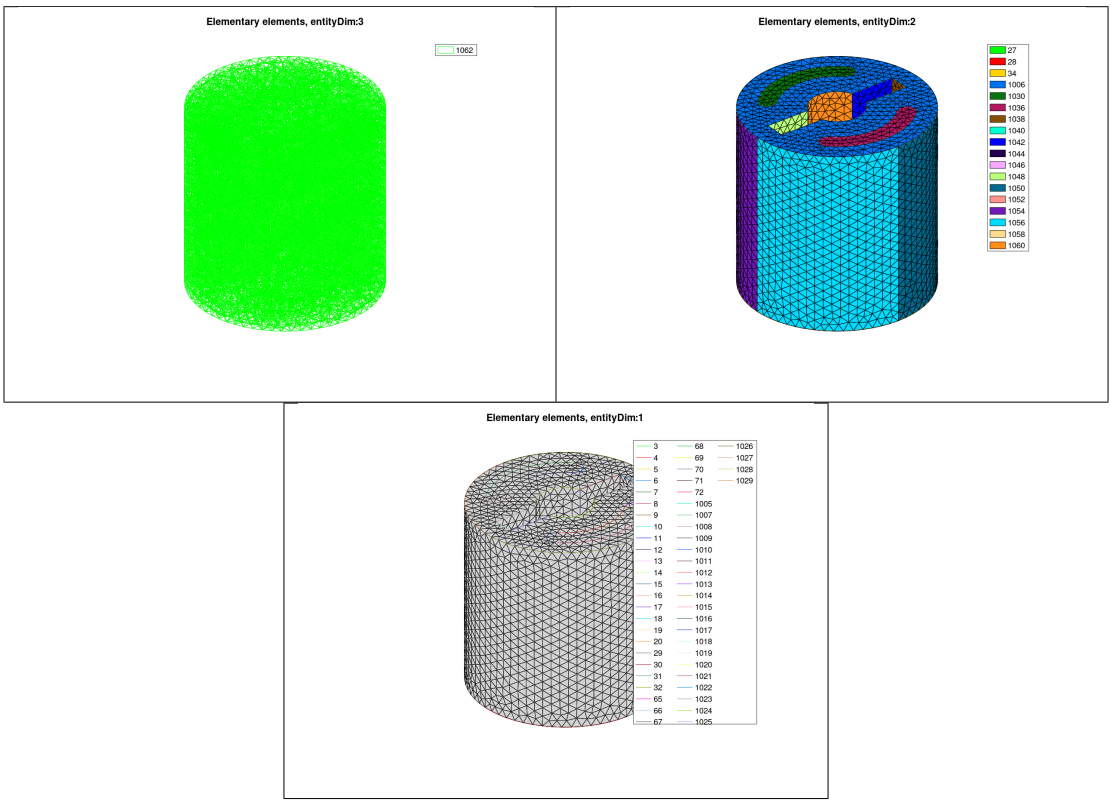
## B.2 method `plotElementaryElements`

This function plot *Elementary Elements* of an `ooGmsh2` or `ooGmsh4` object of *Element Type*

- 1, *2-node line* elements,
- 2, *3-node triangle* elements,
- 4, *4-node tetrahedron* elements.

This function uses the `fc-graphics4mesh` package [1] version 0.1.1.

```
Gh.plotElementaryElements()
plotElementaryElements(Gh)
```




```
meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinderkey',10, 'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile);
Gh.plotElementaryElements()
```

