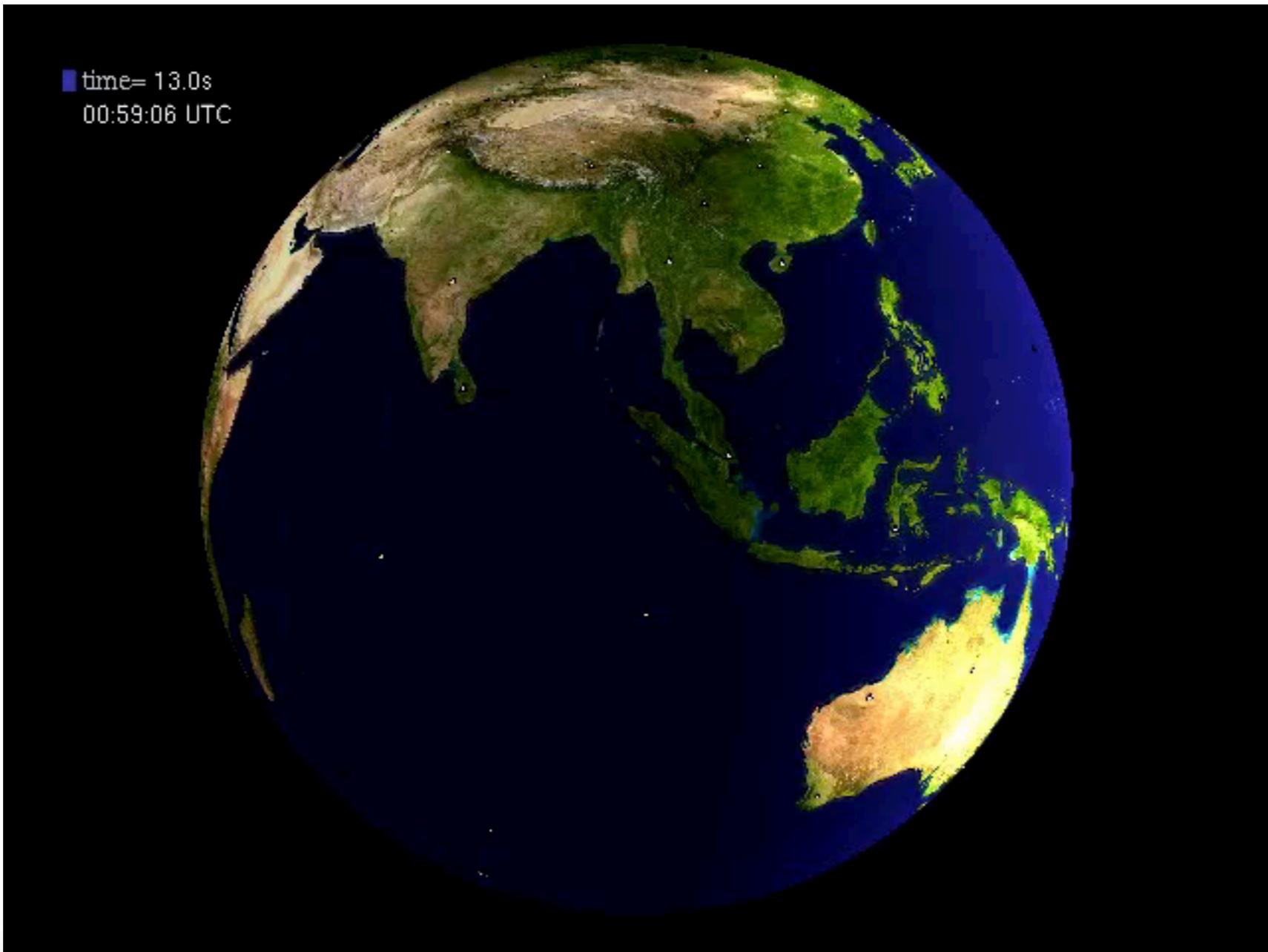


Computational Geophysics

ErSE 390C



Computational Geophysics



Introduction:

- Top500

Geophysics:

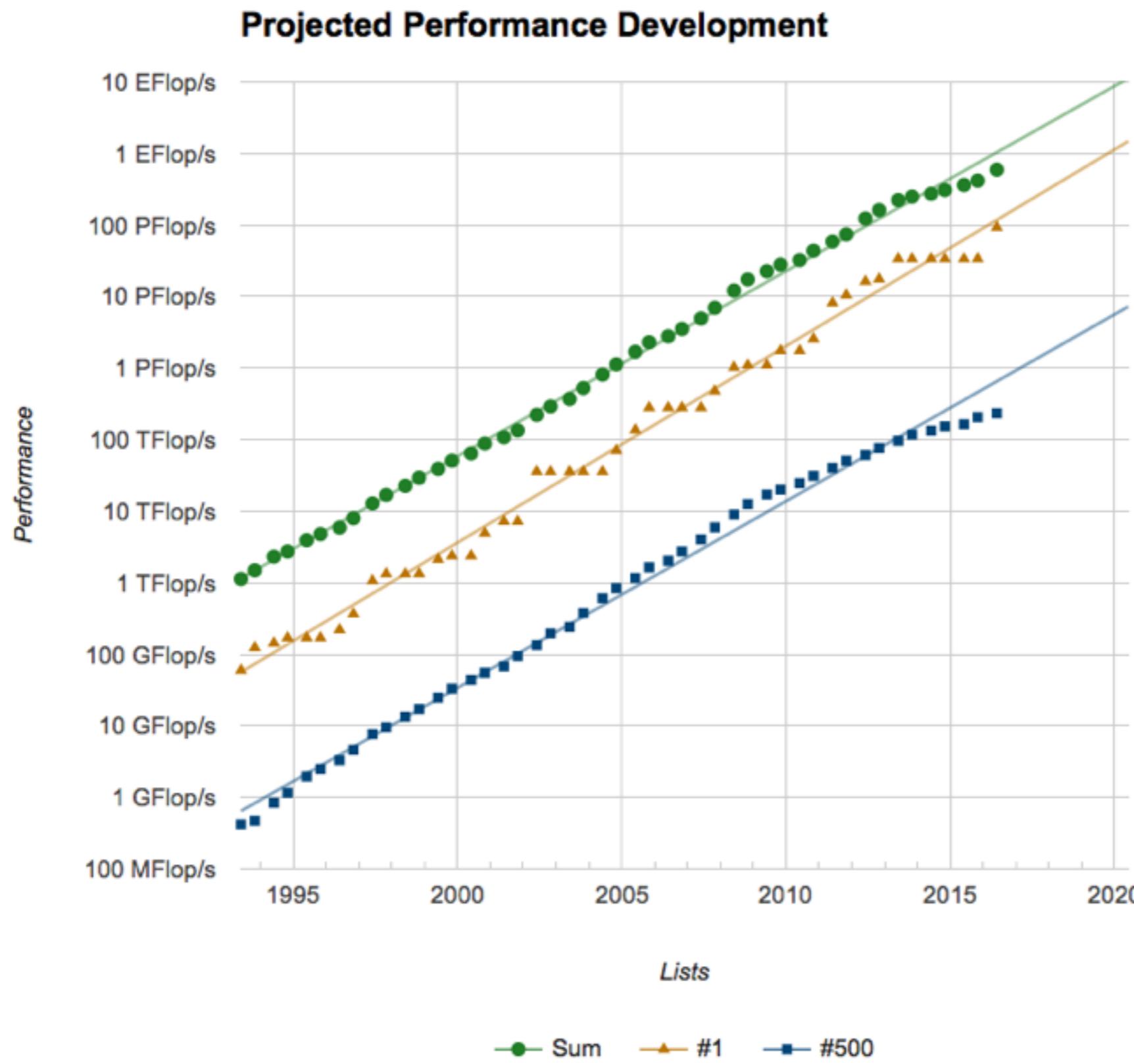
- Heat Flow
- Wave propagation

Numerical methods:

- finite-differences (FD)
- pseudo-spectral (PS)
- finite-element method (FEM)
- spectral-element method (SEM)



