Revised OM2 Monte Carlo modeling set.

802.3aq LRM and T11.2 Fibre Channel: Comparing “Step3” & “Step2” datasets

John Abbott Corning Incorporated

Including 1300nm results of John Ewen JDSU

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Summary

A modified OM2 distribution based strictly on the Gen67YY OM1 distribution but shifted to match the OFL BW distribution of a set of 1998-99 fibers is presented.

This distribution has center perturbations of a similar magnitude as OM1, and similar EMBs with small offset launches, but matches the measured OFL BWs reasonably well.

Testing by J. Ewen shows a significantly higher LX-4 coverage, allowing a 'scaling' at a higher %tile level.

The data set still has a lower LX-4 coverage than OM1, because of the fraction of fibers optimized for 850nm and the effect of center perturbations being larger at the smaller OM2 offset patchcord position. The 'scaled' LRM results show OM2 being slightly better than OM1, while the 'unscaled' LRM results are consistent with the LX-4 results and show OM2 being slightly worse than OM1.

This distribution is recommended for OM2 modeling in LRM & T11.2;

1300nm data at http://www.ieee802.org/3/aq/public/tools/index.html

Introduction-Background

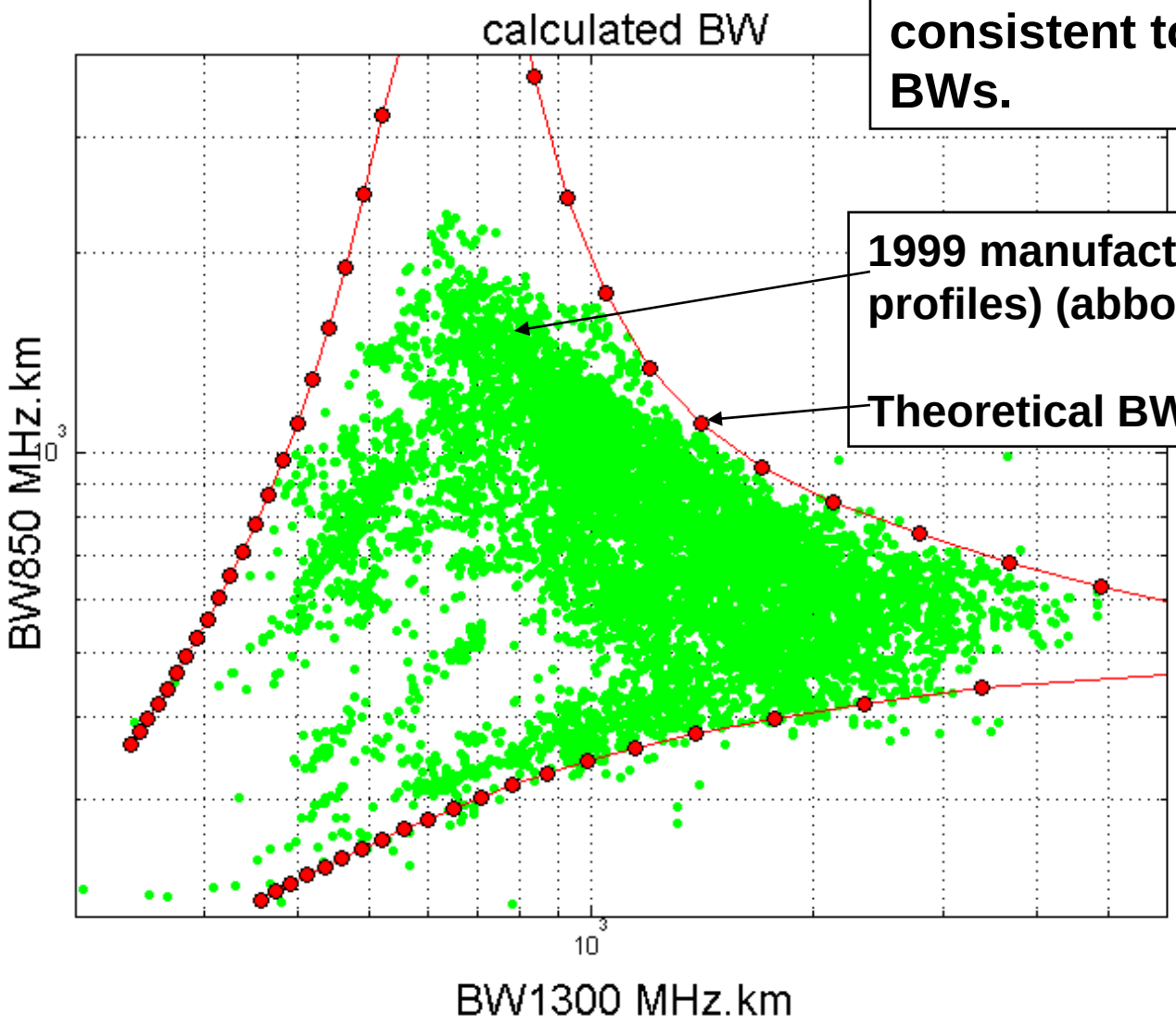
At the 7/2005 LRM meeting in San Francisco an OM2 model data set was presented. 5000 mode delay sets suitable for OM2 were 'shifted' from the MC67YY data set and the modes calculated at both 850nm & 1300nm. This data set was called "Step 2" and it was expanded to 30,000 sets in "Step 3". 5000 'fibers' from the Step 3 set were select to best-fit historical OFL BW data and this was the 850&13000 mode delay sets recommended to 802.3aq LRM(1300) & T11.2(850)

