Higgs searches using subjets

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Boosted Higgs Searches

- Jet substructure in VH [PRL 100 (2008), Butterworth, Davison, Rubin and Salam]
  (Trailblazing paper)

- Fat Jets for a light Higgs [PRL, 0910.5472, Plehn, Salam, MS]
  right now, here -- and by Tilman in 15 minutes

- Discovering the Higgs Boson in New Physics Events using Jet Substructure
  Talk by Adam, right now -- in SUSY 2 [0912.4731, Kribs, Martin, Roy, MS]

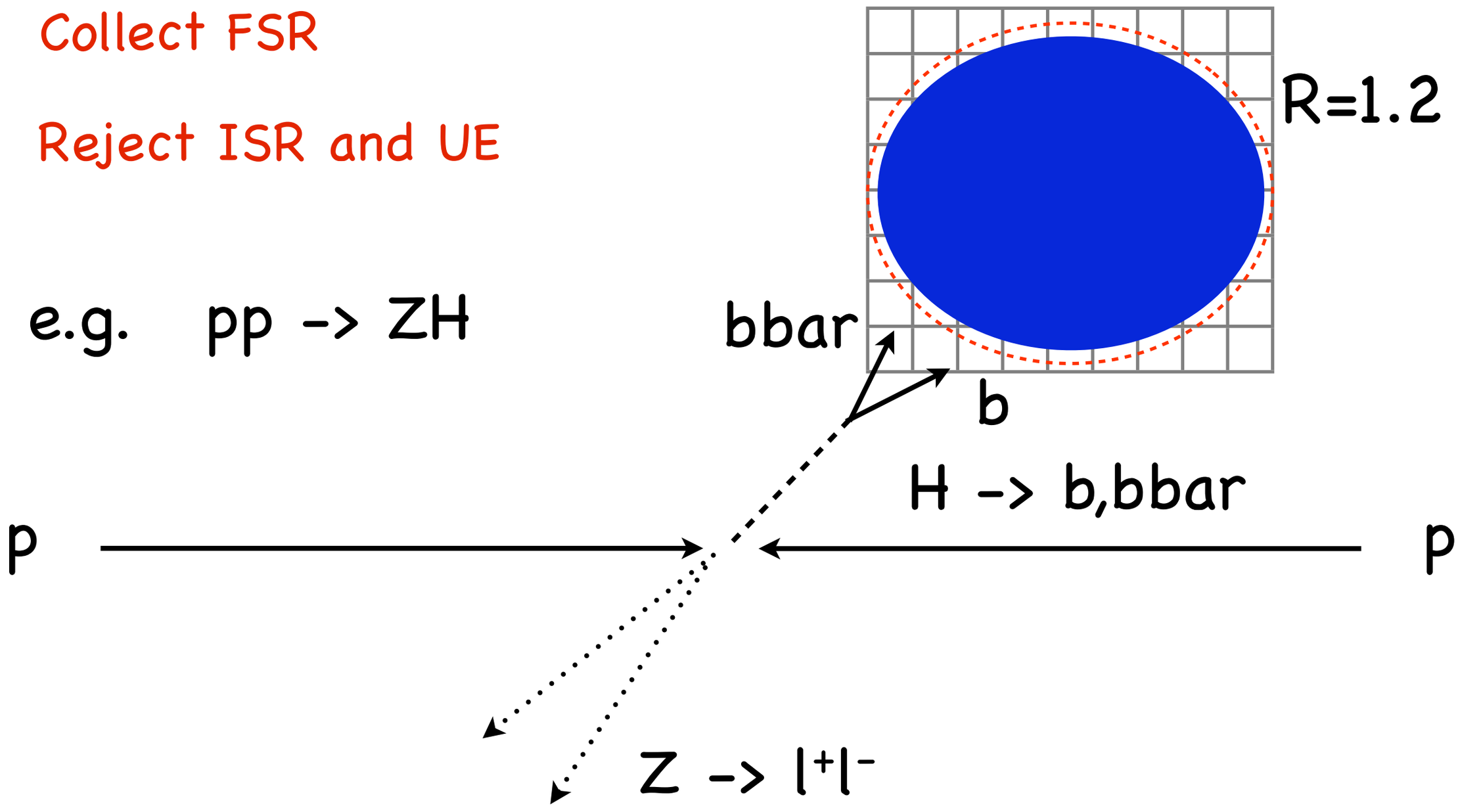
- Combining subjet algorithms to enhance ZH detection at the LHC
  [1005.0417, Soper, MS]

