Hadronic Shower Structure in WHCAL Prototype

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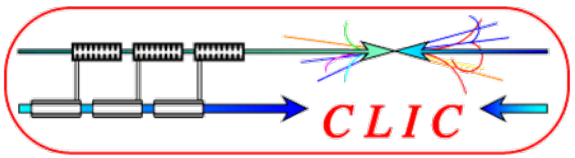
Christian Grefe

CERN, Bonn University



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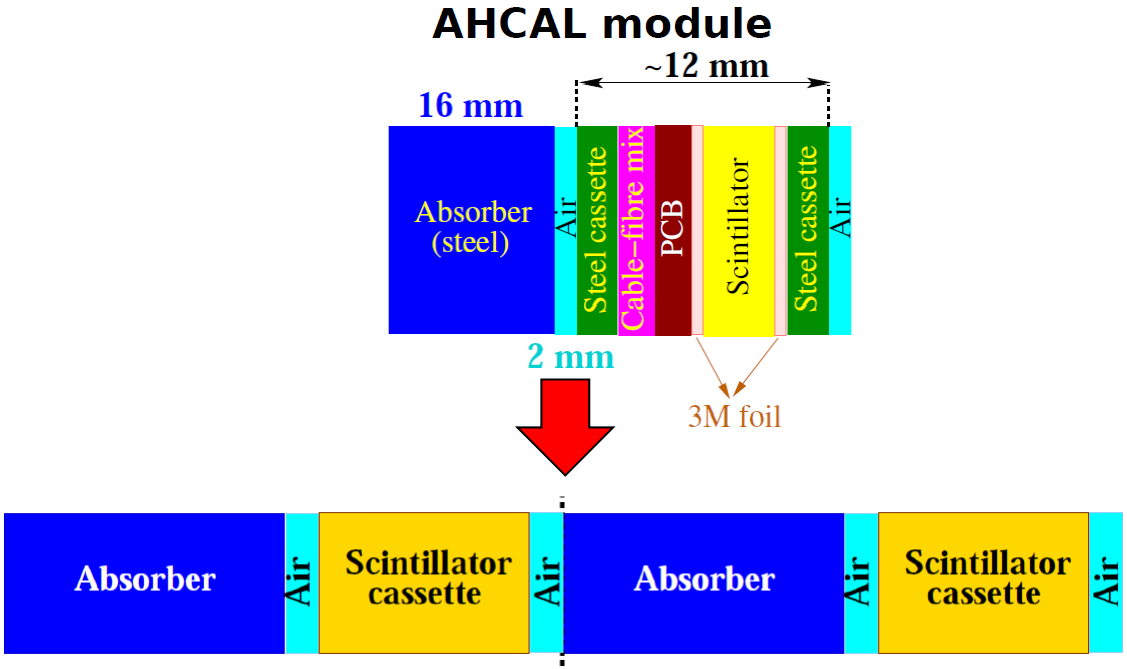
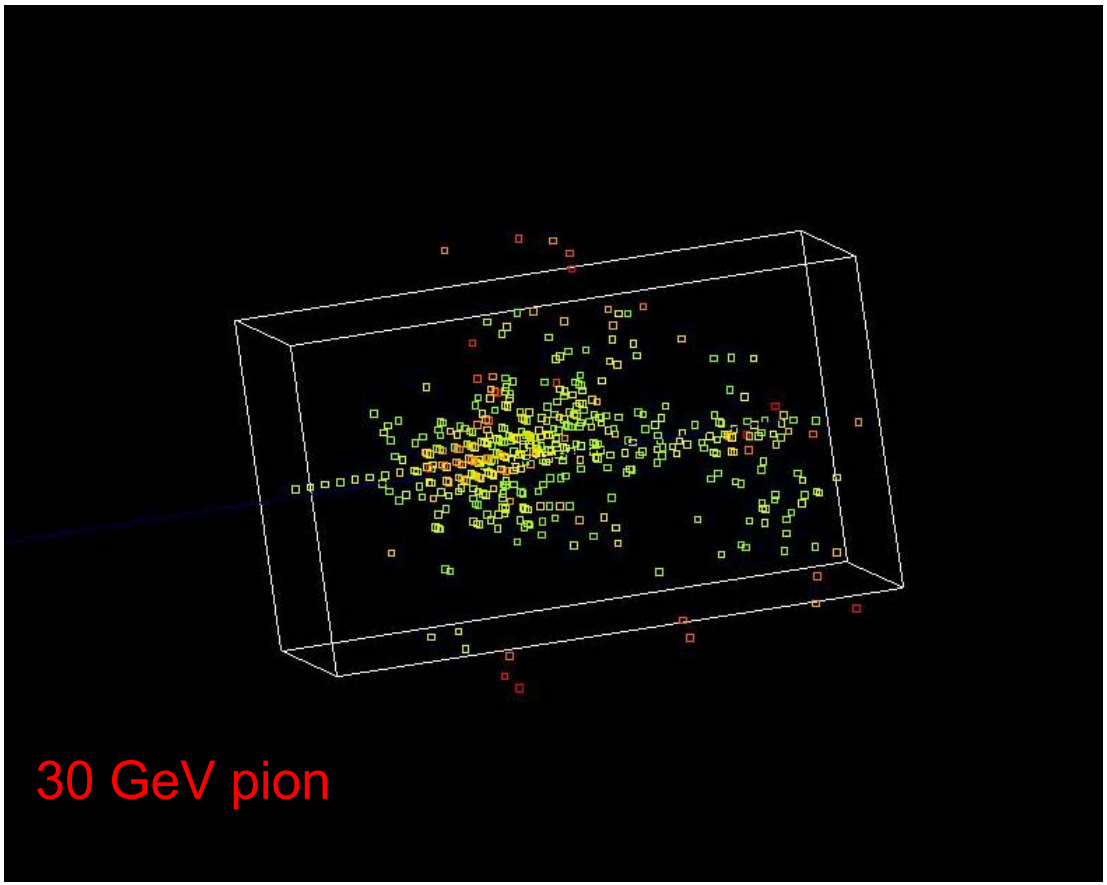
- Four different prototype geometries (40 layers each)
  - CALICE iron prototype (Fe): 16mm Fe + casette (30mm total gap size)
  - W, including steel support plate: 10mm W + 2mm Fe + cassette (30mm total)
  - W, no steel support (W_noFe): 10mm W + cassette (30mm total)
  - W, no steel and minimal air gap (W_noAir): 10mm W + cassette (22mm total)
- Compact.xml allows for easy and quick modification (more setups can be studied easily)

