



Williwaw Engineering

June 1, 2016

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Subject: May 2016 Monthly Report – RCUH P.O. #Z10115098

Dear Luis,

The following constitutes my monthly report for the subject agreement for services associated with May 2016.

Work Completed under Activity 1: “Provide technical and software support services to HNEI technical staff in programming data acquisition (DAS) controllers and analyzing data records in the following areas as assigned”:

- Monitored the device regularly via remote connection to the NWEI host PC in Room 106, Battery French. Downloaded data from PC as necessary, and updated device control settings when necessary.
- Analyzed power data to produce monthly power performance data plots; see Attachment 1 for results.
- Analyzed Azura float angle data using MATLAB to produce a plot of 30 minute average float angle data for the deployment period. The data shows that in mid-May, the second Azura float angle sensor failed (another redundant sensor failed in April). Prior to the failure, the data shows that hull ballast had continued to be stable since the beginning of 2016. See Attachment 2 for these results.
- Plotted daily humidity sensor data for the cRIO controller enclosure and drybox on board the Azura. The drybox, which is entirely sealed from the Azura hull, has a slowly increasing humidity that is now 10%. The humidity inside the cRIO enclosure also continues to slowly increase, and is now at 30%. See Attachment 3 for a plots of these results.
- Uploaded monthly data to DOE repository through end of April.

Please let me know if you have any questions or comments concerning this project.

Sincerely,

Terry Lettenmaier

Attachment 1: Azura power performance data plots

Attachment 2: Azura 30 minute average float angle data plots

Attachment 3: Azura cRIO enclosure and drybox humidity

Attachment 1

Azura power performance data plots

Azura Power Performance – May 2016

Summary

- Azura power performance was calculated and is presented as described in IEC Technical Specification 62600-100.
- Device performance is presented per IEC 62600-100 using capture length and normalized power matrices. Normalized power was calculated from capture length and energy flux of representative spectra for each H_{m0} - T_e bin.
- Average power matrices, 95th percentile power matrices, and percent difference between normalized power and average power are also presented.
- The representative spectra for IEC 62600-100 calculations were calculated by taking the average of all spectra recorded for each bin, then shifting the magnitude and frequency of the average spectra so that their H_{m0} and T_e are at the center of each bin.
- Plots of May 2016 data only are shown on Slides 3-11
- Plots of cumulative data for the entire deployment period January-May 2016 are shown on Slides 13-21
- Azura was operated (output connected to grid) for 733 hours in May (98.6% of month). Most of the down time was during temporary shut downs until the device controller was manually reset after brief grid voltage interruptions.
- Device control was continued through all of May in constant hydraulic motor displacement mode, with the settings cycled between six different settings. This is the simplest control method possible for the Azura.

Azura Power Performance Monthly Data May 2016

Azura Power Performance – May 2016

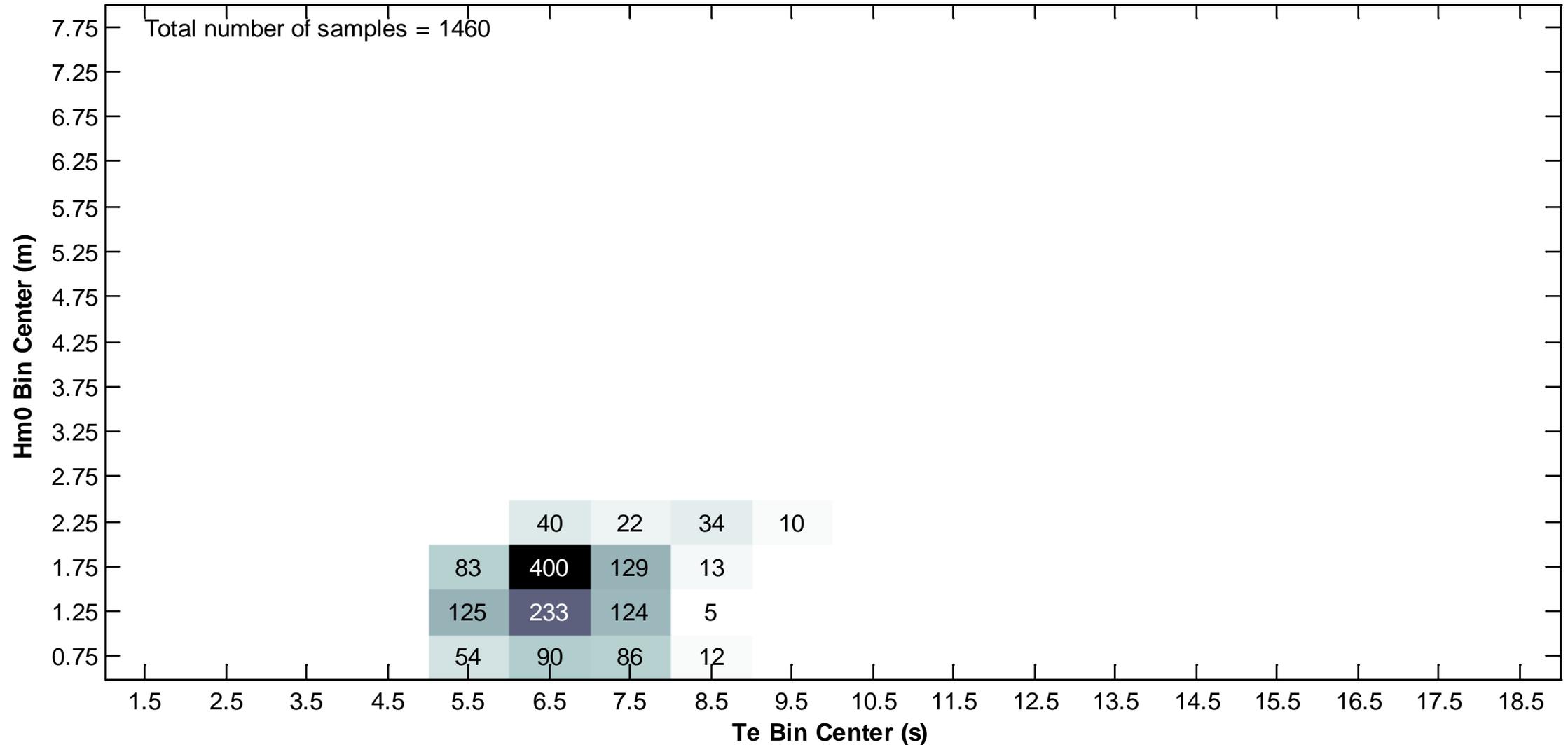


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Data samples collected

Sample Count (30 min sample periods)

Month of May 2016; 30 minute periods with > 20 minutes operation included



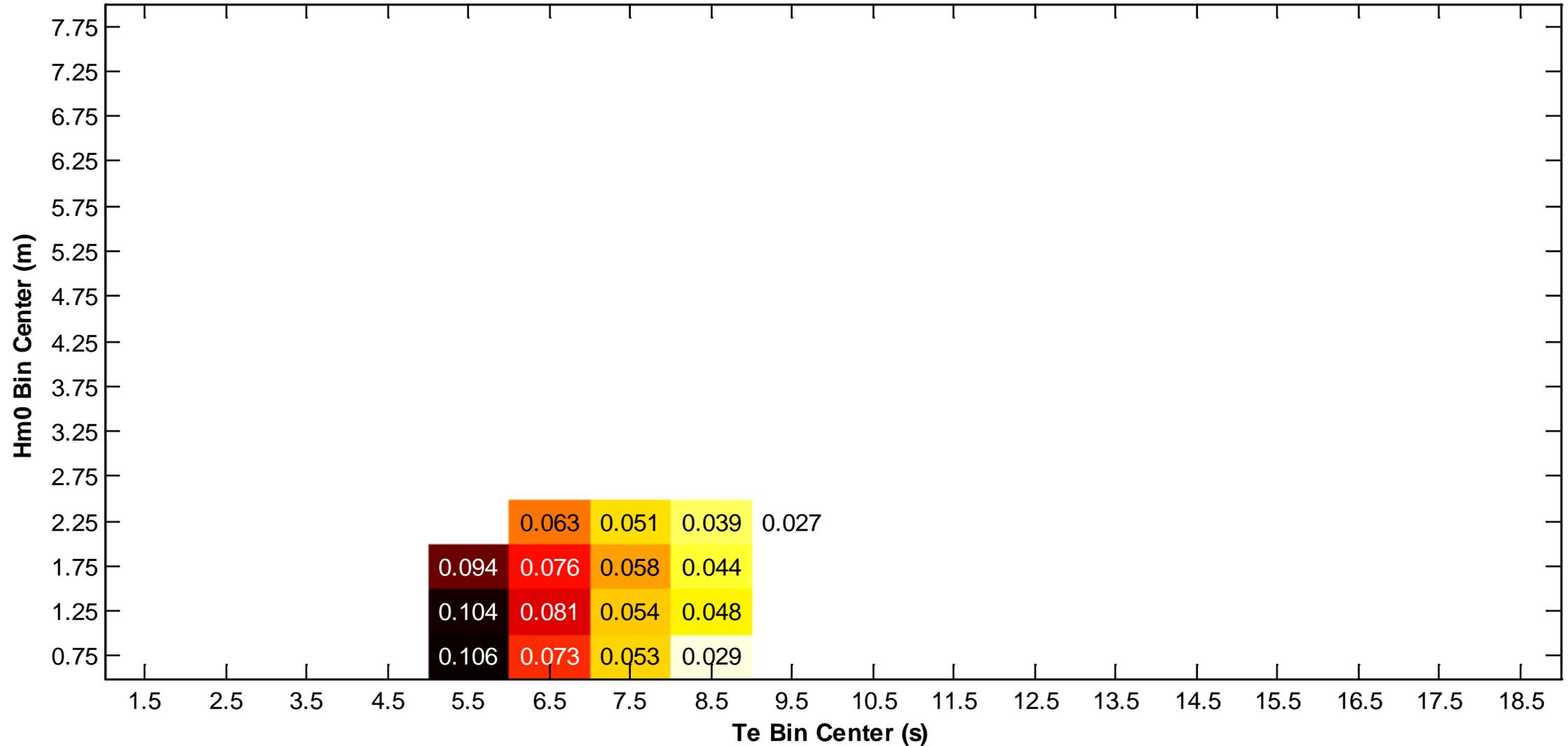
Azura Power Performance – May 2016



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Mean capture length matrix

Mean Capture Length (device dc output power/wave energy flux, m)
Month of May 2016; 30 minute periods with > 20 minutes operation included



