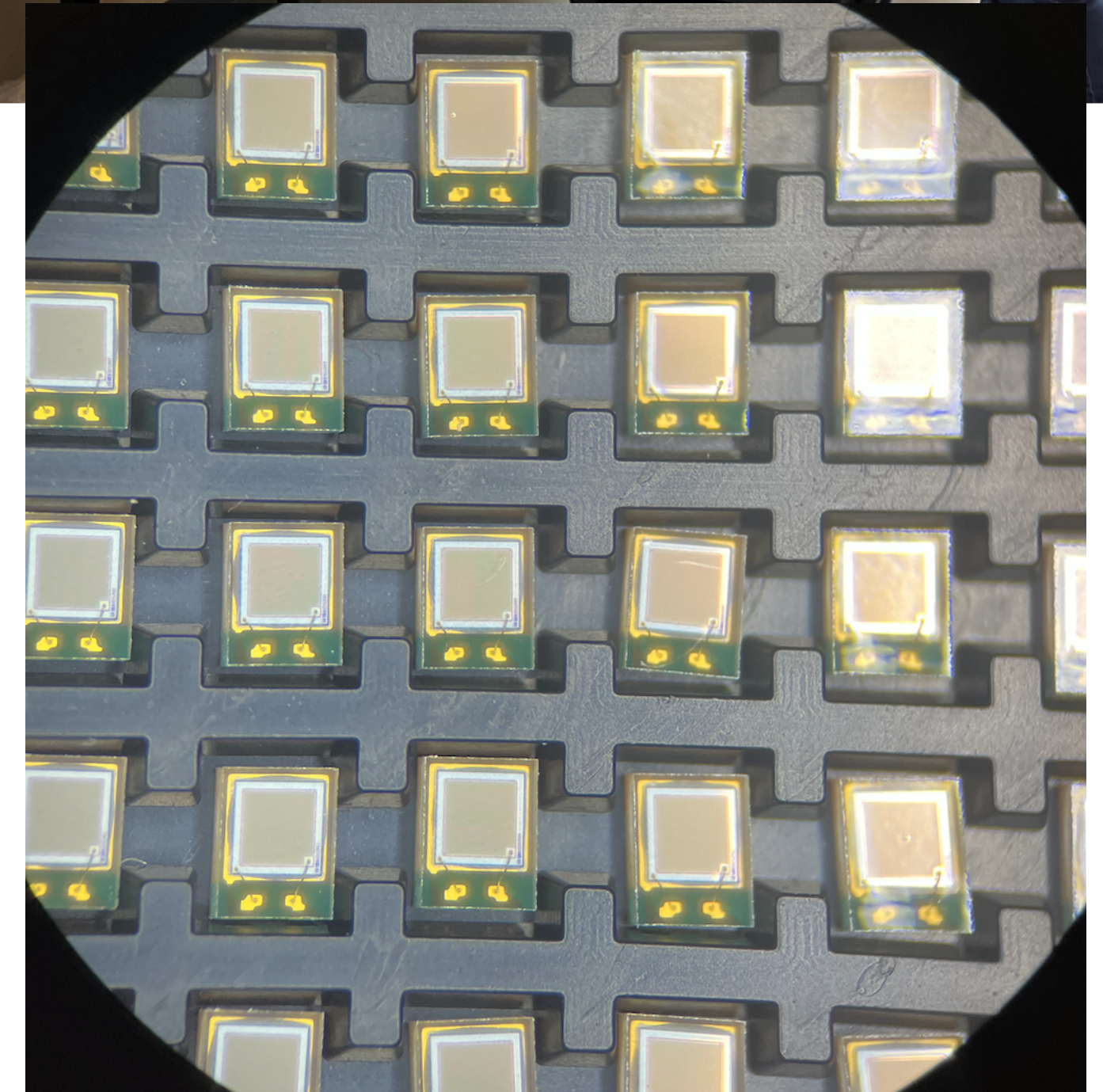


LFHCal SiPM QC

Yale Update

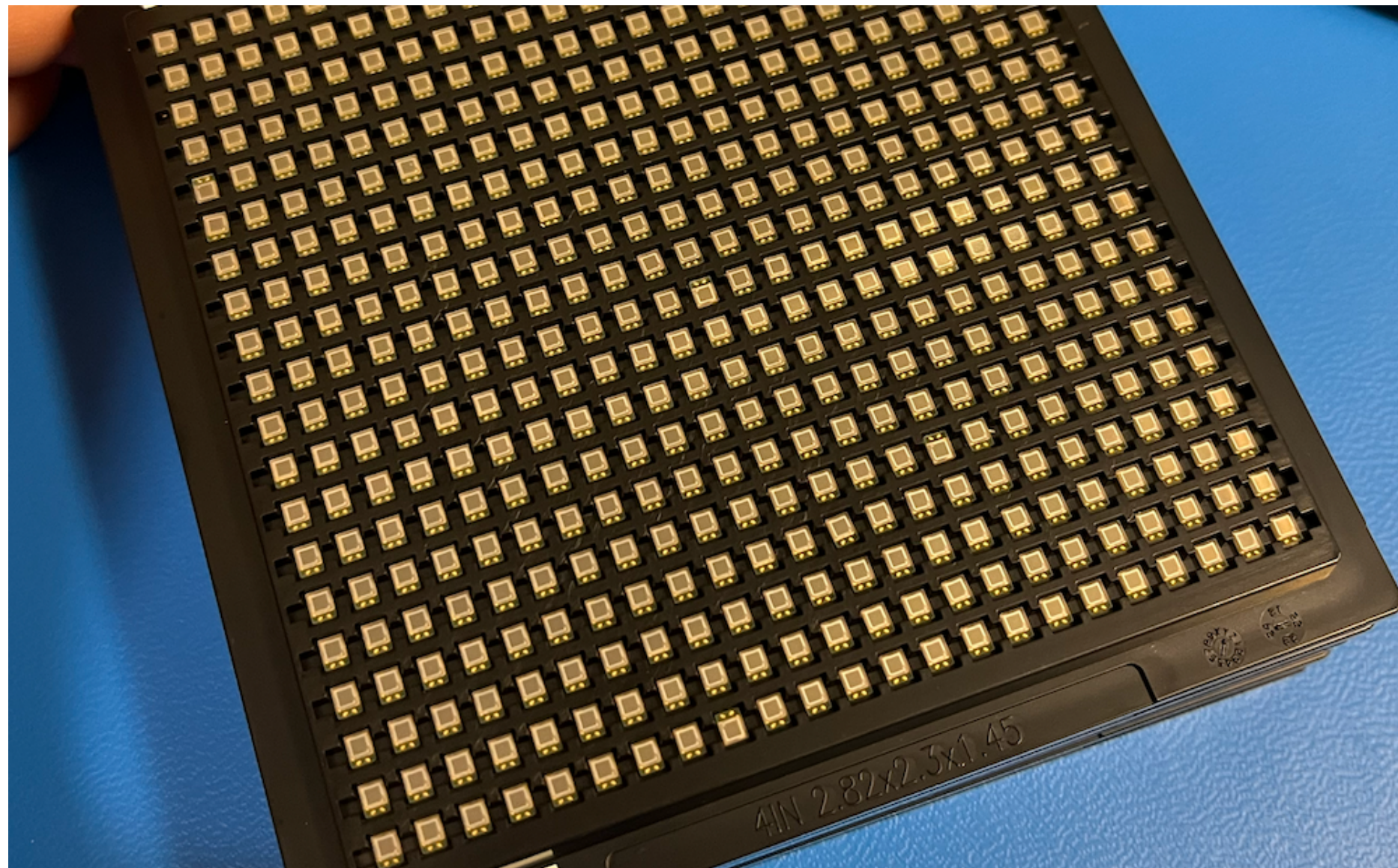
PI	Helen Caines, Laura Havener
Research Scientist	Prakhar Garg
Postdoc	Isaac Mooney
Grad Students	Emily Pottebaum, Ryan Hamilton
Undergrads	Elisa Kim, Langan Zhu



Comparison SiPMs Received!

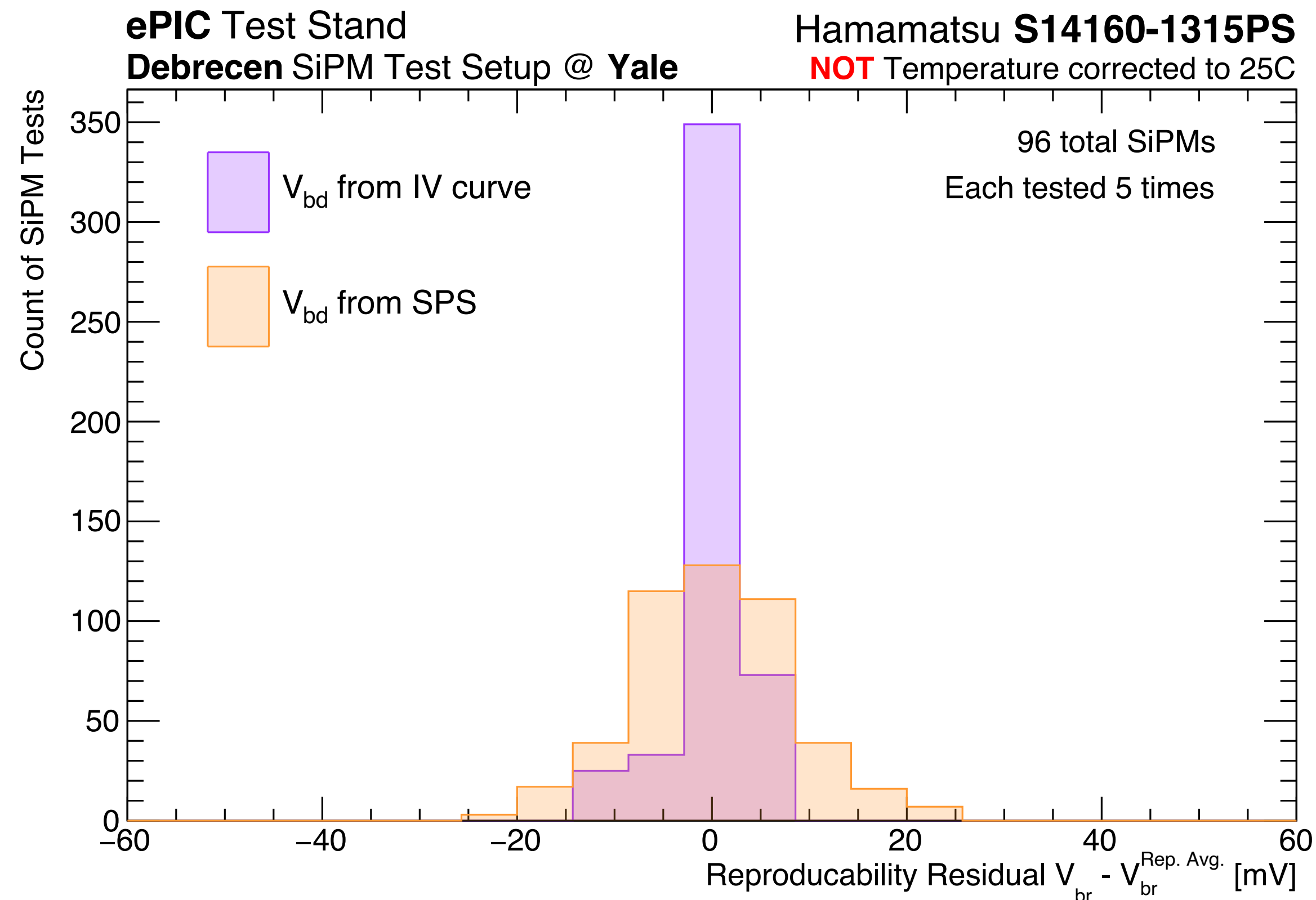
No apparent damage from shipping,
or SiPMs dislodged/disordered

Maintaining order is key for
correlating measurements with ORNL!

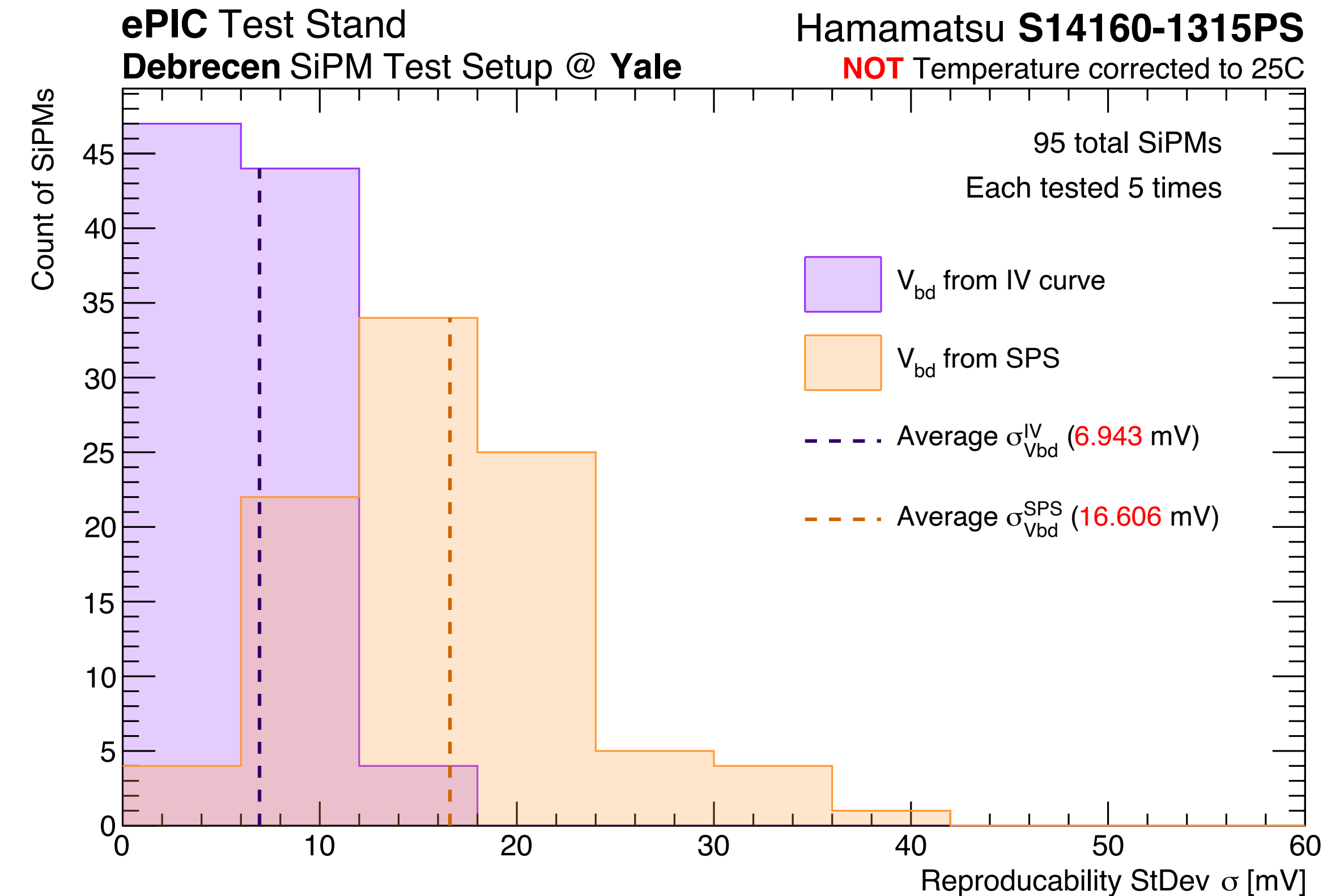


Systematics on the Test Setup

Taking stock with Residual and Variance distributions



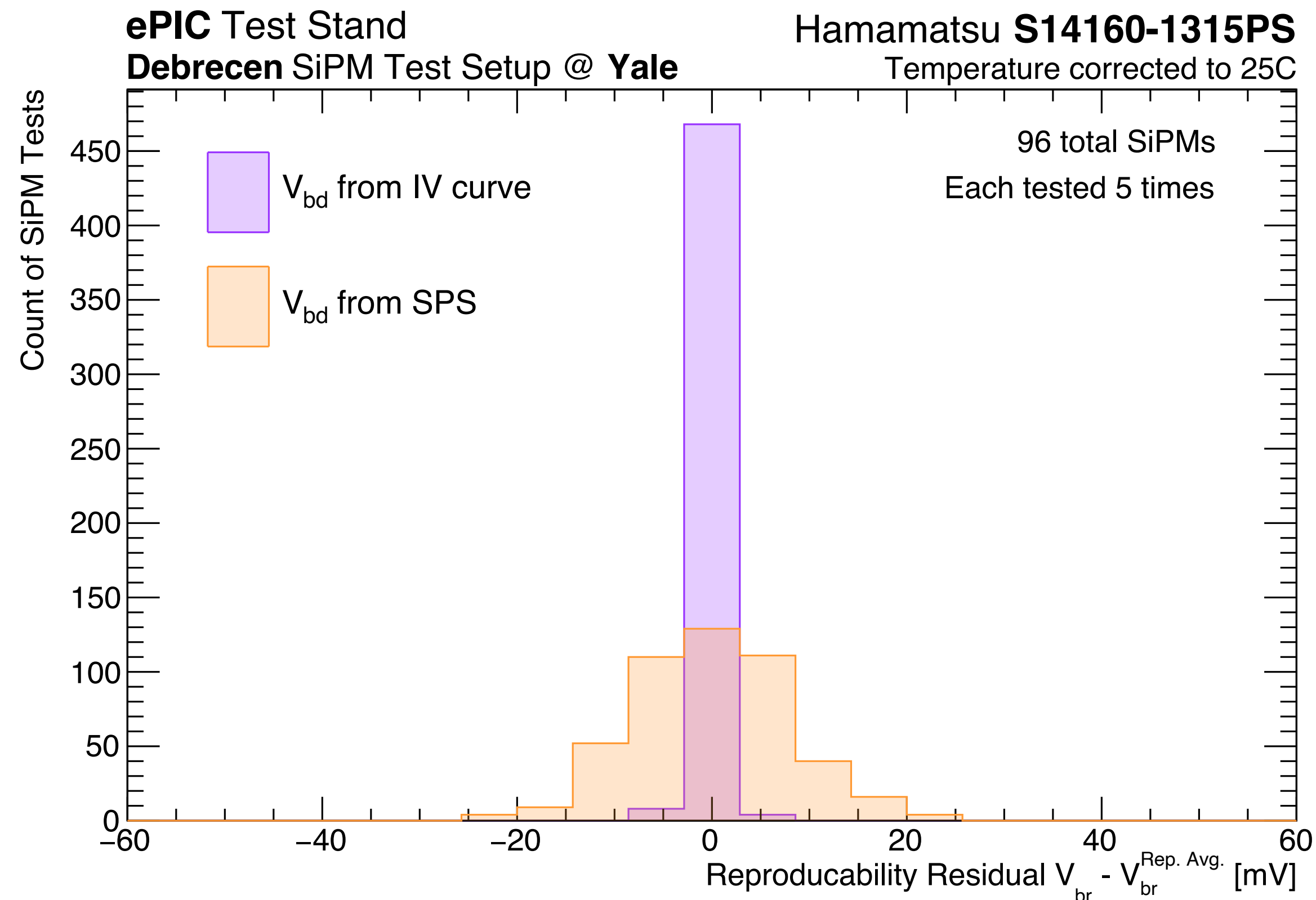
(Previous SiPM distributions aligned around their average over 5 tests)



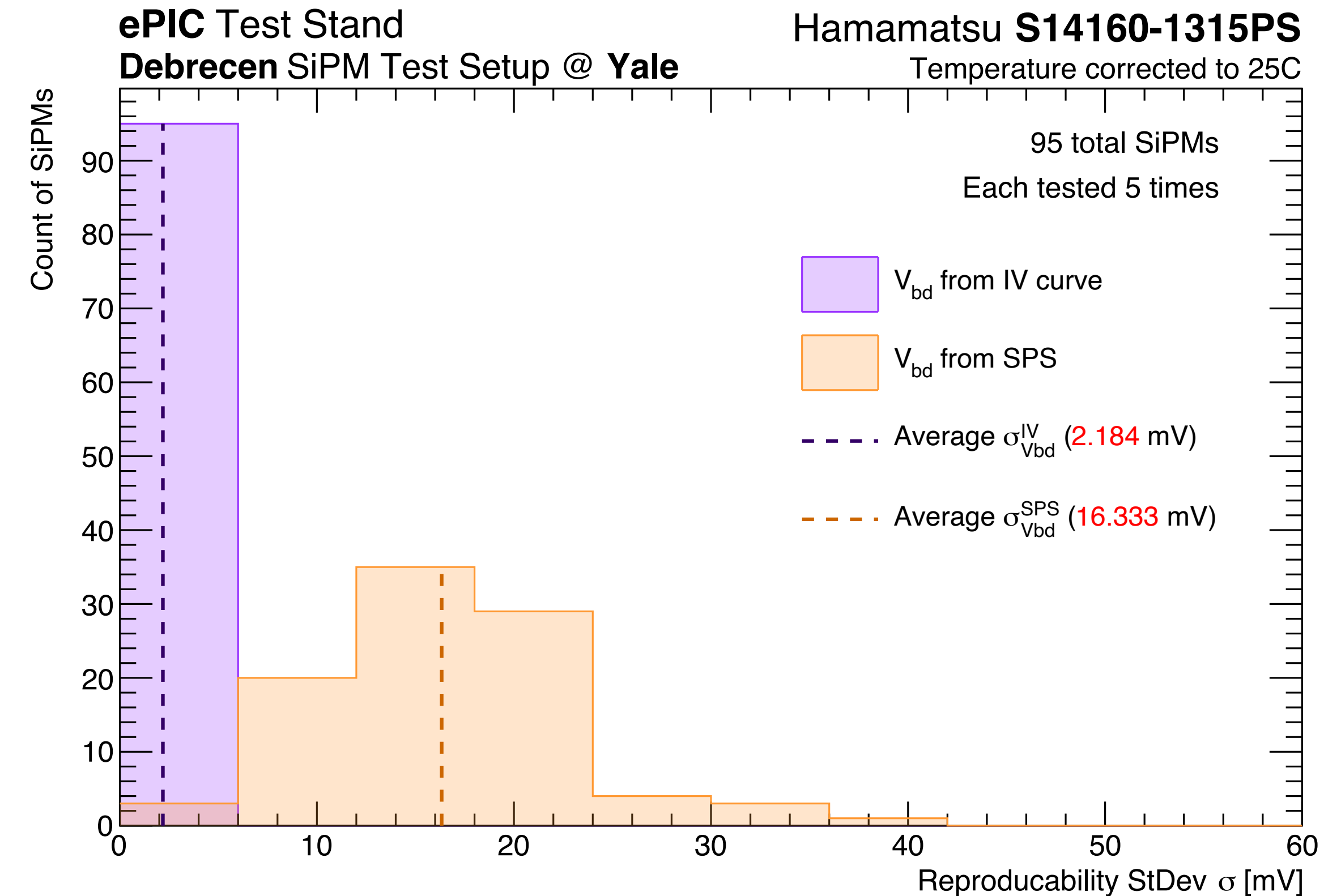
Distribution of sigma from the per-SiPM distributions

