GLAST Large Area Telescope:

Tracker Subsystem
MCM Production Readiness Review

MCM Parts and Materials

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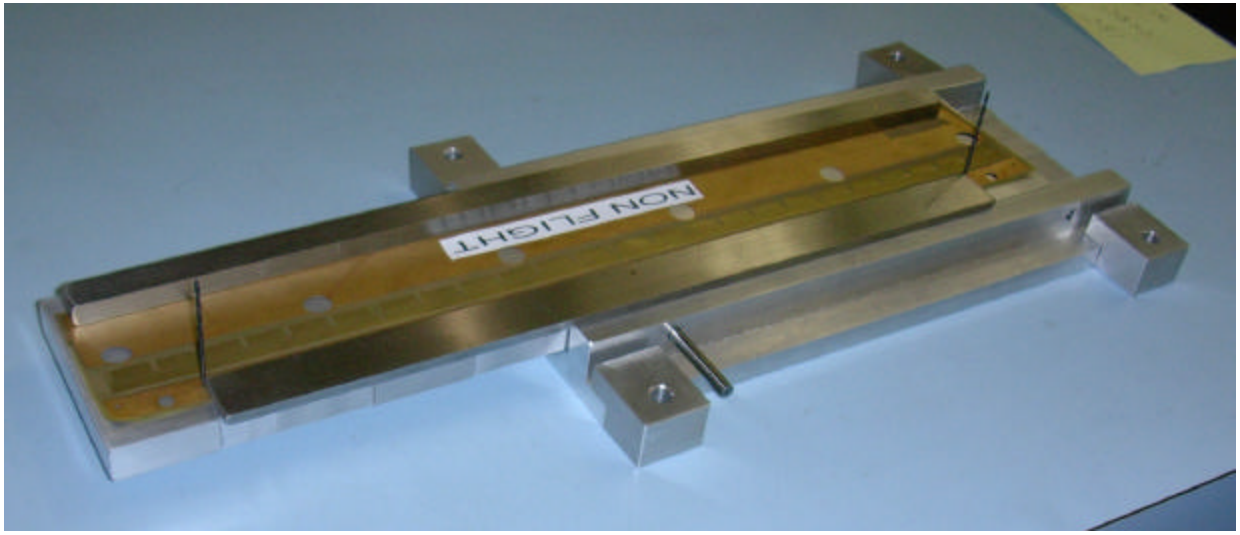
MCM EEE Parts

1. PWB:
   - Approved by LAT PCB.
   - Built by DDI to released drawings LAT-DS-00077-6 and LAT-DS-00368-5 and released specification LAT-DS-01448.
   - Receiving-inspection performed at SLAC (e.g. AIDR #70).
   - Machined by Holt to redlined drawings. All information is now on released drawings LAT-DS-00077-9 and LAT-DS-00368-7.
   - Inspected by CMM at SLAC (e.g. AIDR #70).
   - DDI panel coupons are tested by GSFC. One panel has failed thus far. Speed of coupon testing is an issue being worked by N. Virmani.
   - We have PWBs machined for the first MCM flight lot, and GSFC has been given the corresponding panel numbers for priority testing.
   - We have the list of tested panels and have selected from them PWBs for the next machining operation at Holt.

MCM EEE Parts

2. Pitch Adapter Flex Circuit
   - Manufactured by Parlex to released drawing LAT-DS-00370-6.
   - Class 3, type 1, use A, per IPC 6013 (see notes on drawing).
   - Single-layer circuit, so coupon testing is not needed.
   - New inspection procedure and tooling (see below) to screen these parts for excessive shrinkage (>100 microns).
   - The first lot of parts is being screened this week.
   - Still needs formal PCB approval.



MCM EEE Parts

3. GTFE ASIC (LAT-DS-00389)
   - Fabricated by MOSIS to released specifications LAT-PS-01201
   - Radiation qualification testing was completed on the flight lot.
     - Plan: LAT-PS-01325.
     - Results: see the following slides.
   - Wafer probe screening at UCSC to released and PCB-approved procedures LAT-PS-01250 and LAT-TD-00247. AIDR forms are archived at SLAC and detailed data are in an MS Access database.
   - Wafer lapping, dicing, and inspection by GDSI to released specification LAT-PS-01321.
   - Extensive testing has been done on the Mini-Tower to verify that the Tracker performance specifications are met.
   - Final approval by the LAT PCB awaits completion of qualification testing of flight MCMs (LAT-TD-02366).
   - Flight quantities need to be shipped to Teledyne.

