SiW ECAL with reduced number of layers

preliminary performance studies

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ECAL is a major cost-driver of ILD detector (~30% of cost @ LoI)

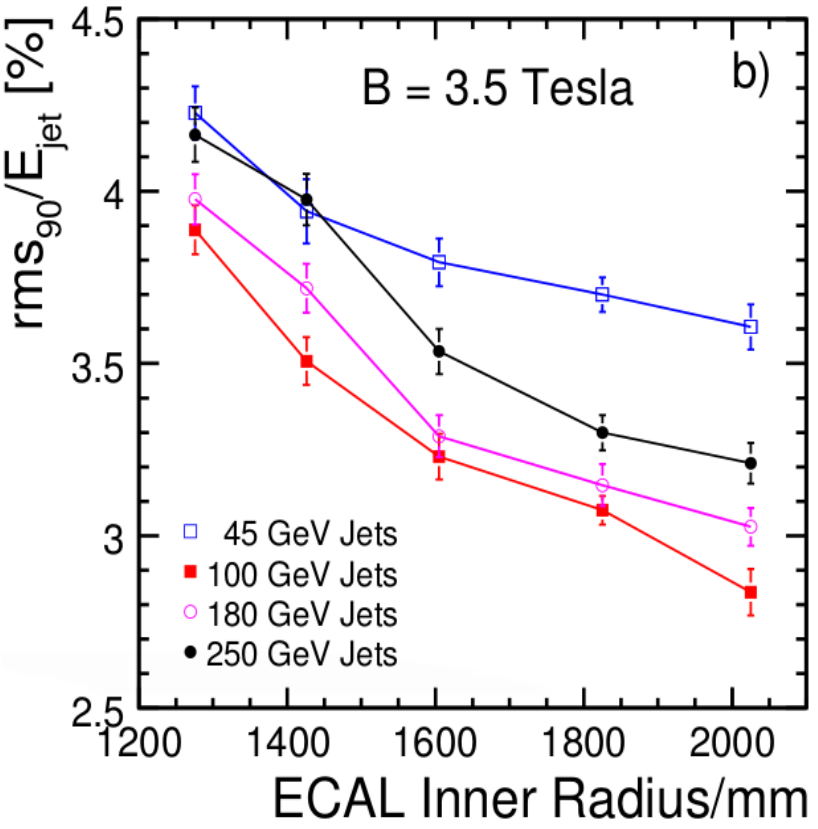
Cost scales more or less with total area of Si

To reduce this area, we can either:

a) reduce TPC size; or

b) reduce number of layers

Mark Thomson already studied (a) for LoI



This presentation is about (b)

how much performance do we lose

by reducing the number of layers ?

Starting from ILD_00 model (used for LoI)

Reminder: 30 silicon layers in ECAL, 29 W layers

Two “stacks”:

first 20 W layers with 2.1mm,

remaining 9 with 4.2mm

Alternative ECALs:

keep ~ same total W thickness

keep 2 stacks ~50%/50% in terms of total W thickness

keep 1:2 ratio of W thicknesses

26 layers:

17 x 2.4mm, 8 x 4.8mm W layers

20 layers:

13 x 3.15mm, 6 x 6.3mm

(30 layers:

