Photonics.

Berkeley 21 March 2005
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- Introduction.
- Photonics development history.
- About muons.
- Future.
- Table production.

Modern Photonics code history

Summer and Fall 2004:

- shower distribution Jacobian bug.
- bin-smaller-than-om bug.
- Y=1 (non)issue. Don't use it!

December 2004:

- Muon generation (level2) reference time calculation error.

11 February 2005:
First attempt to make finite muons in layered ice possible:

- Got rid of high fluctuations caused by too simple binned integration.

oldschool tag.

- stable version, not recommended. :|

Current development

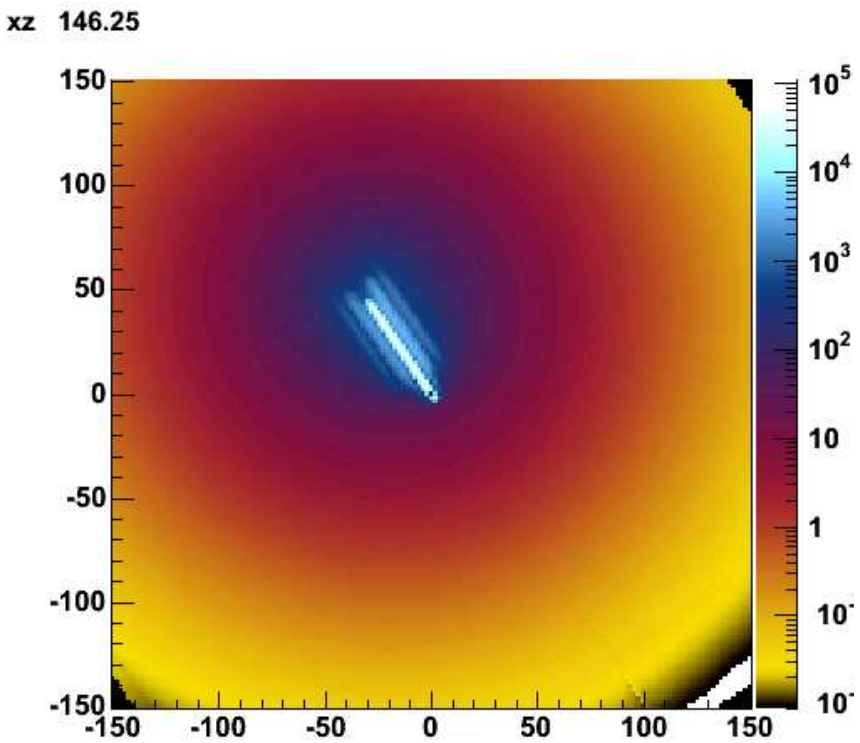
(From 11 February to Mars 19)

- Photonics L2 i/o memory management functionality. (Thomas Burgess)
- IceCube flasher board support. (Michelangelo D'Agostino)

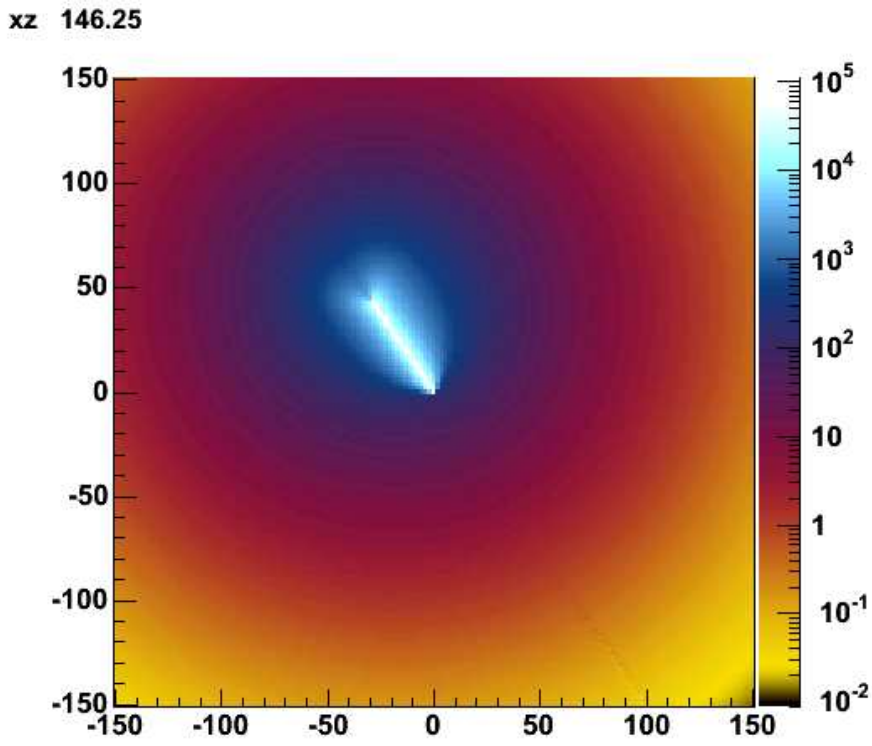
Rework of Photonics' treatment of muons:

- infinite-stopping, starting-stopping, starting-infinite and infinite-infinite muons in layered ice.
- Eliminate redundant muon table information.
- Translate user request to valid table lookups.

