Estimation of Astigmatism Effect on Dark Fringe Power

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OUTLINE:

- Previously on this topic
- Check with Finesse
- Check of the check with Finesse, with DarkF (M.Pichot)
- Conclusions

- previously on this topic:

A large amount of carrier power is present on the dark port before the Output Mode Cleaner see: Marque, logbook entry 26977

This is mainly due to the End Mirror RoC asymmetry.

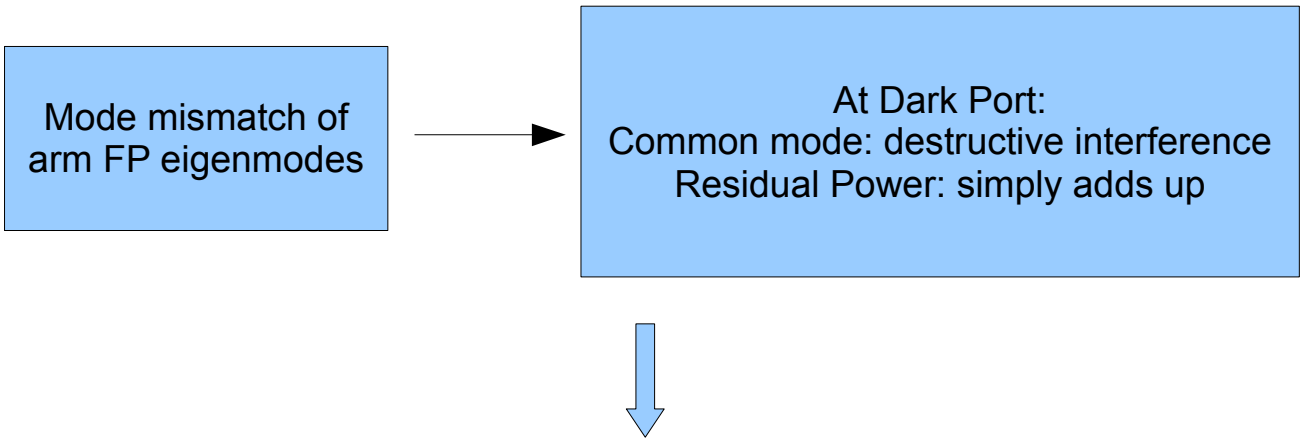
An intervention is foreseen to try and equalize average RoCs by a smart heating of the End Mirrors.

- Question:

Should we go towards North End RoC? West End? An average value? None of these?

- previously on this topic:

Last week (see VIR-0528A-10) Enrico made an estimation of the residual power on the dark port, based on simplified analytical calculations, once that the average RoCs have been equalized at a given value:



NE avg RoC	NE Delta RoC [m]	WE avg RoC [m]	WE Delta RoC [m]	DF power [mW]
3273	0	3273	50	~3.10^2
3403	0	3403	50	100

Check with Finesse:

1) RoC asymmetry acts as additional average losses as for carrier recycling gain:

Actual estimated value

NE RoC [m]	WE RoC [m]	Average rtl [ppm]	CAR rec gain
3273	3403+/-25	450	19
3403	3403+/-25	450	23
3403	3403+/-25	550	19

Simulations carried out with Finesse on the full ITF, no mirror phase maps, maxtem = 6.
Rtl added as end mirror losses.

Check with Finesse:

2) Finesse predicts more or less the same results as the simplified analytical calculations:

NE RoC [m]	3273	3273	3403	3600
WE RoC [m]	3403 +/- 25	3273 +/- 25	3403 +/- 25	3600 +/- 25
DF power	3.2 W	195 mW	101 mW	60 mW
CAR rec gain	19	23	23	23
SB rec gain	44	43	44	46

