Energy efficient computing EAR on Snellius

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HPC Advisor SURF

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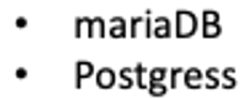
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Energy-aware focus

Application Monitoring
Performance
Power usage

Dynamic Optimization of
Applications
③

②

①
System/Architecture
System Monitoring
Energy Accounting

Energy Aware Runtime (EAR)

Energy Aware Runtime (EAR) package provides an energy management framework for super computers.

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- **EAR Node Manager (EARD) "Daemon"**
  - Energy metrics via the RAPL (Running Average Power Limit) function
  - Global energy limits or just offer global cluster monitoring

- **EARL** is a library that is loaded next to the application
  - Offers application metrics monitoring
  - Can select the frequencies based on the application behavior on the fly.
  - Integrated with SLURM on Snellius.
  - Intercepts the MPI symbols through the PMPI interface to provide "traces" of MPI applications.

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#!/bin/bash

#SBATCH --ntasks=256
#SBATCH --time=24:0:0
#SBATCH -p thin --exclusive

#SBATCH --ear=on
#SBATCH --ear-policy=monitoring

module load 2021
module load foss/2021a
module load CMake/3.20.1-GCCcore-10.3.0
module load VASP6/6.2.1-foss-2021a-CUDA-11.3.1

srun vasp_std
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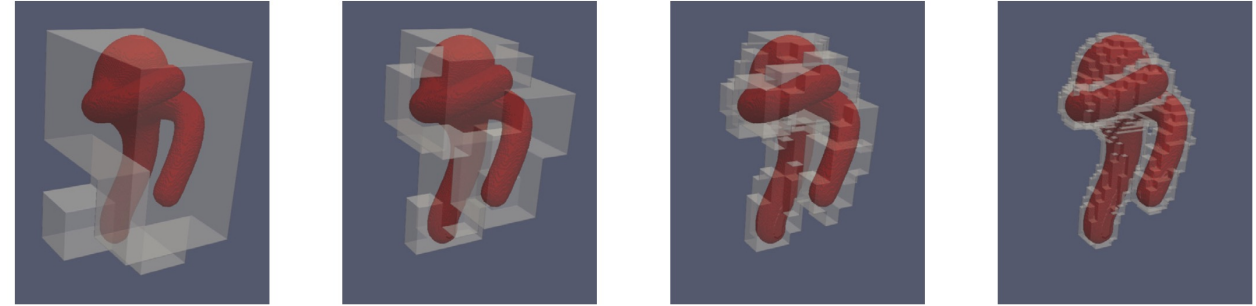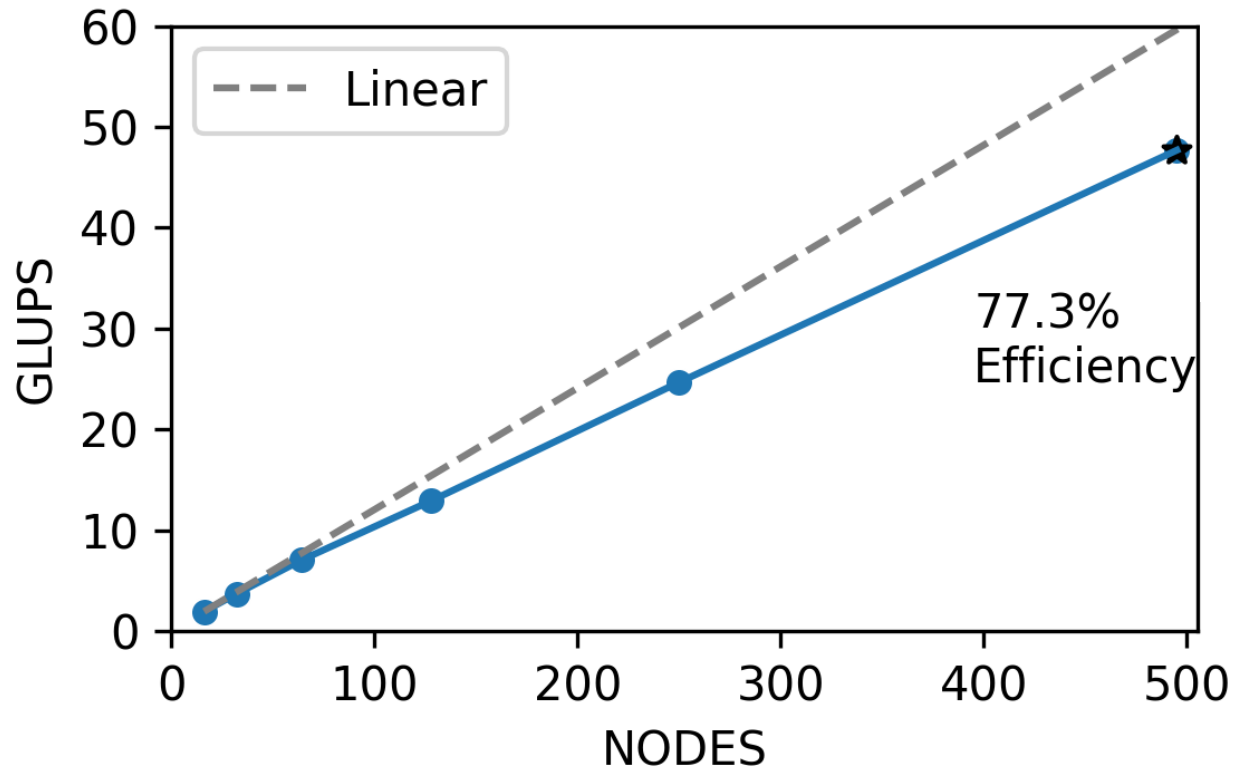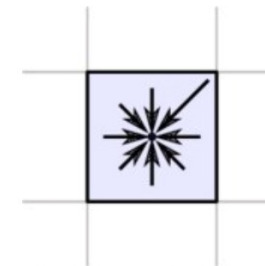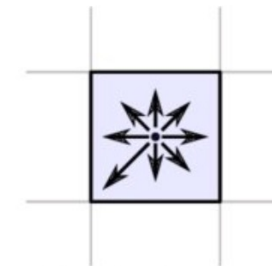
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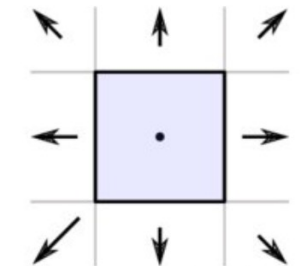# Palabos: Lattice-Boltzmann Solver

