Search for LLPs with Displaced Hadronic Jets in ATLAS

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Benchmark Models

- Hidden Valley
  - Higgs portal – scalar pairs
  - $Z'$ (Run 1 only)
- Stealth SUSY
- WIMP Baryogenesis

![Feynman diagrams for the Higgs portal Baryogenesis model.](image1)

![Feynman diagrams for the Stealth SUSY model.](image2)

![Feynman diagrams for the Higgs decaying into displaced hadronic jets.](image3)
ATLAS Displaced Vertex Reconstruction

MS stand-alone vertex reconstruction (arXiv:1311.7070)
Run 1 RoI Cluster Trigger and MS vertex reconstruction efficiencies
Run 1 Analysis + Results

arXiv:1504.03634v2

- Two reconstructed displaced vertices
  - 2MS vertices or MS vertex plus ID vertex
- Sensitive to Higgs decaying to long-lived scalar pairs
- No evidence for two-vertex events

<table>
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<tr>
<th>Trigger</th>
<th>Applicable topologies</th>
<th>Benchmarks</th>
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<tbody>
<tr>
<td>Muon RoI Cluster</td>
<td>IDVx+MSVx, 2MSVx</td>
<td>Scalar boson,</td>
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<td></td>
<td></td>
<td>Stealth SUSY</td>
</tr>
<tr>
<td>Jet+$E_T^{miss}$</td>
<td>2IDVx, IDVx+MSVx, 2MSVx</td>
<td>$Z'$</td>
</tr>
</tbody>
</table>

ATLAS

13 = 8 TeV, 19.5 fb$^{-1}$

95% CL Upper Limit on $\sigma \times BR$ [pb]

Singlino proper lifetime ($\tau$) [m]

ATLAS

13 = 8 TeV, 20.3 fb$^{-1}$

95% CL Upper Limit on $\sigma \times BR$ [pb]

$\pi_\tau$ proper lifetime ($\tau_\pi$) [m]
Current Searches: Two-Vertex

- Same as in Run 1
- Vertices must be separated by $\Delta R = 1.0$
- Stringent isolation criteria
  - Negligible background
- Stealth SUSY
- Bosons/Higgs $\rightarrow$ Long-lived scalars

Diagram: H. Russell
Current Searches: Single-Vertex

- Single-vertex with two prompt jets
  - Higher backgrounds
  - ABCD method
  - Stealth SUSY
- Single-vertex with minimal additional requirements
  - Baryogenesis Higgs portal
  - Higgs $\rightarrow$ long-lived scalars

Diagram: H. Russell
The Road Ahead

- Approval set for next Wednesday
- Perform same 2 vertex and 1 vertex analysis with the rest of Run 2 data
- Add new models
- Optimize toy MC to extrapolate number of signal events vs lifetime
- MVA analysis (for ABCD plane variables)
- Further investigate noise bursts
- Re-optimize (if needed) MDT, RPC, TGC hits selection
- Studying possible event shape variables
- Thinking to other possible improvements!