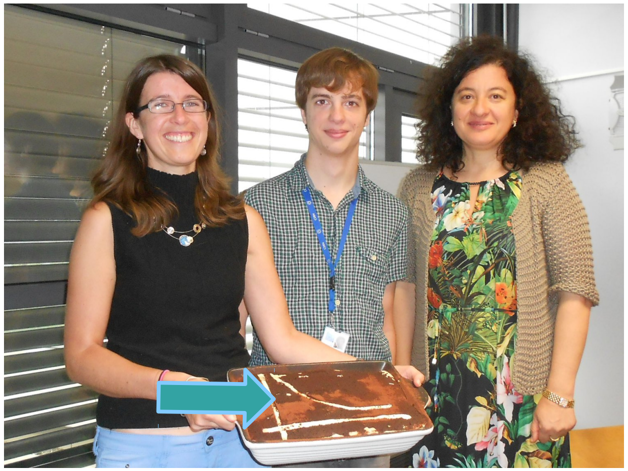

DIJET RESONANCE BENCHMARKS FOR CALORIMETER DESIGN

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OUTLINE

Idea: use benchmarks for **dijet search** as benchmarks for **calorimeter design**

Calorimeter **resolution** affects **width** of resonance
→ might influence **search sensitivity**

Project: Smear new resonance MC samples (q*) with different calorimeter resolution hypotheses, check effect on peak width

ATLAS EXPERIMENT SUMMER STUDENT PROJECT

Full report: https://cds.cern.ch/record/1750237?ln=en

Tools: **Sacrifice steering Pythia8 (35k events) + Delphes**

HCal smearing: start from ATLAS TDR jet resolution

$$\frac{\sigma_{E_T}}{E_T} = \frac{N}{E_T} \oplus \frac{S}{\sqrt{E_T}} \oplus C \qquad N = 5.4\ \mathrm{GeV},\ S = 0.64\ \sqrt{\mathrm{GeV}},\ \mathrm{and}\ C = 0.027$$

Apply analysis selection, check signal width when:

