

UNIVERSITÀ DI PISA



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

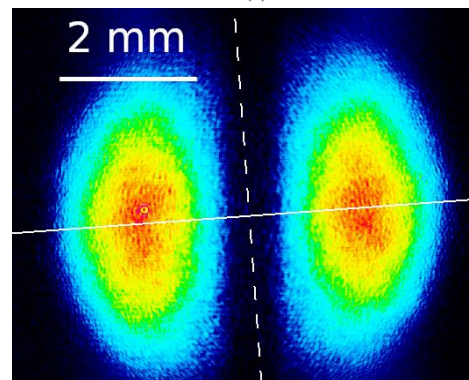
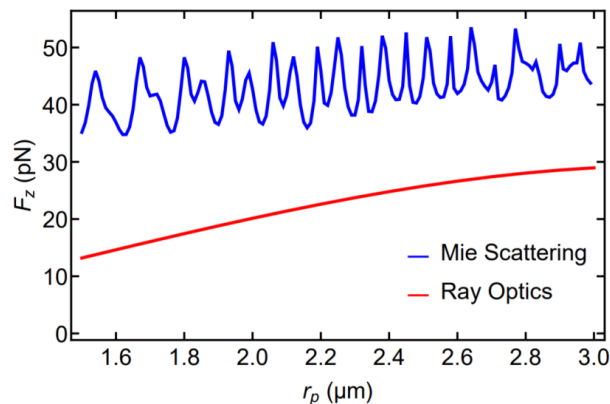
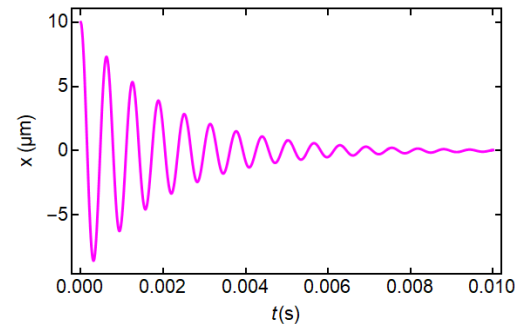
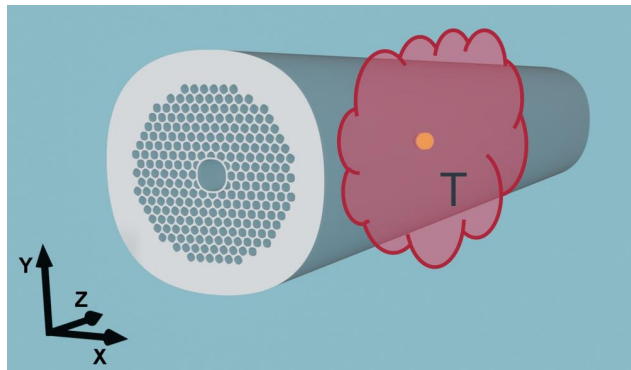
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Content



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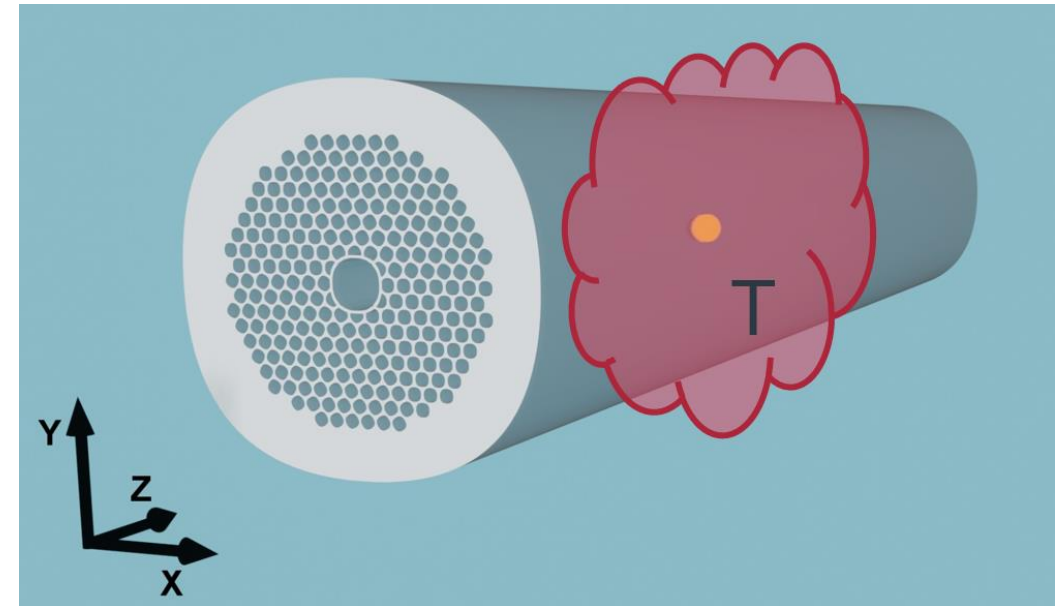
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Temperature must be monitored in the hydrogen burner to prevent flashback

