Short backplanes and the effect of reflections

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Supporters

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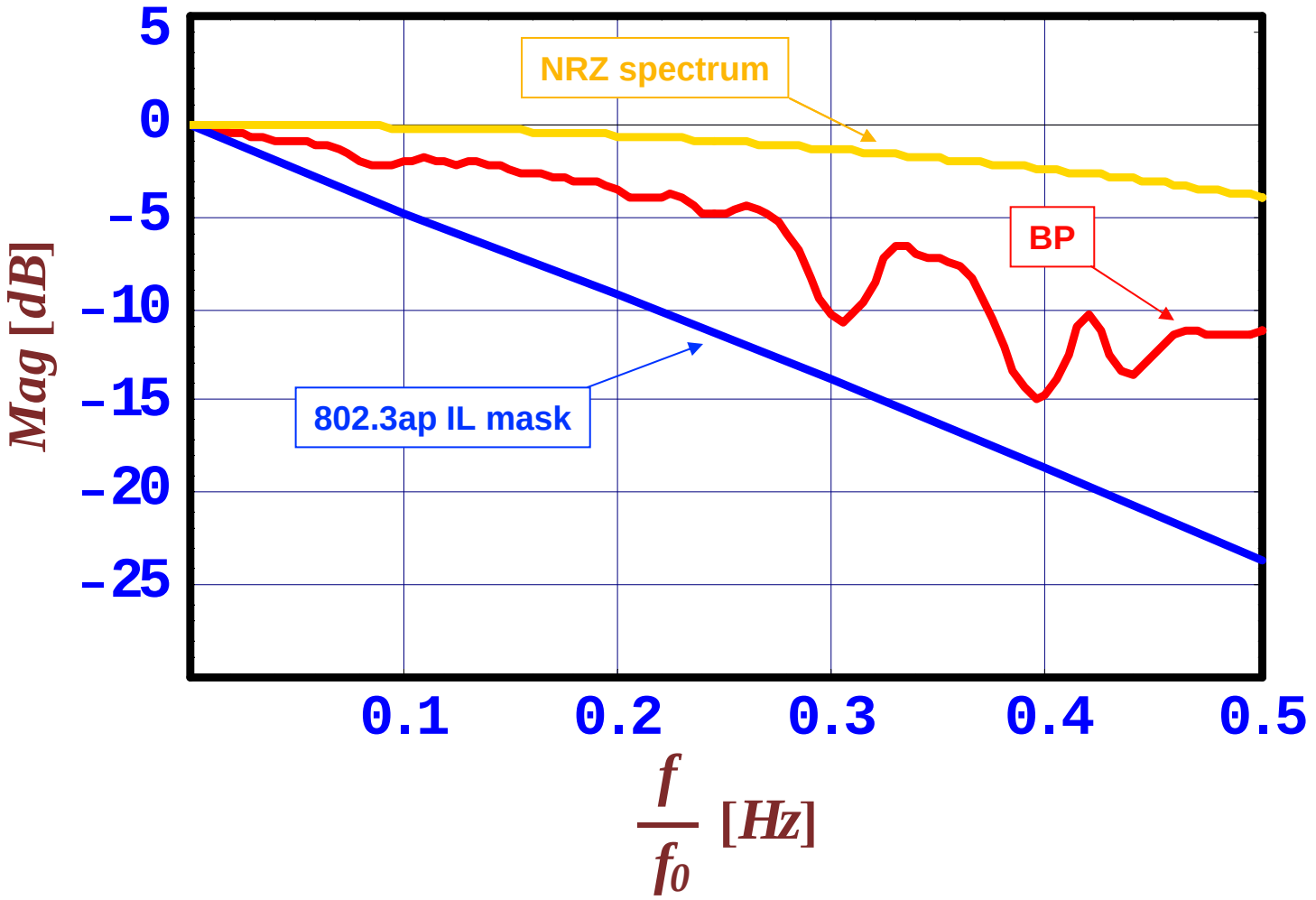
Overview

- In defining a criteria to qualify acceptable backplanes, the Task Force has developed an acceptance mask, defined in the frequency domain. However:
  - It is not clear that this is a sufficient criteria in guaranteeing correct link operation
  - It is not clear that this provides sufficient information to the backplane designer (and the silicon designer) as to how these should be designed.

