LIGO Laboratory / LIGO Scientific Collaboration

LIGO-T1000218-v3 LIGO April 22, 2010

RM3 size and astigmatism of AdvVirgo stable cavity

Hiro Yamamoto

Distribution of this document:
LIGO Science Collaboration

This is an internal working note
of the LIGO Project.

California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

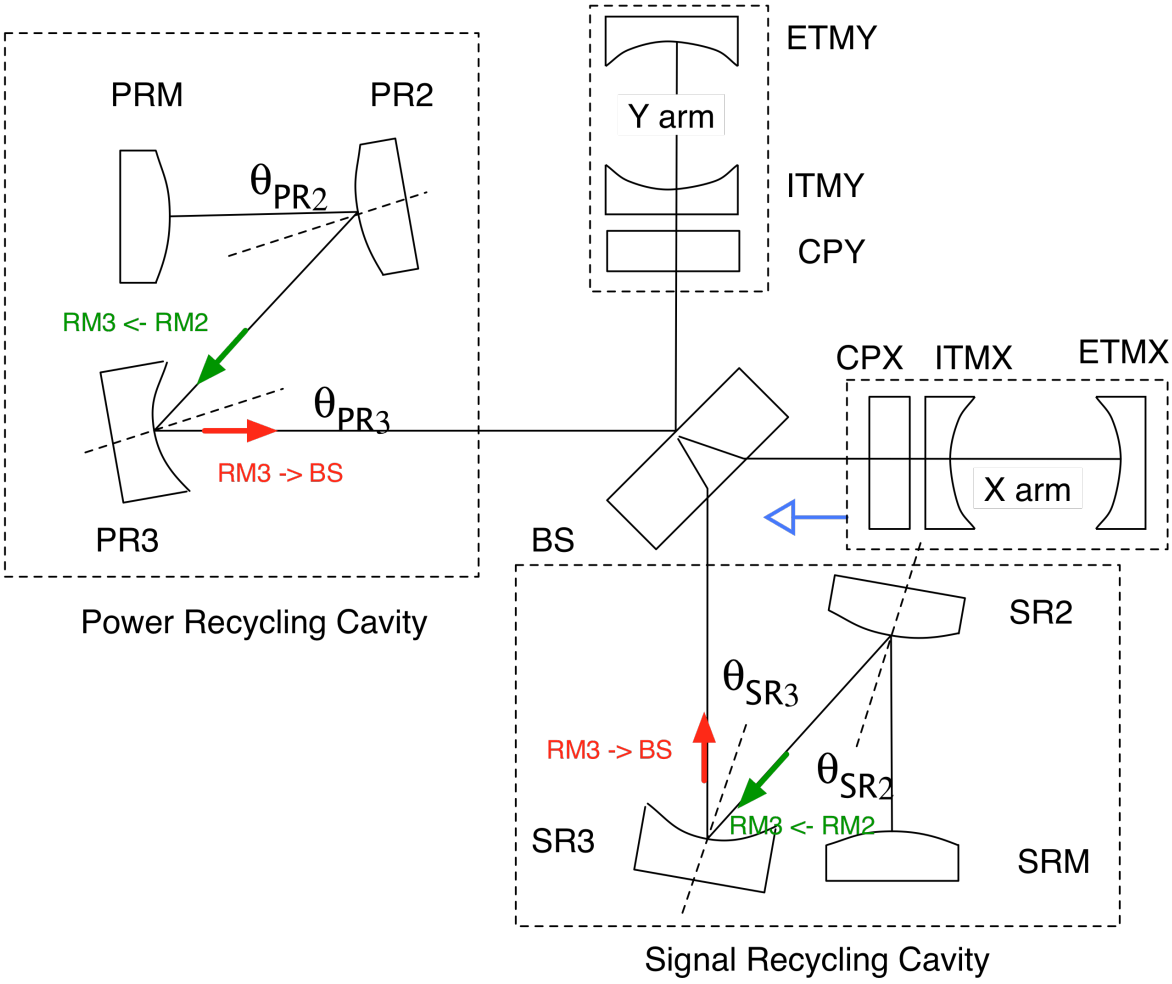
Massachusetts Institute of Technology
LIGO Project – NW17-161
175 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
P.O. Box 1970
Mail Stop S9-02
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

http://www.ligo.caltech.edu/

SIS Stable Coupled Cavity (Power Recycling Cavity and Y-arm, Signal Recycling Cavity and Y-arm) simulation using the following parameters.



