Radial Smearing

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February 2, 2011

Simple radial energy distribution in tower grids

- Ignore longitudinal development
  - Particle energy distributed transverse to direction of flight of particle in a plane through the particle impact point into the calorimeter
  - Shape of distribution from experiment/full simulation
- Integrated energy in profile is the same as particle energy
  - No calibration/acceptance/smearing of energy
- Distributed energies projected into regular eta/phi grid within modeled detector acceptance
  - Fakes calorimeter tower signal definition, including high eta losses
  - Different grid and eta acceptance for EM particles

Radial Energy Projection

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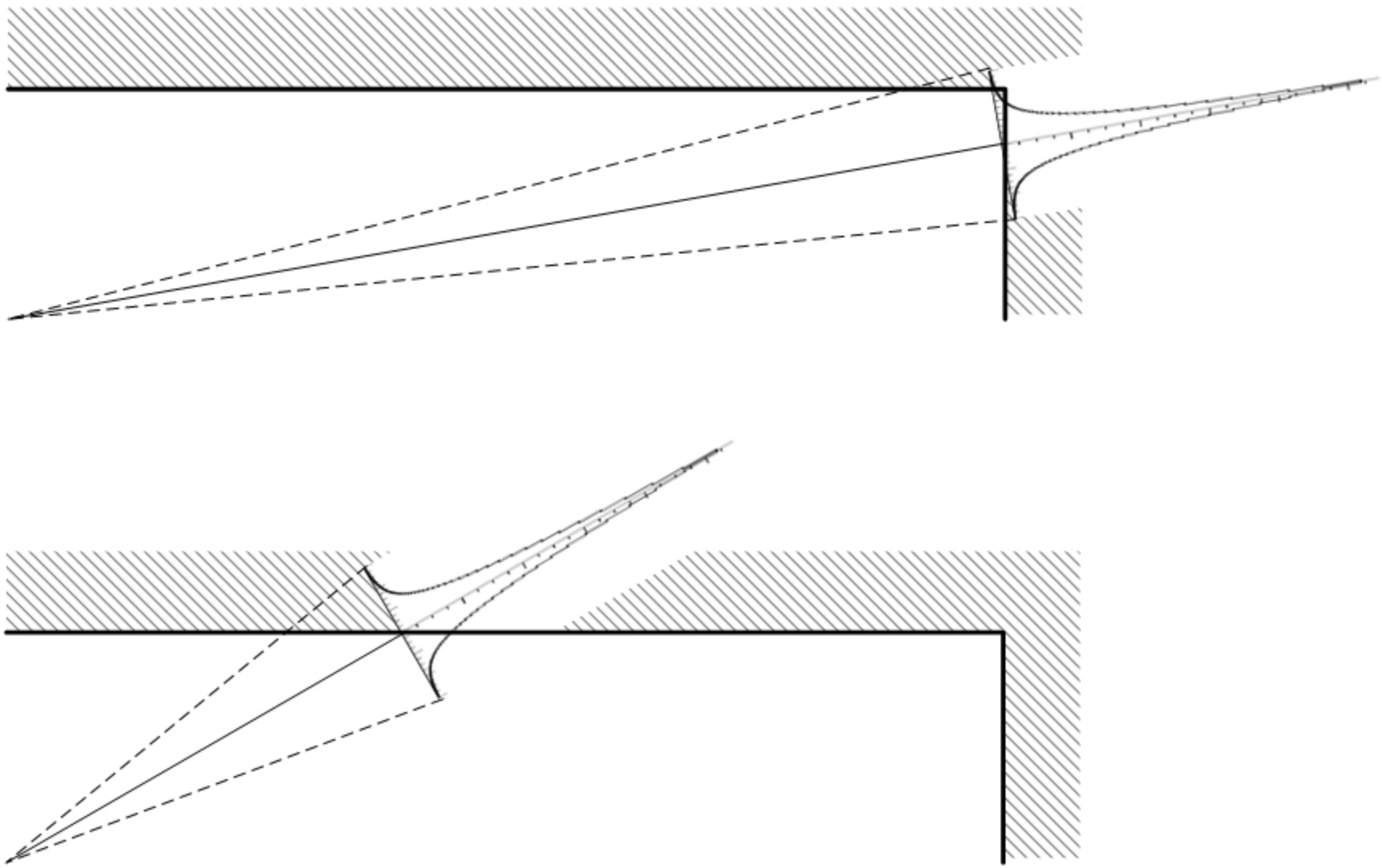

Modeling

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Toy detector defaults

- EM acceptance -2.5 < eta < 2.5
  - Photons/electrons outside are mapped onto HAD towers
- HAD acceptance -5.0 < eta < 5.0
  - Particles outside are ignored completely
- Cylindrical calorimeter
  - R = 1200 mm, -2500 mm < z < 2500 mm
- High granularity
  - 0.025 x 0.025 (EM)
  - 0.1 x 0.1 (HAD)

Shower shapes

- Started with Gaussian within cylinder
  - Lateral extend /cylinder radius 80 mm for EM particles (also in HAD grid!)
  - 160 mm for all others
  - Gaussian showers are too wide, this was just a simplification!
- Now experimental electromagnetic and hadronic shower shapes
  - H1 data easily available (with some help) – representative for ATLAS (CMS?)-like calorimeters
- Energy distributed in small “spots”