Systematics on the Test Setup

Taking stock with Residual and Variance distributions



(Previous SiPM distributions aligned around their average over 5 tests)

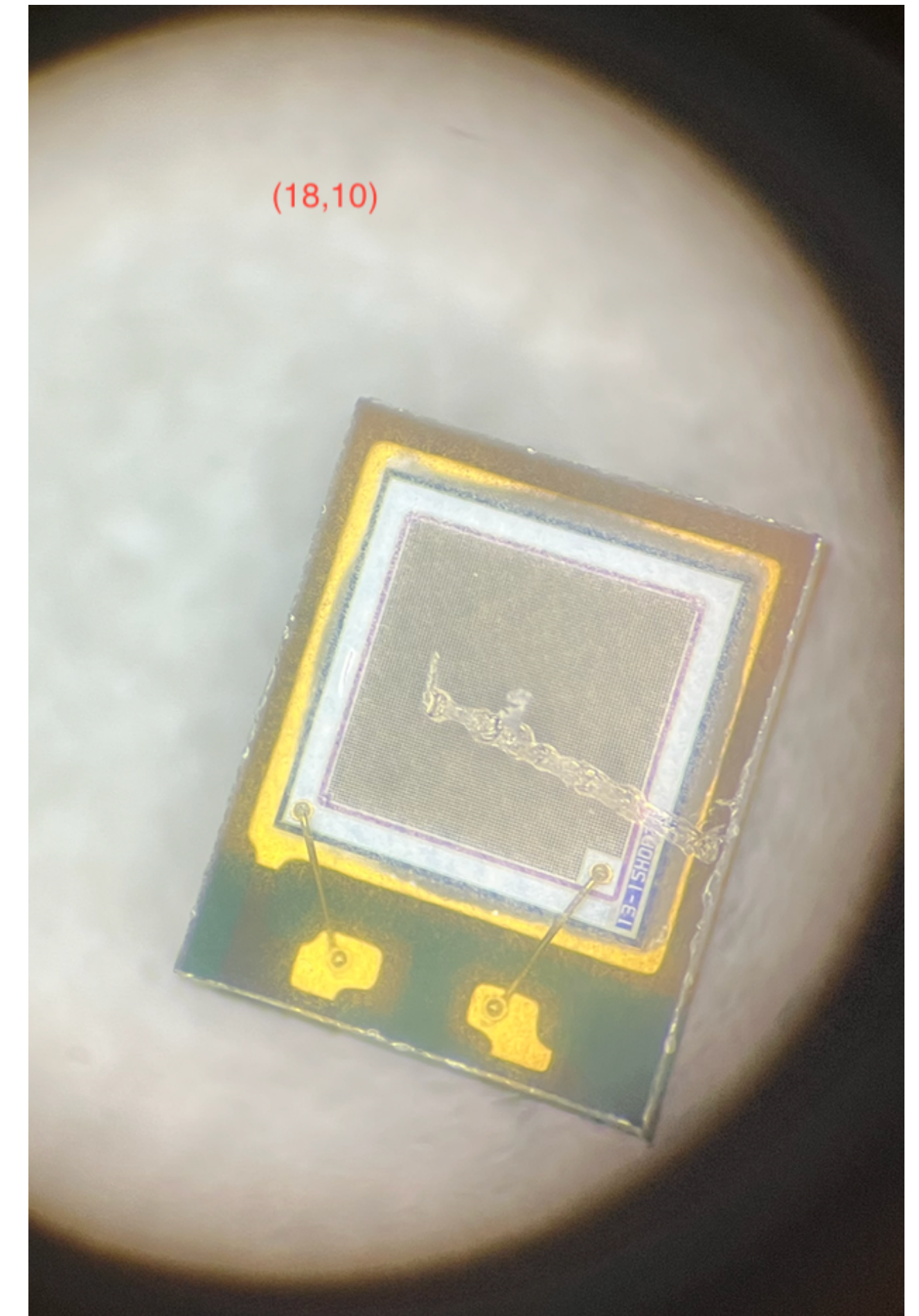


Distribution of sigma from the per-SiPM distributions

Systematics on the Test Setup

More differential systematics to come soon!

- V_{op} scan (i.e. separation from SPS interpolation axis) done and data is processing
- Temperature readjustment of the lab gave the opportunity for a temperature scan
- Test-indexed heat maps suggest not cassette/test index correlated but a more thorough investigation is underway
- SiPM surface defects have been carefully tracked, we're also looking into correlations with obstructed area



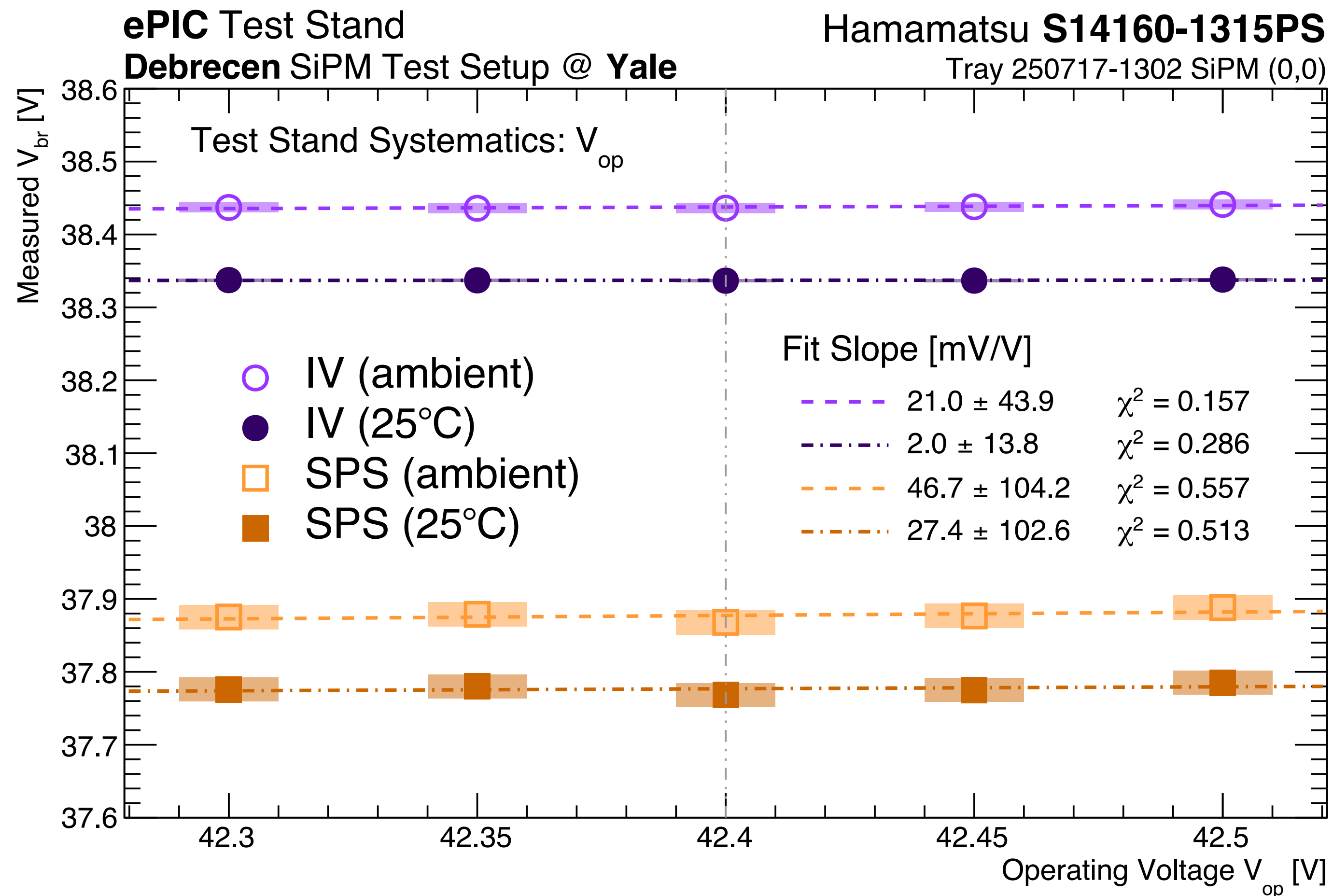
Full photo catalog available here:

https://drive.google.com/file/d/14XNQL0FtxVvq2OZIpTtmdDHcwnalf6B9/view?usp=share_link

Monday 1/5/26
Final Systematics and Current Status

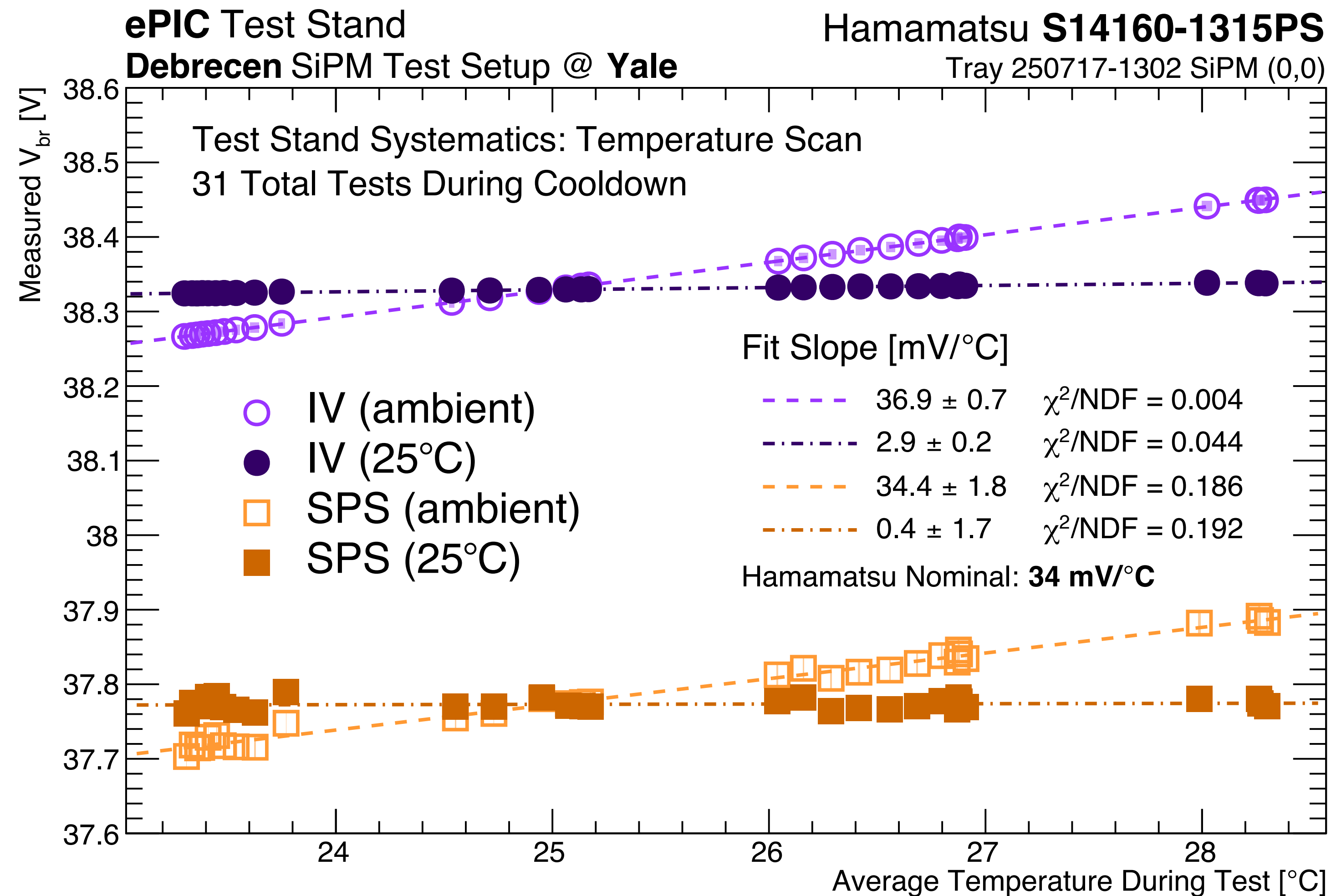
Operating Voltage Scan

Does the chosen V_{op} measurably affect the extrapolated V_{br} ?

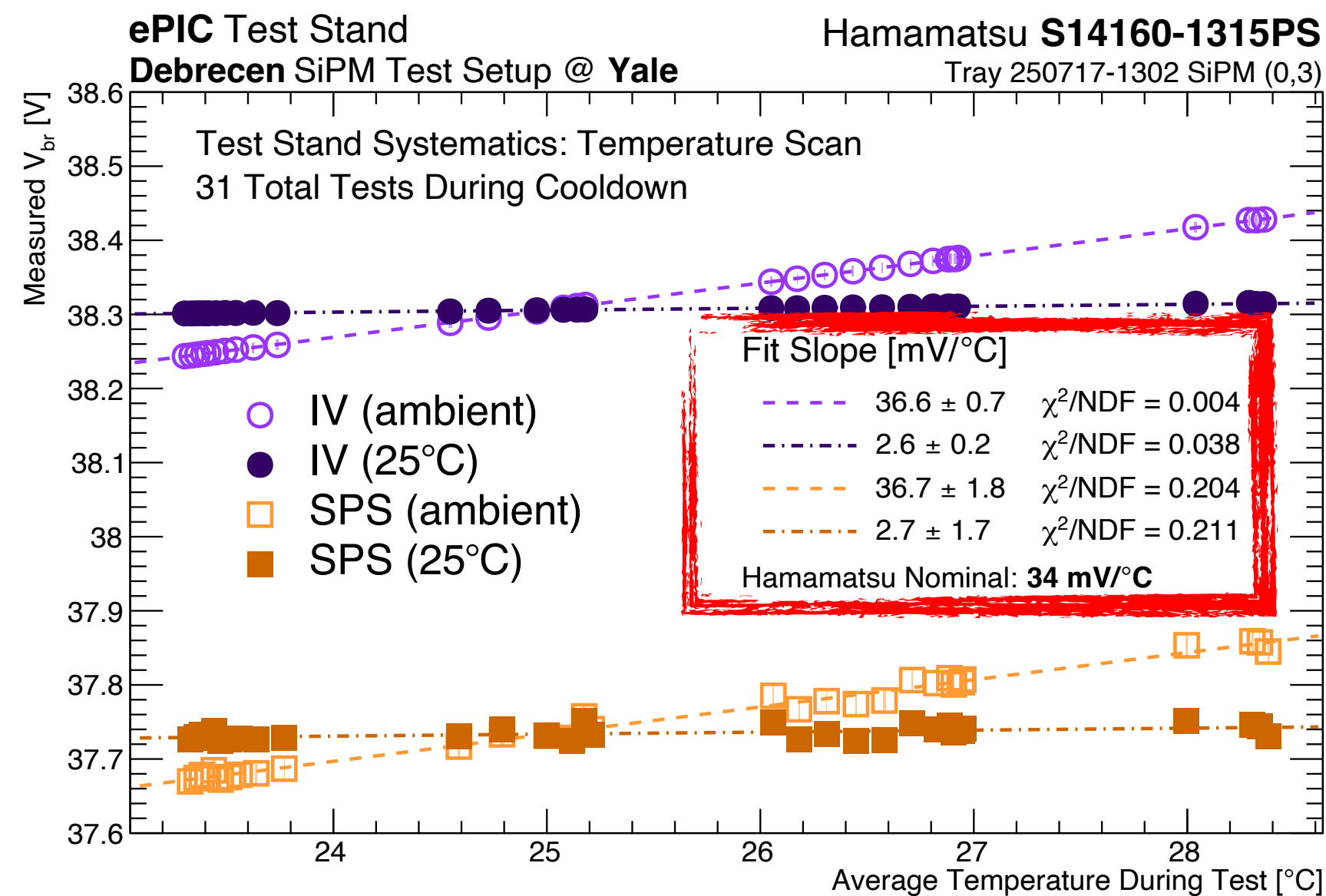
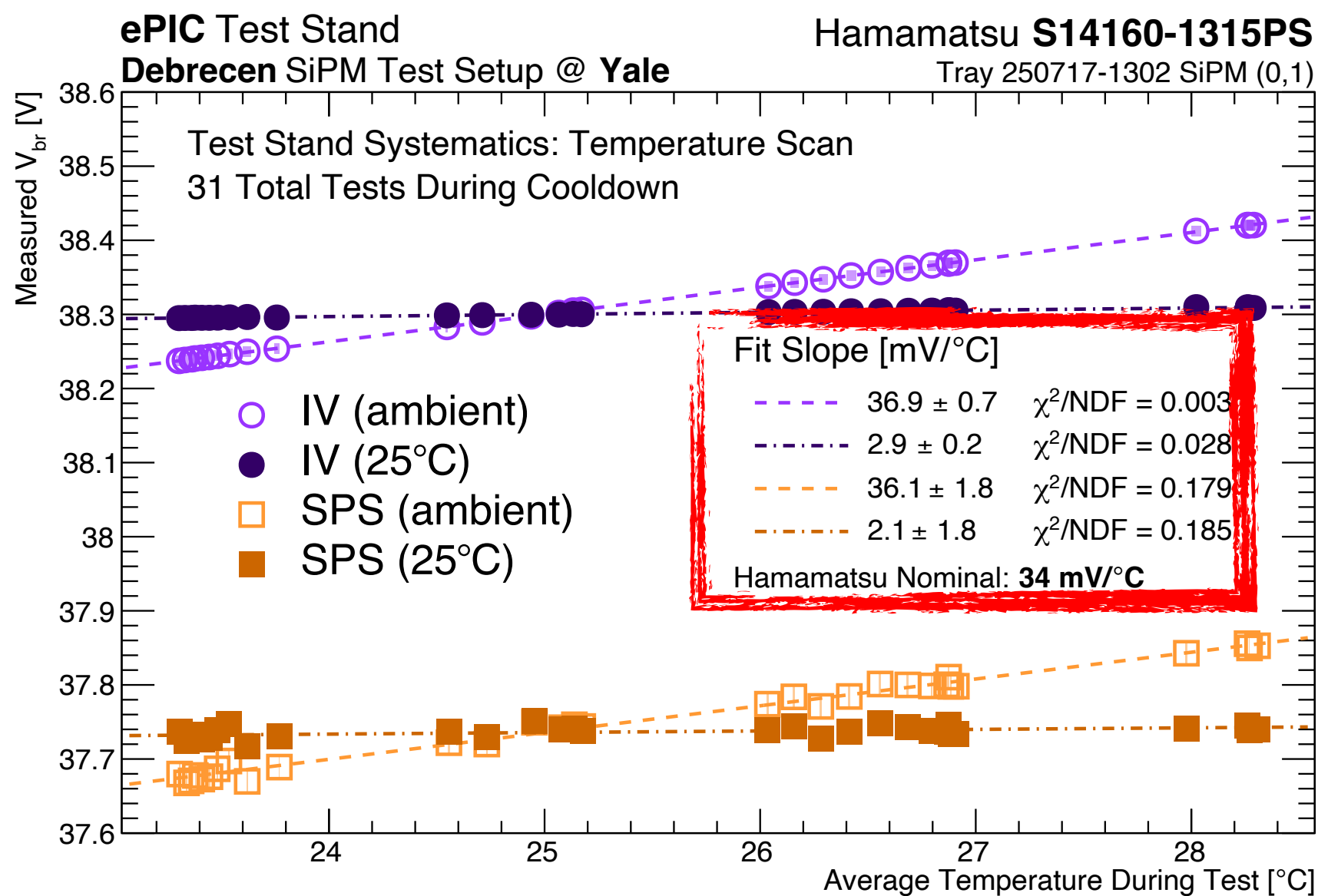
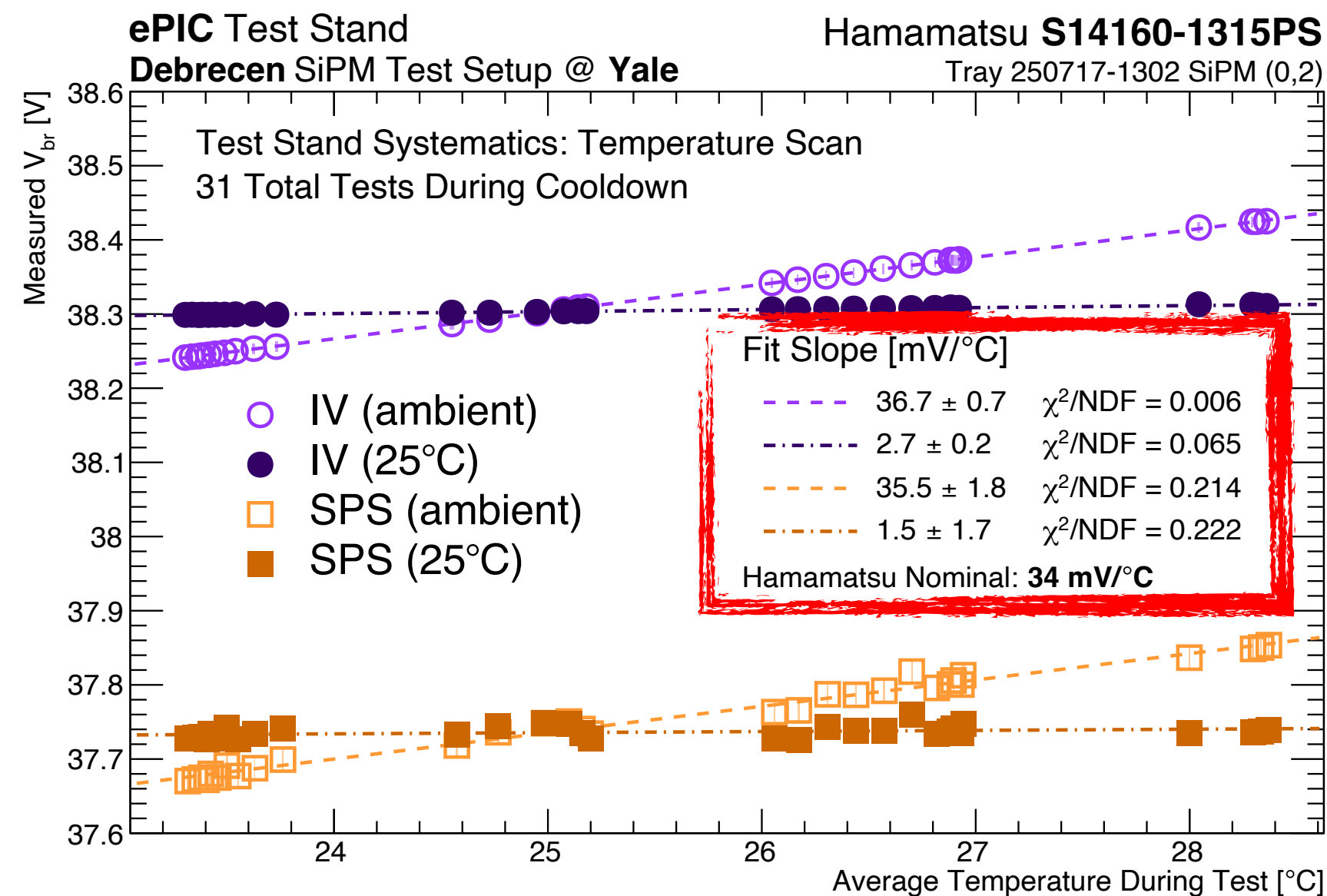
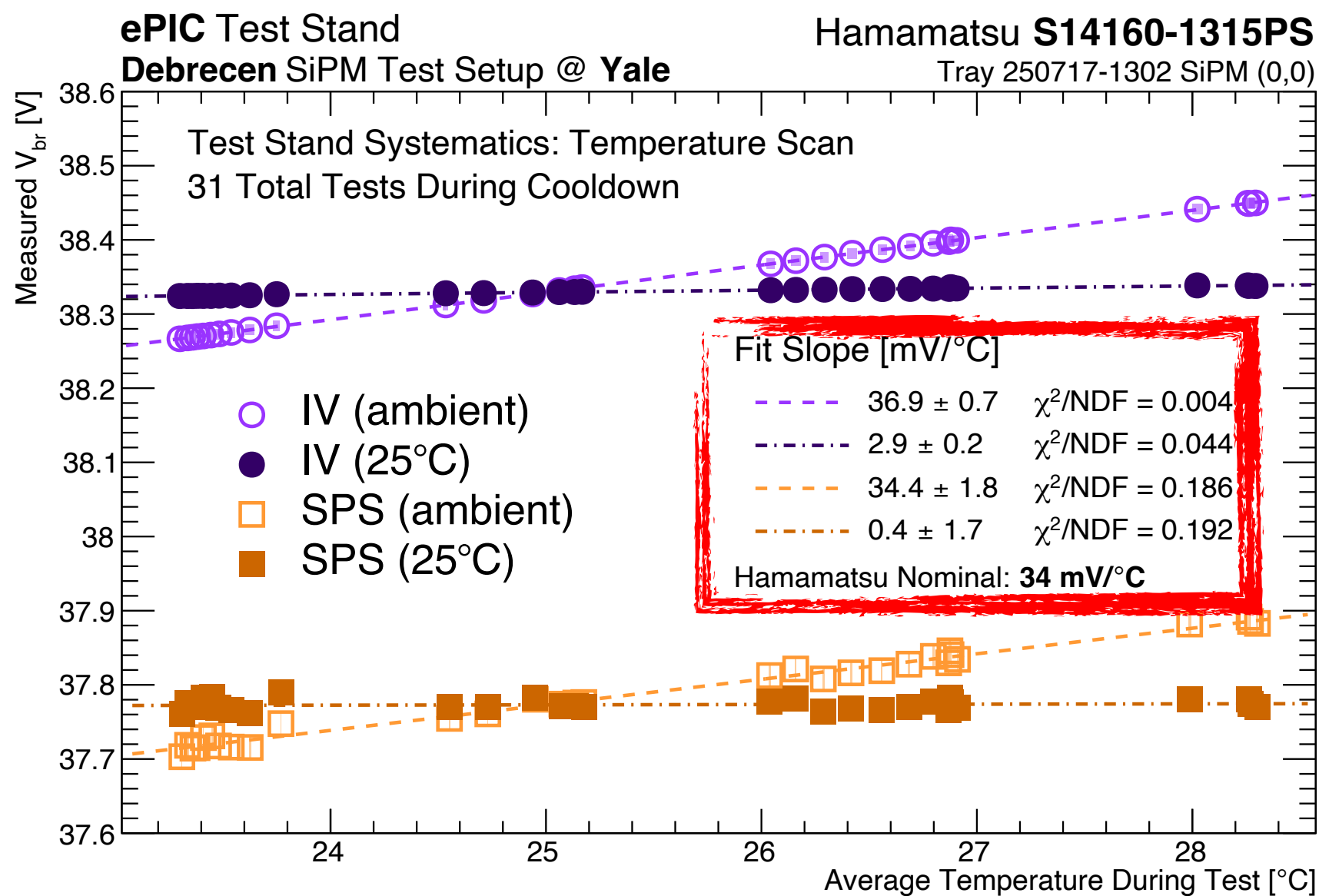


