Analysis of SNR, TWDP and Implementation penalty vs. measured waveforms

Finite EQ lengths

Tom Lindsay, 28 June 2005

General analysis notes

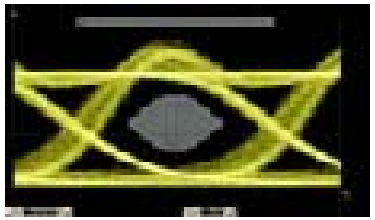
- Waveforms from LRM private area (pre-processed)
- Plotted results are based on finite EQ lengths
  - 2 configurations: 14,5 and 10,3, FF @T/2, FB @T
- Implementation penalty (IP) = $SNR_{infinite} - SNR_{finite}$ (dBo)
- Stressors ~4.5 dB PIE-D from recent Ewen set
  - < 2 dB IP budget for EQ length
  - SNR > 8.5 dB…
- OMA & OMSD for TWDP scaling determined via SW waveform analysis
- Vertical scales in dBo
- Semi-analytic method & MMSE adaptation
- Work in progress…

Measured waveforms for following analyses

1207-01

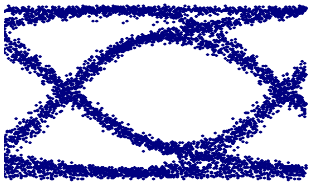
115-01c

1207-03

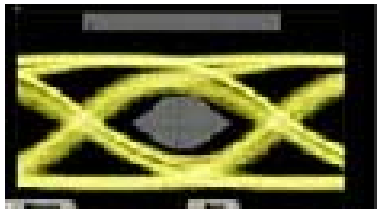


115-02c

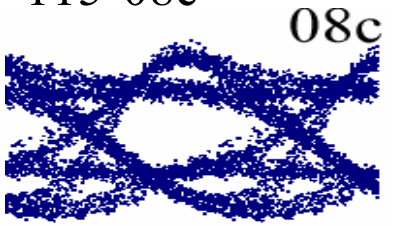
S041106-G15



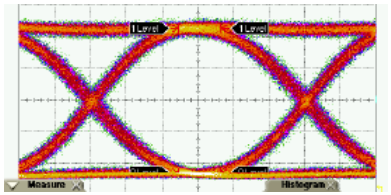
