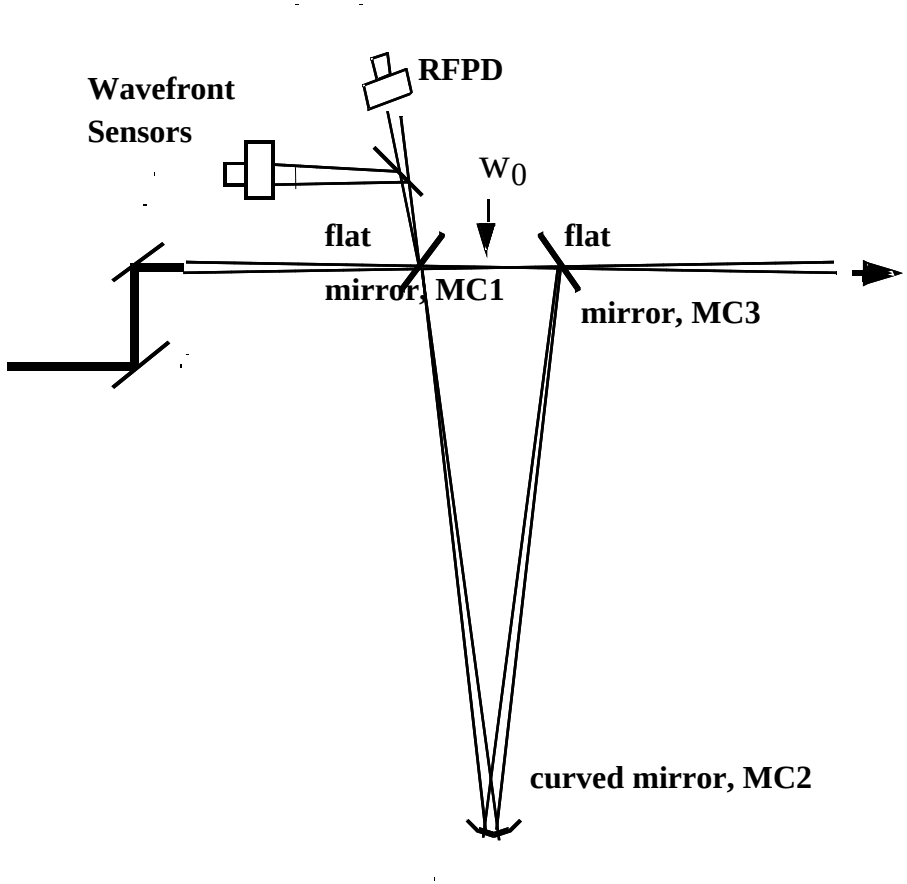
LIGO

Study of thermal distortions in the Advanced LIGO mode cleaner using Melody

Ken Yoshiki Franzen

University of Florida/LIGO Livingston

Mode Cleaner



The Model (I)

- MCellipticalcurvmm_release_2 – July 29, 2004
- by Amber Lynn Bullington (Stanford University) and Ray Beausoleil (HP Laboratories)
- http://www.stanford.edu/~abull/

The Model (II)

Melody includes:

- Thermal focusing
- Surface deformation

in coatings and substrates

New features:

