LIGO
VACUUM EQUIPMENT

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NSF Review May 1995

LIGO-G950025-00-V

VACUUM EQUIPMENT (SCOPE)

- Corner, Mid, and End stations include:
  - Vacuum envelope (all stainless steel)- 34 large chambers, ~1000 feet of 72 inch, 48 inch, 30 inch vacuum pipe, ~100 large diameter bellows and >200 large flange connections, ~1000 smaller flanged connections.
  - Pumping subsystem - 10 Roots pumping carts, 20 turbomolecular pump carts, 100 ion pumps, 12 large cryogenic pumps.
  - Valve subsystem - 4x60 inch, 32x48 inch, ~100 x 10 inch gate valves, plus hundreds of small valves.
  - Monitor and control subsystem - ~100 sets of gauges, ~200 valve controllers, 12 cryogenic pump controllers, 100 ion pump controllers.
  - Vent and purge subsystem - High purity air distribution system with 10 dry air compressors, 20 soft wall clean rooms (class 100).
  - Bakeout subsystem - 10,000 square feet of heating and insulating blanket with ~100 temperature controllers.

VACUUM EQUIPMENT ACQUISITION STRATEGY

- August 94 - Science Review of the Vacuum Equipment Specification.
- November 94 - Procurement plan finalized. Decision was made to have a phased procurement:
  - PHASE A - Three month design competition between two qualified contractors to the PDR level.
  - PHASE B - Final design, fabricate, procure, install and test at the two LIGO sites.
- December 94 - RFP released to industry.
- February 95 - 4 Suitable Proposals received.
- March 95 - Two most qualified contractors selected:
  - Chicago Bridge and Iron - CBI
  - Process Systems International - PSI

VACUUM EQUIPMENT ACQUISITION STRATEGY

- **WHY HAVE A PHASED PROCUREMENT?**
  - ›› Ensure price competition as long as possible.
  - ›› Brings the design to a mature stage to allow more accurate pricing - lower contractor contingency.

- **WHY SELECT CBI and PSI?**
  - ›› Both are highly qualified:
    - — Prior experience in similar large vacuum related tasks.
    - — Personnel have significant vacuum experience.
    - — Facilities for fabrication of large SS vacuum chambers.
    - —E A - Three month design competition between two qualified contractors to the PDR level.

VACUUM EQUIPMENT STATUS/PLANS

- Currently - We are >50% through the Phase A design competition.
- June 95 - PDR material due which includes:
  - Preliminary design.
  - Management plan for Phase B.
  - Fixed price bid proposal for Phase B.
- July 95 - Down selection to one contractor to be based on:
  - Quality of the design material, suitability of the management plan.
  - Price.
- August 95 - One contractor on board for the Phase B portion.
- March 96 - Final design review - begin fabrication and procurement.

VACUUM EQUIPMENT RECOMMENDATIONS

- The September 1994 review committee made 3 recommendations:
  - Issue the RFP as soon as possible
    - Done.
  - Obtain budgetary quotes for the LN2 cryopumps.
    - Budgetary estimates submitted with the contractors' proposals confirm that the LIGO estimate for this component is high. There is a potential $1M savings here.
  - Explore the use of LN2 boiloff for the vent and purge system.
    - Upcoming hazard analysis will investigate the feasibility of this. In any case, the LN2 may be used to improve the dryness of the purge gas.

VACUUM EQUIPMENT SUMMARY

- **Cost estimates provided with contractors' proposals confirm LIGO estimates.**
- **Phase A initiated - on schedule.**
- **Two competent and qualified companies competing for Phase B (fabricate and install).**
- **Downselect for Phase B scheduled for July.**

Start:	04/01/95
Finish:	04/01/95
Time Now:	04/01/95
Project:	SPECIAL
Run:	05/18/95
Page:	1 of 1

Planned
Critical
Actual Dates
Milestone-Baseline
Milestone-Planned
Milestone-Completed
Baseline Dates

