LFHCal SiPM QC

Yale Update

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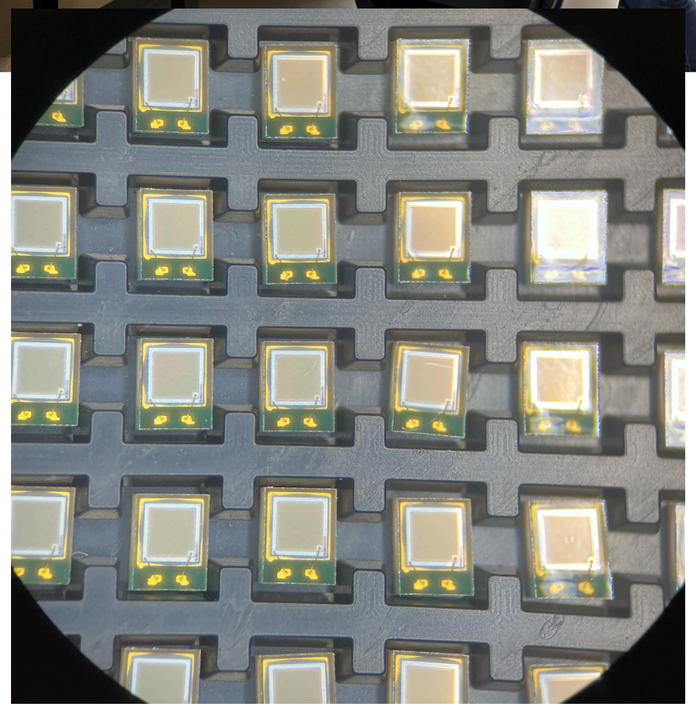
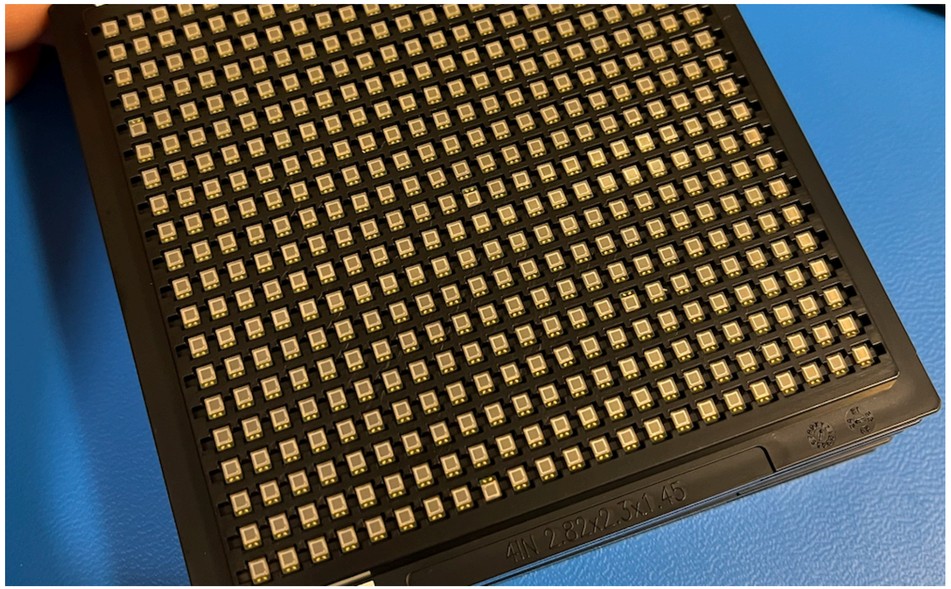
Undergrads	Elisa Kim, Langan Zhu



Comparison SiPMs Received!

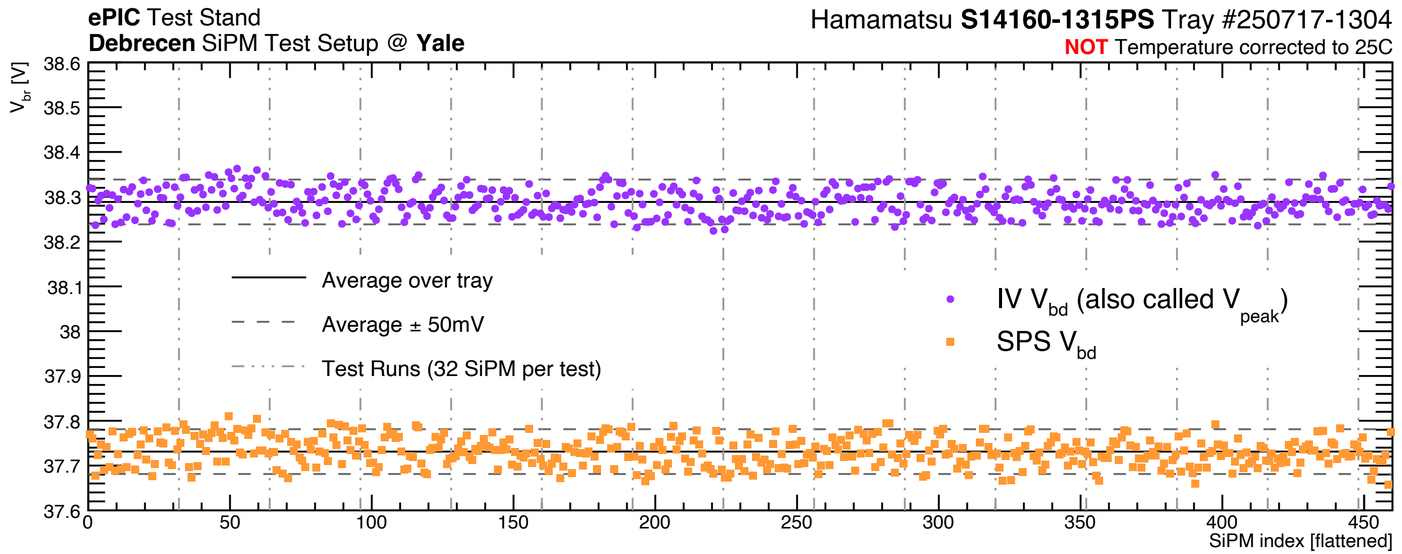
No apparent damage from shipping,
or SiPMs dislodged/disordered

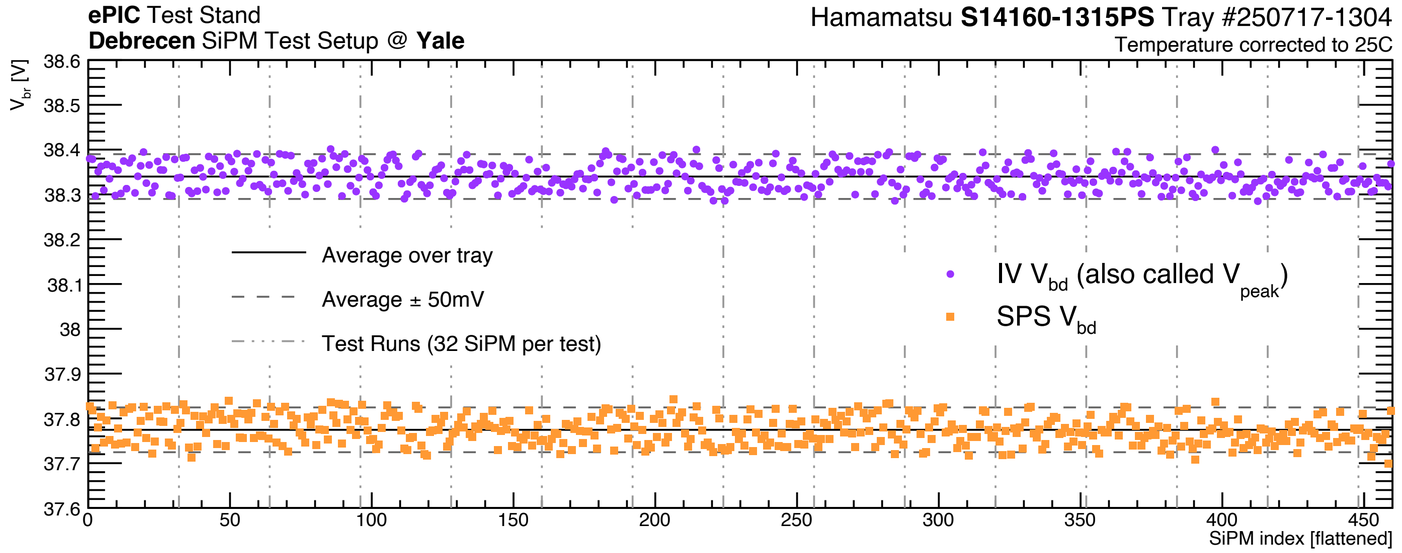
Maintaining order is key for
correlating measurements with ORNL!



One Tray Measured: 250717-1304

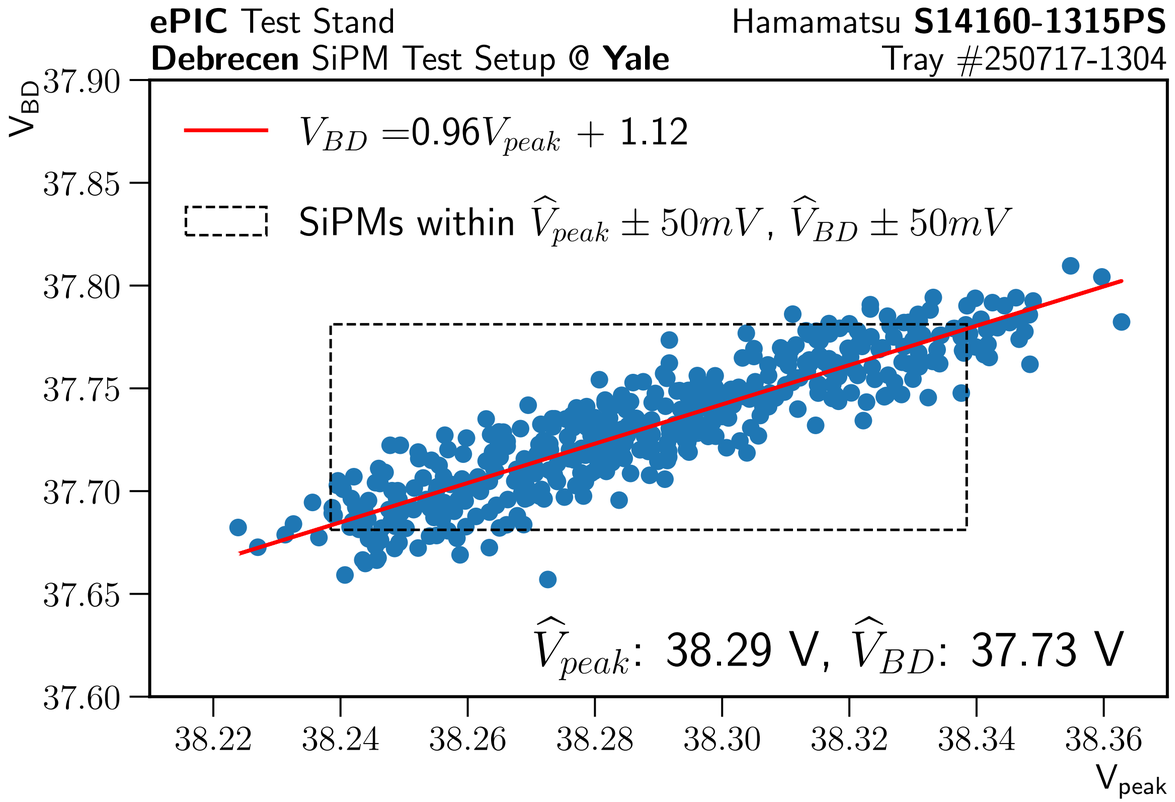
Large difference in outliers from temperature correction!



