

Channel Qualification Based on Salz

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IEEE 802.3bj Task Force, Sep 2012

Outline

- Motivation
- D1.1 93A Issues
- Salz Methodology
- Example Channel Analysis
- Summary Proposal

Operating Margin

- The Concept of Margin is key in communications systems
- Margin based approach is accepted industry-wide, 802.3 usage: BASE-T, RTPGE, also introduced in AP & BA (albeit, not fully utilized)
- BJ “COM” is a significant formalization step forward from the “Eye” based methodology

Why COM analysis?

ran_01a_0712.pdf

- The most important elements of COM are:

- 1. Applying equalization effect assuming **minimum-capability receiver and specified transmitter**. **practical**
- 2. Calculation of specific noise distribution and quantiles.

- Agreement on a common reference is a necessary step for making a meaningful decision.

Which Reference?

- We will show that combined simple-linear and DFE as reference equalization produces better results than each one alone.

Good Observation [also in the Book]

- ? • Assumed minimal capability. Not recommend implementation.

- Detailed calculation of crosstalk and ISI distributions is more justifiable than assuming a Gaussian distribution (as in most textbooks). Results are sometimes very different.

- **Adding arbitrary margins to cope with wide range of inaccuracies, as done in the past, would put many “manageable” channels below passing mark.**

- Using COM provides a more precise discrimination between channels, assuming **minimal capabilities**.

practical

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July 2012

Marked: Agreement in Principle

Transceiver, Annex 93A – Minimum?

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- TX filter – 2nd-order Butterworth at $0.55 \cdot f_B$ for THRU and FEXT, $1 \cdot f_B$ for NEXT
- RX filter – 4th-order Butterworth at $0.75 \cdot f_B$ ¹

Would have required complex poles @ multi-GHz
On-Chip Active Filters ?? LC-Filters (Inductors) ??

0.4 mV AWGN, ~13 GHz BW → **-159 dBm/Hz**
On the edge!

In fact very Challenging Definition for Realization
[Does it solve the problem?]

93A Issues – Normative Annex

- Too Many Parameters: 32+ Most @ TBD
- 25 Expressions – Key equations Do Not allow direct computation
- Many assumptions – Tx, Rx structure, etc., some questionable in math & physics
- Proprietary computing
- PAM4 – still open with No Path
- Is 93A Verifiable, Repeatable?
- Is Computation Tool a Std Responsibility?

