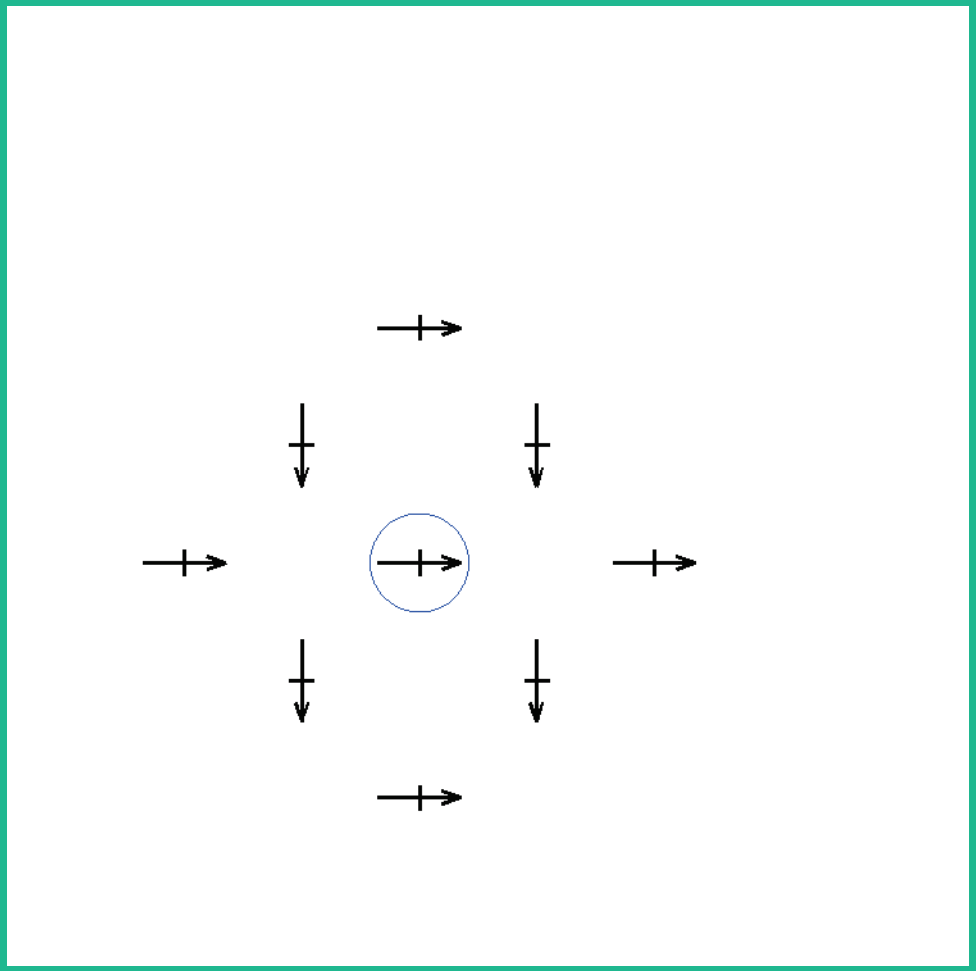
Finite-difference staggered-grid modelling in 3 dimensions

Peter Manning

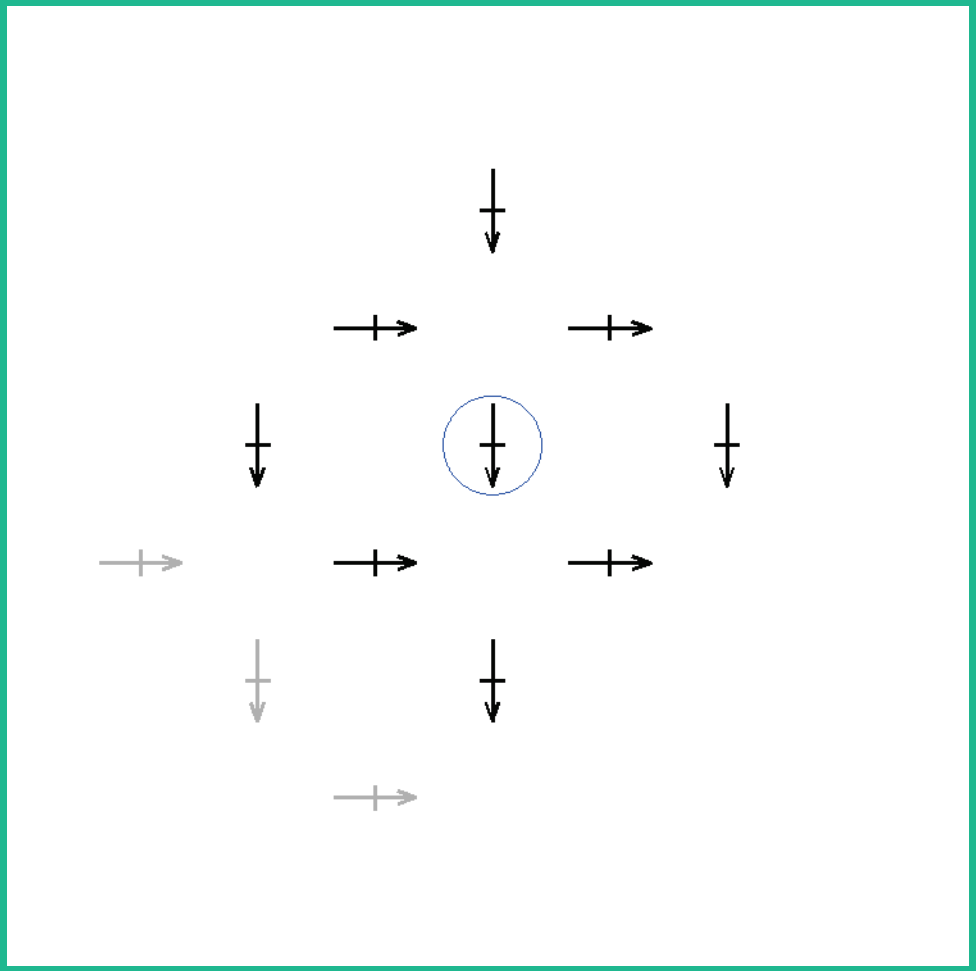
- Introduction
- Display of the staggered grid in 3D
- Energy sources
- Wavefront character from sources
- Theory/model comparison of double-couple
- Conclusions
- Acknowledgements

CREWES

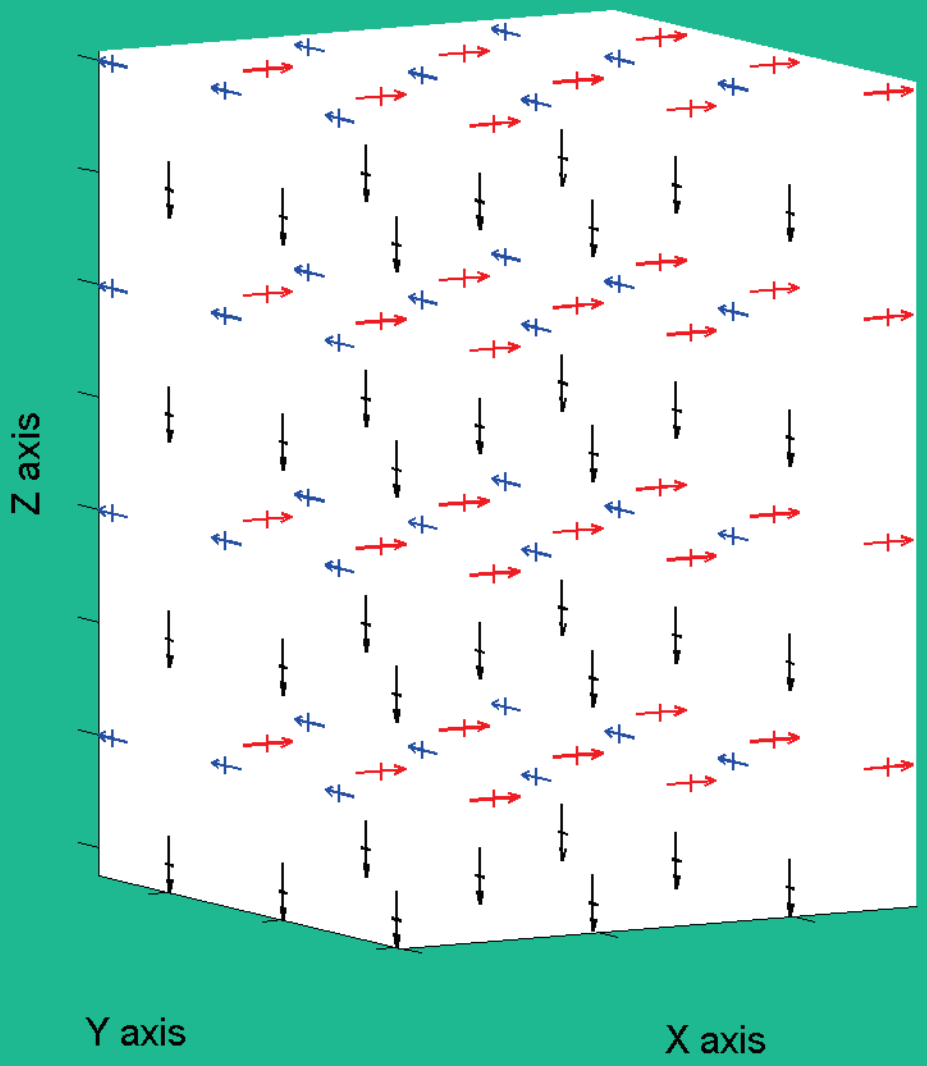
The 2D displacement points contributing to a second derivative calculation at the centre



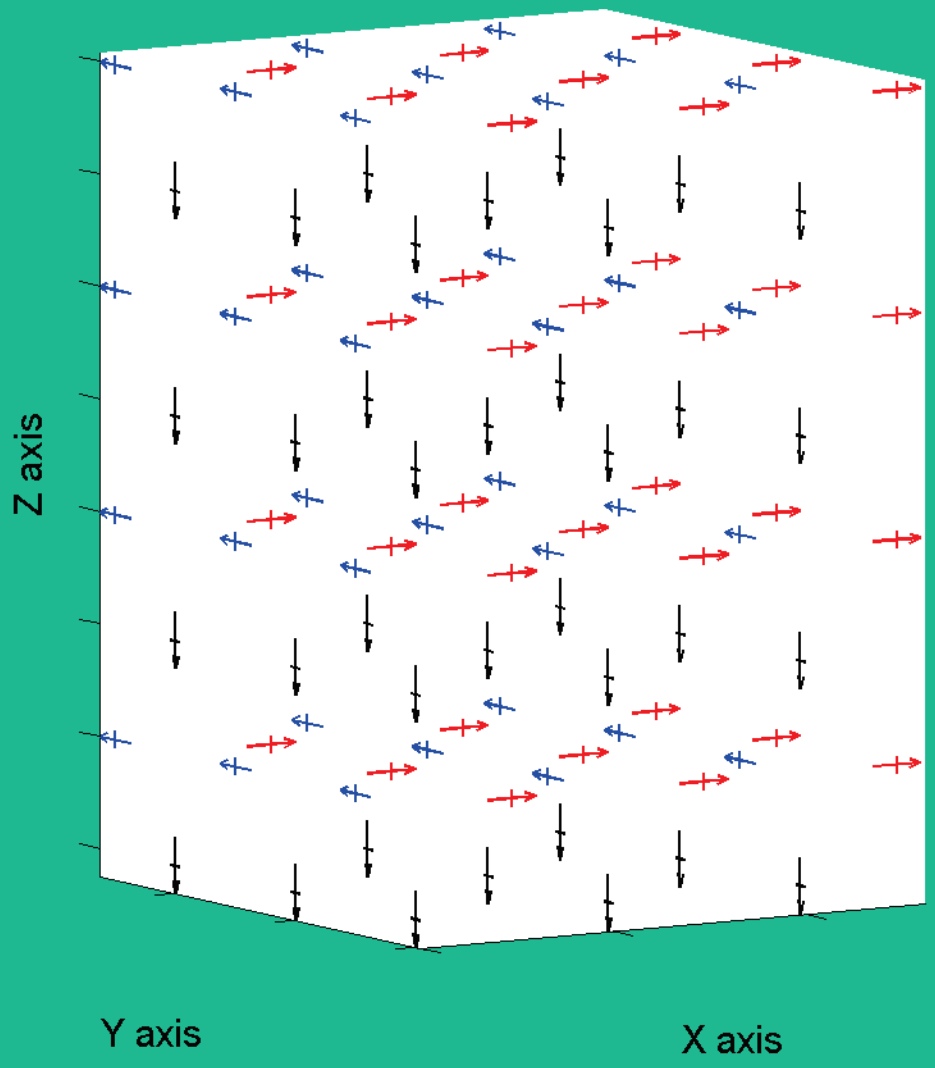
The 2D displacement points contributing to a second derivative calculation at the centre



