# Fabry-Perot Michelson Model

- Find the optimum demodulation phases
  - Maximize BS DoF at AS Q (both f1, f2)
  - Maximize DARM DoF at AS Q (both f1, f2)
  - Maximize CARM DoF at REFL I (both f1, f2)
- How the optimum phase is determined?
- Do they agree with the analytical calculations?

# For f1,
# $\sin(\alpha)$~0.92, $\cos(\alpha)$~0.38

$$\alpha = l_- \omega_m / c,$$
$$\beta = l_+ \omega_m / c$$

| | DARM | MI | CARM |
|---|---|---|---|
| V1 (AS Q) | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ $\times \cos\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 r_{reso} r_{anti}$ $\times \cos\beta \sin\alpha$ | 0 |
| V2 (REFL I) | $-J_0 J_1 \lvert E_1\rvert^2 r_{reso} \lvert r'_{anti}\rvert$ $\times \cos\beta \sin\alpha$ | $J_0 J_1 \lvert E_1\rvert^2 r_{reso} r_{anti}$ $\times \cos\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ $\times \sin\beta \cos\alpha$ |
| V3 (REFL Q) | $J_0 J_1 \lvert E_1\rvert^2 r_{reso} \lvert r'_{anti}\rvert$ $\times \sin\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 r_{reso} r_{anti}$ $\times \sin\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ $\times \cos\beta \cos\alpha$ |

Table made by Koyama-kun,
Analytical calculation by Ando's master thesis

# FPMI Sensing Matrix (f1, 16.88MHz)

| | DARM | MI | CARM |
|---|---|---|---|
| V1 (AS Q1) | 4.35 | 0.0044 | 0 |
| V2 (REFL I1) | 0 | 0 | -3.6 |
| V3 (REFL Q1) | 4.5e-5 | -0.0045 | 0 |

