from CORSIKA to detectors
resampling nearly horizontal particles

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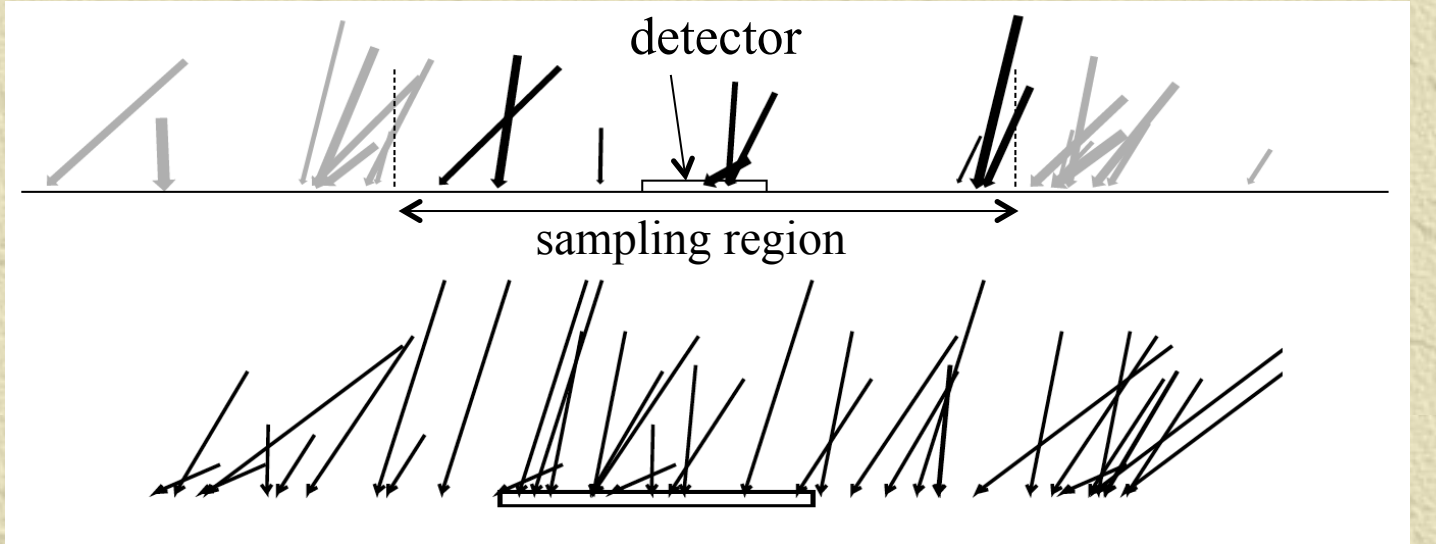
a complement to Astrop. Physics 30-5 (2008) p.270
triggered by discussions with François Montanet and Corinne Bérat
about a monstruous photon in a nice simulated shower

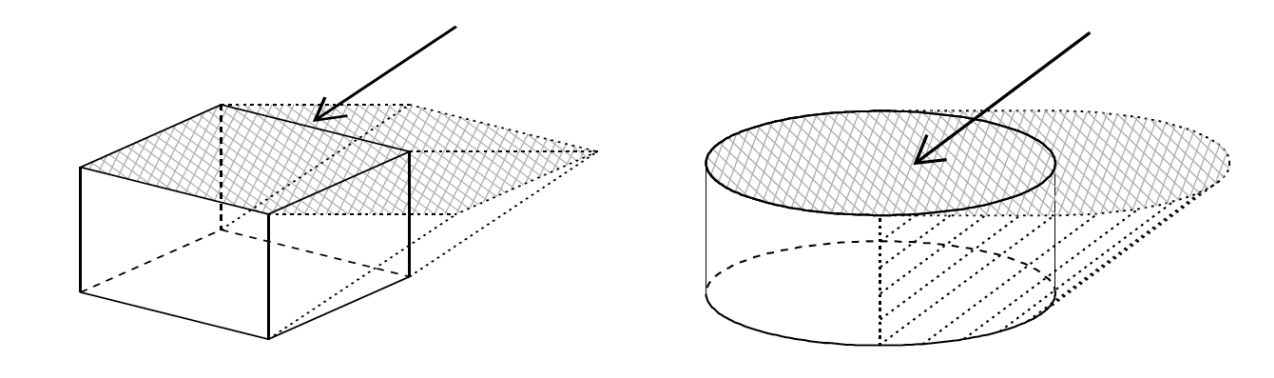
CORSIKA workshop, Heidelberg, July13, 2022

standard resampling of weighted ground particles



weighted
ground particles
in sampling area A

equivalent flux
(clones of particles
uniformly distributed)



regeneration in the detector
factor A_{proj}/A_s to the weight
compute Poisson(weight)
(should be <~1 to avoid
artificial fluctuations)

