AUXILIARY LASER ALIGNMENT SYSTEM: LAYOUT EXERCISE

MEZ

August 31, 1994

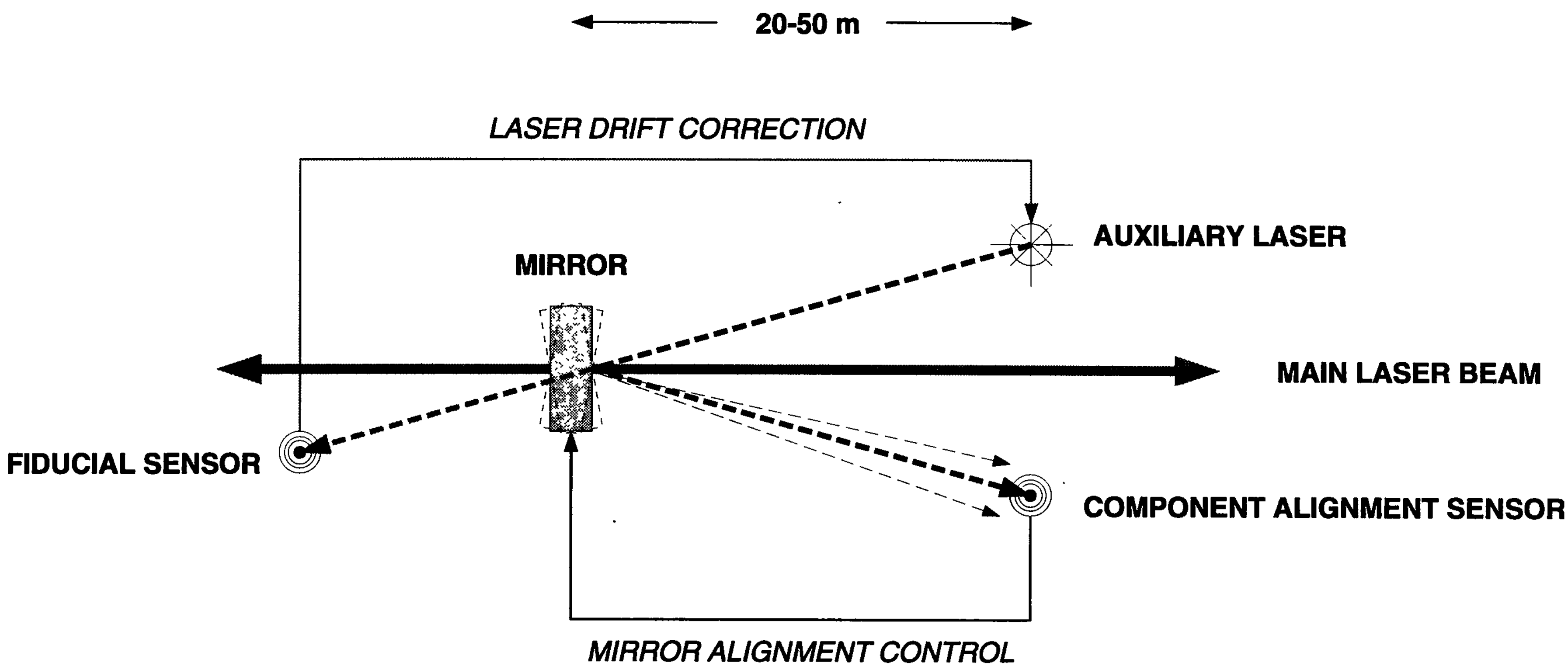
LIGO-G940006-00-D

AUXILIARY LASER ALIGNMENT SYSTEM: LAYOUT EXERCISE

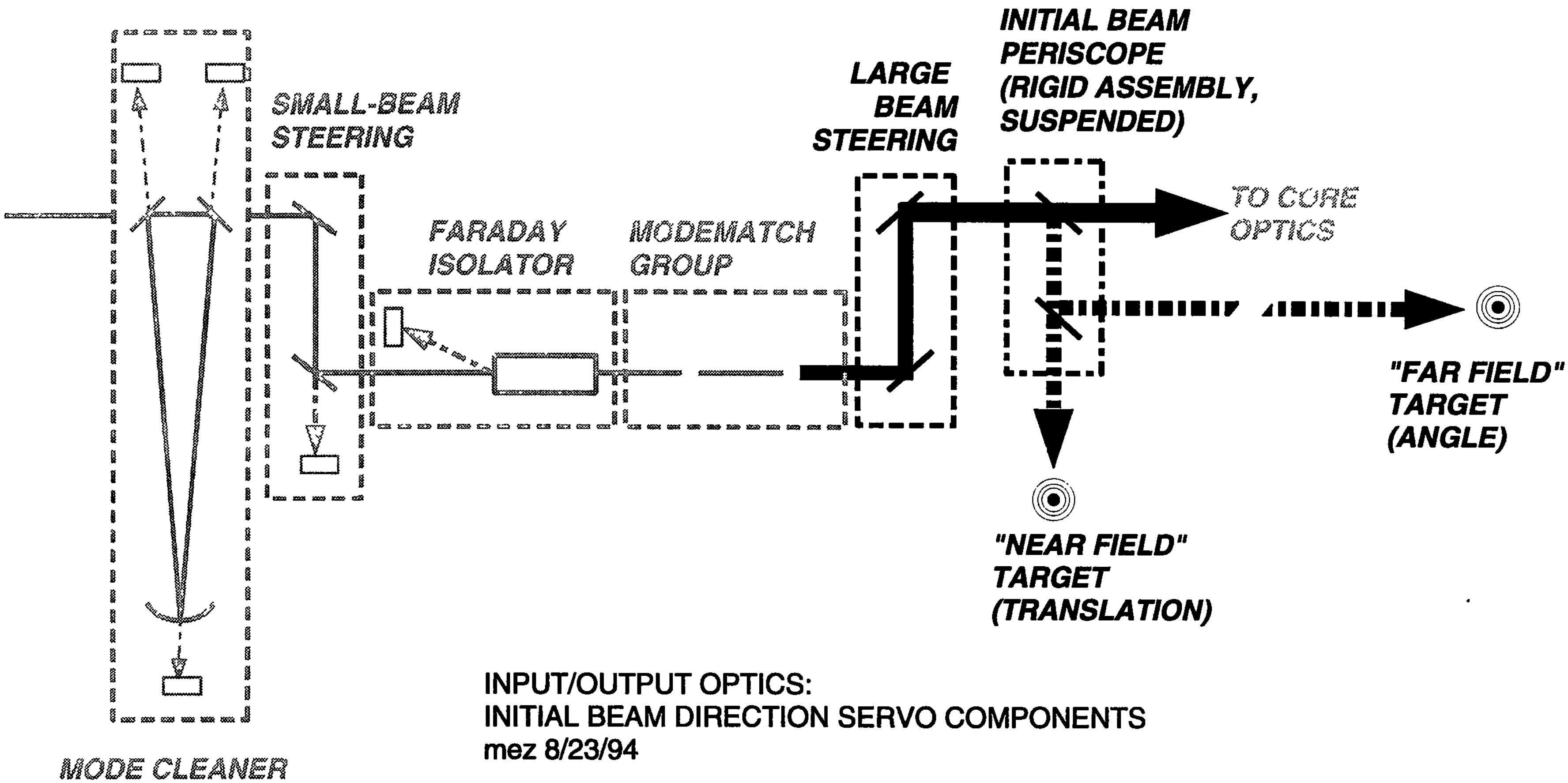
Strategy

- Divide suspended components into classes according to motion sensitivity
  - I/O optics (mostly)
  - Core optics
- Net beam motion after input chain sensed and stabilized using "Initial Beam Direction Servo"
  - Introduce new large-bore optic (sampling periscope)
  - Requires large suspended mirror pair to actuate corrections
- Core optics individually sensed and controlled with "standard" optical levers mounted to external monuments
  - Need "fiducial" (transmitted beam) control to eliminate laser direction drift (adds complexity; three monuments, two sensors per component)
  - Keep baselines $\gtrsim$ 10 m to suppress monument translation

AUXILIARY LASER ALIGNMENT SYSTEM: LAYOUT EXERCISE



AUXILIARY LASER ALIGNMENT SYSTEM: LAYOUT EXERCISE



INPUT/OUTPUT OPTICS:
INITIAL BEAM DIRECTION SERVO COMPONENTS
mez 8/23/94

AUXILIARY LASER ALIGNMENT SYSTEM: LAYOUT EXERCISE

Sample Layouts

Due to extreme aspect ratio, layouts are unreadable in this format. E-size drawings will be shown at review. For preview, load ~mike/vacequip/auxbeams/horwedge/zfig2laux and ~mike/vacequip/auxbeams/verwedge/zfig2m.a into the IDEAS drafting application.

