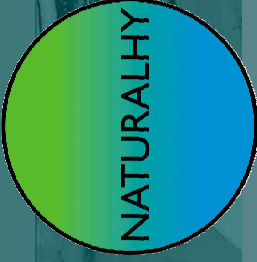


Ignition Energy

Ignition Energy and Ignition Probability of Methane-Hydrogen-Air Mixtures

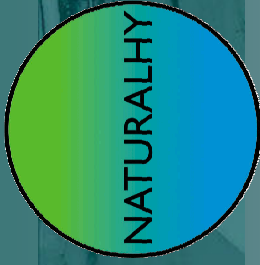
Geoff Hankinson, Hemant Mathurkar and
Barbara Lowesmith
Loughborough University





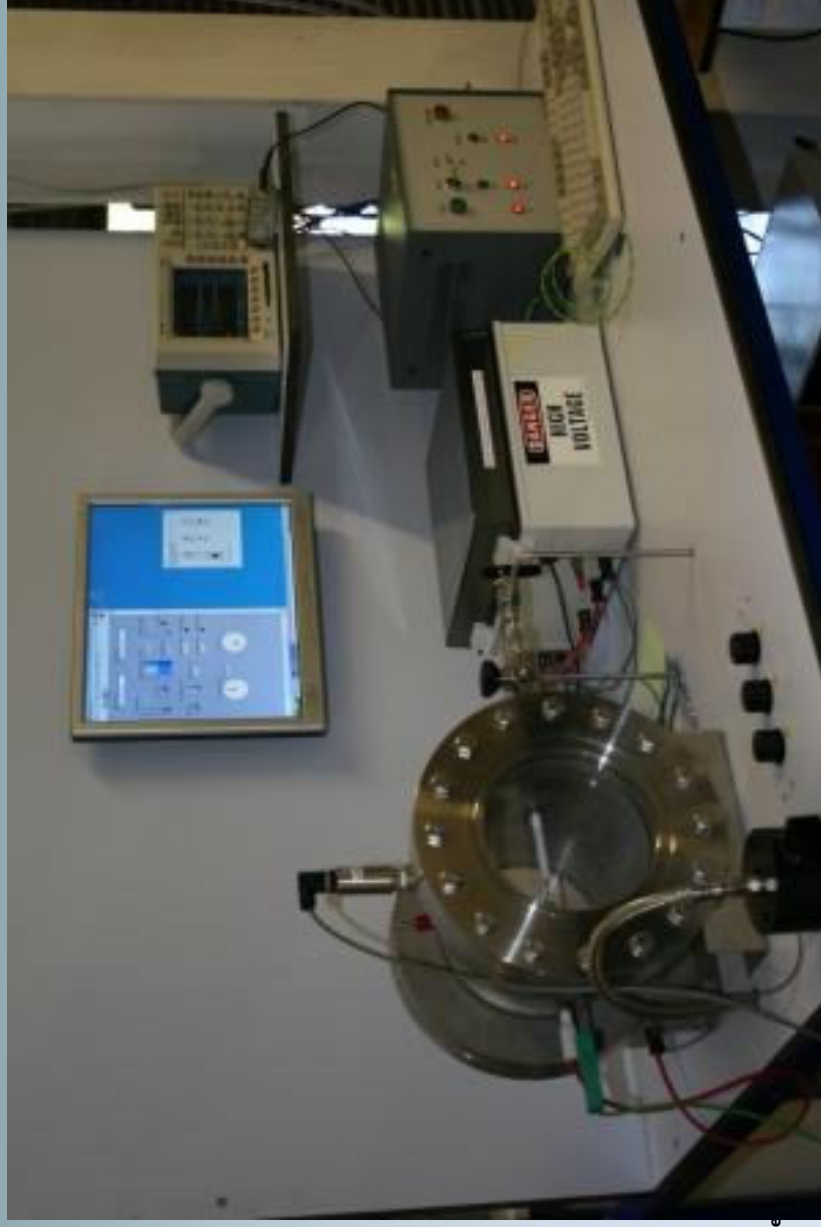
Naturalhy Project

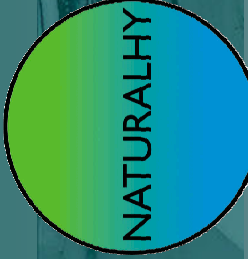
- EC funded project assessing the potential of adding hydrogen to the natural gas system as a means to:
