HD Radio™ Toolbox

Nautel Ltd.

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NABSHOW™ Where Content Comes to Life™

Making Digital Radio Work.

Today's **Agenda**

- Thinking about things over a beer during hockey
- Designs leading to where we are now in HD Radio technology
- Reliable HD Transport review
- HD PowerBoost™ – What is it – What does it do?
- Asymmetric Sideband Operation
- Recap on what helps/hurts transmitter de-rating
- A look down the road – SFN via IQ

Why An HD Radio™ Power Increase?

- Better building penetration
- Reliable outdoor coverage
  - to 60 dBu contour or beyond
    (less blending or multicast dropouts)
- Better reception on portables
- Early talk of this prompted Nautel engineers to start thinking about best practices going forward

Some Nautel Tool Box Items

- First HD Radio equipment manufacturer to engage true dynamic pre-correction (2004)
- As “Exgine” was developed, we noted loss of a single UDP packet punched a 1.4 sec. hole in the IBOC audio
- Developed “Reliable HD Transport” as a means to re-send dropped or damaged packets (2007)
- Elevated sideband power operation (-13) demonstrated in Ukraine (2007)
- Paper on enhanced PAPR shown at NAB (2008)
- Asymmetric IBOC sideband power shown to customers under NDA (2009)

How Much Injection is Enough?

Analyze your digital coverage

- High noise environment?
- Coverage needed?
- Interference to other stations?
- Interference to your own analog?
- Regulatory clearance beyond -14?

Consultants can help

-14dB

-12dB

-20dB

?

-13dB

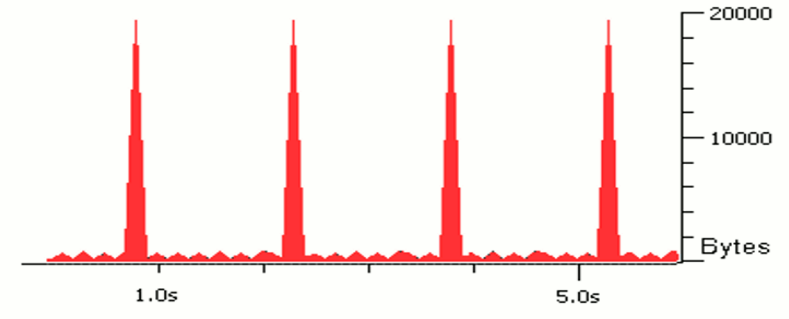
-10dB

-16dB

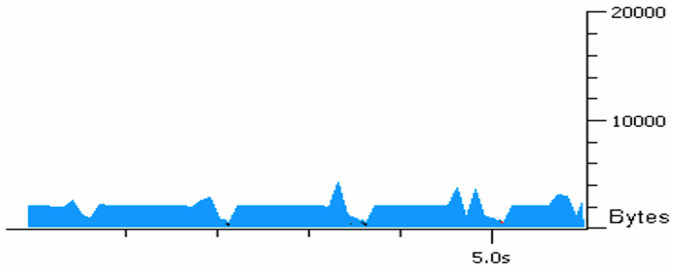
-15dB

Reliable Transport

- Improves reliability by “smoothing out” the HDC E2X data, reducing burst requirements
- Permits re-transmission of lost/damaged packets via IP back-channel

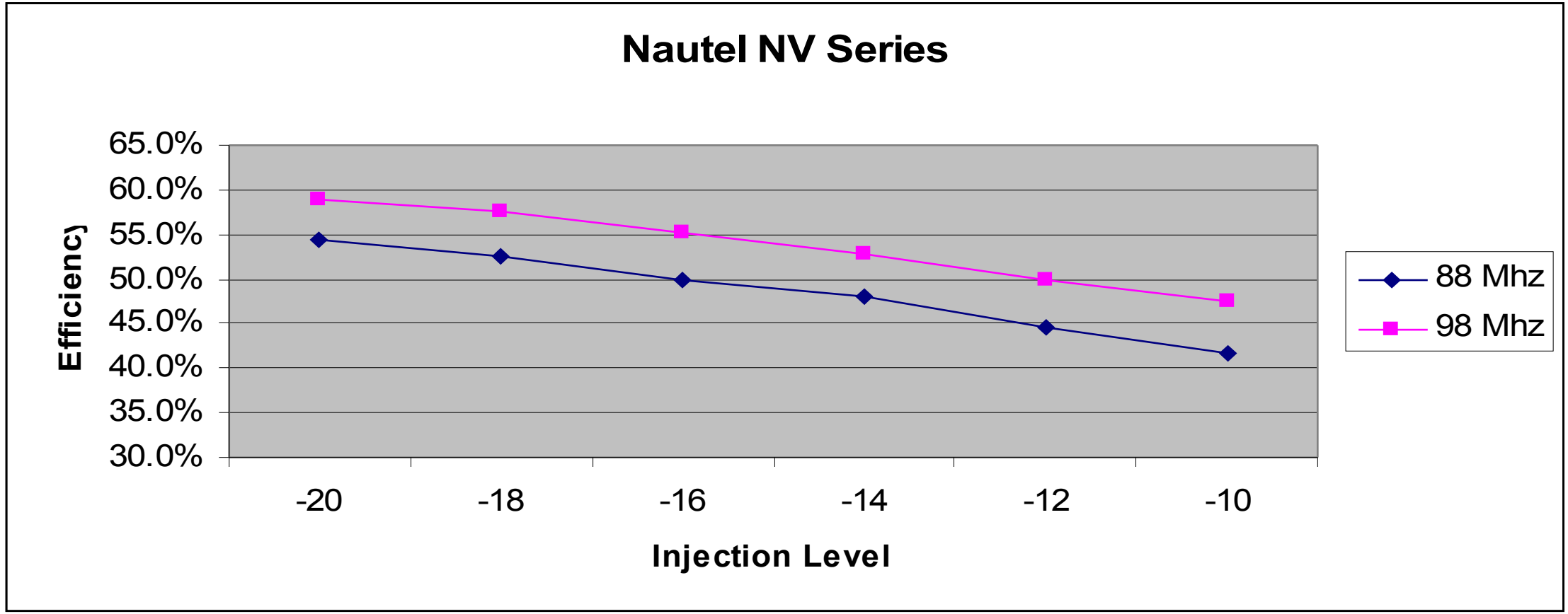


Before Reliable Transport
(E2X connection)



