Numerical investigation of domain walls in constrained geometries

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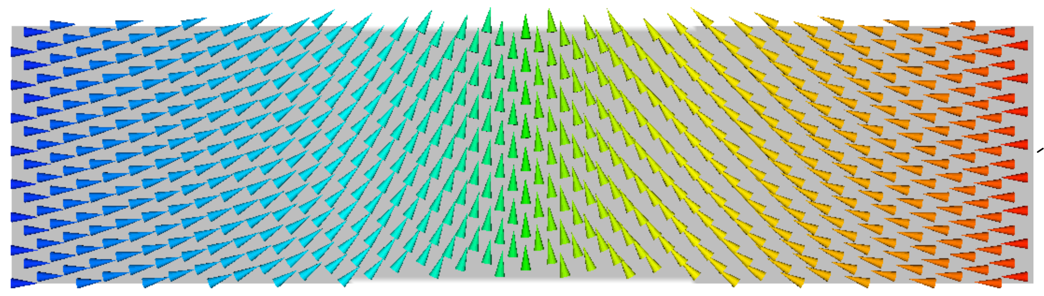
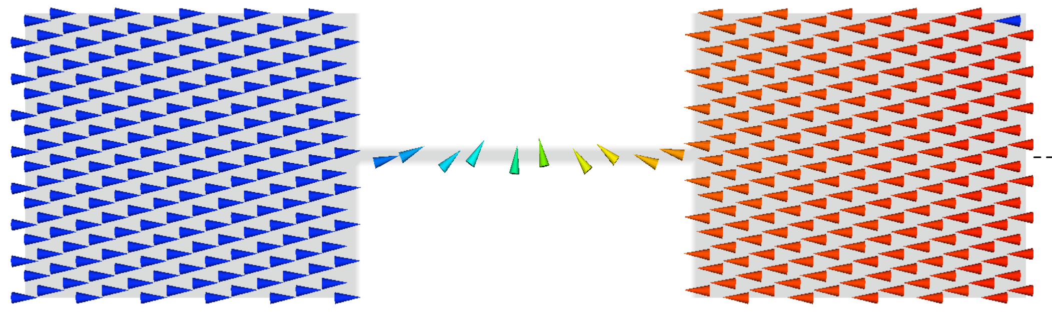
Basic idea

- Energy can be reduced when domain wall squeezes into constriction (Bruno, PRL 1999)
- Example

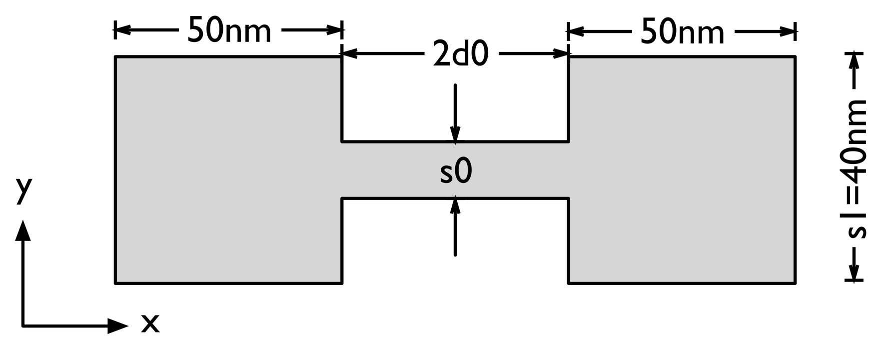


- Same system with *constriction* in the middle results in shorter domain wall:



- Study this *systematically*.