 - Providing mass transportation of hydrogen to facilitate introduction of the hydrogen economy
 - Greening of gas if burned directly
- Safety Work Package looking at the change in risk to the public
 - Fundamental properties of fuel such as ignition energy and probability could affect the risk



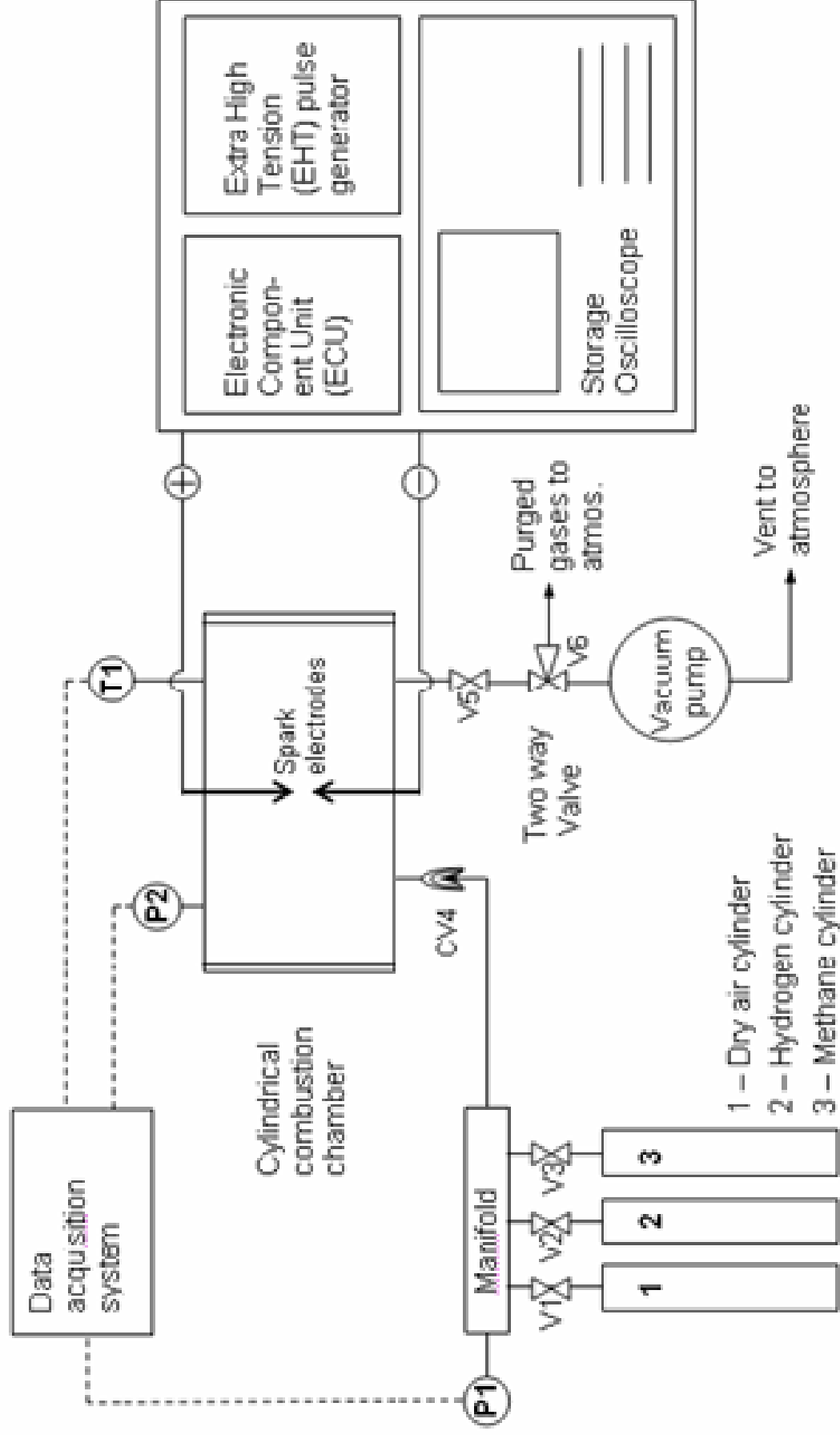
Ignition Energy of Methane/Hydrogen/Air Mixtures