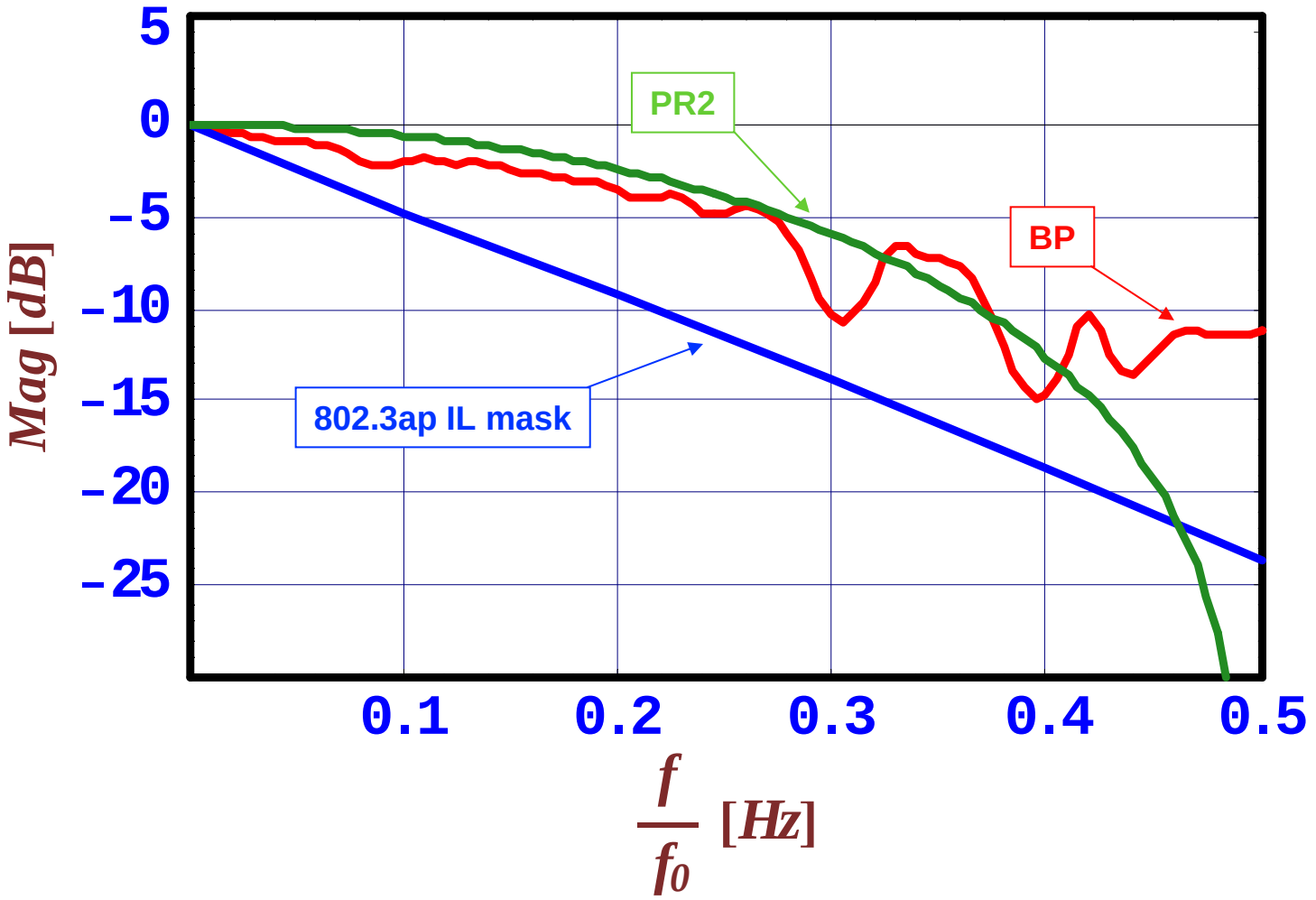
Test case

- **Configuration used for test case is described in http://ieee802.org/3/ap/public/sep04/peters_01_0904.pdf and represents an assembly comprising of:**
  - **1 line card (2.25”)**
  - **1 connector**
  - **1 bp (3”)**
  - **1 connector**
  - **1 line card (2.97”)**
- **S-parameter model file associated with this assembly, peters_01_0904_B3_thru, is available in http://ieee802.org/3/ap/public/channel_model/index.html**
- **No noise, jitter or cross-talk was considered in the simulation results presented here.**

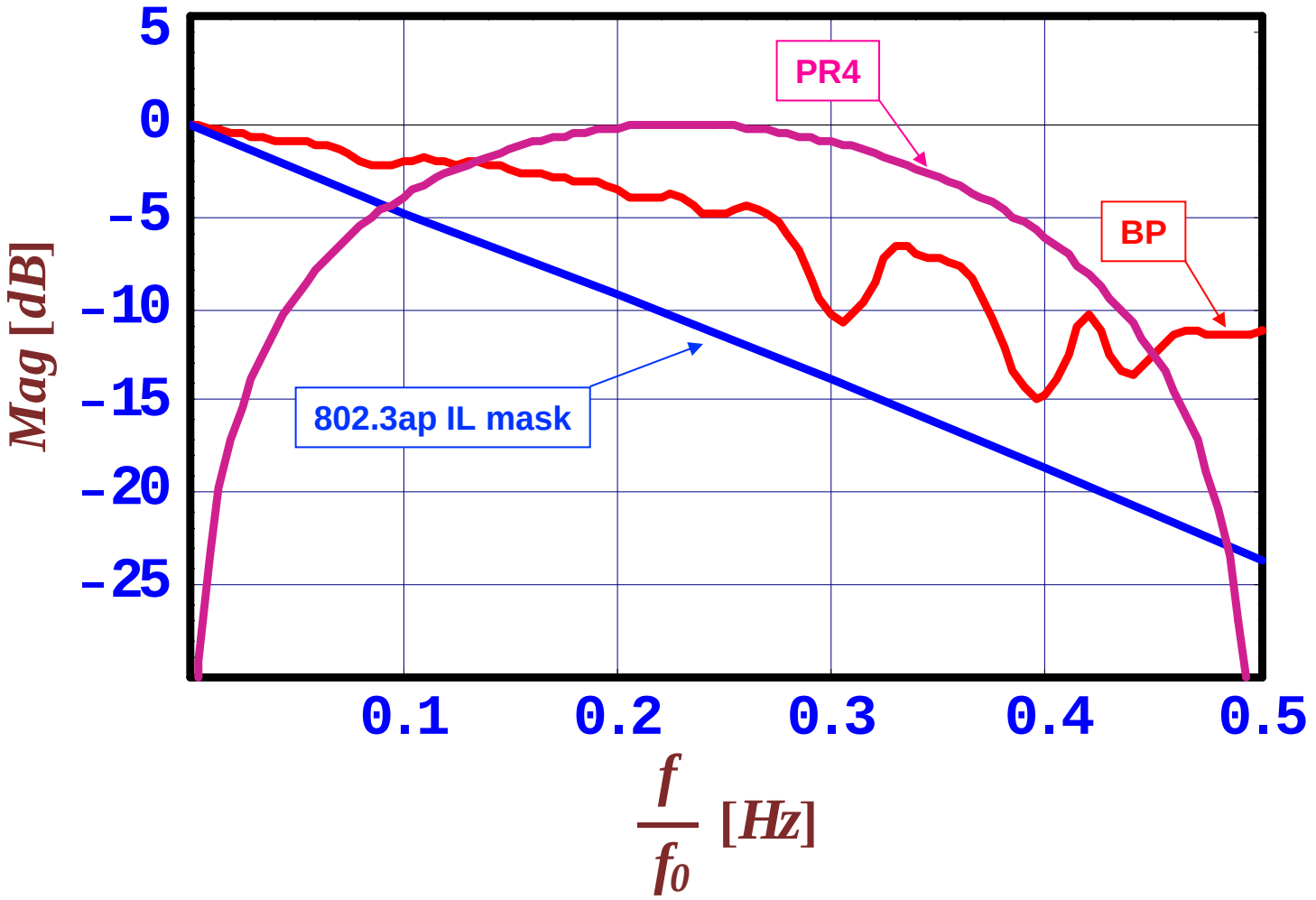
ATCA Backplane (peters_01_0904_B3_thru) : frequency response vs. NRZ spectrum and 802.3ap mask



ATCA Backplane (peters_01_0904_B3_thru) : frequency response vs. PR2 spectrum and 802.3ap mask



