

Imaging steeply dipping reflectors in TI media

Guojian Shan

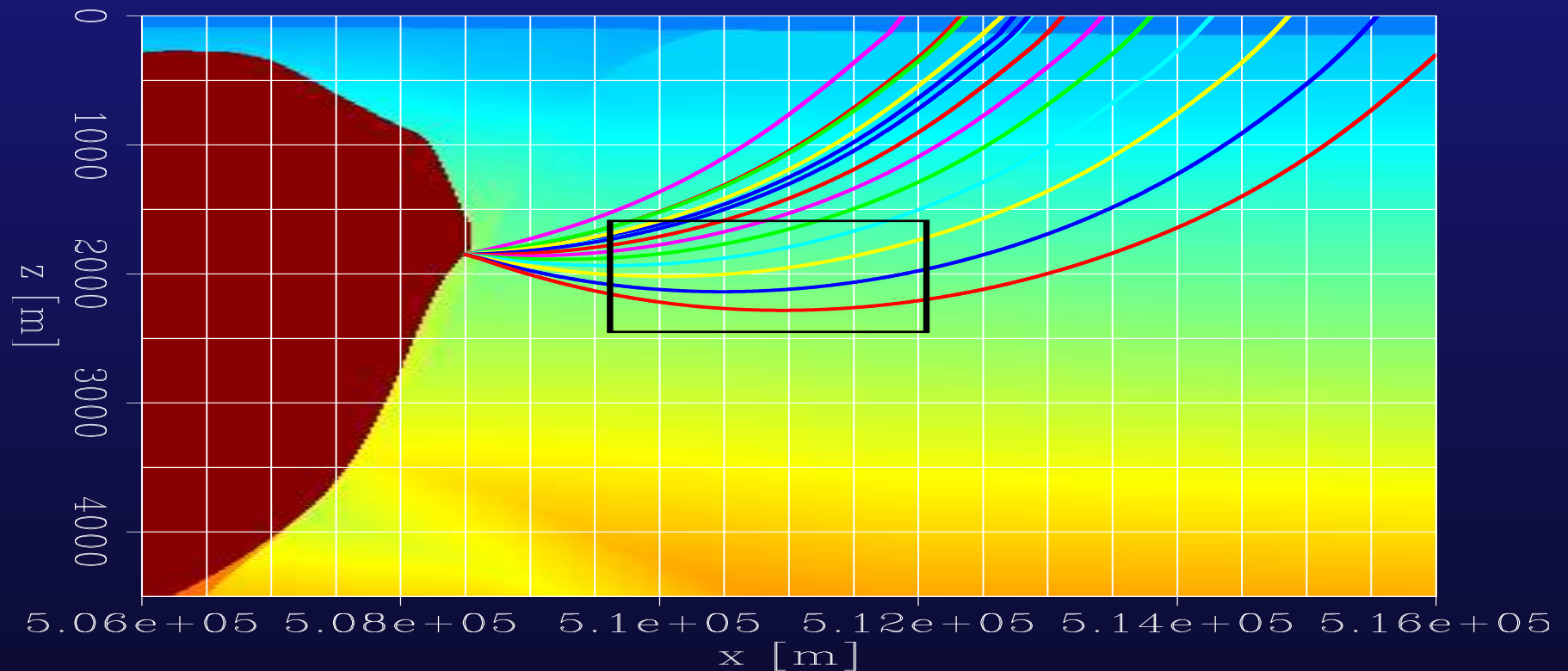
shan@sep.stanford.edu

Biondo Biondi

biondo@sep.stanford.edu

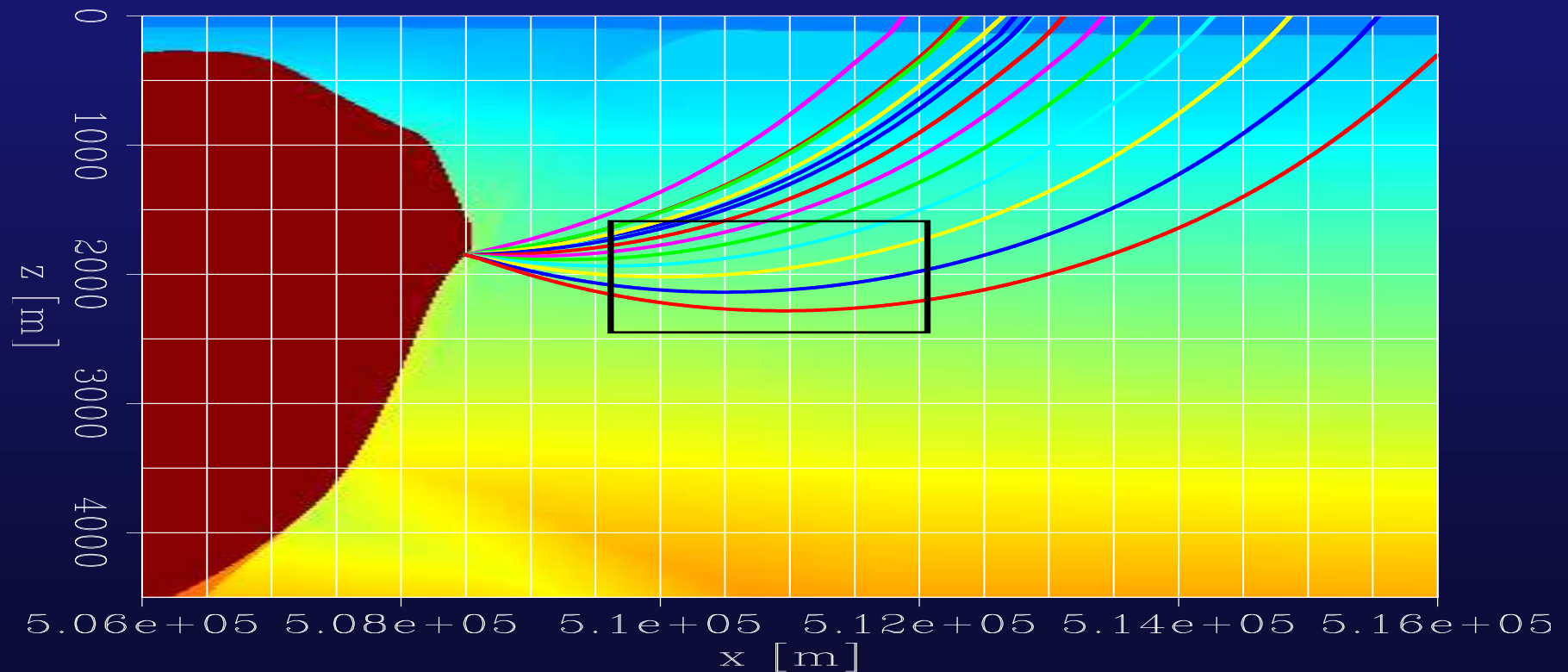
SEP120: pages 63–75

Steeply dipping reflector in TI media



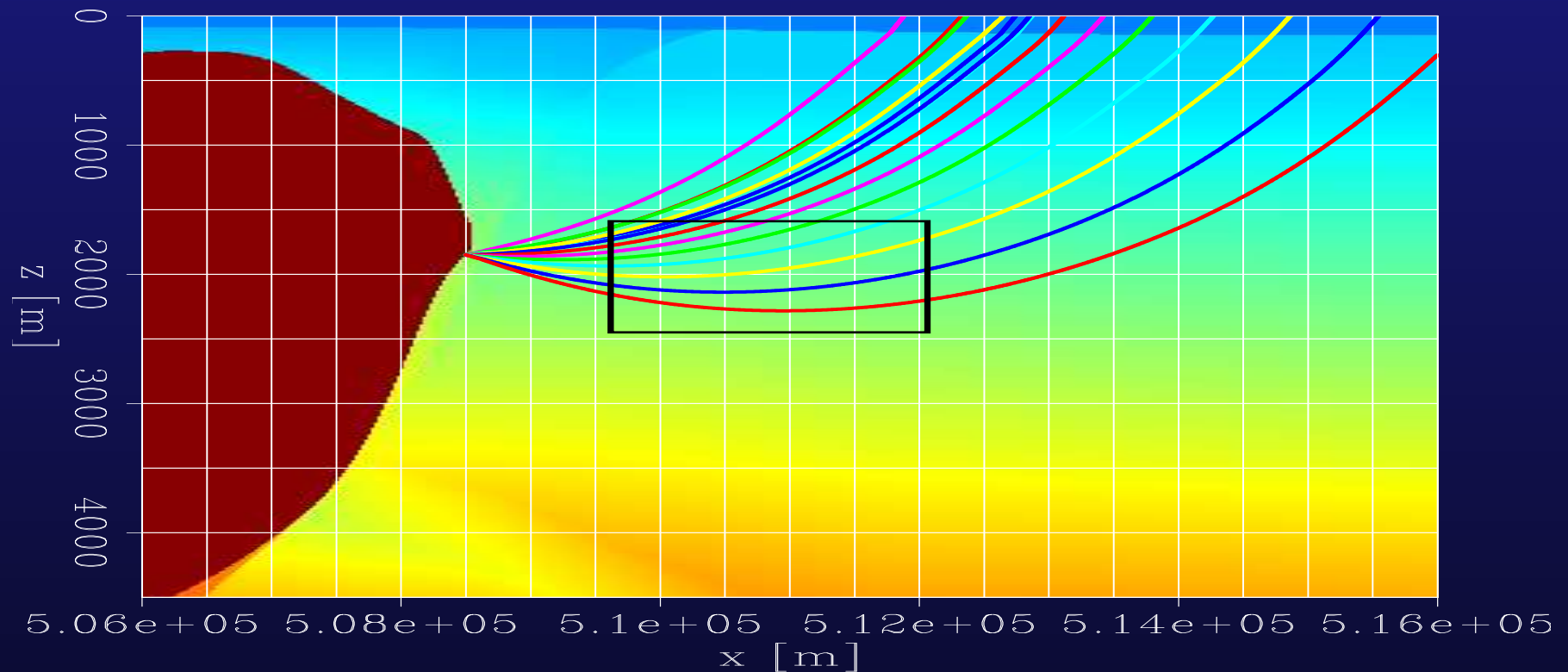
- Propagation direction is almost horizontal.

Steeply dipping reflector in TI media



- Propagation direction is almost horizontal.
 - ★ Downward continuation loses accuracy if waves travel in a direction approaching the horizontal direction.

Steeply dipping reflector in TI media

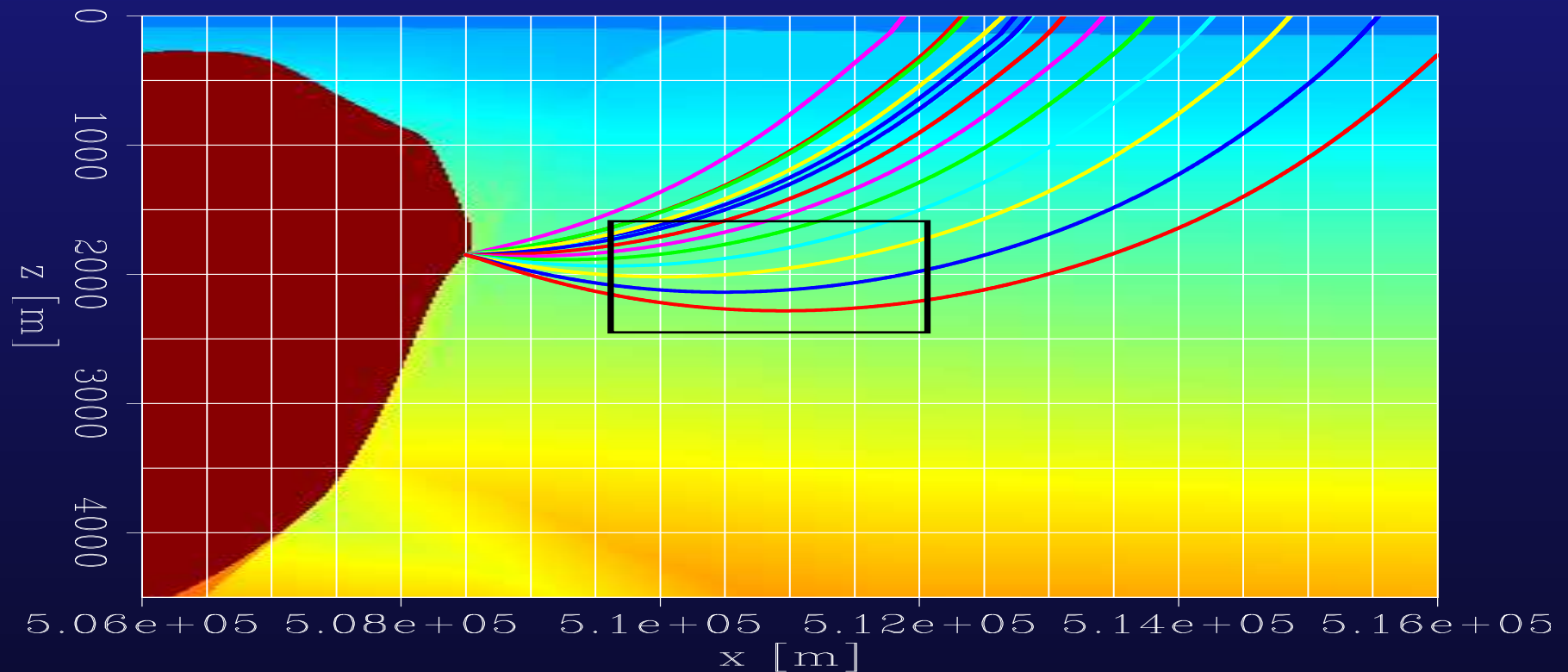


- Propagation direction is almost horizontal.
 - ★ Downward continuation loses accuracy if waves travel in a direction approaching the horizontal direction.
 - ★ If the media are anisotropic, extrapolating the wavefield with the vertical velocity causes big error.

Imaging steeply dipping reflector in TI media

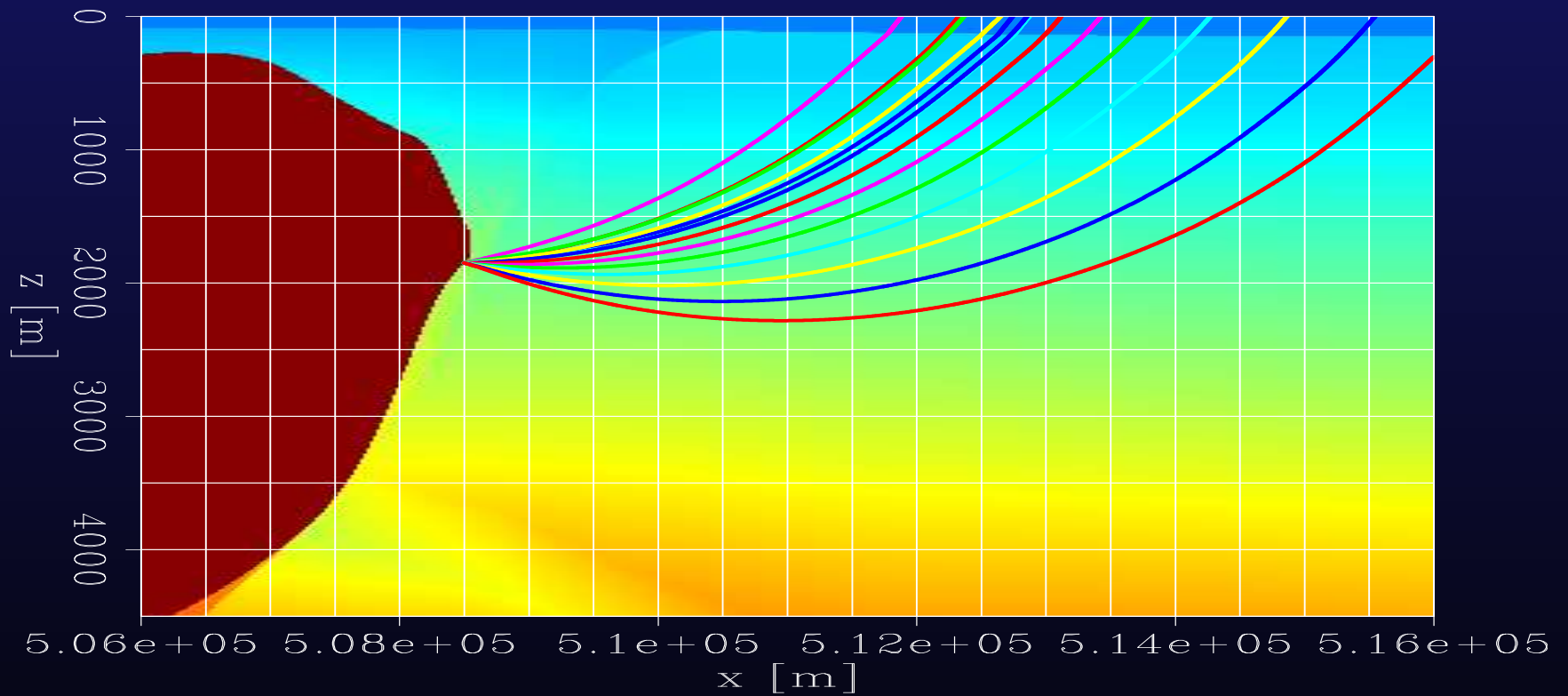
- Plane-wave migration in tilted coordinates
- Isotropic extrapolation operator + anisotropic correction
 - ★ Isotropic extrapolation operator: SSF, FFD, GSP
 - ★ anisotropic correction: Explicit method

