Excess loss due to coatings on mirror substrates

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LSC meeting

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Hanford site

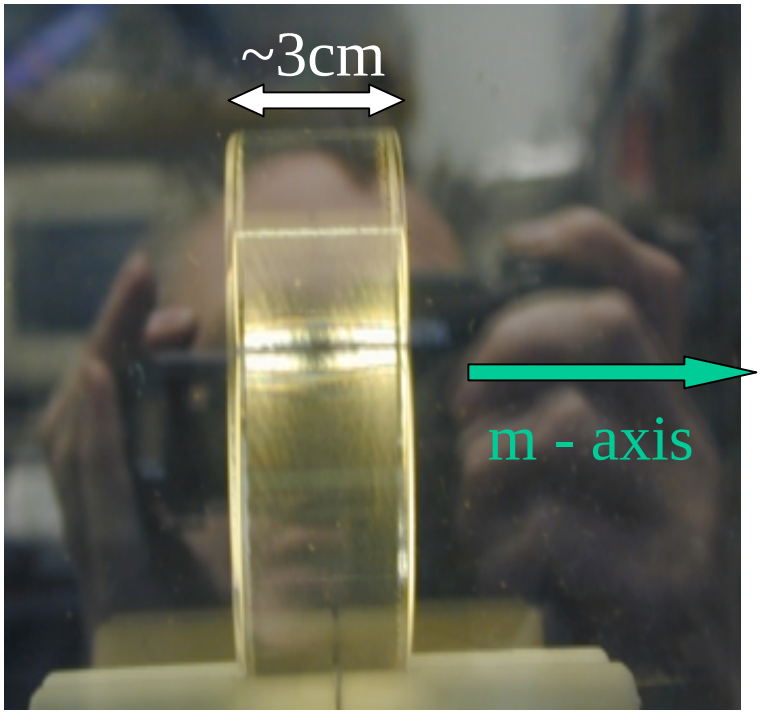
LIGO-G000270-00-D

Excess loss introduced by coatings

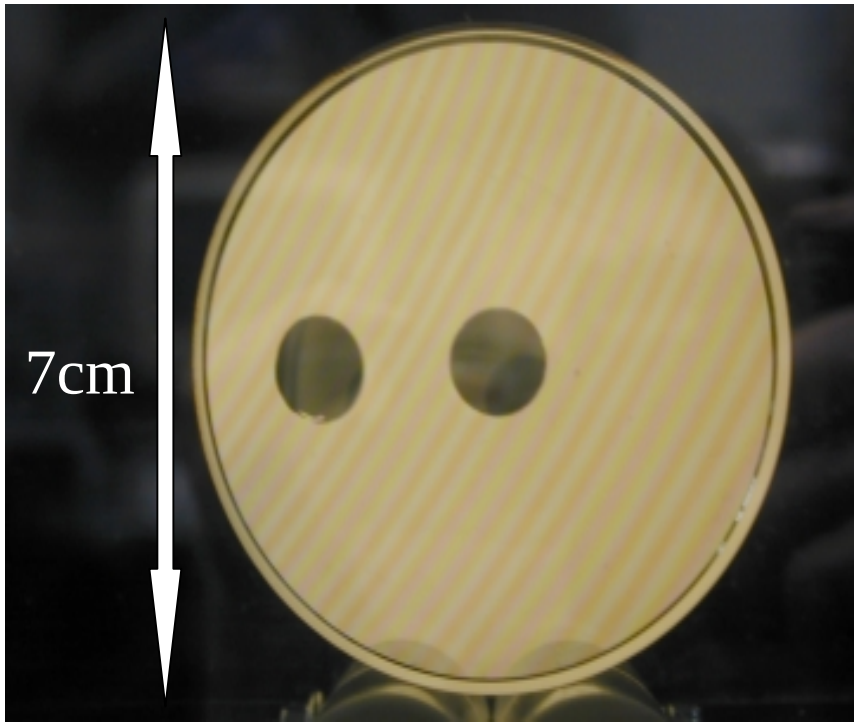
- Aim:
  - Measure Q of a sample before and after application of a dielectric mirror coating to estimate level of any excess loss from coating
- Approach:
  - Identify a mode of a -mirror like- sample which has (a) minimal motion at suspension points (to minimize losses associated with friction at wire suspension) and (b) maximal differential strain across the coating on the mirror face (to maximize losses associated with deformation of coating)
- Initial measurements on m-axis sapphire sample on loan from LIGO

