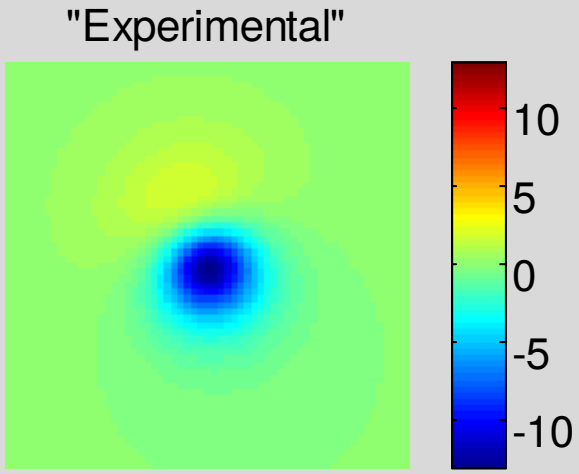
Net Moment Estimation with Multipole Models

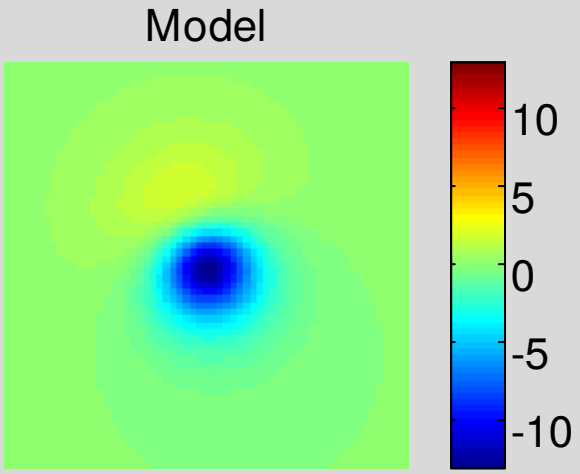
$$\underset{\boldsymbol{x}\in\mathbb{R}^3}{\text{minimize}} \quad \left\| \boldsymbol{b}_z - \boldsymbol{G}(\boldsymbol{x})\boldsymbol{m}(\boldsymbol{x}) \right\|_2^2$$

$$\text{subject to } \boldsymbol{m}(\boldsymbol{x}) = \boldsymbol{G}^{+}(\boldsymbol{x})\boldsymbol{b}_z$$

$$\boldsymbol{G}^{+}(\boldsymbol{x}) = \left(\boldsymbol{G}(\boldsymbol{x})^T \boldsymbol{G}(\boldsymbol{x})\right)^{-1} \boldsymbol{G}(\boldsymbol{x})^T$$

Magnetized Square – Multipole Model





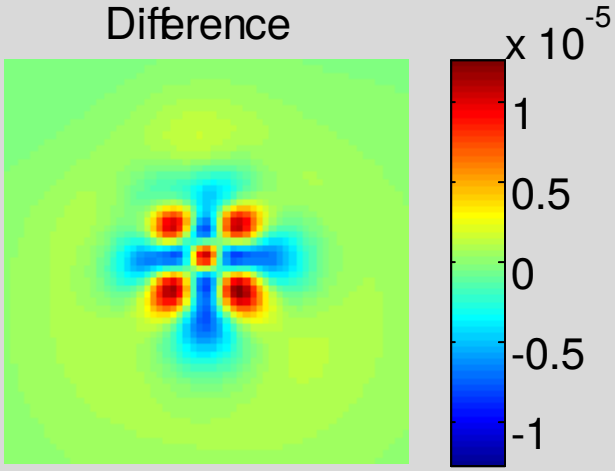
mopt = 1.000 x 10^{-11} (1.000 x 10^{-11})

iopt = -45.00 (-45.00)

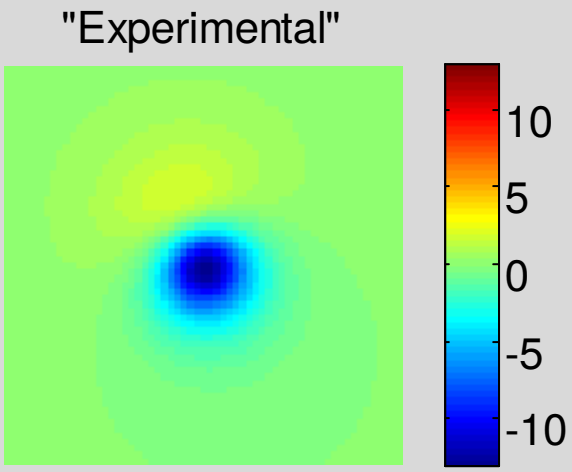
dopt = 20.00 (20.00)

