Title

FLOXCOM – LOW NO_x FLOX COMBUSTOR FOR HIGH EFFICIENCY GAS TURBINES

WP4 – Fuel Injection System Development

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WP4 – Main Tasks

Task 4.1 Design and construction of the wind tunnel and different sets of water atomisers and air injectors;

Task 4.2 Construction of the combustor model;

Task 4.3 Numerical simulation of the combustor model;

Task 4.4 Experimental investigation of the fuel supply system;

Task 4.5 Testing of the combustor model.

Task 4.5 Testing of the Combustor Model

Experimental study of the combustion model at atmospheric pressure:

Under non reacting conditions:

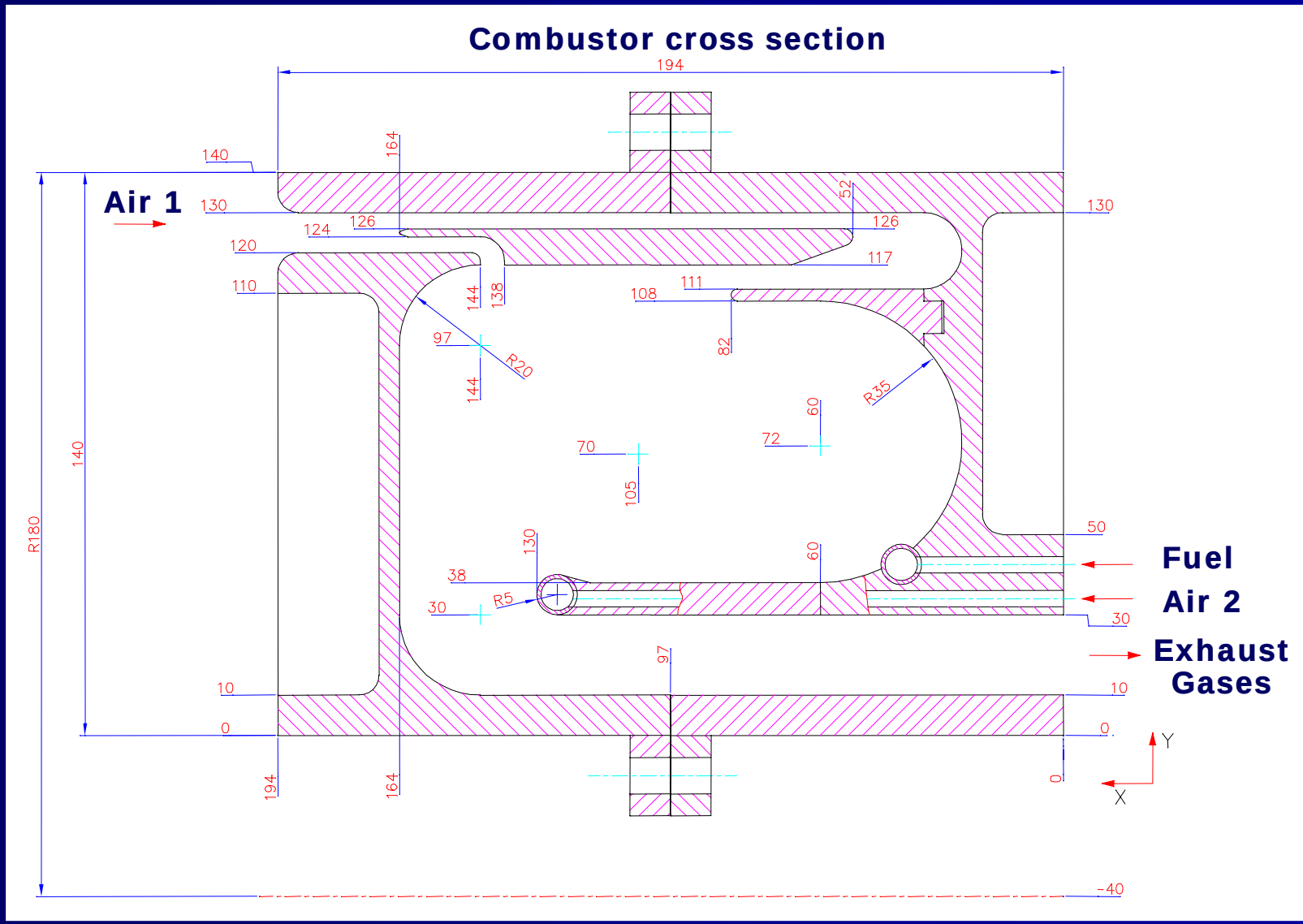
mean and turbulent velocities

Under reacting conditions:

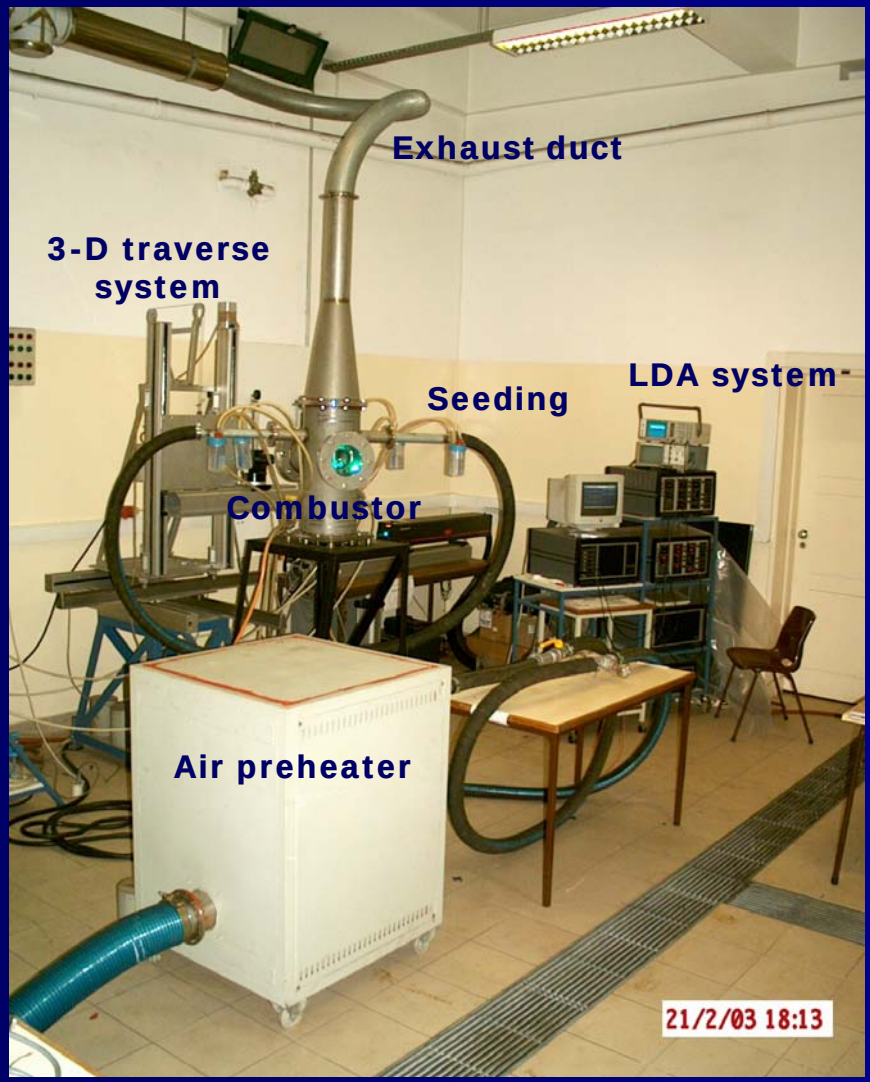
mean gas species concentration

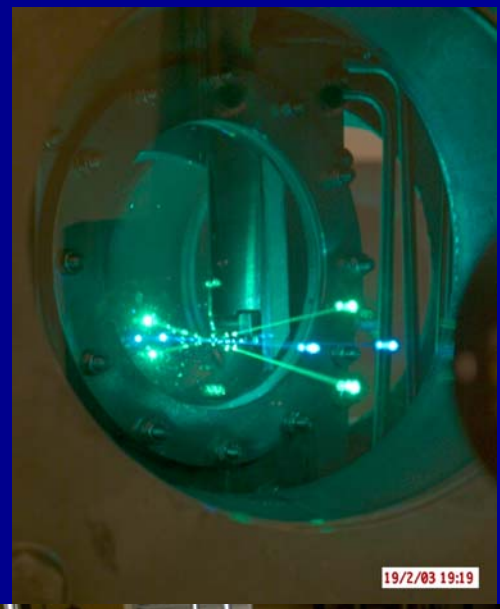
(O_2, CO_2, CO, NO_x, HC).

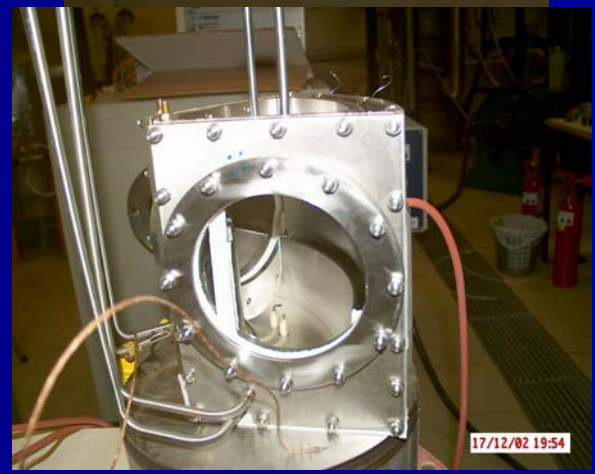
Geometry of the Combustor: Original Model



Experimental Set-up







Study Under Non-Reacting Conditions

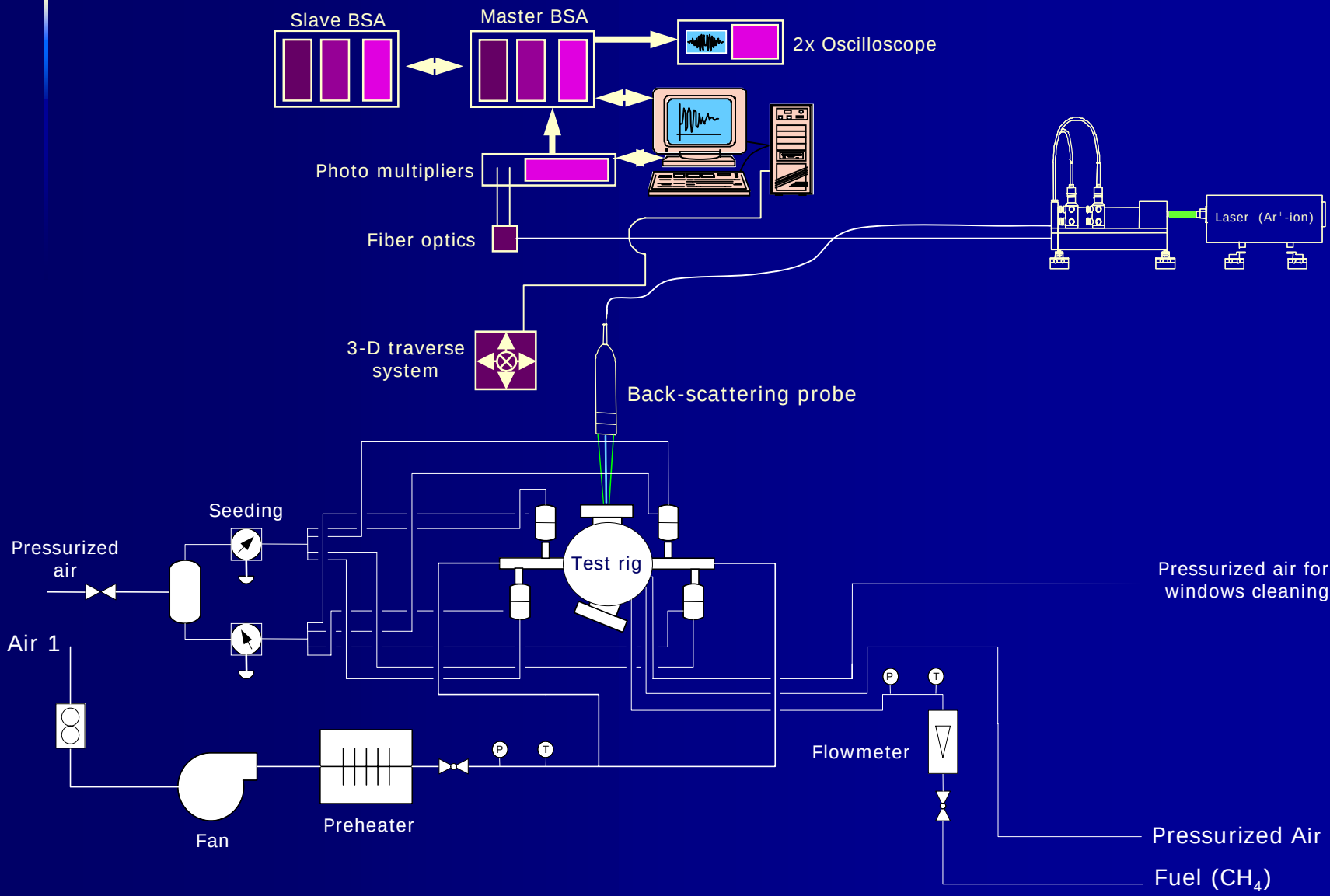
Variables considered:

flow rate of air 1;
preheating of air 1.

Data include:

mean and turbulent velocities.

