

Principali attività di ricerca in corso e possibili sviluppi

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Incontro promozione attività di ricerca DIMA

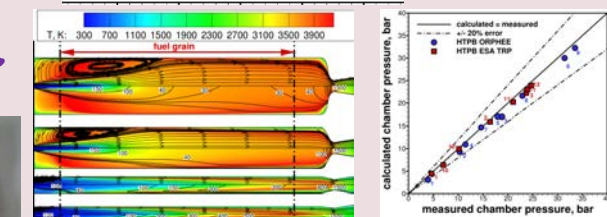
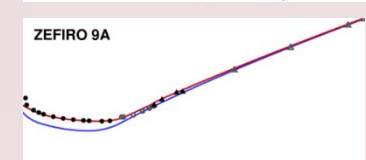
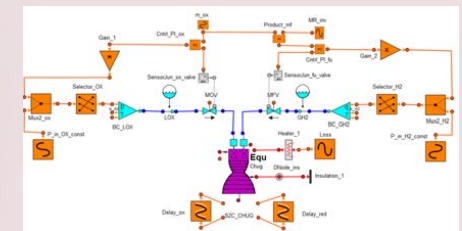
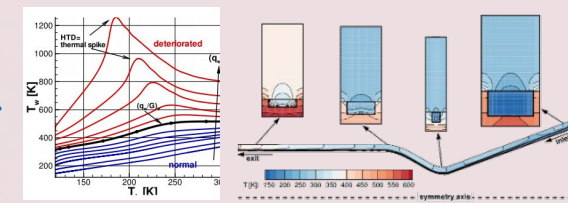
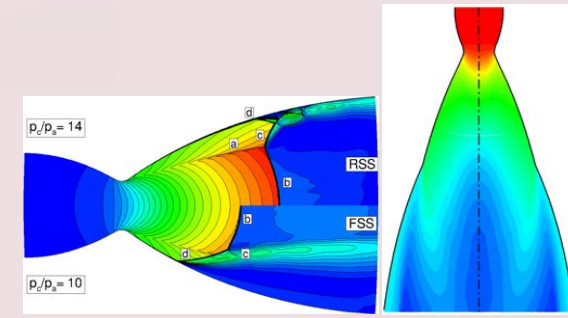
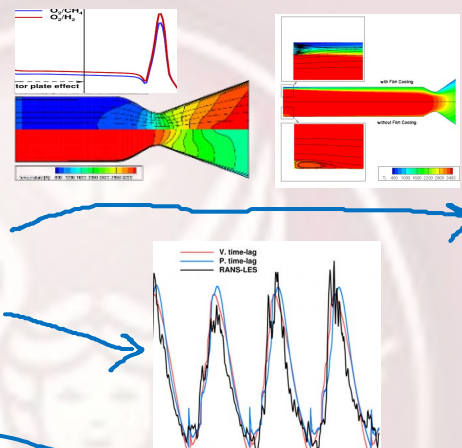
Roma, 6 febbraio 2017



