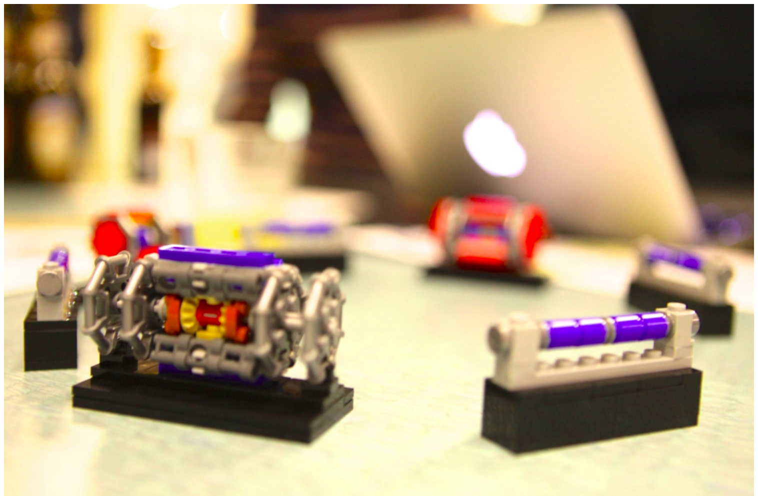

https://cds.cern.ch/record/1992692

DIJET RESONANCE BENCHMARKS FOR CALORIMETER DESIGN

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With help from:
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Suchita Kulkarni – Hephy Wien; Sergei Chekanov - ANL

26/02/2015 – FCC-hh BSM informal meeting

ATLAS EXPERIMENT 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 2014

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

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

Apply analysis selection, check signal width when:

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

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

More recent work:

