

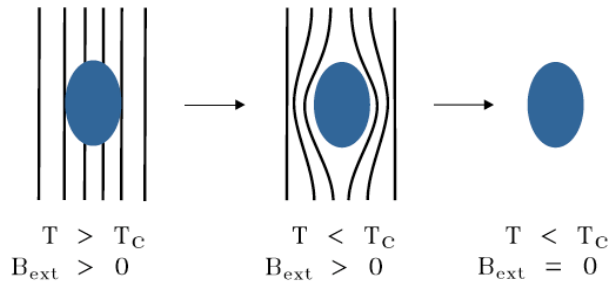


# On Magnetic Flux Trapping in Superconductors

Ralf Eichhorn, Jesse Hoke, Zachary Mayle

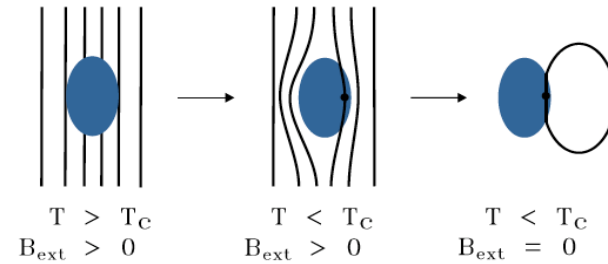


## Ideal superconductor

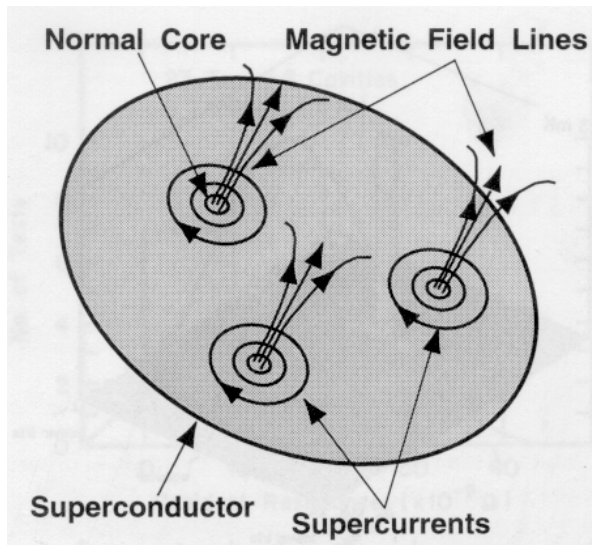


(a) Sketch of the perfect Meissner effect

## A “real” superconductor



(b) Sketch of flux trapping



External magnetic flux can get trapped on cool-down, resulting normal conducting spots.

As a result, in a superconducting cavity the effective surface resistance increases leading to lower quality factors

Sketches from:

H. Padamsee, J. Knobloch and T. Hays,

*RF Superconductivity for Accelerators*, John Wiley, New York 1998.



# CLASSE

Cornell Laboratory of Accelerator-Based Sciences & Education

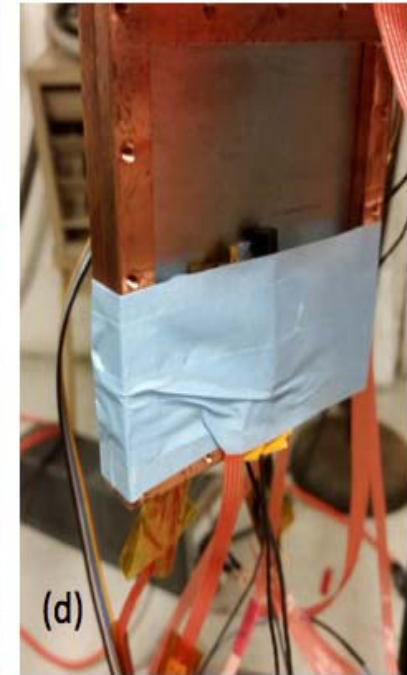
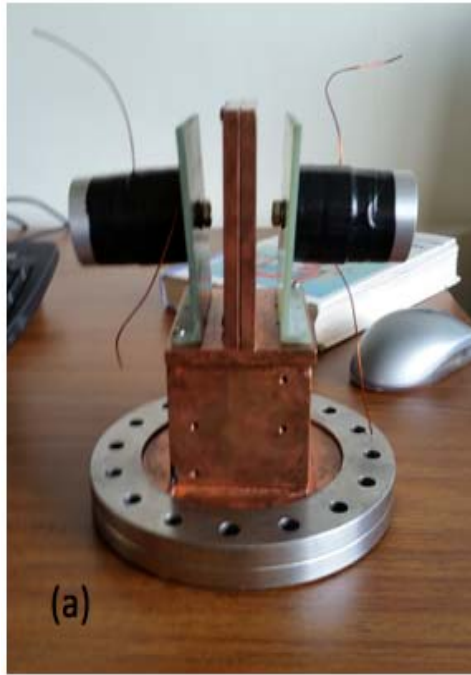
**LINAC 16**  
28<sup>th</sup> Linear Accelerator Conference