As an alternative we took the Step 2 data, and fit it to 5000 random fibers chosen from the the historical data, and compared to Step3. Step 2 and Step 3 agree in the 1300nm OFL BW distribution and 16um offset BW distribution, but the Step 2 distribution has smaller perturbations near the center. Its 4um-5um BW distribution is similar to that of MC67YY.

We suggest using the Step 2 data as an alternative, 'upper bound' to the Step 3 in initial LRM & T11.2 modeling, but feel that a modified Step 3 process is probably the best approach.

Step 1: reference data

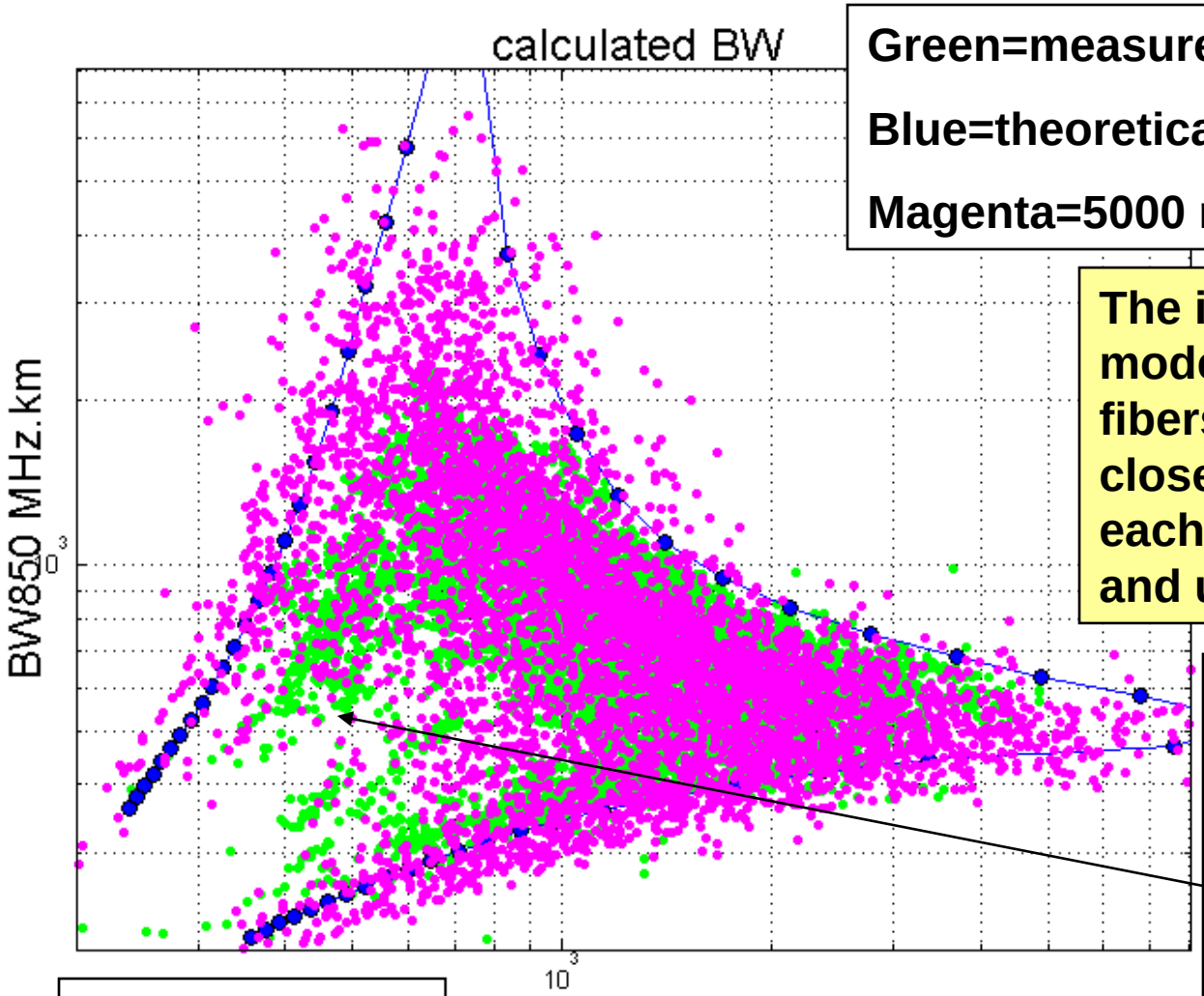
Idea is to force Monte Carlo mode delays to be consistent to measured BWs.



