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FLOXCOM

NNE5-1999-20246

Final meeting

Gioia del Colle, Italy, November 21st

Outline of the presentation

Activities performed in WP 6:

Hot Pressurised Tests of the Combustor Sector

- **Numerical activities. Results of three dimensional calculations of the FLOXCOM combustors type A1 and A2;**

- **Experimental activities. Setting up of the Laser Doppler Anemometry LDA at the Gioia del Colle site**

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Numerical Activities

Aims:

- To provide analyis of experimental data;
- To provide an insight of the phenomena occurring in the combustors
- To assess the accuracy of different combustion models in the actual combustion regime

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Numerical code setting

- **Calculations have been performed with the help of FLUENT 6.0 version code;**
- **We obtained grids with the help of FLUENT pre-processors. We imported CAD data from Technion.**
- **Combustion models:**
  - **Two step EBU (standard FLUENT);**
  - **Three step proprietary mechanism tuned for lean pressurized conditions**

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Combustion models choice

- Combustion is affected by both turbulence field and chemical kinetics;
- Combustion regime is considered neither as diffusion regime nor as premix “traditional” flame regime;

- **Although their physical meaning is weak, EBU-based models are widely used in combustion modeling.**

- **Three step ARI mechanism has been validated in pressurised low Damkhoeler conditions.**

Validation with experimental data is required

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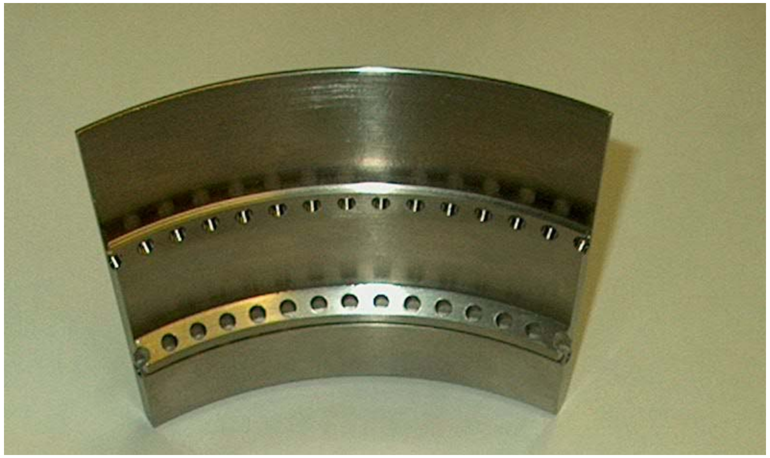
Cases performed

- **We analysed both Type A1 and Type A2 geometry, according to measurements**



Air inlet holes system. Type A1; holes aligned.
Type A2 holes staggered

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Computational grids (1)

- **Grids consist of a 3D sector, which includes both three adjacent air holes (sector 12.8 degree) and six gaseous fuel injectors;**
- **Grids include solid part combustor walls;**
- **Periodic conditions set**

Approximations;

  - **side wall effect neglected;**
  - **side air dilution neglected (calculations simulate the central zone of the combustor, where measurements occurred);**
  - **fuel and air injector periodicity not exact (error of 10%)**

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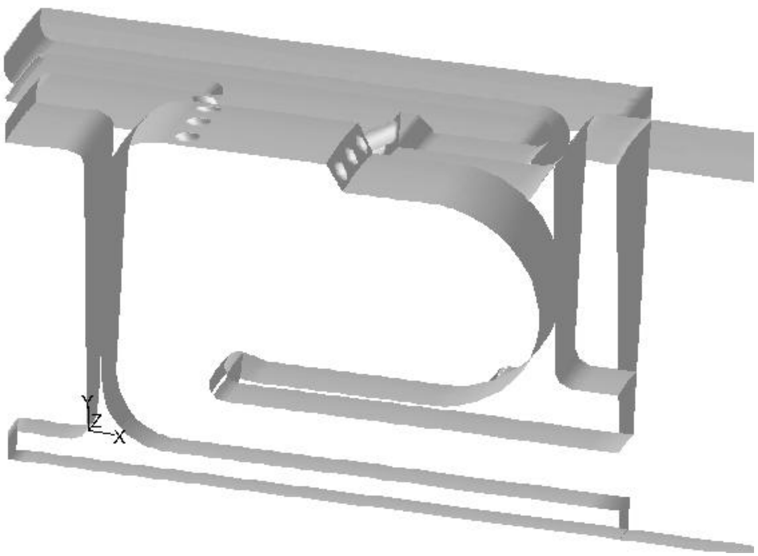
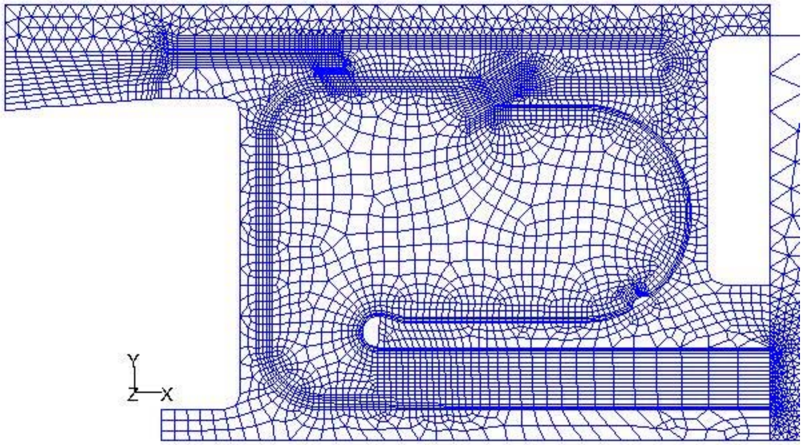
Computational grids (2)