- Elliptical beam represented
- Curvature mismatch operators for beam splitters

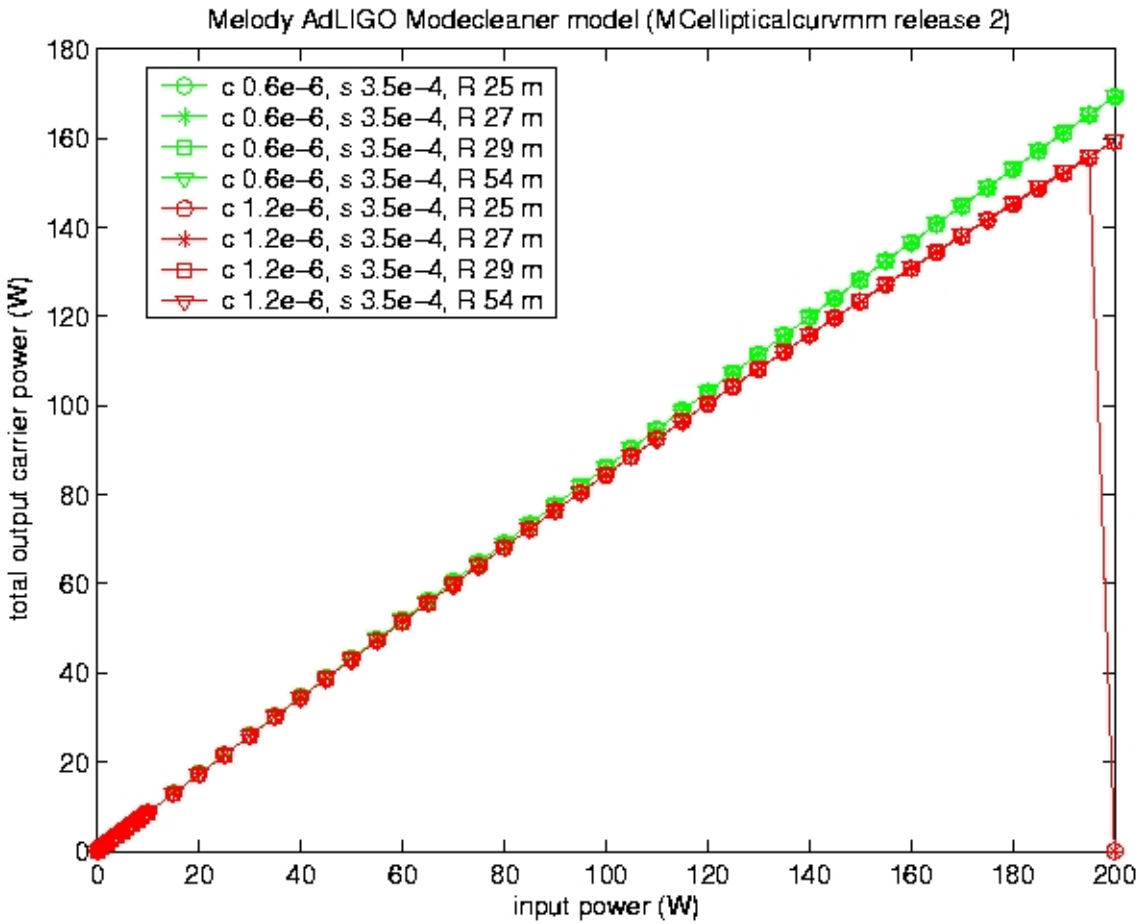
My job

- Crash test dummy
- UF group needs realistic model for design
- Upper limits of coating and substrate absorption coefficients
- Run the code, see what comes out…
- Still some issues with Melody's pseudo-locker and more, under discussion…

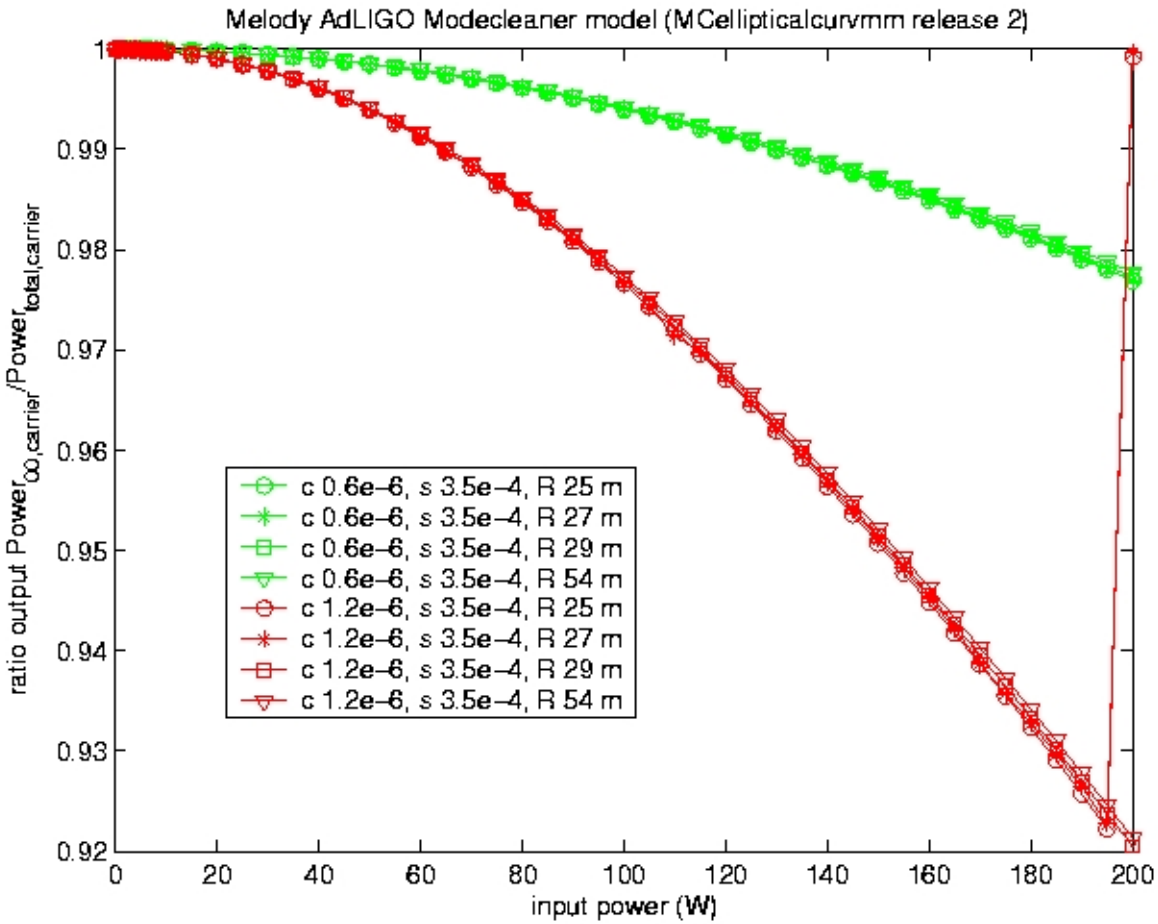
Parameters

- Geometries as in the AdvLIGO IOO design document
- Fused silica
- Modulation index 0.47 (resonant), 0.10 (mode locking)