The ’oldschool’ tagged version



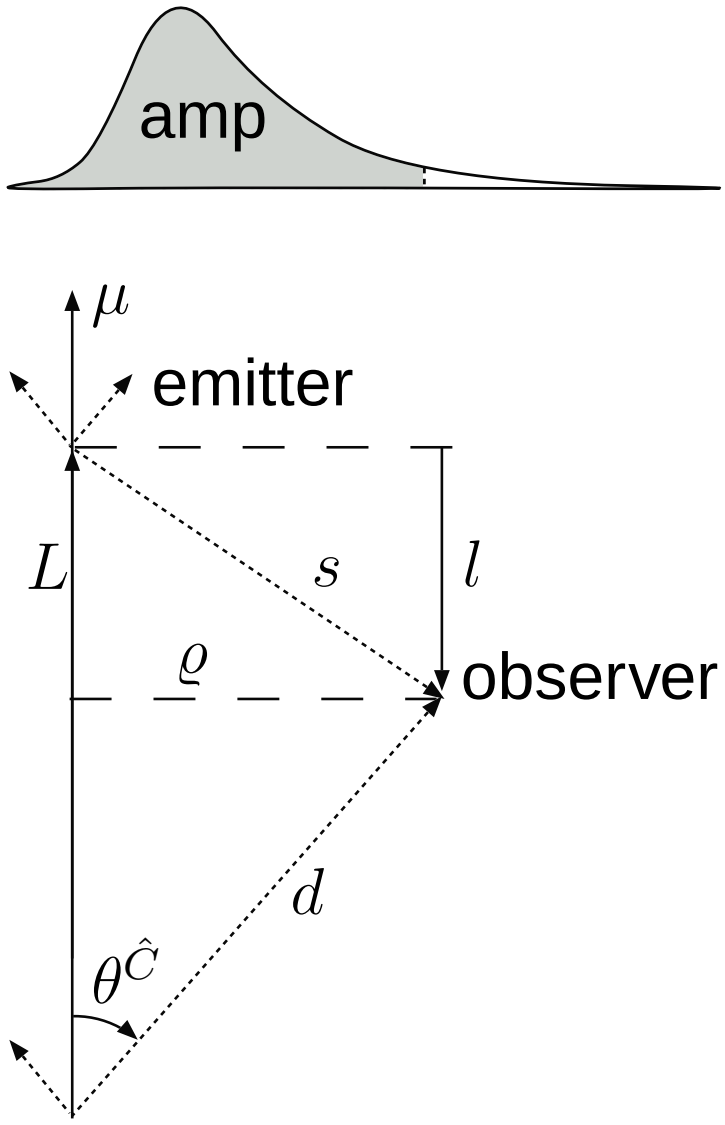
photon distribution.
(before ’oldschool’ tag)



expected distribution.
(generated with PACMAN)

Strange amplitude structures turned out to be a Muon generation (level2) reference **time** calculation error.

The 'oldschool' tagged version: Ref time calculation error



The amplitude is an integral over a fixed muon residual time.

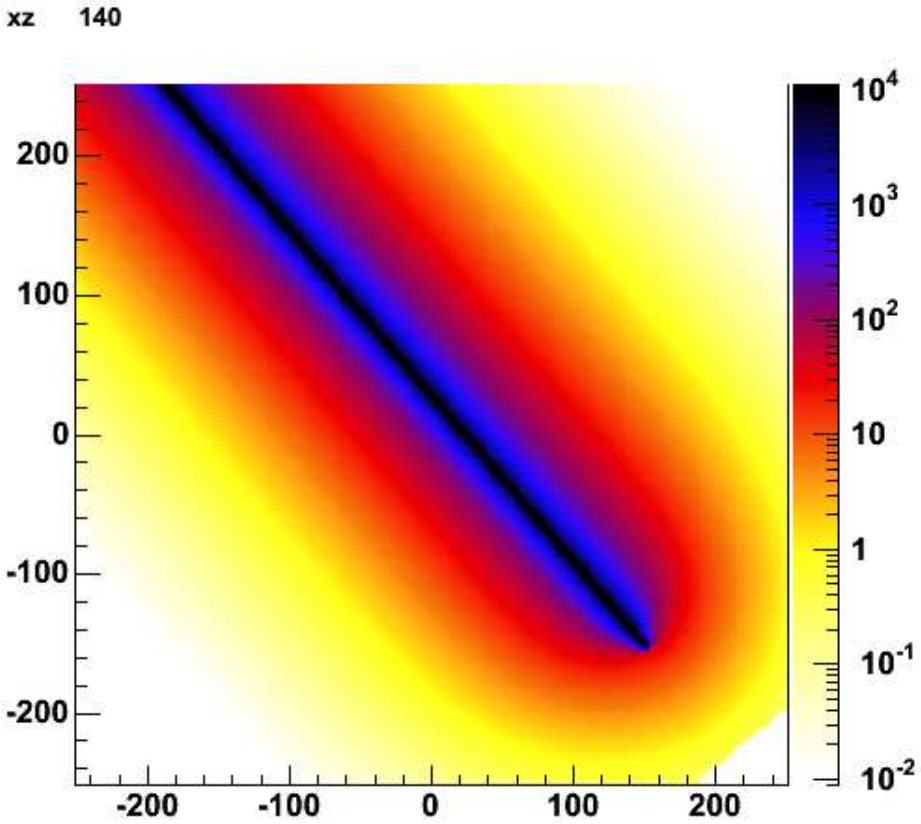
Reference time between direct point source frame and direct muon frame (t_0) was wrong. Factor of 1/C missing in one of the terms.

