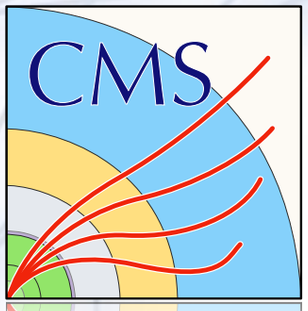
Search for $t\bar{t}$ resonances in CMS

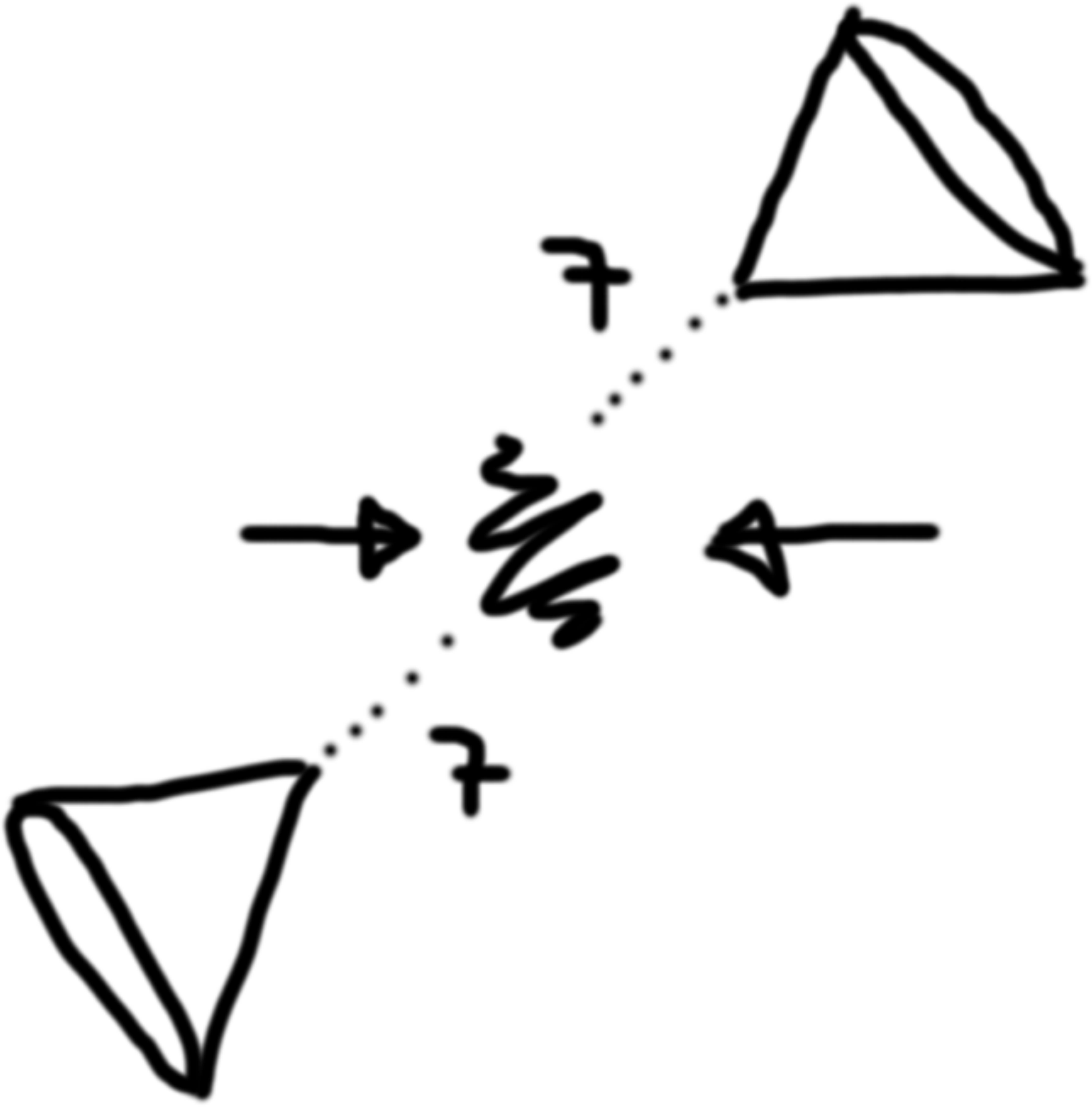
Emanuele Usai

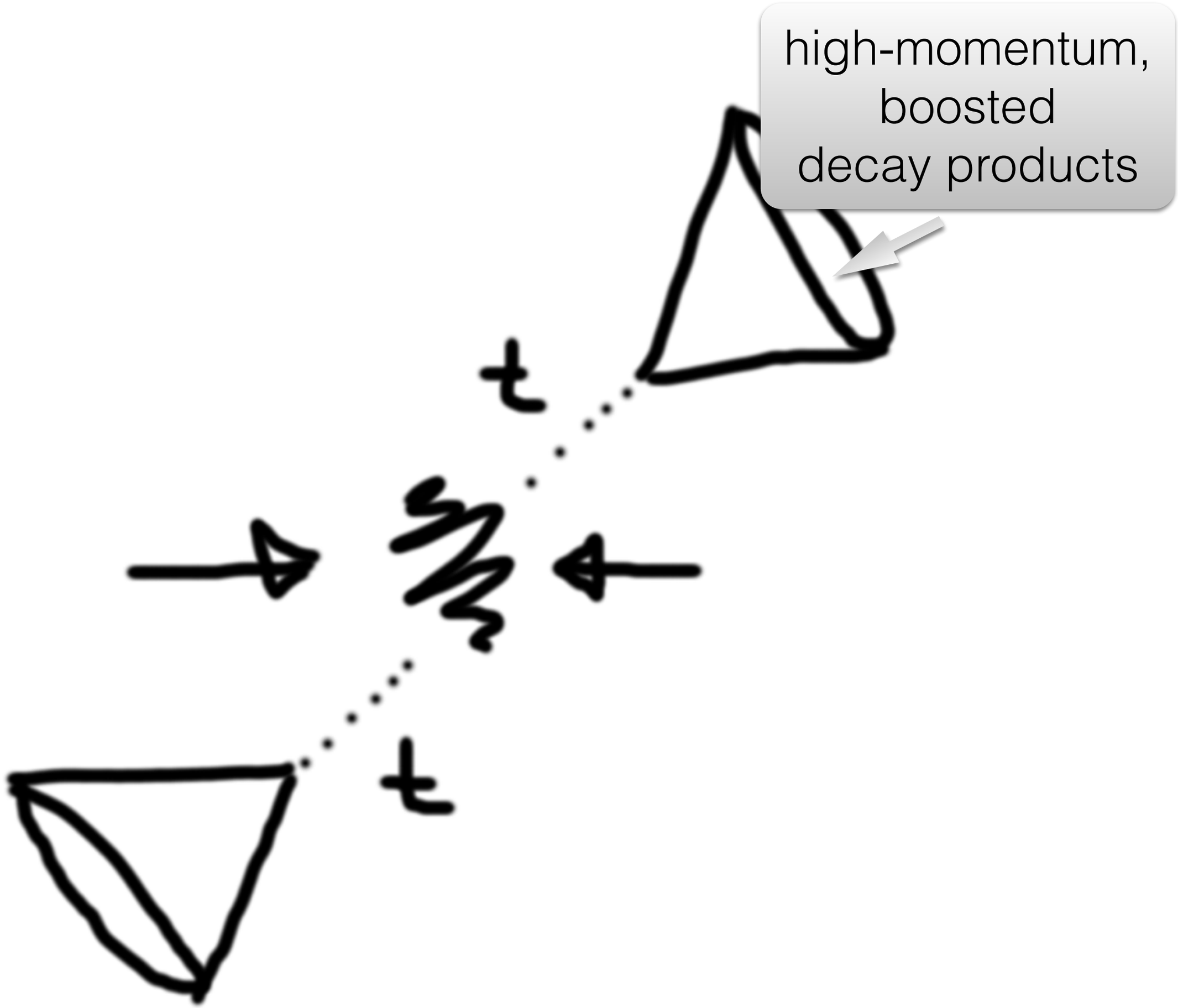


Universität Hamburg