Azura Power Performance – May 2016

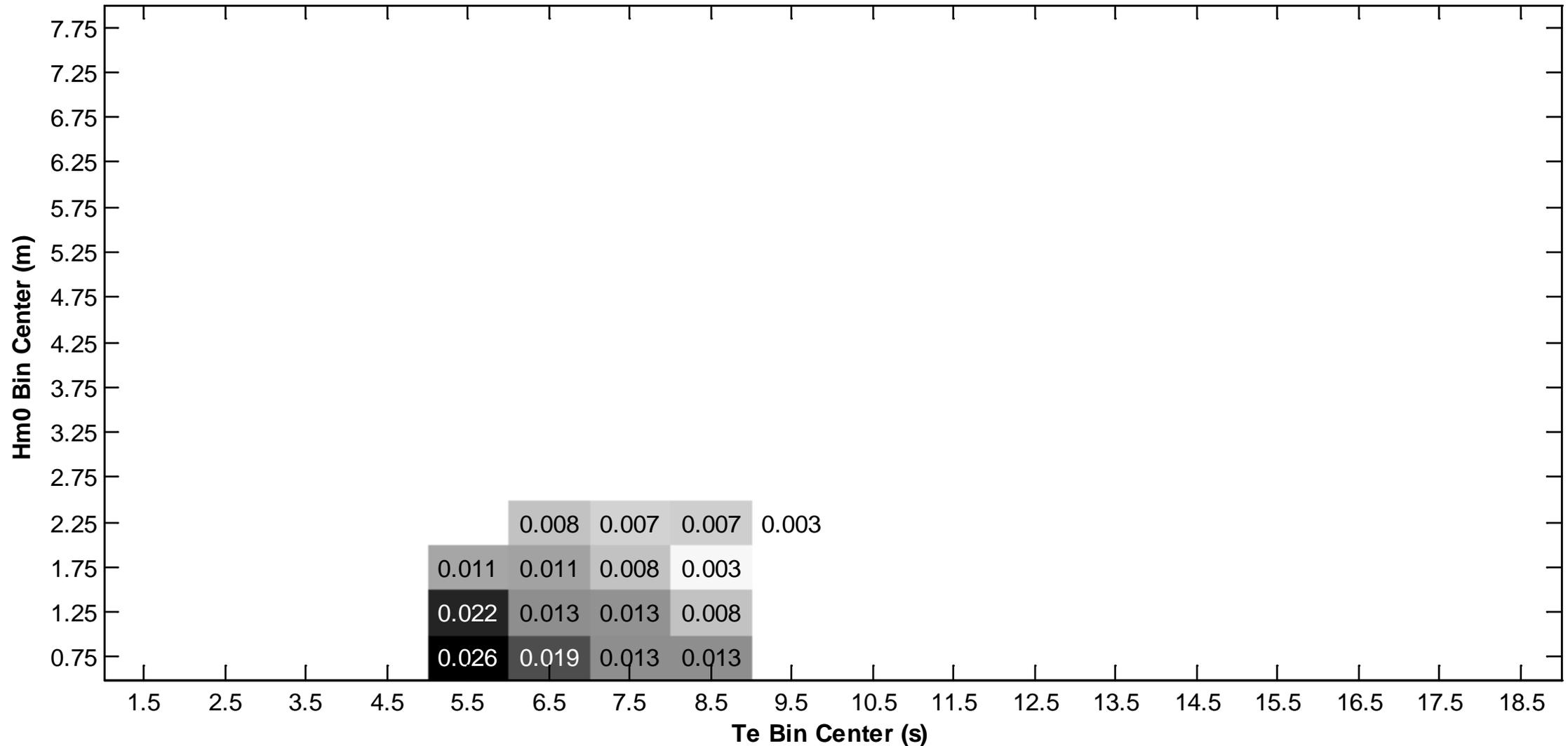


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Standard deviation of capture length

Standard Deviation of Capture Length (m)

Month of May 2016; 30 minute periods with > 20 minutes operation included



Azura Power Performance – May 2016

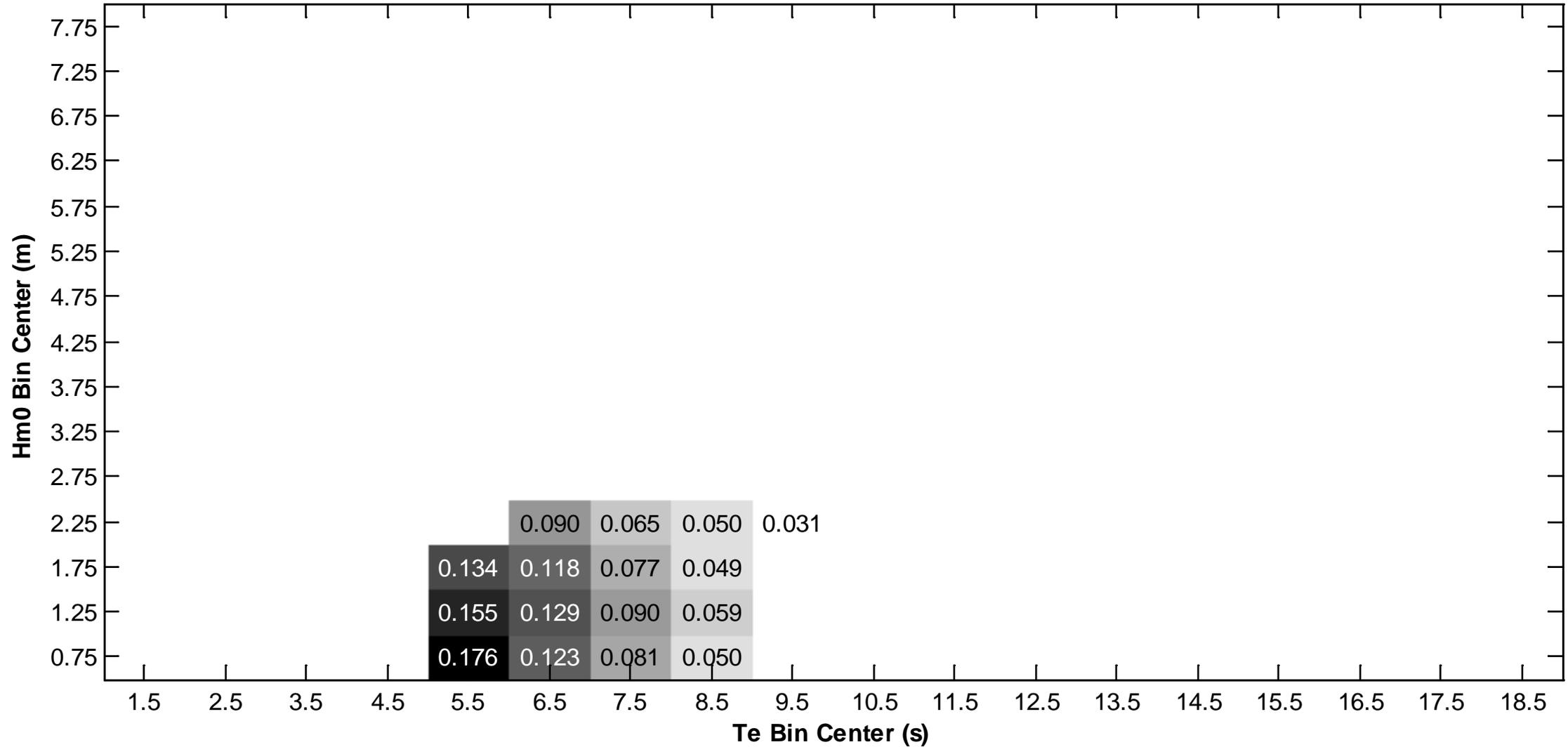


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Maximum capture length matrix

Maximum Capture Length (m)

