HH→4b benchmark for the HTT

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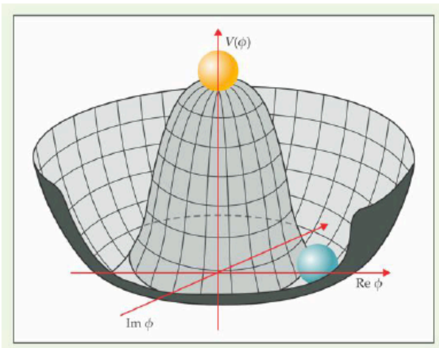
Cofinanciado por:

Outline

- Why HH$\rightarrow$4b
- Parameterization of b-tagging performance
- MC samples
- Some control plots
- Initial rate estimation

$hh \to 4b$ trigger prospects - overview



$hh \to 4b$: key benchmark channel for HL-LHC

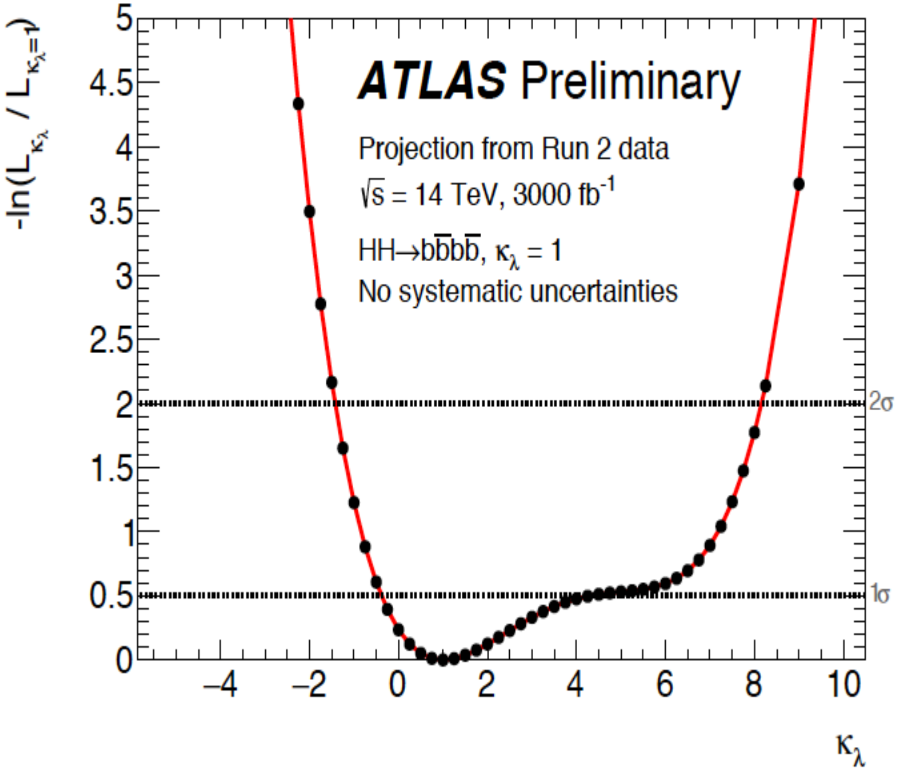
- Sensitivity to shape of Higgs potential