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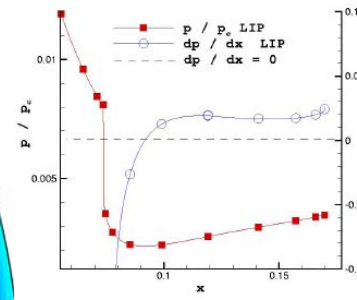
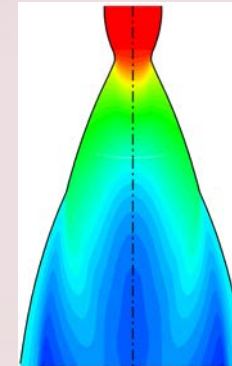
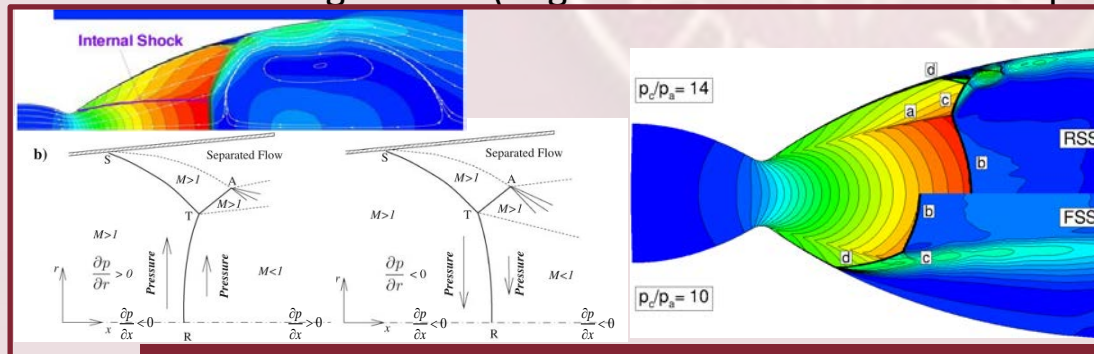
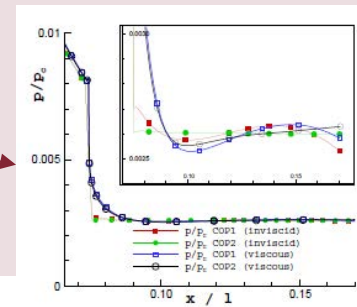
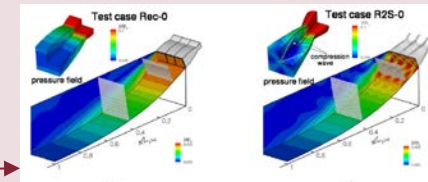
Main activities

- Liquid rockets:
 - Nozzle design
 - Heat loads
 - Thrust chamber cooling
 - Combustion instabilities
 - System analysis
- Solid rockets:
 - Ablative thermal protection systems
- Hybrid rockets:
 - Modeling of gas-surface interaction
 - Liquefying fuels modeling
- Micro-propulsion



Nozzle design and operations

- DIMA personnel (all activities below): Nasuti, Onofri
- Collaborations: Seconda università di Napoli (Martelli)
- Background:
 - First identification of “inviscid flow separation” during engine startup (1995)
 - Explanation and modeling for aerospike nozzle wake closure (1998) + 3D flows (collaboration with Paciorri, 2003)
 - First identification of possible side load issues in dual bell nozzles (“inflection region”) (2001)
- Recent activities:
 - Study of anomalies occurred during Vulcain 2 engine startup in flight V201 (engine shutdown in the launch pad)



Promozione attività di ricerca DIMA

F. Nasuti

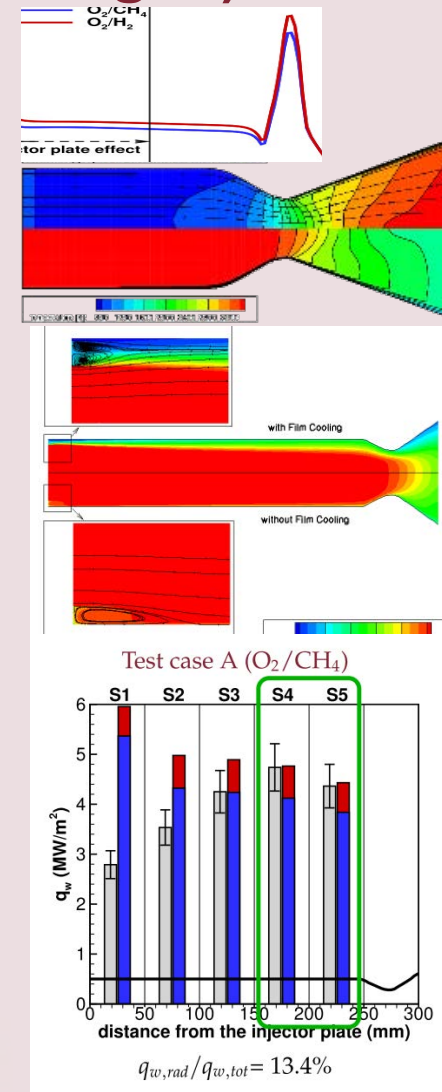
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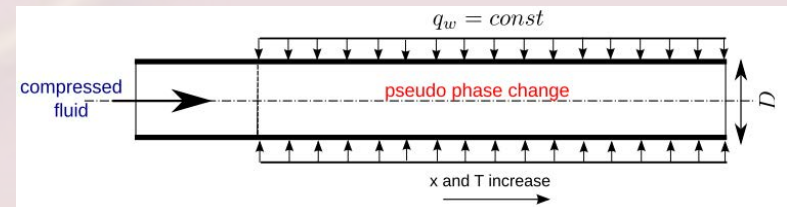
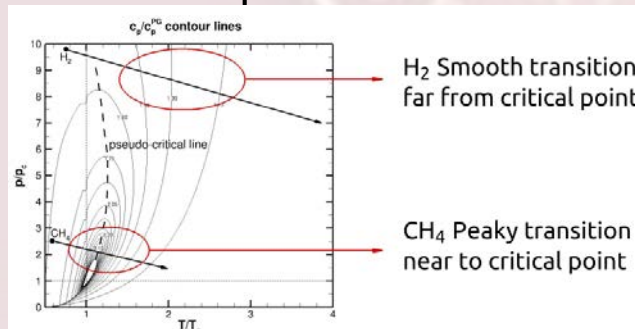
Heat loads (CFD-RANS simulations – ideal gas)

