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	Subsystem/Office Anticoincidence Detector Subsystem	
Document Title **GLAST/ACD Micrometeoroid Shield and Thermal Blanket Fabrication and Design Details**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

GLAST/ACD Micrometeoroid Shield and Thermal Blanket Fabrication and Design Details

ACD-PLAN-000285
Rev A

Prepared by

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Rev # 8 (Diane's Notation) September 2005

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1.0 Purpose

The purpose of this document is to provide procedural information, design details, manufacturing techniques, and material references for the GLAST/Anti-coincidence Detector (ACD) Micrometeoroid Shield (MMS) and Thermal Blanket/Multi-layer Insulation (MLI).

This shall be a living document, updated to reflect changes throughout the development process.

2.0 Scope

This document addresses issues of fabrication, materials, handling, and design details, which consider the requirements for contamination control, venting, and EMC for the GLAST/ACD. It should be used as a guide for GLAST subsystems during component build and I & T. Many blanketing approaches are used in the aerospace community that achieve similar successful results.
This document is not all-inclusive and details for variations can be added in the future.

3.0 Acronyms and definitions

ACD	Anti-Coincidence Detectore
GLAST	Gamma-ray Large Area Space Telescope
LAT	Large Area Telescope
MMS	Micrometeoroid Shield
MLI	Multi-Layer Insulation
Ge/K	Germanium (coated) Kapton (film)
WOA	Work Order Authorization
RFI/EMI	Radio Frequency Interference/Electromagnetic Interference
VDA	Vacuum Deposited Aluminum
CTE	Coefficient of Thermal Expansion

4.0 Applicable Documents

GLAST/ACD Micrometeoroid Shield and Thermal Blanket Specifications and Conceptual Design Doc. # ACD-RQMT-000167.
Germanium Kapton MLI Handling Plan. ACD-PLAN-000286
MMS Fabrication Drawing GE 2054592
MMS Installation Drawing GE205491

5.0 Design Parameters

Refer to Figures 1-5 and others

5.1 There must be MMS between every scintillator and the space environment.
5.2 The MMS and MLI must be kept as close to the scintillator as possible.

5.3 Minimize the linear path length through the blanket.
5.4 Ideally, MMS seams should butt with no gaps and MLI overlaps should be placed so as not to interfere with the stay clear zone.
5.5 Ideally, the seams of similar material layers are to be staggered (seam location varied) to assure that gaps or stress in seams would not cause a loss of coverage.
5.6 Add minimal dimensions between the MMS and tile surfaces to allow for ease of installation and thermal deformation.
5.7 The thickness/depth of MMS shield is not to exceed 3.27 cm. (desire 2cm).
5.8 The MMS does not need to step down on the +Z/top surface to conform to the tiles.
5.9 The MMS & MLI must be capable of withstanding all conditions associated with a Delta 2 launch.
5.10 MMS and MLI Stay-clear. *(Taken from LAT ICD)*
5.10.1 ICD 7.1 Nominal Stay-Clear Dimensions The ACD subsystem components shall stay within the stay-clear volume described in LAT-ACD IDD drawing.
5.10.2 ICD 7.2 Nominal Stay-Clear 10mm outward motion of the MLI shielding.
5.11 The bottom (-Z) edges of the MMS and MLI need to allow for access to the harness connector panels and back shells along the sides of the BEA.
5.12 The exposed tiles underneath the corners of the MMS at the BEA level will be required to be covered with an MMS layering. Refer to Bottom Corner Closeouts.
5.13 Removability (Also refer to Section 13. Fastening/Lifting)
5.13.1 The MMS and MLI are to be designed to allow them to be removed from the ACD without compromising the science, construction, or schedule.
5.13.2 The MMS will be fabricated and handled as one unit, able to slide on and off the ACD without opening of seams.
5.13.3 The MLI will be installed after integration of the MMS and will be multiple pieces.
5.13.3.1 Attachment points for the MMS will be under the blankets.
5.13.3.2 Attachment points for the blankets will be incorporated into the MMS fasteners.
5.13.4 The MLI will be installed as late in the schedule as possible to minimize handling of the Germanium Kapton outer layer.
5.13.5 Holding fixture. If the MMS is removed from the ACD, it can be held on the MMS fabrication/build fixture or kept suspended from the MMS Lift sling for a length of time TBD.
5.13.6 The minimum number of MMS handlings (remove and reinstall) would be one; from the fabrication fixture to the flight hardware.
5.13.7 Requirements for lifting. *(Taken from LAT ICD)*
5.13.7.1 *ICD. 13.1. Integration Stay-clears and Access Requirements.*
The ACD shall be integrated to the LAT vertically, from above.

The ACD shall be capable of being de-integrated from the Grid at any time. The de-integration of the ACD from the LAT will not require disassembly or invalidating verification of any other subsystem.

The MLI/MMS shall either be integrated after the ACD, or its bottom skirt shall be able to be folded up onto the ACD during and after integration, to provide access to the LAT region under the ACD stay-clear. However, the MLI MMS currently ends at the bottom of the ACD BEA making this unnecessary in most instances.
5.13.7.2 *ICD 13.4.. Integration GSE due to crane ops (height limitations @ SLAC, not possible to use Multi-Purpose Sling for ACD @ GSFC.*

6.0 Multilayer Insulation/Thermal Blanket (MLI) Details

Refer to Figures 6,7,8

6.1 The ACD MLI Thermal Blankets will be designed so that they can be easily installed and removed from the MMS.
6.2 Seam overlaps in the design will avoid the stay-clear areas so that additional loft is not factored into stay-out areas.
6.3 The number of fasteners and penetrations shall be minimized. MLI fastener points will be to structure/MMS (see design for MMS fasteners). Seam overlaps will be taped for flight closure.
6.4 Any hole(s) in the MLI for fastening will be patched over with additional MLI to maintain the thermal integrity of the blanketing system
6.5 The inner layers of MLI can be joined with transfer adhesive to prevent shifting.
6.6 The MLIs will be grounded to the BEA.
6.7 The MLI interface/attachment points to LAT are to be negotiated. GSFC will provide a template for the locations of Velcro interface points.
6.8 The flight MLI will be built based on the dimensions of the outer layer of the MMS.
6.9 CTE of MLI materials will be calculated and these dimensions will be accounted for in the MLI design.
6.10 A fabrication plan will be written for the construction details for the MLI. This plan will be attached to the WOA for the blanket fabrication.

7.0 Grounding/EMI/RF

Refer to Figures 9,10,11 and Grounding Matrix/Figure 12

7.1 MMS Grounding. The inner and outer handling layer of the MMS will be aluminized. When properly joined and grounded to the Base Electronics Assembly/BEA/Chassis, these layers will provide the EMC shield. While acting as an EMI shield, these grounded outer layers also enclose the MMS in an ESD safe environment, reducing static charge on the shield from air flow or lifting operations during I & T.
- 7.1.1 The RF grounding requirement for the handling layers of the MMS will be <10.0 ohms from the aluminized surfaces to the structure.
- 7.1.2 The MMS RF shielding will require two 2.0 inch wide connections between the handling layers of the MMS and the BEA. The hardware grounding assembly and locations will be specified by the mechanical group.

7.2 MLI Grounding
- 7.2.1 The MLI grounding requirement is for the purpose of ESD.
- 7.2.2 There will be redundant grounding of all metalized layers.
- 7.2.3 Metalized layers will be tested and measured as they are built. Access to inner layers of MLI pieces will not be an option as construction proceeds.
- 7.2.4 The Germanium Black Kapton outer layer shall be grounded.
- 7.2.5 There will be 2 ground tabs/wire assemblies per blanket with attachment of the wire terminals at 2 points per side of the BEA.
- 7.2.6 The MLI resistance requirement stated is <3.0 ohms. This is not practically achieved with MLI measurements between aluminized surface and chassis. The requirement to be used will be <10.0 ohms.

7.3 Requirements for measurements and individual layer resistance are in the attached grounding matrix. .
7.4 Atomic Oxygen protection is not a grounding requirement driver; however the outer layer of the MLI (Germanium Black Kapton) when properly grounded will provide this protection.
7.5 Resistance measurements will be recorded on logs and attached to the appropriate WOAs.

8.0 Atomic Oxygen (AO) Protection

There are no special requirements for AO protection. However the properties of the Germanium and the grounding system for the outer layer of MLI will provide protection against AO.

9.0 Demisability

Refer to Figures 13,14,15

9.1 All materials will have to break apart during reentry into the earth's atmosphere. Reference ORDEM (Orbital Debris Environment Model).
9.2 Construction techniques and design will assure that the demisability requirements are met.
9.3 The Nextel layers are of the most concern. All other materials will demise.
9.4 Polyester thread will be used for sewn seam closures as the low melting point of polyester will allow for seams to break apart during Spacecraft reentry.
9.5 The maximum area of a piece of MLI or MMS material will be 2.0 m^2 or the dimensions of one side of the MMS. The materials on the +Z/Top face will be seamed as the materials are not wide enough to cover the entire surface with a single piece.

10.0 Contamination

10.1 There are no stringent requirements for fabrication or installation of the MMS or MLI. Use GSFC standard practices.
10.2 Refer to the ACD Contamination Control Plan (443-PLAN-0010*)*
10.3 *ICD 14.2. Particulates and Other Contamination*

- *The ACD shall contain all fracture-sensitive materials such that any particulates produced by a fracture are contained within the stay-clear volume of the ACD.*
- *The ACD shall prevent any venting or shedding of particulates down, or out the bottom of its stayclear, to avoid possible contamination of the spacecraft star tracker.*

10.4 The fixture used to store or hold the MMS in the clean room will be compatible with CC requirements.
10.5 Bake out of materials
10.5.1 A bake-out of Nextel and Kevlar panels prior to the start of construction will eliminate most of the volatiles and pre-shrink the materials. The TML will be mostly water vapor, and there is little that can be done to prevent this from returning to materials.
10.5.2 The MMS will be baked out after its' fabrication and prior to being introduced to the ACD.
10.5.3 A bakeout of all hardware is to be performed at the end of thermal test cycling.
10.5.4 Bakeout reports will be on file with the Lead Contamination Control Engineer.

10.6 Any new materials that are proposed for the MMS or MLI will conform to the guidelines GSFC Outgassing Data guide. Any materials outside of the outgassing guidelines will be subject to project approval and/or waiver. Refer to Figure 25.
10.7 The MMS inner layers will be contained within a handling layer of Kapton/Kevlar film. Filtered vents will be applied to the Kapton/Kevlar handling layers at the lower edge (-Z) to prevent foam or fabric particles and fibers from shedding toward the spacecraft.
10.8 There is no requirement to install filtered vents in the MLI edges however they will installed.

11.0 Venting

11.1 The venting area of the MMS and MLI has been calculated and vents will be incorporated into the design
11.2 Filtered vents will be installed at the bottom edges of the MMS.
11.3 The venting plan takes into account the concerns about air from the MMS and hardware interior cavities pushing out the MMS and/or MLI.
11.4 *ICD 14.1. Venting. During launch, air from the ACD shall be vented outward, away from the inside of the LAT. No ACD venting shall be allowed into the volume surrounding the TKR modules or down past the Grid perimeter.*
11.5 The vent path will be in the direction of the BEA.
11.5.1 Except in area of Star Trackers. This will need to be defined.

12.0 Weights

11.1 Weight charts for materials are available upon request.
appropriate WOA.

13.0 Fastening/Lifting (Refer to Figures 16-20)

13.1 Lifting spools inserted into the MMS during fabrication will provide attachment points to the lift fixture. Spools also hold the MMS together to keep its layers from shifting.

13.2 MMS fasteners (72 places) consist of a base and top unit. The base unit is permanently attached to the ACD tiles, while the top portion provides a quick release for removal of the MMS from the hardware.

13.2.1 The fastener base units, while low profile, may interfere somewhat with the removal of the MMS. Details to avoid this lifting interference will be outlined in an MMS installation/removal procedure.

13.3 There are multiple sizes of fastener tops, with lengths appropriate to their locations on the TSA.

13.4 The fastener tops will have a post for MLI attachment. A snap-ring/washer arrangement will mechanically attach the MLI to these posts. The MLI attachment post is low profile so that the hole location can be patched over in a smooth manner.

13.5 Not all MMS fastener locations will be used for MLI attachment. The number and locations of MLI fastening are documented.

13.6 ICD States: *Bolts, washers, and any other hardware needed to attach the ACD to the Grid. All bolts, washers and other hardware used on the flight article shall be from the NASA/GSFC approved parts list.*

14.0 MMS Material Details and construction guidelines

(Reference ACD Parts list (ACD-MPML-10001.)

14.1 **Kevlar®** A woven Aramid fabric

- Kevlar KM2, Style 705 - 898 (Finish: CS-898)
  Manufacturer's weight = 6.72- 7.2 oz/yard^2 (244.0 gm/meter^2)
  Denier: 850 Thickness: 7.0 – 12.0 mils/ 0.30 mm.
  Weave: Plain Warp & Fill count: 31 x 31 Yarn type: Warp: 850 Fill: 850
  Meets Mil-C 44050 type 3, class 3
  Width ordered: 63" wide
  Source of Supply: Hexcel Schwebel 2200 South Murray Avenue
  http://www.hexcelschwebel.com/ Anderson, SC 29624

Kevlar is a strong fiber that is very difficult to cut. Edges fray and unravel easily.
Ceramic scissors, electric cutters, and knife blades will be used to cut the Kevlar. Any cutting tool will become dull quickly when cutting Kevlar.

- There are 2 edge treatments to be used when cutting Kevlar
  1. A bead of glue is laid onto the fabric where the seam is to be cut. When the glue has soaked into the fibers and dried, the cut is made on the center of the glue bead.
  2. A Merrowed or Serged edge can be utilized on the Kevlar. A Merrow or Serger sewing machine simultaneously cuts the fabric and finishes the edge with a row of stitching which keeps it from unraveling. The threads used in this machine will be polyester.
- Joining of Kevlar seams

- Using either of the above methods for cutting Kevlar, the seams can then be butted together and hand-stitched or machine zig-zagged to join adjacent seams. A combination of both methods can be used.

- Safety issues of Kevlar airborne fibers will be addressed.

14.2 **Nextel®** A Ceramic Fiber/Alumina Boria-Silica continuous fiber

- Nextel 312 Aerospace Fabric Style AF-10
  Warp = 46 threads / Fill = 46 threads Weave: 5 harness satin
  Yarn type: 600 d. thread Finished width: 38.0" wide
  Manufacturer's weight = 8.6 – 8.8 oz/yard^2 Manufacturer's thickness: 0.015"
- There are 2 options for heat cleaned or not heat cleaned. We will require the type that has not been heat cleaned.

Nextel is somewhat easier to cut than the Kevlar but will quickly dull any cutting tool used. It frays very easily when cut and the weave is unstable (a loosely woven fabric makes edge finishes and seaming more difficult as these areas can pull apart when being handled, joined, or lifted.