Basic idea of subjet analysis

Collect FSR

Reject ISR and UE

e.g. pp -> ZH



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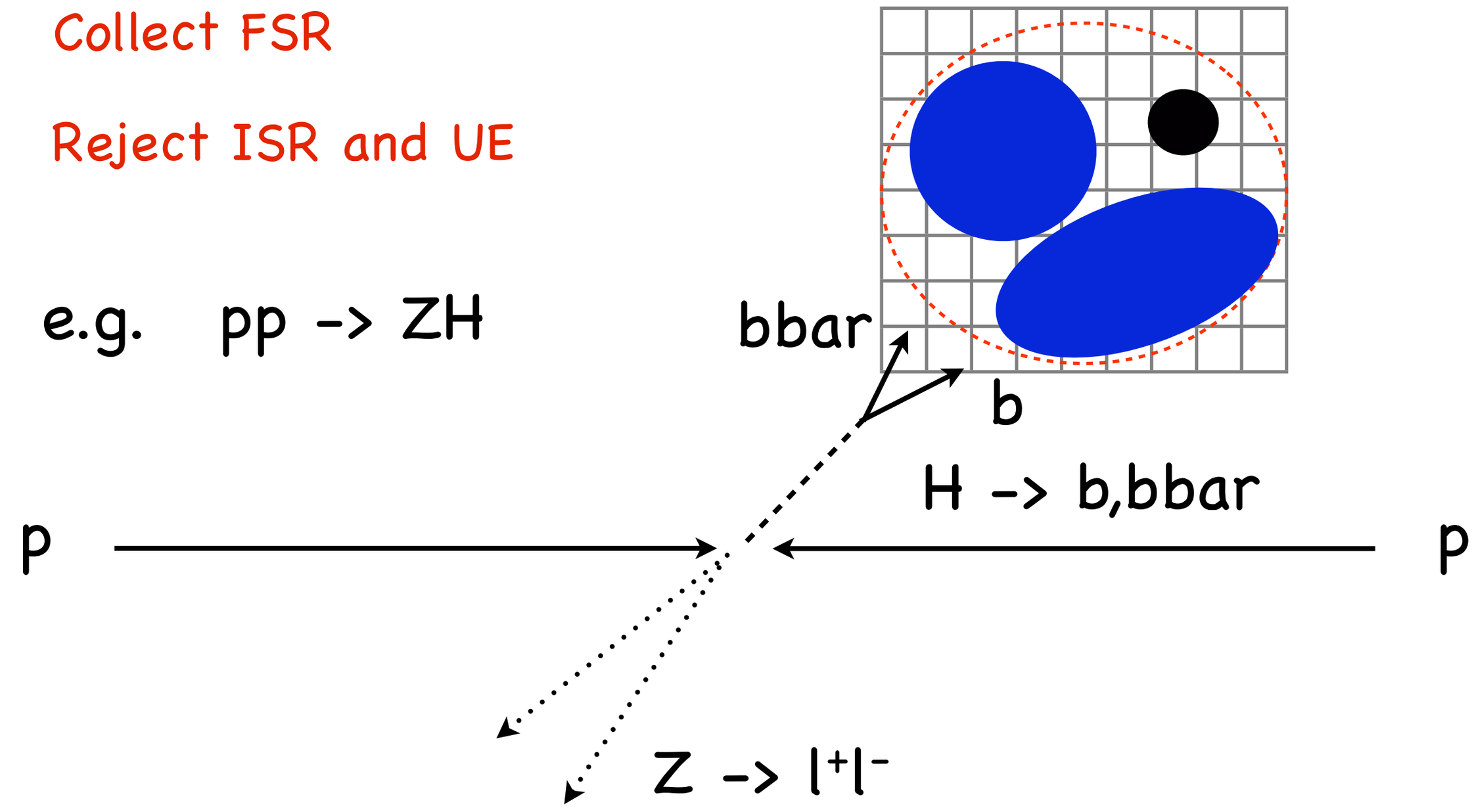

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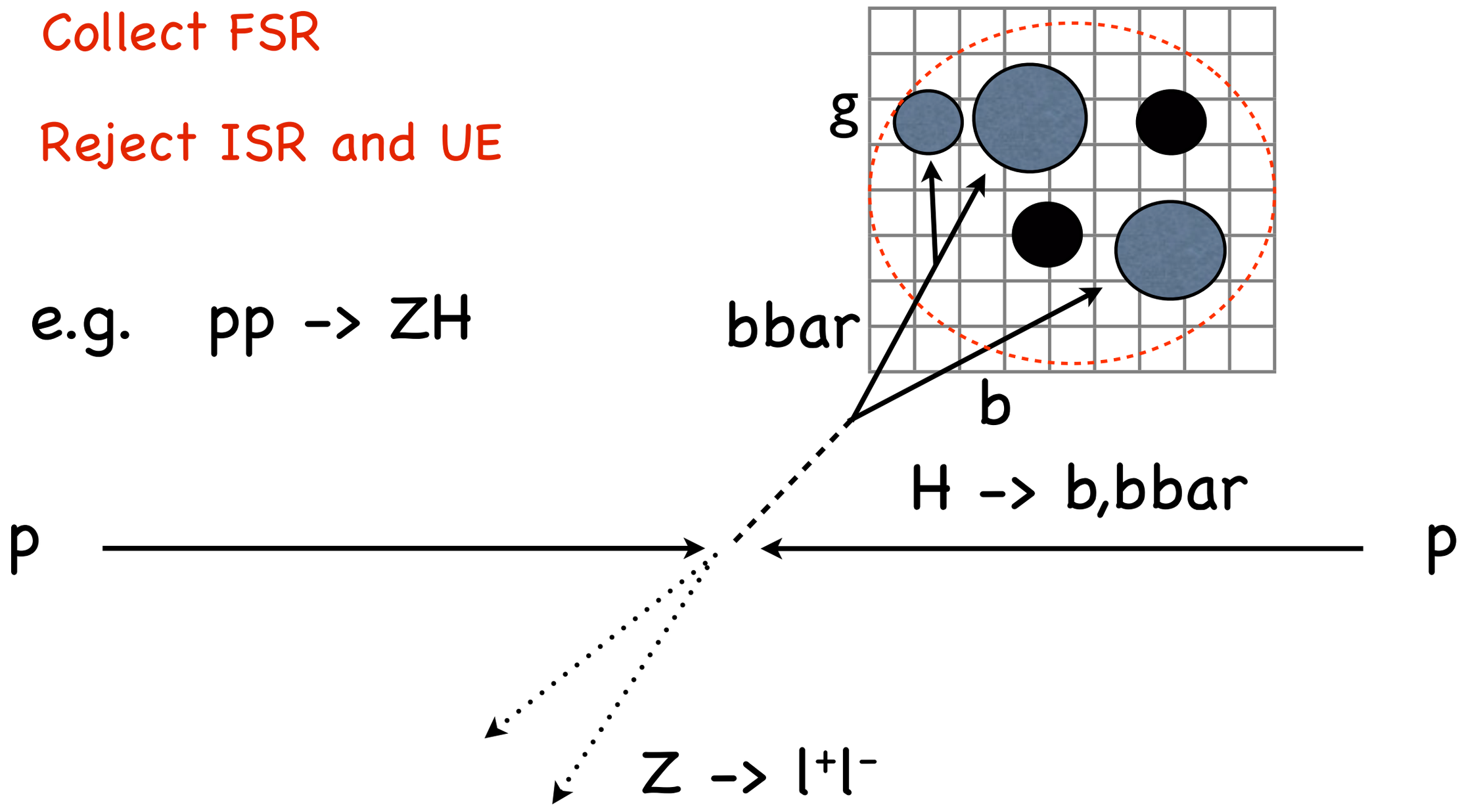
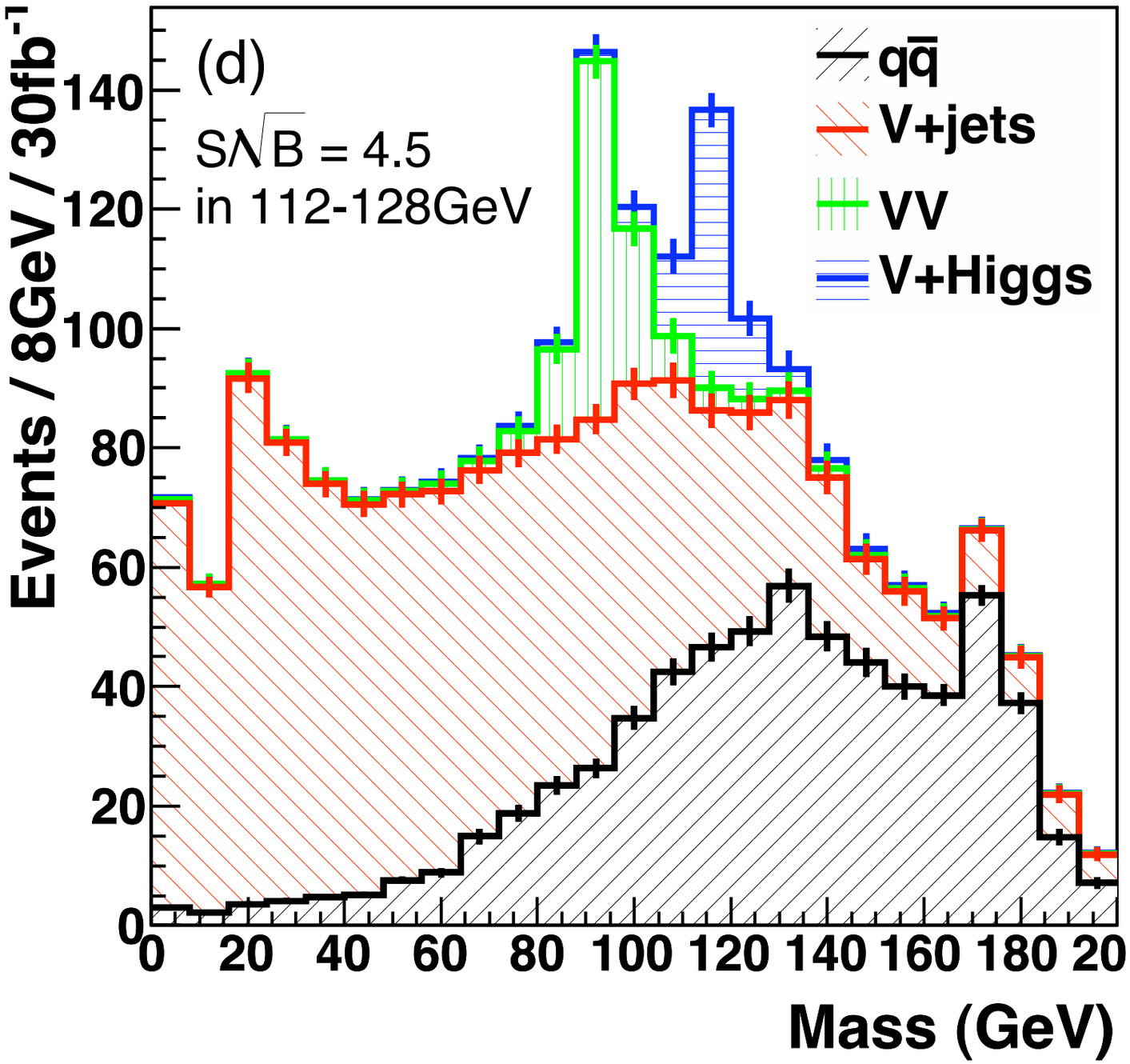