Electron Lateral Profile (H1)

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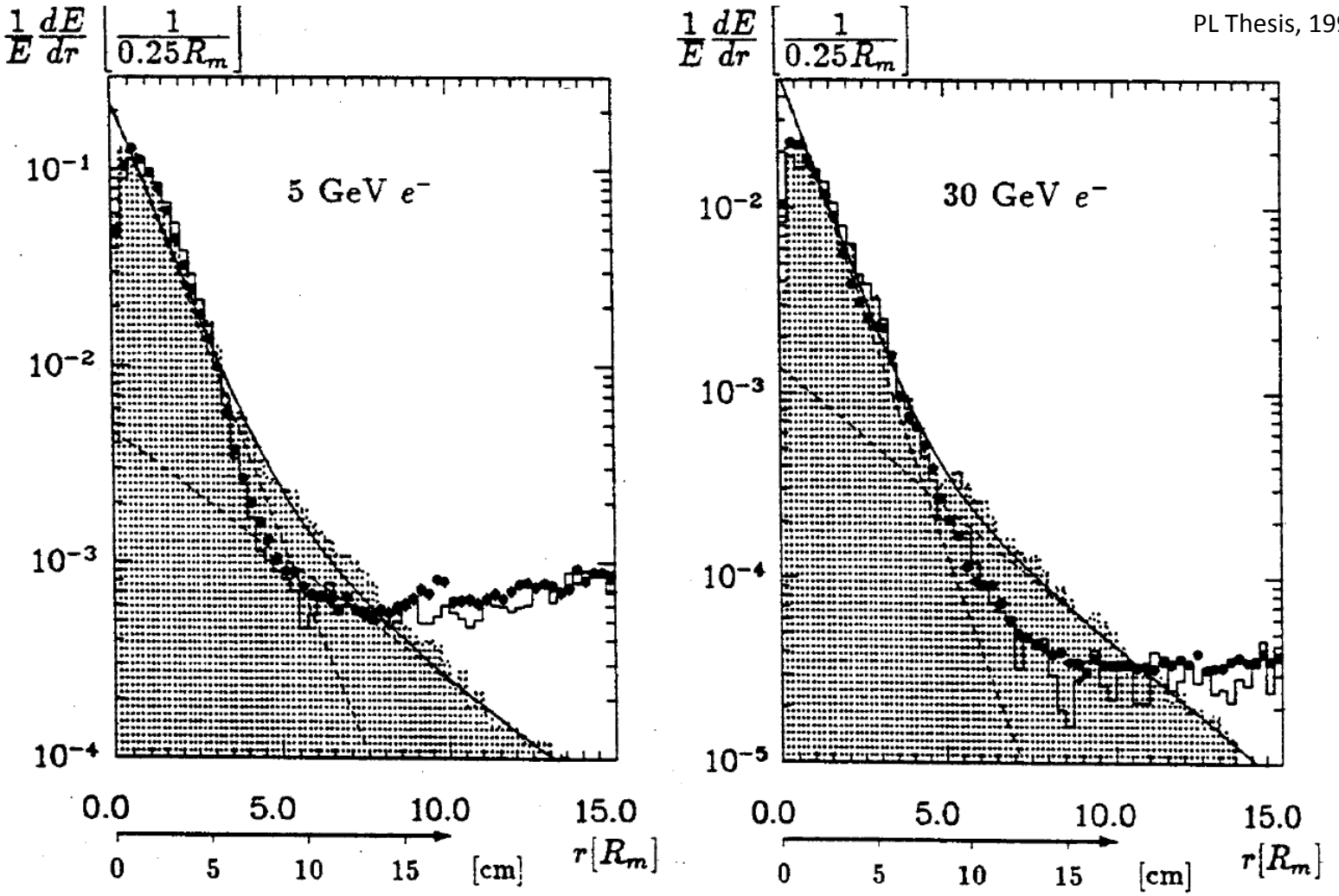
Points/open histogram: data + simulated signal with noise cuts

PL Thesis, 1992



Shaded histogram: simulated shower development, no noise or cuts

Hadronic Lateral Profile (H1)

