TWDP Assessment

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General Procedure

- **Data has been collected for an EML [ER=6dB] using the 2^9-1 pattern and capturing 8 samples / UI for processing through the TWDP code**
- **The current suggested pre-cursor, post-cursor and split-symmetic stressors have been applied with the ISI and PIE-D parameters given below**
- **The fibre emulation was also temporarily removed from the TWDP code and replaced with an "ideal" channel [labelled "No Stressor" on the plots]**

ISI Taps	*Pre-Cursor*	*Split-Symmetric*	*Post-Cursor*
A1	0.168	0.000	0.254
A2	0.188	0.513	0.453
A3	0.527	0.000	0.155
A4	0.117	0.487	0.138
PIE-D	3.824	3.825	4.197

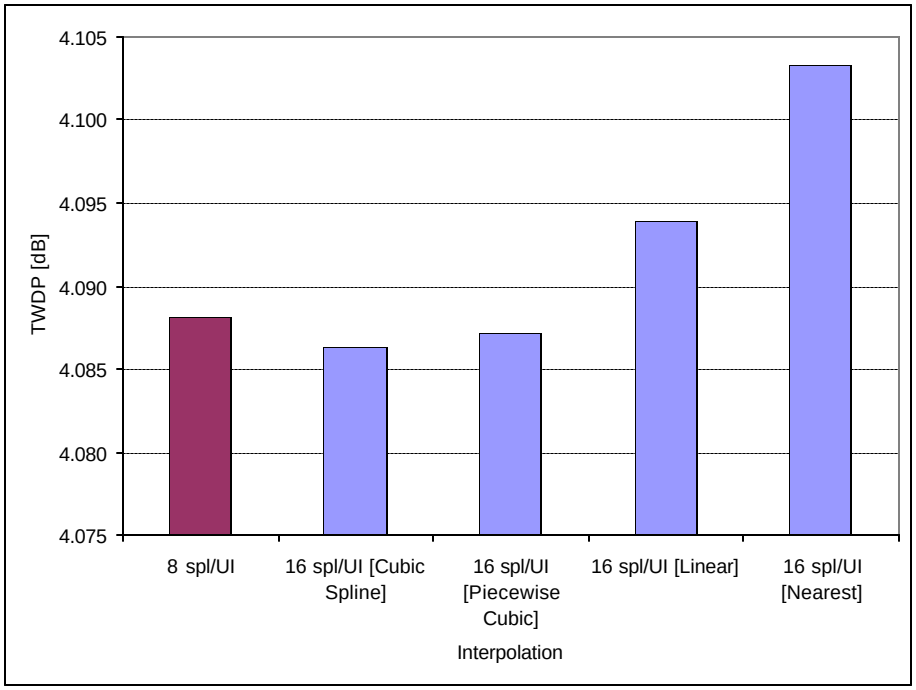
Interpolation Methods - Procedure

- **The TWDP code uses 16 samples / bit which cannot be captured on the scope for a 2^9-1 pattern without stitching the data**
- **Typically 8 samples / bit are captured and converted to 16 samples / bit using interpolation**
- **Matlab has the following interpolation techniques available:**
  - Linear Interpolation
  - Nearest Neighbour
  - Piecewise Cubic Hermite
  - Cubic Spline
- **Each of these have been applied to data measured at 8 samples / UI to convert to 16 samples / UI to see which gives the least degradation in penalty**