Strong Scaling Benchmark
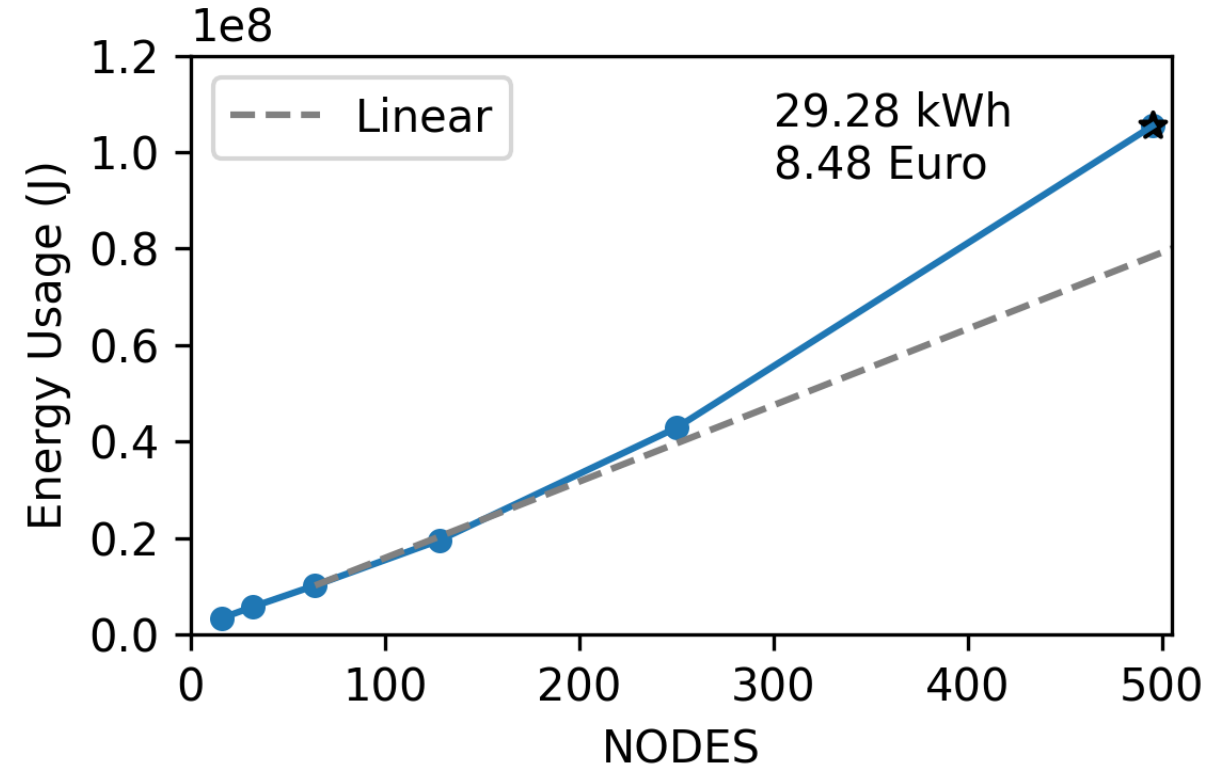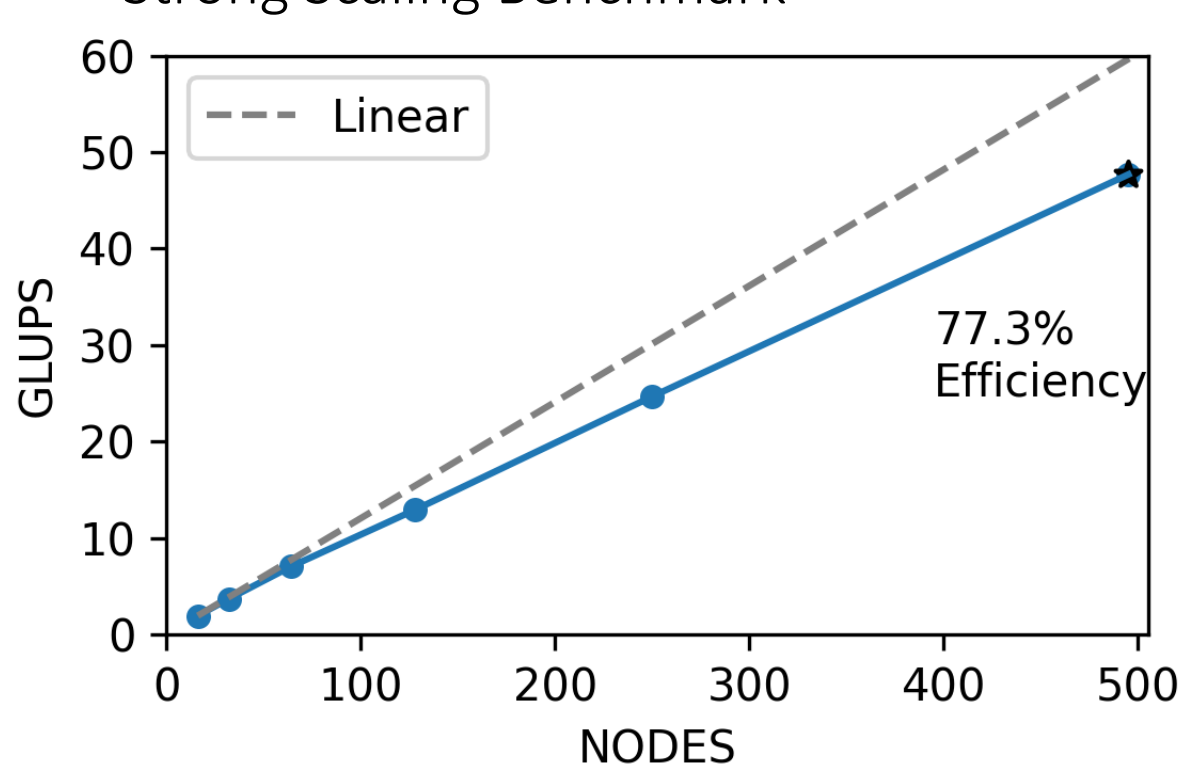
initial constellation · after collision kernel · after propagation, t=t+1

