

# FLAMESEEK -

## FLAME Sensors for Efficient Engine Cycles (humid air turbines)

### Deliverables:

- ✍ Two novel gas turbine combustion sensors
- ✍ Model to predict combustion performance
- ✍ Comparison between prediction and measurements
- ✍ Predicted combustor performance at conditions for >50% efficiency



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## The partners:

- ✍ Rolls-Royce Power Engineering plc. (UK)
- ✍ Alstom Power Sweden AB (Sweden)
- ✍ Imperial College of Science, Technology & Medicine (UK)
- ✍ Lund University (Sweden)
- ✍ Foundation for Research & Technology Hellas (Greece)
- ✍ Twente University (Netherlands)



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## Programme Plan:

Workpackage descriptions	2001	2002	2003
Workpackage 1: Imperial College Manufacture and preliminary evaluation of two optical sensors	[Red arrow spanning from start of 2001 to end of 2002]		
Workpackage 2: Lund University Evaluation of temporal and spatial response of two optical sensors	[Red arrow spanning from start of 2001 to end of 2002]		
Workpackage 3: Rolls-Royce Pressurised flame measurements in HP-CTF using two optical sensors	[Red arrow spanning from start of 2002 to end of 2003]		
Workpackage 4: Twente University Numerical model development	[Red arrow spanning from start of 2001 to end of 2003]		
Workpackage 5: Alstom Power Design guidelines for humid air combustion chambers	[Red arrow spanning from start of 2003 to end of 2003]		
Workpackage 6: Rolls-Royce Coordination	[Red arrow spanning from start of 2001 to end of 2003]		



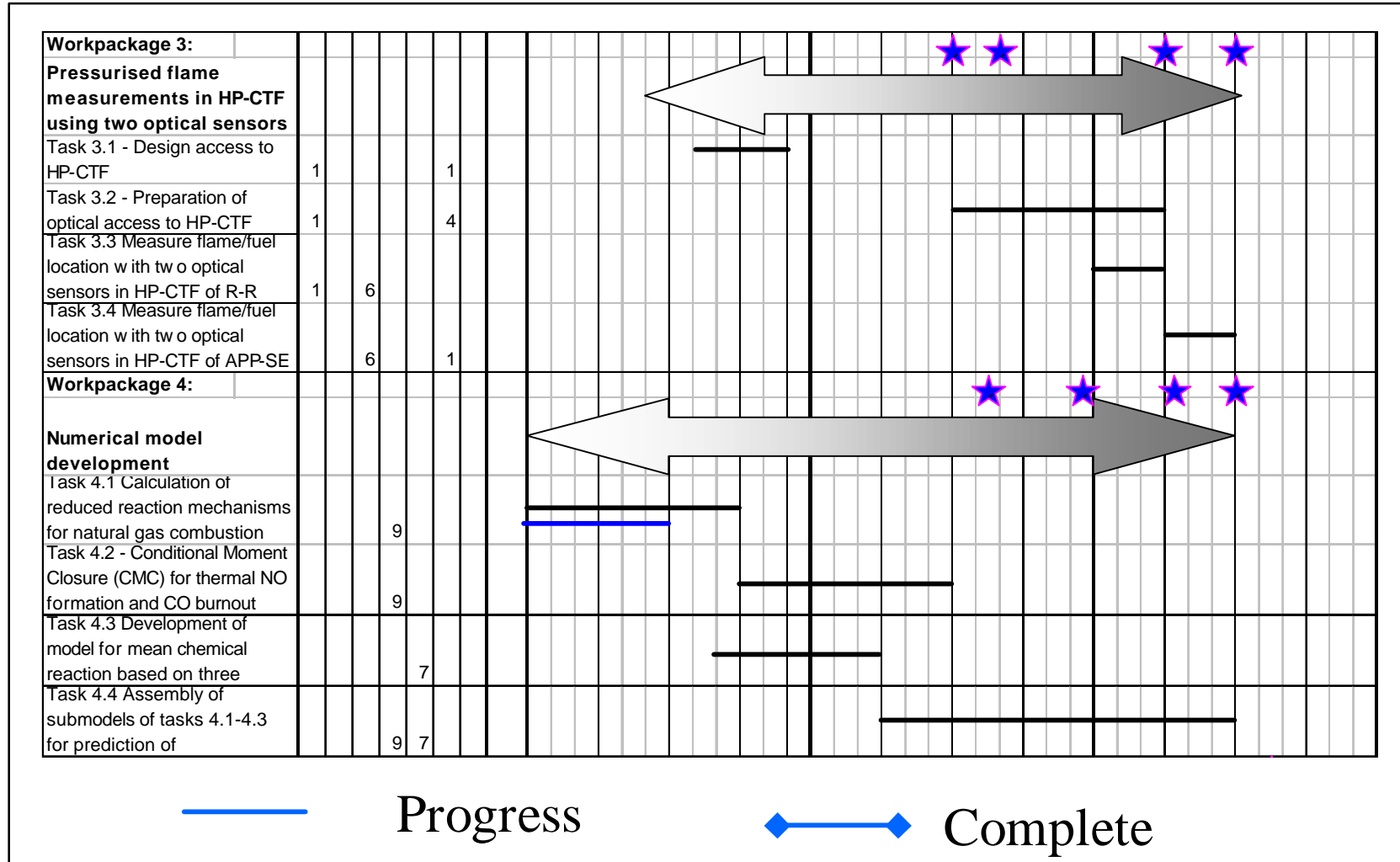
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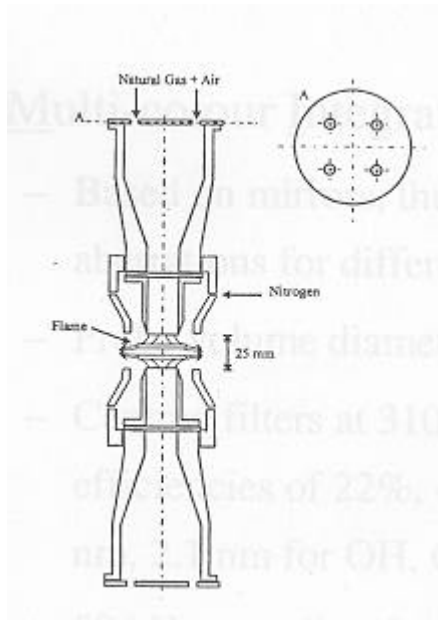
# Work Package Breakdown