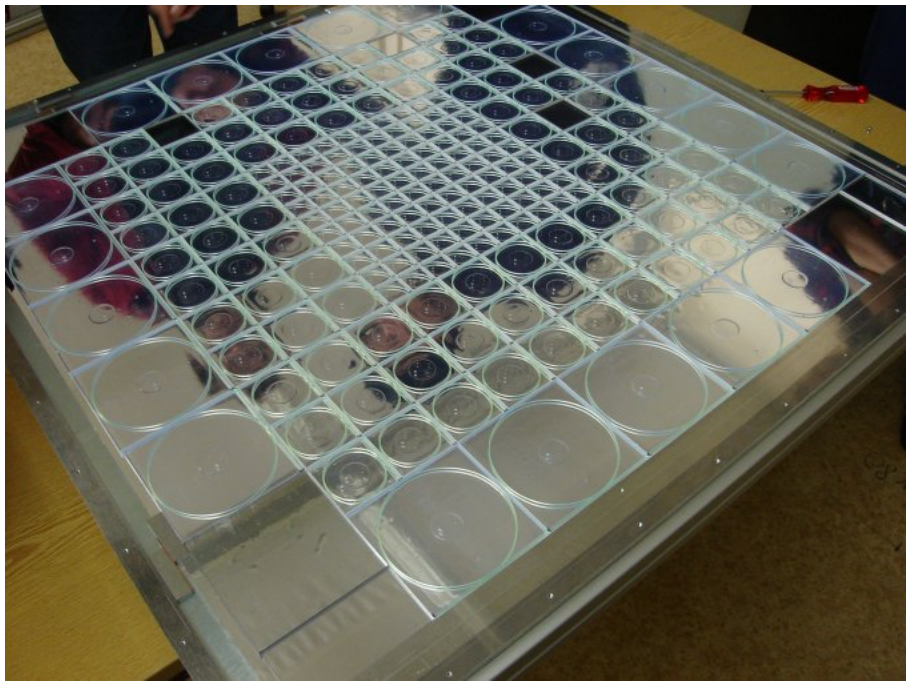


- slic v. 2.8.1 (GEANT4 v.9.2.0)
- QGSP_BERT_HP for high precision neutron tracking
- All four different geometries
- Pions and electrons with 1, 5, 10, 15, 20, 25, 30 GeV
- 1000 events each
- Total of 56000 events
- Only looking at 30 GeV Pions