Geometry



- thickness in z direction is 1nm

Material

Nickel with weak uniaxial anisotropy:

Ms = 490,000 A/m

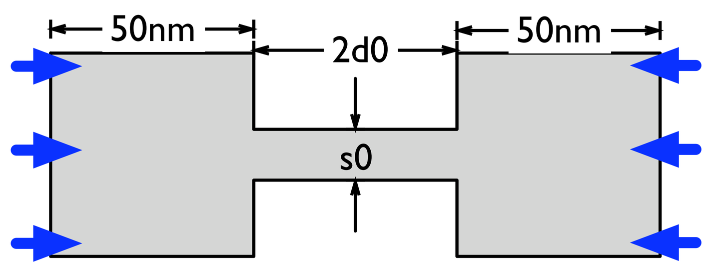
A = $9 \cdot 10^{-12}$ J/m

K1 = 2000 J/m^3

Simulation package

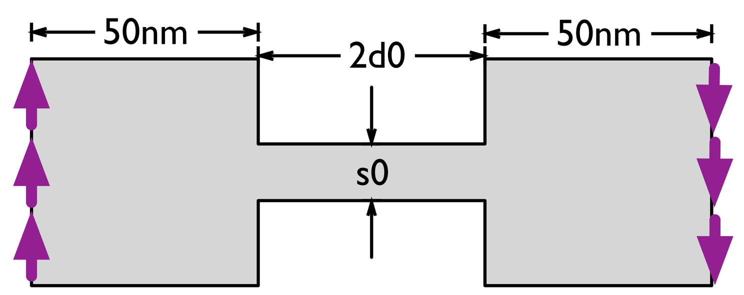
- Used OOMMF for most data points (math.nist.gov/oommf)
- Used nmag to verify selected configurations (nmag.soton.ac.uk)

Case A



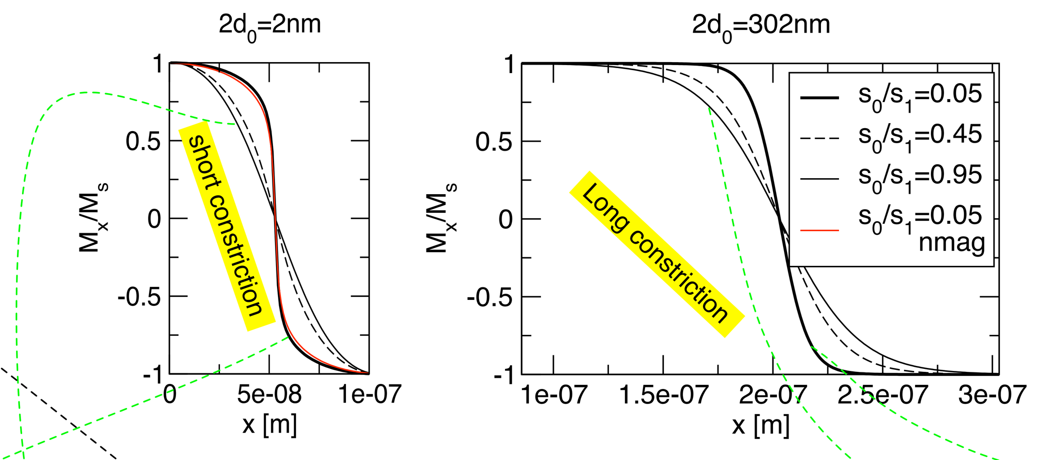
- pinned magnetisation pointing in x-direction
- domain wall length without constriction w_A=69nm