Temperature Scan

Testing while the lab cools down: nice explicit demonstration of linear scaling!



Temperature Scan

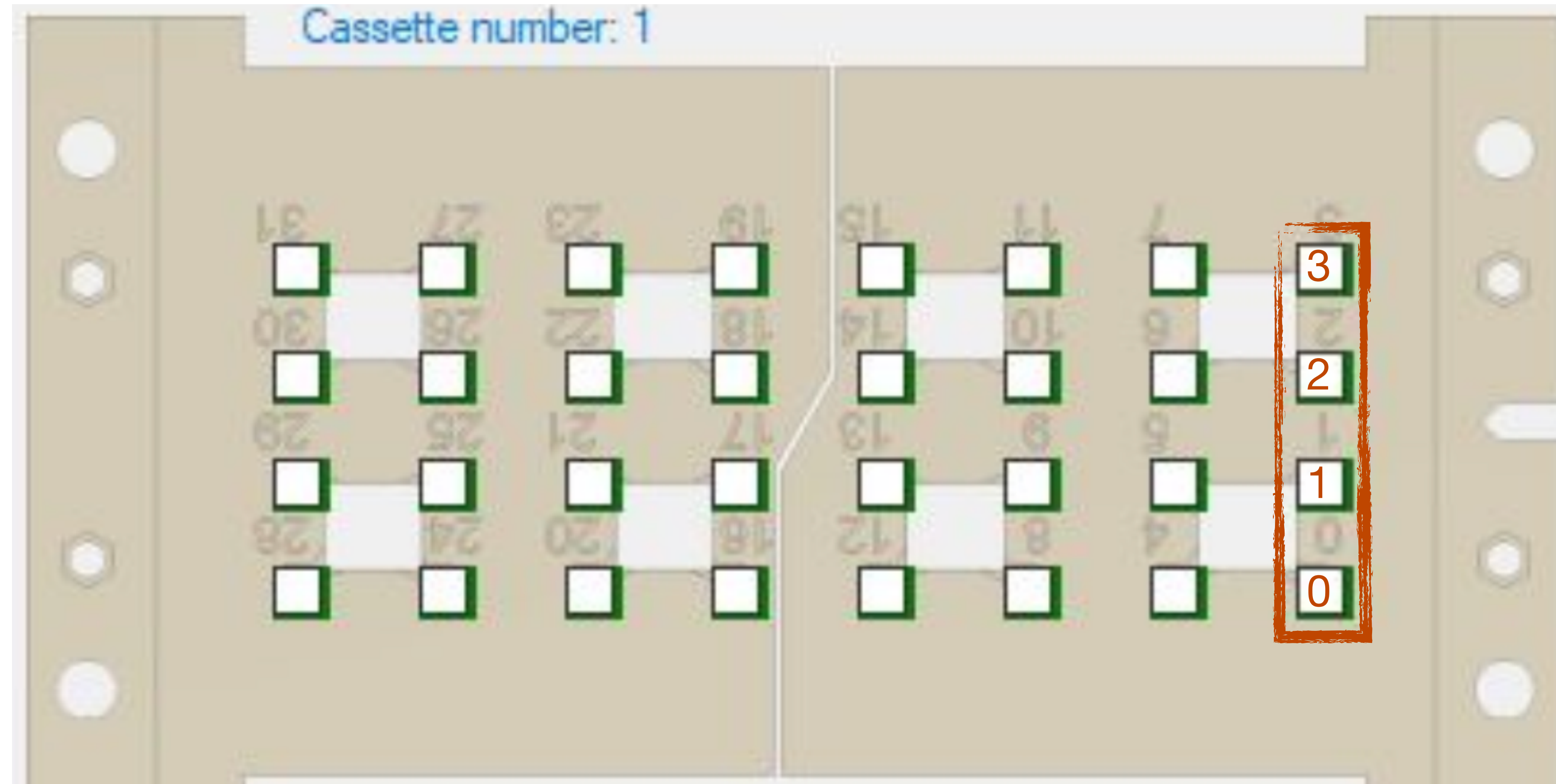


Insight from Balázs:

Temperature correction coefficient depends slightly on the breakdown voltage V_{bd} !

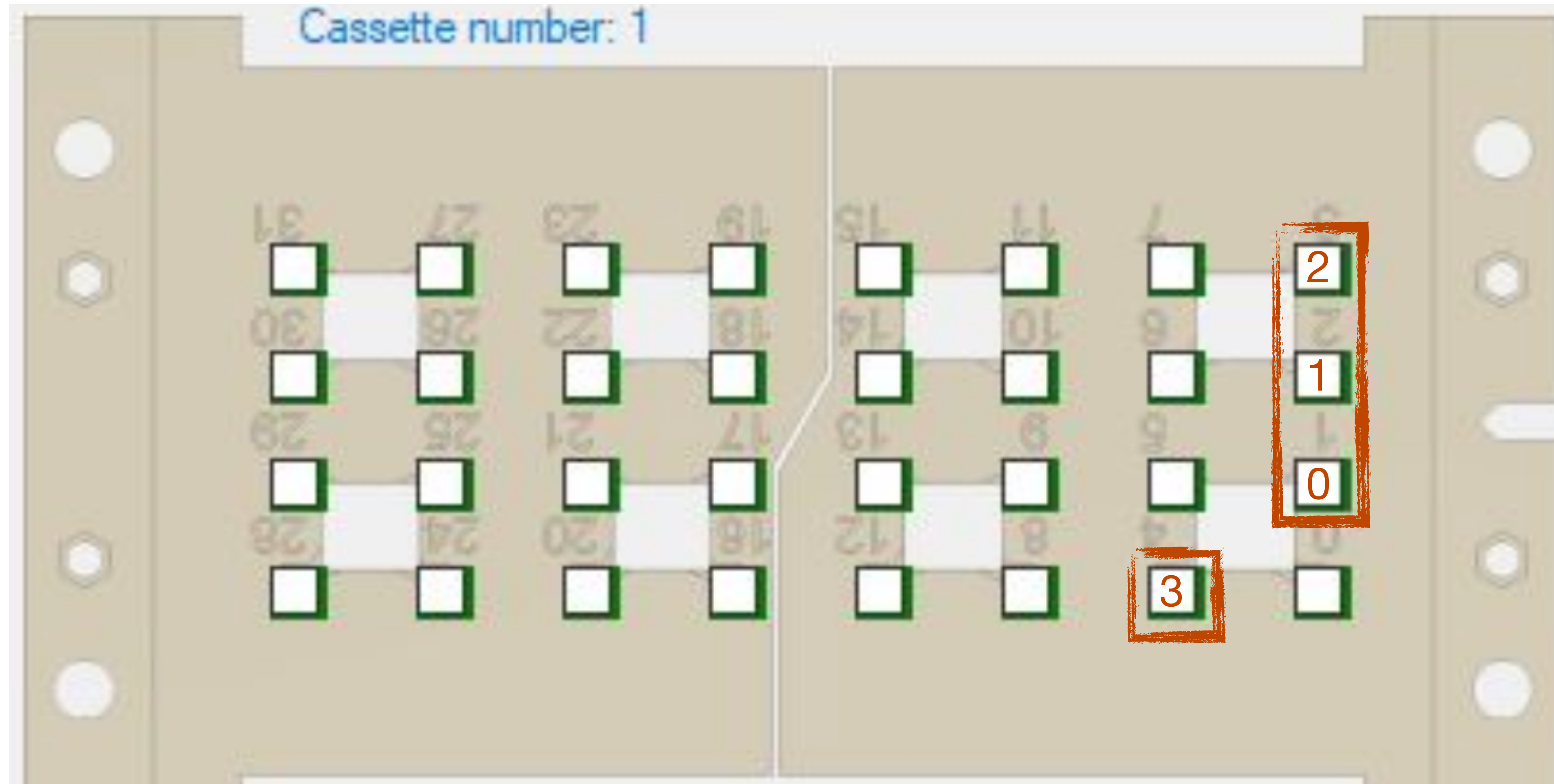
Cycle Test

Do measurements differ between cassette positions?



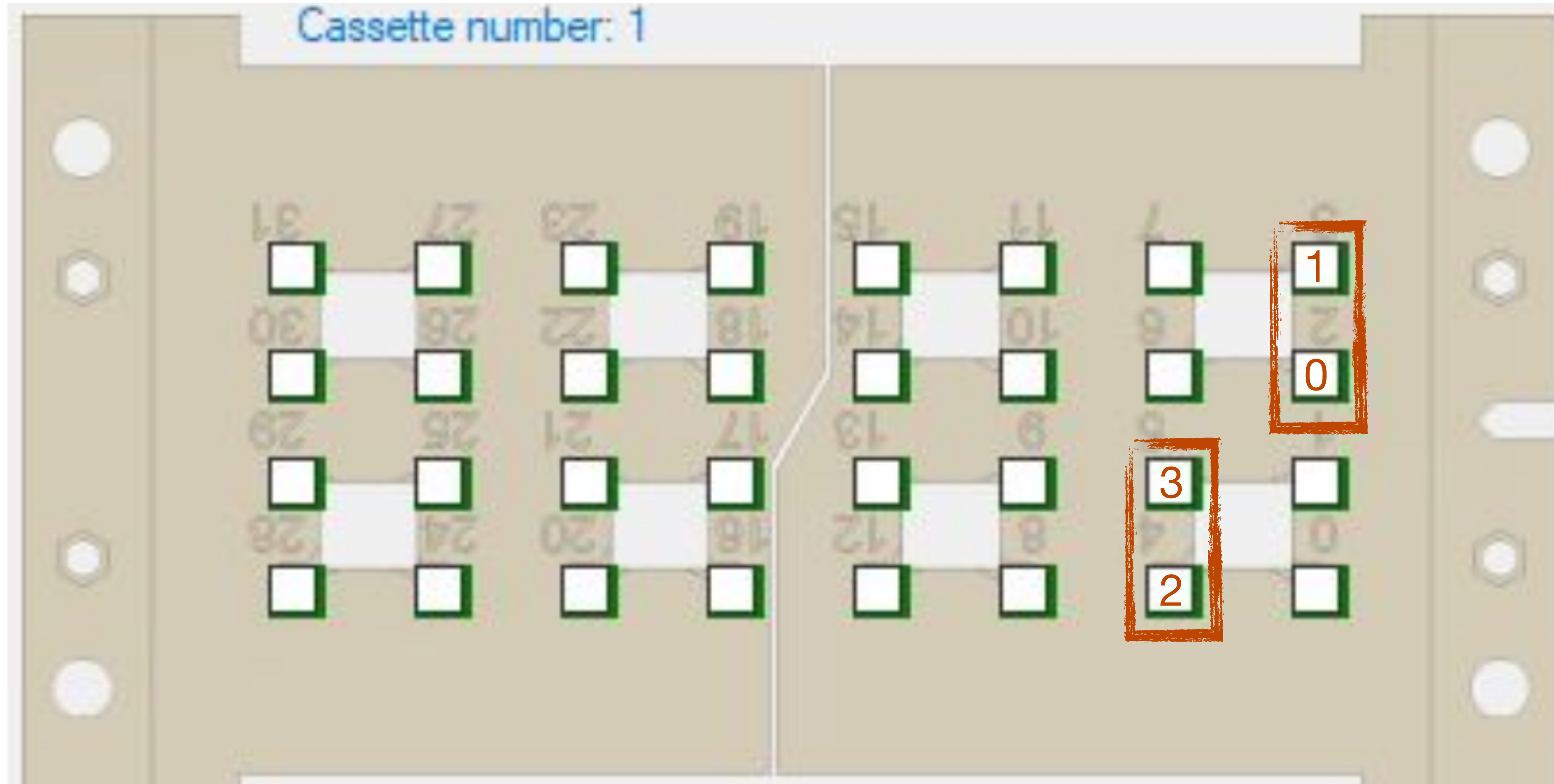
Cycle Test

Do measurements differ between cassette positions?



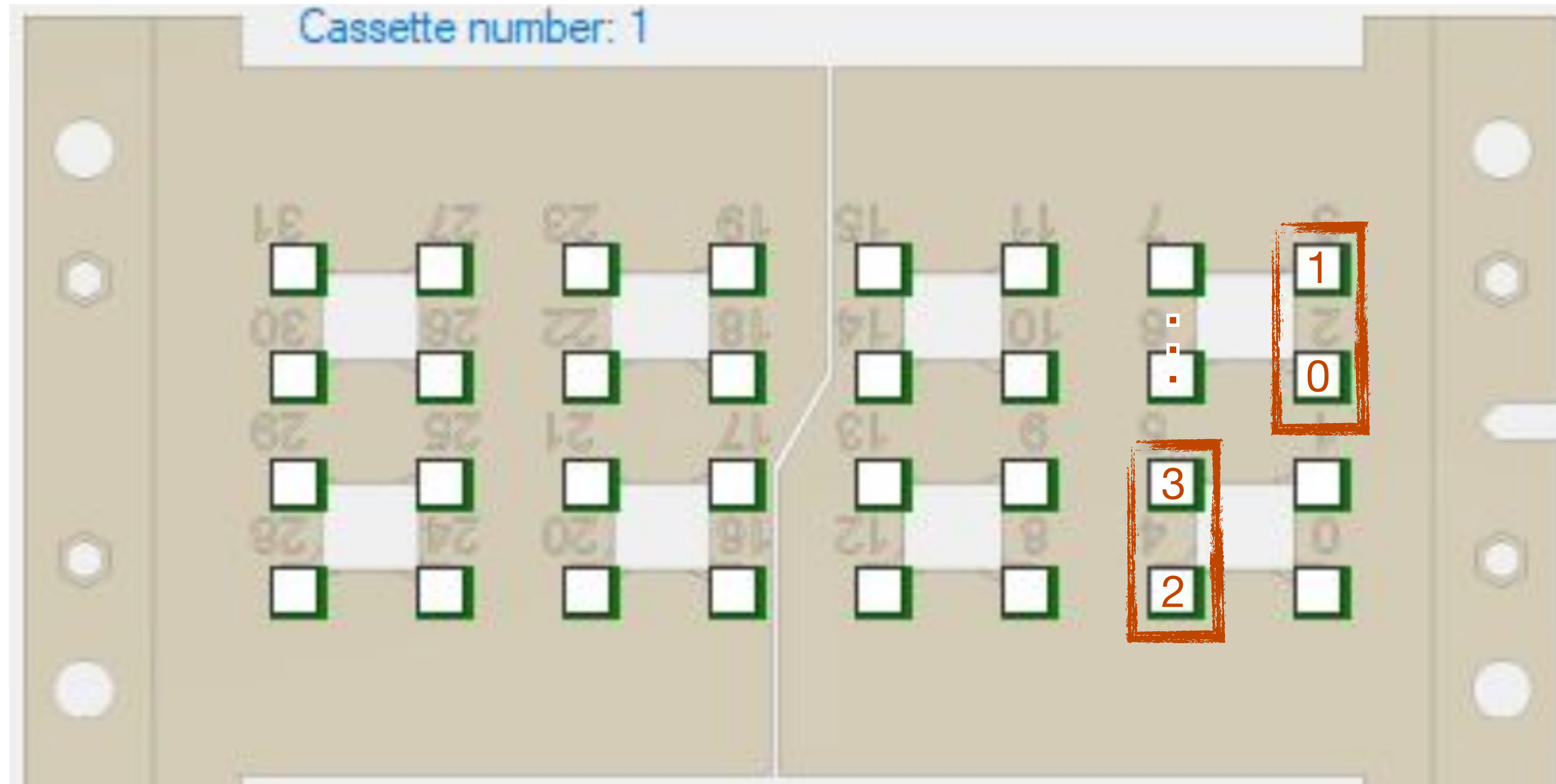
Cycle Test

Do measurements differ between cassette positions?



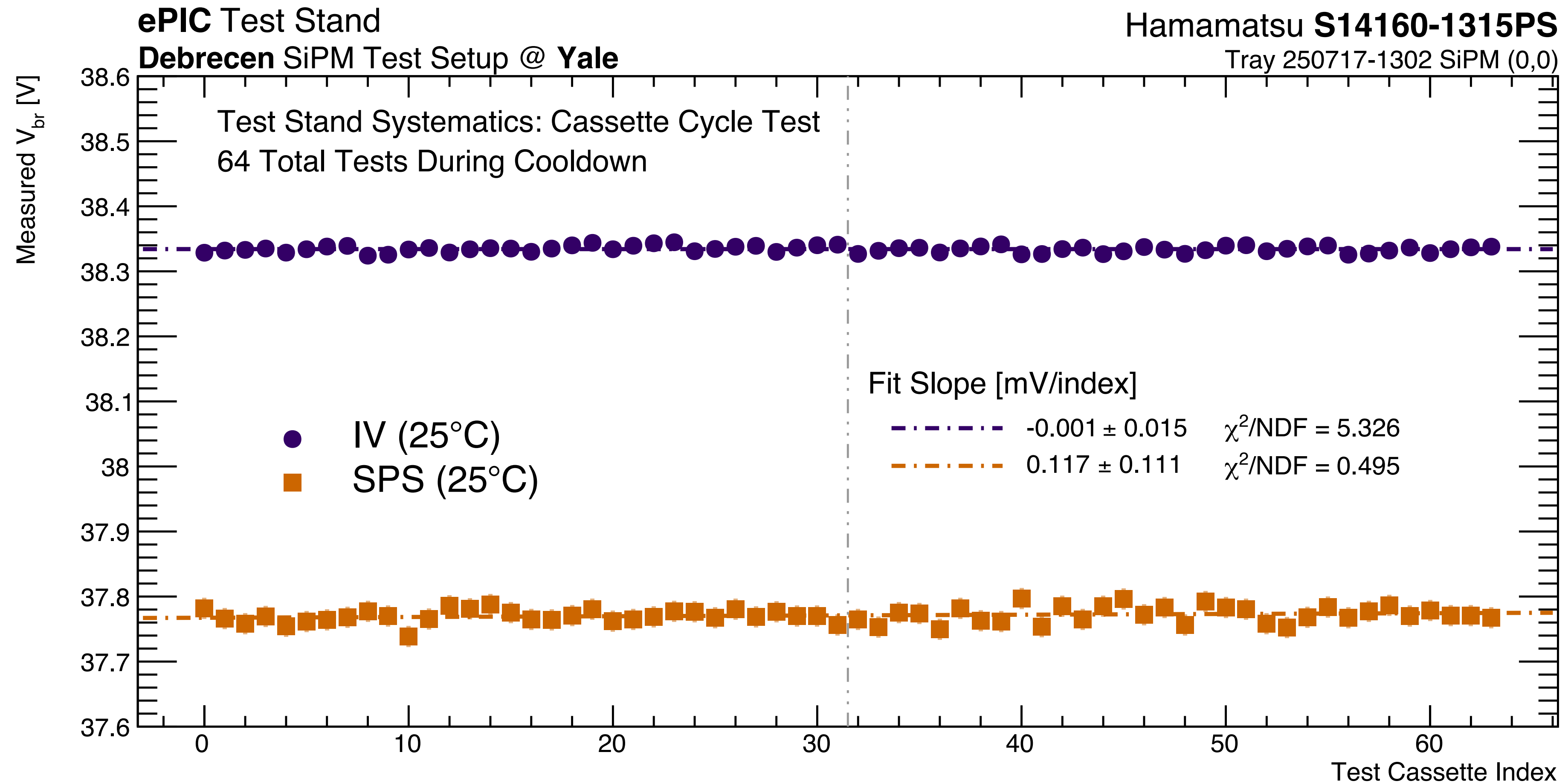
Cycle Test

Do measurements differ between cassette positions?