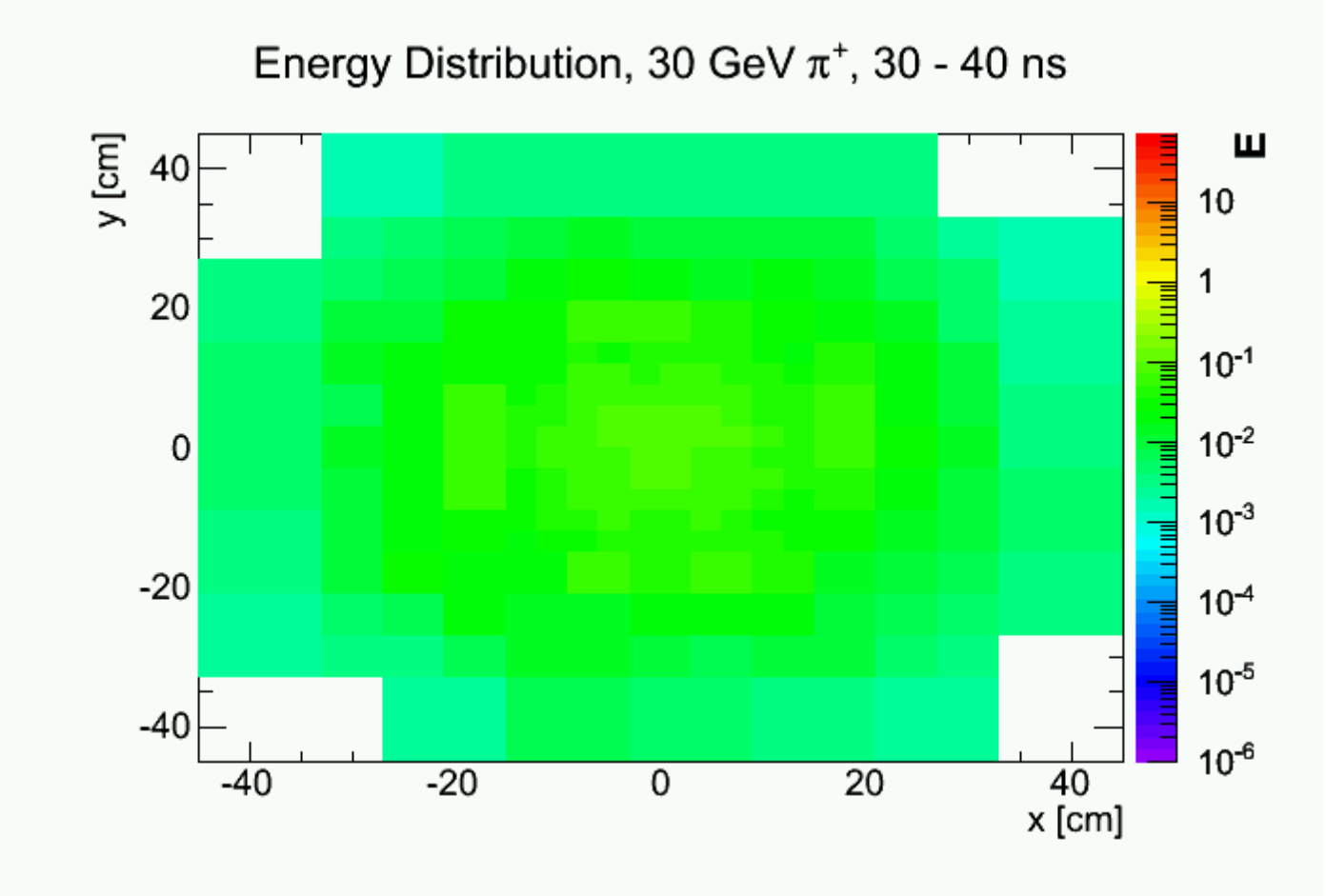


Hit Combination & Digitization

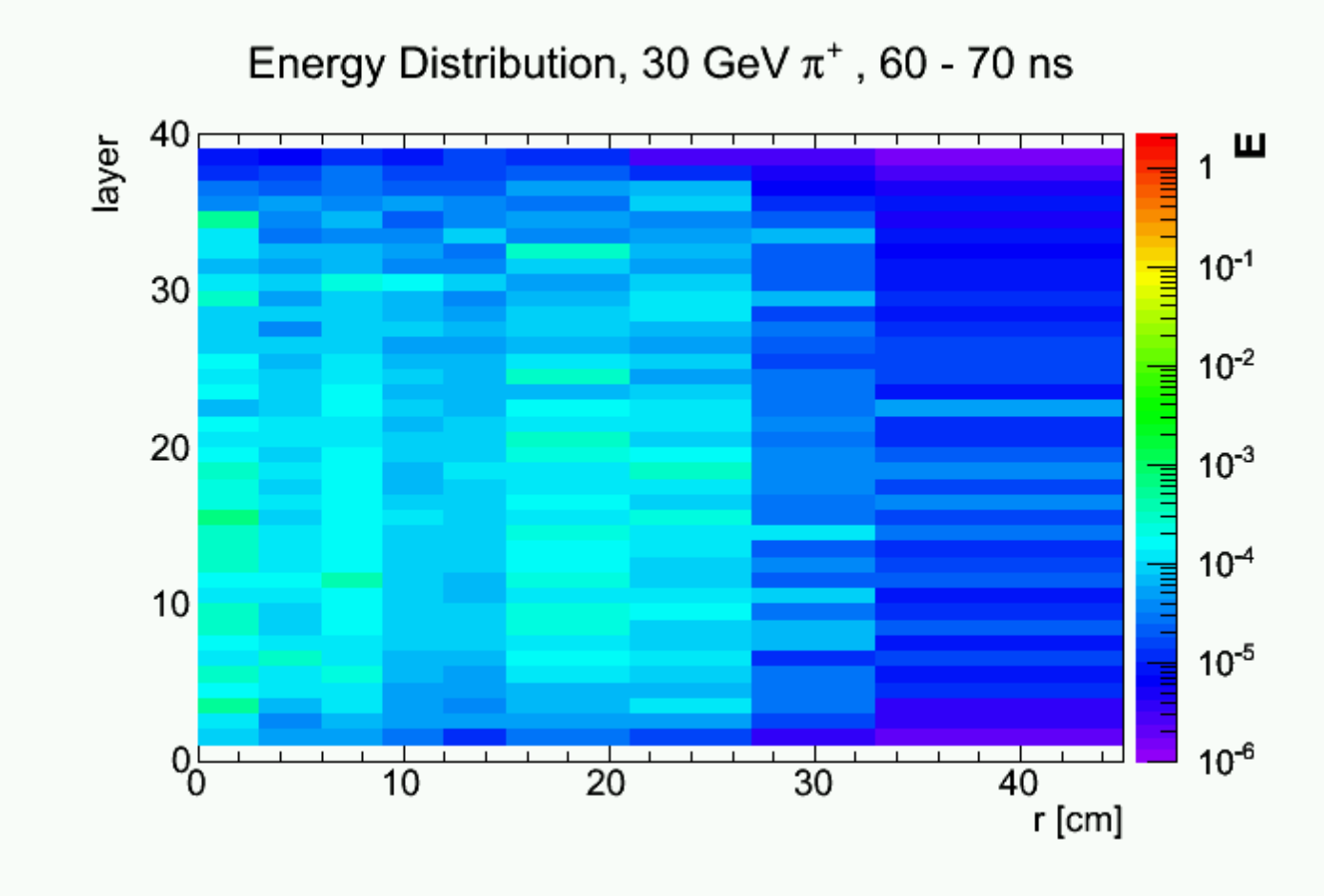
- Simulation uses 3x3 cm^2 cells
- Hits are combined during analysis according to CALICE AHCAL modules
- Threshold set to 250 keV (~1/4 MIP)
- Use only 3x3 and 6x6 cm^2 cells area (66x66 cm^2) because of W plate size