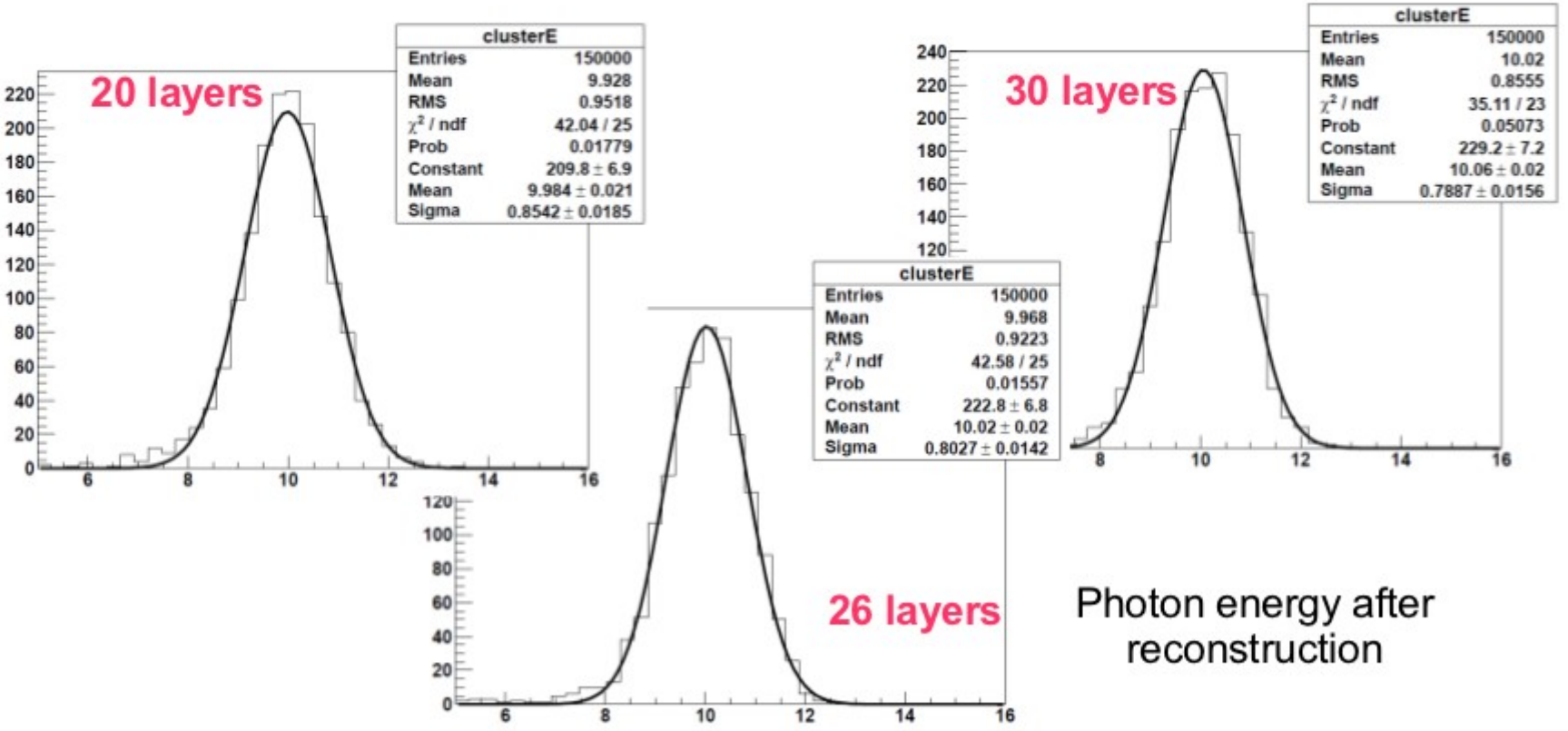
20 x 2.1mm, 9 x 4.2mm)

All other elements unchanged

PCB, carbon fibre, cooling layers, Si thickness...

Calibration

- ECAL calibration were done using 10 GeV single photon events



Reduced number of layers gives reduced sampling fraction
→ loss in intrinsic energy resolution (trivial)

More interesting is to see effect on
PFA performance including
pattern recognition and
single particle energy resolution

Simulate same di-jet events in three models: 30, 26 and 20 layers

at two centre-of-mass energies: 91 GeV (u/d/s) and 250 GeV (u/d)

