A Practical Implementation of FOCI

– FORFOCI Depth Migration

W. Sun, R. Maier, G. Margrave, M. Lamoureux

Outline

- Introduction
- What is FOCI
- The Components of FORFOCI
- The Design of FORFOCI
- Future Work
- Conclusion

Introduction

- FOCI is a 2D prestack short record depth migration
- FOCI was initially implemented in MATLAB
- FORFOCI is written in FORTRAN 95 and C
- FORFOCI is designed to be flexible and efficient.
- A contribution to our sponsors' library.

FOCI

The heart of FOCI is to implement explicit wavefield extrapolation for seismic depth migration in the space frequency domain. Special techniques are involved to improve the stability and efficiency.

The n-dimensional wavefield extrapolation formula in the space-frequency domain is

$$\psi(x, z + \Delta z, \omega) = W(\Delta z) * \psi(x, z, \omega)$$

ψ Is the space-frequency domain wavefield

ω the temporal frequency

$$\hat{W}(\Delta z) = \exp\left(i\Delta z\sqrt{\frac{\omega^2}{v(x)^2} - k_x^2}\right)$$

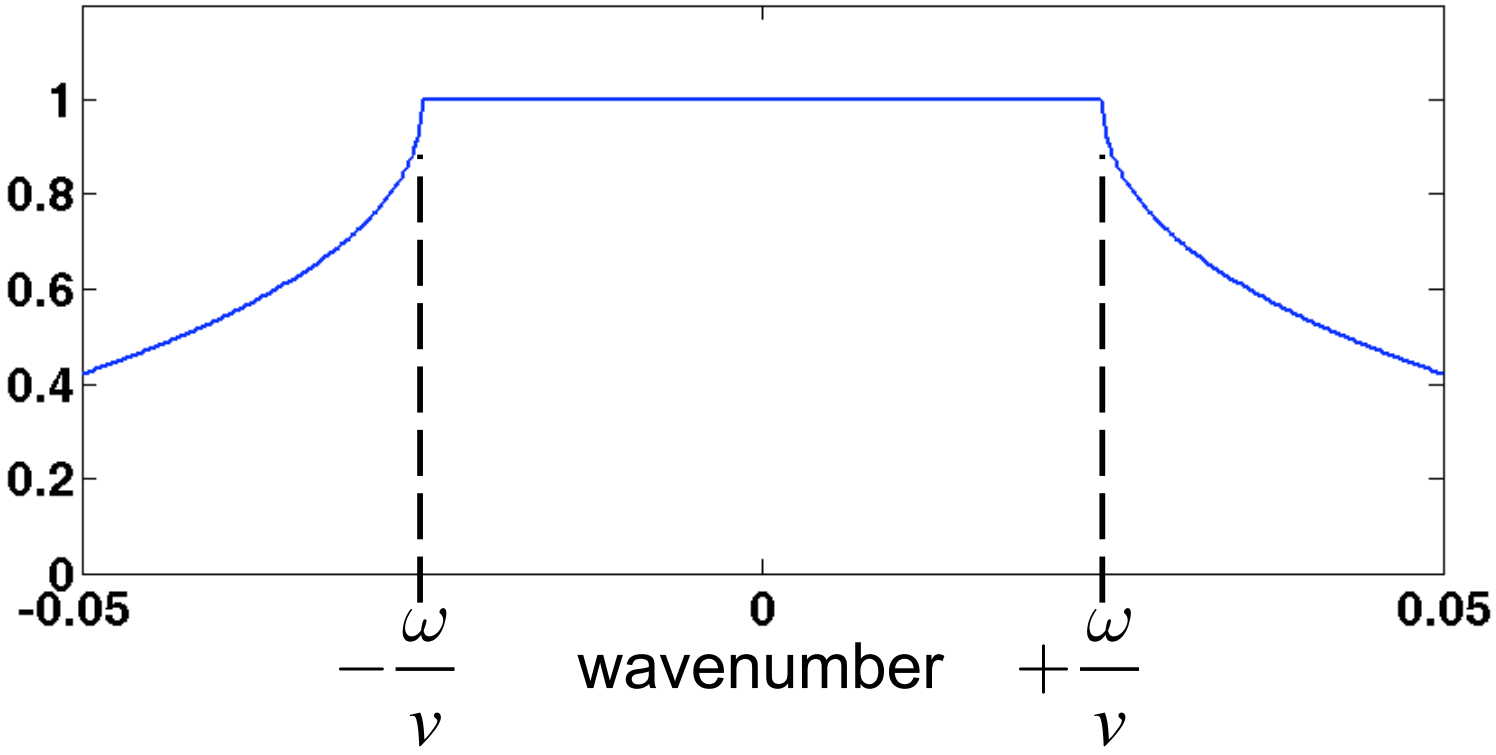
$$W = \mathcal{F}^{-1}(\hat{W})$$

The Two Key Components of FOCI

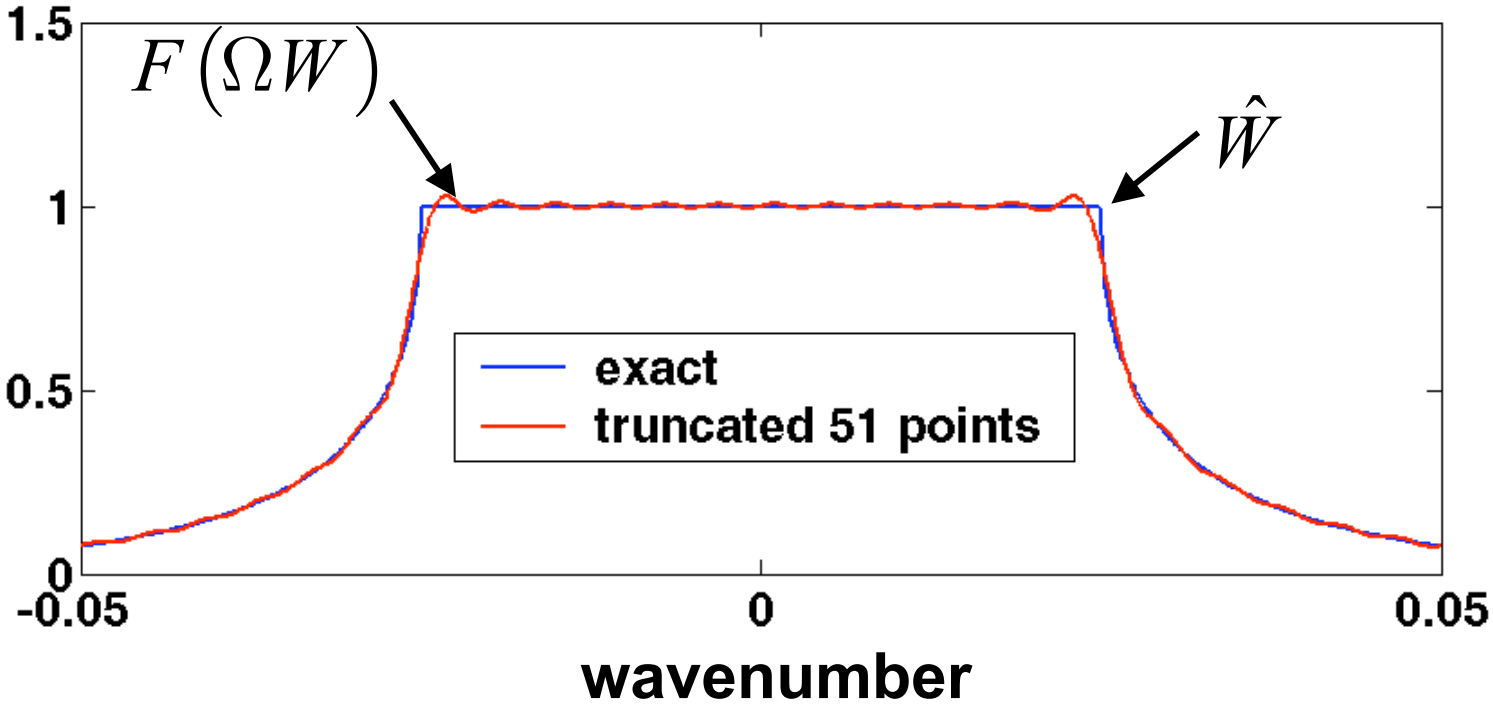
- Operator stabilization by Wiener Filter
- Spatial downsampling of the lower frequencies to increase operator accuracy and decrease run time

