

# **LAST DEVELOPMENTS IN AND AROUND GAETAN**

« *Global Analysis Environment for Thermal Analysis Network* »

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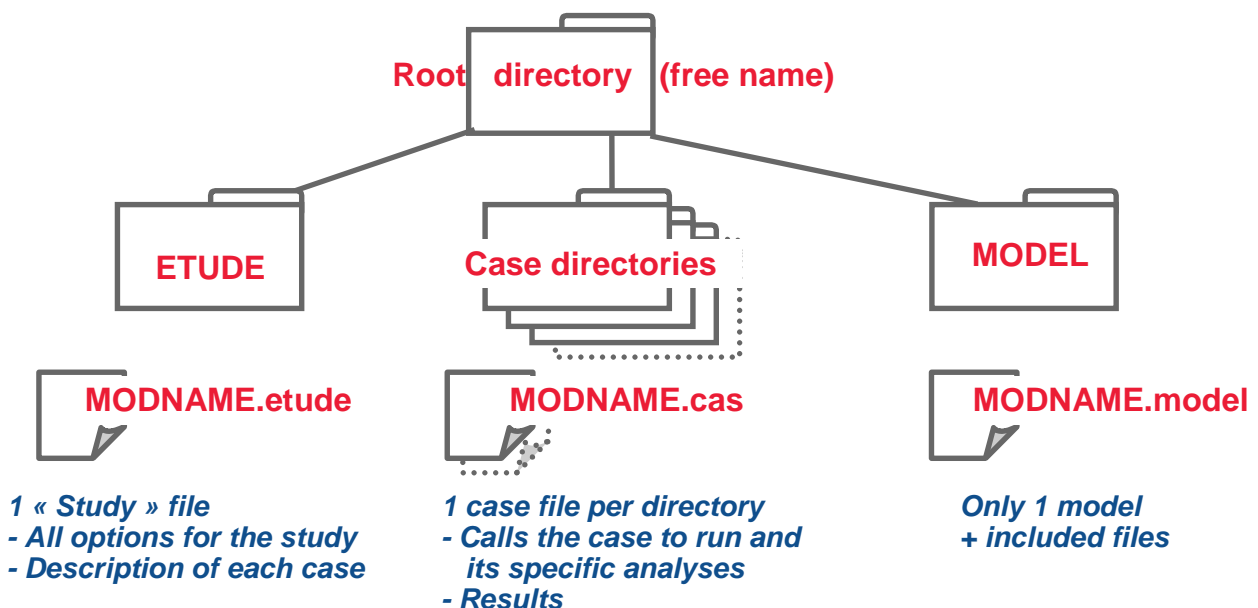
## **Summary**

- **Introduction**
- **New functions for thermal study management**
  - *Thermal study management principle*
  - *Thermal coupling cases analyses*
  - *Thermal sensitivity analyses*
- **Thermal model configuration management**
- **GAETAN I/F with thermal radiative tools (CONDOR , ESARAD)**
- **Future developments**

## Introduction

- **GAETAN V5.2**
- **Environment for thermal analyses**
  - Based on lumped parameter method (i.e. ESATAN)
  - Based on thermal budget analyses
  - Many prepro and postprocessing features
- **Developed since 1996**
- **Harmonized with ESTEC (Use of & I/F with ESATAN - FHTS (in progress) - ESARAD)**
- **5 french industrial sites + CNES**
- **CNES licenses for use and development**
- **Development & maintenance done by Silogic (F.)**

## Thermal study management principle



## Thermal coupling cases analyses What is the problem ?

- **GAETAN principle**
  - ONE thermal model for ALL load cases
- **Difficult to include several values for one coupling in ESATAN models**
  - manual edition
  - use of ESARAD variable geometry
  - ESARAD outputs do not allow several sets of radiative couplings in one model
- **Example**

## Thermal coupling cases analyses Example of problem

### 1st case of GEOMETRY

ESARAD output :  
\$CONDUCTORS  
GR(6,5) = 0.00002 ;

### 2nd case of GEOMETRY

ESARAD output :  
\$CONDUCTORS  
GR(6,5) = 0.00005 ;

Direct \$INCLUDE in same MODEL = ERROR or bad values !