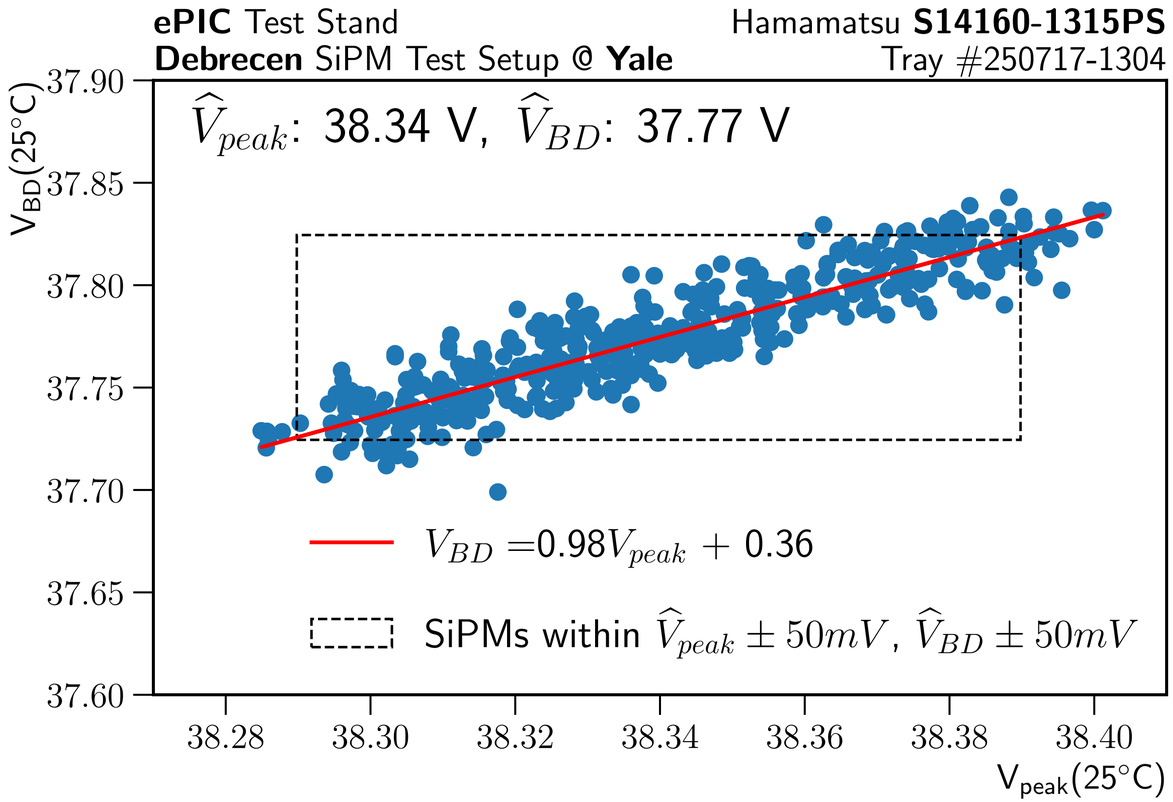


One Tray Measured: 250717-1304

Large difference in outliers from temperature correction!
(I would argue the difference is pretty small -Emily)



Using the 100mV window centered around the mean,
the "outlier" SiPMs fall outside that window
V_{peak} outliers (IV): 29 (6.3%)
V_{BD} outliers (SPS): 48 (10.4%)



Using the 100mV window centered around the mean,
the "outlier" SiPMs fall outside that window
V_{peak} outliers (IV): 22 (4.8%)
V_{BD} outliers (SPS): 44 (9.6%)

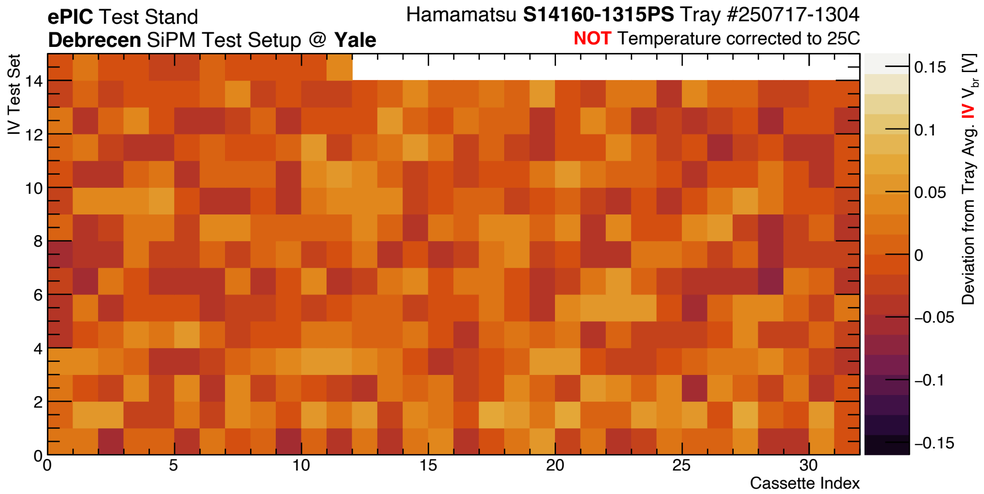
One Tray Measured: 250717-1304

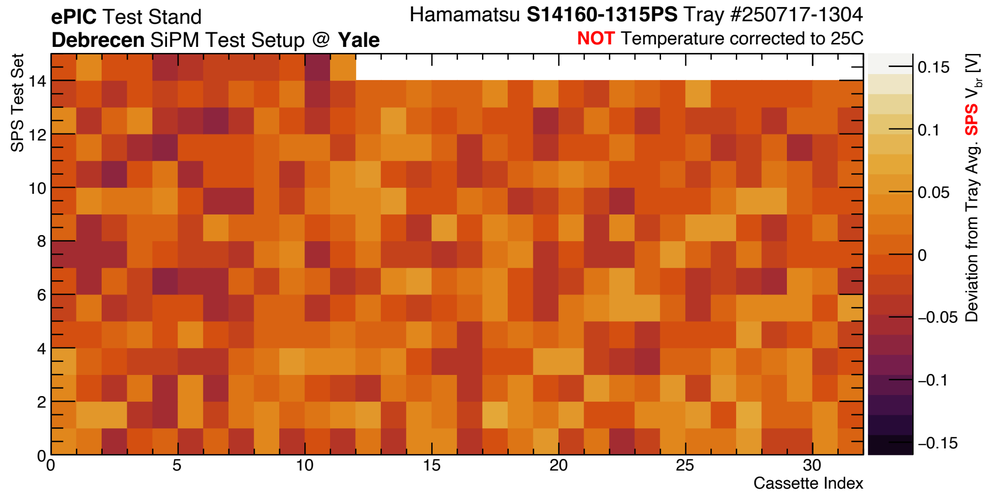
Large difference in outliers from temperature correction!

IV

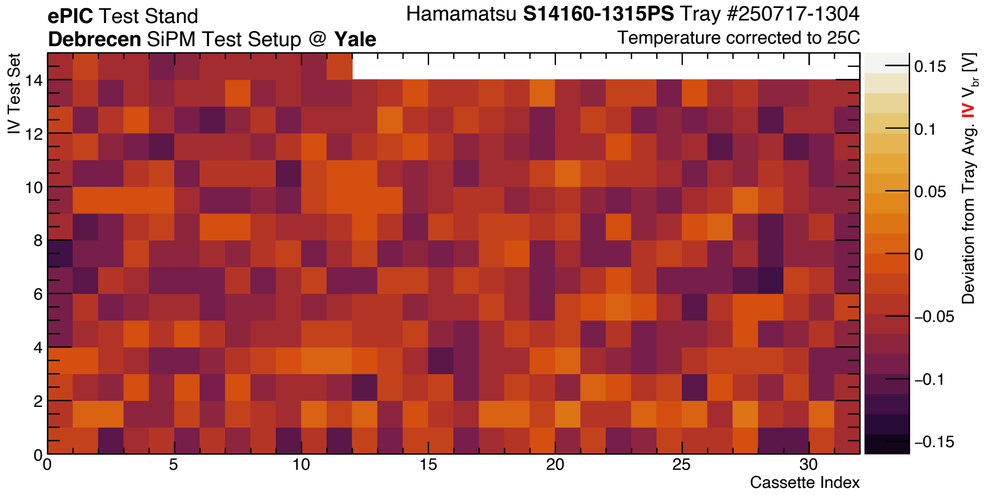
SPS

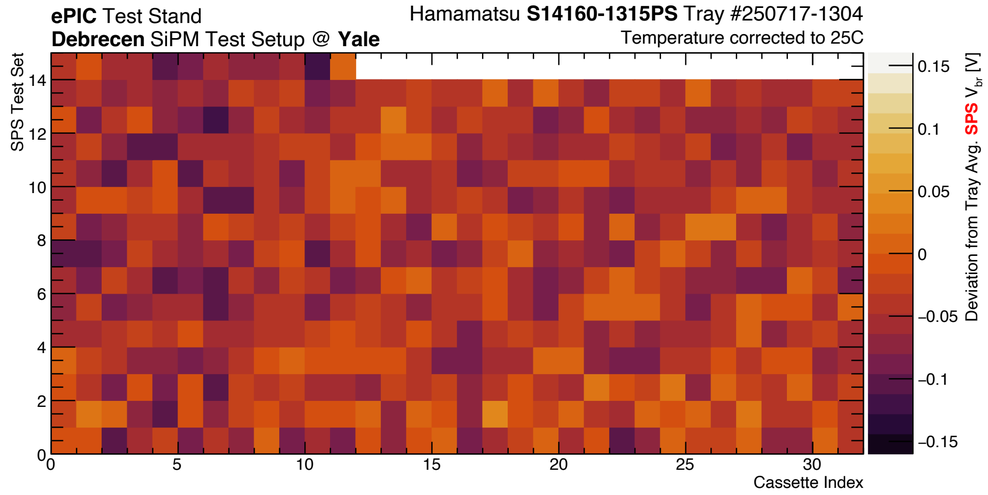
NOT Temp. Corrected





Temp. Corrected





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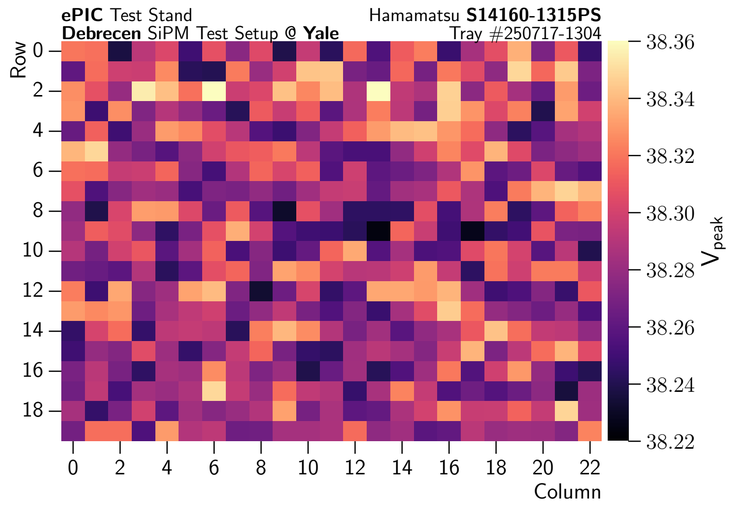
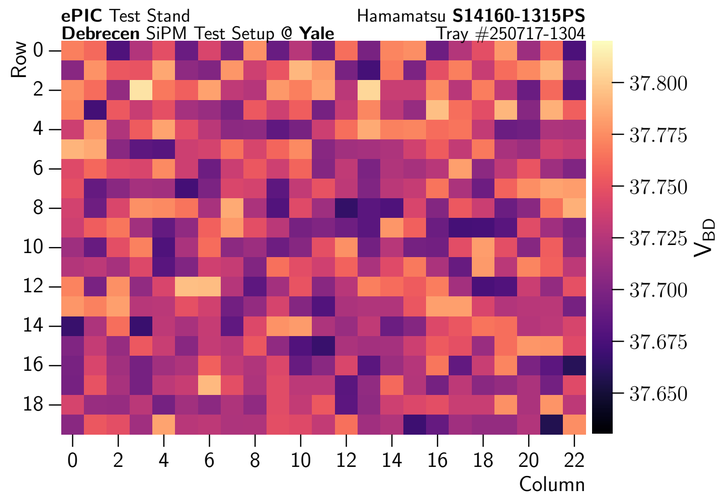
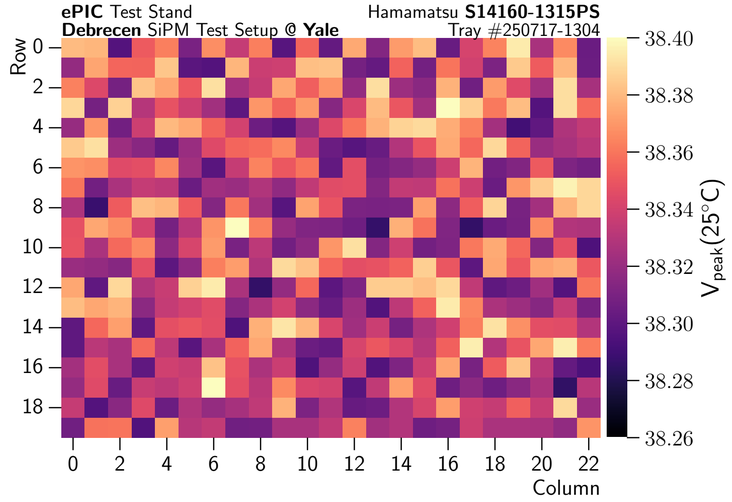
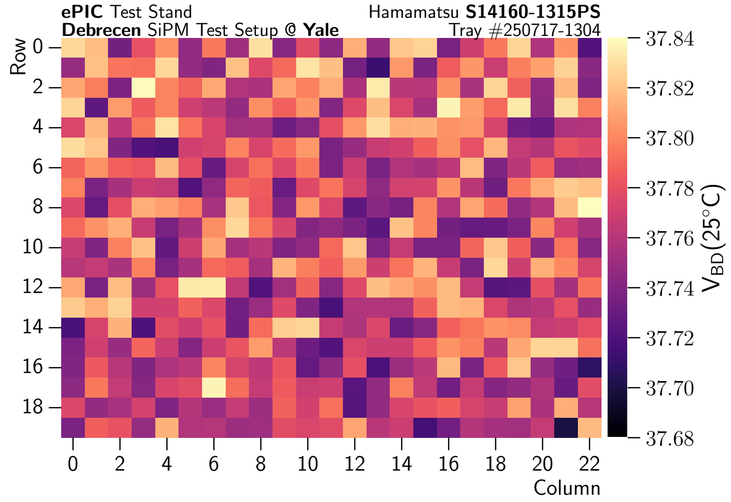