[1]

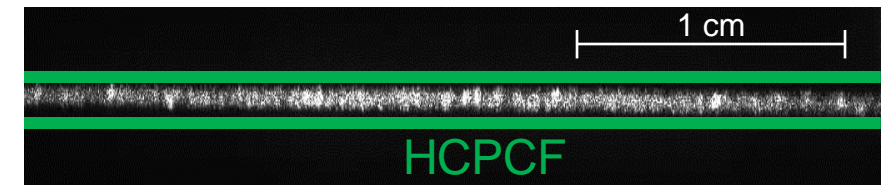
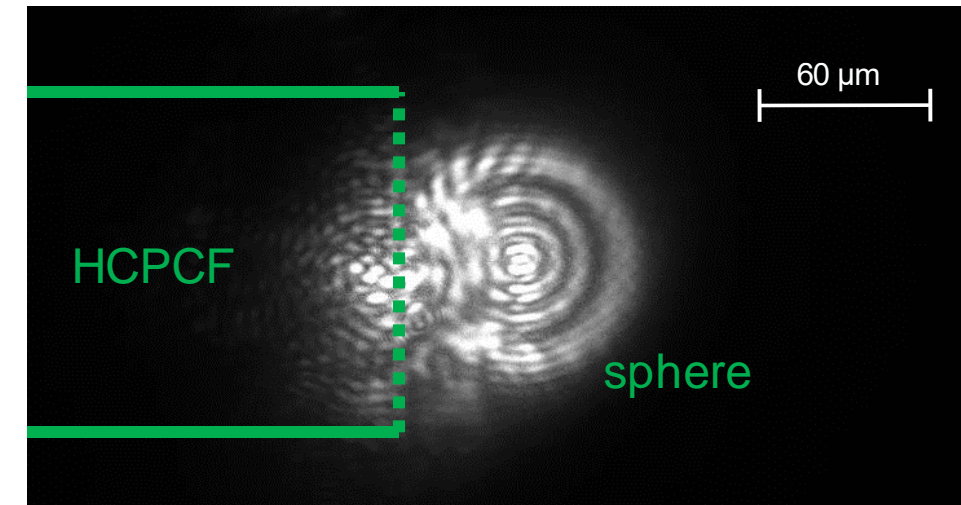
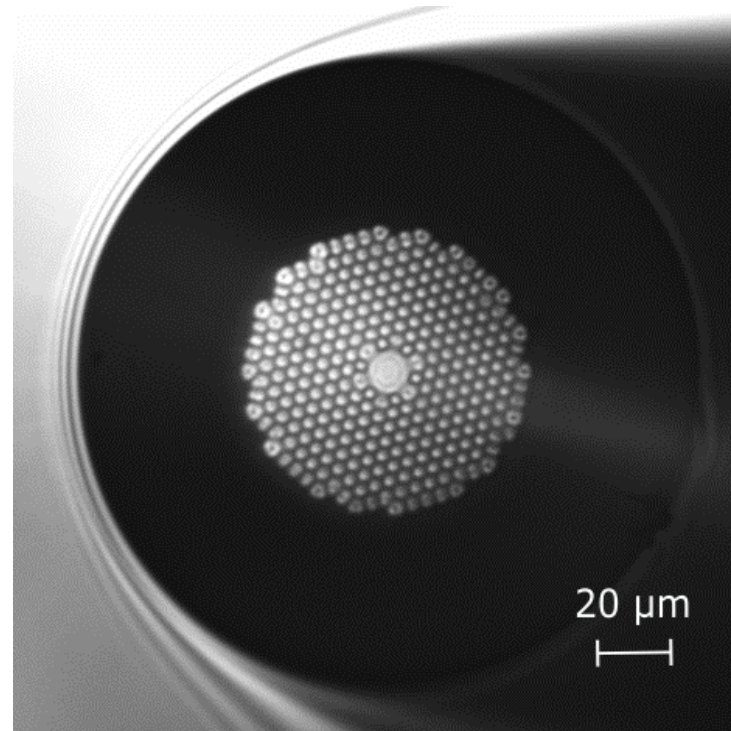


