Microsphere in hollow core photonic crystal fiber as temperature probe for hydrogen combustors

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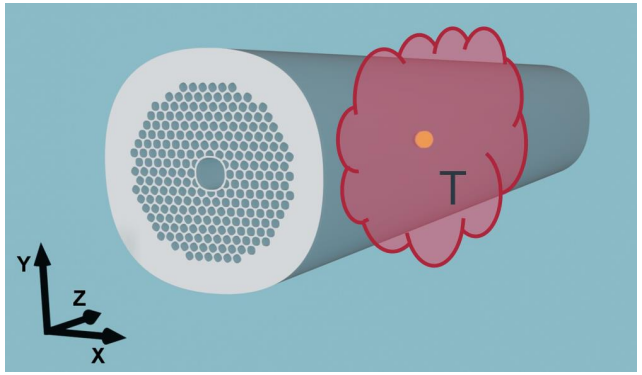
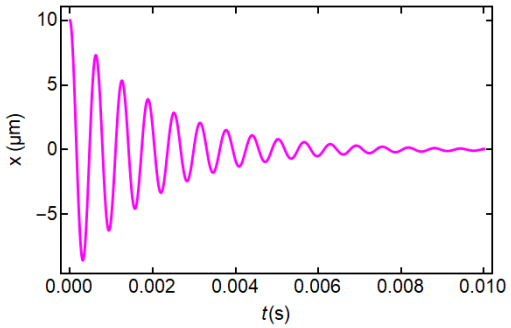
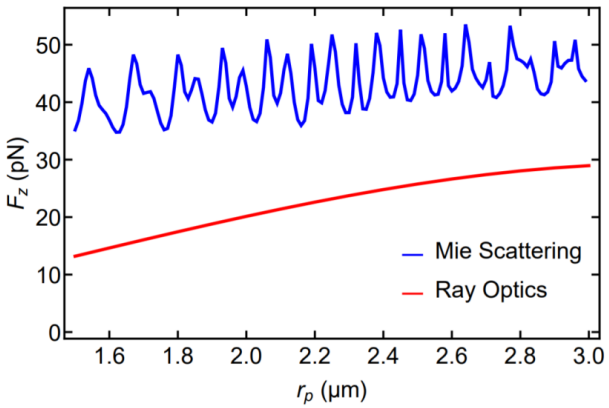
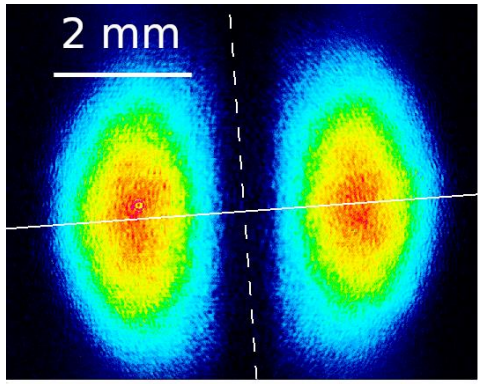
Content









