

Production procedure for ladders and trays for the GLAST Tracker

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1) Introduction

We define our activities for the production and test of the GLAST Tracker in anticipation of our involvement with Italian industry. The estimates reported here refer to the construction of all of the tracker towers, summing the contributions from SLAC and INFN.

We report the different phases of development of the production procedures and of the real production. The activities that will be carried out in the **industry** are individuated. In the development of the construction procedures, we include the assembly of 4 mockup trays and the study of the ladder assembly. These activities will be completed in a few months and the ladders and tools developed in this phase are prototypes.

In the following phase, i.e. during the construction of the engineering tower, the final tools will be produced in the quantities required for full production (Aug 01 – Giu 02).

In the last phase the flight trays are built and the flight towers are assembled (Jul 02 – Dec 03)

2)Construction of the 4 superGLAST mockups.(oct00 – apr 01)

The goal is to produce **4 mockup trays** on which we can perform **thermal cycles and vibrational tests**. This will allow us to define various payload solutions, to test with dummy wafers and trays the full procedure of assembly of the ladders and of the trays and to validate our FEAs.

The trays are composite with an Aluminium honeycomb core, 2 carbon fibre face sheets and close-out in carbon fibre. The core has the final specifications but it is not ventilated (no vacuum tests). The face-sheet and the close-out are mechanically very similar to the final specifications. On the 4 corners of the close-out there are 4 metal inserts. These inserts will be machined to provide reference holes and planes.

0.6mm Tungsten ($18\%X_o$) converters will be glued on each face of the tray. The converters are squares with 2mm ca. clearance between them.

A kapton or G10 bias circuit will be glued on top of the absorbers and above these will be placed the ladders containing dummy detectors.

This activity will be useful to **select an industrial partner** that will provide the final trays with the bias circuits on top

The dummy ladders placed on the mockup trays will be partially assembled by industrial partners to individuate and to qualify the factories that will do this large scale and repetitive job.

The tools to assemble the ladders and to mount the ladders on the trays are already in production. The trays have been ordered. We have contacts with the factories for the assembly of the ladders

The activities reported hereafter refer (quantities and times) to the flight towers production. The numbers are proportional and scale with 11000 wafers. The numbers of wafers on flight tower+spare tower is 9792. The ratio $11000/9792=1.12$ is considered a safety margin in the estimation hereafter.

3)Wafer tests (Jul 01 – Dec 03)

This activity has to be carried out in the **academic or research** institutions. The total number of wafer is about **11000**. The mean test rate will be **20 wafers/day**

1. The wafers are received by the various institutions. The wafers are stored in controlled atmosphere (N₂) cupboards and their associated information is stored in a data base.

time=5min/wafer

2. R and C test on each strip with automatic probe station (6s/channel measurement).

time=60min/wafer

3. V/I test with automatic probe station

time=15min/wafer

4. Check of the wafer dimensions and of the parallelism of the strips to the wafer edge by grabbing the reference crosses on the corners

time 10min/wafer

Total required time: **1.5h/wafer** (16500h full testing, 6600h if R,C test only on 10% sample)

4)Ladder assembly

(Sep 01 – Dec 03)

This activity which requires large clean room spaces and man-power, is preferable not to do in the academic institutions. The operations are repetitive and will be performed by qualified industries. We think that the labs can be a backup solution for emergency situations.

The number of ladders to be produced is about **2750 (11000 wafers)**. The ladder production can begin as soon as the wafers are received. The minimal production rate of the ladders will be **6/day**. The required production capability should be at least 8ladders/day. The times reported here are per ladder.