RESULTS OF TRIAL LAYOUTS

MEZ

August 31, 1994

RESULTS OF TRIAL LAYOUTS
Port Locations

Port Functions

- Pump, vent/purge and gauge ports
- Electrical/fiberoptic feedthrough
    - Large reserve capacity
    - In fixed body (no disconnects req'd for access)
- Interferometer support structure feedthrough
    - Bellows isolate IFO supports from vacuum chamber walls
    - In fixed body (HAM), base (BSC), trunk between airlock and dome flange (TMC)
- Inspection & TV beam imaging
    - High and/or low view angle
    - Can image cavity mirrors at < 60 degrees off normal
    - HAM: on removable covers
    - BSC, TMC: on chamber body

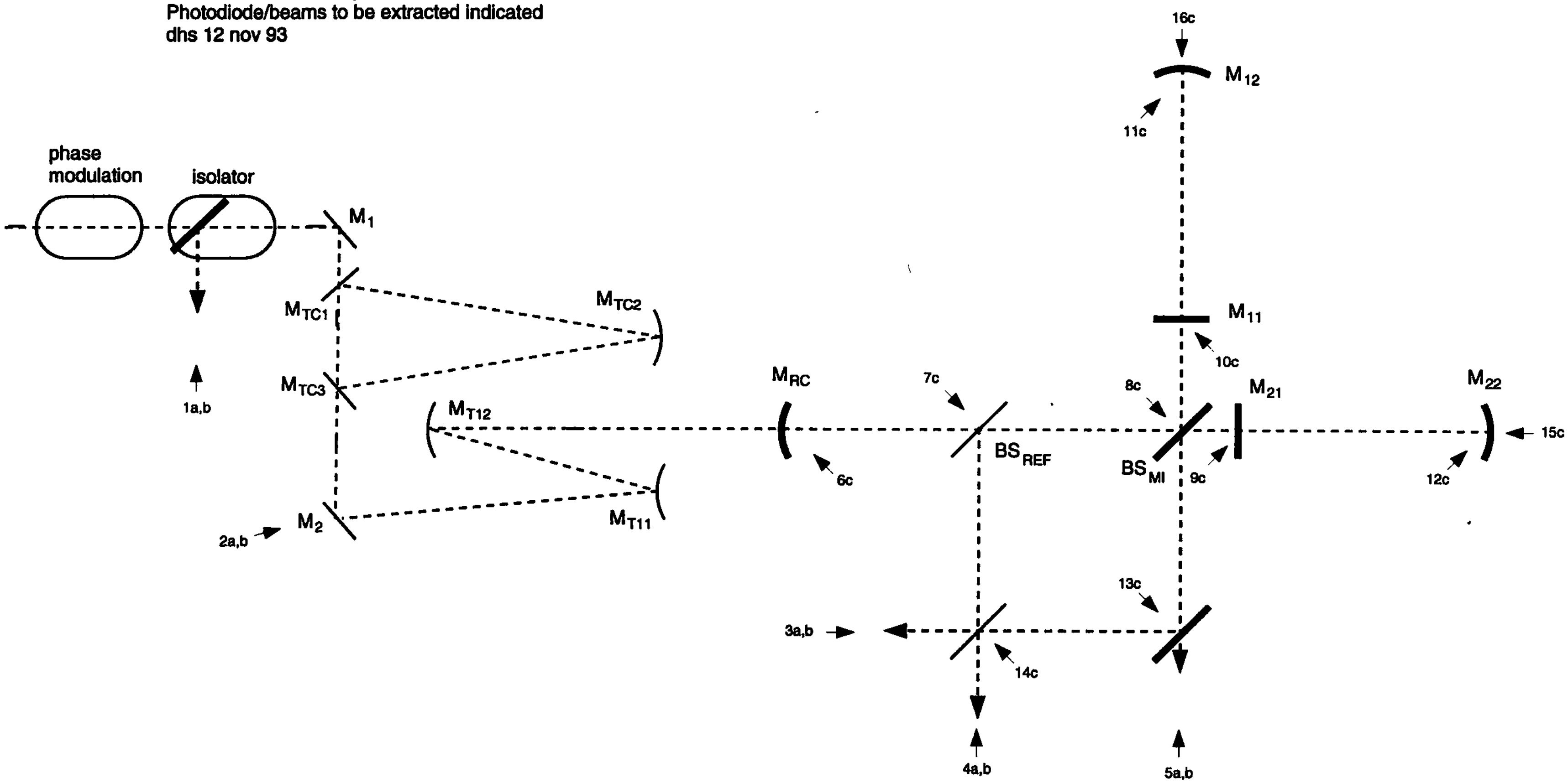
RESULTS OF TRIAL LAYOUTS

- Interferometer laser beam I/O
  - Require full size beam I/O at +/- 12 degree incidence (to clear specular reflection at 1m)
  - 10" nom. O.D. ConFlat type on minimum neck is adequate
  - Implemented on removable covers for reconfigurability
- Auxiliary alignment laser beam I/O
  - Implemented on removable covers
  - Generally in pairs, symmetric about beam axis/component normal
  - Port arrangement in manifold endcaps specific to TM placement in tube aperture

RESULTS OF TRIAL LAYOUTS

Interferometer laser beam I/O

Initial interferometer optical schematic
Photodiode/beams to be extracted indicated
dhs 12 nov 93



NOTES:
1. HEADS ARE ASME F&D.
3. INCLUDE CENTERING PINS ON NOZZLE FLANGES WHERE APPROPRIATE.
3. VIEWPORT (ITEM Ⓕ) MEASUREMENTS REFER TO INTERSECTION OF VIEWPORT AXIS WITH OUTER SURFACE OF VACUUM WALL.

