Laser amplitude noise requirement

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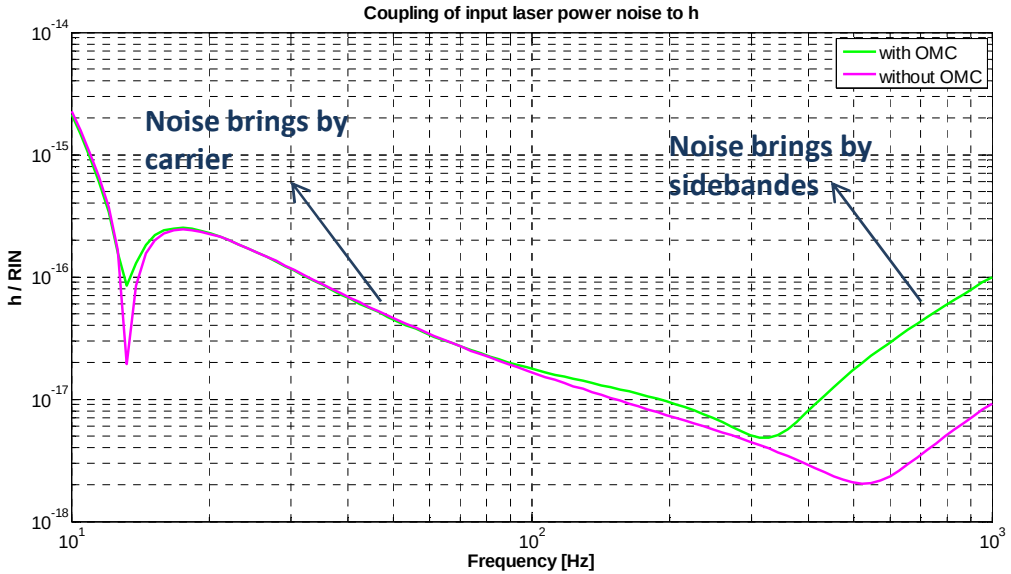
Outline

I. Optickle simulation
II. RIN requirement for various finesse and loss asymmetries
III. RIN control with POBS

Optickle simulation

- Gabriele Vajente optickle model: simulation without Input Mode Cleaner.
  fMod1 = 6270339.2 Hz, fMod2 = 81515709.5 Hz, fMod3 = 8360585.6 Hz ; Lcav = 2999.9 m,
  Lprc = 11.953m, Delta = 0.037m, Lsrc = 11.033m, Lprbs = 5.980m.
- Output mode cleaner : Finesse 200, round trip 40 cm.
  => OMC filter sidebands



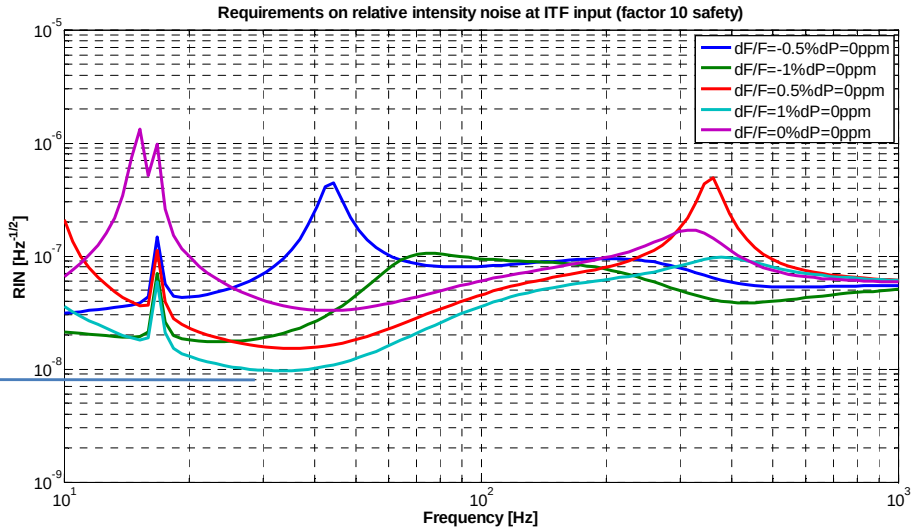
Index modulation of sidebands (without OMC) /100

