



Selective Injection of Magnetic Domain Walls in Permalloy nanostripes.

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IEEE International Magnetic Conference

4 – 8 May 2014, Dresden, Germany

Motivation

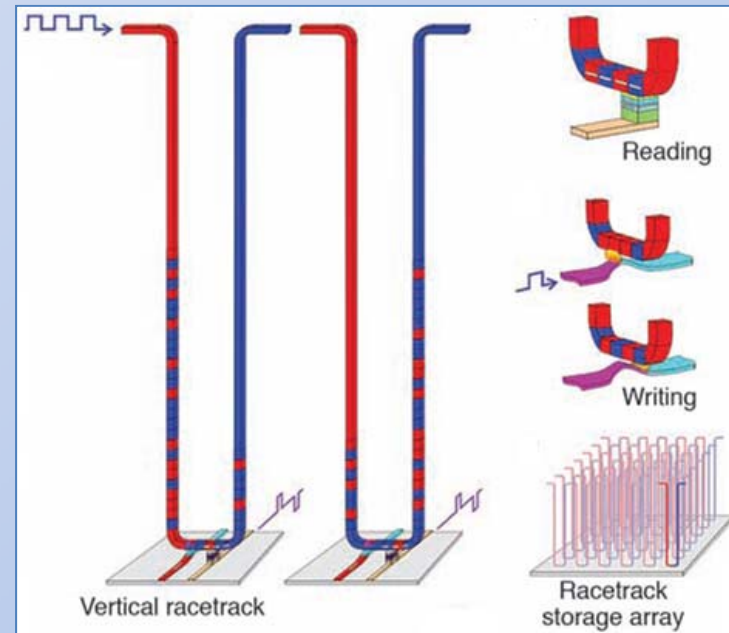
Future Magnetic Memory Devices

Exquisite control

Reliable Injection
Controlled Pinning
Defined Depinning Process

Different types of DWs:

- Notch dimensions (Zhu APL 2012, Faulkner JAP 2004)
- Stripe thickness (Bogart PRB 2009)
- Stochastic behaviour (Boklage APL 2013, Im PRL 2009, Akerman PRB 2010)



S.S.P. Parkin *et al.* Science 320, 190 (2008)

Which type of DW will likely pin??



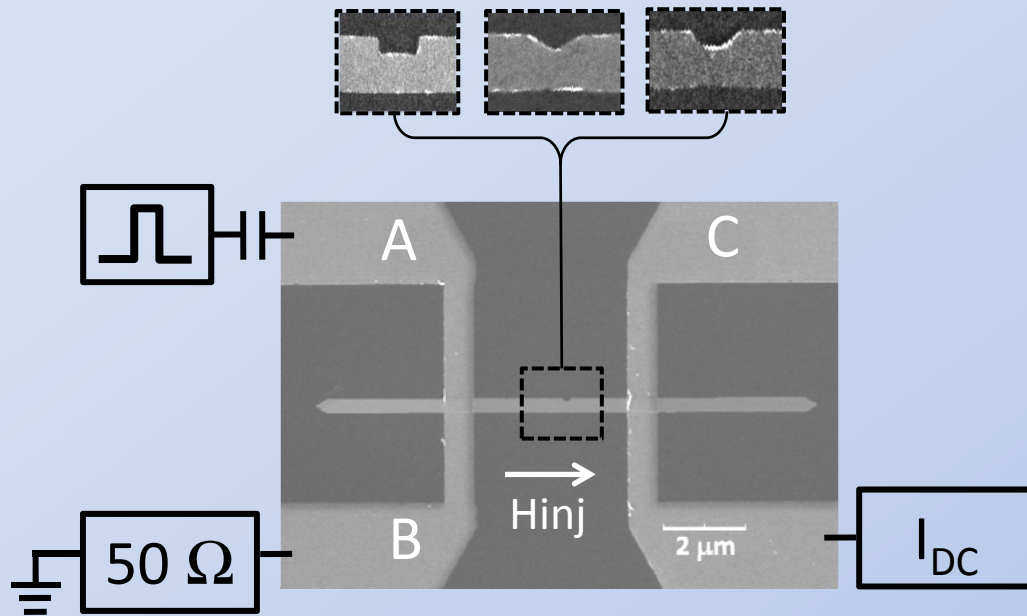
CI Depinning: Joule Heating /STT
• Spatial Distribution of J and magnetization around the notch.