After Reliable Transport
(E2X connection)

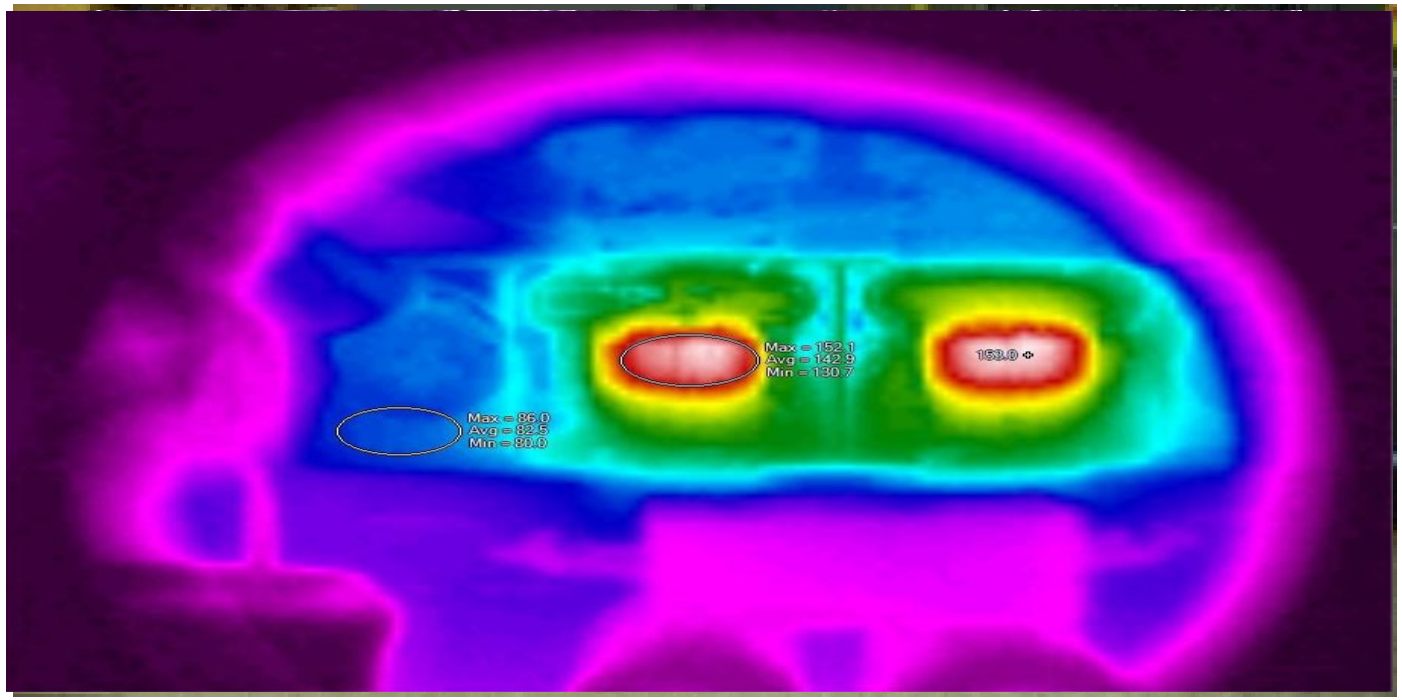
Efficiency vs. Injection Level Common Amp (Low Level)



Transmitters: Higher Injection Implications

Limitations:

- Linearity (spectral mask)
- Thermal dissipation



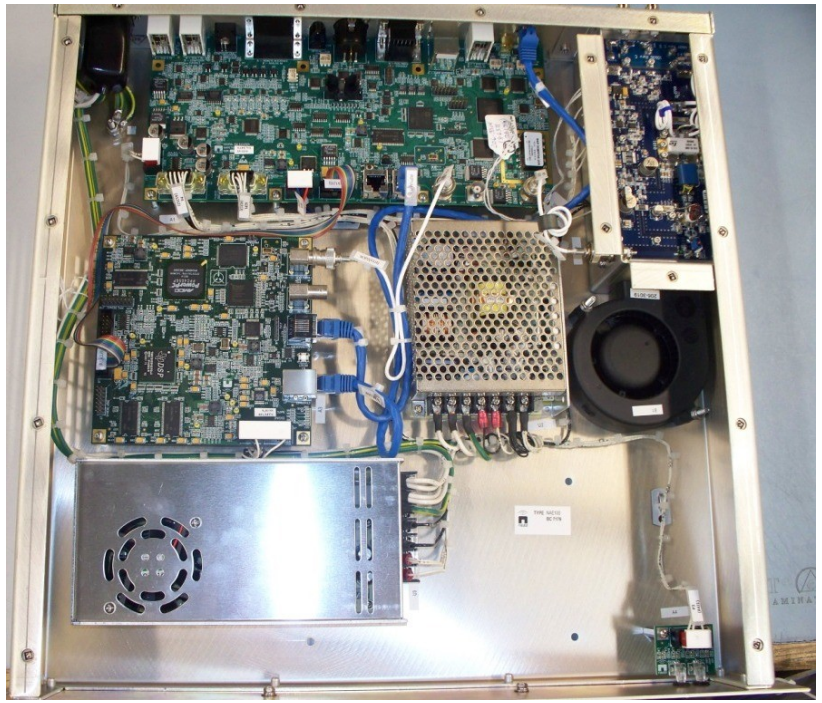
Most transmitters using dynamic pre-correction today are thermally limited
So don't just "turn it up" – talk with your transmitter manufacturer

