Code_Aster

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Responsable : Gérald NICOLAS

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Macro-command `MACR_ADAP_MAIL`

1 Drank

Adapt a mesh with the software HOMARD.

This operation is possible for a formed mesh by meshes-points, segments, triangles, quadrangles, tetrahedrons, hexahedrons, pentahedrons. A field controlling the adaptation will have been possibly calculated. According to its value nets by mesh or node by node, or according to a geometrical directive, the software HOMARD will modify the mesh. It is also possible to interpolate fields at nodes or constant by elements, from the old mesh towards the new one.

One can connect computation and adaptation progressively in a process of improvement of computation. This process can take place on the only one way, or divided into several stages by a `POURSUITE`.

The software HOMARD is presented on the site: http://www.code-aster.org/outils/homard

One finds a description of the technique used there to modify the meshes as well as examples.
More on HOMARD, one can refer to the documents quoted in the bibliography.

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2 Syntax

```
MACR_ADAP_MAIL      (
#choix  of the type of adaptation
♦ADAPTATION=/            "RAFF_DERA"
                /   "RAFFINEMENT"
                /   "DERAFFINEMENT"
                /   "RAFF_DERA_ZONE"
                /   "RAFFINEMENT_UNIFORME"
                /   "DERAFFINEMENT_UNIFORME"
                /   "RIEN"
                /   "MODIFICATION"
                /   "READING"


#le  mesh to modify
♦MAILLAGE_N=man                  [mesh]


#le  new mesh
♦MAILLAGE_NP1=co        (manp1)       [K8]


#un  mesh appendix
◊MAILLAGE_NP1_ANNEXE=co           (manp1ann)        [K8]


#Si the adaptation is free, (RAFFINEMENT, DERAFFINEMENT or RAFF_DERA), choice of
structure containing the field controlling the adaptation:
     ♦/  RESULTAT_N = resun          [result]
          ♦ NOM_CHAM = nomsymb       [K16]
       / CHAM_GD = cham_gd_i         [cham_gd]
     ◊NOM_CMP  = l_cmp            [l_K8]
      #   Selection of the temporal parameter
        / NUME_ORDRE = order       [I]
        / INST = urgent             [R]
           ◊ | accuracy =   prec  [R]
                        / 1.0E-3   [DEFAULT]
          ◊ | CRITERE = "RELATIF [DEFAULT]
                      / "ABSOLU"
     ◊USAGE_CMP   = "NORME_L2"    [DEFAULT]
                    / "ABSOLU"
                    / "NORME_INFINIE"
                    / "RELATIF"
     ◊USAGE_CHAMP  = "MESH"     [DEFAULT]
                    / "SAUT"
     ◊ADAP_INIT    = "TO KEEP"     [DEFAULT]
                    /   "REFINES R "
                    / "DERAFFINER"
#Finsi


#Si L" adaptation takes place according to geometrical zones, (RAFF_DERA_ZONE):
     ♦ZONE   =  _F  (
     #  Standard of the zone
     ♦TYPE   =   "RECTANGLE"
             / "LIMPS"
             / "DISQUE"
             / "SPHERE"
             / "CYLINDRE"
             / "DISQUE_PERCE"
             / "PIPE"
```

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```
        # Use of the zone
      ♦USAGE  =  "RAFFINEMENT"       [DEFAULT]
                 / "DERAFFINEMENT"

      #pour   a rectangular box: coordinates extreme
          ♦X_MINI=       x_mini        [R]
        ♦X_MAXI=       x_maxi        [R]
        ♦Y_MINI=       y_mini        [R]
        ♦Y_MAXI=       y_maxi        [R]
      #pour   a parallelepipedic box: coordinates extreme
        ♦X_MINI=       x_mini        [R]
        ♦X_MAXI=       x_maxi        [R]
        ♦Y_MINI=       y_mini        [R]
        ♦Y_MAXI=       y_maxi        [R]
        ♦Z_MINI=       z_mini        [R]
        ♦Z_MAXI=       z_maxi        [R]
      #pour   a disc: center and radius
        ♦X_CENTER=       x_centre      [R]
        ♦Y_CENTER=       y_centre      [R]
        ♦RAYON=        radius          [R]
      #pour   a sphere: center and radius
        ♦X_CENTER=       x_centre      [R]
        ♦Y_CENTER=       y_centre      [R]
        ♦Z_CENTER=       z_centre      [R]
        ♦RAYON=        radius          [R]
      #pour   a cylinder: center, bases, height and radius
        ♦X_AXE=        x_axe         [R]
        ♦Y_AXE=        y_axe         [R]
        ♦Z_AXE=        z_axe         [R]
        ♦X_BASE=       x_base        [R]
        ♦Y_BASE=       y_base        [R]
        ♦Z_BASE=       z_base        [R]
        ♦HAUTEUR=      height        [R]
        ♦RAYON=        radius          [R]
      #pour   a bored disc: center, radius interior and external
        ♦X_CENTER=       x_centre      [R]
        ♦Y_CENTER=       y_centre      [R]
        ♦RAYON_INT=      rayon_int     [R]
        ♦RAYON_EXT=      rayon_ext     [R]
      #pour   a pipe: center, bases, height and radius interior and external
        ♦X_AXE=        x_axe         [R]
        ♦Y_AXE=        y_axe         [R]
        ♦Z_AXE=        z_axe         [R]
        ♦X_BASE=       x_base        [R]
        ♦Y_BASE=       y_base        [R]
        ♦Z_BASE=       z_base        [R]
        ♦HAUTEUR=      height        [R]
        ♦RAYON_INT=      rayon_int     [R]
        ♦RAYON_EXT=      rayon_ext     [R]
    #Finsi
        )
    #Finsi


    #Si the adaptation includes free refinement (RAFFINEMENT or RAFF_DERA):
      ♦/CRIT_RAFF_PE     =crp         [R]
        /CRIT_RAFF_REL    =crr       [R]
        /CRIT_RAFF_ABS    will =cra       [R]
```

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```
                /CRIT_RAFF_MS =crms      [R]
        #Finsi


        #Si the adaptation includes the free coarsening (DERAFFINEMENT or RAFF_DERA):
            ♦/CRIT_DERA_PE      =cdp            [R]
              /CRIT_DERA_REL    =cdr         [R]
              /CRIT_DERA_ABS    =cda         [R]
              /CRIT_DERA_MS =cdms          [R]
        #Finsi

        #Si the adaptation includes refinement:
            ◊NIVE_MAX  = nivmax          [I]
            ◊DIAM_MIN  = diamin          [R]
        #Finsi

        #Si the adaptation includes coarsening:
            ◊NIVE_MIN  = nivmin          [I]
        #Finsi

        #Si the adaptation includes refinement or coarsening:
            ◊GROUP_MA  = l_grma         [l_gr_maille]
            ◊GROUP_NO  = l_grno         [l_gr_nœud]
        #Finsi

        #       Followed by a border with a grid
        ◊MAILLAGE_FRONTIERE  = maf         [mesh]
            ◊GROUP_MA_FRONT   = l_grma       [l_gr_maille]

        #       Followed by an analytical border
        ◊FRONTIERE_ANALYTIQUE    = _F   (
            #  Name of border
            ♦NOM    =nom            [K]
            ♦GROUP_MA  = l_grma         [l_gr_maille]
            #  Standard of the border
            ♦TYPE   =   "SPHERE"
                      / "CYLINDRE"
                      / "CONE_A"
                      / "CONE_R"
            #pour    a sphere: center and radius
                ♦X_CENTER=        x_centre      [R]
                ♦Y_CENTER=        y_centre      [R]
                ♦Z_CENTER=        z_centre      [R]
                ♦RAYON=        radius            [R]
            #pour    a cylinder: center, bases and radius
                ♦X_AXE=        x_axe        [R]
                ♦Y_AXE=        y_axe        [R]
                ♦Z_AXE=        z_axe        [R]
                ♦X_CENTER=        x_centre      [R]
                ♦Y_CENTER=        y_centre      [R]
                ♦Z_CENTER=        z_centre      [R]
                ♦RAYON=        radius            [R]
            #pour    a cone: center, center and angle
                ♦X_AXE=        x_axe        [R]
                ♦Y_AXE=        y_axe        [R]
                ♦Z_AXE=        z_axe        [R]
                ♦X_CENTER=        x_centre      [R]
                ♦Y_CENTER=        y_centre      [R]
                ♦Z_CENTER=        z_centre      [R]
```

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```
             ♦ANGLE=           angle              [R]
      #pour   a cone: 2 points on the axis and radius
             ♦X_CENTER=         x_centre           [R]
             ♦Y_CENTER=         y_centre           [R]
             ♦Z_CENTER=         z_centre           [R]
             ♦RAYON=           radius               [R]
             ♦X_CENTER2=        x_centre2            [R]
             ♦Y_CENTER2=        y_centre2            [R]
             ♦Z_CENTER2=        z_centre2            [R]
             ♦RAYON2=          rayon2               [R]
       #Finsi
                    )



