I&T Integration Sequence, MGSE, and Procedure Development Plan

1. ABSTRACT
This purpose of this note is to delineate the LAT I&T sequence, the plan for Flight Assembly Procedure (F.A.P.) development, and the schedule for MGSE production.

2. FLIGHT UNIT I&T SEQUENCE AND CONFIGURATION
Note the following definitions regarding orientation of the LAT assembly: “upright” means tracker towers pointing upwards, “upside-down” means tracker towers pointing downwards, “sideways” means tracker towers pointing in a direction parallel to the ground. I&T takes the lead role in all steps except for those noted in bold face type. In those cases, the Subsystem with the lead role is indicated.

a) Flight Grid is mounted into the Grid Support Frame (MGSE-GSF).
b) MGSE-GSF is lifted with Hoisting Spreader Frame (MGSE-HSF)
c) MGSE-GSF is mounted into the Flight Mounting Stand (MGSE-FMS).
d) Grid bay protective closeouts are mounted to all bays. Grid purge lines are connected and dry air purge started.
e) LAT Auxiliary Cooling Plates (MGSE-ACP) integrated to +/- X sides of Grid.
f) Grid bay protective closeout is de-mounted.
g) Flight Grid is oriented upright and leveled.
h) Tracker (TKR) module is lifted with 5-ton crane, aligned, lowered onto and attached to Flight Grid Bay.
i) Calorimeter (CAL) module is lifted from underneath Flight Grid, aligned, inserted into Flight Grid Bay with Calorimeter Lifting Stand (MGSE-CLS), and attached to Flight Grid.
j) LAT is oriented sideways.
k) TEM and TEM Power Supply (TPS) modules are mechanically attached to underside of CAL module.
l) Flight Cables between TKR/CAL and TEM/TPS are mechanically fastened.
m) **Electronics Subsystem performs tower Flight Connector Mates from TKR/CAL to TEM/TPS.**

n) EGSE is connected to TEM/TPS connectors (savers).
o) Generate functional verification data packages for integrated single tower.
p) EGSE is de-connected from TEM/TPS connectors (savers).
q) Repeat steps f) through p) for all 16 towers. Towers may be integrated in parallel when
possible.

r) Heat Pipe Patch Plates, Downspout Heat Pipes, and Radiator Mount Brackets are integrated
to perimeter of Grid.

s) LAT is leveled (sideways orientation).

t) **Mechanical Subsystem thermally tests flight connections.**

u) GASU is mechanically fastened to underside of LAT.

v) Flight Cables between GASU and TEM modules are mechanically fastened to LAT.

w) **Electronics Subsystem performs Flight Connector Mates from GASU to TEM modules.**

x) EPU, SIU, PDU, and spare electronics modules are mechanically integrated to underside of
LAT.

y) Flight Cables between EPU, SIU, PDU, and GASU modules are mechanically fastened to
LAT.

z) **Electronics Subsystem performs Flight Connector Mates between EPU, SIU, PDU, and
GASU modules.**

aa) Flight Cables to inside of Cross-LAT Box Bulkhead Connectors are mechanically fastened to
LAT.

bb) **Electronics Subsystem performs Flight Connector Mates on inside of Cross-LAT Box
Bulkhead Connectors.**

c) EGSE is connected to outside of Cross-LAT Box Bulkhead Connectors (Savers).

d) Generate functional verification data packages for entire LAT without ACD.

e) EGSE is de-connected from outside of Cross-LAT Box Bulkhead Connectors (Savers).

f) LAT is oriented upright and leveled.

g) LAT is lowered so that top surface of tracker towers is at 4’4-5/16” (as per LAT-TD-00623-
01).

h) LAT is surveyed, including surveying of all 16 TKR module tops.

i) Cosmic ray muon surveying run to establish baseline relative position of TKR modules

jj) Auxiliary ACD installation tooling/guides are installed onto MGSE-FMS.

kk) Flight ACD is lifted with 5-ton crane, aligned, lowered onto and attached to Flight Grid.

ll) Auxiliary ACD installation tooling/guides are removed from MGSE-FMS.

mm) LAT is oriented sideways.

nn) **Electronics Subsystem performs Flight Connector Mates between ACD and Cross-LAT Box
Bulkhead Connectors.**

oo) LAT oriented upside-down and leveled.

pp) Cross-LAT Thermal Plate is lifted with 5-ton crane, aligned, lowered onto and attached to
Flight Grid.

