

PROPOSAL for CORSIKA

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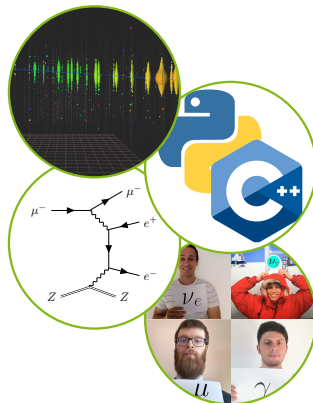
CORSIKA Cosmic Ray Simulation Workshop

25th June 2020

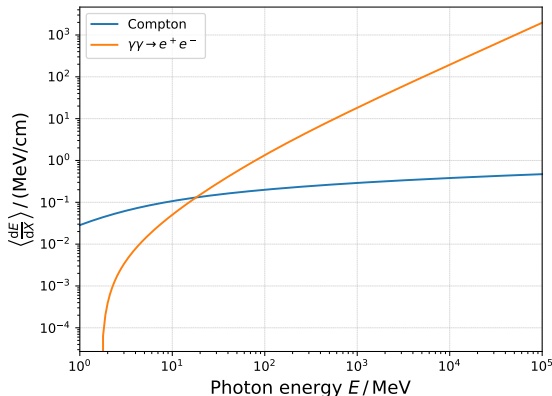
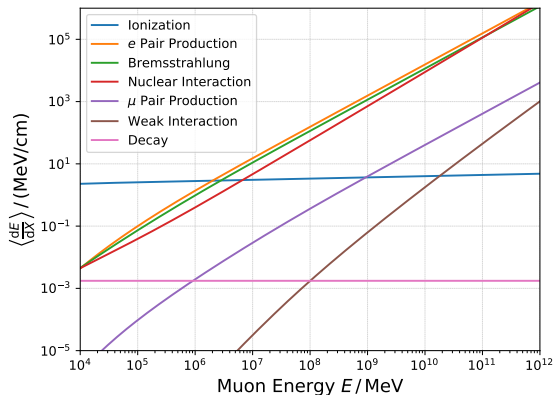
Technische Universität Dortmund

PRopagator with Optimal Precision and Optimized Speed for All Leptons

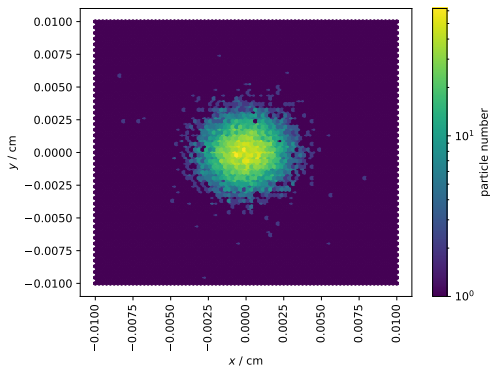
- ▶ Efficient propagation of a primary lepton/photon
- ▶ Physically as accurate as possible
- ▶ Simple prototyping physical problems
 - ▶ Try: `pip install proposal`
- ▶ Produces energy losses and real secondaries
- ▶ Actively maintained
 - ▶ Visit our repo: <https://github.com/tudo-astroparticlephysics/PROPOSAL>



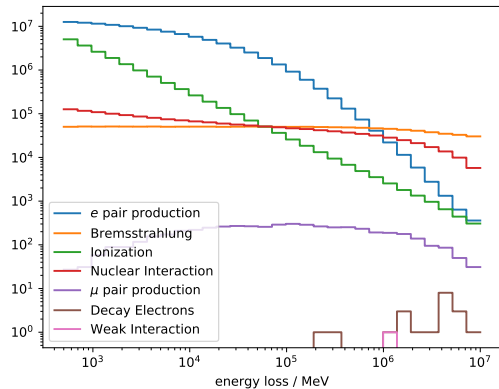
Energy losses for different particles in ice



