$H \rightarrow$ Exotics

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On behalf of many contributors

Y4 - Goals

Goals of the working group

S. Gori @ 10th LHCHXS WS

Searches for new decay modes of the 125 GeV Higgs boson

Four main broad topics:

1. Flavor changing decays. Example: $h \to \tau\mu$
   Rare decays to mesons. Example: $h \to J/\Psi + \gamma$
2. Prompt decays without MET. Example: $h \to aa \to (b\bar{b})(\mu\bar{\mu})$
3. Prompt decays with MET. Example: $h \to \chi\chi \to 2\gamma + \mathrm{MET}$
4. Decays with displaced vertices. Example: $h \to g_B g_B \to 4f$

Constructive relations between theorists and experimentalists

Working mode:

- Motivations
- Benchmark scenarios for the interpretation of the results
- Feasibility studies

- Trigger capabilities
- Efficiency maps for low p_T objects
- Fiducial observables for displaced objects

Theorists ⟷ Experimentalists

Y4 - Summary (Y4 yellow paper report)

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2. Recommendations for searches

Simple list

- Signature based approach
  - Similar signatures appears in different models
  - Combination as a second step
- Quote results in terms of $\sigma \times BR$
  - Allows re-interpretation
  - Ease combination
- Event generators and modeling of Higgs p_T spectrum
  - Decay products tend to be soft
    - Typically at least three particles in the final state
  - Sensitivity depends on the Higgs p_T spectrum
  - Production: MadGraph followed by hadronization & showering with Pythia
  - X-section normalized to WG1 predictions
  - p_T spectrum re-weighted according to HRES

3. No MET: H→XX→4Y - study @ parton level

- Typical signature in many models
  - NMSSM - H decays to two light (pseudo-)scalars
  - Dark matter - no SU(2) WIMP, additional singlet state in a dark sector
  - Hidden naturalness
  - …

2. Decays without MET

S. Gori @ 10th LHCHXS WS

Solid analysis in our survey on Higgs exotic decays
Curtin et al. 1312.4992

Example: $h \to ss \to 4f$

Presentation of the results:

Decay Mode $\mathcal{F}_i$	Projected/Current 2σ Limit on BR($\mathcal{F}_i$) 7/8 [14] TeV	Production Mode	quarks allowed: $\frac{\text{BR}(\mathcal{F}_i)}{\text{BR(non-SM)}}$	quarks allowed: Limit on $\frac{\sigma}{\sigma_{SM}} \cdot$ BR(non-SM) 7/8 [14] TeV
$bbbb$	0.7^R [0.2^L]	W	0.8	0.9 [0.2]
$b\bar{b}\tau\tau$	> 1 [0.15^L]	V	0.1	> 1 [1]
$b\bar{b}\mu\mu$	$(2-7)\cdot 10^{-4\,T}$ [$(0.6-2)\cdot 10^{-4\,T}$]	G	3×10^{-4}	$0.6-1$ [$0.2-0.7$]
$\tau\tau\tau\tau$	$0.2-0.4^R$ [U]	G	0.005	$40-80$ [U]
$\tau\tau\mu\mu$	$(3-7)\cdot 10^{-4\,T}$ [U]	G	3×10^{-5}	$10-20$ [U]
$\mu\mu\mu\mu$	$1\cdot 10^{-4\,R}$ [U]	G	$1\cdot 10^{-7}$	1000 [U]

Run II triggers will be very important for assessing the feasibility/goodness of these searches.
Under investigation

This can be read in terms of a bound on the operator $|H|^2|S|^2$ as a function of the mass m_s

3. No MET: H→XX→4Y - study @ parton level

- Typical signature in many models
  - NMSSM - H decays to two light (pseudo-)scalars
  - Dark matter - no SU(2) WIMP, additional singlet state in a dark sector
  - Hidden naturalness
  - …

Test case: H→2a→4b

- Additional singlet (pseudo-)scalar

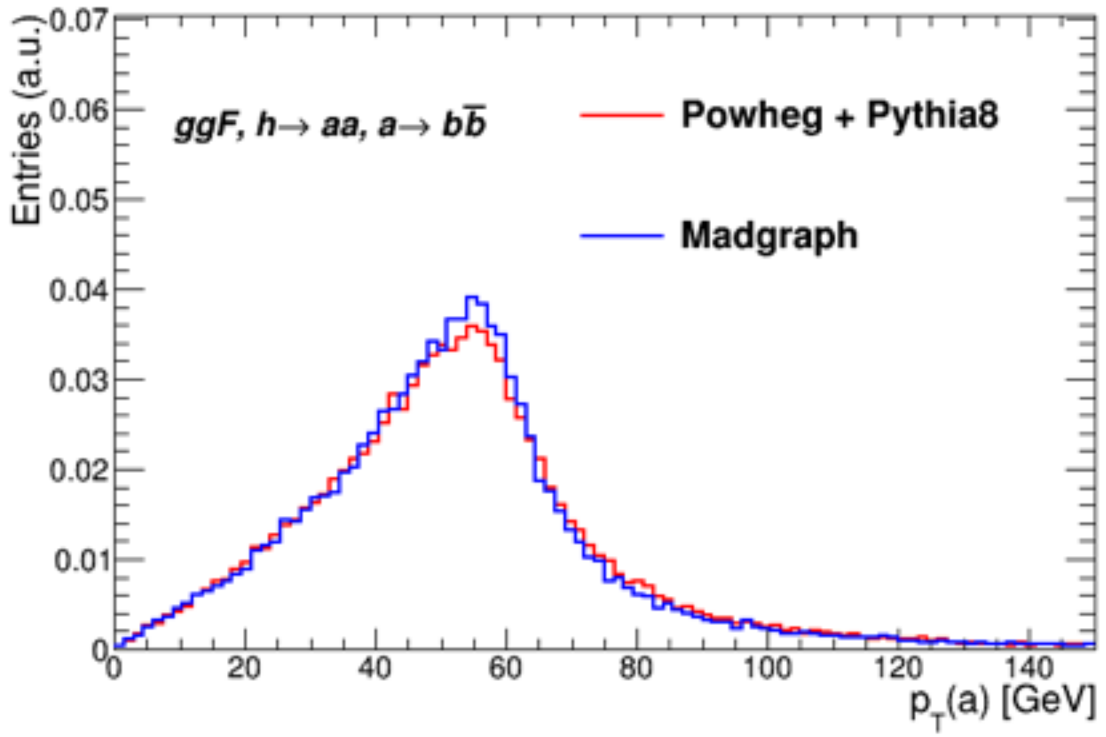
$$\mathcal{L}^{\rm BSM} \supset i y_b^a a \bar{b}\gamma_5 b + \frac{1}{2}\lambda_{aH}(H^\dagger H)a^2 + \frac{1}{2}m_a^2 a^2,$$