- There are 2 edge treatments to be used when cutting Nextel
  1. A bead of glue is laid onto the fabric where the seam is to be cut. When the glue has soaked into the fibers and dried, the cut is made on the center of the glue bead.
  2. A Merrowed or Serged edge can be utilized on the Nextel. A Merrow or Serger sewing machine simultaneously cuts the fabric and finishes the edge with a row of stitching which keeps it from unraveling. The threads used in this machine will be polyester.

- Joining of Nextel seams
  - Using either of the above methods for cutting Nextel, the seams can then be butted together and hand-stitched or machine zig-zagged to join adjacent seams. A combination of both methods can be used.
- Safety issues of Nextel airborne fibers will be addressed.

14.3 **Solimide®** Polyimide (Aramid) open cell foam

- Solimide Foam AC 530
  Thickness ordered: 0.26 inches
  Manufacturer's weight = 5.0 kg/m^3 0.3 lbs/ft ^{3}
  Change in volume @ 204º C = < 2 %
  - Shrinkage/ Volume shrinkage < 2%
- Quantity Ordered: 30 sheets, 4 ft. x 8 ft.
  Manufactured by Inspec Foams Inc.
  Minimal Outgassing/Offgassing. Lightweight. Chemically stable. Fire resistant
  Resistant to hydrocarbons, alcohols and non-concentrated acids
  On MSFC's materials specification selection list…Density ASTM D 3574, Test A

- The Solimide foam performs only as a spacer between Nextel layers.
- The Solimide cuts easily with a sharp razor. Every attempt should be made to maintain a cutting angle of 90º to make the butt joints align properly.
- Joining of Solimide seams
  Although there is no requirement to fasten the foam at seams, to prevent shifting or displacement of foam pieces, the seams will be spot welded with GE RTV 142 adhesive. The spacing of spot tacking of seams will be approximately 4-5" with additional tacking performed at corners.

14.4 **Kapton®/Kevlar®**

- **Kapton®/Kevlar®** Typically a thin layer Kapton with a Kevlar scrim bonded to one side for strength/tear resistance. The thickness of the Kapton and the scrim type and weave can be specified during ordering. This material can be aluminized and perforated or porolated.
- This material has been recommended as an inner and outer handling layer for the MMS.
    - The Kapton side will be aluminized to satisfy EMC requirements and provide grounding of the MMS.
    - As an inner layer it will provide stability to the MMS and protect the woven layers from being snagged on corners of ACD tiles during handling or repeated removals.
    - As an outer layer, it will provide stability and protect the Nextel outer layer from snagging, dirt, oils, and provide a more robust surface during handling or repeated removals.

Kapton®/Kevlar®
½ Mil (0.00050") Kapton with bonded Kevlar scrim, aluminized on the Kapton side.
Weight:
Thickness of Kapton film substrate: ½ mil. Approx. total thickness = 2 mils thick
Width: 46" +/- 1"
Dunmore ordering information: Product Item # MO11616 – 50 DUN-LAM, Clear Kapton/Kevlar
Interply Adhesion = 1.5 Lbs/In. Minimum Requirement (Test Value = 2.9Lbs/In.)

Kevlar scrim specifications: Style 350, Finish CS-800

	Specification		Test Result
Weight (osy):	1.62 Min.	1.98 Max.	1.81
Thickness:	0.0035 Min.	0.0055 Max.	0.0038
Fabric tensile:	Warp 200 lbs f/in		270 lbs f/in
Fill:	200 lbs f/in		286 lbs f/in
Count (thread)	Warp	32 min/36max per/in	35
Fill	32 min/36max per/in		35
Weave:	Plain		

- Seam cutting is easily performed with standard cutting tools.
- Seam joining is typically performed with tape and this film can also be hand or machine sewn. (Tape: Uncoated (clear) Kapton tape with acrylic adhesive for seam sealing. Conductive adhesive tape will also be used to provide EMI/grounding continuity at seam joints.)
- The addition of this layer would only be a substitute for a micrometeoroid penetration layer if the thickness/type/weave of the Kevlar were the same as the Kevlar KM2 S705.
- The aluminized surface of the film can be scratched if inappropriately handled.

14.5 Threads

14.5.1 The baseline thread chosen was polyester. The heat stability of the fiber should be as low as possible. Heat stability is when the fibers will fail before they melt (Melt Temperature). The target stated was 200ºC. (The thickness of thread or twist does not affect the basic fiber melt rates, but assume that the thinner the thread the easier it will break down (seam failure) when exposed to heat.

GLAST Fiber	**Threads** Sticks at:	Melt temp F.	Melt temp C	Heat stable	Note
Kevlar		900 º	480º		
Nomex		700 º	370 º		
Nylon	445º F.	485-500º	251 -260º		
Polyester	440-445º F.	483 º	250 º	To 266º F	(Ironing temperature 150-200º C)
Polypropylene		280º	(140?)160-170 º		
Cotton		300º *	148º *		*Does not melt. Decomposes at temp º

14.5.2 There will be 2 types of threads required as there are 2 different sewing functions.

- The serger machine will cut and finish off raw edges of the fabrics and prefers a thinner thread as 3 needles and 3 thread spools run continuously. This thread's temperature stability is unimportant. Size A thread will be used in this application.
- The zigzag/straight stitch machine and hand sewing will be used to join seams of the fabrics. This is the thread that must break down for the demisibility requirement to be met. Size EE thread will be used.

14.5.3 Polyesters are generally dirtier than Nylons because of the waxes, silicones and oils that are applied to lubricate the thread. Nylons have a higher TML as they hold moisture. Less thread finishes are better in the world of contamination, but some finishes are necessary to allow them to run through the eye of a machine needle at high speeds without fraying or melting. The materials' branch has provided outgassing data for the chosen threads.

14.6 **Glues**

14.6.1 GE RTV 142. To be used to spot weld the Solimide foam seams.
This is a one-part, white, paste, silicone adhesive sealant. Low volatile.
Store and use at room temperature.
Useful temperature range -60ºC to 201ºC (-75ºF to 400ºF).
Specific Gravity: 1.23. Hardness 34 (Shor A). Elongation 400%

14.6.2 Cyanoacrylate (Super Glue). To be used to stabilize Kevlar and Nextel when cutting and hole punching.
Several different viscosities will be used depending on the application.
No Cyanoacrylate passes CVCM requirements and when used, would require a bake-out to meet outgassing standards.

15.0 MLI Materials (Refer to Figure 6)

15.1 Blanket lay up

- 1 Mil Kapton, Aluminized on 1 side (VDA 1), Kapton surface facing outboard, outer handling layer between Ge/Kapton and inner layers.
- 15 layers of B2A (standard) Polyester netting to be used as a separator.
- 14 layers of 1/3 mil Kapton Aluminized on 2 sides (VDA2)
- 2 Mil Kapton, Aluminized on 1 side (VDA 1), Kapton surface facing outboard (MMS outer surface)

15.2 Outboard Layer.
Germanium Coated Black Kapton with Scrim bonded to the inside surface
Dunmore # MO 11053
100 DM = 1.0 Mil Black Kapton XC275
Germanium/Black Kapton with "E7"/ Nomex

Germanium coated Black Kapton film with scrim

15.2.1 Germanium tape will be used to fasten seams.
15.2.2 A handling procedure will be written.
(Reference: Germanium Kapton MLI Handling ACD-PLAN-000286

15.3 **Misc. materials**

15.3.1 3M 1170 Aluminum Foil Tape with acrylic conductive adhesive will be used to join MMS outer handling layer seams to satisfy the EMI requirements.

15.3.2 Filter material for vent areas.
Spectra/Mesh® Macrofiltration Mesh: Spectrum® Part # 146476.
Mesh Opening: 70 μm
Open area: 22% Mesh Thickness: 158 μm

15.3.3 Grounding hardware; brass eyelets and washers, Aluminum foil grounding strips

15.3.4 Clear, uncoated Kapton tape

15.3.5 MLI fasteners; snap rings and washers.

16.0 Flight Fabrication approach and fixture

16.1 The Flight MMS will be fabricated on a fixture that is dimensioned to the inner layer of the MMS. The fidelity and tolerances of the fixture will be determined by the mechanical group.

16.2 Access to the inside of the fixture is required to hand tack the MMS layers together and to access the inside handling layer.

16.3 The fixture will be on wheels and elevated from floor level.

16.4 The build fixture will be constructed of Thermal Vacuum compatible materials.

16.5 After the Flight MMS has been built, dimensions for the Thermal Blankets can be determined and the MLI will be made.

17.0 Instrumentation

17.1 There are no instrumentation requirements on the hardware, MMS, or MLI layers that will affect the build of the MMS/MLI or require removal of the MMS or MLI for access to the hardware underneath.

18.0 Bagging

18.1 A bagging procedure will be provided by the ACD team. The bagging procedure will detail requirements for handling, double bagging, installation and removal of the bag at all levels through launch.

19.0 Documentation

19.1 Templates. Some templates will be made during the MMS fabrication process. In some cases a specific layer may be referenced to a template for dimensions or fabrication details. Templates will be made for the MLI. Templates can be put under configuration control for future reference.

19.2 Construction, fabrication, and installation techniques for the MMS and MLI will be documented in the fabrication and installation WOAs. These sketches and procedures will provide details for the inner layers' seaming, overlaps, sewing, taping, grounding and other construction information.

20.0 Mass Model

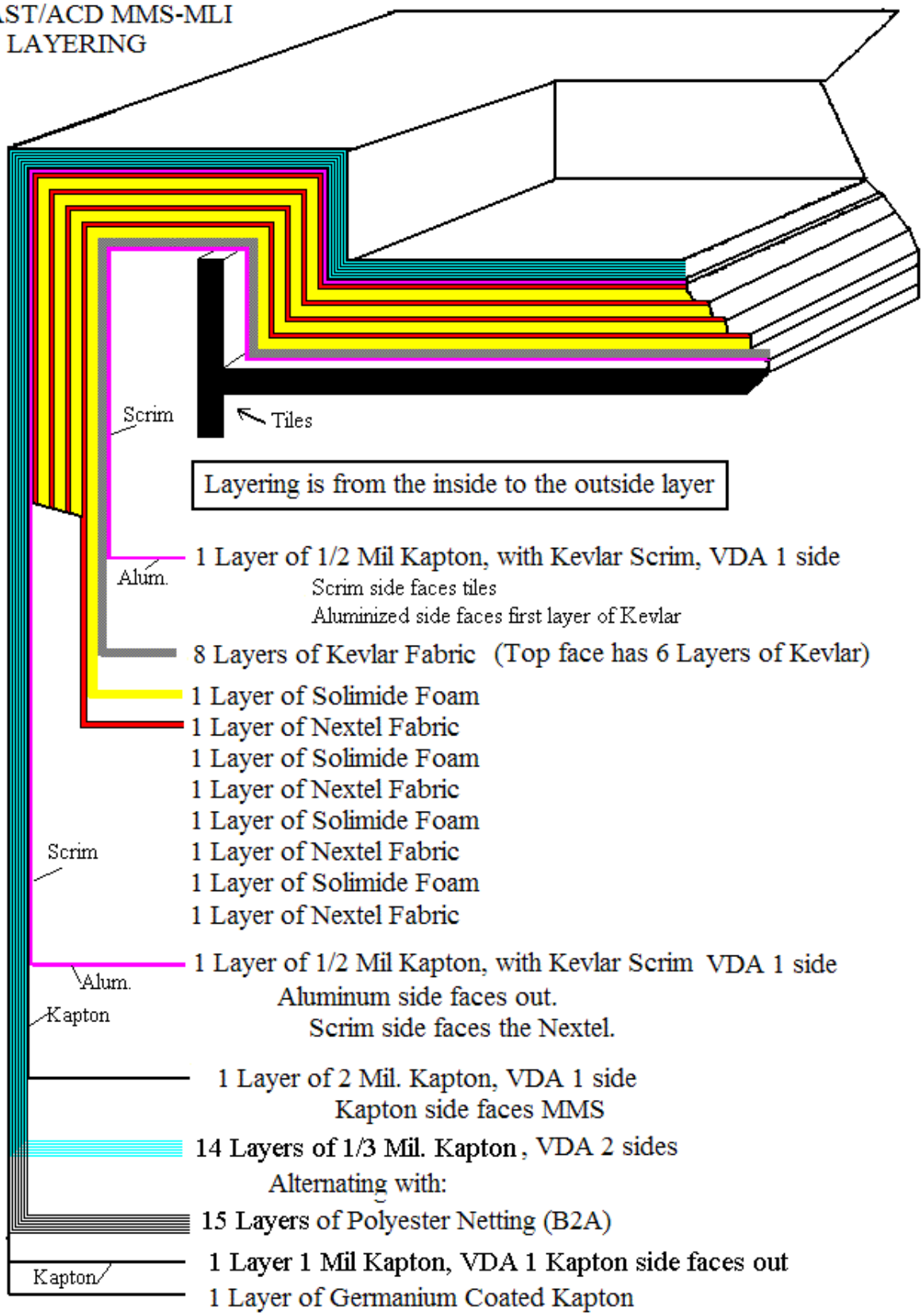
Documentation for the MMS Mass Model fabrication and installation is on file and can be requested.

21.0 Safety

Safety issues for handling of materials will be discussed and addressed. There is some concern for airborne particles created during the cutting of fabrics.