Cavity parameters : new Power Recycling (old PRC) / SRC

ITM.aperture = 0.35
ITM.thickness = 0.2
ITM.opt.T = 0.007
ITM.opt.R = 1 - ITM.opt.T - 37.5ppm
ITM.opt.ROC = 1416

ETM.aperture = 0.35
ETM.thickness = 0.2
ETM.opt.T = 10ppm
ETM.opt.R = 1 - ETM.opt.T - 37.5ppm
ETM.opt.ROC = 1646

BS.aperture = 0.55
BS.thickness = 0.065

RM.aperture = 0.15
RM.thickness = 0.1
RM.opt.T = 0.0464 / 0.11
RM.opt.R = 1 - RM.opt.T
RM.opt.ROC = -2.853 (-12.26288) / -2.866

MMT2.aperture = 0.15
MMT2.thickness = 0.1
MMT2.opt.ROC = -2.853 (-2) / -2.866
MMT2.incident.theta = 0.9 degree

MMT3.aperture = 0.35
MMT3.opt.ROC = 22.543 (23.0304) / 21.626
MMT3.incident.theta = 0.9 degree

FPcav.L0 = 2999.8 (3000)

CCav.RM_MMT2 = 10.027 (10.5) / 9.556
CCav.MMT2_MMT3 = 10.12332322 / 9.65211690 (10.69836864)
CCav.MMT3_BS = 10.45 (6) / 9.952
CCav.BS2ITM = 5.499 (5.55728) / 5.4990

Notation of field

RM3->BS : field on RM3 going out toward BS (red line in the figure)

RM3<-RM2 : field on RM3 coming from RM2 (green line in the figure)

Case compared

RM3 aperture = 35cm, 33cm, 31cm, 29cm, 27cm

AOI on RM2 and RM3 = 0 and 0.9° for PRC and 1.0° for SRC

PRC – Y arm : inject field from RM

SRC – Y arm : CR is anti resonant in SRC.

Signal sideband is generated by shaking ETM.

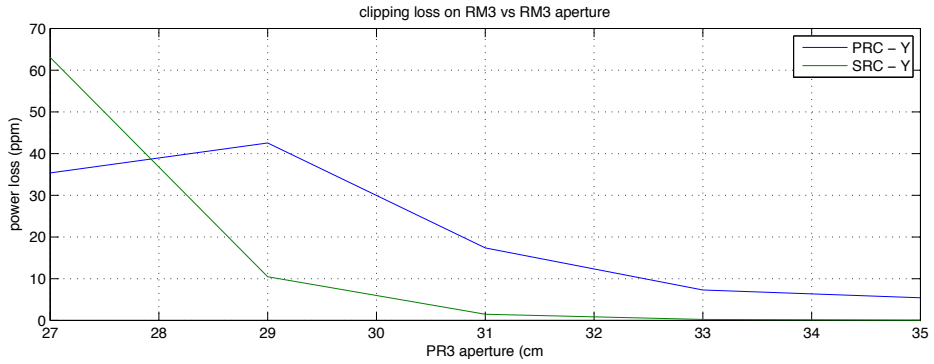
Power in the arm is set to be the same.