Correction made it possible to generate valid starting muon tables.

The ’oldschool’ tagged version. Status.

- Stephan has shown (mail Fri Mar 11 2005) that the number of triggers are reasonable.

Homogeneous ice amplitude:



Animations: Homogeneous ice.

Up going infinite muon:

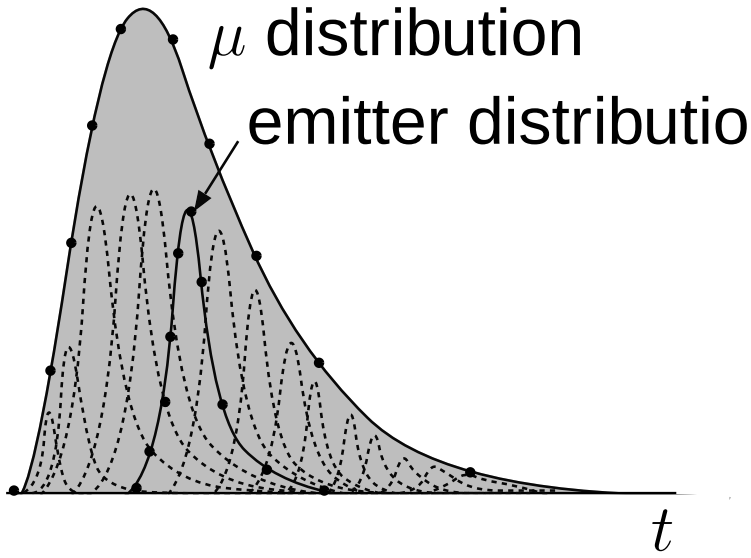
- Light distribution $dN(t)/dt$.
- Independent arriving photon pdf $dP(t)/dt$.

Down going finite muon, 130m.

- Light distribution $dN(t)/dt$.
- Independent arriving photon pdf $dP(t)/dt$.

The 'oldschool' tagged version. Binned integration.

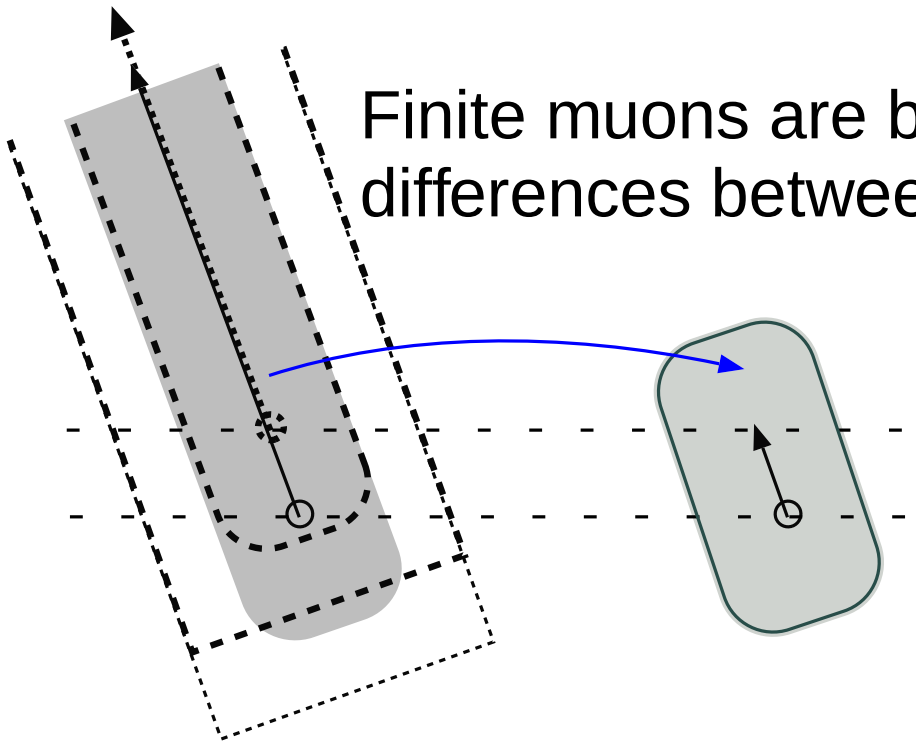
First attempt to make finite muons in layered ice possible:



The numerical, binned integration of Cherenkov emitter distributions to muons was numerically inferior.