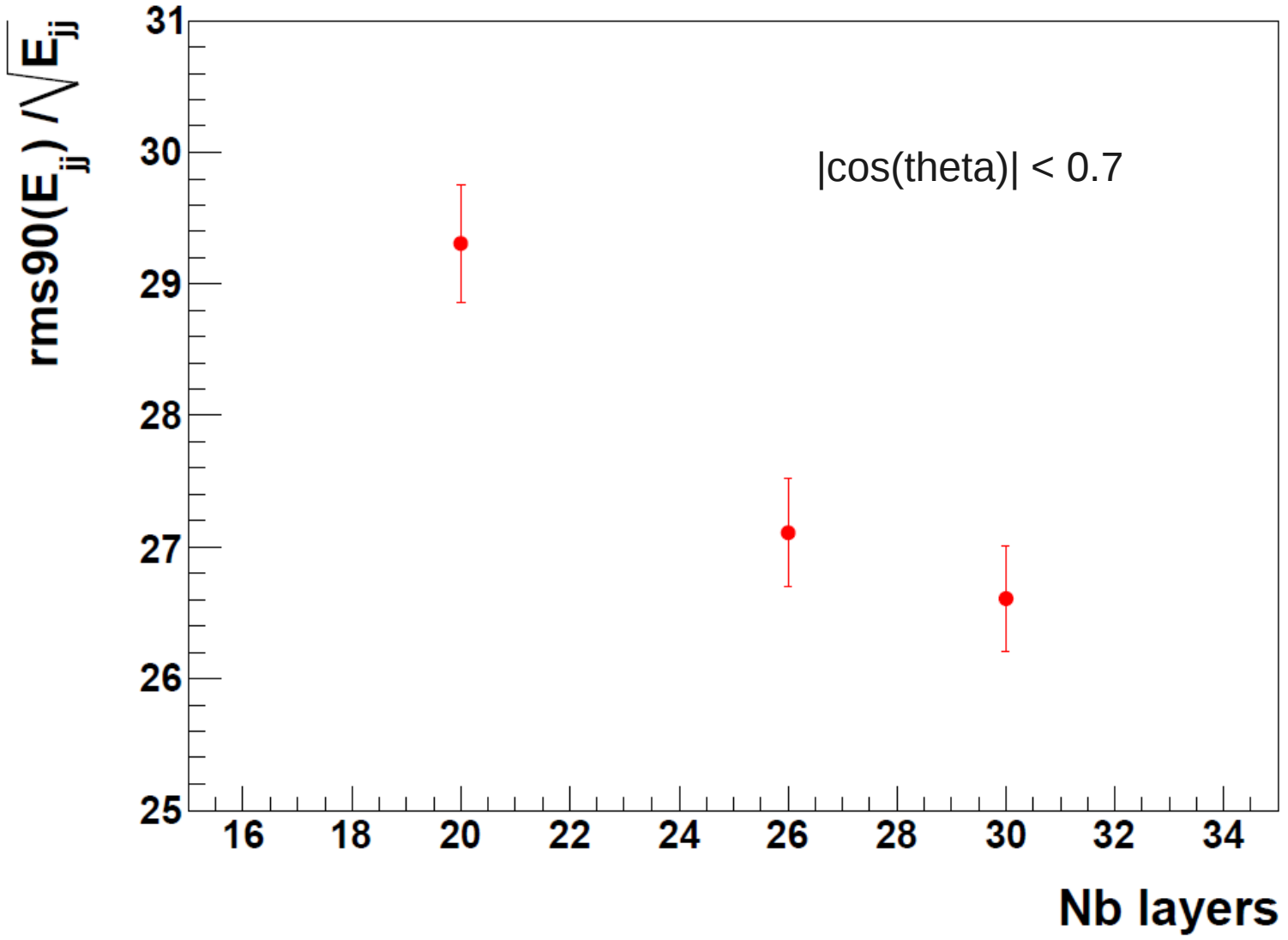
(for 250 GeV sample, remove radiative returns to Z and below)

Analyse events in PandoraPFANew (in ilcsoft v01-11)

No retuning of parameters for different models
(Mark thought this should be OK)