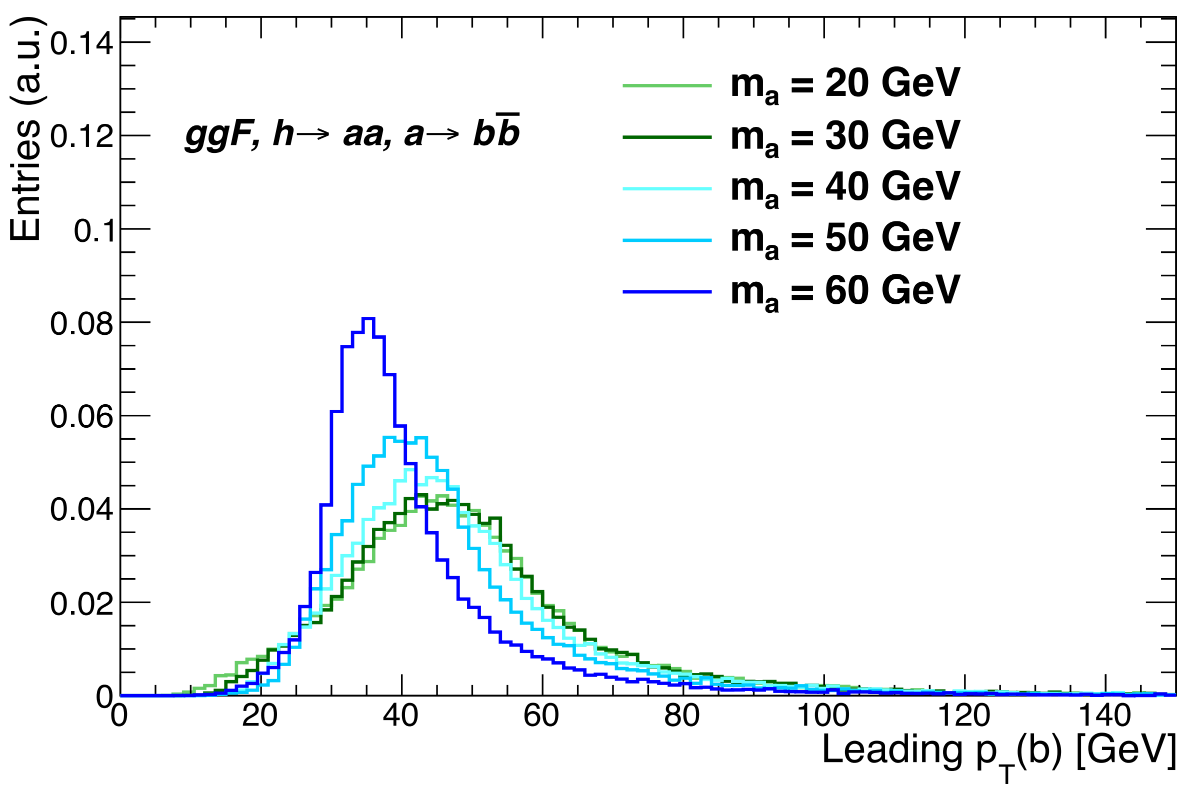
- Considered: ggF, VBF, VH
- Compared LO to NLO
  - Comparing MadGraph & Powheg+Pythia results
- Re-weighting according to HRES predictions - not yet done

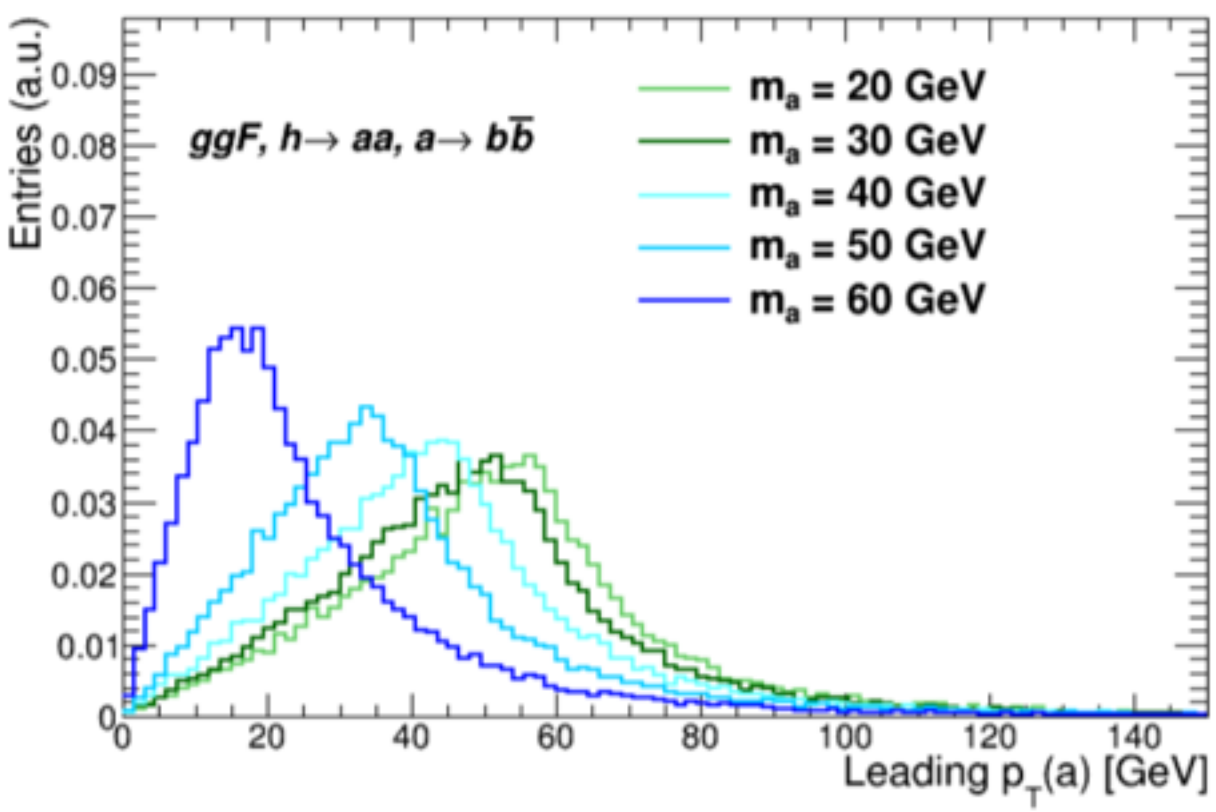
Test case: H→2a→4b

Possible discriminators

- Studied for m_a in the range [20,60] GeV
  - MadGraph/Powheg+Pythia8 in good agreement
- Leading b $p_T \rightarrow$ Soft spectra
- Leading a pT