- Determination of lowest ignition energy for methane, hydrogen, 75:25, 50:50 and 25:75 CH₄:H₂ mixtures in air
- Across full range of flammability

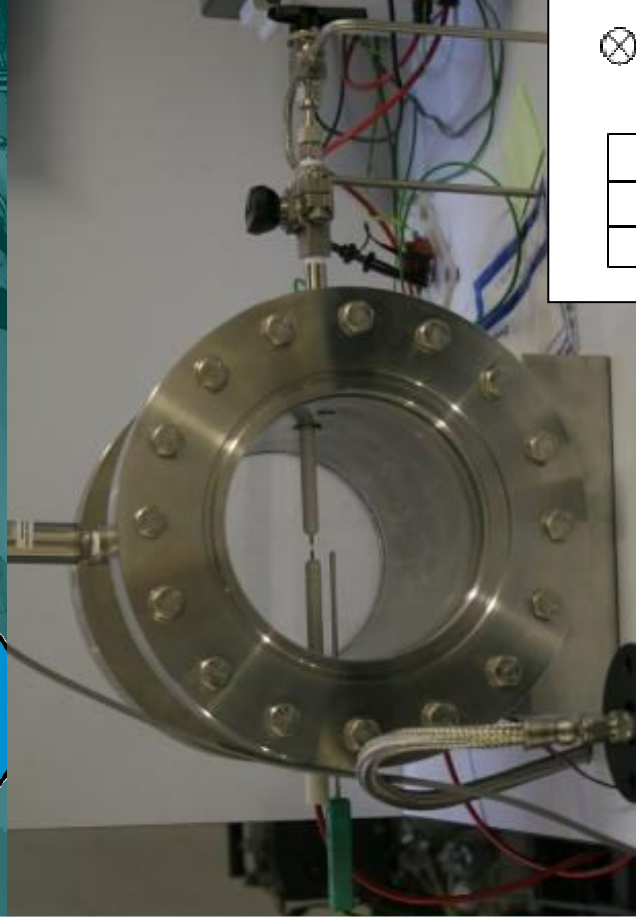




Test Facility-Overall

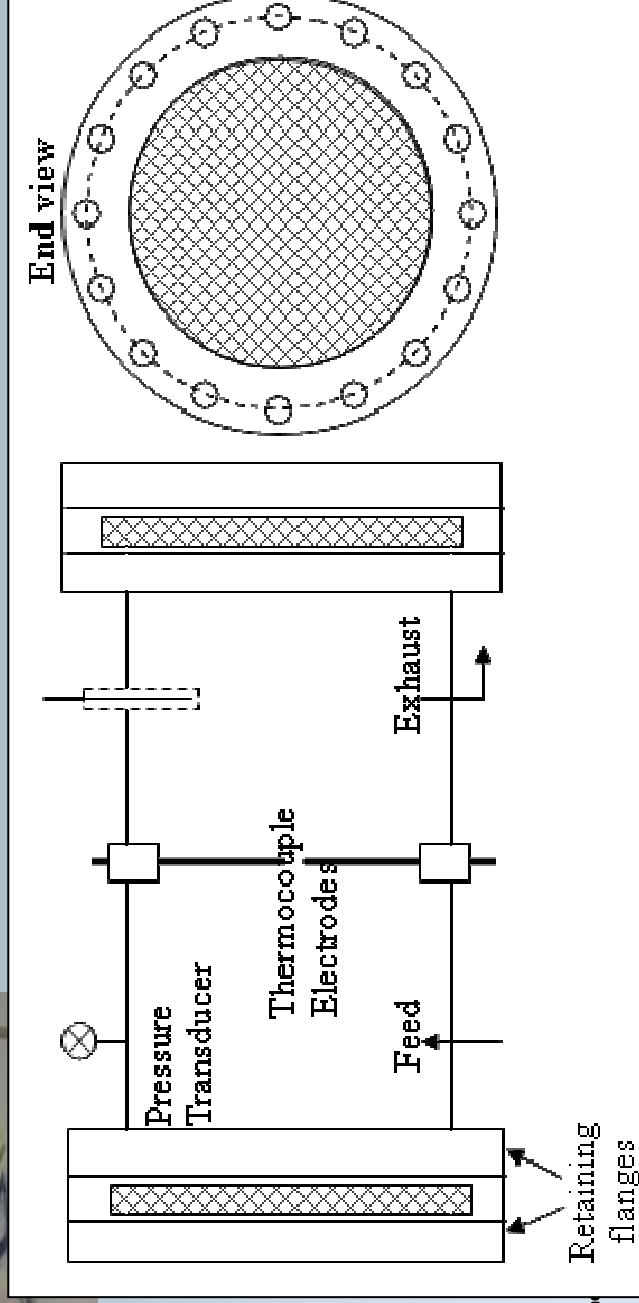


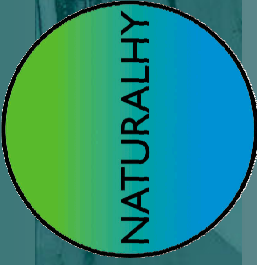
Test Facility-Combustion Chamber



- Ignition detected visually or by pressure sensor

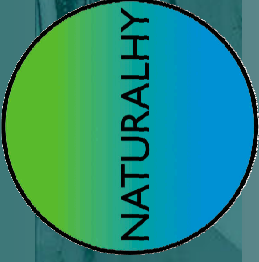
- Spark gap 2mm





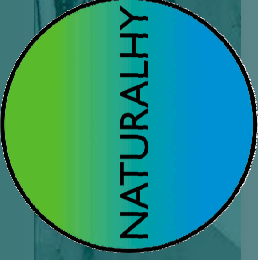
Experimental Programme

Test Series	CH₄ – H₂ Mixture (vol. %)	LFL (vol. %)	UFL (vol. %)	Target concentration of fuel in fuel-air mixture (vol.%)									
A	100 - 0	5.0	15.0	7	8	9	11						
B	75 - 25	4.7	21.1	8	12	16	20						
C	50 - 50	4.4	27.7	6	10	16	20	26					
D	25 - 75	4.2	40.5	8	14	21	28	38					
E	0 - 100	4.0	75.0	6	10	20	30	45	60				

