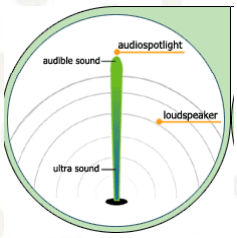
Non-linear acoustics: Directed sound

- Non-linear interaction
- Holosonics: Audio Spotlight
  - http://www.holosonics.com/index.html
- American Technology Corporation: HyperSonic Sound technology:
  - http://www.atcsd.com/site/content/view/13/104/
  - http://www.prosoundweb.com/install/tech_corner/parametric.php



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Egentlig ikke signalbehandling, men akustikk ...

- Mad Labs: Audio Spotlight
  - http://www.youtube.com/watch?v=veDk2Vd-9oQ&feature=related
  - Mad Labs from the National Geographic Channel presents the Audio Spotlight, focused loudspeaker technology, 3 min 12 sec
  - See www.audiospotlight.com for more.

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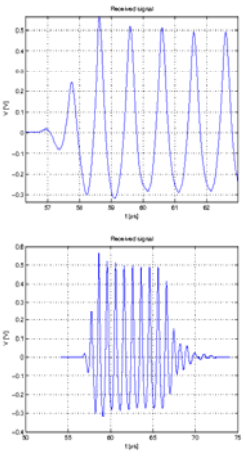
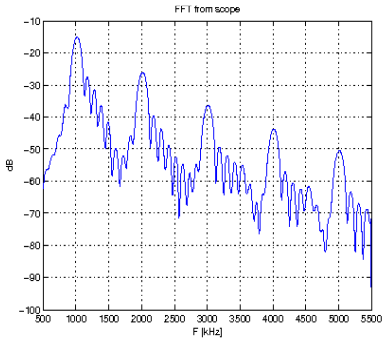
Ikke-lineær pulseform målt i vanntank i DSB-gruppens lab





Fabrice Prieur, dept. 2009

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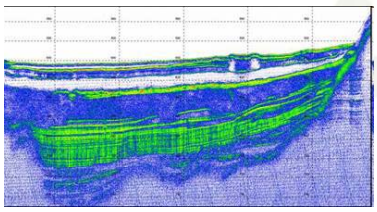
Topas: Parametric profilers



- Kongsberg Defense & Aerospace
- Parametric sub-bottom profilers
- Low frequency sound generation due to non-linear interaction in the water column from two high intensity sound beams at higher frequencies.
- The resulting signal has a high relative bandwidth (~80%), narrow beam profile
- Penetration ~100 m, 150 ms

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Topas: Parametric profilers

	TOPAS PS18	TOPAS PS40
Secondary frequency	0.5-6kHz	1-10kHz
Primary frequencies	15-21 kHz or 30-42 kHz	35-45 kHz or 70-90 kHz
Source levels	Secondary: 208 Primary: 242/225 dB	Secondary: 207 Primary: 241/226 dB
Hor. resolution	<5 x 5 deg	3 x 6 deg
Signatures	CW, Chirp, Ricker	

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Ikke så enkelt likevel

- Ved enkeltsinuser: OK
- Ønsker f.eks 1 and 1.3 kHz
  - Sende 50, 51 and 51.3 kHz
  - Får de ønskede frekvensene + intermodulasjonprodukter ved 0.3 kHz + deres harmoniske ++
  - Resultat: Opp til 50% distorsjon med bredbånds audio
- Kan reduseres ved pre-distorsjon sammen med bredbånds transducere
- Preprosesseringen består i å sende mange frekvenser som kan synes som om de er intermodulasjons-produkter, men som vil kansellere intermodulasjonen i mediet

Pompei, PhD thesis, MIT, 2002

- Carrier frequency:
  - Earlier 30-40 kHz
  - Now 50-70 kHz
- Audio preprocessing and wideband transducers to reduce distortion
  - 50% THD -> 5%

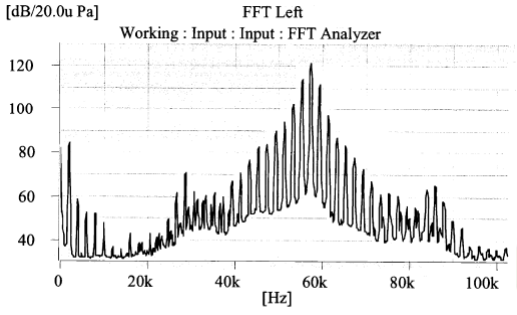

Figure 1. Spectrum of the maximum output of the Audio Spotlight at a 1 meter distance with a 2 kHz audio input. The sound at 1 meter from the transducer was input to a B&K real time analyzer with Pulse software, using a B&K 4939 microphone. The audio input to the Audio Spotlight was adjusted to produce the maximum possible audio and carrier output with distortion of the audio approximately 30 dB below the 2 kHz fundamental (see Figure 5). Note the absence of significant energy in the high audio range (10-20 kHz).