



# z/OS Measurements Basic to Advanced Series: LPAR and CEC Usage and Utilization

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# Abstract (why you're here!)



"How busy is my mainframe?" is arguably the most basic performance question people want answered. And while there's lots of ways to express that measurement, that's only the beginning of understanding what might be impacting your LPARs' performance. In this webinar, we'll start at the basic CEC usage, discuss why the RMF view of that may be misleading, and move to the less-reviewed but important measurements before finally exploring some measurements that you might not have thought to look at before. Join **Scott Chapman** as he breaks down these measurements and shares what he's learned from reviewing hundreds of LPAR configurations over the years.

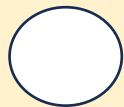
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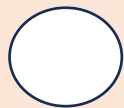
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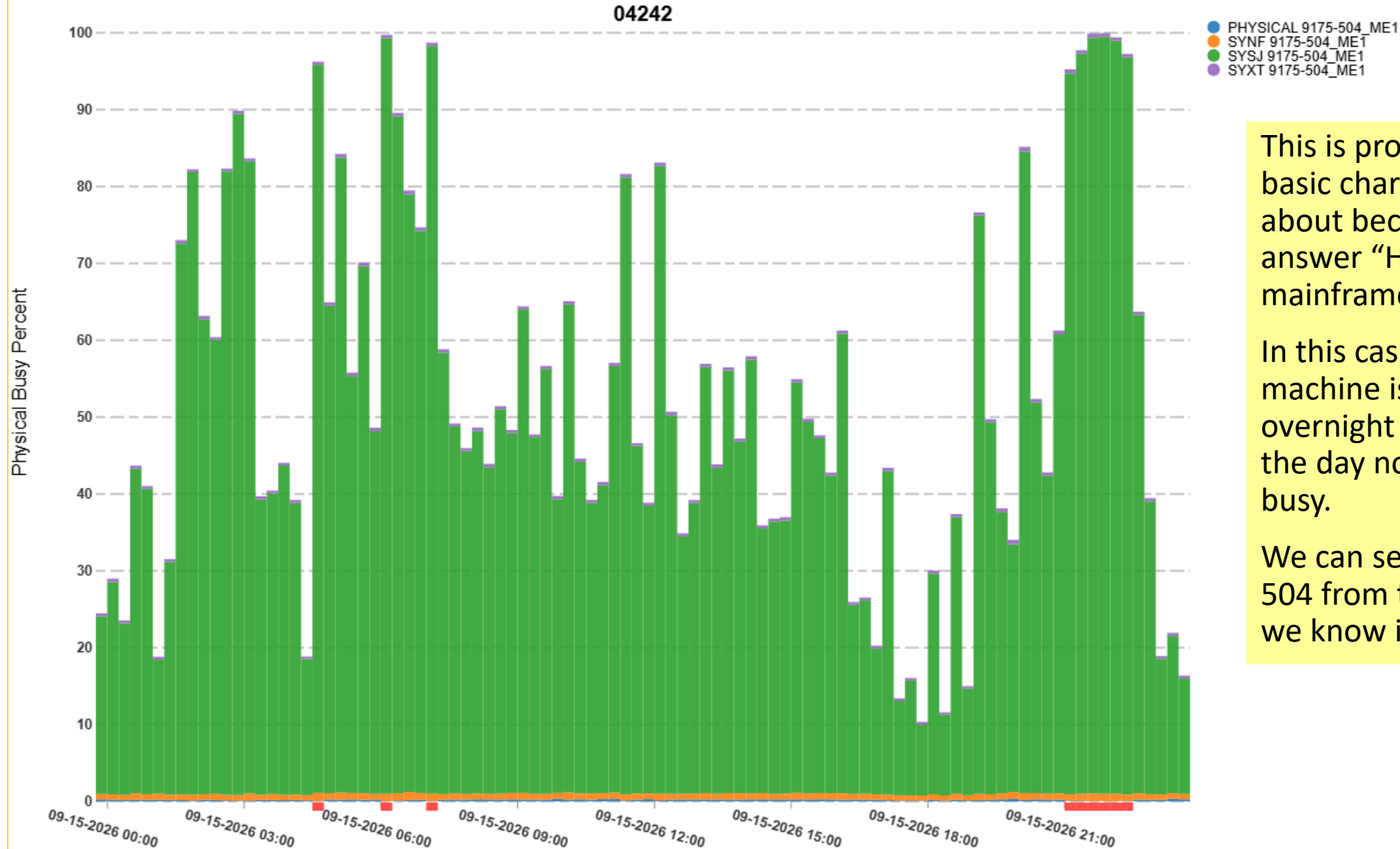
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# Basic

How busy are we?

# CEC Physical Machine CP Busy% by CEC Serial Number

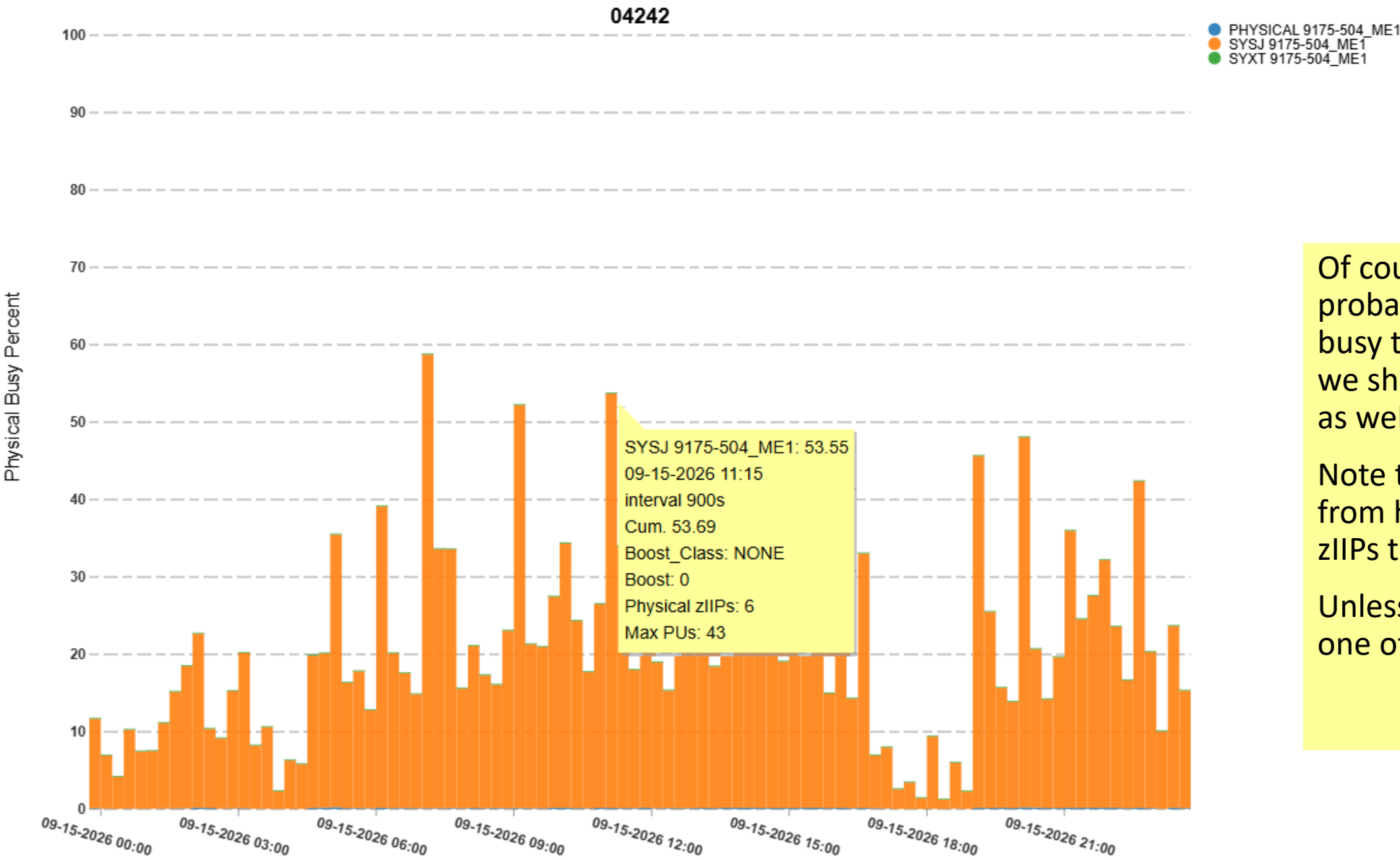


This is probably the one basic chart people care most about because they want to answer “How busy is the mainframe?”

In this case we see the machine is maxed out overnight and for much of the day not apparently very busy.

We can see that this is a z17 504 from the 9175-504 so we know it has 4 GPs.

# CEC Physical Machine zIIP Busy%



Of course, we should probably care about how busy the zIIPs are too, so we should look at those as well.