Month of May 2016; 30 minute periods with > 20 minutes operation included



Azura Power Performance – May 2016

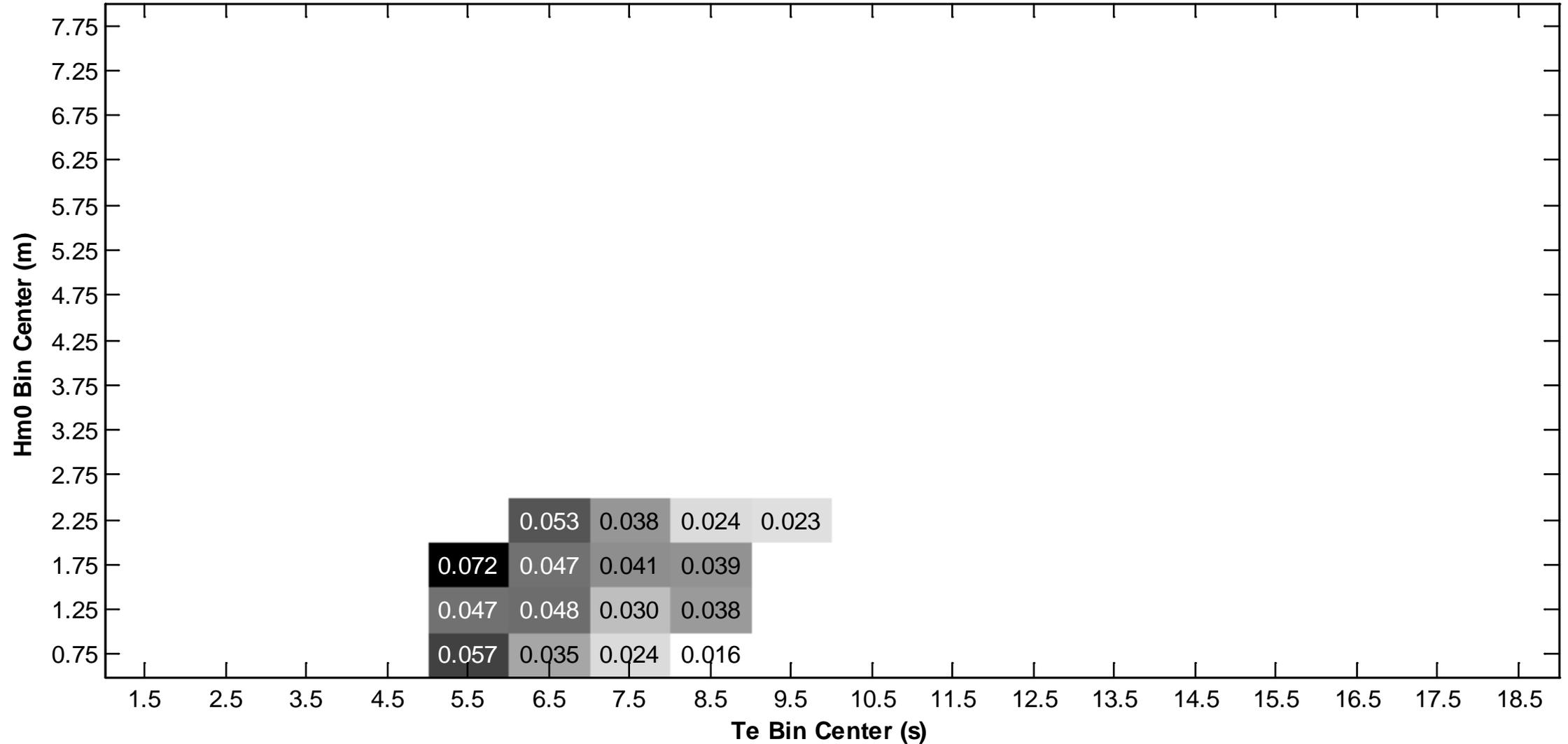


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Minimum capture length matrix

Minimum Capture Length (m)

Month of May 2016; 30 minute periods with > 20 minutes operation included



Azura Power Performance – May 2016

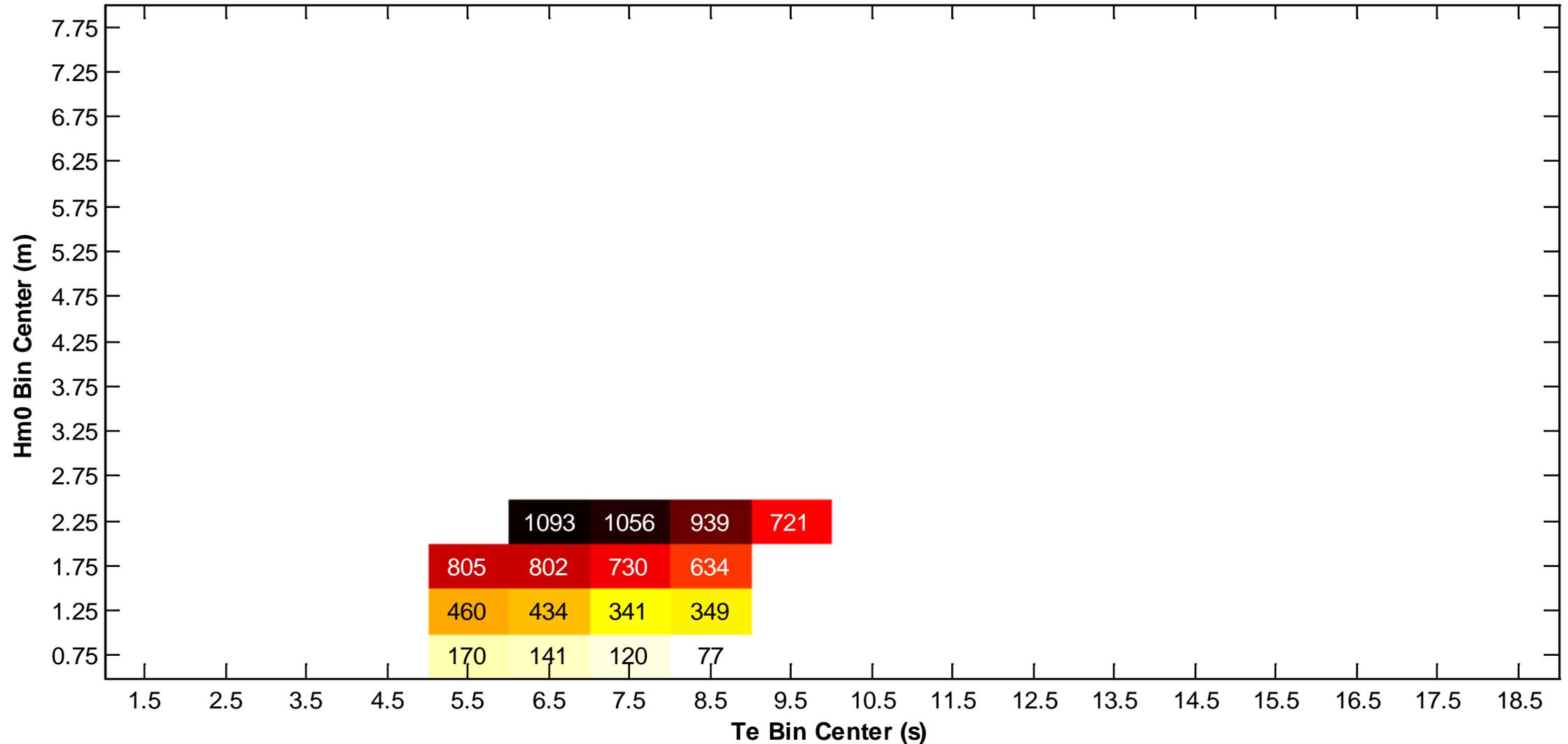


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Normalized power matrix

Normalized Power Matrix (W)

Month of May 2016; 30 minute periods with > 20 minutes operation included



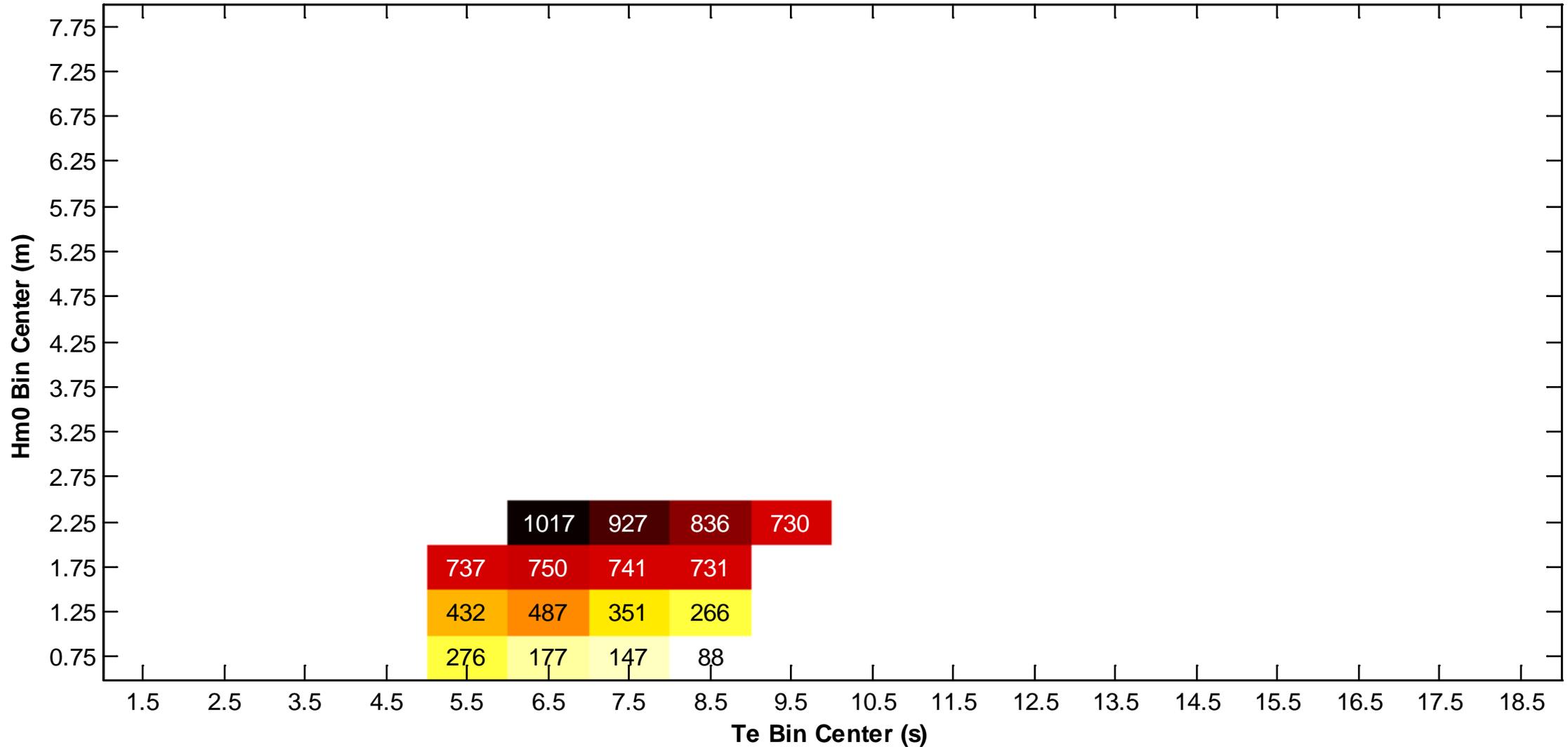
Azura Power Performance – May 2016



Mean power matrix

Mean Device Output Power (W)