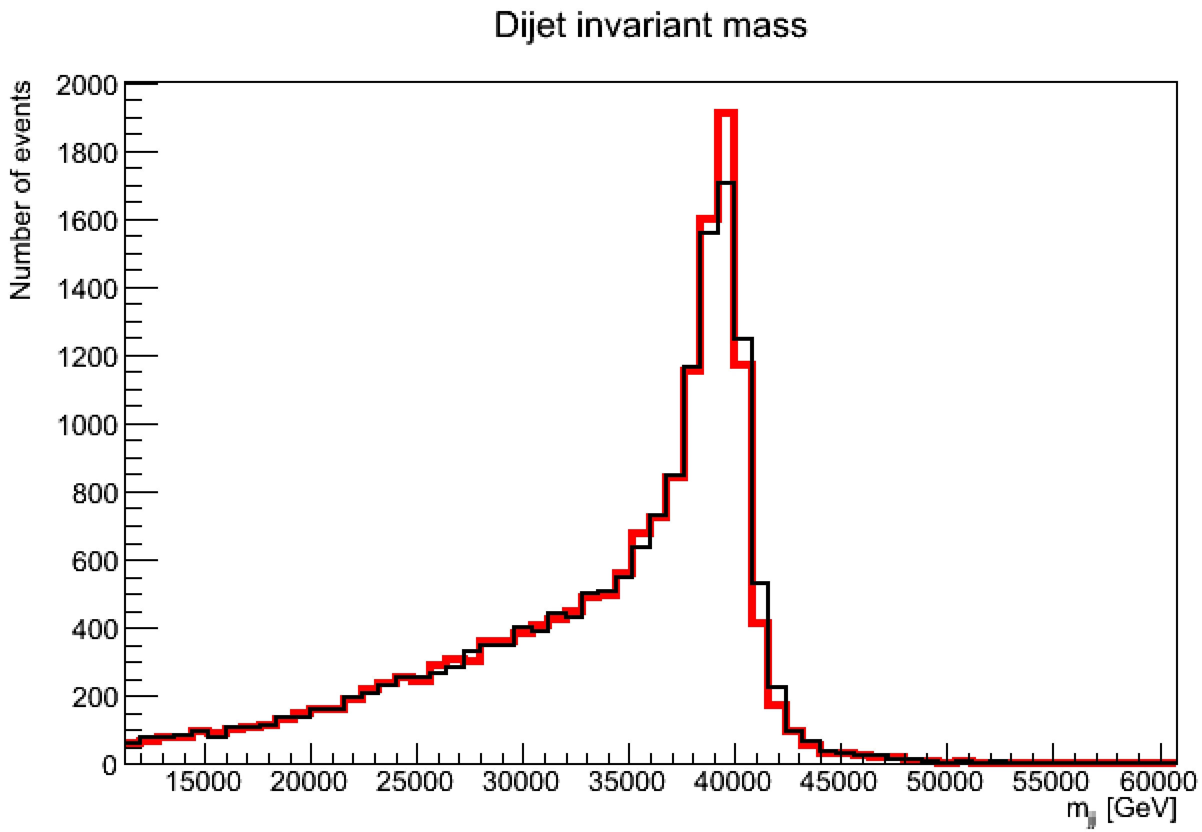
http://madanalysis.irmp.ucl.ac.be/

1. change mass point from 10 to 40 TeV, use **MadAnalysis**
2. cross-check simple study of changing the constant term

(worsening resolution by factor does not seem sufficient to see an effect yet: see this talk)

ATLAS EXPERIMENT Signal generation

Dijet mass plot, no calorimeter smearing vs 50% stochastic / 3% constant term

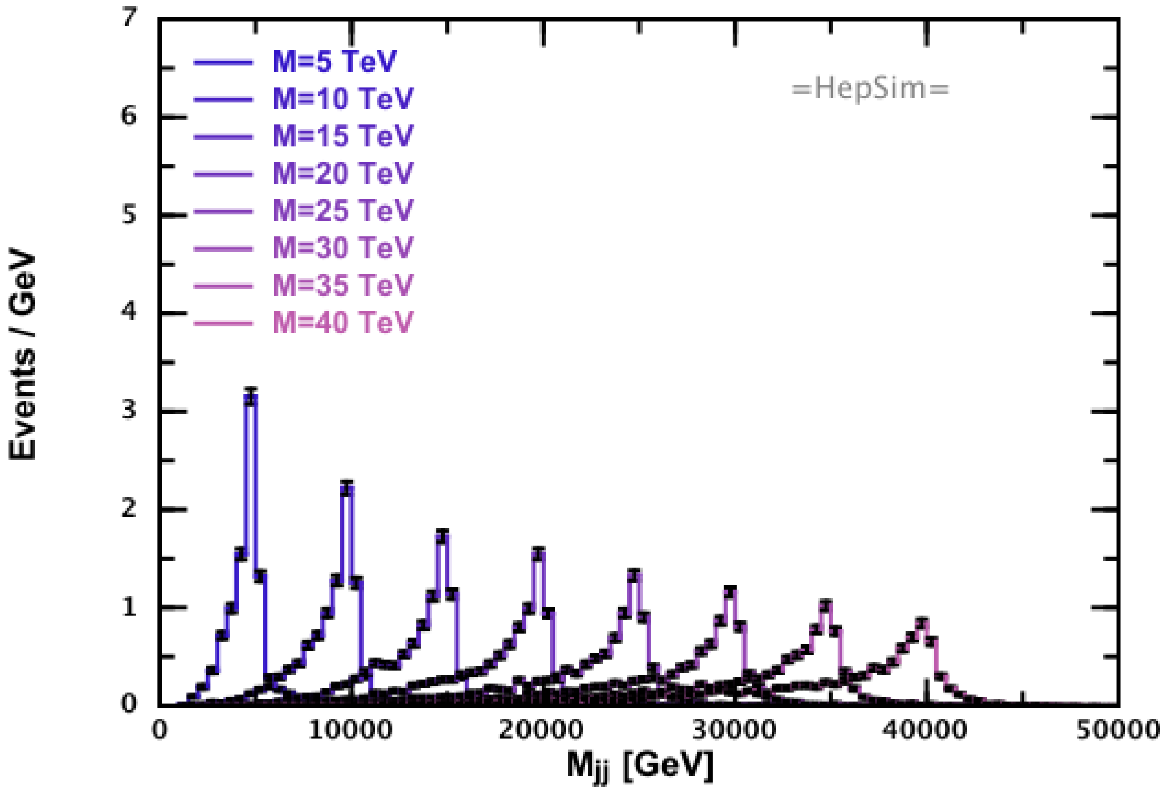


An issue for width estimation: large low-mass tails, already at particle level

(currently using Anti-kT R=0.5 jets)

SIGNAL GENERATION: WHY THE TAILS?

