Essential Changes to Monte Carlo Model

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IEEE P802.3aq 10GBASE-LRM Task Force

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Discovering Beyond Imagination

Introduction/Summary

The Monte Carlo 67YY set needs to be improved to give accurate estimates for the proposed 802.3aq LRM launch conditions, which have changed since the Nov 2004 meeting in San Antonio where the set was presented (abbott_1_1104.pdf) .

The issues and shortcomings of the current set will be summarized.

These include not only the mode delays of the set but also the appropriate mode power distributions which should be used in modeling.

Outline

(A) Issues/shortcomings of the Monte Carlo set.

(B) An example of how modifying the mode power distribution improves the accuracy of the set, even without modifying the mode delays.

(C) Suggested prioritization of improvements needed for 802.3aq LRM

Issues

1. The Monte Carlo set approximates the 98-99 fiber distribution of Corning & OFS. It underestimates the extent of **center perturbations** allowed by the FDDI OFL BW spec which are seen in earlier fiber from all manufacturers and current FDDI fibers from some manufacturers. Because the LRM proposal now has a dual launch condition using a center launch, improving the MC set is essential.

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Issues continued.

2. The Monte Carlo set approximates the "bottom half" of the Corning/OFS 98-99 fiber distribution but overpredicts the upper 50%tile of OFLBW and offset BWs compared to actual data. It may be necessary to address this because of the dual launch statistics.

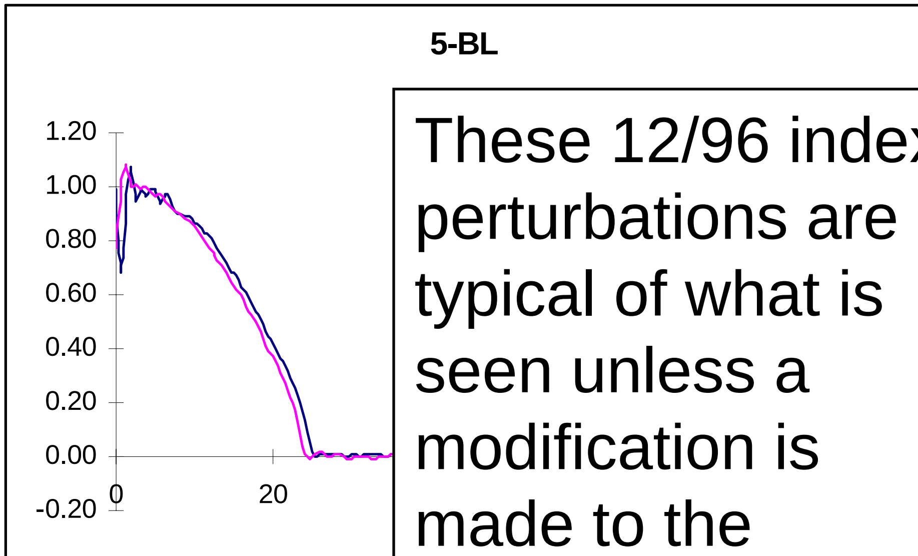
3. The Monte Carlo set shows little correlation between the center-launch PIE-D and offset launch PIE-D; actual data clearly indicates a higher correlation. This needs to be studied further to give the dual launch a solid basis.

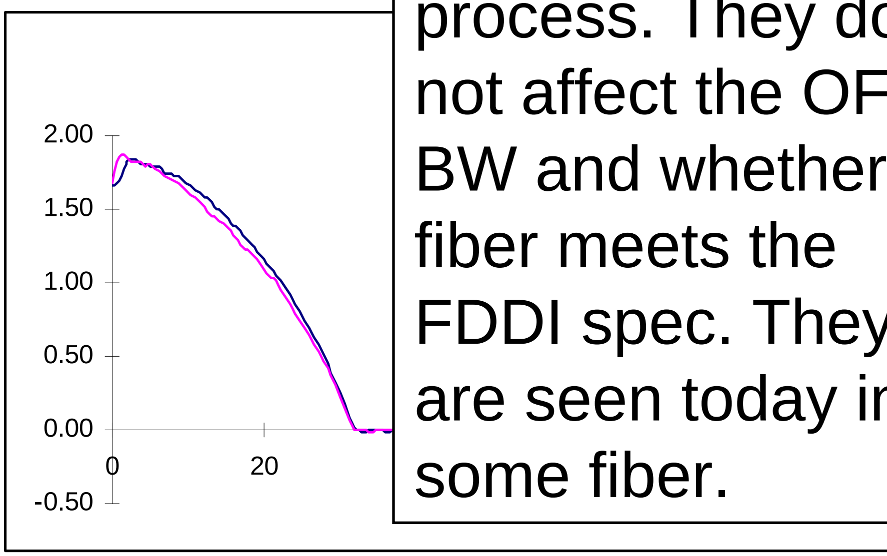
Issues continued.

4. The predicted BWs and PIE-D depend on both mode delays and mode power distribution.

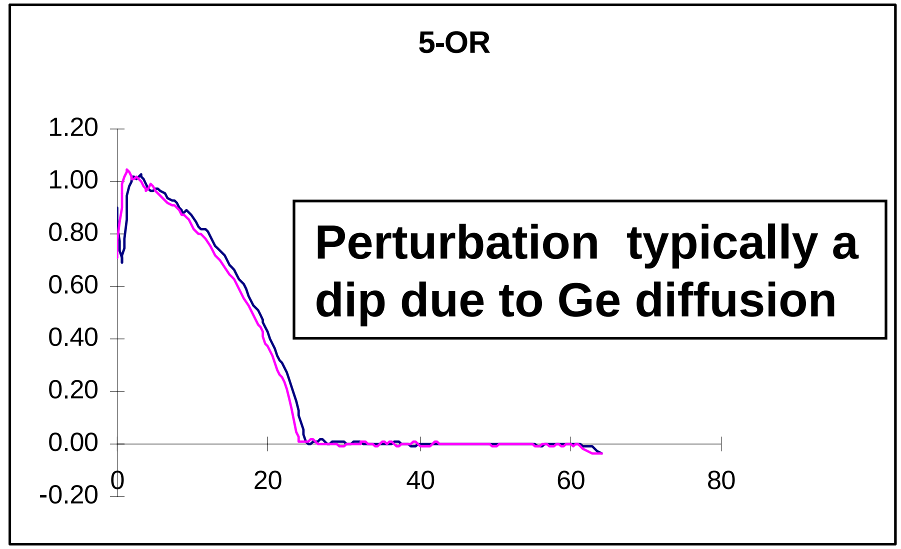
   The predicted BWs using theoretical MPDs are unrealistically high for 0um and 1um offset launches. It appears this needs to be corrected by adjusting the mode power distribution. This is consistent with observations by Agilent, Infineon, Big Bear, and others that the BW and/or PIE-D is sensitive to the polarization or movement of the fiber. It appears that to model the BW conservatively a worst-case modal power weighting needs to be assumed.