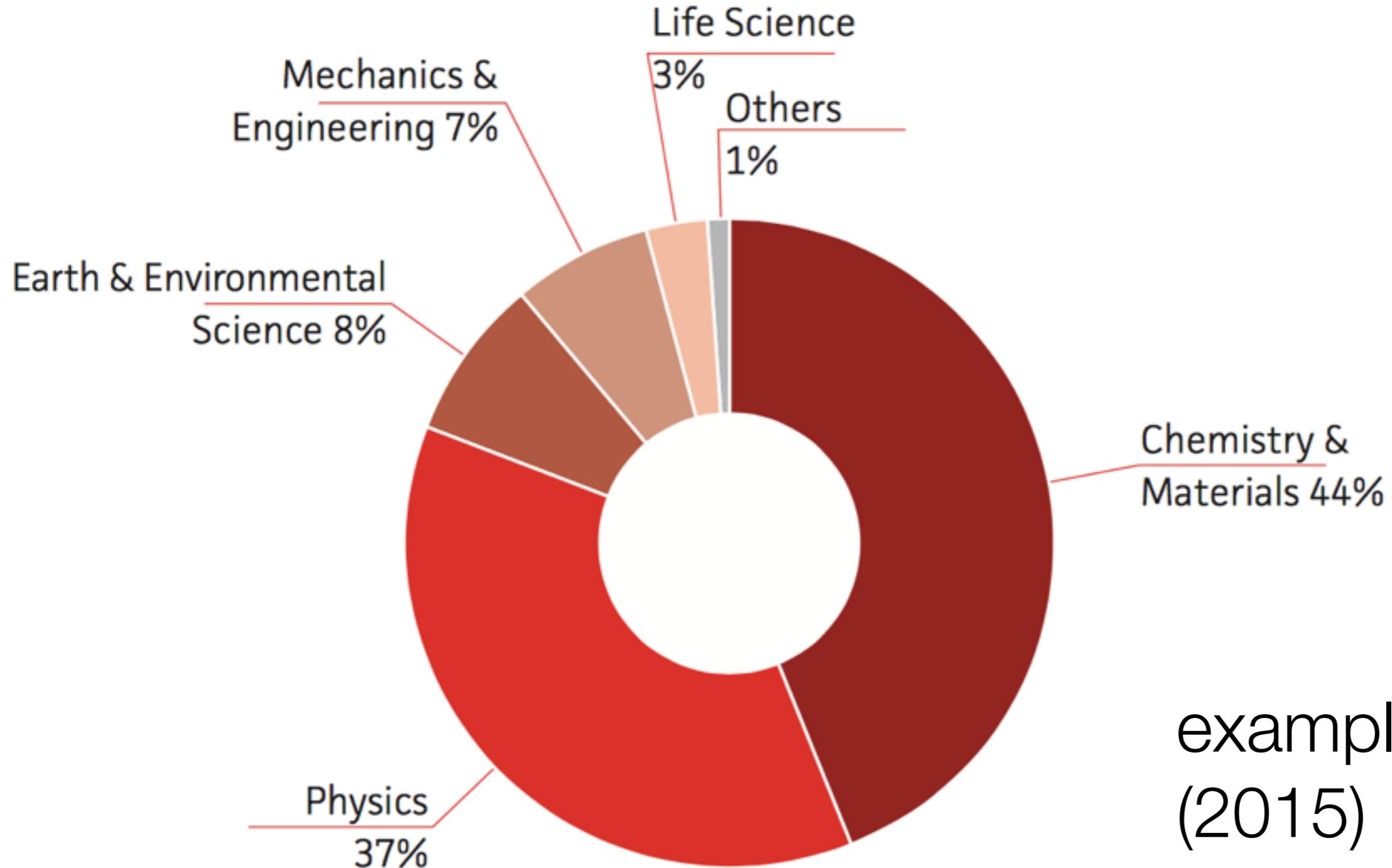
Trends - fastest supercomputers



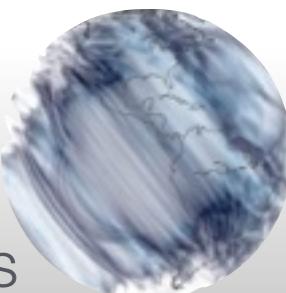
exa-scale system
year ~2020



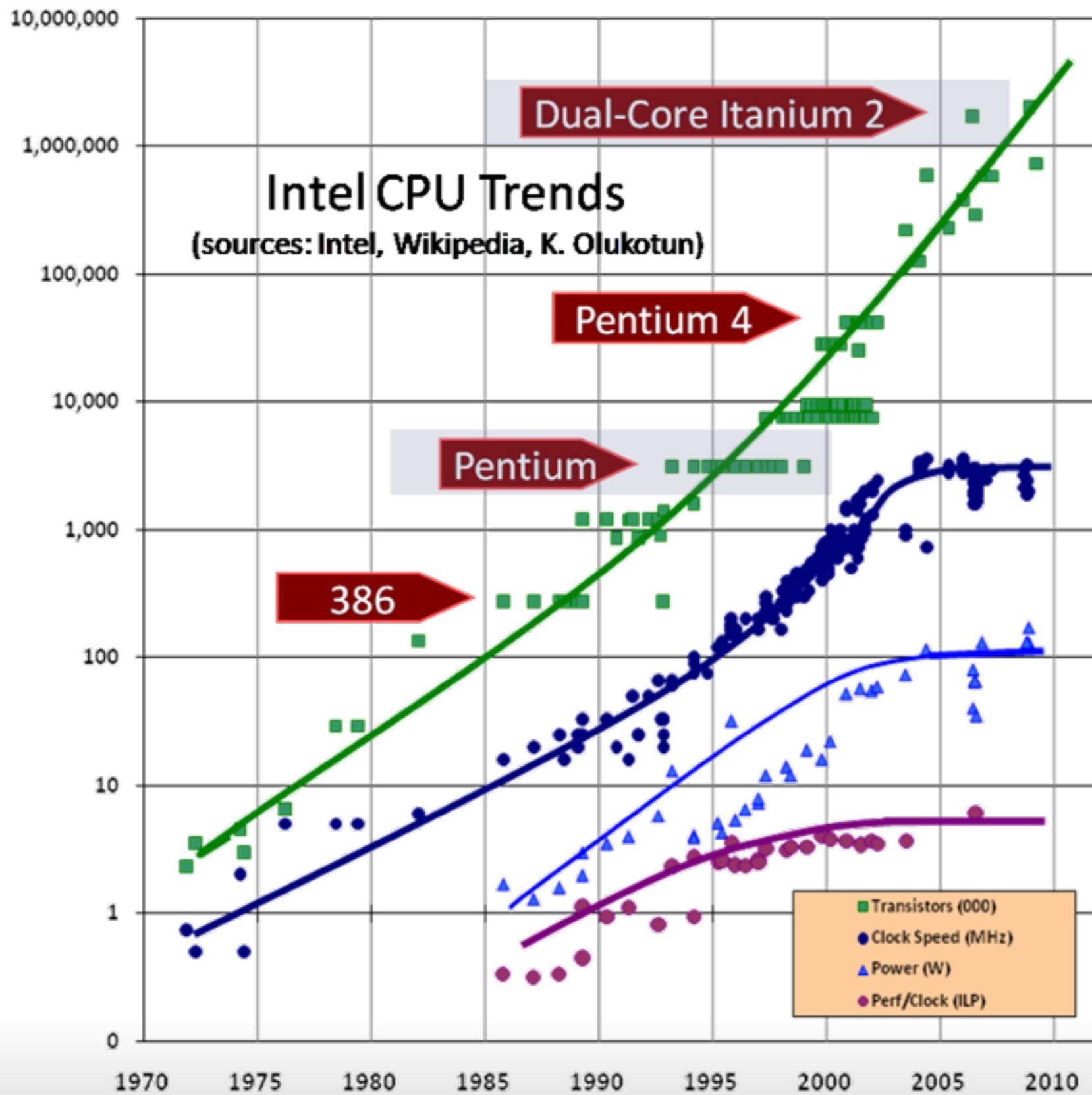
Trends - Usage by Research Field



example CSCS
(2015)