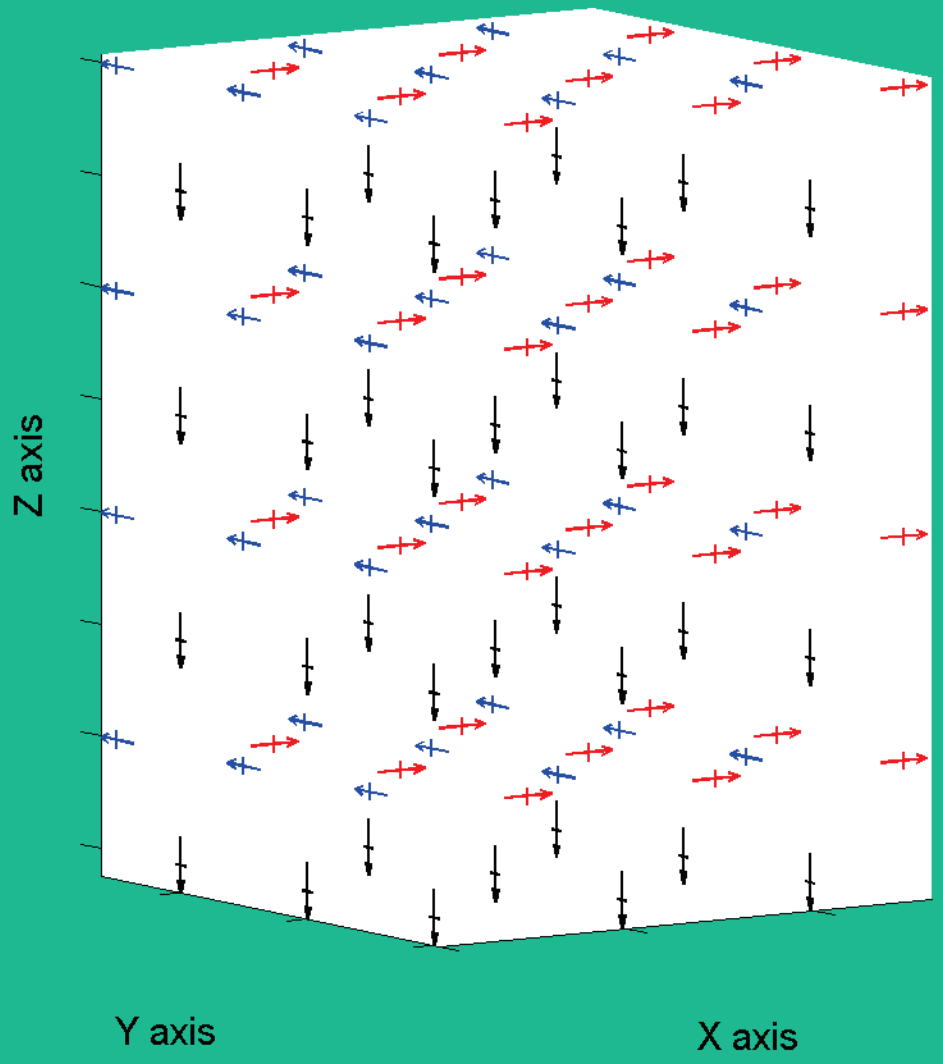
3D staggered grid 30/8



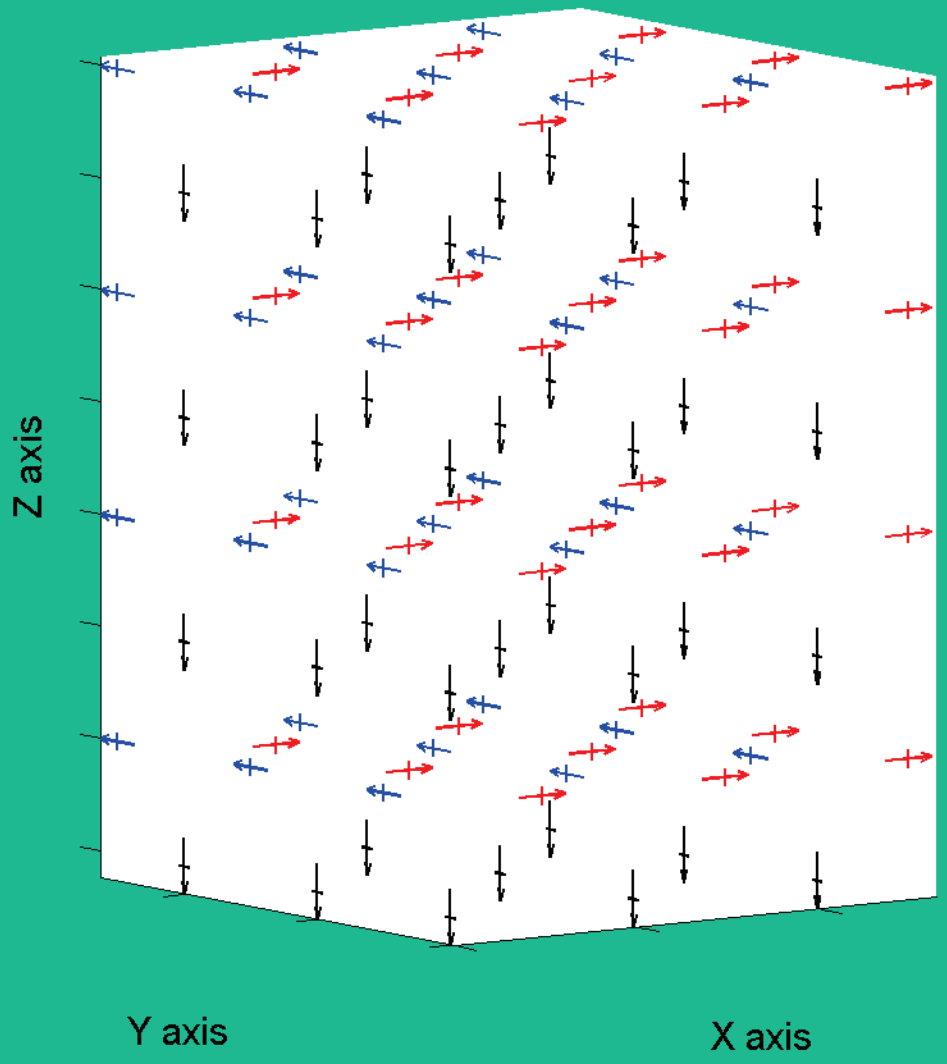
3D staggered grid 32/8



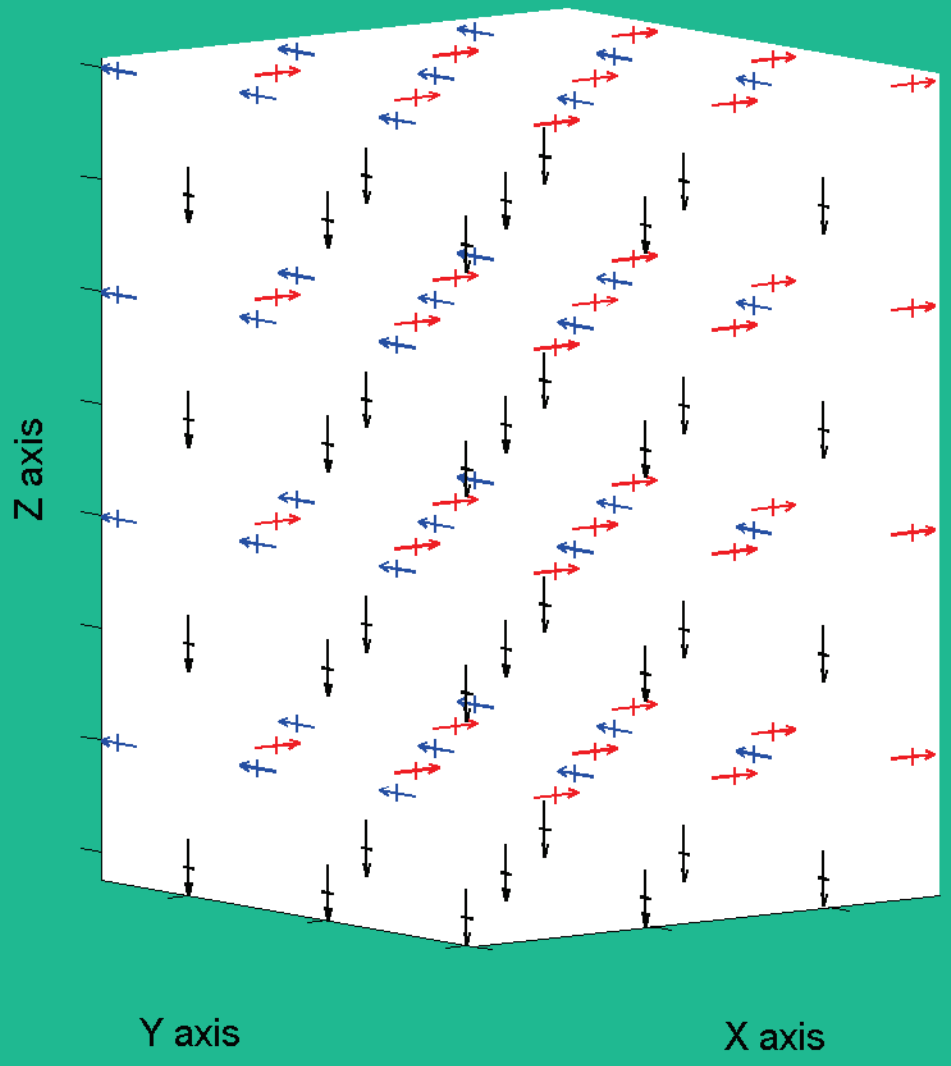
3D staggered grid 34/8



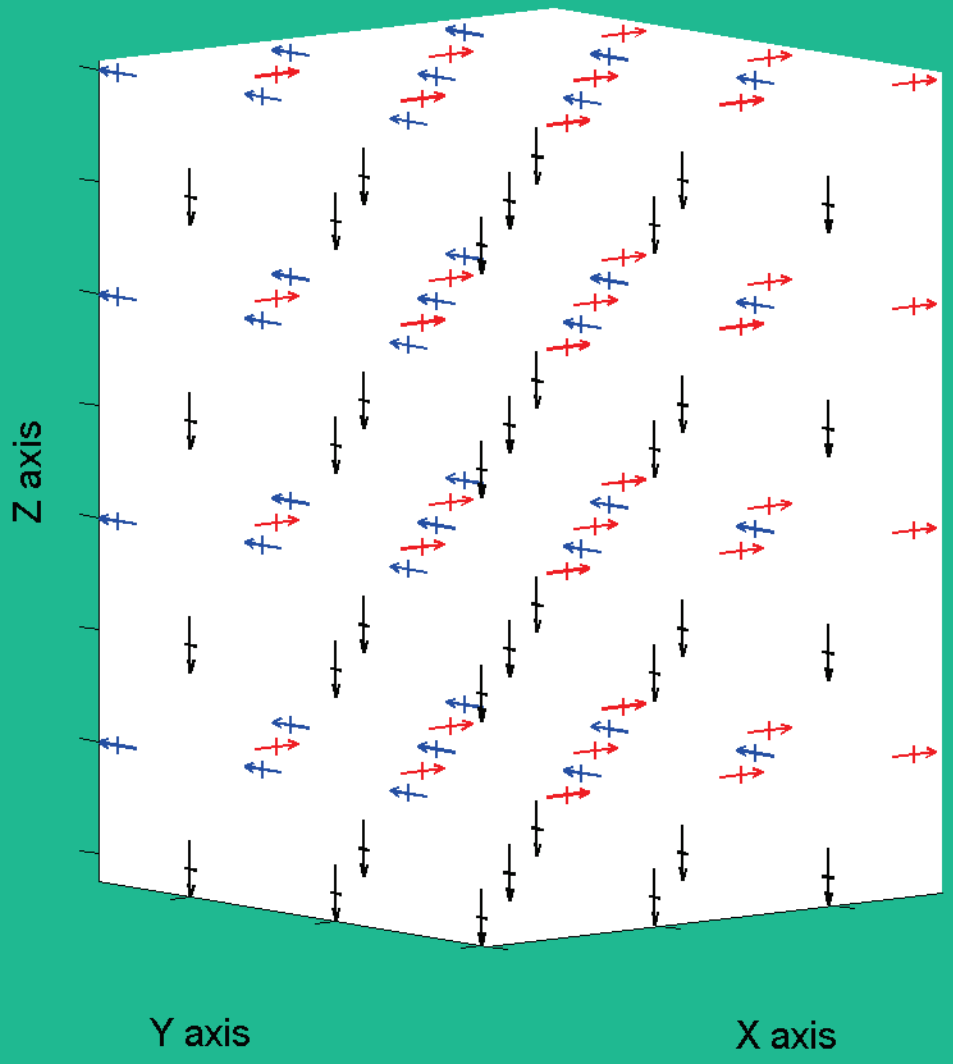
3D staggered grid 36/8