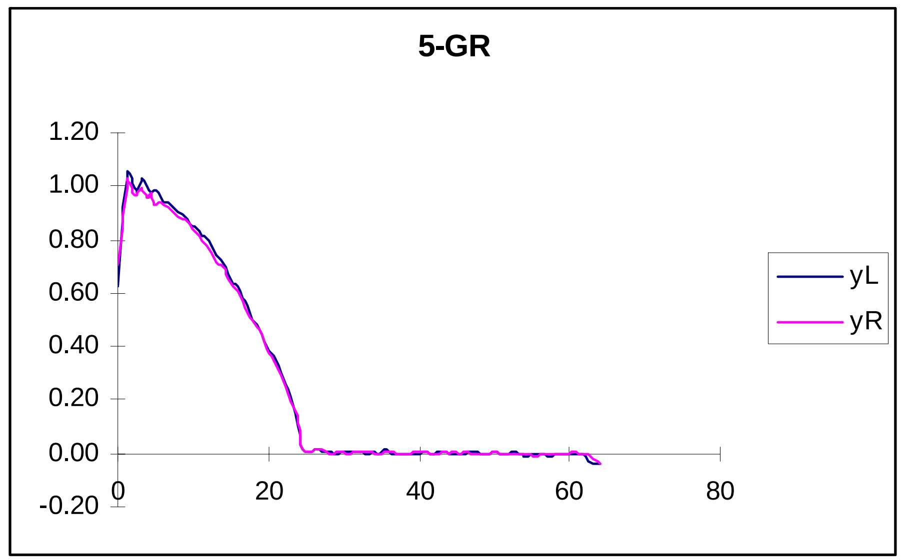
Issue 1 – center perturbations in 12/96 demo





These 12/96 index perturbations are typical of what is seen unless a modification is made to the process. They do not affect the OFL BW and whether a fiber meets the FDDI spec. They are seen today in some fiber.

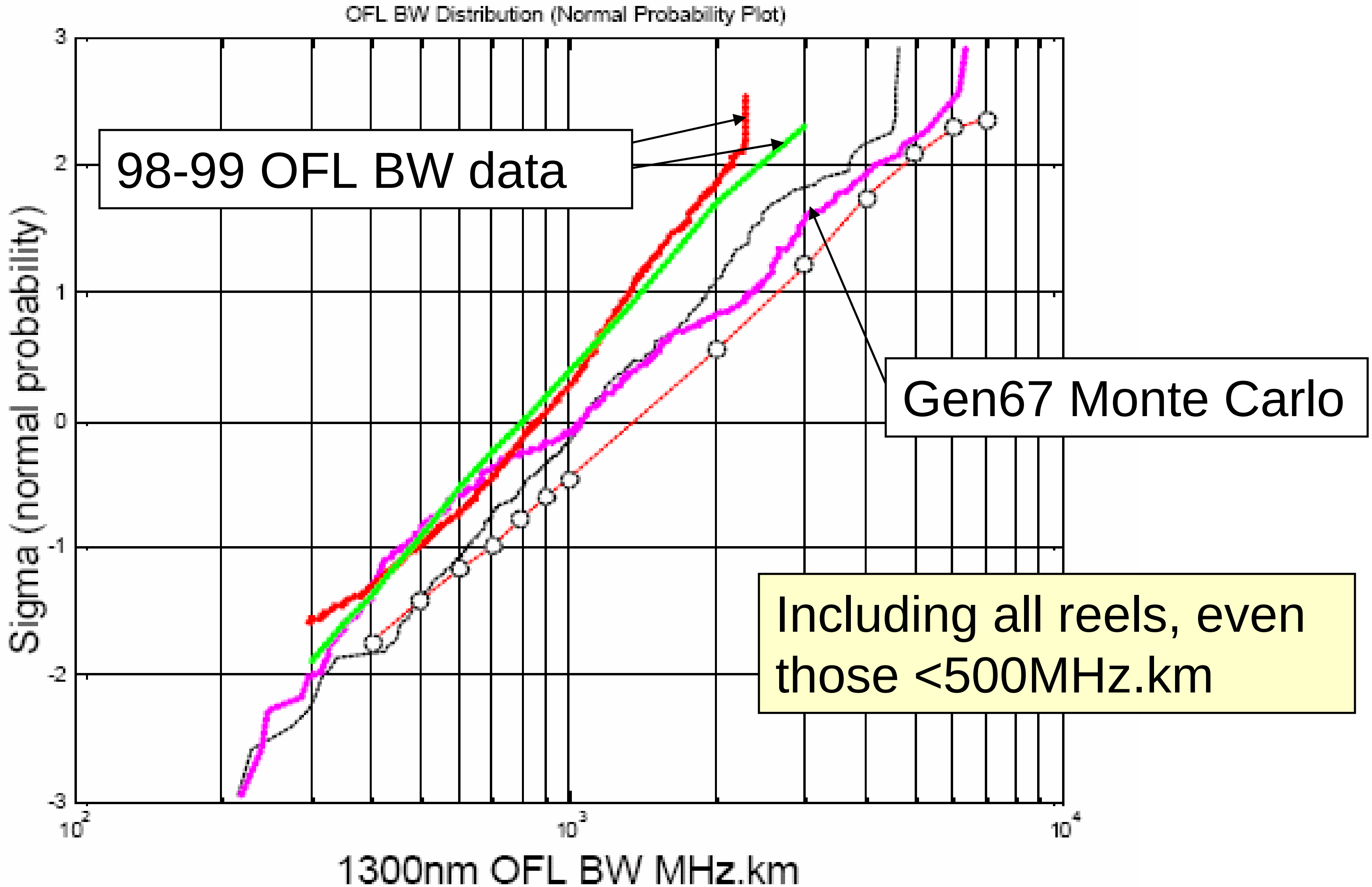




Issue 2 – Improving Fit of Monte Carlo set to Corning-OFS 98-99 data

(Gen67 overpredicts BW)

