Simulations of effects of LLO mode-mismatches on PRFPMI error signals

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PRMI observations:

- Mode-mismatch between x-arm and y-arm (cold case)

- Mostly due to different non-thermal lenses in ITM substrates (ITMX f = +300km, ITMY f = -80km)

- Beams in PRC are larger than expected (7cm/6cm compared to design of 5.3cm)

Possible consequences for PRFPMI:

- More mismatches: eiegnmodes of arm cavities closer to design, mismatch between PRC and arms.

- Carrier: smaller beams due to dominance of arm cavities.

- Control sidebands: large beams as they only see PRMI.

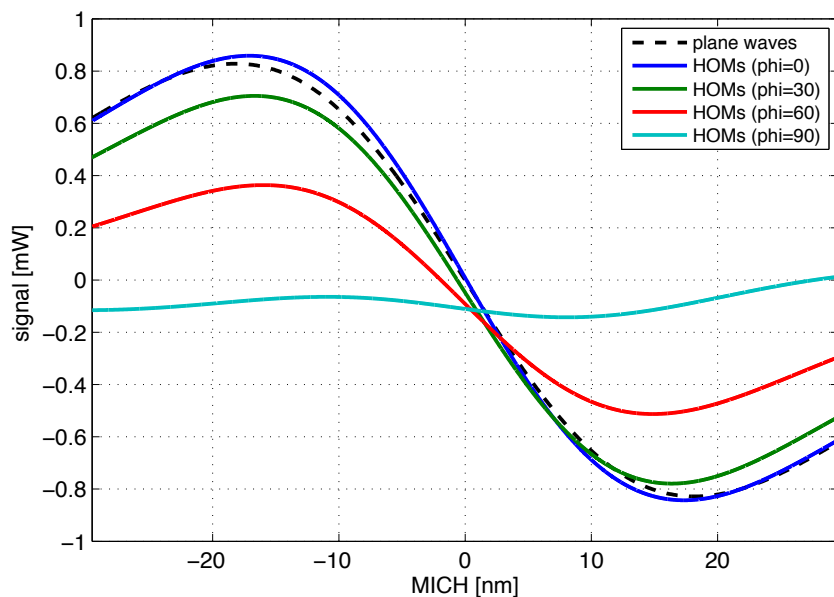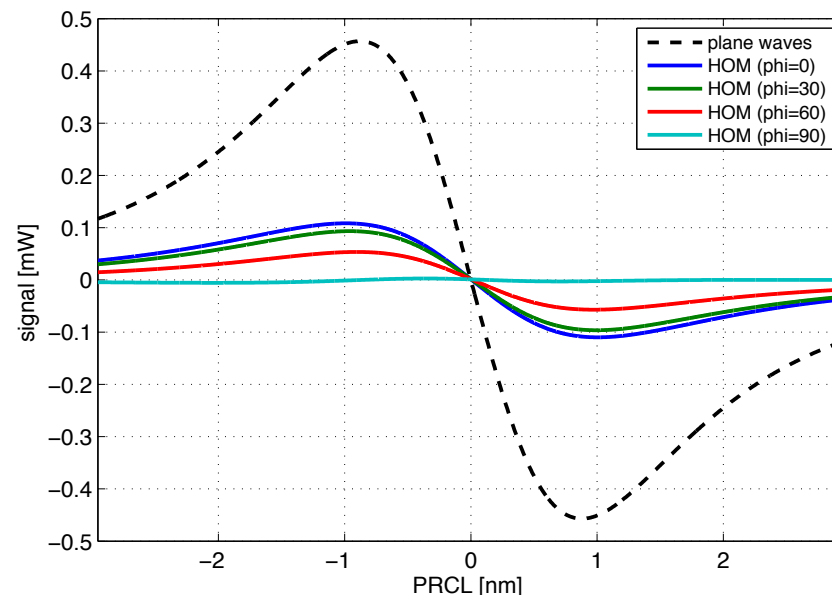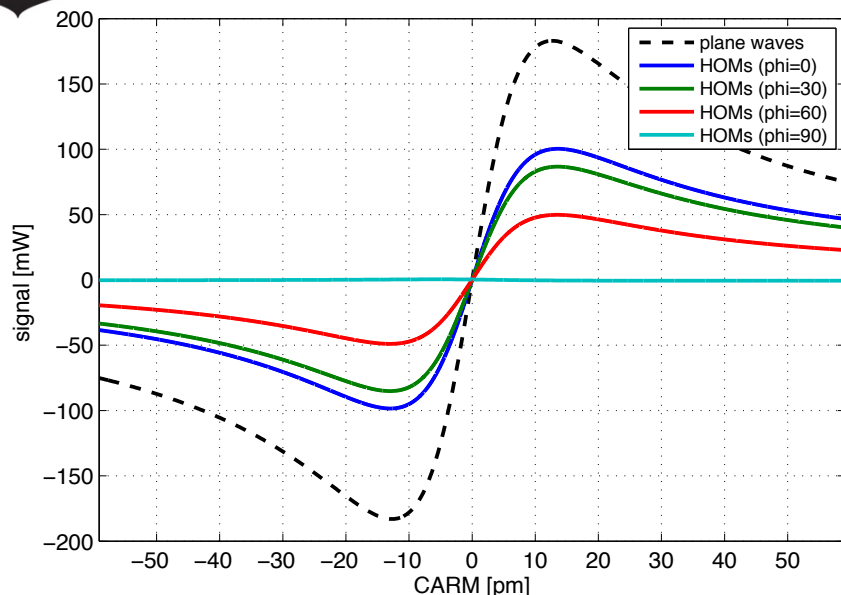- Degradation of overlap between carrier and sidebands.