D. Bykov *et al.* Flying particle sensors in hollow-core photonic crystal fibre. *Nature Photon* 9, 461–465 (2015).

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



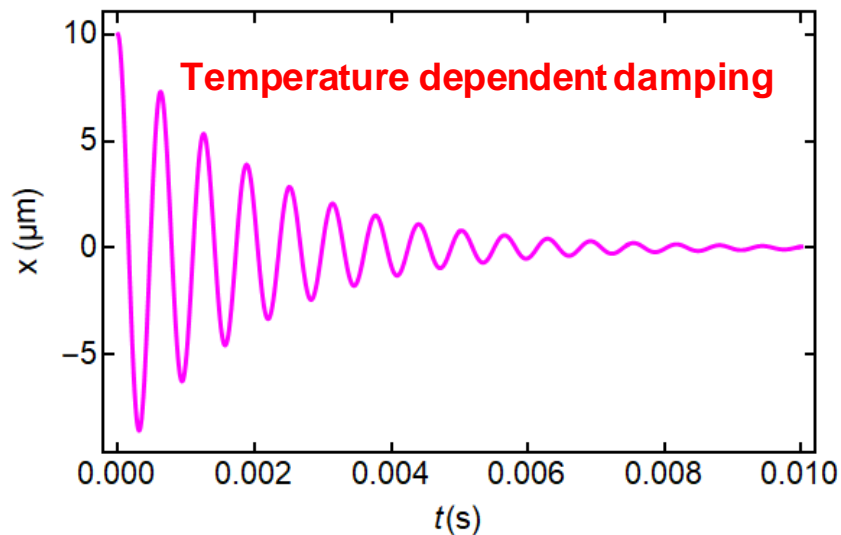
[2]



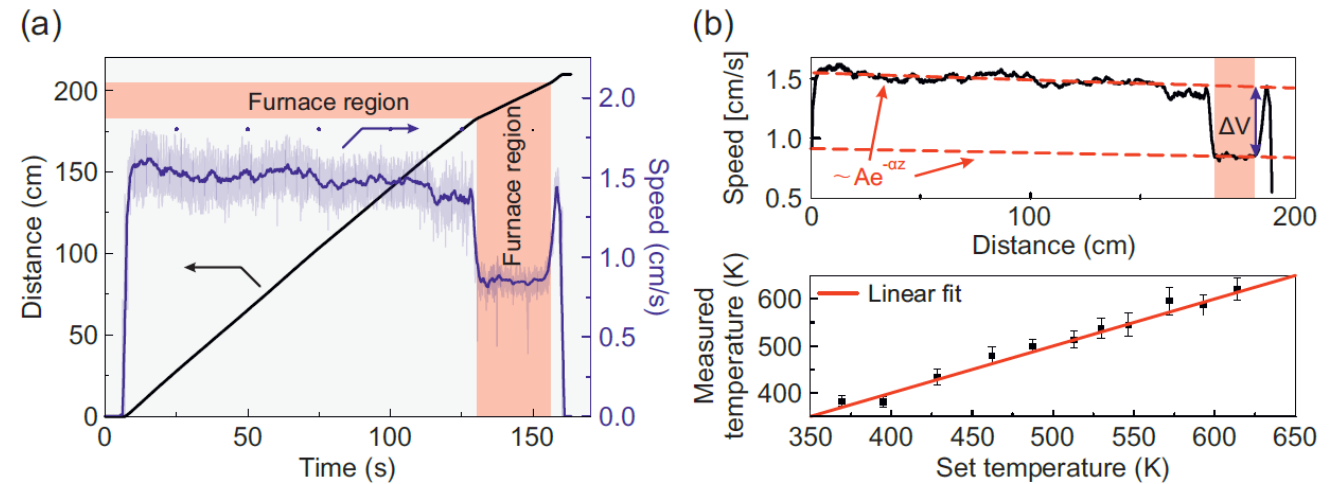
P. S. J. Russell. Photonic-crystal fibers. *J. Lightwave Technol.*, 24(12):4729–4749, Dec 2006

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).