8th Helmholtz Alliance Workshop on “Physics at the Terascale”

2 December 2014




high-momentum,
boosted
decay products
t
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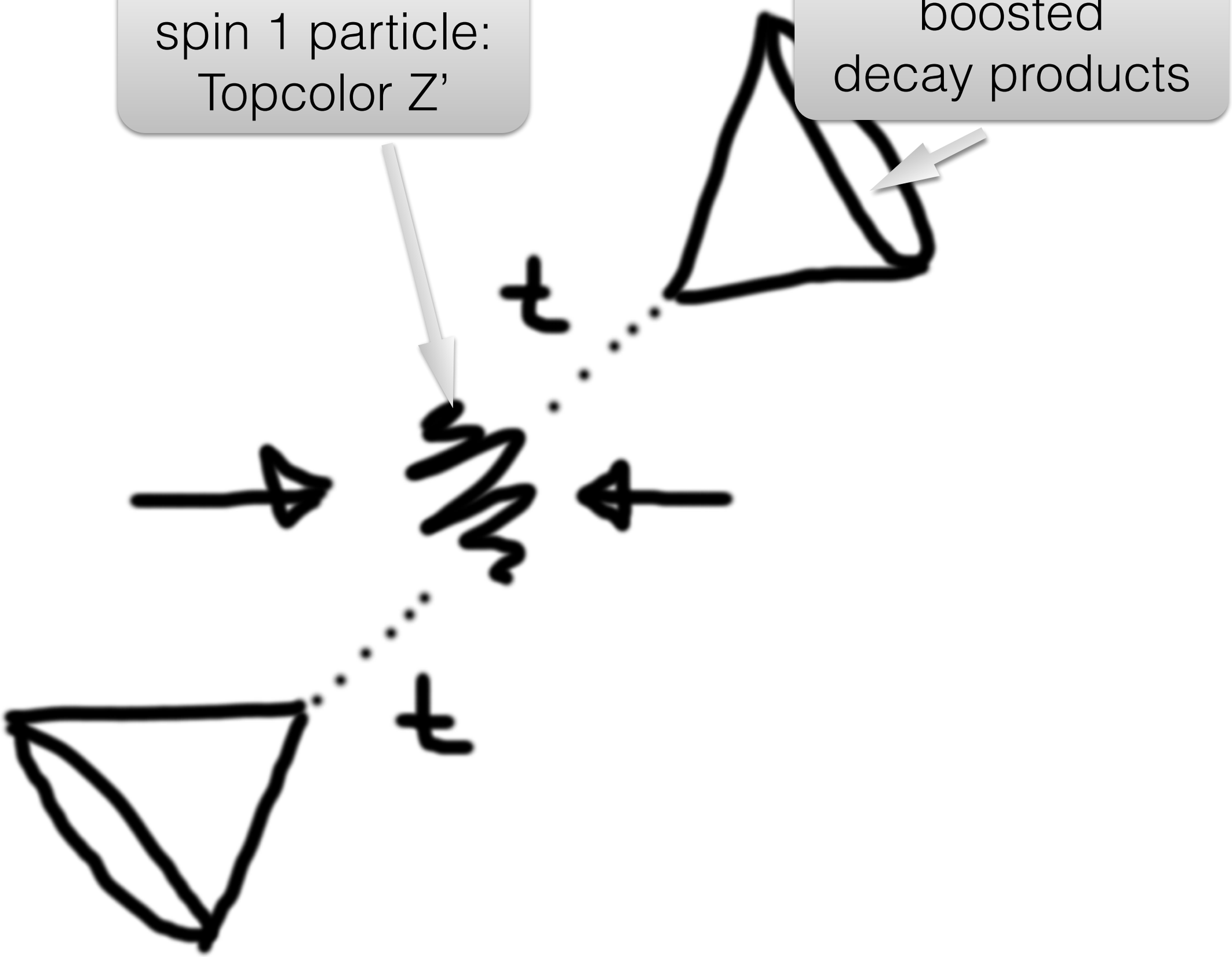
benchmark for spin 1 particle: Topcolor Z’