Palabos: Lattice-Boltzmann Solver
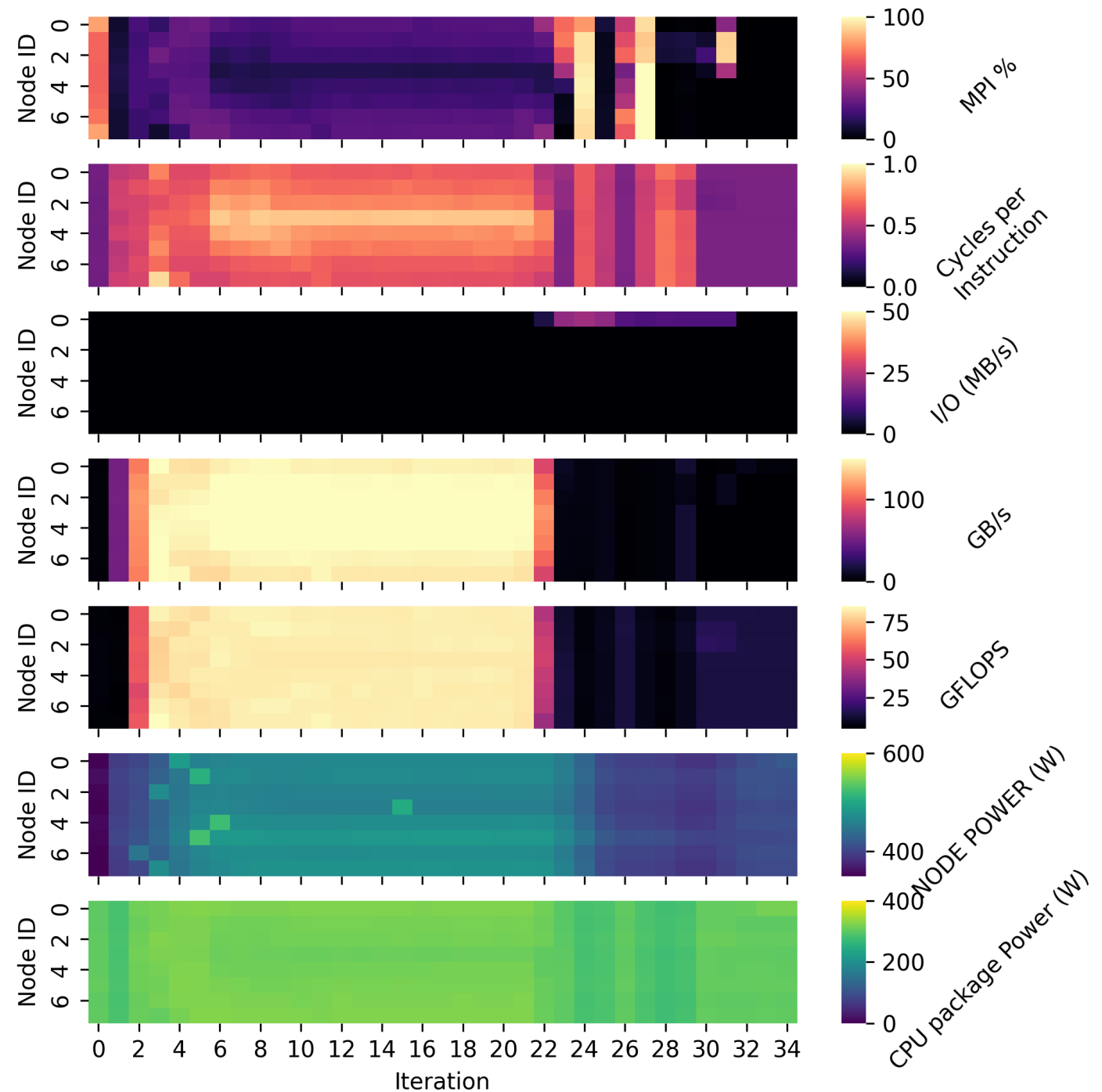
Strong Scaling Benchmark

- An average electric car consumes about 0.2 kwh/km

- 495 node case (which ran for 9 minutes) just drove a car to Leeuwarden (149km from SP)!

Palabos:

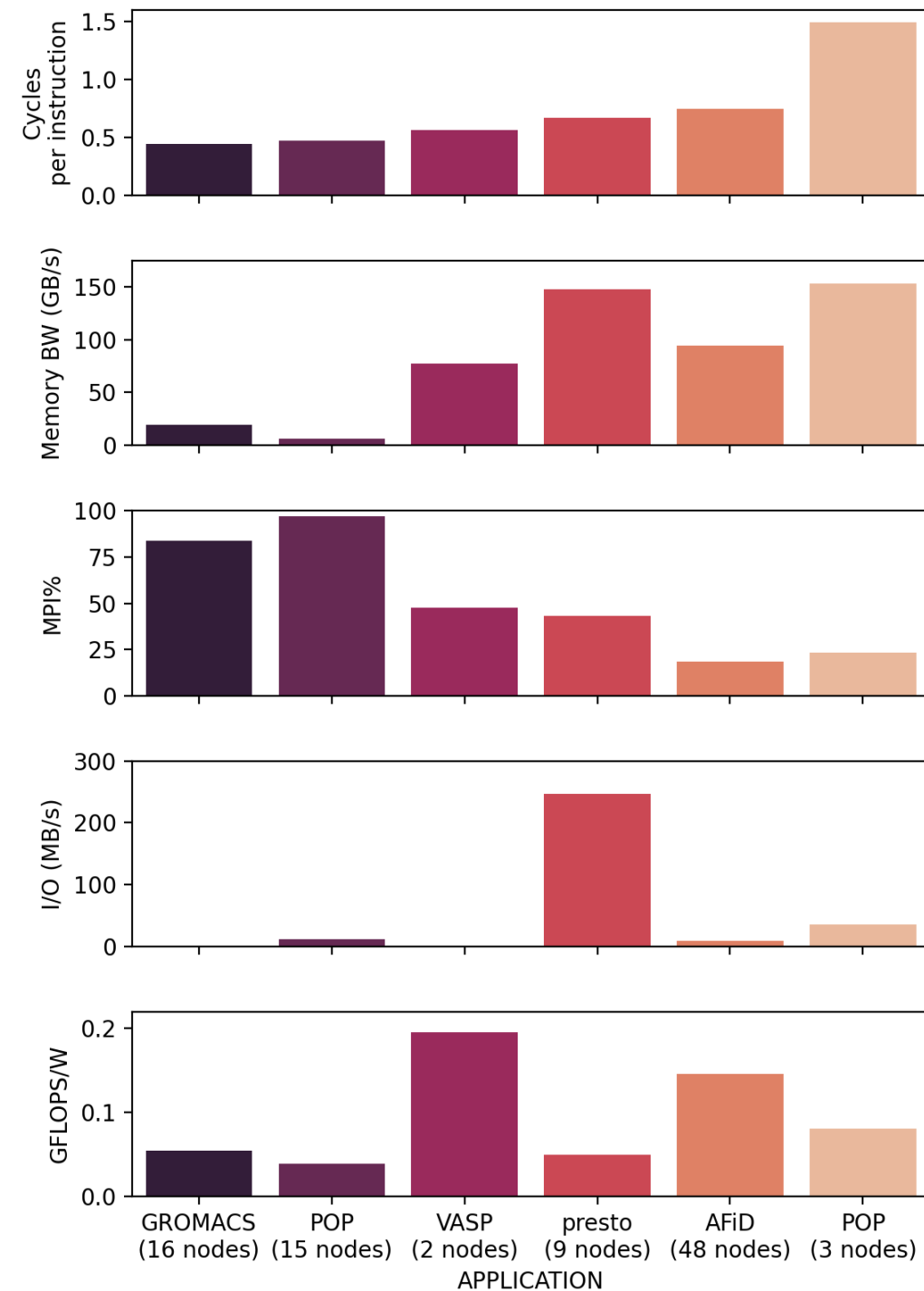Strong Scaling Benchmark

- Per-node, Per-iteration "traces"

