Laboratoire d'Annecy-le-Vieux
de Physique des Particules

Hadronic shower sizes in WHCAL prototype

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WHCAL Workshop, 1 March 2010, DESY

In2p

Overview

The main aim is to determine the optimal dimensions of the tungstate HCAL prototype for a future test beam campaign

Stress is put on comparison of different dedicated studies done recently at LAPP (J. Blaha), CERN (C. Grefe), and DESY (A. Lucaci-Timoce)

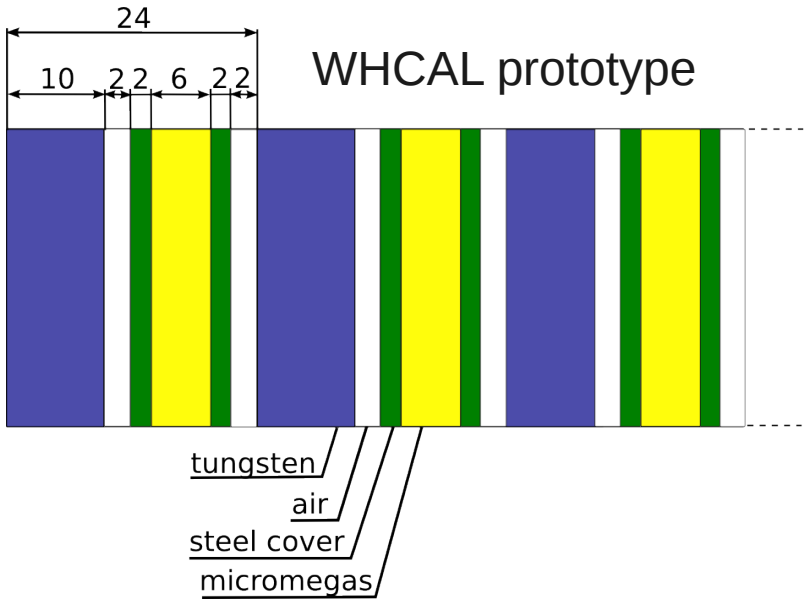
N.B. Studies are shown for 10 GeV pions as a typical energy in T9 PS line

Prototype configurations

Detectors:
- Micromegas with analog and 1 bit digital readout
- Scintilator with analog readout

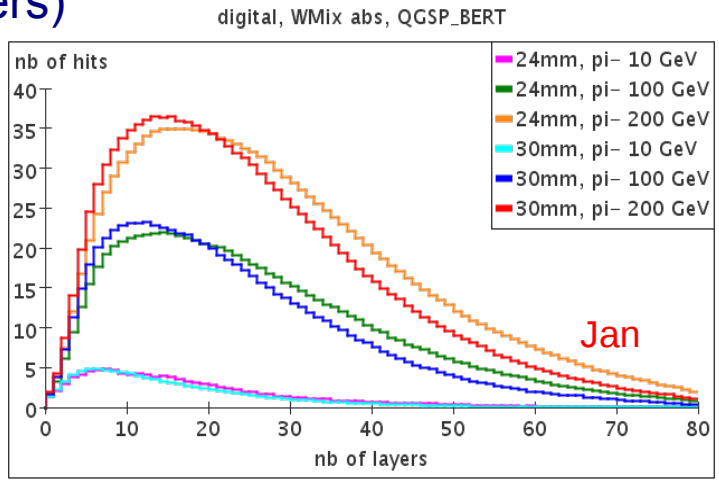
Absorber:
- W with thickness between 10 to 12 mm
- Pure W vs W alloy (92.5% W + 4% Cu + 3.5% Ni)
- W + Fe (supporting material) vs W

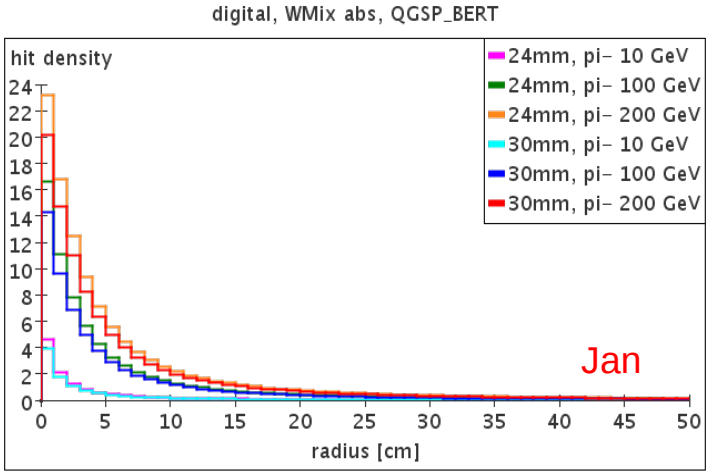
Studies:
- Energy shower size
- Comparison of different absorber materials (W, Fe)
- Comparison of different physics list



