Report on the Vibration tile performance tests

Experimental method. The task of these measurements was to study the tile performance before vibrations, between vibration regimes, and after the vibrations. The method used is called "tomography", where the light yield map is being produced for the tested tile. The instrument to map the tile light yield is "hodoscope" , which consists of two orthogonally-positioned 8-strip detectors.

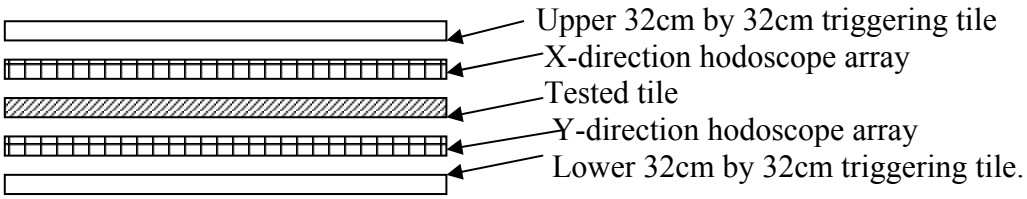

Fig.1 Experimental setup.

Each hodoscope array consists of eight 4cm by 32cm scintillating strips. X- and Y-direction arrays are positioned orthogonally to each other, so selecting the coincidence between pair of strips in X- and Y-hodoscope, we will know the 4cm by 4cm box position of the muon crossing the tested tile. Selecting the signals from tested tile according to this principle, the light yield map with 4cm by 4cm pixels can be created.

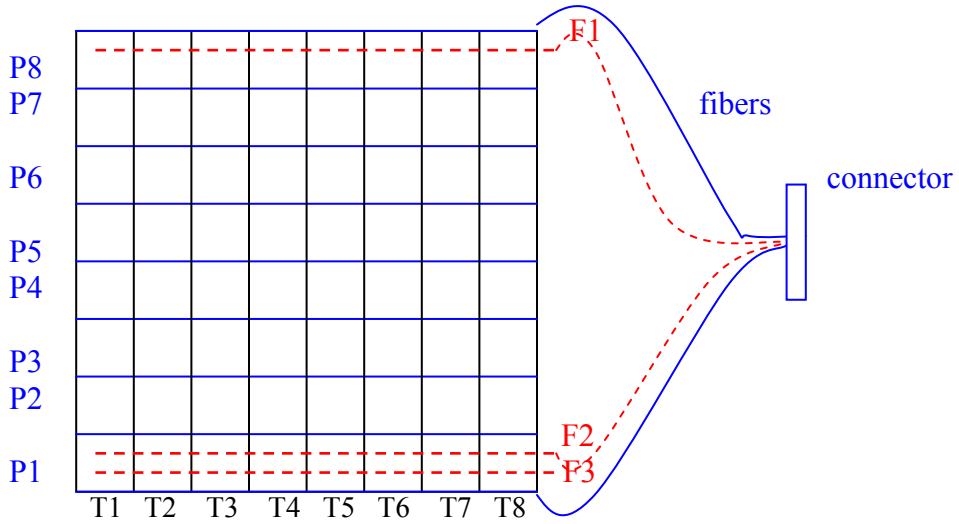

Fig.2. Mapping of the tested tile. Blue lines show X-direction hodoscope, which is along the fibers in the tile, with corresponding hodoscope strip numbers (P1 to P8, in blue), and black lines show the Y-direction hodoscope (across the fibers), with

corresponding strip numbers T1 to T8, in black. Dashed red lines labeled by F1, F2, and F3, show damaged fibers (see section below). P2 hodoscope strip did not work, so the measurements for P2 are missed in the plots.

The tile. Before the vibration tests the tile was checked visually on the subject of defects. It was found that 3 fibers had defects – fiber F1, which is just the edge fiber, is semi-broken (has a sharp kink), fibers F2 and F3 (the very edge and the next to it) have bright rings. These rings indicate the cracks in the cladding; there could be some light leak through these cracks out of fiber (believed to be a minor effect). These defects probably occurred during tile shipping from FNAL, because these tiles have not been annealed before shipping. The annealing is a mandatory procedure, and these tiles were annealed here at GSFC after receiving.