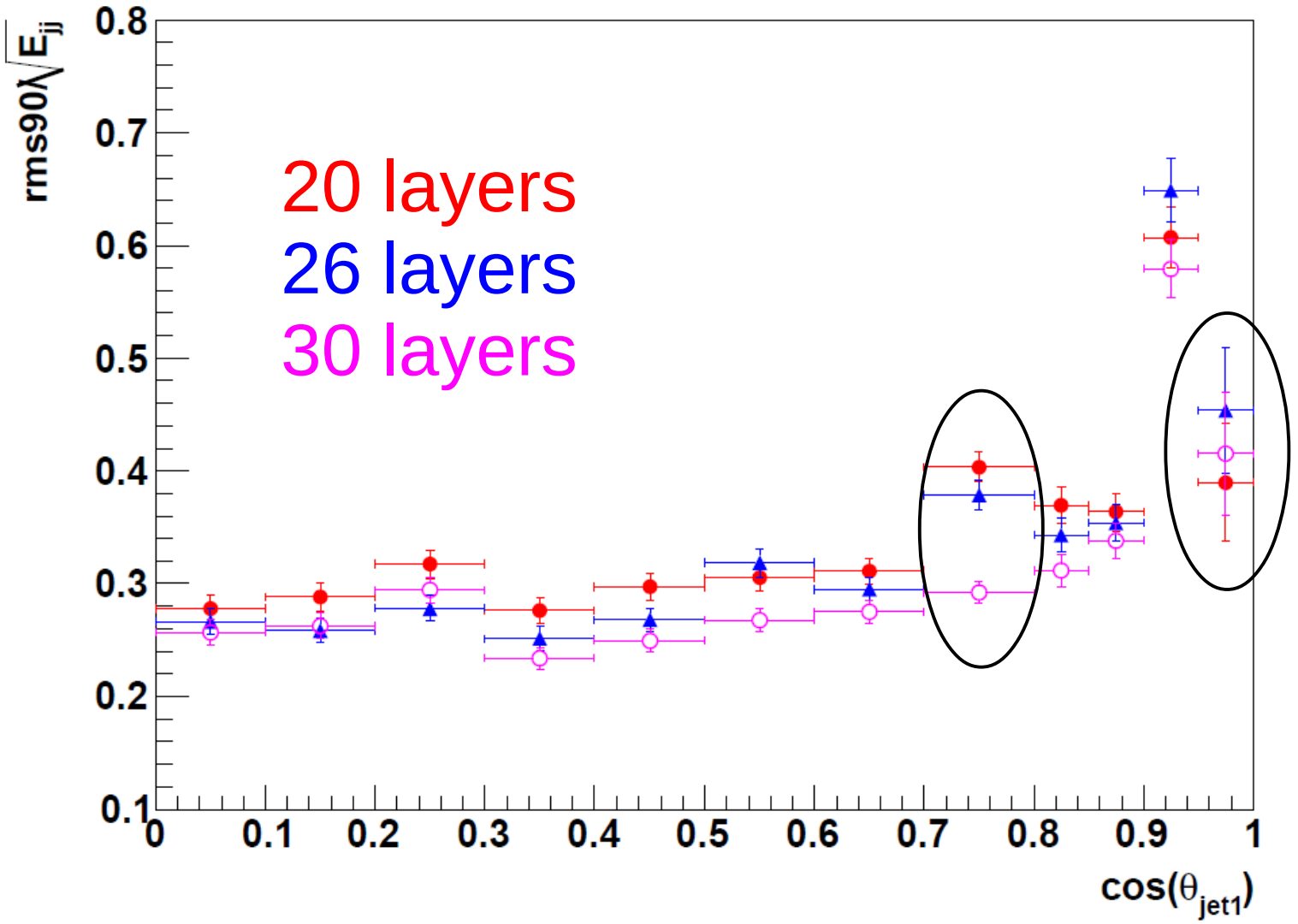
Pattern recognition abilities (confusion) more important @ 250 GeV
Single particle resolution has greater weight @ 91 GeV