- **Multiblock structured-non structured grid. Structured layer at both inner burner wall and air inlet ducts**





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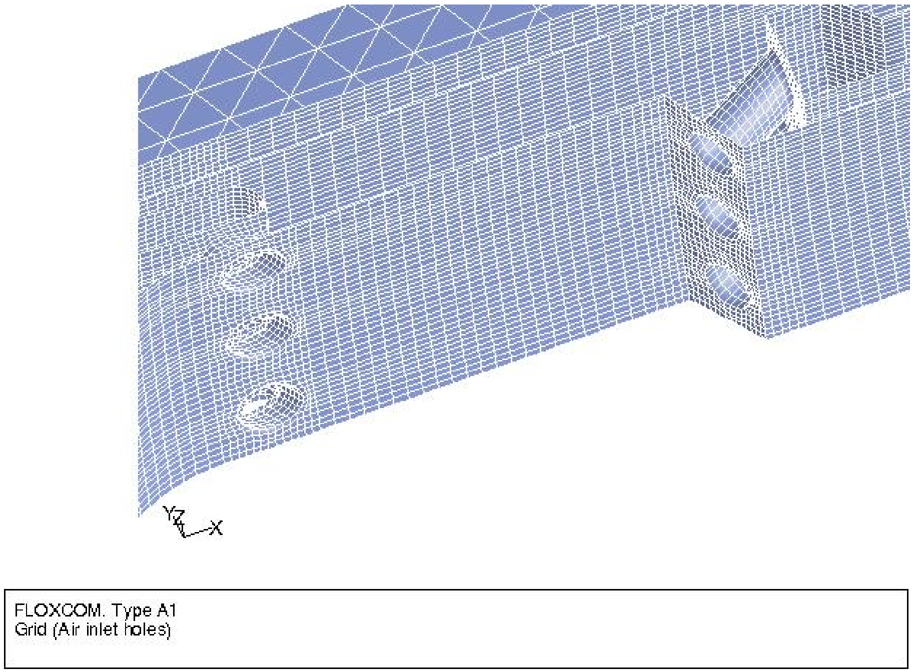
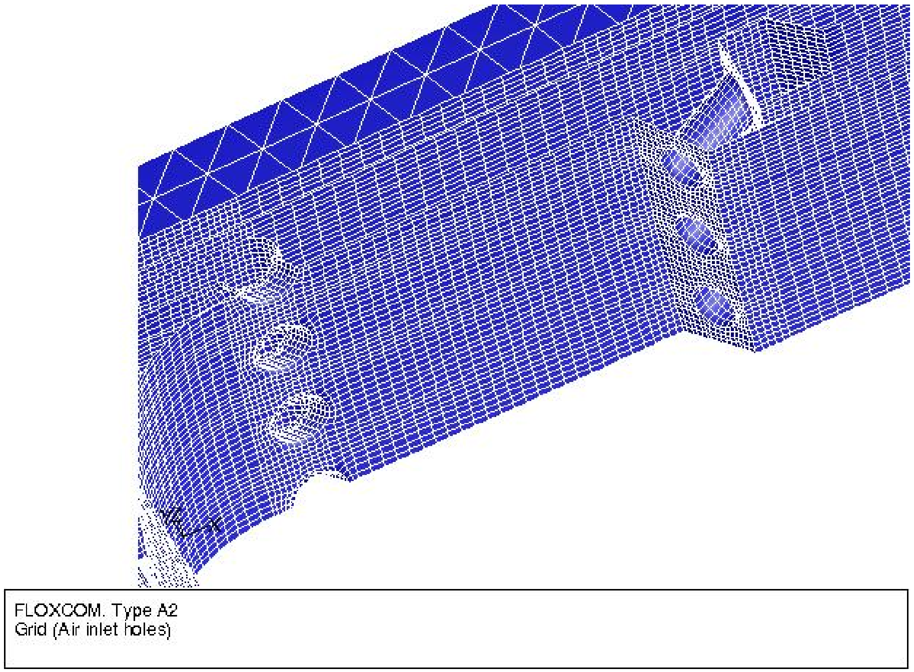
Computational grids (3)





