Power and Energy Code Profiling in Pharo

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Think
Green
Reuse
Recycle

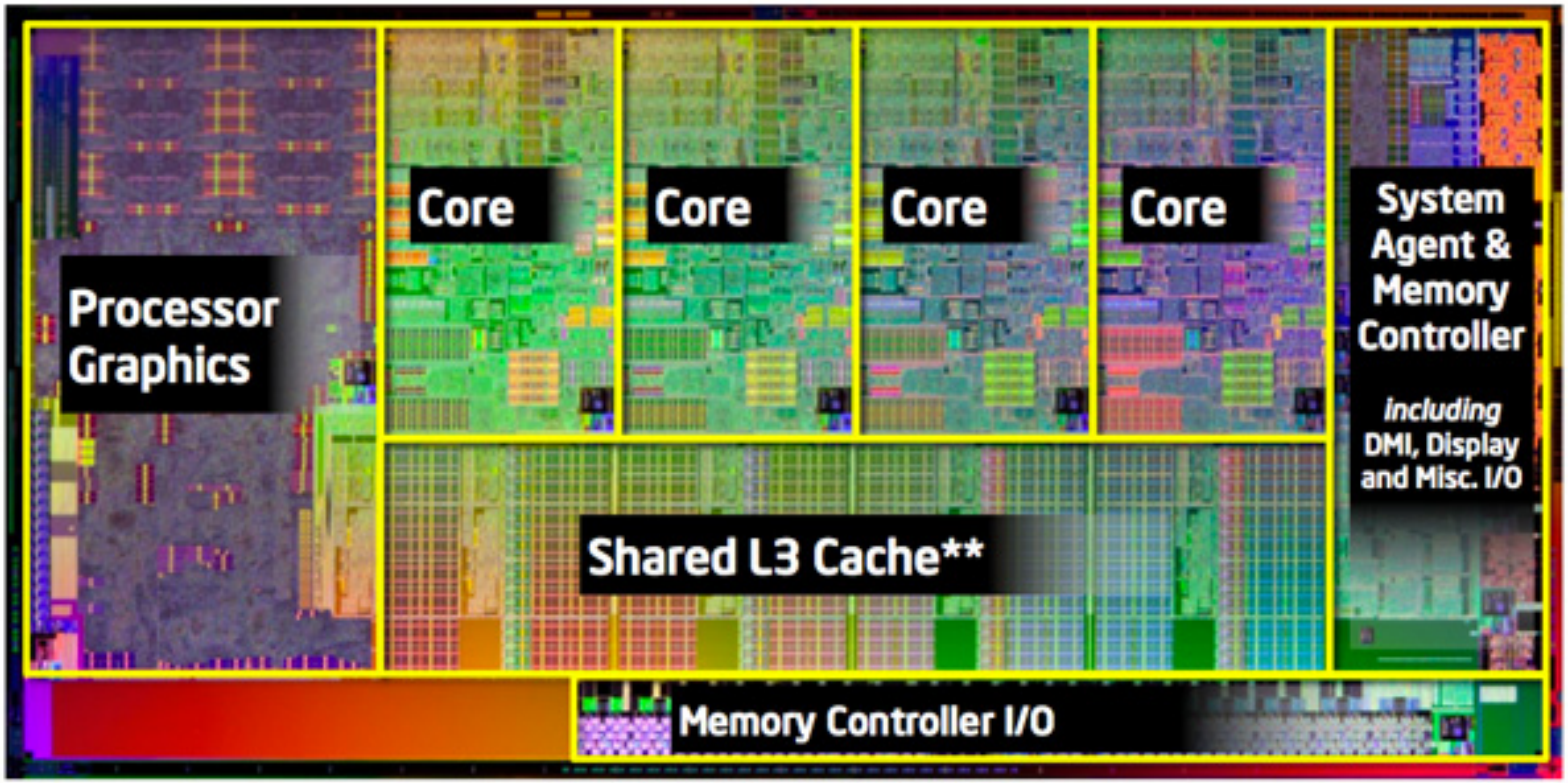
intel
CORE i5
intel

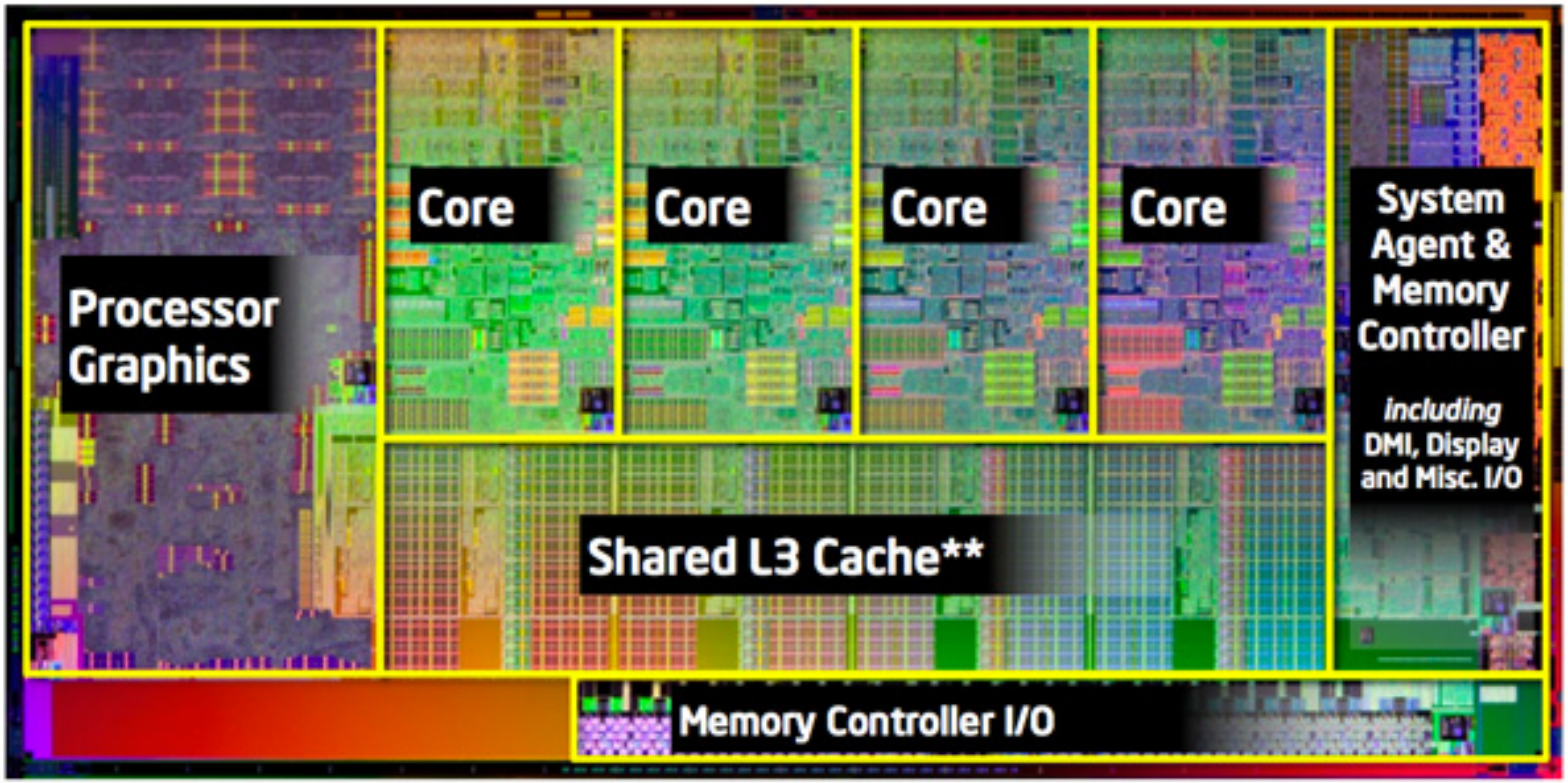
1 meter

Joule (J) is a unit of energy
Lifting 100g by one meter = 1 J

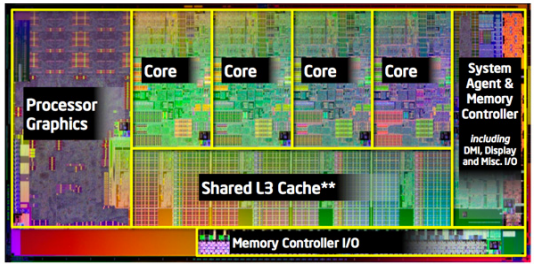
Watt (W) is a unit of power
defined as Joule / second

$$1\ W = 1\ J / s$$


Processor Graphics
Core
Core
Core
Core
System Agent & Memory Controller
including DMI, Display and Misc. I/O
Shared L3 Cache**
Memory Controller I/O



PkgPower for the whole processor (5 <= *PkgPower* <= *40W)*
IAPower for the cores (2 <= *IAPower* <= 35 W)