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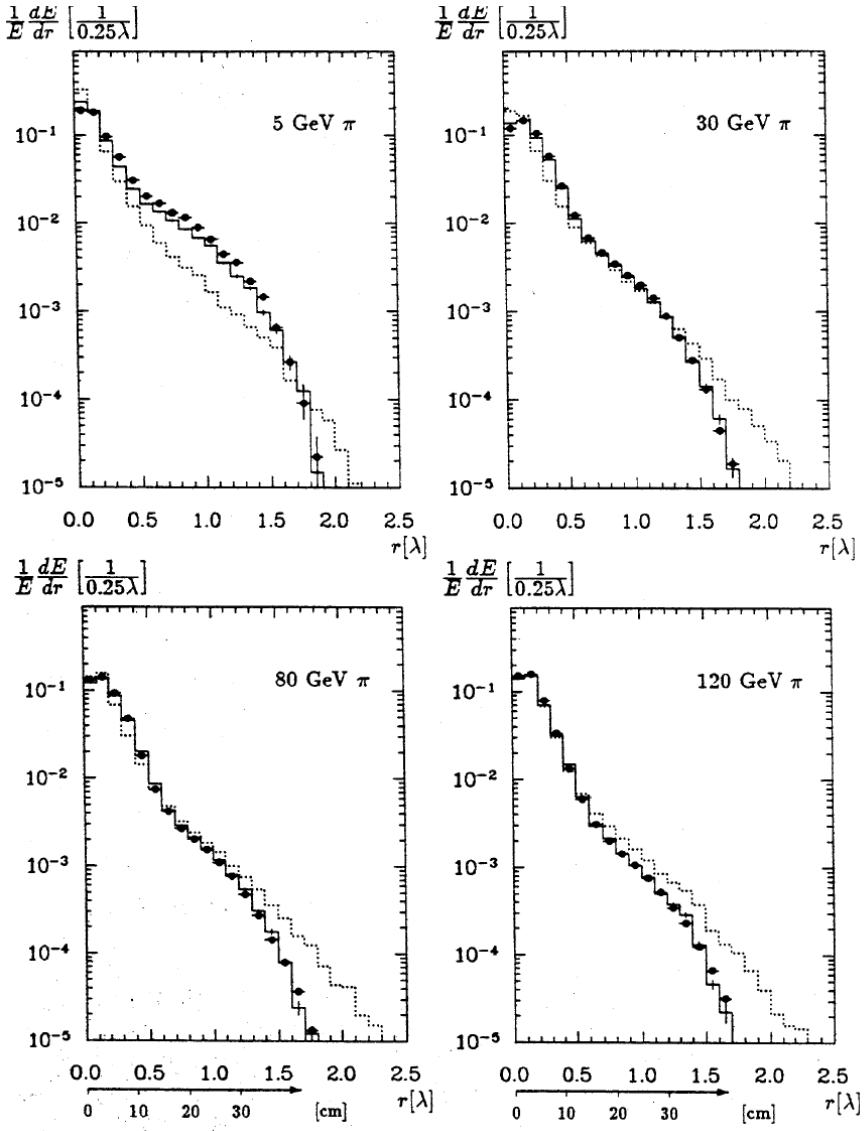
Points/solid line histogram: data + simulated signal with noise cuts

Dashed line histogram: simulated shower development, no noise or cuts



PL Thesis, 1992

Software

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Two files needed:

DetectorModel.h and DetectorModel.cxx

Uses fastjet/PseudoJet.h and STL – nothing else!

Compile DetectorModel.cxx

Usage (default):

```
#include "DetectorModel.h"
...
// default smearing module
DetectorModel::RadialSmearing smear;
... fill std::vector<PseudoJet> input with final state particles and set the user_index of each of those to the particle pdg code!!
// retrieve pseudo-particles after smearing
const std::vector<PseudoJet>& smeared = smear.smear(input);
// do your thing...
```

Observations:

Expect about 20 x more particles than in the generator final state

Topology dependent, here Pythia QCD di-jets

Slow execution

Needs much more optimization

Pythia8 QCD Di-jets

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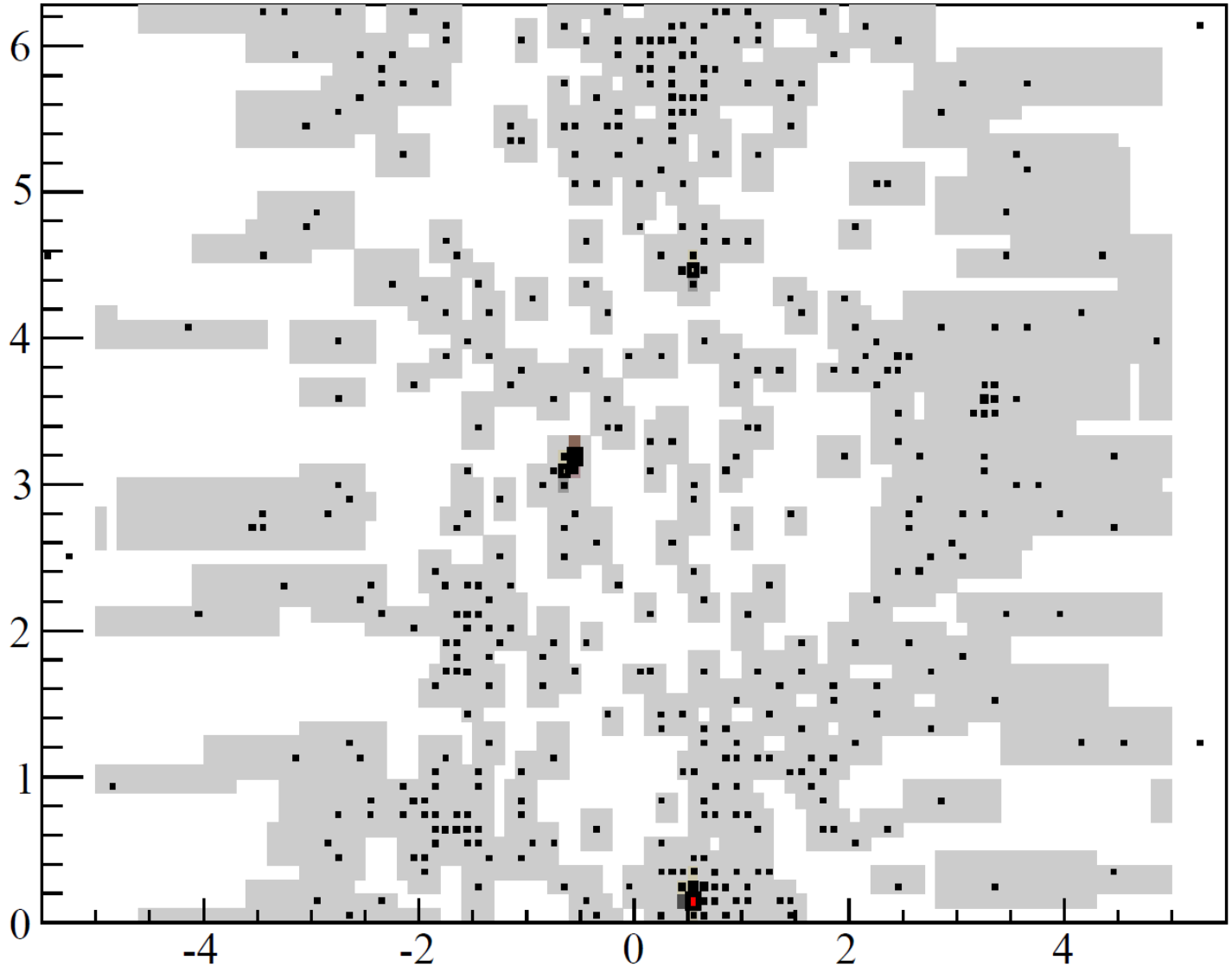