1999 manufacturing data (9000 profiles) (abbott_1_0105.pdf)

Theoretical BWs for α-profiles

Step2: all 5000 model fibers (abbott_1_0705.pdf)



Green=measured data

Blue=theoretical α profiles

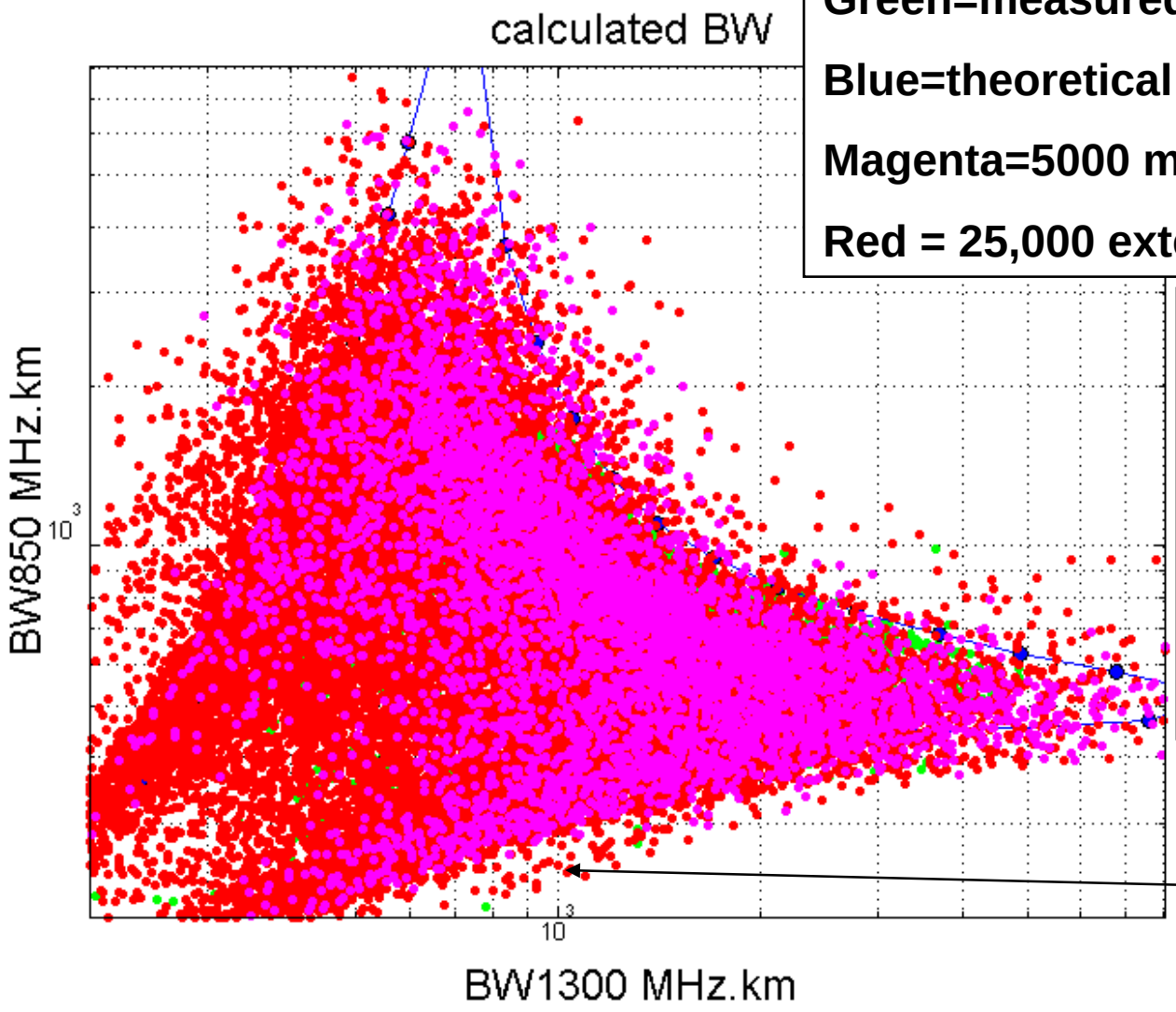
Magenta=5000 model fibers

The idea is to use the model fibers as "test fibers" and find the closest "test fiber" to each "measured fiber" and use that for MC set

