



Ideas for waveform- based cascade reconstruction

Tom McCauley & Spencer Klein
LBL

IceCube collaboration meeting
March 2005



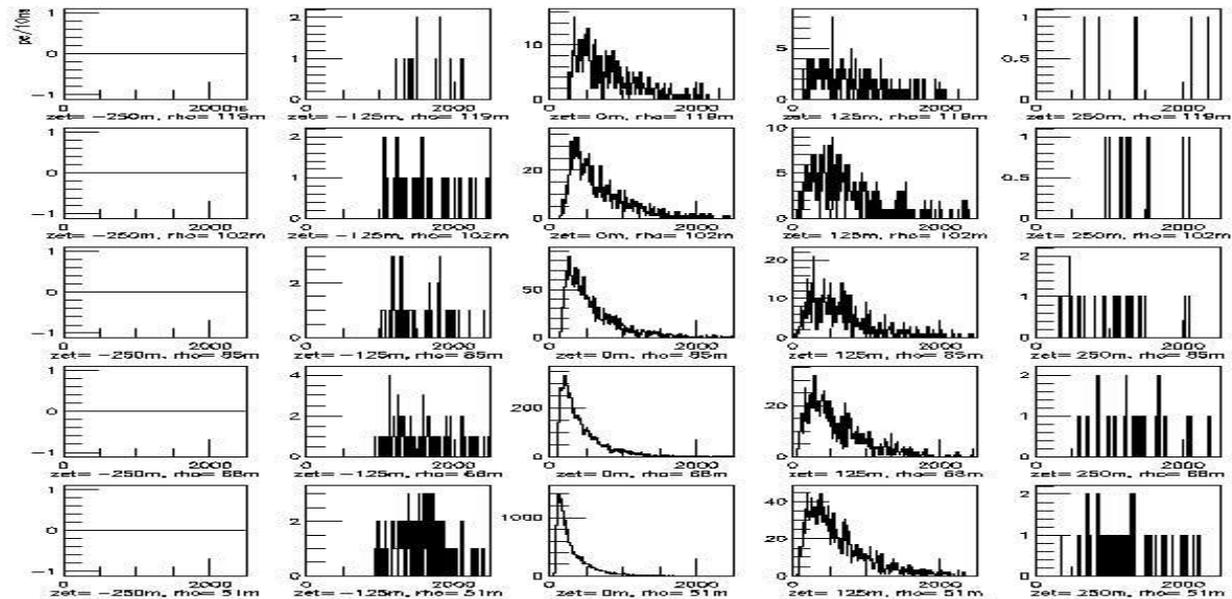
IceCube

Introduction



- In IceCube, we have potentially rich information contained in the full waveforms
- PLAN: Develop algorithms that utilize this information
- Here: Some ideas for cascade reconstruction
- Reconstruction of ν_e utilizing waveforms: RENEW
- Development is dependent on realistic Monte Carlo, particularly of the waveforms (DOMsimulator) -> thus far where most of the effort has been directed