Pythia8 QCD Di-jets

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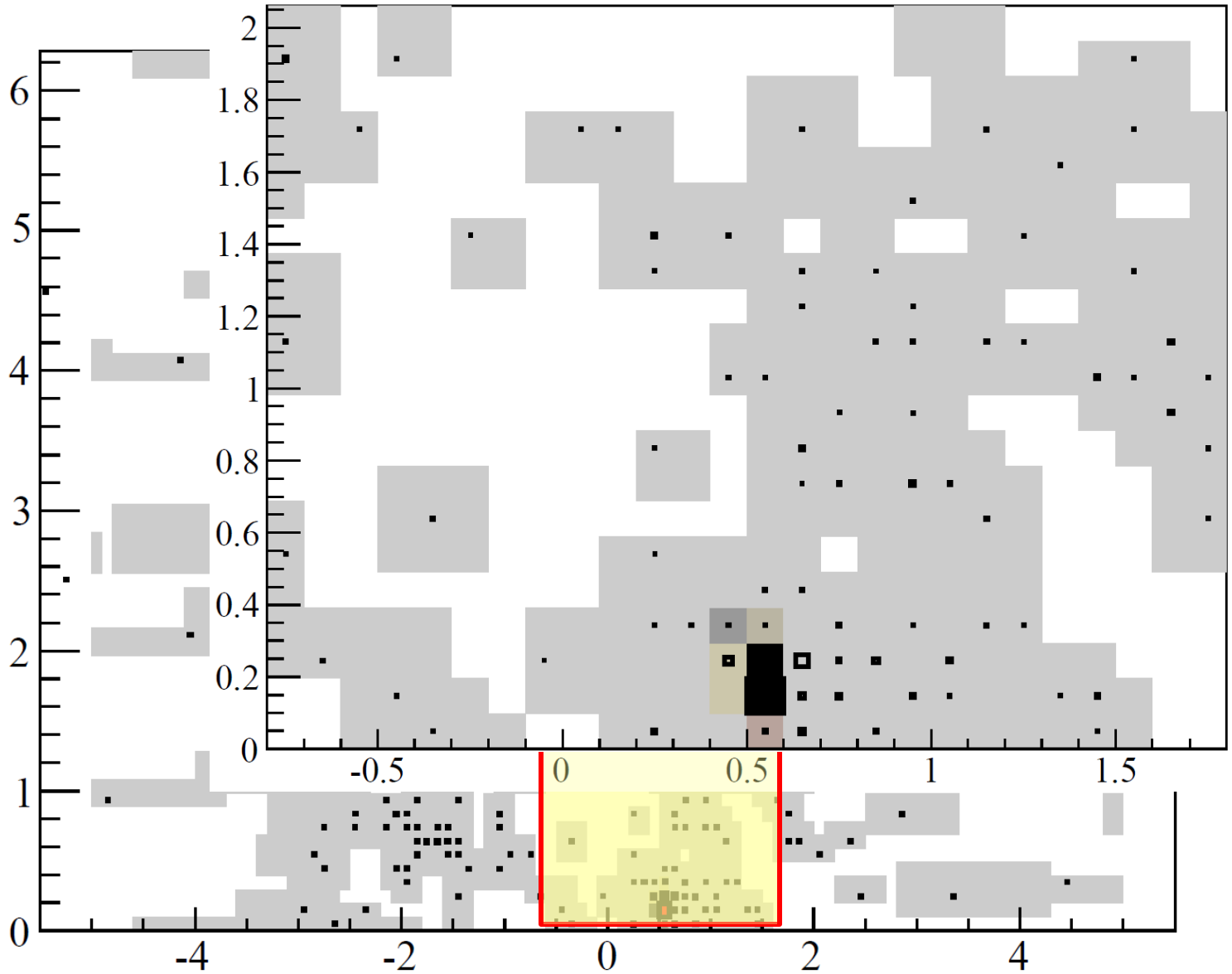

