A new Geant4-based muon/shower Monte-Carlo code

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Problems?

Only a limited number of MC tools are available for KM3NeT

No tool for cross-checks!

No integration of existing tools into the framework (yet)

Solution (part of)

Integration of a Geant4-based simulation in KM3Tray

First step:

- a **full** simulation: **implementation finished!**

Full simulation

Good:

- very **detailed** (propagates every single particle/ photon)
- full Geant4 physics available (up to a few PeV for muons, up to 100TeV for showers)
- independent of OM properties (stores **each photon** hitting the OM, OM simulation can be done in a second step)

Bad:

- SLOW!

Full simulation - output data

Each photon on the OM is stored with its full information:

- position on the OM surface
- direction of the photon track
- wavelength
- time
- number of scatters
- emitting particle type

Then: OM simulation -> **ANTARES** hits, **multiOM** hits, **...** ➡ **flexible**!

Why is it so slow?

Mostly because of e/m showers along the muon track (there are lots of photons in a shower)

light propagation is computationally expensive (**scattering**!)

Solution:

➡ Have a “fast simulation” scheme for showers

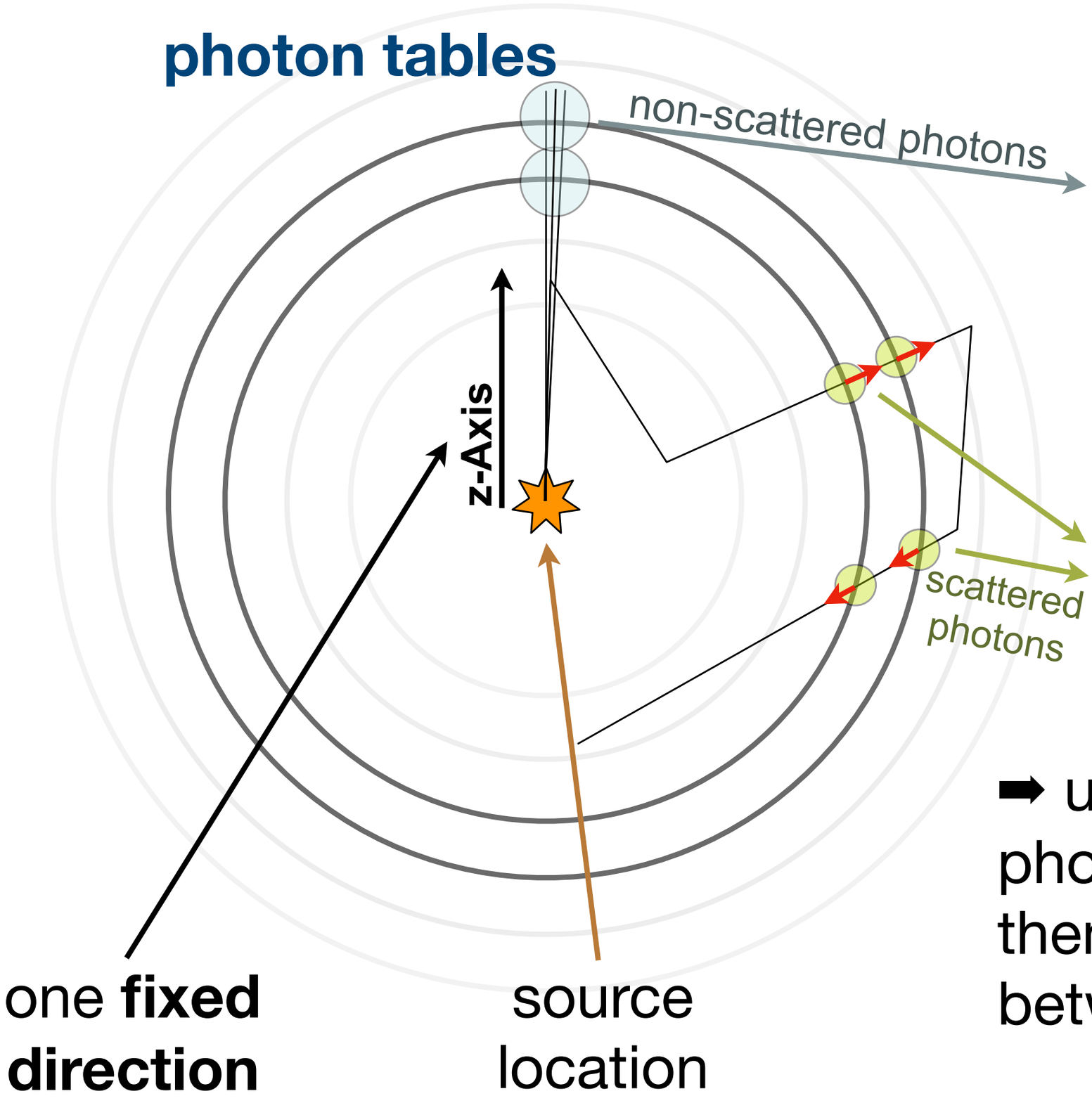
- use a table containing **pre-scattered** photons
- (different from the ANTARES approach, which uses histograms and interpolation)

photon tables

Photons are **pre-propagated** from the shower to concentric **spheres** around the shower

