Measuring better.

New developments and applications in flow instrumentation technology

David M. Birch

EnFlo Atmospheric Wind Tunnel
Centre for Aerodynamics & Environmental Flow

Surrey Sensors Ltd.

How did it come to this?

A “hostile environment”.

“Fluid measurement is not an area of research priority”.

“You can buy this stuff off-the-shelf.”

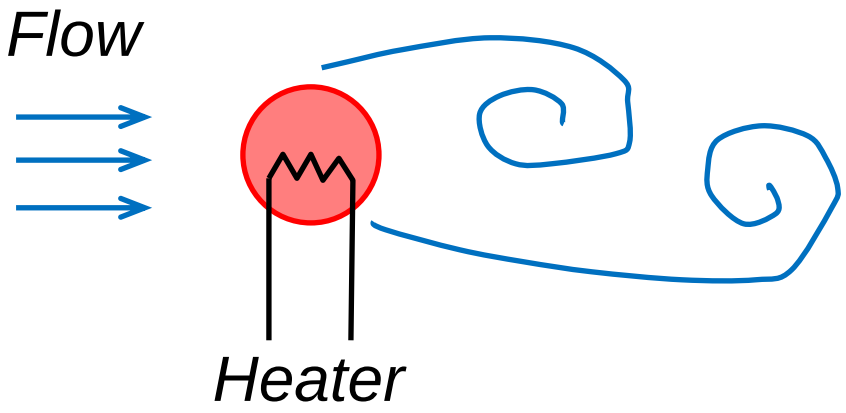
“Experiments are obsolete anyway. Simulation is the future.”

“Making things less expensive is not research.”

“The best research is the most expensive research.”

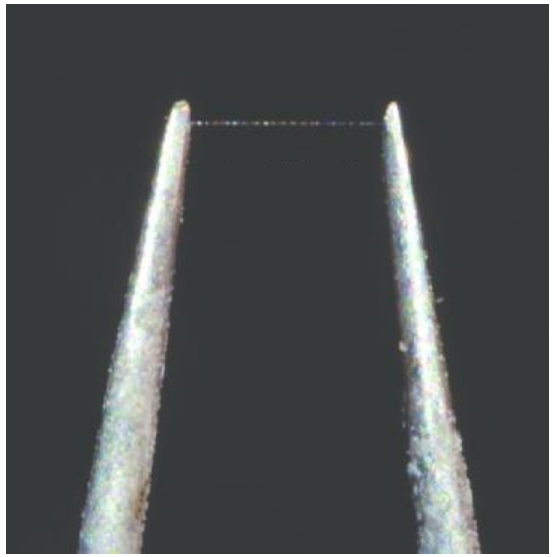
Ultra-low-range, IP68 velocity probe

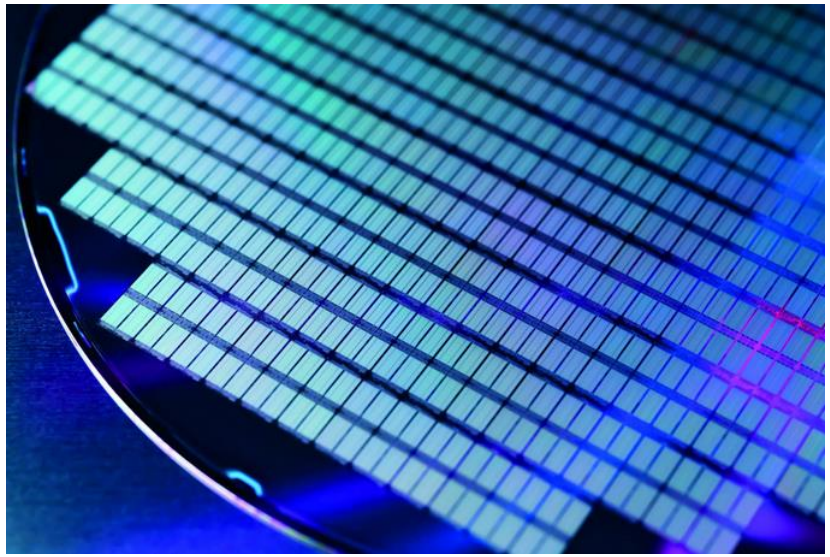
Based on solid-state thermal shear sensors