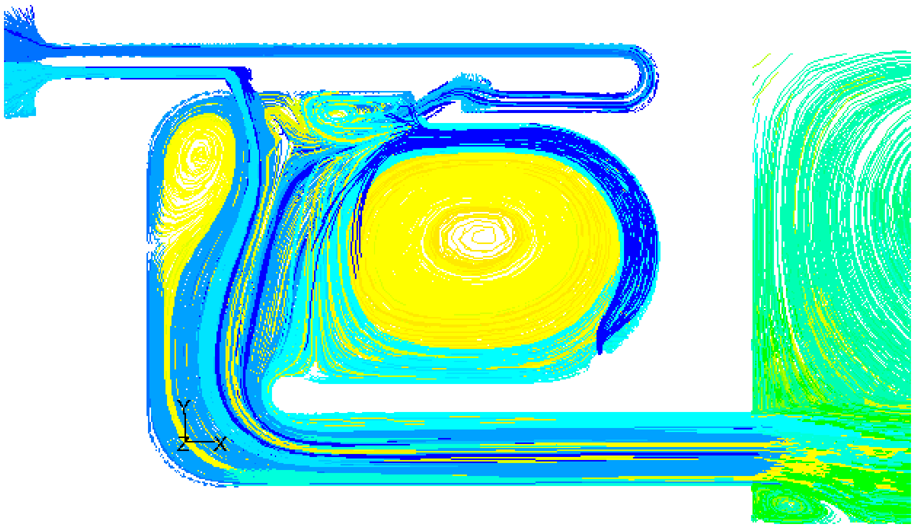
Type A1. Air holes aligned

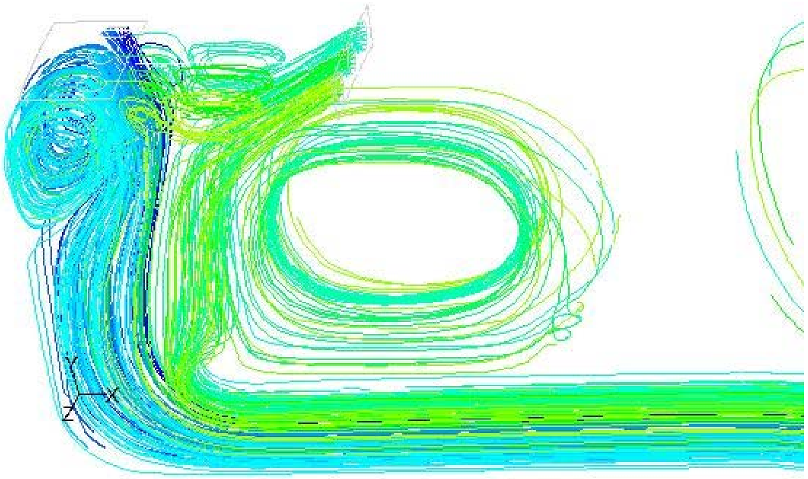
Type A2: Air holes staggered

Results (1.1)