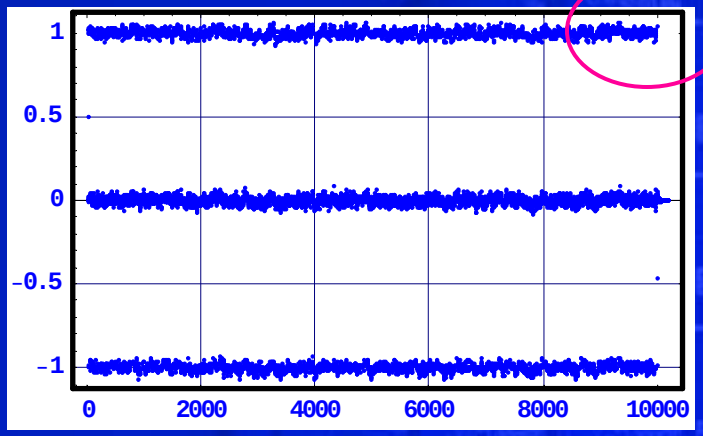
ATCA Backplane (peters_01_0904_B3_thru) : frequency response vs. PR4 spectrum and 802.3ap mask



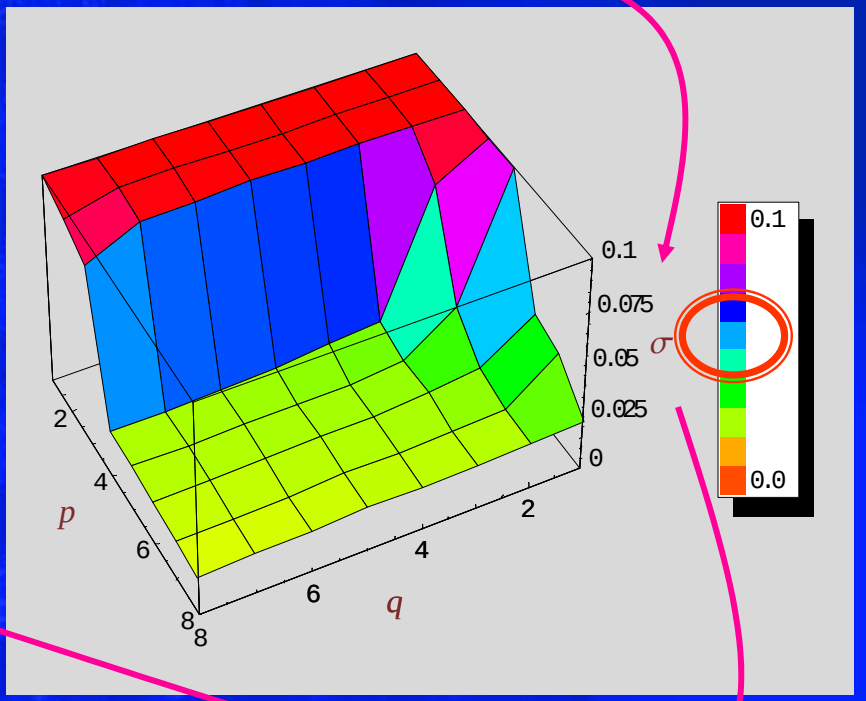
Observations (I)

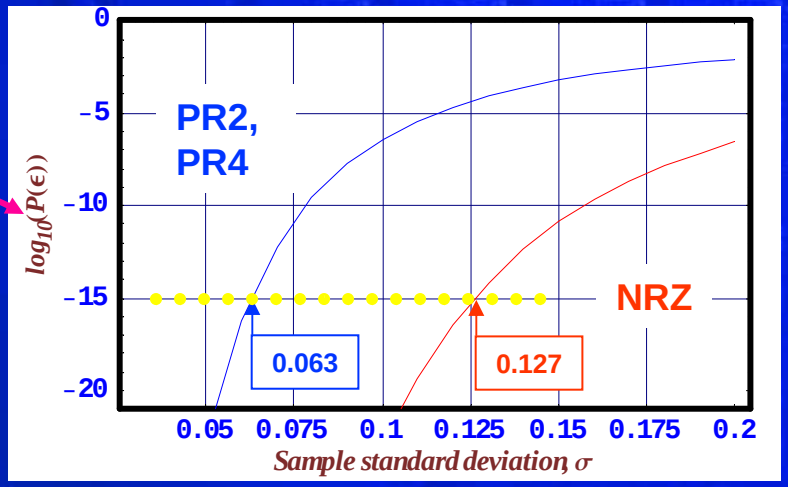
- **Insertion loss curves indicate that the PR2 spectrum is the closest to the *native* response of the 3” backplane.**
- **Inference is that an equalization analysis for this case would indicate that the PR2 case would require minimal *equalization cost* when compared to either NRZ or PR4.**
  - ***equalization cost* is defined as the number of taps required to bring the equalization error within a specified bound.**

Standard deviation as BER indicator



$$P(\epsilon) = \frac{1}{M}\left\{(M-1)\,2\,Q\left(\frac{d_0}{2\sigma_y}\right)\right\}$$