=> OMC and sidebands properties have an effect on RIN requirement

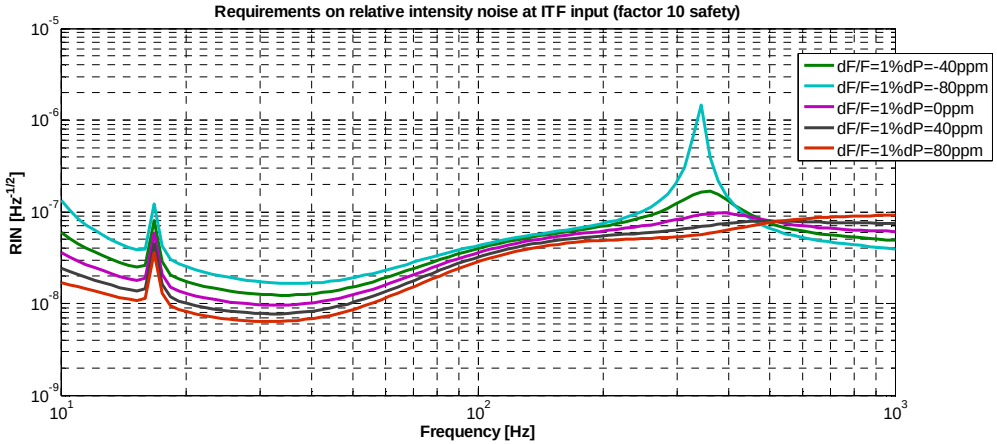
RIN requirement for various asymmetries

- RIN for various finesse asymmetries (factor 10 safety)

Lower RIN for finesse asymmetry of 1%

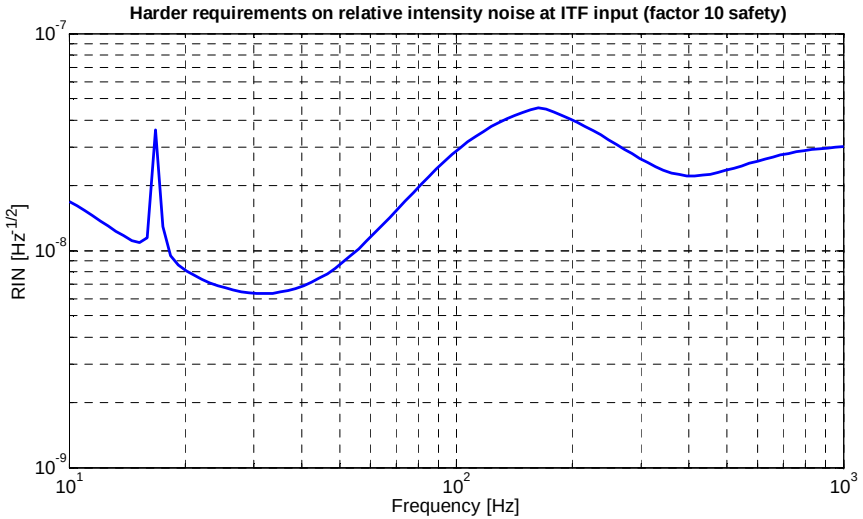


- RIN for various loss asymmetries (@ dF=1%)



Harder RIN requirement

- RIN requirement realized for various loss asymmetries (from -80ppm to 80 ppm with a step of 20ppm) and finesse asymmetries (from -1% to 1% with a step of 0.5%) : Lower RIN is taken between the different files at each frequency => Harder RIN requirement

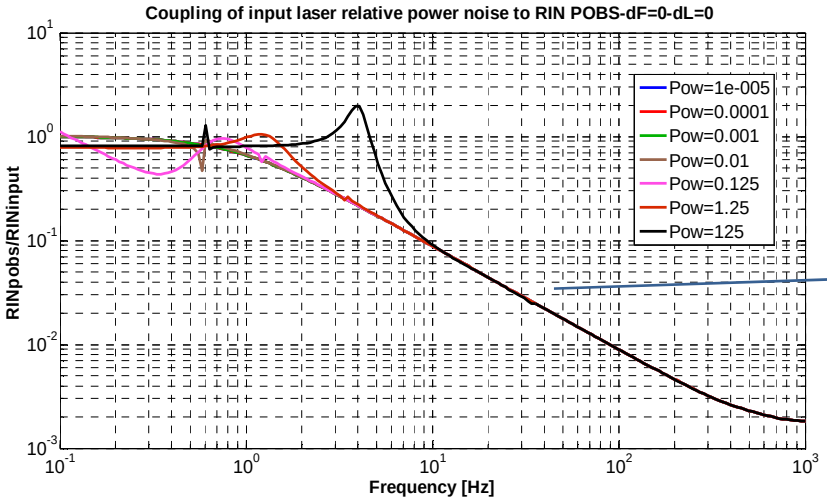


- Noise floor at 6.10^{-9} $.Hz^{-1/2}$=> Power required for intensity noise higher than shot noise ≈ 10 mW.

RIN control with POBS

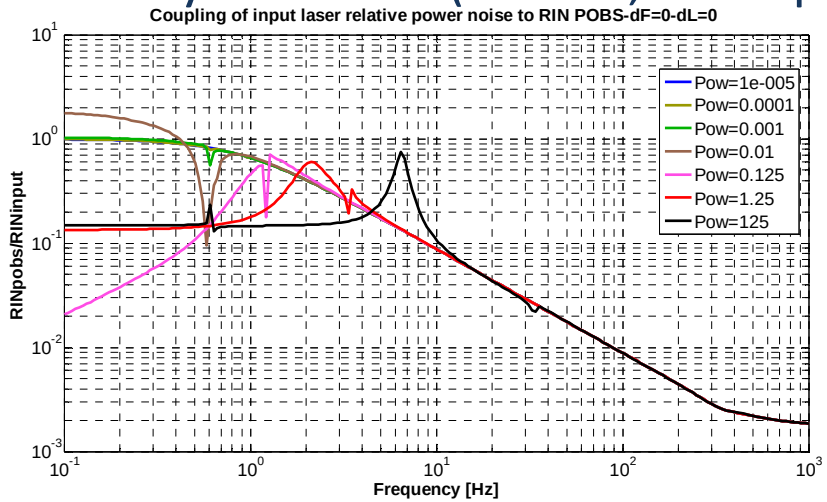
Transfer function: RIN input to RIN on POBS