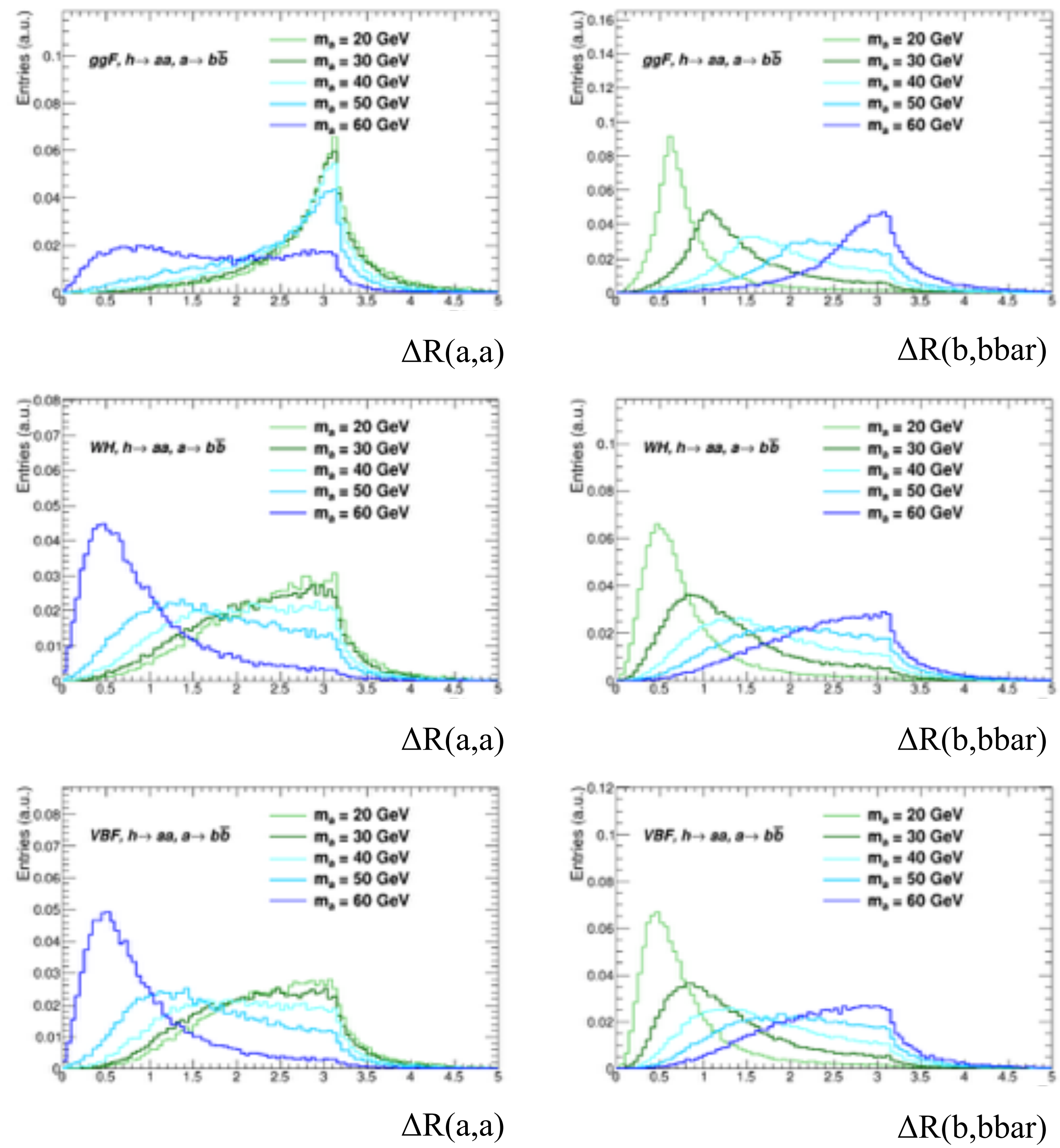




Test case: H→2a→4b

Possible discriminators

- Studied for m_a in the range [20,60] GeV
- Leading b p_T
- Leading a pT
- ΔR(a,a)
  - Lighter a's are back to back
- ΔR(b,bbar)
  - b's from lighter a are collinear



Take away

- MadGraph re-weighted according to HRES is sufficient
- Soft objects in the final state → Pay special attention to selection efficiency and triggers

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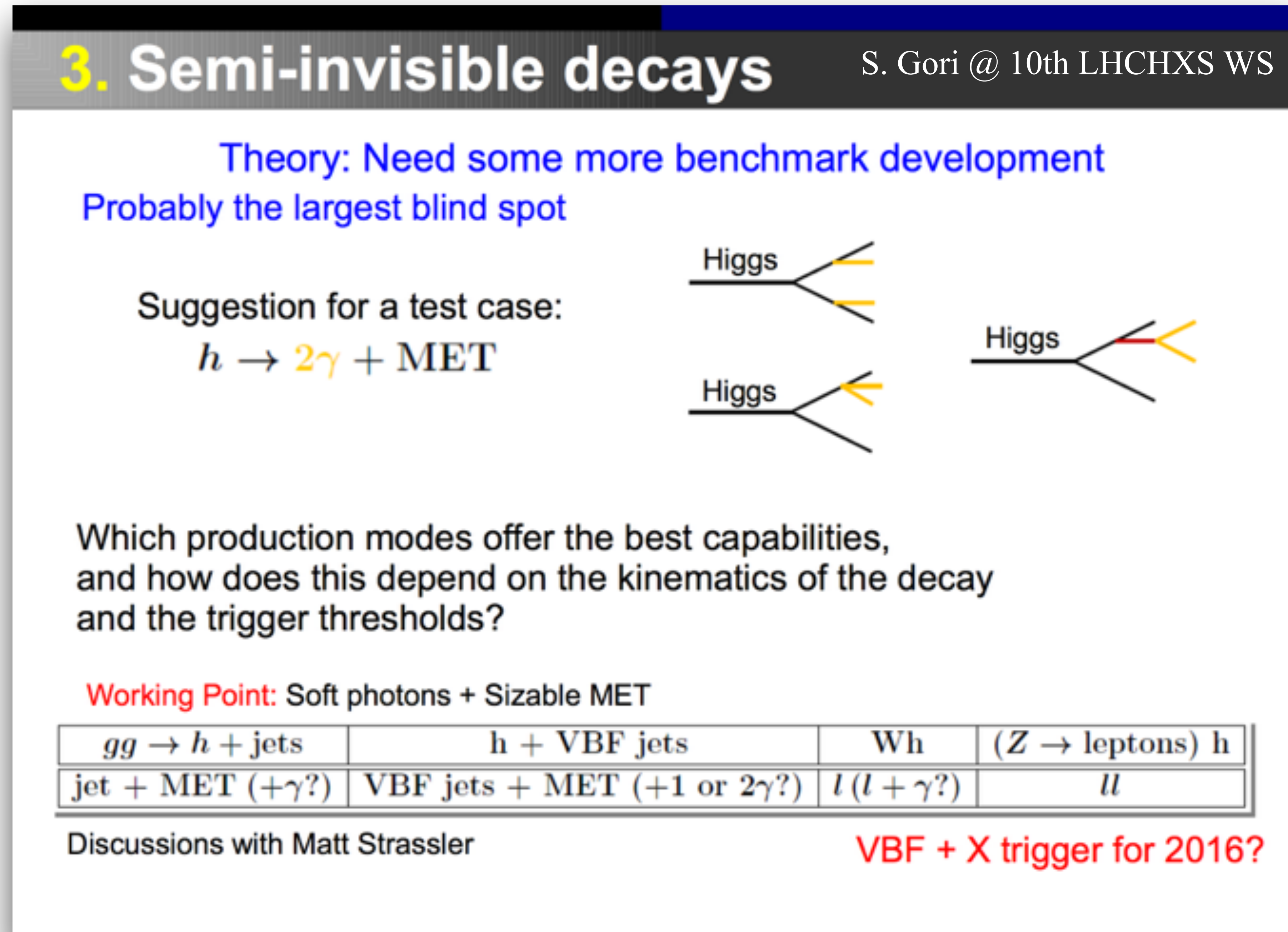
4. Semi-invisible decays

- Typical signature in many models
  - Least studied scenario so far

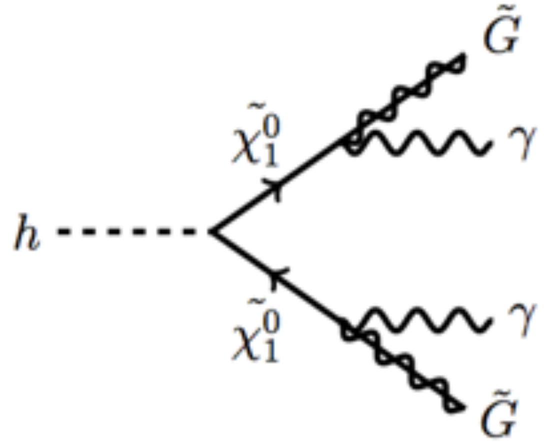


4. H→2γ+MET - feasibility study

- Estimated sensitivity @ sqrt(S)=14 TeV with 100 fb^{-1}
- MadGraph+Pythia followed by DELPHES with CMS card
- Considered: ggF, ZH