NOTE STEP2 does not completely cover the measured distribution

We will only use fibers with OFLBWs>500

Step3: 30000 fibers (abbott_1_0705.pdf)



Green=measured data

Blue=theoretical α profiles

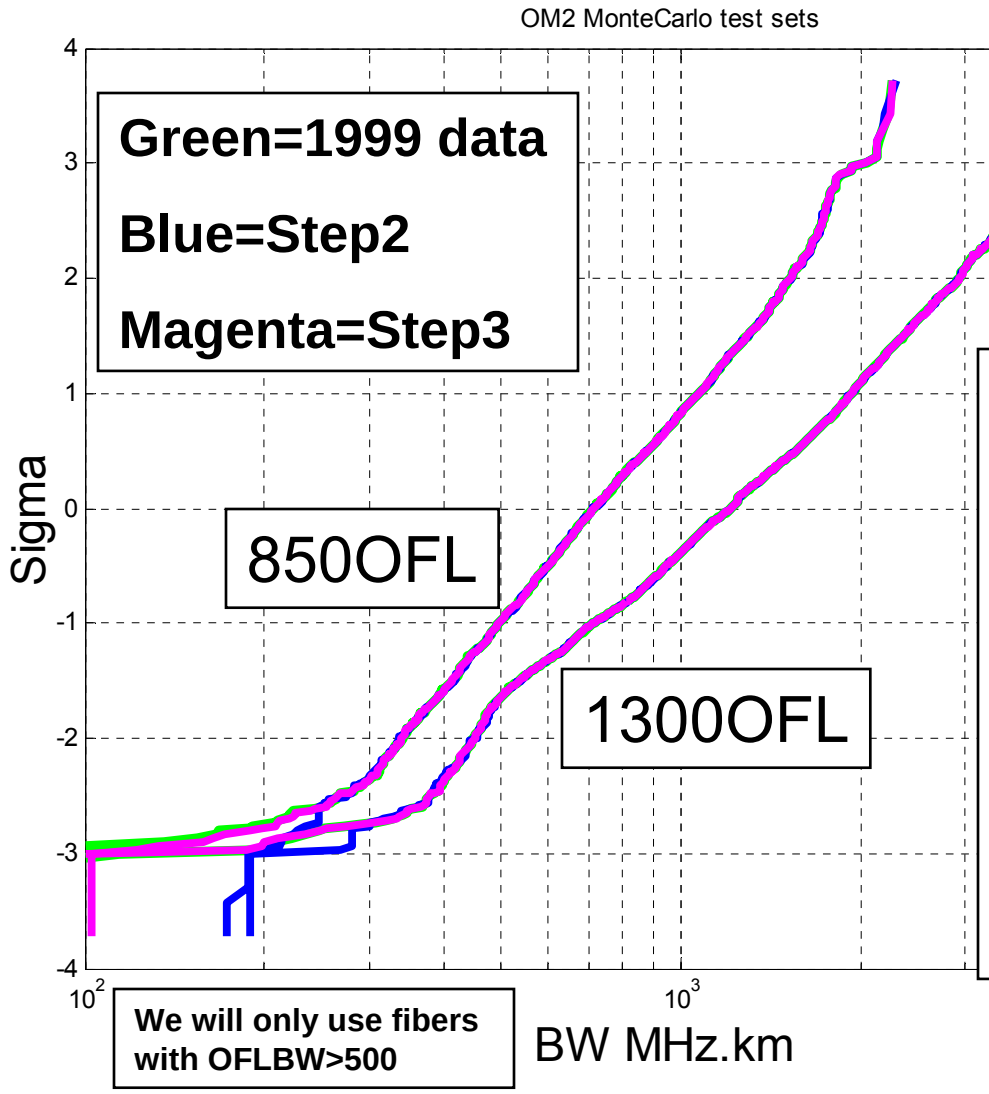
Magenta=5000 model fibers

Red = 25,000 extended model fibers

The idea is to use the model fibers as "test fibers" and find the closest "test fiber" to each "measured fiber" and use that for MC set