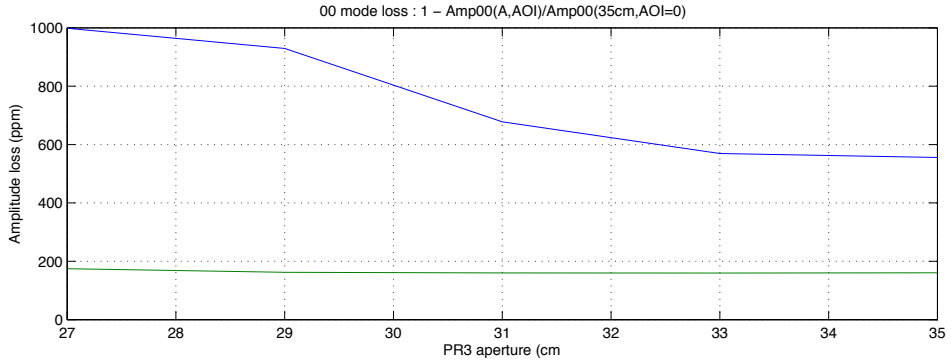
Loss vs aperture (AOI=0.9°)

Top plot : 1 – Power(RM3->BS) / Power(RM3<-RM2)

Bottom plot : 1 – Amp00(RM3 aperture,AOI) / Amp00(35cm,AOI=0)

Amp00 = ∫ E(RM3->BS, aperture,AOI) * E(RM3->BS,aperture=35cm,AOI=0)'





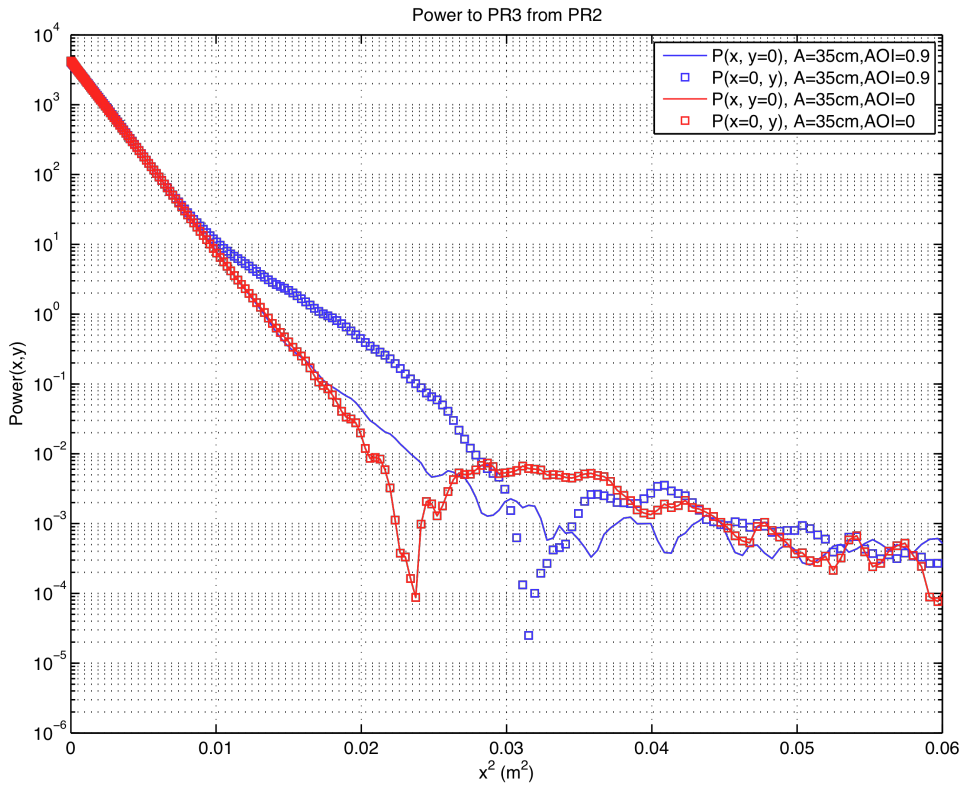
Effect of finite angle of incidence : Power(RM3 <- RM2)

PRC – Y arm : new parameter

Comparison of Power distributions with AOI = 0 and AOI = 0.9°, in the x plane (horizontal) and y plane (vertical), with aperture size = 35cm.