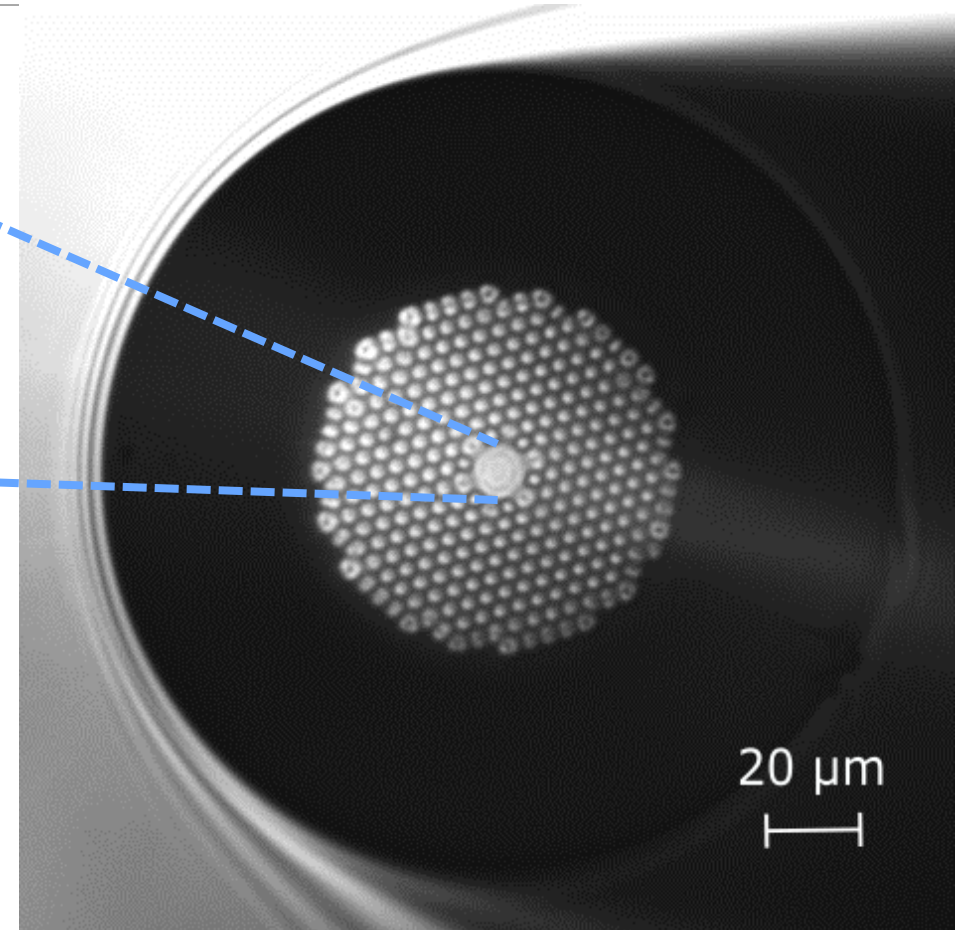
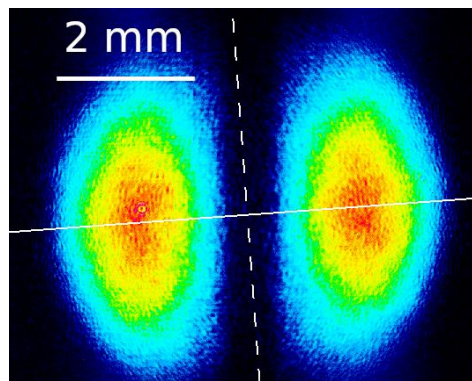
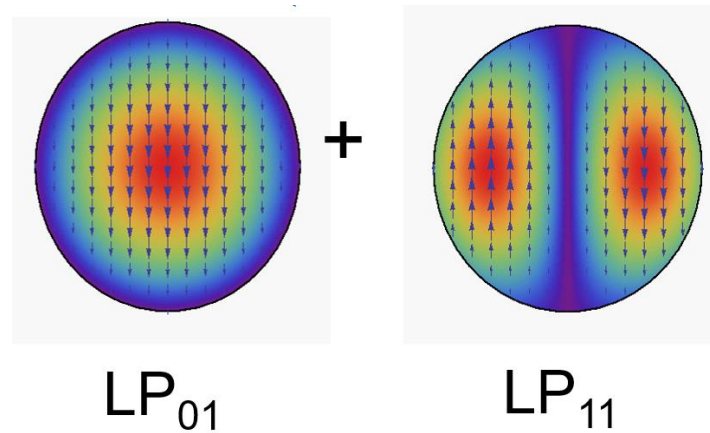
“Ring down”