Done before the actual simulation, stored on disk

photon tables



stored in a **histogram** (wavelength bins)
➡ full information can be re-created)

each scattered photon is **fully stored**

➡ use these tables to get photons **near** an OM, then do a full simulation between two spheres

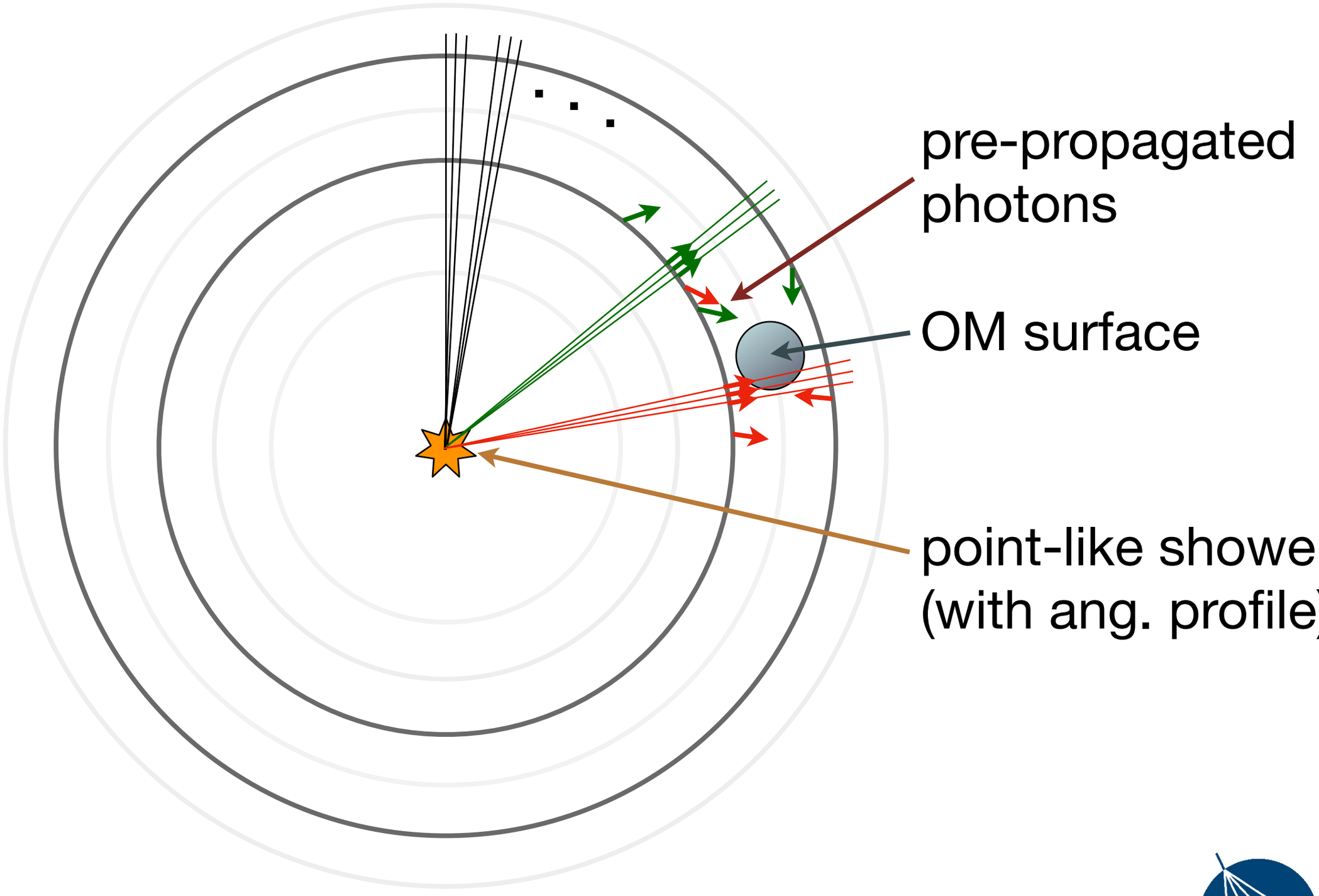
shower simulation

loop over zenith angles, for each angle:

- **randomly** choose an appropriate number of photons **from the table** (distributed according to shower **angular profile**)
- **rotate** the pre-generated photons to this angle
  - randomize the **azimuth** angle
  - **propagate** them from the sphere to the OM (only between the two spheres enclosing the OM)

➡ **point-like** shower

shower simulation



shower simulation - extended showers

distribute the total number of photons over a few point-like showers, spaced according to the **longitudinal profile**

➡ **extended** shower

status

full simulation is **implemented** within KM3Tray

table-based shower simulation is **implemented**
but is still to be **tested**

>10x faster than the full simulation

but: still slow compared to current ANTARES simulation

BUT: much more flexible!

outlook/conclusions

verification of the MC is in progress

tables for **muons** are being implemented

integrated into KM3Tray

➡ **easy to compare** different OM designs (ANTARES storeys/multiOMs) without re-running the whole MC!