   #Si the adaptation is a modification, (MODIFICATION),  choice of the type:
      ◊Changement    of degree
           DEGRE =    "OUI'
                      / "NON"            [DEFAULT]
   #Finsi



   up to date     #Mise of fields on the new mesh
   ◊MAJ_CHAM  = _F   (
      #choix  of structure containing the field to update
      ♦/  RESULTAT = resu            [result]
           ♦ NOM_CHAM = nomsymb        [K16]
        / CHAM_GD = cham_gd              [cham_gd]
   ◊NOM_CMP   = l_cmp          [l_K8]
       #    Selection of the temporal parameter
        / NUME_ORDRE = order        [I]
        / INST = urgent              [R]
           ◊ | accuracy =   prec   [R]
                        / 1.0E-3   [DEFAULT]
           | CRITERE =    "RELATIF [DEFAULT]
                        /   "ABSOLU"
      #choix  of the type of update
      ◊ TYPE_MAJ =   "AUTO"            [DEFAULT]
                  /"ISOP2"
      # name of the field of variables which will contain the new field
      ♦ CHAM_MAJ = Co (chpmaj)              [K8]
      #type   of the field updated
      ♦ TYPE_CHAM = "NOEU_TEMP_R"
                   / "NOEU_DEPL_R"
                   / etc…
         )



   #Ajout  of fields in output on the new mesh
   ◊ADD_CHAM  = _F   (
      # name of the field of variables which will contain the new field
      ♦ CHAM_MAJ = Co (chpadd)            [K8]
      #catégorie     of the field to create
      ♦ CHAM_CAT =   "NIVEAU"
                   / "DIAMETRE"
         )



   #Si L" adaptation is a reading, (READING),  choice of the model:
      ♦MODELE=modele          [model]
```

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```
#Finsi


◊NOMBRE     =     "OUI'          [DEFAULT]
                  / "NON"

◊QUALITE    =     "OUI'
                  / "NON"          [DEFAULT]

◊DIAMETRE  =   "OUI'
                  / "NON"          [DEFAULT]

◊CONNEXITE    =   "OUI'
                  /"NON"          [DEFAULT]

◊TAILLE    =      "OUI'
                  /"NON"          [DEFAULT]

◊PROP_CALCUL  =  "OUI'
                  / "NON"          [DEFAULT]

◊INTERPENETRATION    =      "OUI'
                          / "NON"           [DEFAULT]

◊ELEMENTS_ACCEPTES  =   "HOMARD"      [DEFAULT]
                      / "IGNORER"

◊LANGUE    =      "FRANCAIS"    [DEFAULT]
                  /"FRENCH"
                  /"ANGLAIS"
                  /"ENGLISH"

◊VERSION_HOMARD  =  "V10_6"          [DEFAULT]
                   /"V10_N"
                   /"V10_N_PERSO"

◊LOGICIEL  =logiciel          [K]

#Si the version is the version of development, (V10_N, V10_N_PERSO):
    ◊ UNITE =unite                      [I]
#Finsi

◊INFO   =     1                      [DEFAULT]
            / 2
            / 3
            / 4

)
```

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3 Description of a mesh adaptation

3.1 general Outline of an adaptation

the general principle of a computation with mesh adaptation is the following:

Phase 1: Reading of the initial mesh, M0
          Définition of the materials
Phase 2: • definition of the model, of the loadings on this mesh M0
          • computation producing result a RESU0
          • possible computation of a field controlling refinement, CHAMP0

This initial phase is the standard phase of any computation

Phase 3: Adaptation of the M0 mesh. One recovers a new mesh, M1
Phase 4: • definition of the model, the loadings on the mesh M1,
          • computation producing result a RESU1,
          • possible computation of a field controlling refinement, CHAMP1.

Phase 4 is similar to phase 2. The only thing which changed is the mesh. So all the concepts while depending must be begun again. Today, there is no possibility neither of re-using the old concepts, nor to destroy them automatically.

Then, one can continue, as many times as one wants, the tandem phase 3/phase 4. That is done either by duplicating the instructions, or by writing a loop python.

See the reference [bib1] for a general presentation of the mesh adaptation and HOMARD, accompanied by examples.

3.2 Operation of the macro-command

phase 3 carries out the adaptation of the mesh. It is activated by macro-command MACR_ADAP_MAIL, is described in this document. It has as an essential argument the name of the concept of the current mesh and the name which one will give to the concept of the future mesh. The other compulsory data is the type of adaptation which one wishes: refinement or free coarsening, i.e. according to the values which takes a field on meshes mesh, or of a geometrical zone, or refinement or uniform coarsening, i.e. all meshes are treated same way.

The other data depend then on the options selected.

In complement with the adaptation, HOMARD can provide on request of the assessments on the quality or the diameter of meshes of the mesh, the connexity of the field of computation, the sizes characteristic, the overstrained elements or a control of the NON-interpenetration of meshes. This information is obtained by the activation of the associated key words. One will look with profit the command MACR_INFO_MAIL [U7.03.02] which makes it possible to obtain all this information, independently of any computation.

3.3 Some comments

The mesh adapted contains the same groups as the mesh as starter, with the following rule: a group defines the same locus in the two meshes.
•To use a nodes group amounts defining specific places. The group in the adapted mesh will be the list of the same nodes, neither more, nor less, to represent the same points; only their numbers will have possibly changed.
•To use a group of segments amounts defining lines. The group in the adapted mesh will be the list of the segments which represent the same lines. According to the mode of adaptation, these segments will be either the same ones, except for the number, or the halves of the initial segments.

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•To use a group of triangles and/or quadrangles amounts defining surfaces. The group in the adapted mesh will be the list of the triangles and/or quadrangles which represent same surfaces. According to the mode of adaptation, these meshes will be either the same ones, except for the number, or the fractions of meshes 2D initial.

•In the same way, to use a mesh group 3D amounts defining volumes. The group in the adapted mesh will be the list of meshes 3D which represents same volumes. According to the mode of adaptation, these meshes will be either the same ones, except for the number, or the fractions of meshes 3D initial.

The consequence is the following one. The loadings of mechanical computation or thermal must exclusively be defined by groups of coherent dimension with the phenomenon which one wants to model.

Any other operation will lead to an error in computation on the adapted mesh. To use the meshes definite ones by their number is impossible because classification will change. To use nodes groups or of meshes of the bad dimension will not describe the place completely.

For a more detailed and illustrated explanation, to look at:

`http://www.code-aster.org/outils/homard/usage/regles.fr.htm#CL`

When one wants to adapt several times of continuation a mesh, it is fundamental to respect the character string of the meshes strictly. With the first iteration, the mesh of entry of `MACR_ADAP_MAIL` is the initial mesh of the case which one treats. Then, the mesh of entry of `a MACR_ADAP_MAIL` must be the mesh of output of `the preceding` MACR_ADAP_MAIL. Caution: it is not enough to give a mesh which is formally the same one, following a copy for example. It is imperative to provide the same concept. If one does not proceed thus, one will lose the history of refinement of meshes and it will be impossible later on of déraffiner. More serious, HOMARD not being informed more of additional cuttings which were introduced to ensure conformity, one will be led to cut out meshes by strongly degrading their quality. If this bad setting in data appears, an alarm is emitted.

The mesh adaptation is possible in POURSUITE `mode`. The data necessary to the recovery are automatically filed then read again in the directory of conservation of the base necessary to *Code_Aster*. To use HOMARD in poursuite is thus done in the same way that to use *Code_Aster* in poursuite.

In a general way, the essential printings provided by HOMARD are inserted in the file "`mess`" into the wire of the execution. In the event of error or in mode of information 3 or 4, more detailed printings take place.

4 Operands

4.1 Operand ADAPTATION

```
♦ADAPTATION    =      "RAFF_DERA"
                /   "RAFFINEMENT"
                /   "DERAFFINEMENT"
                /   "RAFF_DERA_ZONE"
                /   "RAFFINEMENT_UNIFORME"
                /   "DERAFFINEMENT_UNIFORME"
                /   "RIEN"
                /   "MODIFICATION"
                /   "READING"
```

This operand make it possible to define the type of adaptation wished.

Initially, one finds the modes of adaptations which are controlled by a field. In other words, the decision of (die) refining a mesh is caught according to the value of a computed field before on this mesh. The choice can be done between three alternatives:
• "RAFF_DERA" : the mesh is refined and déraffiné according to the field. It is the option recommended.
• "RAFFINEMENT": only the function of refinement is activated. No mesh will be déraffinée.
• "DERAFFINEMENT" : it is the reverse; only the function of coarsening is activated. No mesh will be refined.

In second place, one can decide to adapt the mesh in geometrical zones defined by boxes. All meshes whose at least two nodes are present in one of these boxes will be retained. That makes it possible to make refinements or coarsenings *a priori*, without to have done calculation.
• "RAFF_DERA_ZONE": meshes of each definite box are refined or déraffinées.

Lastly, one can activate a uniform adaptation of a mesh. In other words, all meshes of the mesh are treated same way. The choice can be done between three alternatives:
• "RAFFINEMENT_UNIFORME": all meshes are refined,
• "DERAFFINEMENT_UNIFORME" : all meshes are déraffinées,
• "RIEN" : all meshes are preserved; the mesh is the same one at the exit as at the entry.

