CALICE collaboration meeting,
MPI Munich, 09-11.09.2015

ScECAL+AHCAL: towards e/pi separation study

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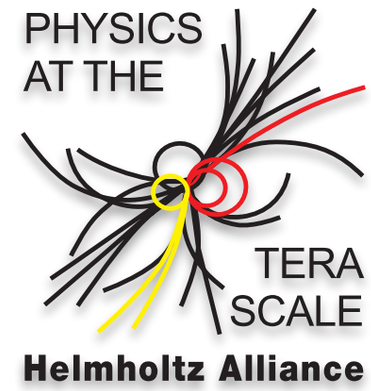

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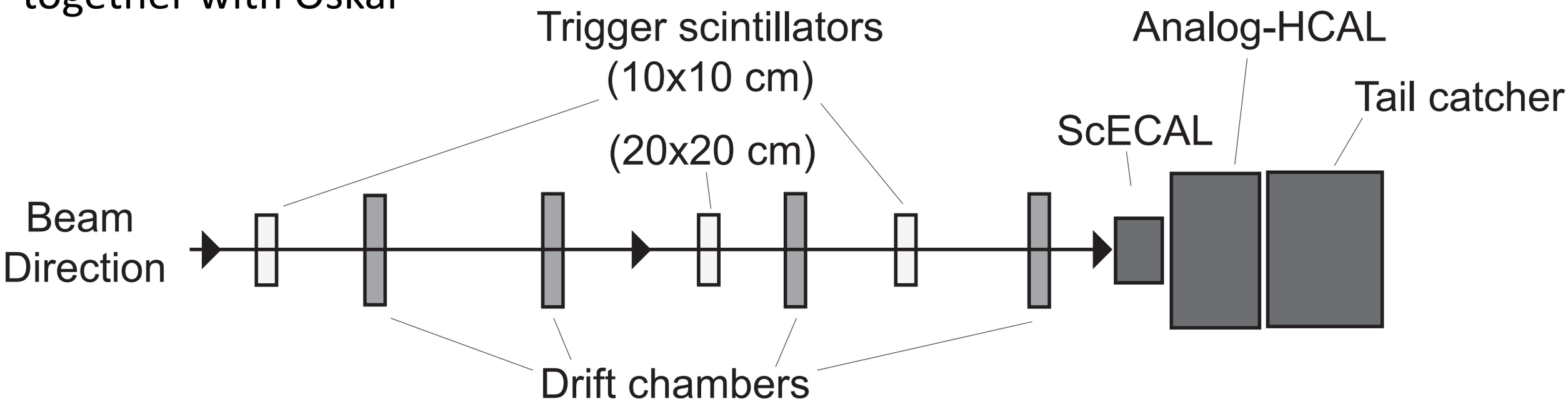
Outline

- Prototype & Testbeam
- Idea for separation
  - very first results
- Strip-Splitting-Algorithm
  - Introduction
  - Adaption on the slightly different geometry
  - Event Displays with SSA
- Conclusion

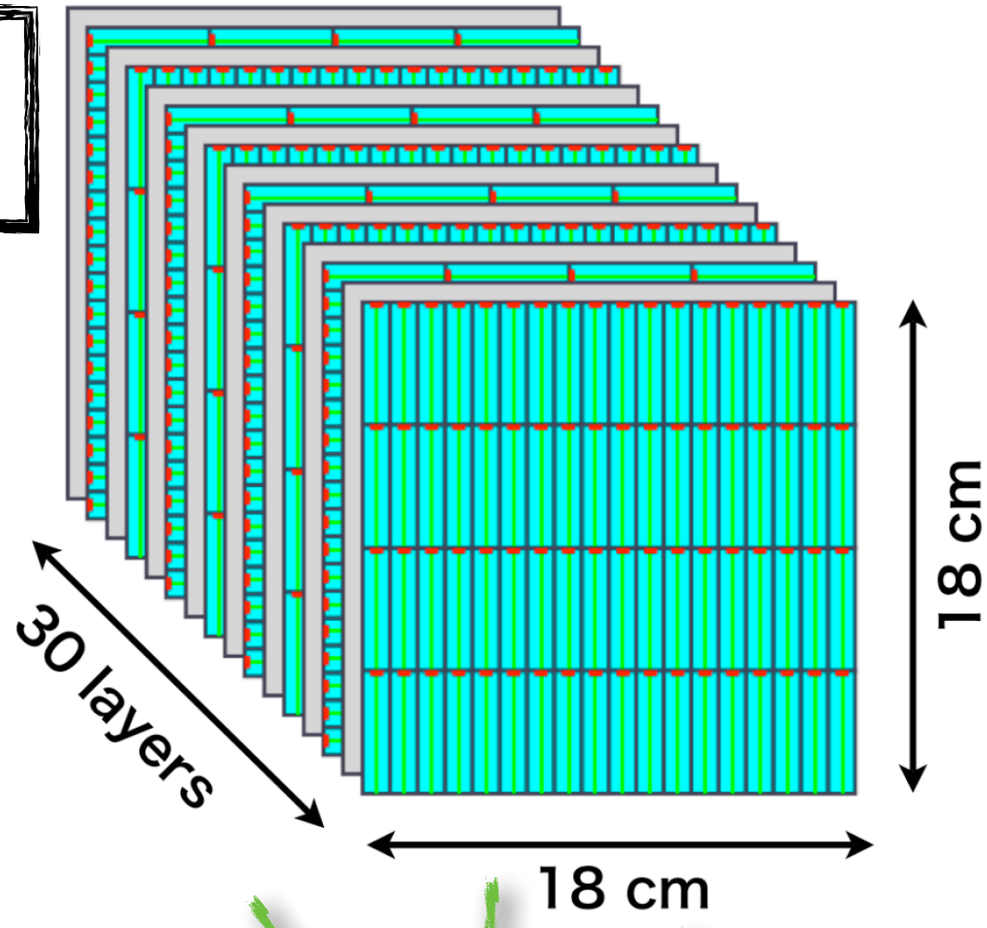
Testbeam - ScECAL, AHCAL

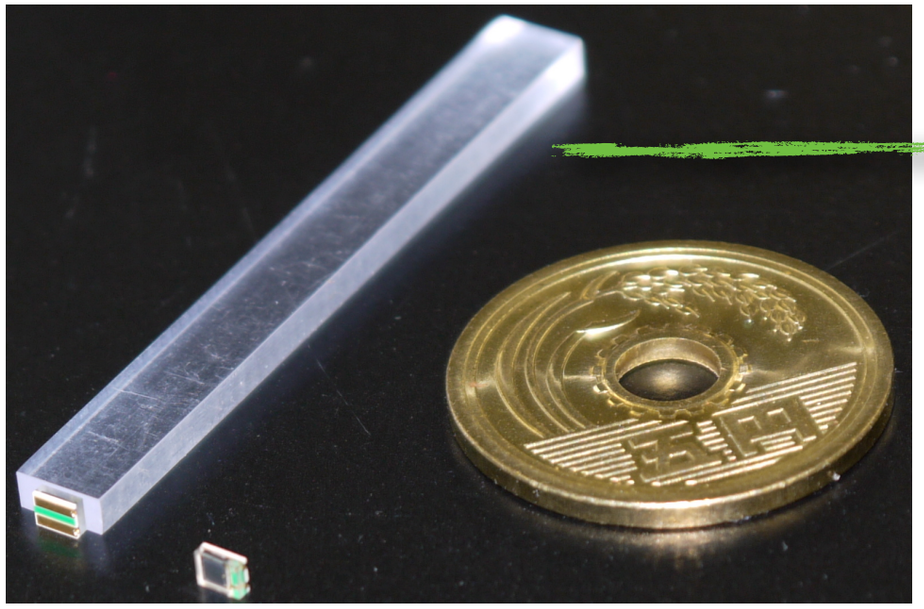
- Combined Testbeam with ScECAL + Fe-AHCAL + (TCMT) in MT6 area in FNAL
  - Sep. 2008 & May 2009
  - Only May 2009 was used (runNumbers 560 XXX)
- Particle's (electrons, muons, pions)
  - Energy range (4-32GeV), Pion dataset largely untouched
  - Unclean Beam
- Runs with rotated calorimeters
- Started analysis of the data together with Oskar

