

CPU Idle Loop Ordering Problem

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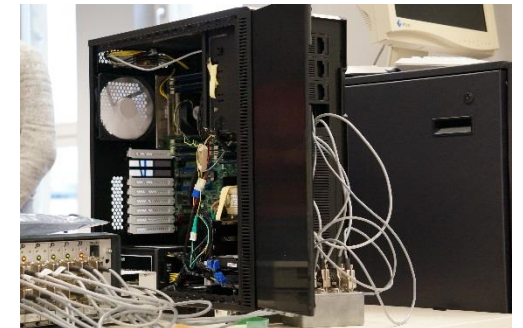
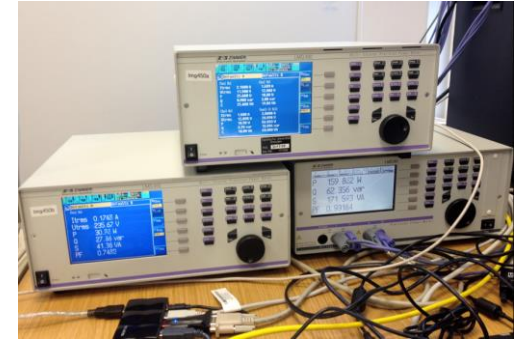
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Observing Power Consumption Anomalies

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- Energy efficiency research
- Fine grained instrumentation (microsecond resolution)
- Large scale instrumentation (HPC system 1400 nodes)
- Tuned for low idle power consumption

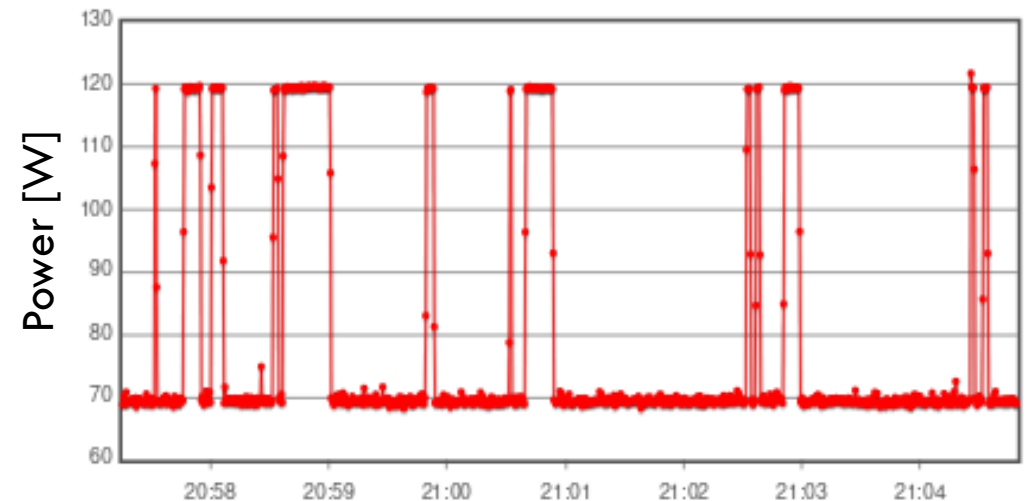
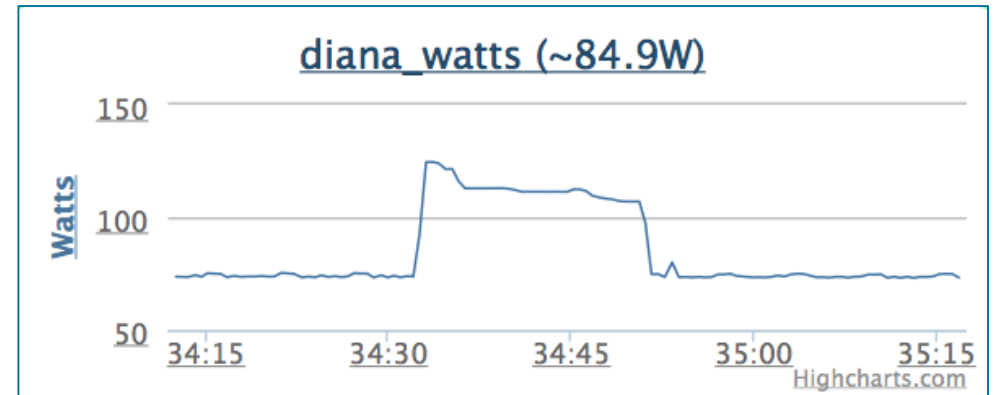