With the new code we do no longer loose photons just because they fall in between two bins in the μ distribution.

Rework of Photonics' muon functionality.

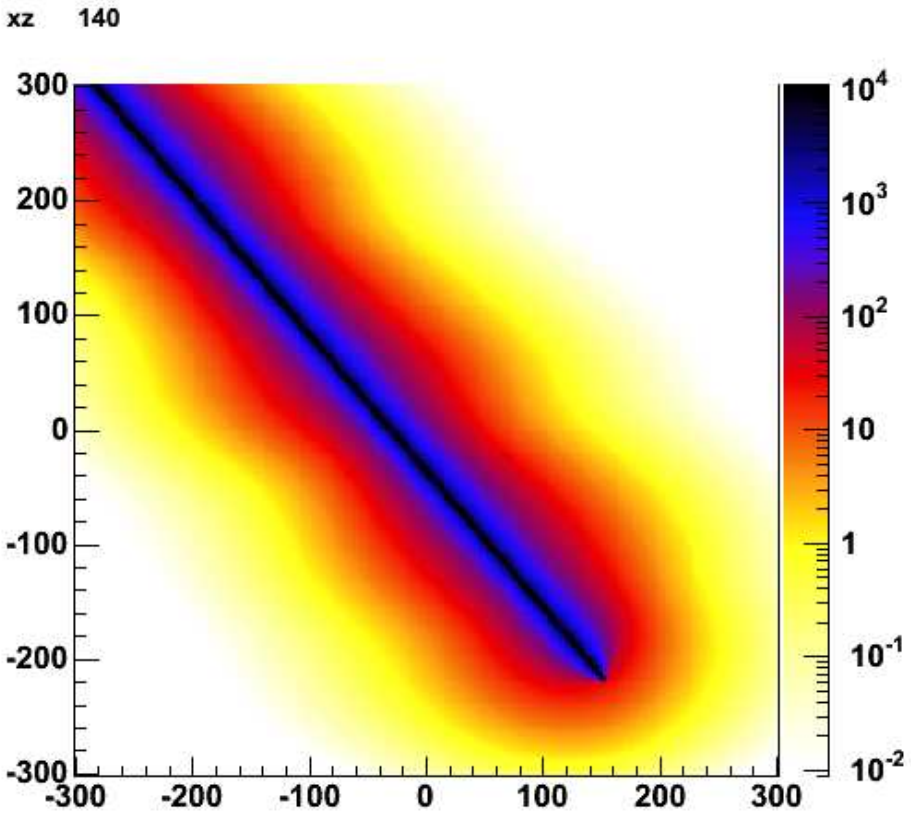


Finite muons are built as the differences between infinite tracks.

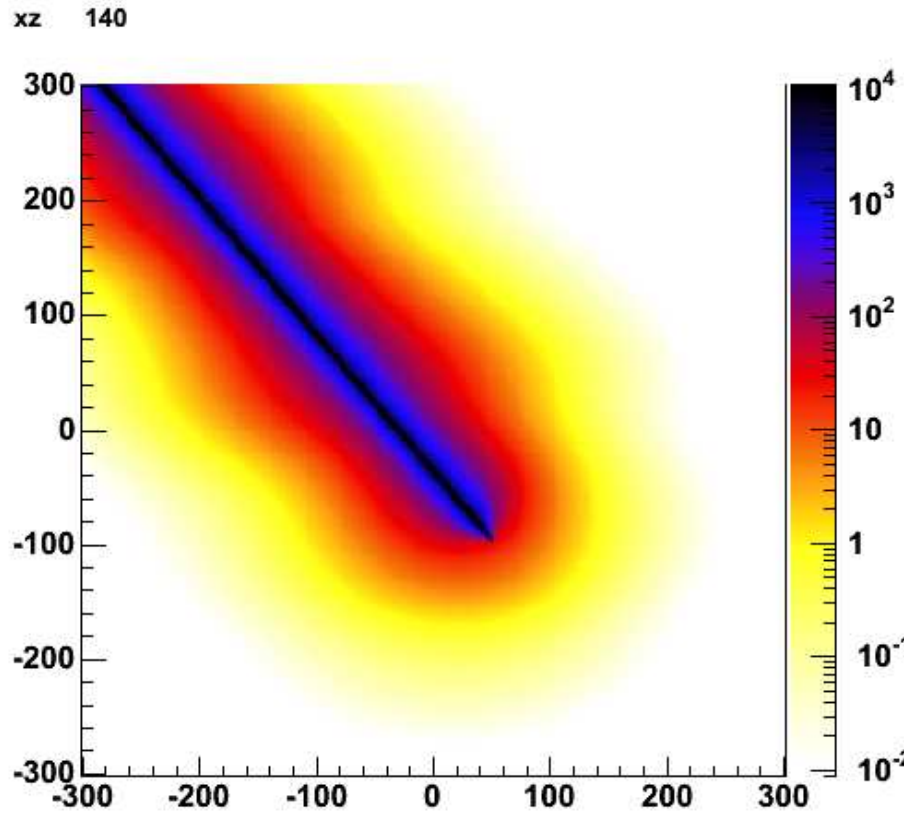
This method *is* clever and works good enough for homogeneous ice.