Wavefield Extrapolators

$$\left|\hat{W}\right|$$



Wavefield Extrapolators



Stabilization by Wiener Filter

1. Compute the compact supported inverse of the FOCI extrapolator by least square

$$W_I(\Delta z/2) * W(\Delta z/2) = \mathcal{F}^{-1}(|\hat{W}(\Delta z/2)|^{\eta})$$

2. The FOCI extrapolator is

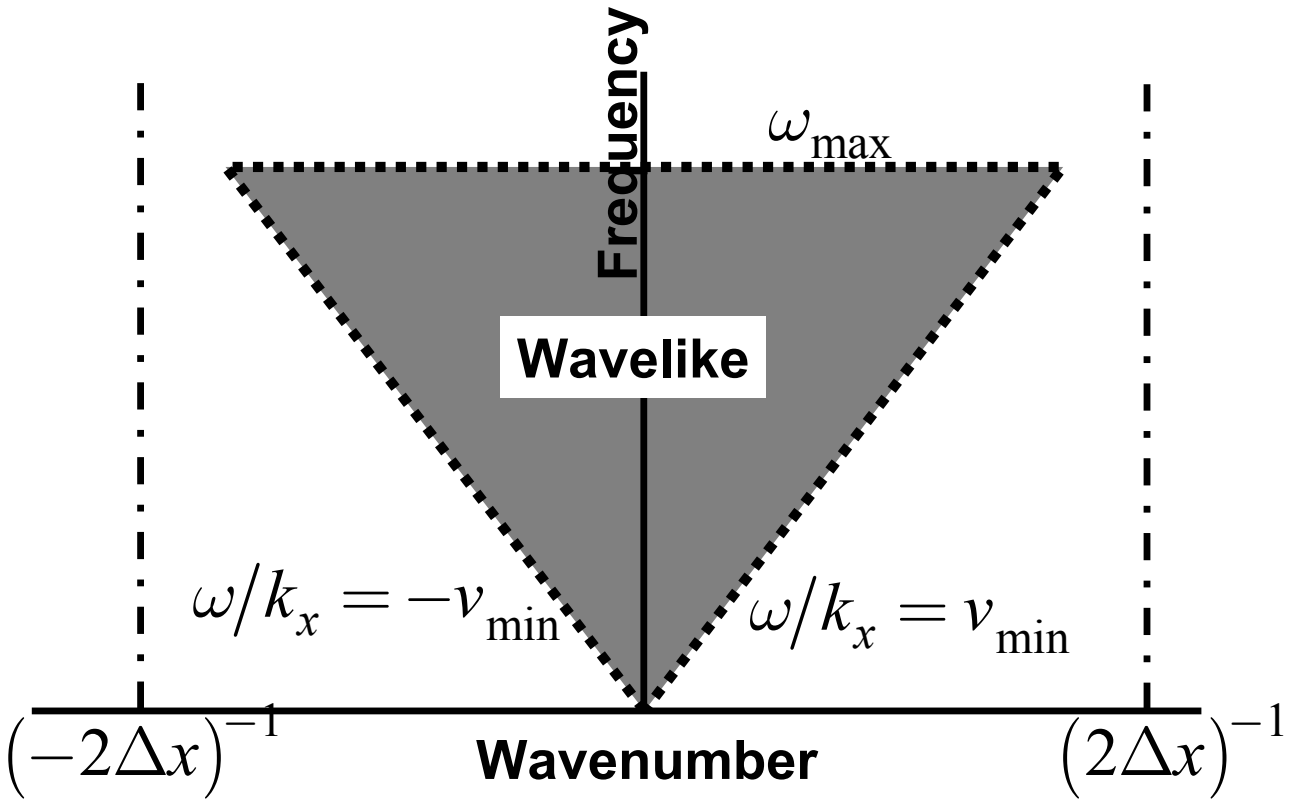
$$W_F(\Delta z) = \overline{W}_I(\Delta z/2) * W(\Delta z/2)$$

