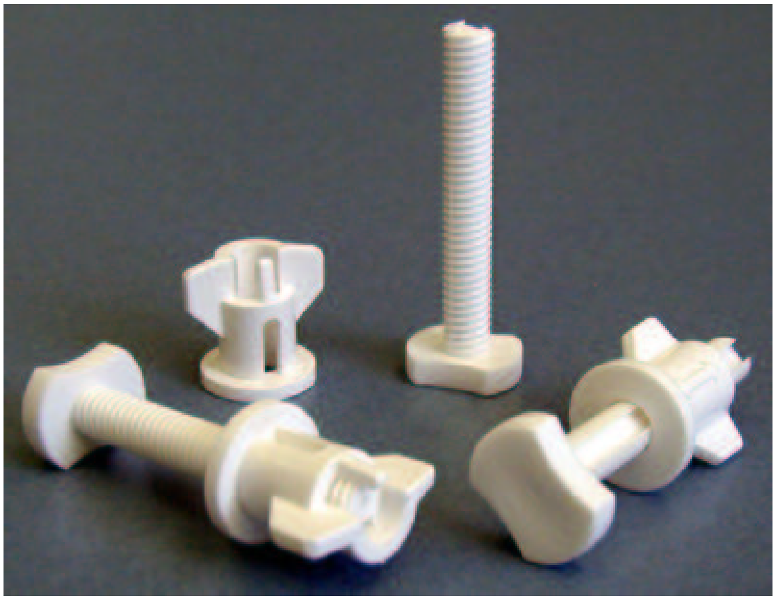
Replacement Baffles for Milagro

Linda Kelley, Julie McEnery, Michael Schneider and David A. Williams

As DAW presented at the last collaboration meeting, the baffles have deteriorated considerably since they were first installed. In many places, the anodized layer on the baffle is completely destroyed and water is beginning to oxidize the aluminum baffle. In some places water has eaten holes into the aluminum. This deterioration was observed to have increased rapidly between the September 2000 tube repair and the September 2001 repair, and it was decided to replace all of the baffles. It appears that whether we replace all of these baffles this summer or stage this replacement over several years is still up for debate, but it is clear that we do want to replace as many of these as possible during the 2002 tube repair. In order to do that, we need a better baffle design. This memo describes and justifies this design.

Building a Better Baffle

Our updated baffle uses only cover material and other polypropylene parts, which should show no degradation in water. The baffle its self is made from cover material which is black on the outside of the baffle and white on the inside. In order to keep this in a cone shape, ¼ inch OD polypropylene tubing is threaded through 8 holes near the rim of the baffle. The fasteners used to close the baffle are polypropylene screws which are designed to be tightened without using tools:



