LASERS AND INPUT OPTICS

SHOT NOISE INVESTIGATIONS

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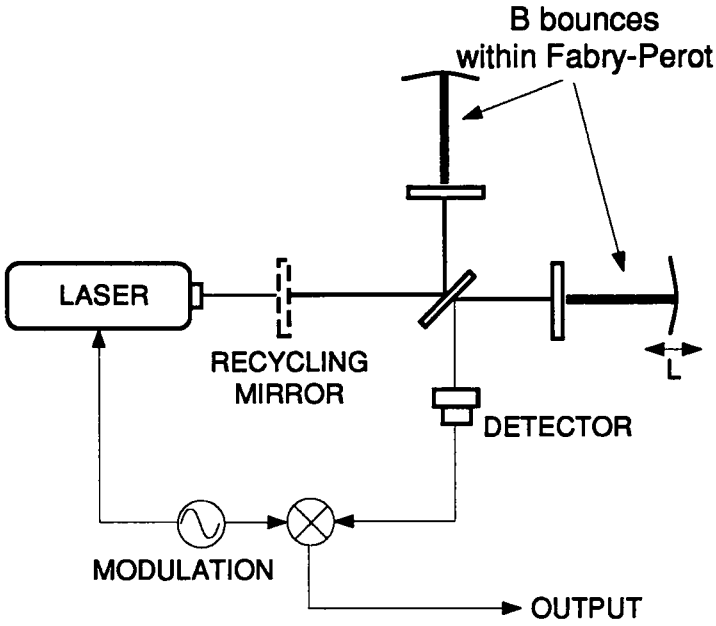
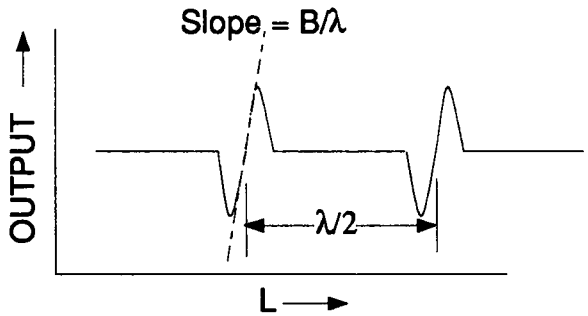
SHOT NOISE LIMIT TO SENSITIVITY



PHASE DETECTION



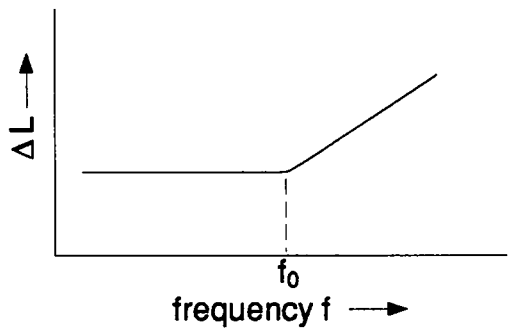
Output $\propto$ Phase ϕ

Precision $\Delta\phi \cong \frac{1}{\sqrt{N}}$

$N \propto$ Power at beam splitter
$\propto$ (Laser power) x (# of recycles)