Lower mass have lower intrinsic widths (guesses: effect of PDFs? Harder radiation?)



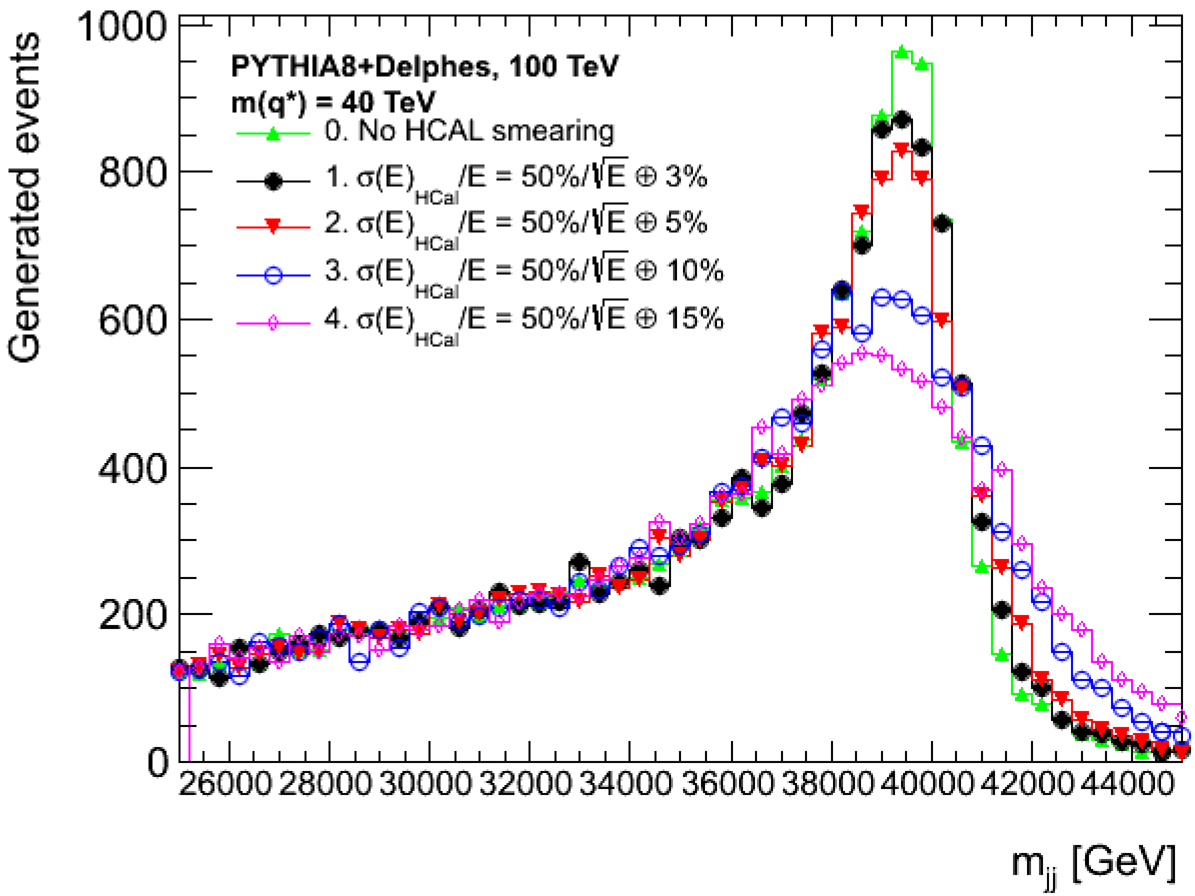
S. Chekanov, http://atlaswww.hep.anl.gov/hepsim/info.php?item=95

HCAL SMEARING CONFIGURATIONS

Start from simple HCAL configuration:

$$\frac{\sigma_{E_T}}{E_T} = \frac{N}{E_T} \oplus \frac{S}{\sqrt{E_T}} \oplus C$$