Steeply dipping reflector in TI media

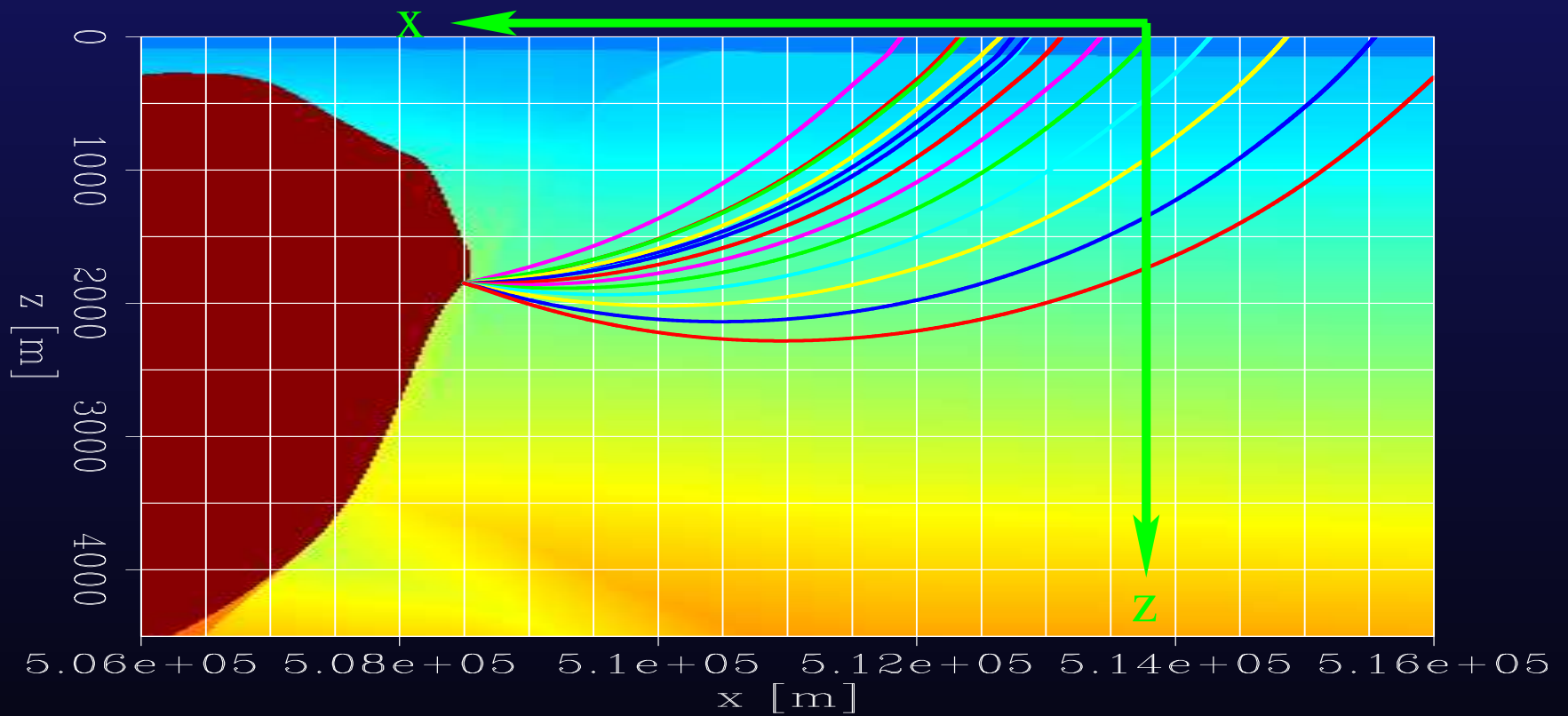


- Propagation direction is almost horizontal.
 - ★ Downward continuation loses accuracy if waves travel in a direction approaching the horizontal direction.
 - ★ If the media are anisotropic, extrapolating the wavefield with the vertical velocity causes big error.

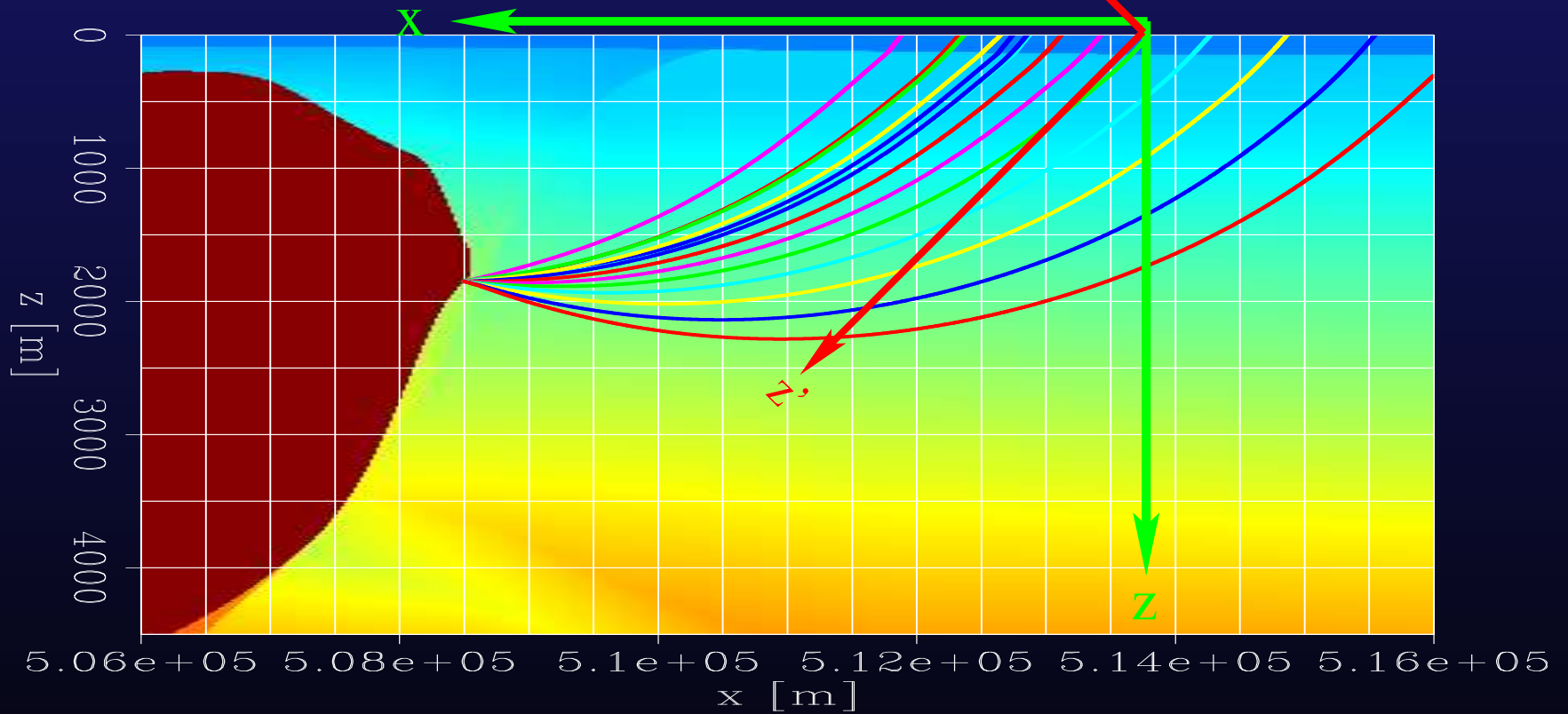
Titled coordinates



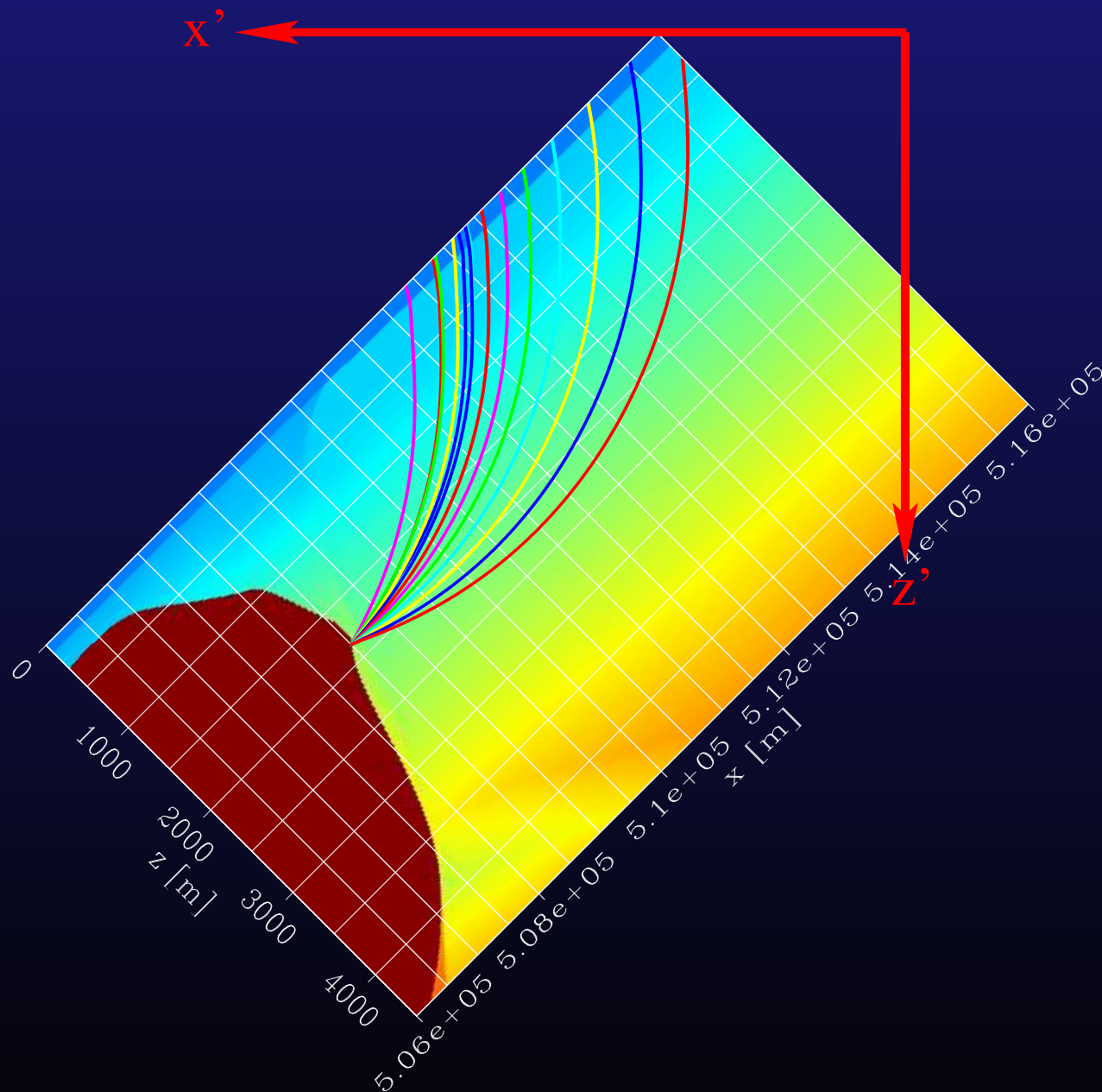
Titled coordinates



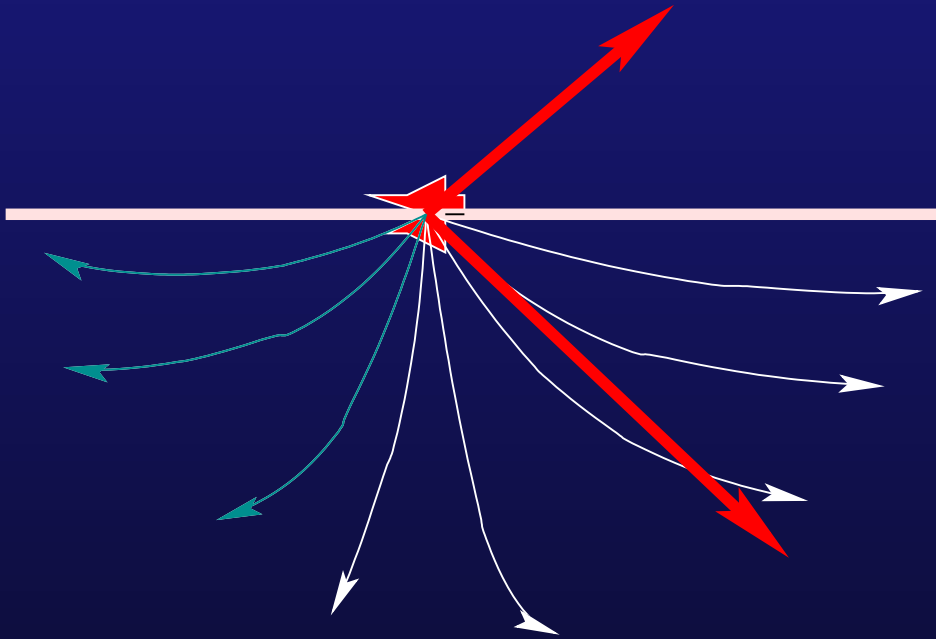
Titled coordinates



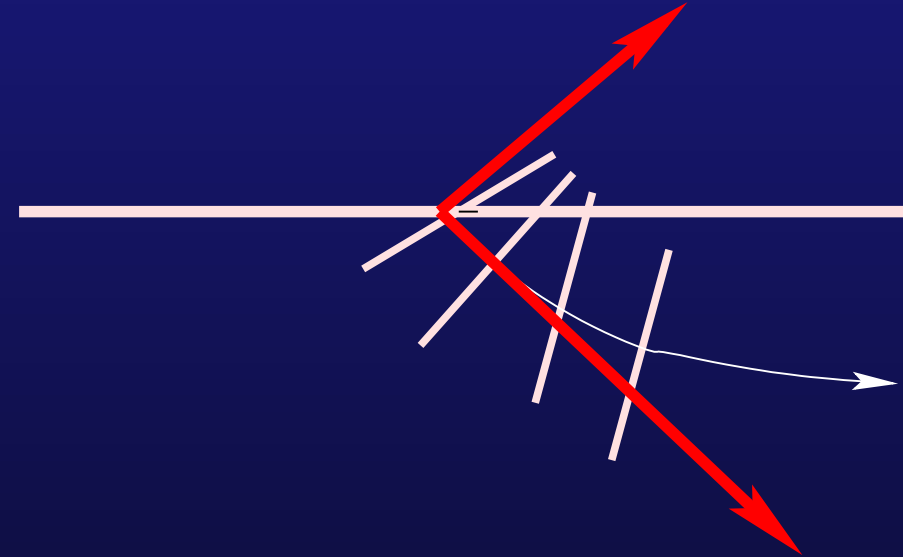
Titled coordinates



Titled coordinates



One tilted coordinate system can not cover all propagation directions of a point source.



One tilted coordinate system can cover the propagation direction of one plane-wave.