Figure 1. GLAST ACD MMS/MLI Layering

GLAST/ACD MMS-MLI
LAYERING



Layering is from the inside to the outside layer

1 Layer of 1/2 Mil Kapton, with Kevlar Scrim, VDA 1 side
Scrim side faces tiles
Aluminized side faces first layer of Kevlar

8 Layers of Kevlar Fabric (Top face has 6 Layers of Kevlar)

1 Layer of Solimide Foam
1 Layer of Nextel Fabric
1 Layer of Solimide Foam
1 Layer of Nextel Fabric
1 Layer of Solimide Foam
1 Layer of Nextel Fabric
1 Layer of Solimide Foam
1 Layer of Nextel Fabric

1 Layer of 1/2 Mil Kapton, with Kevlar Scrim VDA 1 side
Aluminum side faces out.
Scrim side faces the Nextel.

1 Layer of 2 Mil. Kapton, VDA 1 side
Kapton side faces MMS

14 Layers of 1/3 Mil. Kapton, VDA 2 sides
Alternating with:

15 Layers of Polyester Netting (B2A)

1 Layer 1 Mil Kapton, VDA 1 Kapton side faces out

1 Layer of Germanium Coated Kapton
with Scrim bonded to the inside face.
Germanium faces out.

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Figure 2. MMS over TSA Cross-section

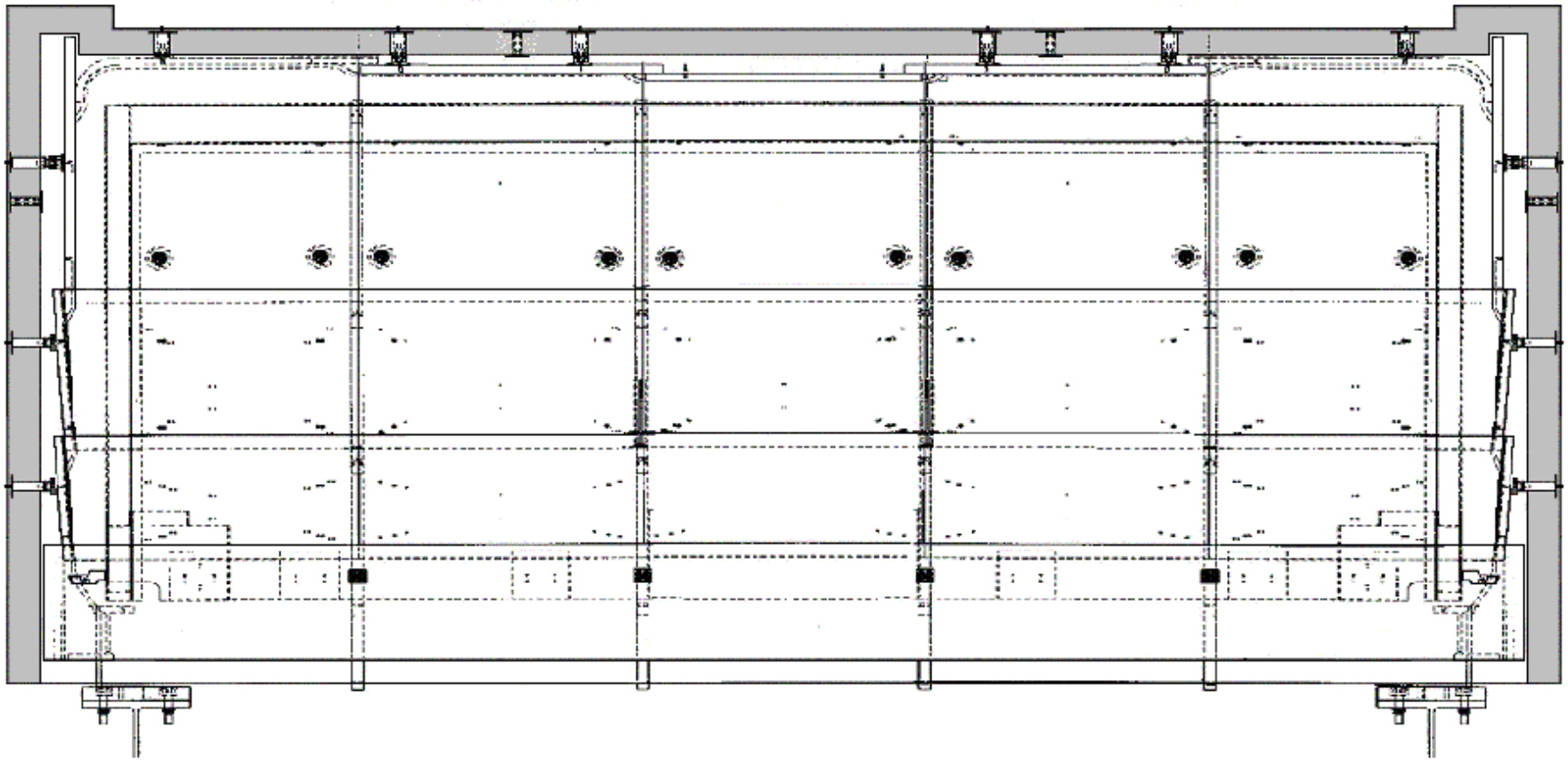


Figure 3 MMS over TSA with dimensions

Note: Dimensions on this drawing were not finalized. Use this only as a guide for the spacing of the MMS from the tile surfaces.

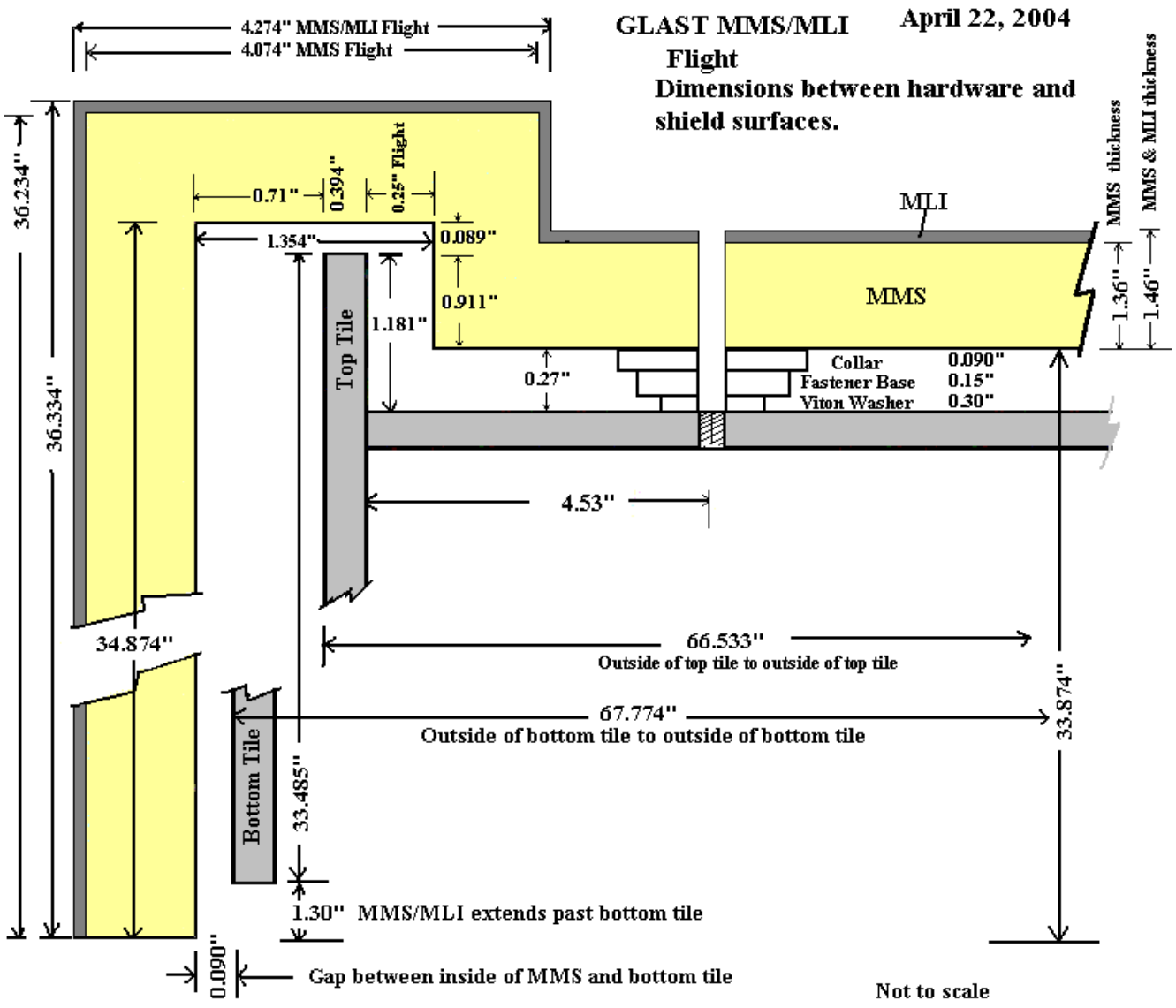
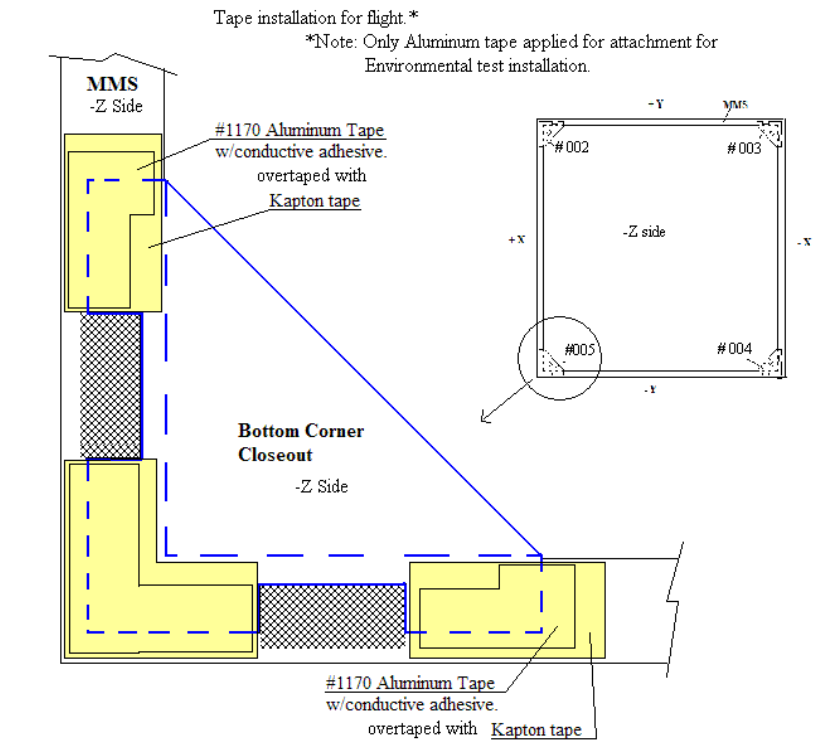


Figure 4. Bottom view of MMS/MLI on TSA and Bottom Corner Closeouts



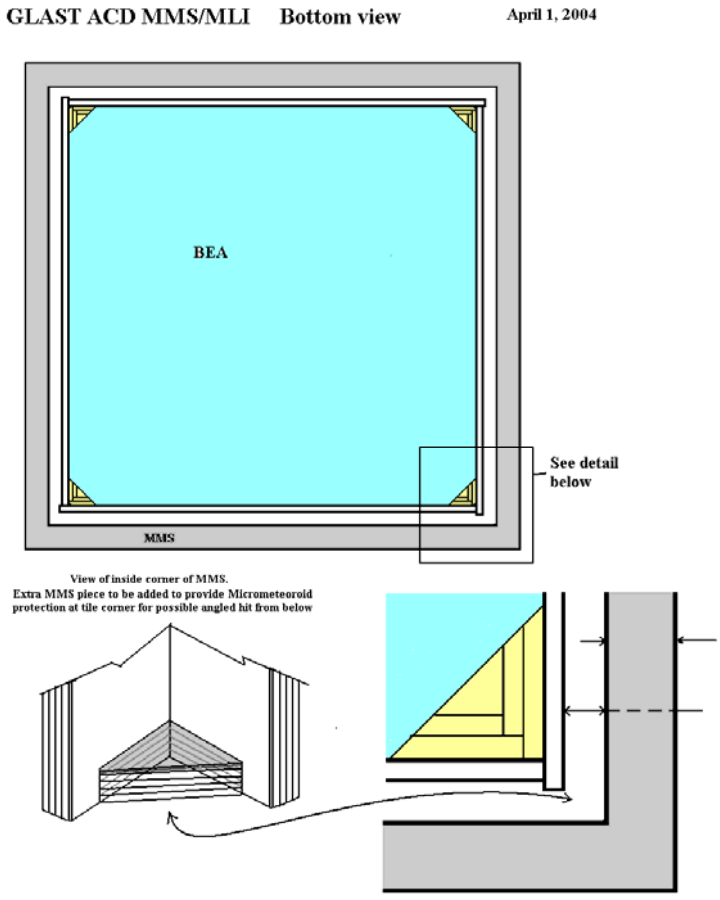


Figure 5. Bottom view of TSA/BEA

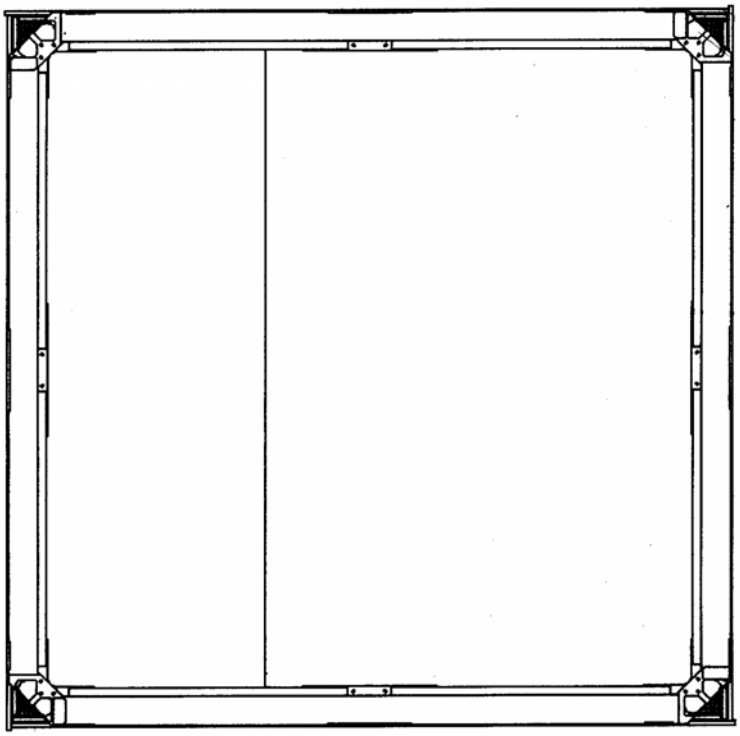


FIGURE 6. MLI Layering

GLAST ACD MLI Lay-up

Germanium coated Black Kapton with Nomex Scrim

Outer layer of 1.0 Mil Kapton film, VDA 1 side,
Kapton side facing out

14 layers 1/3 mil. Kapton, VDA 2 sides
alternating with
15 layers B2A Polyester Netting