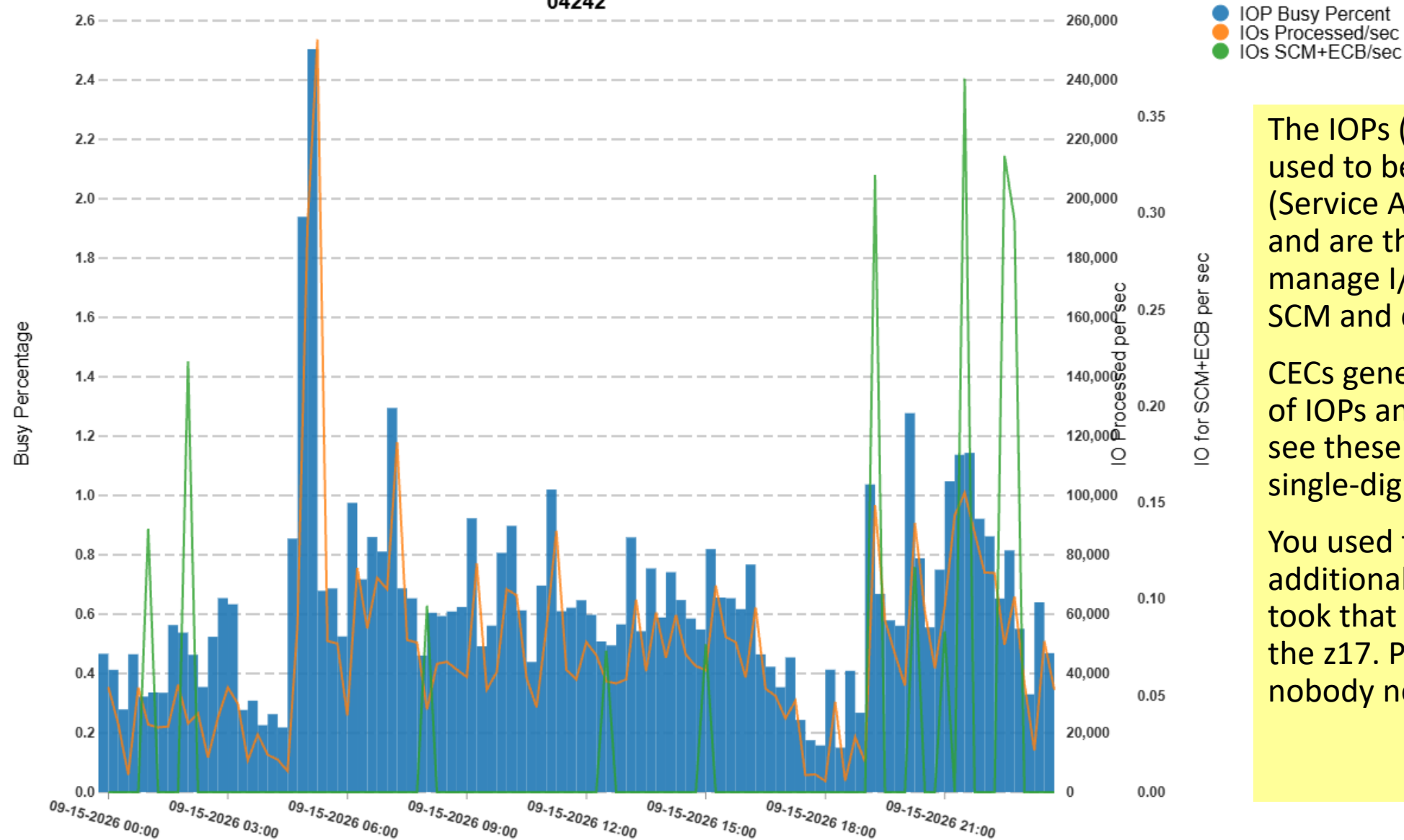
Note that you can't tell from here how many zIIPs the machine has.

Unless we hover over one of the bars.

# IOP Total Busy Percentage

(Total for all IOPs)

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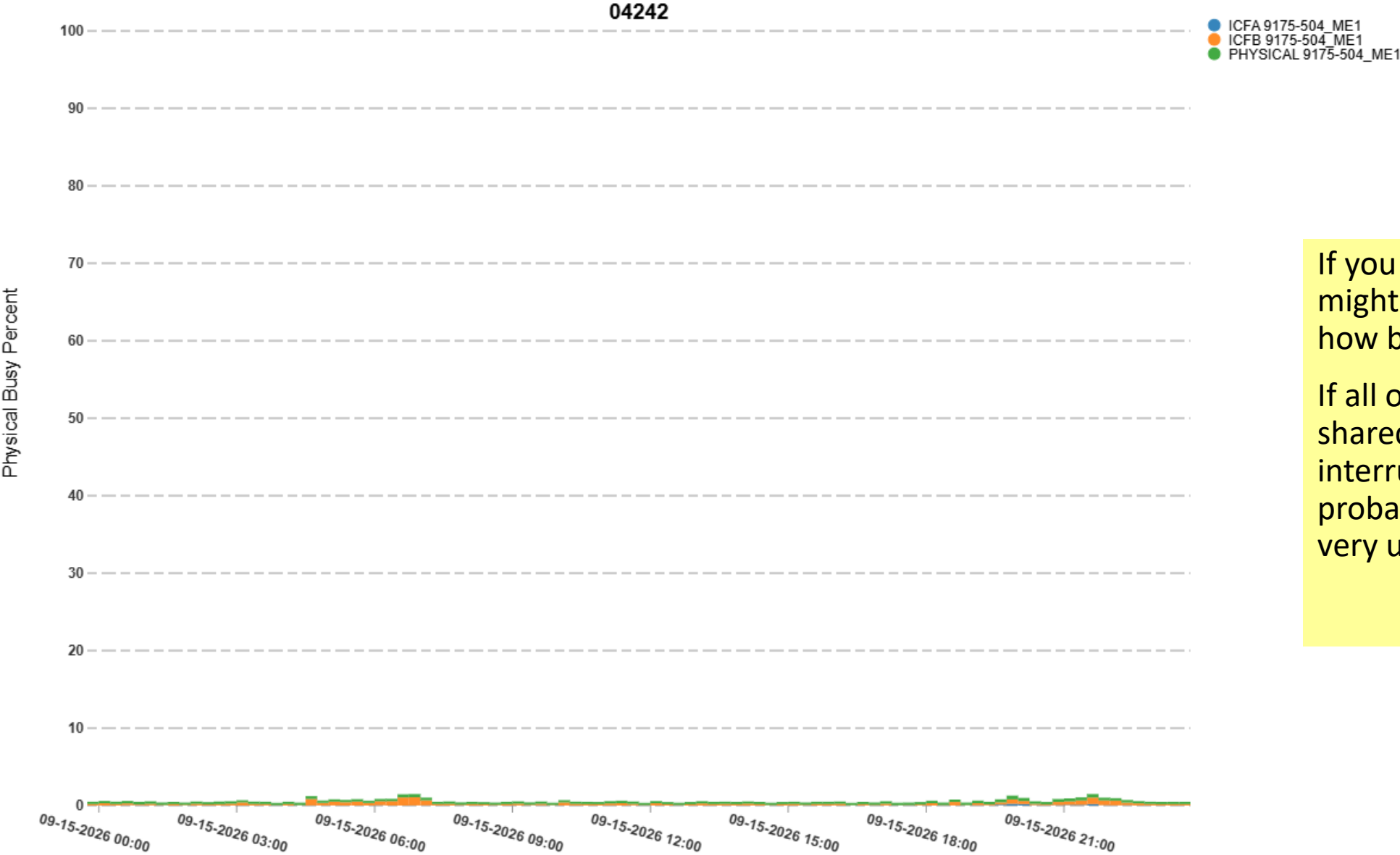


The IOPs (I/O Processors) used to be called SAPs (Service Assist Processors) and are there to help manage I/O and things like SCM and compression.

CECs generally have plenty of IOPs and it's unusual to see these being driven past single-digit percentage busy.

You used to be able to buy additional IOPs, but IBM took that option away with the z17. Presumably because nobody needed them.

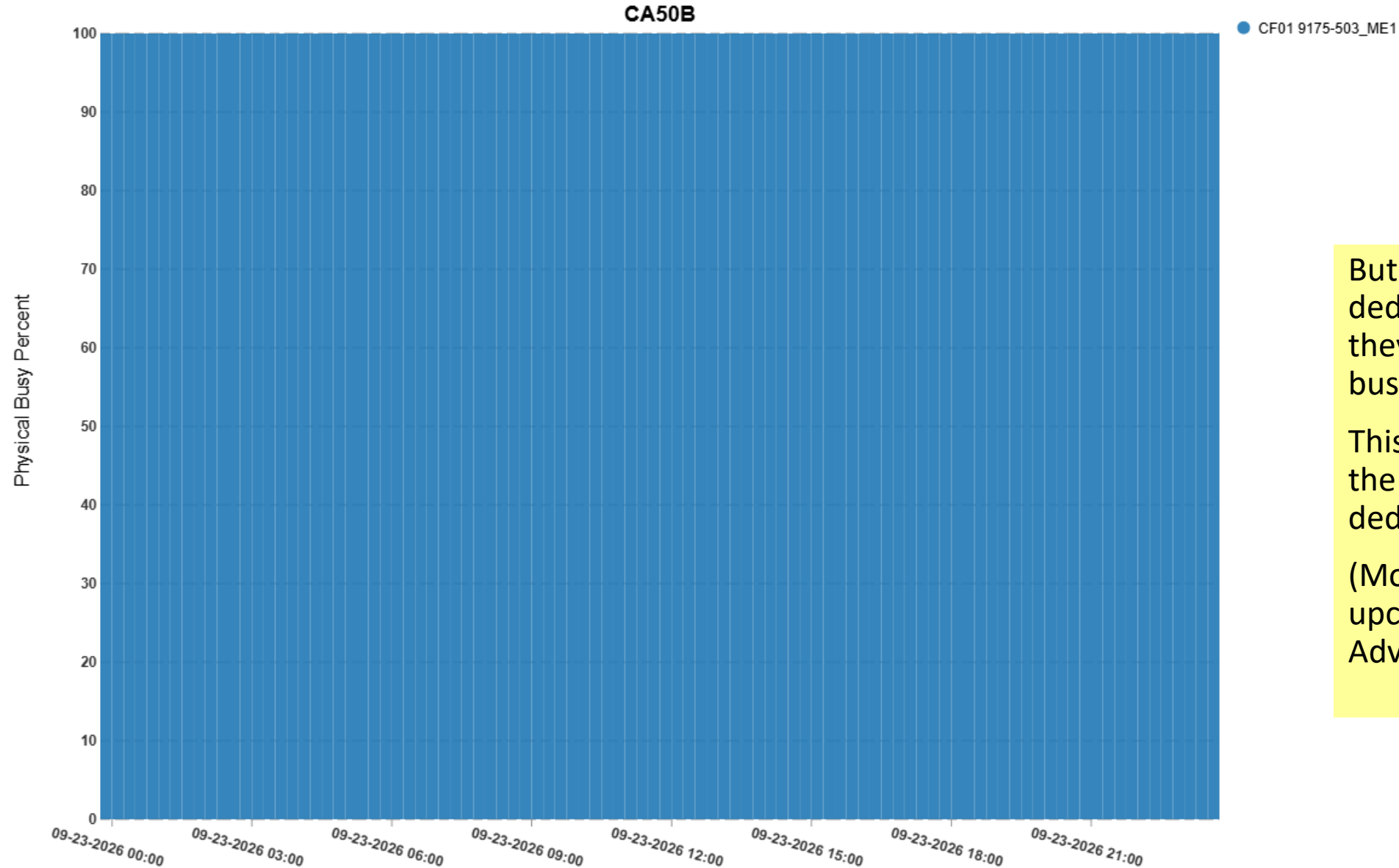
# CEC Physical Machine ICF Busy%



If you have ICFs then you might be interested in how busy they are.

