Testing the feasibility to measure acausally wrong displaced vertices from Lee-Wick particle decays with CMS experiment open data

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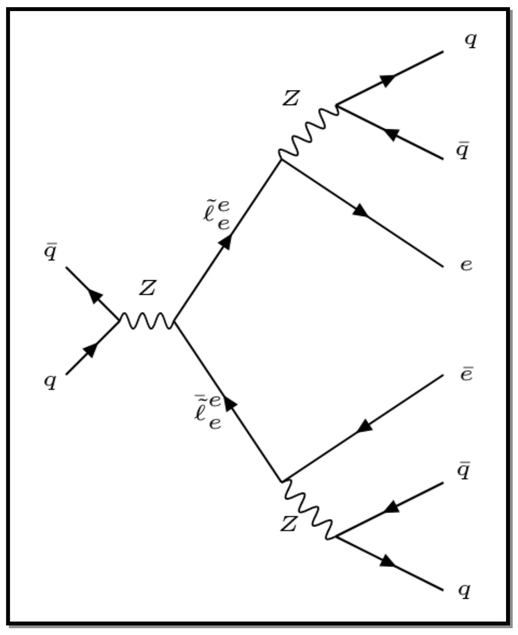
Model Simulation:

Characteristics of the simulation:

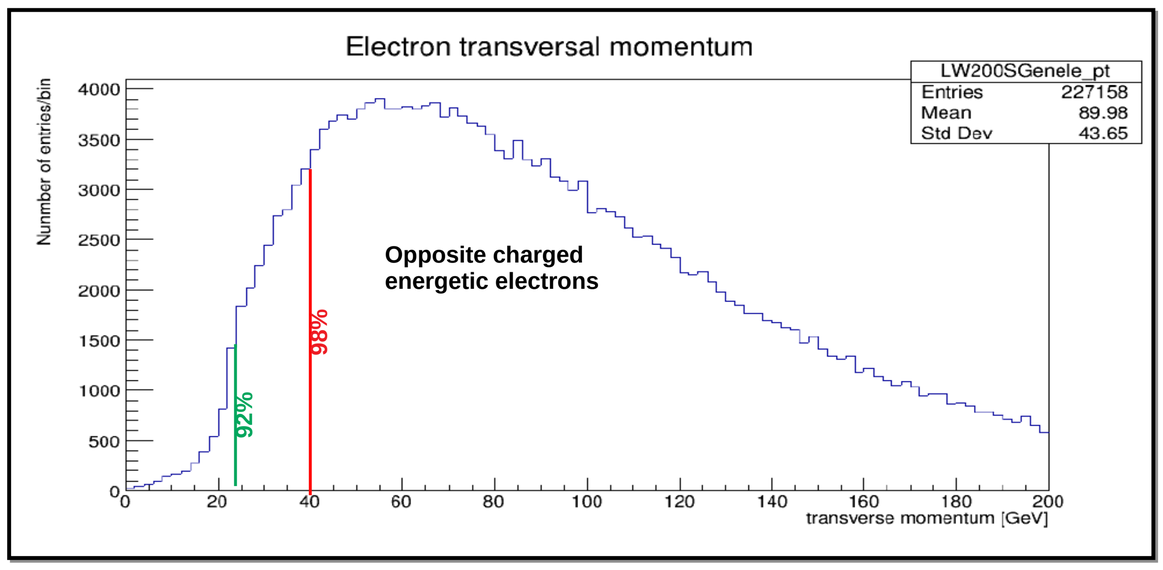
- LW-electron pair production
- Geometrical resolution for DV $\Delta x \approx 0.02\ mm$
- Proton-proton collision at $8\ GeV$
- Integrated luminosity $11.467\ fb^{-1}$