LDA Measurement System



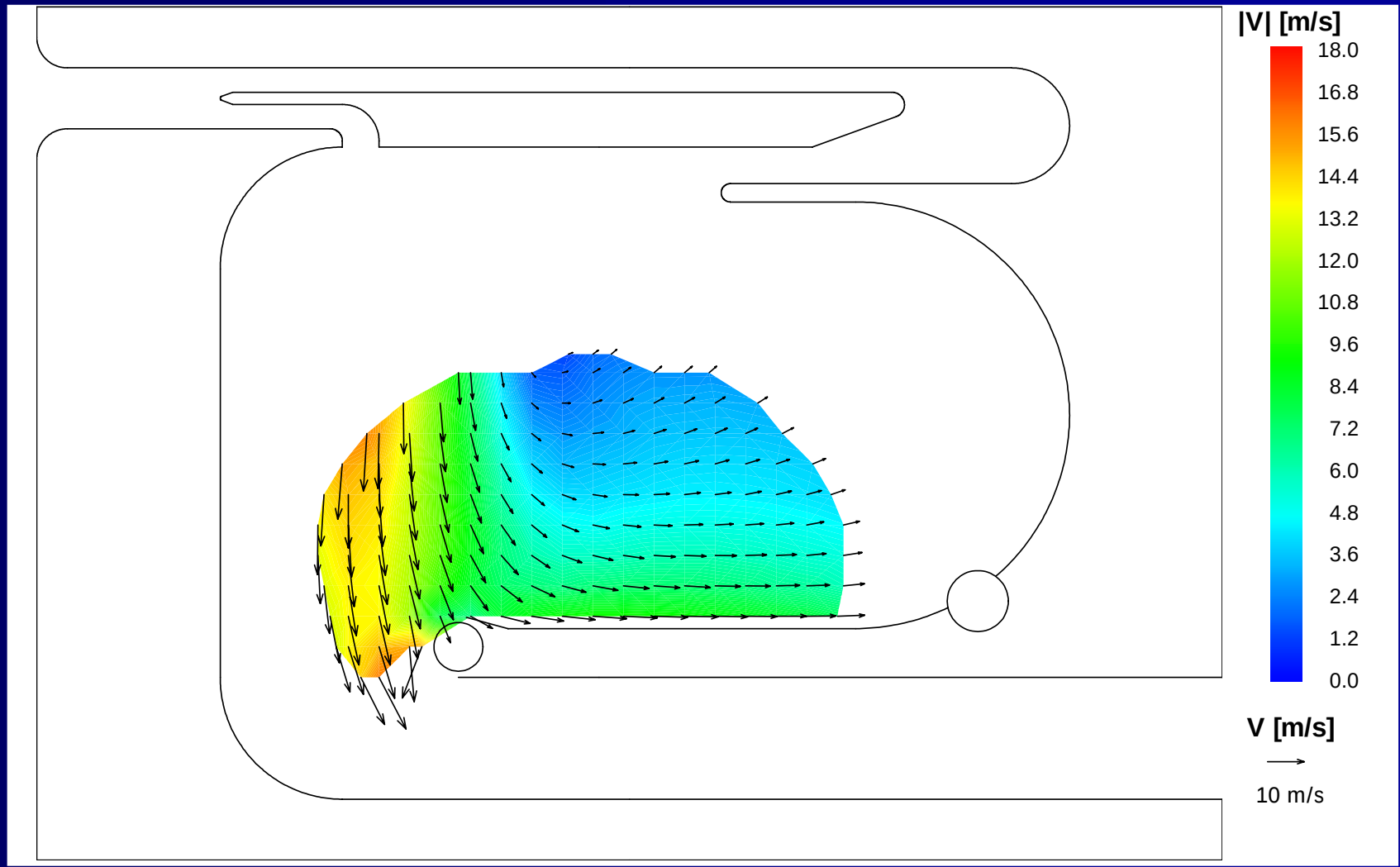
Test Conditions

Test Condition	Air 1			Fuel (Air*)		
	Flow rate [kg/s]	Temperature [K]	Pressure [mbar]	Flow rate [kg/s]	Temperature [K]	Pressure [bar]
1	0.120	293	220	0.00317	293	2.4
2	0.120	330	230	0.00317	293	2.4
3	0.095	330	110	0.00317	293	2.4
4	0.070	330	40	0.00317	293	2.4

*fuel simulation

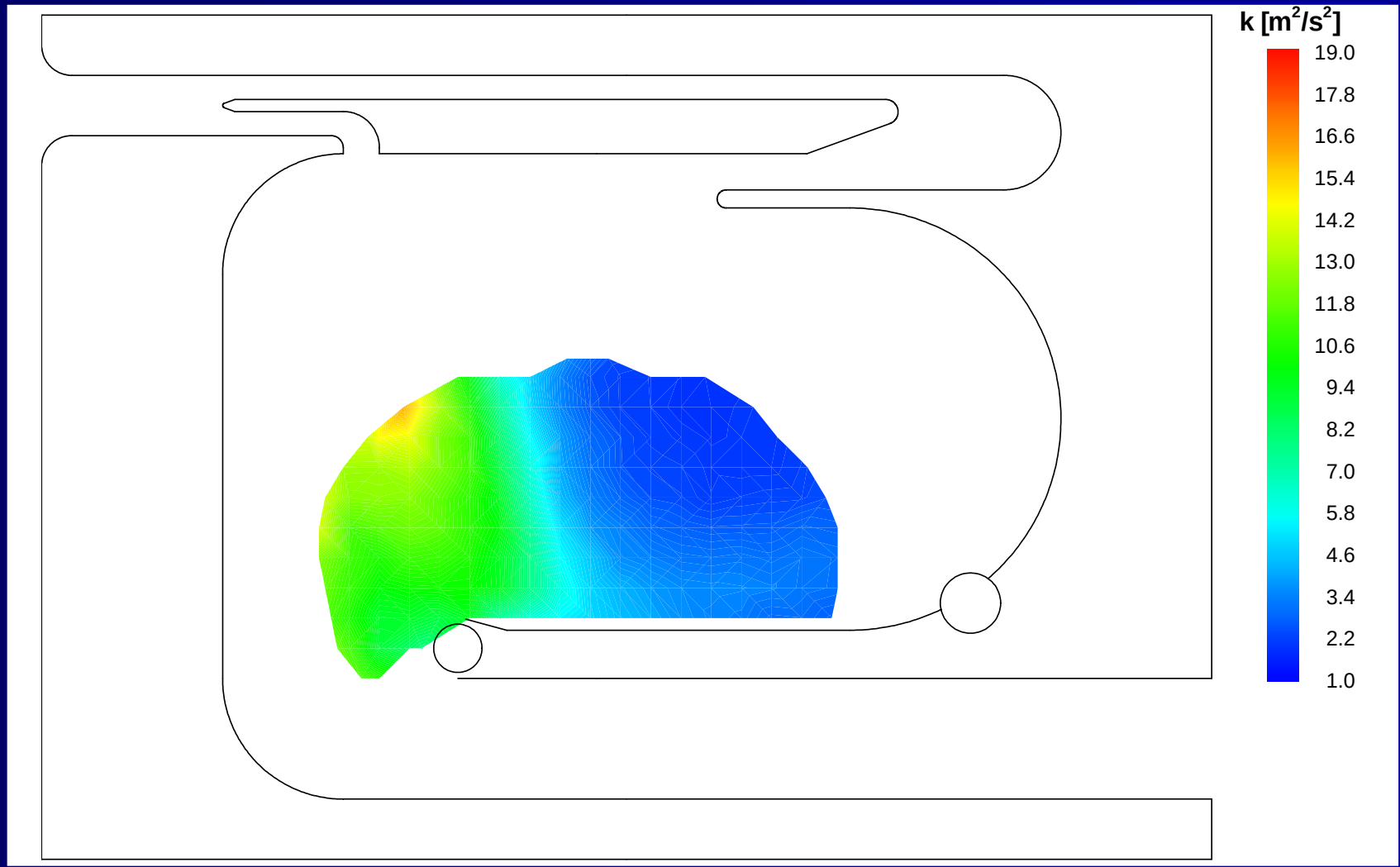
Typical Result for the Mean Flow Structure

Test condition 2 - Air 1: 0.12 kg/s



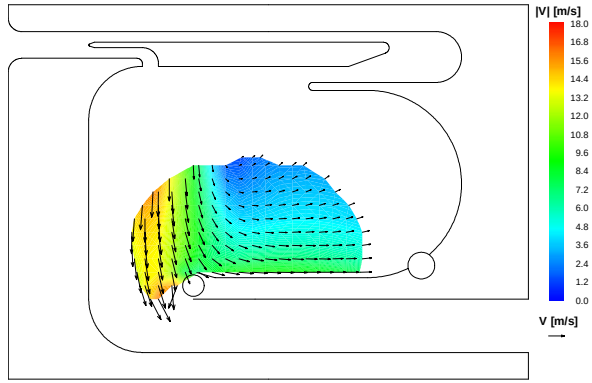
Typical Result for the Turbulence Kinetic Energy

Test condition 2 - Air 1: 0.12 kg/s

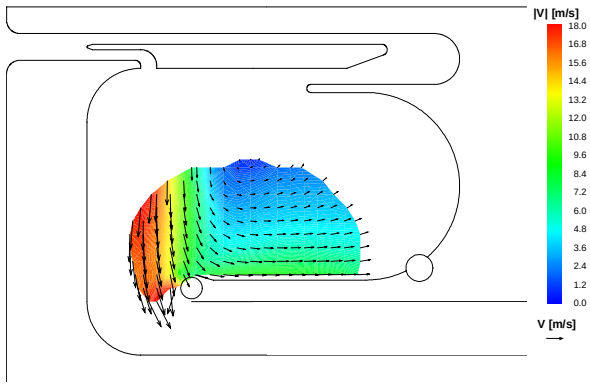


Effect of the Air 1 Flow Rate on the Mean Flow Structure

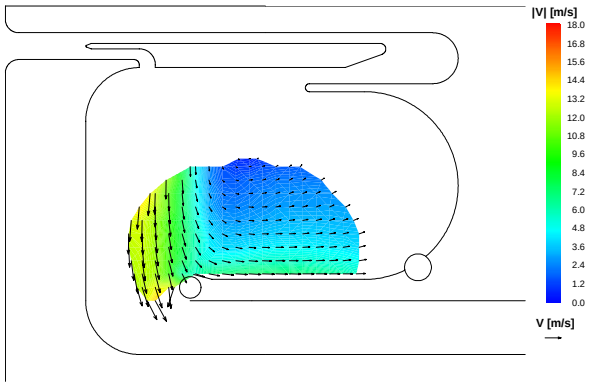
Test condition 2
Air 1: 0.12 kg/s



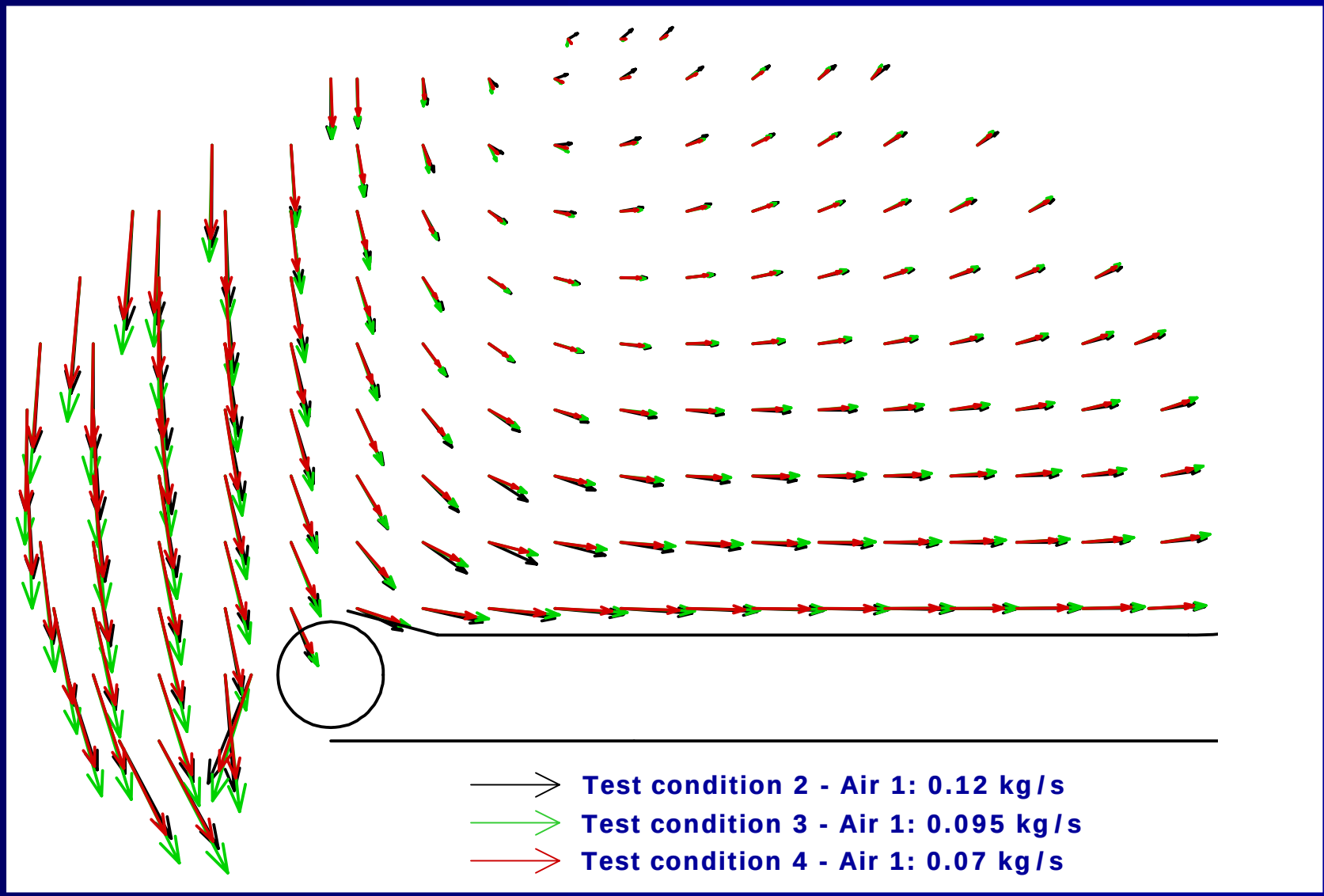
Test condition 3
Air 1: 0.095 kg/s



Test condition 4
Air 1: 0.07 kg/s

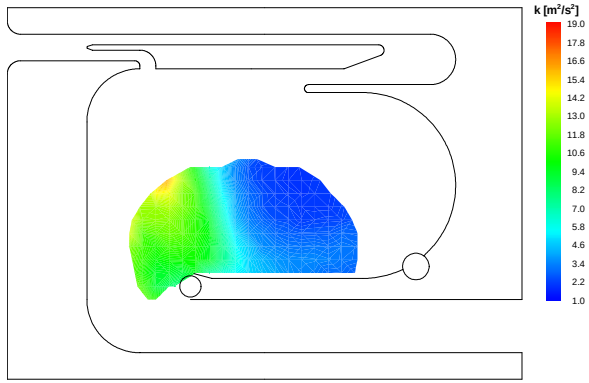


Effect of the Air 1 Flow Rate on the Mean Flow Structure (cont.)