Observing Power Consumption Anomalies

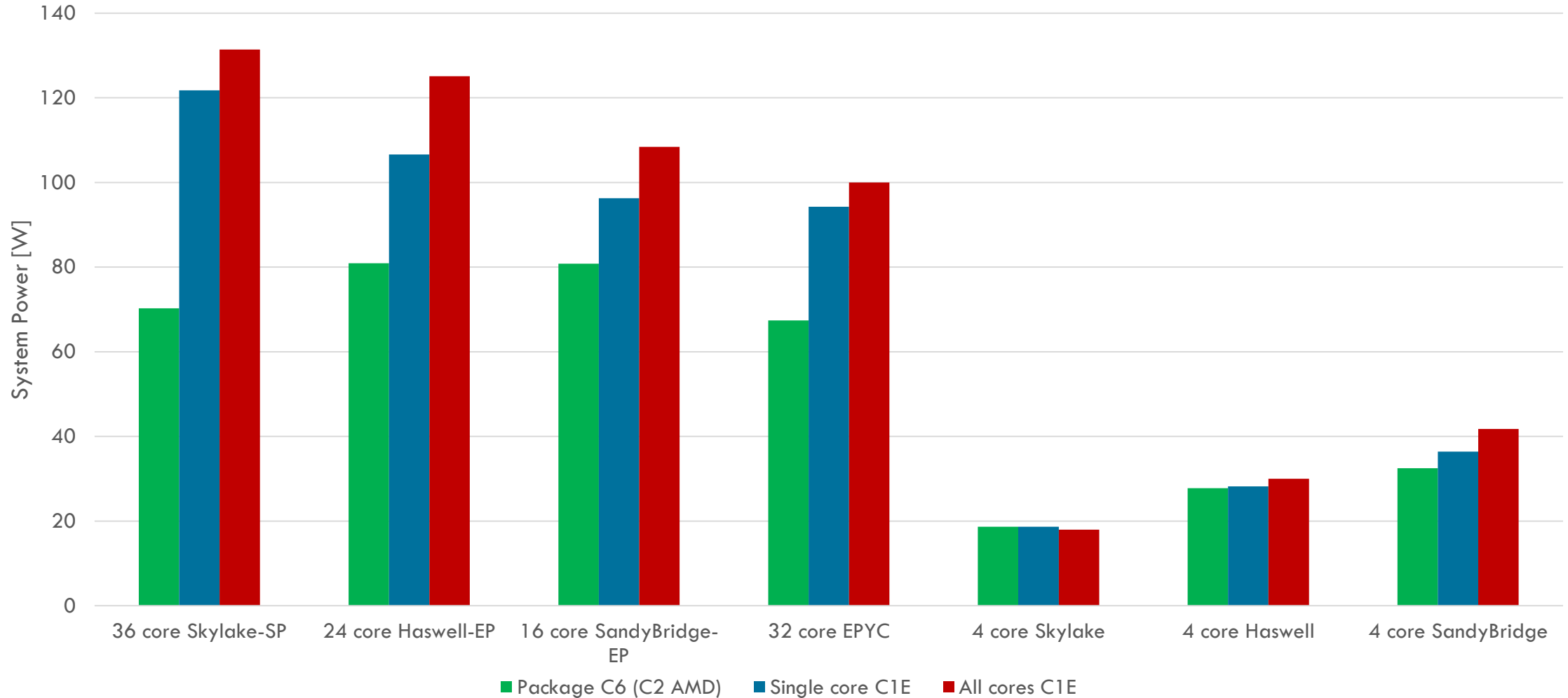
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- ❑ Prolonged phases of high power consumption during idle
- ❑ Disrupted power measurements
- ❑ Significant increase in idle power on Skylake 36 core system with stock Ubuntu installation