Result for ZH and WH combined:



Soper and MS
1005.0417

↓

For ZH channel
improvement in S/B
by factor of 2

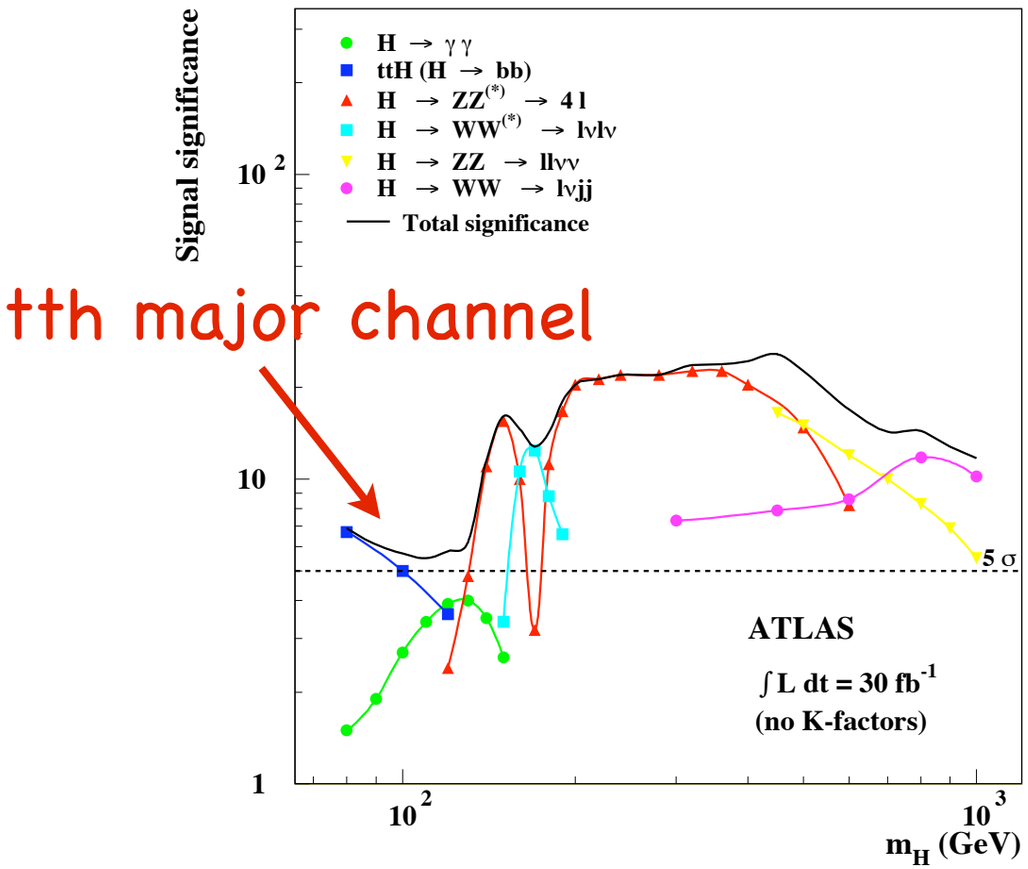
Confirmed by ATLAS analysis with slightly smaller significance
[ATL-PHYS-PUB-2009-088, G. Piacquadio]

tth - using boosted jets

[T. Plehn, G. Salam, MS]