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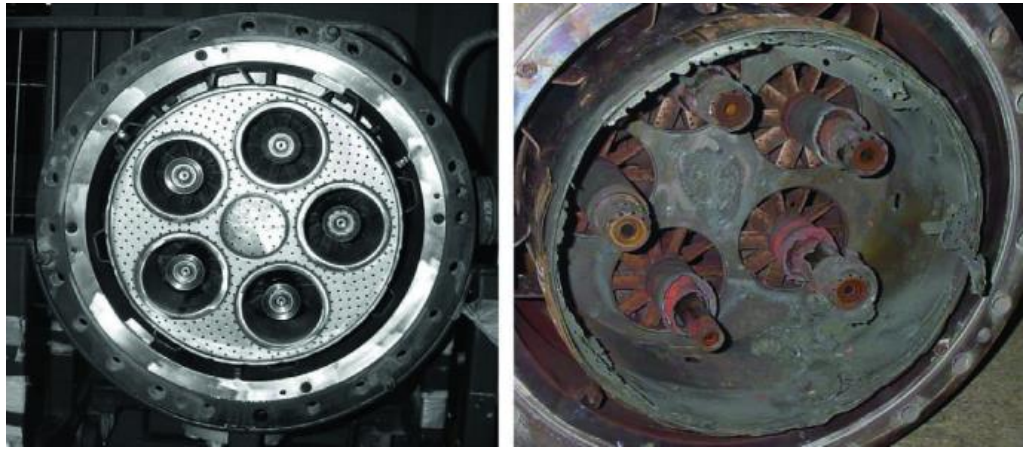
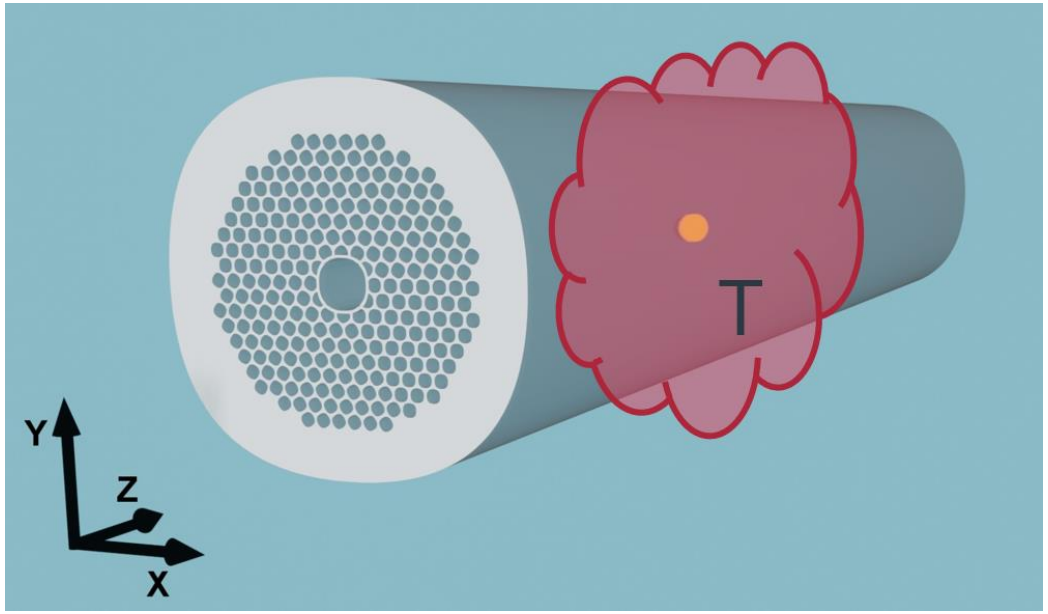
Temperature must be monitored in the hydrogen burner to prevent flashback

[1]