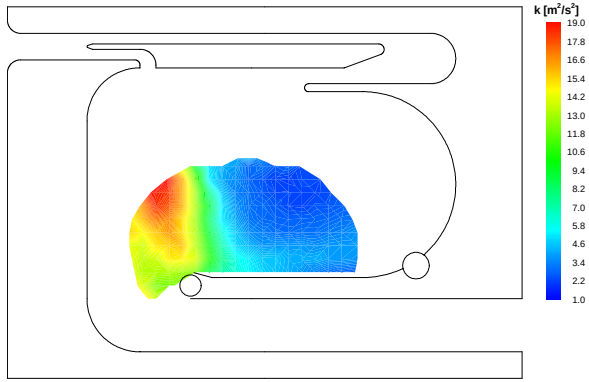


Effect of the Air 1 Flow Rate on the Turbulence Kinetic Energy Contours

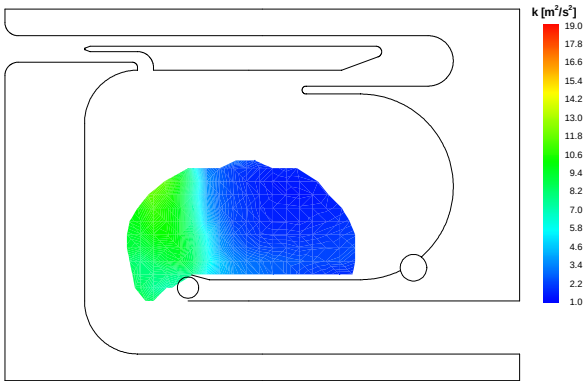
Test condition 2
Air 1: 0.12 kg/s



Test condition 3
Air 1: 0.095 kg/s

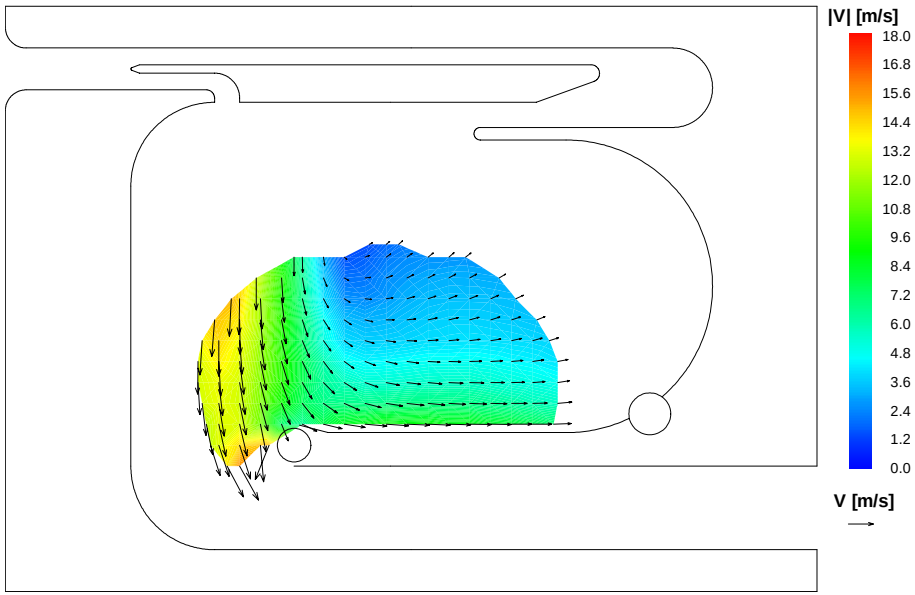


Test condition 4
Air 1: 0.07 kg/s

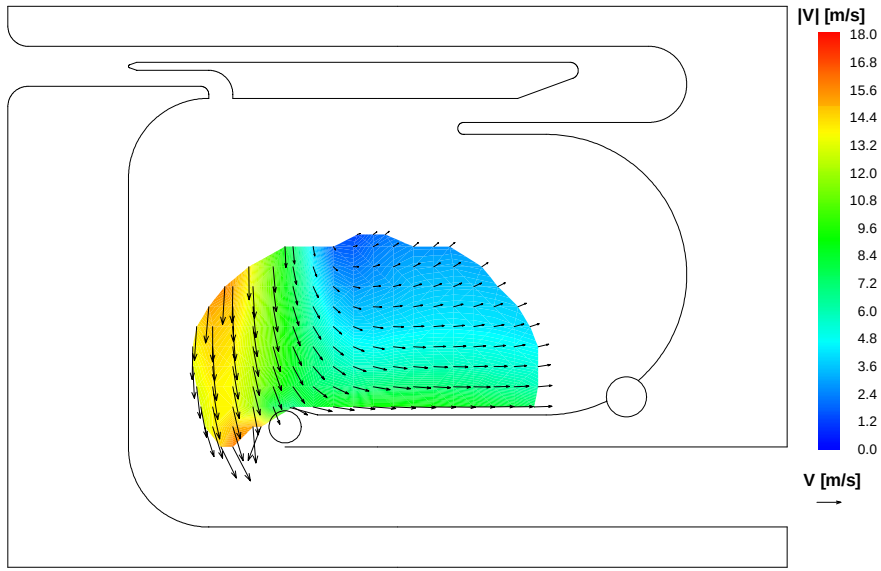


Effect of the Air 1 Inlet Temperature on the Mean Flow Structure

Test condition 1
Temperature of Air 1: 293 K



Test condition 2
Temperature of Air 1: 330 K



Non-Reacting Conditions: Conclusions

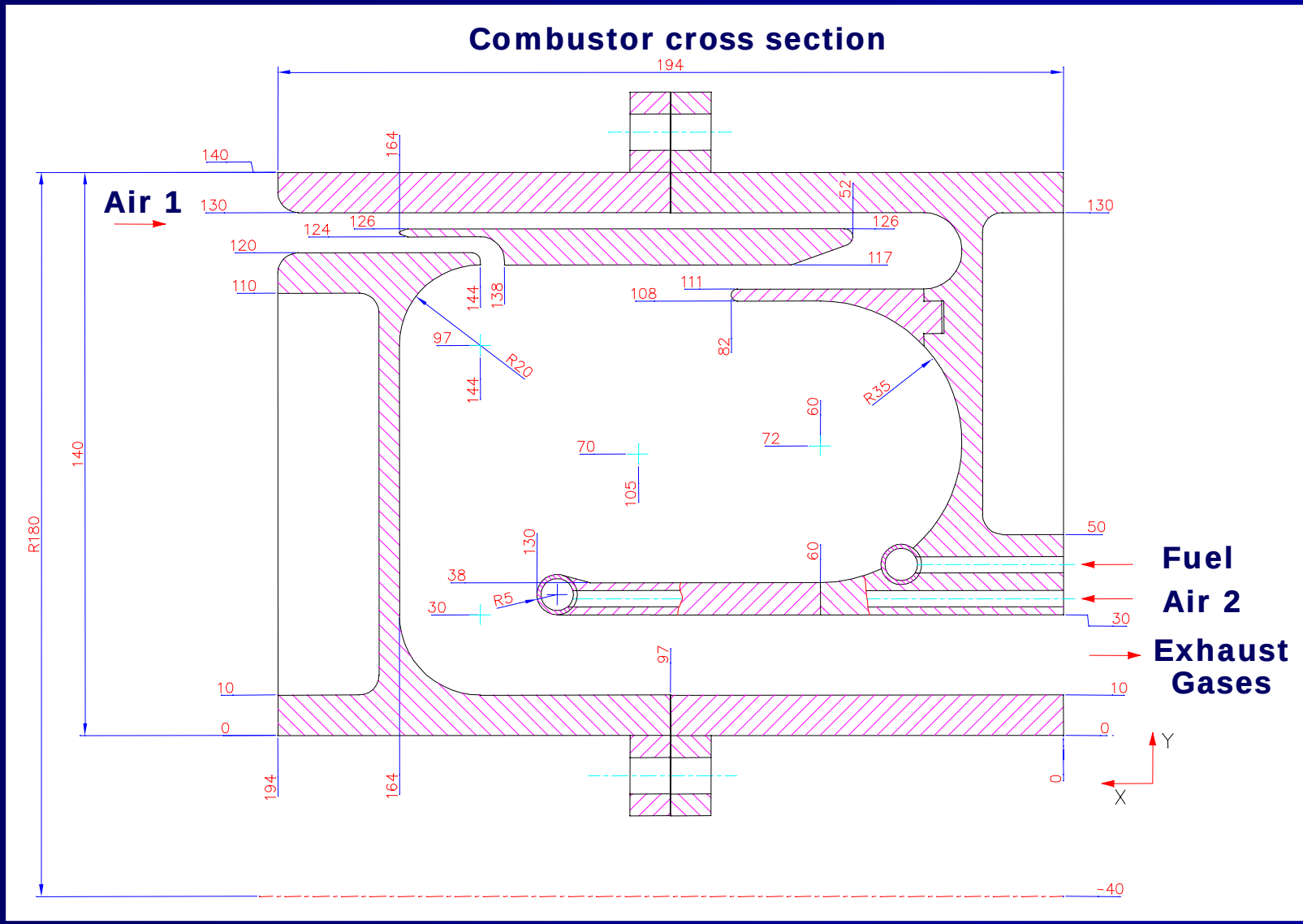
A common feature to all test conditions is the establishment of a large recirculation zone.

Mean and turbulent velocities increase within the recirculation zone as the flow rate of Air 1 increases.

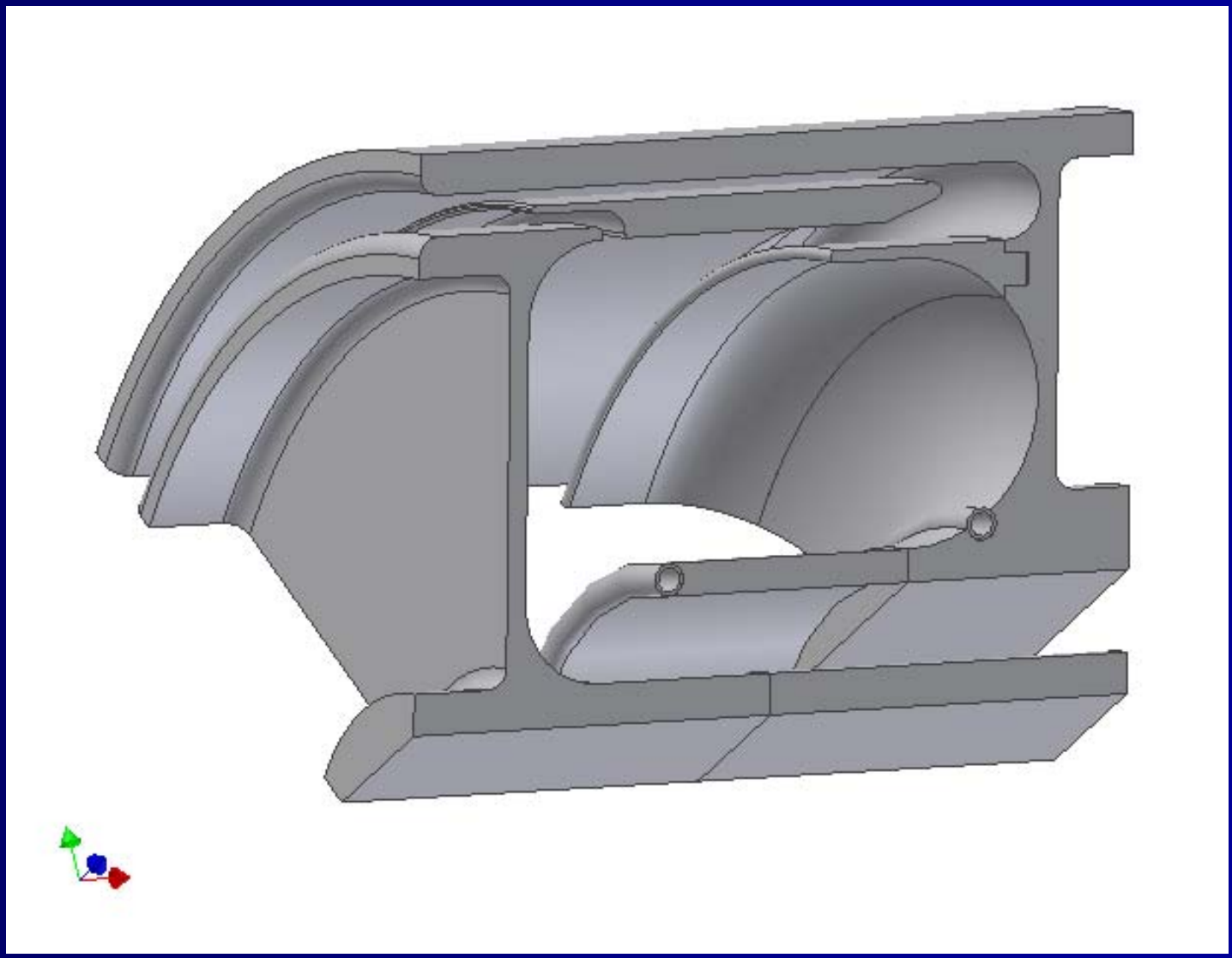
Near the combustor outlet the mean and turbulent velocities are higher for the intermediate Air 1 flow rate tested.

Effect of the inlet temperature of Air 1 on the flow field is marginal.

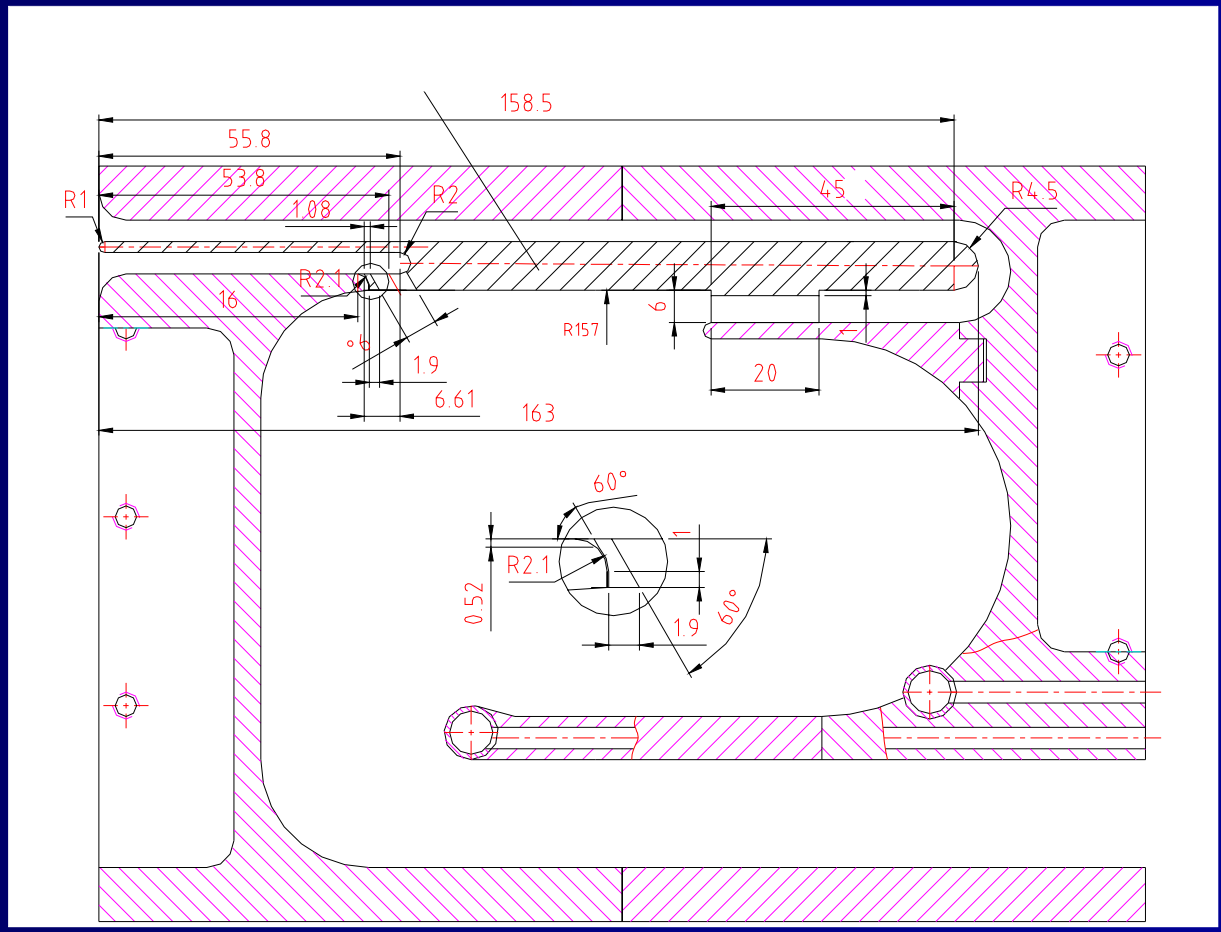
Geometry of the Combustor: Original Model