Rework of Photonics' muon functionality.

Example: Two starting, up going muons



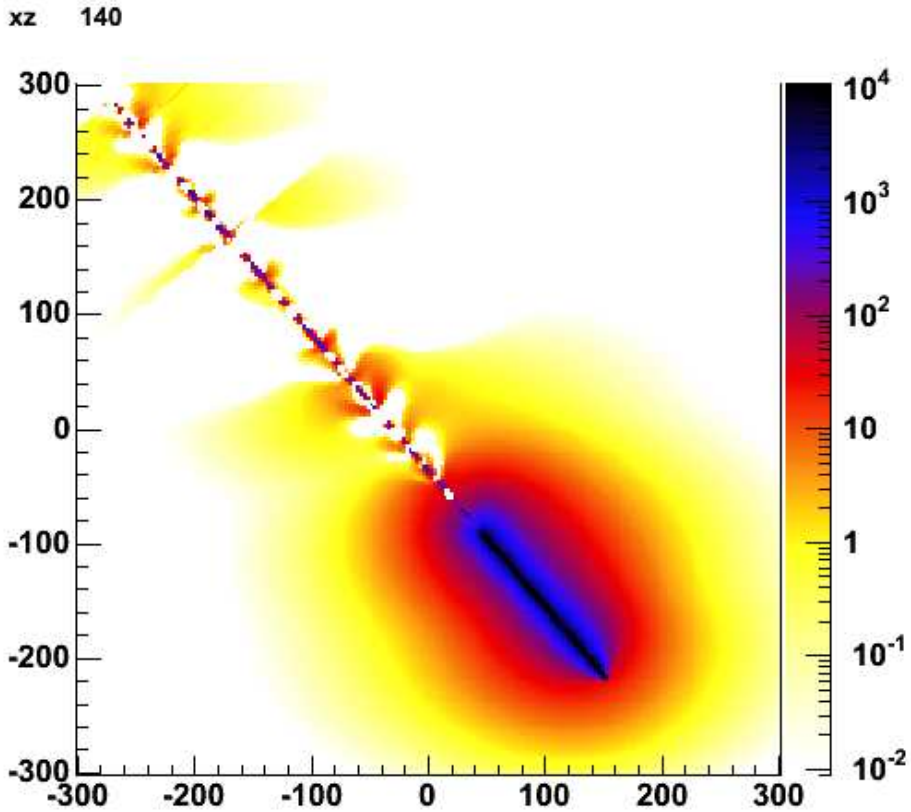
This track, (A)



minus this track... (B)

Rework of Photonics' muon functionality.

... gave this: (A – B)



We can't accurately subtract the two tracks in the regions where A≈B...

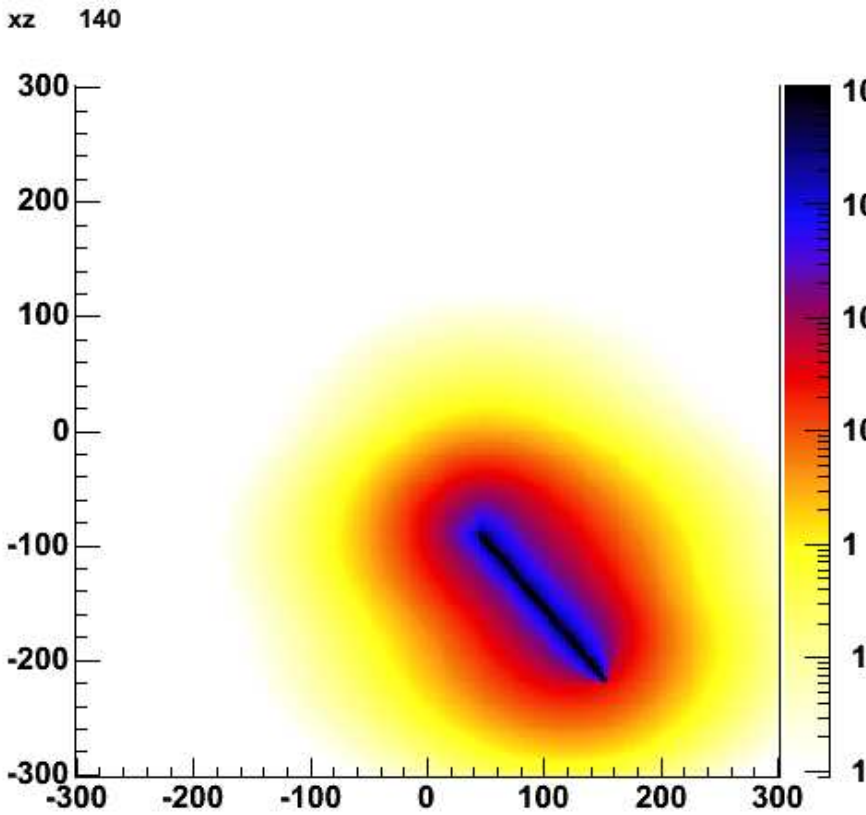
...Not even if we had extremely small relative errors (<10^{-3}) in the underlying table information.