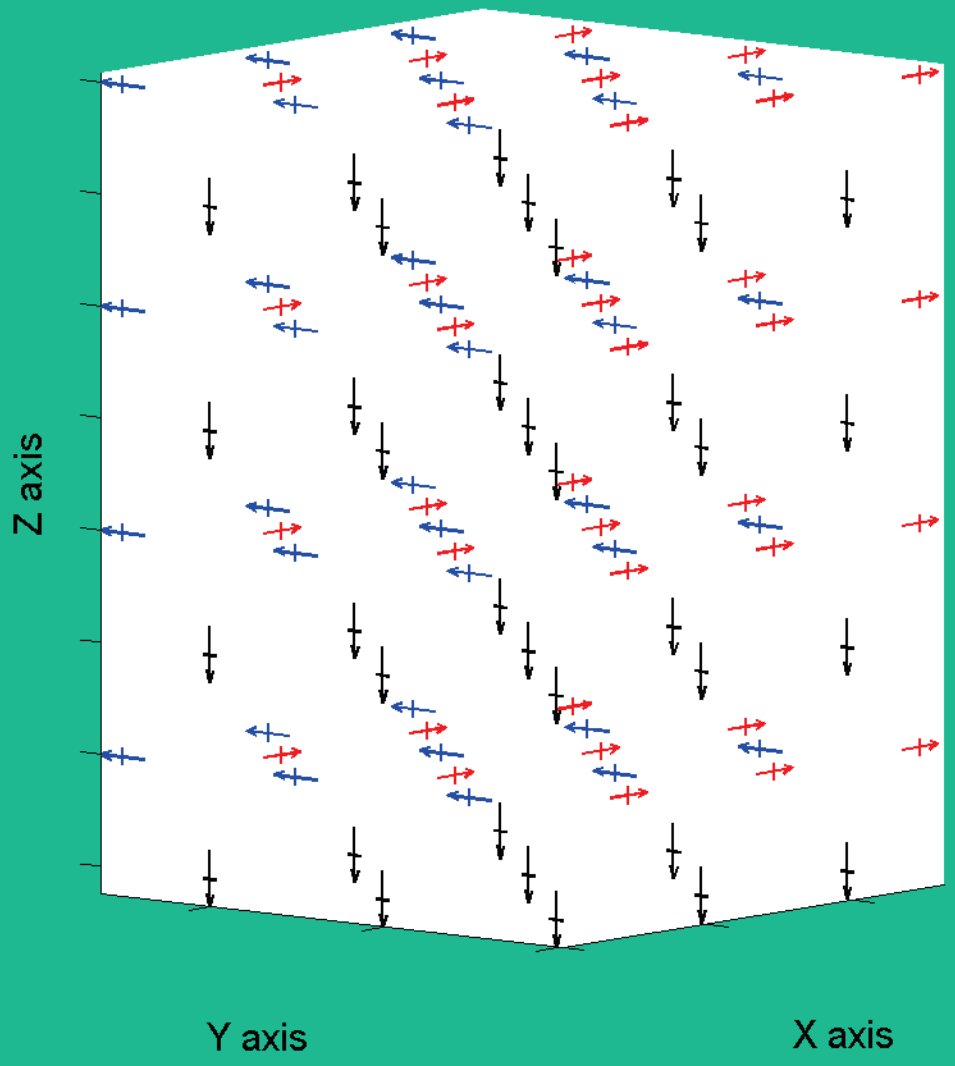
3D staggered grid 38/8



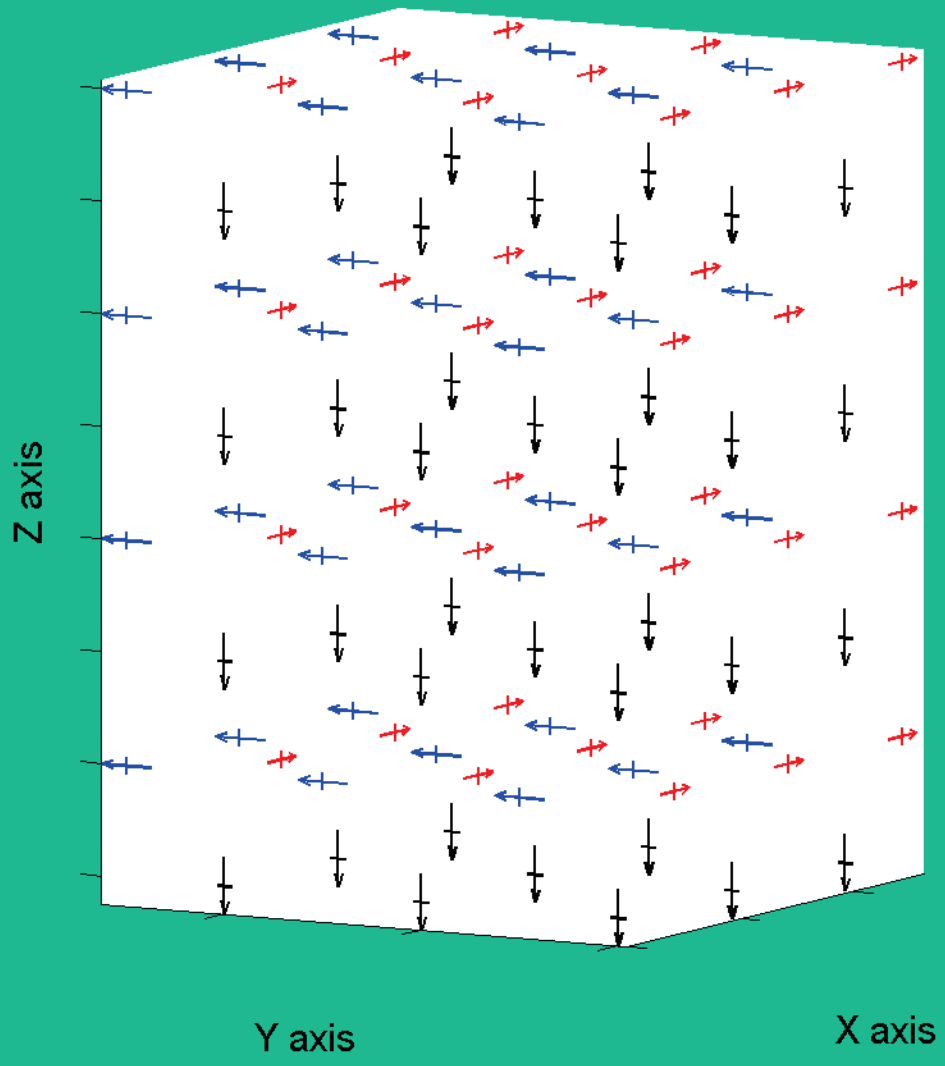
3D staggered grid 40/8



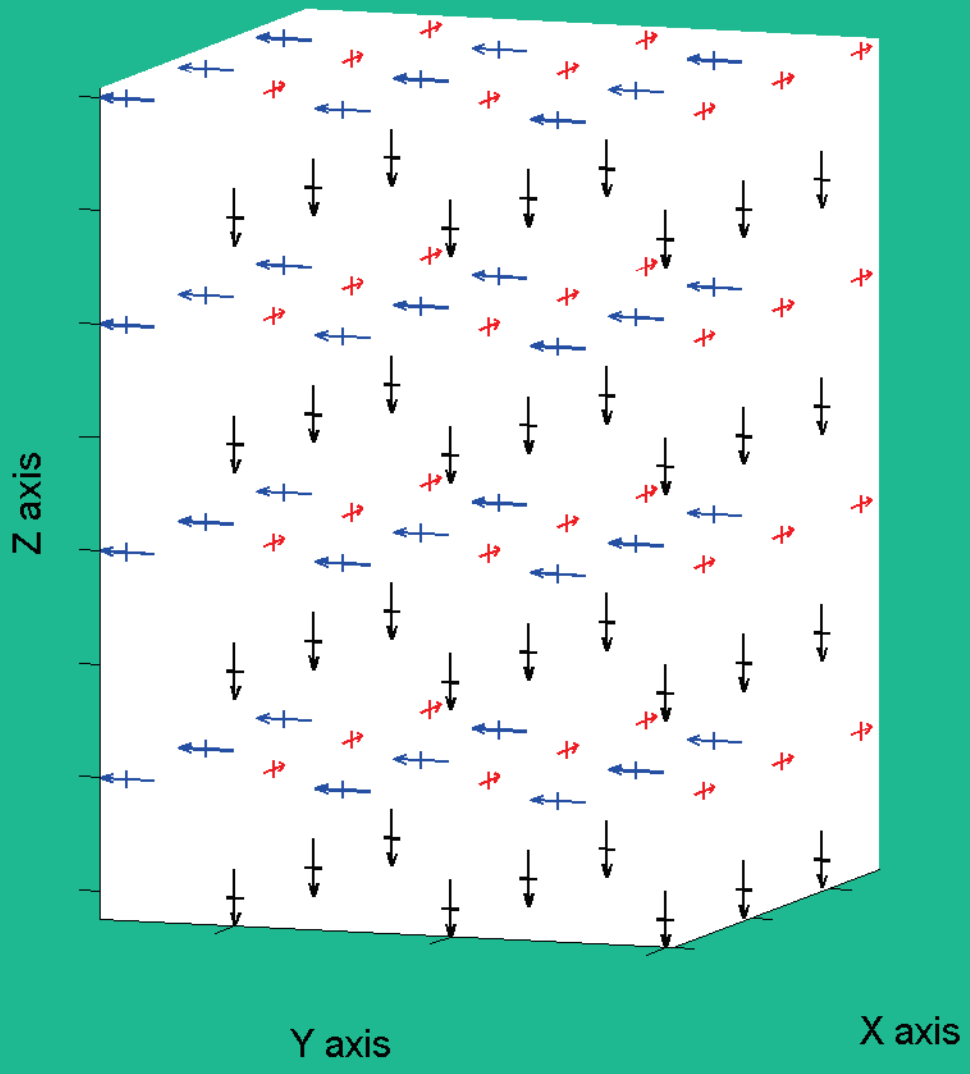
3D staggered grid 50/8



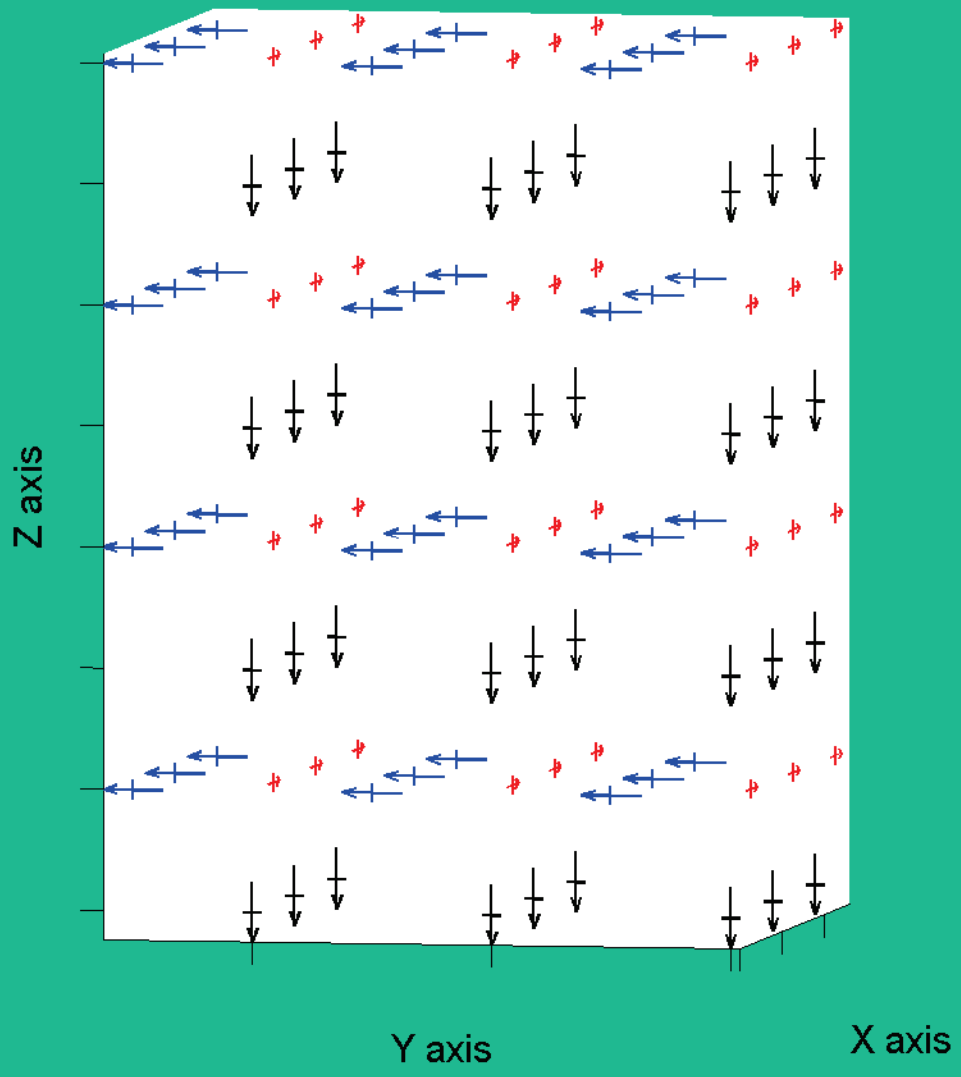
3D staggered grid 60/8