- DIMA personnel (all activities below): Nasuti
- Background (since ~ 2005):
 - Simulations of thrust chamber flows LOx/LH2 and LOx/LCH4
 - Film cooling (European FP7 Project)
 - Coupling with regenerative cooling system
- Recent activities
 - Role of recombination (collaboration Bianchi 2014)
 - Role of gas radiation (collaboration Lentini, Bianchi 2016)
- Ongoing activities
 - Ateneo: DNS and RANS evaluation of heat transfer downstream of a backward facing step aimed at numerical prediction of heat flux in rocket combustion chambers (collaboration Paciorri, Pirozzoli, Bernardini, Bianchi)
- Former DIMA personnel involved: Betti, Martelli



Supercritical fluid cooling of thrust chambers

- DIMA personnel (all activities below): Nasuti
- Background (since ~ 2005):
 - RANS 3D solver for supercritical fluids
 - PNS 2D solver for supercritical fluids
 - Analysis of heated ducts of circular cross section (axisymmetric flow)
 - Analysis of asymmetrically heated rectangular channels
 - Coupled computations including 3D solid walls heat transfer
- Collaborations: CIRA
- Ongoing activities
 - Ateneo (Pirozzoli): DNS/RANS comparison of heat transfer for supercritical methane flow over a flat plate
- Former DIMA personnel involved: Pizzarelli, Urbano