$$U = 2R'\left[\frac{H(v)(R'-R_0)}{\alpha R'}\right]^{\frac{1}{2}}.$$

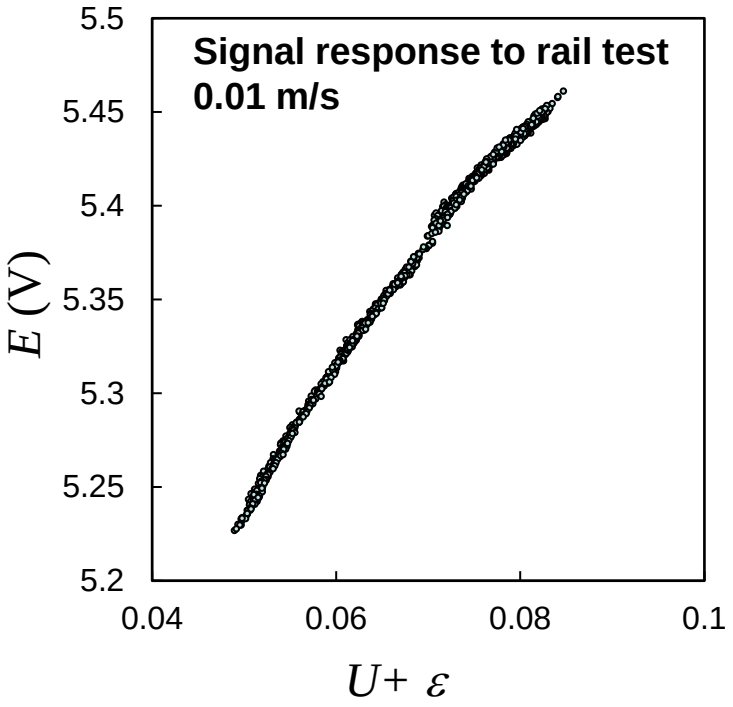
Freymuth (1967)



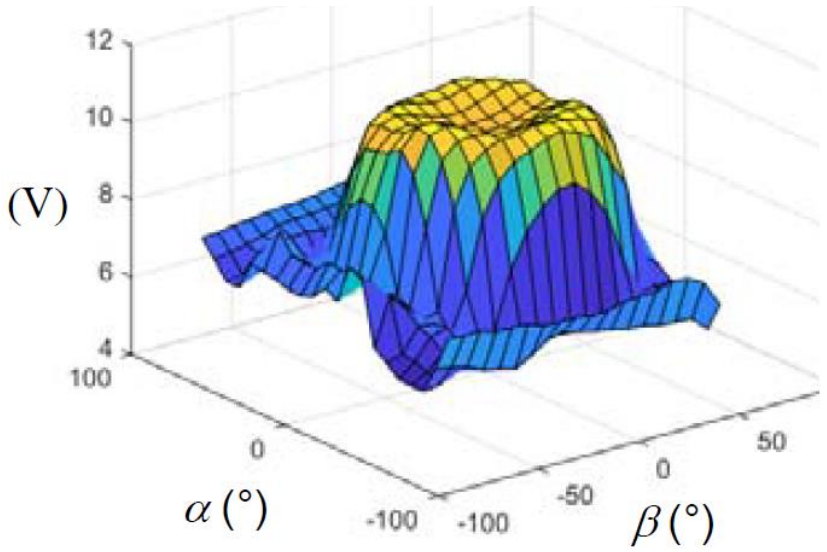


Ultra-low-range, IP68 velocity probe

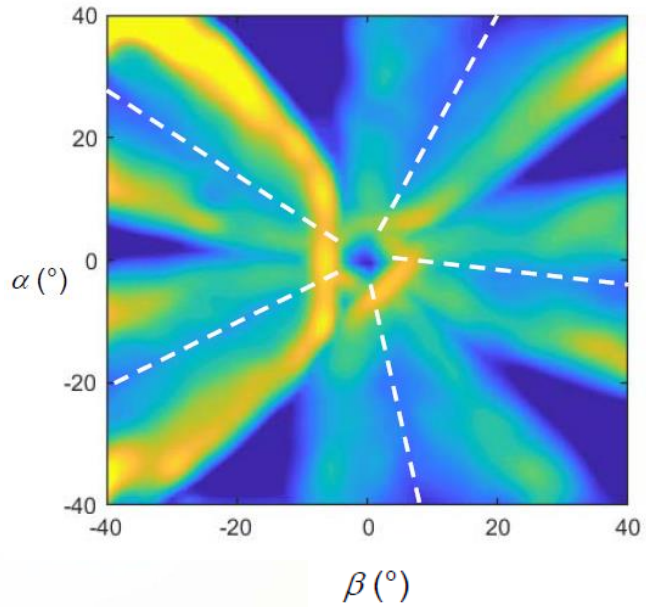
Performance



Directional sensitivity



5-channel probe response



A novel thermal anemometry technique for very-low-velocity flow measurement

Paul Nathan, Alan Robins and David M. Birch*
University of Surrey Centre for Aerodynamics and Environmental Flows, Guildford, Surrey GU2 7XH
* *E-mail: d.birch@surrey.ac.uk*

What about conventional hot wire anemometry?