We explore the conditions of DW injection



Selective Pinning of different types of DWs

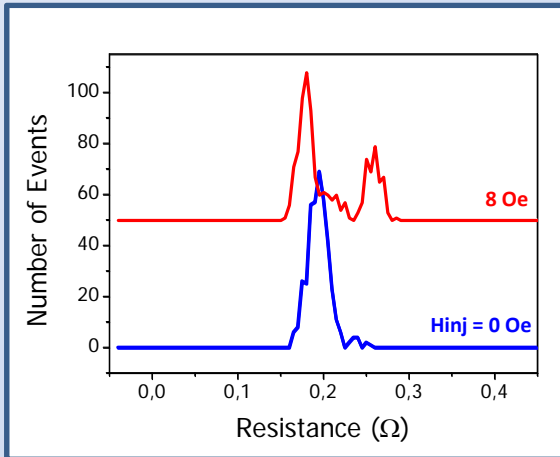
Device Fabrication & Experimental Setup



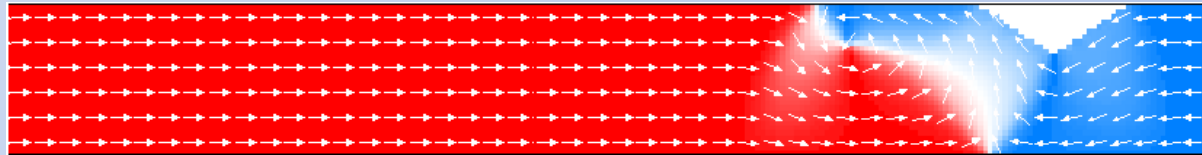
- E-beam Lithography
Sputtering
Lift Off
- Ta/Py(10nm)/Ta/Pt
300 nm wide
- 3 Notch Shapes:
300 nm
100 nm

- V pulse :
1,4V 10ns
- $H_{prop} \approx 2$ Oe Good!!

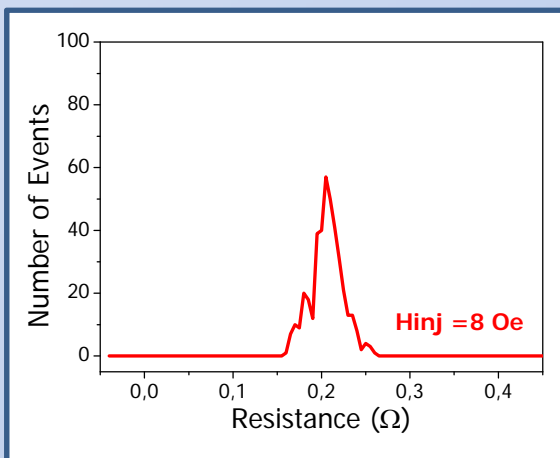
Quasistatic Pinning



- $H_{inj} = 0 \text{ Oe} < H_{prop}$
1 type Unpinned DWs !!! (Prieto PRB 2011, Muñoz Nat Comm 2011)