Spatial Downsampling

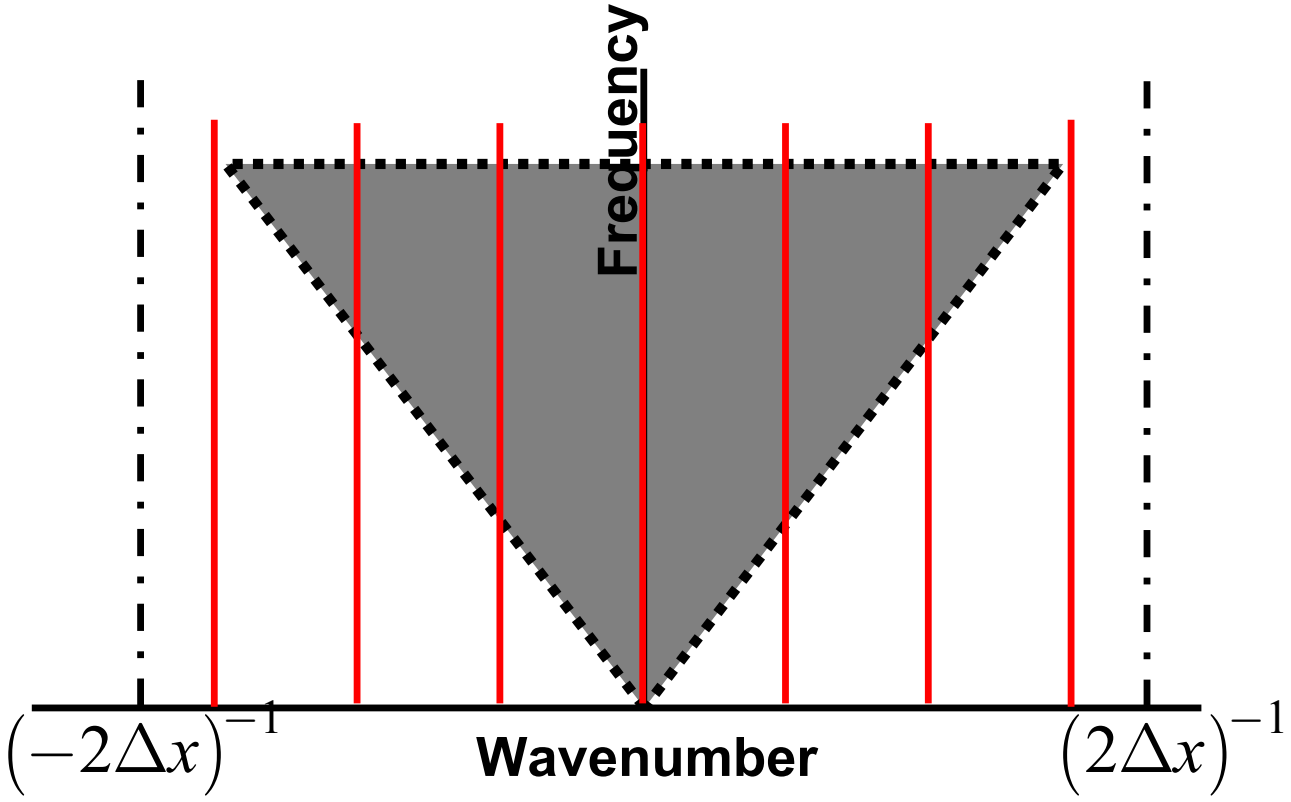
- The frequency region is broken into frequency chunks. Each frequency chunk has its own spatial sample size and operator table

- In each chunk data are resampled in order to keep more operator points in the wavelike region