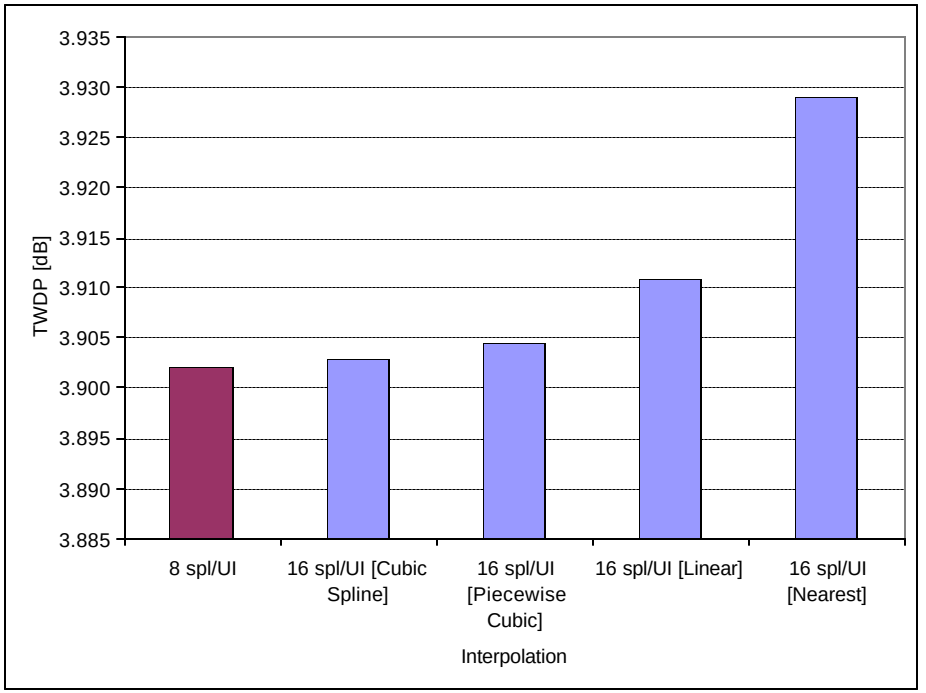
Interpolation Methods - Results

- The plots below show the 4 different interpolated 16 samples / UI results against the original captured 8 samples / UI data, at oversampling = 8