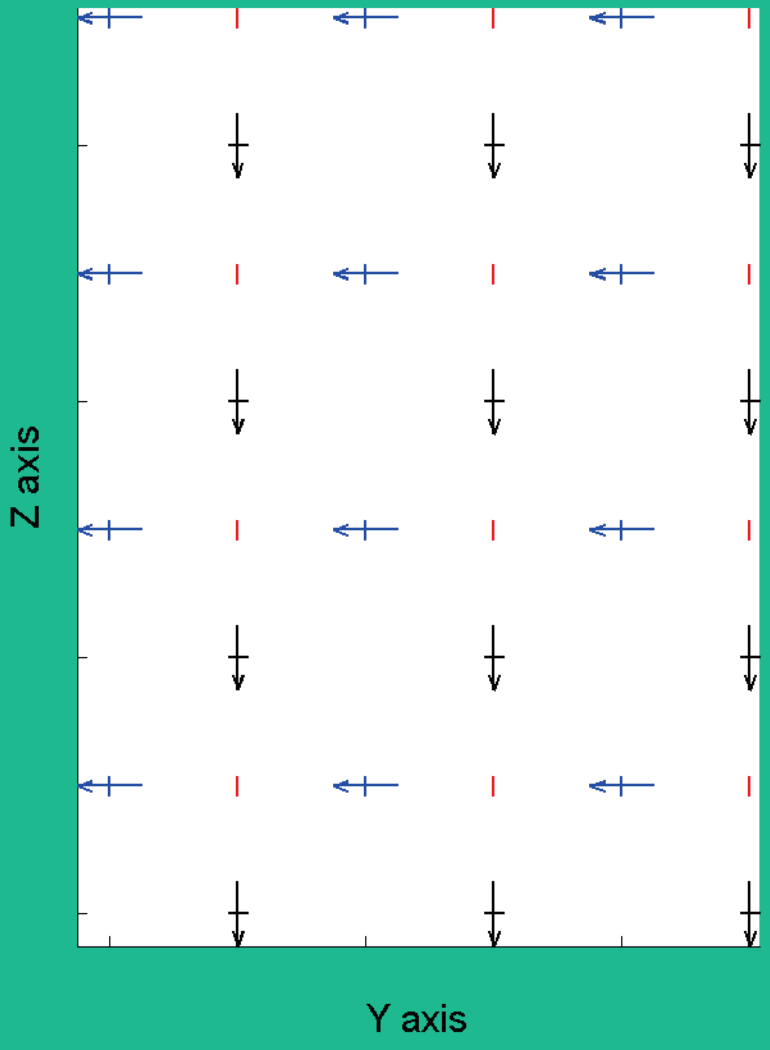
3D staggered grid 70/8



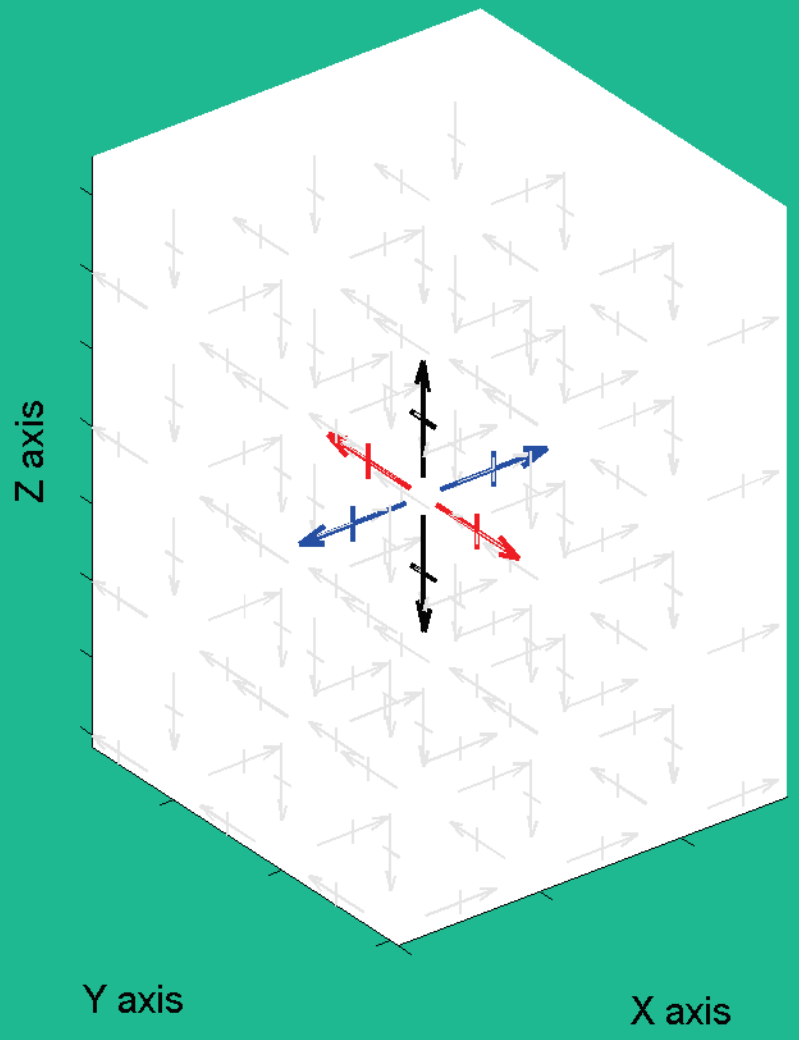
3D staggered grid 80/4



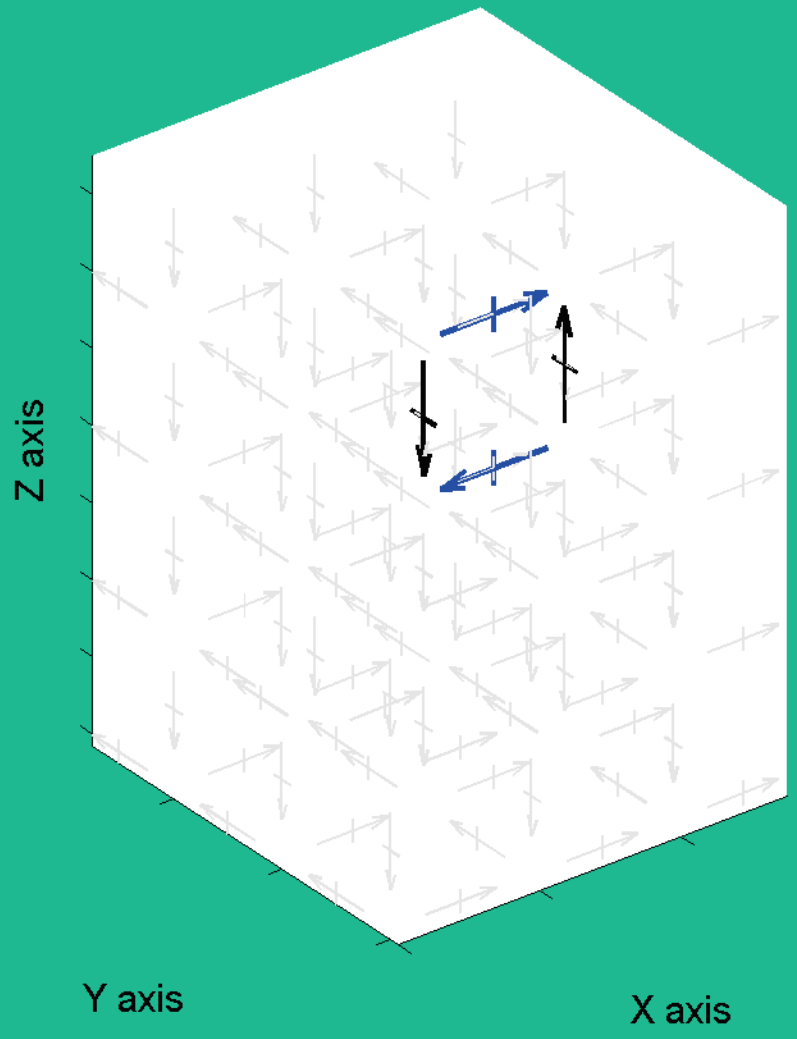
3D staggered grid 90/0



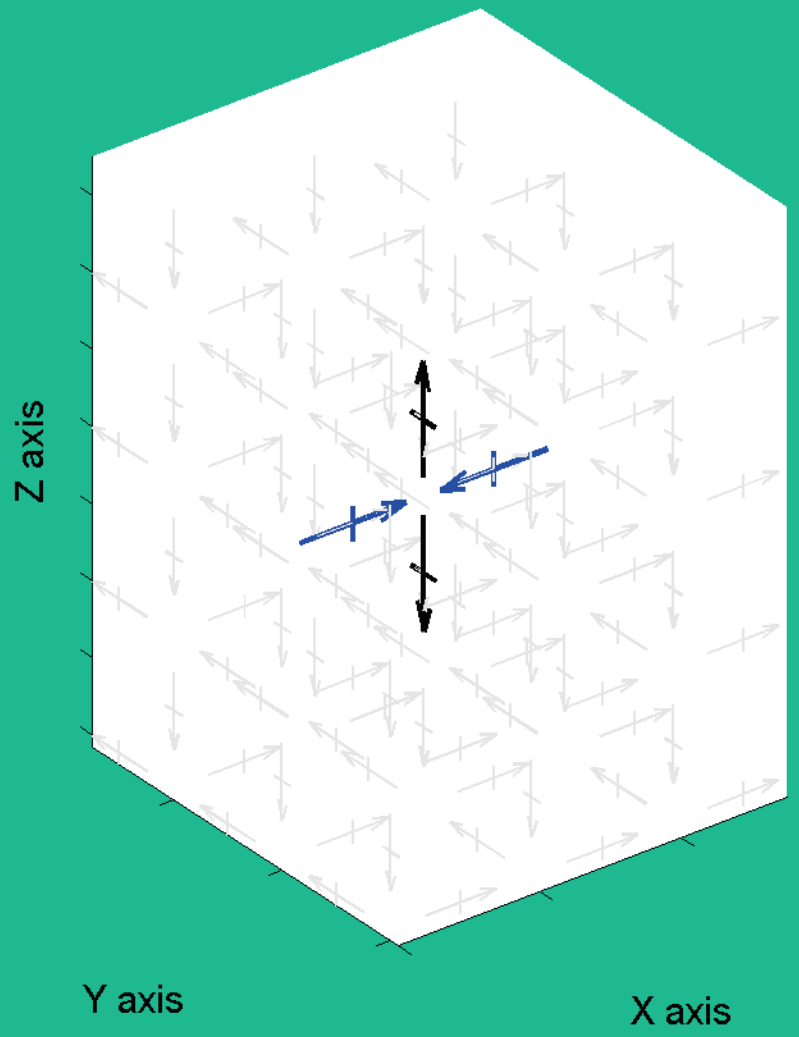
The explosive source