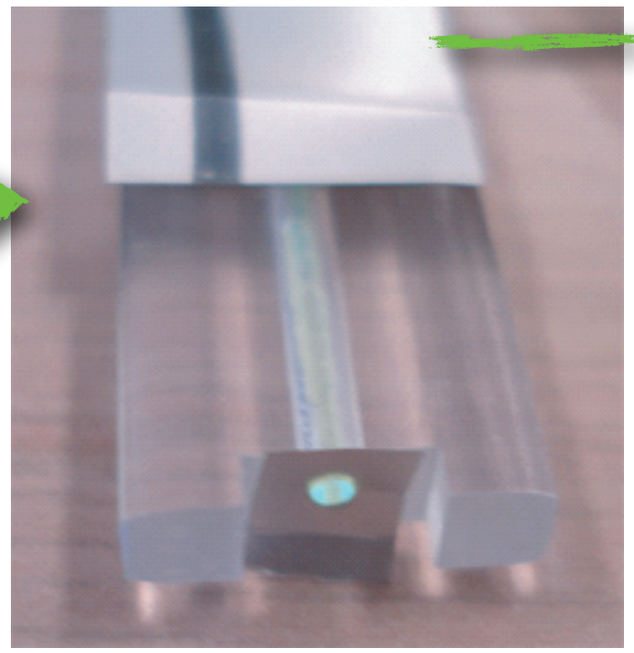


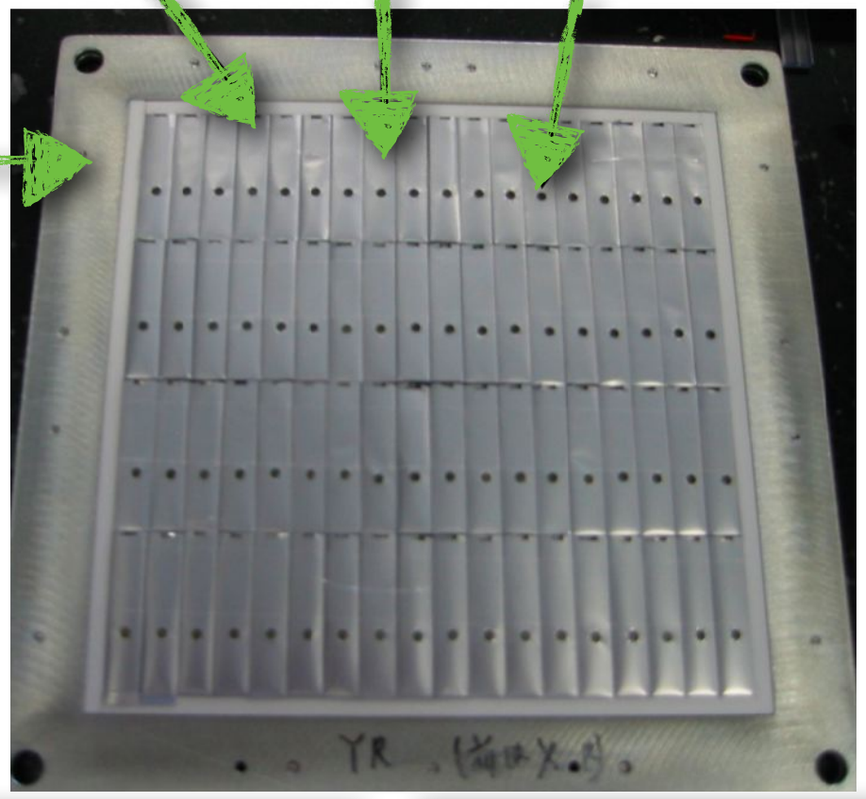
Basic Informations ScECAL

- 30 layers in total
  - Absorber 88% WC (tungsten-carbide), 12% Co
- 72 Scintillator strips (10x45 mm^2) per layer
  - Equipped with 40x40 pixels MPPC
- Layer are in alternating orientation
- Based on AHCAL physics prototype electronics
- Already some CAN's (16-16c)
- Japanese groups: Shinshu, Kyushu, Tokyo, Tsukuba



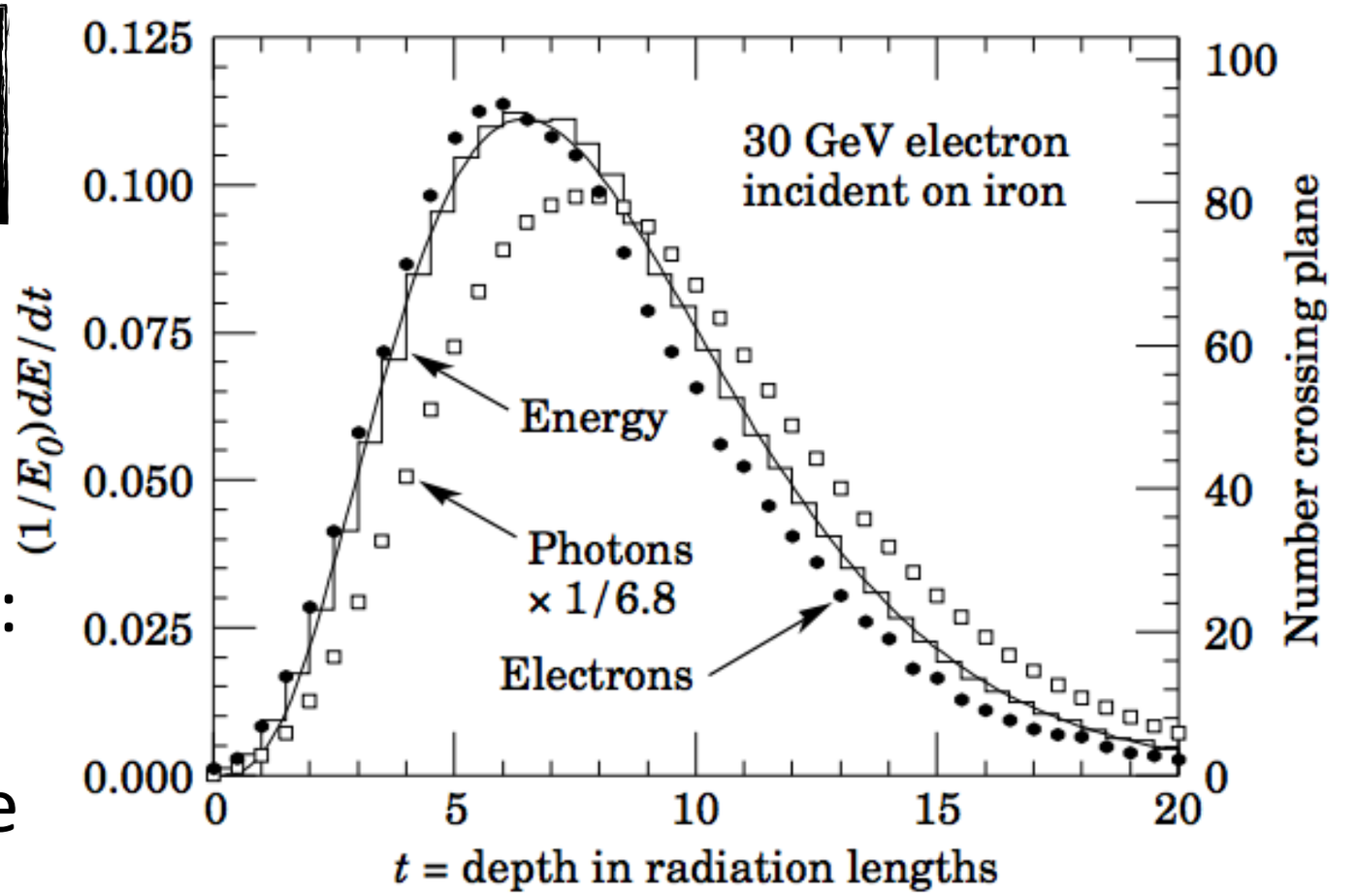






Idea for separation

- Idea:
  - ➡Identify Particle through shower shape
    - ‣ Use Profiles for separation:
      - Longitudinal Profile
      - Radial/transverse Profile
      - Shower Start etc.