qq) LAT is oriented sideways and leveled.

rr) **Mechanical Subsystem thermally tests flight connections.**

ss) EGSE is connected to outside of Cross-LAT Box Bulkhead Connectors (Savers).

tt) LAT System Test Readiness Review at SLAC.

uu) LAT Comprehensive Testing at SLAC.

vv) EGSE is de-connected from outside of Cross-LAT Box Bulkhead Connectors (Savers).

ww) MGSE-ACP are de-integrated from +/- X sides of Grid.

xx) MGSE-HSF is attached to MGSE-GSF.

yy) MGSE-GSF is de-mounted from MGSE-FMS, lifted by 5-ton overhead crane, lowered and
mounted onto Flight Storage Container (MGSE-FSC).

zz) EGSE is connected to outside of Cross-LAT Box Bulkhead Connectors (Savers).

aaa) LAT Auxiliary Cooling Plates (MGSE-ACP) integrated to +/- X sides of Grid.
bbb) Purge line is detached and re-attached through FSC bulkhead.
ccc) FSC is buttoned up and purged. Entire system goes through testing before shipping.
ddd) MGSE-FSC is shipped to NRL by airplane. Airborne Cosmic Test.
eee) MGSE-GSF is de-attached from MGSE-FSC, attached to MGSE-HSF, lifted by overhead crane lowered, and attached to Vibration Table Mount (MGSE-VTM).

fff) Flight Radiators are attached to Flight Grid.

122) LAT/MGSE-VTM assembly is lifted by overhead crane, lowered and attached to NRL Vibration Table.

hhh) MGSE-GSF is de-attached from Flight Grid.

iii) Vibration Table Shake Test.

jjj) MGSE-VTM is de-attached from NRL Vibration Table, MGSE-GSF is re-attached to Grid, LAT/MGSE-VTM is lifted by overhead crane, and lowered onto floor.

kkk) **Mechanical Subsystem thermally tests flight connections.**

lll) LAT is de-attached from MGSE-VTM, lifted by overhead crane, lowered and attached to Thermal Vacuum Mount (MGSE-TVM).

mmm) LAT/MGSE-TVM assembly is lifted with overhead crane, aligned, and mounted onto NRL Large Thermal Vacuum Chamber Table.

nnn) MGSE-GSF is de-attached from Grid and removed.

ooo) Auxiliary Radiation Plates and Nitrogen Shroud added to thermal vacuum chamber.

ppp) Thermal Balance Test.

qqq) Vacuum Cycling Test.

rrr) MGSE-GSF is attached to Flight Grid.

sss) LAT/MGSE-TVM is de-attached from NRL Large Thermal Vacuum Chamber Table, lifted by overhead crane and lowered onto floor.

ttt) MGSE-GSF is de-mounted from MGSE-TVM, lifted by 5-ton overhead crane, lowered and mounted onto MGSE-FSC.

uuu) Purge line is detached and re-attached through FSC bulkhead.

vvv) FSC is buttoned up and purged. Entire system goes through testing before shipping.

www) MGSE-FSC is shipped to truck to SLAC.

xxx) Mission Pre-Ship Review.

yyy) MGSE-FSC is shipped to Spacecraft I&T.

3. **CALIBRATION UNIT I&T SEQUENCE AND CONFIGURATION**

   a) Calibration Unit Frame (MGSE-CUF) is mounted into the Calibration Mounting Stand (MGSE-CMS).

   b) MGSE-CUF is leveled horizontally upright.

   c) Tracker Tower is lifted with 5-ton crane, aligned, lowered onto and attached to MGSE-CUF Bay.

   d) Calorimeter Module is lifted, aligned, inserted into MGSE-CUF Bay with MGSE-CLS, and attached to MGSE-CUF.

   e) MGSE-CUF is leveled vertically.

   f) **Electronics Subsystem performs tower connector saver mate.**

   g) Repeat steps b) through f) for Qualified Spare Tower, Un-Qualified Spare Tower, and two Flight Towers. Towers may be integrated in parallel when possible.

   h) MGSE-CUF is leveled horizontally upright.

   i) Calibration ACD is lifted with 5-ton crane, aligned, lowered onto and attached to MGSE-CUF.