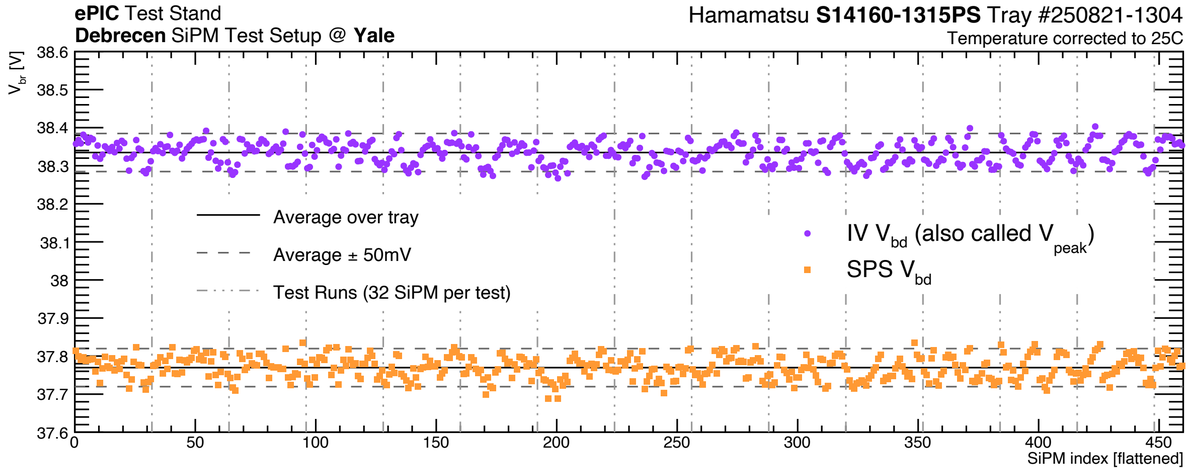
Temp. Corrected



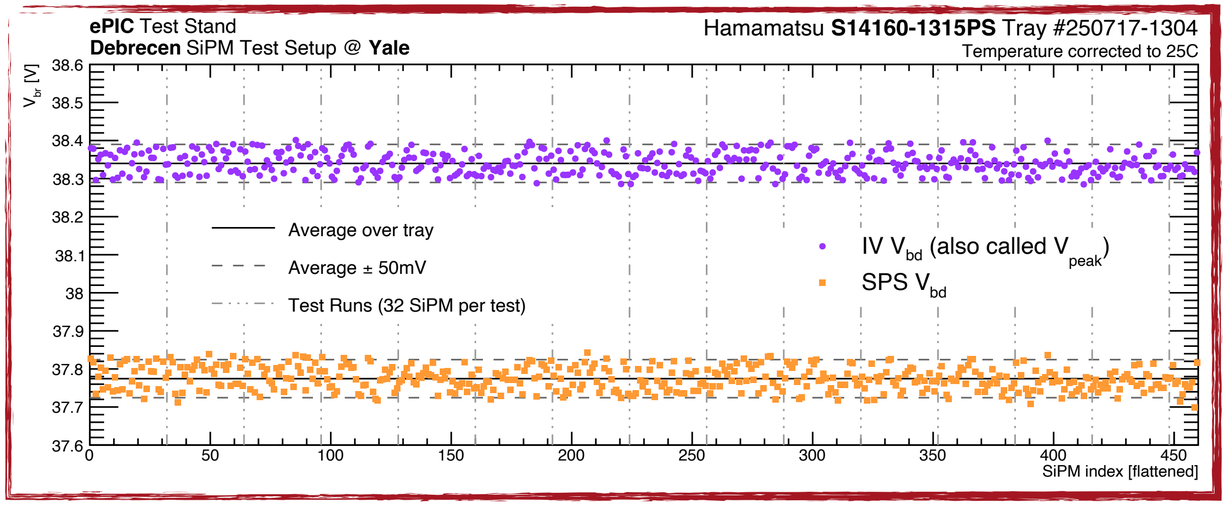


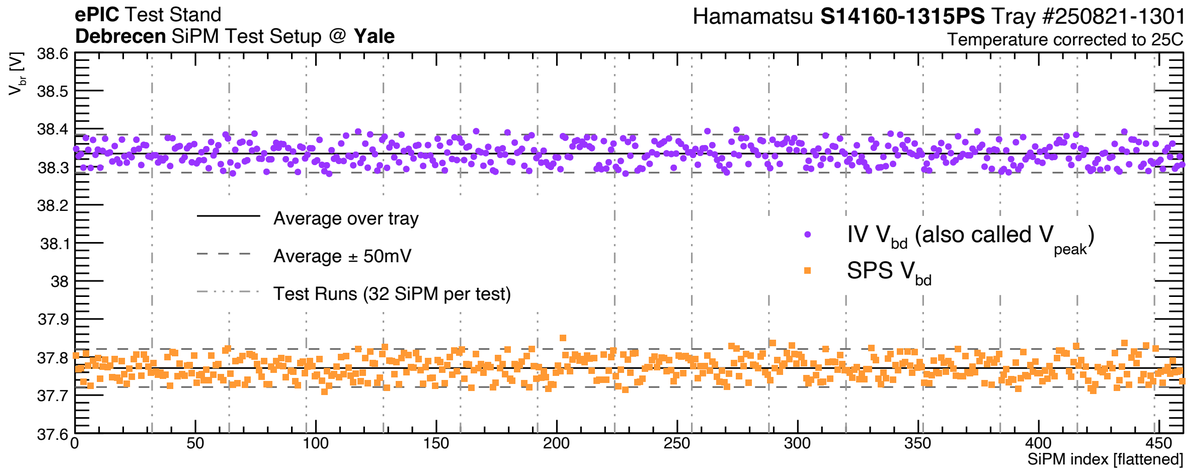
Tray Comparison

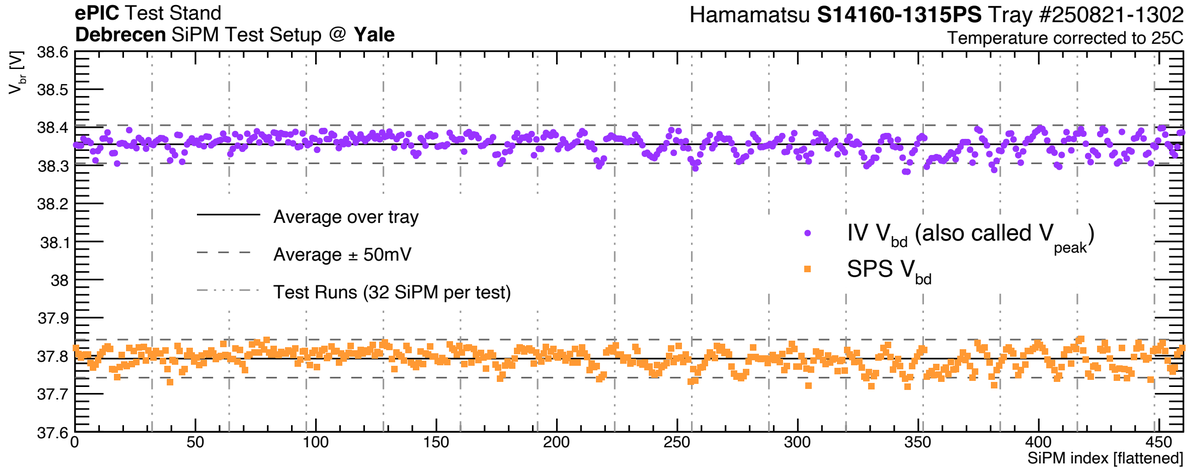
SiPMs seem generally comparable in behavior