Pythia8 QCD Di-jets

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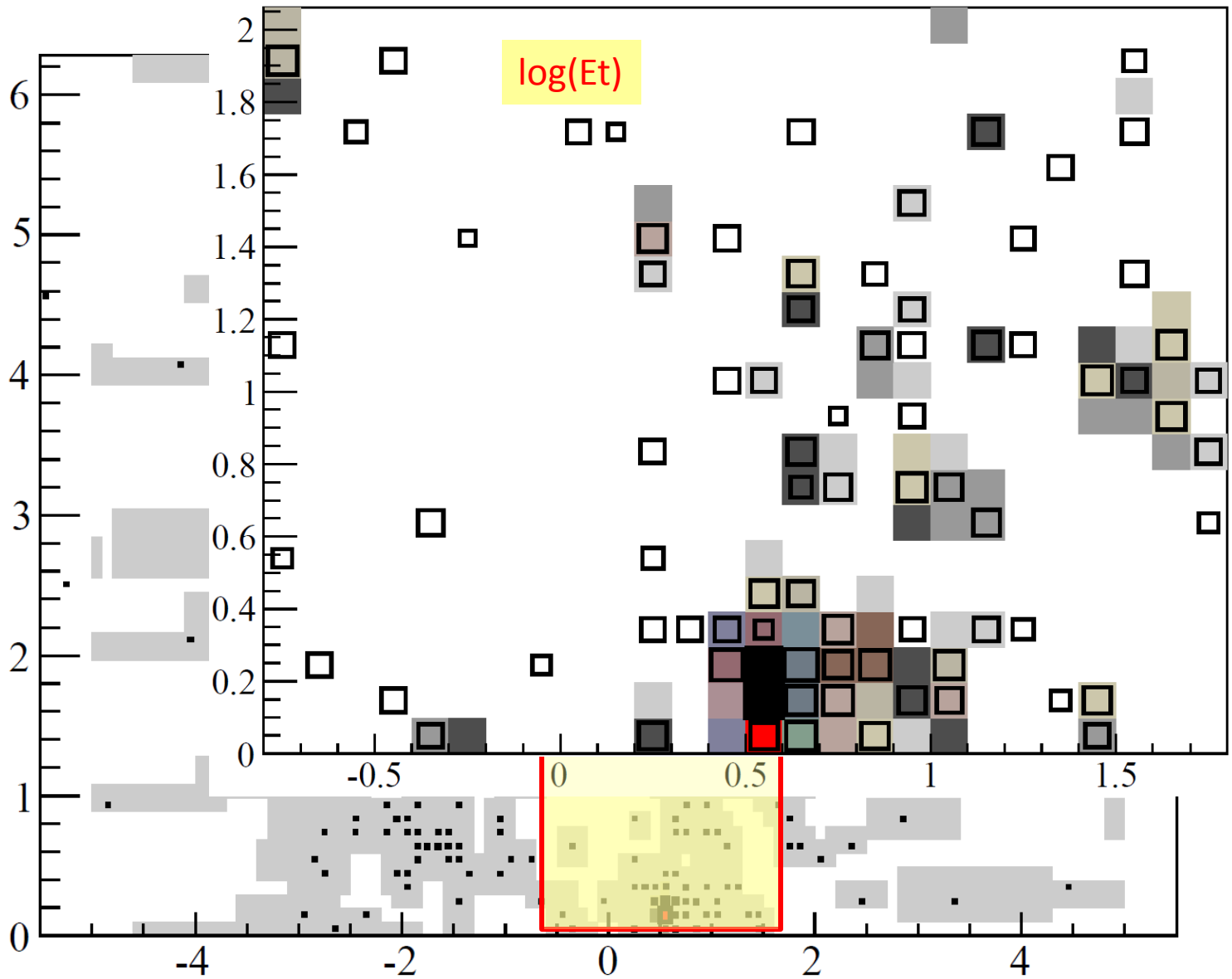