East Lansing, MI USA - 25-30 September



**Does the orientation of the magnetic  
field with respect to the  
superconductor impact flux trapping?**

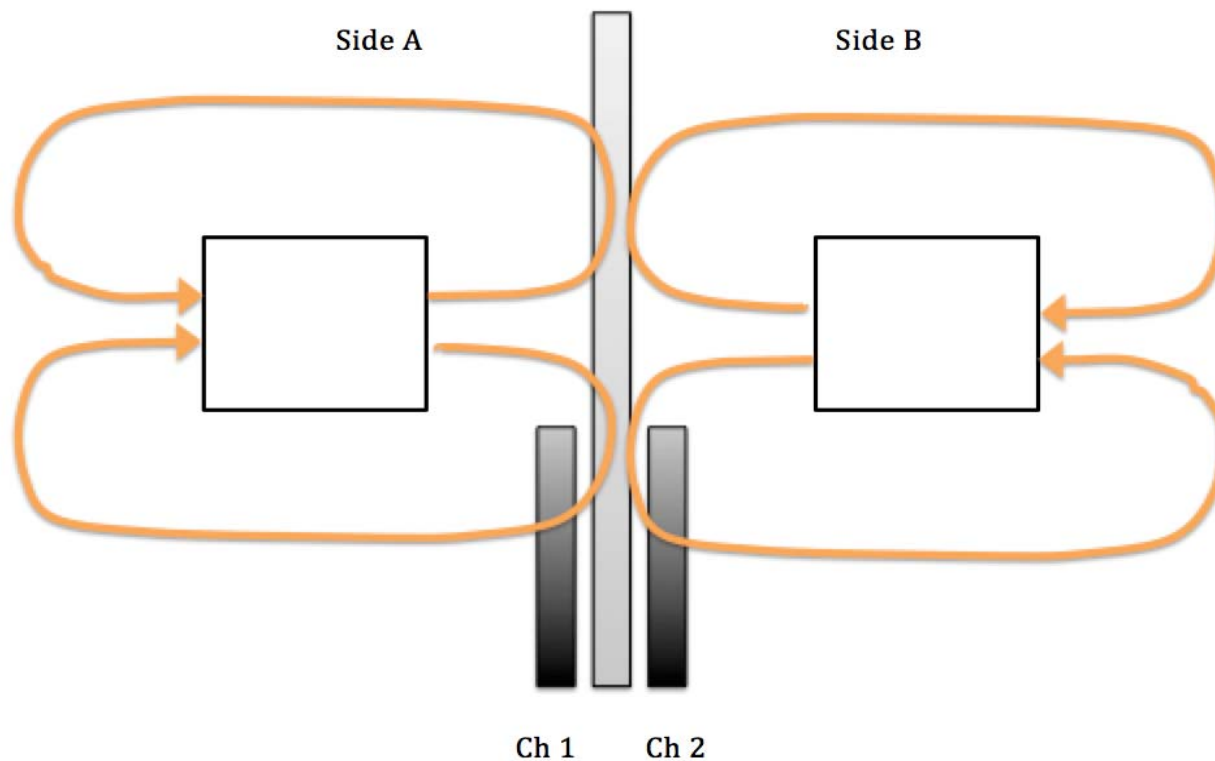




Ingredients: solenoids, flux gates, T sensors and a piece of niobium

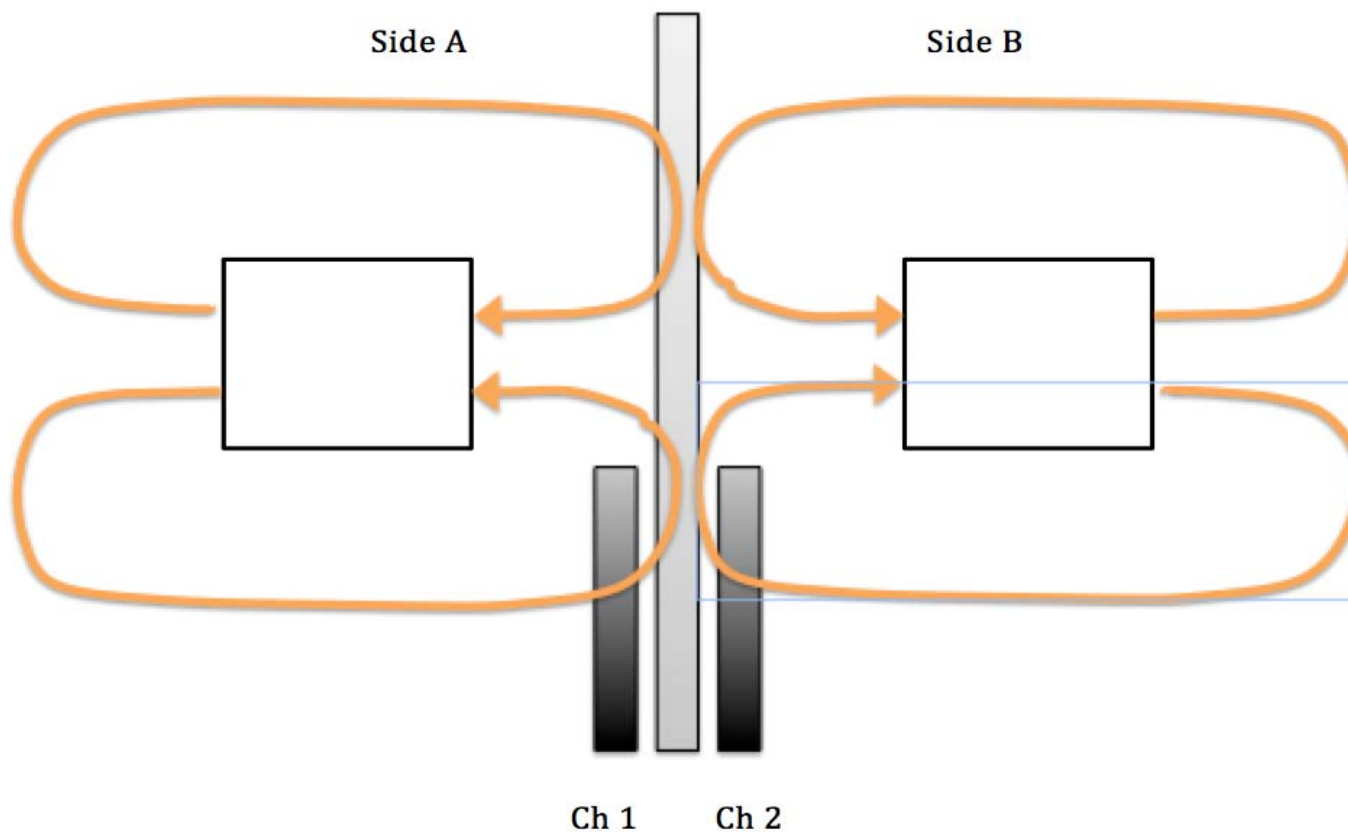