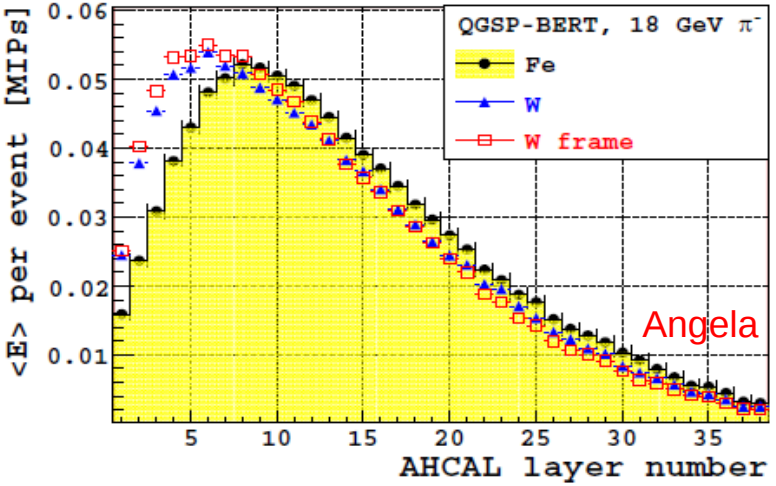
Energy shower profiles

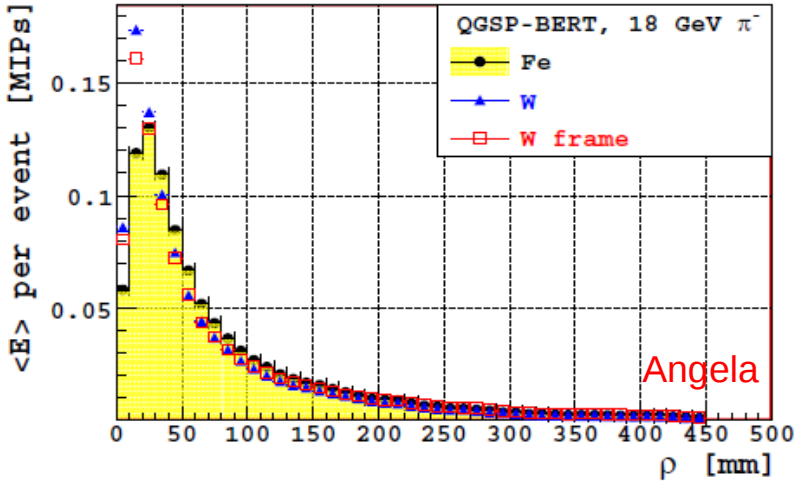
10 mm WMix + μMegas (two 2 mm Fe covers)





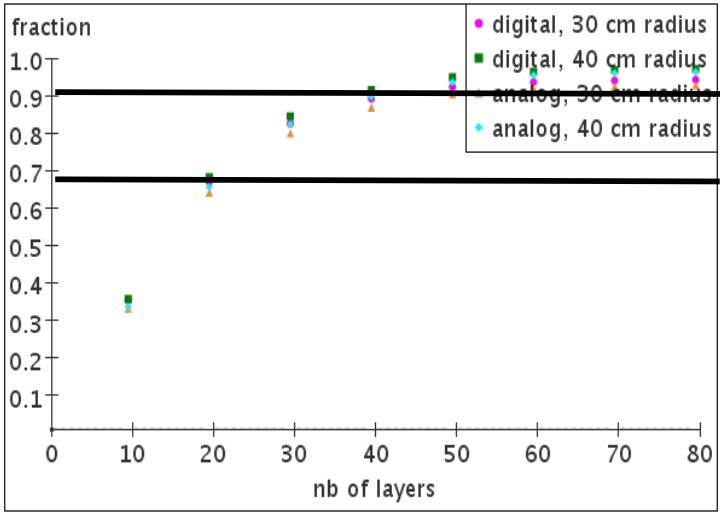
10 mm W + 2 mm air + 5 mm scint, 38 layers AHCAL