Input Shapes Fits To Data

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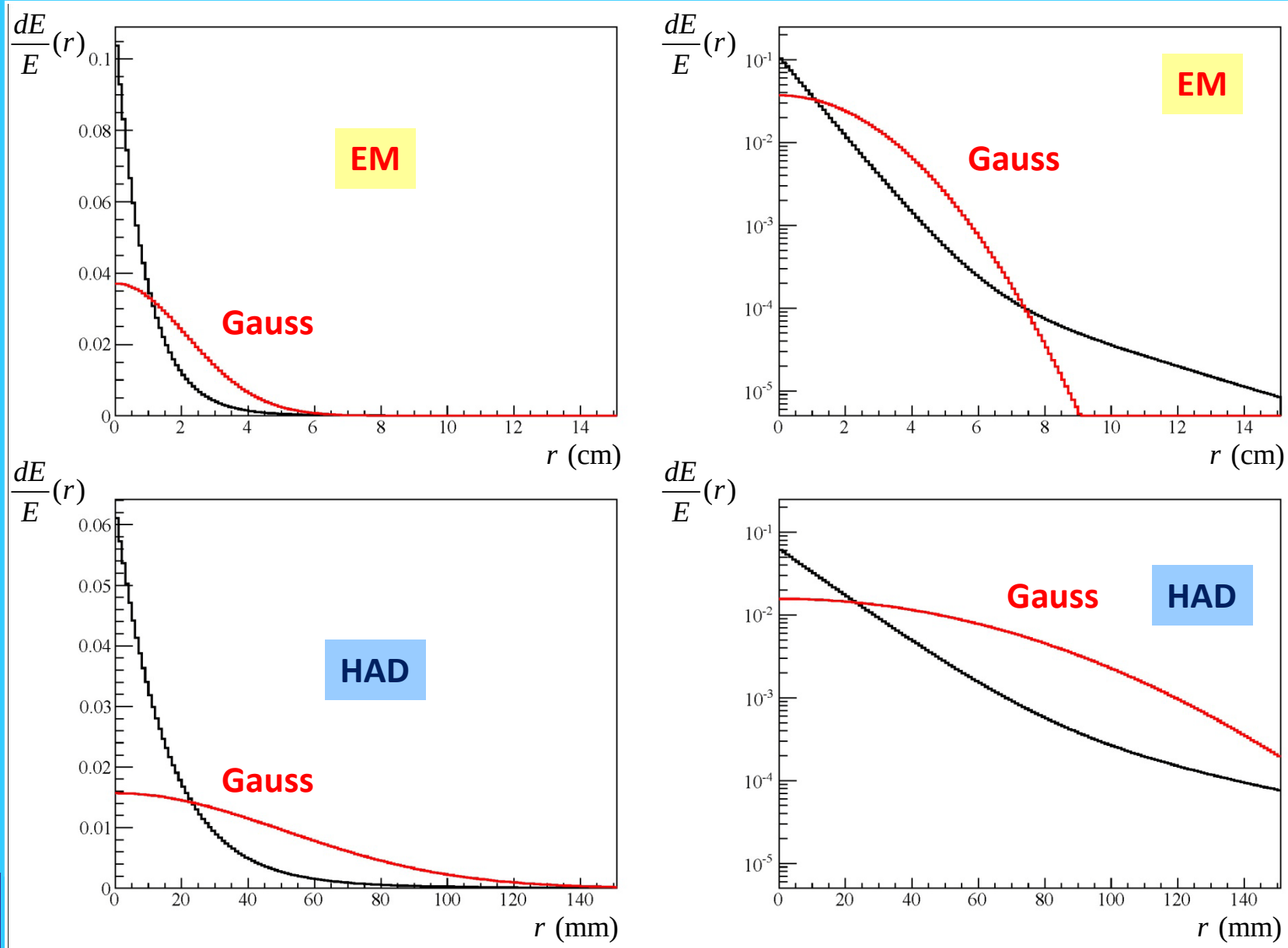

HAD Integrated

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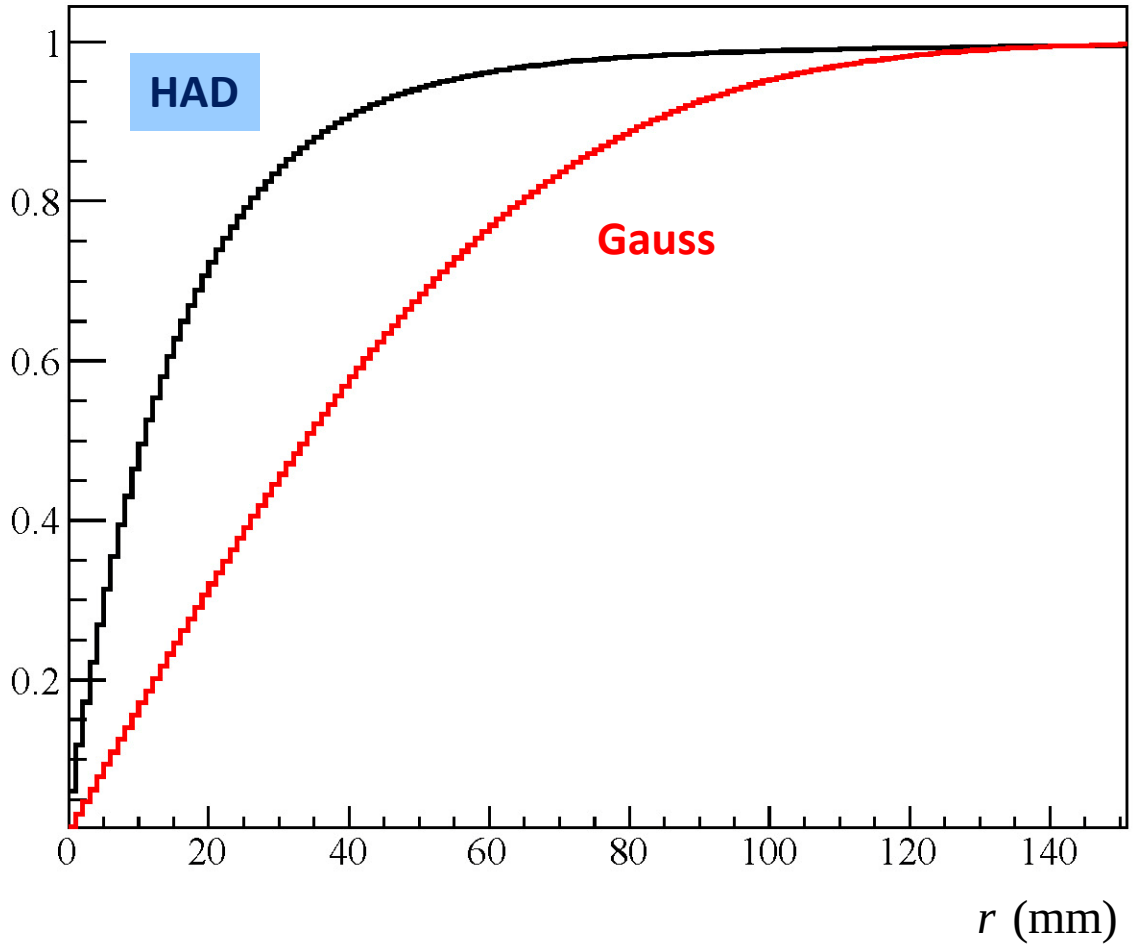
$$\frac{1}{E}\int_0^r dE(r')dr'$$



