LIGO

The Optickle Optical Modeling Tool

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Optickle: Frequency Domain IFO Simulation

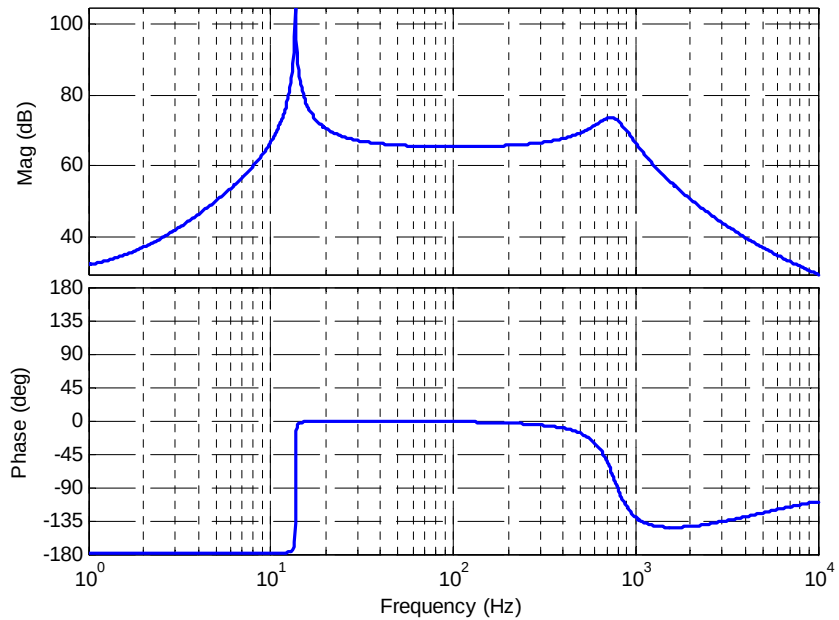
- Optickle is a new frequency domain IFO modeling tool:
  - » Written in Matlab
    - – Matlab allows easy integration to other modeling efforts (a frequency-domain e2e, like LinLIGO)
    - – Easily Extensible
    - – Uses Matlab classes for generality
  - » Uses the methods outlined in T. Corbitt et al: "Mathematical framework for simulation of quantum fields in complex interferometers using the two-photon formalism" (LIGO-P030071-00R) to calculate the IFO opto-mechanical frequency response.
  - » Designed for concrete units (Watts, meters, Hz)

Optickle example: FP cavity

- Includes losses, AR coatings, pickoff fractions, mass
- Build an arbitrary IFO using Optickle class methods:
  - » addOptic
  - » addLink
- Example:

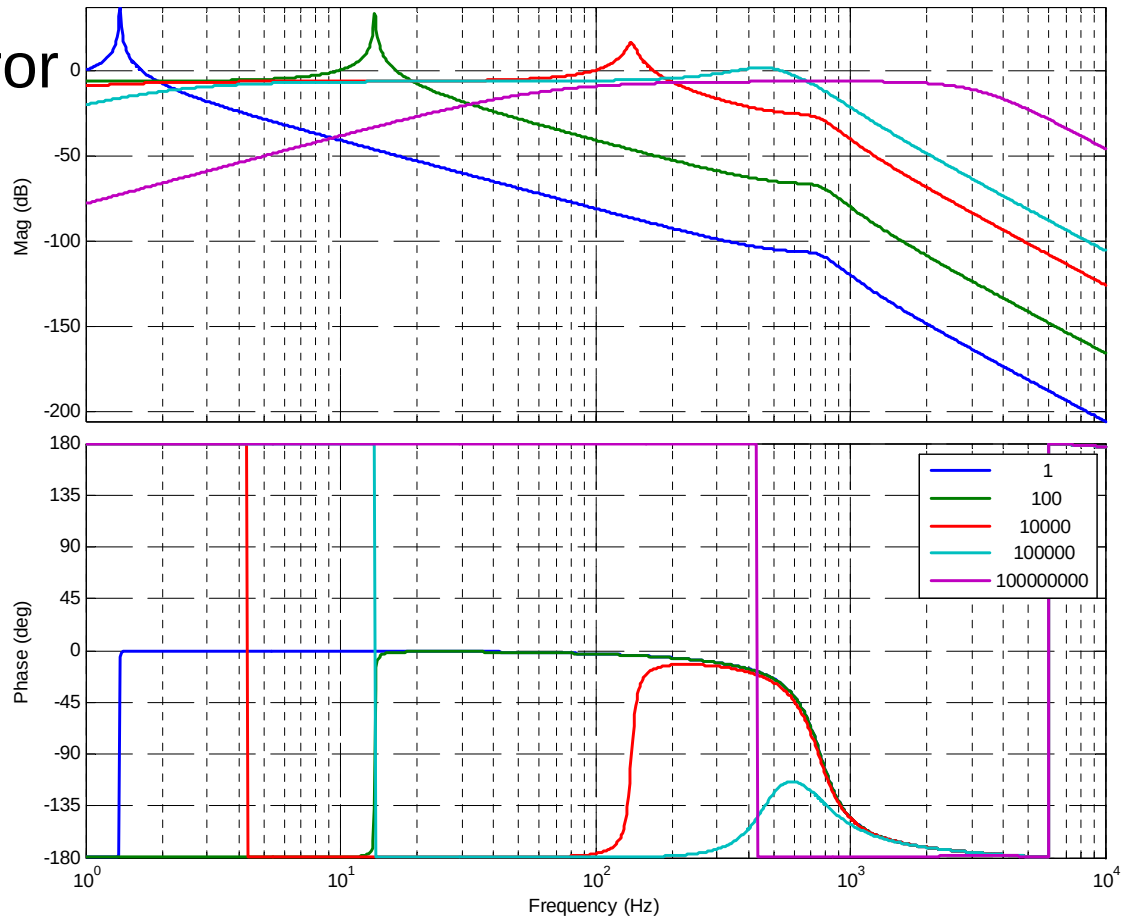
```
% create model
opt = Optickle;
% add optics
[opt, snIX, nIX_HR, nIX_AR] = ...
    addOptic(opt, 'IX', 0.005, 00e-6, 0e-3, 0e-6, 0e-6, 4e2, 0, 10);
 [opt, snEX, nEX_HR, nEX_AR] = ...
    addOptic(opt, 'EX', 10e-6, 00e-6, 0e-3, 0e-6, 0e-6, 4e2, 0, 10);
% add links
opt = addLink(opt, snIX, 1, nEX_HR);
opt = addLink(opt, snEX, 1, nIX_HR);

[mf, mDC1, E_dc] = propFieldsP(opt,f,offsets,Lfield);
bm = getIndexP(opt,snEX,'pos',0);
b2f = getIndexP(opt,snIX,'b',2);
exc = zeros(size(mf,1),length(f));
exc(bm,:) = 1;
resp = fmult(mf,exc);
mybodeplot(f,resp(b2f,:));
```

