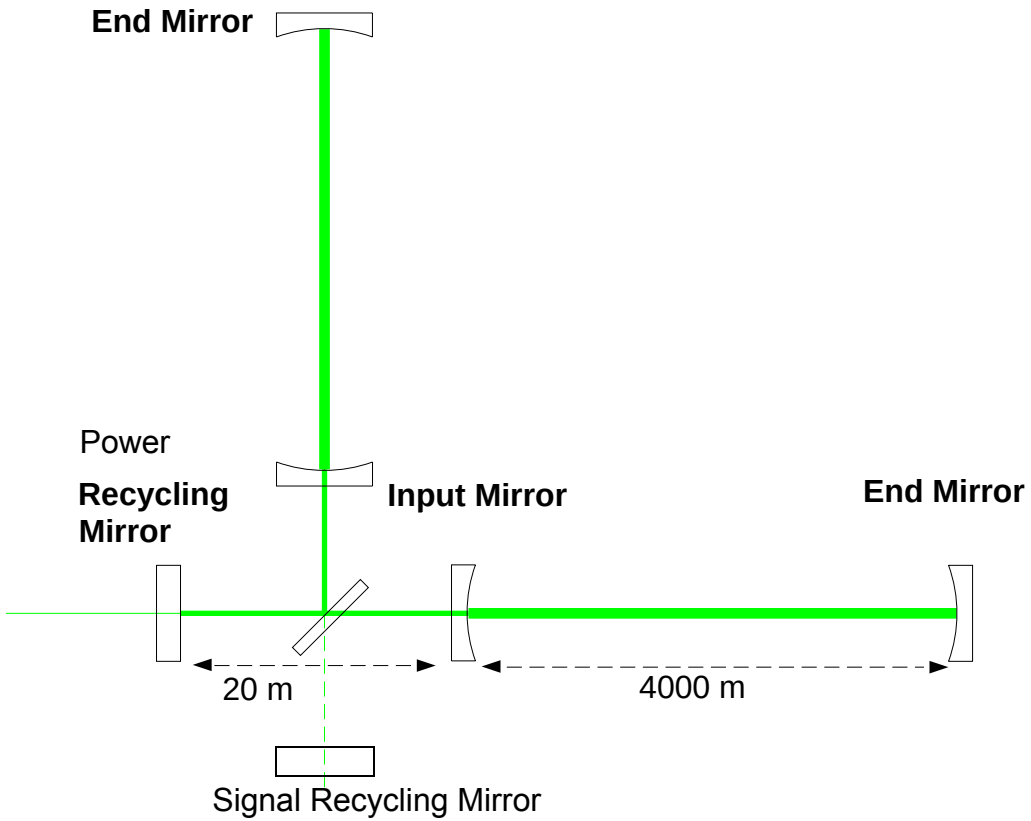
The Core Optics



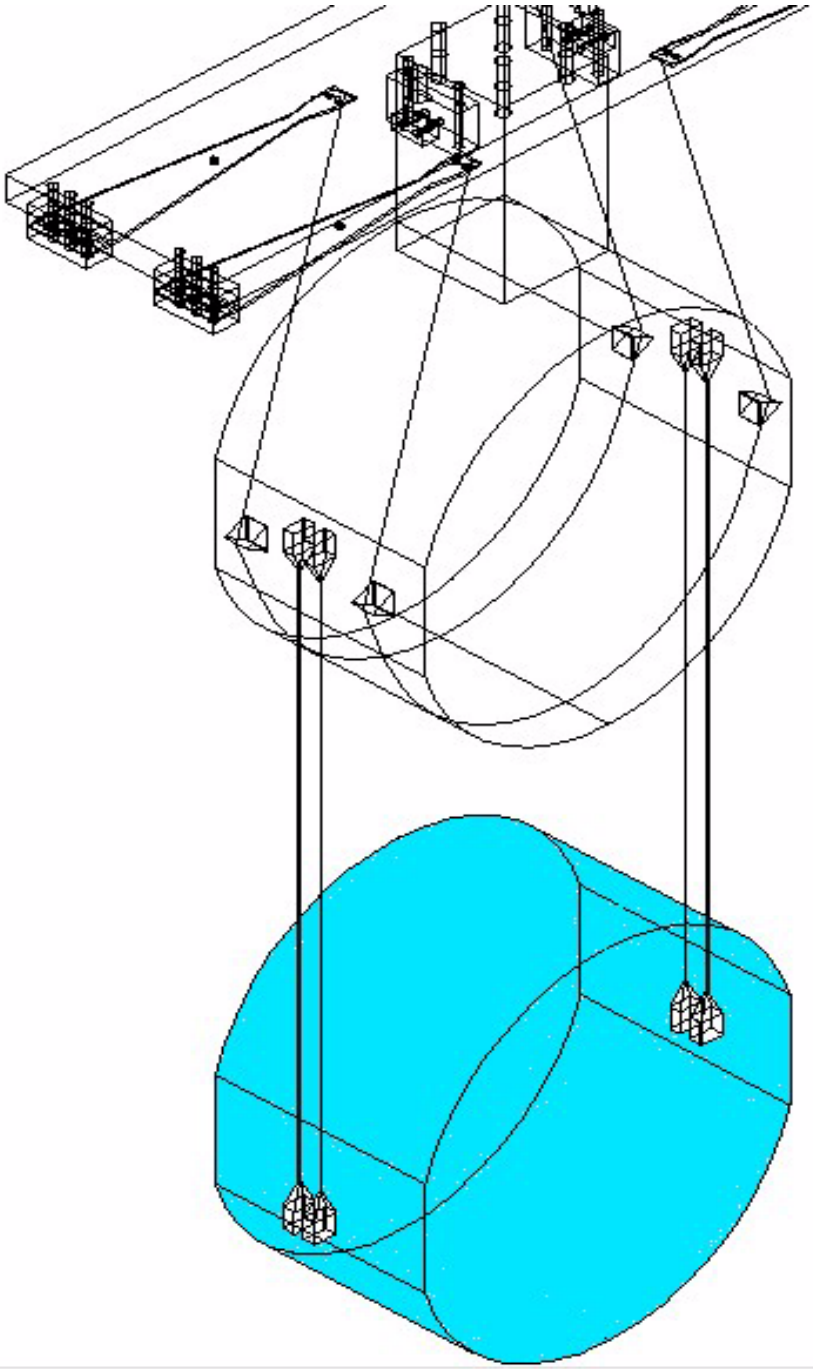
Fold mirrors for the (currently) Washington 2K are also considered core optics

Core Optics Overview

- 3 interferometers
- 23 Core optics
- First installation 2006 - Complete

- Aggressive R&D program - Sapphire, Coating
- Fabrication is subcontracted
- Production Flow
  - Blanks, glass procurement
  - Substrates, polishing
  - Mirrors, coating
  - Final Metrology

COC Boundary



- Interface with SUS, ISC, AOS

Design Parameters
Rely heavily on modeling

	PRM	SRM	BS	FM	ITM	ETM
Baseline Optic size (mm)	254 x 100	254 x 100	350 x 60	350 x 118	314 x 135 (40Kg)	314 x 135 (40Kg)
Baseline Material (fall back material is all FS)	Low inclusion FS	Low inclusion FS	Low absorption FS	FS	Sapphire	Sapphire
Clear Aperture	224	224	330	330	300	300
Sagitta (nm) over central 215 mm dia (2*wo dia)	240	240	Flat	Flat	165 ± 10	165 ± 10
Surface error -TPA (nm rms) over central 215 mm diameter	< 1.6	< 1.6	< 1.6	< 1.6	< 0.8	< 0.8
Bulk Homogeneity (nm rms)			<10		<10	
Coating Absorption Requirement Goal (ppm)	< 1	< 1	< 1	< 1	< 0.50 < 0.05	< 0.50 < 0.05
Coating Thickness Uniformity (%)			0.1		0.1	0.1

