Finite-difference modelling with correction filters in a variable velocity medium

Peter Manning and Gary Margrave

- Introduction: uniform velocity corrections

- Finite spatial correction filter examples

- 1D model correction example

- 2D model correction movies

- Conclusions

- Acknowledgements

CREWES

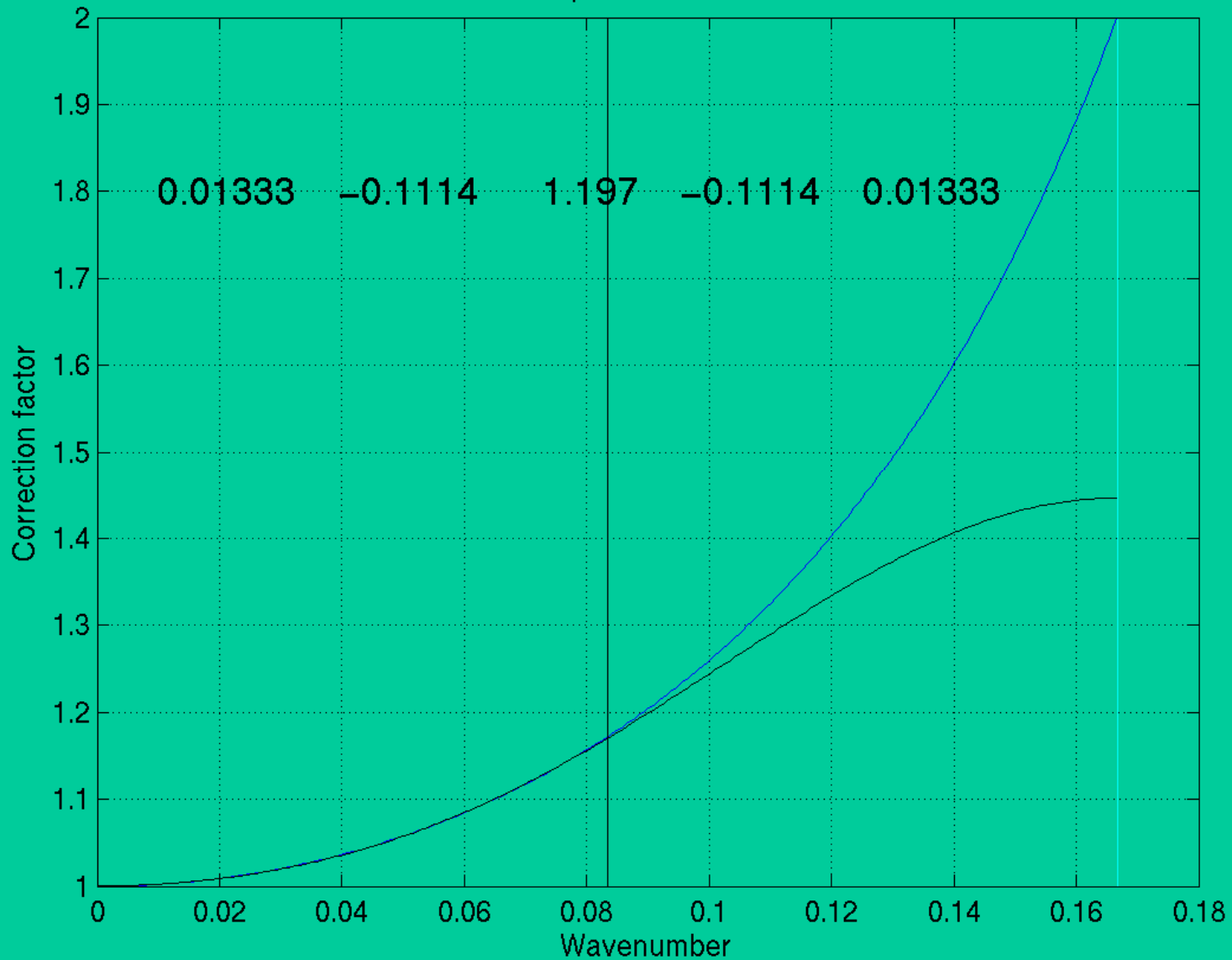# Finite-difference time-stepping equation in 1D
<u>corrected</u>

$$\phi\left(x, t+\Delta t, k\right) = 2\phi\left(x, t, k\right) - \phi\left(x, t-\Delta t, k\right)$$

$$+\left(\frac{v\Delta t}{\Delta x}\right)^2 \left[\frac{\mathrm{sinc}^2\left(\frac{kv\Delta t}{2}\right)}{\mathrm{sinc}^2\left(\frac{k\Delta x}{2}\right)}\right] D_x^{\,2}\phi\left(x, t, k\right)$$

Correction factor in the box

Short filter spectrum

Correction multiplier, Pvel=1000 Dx=3 Dt=0.0015
Operator size 5

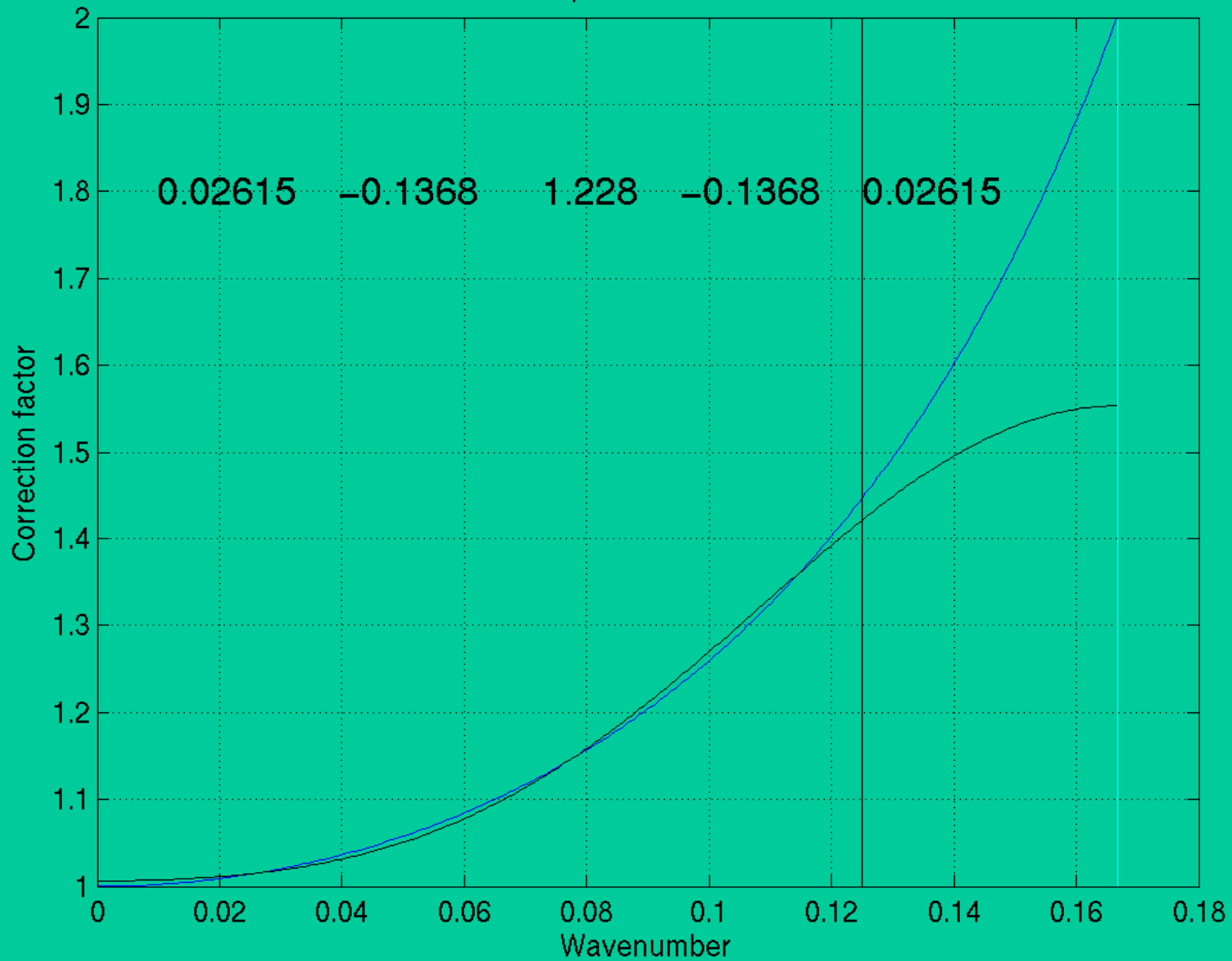0.01333   −0.1114   1.197   −0.1114   0.01333

