

Direct hole-ice simulations with Upgrade-like geometry

IceCube Calibration Call 2018-10-19

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2018-10-19

Document 2018-ahch8Phe

2018-11-07: Updated version with more statistics and effective rather than geometric scattering lengths where the effects are more prominent.

New steamshovel video: <https://youtu.be/Wiu8CpVQn14>



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Resources

Scripts and plots for this talk:

<https://github.com/fiedl/hole-ice-study/issues/117>

YouTube video with Steamshovel visualization:

<https://youtu.be/Wiu8CpVQn14>

Thesis (2018-09-05) with more info on direct hole-ice simulation:

<https://github.com/fiedl/hole-ice-latex>

Previous talks:

<https://github.com/fiedl/hole-ice-talk/releases>

LATEX version of these presentation slides:

<https://github.com/fiedl/hole-ice-talk>

Simulation scenario

For each angle polar and azimuthal angle, shoot photons onto the DOM, possibly propagate through the bubble column, and count hits.

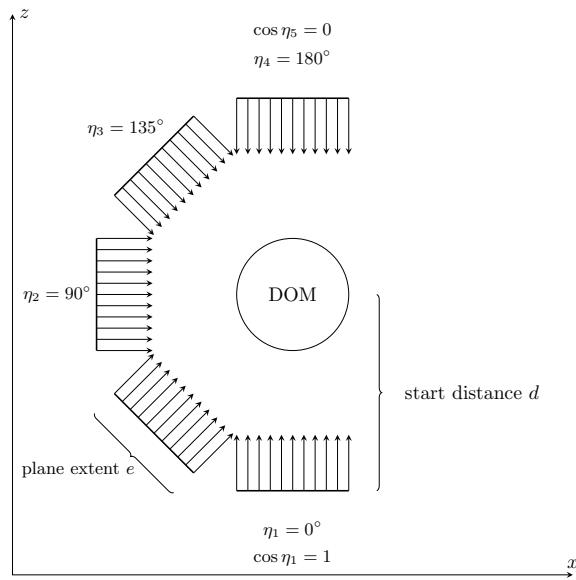


Figure: View from the side. Shooting photons from different polar angles.

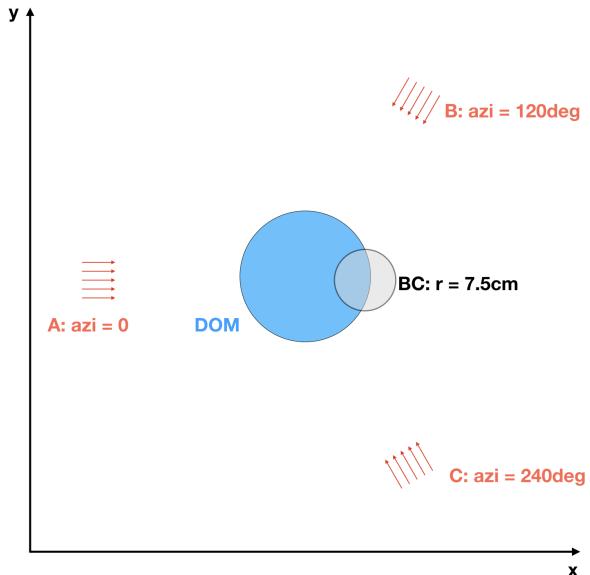
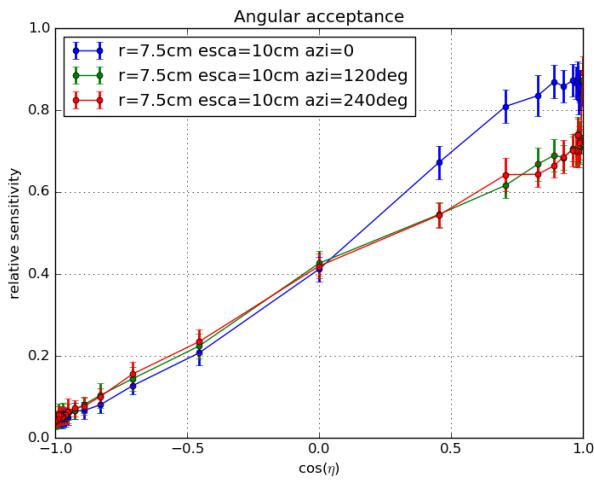


Figure: View from above. Shooting photons from different azimuthal angles.