OFL BW distributions from abbott_1_1104.pdf



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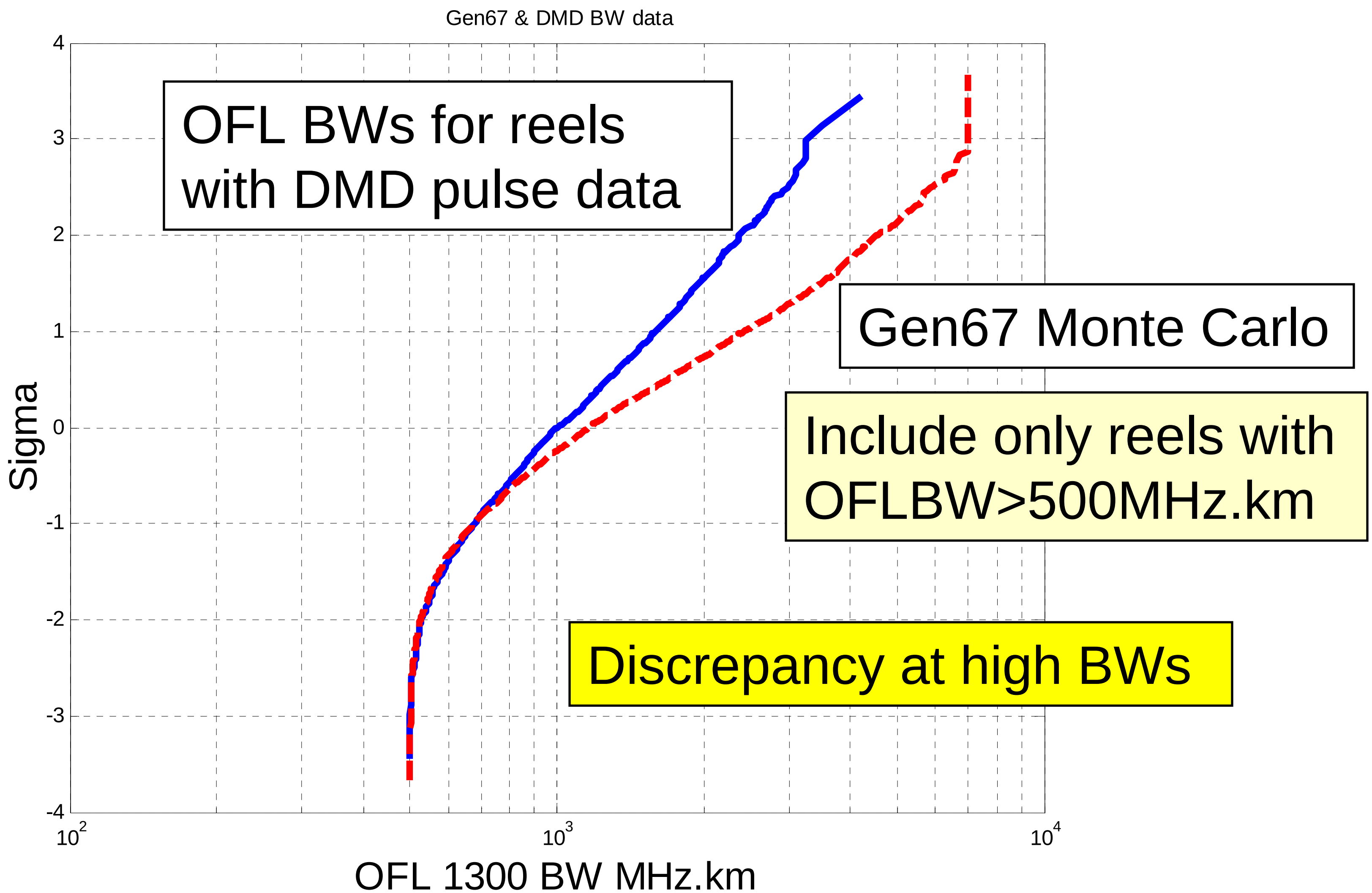
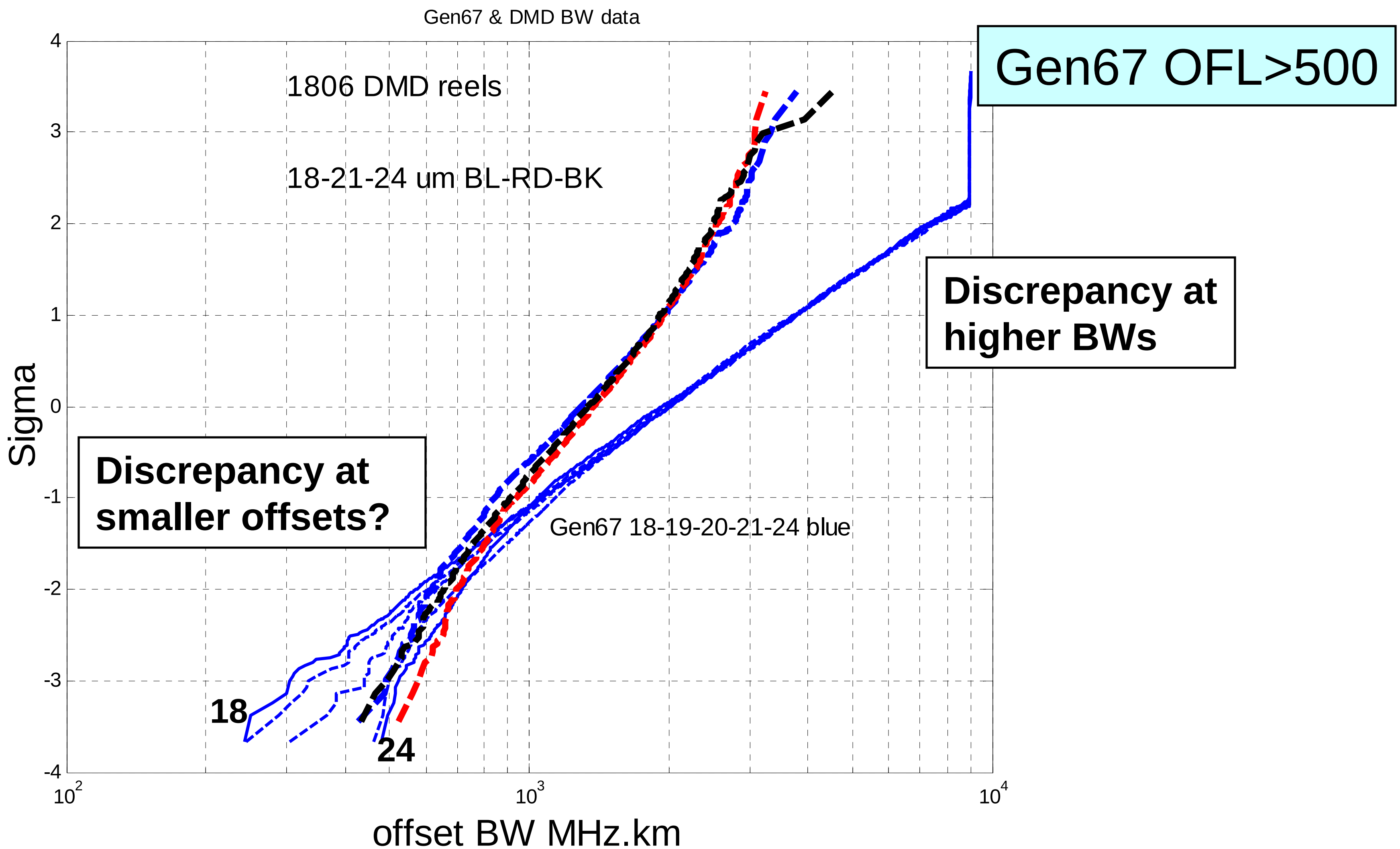
OFL BW distributions for Gen67 & DMDset

