End mirrors radius of curvature

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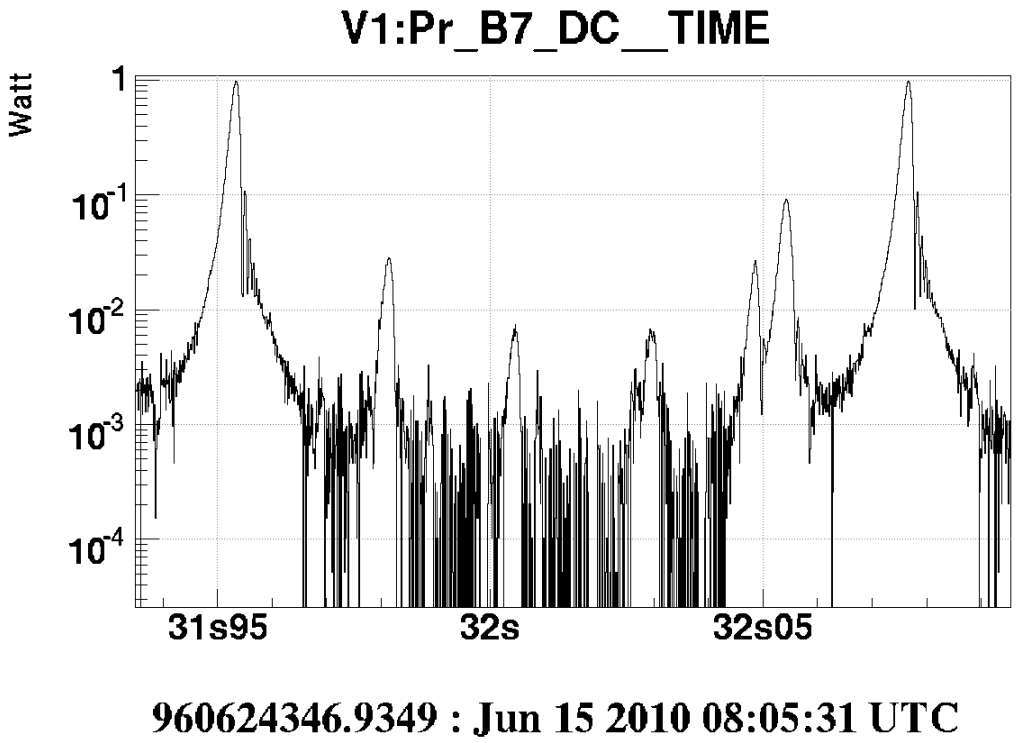
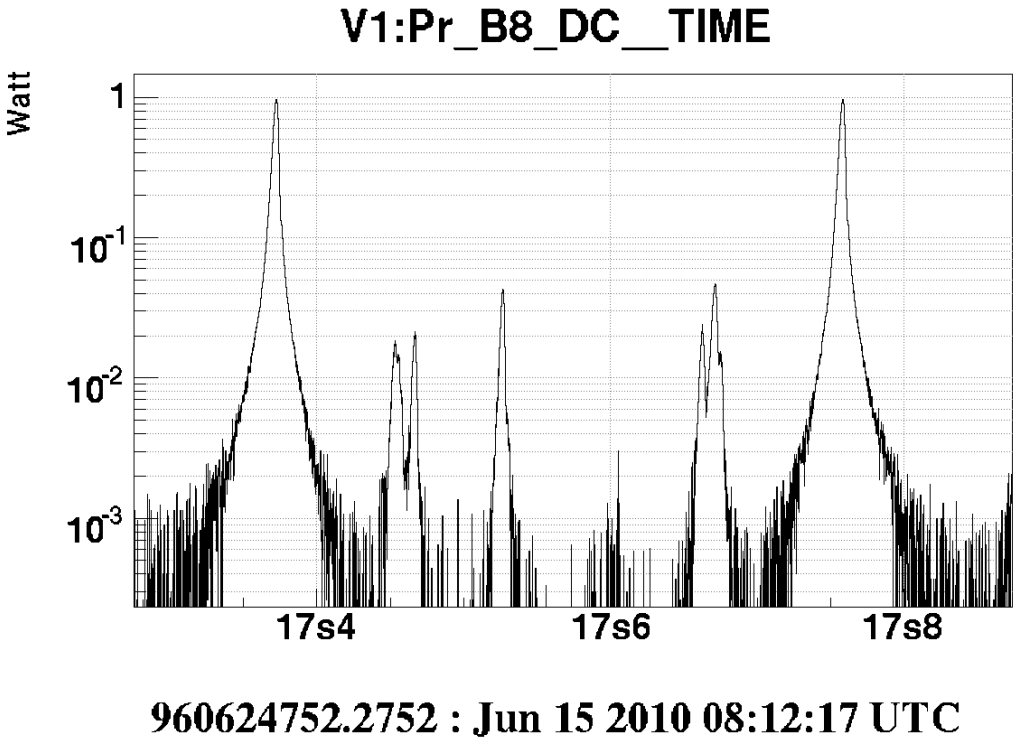
Free swinging cavities





