Fluid Mechanics with Helium: A Few Examples

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Outlook

I- Mini-jet: CRTBT (Grenoble)

II- GReC Experiment: CRTBT, LEGI (Grenoble), CERN

III- “Combustion” experiment: CRTBT

Mini-jet Experiment

Bernard HEBRAL

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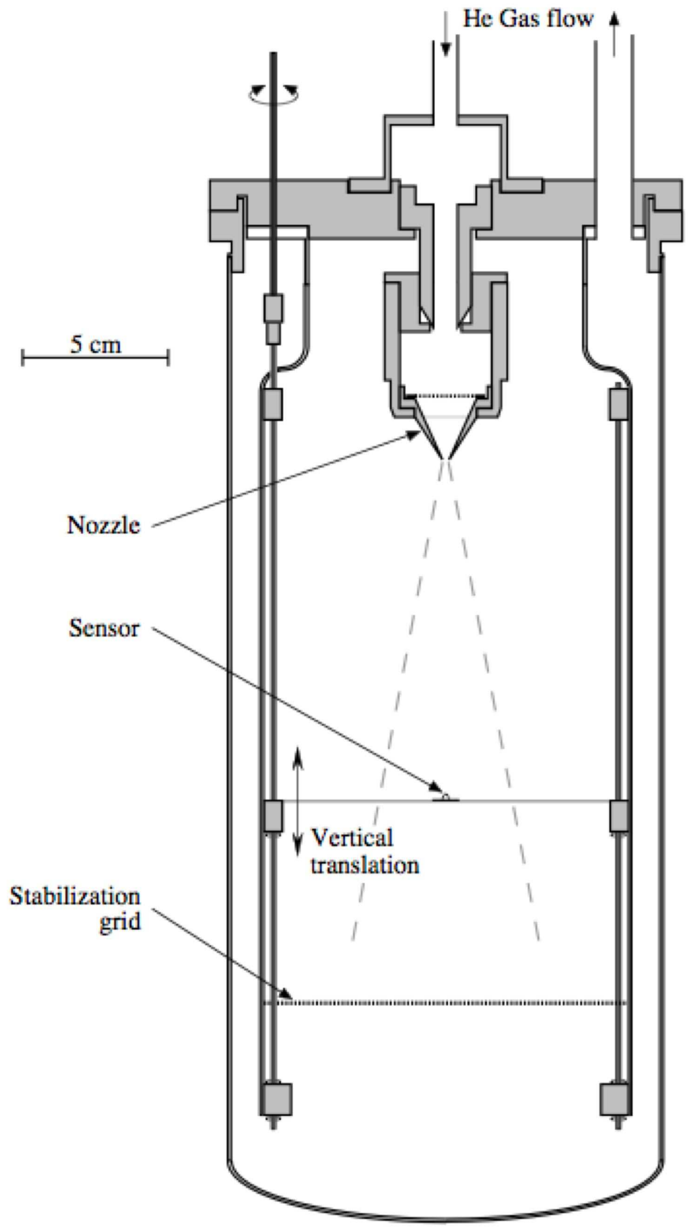
Joachim PEINKE

Bruno BAGUENARD

Francesca CHILLA

Mini-jet Experiment



Mini-jet Experiment

Velocity sensor: a hot wire (see later)
Main advantages:

- A wide range of Reynolds numbers:

$$80 < R_\lambda < 1100$$

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- With constant “boundary” dimensions:
  Constant integral scale .... but also “spurious” scales: sensor’s size and resolution, *etc*

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Velocity statistics: Time differences: $\delta v = v(t+\tau) - v(t)$

Taylor Hypothesis: Time $\tau \Longleftrightarrow$ distance $r = V\tau$

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Flatness: $\frac{<\delta v^4>}{<\delta v^2>^2}$ ... *etc*