1207-04



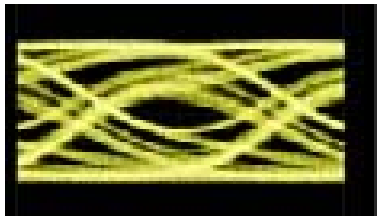
115-08c



Page6left

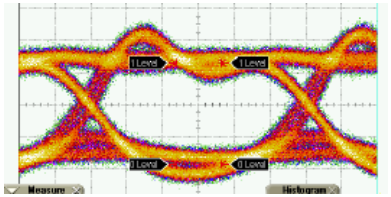


1207-05

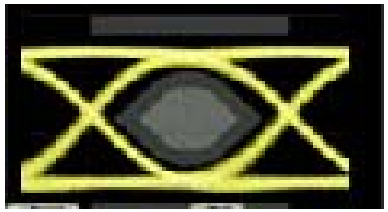


115-09c

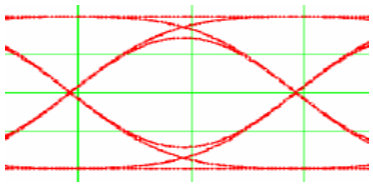
Page7right



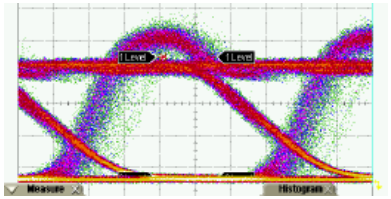
1207-05



47.1 psec Gaussian



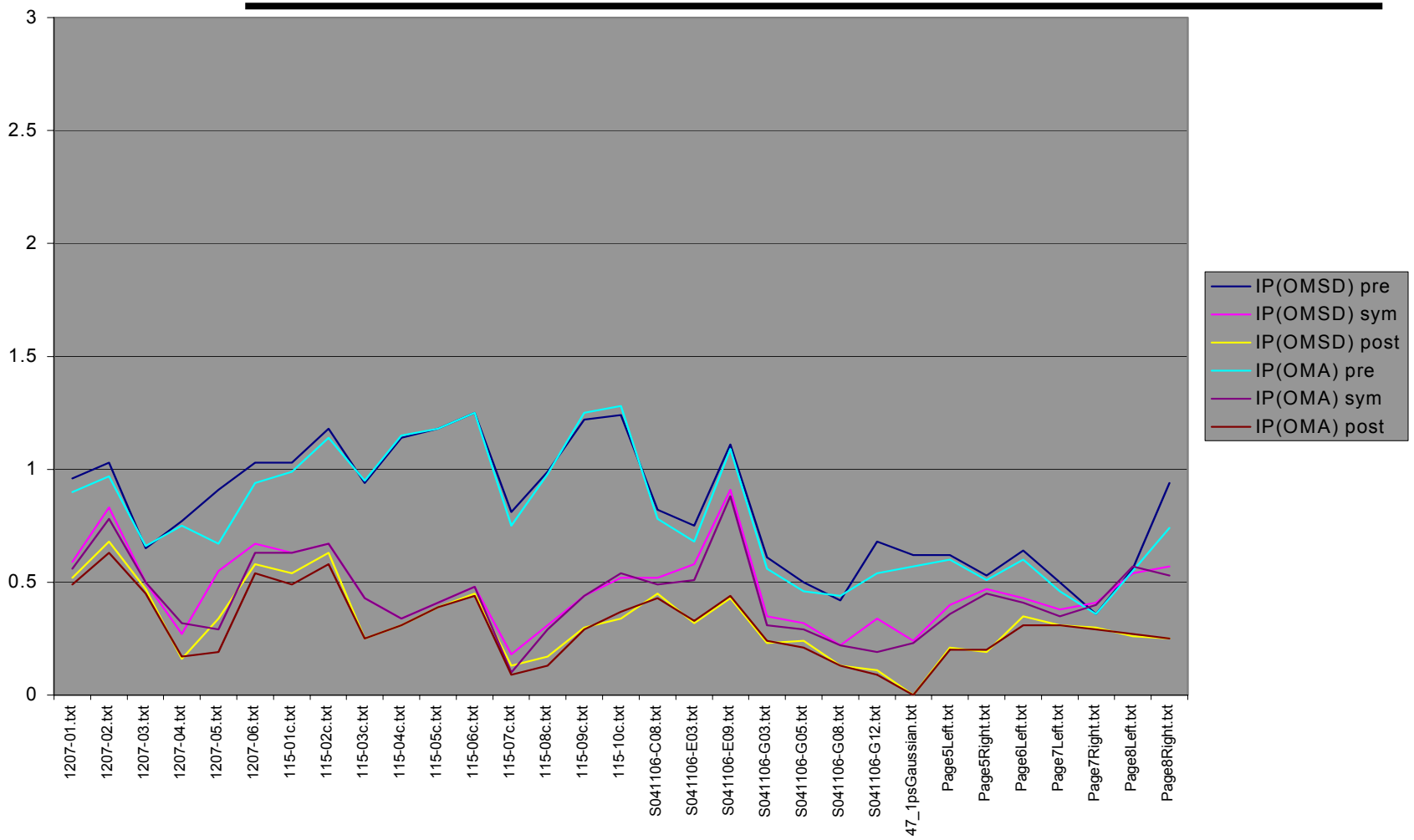
Page8left



pre, symmetrical, and post cursor channels

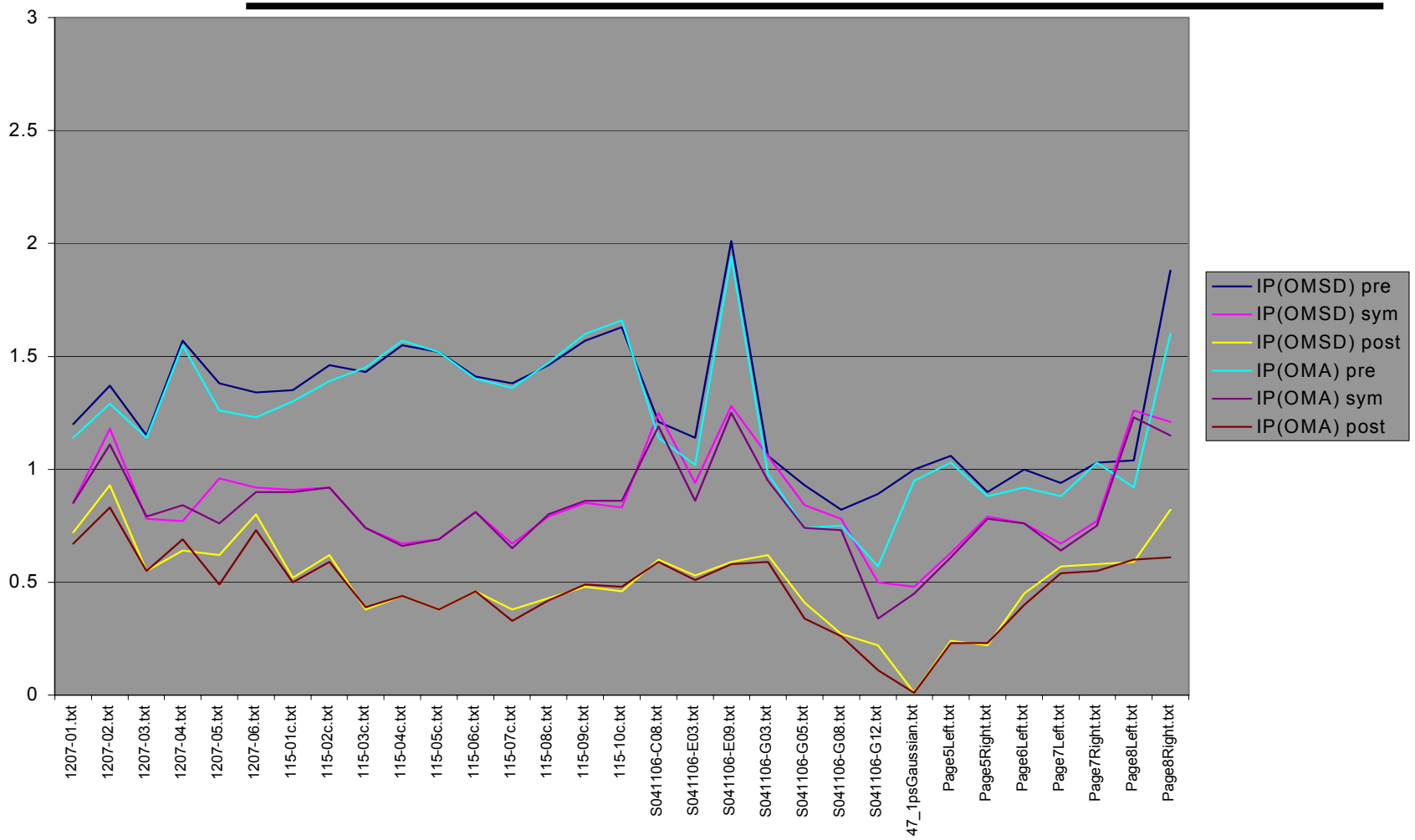
- Next 2 plots show that pre-cursor fiber is almost always most stressful to shorter length EQs
  - Not surprising…
  - Not always true for very long lengths, but differences are small (not plotted)
  - Differences greatest for pre-emphasized waveforms
    - Shape not optimized for pre-cursor
- IP results are from OMA & OMSD scaled waveforms
  - Little difference
  - FYI, unscaled waveform IPs tend in the same direction as actual power