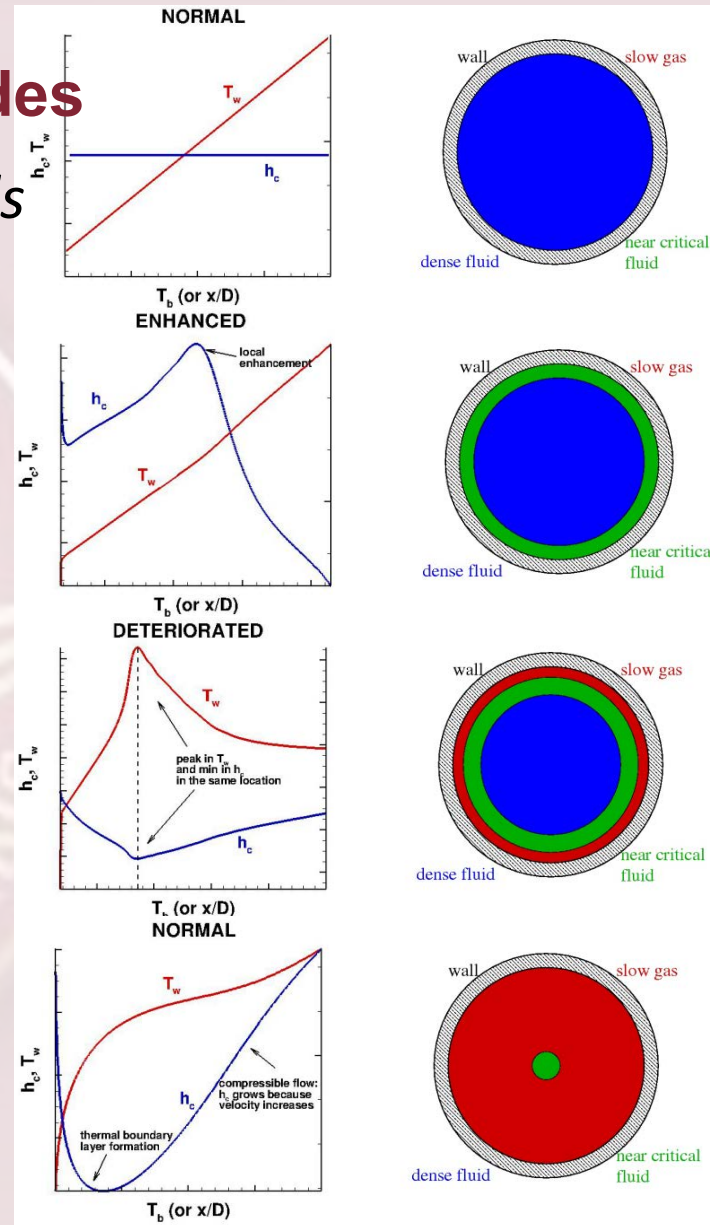
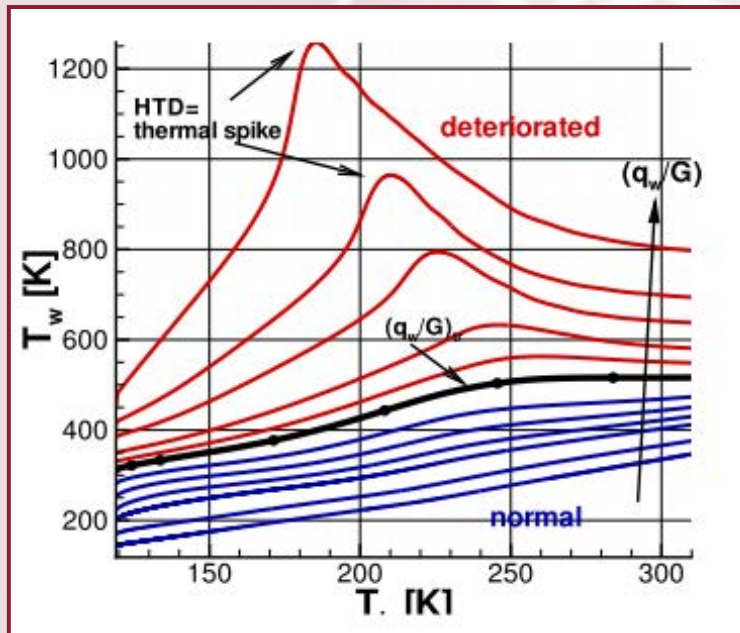


Supercritical pressure HT modes