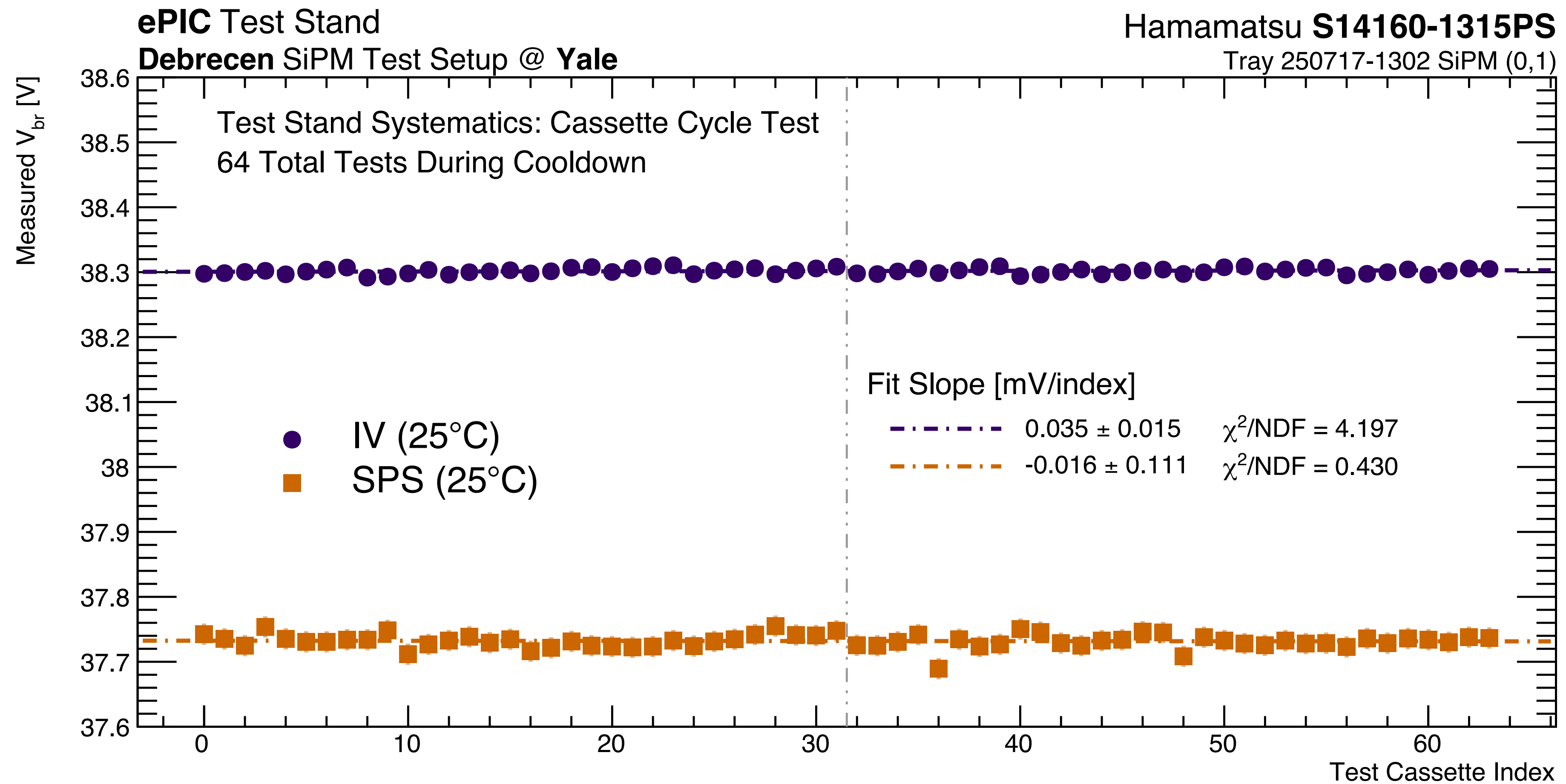
Cycle Test

Do measurements differ between cassette positions?



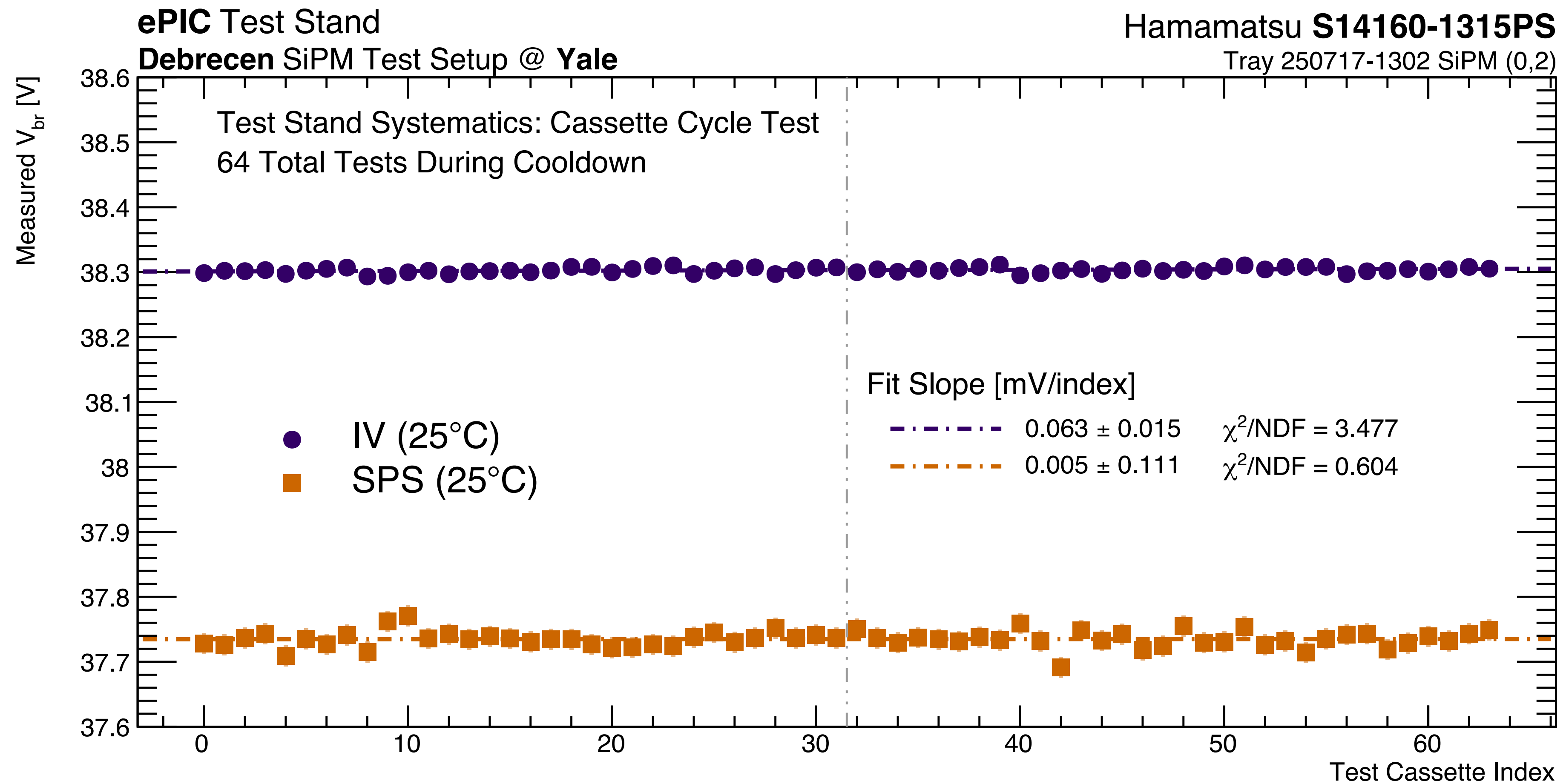
Cycle Test

Do measurements differ between cassette positions?



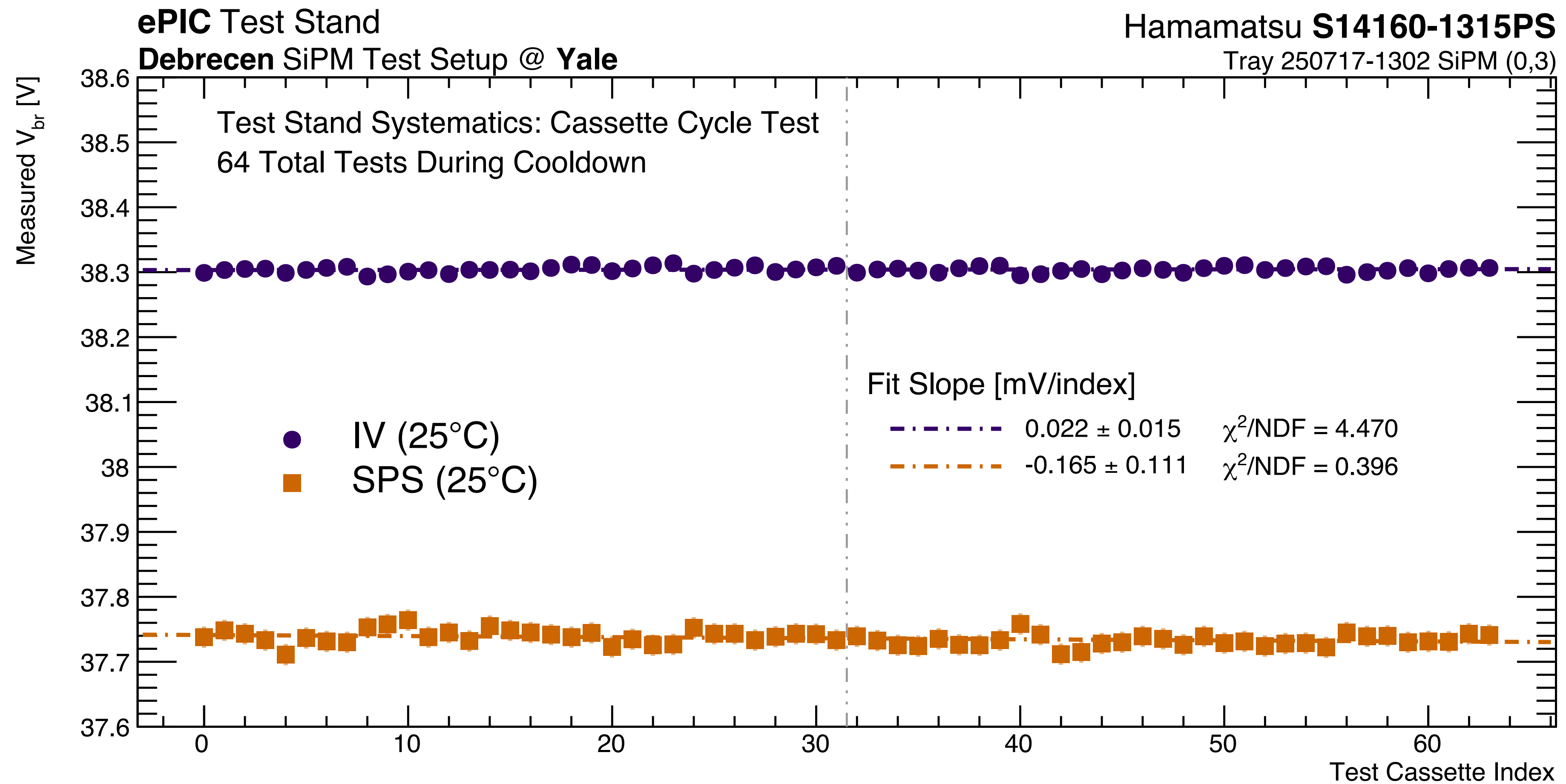
Cycle Test

Do measurements differ between cassette positions?



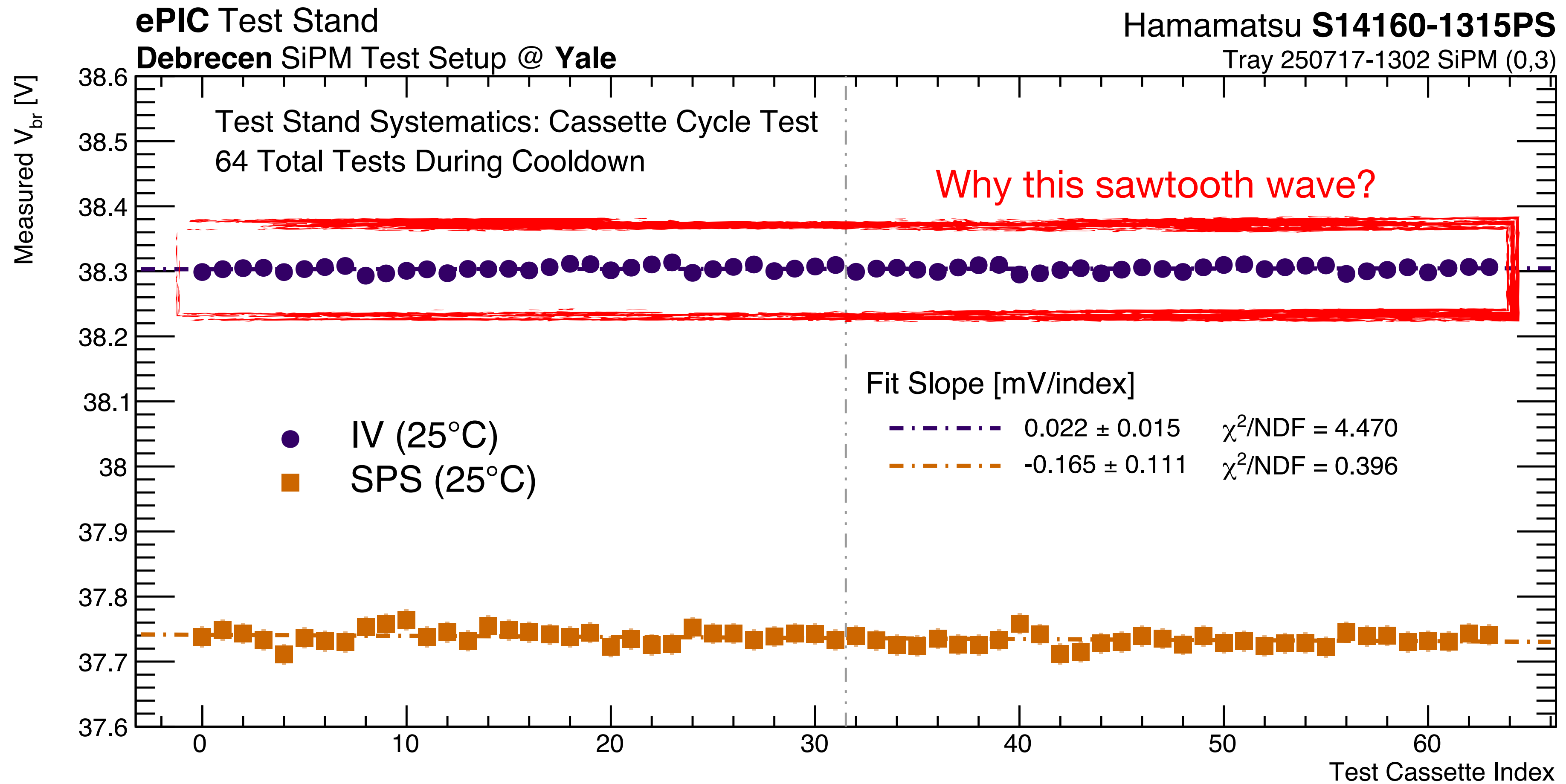
Cycle Test

Do measurements differ between cassette positions?



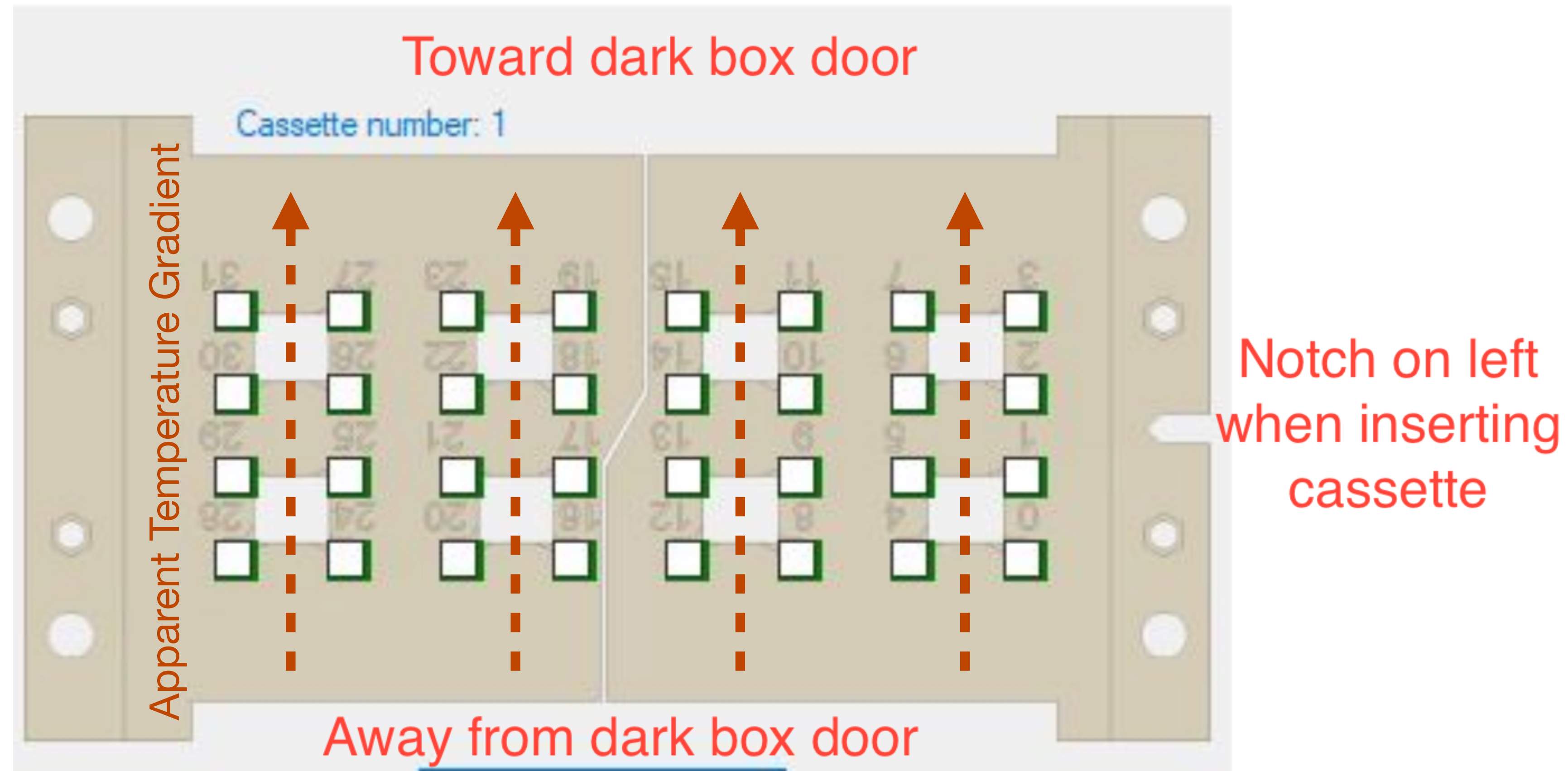
Cycle Test

Do measurements differ between cassette positions?