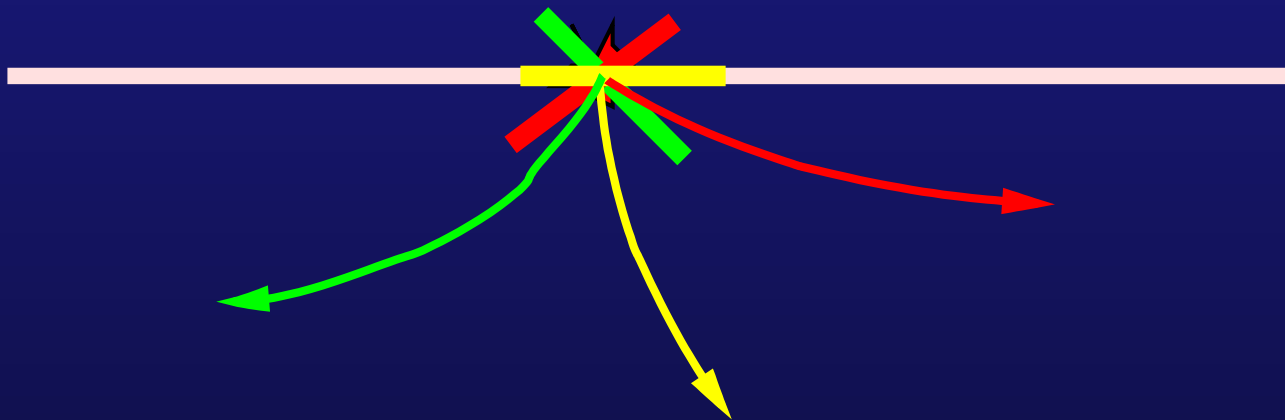
Plane-wave migration in tilted coordinates



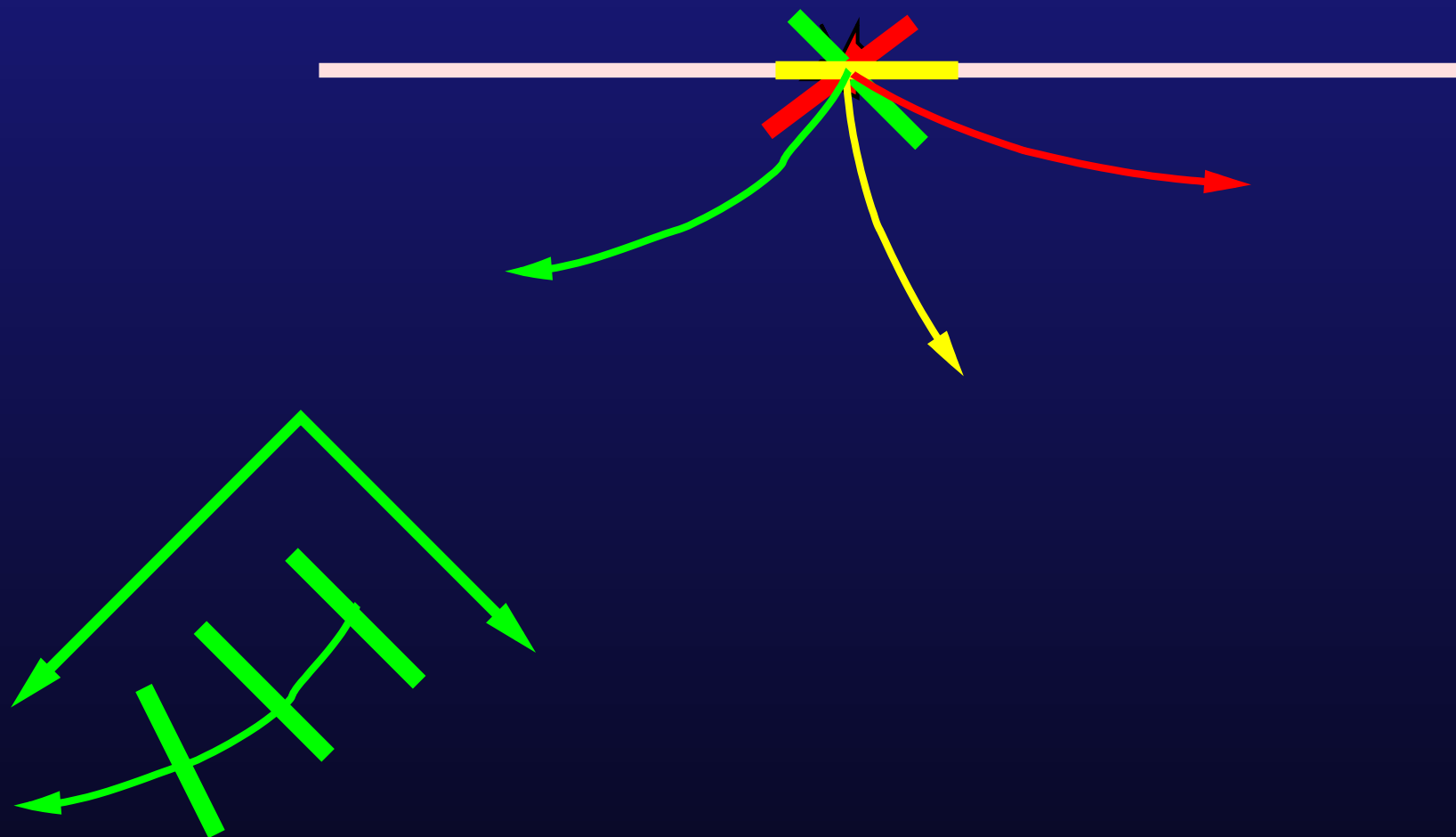
Plane-wave migration in tilted coordinates



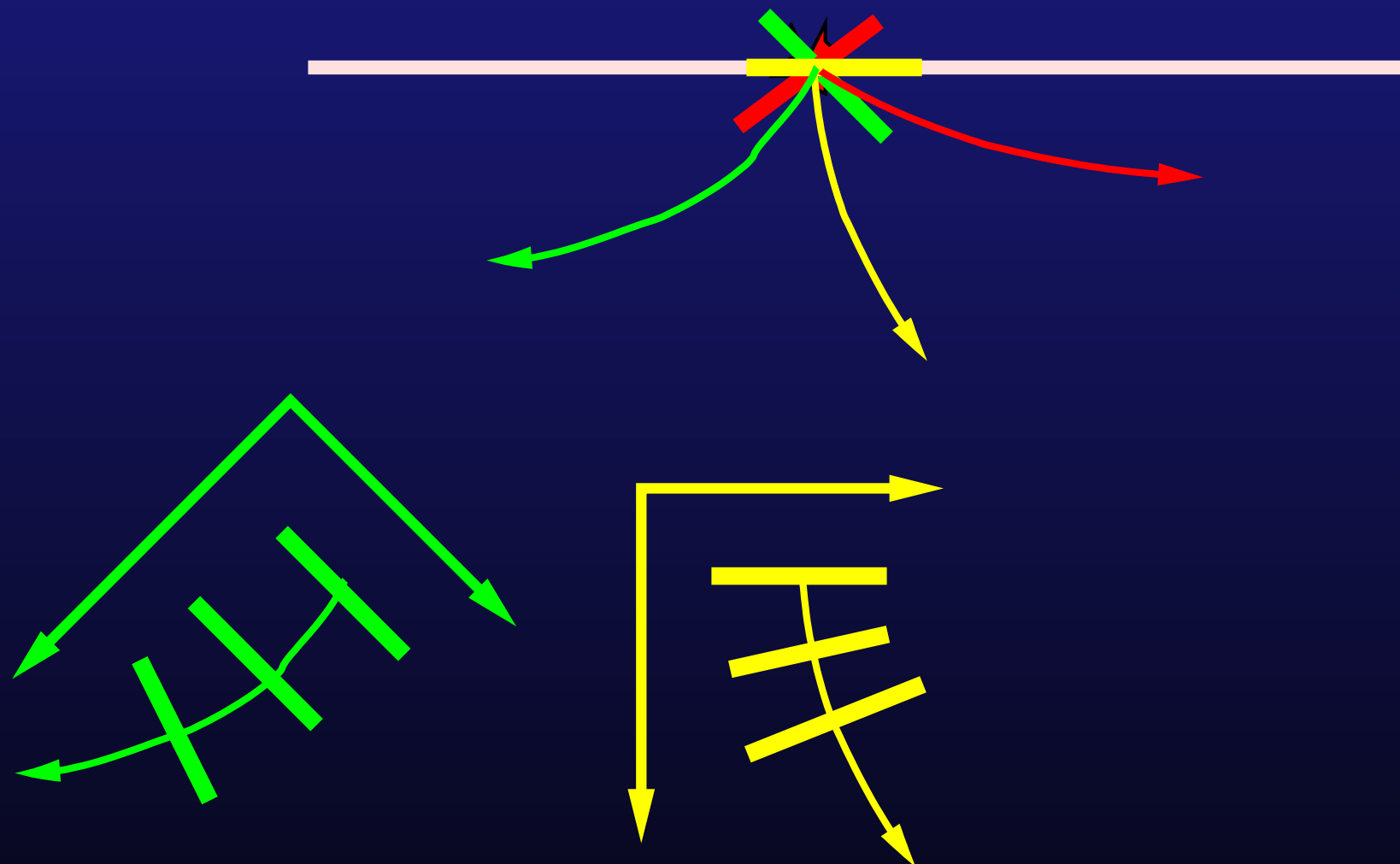
Plane-wave migration in tilted coordinates



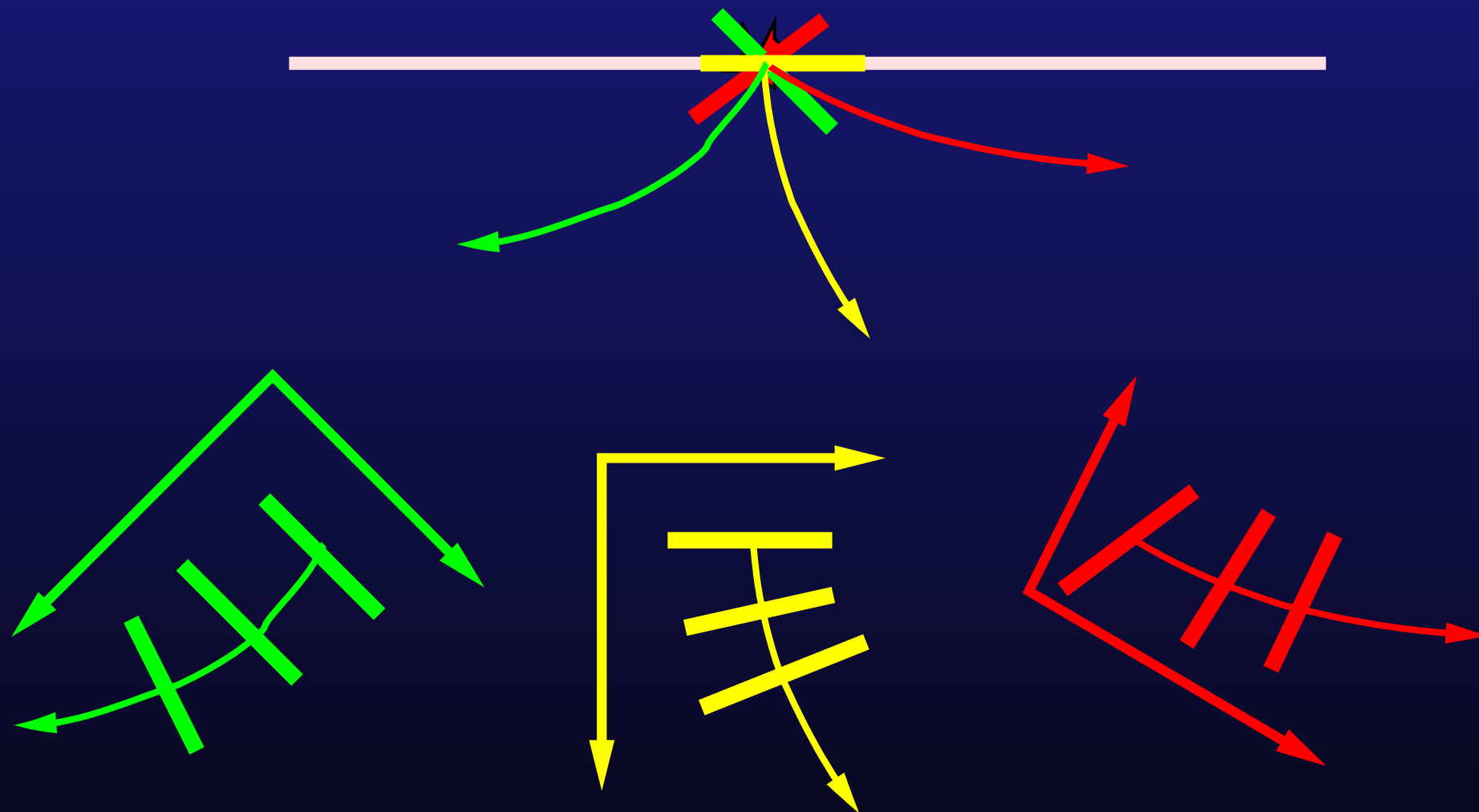
Plane-wave migration in tilted coordinates



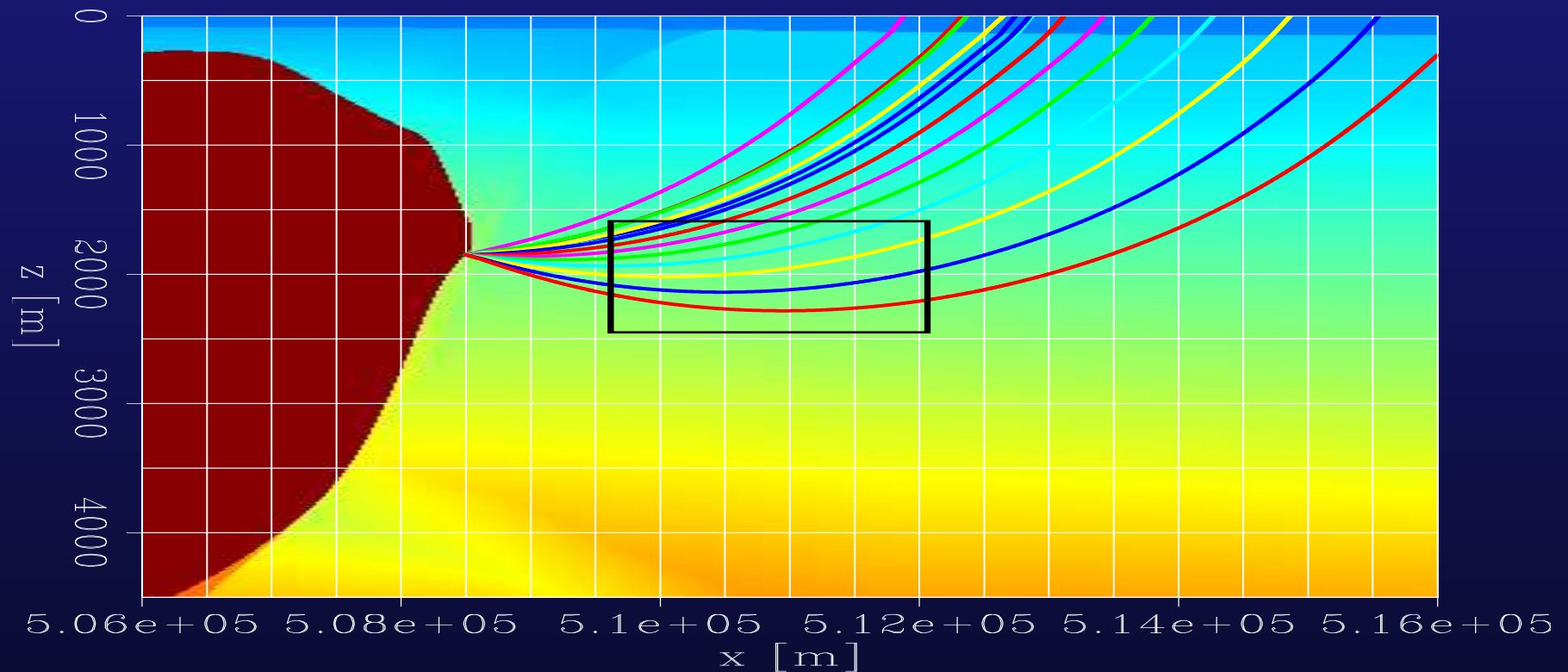
Plane-wave migration in tilted coordinates



