非侵入式頻域光子遷移檢測系統之微型化接收機研製

Investigation and Design of Miniature Receivers for Non-Invasive Frequency Domain Photon Migration Examination Systems

國立成功大學 電機工程研究所 儀器系統與晶片組

無線創新系統及應用電磁實驗室

(Wireless Innovation System and EM-applied Lab)

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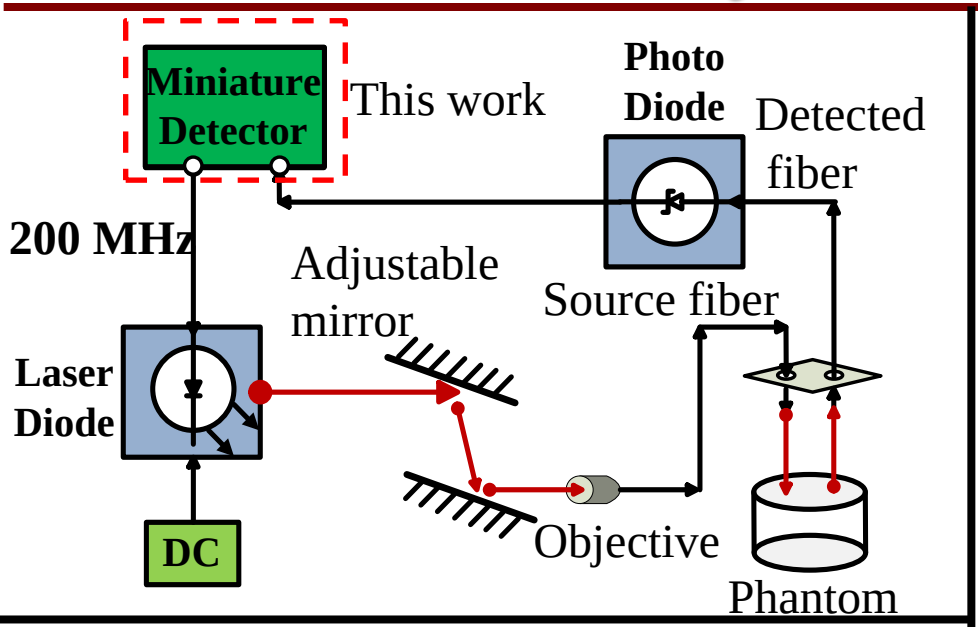
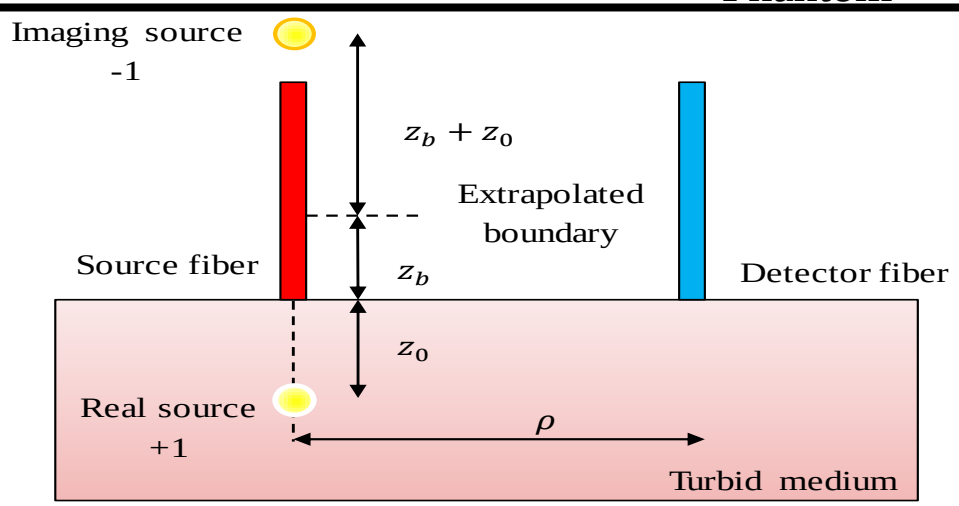
FDPM System and Theory





Based on diffusion theory

$$R = C_1\emptyset - C_2 D\nabla\emptyset \cdot (-\hat{z})$$

$$D \equiv [3(\mu_a + \mu_s')]^{-1}$$

$$\emptyset = \frac{P}{4\pi D}\left[\frac{\exp(-kr_s)}{r_s} - \frac{\exp(-kr_i)}{r_i}\right]$$

$$D\nabla\emptyset \cdot (-\hat{z}) = \frac{P}{4\pi}\left[Z_o\left(k + \frac{1}{r_s}\right)\frac{\exp(-kr_s)}{r_s^2} + (z_o + 2z_b) \times \left(k + \frac{1}{r_i}\right)\frac{\exp(-kr_i)}{r_i^2}\right]$$