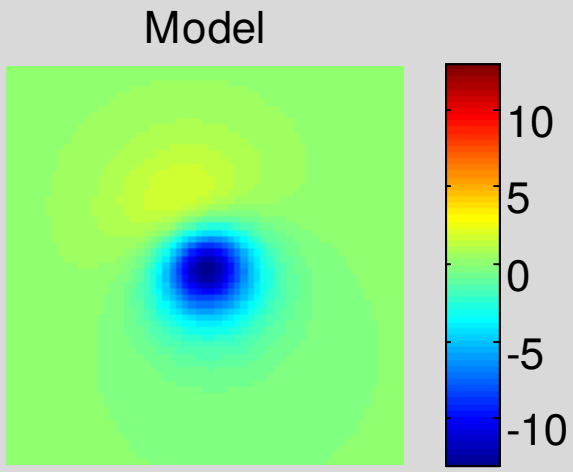
hopt = 501 x 10^{-6} (500 x 10^{-6})

resid = 1.06 x 10^{-6}



Magnetized Square – Dipole Model





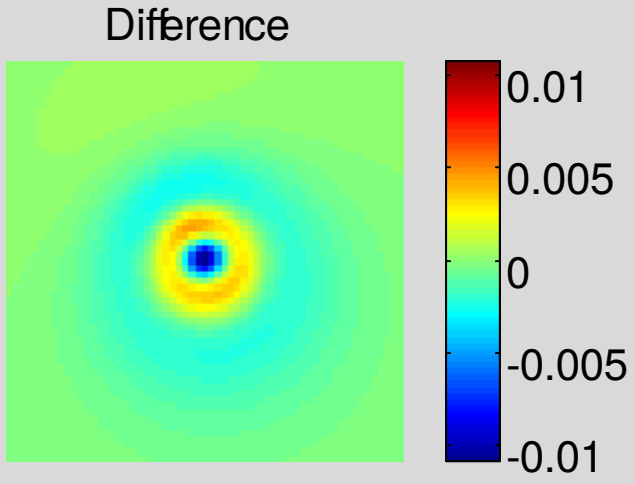
mopt = 1.002 x 10^{-11} (1.000 x 10^{-11})

iopt = -45.00 (-45.00)

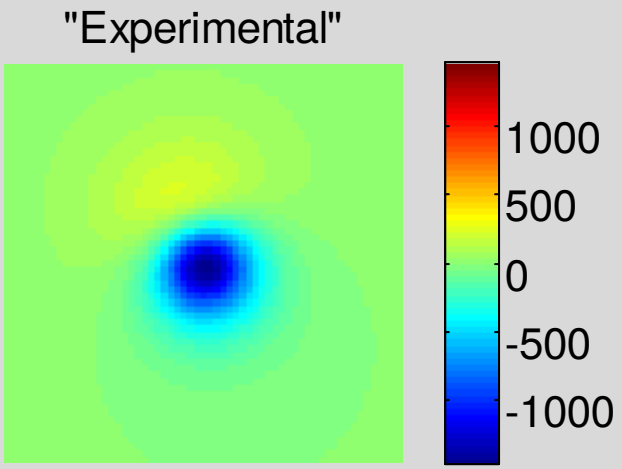
dopt = 20.00 (20.00)

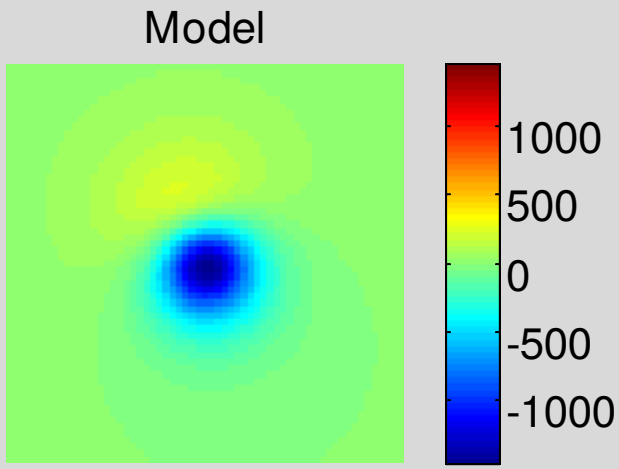
hopt = 501 x 10^{-6} (500 x 10^{-6})

resid = 6.44 x 10^{-4}



Magnetized Square – Multipole Model





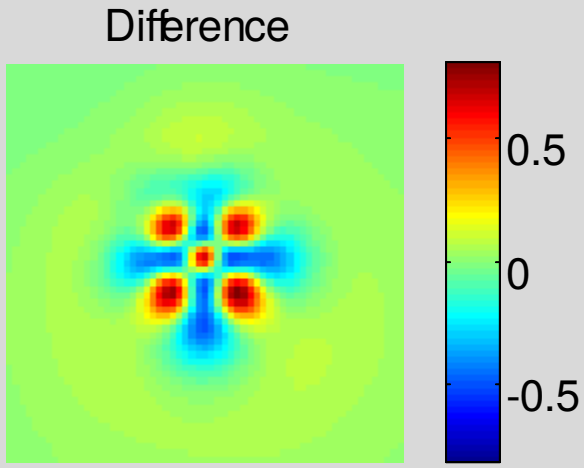
mopt = 0.998 x 10^{-11} (1.000 x 10^{-11})

iopt = -45.01 (-45.00)

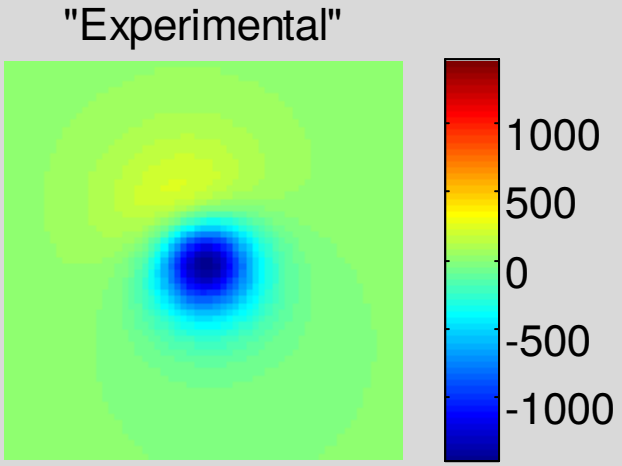
dopt = 20.00 (20.00)