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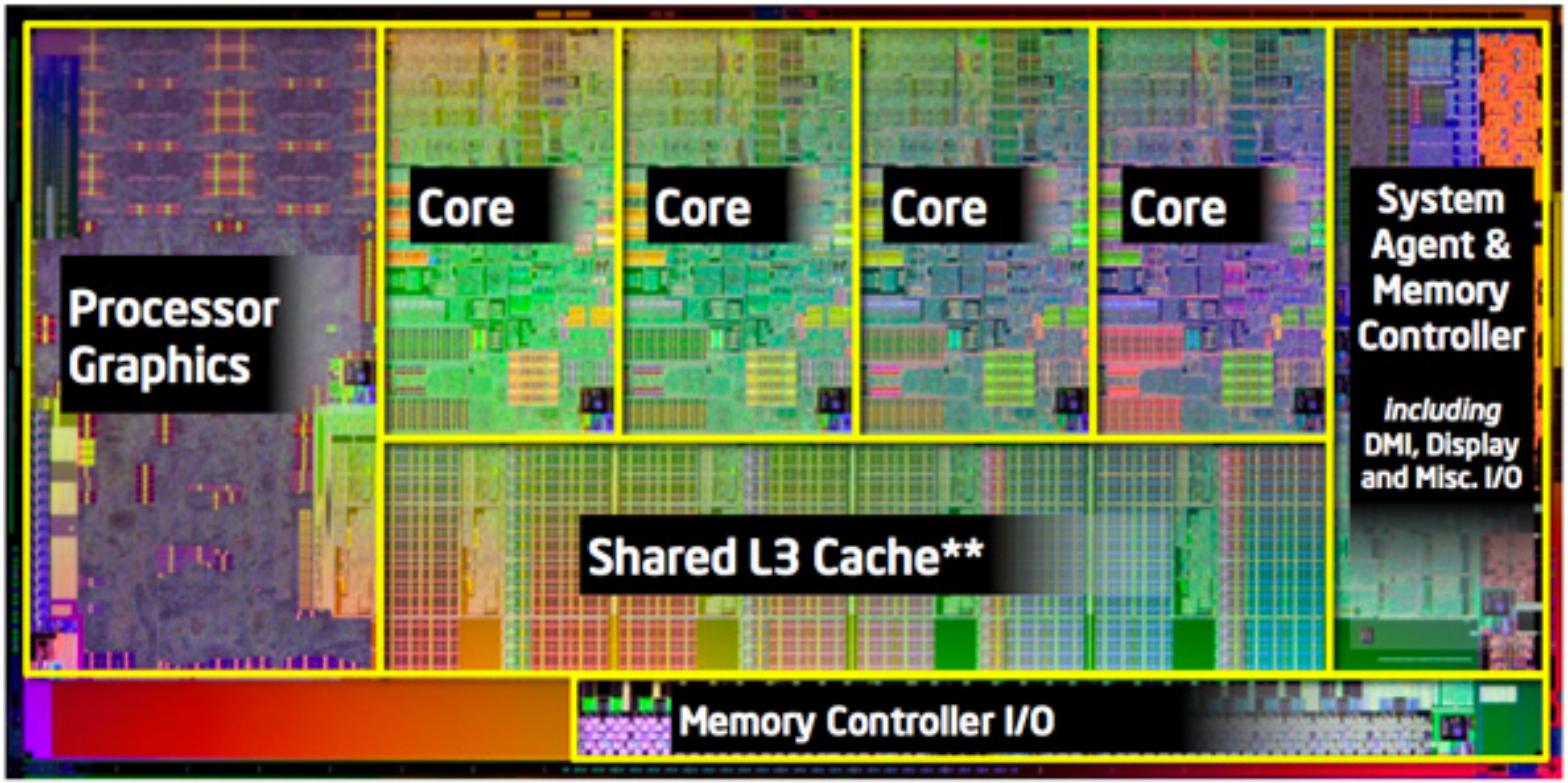

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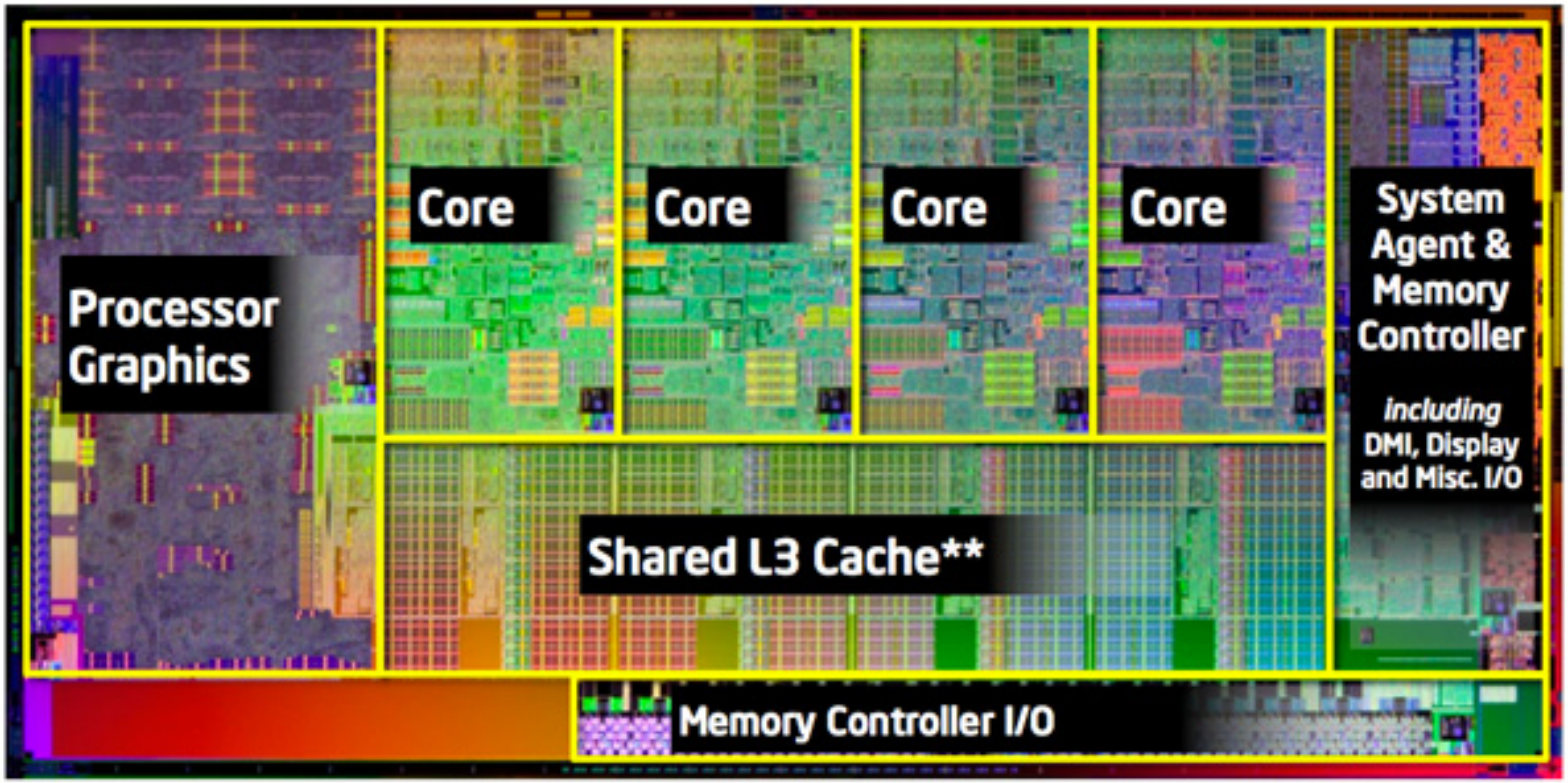
PkgTemp graphic & cores (between 40 and 60 C)