IP vs. waveform for pre, symmetrical, and post cursor channels; 14,5 EQ*



*Additional waveforms tested here, beyond those displayed on slide 3.

IP vs. waveform for pre, symmetrical, and post cursor channels; 10,3 EQ*

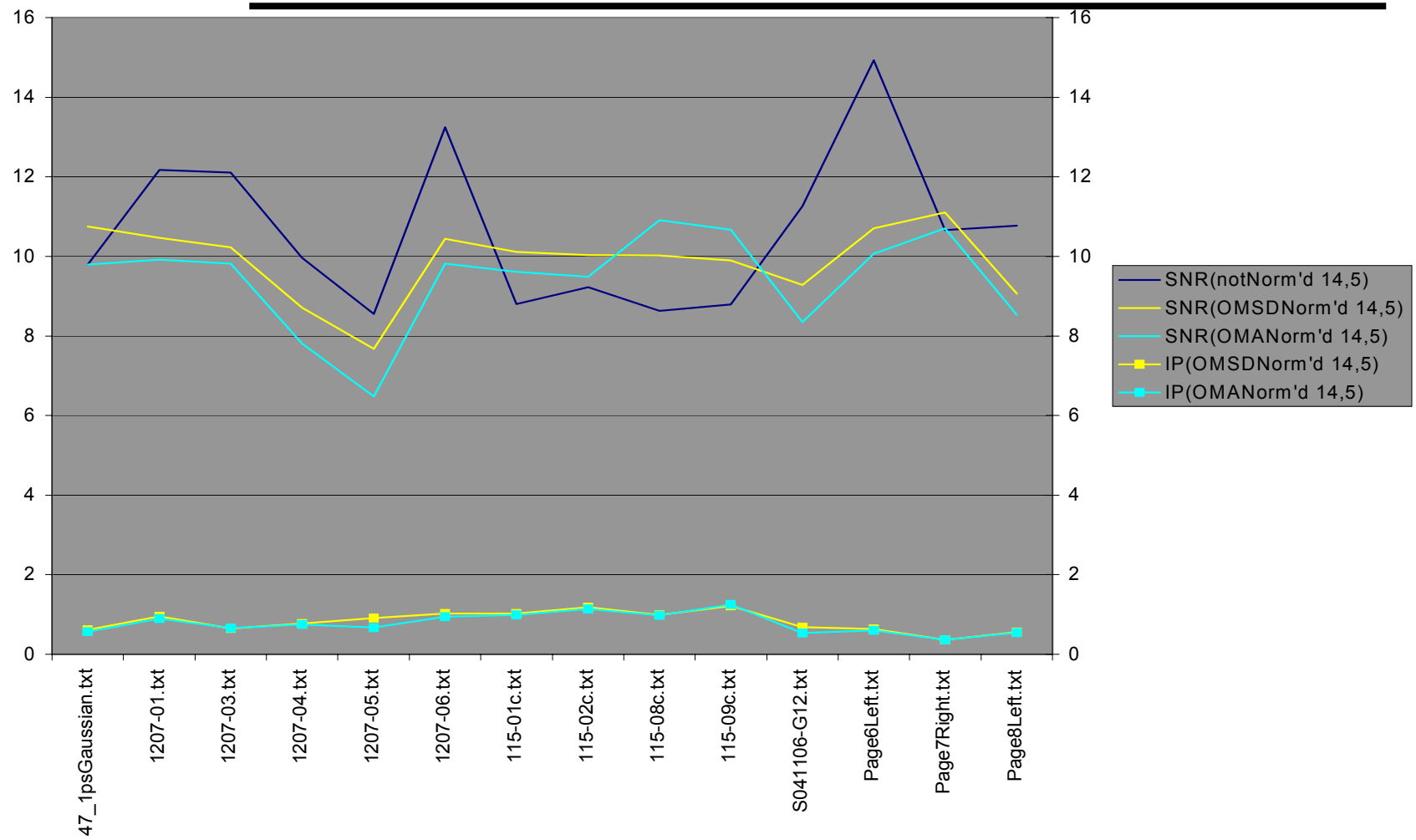


*Additional waveforms tested here, beyond those displayed on slide 3.