Case B



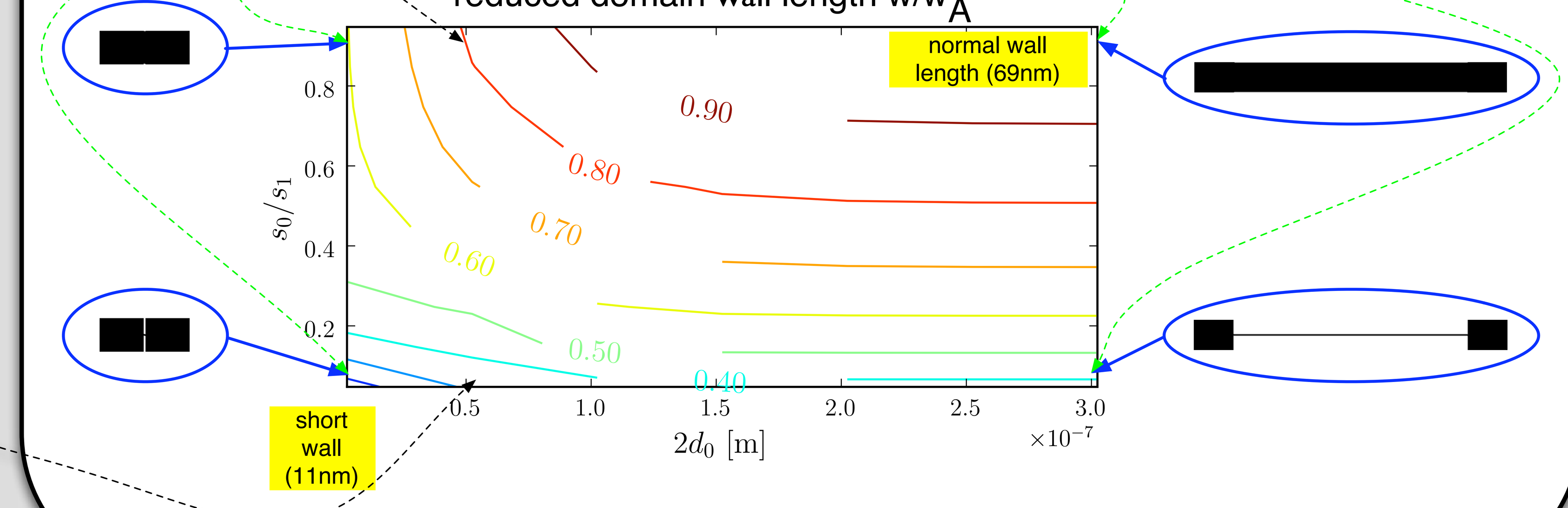
- pinned magnetisation pointing in y-direction
- domain wall length without constriction w_B=98nm

Case A: results

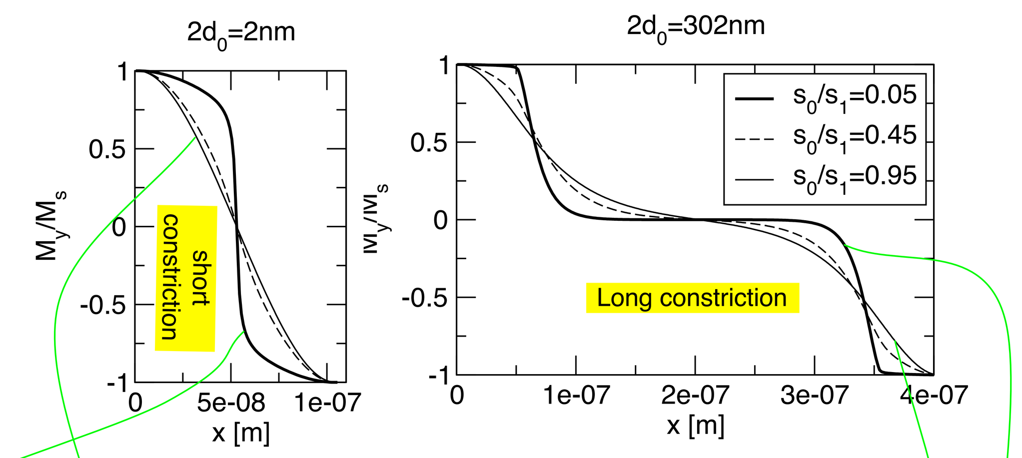


Observations:
- both height (s0) and width (s1) affect domain wall length
- domain wall length reduces from w_A=69nm to w=11nm