HD Power**Boost™**

- A Nautel innovation which applies PAPR techniques to the ***entire*** transmitted signal.
- More digital power (Up to 30% increase @-10)
- Substantially higher efficiency (up to 7%)
- Upgraded hardware for NVE exciters.
- Optional software suite implemented in NVE
- Typical ROI less than 2 years
- Product Availability Q3 2010

HD PowerBoost: Hardware implementation

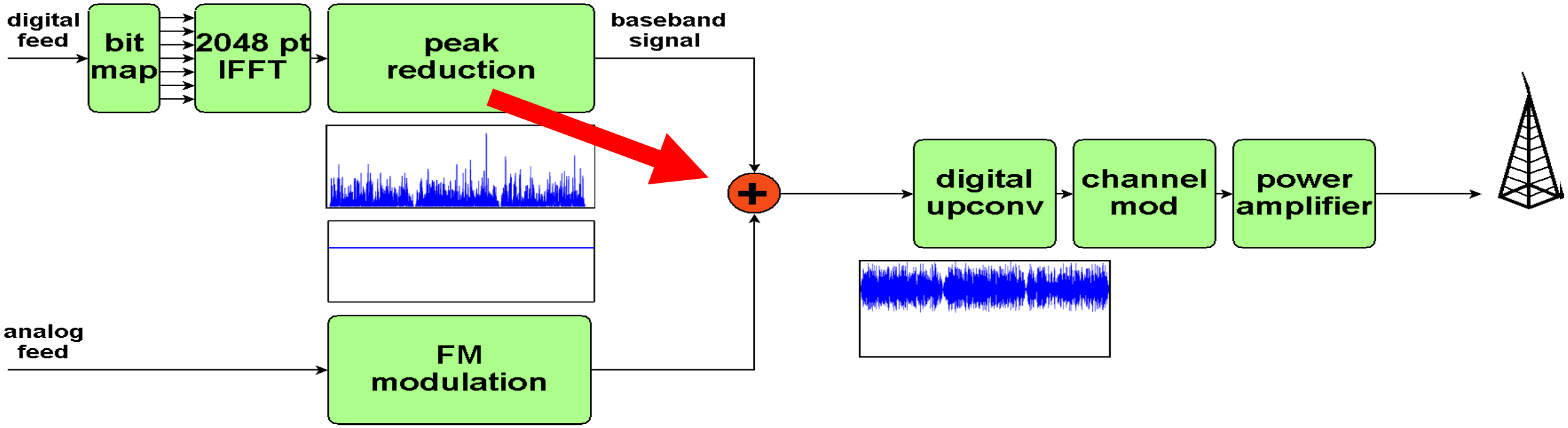
Our demonstration at NAB 2009 used a very high power 8-core industrial PC



Current Product Implementation

Nautel's PAPR Reduction

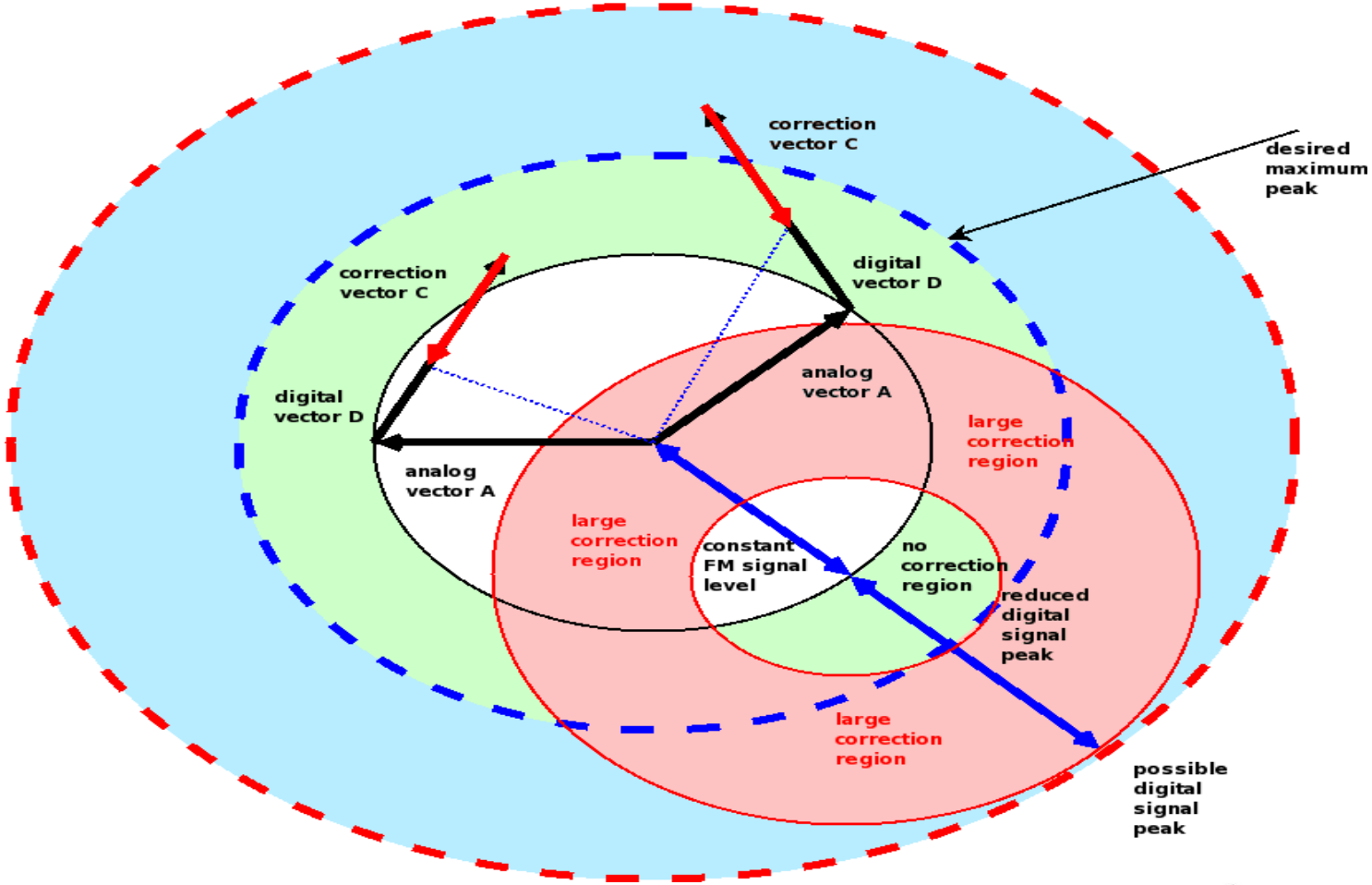
Standard PAPR reduction only considers the IBOC signal …



...what if we considered both the analog and digital signals together?