Outer layer of 2.0 Mil Kapton film, VDA 1 side,
Kapton side facing out

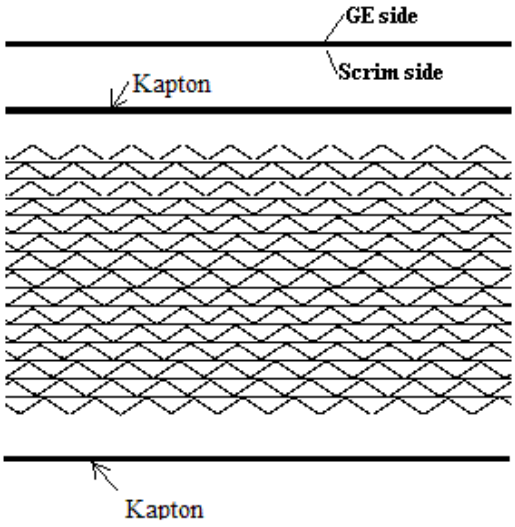


FIGURE 7. MLI Design Concept Cross-section

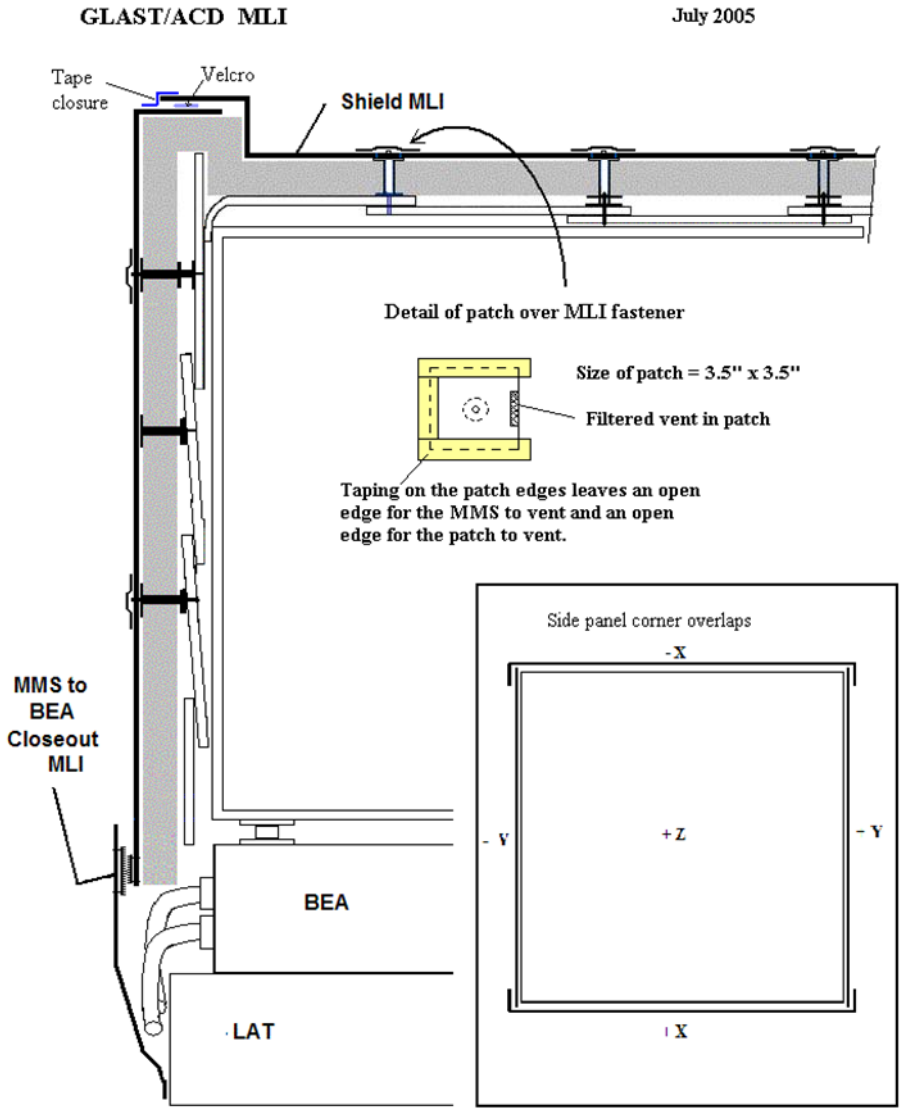


FIGURE 8. MLI Exploded View

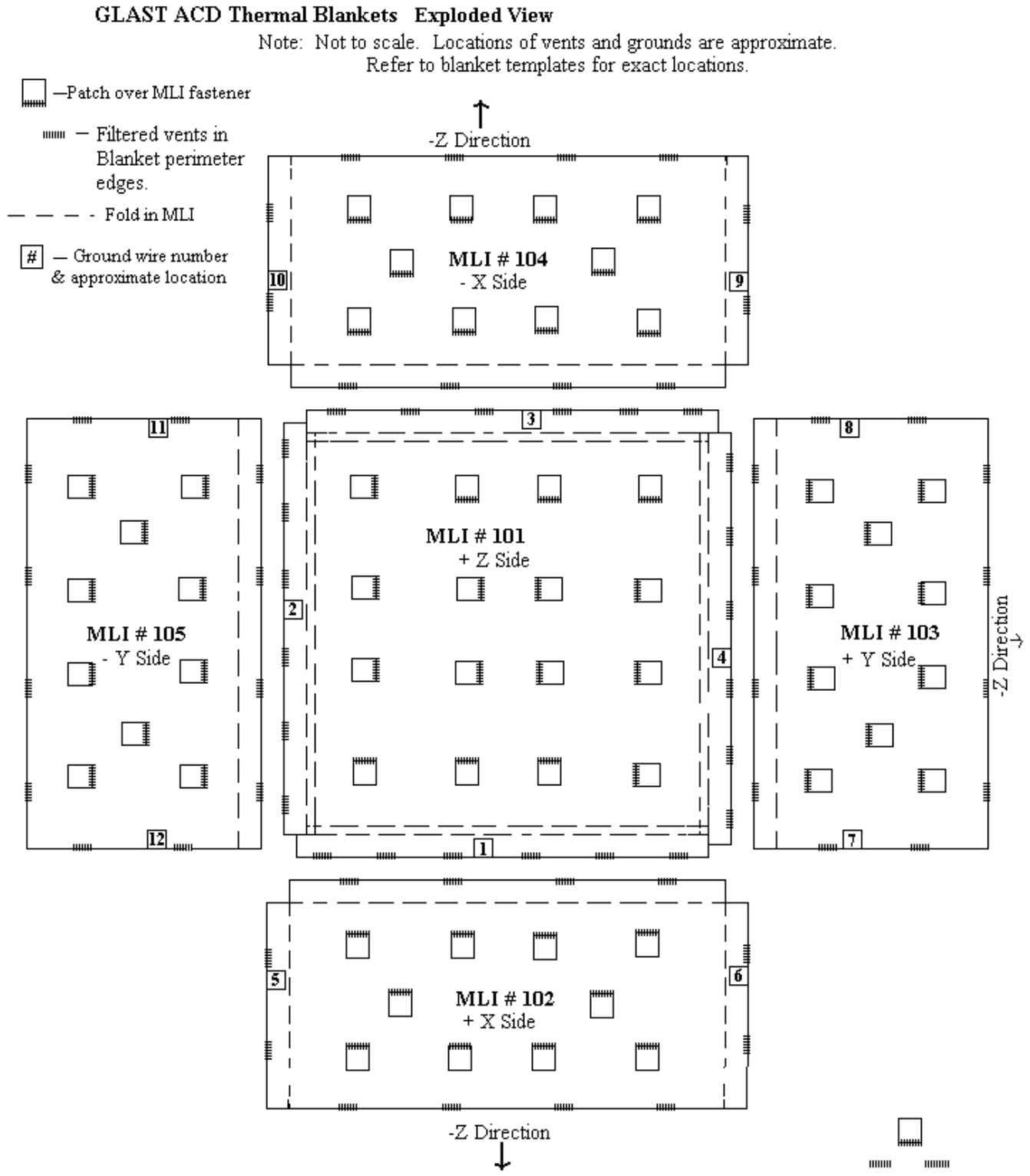


Figure 8-1

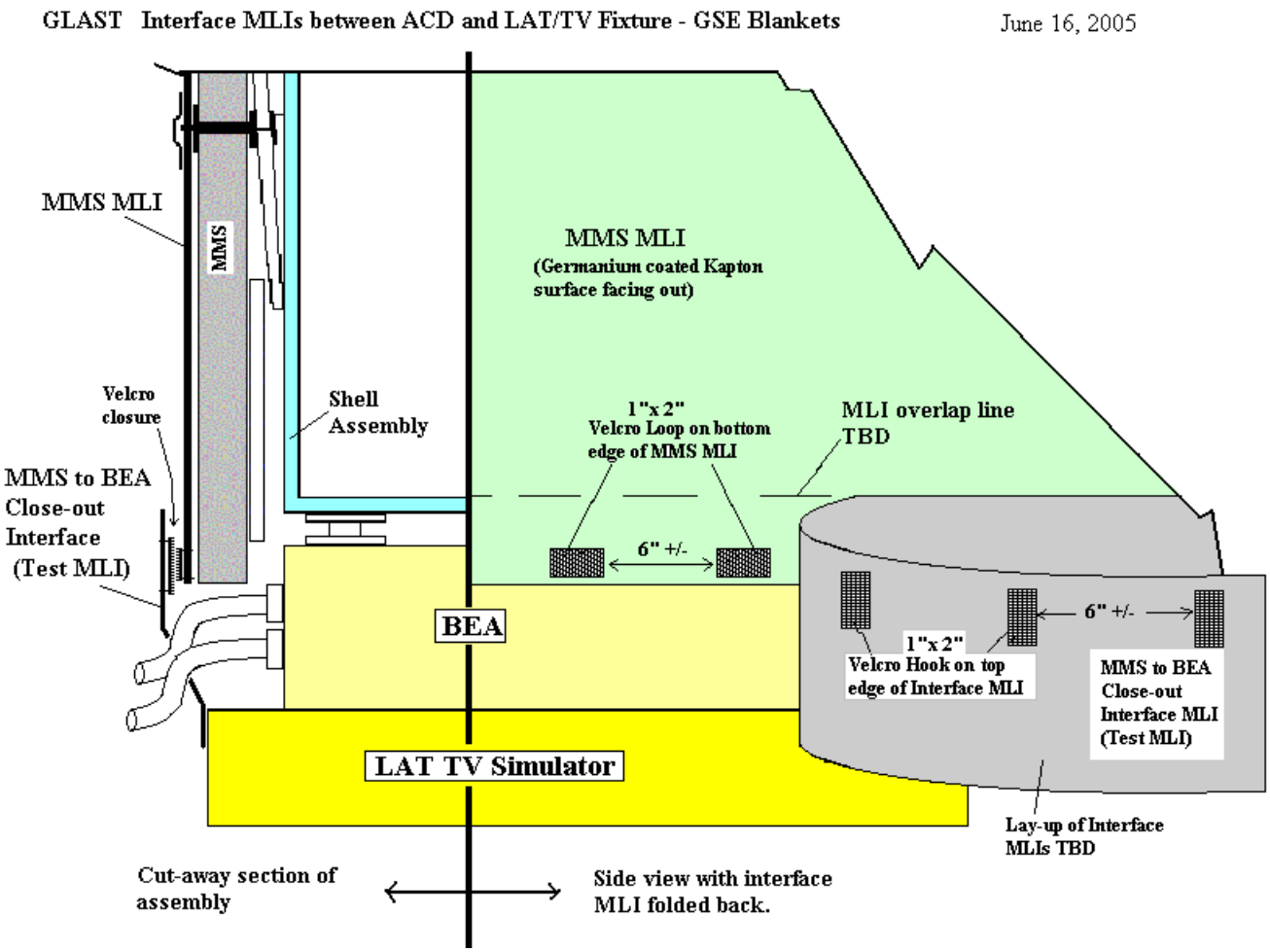

GLAST Interface MLIs between ACD and LAT/TV Fixture - GSE Blankets
June 16, 2005
MMS MLI
MMS
MMS MLI
(Germanium coated Kapton surface facing out)
Velcro closure
Shell Assembly
1"x 2" Velcro Loop on bottom edge of MMS MLI
MLI overlap line TBD
MMS to BEA Close-out Interface (Test MLI)
6" +/-
BEA
1"x 2" Velcro Hook on top edge of Interface MLI
6" +/-
MMS to BEA Close-out Interface MLI (Test MLI)
LAT TV Simulator
Lay-up of Interface MLIs TBD
Cut-away section of assembly
Side view with interface MLI folded back.

FIGURE 8-2 MLI Fastener locations

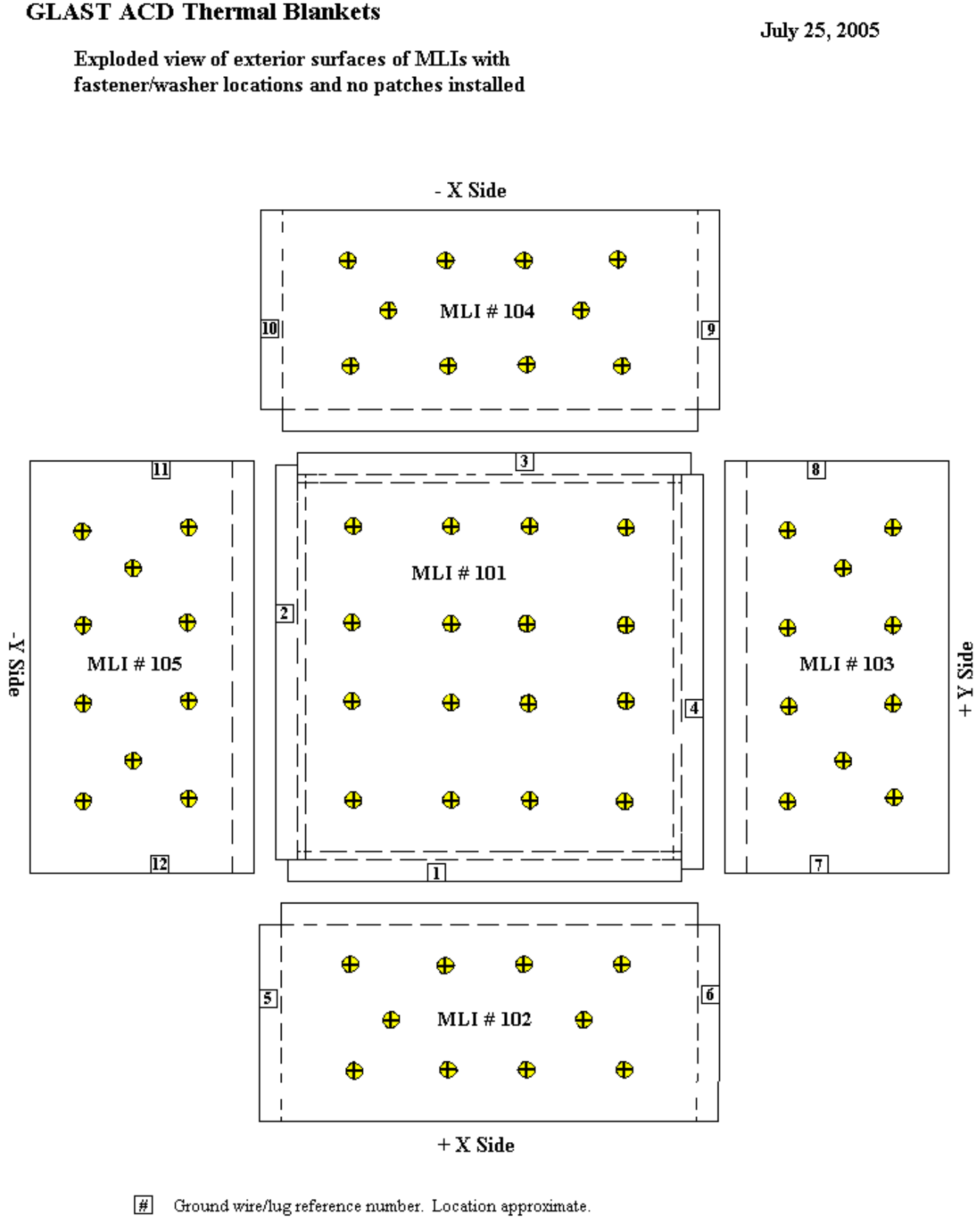
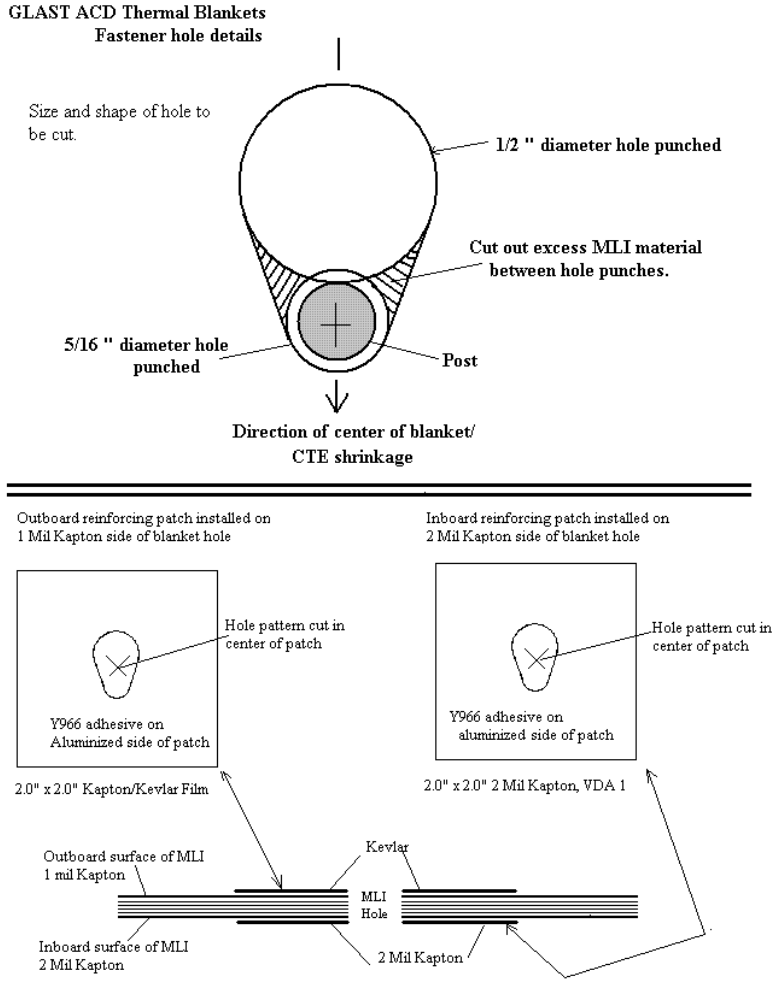