- Longitudinal Profile:
  - Well known for electron's
  - Shower Max is well known and 7-10 X_0's and goes with $t_{max} \sim \ln(E_0)$
  - Parameter b depend on the Material

$$\frac{dE}{dt} = E_0 b \frac{(bt)^{a-1} e^{-bt}}{\Gamma(a)}$$

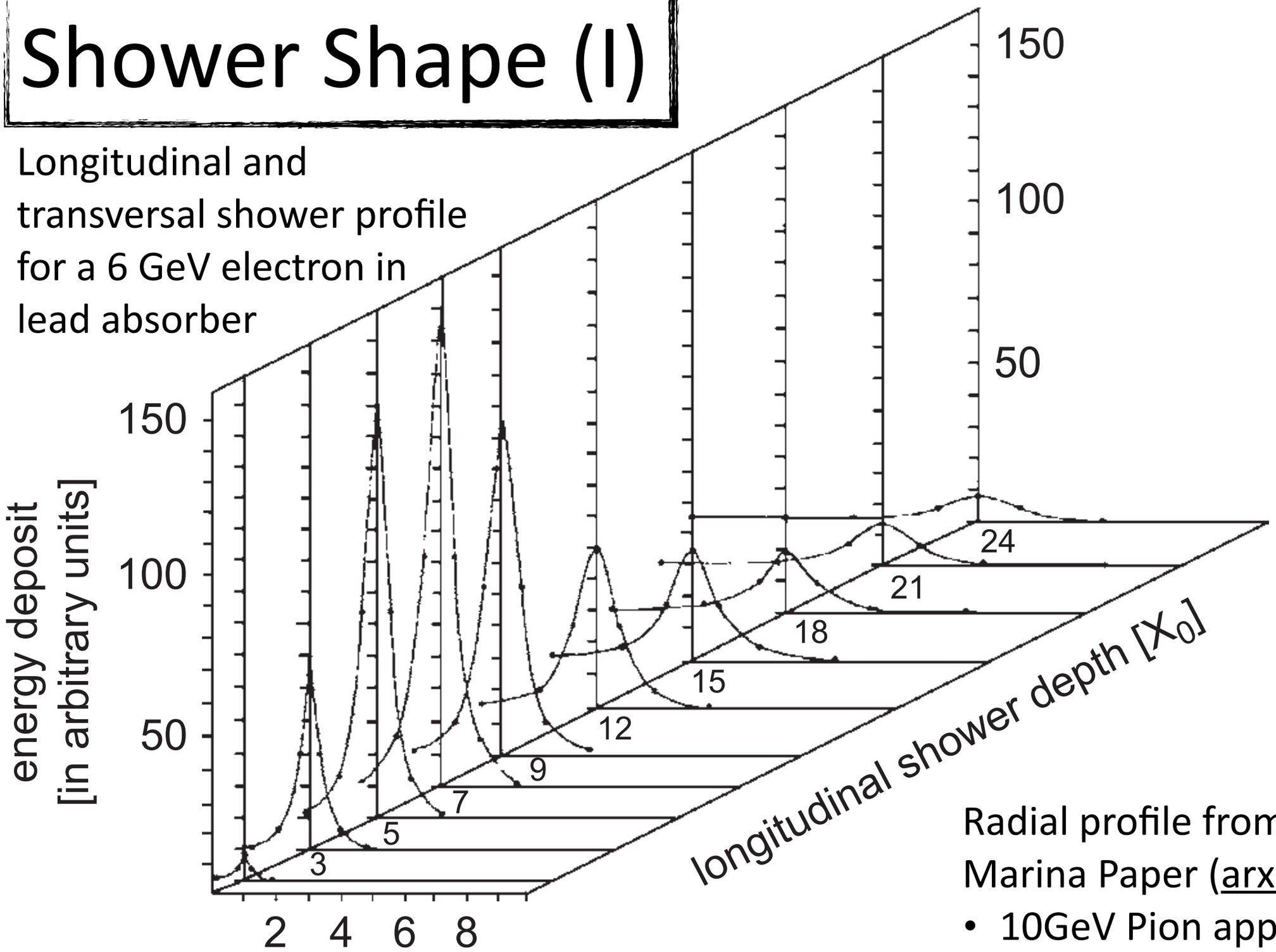
$$t_{max} = (a-1)/b = 1.0 \times (\ln y + C_j)$$

$$t = x/X_0$$

tungsten -> Radiation length = 0.3504 cm
tungsten -> Hadronic interaction length = 11.33 cm

Shower Shape (I)

Longitudinal and transversal shower profile for a 6 GeV electron in lead absorber

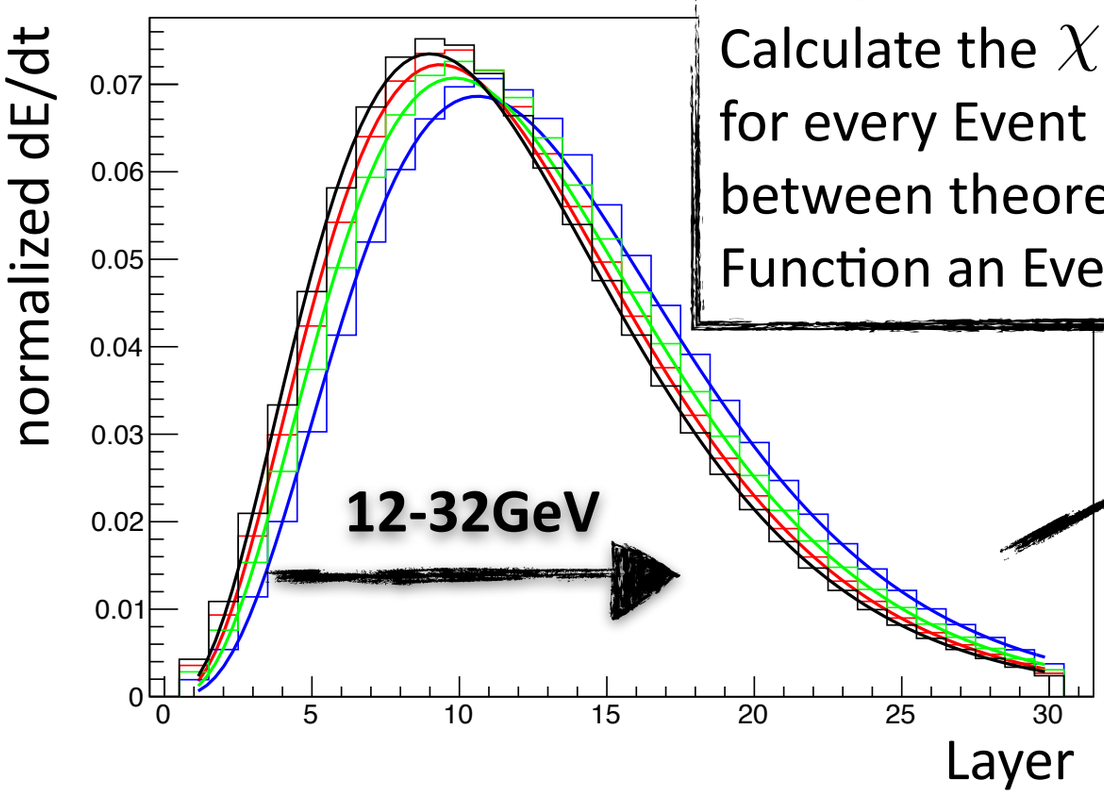


Radial profile from pions much bigger.