- (Energy normalized to cell)

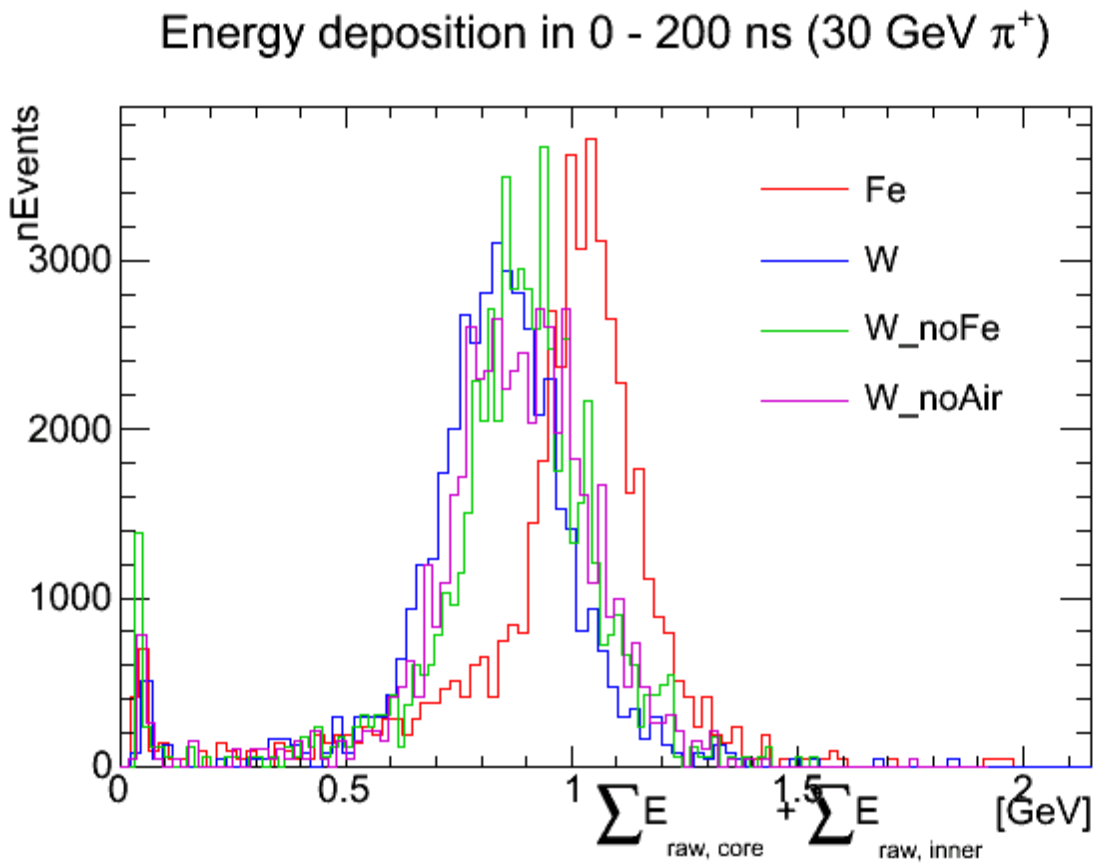


- (Energy normalized to ring area)