# Work Package 1 Sub Task 1.1

## Construct Atmospheric Burner (ICSTM)

Gas fuelled counter flow burner  
Offers good optical access



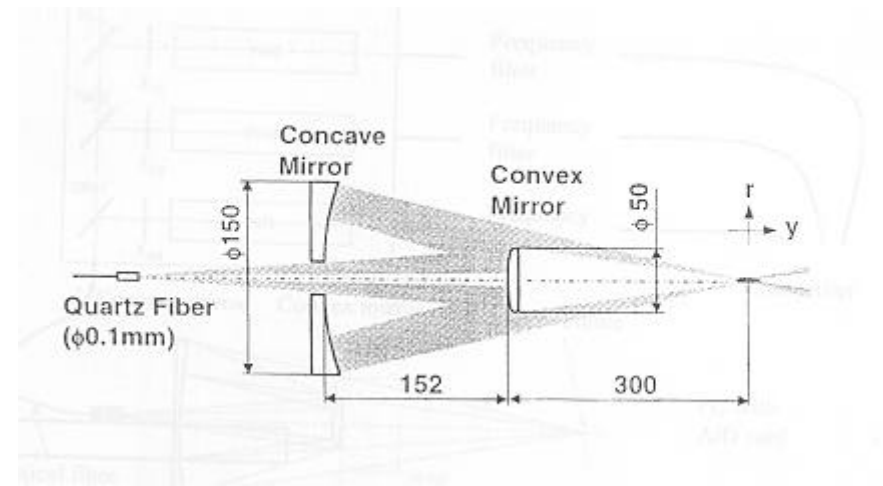
Advantages of burner

- Easily varied flow and combustion parameters
- Can therefore vary bulk strain rate and equivalence ratio
- Spatially stabilised flame front close to the stagnation plane
- Constant known strain rate along the flat reaction zone