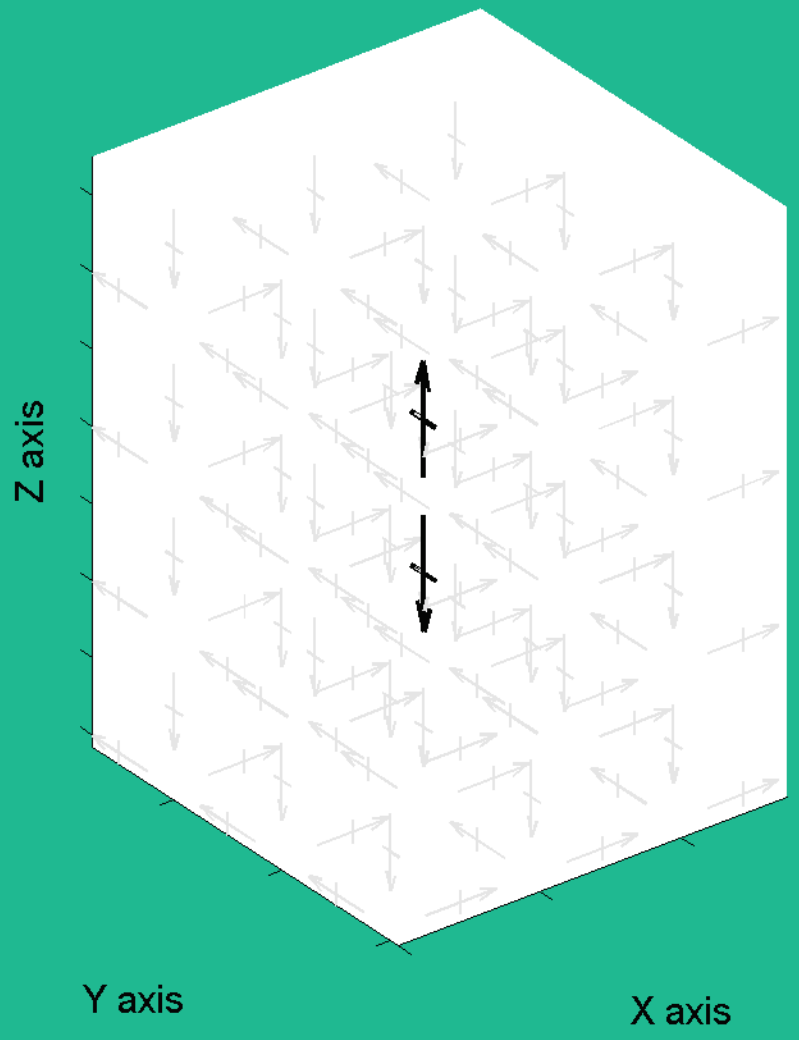
The double couple source



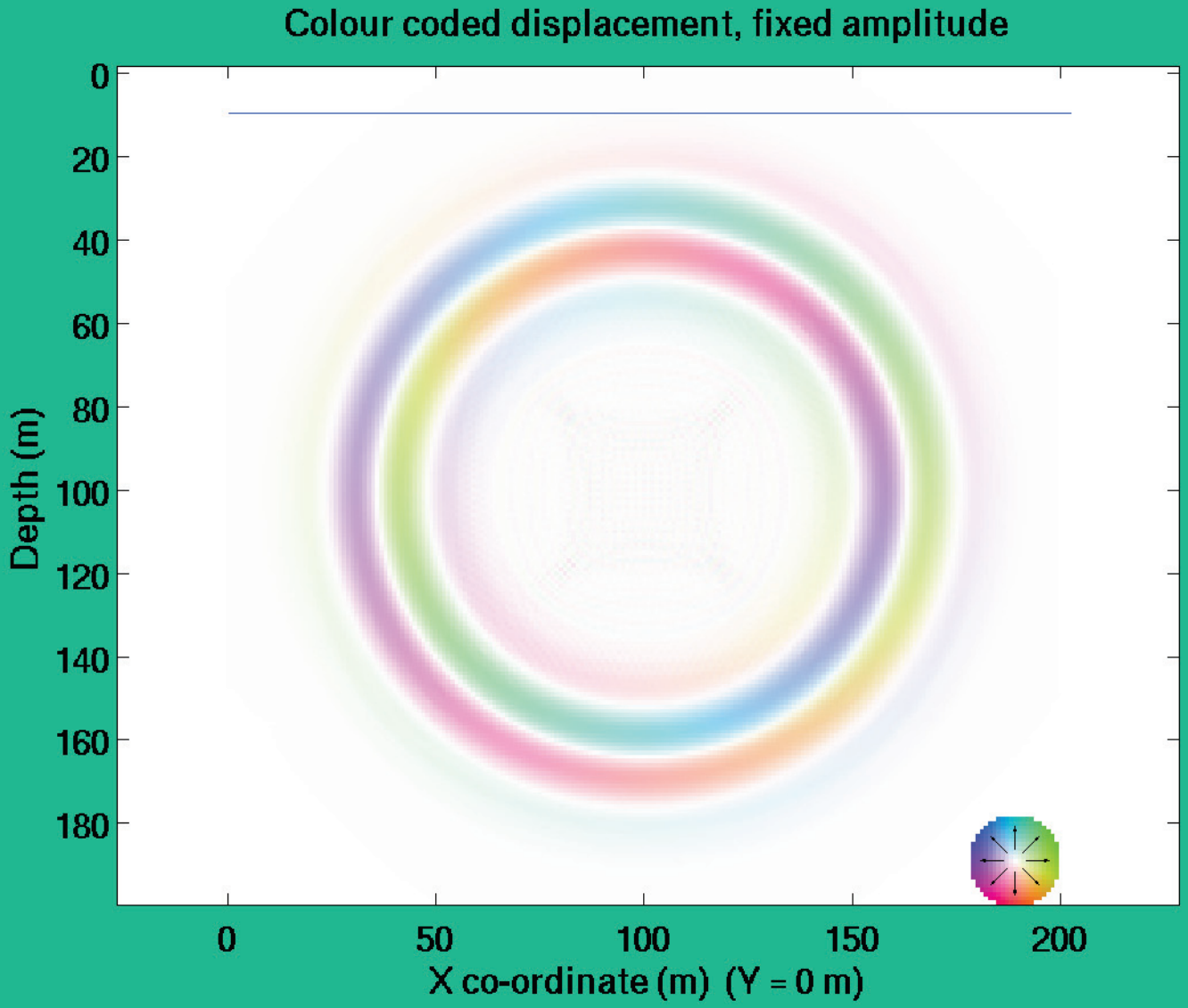
The squeeze-bulge source



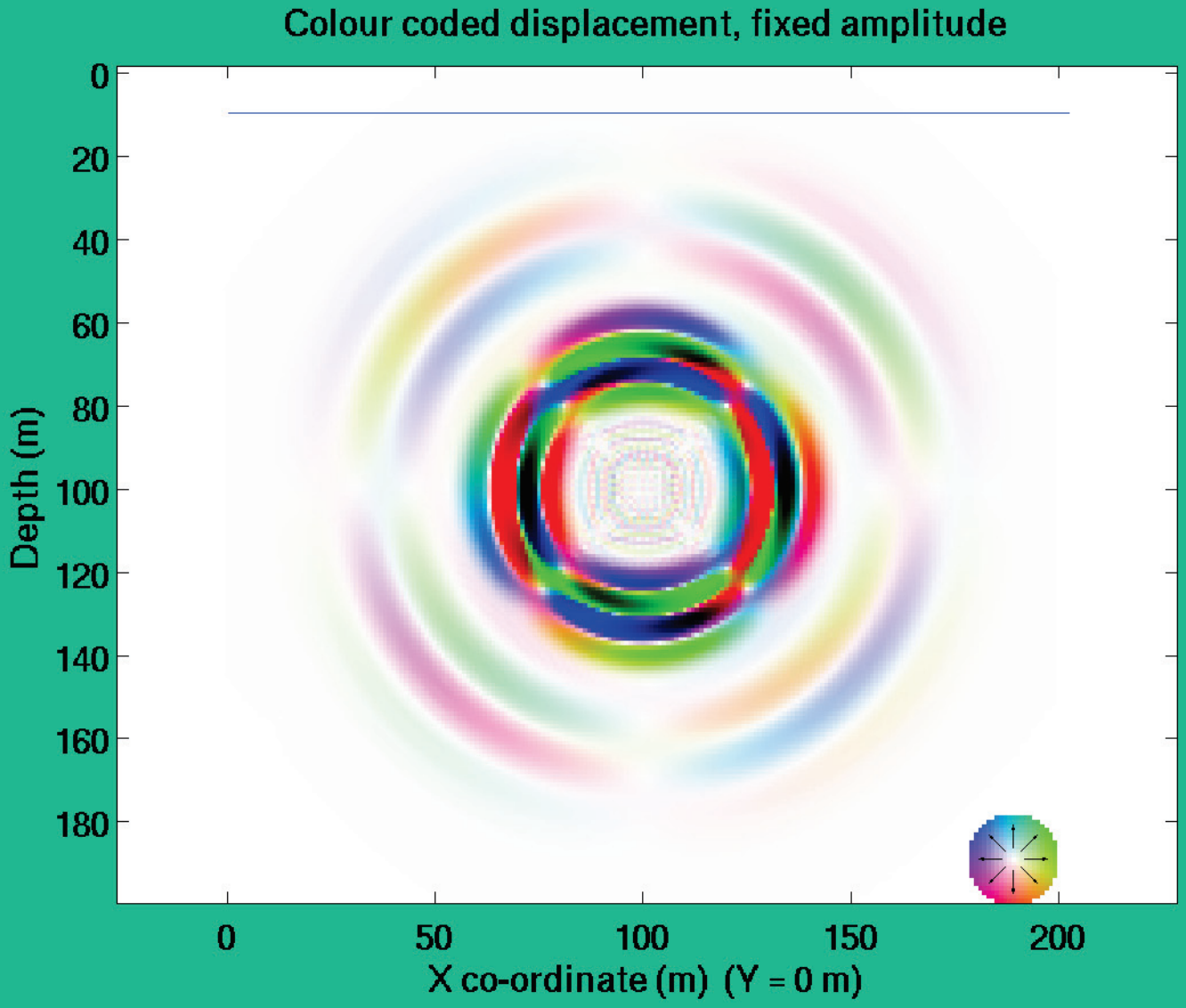
The Z-rupture source



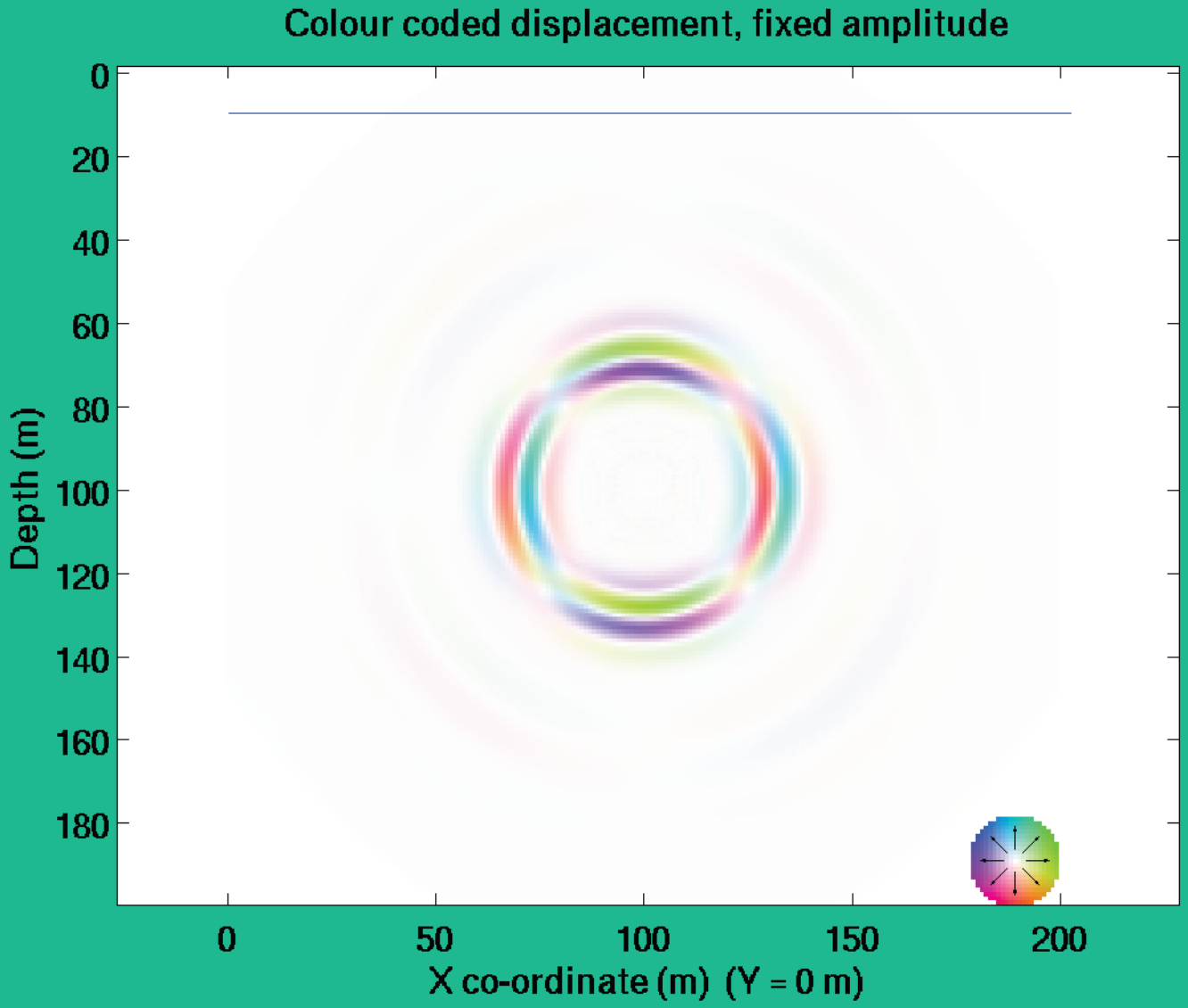
Explosive source wavefront