91 GeV events: total event energy resolution (RMS90)



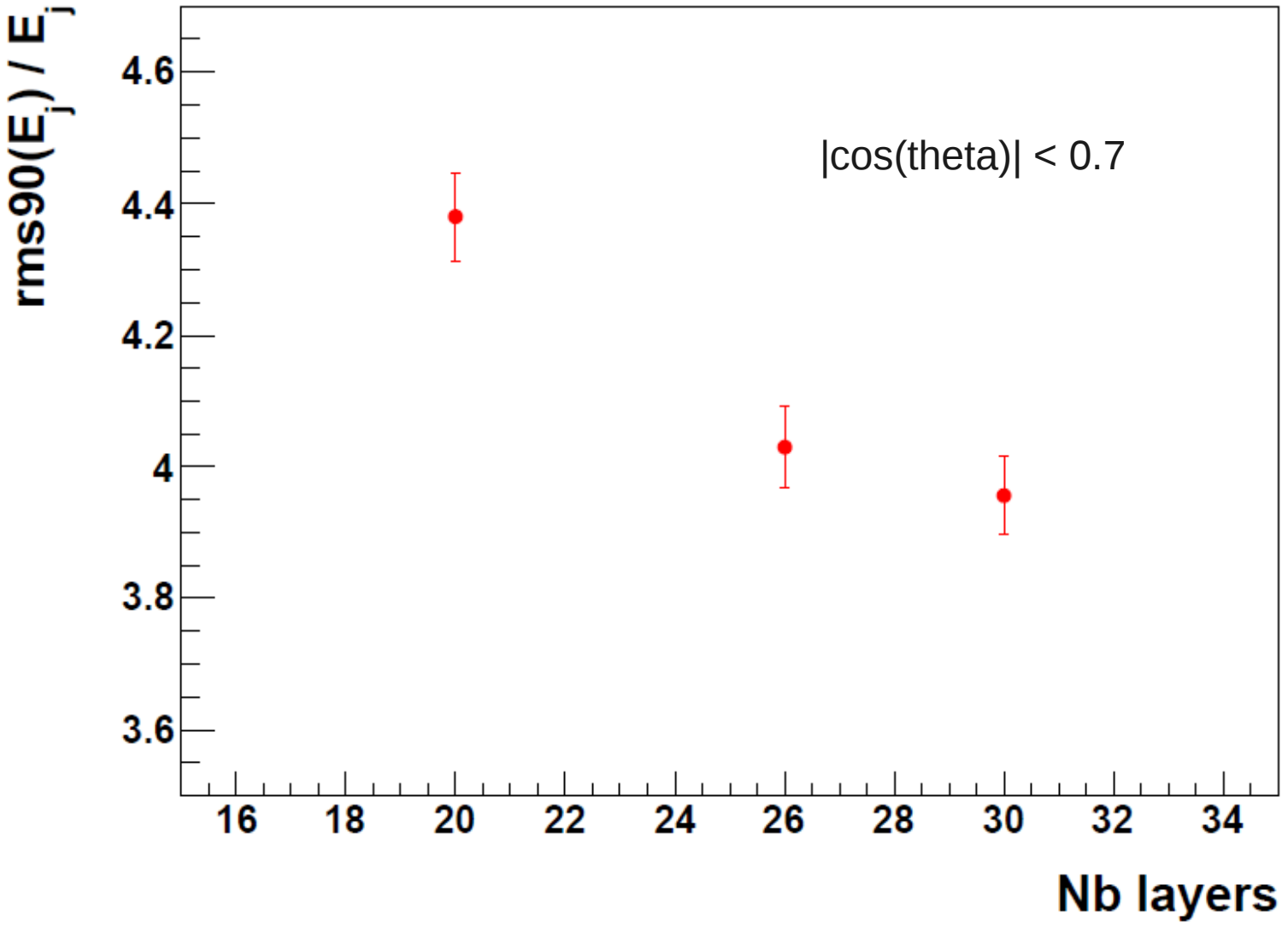
The 30 layer result looks somewhat worse than Mark's result ~25%

91 GeV events: as function of | cos(theta) |



26 and 20 layer models have problems in barrel/endcap overlay, not seen for 30 layers
Behaviour in forward looks a little strange...

