LIGO

Explore demodulation phase for DDM on 40m RSE prototype

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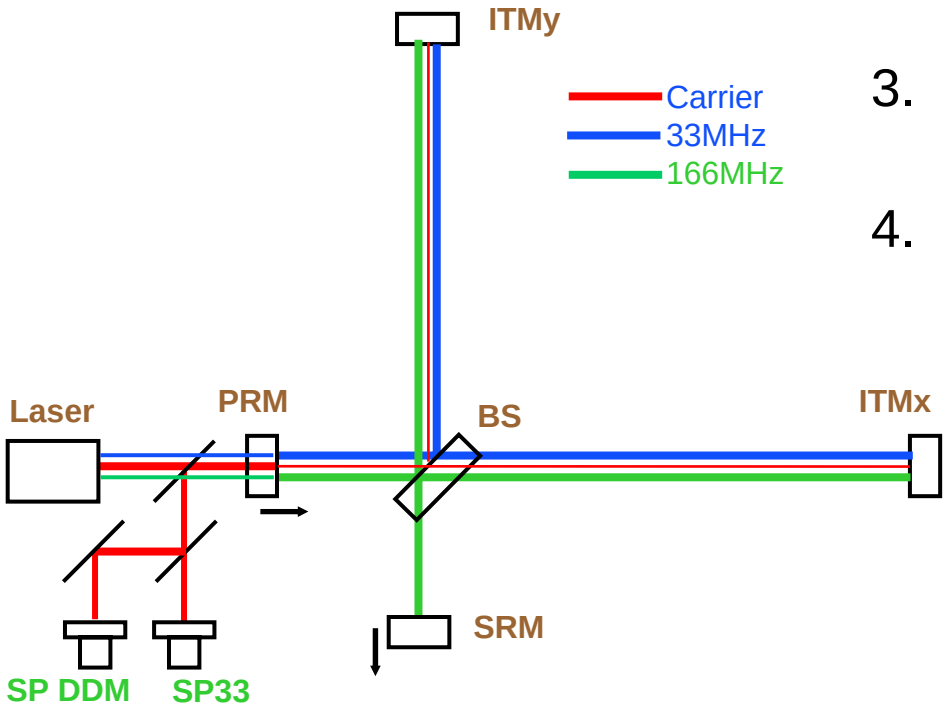
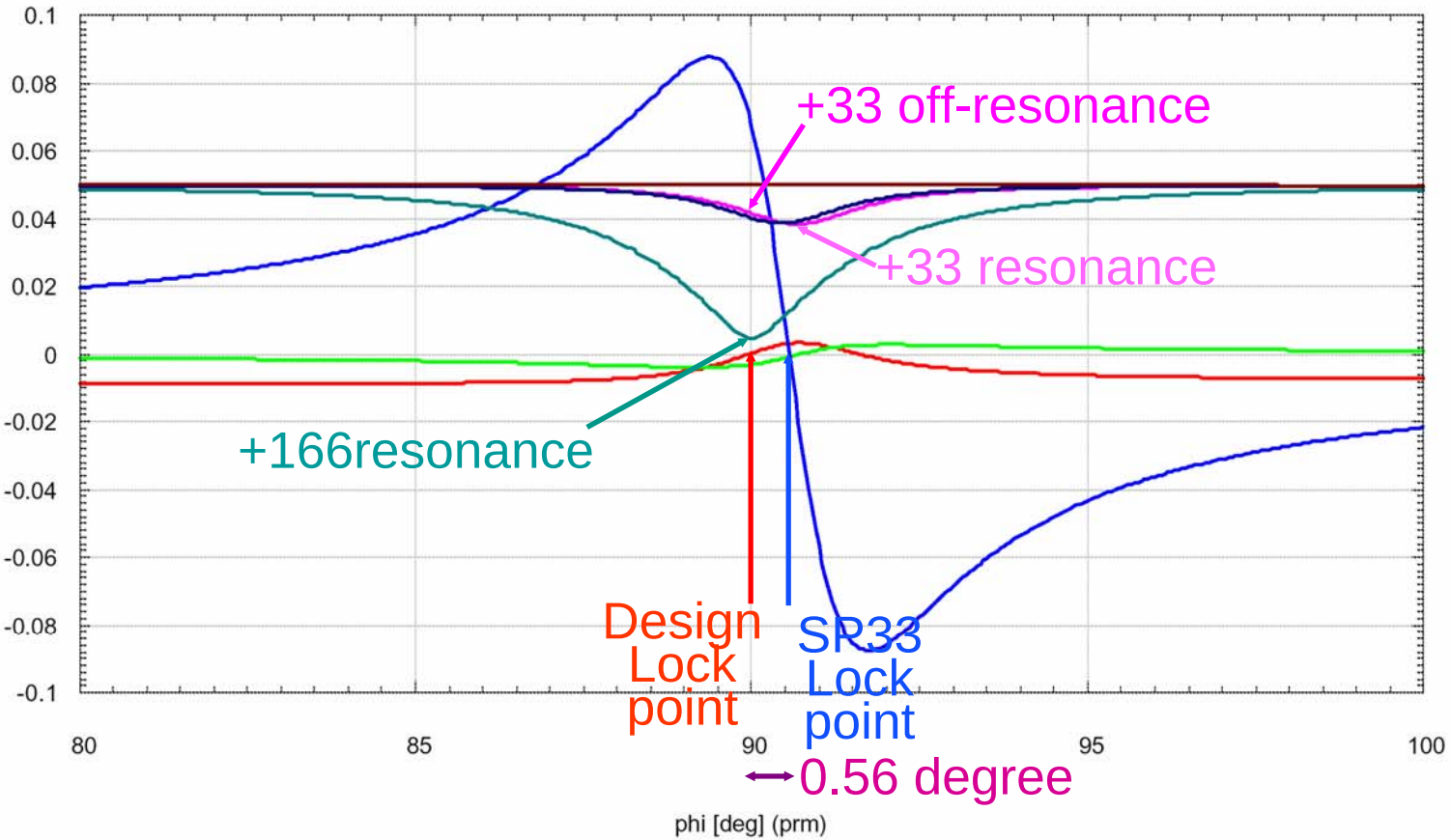
LIGO-G050004-00-R

