WG3 summary

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Main topics touched in Split

Jet substructure
- Quark/gluon tagging
- W/Z(/top/Higgs) tagging

Pileup mitigation

Effects on VBS/VBF forward jet selection

Jet substructure

Different tagging techniques

3 different approaches

- n_trk-tagger: single variable using charged particle multiplicity
  - nTracks powerful variable especially at high p_T
  - commissioned and already in use in ATLAS analyses

- MVA: few discriminating variables combined in BDT
  - combine variables that perform best in different p_T bins
  - also for higher η regions

- CNN: discriminating jet images with convolutional neural networks
  - especially useful for η regions without tracking
  - different approach on using calorimeter information

multivariate techniques slightly improve the already existing n-trk_tracker

Jet substructure

Widely used in the experiments

Top/W/Z/Higgs tagging techniques well established in both ATLAS and CMS

But careful with the estimation of **theoretical uncertainties**

- Because all substructure techniques depend or may depend on the interplay between the perturbative and non perturbative part of an event simulation
- First studies presented on q/g separation
- Same should probably be done for V/H tagging in this WG

Uncertainties on q/g tagging

Large differences between generators

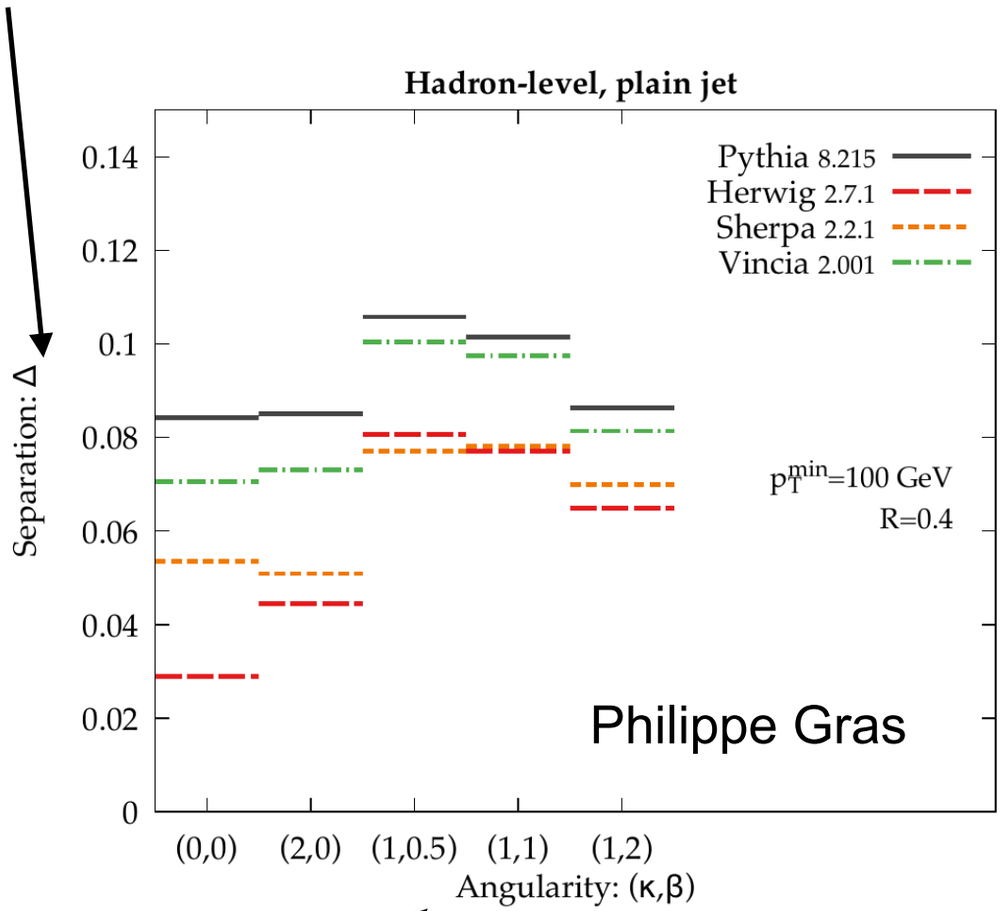
- Herwig is the most pessimistic in terms of separation power, Pythia is the optimistic guy
- Differences visible also at parton level → not purely a non perturbative effect

Discrepancies are reduced including soft stuff grooming

→ Interesting!