Ideal spectrum in blue

Short filter spectrum

Correction multiplier, Pvel=1000 Dx=3 Dt=0.0015

Operator size 5

0.02615   −0.1368   1.228   −0.1368   0.02615

Correction factor

Wavenumber

Ideal spectrum in blue

Uncorrected/corrected comparison

- - - - Initial wavelet
—— Propagated wavelets

- - - - Initial wavelet
—— Propagated wavelets

Fine-uncorrected/corrected comparison

Legend:
- - - - Initial wavelet
──── Propagated wavelets

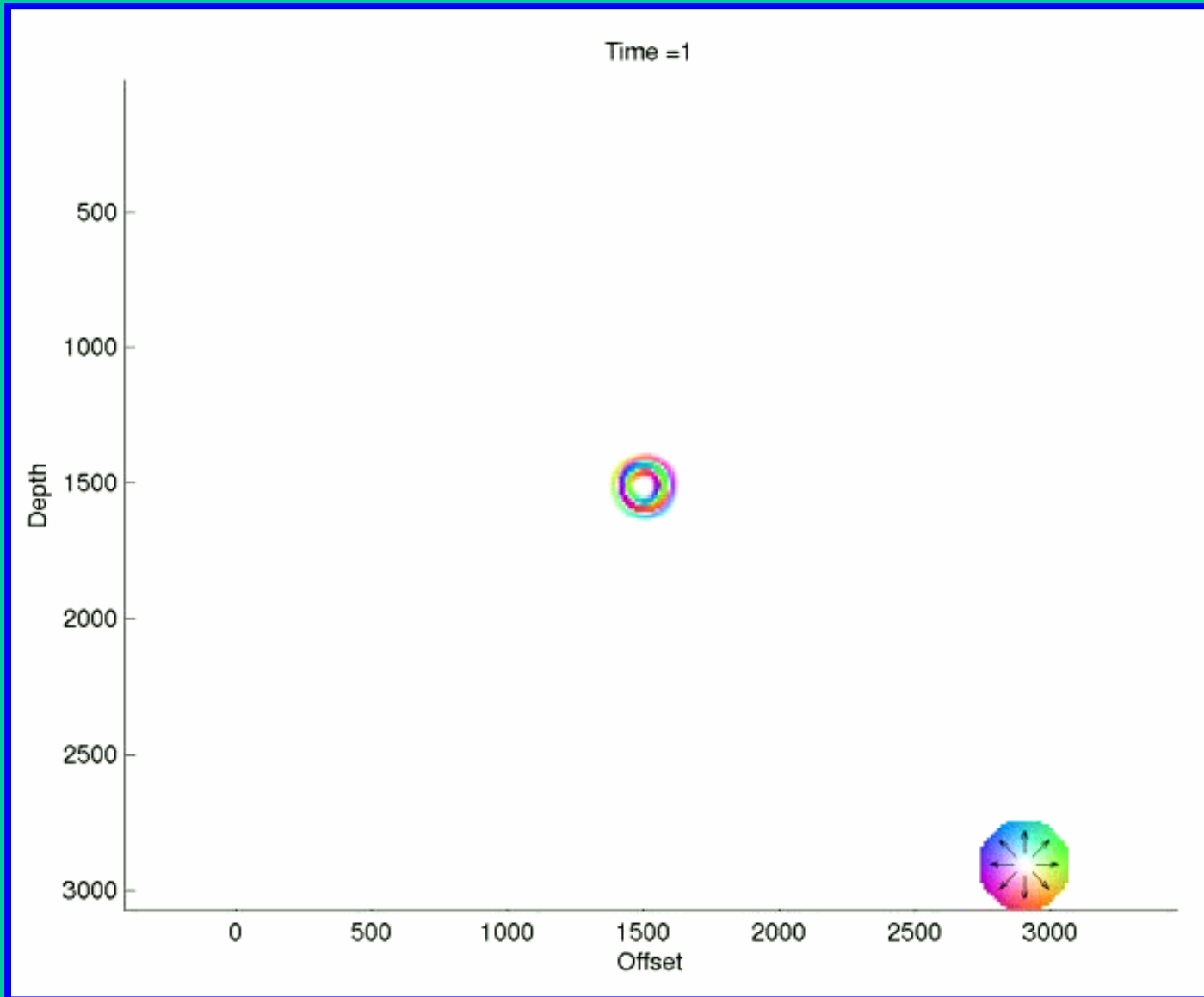- - - - Initial wavelet
──── Propagated wavelets
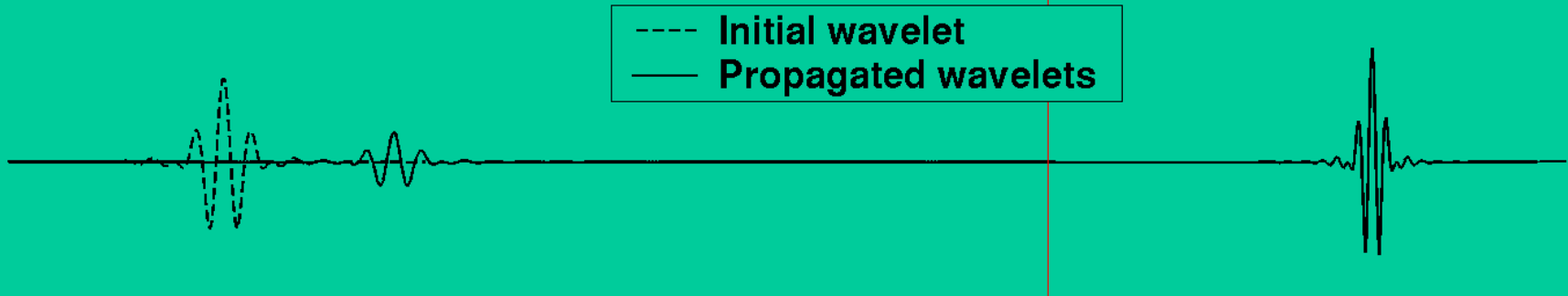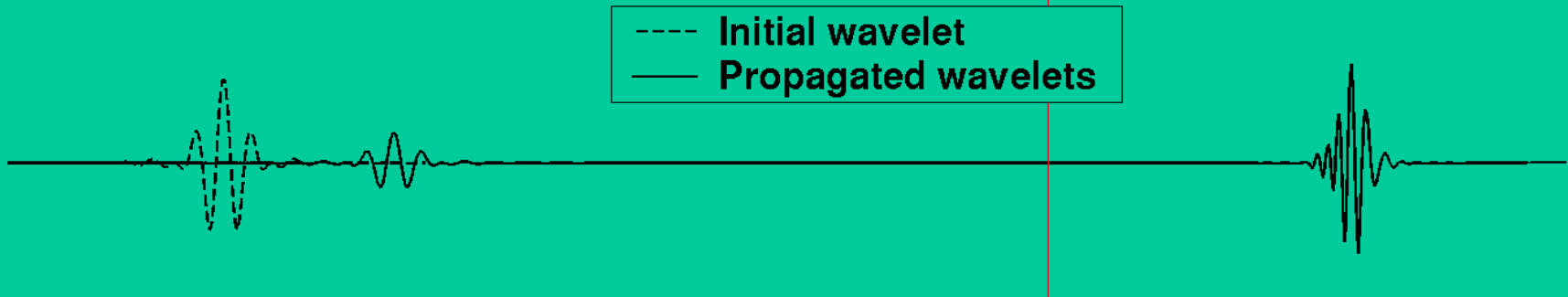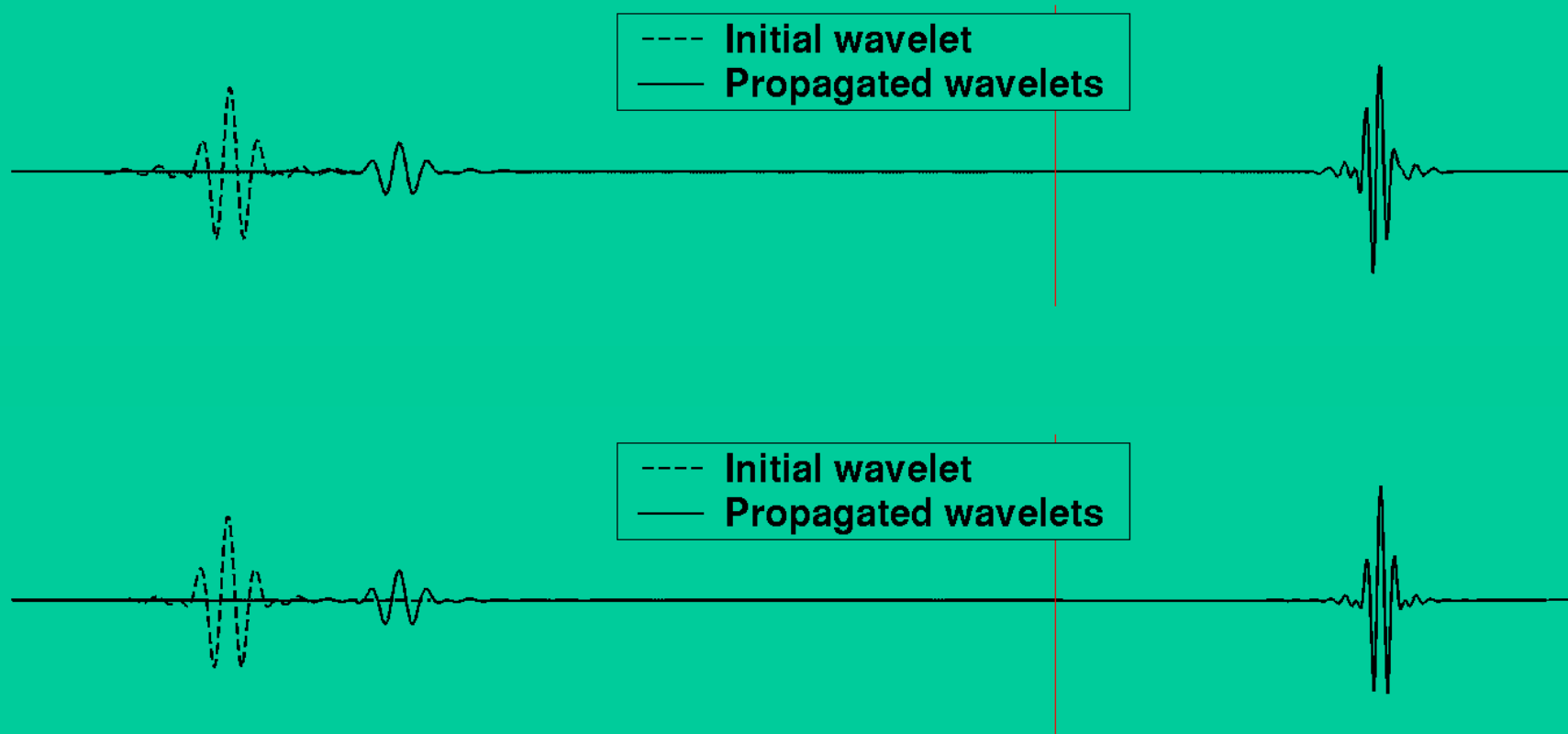
Fine model 1/2 sample rates of corrected