93A Issues – Early Feedback

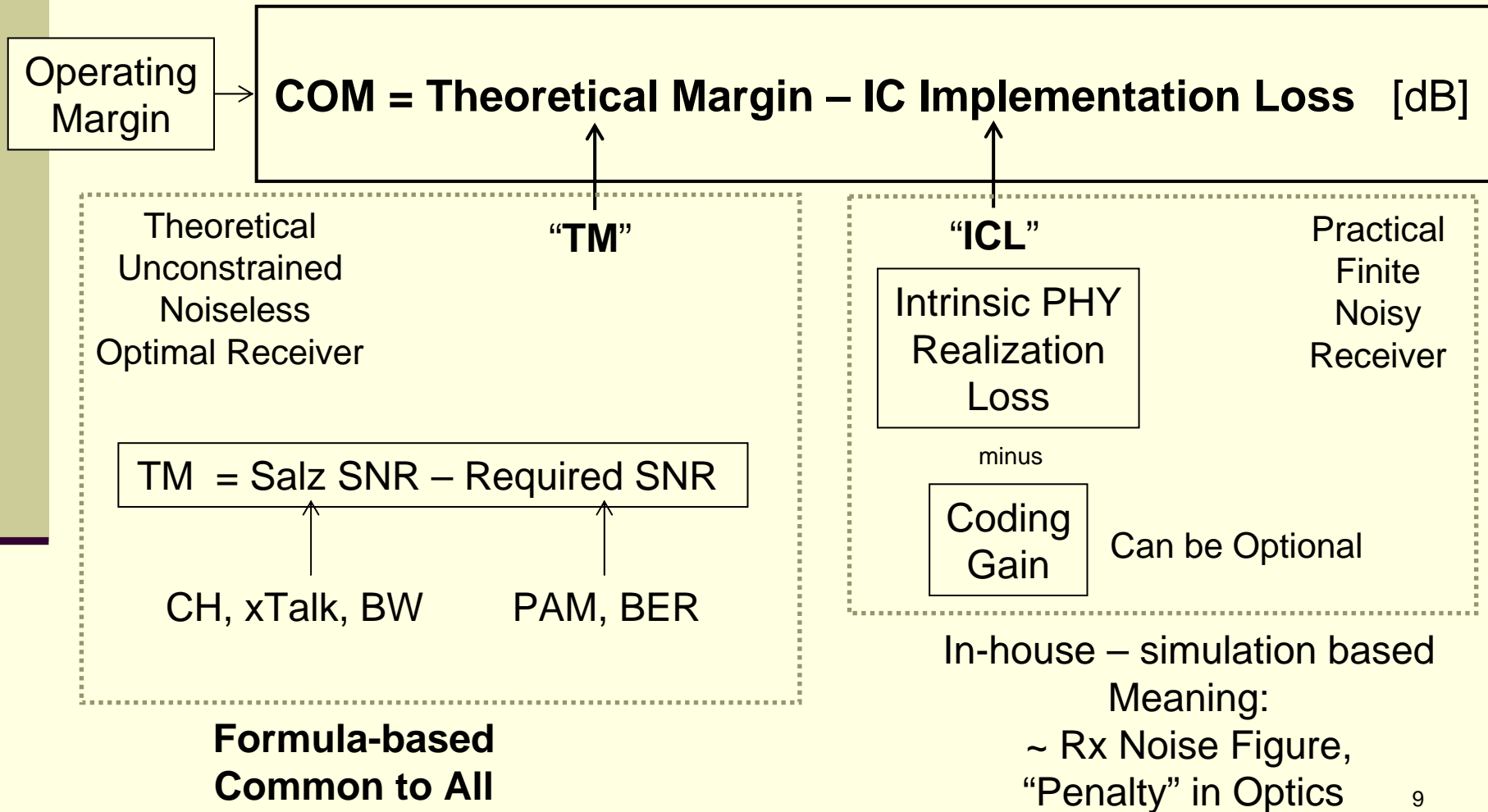
CI 93A	SC 1.6.1	P218	L 30	# 34
Moore, Charles		Avago Technologies		
Comment Type	T	Comment Status	X	
Equation 93A-20 represents <u>a really painful way</u> of computing σ^2_m . Much simpler is				
$\sigma^2_m = \sum_{n=0 \rightarrow N-1} (H_m(n)^2)$				
<i>Suggested Remedy</i>				
Delete equation 93A-20. Insert				
$\sigma^2_m = \sum_{n=0 \rightarrow N-1} (H_m(n)^2)$				
prior to equation 93A-17. Move verbage associated with equation 93A-20 having to do with selecting value of m giving maximum σ_m up to the new equation. Add statement that equation 93A-17, 93A-18, and 93A-19 need only be applied for the value of m giving maximum σ_m				
<i>Proposed Response</i>		<i>Response Status</i> O		

[Salz Uses One Basic Equation]

Why Base “COM” on Salz

- Fundamental – Fully Covers PAM (2 & 4)
- Objective –
 - Textbook-validated Expression (one)
 - Channel-Noise Only, No Actual Design
 - Direct Computational
 - No Arbitrary Assumptions
- Simple & Reliable –
 - Few Parameters
 - Repeatable
 - Anyone can Independently Do&Verify