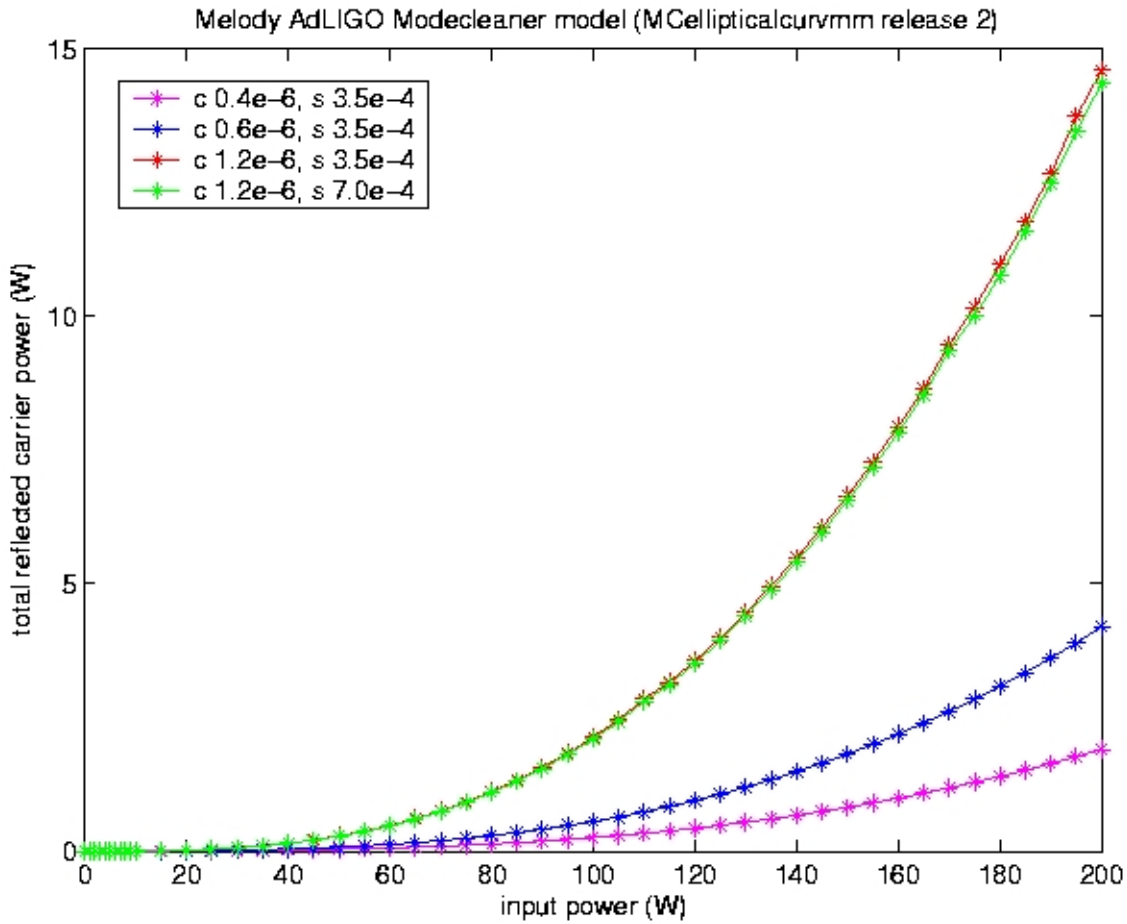
Output (I)


Melody AdLIGO Modecleaner model (MCellipticalcurvmm release 2)
c 0.6e–6, s 3.5e–4, R 25 m
c 0.6e–6, s 3.5e–4, R 27 m
c 0.6e–6, s 3.5e–4, R 29 m
c 0.6e–6, s 3.5e–4, R 54 m
c 1.2e–6, s 3.5e–4, R 25 m
c 1.2e–6, s 3.5e–4, R 27 m
c 1.2e–6, s 3.5e–4, R 29 m
c 1.2e–6, s 3.5e–4, R 54 m
total output carrier power (W)
input power (W)
0
20
40
60
80
100
120
140
160
180
200