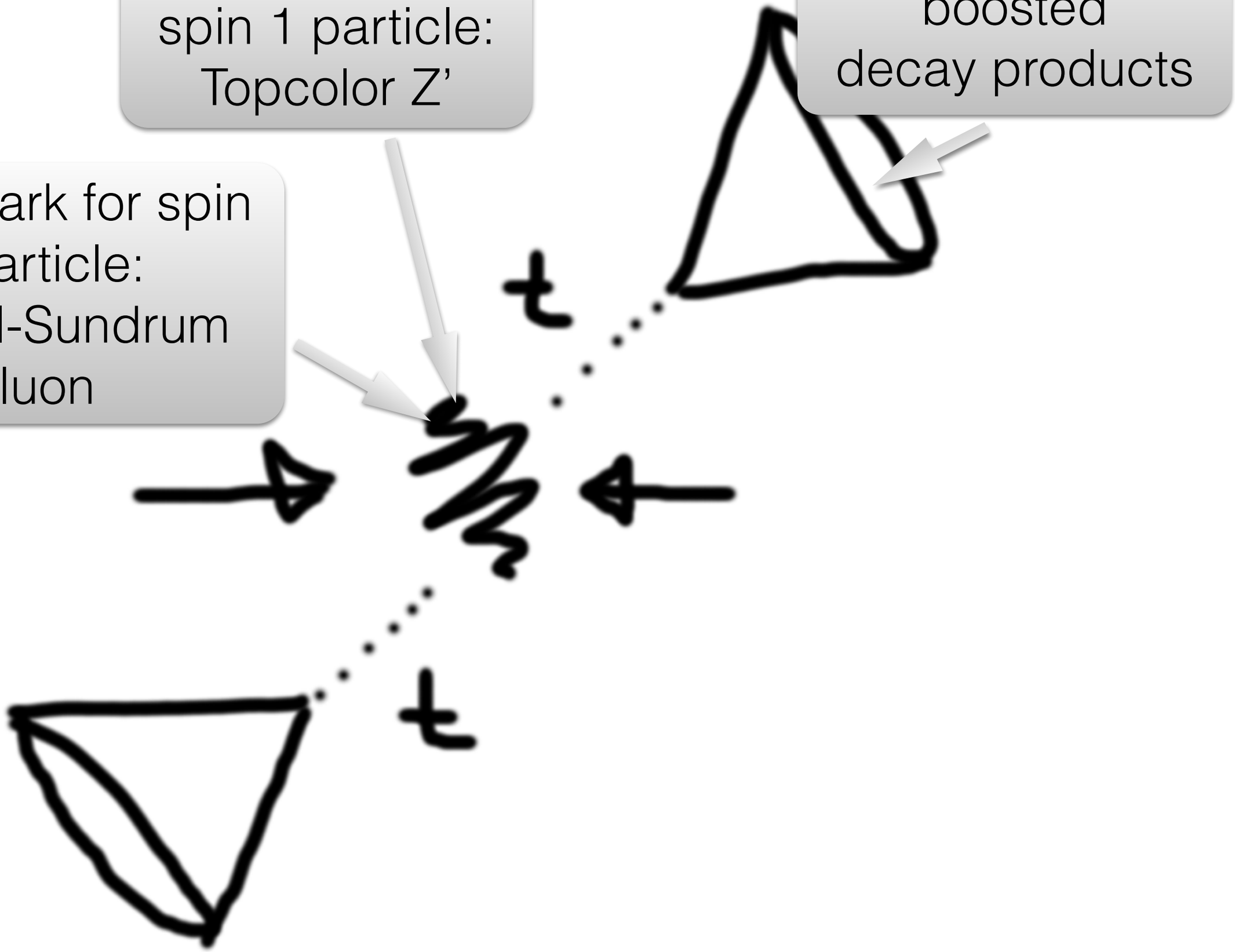
high-momentum, boosted decay products



benchmark for spin 1 particle: Topcolor Z'

high-momentum, boosted decay products

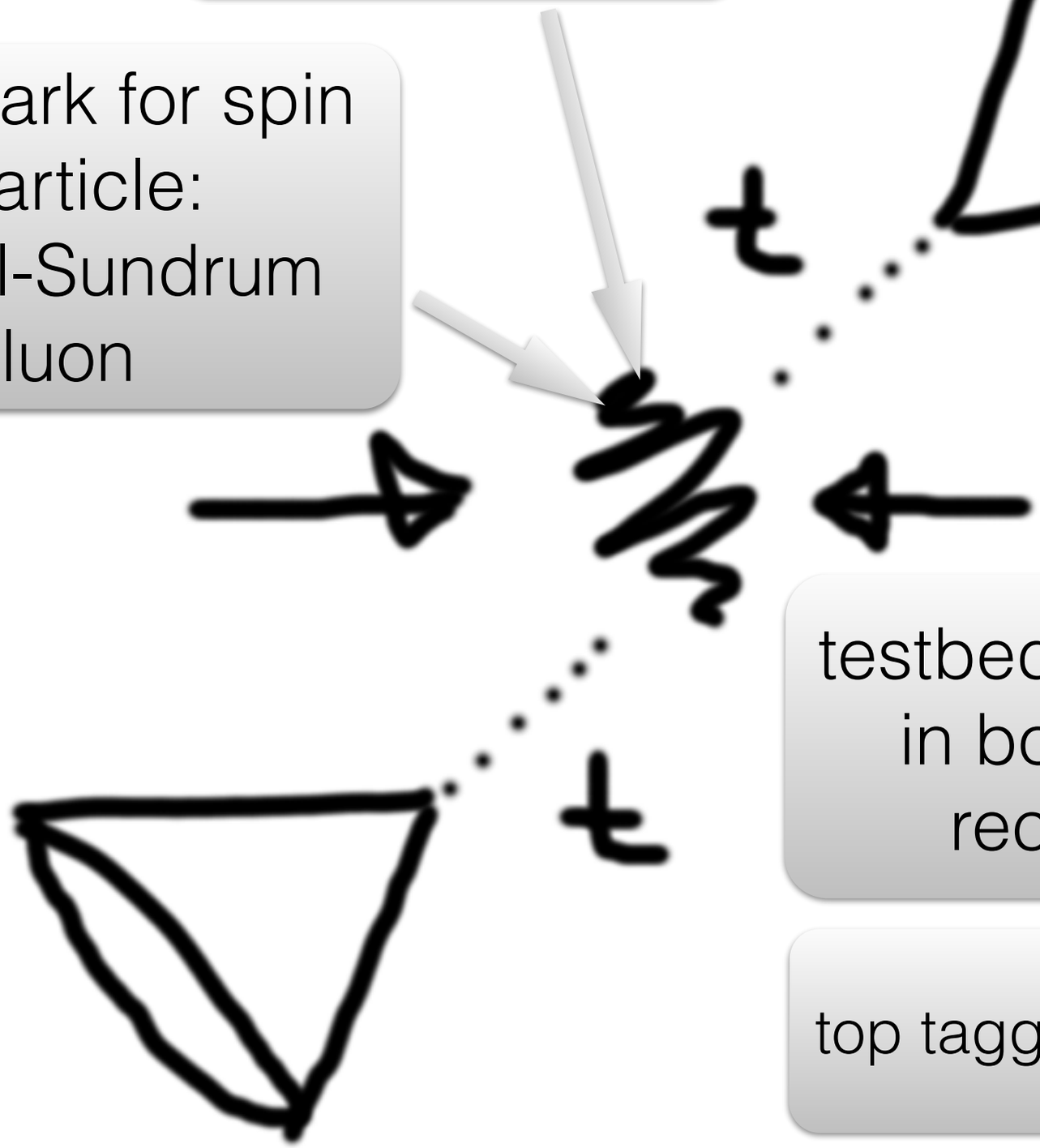
benchmark for spin 2 particle: Randall-Sundrum gluon



benchmark for spin 1 particle: Topcolor Z'

high-momentum, boosted decay products

benchmark for spin 2 particle: Randall-Sundrum gluon



testbed for techniques in boosted object reconstruction

top taggers

jet substructure variables

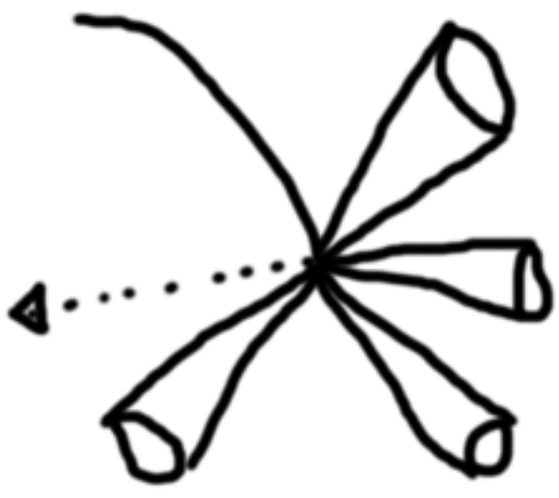
- current status
- improvements to the all hadronic analysis