4. TOLERANCES, UNLESS OTHERWISE SPECIFIED: LINEAR, ±0.25 CM
ANGULAR, ± 1 DEGREE

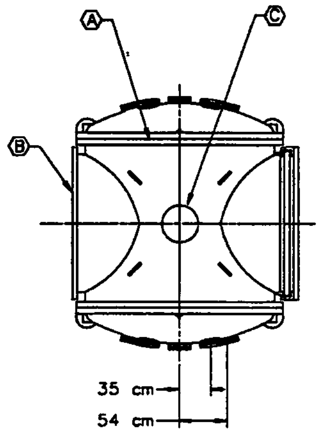
5. NOZZLE SCHEDULE PER TABLE BELOW:

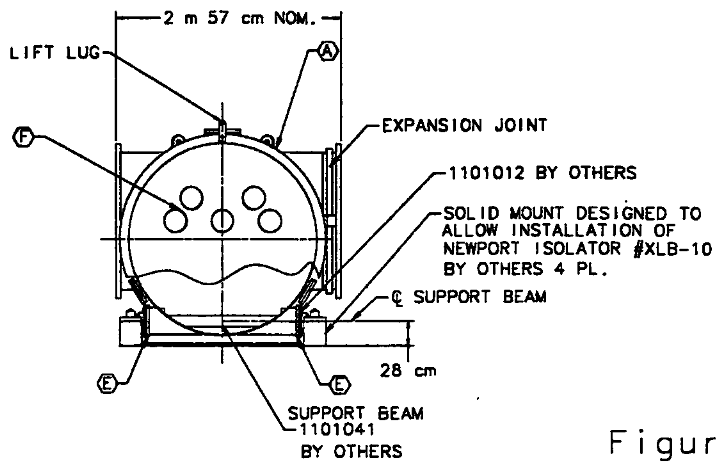
ITEM	SIZE	QUANTITY	FLANGE TYPE	PURPOSE
Ⓐ	213cm ID TUBE	2	O/O-O/METAL*	MAJOR ACCESS
Ⓑ	152cm ID TUBE	2	O/O-O/METAL*	LASER BEAM
Ⓒ	35cm TUBE	1	CONFLAT**, WITH BLIND FLANGE	ION PUMP/AIR SHOWERS, BACK-TO-AIR PURGE
Ⓓ	25cm OD TUBE	8	CONFLAT**, WITH BLIND FLANGE	ELECTRICAL FEEDTHROUGHS, UTILITY
Ⓔ	30cm OD TUBE	4	CONFLAT**	SUPPORT BEAMS
Ⓕ	20cm OD TUBE***	10	CONFLAT**, WITH BLIND FLANGE	OBSERVATION, PICKOFFS
Ⓖ	3.8cm TUBE	1	CONFLAT**, WITH BLIND FLANGE	ANNULUS PUMPOUT (NOT SHOWN)

* DUAL O-RING DESIGN, WITH CAPABILITY OF REPLACING INBOARD O-RING WITH METAL SEAL. THESE FLANGES EACH INCLUDE AN ANNULAR CHANNEL BETWEEN O-RINGS, MANIFOLDED TO A SINGLE PUMPOUT PORT ON EACH CHAMBER, WITH CONFLAT** SEAL.

** REGISTERED TRADEMARK, VARIAN VACUUM PRODUCTS; COMPATIBLE ALTERNATIVES ARE ACCEPTIBLE

*** THESE FLANGES ARE TANGENT TO LOCAL VACUUM WALL, WITH MINIMUM NECK LENGTH





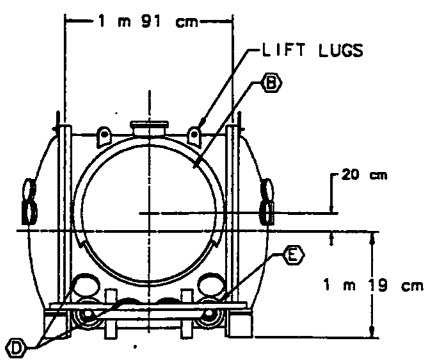


Figure 11.