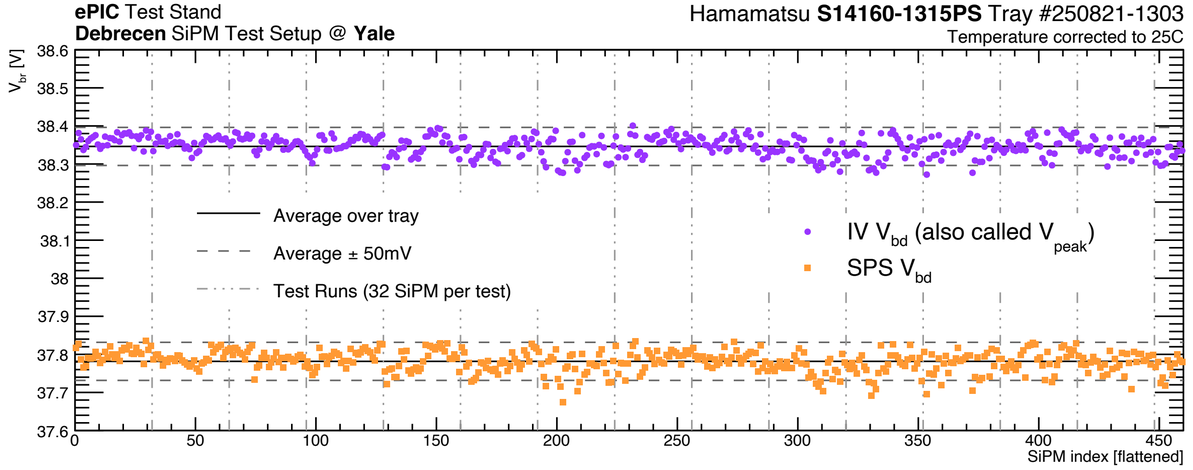


New Tray 250717-1304









Tray Comparison

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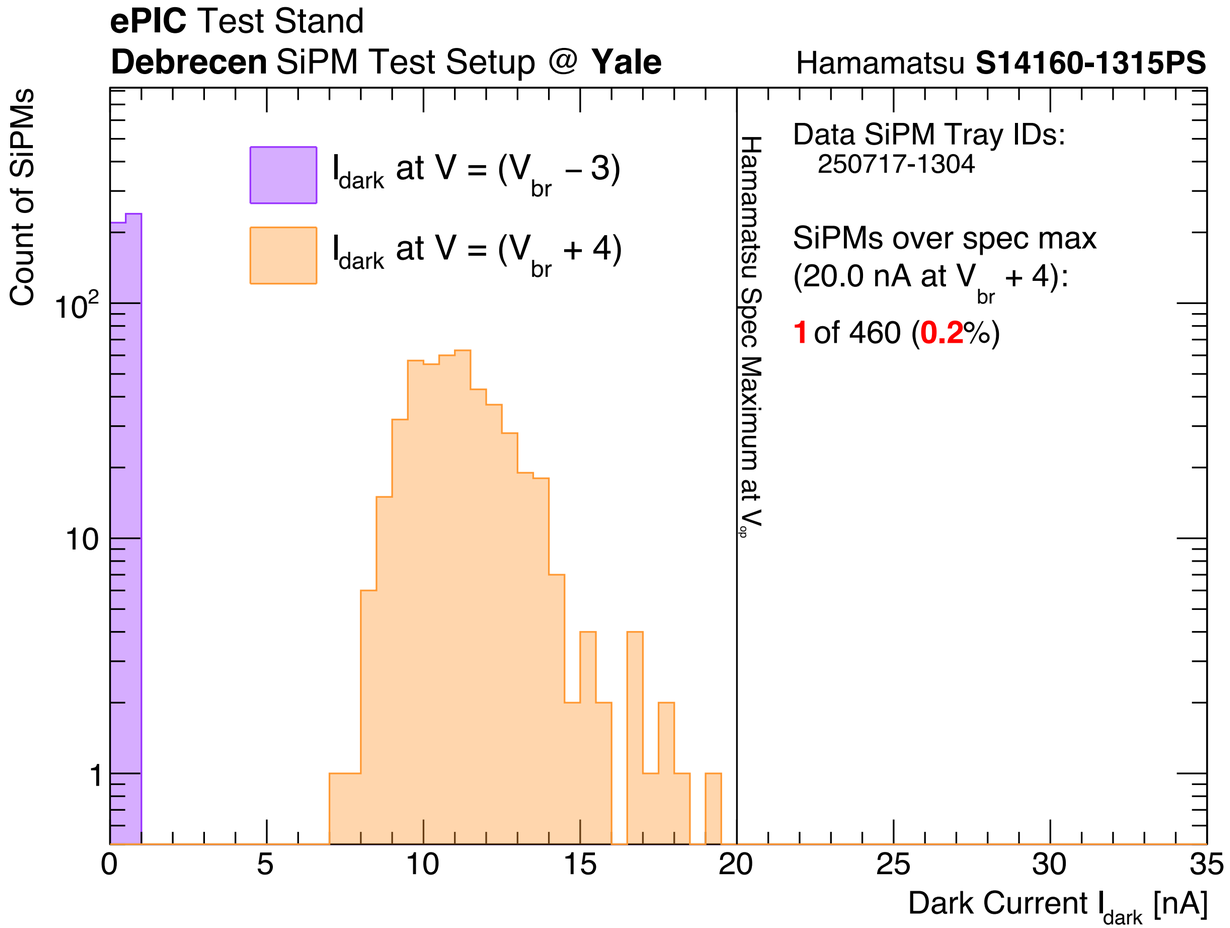
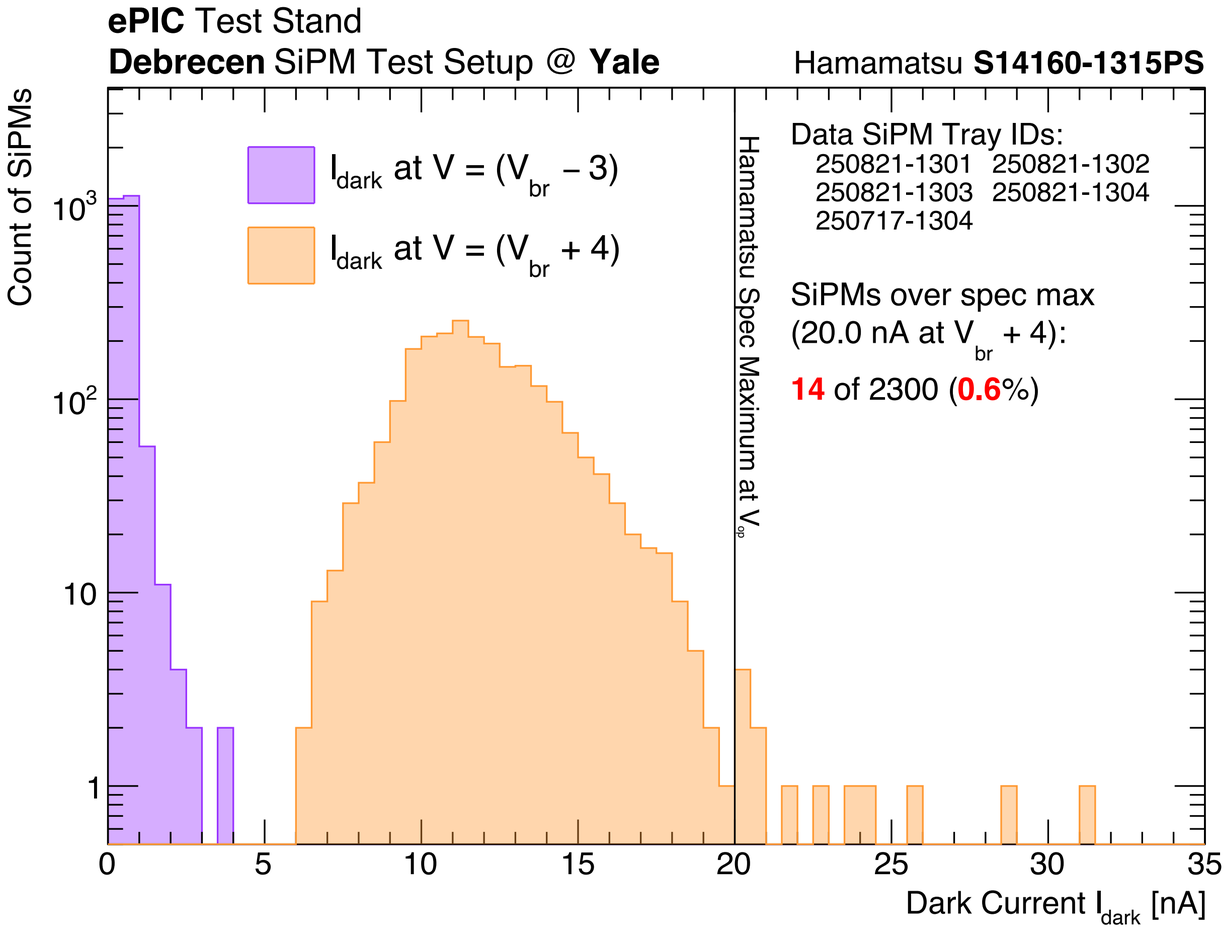
New Tray 250717-1304

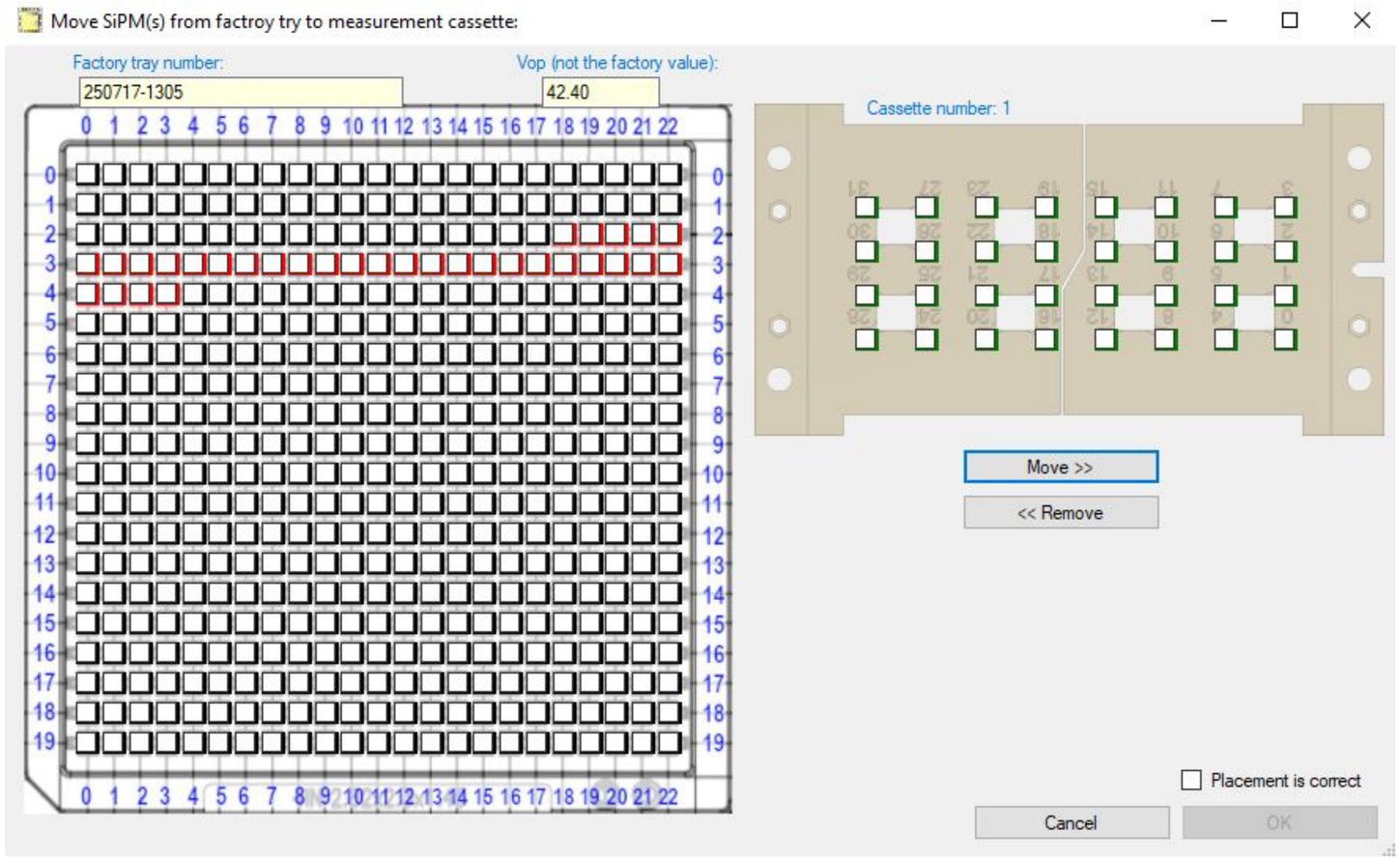


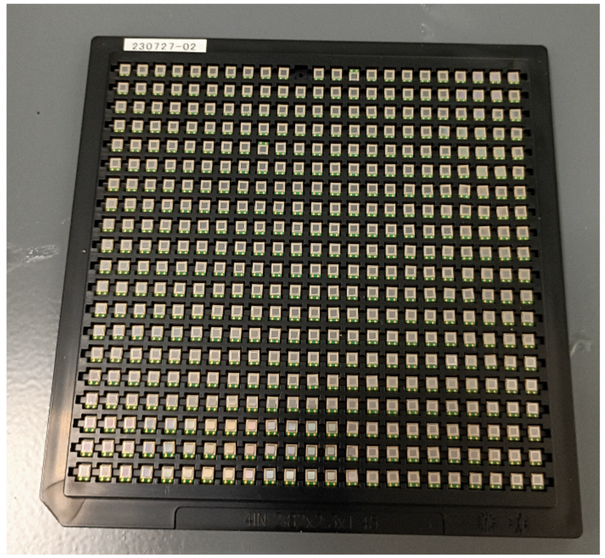
All Tray Data

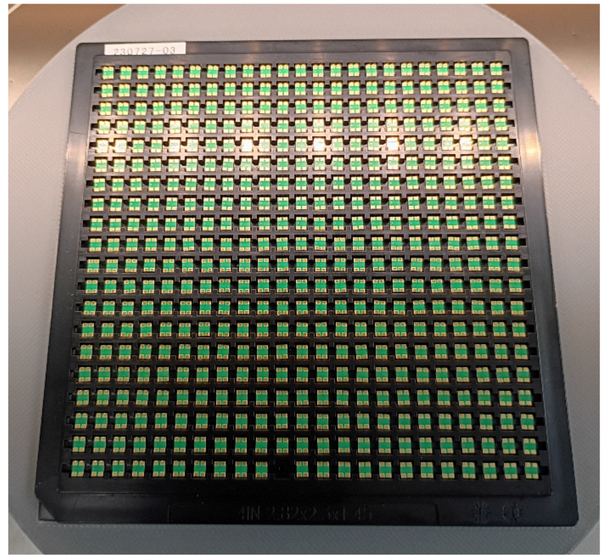


Next Step: Correlating with ORNL

Do we see the same outliers?