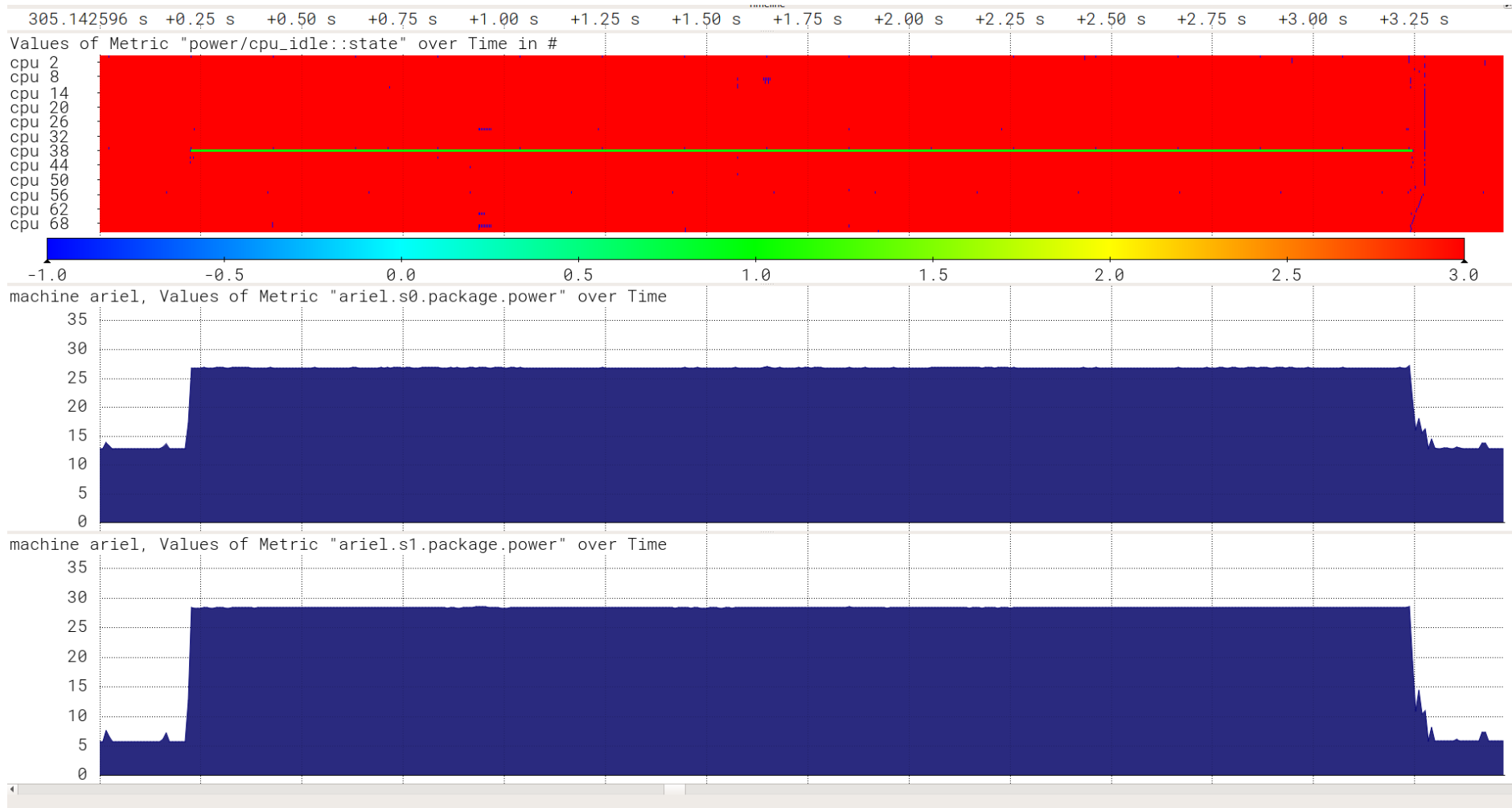
Impact of Package C States



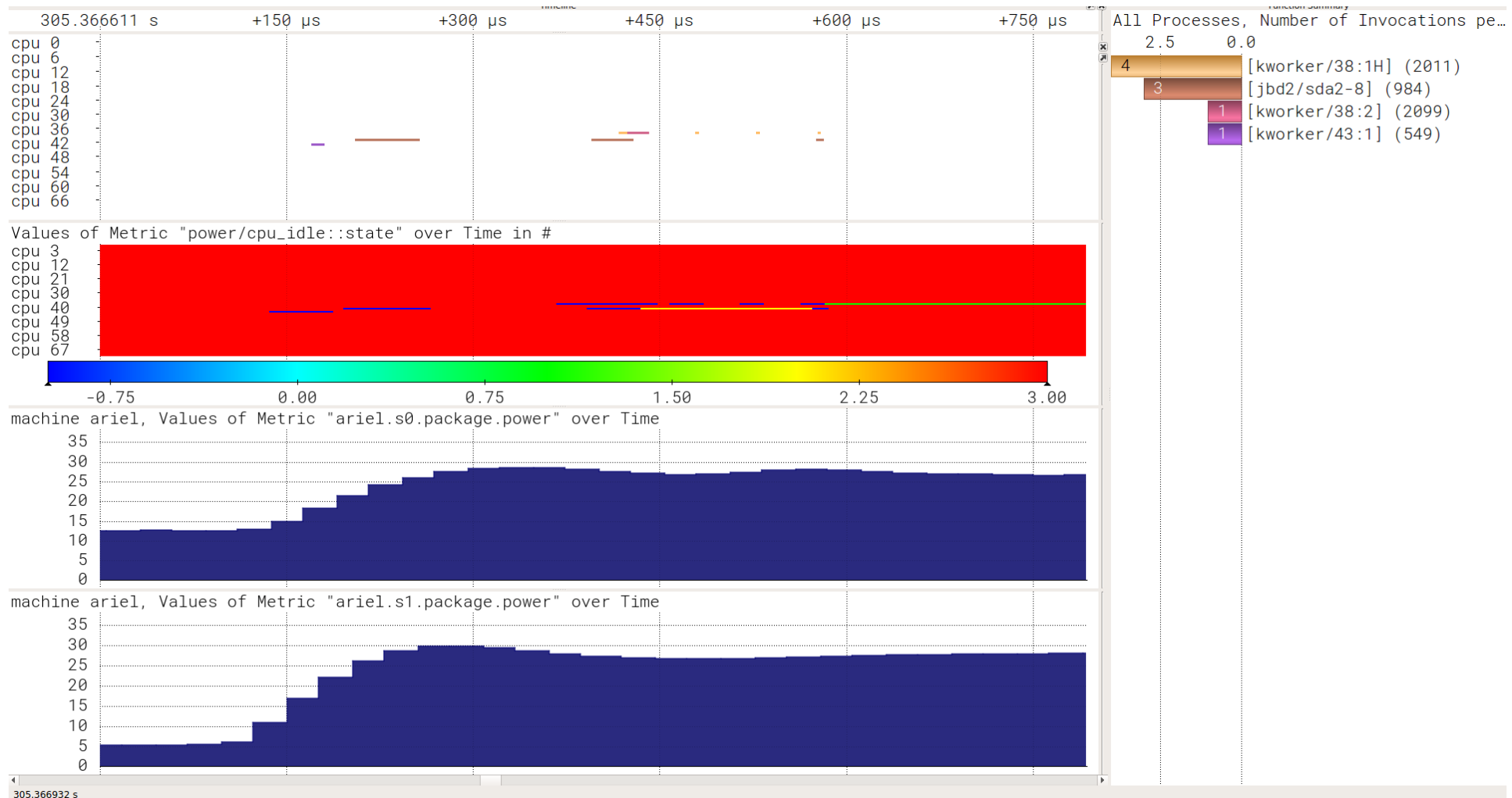
Understanding Power Anomalies

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Understanding Power Anomalies