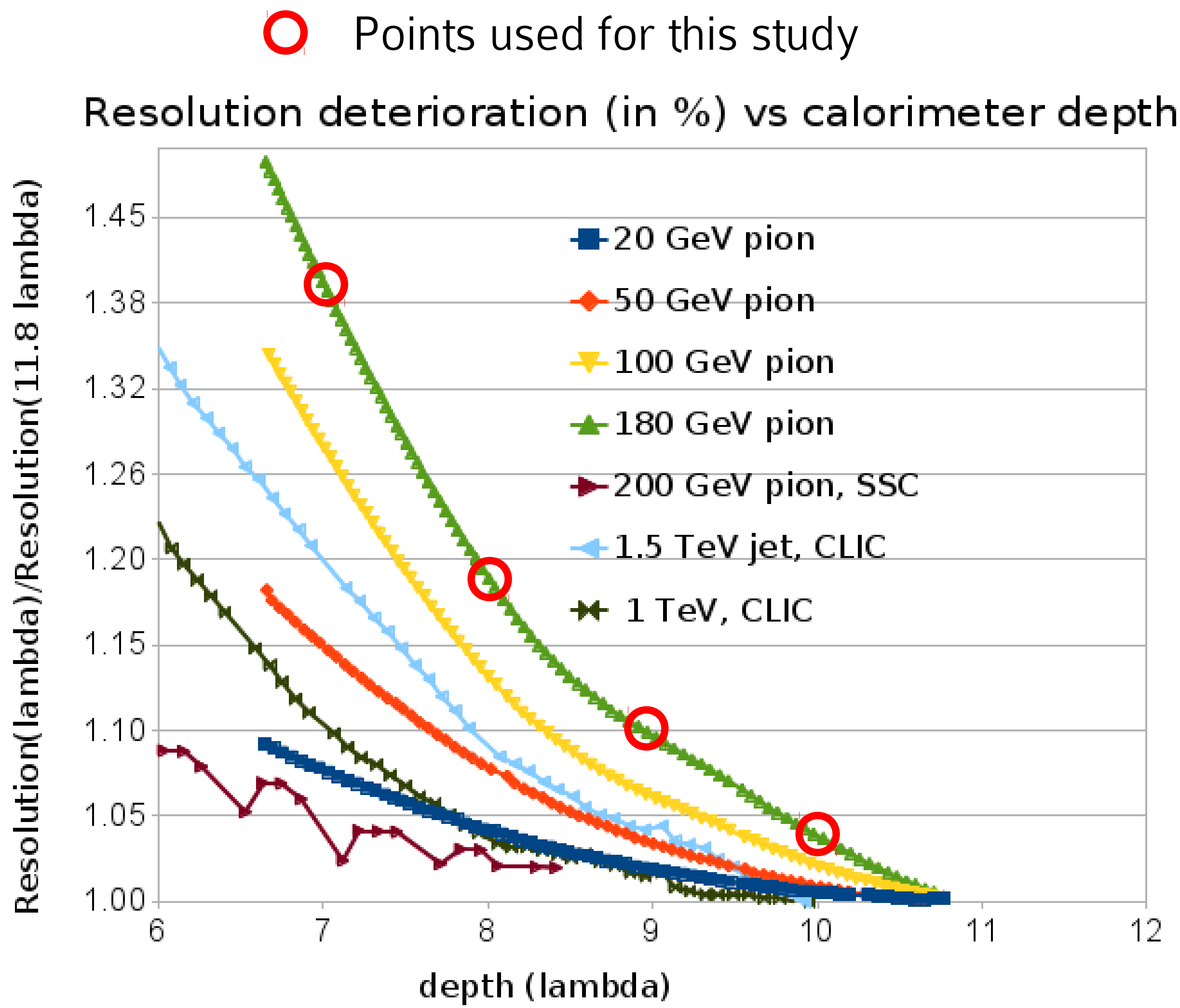
1. changing constant term in 2% steps (from 2.7% to 10%)

2. worsening resolution by factor obtained from Test-beam results with different calorimeter