Type A1 results

Flow field

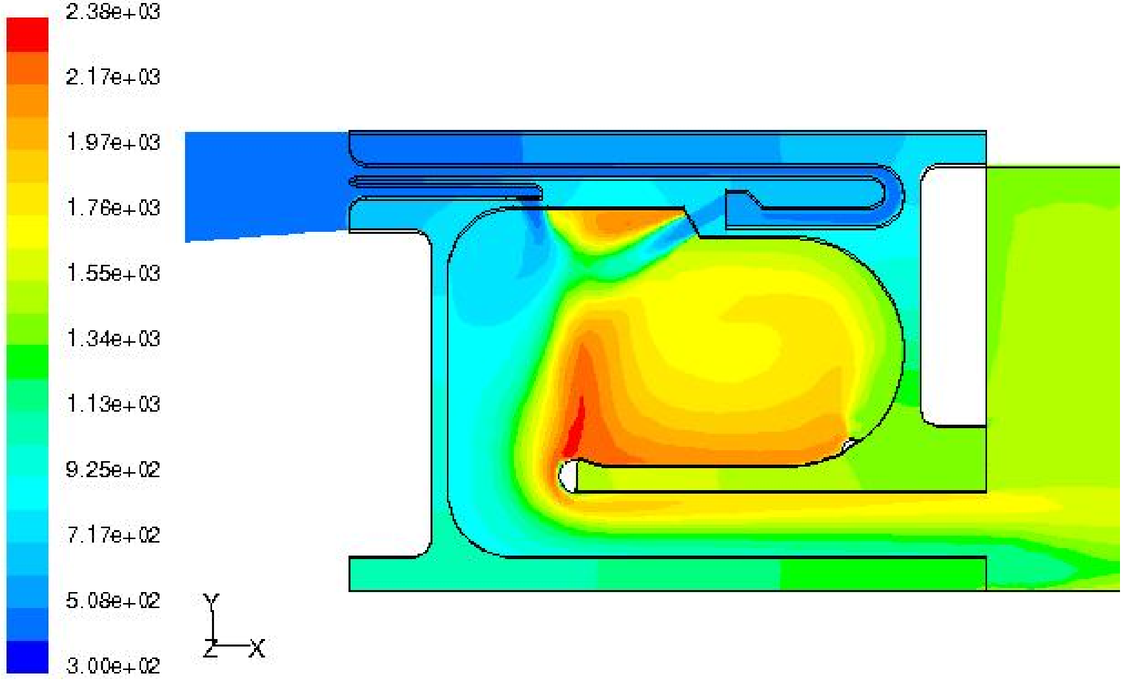




Results (1.2)

Type A1 results

Temperature



FLOXCOM. Type A1
Contours of Static Temperature (k)
Meridional plane crossing air holes axis

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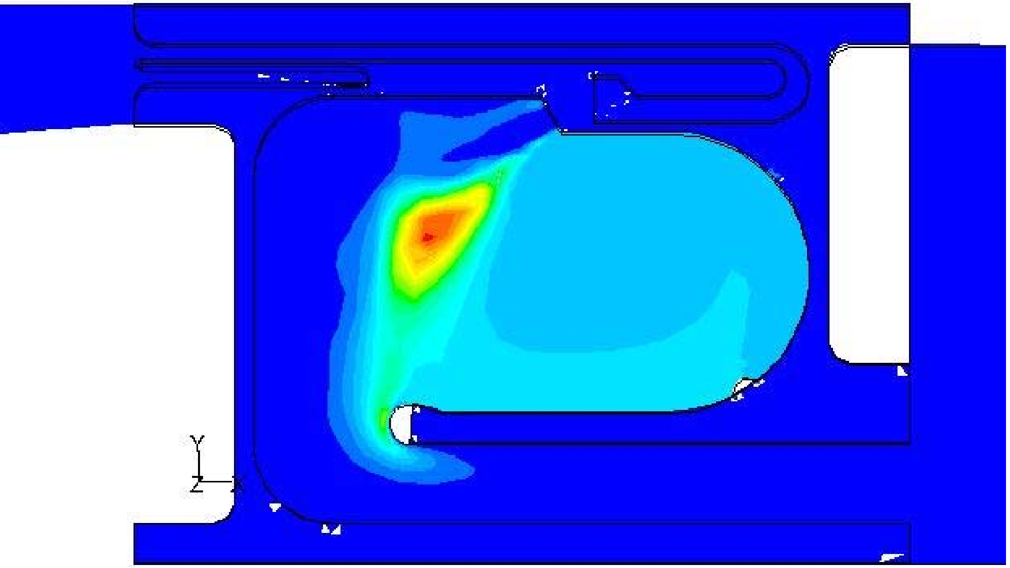
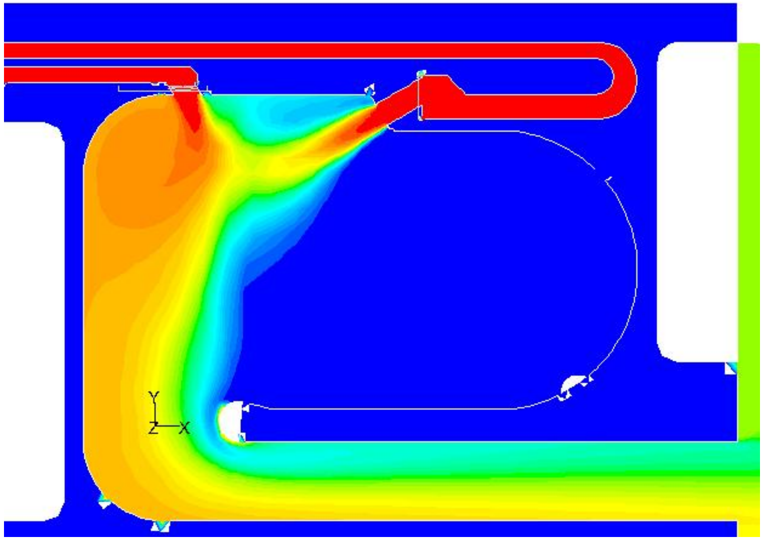
Results (1.3)

