trigger studies for di-Higgs search in 0-lepton bbWW channel

2023 US ATLAS SUPER Symposium

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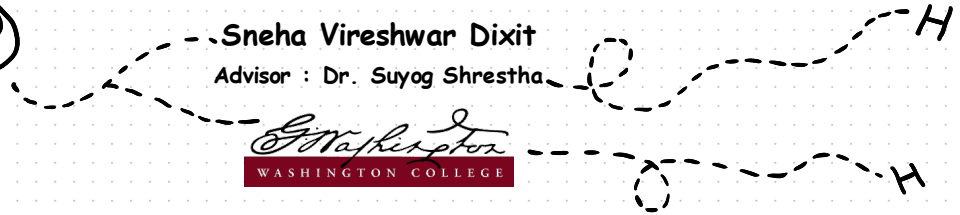
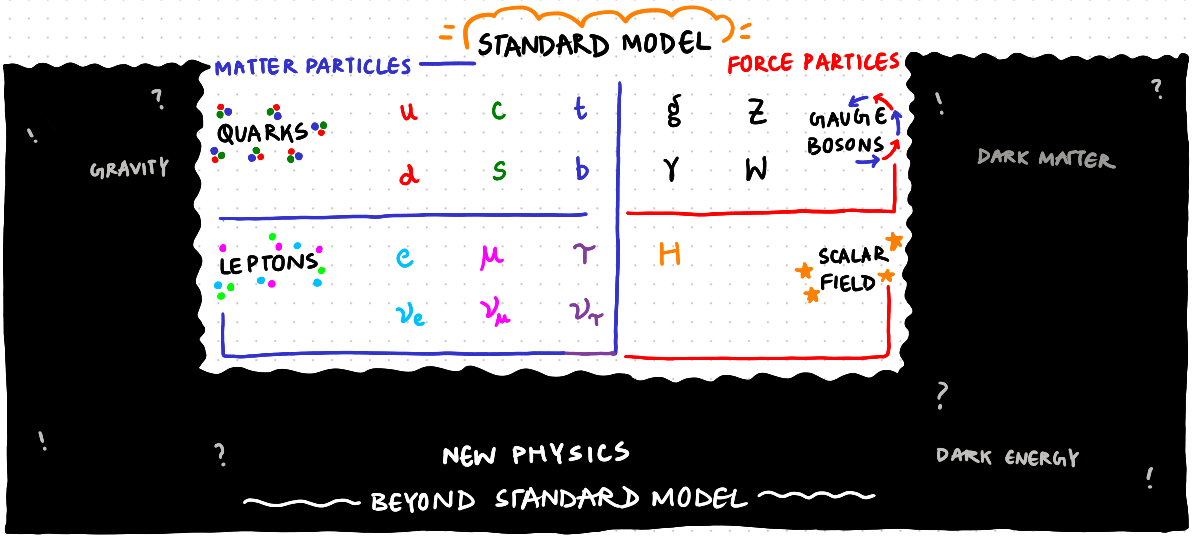
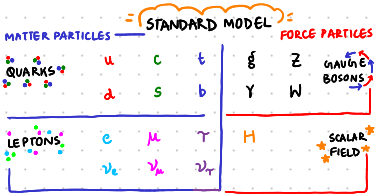
WASHINGTON COLLEGE



why study HH pairs ?


STANDARD MODEL
MATTER PARTICLES
FORCE PARTICLES
QUARKS
u
c
t
d
s
b
LEPTONS
e
μ
τ
νe
νμ
ντ
g
Z
γ
W
H
GAUGE BOSONS
SCALAR FIELD
GRAVITY
DARK MATTER
DARK ENERGY
NEW PHYSICS
BEYOND STANDARD MODEL



STANDARD MODEL MAKES PREDICTIONS ABOUT HIGGS BOSON PROPERTIES

DO PREDICTED PROPERTIES MATCH OBSERVATION?