Pre-Cursor



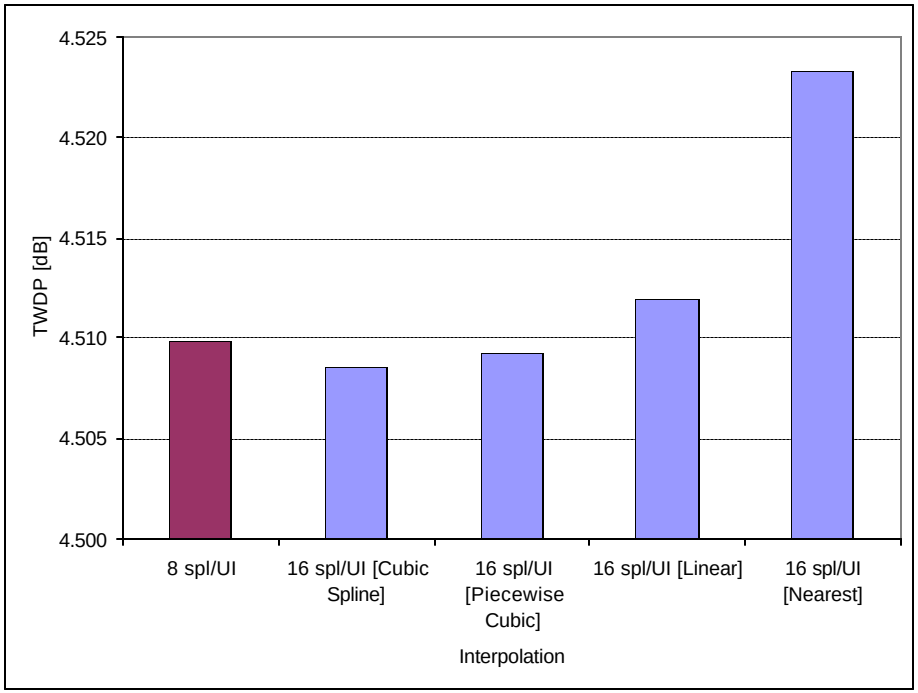
Split-Symmetric



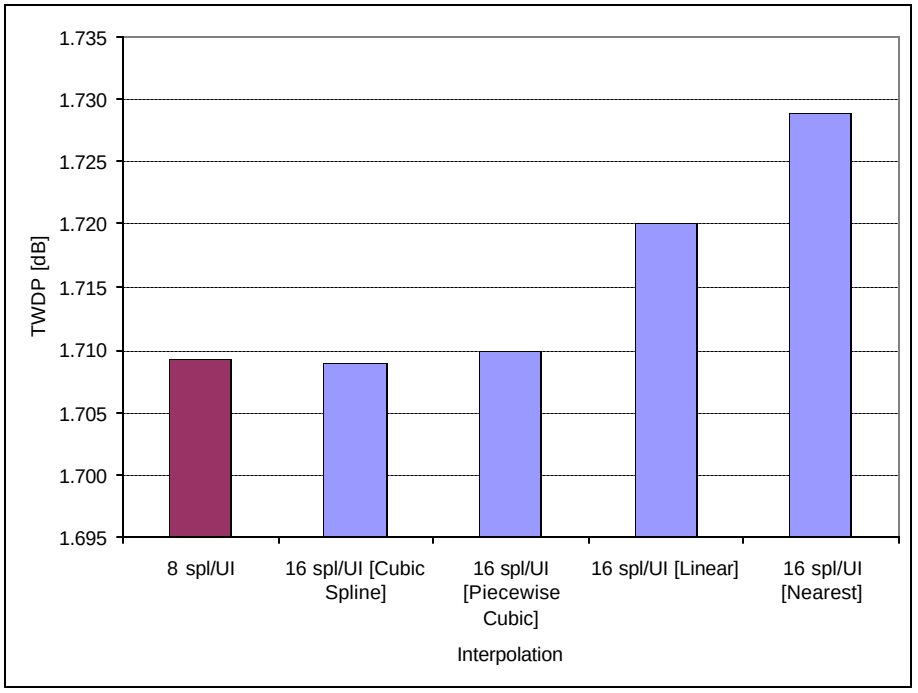
Interpolation Methods - Results

- The plots below show the 4 different interpolated 16 samples / UI results against the original captured 8 samples / UI data, at oversampling = 8

Post-Cursor

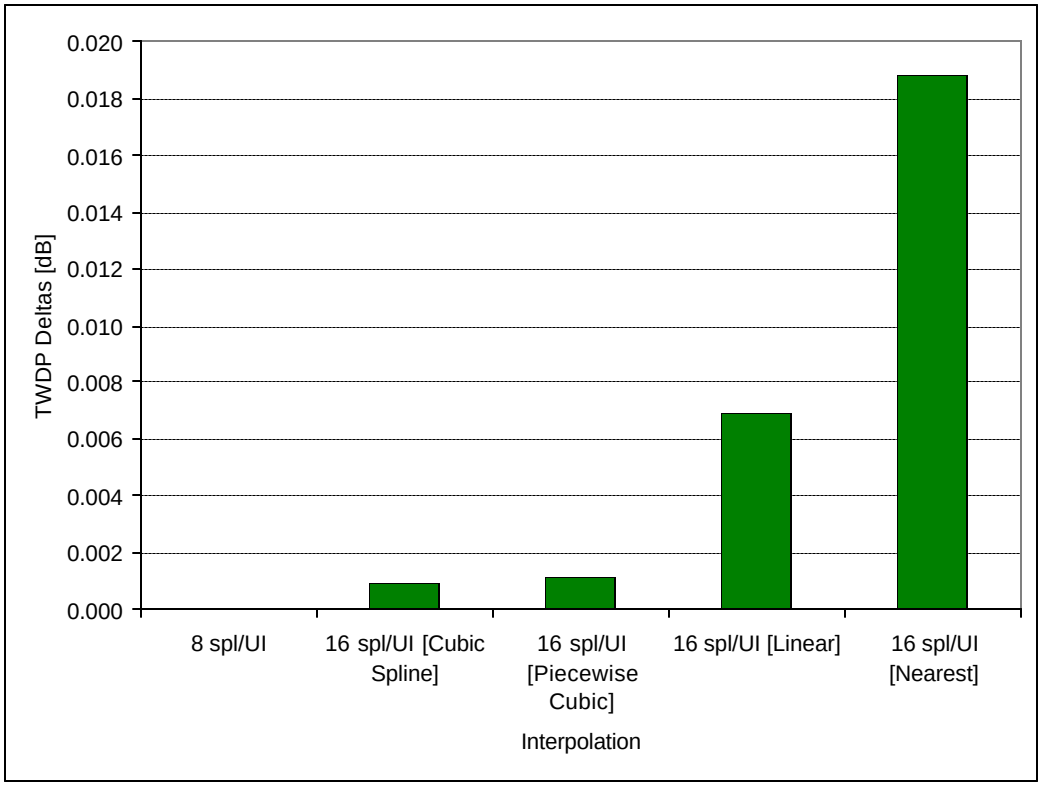


No Stressor



Interpolation Methods - Results

- **Comparing the average magnitude of the TWDP deltas arising from the different interpolation techniques, for the 3-different stressors and the case with no fibre emulation, it is clear that Cubic Spline offers the least difference from the measured data, with Piecewise Cubic a close second**