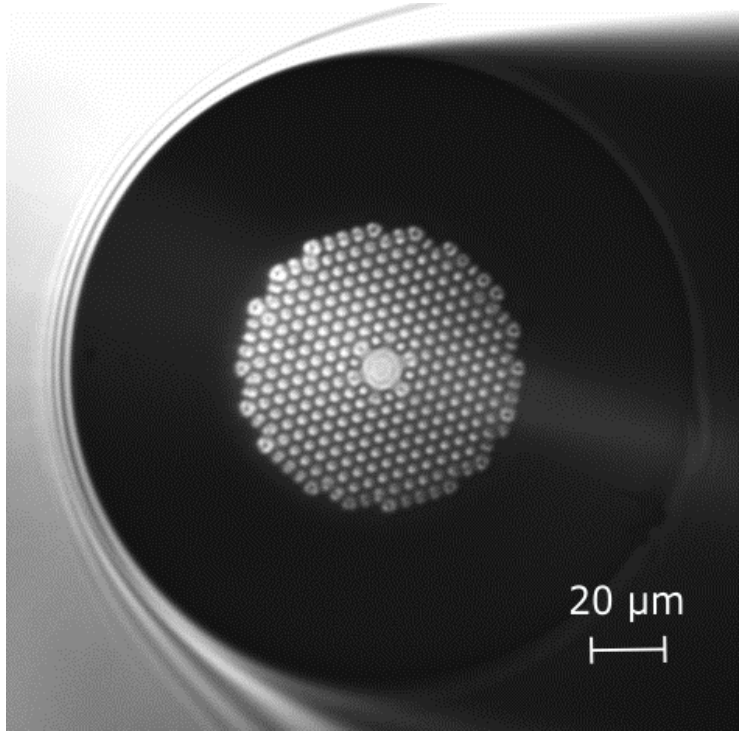


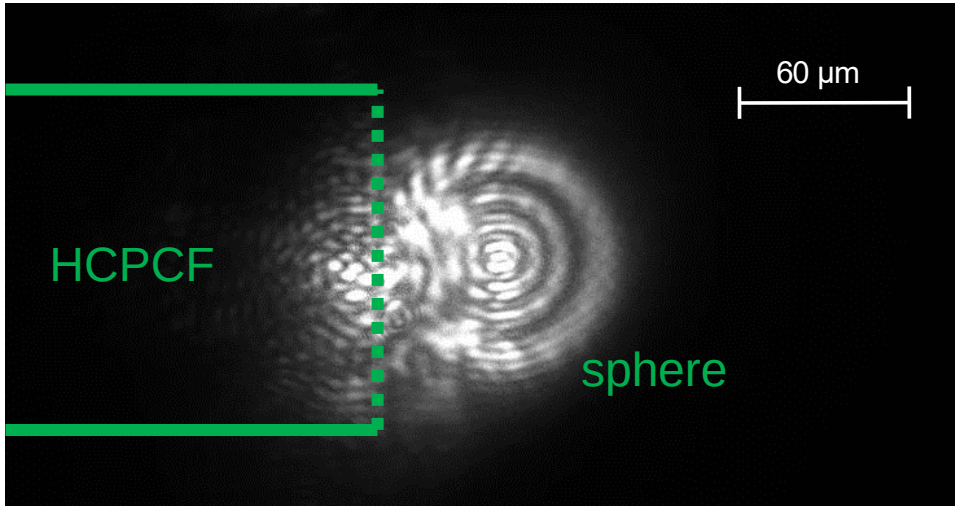


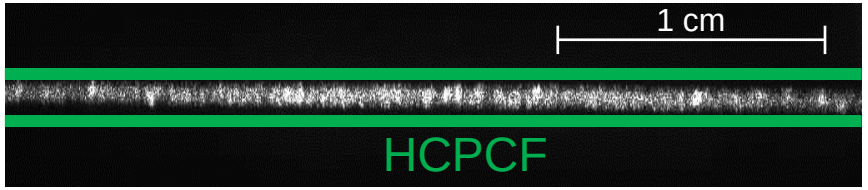
D. Bykov *et al.* Flying particle sensors in hollow-core photonic crystal fibre. Nature Photon 9, 461–465 (2015).

Hollow core photonic crystal fibers allow the introduction of a temperature probe inside the core

[2]