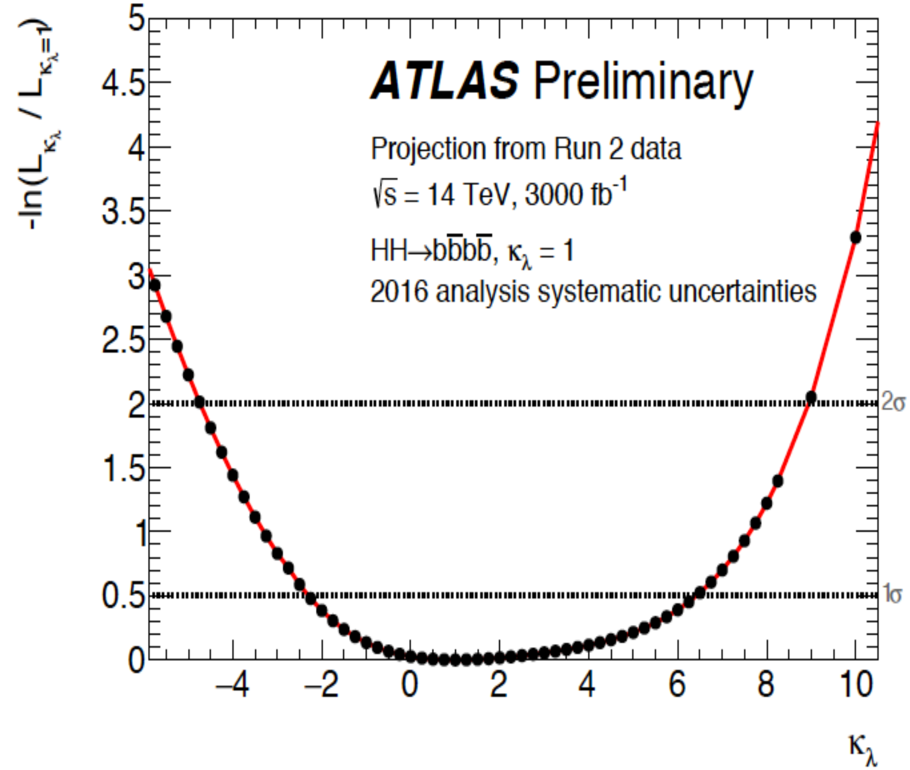
- *How can this channel benefit from improved b-tagging at the trigger provided by the HTT?*

Goal: Understand how the b-tagging performance of HTT influences the triggers used in the searches for $hh \to 4b$ as well as the sensitivity of the offline analysis

Current estimates

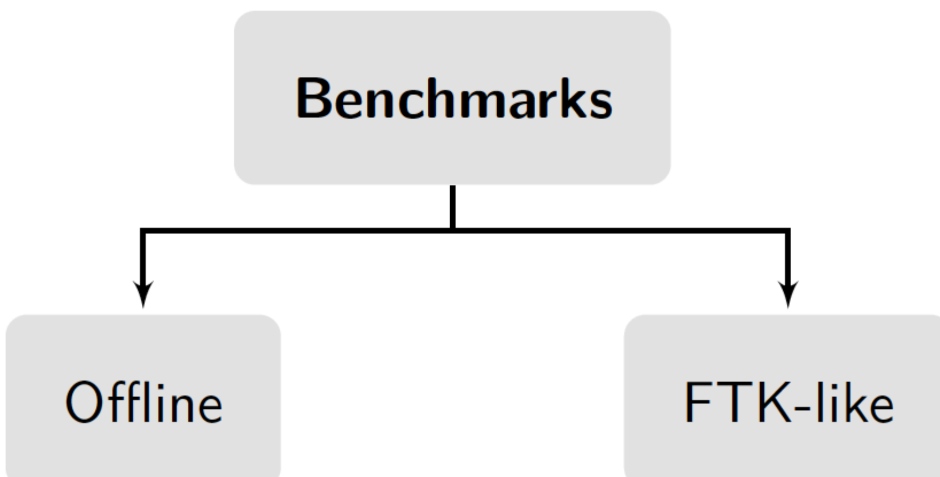
- Current prospects for di-Higgs at HL-LHC (ATL-PHYS-PUB-2018-053)
  - bbγγ, bbττ, bbbb for 3000 /fb
  - 3.0 σ significance
  - Uncertainty on $\mu_{HH} \approx 30$ - 40%
  - $\lambda_{HHH} / \lambda_{SM}$ expected 1±0.7





Strategy - I

- Start from **UpgradePerformanceFunctions**: given the truth flavor, p_T and η of a jet return the expected offline b-tagging efficiency for the HL-LHC runs
- Use this parameterization as **baseline**: *what is the signal acceptance and background rejection if the b-tagging at the trigger were as good as the offline b-tagging?*
- Worsen b-tagging efficiency and mistag rates to emulate performance at the trigger



Strategy - II

FTK-like b-tagging parameterization:

- Charm and light mistag rates increased by a factor of 2 w.r.t. offline (left plot tells us this assumption is not ridiculous)
- B-tagging efficiency parameterized according to right plot

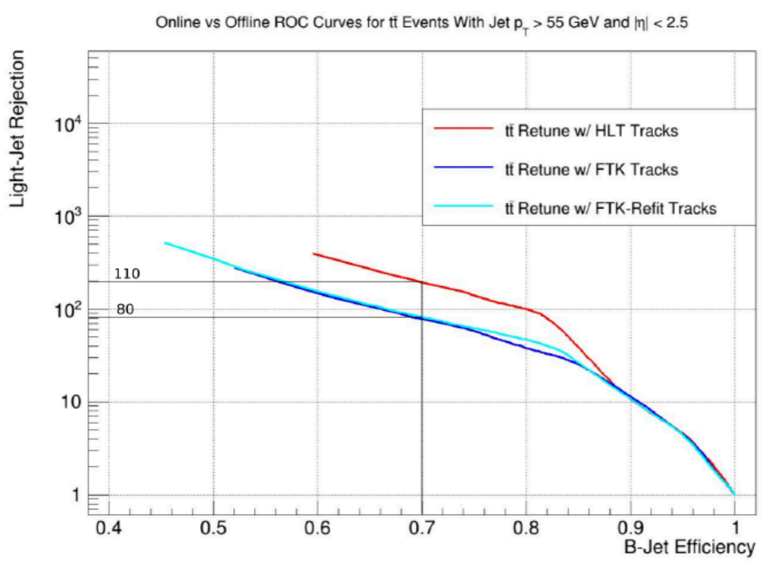


Figure: MV2c10 b-tagging efficiency vs light-jet rejection for FTK (100k events). Christopher Milke preliminary plot [1]