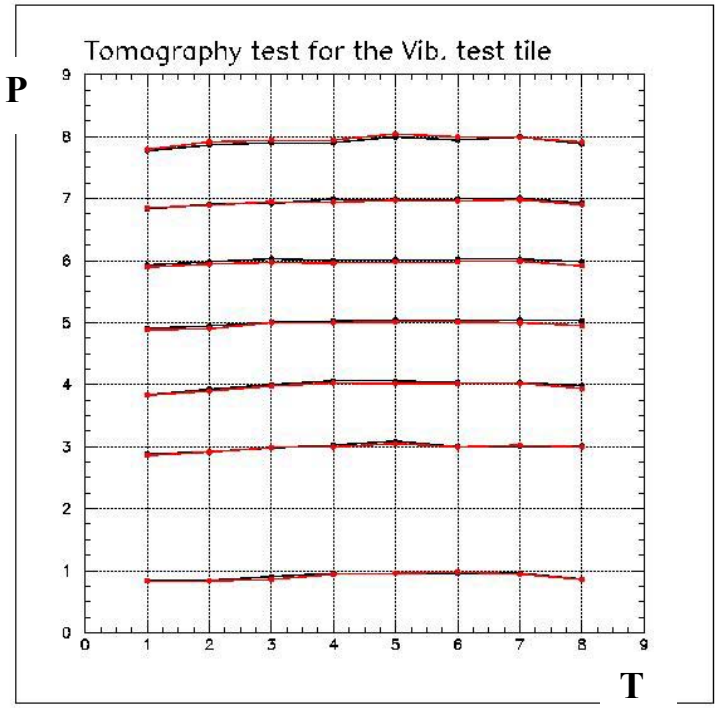

Fig. 3. Tomography test before vibrations. Numbering on the axes correspond to the hodoscope strip number. The points represent the relative light yield from corresponding pixel in the tested tile. The edge effects are seen as a decrease of the light yield at the edges; also the light attenuation in the fibers embedded in the tile is seen as lower light yield at farest from the connector tile side (T=1) in respect to the closest side (T=8). Black lines correspond to PMT1, and the red ones – to PMT2 from the tested tile.