PkgPower for the whole processor (5 <= *PkgPower* <= *40W)*
IAPower for the cores (2 <= *IAPower* <= 35 W)
PkgTemp graphic & cores (between 40 and 60 C)
IAFreq CPU frequency (1.7 Ghz <= 3.2Ghz I5 <= 3.6)

Software & Hardware

Pharo 5 image & Cog

OS X El Capitan, version 10.11.4

Studied Intel Core i5 on an iMac (3.2Ghz)

Experiments have been made at 22 C

Network and screen disabled

Virtual Machine Launch & Being Idle

Operating system

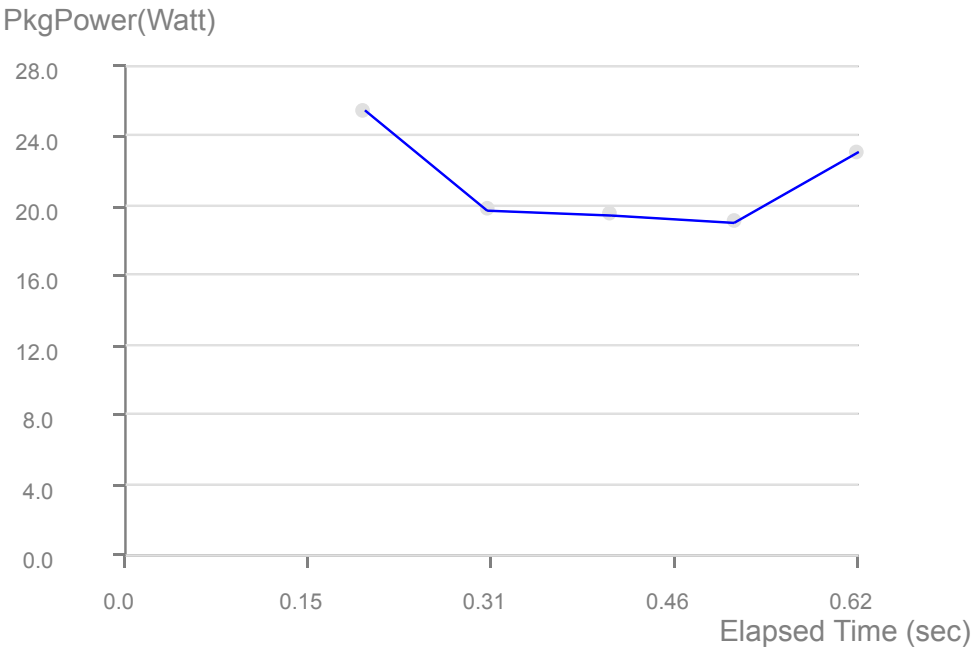
- PkgPower = 6W
- IAPower = 2.5W
- PkgTemp = 42C
- IAFreq = 1.78Ghz

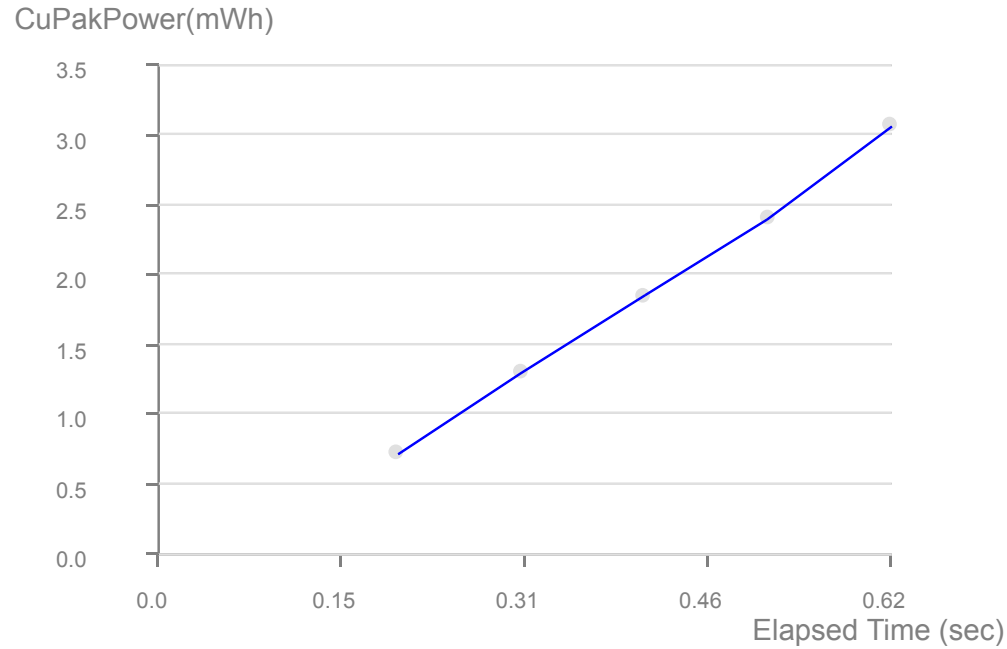
VM Launch

- Opening a 47Mb image consumes 3mWh

Pharo open and doing nothing

- PkgPower = 6W (despite the few % of CPU consumption)