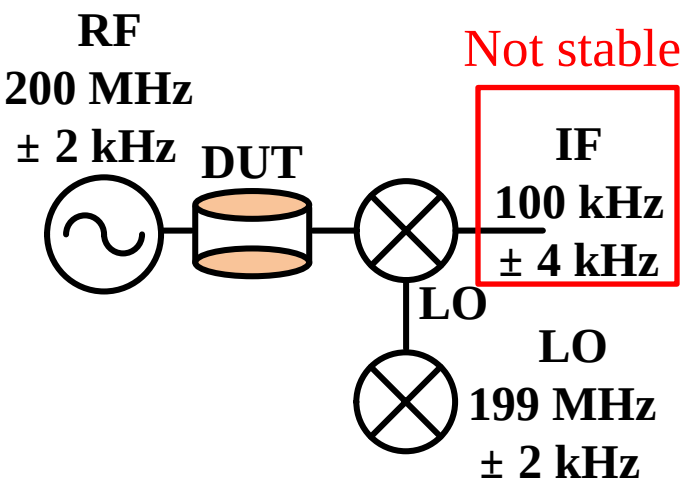
$$k = k_{real} + ik_{imag}$$

$$k_{real} = \left[\frac{3}{2}\mu_a(\mu_a + \mu_s')\right]^{1/2}\left\{\left[1 + \left(\frac{\omega}{\mu_a c}\right)^2\right]^{1/2} - 1\right\}^{1/2}$$

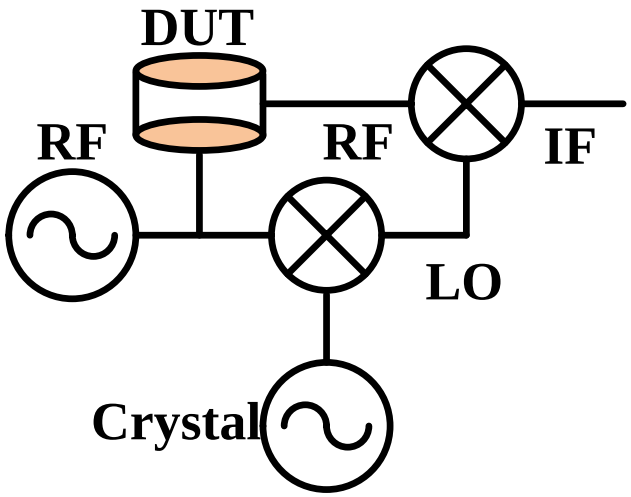
$$k_{imag} = \left[\frac{3}{2}\mu_a(\mu_a + \mu_s')\right]^{1/2}\left\{\left[1 + \left(\frac{\omega}{\mu_a c}\right)^2\right]^{1/2} + 1\right\}^{1/2}$$

Receiver Structure Analysis

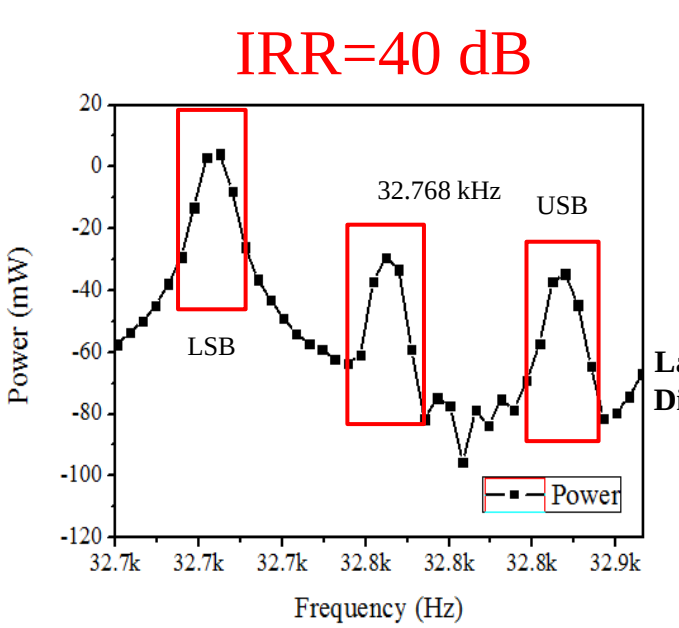
- Disadvantages of separate signal source FDPM receiver
  - ➢ Need two independent RF and local signal sources
  - ➢ Frequency stability is an severe issue