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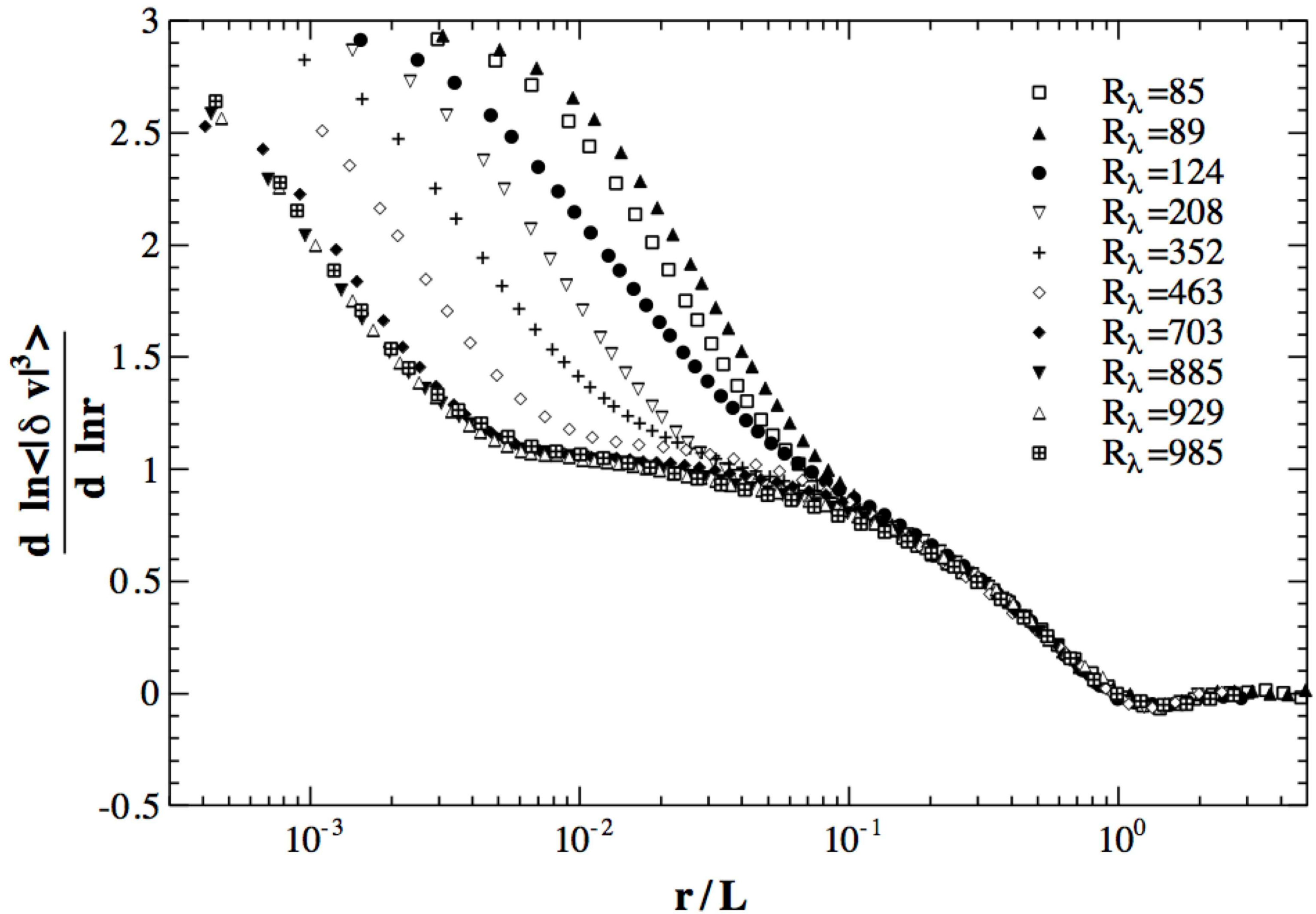
Power laws $\Longleftrightarrow$ plateaus in $\dfrac{d \ln <\delta v^p>}{d \ln r}$