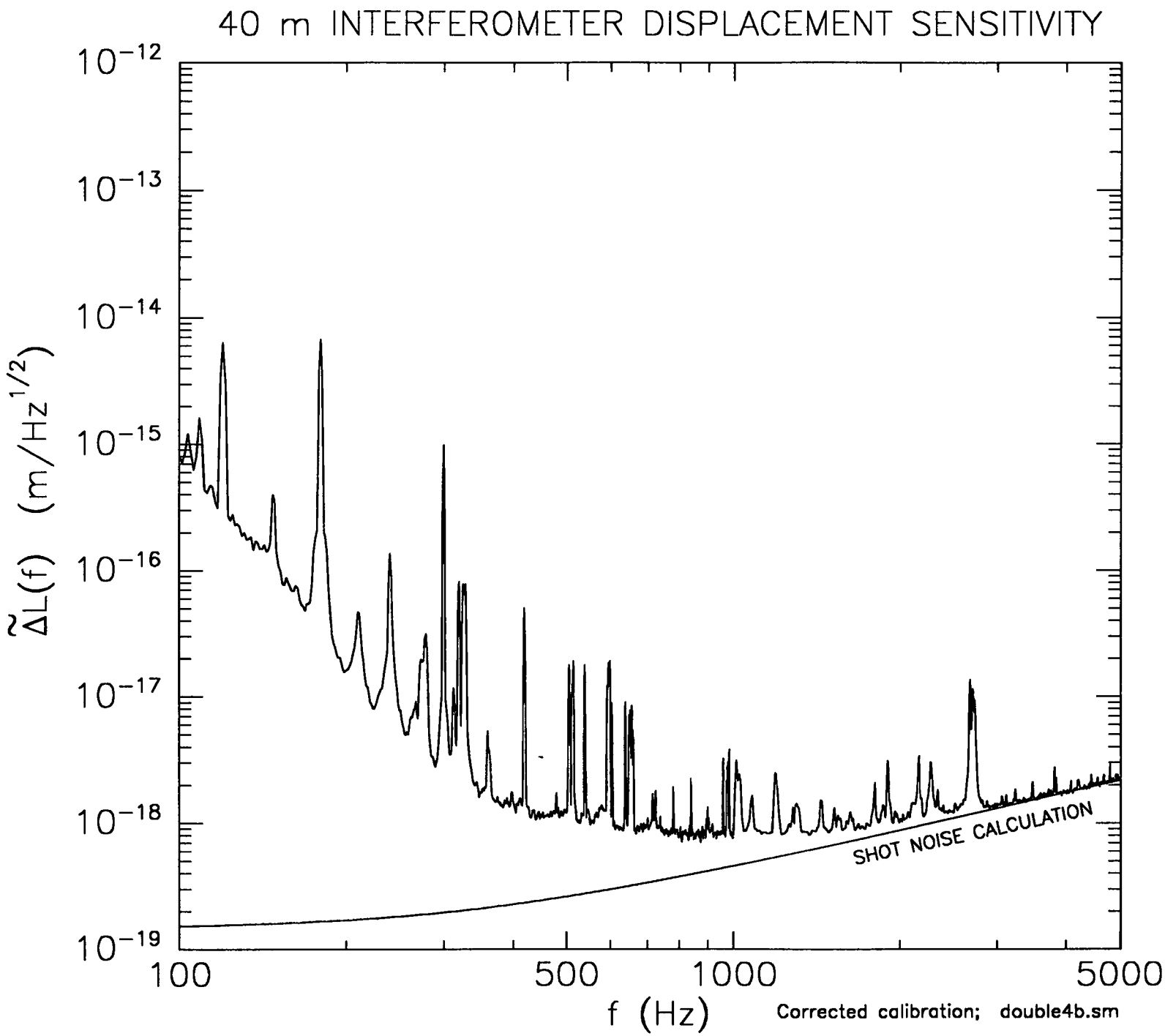
Noise Equivalent $\Delta L \cong \frac{\lambda}{B}\frac{1}{\sqrt{N}}$