Motivation:
- sizable cross-section
- Higgs discovery contribution in low mass range
- access to t- and b-Yukawa couplings

High expectations:



tth major channel

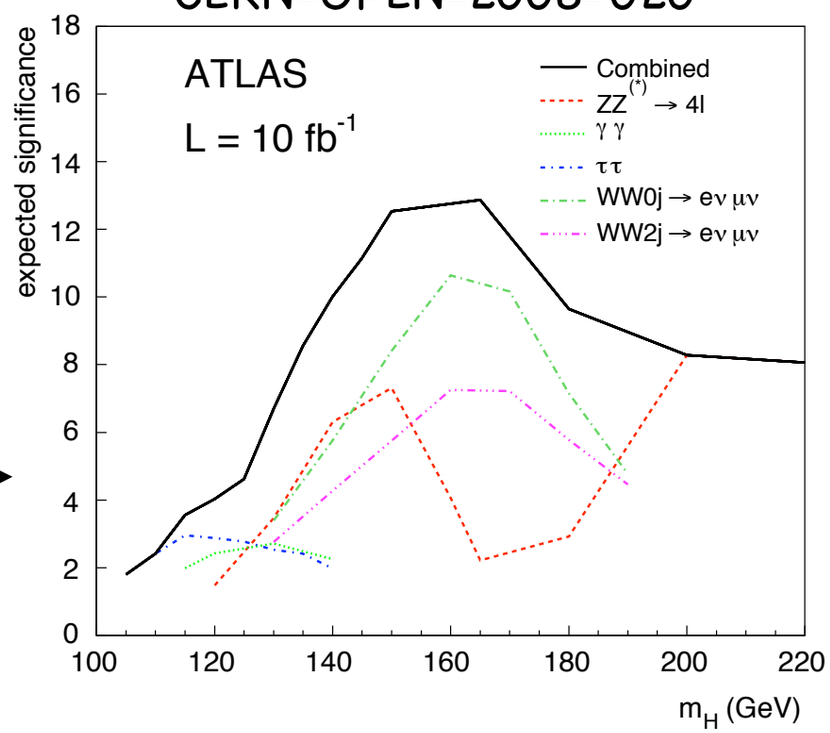
[ATLAS TDR 1999]

Cammin and Schumacher (ATLAS)

$S/B \simeq 1/9$

$S/\sqrt{B} \simeq 2.2$

Expected Performance of the ATLAS Experiment, CERN-OPEN-2008-020



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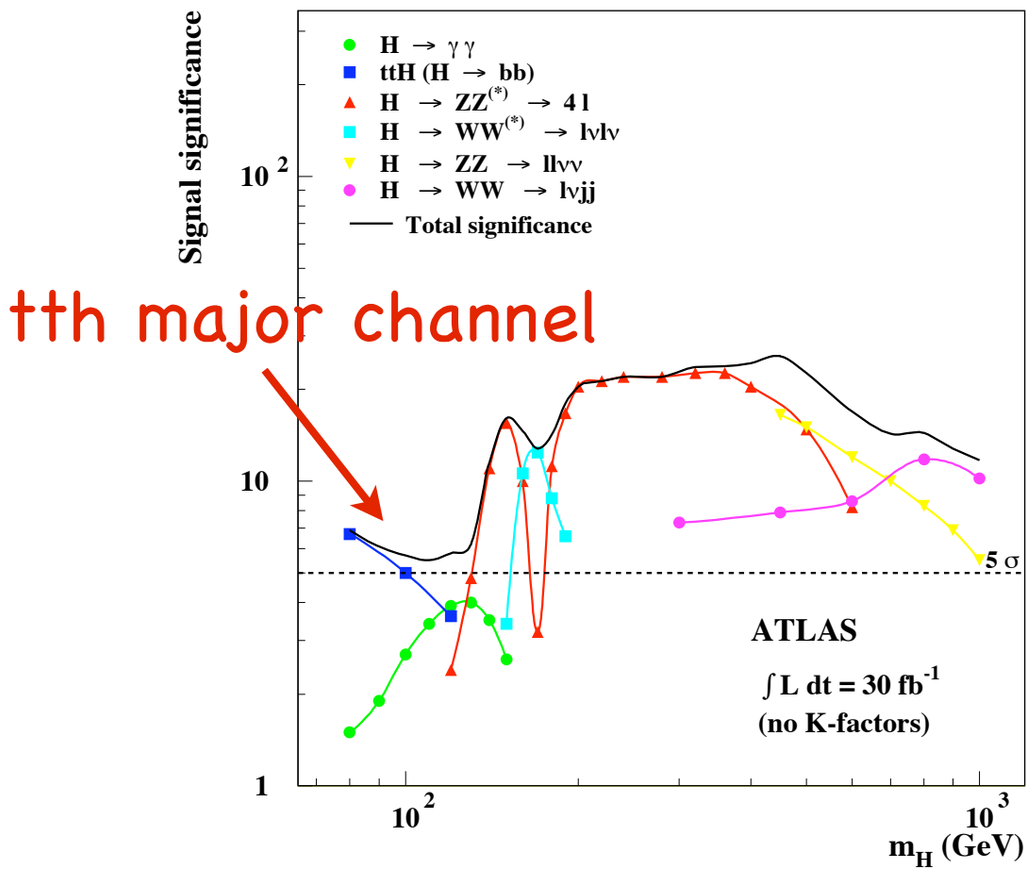