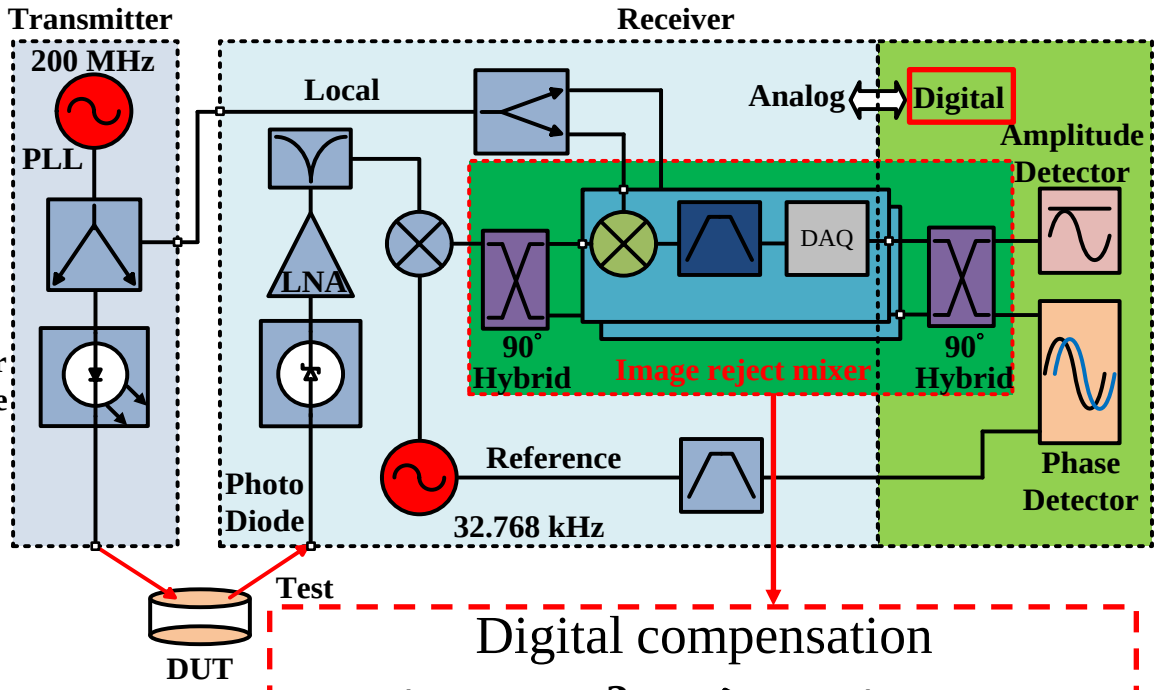


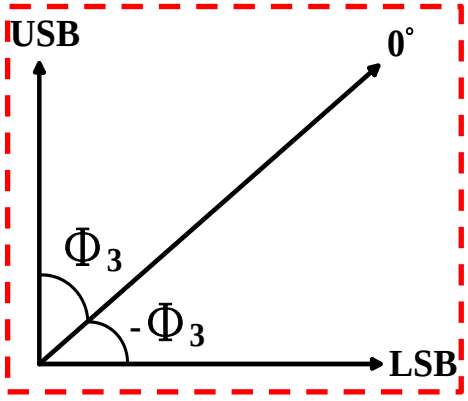
- Joint source FDPM receiver
  - ➢ Need only one RF signal source
  - ➢ Ideally, don't need very stable source
- Serious problem in joint structure
  - ➢ Phase cancellation (DSB)



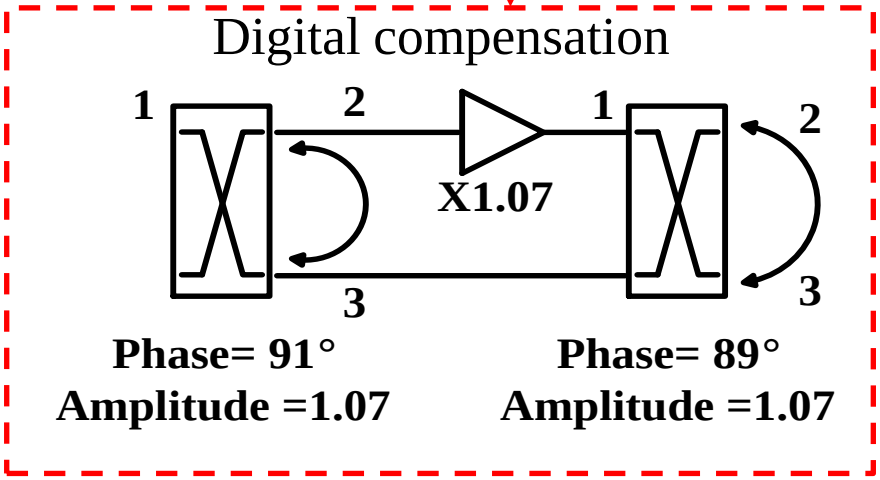
Receiver Block Diagram







IRM solves phase cancellation problem



Experiment Setup and Results

SP12	μ_a	μ_s'	Error of μ_a	Error of μ_s'
NA	0.0278	3.8313	4.67 %	-3.38 %
Proposed	0.0264	3.9608