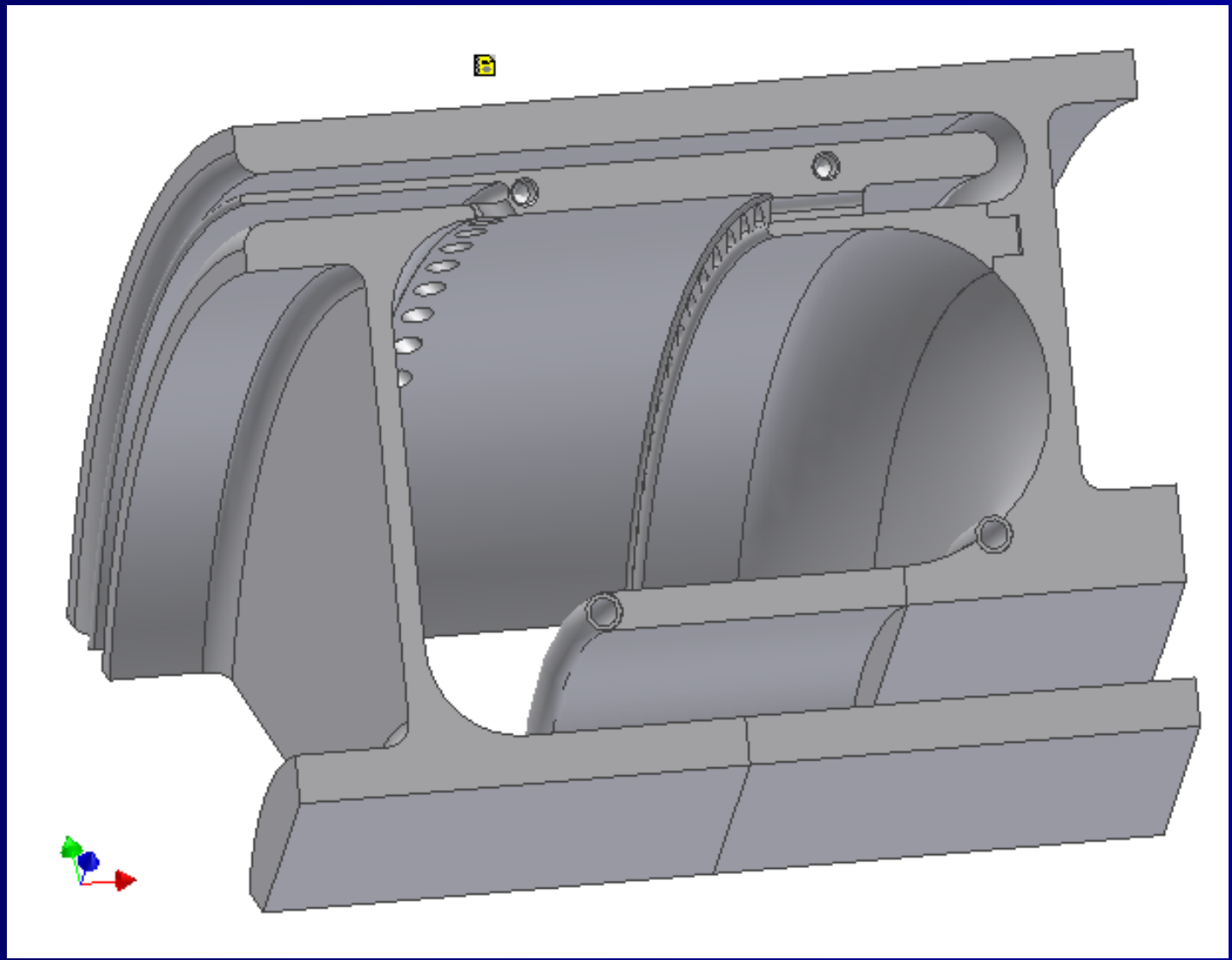
Geometry of the Combustor: Original Model



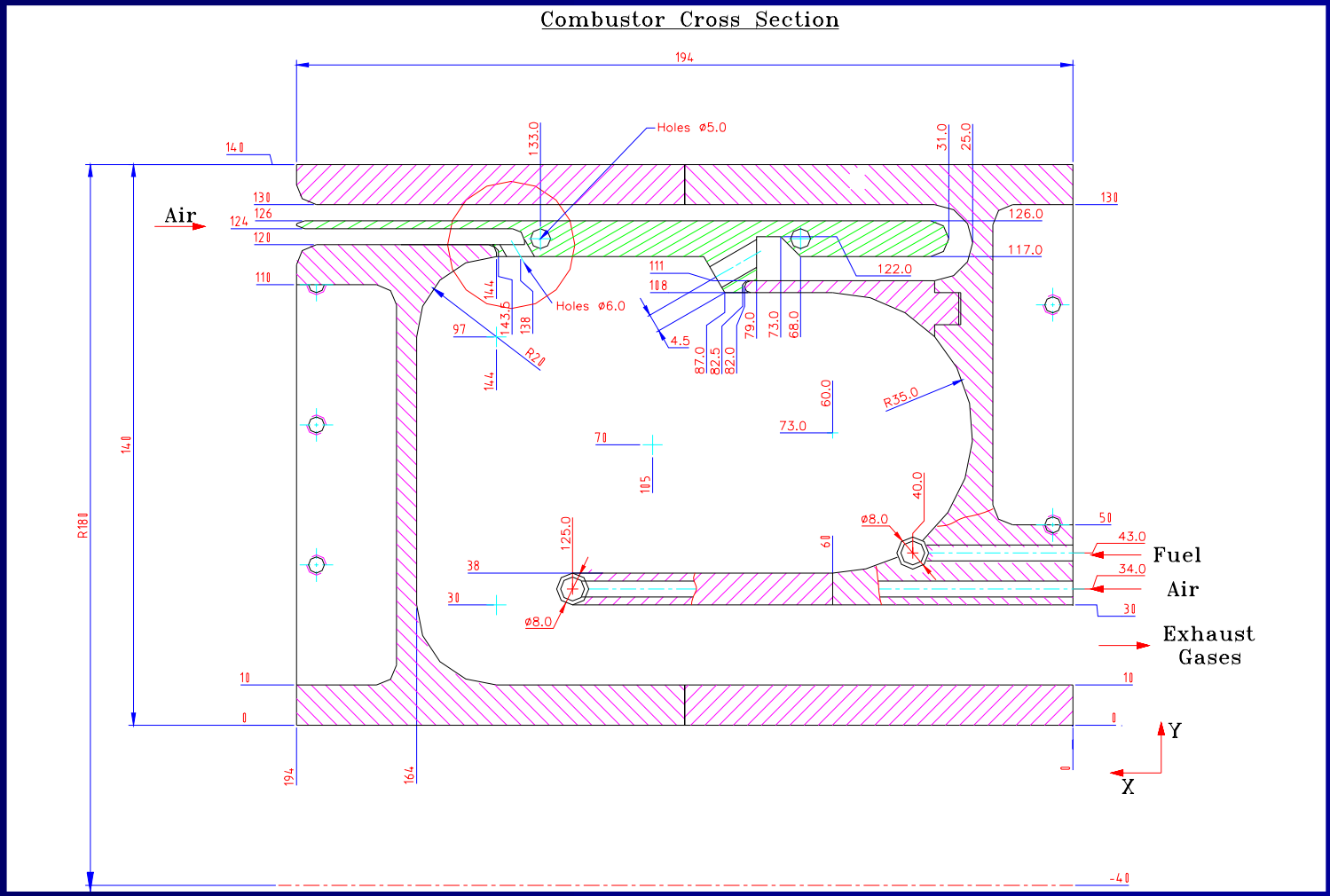
Geometry of the Combustor: Modified Model A



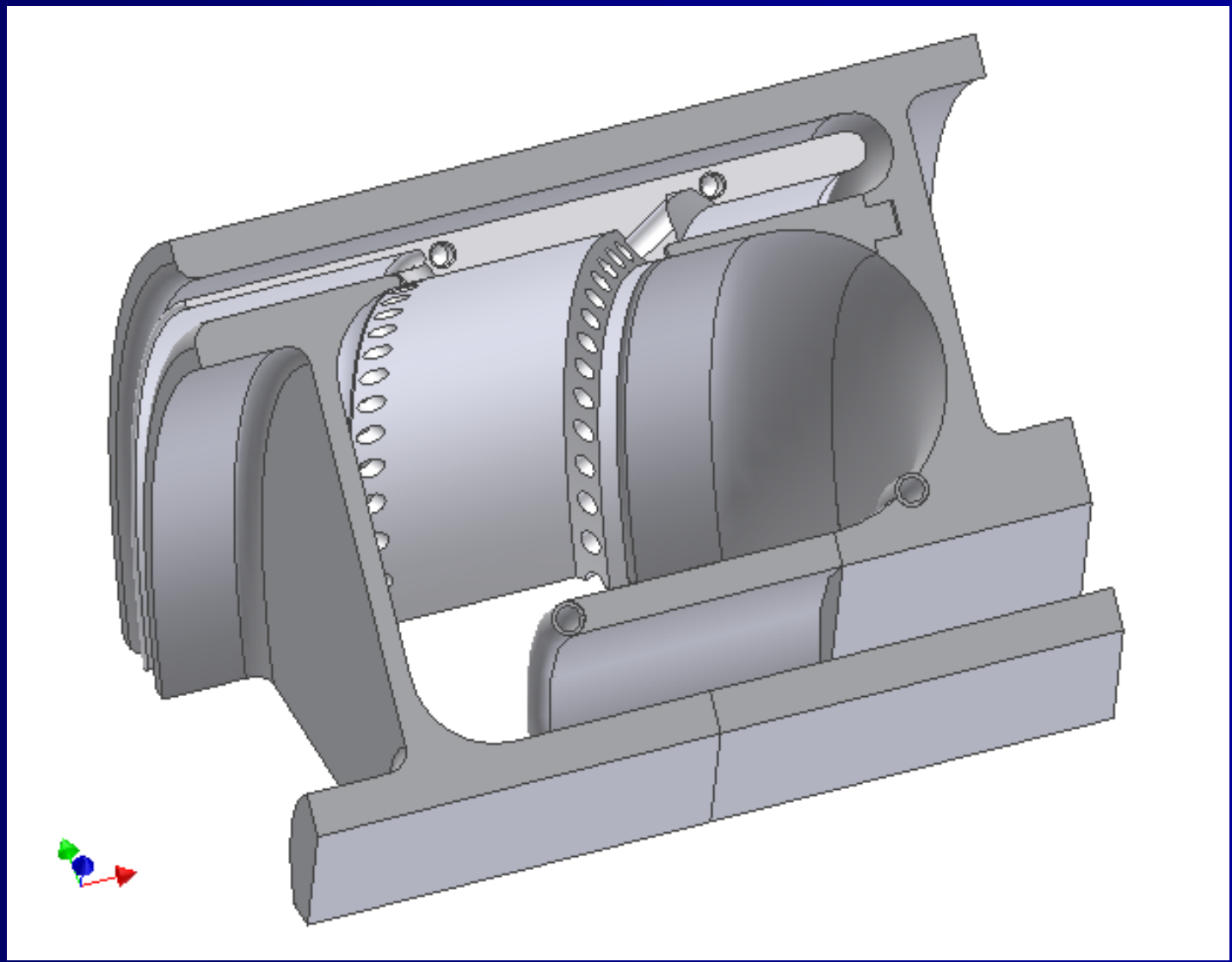
Geometry of the Combustor: Modified Model A



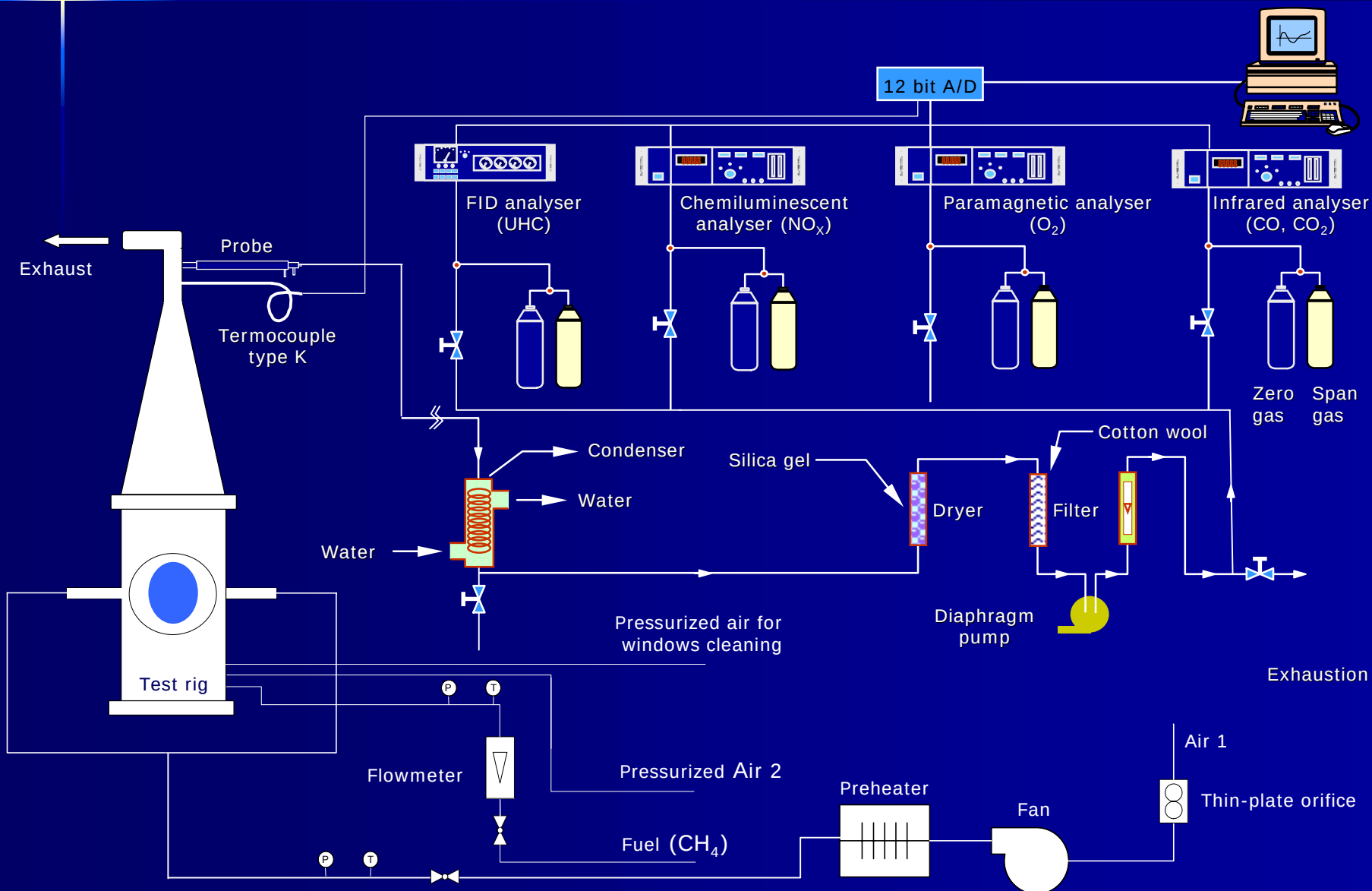
Geometry of the Combustor: Modified Model B