Salz Applied



Channel Qualification

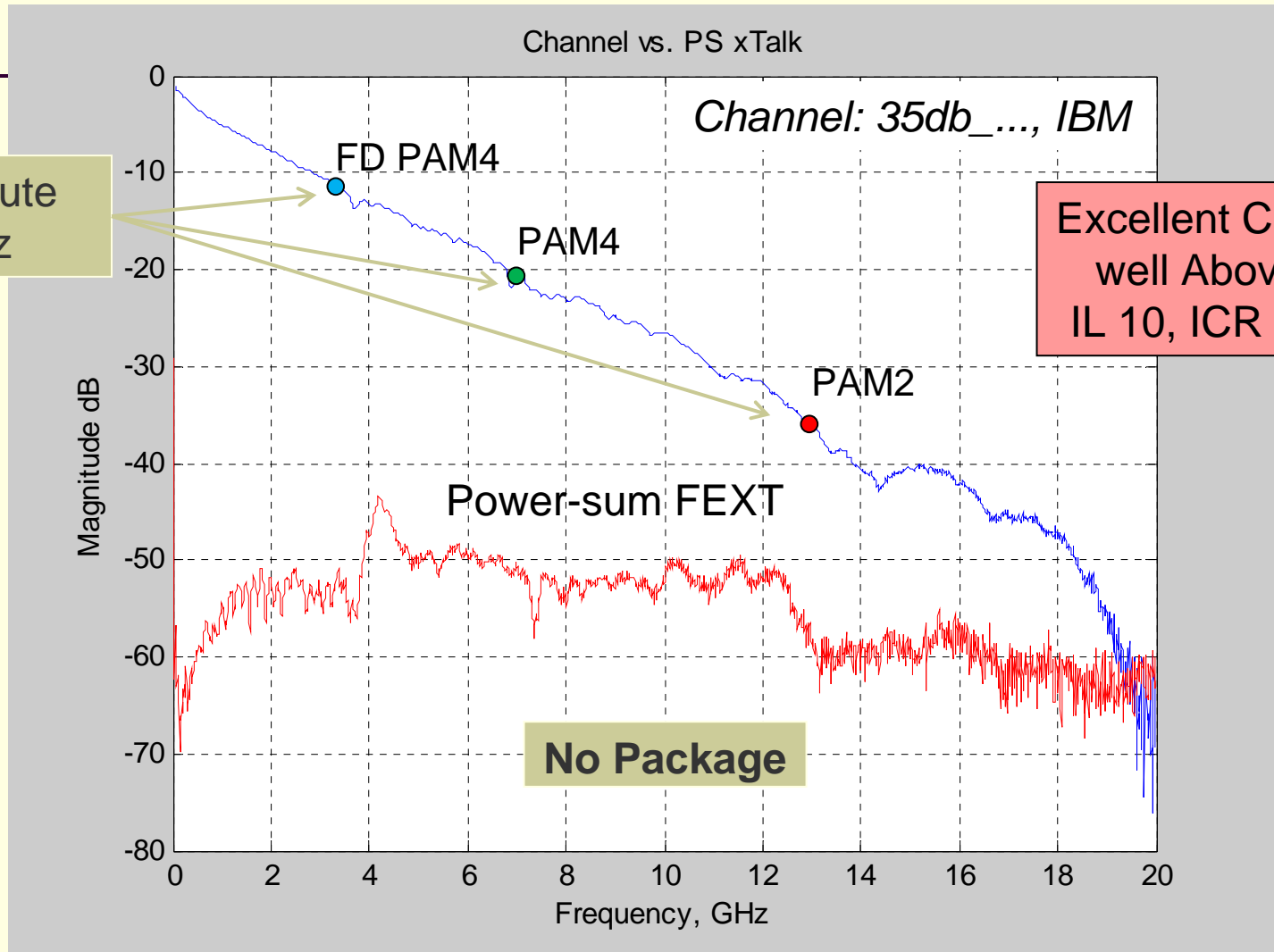
- Set Desired “COM” → 3 dB ? (Sys vendors)
- Agree on “ICL” → 10-12 dB ? (IC+Sys vendors),
Consider Basics for Target Application –
 - PAM2 or PAM4
 - FEC Mandatory/Optional
 - Fundamental System Floor (AWGN) & Tx Spectral
 - Balance Materials Cost vs. IC
- Channel Qualified if $TM \geq COM + ICL$

Note, realization loss derivation is Vendor internal – only need to agree on outcome. Some examples how to get ICL follow.