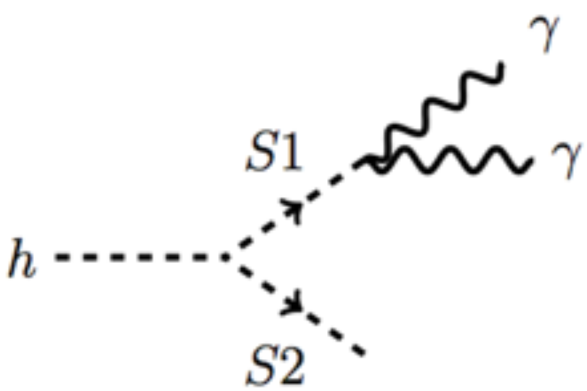
Non-resonant

- H→XX; X→γY
  - Y - stable neutral
  - Example GMSB
- Benchmark
  - GMSB cascade decay
  - Gravitino mass ~0
  - Neutralino mass in the range [10,60] GeV



Resonant

- H→S_1S_2; S_1→2γ; S_2 escapes detection
  - Benefits from a 2γ peak
- Benchmark
  - S_1 and S_2 have the same mass in the range [10,60] GeV



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4. H→2γ+MET - feasibility study

SM background

- Main sources: γ/Z/W+jets
- Di-boson
- QCD sub-dominant

Analysis strategy

- Derived from the trigger

	gluon Fusion			ZH
Variable	Asymmetric $\gamma\gamma$	Symmetric $\gamma\gamma$	$\gamma + E_{\mathrm{T}}^{\mathrm{miss}}$	
Number of photons	> 1	> 1	> 1	> 1
$p_T(\gamma_1)$	> 45 GeV	> 40 GeV	> 55 GeV	> 15 GeV
$\lvert\eta(\gamma_1)\rvert$	< 2.5	< 2.5	< 1.4	< 2.5
$p_T(\gamma_2)$	> 30 GeV	> 40 GeV	> 15 GeV	> 15 GeV
$\lvert\eta(\gamma_2)\rvert$	< 2.5	< 2.5	< 2.5	< 2.5
$M(\gamma\gamma)$	$\in [15, 100]$ GeV	< 100 GeV	< 100 GeV	< 100 GeV
$E_{\mathrm{T}}^{\mathrm{miss}}$	> 40 GeV	> 40 GeV	> 50 GeV	> 40 GeV
Number of leptons	< 1	< 1	< 1	-
Number of muons	-	-	-	> 1
$p_T(\mu_{1,2})$	-	-	-	> 20 GeV
$\lvert\eta(\mu_{1,2})\rvert$	-	-	-	< 2.5
$M(\mu\mu)$	-	-	-	$\in [70, 110]$ GeV

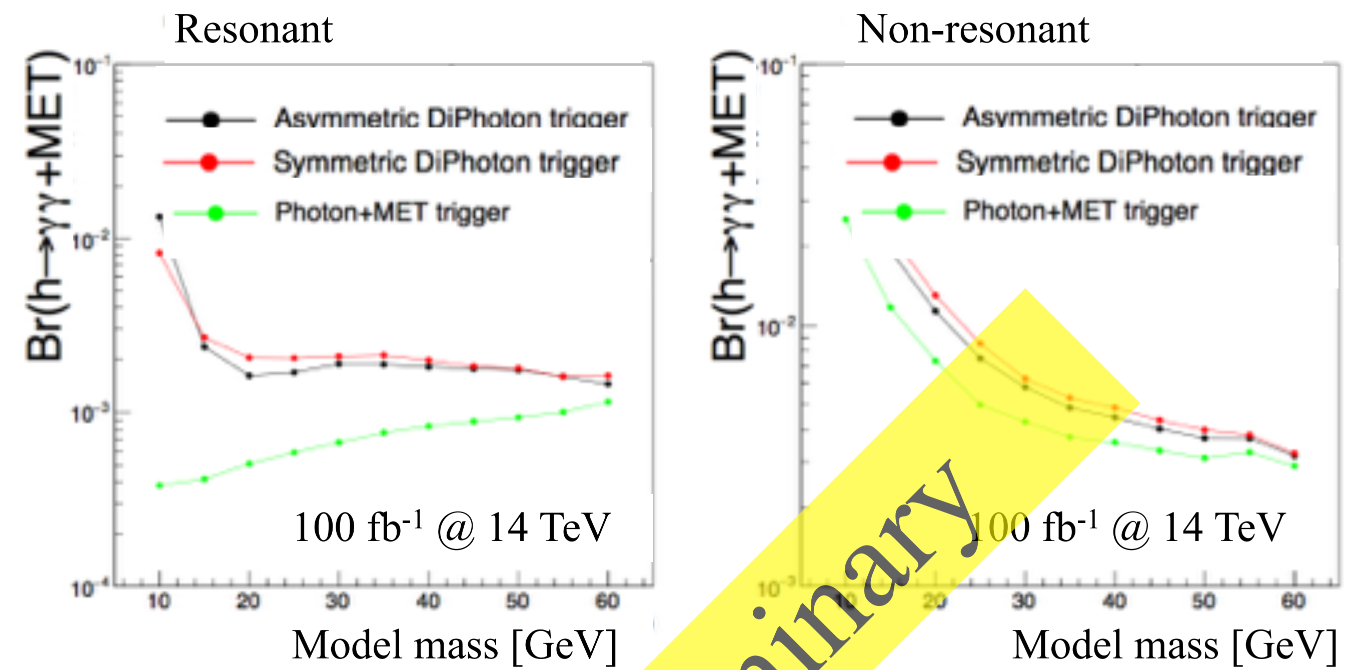
Resonant case - cut also on $m_{\gamma\gamma}$