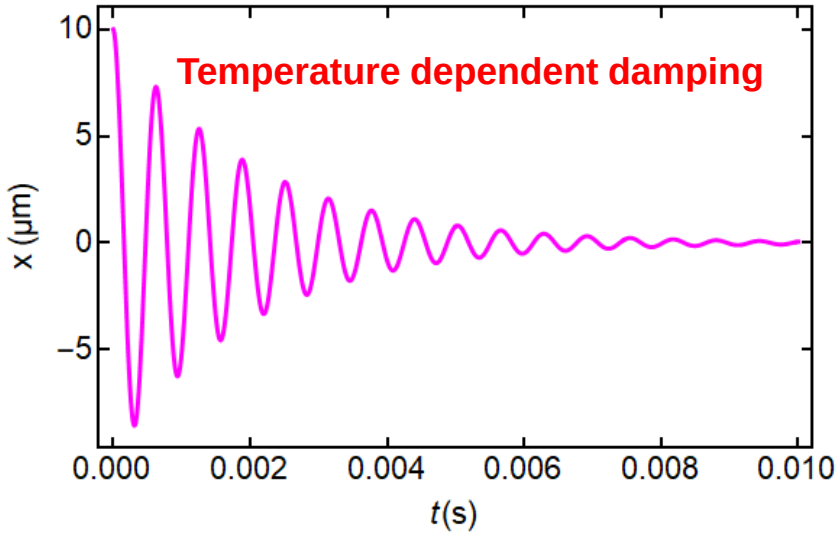




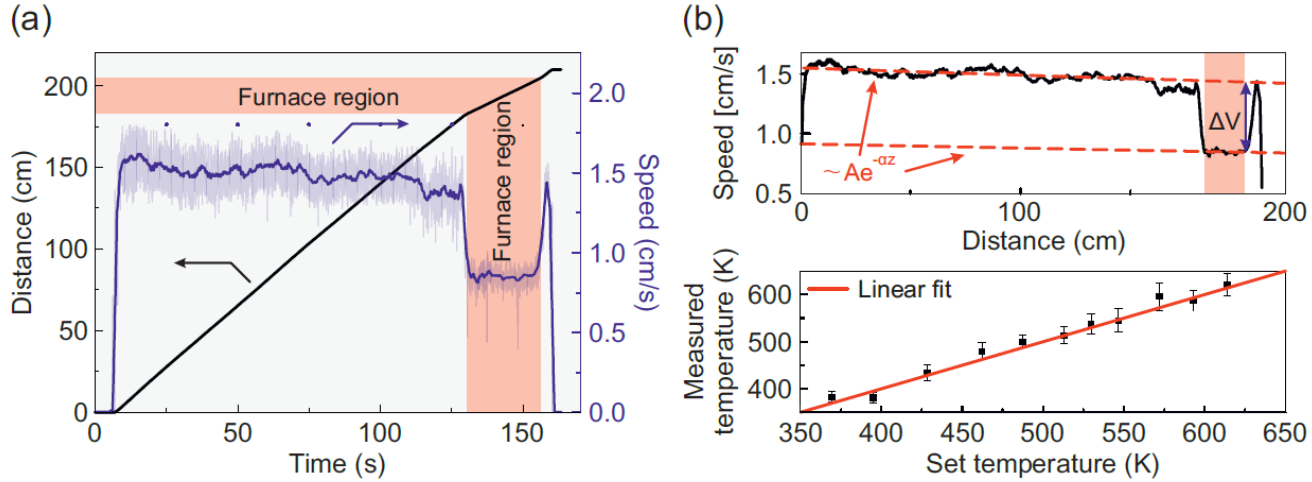
P. S. J. Russell. Photonic-crystal fibers. J. Lightwave Technol., 24(12):4729–4749, Dec 2006

Temperature may be measured through the particle's motion

P. S. Kincaid *et al.,* Hollow core photonic crystal fibers for temperature measurement in hydrogen combustors. Proceedings of the 27th International Congress on Sound and Vibration (2021).



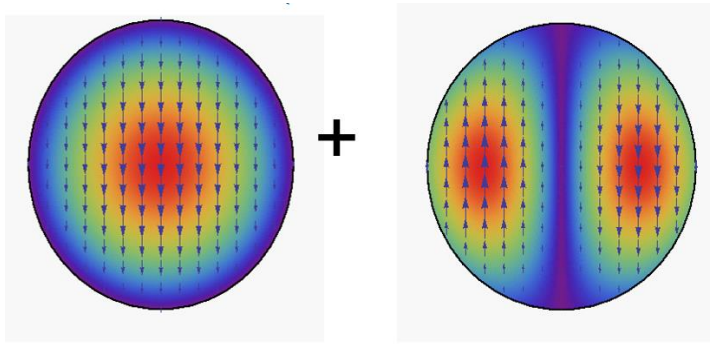
"Ring down"



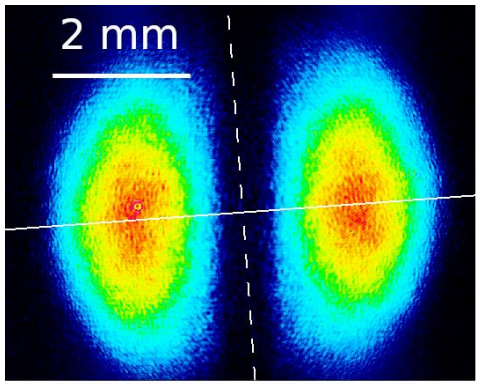
"Flying particle"