Intrinsic PHY Realization Loss & Margin Analysis Example

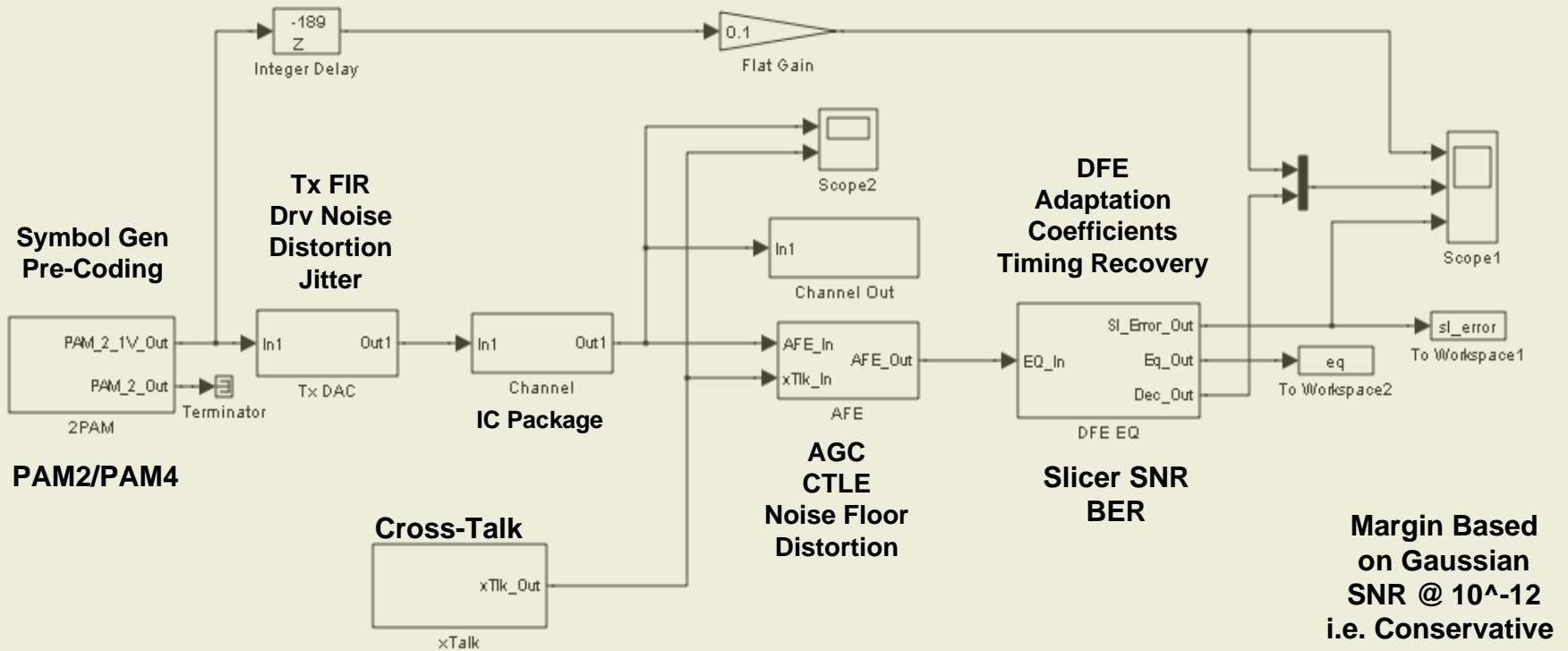
Example Channel Characteristics



~78cm BP, No NEXT, same as "IBM_35db" in *ran_01a_0712.pdf*