- Position
- Direction
- Energy
- Simulation
- To do

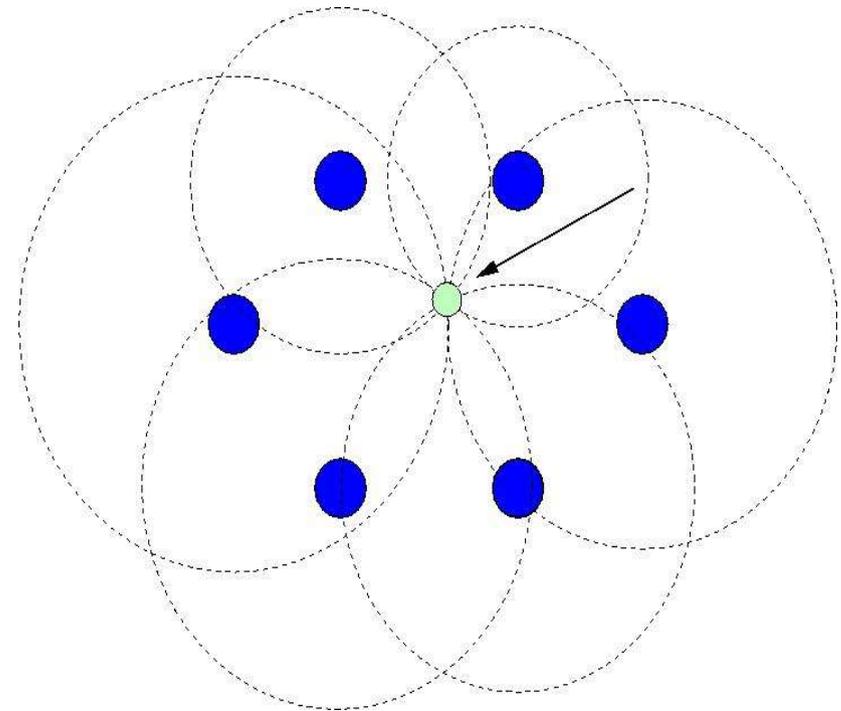




Position of the vertex



- $D_{\text{v-string}} \sim 30\text{-}60 \text{ m} \gg L_{\text{scattering}}$
- The width of the waveform is expected to depend dominantly on the distance from the source
- It may in principle be possible to estimate the distance D from the waveforms on an DOM-by-DOM basis
- **Vertex:** a sphere of radius D can be constructed around each DOM and the vertex should lie at the intersections
- For μ bremsstrahlung, the μ track will alter the size of one of the spheres, and increase the χ^2 of the fit





Direction



- In the limit of many light scatterings and isotropic emission, direction finding should prove to be tough...
- Compare the light at each OM to that expected for isotropic emission
 - Ratio = $\text{light} / \text{light}_{\text{Isotropic}}$
 - Form vectors $(\text{Ratio}-1) \cdot (\mathbf{X}_{\text{om}} - \mathbf{X}_{\text{cascade}})$
 - Sum of vectors --> cascade direction