Plane-wave migration in tilted coordinates

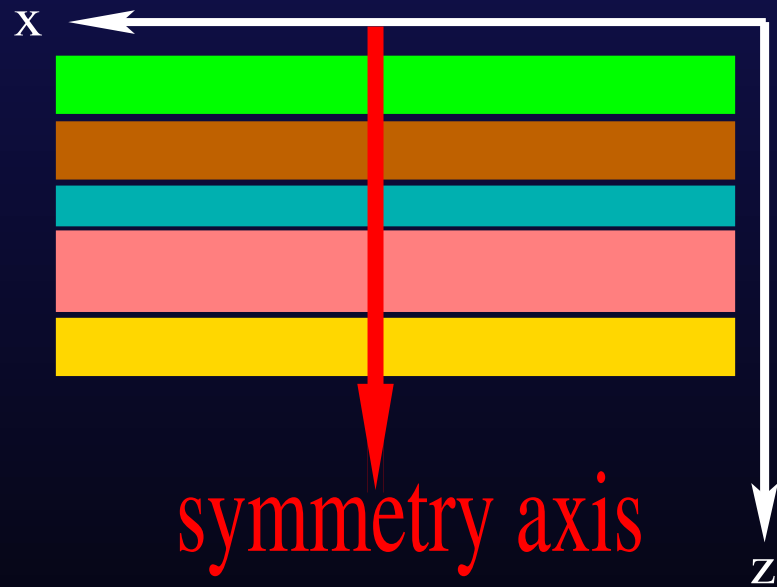


Steeply dipping reflector in TI media

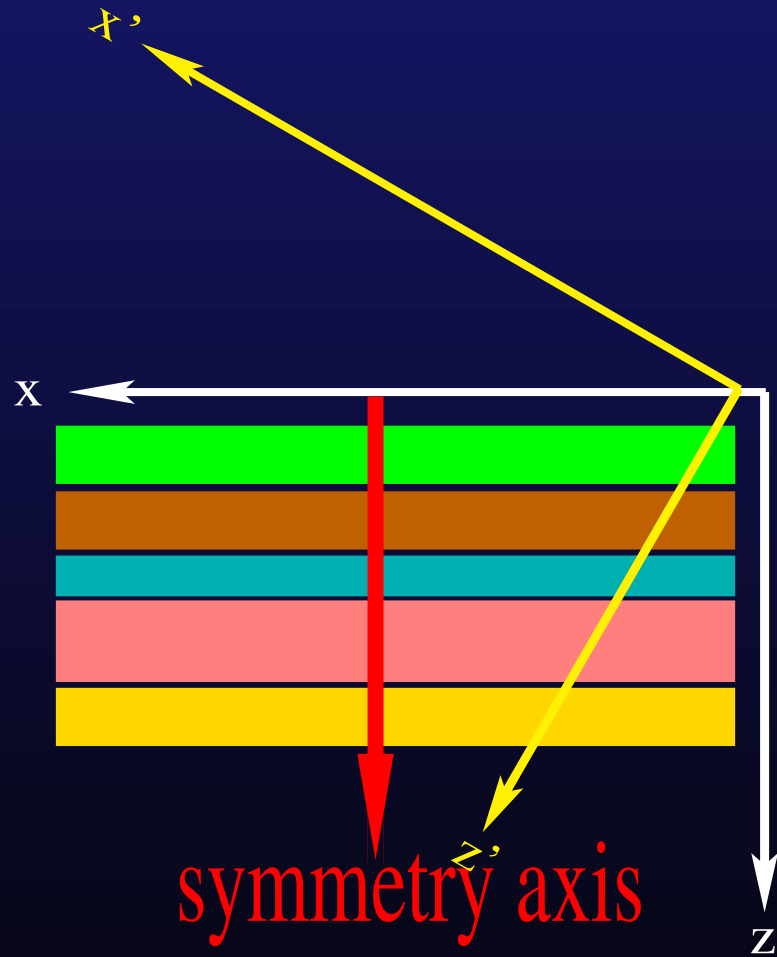


- Propagation direction is almost horizontal.
 - ★ Downward continuation loses accuracy if waves travel in a direction approaching the horizontal direction.
 - ★ If the media are anisotropic, extrapolating the wavefield with the vertical velocity causes big error.

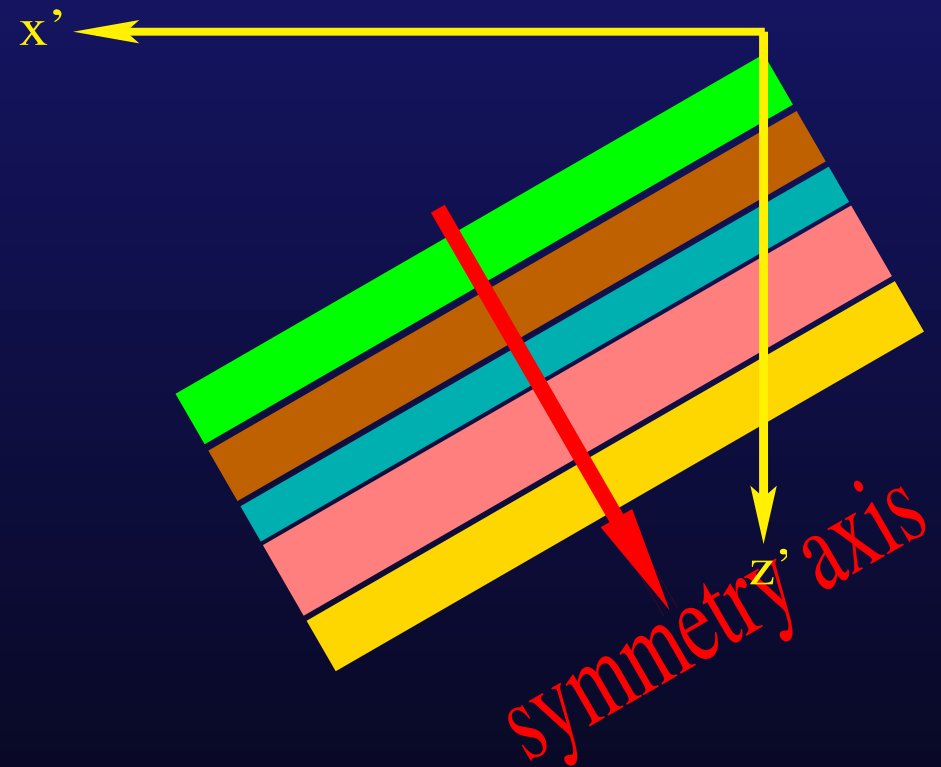
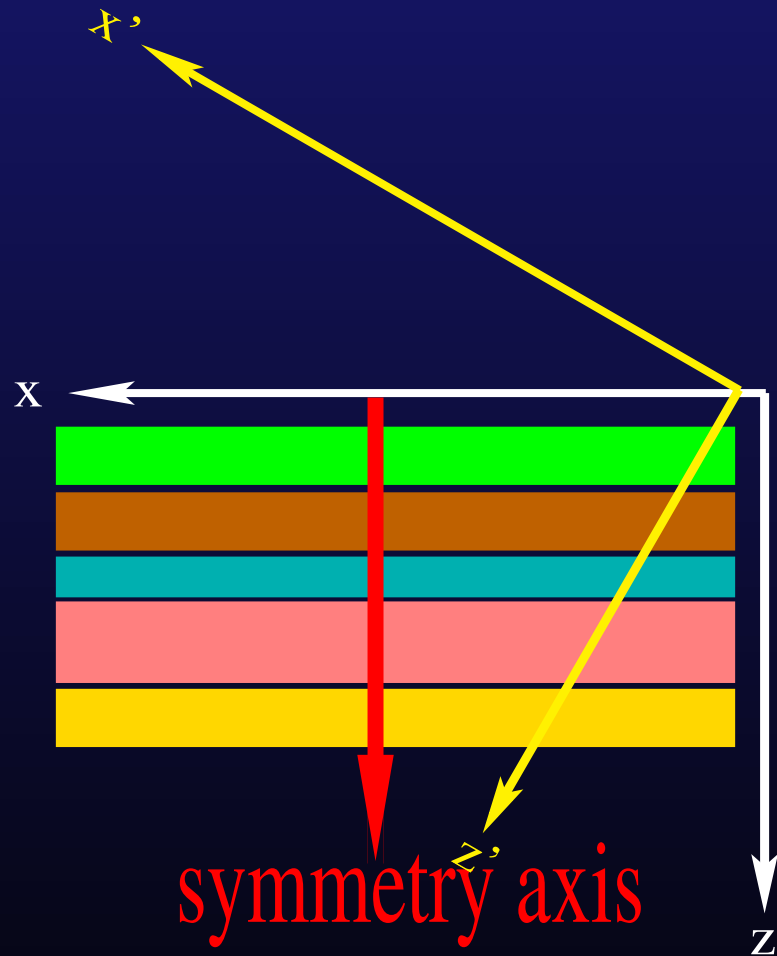
VTI media in tilted coordinates



VTI media in tilted coordinates



VTI media in tilted coordinates



VTI media become tilted
TI media in tilted
coordinates.

Wavefield extrapolation in tilted TI media

- SEP120 pages:63-82
 - ★ Implicit isotropic extrapolation
 - ★ Explicit anisotropic correction

Anisotropic plane-wave migration in tilted coordinates

- Plane wave decomposition by delaying shots.

Anisotropic plane-wave migration in tilted coordinates

- Plane wave decomposition by delaying shots.
- Given a plane wave, find tilted coordinates with a proper tilting angle.

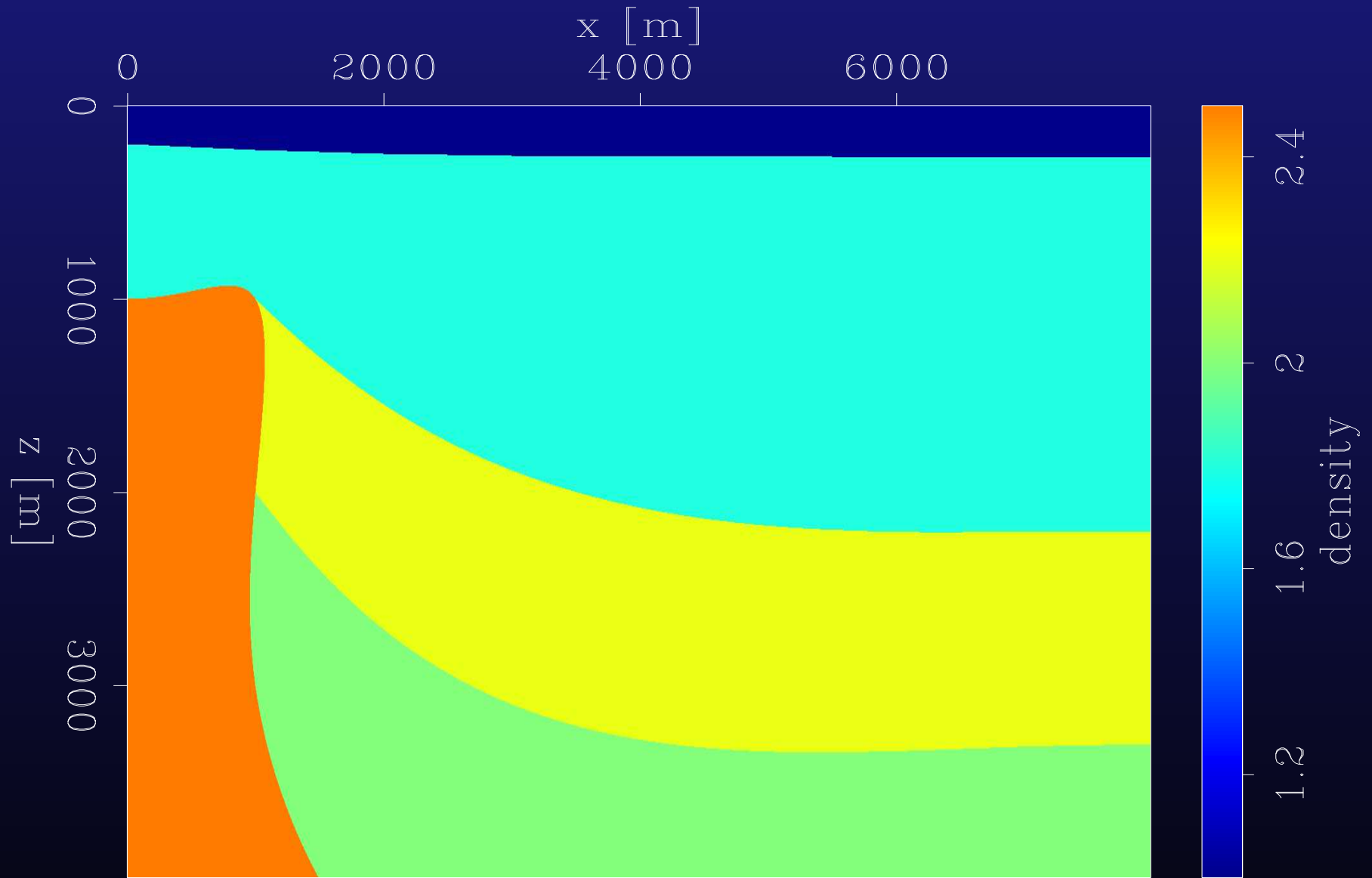
Anisotropic plane-wave migration in tilted coordinates

- Plane wave decomposition by delaying shots.
- Given a plane wave, find tilted coordinates with a proper tilting angle.
- Build the convolution coefficient table for the anisotropic correction operator.

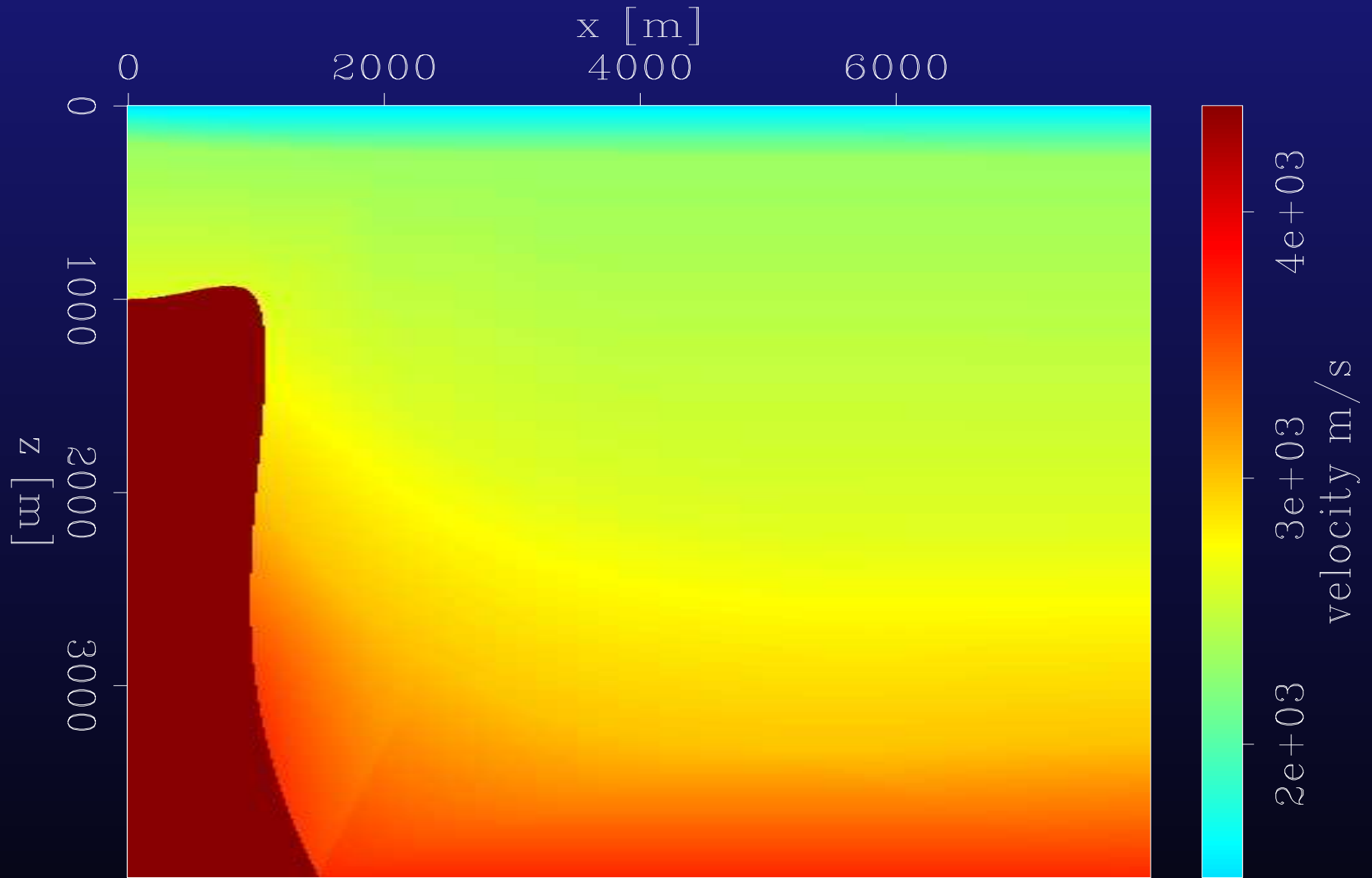
Anisotropic plane-wave migration in tilted coordinates