Month of May 2016; 30 minute periods with > 20 minutes operation included



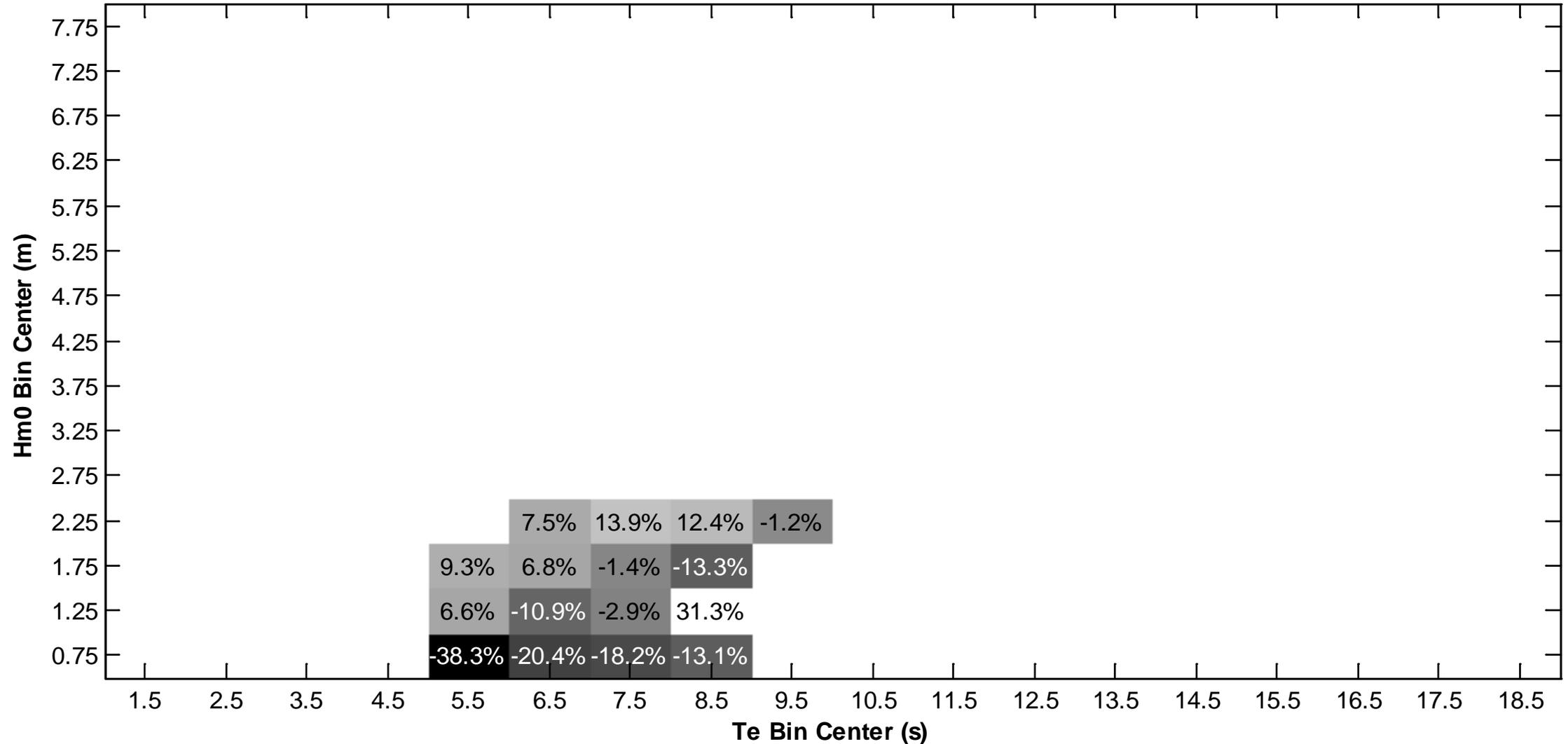
Azura Power Performance – May 2016



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Percent difference between normalized and mean power matrix

**Percent difference between normalized and direct measured power matrices
Month of May 2016; 30 minute periods with > 20 minutes operation included**



Azura Power Performance – May 2016

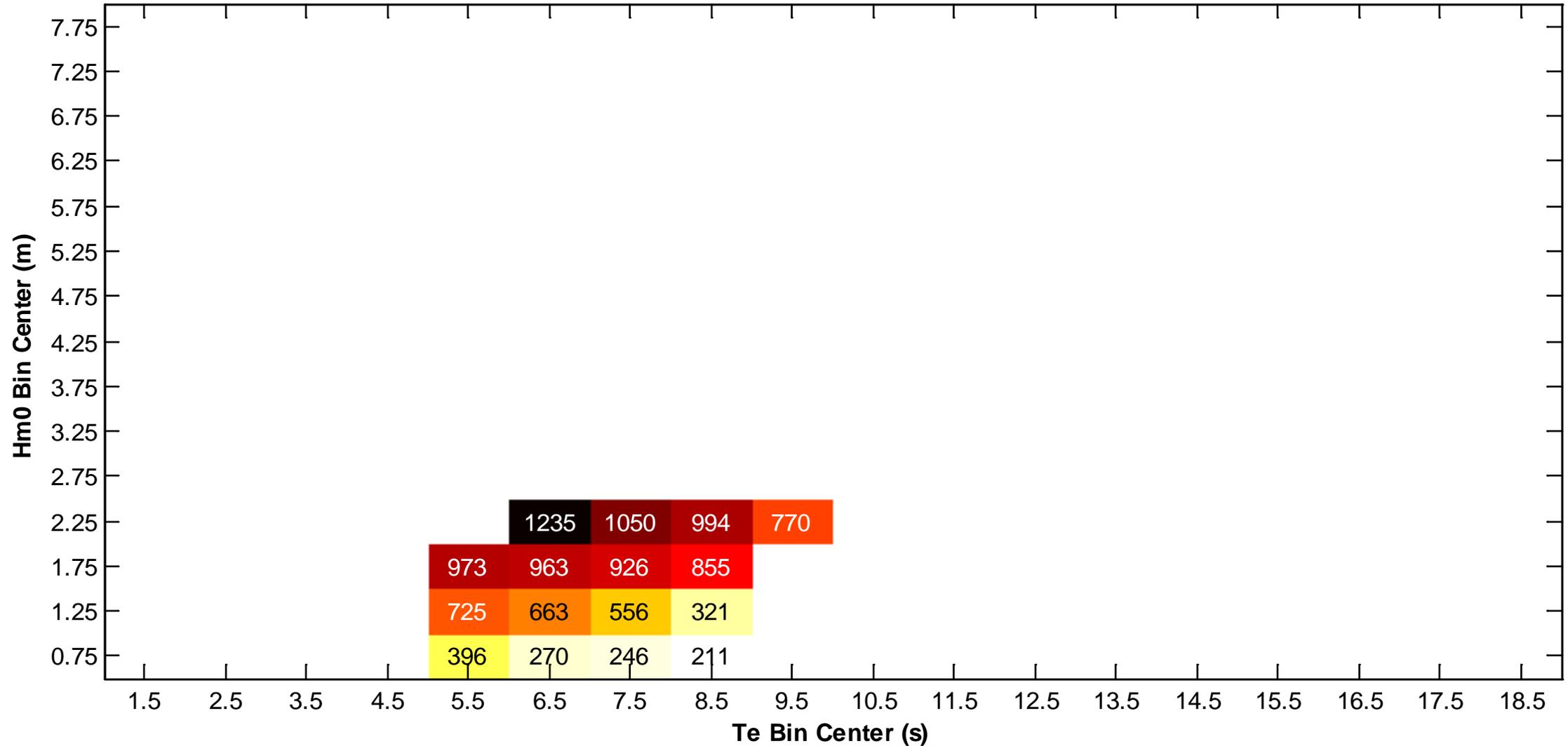


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95th percentile power matrix

95th Percentile Device Dc Output Power (W)