If all of your ICFs are shared with thin interrupts enabled they probably will show as very unbusy.

# CEC Physical Machine ICF Busy%



But if you are using dedicated ICF engines, they will show as 100% busy.

This is expected because the engines are dedicated.

(More about CFs in an upcoming Basics to Advanced webinar. )

# Where do these numbers come from?



- The details are in the SMF 70 records
- The system records how many seconds the CPU was dispatched to each of the LPARs for each processor
- Percent busy is really just: 
$$\frac{\text{total dispatch}}{\text{interval duration} * \text{CPU count}}$$
- Formula is same regardless of processor type
  - There's an interesting twist for zIIPs with SMT though
- Note that this is effectively an average utilization over the interval
  - Most customers are on 15 minute intervals (80-85% of all systems we see)
  - More on this later...

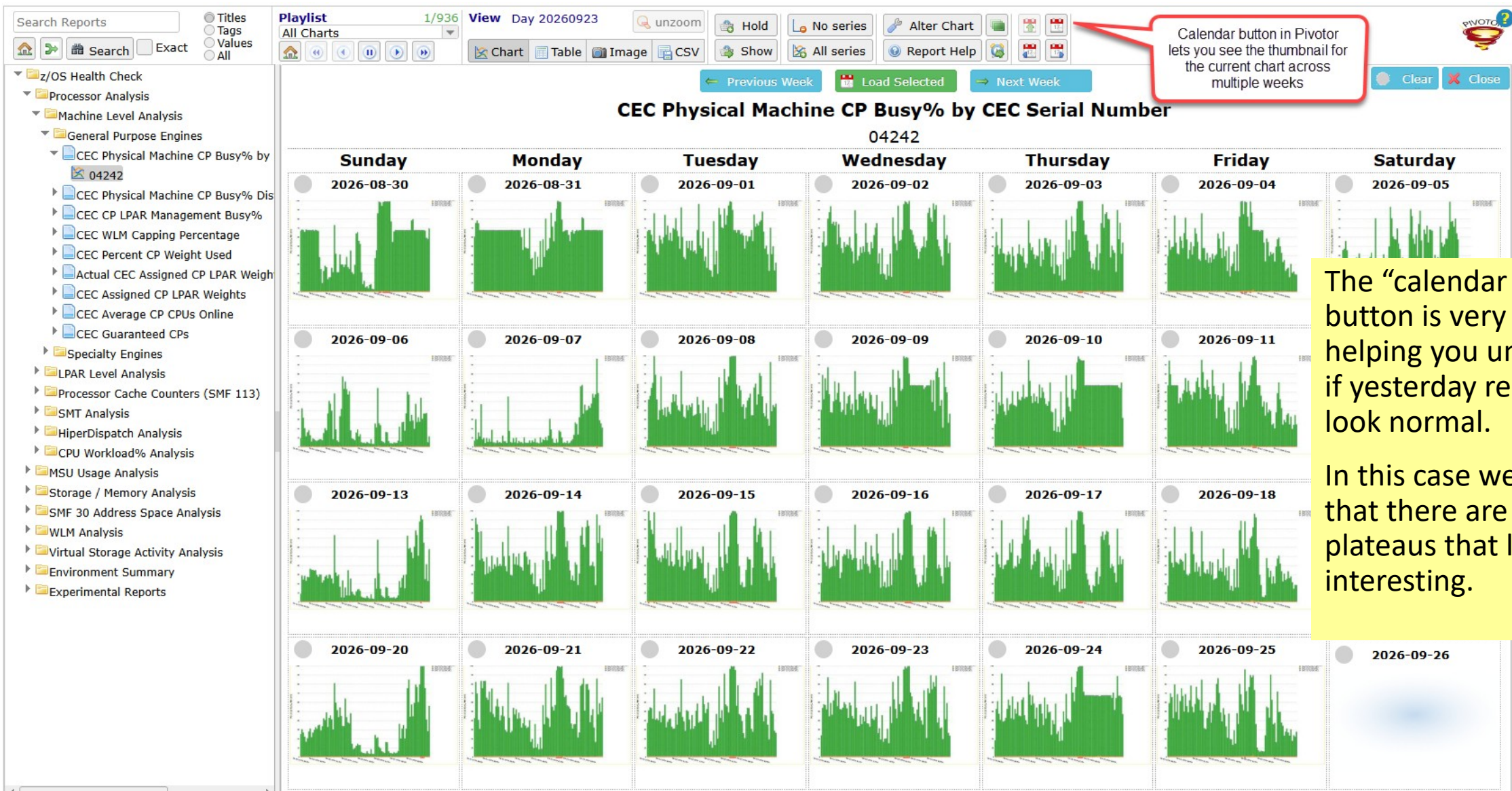


# Intermediate

# Why do people care about CEC Busy?



- Some common reasons:
  - Is the capacity of the CEC limiting the performance of the work?
  - Did the pattern of usage for the LPARs look “right” yesterday
  - When are we going to need more CEC capacity?
- But... the CEC Busy chart is only the most basic place to start answering these questions
  - There are multiple limits that may impact the LPARs’ performance that are unrelated to the total capacity of the machine
  - You need to be aware of those limits for capacity planning
  - “Was yesterday unusual looking?” is always a good thing to keep an eye on!
    - I.E. this would be on my list to look at daily, even if I only have a few minutes to do so each day



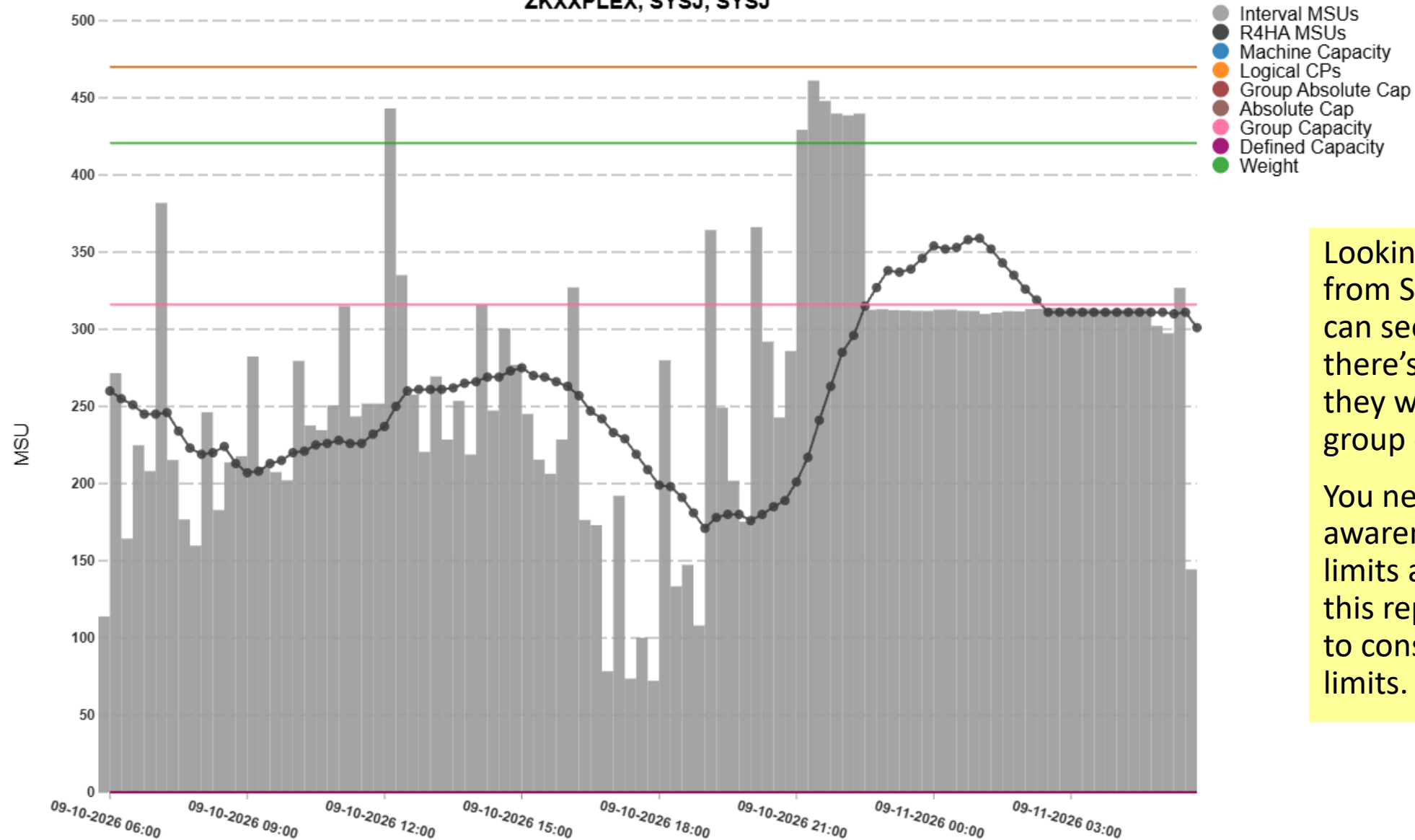
The “calendar view” button is very handy for helping you understand if yesterday really did look normal.

In this case we also see that there are some plateaus that look interesting.