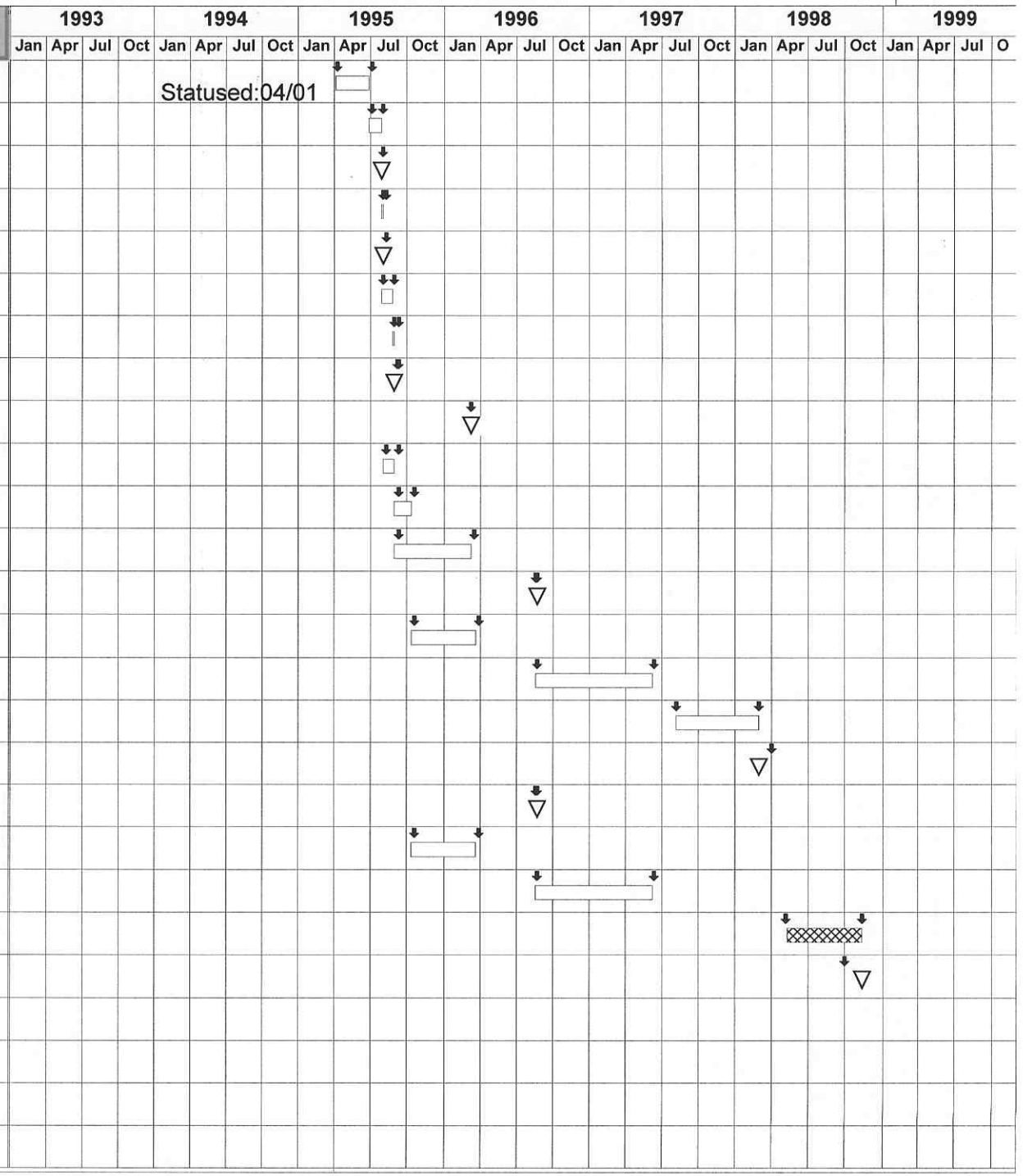
Caltech

VACUUM EQUIPMENT DESIGN / FAB / INSTALLATION

Open Plan Professional by Welcom Software

LIGO

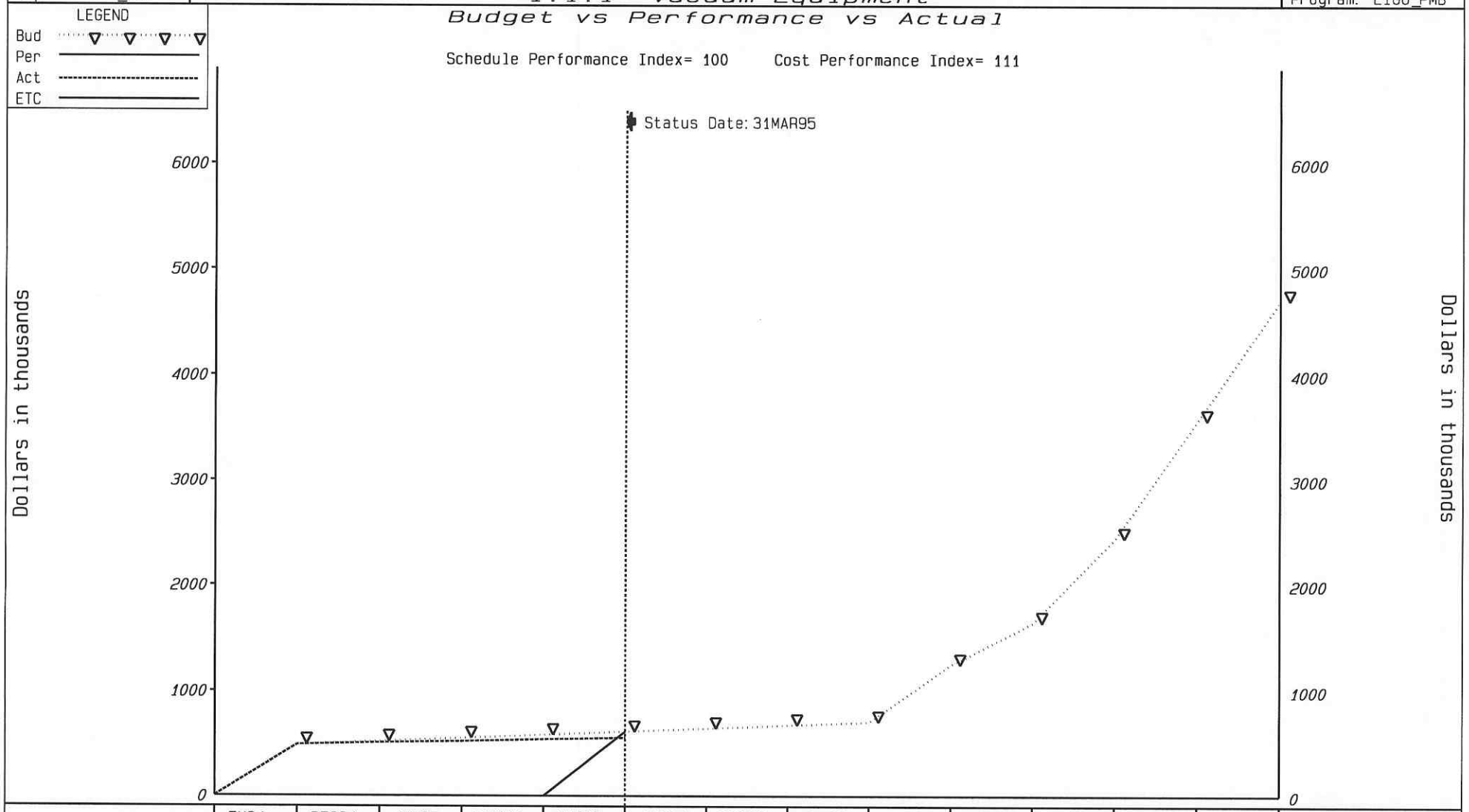
Activity Desc.	EStart	EFinish
VACUUM EQUIPMENT DESIGN COMPETITION	04/03/95	06/26/95
EVALUATE DESIGNS	06/27/95	07/26/95
SELECT VE CONTRACTOR	07/26/95	07/26/95
ISSUE LETTER CONTRACT	07/27/95	08/02/95
VE CONTRACT START	08/02/95	08/02/95
NSF REVIEW	07/27/95	08/23/95
VE DEFINITIZED FINAL CONTRACT	08/24/95	08/30/95
VE PDR	08/30/95	08/30/95
VE FDR	03/08/96	03/08/96
DESIGN UPDATE	08/03/95	08/30/95
BEAM TUBE TERMINATION DESIGN	08/31/95	10/12/95
VE FINAL DESIGN - CONTRACT	08/31/95	03/08/96
INITIATE VACUUM EQUIPMENT FAB - WA	08/21/96	08/21/96
SUPPLY BEAM TUBE TERMINATION - WA	10/13/95	03/22/96
FABRICATE VACUUM EQUIPMENT - WA	08/21/96	06/06/97
INSTALL AND CHECK VACUUM EQUIPMENT - WA	08/05/97	02/26/98
ACCEPT VACUUM EQUIPMENT - WA	02/26/98	02/26/98
INITIATE VACUUM EQUIPMENT FAB - LA	08/21/96	08/21/96
SUPPLY BEAM TUBE TERMINATION - LA	10/13/95	03/22/96
FABRICATE VACUUM EQUIPMENT - LA	08/21/96	06/06/97
INSTALL AND CHECK VACUUM EQUIPMENT - LA	05/11/98	11/11/98
ACCEPT VACUUM EQUIPMENT - LA	11/11/98	11/11/98