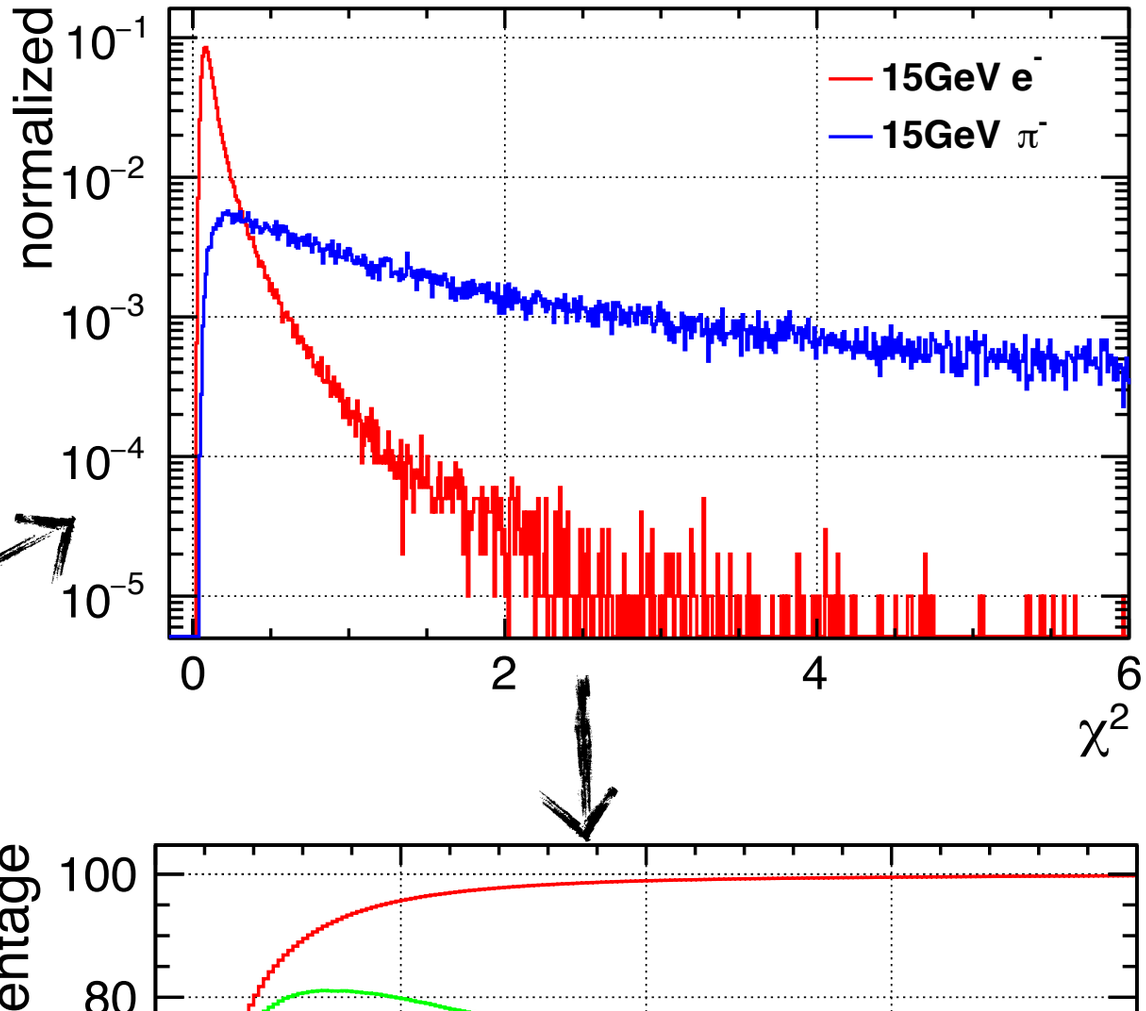
Marina Paper (arxiv 1412.2653v2):

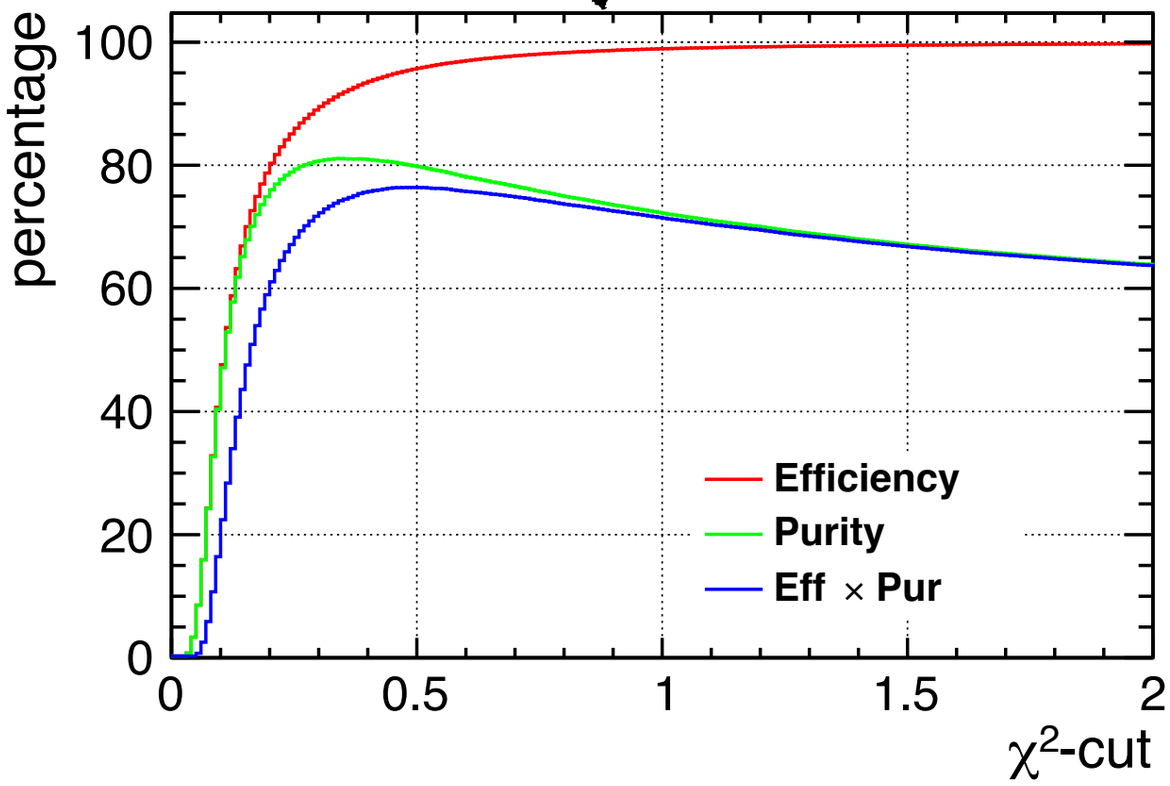
- 10GeV Pion approx. 95mm
- 80GeV Pion approx. 65mm
- Electron < 37mm (her cut)

First analysis on longitudinal Profil



Calculate the χ^2 for every Event between theoretical Function an Event Data





- Used MC from 12-32 GeV and only ScECAL (with Noise from real data)
- 1 Layer -> 0.7 X_0
- Purity from max ~80% at the moment
- First Results, a lot of space to improve results.
  - ➡ No Shower-Start finding used
  - ➡ No other cuts applied

Shower Shape (II)

- Currently studying: lateral shower shape
- Planed: Shower-Start, Radius
- Separation:
  - ➡ Cut based
  - ➡ neural Network
  - ➡ BDT
  - ➡ ....