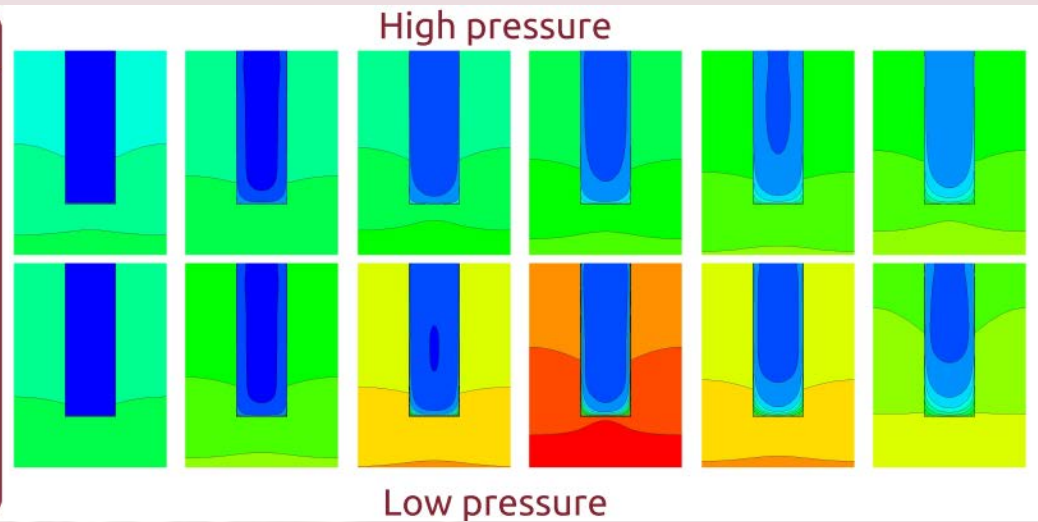
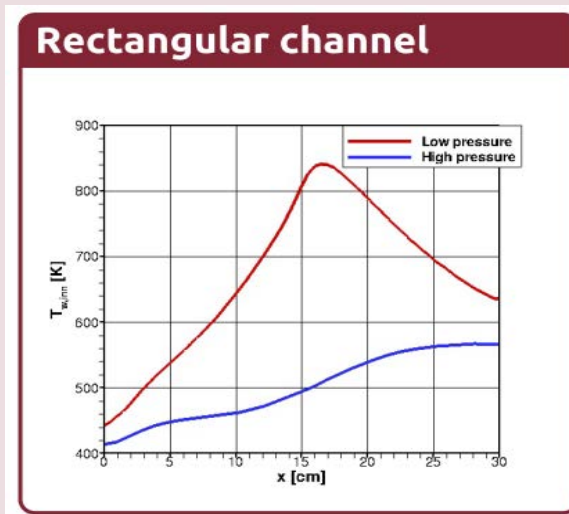
Heat transfer to supercritical fluids