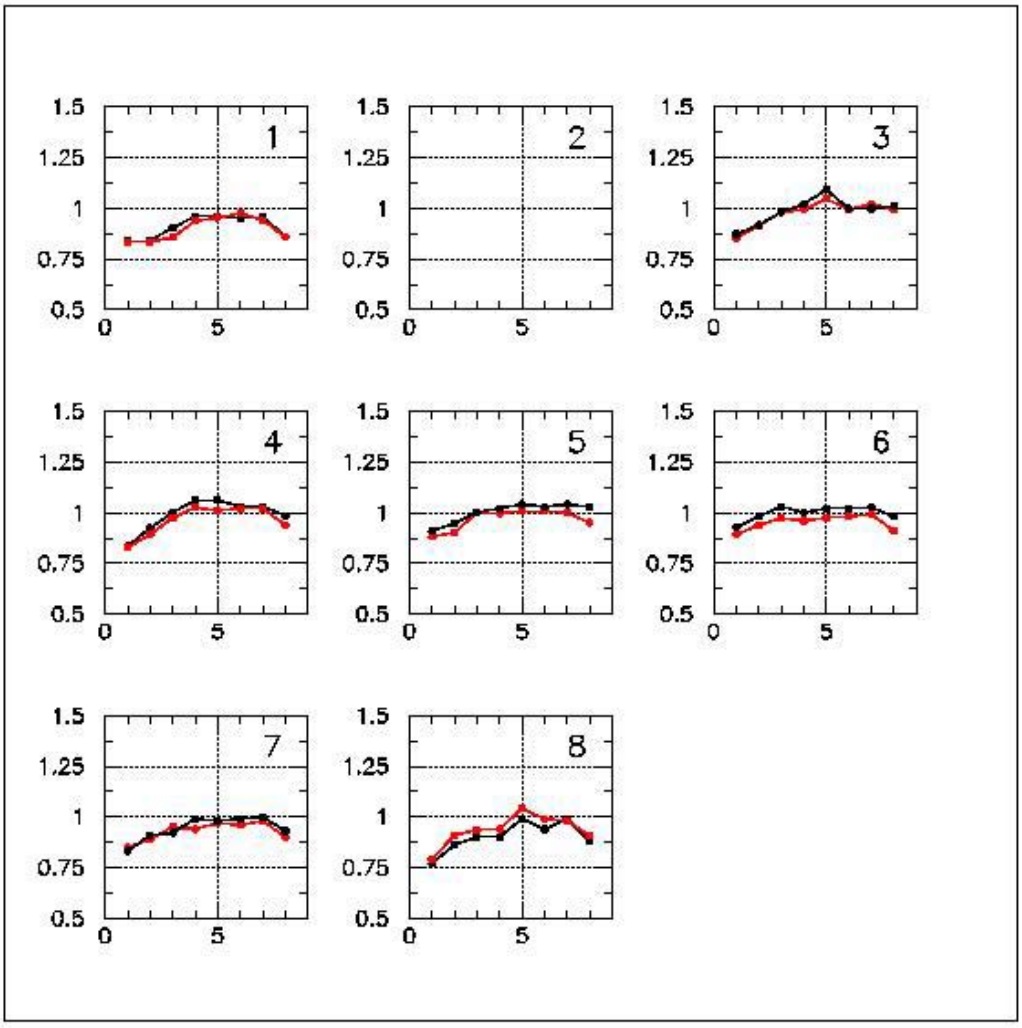

Fig.4 . Light yield mapping before vibrations (detailed view). Each box corresponds to single X-direction strip (P) with the number provided in the right upper corner of each box. The numbers of T-strips are given at X-axes of the plots.