N=0%, S=50%, C=3%, 5%, 10%, 15%



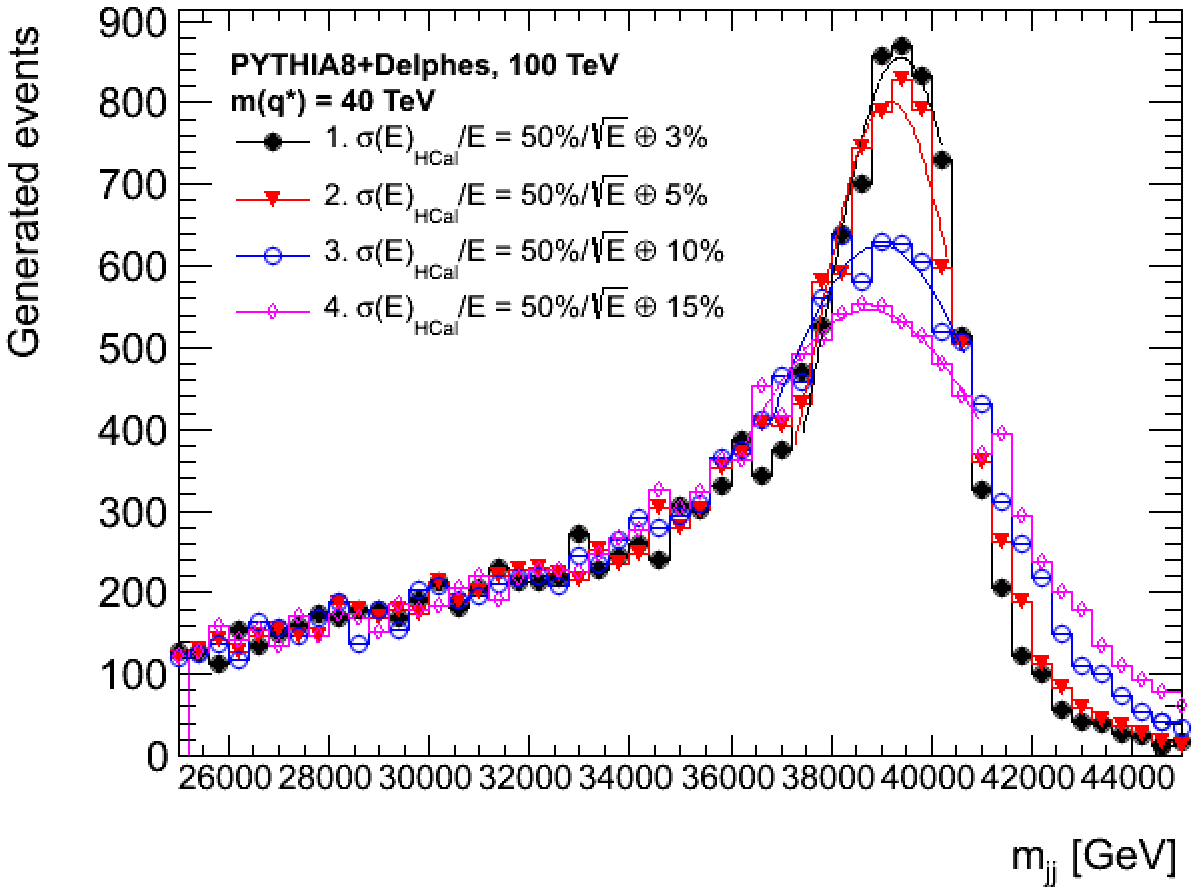
FITTING WIDTHS? NOT OPTIMAL...

