Second CC loop

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1 CC control Phase

The CC field provided by the CC laser on the squeezer bench and sent to the OPA is

$$E_{CC}(t) = \alpha \cdot Cos(\omega_0 t + \varphi + \Omega) \tag{1}$$

where ω_0 is the ITF carrier frequency and φ the relative phase on which the second CC loop act. After the non linear interaction on the OPA with the pump field $E_p(t) = \beta \cdot Cos(2\omega_0 + \Phi)$ (Φ is kept constant by the first CC loop) the second sideband at $' - \Omega'$ is created and the CC beam becomes (see for instance PhD Chelkowski pag.167).

$$E_{CC}(t) \propto \alpha \frac{1+g}{\sqrt{2g}} Cos(\omega_0 t + \varphi + \Omega t) - \frac{1-g}{\sqrt{2g}} Cos(\omega_0 t + \varphi - \Omega t - 2\Phi) \tag{2}$$

where $'g'$ is the parametric gain. This field is sent to the dark port of the interferometer and produce a beat note with the carrier $Cos(\omega_0 t)$ on B1. The beat note $B(t)$ (at frequency Ω) is

$$B(t) \propto (1+g)Cos(\Omega t + \varphi) - (1-g)Cos(-\Omega t + \varphi - 2\Phi) \tag{3}$$

That can be written as

$$B(t) \propto Cos(\Omega t)[(1+g)Cos(\varphi) - (1-g)Cos(\varphi - 2\Phi)] + Sin(\Omega t)[-(1+g)Sin(\varphi) - (1-g)Sin(\varphi - 2\Phi)] \tag{4}$$

So the phase measured Φ_{meas} after demodulating at Ω is thus

$$\Phi_{meas} = ArcTang \frac{-(1+g)Sin(\varphi) - (1-g)Sin(\varphi - 2\Phi)}{(1+g)Cos(\varphi) - (1-g)Cos(\varphi - 2\Phi)} \tag{5}$$

The relation between Φ_{meas} and the actuation phase φ is not linear (unless we don't have parametric gain, i.e. g=1).