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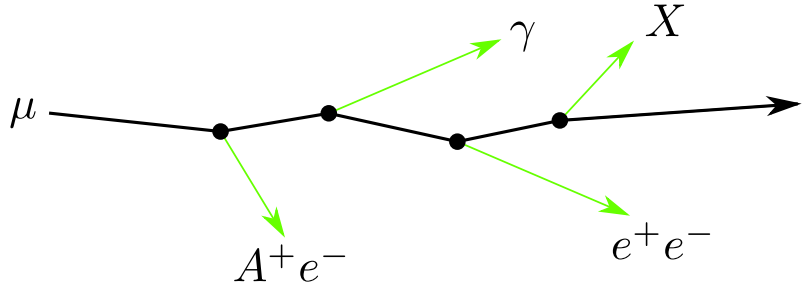

EM shower call meeting - PROPOSAL update

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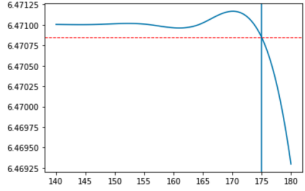
Current status

- Current version of PROPOSAL used on CORSIKA master: `v7.0.5`
- Since then two patch releases: `v7.0.6` and `v7.0.7`
- New minor release: `v7.1.0`
- This talk: Overview over changes that are relevant to CORSIKA 8

Changes in patch releases (`v7.0.6` and `v7.0.7`)

Fix boost interpolation error (PR #185):

- Added fallback if Newton Raphson method of `cubic_interpolation` library fails due to interpolation splines overshooting
- Fixes errors of the type "`RuntimeError: Error in function boost::math::tools::newton_raphson_iterate<double>`"



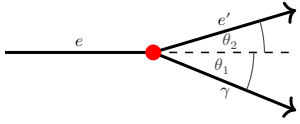
Photonuclear interactions - Keep initial lepton with updated energies (PR #199):

- PROPOSAL can not (yet) sample secondaries of photonculear interactions of charged leptons (i.e. $e^- + Z \rightarrow e^- +$ hadronic)
- Before this release, PROPOSAL discarded both the produced hadronic cascade and the initial lepton entirely
- The initial lepton is now put back onto the stack with an updated particle energy
- Preparations were done to combine PROPOSAL with an hadronic event generator

Changes in the minor release **v7.1.0**

Add sampling methods for bremsstrahlung photons (PR #189):

- Until now, both a bremsstrahlung photon and the initial lepton kept their initial directions during the bremsstrahlung process
- Three different methods to calculate the bremsstrahlung angle were implemented:
  - → No deflection
  - → Simple EGS4 approximation: $\theta_1 = {}^{m}/_{E}$
  - → More sophisticated distribution based on KochMotz parametrization (see PIRS-0203)
- Deflection of initial electron θ_2 is calculated assuming momentum conservation (neglecting momentum transfer to nucleus)

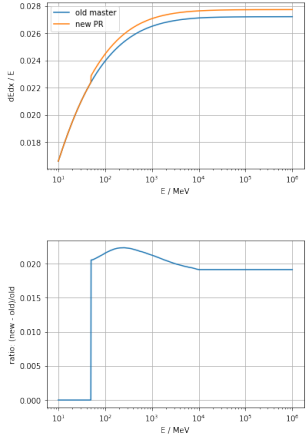


Changes in the minor release **v7.1.0**

Fix usage of emprical correction factor for Bremsstrahlung parametrization (PR #202):

- For e^-/e^+ we currently use the parametrization also used by EGS
- The cross section includes an empirical correction factor for energies below 50 MeV: $\frac{\mathrm{d}\sigma}{\mathrm{d}v} = A'_{\text{empirical}}(E, Z) \cdot \frac{\mathrm{d}\sigma}{\mathrm{d}v}'$
- Erroneously, PROPOSAL used this correction factor also for energies above 50 MeV (above 50 MeV, this meant that the Coulomb correction was accounted for by both the empirical corrections and a correction term in fhe formula)
- This introduced an error of 2 % in the bremsstrahlung cross section for high energies.

Average energy loss of e^-/e^+ in ice due to bremsstrahlung:

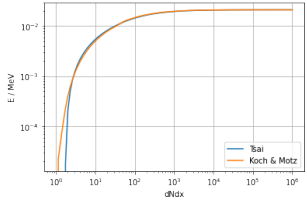


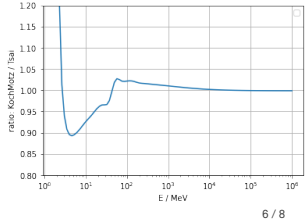
Changes in the minor release **v7.1.0**

Implement KochMotz parametrization for Photopairproduction (PR #191):

- Until now, photopairproduction ($\gamma \rightarrow e^- + e^+$) has been described using the parametrization by Tsai
- As an alternative parametrization, the parametrization by Koch and Motz (also used in EGS) has been implemented
- Parametrization includes empirical corrections below 50 MeV (based on Storm and Israel data)

Total cross section in ice due to photopairproduction:





Changes in the minor release `v7.1.0`

Improvements in calculation of ionization secondaries (PR #205):

- Fix: Initial electron rest mass as been neglected so far when assigning the energy to the delta electron
- Feature: Before, both the initial lepton and the ionized delta electron kept the direction of the initial electron
  → Directions of particles are now calculated according to four-momentum conservation

Fix bug in calculation of photonuclear secondaries (PR #207):

- `v7.0.7` introduced a bug in the calculation of secondary energies for photonuclear interactions
  → Do not use `v7.0.7` for shower production, since CORSIKA 8 might crash when a lepton makes a photonuclear interaction!

Next steps

- New PROPOSAL version has been released: `v7.1.0`
- PROPOSAL `v7.1.0` is in the pipeline to be published on conan-center-index (PR #7683)
- As soon as this is finished, I will create a PR to include the new PROPOSAL version on the CORSIKA master
- We have to look at the results of these changes (also together with the bug fixes found by the radio people)