

Working Group 1: Simplified models / Monte Carlo / reinterpretation and RECAST-ing

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Main goal: ensure LHC LLP searches are optimally useful in the future, cover all relevant signatures, and final states

Specific tasks:

- 1) Presentation of LLP experimental results
- 2) Strengthen RECAST for long-lived particle searches
- 3) Define a few benchmark simplified models
- 4) Identify gaps in LHC sensitivity

Presentation of Results

Theorists

Want enough
information for reliable
theorist recasting

i.e., efficiency maps
for physics objects

Experimentalists

Want to provide
simplified model
interpretations

i.e., a {few} mass vs
lifetime exclusions

Presentation of Results

MORE IS BETTER

Recasting valuable — cut flow tables for a few points, detailed description of signal (MC best), digitized data, plots of observables, detailed description of trigger, efficiency maps

- 1) Efficiency maps for LLPs ($\epsilon(m, \beta, \theta, L)$, a la CMS HSCP)
- 2) Simplified models, m vs $c\tau$ efficiencies
- 3) Compromise? $\epsilon(L, \beta)$ for a few $m / \Delta m$

Special thanks to Eric Conte, Jong Soo Kim, and Michele Selvaggi

RECAST

Another complementary path is RECAST

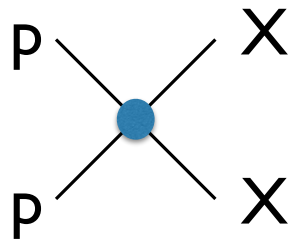
Framework is now heavily developed

Currently no LLP searches implemented,
but we should change that

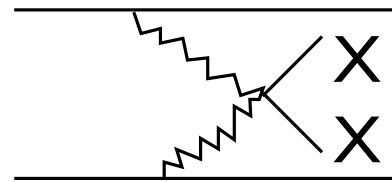
Experimentalists should have a comprehensive
reinterpretation strategy independent of theorists
aided by the RECAST framework

Simplified Models

LLP production modes

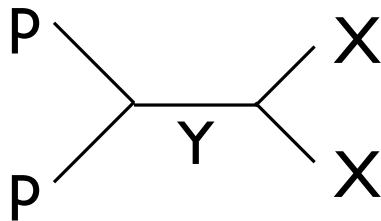


Pair
Production

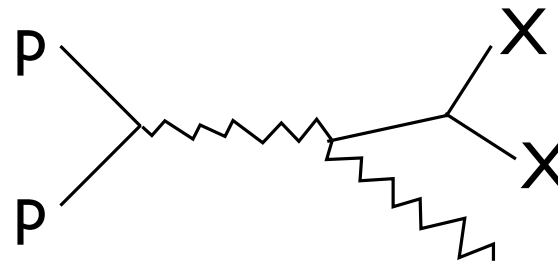


VBF

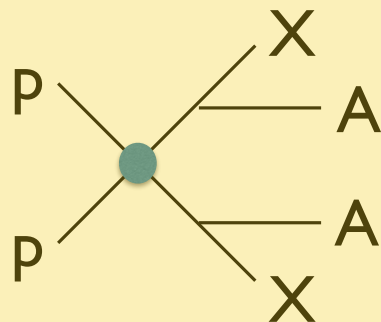
lovely image by DC



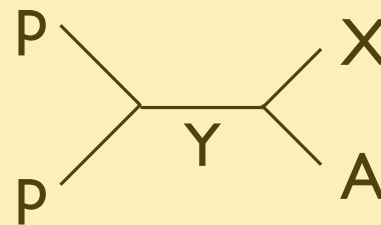
Resonance



Associated
Production



Heavy
Parent



Single
Production

A = invis, j, top, W, Z, L, h (oof...) ... maybe even γ ?

Simplified Models

LLP decay modes

$e + \text{inv}$	ee			
$\mu + \text{inv}$	$\mu\mu$	ej	μe	$e\gamma$
$\tau + \text{inv}$	$\tau\tau$	μj	$\mu\tau$	$\mu\gamma$
$j + \text{inv}$	jj	τj	τe	$\tau\gamma$
$\gamma + \text{inv}$	$\gamma\gamma$			$j\gamma$

Also, $xy + \text{inv}$ with or without xy resonance

Simplified Models: Option 1

production \otimes decay spans
most LLP simplified models*

Prescription generates simplified models!

Reserve of Production MC \otimes Decay MC?

Very sensible for LLP!

All production \otimes Decay relevant for your search

* not dark showers

Simplified Models: Option 1

production \otimes decay spans
most LLP simplified models*

Prescription generates simplified models!

ON THE OTHER HAND...

~ few hundred (mostly redundant) cases

Lacks theory guidance

Encroaches on complete coverage

... but very unwieldy

* not dark showers

Simplified Models: Option 2

Consider a few good models

“Gauge”/
“Yukawa”

“Stau”

“Slepton”

“Bino”

ee

$\tau + \text{inv}$

e + inv

$\gamma + \text{inv}$

$\mu\mu$

$\mu + \text{inv}$

$\tau\tau$

jj

High theory motivation

Span a lot of un(der)charted territory

Very manageable

Simplified Models: Option 2

Consider a few good models

“Gauge”/
“Yukawa”

“Stau”

“Slepton”

“Bino”

ee

$\tau + \text{inv}$

e + inv

$\gamma + \text{inv}$

$\mu\mu$

$\mu + \text{inv}$

$\tau\tau$

jj

ON THE OTHER HAND...

Definitely not comprehensive!!!

Less generic

Simplified Models: Option 3

Combine options 1 & 2?

Reserve of Production MC \otimes Decay MC

Tie into motivated theory scenarios

Maybe the best of both worlds?

Simplified Models: Option 3

Combine options 1 & 2?

Reserve of Production MC \otimes Decay MC

Tie into motivated theory scenarios

ON THE OTHER HAND...

The most work

Simplified Models

Regardless of option, augment searches once designed with simplified models that probe the **limitations** of the search

Many models can produce the displaced dilepton signature ($\mu^+\mu^-$)

Where can this search lose sensitivity?

1. Low cross-section / long or short lifetime

Almost any benchmark will do! Pick the “most motivated” one!

2. Low LLP mass

Complementarity with lepton-jets?

3. High LLP boost (i.e. collimated decay products)

Scalar resonance to two pseudoscalars $pp \rightarrow S \rightarrow aa, a \rightarrow \mu^+\mu^-$
for fixed xsec and lifetime (or $\gamma c\tau$), (1) m_a vs ϵ , (2) m_S vs ϵ

4. Soft decay products

SUSY higgsino + singlino, $\tilde{\chi}^0 \rightarrow \tilde{S}(Z^* \rightarrow \ell^+\ell^-)$, fixed $m_{\tilde{\chi}}$, Δm vs ϵ

Moving Forward

- 1) Decide what to do about simplified models
- 2) Acceptable solution for presentations of results
- 3) Examine prompt sensitivity to LLPs via RECAST
- 4) Implement LLP searches in RECAST
- 5) Use simplified models to expand LLP program

Discussion?