Geometry of the Combustor: Modified Model B



Combustion Measurement System

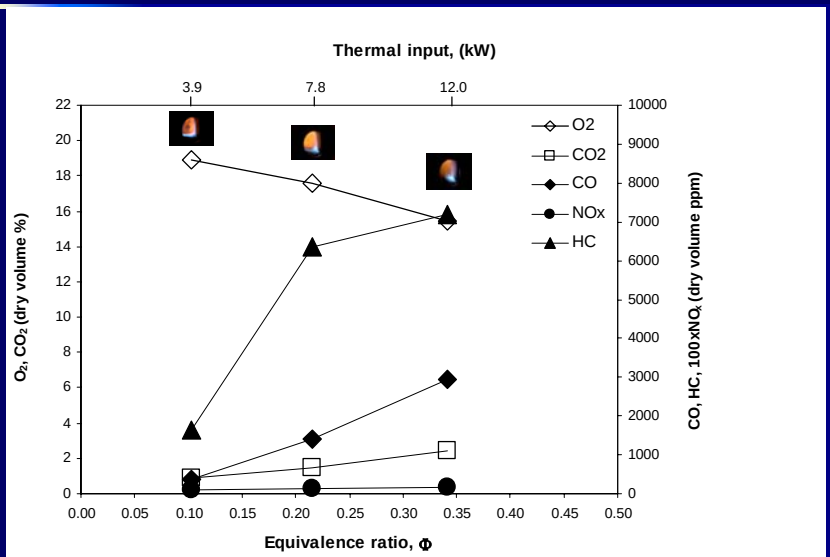


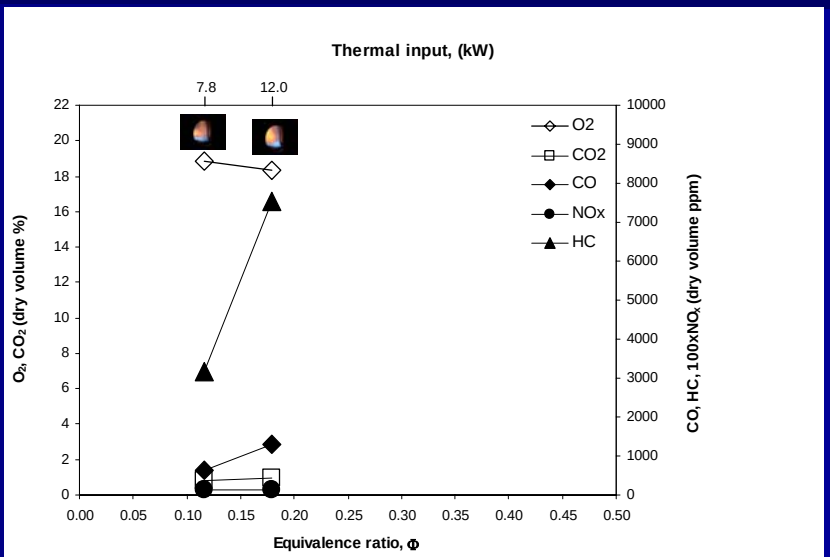
Test Conditions

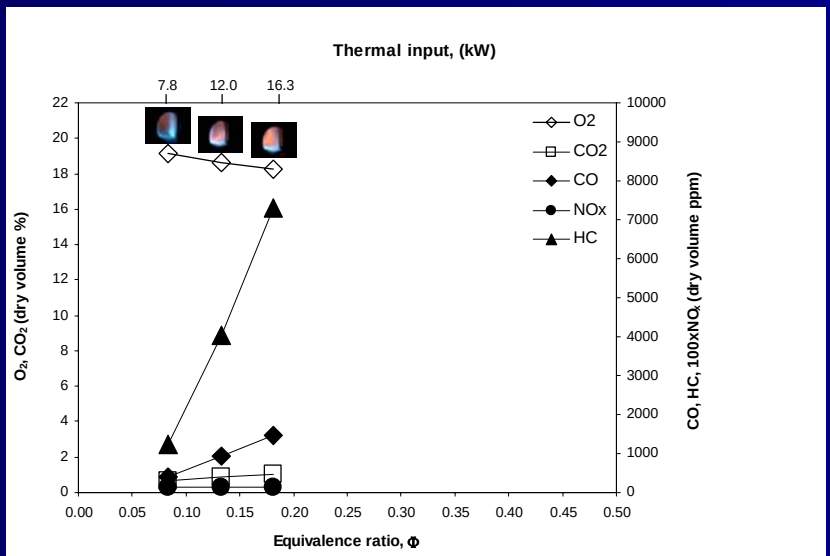
Test Condition	Air 1		Methane	Equivalence ratio, Φ
	Flow rate [kg/s]	Temperature [K]	Flow rate [kg/s]	
Original Model Configuration				
1	0.012	380	7.79E-05	0.10
2		387	1.56E-04	0.22
3		387	2.39E-04	0.34
4	0.023	361	1.56E-04	0.12
5		361	2.39E-04	0.18
6	0.031	369	1.56E-04	0.08
7		368	2.39E-04	0.013
8		368	3.27E-04	0.18
9	0.038	368	1.56E-04	0.07
10		368	2.39E-04	0.11
11		368	3.27E-04	0.15
12		369	4.18E-04	0.19

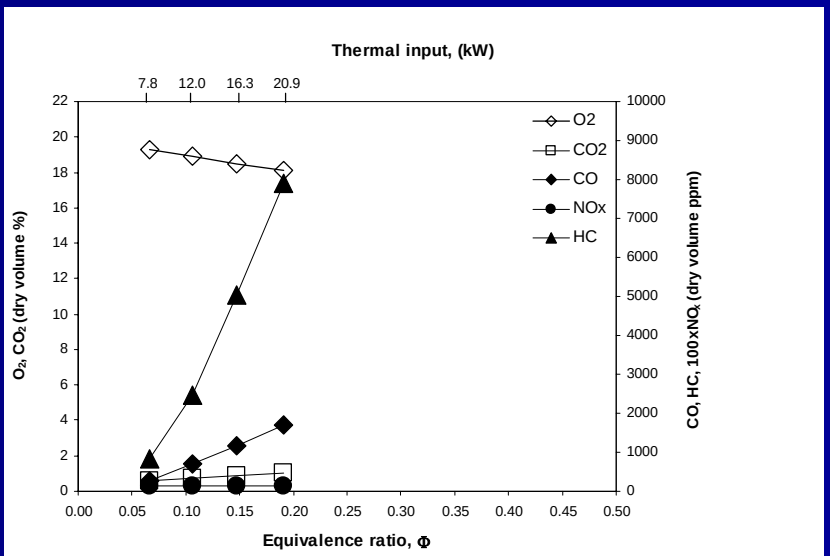
Test Condition	Air 1		Methane	Equivalence ratio, Φ
	Flow rate [kg/s]	Temperature [K]	Flow rate [kg/s]	
Modified Model Configuration A				
1	0.012	378	1.17E-04	0.17
2		378	1.56E-04	0.22
3		384	2.39E-04	0.34
4	0.020	403	1.56E-04	0.13
5		402	2.39E-04	0.20
6		403	3.27E-04	0.28
7		405	4.18E-04	0.35
8	0.027	409	2.39E-04	0.15
9		407	3.27E-04	0.20
10		407	4.18E-04	0.27
11		409	5.12E-04	0.33
12	0.035	411	3.27E-04	0.16
13		411	4.18E-04	0.21
14		414	5.12E-04	0.25
15		417	6.22E-04	0.30

Flue-Gas Data for the Original Model Configuration

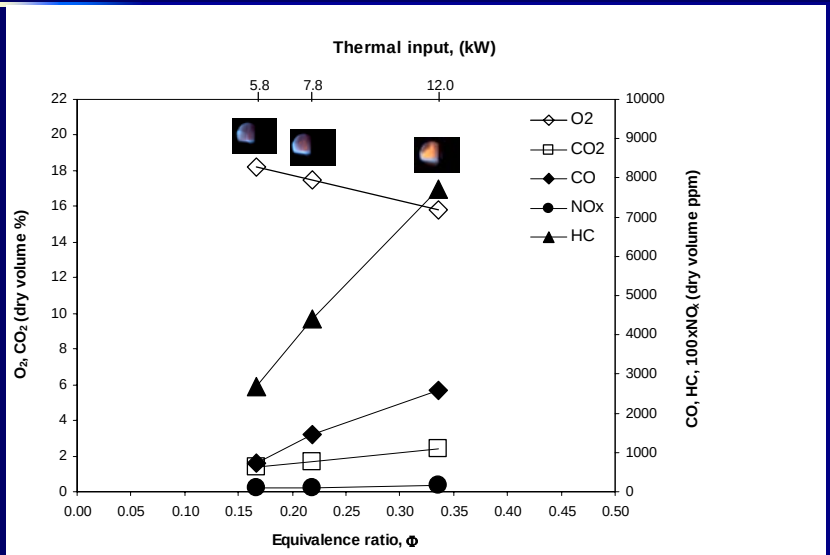


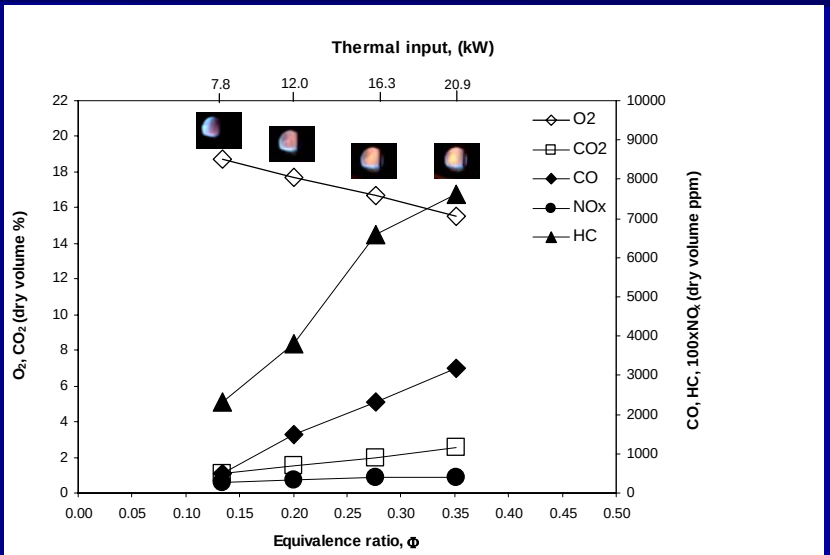


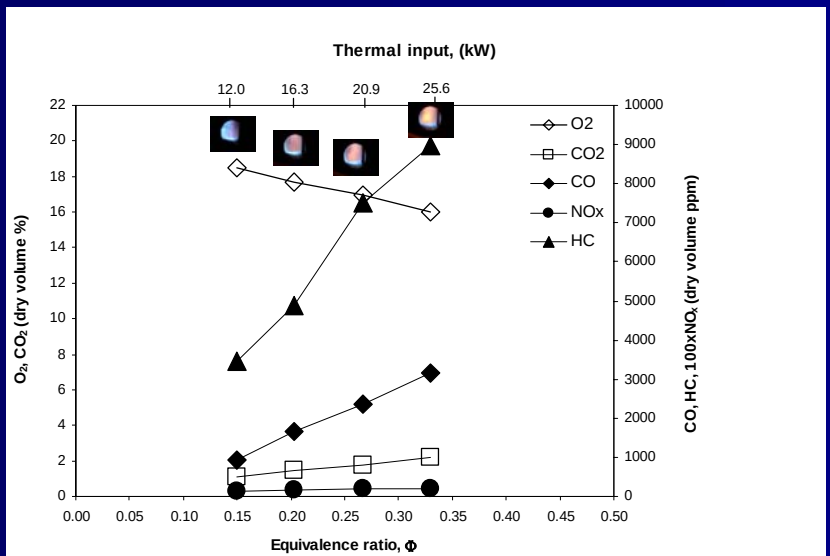


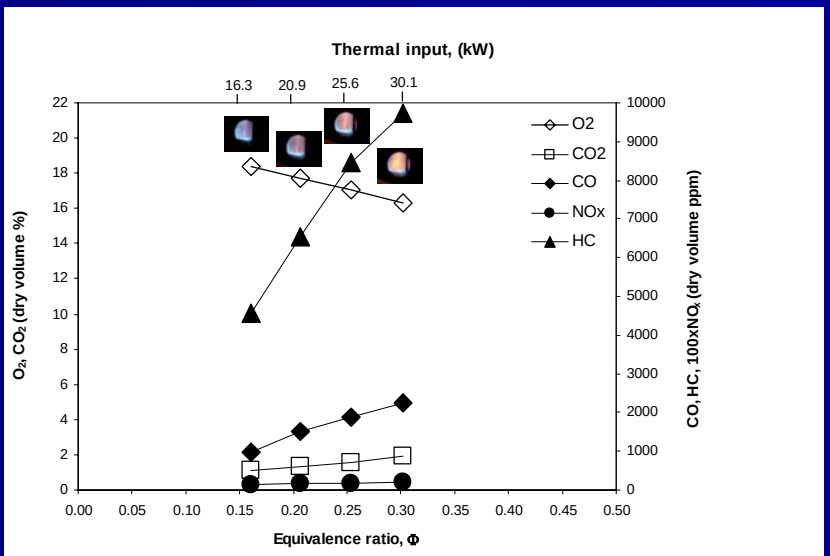


Flue-Gas Data for the Modified Model A Configuration









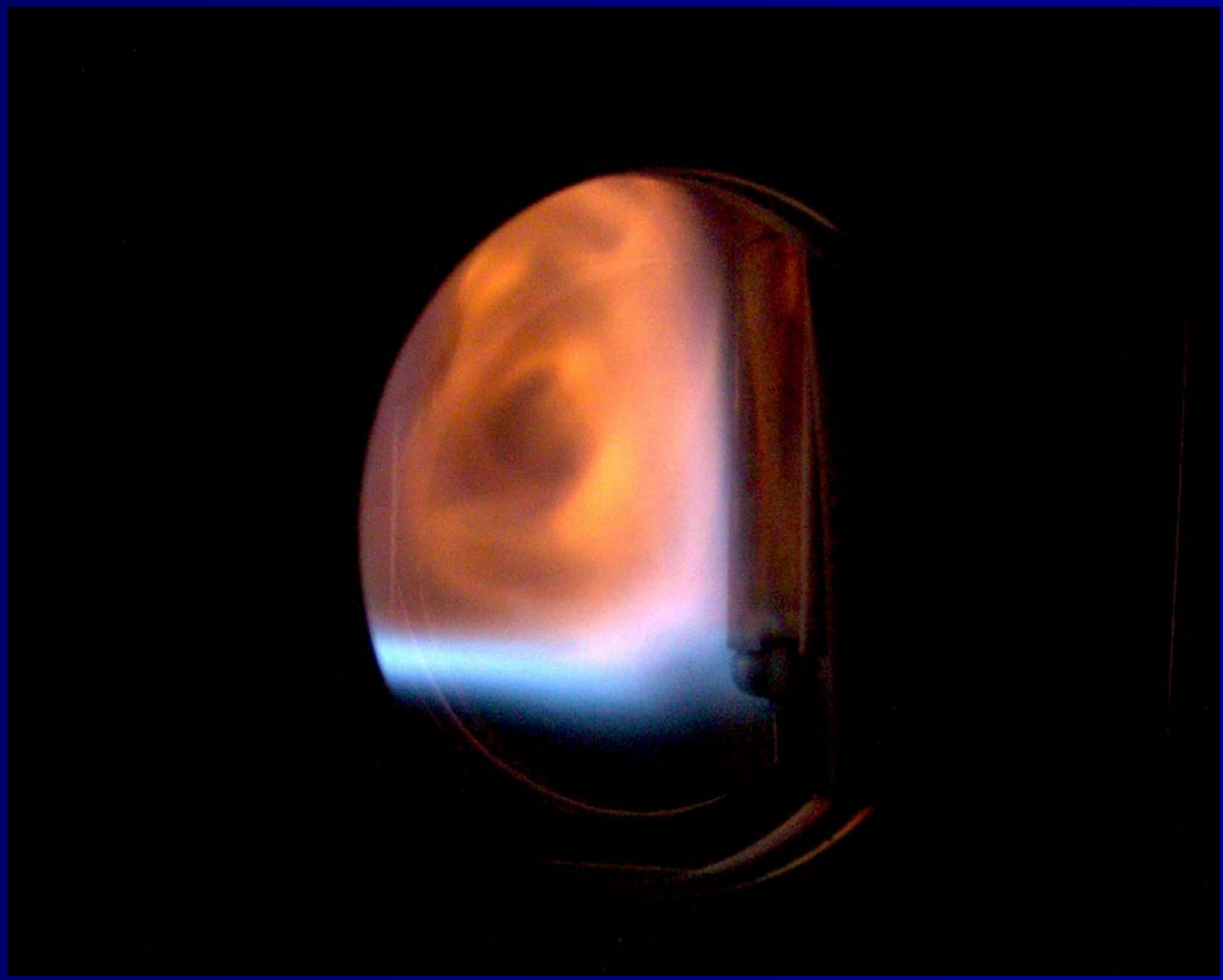
Reacting Conditions: Conclusions

Combustion performance is higher for both lower values of thermal input and equivalence ratio.