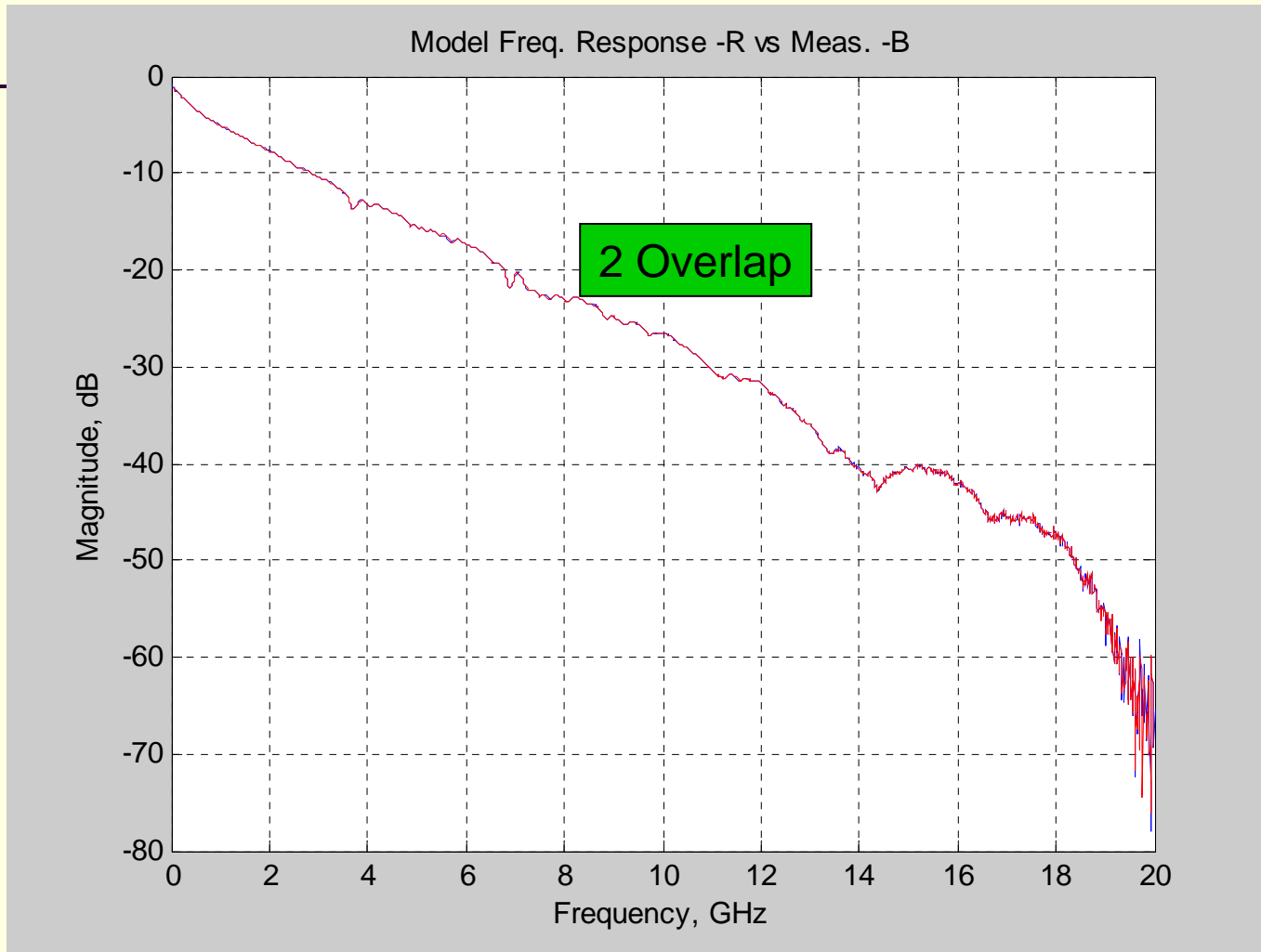
Example PHY Implementation Loss Analysis

Simpler than “93A” System Definition and Different Optimization
Mix-Signal, Not DSP