- Plane wave decomposition by delaying shots.
- Given a plane wave, find tilted coordinates with a proper tilting angle.
- Build the convolution coefficient table for the anisotropic correction operator.
- At each depth step:
 - ★ Isotropic extrapolation
 - ★ If the medium at the grid point is anisotropic, run an explicit correction

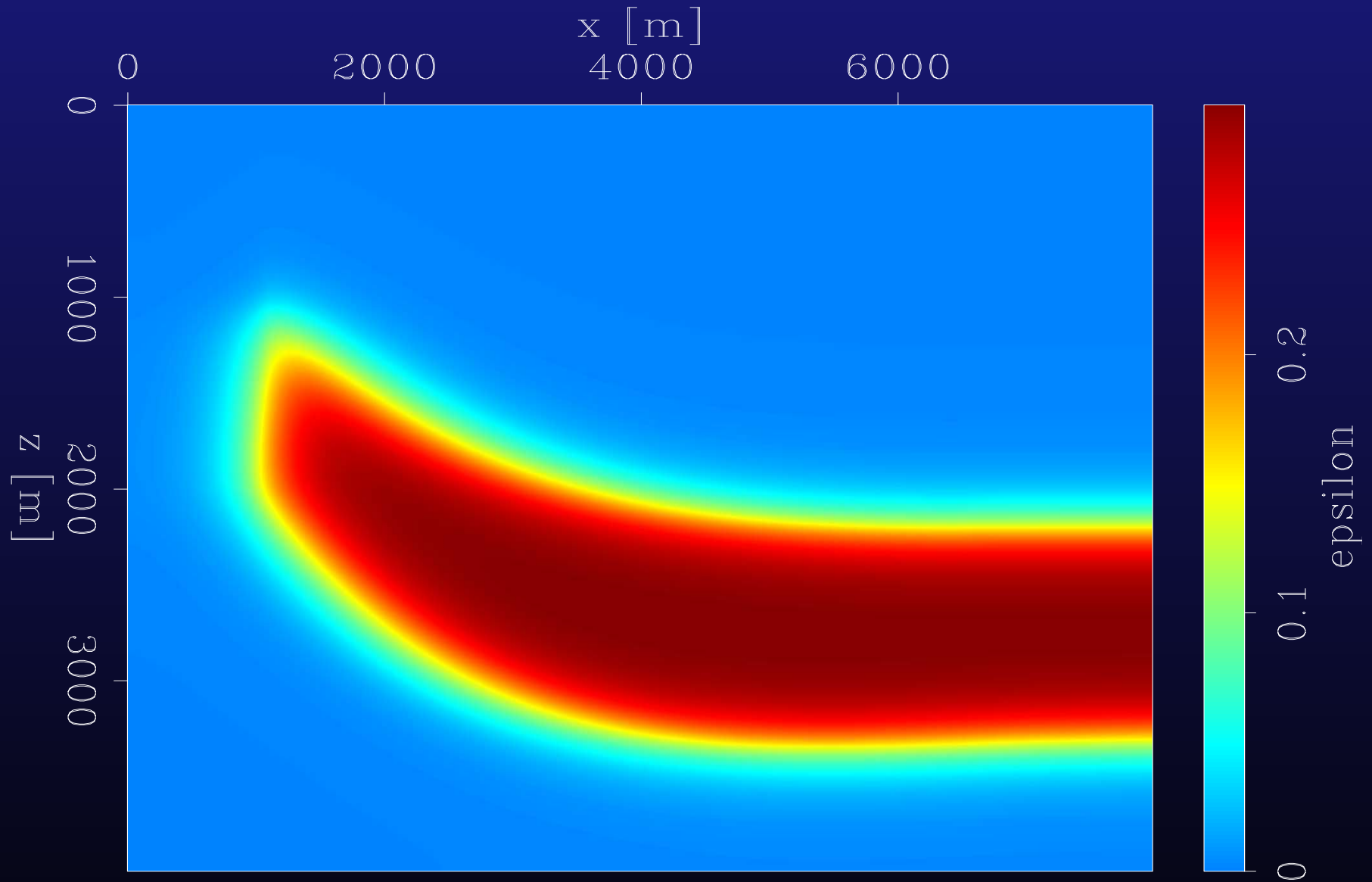
Density Model



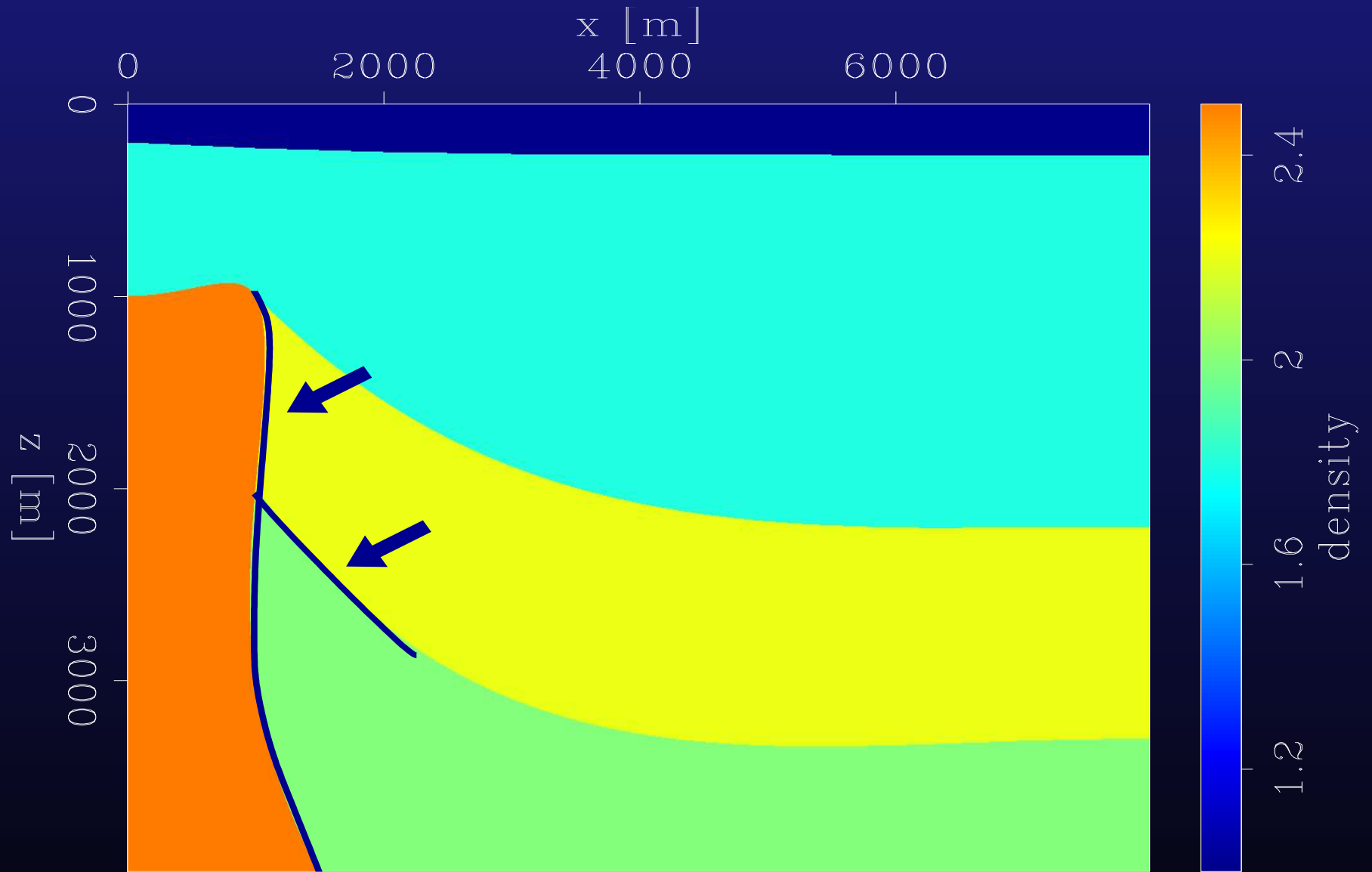
Velocity Model



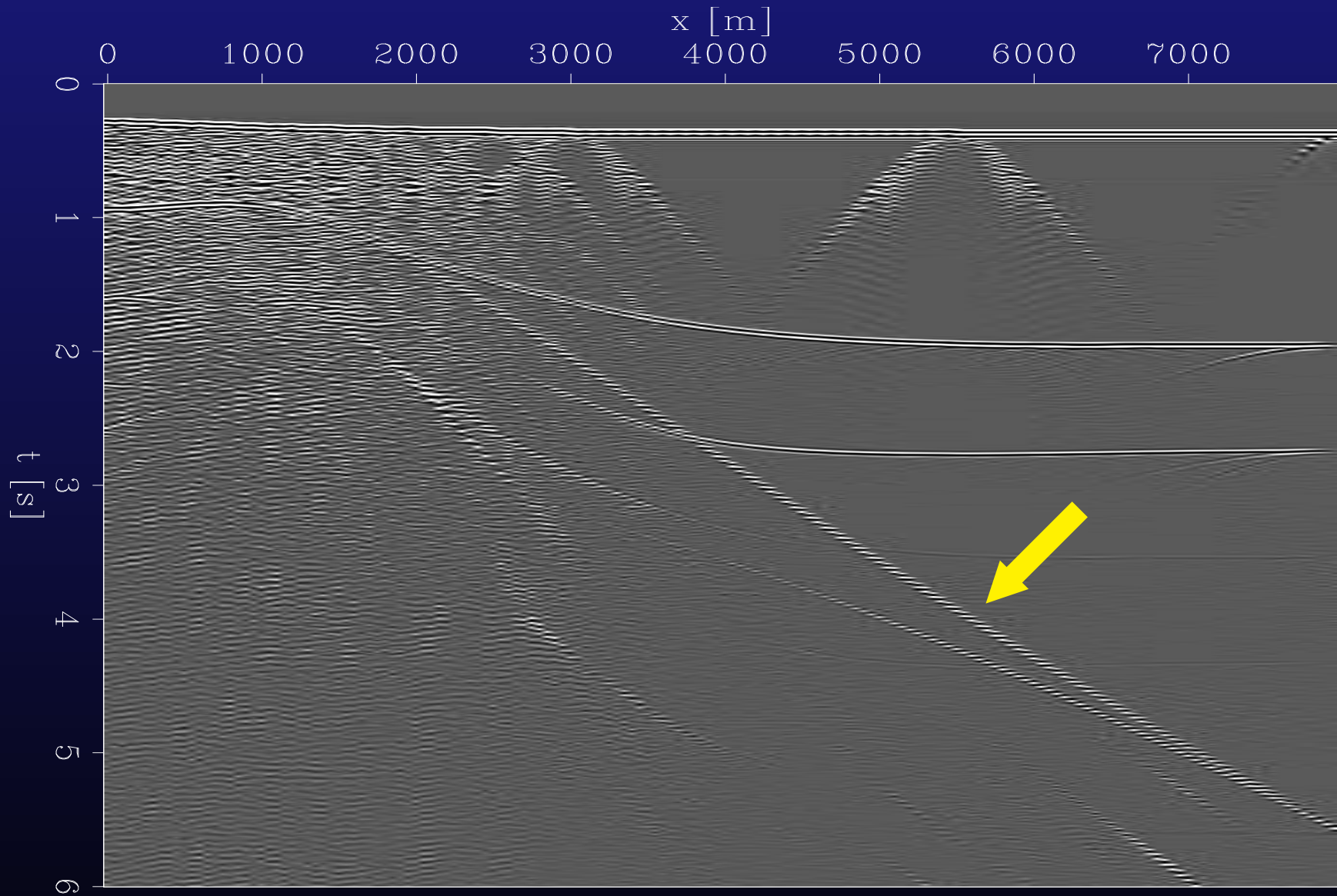