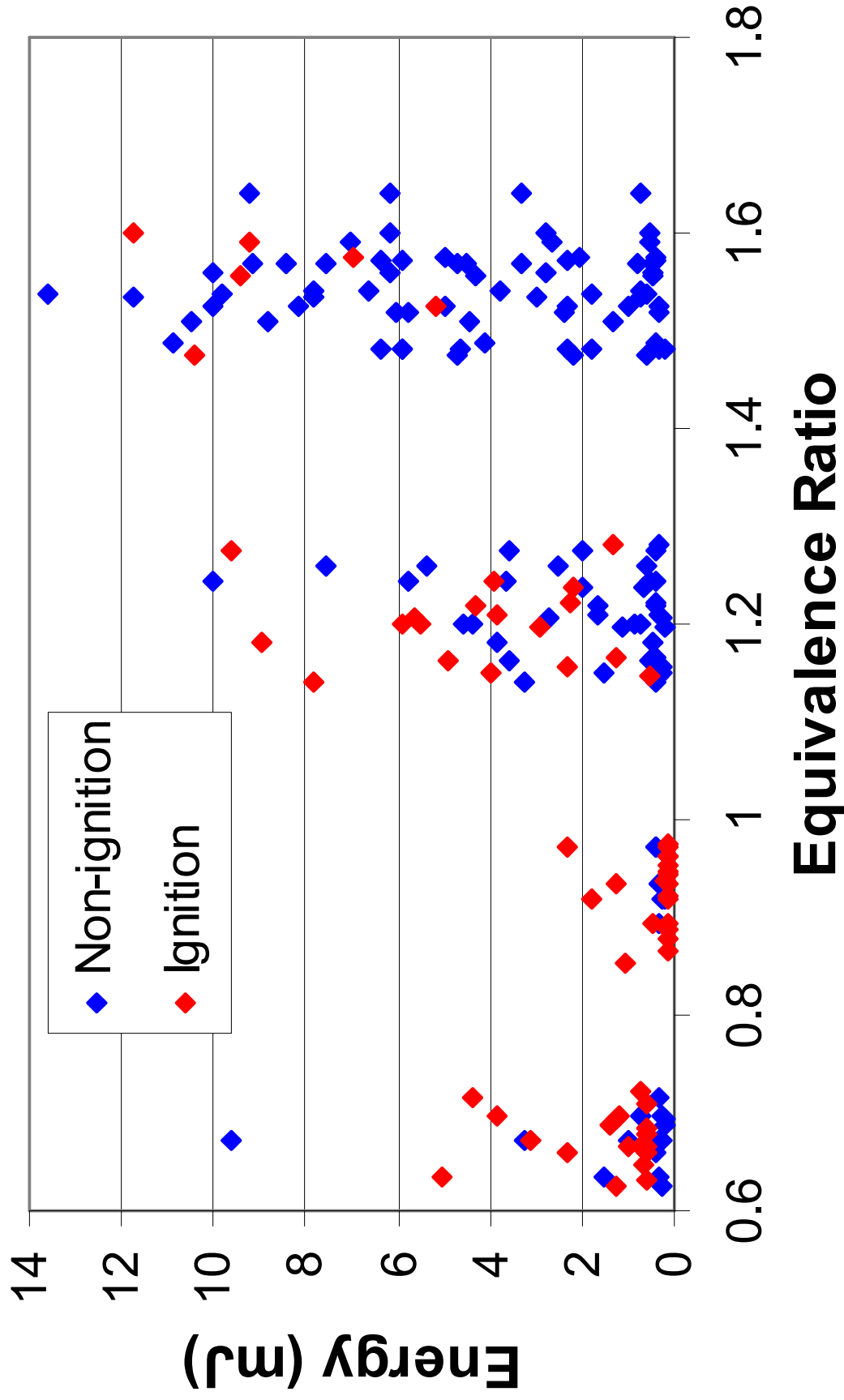


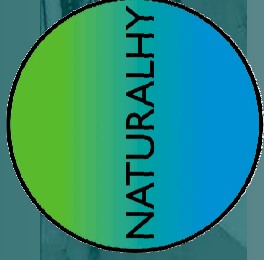
Typical Results

- Ignition energy lower for gas/air mixtures around stoichiometric
- Ignition at a given energy (above minimum) is not guaranteed
 - Probabilistic element
 - Higher probability for higher energy level
- Ignition energy reduces as hydrogen added to the methane