Stuck in the 1970s…

Hot wires remain the only viable instrument for high-bandwidth turbulence measurement.

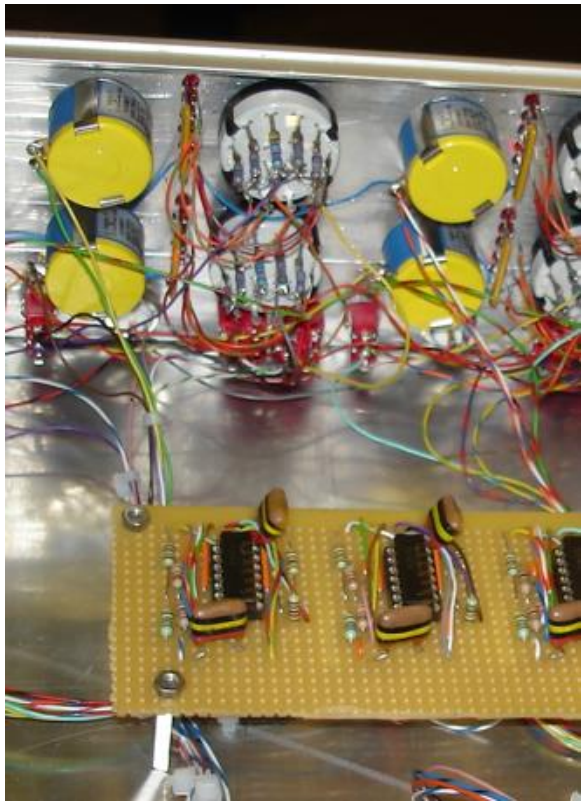
CTA systems are not commercially viable.

- Auspex & TFI ceased operation
- TSI exited market

But why???

What about conventional hot wire anemometry?

Stuck in the 1970s…



“Home-made” CTA system (2006)

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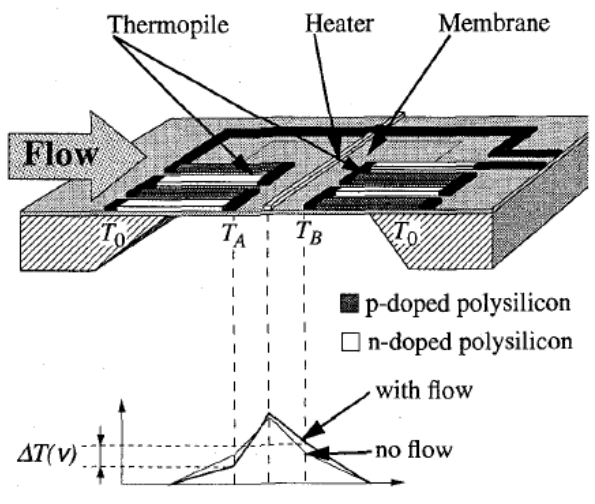
An innovative low-profil

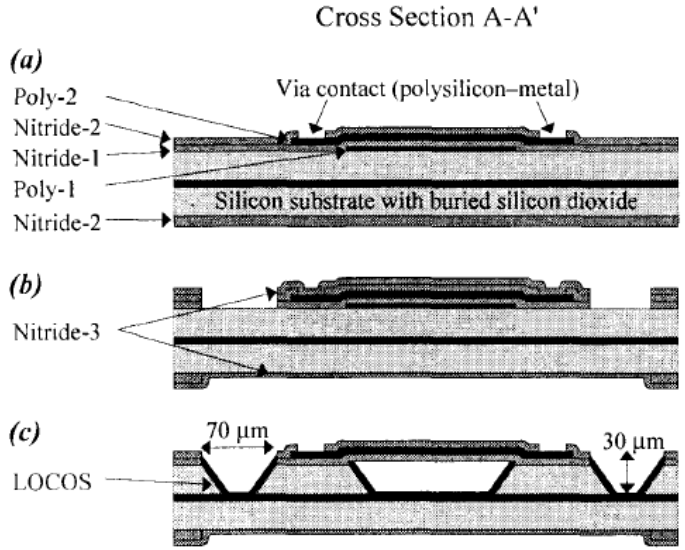
Da

a Faci
b Dep
London, UK

“This is an uninteresting, mature technique”.