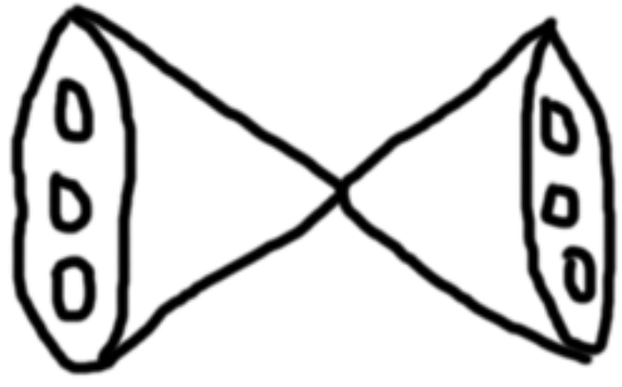
current status

(arXiv:1309.2030)

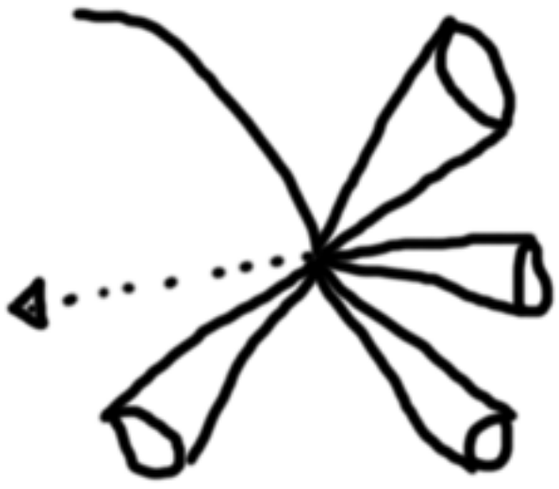
strategy

semileptonic “resolved”	semileptonic “boosted”	boosted all hadronic
ideal for low mass resonances	ideal for high mass resonances	challenging final state



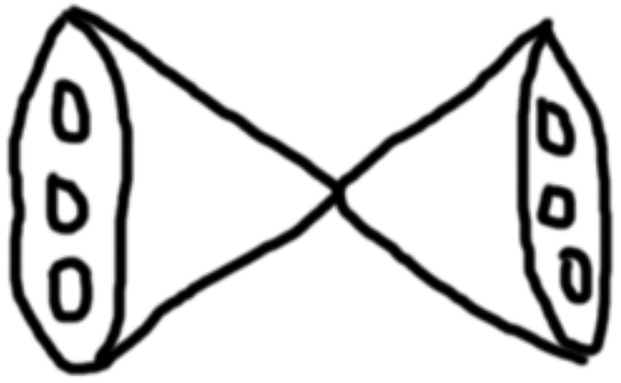


selection



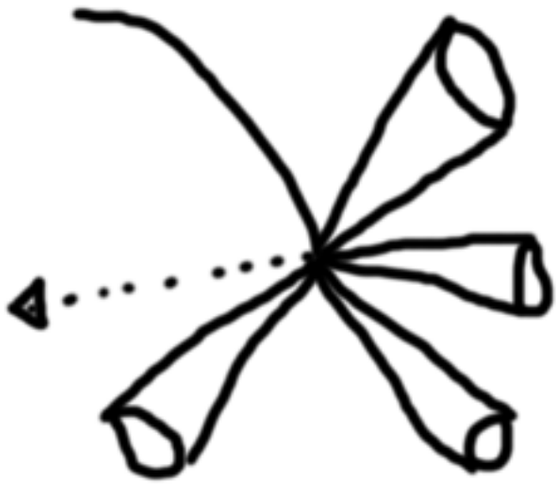
- isolated μ or e (pT > 26, 30 GeV)
- 4 jets, pT > 70, 50, 30, 30 GeV
- MET > 20 GeV
- N(btag)=1 or >1

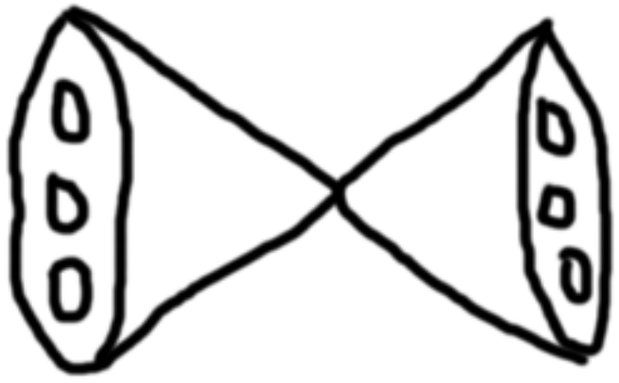
- non isolated μ or e (pT > 45, 35 GeV)
- 2 jets, pT > 150, 50 GeV
- MET > 50 GeV
  MET+pT(lepton) > 150 GeV
- N(btag)=0 or >0