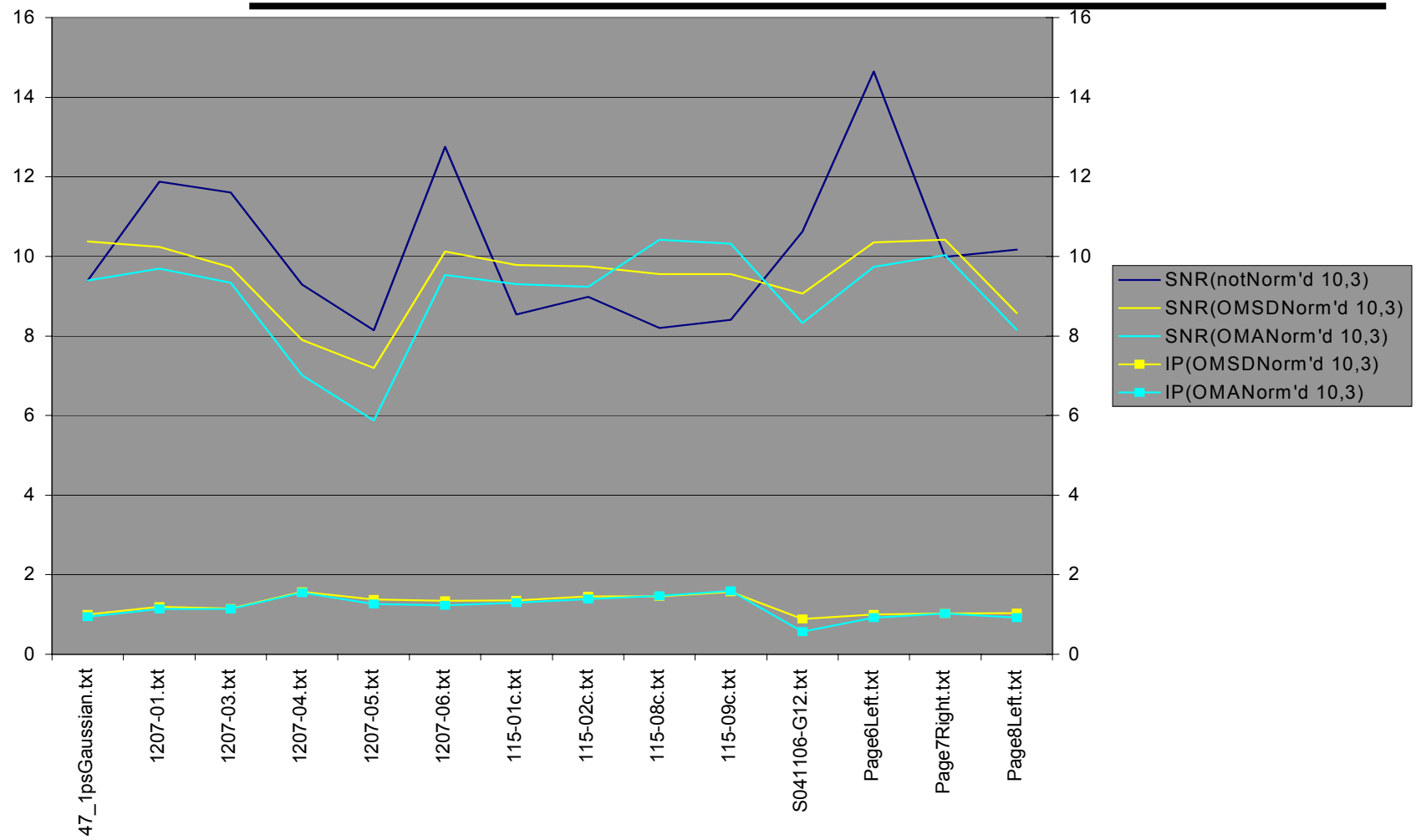
Slicer SNR

- 3 SNR traces vs. LRM reference Rx
  - Unscaled optical power
  - Scaled to match OMSD to OMSD of ideal reference Tx
    - Waveform has same MFB SNR at TP2 as reference (14.97 dB)
  - Scaled to match OMA to OMA of ideal reference Tx
    - Waveform has same OMA at TP2 as reference (-4.5 dBm)
- Actual power has direct effect on SNR
  - Scaling hides effect of actual power
- Waveshape also has strong effect on SNR
  - Effect of IP is secondary
- Pre-emphasized waveforms show advantage when scaled via OMA
  - But, is it real? More to come…
- As expected, 14,5 EQ shows higher SNR & lower IP than 10,3

SNR & IP vs. waveform for pre-cursor channel; 14,5 EQ



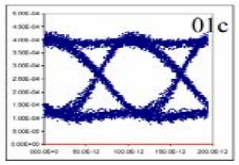
SNR & IP vs. waveform for pre-cursor channel; 10,3 EQ