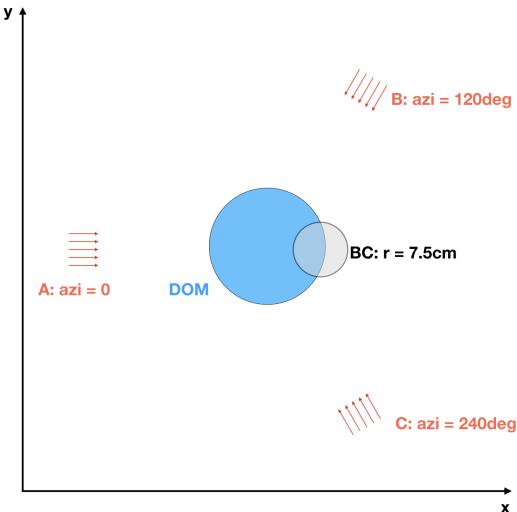
Simulation results



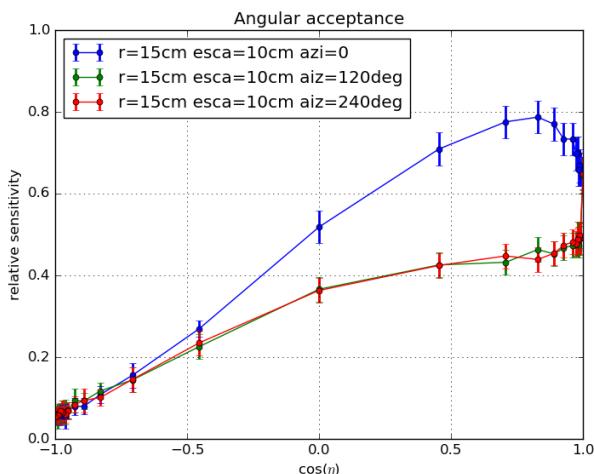
Total photon hit count: 118441 / 1e7

Configuration: Starting distance 3 m, plane-wave extent 3 m, bubble-column geometric scattering length 10 cm, bulk-ice geometric scattering length 130 cm.

- For lower polar angles ($\cos \eta \approx 1$), less photons should arrive from azimuths B and C as from azimuth A as the DOM's PMTs look downwards and photons from B and C are more likely to cross the bubble-column cylinder. ✓
- From azimuths B and C, the same number of photons should arrive due to the symmetry of the scenario (right image). ✓



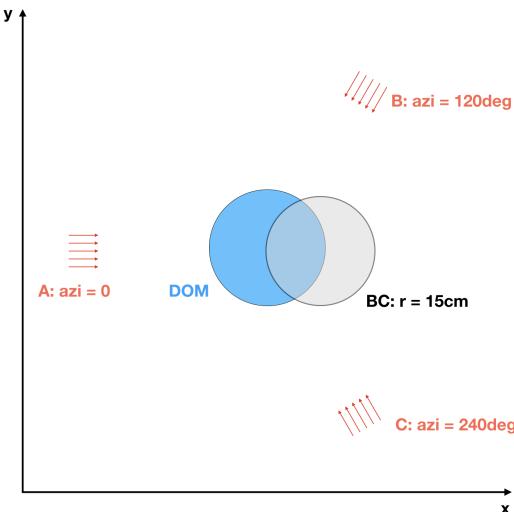
Simulation results



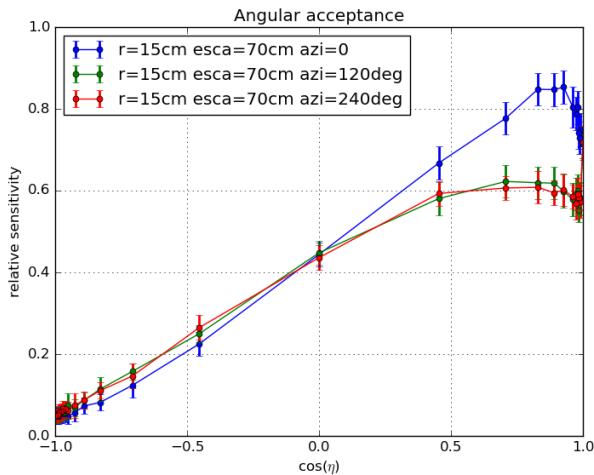
Total photon hit count: 94866 / 1e7

Configuration: Starting distance 3 m, plane-wave extent 3 m, bubble-column geometric scattering length 10 cm, bulk-ice geometric scattering length 130 cm.

- For a larger bubble column with same scattering length, the effect should increase. ✓
- For photons coming from below, the blue curve should see a stronger effect as well. ✓