Geometry phase diagram:
reduced domain wall length w/w_A

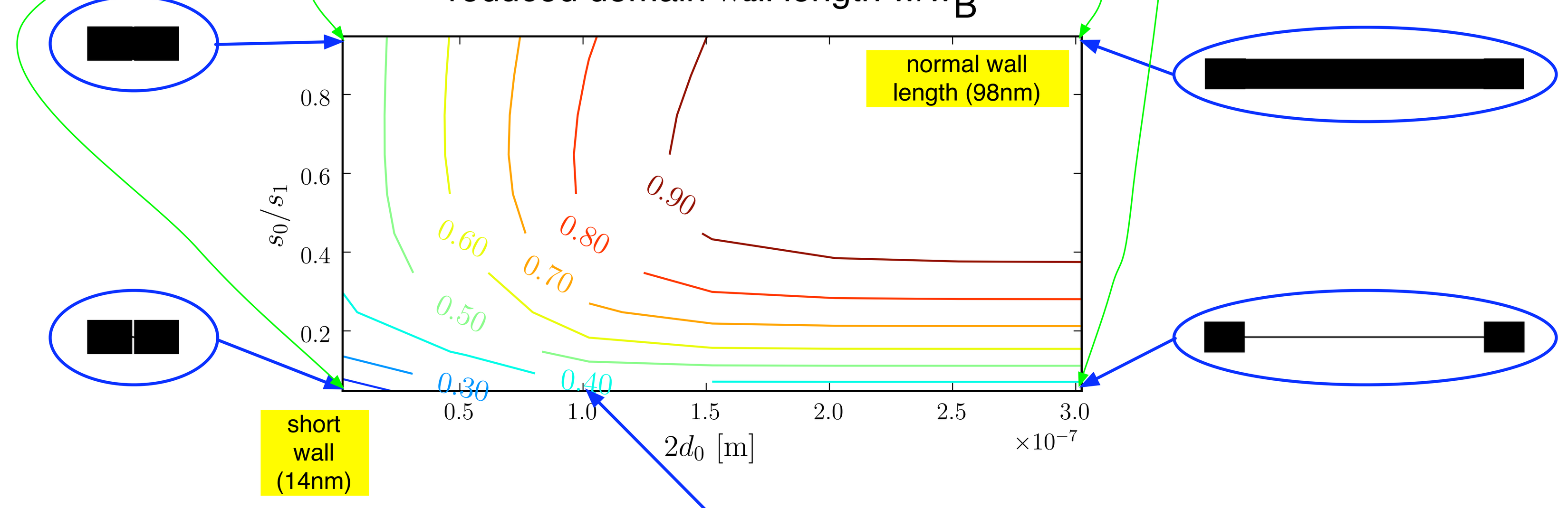


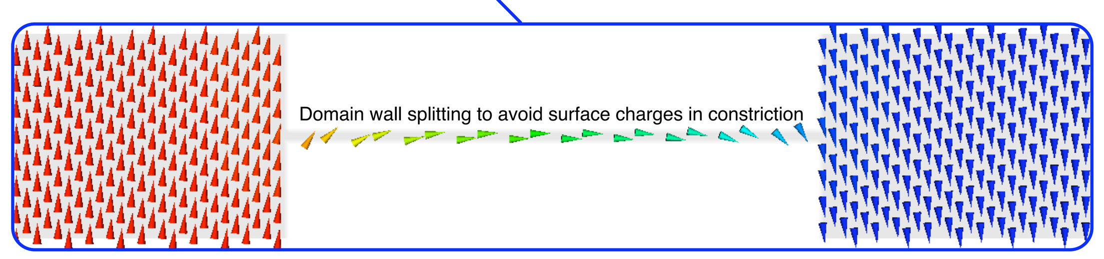
Case B: results



Observations:
- domain wall splits into two 90 degree walls in long constriction
- domain wall length reduces from w_B=98nm to w=14nm

Geometry phase diagram:
reduced domain wall length w/w_B





Summary

- simulate domain walls in constrictions
- find reduction of domain wall length by factor 6
- domain wall splitting for case B but not for case A