Solenoids Inward



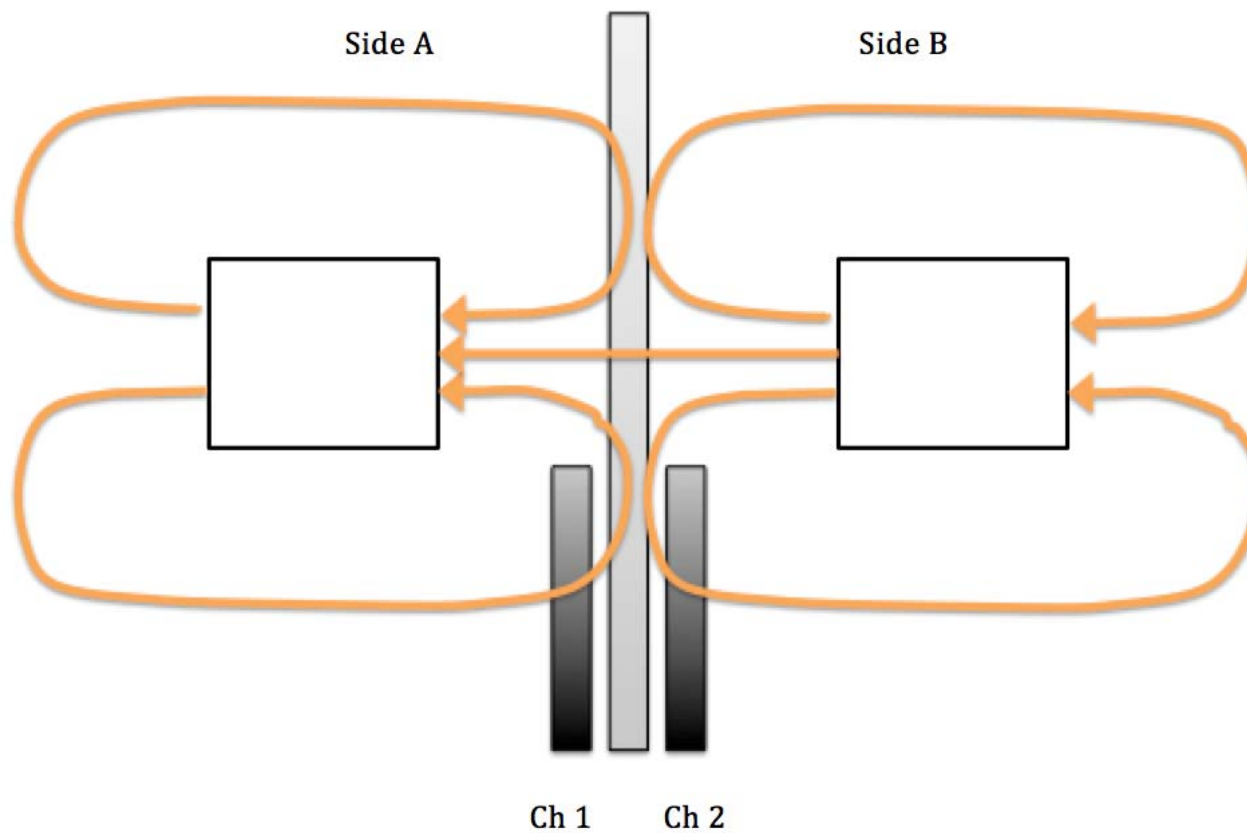


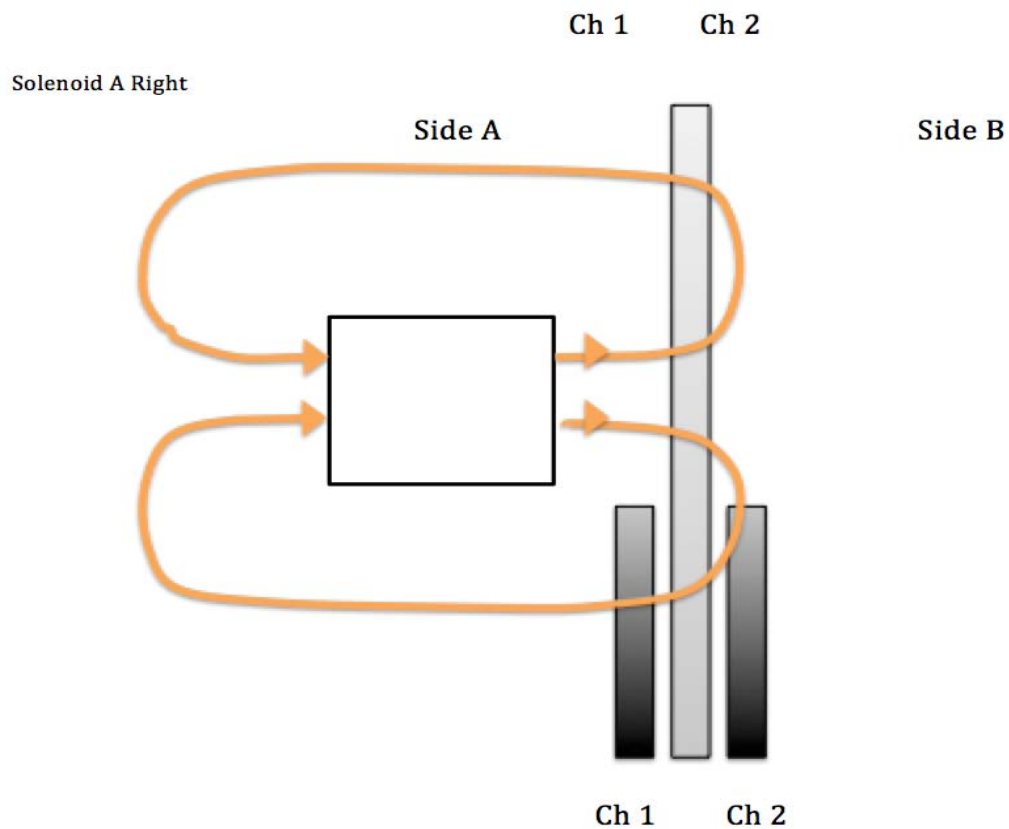
Solenoids Outward

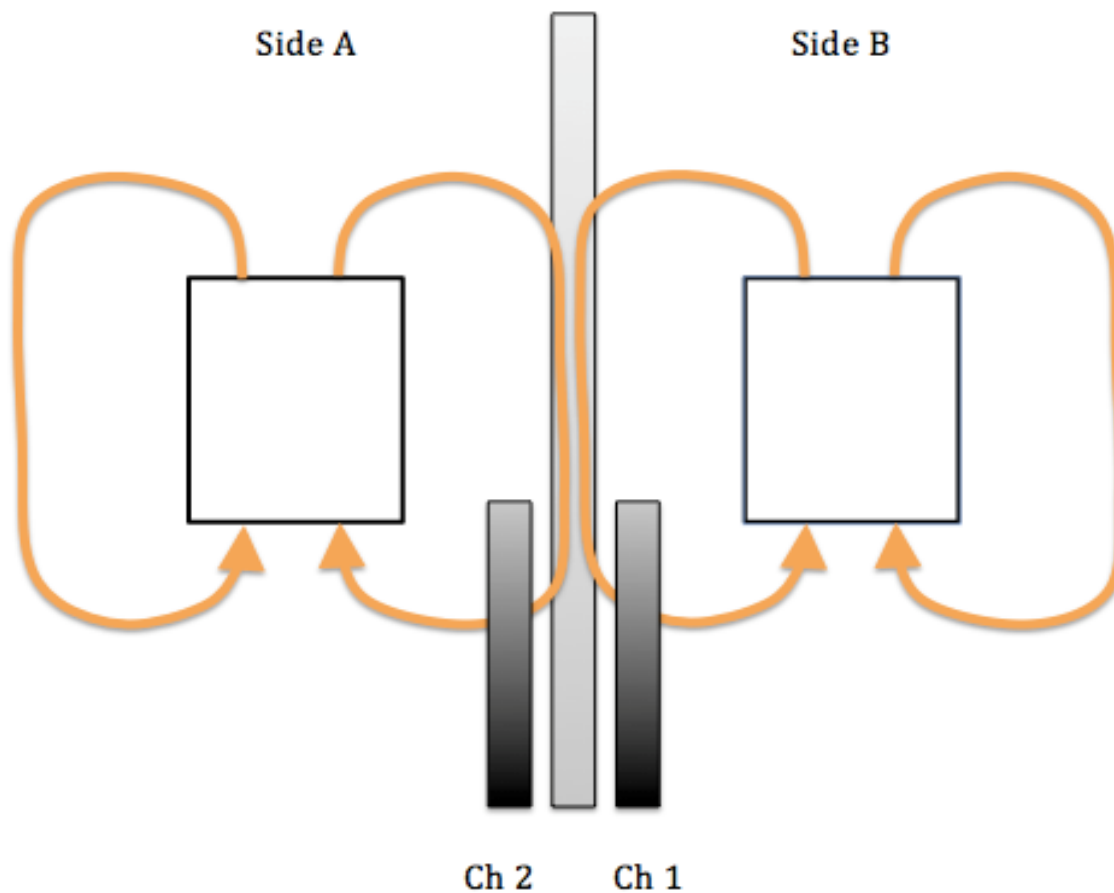


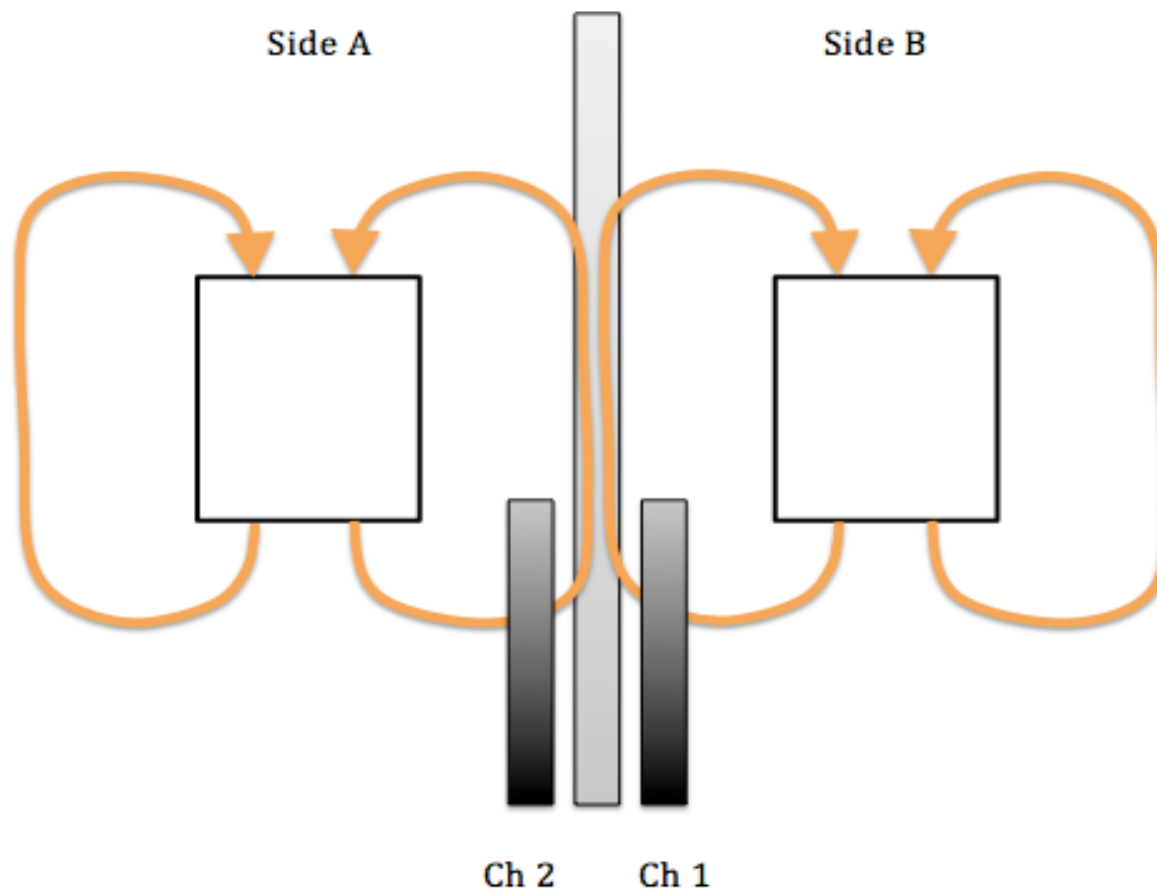


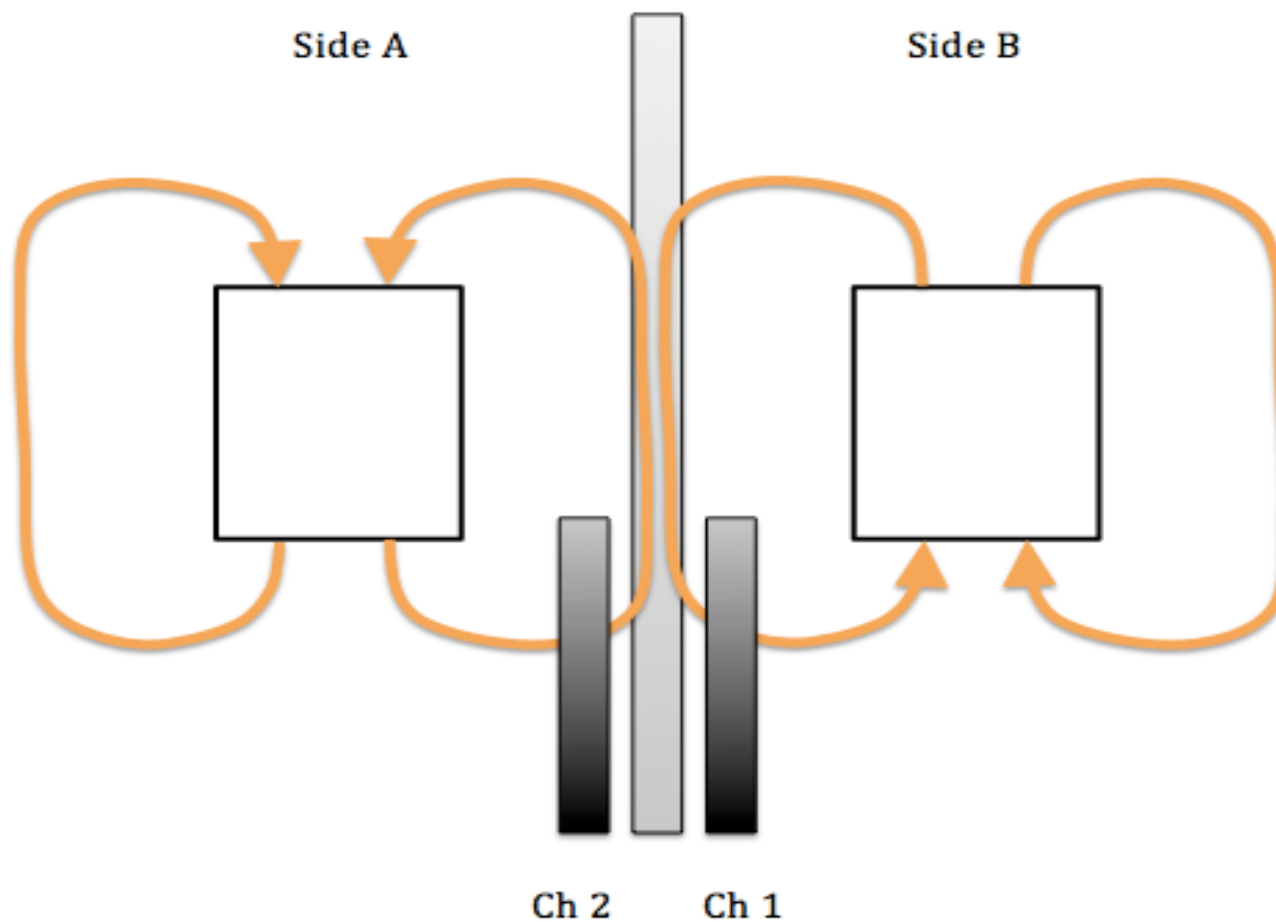
Both Solenoids Pointed Toward Side A (Left)