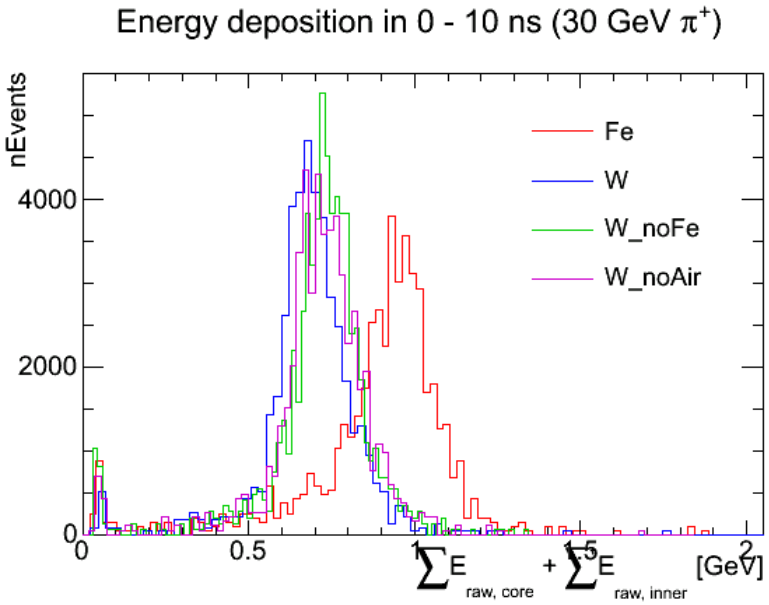
Energy Deposition – W vs. Fe

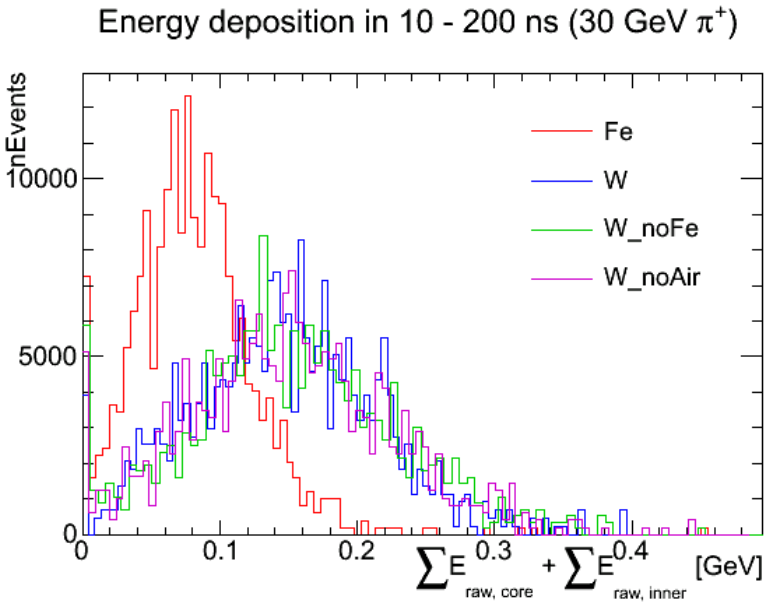
- More energy deposited in steel prototype → late neutrons escape
- Broader distribution in W
- W dominates effect → negligable impact from gap size / steel support plate