These studies should be carried on also in the context of other jet substructure techniques, i.e. boson/top taggers

A measure of the degree of separation achieved



several taggers, based on different jet constituents measures

Vector boson tagging

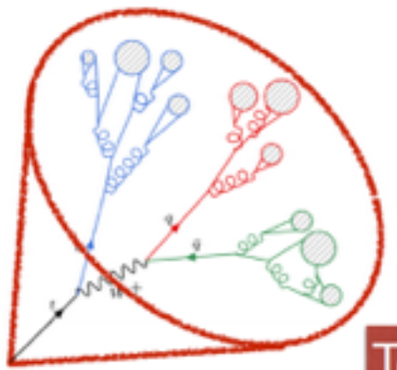
- Vast zoology of techniques
- Each experiment has its own preferred flavor, mainly because of differences in
  - Pile-up mitigation
  - Global event reconstruction (PF vs calo + track)
- CMS → soft-drop jet mass (including PU mitigation) + τ_{21}
- ATLAS → trimmed jet mass + energy correlation functions

Jet mass

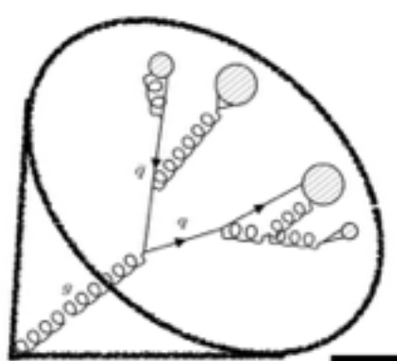
$$m_{jet}^2 = \left(\sum_i E_i\right)^2 - \left(\sum_i p_i\right)^2$$