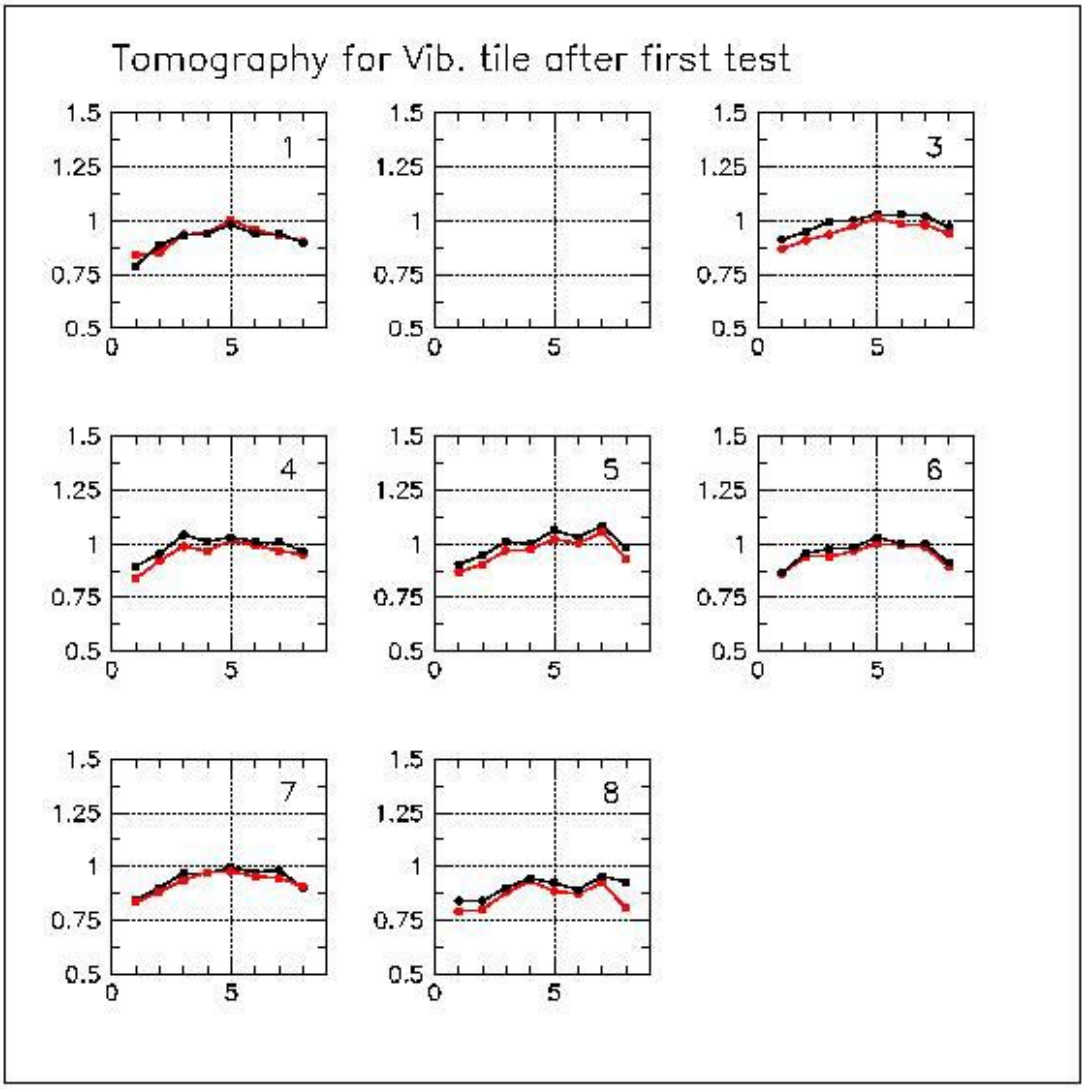

Fig.5. Light yield mapping after the first axis vibration.

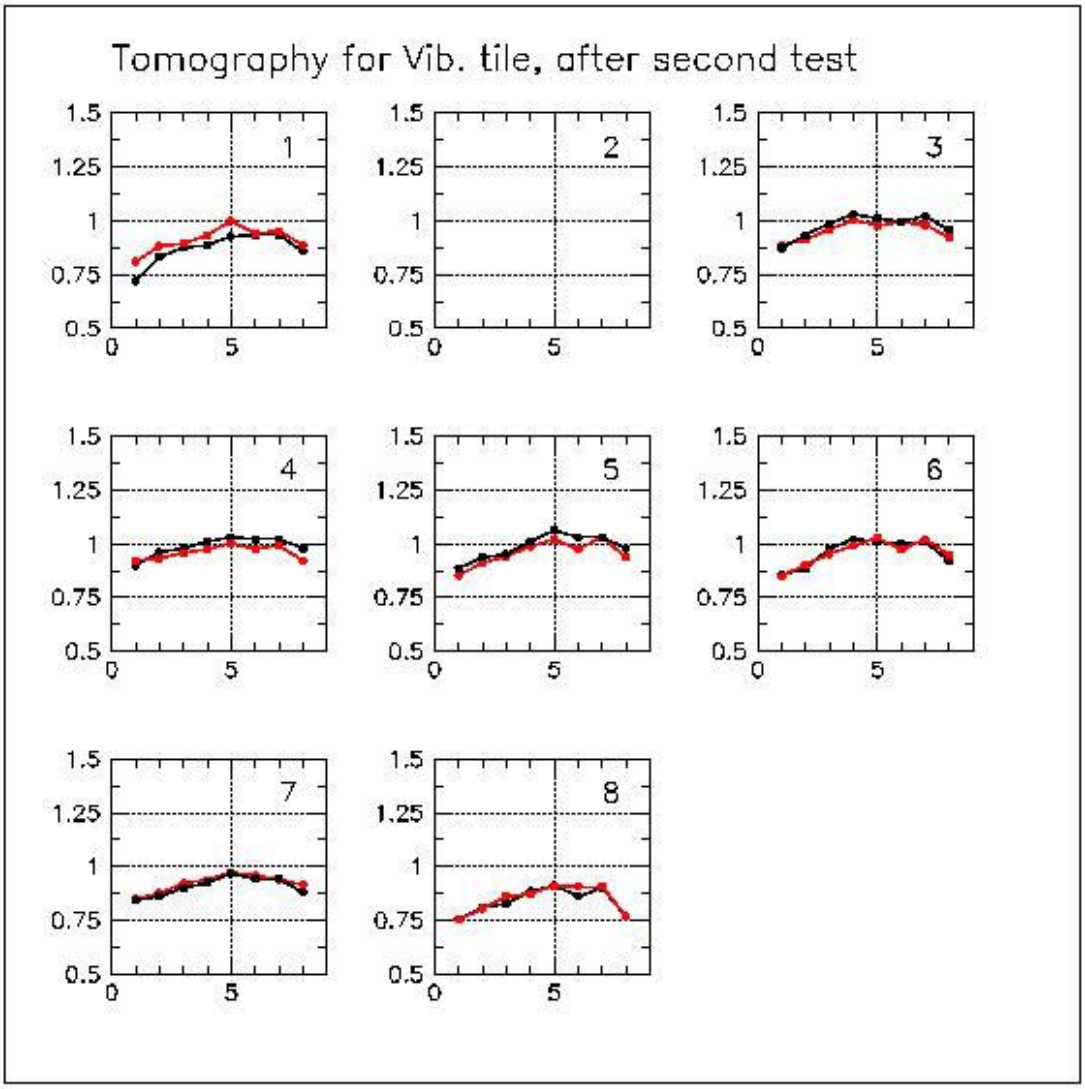

Fig.6. Light yield mapping after the second axis vibration.