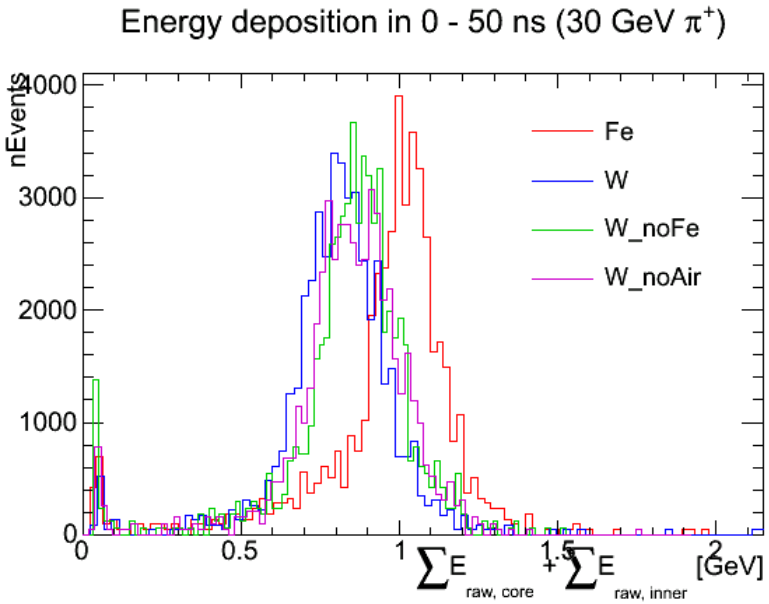
Early Energy Deposition

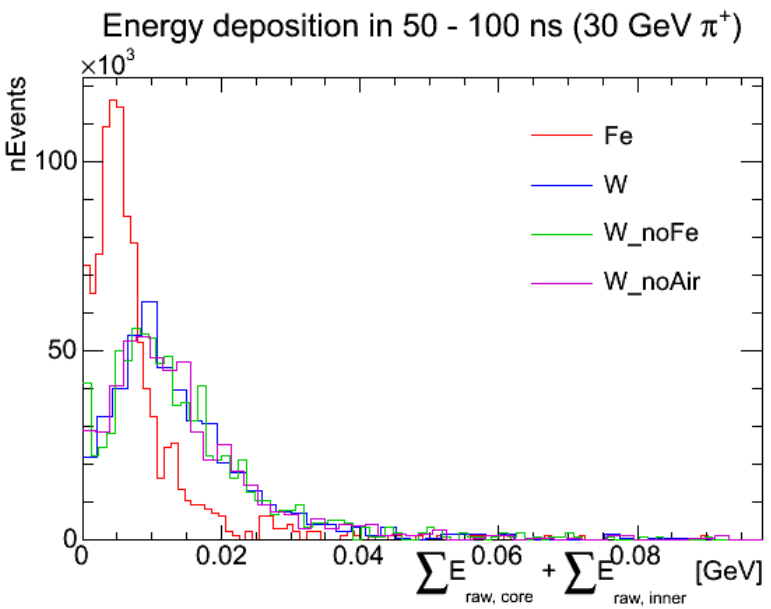
- Almost all energy deposited within first nanoseconds
- Clear distinction between steel and tungsten setups