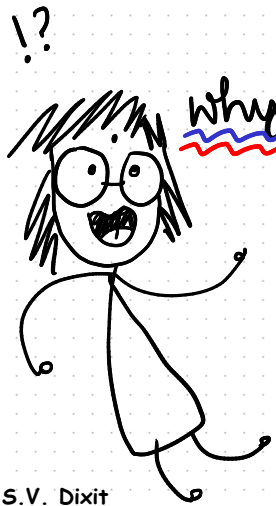
YES

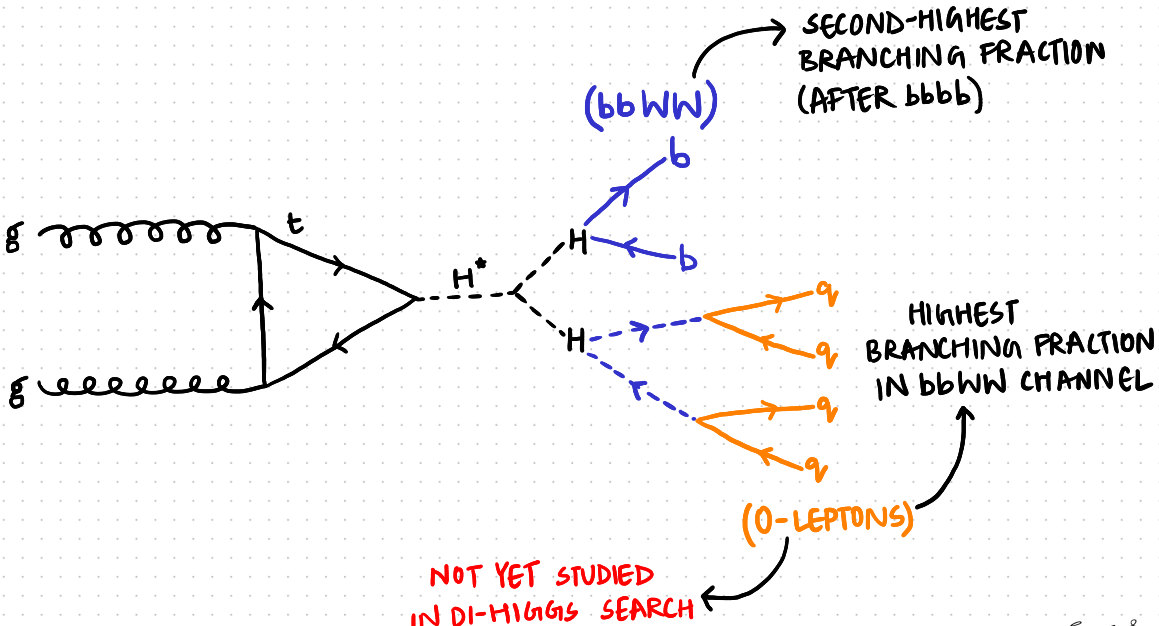
VALIDATION OF S.M. HIGGS MECHANISM

NO

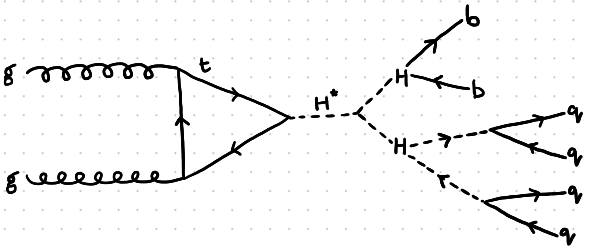
NEW PHYSICS?

Why study 0-lepton bbWW?



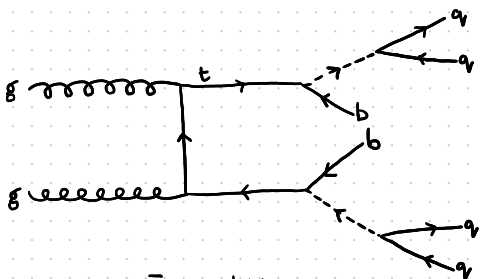

(bbWW)
SECOND-HIGHEST BRANCHING FRACTION (AFTER bbbb)
g
t
g
H*
H
b
b
H
q
q
q
q
HIGHEST BRANCHING FRACTION IN bbWW CHANNEL
(0-LEPTONS)
NOT YET STUDIED IN DI-HIGGS SEARCH

signal



$HH \longrightarrow bbWW$

primary background



$t\bar{t} \longrightarrow bbWW$

project timeline

MONTE CARLO SAMPLE GENERATION → KINEMATIC STUDY → TRIGGER STUDIES @ TRUTH LEVEL

MC sample generation (signal + background)

