Chapter 10 – Fused Silica Glass, Mirrors, and Coatings

1. Overview: Material properties
       A. Fundamental noise issues: Brownian thermal noise, thermo-optic noise, thermo-elastic noise
       B. Non-fundamental noise issues: Charge build up, stress release, scatter
       C. Fabrication issues: Size, annealing, fiber drawing and strength, IBS coating, polishing
       D. Connections: Welding, silicate bonding, IBS coating, epoxies?
       E. Interaction with Light: Absorption, scatter, index of refraction
2. Fused silica glass (get input from Steve Penn and Garilynn)
       A. Types of silica; OH content, Cl level, manufacturing, inclusions
       B. Low OH vs regular silica; cost
            1. Optical; absorption, homogeneity
            2. Mechanical loss; Wietersich model, frequency dependence, annealing, thin films,
            3. Other; Young's modulus, thermal properties
       C. Silica fibers
            1. Drawing techniques; CO_2 laser, flame welding, annealing
            2. Properties; mechanical loss, surface loss, strength, thermoelastic, spring constant
3. Mirrors (get input from Garilynn)
       A. Mirror types; TM, RM, BS, FM, CP
       B. Size; diameter, mass, thickness, wedges
       C. Polishing; microroughness, uniformity, figure, ROC, metrology, bevel, flats
       D. Bonding; silicate bonds, epoxy?, strength, mechanical loss
       E. Thermal properties; absorption, TCS, thermal noise
       F. Thermal noise; Brownian and thermoelastic
       G. Optical issues; absorption, uniformity, scatter, beam size
       H. Other issues; conductivity and charge noise, attachments?, cleaning?, storage?, transport ?
4. Optical Coatings (get input from Garilynn and Bill Kells)
       A. Coating types; HR, ITM, BS, AR
       B. Materials; silica, tantala, titania-tantala
       C. Deposition process; IBS, planetary, cleanliness, annealing, process parameters
       D. Optical design; multilayer interference, transmission, AR, BS, dichroic, optimization
       E. Thermal noise
            1. Brownian; mechanical loss, Young's modulus, layer thickness, Gretarsson-Nakagawa
            2. Thermo-optic; Evans model, index, thermal parameters
       F. Optical issues; absorption, scatter, uniformity, transmission matching
       G. Other noise; stress relief, charge buildup
5. Suspension Fibers (get input from Giles and Alastair)
       A. Bounce mode; GW bandwidth, isolation, strength
       B. Dissipation dilution; thickness profile, dumbbell shape
       C. Brownian and thermoelastic noise; mechanical loss, thermomechanical properties, non-linear
       D. Fabrication and connection (storage and transport?); welding; annealing, ears, stress relief