Uncorrected model

Time =1

Depth

Offset
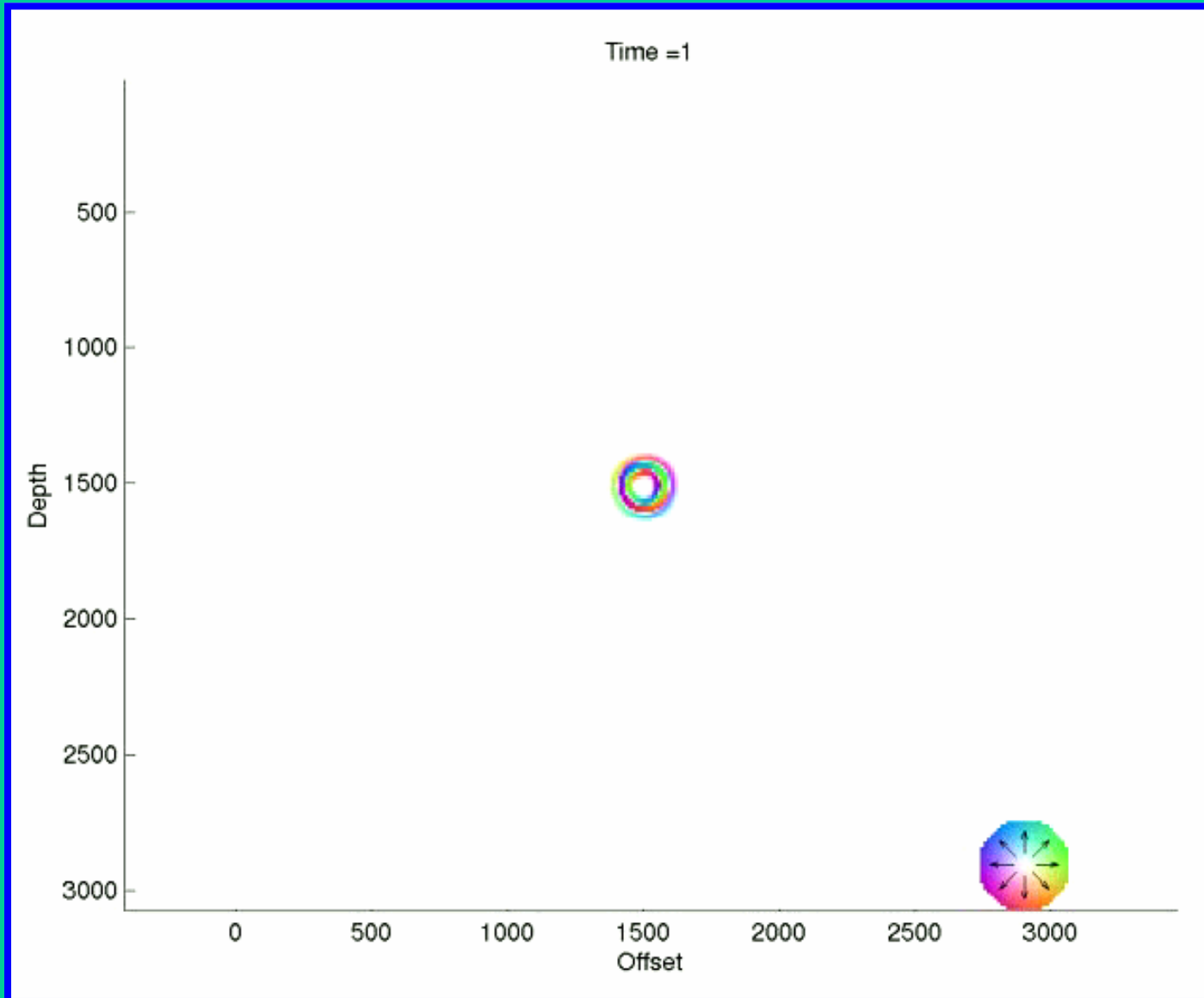
Movie

Corrected model

Movie

Uncorrected model

No correction
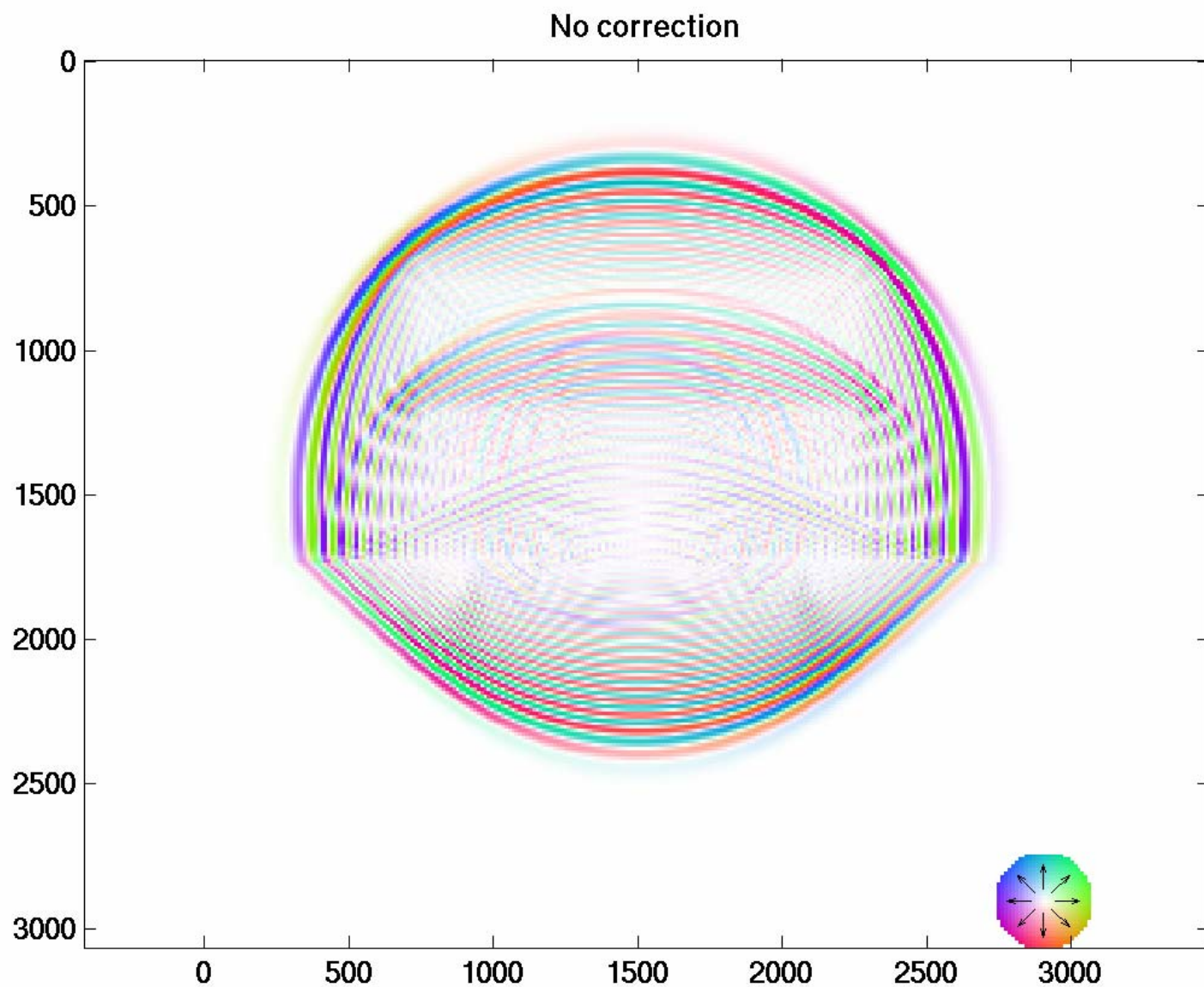
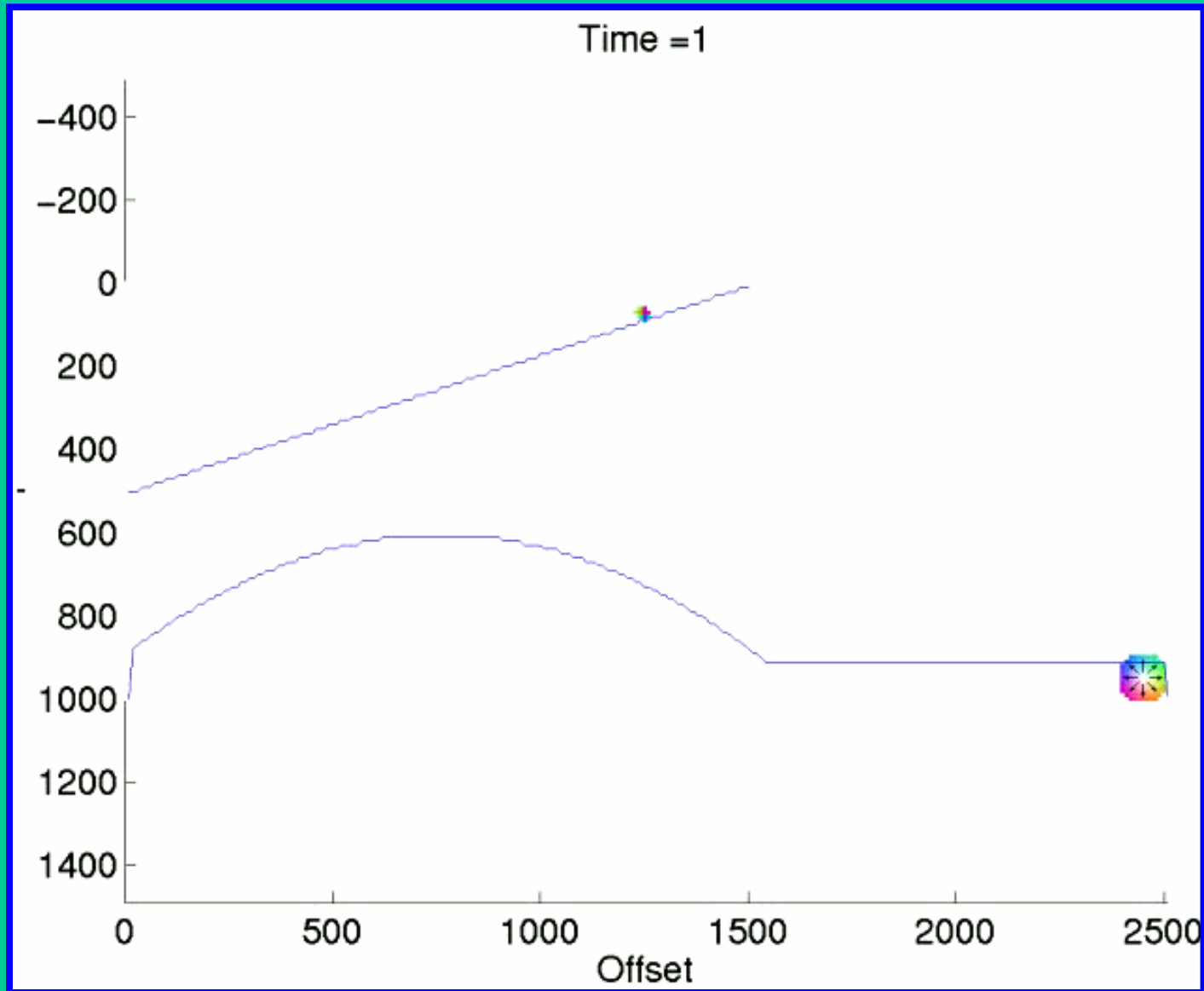