FIGURE 8-3 CTE of MLI and hole pattern for attachment



GLAST ACD MMS/MLI
Maximum CTE calculated.
(for allowances in MLI and hole size)

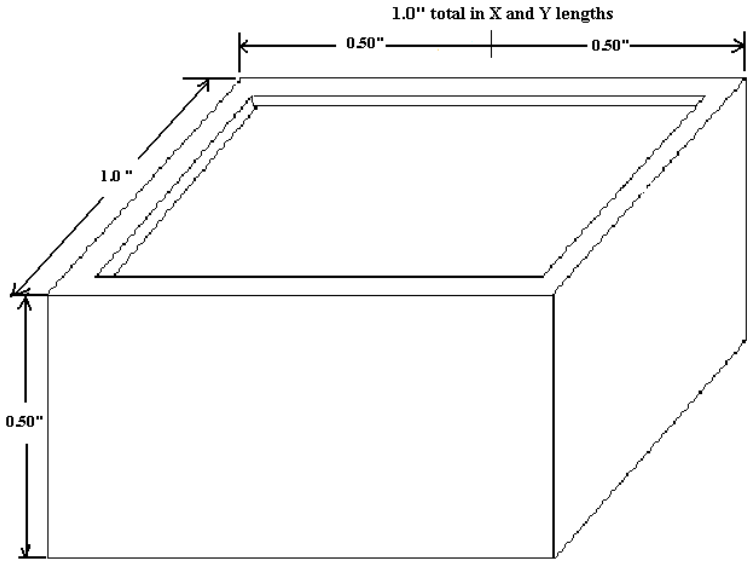
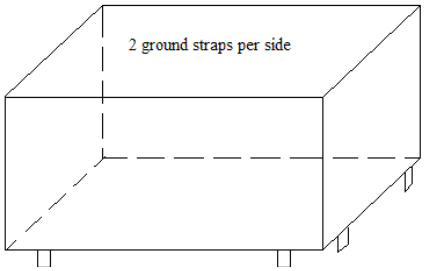


FIGURE 9. Grounding locations of the MMS to the BEA

GLAST ACD MMS/MLI Grounding locations of MMS/MLI to BEA

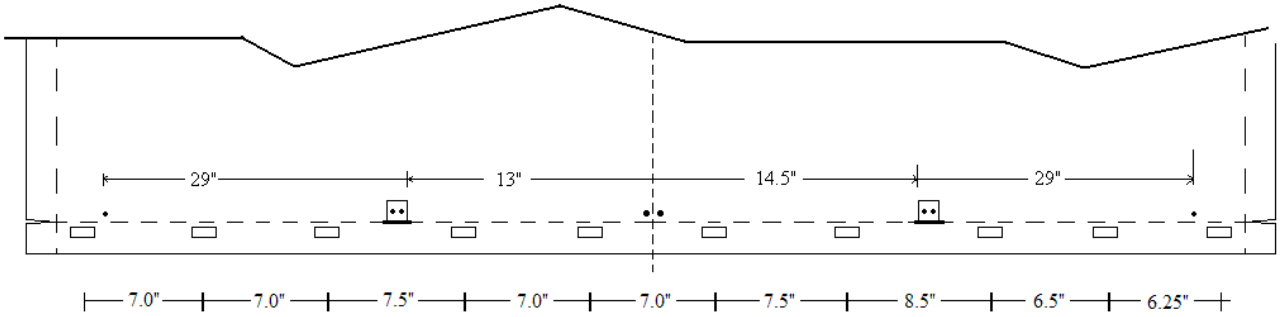


8 Places

GLAST ACD MMS Vent and Ground Strap Locations

April 6, 2005

Locations of grounding tabs, vent locations, and lift fixture attachment points are as shown on the bottom of the MMS side templates. Measurements are approximate. Exact locations are marked on templates.



▭ — 2.0" x 0.60" Filtered vents, 10 locations per side

⚏ — 2.0" x 2.0" Grounding Tab, 2 locations per side

• — Screw hole locations under the MMS for attachment of lift fixtures, 4 places per side.

Notes:
Vent measurements are from centers of cutouts.

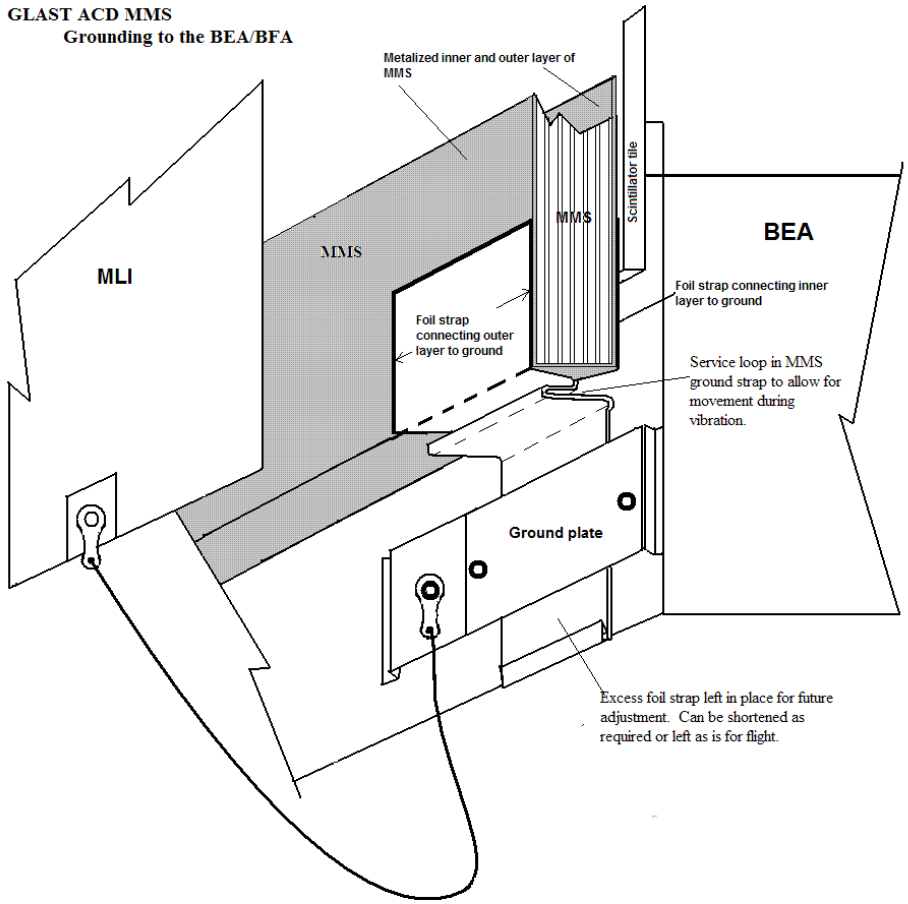
Pattern is not symetric as grounding brackets are not mirror images

Required Vent Area ($in.^2$) with filter installed = 27.9" *

Filtered Vents provided in MMS:
2.0" x 0.06" x 10 per side x 4 sides =
48.0 in^2 total vent area.

(* From Venting Volume Analysis/Summary provided.
S. Chaykovsky Aug 2004)

FIGURE 10. MMS & MLI Grounding Details

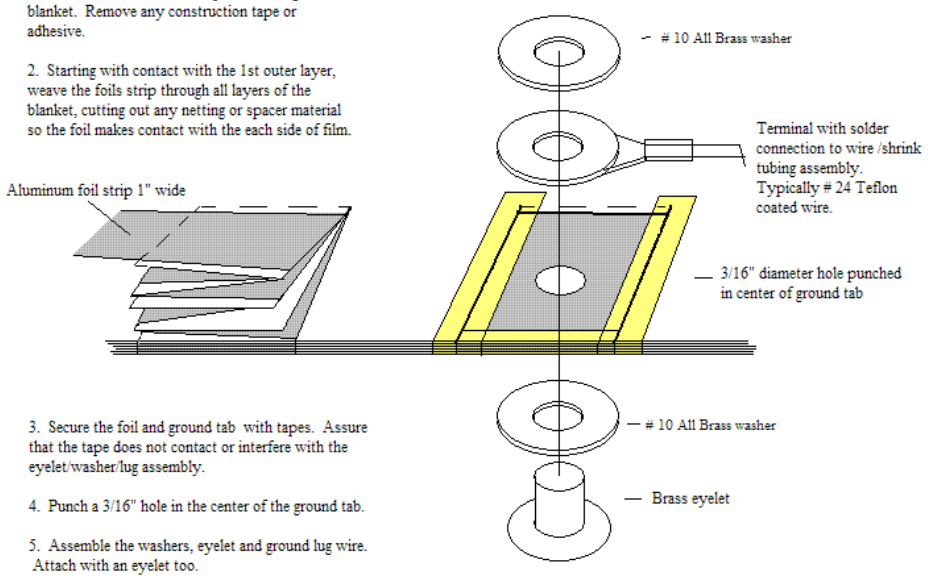


THERMAL BLANKET Grounding tab and wire assembly.
Note: Materials and their specifications are subject to project requirements.

Steps:

1. Cut a 1.0" wide tab at the perimeter edge of the blanket. Remove any construction tape or adhesive.

2. Starting with contact with the 1st outer layer, weave the foils strip through all layers of the blanket, cutting out any netting or spacer material so the foil makes contact with the each side of film.



3. Secure the foil and ground tab with tapes. Assure that the tape does not contact or interfere with the eyelet/washer/lug assembly.