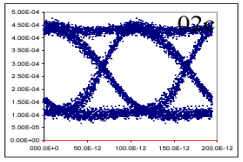


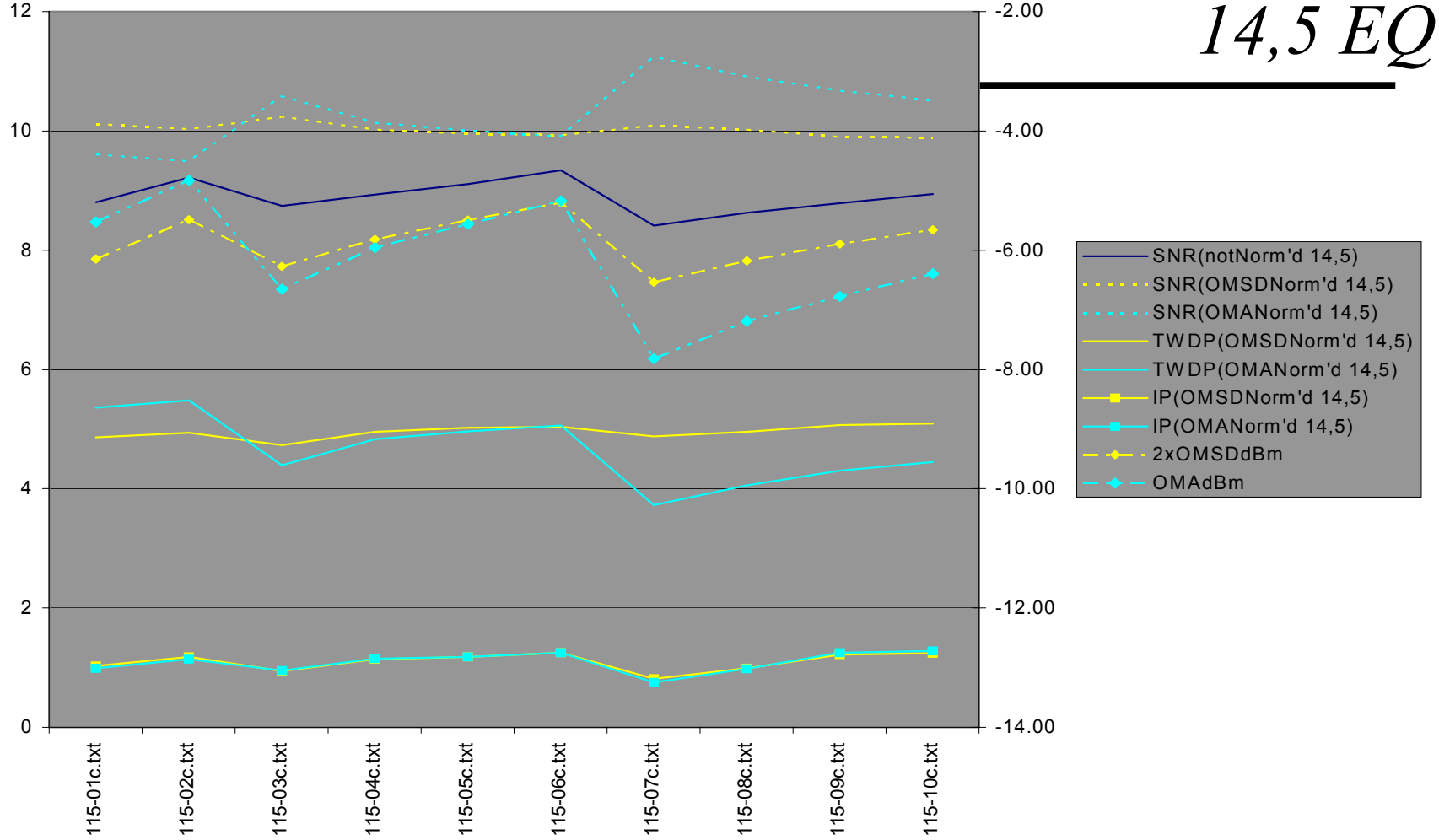
Is current pre-emphasis advantage real?

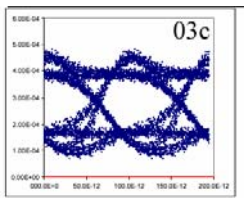
- Unscaled SNR (blue) changes as expected per eyes
  - Eye powers are to same scale
- Slicer SNR has similar trends as input OMSD and OMA
  - Better tracking of OMSD than OMA
- With constant input power at TP2
  - Constant OMSD results in ~constant SNR; this is not surprising as MFB SNRs at TP2 are all the same
  - Constant OMA does not result in constant SNR
  - Neither scaling method predicts actual SNR
    - Direct effect of power on SNR is removed by scaling
- With current pre-emphasis method
  - Better $TWDP_{OMA}$ does not relate to better SNR or finite length IP
  - IP tends in same direction as $TWDP_{OMSD}$

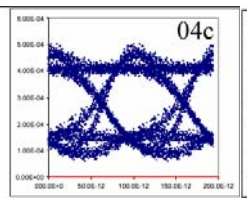
TWDP & IP vs. pre-emphasized waveforms for pre-cursor channel; 14,5 EQ