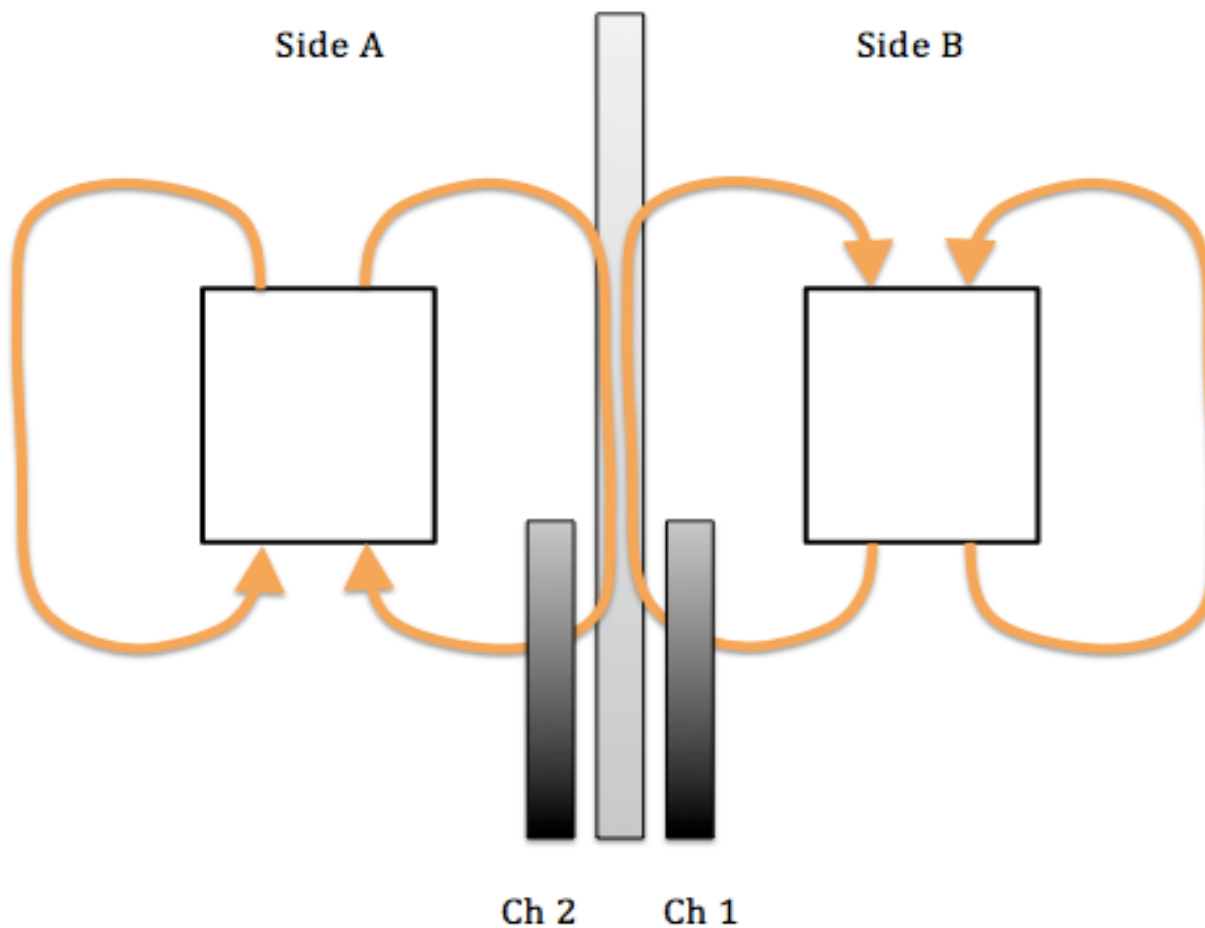






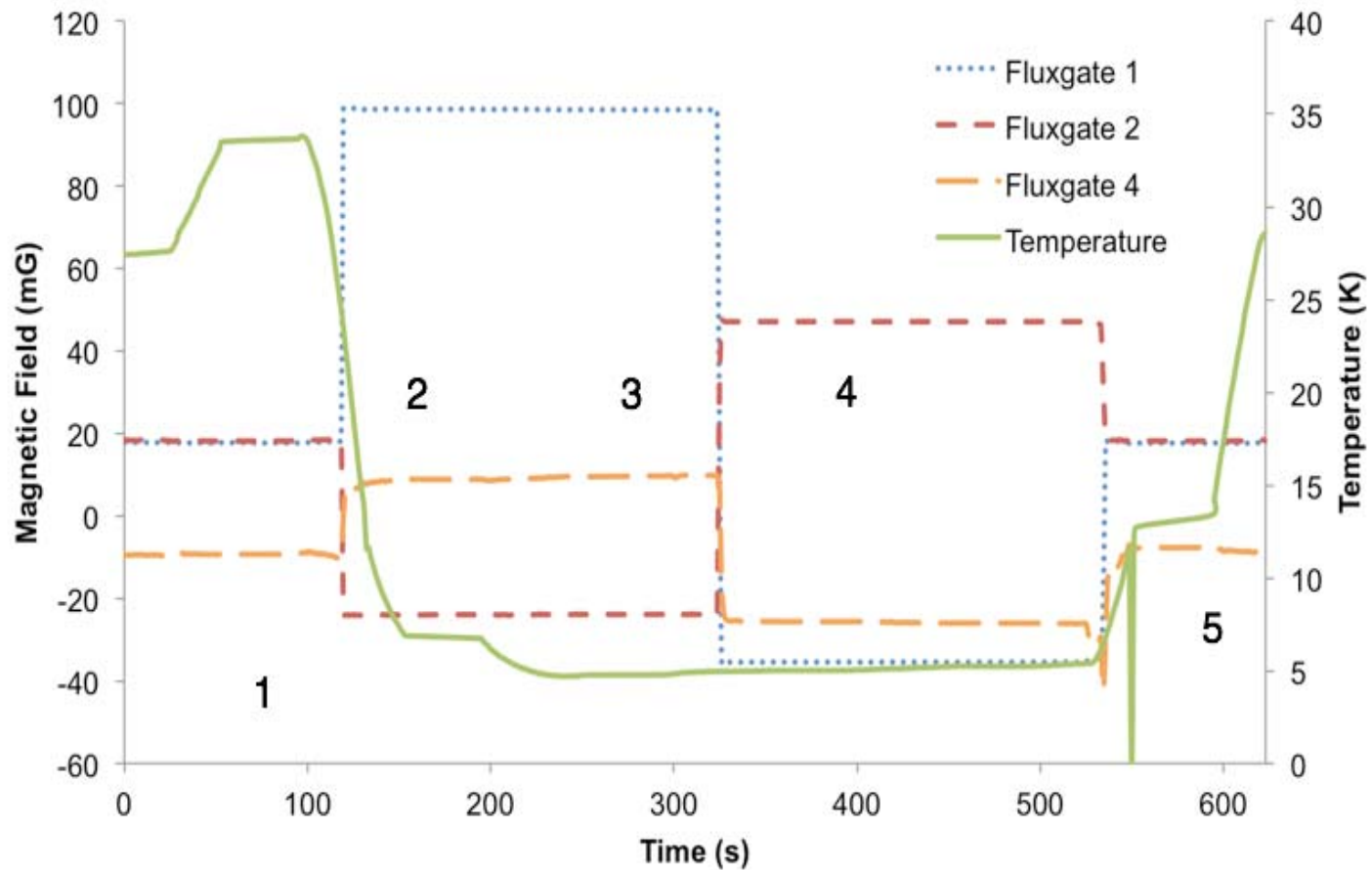


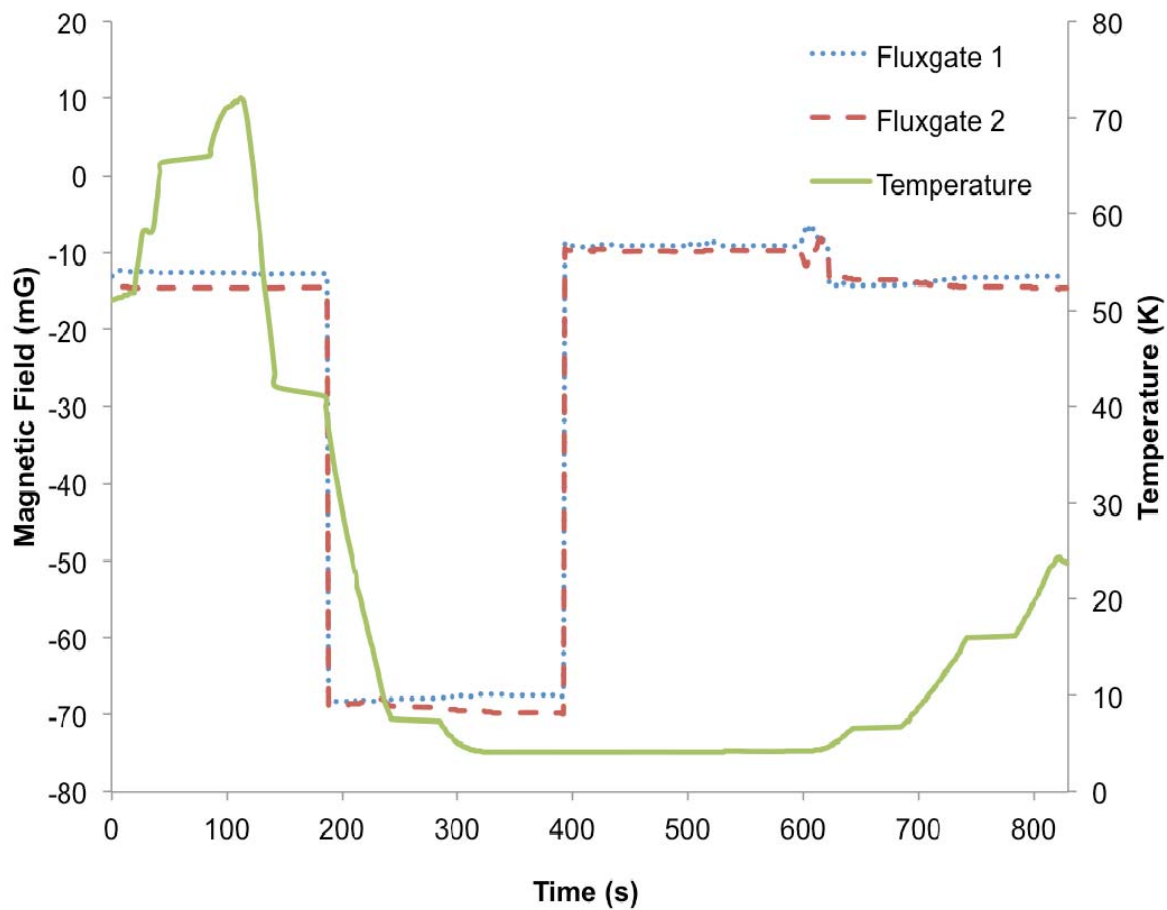


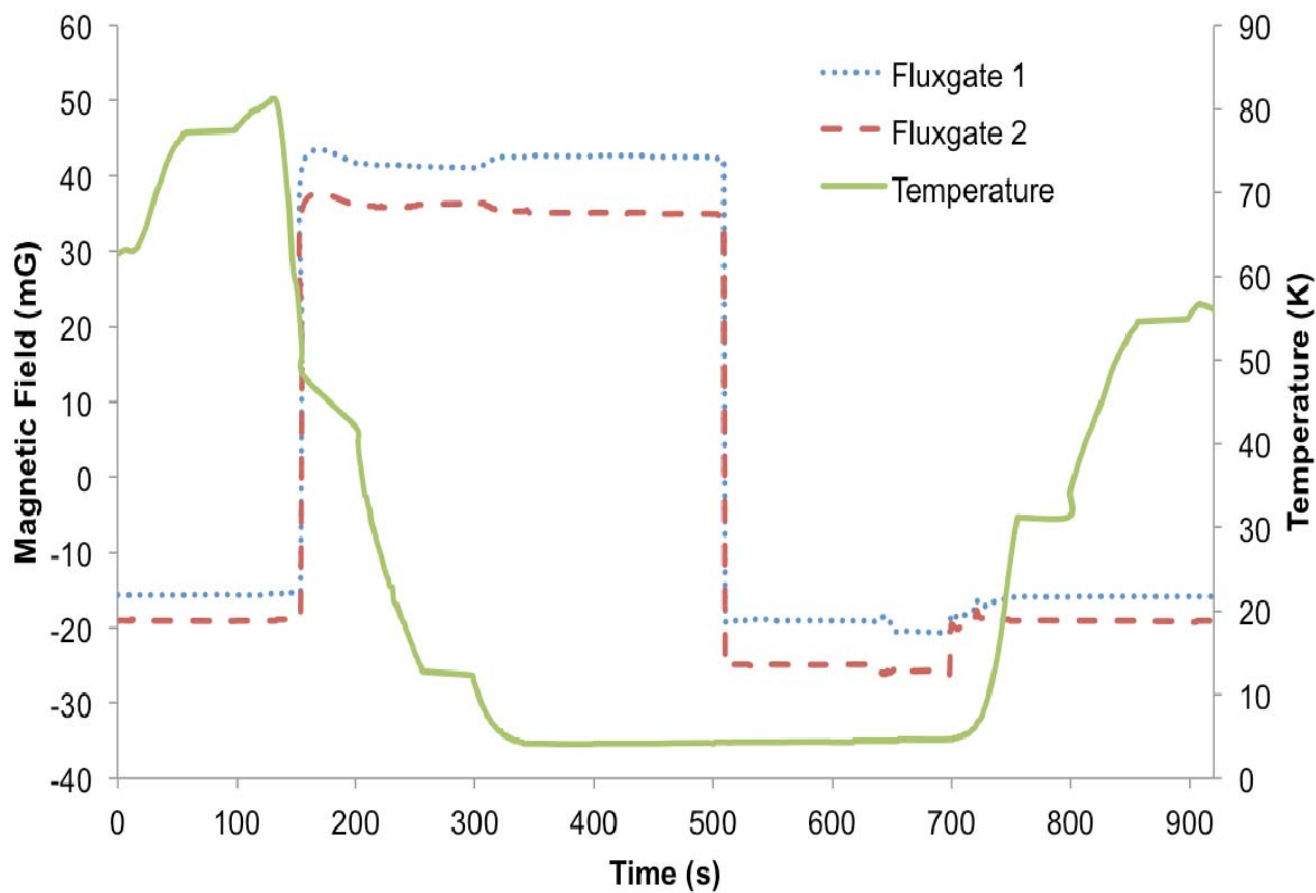


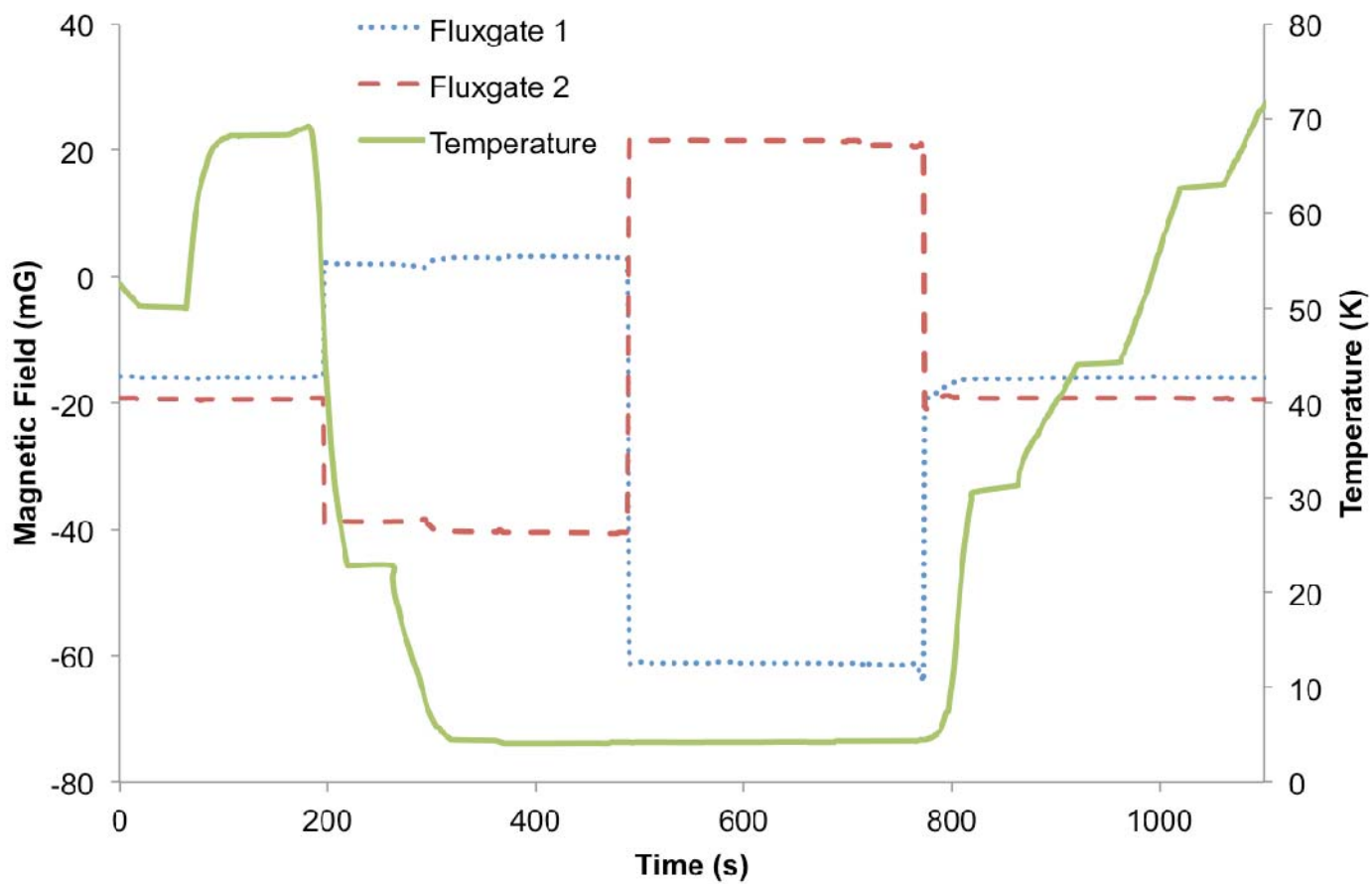
