Preliminary SQUID Gradiometer Placement and Expected Signal

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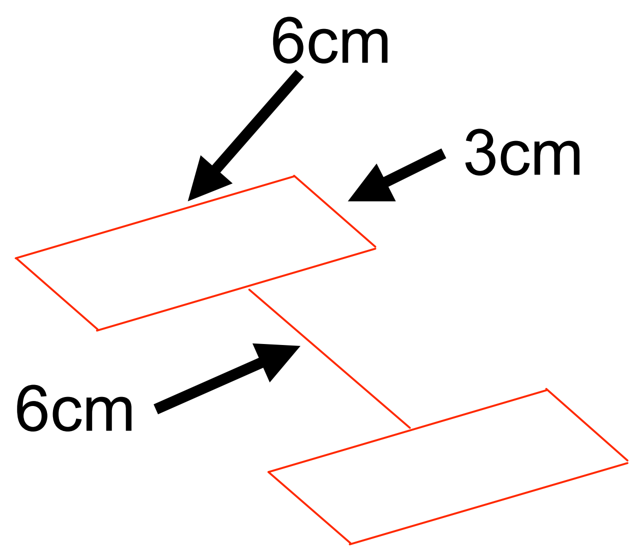
Purpose of model calculations

- Determine expected signal
  - Strength
  - Geometrical sensitivity
- Imaging 3He distribution
- Imaging 3He fill

“BigBoy” SQUID gradiometer:



Calculations

flux density from ^{3}He within pickup loop

flux through pickup loop "P": $\Phi = \oint_P B_{3He} dS$

number of ^{3}He at position "i"

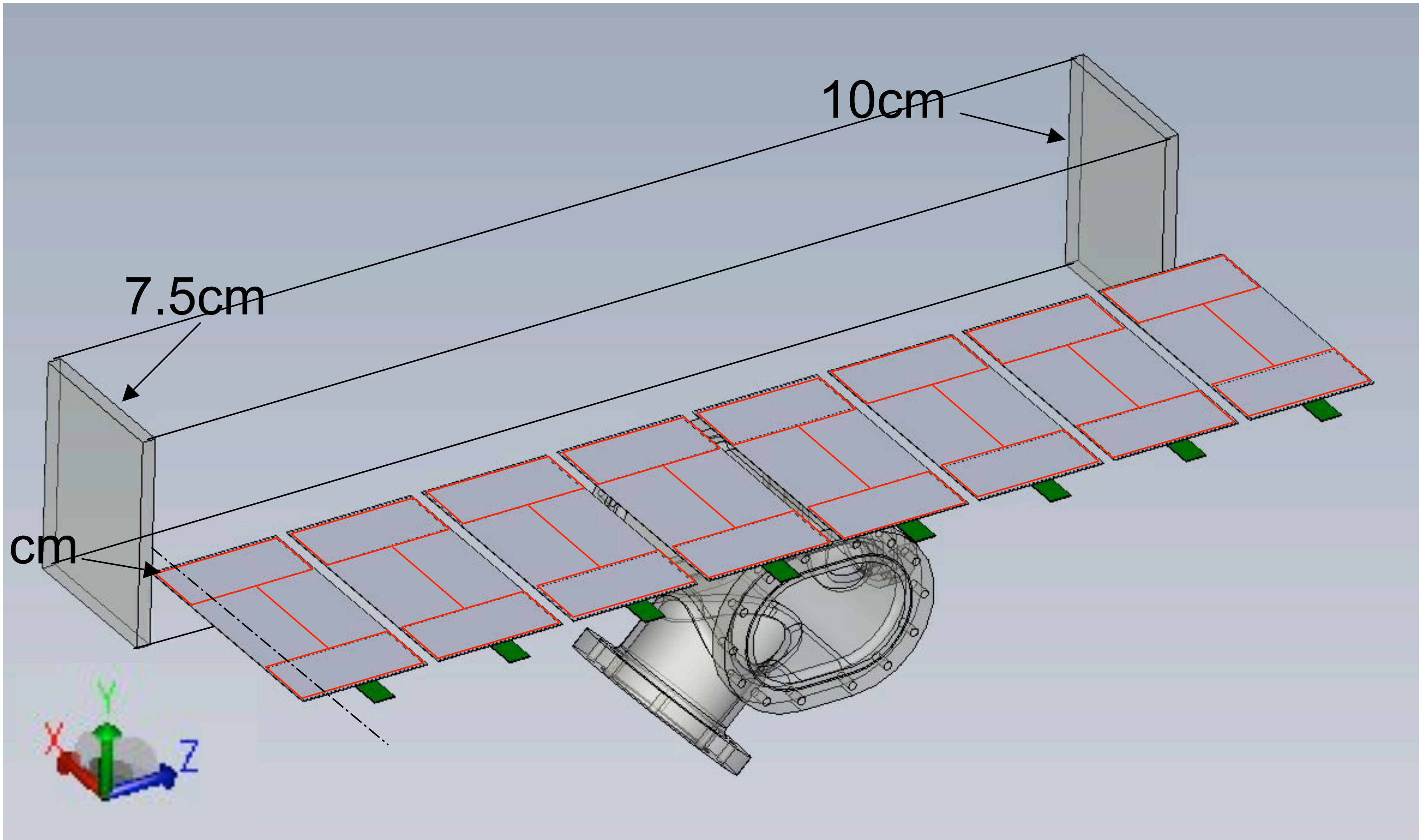
change in pickup loop flux from spin flip of ^{3}He at position "i"