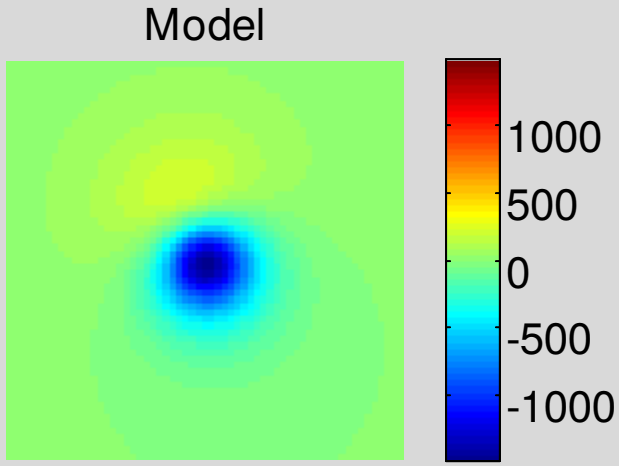
hopt = 105 x 10^{-6} (100 x 10^{-6})

resid = 5.96 x 10^{-4}



Magnetized Square – Dipole Model





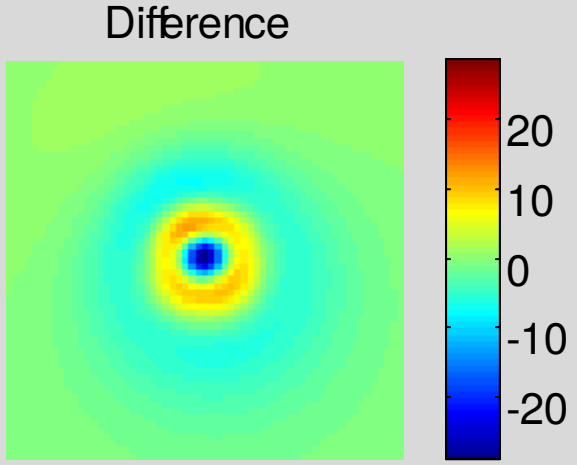
mopt = 1.051 x 10^{-11} (1.000 x 10^{-11})

iopt = -44.98 (-45.00)

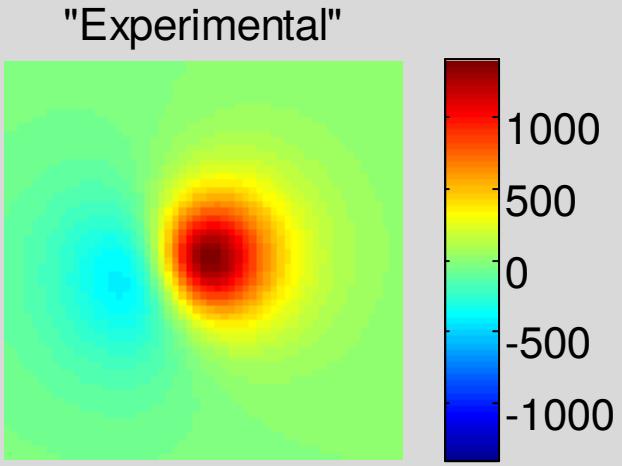
dopt = 20.00 (20.00)

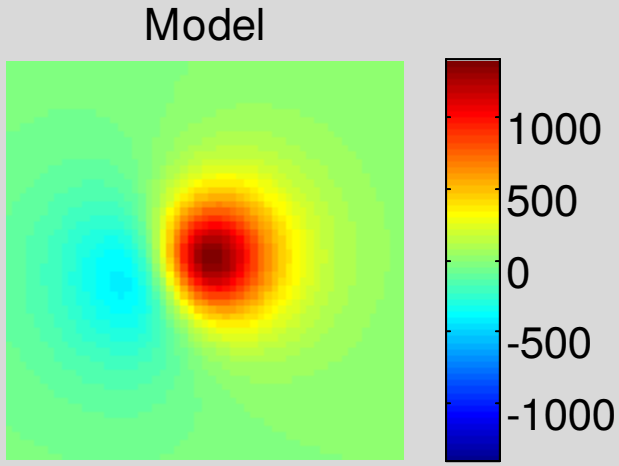
hopt = 105 x 10^{-6} (100 x 10^{-6})

resid = 1.56 x 10^{-2}



Magnetic Dipole – Multipole Model





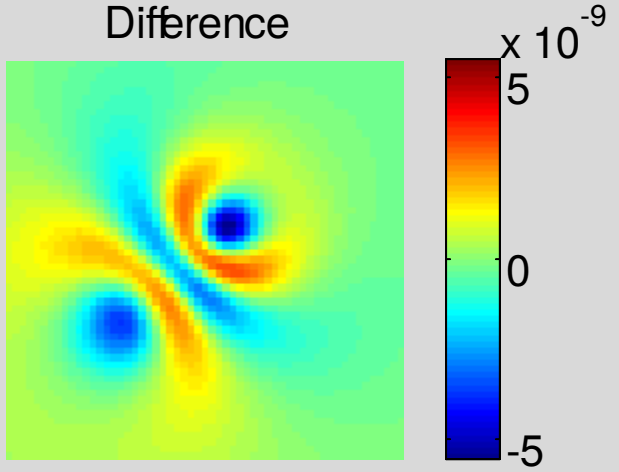
mopt = 1.000 x 10^{-11} (1.000 x 10^{-11})

iopt = 30.00 (30.00)