Note:
> *When an option of coarsening is applied, one does nothing but reconsider behind former refinements. It is necessary to understand this option like die-refinement. In particular, one will be able to never obtain a mesh coarser than the initial mesh.*
> *The options of refinement or coarsening can apply only to part of the mesh. That is obtained by the option of filtering GROUP_MA or GROUP_NO.*

Two complementary options exist :
The first allows the modification of mesh, to change the degree of mesh:
• "MODIFICATION" : the mesh is modified overall.
The second makes it possible to read fields with Gauss points which were updated on the new one mesh:
• "READING" : the fields with Gauss points are read.

4.2 Operand MAILLAGE_N

♦MAILLAGE_N=man

The mesh of type [mesh] to adapting or modifying. Attention, the adaptation can relate only to the meshes following ones: meshes-points, segments, triangles, quadrangles, tetrahedrons, hexahedrons or pentahedrons. If one meshes provides a mesh comprising of others, for example pyramids, two

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cases are possible: either a stop in error, or an adaptation on the authorized zone and a restitution with identical moreover mesh. The choice between these two operating modes is made by the key word `ELEMENTS_NON_HOMARD`.

The mesh is in degree 1 or 2, but it is not possible to mix both.

In all the cases, the presence of meshes enriched the `HEXA27` is prohibited.

When the choice was made to read fields with Gauss points, one gives here the mesh on which they are.

4.3 Operand `MAILLAGE_NP1`

◊`MAILLAGE_NP1=co`   (manp1)

the name of the concept of the type [`mesh`] which will contain the mesh resulting from the adaptation. This name must respect the usual stresses of the names of concept (8 characters to the maximum) and not to be already used.

4.4 Operand `MAILLAGE_NP1_ANNEXE`

♦`MAILLAGE_NP1_ANNEXE=co`   (manp1ann)

This operand makes it possible to produce a mesh similar to the mesh obtained by operand `MAILLAGE_NP1`, but from different degree. It is useful into thermomechanical where thermal computation takes place on the mesh in degree 1 and the mechanics on the same mesh but in degree 2. This name must respect the usual stresses of the names of concept (8 characters to the maximum) and not to be already used.

4.5 Choice of the field of control of the adaptation

In the case of a free adaptation, the control of meshes to refine or déraffiner is carried out by a field. This field is contained either in a structure of result, or in a field of variables. This field can be a field of error indicator to the numerical meaning of term (`QIRE_ELEM` for example) but it is not compulsory; any field can be used. One can for example control the adaptation by the field of the stresses or by a field builds purposely like a distance or a criterion from damage. It is enough that this field is defined by its name as described in the documents [U4.81.01], [U4.81.02] or [U4.81.03].

If the field is a field at nodes, the decision of refinement/coarsening will be made on each edge according to the values of the field on its nodes. If the field is a constant field by element, it is this value which will control refinement/coarsening of the mesh. If the field is a field at nodes by element or with Gauss points, the algorithm will be based on the maximum value in the mesh to decide refinement/coarsening.

4.5.1 Operand `RESULTAT_N`

/◊`RESULTAT_N=resun`

This operand makes it possible to indicate the concept of the type [`result`] which contains the field to be used for free adaptation.

4.5.1.1 Operand `NOM_CHAM`

◊`NOM_CHAM=nomsymb`

One specifies here which is the field which is used to control the adaptation.

Caution:
  The field must be present as a result; if it is absent, it is not calculated of office.

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4.5.2 Operand CHAM_GD

/ ◊ CHAM_GD=cham_gd_i

This operand makes it possible to indicate the concept of the type [cham_gd] which contains the field to be used to control the free adaptation.

4.5.3 Operand NOM_CMP

◊NOM_CMP=l_cmp

Name of the component of the field which must be used to control the mesh adaptation. If several components are wished, to give the list here.
If no component is here defined, the command will take all those which exist in the transmitted field.

The type of taking into account of or of the components is controlled by USAGE_CMP.

4.5.4 Selection of the temporal parameter of the field

If the structure of result contains the field necessary only for one sequence number, nothing is to be specified. In fact the values of the field to this sequence number will be used.
If not, it is necessary to specify about which number it is. That is done by the designation of a sequence number or a value of time. To refer to the document [U4.71.00] for the details on these key words.

4.5.5 Operand USAGE_CMP

◊USAGE_CMP=/   "NORME_L2"   [DEFAULT]
              /   "NORME_INFINIE"
              /   "ABSOLU"
              /   "RELATIF"

One specifies here how to treat the various components of the field controlling the adaptation. One leaves the principle which refinement carries on the great examined values and, symmetrically, the coarsening relates to the small values. By default, one will filter refinement and the coarsening by examining the norm L2 of the components field on meshes (or the nodes), i.e. the square root of the sum of the squares of the values of the components (norm known as Euclidean).
If several components were retained, one can choose between two types of norm: either the norm L2, choice by default, or the infinite norm, i.e. largest of the absolute values of the components.

If only one component is retained to control the adaptation, choices NORME_L2, NORME_INFINIE and ABSOLU are equivalent: the absolute value of the field will be examined. An alternative is possible: to use RELATIF makes it possible to control the adaptation with the gross amounts of the field. In this case, for a field whose values are negative, bearing refinement on the maximum values, in fact the zones where the value is close to 0 will be refined; symmetrically, the coarsening will relate to the zones where the value is very large negatively.

4.5.6 Operand USAGE_CHAMP

◊USAGE_CHAMP = "MESH"   [DEFAULT]
                 /"SAUT"

By default, the control of the adaptation is done by the sort of the values of the transmitted field, mesh by mesh or node by node.
With the alternative SAUT, HOMARD one will sort on the jump of the field enters meshes, according to the following process. For each mesh, HOMARD starts by calculating the maximum of absolute deviation between the value of the field on the current mesh and its value on each of meshes close.

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This maximum is allotted to the current mesh. Then, one sorts meshes on these maximum departures according to the usual criteria.

In 2D, the examined neighbors are the triangles/quadrangles which divide an edge with the mesh in progress.

In 3D, they are the meshes voluminal ones which divides a triangular or quadrangular face with the current mesh.

If the field is defined by node, the neighbors are the nodes which divide an edge with the current node.

Note:

>*This option makes it possible to easily adapt the mesh by setting like purpose a regular variation of a field of a mesh to the other. Thus, to choose the type SAUT and field SIEF_ELGA makes it possible to obtain a mesh where the strong variations of stresses of a mesh to its neighbor will attenuate.*

4.5.7 Operand ADAP_INIT

◊ADAP_INIT=/   "TO KEEP"   [DEFAULT]
           / "TO REFINE"
           / "DERAFFINER"

When the field controlling the adaptation is defined on all the mesh, this option is without effect.

In the contrary case, it makes it possible to specify how the areas are treated where this field is not defined.

With the alternative TO KEEP, meshes areas where the indicator is not defined *are kept* a priori such as they are. It is the option by default.

With alternative RAFFIN ER , meshes of the areas where the indicator is not defined are *a priori* R closely connected ées.

With alternative D ERAFFIN ER , meshes of the areas where the indicator is not defined are *reactivated* a priori.

Obviously, that is only one initialization and these decisions can evolve to ensure the conformity of the mesh, taking into account as of decisions brought to meshes close.

Note:

>*This option is particularly useful when one uses an indicator built from a field. For example, one uses the damage calculated in a given area whereas elsewhere, it is not defined. One will be able to choose not to touch with the others meshes or to try of the déraffiner.*
>
>*For example: in computations of excavation, meshes are withdrawn from the model to simulate the digging; C be meshs do not carry more value of indicator. If nothing is done, they remain in the mesh. If one chooses alternative ERAFFIN ER D , they will be déraffinées as the progression of the excavation.*

4.6 Free CRIT_RAFF_xxxx

operand In the case of adaptation implying of the refinement of mesh, it is necessary to define a high criterion of refinement. All meshes for which the field is higher than this criterion will be refined. It is important to look at a posteriori the pace of the distribution of the field. That is possible thanks to the printings carried out by HOMARD in the file mess. One will find there in particular a table presenting this distribution in the form of histogram; to see chapter 5 for an example with accompanying notes.

For the choice of the criterion, four alternatives are possible:

4.6.1 Operand CRIT_RAFF_PE

◊/ CRIT_RAFF_PE =crp

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the criterion is defined by a proportion of meshes to refine. It is a real number ranging between 0 and 1. The process is the following:

•computation amongst meshes N corresponding to the proportion defined by crp is N = crp X nombre total of meshes

•refinement of N meshes with the strongest value of the field.

4.6.2 Operand CRIT_RAFF_ABS

/CRIT_RAFF_ABS will =cra

the criterion is defined by an absolute value of the field. All meshes with a value higher than this value will be refined.

4.6.3 Operand CRIT_RAFF_REL

/CRIT_RAFF_REL =crr

the criterion is defined by a relative value of the field. It is a number ranging between 0 and 1. The process is the following:

•computation of the minimal and maximum values of the indicator,

•computation of the value corresponding to the necessary proportion: v= vmin + crr (vmax-vmin),

•refinement of all meshes where the field is higher than this value.