Anisotropy parameter ϵ Model



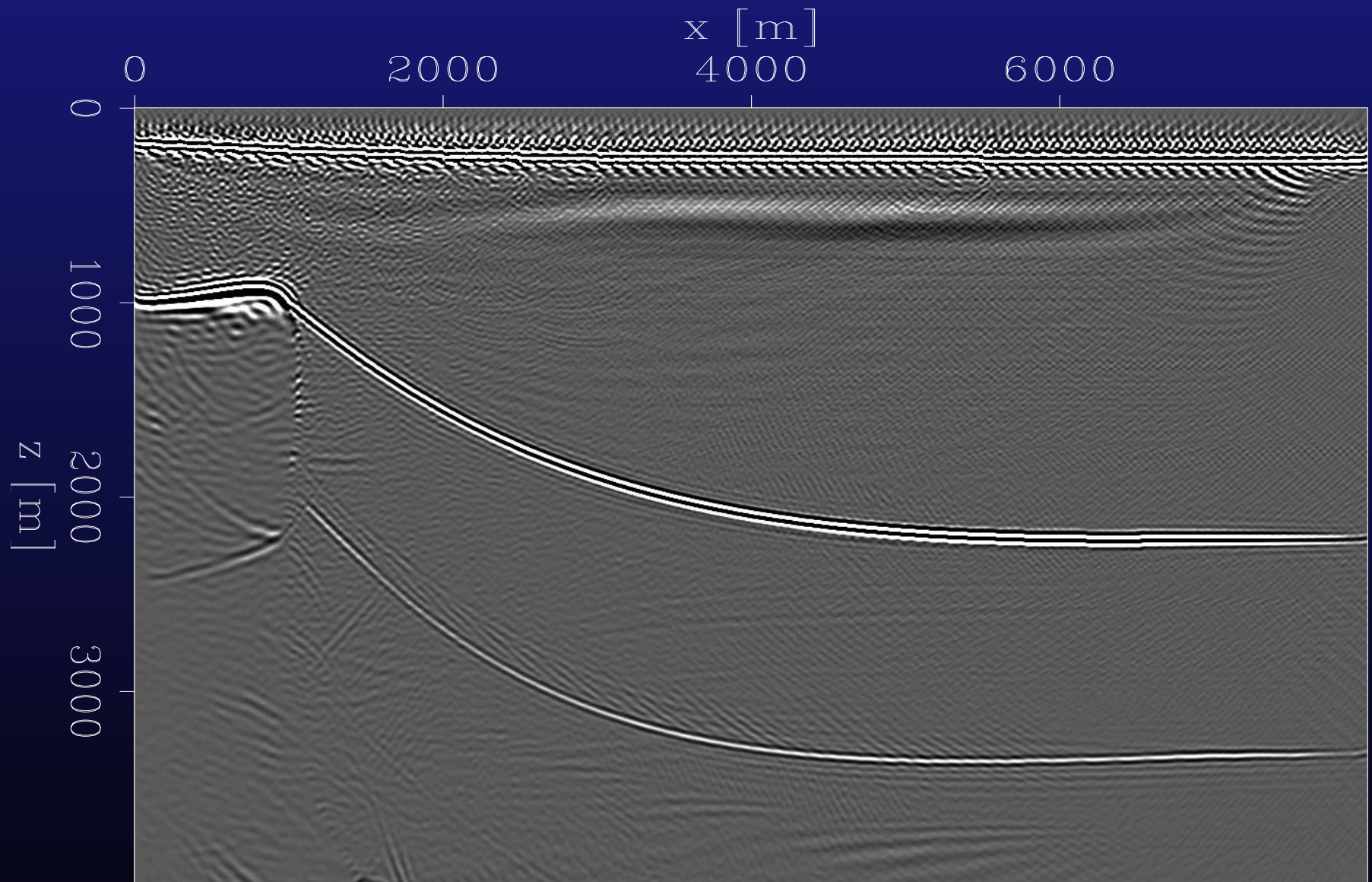
Density Model



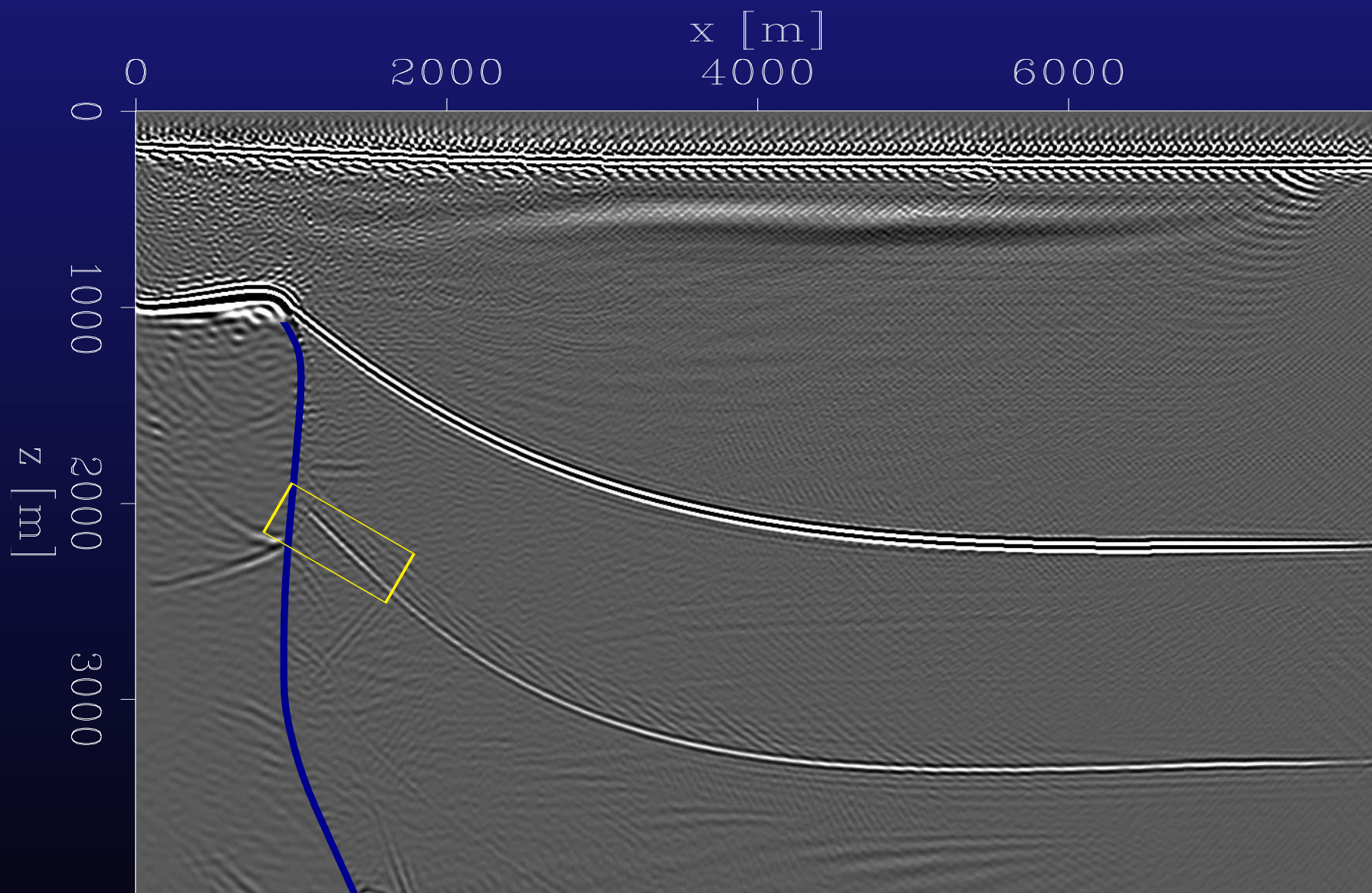
Near offset dataset



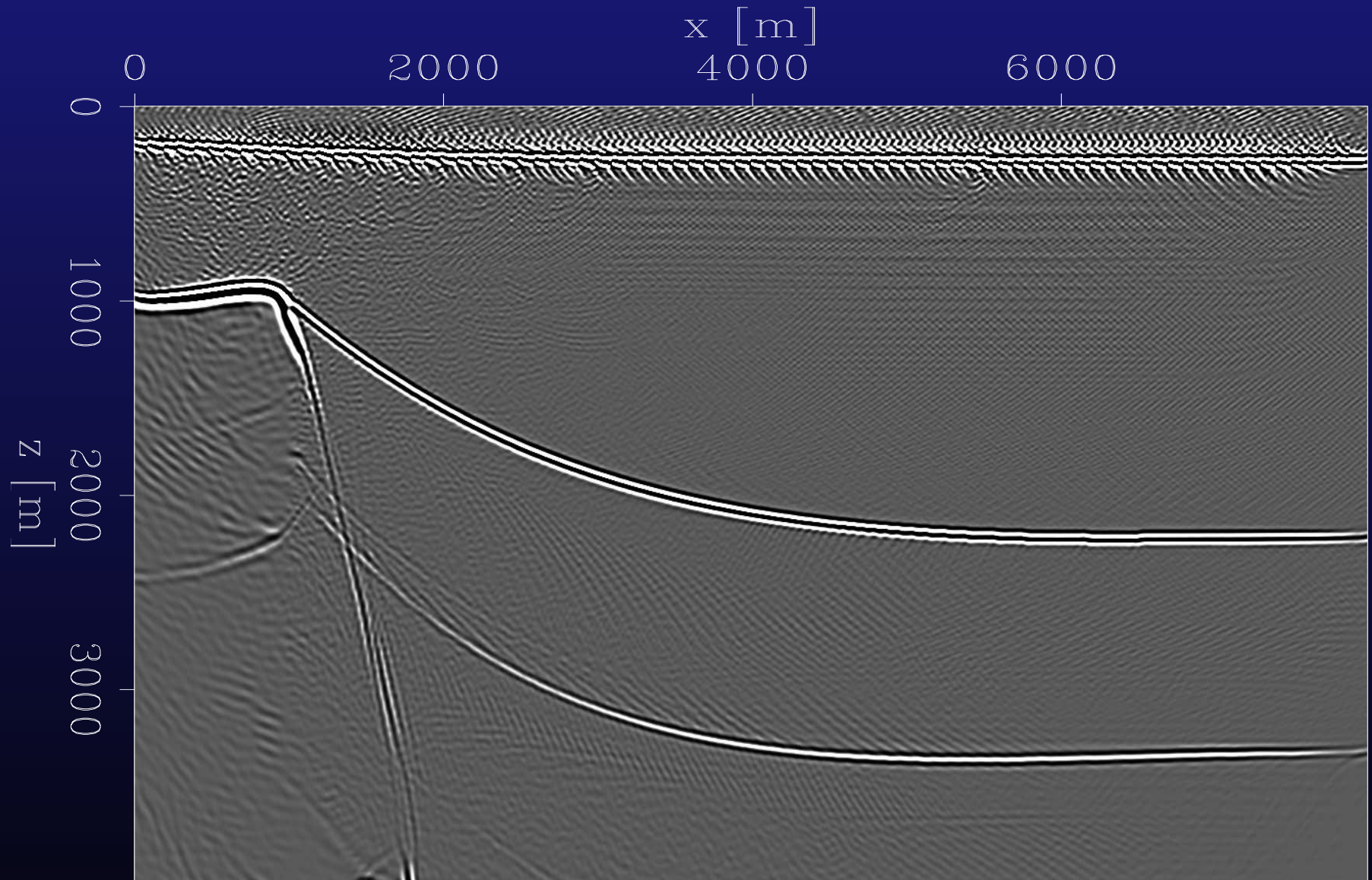
Isotropic migration in Cartesian coordinates



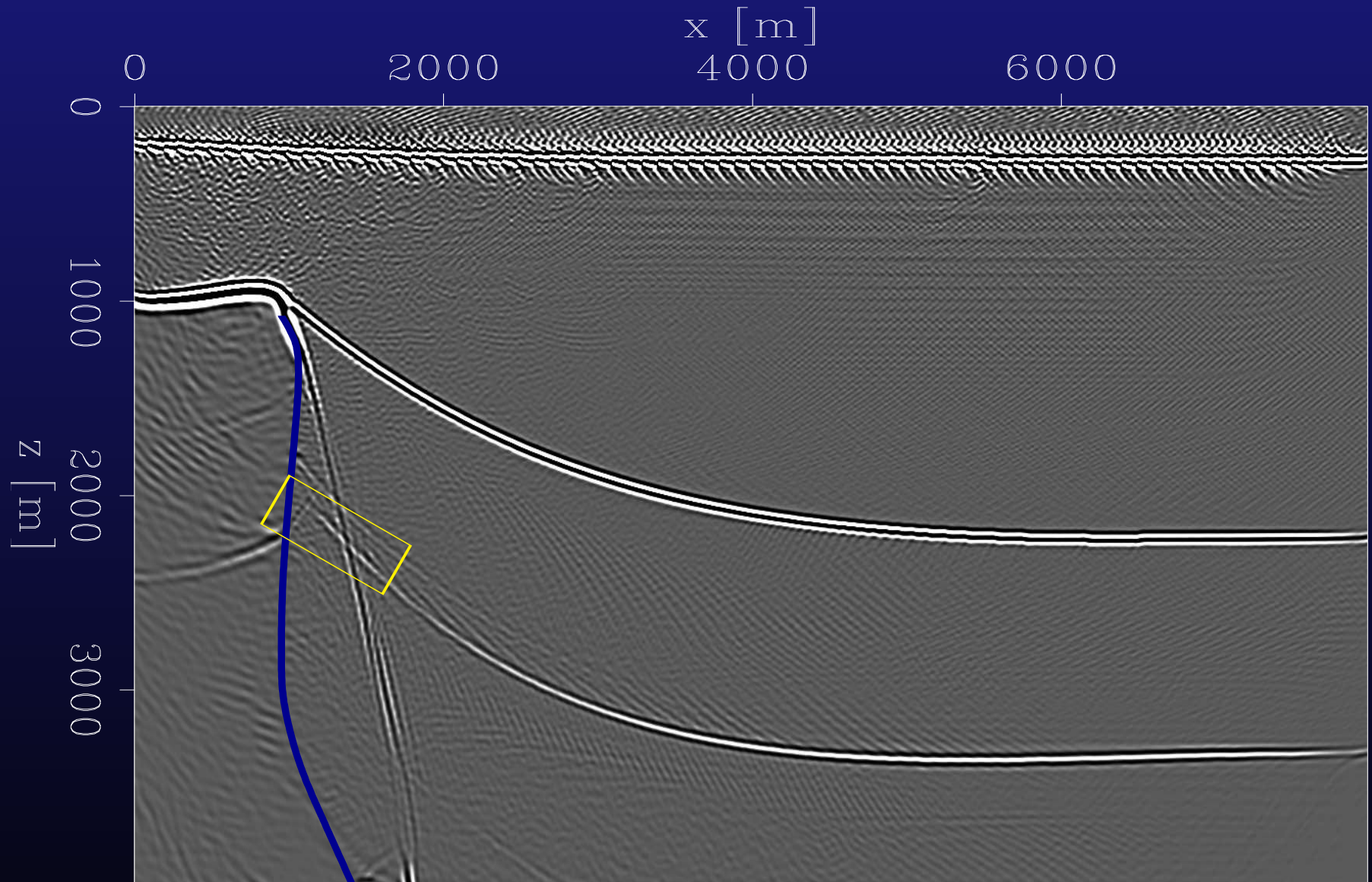
Isotropic migration in Cartesian coordinates



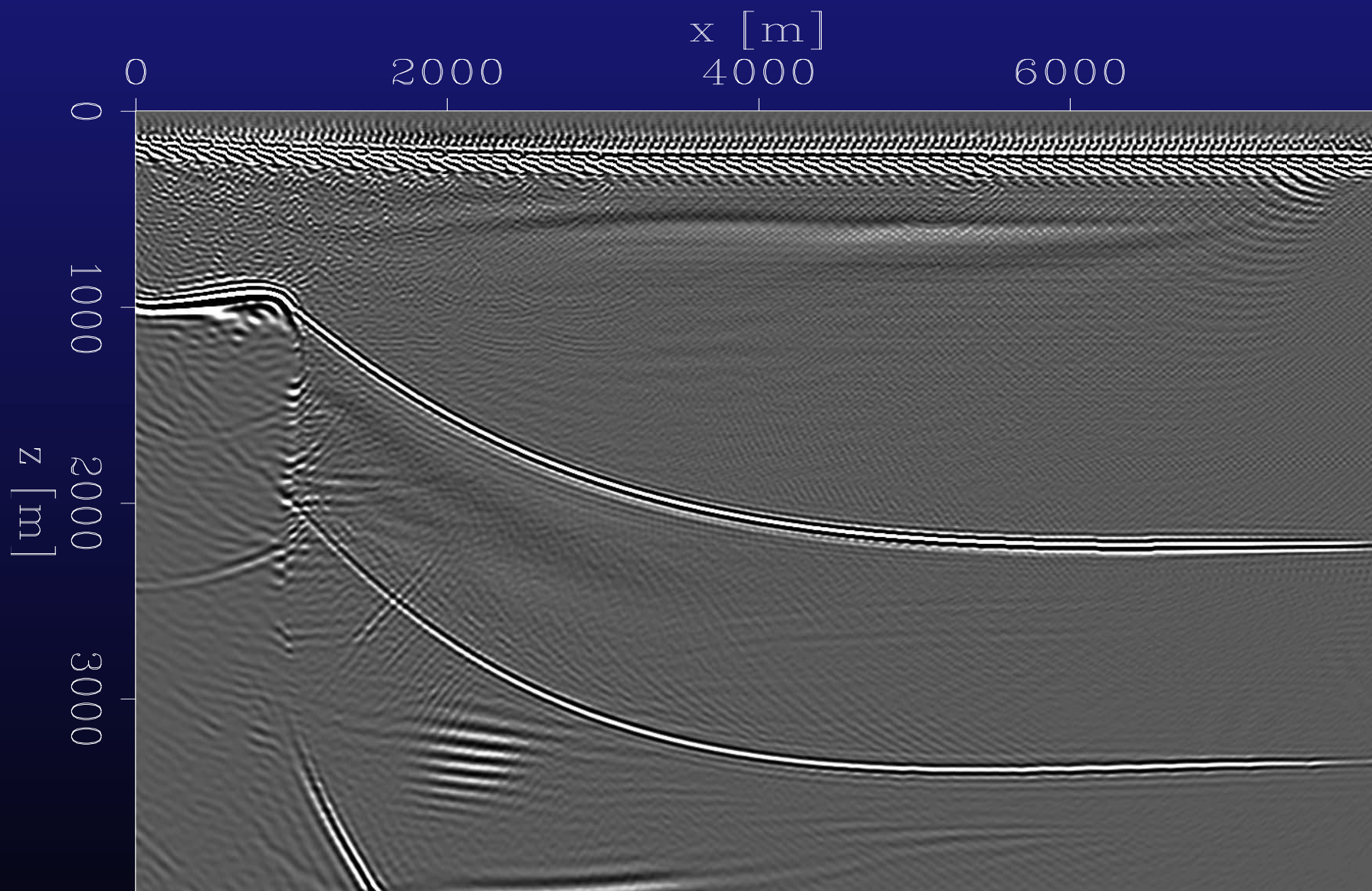
Isotropic migration in tilted coordinates



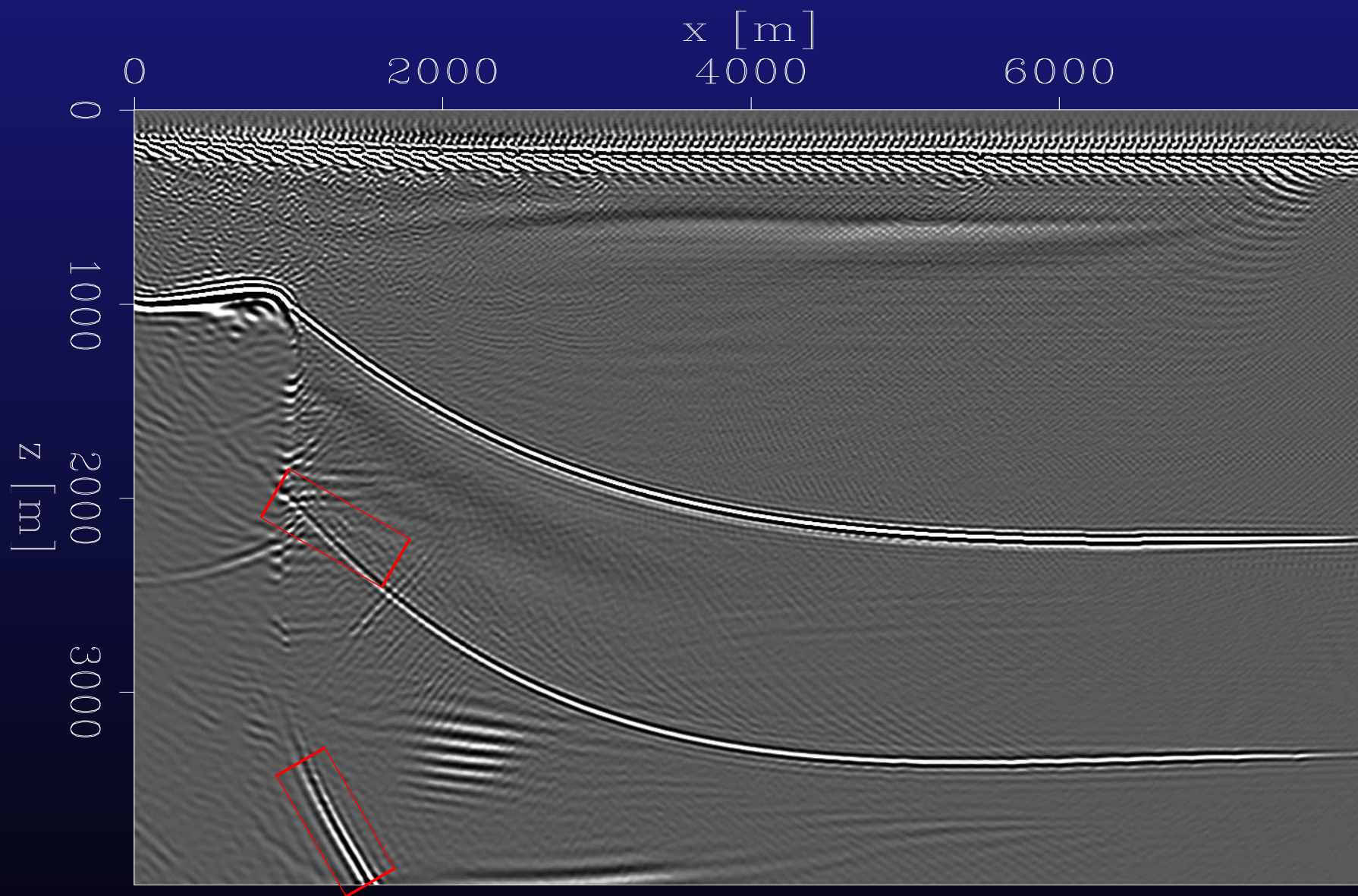
Isotropic migration in tilted coordinates