# Work Package 1 Sub Task 1.2

## Design, construct and evaluate chemiluminescence (ICSTM)

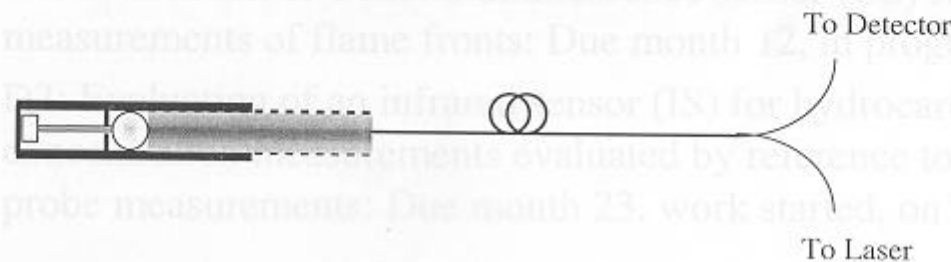
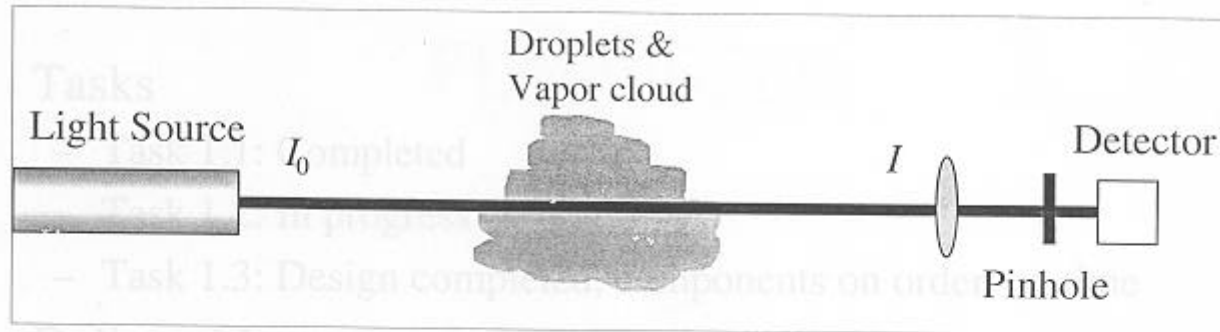


- MICRO optics (Multi-colour Integrated Cassegrain Receiving Optics)
- Uses mirrors instead of lenses which avoids aberration for different wave lengths
- Probe volume of  $100\mu\text{m}$  and length of  $2\text{mm}$
- The temporal variation of the radicals OH, CH and  $\text{C}_2$  with a cut-off frequency of  $4\text{ kHz}$  can be obtained



# Work Package 1 Sub Task 1.3

## Design, construct and evaluate Infra Red sensor (ICSTM)



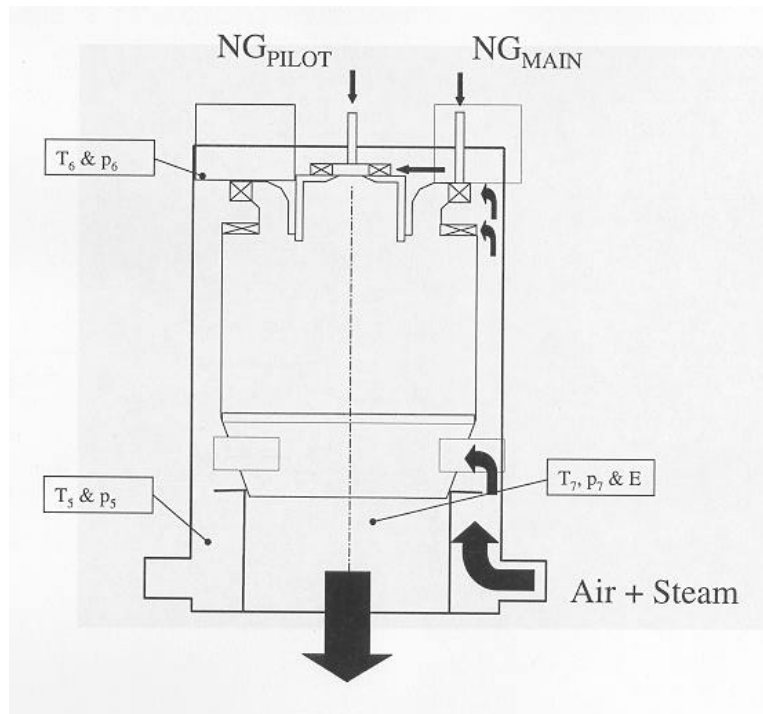
- Line of sight measurement based upon Lambert-Beer law for infra red light absorption by hydrocarbons
- Path lengths and beam diameters chosen for maximum sensitivity at combustor operating conditions





# Work Package 2 Sub Task 2.1

## Construct Atmospheric Burner (LUND)



Combustion chamber (VT40)  
manufactured by Turbec AB  
36 kW at atm

Utilises both premixed and  
diffusion combustion

- diffusion pilot
- premixed main
- upto 20% by wt of air  
can be added of steam (humidified)