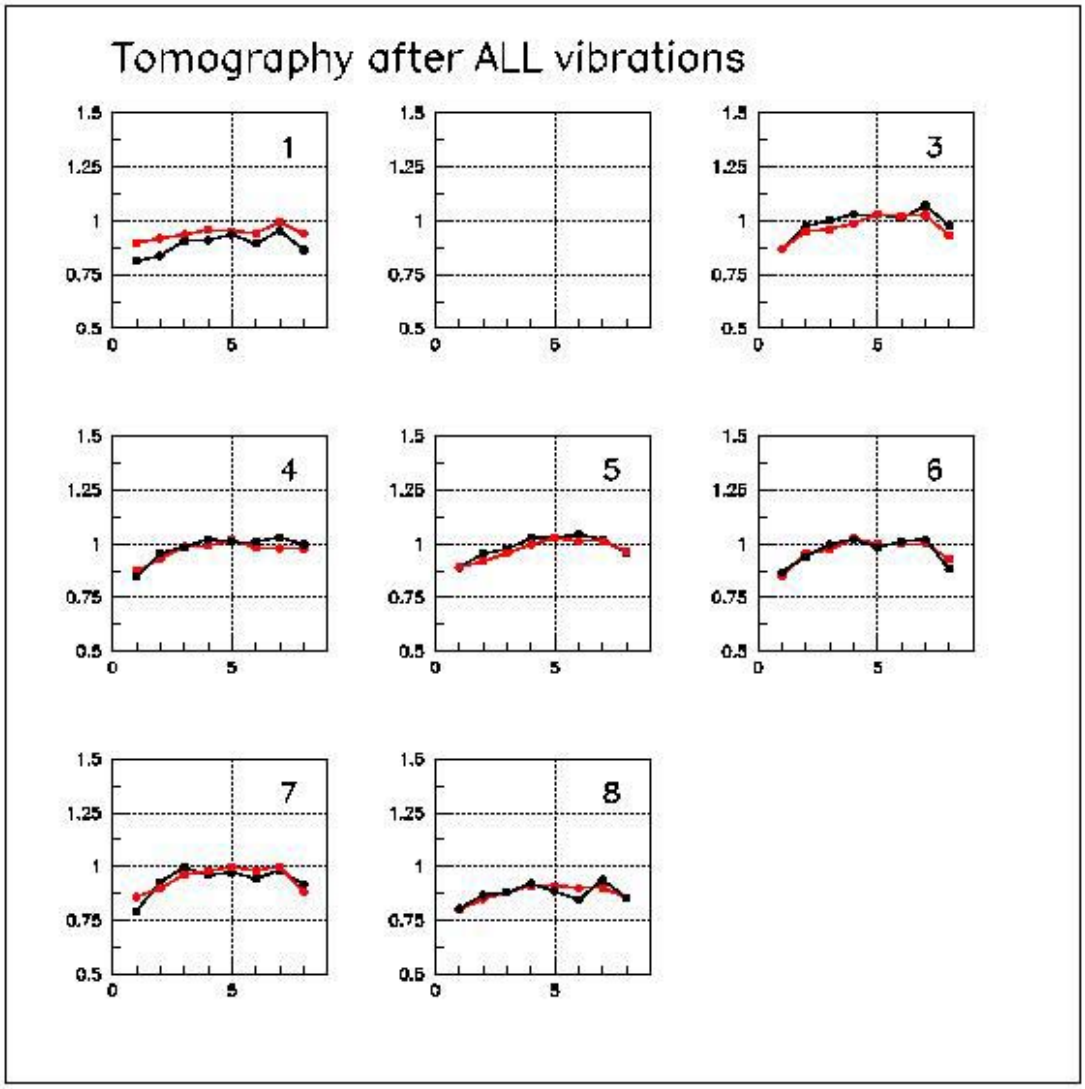

Fig.7. Light yield mapping after all vibrations.