Setup



1. Signal for I_+ is extracted from Symmetric Port (SP).
2. SP33 is a 33MHz single demodulation PD used for lock acquisition.
3. Then it switches to SP DDM (double demodulation).
4. We assume that I_s and I_- are locked.

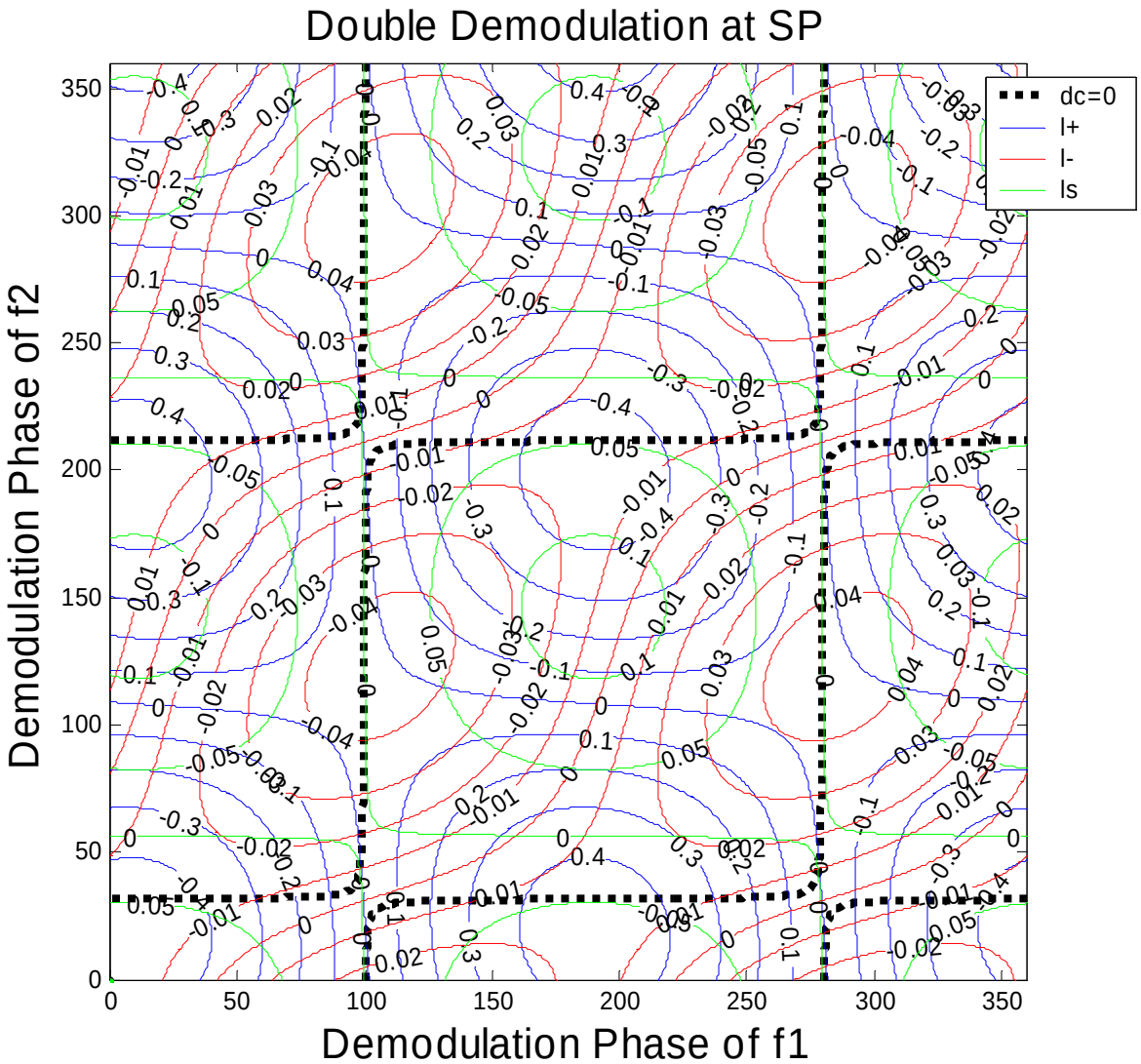
SP33,DDM,+/-33M,+/-166M@SP



Original design (no offset)