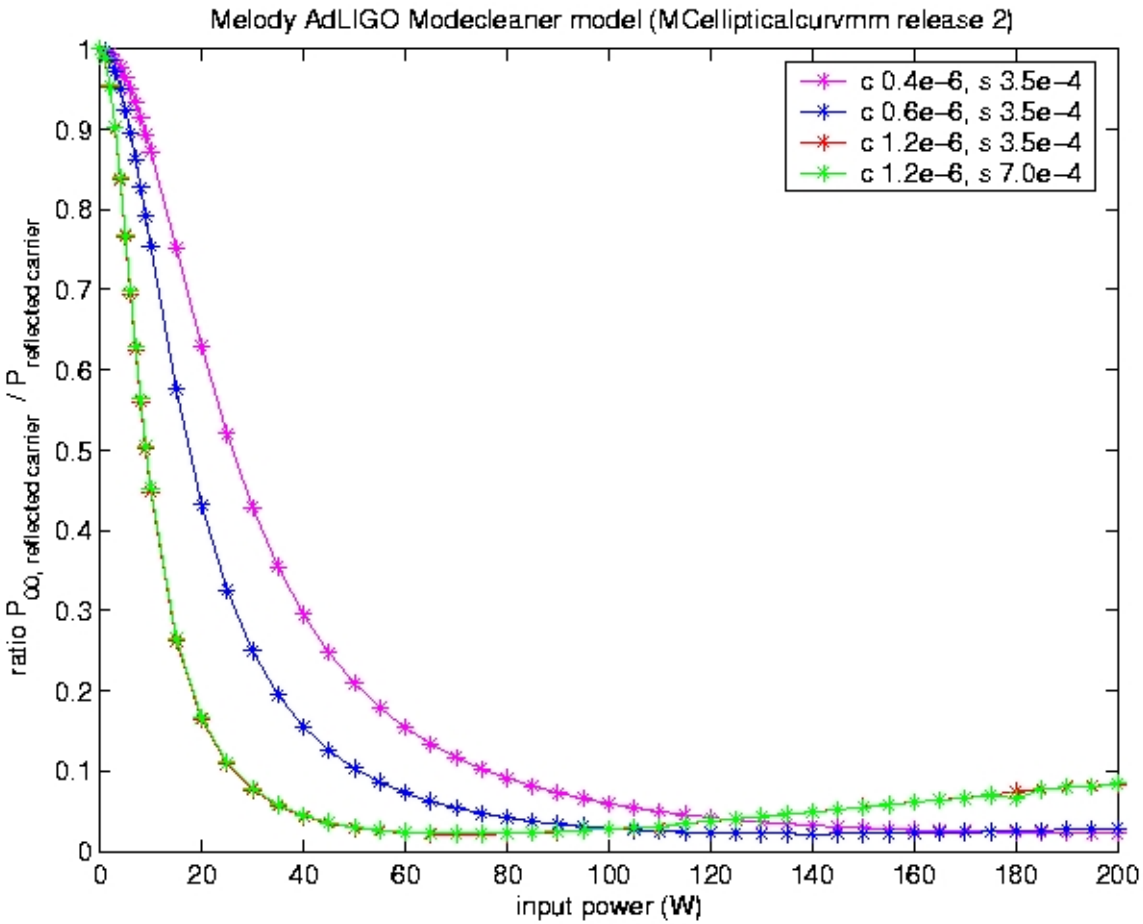
Output (II)


Melody AdLIGO Modecleaner model (MCellipticalcurvmm release 2)
ratio output Power ω,carrier /Power total,carrier
input power (W)
c 0.6e−6, s 3.5e−4, R 25 m
c 0.6e−6, s 3.5e−4, R 27 m
c 0.6e−6, s 3.5e−4, R 29 m
c 0.6e−6, s 3.5e−4, R 54 m
c 1.2e−6, s 3.5e−4, R 25 m
c 1.2e−6, s 3.5e−4, R 27 m
c 1.2e−6, s 3.5e−4, R 29 m
c 1.2e−6, s 3.5e−4, R 54 m
1
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0
20
40
60
80
100
120
140
160
180
200