4.6.4 Operand CRIT_RAFF_ ms

◊/ CRIT_RAFF_MS =crms

the criterion is defined by an absolute value of the field, calculated according to the average and of the standard deviation of this field. All meshes with a value higher than this value will be refined. The criterion is worth: average + n*sigma, where N is the provided coefficient, strictly positive.

4.7 Free CRIT_DERA_xxxx

operand In the case of adaptation implying of the coarsening, it is necessary to define a low criterion of coarsening. All meshes where the field is lower than this criterion will be déraffinées. Three alternatives are possible.

4.7.1 Operand CRIT_DERA_PE

◊/ CRIT_DERA_PE =cdp

the criterion is defined by a proportion of meshes in déraffiner. It is a number ranging between 0 and 1. The process is the following:

•computation amongst meshes N corresponding to the proportion defined by cdp is N = cdp X

•coarsening of N meshes with the low value of field.

4.7.2 Operand CRIT_DERA_ABS

/CRIT_DERA_ABS =cda

the criterion is defined by an absolute value of the field. All meshes with a value of field lower than this value will be déraffinées.

4.7.3 Operand CRIT_DERA_REL

/CRIT_DERA_REL = cdr

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the criterion is defined by a relative value of the field. It is a number ranging between 0 and 1. The process is the following:
•computation of the minimal and maximum values of the indicator,
•computation of the error value *v* corresponding to the proportion `cdr` such as: v= vmin + cdr (vmax-vmin),
•coarsening of all meshes where the field is lower than this value.

4.7.4 Operand `CRIT_DERA_MS`

◊/ CRIT_DERA_MS =cdms

the criterion is defined by an absolute value of the field, calculated according to the average and of the standard deviation of this field. All meshes with a value lower than this value will be déraffinées. The criterion is worth: average - n*sigma, where `N` is the provided coefficient, strictly positive.

4.8 Key word `ZONE`

♦ZONE = _F   (

In the case of a request for adaptation per zone, it is necessary to define at least a zone. This key word is to be employed as many times as one wants to define zones of adaptation. The principle is the following: one defines a zone by coordinates then each mesh of which at least one of the edges is in this zone will be selected.
One has the choice between several types of zones.

Caution:
For a computation which would be 2D, the types of zone are in fact of the rectangles or the circles. But as the notion of mesh strictly 2D is unknown in Code_Aster at the time of the creation of the commands, one will suppose that 3rd coordinate Z is null.

4.8.1 Type of zone

♦TYPE=/   "RECTANGLE"
       /   "LIMPS"
       /   "DISQUE"
       /   "SPHERE"
       /   "CYLINDRE"
       /   "DISQUE_PERCE"
       /   "PIPE"

This operand makes it possible to define the type of zone wished.

4.8.2 Use of zone

♦USAGE=/   "RAFFINEMENT"   [DEFAULT]
       /   "DERAFFINEMENT"

This operand makes it possible to define the use allotted to the zone. With choice "RAFFINEMENT", all the edges whose two ends belong to the zone will be cut. With choice "DERAFFINEMENT", all meshes previously cut out and of which all the tops belong to the zone will be reactivated.

4.8.3 Cases of the rectangle

4.8.3.1 Operands `X_MINI`, `X_MAXI`, `Y_MINI`, `Y_MAXI`

♦X_MINI=x_mini
♦X_MAXI=x_maxi

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```
♦Y_MINI=y_mini
♦Y_MAXI=y_maxi
```

They are the extreme values of the coordinates of the rectangle including meshes to refine.

4.8.4 Cases of the parallelepipedic box

4.8.4.1 Operands `X_MINI`, `X_MAXI`, `Y_MINI`, `Y_MAXI`, `Z_MINI`, `Z_MAXI`

```
♦X_MINI=x_mini
♦X_MAXI=x_maxi
♦Y_MINI=y_mini
♦Y_MAXI=y_maxi
♦Z_MINI=z_mini
♦Z_MAXI=z_maxi
```

They are the extreme values of the coordinates of the box including meshes to refine.

4.8.5 Cases of the disc

4.8.5.1 Operands `X_CENTRE`, `Y_CENTRE`

```
♦X_CENTER=x_center
♦Y_CENTER=y_center
```

They are the coordinates of the center of the disc.

4.8.5.2 Operand `RADIUS`

```
♦RAYON=rayon
```

It is the radius of the disc.

4.8.6 Cases of the sphere

4.8.6.1 Operands `X_CENTRE`, `Y_CENTRE`, `Z_CENTRE`

```
♦X_CENTER=x_center
♦Y_CENTER=y_center
♦Z_CENTER=z_center
```

They are the coordinates of the center of the sphere.

4.8.6.2 Operand `RADIUS`

```
♦RAYON=rayon
```

It is the radius of the sphere.

4.8.7 Case of the cylinder

the cylinder is defined by an axis and a radius. It is limited by two planes perpendicular to the axis. The foreground is positioned by a point on the axis. The second plane is distant first a height, in the meaning of the definite axial vector.

4.8.7.1 Operands `X_AXE`, `Y_AXE`, `Z_AXE`

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```
♦X_AXE=x_axe
♦Y_AXE=y_axe
♦Z_AXE=z_axe
```

They are the coordinates of the directing vector of the axis of the cylinder. The directional sense does not have importance. The vector is not necessarily normalized.

4.8.7.2 Operands X_BASE, Y_BASE, Z_BASE

```
♦X_BASE=x_base
♦Y_BASE=y_base
♦Z_BASE=z_base
```

They are the punctual coordinates at the base of the cylinder and located on the axis.

4.8.7.3 Operand RADIUS

```
♦RAYON=rayon
```

It is the radius of the cylinder.

4.8.7.4 Operand HEIGHT

```
♦HAUTEUR=hautor
```

It is the height of the cylinder.

4.8.8 Cases of a disc bored

4.8.8.1 Operands X_CENTRE, Y_CENTRE

```
♦X_CENTER=x_center
♦Y_CENTER=y_center
```

They are the coordinates of the center of the disc.

4.8.8.2 Operands RAYON_INT, RAYON_EXT

```
♦RAYON_INT=rayon_int
♦RAYON_EXT=rayon_ext
```

They are the radius interior one and outside of the bored disc.

4.8.9 Case of the pipe

the pipe is defined by an axis and its radius interior and external. It is limited by two planes perpendicular to the axis. The foreground is positioned by a point on the axis. The second plane is distant first a height, in the meaning of the definite axial vector.

4.8.9.1 Operands X_AXE, Y_AXE, Z_AXE

```
♦X_AXE=x_axe
♦Y_AXE=y_axe
♦Z_AXE=z_axe
```

They are the coordinates of the directing vector of the axis of the pipe. The directional sense does not have importance. The vector is not necessarily normalized.

4.8.9.2 Operands X_BASE, Y_BASE, Z_BASE

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♦X_BASE=x_base
♦Y_BASE=y_base
♦Z_BASE=z_base

They are the punctual coordinates at the base of the pipe and located on the axis.

4.8.9.3 Operands `RAYON_INT, RAYON_EXT`

♦RAYON_INT=rayon_int
♦RAYON_EXT=rayon_ext

They are the radius interior one and outside of the pipe.

4.8.9.4 Operand `HEIGHT`

♦HAUTEUR=hautor

It is the height of the pipe.

4.9 Operands `GROUP_MA` / `GROUPE_NO`

◊GROUP_MA=l_grma
◊GROUP_NO=l_grno

If this option is absent, the control of the adaptation applies to all the mesh. If one wishes to restrict this control with part of the mesh, one gives here the list of the groups which define this part.
Example 1, to refine an area of mesh: uniformly for uniform refinement is asked and one gives the list of the mesh groups forming this area.

Example 2, to apply the field of control of the adaptation only to certain areas: one asks refinement/for coarsening with the field and one provides the list of the mesh groups forming this area.

> **Note:**
> *For all meshes 1D, 2D or 3D contained in the groups of the list, there is refinement according to the criteria selected. For meshes the 0D or the nodes contained in the groups, one retains the edges whose two ends are in these lists.*
> *Meshes retained are adapted, but the adaptation will go certainly one further being able to provide a mesh conforms in output.*

4.10 Operand `DIAM_MIN`

◊DIAM_MIN = diamin

One recalls that the diameter of a mesh is the length of the greatest segment than it is possible to trace inside. For a triangle or a tetrahedron, the diameter is the length on the largest side. For a quadrangle, a hexahedron or a pentahedron, the diameter is the length of the largest diagonal.
To give a value to diamin makes it possible not to make a mesh extremely fine. A mesh which would be selected like front being refined because of field of control or of the geometrical zone but whose diameter is already lower than this minimal value diamin will not be cut out; it will be kept such as it is. Caution: it is nevertheless possible that with final it is nevertheless cut out if its neighbors are it, to respect the conformity of the final mesh.
By default, no limit is given: one can obtain meshes as small ones as one wants.

4.11 Operand `NIVE_MAX`

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◊NIVE_MAX = nivmax

It is the maximum level of refinement of the mesh. In other words a mesh of the initial mesh could not be divided more `nivmax` time as a whole of the process. That makes it possible to ensure that the mesh will not become extremely fine in the vicinity of a singularity: the minimal size of an edge will be its initial size divided by 2nivmax.
By default, no limit is given: one can cut out as much as one wants.