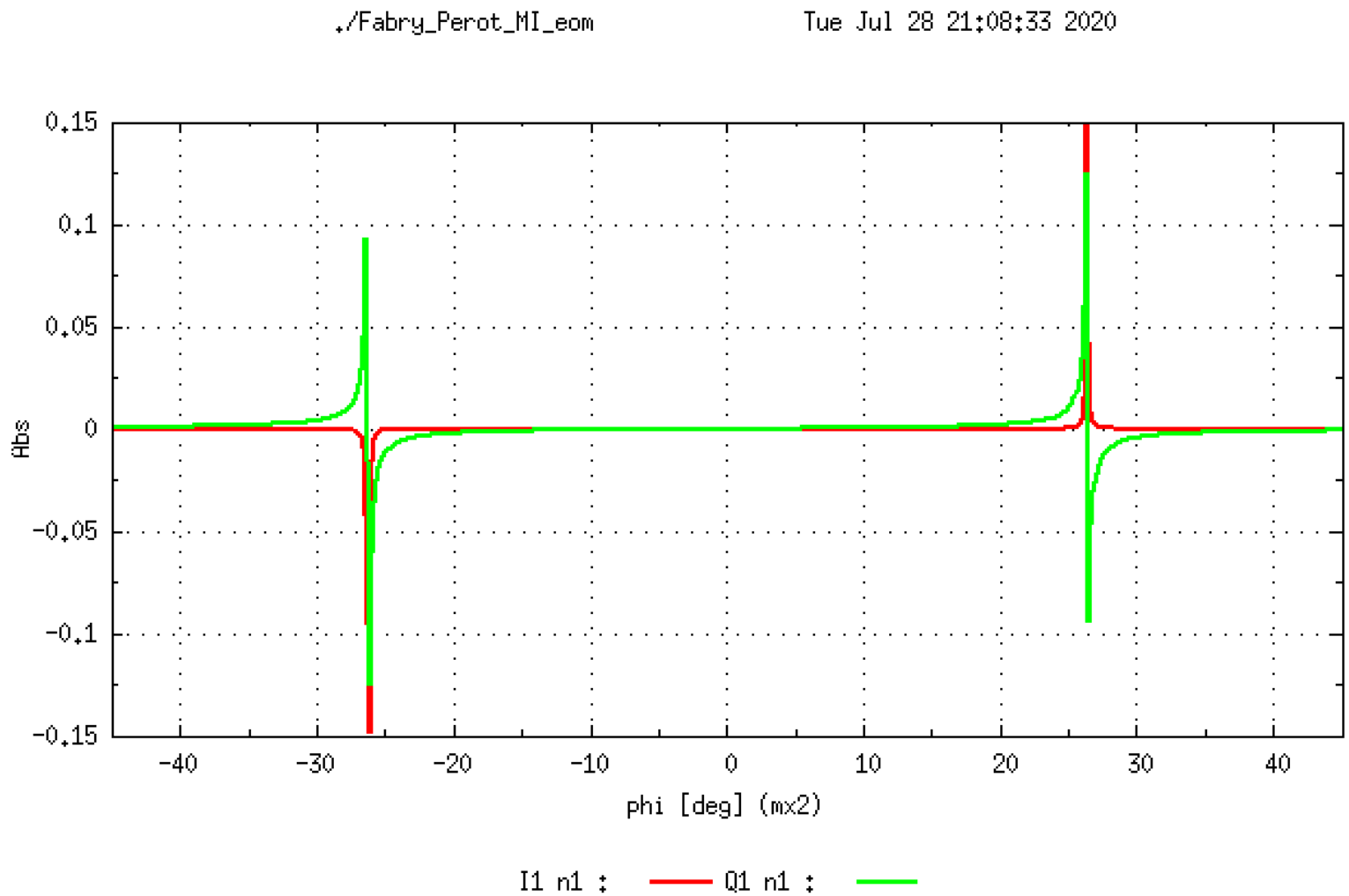
Be careful of fake signal

weak (see, next page)

Demod phases I = 66.2 , Q = 156.2
lsym*16.881e+6*2*pi/c * 180/pi -360*3 = -66.5

This column might be x2
Depending on definitions

# DARM error signals REFL I2 and Q1 (v2 and v3)



# For f2,
# sin($\alpha$)~0, cos($\alpha$)~1,

| | Φ- アーム差動 | Φ- マイケルソン | Φ+　アーム同相 |
|---|---|---|---|
| V1 (AS Q) | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ $\times \cos\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 r_{reso} r_{anti}$ $\times \cos\beta \sin\alpha$ | 0 |
| V2 (REFL I) | $-J_0 J_1 \lvert E_1\rvert^2 r_{reso} \lvert r'_{anti}\rvert$ $\times \cos\beta \sin\alpha$ | $J_0 J_1 \lvert E_1\rvert^2 r_{reso} r_{anti}$ $\times \cos\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ $\times \sin\beta \cos\alpha$ |
| V3 (REFL Q) | $J_0 J_1 \lvert E_1\rvert^2 r_{reso} \lvert r'_{anti}\rvert$ $\times \sin\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 r_{reso} r_{anti}$ $\times \sin\beta \sin\alpha$ | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ $\times \cos\beta \cos\alpha$ |

Table by Koyama-kun

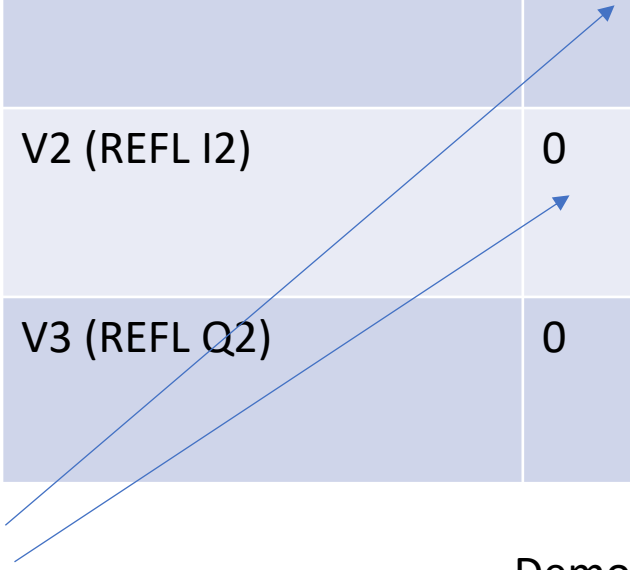
# For f2,
# $\sin(\alpha)$~0, $\cos(\alpha)$~1,