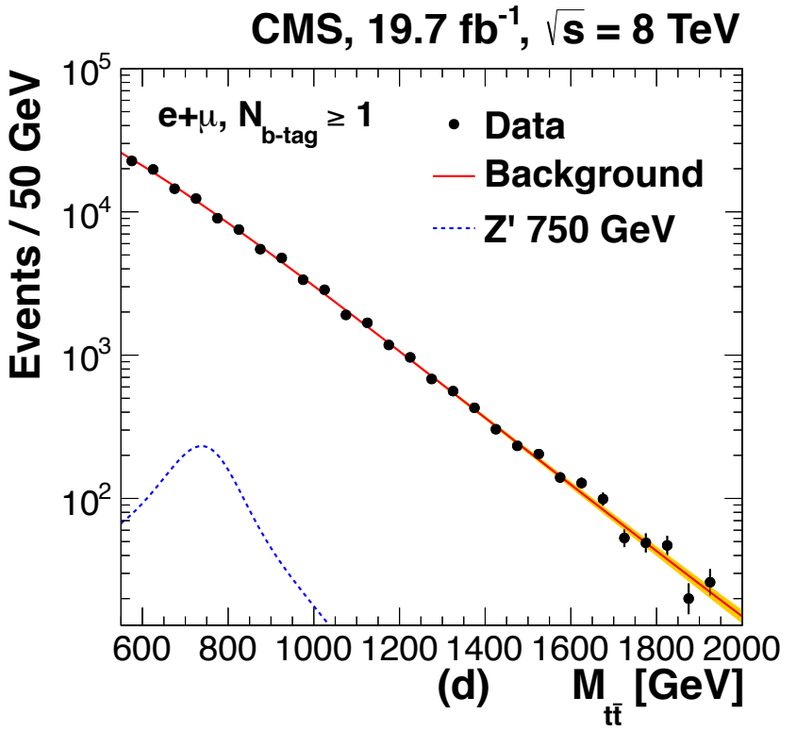


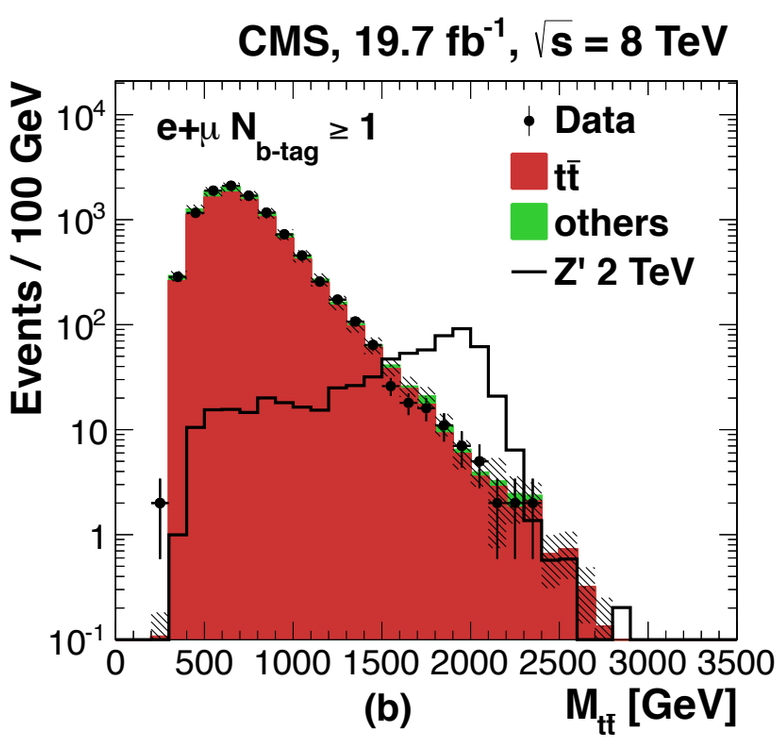
- 2 R=0.8 jets, pT>400 GeV
- 2 x CMSTopTag
- $|\Delta\phi|>\pi/2$, $|\Delta y|<1$

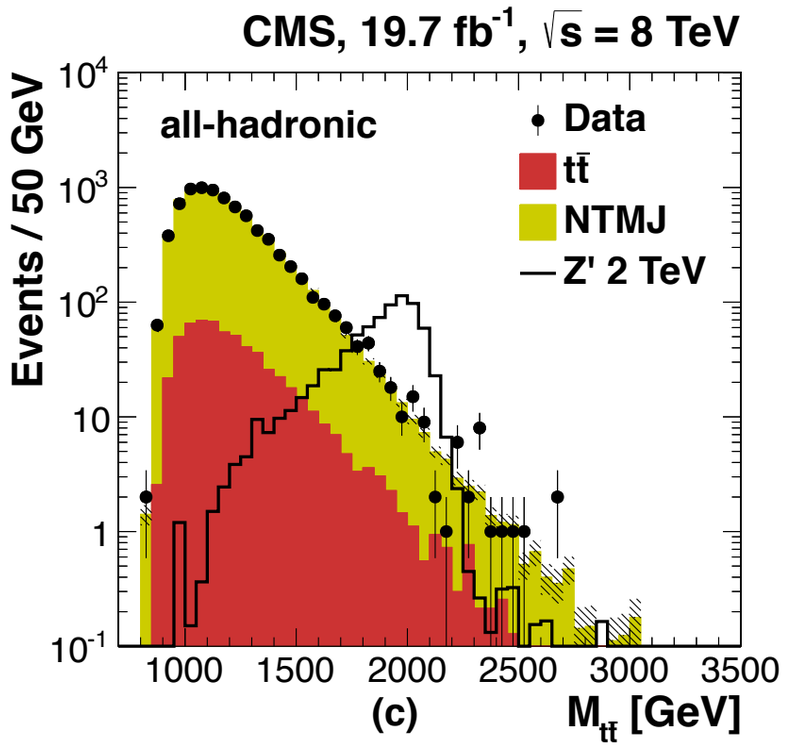
results







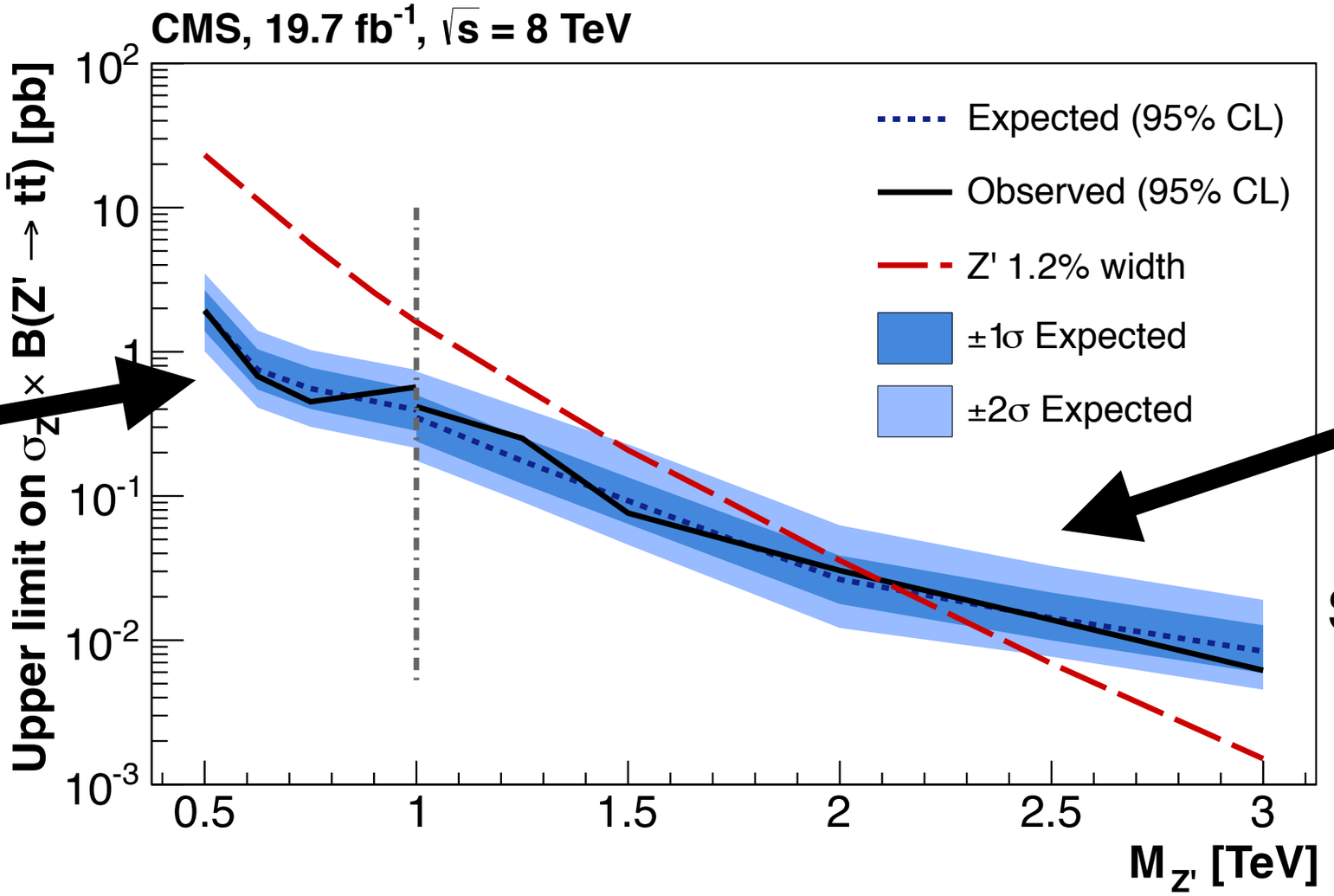




(arXiv:1309.2030)

results

resolved analysis



boosted analysis

semileptonic
+
all hadronic

Model	Observed Limit	Expected Limit
Z', $\Gamma_{Z'}/M_{Z'} = 1.2\%$	2.1 TeV	2.1 TeV
Z', $\Gamma_{Z'}/M_{Z'} = 10\%$	2.7 TeV	2.6 TeV
RS KK gluon	2.5 TeV	2.4 TeV