MCM EEE Parts

5. GTRC ASIC (LAT-DS-00893)
   - Fabricated by MOSIS to released specifications LAT-PS-01222.
   - Radiation qualification testing was completed on Version 6, and total dose testing is being repeated on the Version 7.
     - Plan: LAT-PS-01325.
     - Results: see the following slides.
   - Wafer probe screening at UCSC to released and PCB-approved procedures LAT-PS-01250 and LAT-TD-00248. AIDR forms are archived at SLAC and detailed data are in an MS Access database.
   - Wafer lapping, dicing, and inspection by GDSI to released specification LAT-PS-01321.
   - Extensive testing has been done on the Mini-Tower to verify that the Tracker performance specifications are met.
   - Final approval by the LAT PCB awaits completion of qualification testing of flight MCMs (LAT-TD-02366).
   - Enough parts have been tested, diced, screened, and shipped for 3 towers. Testing of the remaining wafers is almost completed.

LAT TKR RADIATION TESTING: TID

5 year Total Dose in LAT:

Expected 5 Y TID **< 0.8 krad**

(includes LAT self-shielding)

Design 5 Y TID **= 4 krad**

Testing TID **= 10 krad**

LAT TID Testing Status:

Testing by INFN Padova (R. Rando)
TKR ASICs rad hard beyond 40krad
GTFE & GTRC6 done, GTRC7 planned for Feb. 2004 at Legnaro

ASIC Functionality Tests

Test	Short Description
GTRC Register R/W	Load bit pattern in GTRC registers, read it back and check for errors.
GTFE Register R/W	Load bit pattern in GTFE registers, read it back and check for errors. Access GTFE individually.
GTFE Register Broadcast R/W	Load bit pattern in GTFE registers, read it back and check for errors. Broadcast commands.
GTRC Addressing	GTRC register R/W test, repeat for all possible GTRC layer Ids.
Hard and Soft Reset	Load non-default pattern in GTFE registers. Reset and read back pattern. Repeat for soft and hard reset.

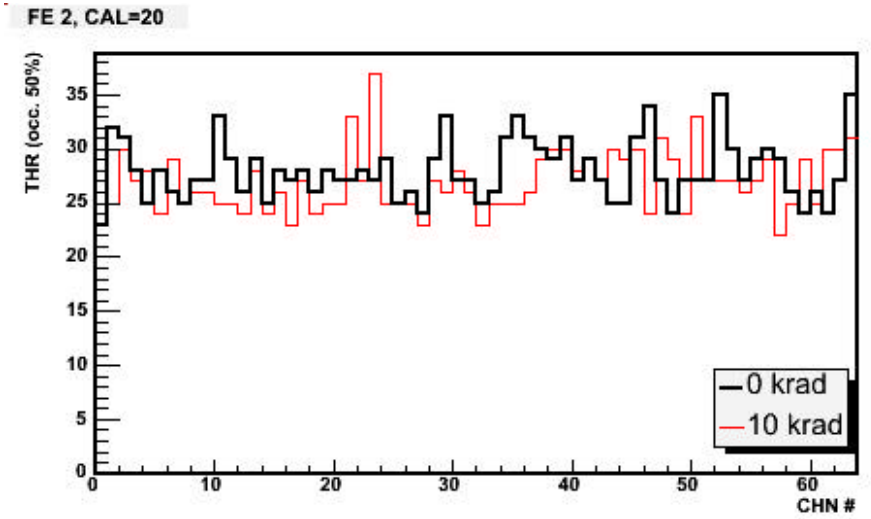
GTFE Performance Tests

Test	Short Description
Noise Rate	Measure noise rate on Layer-OR channel. No calibration strobe.
Readout with Charge Injection	Complete readout sequence, with calibration strobe. Repeat for all GTFE internal buffers. Check event buffer and Layer-OR.
Register Mask Tests	Disable all channels. Complete readout sequence, with calibration strobe. Check event buffer and Layer-OR to be empty.
Threshold Test with Charge Injection	Set threshold to Complete readout sequence, with calibration strobe. Check event buffer and Layer-OR.

