



Adaptive Sampling in Simulations for IACTs

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whoami

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- ⇒ PhD student @ TU Dortmund University
- ⇒ IACT Background
- ⇒ working for several months on the project



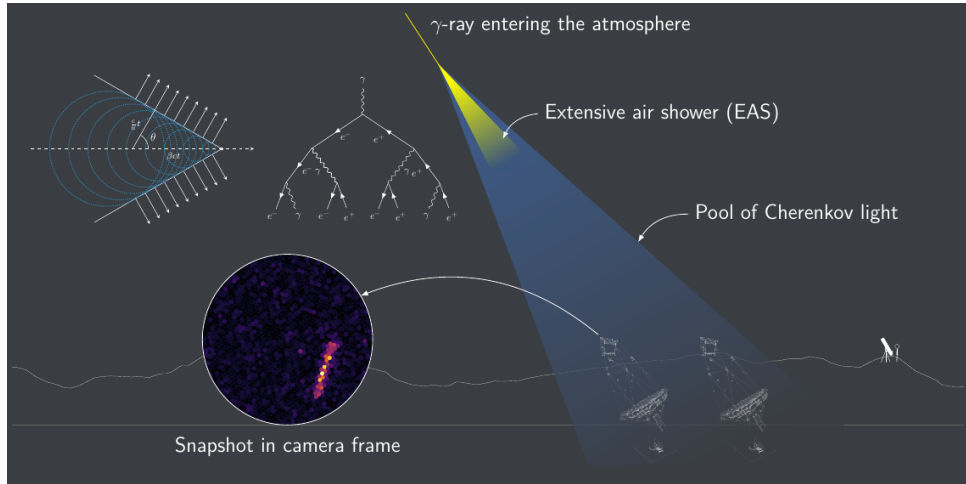
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Imaging Air Cherenkov Telescopes

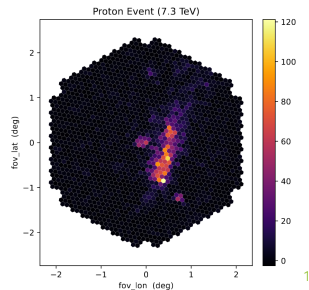
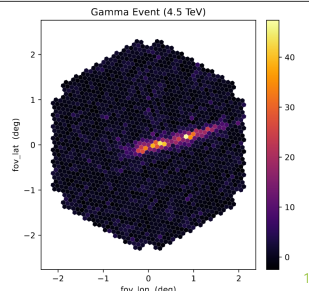


¹https://github.com/aknierim/TikZ_assortment/tree/main/IACT

IAC Analysis Taks

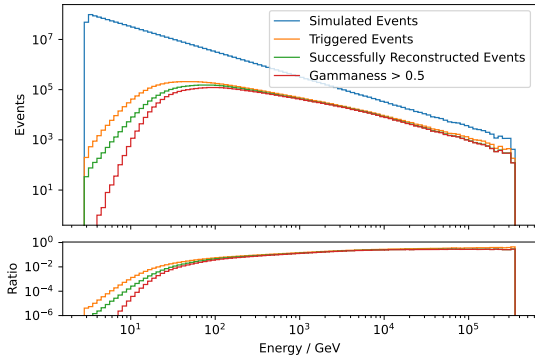
1. Gamma/Hadron Separation
2. Directional Reconstruction
3. Energy Reconstruction

⇒ highly depending on Monte Carlo simulations (Particle Classifier, Energy Regressor, IRFs(even more so due to atmosphere!))



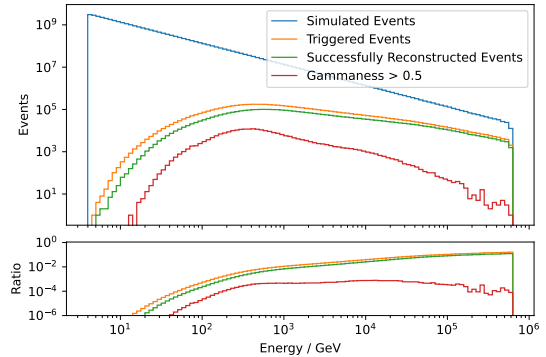
The Problem

⇒ Gamma



¹

⇒ Proton



¹

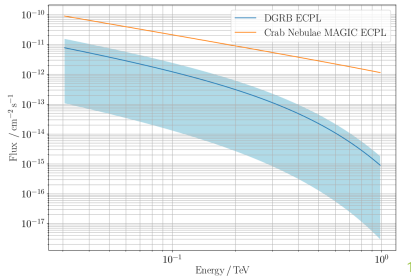
¹kindly provided by Dr. Max Linhoff

The Plan

- Continuous Energy/spatial simulation.

⇒ oversampling medium energies due to telescope acceptance.