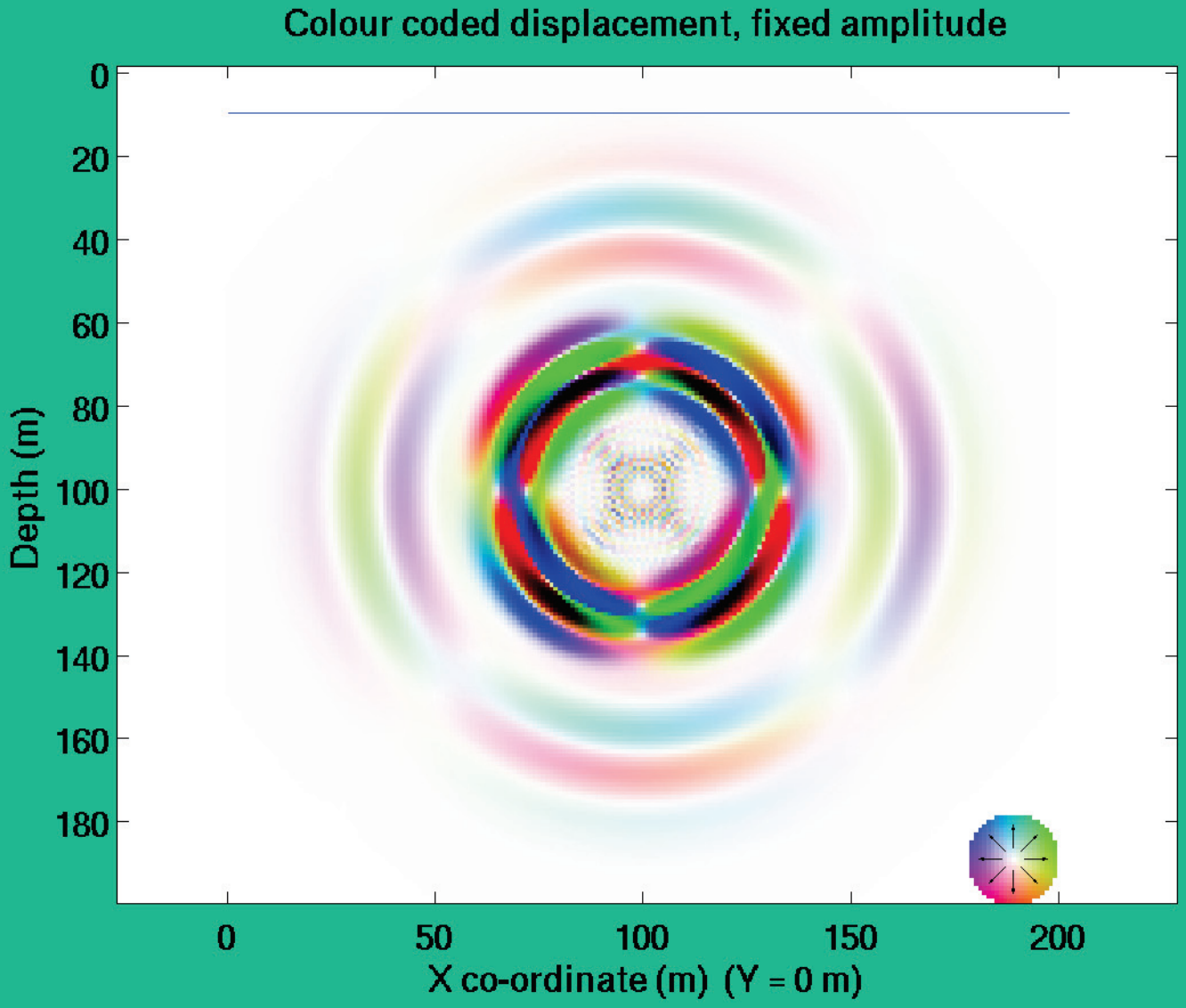
Double-couple source wavefronts



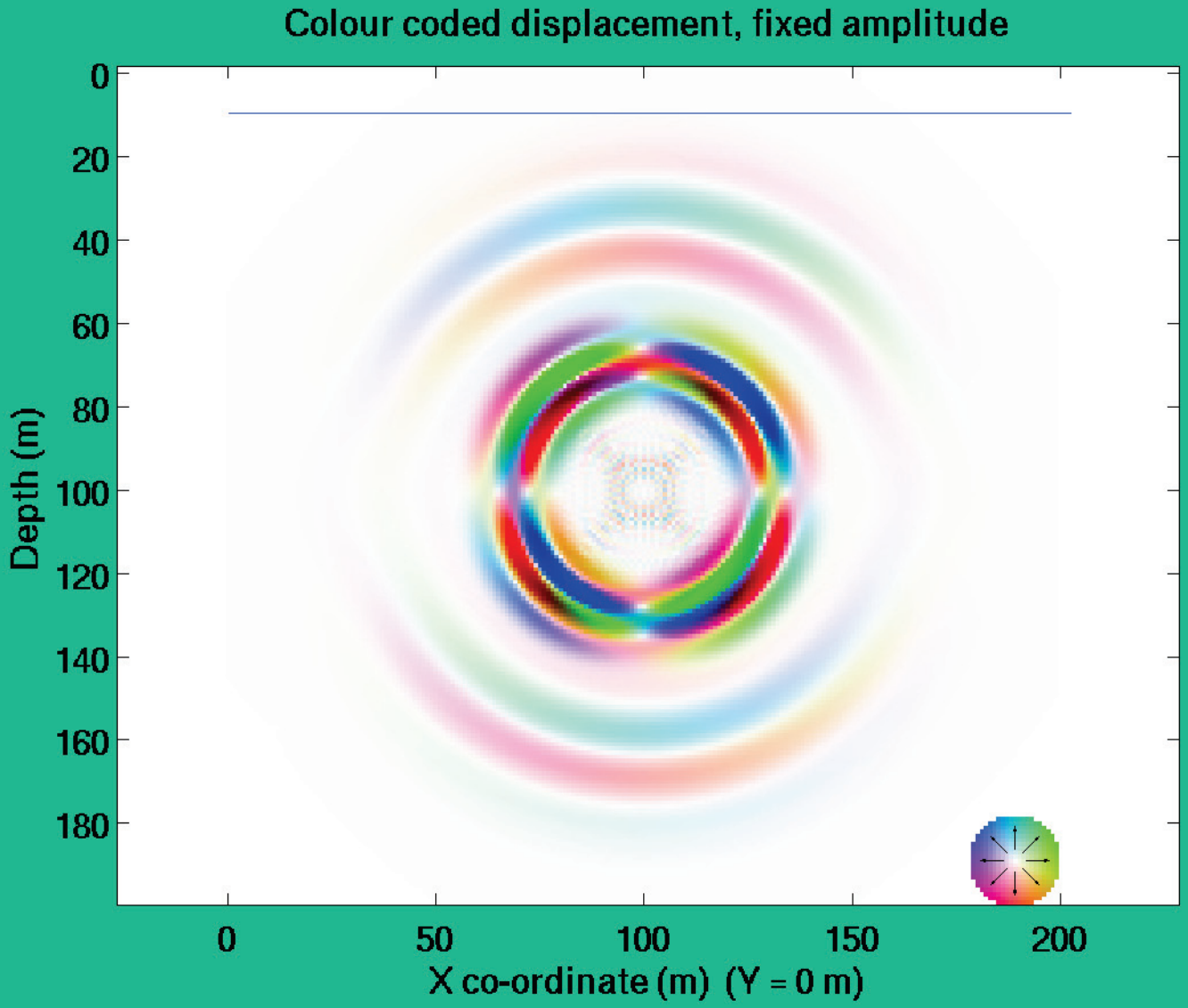
Double-couple low amplitude



Squeeze-bulge source wavefronts



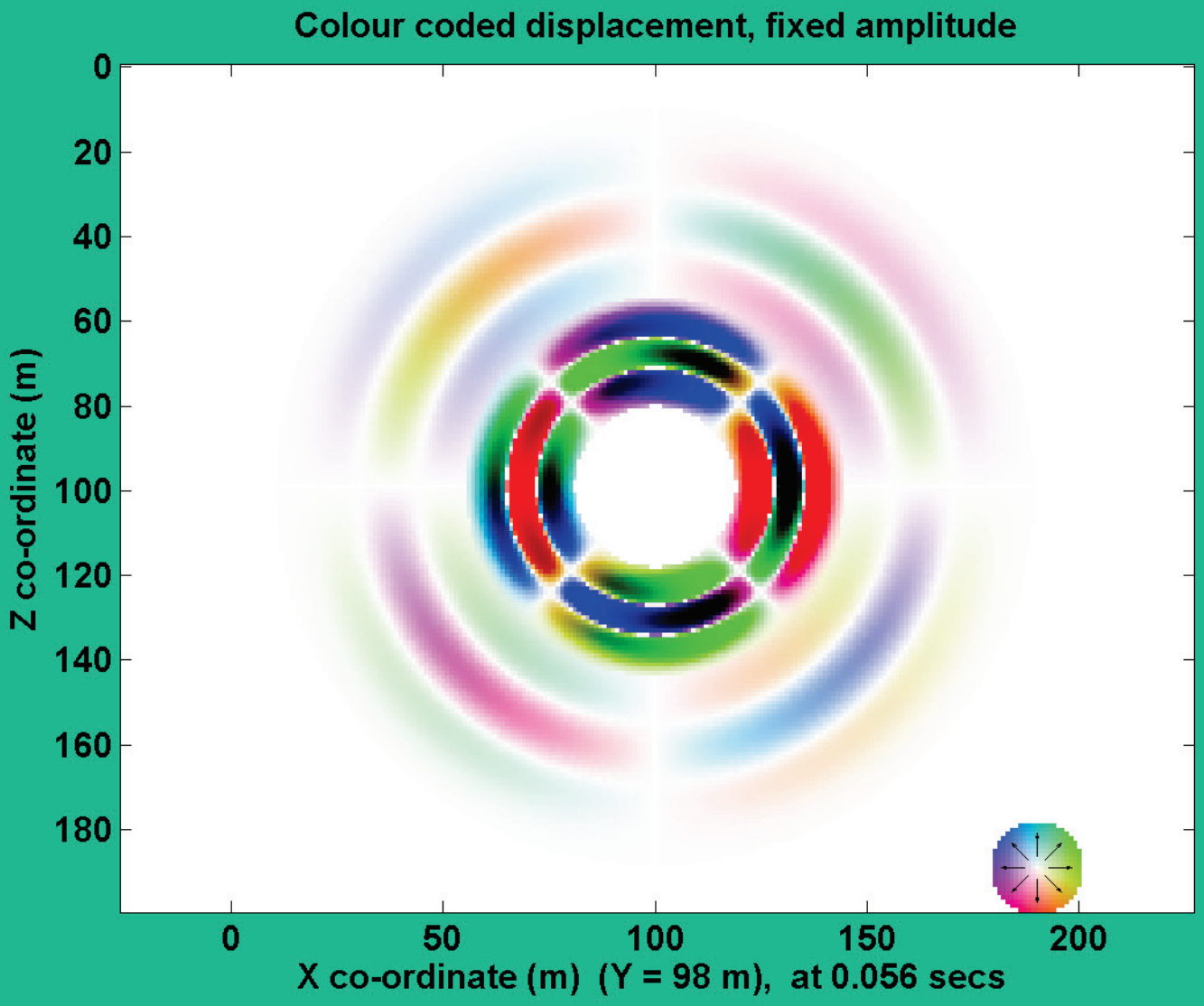
Z-rupture source wavefronts