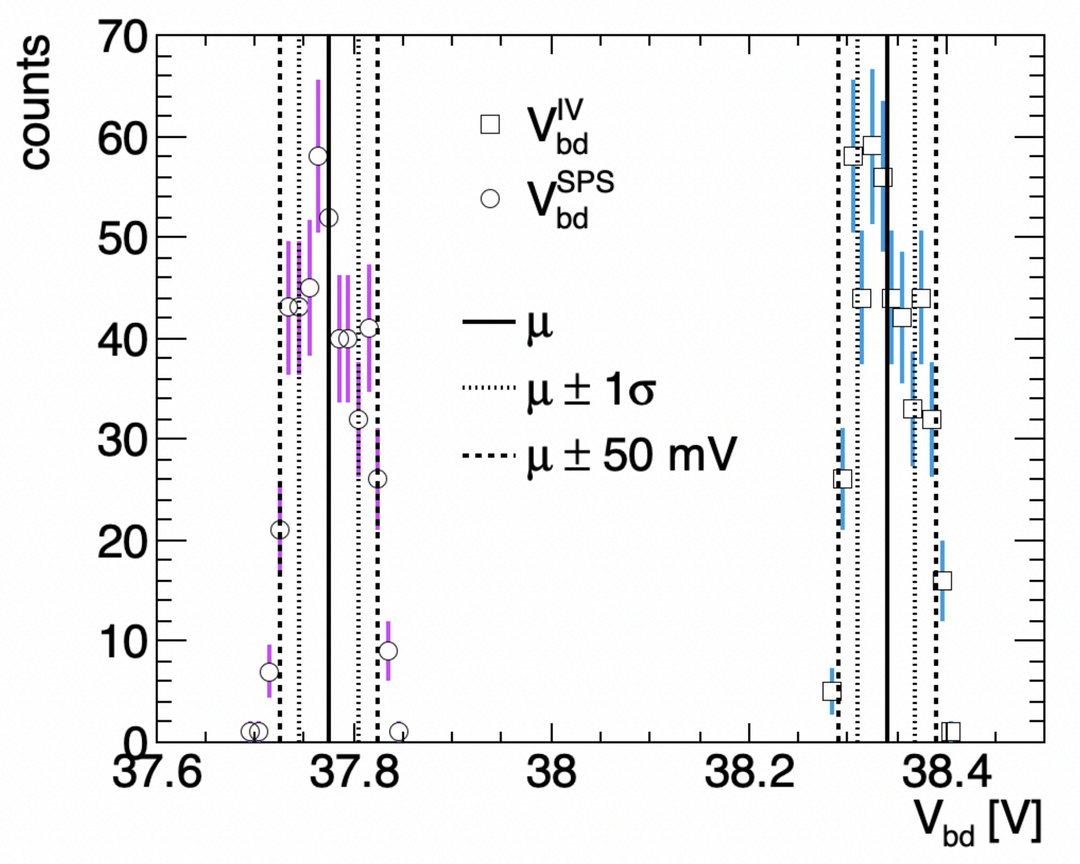






Breakdown voltage distribution

(Temperature-corrected, 250717-1304)



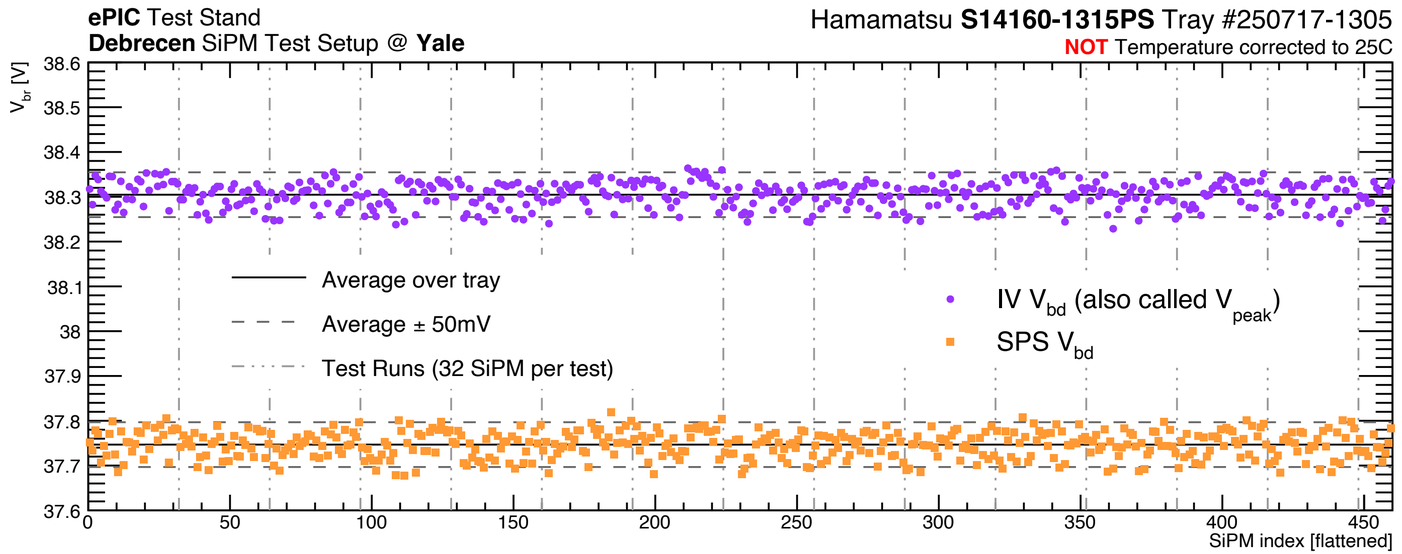
Technically, 10.8% and 11.9% outliers for the two methods, respectively, after temperature correction.
[Different from numbers quoted on s. 4 due to different method for calculation. Either way, by qualitative visual analysis, looks on par with what we have had for previous trays.]

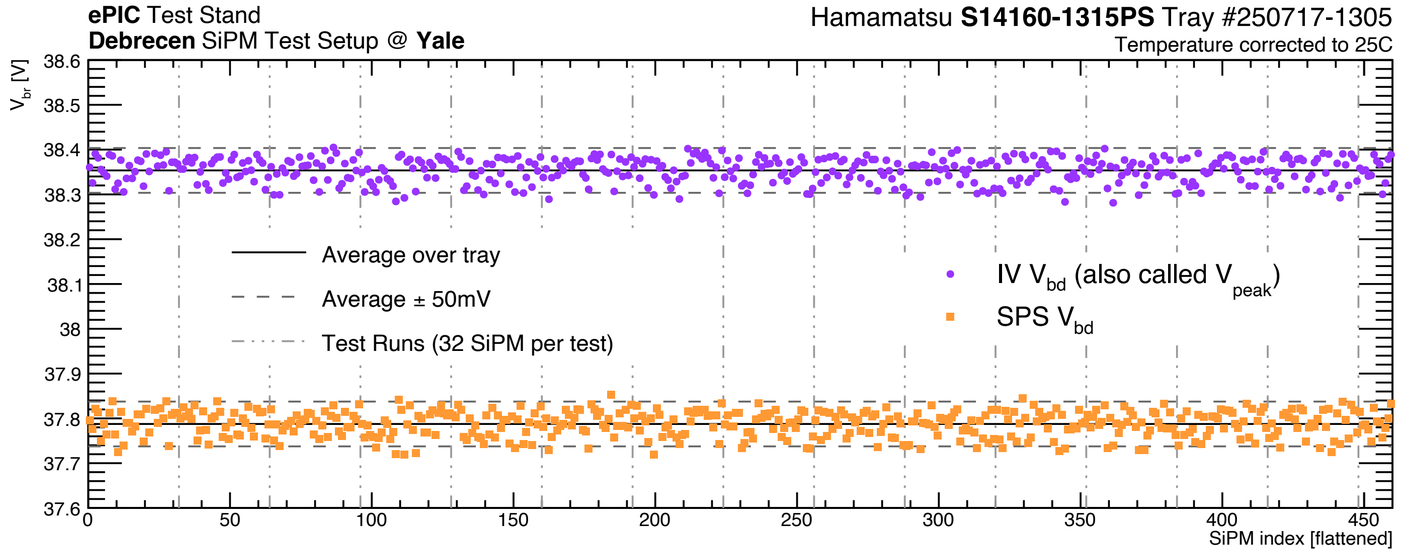
Wednesday 10/29

Another Tray Measured: 250717-1303

Comparable to 250717-1304:

- Some structured correlations with tray index but largely random

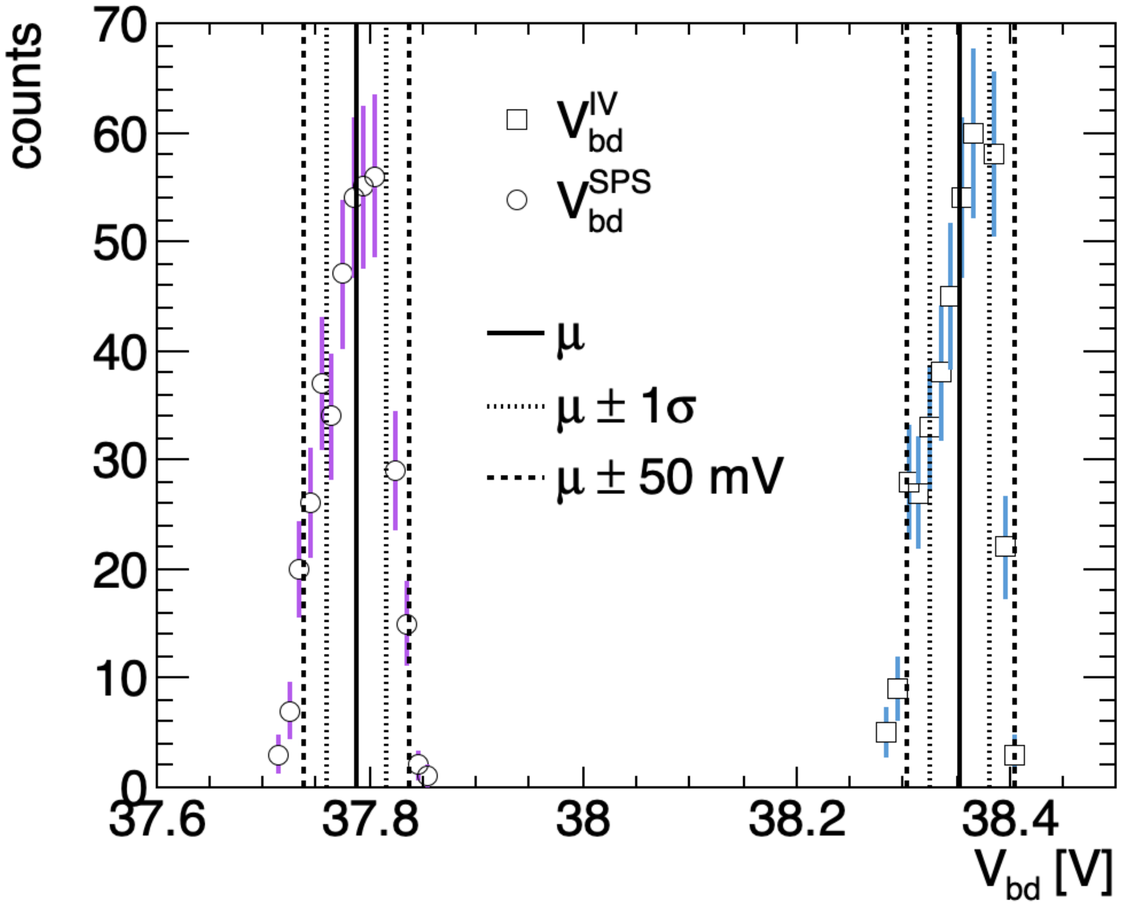




Another Tray Measured: 250717-1305

Comparable to 250717-1304:

- Some structured correlations with tray index but largely random
- Fewer outliers in the new tray
- On the same order (~5%) as batch 250821, with most of these close to +/- 50 mV boundary