Last frame

Corrected model

Correction 7x7 to 75% of spectrum
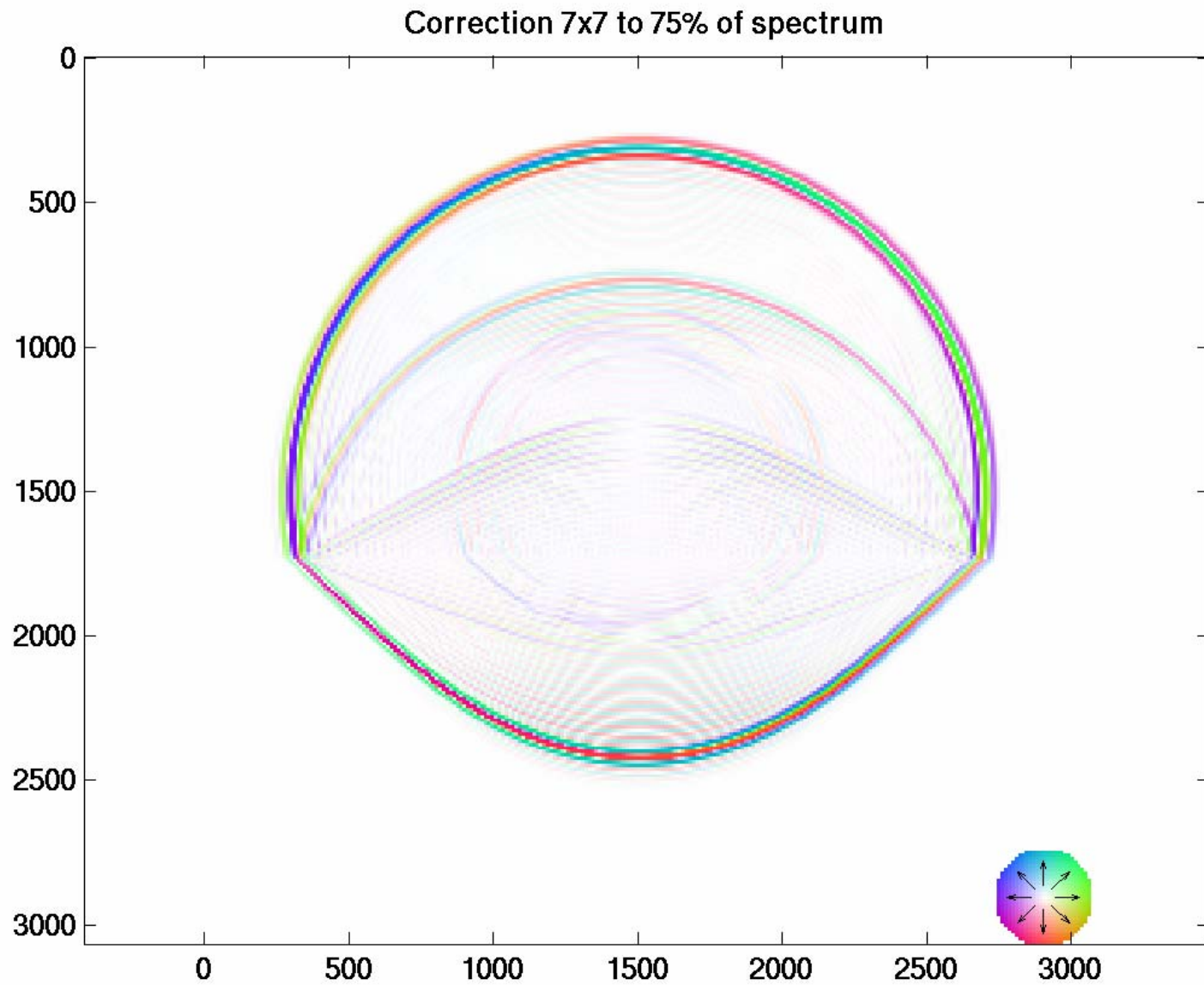
Last frame