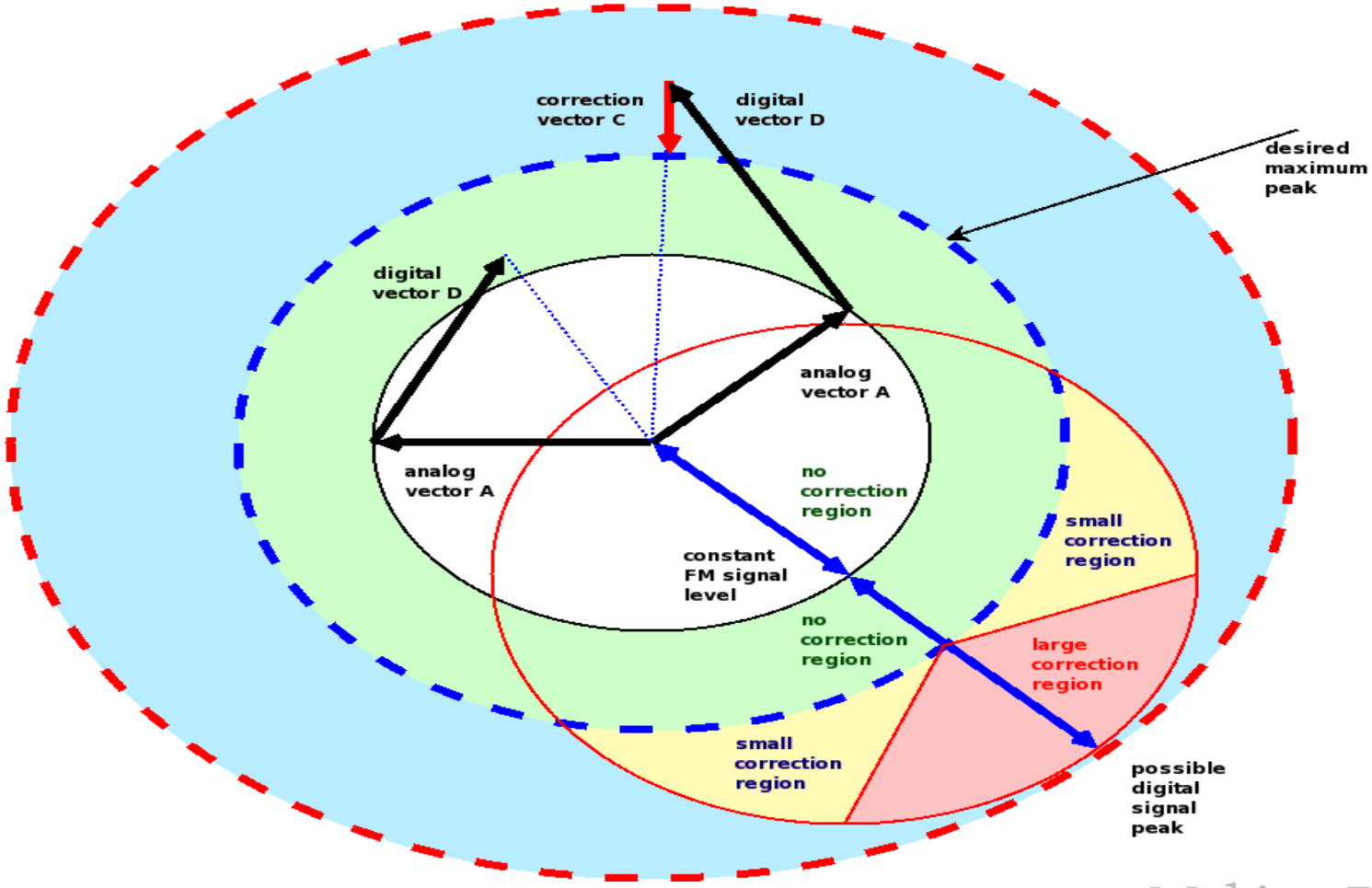
iBiquity PAPR Reduction

Standard PAPR reduction applied to ONLY IBOC signal

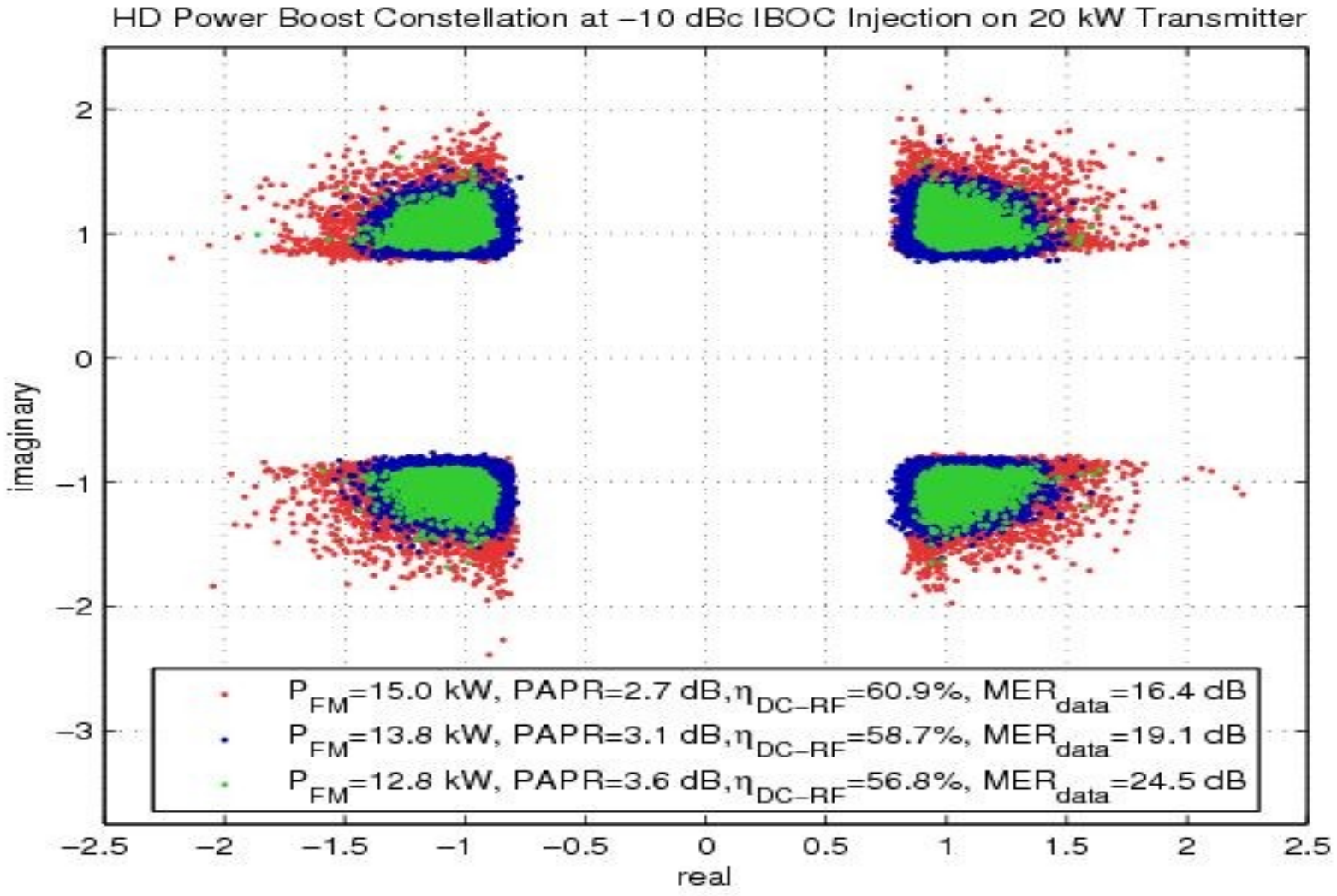


Nautel's PAPR Reduction

PAPR reduction applied to hybrid FM+IBOC signal



HD PowerBoost: additional clean power