Energy

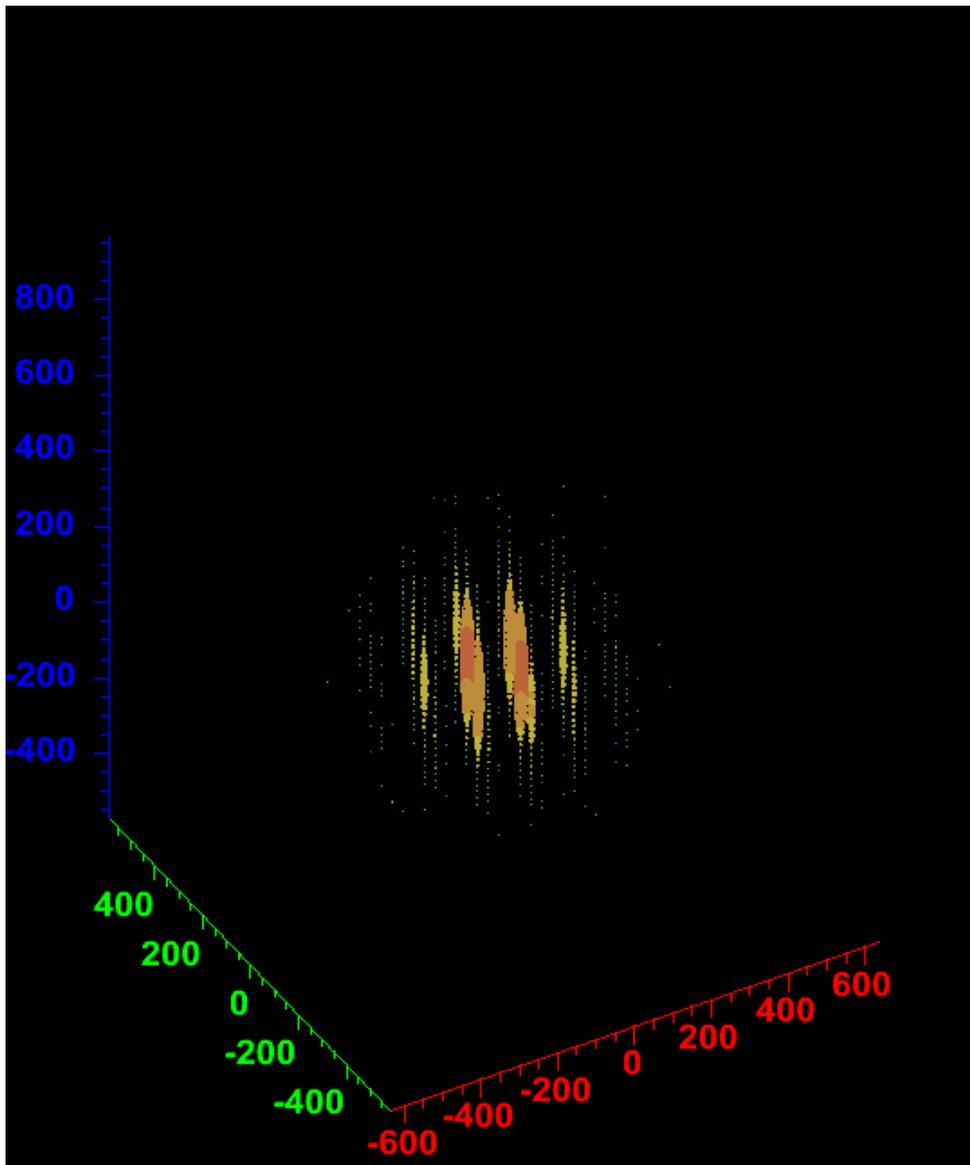


- For a DOM, # of photons $\sim \text{Energy}^\beta \cdot f(D)$ ($\beta \sim 1$)
- $F(D) = \exp(-\alpha D)/D$ for diffusion (total photon path length $\gg D$ because of scattering)
- From a determination of D one could find the energy on an DOM-by-DOM basis
- Compare $E \rightarrow$ consistency check : Reject μ bremsstrahlung
 - If the track goes near an OM, that OM will find a much higher energy
 - Also true for ν_e cascades that produce μ

Estimation of cascade parameters on an DOM- by- DOM basis should provide internal consistency checks