**SOLUTION : CONDITIONNAL INCLUDE AS A FONCTION OF A VARIABLE**

# Thermal coupling cases analyses Principle

## In the Study file

```

...
$CHARGE_CASES_DEFINITIONS
  @NEW_CHARGE_CASE_DEFINITION
    CHARGE_CASE_NAME =          'CD FORT';
    EXTERNAL_FLUXES_CASE =      'EOL';
    COUPLING_CASE =             'CACOUP = fort';

  @NEW_CHARGE_CASE_DEFINITION
    CHARGE_CASE_NAME =          'CD FAIBLE';
    EXTERNAL_FLUXES_CASE =      'EOL';
    COUPLING_CASE =             'CACOUP= faible';
...
    
```

## In the Model (or included) file

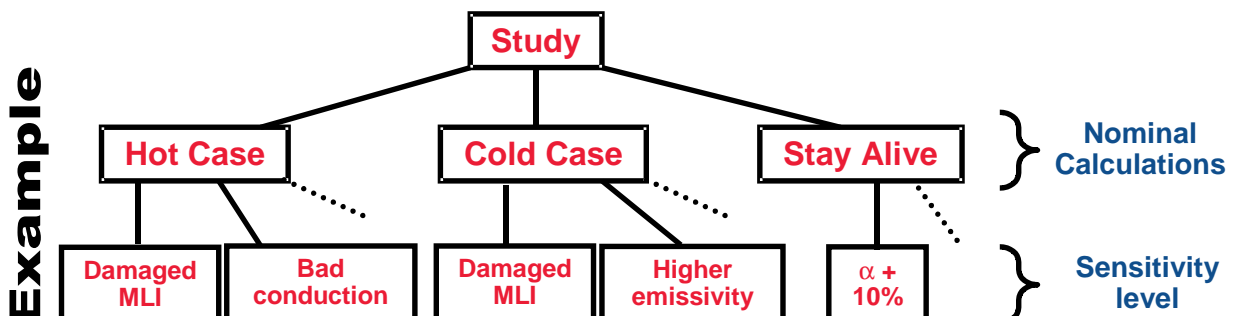
Included only if variable « CACOUP » is equal to ' fort '

```

...
#READ conductif.1      :: CACOUP = 'fort'
#READ conductif.2      :: CACOUP = 'faible '
...
    
```

# Thermal sensitivity analyses Principle

- Each “nominal” case gets sensitivity cases
- Sensitivity cases are automatically :
  - Calculated,
  - Analysed
  - Archived in the comparison database
  - Compared to their nominal case



# Thermal sensitivity analyses

## Example of input

```
$CHARGE_CASES_DEFINITIONS
@NEW_CHARGE_CASE_DEFINITION
    CHARGE_CASE_NAME = 'NOMINAL';
    EXTERNAL_FLUXES_CASE = 'TOTO';
    SENSITIVITY_CASE = 'COUPCA = fort';
    SENSITIVITY_CASE = 'CASRAD = fort';
    EXTERNAL_FLUXES_SENSITIVITY_NAME = 'test';
    EXTERNAL_FLUXES_ENTITIES_LIST = 'QS' ;
    EXTERNAL_FLUXES_MULTIPLICATIVE_FACTORS = '0.5' ;

[ . . . ]

$THERMAL_RESULTS_COMPARISON
@GENERAL_OPTIONS
    NODES_SELECTION = '140,160,200' ;
    THERMAL_SPECIFICATIONS_CASE_NAME = 'nominal' ;

@SENSITIVITY_COMPARISON
    CURRENT_CALCULATION_CASE = 'NOMINAL' ;
    TO_COMPARE_WITH = 'COUPCA=fort' ;

@NODES_TEMPERATURE_LEVELS
@HEATERS_CONSUMPTIONS
@BOUNDARY_FLUXES
```

# Thermal sensitivity analyses

## Example of model programming

```
[...]

$CONDUCTORS

    GR(10,20) = 0.0002 * VAR ;

    #READ conductif.fort :: COUPCA = 'fort '

[...]

$INITIAL

    IF (CASRAD .EQ. 'fort ') then
        VAR = 1.2
    ENDIF

[...]
```

