

Power-Recycled Fabry-Perot Michelson Sensing Matrix

Analytical Calculation v.s. Finesse

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Power Recycling Cavity Parameters

Parameters	Design Values	Simulation
Power Recycling Gain	$G = \frac{t_R^2}{(1 - r_R r_{com})^2} = 32.9$ <p>rcom: complex reflectivity of the FPMI part</p>	33.9
PRC Length	66.591	
PRC FSR	2.25 MHz	
PRC Finesse for carrier	55	
PRC cutoff frequency	20 kHz	

PRFPMI Sensing Matrix (Analytical Calculation)

	Φ- アーム差動 DARM	Φ- マイケルソン MICH	Φ+ アーム同相 CARM	Φp PRC長 PRCL
AS Q1	$g_0 g_1 r'_{\text{reso}} r_{\text{anti}} \sin \alpha$	$g_0 g_1 r_{\text{reso}} r_{\text{anti}} \sin \alpha$	0	0
REFL I1	0	0	$-g_0^2 r'_{\text{reso}} r_{\text{rec1}} + g_1^2 r_{\text{rec0}} r'_{\text{anti}} \cos \alpha$	$-g_0^2 r_{\text{reso}} r_{\text{rec1}} - g_1^2 r_{\text{rec0}} r_{\text{anti}} \cos \alpha$
REFL Q1	$g_1^2 r_{\text{rec0}} r'_{\text{anti}} \sin \alpha$	$-g_1^2 r_{\text{rec0}} r_{\text{anti}} \sin \alpha$	0	0
POP I1	0	0	$g_0 g_1 \frac{r_{\text{P}}^2}{t_{\text{R}}} (g_0 r'_{\text{reso}} r_{\text{anti}} + g_1 r_{\text{reso}} r'_{\text{anti}}) \cos \alpha$	$g_0 g_1 \frac{r_{\text{P}}^2}{t_{\text{R}}} (g_0 - g_1) r_{\text{reso}} r_{\text{anti}} \cos \alpha$
POP Q1				

$$g_0 = \frac{t_{\text{R}}}{1 - r_{\text{R}} t_{\text{P}}^2 r_{\text{reso}}}$$

$$g_1 = \frac{t_{\text{R}}}{1 + r_{\text{R}} t_{\text{P}}^2 r_{\text{anti}} \cos \alpha}$$

$$r_{\text{rec0}} = -r_{\text{R}} + \frac{t_{\text{R}}^2 t_{\text{P}}^2 r_{\text{reso}}}{1 - r_{\text{R}} t_{\text{P}}^2 r_{\text{reso}}}$$

$$r_{\text{rec1}} = -r_{\text{R}} - \frac{t_{\text{R}}^2 t_{\text{P}}^2 r_{\text{anti}} \cos \alpha}{1 + r_{\text{R}} t_{\text{P}}^2 r_{\text{anti}} \cos \alpha}$$

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PRFPMI Sensing Matrix (Analytical Calculation for f1)

	Φ- アーム差動 DARM	Φ- マイケルソン MICH	Φ+ アーム同相 CARM	Φp PRC長 PRCL
AS Q1	-2670	-2.67	0	0
REFL I1	0	0	30200	30.3
REFL Q1	0.0010	0.203	0	0
POP I1	0	0	-10	-0.0093
POP Q1				

$$g_0 = \frac{t_R}{1 - r_R t_P^2 r_{\text{reso}}}$$
$$g_1 = \frac{t_R}{1 + r_R t_P^2 r_{\text{anti}} \cos \alpha}$$

$g_0=5.8$ $g_1=0.50$

$r_{\text{reso}} = 0.998$ $r_{\text{reso}}' = -996i$

$r_{\text{anti}} \sim -1$ $r_{\text{anti}}' \sim 0.001i$

$r_{\text{rec}0} \sim 0.89$ $r_{\text{rec}1} \sim -0.89$

$\cos \alpha \sim 0.38$ $\sin \alpha \sim 0.92$

PRFPMI Sensing Matrix (demodulated at 16.88MHz)

Demodulation phase

AS: Q = 213

REFL: I = 0, Q = 90

POP: I = 119, Q=209

	Φ- アーム差動 DARM	Φ- マイケルソン MICH	Φ+ アーム同相 CARM	Φp PRC長 PRCL
AS Q1	-13	-0.013	0	0
REFL I1	-145	-0.14	-290	0.3
REFL Q1	-0.0028	0.0010	0	0
POP I1	-0.05	-4.5e-5	-0.1	9e-5
POP Q1	0	-1e-5	0	0

Finesse diff gives wrong answer

Sign doesn't agree

Sign doesn't agree

Error signals are 0 and correct
but diff results are wrong

Factor of 2 larger than the analytic formulae

PRFPMI Sensing Matrix (Analytical Calculation for f2)

	Φ- アーム差動 DARM	Φ- マイケルソン MICH	Φ+ アーム同相 CARM	Φp PRC長 PRCL
AS Q2	-0.045	-4.5e-5	0	0
REFL I2	0	0	33900	34.0
REFL Q2	1.1e-9	1.1e-6	0	0
POP I2	0	0	8.7	0.0085
POP Q2				

g0=5.8
g1=0.16

r_reso = 0.998
r_reso' = -996i

r_anti ~ -1
r_anti' ~ 0.0001i

r_rec0 ~ 0.89
r_rec1 ~ -1

cos α ~ -1
sin α ~ 4.8e-5 ~ 0

PRFPMI Sensing Matrix (demodulated at 45MHz)