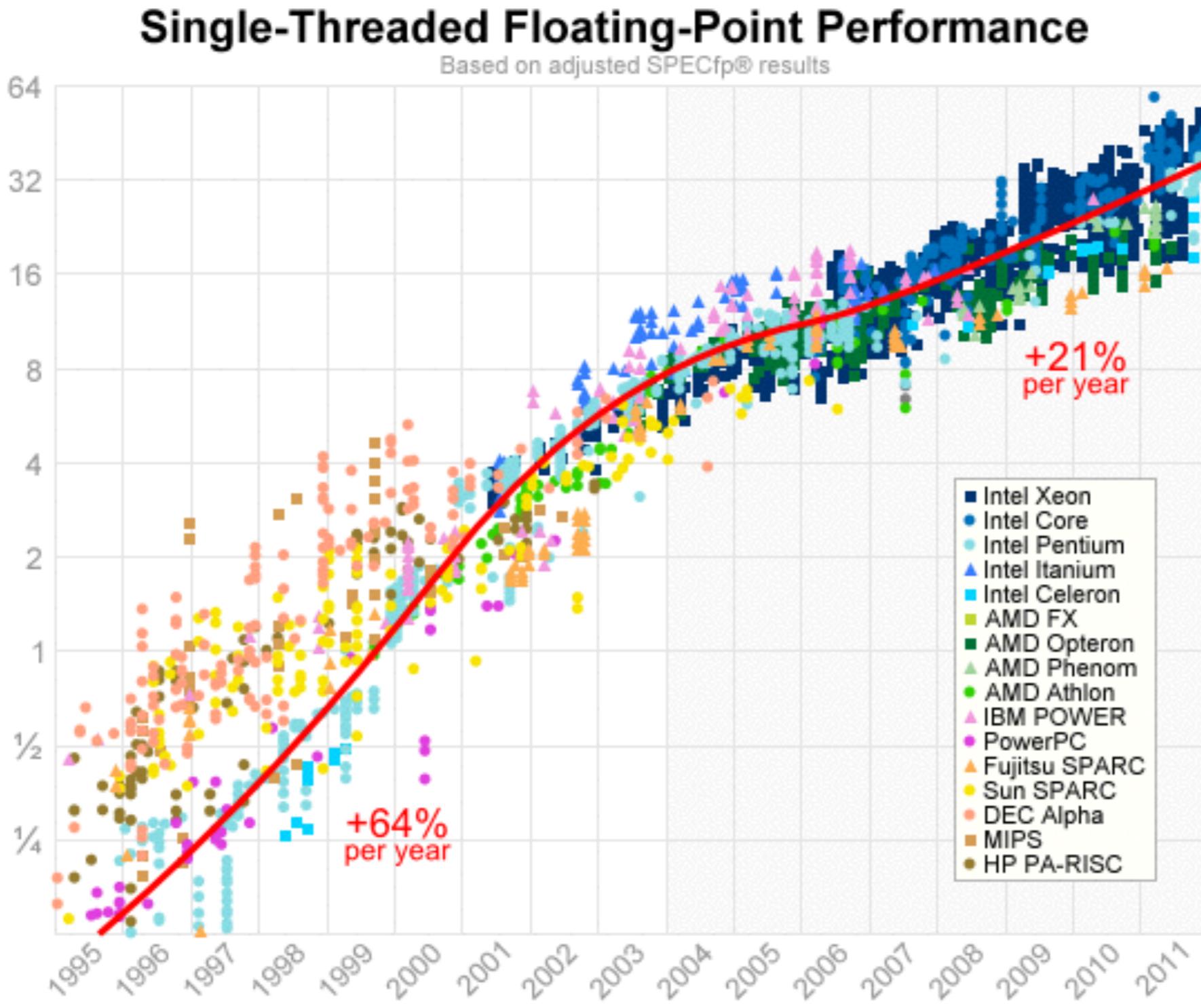
Trends - CPU



multi-core CPUs
since ~2006



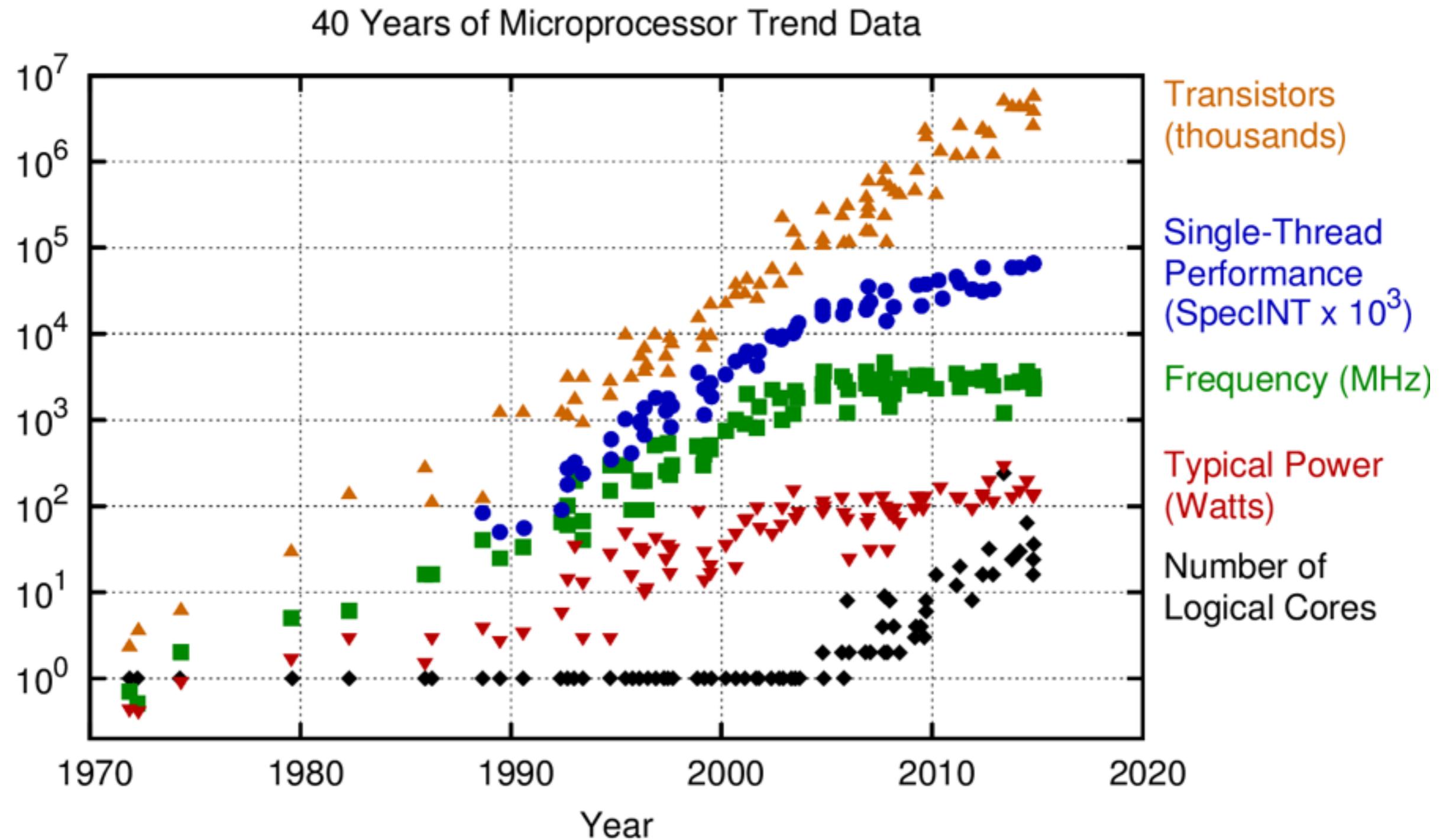
Trends - CPU



slow-down
since ~2003



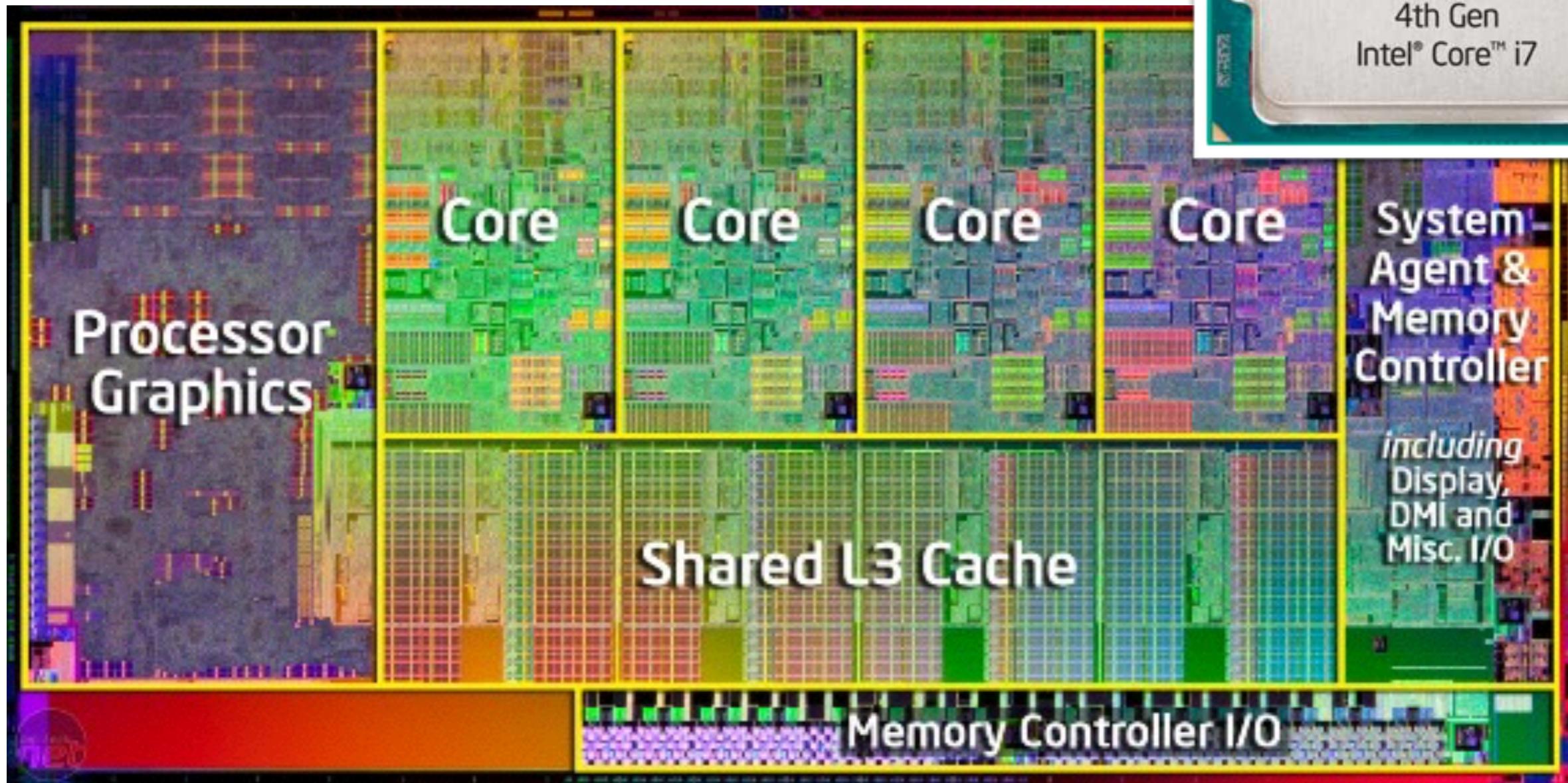
Trends - CPU



Original data up to the year 2010 collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond, and C. Batten
New plot and data collected for 2010-2015 by K. Rupp