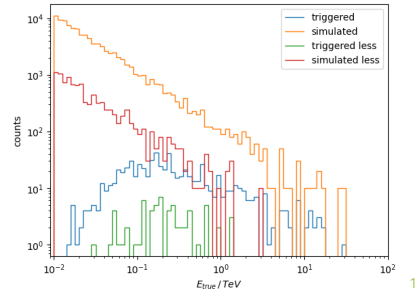
⇒ **going from continuous to discrete spatial/energy distribution.**



- Acceptance Problem described above.

⇒ trying to bring the simulation/trigger curve closer.

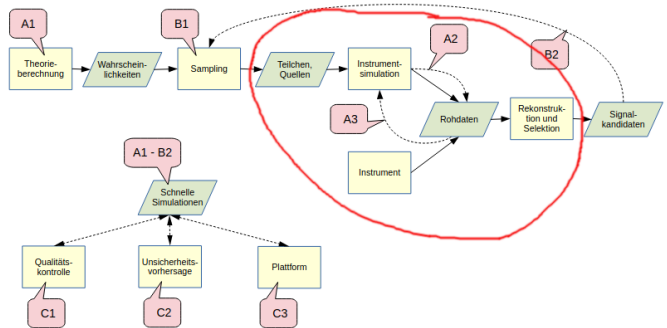
⇒ **Brute Force NN optimizing 30+ parameters**



The Plan

- Framework for efficient calling and simulation
 - ⇒ Does (of course) exist in parts.
 - ⇒ needs adaption for discretization.

- revolves around package simtools
 - ⇒ Access to telescope parameter database.



The Plan

- discrete simulation of events on a grid (in FoV and energy)

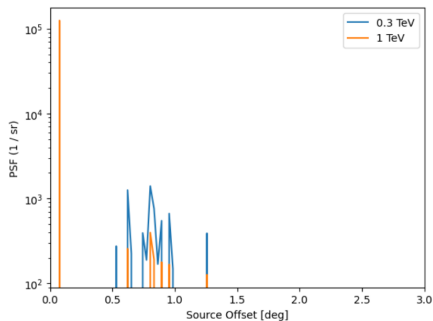
⇒ Until binwise significance (e.g. Li&Ma) threshold is reached.

$$S_{lima} = \left[2n_{on} \left(\frac{n_{on}}{\mu_{bkg}} \right) - n_{on} + \mu_{bkg} \right]^{\frac{1}{2}} \quad (1)$$

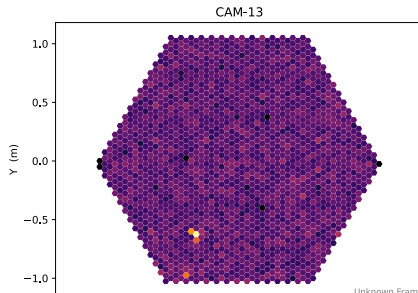
⇒ In general finding a metric 'when to have enough statistic' is difficult.

Simulation Framework

⇒ works so far, the rest not so much.



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ExtraTreesClassifier_prediction	ExtraTreesClassifier_is_valid	ExtraTreesClassifier_goodness_of_fit	ExtraTreesClassifier_telescopes	ExtraTreesRegressor_energy
float64	bool	float64	bool[84]	TeV
0.14899750298409153	True	nan	False .. False	110.96468897229005
0.28703005677725685	True	nan	False .. True	71.26716936837552
0.3486682727145307	True	nan	False .. False	56.34014680912194
0.4476991631030648	True	nan	False .. False	0.08124603566916809
0.29624520665616644	True	nan	False .. True	0.1603761396373881
0.4882438774797522	True	nan	True .. False	0.07650260391485116
0.5503252777309903	True	nan	True .. False	0.07633179170705648
0.41387609068373327	True	nan	False .. False	0.06801596636953049
0.4867976757372909	True	nan	False .. False	0.30768329223350366
...	...	...	...	...
0.3608475681726255	True	nan	False .. False	0.31747310185805117
0.42580060574836337	True	nan	False .. False	0.4226526650627344
0.5133718859568569	True	nan	False .. False	0.364660807491993
0.5090487864355188	True	nan	False .. False	0.2785480913477762
0.39371531883112143	True	nan	False .. False	0.5201812445845481
0.35932851705644536	True	nan	False .. False	0.4891403579436723
0.4434627201829278	True	nan	False .. False	0.11169552480684675
0.5209936859295528	True	nan	False .. False	0.5255170548345243
0.47006459124970196	True	nan	False .. False	0.555941033373644
0.29322084743063037	True	nan	False .. False	1.7452427131884034

1

Outlook

- still a lot to do
 - ⇒ define meaningful metric.
 - ⇒ develop meaningful sample mechanism (until DPG SC).
 - ⇒ 'right' Problem not even touched.