LIGO PROJECT
DRWN J. JOOELE
HORIZONTAL AXIS MODULE (HAM)
1101010

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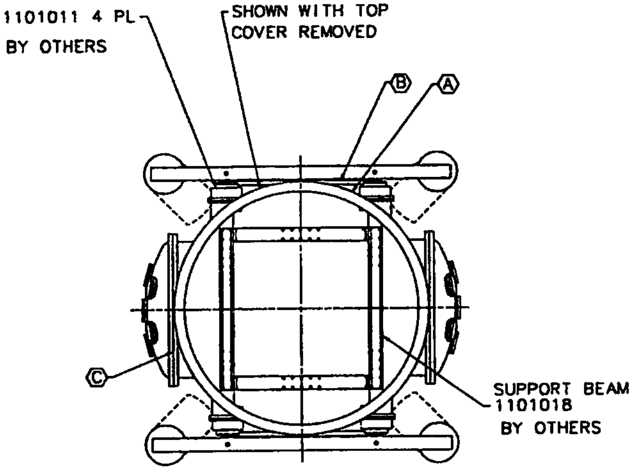

5. NOZZLE SCHEDULE PER TABLE BELOW:

ITEM	SIZE	QUANTITY	FLANGE TYPE	PURPOSE
Ⓐ	264cm ID TUBE	1	O/O-O/METAL*	MAJOR ACCESS
Ⓑ	152cm ID TUBE	2	O/O-O/METAL*	LASER BEAM, ACCESS (MINIMIZE NECK LENGTH)
Ⓒ	152cm ID TUBE	2	O/O-O/METAL*, WITH BLIND FLANGE	ACCESS (MINIMIZE NECK LENGTH)
Ⓓ	35cm OD TUBE	4	CONFLAT**	SUPPORT BEAMS
Ⓔ	35cm OD TUBE***	8	CONFLAT**, WITH BLIND FLANGE	AIR SHWR, BACK-TO-AIR PURGE ROUGHING & ION PUMPS, UTILITY
Ⓕ	25cm OD TUBE***	6	CONFLAT**, WITH BLIND FLANGE	ELECTRICAL FEEDTHROUGHS
Ⓖ	20cm OD TUBE***	22	CONFLAT**, WITH BLIND FLANGE	OBSERVATION, BEAM PICK-OFFS
Ⓗ	3.8cm OD TUBE	1	CONFLAT**, WITH BLIND FLANGE	ANNULUS PUMPOUT (NOT SHOWN)

*DUAL O-RING DESIGN, WITH CAPABILITY OF REPLACING INBOARD O-RING WITH METAL SEAL. THESE FLANGES EACH INCLUDE AN ANNULAR CHANNEL BETWEEN O-RINGS, MANIFOLDED TO A SINGLE PUMPOUT PORT ON EACH CHAMBER, WITH CONFLAT** SEAL.
**REGISTERED TRADEMARK, VARIAN VACUUM PRODUCTS; COMPATIBLE ALTERNATES ARE ACCEPTABLE.
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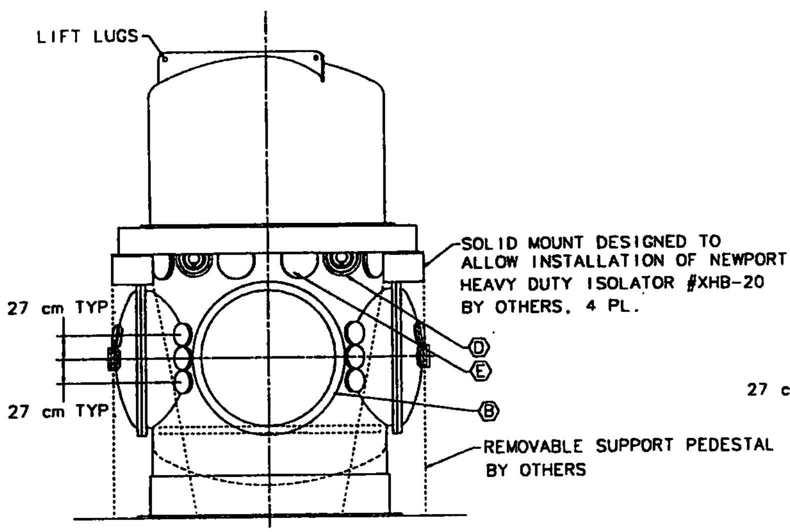