Month of May 2016; 30 minute periods with > 20 minutes operation included



Azura Power Performance Cumulative Data January – May 2016

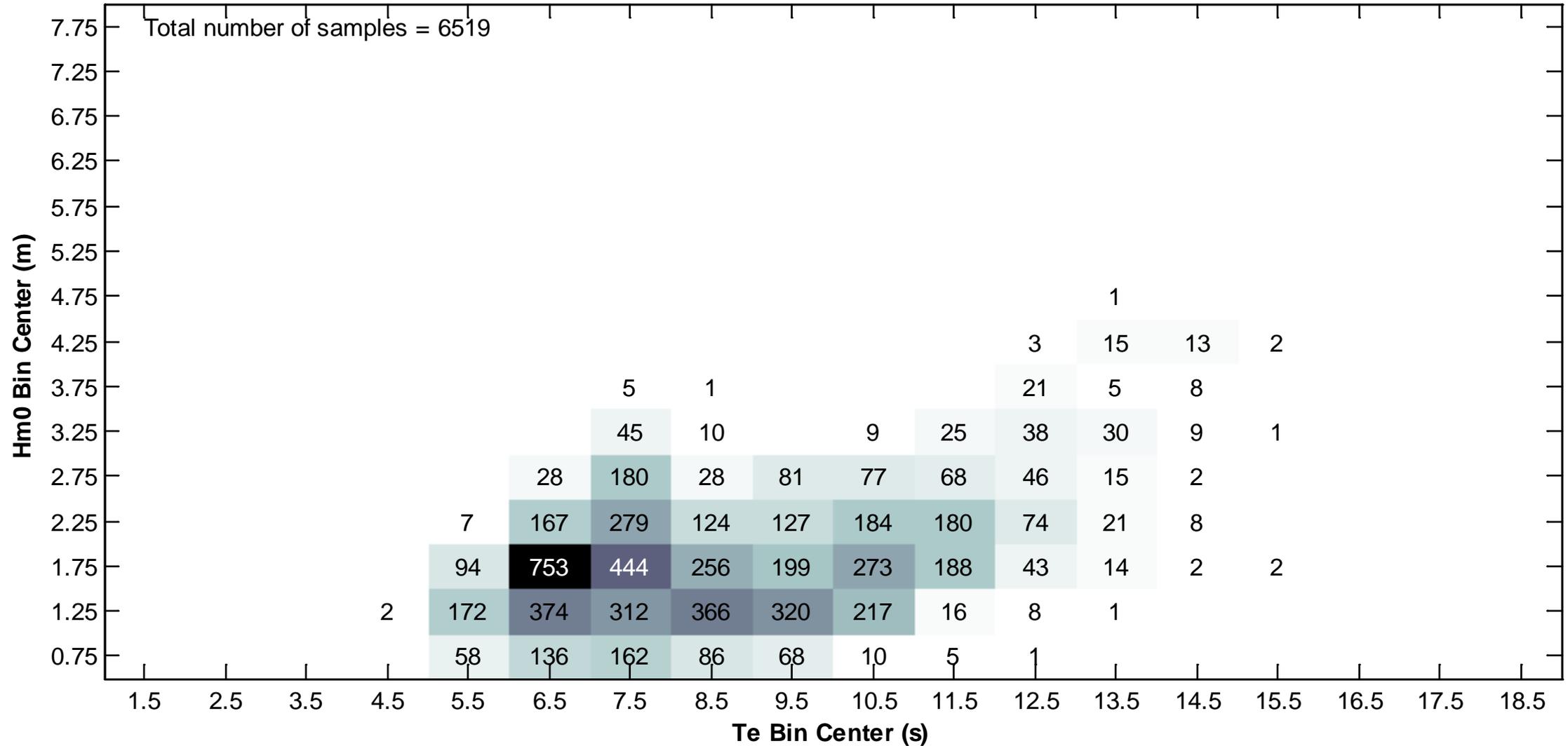
Azura Power Performance – Jan-May 2016



Data samples collected

Sample Count (30 min sample periods)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



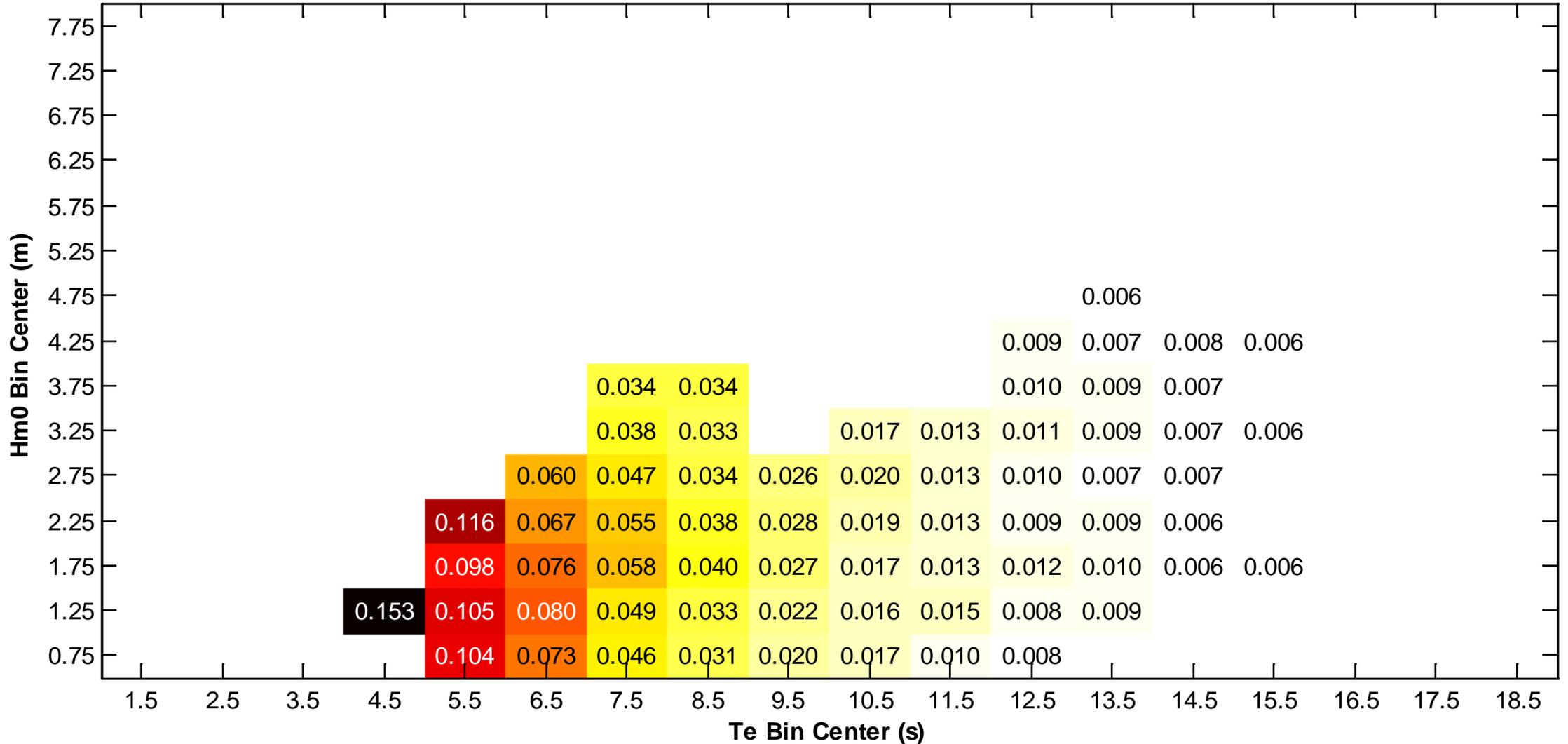
Azura Power Performance – Jan-May 2016



Mean capture length matrix

Mean Capture Length (device dc output power/wave energy flux, m)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



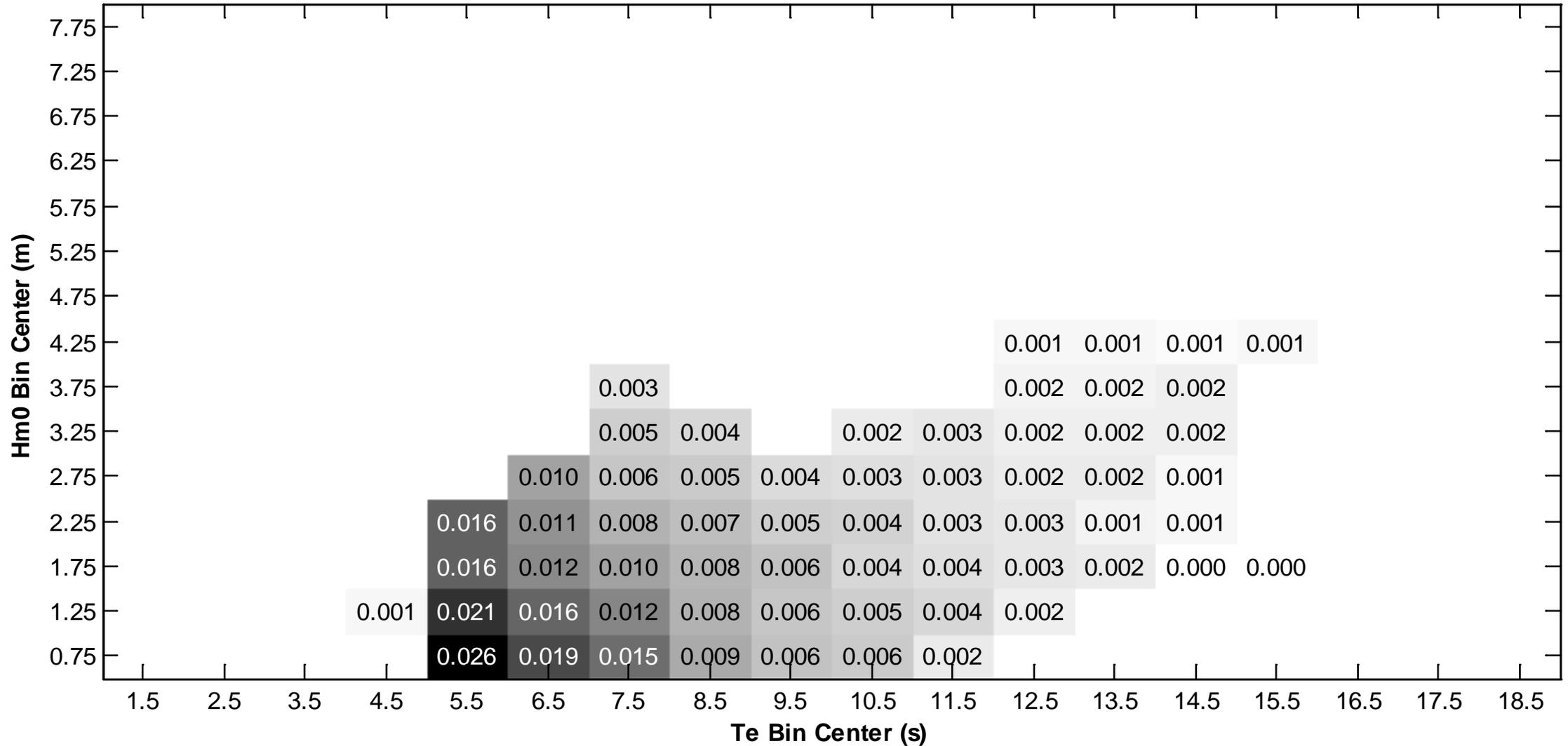
Azura Power Performance – Jan-May 2016



Standard deviation of capture length

Standard Deviation of Capture Length (m)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