- First Step is to get a smaller effective Cell size
  - ➡ Strip-Splitting (K. Kotera, D. Jeans,...) http://arxiv.org/abs/1405.4456v2
- Profit from high granularity

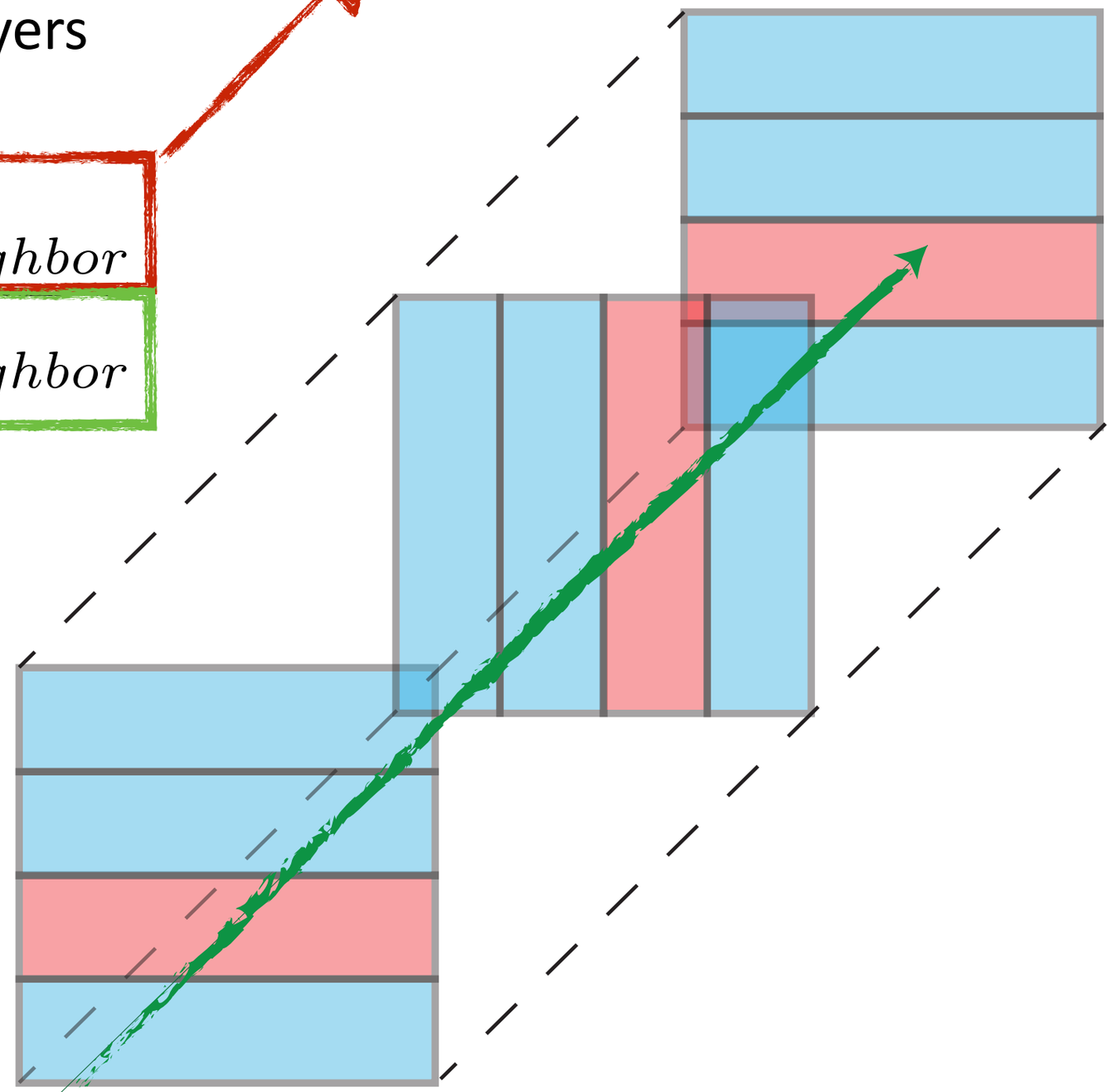
Strip-Splitting (I)

- Algorithm to extract fine granularity information by using the adjacent Layers

$$E^k_{virtual} = E_{strip} \cdot \frac{\sum_i E^{i,k}_{neighbor}}{\sum_i E^{i}_{neighbor}}$$