- Initial operating point achieved by maximizing carrier in arms and PRC, and minimizing power at AS. Need to use error signals to get near the right operating point.
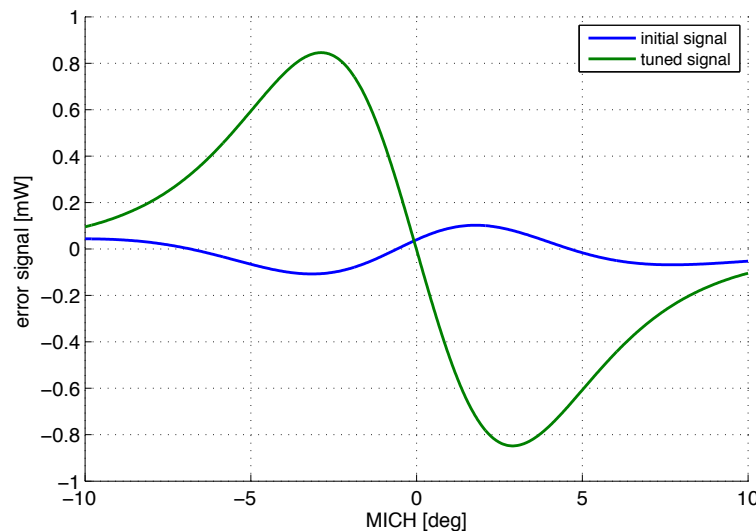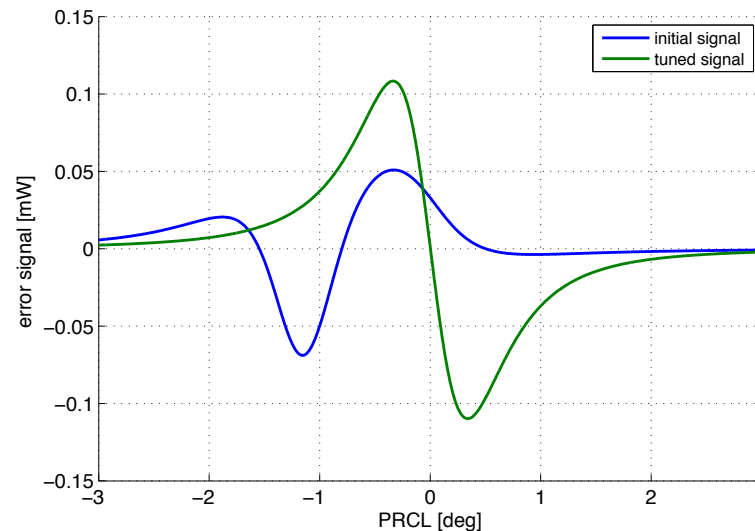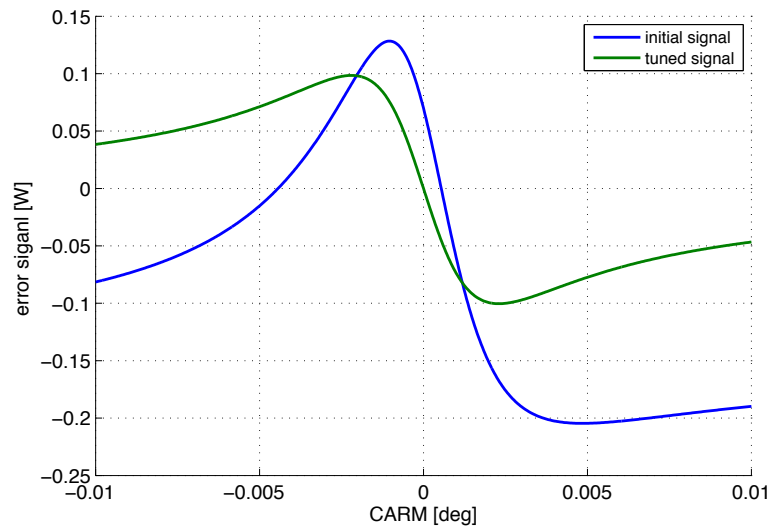
- CARM: f1, REFL

- PRCL: f1, POP

- MICH: f2, POP

Simulated error signals

CARM and PRCL:

- reduced amplitude compared to plane wave model.

- small offsets for different demodulation phases

MICH:

- larger offsets

- potential coupling with DARM?

Outlook

- Increase maxtem.

- Implement output mode-cleaner for more realistic DARM control.

- Try control sequence representative of real sequence: PRMI locked and bringing arms into resonance.

- Tune modulation frequencies.

- Effect of BS clipping.

Simulation details

Included in model:

- Measured ETM/ITM Rcs

- Measured ITM non-thermal lenses

- Measured PR cavity lengths/Rcs

- Higher order modes up to (maxtem) 4

- Modeled in cold state (no thermal lensing)

To include:

- Higher maxtem

- Output mode-cleaner

- Apertures on BS

- Ring heater actuation

- Thermal lenses