- Node Power

- Avg CPU Freq (node)

- Main memory BW (GB/s)

- CPI (Cycles per instruction)

- MPI% (percentage spent in MPI calls)
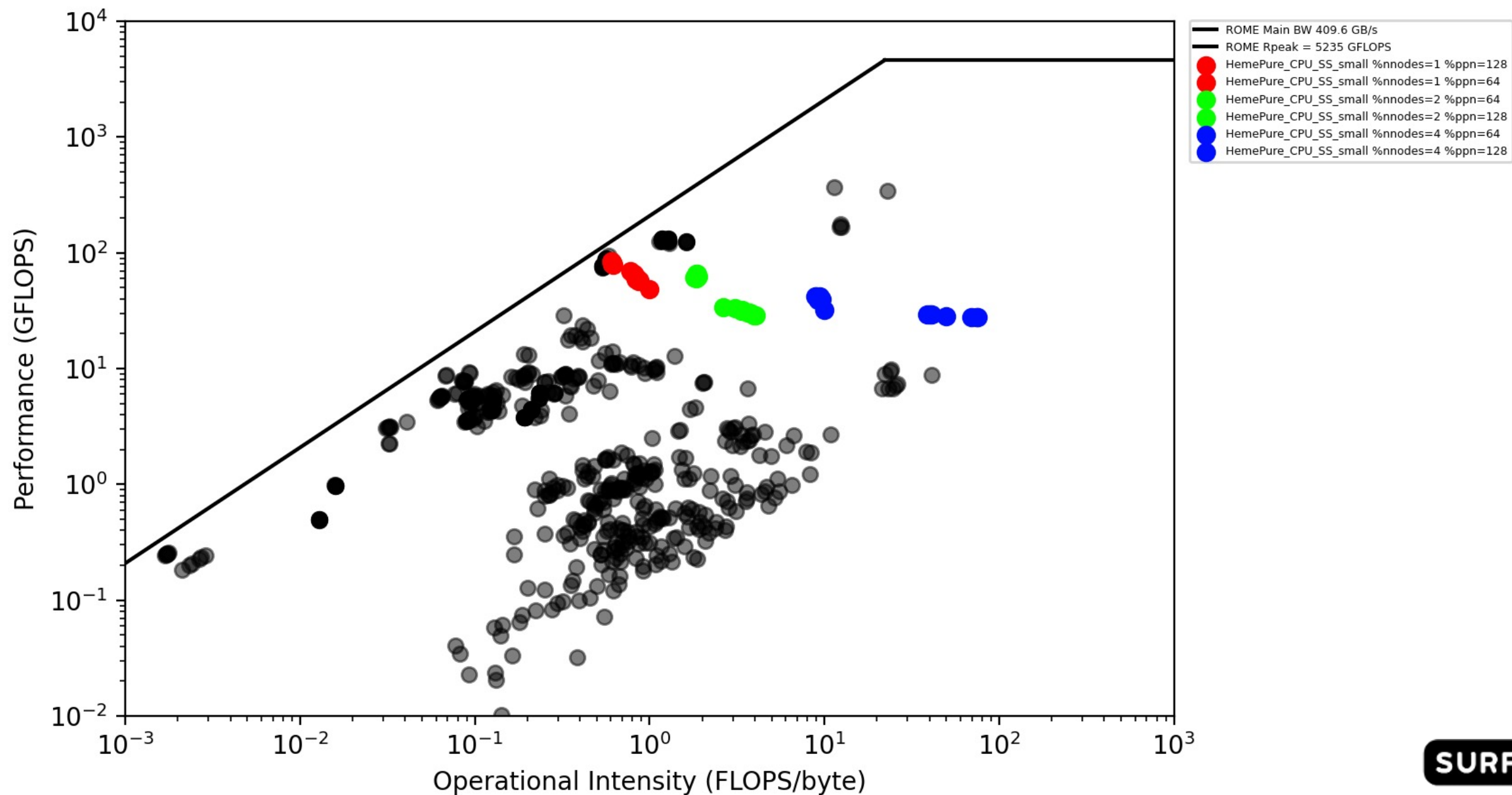
- I/O (network communication)

Application Characterization
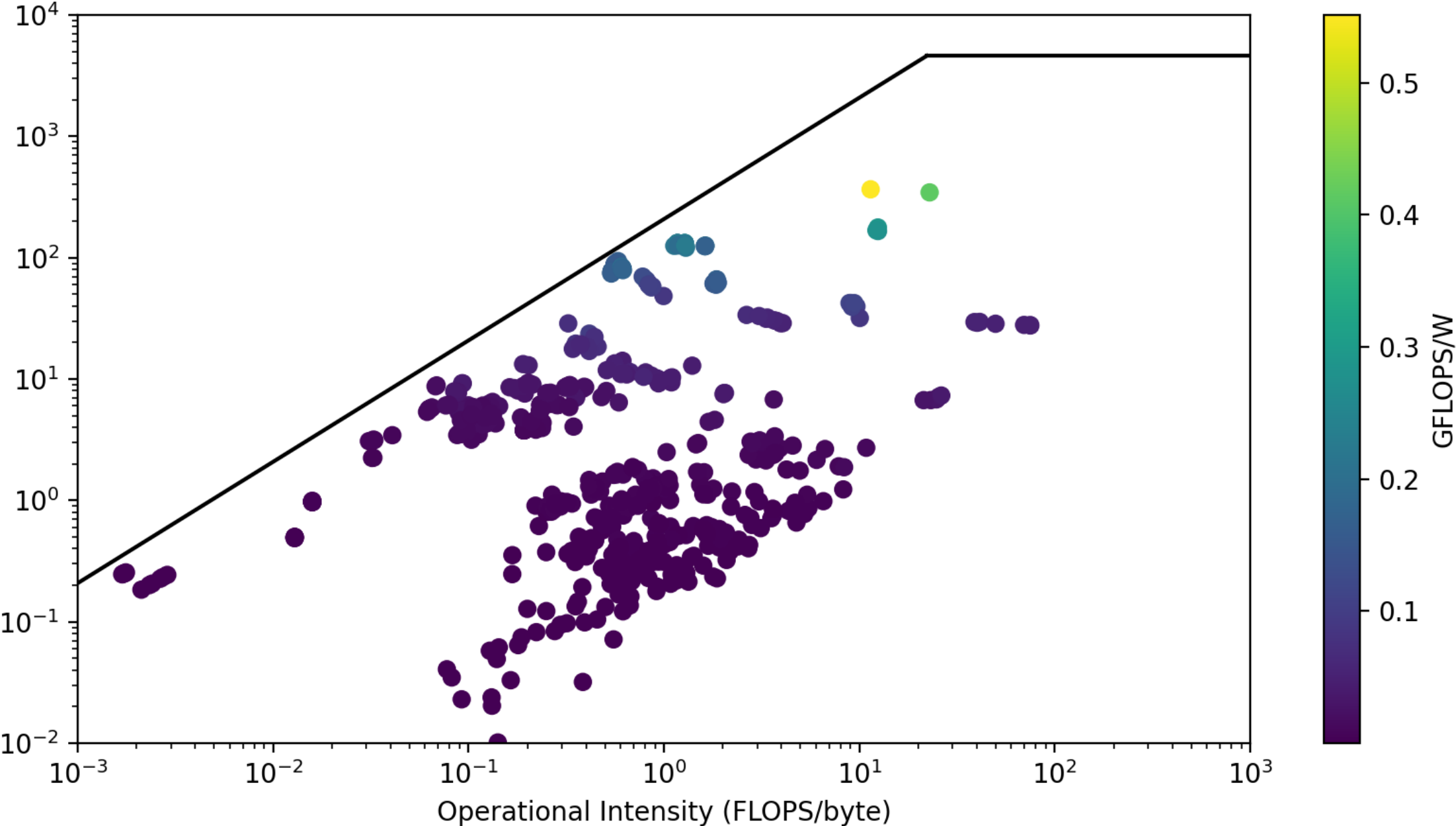Surf Application Benchmark Suite (SABS)

