

# Exotic diboson searches in the $lvqq$ final state using data at $\sqrt{s} = 13$ TeV collected with the ATLAS detector [1]



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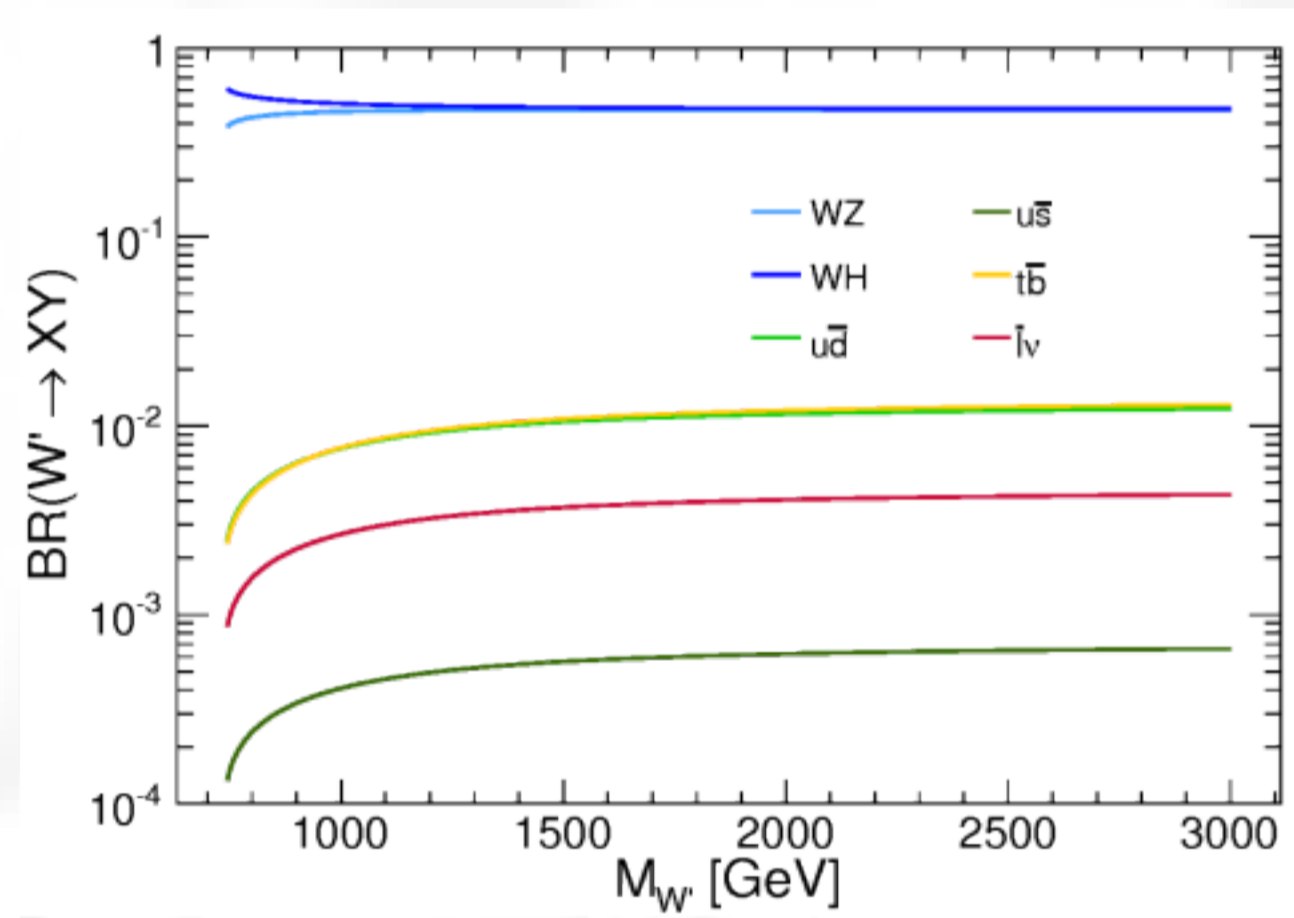


## Theoretical motivations and models

- Search for hints on physics Beyond the Standard Model (BSM)
  - Precision tests of the Standard Model (SM) itself
  - Direct search of possible new phenomena
- Di-boson resonances are predicted by several new physics models
- Few Lagrangians are used as benchmark model.