+33 : off-resonant
-33 : off-resonant
+166: resonant
-166 : anti-resonant

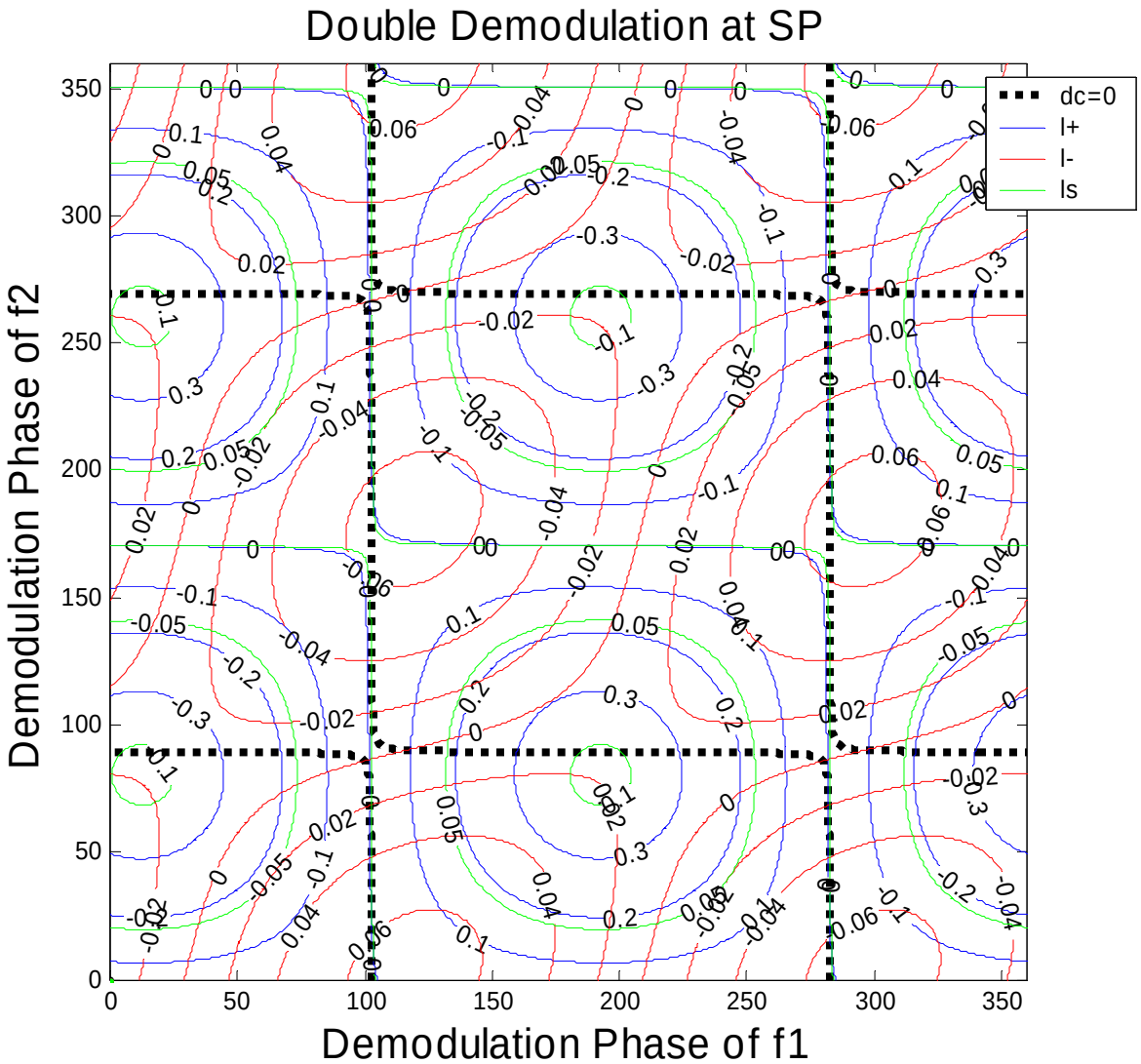
- I_+ and I_s plot separated
- Difficult



I_+ +0.56 degree, I_s +0.56 degree

+33 : resonant
-33 : resonant
+166: resonant
-166 : anti-resonant

- I_+ and I_s plot overlapping
- DC line changed
- Easy (if I_+ is moved, servo try to move I_s.)



