Stronger UIM and PM actuators for the QUAD suspensions

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Requirements

- Rana and Peter's work on force requirements
  - LSC model, semi-realistic, good enough for a start!
  - models of noise in various states of commissioning
  - allow estimates of required force
  - UIM (per 4 actuators):
    - *rms* 240 mN (perhaps 120 with feedback to SEI)
    - peak: up to 5N (20x *rms*)
  - PM (per 4 actuators):
    - *rms* 2.5 mN
- Peter's work on magnetic coupling LIGO-T050271-00-D
- coupling stronger than expected, little cancellation by reversing 2/4 mangets
    - UIM each magnet <~0.11 Am^2, PM<3.6mAm^2

Response (T060001-00-K)

- Quick calculations show it is impractical to meet the goals with existing designs
- Look for minor design changes that should meet/approach goals
- Argue that we can reduce requirement for UIM by off-loading some LF actuation to SEI platform, and that 20x above *rms* is too large a margin to have as a *requirement* for a noisy commissioning stage
- Plan
  - Shield magnets
  - Extend UIM coils (keep ID, ODmax and wire the same)
  - Manage drive currents carefully

Shielding magnets

- PM
  - if we can use ~6 times stronger than allowed (2~3 times stronger than planned) we can meet the force goals with existing coils (initial LIGO macor bodies)
  - it seems highly likely that opposed magnets, about 3cm apart (aligned on the longitudinal actuation axis) will meet the coupling requirements
  - note that it is VERY hard to understand the existing coupling and so hard to extend the model to a new solution
- UIM
  - essentially as PM (2 times stronger than planned 4~5 times stronger than allowed if unshielded)

Extend coils (UIM)

- What is to gain?
  - Normally only power/volume matters
  - but the coil is short compared to the magnet, so extending it gives some increase in efficiency (~30% for 4 mm to 8 mm)
  - note that the OD of the coil (32mm nominal) is not very critical, and that reducing the number of turns and increasing the current is OK.
  - table shows two cases for 1W (short term dissipation) coils which come close to meeting the requirements

length (mm)	depth (mm)	imax (A)	fmax (N)
8	4	0.38	0.48
8	8	0.24	0.50

Manage drive currents

- *rms* requirements can be met with the stronger magnets and acceptable dissipation
- peak requirement (~10x current, ~100x power) cannot be sustained beyond a few seconds without overheating windings (therefore outgassing)
  - metal bodied coils should be better in this respect
  - coils/clamps etc. should absorb heat for ~10s at 1W
  - windings should never rupture below 400 mA
- require long term (slow blow?) and short term current limiting
  - perhaps something more sophisticated than a slow-blow fuse could be used in addition (digital?) to push the force-time envelope to the maximum