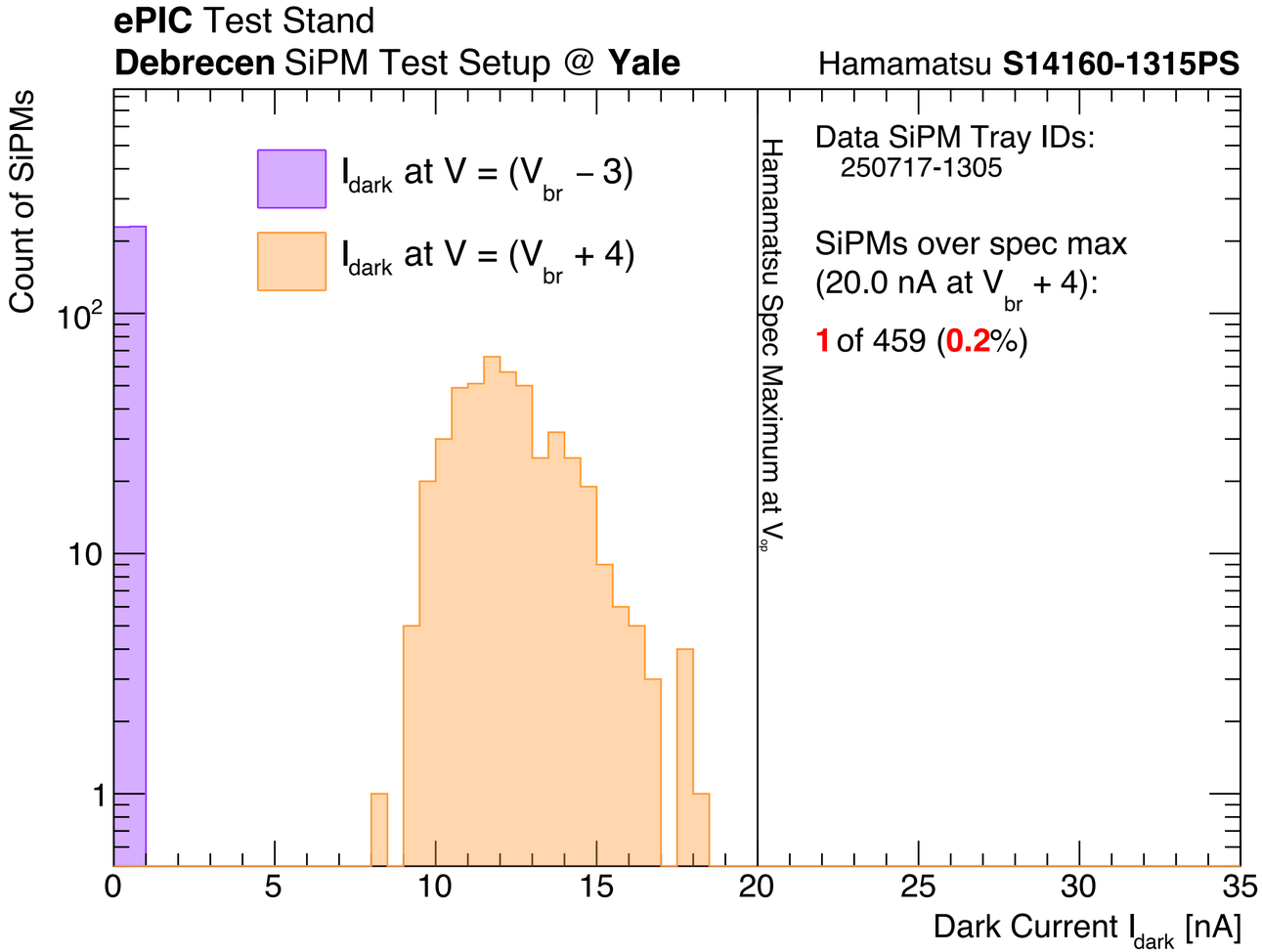
6.5% outliers

3.9% outliers

Another Tray Measured: 250717-1305

Comparable to 250717-1304:

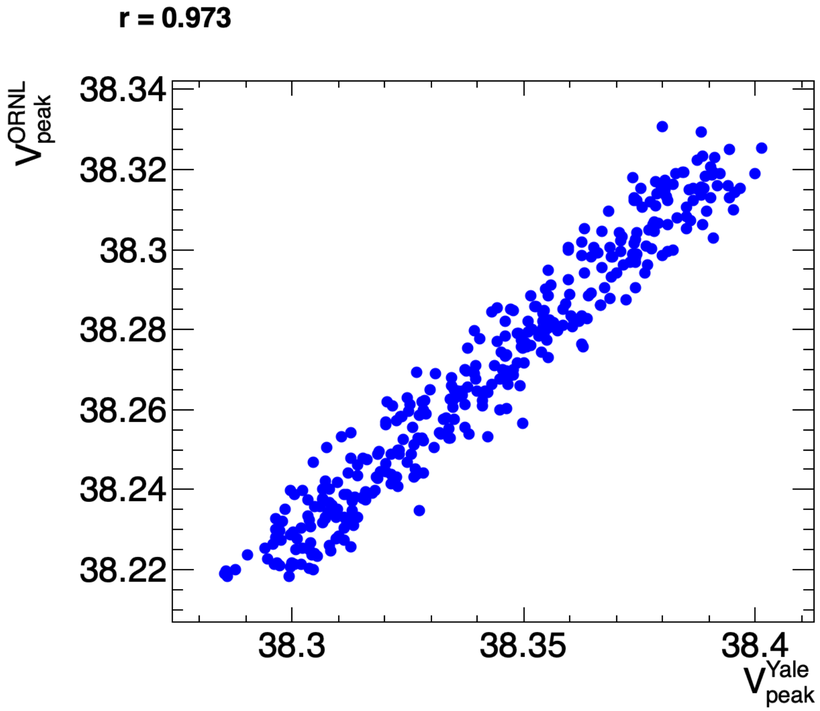
- Some structured correlations with tray index but largely random
- Fewer outliers in the new tray
- On the same order (~5%) as batch 250821, with most of these close to +/- 50 mV boundary
- Dark current is very well below limits compared to batch 250821



ORNL / Yale Comparisons (250717-1304)

Tray 250717-1304

- Observations:
  - Either Yale's T correction seems smaller than expected (~40 mV/C), or another systematic in play
    (25C at Yale vs 20C at ORNL, but only 70 mV offset on average)
  - Tight SiPM-to-SiPM correlation for this tray (~7 mV spread)

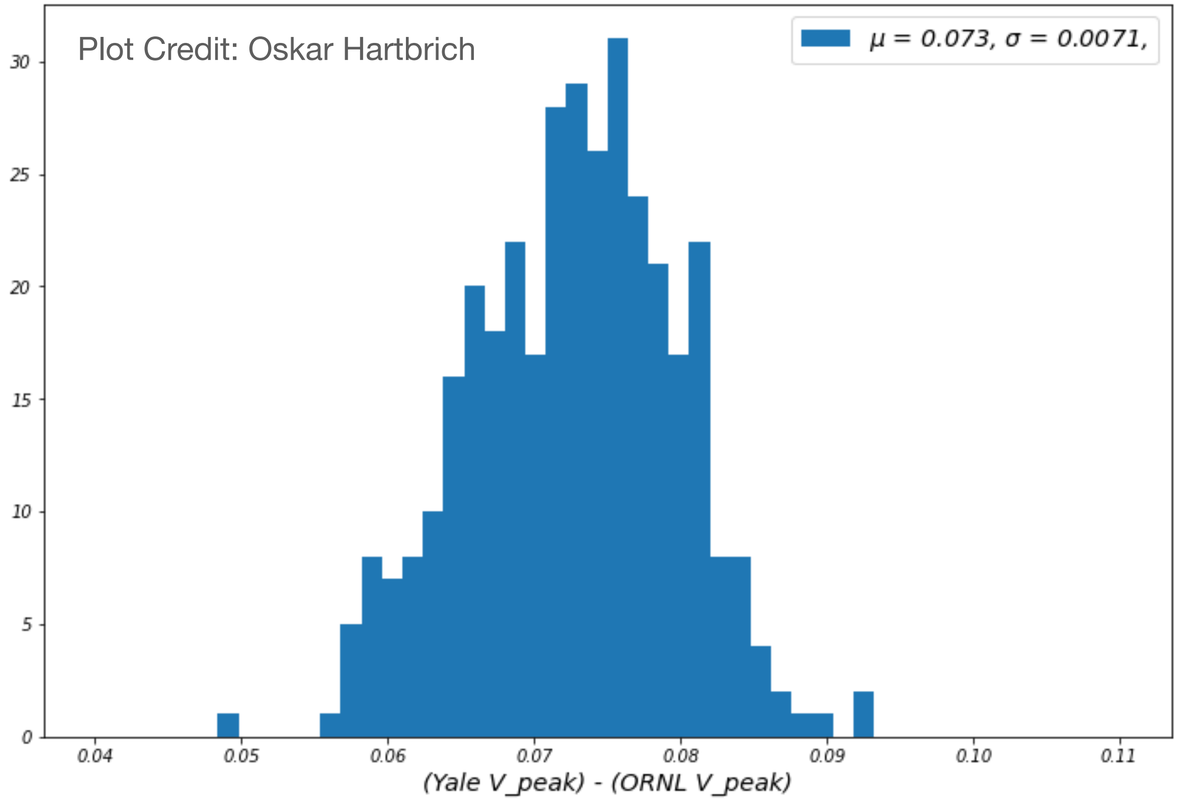


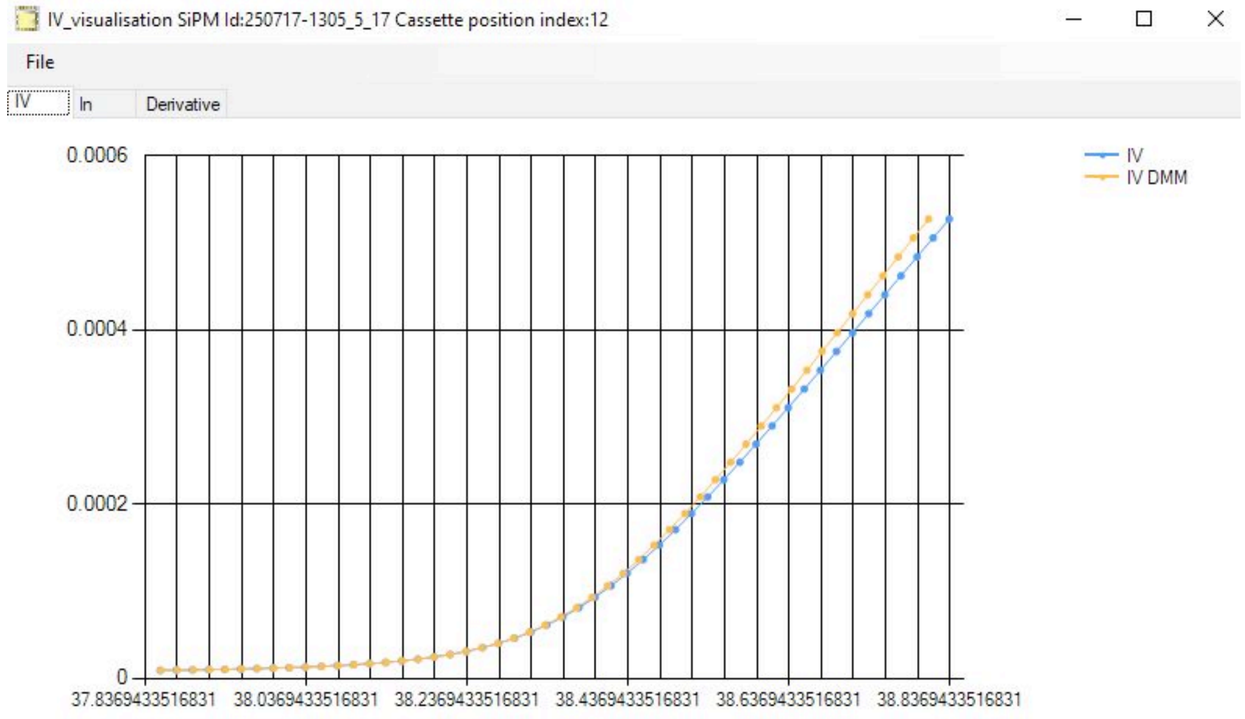
[Note: this plot is only for ~350 SiPMs]

ORNL / Yale Comparisons (250717-1304)

Temperature Correction

IV Measurement to blame for a constant offset?





Debrecen code: 50 step measurement, smoothed with ROOT::Smooth()

ORNL / Yale Comparisons (250717-1304)

Temperature Correction

How is the Temperature Correction performed?

Code is (if I'm looking in the right place) constant offset, but output data seems more dynamic?