Coverage Reduction by increased **MER**

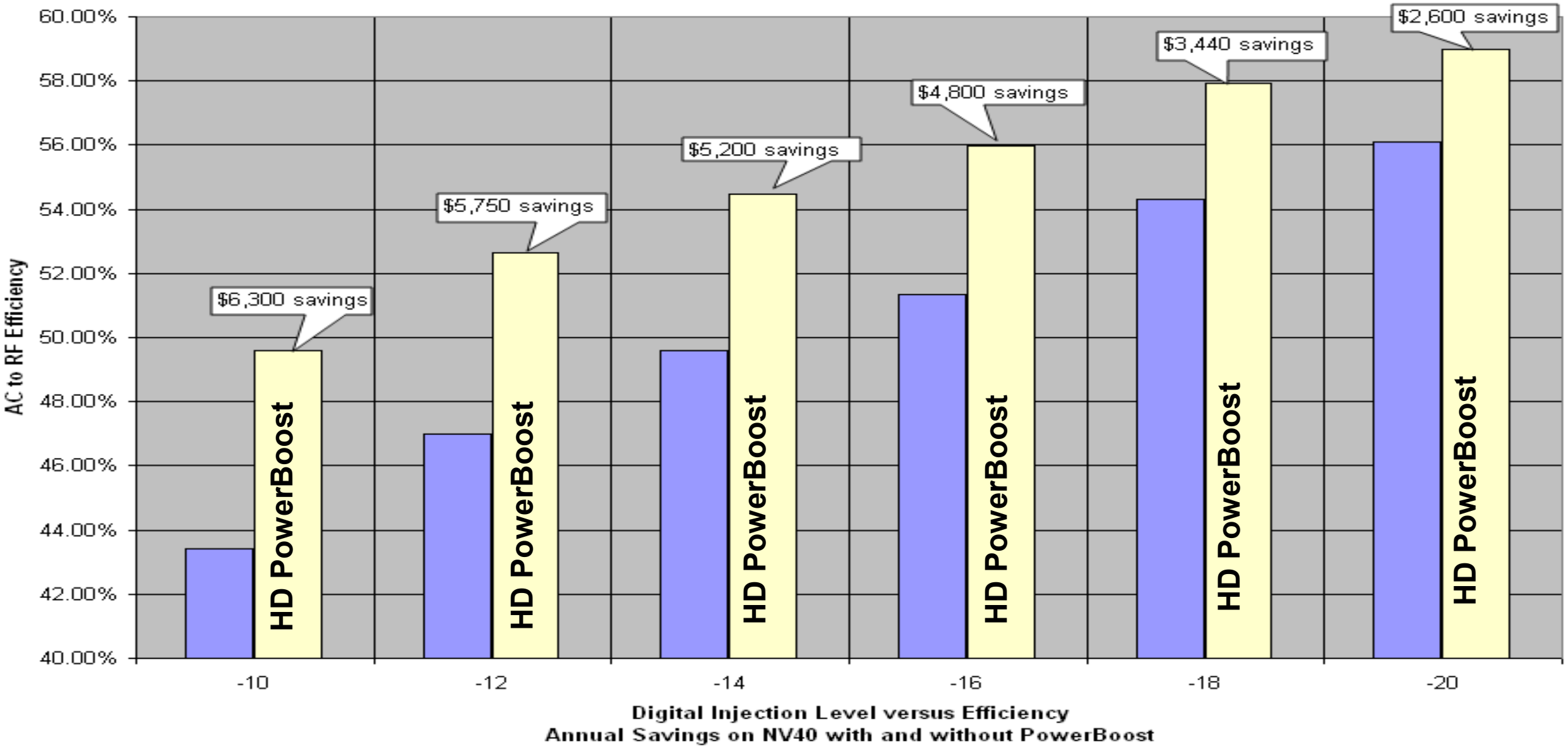
Data Carrier MER	Reduction in Service Contour
18 dB	.22 dB
17 dB	.25 dB
16 dB	.31 dB
15 dB	.37 dB
14 dB	.48 dB
13 dB	.59 dB
12 dB	.74 dB
11 dB	.91 dB
10 dB	1.13 dB
9 dB	1.38 dB
8 dB	1.73 dB