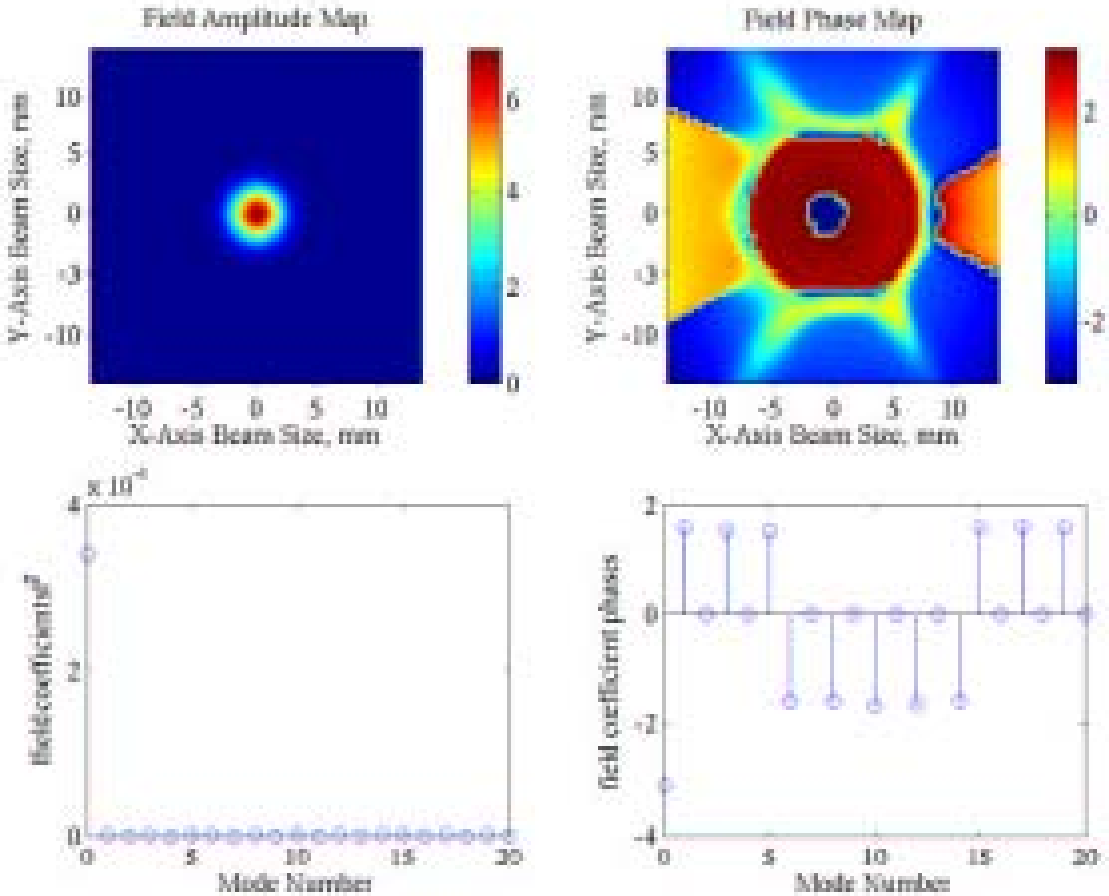
Reflected beam (I)



Reflected beam (II)