Mayer et al. (1997)

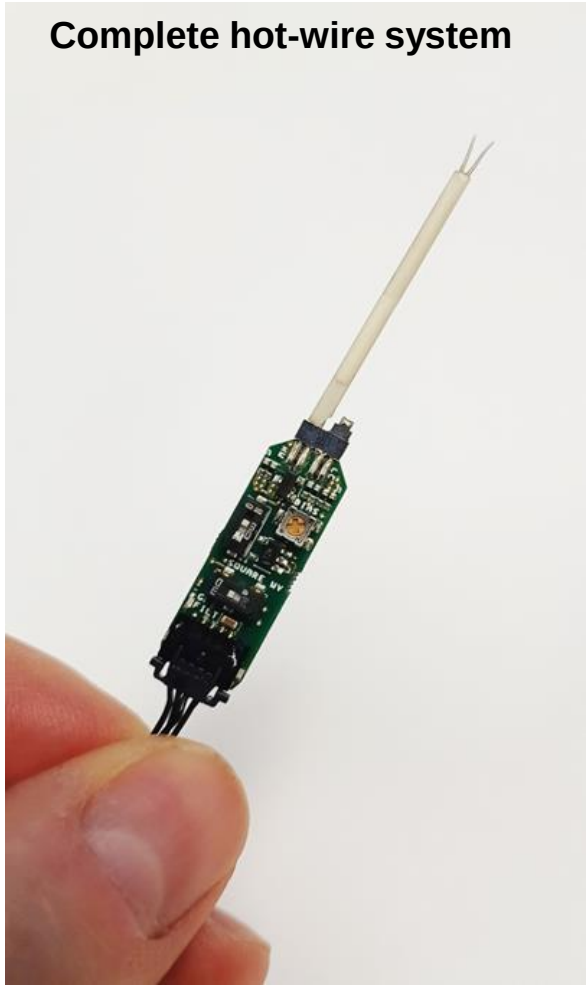


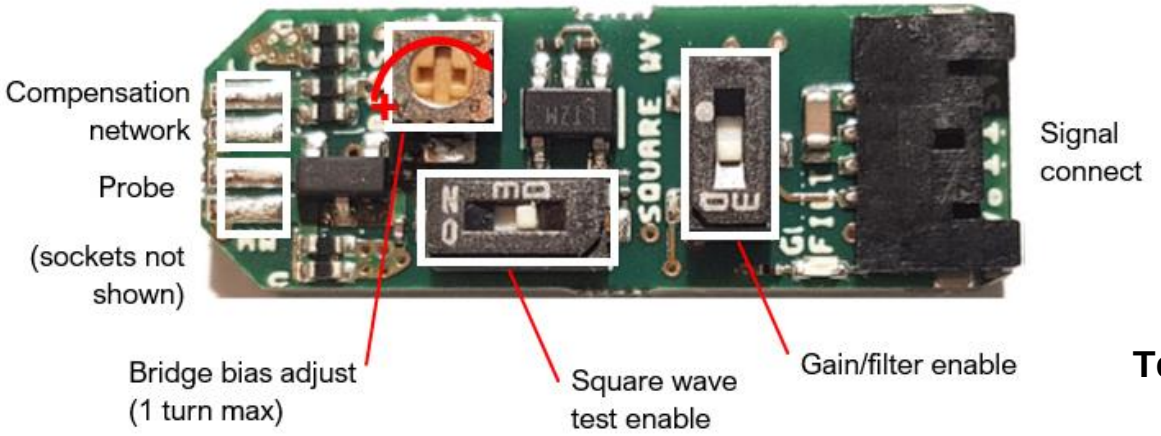
Ebefors et al. (1998)