Mini-jet Experiment



Mini-jet Experiment

Collaboration:

A. Arnéodo, J.F. Muzy, J. Delour, L. Chevillard

Two important results:

- Frisch and Vergassola effect:
  $< \delta v^4 >$ comes to a viscous behaviour
  at smaller scales than $< \delta v^2 >$

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Two important results:

- Frisch and Vergassola effect:
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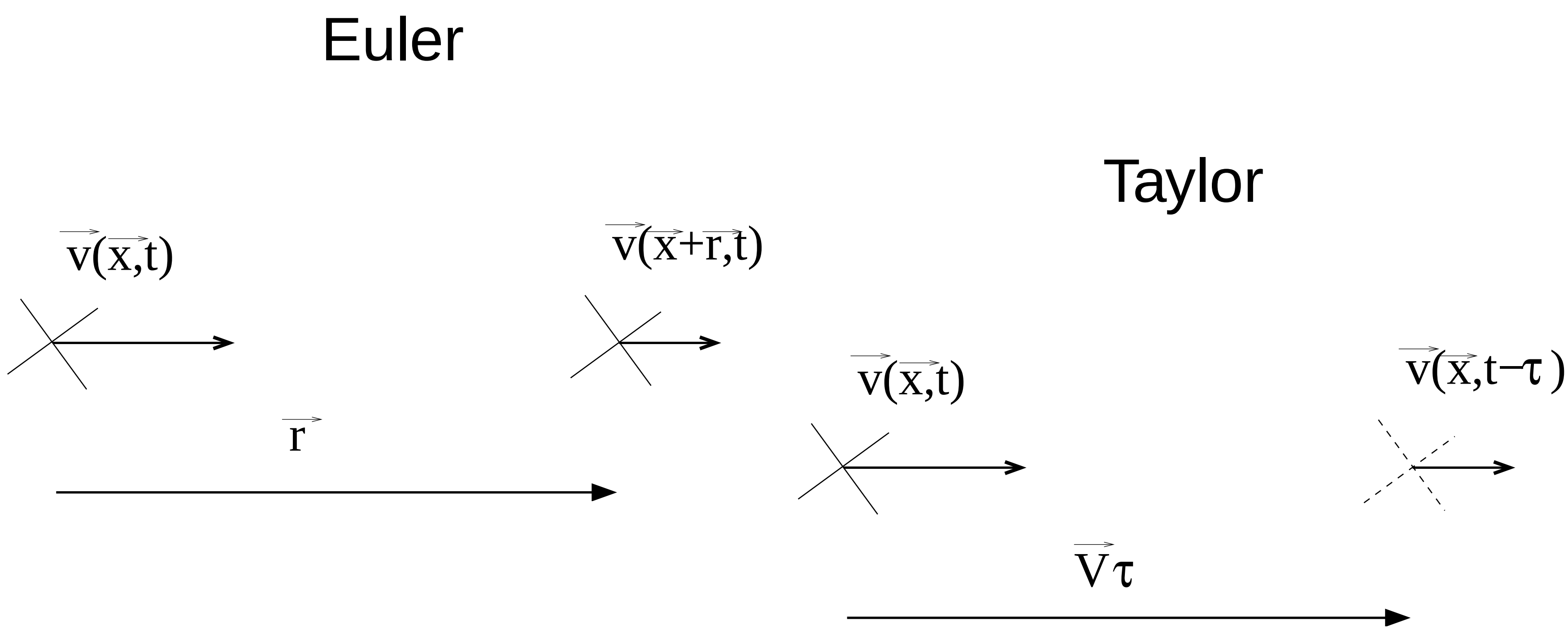
- Two points correlations:
  Differences between Taylor and true Euler sampling