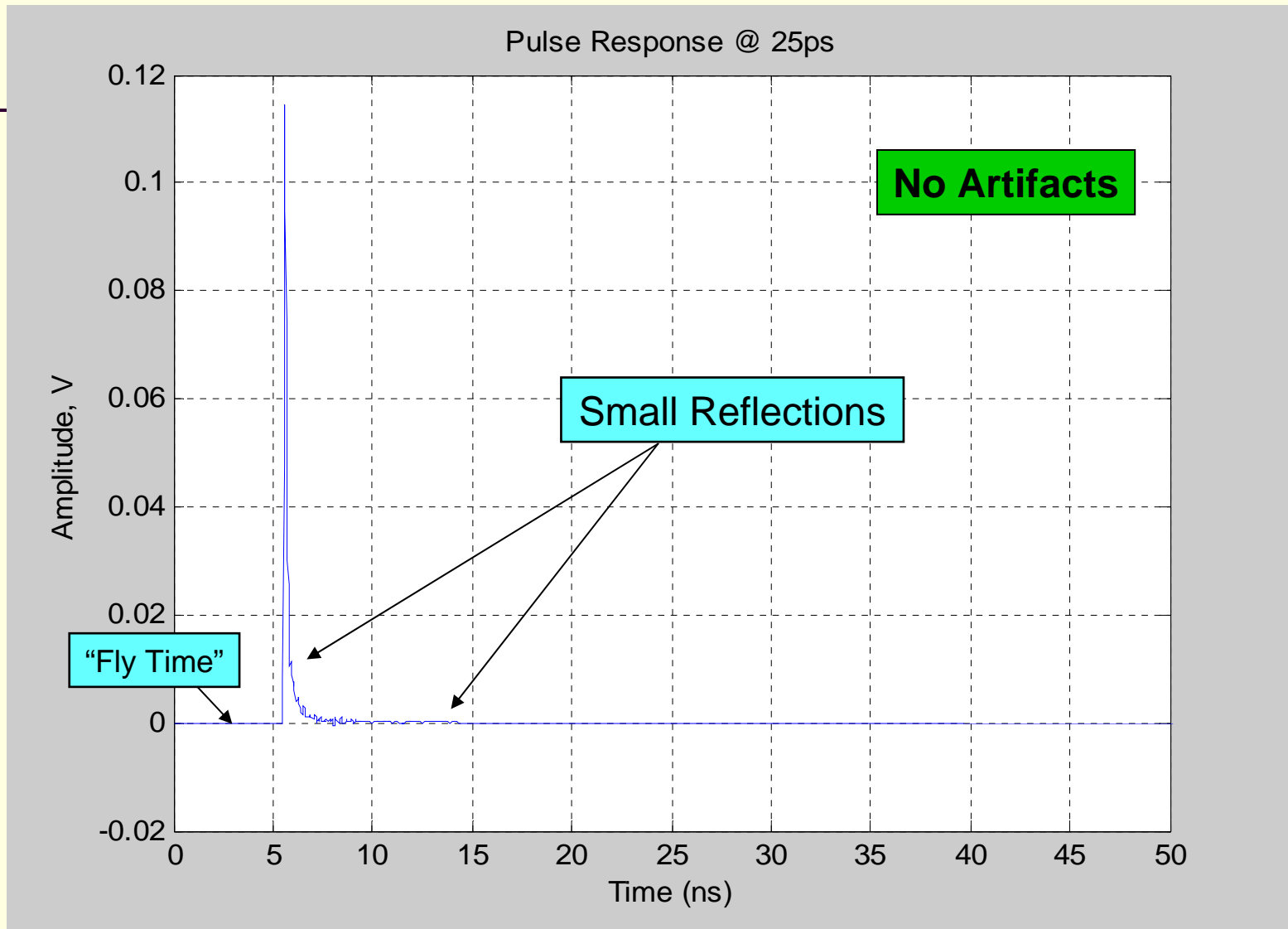
Use Behavioral Modeling (“System Spice”) to analyze **key transceiver impairments**, as opposed to hand/formula-based “93A” calculations, prone to error or potentially inadequate in high complexity env.