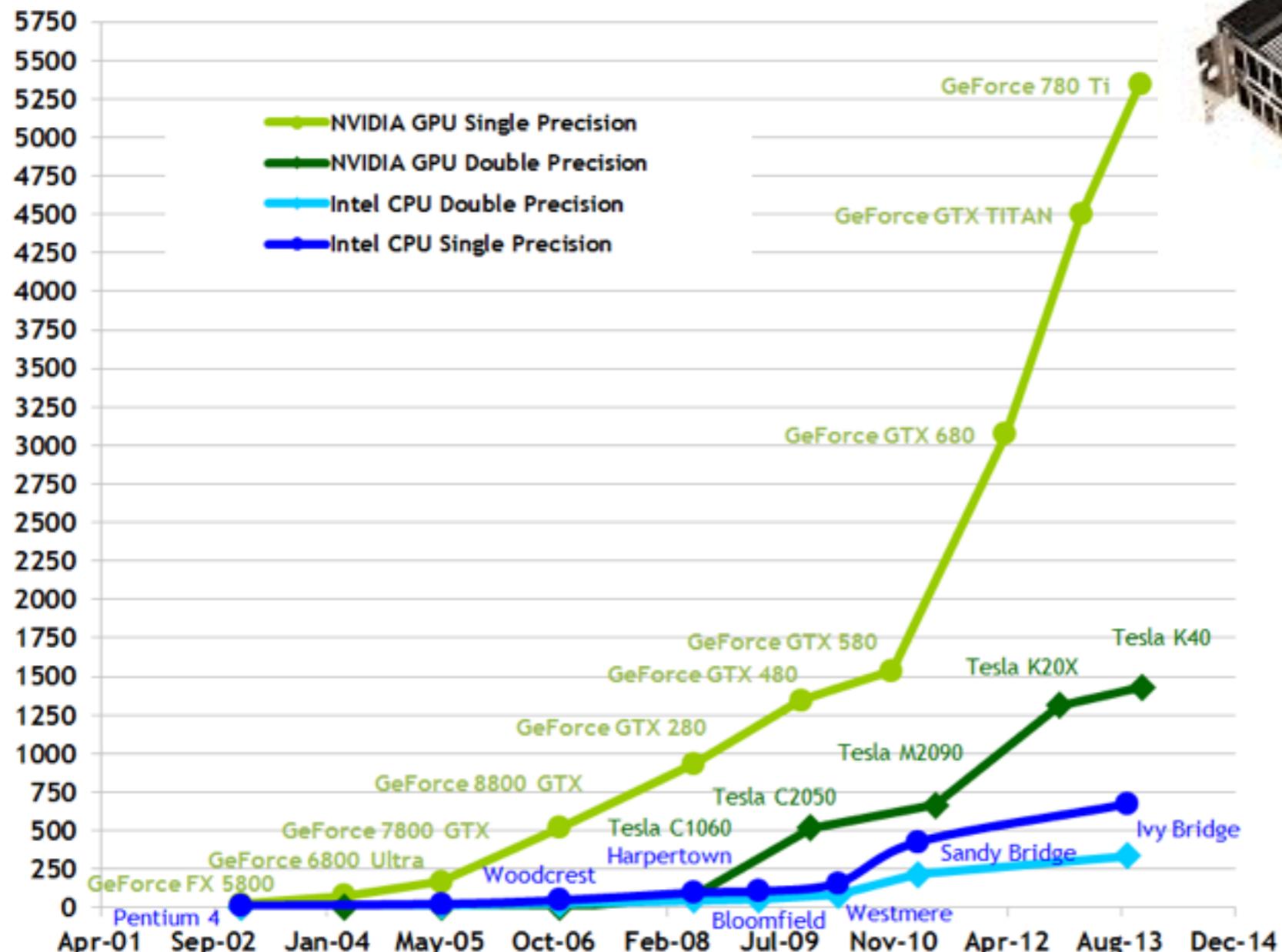


Trends - CPU



Trends - GPU

Theoretical GFLOP/s

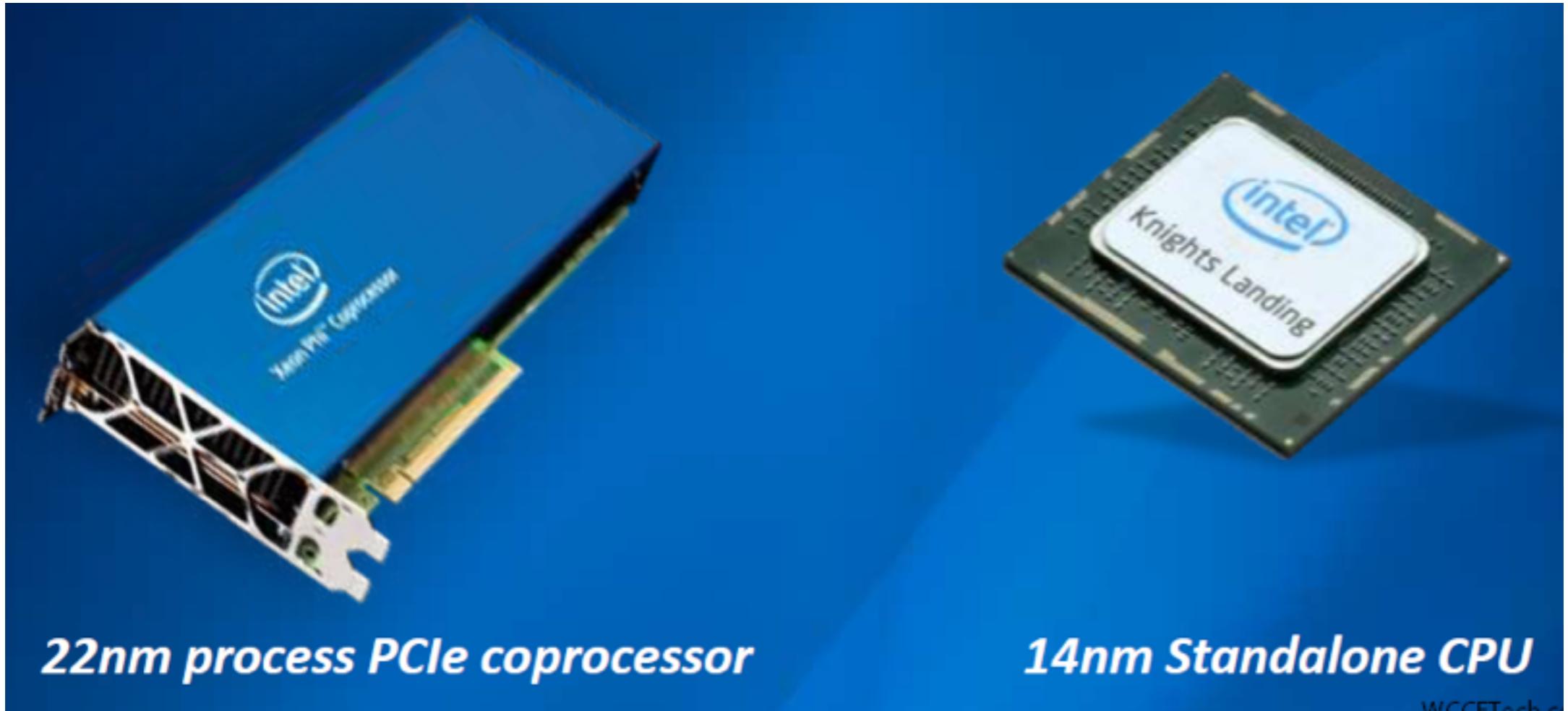


hardware
accelerators

Floating-Point Operations per Second - Nvidia CUDA C Programming Guide
Version 6.5 - 24/9/2014 - copyright Nvidia Corporation 2014



Trends - Intel Phi