HAD Energy Dependence

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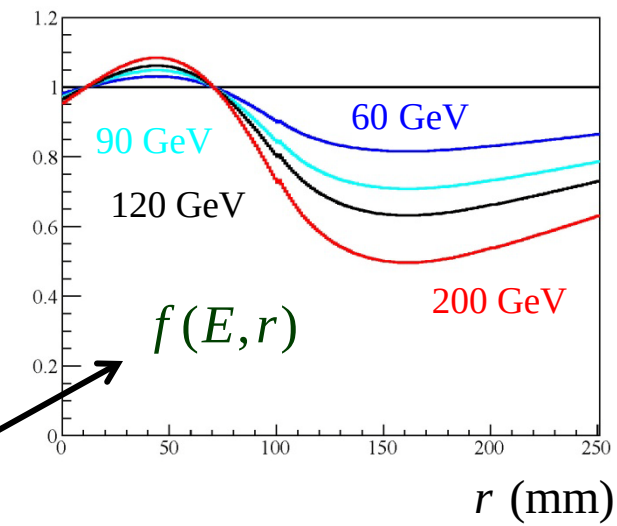
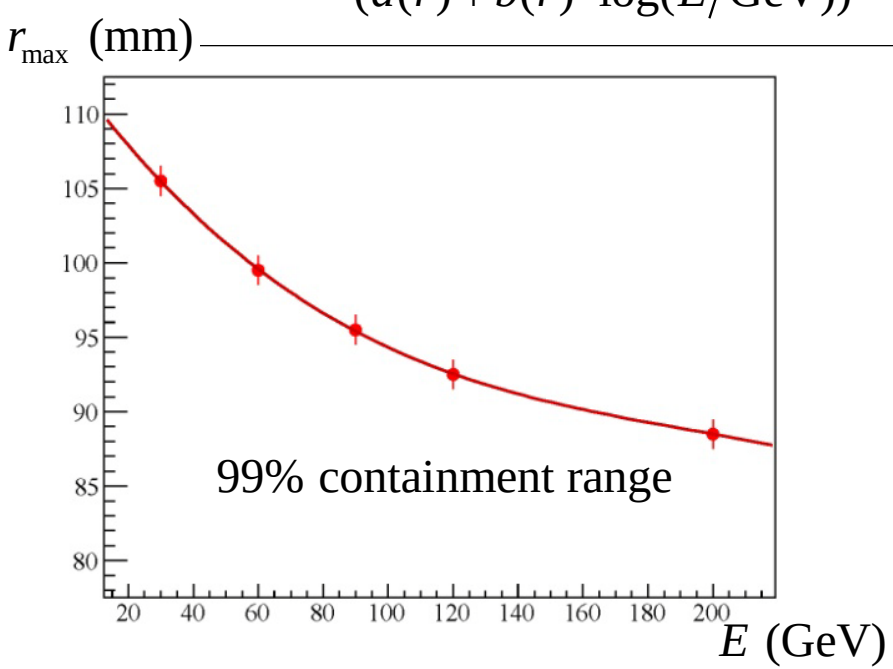
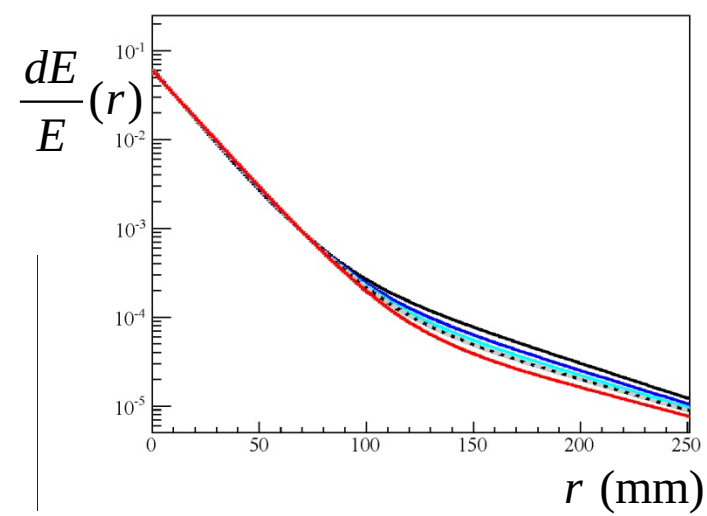
Some energy dependence observed