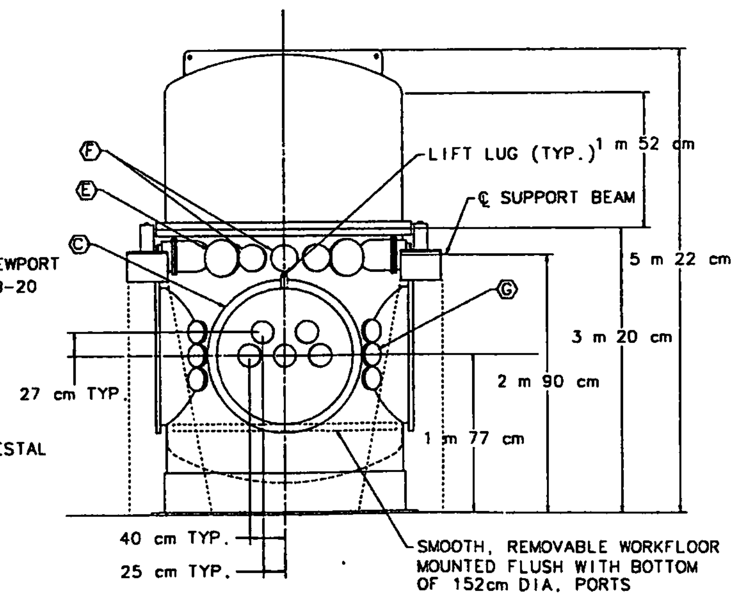
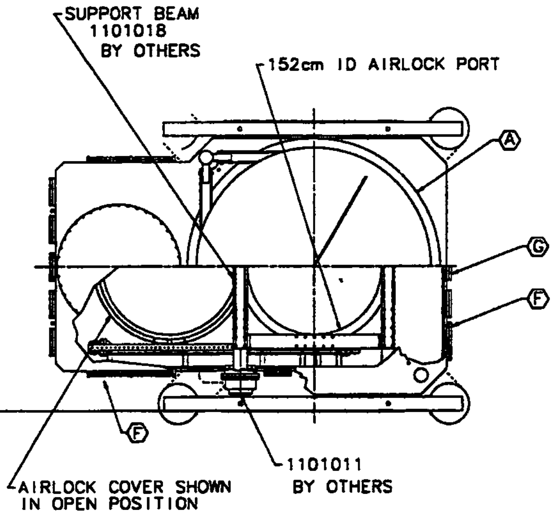


Figure 8.

LIGO PROJECT
BEAM SPLITTER CHAMBER (BSC)
J. JOOELE
1101009



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ANGULAR, ± 1 DEGREE

5. NOZZLE SCHEDULE PER TABLE BELOW:

ITEM	SIZE	QUANTITY	FLANGE TYPE	PURPOSE
Ⓐ	264cm ID TUBE	1	O/O-O/METAL*	MAJOR ACCESS
Ⓑ	183cm ID TUBE	2	METAL SEAL	LASER BEAM
Ⓒ	122cm ID TUBE	1	O/O-O/METAL*	LASER BEAM
Ⓓ	122cm ID TUBE	1	O/O-O/METAL*, WITH BLIND FLANGE	EMERGENCY ACCESS (MINIMIZE NECK LENGTH)
Ⓔ	35cm OD TUBE	4	CONFLAT**	SUPPORT BEAMS
Ⓕ	35cm OD TUBE	6	CONFLAT**, WITH BLIND FLANGE	ELECTRICAL FEEDTHROUGHS ROUGHING & ION PUMPS, UTILITY
Ⓖ	25cm OD TUBE	12	CONFLAT**, WITH BLIND FLANGE	ELECTRICAL FEEDTHROUGHS, BACK-TO-AIR PURGE
Ⓗ	20cm OD TUBE***	12	CONFLAT**, WITH BLIND FLANGE	OBSERVATION, BEAM PICKOFFS
Ⓘ	3.8cm OD TUBE	1	CONFLAT**, WITH BLIND FLANGE	ANNULUS PUMPOUT (NOT SHOWN)