iBiquity system typically is 17.5 dB

Nautel's most aggressive PAPR is 16.5, well exceeding the spec of 14

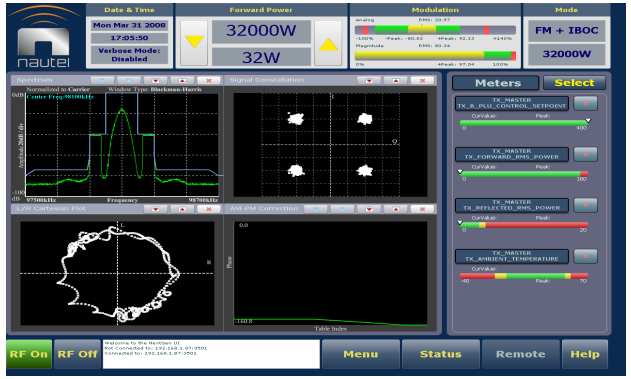
Means a 20 kW transmitter can produce 15 kW of analog + HD (at -10 dBc) compared with ~11 kW without Nautel PAPR.

HD PowerBoost: Efficiency



Nautel -10dB/-14dB Solutions

- HD PowerBoost
- Asymmetrical Sidebands
- NV Series High Power Solid State



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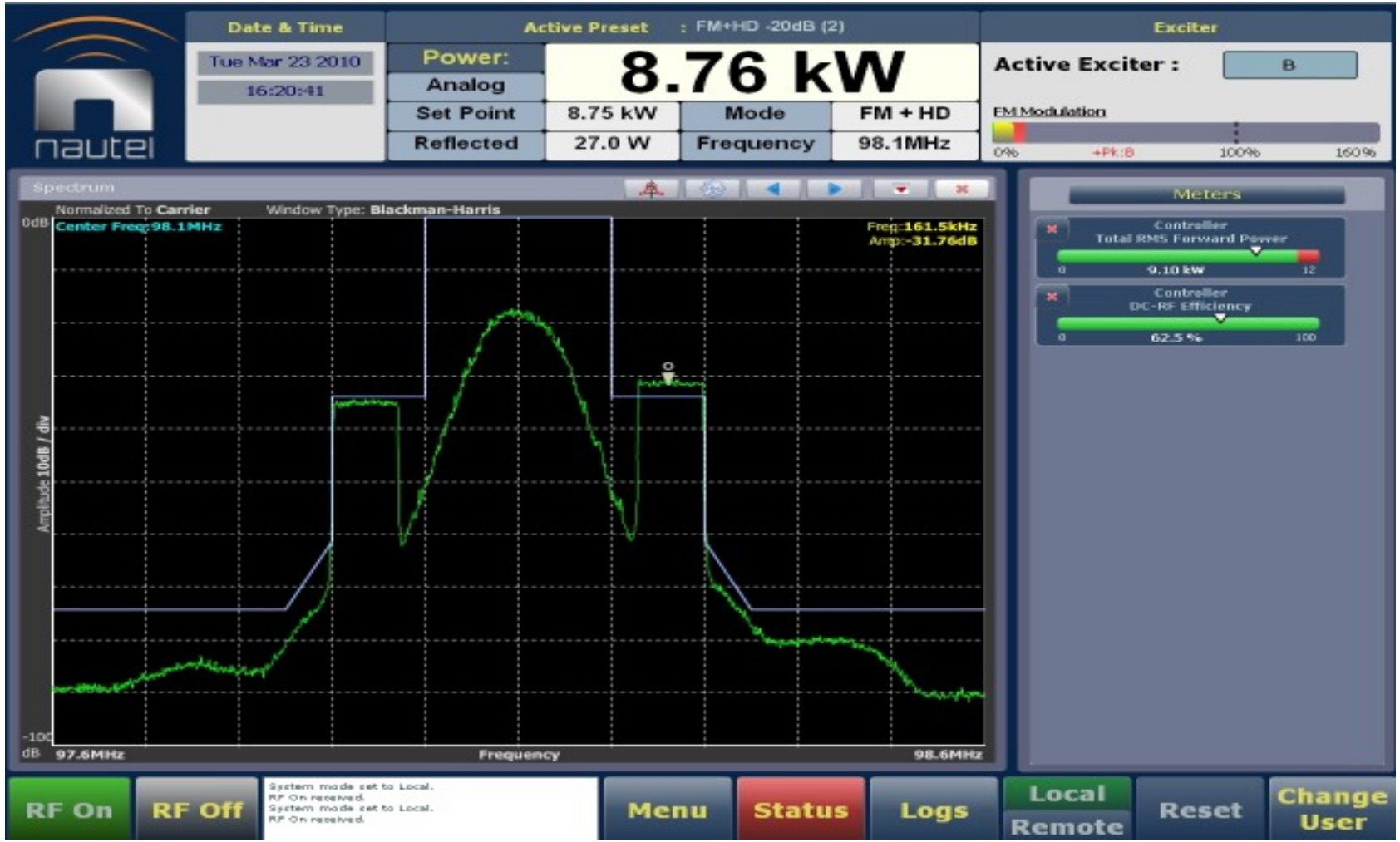
MIA-FLL-WPB MARKET **HIGHLIGHTS**