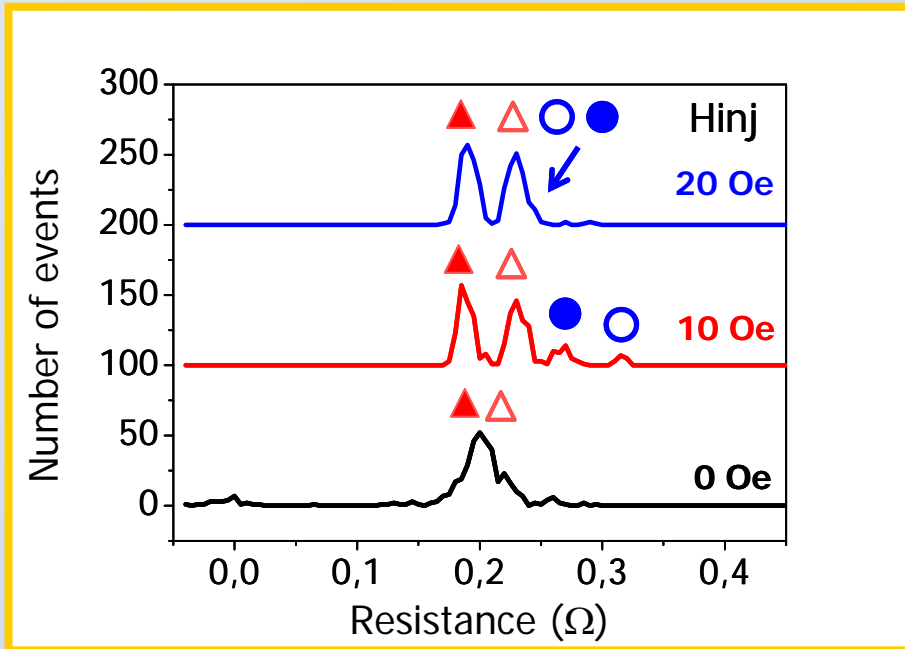
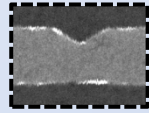
Dynamic Pinning



- $H_{inj} = 8 \text{ Oe} > H_{prop}$
1 Type Pinned DWs !!!



Results



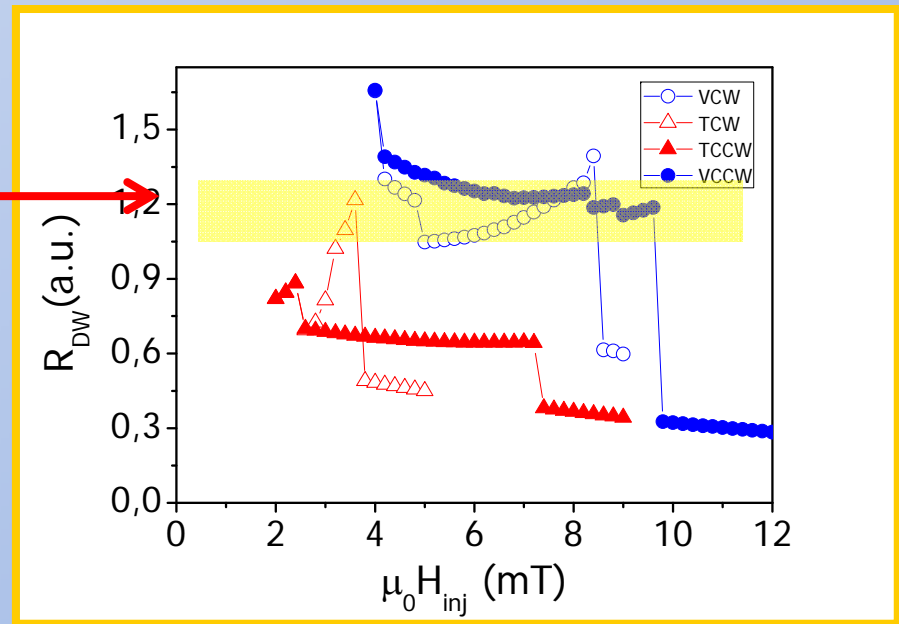
- $H_{inj} = 0$ Oe
1 peak at 0.20Ω Unpinned TWs
- $H_{inj} = 10$ Oe $\approx H_{walker}$
 - ▲ 0.19Ω
 - △ 0.22Ω
 - 0.27Ω
 - 0.32Ω
- $H_{inj} = 20$ Oe
Only 2 peaks??!