4. Punch a 3/16" hole in the center of the ground tab.

5. Assemble the washers, eyelet and ground lug wire. Attach with an eyelet too.

6. Tape over the completed assembly and secure the ground wire.

FIGURE 11. EMI Shielding

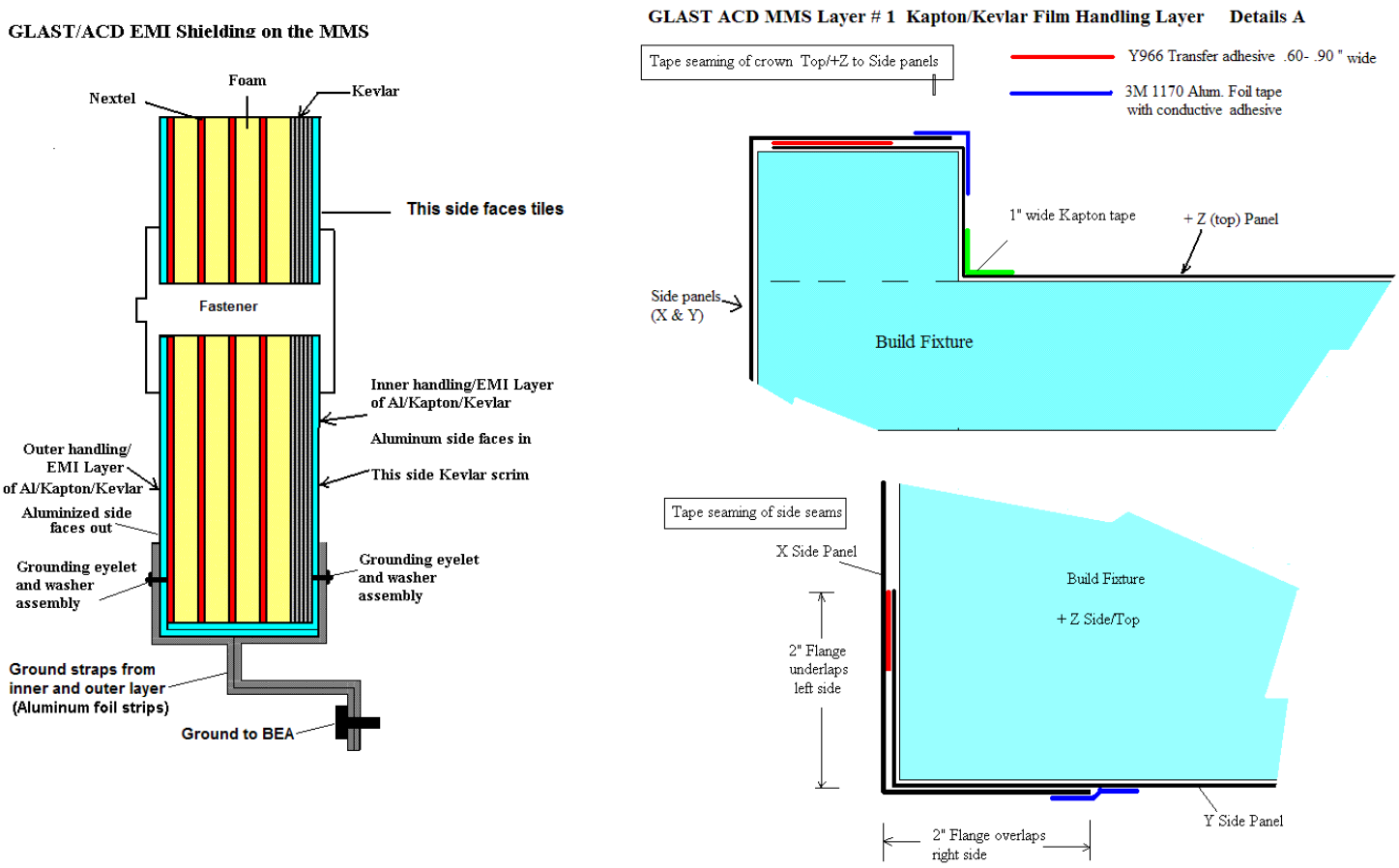
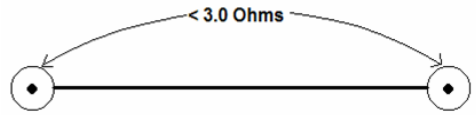
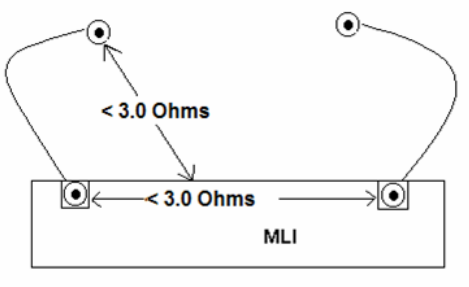
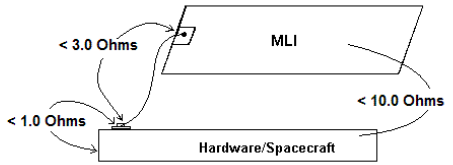


Figure 12. Grounding Matrix

ITEM	COMPONENT	REQUIREMENT	DESIGN/ IMPLEMENTATION	EVENT	VERIFICATION	
1	Ground wire assembly	<3.0 ohms lug to lug	Lug to Lug	Wire assembly		
2	Thermal Blanket ground tab to ground tab, or metallized layer to ground tab on individual MLI pieces.	< 3.0 ohms	Any metalized layer to lug end or lug to lug on one MLI.	Fabrication	MLI technician to measure resistance between random metalized layer or between multiple ground lugs after MLI fabrication.	
3	Thermal Blanket Area	None	No ground required on any metalized piece measuring 100 cm. sq. or less.	Fabrication		
		< 10.0 ohms from any MLI metalized layer to structure/SC	MMS or MLI layers will require 2 grounds.	Fabrication	MLI technician to measure resistance during fabrication.	
			Any point on the blanket to be within 2 meters of a ground tab. Keep grounding tabs on opposites sides of MLI (as practical).	Fabrication		
4	Ground wire lug to hardware (S/C attachment point)	<1.0 ohms	Fastener and surface area to make good contact.	Installation		

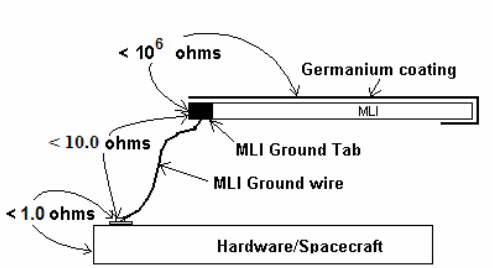
ITEM	COMPONENT	REQUIREMENT	DESIGN/ IMPLEMENTATION	EVENT	VERIFICATION	
5	Thermal Blanket aluminized surfaces	< 10.0 ohms to spacecraft ground lug	After connection of ground wire lugs to spacecraft.	Installation	Check random inner layer of MLI.	
6	Germanium/ Black Kapton/Scrim					
6a	Germanium coating	<10^6 ohms/Sq.		Materials Acceptance	Measure with 2 point probe.	
6b	Black Kapton	Surface resistance	Contact ground through Germanium	Materials Acceptance	Cannot measure. Black Kapton layer is sandwiched between Germanium & scrim.	Germanium coated Black Kapton film with scrim 
6c	Germanium coating to MLI Ground tab	<10^6 ohms/Sq.	Through woven ground tab on MLI, contact ground with MLI tab.	Installation		
6d	Germanium/Black Kapton/Scrim to structure	<10^6 ohms/Sq.	From outer Ge coating to structure	Installation		

FIGURE 13. Kevlar and Nextel Layers and seaming - Exploded View

Note that the position of seams is staggered from layer to layer. Refer to the WOA for seam and material overlap details

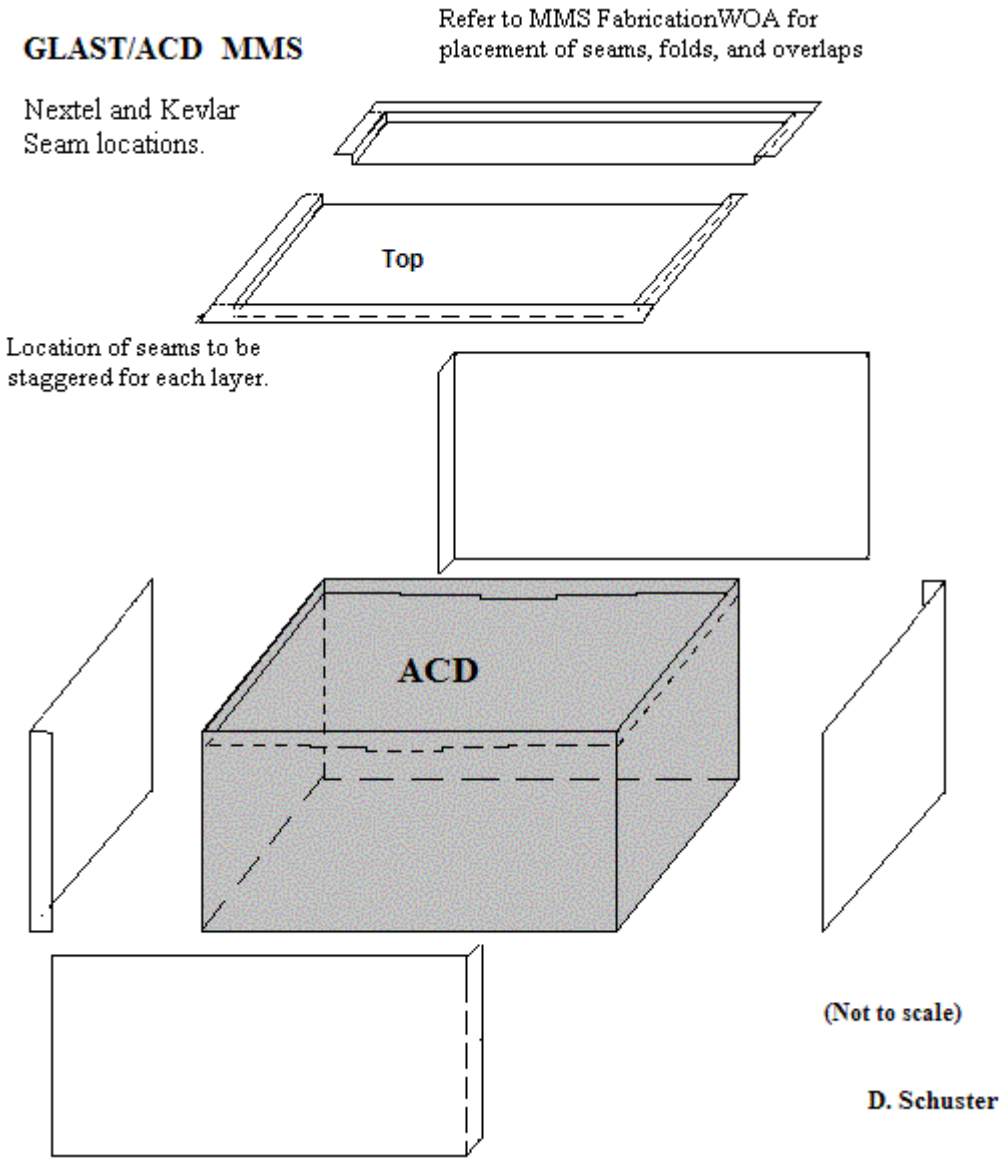
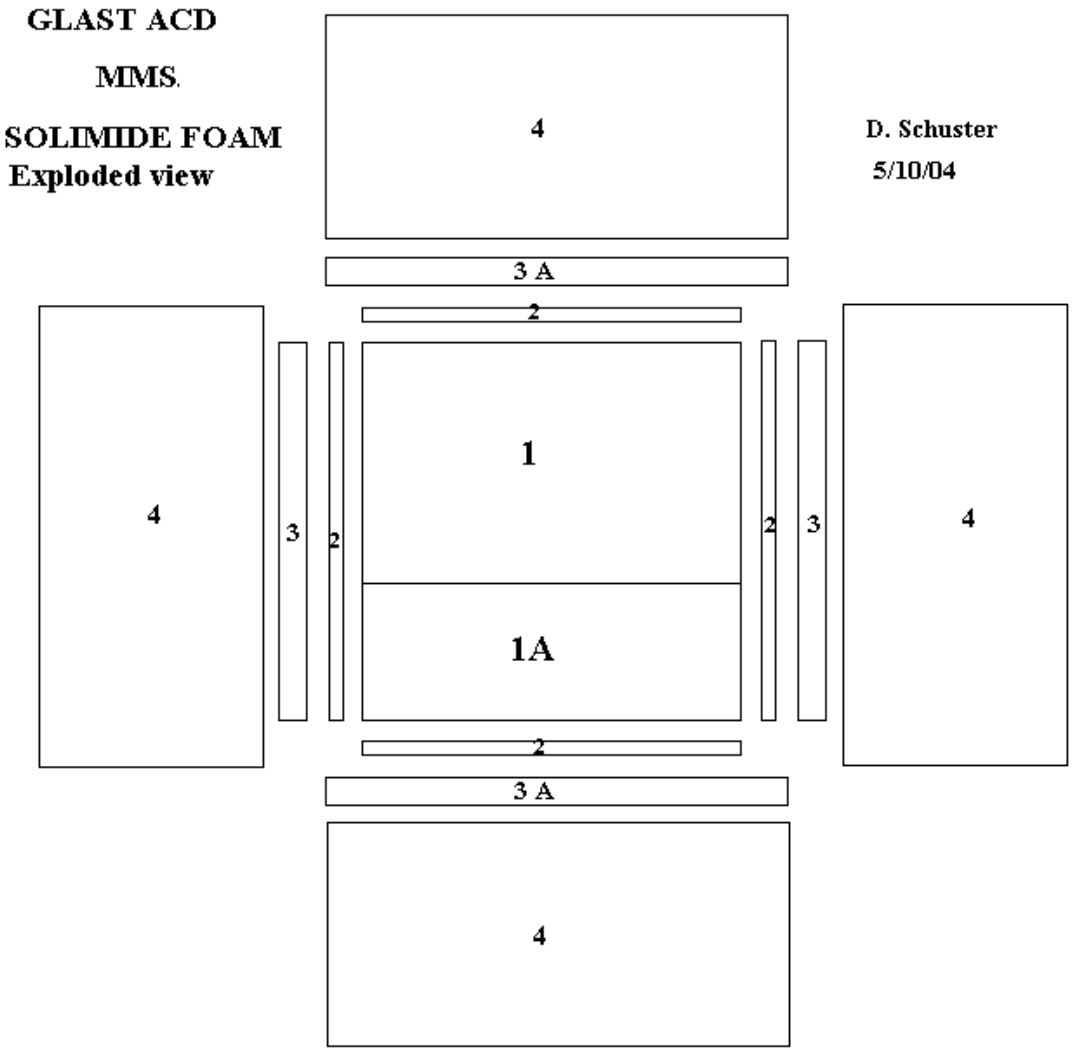


FIGURE 14. Solimide Foam Layers of MMS – Exploded view



Minimum number of pieces to cut and assemble per layer = 14 pieces

All pieces to be cut with right angle edges so that edges will butt flush to each other for spot welding.