4. H→2γ+MET - feasibility study

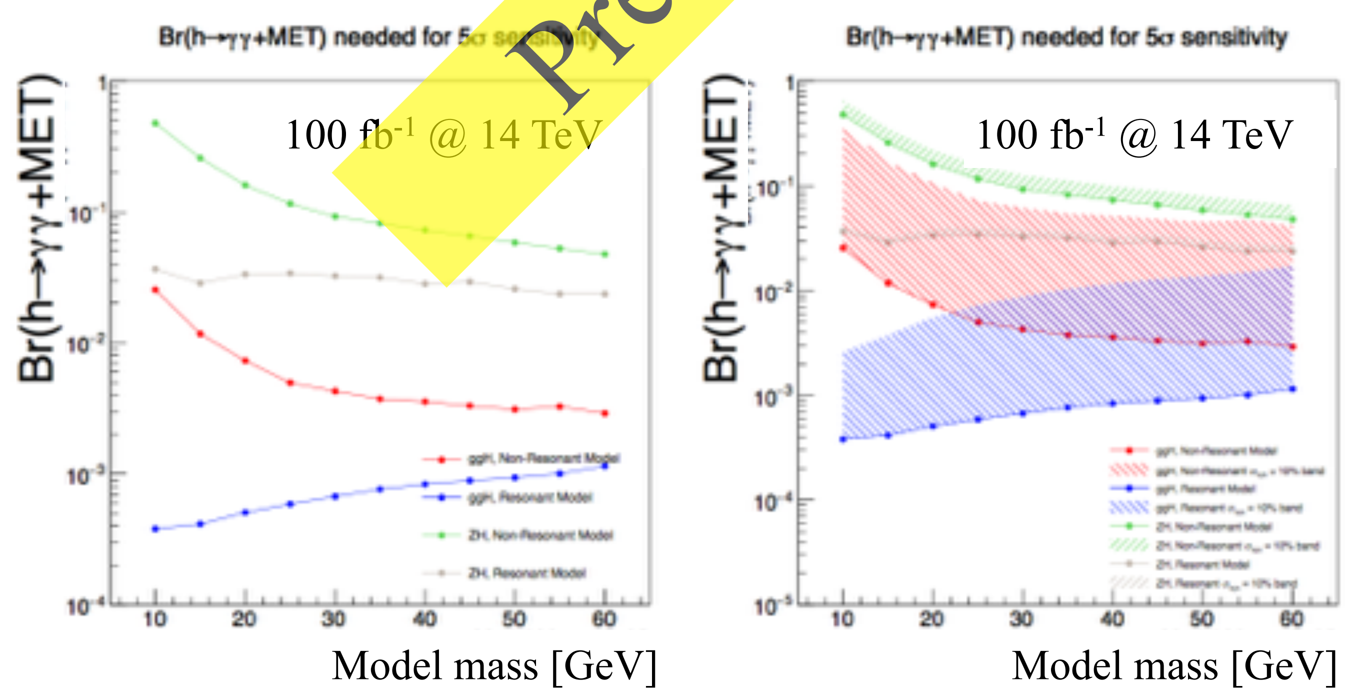
Expected sensitivity

- 5σ sensitivity for the different trigger scenarios
  - No systematic uncertainties
  - ggF

$$S = \frac{N_{\mathrm{Signal}}}{\sqrt{N_{\mathrm{Background}}}}.$$



- 5σ sensitivity for the different trigger scenarios
  - 10% systematic uncertainties
  - ZH



$$S_{sys} = \frac{N_{\mathrm{Signal}}}{\sqrt{N_{\mathrm{Background}} + \sigma_{sys} \times N_{\mathrm{Background}}}},$$

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5. Long-lived particles (Displaced Vertices) - survey

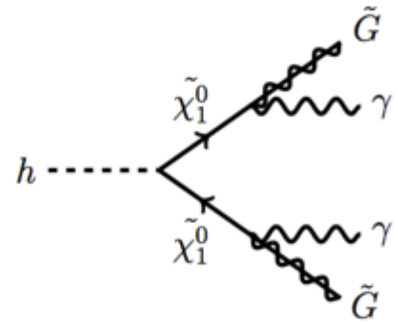
- Particles with proper life time $C\tau \geq \mu m$ arise in many BSM scenarios
- Decays in a measurable distance from the interaction point
- An on-going experimental/phenomenological effort

hXX-HF

- $h \rightarrow XX \rightarrow SM$
  - X - hidden sector (pseudo-)scalar
  - Coupling to SM inherited from mixing with SM-like Higgs
  - Preferred third generation fermions $\rightarrow$ Heavy Flavour (HV)

Displaced photons

- Low scale GMSB
  - Long-lived bino like neutralino



Displaced spin-one bosons

- $H \rightarrow \gamma_D \gamma_D \rightarrow SM$

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5. Long-lived particles (Displaced Vertices) - survey

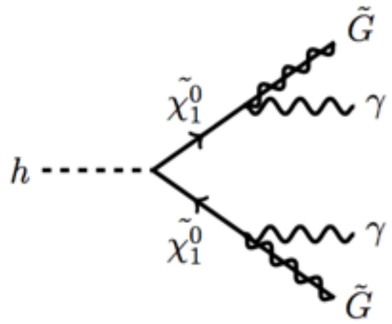
- Particles with proper life time $C\tau \geq \mu m$ arise in many BSM scenarios
- Decays in a measurable distance from the interaction point
- An on-going experimental/phenomenological effort

hXX-HF

- $h \to XX \to SM$
  - X - hidden sector (pseudo-)scalar
  - Coupling to SM inherited from mixing with SM-like Higgs
  - Preferred third generation fermions $\to$ Heavy Flavour (HV)
- Several searches are being done
- Improve sensitivity by requiring 1 DV
  - Low threshold on associated objects is needed for triggering

Displaced photons

- Low scale GMSB
  - Long-lived bio like neutralino



Displaced spin-one bosons

- $H \to \gamma_D \gamma_D \to SM$

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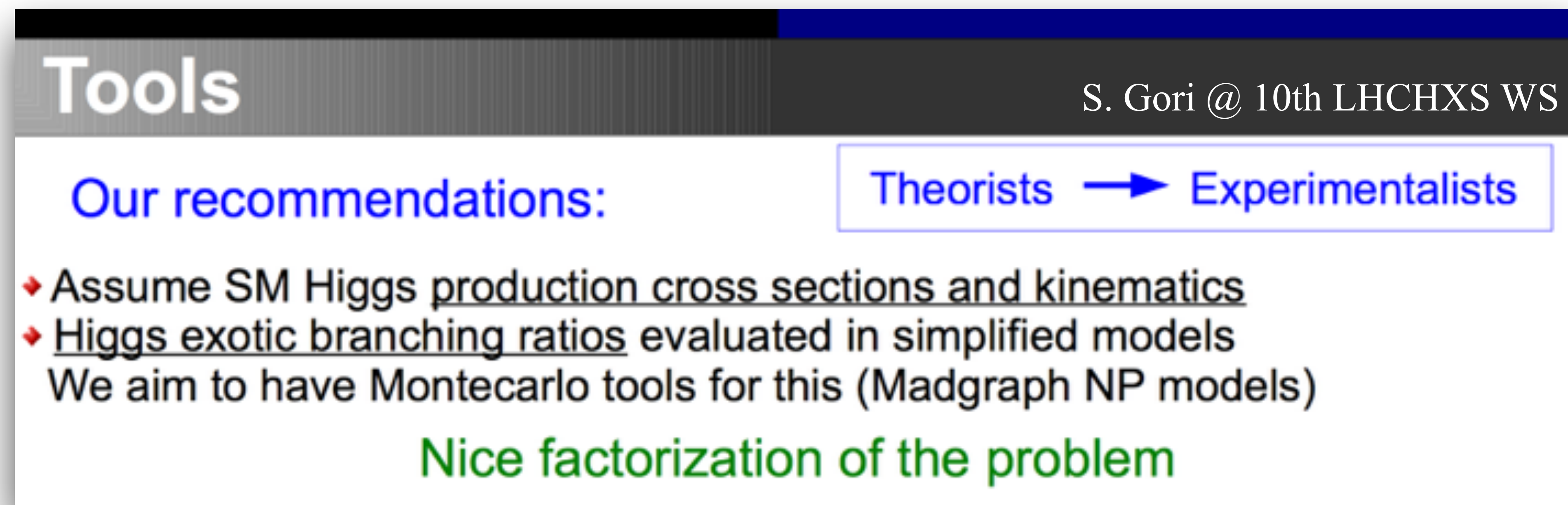
5. Long-lived particles (Displaced Vertices) - survey

hXX-HF - simplified model

$$\mathcal{L} \supset \frac{1}{2}(\partial_\mu X)^2 - \frac{1}{2}m_X^2 X^2 - g_X v h X X - \epsilon_v v^2 h X$$

- Small h/X mixing
  - $\epsilon_v \leq 10^{-4}$ has negligible effect on m_h and BR(h→SM)
- h→XX controlled by g_X - effective coupling independent of the mixing