problem with nearly horizontal particles: undersampled in the ground file

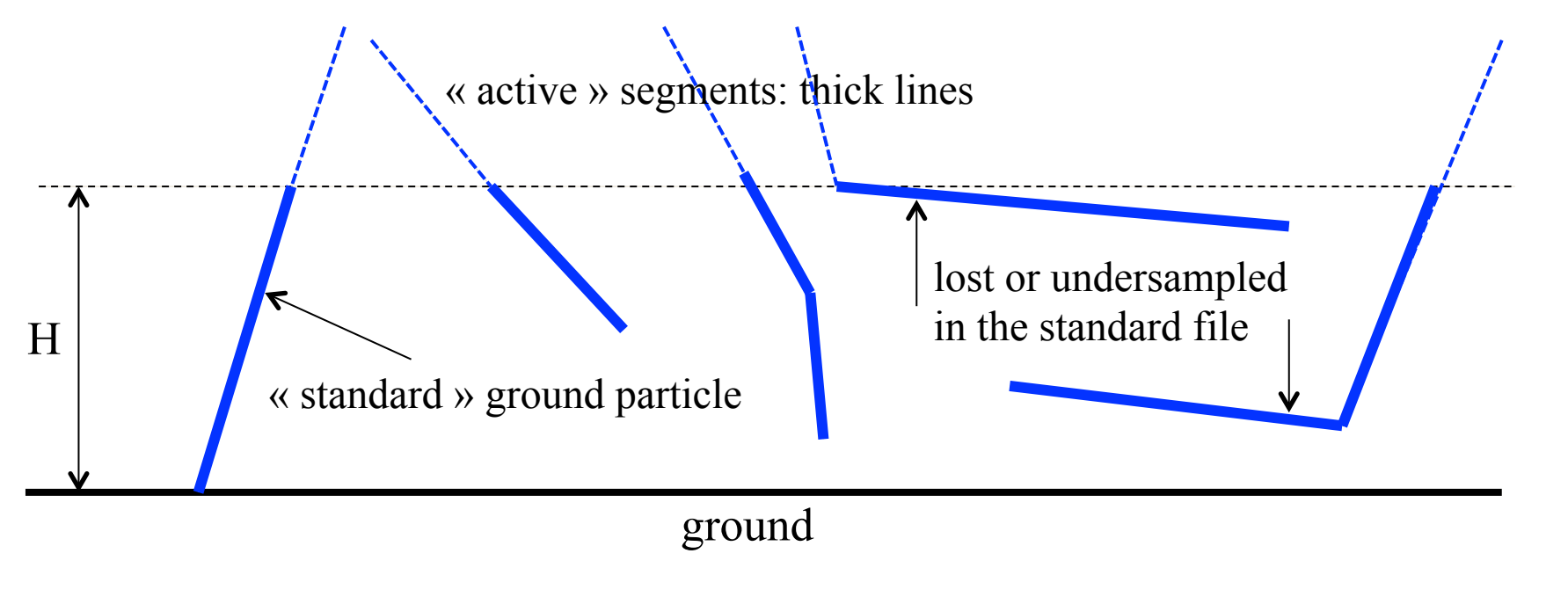
➔ large resampling factor ➔ large number of clones

a possible solution

(needs some help from CORSIKA)

principle:

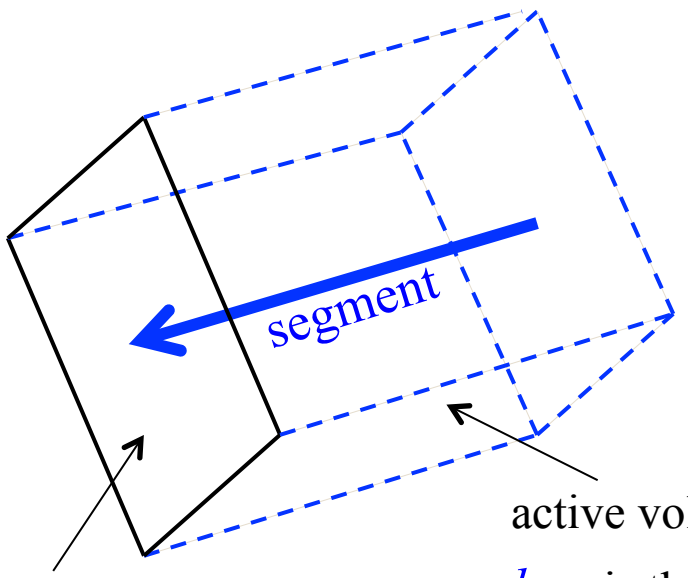
- define a « sampling volume » : thickness H above the ground surface
- collect all particle segments within this volume (hitting the ground or not)
- for each one: collect the length in addition to x,y,z,p_x,p_y,p_z



advantage: nearly horizontal particles are efficiently sampled

resampling in one detector

principle: each segment represents a flux of identical particles (same nature, energy, direction) flowing onto the detector



a particle enters the wall iff it starts within the active volume *v*

the expected number of such particles hitting the wall element is $n = w.v/V$

V : *volume of the sampling region*

w ; *weight of the ground particle*

active volume $v = a.l_{perp}$

planar wall element (area *a*)

l_{perp} is the lentgh of the segment *projected onto the normal to the wall*

then: inject Poisson(n) clones to be injected through the wall element (with random uniform position in the planer element)

Note: use the direction of the particle (not the direction of the shower axis)

request to CORSIKA

- define a height *H* of the sampling domain, and keep memory of position when crossing the upper plane
- put in the ground files all « segments » as defined above, each one with start and end points
- no need for separate outputs: this one includes the standard ground file (particles with end point at *z=0*), which may be handled as usual.

advantages

- no problem of size: with a reasonable value of H, most of the segments are actually standard ground particles; the other ones correspond to cases where the modification is really useful (typical example: neutrino induced showers)
- another byproduct: the output file may contain *upgoing* particles, produced in atmosphere or backscattered from ground

conclusion

easy, no nuisance, solve marginal (but worrying) problems

remark: *the monster of François and Corinne was weakened, but not fully killed*

(strange energetic photon at a large angle from the shower axis with a relative large weight; not expected anyway !)