High velocity wedge model – displacement

Uncorrected

High velocity wedge model – displacement

Time =1
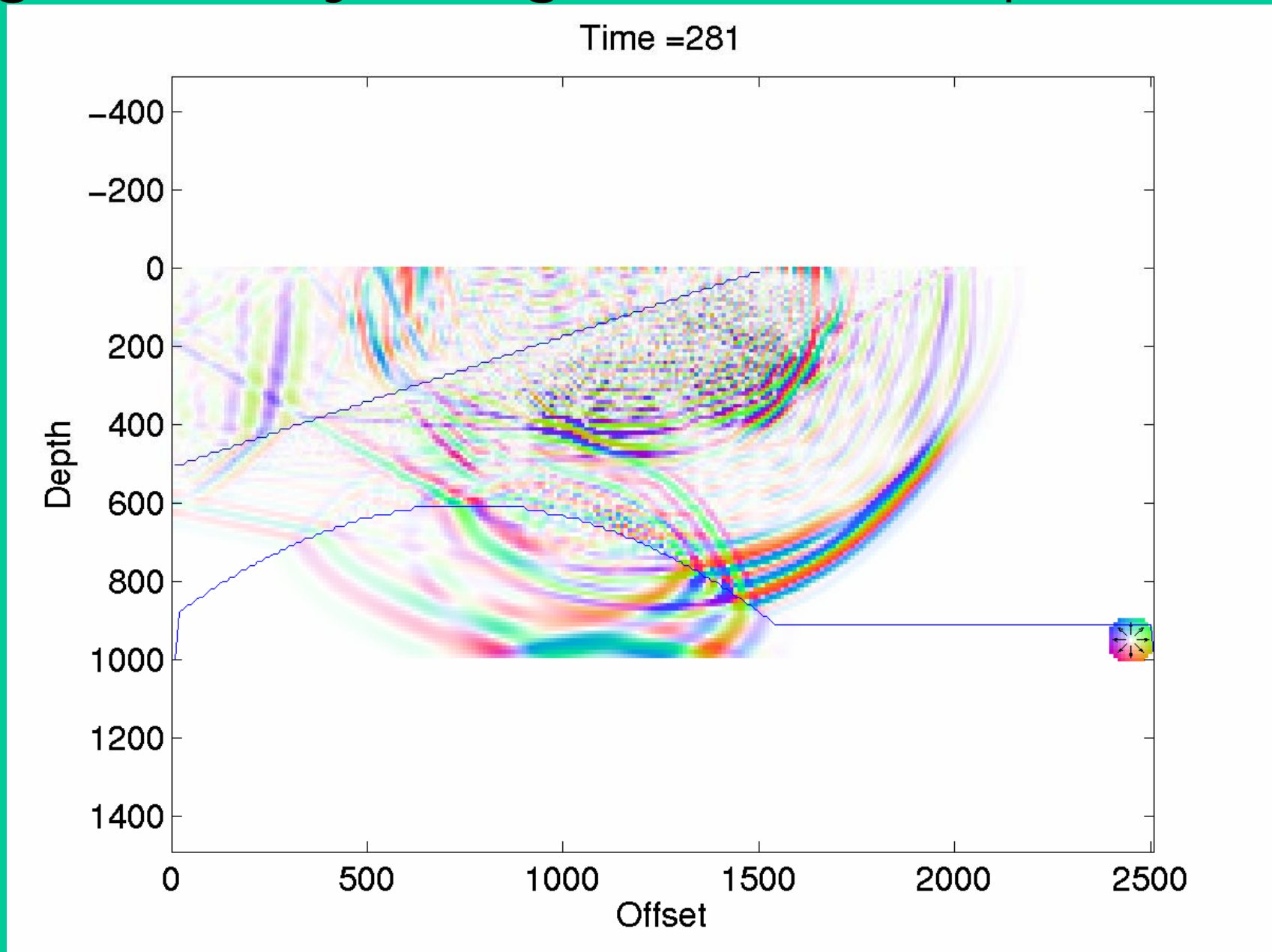
Offset

Corrected