Each experiment had 5 phases:

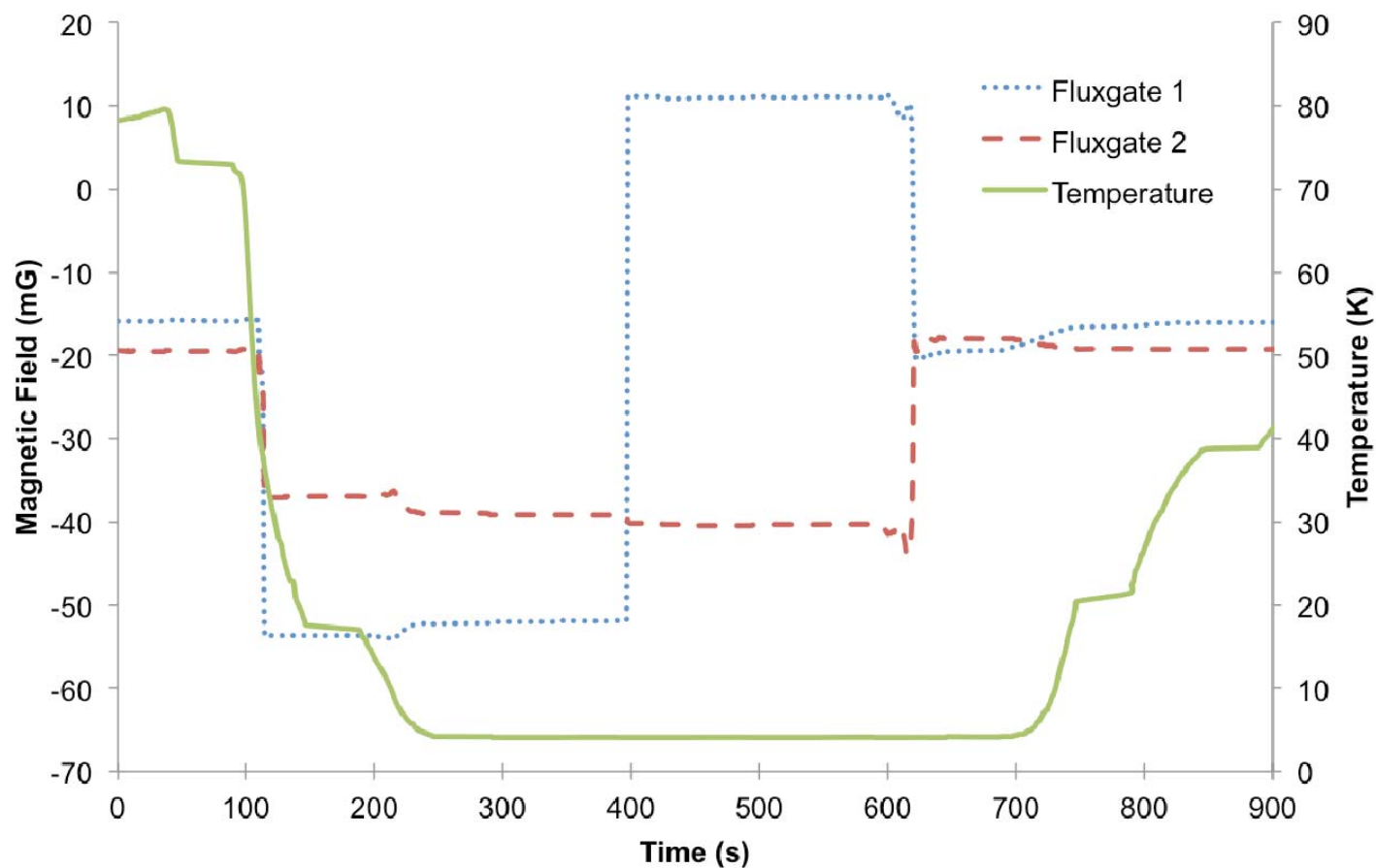
- 1:  $T > T_c$ , solenoids off
- 2:  $T > T_c$ , solenoids on
- 3:  $T < T_c$ , solenoids on
- 4:  $T < T_c$ , solenoids off
- 5:  $T > T_c$ , solenoids off