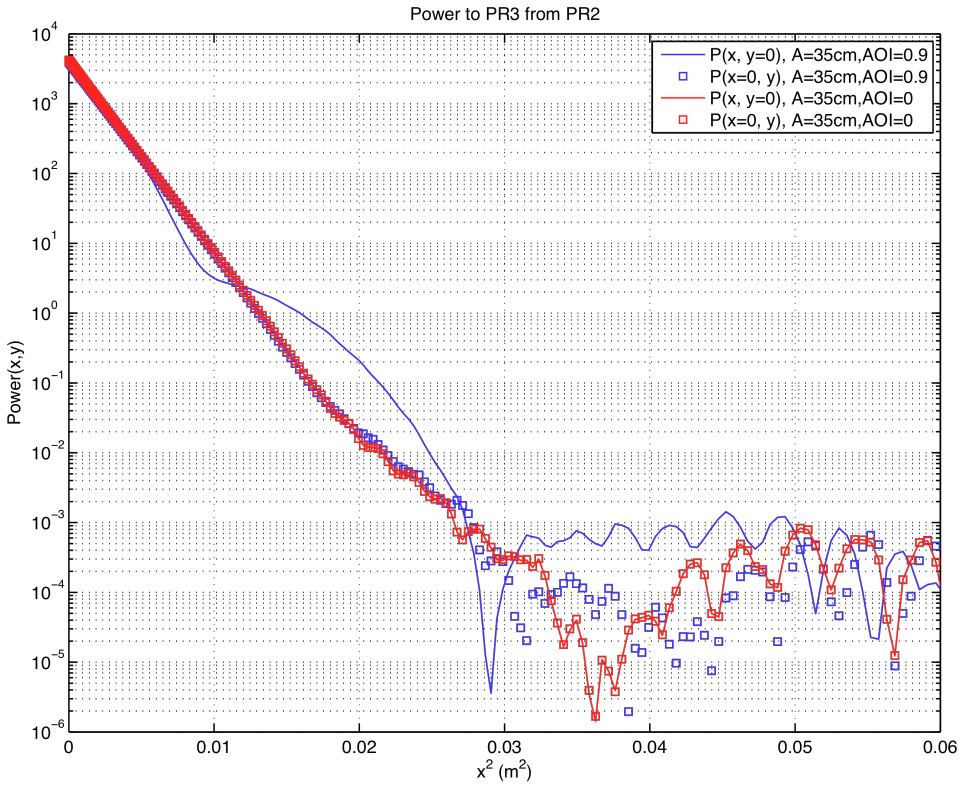
Log(power) vs x^2, so a straight line slope means a perfect Gaussian power distribution. P(x,y=0) is the horizontal distribution in the plane at y=0, and P(x=0,y) is the vertical distribution in the plane at x=0.

With AOI=0, the horizontal (red solid) and vertical (red square) distributions are the same. With AOI=0.9°, the horizontal distribution (blue solid) is almost the same as no AOI case, but the vertical distribution (blue cross) deviates from the Gaussian shape at around x=10cm (0.01 in the plot).