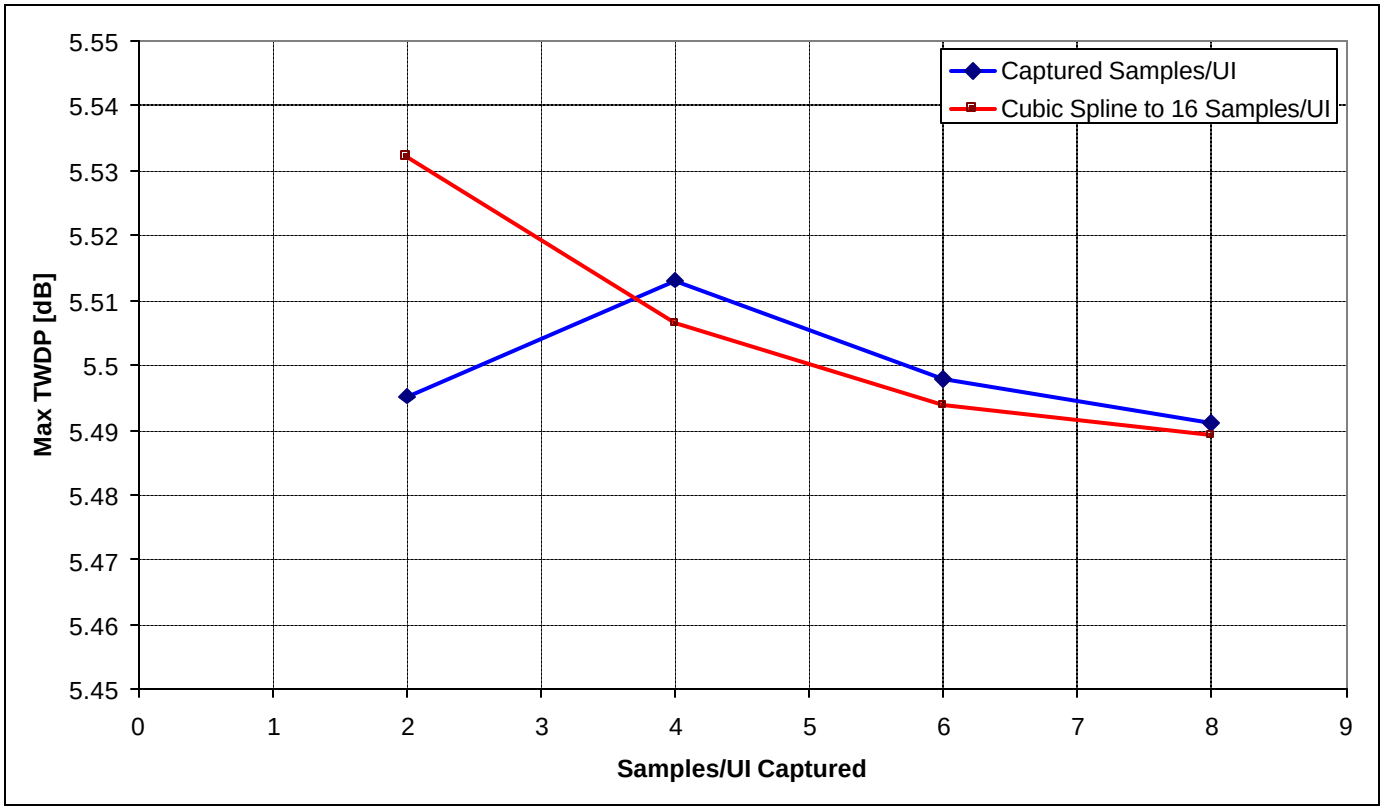
TWDP Delta = unsigned difference *ie* abs(x-y)

Sampling Rate - Procedure

- "Cubic Spline" has been found to yield the best results, so this was the interpolation technique used for this section of the study
- Waveforms have been captured at 2,4,6,8 samples / bit and oversampled to 16 samples / bit
- Also, the oversampling rate has been adjusted in the TWDP code to match the measured sampling rate to establish the impact on the reported penalty
- From the previous slide, the difference between measuring data and running the code at 8 samples / UI compared to measuring at 8 samples / UI and running the code at 16 samples / UI is 0.001dB suggesting that analysis at 8 samples / UI should be as acceptable

Sampling Rate - Results

- As expected, interpolating to 16 samples / bit improves in accuracy as the captured samples / bit increase
- Large errors arise at <4 measured samples / bit