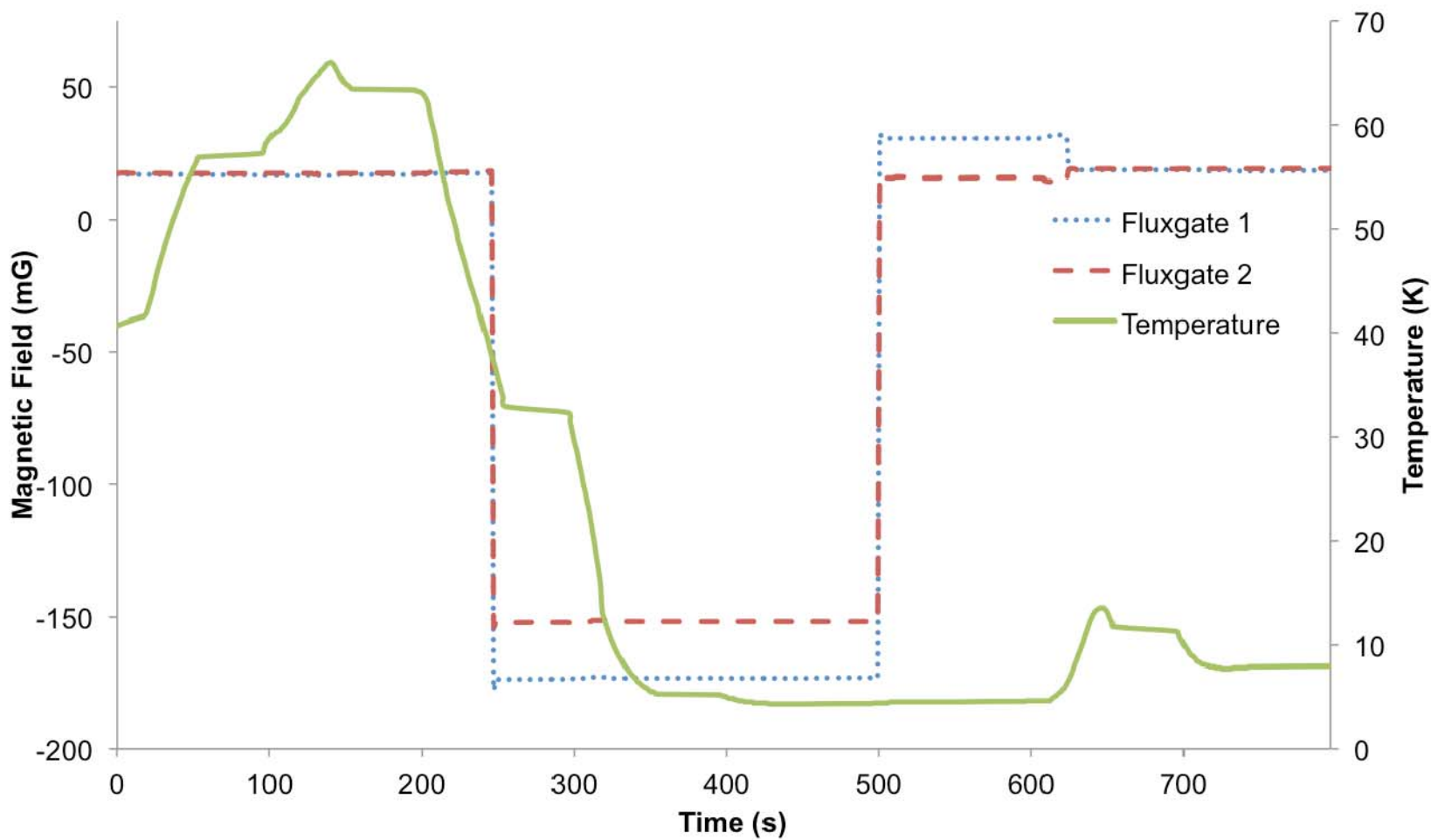


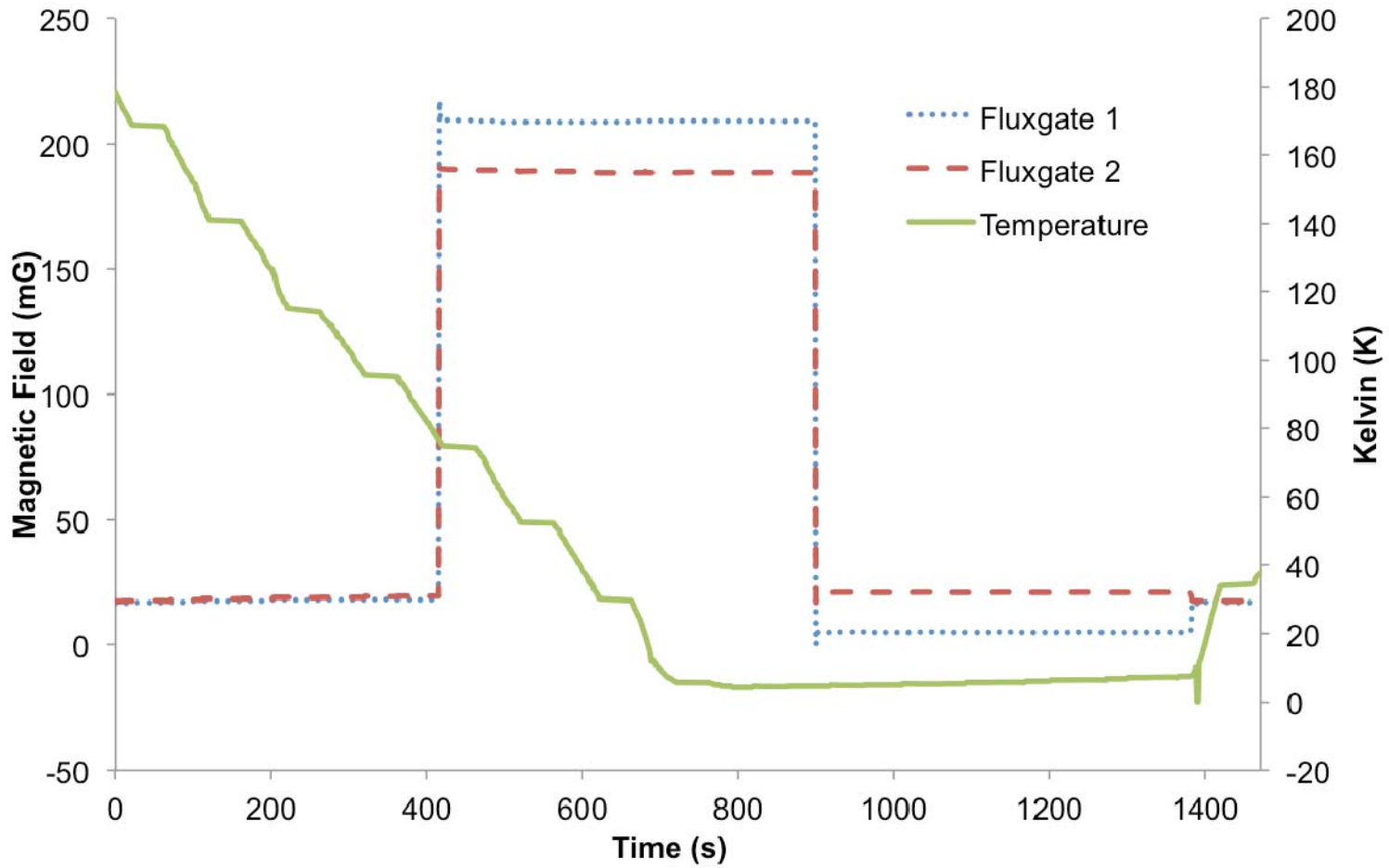


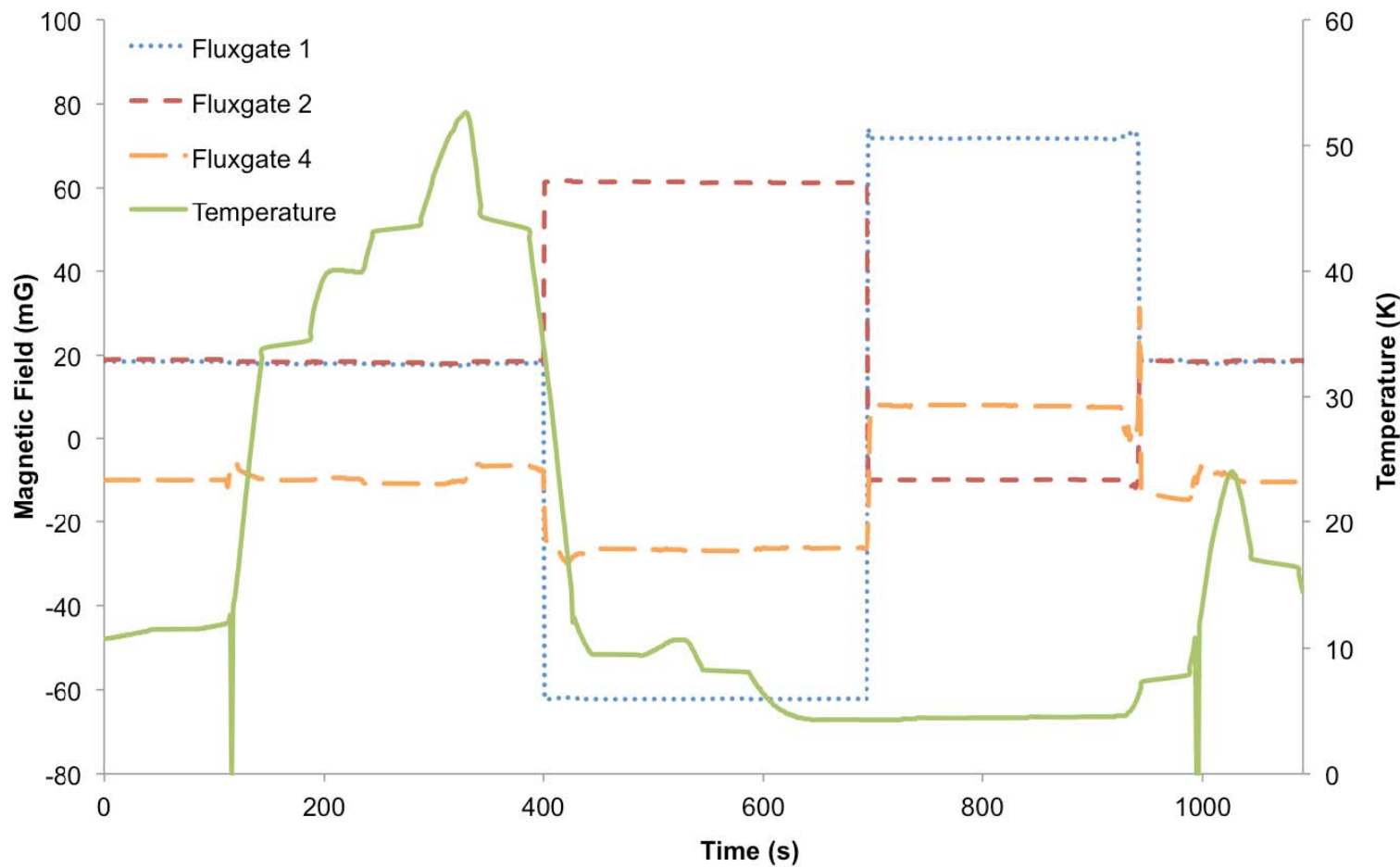


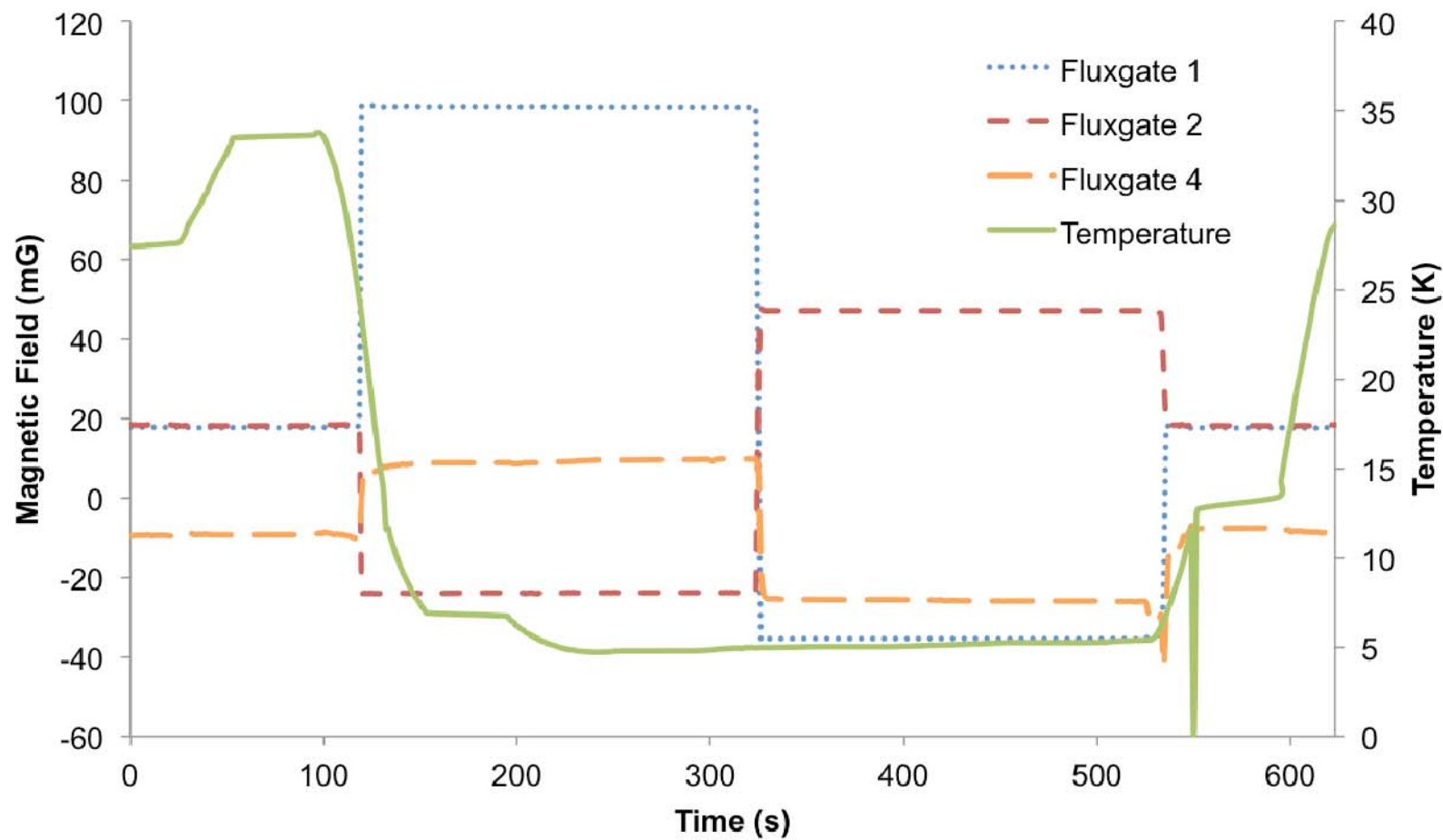






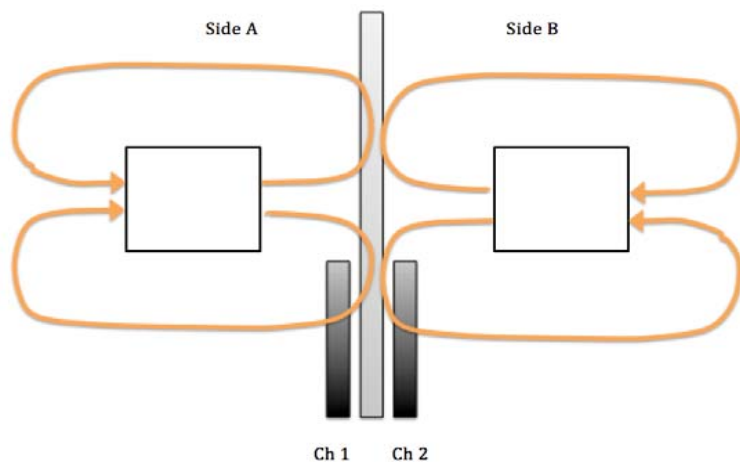




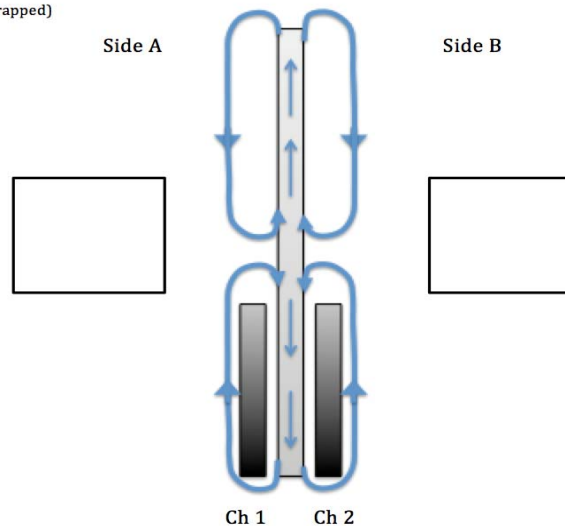




Solenoids Inward