Designovations Nuloc 2 Fastener

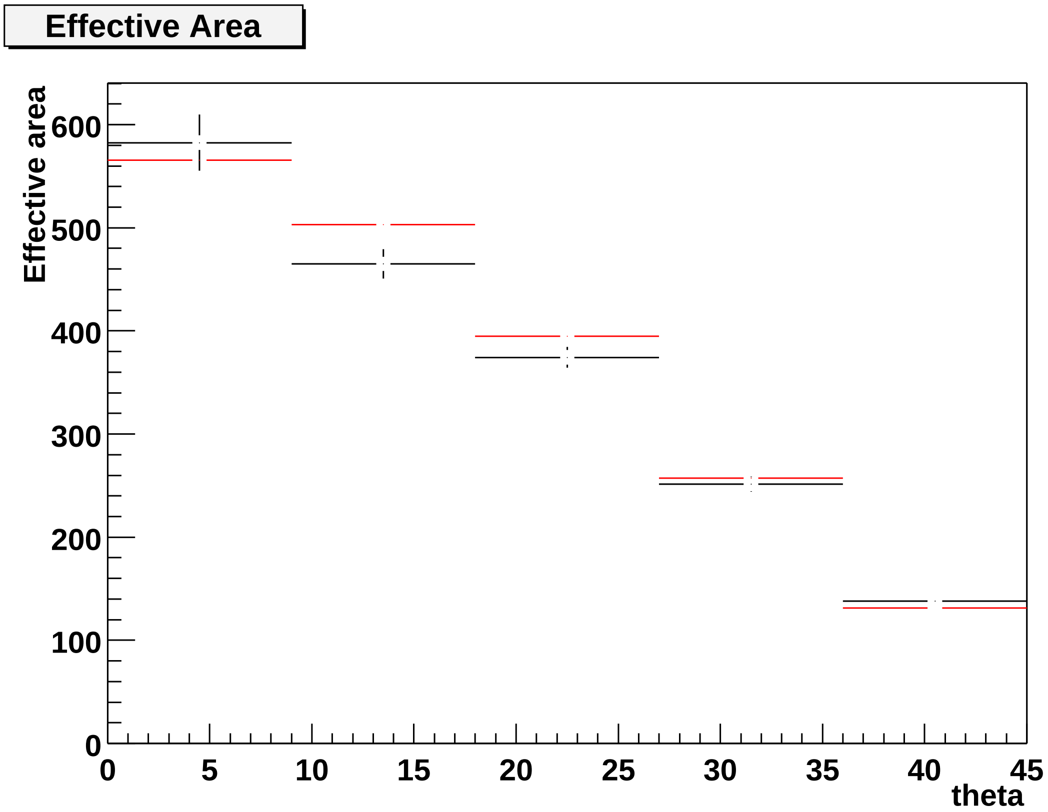
The "nut" slides into a grooved, threaded screw until it is up against the baffle material and then it is turned one half turn to a stop on the grove to lock it into place. We believe that this fastener can be attached underwater while wearing dive gloves, so that it should be possible to install these baffles underwater.

All of the materials used are slightly buoyant (each has a specific gravity of about 0.9), and the entire baffle is designed to float up to the PVC seal at the PMT/housing interface. It does not need to be placed in the grove on the housing or held by cable ties or any

Side and top views of a prototype baffle.

other means.   We have tested this design in a water tank here, at it is very stable underwater.
The pictures of a prototype baffle shown here have extra holes along the rim which are not used in the final design. The top of the baffle is designed to be flush with the top of the PMT.