Simulation



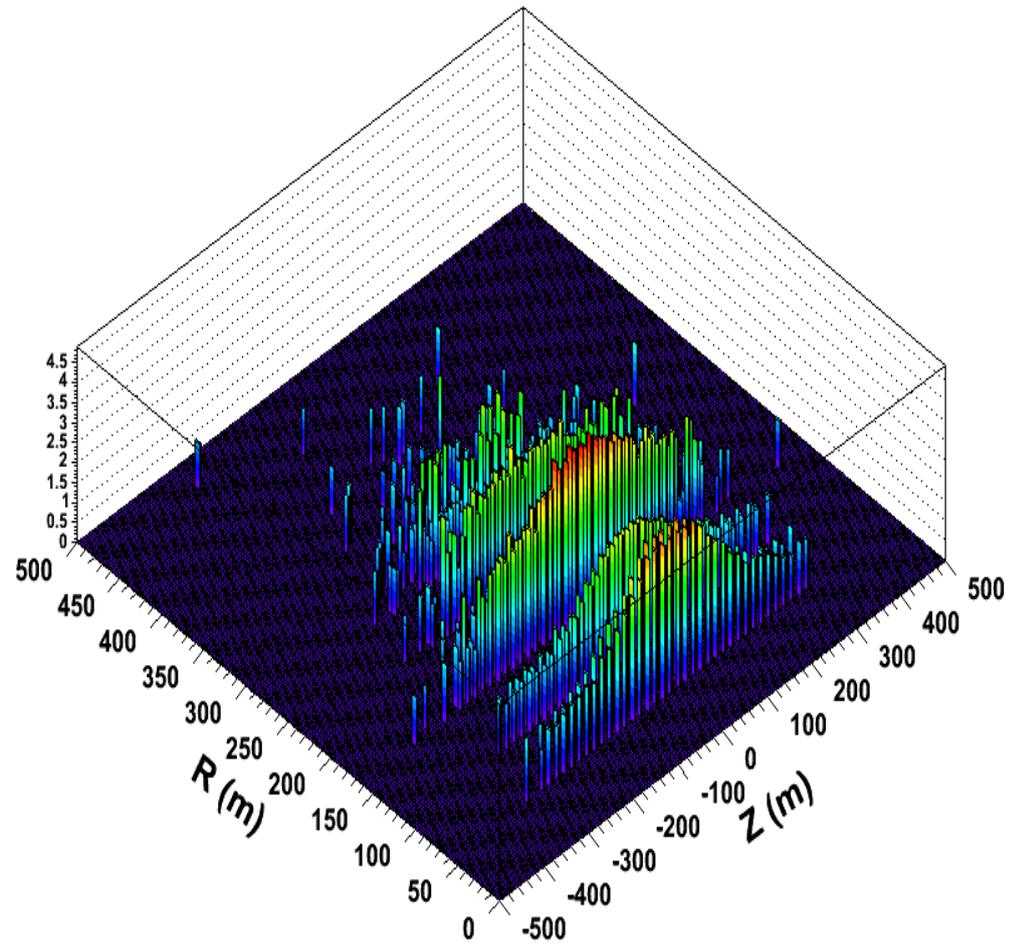
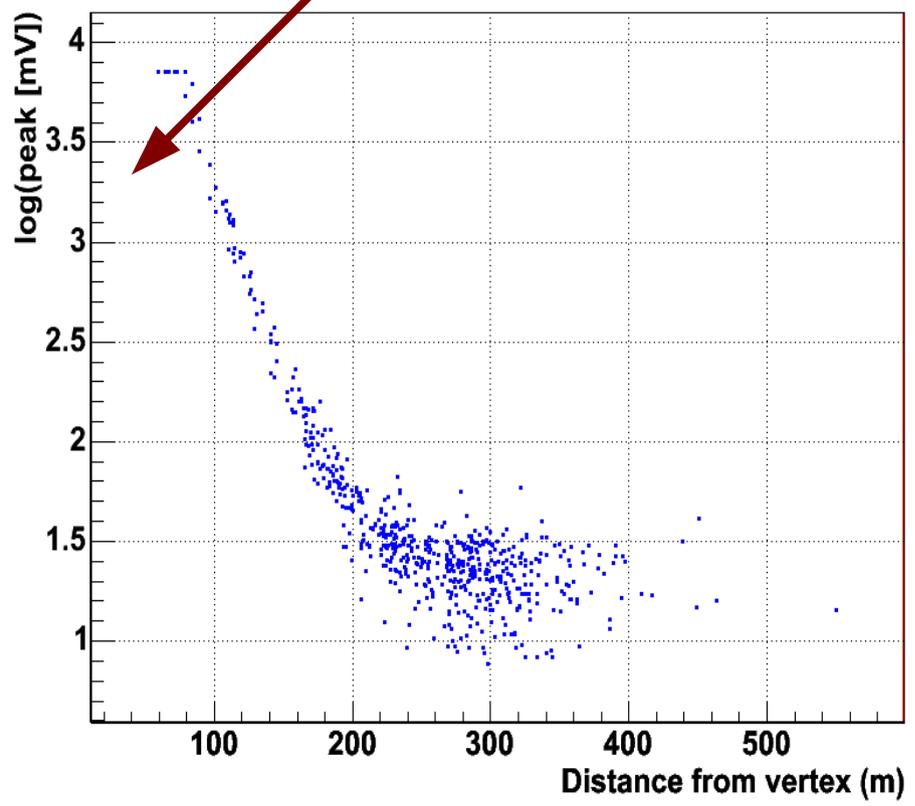
- Development of the algorithm done w/ IceTray: SIMULATION v0.2 (with a few customizations)
- Photonics: bulk ice tables from www.physto.se/~burgess/work/PSInterface/
- 1 PeV cascade in the center of the array
- Issues: saturation



Simulation



ATWD max. readout: ~ 2 V





Conclusions and future work



- In IceCube full waveforms
 - waveform width
 - leading edge of the waveform
 - total number of photons
- In order to develop algorithm (and determine its feasibility) realistic, reliable MC is needed: work is underway -> currently SIMULATION v0.2 available
- Contribution from Photonics is important
- It remains to be seen how results compare with AMANDA algorithms: could provide cross- checks
- Clearly, a lot of work to do
- So far, development of the algorithm has provided input in development of the simulation; hopefully soon the situation will be reversed