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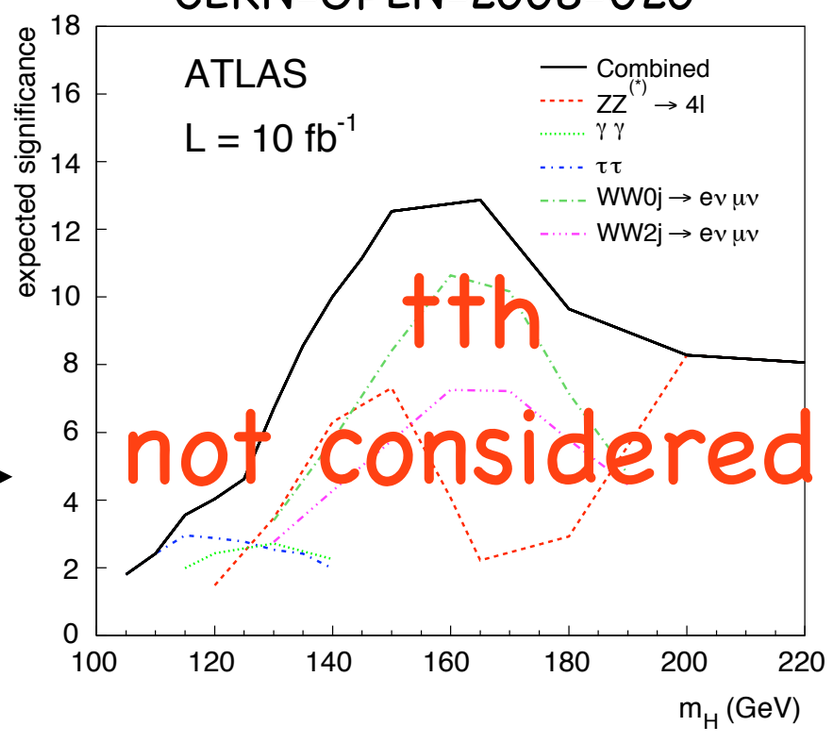
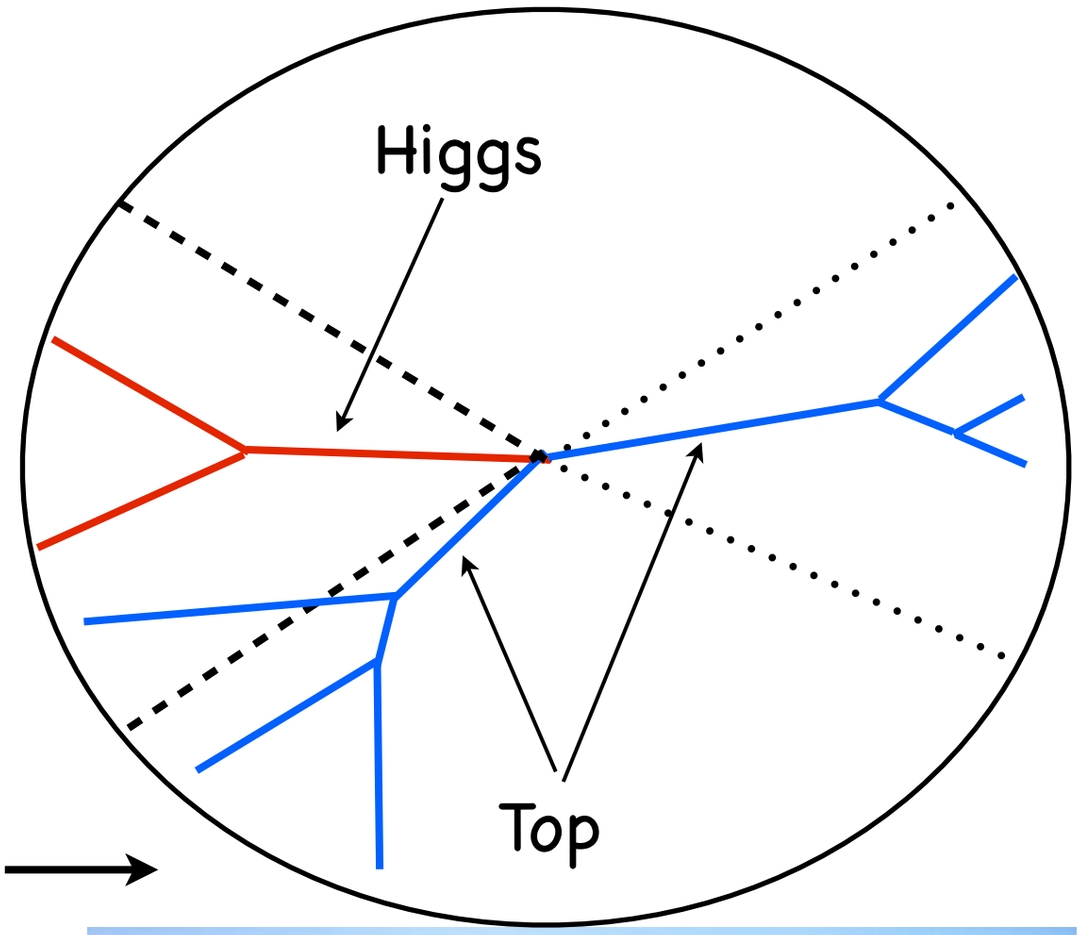


Boosted scenario should help!



Cambr/Aachen
Jet-algorithm

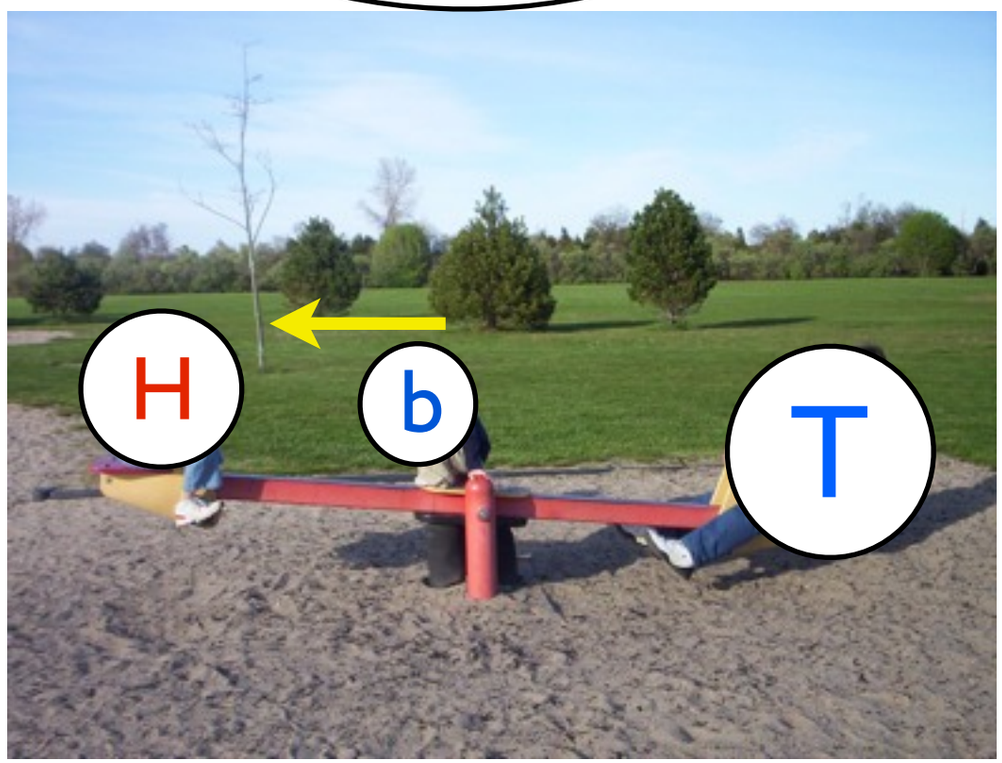
R=1.5

min. selection cuts:

2 Jets with
$p_{T,j} \geq 200$ GeV

isolated Lepton with
$p_{T,l} \geq 15$ GeV

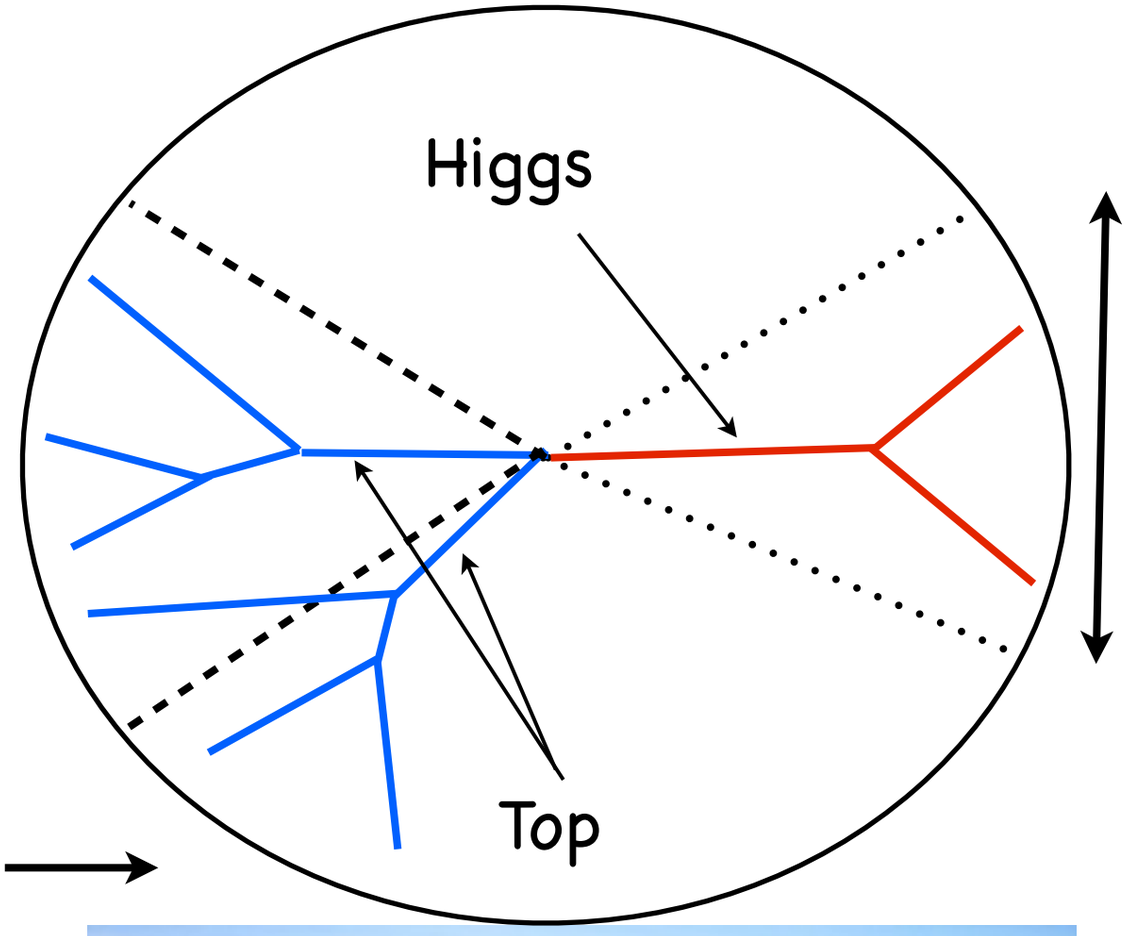
Signal ~ 24.1 fb



Only 2 or 3 b in one cone reduces combinatorics

Boosted scenario should help!

LHC



pT plane →

Cambr/Aachen Jet-algorithm

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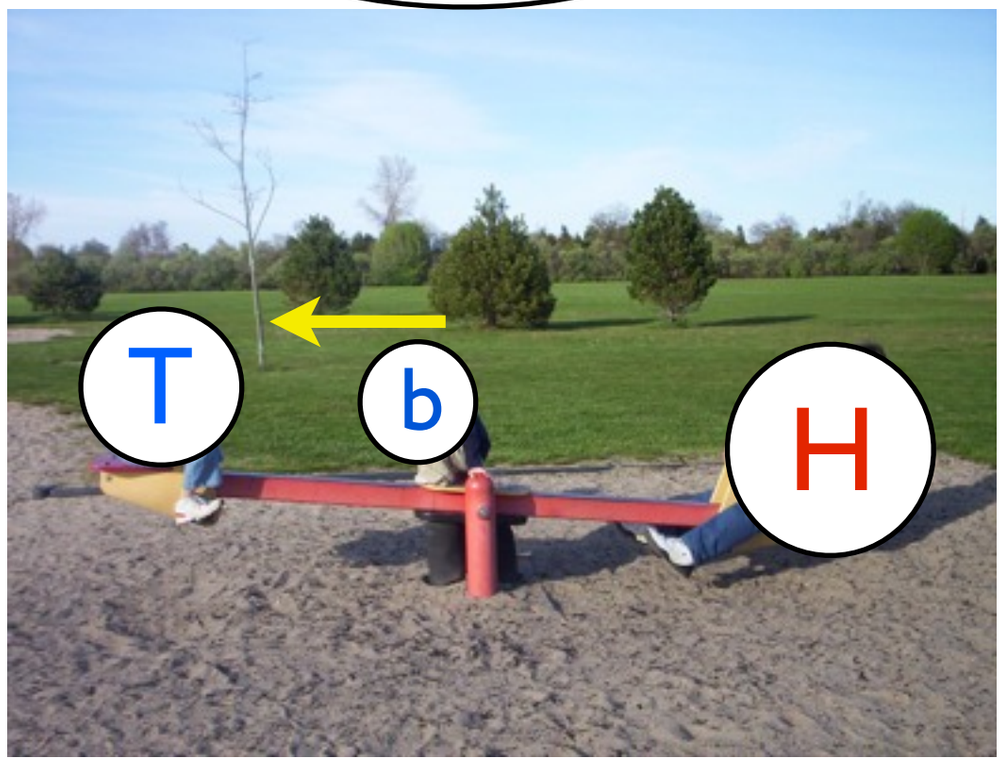