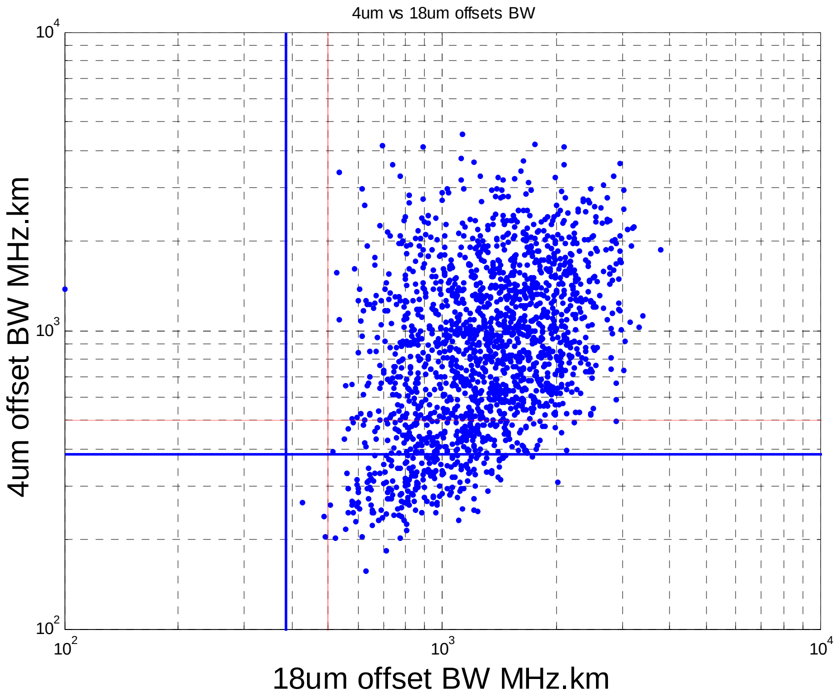


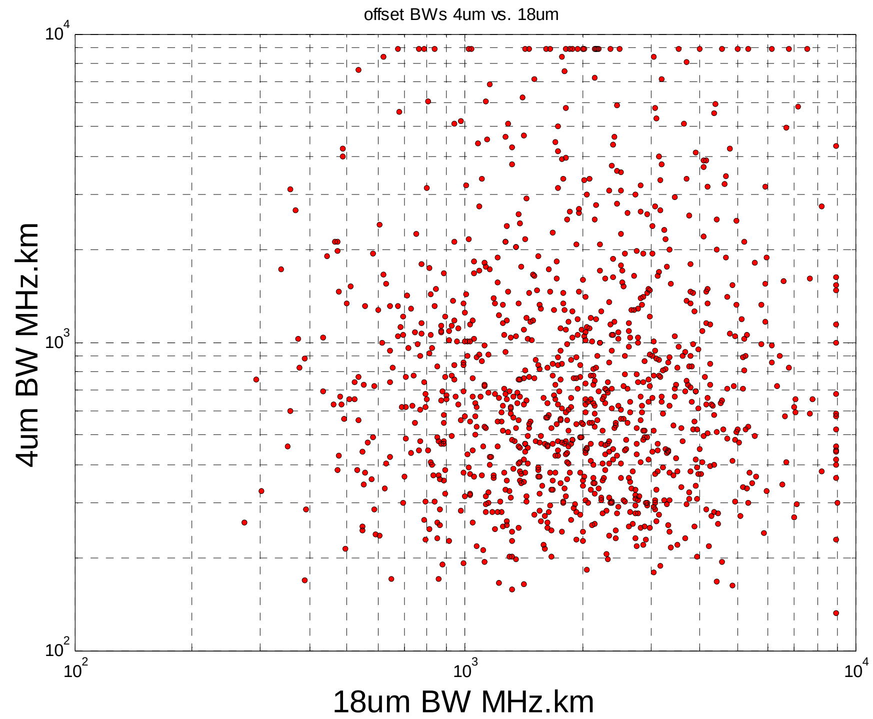
Offset BW distributions for 18-24 offsets



Issue 3 – Correlation between center launch PIE-D and offset launch PIE-D

Correlations relevant to dual launch





1998-99 DMD pulse data: low 4um BW tends to go with low 18um BW.