I_+ +0.56 degree

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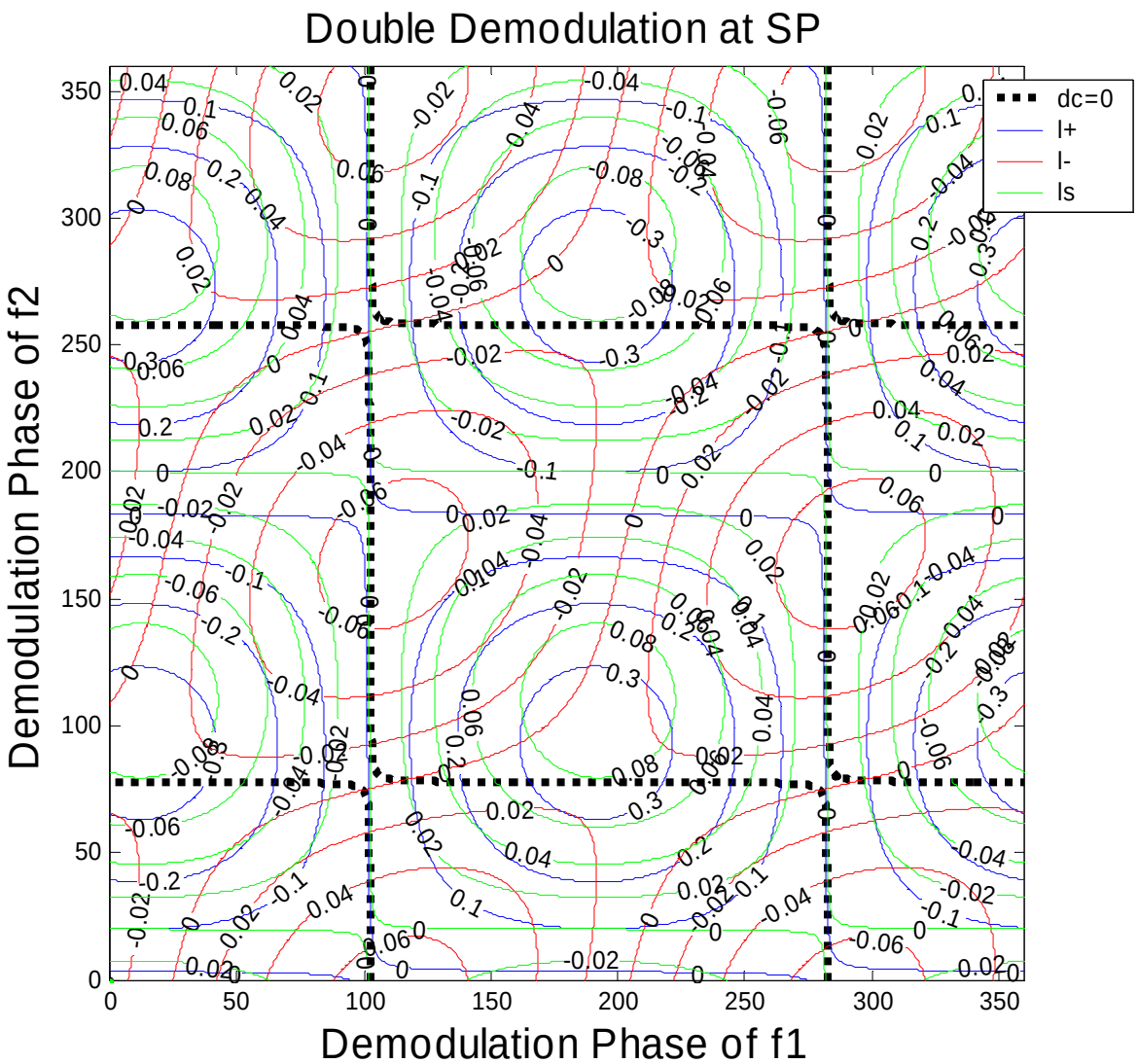
