New Folder Name Requirements for Wedges

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Requirements for Wedges in the LIGO Interferometer

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Chapter 1 Motivation

1. Do we need beam pick-off at all ?

   Maybe not, depend on interferometer topology to be determined.
   Signals from a pick-off are believed to be easy to interpret, and may be used during acquisition.

2. Why use Wedges as pick-off ?
   ADVANTAGES:

   a. Wedged may be already there.
      (unless parallel components are used)
   b. No parasitic interferometers.
   c. Less optical components in the beam train:
      - less components to hang
      - less loss
      - less noise (due to movement and scattering)
      - less beam distortion (due to component imperfection and heating)
   d. A wedge can indicate the angular direction of a mirror, using the main beam as a pilot beam. It can be used for initial alignment before a lock is achieved

Chapter 2 Calculations regarding wedges

1. Reflectance of the coating of the wedged surface.

   The power circulating between the recycling mirror and the test masses is:
   $I_{circulating} = I_{laser} \times$ Recycling Gain $\tilde{}$ 3 [Watt] $\times$ 30 = 90 Watt
   For low noise detection of error signal, I estimated a pick-off intensity I_{pick} of 10 to 100 mW. The reflectance of the coating is :
   $R = I_{pick} / I_{circ} = 10^{-4}$ to 10^{-3}
   The best AR coating is ~100 ppm or 10^{-4} and typical is 500 ppm so this coating is:

   a. not too demanding

b. does not introduce excessive loss

2. What do we probe with a wedge pick-off ?.

   a. Wedge on the test mass.
   As in normal pick-off beam splitter, beam 1 gives information on the field injected into the F. P. cavity, while beam 2 probes the field reflected from the cavity. Beam 2 may be used to lock the cavity length through usual reflection locking servo and for Auto Alignment of the cavity. (see fig 1. in ref 1)

   b. Wedge on the beam splitter

      - wedge towards the recycling mirror.
      - wedge towards the F. P. cavity.

3. Separation needed between the main bean and the picked-off beam.

   a. the servo detector should not cause loss to the main beam
   b. the servo detector should intercept enough of the picked-off beam to be effective
   c. the servo detector should not induce noise by scattering of the main beam or picked-off.

4. Minimum distance from the tube wall.

5. At what angels the picked-off beams are going.

   a. Wedge on the test mass.

   b. Wedge on the beam splitter

      - wedge towards the recycling mirror.

      - wedge towards the F. P. cavity.

(some drawings will be here)

6. Minimum wedge angle

   a. manufacturing problem ?
   b. to ensure the required separation of the picked-off beam from the main before the next optical component (section 2.3)

7. Distortion to the main beam due a wedge. (Astigmatic aberration)

   a. Wedge on the test mass.
   b. Wedge on the beam splitter

   (some drawing will be here)

8.

9. Loss of coupling into the cavities due to distortion.

10. Loss of recycling gain due to distortion

11. Loss of dark fringe contrast due to distortion

12. Maximum angle for wedge

    a. allowed distortion
    b. manufacturing cost
    c. testing cost ?

Chapter 3 Servo detectors

1. What kind .
   (unknown, theory of coupled cavities is needed)
2. Where they will be placed.
   (unknown, interferometer topology to be determined)
3. In or out of the vacuum envelope.

Some examples of single cavity auto-alignment detectors will be given here

Chapter 4 Can we fit it in the vacuum envelope ?

How many interferometers are in the tube ? Where are the main beams ? Only one full length and one half length will be assumed.

1. test masses
   (basically no problems)

2. Beam splitter

3. Recycling mirror
   (shift of the main beam)

4. Mode cleaner
   (what is the mode matching telescope strategy ?
   are their stirring mirrors?)

5. Gravity wave detector arm

6. Half length interferometer

7. Detectors
   (ports ?)

8. Beam dump for higher order pick-off

Chapter 5 Conclusions and recommendations

Chapter 6