NOTE STEP3 may have introduced too much variability

Both Step2 & Step3 match OFL BW distribution



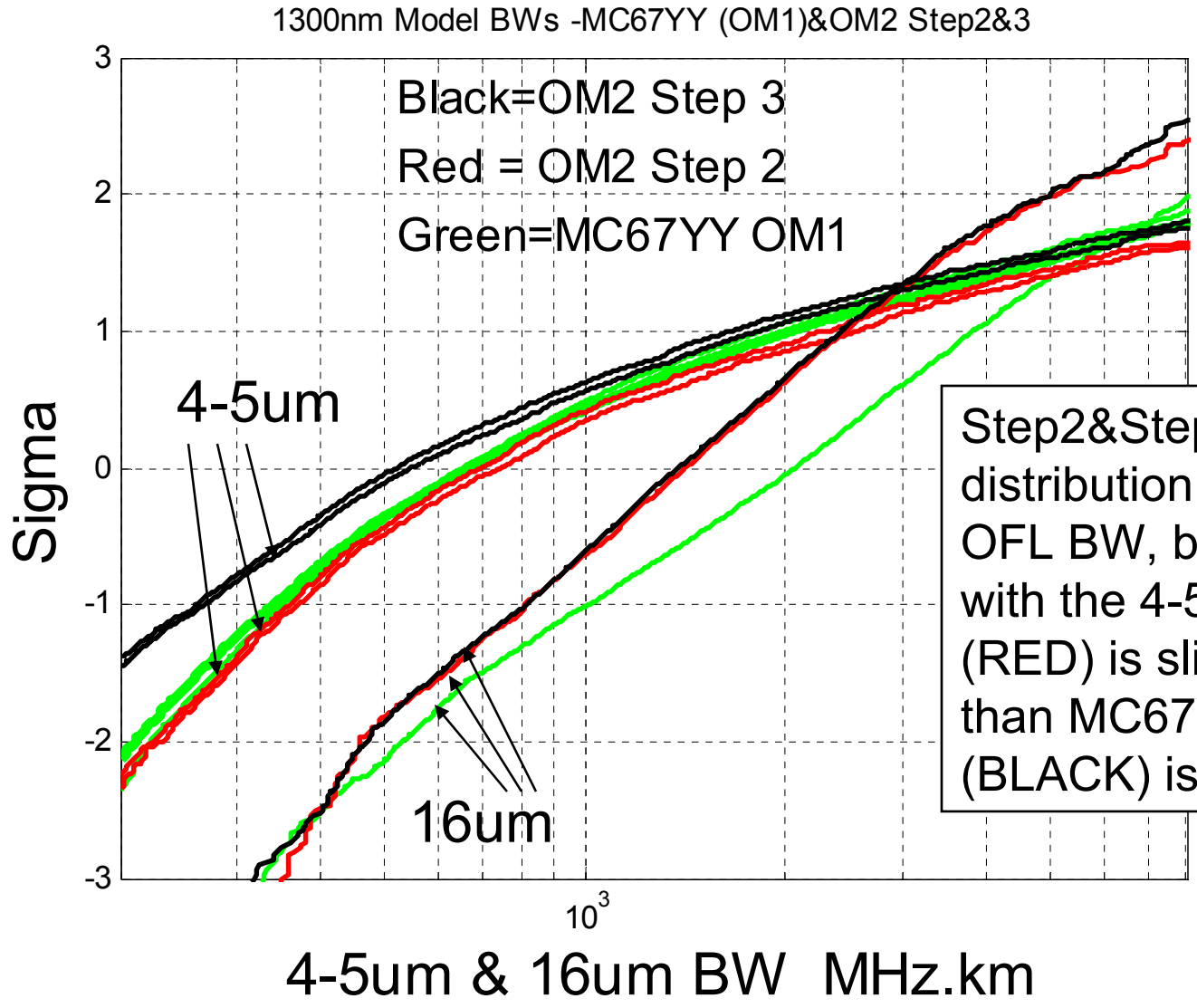
The two model distributions overlay the actual data