# LPAR Limits and Utilization

Expressed as MSUs

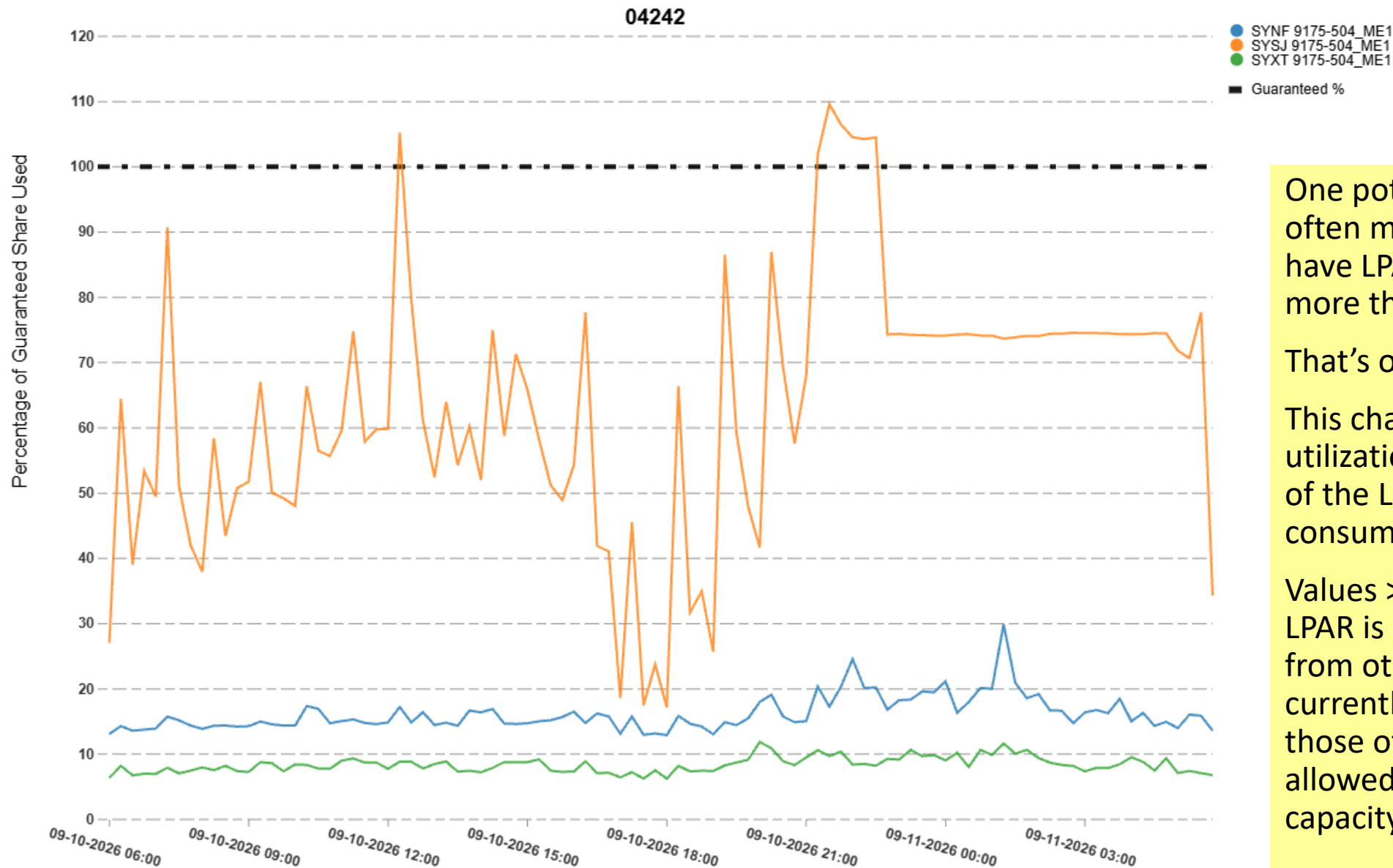
ZKXXPLEX, SYSJ, SYSJ



Looking into the details from September 10<sup>th</sup> we can see exactly why there's that plateau: they were hitting their group capacity limit.

You need to have an awareness of what the limits are for the LPARs, this report just happens to consolidate those limits.

# CEC Percent CP Weight Used



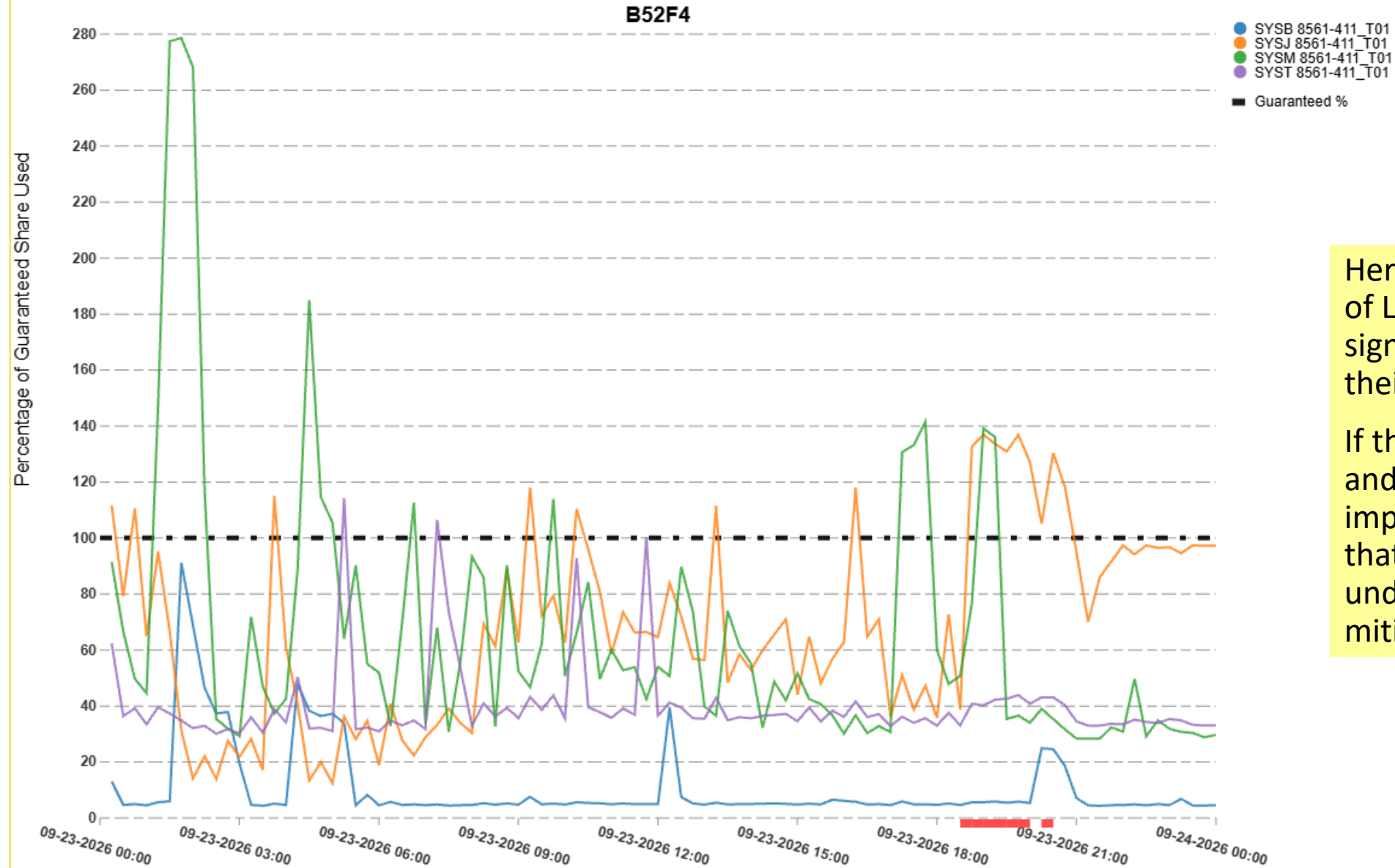
One potential issue people often miss is that they may have LPARs that are using more than their weight.

That's ok... until it isn't.

This chart shows each LPAR's utilization as the percentage of the LPAR's weight that it is consuming.

Values > 100% means the LPAR is borrowing weight from other LPARs that aren't currently demanding it. But those other LPARs will be allowed to consume that capacity if they "want" it.

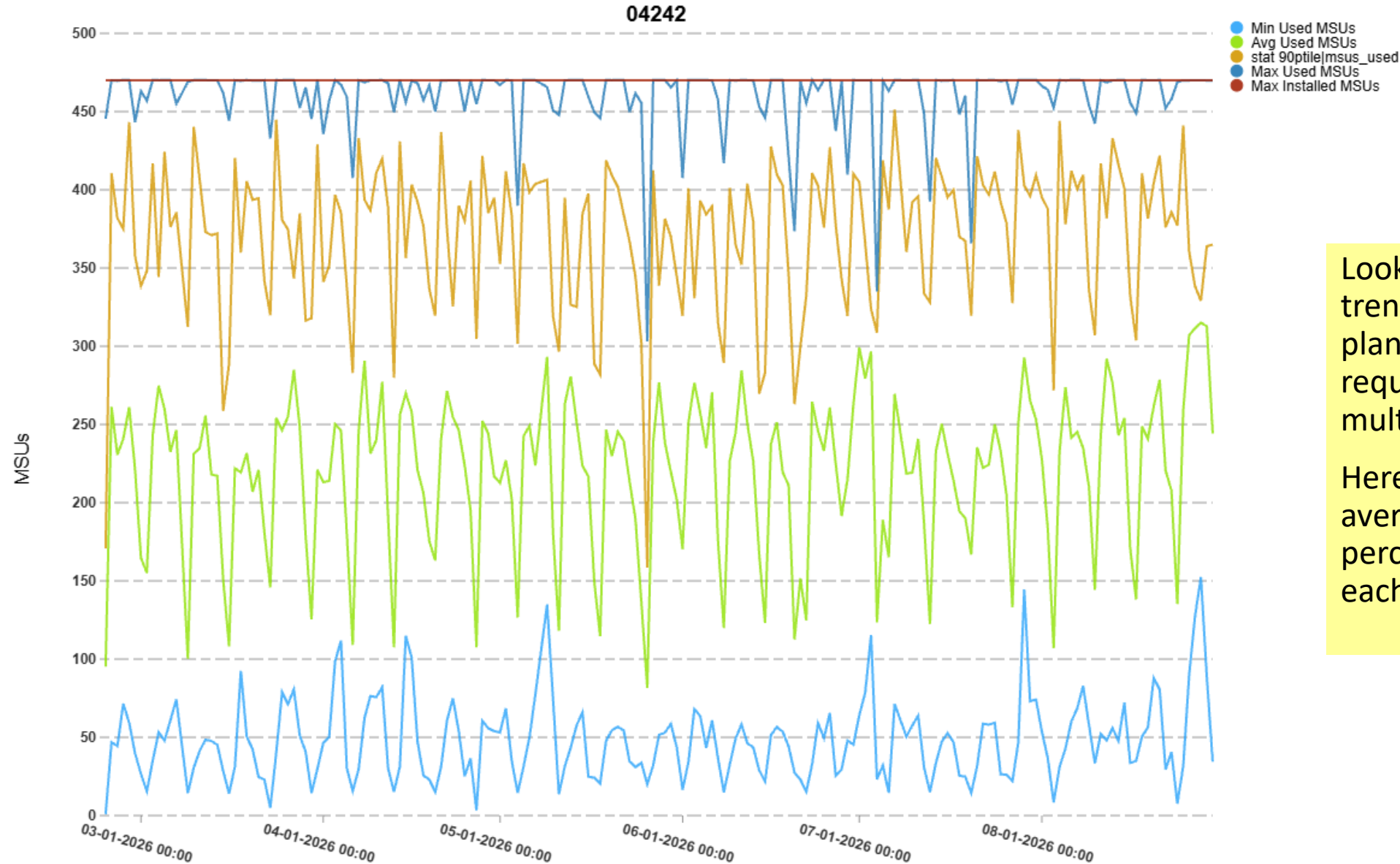
# CEC Percent CP Weight Used



Here we have a couple of LPARs that are using significantly more than their weights.