Effect of the air inlet configuration on both combustor performance and pollutant emissions is marginal.

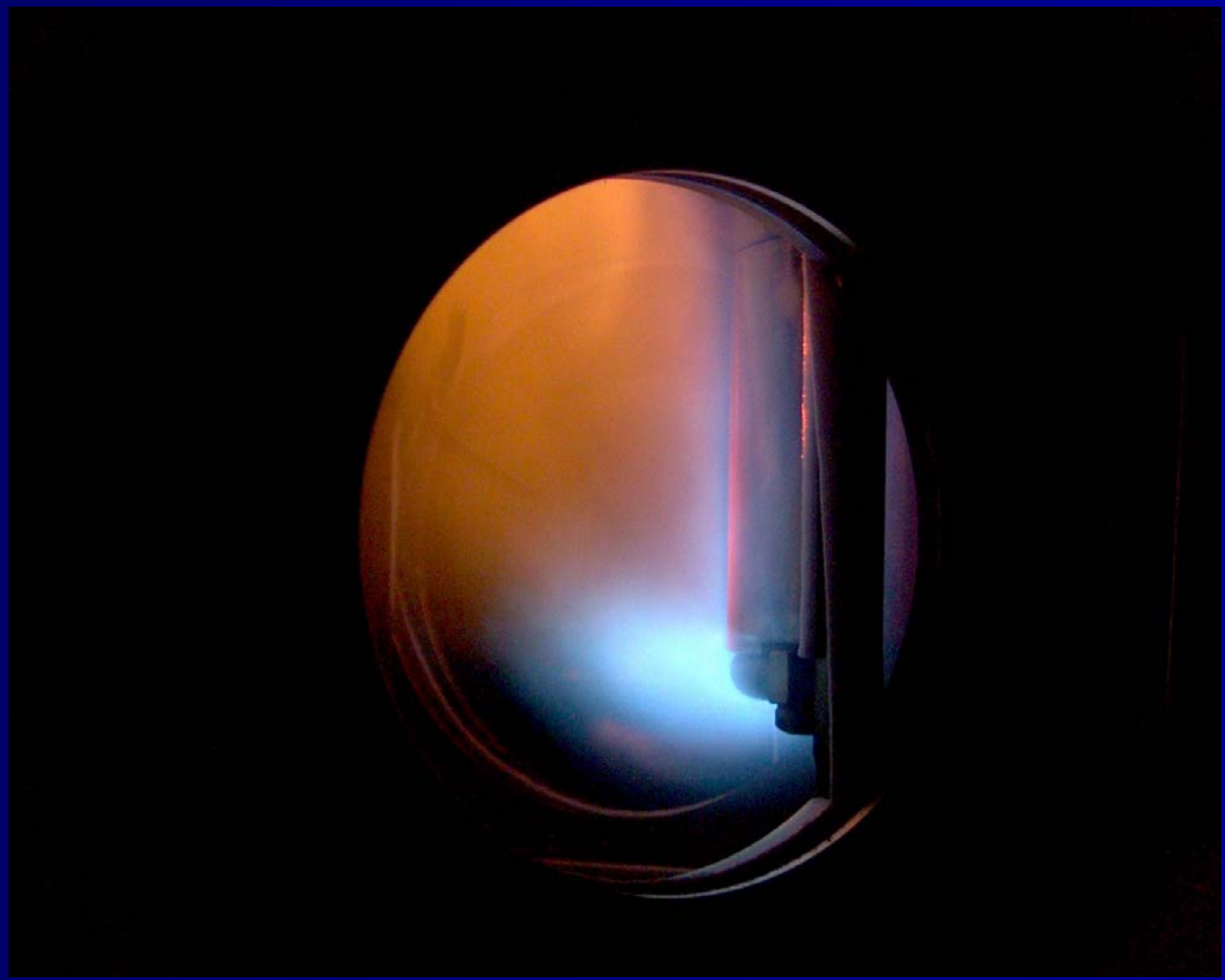
NO_x emissions are very low regardless of the combustor operating conditions.