Listing 9: Using `plotElementaryElements` method

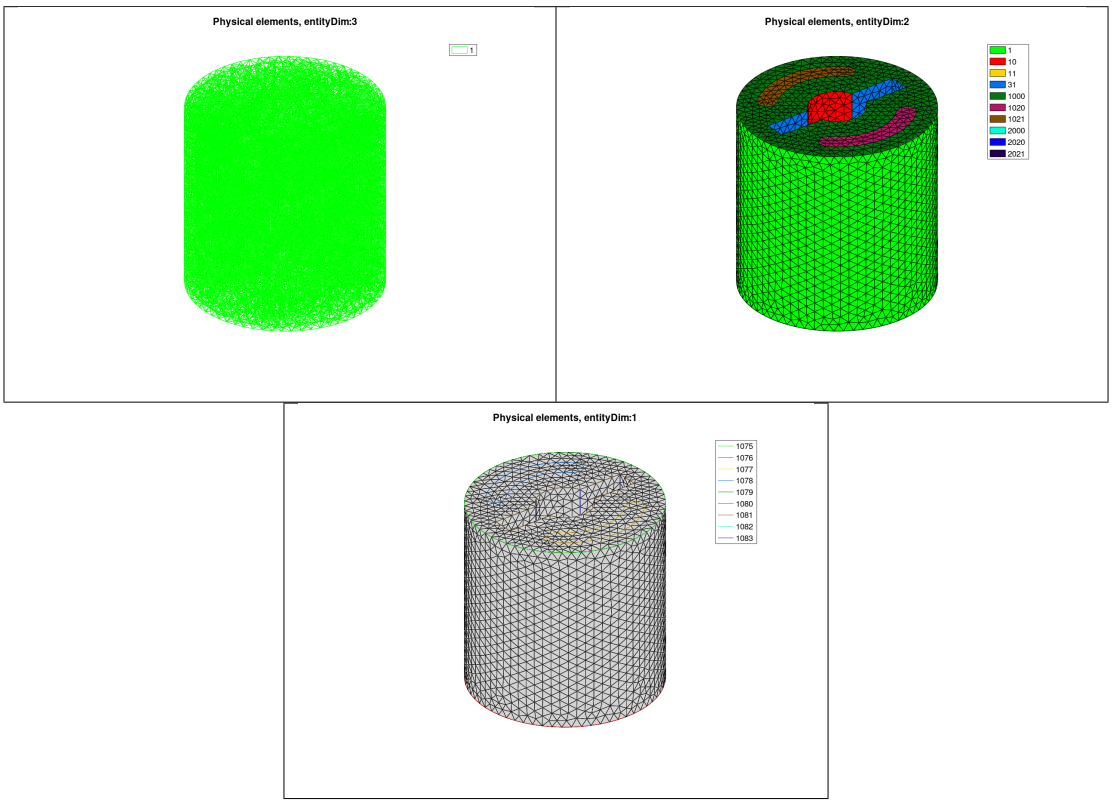
## B.3 method `plotPhysicalElements`

This function plot *Physical Tags* of an `ooGmsh2` or `ooGmsh4` object of *Element Type*

- 1, *2-node line* elements,
- 2, *3-node triangle* elements,
- 4, *4-node tetrahedron* elements.

This function uses the `fc-graphics4mesh` package [1] version 0.1.1.

```
Gh.plotPhysicalElements()
plotPhysicalElements(Gh)
```




```
meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinderkey',10, 'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile);
plotPhysicalElements(Gh)
```

Listing 10: Using `fc_oogmsh.plotPhysicalElements` function

## B.4 method `plotPartitionElements`

This function can be used with partitioned mesh file built with one of the following functions:

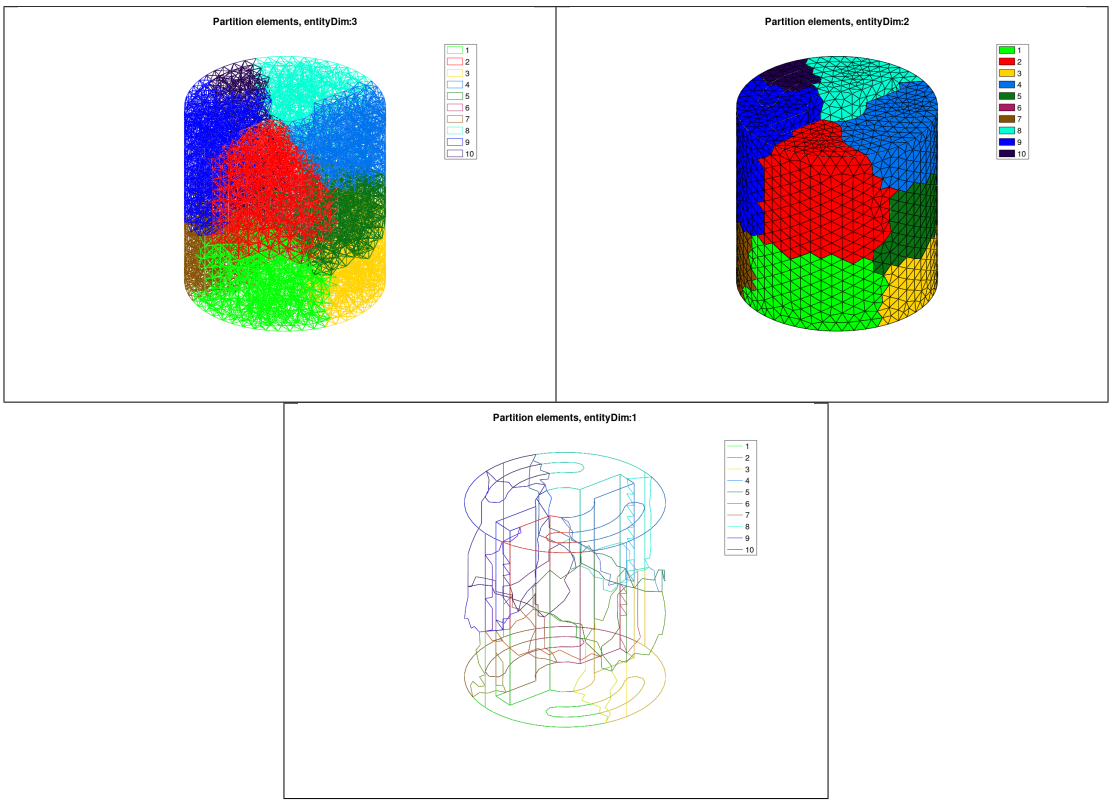
`fc_oogmsh.gmsh.buildpartmesh3d`,
`fc_oogmsh.gmsh.buildpartmesh3ds`,
`fc_oogmsh.gmsh.buildpartmesh2d`.