PkgPower(Watt)
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
0.0
0.15
0.31
0.46
0.62
Elapsed Time (sec)


CuPakPower(mWh)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.15
0.31
0.46
0.62
Elapsed Time (sec)

5 Micro-benchmarks

- *G1*: Creation and elimination of memory blocks large of 3 Mb, represented as an `Array`.
- *G2*: G1 and the memory space are sequentially filled with an arbitrary immediate value.
- *G3*: Creation and elimination of small memory blocks, large of 10 Kb, represented as an `Array`.
- *G4*: G3 and the memory space are sequentially filled with an arbitrary immediate value.
- *Rec*: Recursively computing a large numerical sequence.

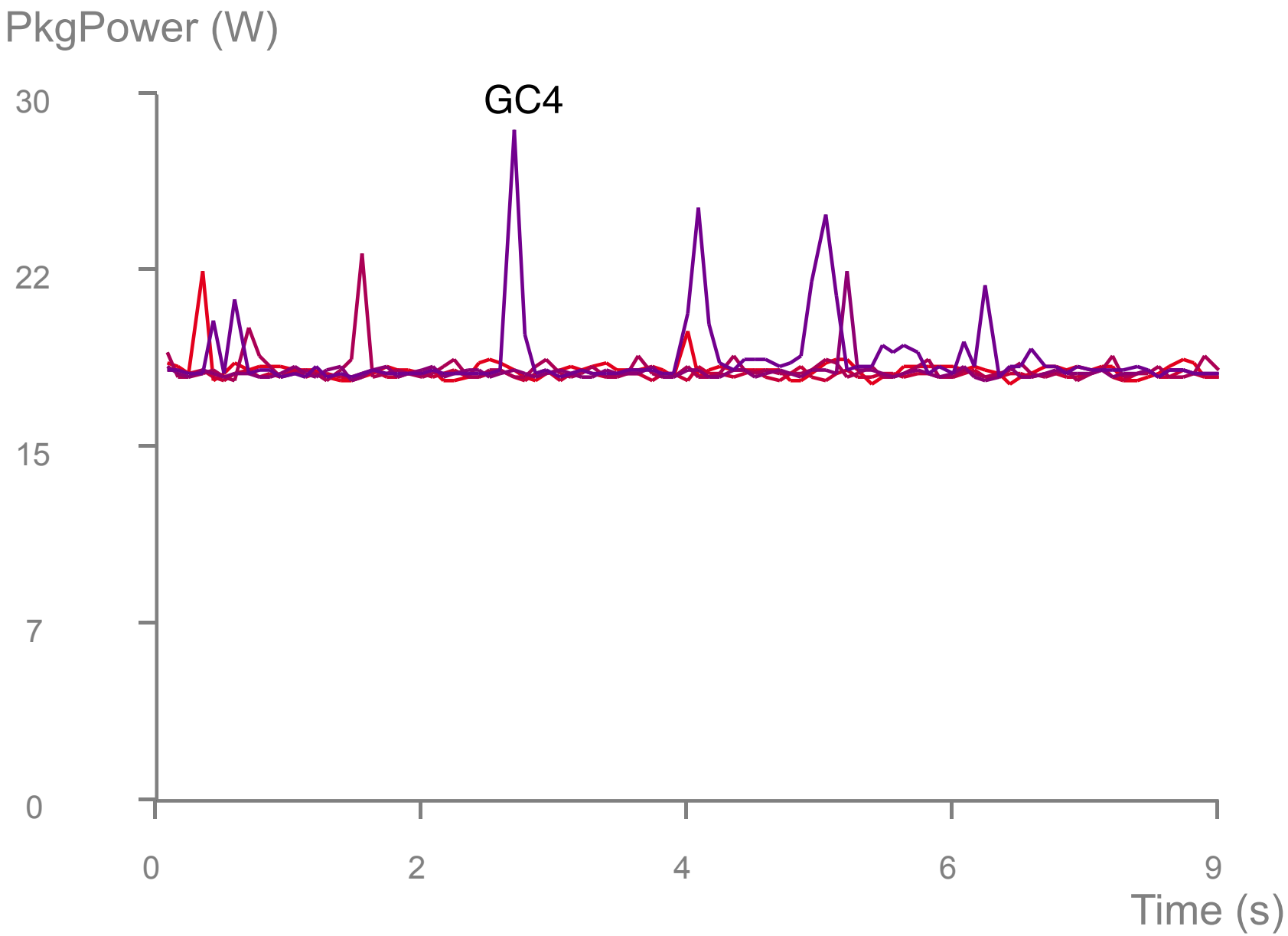
4 Macro-benchmarks

- *FB*: Computing a force based layout on a graph made of 5,000 nodes and 5,000 edges.
- *Graph*: Constructing a graph large 70,000 nodes and 70,000 edges.
- *Plot*: Plotting 30,000 numerical values.
- *Comp*: Compiling over 3,800 Pharo methods.