| | Φ- アーム差動 | Φ- マイケルソン | Φ+　アーム同相 |
|---|---|---|---|
| V1 (AS Q) | 0 | 0 | 0 |
| V2 (REFL I) | 0 | 0 | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ × $\sin\beta\cos\alpha$ |
| V3 (REFL Q) | 0 | 0 | $-J_0 J_1 \lvert E_1\rvert^2 \lvert r'_{reso}\rvert r_{anti}$ × $\cos\beta\cos\alpha$ |

Table by Koyama-kun

# FPMI Sensing Matrix
# (復調位相最適化後、45MHz 復調)

| | Φ- アーム差動<br>DARM | Φ- マイケルソン<br>MI | Φ+　アーム同相<br>CARM |
|---|---|---|---|
| V1 (AS Q2) | 0 | ~0 | 0 |
| V2 (REFL I2) | 0 | ~0 | 9.4 |
| V3 (REFL Q2) | 0 | ~0 | 0 |

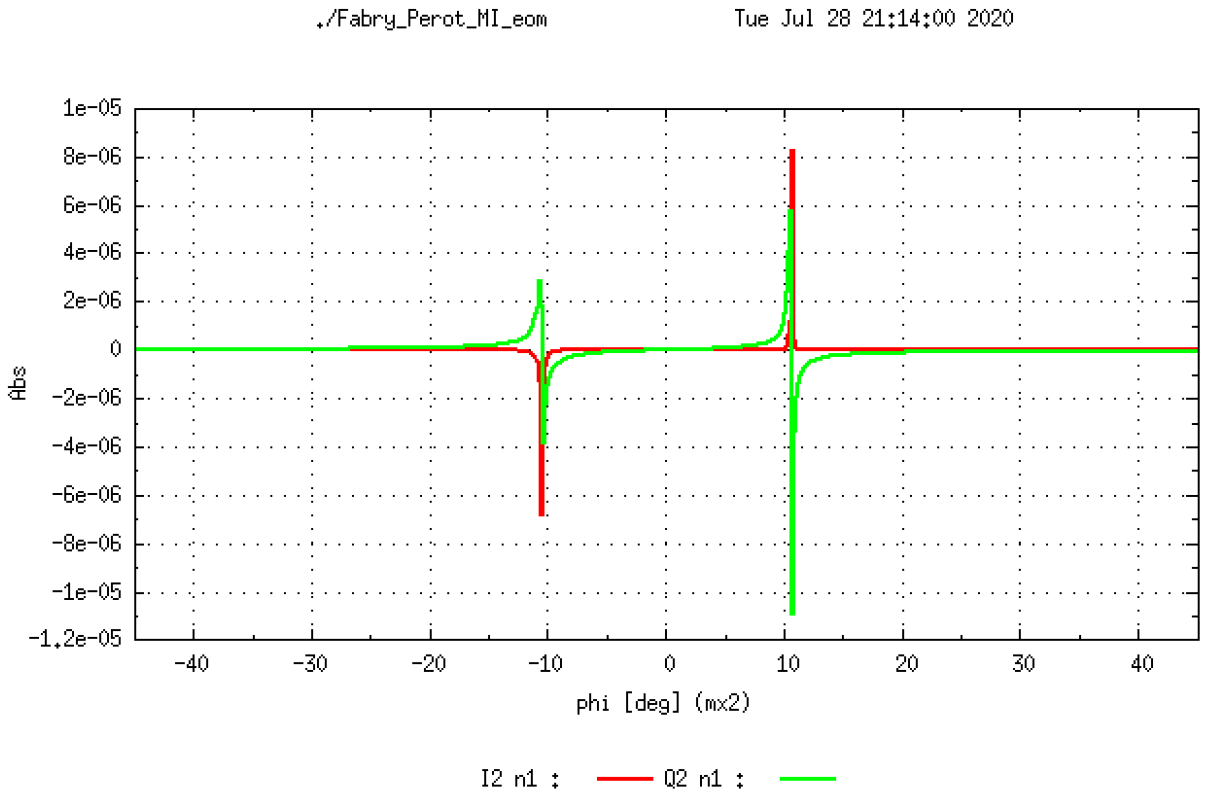


Be careful of fake signals

Demodulation phases I = 176.56 , Q = 266.56
lsym*45.0159e+6*2*pi/c * 180/pi - 360*8 = -177.18