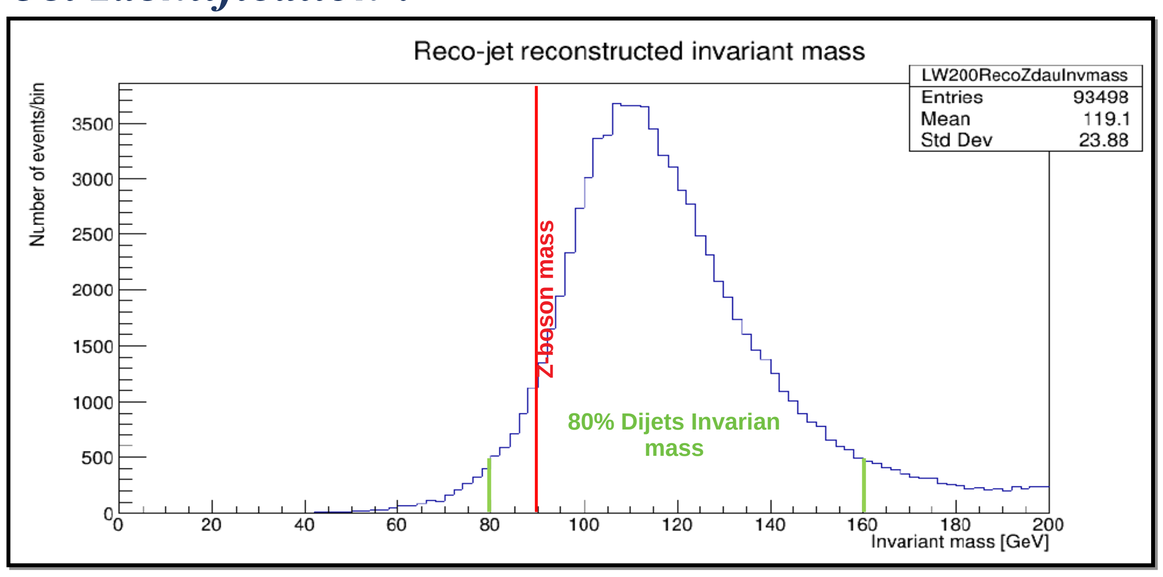
M_ℓ(GeV)	σ (fb^{-1})	λ (mm)
200	5.97	2.70765×10^{-2}
300	0.96	1.64300×10^{-2}
400	0.23	1.21212×10^{-2}
500	0.06	9.65243×10^{-3}

$$\lambda = v_T\, \gamma\, \tau > \Delta x$$

Electron identification:



Jet Identification :



Displaced vertex:

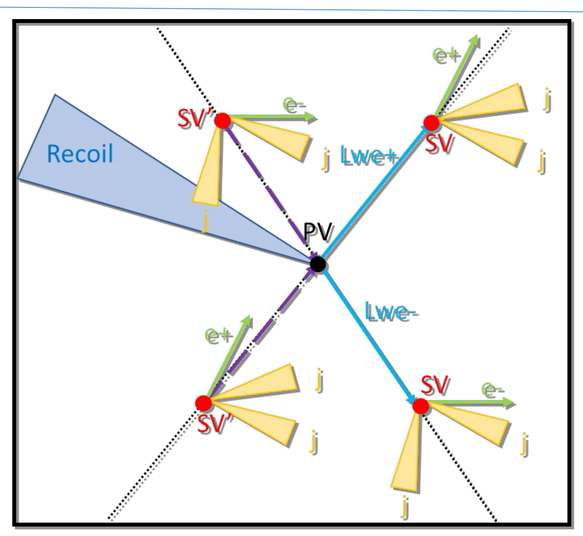
Reconstruction from selected electrons and jet pairs:

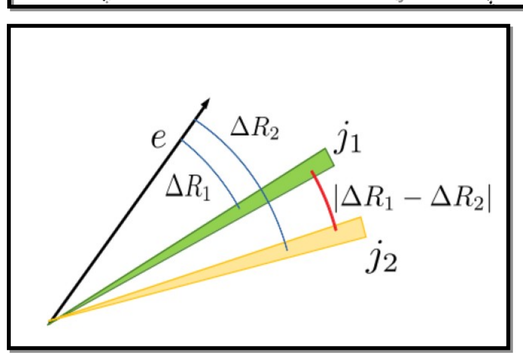
- Transverse separation from beam-spot $\overrightarrow{DV}^T > 0.02\ mm$
- Transverse momentum of components $\vec{P}^T > 20\ GeV$

DV Geometry selection:

- Jet-electron structure
- Negative values of "***Parallelity***":

