



Estimating Displaced Vertex Backgrounds in ATLAS

(The DV+Jets Analysis)

David Rouso

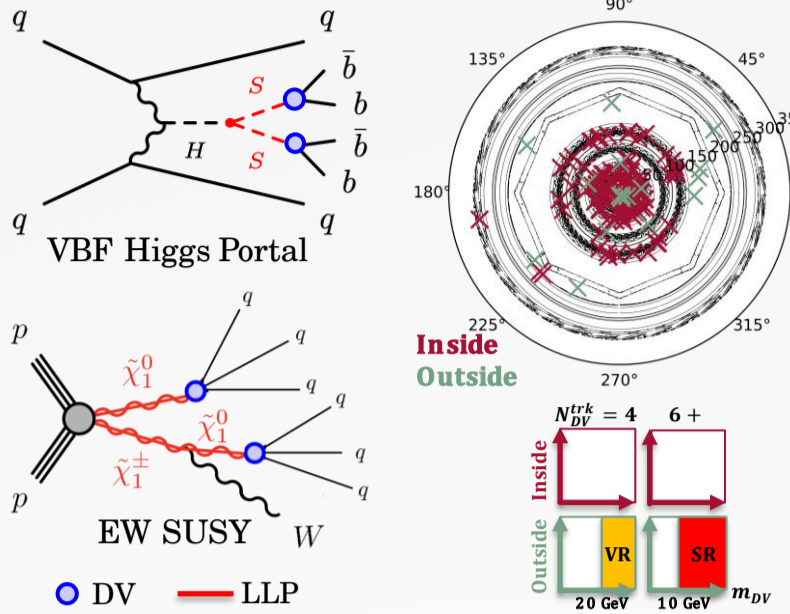
On behalf of the ATLAS Collaboration



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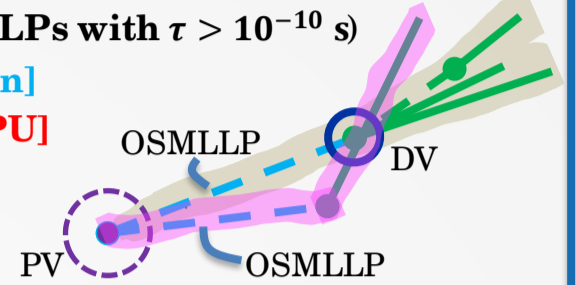
1. Motivation

- **BSM particles could be long-lived** if coupling to SM is weak (e.g. RPV λ'')
- Search for long-lived particles (LLPs) with **displaced vertex (DV)** signatures in **pixel detector** in presence of **jets**
- **Signal region** requires number of tracks in DV $N_{DV}^{trk} \geq 5$, DV mass $m_{DV} \geq 10$ GeV, and DV falls **outside of detector material**. **Trackless** and **High pT SRs**.
- Sensitive to many models, including **Higgs Portal** and **SUSY** ($\tau \approx 0.01-10$ ns)

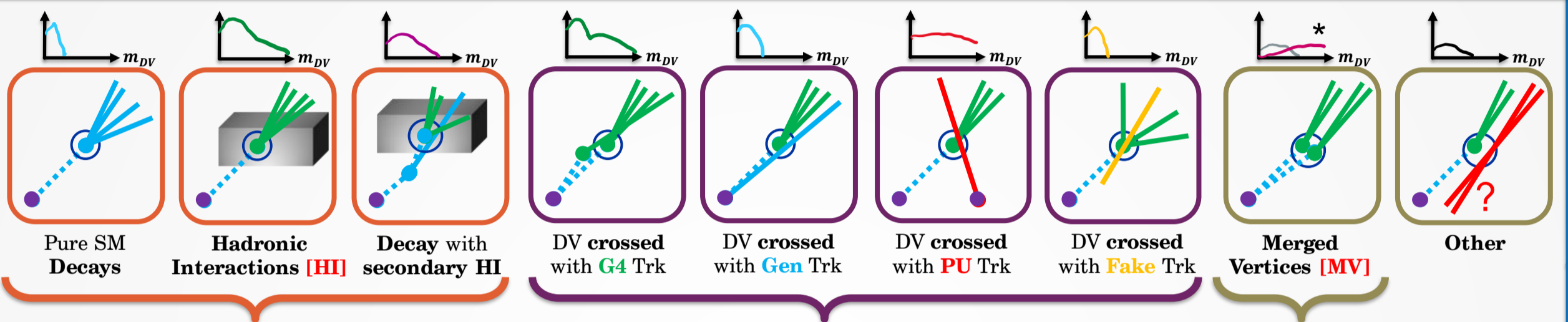


2. Framework for Truth Studies

- Use **di-jet MC** to look at **truth** info (w/o event selections)
- Categorize DVs by **tracing tracks back** to their **originating ancestor SM LLP** (OSMLLP)
- Tracks either from:
 - **GEANT4 [G4]** (models **material interactions** & SM decays for LLPs with $\tau > 10^{-10}$ s)
 - **Generator [Gen]**
 - **True Pileup [PU]**
 - **Fake Tracks**