i = all cluster

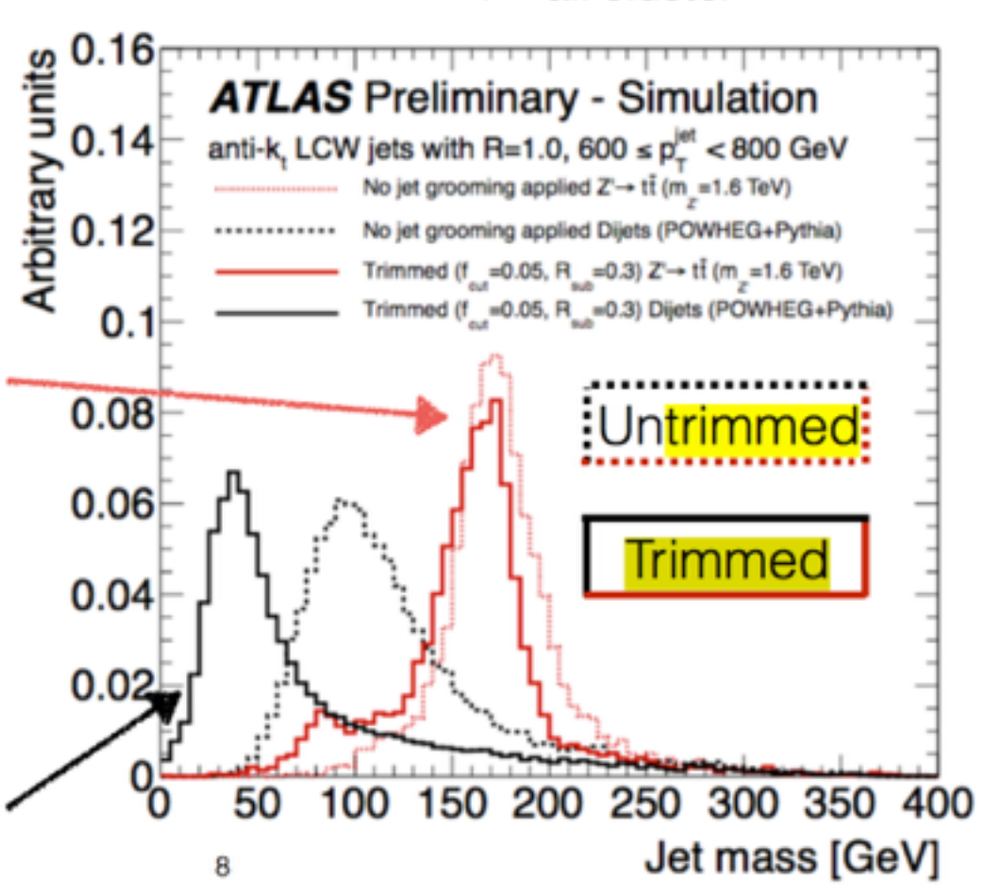
Christoph Anders



Top



QCD

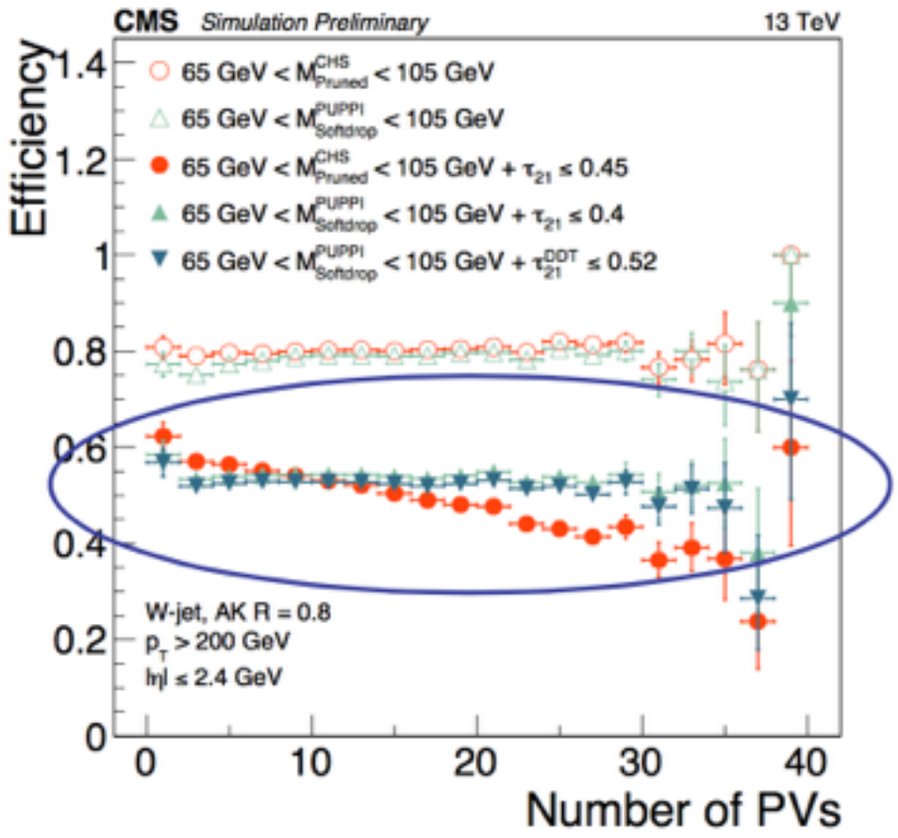