depths (smearing increased up to 30%)

More recent work:

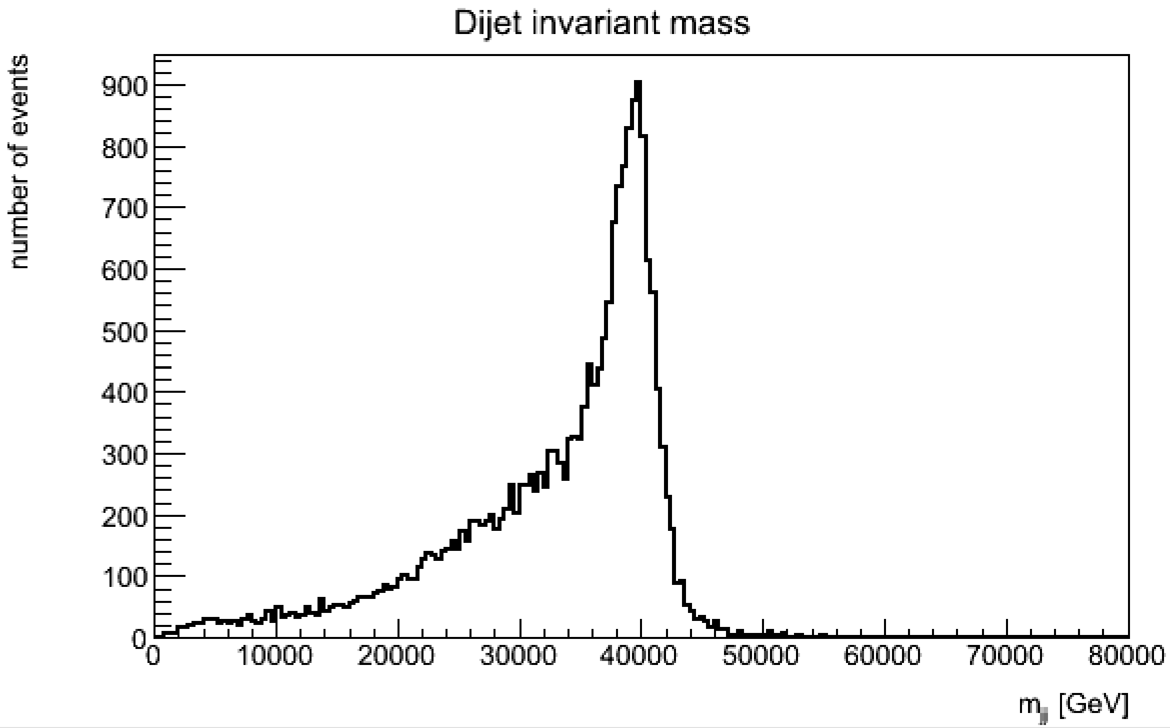
1. change mass point from 10 to 40 TeV
2. improve statistics and fits for point 2. above