Mini-jet Experiment



GReC Experiment

S. Pietropinto	Y. Ladam	
B. Hébral	C. Baudet	P. Lebrun
B. Chabaud	Y. Gagne	O. Pirotte
P. Roche	C. Poulain	J.P. Dauvergne

GReC Experiment

Mini-jet: up to 4g/s

GReC: up to 300 g/s

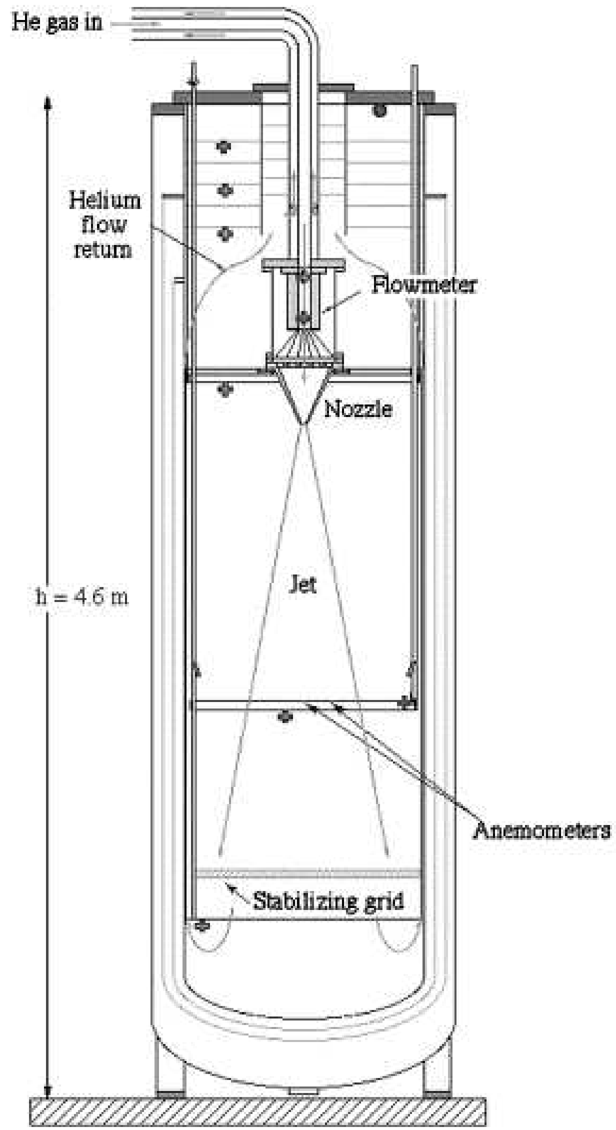
GReC Experiment

Mini-jet: up to 4g/s GReC: up to 300 g/s