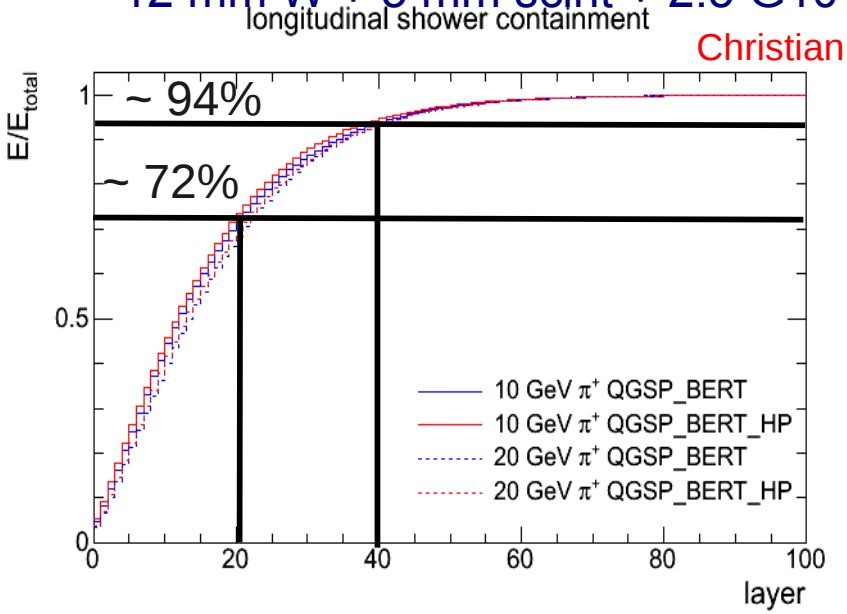


Longitudinal containment

10 mm WMix + μMegas (two 2 mm Fe covers)



12 mm W + 5 mm scint + 2.5 G10



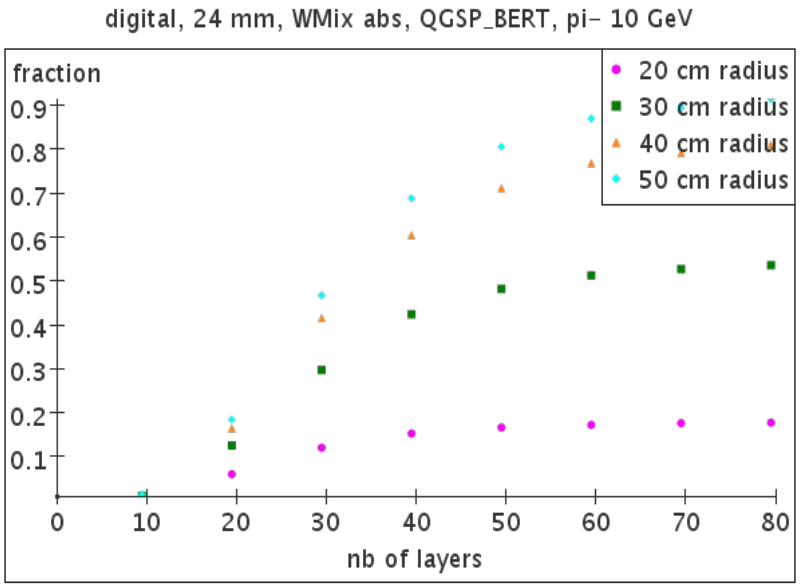
Infinite calorimeter

10 GeV pions	20 layers	40 layers
60 x 60 cm^2	68 %	89 %
80 x 80 cm^2	69 %	91 %

- Difference between Micromegas and scintillator prototype is due to absorber composition (W alloy vs pure W), its thickness, detector materials and active medium, and lateral prototype size. Each of that can contribute in order of percent
- Generally the longitudinal size is not a critical issue for WHCAL prototype, we can simply add more layers when they are available

Fraction of 95 % contained events

10 mm WMix + μMegas (two 2 mm Fe covers)