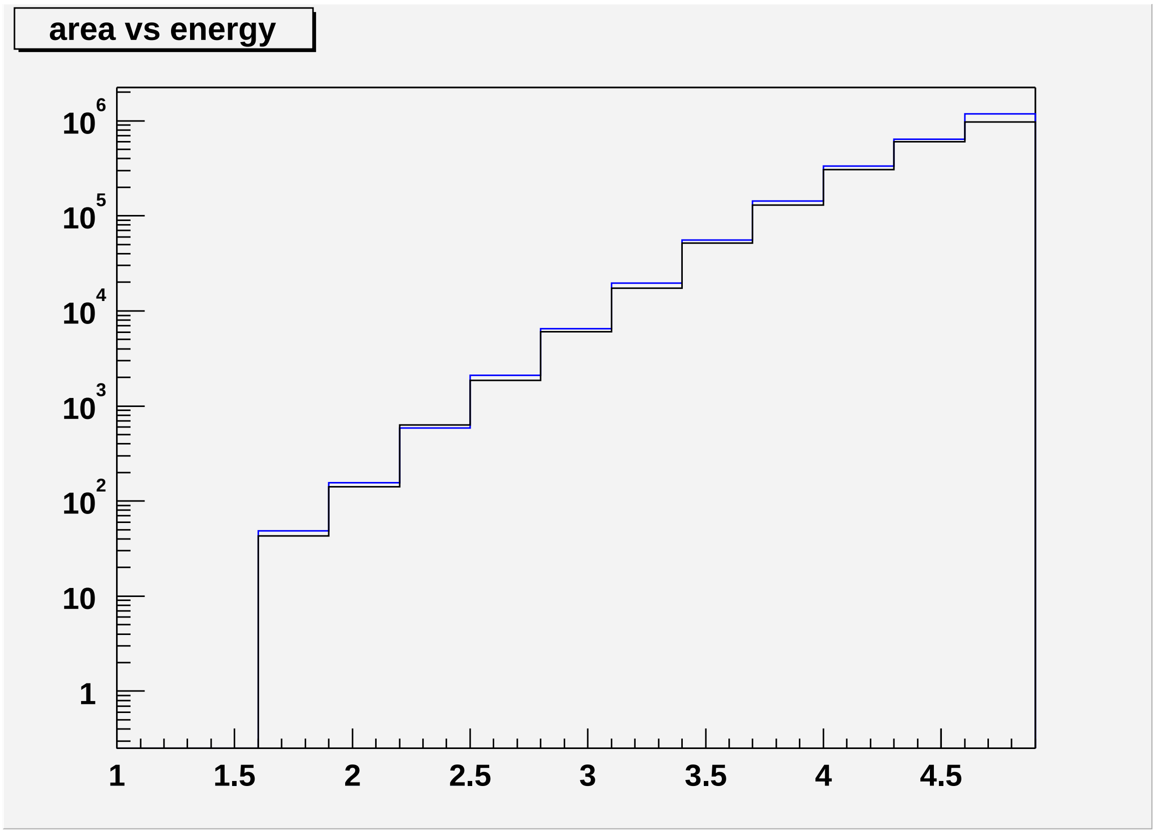
Simulation studies of the new baffle design are underway.   In a memo written in 1994, David Schmidt investigated the reflectivity of various materials including white cover material for use in the muon boxes proposed for Milagro. He estimated the reflectivity of white cover material to be above 90% for wavelengths above ~420nm. At the peak of the detected Cherenkov spectrum (350−400nm), the reflectivity is between about 10% and 60%.   Tyvek was found to be a better reflector in the 350−400nm range, with about 60% to 90% reflectivity.
Julie has compared a black cover material baffle which is taken to be 5% diffusely reflecting with the simulation of our current baffles. The simulations all use proton showers.   In the following plot, our current baffle simulation is represented by red points and black cover material baffles are the black points.



Effective area vs. Theta for black baffles and our current baffles.

You can see that our current baffles do better at angles of about 10−30degrees, when some of the Cherenkov photons are reflecting at relatively small angles off the baffle. For showers from near zenith (Cherenkov photons at about 40degrees) this advantage is lost for the specular reflector, and a diffuse reflector should increase the collection area. Our current baffle simulation assumes that the aluminum baffle is a specular reflector with 88% reflectivity. This is likely to be an overestimate of the reflectivity given the degradation of our baffles, and this reflectivity will get worse over time. In addition, this is the reflectivity of the aluminum at longer wavelengths. Michael measured the reflectivity of a piece of a baffle which came out of the pond in September 2001. At a wavelength of 425nm is was measured to be about 65% reflective.

The plot of effective area vs. energy, this time with current baffle simulation in blue, shows very little difference between the black baffle and the aluminum baffle.



Effective area vs. Energy for our current baffles and black cover material baffles

We are waiting for simulations of a white cover material baffle to finish, but given the small differences in the effective area seen above, the results already look encouraging.

Conclusions

It is clear that our current baffles will not survive much longer in the pond. We propose removing the current baffle and baffle wrapper and replacing these with a buoyant cover material baffle. Monte−carlo simulations are underway for this configuration. Preliminary results for a black baffle show a small decrease in effective area for incident particle angles from about 10−30 degrees. The proposed baffle design is easy to build and install compared to the current baffle: it does not contain two pieces (which would also be required for a tyvek baffle with wrapper) and it uses hardware which can be fastened by hand. It is buoyant and it does not rely on the grove in the PMT housing or other fastening to the housing to determine its height and orientation.