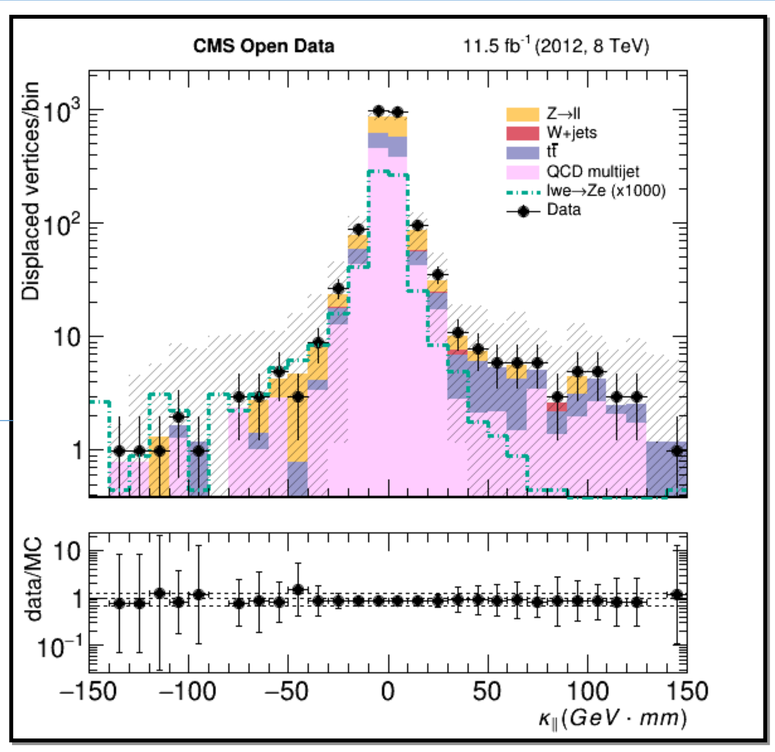
$$\kappa_{\parallel} = \overrightarrow{DV}^T \cdot \vec{P}^T$$





Parallelity distribution:

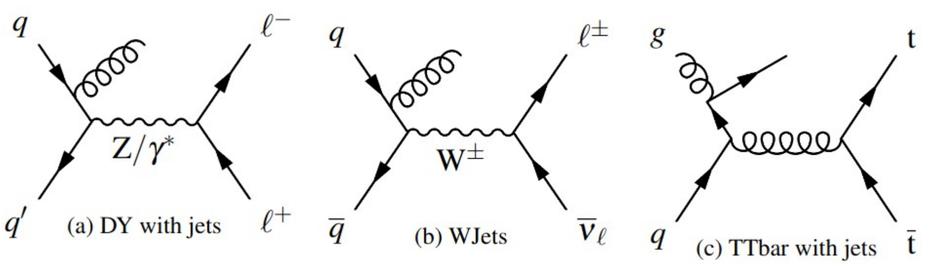
Asymmetry in the parallelity distribution suggest the feasibilty to identify acausal WDV if present. This is model dependant.



Background and data selection:

Comparison among data:

- Generated LW-electron pair production
- Backgrounds: Drell-Yang, W-Jets, top quark pair production
- QCD background from asyptotic topology
- Double Photon CMS-OpenData 2012



Data skimmed trough 7 selection cuts:

Trigger filtering **TF**; Trigger object matching **TO**; Electron quality selection **HQ**; Jet quality selection **JetS**; Electron-Jet structure **DRC**; Topology match **SG**; Negative parallelity **IPP.**

Selection cut	DY	TTbar	WJets	QCD	LW200	LW300	LW400	LW500	Data
NF	40176928	2582368	96706945	-	67.7	11.0	2.6	0.7	66235981
TF	3953503.5	28237.1	46511.5	224649	51.2	9.2	2.3	0.6	5816590
TO	2005875	14889	15608	12140	28.8	5.7	1.5	0.4	2318120
HQ	1971623	14653	15297	9755	28.4	5.6	1.5	0.4	2251784
JetS	38282	3965	595	4721	11.4	2.3	0.6	0.2	69803
DRC	37547	3696	590	4768	10.7	2.2	0.6	0.2	68795
SG	31849	2740	330	1665	10.4	2.2	0.6	0.2	48857
IPP	10.6	22.5	2.5	55.1	0.02436	0.00440	0.00109	0.00030	144

References:

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- Khachatryan, V., Sirunyan, A. M., Tumasyan, A., Adam, W., Asilar, E., Bergauer, T., ... & Dogra, S. (2017). Search for R-parity violating supersymmetry with displaced vertices in proton-proton collisions at s= 8 TeV. Physical Review D, 95(1), 012009.
- CMS collaboration. (2012). Search in leptonic channels for heavy resonances decaying to long-lived neutral particles. arXiv preprint arXiv:1211.2472.