Azura Power Performance – Jan-May 2016

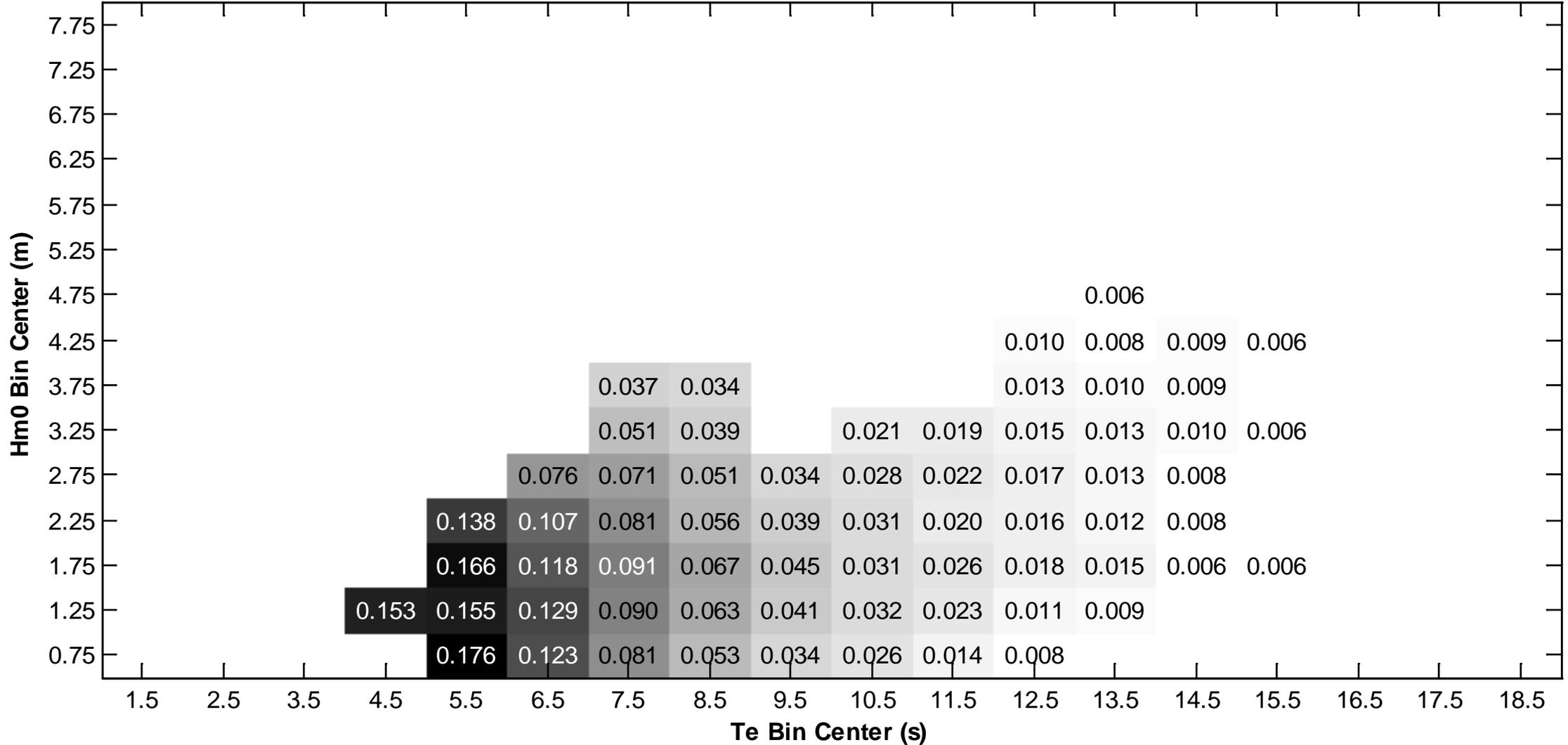


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Maximum capture length matrix