If this is a regular pattern and that work is important, this is a risk that should be understood and possibly mitigated.

# Daily CEC Usage in MSUs



Looking at long term trends for capacity planning purposes can require looking at multiple high-level stats.

Here we see min, max, average, and 90<sup>th</sup> percentile CEC busy for each day.



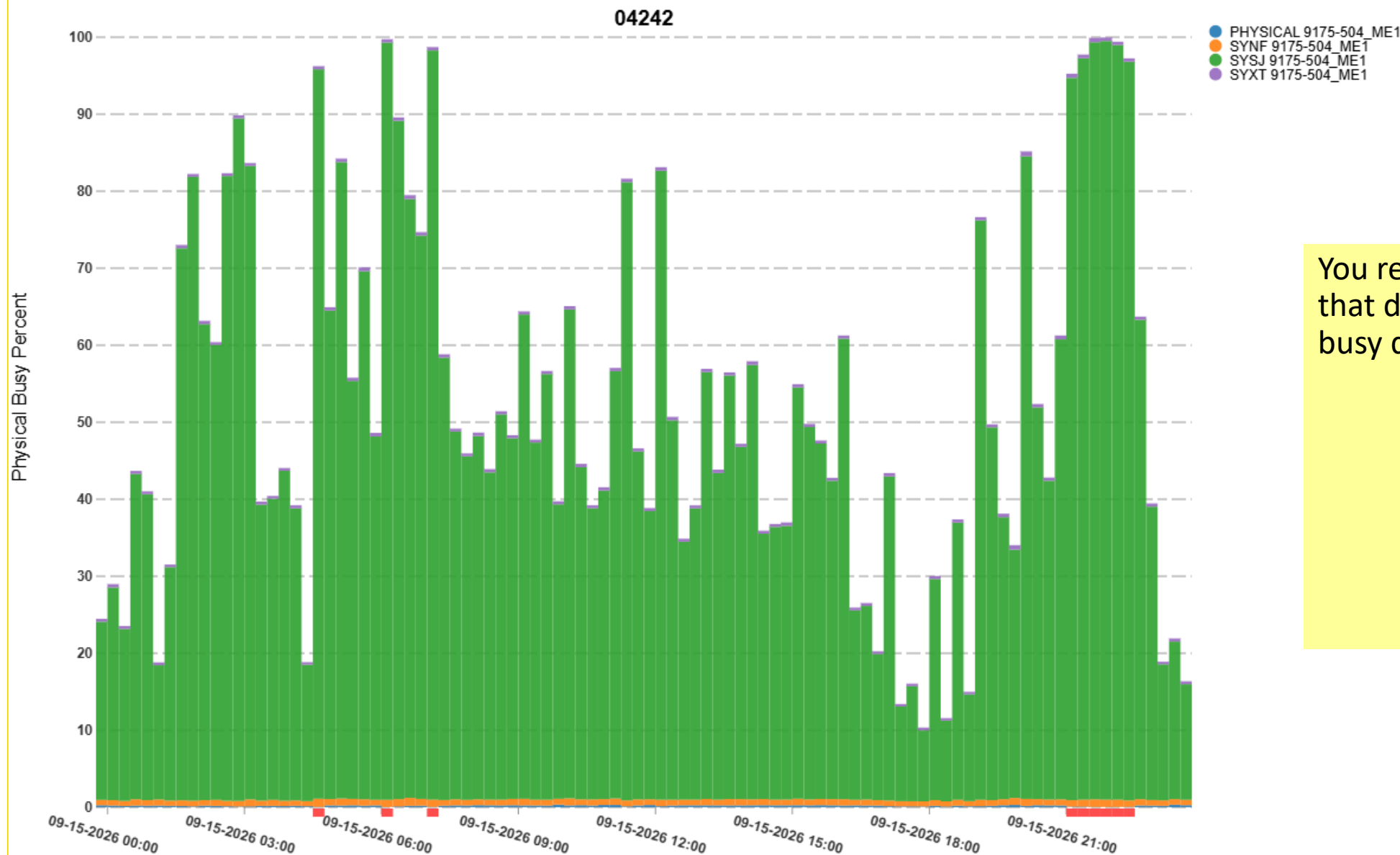
# Advanced

# RMF Intervals: Too Long?



- As mentioned, ~85% of systems use 10+ minute intervals
  - About 80% at 15 minutes, 5% at 10 minutes
- A lot can happen within 10-15 minutes!
- Your reported utilization is an average across that interval
  - But likely utilization fluctuated within that interval, possibly significantly
- 15 minute averages can provide a false sense of security
  - “The WLM policy only matters when the machine is busy, and we’re not”
  - You’re probably busier than you think more often than you think

# CEC Physical Machine CP Busy% by CEC Serial Number

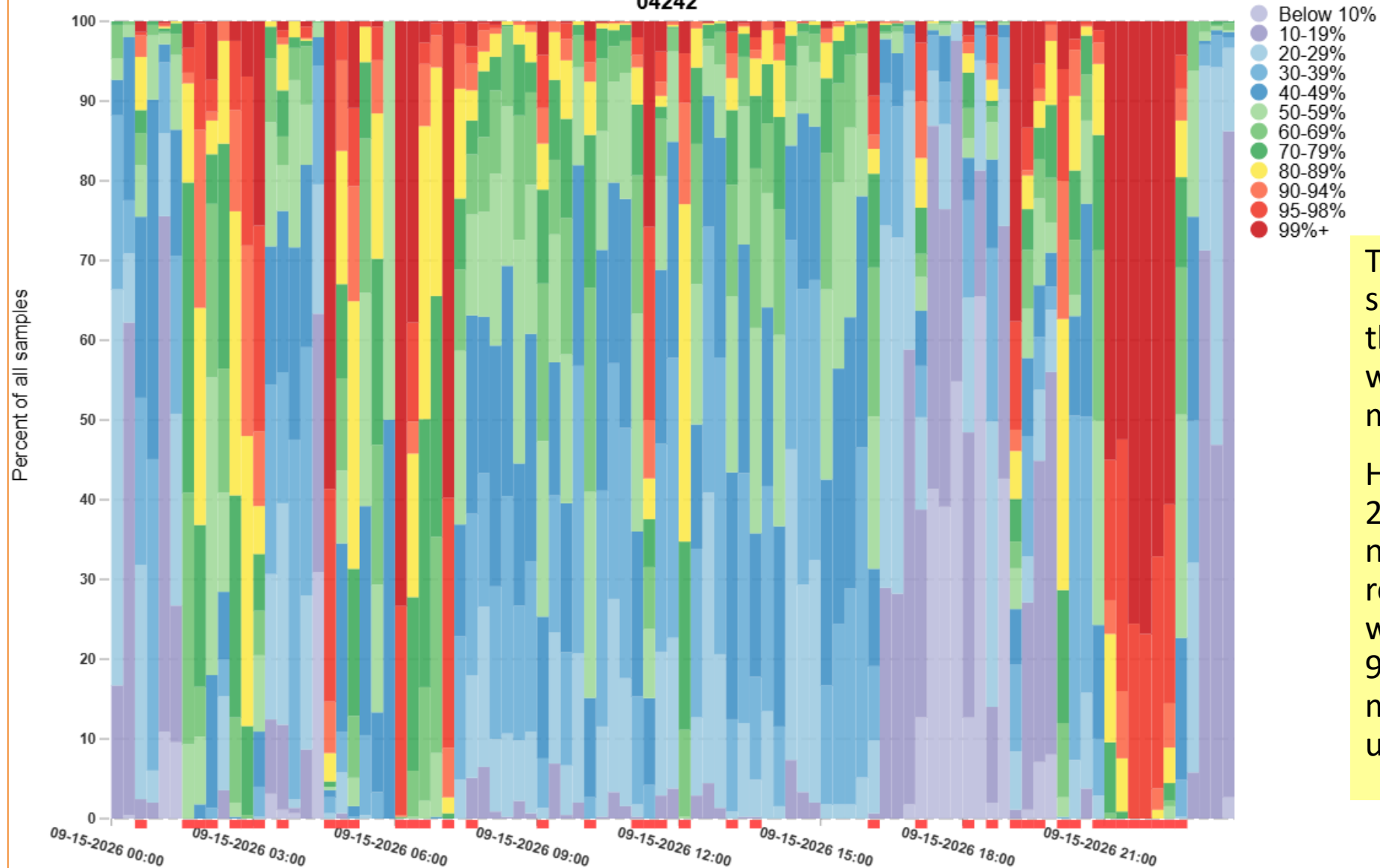


You remember this CEC that doesn't seem very busy during the day?