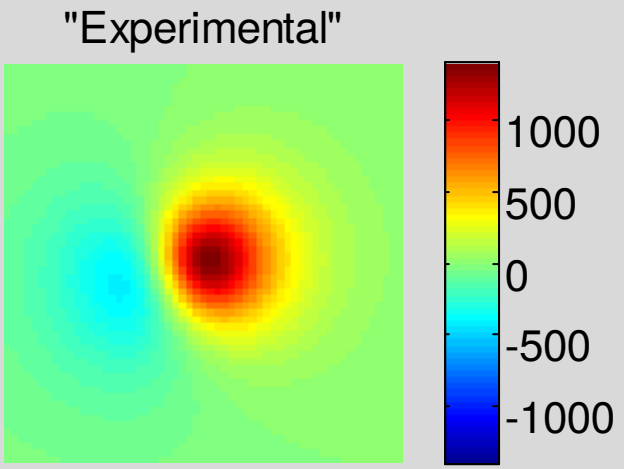
dopt = 285.00 (285.00)

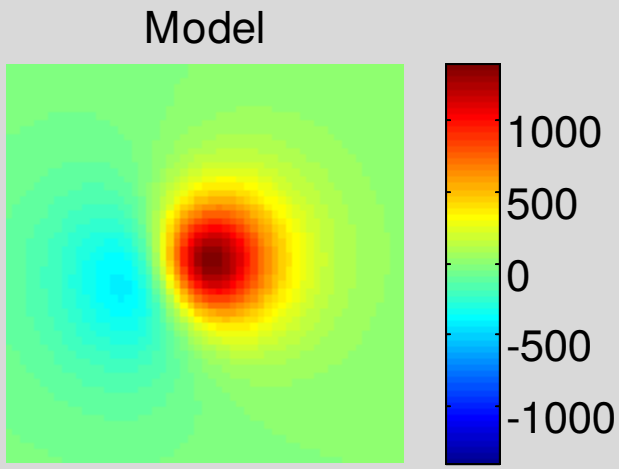
hopt = 105 x 10^{-6} (100 x 10^{-6})

resid = 3.79 x 10^{-12}



Magnetic Dipole – Dipole Model





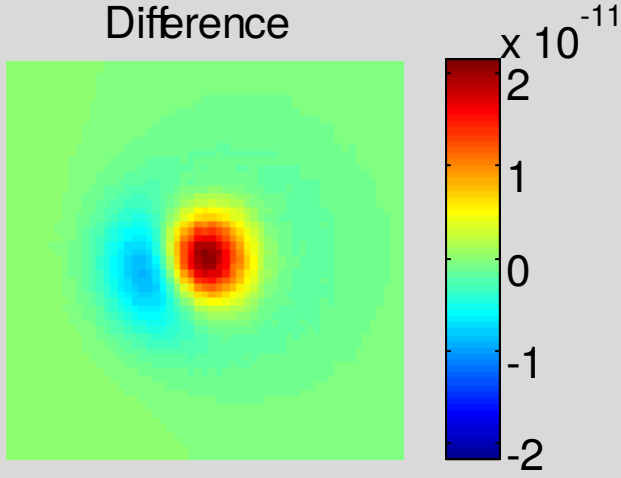
mopt = 1.000 x 10^{-11} (1.000 x 10^{-11})

iopt = 30.00 (30.00)