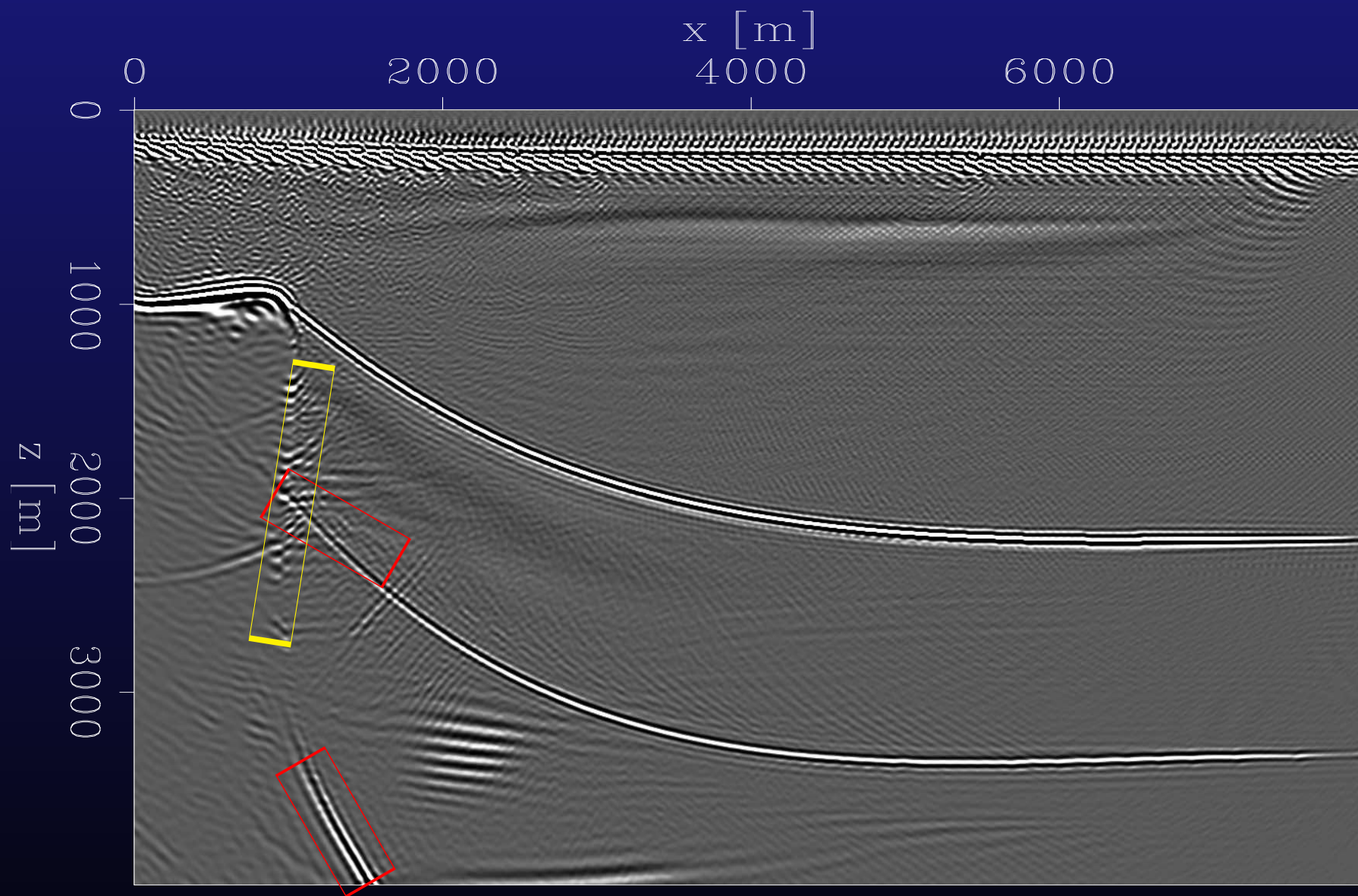
Anisotropic migration: Cartesian coordinates



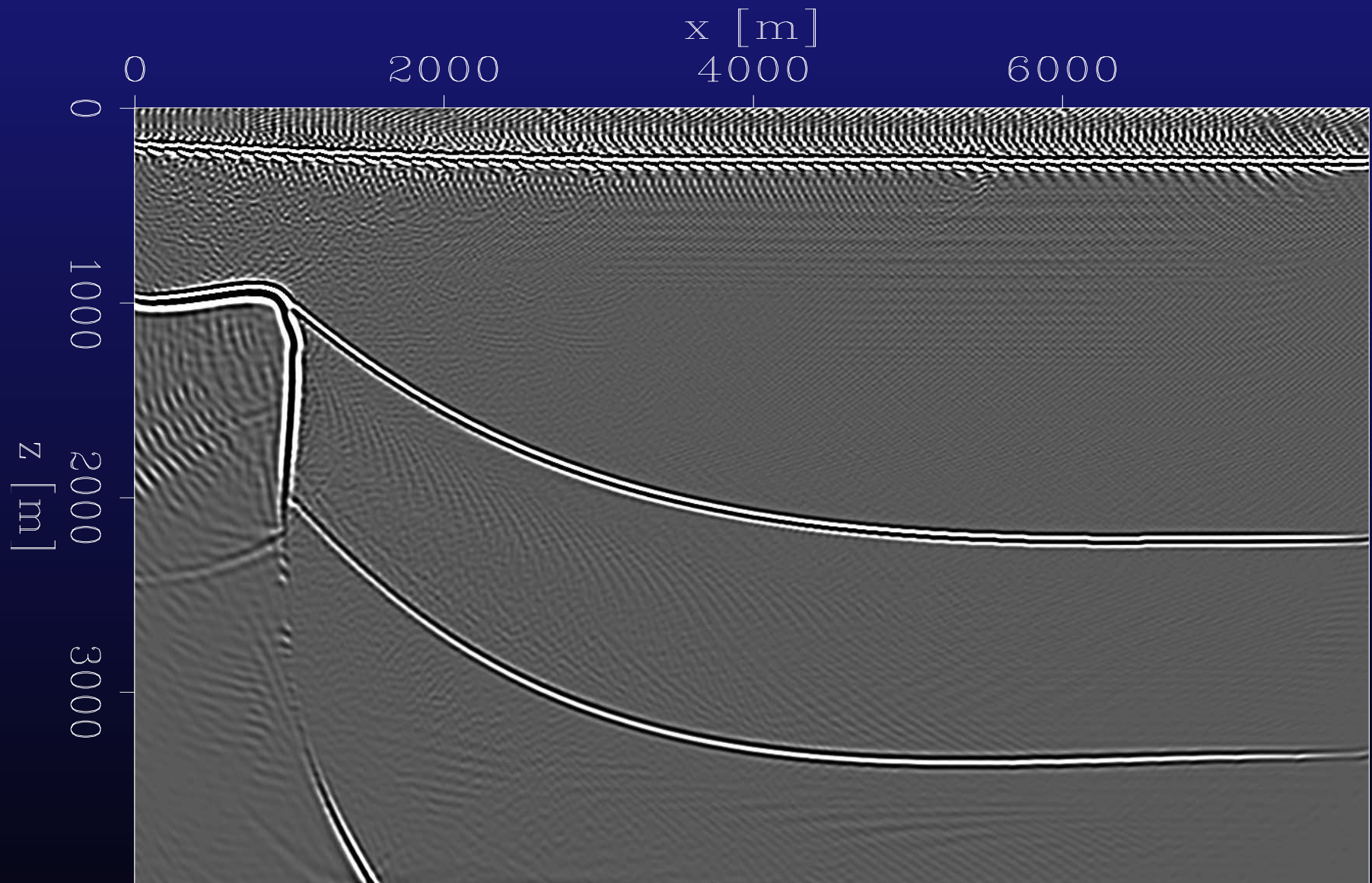
Anisotropic migration: Cartesian coordinates



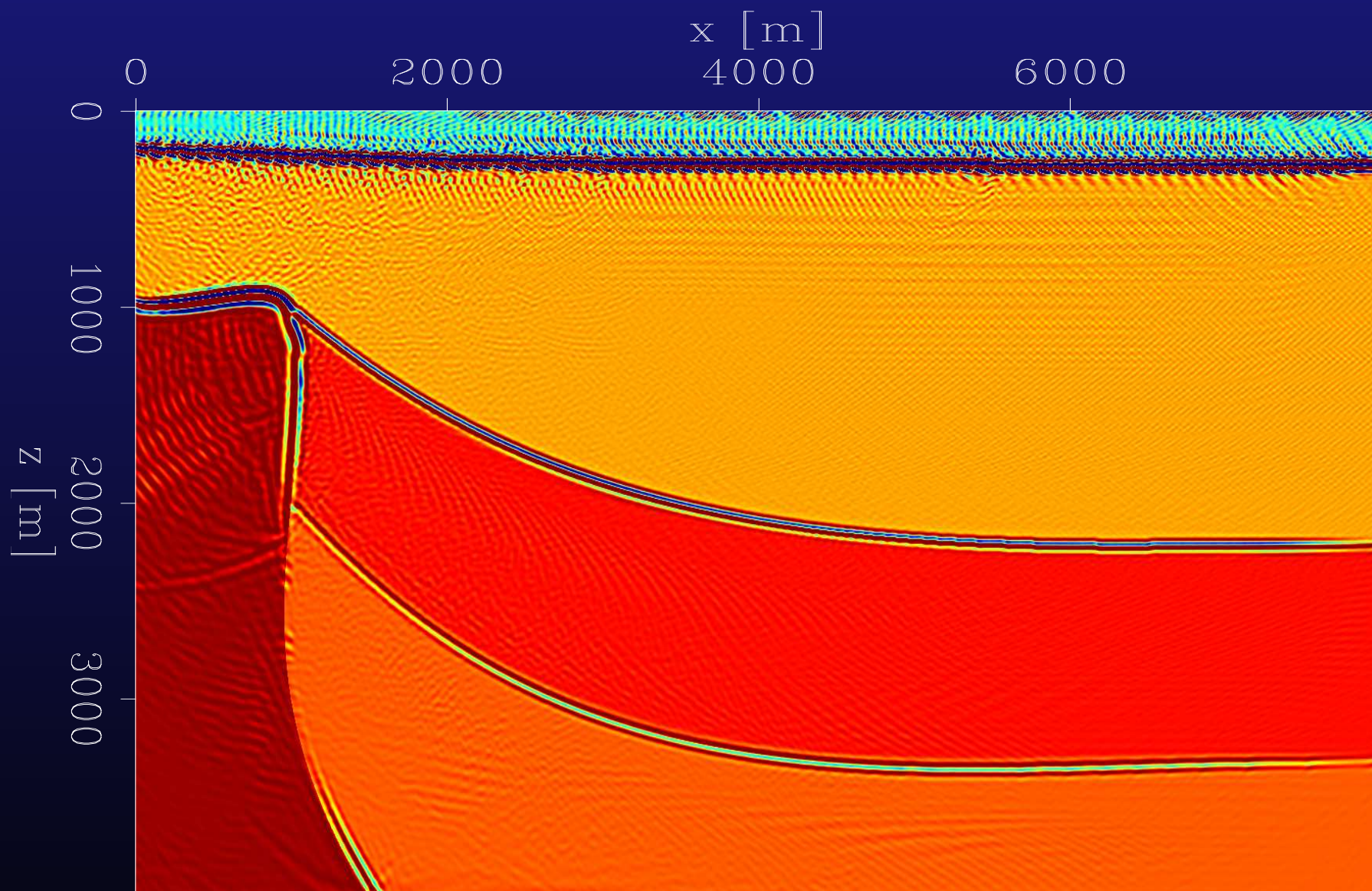
Anisotropic migration: Cartesian coordinates



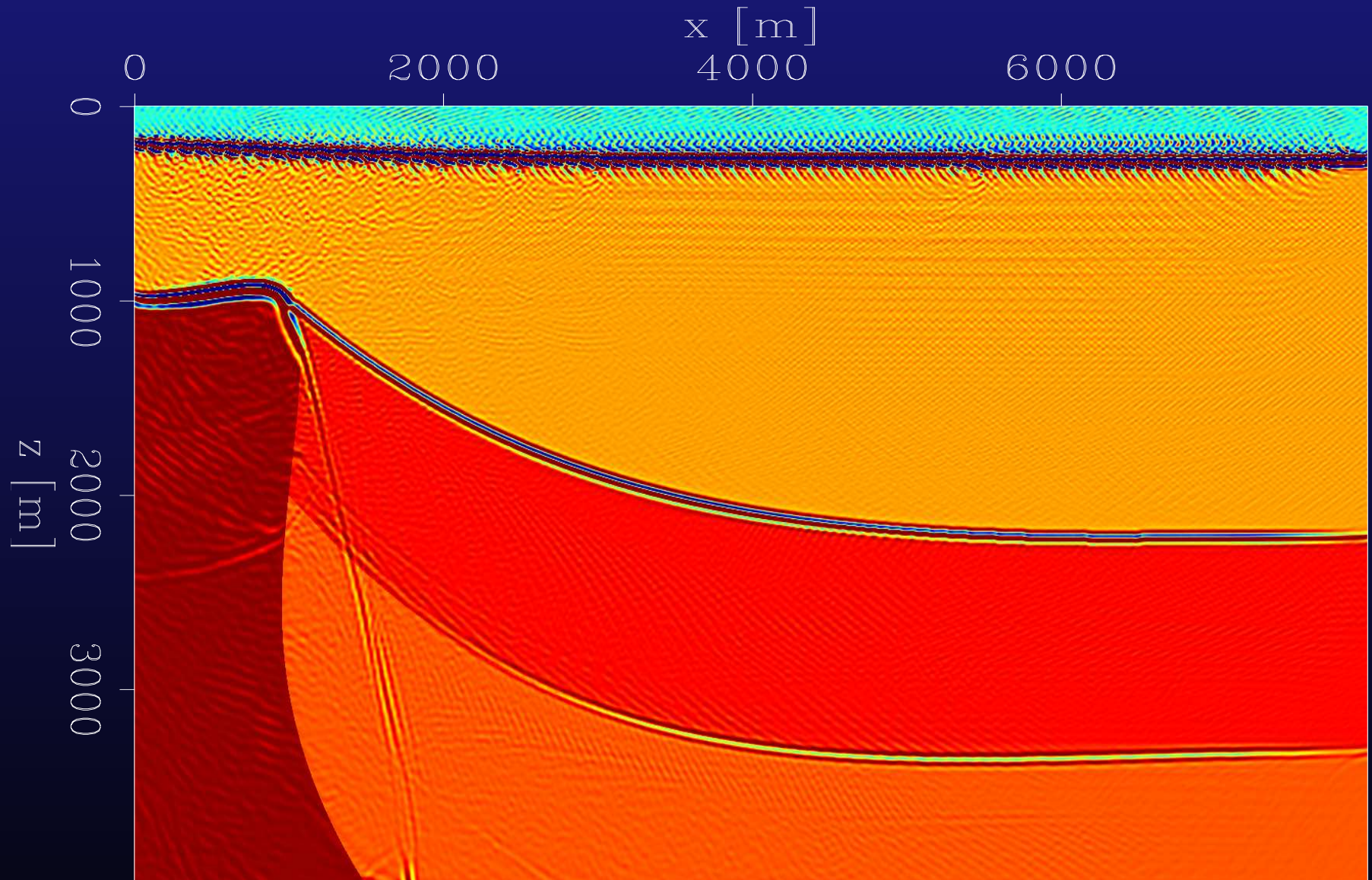
Anisotropic migration: tilted coordinates