Gen67YY

Issue 4 – BW & PIE-D depend on both mode delays and mode power distribution.

Work in 802.3aq suggests that the MPD between groups can vary, depending on launch, polarization, shifting of the fiber, etc.

The MPD used in Monte Carlo simulations needs to reflect this. In 1GbE the MBI developed the idea of worst case modal BW with equal power among relevant groups and this still seems relevant.

Index Profile --- measured DMD

For ~20% of the fibers we have overlapping data sets: DMD pulse data as well as a measured index profile from the same blank (not same fiber). This can give some insight into what index perturbations need to be included to model the 98-99 fiber data, and what MPDs are needed to predict the fiber measurements.

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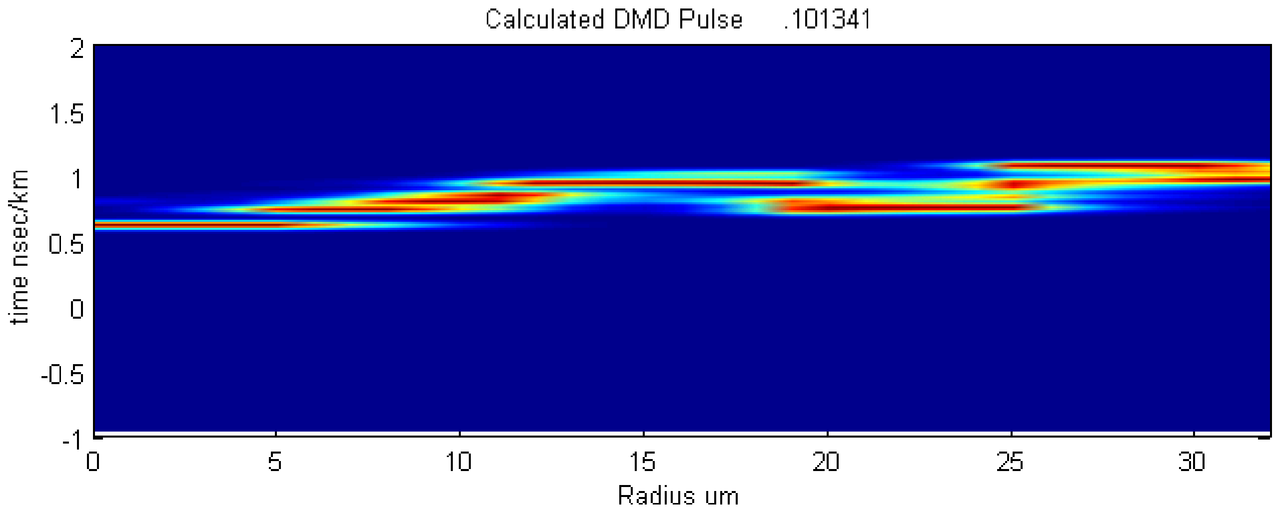
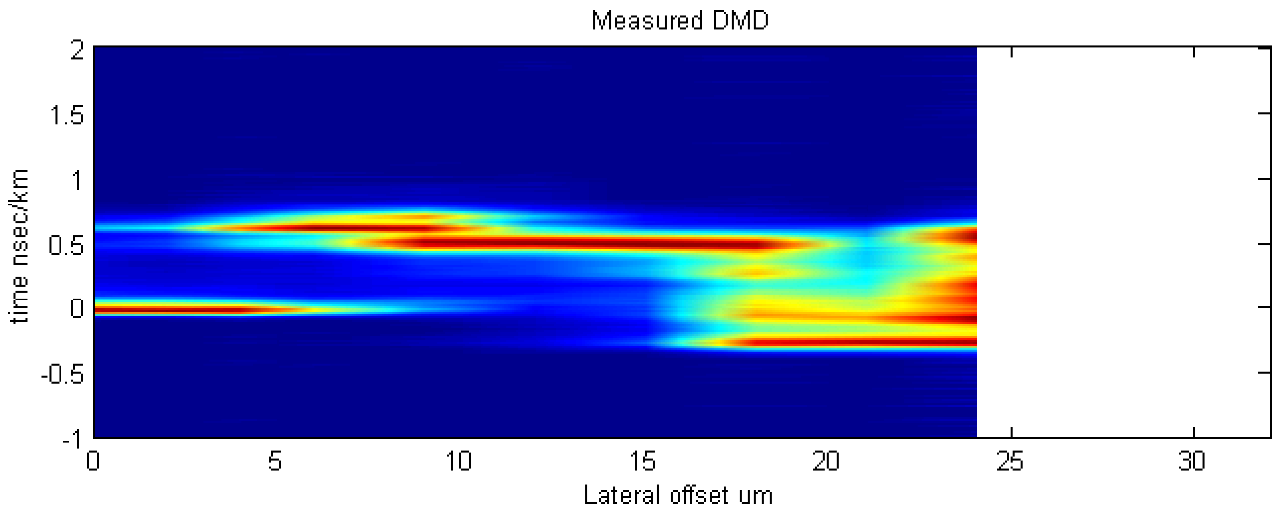
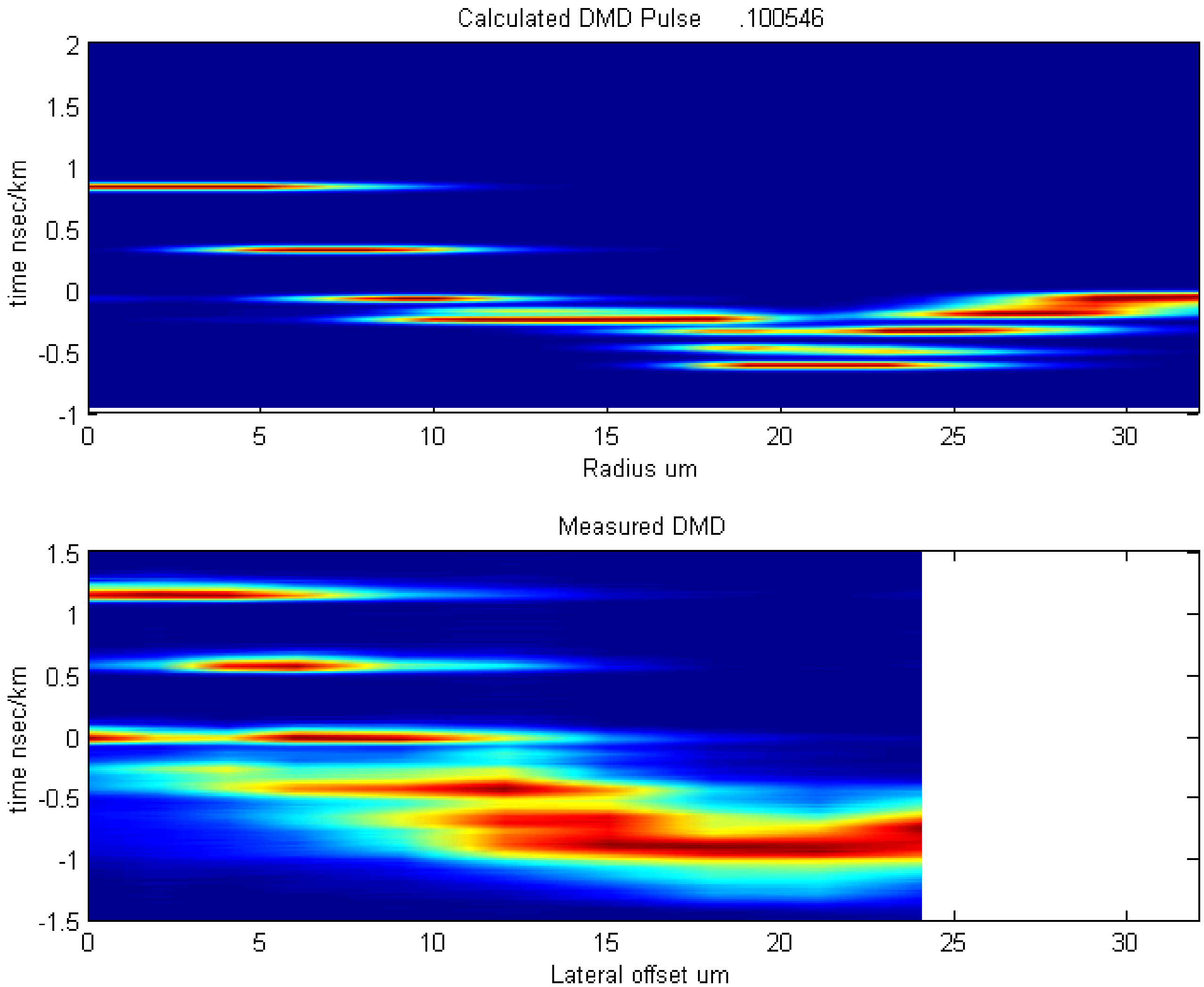