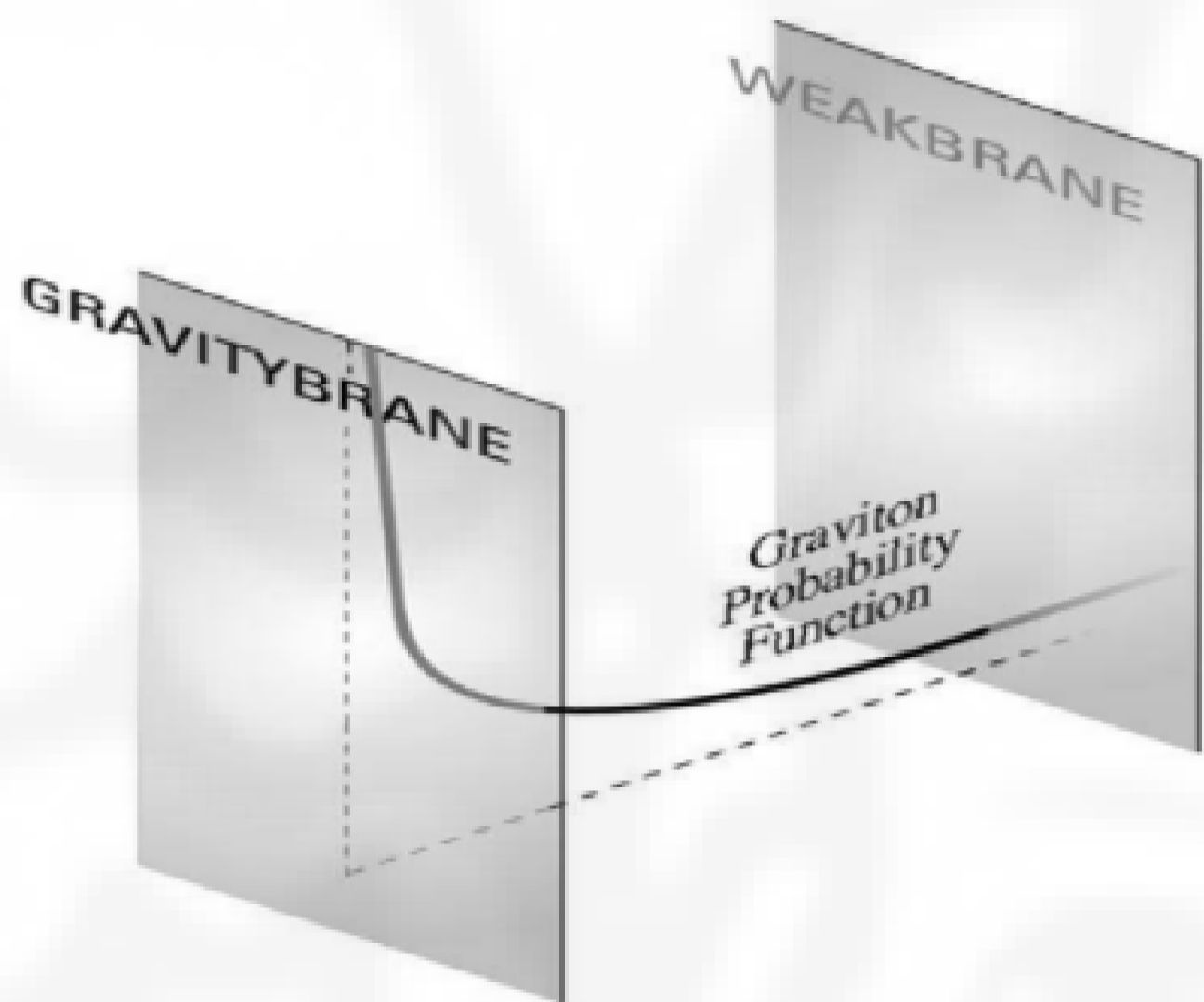
### The Heavy Vector Triplet (HVT)