The *first* part of the track is valid since A > B and we basically get the accuracy of A. The same holds for time/prob information.

Rework of Photonics' muon functionality.

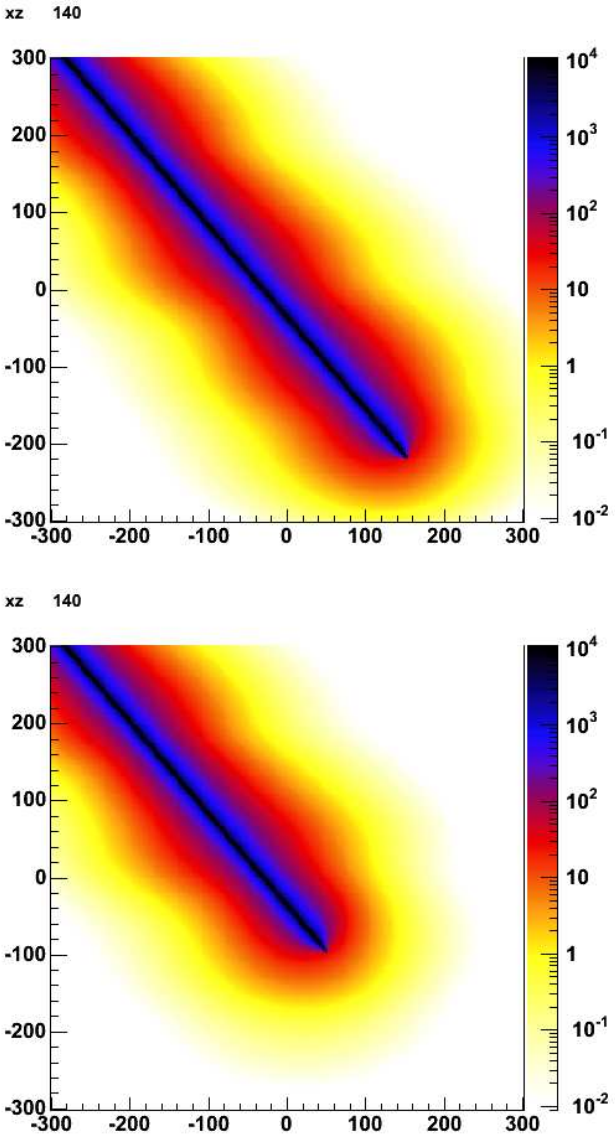
The problem was solved by using both starting and stopping tables, depending on the track–observer relation.

In the fi rst part of the track we subtract two starting tables, while in the last part we subtract two stopping.



Rework of Photonics' muon functionality.

Something about redundant table information.



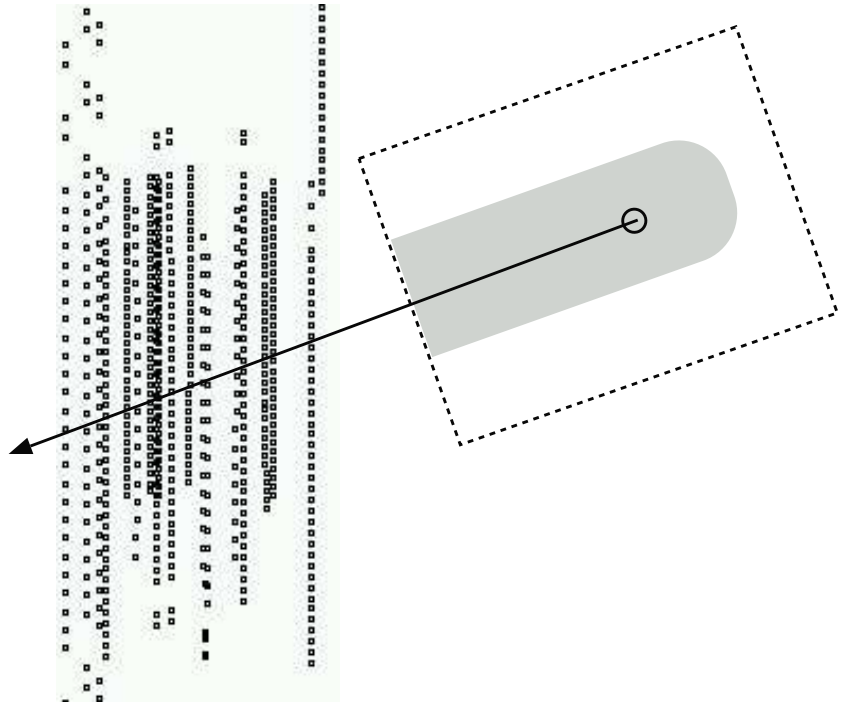
By construction tables were very overlapping. – New table selection code fi nds the best matching valid information for the specifi c angle and observer location.