Calculated DMD Pulse .101341
time nsec/km
2
1.5
1
0.5
0
-0.5
-1
0
5
10
15
20
25
30
Radius um

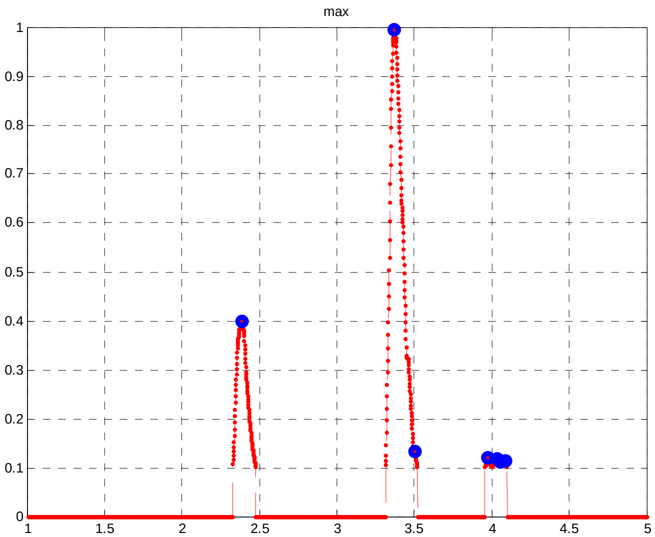


Measured DMD
time nsec/km
2
1.5
1
0.5
0
-0.5
-1
0
5
10
15
20
25
30
Lateral offset um