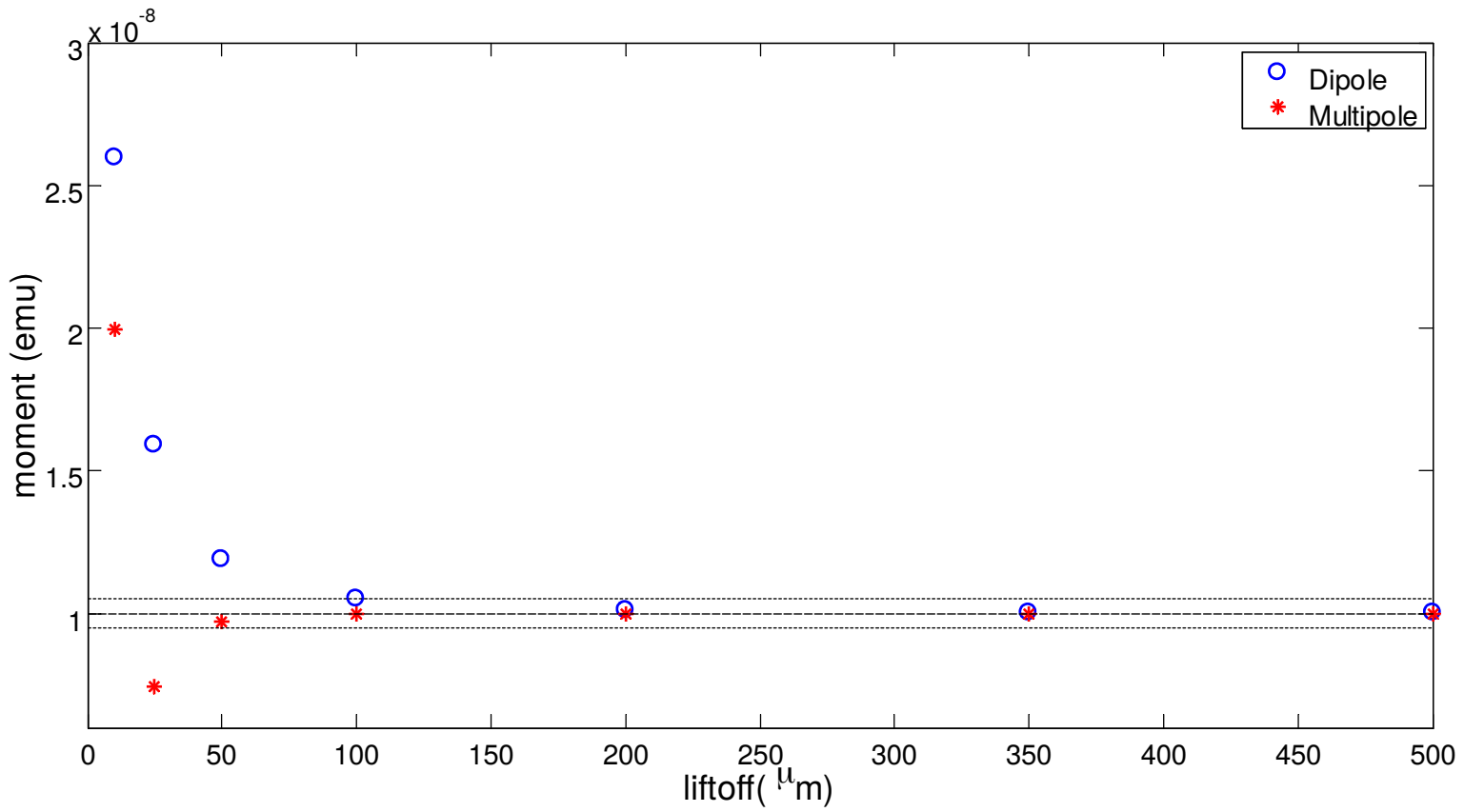
dopt = 285.00 (285.00)

hopt = 100 x 10^{-6} (100 x 10^{-6})