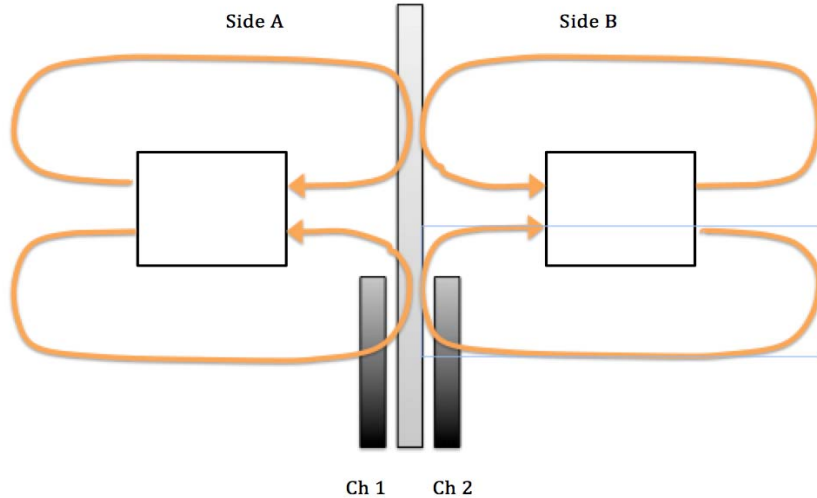


Solenoids Inward (Trapped)

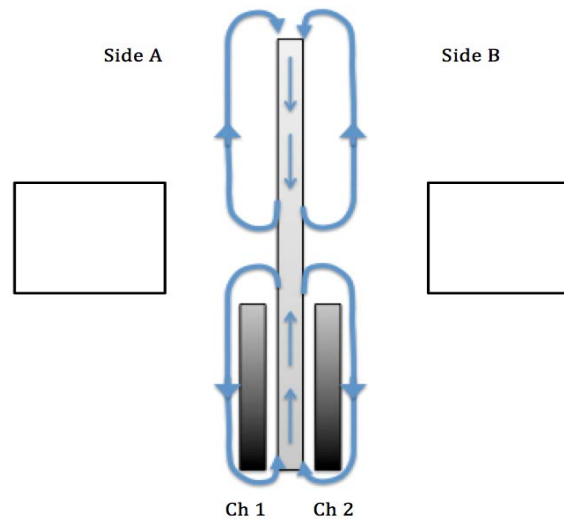




Solenoids Outward

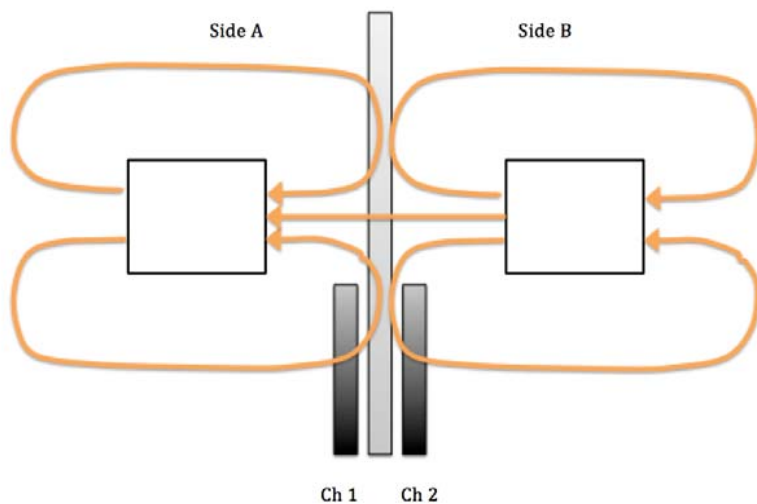


Solenoids Outward

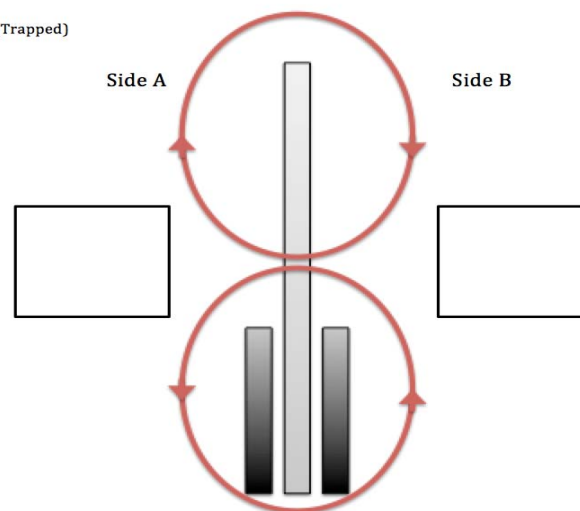


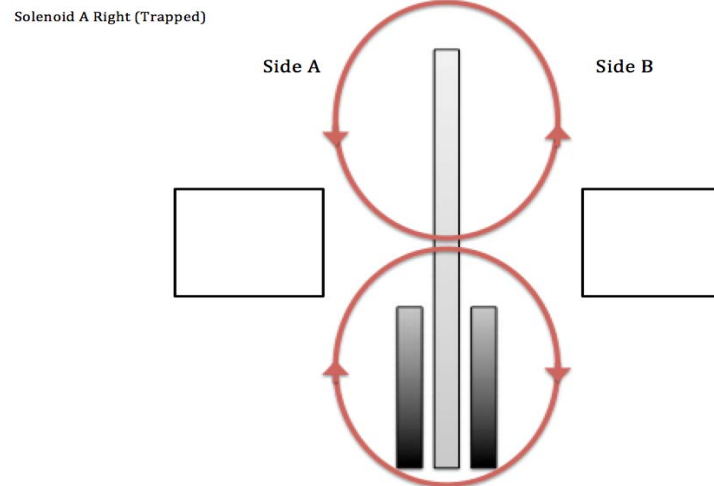
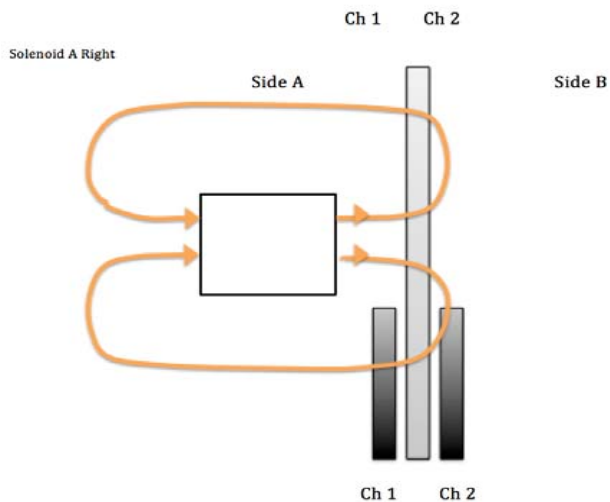