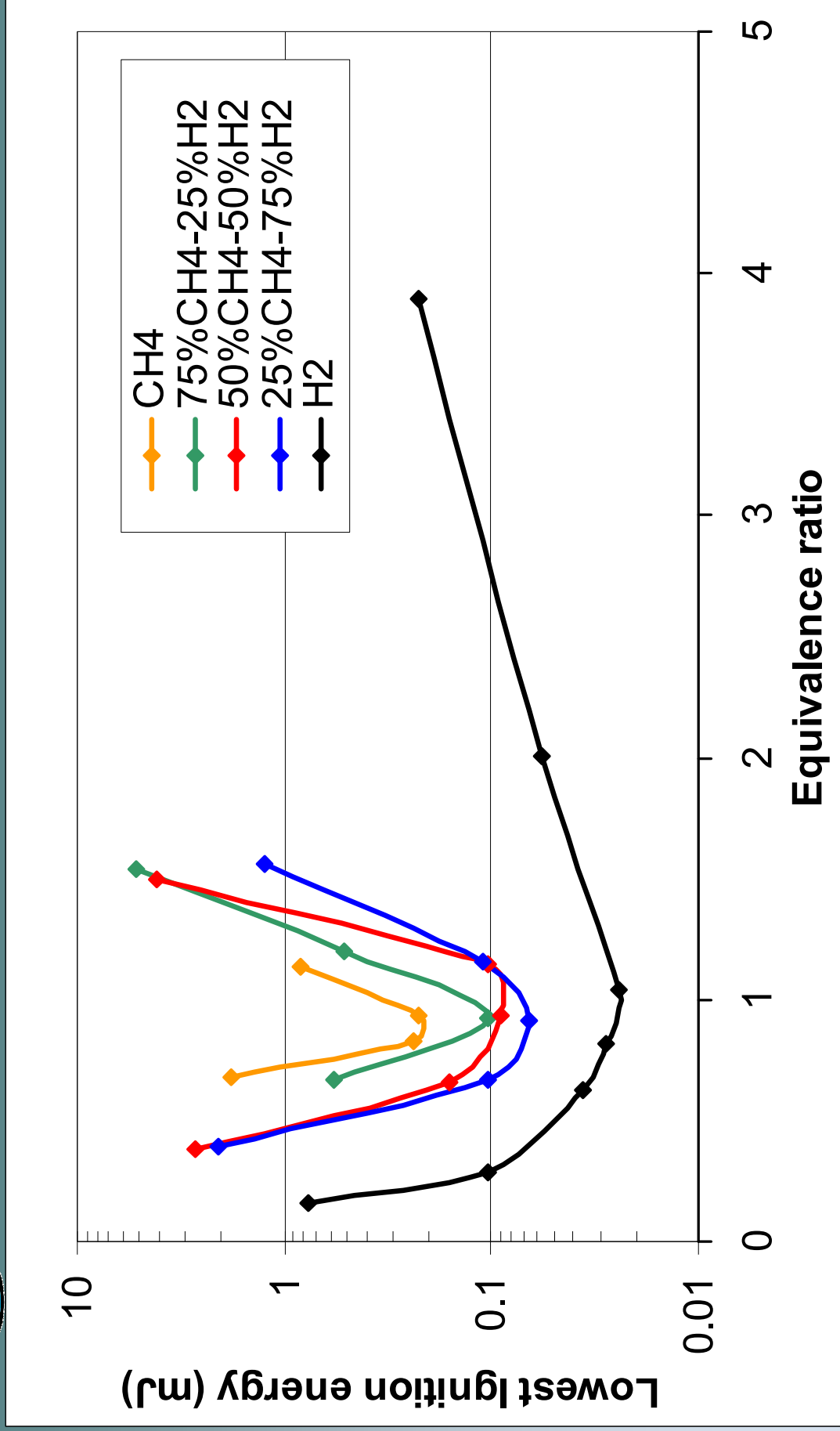


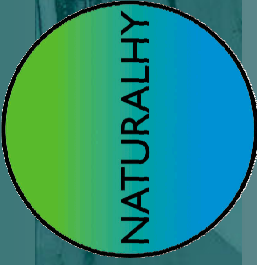
Results for 75:25 CH₄:H₂





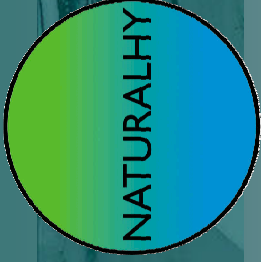
Lowest Ignition Energy



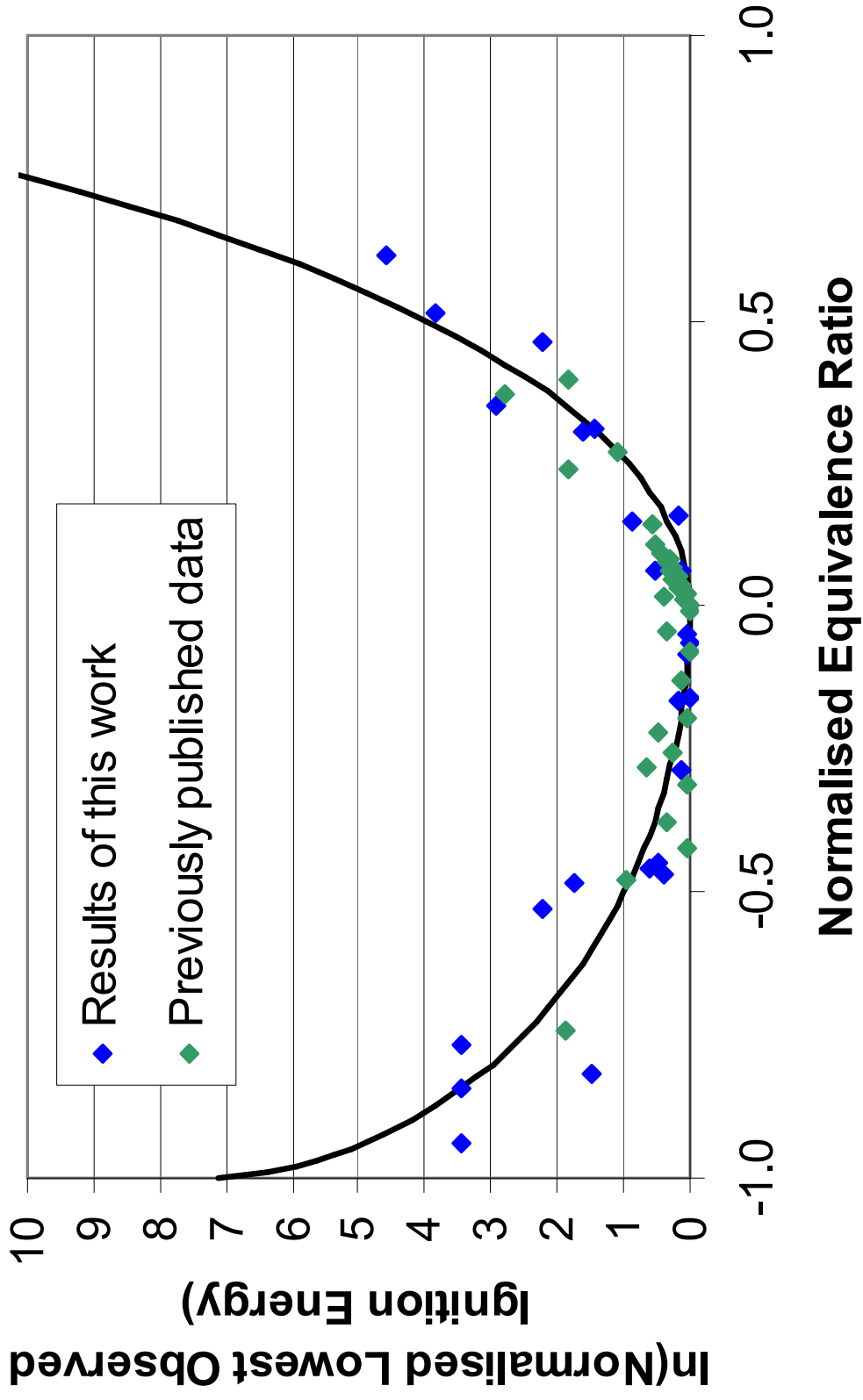


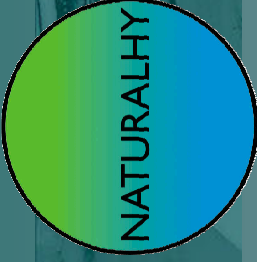
Data Normalisation

- ER normalised relative to the ER where the minimum ignition energy occurred and the ER at the flammability limits
- Lowest ignition energy for each gas/air mixture normalised relative to the minimum ignition energy