COBRA (R)
Report: SPA_XM

LIGO PROJECT
1.1.1 Vacuum Equipment
Budget vs Performance vs Actual

Date: 18MAY95
Program: LIGO_PMB



	FY94	DEC94	JAN95	FEB95	MAR95	APR95	MAY95	JUN95	JUL95	AUG95	SEP95	OCT95	NOV95	SCALE
Budget	487	518	549	580	611	642	673	704	1,246	1,642	2,441	3,568	4,695	K$
Performance	0	0	0	0	611									K$
Actual/Forecast	487	505	517	538	552									K$
Schedule Variance	- 487	- 518	- 549	- 580	0									K$
Cost Variance	- 487	- 505	- 517	- 538	59									K$

Schedule Variance = Perf-Budg Cost Variance = Perf-Actual Schedule Performance Index= Perf/Budg Cost Performance Index= Perf/Actual

*** Prepared by LIGO Project Controls Group ***

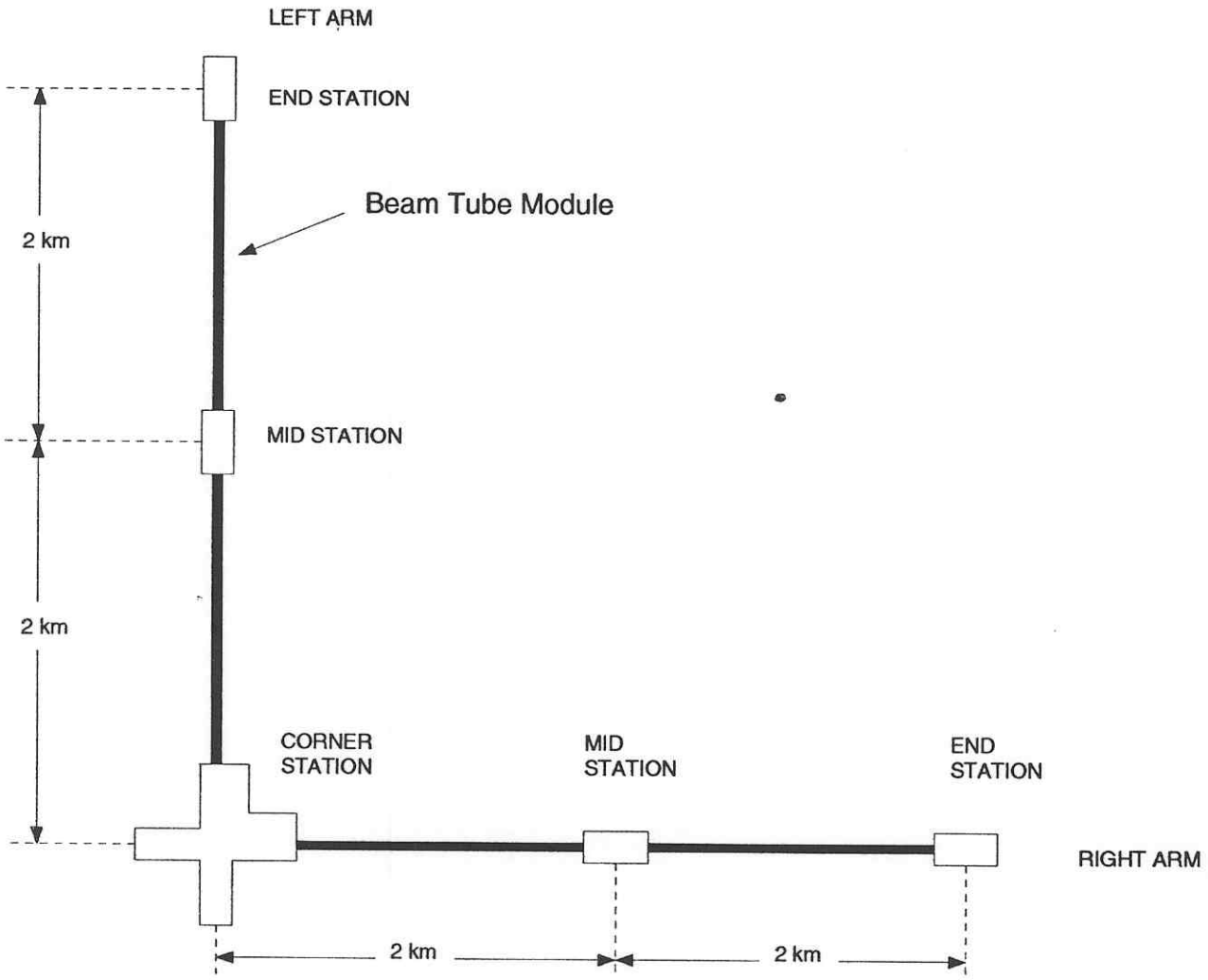


Figure 1. LIGO Geometry

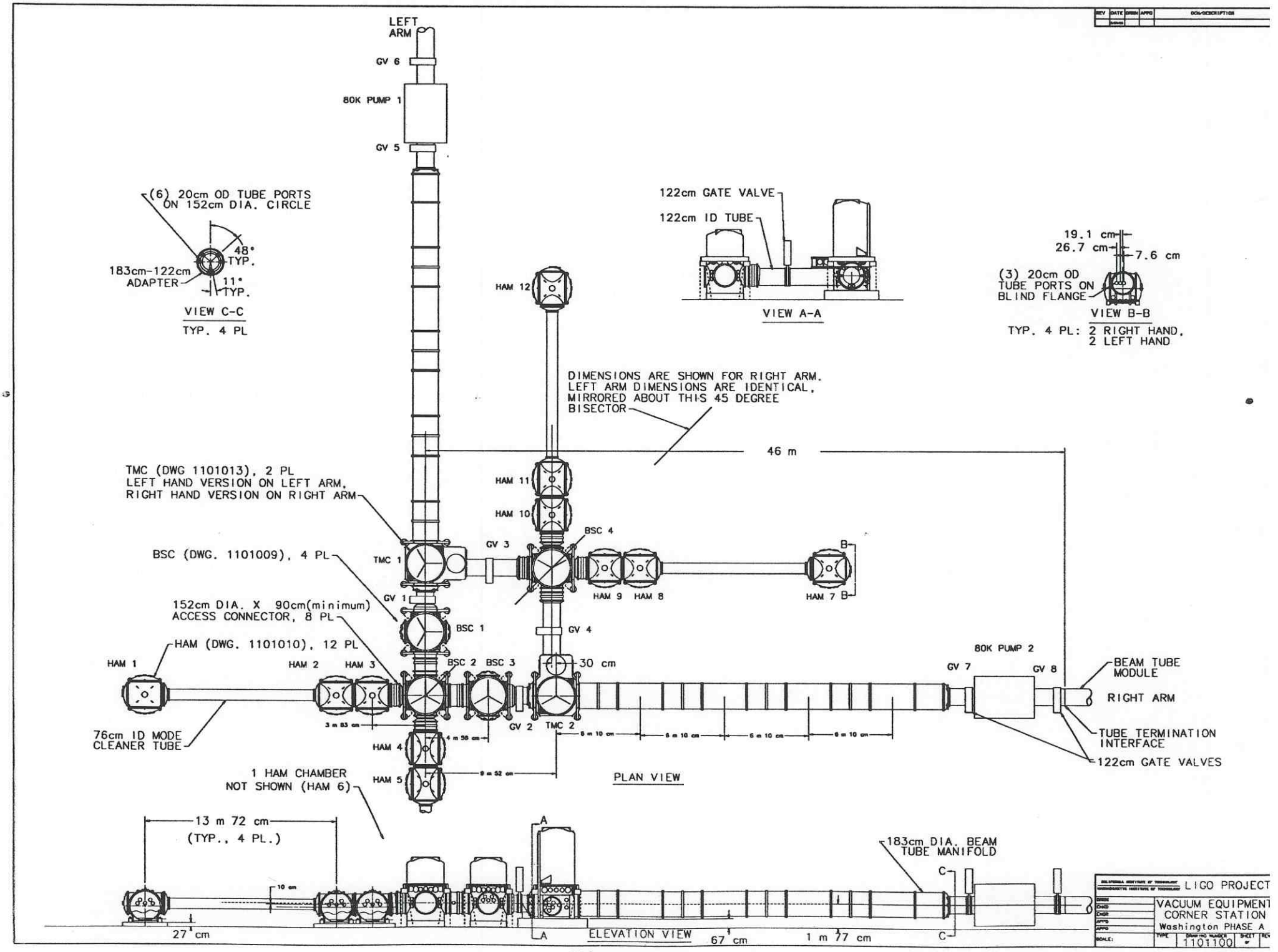

LEFT ARM
GV 6
80K PUMP 1
GV 5
(6) 20cm OD TUBE PORTS ON 152cm DIA. CIRCLE
48° TYP.
183cm-122cm ADAPTER
11° TYP.
VIEW C-C
TYP. 4 PL
122cm GATE VALVE
122cm ID TUBE
VIEW A-A
19.1 cm
26.7 cm
7.6 cm
(3) 20cm OD TUBE PORTS ON BLIND FLANGE
VIEW B-B
TYP. 4 PL: 2 RIGHT HAND, 2 LEFT HAND
DIMENSIONS ARE SHOWN FOR RIGHT ARM. LEFT ARM DIMENSIONS ARE IDENTICAL, MIRRORED ABOUT THIS 45 DEGREE BISECTOR
46 m
TMC (DWG 1101013), 2 PL LEFT HAND VERSION ON LEFT ARM, RIGHT HAND VERSION ON RIGHT ARM
BSC (DWG. 1101009), 4 PL
152cm DIA. X 90cm(minimum) ACCESS CONNECTOR, 8 PL
HAM (DWG. 1101010), 12 PL
76cm ID MODE CLEANER TUBE
1 HAM CHAMBER NOT SHOWN (HAM 6)
HAM 12
HAM 11
HAM 10
HAM 9
HAM 8
HAM 7
HAM 1
HAM 2
HAM 3
HAM 4
HAM 5
TMC 1
TMC 2
BSC 1
BSC 2
BSC 3
BSC 4
GV 1
GV 2
GV 3
GV 4
GV 7
GV 8
30 cm
80K PUMP 2
BEAM TUBE MODULE
RIGHT ARM
TUBE TERMINATION INTERFACE
122cm GATE VALVES
PLAN VIEW
13 m 72 cm
(TYP., 4 PL.)
183cm DIA. BEAM TUBE MANIFOLD
27 cm
67 cm
1 m 77 cm
ELEVATION VIEW
LIGO PROJECT
VACUUM EQUIPMENT
CORNER STATION
Washington PHASE A
1101100

Figure 4.