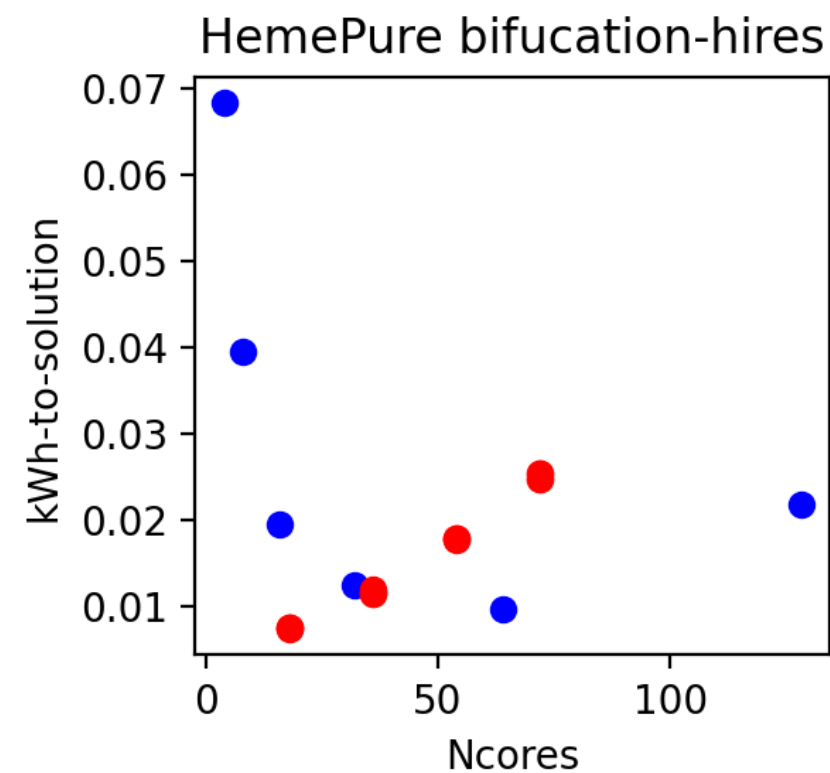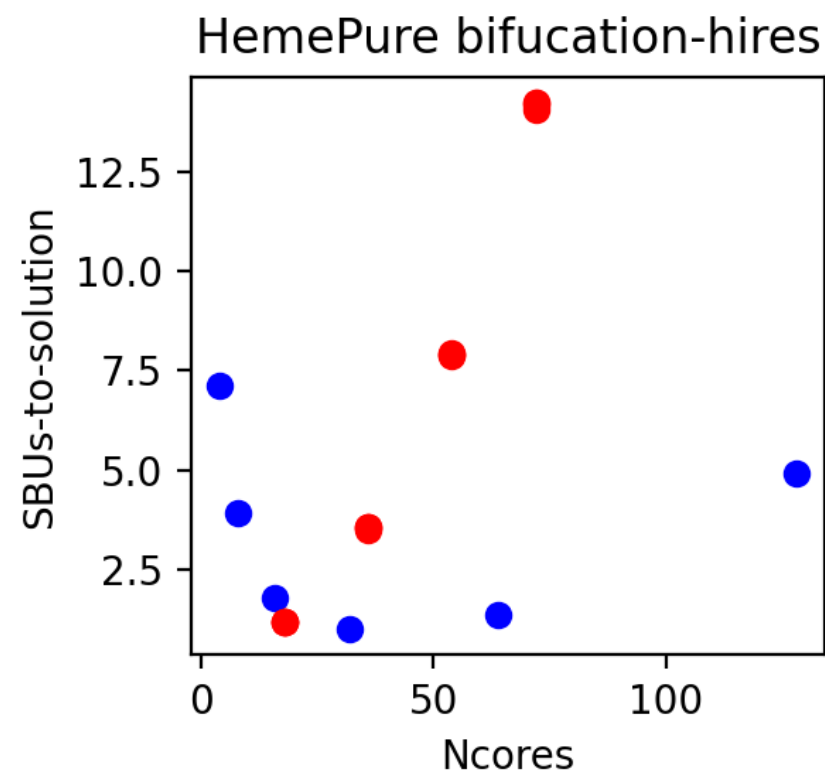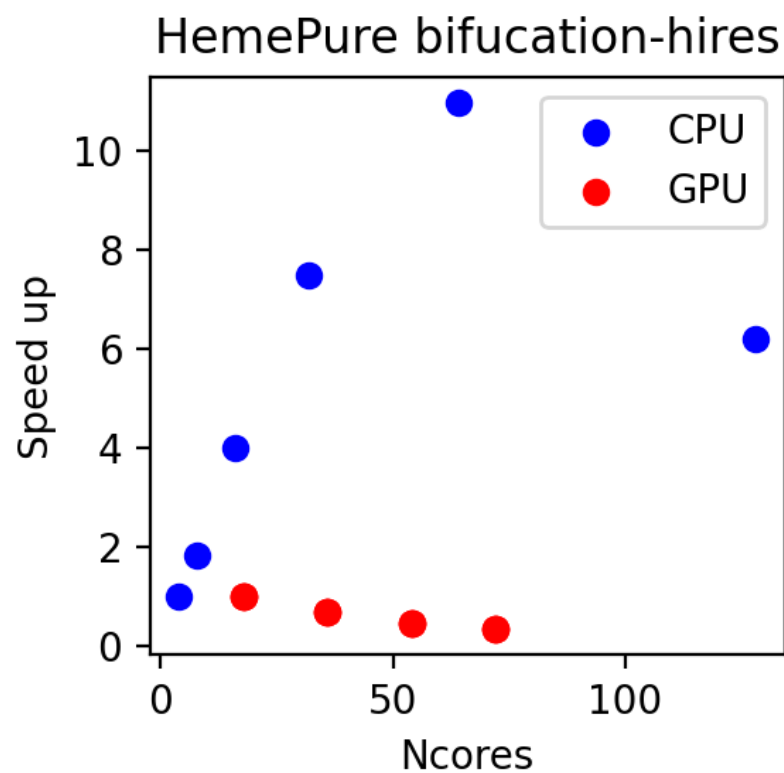- What aggregate metrics can we use to characterize an application?
