Projections for Di-Higgs searches in 4b final state at the High Luminosity LHC

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HH-PRODUCTION & DECAY CHANNELS

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Importance for SM Higgs physics
- Higgs trilinear coupling ($\lambda_{hhh}$)
- Shape of Higgs-potential

BSM Non-Resonant Production
- Via contact interaction with a heavy BSM mediator
- Modify $\lambda_{hhh}$ or introduce new vertices

BSM Resonant Production
- Higgs coupling with heavy resonance $X$
- Cross section enhancement on resonance

HH→ 4b Decay Channel
- Highest branching ratio (33%):
  - plenty of signal for study.
- With MIP timing detector (MTD):
  - Assume improvement in b-tagging performance
- Challenges:
  - Huge Multijets background contribution
  - Need proper background modelling

NON-RESONANT SEARCHES

BSM Non-Resonant Production
- Via contact interaction with a heavy BSM mediator
- Modify $\lambda_{hhh}$ or introduce new vertices

BSM Resonant Production
- Higgs coupling with heavy resonance $X$
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WARPED EXTRA DIMENSION BSM

Model:
- Predict spin-2 KK-Graviton particle
- Resonance may not couple to quarks and Gluons
  - VBF production might be dominant

Motivation:
- VBF channel accessible at HL-LHC
- With CMS Phase-2 analysis benefits in:
  - Boosted $H \rightarrow bb$ tagging with extended tracker coverage
  - VBF Jets identification with HGCal

Event selections:
- Higgs Jet Selection:
  - AK8 Jets with $p_T > 300$ GeV
  - $|\eta| < 3$
  - NSubtettiness < 0.6
  - Soft-Dropped Mass = [90, 140]
  - Subjet b-tagging with DeepCSV

RESULTS: $M_{jj}$ spectrum
- Background Estimation:
  - Background reweighted with subjet b-tagging efficiency for $M_{jj}$ distribution

RESULTS: Significance
- Calculated with 3b and 4b categories combinely.
- Possible Evidence of 3 TeV Graviton.

REFERENCES:
1. Search Sensitivity for BSM resonances in 4b final state at HL-LHC - CMS PAS FTR-18-003
2. Higgs measurements at HL-LHC - CMS PAS FTR-18-019