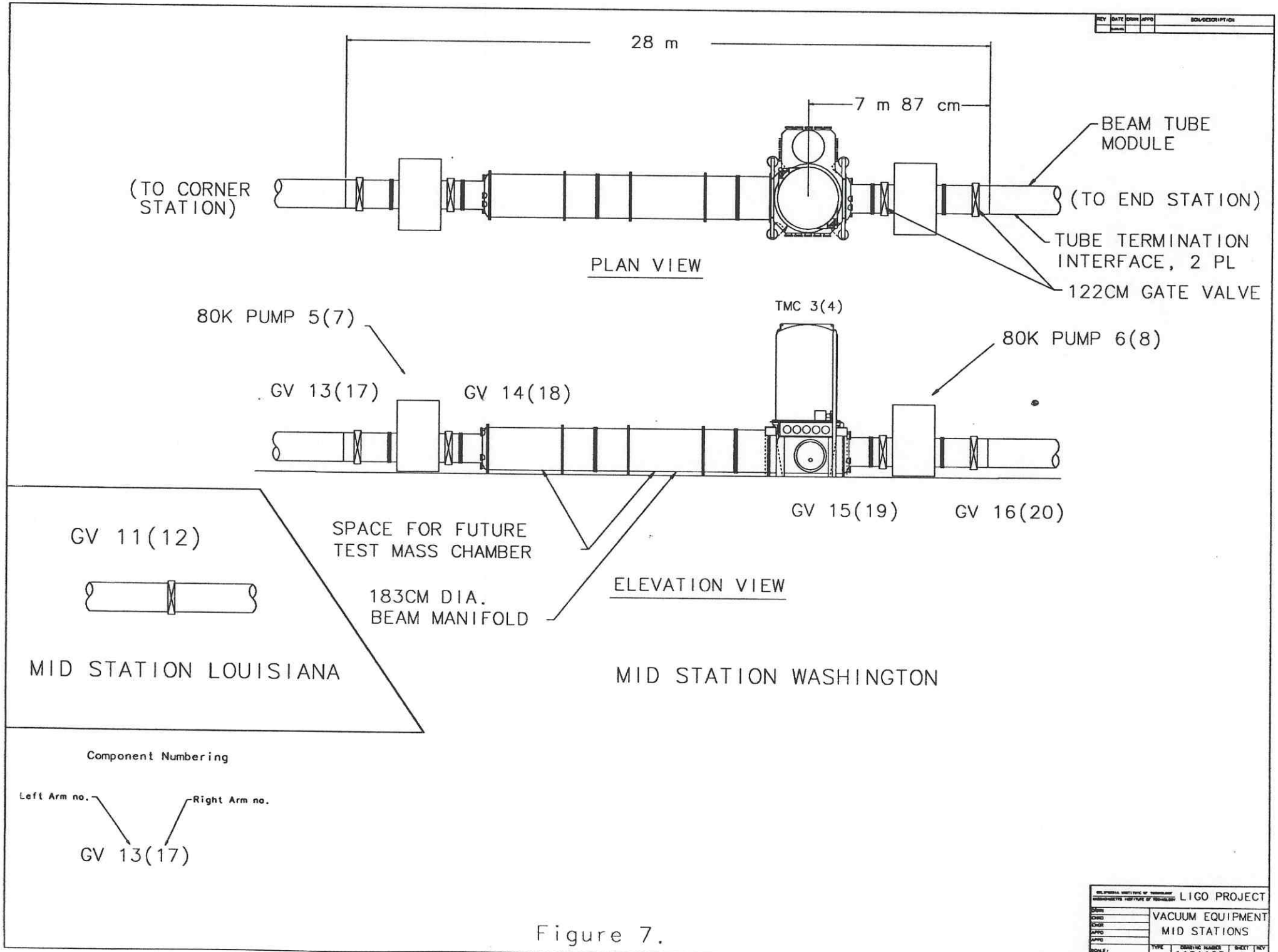
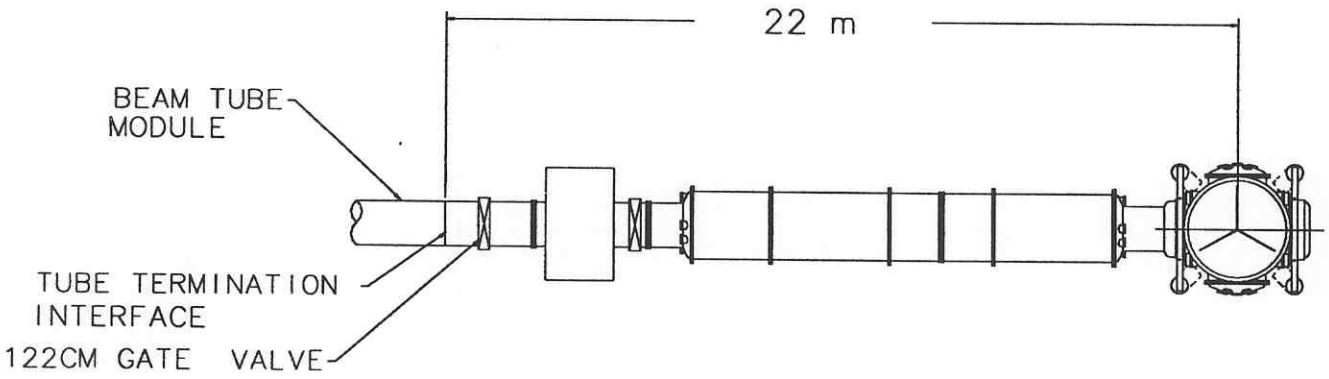
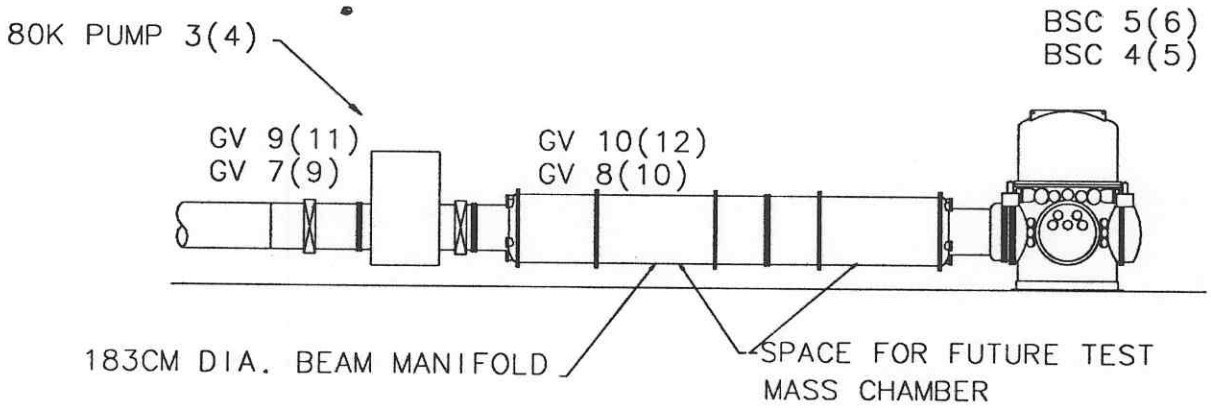


Figure 7.

LIGO PROJECT
VACUUM EQUIPMENT
MID STATIONS
1101103

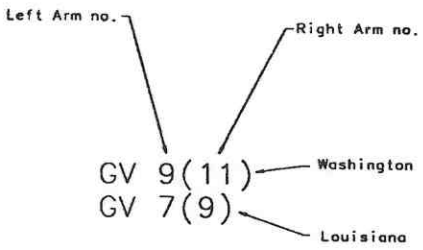


PLAN VIEW



ELEVATION VIEW

Component Numbering



END STATION
BOTH SITES WA and LA

Figure 6.

LIGO PROJECT
VACUUM EQUIPMENT
END STATIONS
1101102