   j) MGSE-CUF is leveled vertically.
k) **Electronics Subsystem attaches Calibration Electronics.**  
   l) MGSE-CUF is de-mounted from MGSE-CMS, lifted by 5-ton overhead crane, aligned, lowered and mounted onto Beam Table Mount (MGSE-BTM).
   m) MGSE-BTM is lifted by 5-ton overhead crane, aligned, and mounted into Calibration Transport Support (MGSE-CTS).
   n) MGSE-CTS is transported to SLAC End Station A.
   o) MGSE-BTM is de-attached from MGSE-CTS, lifted by overhead crane, aligned, and mounted onto Beam Test Table (MGSE-BTT).
   p) SLAC Beam Test.
   q) MGSE-CTS is de-mounted from MGSE-BTT, lifted by overhead crane, aligned, and mounted into MGSE-CTS.
   r) MGSE-CTS is transported to LAT High Bay Integration Room.
   s) MGSE-BTM is de-attached from MGSE-CTS, lifted by 5-ton overhead crane and lowered onto floor.
   t) MGSE-CUF is de-attached from MGSE-BTM, lifted by 5-ton overhead crane, aligned, lowered onto and mounted to MGSE-CMS.
   u) MGSE-CUF is leveled vertically.
   v) **Electronics Subsystem de-attaches Calibration Electronics.**
   w) MGSE-CUF is leveled horizontally upright.
   x) Calibration ACD is de-attached from MGSE-CUF and removed with 5-ton crane.
   y) MGSE-CUF is leveled vertically.
   z) **Electronics Subsystem performs connector saver de-mate.**
   aa) MGSE-CUF is leveled horizontally upright.
   bb) Calorimeter Module is de-attached and lowered out of MGSE-CUF Bay with MGSE-CLS.
   cc) Tracker Tower is de-attached and lifted off of MGSE-CUF Bay with 5-ton crane.
   dd) Steps bb) through cc) repeated for Qualified Spare Tower, Un-Qualified Spare Tower, and two Flight Towers. Towers may be de-integrated in parallel when possible.
   ee) Flight Towers and Qualified Spare Tower ready for integration in to Flight Unit.

4. **MGSE DICTIONARY AND REQUIREMENTS**
   a) MGSE-GSF is a frame, which attaches to the Flight Grid and provides an area for support, lift, and rotation fixtures. The outer dimension must fit into the inner dimension of the Large Thermal Vacuum Chamber at Naval Research Lab. MGSE-GSF must allow integration and de-integration of the Radiators and ACD.
   b) MGSE-FMS is a stand, which supports the full weight of the Flight Unit without radiators and allows vertical and rotational motion. Vertical motion will allow movement of the lower surface of the Cross-LAT Thermal Plate between 6” of the floor (defined by LAT-TD-00623-01) and 5’ (defined by convenient access to integration of Tracker Tower Flexures). Rotational motion requirements are summarized in the following table:

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Tracker</th>
<th>Calorimeter</th>
<th>Electronics</th>
<th>ACD</th>
<th>X-LAT</th>
<th>Radiators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upright</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upside down</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
   c) MGSE-CLS is a stand for lifting and aligning a single Calorimeter Module in a Flight Grid Bay.
   d) MGSE-GHE is a unit for ground heat exchange; will be used for cooling, as well as thermal driving test at SLAC.
e) MGSE-FSC is a temperature, humidity, and shock controlled shipping container for Flight Unit without Flight Radiators.

f) MGSE-VTM is a mounting stand designed to hold Flight Unit in a sideways orientation and attach to the NRL Vibration Table.

g) MGSE-TVM is a mounting stand designed to hold Flight Unit in a sideways orientation and attach to the NRL Large Thermal Vacuum Chamber.

h) MGSE-CUF is a frame designed to hold Calibration Unit Towers and provide mounting points for MGSE-CMS, MGSE-BTM.

i) MGSE-CMS is a stand, which supports the full weight of the Calibration Unit and allows vertical and rotational motion. Vertical motion will allow movement of the lower surface of the Calibration Unit Electronics between 6” of the floor and 5’ (defined by convenient access to integration of Tracker Tower Flexures). Rotational motion requirements are summarized in the following table:

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Tracker</th>
<th>Calorimeter</th>
<th>Electronics</th>
<th>CU Electronics</th>
<th>CU ACD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upright</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Upside down</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

j) MGSE-BTM is a mounting stand designed to hold Calibration Unit in a MGSE-CUF vertical orientation and attach to the MGSE-BTT.

k) MGSE-CTS is a support assembly, which facilitates safe transport of Calibration Unit between Building 33 and End Station A on SLAC site.

l) MGSE-BTT is a table, which provides mounting points for MGSE-BTM, supports the full weight of the Calibration Unit, and allows vertical, horizontal, and vertical rotation. All motion is specified by the Particle Test Manager (GLAST LAT WBS 4.1.9.7.1).