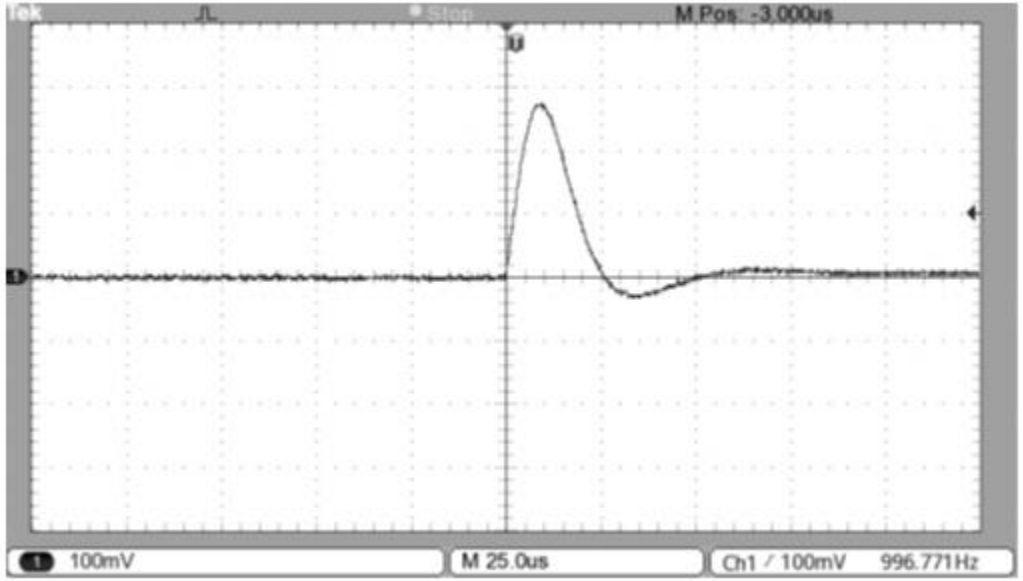
What about conventional hot wire anemometry?

Stuck in the 1970s…

Complete hot-wire system







Temperature compensation:

$$f(Re) = \left(C\frac{V_B^2}{2kT_f} - A\right)\left(Bg(Pr)\right)^{-1}$$

$$\begin{aligned} A &= 0.3 \\ B &= 0.62 \\ g(Pr) &= Pr^{1/3}\left(1 + 0.54288Pr^{-2/3}\right)^{-1/4} \end{aligned}$$

Nathan (2025)

Concentration measurements?

For dispersion experiments

Measuring trace amounts of hydrocarbons in air at 400 Hz.

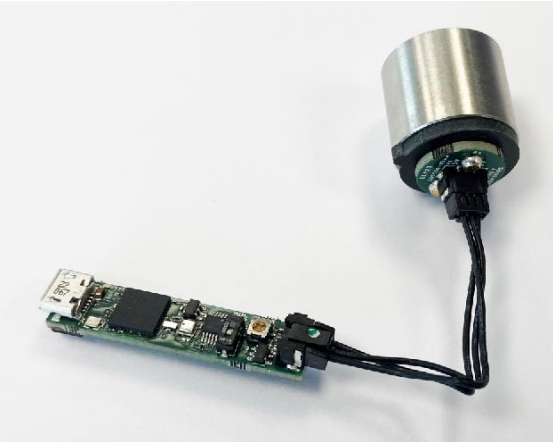
- Instruments are large and can cause blockage
- ~£40k per channel
- Requires heavy umbilical (vacuum line, fuel gas lines, signal cables)