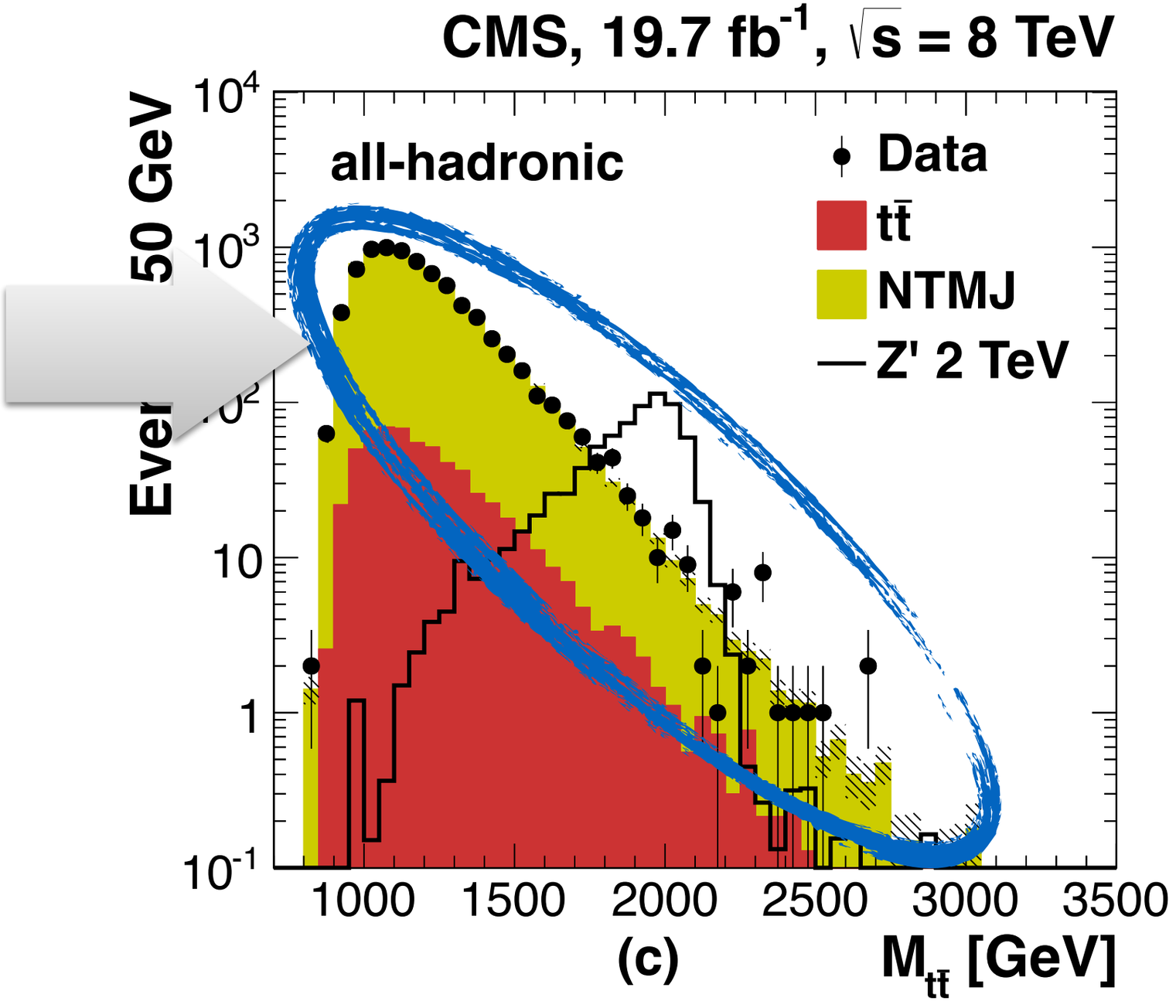
(arXiv:1309.2030)

improvements to the all hadronic analysis

the problem

analysis spoilt by multijet background

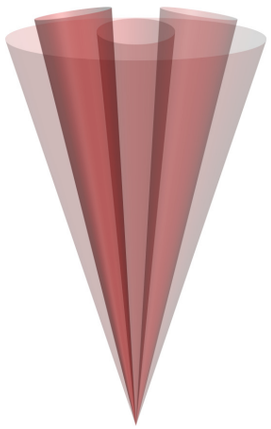
this is reducible background



top tagging

CMS Top Tagger
(Kaplan et al., arXiv:0806.0848)

CA Jet, R=$\sqrt{\Delta\phi^2 + \Delta\eta^2}$=0.8

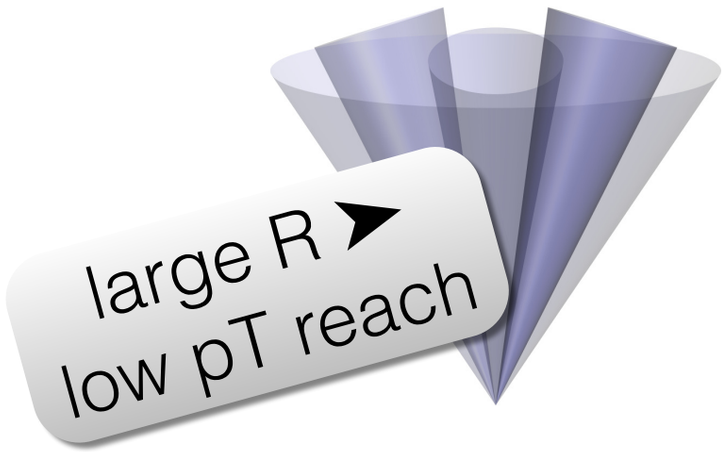


$p_T \gtrsim 400$ GeV

- Covers very boosted region
- Uses adjacency and p_T fraction filtering to find up to 4 subjets

HEP Top Tagger
(Plehn et al., arXiv:1006.2833)

CA Jet, R=$\sqrt{\Delta\phi^2 + \Delta\eta^2}$=1.5



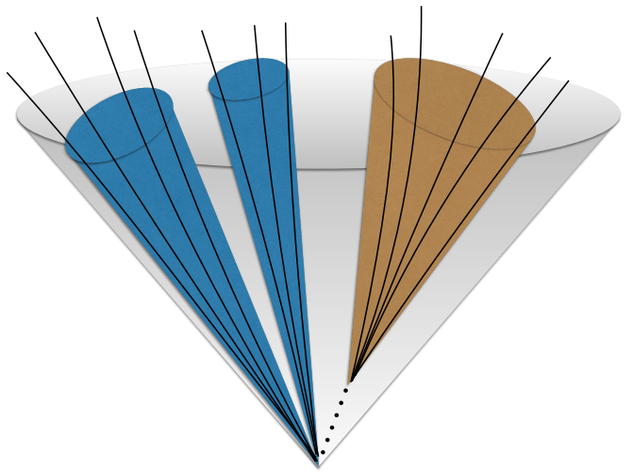
$p_T \gtrsim 200$ GeV

- Covers transition region from moderate to large boosts
- Uses mass drop and filtering to find 3 subjets, apply m_W cuts
- recently commissioned in CMS

