Supplementary Figure S1. Schematic representation of different functionalities that could be obtained using the fiber-bundle approach

This schematic representation shows some example of the possible functions that could be realized using the proposed structure. In a) the possibility to realize multiple traps along the probe axis, just by using a different cutting angle $\theta$ on three of the fibers, is shown. A possible steering of the fiber beams necessary to realize multiple traps at the same distance from the probe end is shown in b). As depicted in c), it is also interesting to notice that the radiation pressure that can be exerted, on a trapped particle, by using the light output from the central fiber can be used to slightly modify the trapping position, thus allowing to realize a particle translation or oscillation. Finally in d) a schematic representation of an optical-analysis configuration is used. Some fibers (e.g. those with pink cores in the figure) can be used to trap the particle, while other fibers (blue cores in the example) can optically excite the sample, and the central fiber can be used for the collection of the emitted signal. It is also interesting to notice that different fibers can be used for the different tasks (e.g. a large-mode-area fiber can be used to increase signal collection)
Supplementary Figure S2. Scanning-electron-microscope image of the probe end-face after the polishing procedure

This picture shows the structure of the fabricated fiber bundle. Four fibers (diameter ~80 μm) have been inserted inside a capillary, composed by a 75 μm thick silica tube and covered with a 5 μm layer of polyimide to increase its mechanical resistance. The inner diameter (I.D.) of the probe is 200 μm, and the outer diameter (O.D.) is 360 μm (200 + 2×75+ 2×5). The same O.D. is obtained when 7-fibers bundles are realized by using a larger I.D. (250 μm), and a thinner silica wall (50 μm). The fibers are fixed in the capillary by inserting a low-viscosity epoxy resin.

From the picture obtained through SEM it is possible to observe the fairly symmetrical distribution of the fibers, as highlighted by the reported measurements. The distance between centres of adjacent fiber is quite regular (always between 81.7 μm and 82.8 μm), and also the distance between the opposing fiber couples is almost identical (116 μm and 117 μm)
Supplementary Figure S3. SEM image of two different holes realized on the fiber end.

In a), it is shown the structure and the dimensions of the slanted hole realized on fibers end, as viewed from above. In b) the same hole is observed from the direction used to micro-machine the fiber with the focused ion beam (FIB), 20° with respect to the probe axis. The hole shape is not a perfect trapezium, because of the re-deposition effect of the sputtered material. As it can be easily seen, the lower region of the hole, where a second FIB-scanning is performed on the same area, results slightly larger than what expected looking at the higher part of the trapezium. The inset, where the hole is seen from a different perspective, allows observing its particular shape and the flatness of the realized surfaces.
Supplementary Figure S4. Sequence showing the probe micro-fabrication procedure

This picture shows the different stages of probe micro-machining. The symmetry and surface quality is first verified, a). After this check the probe is rotated, so that one fiber is in the lower possible position, and that fiber is then drilled at the proper angle, b). The probe is subsequently rotated by 90° steps and the procedure is repeated on the remaining fibers, c), d), e). The images highlight the strong reproducibility of the procedure and the high quality of the surfaces. The final result on the probe is shown in f).
Supplementary Figure S5. Schematic pictures of the experimental setups realized

This picture shows the setups used for the different experiments. All the elements are not to scale.

In a) we show the setup used for the beam convergence analysis, which is performed by moving the optical fiber probe in the vertical direction. The “power splitting / monitoring block” is composed by a fiber optic splitter which divides the optical power equally into four fibers. The radiation
carried by each fiber passes through a variable optical attenuator, to trim its power level, and is then input to a 99%-1% splitter. The 99% arm is connected to the fiber probe, while the 1% arm is used for monitoring purposes.

In b) the simple all-fiber setup used for the trapping experiments is reported. The “power splitting / monitoring block” is the same shown with greater detail in a).

In c) the setup has been modified to allow the insertion and extraction of optical beams (at different wavelengths) in order to trap, excite the particle, and to detect the fluorescent radiation emitted by the trapped bead. The beam coupling / decoupling has been obtained using two dichroic mirrors, instead of fiber couplers, due to the large wavelength difference. The collected light is coupled to the fluorescence spectral detector by means of a multi-mode fiber to reduce the coupling losses.
Supplementary Video 1. Video file showing the beam convergence effect (see separate file “Supp_Video1_Beam_convergence.mpg”)

The shaded regions in this picture correspond to the sections of the four fibers in the bundle. The arrows indicate the direction of light propagation, from the fiber core towards the centre. In the movie, the focal plane is set so as to see the fiber surfaces at first, while the light distribution on focal planes with a growing distance from the fiber end is then shown for the first 14 seconds. Afterwards the direction of the fiber movement is reversed, till the fibers are in focus once again. It is possible to observe that all the four beams converge on the same focal plane, thus producing the desired beam focalization effect.
Supplementary Video 2. Video file showing the trapping effect (see separate file “Supp_Video2_Trapping_20x.mpg”)

This movie shows the trapping of two particles by the realized probe. The probe is moved (right, up, left, down, and right again) above the cover-slip, at a distance of few millimetres, by using micro-translation stages and the infrared light scattered by the probe and particles is recorded by a CCD camera.