Demodulation phase
AS: Q = 178
REFL: I = 0, Q = 90
POP: I = 78, Q = 168

	Φ- アーム差動 DARM	Φ- マイケルソン MICH	Φ+ アーム同相 CARM	Φp PRC長 PRCL
AS Q2	0.008	8.1e-6	0	0
REFL I2	160	0.00055	318	-0.0012
REFL Q2	0	-2.1e-5	0	0
POP I2	1.6	-7e-5	3.2	0.00014
POP Q2	0	1.5e-7	0	0

Finesse diff gives wrong answer

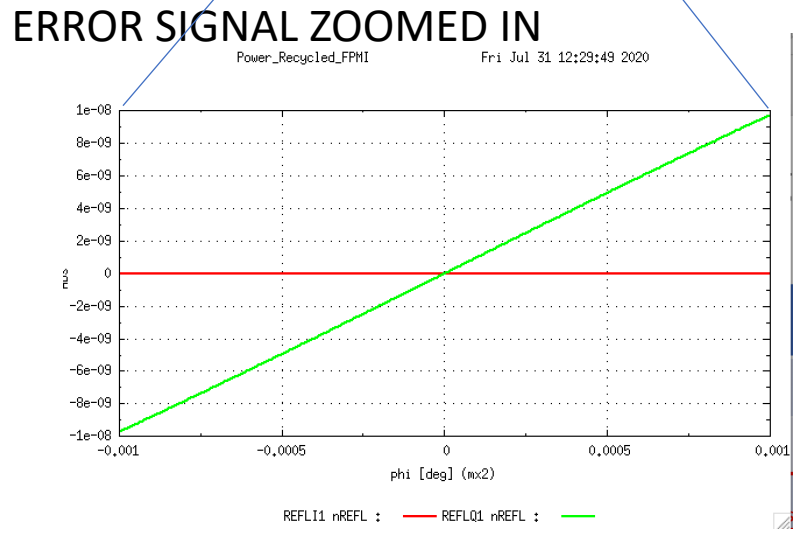
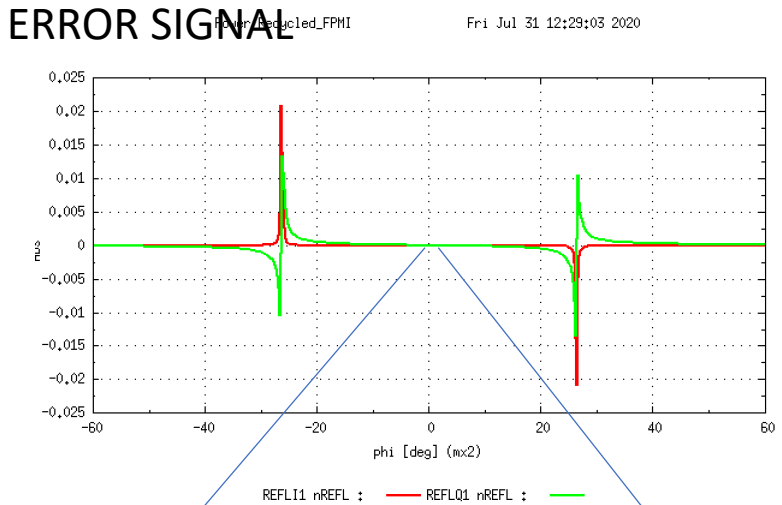
Sign doesn't agree

Error signals are 0 and correct
but diff results are wrong

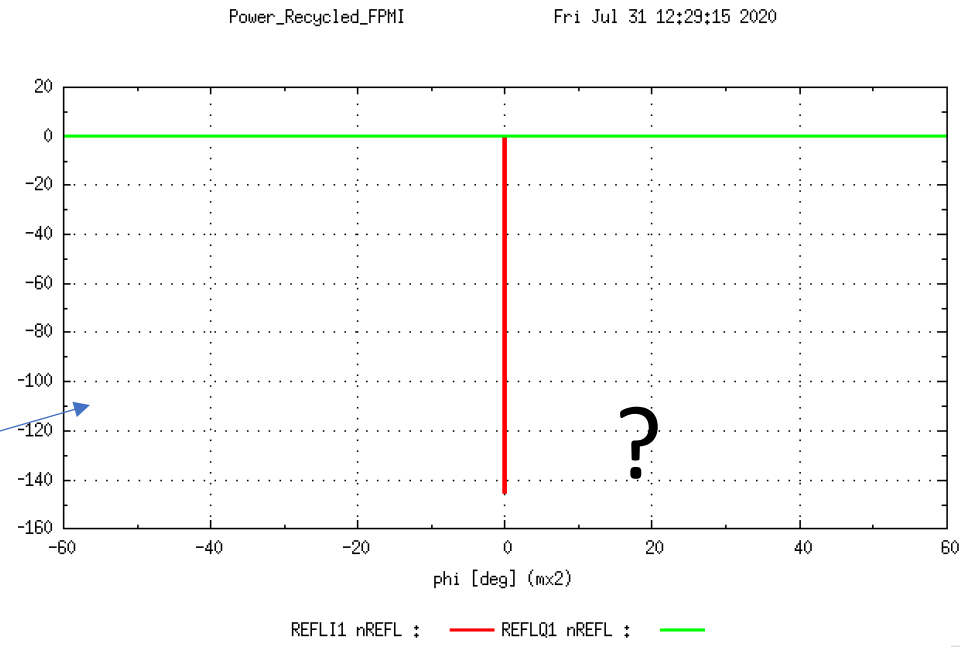
Totally disagreed?

Checked that the assumption $r_{SB} \approx r_{anti}$
was not the problem

DARM diff at REFL/POP something wrong



DIFF (SLOPE)



Changing deriv_h in kat.ini doesn't solve