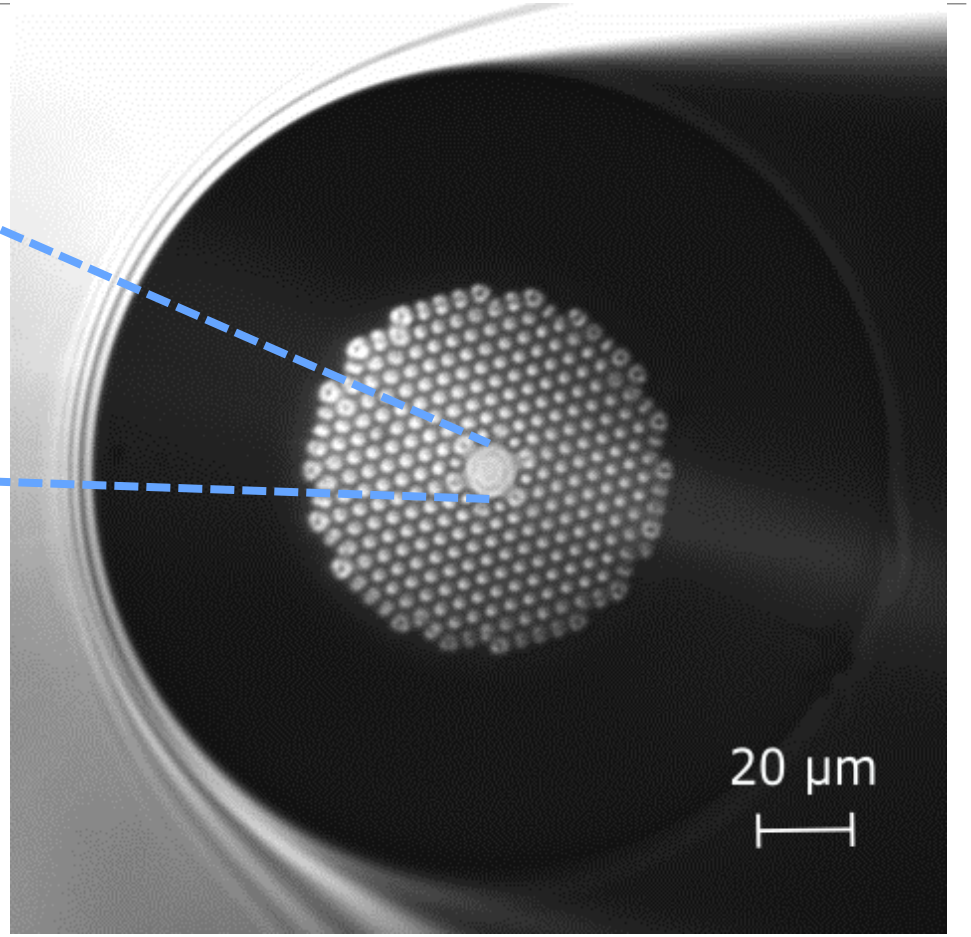
D. Bykov *et al.* Flying particle sensors in hollow-core photonic crystal fibre. Nature Photon 9, 461–465 (2015).

Modes guided by the fiber are similar to those that propagate in cylindrical waveguides