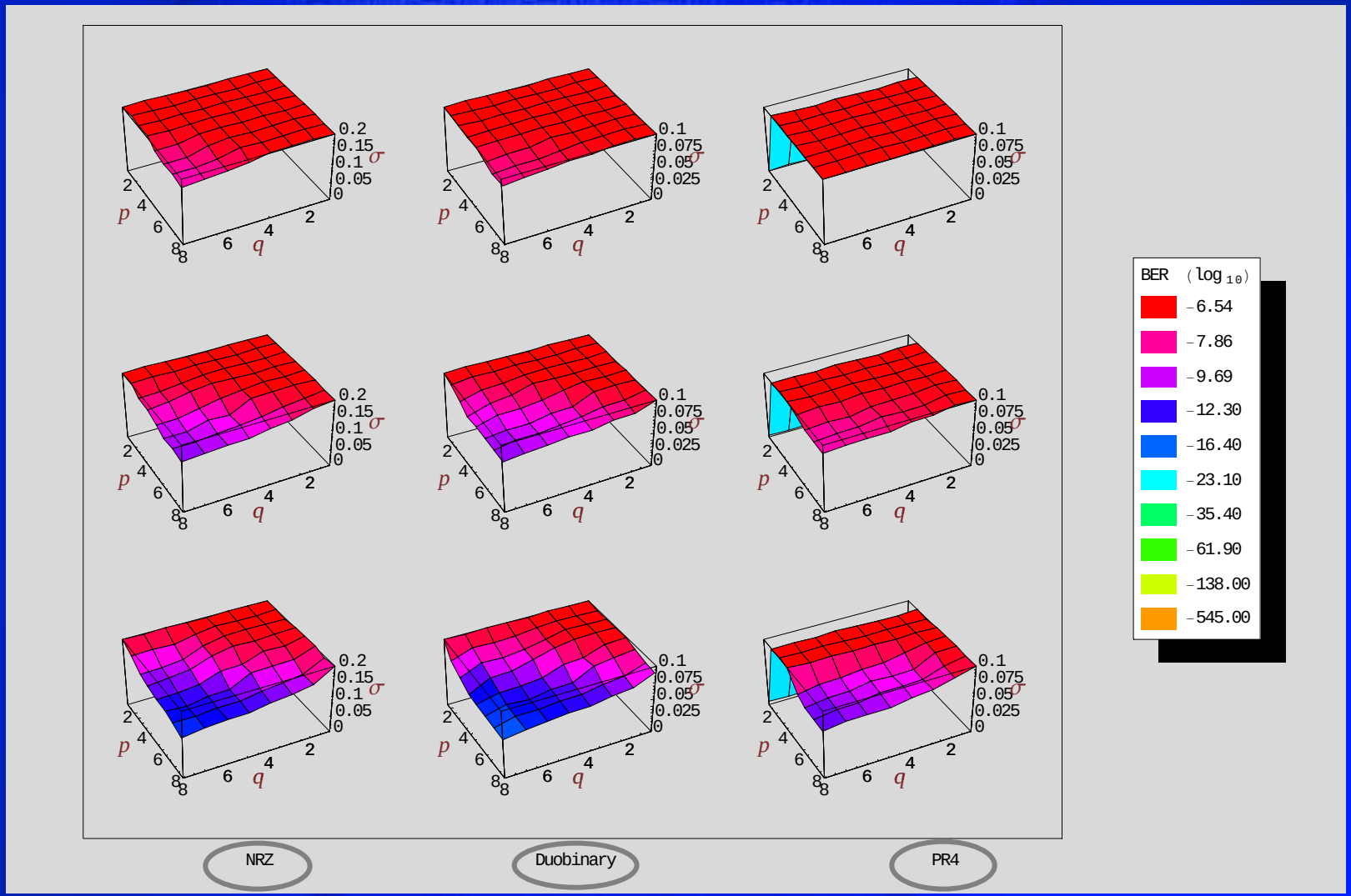


p = taps in the forward filter

q = taps in the feedback filter

Equalization cost analysis

ATCA Backplane (peters_01_0904_B3_thru)

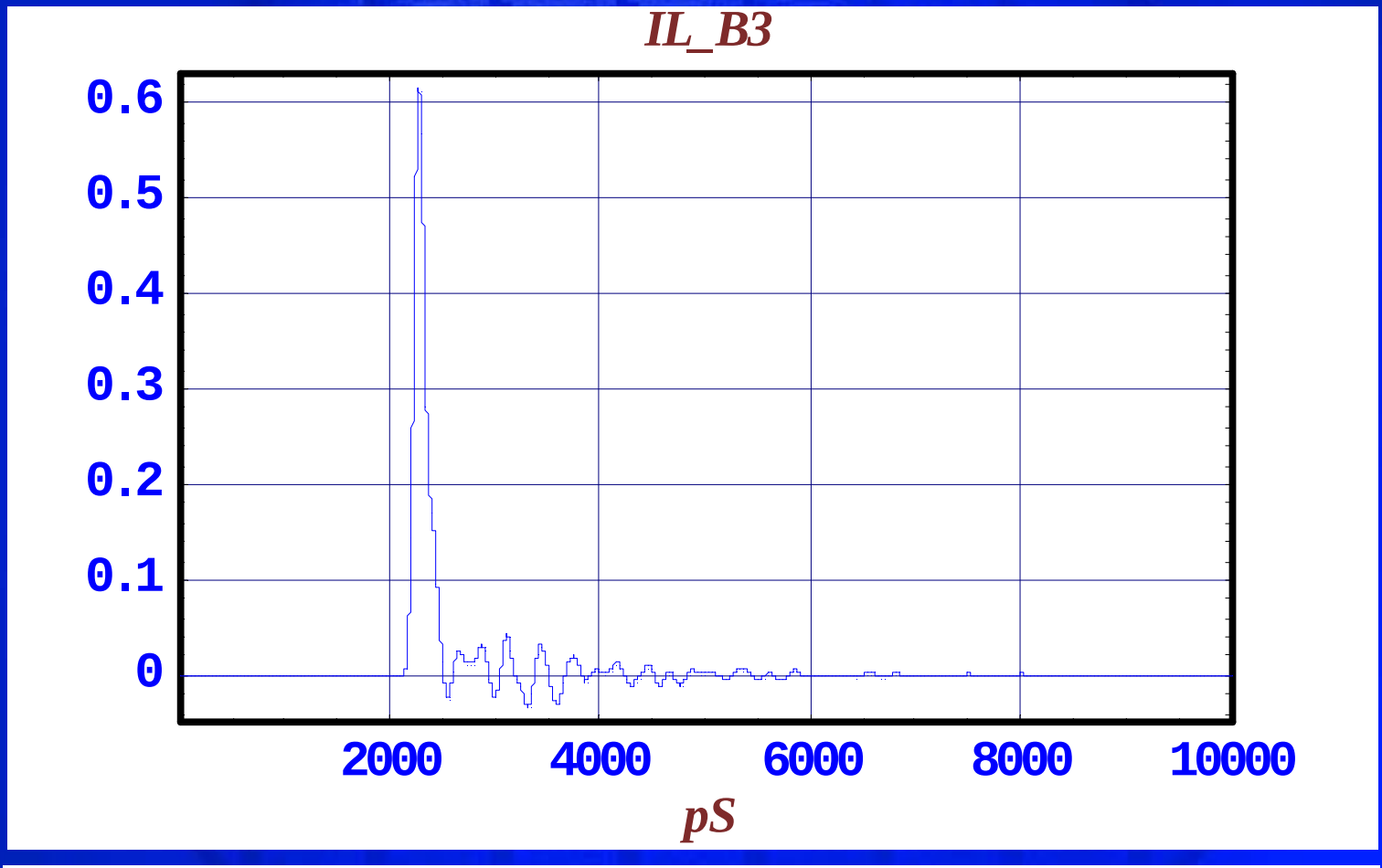


Observations (II)