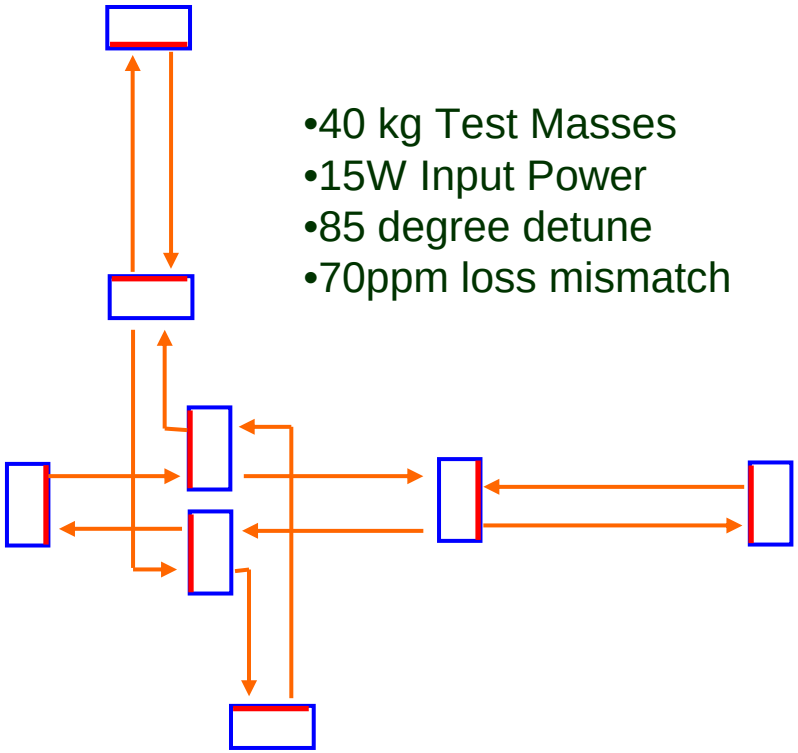


Optickle Example: FP cavity

- Response of front mirror to back mirror ‘excitation’
- 1 nm detune
- finesse ~ 1200