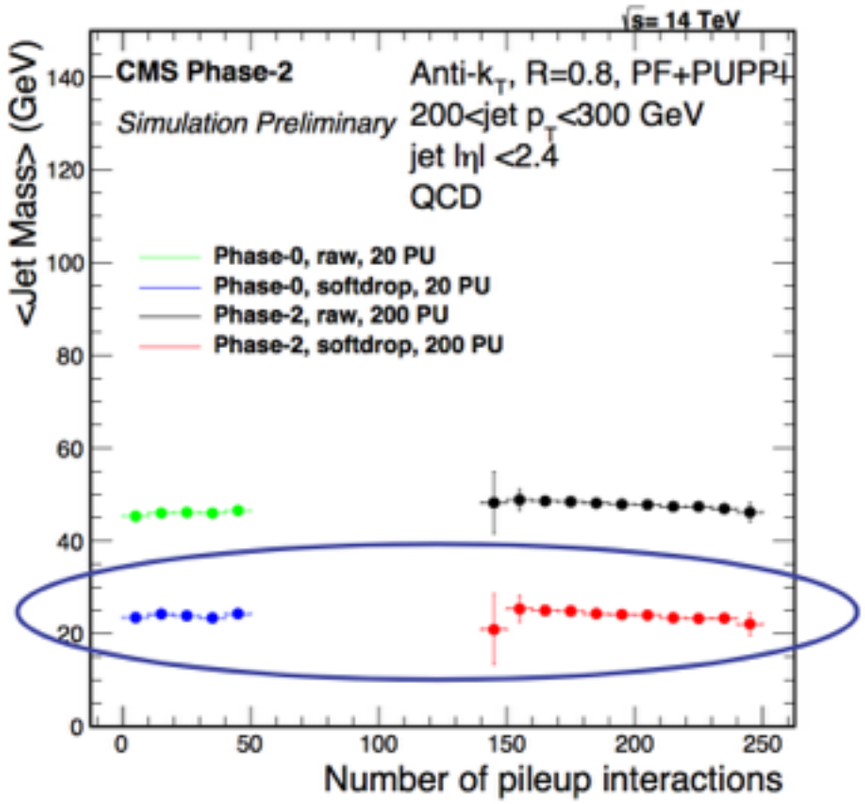
Vector Boson tagging: PU resilience

In combination with PU subtraction techniques, methods are very robust against PU