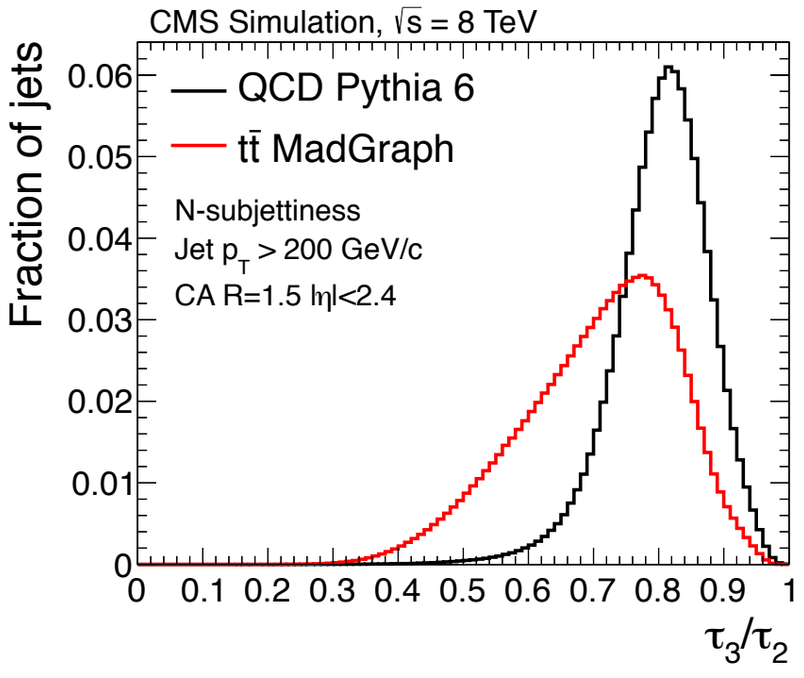
Further jet substructure techniques

Subjet b-tagging

- based on Combined Secondary Vertex (CSV): secondary vertex + single track information.
- CSV b-tagger applied to subjets



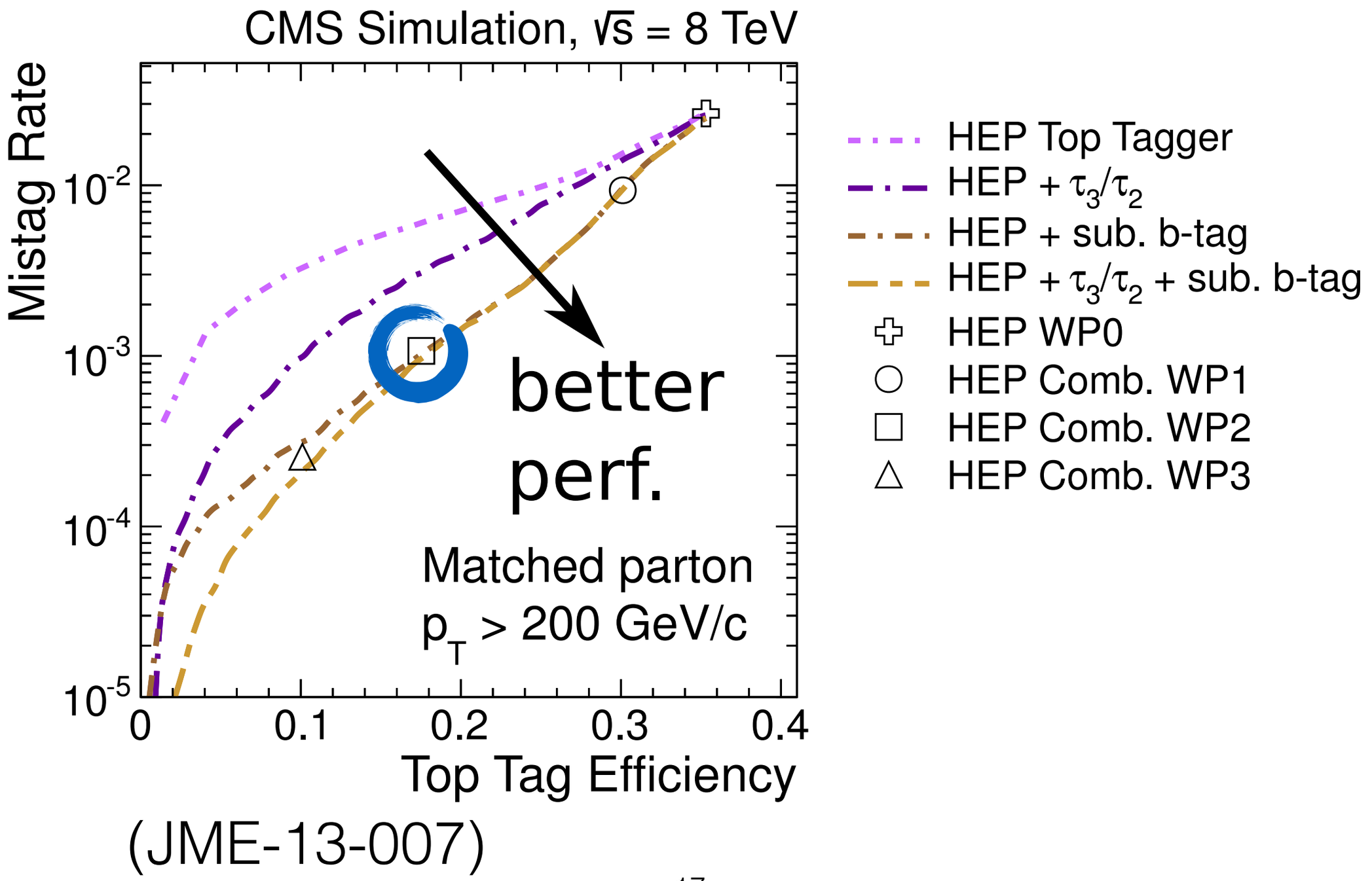
N-subjettiness τ_N



(JME-13-007)

- measures how many subjets a jet has
- $\tau_N \to 0 \Rightarrow$ likey to have N subjets
- τ_3/τ_2 interesting for top jets