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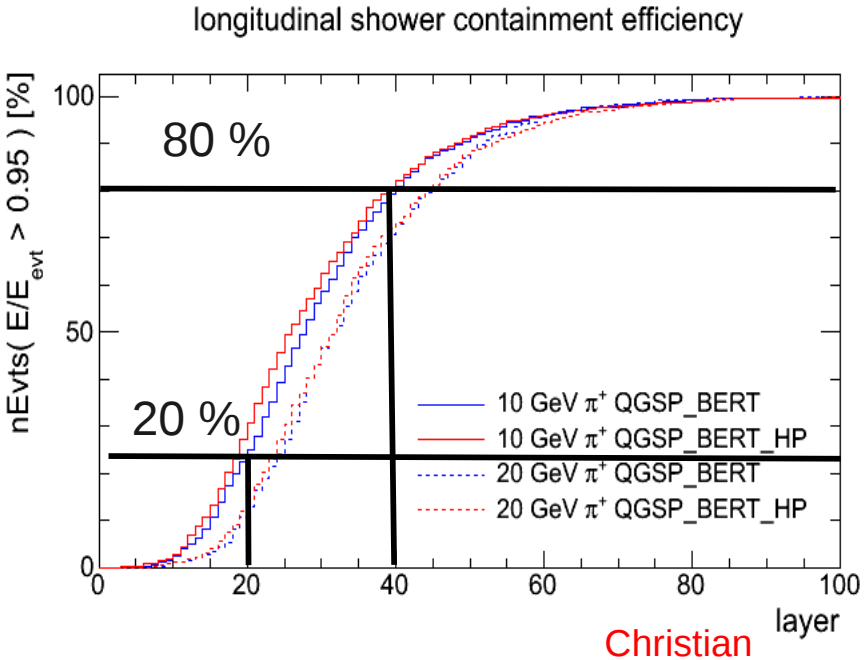
12 mm W + 5 mm scint + 2.5 G10



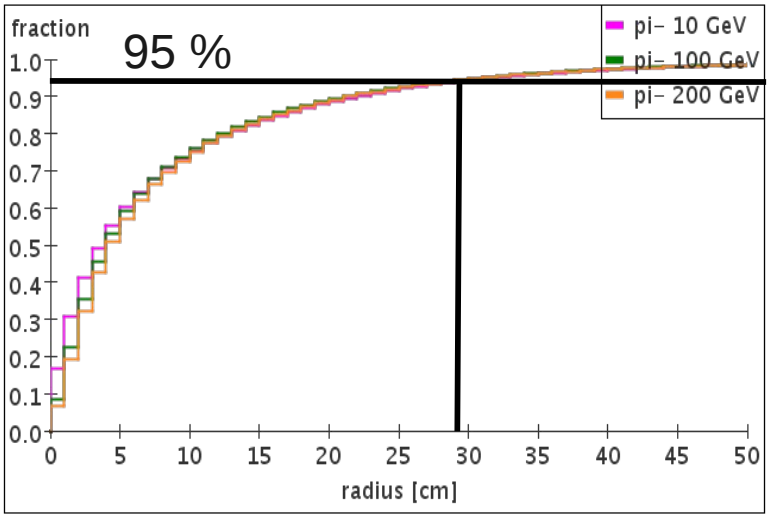
Christian

10 GeV pions	20 layers	40 layers
60 x 60 cm^2	12 %	41 %
80 x 80 cm^2	16 %	60 %

Lateral containment

10 mm WMix + μMegas (two 2 mm Fe covers)