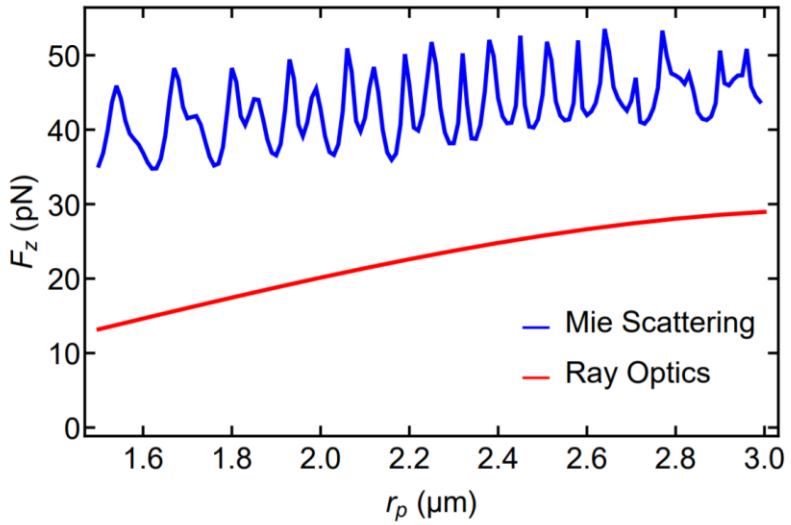


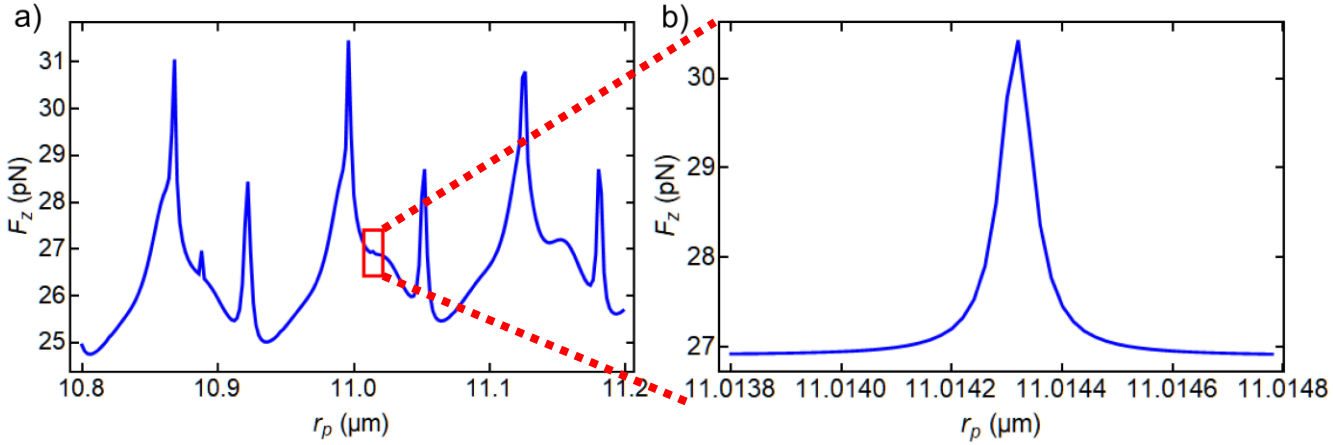
LP_{01} LP_{11}





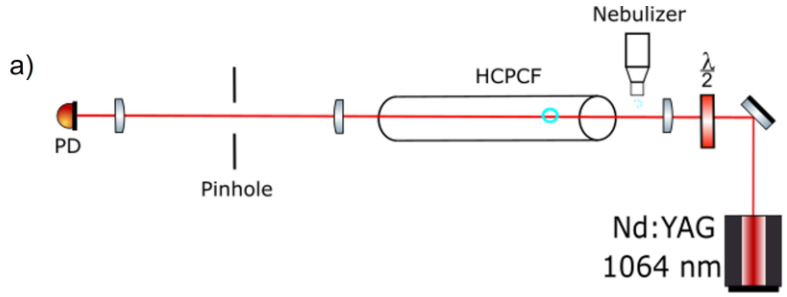
The ray optics model does not accurately predict the optical forces on the sphere