PRC – Y arm : old parameter

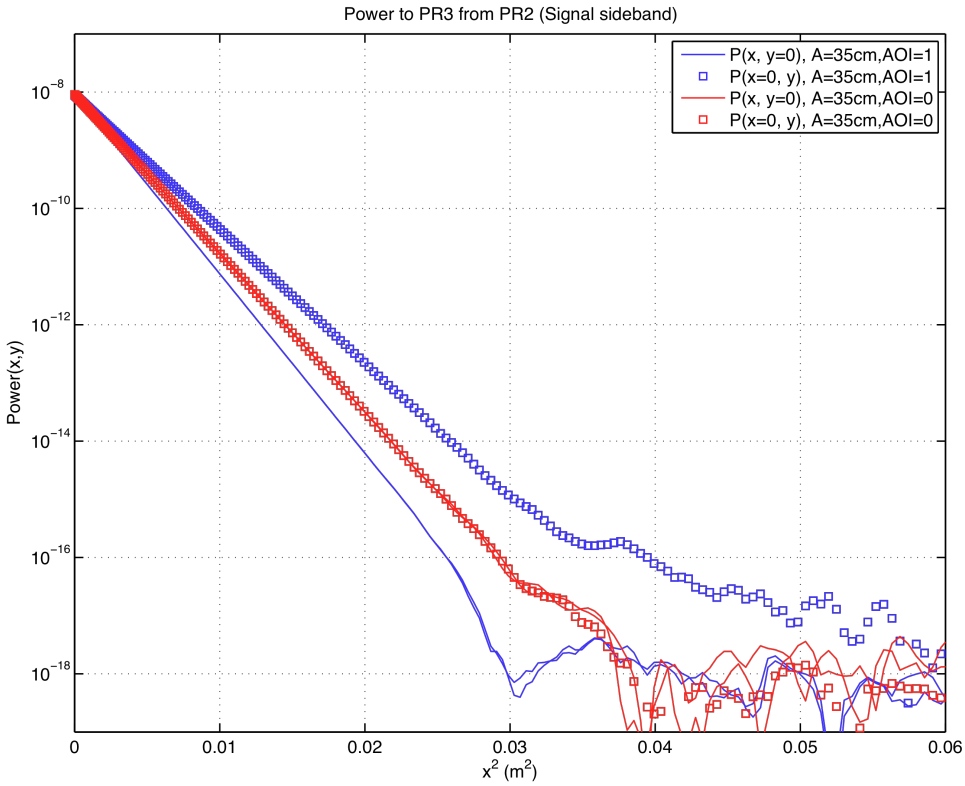
The behavior is different in the configuration using the old parameter set.



SRC – Y arm

Field structure in the horizontal and vertical planes are the ones in a recycling cavity without AOI, but the ROC(RM2 and RM3) are multiplied or divided by cos(AOI).

The field curvature on RM does not perfectly match with ROC of RM, one direction larger and the other direction smaller.