Type A1 results

Chemical reactions



CO Mole fraction



O2 Mole fraction

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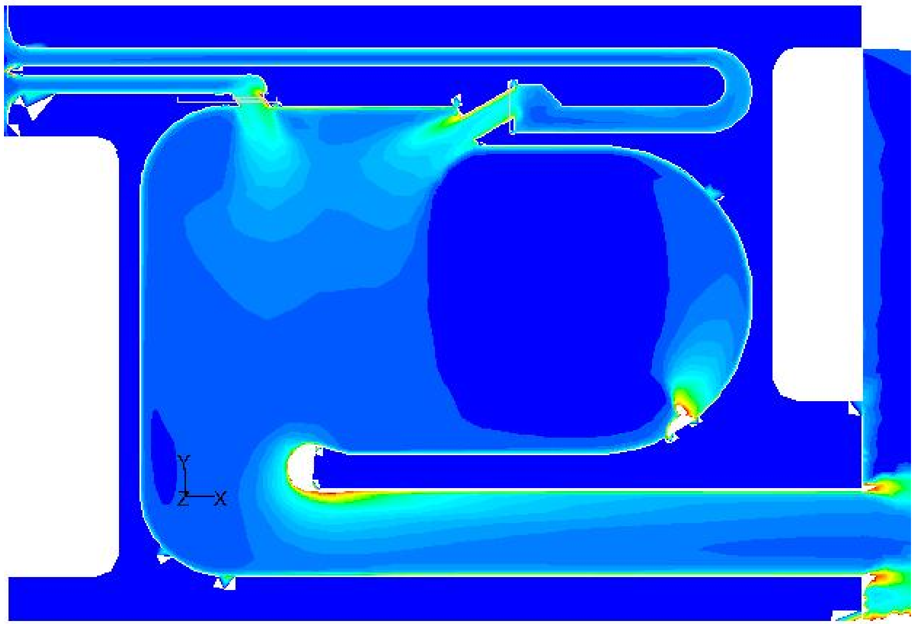
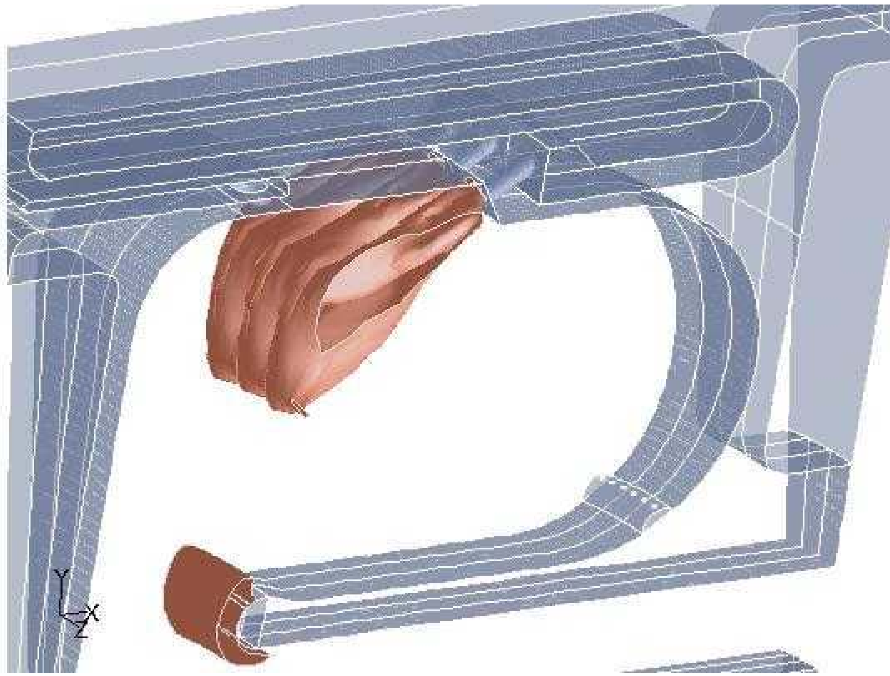
Results (1.4)