Micromagnetic Simulations: OOMMF

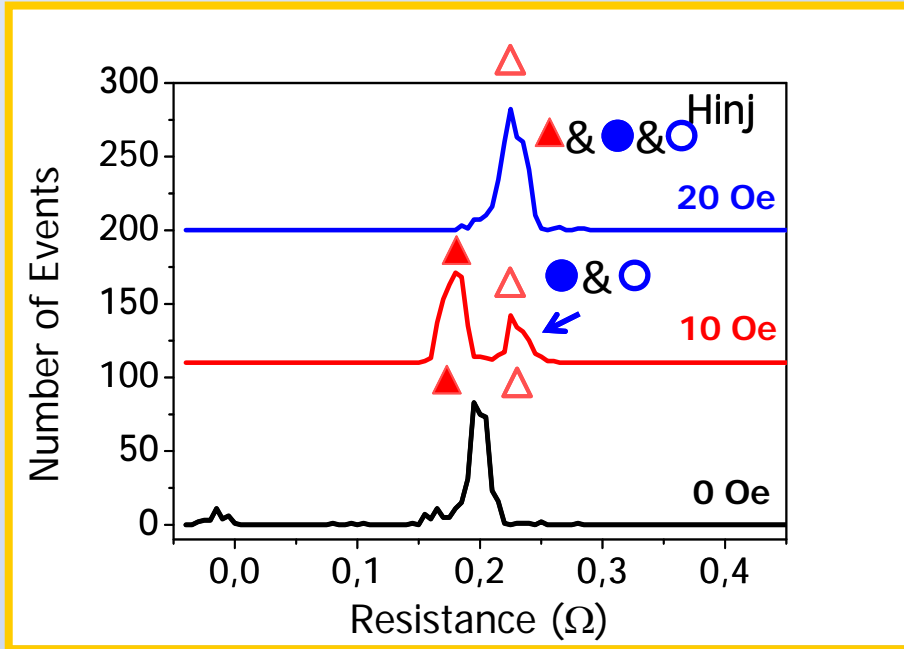
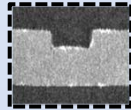
- $\alpha = 0.01$
- $H_{\perp} = 5.5$ mT
- VCCW \rightarrow TCCW

Similar AMR Value

Above H_{walker} + No depinning events
All DWs types should be there!!