Results of two subsequent Gaussian fits

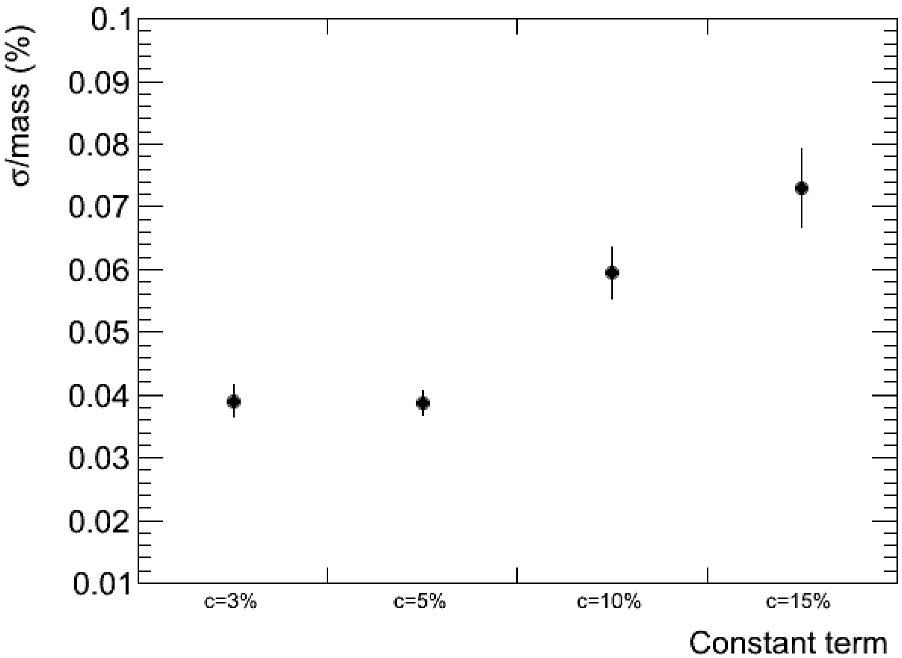
(tried various options: very limited fitting range, limited parameters...)

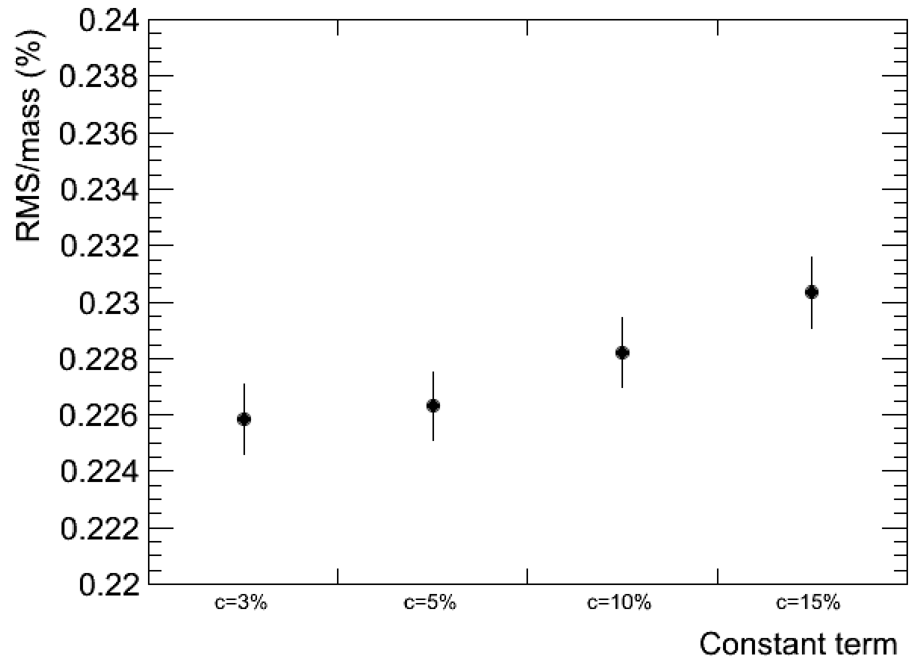
Obvious point: fitting needs to be improved