3.9 kW, Φ = 0.10



7.8 kW, Φ = 0.22

12.0 kW, Φ = 0.34



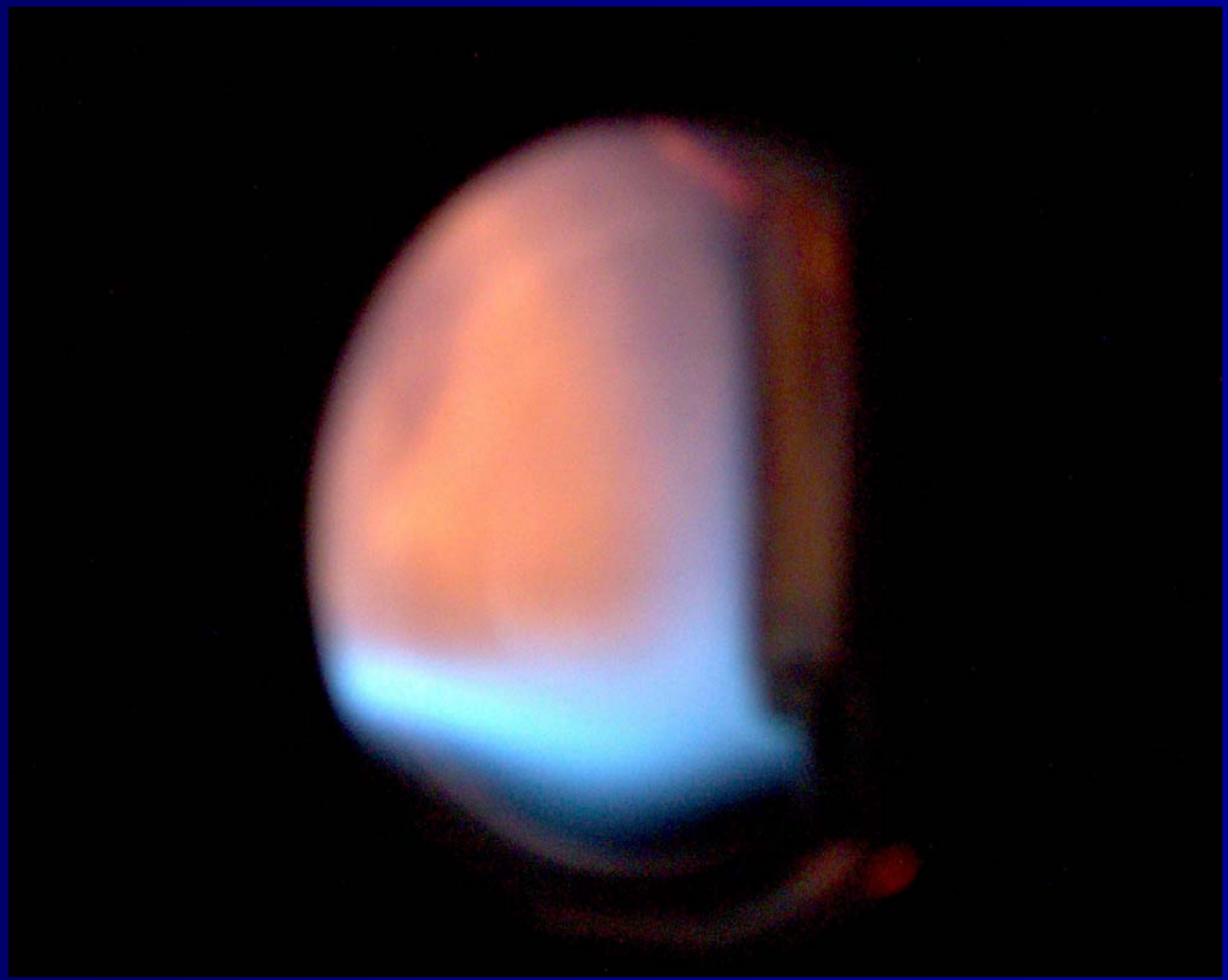
7.8 kW, Φ = 0.12

12.0 kW, Φ = 0.18

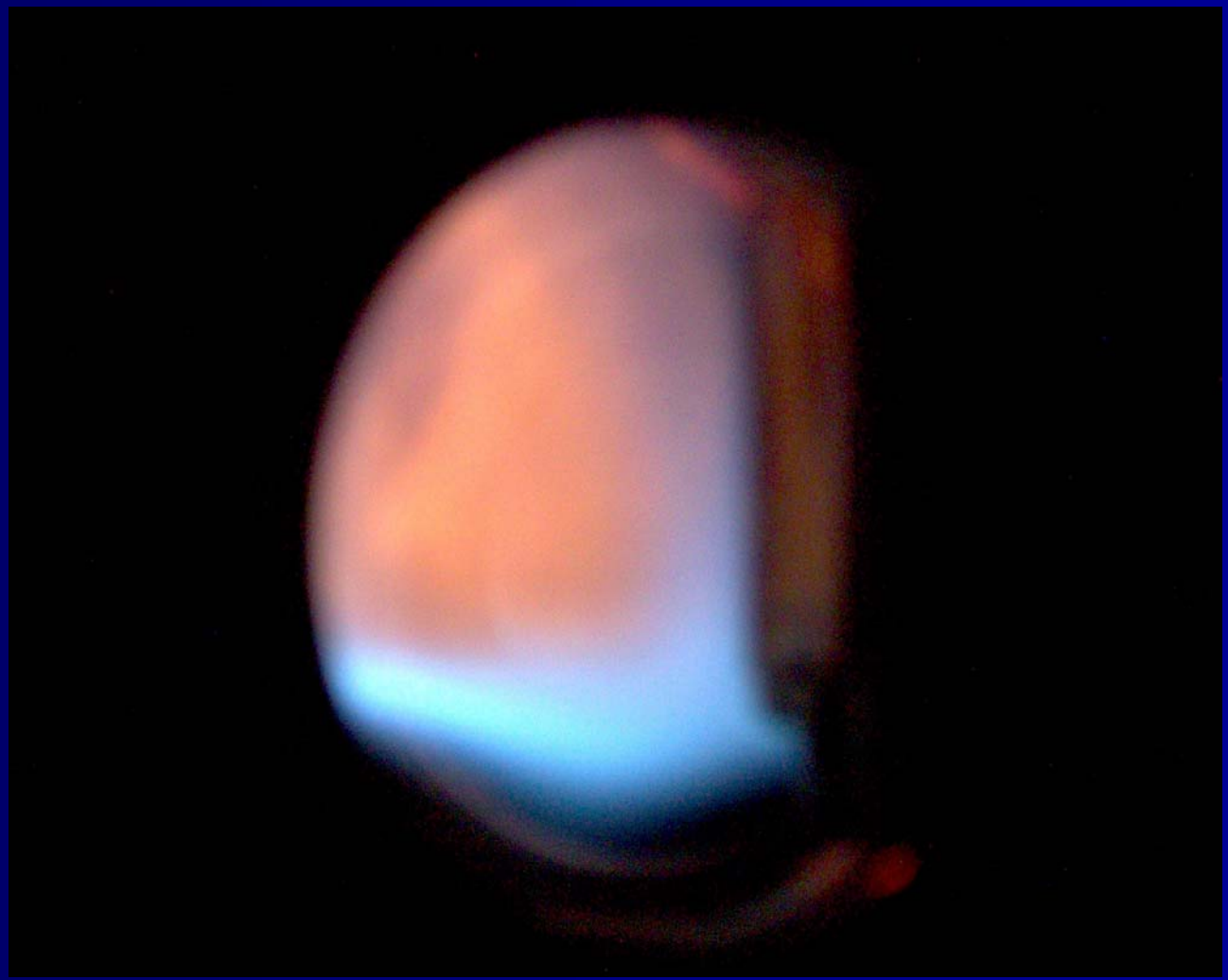
7.8 kW, Φ = 0.08

12.0 kW, Φ = 0.13

16.3 kW, Φ = 0.18



16.3 kW, Φ = 0.18



5.8 kW, Φ = 0.17

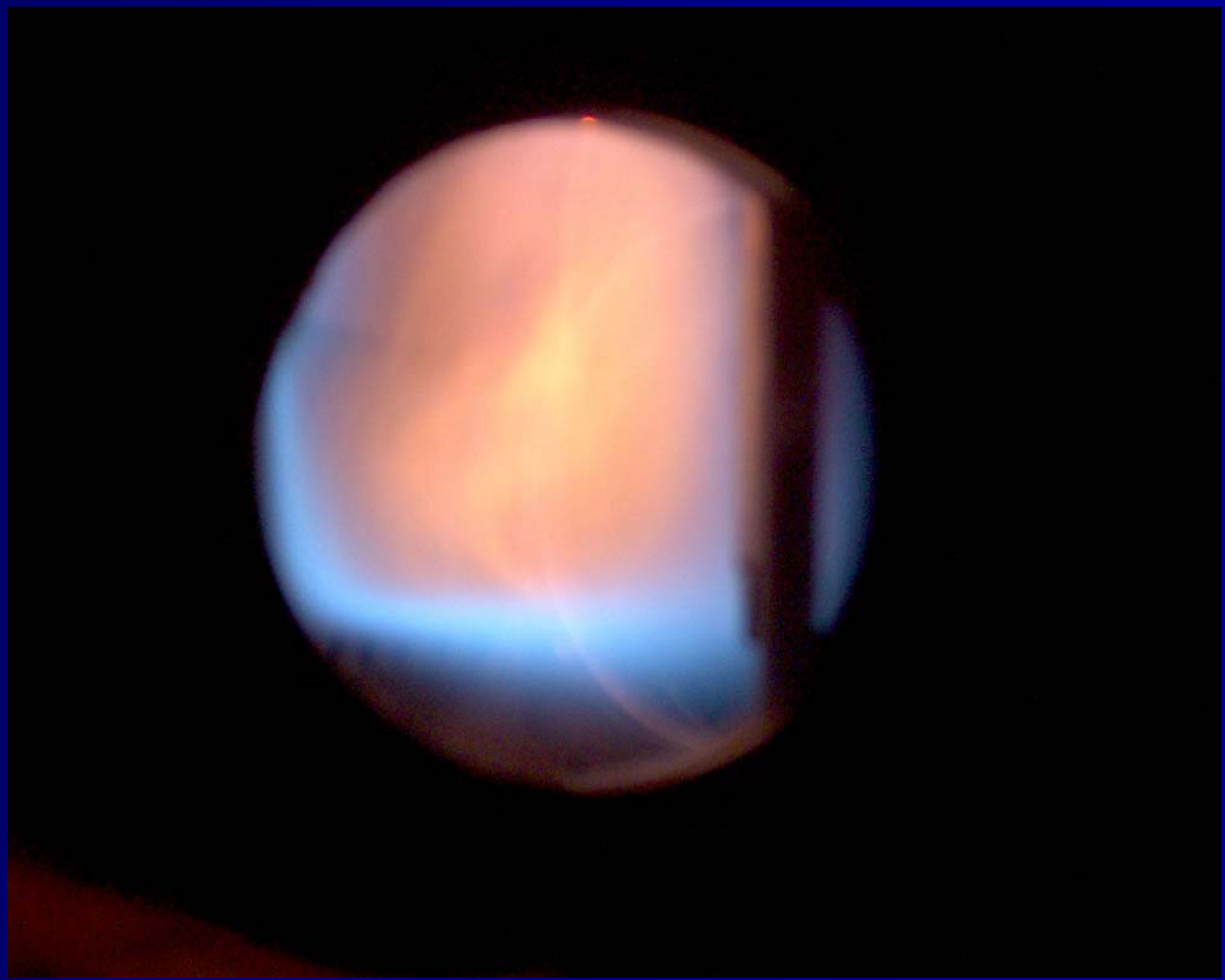
7.8 kW, Φ = 0.22

12.0 kW, Φ = 0.34

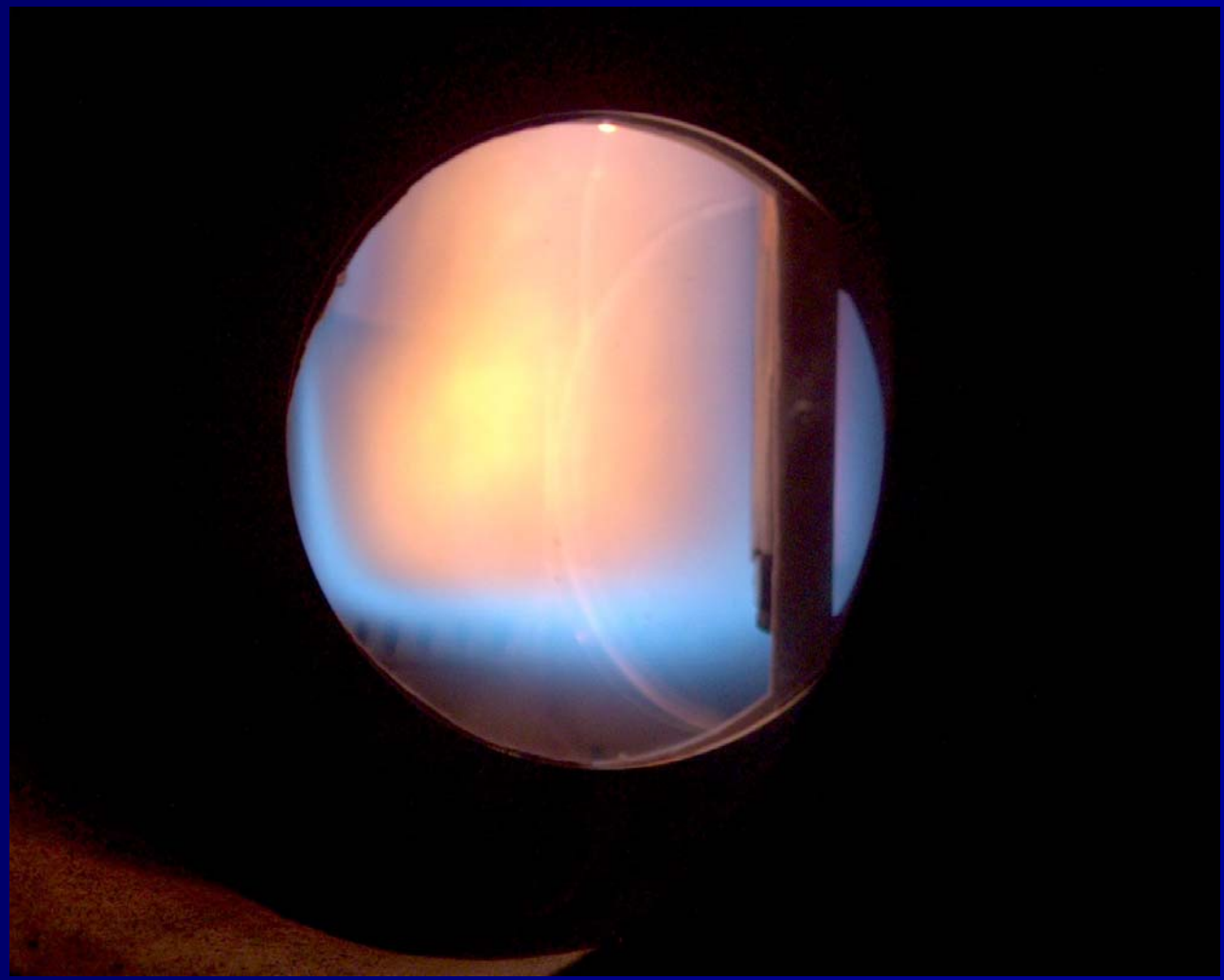
7.8 kW, Φ = 0.13

12.0 kW, Φ = 0.20

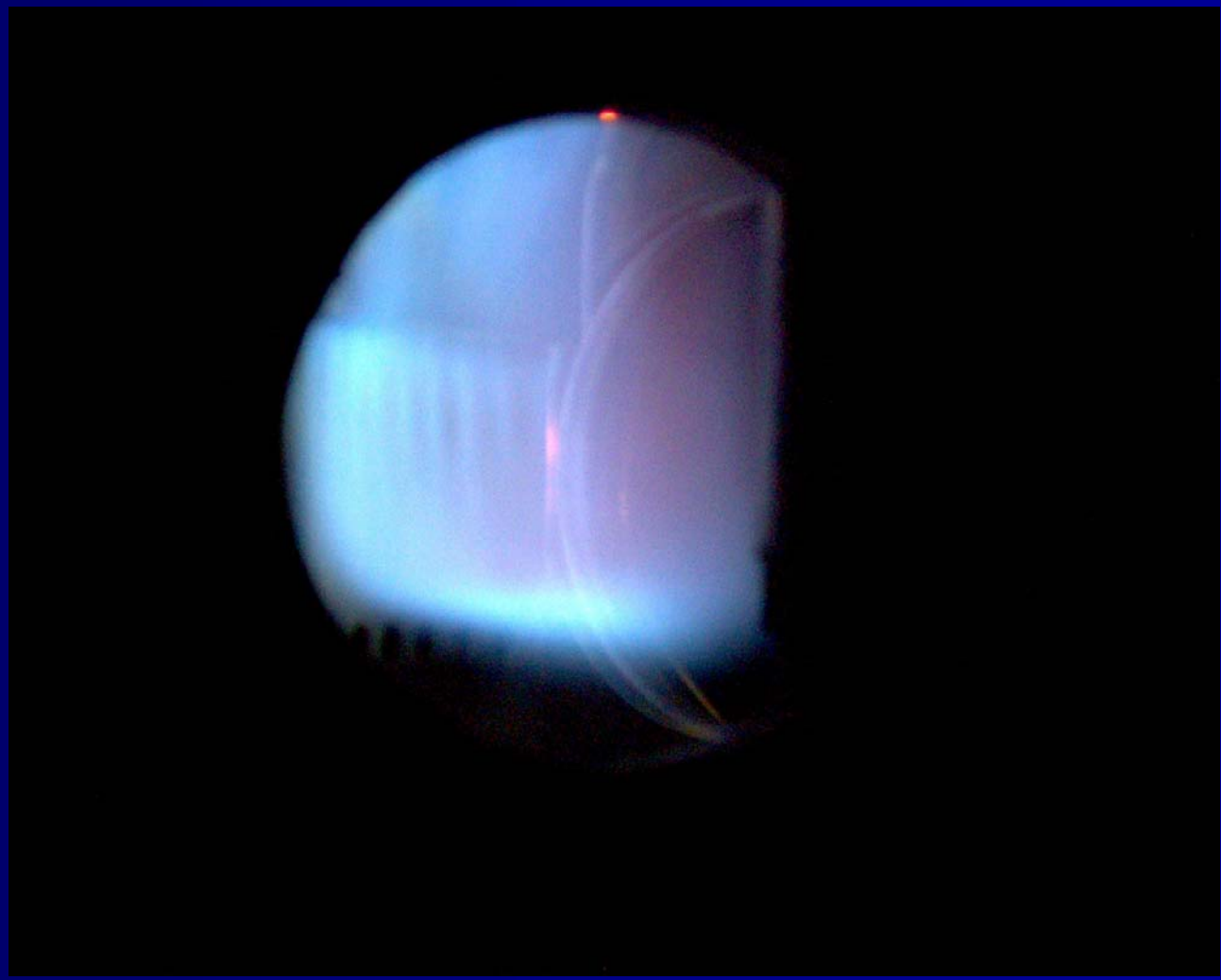