► flexible in choice of parametrization

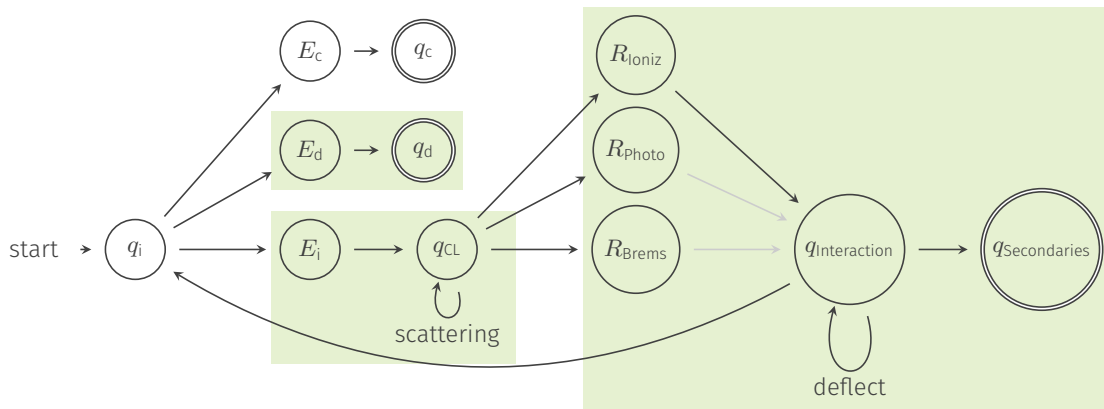


Scattering of 10^4 muons with $E_i = 10^9$ MeV after $z = 10^4$ cm



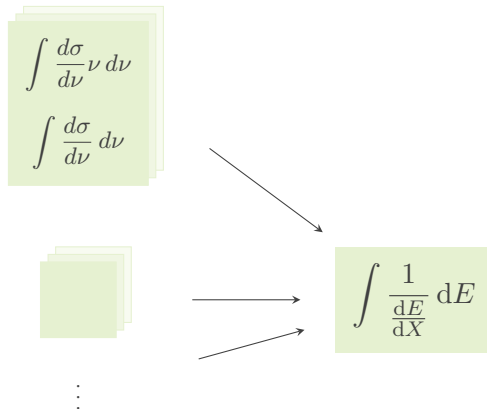
Secondary distribution of 10^7 muons with $E_i = 10^7$ MeV after $z = 10^4$ cm

How does it work?

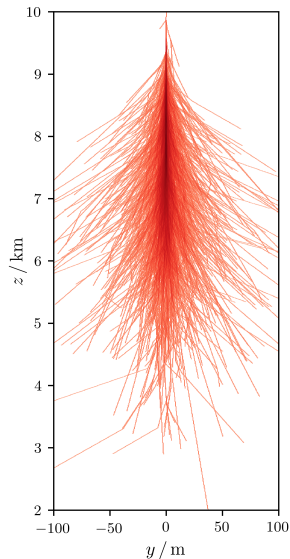


Maximize efficiency

- Interpolation tables are used to reduce number of integrations
- Interpolate integrals necessary for propagation



- First simulation of an electromagnetic shower using PROPOSAL
- Shower with $E_i = 10^6$ MeV in homogeneous air at sea level
- Until now a PROPOSAL-internal proof of concept



Only stochastic processes propagation

- ▶ Tau regeneration case study
 - ▶ CC and NC cross sections
 - ▶ No Glashow Resonance or Neutrino Oscillation yet
- ▶ Photon propagation as only stochastic process

$$\log(\xi_{[0,1)}) = - \int \frac{\sigma(E)}{dE/dx} dE$$

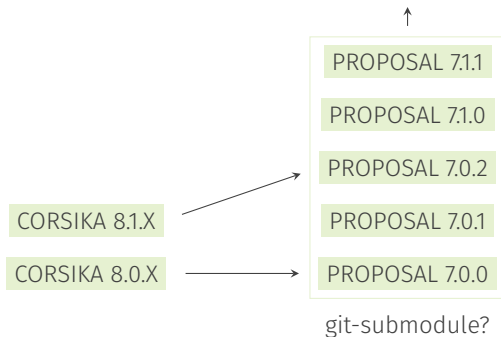
$$x_f - x_i = \int \left(\frac{dE}{dx} \right)^{-1} dE$$

↓

$$x_f - x_i = - \frac{\log(\xi_{[0,1)})}{\sigma(E)}$$

Avoid divergence of code

- Separate em physik from interface
- Tagged 3rd library versions for extensive testing



Current Status

- ▶ Transformed from propagation loop to modularized lib
- ▶ Calculates in gramage
- ▶ *Hopefully* one bug away from em-shower

Open Issues

- ▶ Treatment of photonuclear secondaries
- ▶ Medium density dependent ionization constants
- ▶ Testing results

Outlook

Short-term (~weeks)

- ▶ Finalize CORSIKA interface

Mid-term (~months)

- ▶ Installation process
- ▶ LPM in inhomogenous media
- ▶ Photoelectrical effect (?)

Long-term (~years)

- ▶ Logging

Current Work:

- ▶ corsika merge request #169
- ▶ proposal branch `restructure_parametrization`