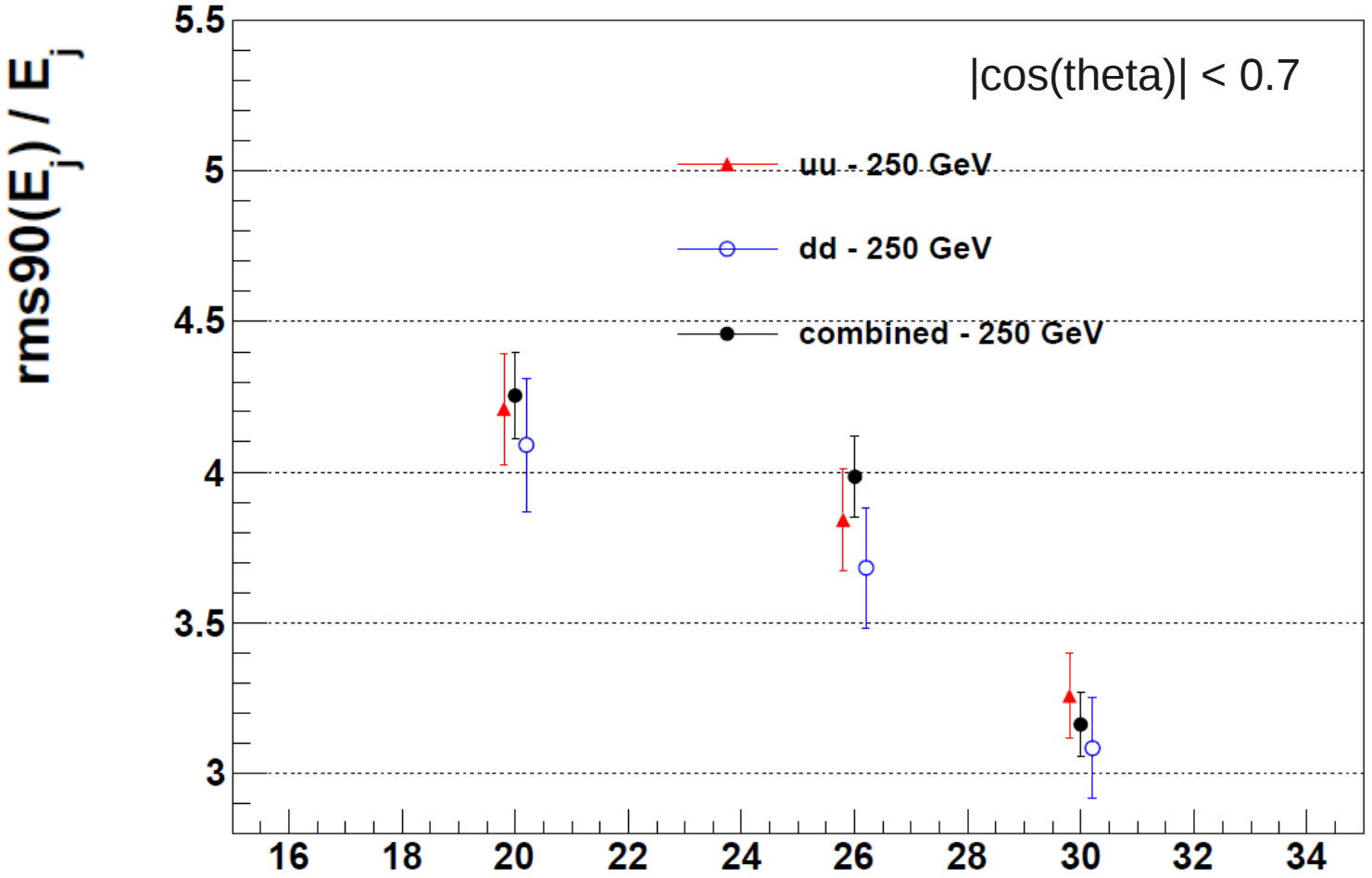
91 GeV events: transform to single jet energy resolution @ 45 GeV



Around 10% degradation from 30 → 20 layers

caveat: absolute value looks too high @ 30 layers (cf 3.6%)

250 GeV events: single jet energy resolution @ 125 GeV



~30% degradation in JER going from 30 → 20 layers

“official” PandoraPFANew results ~ 2.9% - looks more consistent than at 91 GeV

Summary

Preliminary results

- Our 30 layer numbers not completely consistent with “official” ones
- Some as-yet not understood behaviour in barrel/endcap overlap

Reducing ECAL from 30 to 20 layers:

- 10% worse JER for 45 GeV jets (single particle)
- 30% worse JER for 125 GeV jets (pattern recognition)