# Thermal sensitivity analyses Example of result file

```

=====
Comparaisons multi-cas avec le cas de specification: nominal
Cas de calcul compares:          NOMINAL  NOMINAL  NOMINAL  NOMINAL
Code caractère du calcul:        A          B          C          D
Code de sensibilité:             none  CASRAD=fort  COUPCA=fort  EXT_F=test
=====

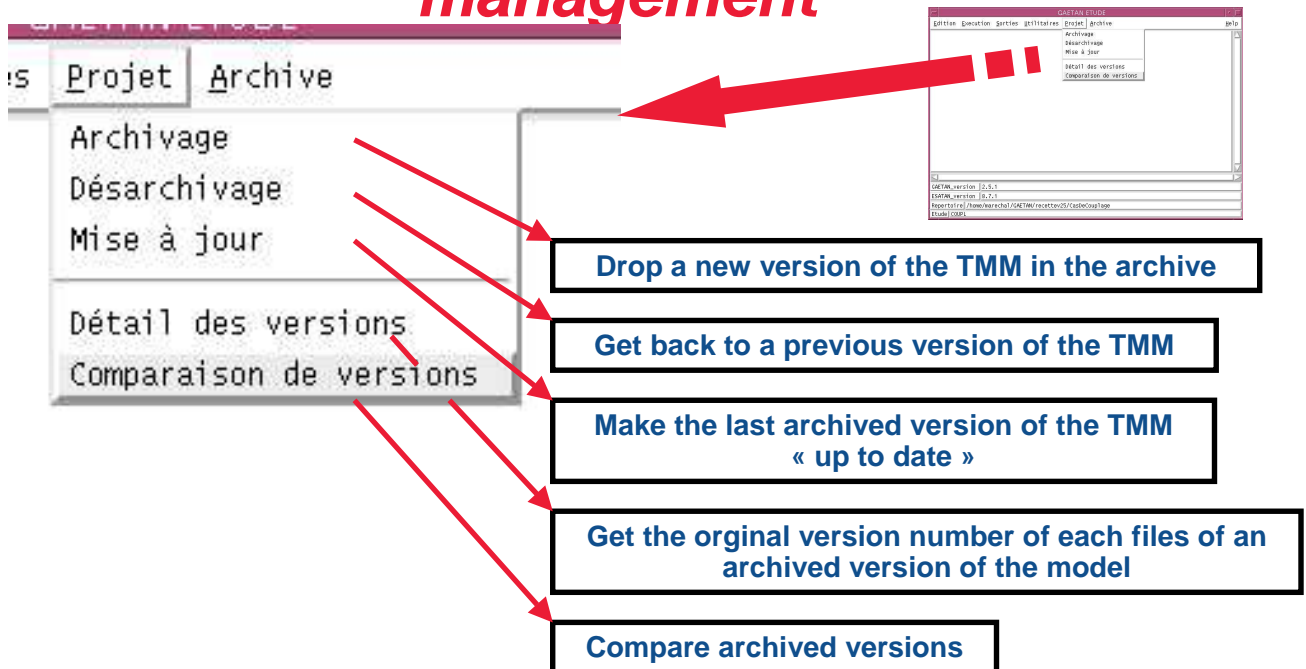
Edition des temperatures soumises a specification avec marge de calcul
=====
NOEUD      LABEL          Perf.basse(C) Perf.haute(C) Tmin(C) Tmax(C) Ecart/min(C) Ecart/max(C)
SENSI:140  Diffus froid    6.90 B        57.88 C      -80.00   150.00    86.90     102.12
SENSI:160  Diffus chaud   65.48 A       89.71 C      -10.00    75.48
=====

Edition des pentes de temperature soumises a specification avec marge
=====
NOEUD      LABEL          Perf.haute(C/s ) Pente max(C/s )  Ecart/max(C/s )
SENSI:140  Diffus froid    -7.56 B        0.09          7.65     HORS MARGES
=====

Edition des flux d'interface soumis a specification avec marge de calcul
=====
NOEUD      LABEL          Perf.haute(W )  Puiss.max(W )  Ecart/max(W )
SENSI:200  Environnement  -6.73 C        3000.00       3006.73
    
```