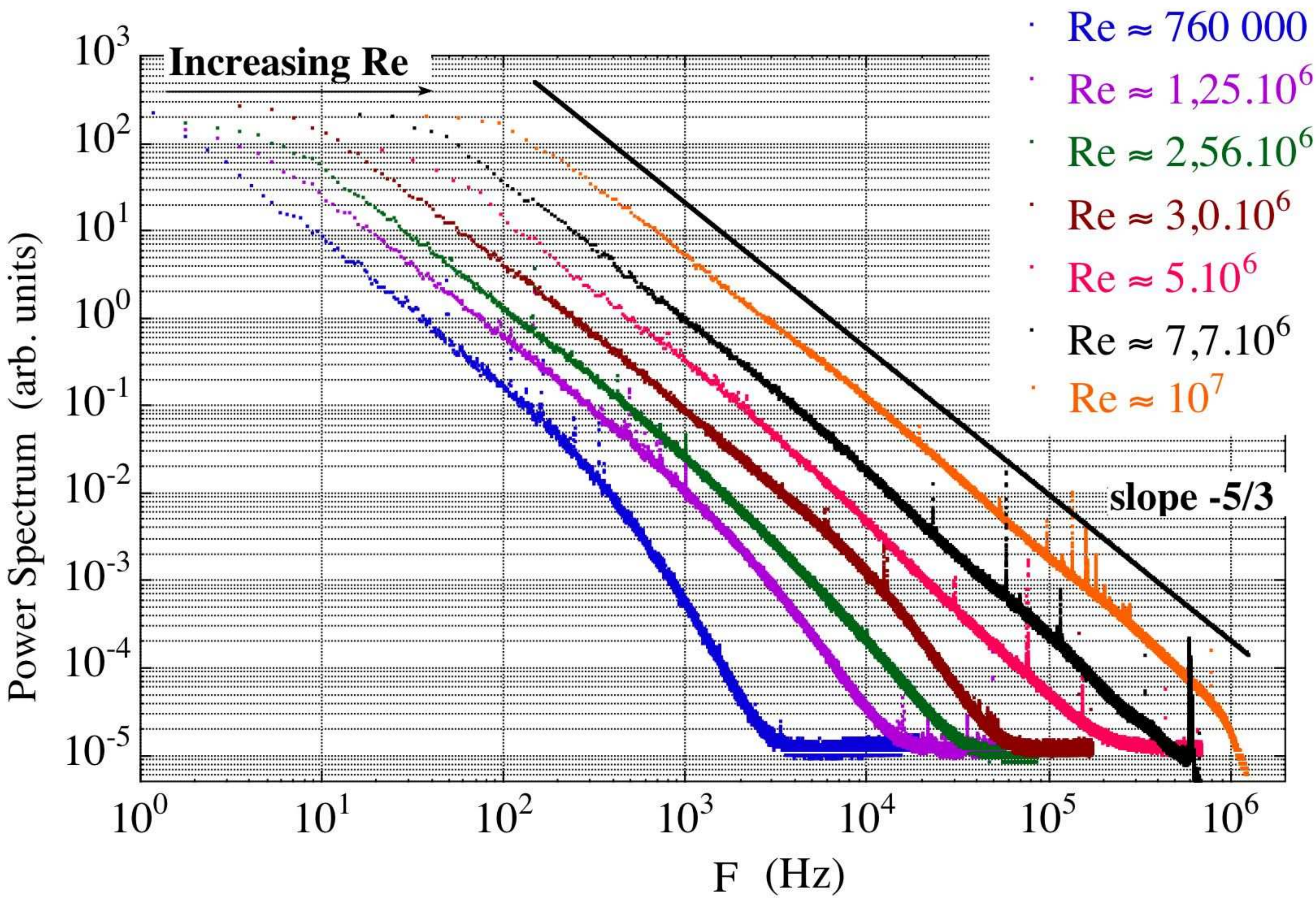
GReC:

$$1200 < R_\lambda < 6000$$

GReC Experiment



GReC Experiment



GReC Experiment

To make short:

Good points:

Characteristics of the flow, Laboratory conditions

Signal to noise ratio (> 80dB)

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Characteristics of the flow, Laboratory conditions