Cause, Trigger, Contributing Factors

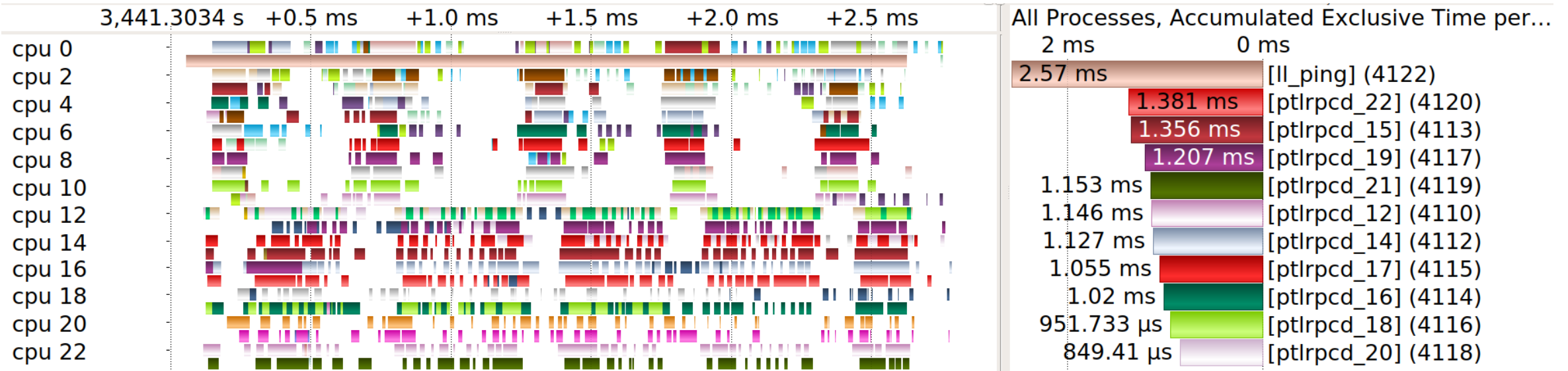
- Cause
 - ▣ Menu governor heuristic underestimates sleep time
 - ▣ Uses repeatable interval detector with 8 data points
 - ▣ Non-optimal C state is selected
- Trigger
 - ▣ Short sleep phases on one core
 - ▣ Interaction between processes, e.g. kworkers, ssh/zsh/screen, lustre ping
 - ▣ Synthetic: burst sleep intervals
- Contributing factors
 - ▣ Long idle phase, no correction of wrongly selected C state
 - ▣ Stubborn heuristic
 - ▣ High impact of single core in wrong state

Understanding Power Anomalies (HPC System)

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- ❑ Found on production HPC System with > 1400 nodes
- ❑ Lustre related pattern every 25 seconds

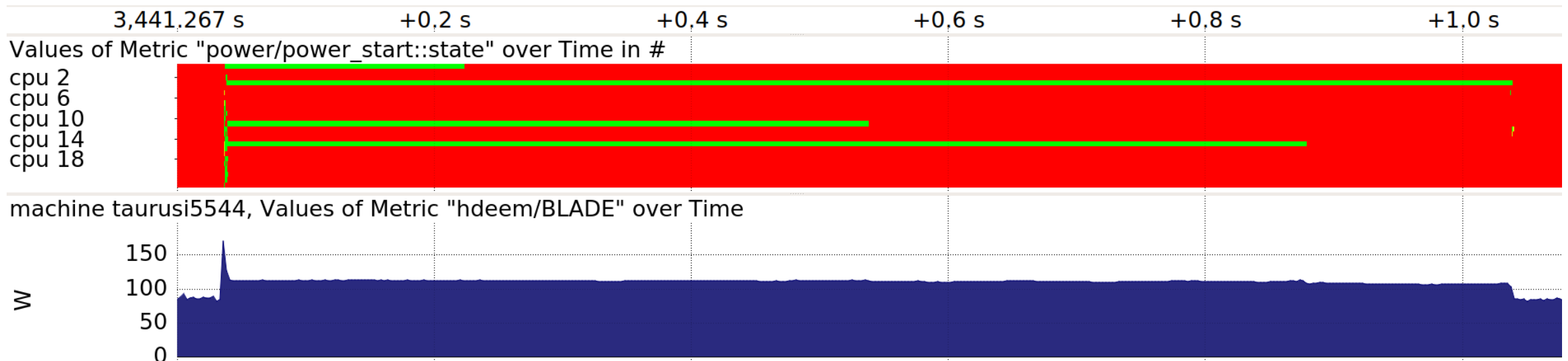


Understanding Power Anomalies (HPC System)