Maximum Capture Length (m)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



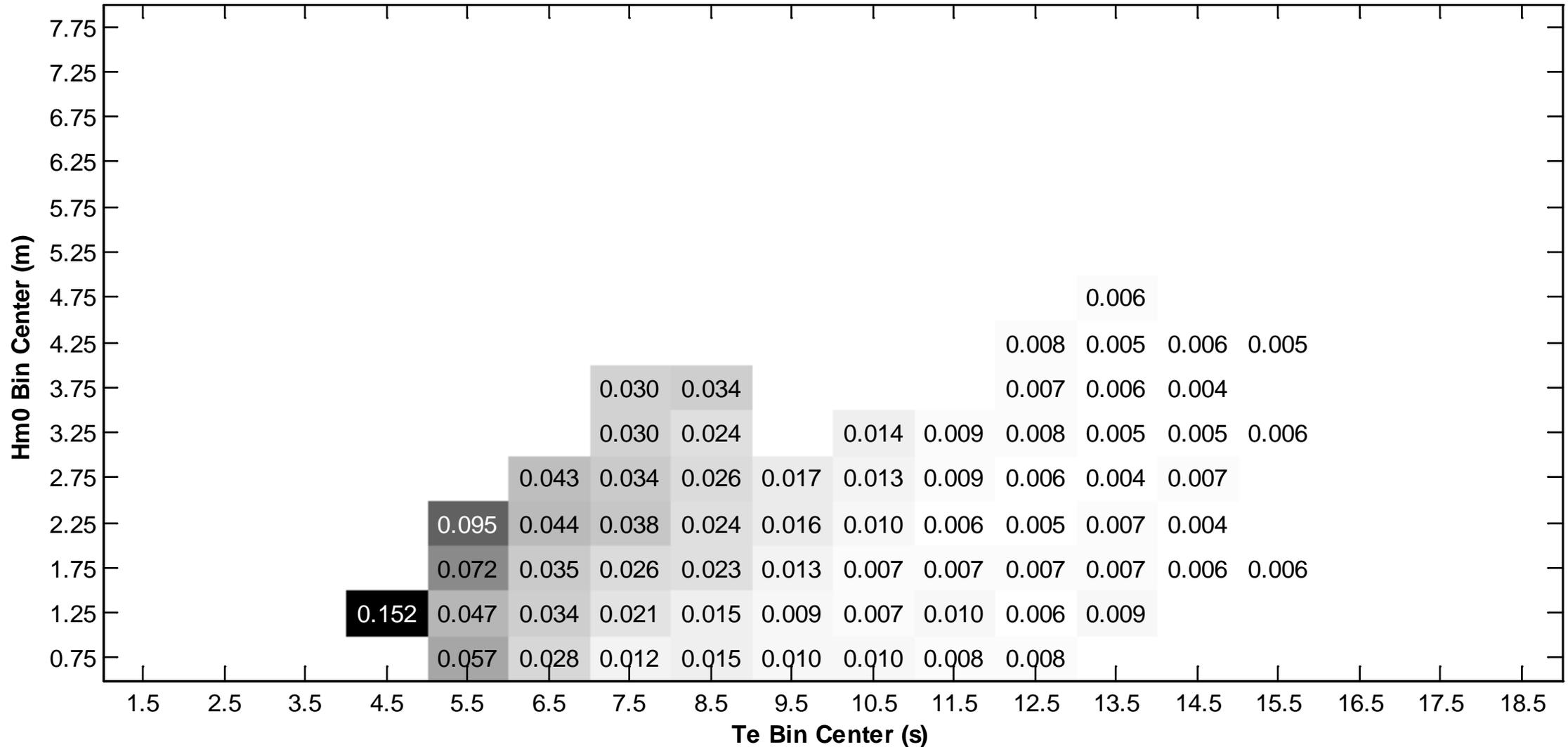
Azura Power Performance – Jan-May 2016



Minimum capture length matrix

Minimum Capture Length (m)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



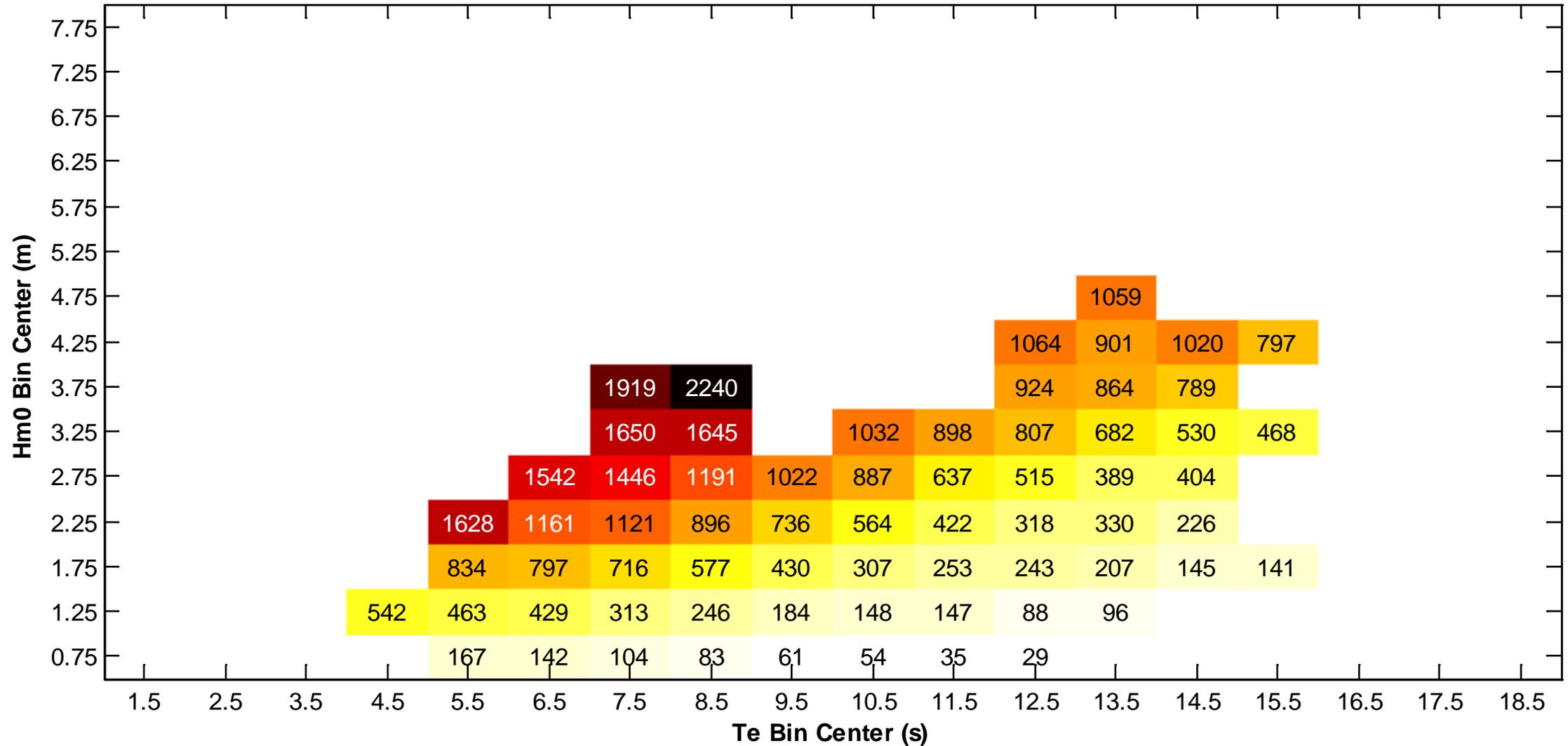
Azura Power Performance – Jan-May 2016



Normalized power matrix

Normalized Power Matrix (W)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



Azura Power Performance – Jan-May 2016

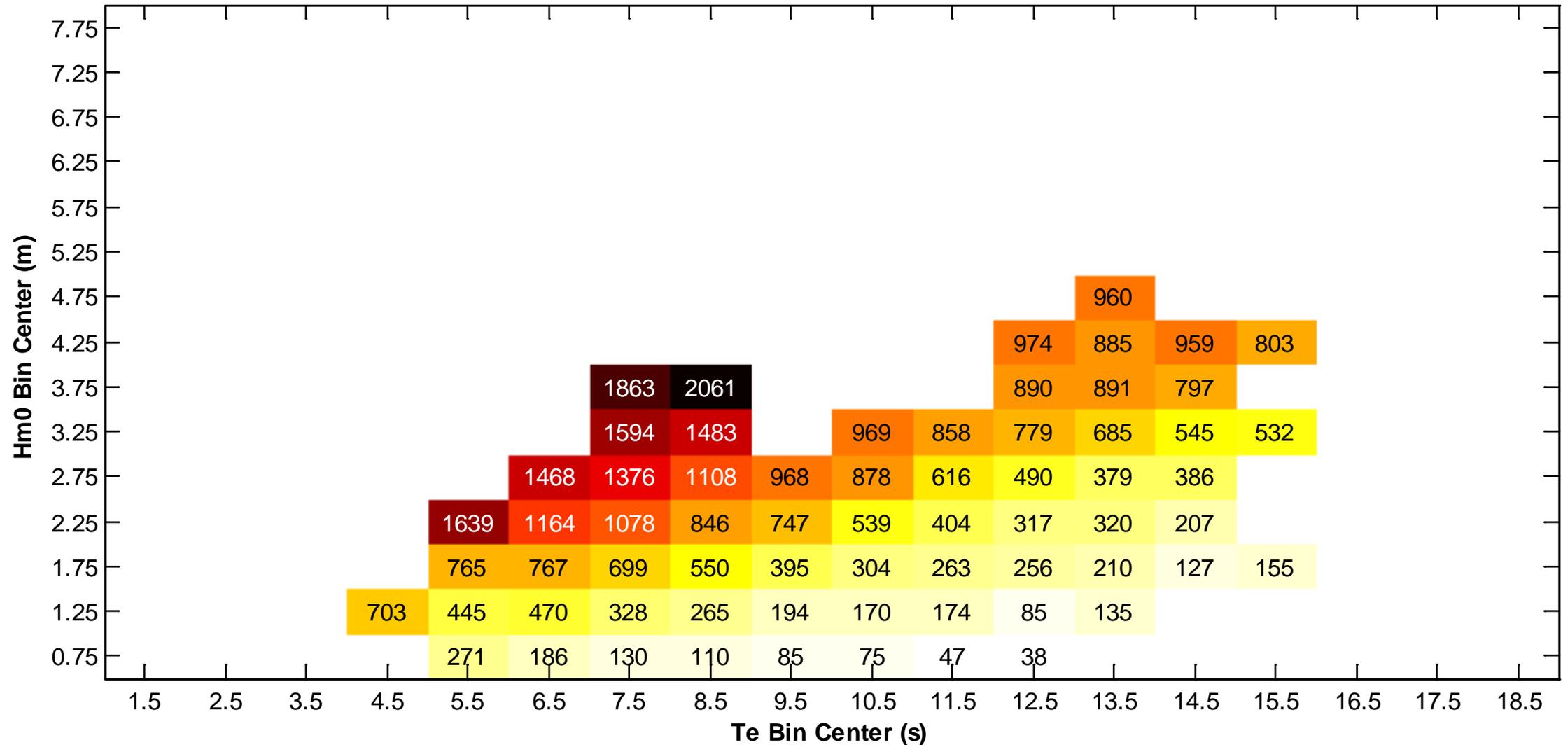


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Mean power matrix

Mean Device Output Power (W)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



Azura Power Performance – Jan-May 2016

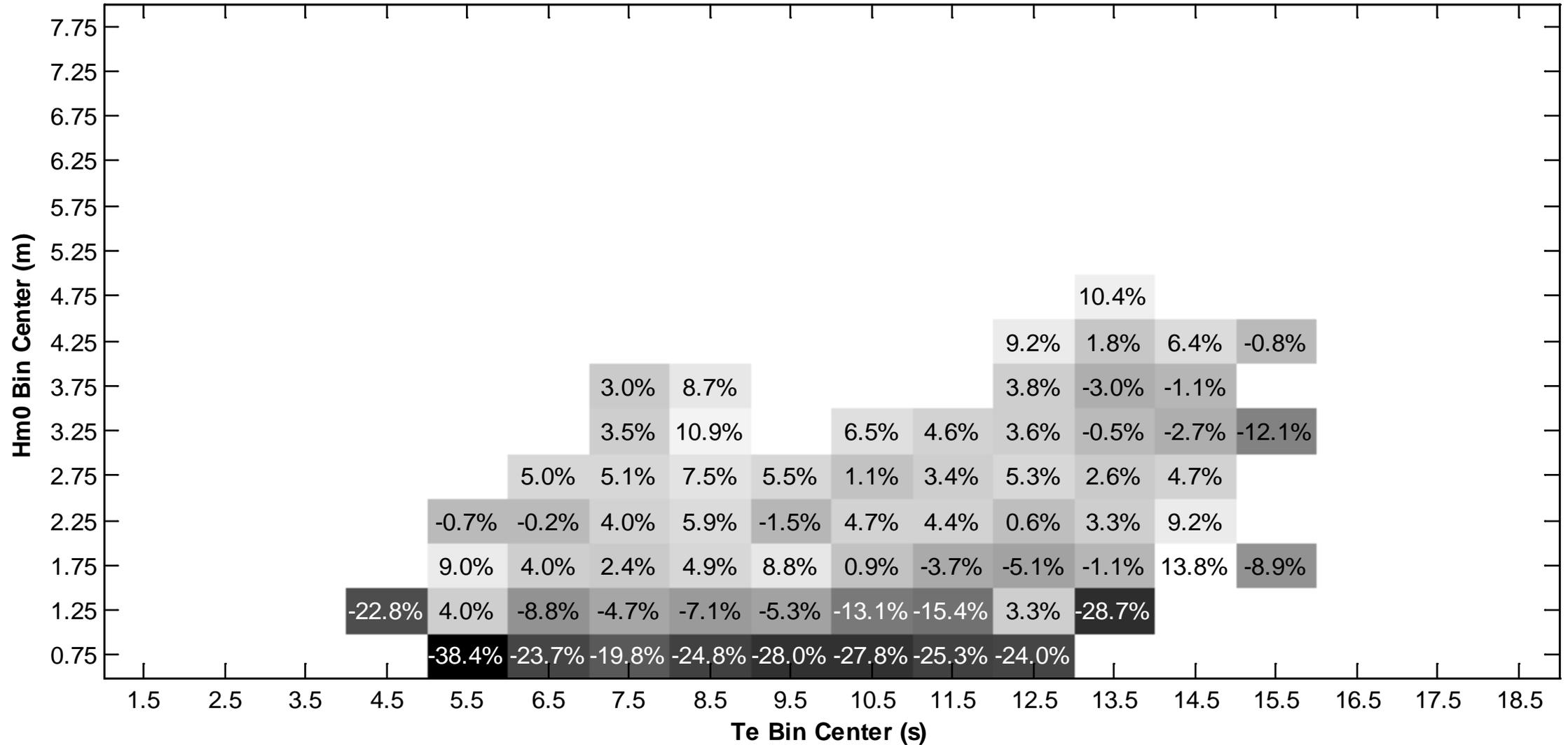


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Percent difference between normalized and mean power matrix