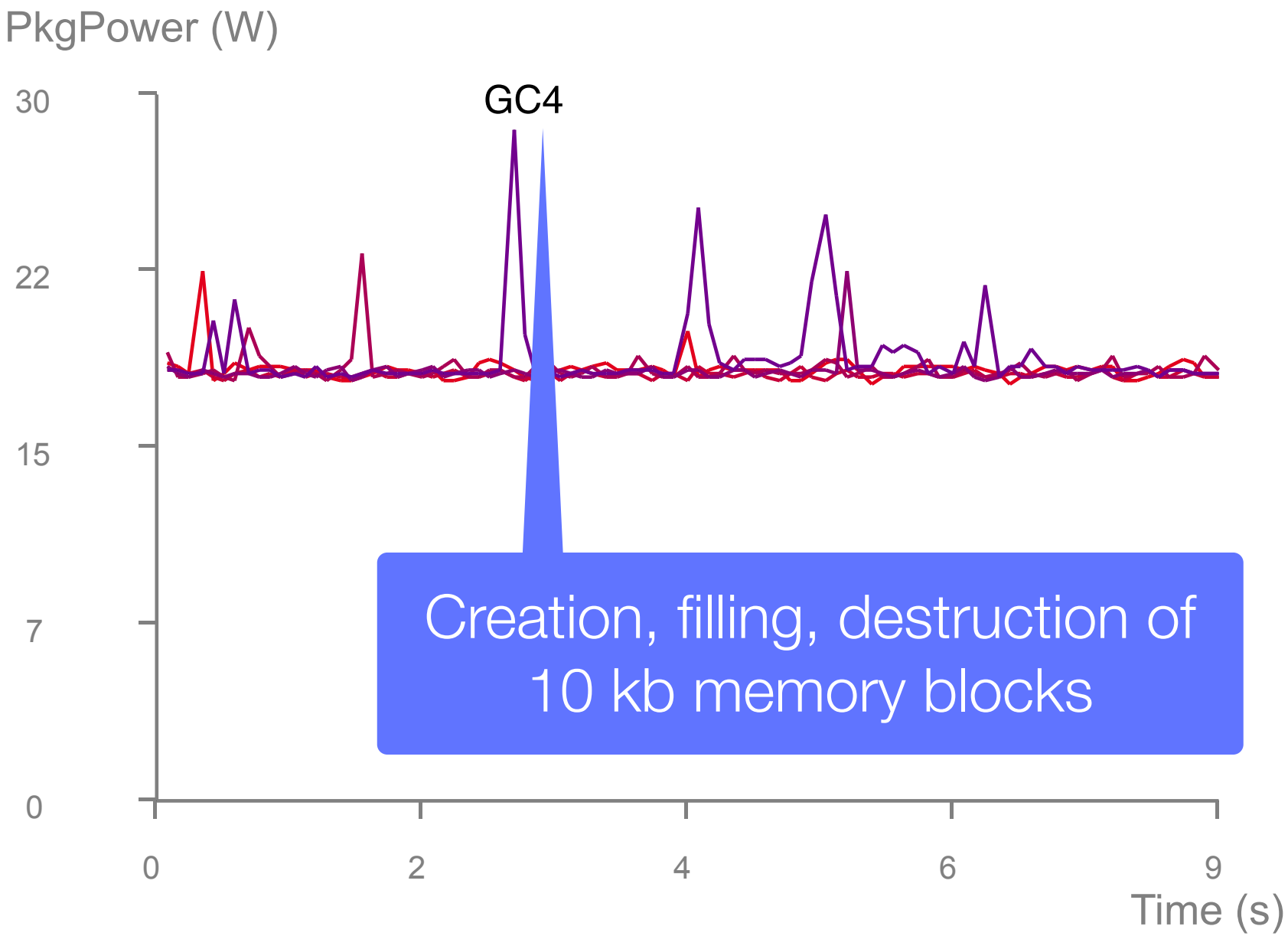
Benchmark execution

Wait 10 seconds between each run, to make sure that the CPU cools down

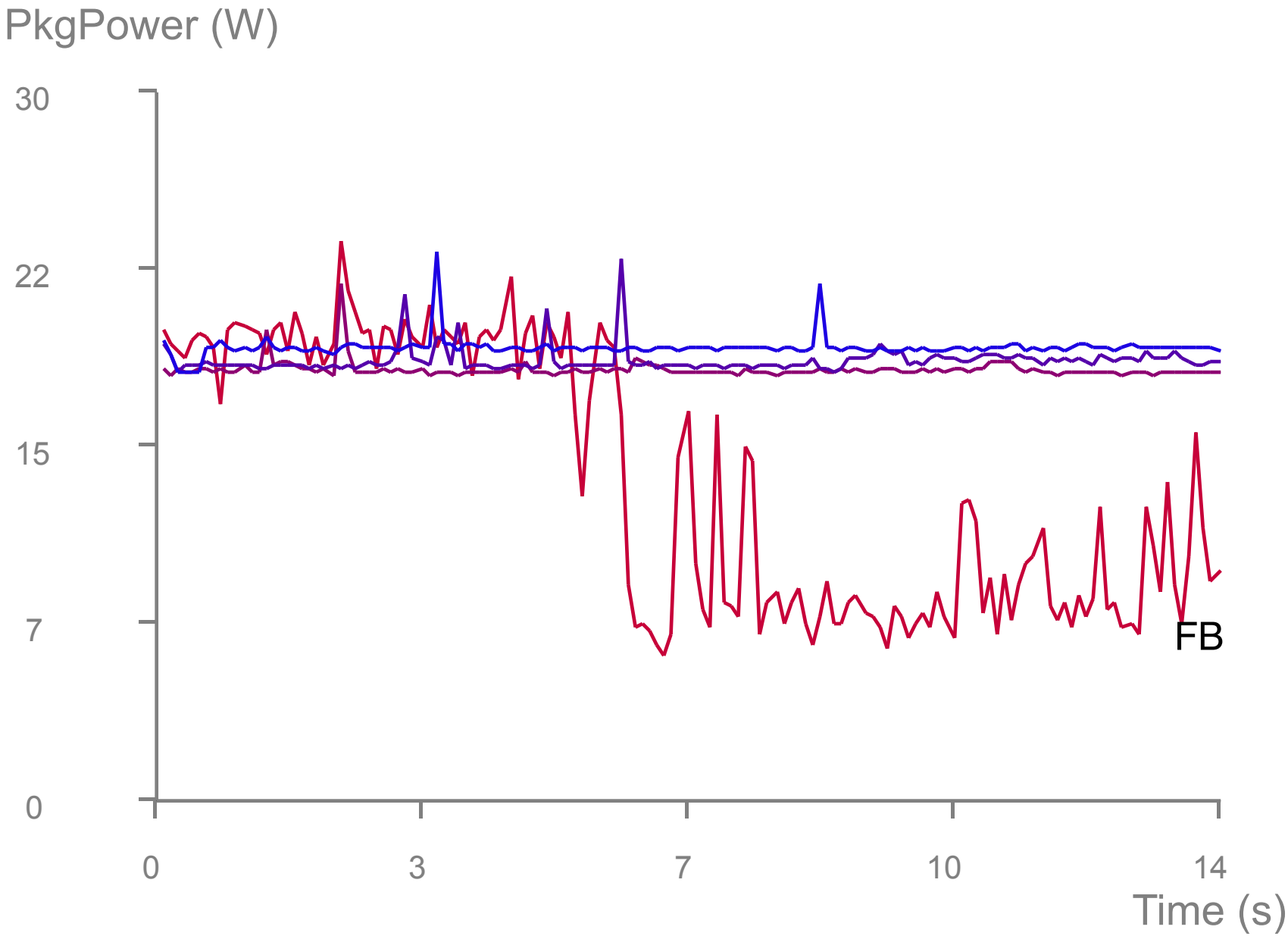
Micro-Benchmark execution



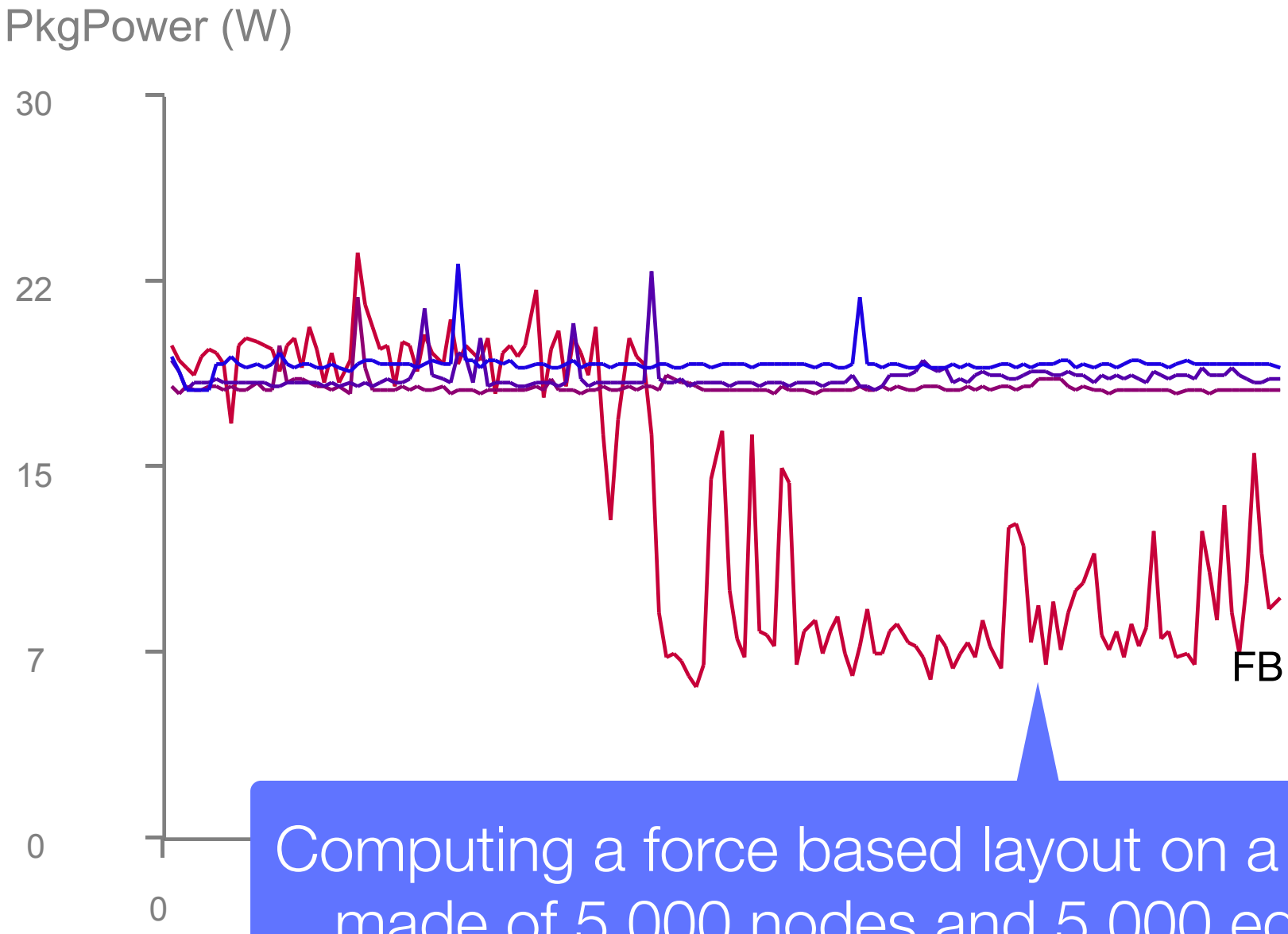
Micro-Benchmark execution



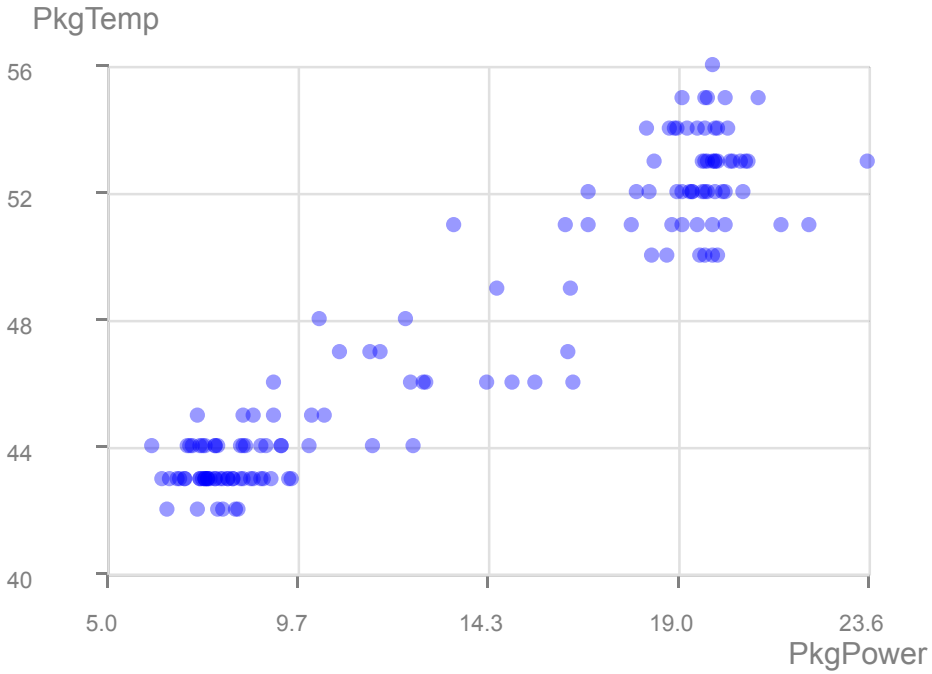