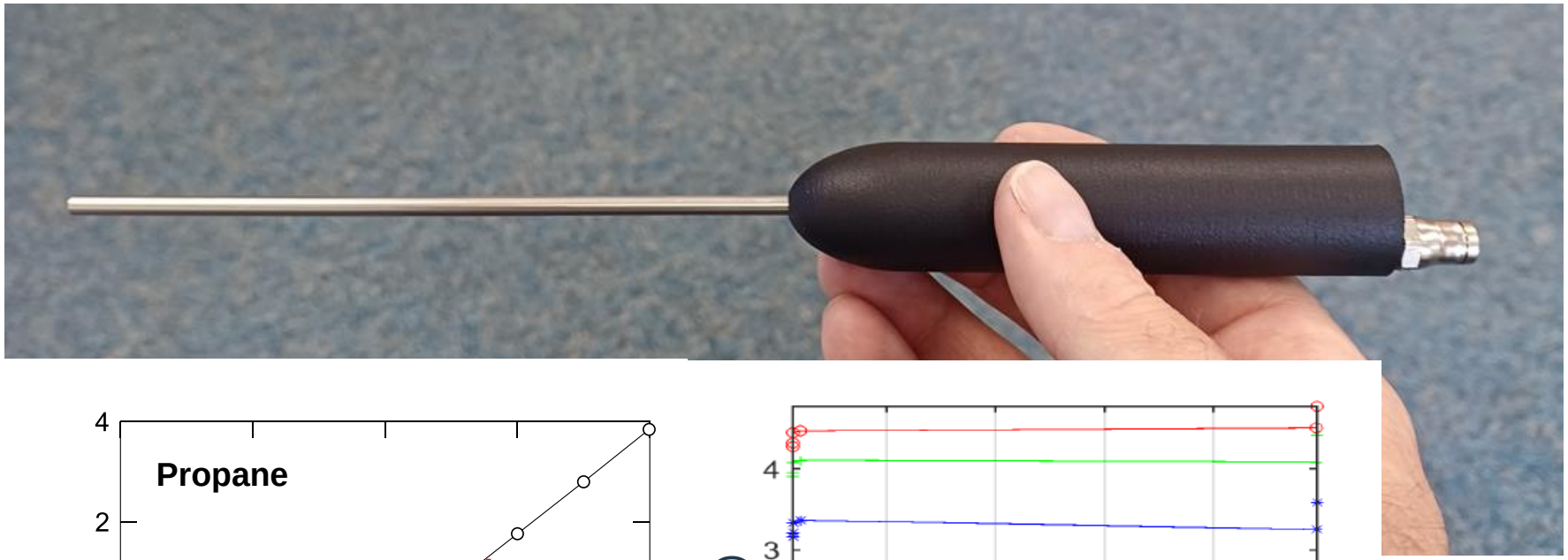
Pt-Rh coated ceramic pyrocatalytic bead

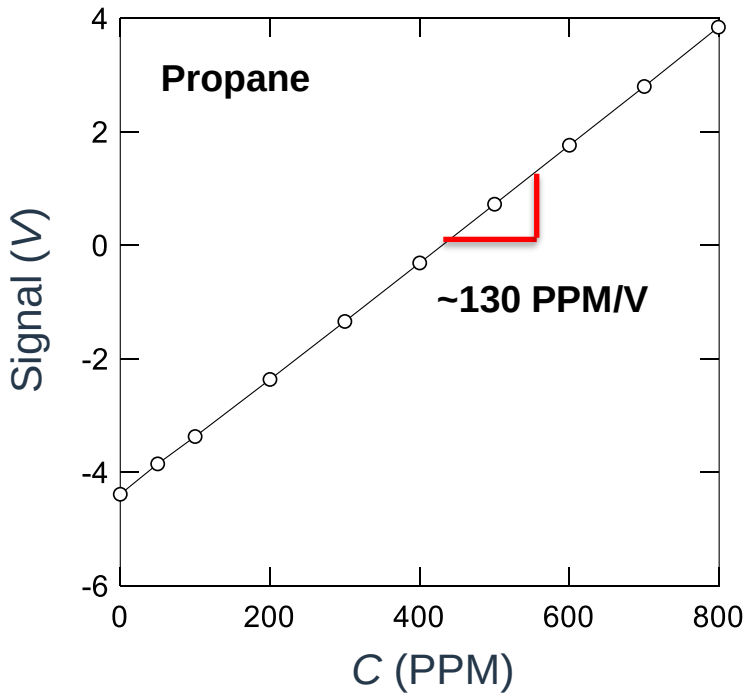
- Cheap as chips
- Not particularly sensitive (need low PPM)
- Relies on viscous diffusion
- Drift

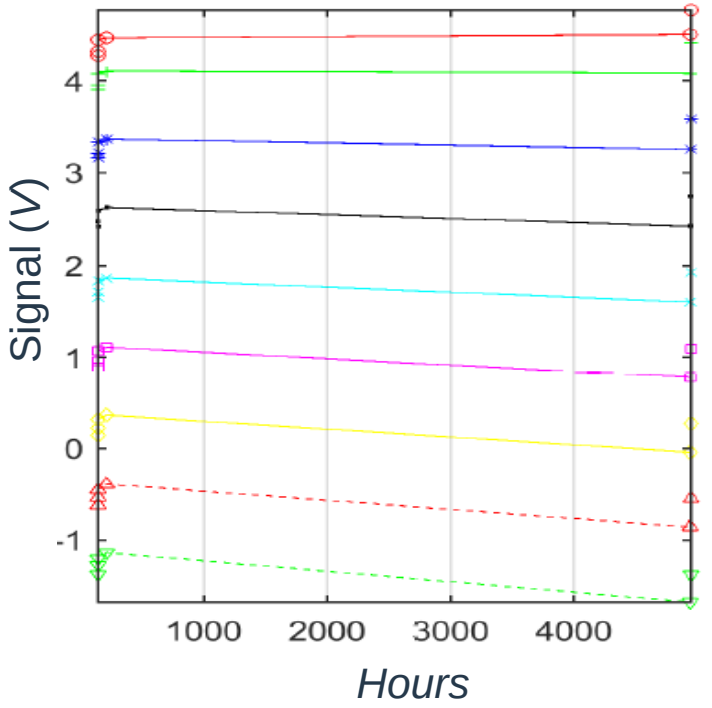
Concentration measurements?