- Not very significant
  - Implemented it anyway
- Only two profiles used
  - E = 30, 120 GeV
- Log-like interpolation between those

$$S(E,r) = S(30\ \text{GeV}, r) \cdot f(E,r)$$
$$= (a(r) + b(r) \cdot \log(E/\text{GeV}))$$







SW Performance Snapshots

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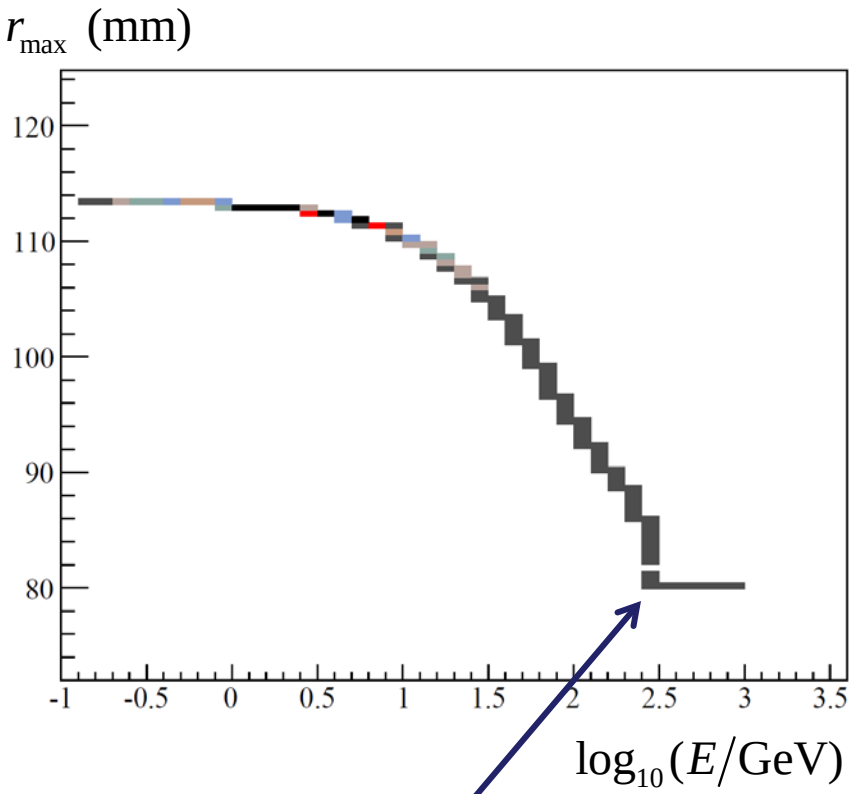
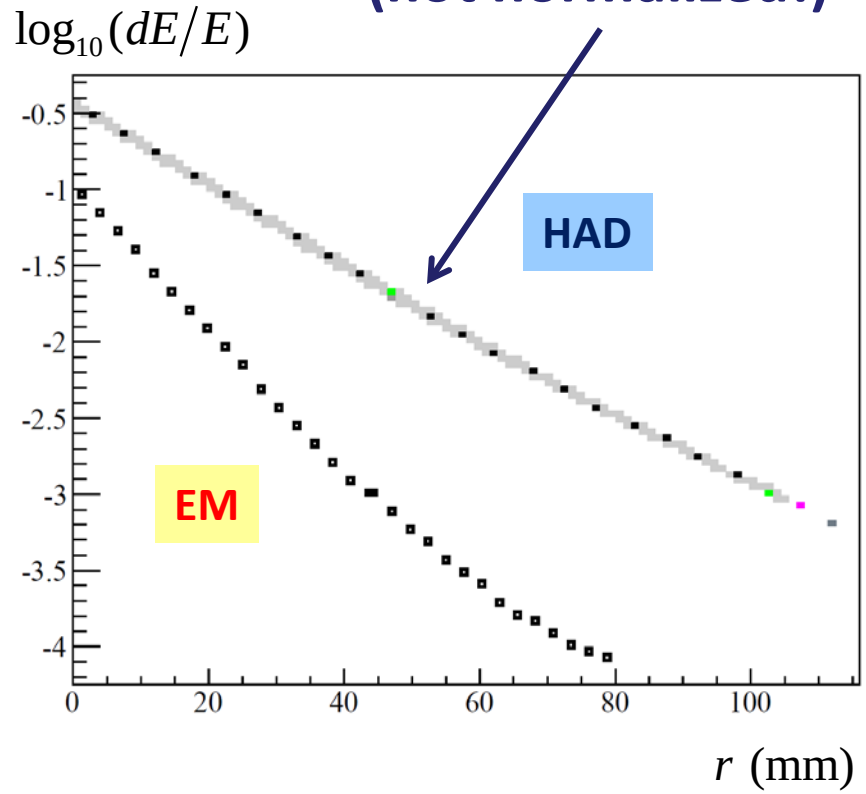


(not normalized!)



(r_{max} = 80 mm for E>200 GeV)