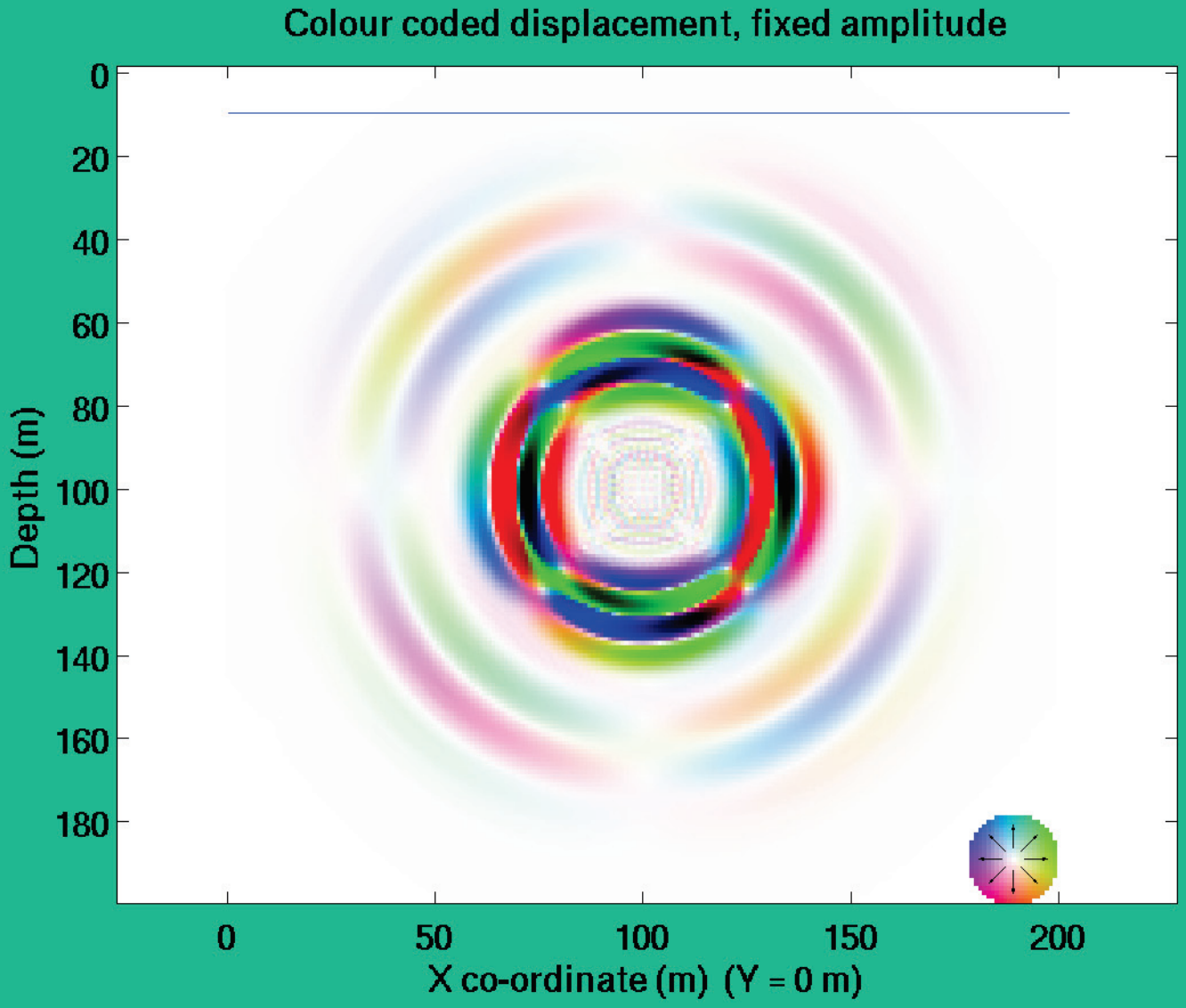
Aki/Richards theoretical wavefront (partial)

$$u(x,t) = \ldots + \frac{1}{4\pi\rho\alpha^3} A^{FP} \frac{1}{r} M_0\left(t - \frac{r}{\alpha}\right) + \frac{1}{4\pi\rho\beta^3} A^{FS} \frac{1}{r} M_0\left(t - \frac{r}{\beta}\right)$$