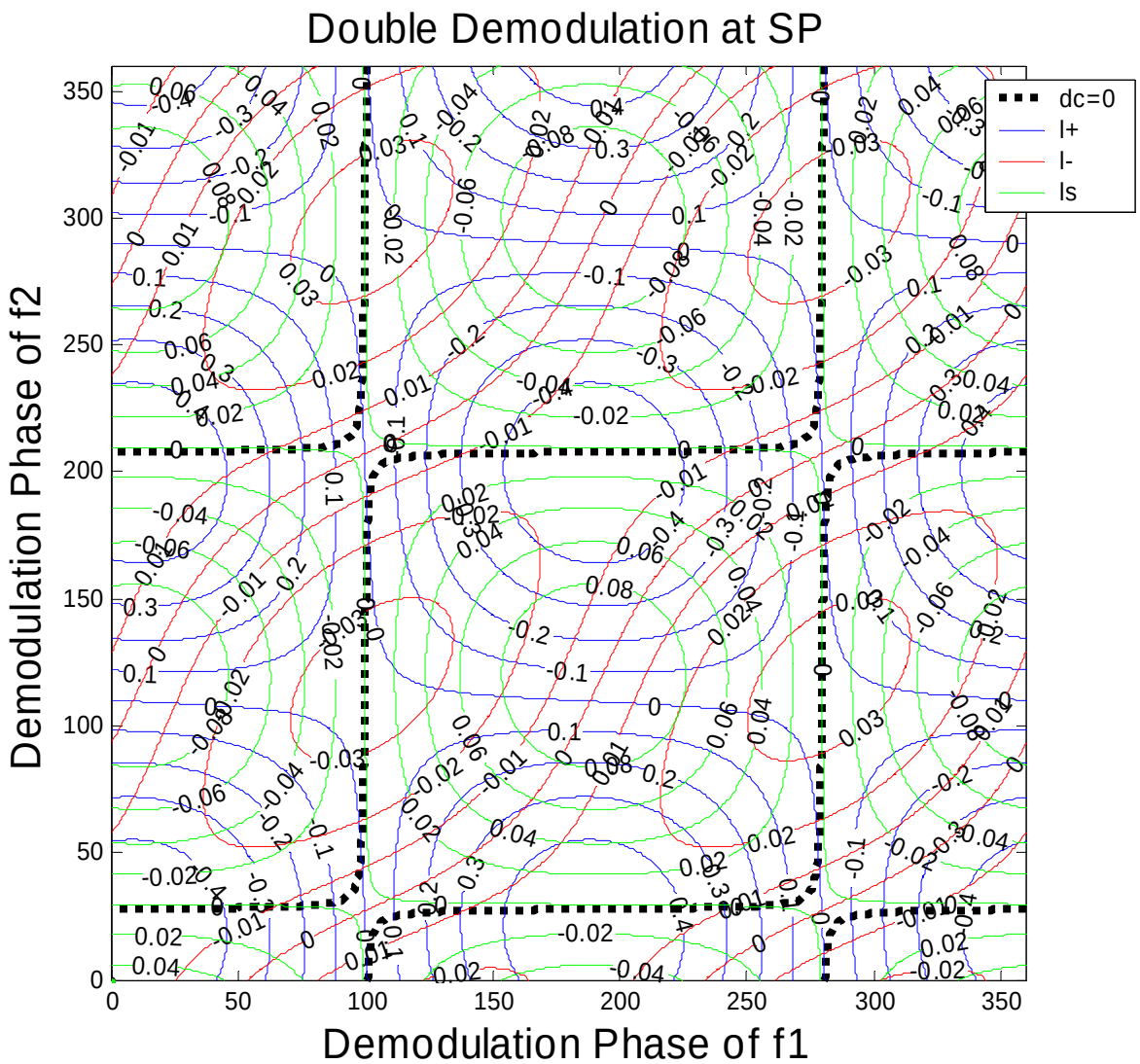
- DC line changed
- Difficult