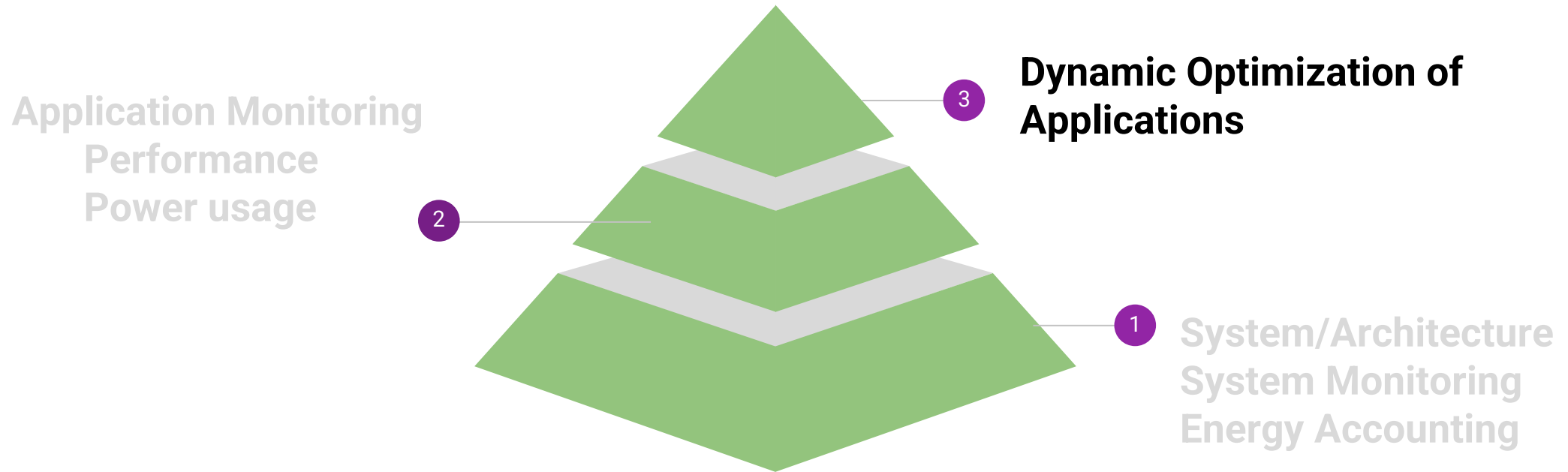
Application characterization
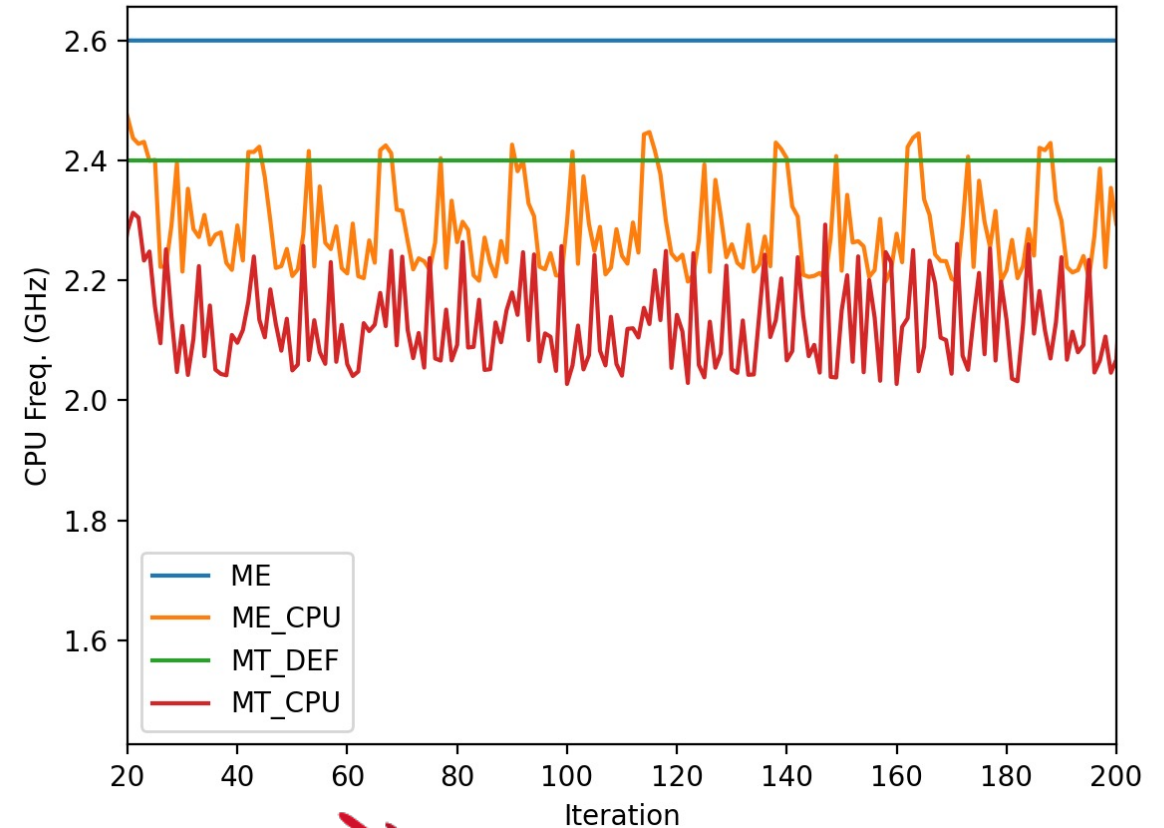
Application characterization