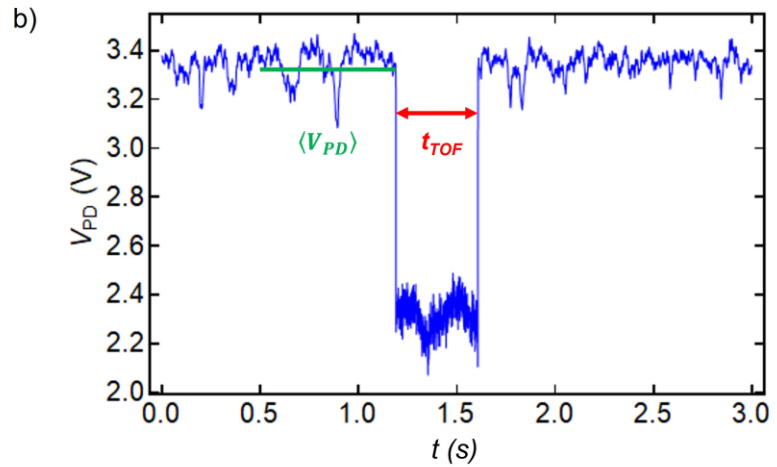




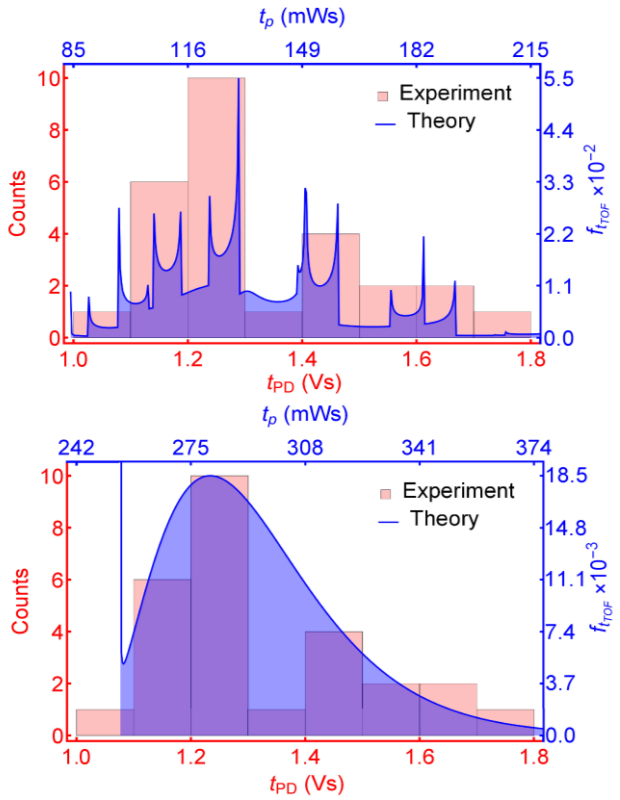
Peter Seigo Kincaid *et al.*, "Size-dependent optical forces on dielectric microspheres in hollow core photonic crystal fibers," Opt. Express 30, 24407-24420 (2022).

Mie Scattering model predicts time of flight distribution more consistent with experiment