1. Normal
2. Enhanced
3. Deteriorated
4. Normal

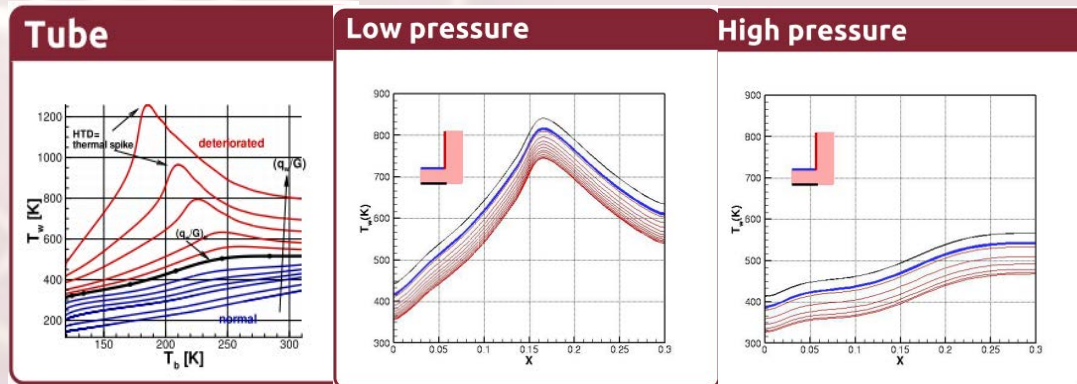
Threshold value $(q_w/G)_{tr}$



Wall temperature evolution

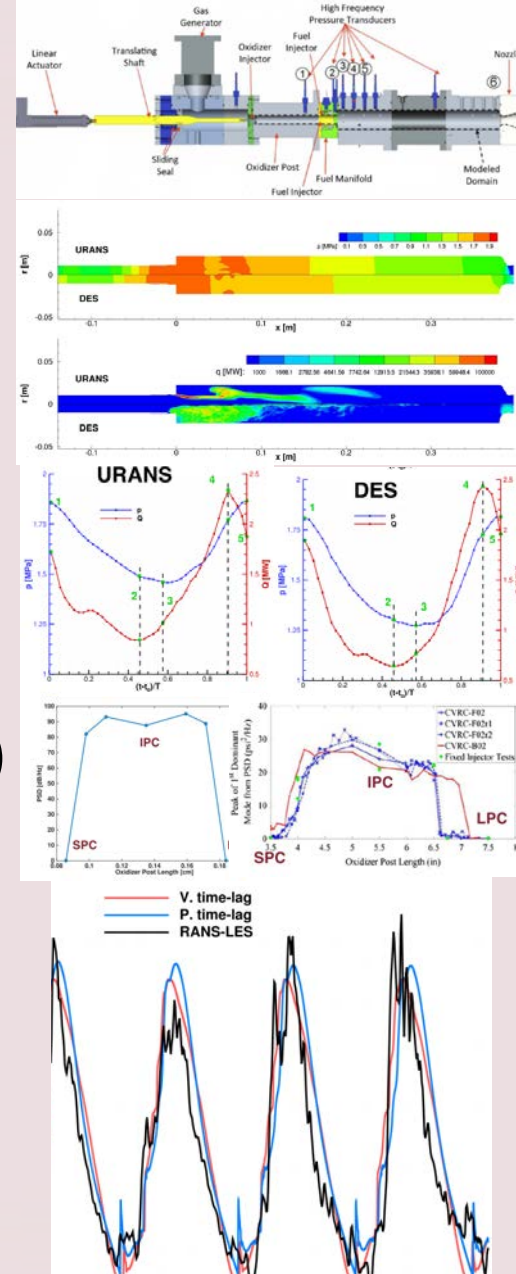


- Same kind of T_w transition as in tube
- Same behavior of wall temperature at all locations
- Evidence of HTD at low pressure
- Transcritical effects mitigated at high pressure



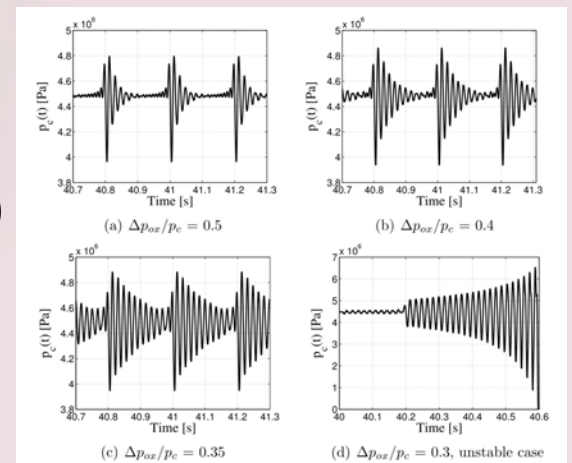
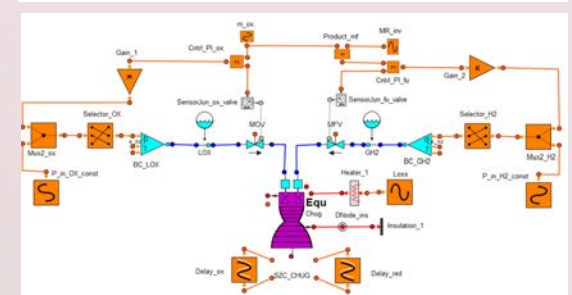
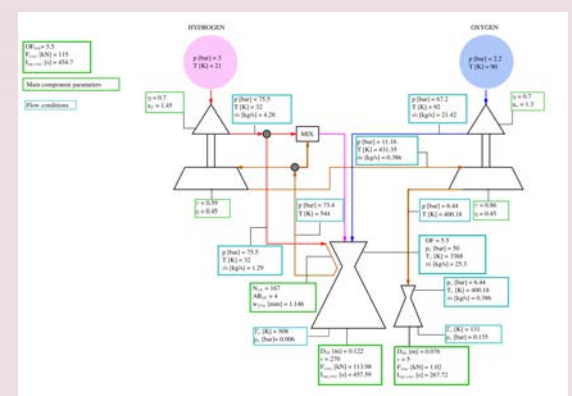
Combustion instability

- DIMA personnel (all activities below): Nasuti, Frezzotti
- Background (since ~ 2012):
 - 1D solver + n-tau response function model (collaboration with Favini, 2016)
 - URANS simulations of Purdue CVRC combustor
- Collaborations: Purdue University (Anderson)
- Ongoing activities
 - Further developments of the 1D model
 - URANS CFD simulations
 - Phd thesis aiming to extend modeling to multidimensional simulations



System analysis

- DIMA personnel (all activities below): Nasuti, Leonardi
- Background (since ~ 2012):
 - Component development aiming to increase performance of a system analysis solver (EcoSimPro) – [ESA sponsored activity]
 - System startup of Hydrogen expander bleed system
- Collaborations: Purdue University (Anderson)
- Ongoing activities
 - Methane fueled engine simulations
 - Chugging (low-frequency) instabilities



Micro-propulsion

- DIMA personnel: Nasuti, Piergentili
- Collaborations: Santoni (DIAEE), Balucani (DIET)
- Ongoing activities
 - Realization and in-orbit testing of a 2mN cold gas thruster with micromechanical/MEMS techniques (launch April 2017)