# Thermal model configuration management



## ***Thermal model configuration management***

- ***Based on CVS (Configuration management freeware)***
- ***As simple as possible***
  - ***Basic functions***
  - ***Only through GAETAN IHM***
- ***Each archived version gets***
  - ***A number (1, 2 ...) (no 1.1 , 1.2 ...)***
  - ***An archive date***

## ***CONDOR***

- ***Software for efficient evaluation of external orbital conditions :***
  - ***Solar / Albedo / Planetary fluxes chained calculations : search of thermal dimensionning cases***
  - ***Sucess criteria based on any type of CONDOR but also GAETAN / ESATAN results : fluxes, T°, DT, DT/Dt, min / max, heating power, a.s.o. ...***
- ***Not part of GAETAN***
- ***CNES internal tool***
- ***CONDOR can drive GAETAN (ESATAN / FHTS) and ESARAD***

## **CONDOR - Geometry**

- **Cube**
- **Plate 2 sides (1mx1m)**
- **Cylinder**
- **Sphere**
- **Solar panel**
  - *Solar pointing*
- **Any ESARAD Geometry**
  - *if so, CONDOR runs ESARAD*

## **CONDOR - Orbit**

- **Geostationnary**
- **Heliosynchronous**
- **Polar**
- **Circular**
- **Elliptical**
- **Tabulated (Time and position tabulated)**



## **CONDOR - Attitude**

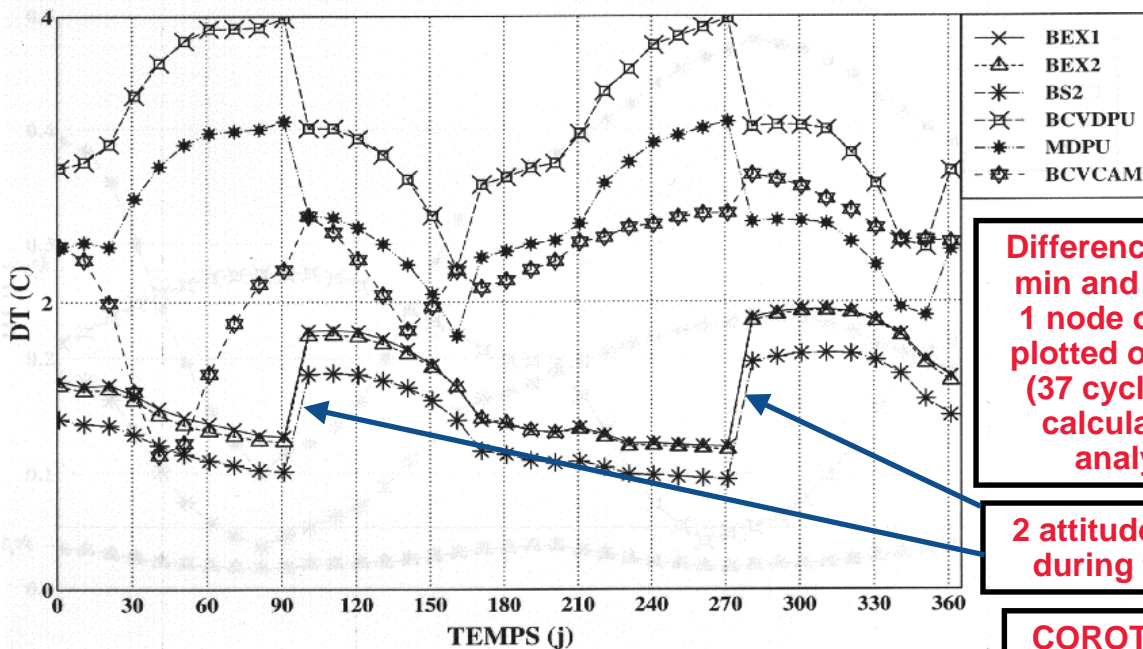
- **Geocentric reference frame**
- **Inertial reference frame**
- **Solar reference frame**
- **Tabulated (Time vs attitude quaternions in inertial equatorial reference frame)**