Percent difference between normalized and direct measured power matrices

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



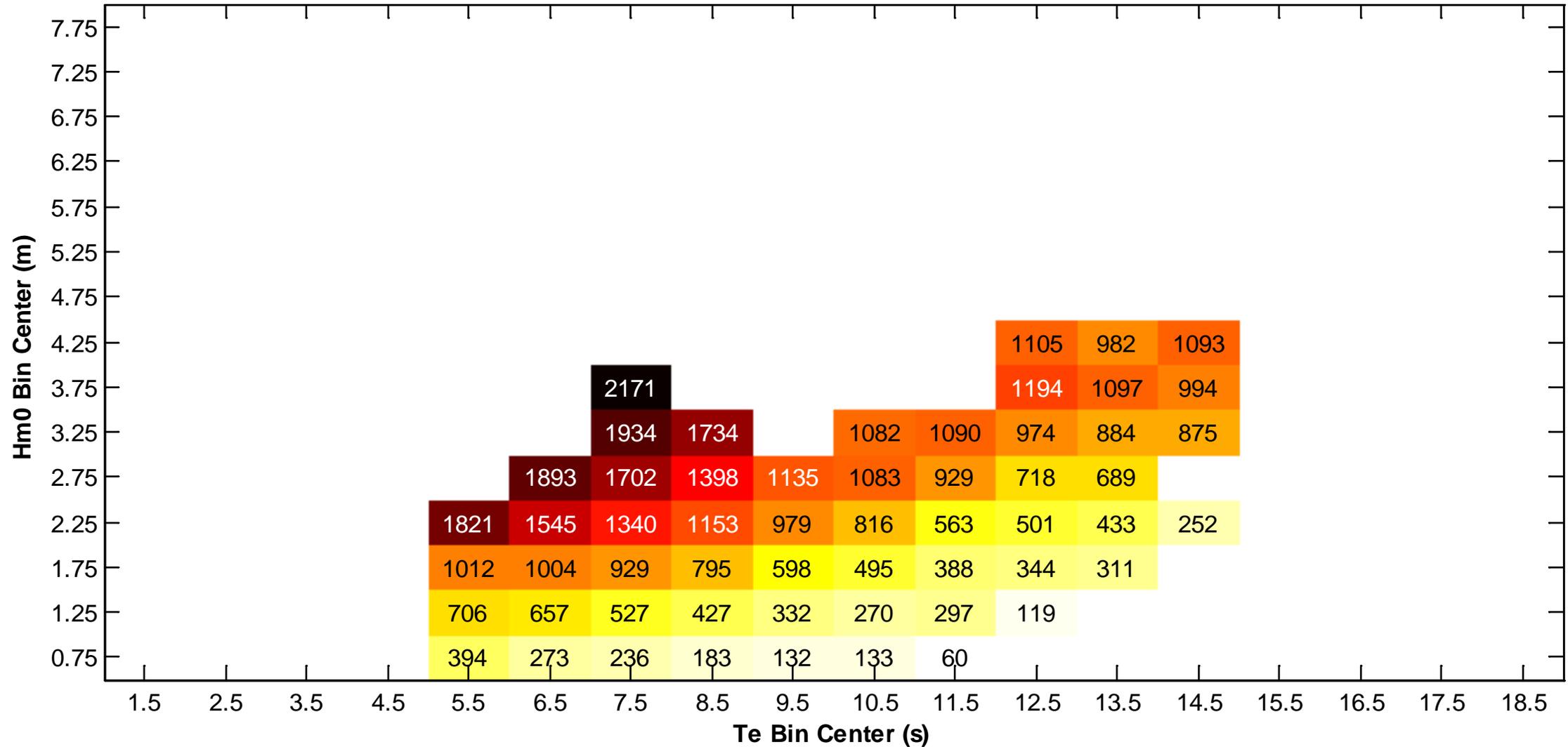
Azura Power Performance – Jan-May 2016



95th percentile power matrix

95th Percentile Device Dc Output Power (W)

Cumulative data, months of Jan 2016 - May 2016; 30 min periods with > 20 min operation and constant disp. control included



Attachment 2

Azura 30 minute average float angle data plots

Azura 30 minute average float angle data – May 2016

Summary

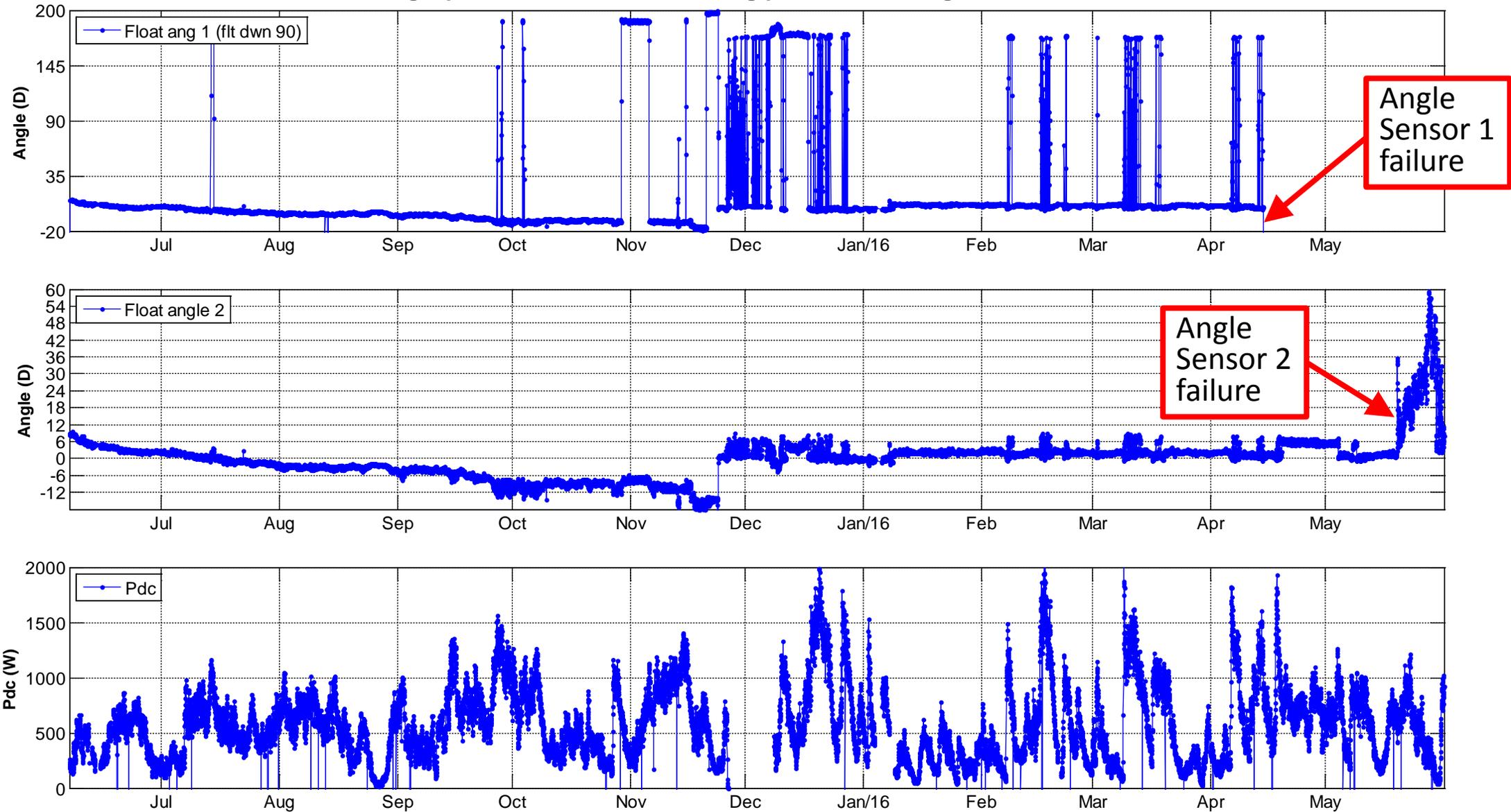
- See Slide 2 for plot of June 2015 – May 2016 data
- Angle sensor 2 failed in mid-May 2016 and has had a large zero drift since then. Videos of the device confirm that the average float angle readings during the second half of May have been incorrect.
- Angle data before mid-May indicates that the device ballasting has been near ideal and steady since Dec 2015.
- Angle sensor 1 failed a month earlier, on April 14.

Azura 30 min average float angle data through May 2016



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Float angle plots from file NWEI 30m avg power w float angle 201506 to 201605.txt



Attachment 3

Azura cRIO enclosure and drybox humidity plots

Azura cRIO enclosure and drybox humidity May 2016