-10 dBc (both SB)	Asymmetrical	-14 dBc (both SB)
WHDR	WDNA -14 / -10	WLDI
WMIA	WLRN -10 / -14	
WMGE	WLYF -13 / -10	
WPOW	WXEL -14 / -10	
WFLC	WKGR -14 / -10	
WRTO -12 / -12		
WEDR		
WKIS		
WMXJ		
WMIB		
WHQT		
WBBG		
WEAT		
WIRK		

Asymmetrical Sidebands

- Not yet FCC approved
- Capability comes with HD PowerBoost
- Optimizes coverage to actual interference conditions.
- Individual sidebands adjustable in 1 db increments from -20 up to -10 dBc through AUI
- Can be used with or without PowerBoost



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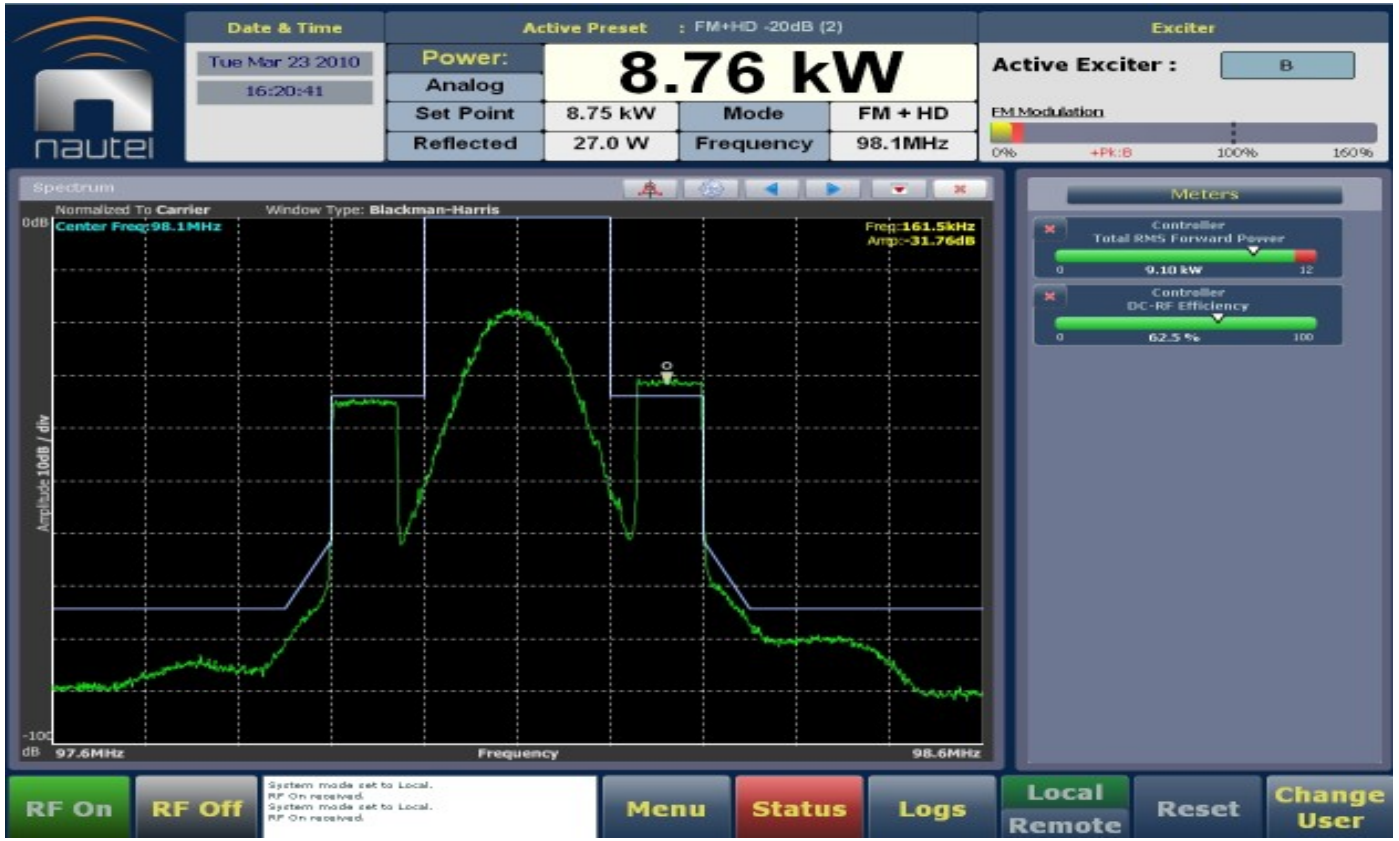
Factors That Can Improve **De-rating**

- Peak-to-Average Power Ratio Reduction (PAPR) such as Nautel's PowerBoost™ can yield an additional 30% in available analog power @ -10 dBc
- Asymmetrical sideband technology – optimizes power in upper and lower sidebands.



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Demonstration PowerBoost and Differential Sideband Power

Factors That Can Degrade **De-rating**

- Tube vs. Solid State – Tubes generally de-rate faster as injection approaches -10 dBc
- Extended hybrid modes – Depending on the Mode (MP2, MP3, MP11,etc.), require additional de-ratings due to additional digital carriers
- MP3 mode ~6% at -10 dBc (2 extended partitions)
- MP11 mode ~13% at -10 dBc (4 extended partitions) (Note – Mode not commercialized)
- Check with your transmitter manufacturer!!

Transmitters: Power Ratings

HD Radio Injection Level Analysis Tool

HD PowerBoost → No
Enter VSWR Capability → 1.2:1
Enter HD mode → MP1
Enter Frequency → 98.1 MHz.

