to the cell window. Once ASE has started, subsequent pump light is efficiently converted into ASE light in a cyclic absorption–stimulated emission process, and will not penetrate beyond the active region. On the other hand, for a spatially narrow pump pulse, no significant ASE will develop across its diameter. The initial bleaching will live longer and pump light will penetrate deeper. A pencil-shaped amplifying region is formed which, once long enough, will yield ASE parallel to the pump beam. For the pump geometry used by Lawandy *et al.* one would expect ASE parallel to the front cell window.

We pumped a clear dye solution in this geometry and, like Lawandy *et al.*, observed broad-banded and long-pulsed light, emerging from the front window of the cell. This is spontaneously emitted light that has travelled through the amplifying region over (at most) its very limited thickness. However, we also observed from a clean dye solution, far more intense, narrow-banded (Fig. 1), and short-pulsed (Fig. 2) light emerging from the side windows. This is a ASE light which has the same 'laser-like' characteristics as the output that Lawandy *et al.* observed from colloidal suspensions (Figs 1 and 5 of ref. 1).

We think that the reason that Lawandy *et al.* did not observe ASE from clear dye solutions is that they studied emission through and not parallel to the front window. With TiO_2 added, they did observe narrow-banded emission, because the particles scatter some ASE light out of its plane. We think that the main role of the particles in Lawandy's experiments is not feedback, but post-processing: they direct ASE light to the detector.

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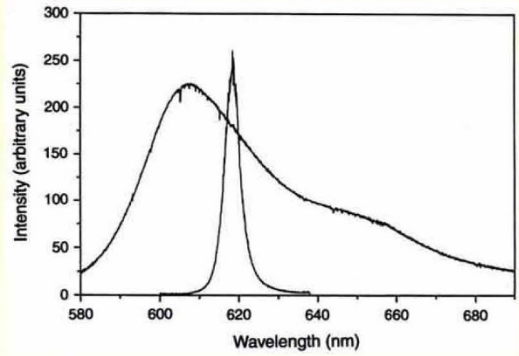

FIG. 1 Emission spectrum of a 2.5×10^{-3} M solution of rhodamine 640 perchlorate in methanol pumped by 3-mJ (10-ns) pulses at 532 nm. Pump beam diameter 1.5 mm. The broad spectrum corresponds to the (spontaneous) emission from the front window of the dye cell whereas the narrow spectrum corresponds to the emission (ASE) from the side windows.

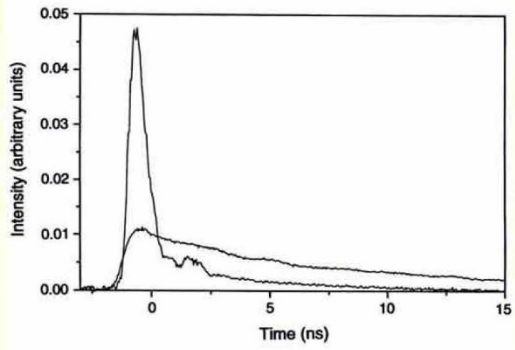

FIG. 2 Temporal emission of the same dye solution as in Fig. 1, pumped with 58-μJ (30-ps) pulses at 532 nm. The slowly decaying peak corresponds to the spontaneous emission from the front window whereas the short peak corresponds to the emission (ASE) from the side windows. The width of the short peak is determined by the time resolution of the detector, which is about 1 ns. The rapid structure following the short peak is a common artefact from ringing in the fast detection system.

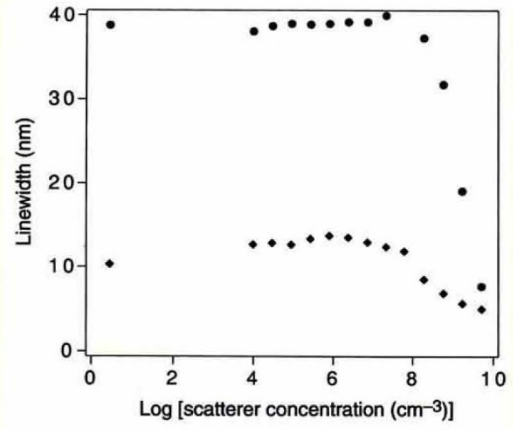

FIG. 3 Linewidth of the front (circles) and side (diamonds) emission as a function of scatterer concentration at a constant fluence of 8.5 mJ cm^{-2}. The sample consisted of TiO_2 scatterers (diameter ~250 nm) in a 2.5×10^{-3} M solution of rhodamine 640 perchlorate in methanol and was pumped using 80-ps pulses at 532 nm from a frequency doubled, Q-switched mode-locked Nd:YAG laser.

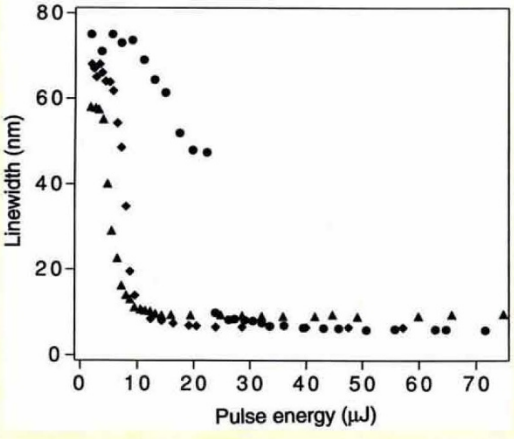

FIG. 4 Linewidth as a function of the pump pulse energy for transport lengths (circles, 690; diamonds, 69; triangles, 11 μm). The area of the pump beam at the cell face was 3×10^{-3} cm^2. The rest of the experimental arrangement was as for Fig. 3.

Finally, recent temporal emission measurements reveal pulse durations of 100 ps as opposed to the pure dye side-emission results of ~ 900 ps as reported by Wiersma *et al.*

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LAWANDY AND BALACHANDRAN REPLY— Wiersma *et al.* state that scattering in our experiments[1] does not provide a feedback mechanism for laser action but that instead all the observed effects are due to amplified spontaneous emission and redirection of light. Their conclusions are based on experiments in which they did not add scattering particles to their dye solutions, and are simply reporting a phenomenon known since the 1960s.

Referring to their geometry, we present data in Fig. 3 on the dependence of the emission linewidth as a function of scatterer concentration for both side and front emission. The data clearly show that particles drive linewidth collapse in both directions. Further proof that their interpretation is naive and incorrect is shown in Fig. 4, where the front emission is shown to collapse at decreasing pump energies with increasing particle density.

1. Lawandy, N. M., Balachandran, R. M., Gomes, A. S. L. & Sauvain, E. *Nature* **368**, 436 (1994).
2. Siegman, E. *Lasers* (University Science Books, Mill Valley, California, 1986)
3. Stitch, M. L. *Laser Handbook* Vol.3 (North-Holland, Amsterdam, 1979).