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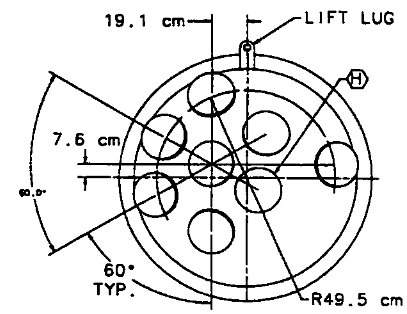
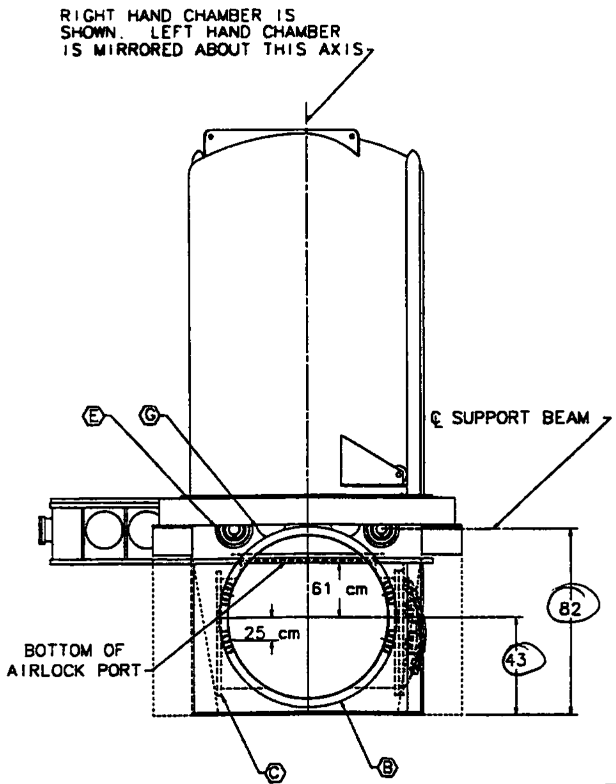


122cm BLIND FLANGE DETAILS
SEE NOTE 3.



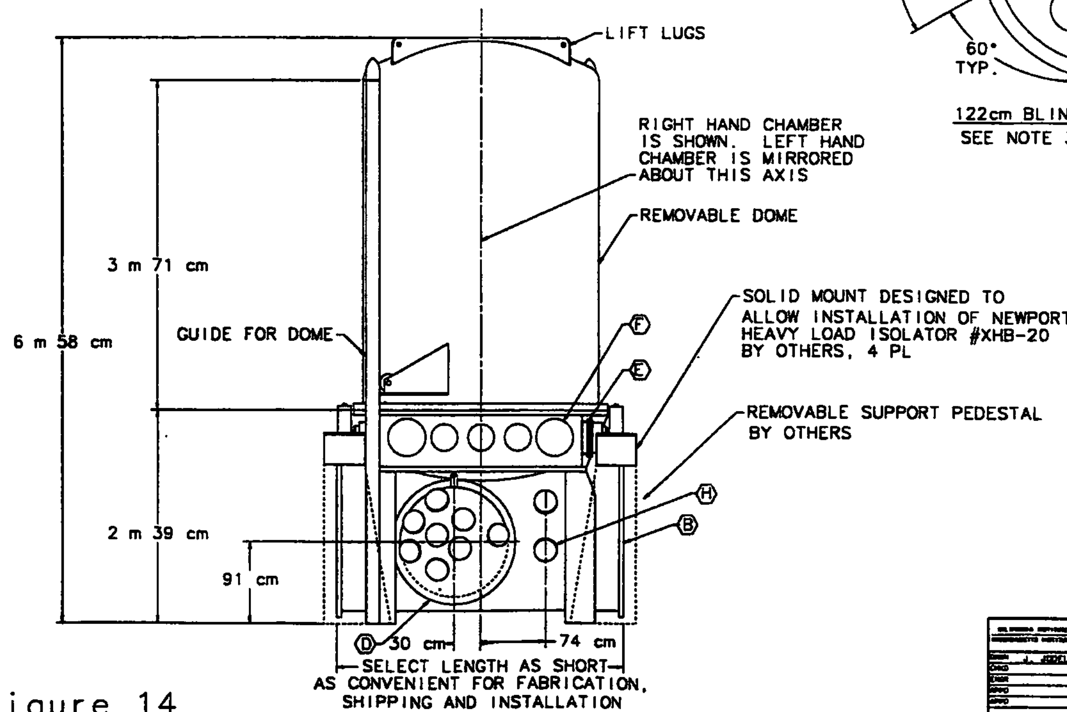
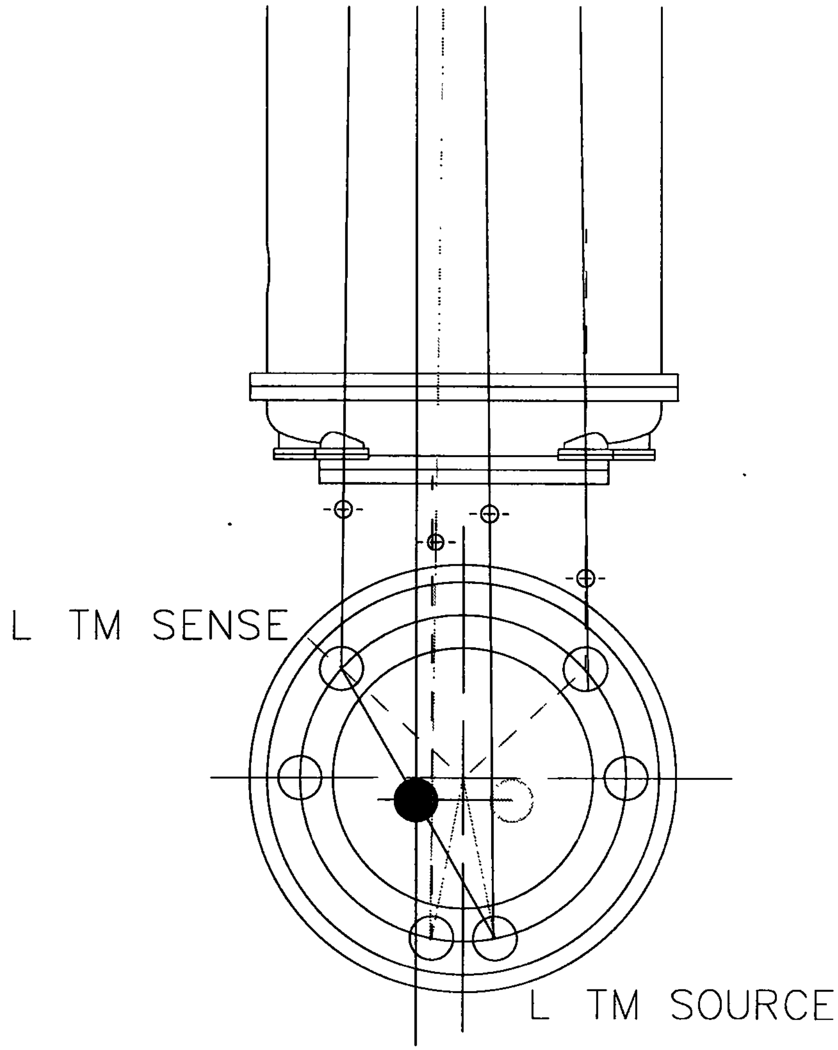