GENERATED USING POWHEG-BOX@2 @NLO+FT, PYTHIA-8

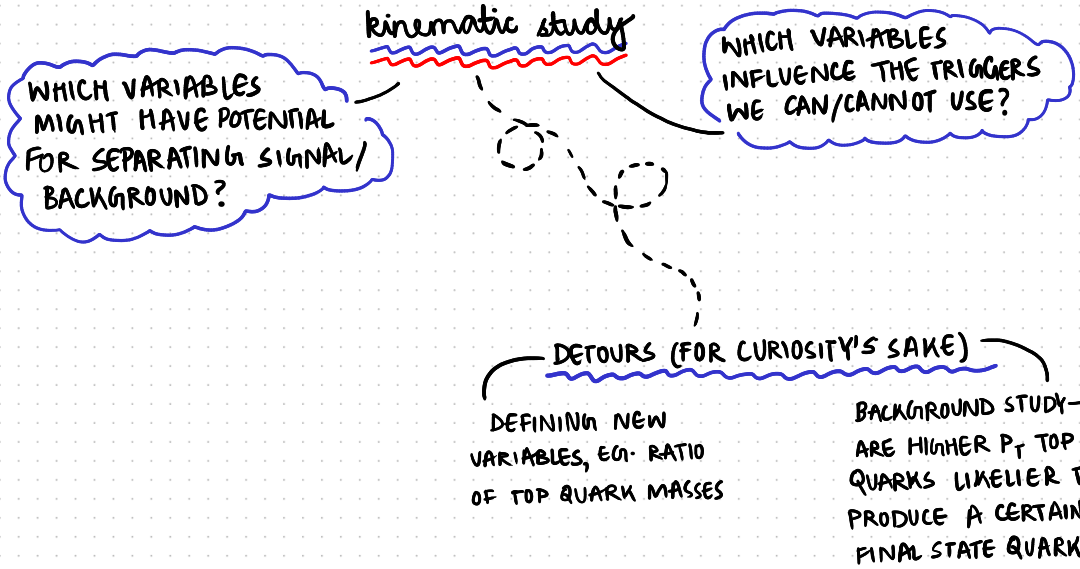
WORKED ON LXPLUS

PART OF JOBS SUBMITTED TO CONDOR

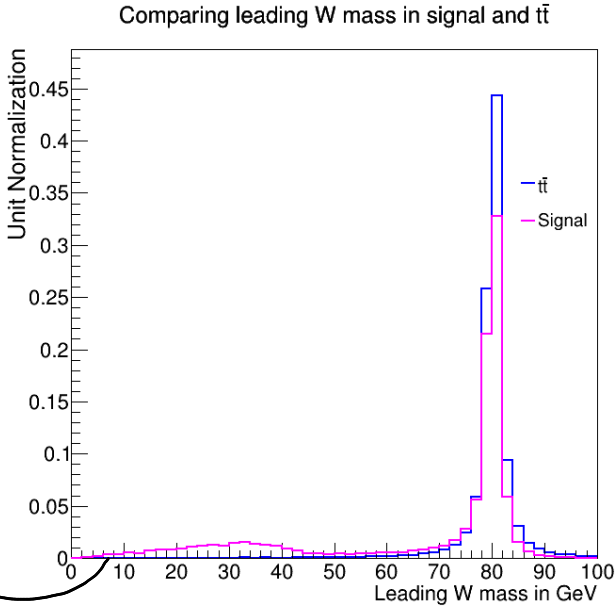
CHALLENGES FACED ☹

CONDOR— LARGE JOBS = MEMORY OVERFLOW, JOBS ABORTED.

SOLUTION— SUBMIT JOBS IN SMALLER BATCHES.