Sum Of Energy of strips which are intersecting with the **virtual cell**

Sum Of Energy of strips which are intersecting with the current **Strip**



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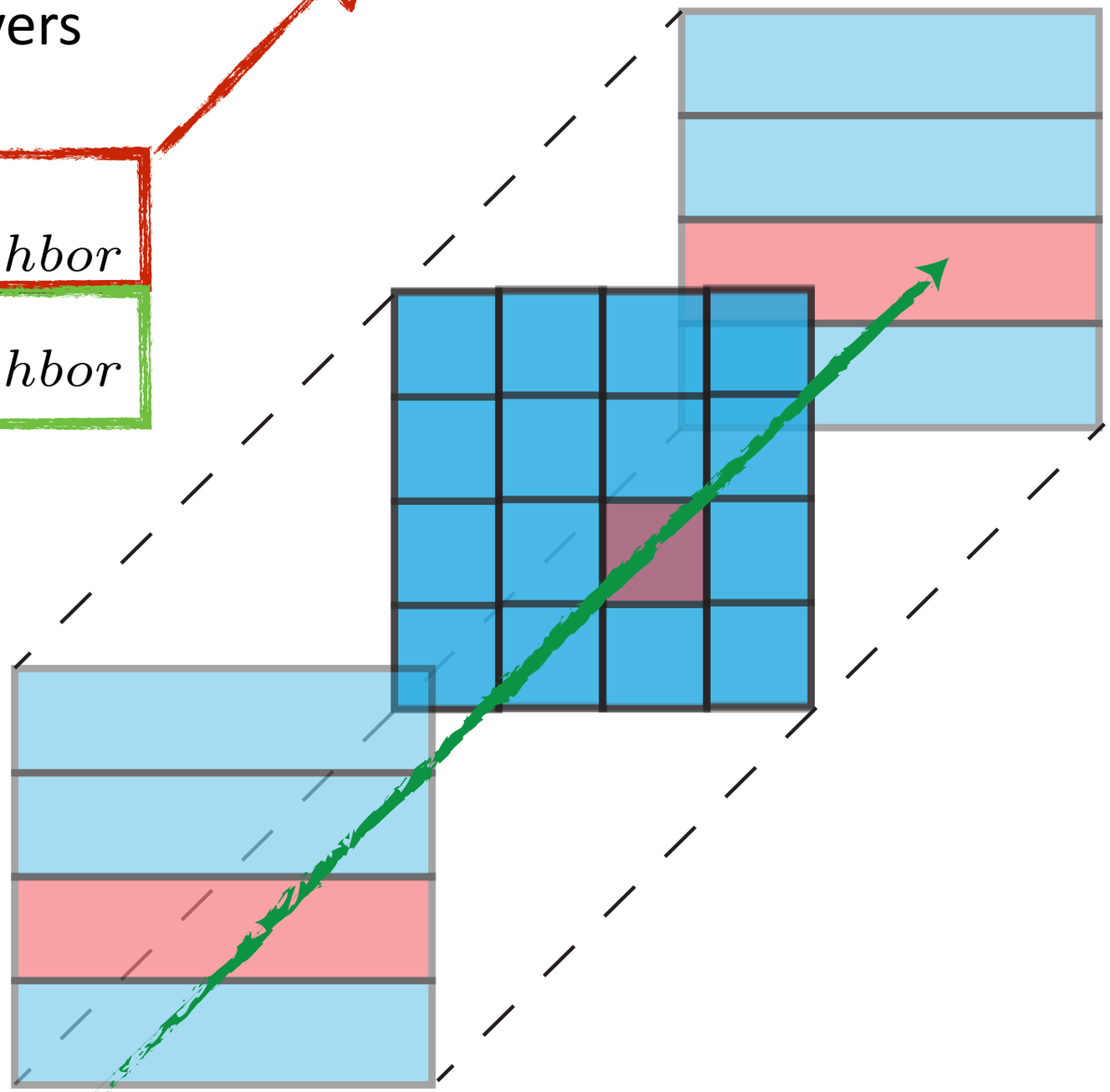
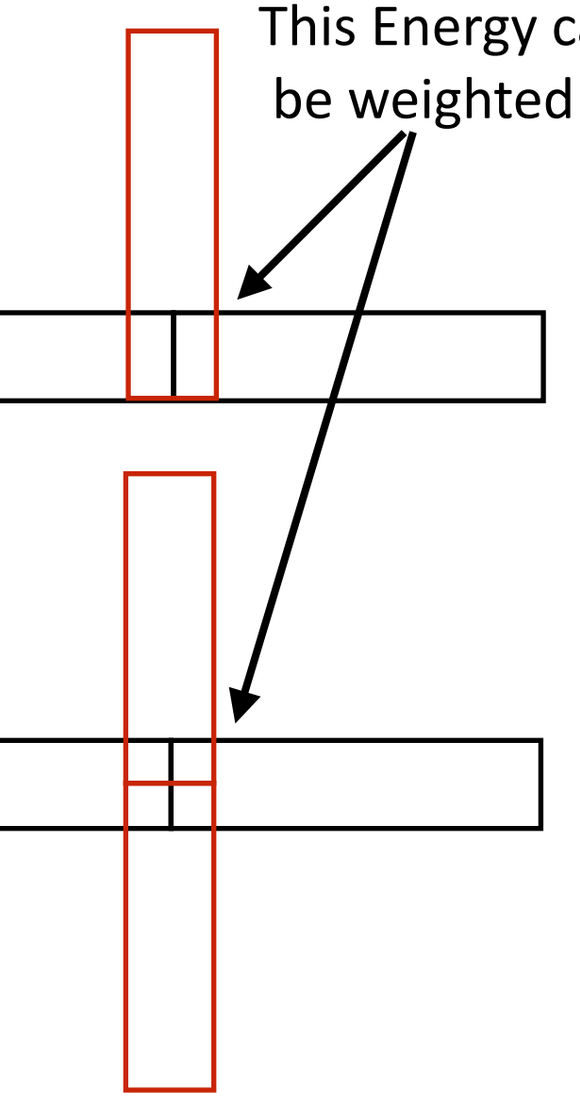
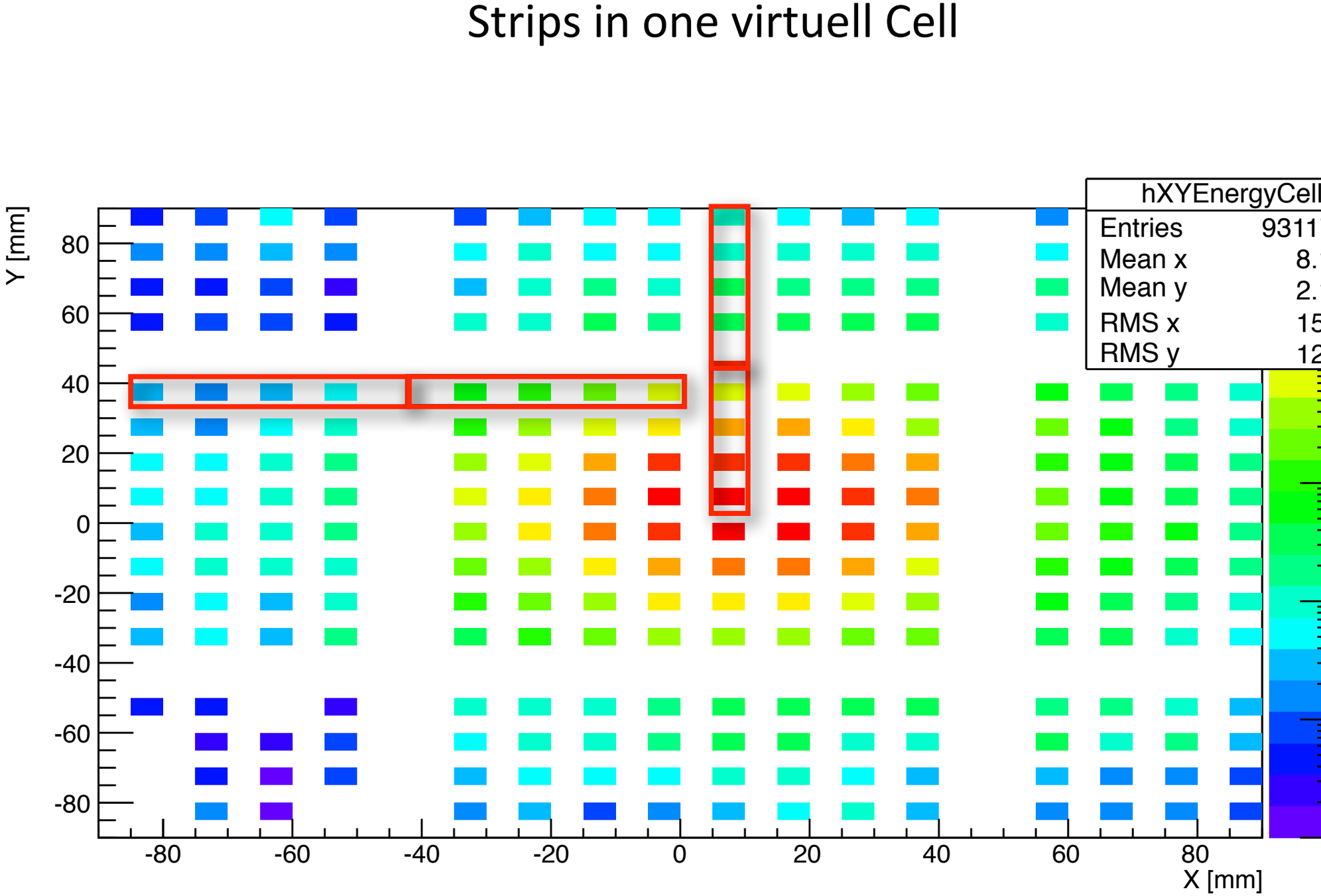


Strip-Splitting (II)

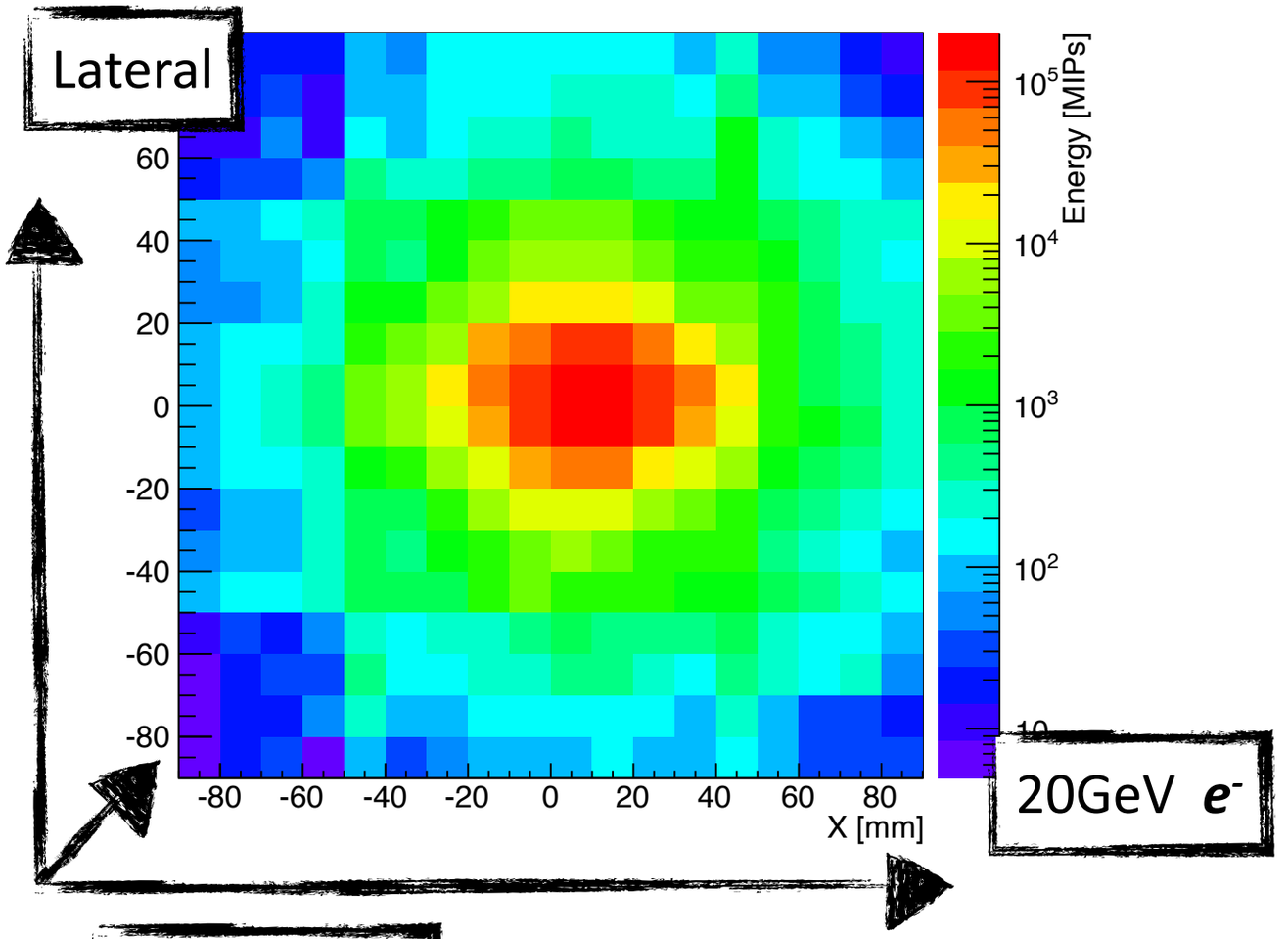
- Paper was for Strips with 45x5mm^2 (9 cells)
- Not that easy
  - ➡ Strips are 45x10mm^2 -> Overlap of Strips in one virtuell Cell