- Use position of HOM to determine ROC
- West cavity has split modes
- Noisy measurement due to lower mirror transmission

Theory

Flat-concave cavity: modes with m+n=q are degenerate

$$\frac{2\pi}{\lambda}L-(m+n+1)\varphi=p\pi$$

Gouy phase

$$\tan(\varphi)=\frac{L}{z_R}$$

ROC

$$R=L\left[1+\left(\frac{z_R}{L}\right)^2\right]=L\left[1+\frac{1}{\tan(\varphi)^2}\right]=\frac{L}{1-\cos(\varphi)^2}$$

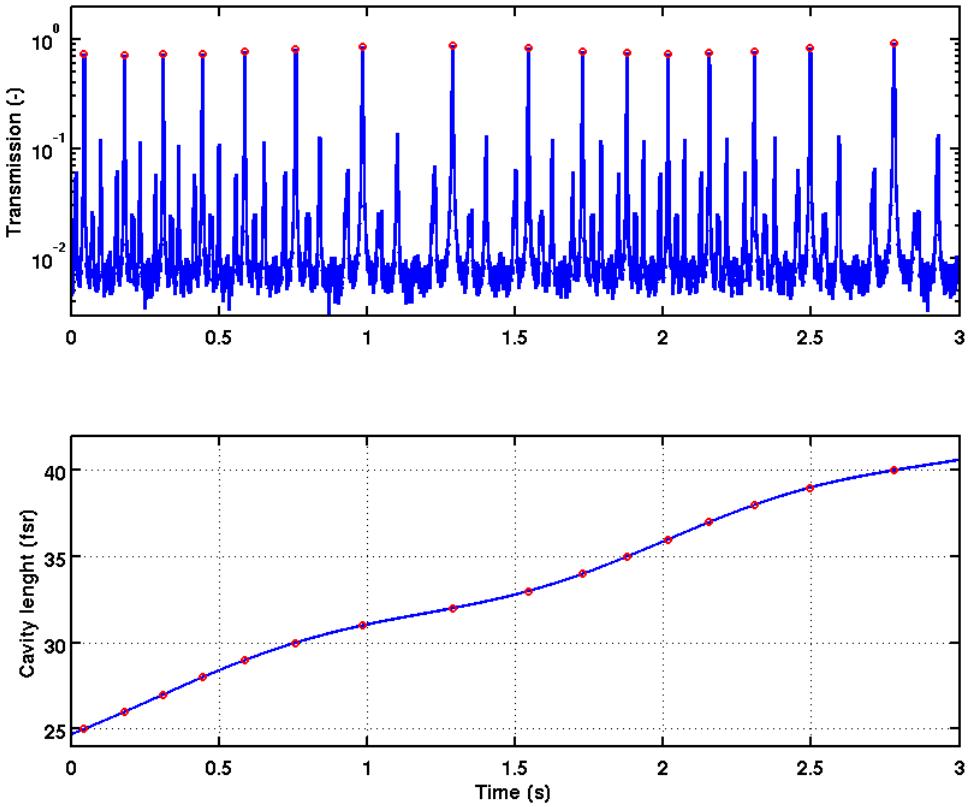
Astigmatic cavity: modes with m+n = q split in q+1 peaks