This allows smaller tables: We limit the length of the tables so that we only have as much 'infi nite information' as we need.

Saving 30%–40% of table memory. More for icecube.

Rework of Photonics' muon functionality.

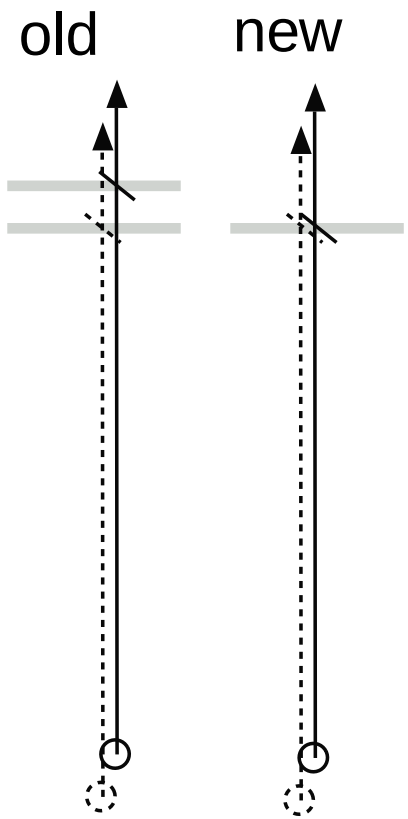
Something about redundant table information.



Translating Photonics coordinates to get the best infi nite table information. Old code:

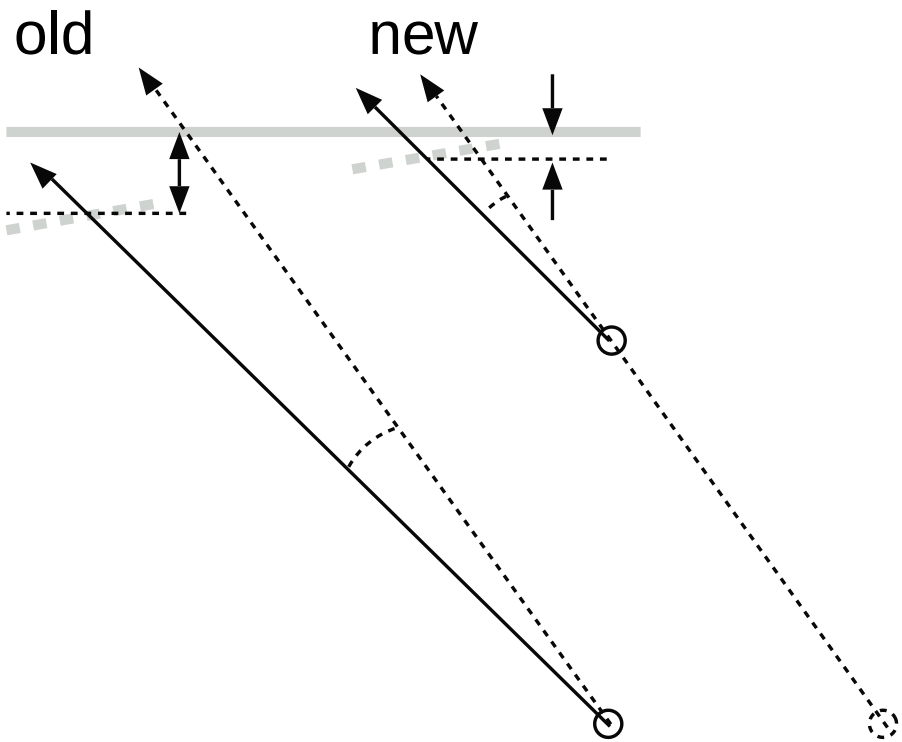
- Even with the old kilometer length tables, muons started far away gave null results without warning!

Rework of Photonics' muon functionality.



Example: Old code went directly to the closest available source bin (solid line). New code translates the request so that we get the correct ice layer.

Rework of Photonics' muon functionality.



Additionally: For angles not exactly matched by a table angle: Old code went directly to the closest available source bin (solid line). New code makes a better job. In reality we also interpolate! (*Could* be further improved, but this was what we got for free.)

Rework of Photonics' muon functionality.

New level2 table generation functionality:

- '–C' option for generation of stopping tracks.
- 'Infi nite' tracks no longer stop (start) at cylinder edge.

New level2 table loading functionality:

Specifi cation of starting/stopping tables done by simply adding **@starting:** or **@stopping:** to the driver fi le lines.

Simulation tools (PSI/Amasim) must be able to request any muon; starting, stopping or infi nite. New code!

Rework of Photonics' muon functionality. New 'user' functions:

get_level2_general_photon_density:

- Takes user requests in Photonics coordinates.
- Determines which table(s) to use: starting/stopping source tables for both fi nite and (semi)infi nite tracks.
- Deals with muons crossing outer ice boundaries.
- Translates Photonics coordinates to get valid infi nite table information.
- Does subtraction to fi nite muon when needed.
- Returns amplitude and handles for delay/delay_prob.