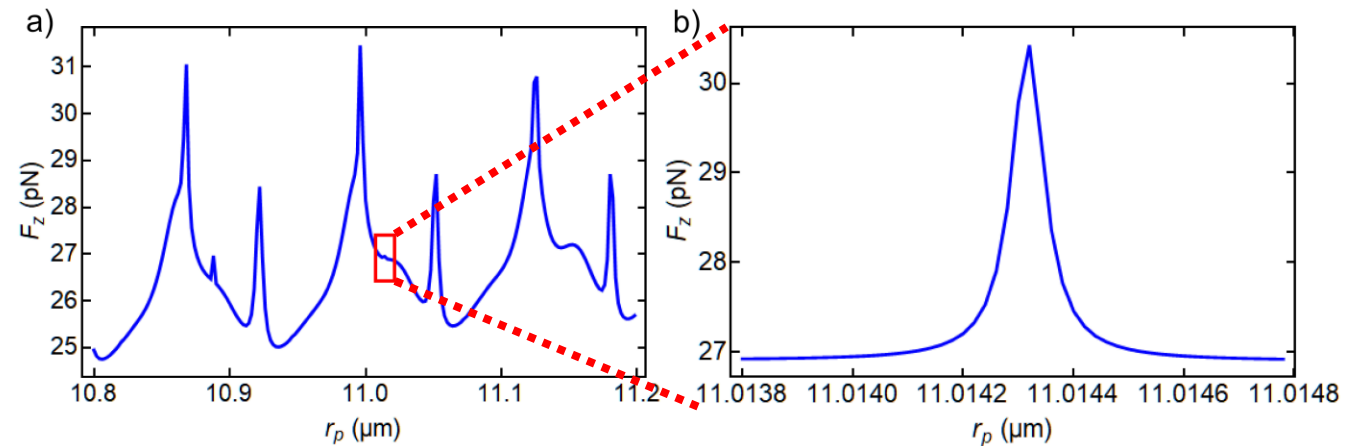
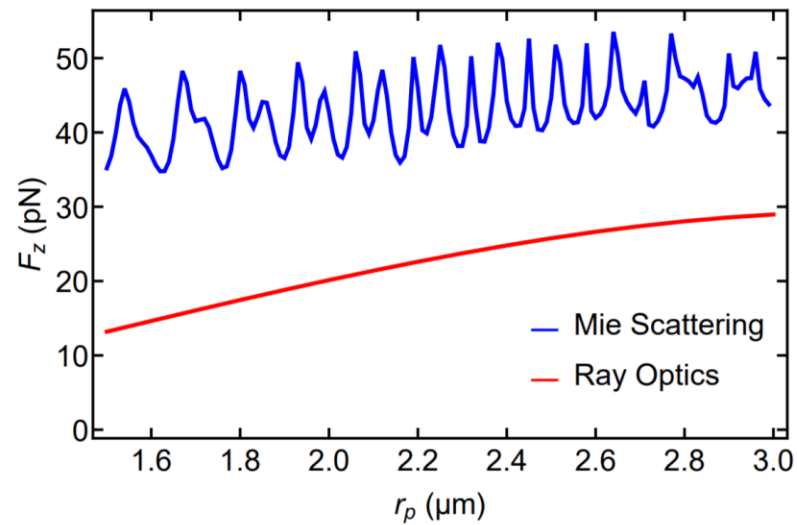
“Flying particle”

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

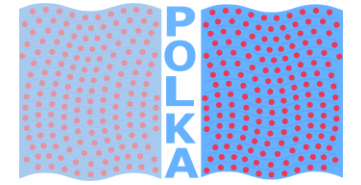
Modes guided by the fiber are similar to those that propagate in cylindrical waveguides