l_s +0.56 degree,

+33 : off-resonant
-33 : off-resonant
+166: resonant
-166 : anti-resonant

- l_+ and l_s plot separated
- Same DC line
- Difficult



Exploring phase

1. Lock I_+ to SP33.
2. Adjust gain during SP33, SP133 and SP199.
3. Find maximum I_+ signal on SP133 and SP199.
4. Move to DC=0 line.
5. Add calculated phase on SP133 and SP199.
6. Add offset on SP33 until SP DDM has no offset.
7. Switch SP33 to DDM.

40m vs. Ad-LIGO

40m

Table 4: Length sensing signals. $\otimes$ means double demodulation.

Signal	L_+	L_-	l_+	l_-	l_s
SP, f_1	**15.2**	0.000	-0.062	0.064	-0.001
AP, f_2	0	**1.69**	0	0.002	0
SP, $f_2 - f_1$	-0.0003	0.0001	**0.214**	0.029	0.039
AP, $f_2 \otimes f_1$	0	0	0.0025	**-0.0034**	-0.0004
PO, $f_2 - f_1$	0.005	-0.004	1.000	-0.277	**-2.980**

x6

Table 5: Length sensing signals for Advanced LIGO. $\otimes$ means double demodulation. These numbers agree, up to an overall constant, with the table Peter Fritchel showed at the August 2000 LSC meeting (LIGO-G000225).

Ad-LIGO

Signal	L_+	L_-	l_+	l_-	l_s
SP, f_1	**1890**	0.00	-1.94	0.11	0.00
AP, f_2	0	**-1500**	0	-1.88	0
SP, $f_2 - f_1$	-0.11	-0.01	**19.5**	-0.11	8.66
AP, $f_2 \otimes f_1$	0.000	0.001	-0.031	**0.242**	0.005
PO, $f_2 - f_1$	-0.42	-0.01	8.84	5.81	**245**

x2

Summary

- Off-resonance of 33MHz makes good signal separation between I_+ and I_s.
- We can find a way to optimize demodulation phase for DDM at SP, which has good signal separation and no offset.
- Ad-LIGO using 9-180MHz sidebands has less signal separation between I_+ and I_s, but better signal separation for I_- and I_s