Macro-Benchmark execution



Macro-Benchmark execution

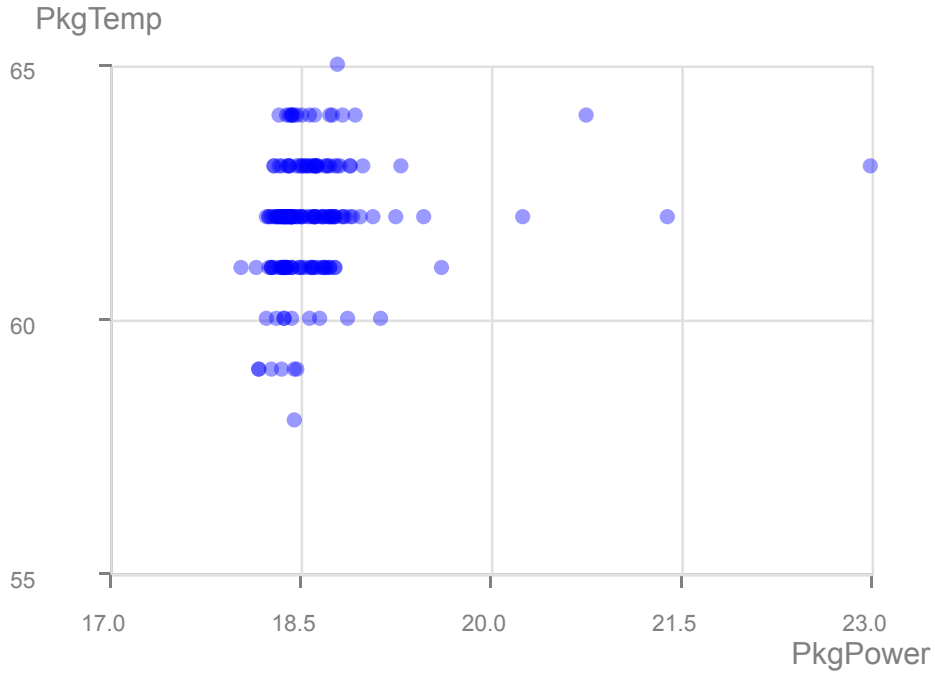


PkgPower x PkgTemp



FB Benchmark

(force based layout on
5K nodes & 5K edges)



Plot Benchmark

(plotting 30K values)

Implementation

```
EnergyProfiler new profile: [ …]
```

```
EnergyProfiler new
    profile: [ (Delay forSeconds: 2) wait ]
```

Can export to CSV, Roassal
Low level measurement using Intel Power Gadget
 & OSSubProcess

Future work

New, challenging, exciting area

Many possible future works

- replication across processors
- page swapping
- processor and VM intern caches