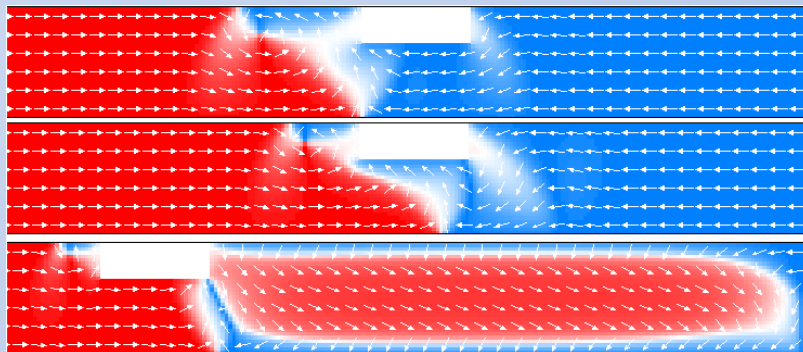


Results

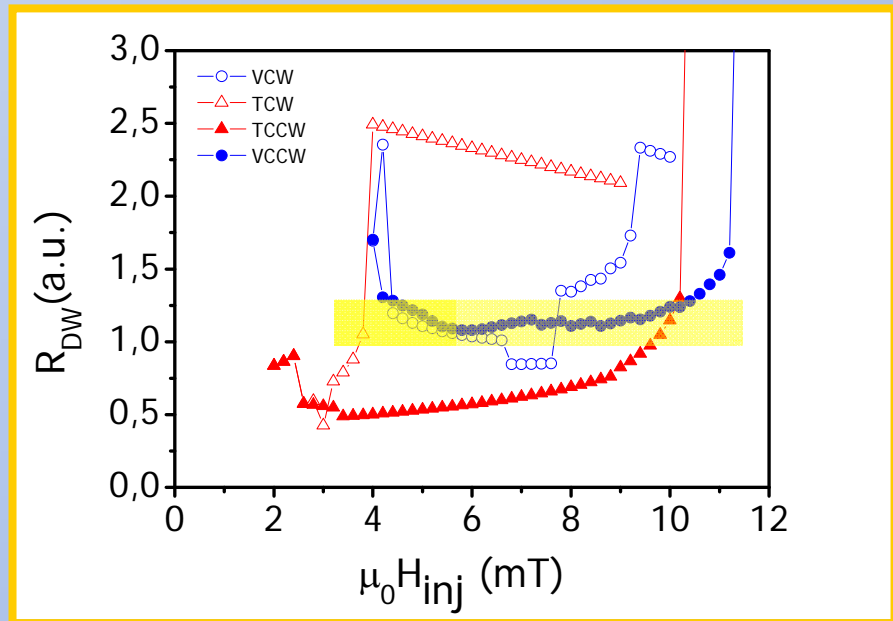


Micromagnetic Simulations: OOMMF

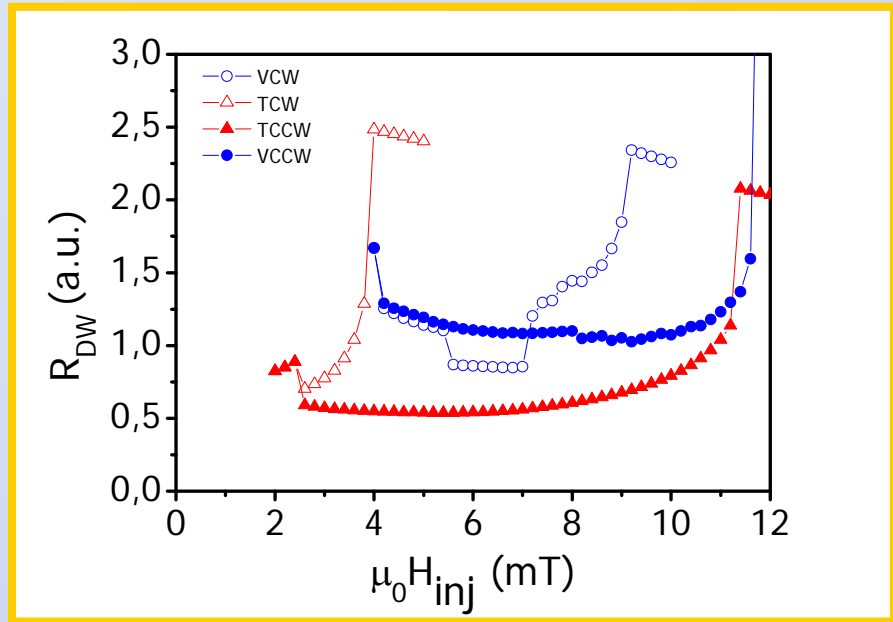
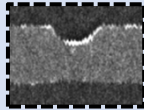
- VCCW \rightarrow TCCW. 360°



- $H_{inj} = 0$ Oe
1 peak at 0.20 Ω Unpinned TWs
- $H_{inj} = 10$ Oe
1st peak at 0.185 Ω \blacktriangle
2nd peak at $\left\{ \begin{array}{l} 0.220 \Omega \ \triangle \\ 0.230 \Omega \ \bullet \circ \end{array} \right.$
- $H_{inj} = 20$ Oe
1 peak

