**Numerical modeling of single-molecule detection and trapping
in a nanochannel** WILLIAM ROBINSON, ZBIGNIEW SIKORSKI, LLOYD M.
DAVIS, UTSI — Confocal fluorescence microscopy with single-photon counting en-
ables detection of individual fluorescent molecules as they randomly diffuse through
a tightly focused laser beam. However, for many biophysical studies, there is a need
to observe the same molecule for an extended duration, without immobilizing it to a
surface. The problem of trapping a single fluorescent molecule in solution is exam-
ined here via numerical simulation. Optical trapping provides insufficient force for
trapping small biomolecules. Instead, a means for sensing the molecule's position
and applying real-time feedback of motion to compensate diffusional displacement
is used for trapping. The use of a nanochannel to confine the molecule reduces the
problem to one dimension. The position of the molecule along the nanochannel
is measured from its fluorescence induced by a pulse-interleaved two-beam laser-
irradiance pattern. The time-gated photons are analyzed via maximum-likelihood
methods and an electrophoretic motion provides the trapping mechanism. Flexible
parameters allow a multi-variable analysis of the trapping efficiency and effective-
ness. The reaction of the flow is set to the time-delayed response of a realistic
field-programmable gate array (FPGA) controller. Trapping algorithms developed
in the simulation are to be experimentally implemented in the FPGA.

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Date submitted: 16 Aug 2007   Electronic form version 1.4