Penalties of a Real Tx Relative to PIE-D with Gaussian Tx - Procedure

- Data has been collected for an EML using the 2^9-1 pattern and capturing 8 samples / UI for processing through the TWDP code

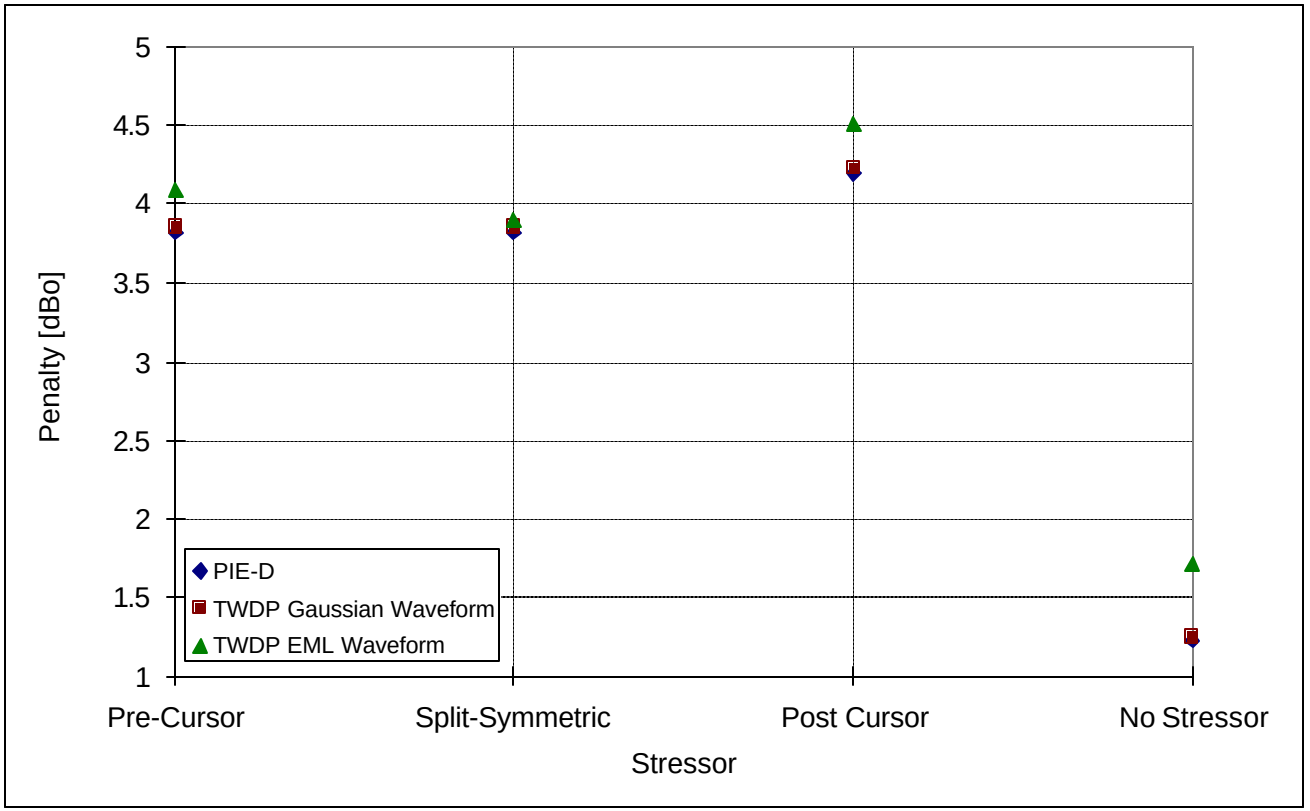
- The pre-processed Gaussian waveform [uploaded by Clariphy] has also been assessed as a baseline for the TWDP code against PIE-D

- The fibre emulation was also temporarily removed from the TWDP code and replaced with an “ideal” channel [labelled “No Stressor” on the plots]

- As shown on the RHS of the plot overleaf, the PIE-D code reports a penalty of 1.2303 dB for a 47.1ps Gaussian Tx, whilst the TWDP code [with the pre-processed Gaussian waveform and no stressors] reports 1.2533 dB