16.3 kW, Φ = 0.28



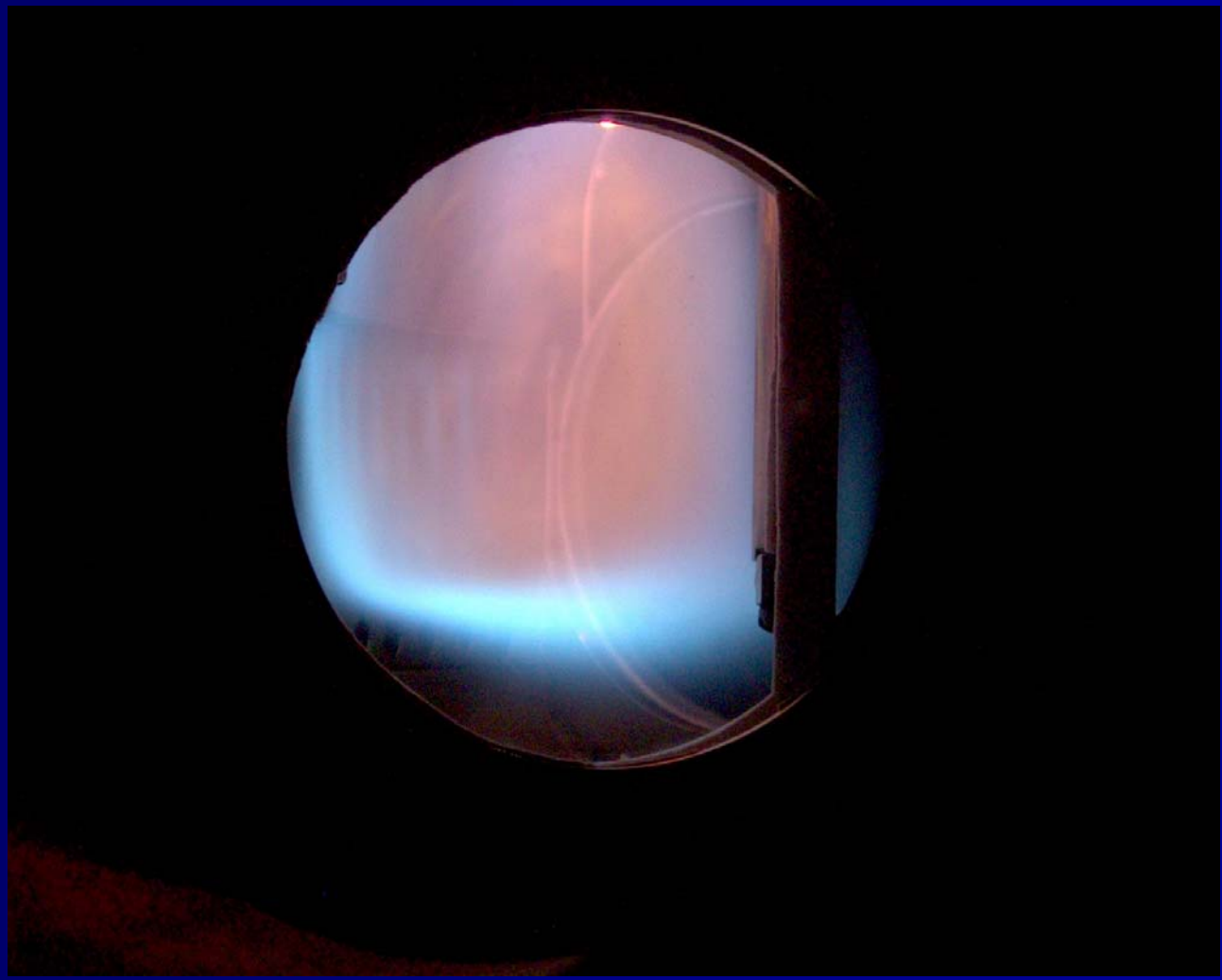
25.6 kW, Φ = 0.33



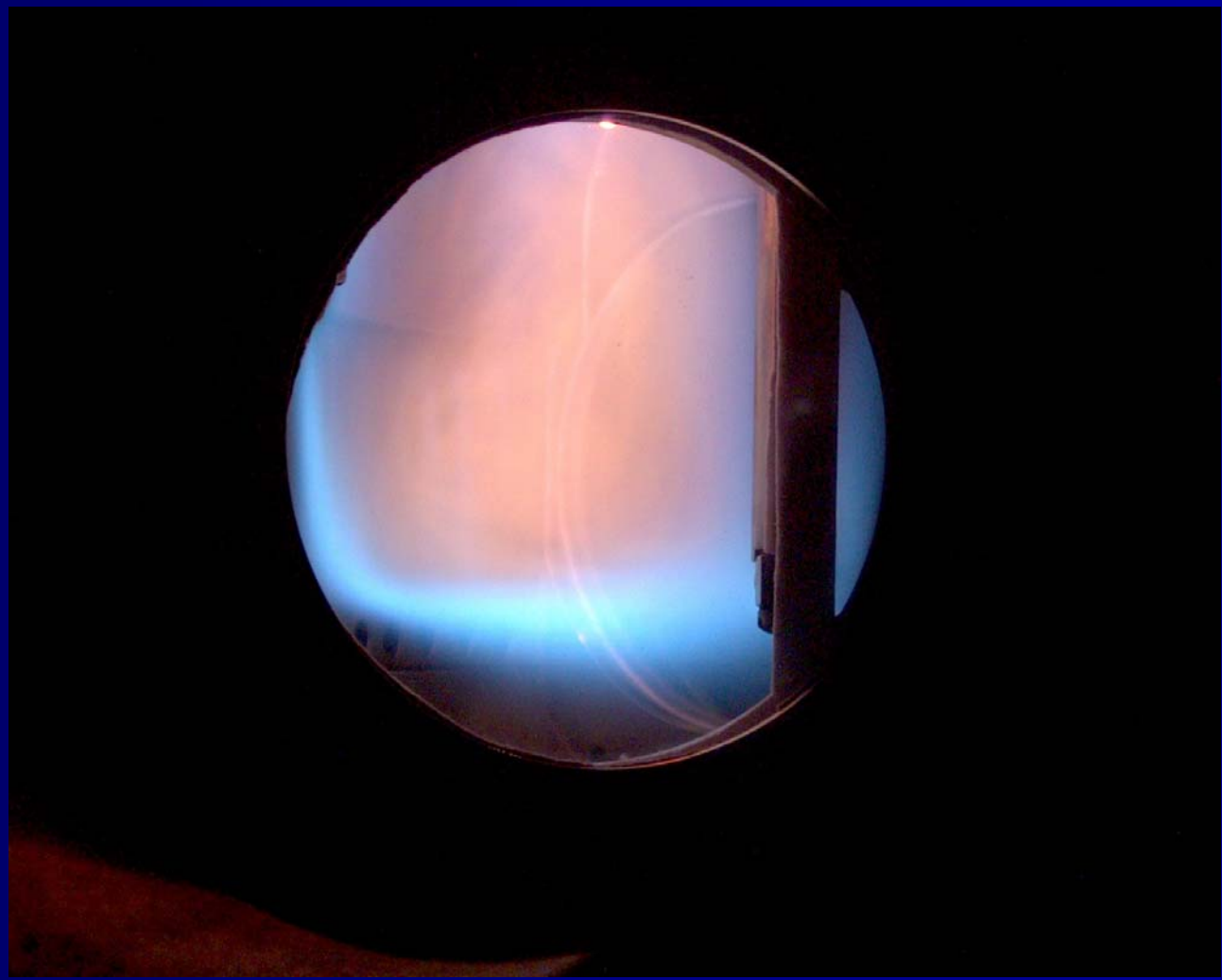
12.0 kW, Φ = 0.15



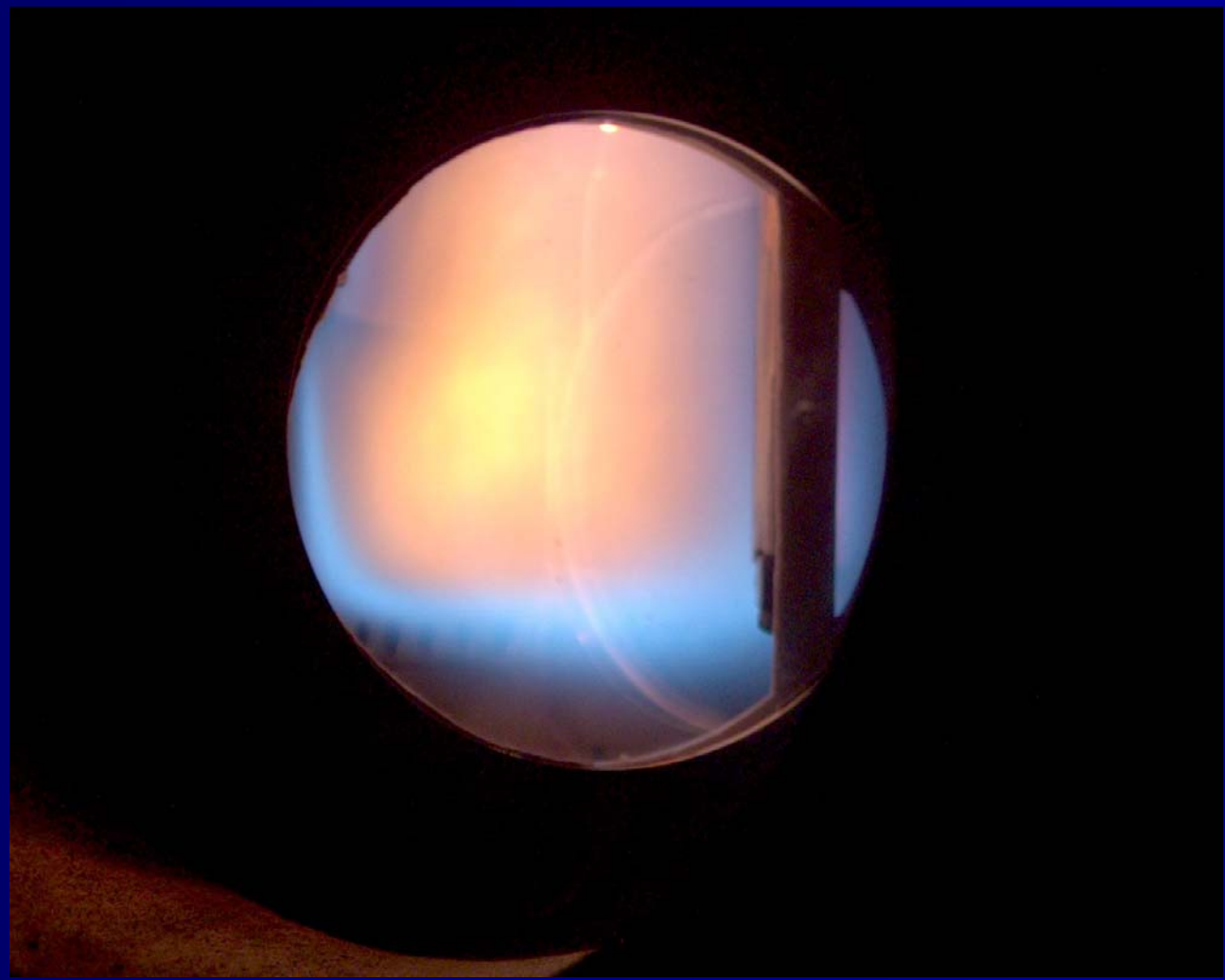
16.3 kW, Φ = 0.20



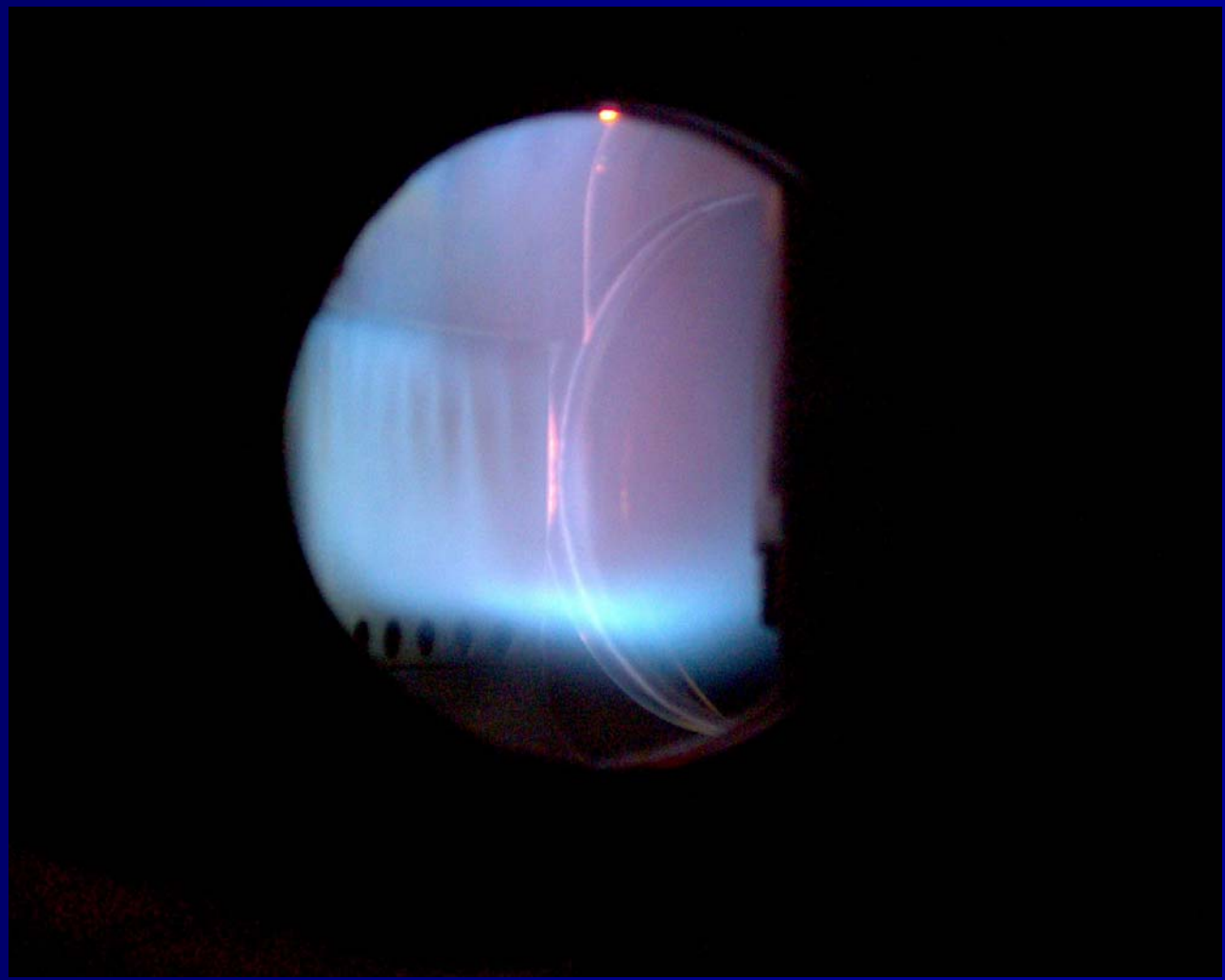
20.9 kW, Φ = 0.27



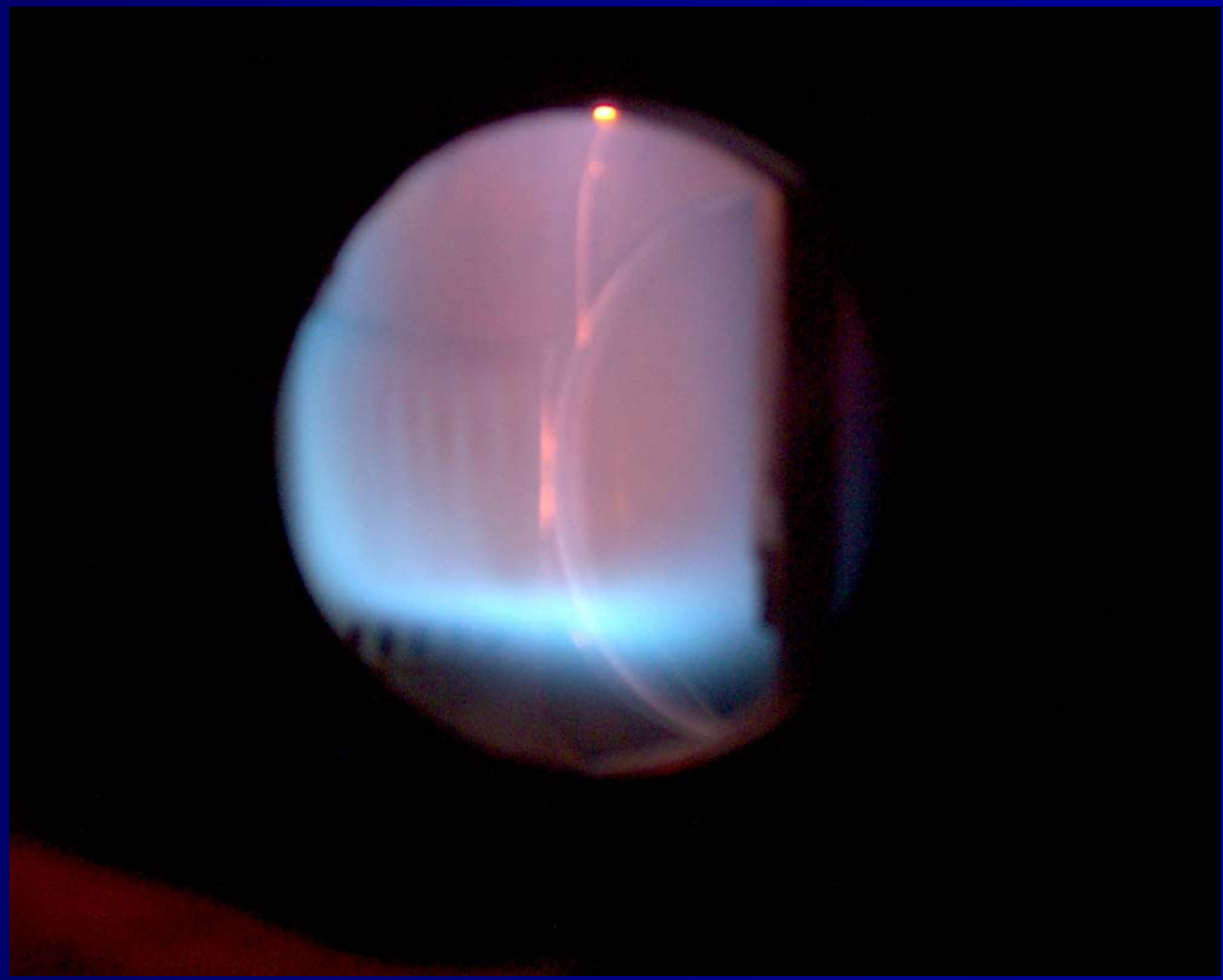
25.6 kW, Φ = 0.33



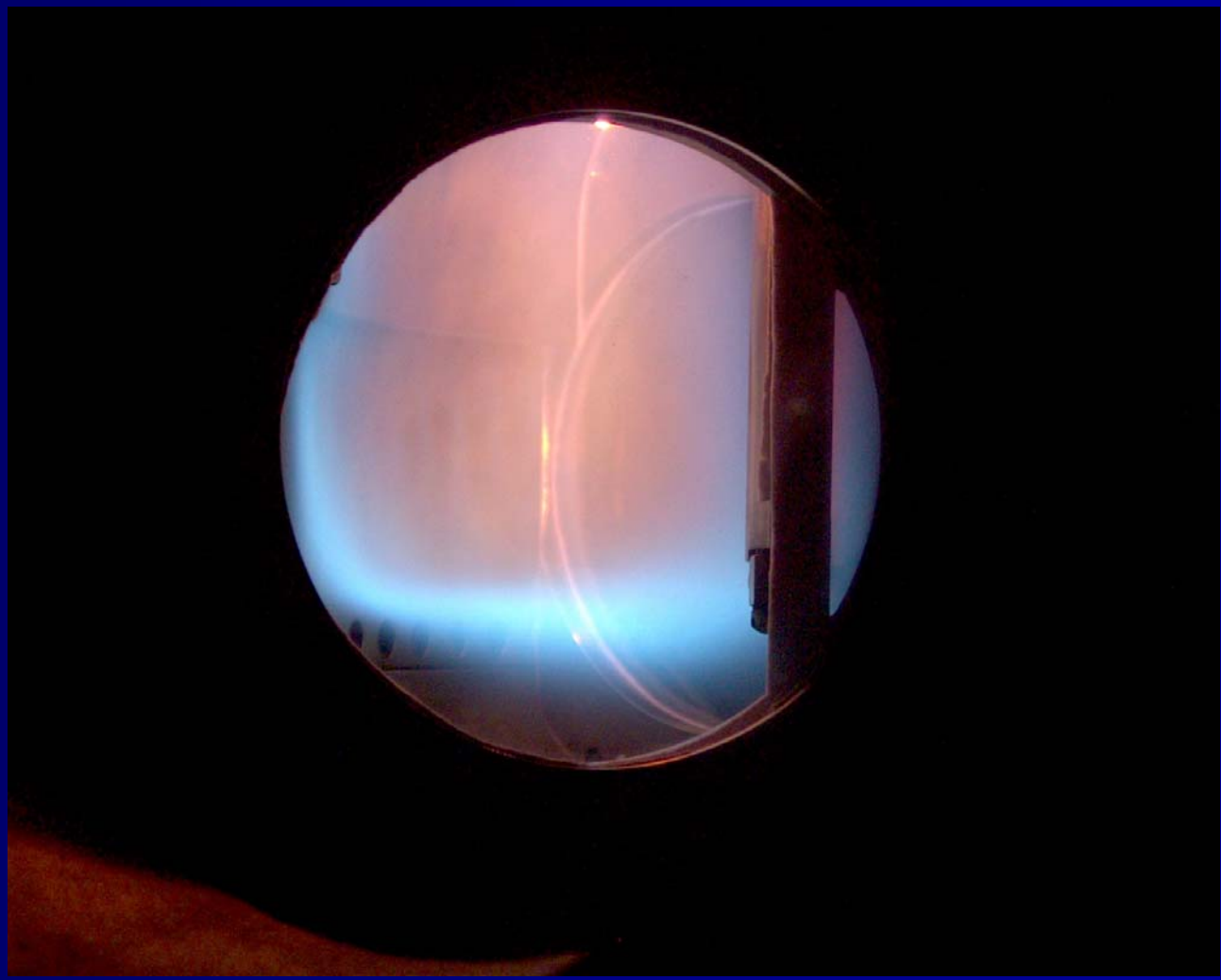
16.3 kW, Φ = 0.16



20.9 kW, Φ = 0.21



25.6 kW, Φ = 0.25



30.1 kW, Φ = 0.30