# CEC Physical Machine CP Busy% Distribution

(% CP Busy for this CEC in the interval)

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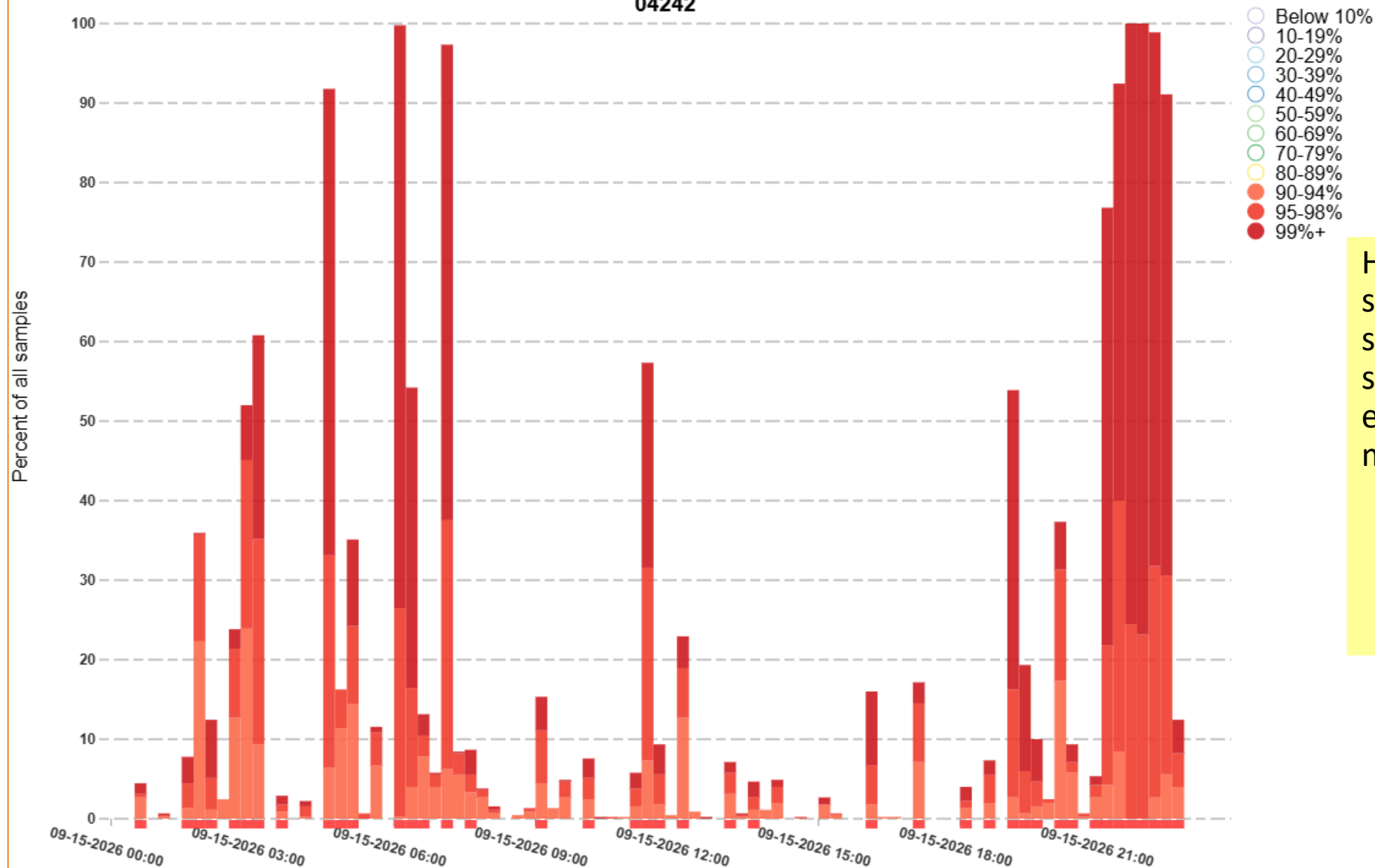
Turns out there's substantial parts of even those daytime intervals where the machine is more than 90% busy.

Here we've summarized 2-second CEC utilization numbers from the 99.12 records and to show what percentage of each 900 second interval the machine is in what utilization band.

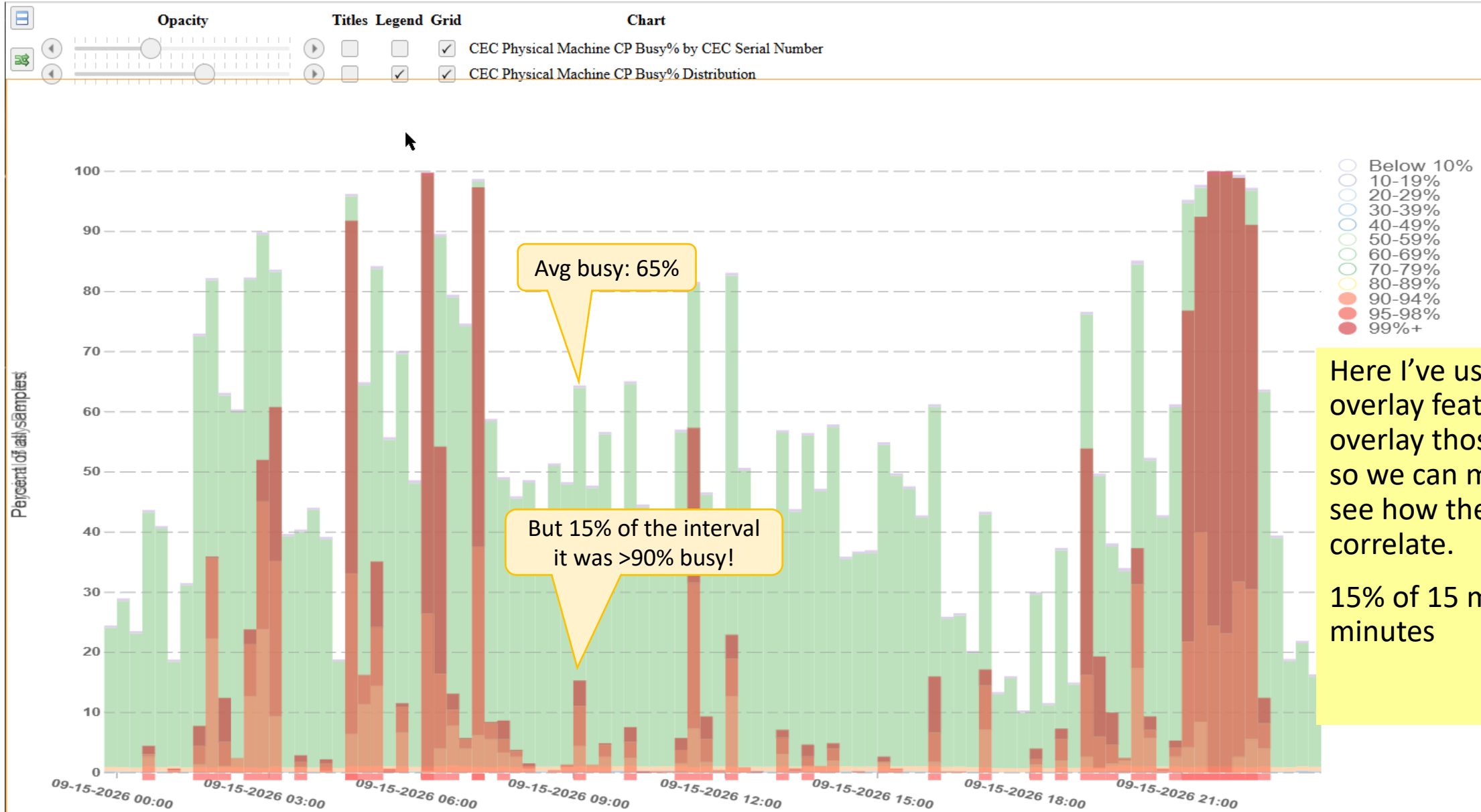
# CEC Physical Machine CP Busy% Distribution

(% CP Busy for this CEC in the interval)

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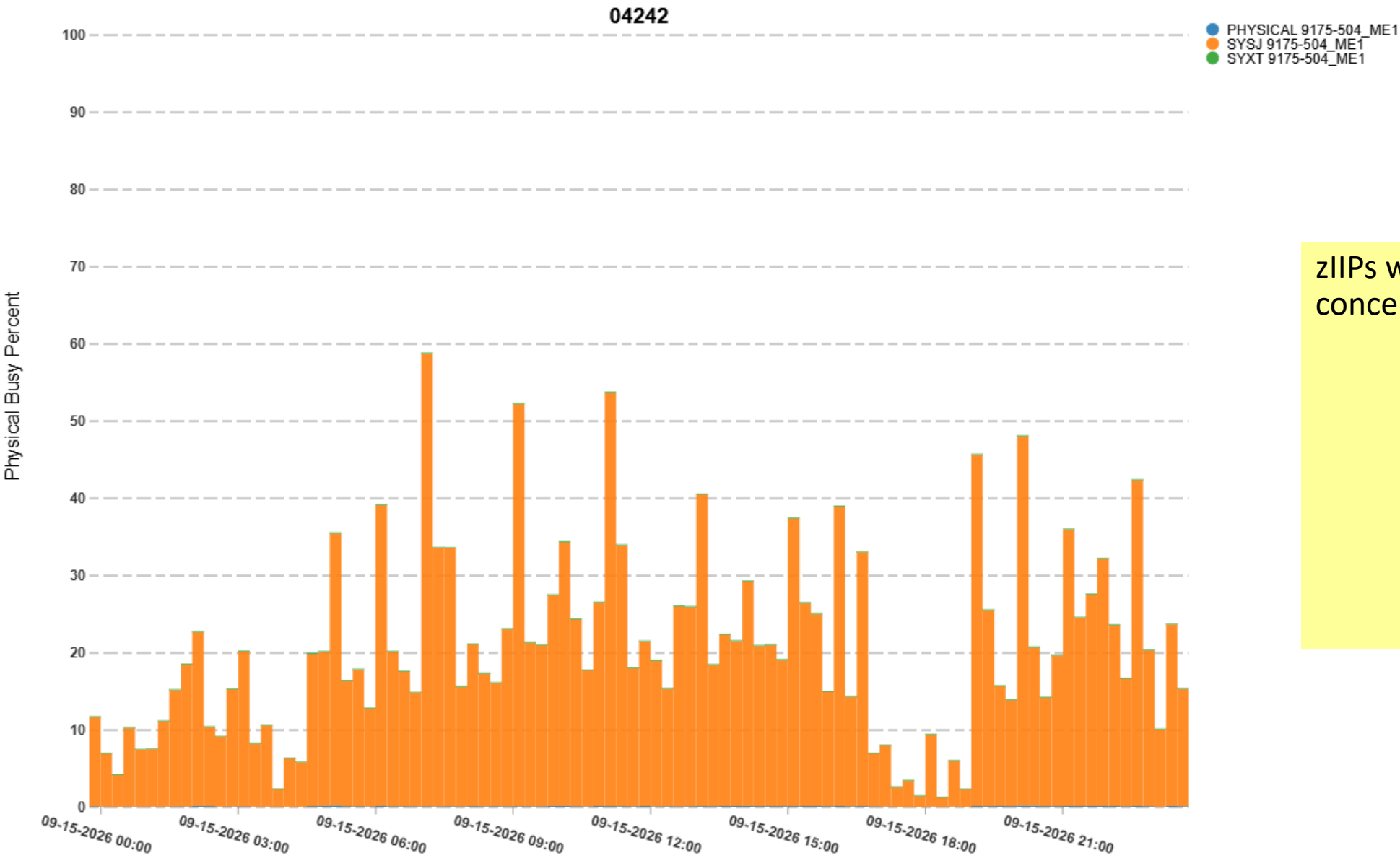
Here I just turned off all series except for 90%+ so we can more easily see what percentage of each interval the machine is >90% busy.



