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Fabrication of Scintillator "Multitiles" for the LBL SDC ECEM "4 X 4" Test Module

Author
Hoff, M.D.

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M.D. Hoff

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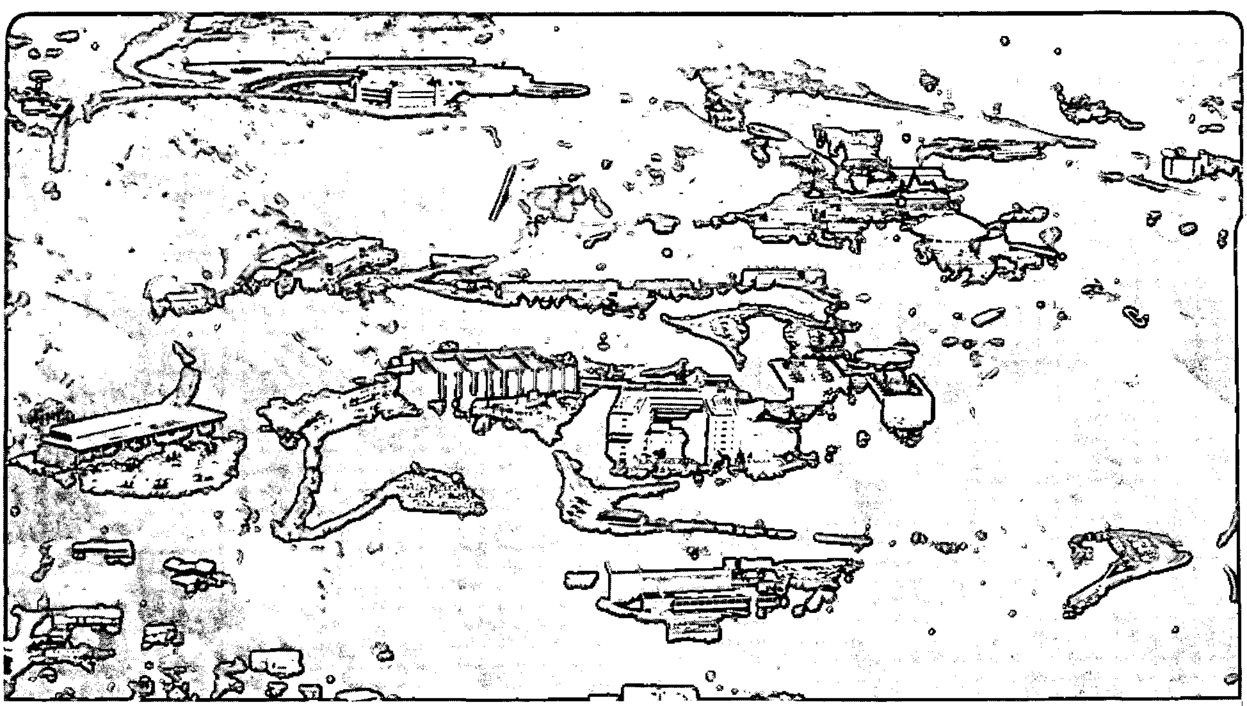

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SOLENOIDAL DETECTOR

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Distribution:

T. Firpo
R. Fulton
W. Greenway
D. Lester
M. Long
R. Kuiper
W. Thur
V. Wray

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Background: In reconfiguring the ECEM 4 x 4 test module for its second round of particle beam testing, the latest ECEM design details were represented as closely as possible. Even though the schedule was tight, it was decided to attempt single piece "multitiles" rather than the 16 separately wrapped tiles per layer used in the original 4 x 4. Multitiles provide more controlled tile edge gaps and potential cost savings. The 4 x 4 provided us with an opportunity to work on fabrication techniques and performance, especially cross-talk. The following is a description of the fabrication process:

The 4 millimeter thick 3HF scintillating tile material arrived at LBL from Japan in sheets 1 meter square, packed in a cardboard box. The box was opened on June 4, 1993, in Building 50, and the sheets were immediately bandsawed into 50 cm. square pieces. The bandsaw in room 50-335 with a metal cutting blade was used for the cutting without any special cleaning except for a quick wipe of alcohol. The protective paper face sheets were left in place for this operation. Matt Hoff, Mike Long, and Richard Kuiper were the technicians.