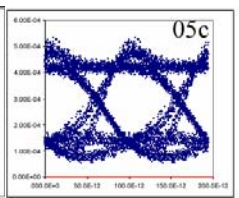


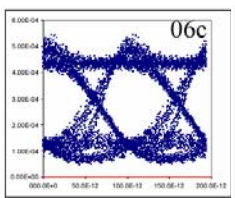


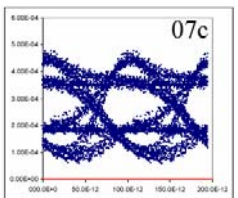


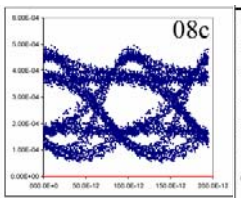


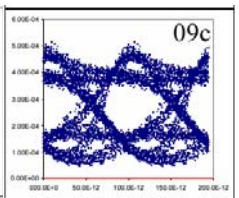


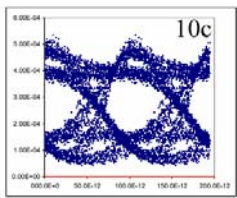




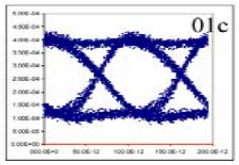


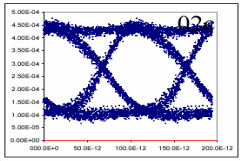


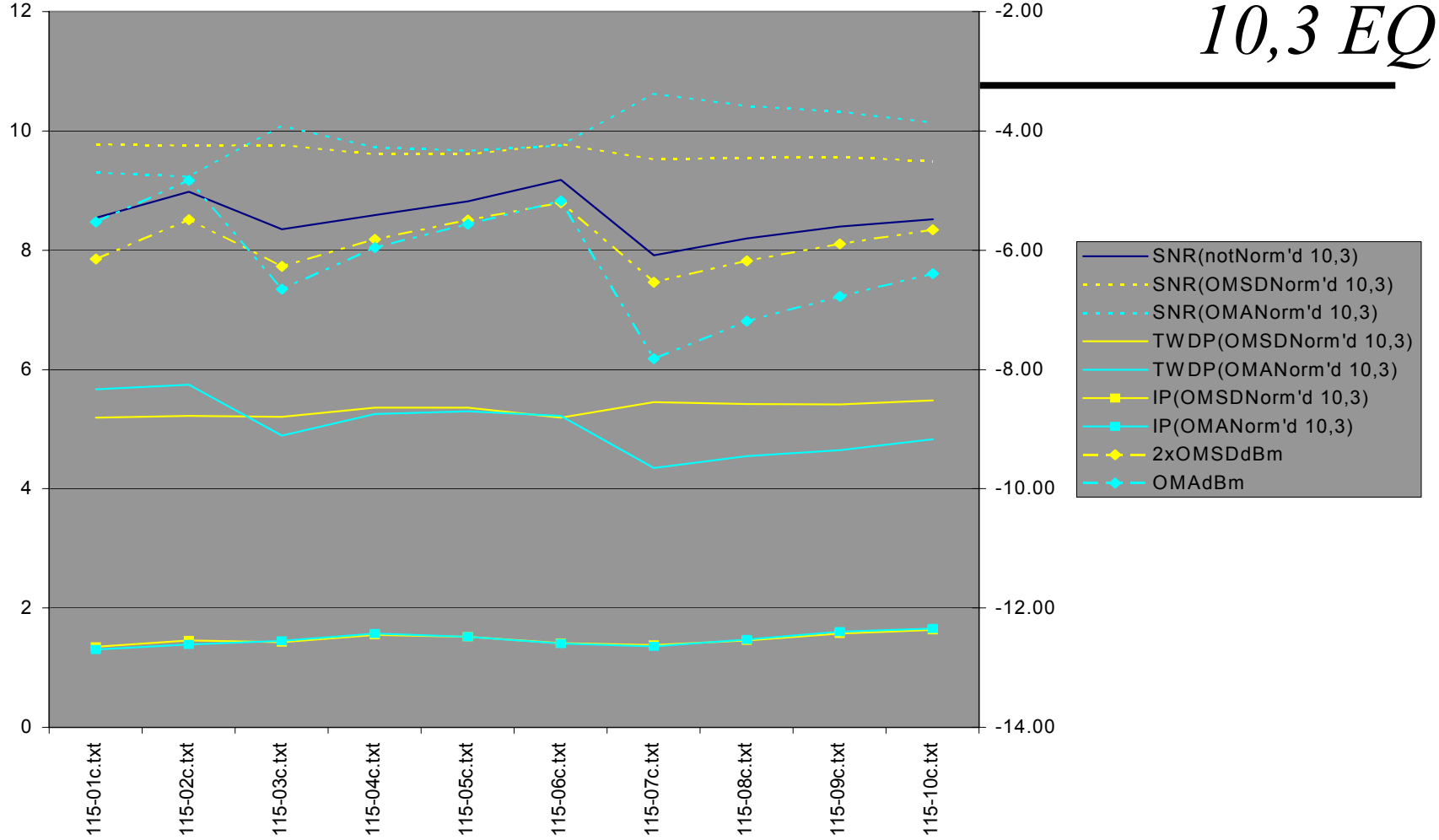


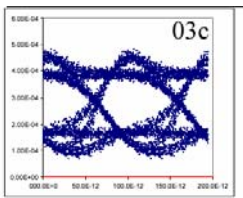


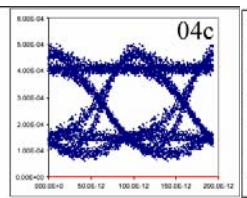
TWDP & IP vs. pre-emphasized waveforms for pre-cursor channel; 10,3 EQ