$$\frac{2\pi}{\lambda}L-(m+1/2)\varphi_x-(n+1/2)\varphi_y=p\pi$$

Different ROCs in x and y

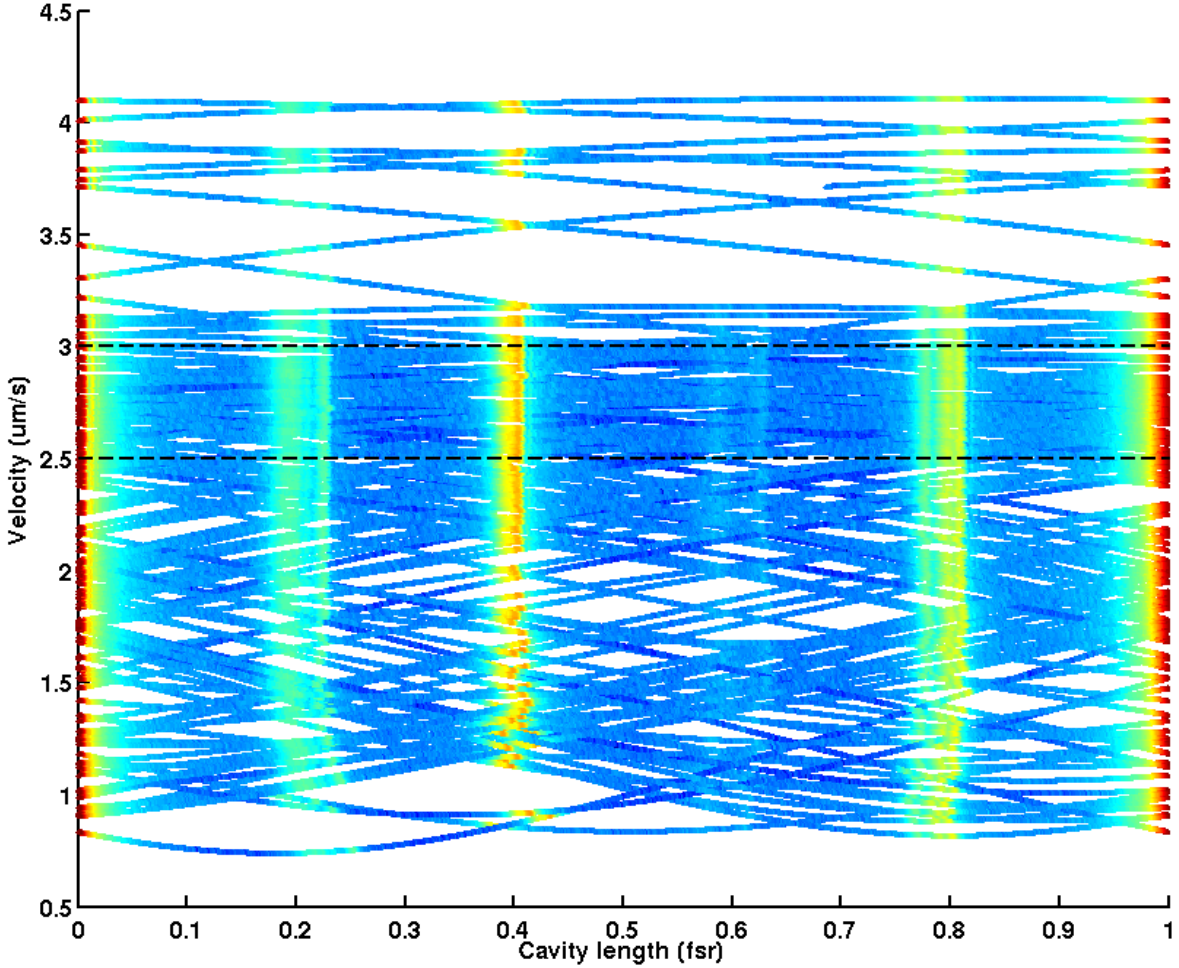
$$R_x=\frac{L}{1-\cos(\varphi_x)^2} \qquad R_y=\frac{L}{1-\cos(\varphi_y)^2}$$