Increase of smearing from test-beam data



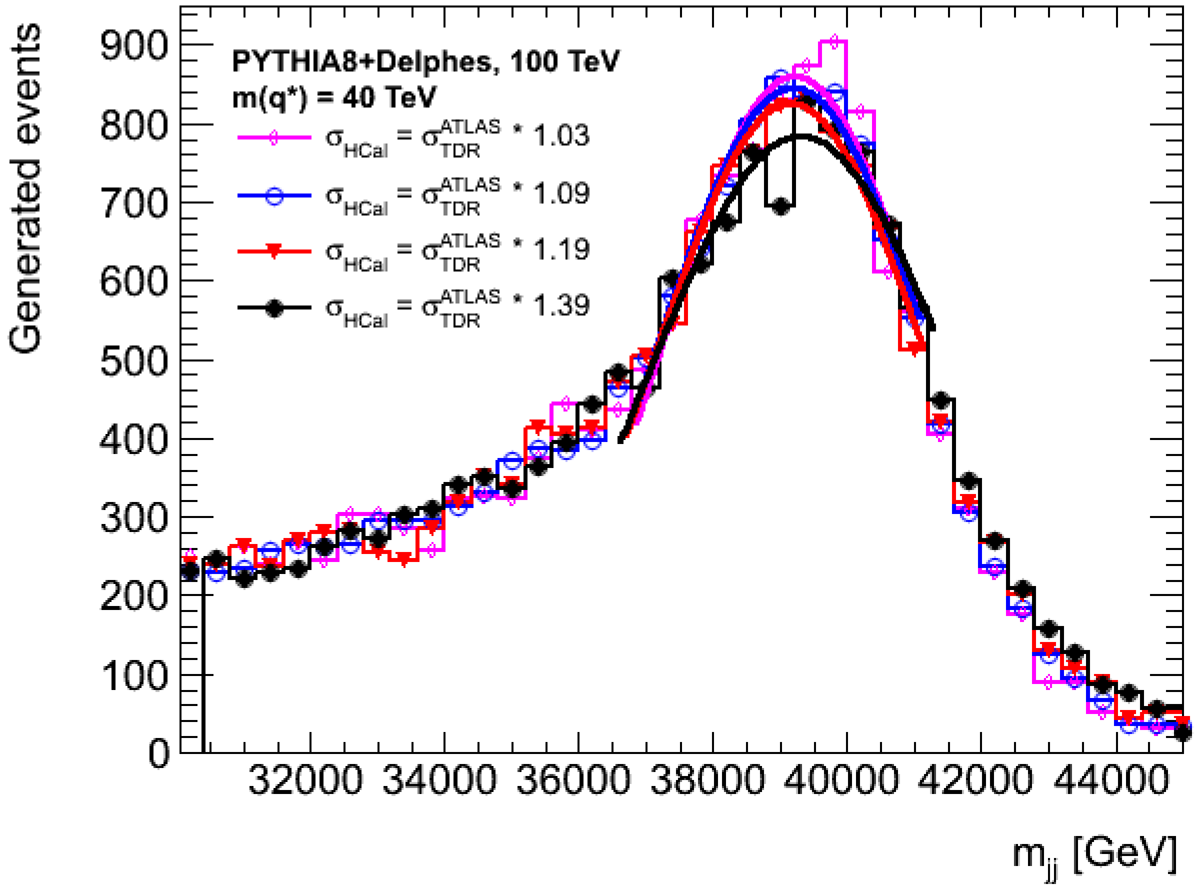
SIGNAL GENERATION

Example plot: smearing increased by 3%



First issue for width estimation: **large low-mass tails**
(to be investigated, currently using Anti-kT R=0.5 jets)

ATLAS EXPERIMENT RESULTS



Fit details: similar results with

1) rebinning (according to Scott's rule) + 0.5-sigma fit around nominal mass

2) rebinning + subsequent 1/0.5 sigma fits around nominal mass

ATLAS EXPERIMENT Results, tabulated

#sigma_{HCal} = #sigma_{TDR}^{ATLAS} * 1.03
Smallest interval containing 90% percentage of signal:18 – 42.8 TeV (24.8 TeV wide)
Peak mean: 39217+/-39 GeV, Peak width: 1962+/-65 GeV
#sigma_{HCal} = #sigma_{TDR}^{ATLAS} * 1.09
Smallest interval containing 90% percentage of signal:18.4 – 43.2 TeV (24.8 TeV wide)
Peak mean: 39189+/-42 GeV, Peak width: 2040+/-73 GeV
#sigma_{HCal} = #sigma_{TDR}^{ATLAS} * 1.19
Smallest interval containing 90% percentage of signal:18.4 – 43.6 TeV (25.2 TeV wide)
Peak mean: 39149+/-41 GeV, Peak width: 2036+/-73 GeV
#sigma_{HCal} = #sigma_{TDR}^{ATLAS} * 1.39
Smallest interval containing 90% percentage of signal:18.4 – 43.6 TeV (25.2 TeV wide)
Peak mean: 39300+/-56 GeV, Peak width: 2292+/-102 GeV

Observations:

1. tails deteriorate fit stability (this is not a Gaussian. Other functional forms and jet algorithms can be tried, but need justified)
2. not sufficient information to justify calorimeter design using those benchmarks (already known that JER does not affect search dramatically, unless the deterioration is dramatic. Biggest effect on width: parton → particle)

ATLAS EXPERIMENT Interim conclusions and outlook

Simple study of q* → dijet mass peak width
not sufficient for for calorimeter design
(width does not deteriorate enough with reasonable assumptions)

How to improve / conclude on this study:

1. understand tails in the peak, or find another functional form
2. understand particle composition, see if shifting entire resolution is pessimistic wrt what's done now

What can be done next:

1. study punch-through in more detail (simulation?)
2. join substructure studies for granularity

BACKUP SLIDES

Signal generation commands (10 TeV)

```
pythia --collision-energy 100000 -i AU2-CTEQ6L1 -c
"ExcitedFermion:dg2dStar = on" -c "ExcitedFermion:ug2uStar = on"
-c "4000001:m0 = 10000" -c "4000002:m0 = 10000" -c
"ExcitedFermion:Lambda = 10000" -c "ExcitedFermion:coupF = 1.0"
-c "ExcitedFermion:coupFprime = 1.0" -c "ExcitedFermion:coupFcol
= 1.0" -c "4000001:mayDecay = on" -c "4000002:mayDecay = on" -c
"PhaseSpace:pTHatMin=30" -n 10000
```

Analysis selection

- Leading and subleading jets must have $p_T > 50$ GeV and rapidity $|y| < 2.8$
- Events must satisfy $\frac{1}{2}|y_{lead} - y_{sublead}| < 0.6$
- The dijet invariant mass of the leading and subleading jets must be greater than 250 GeV