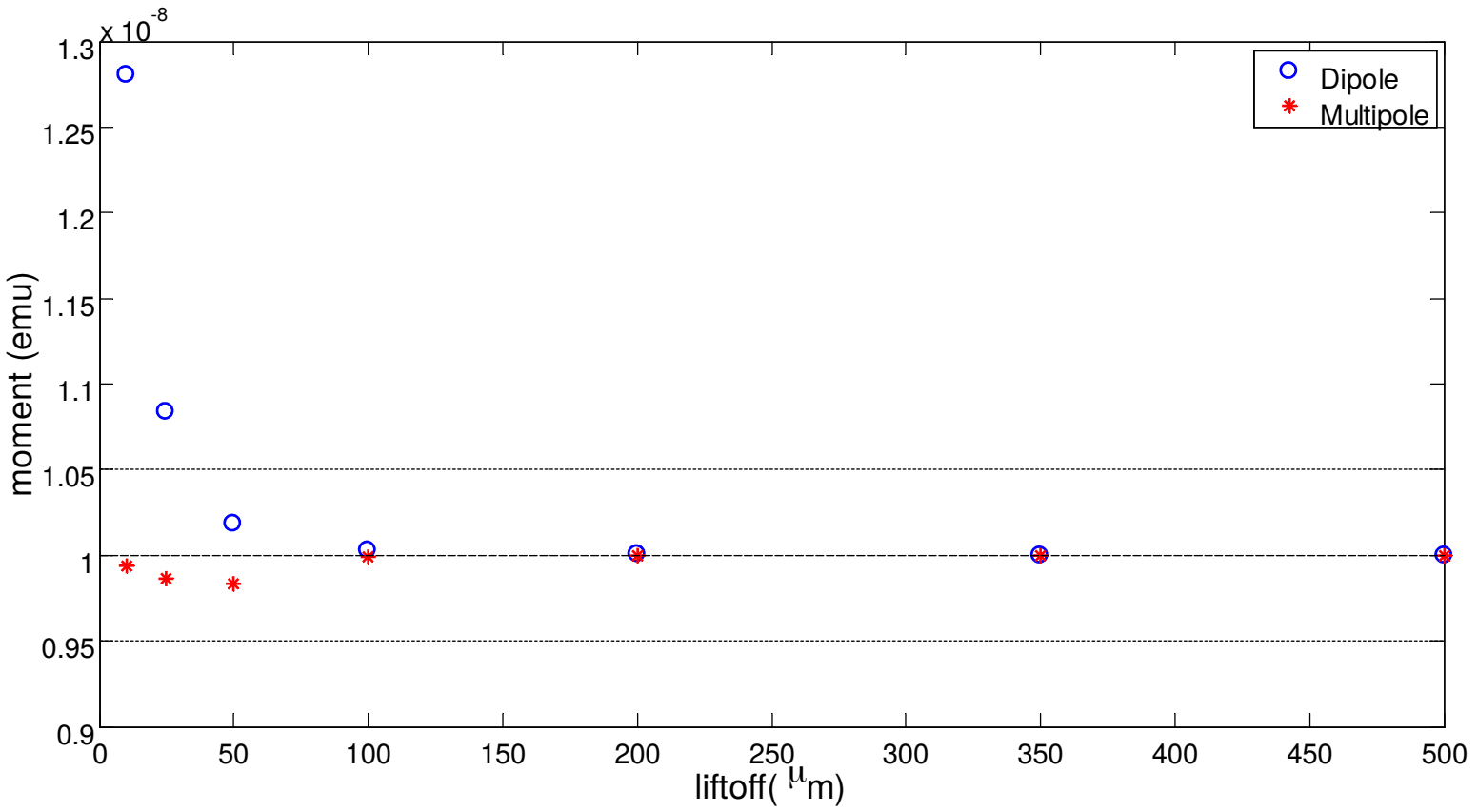
resid = 1.06 x 10^{-14}



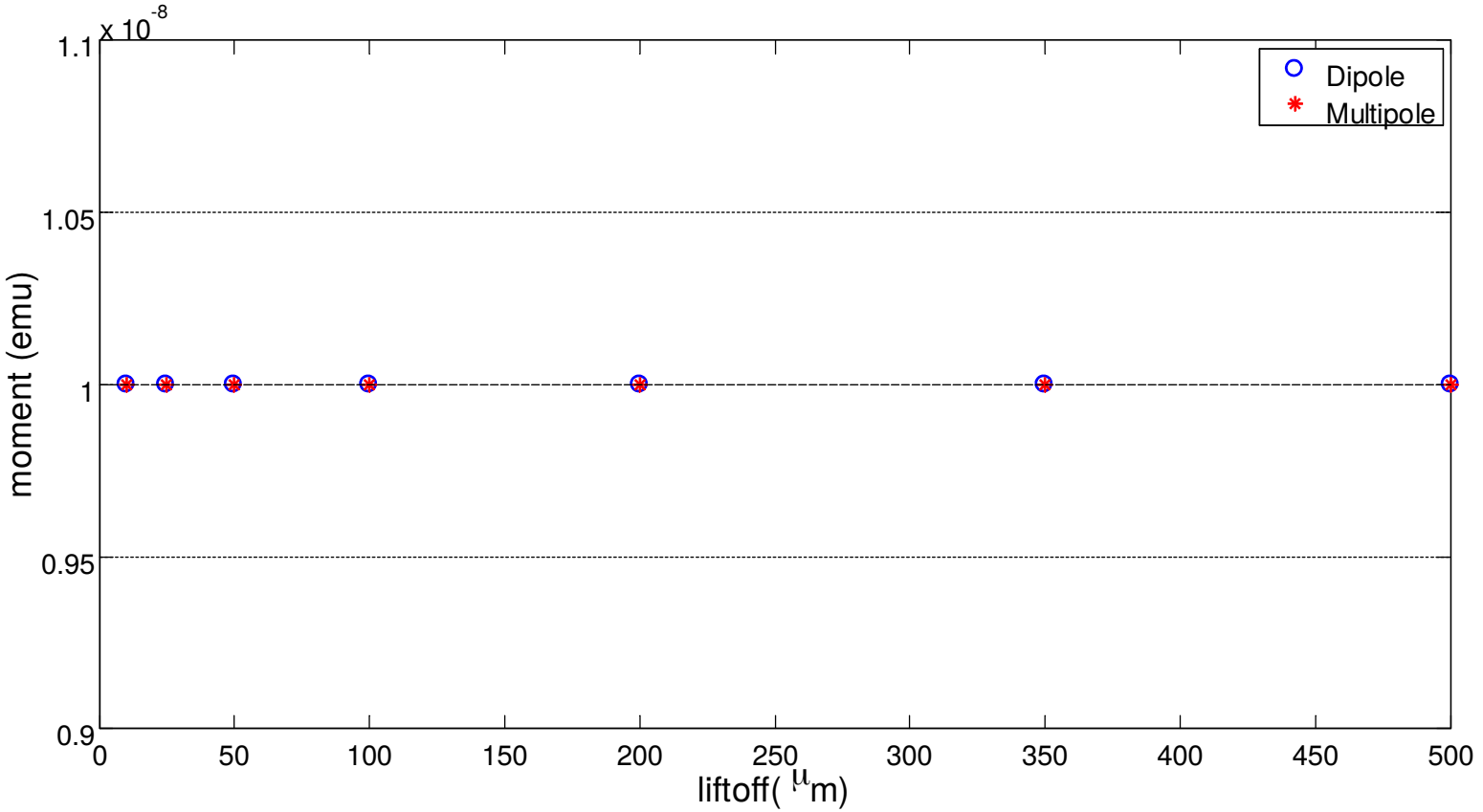
Magnetized Square (50 x 50 mm^2)



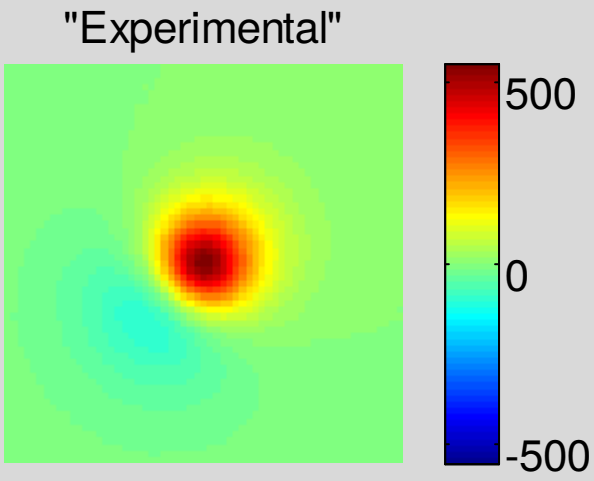
Magnetized Cube (50 x 50 x 50 mm^3)