- Two new heavy spin-1 bosons:  $W'$  (charged),  $Z'$  (neutral)
- Many BSM models such as Little Higgs, Composite Higgs, Minimal walking technicolor, extended gauge models, described in the HVT framework by an effective lagrangian [6]
- Two scenarios with different coupling to SM bosons ( $g_h$ )
  - Model A:  $g_h = 1$ , dominated by coupling to fermions
  - Model B:  $g_h = 3$ , coupling to fermions are suppressed w.r.t SM bosons



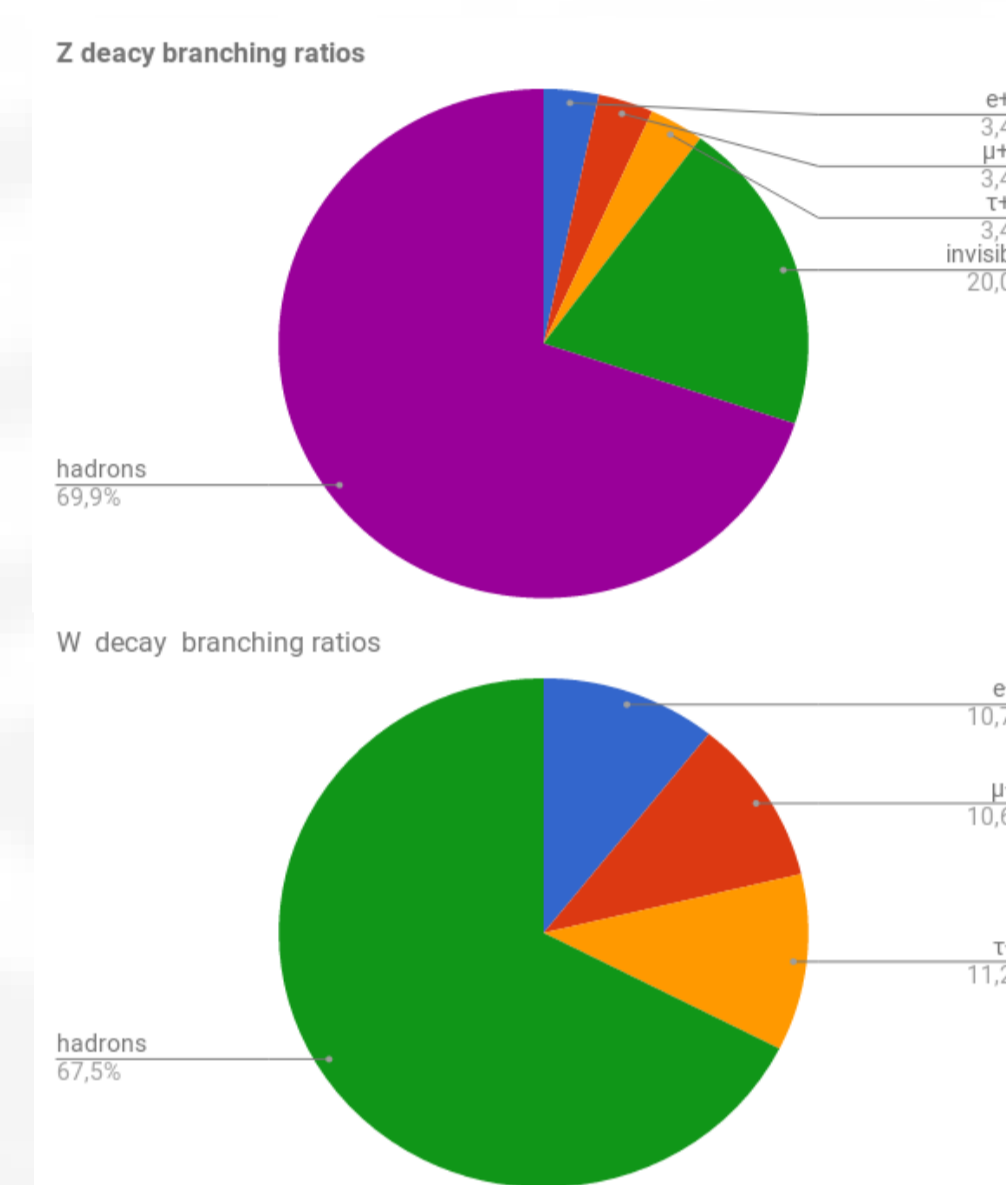
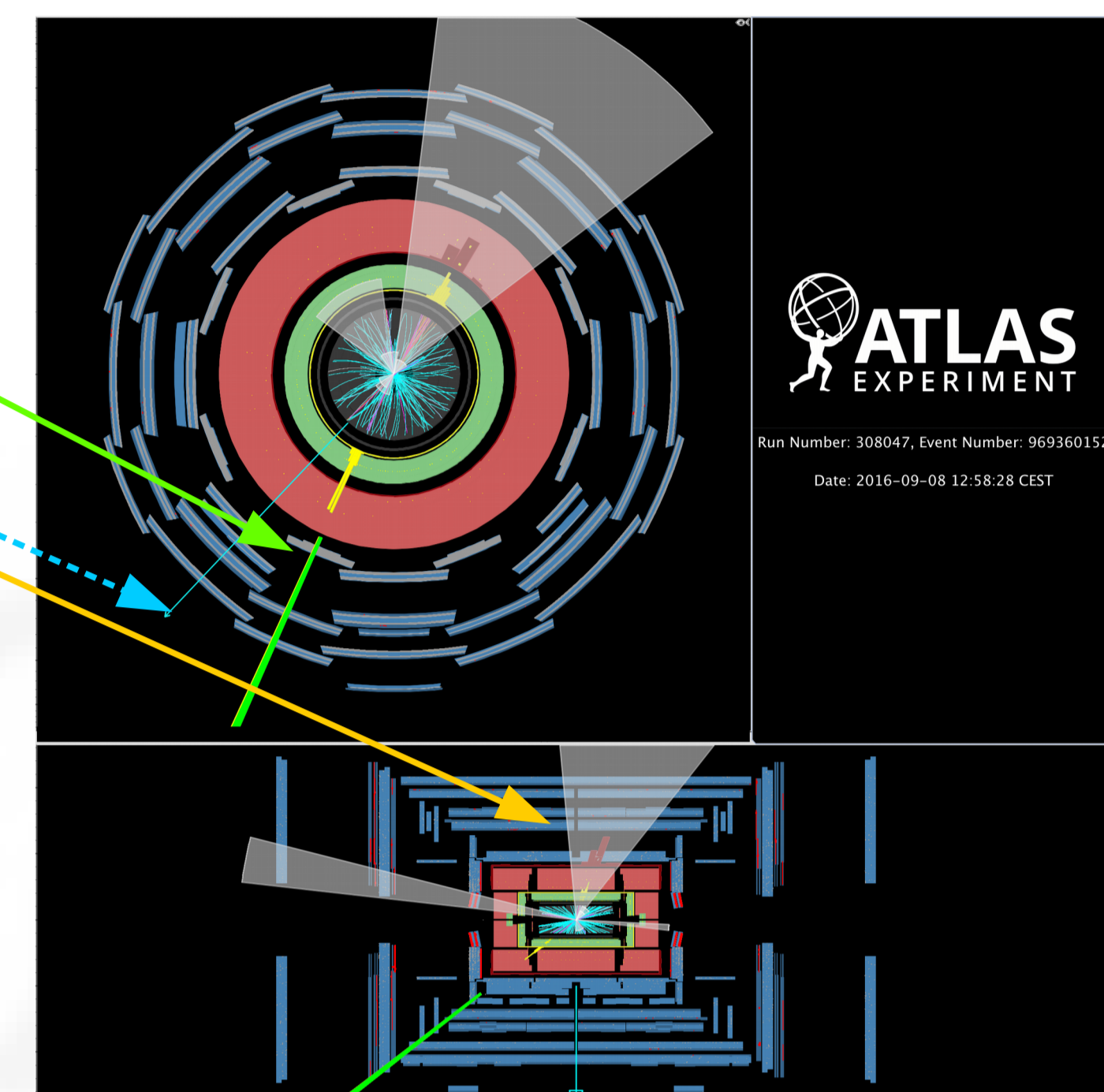
### Warped extra dimensions (WED)