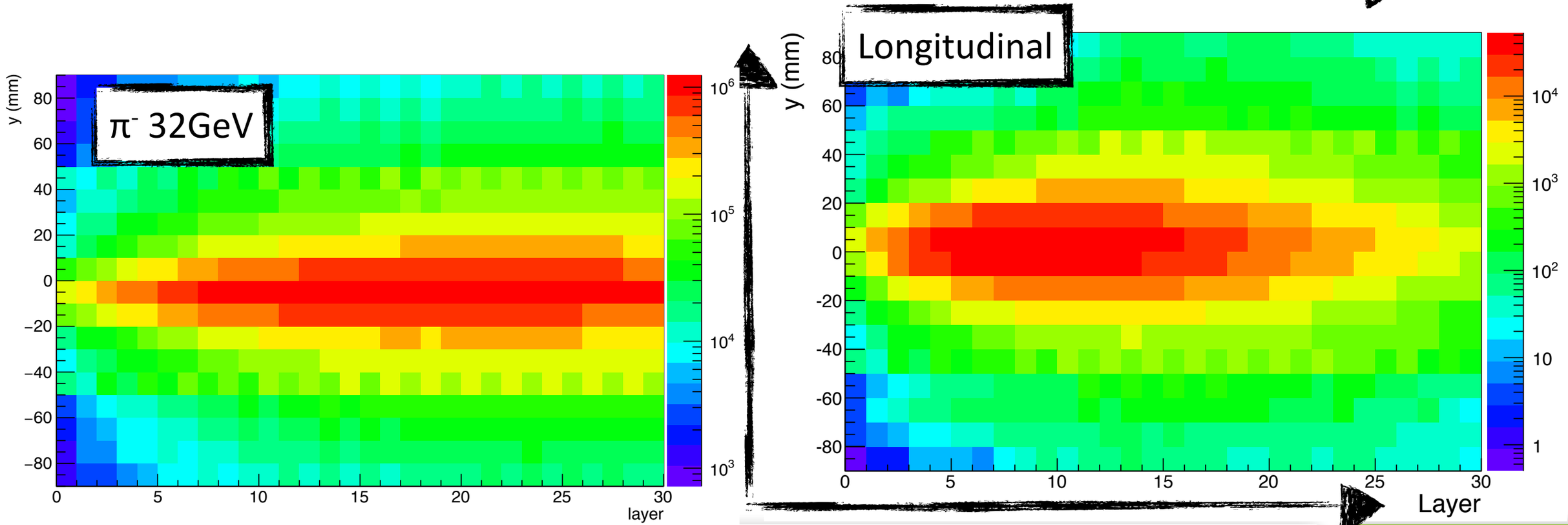




Strip-Splitting (III)

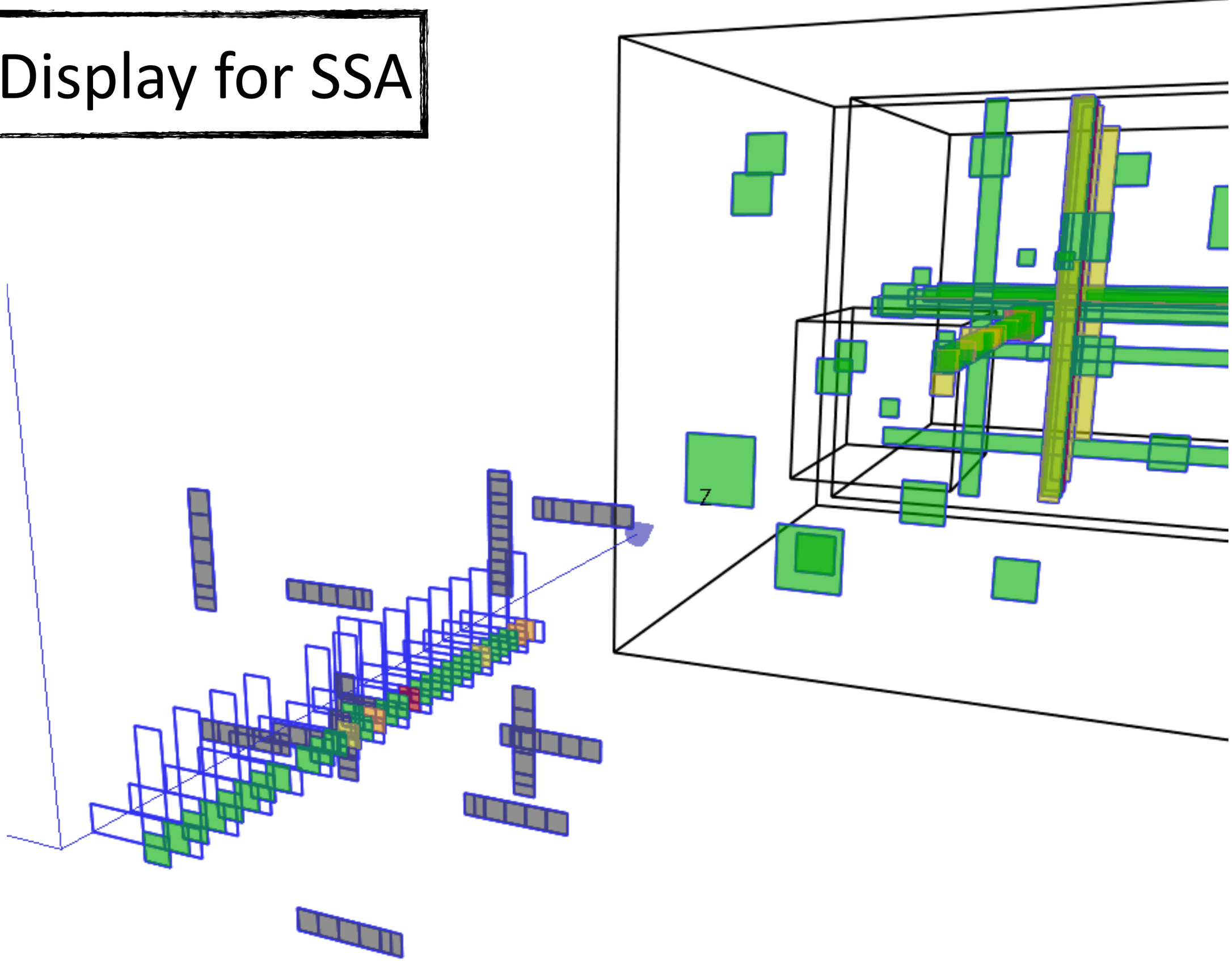
- First Results for Data
  - ➡ Sum over all cells and layers in different directions for a complete Run
- Get a better feeling about shower development
- Mapping Crosschecks were fine