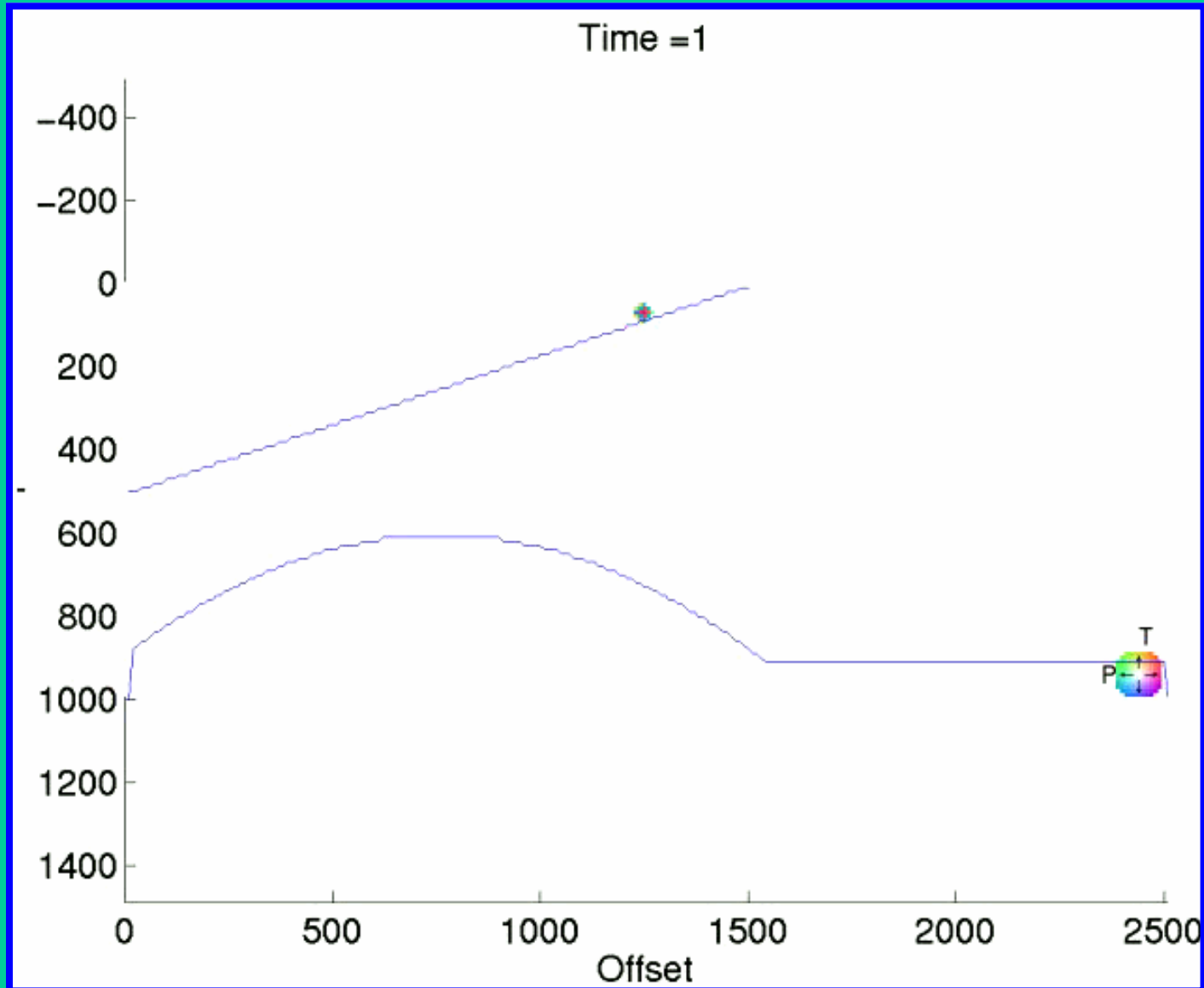# High velocity wedge model – displacement

Time =281
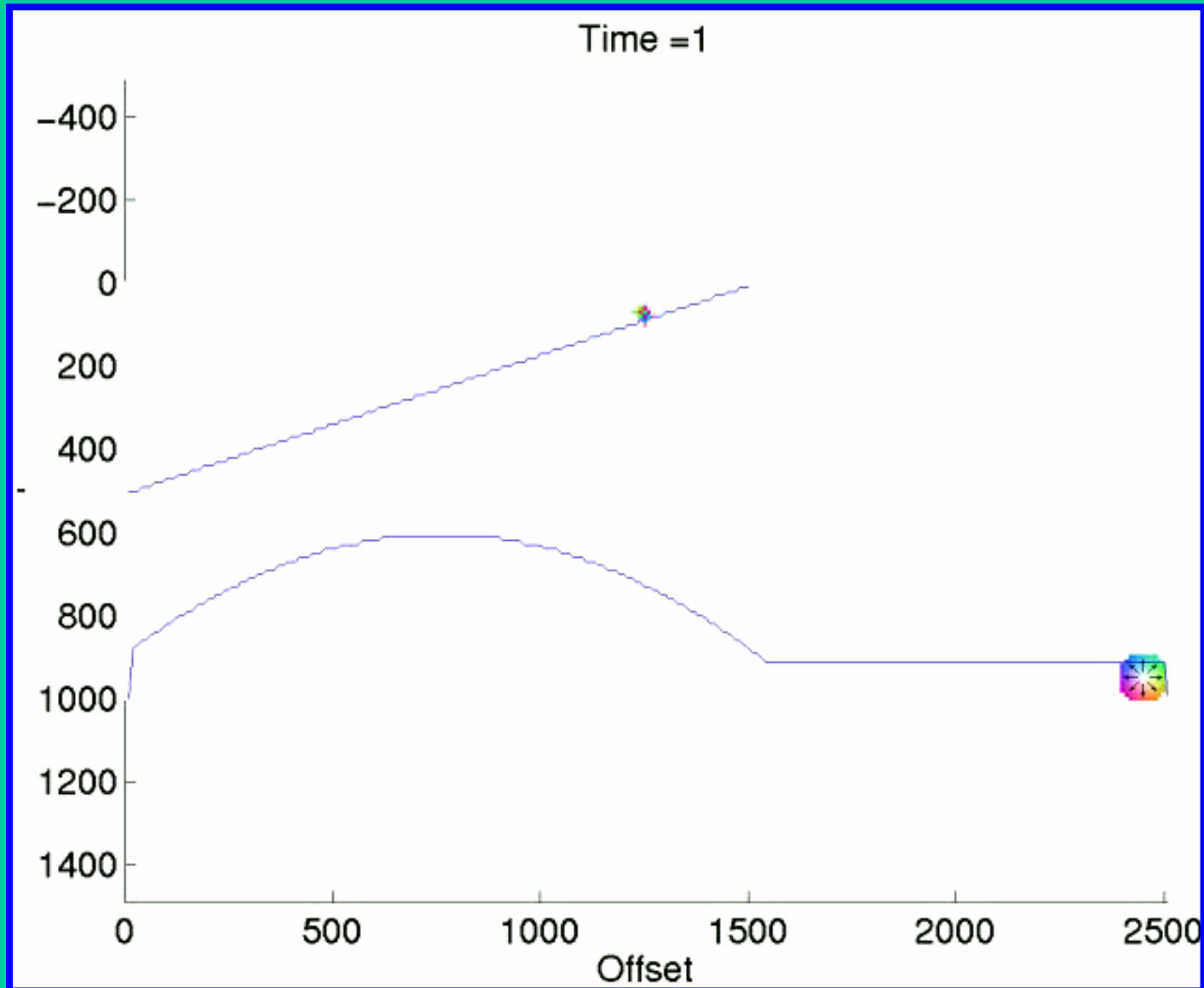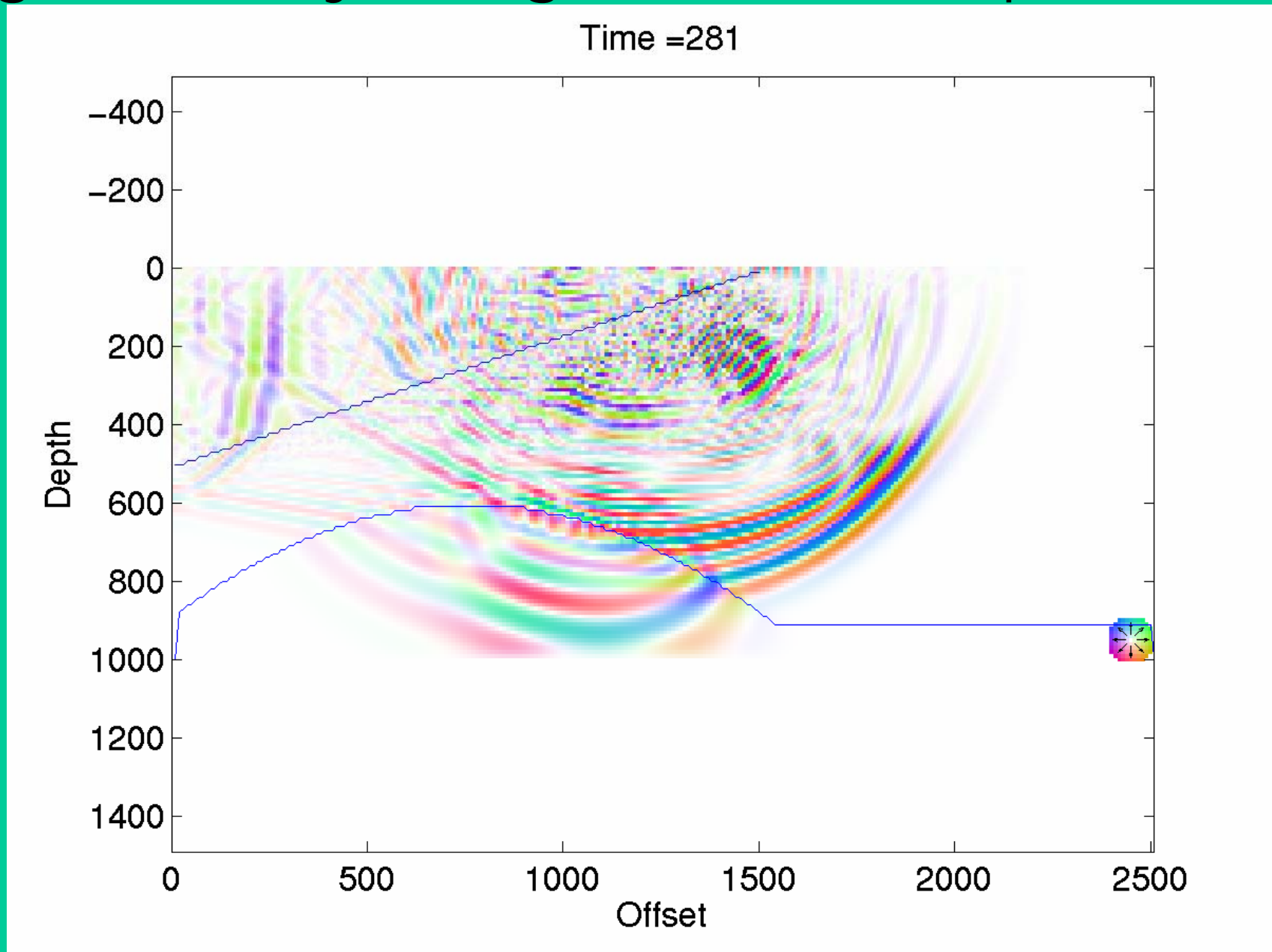
Final frame - uncorrected