Here I've used our overlay feature to overlay those two charts so we can more easily see how the two charts correlate.

15% of 15 minutes > 2 minutes

# CEC Physical Machine zIIP Busy%

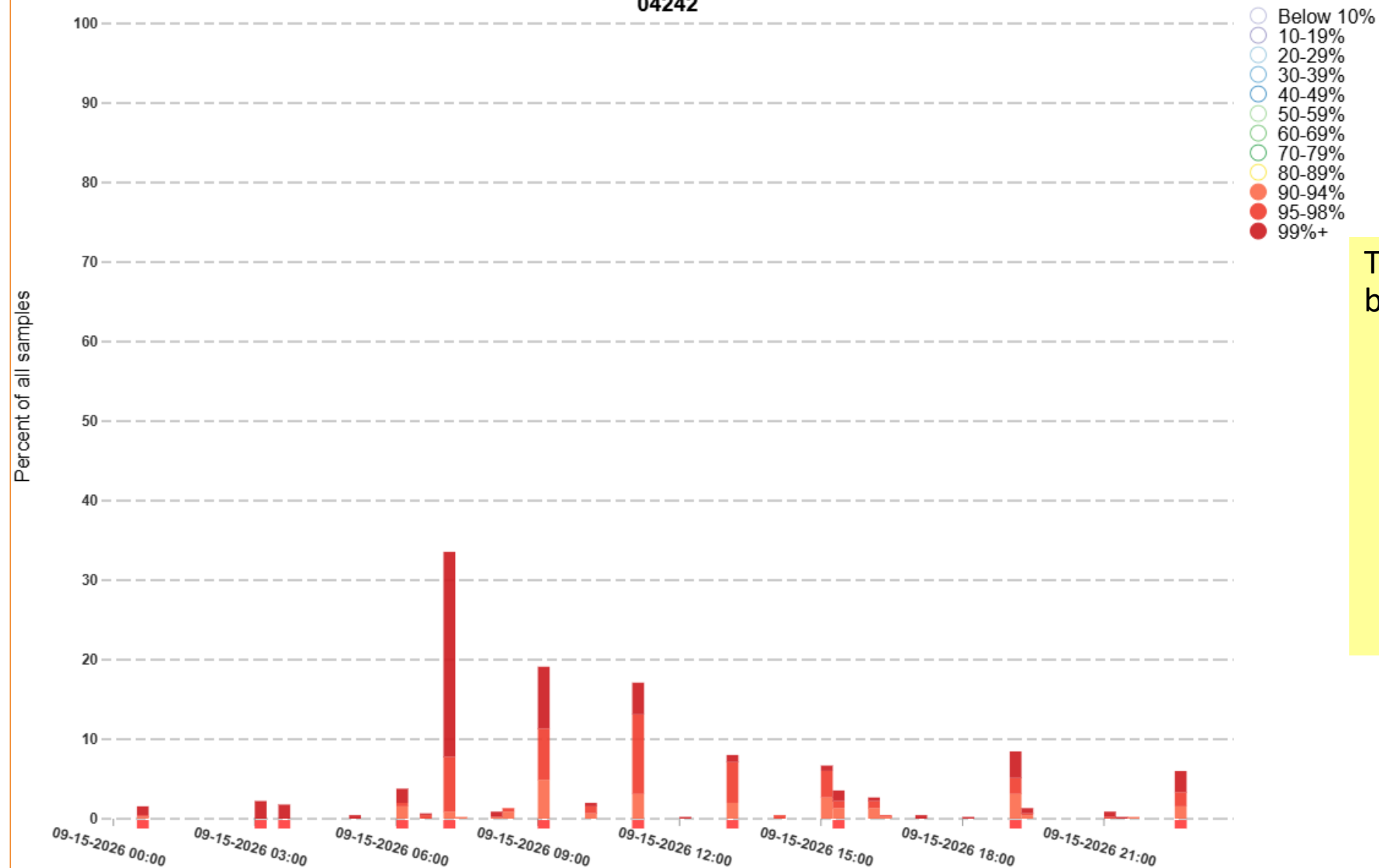


zIIPs were even less of a concern, right?

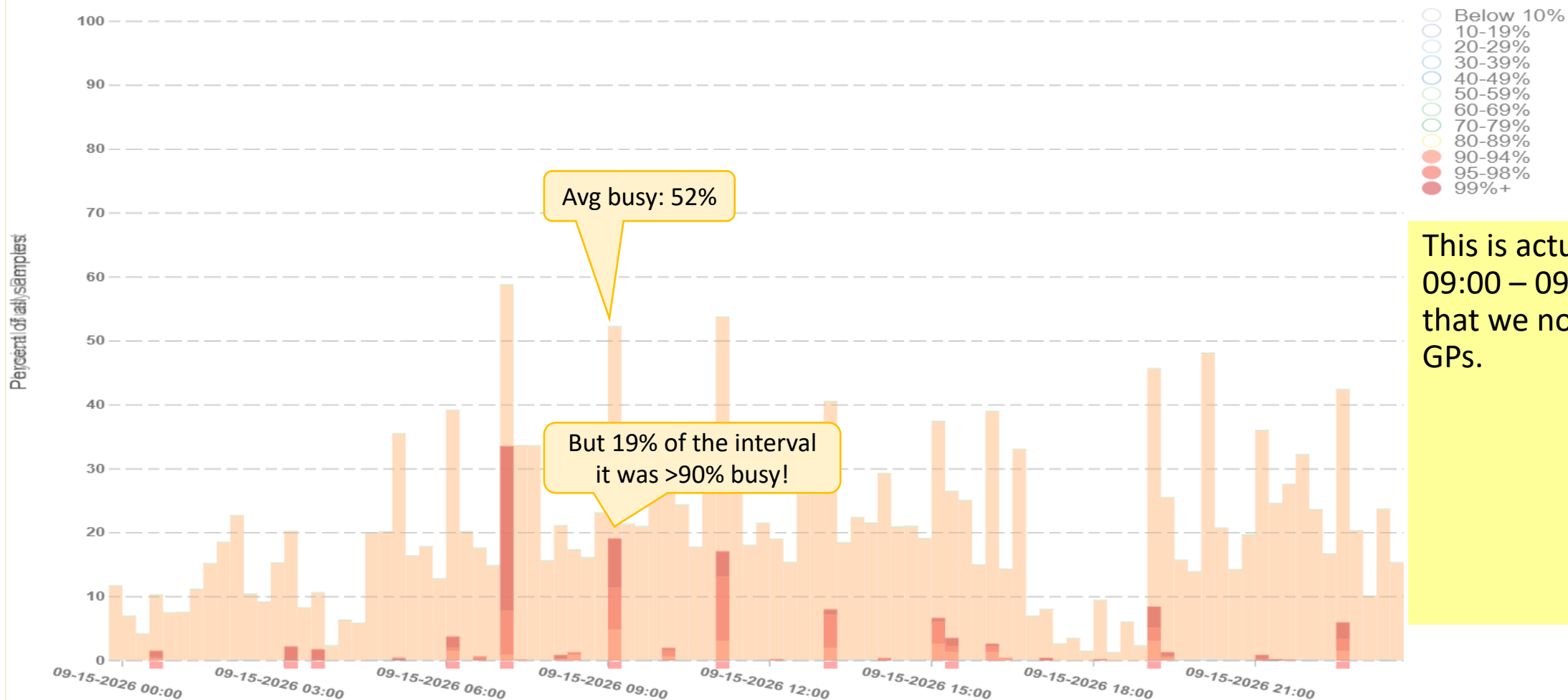
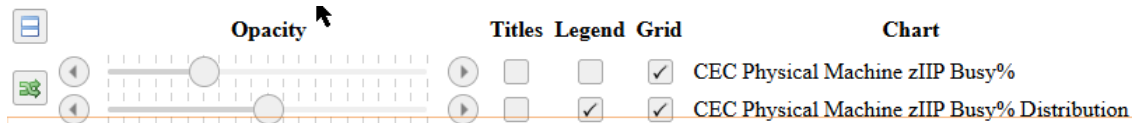
# CEC Physical Machine zIIP Busy% Distribution

(% zIIP Busy for this CEC in the interval)