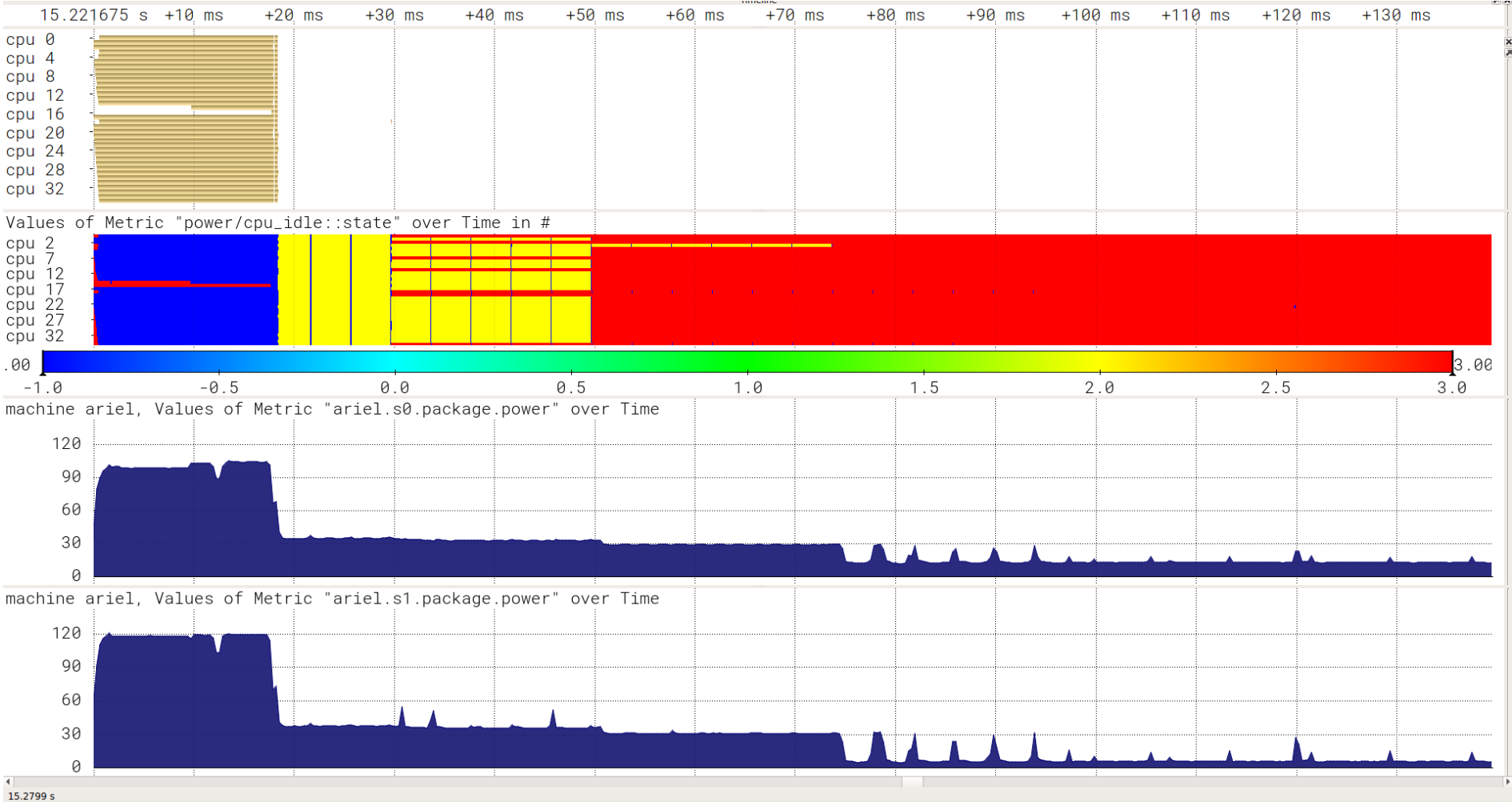
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- ❑ Found on production HPC System with > 1400 nodes
- ❑ Lustre related pattern every 25 seconds
- ❑ Triggers up to one second Powernightmare
- ❑ 87 W \rightarrow 131 W
- ❑ Lower impact due to regular background activity