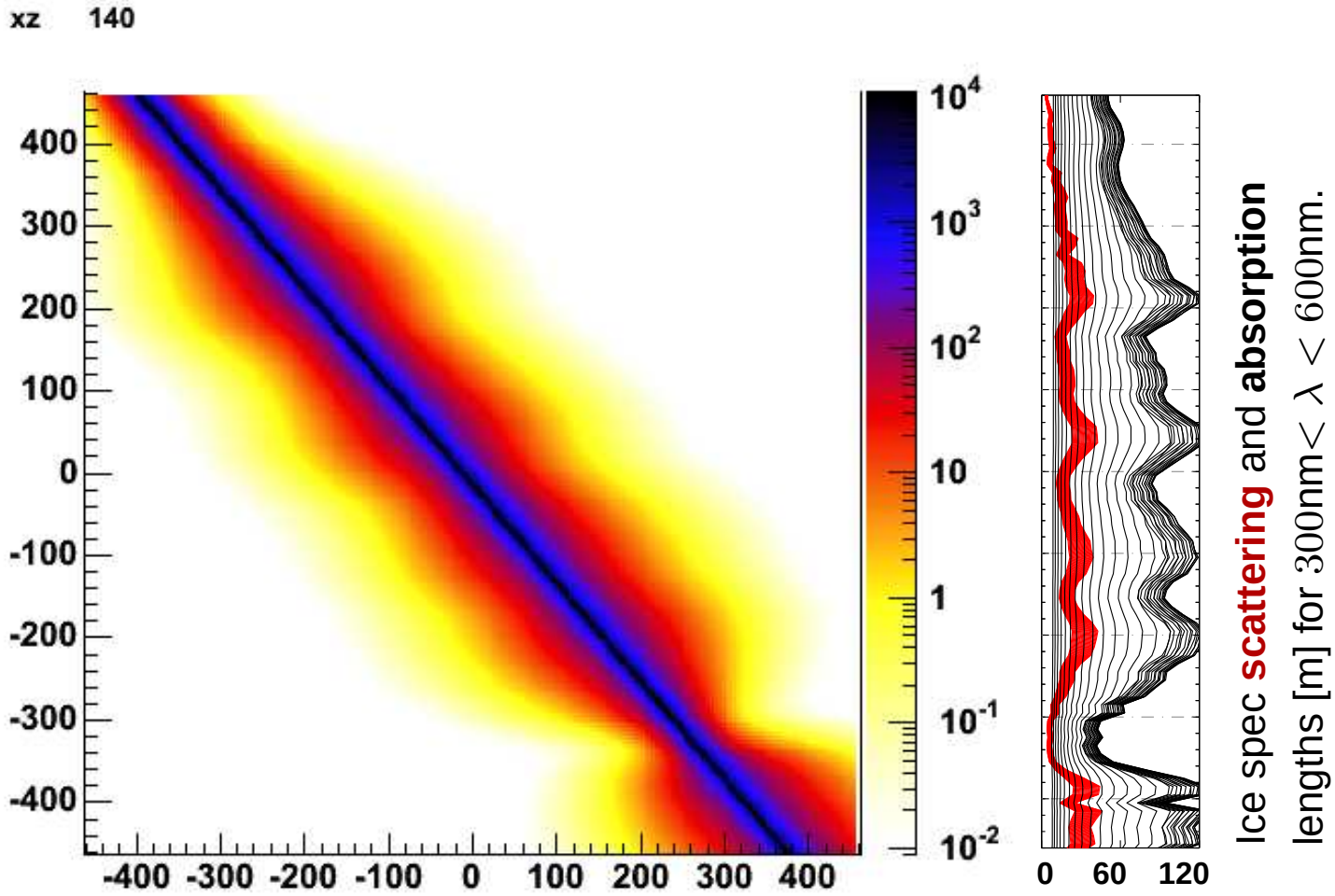
get_level2_general_delay

get_level2_general_delay_prob

set_level2_verbosity

The new Photonics version. Status.

Infi nite up going muon in the layered ice.



Photon/m^2 amplitude. The xz-plane. x and z in meters.

The new Photonics version. Status.

Simulation support for new functionallity:

- PSI: Done.
- Amasim: Very soon.

Animations: Muons in layered ice.

Up going infinite muon:

- Light distribution $dN(t)/dt$.
- Independent arriving photon pdf $dP(t)/dt$.

Up / Down going finite muon, 130m.

- Light distribution $dN(t)/dt$.
- Independent arriving photon pdf $dP(t)/dt$.

Conclusion/Future

- We can do showers and muons!
- Photonics in *'pre-1.18 stable candidate'* state.
- Users should *check it out*.
- Continued testing important.
- Optimizations for speed if needed.
- Integration in simulation (and reconstruction.)

Swedish Table Production.

Generation simple once creation details are fixed.

Amanda:

- Working starting/stopping layered muon table set available.
- Layered shower table set available.
- Next set of tables (Production set) should have hole ice and a little higher statistics.
- All new tables should be sanity checked before use!!!

IceCube:

- Let’s do it!