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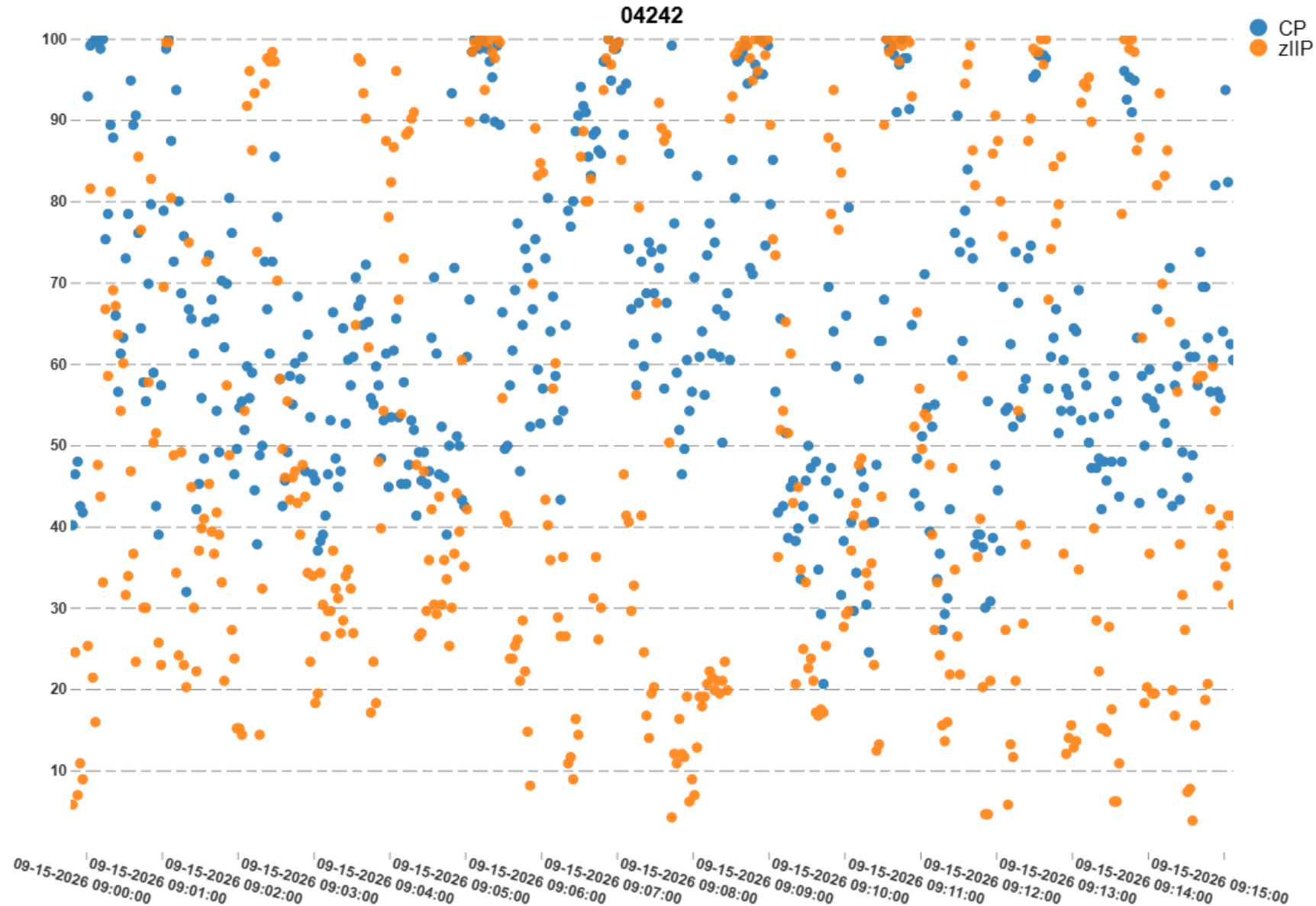


The zIIPs get above 90% busy at times too!



This is actually the same 09:00 – 09:15 interval that we noted for the GPs.

# HiperDispatch CEC Utilization



Here's the detailed data from the 99.12 records: CEC utilization on 2 second intervals for that 09:00 to 09:15 interval.

Interesting bursty pattern for both GPs and zIIPs, probably related something using both like DDF.

This data is very handy for diagnosing brief performance problems caused by a capacity constraint that doesn't show up in the RMF interval data!

# Busy = Utilization?



- So far I've lazily used Busy and Utilization to mean the same thing
  - This is usually fine
- But... with SMT involved zIIP “busy” and zIIP “utilization” can be different!
  - Core Busy = time core is executing instructions in either TD1 or TD2
    - When not in SMT, busy % = utilization %
    - If executing instructions at TD1, even though the core is “busy” it could still do more work
  - Productivity = Estimate of completed work vs work that could be completed at TD2
- **Core Utilization % = Core Busy % \* Productivity %**
- This makes capacity planning for SMT-enabled zIIPs difficult

# Core Utilization Example



|              | TD1                | TD2                | TD1       |           | TD1                | TD2       |     |
|--------------|--------------------|--------------------|-----------|-----------|--------------------|-----------|-----|
| Thread 0     | Actively Executing |                    | Available |           | Actively Executing | Available |     |
| Thread 1     | Available          | Actively Executing |           | Available | Actively Executing | Available |     |
| Time         | 4μs                | 2μs                | 5μs       | 2μs       | 2μs                | 7μs       | 2μs |
| Instructions | 14k                | 12k                | 20k       |           | 9k                 | 49k       |     |

Core Busy =  $(4+2+5 + 2+7)/(4+2+5 + 2 + 2+7 +2) = 20 / 24 = 83.3\%$

Capacity Factor =  $5,200 \text{ i}\mu\text{s} / 3,909 \text{ i}\mu\text{s} = 1.33$

Maximum Capacity Factor =  $6,778 \text{ i}\mu\text{s} / 3,909 \text{ i}\mu\text{s} = 1.73$

Productivity =  $1.33 / 1.73 = 76.9\%$

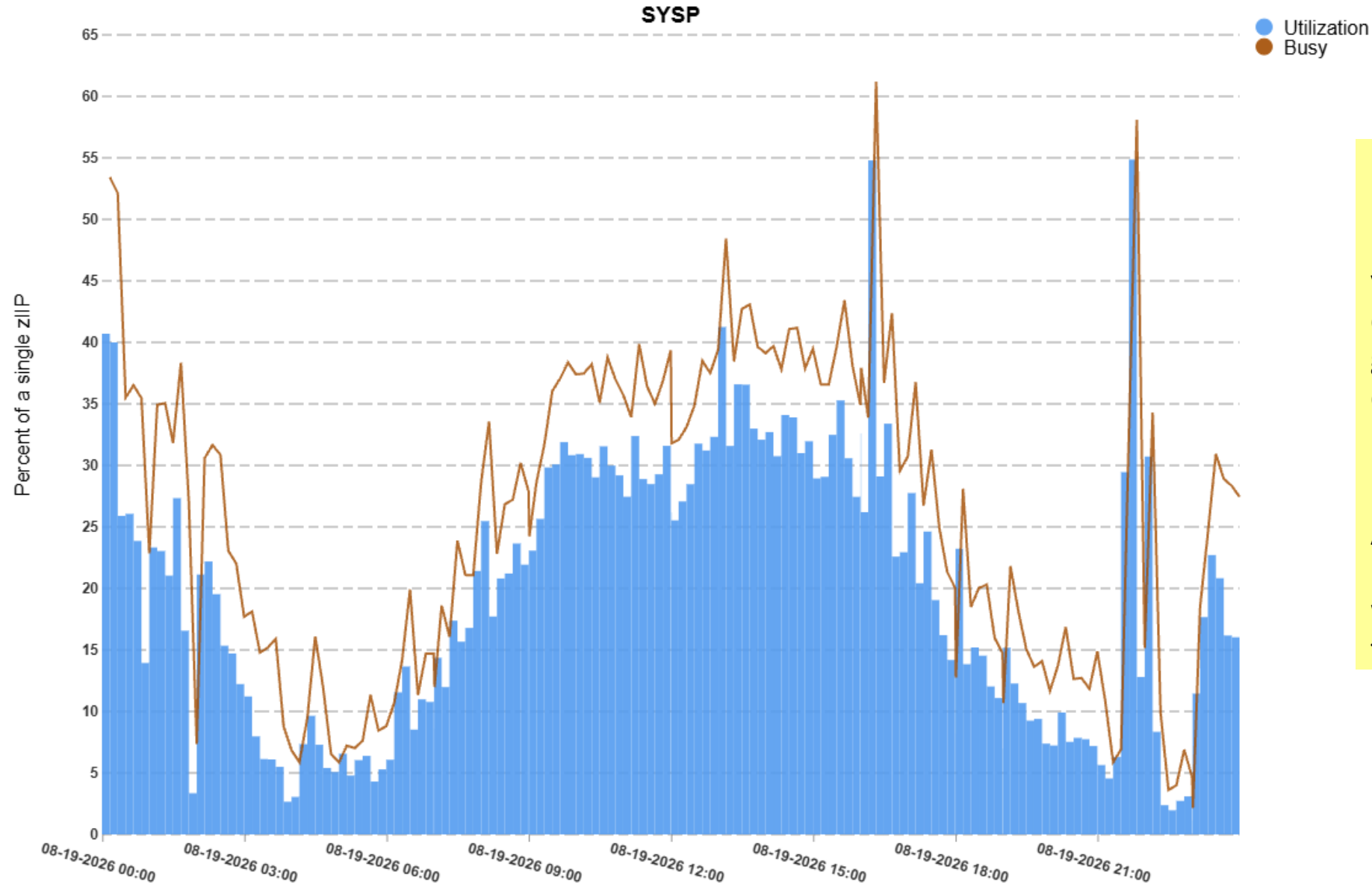
Core Utilization =  $83.3\% * 76.9\% = 64.1\%$

For all the SMT details see this presentation on our website:

[https://www.pivotor.com/library/content/Chapman\\_SMT\\_MeasureDecide\\_201811\\_GSEUK.pdf](https://www.pivotor.com/library/content/Chapman_SMT_MeasureDecide_201811_GSEUK.pdf)

# LPAR Physical zIIP Busy% vs Utilization%

(IBM Definition of Utilization% with SMT Enabled)



If SMT is enabled, we do report on the two measures together so you can see the difference, but we generally recommend doing your planning based on the higher busy%.

Also, we generally don't recommend using SMT without a clear reason for enabling it.



# Wrap-up

# Summary



- LPAR CPU consumption summed/stacked up lets you see how busy your mainframe is
  - Will want to look at the different processor types separately
- But understanding the impact to the work requires understanding more limits than just the capacity of the machine
  - Things like weight enforcement and capping can impact work even if the machine isn't 100% busy
- 15 minute RMF intervals can hide peaks that may be important to you
  - SMF 99.12 has 2 second CEC utilization numbers
- With SMT enabled on your zIIPs, busy and utilization are not the same
  - Note IOPs now are SMT-enabled as well, but generally a moot point
  - If you need more zIIP capacity, prefer to buy more zIIPs rather than enabling SMT



# Questions?