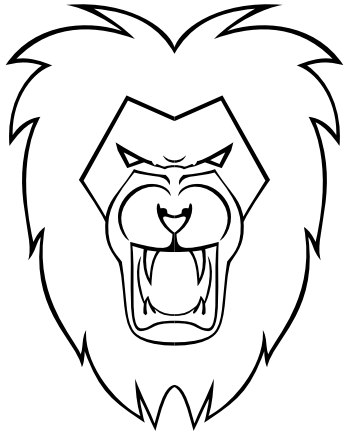
BEAST: a framework for interior eigenvalue problems



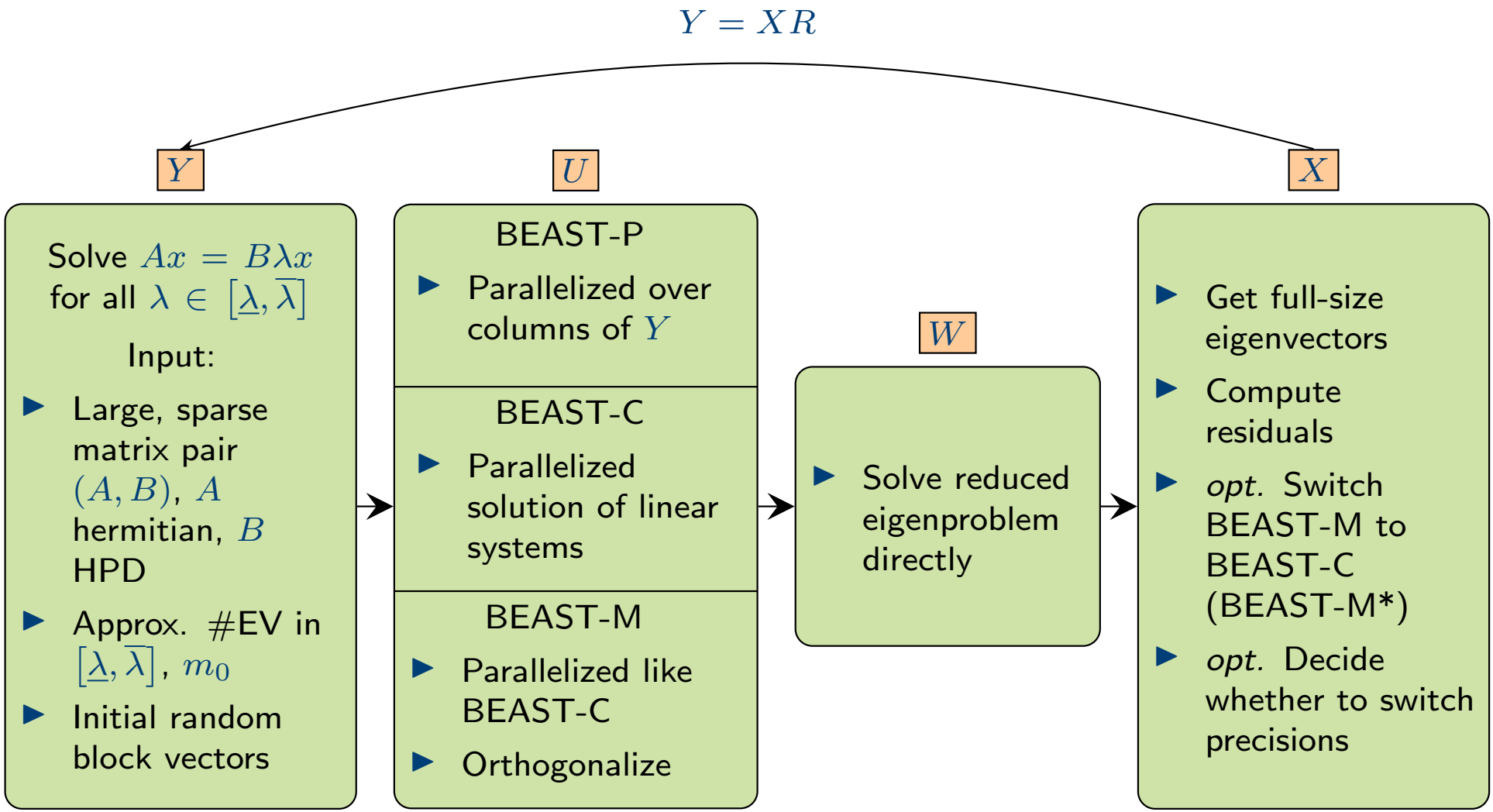
- Large scale solution of interior eigenproblems
- Incorporates several subspace-iterative algorithms
- + Parallelism
- + Algorithmic improvements (adaptivity, locking, etc.)
- Developed within ESSEX project for exascale eigensolvers