$r_p = 1.59 \pm 0.16$ µm



Mie scattering

Ray optics

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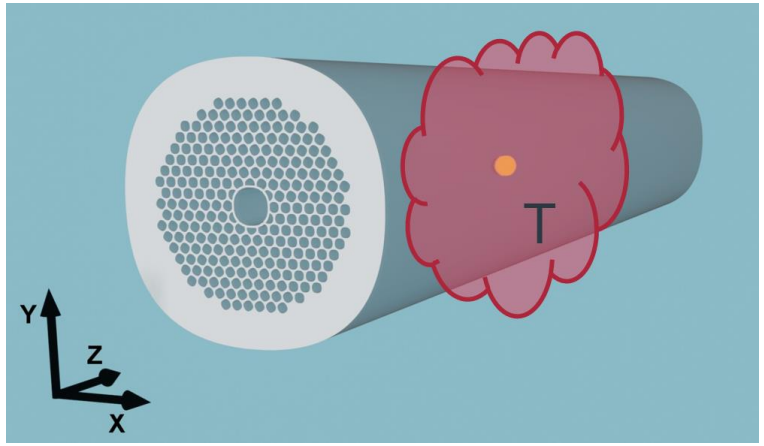
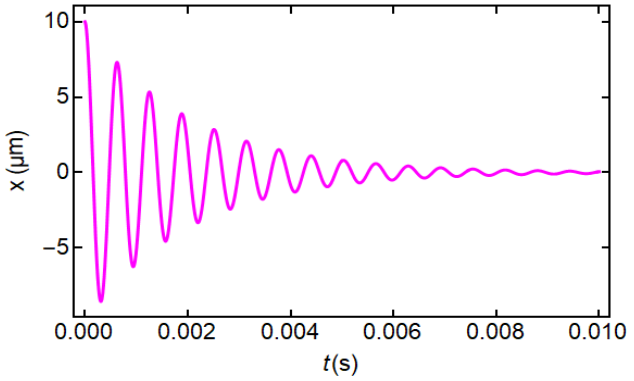
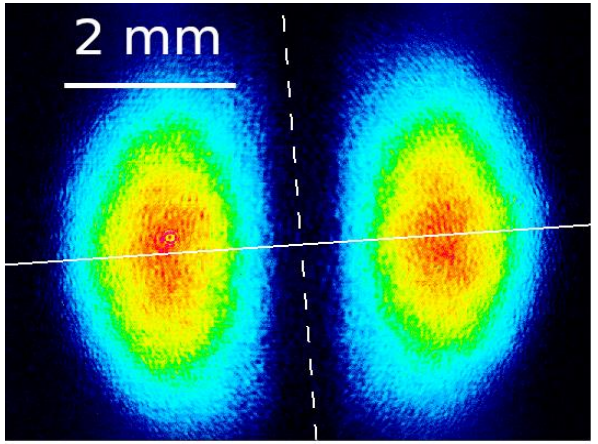
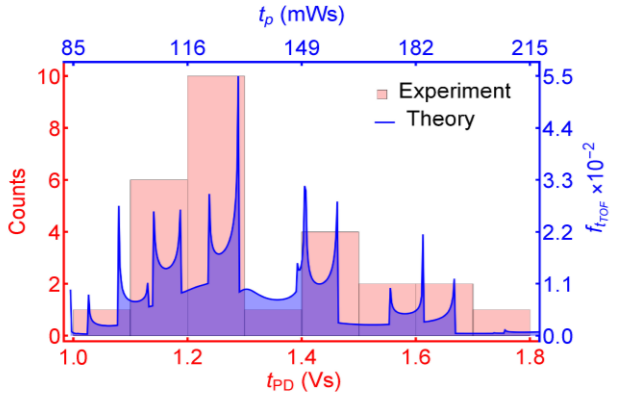
Microspheres inside HCPCF could be used as temperature probes in hydrogen combustors









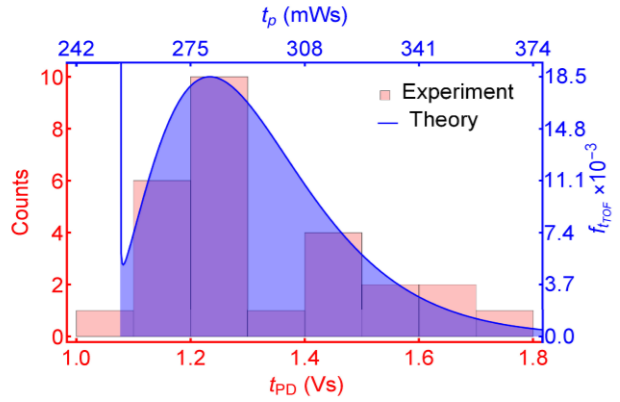


Image references

[1] – Nemitallah, M.A., Abdelhafez, A.A., Habib, M.A. (2020). Premixed Combustion for Gas-Turbine Applications. In: Approaches for Clean Combustion in Gas Turbines. Fluid Mechanics and Its Applications, vol 122. Springer, Cham. https://doi.org/10.1007/978-3-030-44077-0_2

[2] - L.P. Biró, K. Kertész, Z. Vértesy, G.I. Márk, Zs. Bálint, V. Lousse, J.-P. Vigneron, Living photonic crystals: Butterfly scales — Nanostructure and optical properties, Materials Science and Engineering: C, Volume 27, Issues 5–8, 2007, Pages 941-946