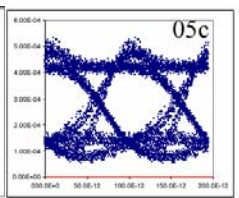


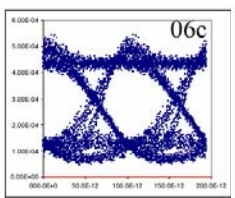


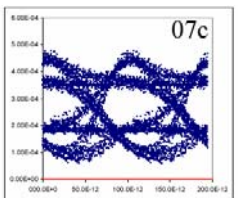


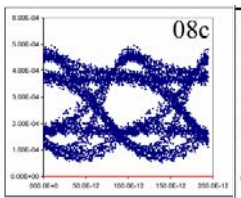


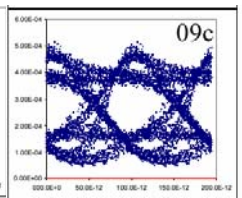


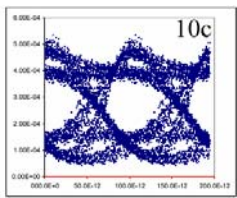








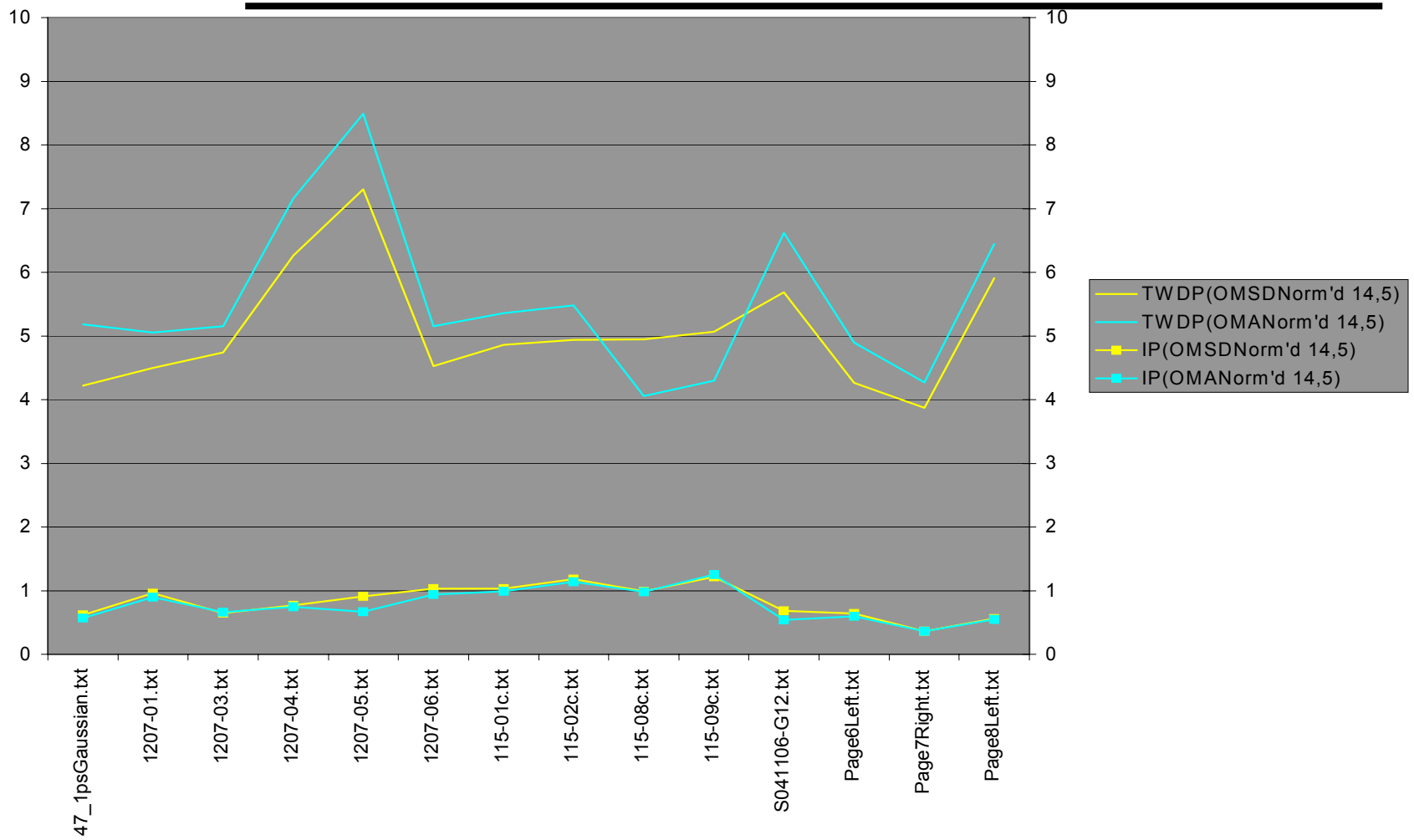




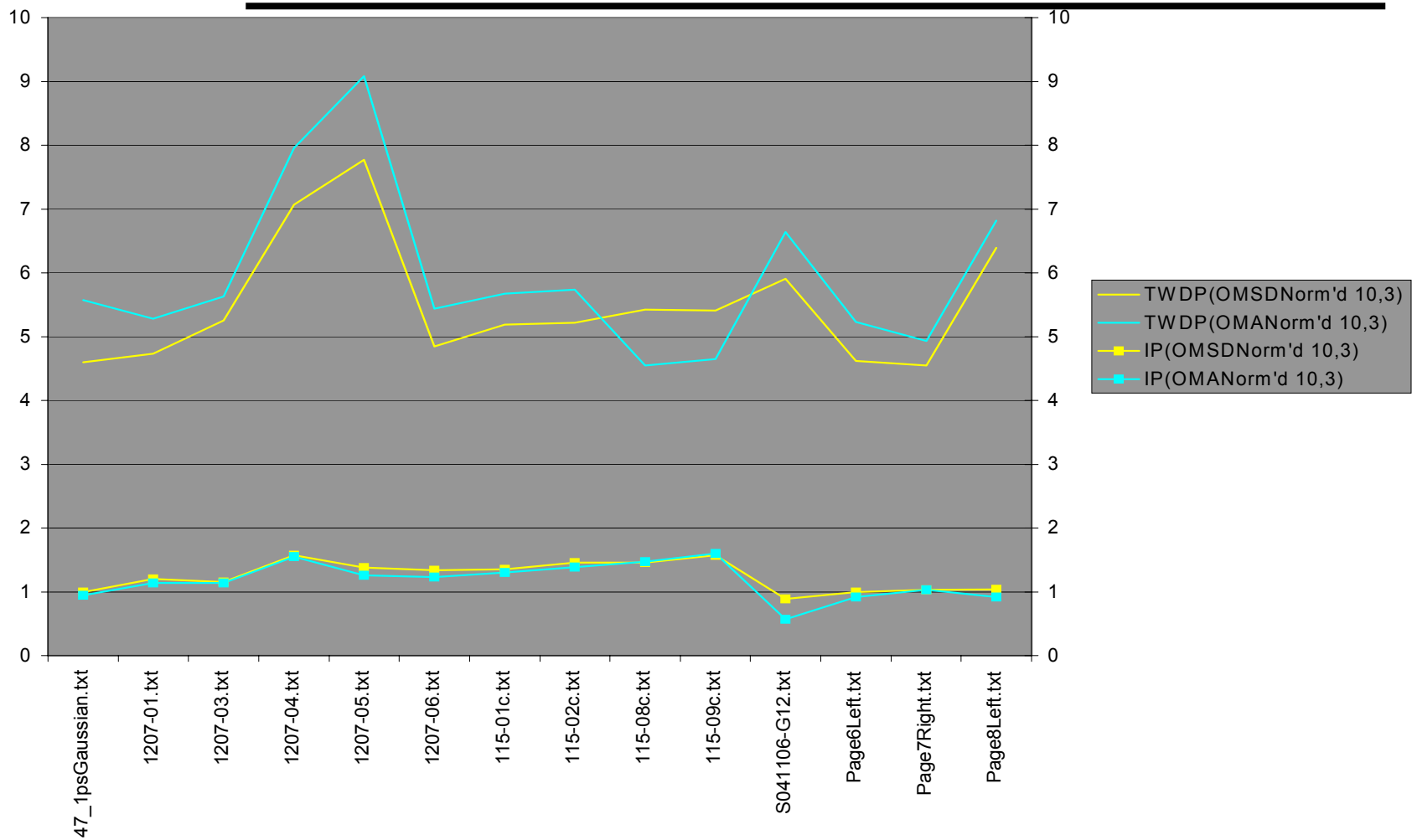
TWDP

- 2 traces
  - OMSD scaling
  - OMA scaling
    - Per D2.0
- Impact to TWDP dominated by channel waveshape
  - Effect of IP is secondary
  - Scaling removes effect of actual power
- Pre-emphasized waveforms show advantage when scaled via OMA
  - But, from above, it may not be real with current method
- As expected, 14,5 EQ shows lower TWDP & IP scores than 10,3

TWDP & IP vs. waveform for pre-cursor channel; 14,5 EQ



TWDP & IP vs. waveform for pre-cursor channel; 10,3 EQ



ClariPhy Communications, Inc.

Summary

- Pre-cursor channel most challenging for finite EQ
- Actual optical power has direct effect on slicer SNR
  - Scaling, if used, hides effect of actual power
- Waveshape has strong effect on SNR & TWDP
  - Effect of finite length IP is secondary
- Pre-emphasized waveforms show advantage when scaled via OMA
  - But, better $TWDP_{OMA}$ does not result in better SNR or finite length IP for current method
  - Scaling with OMSD results in better tracking among SNR, TWDP, and IP
  - Current pre-emphasis not optimum for pre-cursor

Need other IP mechanisms to test

- EQ length being done
- Others readily implemented in TWDP-like code
  - Threshold
  - Timing
  - Rx bandwidth
- More?