$$\delta\Phi_i = 2\mu N_i \left(\frac{B_i}{I}\right)_P$$

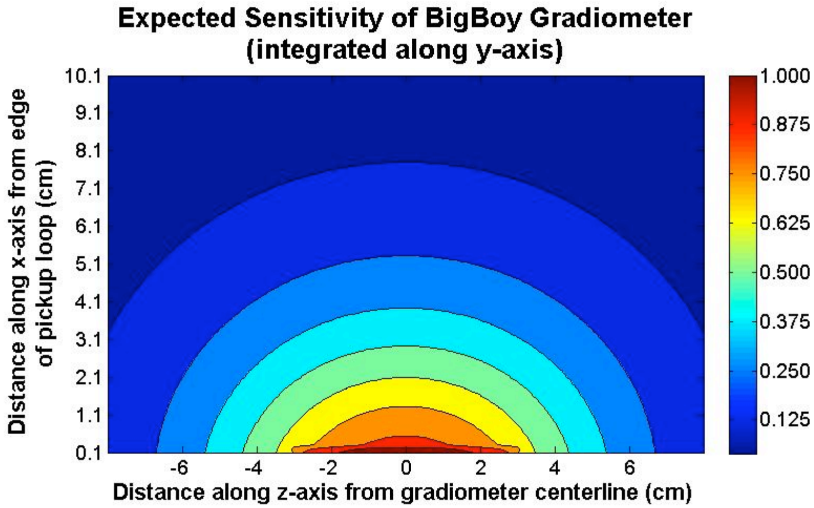
flux density per unit current at position "i" from pickup loop