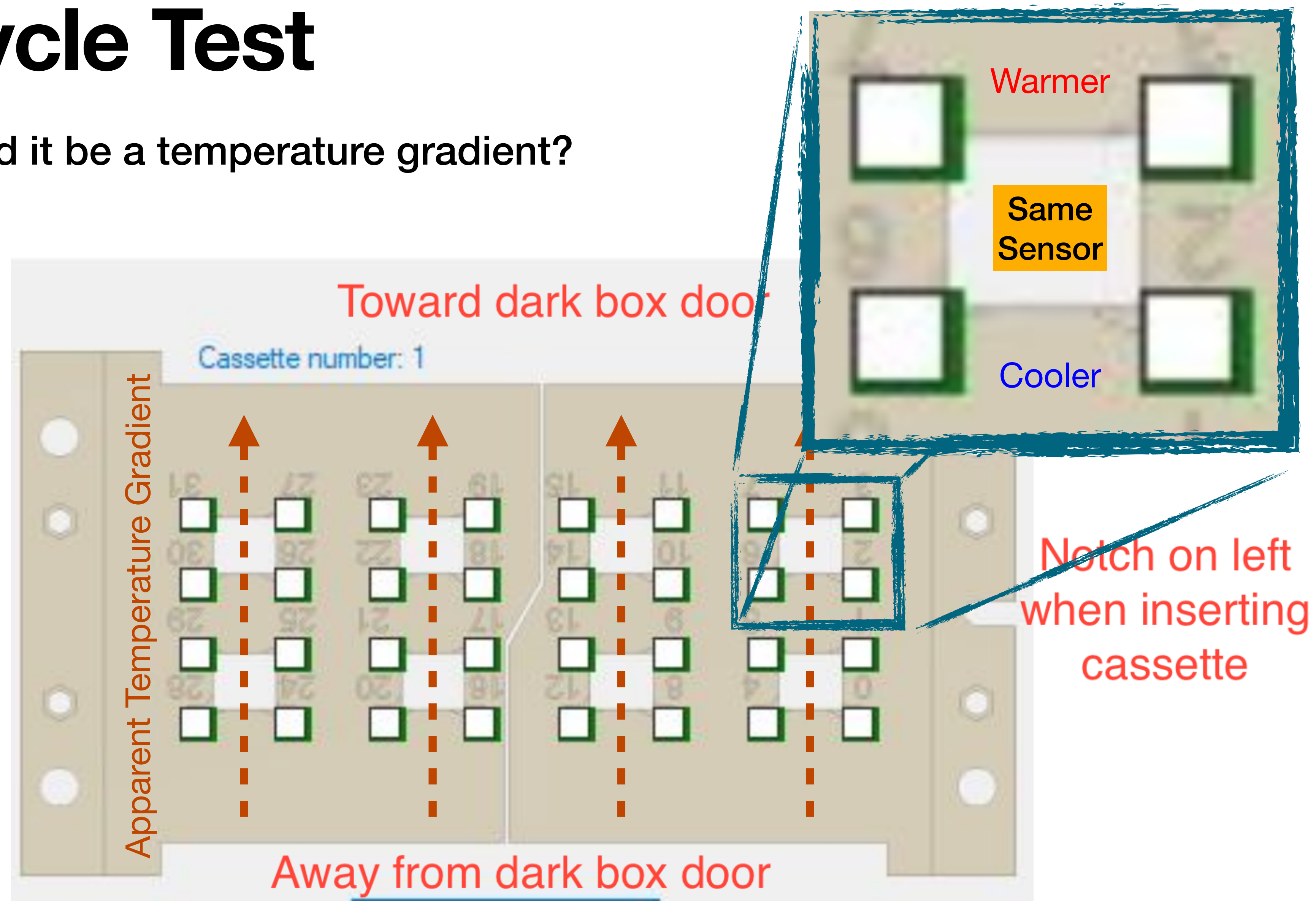
Cycle Test

Could it be a temperature gradient?



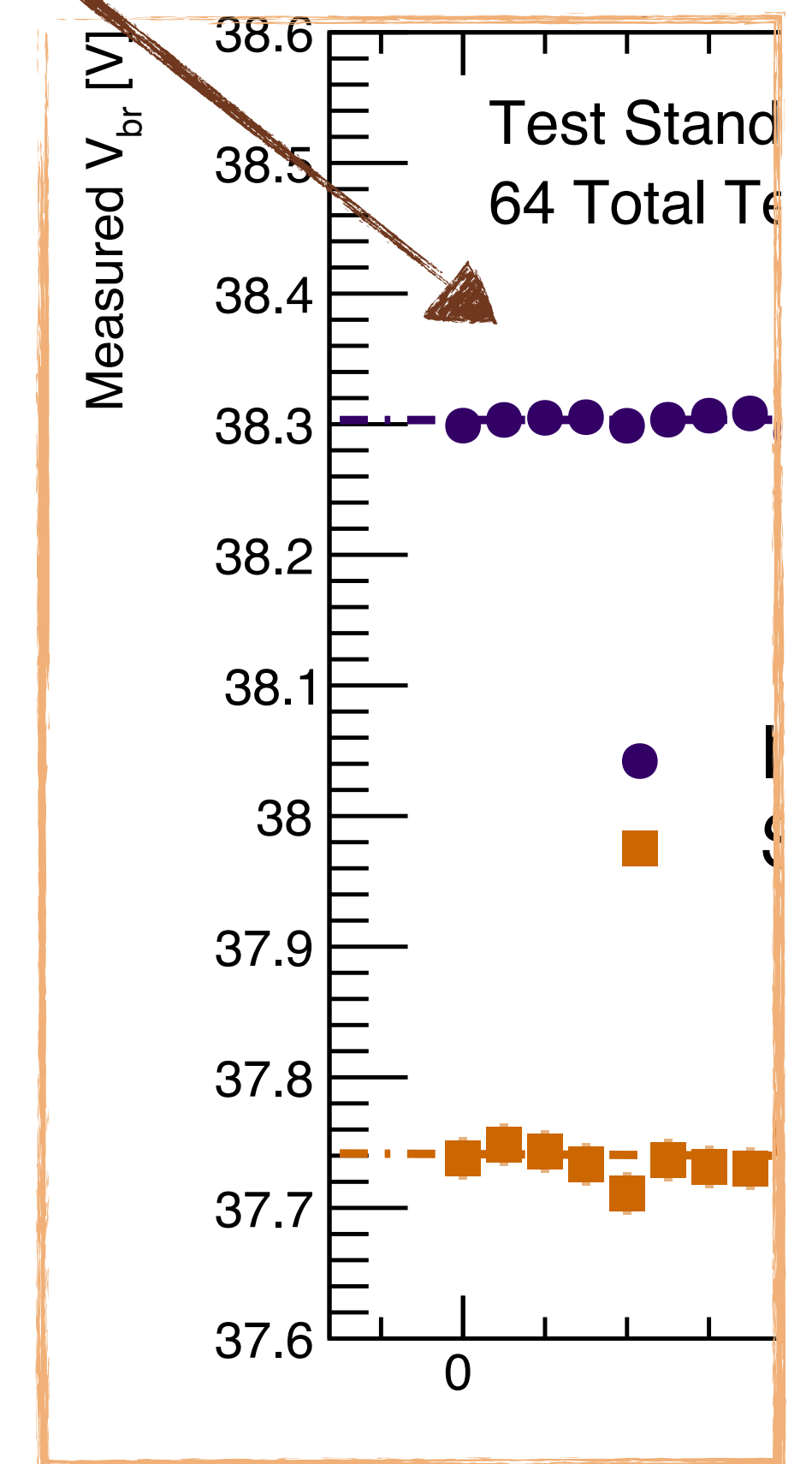
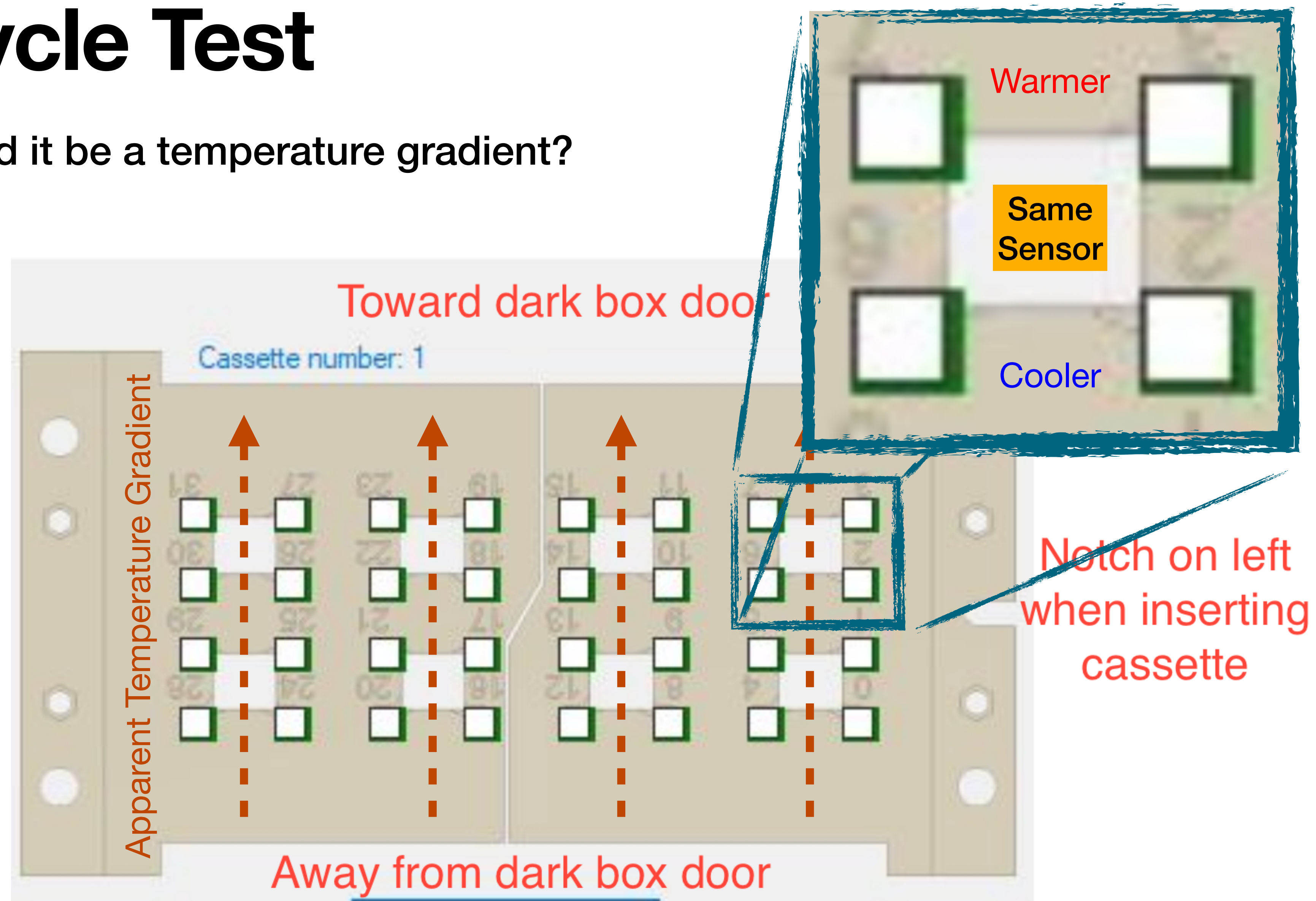
Cycle Test

Could it be a temperature gradient?



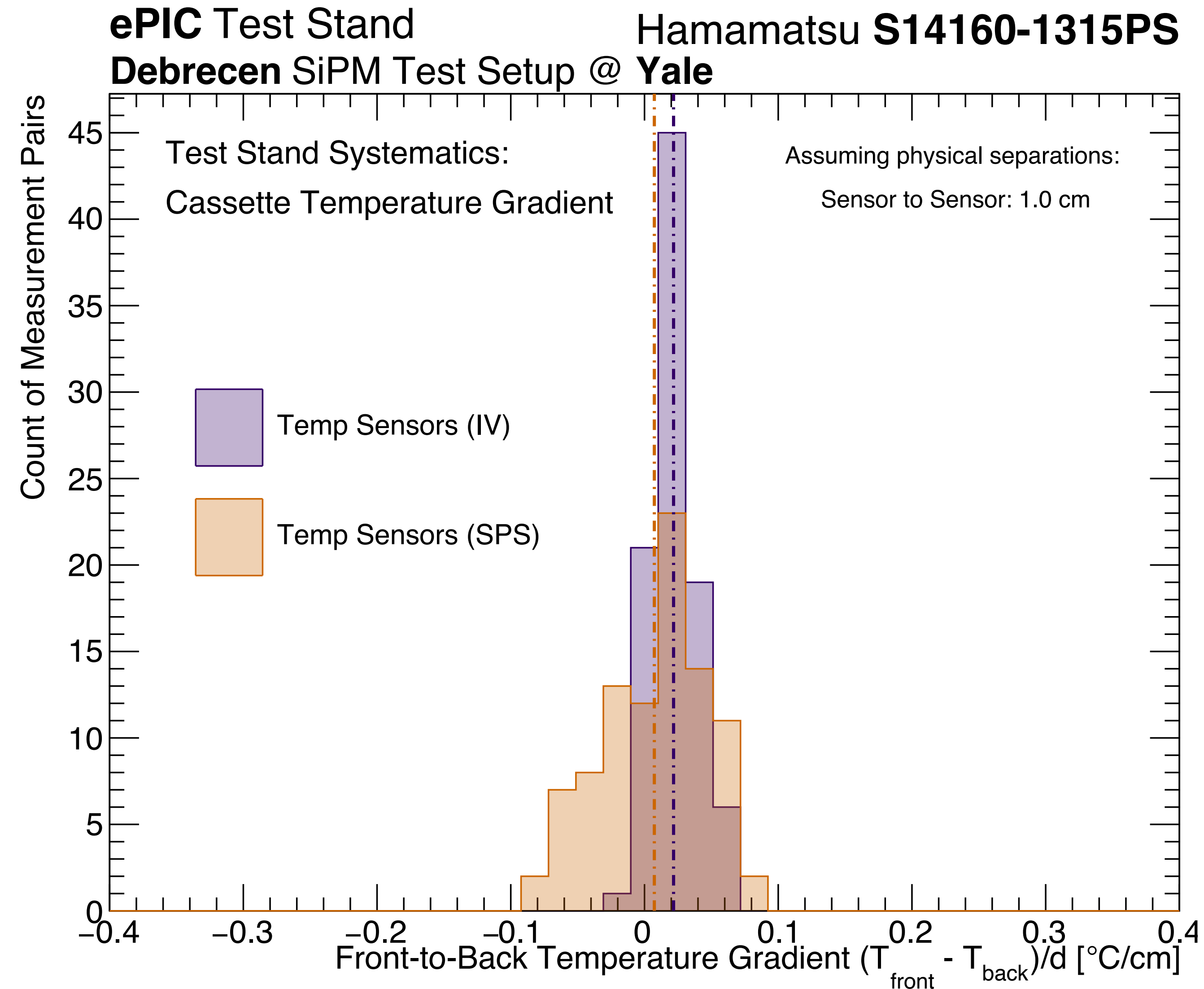
Cycle Test

Could it be a temperature gradient?



Temperature Gradient

A new mystery

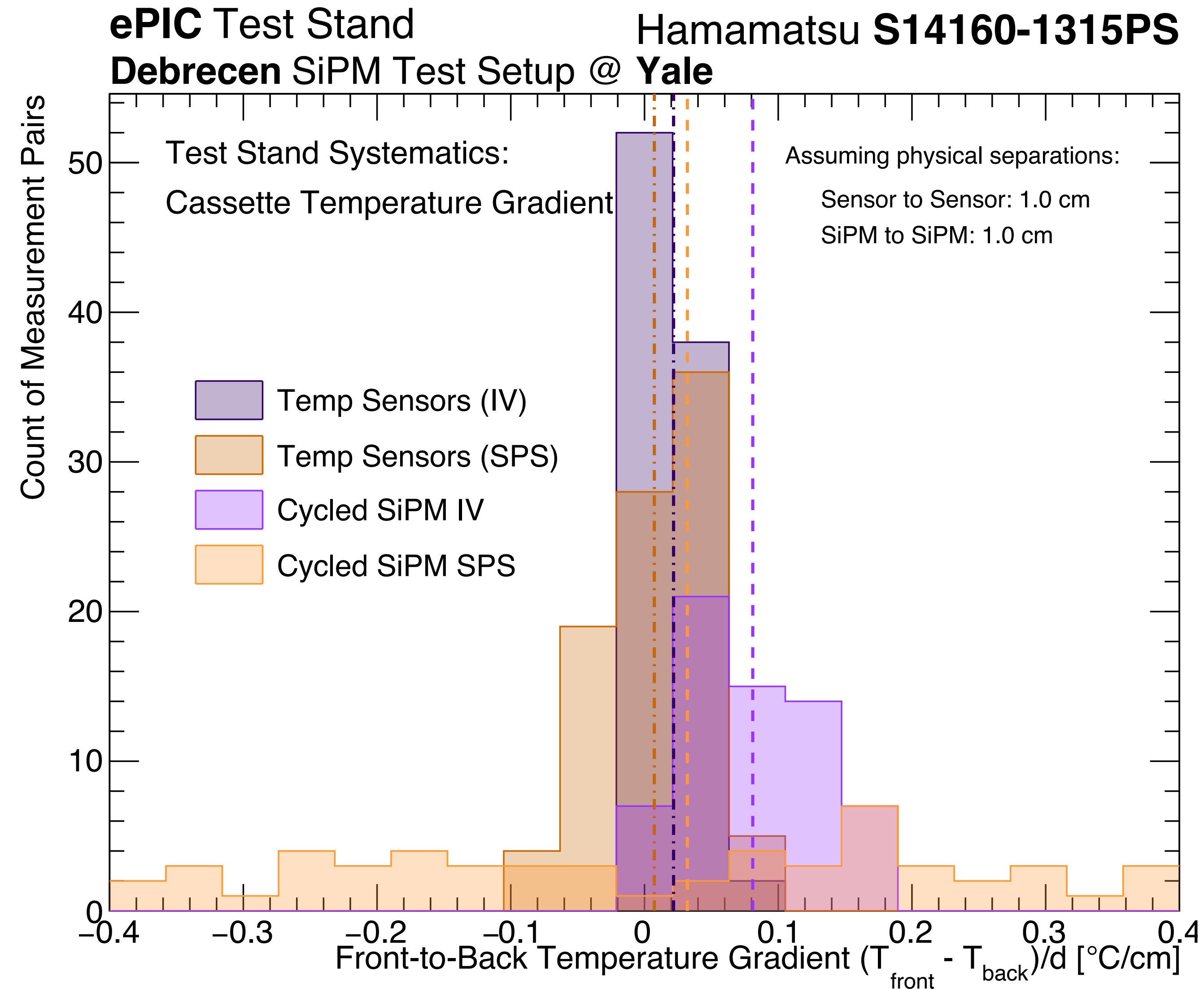


There is a slight gradient...

Is this enough to
account for the difference
we see?

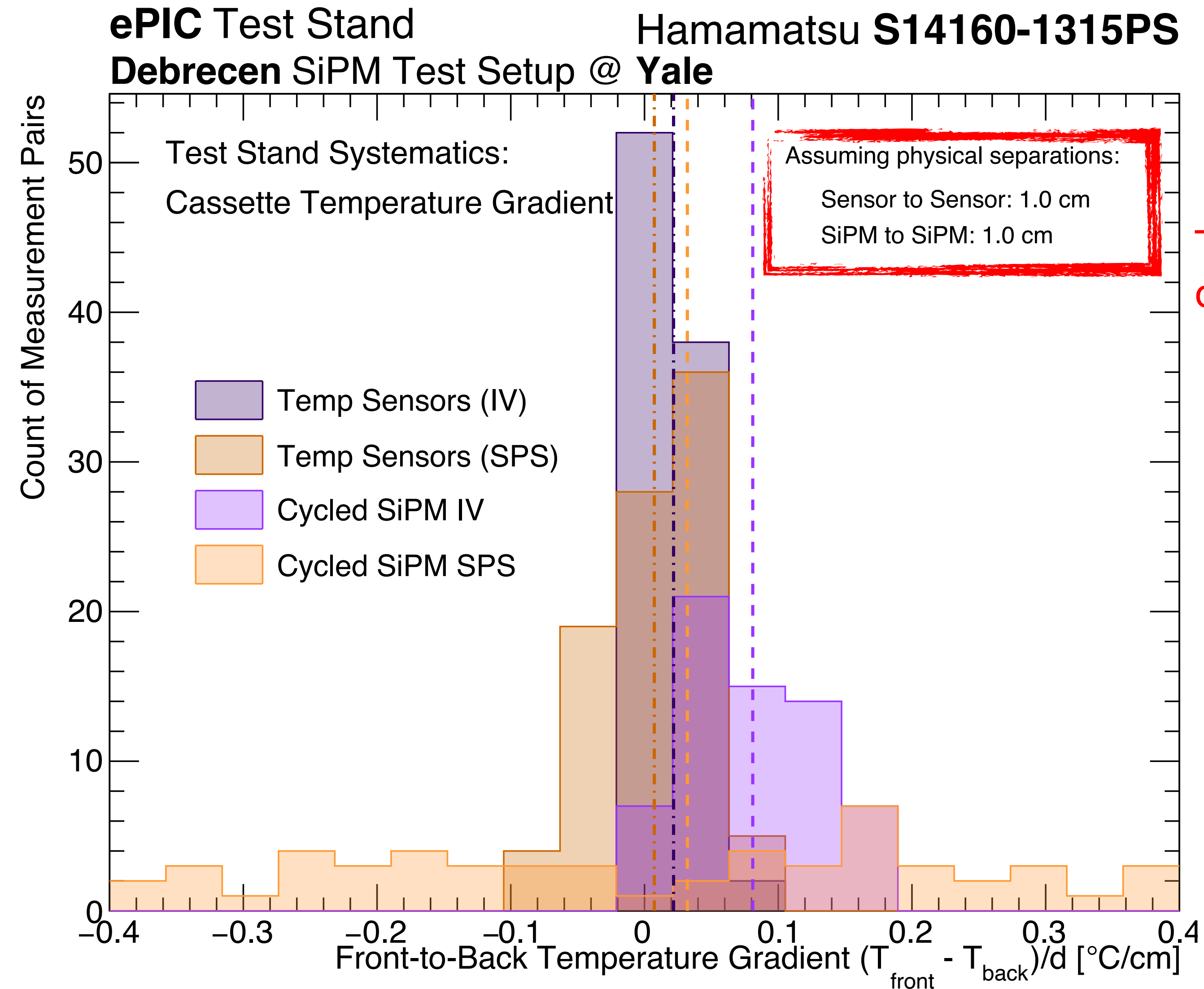
Temperature Gradient

A new mystery



Temperature Gradient

A new mystery



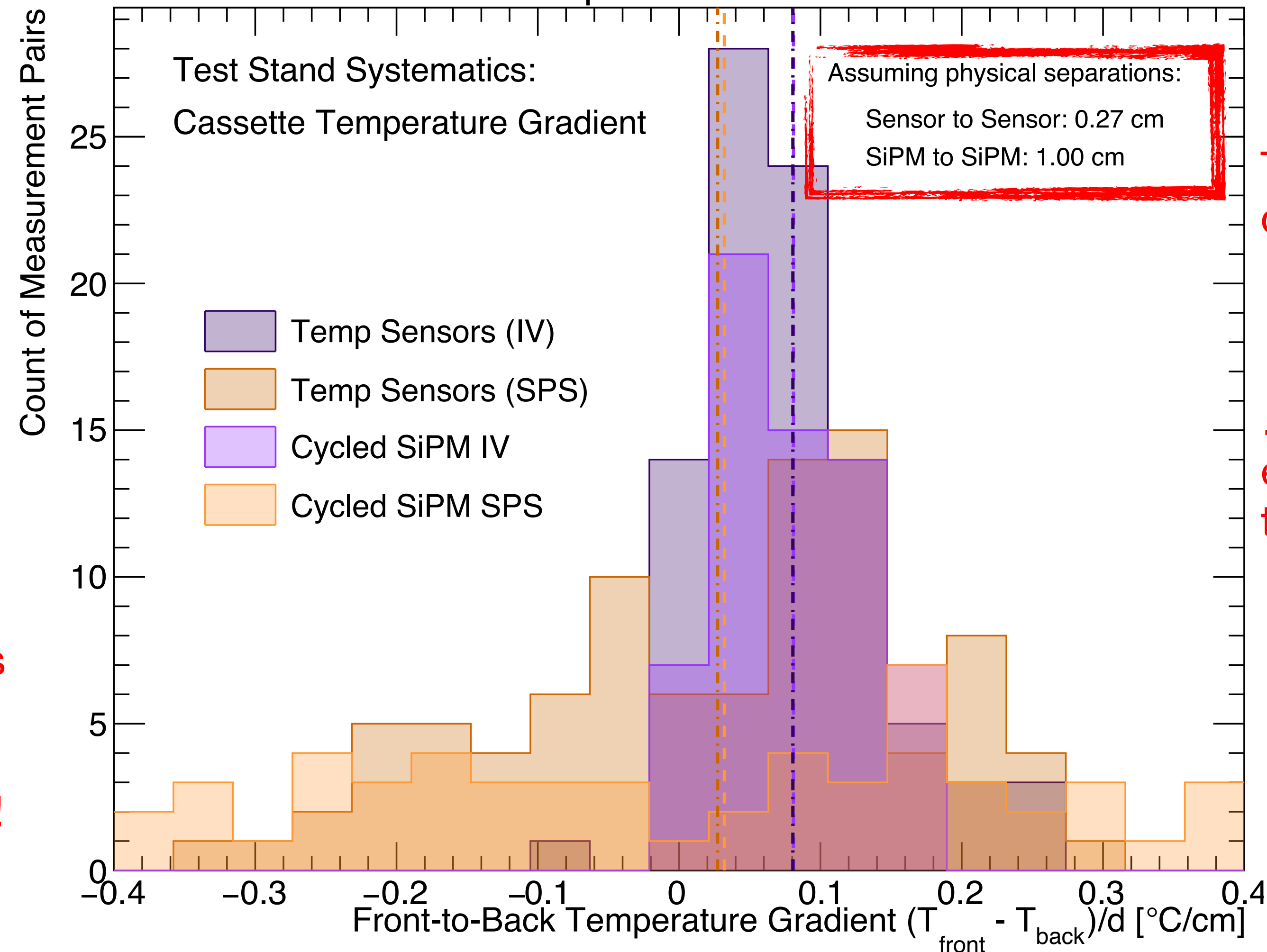
These physical distances are definitely not right...