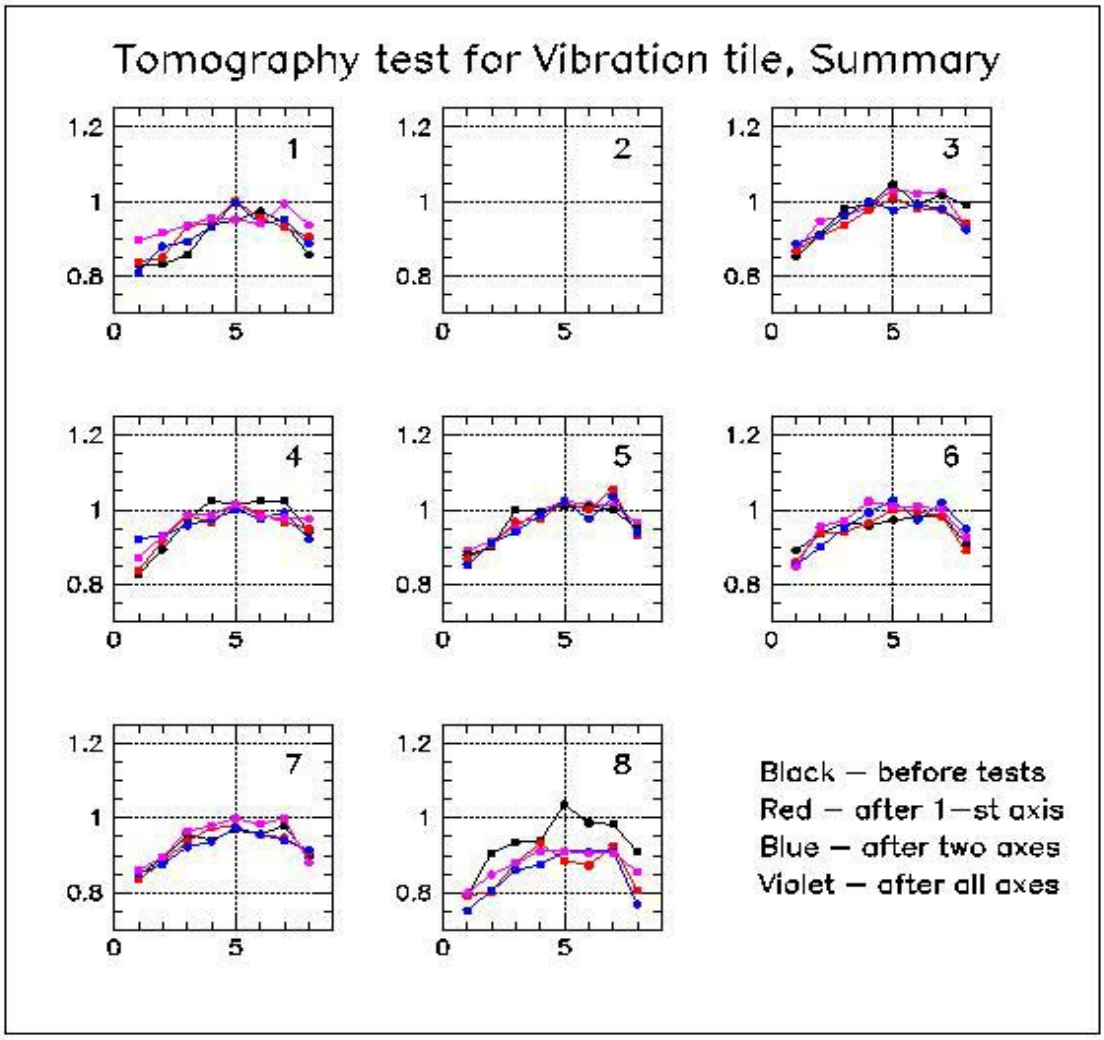

Fig.8. Comparison of the light yield through all vibrations (resulting plots)

Conclusion. The tile was unwrapped and visually inspected between all vibration regimes and after all vibrations completed. **No visible changes in respect to that observed before the tested have been found.** Looking at the resulting measurements plots in fig.8, we can conclude that the light yield through the vibrations is **well within required 10% variation, meaning that the tile successfully passed the vibration tests.** There is one concern about panel 8 in fig.8 where the initial light yield (black line) is approximately 15% higher than all others. This box corresponds to the area where the "semi-broken" fiber is located. I can explain this light decrease by increasing crack in a fiber which was already broken before the vibrations. I believe this is completely understandable effect, and it occurred only because the fiber was already broken. If it would not so, there would be a reason to consider the test failed.