Type A1 results

Chemical reactions



Turbulence frequency



Constant reaction rate surface

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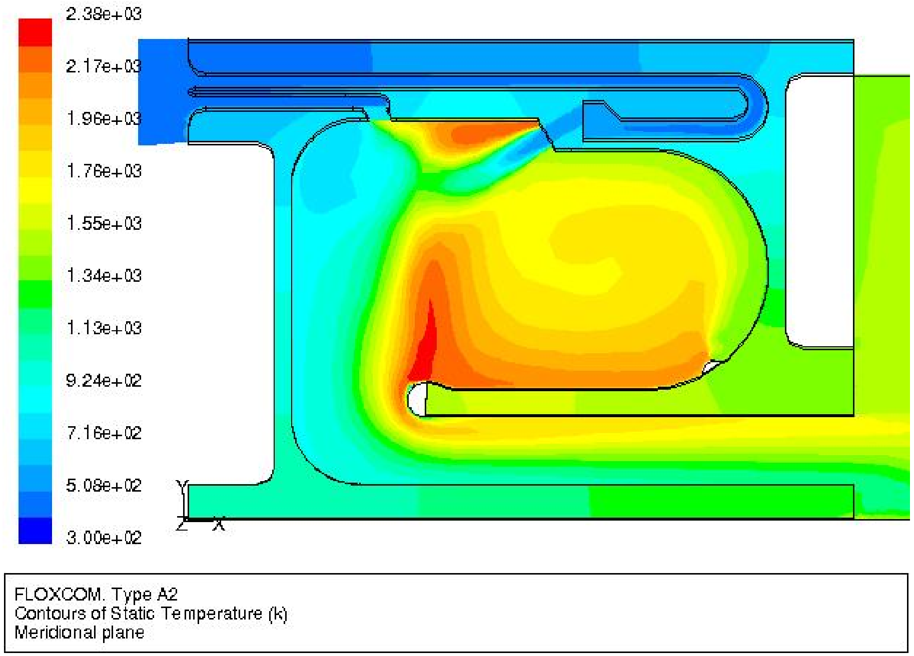
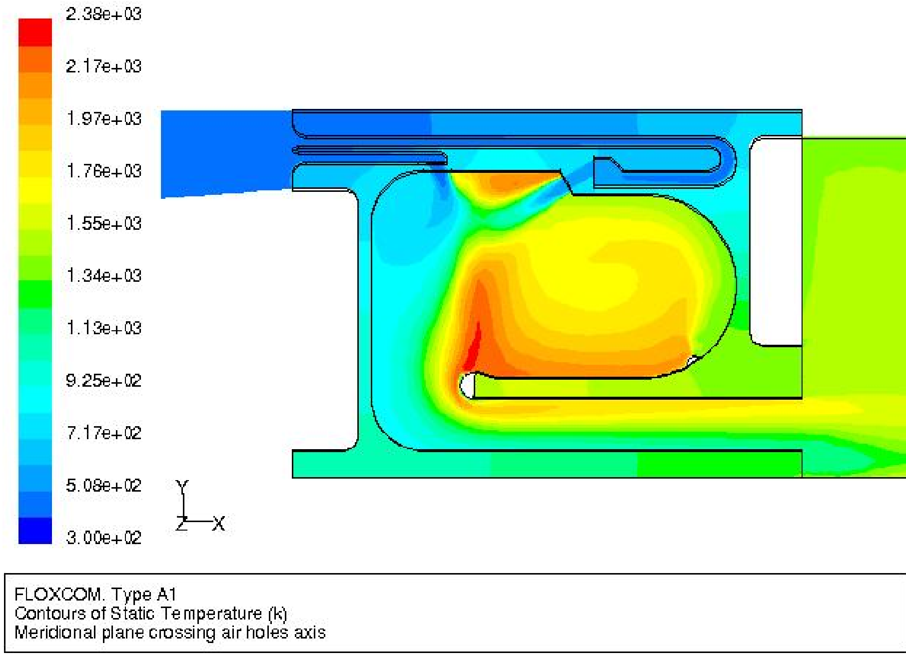
Results (2)