Synthetic trigger with idle-loop v9

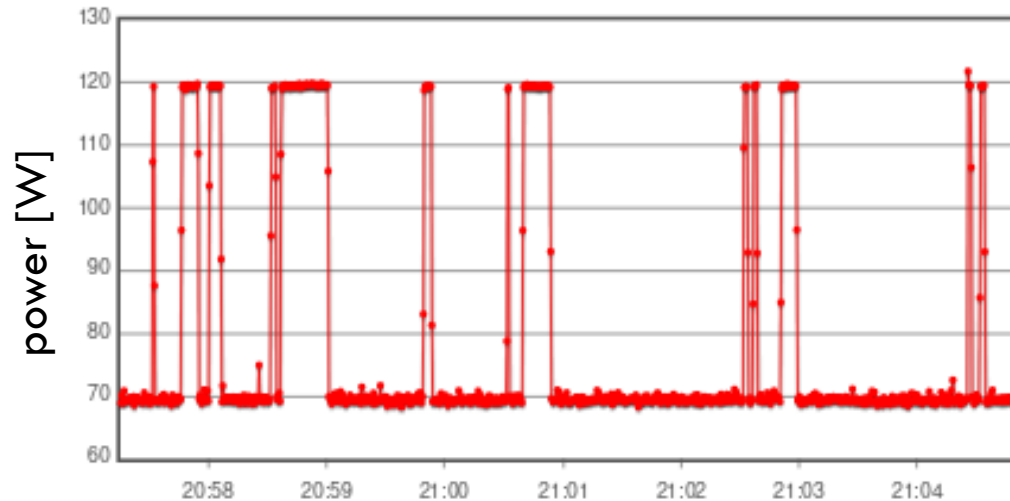


Fixing Powernightmares for Linux 4.17

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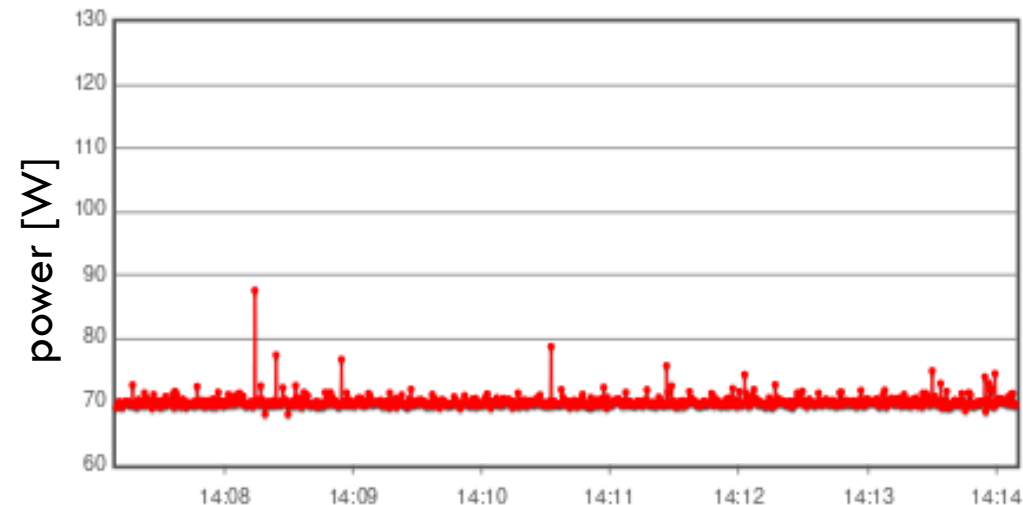
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Linux 4.4



- Dual socket, 36 core SKL-SP system
- Default Ubuntu server installation, fully idle, no extra services
 - ▣ Frequent power spikes up to **120 W**
 - ▣ Average system power **78 W**

Linux 4.17



- Upcoming kernel 4.17
 - ▣ Constant, low idle power
 - ▣ Average system power **70 W (-10.3%)**

References

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"lo2s – Multi-Core System and Application Performance Analysis for Linux"
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↪ <https://github.com/tud-zih-energy/lo2s>
- Thomas Ilsche, Robert Schöne, Joseph Schuchart, Daniel Hackenberg, Marc Simon, Yiannis Georgiou and Wolfgang E. Nagel.
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