Status Report of boosted HH->bbττ analysis

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Outline

- * Introduction
- * Object tagging
- *** Event Selection**
- * Background estimation
- ***** Systematic uncertainties
- * Results

Introduction



*** Motivation of boosted analysis:**

- Searching for 2HDM Higgs and R-S model Graviton with M >= 1TeV.
- Cover high Higgs pT phase space.

*** Boosted topology:**

- Standard reconstruction techniques cease to resolve individual decay products.
- New reconstruction techniques are developed which are sensitive to boosted topology.

Object tagging



Large-R Jet:



- * One single anti-kT (R=1.0) jet
- * Leading two ghost-associated VR track jets with MV2c10@70%
 - VR track jets selection:
 - pT>10GeV, letal<2.5, N_track>2



Di-Tau (fully hadronic)

- * Di-Tau tagging:
- High-pT Large-R Jet with at least 2 anti-kT subjets (R=0.2)
- ID based on BDT with variables from calorimeter cells/clusters, tracks and vertices

Event Selection

- * Trigger: Large-R Jet trigger
- * Preselection:
 - MET > 10 GeV
 - Medium ID, OS Di-Tau selections (pT > 300 GeV, …)
 - Fake estimation from SS region
 - high-pT Large-R Jet selections (no match Di-Tau, pT > 300 GeV, ...)
- * Regions: Δφ(Di-Tau. MET)
 - QCDCR: Δφ>1, 0/1/2-tag
 - ZCR: Δφ<1, 0-tag
 - SR: Δφ<1, 1/2-tag</p>

Event Selection (can be optimized)

- * Trigger: Large-R Jet trigger
- * Preselection:
 - MET > 10 GeV ==> remove this cut to gain statistics in QCD region
 - Medium ID, OS Di-Tau selections (pT > 300 GeV, …)
 - Fake estimation from SS region ==> from SS 0-tag region
 - high-pT Large-R Jet selections (no match Di-Tau, pT > 300 GeV, ...)
- * Regions: Δφ(Di-Tau. MET)
 - QCDCR: $\Delta \phi > 1$, 0/1/2-tag ==> veto the Higgs mass window
 - ZCR: Δφ<1, 0-tag</p>
 - SR: $\Delta \phi < 1$, 1/2-tag ==> may drop 1-tag. Investigate mass window cut

Background estimation

* Monte Carlo:

- Z(->II)+jets, W+jets, single top, ttbar, Di-Boson
- Estimate truth Di-Taus and fake Di-Taus
- Sherpa Z+heavy flavour jets needs correction:
 - Calculate scale factors from VHbb Z+HF-riched region.Apply to HH bbtautau 2-tag SR.
 - Prelim SF = 1.198 +- 0.206
- * Data-driven method:
 - QCD multijets fake Di-Taus
 - Calculate fake factors in Same Sign (SS) region. Apply in Opposite Sign (OS) region
 - Di-tau fakes with high subleading pT have a better chance to pass the ID
 - Fake factors are binned in Di-Tau pT and subleading tau pT
 - Validate in QCD Control Regions



Background estimation (can be improved)

* Monte Carlo:

- Z(->II)+jets, W+jets, single top, ttbar, Di-Boson
- Estimate truth Di-Taus and fake Di-Taus
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* Data-driven method:

- QCD multijets fake Di-Taus
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==> ttbar modeling?

- ==> Extract true di-tau efficiency SFs from Z control region
- ==> Investigate ptBB dependence
- ==> Enlarge the uncertainty, check the impact on upper limits
- ==> Calculate in 0-tag SS, can also validation in 1/2-tag SS region (enriched with QCD process)
- ==> Alternative binning
- ==> Alternative method..

Systematics included

* **CP**:

- DiTau, LRJ, MET
- * Background modeling:
 - QCD FF, Z+HF SF

* ...

Systematics (should check/add)

* **CP**:

- DiTau, LRJ (new recommendation), MET
- b-tagging scale factor and uncertainties (CDI updates)
- * Background modeling:
 - QCD FF (only from statistics, additional systematics needed)
 - Z+HF SF (current uncertainty 2xstatistics not enough?)
 - Di-Tau efficiency SFs and uncertainty (extract from Z CR)
 - Material transport issue study (may need SFs or/and uncertainty)
 - ttbar modeling?
- * Signal theoretical:
 - Discrepancy between different parton shower generator.

Results 0-tag QCD CR



Results 1-tag QCD CR



Results 2-tag QCD CR



Results 0-tag Z CR



Results 1-tag SR



Results 2-tag SR



Results - Preliminary Exp σxBR limits @ CL=95%



Mass	-2σ	-1σ	Exp(fb)	+1σ	+2σ
1000	1.45	1.94	2.70	3.76	5.04
1200	0.28	0.38	0.53	0.73	0.98
1400	0.18	0.24	0.33	0.46	0.61
1600	0.14	0.19	0.26	0.36	0.48
1800	0.12	0.16	0.22	0.31	0.41
2000	0.11	0.15	0.21	0.29	0.38
2500	0.11	0.15	0.21	0.30	0.40
3000	0.15	0.20	0.28	0.38	0.52

Results - (to be checked)



==> 2-tag only (very small contribution from 1-tag SR) add 2-tag QCD region in the fit?

==> add systematics

. . .

==> calculate with ToyMC approach (here is asymptotic approach)

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