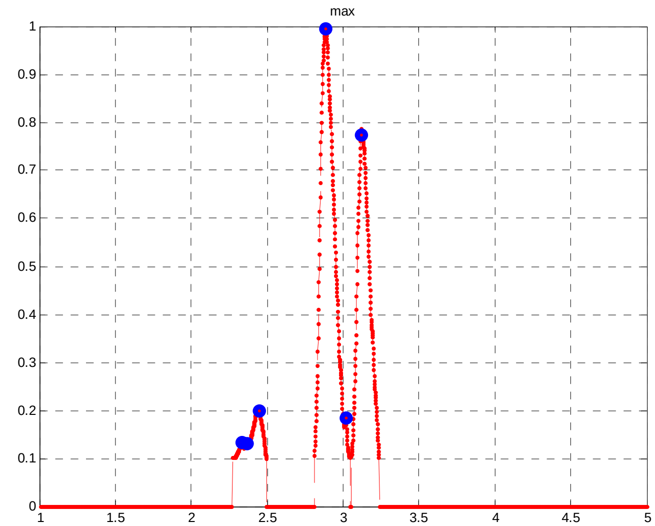
100546

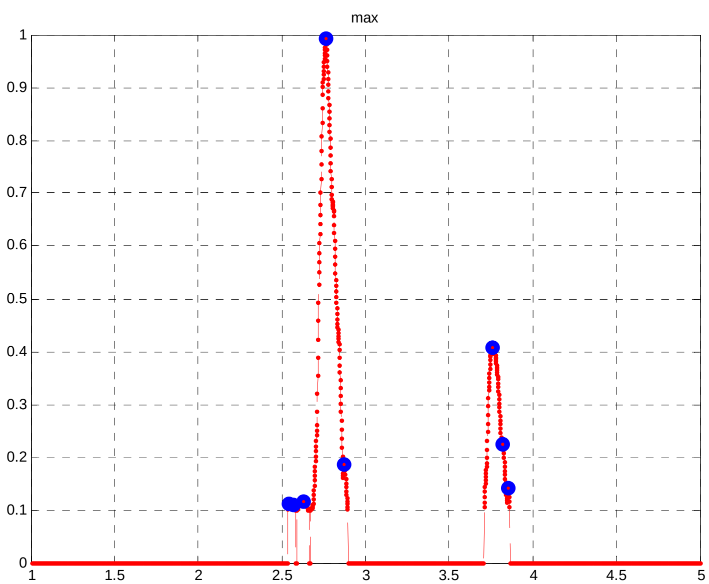

Calculated DMD Pulse .100546
time nsec/km
2
1.5
1
0.5
0
-0.5
-1
0
5
10
15
20
25
30
Radius um
Measured DMD
time nsec/km
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20
25
30
Lateral offset um

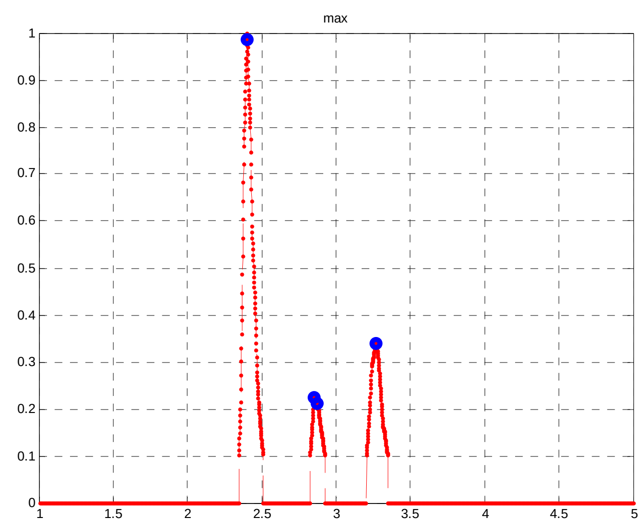
Examples of peak finding in DMD pulse data



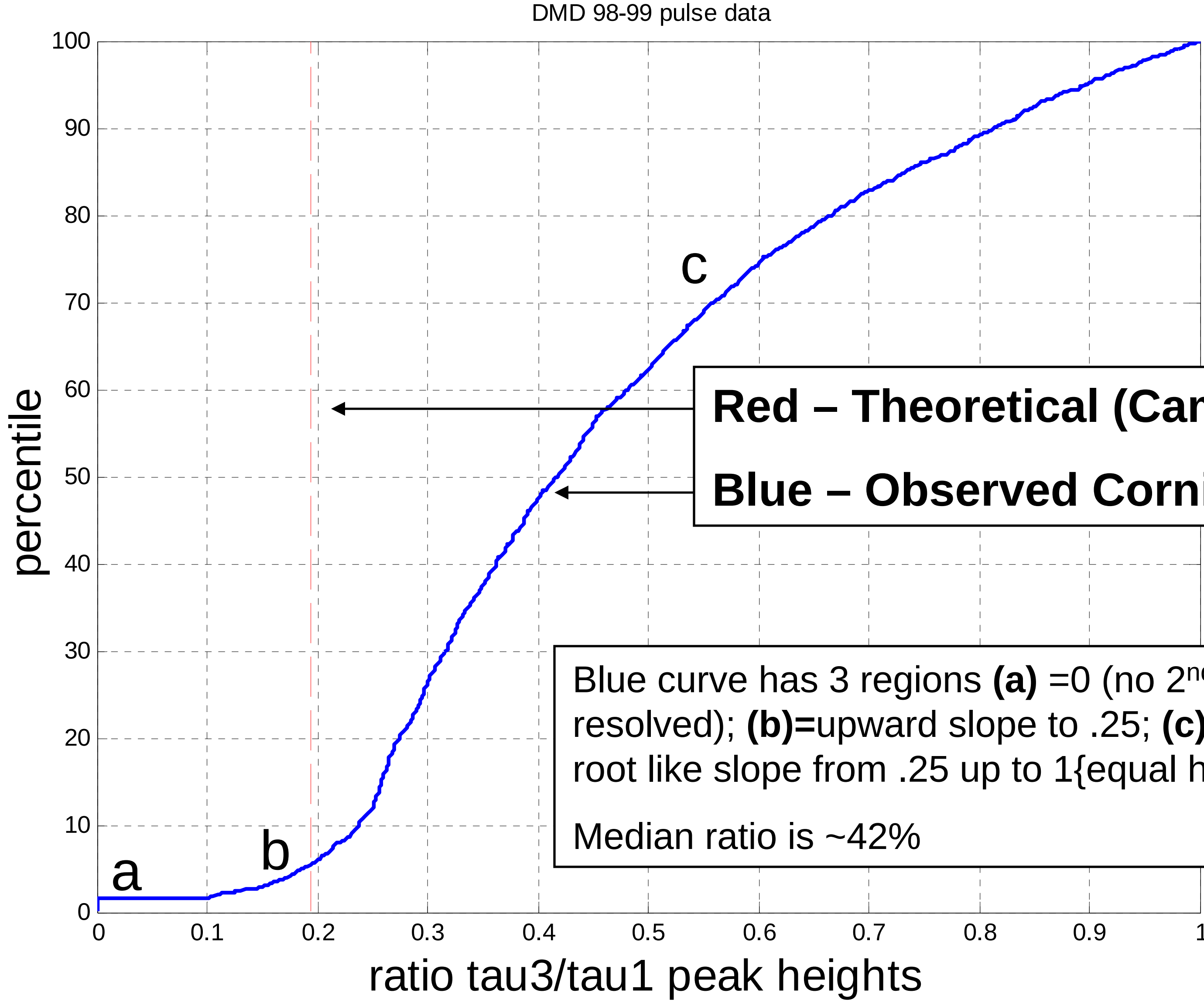
0um launch







Ratio of peak heights: tau3 to tau1



Red – Theoretical (Cambridge) =.194

Blue – Observed Corning 98-99 DMD

Blue curve has 3 regions **(a)** =0 (no 2nd peak resolved); **(b)=**upward slope to .25; **(c)** square-root like slope from .25 up to 1{equal height}.