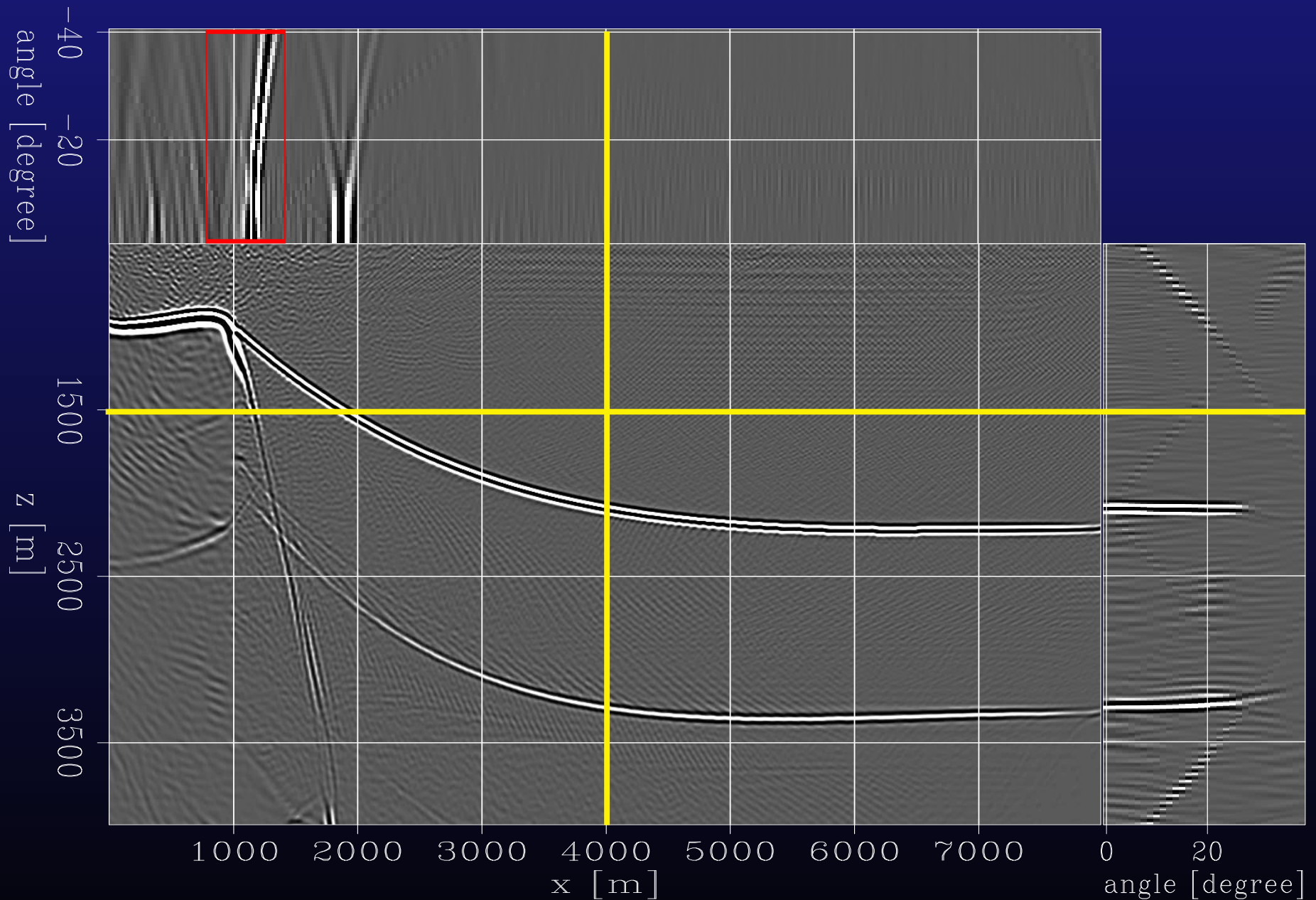
Anisotropic migration: tilted coordinates



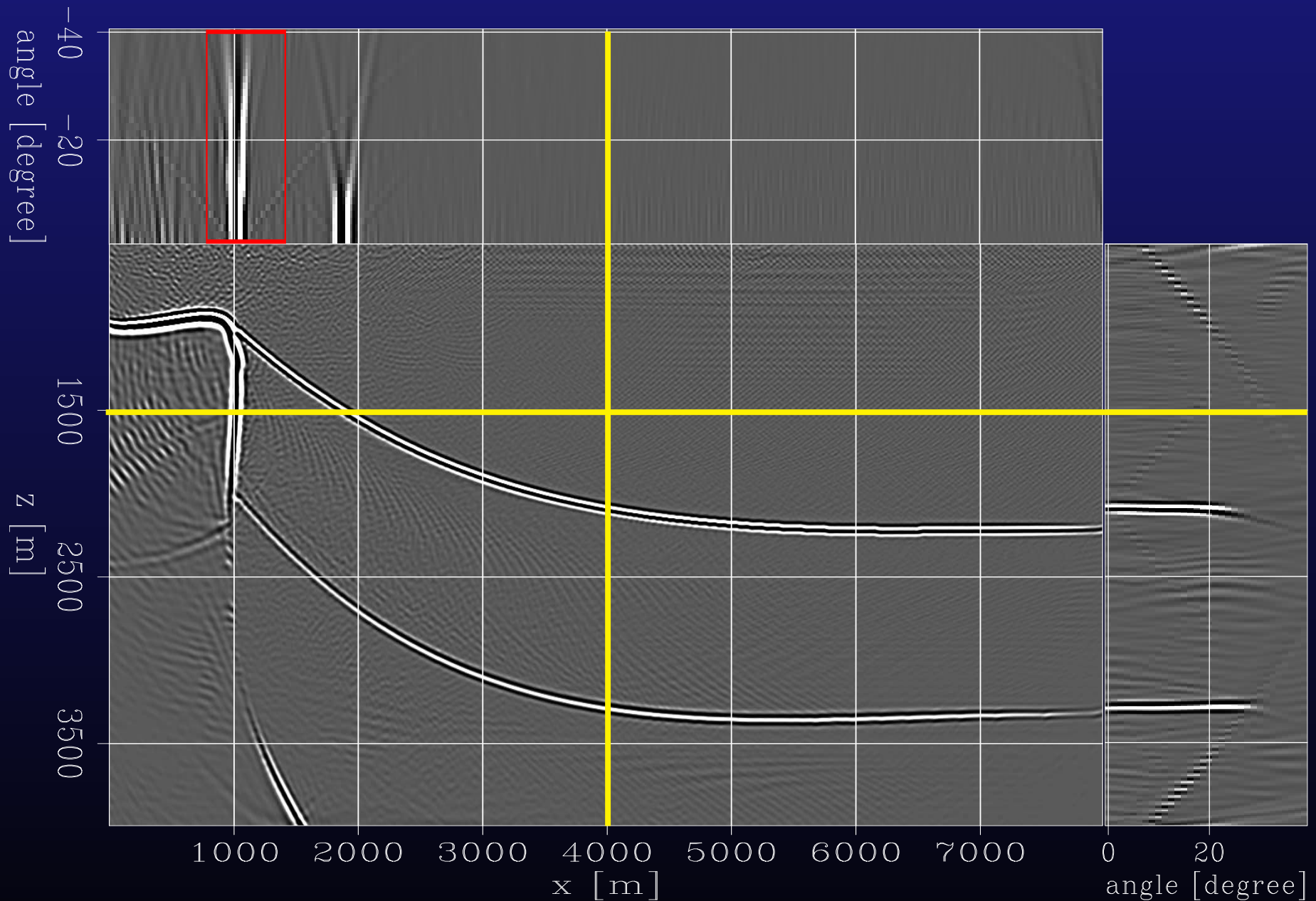
Isotropic migration: tilted coordinates



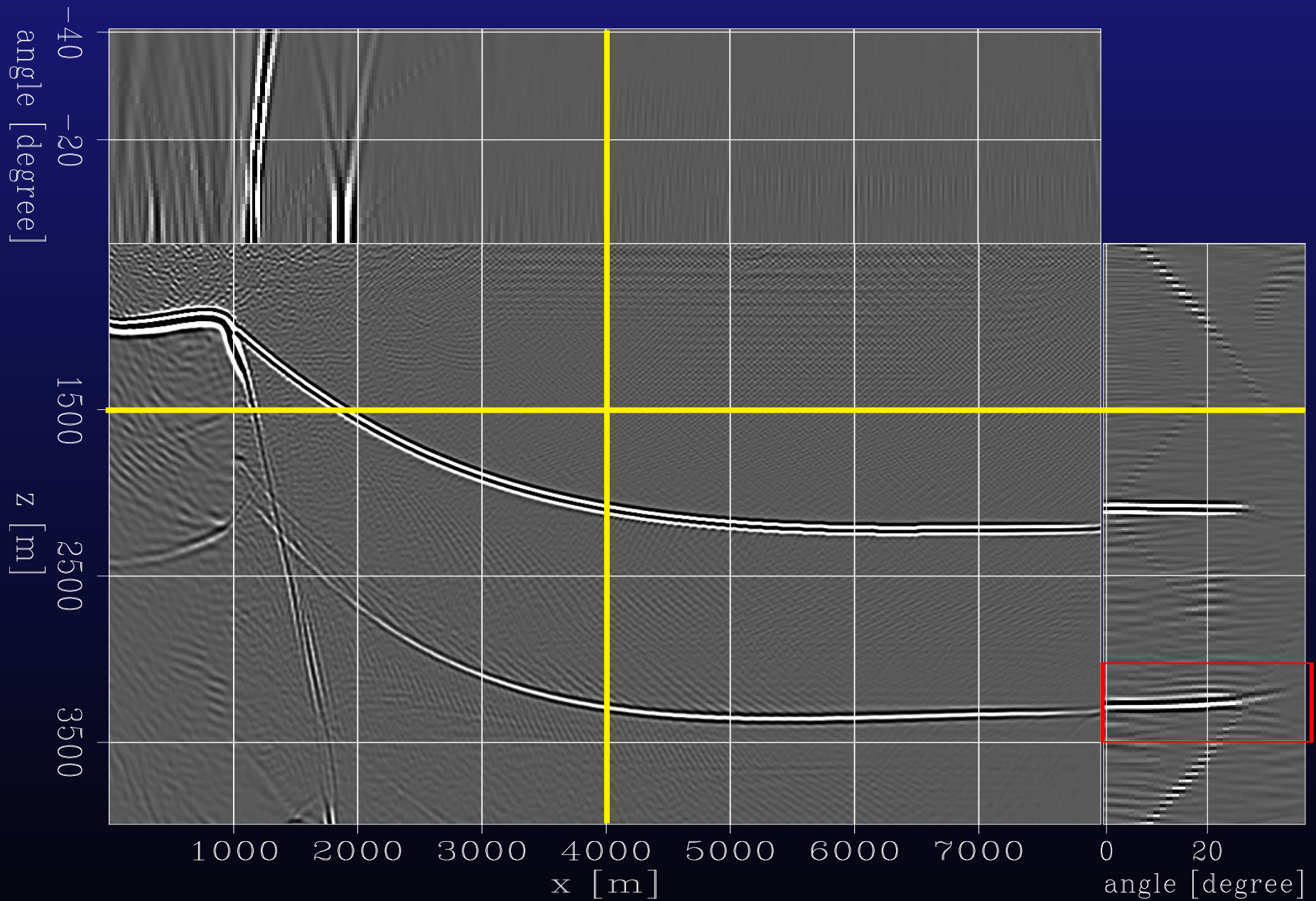
Angle-domain CIG: isotropic migration



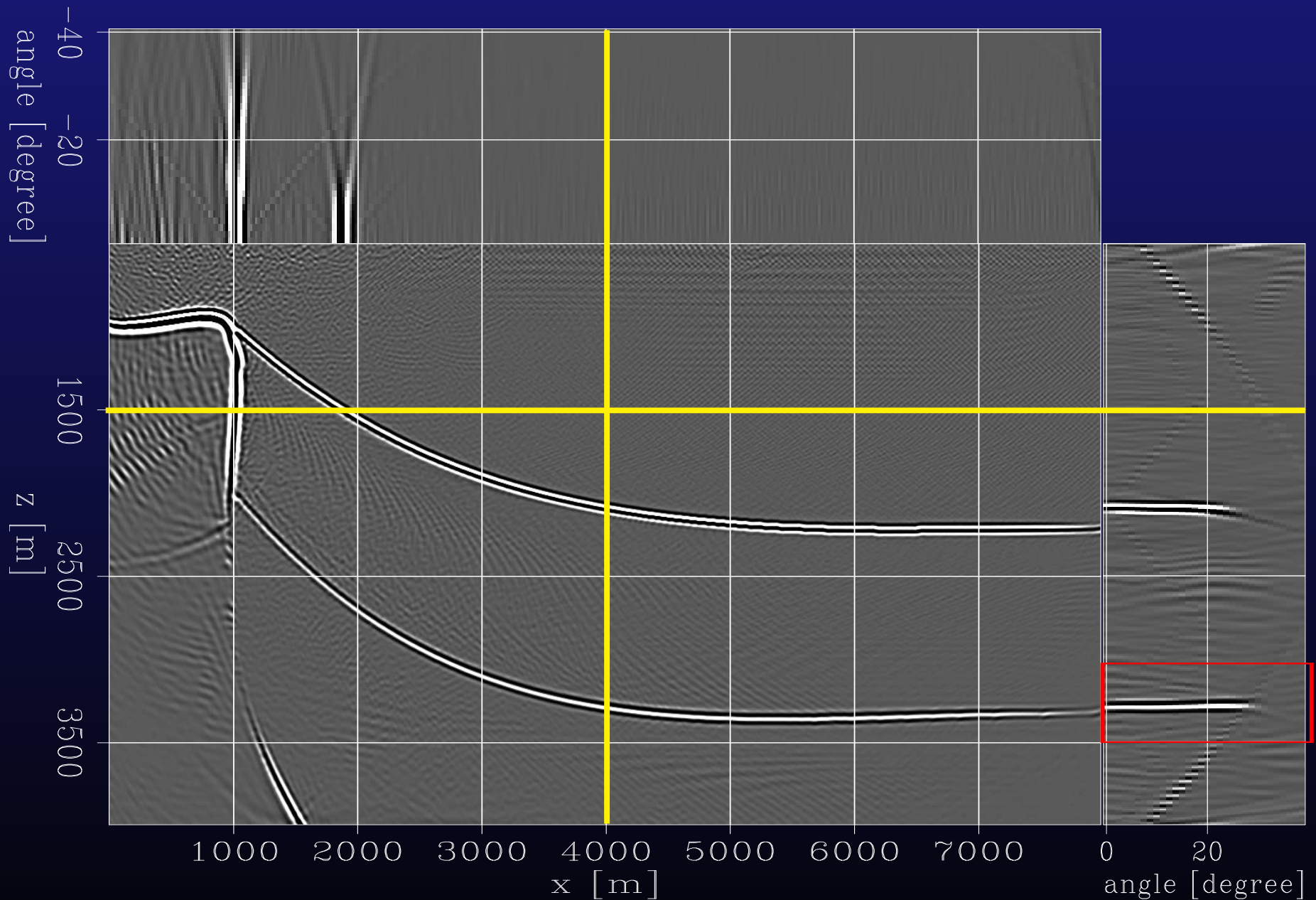
Angle-domain CI-G: anisotropic migration



Angle-domain CIG: isotropic migration



Angle-domain CI-G: anisotropic migration



Conclusion

- Plane-wave migration in tilted coordinates can handle waves propagating in a direction far from vertical.
- By the anisotropic plane-wave migration in tilted coordinates, we can image steeply dipping reflectors accurately in VTI media.
- Angle-domain CIGs at steeply dipping reflectors provide useful information for checking the error of anisotropic parameter.

Acknowledgements

We thank ExxonMobil for making the data available.