Temperature Gradient

A new mystery

ePIC Test Stand
Debrecen SiPM Test Setup @ Yale

Hamamatsu S14160-1315PS



These physical distances are definitely not right...

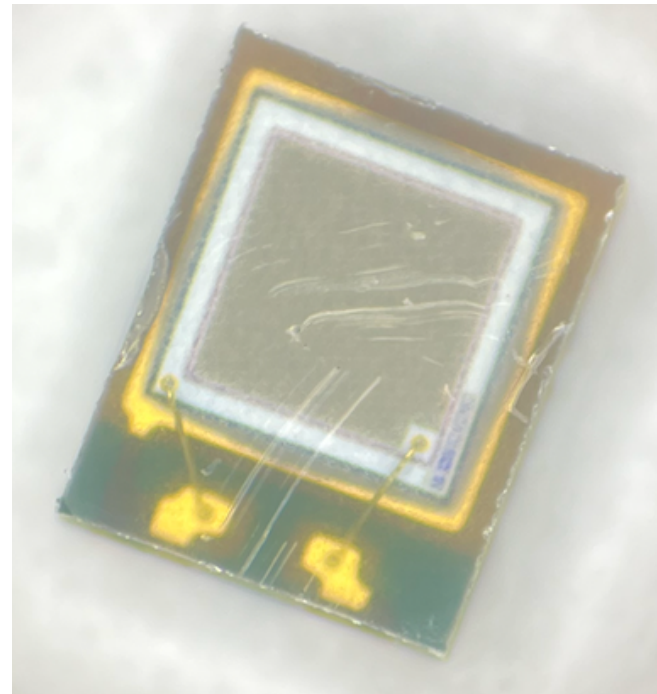
...but if we make them even more wrong, the two align??

In other words, the SiPMs seem to see more temperature gradient than the sensors suggest!

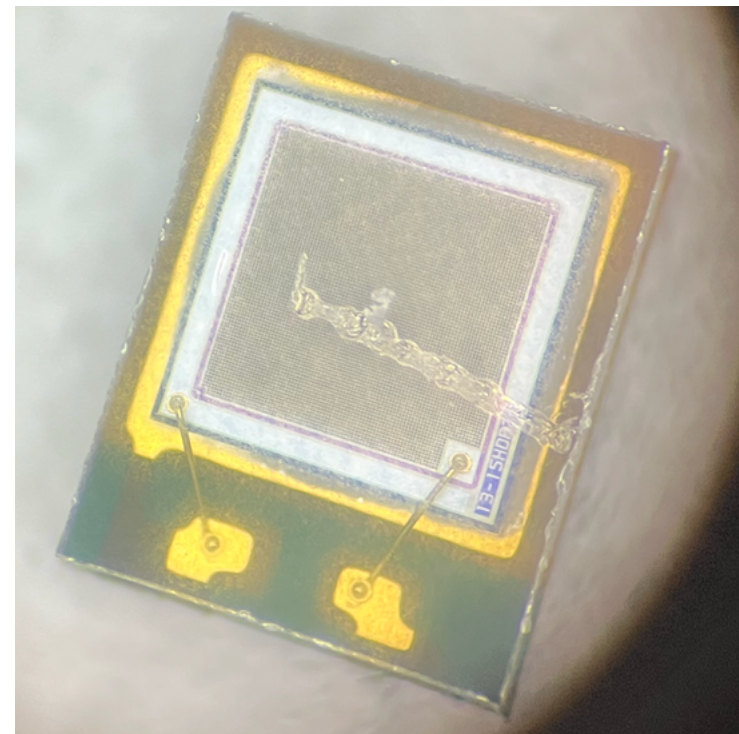
Surface Imperfections

Last but Not Least

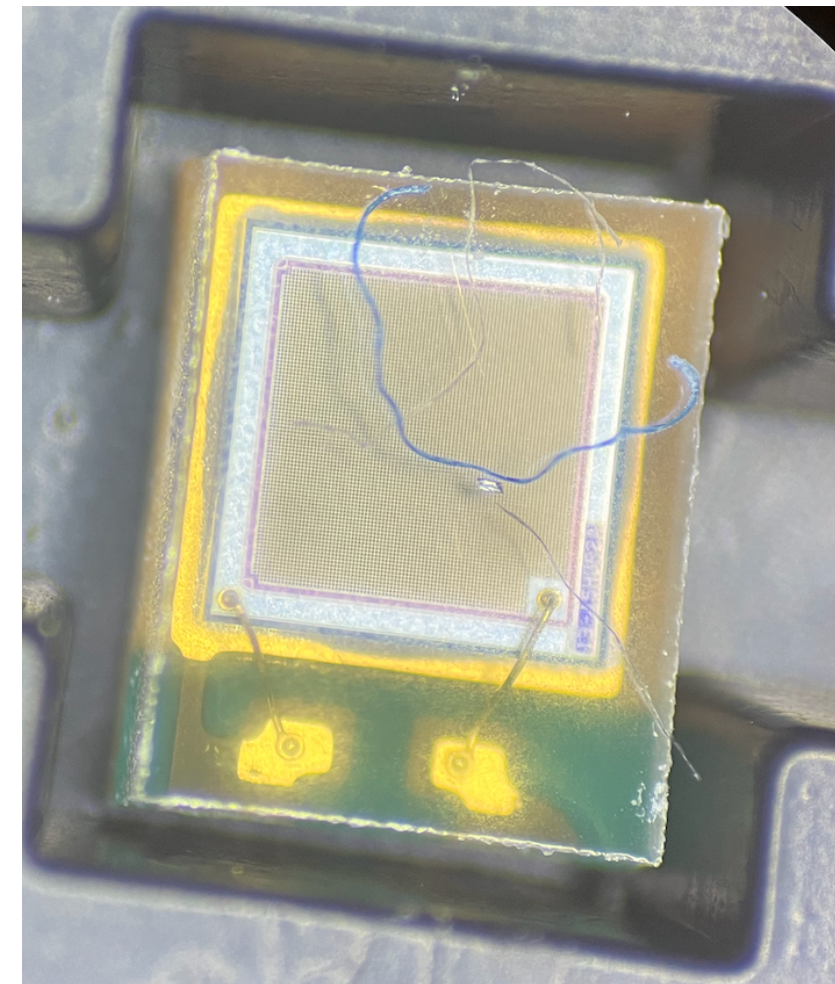
Surface Scratch



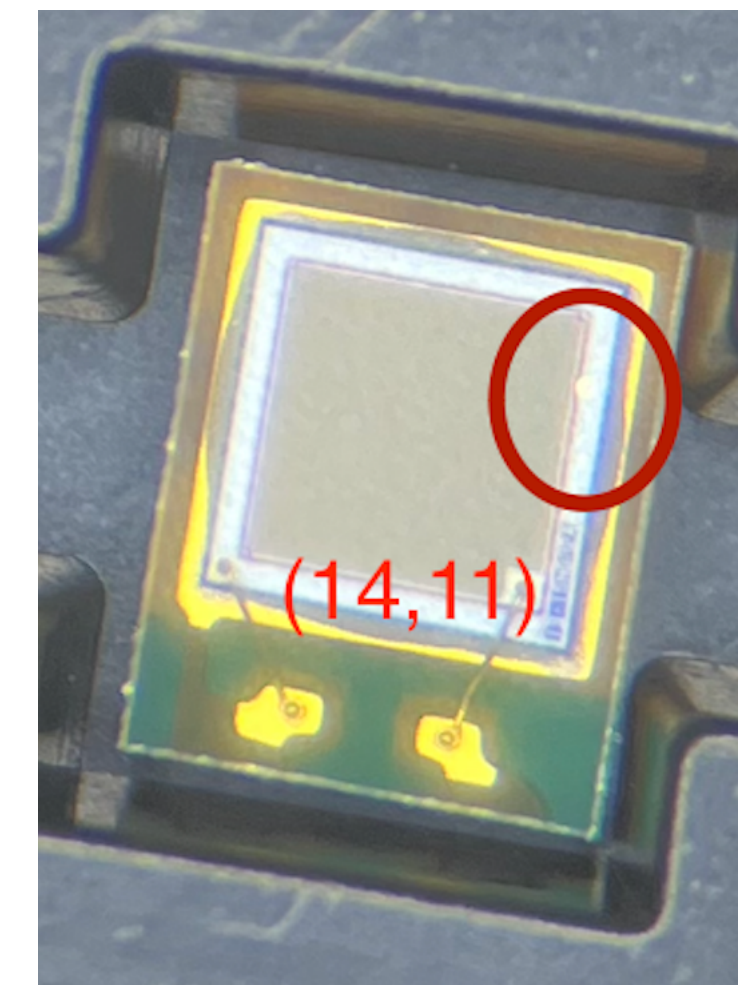
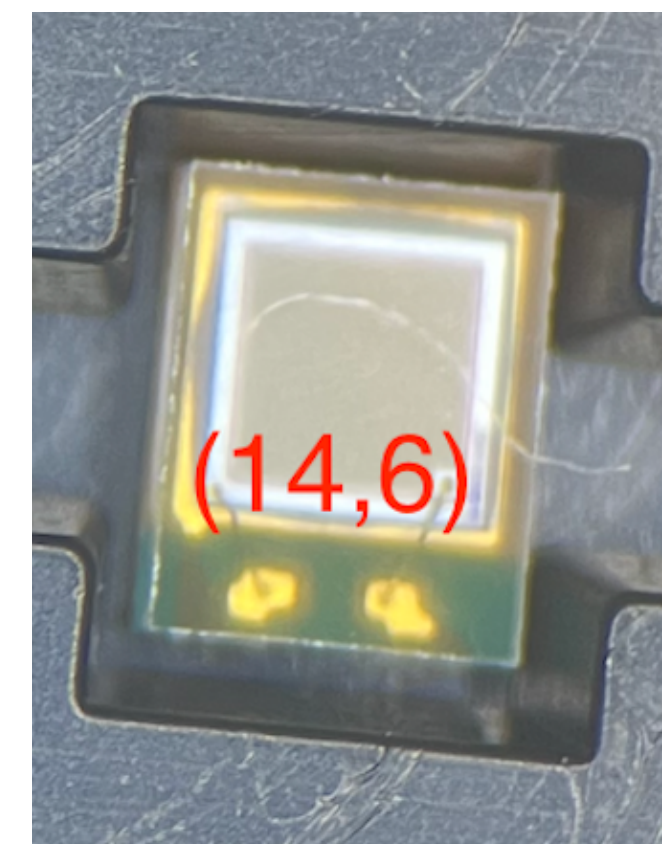
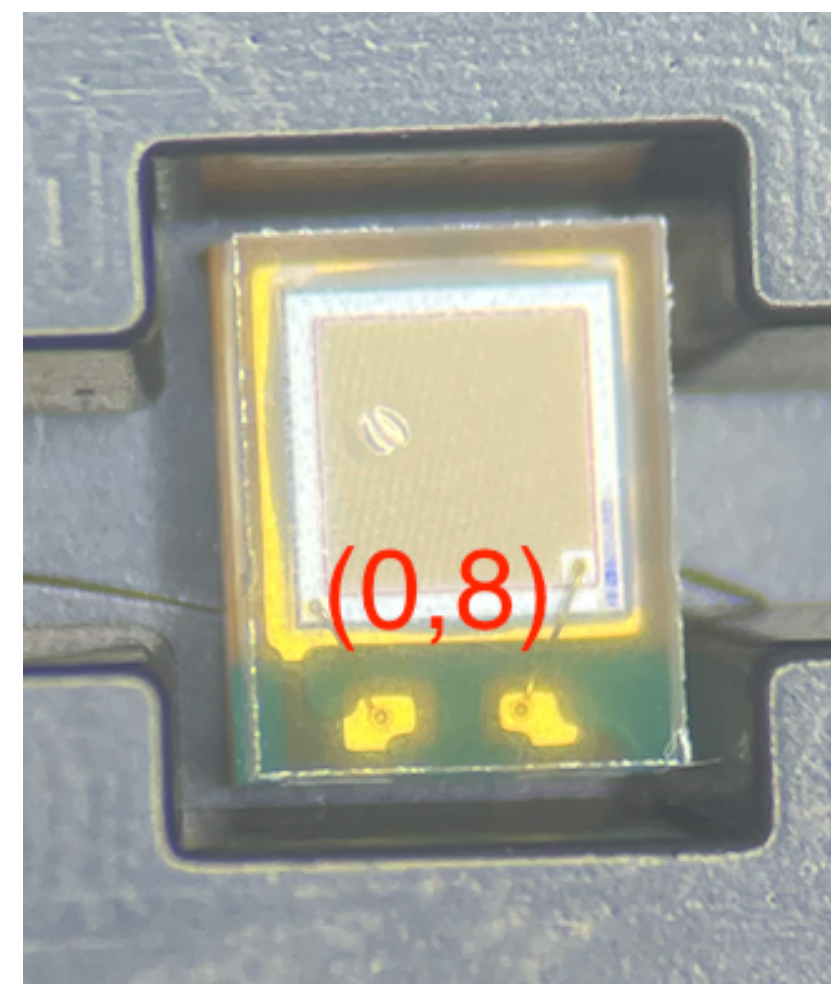
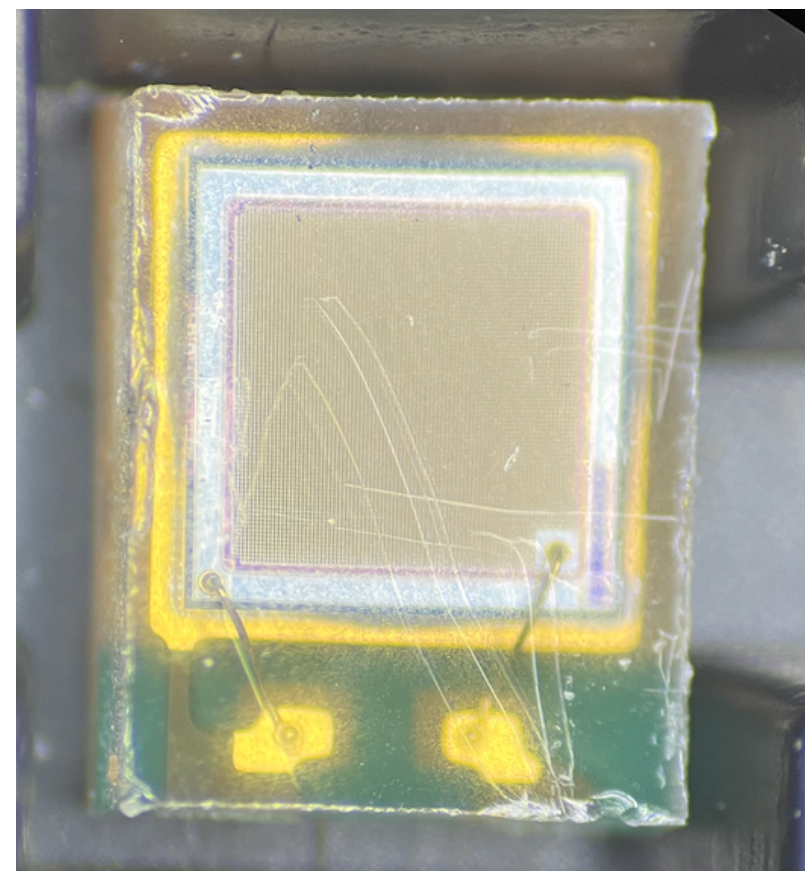
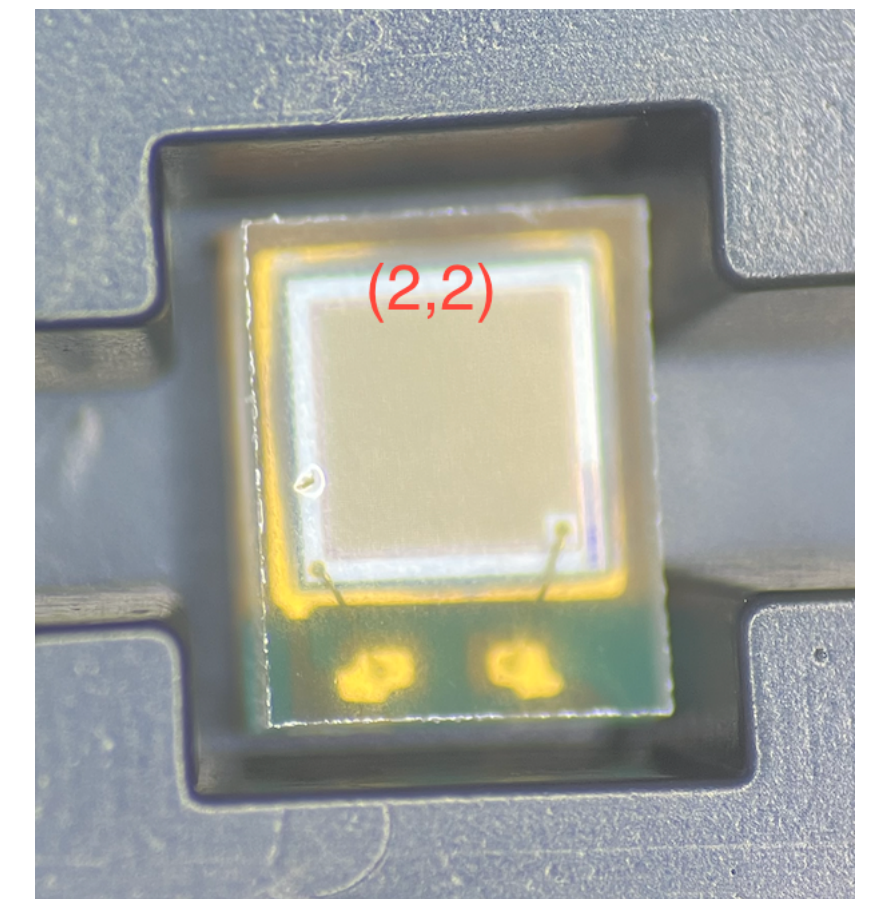
Surface Bubble