12 mm W + 5 mm scint + 2.5 G10



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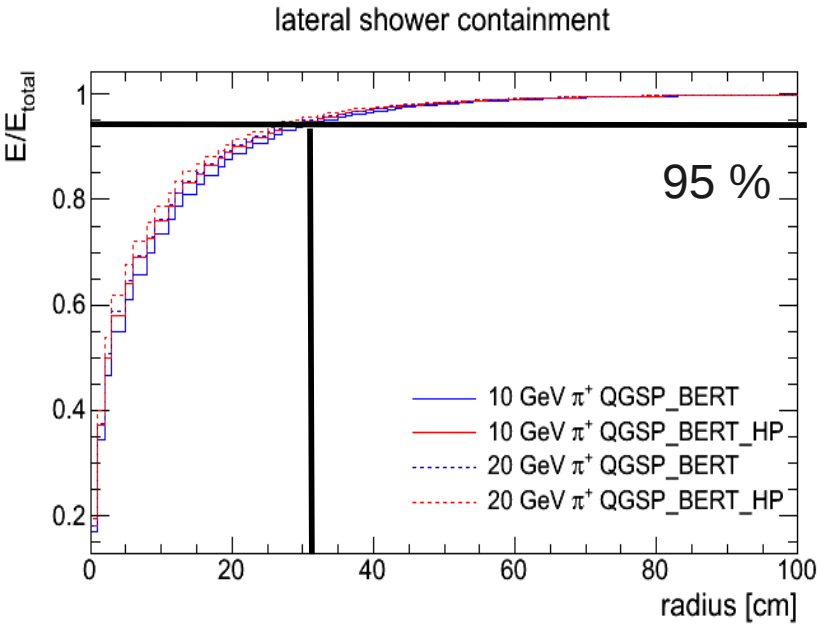

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- In deep calorimeter (80 layers or “infinite”), 95 % of energy is contained in calorimeter with lateral size ~ 60 cm

Lateral containment

10 mm WMix + μMegas (two 2 mm Fe covers)

10 mm W + 2 mm air + 5 mm scint, 38 layers AHCAL

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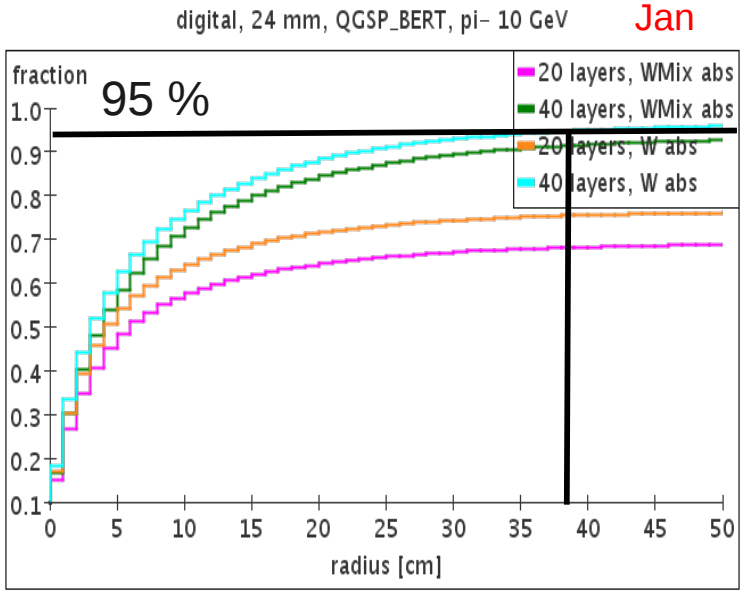
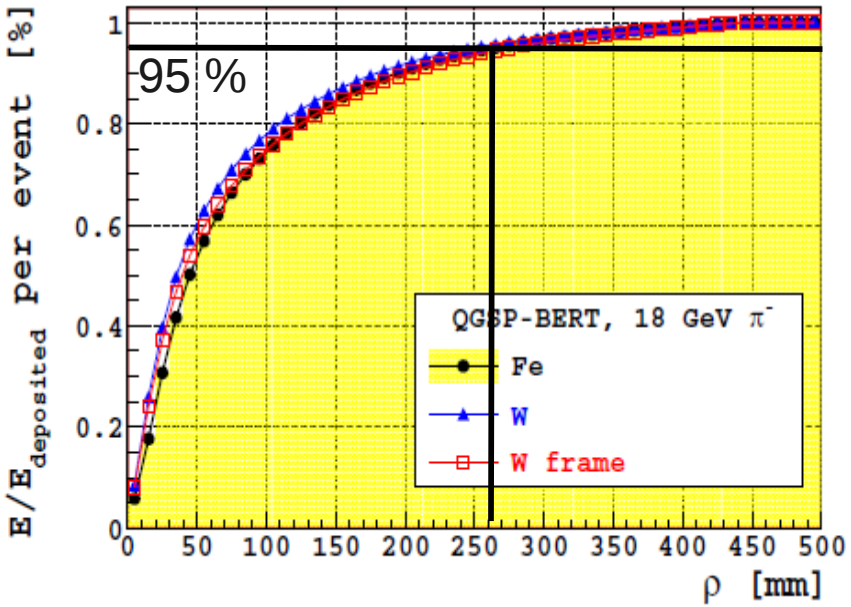