- **Type A2 results.**
- **No relevant differences between two cases**

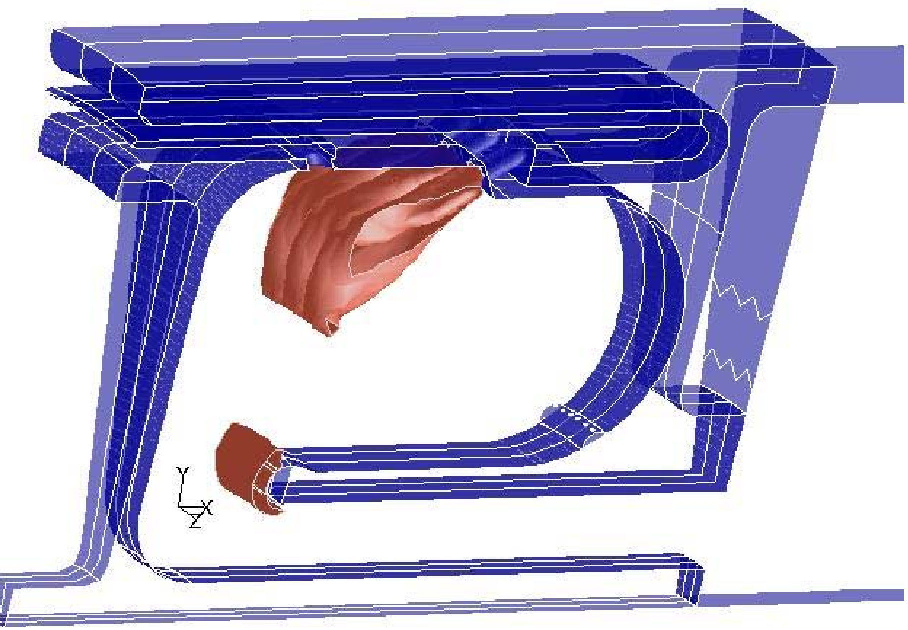




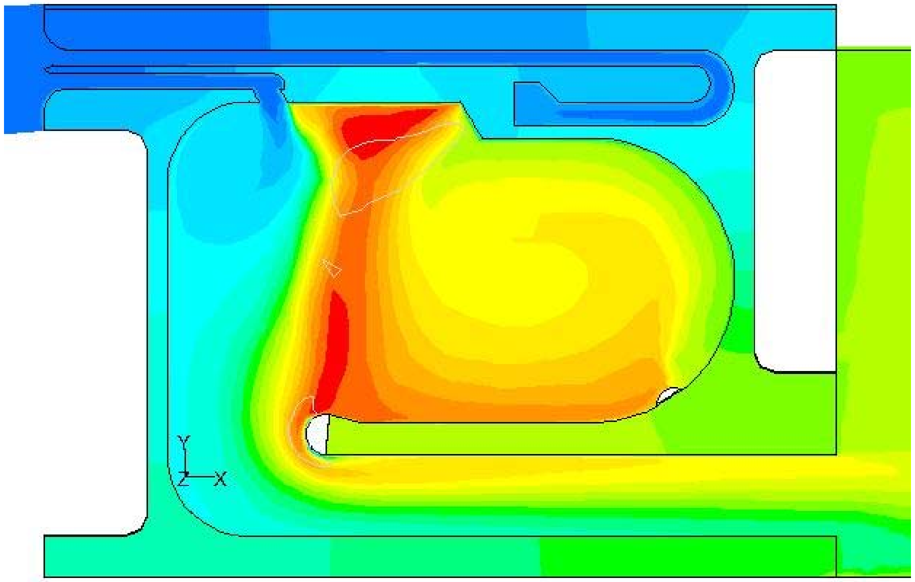
Type A2 **Temperature field** **Type A1**

Results (2)