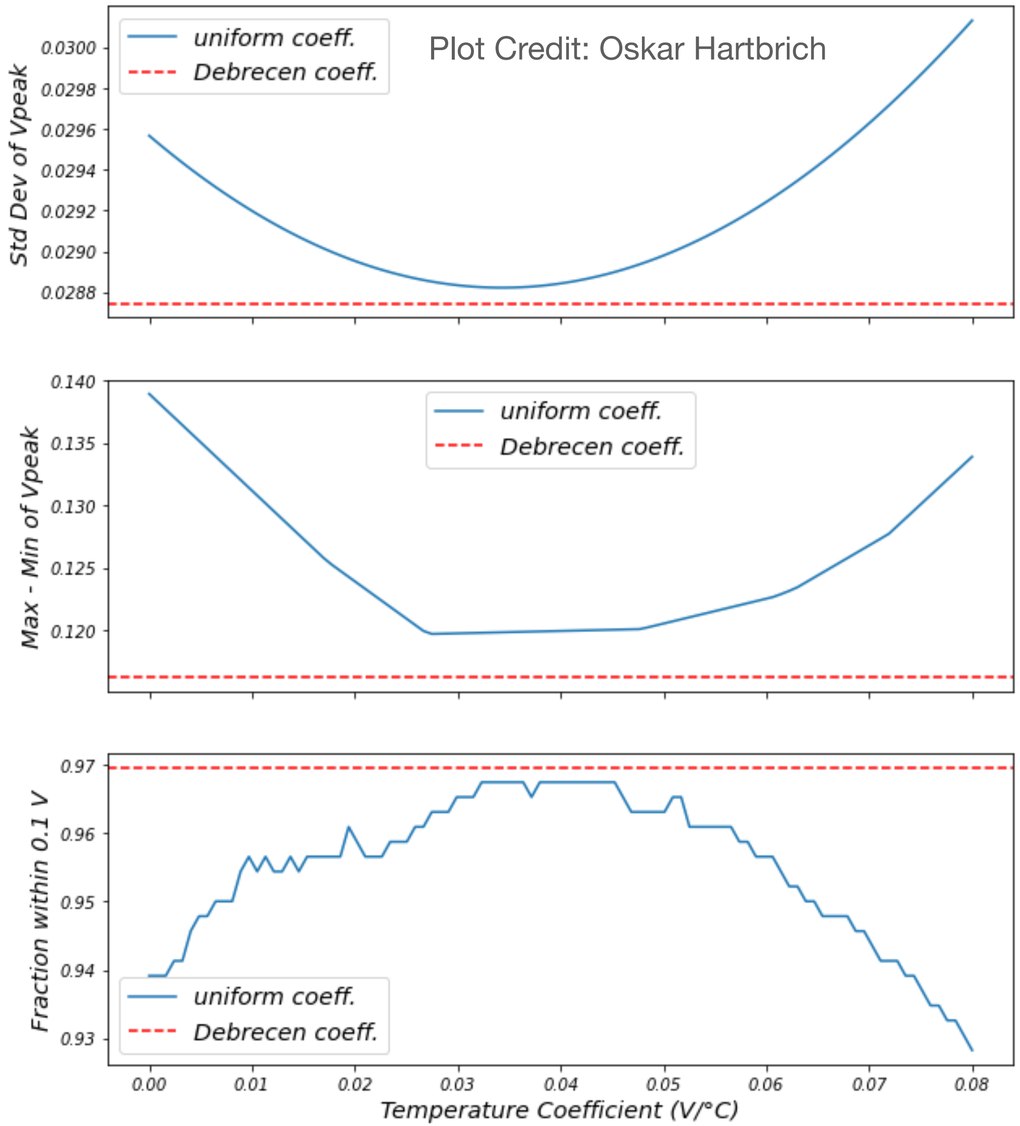
```
const double tempCoeff  = 0.034;  //temperature compensation coefficient V/Celsius  from
    SP14160-1315PS datasheet
```

```
double calcBreakdownTo25C_nearest(double BreakdownVoltage)
{
  double temp = GetSIPMTemp();
  const double operatingTemp = 25.0; // Celsius

  return BreakdownVoltage + ((operatingTemp - temp) * tempCoeff);
}

double calcBreakdownTo20C_nearest(double BreakdownVoltage)
{
  double temp = GetSIPMTemp();
  const double operatingTemp = 20.0; // Celsius

  return BreakdownVoltage + ((operatingTemp - temp) * tempCoeff);
}
```



ORNL / Yale Comparisons (250717-1304)

Temperature Correction

Possibly due to temperature measurement averaging?

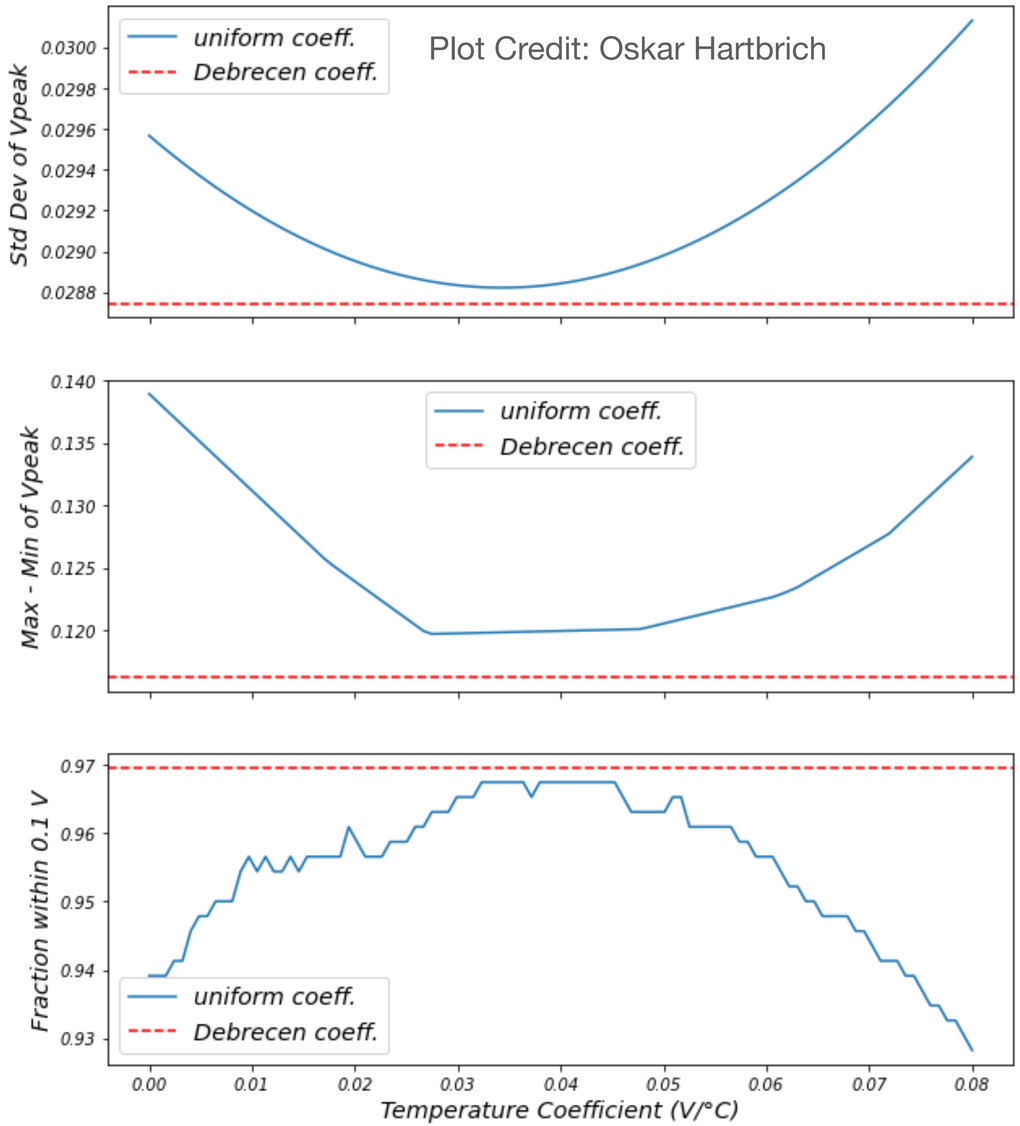
```
const uint8_t temp_sensor_lut[32] =
    {0,0,4,4,0,0,4,4,1,1,5,5,1,1,5,5,2,2,6,6,2,2,6,6,3,3,7,7,3,3,7,7};

double GetSIPMTemp()  //gradiens kompenzáció??? uint8_t SIPM_pos, uint8_t socket
{
  double temp = 0;
  double avg_temp[8];


  for(int i=0;i<8;i++)
  {
    avg_temp[i] = (InitialTemp[i] + FinalTemp[i])/2;
  }


  temp = avg_temp[temp_sensor_lut[socket]];


   return temp;
}
```



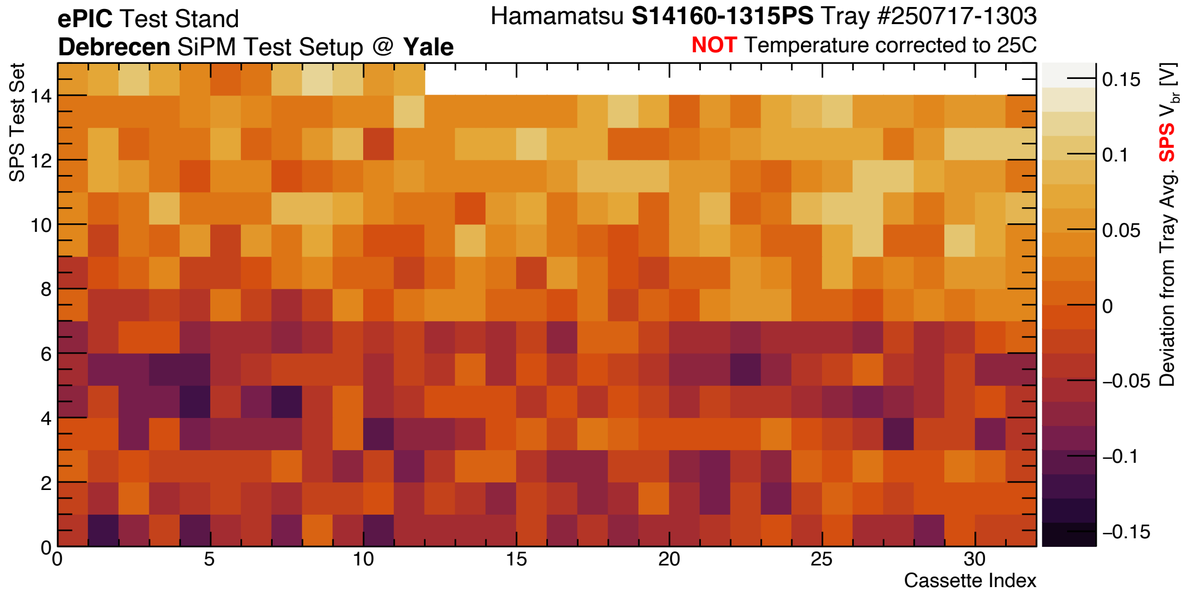
Monday 11/3

Another Tray Measured: 250717-1303

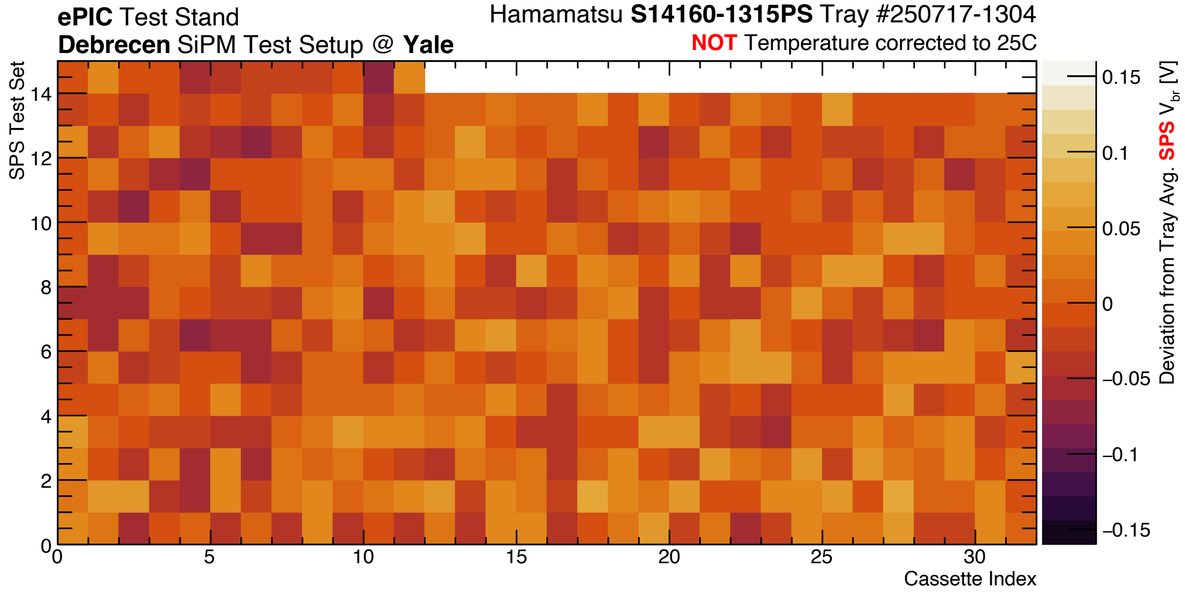
Some interesting results”