4.12 Operand NIVE_MIN

◊NIVE_MIN =nivmin

It is the minimal level of coarsening of the mesh. I.e. only the meshes resulting ones from at least `nivmin` cuttings of mesh can be déraffinées. That makes it possible to ensure that one from there will not go up too high in the coarsening: one thus keeps a minimal smoothness with the mesh.
By default, no limit is given: one can déraffiner until finding the initial mesh.

4.13 Key word MAILLAGE_FRONTIERE

◊MAILLAGE_FRONTIERE = maf

the choice of this option makes it possible the process of adjustment to follow the curvature of edges of the mesh. The option applies exclusively on board 1D. For edges 2D, it is necessary to use option FRONTIERE_ANALYTIQUE. Here a concept Code_Aster *is provided* of mesh type which contains a fine mesh of unidimensional edges of the geometry. This mesh is thus made *a priori* only of segments. Their lengths are much lower than those of the edge segments of the mesh to adapting. If the process of adjustment is brought to cut an edge segment, the new node will be placed on the mesh of the border. Thus the angles will be softened as adaptations.
The location of various edges is done by the groups with the following rules:
•the edges are described by groups of segments;
•an edge is described by the same name of group in the mesh of computation and the mesh of the borders;
•an edge can have only two ends;
•an edge cannot be one line closed (whole circle for example);
•it neither essential nor is disadvised including rectilinear edges;
•the edge can as well be external, more running, which interns, to separate two materials.
•the edge is not necessarily plane; it can be a space curve 3D like the intersection of two cylinders for example.

Known as differently, a group of edge segments must comprise a list of segments line forming one having a beginning and an end.

Note:

> *One will look at the zzzz121d* `benchmarks,` `zzzz175a` *and* `zzzz259a` *for examples of control of the follow-up of border as well as the Web site of HOMARD for a graphic illustration of result obtained.*

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Example:

Let us consider a two-dimensional object whose border is not always rectilinear. This border will have been with a grid by elements SEG2 or SEG3 as well in the mesh of computation as in the additional mesh. These meshes of edge are put in the same groups.
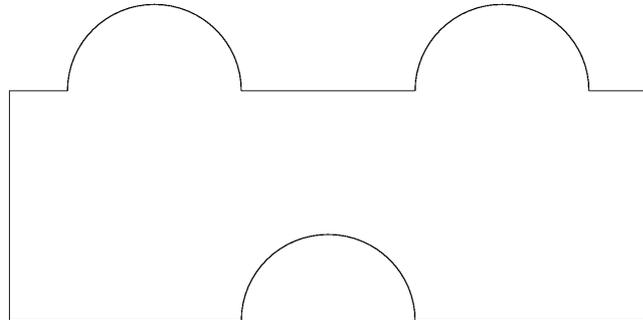
The bad solution is this one: to locate meshes curved edges and to store all in the same group. HOMARD cannot manage a split edge; there will be stop with a message meaning that line is in several pieces.
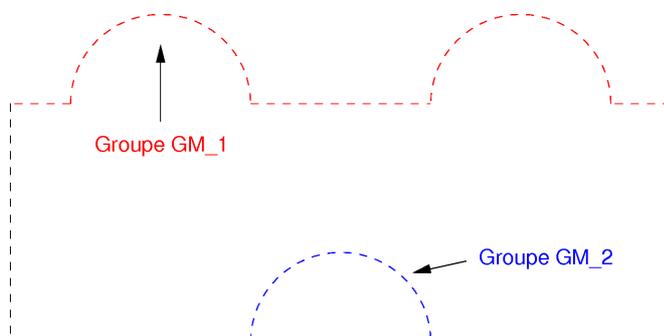
Groupe GM
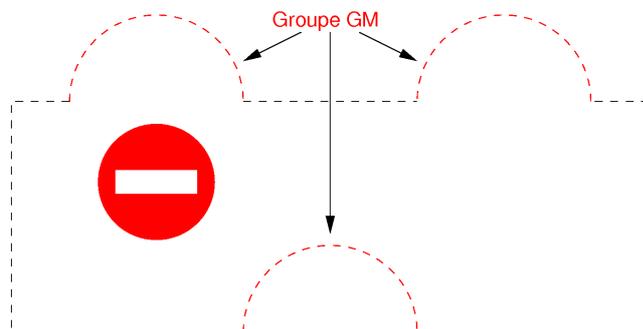
A first good way of making consists in creating groups as many as zones of interest.

Groupe GM_1   Groupe GM_2

Groupe GM_3
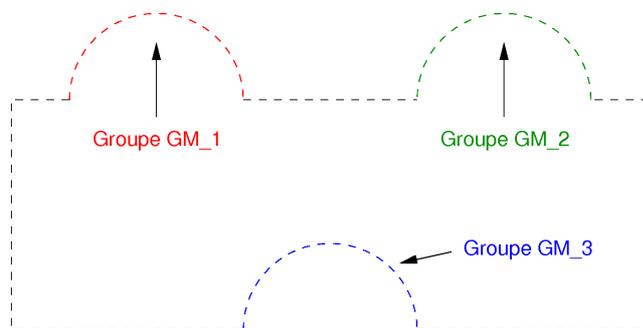
Another acceptable solution consists in gathering section by section.

Between the two methods, not of difference for HOMARD: essence is not to make the full rotation (if not, not of end) and not to cross (if not, too many ends!). One will choose the method easiest to realize in the mesh generator.

Groupe GM_1

Groupe GM_2

4.13.1 Operand `GROUP_MA_FRONT`

◊GROUP_MA_FRONT = l_grma

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If this option is absent, the follow-up of the border is done for all the groups defined in the mesh of the border. If one wishes to restrict this follow-up with part of the border, one gives here the list of the groups of segments which define this part of border.

4.14 Key word FRONTIERE_ANALYTIQUE

◊FRONTIERE_ANALYTIQUE   = _F   (

This key word is with being informed as many times as one wants to define analytical borders. The choice of this option makes it possible the process of adjustment to follow the curvature of edges of the mesh. The option applies exclusively on board 2D. For edges 1D, it is necessary to use option MAILLAGE_FRONTIERE. One provides here the analytical description of each border to be followed. If the process of adjustment is brought to cut an edge mesh, the new node will be positioned on the border, via its description. Thus the angles will be softened as adaptations.

Note:

> *One will look at the zzzz175a* `benchmarks` *and* `zzzz259a` *for an example of analytical follow-up of border.*
> *When several times of continuation the adaptation is launched, it is essential that each analytical border is defined same way with each invocation of* `MACR_ADAP_MAIL` *: name, type, list of groups, characteristics geometrical.*

4.14.1 Name of the border

♦NOM=nom   [K]

This operand makes it possible to define the name associated with the border. The choice of this name is free.

4.14.2 Type of border

♦TYPE=/   "SPHERE"
      /   "CYLINDRE"
      /   "CONE_A"
      /   "CONE_R"

This operand makes it possible to define the type of border wished: sphere, cylinder, cone defined by a center, an axis and an angle or a cone defined by two points on the axis and the radius associated.

4.14.3 Operand GROUP_MA

♦GROUP_MA=l_grma

One gives here the list of the mesh groups which define the part of border represented by this analytical definition.

4.14.4 Cases of the sphere

4.14.4.1 Operands X_CENTRE, Y_CENTRE, Z_CENTRE

♦X_CENTER=x_center
♦Y_CENTER=y_center
♦Z_CENTER=z_center

They are the coordinates of the center of the sphere.

4.14.4.2 Operand RADIUS

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♦RAYON=rayon

It is the radius of the sphere.

4.14.5 Case of the cylinder

the cylinder is defined by an axis, a point on the axis and a radius.

4.14.5.1 Operands X_AXE, Y_AXE, Z_AXE

♦X_AXE=x_axe
♦Y_AXE=y_axe
♦Z_AXE=z_axe

They are the coordinates of the directing vector of the axis of the cylinder. The directional sense does not have importance. The vector is not necessarily normalized.

4.14.5.2 Operands X_CENTRE, Y_CENTRE, Z_CENTRE

♦X_CENTER=x_center
♦Y_CENTER=y_center
♦Z_CENTER=z_center

They are the punctual coordinates located on the axis of the cylinder.

4.14.5.3 Operand RADIUS

♦RAYON=rayon

It is the radius of the cylinder.

4.14.6 Case of the cone defined by an axis and an angle

the cylinder is defined by a center, an axis and an angle.

4.14.6.1 Operands X_AXE, Y_AXE, Z_AXE

♦X_AXE=x_axe
♦Y_AXE=y_axe
♦Z_AXE=z_axe

They are the coordinates of the directing vector of the axis of the cone. The directional sense does not have importance. The vector is not necessarily normalized.

4.14.6.2 Operands X_CENTRE, Y_CENTRE, Z_CENTRE

♦X_CENTER=x_center
♦Y_CENTER=y_center
♦Z_CENTER=z_center

They are the coordinates of the center of the cone.

4.14.6.3 Operand ANGLE

♦ANGLE=angle

It is the aperture of the cone in degree. This angle lies between 0 and 90 degrees.

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4.14.7 Case of the cone defined by two radius

the cylinder is defined by two points on the axis and the radius associated.