5. F.A.P. DEVELOPMENT PLAN AND SCHEDULE
The F.A.P. Manager will document and update all F.A.P.s. The F.A.P. Manager will document Quality Assurance Checkpoints in coordination with the QA Manager. Development of the F.A.P. is a pre-condition for Flight Hardware assembly. F.A.P.s will be developed with exercise of the associated MGSE and Engineering Models (EM) when possible. MGSE and EM Need Dates are defined by when they are available from subsystems and/or needed for F.A.P. development. The preparation of F.A.P.s will be broken down into 6 training periods, denoted A-F. The dates for the training periods are given in the following table:

<table>
<thead>
<tr>
<th>Training Period</th>
<th>Dates</th>
<th>FU F.A.P.s</th>
<th>CU F.A.P.s</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>July 1 – July 31, 2002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Aug.1 – Sept.15, 2002</td>
<td>a-h</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Jan.21 – Mar.15, 2002</td>
<td>i-p</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Aug.1 – Aug.31, 2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Nov.1 – Dec.15, 2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>July 6 – Aug.15, 2003</td>
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6. EQUIPMENT NEED DATES

<table>
<thead>
<tr>
<th>Training Period</th>
<th>Equipment</th>
<th>Need Date</th>
<th>Responsible Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Nelson Model</td>
<td>July 1, 2002</td>
<td>D. Nelson</td>
</tr>
<tr>
<td>B</td>
<td>MGSE-CMS</td>
<td>August 1, 2002</td>
<td>J. Broeder</td>
</tr>
<tr>
<td>Letter</td>
<td>Description</td>
<td>Date</td>
<td>Author</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td>B</td>
<td>EM MGSE-GSF</td>
<td>August 1, 2002</td>
<td>J. Broeder</td>
</tr>
<tr>
<td>B</td>
<td>MGSE-HSF</td>
<td>August 1, 2002</td>
<td>J. Broeder</td>
</tr>
<tr>
<td>B</td>
<td>EM Grid (2x2 Bay)</td>
<td>August 1, 2002</td>
<td>M. Foss</td>
</tr>
<tr>
<td>B</td>
<td>4x4 Extension of EM</td>
<td>August 1, 2002</td>
<td>J. Broeder</td>
</tr>
<tr>
<td>B</td>
<td>EM Tracker Tower</td>
<td>August 29, 2002</td>
<td>T. Borden</td>
</tr>
<tr>
<td>C</td>
<td>Mini-EM Tracker</td>
<td>December 1, 2002</td>
<td>T. Borden</td>
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<tr>
<td>C</td>
<td>MGSE-CLS</td>
<td>January 21, 2003</td>
<td>J. Broeder</td>
</tr>
<tr>
<td>C</td>
<td>EM Calorimeter</td>
<td>January 21, 2003</td>
<td>N. Johnson</td>
</tr>
<tr>
<td>C</td>
<td>EM EGSE</td>
<td>January 21, 2003</td>
<td>R. Claus</td>
</tr>
<tr>
<td>D</td>
<td>MGSE-BTT</td>
<td>August 1, 2003</td>
<td>MGSE Engineer</td>
</tr>
<tr>
<td>D</td>
<td>MGSE-CTS</td>
<td>August 1, 2003</td>
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<td>MGSE-BTM</td>
<td>August 1, 2003</td>
<td>MGSE Engineer</td>
</tr>
<tr>
<td>D</td>
<td>MGSE-CUF</td>
<td>August 1, 2003</td>
<td>MGSE Engineer</td>
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<td>G. Haller</td>
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<td>E</td>
<td>MGSE-ACP</td>
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<td>M. Foss</td>
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<td>F</td>
<td>MGSE-FSC</td>
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<tr>
<td>F</td>
<td>MGSE-VTM</td>
<td>July 6, 2004</td>
<td>MGSE Engineer</td>
</tr>
<tr>
<td>F</td>
<td>MGSE-TVM</td>
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