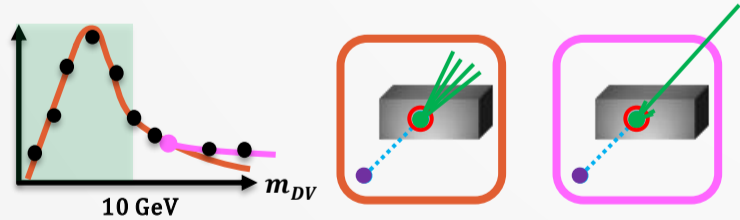


3. Combined Background Estimate



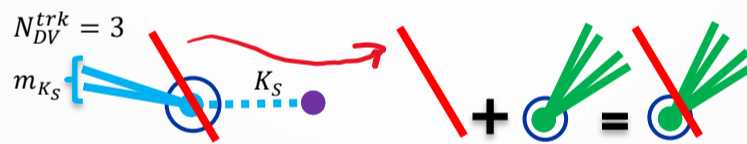
4. Single-Process DVs

- **Inside/Outside material different** due to different relative compositions
- **SM decays don't exist in SR**
- **Estimate** by **fitting function** (rising line + exponential decay) in low mass, extrapolate to high mass
- **Elastic HI** causes **additional secondary high-mass exponential tail**
- **Correction ratio** of secondary tail to nominal **propagated from full-range MC Inside 2-tail fit**
- **Uncertainty on knowledge** of secondary component behaviour (i.e. MC statistical uncertainty) **propagated to result**



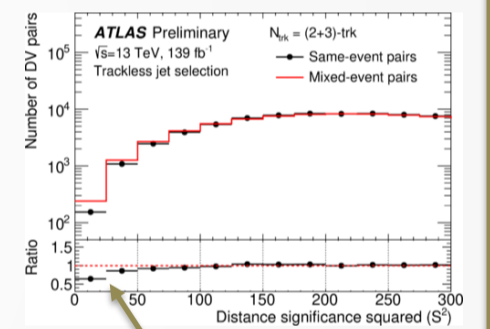
5. Single-Process DVs + Track

- **Add random track** to each $N_{DV}^{trk} - 1$ DV
- **Library** of random tracks from **3-trk DVs** where 2 trks give K_S resonance
- **Normalize** using **ratio of K_S peaks** in 3-choose-2-trk DVs to 2-trk DVs



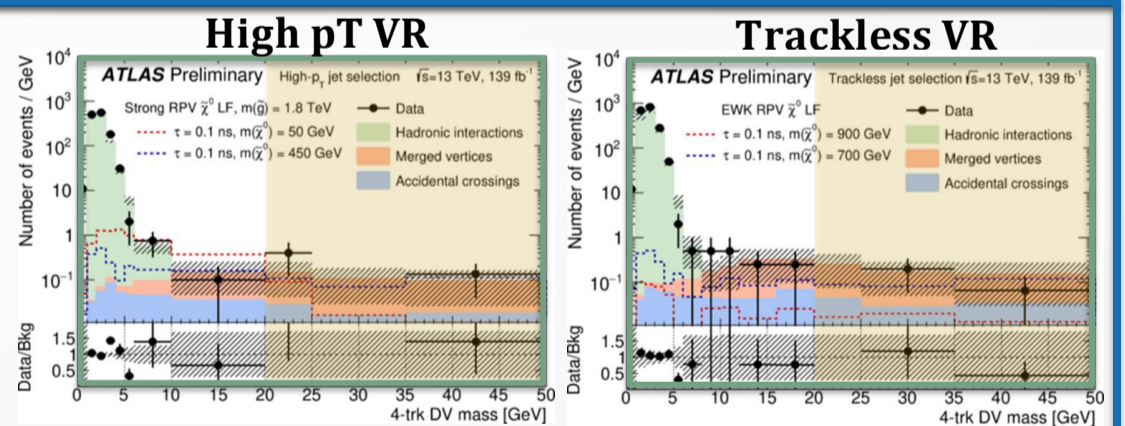
6. Merged Vertices

- Compare **distance significance** between **pairs of DVs** from **same and different events**
- **Deficit in same events** were those DVs **improperly merged**



7. Combination and Validation

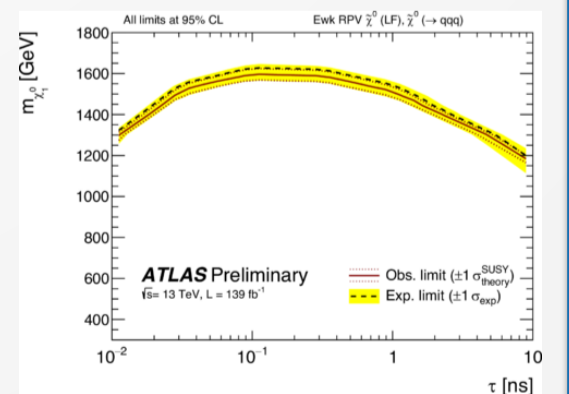
- Add together the 3 estimates to form **combined background estimate**
- Estimate tested in **data** $N_{trk} = 4, m_{DV} > 20$ GeV, **Outside Validation Region**.
- **Agrees well**



8. Results

- **Another background estimate** method based on **DV proximity to jets** ("Inclusive" estimate) exists so independent estimates can cross check each other
- Estimates see **good agreement** with each other
- **Data agrees well with estimate**
- **Exclusion limits** shown for **electroweak SUSY production**

Signal Region	Estimate	Observed
High pT	1.08 ± 0.69	1
Trackless	2.1 ± 1.1	0



9. Conclusions

- **No excess** was observed
- **Higgs portal** interpretation still **underway**
- Able to **exclude electroweakino** masses below **1.2 TeV** between **0.01 and 10 ns**
- **Paper** currently undergoing **approvals** process

References & Acknowledgements

Results and Plots: ATLAS-CONF-2022-054
 Part of the DV+Jets Analysis
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