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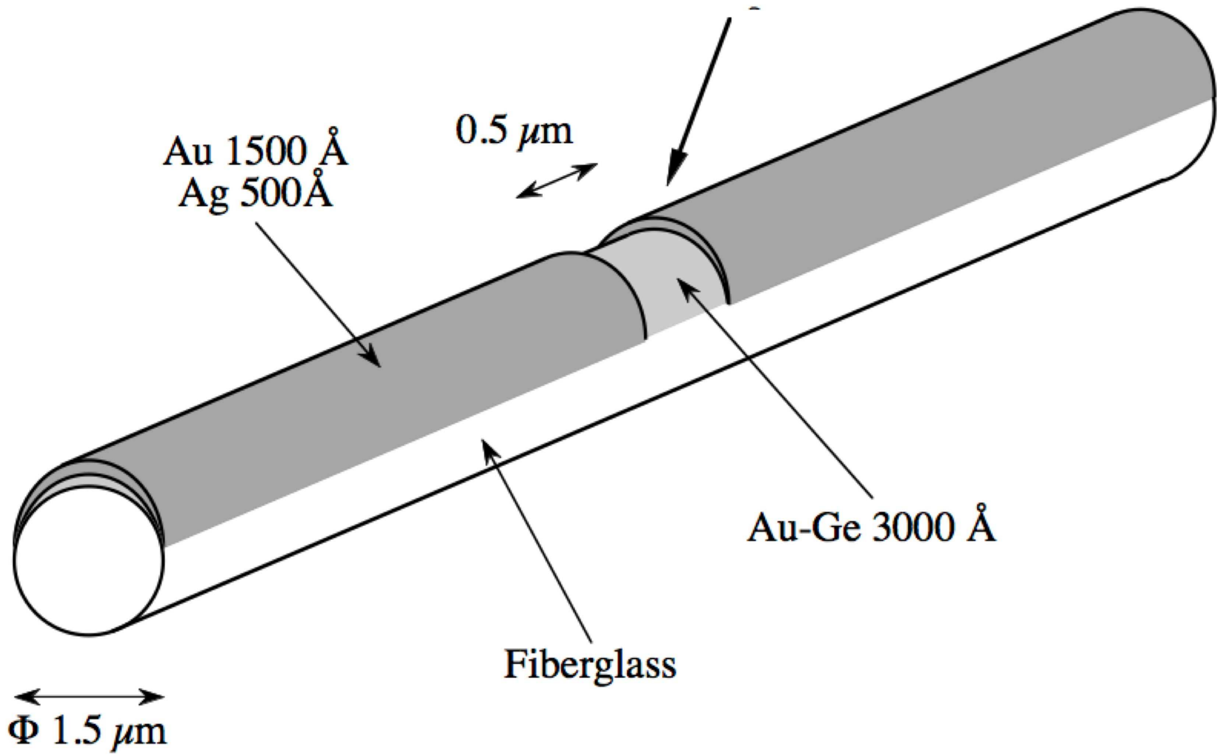
Bad point:

Fabrication of the sensor

GReC Experiment



“Combustion” experiment

Yves Ladam

Pierre Thibault

Etienne Wolf

Laurent Puech

“Combustion” experiment

Cryogenic Rocket Engines:
Coaxial injection of H_2 and O_2 (Critical, 5MPa, 90K)

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Cryogenic Rocket Engines:
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H_2 $\longrightarrow$ 80K He

Same density ratio, close Re, Ma, ... *etc* numbers.
Mixing probed by the temperature.