- **Why is the equalization cost higher than what is expected from the backplane IL curve?**
- **Why is this case paradoxically more difficult than one where a long backplane introduces larger insertion loss?**

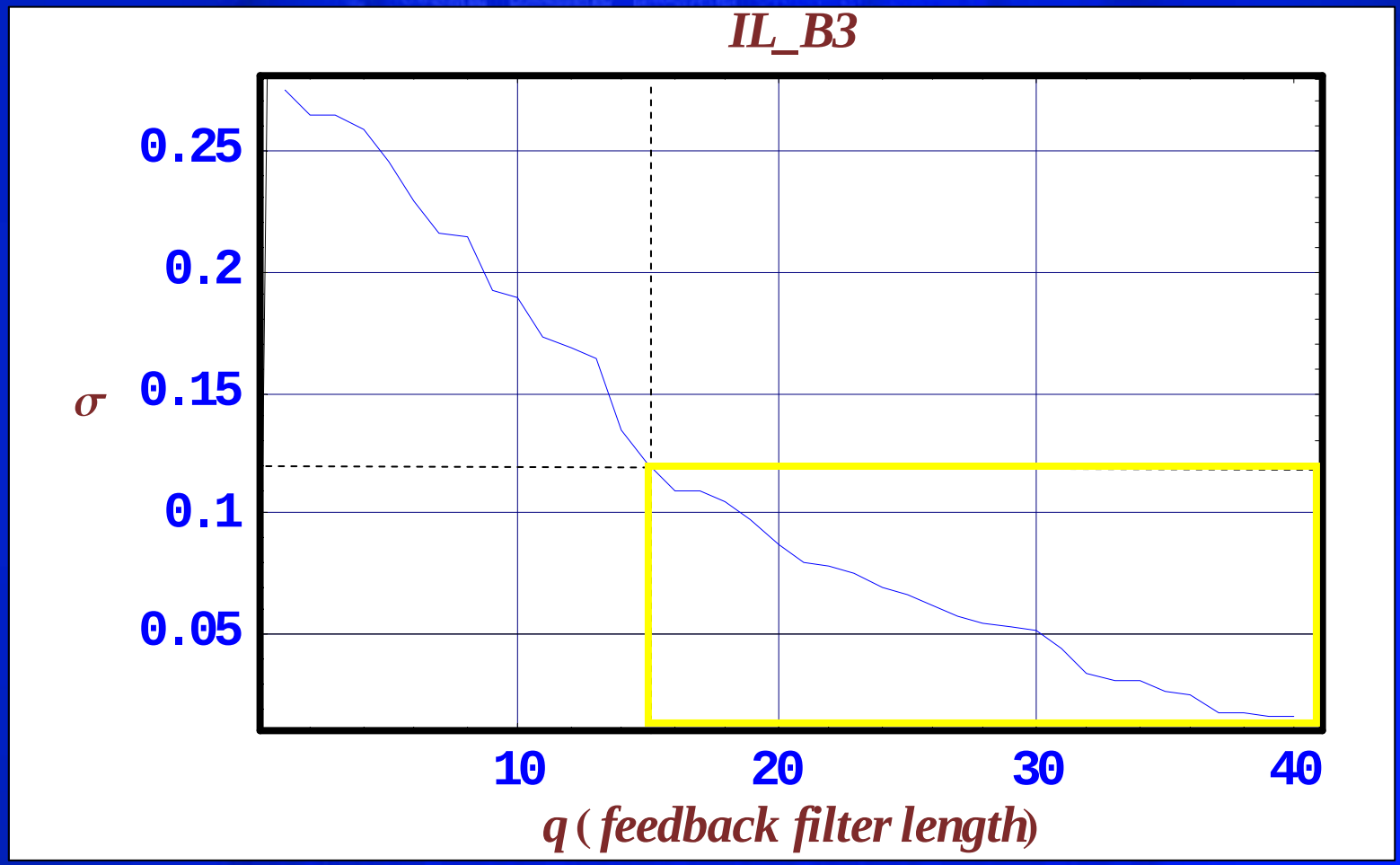
- **The answer must be looked for in the time domain.**

ATCA Backplane (peters_01_0904_B3_thru): impulse response



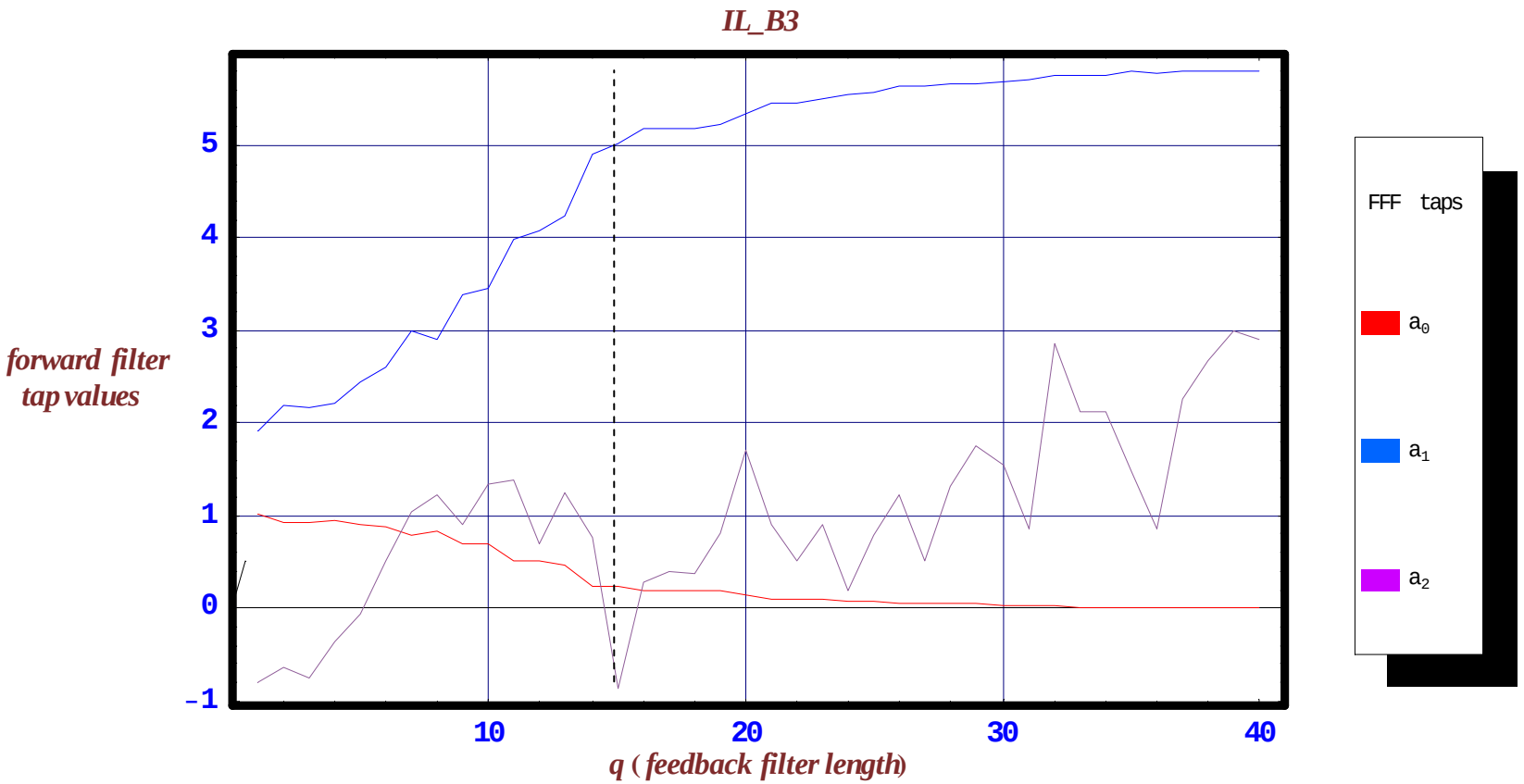
- Post-cursors remain significantly different than zero for a long time (~ 40 UI)