HD Injection Level / Analog TPO

Model	-20dB	-18dB	-16dB	-14db	-12dB	-10dB
NV3.5	3,707	3,537	3,369	3,032	2,560	2,107
NV5	4,942	4,716	4,492	4,042	3,413	2,809
NV7.5	7,413	7,074	6,738	6,063	5,119	4,214
NV10	9,884	9,432	8,983	8,084	6,826	5,618
NV15	14,827	14,148	13,475	12,126	10,239	8,428
NV20	19,769	18,864	17,967	16,169	13,652	11,237
NV30	29,653	28,296	26,950	24,253	20,477	16,855
NV40	39,537	37,728	35,934	32,337	27,303	22,474
NV60	59,306	56,592	53,900	48,506	40,955	33,711
NV80	79,075	75,456	71,867	64,674	54,606	44,948

All specifications subject to change. CK 3/24/10
All specifications based on 3dB mask headroom, and the NRSC measurement protocol.

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HD PowerBoost → Yes
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Enter Frequency → 98.1 MHz.

HD Injection Level / Analog TPO

Model	-20dB	-18dB	-16dB	-14db	-12dB	-10dB
NV3.5	3,799	3,723	3,650	3,411	3,076	2,715
NV5	5,066	4,964	4,866	4,547	4,101	3,620
NV7.5	7,599	7,446	7,299	6,821	6,151	5,430
NV10	10,131	9,928	9,732	9,095	8,201	7,240
NV15	15,197	14,893	14,598	13,642	12,302	10,859
NV20	20,263	19,857	19,464	18,190	16,403	14,479
NV30	30,394	29,785	29,196	27,285	24,604	21,719
NV40	40,526	39,714	38,928	36,379	32,806	28,958
NV60	60,789	59,571	58,392	54,569	49,208	43,437
NV80	81,052	79,428	77,856	72,759	65,611	57,916

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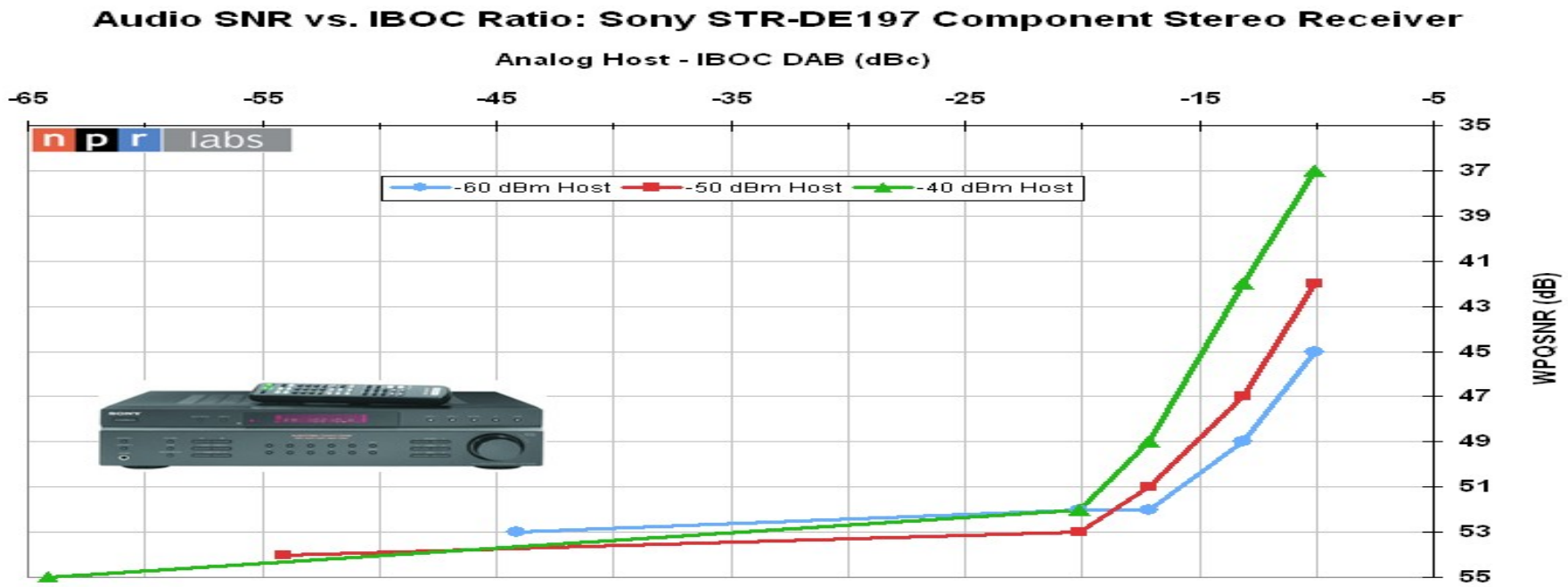
Digital Host **Interference**



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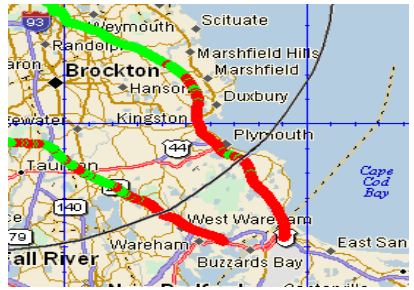
- Good FM audio at -20 dBc IBOC carriers
- Added FM noise with carrier increase
- Higher signal strength => more distortion
- Highly receiver dependent

Summary: Digital Coverage

- HD injection level requirements range from -20dB to -10dB depending on noise environment/allocation
- Good news: A wide range of increased digital injection strategies exist
- Nautel has single box solid state transmitter solutions up to 44kW analog, 36kW at -14dB
- HD PowerBoost may permit the purchase of a smaller transmitter size + increase efficiency

Booth C2615 – LIVE HD PowerBoost Demo with asymmetric sideband power



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Acknowledgements

- Putting the Quality Metric to the Test (Philipp Schmid, Nautel 2010)
- A New Approach to Peak-to-Average-Power Reduction for Hybrid FM+IBOC Transmission (Philipp Schmid, Nautel 2008)
- FM+IBOC Broadcast Systems Architecture Considerations for Single Frequency Networks (Philipp Schmid, Nautel 2009)

Questions? We're ready to help.

- www.nautel.com

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