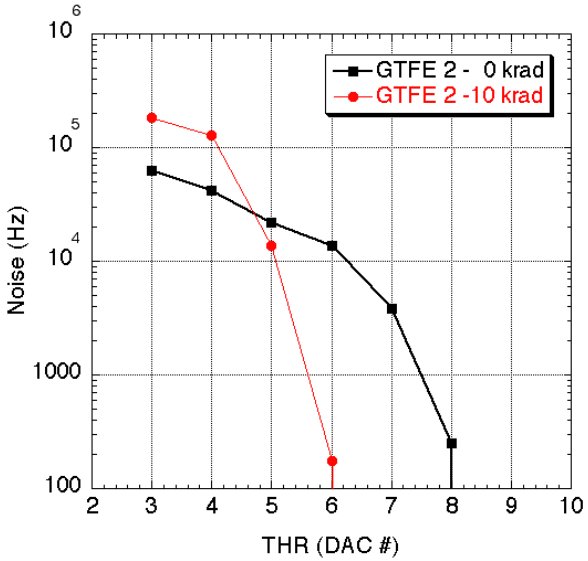
LAT TKR TID TEST RESULTS

Power: <5% increase in 10 kRad

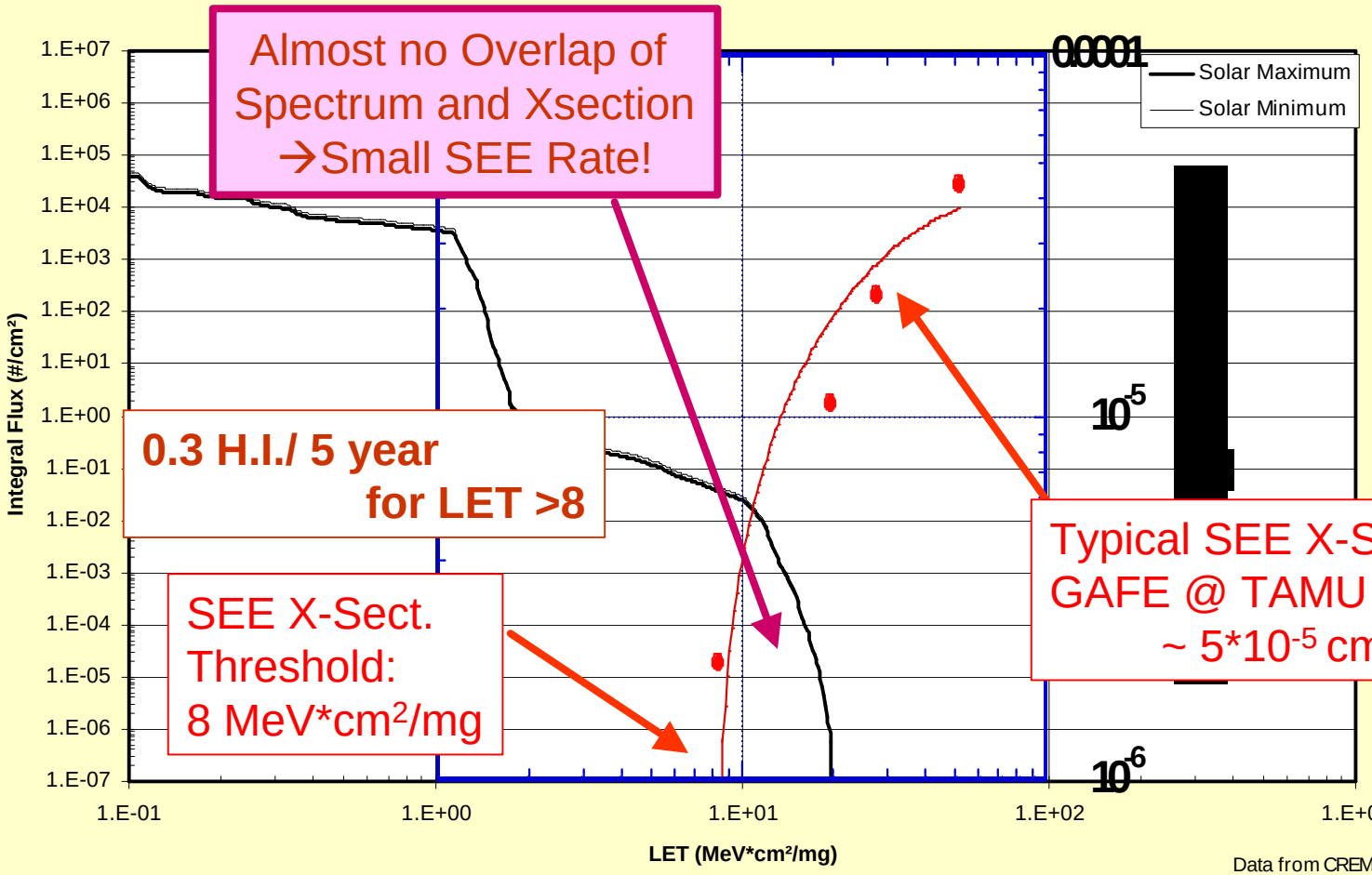
GTFE Gain:
No change in 10 krad



GTFE Noise
ASICs without load



ASIC SEE XSECTIONS & H.I. SPECTRUM



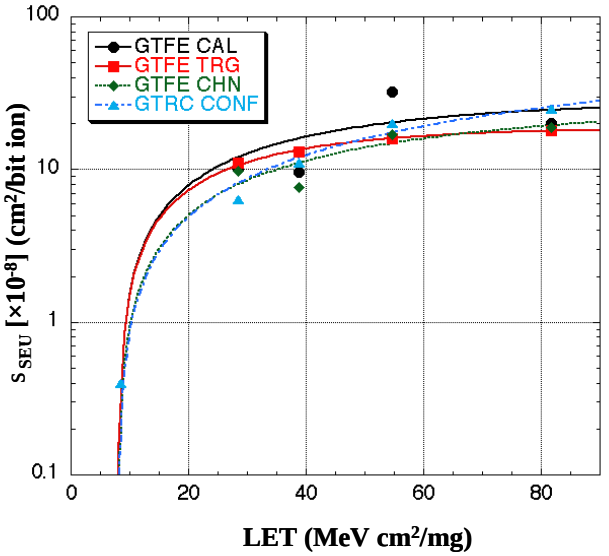
SEE RATES in LAT TKR

All LAT ASICs have by now been irradiated with H.I.
TKR ASICs were irradiated by INFN Padova at Legnaro (R. Rando)

No Latch-up (SEL) event (potentially destructive) has been observed for LAT ASICs (either at BNL, Texas A&M U. or Legnaro (Italy)).
Saturation Device SEL Xsection S < 10^{-9} cm^2
For entire LAT TKR: SEL Rate < $1.5*10^{-6}$ in 5 years

Bit Upset (SEU) corrupt Configuration/Data
Xsections depend on functionality
Device cross section S ~10^{-5} cm^2

Name	# in LAT	S [cm^2]	# SEU / 5 Years
GTFE	13,824	4.9E-05	7.E-03
GTRC	1,152	1.0E-05	1.E-04



Applicable LAT TKR DOCUMENTS

- **Radiation Levels:**
  - 433-SPEC-0001 GLAST Mission System Specification, CH 07
  - LAT-SS-01165 TID Self-Shielding of the GLAST LAT TKR
- **Radiation Test plans:**
  - LAT-PS-01325 Radiation Test Plan for the LAT TKR ASICs
  - LAT-PS-01604 Radiation Test Plan for the LAT DAQ ASICs
- **Radiation Test Results with Flight Parts :**
  - LAT-TD-02982 LAT TKR SEE Tests at Legnaro
  - LAT-TD-02497 LAT TKR SEE Tests at TAMU
  - LAT-TD-0xxxx LAT TKR ASIC TID Tests

MCM EEE Parts

4. Omnetics male nano-connector (A8485).
   - Passed qualification tests at GSFC, until we found the problem of unreliable bonding of the metal shell.
   - Omnetics has improved their process, using bead blasting of the surfaces before bonding.
   - A first lot of new connectors is expected this week.
   - Some of these connectors need to go back to GSFC for final qualification.
   - LAT PCB approval is pending completion of GSFC qualification.
8. Novacap 56 nF, 250 V capacitor (1210B563K251YHTM)
   - Special procurement, to specification LAT-PS-01194.
   - This specification includes rigorous screening requirements.
   - Paired in series on the PWB, for increased safety against failure, which would short circuit the bias of an SSD ladder.
   - Approved by the LAT PCB.
   - These parts were drop shipped to Teledyne, and the lot/date codes are in the Teledyne system.

MCM EEE Parts

26. Omnetic Connector Saver (A8597)
  - This part is EGSE; it does not fly.
  - Most existing parts suffer from 3 problems:
    - Jack screws are too long, making mating dangerous.
      - Preproduction work-around is to mate them to the male connectors before mounting the connectors to the MCM.
    - The metal shells on the female end are not strong enough to withstand the torque on the jack screws.
      - Omnetics is correcting this with a new design.
    - The metal shells debond too easily.
      - Require the same correction as for the male connectors.
  - To proceed with production while waiting for new parts from Omnetics, we can use the above work-around and mate them with minimal torque.