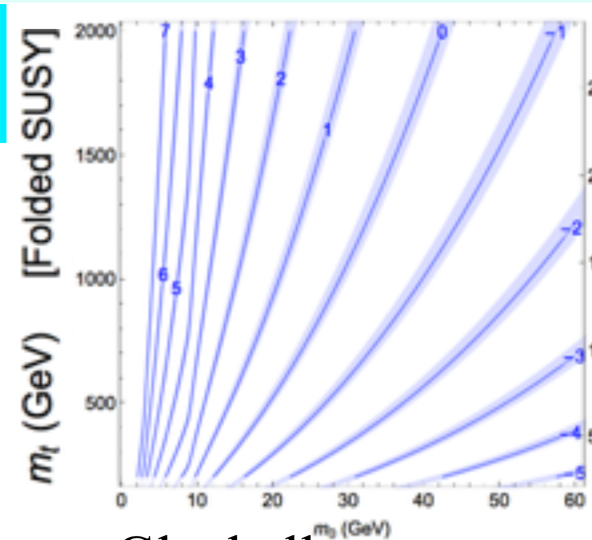
- Realized in MadGraph
  - http://insti.physics.sunysb.edu/~curtin/hahm_mg.html
- Building a model library is a parallel effort to the Y4 report

5. Long-lived particles (Displaced Vertices) - survey

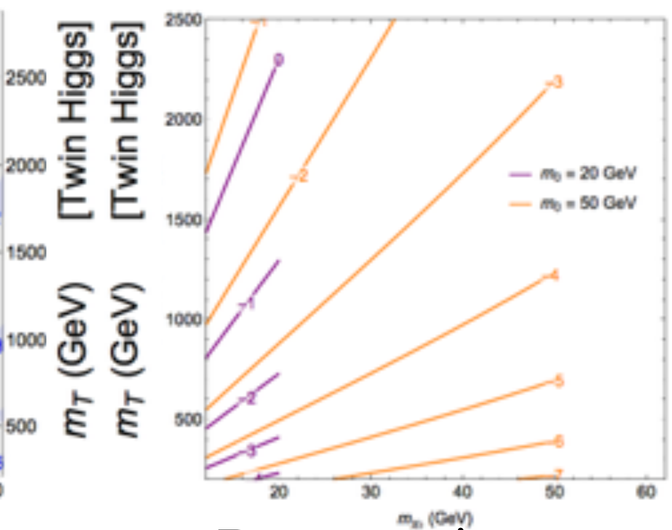
Neutral naturalness

- Top partner related to the top through a discrete symmetry
  → leads to color neutral top
- Hidden QCD group ensures similar running of the top and its partner
  - Needed for loop cancellation
- Realization of the hidden valley scenario
  - Allows for the hidden gluons, hadrons, glueballs and quarkonia

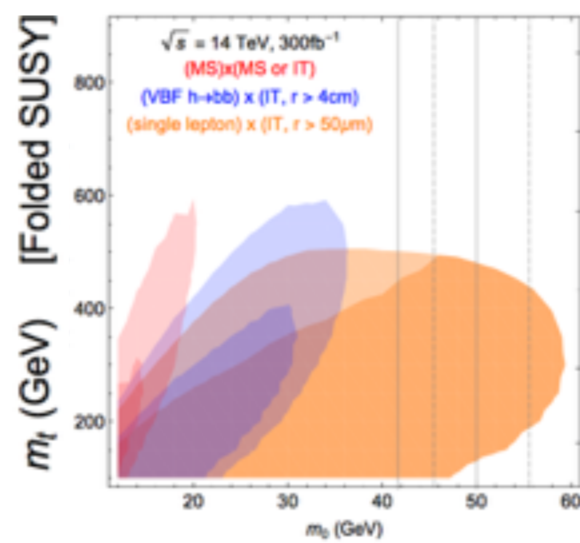
- Realizations: **Folded SUSY** and **Twin Higgs**
- Reach list of suggested searches
  - One DV + associated object
    - Trigger on the other object
    - Better sensitivity to shorter life times

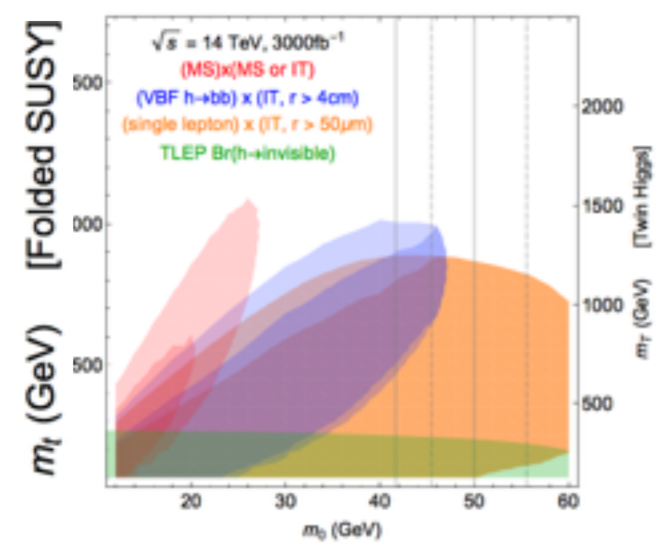


Glueball mass



Bottomonium mass





		$c\tau_X$ (m)		
		10^{-5}	10^{-1}	10
m_X (GeV)	7	short7	medium7	long7
	15	short15	medium15	long15
	40	short40	medium40	long40
	55	short55	medium55	long55

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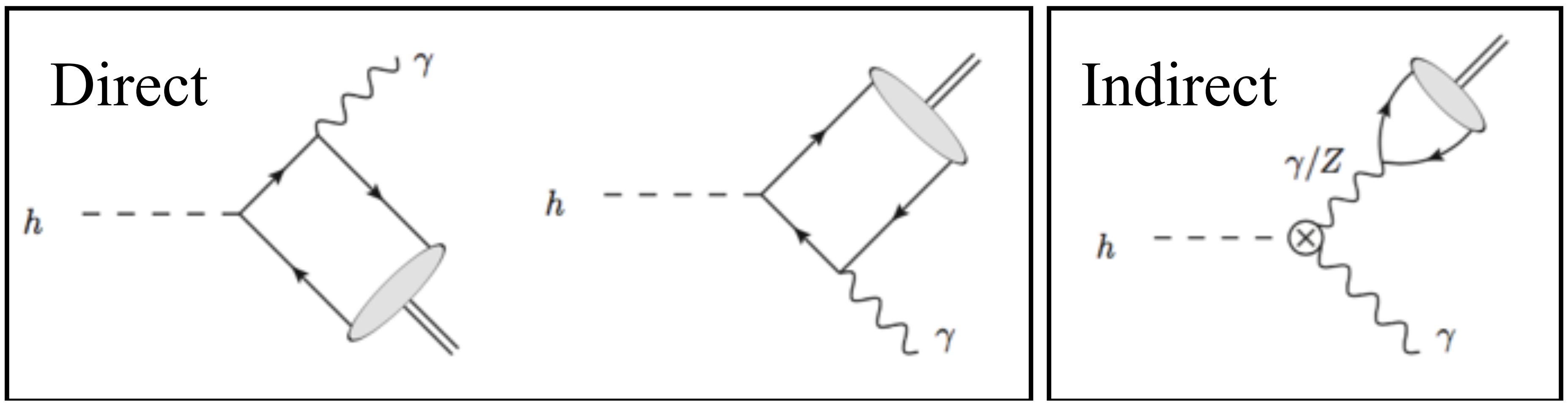
6. Exclusive mesonic decays - survey

H→Vγ | In the SM

- A probe of the Higgs coupling to light quarks
  - Sensitivity only at Hadron Colliders due to the small BR



Mode / Method	Branching Fraction $[10^{-6}]$ NRQCD [60]	LCDA LO [59]	LCDA NLO [62]
$\mathrm{Br}(H \to \rho^0 \gamma)$	–	19.0 ± 1.5	16.8 ± 0.8
$\mathrm{Br}(H \to \omega \gamma)$	–	1.60 ± 0.17	1.48 ± 0.08
$\mathrm{Br}(H \to \phi \gamma)$	–	3.00 ± 0.13	2.31 ± 0.11
$\mathrm{Br}(H \to J/\psi\, \gamma)$	–	2.95 ± 0.17	$2.79\,^{+0.16}_{-0.15}$
$\mathrm{Br}(H \to \Upsilon(1S)\, \gamma)$	$(0.61\,^{+1.74}_{-0.61}) \cdot 10^{-3}$	–	$(4.61\,^{+1.76}_{-1.23}) \cdot 10^{-3}$
$\mathrm{Br}(H \to \Upsilon(2S)\, \gamma)$	$(2.34\,^{+0.76}_{-1.00}) \cdot 10^{-3}$	–	$(2.02\,^{+1.86}_{-1.28}) \cdot 10^{-3}$
$\mathrm{Br}(H \to \Upsilon(3S)\, \gamma)$	$(2.13\,^{+0.76}_{-1.13}) \cdot 10^{-3}$	–	$(2.44\,^{+1.75}_{-1.30}) \cdot 10^{-3}$

Table 2: Theoretical predictions for the $H \to V\gamma$ branching ratios in the SM, obtained using different theoretical approaches.