ATCA (peters_01_0904_B3_thru) : NRZ



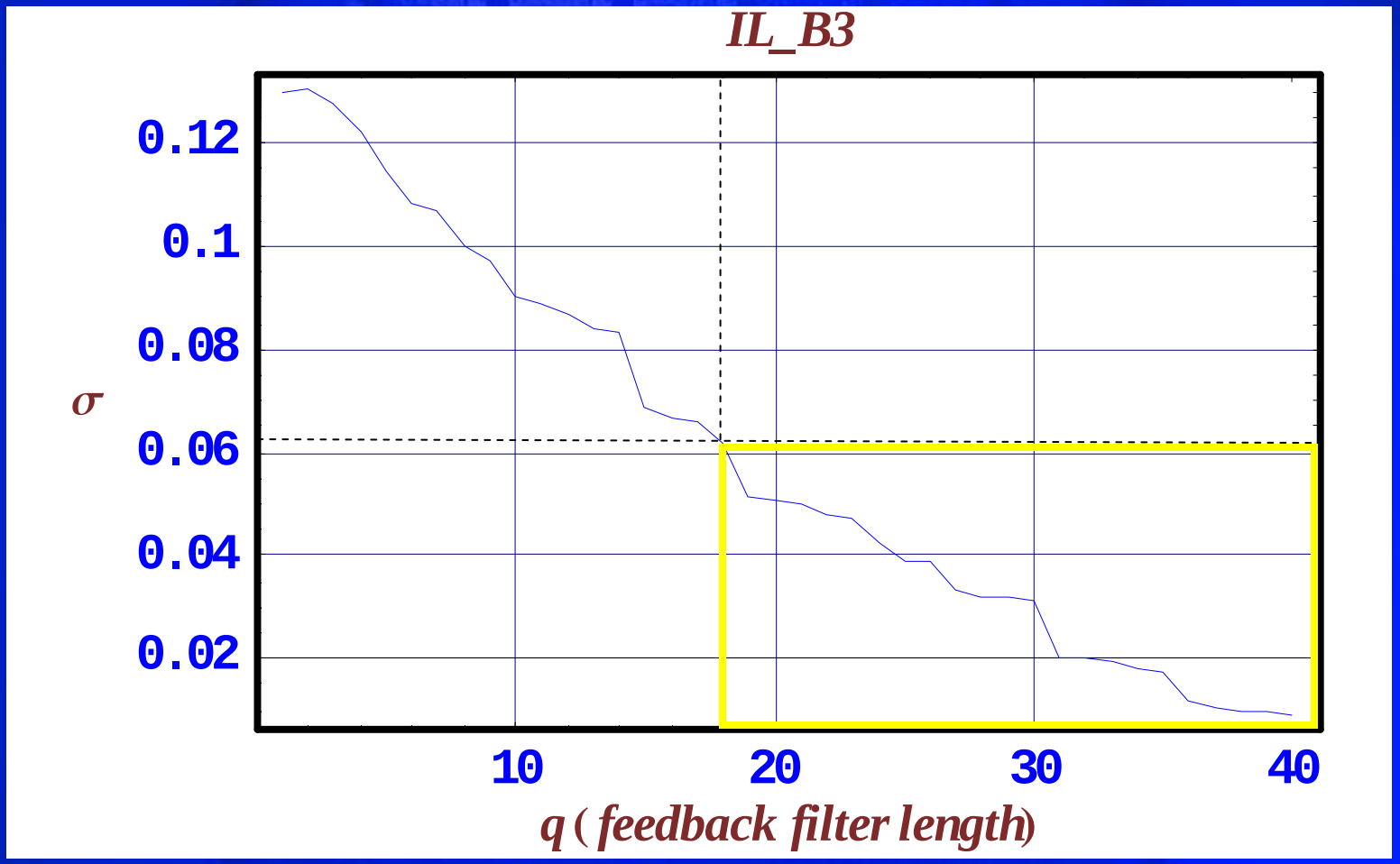
- For p = 3, target BER (10^{-15}) requires q ≥ 15 !