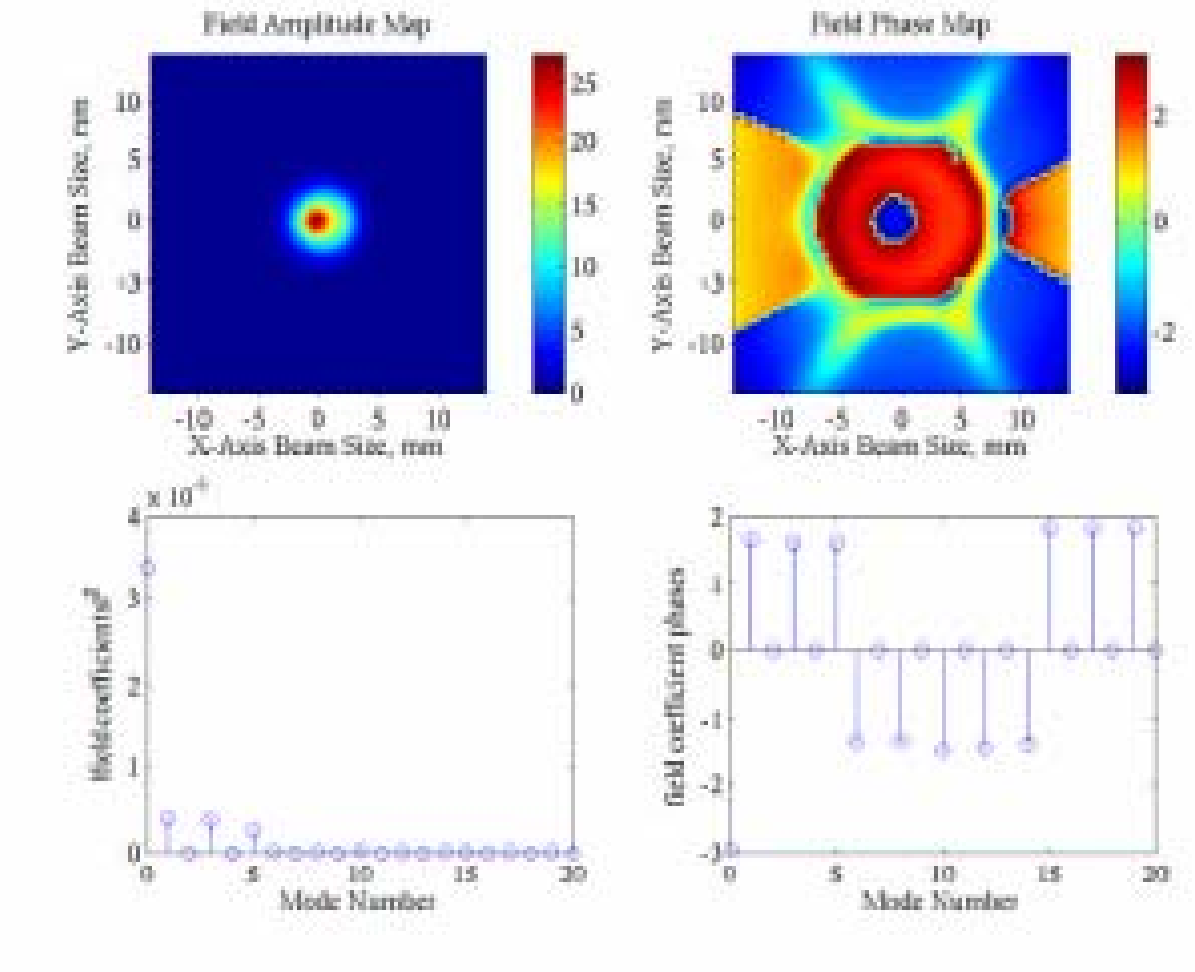


Reflected beam (III)



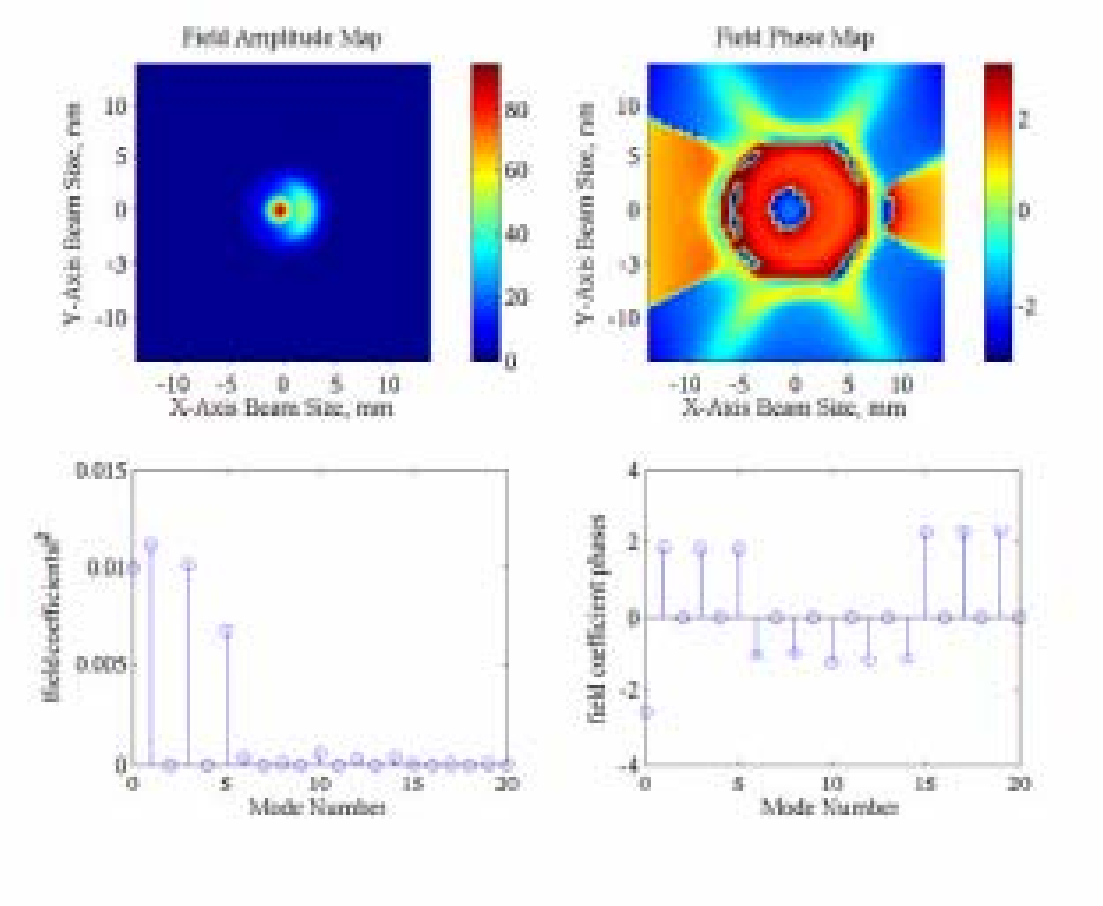
3 W into mode cleaner, coating abs. 0.6 ppm

Reflected beam (IV)