MCM EEE Parts

All of the following surface mount parts are fully qualified QML parts, with full traceability. All are approved by the LAT PCB. All were drop-shipped to Teledyne, and the lot and date codes are in the Teledyne system.

BOM	Part Number	Description
6	CDR01BX332 BKSR TM	CAP 3.3 nF, 100 V Avnet
7	CWR09CC475KBB/TR	CAP 4.7uF, 4V VISHAY SPRAGUE
10	H0505CPX000	RES, 0 OHMS, SOTA
11	M55342M02B12K0R	RES, 12K 5%, SOTA
12	M55342M02B39K0R	RES, 39K 5%, SOTA
13	M55342M02B100DR	RES, 100 1%, SOTA
15	D55342M07B270KR	RES, 270K 5%, SOTA
16	M55342M02B680KR	RES, 680K 5%, SOTA
17	CWR09CC685KBB/	CAP, 6.8UF, 4V, VISHAY SPRAGUE

MCM EEE Parts

9. Tyco Raychem 300 mA Polyswitches (SMDC014-2).
   - Special procurement to specification LAT-SS-01116.
   - This specification includes screening and qualification requirements.
   - All parts have been screened, and the qualification program is complete (see following slide).
   - The parts were drop shipped to Teledyne, and the lot and date codes are in the Teledyne system.
   - Applicable documents:
     - LAT-SS-01116-05 Polyswitch Specifications
     - LAT-PS-02245 Procedures for Acceptance Testing
     - LAT-TD-02603 Technology Acceptance Testing
     - LAT-TD-02500 Accelerated Thermo-vac Aging Testing
     - LAT-TD-02591 Results from 10% Testing at Raychem

Polyswitches for LAT TKR

Space Qualification of "resettable fuses" for Space Flight

Raychem generic part miniSMD014

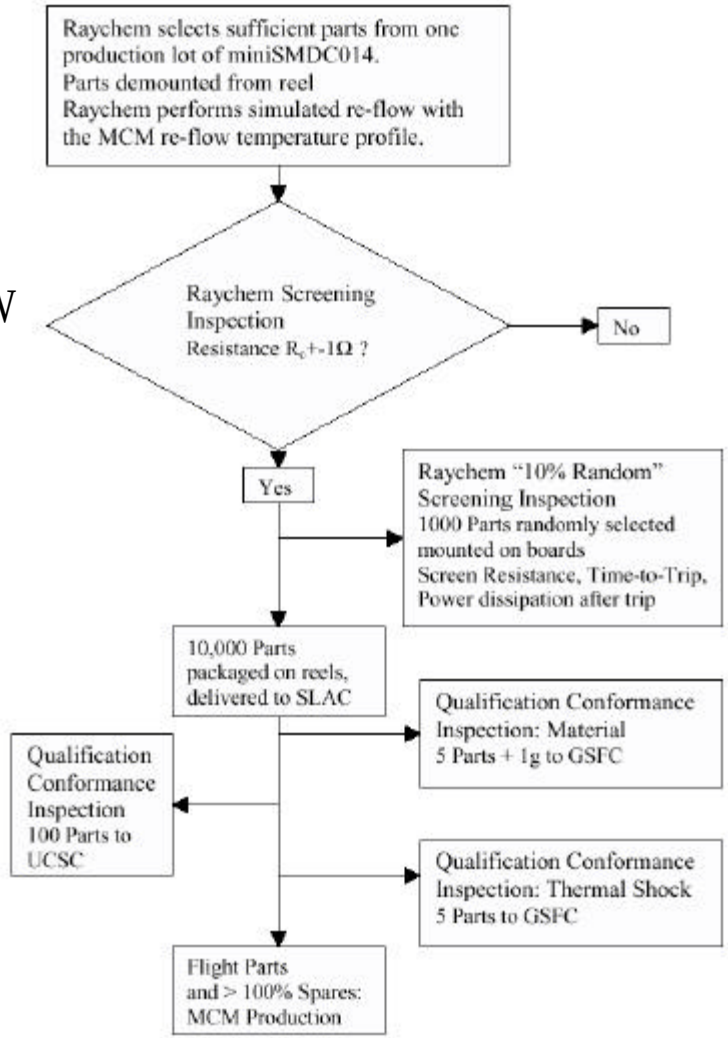
Test Program:

Tight Screening 100% by Raychem R = 4 +-1W (10,000 parts)

10% Testing at Raychem for Resistance R, Time-to-Trip TTT, Post-trip Power (1,000 parts)

Technology Acceptance (UCSC) (36 parts)

Accelerated Thermo-vac Aging (UCSC) (50 parts)



No part failed (open or closed) during any test

Polyswitches for LAT TKR

Qualification Tests at UCSC. UC Santa Cruz undergrads: J. Numinosum, M. Auric, J. Wray

Test Flow	# of pieces	Test # (See Tables 7-11)
Visual	100	421
E: Electrical / Environmental	30	Without conformal coating: 521, 522, 532, 534 and followed by checks # 411, 412, 413, 414, 421
	6	with conformal coating 535 , 521, 522, 532, 534 and followed by checks # 411, 412, 413, 414, 421
L: Accelerated Aging	50	536, followed by checks # 411, 412, 413, 414, 421
S: Soldering / Reworking	6 (from E)	511, 512, 513 and followed by checks # 411, 412, 413, 414, 421
M: Material	5 + ~1g	Checks # 431, 432
T: Thermal Shock	5	533
Visual	95	Check # 421

Raychem 10% Testing

Parameter Screened (at 22+- 5ºC)	Acceptance Range From ERPQ41898-11
Resistance R	3 Ω < R < 6 Ω
Time-to-Trip TTT @ 1.5A	30ms < TTT < 200ms
Power Dissipation after trip @ 60V	0.55 W < P < 0.65W

Polyswitches for LAT TKR

Table 8. Qualification Electrical Check Definitions

Test	Check #	Purpose	Specification	Condition	Configuration
Resistance during closed condition	411	Verify resistance at closed condition	Resistance shall be within $R_c \pm 1\ \Omega$, $3.5\ \Omega < R_c < 4.5\ \Omega$.	Ambient, MCM mounted	Measure at 0.5V
Current carrying capability (Hold current)	412	Verify current carrying capacity	The current shall be more than 140 mA	Ambient, MCM mounted	Measure at 140 mA for 30 minutes
Power dissipation after trip	413	Verify power dissipationc apacity after trip	The power consumption shall be greater than 0.5W and less than 1.0 W.	Ambient, MCM mounted	Measure at 5V
Time to Trip	414	Verify time to trip	Trip time shall not exceed 100 ms at 2 A.	Ambient, MCM mounted	Source 2.0 A current, with 20V supply

MCM Parts

18. Screws for mounting the connectors: M1X0.25 X 0.120" LG FLAT HD CS, SST. All parts are in hand; need to ship to Teledyne.
28. Custom storage base (Azimuth Electronics): all parts are in hand; need to ship to Teledyne.
29. Custom storage cover (Azimuth Electronics): all parts are in hand; need to ship to Teledyne.
30. Magnetic screws for mounting the MCM into the storage base: M1.6 X 0.45 X 4 MM SHCS ALLOY STL 12.9. About half the required parts are in hand; need to ship to Teledyne.

Materials

BOM	Description	LAT Approved	Part Number
21	HYSOL FP4450, DIE ENCAPSULANT	Yes	TELEDYNE #7261693-1
14	HYSOL FP4451, DIE ENCAPSULANT DAM	Yes	TELEDYNE #7261685-1
19	BOND WIRE AL 99%, Si 1%, .001" DIA	Yes	TELEDYNE #7118118-23
20	SCOTCHWELD 1838 B/A, EPOXY, GREEN	Yes	TELEDYNE #7261679-1
22	EPO-TEK H20E, DIE ATTACH, EPOXY	Yes	TELEDYNE #7261105-1
23	SOLDER WIRE	Not yet	TELEDYNE #7506502
25	SN62, SOLDER PASTE	Not yet	TELEDYNE #7506598 OR # 7506598-1
27	HUMISEAL 1A2O, CONFORMAL COATING and THINNER	Yes	TELEDYNE #7261633 & TELEDYNE #7261638

Traceability

- Teledyne has entered into their system the lot/date codes of the flight parts that they have received.
- Teledyne has provided those codes to us, which can be found on the MCM EEE parts Excel spreadsheet.
- SLAC will send the relevant traceability information for those flight parts yet to be shipped to Teledyne.