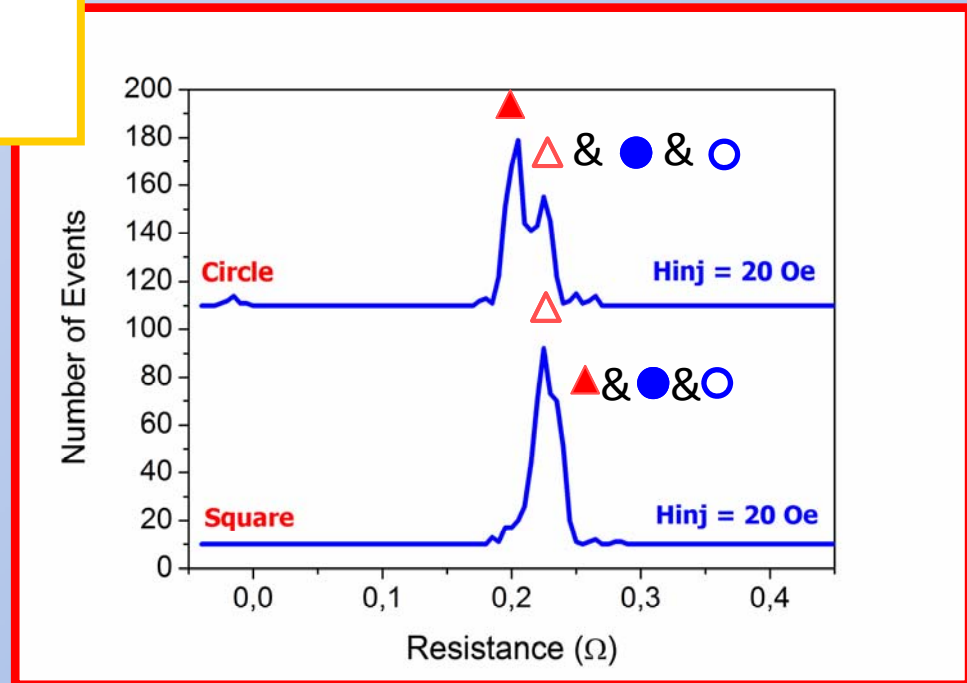


Notch



Micromagnetic Simulations: Oommf

- Similar to Square notch.
- TCCW smaller dependency with H_{inj}
0,19 Ω at $H_{inj} = 20$ Oe



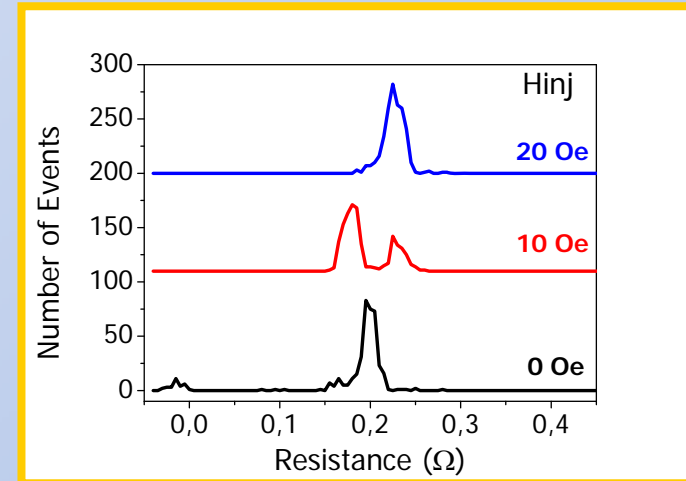
Conclusions

- We have studied the conditions of DW injections that allow selective pinning of different types of DWs.