$$\Phi = 2\mu(n\Delta V)\sum_i \left(\frac{B_i}{I}\right)_P$$

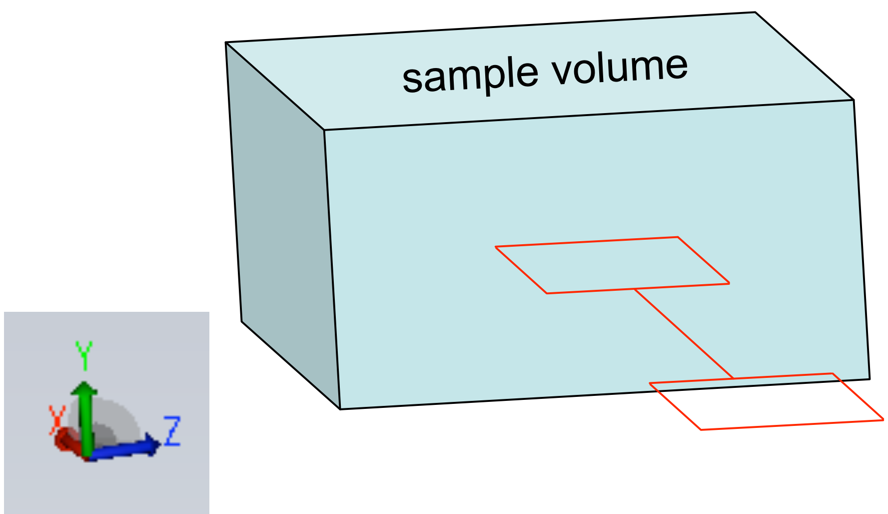
Current design geometry

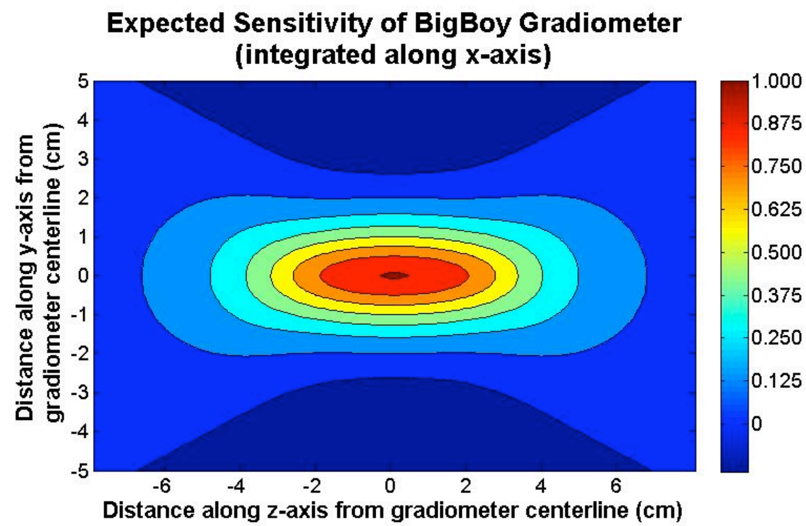


Single SQUID gradiometer

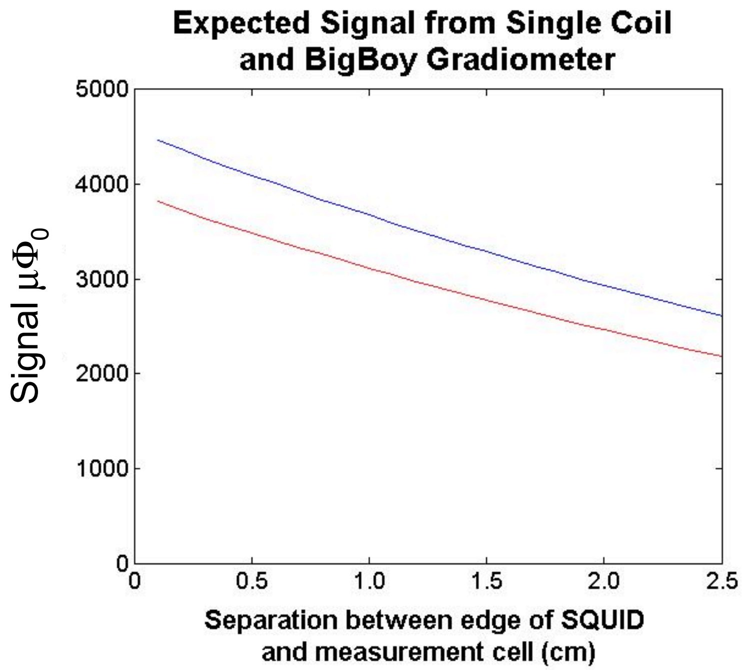


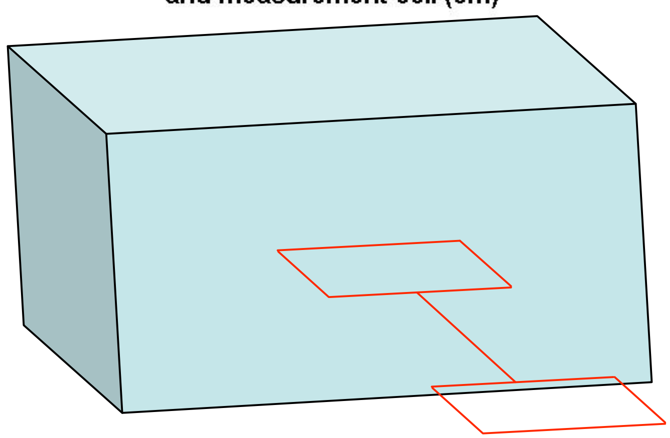
- 50% of signal from ^{3}He within 2-3 cm of edge of cell
- Assumed SQUID edge 1 cm from edge of cell