no smearing case: fit does not catch the peak



Width progression with increasing smearing



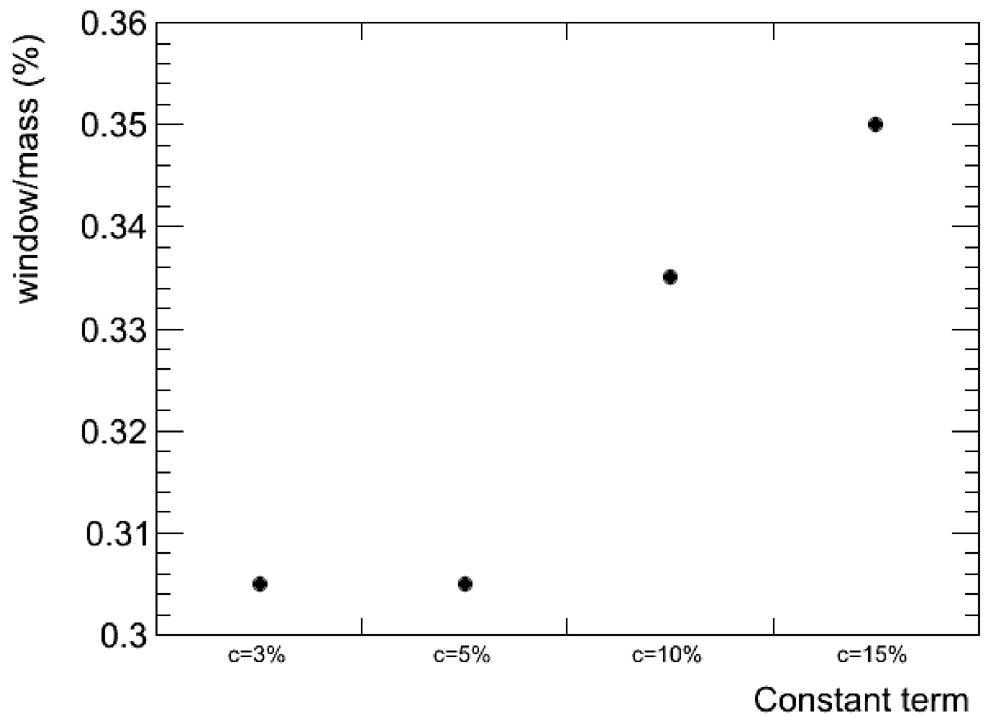


Increase in width from fit from resolution smearing noticeable

RMS dominated by **low-mass tails**

Minimum window containing 68% of signal

Inspired by http://xxx.tau.ac.il/pdf/0806.3958.pdf



This figure of merit is still dominated by **low-mass tails**

but search sensitivity dominated by a high-mass bins with low bkg

→ need to add backgrounds to the study, quantify S/sqrt(B) in window

See also R. Torre, M. Mangano: https://indico.cern.ch/event/345676/contribution/5/material/slides/0.pdf

Interim conclusions and outlook

Simple study of q* → dijet mass peak width effects from calorimeter resolution ongoing

How to improve / conclude on this study:

1. understand tails in the peak/find another functional form
2. add background for quantitative S/B and sensitivity statements
3. move to FCC software when ready for full chain

PREPARATION OF 2015 SUMMER STUDENT PROJECT

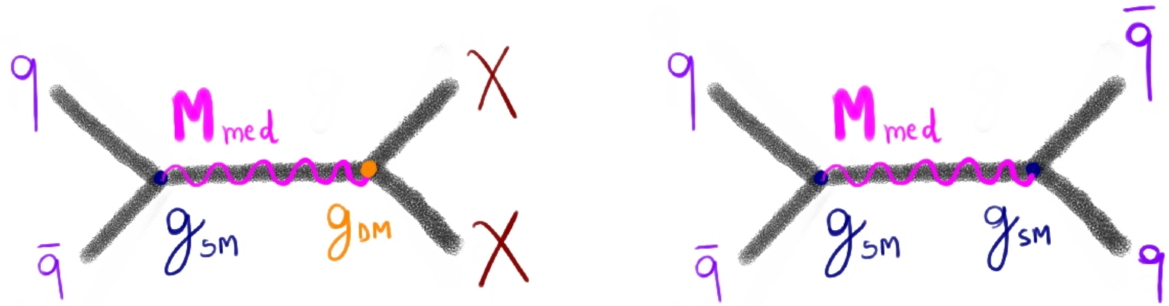
https://hrapps.cern.ch/auth/f?p=112:1:213719908647611::NO::P1_PROJECT_ID:15535

Simple study of q* → dijet mass peak width

might not be sufficient for for calorimeter design

(width does not deteriorate enough with reasonable assumptions)

Plan: introduce more complex signals = with MET



Question motivating the study: is it better to discover dark matter and its mediator particles with dijets or with monojet search (given a benchmark point), with a given calorimeter configuration?