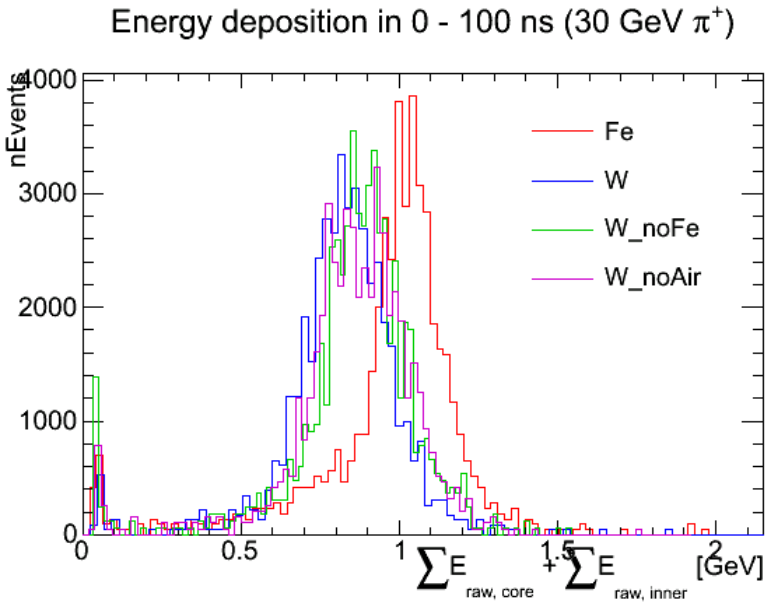


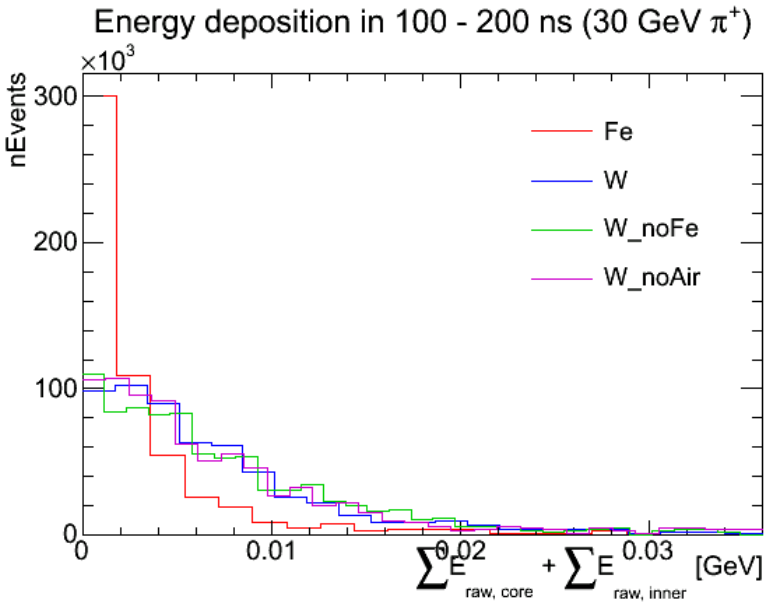


Later Energy Deposition

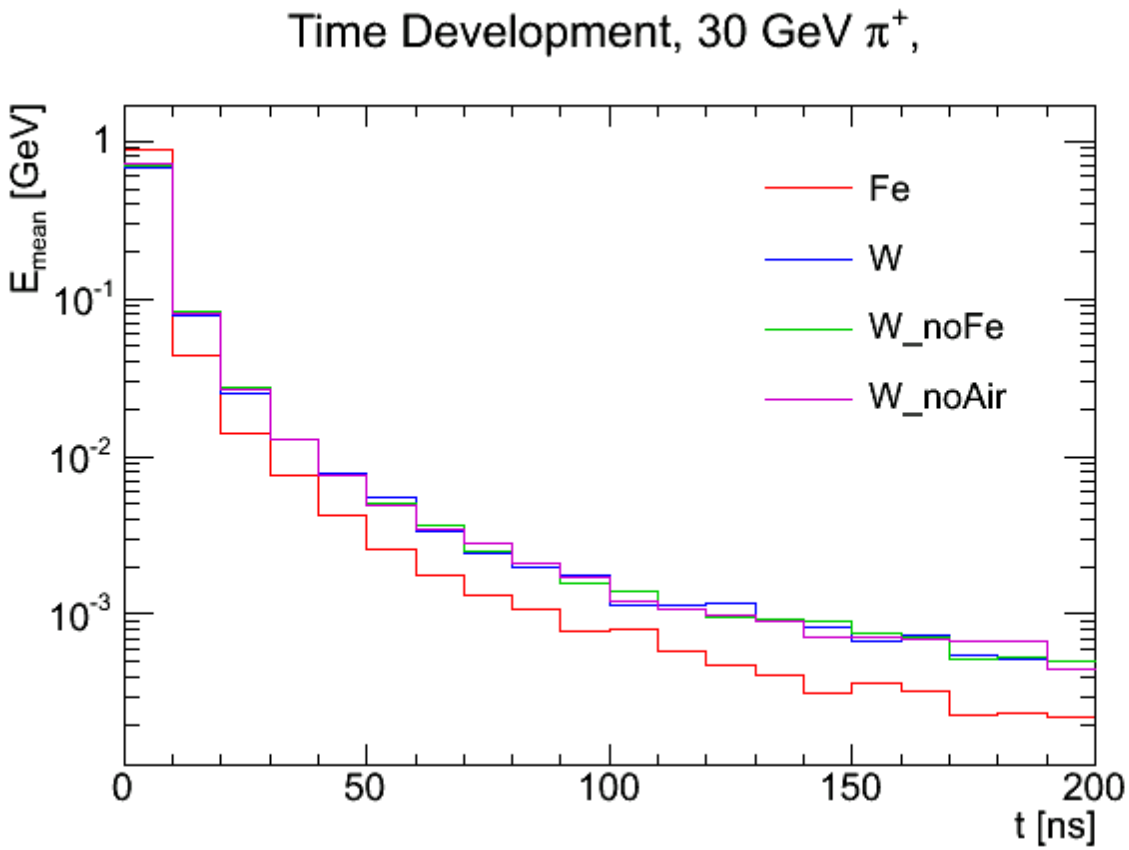






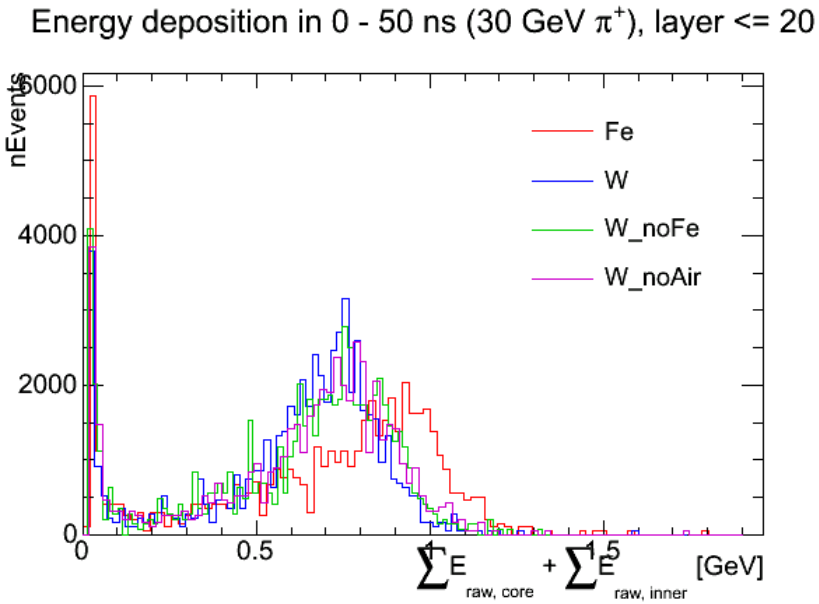


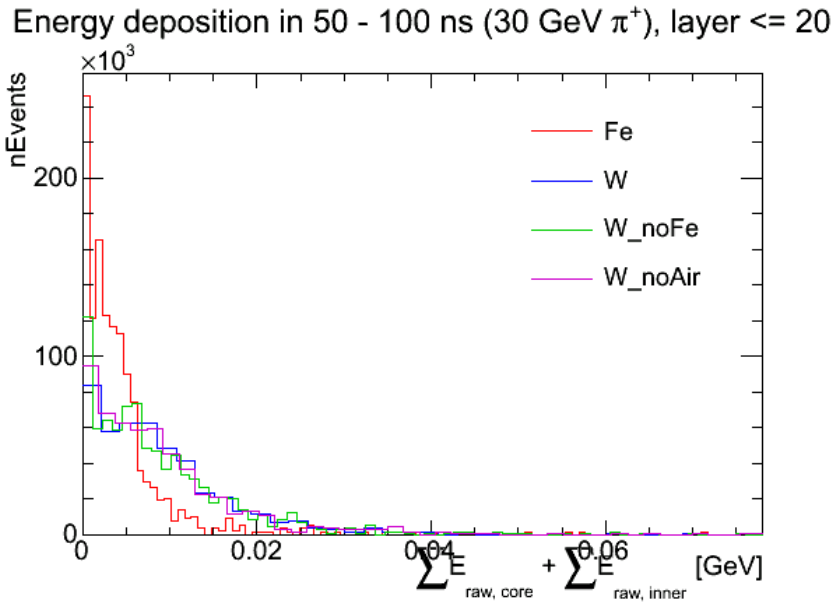
- (total energy deposition in 66x66 cm² area)



Energy Deposition in First 20 Layers

- More mip-like events
- Still clear difference in signals for Fe and W