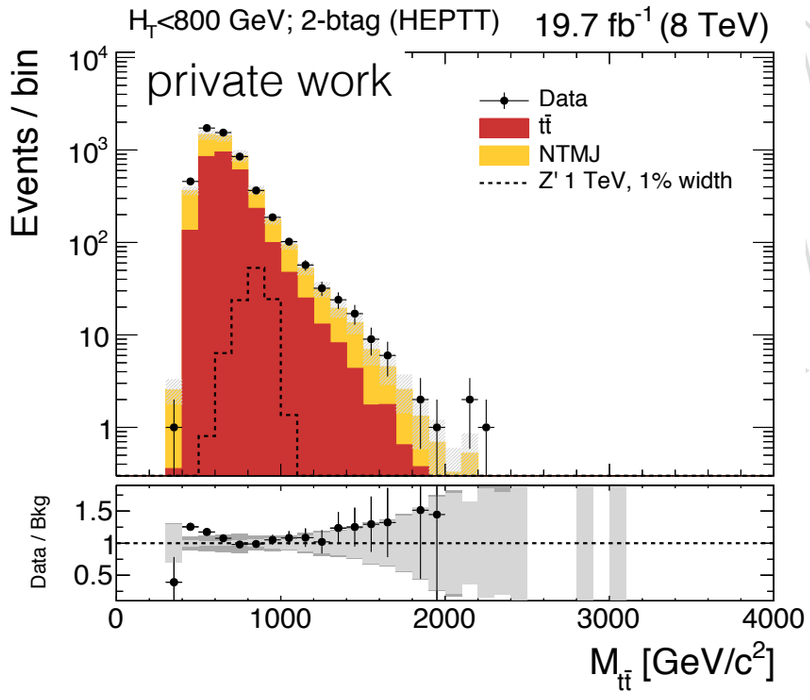
performance



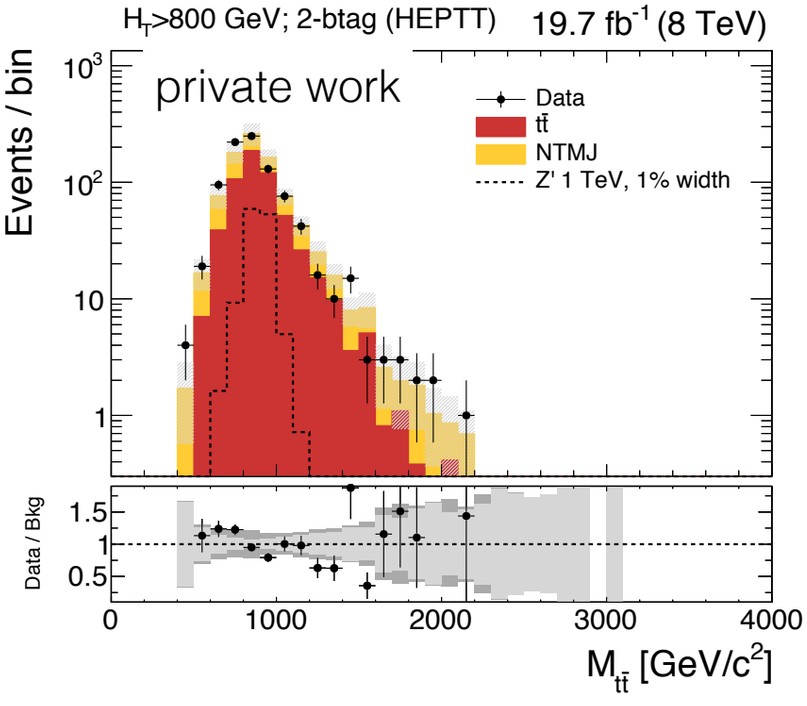
(JME-13-007)

results

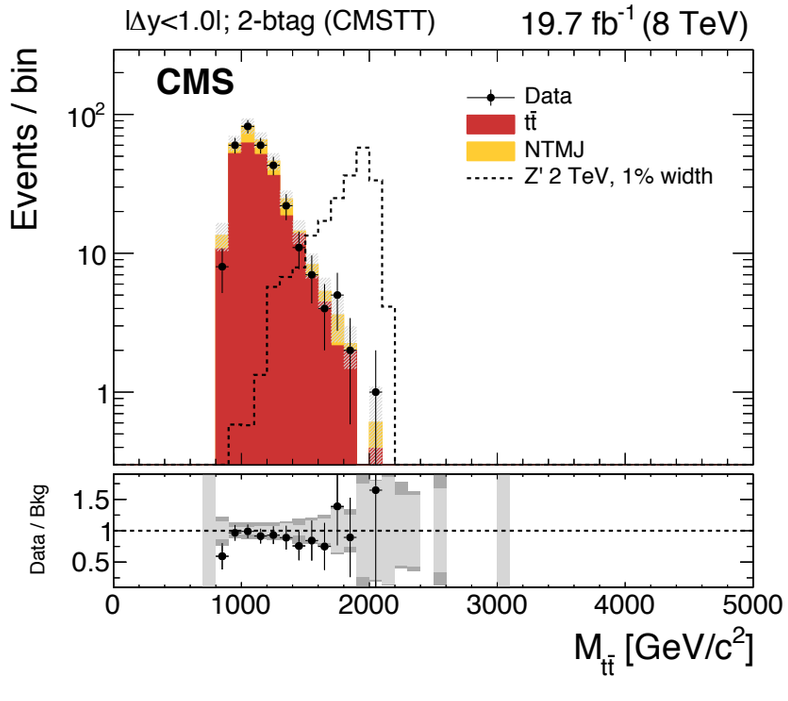
2 b tag, HEP Tagger
HT<800 GeV

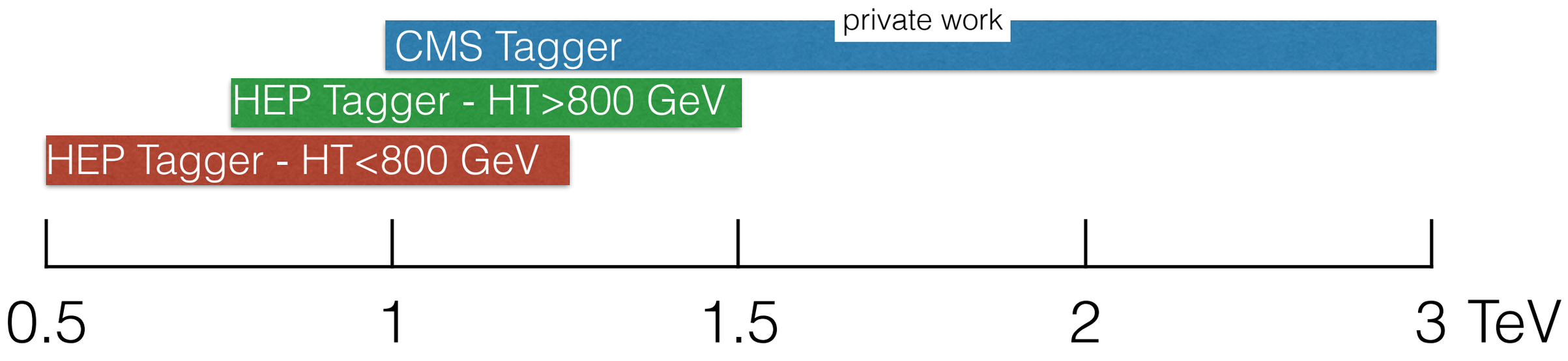


2 b tag, HEP Tagger
HT>800 GeV



2 b tag, CMS Tagger
N-subjettiness cut





outlook

- recovered sensitivity
- leptonic analysis also improved
- final results to be published soon

challenges ahead

- new top taggers and jet substructure techniques
- how to trigger low-HT hadronic events?
- understand large-radius jet behavior at 13 TeV