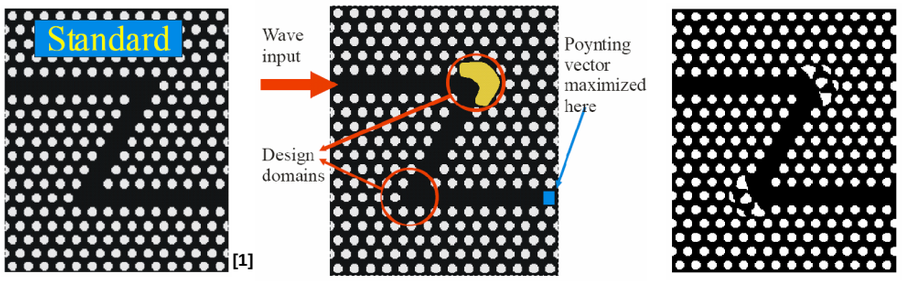
12 Optimization

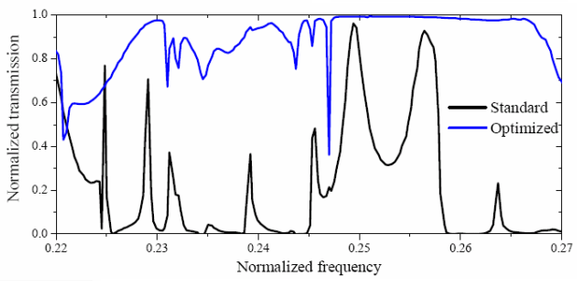
"Even if each FDTD run is fast, don't you still need many runs to do optimization?"

Adjoint methods

"Topology optimization"

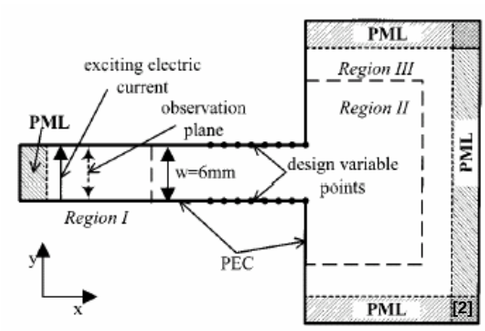
Finite-element analysis (here 2-D) gives derivatives vs. design variables



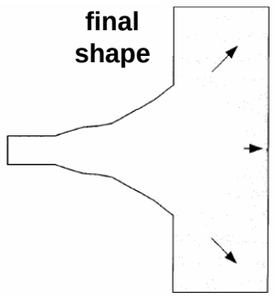


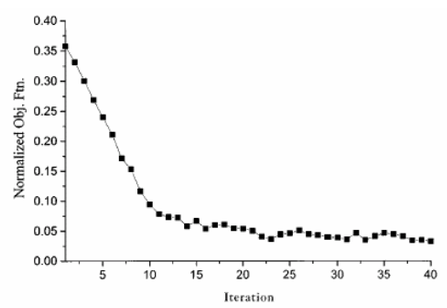
Recent work showing similar adjoint techniques for

- **unstructured FDTD /Finite-element [2]**
- **regular FDTD [3]**



final shape

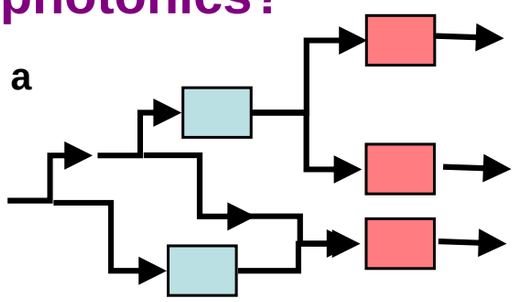




[1] P. I. Borel, A. Harpøth, L. H. Frandsen, M. Kristensen, P. Shi, J. S. Jensen and O. Sigmund, Opt. Expr., **12**(9), 1996 (2004).
[2] Y. S. Chung, C. Cheon, I. H. Park, and S. Y. Hahn, IEEE Transactions on Magnetics, **37**(5), 3255, (2001).
[3] N. K. Nikolova, H. W. Tam, and M. H. Bakr, preprint at < www.ece.mcmaster.ca/faculty/georgieva/papers/AVM_FDTDfinalID1750.pdf > 2004

Does this mean that "innovation is dead" in nanophotonics?

No, we're likely to always need a modular approach to complicated systems...



Fast but approximate methods

...using a combination of modeling techniques.

Plus, anything that extends a designer's intuition — either by approximate methods or with the same engine as the computer optimizes with — is incredibly useful,

FDTD **Slow but precise methods**

The importance of good initial design points cannot be overstated.