FIGURE 15. Fastener Types and Locations Note: Changes were made to quantity and placement of the Post tops during installation. This drawing is here as a reference only,

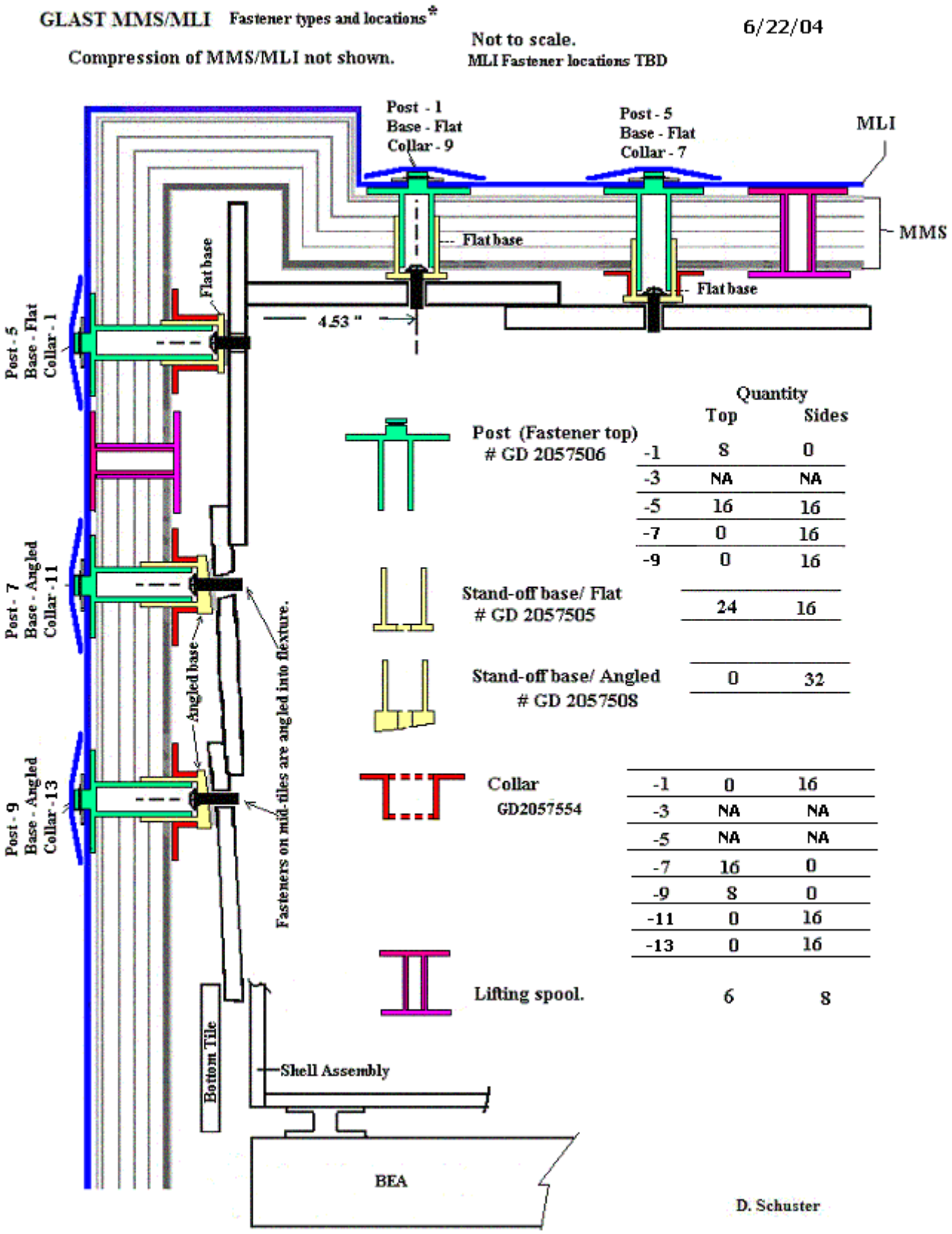


FIGURE 16. MMS Fastener Locations

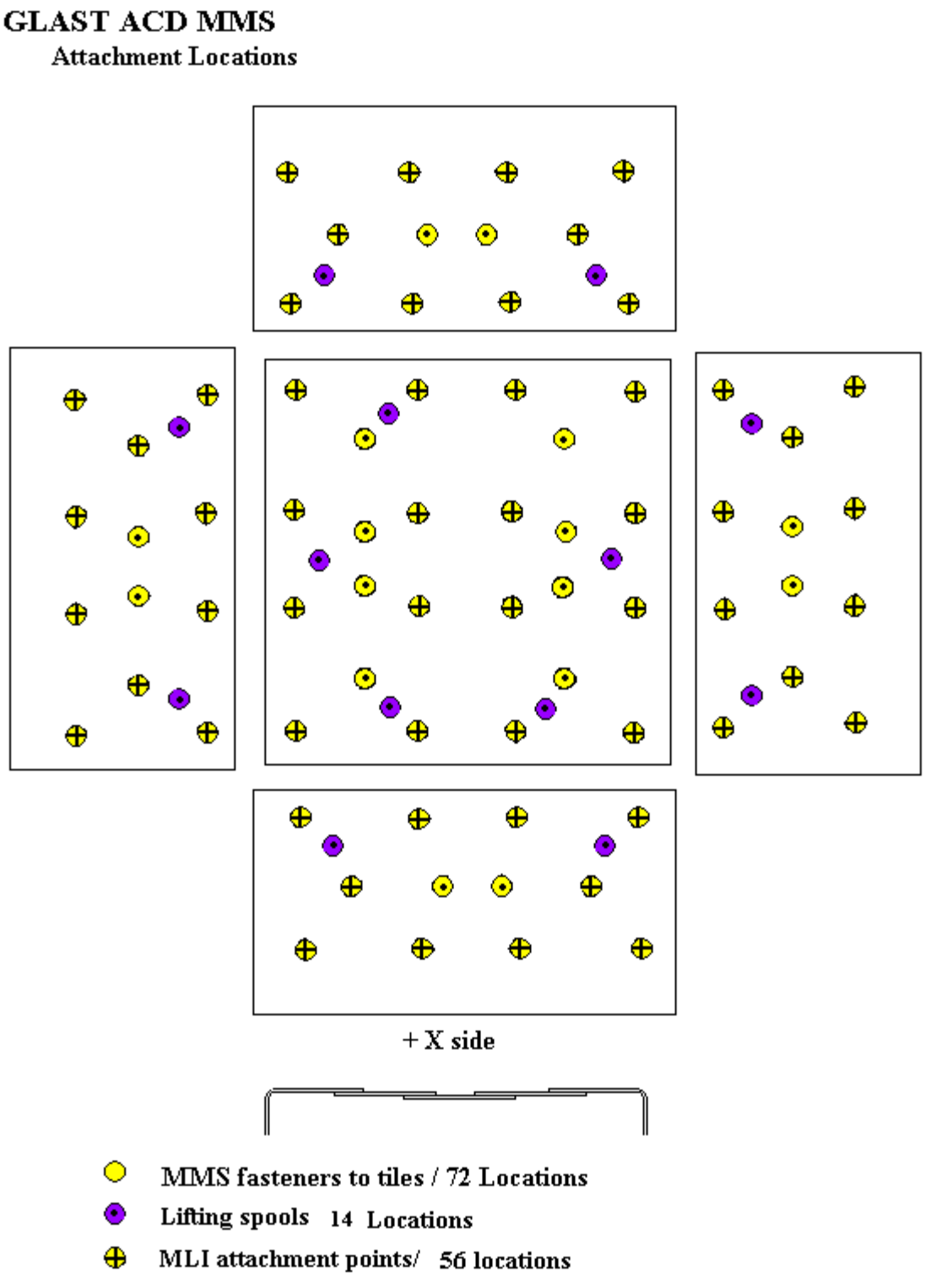
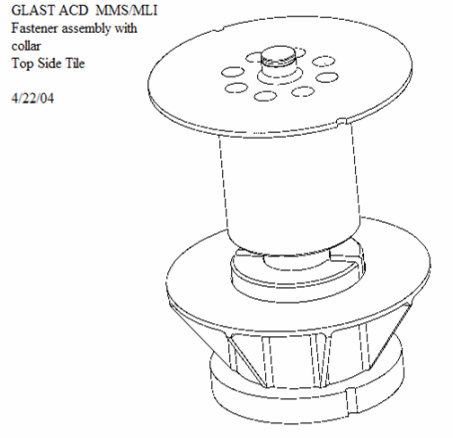
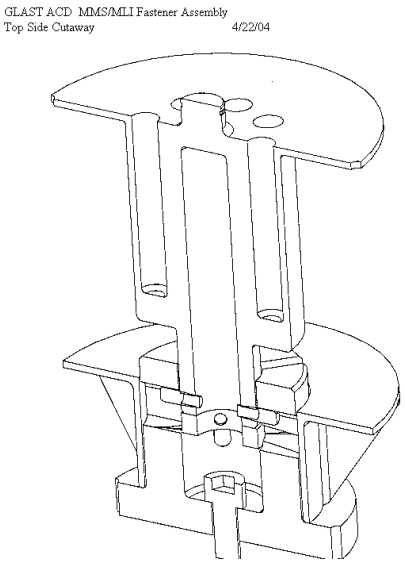


FIGURE 17. Details for fasteners





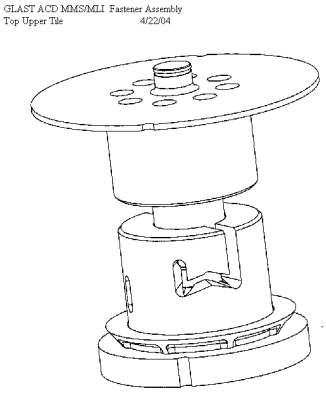


FIGURE 18 Lifting Spool

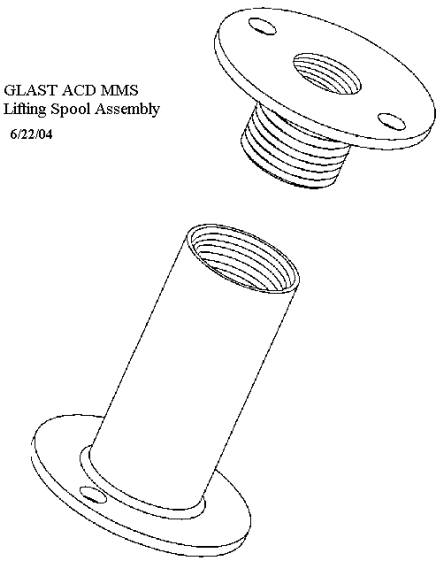


FIGURE 19. Lifting Spool with reinforcements

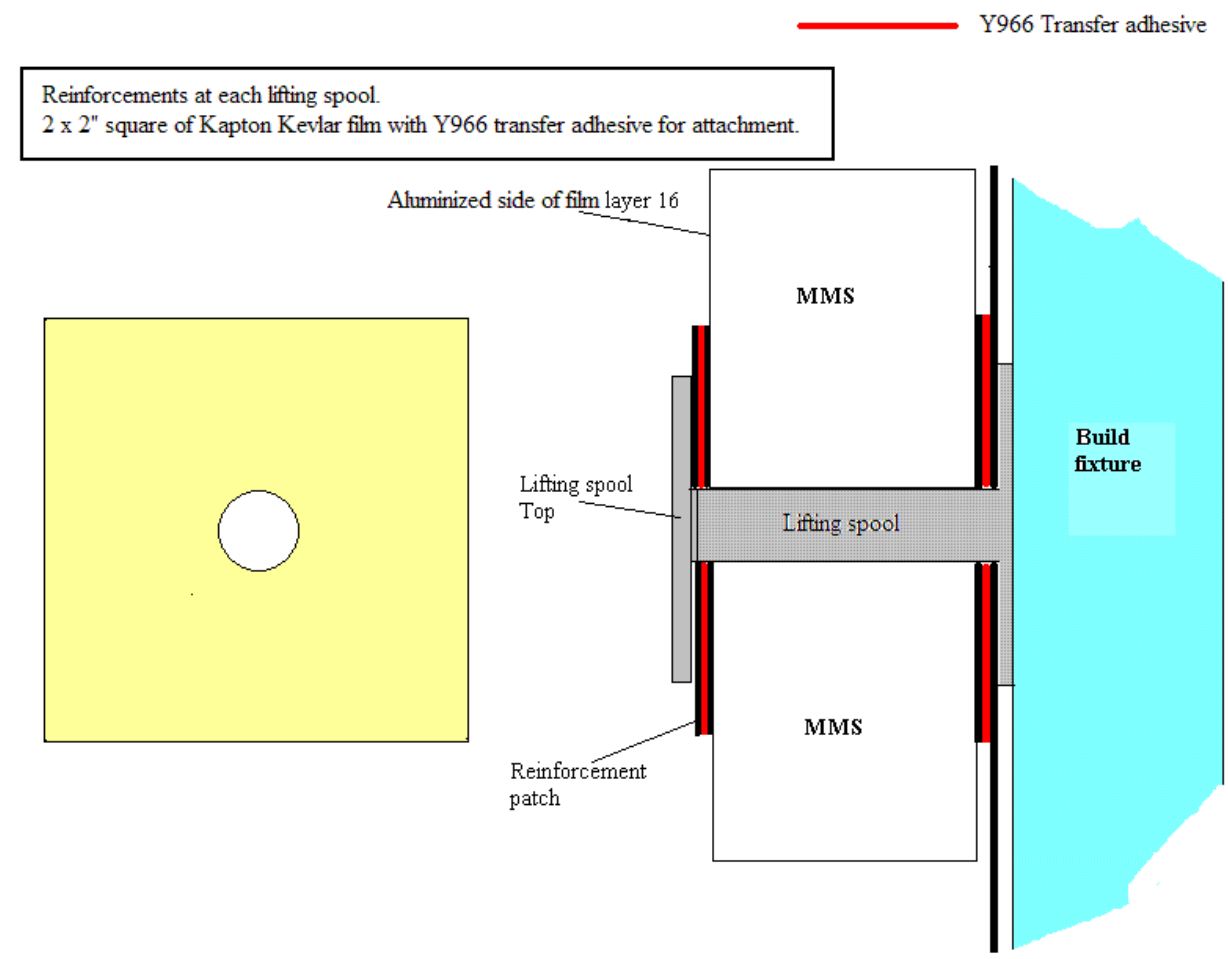


FIGURE 20. Cross-section of fastener detail with MMS/MLI

Note: Dimensions on this drawing wer not finalized using adjusted MMS Thickness. Use only as a reference.