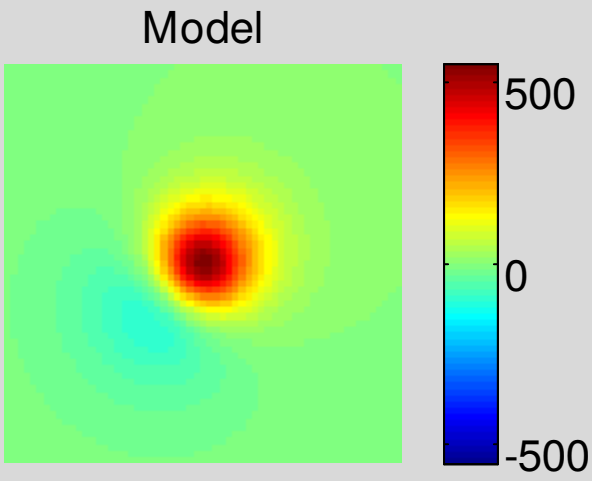


Magnetic Dipole



Lonar Spherule – Multipole Model





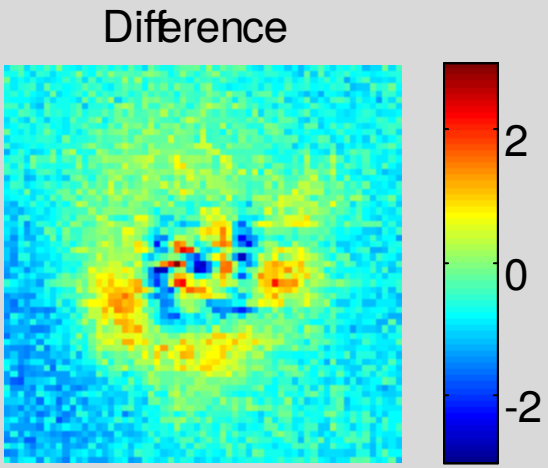
mopt = 2.018 x 10^{-9} (2.00 x 10^{-9})

iopt = 41.67 (42.6)

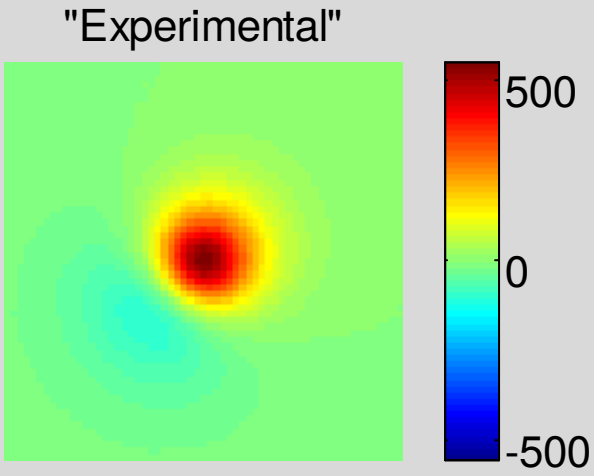
dopt = 315.4 (318.5)

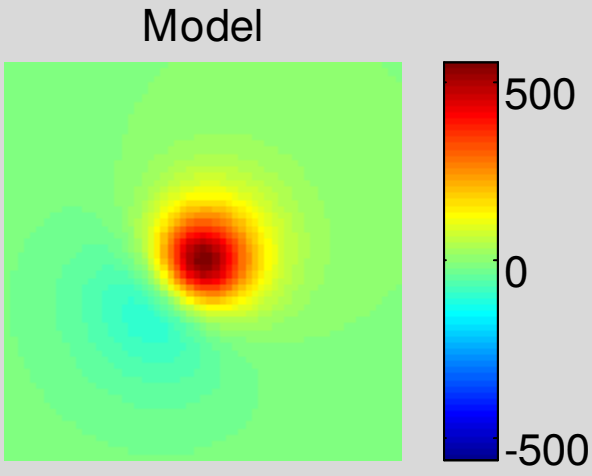
hopt = 753 x 10^{-6} (>675 x 10^{-6})

resid = 8.91 x 10^{-3}



Lonar Spherule – Dipole Model





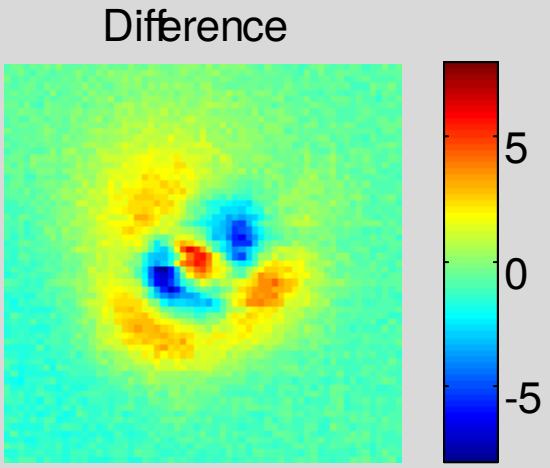
mopt = 2.054 x 10^{-9} (2.00 x 10^{-9})

iopt = 41.75 (42.6)

dopt = 316.33 (318.5)