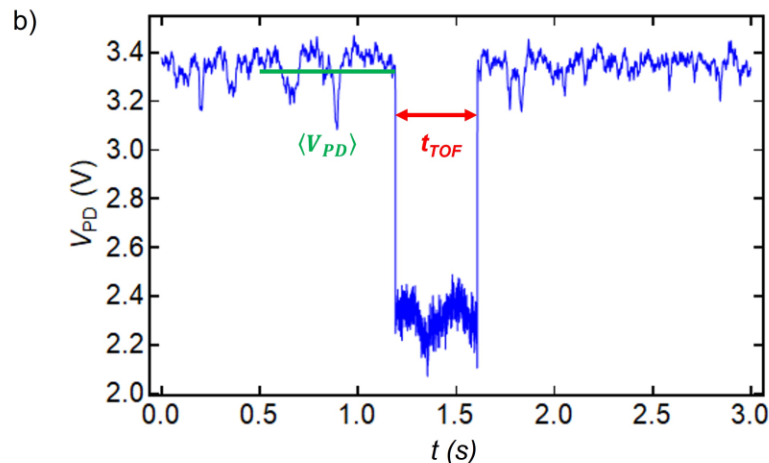
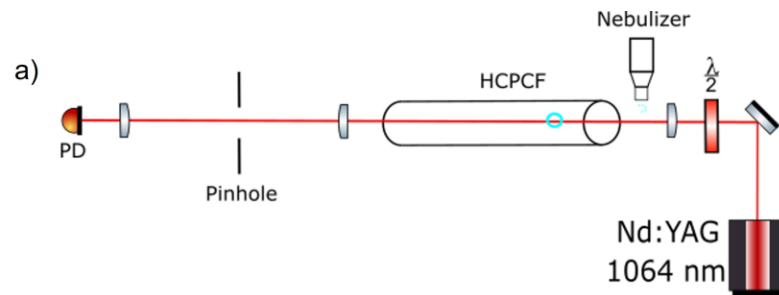
The ray optics model does not accurately predict the optical forces on the sphere



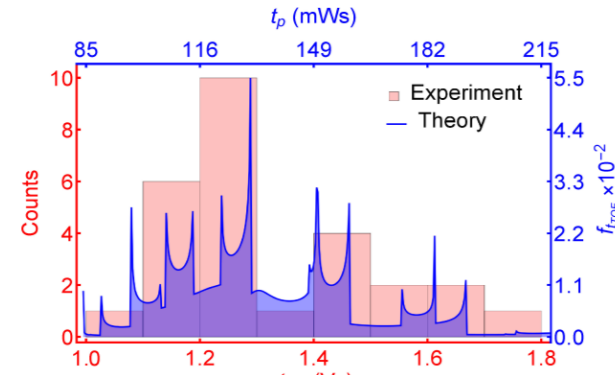
Peter Seigo Kincaid *et al.*, "Size-dependent optical forces on dielectric microspheres in hollow core photonic crystal fibers," *Opt. Express* 30, 24407-24420 (2022).



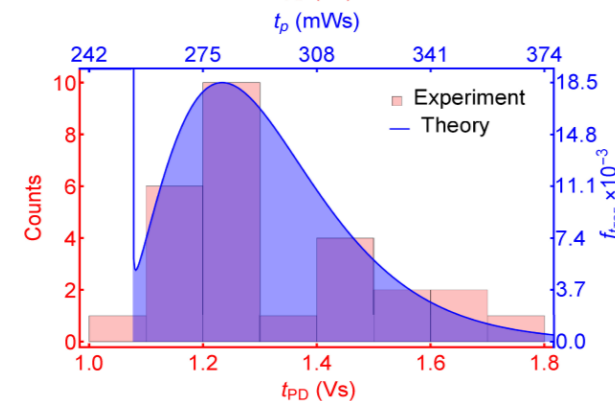
Mie Scattering model predicts time of flight distribution more consistent with experiment