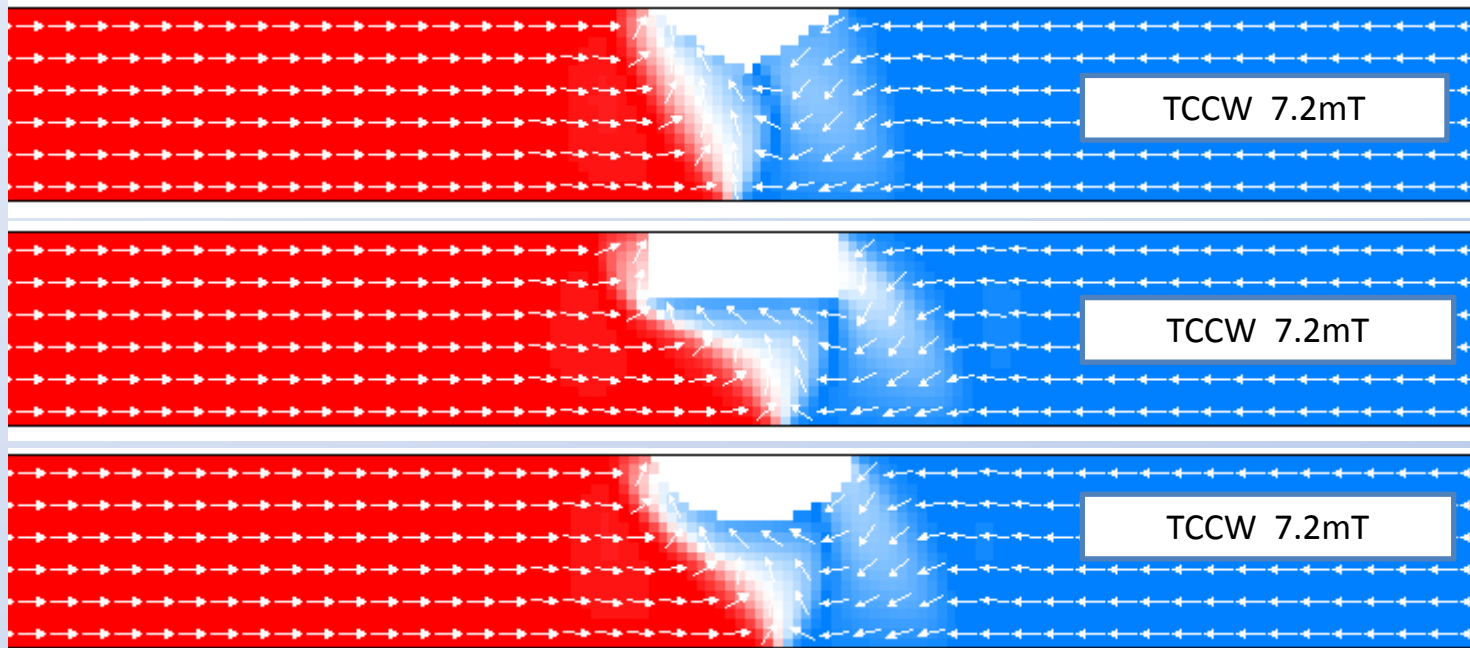
- $H_{inj} = 0 \text{ Oe}$ TCCW + TCW

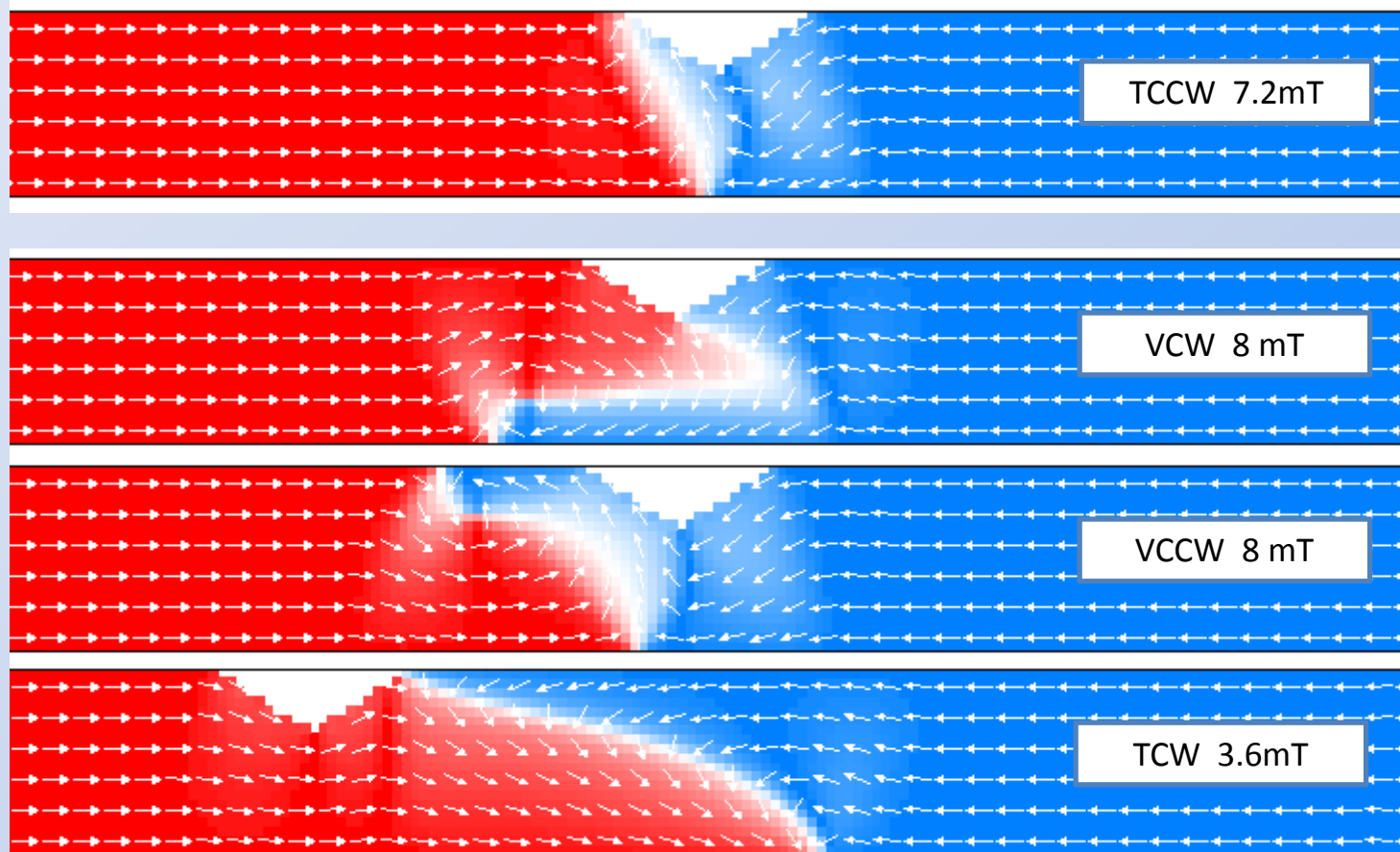
$H_{inj} > H_{walker}$ + No depinning events

- The apparent absence of some DWs at high or moderate H_{inj} indicates that AMRs of different DWs gets similar!
- Changing the shape of the notch alters slightly the notch pattern.
- Careful should be taken when associating a value of AMR to a type of DW!!!



Thank you for your attention





Mismo tamaño misma AMR

Esto explica los dos picos del triangulo a $H_{inj}=200e$.

Es el valor de la ARM de la pared justo antes de depinarse. Fact 1

Todo cuadraría si no fuera porque la TCW va a su puta bola básicamente y no puedes decir a campo "a campo alto" para esto porque en teoría a campo alto debería haberse ido.

Si te fijas en la tesis de Hayashi, en la imagen de MFM la TC (pag 57) aparece pineada en el centro del notch y no a su derecha como en mis simulaciones. Esto explica que se necesite mas campo para depinearla, en la realidad que en la simulaciones. ¿Porque pasa esto? Se podría argumentar esto con el Stochastic pinning que a campo alto la pared esta mas distorciónada y se pinea mas? Por eso cuando debería desanclarse sigue pineada, que en la simulaciones no se ve pero en la realidad existe y esta medido. Fact 3