ATCA (peters_01_0904_B3_thru) : NRZ



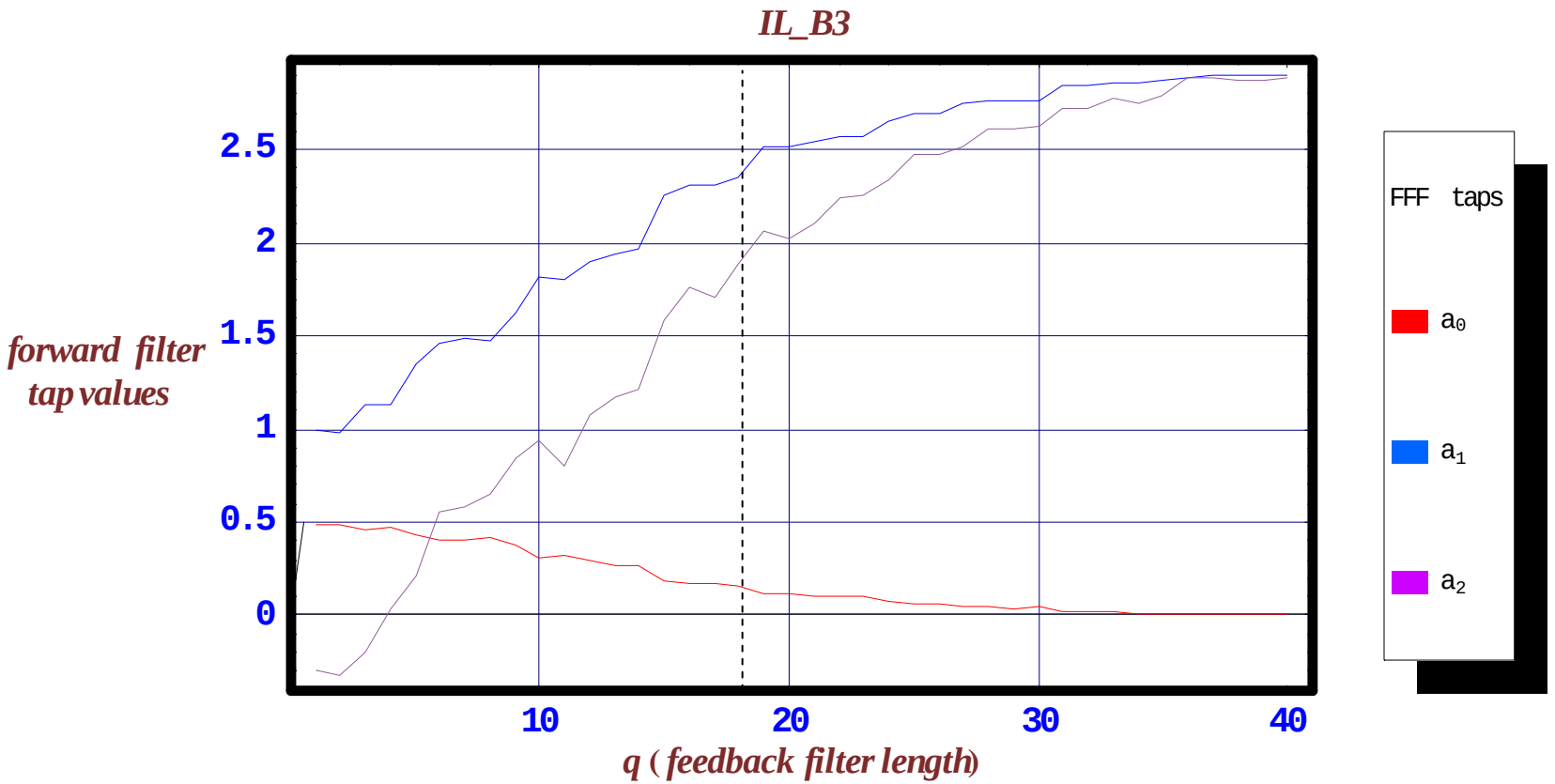
- Regardless of the feedback filter length, q, the forward filter is always providing additional equalization. This is consistent with the fact that the NRZ target spectrum differs significantly from the *native* backplane response.

ATCA (peters_01_0904_B3_thru) : PR2



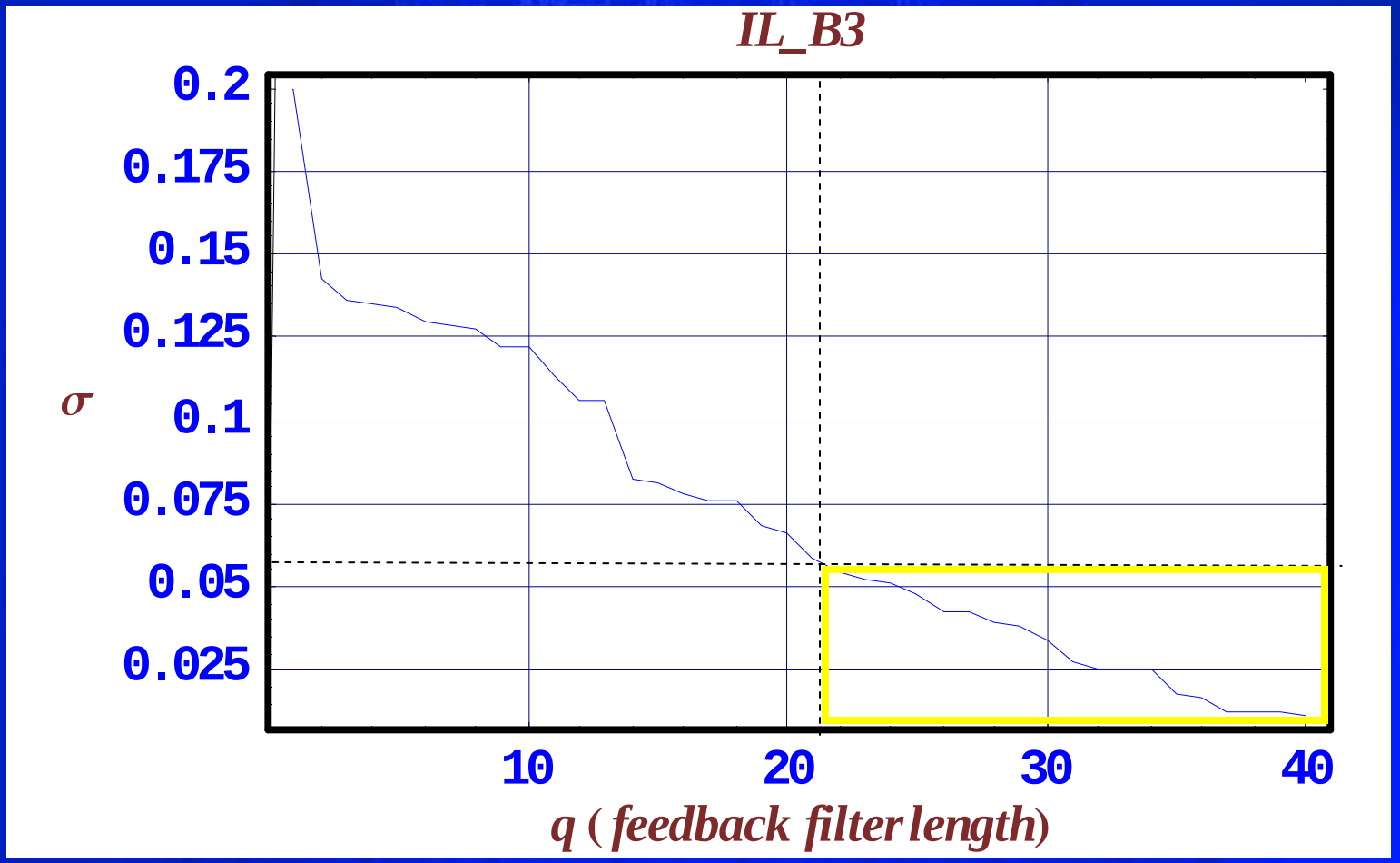
- For p = 3, BER requires q ≥ 18 !