- Wild temperature change as Lab heating kicks on

New Tray



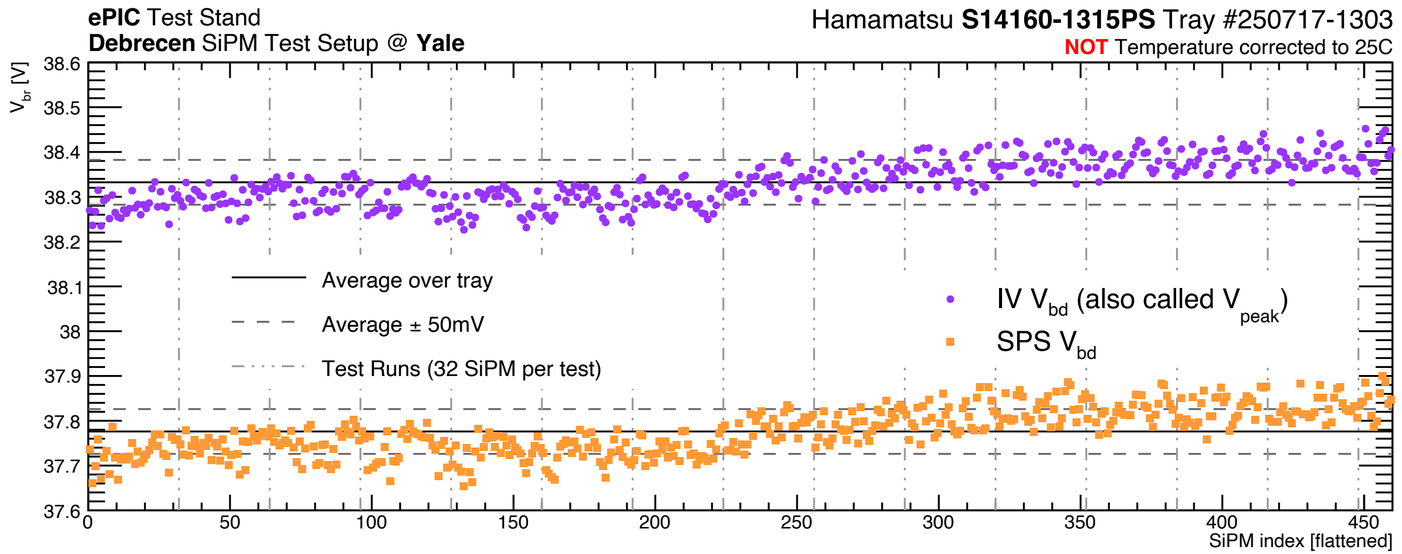
Last Tray

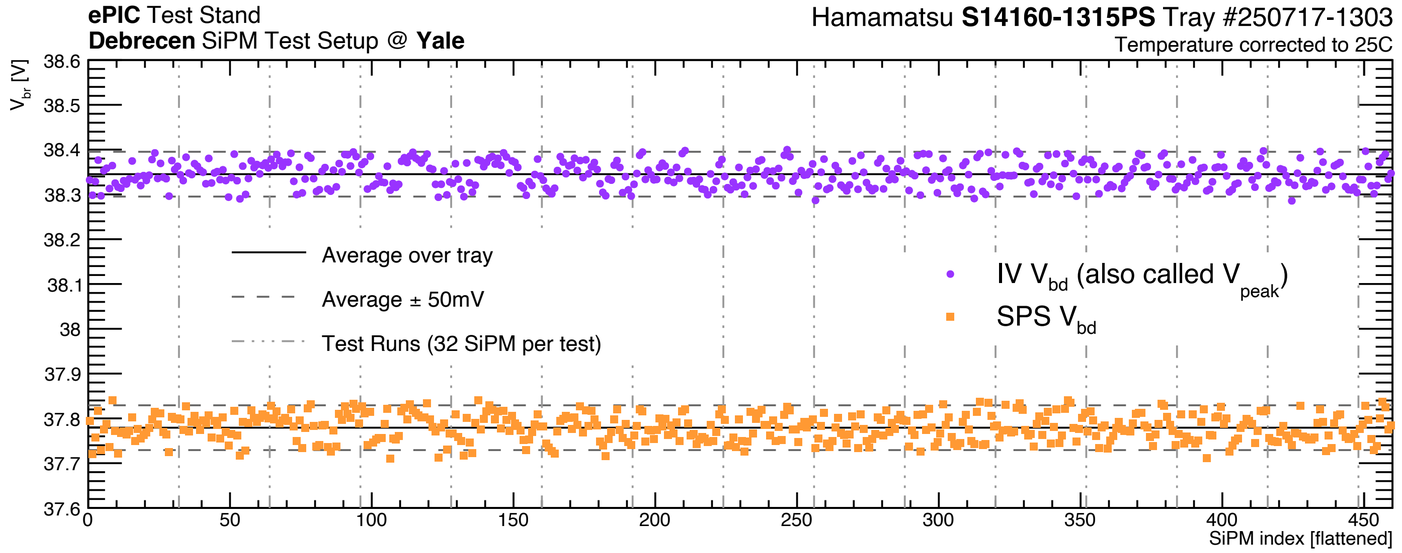


Another Tray Measured: 250717-1303

Some interesting results”

- Wild temperature change as Lab heating kicks on
- Temperature correction seems to still work quite well!
- 36 outliers from avg +/-50mV (~7.6%), more than 1305 but less than 1304

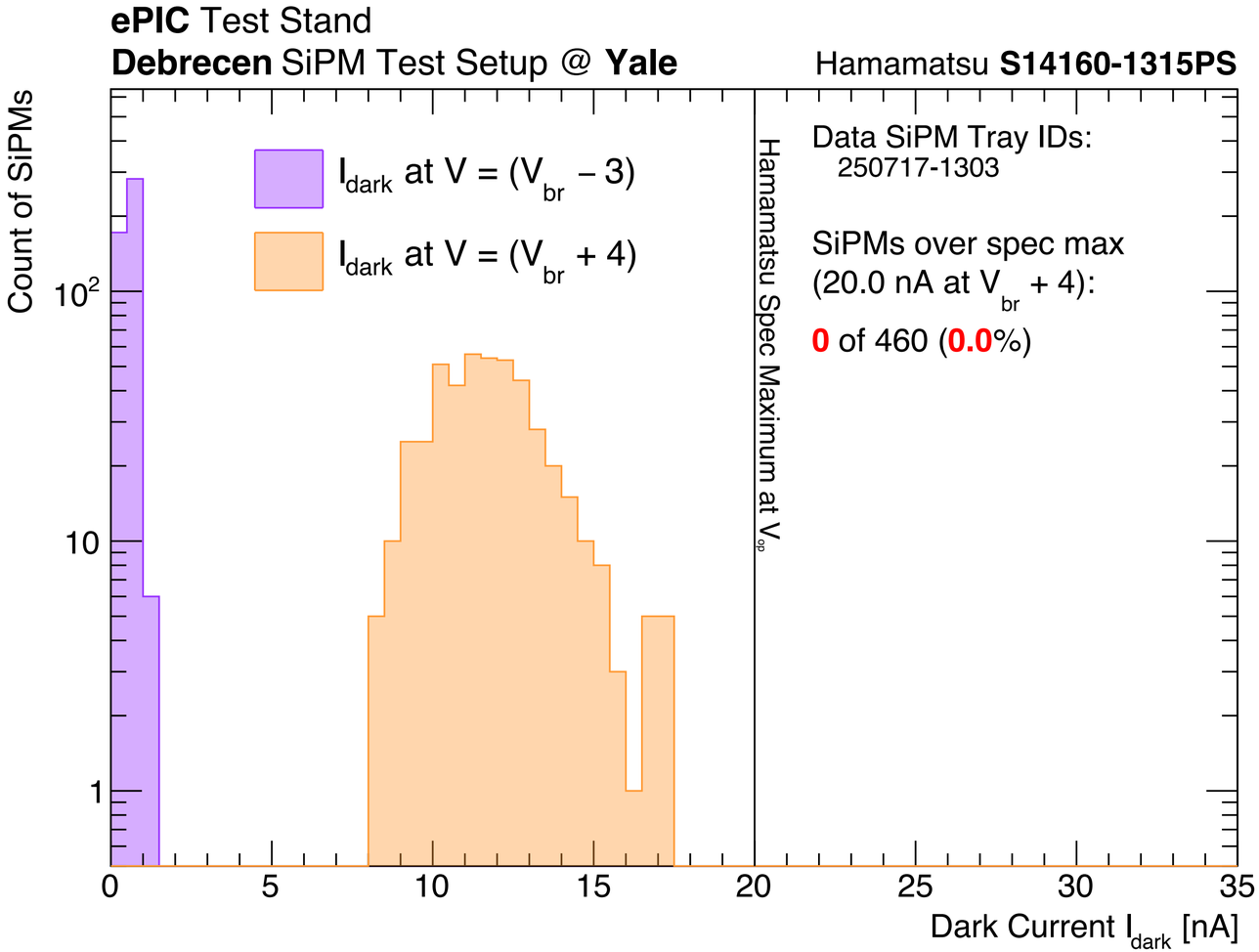




Another Tray Measured: 250717-1303

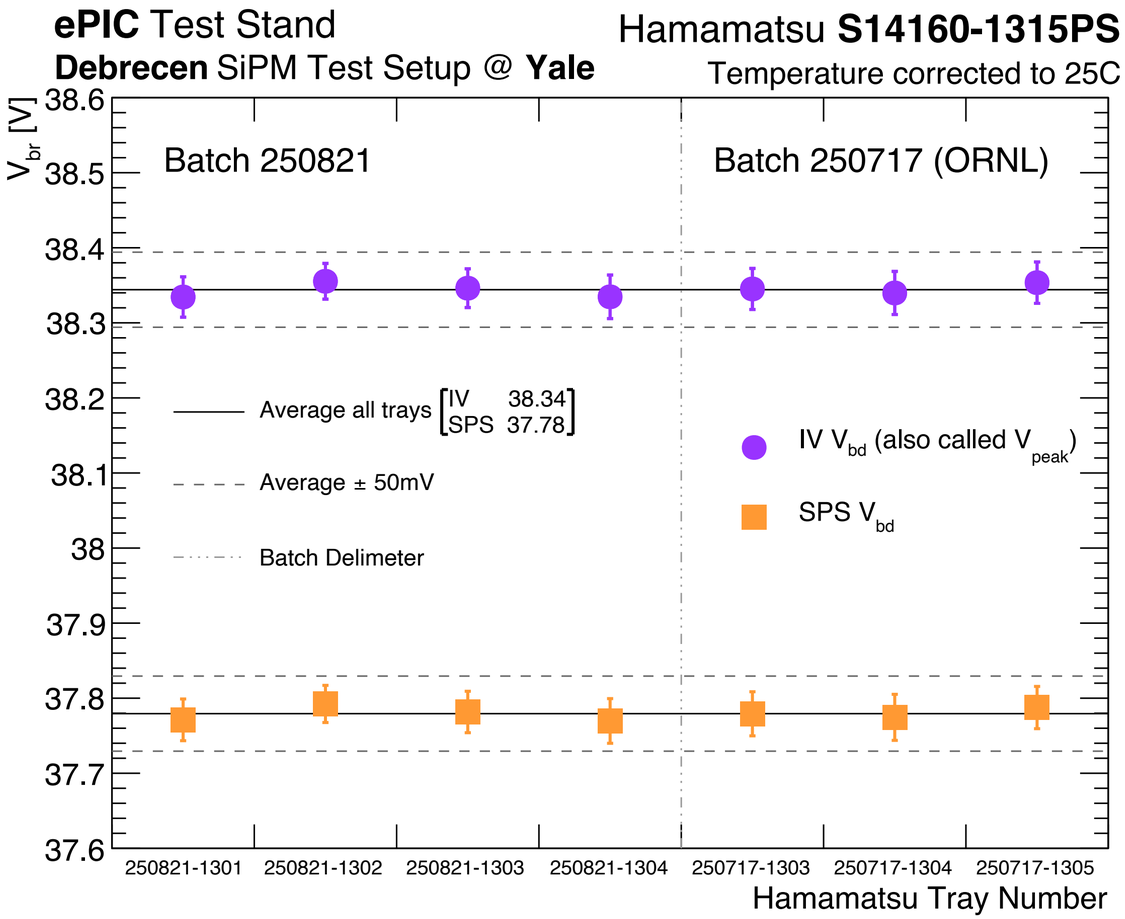
Some interesting results”

- Wild temperature change as Lab heating kicks on
- Temperature correction seems to still work quite well!
- 36 outliers from avg +/-50mV (~7.6%), more than 1305 but less than 1304
- No dark current outliers, in line with other 250717 trays.



All Data So Far

Total V_{bd} outliers: 234 of 3219 (7.3%)
(relative to global average, 129 for +/- 55mV)



Total I_{dark} outliers: 15 of 3219 (0.5%)