Energy/Time to solution

Energy-aware focus

Application Monitoring
Performance
Power usage

Dynamic Optimization of Applications

System/Architecture
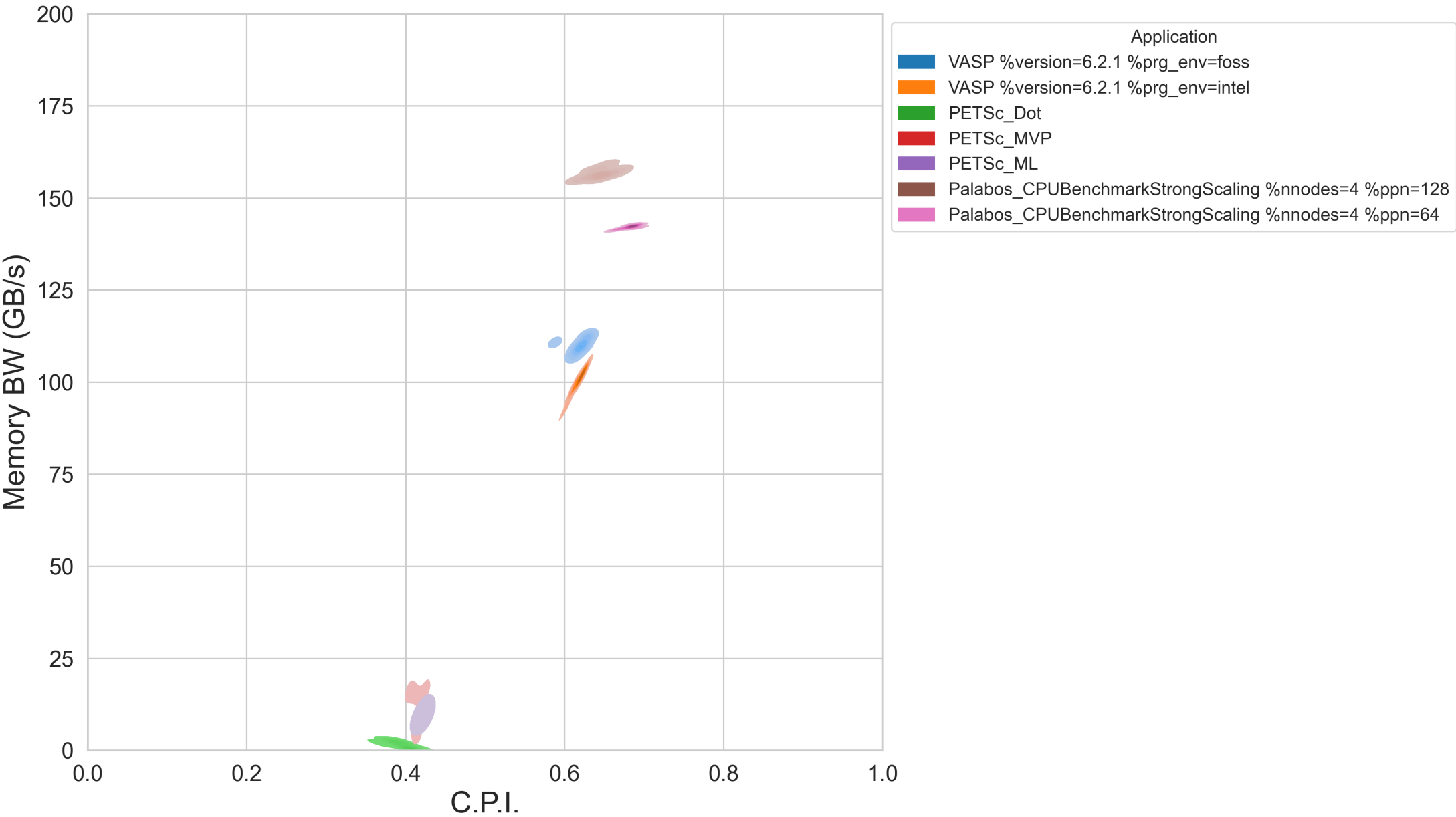System Monitoring
Energy Accounting

SURF

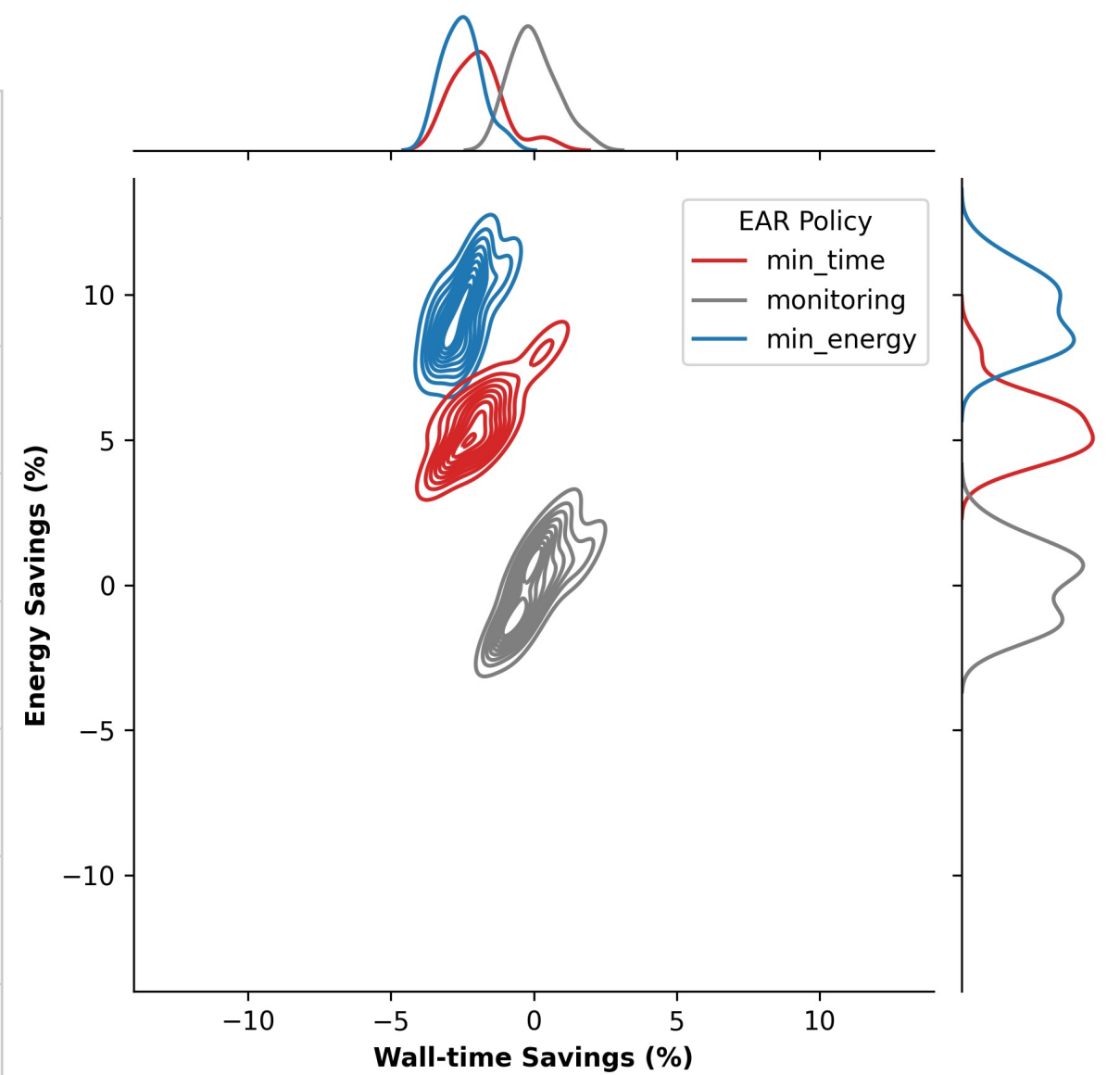# Application Optimization via EAR Policies