- **Type A2 results. Chemical reactions**



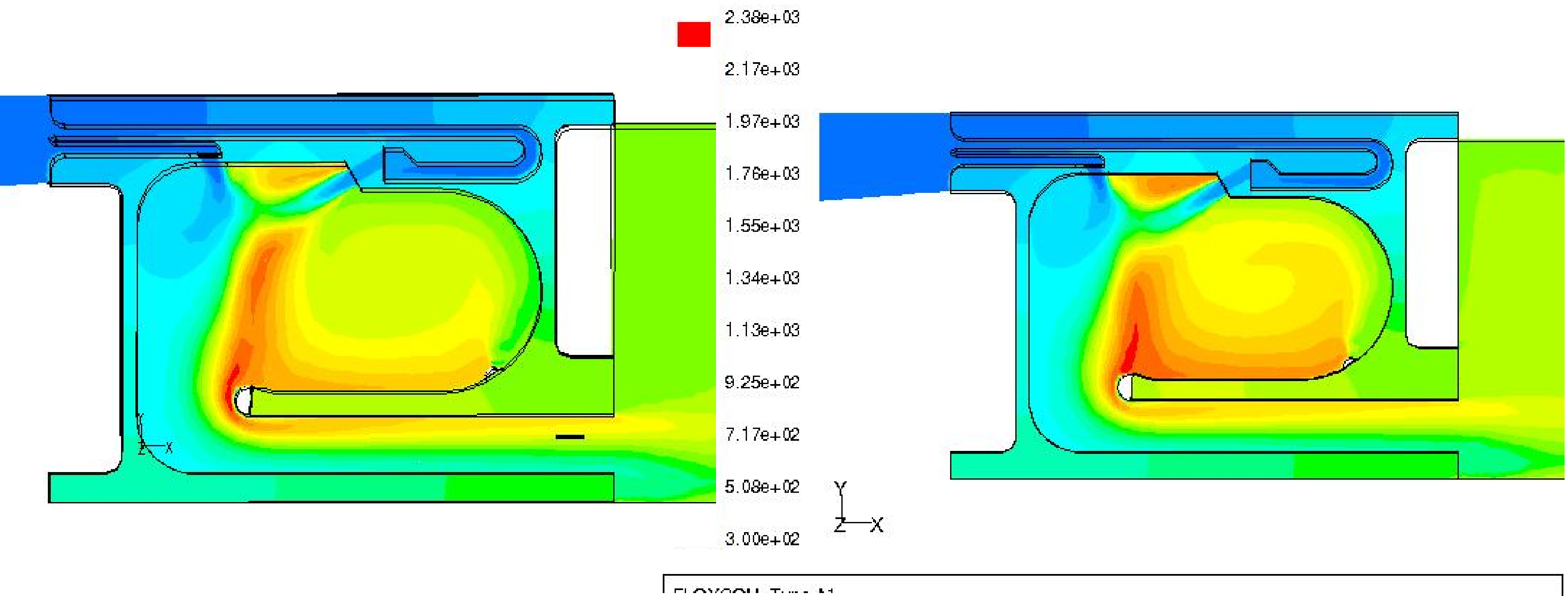
Surface of constant reaction rate



Temperature field on periodic surface

Results (3)

- **Type A1. Three-step mechanism results**



Three step **Temperature** **Standard UBU Two step**

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Numerical activities. Main conclusions

- **Flow field: a stable recirculation zone is established in the combustion zone. Air holes systems allow fresh air trapping within this zone;**

- **Inside combustion zone, the average temperature of the mixture is higher than required for flameless oxidation;**

- **EBU shows one flame front rather than homogenous diffused oxidation. This is likely to be due to combustion model limits (reaction rate is limited by turbulence parameters);**

- **Both CO and unburned hydrocarbon are negligible at the combustor outlet**

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Experimental activities

Aims:

- **To prepare LDV measurement system suitable for FLOXCOM combustor**
- **To set up the LDA system at the Gioia del Colle test rig**
- **To perform measurements and to elaborate their data**
- **To understand data together with numerical results**

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LDA system lay-out

- Laser beam geometry;
  - we investigated laser optics across two inclined windows in order to assess main diagnostics parameters (data valid,…)
- Insemination system
  - We built and mounted the cyclone insemination system on the test rig
- LDA systems transferred from ARI labs. Genoa to Gioia del Colle labs.
- Suitable synchronisation of laser diagnostics with other diagnostics is provided

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LDA measurements

- We are ready to perform in-field measurements on the pressurised sector in the nominal conditions
- Measurements scheduled in the second half of November 2003

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General Conclusion

- Work in the WP 6 carried out following original planning. Activities performed in strictly co-operation with Ansaldo Caldaie

- Results/Outputs of the project are of relevant interest as for:
  - Exploitation of novel technologies in Gas Turbine industry;
  - Knowledge in combustion technologies
  - Last but not least…meeting a great group of competent, kind, warm people

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