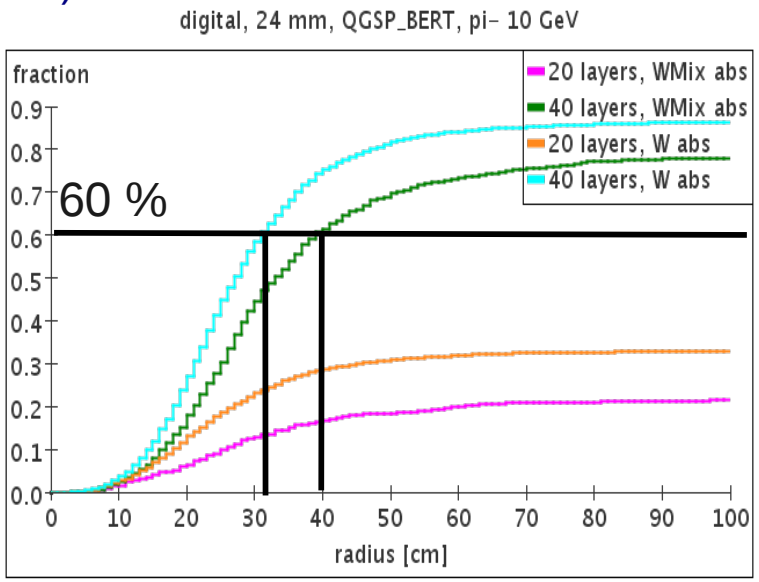
Angela



- In a short calorimeter, as it is case of the WHCAL prototype, only a fraction of the shower will be measured
- Larger lateral size should be consider in comparison with a deep calorimeter or select only contained events (reduced statistics)

Fraction of 95% contained events

10 mm WMix + μMegas (two 2 mm Fe covers)



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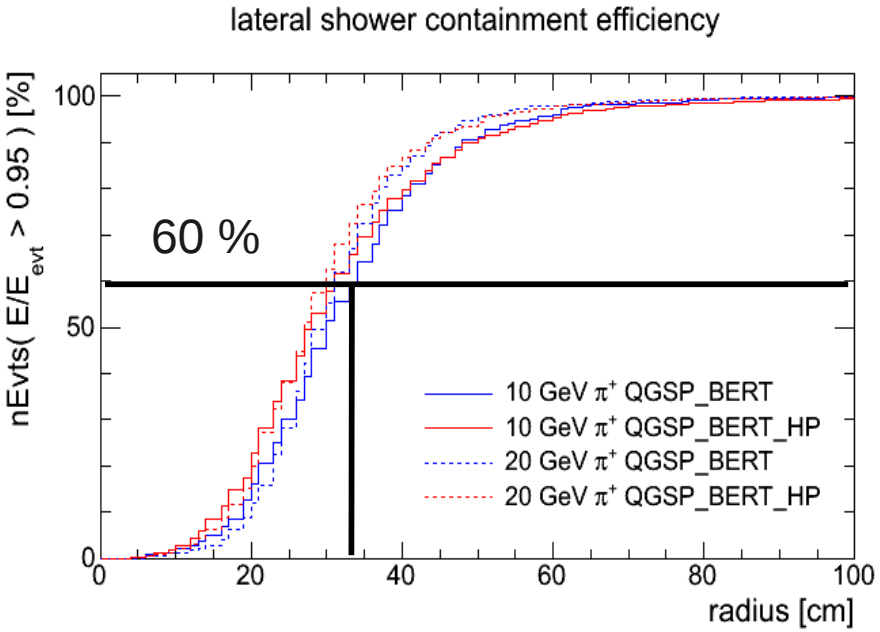
12 mm W + 5 mm scint + 2.5 G10



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- Significant difference in number of fully contained events for W alloy and pure W → larger lateral size should be considered for WHCAL prototype with alloy absorber in comparison with pure W

Conclusions

Presented studies are consistent in their results when one consider differences in calorimeter geometry, materials, etc.

For choice of suitable lateral size of the prototype, one must take into account: limited size of prototype depth, absorber material (W alloy and not pure W), energy containment and fraction of fully contained events → larger lateral size (~ 80 cm) is a safer choice