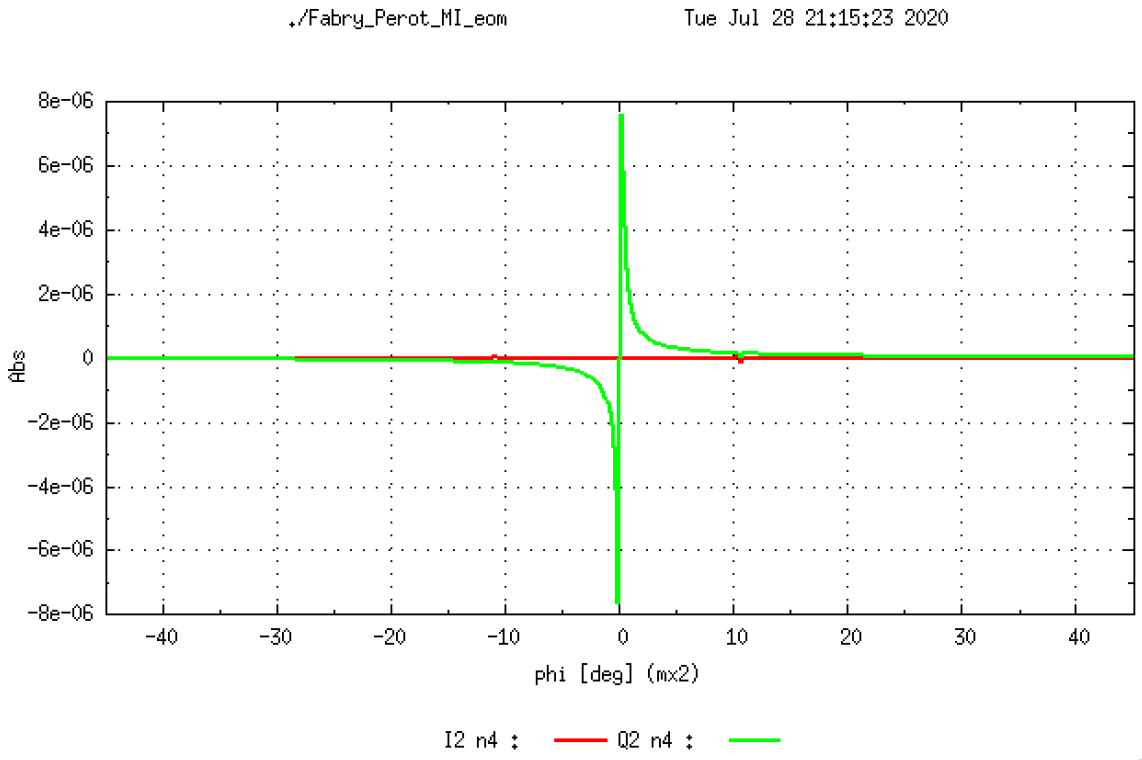
# DARM error signals at AS and REFL

REFL




REFL: 0 まわりの傾きほぼなし

AS




AS: 信号がありそうだが絶対値がものすごく小さい

# Fabry-Perot Michelson Model

## Parameter Summary

| Parameter | Design values (lossless case) |
|---|---|
| Arm finesse | 1550 |
| Arm FSR | 50 kHz |
| Arm cutoff frequency | 16 Hz |
| 腕共振器の複合反射率 (Carrier 共振) | -0.996 |
| Transmission at MI for f1 | 0.9239 (amplitude) |
| Transmission at MI for f2 | 0.000048 (amplitude) |