R&D

- Test Mass Material Selection - Decision in ‘02
  - Which material yields the most sensitivity -
    - Sapphire (the heading for an entire talk by Jordan Camp)
    - Fused Silica
- Coating Development
  - Absorption - Ties in to material selection
  - Uniformity

Pathfinder - Three Phases

- A. Demonstrate polishing of Sapphire to required levels
  - ››Two half size pieces sent to LIGO polishers
- B. Survey several different polishers using a competitive process.
  - ››Half size pieces sent to several polishers
- C. Demonstrate polishing and coating on full size pieces.
  - ››Metrology before and after coating
  - ››Full size pieces go to LASTI after Pathfinder metrology is complete

Production flow

- Blank Fabrication
  - Possible vendors: Crystal systems, Heraeus, Corning...
  - QA includes absorption tests to sort Test Mass optics for use
    - ITM only if using Fused Silica Test Masses
    - ITM and ETM if using Sapphire Test Masses

Polishing

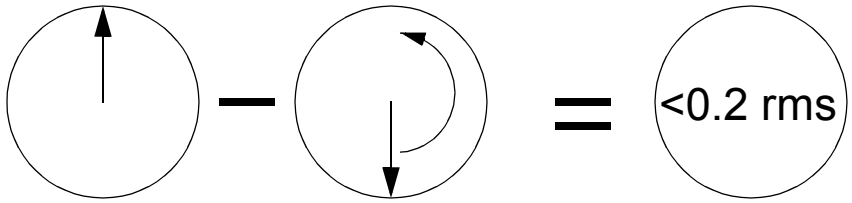
- Machine optics at a high volume facility
- Ship for final polish
  - Possible vendors:
    - CSIRO
    - General Optics
    - Raytheon (formerly HDOS)
    - .....?
- Surface and bulk metrology before coating

Coating

- R&D
  - Uniformity
  - Absorption
- We need to coat with the same vendor who performs the R&D
  - CSIRO
  - General Optics
  - Japan (for TAMA)
  - Max Plank (LZH)
  - MLD
  - REO
  - Virgo
  - Zeiss
- Surface metrology after coating

Metrology

- CIT - Demonstrated repeatability upon rotation of <0.2 nm rms over 80 mm aperture (Initial LIGO beam waist ~ 60 cm diameter)



Challenge:

- Beam waist of new design is ~ 120 mm in diameter, Test Mass is 314mm. How to handle the outer 95 mm annulus?

- Goal of Metrology is to certify optics and to support modeling

Other COC Tasks

- Design and Test of Cleaning Process and Equipment
- Design Handling Fixtures (40 kg!)
- Carriers
- Metrology Fixtures

Number of COC required

Optic Type	First Interferometer		Second Interferometer		Third Interferometer		Total 44
	Required	Spares	Required	Spares	Required	Spares	
Power Recycling Mirror	1	2	1	1	1	1	7
Signal Recycling Mirror	1	2	1	1	1	1	7
Beamsplitter	1	2	1	0	1	0	5
Folding Mirror					2	1	3
Input Test Masses for the first 2 IFOs	2	4	2	0			8
Input Test Masses for the third IFO					2	2	4
ETM	2	4	2	0	2	0	10

One piece fabrication time: ~ 1 year

Fortunately the optics are fabricated in parallel.

COC
Schedule Highlights

- Sapphire-Fused Silica decision - 2Q02
- Deliver prototype test masses to LASTI - 2Q03
- Start Procurements for First IFO - 1Q04
  - ›› Fabrication cycle for first IFO (19 optics) ~ 21 mos.
- First IFO optics (all) ready for installation - 4Q05