Median ratio is ~42%

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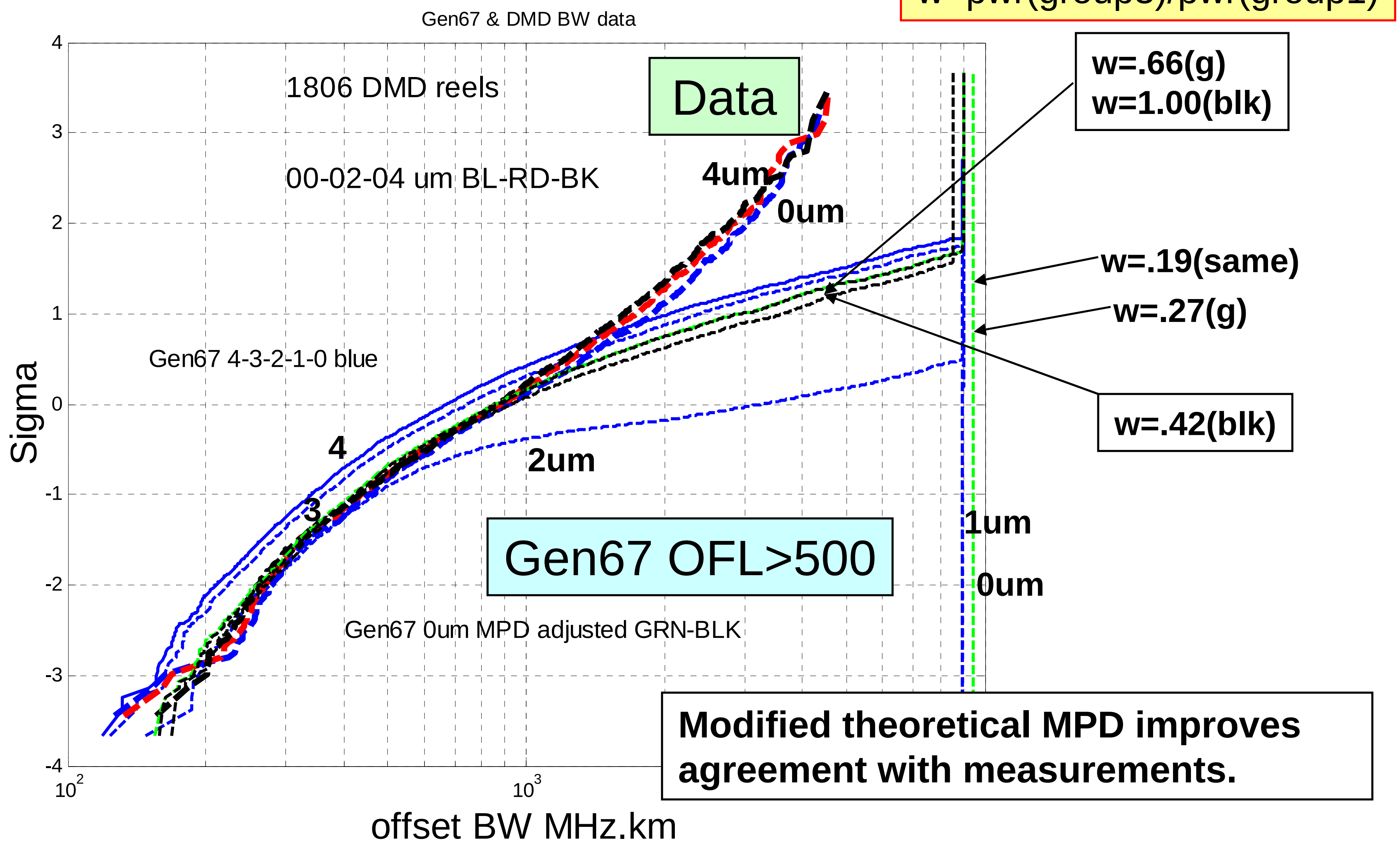
Example of how modifying the mode power distribution improves the accuracy of the set

BW distributions for near-0um offsets

w=pwr(group3)/pwr(group1)



Modified theoretical MPD improves agreement with measurements.

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Conclusion: Prioritizing

Suggested Priority assuming Dual Launch:

1. Include larger center perturbations approximating a consensus of installed base.

2. Test alternate MPD consistent with DMD pulse data and measurements at Agilent/Infineon/IBM/Big Bear etc. of demo cable fibers. (Analogous to ROFL?)

3. Re-check correlation between center launch & offset launch after (1) and (2).

4. Adjust mode delays to better match OFL BW distribution; is this tied to correcting offset MPDs?

Use available data.

Additional Slides.

PIE-Ds for examples with predicted and measured DMDs.

PIE-Ds for selected DMDs from 1806 set.

PIED04	**PIED18**	PIED21	PIED24	NEWFIBERID
4.936	4.513	5.966	7.936	102537
5.580	4.096	5.681	6.992	102686
6.522	4.655	5.524	4.456	101264
6.541	4.403	5.392	4.218	102628
6.125	5.838	5.232	4.425	102522
5.476	5.421	5.158	3.657	100953
5.280	3.859	5.156	3.981	100886
4.939	6.093	5.023	6.445	101341
6.135	4.292	4.972	5.617	101756
5.536	3.506	4.794	3.055	101044
6.208	5.461	4.791	4.524	100546
6.259	5.091	4.790	4.814	101045
5.137	4.865	4.754	3.728	101345