This function plot *Partition Tags* of an `ooGmsh2` or `ooGmsh4` object of *Element Type*

- 1, *2-node line* elements,
- 2, *3-node triangle* elements,
- 4, *4-node tetrahedron* elements.

This function uses the **`fc-graphics4mesh`** package [1] version 0.1.1.

```
Gh.plotPartitionElements()
plotPartitionElements(Gh)
```




```
meshfile=fc_oogmsh.gmsh.buildpartmesh3d('cylinderkey',10,'N',8,'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile); %
plotPartitionElements(Gh)
```

Listing 11: Using `fc_oogmsh.plotPartitionElements` function

## B.5 method `plotInterfaceElements`

This function can be used with partitioned mesh file built with one of the following functions:

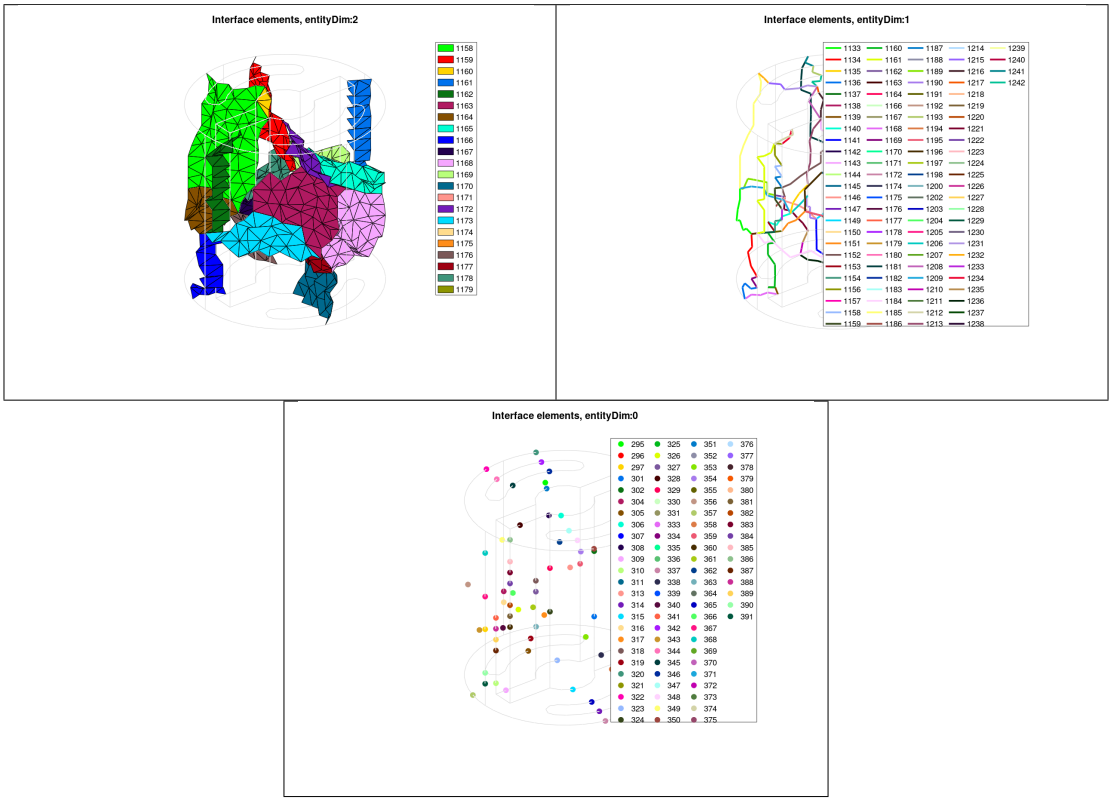
`fc_oogmsh.gmsh.buildpartmesh3d`,
`fc_oogmsh.gmsh.buildpartmesh3ds`,
`fc_oogmsh.gmsh.buildpartmesh2d`.