Example from CMS

Performance vs. pileup



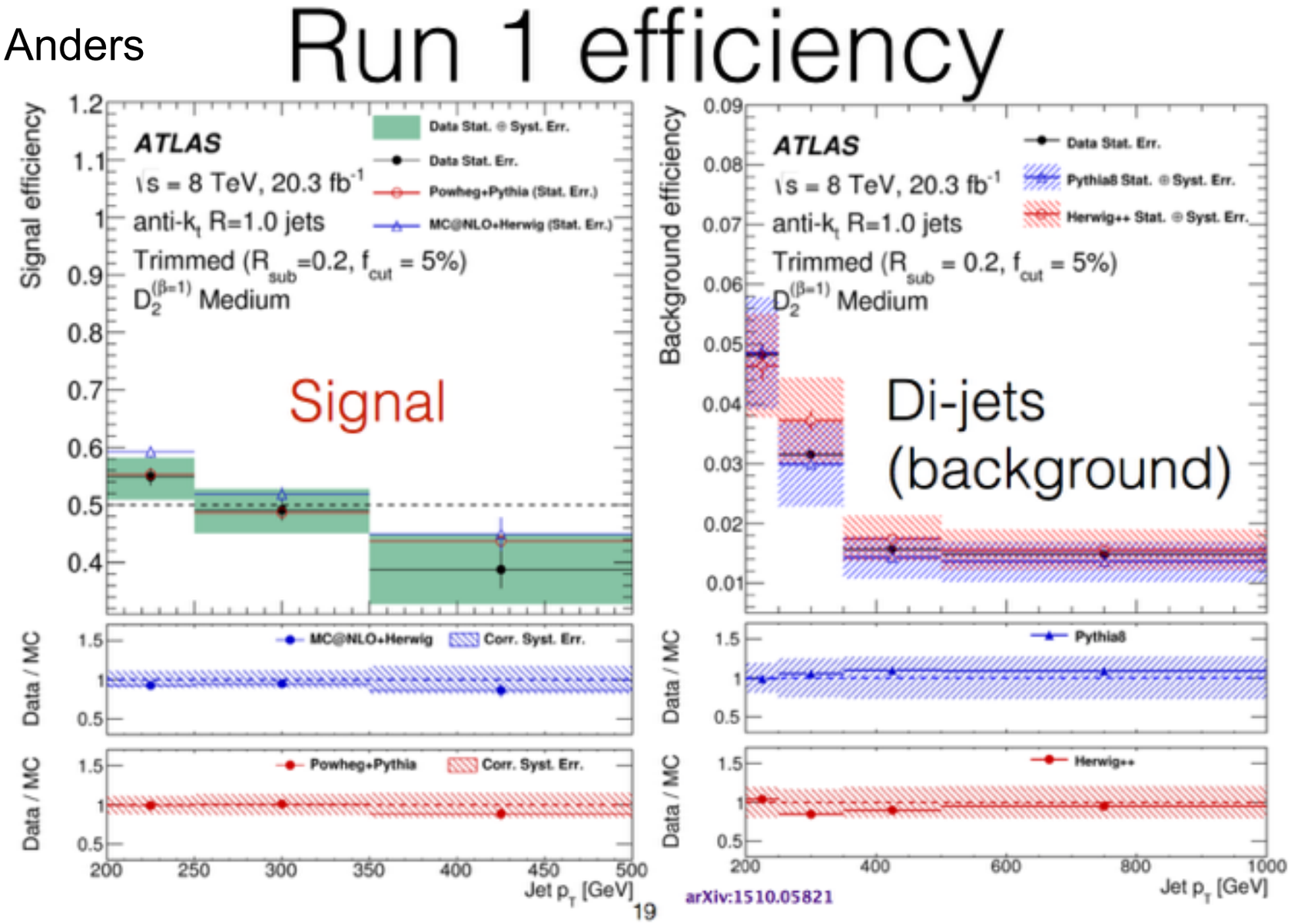


CMS-TDR-17-001

- Current W/Z-tagging techniques with PUPPI stable again pileup
- After phase-II tracker upgrade can even deal with 200 PU interactions

Performance with jet pT

Christoph Anders



Could be a coincidence, but Herwig predicts higher fake rate than Pythia

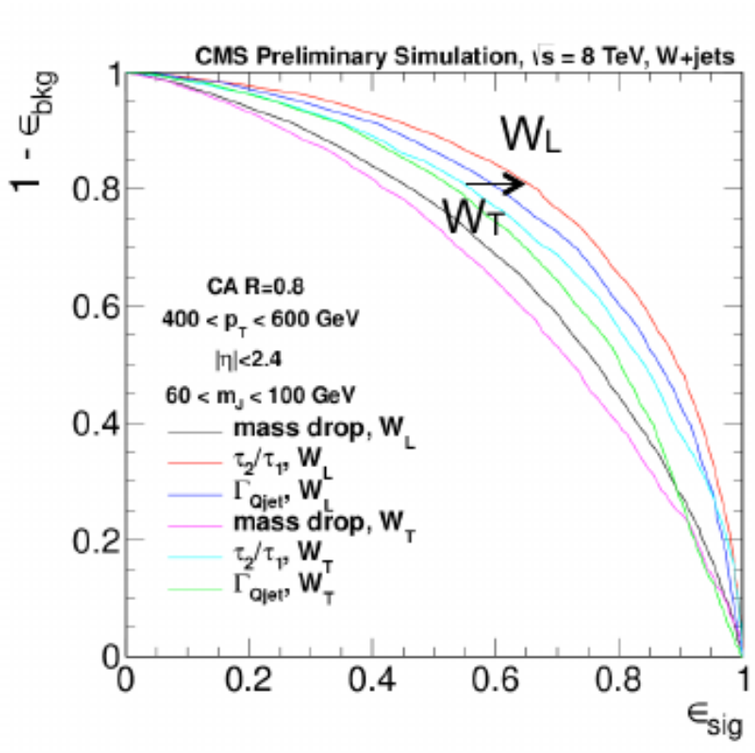
Could it be a similar effect to what was shown on q/g tagging, with Herwig being the pessimistic guy? It is maybe worth further investigation