- Simulation without asymmetries. => effect of radiation pressure



Power Recycling Cavity (pole of few Hz)

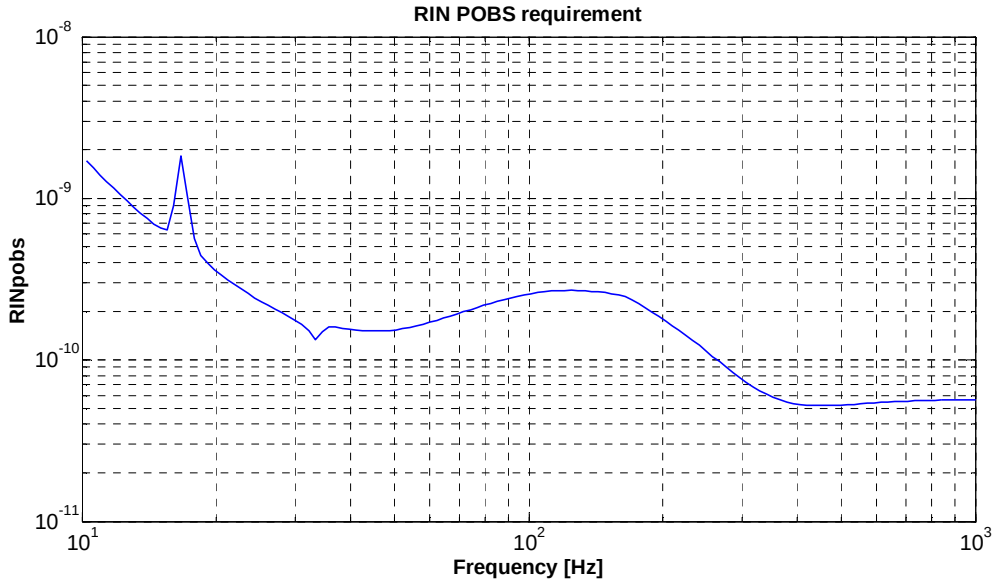
- Simulation with asymmetries (DF=1%,DL=80ppm)



Power Recycling Cavity and radiation pressure effect reduce the transfer function

RIN requirement on POBS

- Simulation with asymmetries (DF=1%,DL=80ppm) and harder RIN

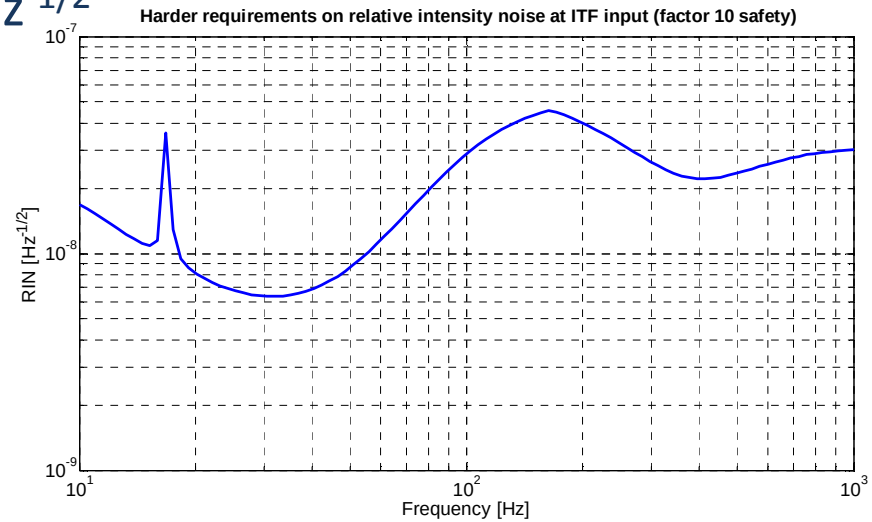


=> Lower RIN requirement at 5.10^{-11} .$Hz^{-1/2}$ => Power required at the detection: 149 W

Conclusion

- RIN requirement for various asymmetries: Harder RIN requirement

Noise floor at $6.10^{-9}.Hz^{-1/2}$



- RIN control with POBS : difficult solution (Power recycling cavity, radiation pressure effect)
- Perspective: update requirement when final recycling cavity lengths.

Asymmetries definition

- Loss asymmetry ΔL:
- LIX=LEX= Ltot/2+ΔL/4,
- LIY=LEY= Ltot/2-ΔL/4.
- Finesse asymmetry ΔF:
- FX= F*(1+ΔF/2),
- FY= F*(1-ΔF/2).