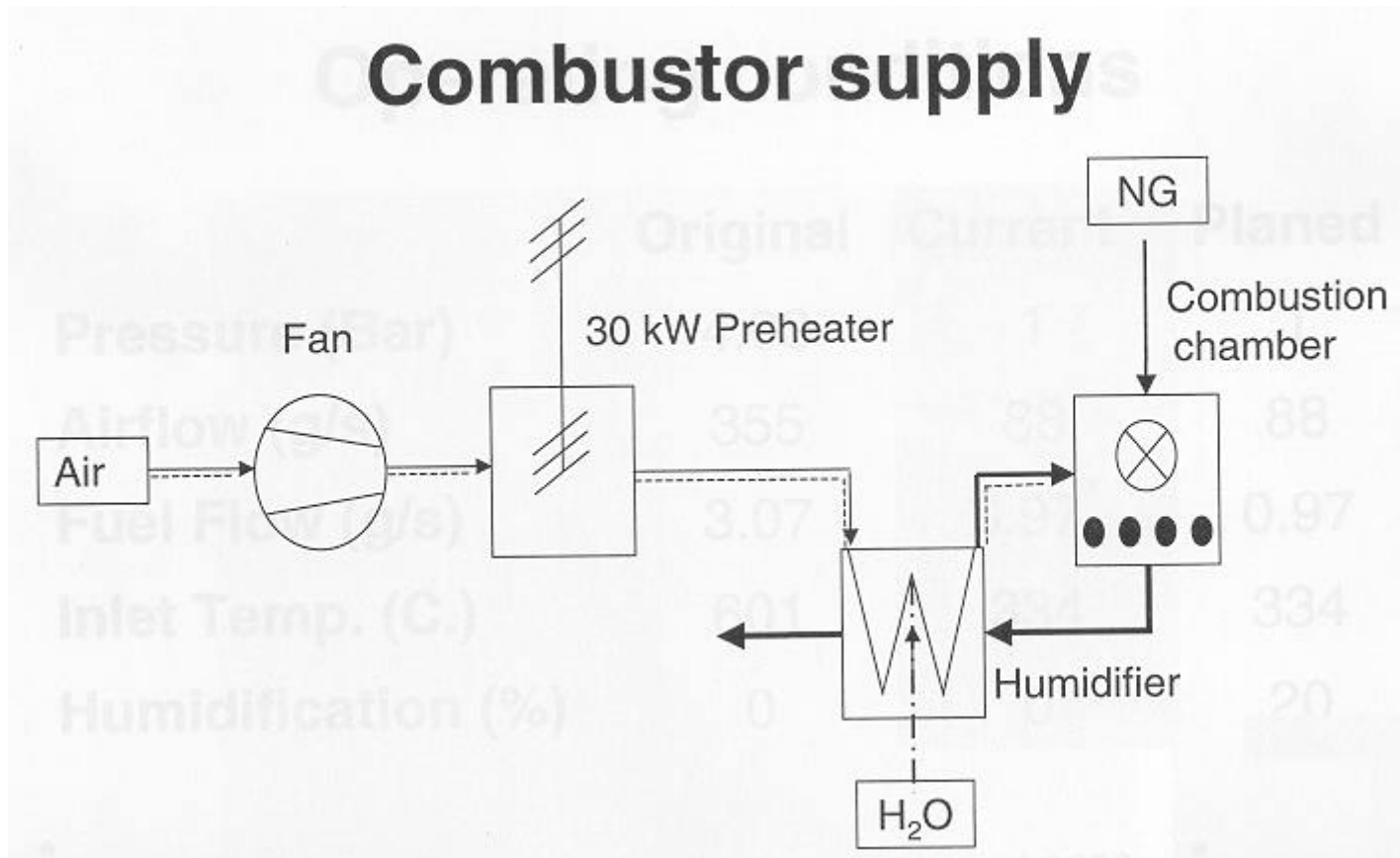
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# Work Package 2 Sub Task 2.1

## Construct Atmospheric Burner (LUND)



Ability to extensively study effect of humidification upon both premixed and diffusion flames emission levels

# Work Package 4 Sub Task 4.1

## Calculation of reduced reaction mechanisms (ICEHT)

Three detailed mechanisms have been procured and examined

- A skeletal mechanism (Peters)

lean combustion, thermal and prompt NO,  
only includes methane

- Konnov reaction mechanism

800 reactions (too unwieldy)

- GRI 3.0 mechanism

53 species, 279 reactions designed for natural gas combustion  
includes thermal, prompt and N<sub>2</sub>O reactions as well as unburnt  
Hydrocarbons up to Propane

GRI has been chosen to be used for the reduced reaction mechanisms