ATCA (peters_01_0904_B3_thru) : PR2



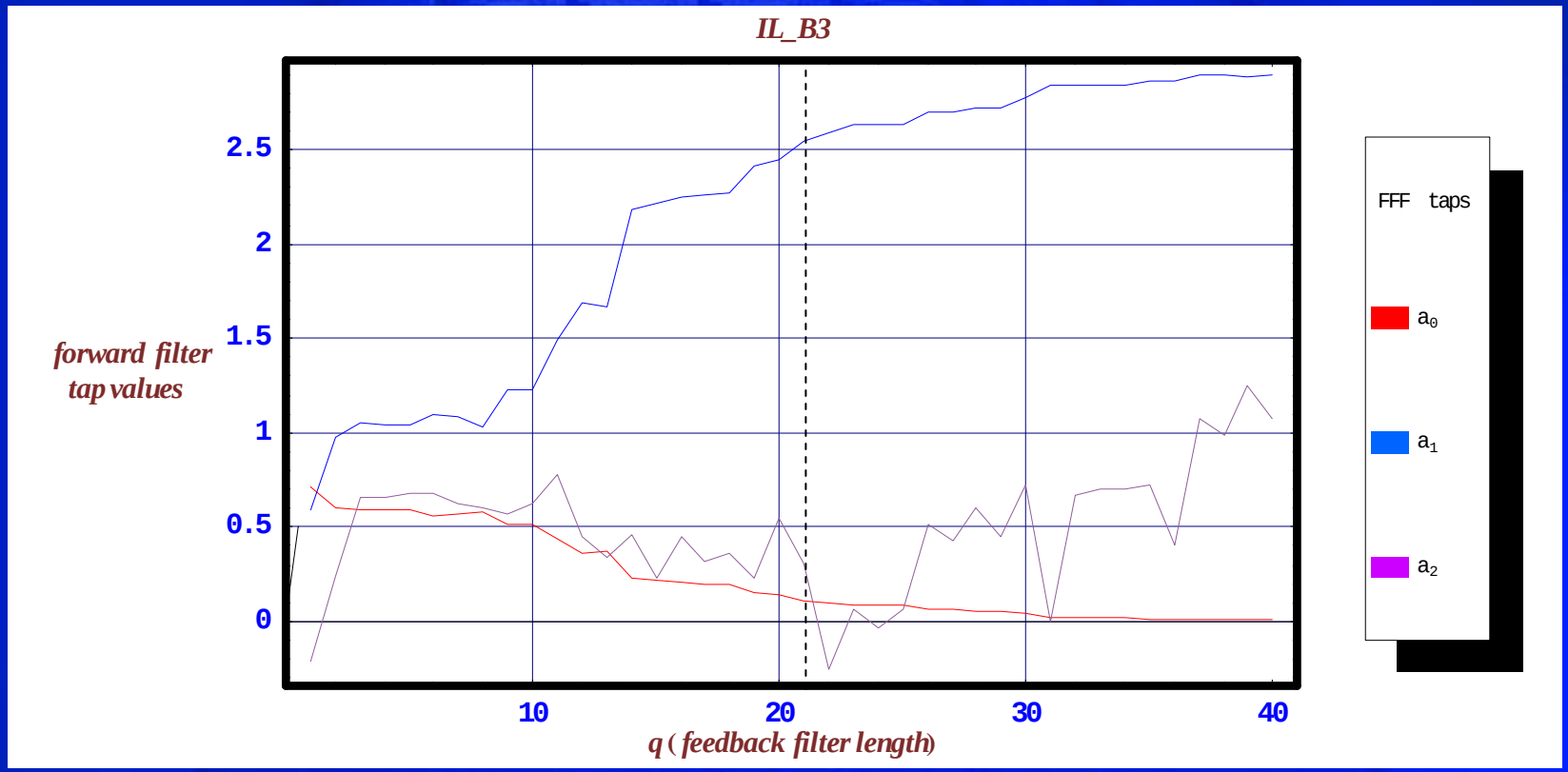
- As the length of the feedback filter decreases (and the post-cursor cancellation becomes less effective) the forward filter reconfigures itself to provide boost.

ATCA (peters_01_0904_B3_thru) : – PR4



- For p = 3, BER requires q ≥ 21 !

ATCA (peters_01_0904_B3_thru) : PR4



- Except for a relatively narrow range, the three taps in the receiver FFE are always providing additional equalization.

Summary

- **Time domain characteristics rather than frequency domain characteristics prove to be a better indicator of the backplane quality.**
- **Extended post-cursor ringing in the impulse response is very difficult to cope with while maintaining the equalizer complexity under reasonable limits.**
  - **It should be pointed out that besides "implementation cost" considerations, there are error propagation reasons which tend to limit the length of a feedback filter in a DFE receiver.**
  - **Linear equalization solution, which in principal avoid the error propagation issue, are too power hungry to be practical**
- **This *trend* has been verified on different backplane vendors**

Conclusions

- It appears that the adoption of an Insertion Loss mask criteria to qualify acceptable backplanes while provides condition that need to be met does not insure that the link would work.
  - this issue transcends whether a given signaling scheme is better or worse than another .
- It is recommended that the Task Force consider the adoption of additional criteria (preferably time domain based) to guarantee proper operation .
  - ideally this should be done in such a way to provide guidance to both silicon and backplane designers.
  - ideally this should also settle the debate concerning the type of backplanes that ought to be considered by the task force