Green=1999 data

Blue = **STEP2**: 5000 fibers derived from Gen67

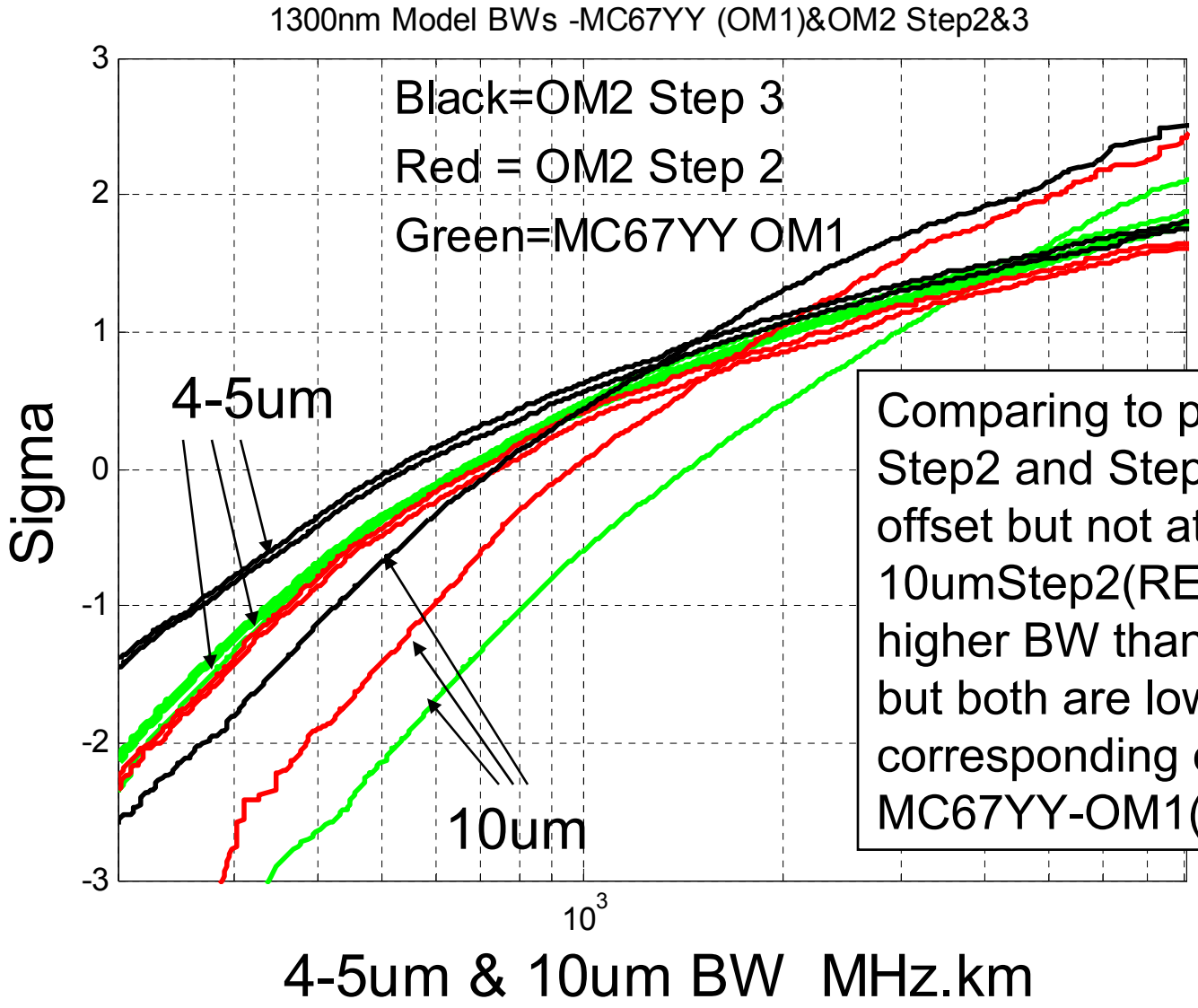
Magenta=**STEP3**: 30,000 fibers derived from Gen67 + 25,000 scaled fibers

Cumulative Probability Plots – offset BW



Step2&Step3 agree with 16um distribution, as they did for OFL BW, but they disagree with the 4-5um offset. Step 2 (RED) is slightly higher BW than MC67YY and Step 3 (BLACK) is lower.