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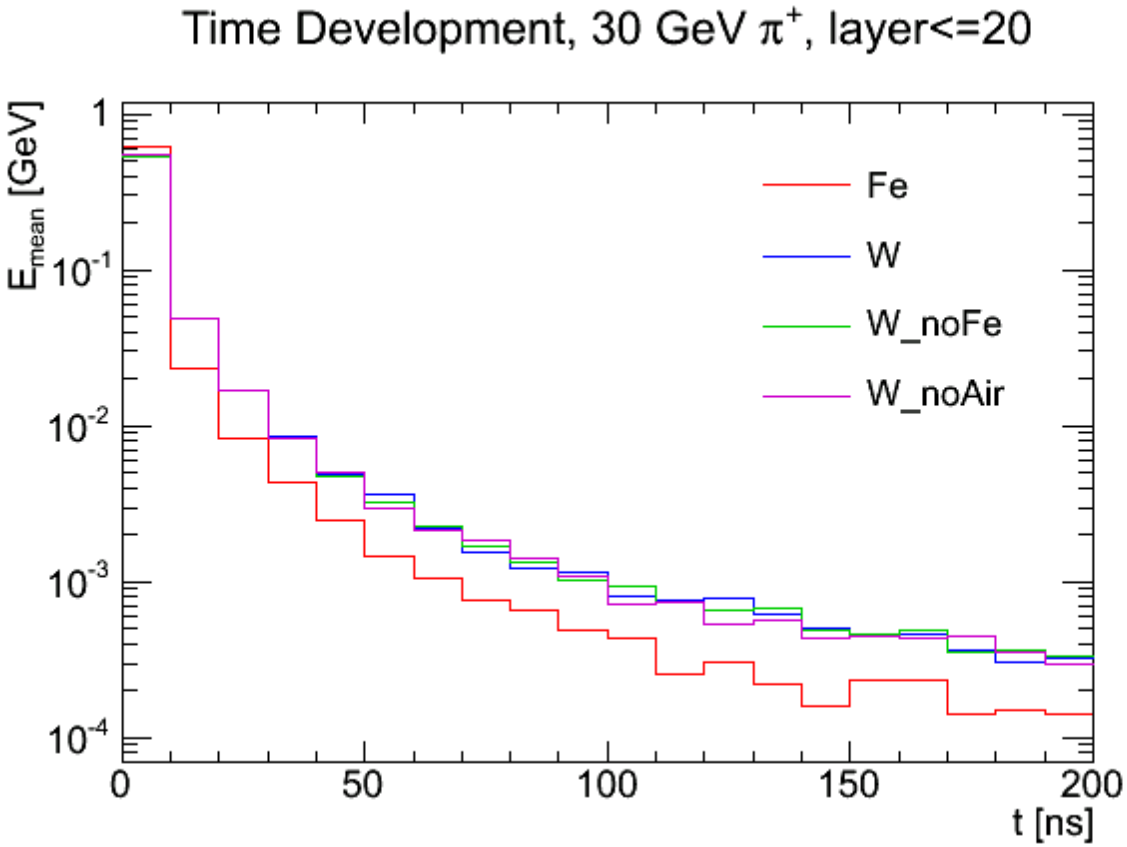

Conclusion

- Simulations performed for four different prototype geometries
- Clear difference between showers in Fe and W
- Only marginal differences for different W setups (steel support, air gap)
- Already the small setup (20 layers, only use inner 66x66 cm^2 area) can be used to investigate the hadronic shower structure
- Big potential for studying hadronic shower development in tungsten