Heat and Mass Transfer Technological Center (CTTC)

Universitat Politècnica de Catalunya BARCELONA TECH (UPC)
CTTC director founder: Prof. Assensi Oliva
CTTC director: Prof. Carlos D. Pérez-Segarra
CTTC codirector and promoter: Prof. Joaquim Rigola
CTTC personnel: 50 persons full time (30 Ph. D. students)
More than 100 international journal papers in last 10 years
More than 60 research projects with companies, and within national and EU frameworks in last 10 years

A renowned worldwide research group in Solar Energy, Thermal Systems and Computational Fluid Dynamics and Heat Transfer

Mathematical formulation, numerical resolution and experimental validation of heat and mass transfer phenomena.

- Natural and forced convection
- Turbulence simulation (RANS, LES, DNS)
- Combustion
- Two-phase flow (VOF, two fluid models)
- Solid-liquid phase change (PCM materials)
- Radiation (surface and participating media)
- Porous media
- Computational Fluid Dynamics and Heat Transfer (CFD&HT)
- Compressible effect and noise evaluation
- Computational Structure Dynamics (CSD) and Fluid Structure Interaction (FSI)
- Aerodynamics
- High performance computing: Numerical algorithms and solvers, parallel computing, etc.

Thermal and fluid dynamic optimization of thermal systems and equipments. Application of the acquired know-how from the basic studies

- Refrigeration (vapour compression cycles, absorption refrigerating systems, compressors, expansion devices, etc.).
- HVAC (ventilation, diffusion of contaminants in buildings,...).
- Active and passive solar systems (solar collectors using transparent insulation materials, building facades with transparent layers and ventilation, etc.).
- Concentrated Solar Plants (CSP) (solar tower, storage tanks, etc.)
- Wind Energy (blade design, thermal nacelle, wind farms, etc.)
- Heat exchangers (single – phase and two – phase heat exchangers, combustion heaters,...).
- Heat storage by liquids and using phase change materials.
- Engine cooling and air conditioning in the automobile and the aeronautical fields.
- Aerodynamics, etc..
Computational Fluid Dynamics and Heat Transfer (CFD&HT): TermoFluids code

- 3D parallel unstructured code
- DNS, RANS and LES turbulence models
- Dynamic mesh methods for CSD and FSI
- Radiations, combustion
- Multi phase phenomena
- Multi physics modelling

Object Oriented tools for thermal systems and equipments: NEST code

- Modular object-oriented buildings (rooms, walls, HAM+VOC; IAQ, active virtual control): NEST buildings
- Multiscale approach wind energy applications : NEST wind farms
- Multiscale approach solar tower receivers: NEST CSP
- Thermal Energy Storage Tanks: NEST STES & LTES
- Vapor Compression, absorption and adsorption refrigeration and systems NEST cycle
- Condensers, evaporators and radiators : NEST heat exchangers
- Hermetic reciprocating compressors: NEST compressors
CTTC High Performance Cluster (HPC – JFF)

- Infiniband DDR 4X network interconnection between nodes with latencies of 2.25 microseconds with a 20Gbits/s bandwidth.
- The system of files allow unified capacities of several Petabytes highly scalable.
- 128 nodes, each node has two Quad-core CPUs, total of 1024 processing cores.
- 40 nodes, each node has 32 Cores, total of 1280 processing cores.
- 40 nodes, each node has 40 Cores, total of 1600 processing cores. Under upgrade process

CTTC Experimental facilities

- Vapor compression refrigerating systems (R600a, R134a, CO₂, etc.)
- Calorimeter compressor test
- Fin and tube heat exchangers test loop
- Climate chamber
- Motor bench
- Storage tanks
- Flat plate solar collectors
- Different types of ventilated façades
- Bioclimatic building
Top 10 CTTC - UPC research projects within last 5 years

- CAROLINA (EIT Urban Mobility E-01545) Titol: Real-time pollution City mAp thRough cOLlaborative sensIng aNd Analysis (CAROLINA) Periode: 2020 Funding: 118.124€
- Research project H2020-CS2-CFP07-2017-02 Cleansky project: Funding: 239.070 Euros, Title: A New proTection device for FOD (ANTIFOD), Period: 2018-2020
- Research project ENE2017-88697-R; MEC (Spanish Government); Funding: 151.250 Euros; Title: Algorimtos numéricos avanzados para la mejora de la eficiencia energética en los sectores eólico y solar-termico: Desarrollo/adaptación a nuevas arquitecturas computacionales. Period: 2018-2021.
- Research project ENE2015-70672-P; MEC (Spanish Government); Funding: 120.500 Euros; Title: Modelización Multiescala y Simulación Numérica Directa de Flujos Multifasisicos Gas Liquid en Burbujas, Películas y Esprays. Period: 2016-2018.
- Research project Q00043; Funding: 249.600 euros; Title: "Solar dryer based on Fresnel concentration system (SIROCCO); Period: 2016-2018
Most relevant CTTC-UPC advanced computing projects within last years


8. PRACE Project ref. 2015133120 SANDGRAIN. Understanding the effects of wall-surface roughness on the flow past circular cylinders. 31 milions of CPU hours (2016-2017)


10. PRACE Project ref. 2012071290 DRAGON - Understanding the DRAG crisis: ON the flow past a circular cylinder from critical to trans-critical Reynolds numbers . 23 milions of CPU hours (2013-2014)
TF’s business overview

HT&CFD – HPC – Multi-scale – Multi-physics – High Efficiency Systems