Spatial Resampling

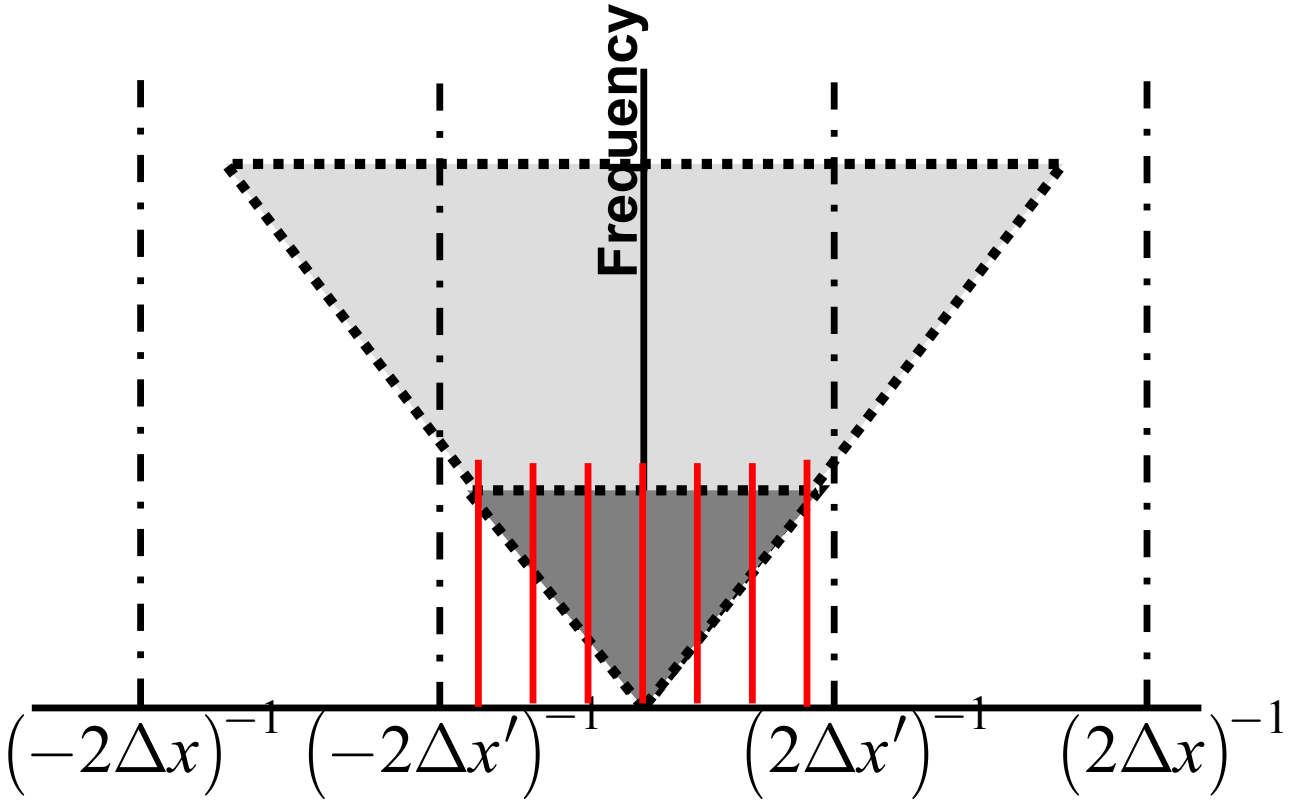


Spatial Resampling



In red are the wavenumbers of a 7 point filter

Spatial Resampling



Downsampling for the lower frequencies uses the filter more effectively

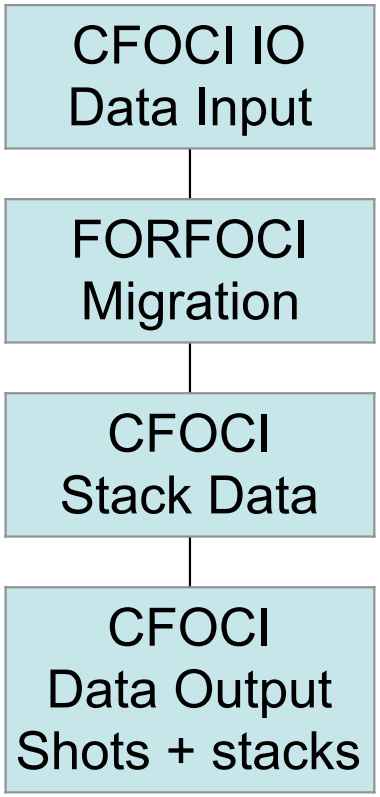
The Design Of FORFOCI

- FORFOCI can be extended easily
- SEGY input and output in C
- Object oriented design
- Code re-usable through modular design

Components of FORFOCI

- CFOCI --- in C, the general I/O module which reads in SEGY data, generates parameters for extrapolation, stacks the data, outputs stacks and shots.
- FORFOCI --- in Fortran 95, takes the prestacked data and carries out the wavefield extrapolation using the FOCI algorithm.