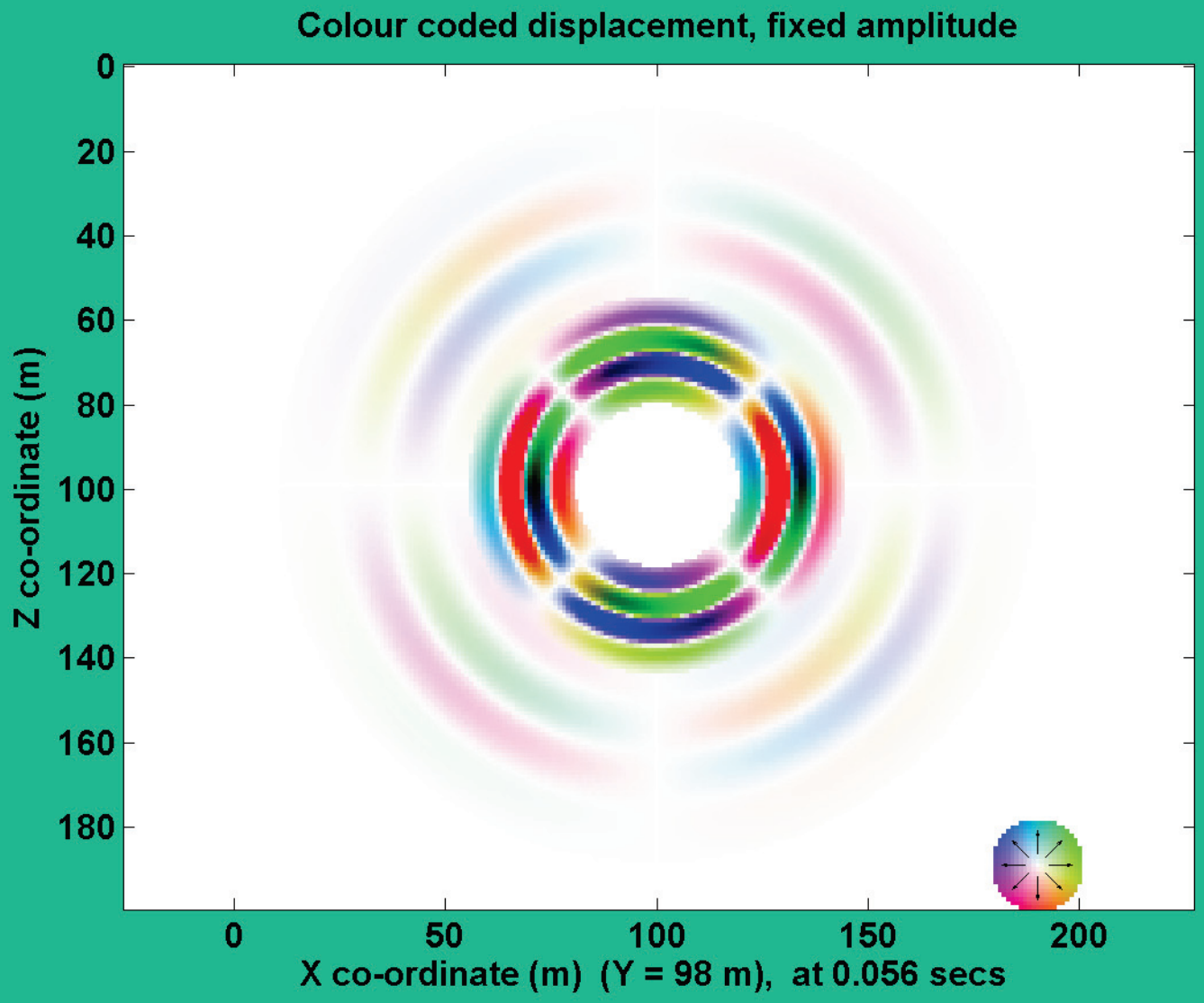
Aki-Richards theory wavefronts



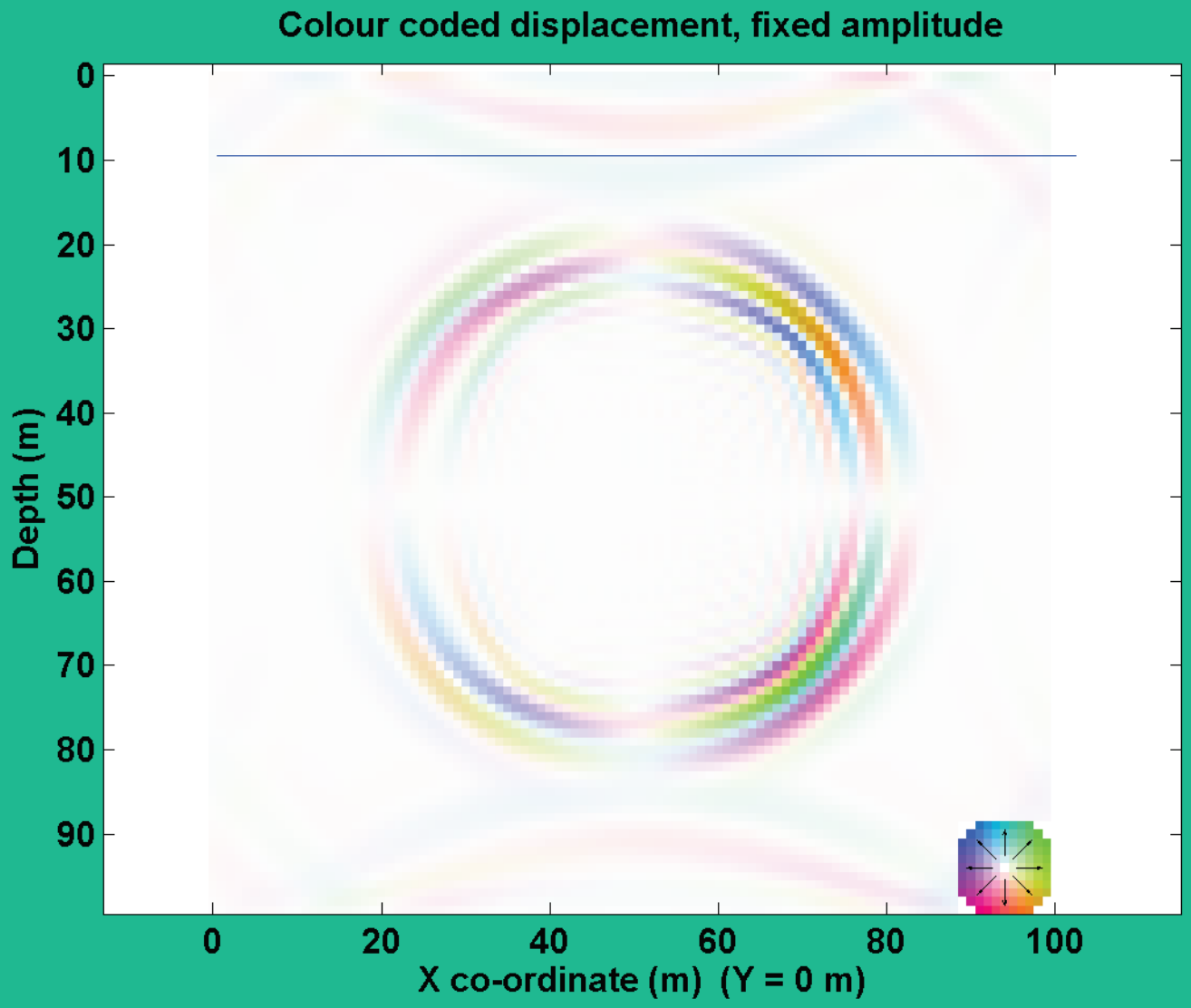
Double-couple source wavefronts



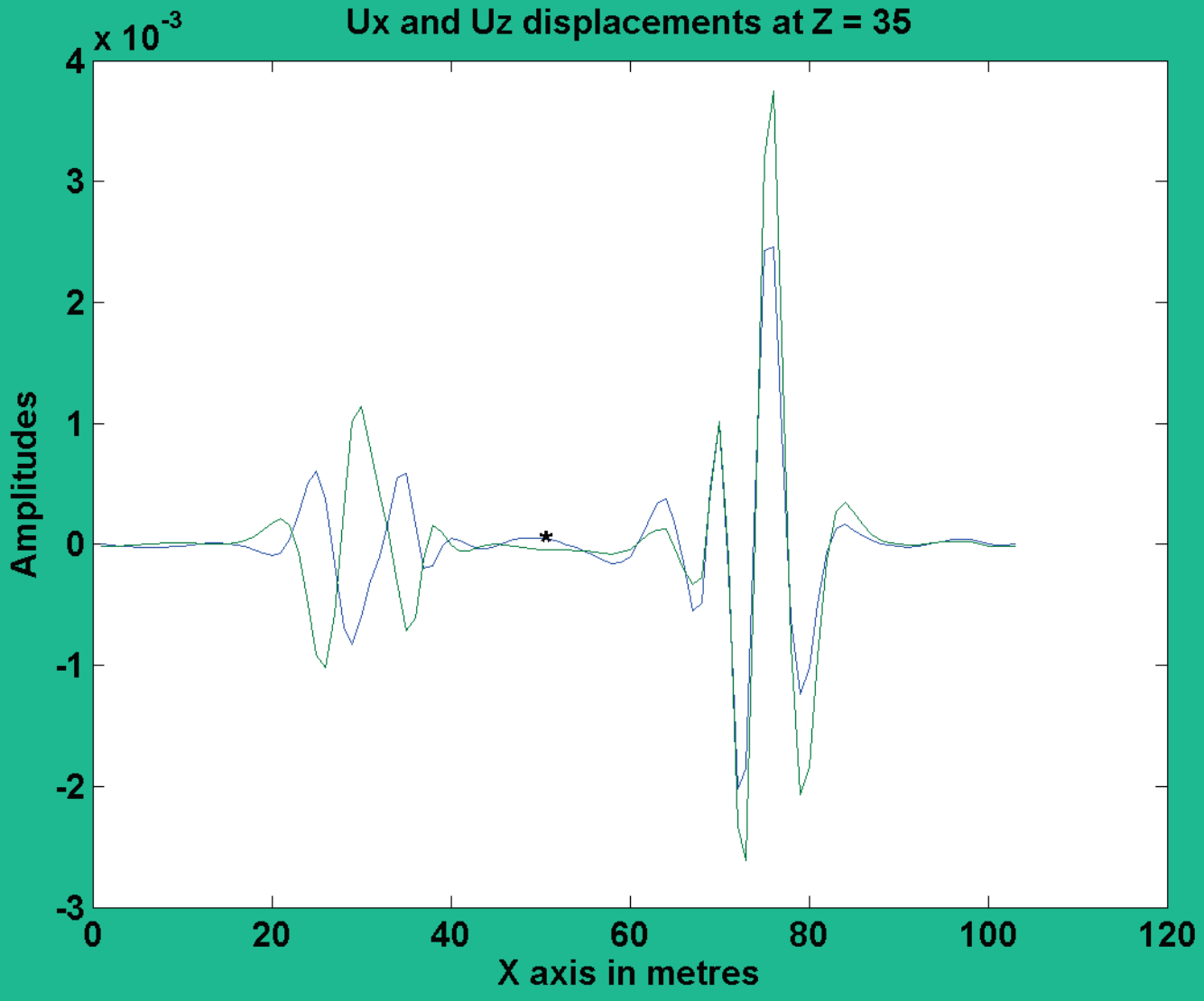
Aki-Richards 1st derivative wavefronts



100 Hz rupture moving 2 m. right



100 Hz rupture moving 2 m. right



Conclusions

- Finite-difference models in three dimensions can make use of several types of realistic energy sources.
- The double couple finite-difference energy source has an encouraging similarity to its theoretical equivalent.

Future work

- Vibroseis type energy sources need to be developed and tested.

- Colour coded wavefield presentations must be improved so that slices through arbitrary volumes are meaningful.

Acknowledgements

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