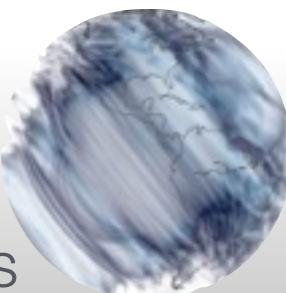


22nm process PCIe coprocessor

14nm Standalone CPU

WCCETech.com

hardware accelerators



Trends - Supercomputers w/ hardware accelerators



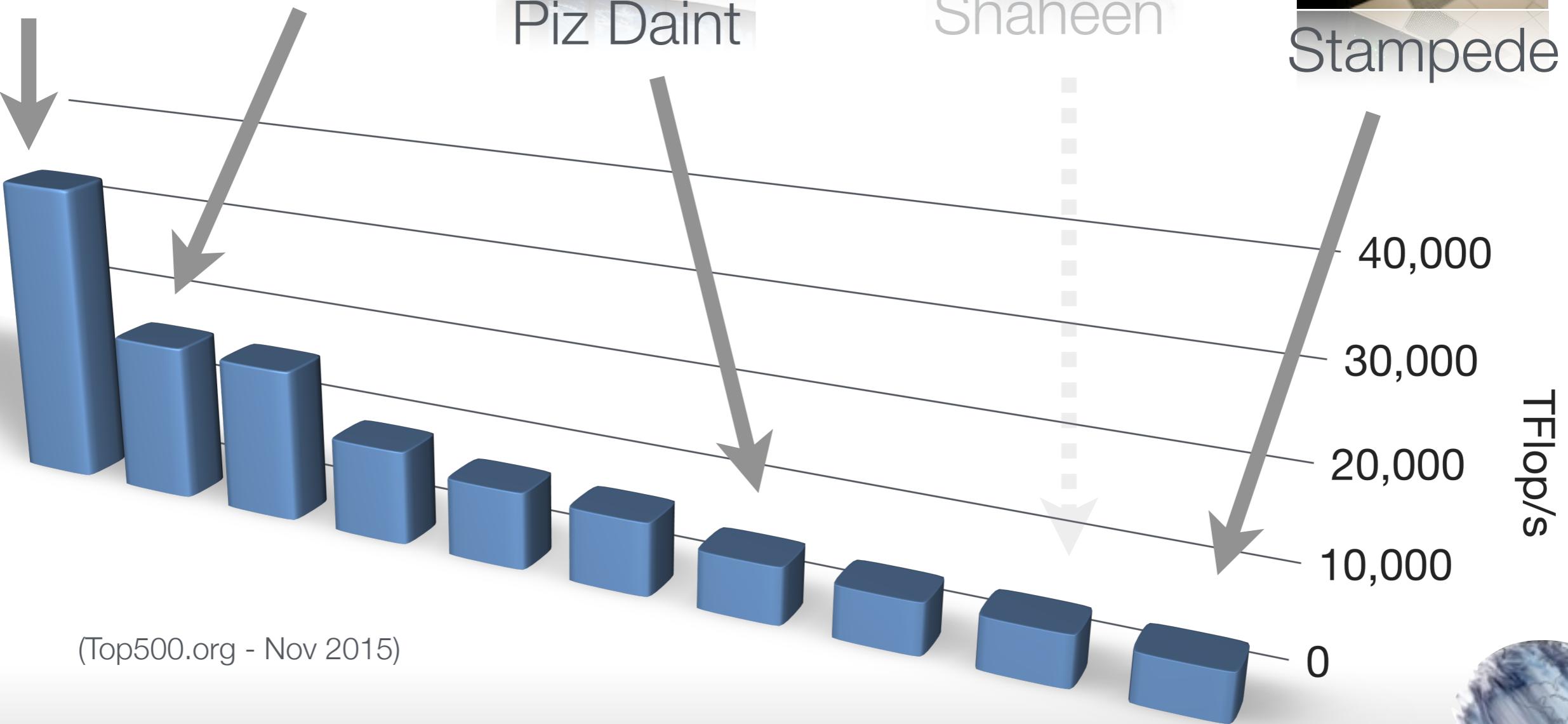
Tianhe-2

Titan

Piz Daint

Shaheen

Stampede



Introduction:

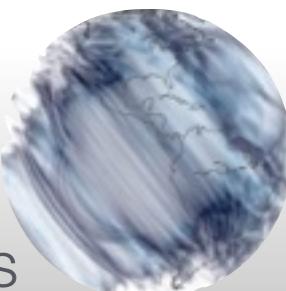
- Top500

Geophysics:

- Heat Flow
- Wave propagation

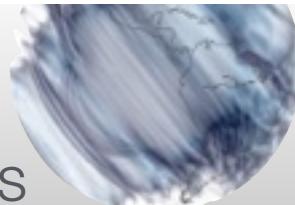
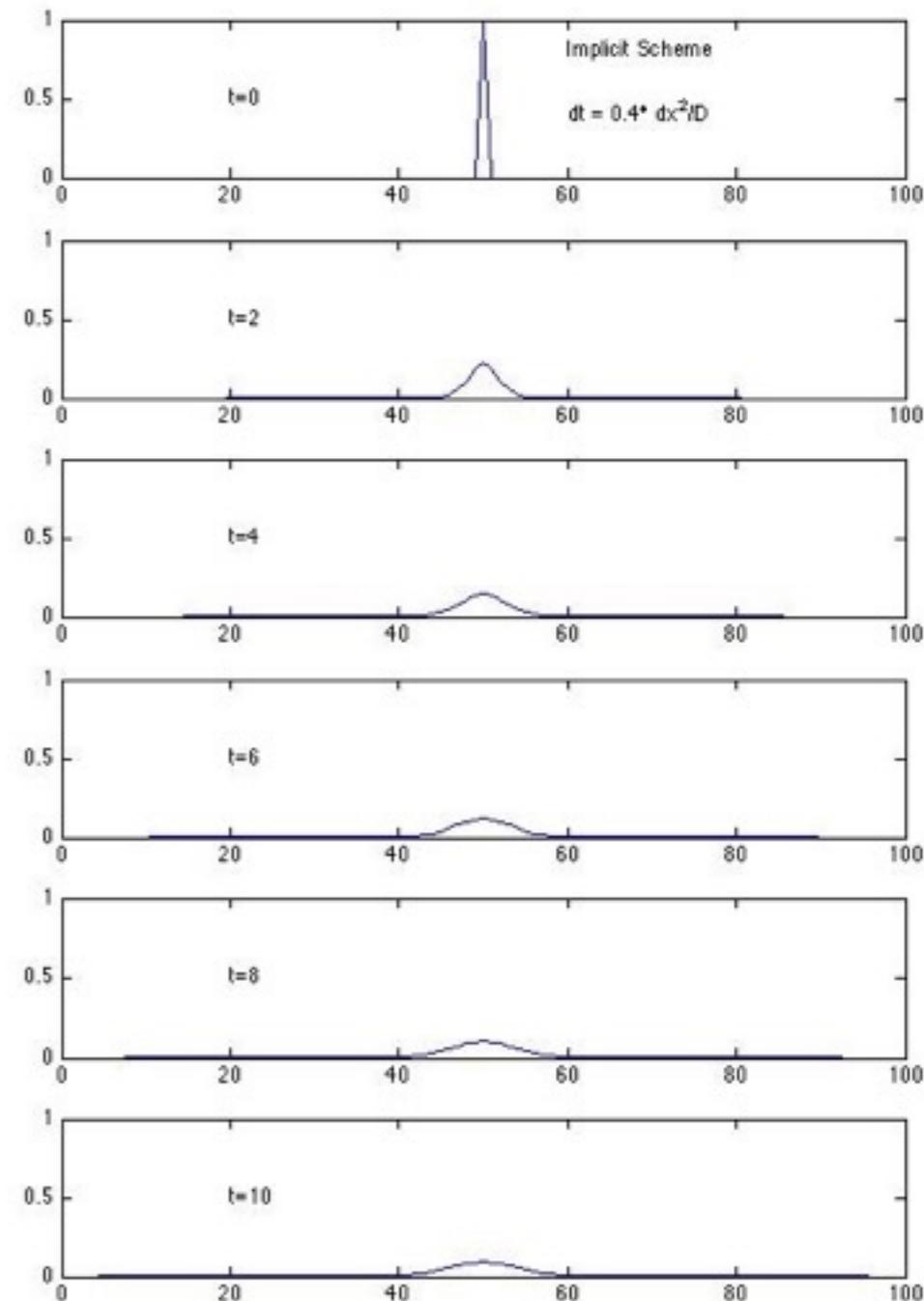
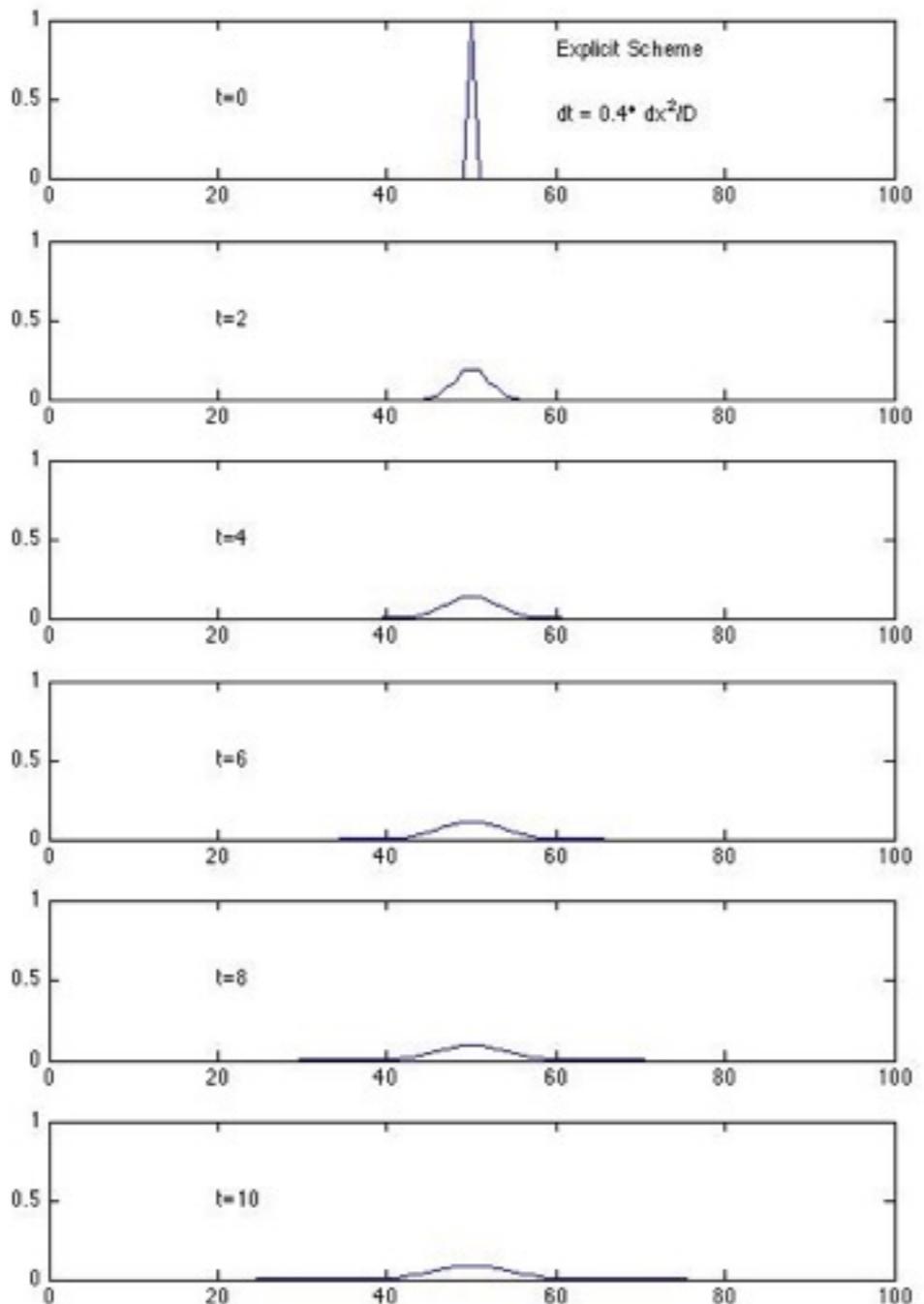
Numerical methods:

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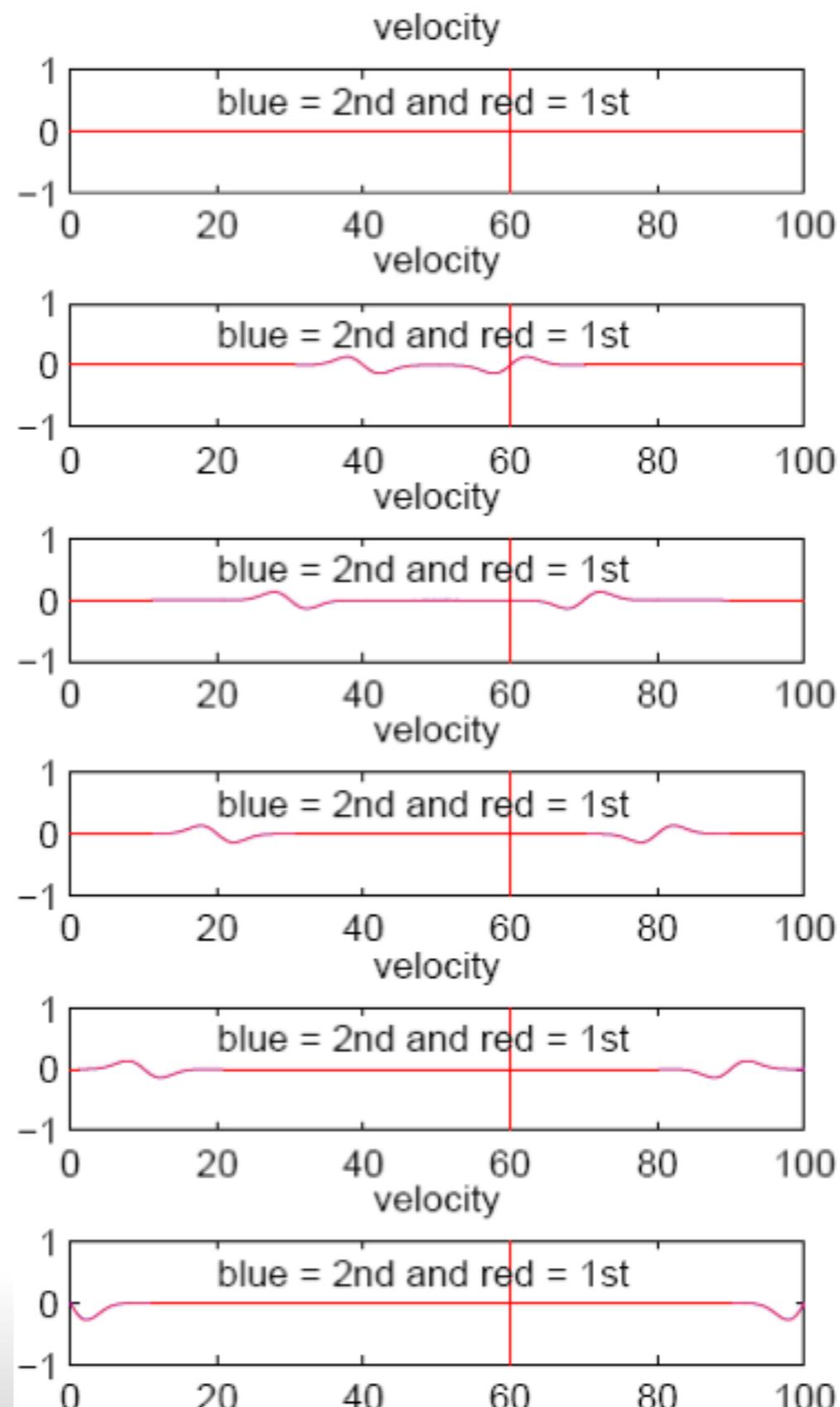
Numerical methods - Finite-Differences

heat flow



Numerical methods - Finite-Differences

wave propagation



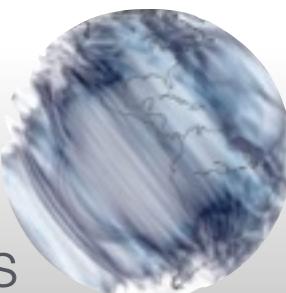
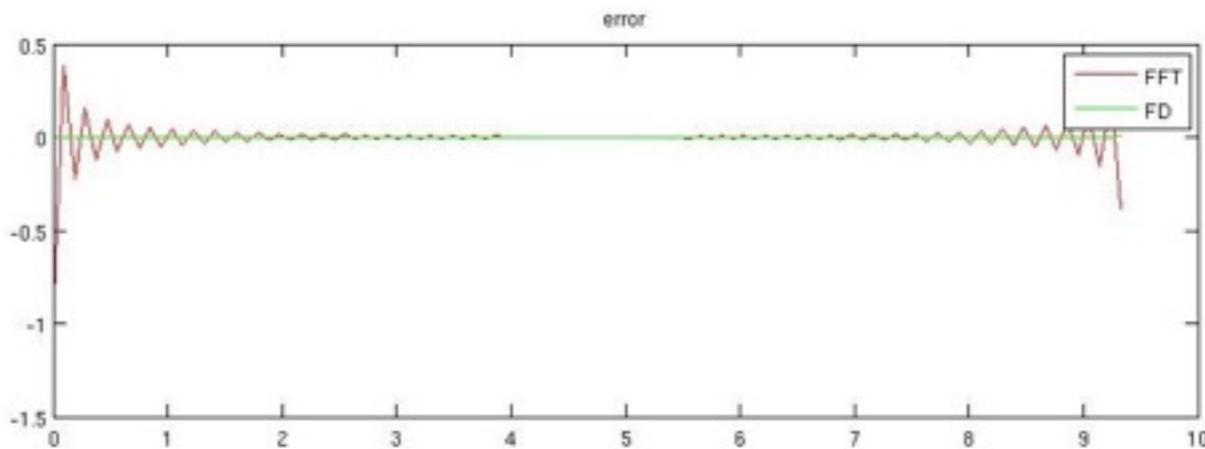
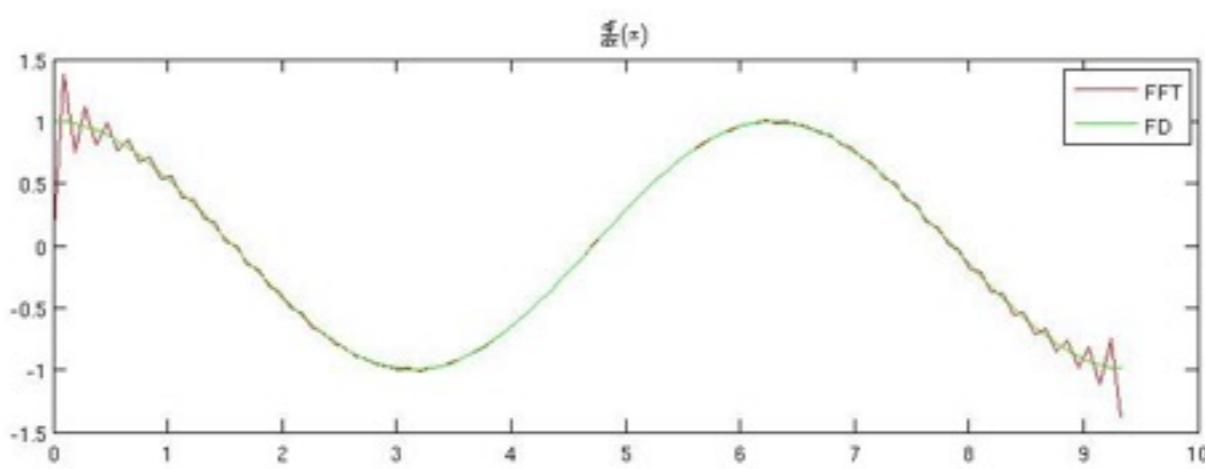
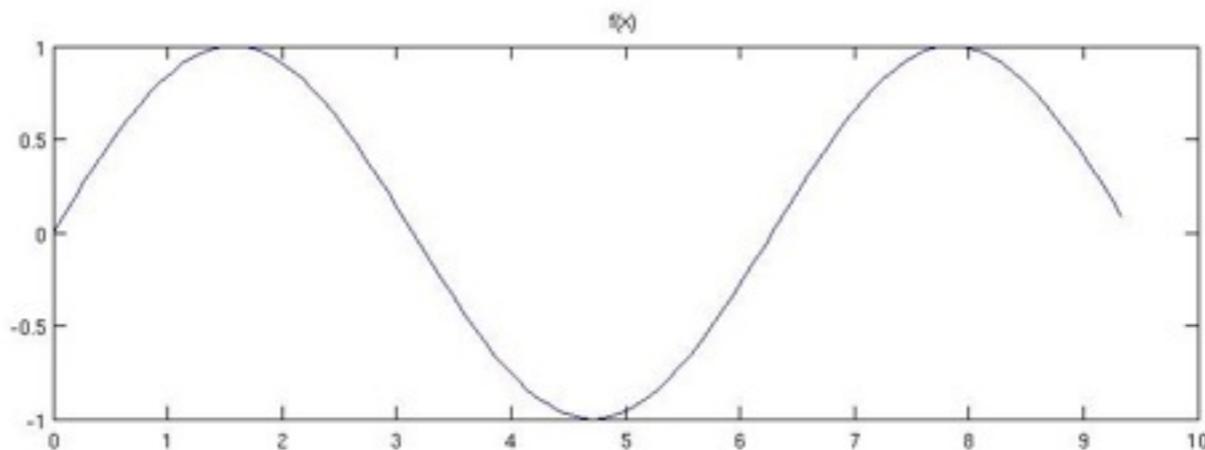
Numerical methods - Finite-Differences