Only 2 or 3 b in one cone reduces combinatorics

Things we had to develop

[Tilman's talk -- in about 4 minutes]

I. Working Top-tagger:

- Has to work in busy final-state
- Has to be insensitive against UE
- Based on MW and MT reconstruction

After positive identification of top run
Higgs-tagger on remaining jets

II. Working Higgs-tagger (based on WH/ZH study):

- Has to work in busy final-state
- Has to be insensitive against UE
- No Higgs mass should be assumed

Nasty backgrounds.....

tth (Signal)

Beenakker et al., PRL 87 2001; Reina et al., PRD 65 2002

→ K=1.57

ttbb

Bredenstein et al., PRL 103 2009; Belivacqua et al., JHEP 0909 2009

→ K=2.3

tt+jets

Dittmaier et al, PRL 98 2007 Bevilacqua et al., PRL 104 2010

→ K=1.0

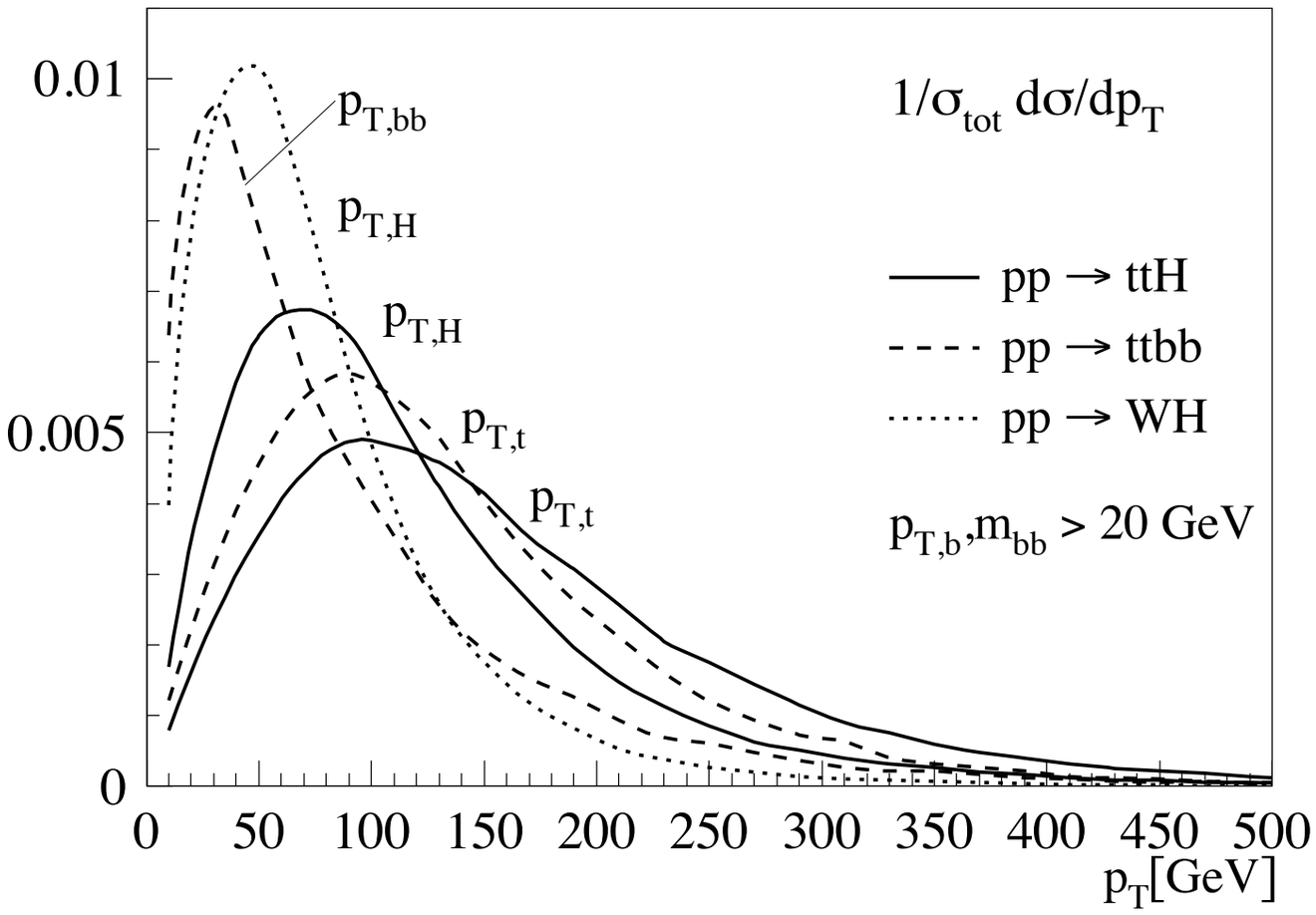
ttz

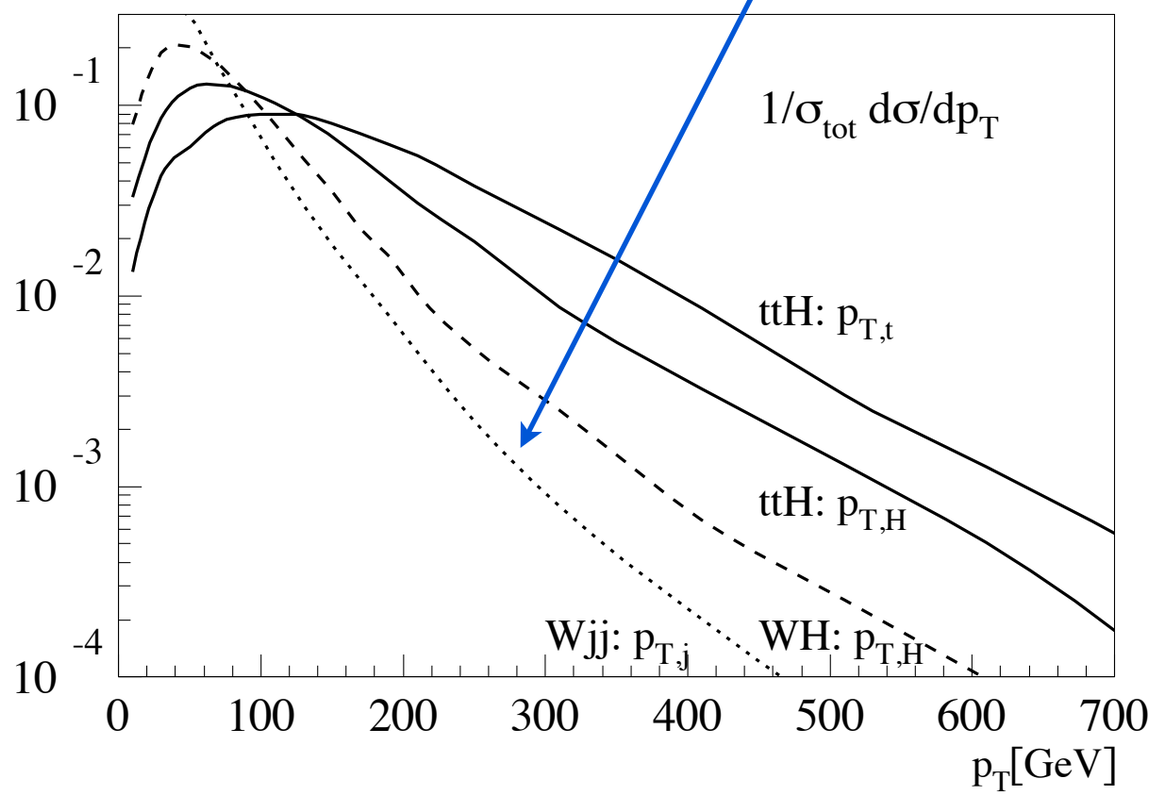
Lazopoulos et al., PLB 666 2008

→ k=1.53

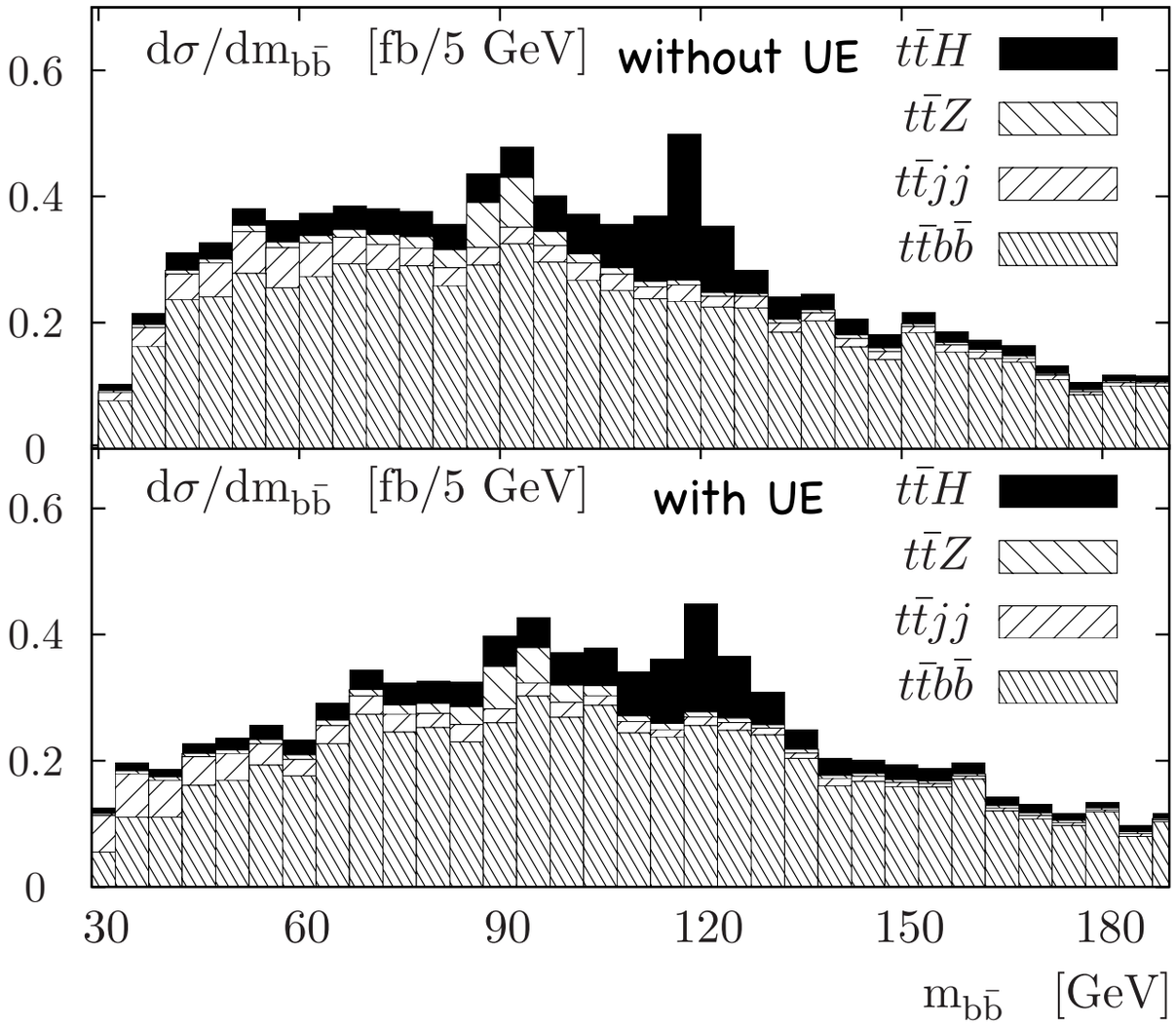
w+jets

negligible after b-tags and taggers





Results



for 100 1/fb

with 2 b-tags	$S[\mathrm{fb}^{-1}]$	$B[\mathrm{fb}^{-1}]$	S/B	$S/\sqrt{B}$
$m_H = 115$ GeV	1.2	3.8	1/3.2	6.2
120 GeV	1.0	3.8	1/3.8	5.1
130 GeV	0.51	3.3	1/6.5	2.8

with 3 b-tags	$S[\mathrm{fb}^{-1}]$	$B[\mathrm{fb}^{-1}]$	S/B	$S/\sqrt{B}$
$m_H = 115$ GeV	0.57	1.18	1/2.1	5.2 (5.7)
120 GeV	0.48	1.15	1/2.4	4.5 (5.1)
130 GeV	0.29	1.03	1/3.6	2.9 (3.0)

→ tremendous improvement on S/B in tth

→ tth might contribute to Higgs discovery

→ tth might be a window to Higgs-top coupling