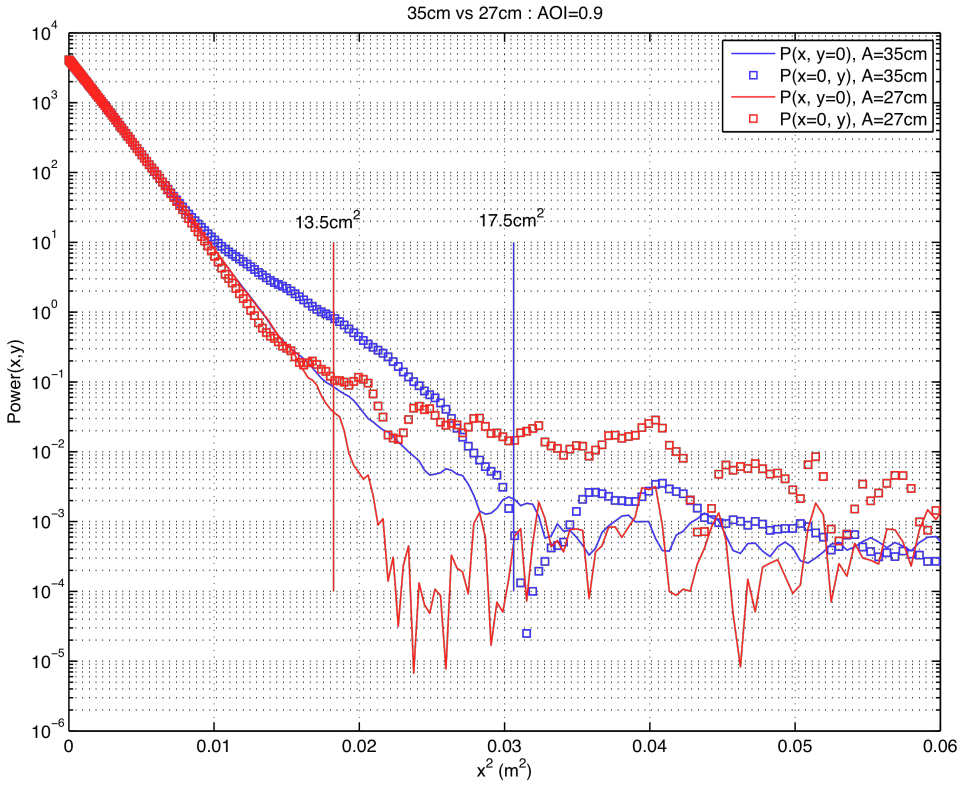


Effect of different PR3 aperture : Power(RM3 <- RM2)

The following plot compares two cases with aperture 35cm and 27cm.

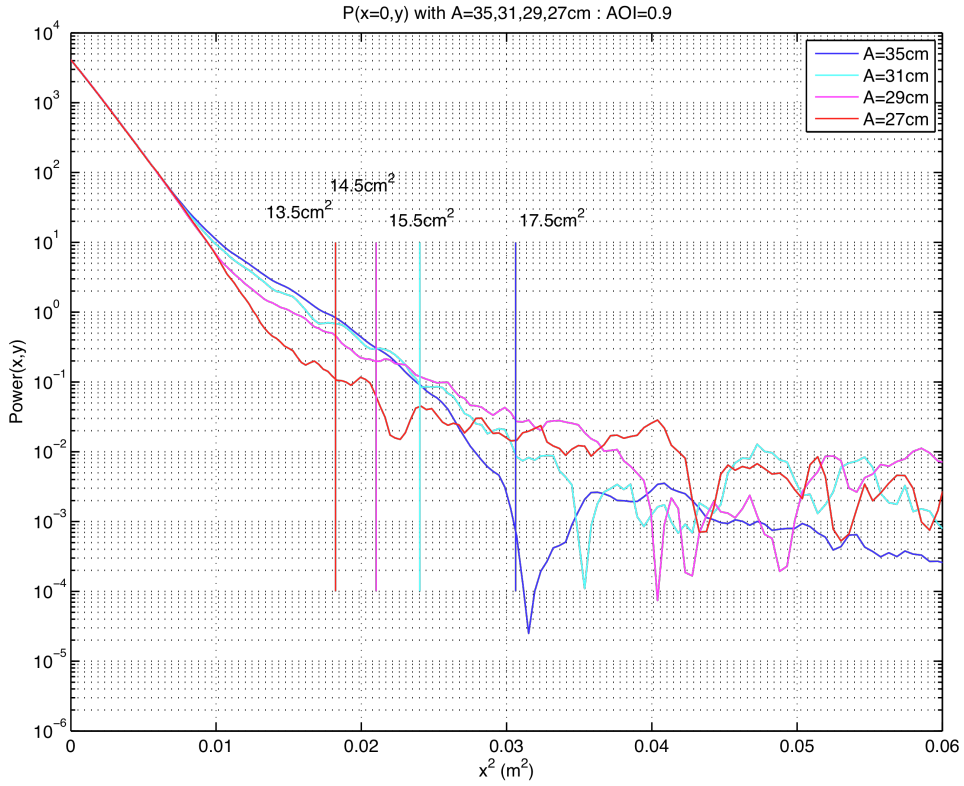
The horizontal distributions (red and blue solid) do not change much, but the vertical distributions are (red and blue square lines).

Powers right side of two lines, marking the mirror sizes, are lost.



Effect of different PR3 aperture : Power(RM3 <- RM2)

The following plot compares the horizontal distributions, P(x,y=0), with four apertures.



Conclusion

Virgo roundtrip loss criteria will be used to impose the aperture limit.