1. The wafers are received by the various assembly facilities. The wafers are stored in controlled atmosphere (N₂) cupboards and their associated information is stored in a data base. The wafers are distributed to the assembling stages
time=30min
2. 4 wafers are glued edge to edge to form a unique detector 8.95mmx358mm. The glueing and alignment procedure requires the use of a vacuum chuck with mechanical references. The wafers are guaranteed cut with a tolerance of $\pm 20\mu\text{m}$. The alignment of the wafers shall be within $\pm 30\mu\text{m}$ (with pre-selection of the wafers)
time=30min
3. Placement of the ladder on a service box using a vacuum pick and place tool. The service box is itself a vacuum chuck and supports the ladder during bonding, testing and incapsulation operations. In addition it possesses a kapton circuit which allows biasing of the detector. Measurement of the wafer alignment grabbing the references crosses on one edge of the ladder
time=10min
4. Bonding in series of all the signal and bias pads. For safety we propose to bond the Nsub pads in series. We have to do 1164 bonds with an automatic bonding machine (wedge bonding, 25Al wire, 4g bond resistance) Bonding rate=1bond/s+10min setup
time=30min
5. Measurement of the V/I curve up to 200V (I~1 μ A), in 5V steps, measurement of the decoupling capacitance of each channel (C~2nF) with an automatic probe station
time=1h
6. Bonds incapsulation with an automatic glue dispenser
time=10min
7. Ladder storage (up to 1 year) in suitable boxes placed in controlled atmosphere (N₂) cupboards
time=10min

Time required = 3h/ladder, total time 8250h

5)Tray construction

(Jul02 – Jul 03)

The mechanics of the trays will be carried out by factories specialized in carbon and composite materials. We will get the trays comprising the converters and with the bias circuit. Thermo-vacuum and vibrational tests of the tray at this level could be important for safety. The number of trays is **350 ca.**, the production rate is close to **30 trays/month.**

6)Hybrid mounting

(Jul02 – Nov 03)

The fully tested hybrids are mounted on the trays . A second test of the hybrids is performed. We consider that this activity will be done in the labs. We estimate (very roughly) **4h/tray with a team of 2 persons.**

7)Tray assembly

(Jul 02 – Dec 03)

The assembly of the 350 flight trays comes after the Engineering Model qualification. The mean production rate will be 1.75/day; The required production capability should be at least 2trays/day. This activity will be carried out in the same industries that assemble the ladders. The labs have to be ready as a backup solution.

The ladders are placed on the trays as follows:

1. The ladders are removed from the custom storage boxes by means of a vacuum pick and place tool. The glue is dispensed over the tray by means of an automatic dispenser in a regular pattern. The ladder is aligned mechanically on a reference bed. We envisage that this reference bed could be exactly the same tool where the ladder was assembled. A vacuum chuck guided by reference dowels picks up the ladder and places it on the tray where it is aligned using 2 additional dowels. This operation is repeated for the other 3 ladders
time=2h/face
2. The alignment of the ladders is measured with an optical inspection system
time=30min/face
3. Wedge bonding with 25µm Al wire of the wafers and of the bias circuit to the pitch-adaptor. 1560 bonds/hybrid, time required= 1560s+10min setup+20min QC
time=1h/hybrid
4. Simple functional test of the tray to check HV and bias connections, channel connections
time=1h/hybrid
5. Bonds incapsulation with an automatic glue dispenser
time=30min/face
6. Tray storage in custom boxes in controlled atmosphere (N2) cupboards
time=15min/tray

Time for **tray assembling 10h**, **total time=3500h**.

8) Tests of the flight trays.

For this activity we only list a series of activities for the tray qualification.

1. Thermo-vacuum test (in specialized institution)
2. Vibrational test (in specialized institution)
3. Burn-in test (in the labs). For this test we envisage to build an 'open tower'. The open tower has the same read-out of a flight tower, but the longer cables and the mechanics of this structure allow to insert or to extract each single tray. The open tower can take cosmic rays data with a 2Hz rate if the open tower is about 1m high. One open tower can collect 10^2 events/channel/day.

9) Flight tower assembly

The same team responsible for the open-tower will assemble the tested trays in the flight tower with the help of a technician and of an engineer. The functional test is performed by means of a DAQ, twin of the open tower DAQ.

10) The Engineering Model

All the production steps here quoted have to be finalized during the Engineering Model production. All the tools and procedure will be fully developed in the labs in parallel with the industrial partners. We foresee to share the production of the trays of the E.M. between industrial partners and the labs in this phase. In every case, for safety reasons, the labs shall have the production capability of the full Engineering Model Tower.