FREQUENCY DEPENDENCE

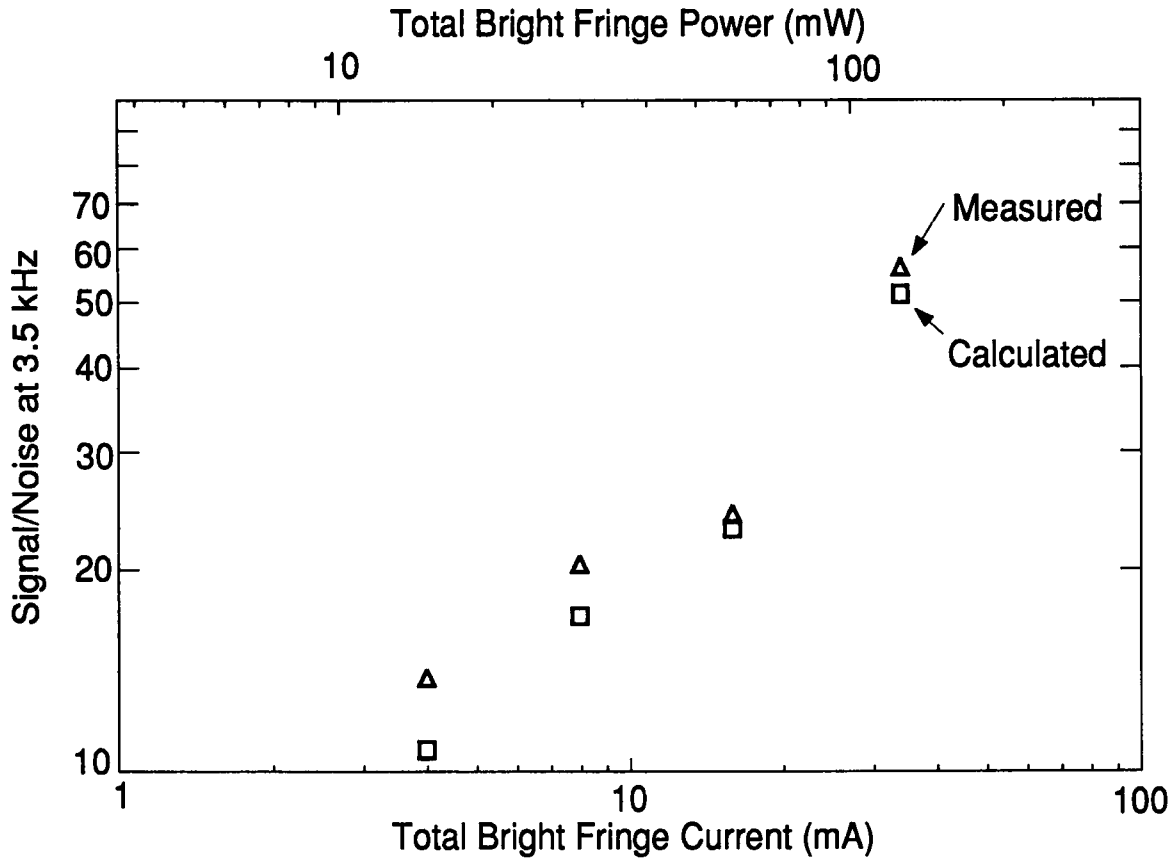


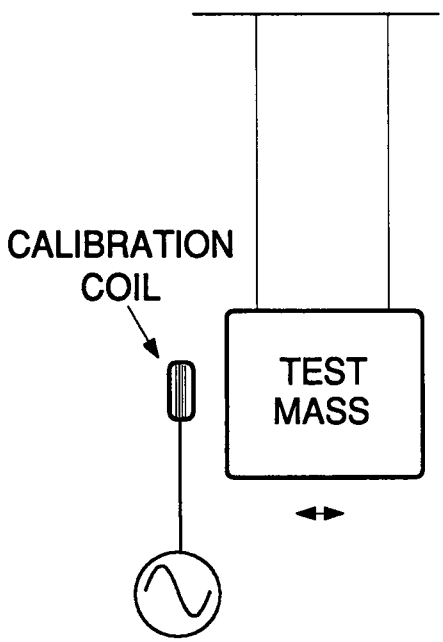
Noise Equivalent $\Delta L \propto \sqrt{1 + (f/f_0)^2}$

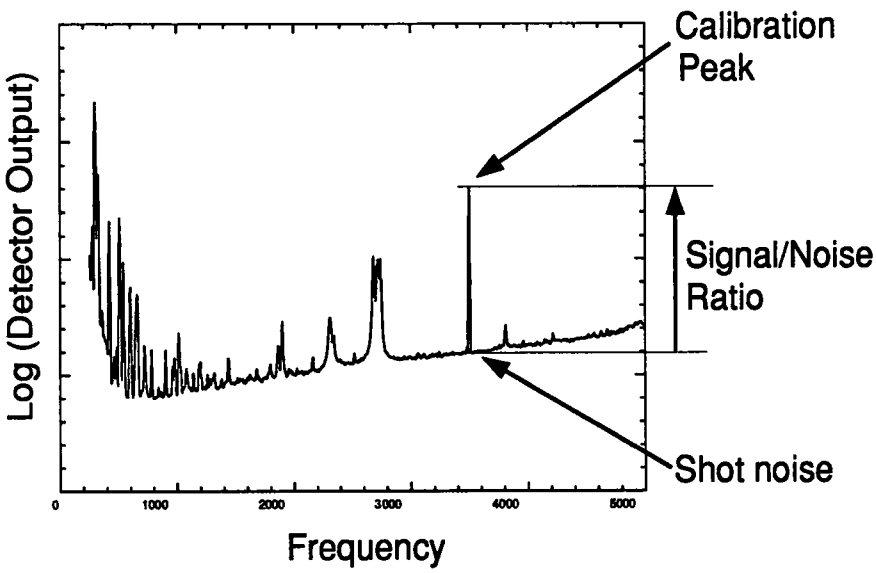
set $f_0 \cong$ lowest expected signal frequency


40 m INTERFEROMETER DISPLACEMENT SENSITIVITY
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
10^{-19}
$\tilde{\Delta}L(f)$ (m/Hz$^{1/2}$)
100
500
1000
5000
f (Hz)
SHOT NOISE CALCULATION
Corrected calibration; double4b.sm

POWER DEPENDENCE OF SHOT NOISE







PARAMETERS THAT AFFECT SHOT NOISE

	DESCRIPTION	INITIAL	ADVANCED	NOTES
λ	Laser wavelength	514 nm	532 nm	
L	Arm Length	4 km	4 km	
m	Cavity mirror mass	10.8 kg	100 kg	Sets radiation pressure noise.
T_1	Input mirror power transmission	3%	1.5%	T_1 is dominant loss. Noise insensitive to T_1 for $f > f_k$.
$T_{\rm R}$	Recycling mirror transmission	3.3%	1%	
f_k	Knee frequency	90 Hz	45 Hz	$2\pi f_k = cT_1/4L$
ηP	Interferometer input power	2 W	60 W	Corrected for inefficiencies.
$B_{\rm rec}$	Recycling factor	30	100	Power buildup at beamsplitter.