Sapphire - dielectric coatings

Views of sample through crossed polarisers



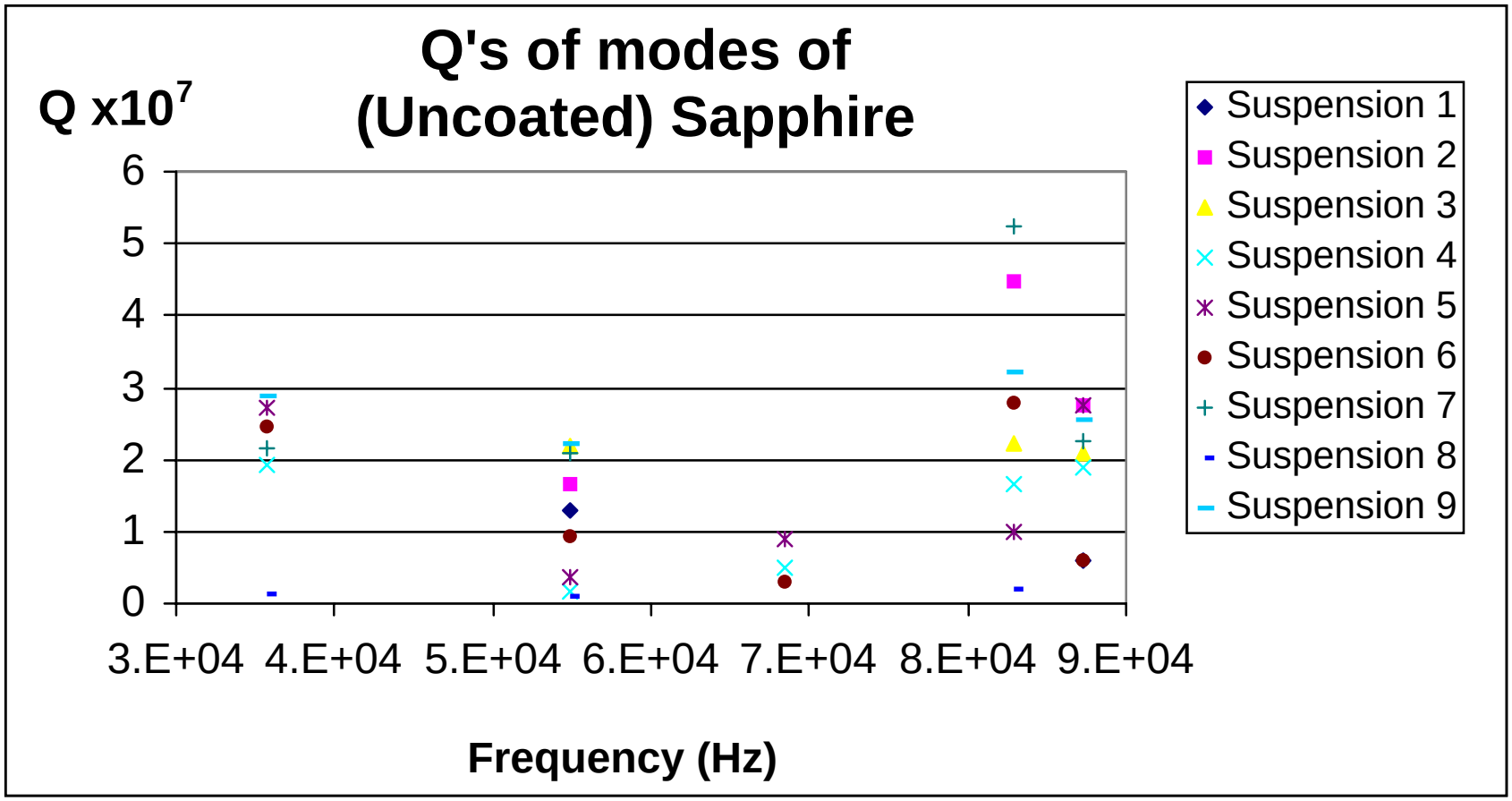
Cross is characteristic pattern seen when looking along C - axis (optic axis)



Fringes appear to point along direction of wedge, ~ 10 degrees to c - axis

- Suspend sample on single loop of wire
- Measure Q of variety of modes of mass

Results



- Highest Q for any mode ~ 5.2 x 10^7
- Barrel polish on sample visibly worse than on samples measured to have higher Q - may be affecting results

Mode identification

- Approximate sample as isotropic with mechanical properties of m-axis direction
- Use results from McMahon, J. Acoust. Soc. Am. to calculate expected mode frequencies and modeshapes

Measured:	Calculated:	Mode identification:
35 672 Hz	34 031 Hz	n = 2 higher order mode
54 849 Hz	54 449 Hz	n = 0 first drum mode
68 430 Hz	62 227 Hz	n = 3 higher order mode
82 979 Hz	82 451Hz	n = 0 fund. longitudinal mode
87 268 Hz	85 562 Hz	n = 3 higher order mode

- Reasonable agreement - would like more accurate model to incorporate an-isotropic properties of sapphire
- K. Numata of TAMA project adapting his FEM code to allow this

Conclusions

- Calculated and measured frequencies do not yet agree to desired accuracy
- Need to verify cut of crystal and values for elastic constants
- Crystal returned to LIGO for coating
- Q will be re - measured after coating

- Two further samples are being fabricated for coating studies
  - One c-axis piece
  - One 90 degree piece
  - Measurements on these should give more data to tie up with existing models