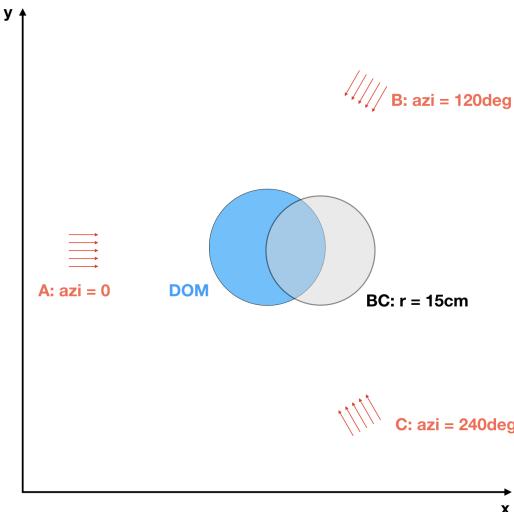
Simulation results



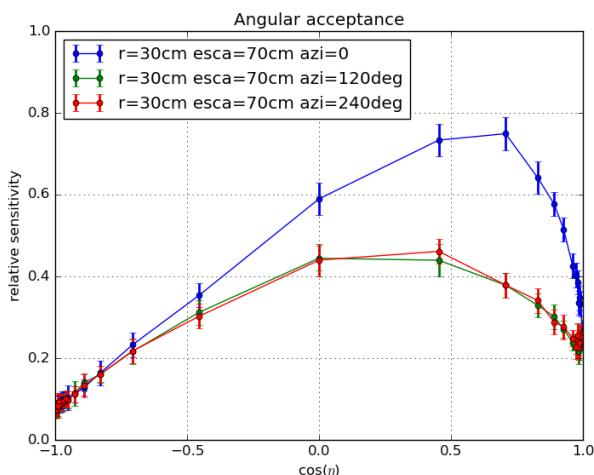
Total photon hit count: 108198 / 1e7

Configuration: Starting distance 3 m, plane-wave extent 3 m, bubble-column geometric scattering length 70 cm, bulk-ice geometric scattering length 130 cm.

- For a larger scattering length (weaker bubble column), the effect should decrease. ✓



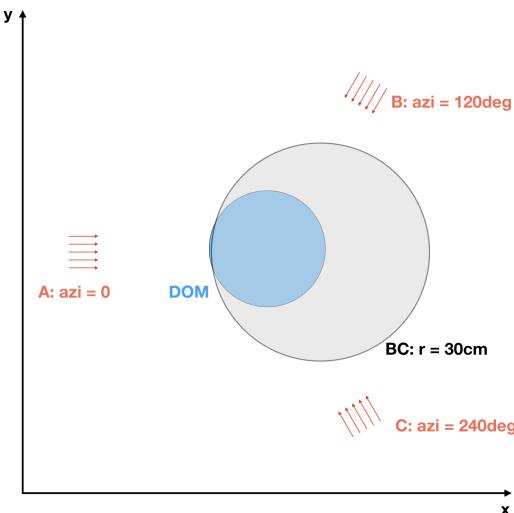
Simulation results



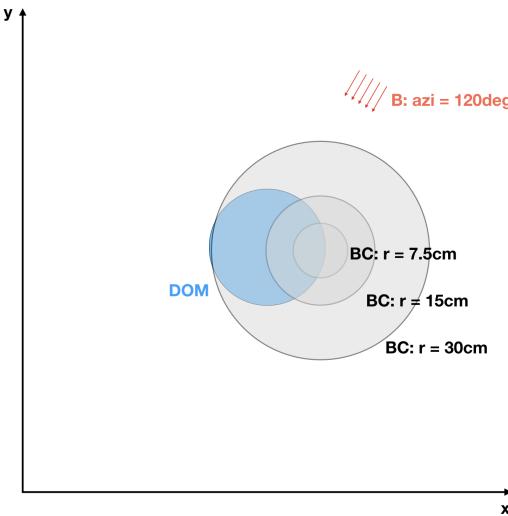
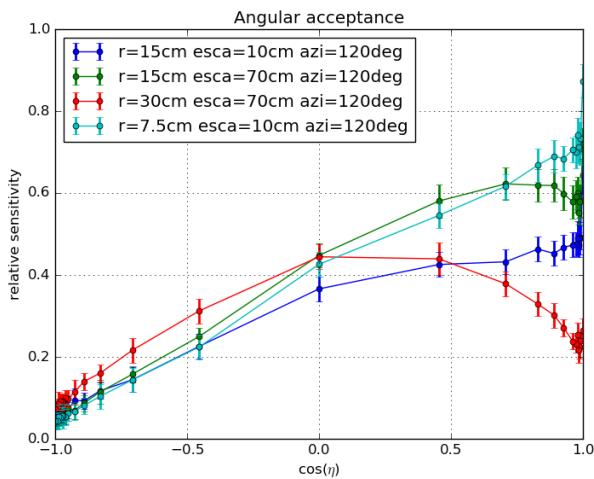
Total photon hit count: 72595 / 1e7

Configuration: Starting distance 3 m, plane-wave extent 3 m, bubble-column geometric scattering length 70 cm, bulk-ice geometric scattering length 130 cm.

- For a larger bubble column, the effect should increase. ✓
- Less photons should arrive in total as the whole DOM is now shielded by the hole ice. ✓



Simulation results



Configuration: Starting distance 3 m, plane-wave extent 3 m, bulk-ice geometric scattering length 130 cm.

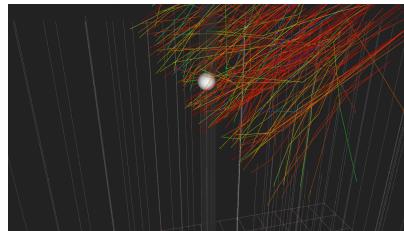
- Comparing different bubble columns for the same direction of incoming photons.
- For a stronger or larger bubble column, the effect should increase. ✓

Thanks for your attention!

Any input you might have is welcome:

<https://github.com/fiedl/hole-ice-study/issues/117>

Slack: @sblot & @fiedl



YouTube video of the simulation:

<https://youtu.be/Wiu8CpVQn14>