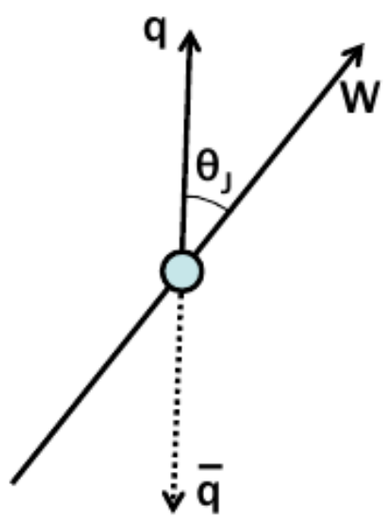
W polarization with jet substructure

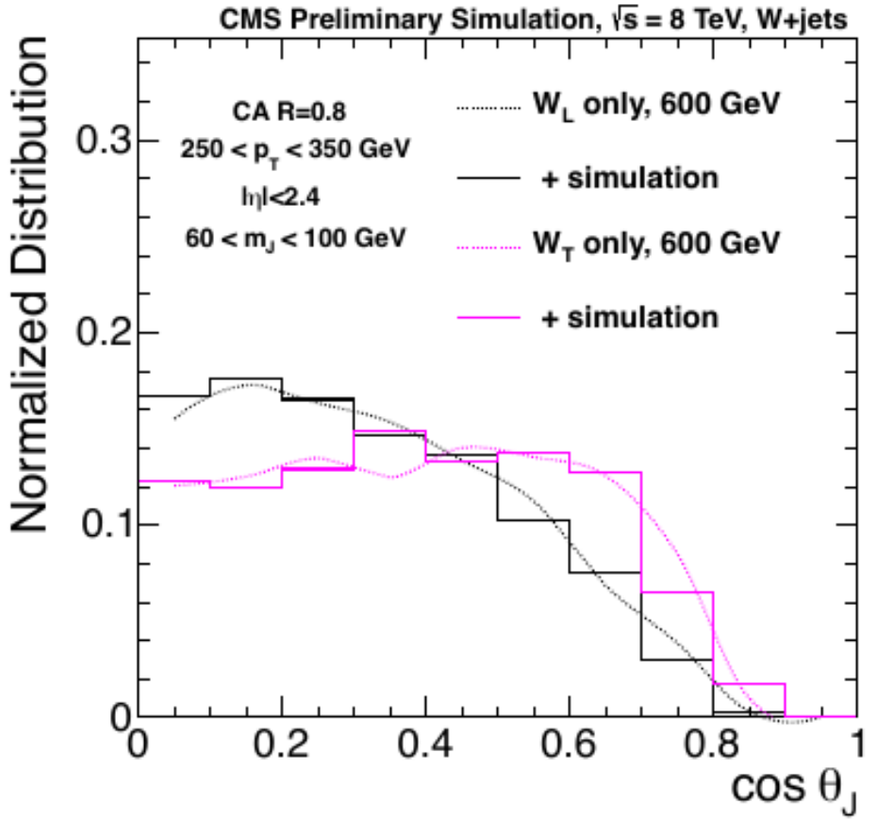
W/Z polarization

longitudinally polarized, W_L: decay products away from W direction, $\propto 1 - \cos^2\theta$
transversely polarized, W_T: decay products along the flight of W, $\propto 1 + \cos^2\theta$

- At same q/g-rejection get ~10% higher efficiency for W_L than for W_T
- Can reconstruct the W polarization from the helicity angle from subjets obtained by undoing the last clustering step