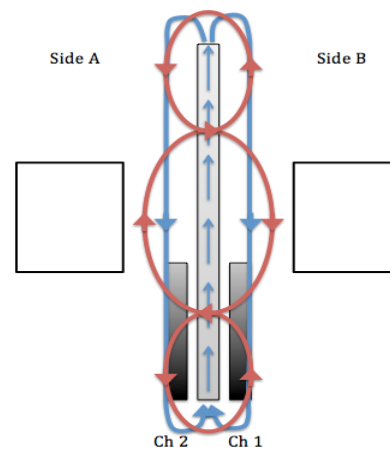
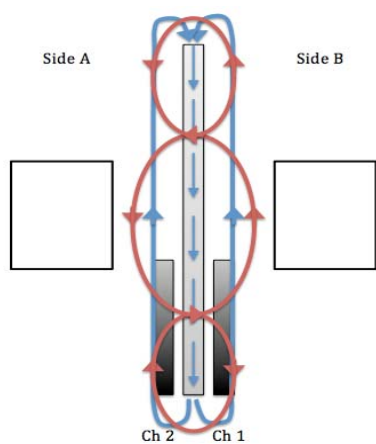
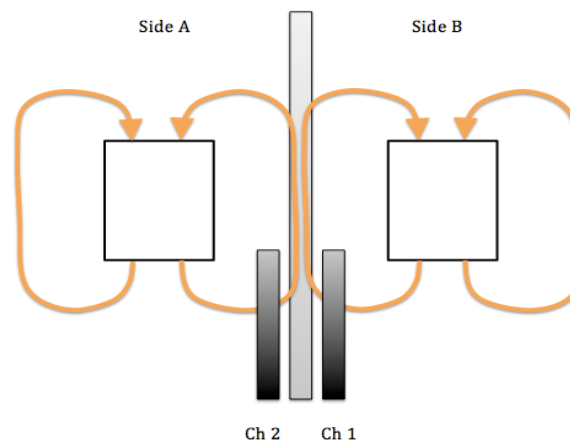
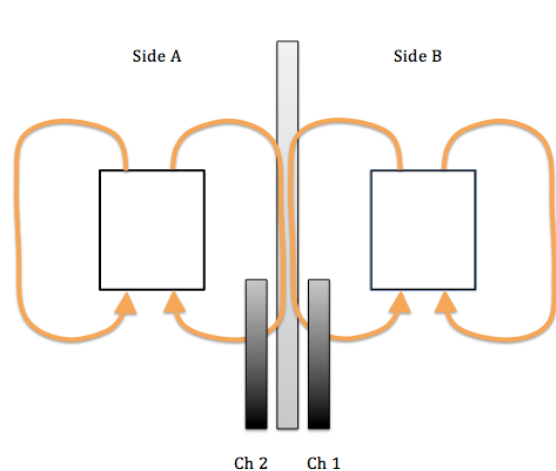
Both Solenoids Pointed Toward Side A (Left)

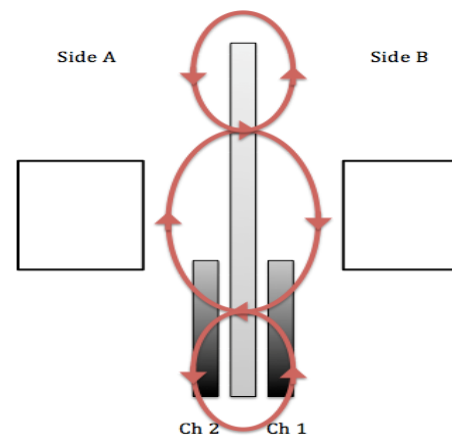
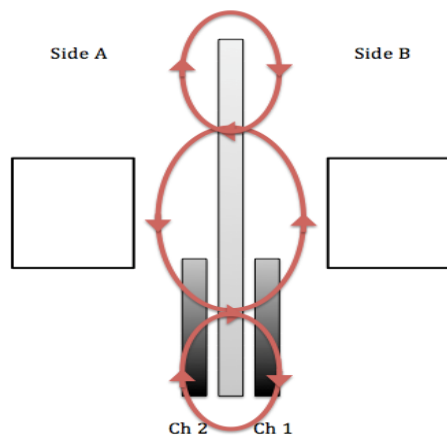
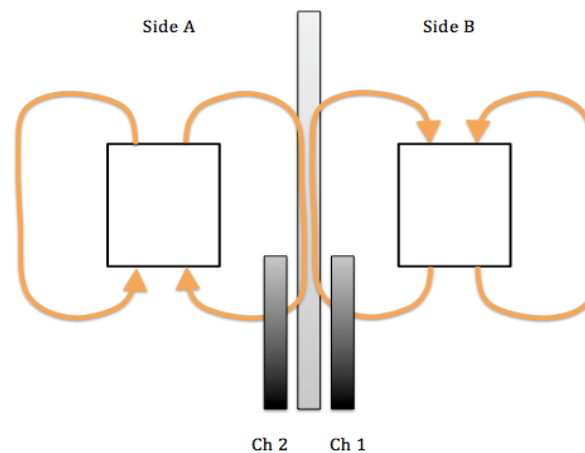
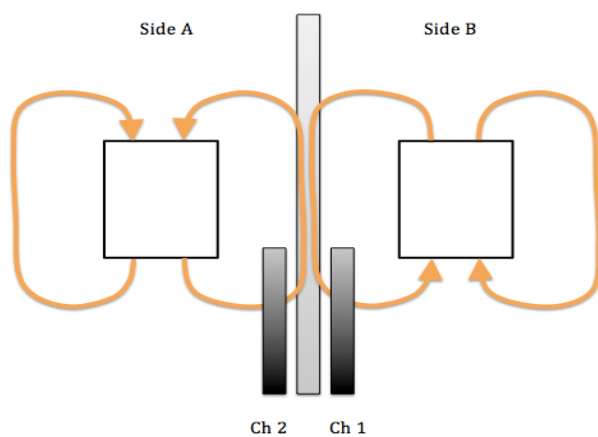


Both Solenoids Left (Trapped)











# CLASSE

Cornell Laboratory of Accelerator-Based Sciences & Education

## LINAC 16

28<sup>th</sup> Linear Accelerator Conference

East Lansing, MI USA - 25-30 September



# Time to breath!



Cornell Laboratory for  
Accelerator-based Sciences  
and Education (CLASSE)





| S1 | S2 | Fluxgate Channel | B <sub>1</sub> [mG] | B <sub>2</sub> [mG] | B <sub>3</sub> [mG] | B <sub>4</sub> [mG] | B <sub>5</sub> [mG] | B <sub>Trapped</sub> [mG] | B <sub>Solenoid</sub> [mG] | Trapping |
|----|----|------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------------|----------------------------|----------|
| R  | L  | 1                | -12.6               | -68.2               | -67.6               | -8.81               | -13.6               | 4.75                      | -54.6                      | 8.7%     |
| R  | L  | 2                | -14.6               | -68.5               | -69.5               | -9.80               | -14.1               | 4.33                      | -54.4                      | 8.0%     |
| L  | R  | 1                | -15.6               | 41.4                | 42.5                | -18.9               | -16.0               | -2.91                     | 57.3                       | 5.1%     |
| L  | R  | 2                | -19.1               | 36.0                | 35.2                | -23.8               | -19.1               | -4.72                     | 55.1                       | 8.5%     |
| R  | -  | 1                | -15.8               | -53.7               | -52.0               | 11.0                | -16.4               | 27.4                      | -37.3                      | 73.5%    |
| R  | -  | 2                | -19.4               | -36.9               | -39.2               | -40.3               | -19.2               | -21.1                     | -17.7                      | 119%     |
| U  | U  | 1                | 17.0                | -173                | -173                | 30.9                | 18.6                | 12.3                      | -192                       | 6.4%     |
| U  | U  | 2                | 17.5                | -152                | -152                | 15.7                | 19.2                | -3.50                     | -171                       | 2.1%     |
| D  | D  | 1                | 17.7                | 208                 | 208                 | 5.16                | 16.9                | -11.8                     | -191                       | 6.2%     |
| D  | D  | 2                | 18.7                | 188                 | 188                 | 20.9                | 17.5                | 3.40                      | -171                       | 2.0%     |
| D  | U  | 1                | 18.0                | -62.1               | -62.1               | 71.9                | 18.1                | 53.8                      | -80.2                      | 67.1%    |
| D  | U  | 2                | 18.4                | 61.4                | 61.2                | -9.77               | 18.1                | -27.9                     | -43.3                      | 64.4%    |
| U  | D  | 1                | 17.8                | 98.8                | 98.5                | -35.3               | 17.8                | -53.1                     | 81.0                       | 65.6%    |
| U  | D  | 2                | 18.4                | -24.0               | -23.9               | 46.8                | 18.3                | 28.5                      | -42.3                      | 67.4%    |



# CLASSE

Cornell Laboratory of Accelerator-Based Sciences & Education

## LINAC 16

28<sup>th</sup> Linear Accelerator Conference

East Lansing, MI USA - 25-30 September



**Does the orientation of the magnetic  
field with respect to the  
superconductor impact flux trapping?**



Cornell Laboratory for  
Accelerator-based Sciences  
and Education (CLASSE)





# CLASSE

Cornell Laboratory of Accelerator-Based Sciences & Education

## LINAC 16

28<sup>th</sup> Linear Accelerator Conference

East Lansing, MI USA - 25-30 September



**Does the orientation of the magnetic  
field with respect to the  
superconductor impact flux trapping?**

**Find out at poster  
TUOP08/ TUOPRC030**