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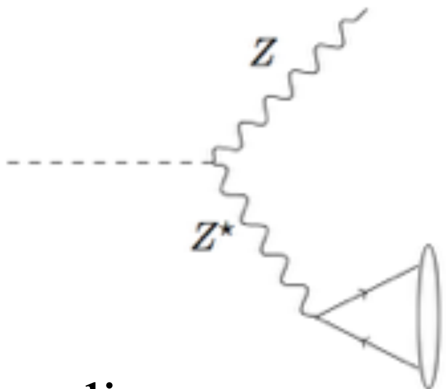
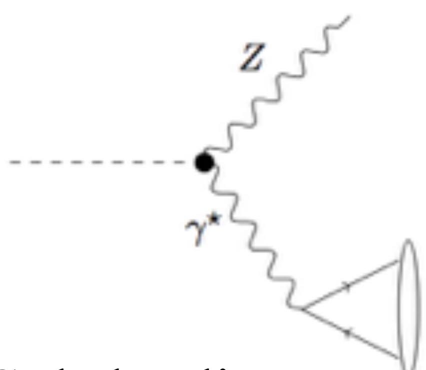
6. Exclusive mesonic decays - survey

H→VP (massive gauge bosons)

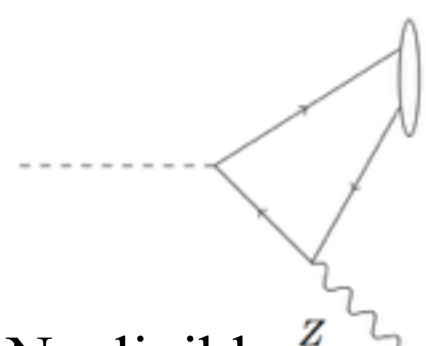
In the SM



Leading



Sub-leading



Negligible

VP mode	P mass	F_P	$\mathcal{B}^{SM}$	Th. Error
$W^-\pi^+$	139.57018 ± 0.00035 MeV	126.6 ± 1.4 MeV	0.42×10^{-5}	±5%
W^-K^+	493.677 ± 0.016 MeV	35.2 ± 0.3 MeV	0.33×10^{-6}	±4%
$W^-D_s^+$	1968.30 ± 0.11 MeV	248.6 ± 2.4 MeV	1.6×10^{-5}	±4%
W^-D^+	1869.61 ± 0.09 MeV	47.07 ± 2.4 MeV	0.58×10^{-6}	±11%
W^-B^+	5279.29 ± 0.15 MeV	0.79 ± 0.10 MeV	1.6×10^{-10}	±26%
$W^-B_c^+$	6275.1 ± 1.0 MeV	7.82 ± 0.42 MeV	1.6×10^{-8}	±11%
$Z^0\pi^0$	134.9766 ± 0.0006 MeV	92.1 ± 1.0 MeV	0.23×10^{-5}	±5%
$Z^0\eta_c$	2984.3 ± 0.84 MeV	197.4 ± 0.30 MeV	1.0×10^{-5}	±5%

Preliminary

$VP^\star$ mode	$P^\star$ mass	$F^\star_P/2$	$\mathcal{B}^{SM}$	Th. Error
$W^-\rho^+$	775.26 ± 0.25 MeV	210 ± 5.5 MeV [12]	1.5×10^{-5}	±6%
$W^-K^{\star+}$	891.66 ± 0.026 MeV	35.8 ± 0.3 MeV	4.3×10^{-7}	±4%
W^-D^+	2010.26 ± 0.07 MeV	61.1 ± 0.6 MeV	1.3×10^{-6}	±6%
$W^-D_s^{\star+}$	2112.1 ± 0.4 MeV	320.5 ± 3.1 MeV	3.5×10^{-5}	±6%
$W^-B^{\star+}$	5325.2 ±0.4 MeV	194.3 ± 15.8 MeV [13]	1.3×10^{-5}	±17%
$Z^0J/\Psi(1S)$	3096.916 ± 0.011 MeV	405 ± - MeV	3.2×10^{-6}	± − %
$Z^0J/\Psi(2S)$	3686.109 ± 0.013 MeV	290 ± - MeV	1.5×10^{-6}	± − %
$Z^0\Upsilon(1S)$	9460.30 ± 0.26 MeV	680 ± - MeV	1.7×10^{-5}	± − %
$Z^0\Upsilon(2S)$	10023.26 ± 0.31 MeV	485 ± - MeV	8.9×10^{-6}	± − %
$Z^0\Upsilon(3S)$	10355.2 ± 0.5 MeV	420 ± - MeV	6.7×10^{-6}	± − %
$Z^0\rho^0$	775.26 ± 0.25 MeV	216 ± 5.5 MeV [12]	1.4×10^{-5}	±6%
$Z^0\omega^0$	782.65 ± 0.12 MeV	216 ± 5.5 MeV	1.6×10^{-6}	±6%
$Z^0\phi^0$	1019.461 ± 0.019 MeV	233 ± 5 MeV [14]	4.2×10^{-6}	±6%

P- pseudo-scalar; P*- vector meson

6. Exclusive mesonic decays - survey

New Physics models | Enhanced BR (Flavour conserving)

Model	κ_t	$\kappa_{c(u)}/\kappa_t$	$\tilde{\kappa}_t/\kappa_t$	$\tilde{\kappa}_{c(u)}/\kappa_t$
SM	1	1	0	0
NFC	$V_{hu}\, v_W/v_u$	1	0	0
MSSM	$\cos\alpha/\sin\beta$	1	0	0
GL	$1+\mathcal{O}(\epsilon^2)$	$\simeq 3(7)$	$\mathcal{O}(\epsilon^2)$	$\mathcal{O}(\kappa_{c(u)})$
GL2	$\cos\alpha/\sin\beta$	$\simeq 3(7)$	$\mathcal{O}(\epsilon^2)$	$\mathcal{O}(\kappa_{c(u)})$
MFV	$1+\frac{\mathrm{Re}(a_u v_W^2+2b_u m_t^2)}{\Lambda^2}$	$1-\frac{2\mathrm{Re}(b_u)m_t^2}{\Lambda^2}$	$\frac{\Im(a_u v_W^2+2b_u m_t^2)}{\Lambda^2}$	$\frac{\Im(a_u v_W^2)}{\Lambda^2}$
RS	$1-\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$	$1+\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$	$\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$	$\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$
pNGB	$1+\mathcal{O}\left(\frac{v_W^2}{f^2}\right)+\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$	$1+\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$	$\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$	$\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$

Table 3: Predictions for the flavor diagonal up-type Yukawa couplings in a number of new physics models (see text for details).