→ simple study of sensitivity of dijet and monojet analysis at 100 TeV, given different calorimeter configurations

work on benchmarks being done within ATLAS/CMS DM Forum at 13 TeV, A. Boveia will help with 100 TeV signals

BACKUP SLIDES

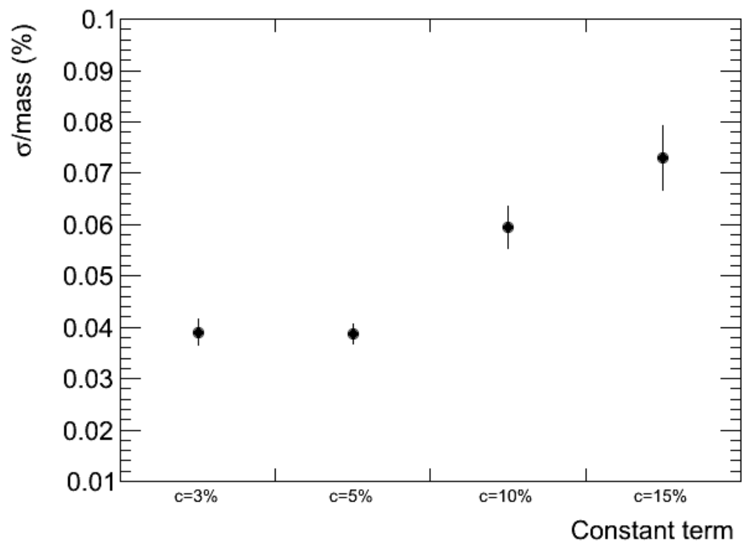
Signal generation commands (10 TeV)

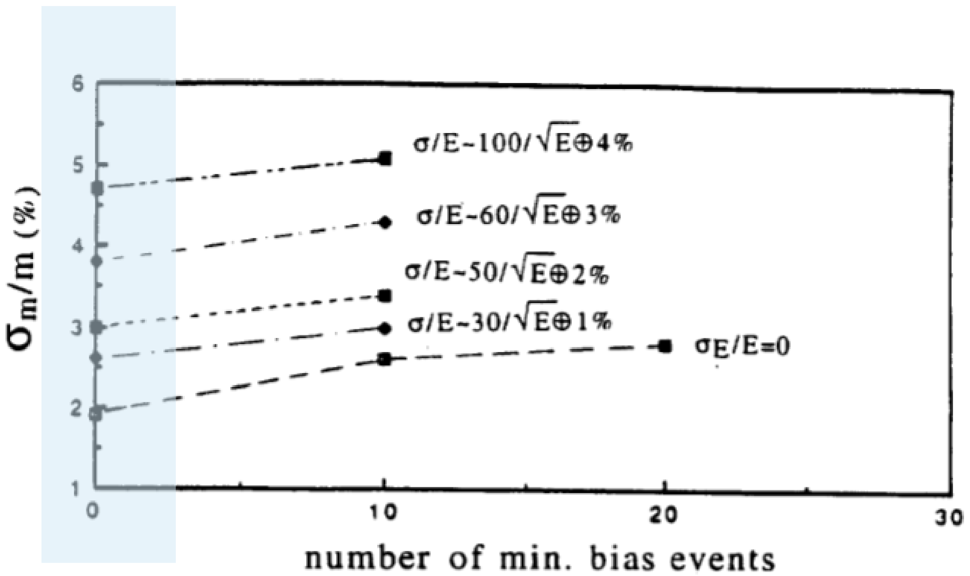
```
pythia --collision-energy 100000 -i AU2-CTEQ6L1 -c
"ExcitedFermion:dg2dStar = on" -c "ExcitedFermion:ug2uStar = on"
-c "4000001:m0 = 10000" -c "4000002:m0 = 10000" -c
"ExcitedFermion:Lambda = 10000" -c "ExcitedFermion:coupF = 1.0"
-c "ExcitedFermion:coupFprime = 1.0" -c "ExcitedFermion:coupFcol
=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

Comparison to previous Z' study





https://cds.cern.ch/record/682130/files/phys-92-010.pdf