DFG SPPEXA

MATHEMATICAL MODELLING, ANALYSIS AND COMPUTATIONAL MATHEMATICS

BERGISCHE UNIVERSITÄT WUPPERTAL

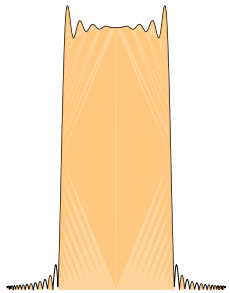
BEAST overview



GHOST for fast, scalable matrix operations

How to build your subspace

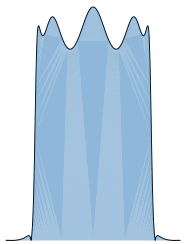
Polynomial Approximation
BEAST-P



$$U = \sum_{j=1}^{N} \alpha_j A^j Y$$

Many block matrix-vector products
Standard eigenproblem only

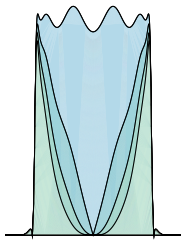
FEAST-type
BEAST-C



$$U = \sum_{j=1}^{N} \omega_j (z_j B - A)^{-1} BY$$

Very effective filter
Must solve ill-conditioned block linear systems

SSM-type
BEAST-M

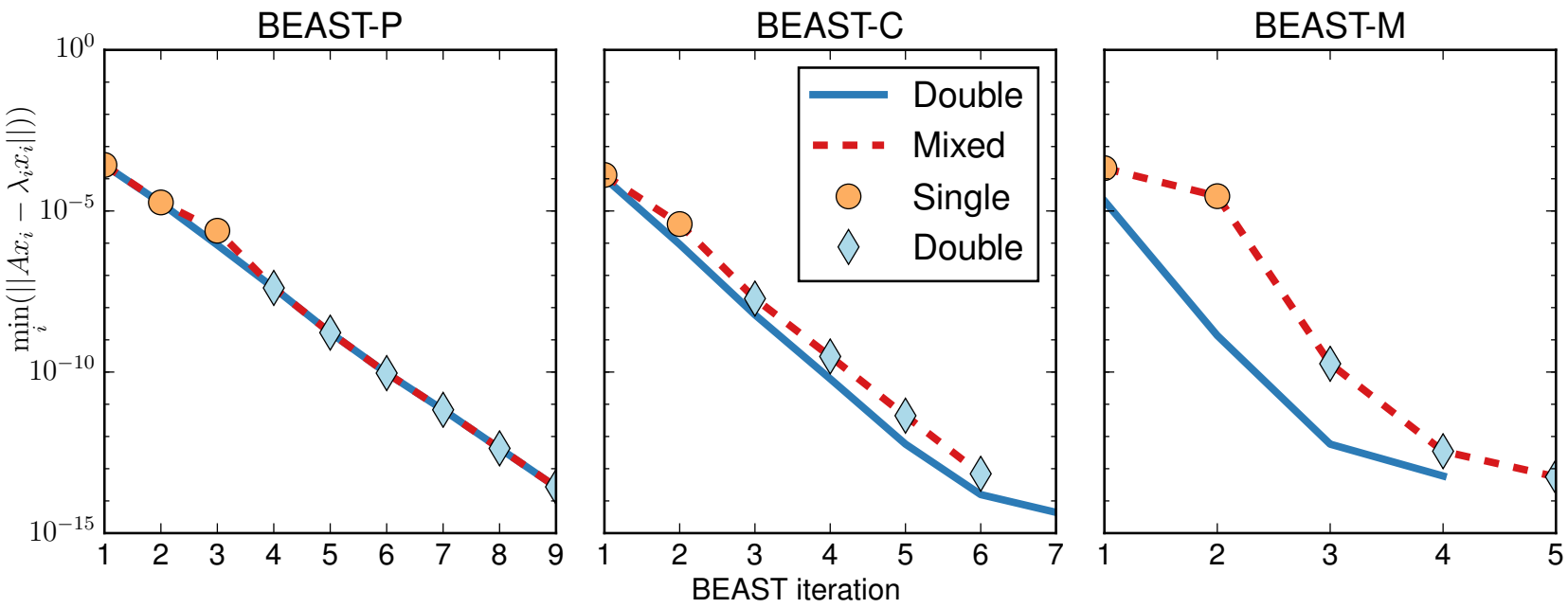


$$U_k = \sum_{j=1}^{N} \omega_j \zeta_j^k (z_j B - A)^{-1} BY$$

$$U = [U_0, ..., U_{l-1}]$$

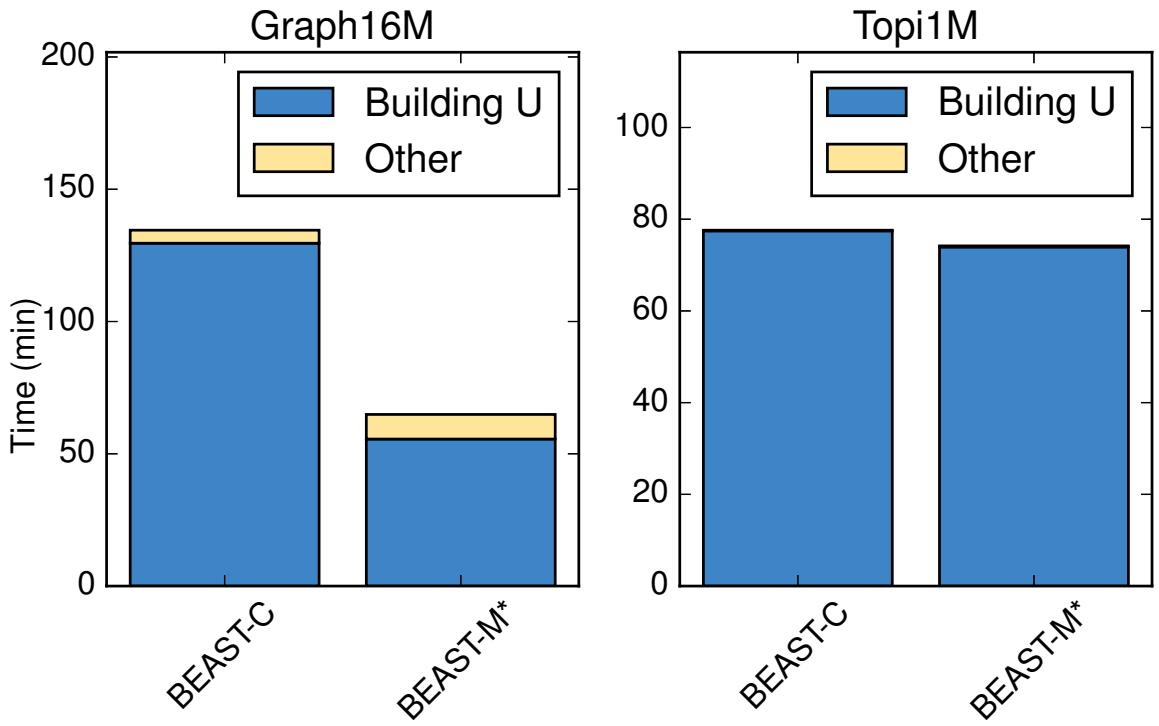
Solve ill-conditioned block linear systems
Lower cost for constrained subspace size

Using mixed precision



- Start in single precision, switch to double after reaching threshold
- Roughly same number of iterations required to reach desired accuracy threshold

Switching BEAST type



- BEAST-M*: switch from BEAST-M to BEAST-C if convergence stalls
- Faster due to fewer overall right hand sides in linear solves