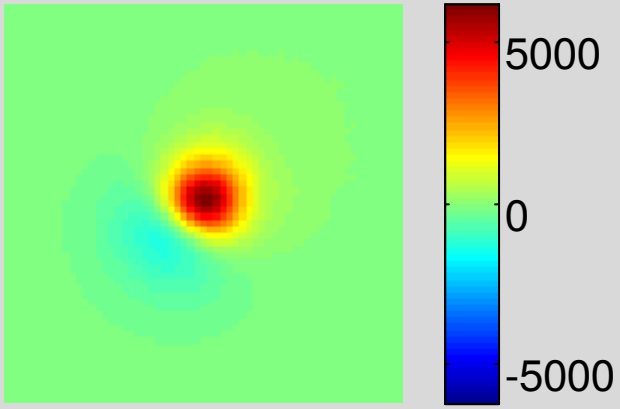
hopt = 835 x 10^{-6} (>675 x 10^{-6})

resid = 15.16 x 10^{-3}

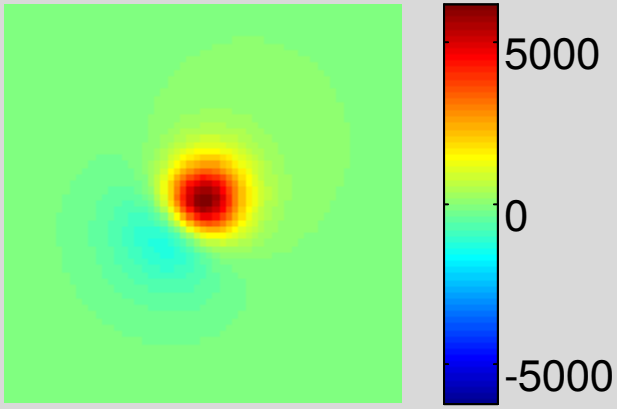


Lonar Spherule – Multipole Model

"Experimental"



Model



mopt = 2.517 x 10^{-9} (2.00 x 10^{-9})

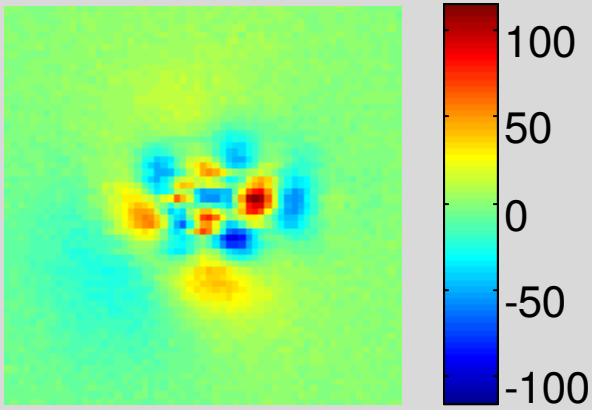
iopt = 39.11 (42.6)

dopt = 316.4 (318.5)

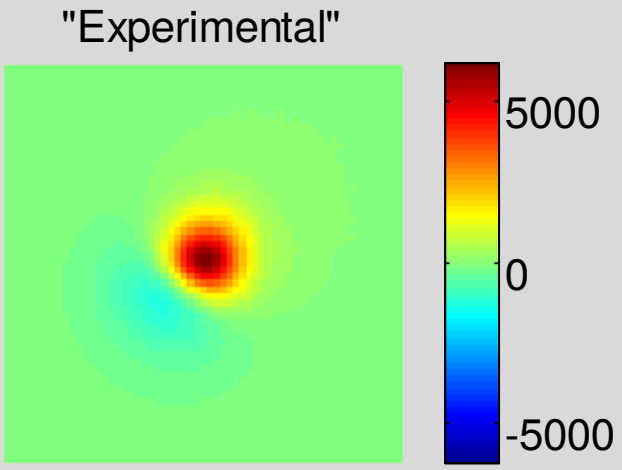
hopt = 427 x 10^{-6} (>200 x 10^{-6})

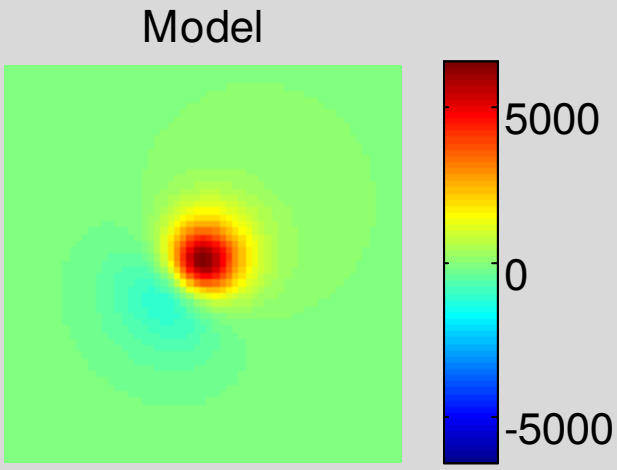
resid = 20.21 x 10^{-3}

Difference



Lonar Spherule – Dipole Model





mopt = 2.829 x 10^{-9} (2.00 x 10^{-9})

iopt = 41.50 (42.6)

dopt = 317.39 (318.5)

hopt = 410 x 10^{-6} (>200 x 10^{-6})

resid = 48.35 x 10^{-3}