Normalised Results



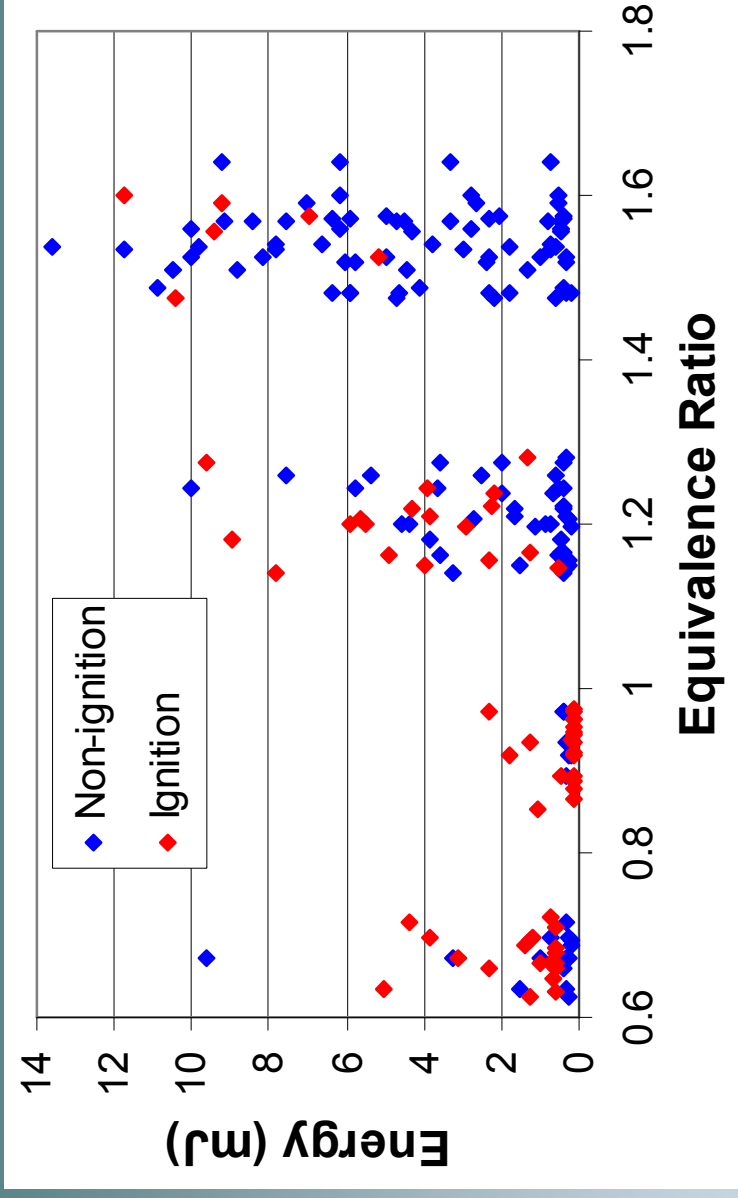


Normalised Results

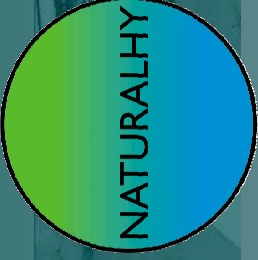
- Curves fitted to curve
- Enables the lowest ignition energy of any methane/hydrogen/air mixture to be predicted across the flammable range provided minimum ignition energy known and the ER where that occurs

Ignition Probability

- Probabilistic element



- Energy levels divided into bands so that probability of ignition within each band could be determined



Ignition Probability- 75:25 CH₄:H₂

