



LIGO Laboratory / LIGO Scientific Collaboration

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Parameters for current ETM/ITM main chain noise prototype design

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Rev 00: With comments from C. Torrie and M. Perreur-Lloyd

Rev 01: With comments on C-PTYPE and N-PTYPE by Justin. Also includes comments added by CIT

Parameters for ETM/ITM main chain design as currently proposed.**12th November 2004, NAR****LIGO-T040214**

(all values in SI units)

	nwn: 2
g: 9.8100	nw1: 4
mn: 21.9600	nw2: 4
Inx: 0.4740	nw3: 4
Iny: 0.0704	rn: 5.4000e-004
Inz: 0.4754	r1: 3.5000e-004
m1: 22.1600	r2: 3.1000e-004
I1x: 0.4921	r3: 2.0000e-004
I1y: 0.0624	Yn: 2.2000e+011
I1z: 0.4953	Y1: 2.2000e+011
ix: 0.1300	Y2: 2.2000e+011
ir: 0.1570	Y3: 7.0000e+010
den2: 3860	ufcn: 2.3300
m2: 38.4000	ufc1: 2.4800
I2x: 0.4733	ufc2: 1.8100
I2y: 0.2907	dm: 0.0010
I2z: 0.2907	dn: 0.0010
tx: 0.1300	d0: 0.0010
tr: 0.1570	d1: 0.0010
den3: 3980	d2: 0.0010
m3: 39.6100	d3: 0.0010
I3x: 0.4830	d4: 0.0010
I3y: 0.3020	twistlength: 0
I3z: 0.2920	d3tr: 0.0010
ln: 0.4450	d4tr: 0.0010
l1: 0.3085	sn: 0
l2: 0.3400	su: 0.0030
l3: 0.6000	si: 0.0030

sl: 0.0150	tl3: 0.6020
nn0: 0.2500	l_suspoint_to_centreofoptic: 1.6363
nn1: 0.0900	l_suspoint_to_bottomofoptic: 1.7933
n0: 0.2000	bd: 0
n1: 0.0600	longpitch1: [0.3797 0.4408 0.9898 1.2736]
n2: 0.1400	longpitch2: [1.6838 1.9753 2.9580 3.3722]
n3: 0.1635	yaw: [0.6590 1.4025 2.4352 3.0997]
n4: 0.1585	transroll1: [0.4464 0.7319 1.0058 2.0014]
n5: 0.1585	transroll2: [2.6523 3.3586 3.7558 12.6362]
tl_n: 0.4162	vertical: [0.6602 2.4795 4.1289 8.8326]
tl1: 0.2769	
tl2: 0.3412	

Notes

1) These numbers represent our current set of parameters for the design of the main chains of the ETM and ITM, as modeled in MATLAB. They include an SF2 penultimate mass, fused silica fibres (modeled in MATLAB as circular with same cross-section as the baseline ribbon dimensions) and a sapphire test mass. The mass and moments of inertia for the sapphire test mass are taken from document [T040013-05-D](#), page 14, and assume 9.5 cm flats on the side. The mass of the SF2 also assumes 9.5 cm flats (currently the moments of inertia are for a simple cylinder, should be updated). This is a snapshot in time, since the detailed design is constantly evolving.

Since these numbers model a sapphire test mass, silica fibres and heavy glass penultimate mass, they represent our current best estimate of the parameters for the noise prototype. The controls prototype differs from these in the parameters pertaining to the penultimate and test mass, made of metal (with optional glass faces for the test mass), and the final stage steel wires. The masses are designed to represent as closely as possible the masses and moment of inertias of the sapphire and heavy glass.

2) These numbers are generated by running the program `quad_ref` from the `QUAD_April_04` set of MATLAB files, which have been updated to include amendments made since that time as the design has matured. A reminder re mode frequencies: the second highest transroll mode is not well modeled with the MATLAB code at present (it is underestimated), as previously noted in [T040028-00-R](#). M Barton's

Mathematica model can be used to get a more accurate value when we come to compare experiment to theory.

3) The naming conventions used for the various parameters can be found in [LIGO-T040072](#).

4) The numbers for mass and moments of inertia for the top mass and upper intermediate mass are as provided by MPL in e-mails 29 Oct 04. The top mass numbers are 'As-Manufactured' SolidWorks numbers. The upper intermediate mass numbers are the current design, still being developed. More details on the design of the top mass and upper intermediate mass can be found in the documents [LIGO T040071](#) and [LIGO T040096](#) respectively.

The original numbers for the top mass and upper intermediate mass, corresponding to simple blocks, and used as a reference against which to compare the detailed numbers as the design matures, are m: 21.840, Ix: 0.4678, Iy: 0.0436, Iz: 0.4858

5) The blade parameters which come from the optimising routine opt.m, have been commented out, and replaced by the estimated uncoupled mode frequencies of each of the three stages with blades, based on the blade designs and masses which are currently being used. The details of the parameters for the three sets of blades which are being manufactured are given in a separate document: [LIGO T040153](#).

6) The blade flexure points are calculated for the actual wire diameters, as per those supplied by the manufacturer, are calculated and stated in [LIGO-D040183](#).

7) The lever arms and the number of coils (in brackets) corresponding to the angular degrees of freedom, as specified in the current design, are

pitch 110 mm (1) , roll 160 mm (2), yaw 120 mm (2)

8) Two further useful references:

a) ETM Controls Prototype: Mass Estimate of an ETM Suspension Layout [T030137-05](#),

b) ETM Controls Prototype Information Related to Design, [T040013-05](#).