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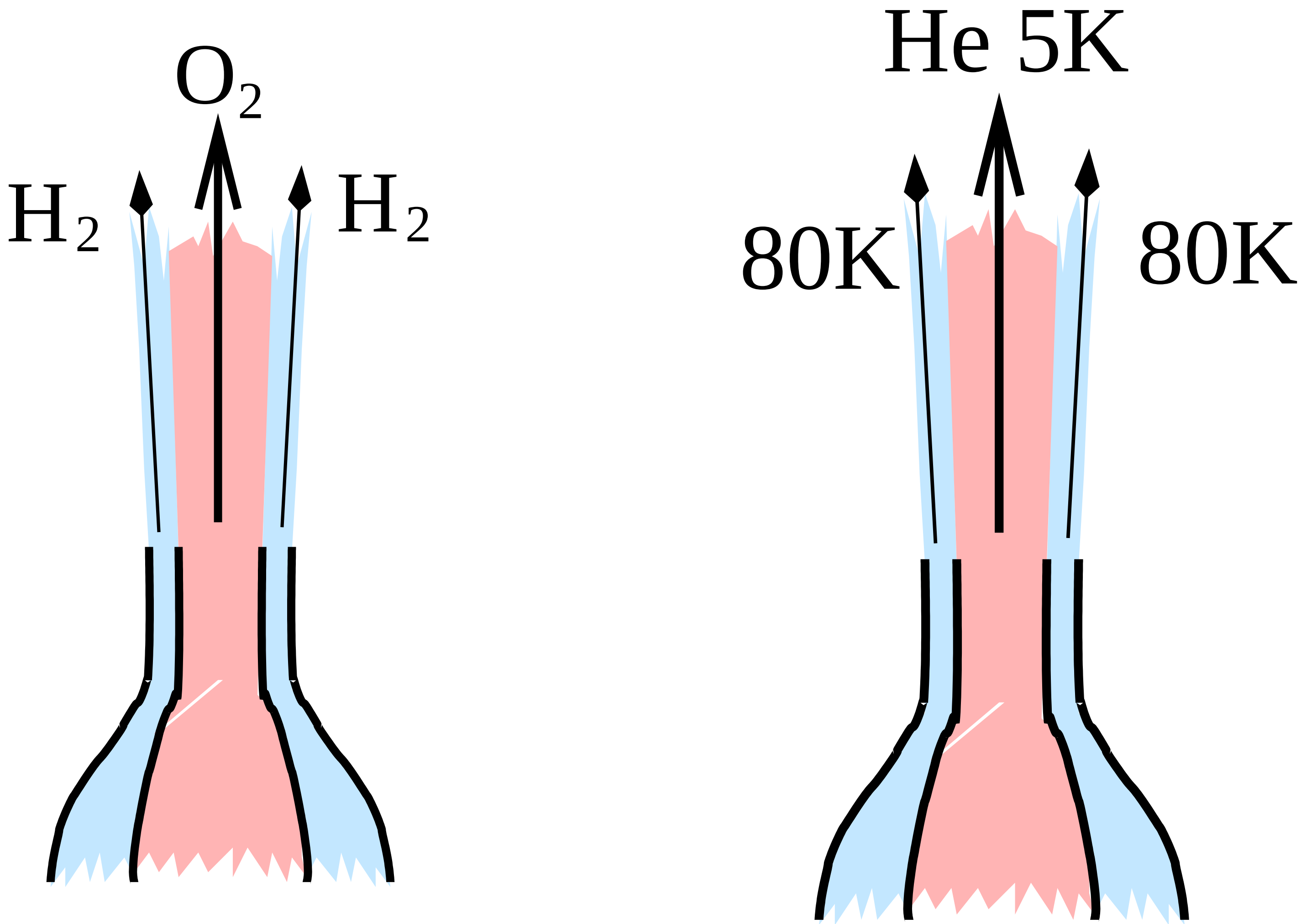