Reconstruct mirror motion



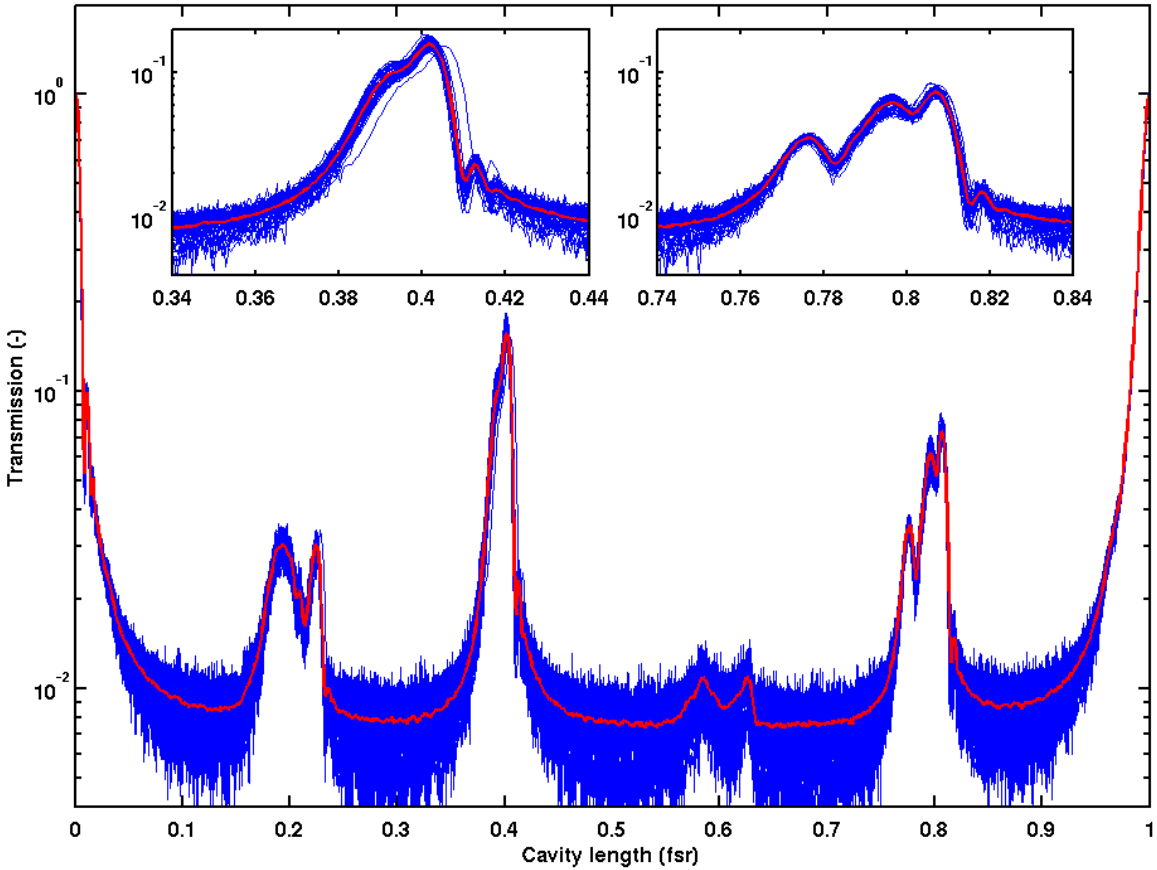
- Determine direction using ACp/DC
- 'Unwrap' to get integer number of FSRs
- Cubic spline interpolation to get position between resonances