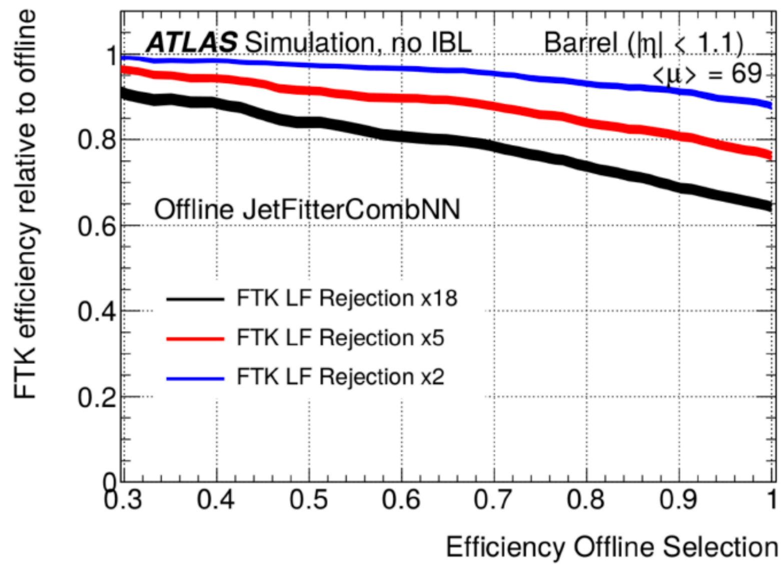


Figure: FTK b-tagging efficiency w.r.t. to offline

B-tagging parameterizations

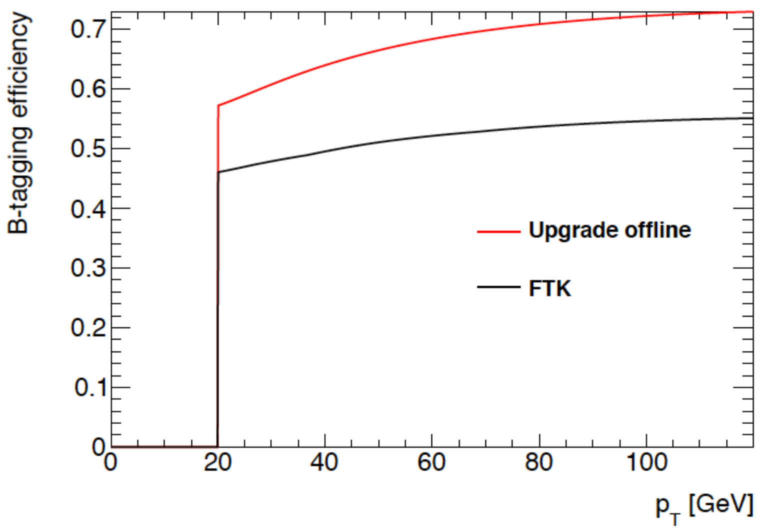


Figure: B-tagging efficiency for true b-jets as a function of the jet's p_T

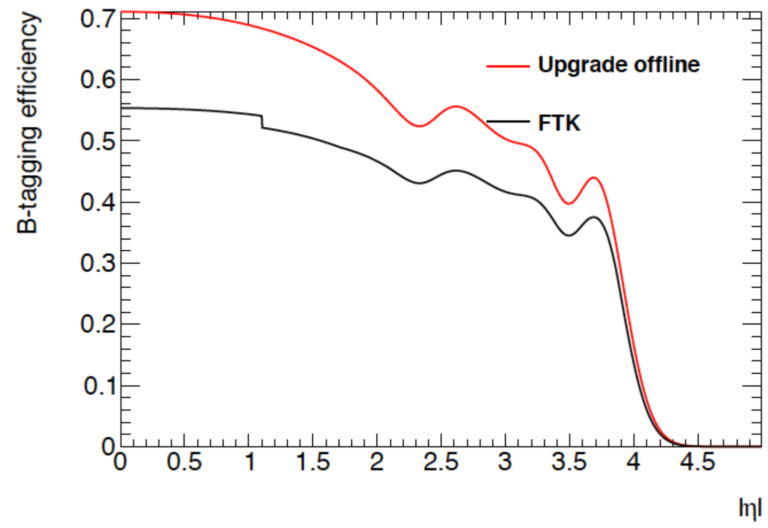


Figure: B-tagging efficiency for true b-jets as a function of the jet's η

	B-tag efficiency	**C-mistag**	**L-mistag**
Offline	0.72	0.05	0.001
FTK-like	0.56	0.1	0.002

Table: Summary of b-tagging efficiency and mistag rates. Values for $p_T = 50$ GeV and $\eta = 0$

Technical details

Samples

- Full simulation upgrade xAOD's with $< \mu > \sim 200$, $\sqrt{s} = 14$ TeV
- Signal: $pp \rightarrow G(800 \text{ GeV}) \rightarrow hh \rightarrow 4b$ (no SM samples available)
- Background: dijets (dominant)

- Jet collection: AntiKt4EMPFlowJets
- Geometry: ATLAS-P2-ITK-20-00-00

Framework:

- Using EventLoop with AnalysisBase 21.2.68

Control plots - jets pT

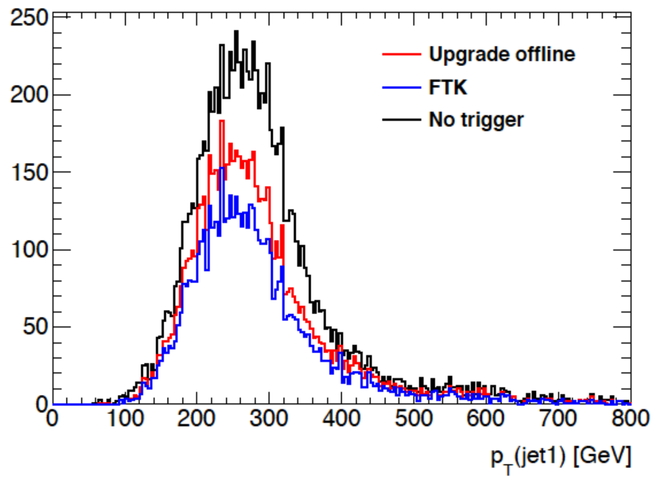


Figure: Leading jet p_T

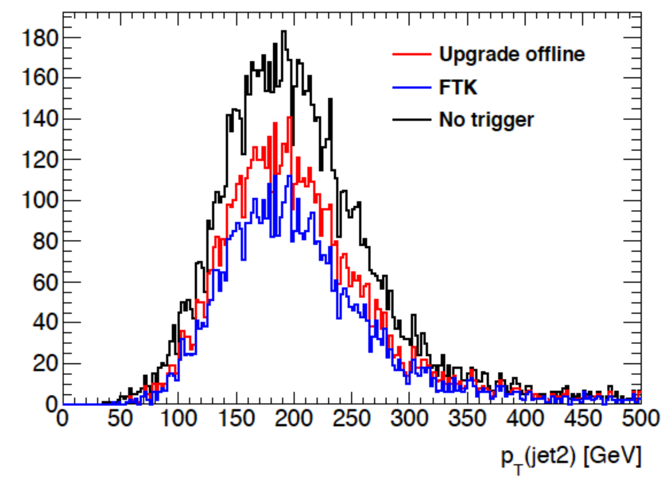


Figure: Sub-leading jet p_T

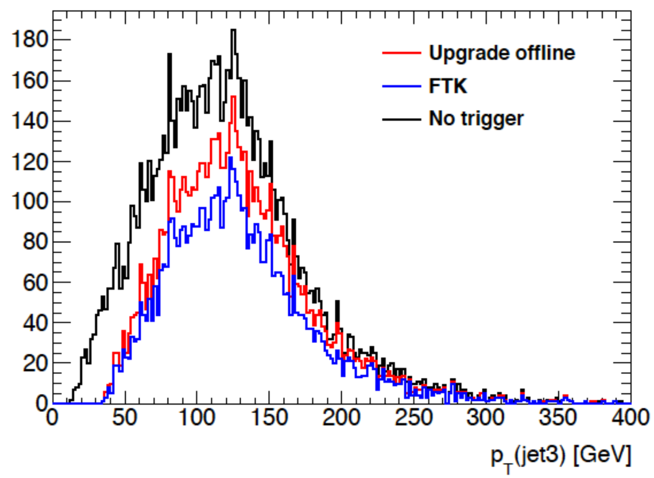


Figure: 3rd jet p_T

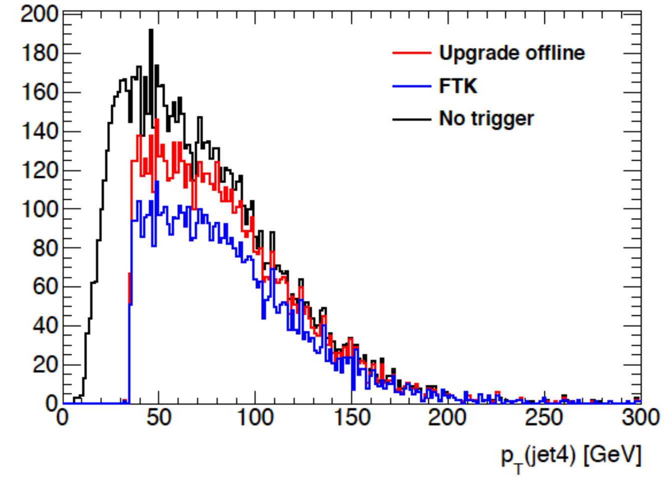


Figure: 4th jet p_T

Control plots - mass peaks

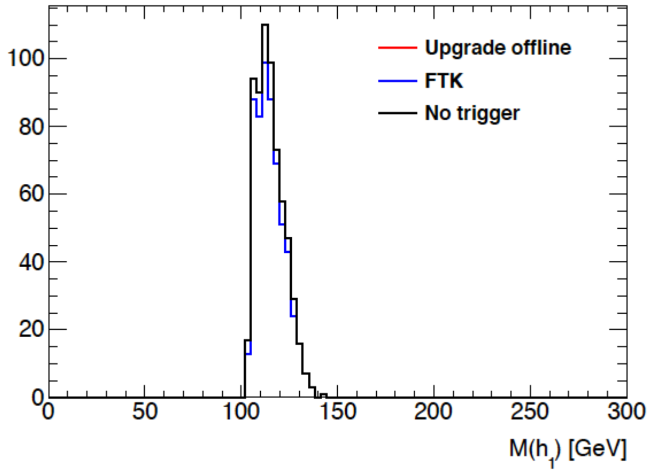


Figure: Leading Higgs mass

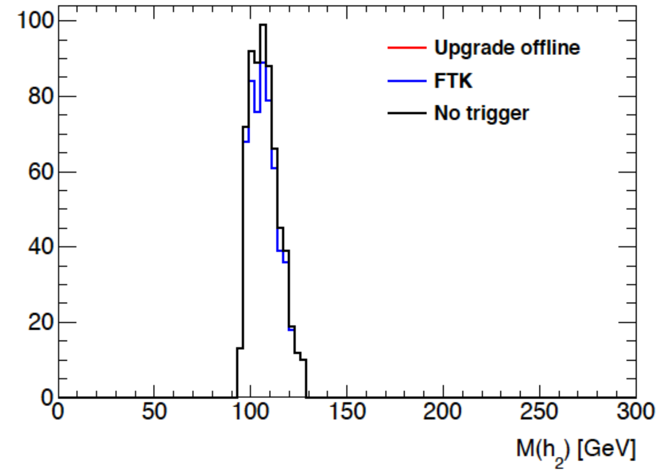
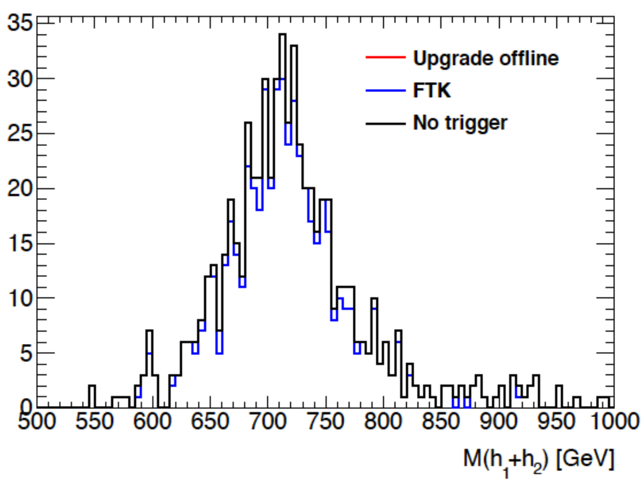


Figure: Sub-leading Higgs mass



- Identical peaks when no trigger selection is applied and when using offline b-tagging
- Less events when using FTK b-tagging, as expected

Preliminary results - trigger rates

Trigger chain: HLT_2b35_2j35_L1_4j15

Sample: Dijet JZ1 ($20 < p_T^{\text{QCD truth jet}} < 80$ GeV) (#events=999800)

$$\text{Rate} = \mathcal{L} \times \epsilon_{\text{trigger}} \times \sigma$$

	Rate @ 1.78e34 cm^{-2}s^{-1} [Hz]
Offline	21 ± 3
FTK-like	18 ± 3

Table: HLT_2b35_2j35_L1_4j15 trigger rates for offline and FTK-like parameterizations

- Rates consistent within (statistical) uncertainties
- Number consistent with Run-II online rate of ~ 50 Hz
- Rate dominated by b-tagging efficiency (see next slide)

Caveats

- Limited statistics
- Next p_T slices might slightly increase these numbers

Preliminary results - b-tagging purity

Trigger chain: HLT_2b35_2j35_L1_4j15

Sample: Dijet JZ1

$$\text{Purity} = \frac{\#\text{true b-jets}}{\#\text{b-tagged jets}}$$

	# b-tagged jets	# true b-jets	Purity
Offline	89 ± 13	78 ± 13	0.88 ± 0.19
FTK-like	80 ± 13	49 ± 11	0.61 ± 0.17

Table: Number of b-tagged jets, true b-jets and purity for events that pass the HLT_2b35_2j35_L1_4j15 trigger for offline and FTK-like parameterizations

- Purity is higher for offline parameterization, as expected

Next steps

- Working on first version of HTT fast simulation
  - Based on easy to change parameterization
- Re-do analysis with non-resonant signal sample
- Significance estimate will be useful as HTT benchmark