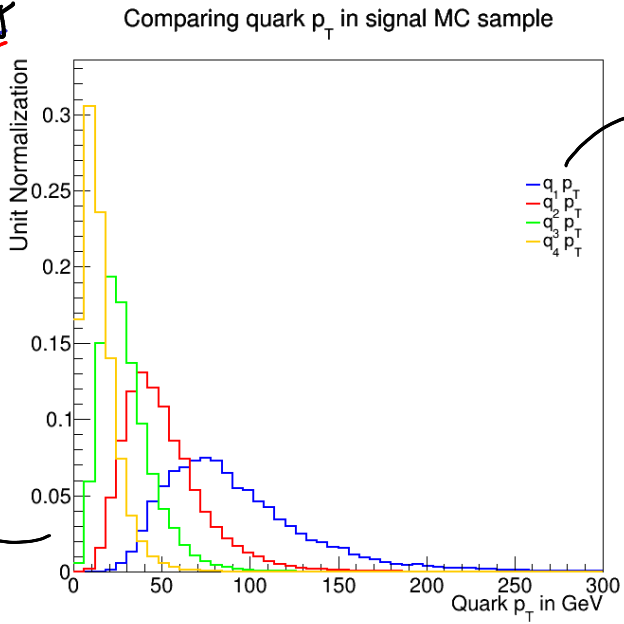

kinematic study
WHICH VARIABLES MIGHT HAVE POTENTIAL FOR SEPARATING SIGNAL/ BACKGROUND?
WHICH VARIABLES INFLUENCE THE TRIGGERS WE CAN/CANNOT USE?
DETOURS (FOR CURIOSITY'S SAKE)
DEFINING NEW VARIABLES, EG: RATIO OF TOP QUARK MASSES
BACKGROUND STUDY- ARE HIGHER P_T TOP QUARKS LIKELIER TO PRODUCE A CERTAIN FINAL STATE QUARK?

kinematic study



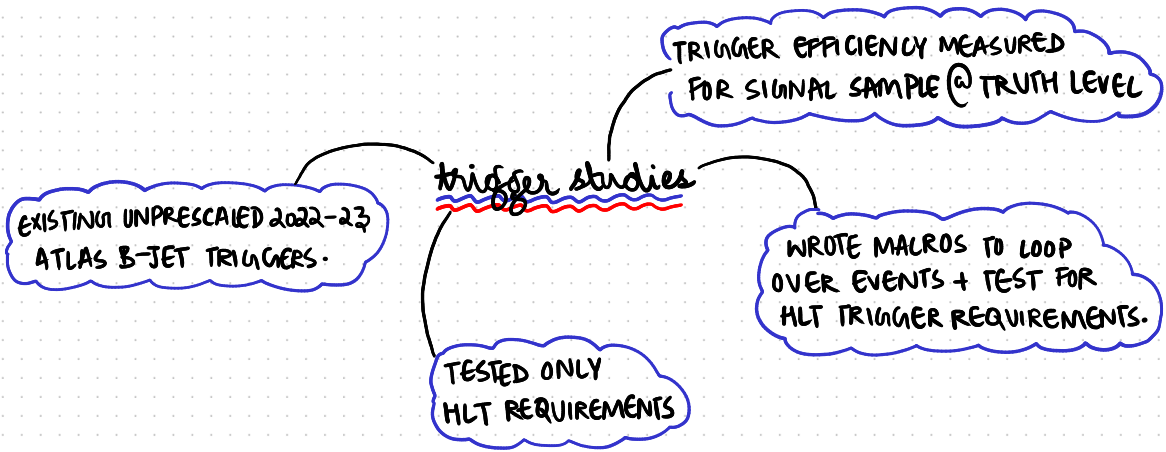
ONLY SIGNAL CURVE SHOWS OFF-SHELL PEAK.

kinematic study



q_1 = QUARK W/ HIGHEST P_T.
q_4 = QUARK W/ LOWEST P_T.