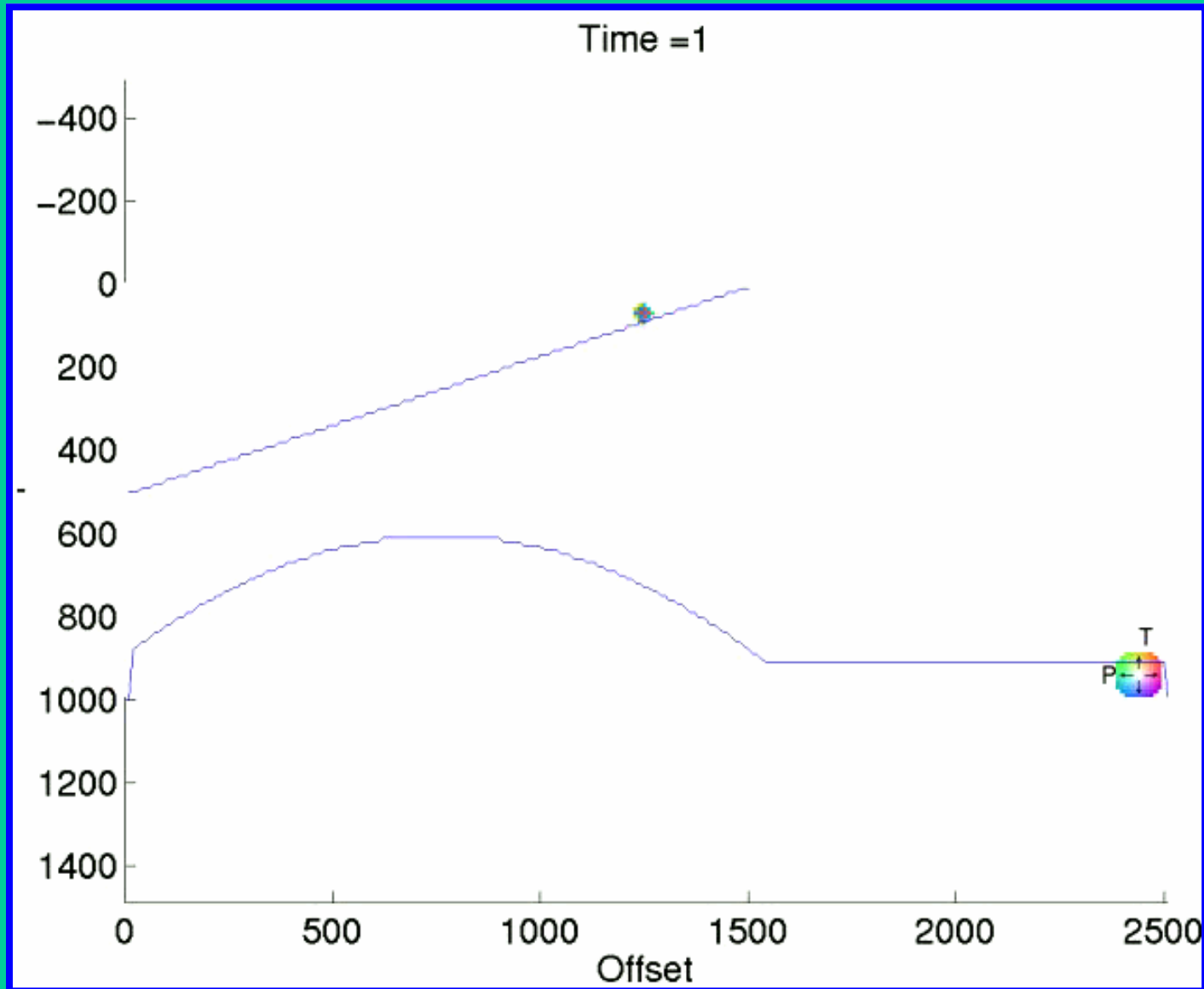# High velocity wedge model – displacement