The next series of operations took place in Building 58 on the new Fadal VMC 4020 CNC 5 axis vertical milling machine. The first step was for the technician, Wayne Greenway, to peel away the protective brown paper from one side and replace it with a **thicker** protective tape. (3M #346 24" wide protective tape - heavy duty) The original protective paper that came on the scintillator sheet was .12 mm. (.005") thick and the thick protective tape was .40 mm. (.016") thick. The wide, heavy duty tape, utilizing a "soft adhesive", was applied loosely; then squeegeed to remove air bubbles; then trimmed to size. Next, the blank was placed on a custom vacuum table in the milling machine, thick protective tape down. The vacuum table was powered by a .48 cubic meter per second vacuum pump. The NC machining program started by taking three passes with a straight end mill to rough cut the fiber grooves. The groove pattern was repeated 16 times across the sheet. Then the straight end mill was changed to a ball end mill, which took one more pass in each groove to finish the 16 fiber groove patterns. Both end mills were two flute, solid carbide, running at 10,000 RPM, traveling at 380 millimeters per minute. The time required to mill the 16 fiber grooves per sheet was about one hour. For groove size and shape see drawing 20M8634.

Next, a right angle head was manually attached to the milling machine spindle. A 101.6 mm. diameter x .635 mm. thick x 32 tooth solid carbide slitting saw was programmed to cut slots spinning at 375 rpm, traveling at 380 millimeters per minute. Each slot was made in two passes leaving a cut completely through the plastic, but not through the heavy duty protective tape. The time required to saw slit each sheet was about one hour.

Cutting fluids were forbidden on the scintillating plastic. As a substitute, filtered shop air, at 586 kilopascal (85 PSI), before filters, was directed at the cutting tools. On the last sheet the technician increased the slitting saw travel to 572 millimeters per minute; having felt all along that the cutting speed could be increased. The results were satisfactory. The technician also thought that with enough air pressure and possibly multiple air jets to clear chips, that the end mill travel speed could be increased.

After machining, the multitiles were moved to Building 77 where technicians Vic Wray and Don Lester started the gluing work. Step one was to pull off the thin protective paper that was machined thru; then push out the polystyrene chips stuck in the slots from machining and blow clean with dry nitrogen. A new sheet of thick protective tape was then applied. Next the tile was flipped over and the old layer of thick protective tape was removed, and the tile slots were again cleaned and blown with dry nitrogen. The slot ends were taped closed and white epoxy was injected into the slots. The white epoxy was a mixture of 30% titanium dioxide (by weight) and Stycast 1266 (by Emerson & Cummings). The epoxy was degassed after mixing. The mixture was injected into the slots using a manually controlled compressed gas glue dispenser (EFD Dispensing Components, Gardner and Associates Inc.) and a 21 gauge (.50 mm I.D. x .813 mm O.D.) hypodermic needle that was slightly flattened on the end to fit into the slot. The epoxy was injected into the bottom of the slot and allowed to fill flush with the surface. After all the slots were filled, the excess epoxy was wipe up with 190 proof alcohol and a very soft wipe. After 4 to 5 hours, when the epoxy was set, but not dry, the slots were wiped again with 190 alcohol and a soft wipe. This step removed the epoxy film around the slots without pushing any epoxy from the slots. The sheet was then allowed to dry overnight. The cleaning and new protective tape took about 1 hour per sheet, and the slot gluing took about 30

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minutes per sheet. The two slot wiping steps took 5 minutes total per sheet. The slot gluing step always took place on a granite inspection table to insure a flat multitile.

After drying, the taped slot ends and protective paper were trimmed off. Then a small bead of white epoxy was placed in the meniscus of the glued slots, and a sheet of .005 thick Tyvek (DuPont type 1025D) was placed over top. The Tyvek was weighted down with a flat aluminum plate and lead bricks, and left to dry over night. The trimming of the slot end tape and protective tape took about 15 minutes and the gluing of the Tyvek took about 30 minutes per sheet.

The next morning the Tyvek was trimmed to the edge with a razor blade. Then the tile was flipped over and the last remaining sheet of protective tape was removed and a bead of white epoxy applied over all the slot locations. A second piece of Tyvek with small slots to align with the fiber exit hole was applied, covered with an aluminum plate, and weighted down with lead bricks. This step required about 20 minutes to cut the fiber exit holes, and 30 minutes to glue the Tyvek down. After drying over night, the second Tyvek sheet was trimmed to the edge and ready for edge painting.

The edge painting was done in Building 50 room 2177 by Thomas Firpo. The multitile edges were painted one at a time with a foam paint brush and special Bicron BC-620 reflective paint. Each coat of paint took 5 minutes to apply and 20 minutes to dry. Two coats of paint per multitile.

After painting the last step was to insert the fibers by pushing them into the fiber exit openings. This step required only about 10 minutes for the 16 fibers. At this point the tile was completely finished and ready for testing.

The sum total of time required to manufacture one multitile sheet containing 16 tiles was just over 6 hours.

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UNIVERSITY OF CALIFORNIA
TECHNICAL INFORMATION DEPARTMENT
BERKELEY, CALIFORNIA 94720