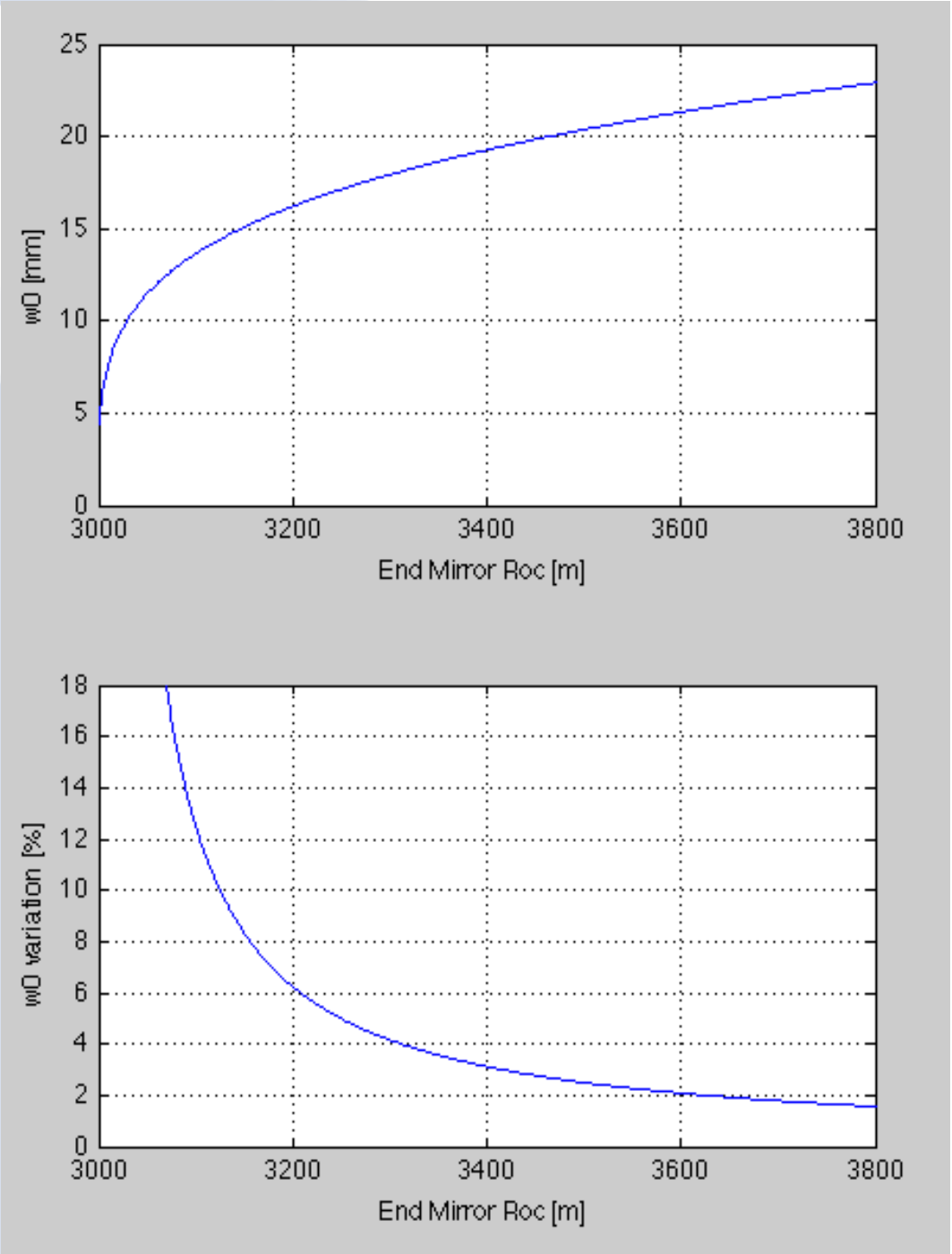
Simulations carried out with Finesse on the full ITF, no mirror phase maps, maxtem = 6.
Rtl added as end mirror losses: 450ppm average.

Check of the check with Finesse, with DarkF (M.Pichot):

3) DarkF predicts the same results as Finesse:

NE RoC [m]	3273	3273	3403	3600
WE RoC [m]	3403 +/- 25	3273 +/- 25	3403 +/- 25	3600 +/- 25
DF power	3.02 W	199 mW	104 mW	62 mW
CAR rec gain	19	22.4	22.9	23
LSB rec gain	45.5	44	46	46
USB rec gain	42.7	42.8	43.3	44

Simulations carried out with DarkF on the full ITF, no mirror phase maps.



Why has the same astigmatism such a different impact on the carrier power at the dark fringe, when the average RoC changes?

Because waist variation depends on the ratio RoC over cavity length:

Dw0 / w0 = ¼ (RoC / L – 1)^-1 dRoC / L

L = 2999.9 m;

RoC [m]	¼ (RoC / L – 1)^-1
3273	2.7
3403	1.9
3600	1.25

- astigmatism for different end mirrors:

(see Galimberti VIR-0422A-10)

mirror	substrate	gaussian RoC (m)	principal RoC 1 (m)	principal RoC 2 (m)	astigmatism (m)
Virgo+ NE	VEM10	3273	3285	3260	25
Virgo+ WE	VEM09	3403	3425	3382	43
Virgo NE (before 2008)	*VEM04*	*3584*	*3594*	*3574*	*20*
Virgo WE	*VEM01*	*3624*	*3649*	*3600*	*49*
VEM11 **(no coating)**		3340	n/a		61

CONCLUSIONS:

1) RoC asymmetry acts as additional average losses as for carrier recycling gain (around 100ppm more for current RoC values).

2) The longer the average common RoC, the less the residual power at the dark fringe due to the (same) astigmatism.

3) Simplified analytical calculations, Finesse and DarkF simulations agree (!)

Advice:

- try and adjust RoCs towards longer values