FORFOCI Flow Chart



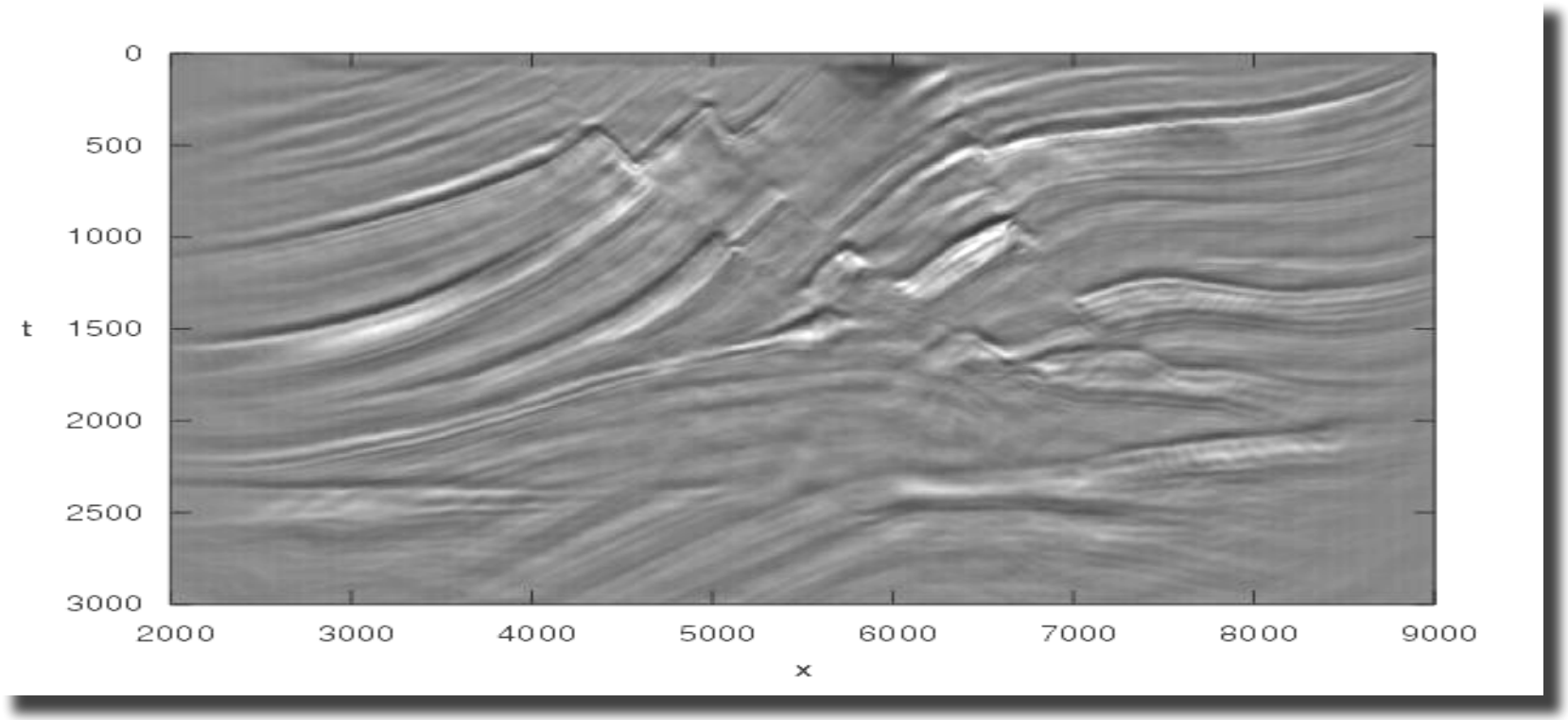
Modular Design

- All applications are packed in modules---Math module (LAPACK), IO module and FOCI module, etc
- Overloaded function design
- General IO design for SEGY data

Data Tests

- Marmousi Data

20 hours for 240 shots on PC (aiming for 2 hours)



Future Work

- Optimization (twice faster than MATLAB)
- Parallel computing
- 3D FOCI

Conclusion

- A practical implementation of FOCI in C and FORTRAN
- A contribution to the seismic imaging library
- Optimization and extension of FOCI is under developing

Acknowledgement

- CREWES
- PIMS
- MITACS
- POTSI