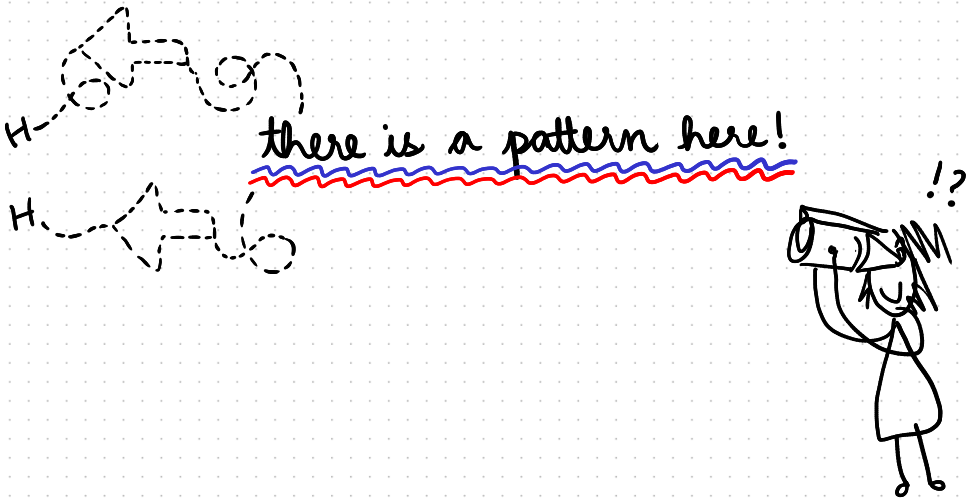
NOTE SMALL P_T OF SOFTER QUARKS


trigger studies
EXISTING UNPRESCALED 2022-23 ATLAS B-JET TRIGGERS.
TRIGGER EFFICIENCY MEASURED FOR SIGNAL SAMPLE @ TRUTH LEVEL
WROTE MACROS TO LOOP OVER EVENTS + TEST FOR HLT TRIGGER REQUIREMENTS.
TESTED ONLY HLT REQUIREMENTS

trigger studies

Trigger Name	Trigger Type	Efficiency
HLT_j75_0eta290_020jvt_bdl1d60_3j75_pf_ftf_preselj50b85XX3j50_L14J20	1b-jet + 3 jet	0.0534709
HLT_j175_0eta290_020jvt_bdl1d60_j60_0eta290_020jvt_bdl1d60_pf_ftf_ preselj140b85XXj45b85_L1J100	2b-jet	0.0756757
HLT_j150_2j55_0eta290_020jvt_bdl1d70_pf_ftf_preselj80XX2j45b90_L1J85_3J30	2b-jet +1 jet	0.122889
HLT_2j35c_020jvt_bdl1d60_2j35c_020jvt_pf_ftf_presel2j25XX2j25b85_L14J15p0ETA25	2b-jet +2 jet legacy HH	0.49531
HLT_2j45_0eta290_020jvt_bdl1d60_2j45_pf_ftf_presel2j25XX2j25b85_L14J15p0ETA25	2b-jet +2 jet	0.341151
HLT_2j35_0eta290_020jvt_bdl1d60_3j35_pf_ftf_presel3j25XX2j25b85_L15J15p0ETA25	2b-jet +3 jet	0.321451
HLT_2j35_0eta290_020jvt_bdl1d60_3j35_pf_ftf_presel3j25XX2j25b85_L15J15p0ETA25	2b-jet +3 jet	0.374903
HLT_2j45_0eta290_020jvt_bdl1d60_3j45_pf_ftf_presel3j25XX2j25b85_L15J15p0ETA25	2b-jet +3 jet	0.201544
HLT_j80c_020jvt_j55c_020jvt_j28c_020jvt_j20c_020jvt_SHARED_2j20c_020jvt_bdl1d77_pf_ftf_presel2c20XX2c20b85_L1J45p0ETA21_3J15p0ETA25	2b-jet +3 jet	0.685714

$$\text{EFFICIENCY} = \frac{\text{NO. OF EVENTS SATISFYING TRIGGER REQUIREMENTS}}{\text{TOTAL NO. OF EVENTS IN SAMPLE}}$$


H
H
there is a pattern here!
!?

TRIGGERS REQUIRING LOW LIGHTJET P_T ($\leq$ 35 GeV) ✓

TRIGGERS REQUIRING $\leq$ 2 BJETS ✓

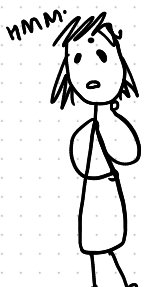
TRIGGERS REQUIRING $\leq$ 3 LIGHTJETS ✓

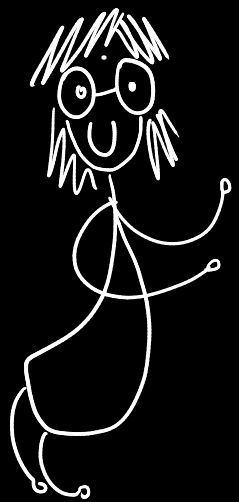
what to consider for trigger selection for 0-lepton bbWW?

TRIGGERS REQUIRING >1 LIGHTJET WITH $P_T \geq$ 40 GeV ✗

TRIGGERS REQUIRING >2 BJETS ✗

TRIGGERS REQUIRING >3 LIGHTJETS ✗





thank you!

+ questions?

SPECIAL THANKS TO

DR. SUYOG SHRESTHA (WASHINGTON COLLEGE)

ROSHAN JOSHI (OHIO STATE UNIVERSITY)