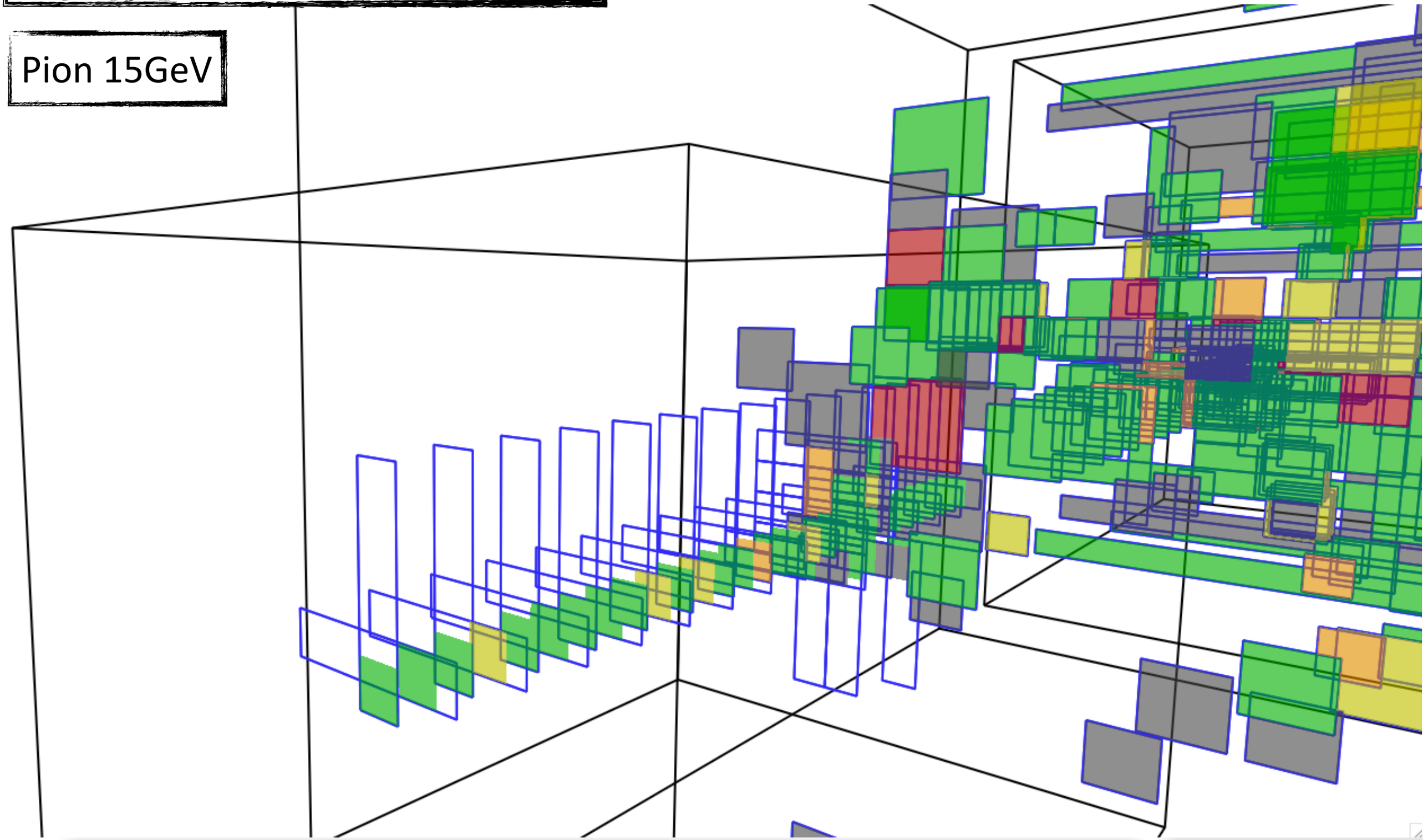
Event Display for SSA

Myon



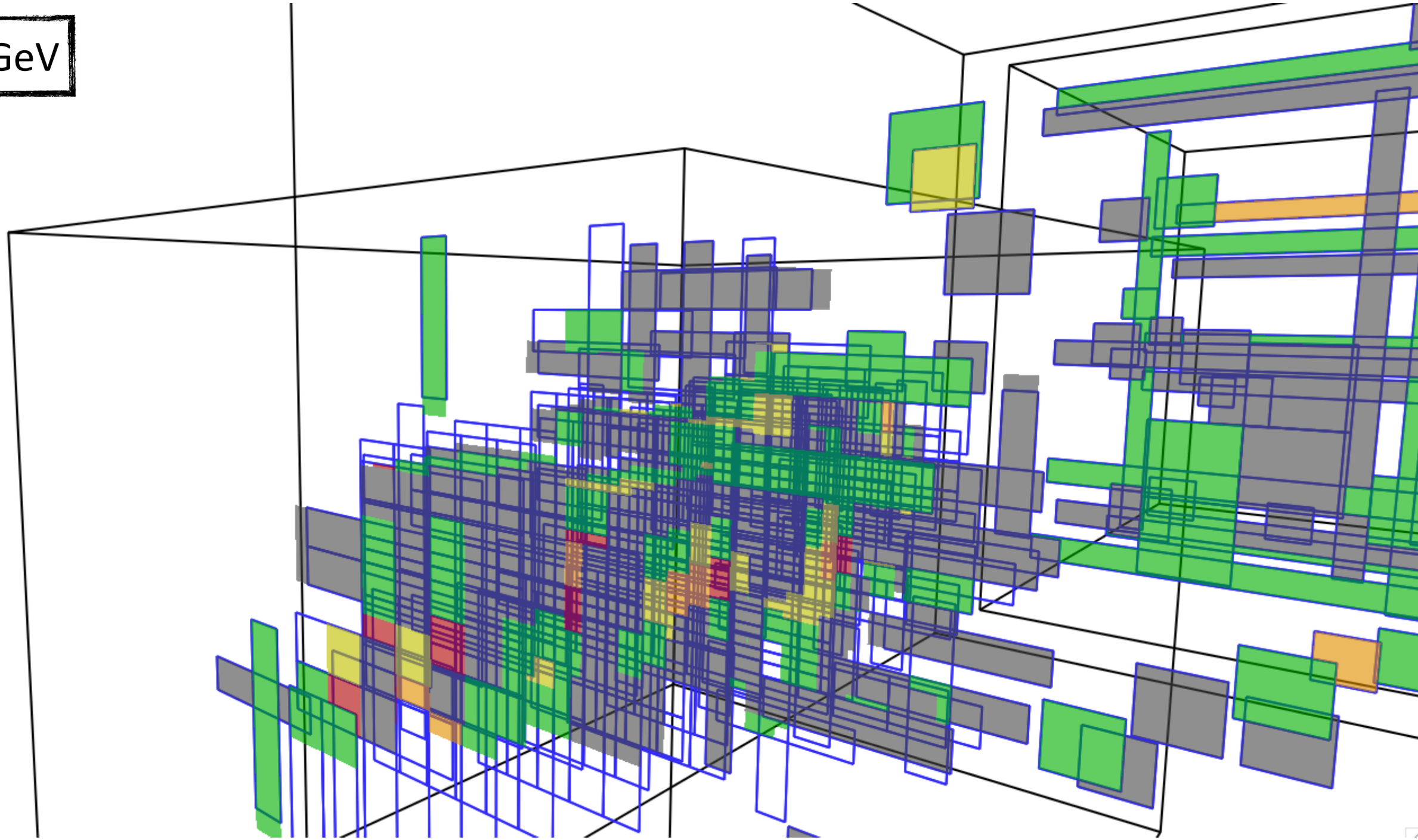
Event Display for SSA

Pion 15GeV



Event Display for SSA

e 15GeV



Conclusion/ Outlook

- Aim at e/pi separation
- First look at ECAL only separation by means of the of the longitudinal shower shape
- currently implementing lateral shower shape
- Strip splitting implemented to exploit the x and y orientation of strips

Thank you for your attention!