Transmission vs speed



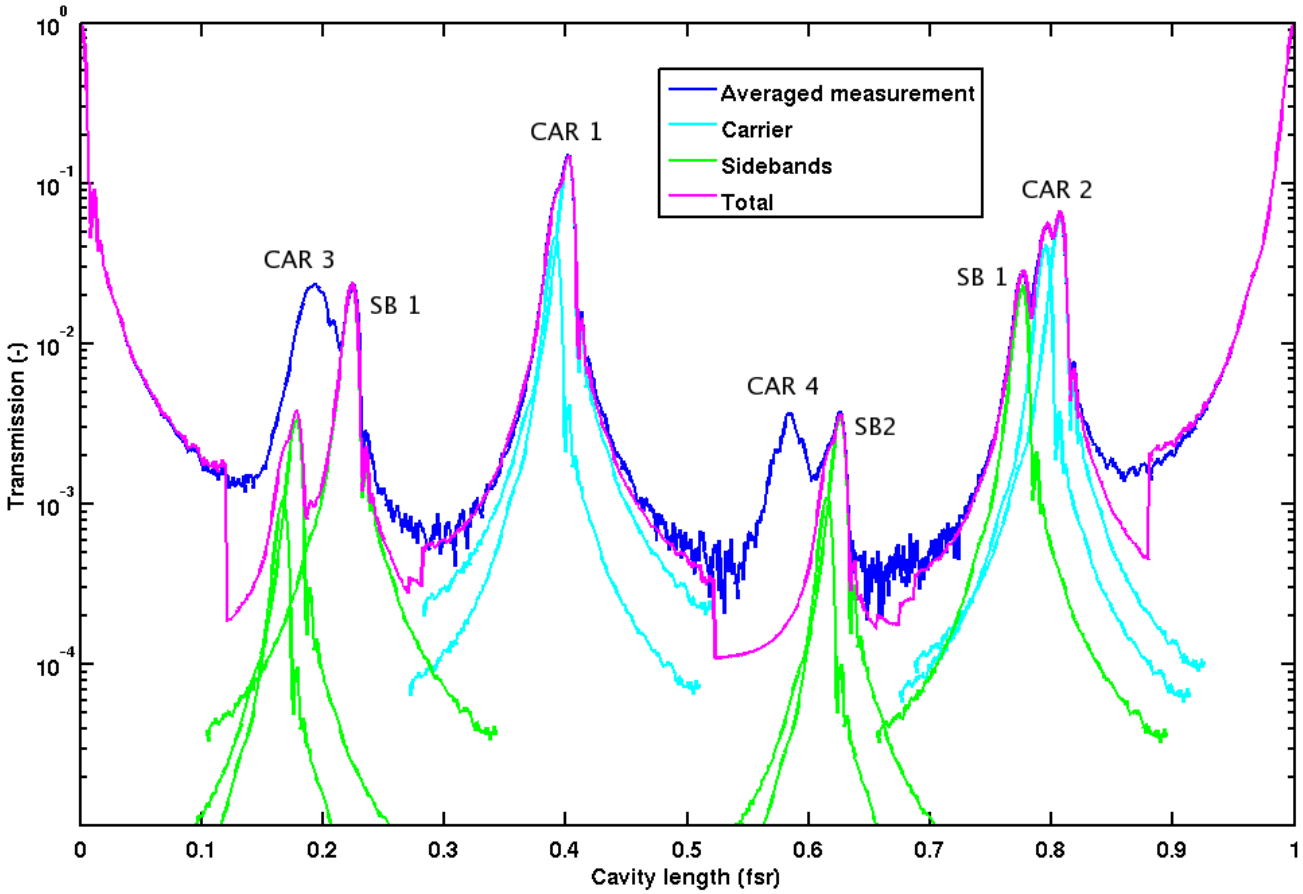
- Speed too low: interpolation fails
- Speed too high: too much ringing

Average



- Average over ~ 50 sweeps, as a function of interpolated position
- Accuracy ~ fsr / 1000

Fit peaks



- Slide and scale copy of TEM00 peak, fit by hand
- Sum of sub-peaks accurately matches measurement
- Only TEM02 and TEM20 visible, TEM11 hard to excite ??

Results (preliminary)

Mode	Phase (degrees)	ROC (m)
CAR10	70.4 (0.2)	3381 (8)
CAR01	72.4 (0.2)	3303 (8)
CAR20	143.1 (0.2)	3334 (4)
CAR02	145.3 (0.2)	3293 (4)
SB00	40.3 (0.2)	
SB00	139.7 (0.2)	

- Note: TEM2 modes not exactly double of TEM1, mirror shape might be more complex than ROCx and ROCy
- Fit with LMA data: R = 3400 - 3410
- See Antonino's talk
- Check with sidebands:
  - Lcav = 2999,798 +- 0.003 m
  - modulation index = 0.3,

Concluding

- West cavity
  - Free swinging cavity data suggest cavity is astigmatic
  - Accurately determined locations of HOMs using averaging
  - Results not yet completely understood, should be matched with LMA surface data
- North cavity
  - Tried a similar measurement for the North cavity, but data not clean. To be repeated ...
  - Quick measurement by Gabriele shows no visible splitting, ROC = 3260 +- 40 m

End