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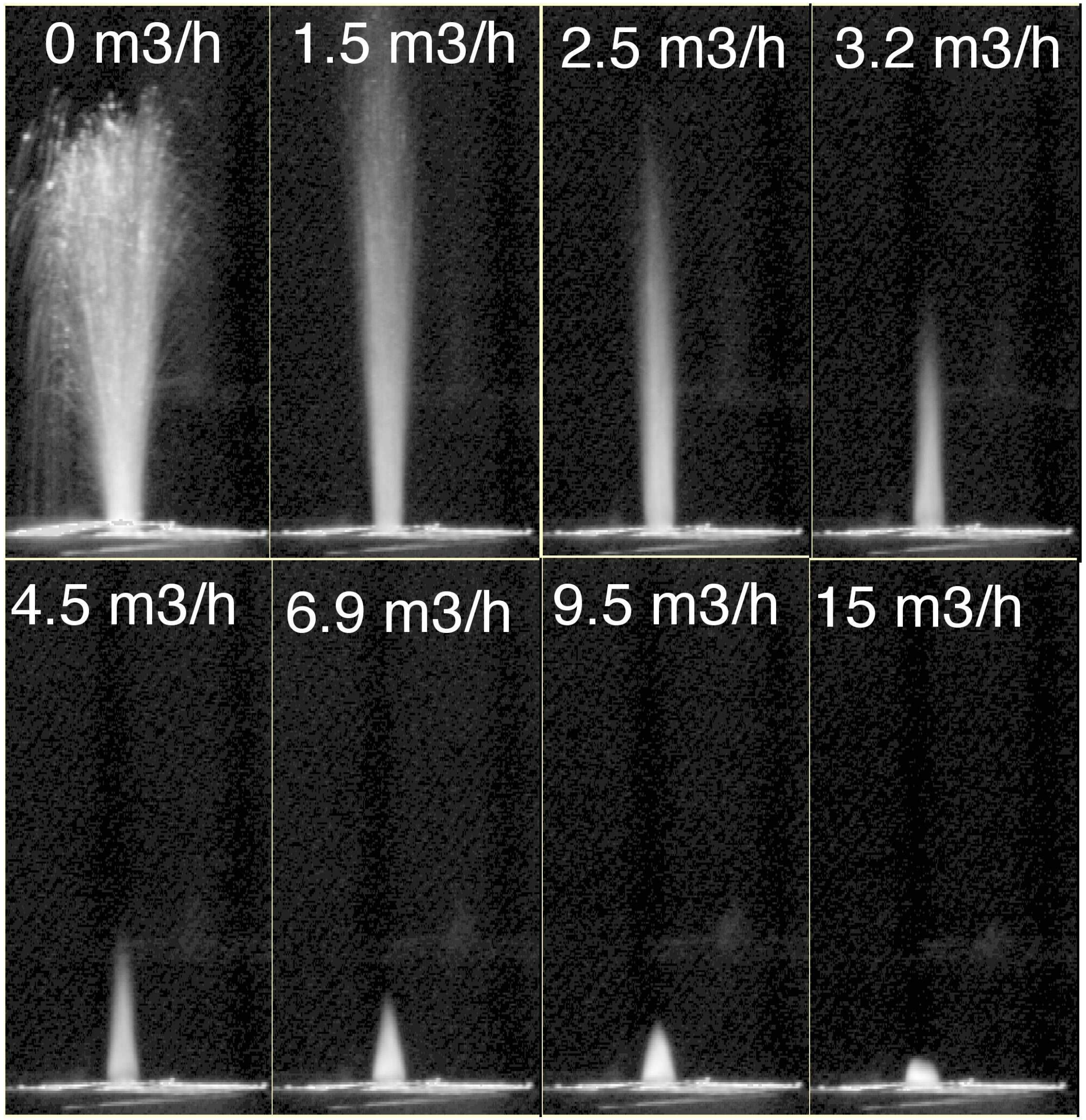

Liquide : 6.5 m3 TPN/h Gaz à 80 K

“Combustion” experiment

Experiments with classical fuel, and air,
found droplets far downstream

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H_2/O_2 flame (3000K): no droplets either.

Crucial parameter: (Flame temperature)/(“Liquid” $T_c)$:

Classical fuel: $\frac{1600}{400} = 4$; H_2/O_2: $\frac{3000}{90} = 33$; He: $\frac{80}{5} = 16$

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  “Easy” use of Helium.

To conclude

'Easy' thanks to:

- P. LEBRUN, O. PIROTTE, J.-P. DAUVERGNE
- S. KNOOPS , R. VAN WEELDEREN, A. BEZAGUET, L. TAVIAN, N. DELRUELLE, M. PEZETTI
- And several other helpful and highly qualified people

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  "Easy" use of Helium. (As easy as Air or Water)
- Needs for a wide collaboration on sensors: towards robustness and variety (hot-wire, PIV, LDV, Acoustics, ...)
- And a long term reflexion on tractable problems:
  Mixing, Clusterization, Boundary layer detachment and control, Combustion(?) ...