$$r_p = 1.59 \pm 0.16 \mu\text{m}$$



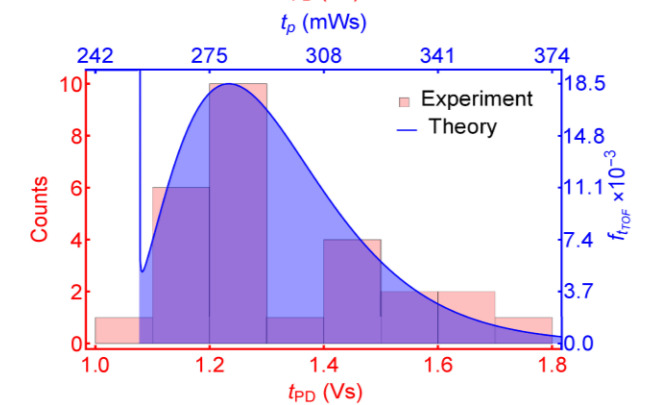
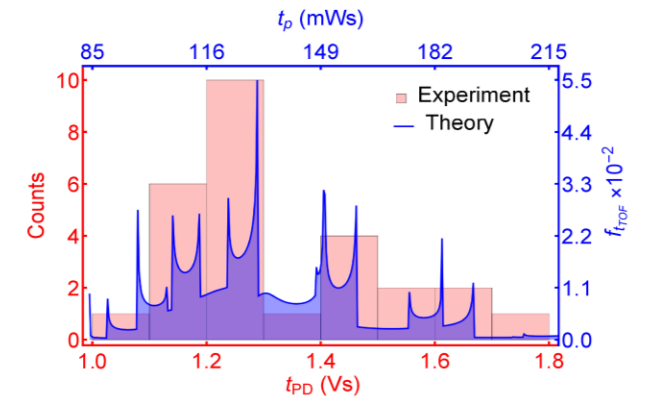
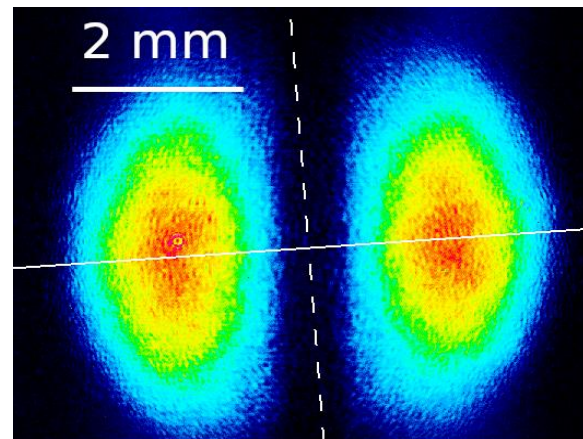
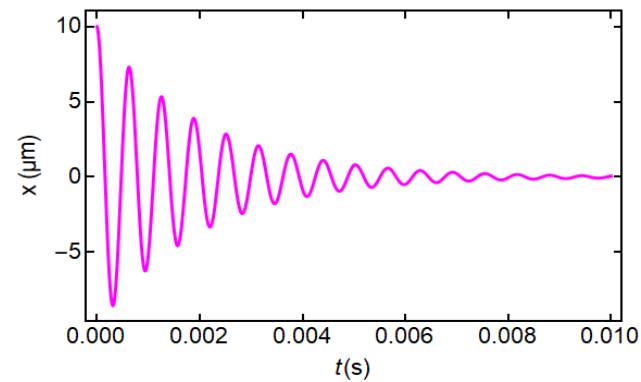
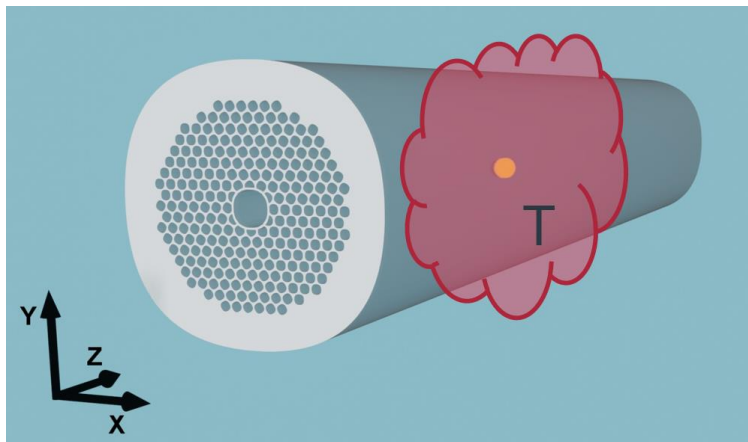
Mie scattering



Ray optics

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

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



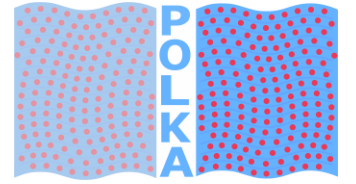


Image references

[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