Obstructing Debris



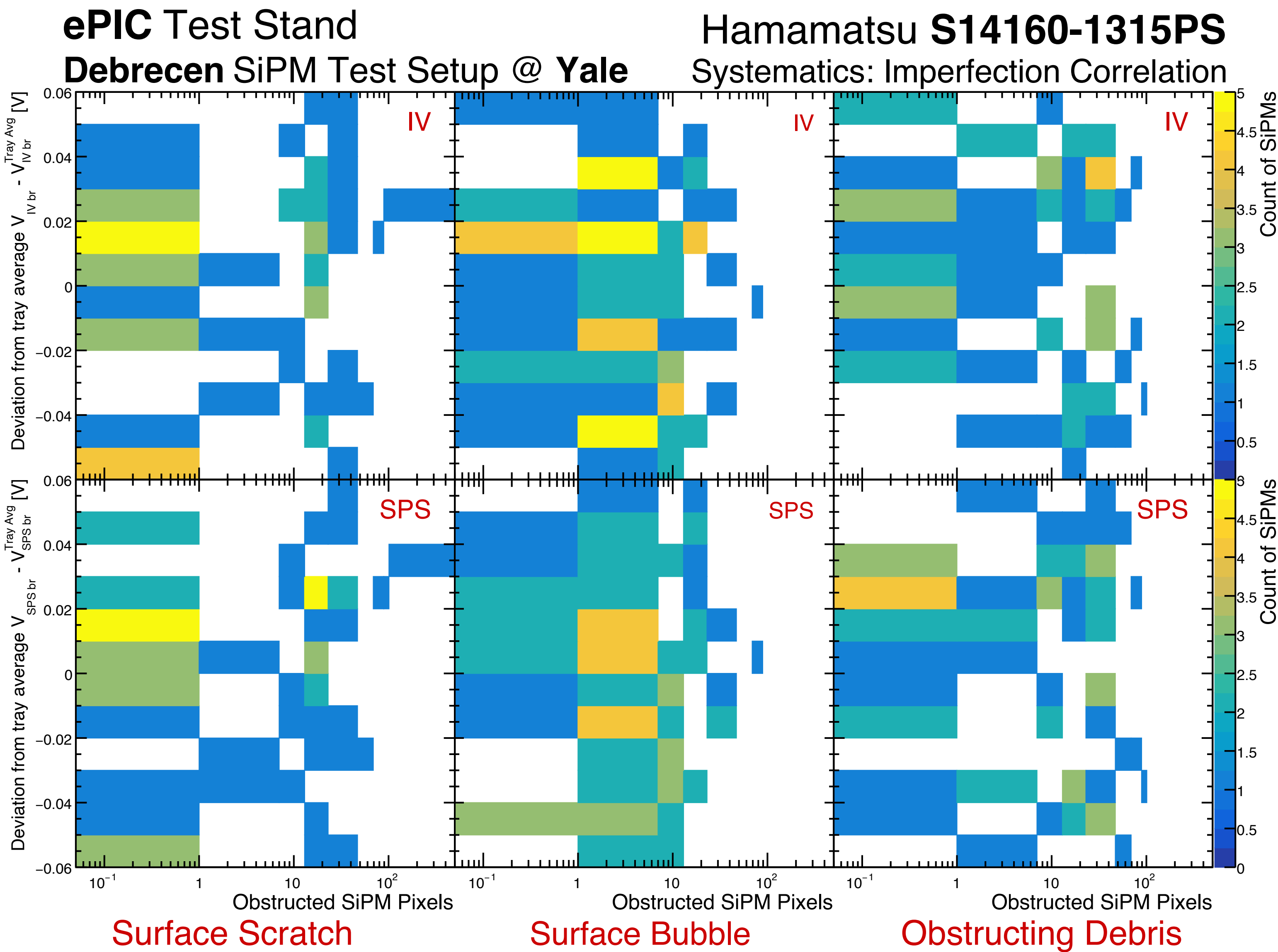
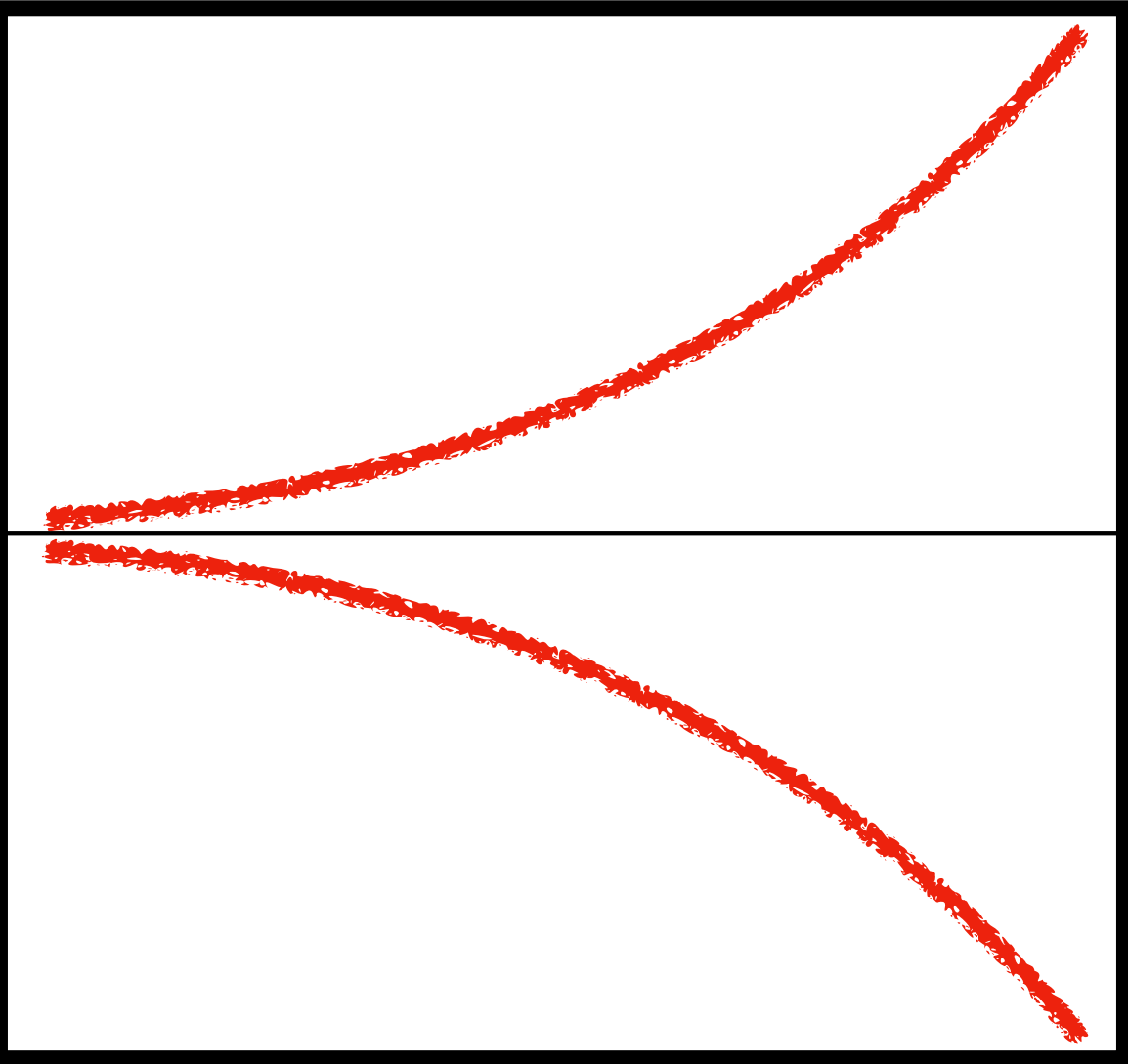
Control—Not On Pixels



Surface Imperfections

Last but Not Least

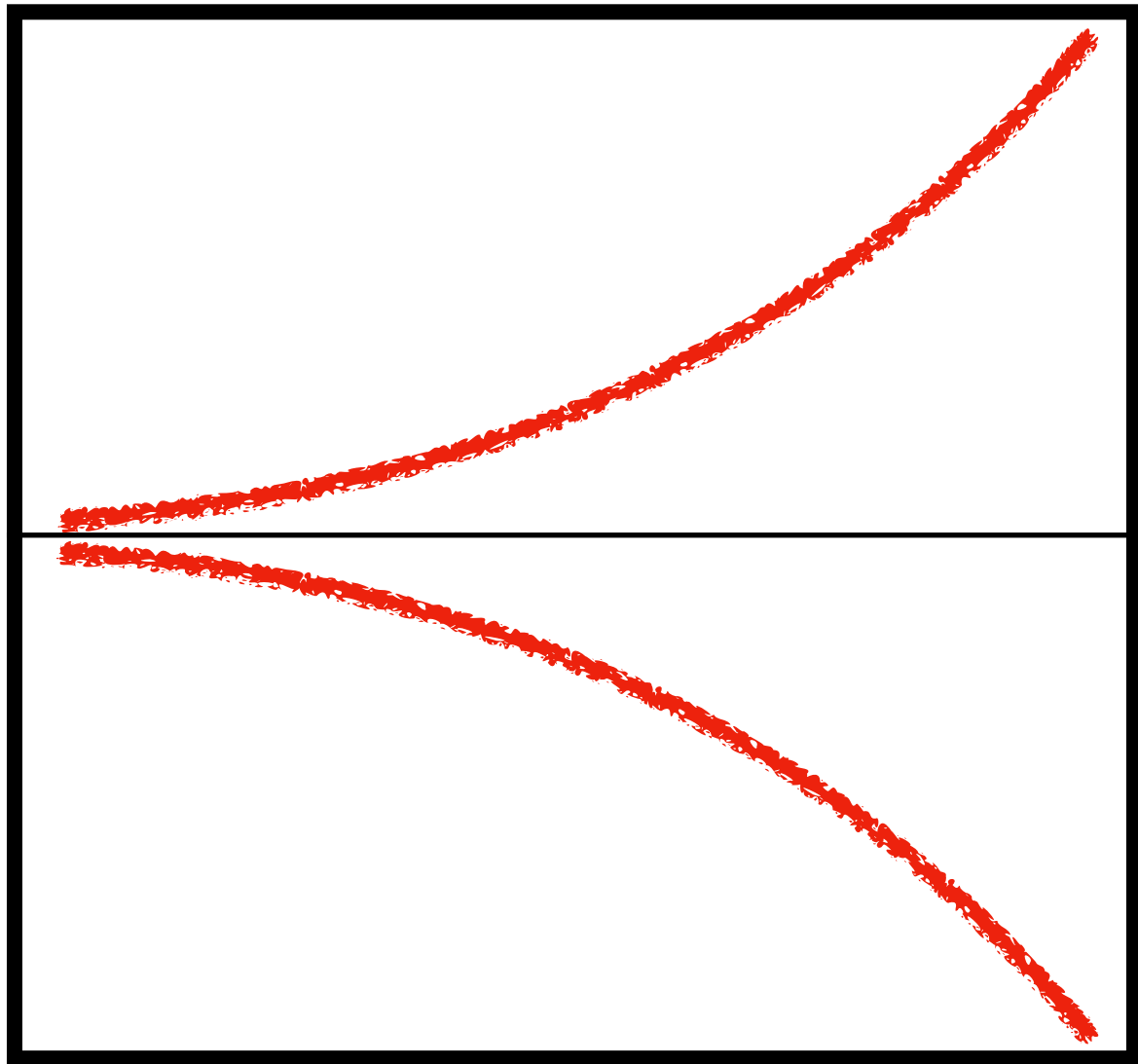
Expected Trend if Correlated:



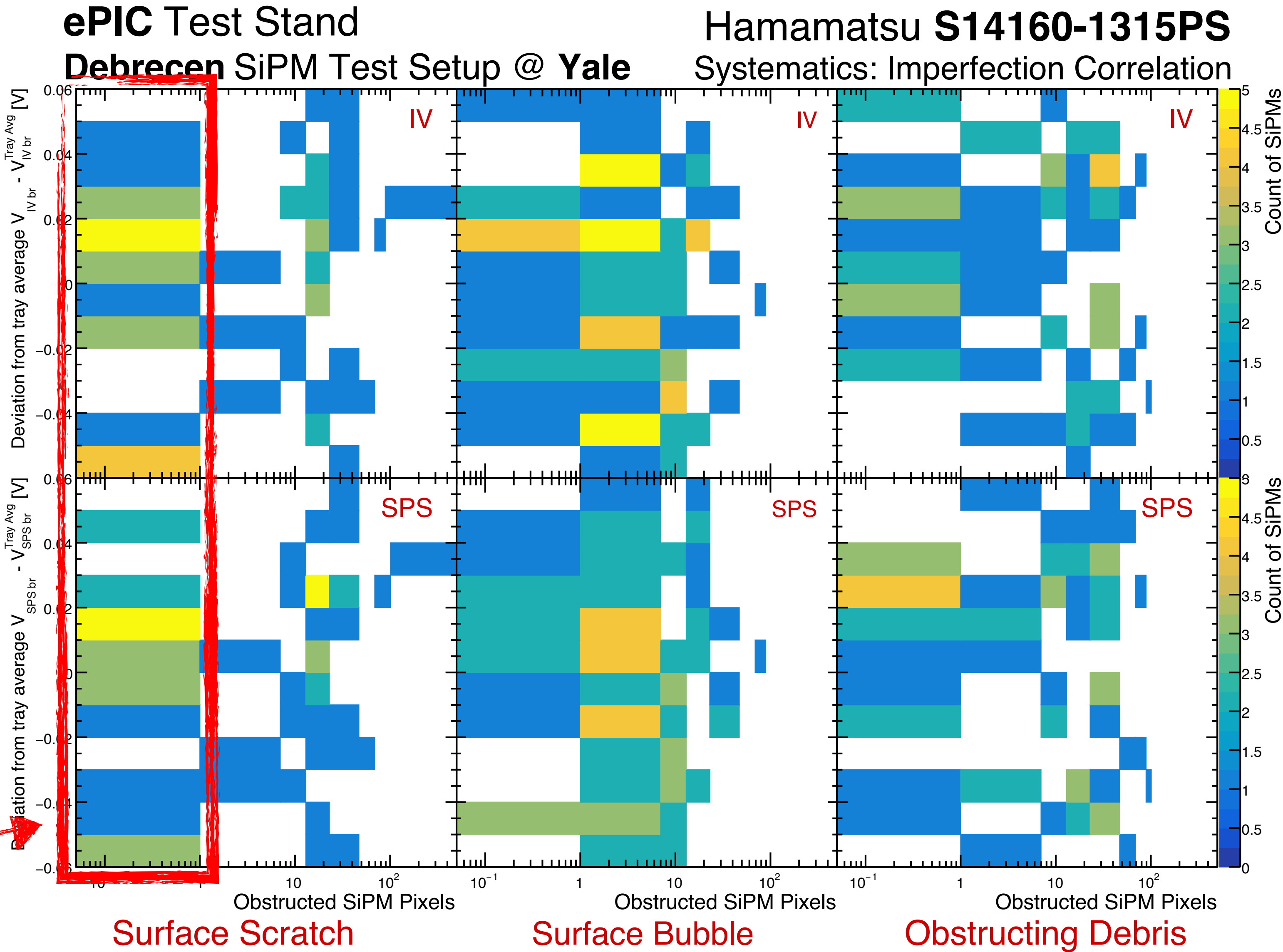
Surface Imperfections

Last but Not Least

Expected Trend if Correlated:



Control group: Defect is far from SiPM pixels



Surface Imperfections

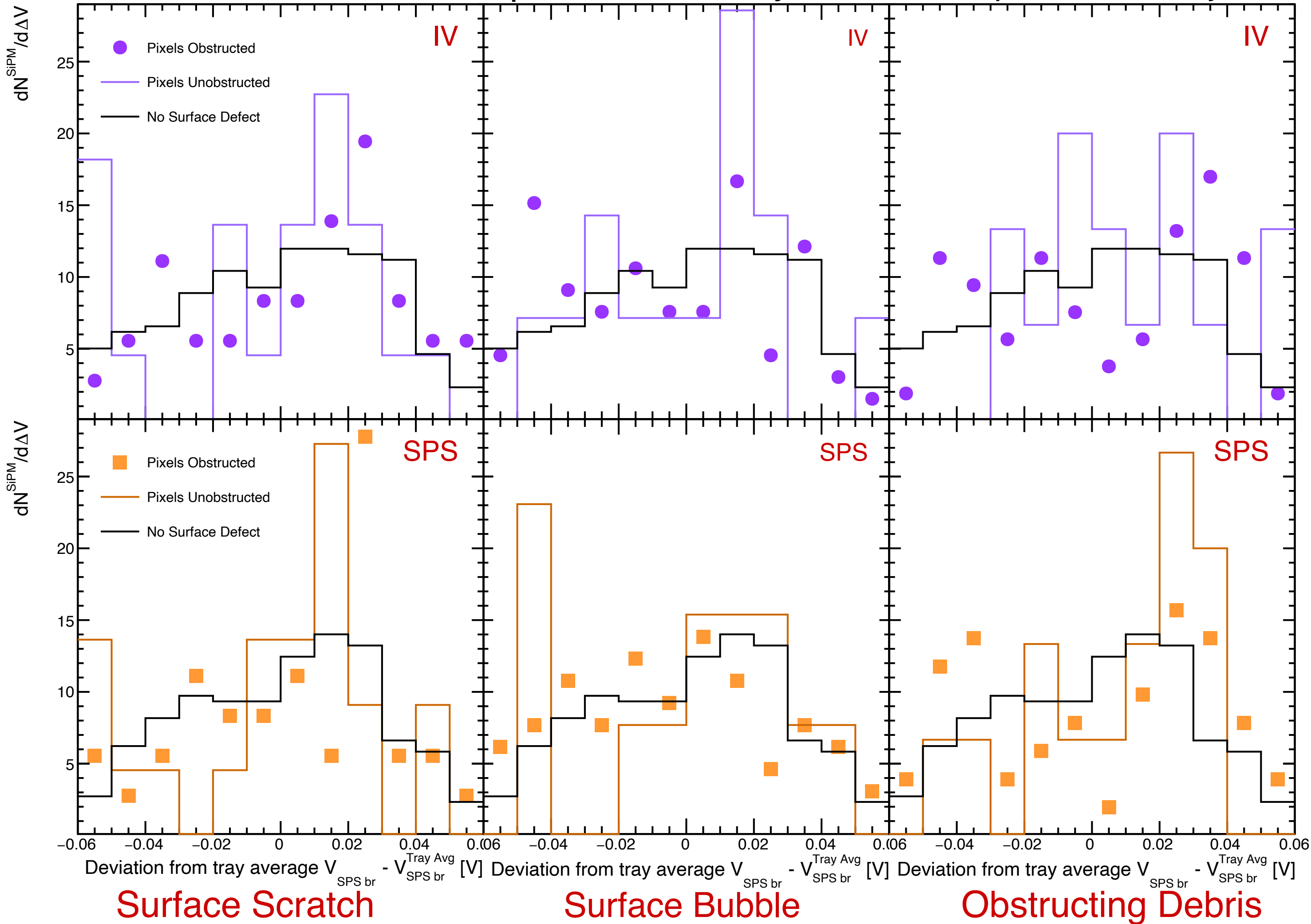
Projecting onto y-axis

ePIC Test Stand
Debrecen SiPM Test Setup @ Yale

Hamamatsu S14160-1315PS
Systematics: Imperfection Projection

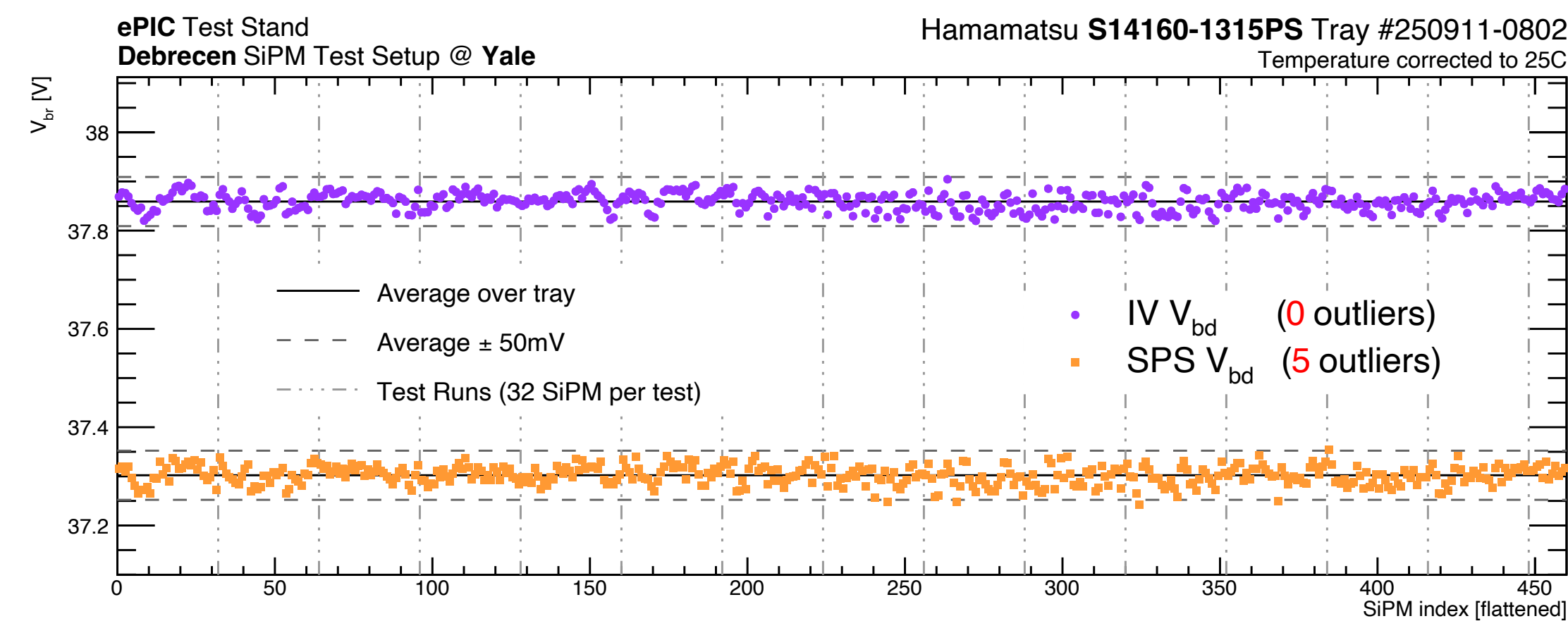
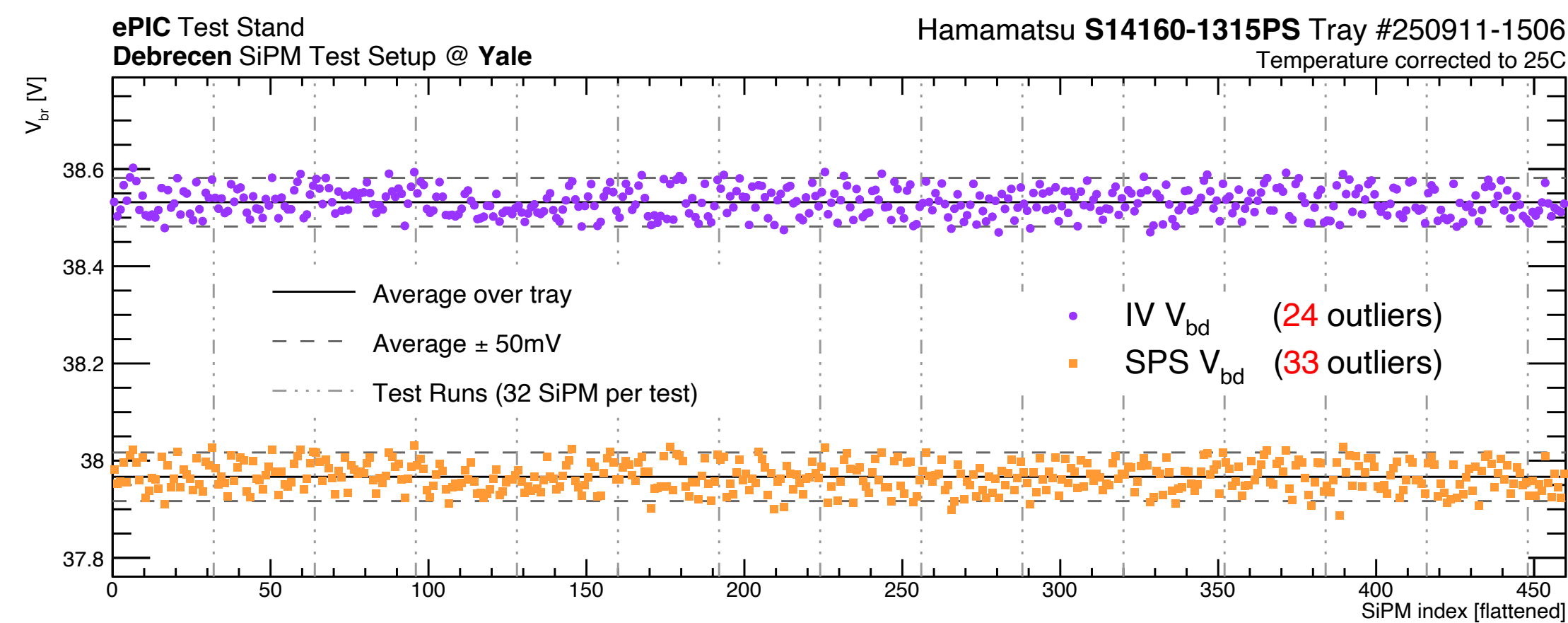
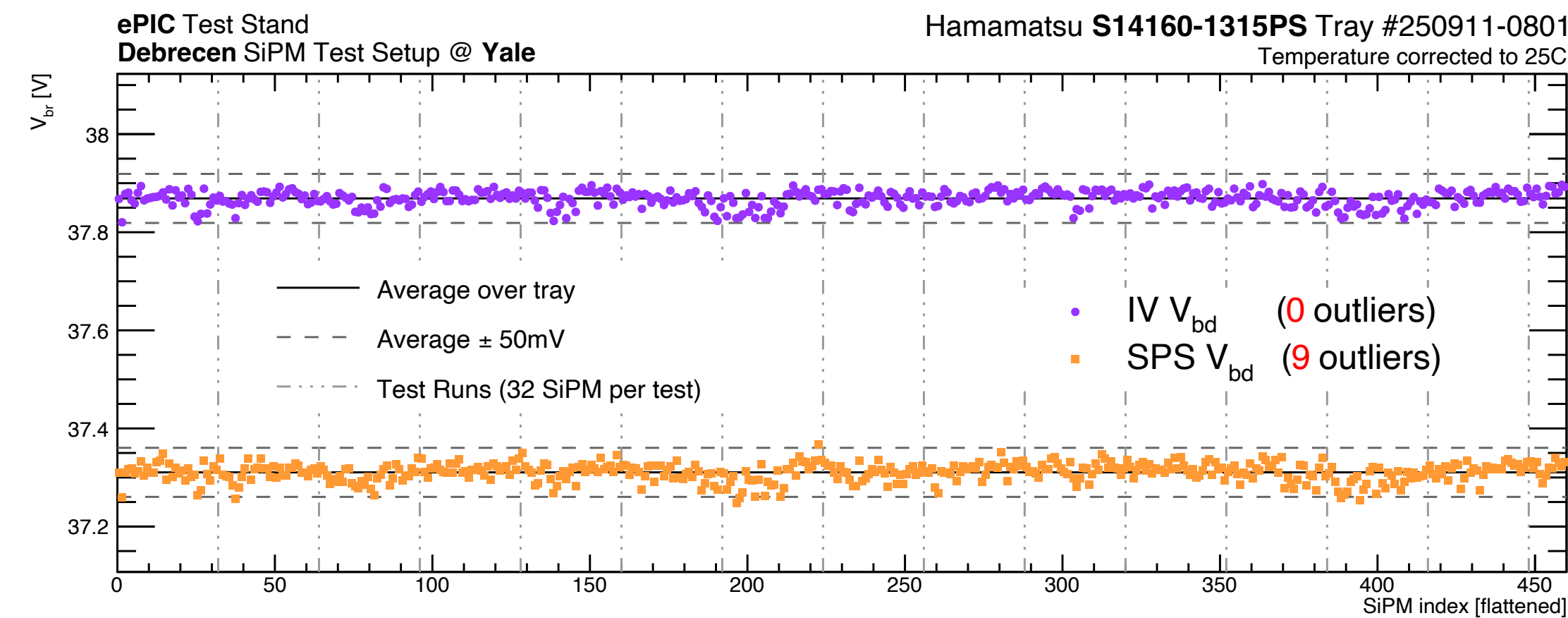
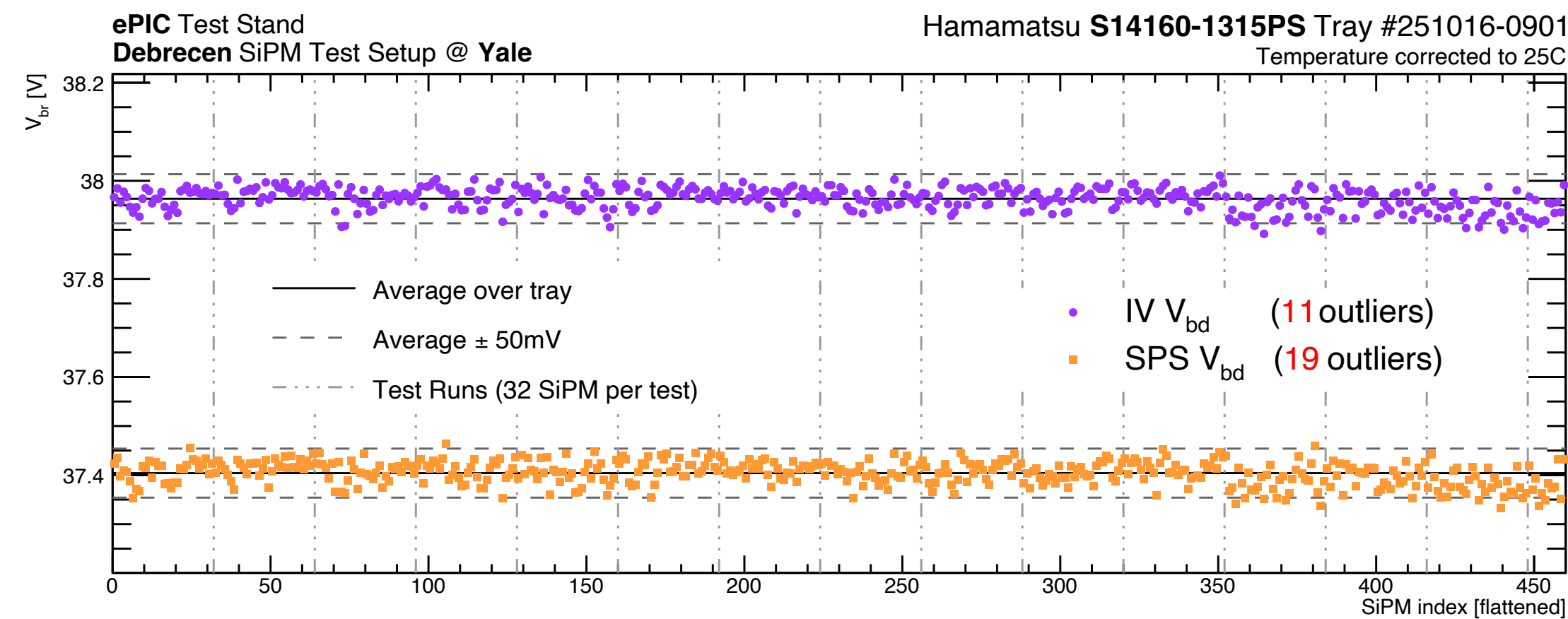
No clear evidence for a correlation
between surface defects and
measured breakdown voltage...

more data may help resolve this
with more clarity/statistics
(only have data from ORNL trays
here so far)



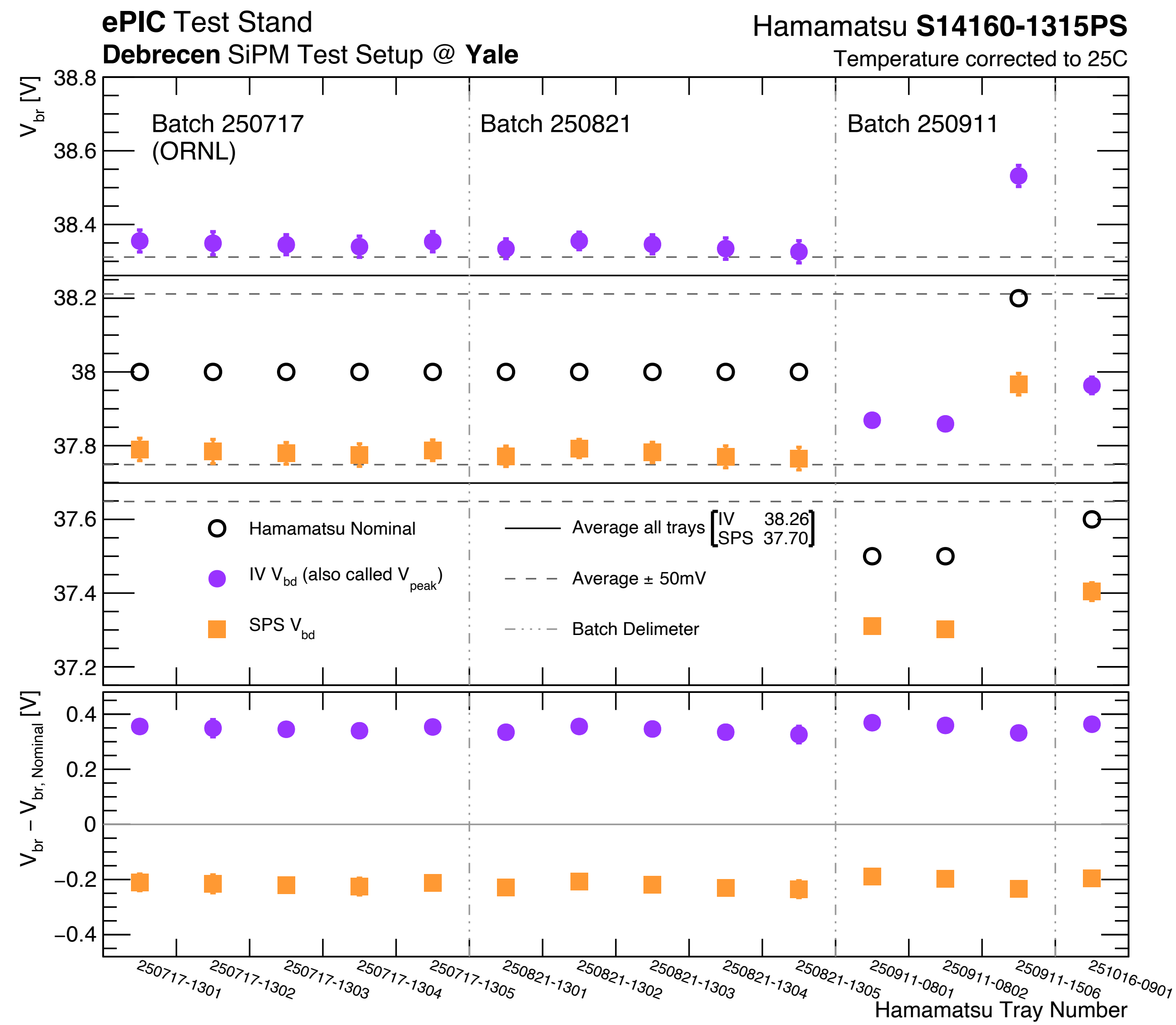
All Measurements So Far

4 Trays done over Holidays—Thanks Prakhar!



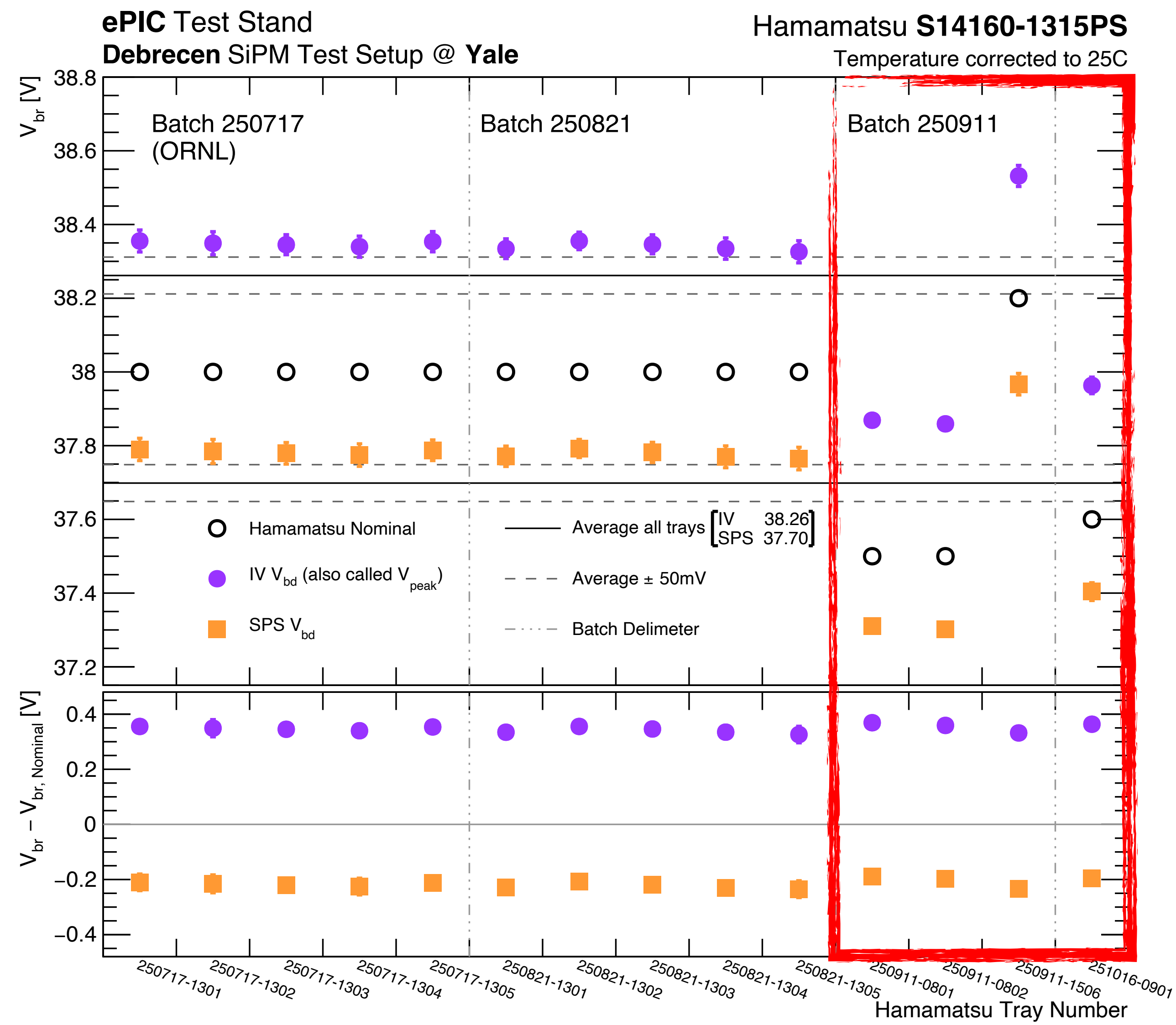
All Measurements So Far

Taking Stock



All Measurements So Far

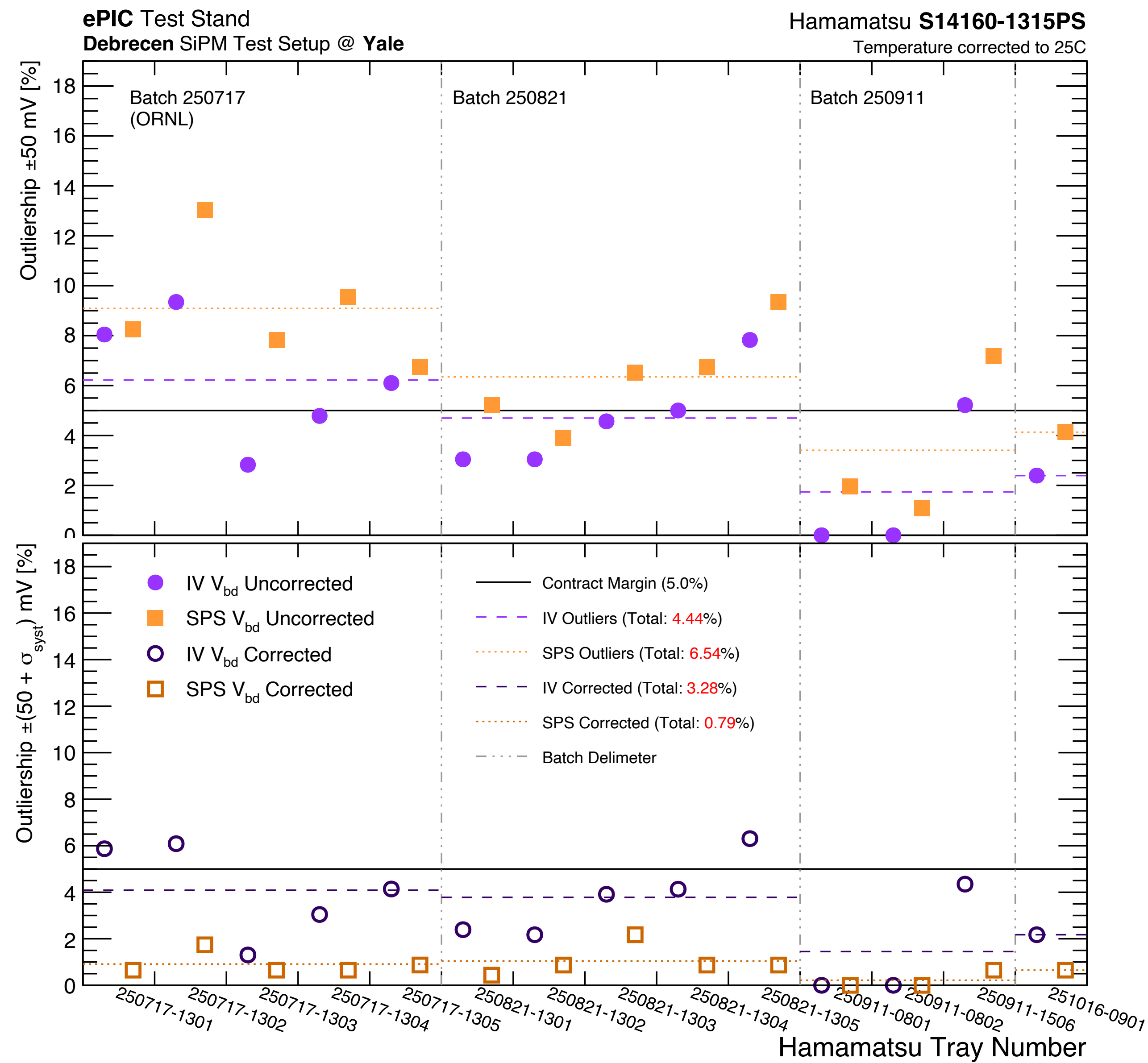
Taking Stock



New trays have varied widely in operating voltage baseline

All Measurements So Far

Taking Stock

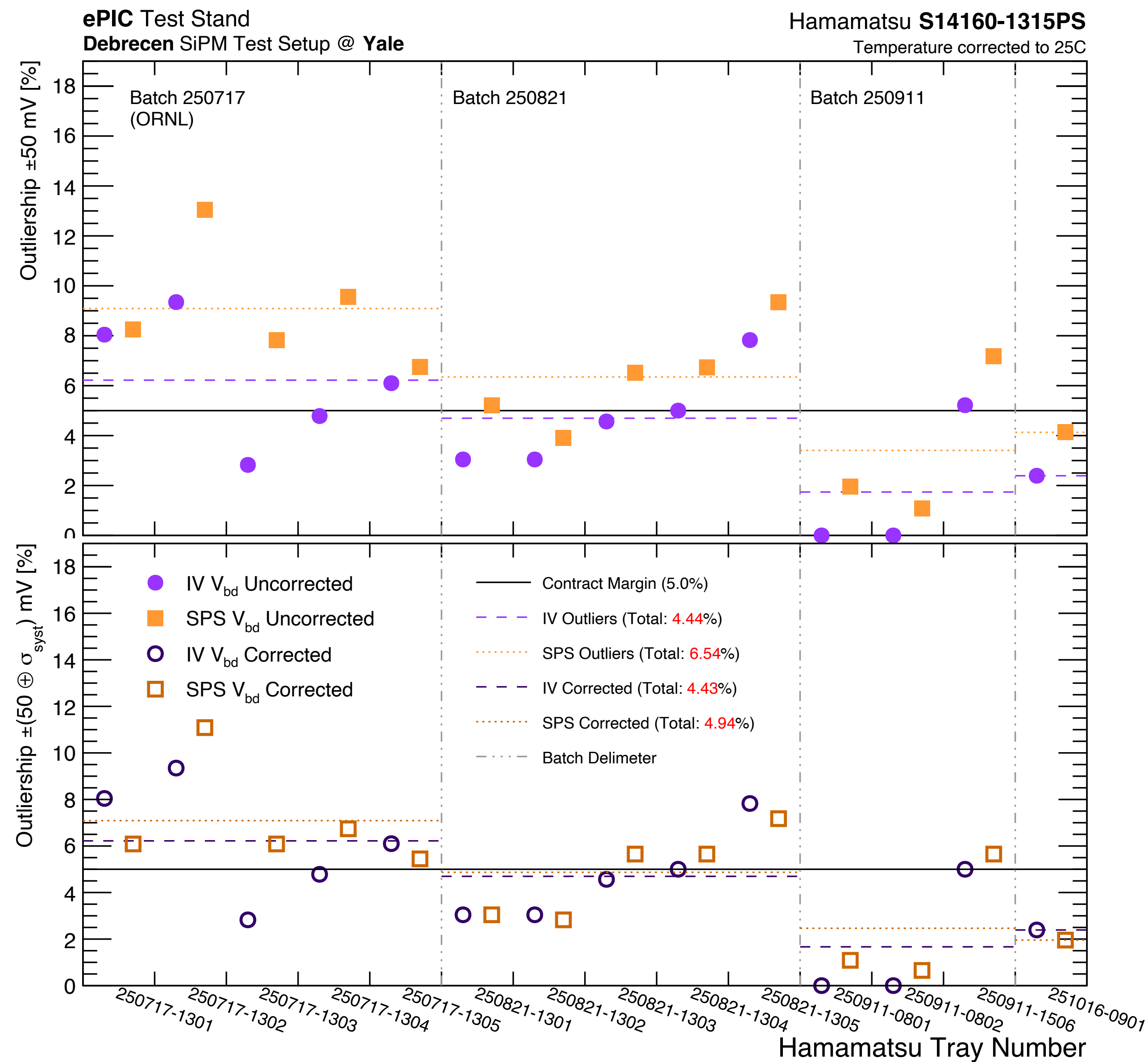


Outliers to +/- 50 mV

Outliers to +/- (50 + syst error) mV
Direct sum of error

All Measurements So Far

Taking Stock



Outliers to +/- 50 mV

Outliers to +/- (50 + syst error) mV
Quadrature sum of error

Aligns IV, SPS well!
True number of outliers?