4.14.7.1 Operands `X_CENTRE`, `Y_CENTRE`, `Z_CENTRE`

♦X_CENTER=x_center
♦Y_CENTER=y_center
♦Z_CENTER=z_center

They are the coordinates of the first point on the axis of the cone.

4.14.7.2 Operand `RADIUS`

♦RAYON=rayon

It is the radius of the cone associated with the first point on the axis.

4.14.7.3 Operands `X_CENTRE`, `Y_CENTRE`, `Z_CENTRE`

♦X_CENTER2=x_center2
♦Y_CENTER2=y_center2
♦Z_CENTER2=z_center2

They are the coordinates of the second point on the axis of the cone.

4.14.7.4 Operand `RAYON2`

♦RAYON2=rayon2

It is the radius of the cone associated with the second point on the axis.

4.15 Key word `MAJ_CHAM`

◊   MAJ_CHAM = _F (

This key word is to be employed as many times as one has fields to update old mesh towards the adapted mesh. This field is contained either in a structure of result, or in a field of variables.

4.15.1 Operand `RESULTAT`

/◊RESULTAT   = resu

Name of the concept [result] containing the field to be updated.

4.15.1.1 Operand `NOM_CHAM`

◊NOM_CHAM = nomsymb   [K16]

Symbolic name of the field which one wishes to express on the new mesh.

4.15.2 Operand `CHAM_GD`

/◊CHAM_GD   =cham_gd

Name of the concept [cham_gd] containing the field to be updated.

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4.15.3 Operand NOM_CMP

◊NOM_CMP=l_cmp

Name of the component of the field which must be updated. If several components are wished, to give the list here.

If no component is here defined, the command will take all those which exist in the transmitted field.

4.15.4 Selection of the temporal parameter of the field to update

the selection of the sequence number associated with the field to be interpolated is done by the designation of a sequence number or a value of time. To refer to the document [U4.71.00] for the details on these key words.

4.15.5 Operand TYPE_MAJ

◊TYPE_MAJ=/ "AUTO" [DEFAULT]
/ "ISOP2"

One specifies here the type of update wished.
By default, operation "AUTO", is… automatic: the interpolation is made according to the nature of the field.
For a constant field by element, if a mesh is cut out, the value of the field is deferred such as it is on meshes the girls.
For a field at nodes, the interpolation takes place with the shape functions P1 or P2 according to the support of the field. An alternative is possible for the fields at nodes expressed on a mesh of degree 2. By specifying "ISOP2", the interpolation is made by shape functions P1 expressed on under-meshes element. This technique guarantees that the interpolated field respects the extreme values of the initial field on a mesh.
For a field with Gauss points, the update takes place only whenever the types of meshes are homogeneous between the entry and the output: triangle or tetrahedron. For the quadrangles, the hexahedrons or the pentahedrons, kidney is not made because one cannot of Gauss points define the families on the produced triangles or tetrahedrons. For a mesh in triangles, one proceeds as follows:
•for an unchanged triangle after the adaptation, the values with Gauss points are renewed with the identical one.
•for a cut out triangle, into 2 or 4, one calculates the mean value of the field on all the Gauss points and this value is allotted to all Gauss points all triangles wires.
•for a triangle which disappears (in the event of coarsening), one on all the calculates the average of the field Gauss points of this triangle and of his/her brothers and this value is allotted to all Gauss points triangle father which reappears.
This mechanism makes it possible to guarantee that the extreme limits are not crossed. Same the technqiue is applied to the tetrahedrons.

Caution:
There cannot be of consistency check between the type requested and the true type of the field to be interpolated.

4.15.6 Operand CHAM_MAJ

♦CHAM_MAJ=co (chpmaj) [K8]

Name of the concept which will contain the field expressed on the new mesh. This concept should not exist. It will be automatically created.
A field at nodes or with the elements will be read automatically by the macro-command which requires the adaptation or the modification of the mesh. It will be available in the clearance of computation as of the end of the execution of the macro-command. On the other hand, that is not possible for a field expressed with Gauss points because Code_Aster needs to know the model for reading. It is necessary for that to proceed in 3 times. The field is calculated by the macro-command which required

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the adaptation or the modification of the mesh, as for a field at nodes. Then, a new model must be applied to new mesh by the command AFFE_MODELE. Lastly, the reading will be made by a new invocation of MACR_ADAP_MAIL with the help of the parameter ADAPTATION = "READING" and the supply of the mesh and the model.

Note:
One will look at the zzzz175b benchmark for an example of update and reading of fields of various types.

4.15.7 Operand TYPE_CHAM

```
♦TYPE_CHAM   =   "NOEU_DEPL_R"
                /"NOEU_TEMP_R"
                /"ELGA_SIEF_R"
                /etc…
```

One indicates the type of the concept here to be updated on the new mesh. The name of this type is built with the usual logic of *Code_Aster*. The first 4 characters are "NOEU", "ELEM" or "ELGA". One finds "_then". The following sequence defines the type of field: "TEMP", "DEPL", etc the name ends in "_R" for a real field.

Example: "NOEU_TEMP_R", "NOEU_DEPL_R", etc

Attention:
There cannot be of consistency check between the type requested and the true type of the field to be interpolated.

4.16 Key word ADD_CHAM

```
◊   ADD_CHAM = _F (
```

This key word is to be employed to produce particular fields on the adapted mesh.

4.16.1 Operand CHAM_GD

```
♦CHAM_GD   =co   (chpmaj)          [K8]
```

Name of the concept which will contain the field expressed on the new mesh. This concept should not exist. It will be automatically created.

Note:
One will look at the benchmarks zzzz121 B and zzzz121f for an example of additions of fields of various types.

4.16.2 Operand CHAM_ CAT

```
♦CHAM_CAT  =   "NIVEAU"
               /"DIAMETRE"
```

One indicates here the category of the field which one wants to produce.
With " NIVEAU ", the produced field will contain for each mesh its level. It is pointed out that a mesh of the initial level is level 0. Then a mesh resulting from n standard cuttings of an initial mesh will carry the level n. A mesh which ensures the transition from conformity between the level n and the level $n+1$ will carry the level $n+0,5$.
With " DIAMETRE ", the produced field will contain the value of the diameter for each mesh.

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4.17 MODEL operand

◊MODELE   =modele   [model]

Attention:
> *This operand is active only when one chose "READING" like type of adaptation.*

This operand makes it possible to specify the model which was affected with the mesh on which the update of fields expressed with Gauss points took place.

Note:
> *One will look at the zzzz175b benchmark for an example of update and reading of fields to Gauss points.*

4.18 Operand DEGRE

◊DEGRE = "OUI'
            /"NON"   [DEFAULT]

Attention:
> *This operand is active only when one chose "MODIFICATION" like type of adaptation.*

If the choice is "NON", nothing occurs.
If the choice is "OUI', the degree of the mesh is changed overall.

Note:
> *Compound with MAJ_CHAM, operand DEGRE can be used for example for the postprocessing of the pressure in THM (cf Doc. [U2.04.05]). For certain studies 3D with bulky meshes, it can appear sometimes more powerful than PROJ_CHAMP.*

4.19 Operand NOMBRE

Note:
> *One will consult the document [U7.03.02] describing command MACR_INFO_MAIL for comments on the restitutions of operands QUALITE, INTERPENETRATION, NOMBRE, CONNEXITE and TAILLE.*

◊NOMBRE   = "OUI'   [DEFAULT]
             /"NON"

If the choice is "NON", nothing occurs.
If the choice is "OUI', an assessment of the numbers of nodes and meshes is printed on the file of messages.

4.20 Operand QUALITE

◊QUALITE=/   "OUI'
          / "NON"   [DEFAULT]

If the choice is "NON", nothing does not happen.
If the choice is "OUI', an assessment of the quality of meshes is printed on the file of message. The quality of a triangle is defined as being the relationship between the length on the largest side and the radius of the inscribed circle. The quality of a quadrangle is defined like the quotient of the product biggest length and averages on the sides and the diagonal by smallest of surfaces of the internal triangles to the quadrangles. In the same way, the quality of a tetrahedron is defined as being the relationship between the length on the largest side and the radius of the registered sphere. These

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ratios are standardized to be worth 1 in the case of an equilateral triangle, of a square, a tetrahedron or an equilateral hexahedron. For any nonequilateral element, quality is higher than 1. See the reference [bib1] for detailed explanations.

Result is presented in the form of tables, with the extreme values.

4.21 Operand DIAMETRE

```
◊DIAMTRE=/              "OUI'
          /  "NON"      [DEFAULT]
```

If the choice is "NON", nothing does not happen.
If the choice is "OUI', an assessment of the diameters of meshes is printed on the file of message. The diameter of a mesh is defined as the length of the greatest segment than it is possible to insert in the mesh.
For a triangle or a tetrahedron, the diameter corresponds to the length on the largest side.

For a quadrangle, a hexahedron, a pentahedron or a pyramid, the diameter are the maximum between the length on the largest side and the length of the largest diagonal.

Result is presented in the form of tables, with the extreme values.

4.22 Operand INTERPENETRATION

```
◊INTERPENETRATION=/            "OUI'
                   /  "NON"   [DEFAULT]
```

If the choice is "NON", nothing does not happen.
If the choice is "OUI', it is checked that the mesh is correct from the point of view of covering: no mesh enters another.