- monitoring
  - Does not affect the CPU Freq. Only monitors applications.
- min_energy
  - Memory intensive applications
    - Minimize the energy consumed with a limit to the performance degradation.
- min_time
  - CPU intensive applications
    - The goal of this policy is to improve the execution time while guaranteeing a minimum ratio between performance benefit and frequency increment that justifies the increased energy consumption from this frequency increment.

Application characterization

Application
- VASP %version=6.2.1 %prg_env=foss
- VASP %version=6.2.1 %prg_env=intel
- PETSc_Dot
- PETSc_MVP
- PETSc_ML
- Palabos_CPUBenchmarkStrongScaling %nnodes=4 %ppn=128
- Palabos_CPUBenchmarkStrongScaling %nnodes=4 %ppn=64

Memory BW (GB/s)

C.P.I.

Application characterization/optimization
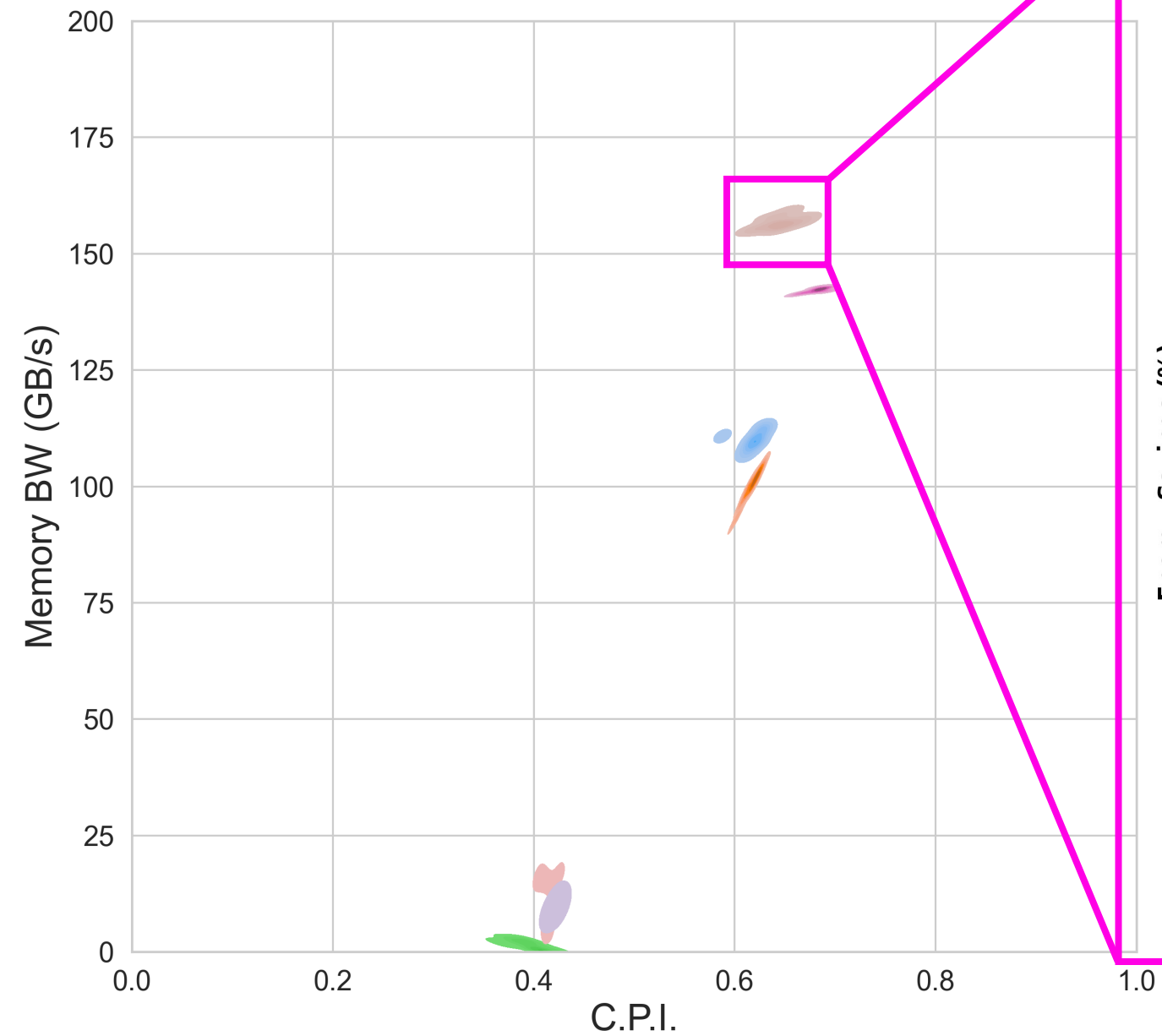
SURF - Energy Aware computing

- Contact us

  - https://servicedesk.surf.nl/

- EAR User Tutorial on Snellius

  - https://servicedesk.surf.nl/wiki/display/WIKI/Energy+Aware+Runtime+(EAR)

- Energy Aware Runtime (EAR) --- Energy Aware Solutions

  - https://www.eas4dc.com/solutions

  - https://gitlab.bsc.es/ear_team/ear/-/wikis/home