For dispersion experiments



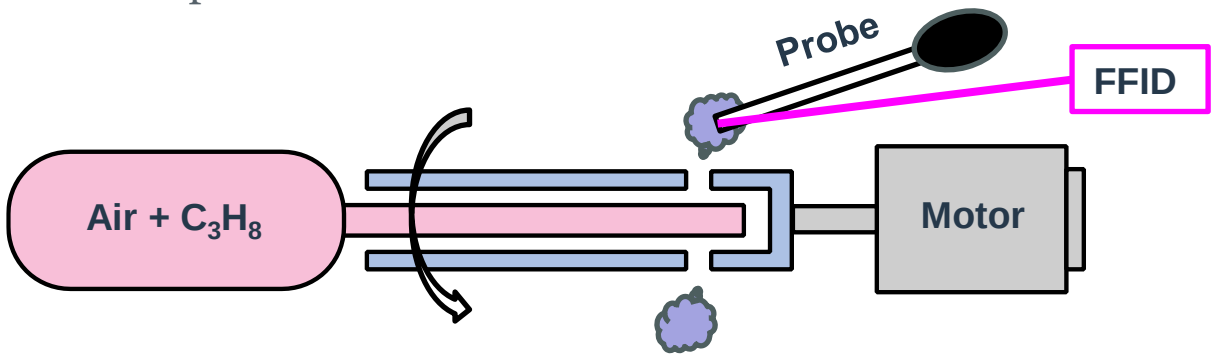


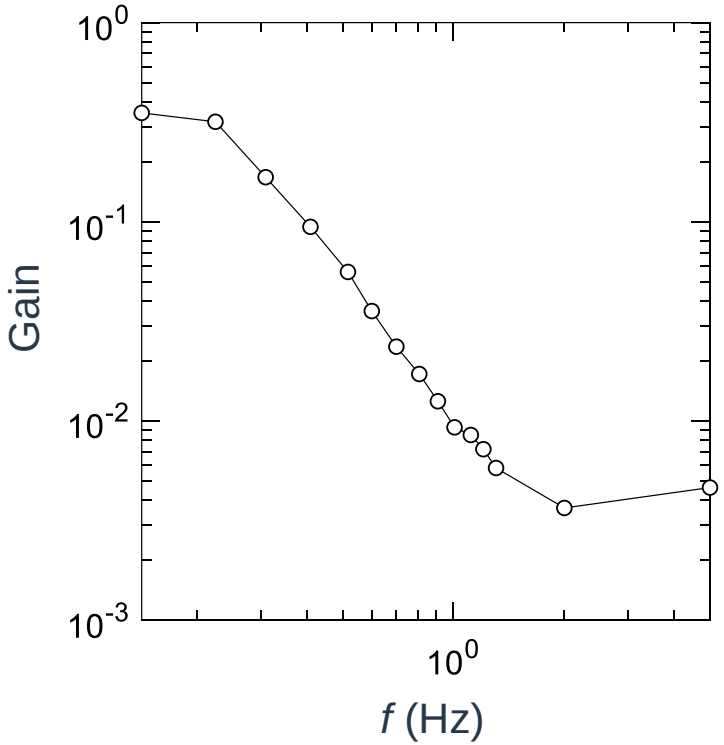




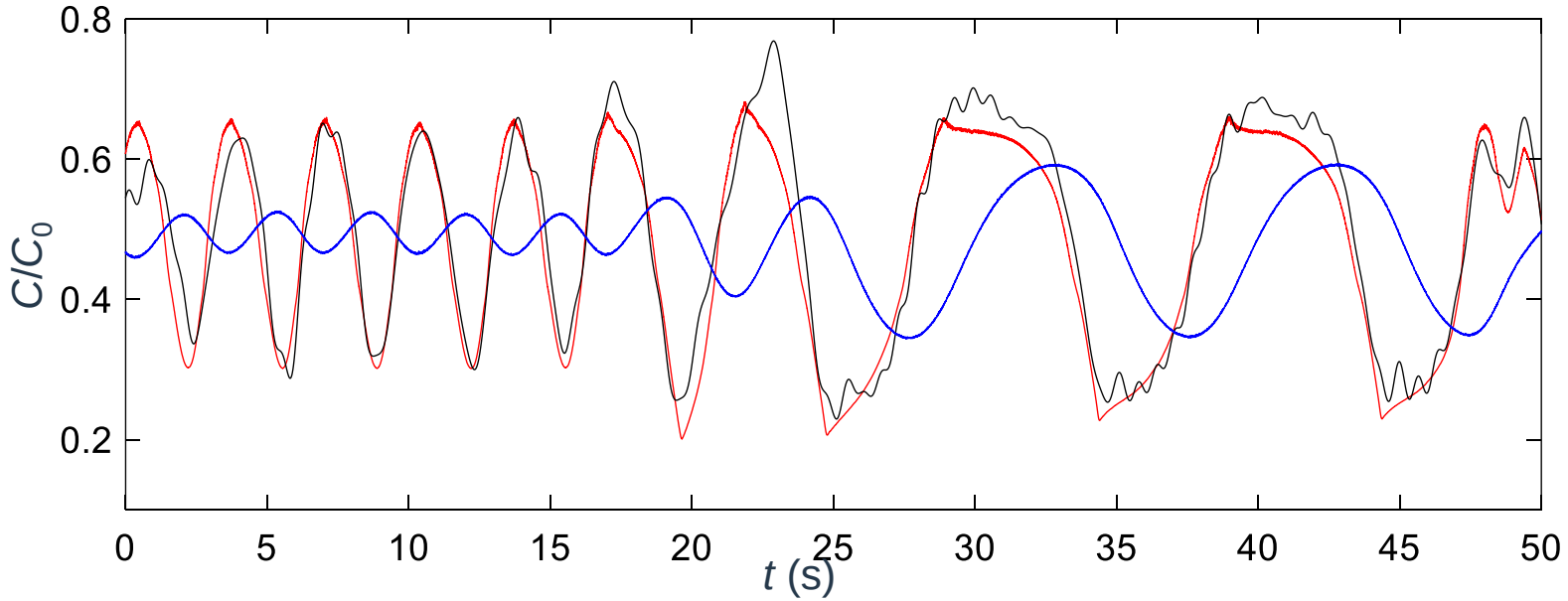
Concentration measurements?

Time response





Reference FFID
Raw SFID
Calibrated SFID



Other interesting developments…

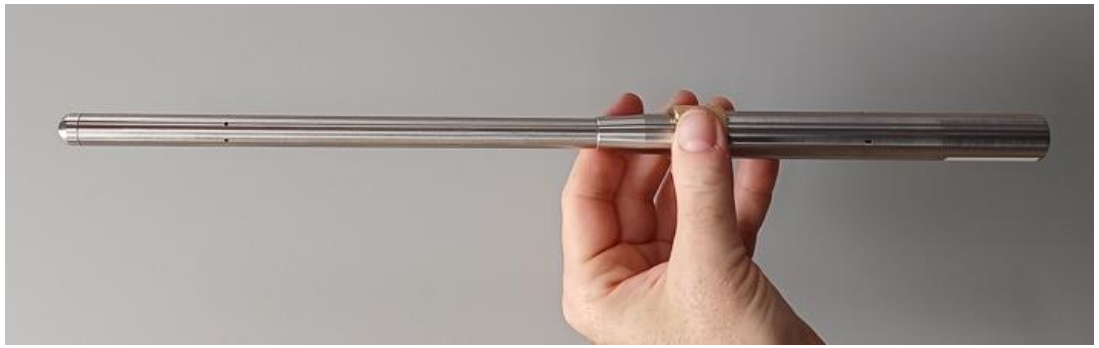
(a bit more specialized)

Very hot probes?

- Total temperature and pressure; SiN ceramic body with type S thermocouples & Inconel 700

Very smart probes?

- Build an air-data computer into standard digital 7-hole probe



Other interesting developments…

(a bit more specialized)

Very fast probes?

- Adaptive active-feedback dynamic calibration for high-bandwidth ‘Cobra’ probes

Questions?

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