Expected total flux

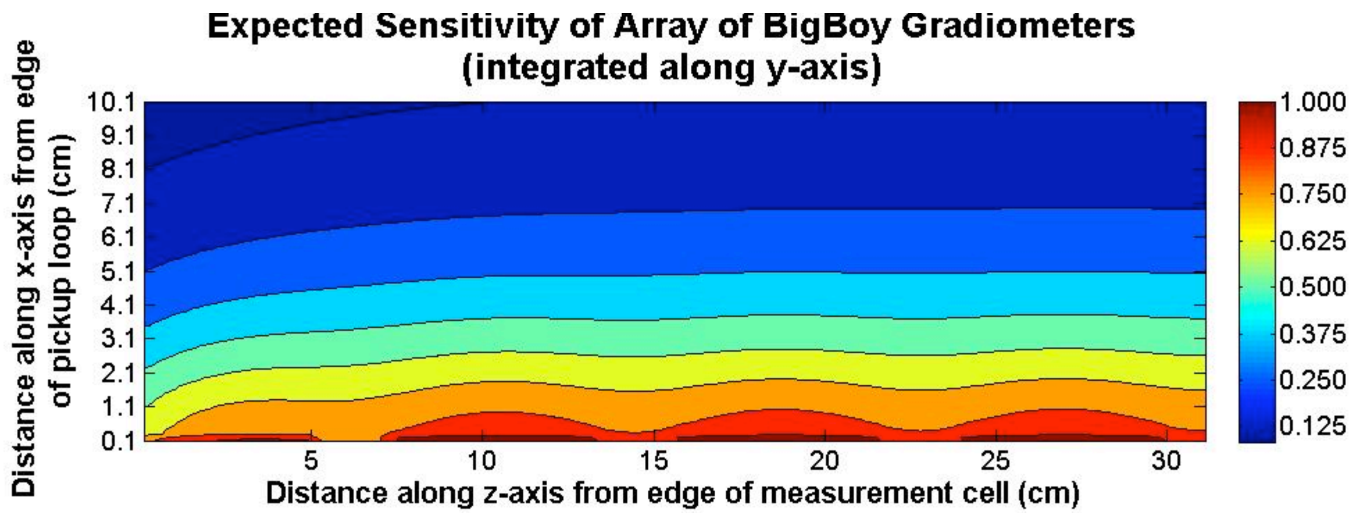


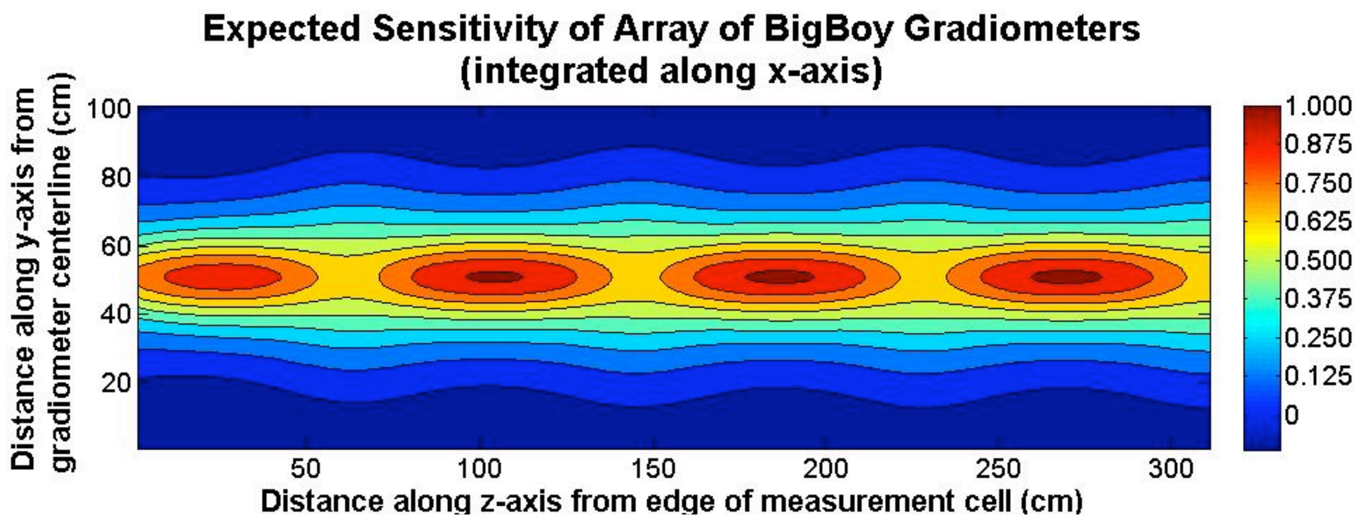


- Flux at SQUID reduced by ~100 from small mutual inductance
- Expected noise of 1.5 $\mu\Phi$ /sqrt(Hz) from previous LANL work and increased temp.
- δf_3 = 3 μHz (required is 26 μHz)