4.23 Operand CUTS

```
◊TAILLE=/            "OUI'
         /  "NON"     [DEFAULT]
```

If the choice is "NON", nothing does not happen.
If the choice is "OUI', an assessment of the sizes of the subdomains is printed on the file of messages. A subdomain is defined like a set of meshes of the same dimension and pertaining to the same groups.

4.24 Operand CONNEXITE

```
◊CONNEXITE   =     "OUI'
              /  "NON"        [DEFAULT]
```

If the choice is "NON", nothing does not happen.
If the choice is "OUI', an assessment of the connexities is printed on the file of messages. It will be known then if the segments, the elements 2D (triangles and quadrangles joined together) or meshes 3D (tetrahedrons, hexahedrons, pentahedrons and pyramids joined together) of only one holding or are divided into several blocks. One will also know the number of holes of structure: crossing holes or internal holes.

4.25 Operand PROP_CALCUL

```
◊PROP_CALCUL=/            "OUI'
             /  "NON"        [DEFAULT]
```

If the choice is "NON", nothing does not happen.

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If the choice is "OUI', a diagnosis on the properties of meshes as elements for computation is printed on the file of messages. One counts the number of overstrained elements: the elements of which all the tops are located on edge. One counts the meshes voluminal ones (resp. surface) which touches edge of the field but which is not bordered by the meshes surface ones (resp. linear).

4.26 Operand LANGUE

◊LANGUE=/   "FRANCAIS"   [DEFAULT]
          / "FRENCH"
          / "ANGLAIS"
          / "ENGLISH"

This operand specifies the language in which the messages resulting from HOMARD are printed.

4.27 Operand VERSION_HOMARD

◊VERSION_HOMARD=/   "V10_6"   [DEFAULT]
               / "V10_N"
               / "V10_N_PERSO"

This operand makes it possible to select the HOMARD version which is used for the adaptation. By default, HOMARD 10.6 is launched. It is the version of reference. The choice "V10_N" activates the version 10.n HOMARD which is the version of development. The choice "V10_N_PERSO" activates a version of development specific to the user. This option makes it possible to the development team of HOMARD to develop new features. She also makes it possible to make profit the user from an innovation in HOMARD before the commissioning in *Code_Aster*.

4.28 Operand LOGICIEL

◊LOGICIEL =logiciel   [K]

This option proposes to use another interface of coupling between *Code_Aster* and HOMARD that provided by default in the directory of the tools associated with *Code_Aster*. This option in fact is reserved to the development team of HOMARD to develop new features. She makes it possible to test innovations before to have modified the macro-command of control.

4.29 Operand UNITE

◊UNITE=unite   [I]

This option is possible only if one activated the version of development of HOMARD, 10.n. The data file transmitted by the user under this number of logical unit will be directly transmitted like complement to the file of HOMARD configuration. This option in fact is intended to the development team of HOMARD to develop new features. She makes it possible to test innovations before to have modified the macro-command of control.

4.30 Operand ELEMENTS_ACCEPTES

◊ELEMENTS_ACCEPTES=/   "HOMARD"   [DEFAULT]
                  / "IGNORE_PYRA"

In its current version, HOMARD can read all the types of meshes but makes carry the adaptation only on some: meshes-points, segments, triangles, quadrangles, tetrahedrons, hexahedrons or pentahedrons. The mesh is in degree 1 or 2, but it is not possible to mix both.
By retaining the option "HOMARD", transmission of a mesh containing another thing which these types of meshes will involve a stop in error. It is the option by default.

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By choosing option "IGNORE_PYRA", one will be able to transmit a comprising mesh of the pyramids. The adaptation will relate only to the zones authorized by HOMARD. So in consequence of propagation of refinement, a closed area comes to be touched, there will be a stop in error. If not, when refinement is limited to the authorized zone, the others meshes are restored without change.

In all the cases, the presence of meshes enriched the HEXA27 is prohibited.

4.31 Operand INFO

```
◊INFO=/1
       /2
       /3
       /4
```

If INFO is worth 1, the printings are minimal; one obtains only those which were explicitly required, the quality of meshes for example, and the possible error messages.
If INFO is worth 2, one will obtain the messages transmitted by the commands subjacent with the macro-command: IMPR_RESU, LIRE_MAILLAGE, LIRE_RESU.
If INFO is worth 3, there will be the standard HOMARD messages, recapitulating the execution.
If INFO is worth 4, one will have all the messages transmitted by HOMARD, for déboggage.

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5 Example

One will look with profit the command files associated to the zzzz121a benchmarks, B, C, D, E, F and zzzz175a, B. They express the processes of mesh adaptation either per sequence of the commands or in the form of a loop in language Python.

Here an example of parameter setting of the macro-command.

```
MACR_ADAP_MAIL    (
        ADAPTATION = "RAFF_DERA",
        MAILLAGE_N = mun,
        MAILLAGE_NP1 = CO ("mdeux"),
        RESULTAT_N = remeun,
        NOM_CHAM = "QIRE_ELEM",
        NOM_CMP = "ERREST"
        NUME_ORDRE = 3,
        CRIT_RAFF_PE = 0.01,
        CRIT_DERA_PE = 0.25,
        NIVE_MAX = 5
        MAJ_CHAM=  _F (
              RESULTAT = rethun,
              NOM_CHAM = "TEMP",
              TYPE_CHAM = "NOEU_TEMP_R",
              INST = 12.5,
              CHAM_MAJ = CO ("tempdeux")
              ),
        QUALITE = "OUI',
        INTERPENETRATION = "NON"
     )
```

This sequence will adapt the mesh contained in the concept mun and will restore a concept mesh of mdeux name. The adaptation is done by refinement and free coarsening, according to the field contained in field QIRE_ELEM of result the remeun, at the 3rd time; the component used is ERREST. Meshes will be classified according to their level of error decreasing. First % will be refined; the 25% last will be candidates with the coarsening. No mesh of the final mesh will have to result of more than 5 refinements.

Field TEMP of result the rethun at time 12,5 is expressed on the mesh mun. It will be expressed on the mdeux mesh in the shape of the field of temperature to the tempdeux nodes.

A summary of the quality of meshes of the new mesh is produced. One does not control the interpenetration of meshes.

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Here an example of the table presenting the distribution of the field controlling the adaptation of the mesh.

```
        ************************************************************
        *             Field controlling the adaptation          **
               Value on        the 936 triangles          *
        ************************************************************
        *    Minimum:  0.35358E-05        Maximum:  0.33395E-03   **
          Average:  0.66371E-04    Standard deviation:  0.51323E-04   *
        ************************************************************
        *                 Function of distribution              **
           Values         *      Mini           Number of meshes
            ** <   < Maximum  *     per class     *       office plurality
   ***
           10 ** - 4       *   in % . number  *  in % . number  *
        ************************************************************
        *    0.000 <   0.170 *  11.65.      109 *  11.65.      109 **
           0.170 <   0.340 *  21.15.      198 *  32.80.      307 **
           0.340 <   0.510 *  15.60.      146 *  48.40.      453 **
           0.510 <   0.680 *  12.71.      119 *  61.11.      572 **
           0.680 <   0.850 *  10.79.      101 *  71.90.      673 **
           0.850 <   1.020 *   7.37.       69 *  79.27.      742 **
           1.020 <   1.190 *   6.30.       59 *  85.58.      801 **
           1.190 <   1.360 *   4.59.       43 *  90.17.      844 **
           1.360 <   1.530 *   2.35.       22 *  92.52.      866 **
           1.530 <   1.700 *   1.50.       14 *  94.02.      880 **
           1.700 <   1.870 *   2.24.       21 *  96.26.      901 **
           1.870 <   2.040 *   1.39.       13 *  97.65.      914 **
           2.040 <   2.210 *   1.50.       14 *  99.15.      928 **
           2.210 <   2.380 *   0.43.        4 *  99.57.      932 **
           2.380 <   2.550 *   0.21.        2 *  99.79.      934 **
           2.550 <   2.720 *   0.00.        0 *  99.79.      934 **
           2.720 <   2.890 *   0.00.        0 *  99.79.      934 **
           2.890 <   3.060 *   0.00.        0 *  99.79.      934 **
           3.060 <   3.230 *   0.00.        0 *  99.79.      934 **
           3.230 <   3.400 *   0.21.        2 * 100.00.      936 *
        ************************************************************
```