tsunami waves



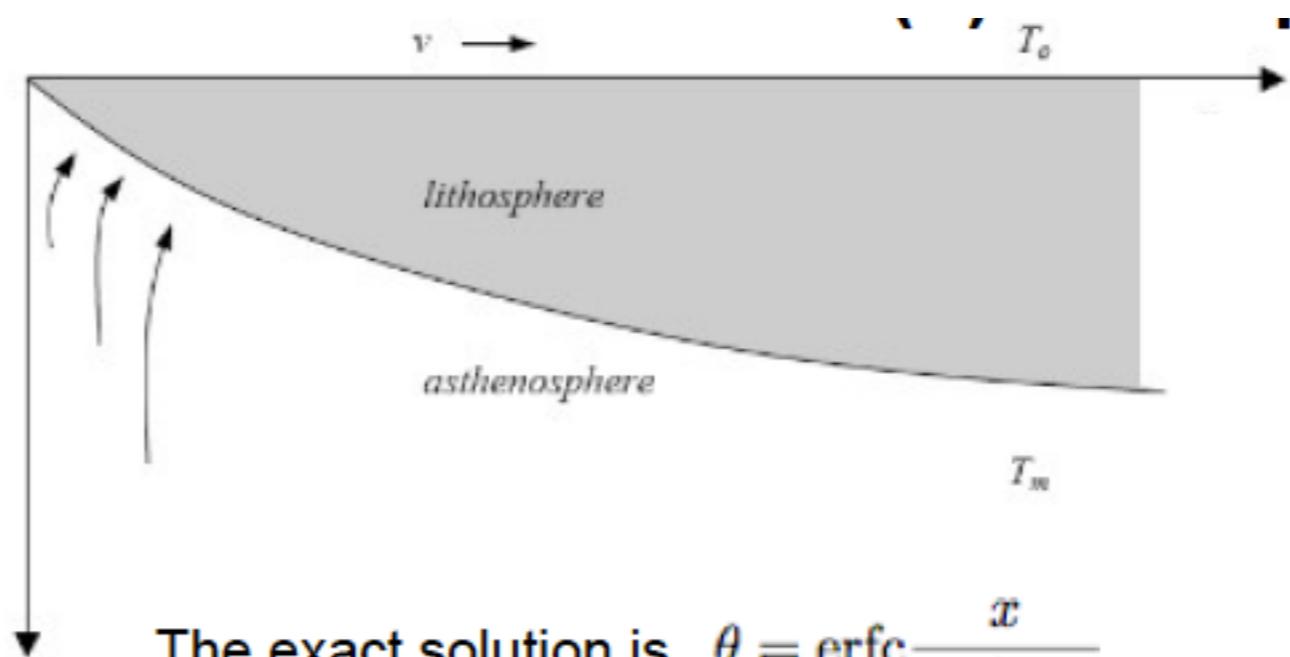
Numerical methods - Pseudo-Spectral

wave propagation

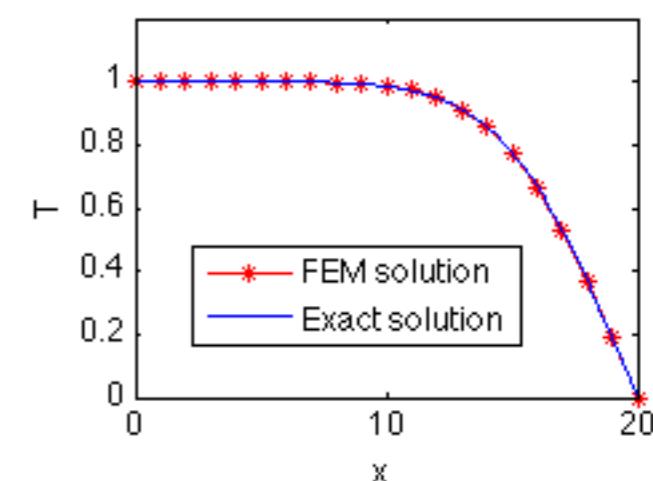
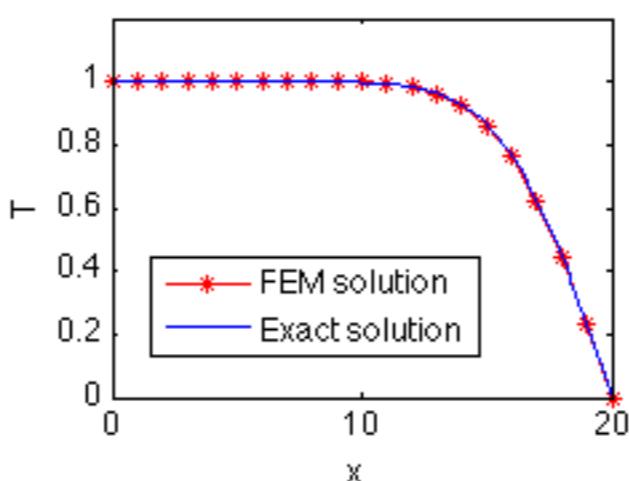
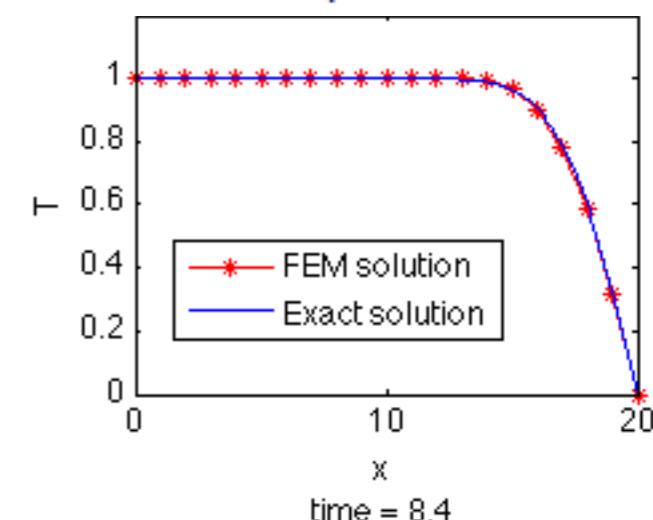
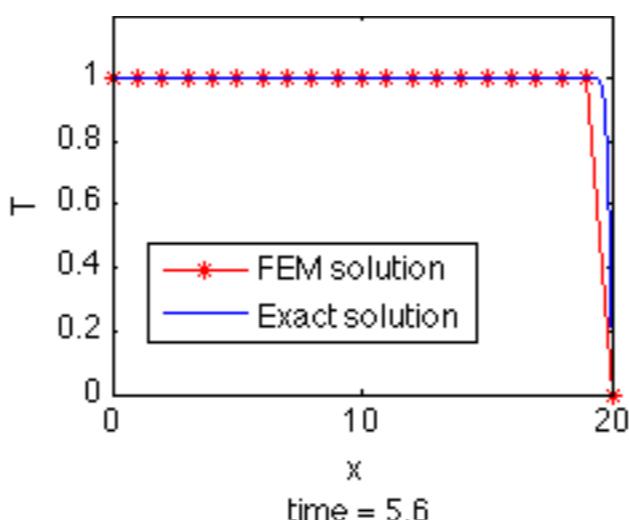


Numerical methods - Finite-element method

half-space cooling



The exact solution is $\theta = \text{erfc} \frac{x}{2\sqrt{\frac{\kappa}{\rho c_p} t}}$



Numerical methods - Spectral-element method

wave propagation