Model	κ_b	$\kappa_{s(d)}/\kappa_b$	$\tilde{\kappa}_b/\kappa_b$	$\tilde{\kappa}_{s(d)}/\kappa_b$
SM	1	1	0	0
NFC	$V_{hd}\, v_W/v_d$	1	0	0
MSSM	$-\sin\alpha/\cos\beta$	1	0	0
GL	$\simeq 3$	$\simeq 5/3(7/3)$	$\mathcal{O}(1)$	$\mathcal{O}(\kappa_{s(d)}/\kappa_b)$
GL2	$-\sin\alpha/\cos\beta$	$\simeq 3(5)$	$\mathcal{O}(\epsilon^2)$	$\mathcal{O}(\kappa_{s(d)}/\kappa_b)$
MFV	$1+\frac{\mathrm{Re}(a_d v_W^2+2c_d m_t^2)}{\Lambda^2}$	$1-\frac{2\mathrm{Re}(c_d)m_t^2}{\Lambda^2}$	$\frac{\Im(a_d v_W^2+2c_d m_t^2)}{\Lambda^2}$	$\frac{\Im(a_d v_W^2+2c_d\lvert V_{ts(td)}\rvert^2 m_t^2)}{\Lambda^2}$
RS	$1-\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$	$1+\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$	$\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$	$\mathcal{O}\left(\frac{v_W^2}{m_{KK}^2}\bar{Y}^2\right)$
pNGB	$1+\mathcal{O}\left(\frac{v_W^2}{f^2}\right)+\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$	$1+\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$	$\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$	$\mathcal{O}\left(y_*^2\lambda^2\frac{v_W^2}{M_*^2}\right)$

Table 4: Predictions for the flavor diagonal down-type Yukawa couplings in a number of new physics models (see text for details).

6. Exclusive mesonic decays - survey

New Physics models	Enhanced BR (Flavour violating)

Model	$\kappa_{ct(tc)}/\kappa_t$	$\kappa_{ut(tu)}/\kappa_t$	$\kappa_{uc(cu)}/\kappa_t$
GL & GL2	$\epsilon(\epsilon^2)$	$\epsilon(\epsilon^2)$	ϵ^3
MFV	$\frac{\mathrm{Re}\left(c_u m_b^2 V_{cb}^{(*)}\right)}{\Lambda^2} \frac{\sqrt{2} m_{t(c)}}{v_W}$	$\frac{\mathrm{Re}\left(c_u m_b^2 V_{ub}^{(*)}\right)}{\Lambda^2} \frac{\sqrt{2} m_{t(u)}}{v_W}$	$\frac{\mathrm{Re}\left(c_u m_b^2 V_{ub(cb)} V_{cb(ub)}^*\right)}{\Lambda^2} \frac{\sqrt{2} m_{c(u)}}{v_W}$
RS	$\sim \lambda^{(-)2} \frac{m_{t(c)}}{v_W} \bar{Y}^2 \frac{v_W^2}{m_{KK}^2}$	$\sim \lambda^{(-)3} \frac{m_{t(u)}}{v_W} \bar{Y}^2 \frac{v_W^2}{m_{KK}^2}$	$\sim \lambda^{(-)1} \frac{m_{c(u)}}{v_W} \bar{Y}^2 \frac{v_W^2}{m_{KK}^2}$
pNGB	$\mathcal{O}(y_*^2 \frac{m_t}{v_W} \frac{\lambda_{L(R),2}\lambda_{L(R),3} m_W^2}{M_*^2})$	$\mathcal{O}(y_*^2 \frac{m_t}{v_W} \frac{\lambda_{L(R),1}\lambda_{L(R),3} m_W^2}{M_*^2})$	$\mathcal{O}(y_*^2 \frac{m_c}{v_W} \frac{\lambda_{L(R),1}\lambda_{L(R),2} m_W^2}{M_*^2})$

Table 5: Predictions for the flavor violating up-type Yukawa couplings in a number of new physics models (see text for details). In the SM, NFC and the tree-level MSSM the Higgs Yukawa couplings are flavor diagonal. The estimates of the CP-violating versions of the flavor-changing transitions, κ_{ij}/κ_t, are the same as the CP-conserving ones, apart from substituting "Im" for "Re" in the "MFV" row.

Model	$\kappa_{bs(sb)}/\kappa_b$	$\kappa_{bd(db)}/\kappa_b$	$\kappa_{sd(ds)}/\kappa_b$
GL & GL2	$\epsilon^3(\epsilon^2)$	ϵ^2	$\epsilon^3(\epsilon^4)$
MFV	$\frac{\mathrm{Re}\left(c_d m_t^2 V_{ts}^{(*)}\right)}{\Lambda^2} \frac{\sqrt{2} m_{s(b)}}{v_W}$	$\frac{\mathrm{Re}\left(c_d m_t^2 V_{td}^{(*)}\right)}{\Lambda^2} \frac{\sqrt{2} m_{d(b)}}{v_W}$	$\frac{\mathrm{Re}\left(c_d m_t^2 V_{ts(td)}^* V_{td(ts)}\right)}{\Lambda^2} \frac{\sqrt{2} m_{s(d)}}{v_W}$
RS	$\sim \lambda^{(-)2} \frac{m_{b(s)}}{v_W} \bar{Y}^2 \frac{v_W^2}{m_{KK}^2}$	$\sim \lambda^{(-)3} \frac{m_{b(d)}}{v_W} \bar{Y}^2 \frac{v_W^2}{m_{KK}^2}$	$\sim \lambda^{(-)1} \frac{m_{s(d)}}{v_W} \bar{Y}^2 \frac{v_W^2}{m_{KK}^2}$
pNGB	$\mathcal{O}(y_*^2 \frac{m_b}{v_W} \frac{\lambda_{L(R),2}\lambda_{L(R),3} m_W^2}{M_*^2})$	$\mathcal{O}(y_*^2 \frac{m_b}{v_W} \frac{\lambda_{L(R),1}\lambda_{L(R),3} m_W^2}{M_*^2})$	$\mathcal{O}(y_*^2 \frac{m_s}{v_W} \frac{\lambda_{L(R),1}\lambda_{L(R),2} m_W^2}{M_*^2})$

Table 6: Predictions for the flavor violating down-type Yukawa couplings in a number of new physics models (see text for details). In SM, NFC and tree level MSSM the Higgs Yukawa couplings are flavor diagonal. The estimates of the CP-violating versions of the flavor-changing transitions, κ_{ij}/κ_b, are the same as the CP-conserving ones, apart from substituting "Im" for "Re" in the "MFV" row.

6. Exclusive mesonic decays - survey

Prospects for H→DW

- Clean signature
  - Trigger on the high p_T lepton (muon) from the W decay
  - Displaced vertex from the D decay
- Focus on the decay $H \to \bar{W} D_s^{(*)}$
  - ggF & VBF
  - Background W+c-quark
    - SM production already measured - a proof that hadronic c-meson decays can be measured
- Main discriminant - the Higgs mass
- Expected reach @ 3000 fb^{-1} BR($H \to \bar{W} D_s^{(*)}$)$<7\times10^{-4}$

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Summary & Future plans

- Y4 - Exotic Higgs decays were addressed for the first time within the LHCHXS
  - Identified the 4 main topics
  - Defined the theoretical neighborhood (longer surveys)
  - Point at the experimental challenges (soft objects, DV, trigger)

- Y5 - Focus on feasibility studies
  - Similar to the $H \rightarrow 2\gamma$+MET study presented here
  - Suggest analysis strategy
  - Exploit different triggers
  - Investigate sub-dominant decays