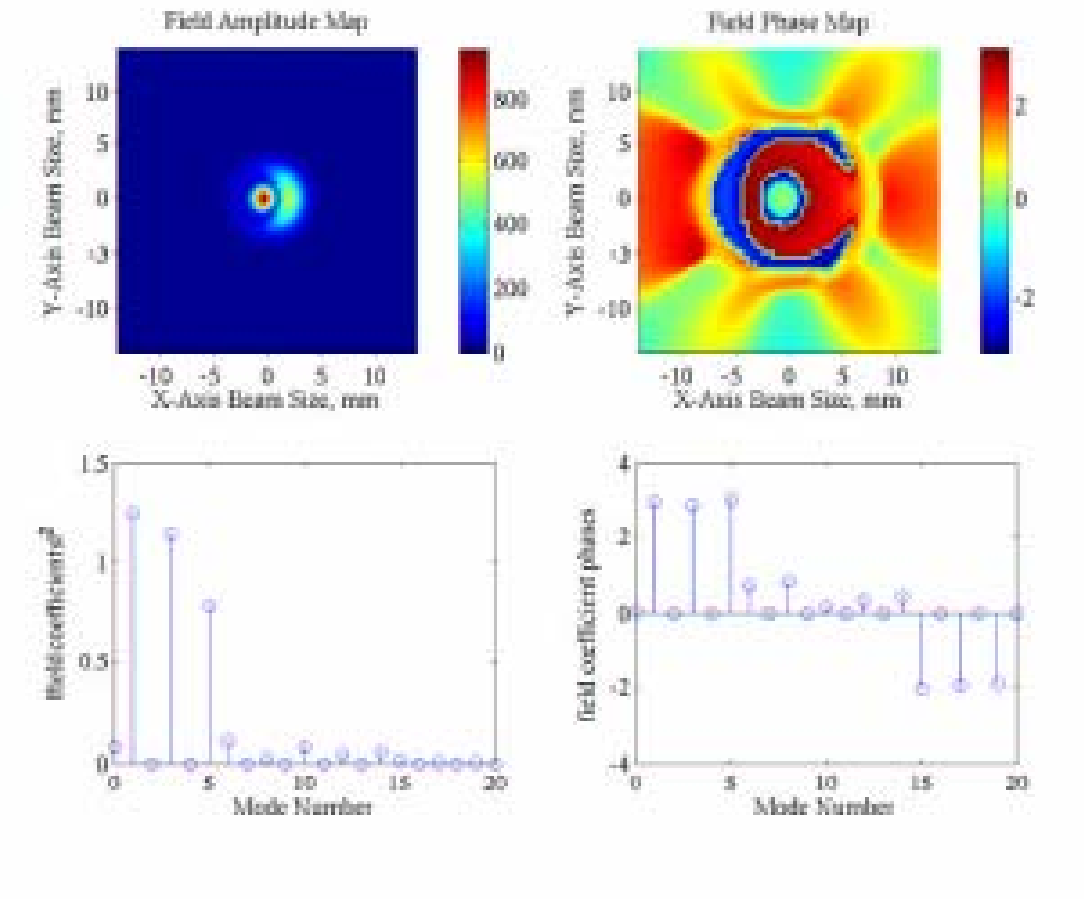
10 W into mode cleaner, coating abs. 0.6 ppm

Reflected beam (V)



30 W into mode cleaner, coating abs. 0.6 ppm
Problem with angular control (WFS)?

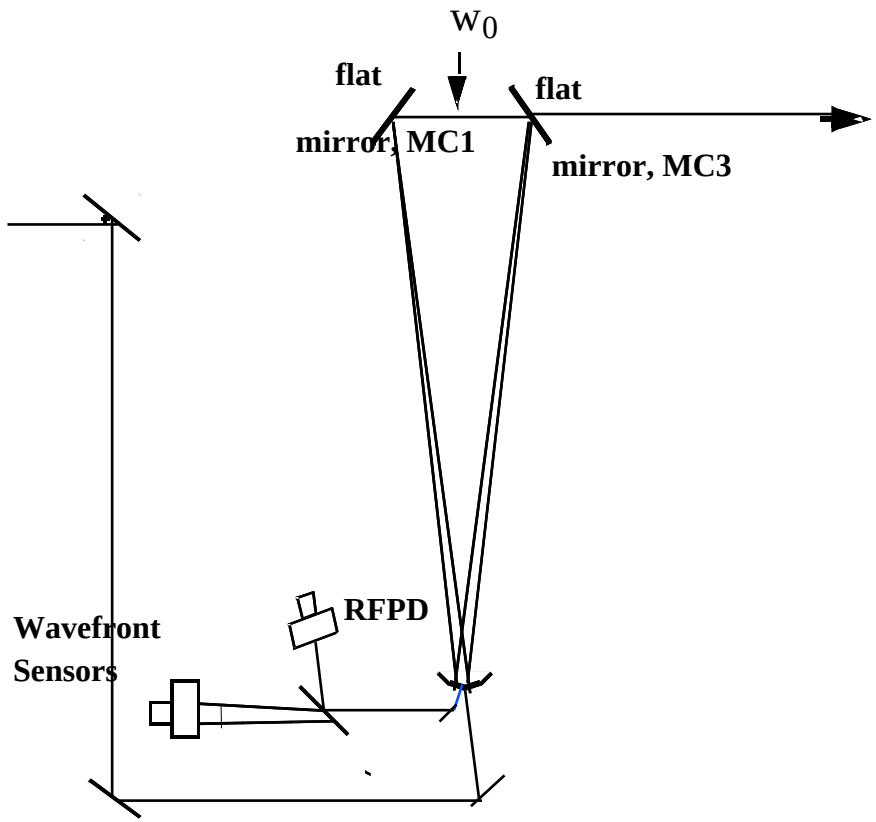
Reflected beam (VI)