## **CONDOR - General**

- **Outputs**
  - **External fluxes and radiative sink temperatures**
    - » **Over any orbit**
    - » **Any orbit : Orbital average over a year**
- **Very easy attitude and orbit definition**
  - **Input parameters depend on type of orbit and attitude**
- **If the TMM exists**
  - **CONDOR launches the temperature calculations**
  - **On each chosen day of the year**
  - **Launches GAETAN analyses for comparison of the any results ( $T^\circ$ ,  $DT$ ,  $dT/dt$ ,  $DT/(t1-t2)$ , min/max, heating power, fluxes, boundary fluxes, a.s.o. ...)**
- **Very powerful tool to find dimensionning cases**

# CONDOR : Example

## ECART MIN / MAX SUR 1 ORBITE



Difference between min and max T° of 1 node on 1 orbit, plotted over 1 year (37 cycled orbits calculated and analysed)

2 attitude changes during the year

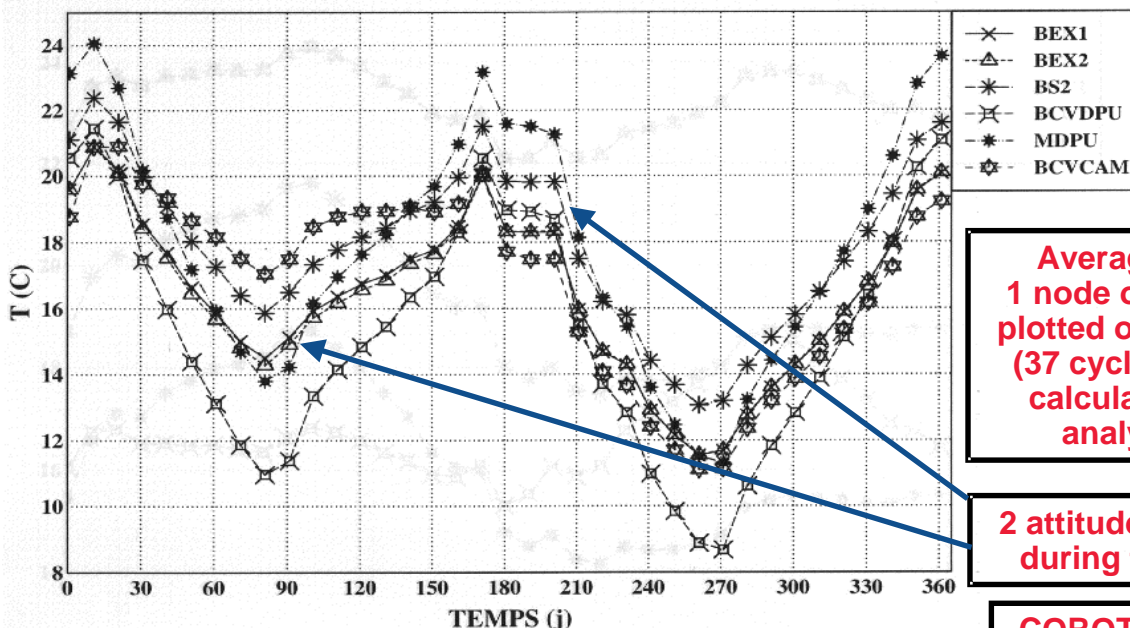
COROT Project

PC2 : dpt0\_2h  
CONTEXTE CHAUD, RÉCH. CASE ET CU OFF



# CONDOR : Example

## TEMPERATURE MOYENNE ORBITALE



Average T° of 1 node on 1 orbit, plotted over 1 year (37 cycled orbits calculated and analysed)

2 attitude changes during the year

COROT Project

PC2 : dept0\_2h  
CONTEXTE CHAUD, RÉCH. CASE ET CU OFF



## ***Future developments***

- ***GAETAN compatibility with FHTS (To 10/2002)***
  - *Management of fluidic entities*
  - *Power budget calculations*
  - *Simplified mass and volume budgets*
- ***Semi-automatic thermal model reduction - Energetic method (mid-2003)***
- ***IHM and command language for CONDOR***

## ***Contacts***

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### To ask for a licence :

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