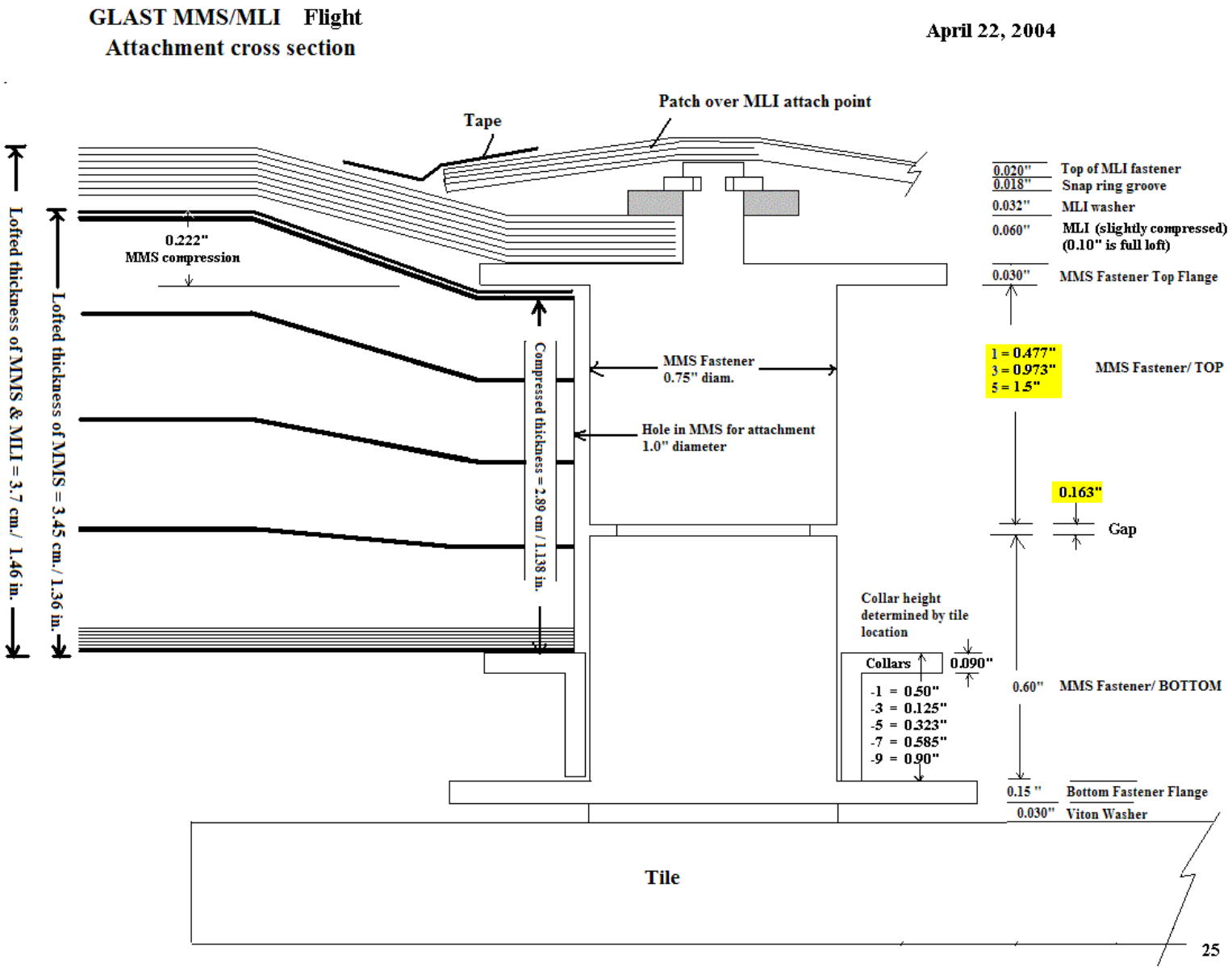


FIGURE 21. MMS LIFT FIXTURE

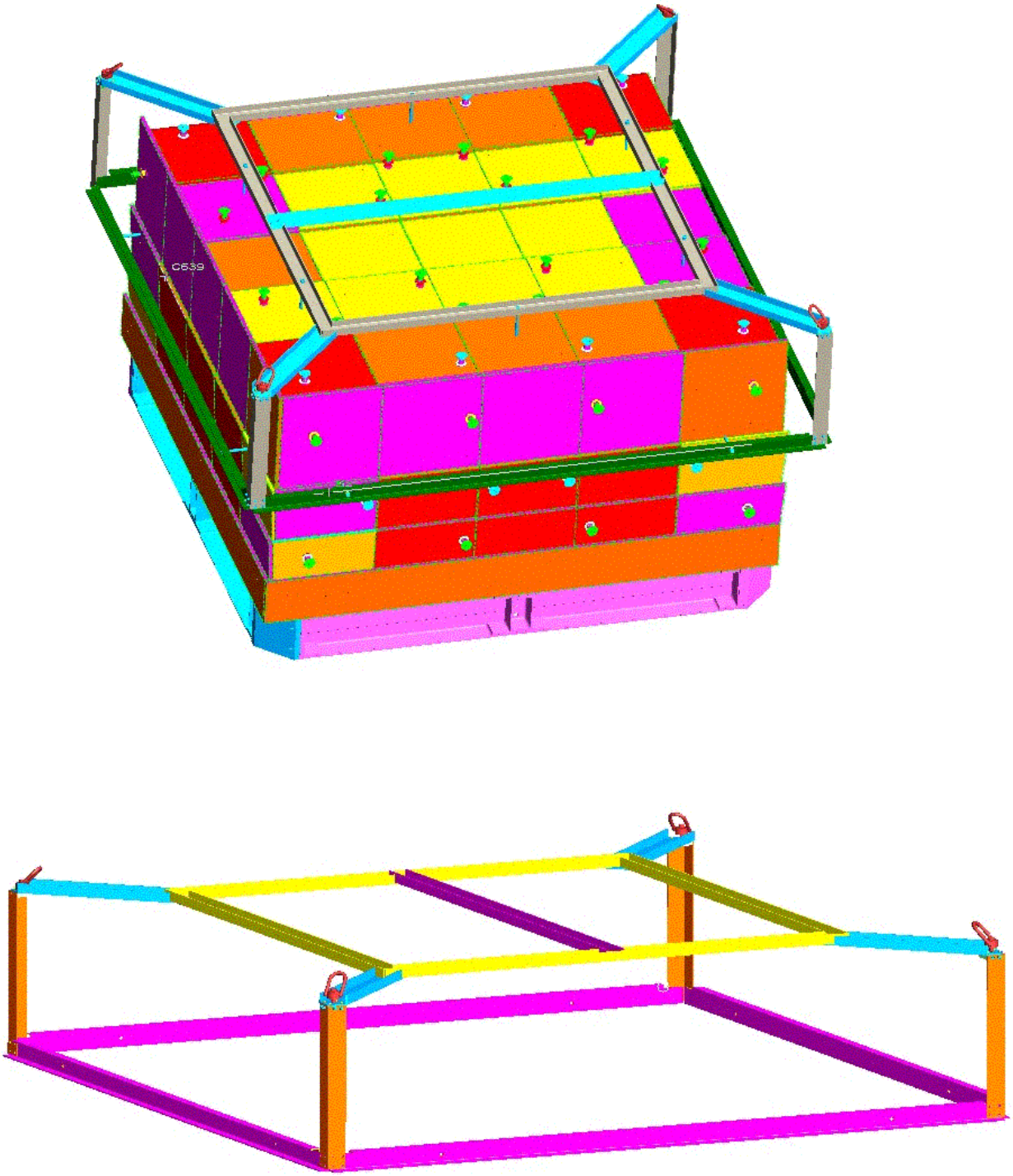


Figure 22. Venting

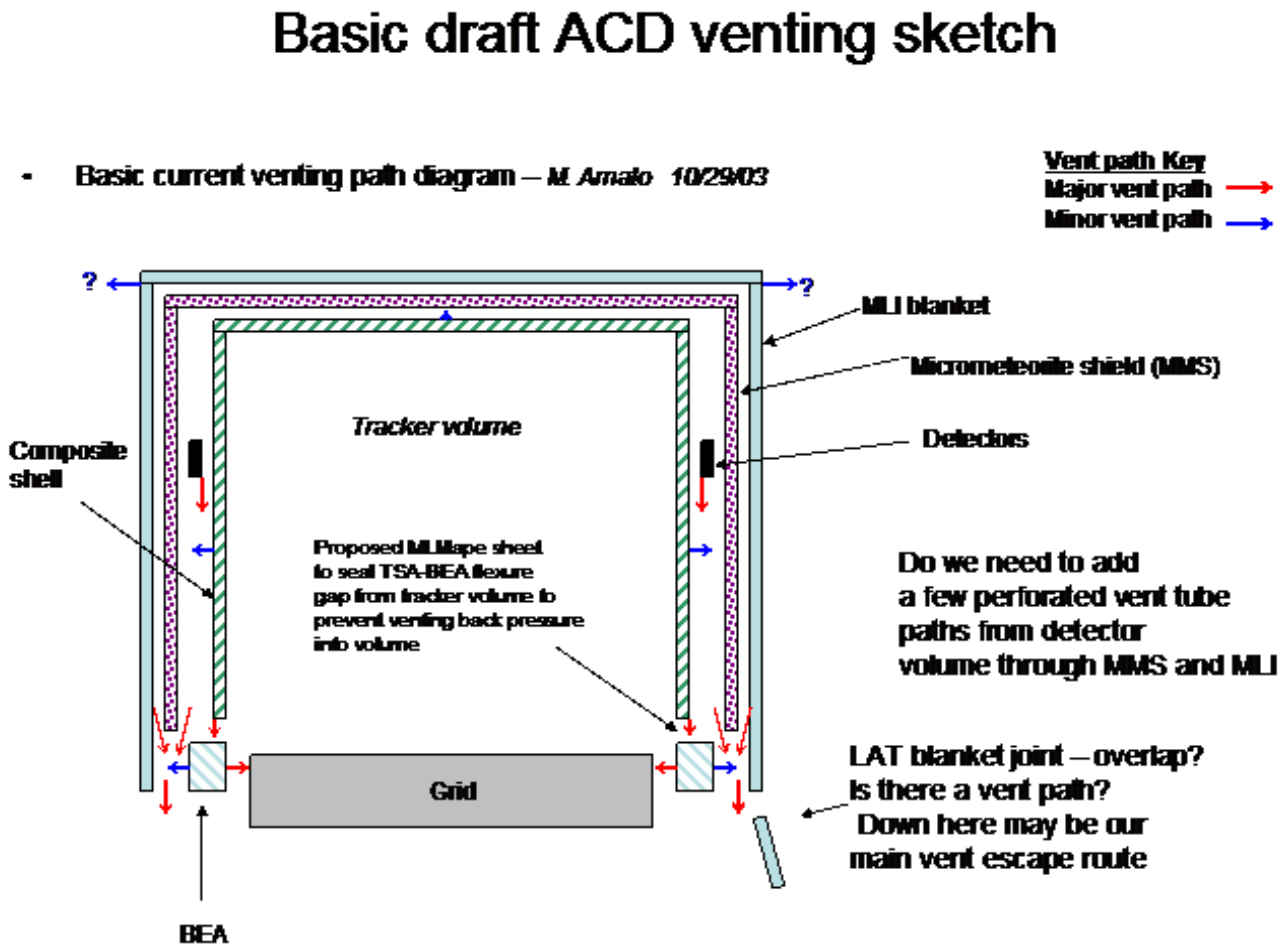


Figure 23. GLAST ACD Venting Volume Summary - Swales/ August 24, 2004

Volume description*	Volume (in^3)	Required Vent Area (in^2)**	
		Filtered	Unflitered
ACD	85300	106.6	21.3
ACD + Tracker	209000	261.3	52.3
MMS	22340	27.9	5.6
MLI	1643	2.1	0.4

* Volumes conservatively calculated. Assumes entire component volume is air and does not account for displacement of air by any matter within the volume.

** Calculated by using same assumptions as found in GLAS VENTING MEMO by E. Grob, dated 5/1/2001 including same launch environment (Delta II). Also assumes same filter capacities.

Figure 24. MMS Vent/Filter Plan

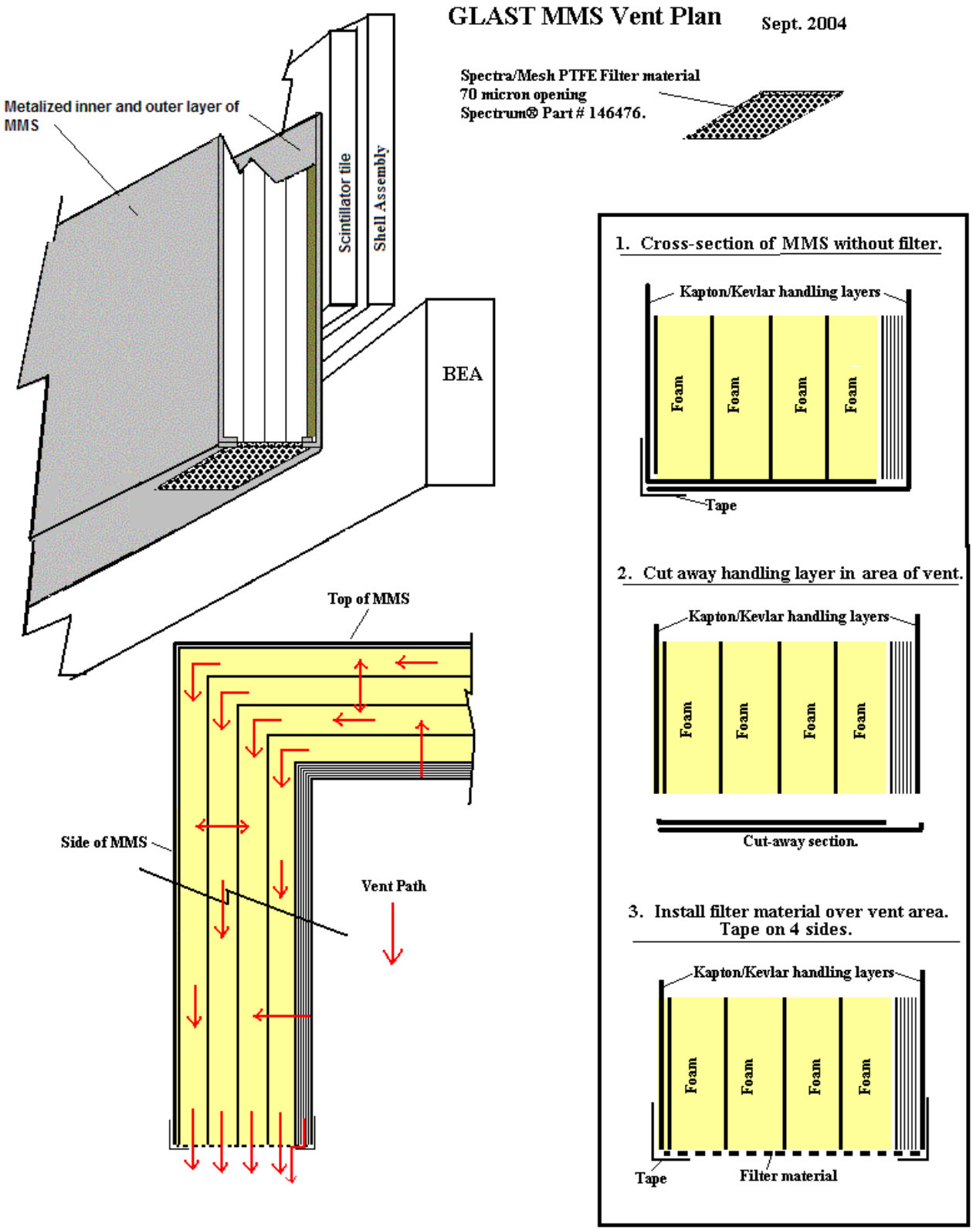


Figure 25. Outgassing Data

OUTGASSING DATA

GLAST/ACD MMS-MLI Outgassing Material Reference **August 5, 2003**

		Outgassing				
	Material	**(TML<1.0, CVCM<0.1)**				
		TML	**CVCM**	**WVR**	**Shrink.**	**Notes**
1	**Kevlar KM2 Style 705 -898**	?	?	?		Not tested. Specs are from 2 other Kevlar types.
		1.91_a	0.08	1.15		a)Fabric 645 Yarn 195
		3.13_b	0.19			b)Kevlar 29 Yellow Fibers
2	**Solimide AC 530**	1.51	0.01	1.06	<2%*	* Volume shrinkage@204° C.
3	**Nextel 312 AF-10**	0.01	0.01	0.00		Cure temp 550/Air (1Hr.)
	312 AF-12 (for reference)	0.07_c	0.00	0.00		cHeat cleaned
	312 AF-12 (for reference)	0.63_d	0.12	0.06		dNot cleaned
4	**0.5 Mil Kapton w/Kevlar Scrim**	?	?	?		Cannot find a record of this being tested. Fred and I are looking.
5	**Germanium/Black Kapton/Scrim**	1.63	0.01	1.27		Unclear if this is the same material for ACD
6	**Dacron netting/B2A**	0.34	0.01	0.11		Multiple references in Outgassing Data Guide
		0.15	0.00	0.09		
	Tapes and Fasteners TBD					