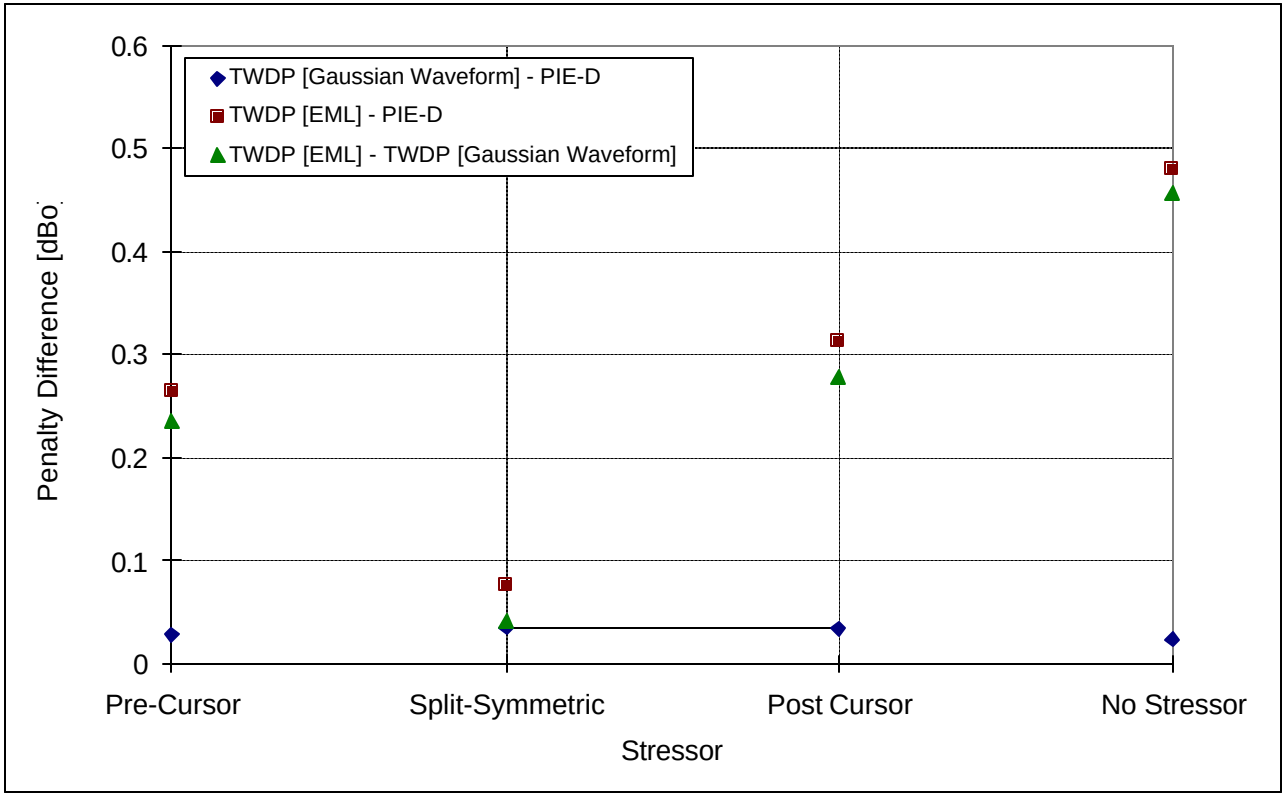
Penalties Relative to PIE-D with Gaussian Tx - Results

- Very good agreement is found between the given PIE-D values of the stressors [and the case with no stressors] and the TWDP with a Gaussian waveform – average difference is 0.03 dB as shown overleaf



Penalties Relative to PIE-D with Gaussian Tx - Results

- **Introducing the EML waveform yields a TWDP difference from PIE-D of 0.48 dB for the case with no stressors, down to 0.08 dB for the split-symmetric case, with 0.26 dB and 0.31 dB for pre- and post-cursor cases respectively**



Penalty Difference = unsigned difference *ie* abs(x-y)

Summary

- "Cubic Spline" yields the best interpolation results, with "Piecewise Cubic Hermite" a close second

- Capturing the data at 8 samples / UI and matching the oversampling rate in the TWDP code is as good as converting to 16 samples / UI [to within 0.001 dB] suggesting that 8 samples / UI should be an acceptable rate

- A systematic difference of ~0.03 dB is found between PIE-D and TWDP [with a pre-processed Gaussian waveform]

- For a real EML transmitter, the worst TWDP difference relative to PIE-D arises from the case with no fibre emulation