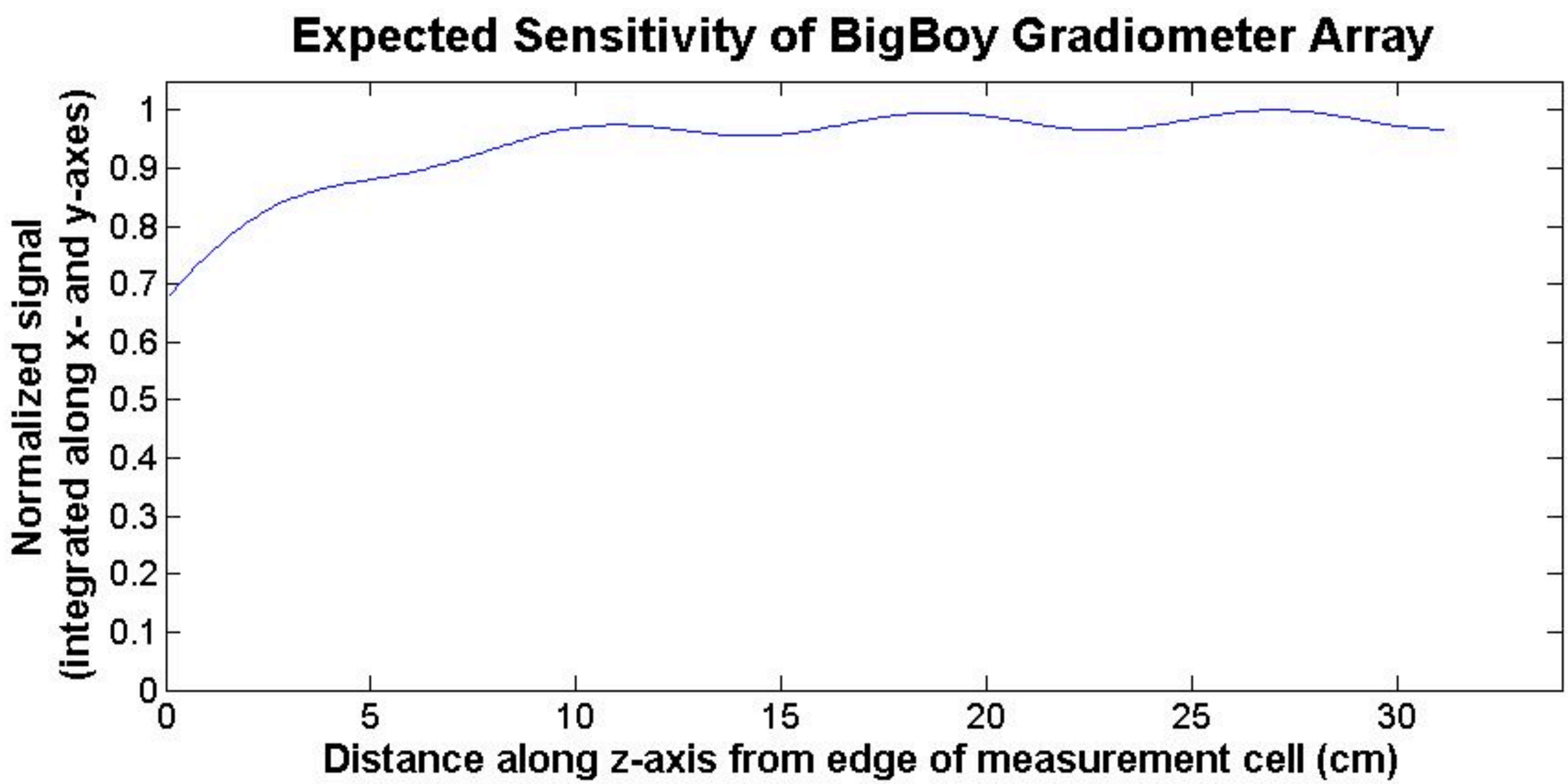
$$\Phi_{SQUID} = \Phi_{grad}\left(\frac{L_M}{L_{grad} + L_{input}}\right)$$

Array of SQUID gradiometers





Signal uniformity



Signal uniformity