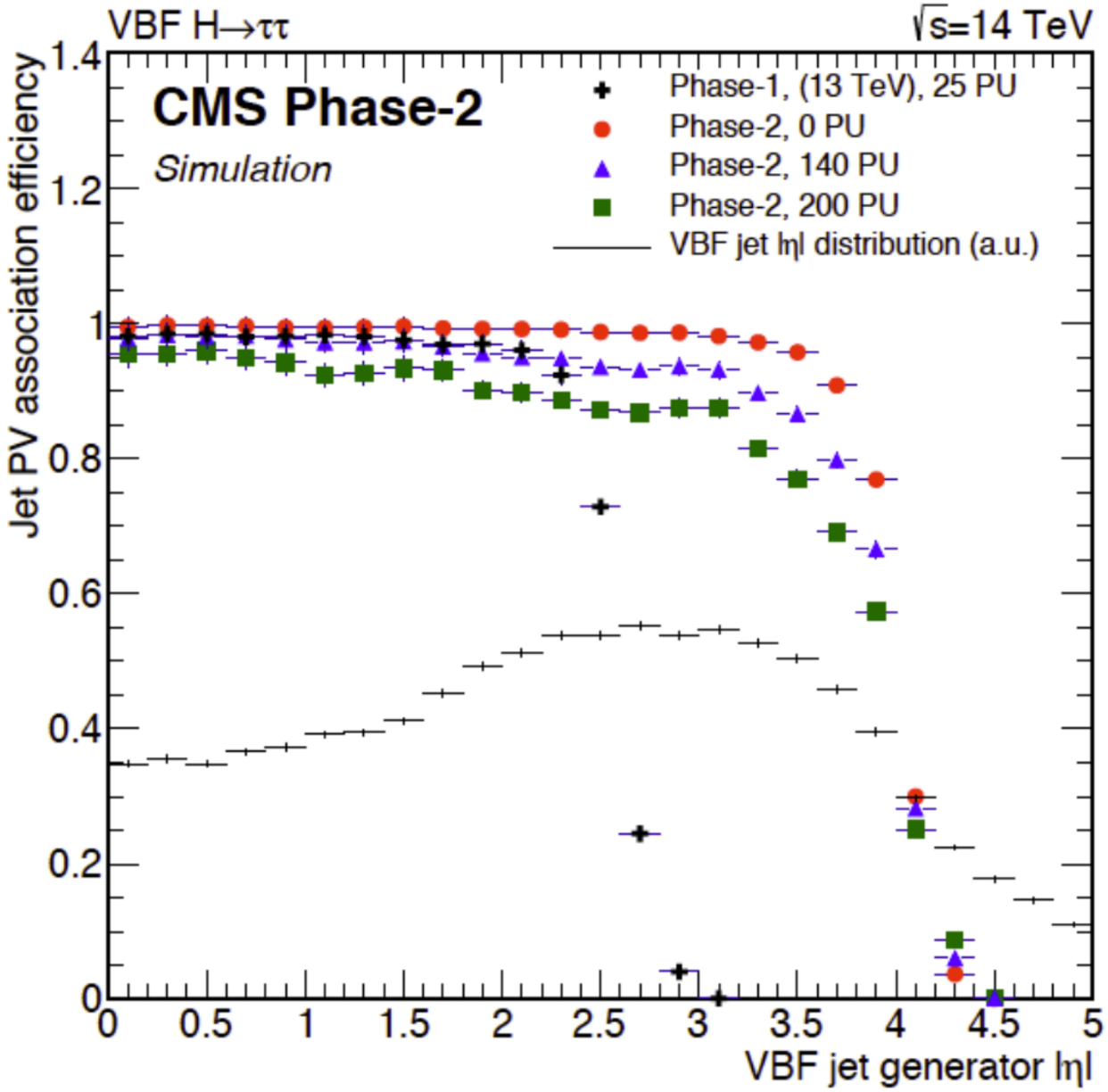






A look to the future ahead

- Extension of tracker acceptance for Phase 2 upgrade has the potential of significantly improving our ability to recognize VBS tagging jets
  - ➡ Worth studying it in detail in WG3
- boosted W tagging is mostly useful for non SM-studies where there is a increase of the pT of the W(like for example in VBS processes with heavy resonances)
- We could study new subjet tagging techniques like the use of variable radius trackjets



Conclusions

Plans for next meeting:

- We will contact the people that expressed interest for a given topic to give a first status report (as plans, timescales, manpower and preliminary studies)
- We need to setup Delphes cards, especially for ATLAS, in collaboration with Delphes developers
- We need to agree with WG1 and 2 for sample production
- We plan to have our next meeting on July

Contacts

If interested, please subscribe to our mailing list

Links to VBSCan twiki pages:

- General one here
- WG3 dedicated here

NB: are accessible only if you subscribe to the cern group vbscan-general

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For further informations, please write us an email piergiulio.lenzi@cern.ch, lucrezia.stella.bruni@cern.ch