Modeling – Validate Model Responses



Measured Channel -Blue, “Extracted” Model -Red

Channel Model Time Domain Validation

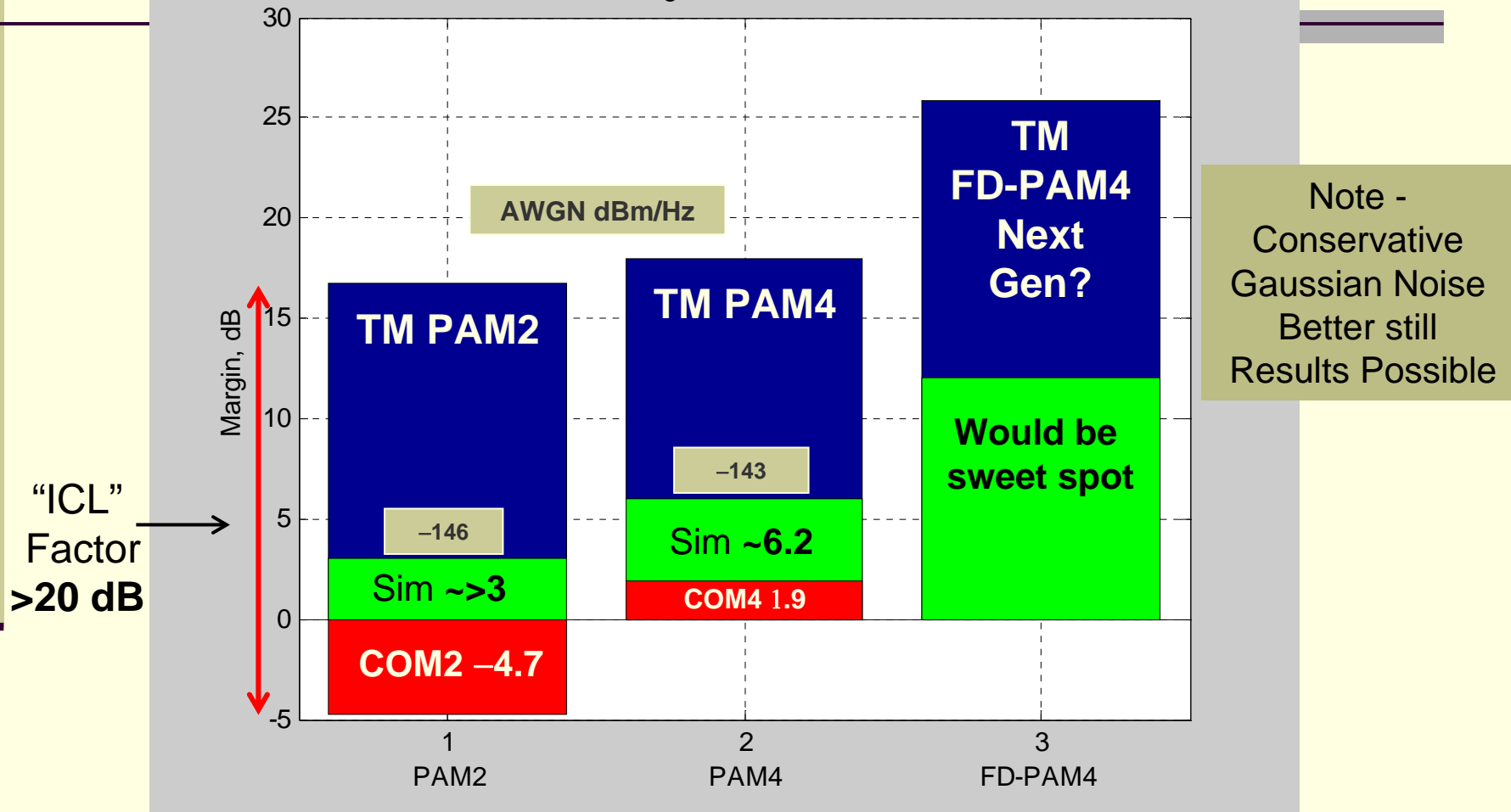


Important: True Causal Time Domain Pulse Response

Channel Theoretical & Operating Margin

Study-Transceiver: PAM2 & PAM4 vs. 93A

Channel Theoretical Margin -B, COM 93A -R, Sim -G vs. PAM



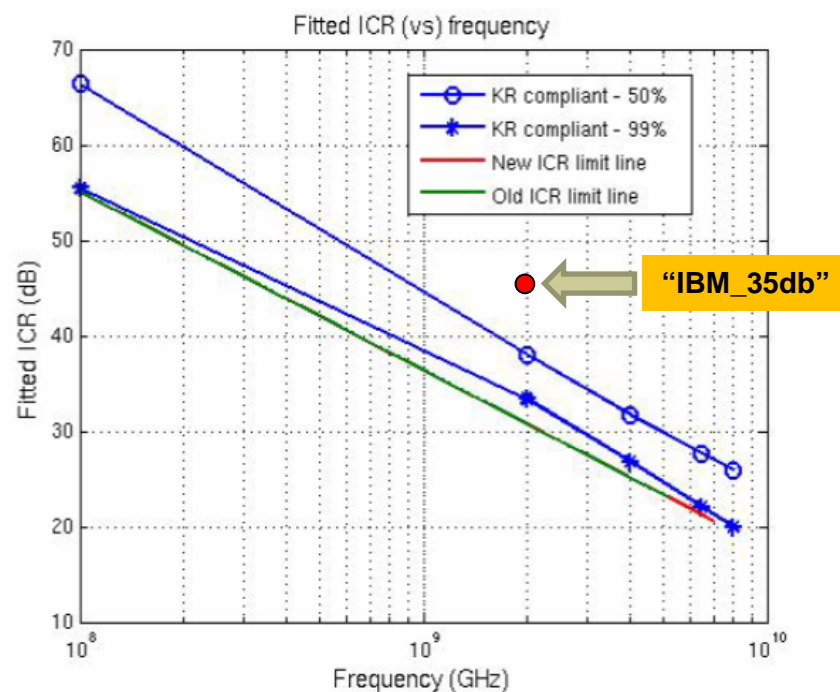
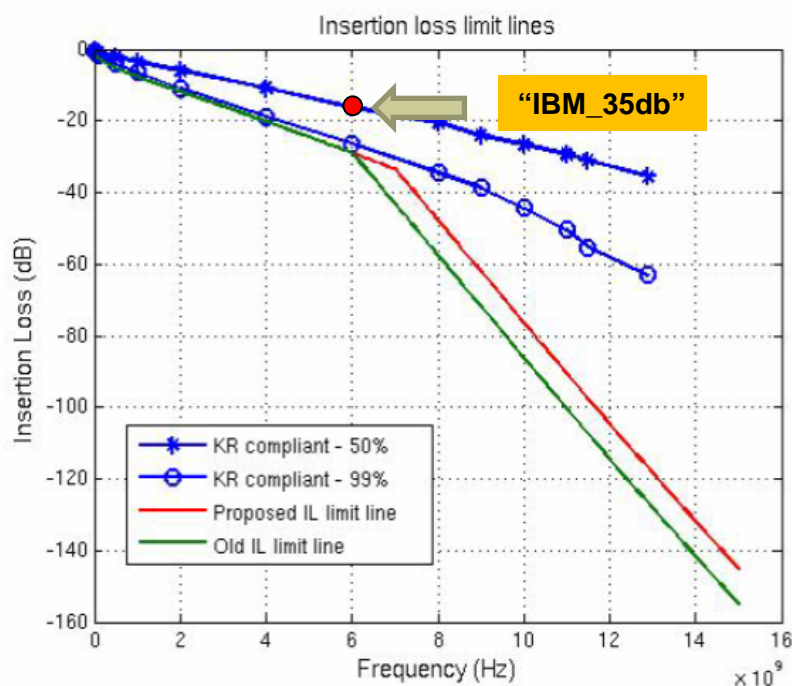
93A Channel Penalty ~20 dB is Excessive,
~12 dB readily demonstrable

What Channels 93A Receiver Can Support?

Previously proposed limits to 7 GHz

frazier_01_0112.pdf

Have we changed Objectives and/or Broad Market Potential?



Less than 50% might pass – more than 50% would **certainly Fail**

Summary Proposal

- D1.1 Annex 93A treatment for COM derivation is not well suited as Normative Channel Qualification – Make 93A Informative if desired
- 93A would Significantly Penalize Workable Channels if enforced
- Define Normative Channel Qualification based on Salz SNR – Objective, Simple and Repeatable
- Discuss & Agree Practical IC Realization Loss: 10-12 dB