Final frame - corrected
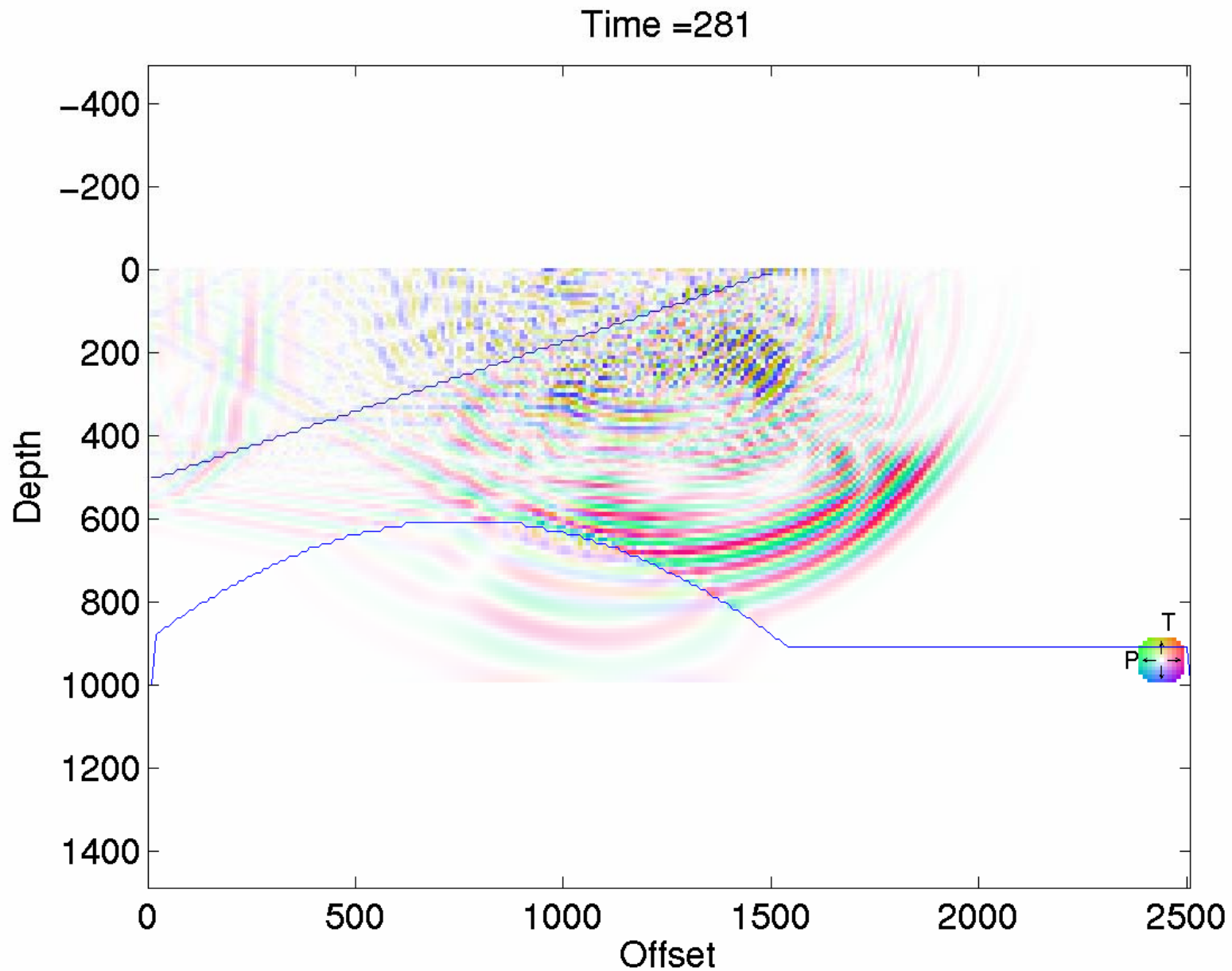
High velocity wedge model – P/T

Uncorrected

High velocity wedge model – P/T
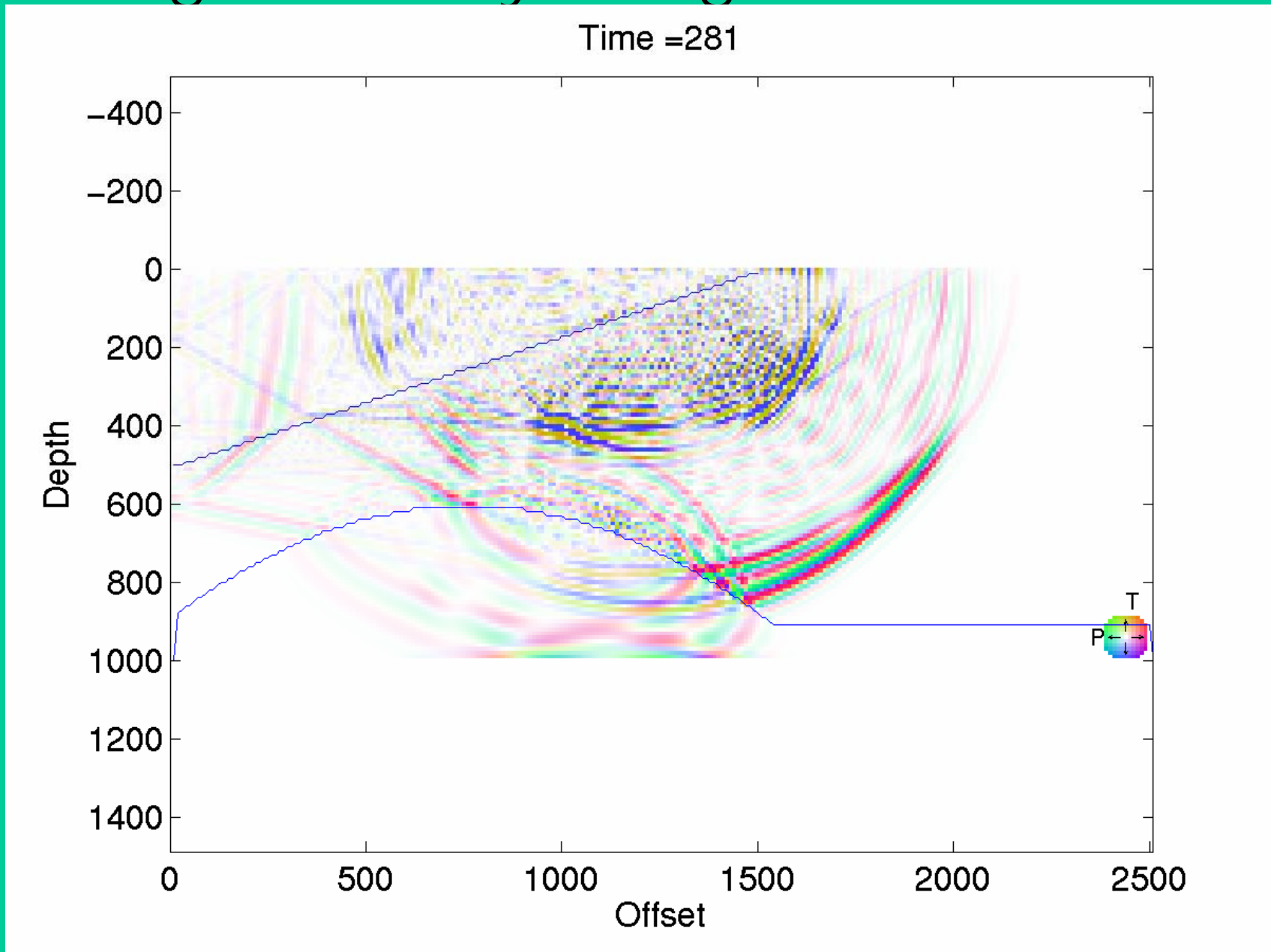

Corrected

High velocity wedge model – P/T

Time =281

Final frame - uncorrected

High velocity wedge model – P/T

Final frame - corrected

Conclusions

- The 'corrections' developed in earlier papers may be approximated by small spatial filters.

- Spatial filters may be applied to inhomogeneous velocity models, with good results.

Future work

- Correction filters will be designed for a velocity range, so a limited set of filters may be applied to an arbitrary model.

- More efficient computation methods will be investigated.

Acknowledgements

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