Cumulative Probability Plots – offset BW cont.



Comparing to previous slide, Step2 and Step3 agreed at 16um offset but not at 10um offset. At 10umStep2(RED) is definitely a higher BW than Step3(BLACK), but both are lower than the corresponding offset with MC67YY-OM1(GREEN).

Summary of Observations

1. Step2 distributions matches OFL BW distribution of measured data (like Step3), especially above 500MHz.km
2. Step2 distribution gives a 4-5um offset BW distribution similar to OM1, consistent with similar center perturbations which stay relatively constant as the OM1 distribution is reduced to an index perturbation and then shifted toward 850nm.
3. Step2 & Step3 distributions are similar for 16um offset – larger offsets correlate more with OFL launch. Step2 10um EMB distribution is shifted higher than Step3.
4. OM2 16um EMB is shifted DOWN from OM1 16um EMB

Suggestions

1. **Use Step2 distribution for test-modeling**
2. Modify Step3 distribution: rather than using a multiplier in tau from 1.2 to 2.0 (1.2,1.4,1.6,1.8,2.0), use (1.04,1.08,1.12,1.16,1.20) for Step 3b. Check coverage plot and 1300nm offset results.
3. Generate a Step2 type distribution by re-generating the underlying OM1 distribution with a set of 10,000-40,000 data points, rather than using an augmentation procedure between steps 2 & 3. This ensures that the distribution of perturbations is consistent between the OM1 & OM2 data sets.

BACKUP

Ewen modeling using OM2 Step2 data set

Summary of OM2 Step2 LRM coverage

Scaled as previous JE OM2 procedure

(single link coverage)

94.4% gives 220m PIE-D = 3.6 300m PIE-D = 4.05

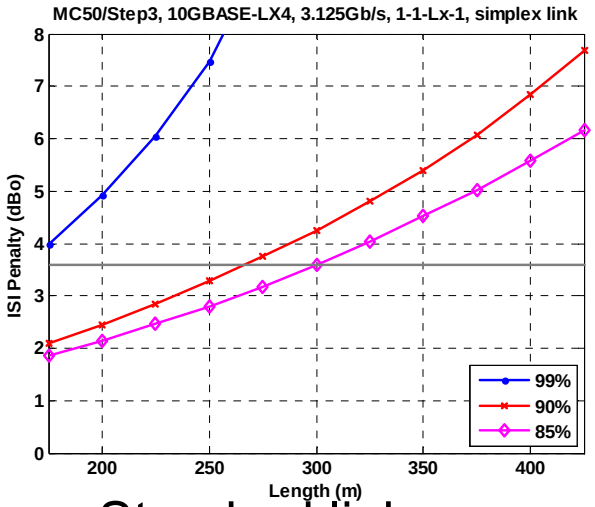
Unscaled to 99% as JE OM1 procedure

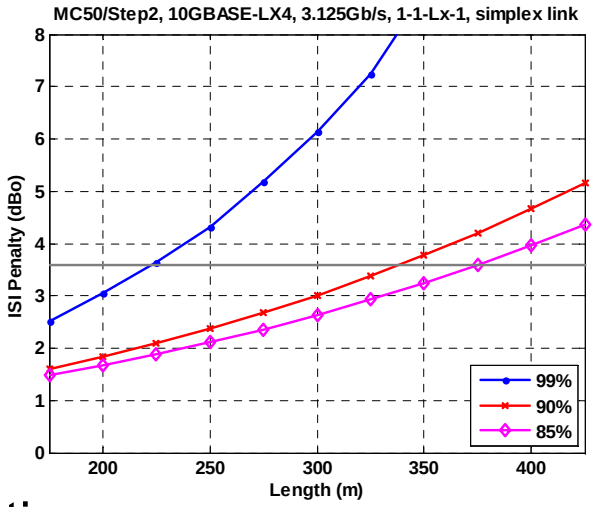
99% gives 220m PIE-D = 4.25 300m PIE-D=4.55