This function plot *Interface Tags* of the interfaces between partitions of an `ooGmsh2` or `ooGmsh4` object of *Element Type*

- 1, *2-node line* elements,
- 2, *3-node triangle* elements,
- 4, *4-node tetrahedron* elements.

This function uses the `fc-graphics4mesh` package [1] version 0.1.1.

```
Gh.plotInterfaceElements()
plotInterfaceElements(Gh)
```




```
meshfile=fc_oogmsh.gmsh.buildpartmesh3d('cylinderkey',10,'N',8,'verbose',0,'force',true);
Gh = fc_oogmsh.ooGmsh4(meshfile); %
plotInterfaceElements(Gh)
```

Listing 12: Using `fc_oogmsh.plotInterfaceElements` function

# B References


[1] F. Cuvelier. fc_graphics4mesh: an Octave package for displaying simplices meshes or datas on simplices meshes. `http://www.math.univ-paris13.fr/~cuvelier/software/`, 2017. User's Guide.

[2] C. Geuzaine and J.-F. Remacle. Gmsh: A 3-D finite element mesh generator with built-in pre- and post-processing facilities. *International Journal for Numerical Methods in Engineering*, 79(11):1309–1331, 2009.

[3] C. Geuzaine and J.-F. Remacle. Gmsh 2.15.0. `http://gmsh.info`, 2016.

[4] C. Geuzaine and J.-F. Remacle. Gmsh 4.2.1. `http://gmsh.info`, 2019.

# Informations for git maintainers of the fc oogmsh Octave package

git informations on the packages used to build this manual

```
-------------------------------------------------
   name : fc-oogmsh
    tag : 0.2.2
 commit : 90fc9826fea6eb8dd66afc3a58677564c8f7f442
   date : 2020-02-17
   time : 13-31-05
 status : 0
-------------------------------------------------
   name : fc-tools
    tag : 0.0.30
 commit : 773f018c72144189f34c69cef3b4e8f0adac4b25
   date : 2020-02-15
   time : 09-39-43
 status : 0
-------------------------------------------------
   name : fc-bench
    tag : 0.1.2
 commit : 666dc60d1277f5fa9c99dee4ae1c33270f22c57d
   date : 2020-02-16
   time : 06-38-46
 status : 0
-------------------------------------------------
   name : fc-amat
    tag : 0.1.2
 commit : 957340f6e71d805dbd8b9d04c434b24fd3f92591
   date : 2020-02-16
   time : 06-39-42
 status : 0
-------------------------------------------------
   name : fc-meshtools
    tag : 0.1.3
 commit : cdbc41bc98af4e4facc1746024aced1f21aae53
   date : 2020-02-17
   time : 10-52-56
 status : 0
-------------------------------------------------
   name : fc-graphics4mesh
    tag : 0.1.1
 commit : 94fbc0760793424515d9cb7b3c0d552c49682d7e
   date : 2020-02-17
   time : 11-05-19
 status : 0
-------------------------------------------------
```

git informations on the LaTeX package used to build this manual

```
-------------------------------------------------
   name : fctools
    tag :
 commit : 57968c4a96c2593cccc9da9efd3e52b2ff012cb5
   date : 2020-02-07
   time : 06:41:09
 status : 1
-------------------------------------------------
```

Using the remote configuration repository:

| | |
|---|---|
| url | ssh://lagagit/MCS/Cuvelier/Matlab/fc-config |
| commit | 5c83c4d79816e51c5f85c2c16df8f93b701c5f96 |