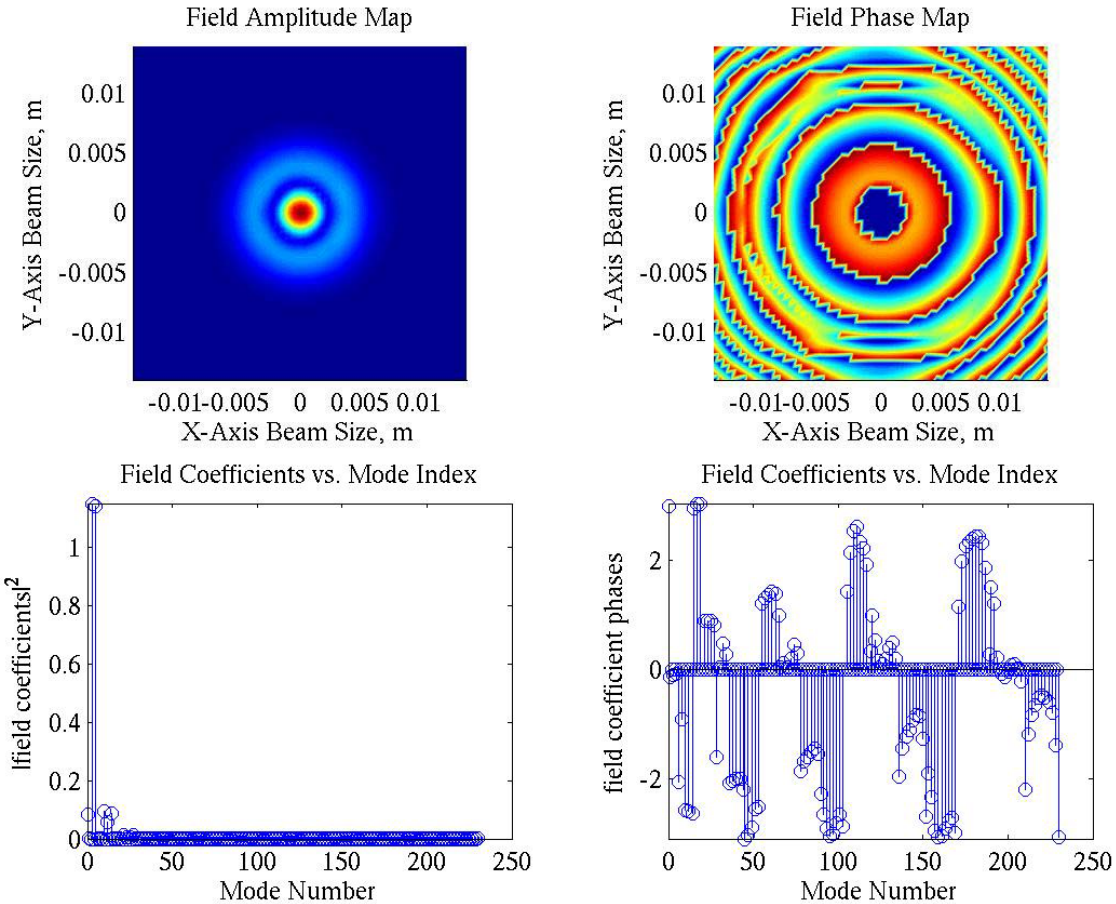
150 W into mode cleaner, coating abs. 0.6 ppm

Alternate MC geometry

- Inject beam into MC2
  - » Lower AOI
- Requires some re-routing of beams in HAMs
  - » IOT table moves to HAM2



Reflected beam (VII)



150 W into mode cleaner, coating abs. 0.6 ppm

Injected trough the curved mirror

Reflected beam summary

- Asymmetry in reflected beam at high power caused by passing through region off-center of non-spherical thermal lens…
- Is this a problem?
- Could be avoided by injecting beam through curved mirror instead of one of the flats
- Please verify by other code
- Should start to see effects above 10 W. That is soon!

Conclusion

- Substrate absorption not so critical
- Even at 0.6 ppm coating absorption the higher order mode contamination will be more than 1%. OK?
- Reflected beam will be terrible. OK? Consider alternative injection scheme.
- Melody issues need to be resolved (pseudo-locker and more). Need volunteers.