Figure 14.

LIGO PROJECT
J. JOEKLE
TEST MASS
CHAMBER (TMC)
1101013

RESULTS OF TRIAL LAYOUTS

Manifold Ports



RESULTS OF TRIAL LAYOUTS

Initial Interferometer Compatibility

- "Generic Interferometer" trial layouts successful and relatively straightforward
- Stray beam handling, auxiliary alignment systems took up much of space vacated by "excess" components found in '89 IFO design
- Unique wedge angles seem necessary for particular locations (some loss of optic interchangeability)
- Fine tuning of auxiliary laser paths much less stringent with "vertical" component wedges
- Compact alignment system, better AR coatings than assumed in baseline will increase margins still further

RESULTS OF TRIAL LAYOUTS

Advanced Interferometer/Phase C Compatibility

SATISFACTORY:

- **200 kg quartz TM's**
- **advanced (e.g. Perth design) stacks in BSC and TMC**
- **double suspensions (all chamber types)**
- **dual recycling**
- **output mode cleaners**
- **suspension-point interferometers**

RESULTS OF TRIAL LAYOUTS

PROBLEMS:

- beam crossings for Phase C
  - proposal design (fancy crossing adapters) marginal, probable conflict with stray beam req's.
  - allowing periscopes to shift alternate HAM chains to higher tier solves problem
  - CRANE HOOK HEIGHT OVER HAM's SHOULD BE ADEQUATE TO CLEAR TWO-TIER ARRANGE-MENT
- stray beam dumping for Phase C
  - better understanding of internal scattering needed to evaluate solutions
  - use of different wavelengths should mitigate interference between IFO's
- auxiliary laser alignment for Phase C
  - need compact alignment system
  - wavefront sensing a promising solution
- advanced (low frequency) isolation stacks in HAM chambers
  - intrinsic height restriction probably rules out sub-10 Hz isolation for mode cleaner, recycling mirror; resulting frequency noise too large to reject
  - may be able to replace with tall chambers
  - may add external satellite chambers at support feedthroughs for new isolators (original design feature)
- 100 meter mode cleaners
  - require facility reconfiguration & building modification
  - BUILDING LAYOUT SHOULD PERMIT EXTENSIONS OF MC VACUUM SYSTEM ALONG ARM

RESULTS OF TRIAL LAYOUTS

Summary: Adopted Changes from '89 Proposal Design

- Pump strategy revised
- BSC 60" side ports symmetrized
- BSC switched to "high stack" design like TMC–2 (no trench in facility floor req'd.)
- (TMC–2 identical to BSC now; designation dropped)
- Height adaptation (offset adaptor) now between BSC and first HAM
- HAM chamber body lowered w.r.t. beam height to add more room for stacks
- Port locations finalized