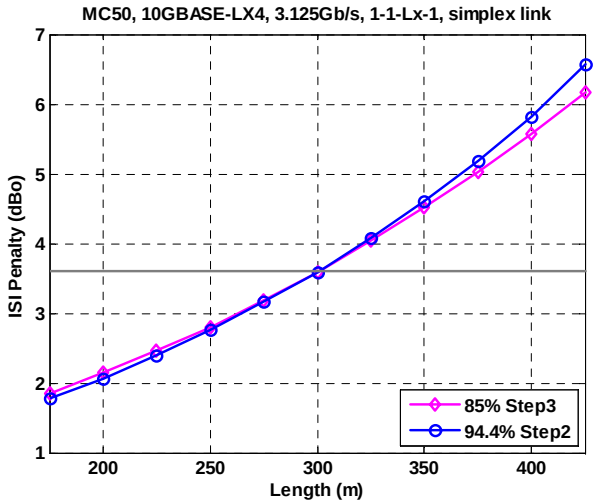
OM1 (http://www.ieee802.org/3/aq/public/sep05/ewen_1_0905.pdf)

99% 220m PIE-D= 4.05 300m PIE-D=4.55

MC50 / 10GBASE-LX4: Step2 vs. Step3 [JE]

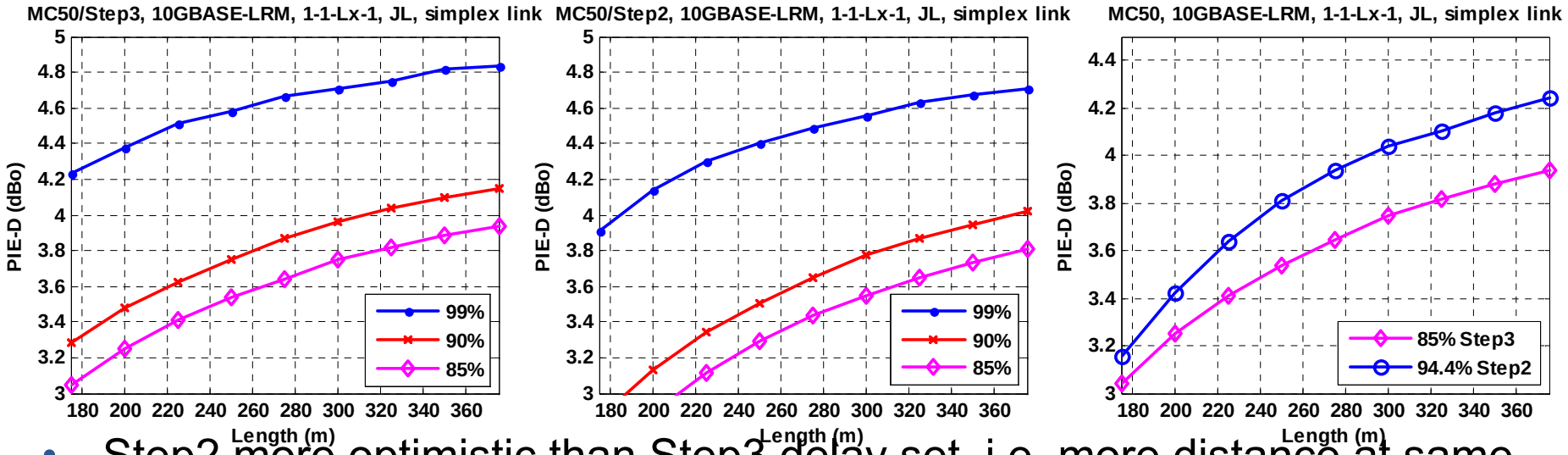






- Standard link assumptions
  - Rayleigh distributed connector offsets, 50µm offset launch (10µm → 16µm offsets), total connector loss ≤ 1.5dB, only passing fibers included (≥500MHz·km OFL BW at 850nm & 1300nm)
- Step2 more optimistic than Step3 delay set
- 3.6dB ISI penalty (spreadsheet limit)
  - 85%-tile for Step3 delay set
  - 94.4%-tile for Step2 delay set

MC50 / 10GBASE-LRM: Step2 vs. Step3 [JE]



- Step2 more optimistic than Step3 delay set, i.e. more distance at same PIE-D and %-tile
- Using LX4 as benchmark → Step2 more pessimistic than Step3
  Step2 @ 94.4%-tile give less distance than Step3 @ 85%-tile
  - "Benchmarked" Step2 LRM curve is offset from Step3 LRM curve
  - "Benchmarked" LX4 curves are very similar for Step2 & Step3 delay sets
- Step3 predicts OM2 dramatically better than OM1
- Step2 predicts OM2 slightly better than OM1

NOTES on # of groups

OM1 1300: 20+ groups, using 19 (file has 19 groups)

OM2 850: 18-19 groups, using 17 (file has 18 groups)

OM2 1300: 12-13 groups, using 10 (file has 12 groups)

OM3: same as OM2