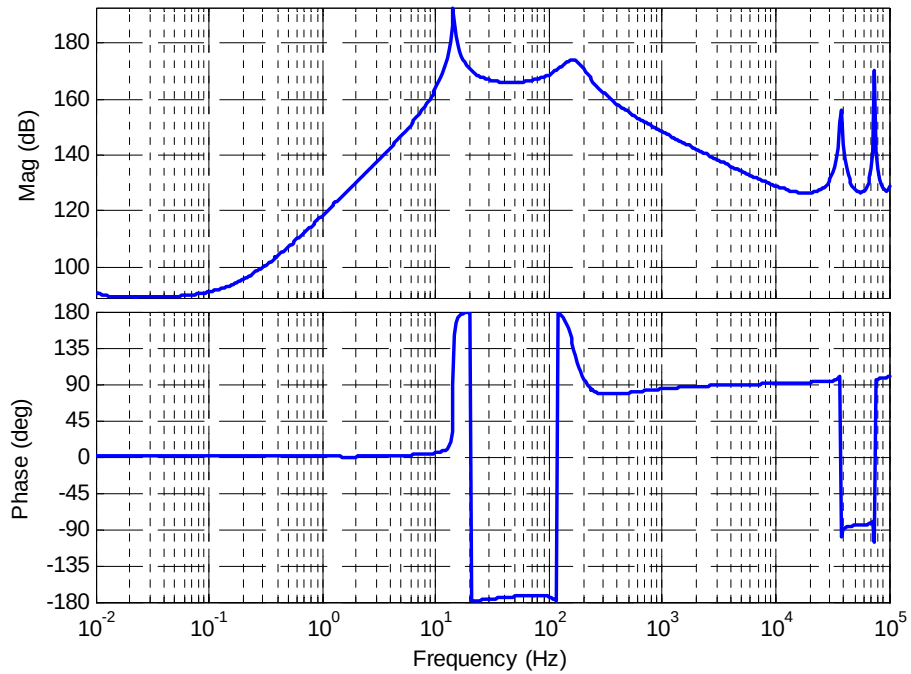


Optickle Example: AdLIGO



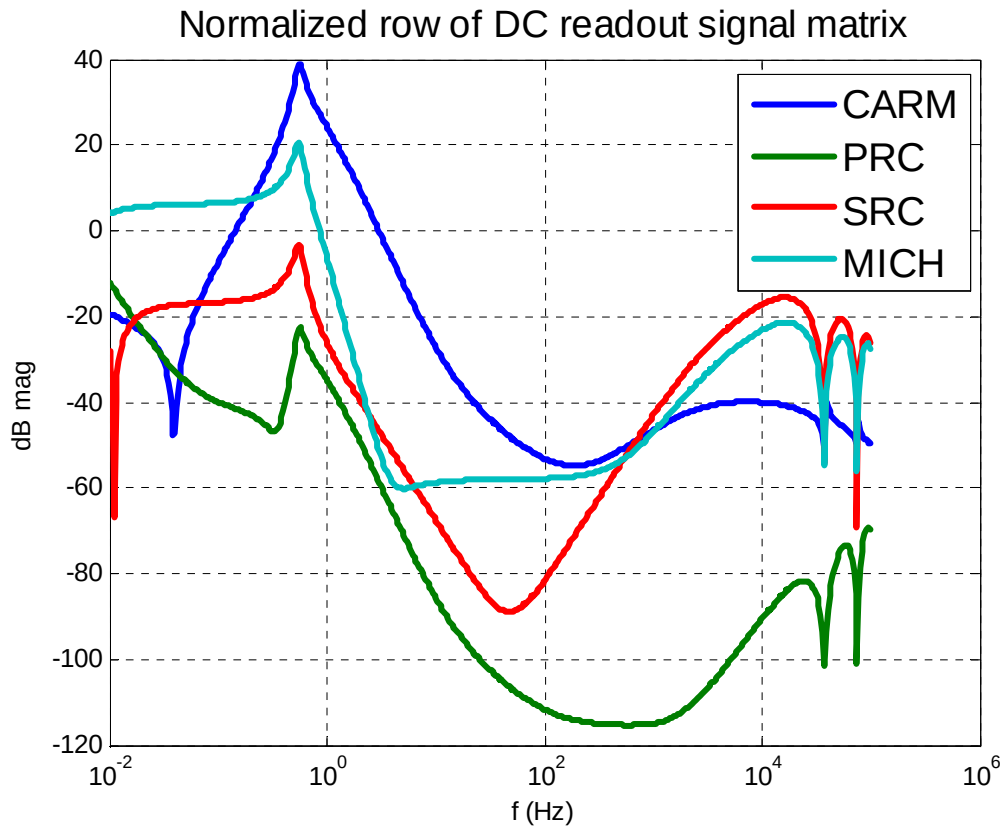
- 40 kg Test Masses
- 15W Input Power
- 85 degree detune
- 70ppm loss mismatch

DC Readout GW response, W/m
3pm DARM offset, 70ppm mismatch



Optickle Example: AdLIGO

- Easy to create a frequency dependent coupling matrix, useful for, e.g., estimating the contribution of loop noise to DARM.



Optickle status

Current:

- Free masses (no pendulum yet)
- Carrier and signal sidebands only (no RF sidebands)
- No servos
- No beamsplitters (-> incorrect radiation pressure at BS)
- Plane waves
- No input vacuum fields

Future:

- Validation against theoretical calculations
- Pendulum response for masses (quad?)
- more high level methods (addSignal, addPD, addRFsideband, etc).
- RF detection (no radiation pressure on RF sidebands?)
- Vacuum noise
- Force to position
- servos?
- Hermite Gaussian?

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Optickle

http://www.ligo.caltech.edu/~rward/Optickle/