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the diagnosis on the distribution of the field controlling the mesh adaptation points out initially the extreme values recorded in computation in progress. Here the minimum is of 0,353585x10-5 and the maximum of 0,33395x10-3. One specifies the mean value, 0,66371x10-4, and the standard deviation, 0,51323x10-4. Then one presents the distribution by equidistant slice from the optimum value, 0. It is seen that for 880 triangles, the value of the field is lower than 1,70x10-4, that is to say 94,02% of the nombre total of triangles. Then, for 21 triangles the value of the field lies between 1,70x10-4 and 1,87x10-4, is 2,24% of the nombre total of triangles. In cumulated, one thus notes that for 901= 880 + 21 triangles, the value of the field is lower than 1,87x10-4, that is to say 96,26% of the total. And so on. For example, for 99,79% of meshes, the value of the field is lower than 2,55x10-4.
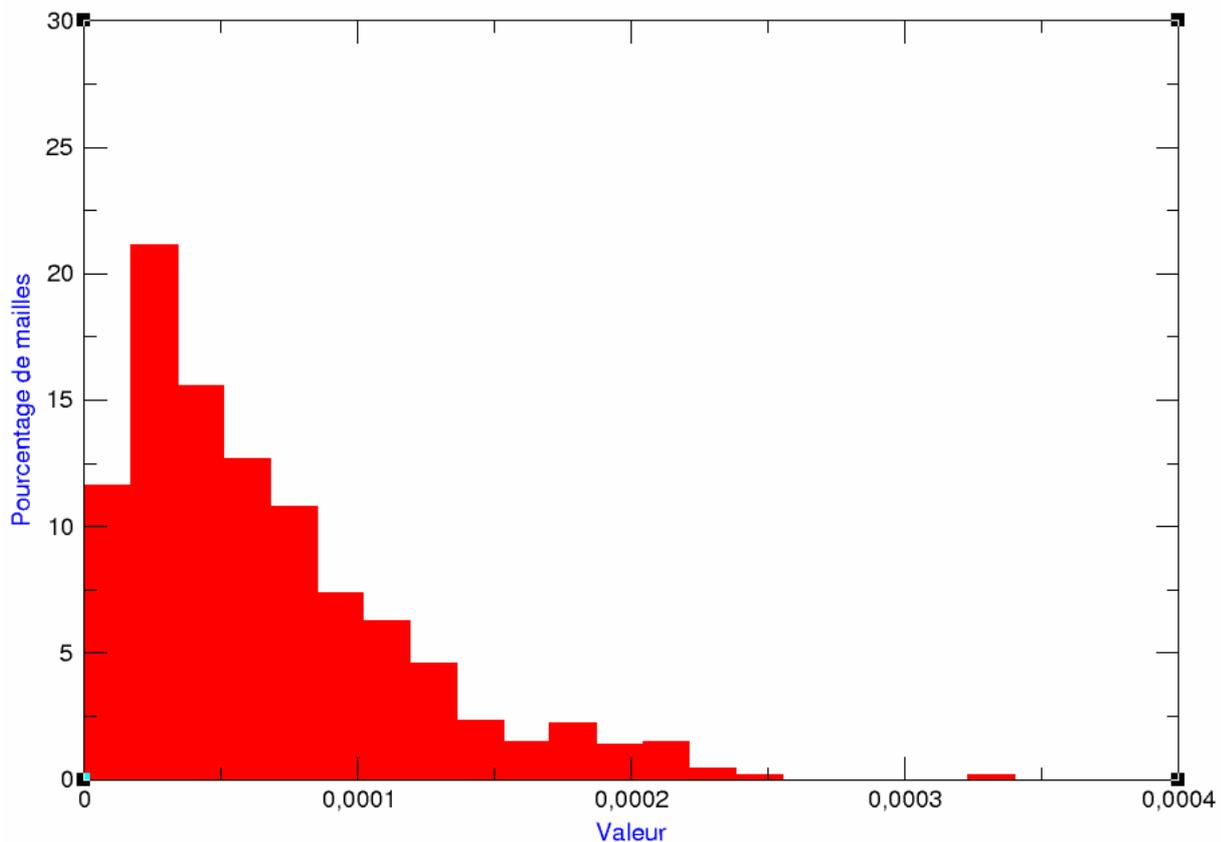
On the preceding figure, one can see the representation in the form of histogram of the percentages of meshes in each beach of value concerned. As one could also note it in the preceding table, one notes that very few meshes concentrates the strong values.
By visualizing a representation of the percentage cumulated of meshes in a beach of value given, there is the following figure.

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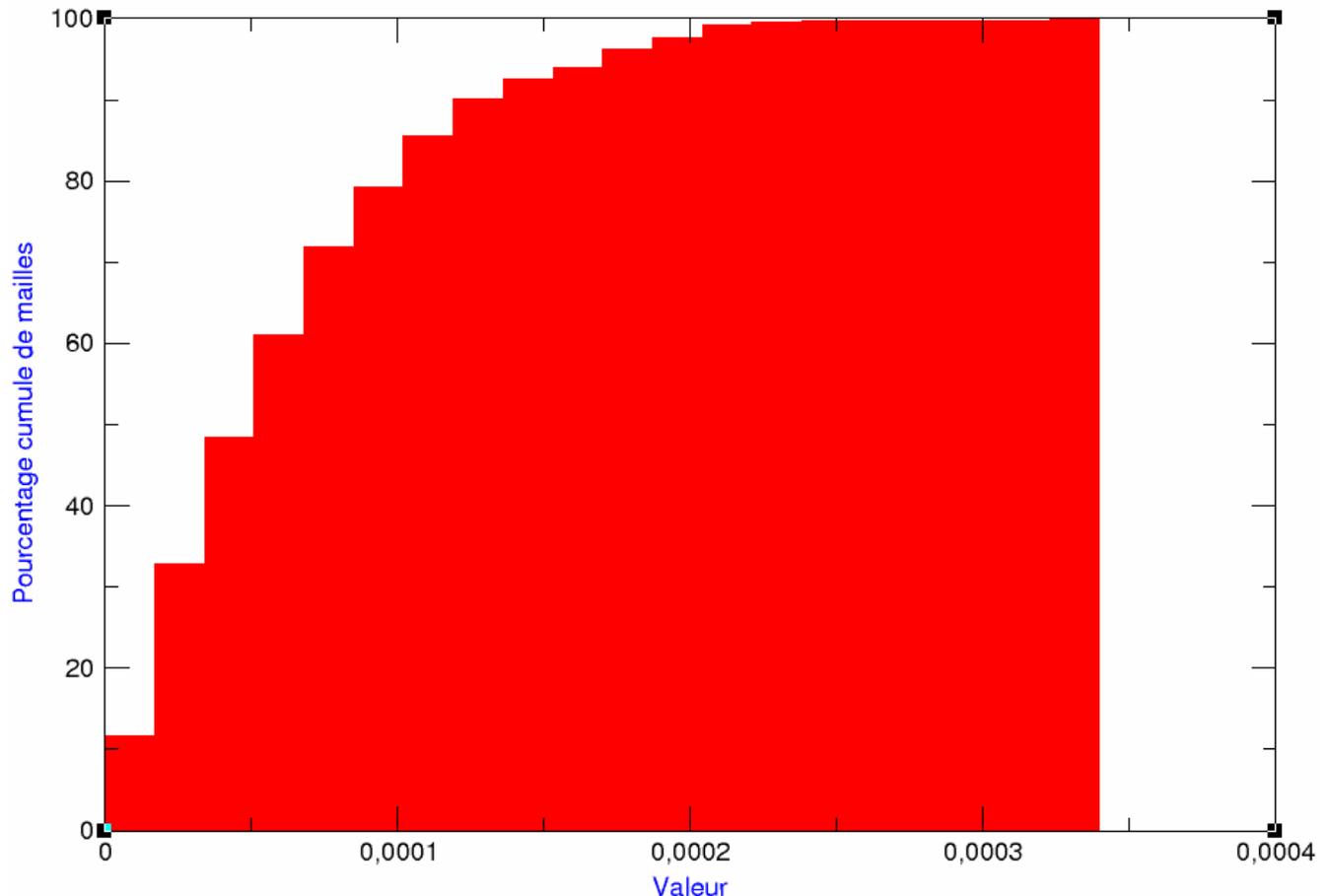
From this distribution of the values, one can deduce two consequences on the strategies from refinement.

If one asks for a refinement on a relative criterion of the value of the field, key word `CRIT_RAFF_REL`, that amounts selecting meshes the elements which are on the right of the line vertical one passing by this criterion. For example if one asks `CRIT_RAFF_REL = 0.77`, one will meshes select all whose L `error is higher than $0.35358 \times 10^{-5} + 0,77 \times (0.33395 \times 10^{-3} - 0.35358 \times 10^{-5})$, that is to say $2,58 \times 10^{-3}$. It is noted that corresponds to very few meshes: 2 only exceed this value, that is to say 0,21% of the total. One had the feeling to ask for an important refinement, 0,77 is a quarter *roughly speaking*, but one makes some does not refine almost nothing.

If one asks for a refinement on a percentage of meshes, key word `CRIT_RAFF_PE`, that amounts selecting meshes which is above the line horizontal one passing by this criterion. For example if one asks `CRIT_RAFF_PE = 0.10`, one will select the 10% of meshes worst, that is to say 93 meshes. It is the line horizontal one to 90%. Among these meshs, "least worse" carry a value lower than $1,36 \times 10^{-4}$, that is to say 40% of the maximum value. It is rather effective since the large variations will have been trapped.

The consequence of these remarks is that it is advisable to make a first analysis of the distribution of the values of the field before choosing the type and the values of the criteria of refinement. It is indeed useless, even expensive in term of increase in the size of mesh, to refine in zones where the field is not very strong. The adaptation will be all the more powerful as one will have known to reduce meshes to strong value until obtaining an equilibrium in the mesh.

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