- WED as a possible solution to hierarchy problem introducing a new cutoff scale
- Signal is a spin-2 excited state of the bulk graviton in the Randall-Sundrum model [7]
- Decays to  $WW, ZZ, HH$
- Mass scale dominated by  $k/\bar{M}_p$ ;  $k$  is the warp factor,  $\bar{M}_p$  is the reduced plank mass

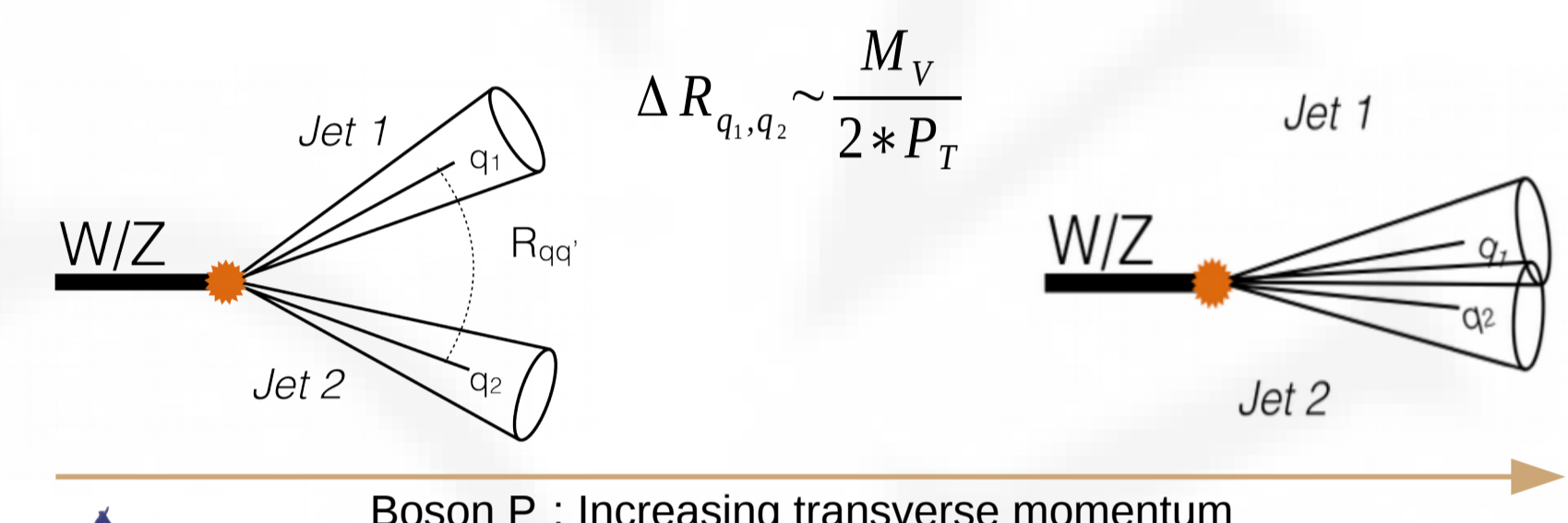


## Basic selection for $X \rightarrow WV \rightarrow (lv)(qq)$

- Exactly 1 charged lepton ( $e^\pm, \mu^\pm$ )
- $E_T^{Miss} > 100$  GeV
- Hadronic sector:
  - Merged:** 1 Anti-Kt 1.0 jet
  - Resolved:** 2 Antik-Kt 0.4 jets
- Production mode
  - Vector Boson Fusion (VBF):** 2 Antik-Kt 0.4 ( $m_{jj}^{tag} > 770$  GeV and  $\Delta\eta_{jj}^{tag} > 4.7$ )
  - Drell-Yand (DY):** event fails VBF selection

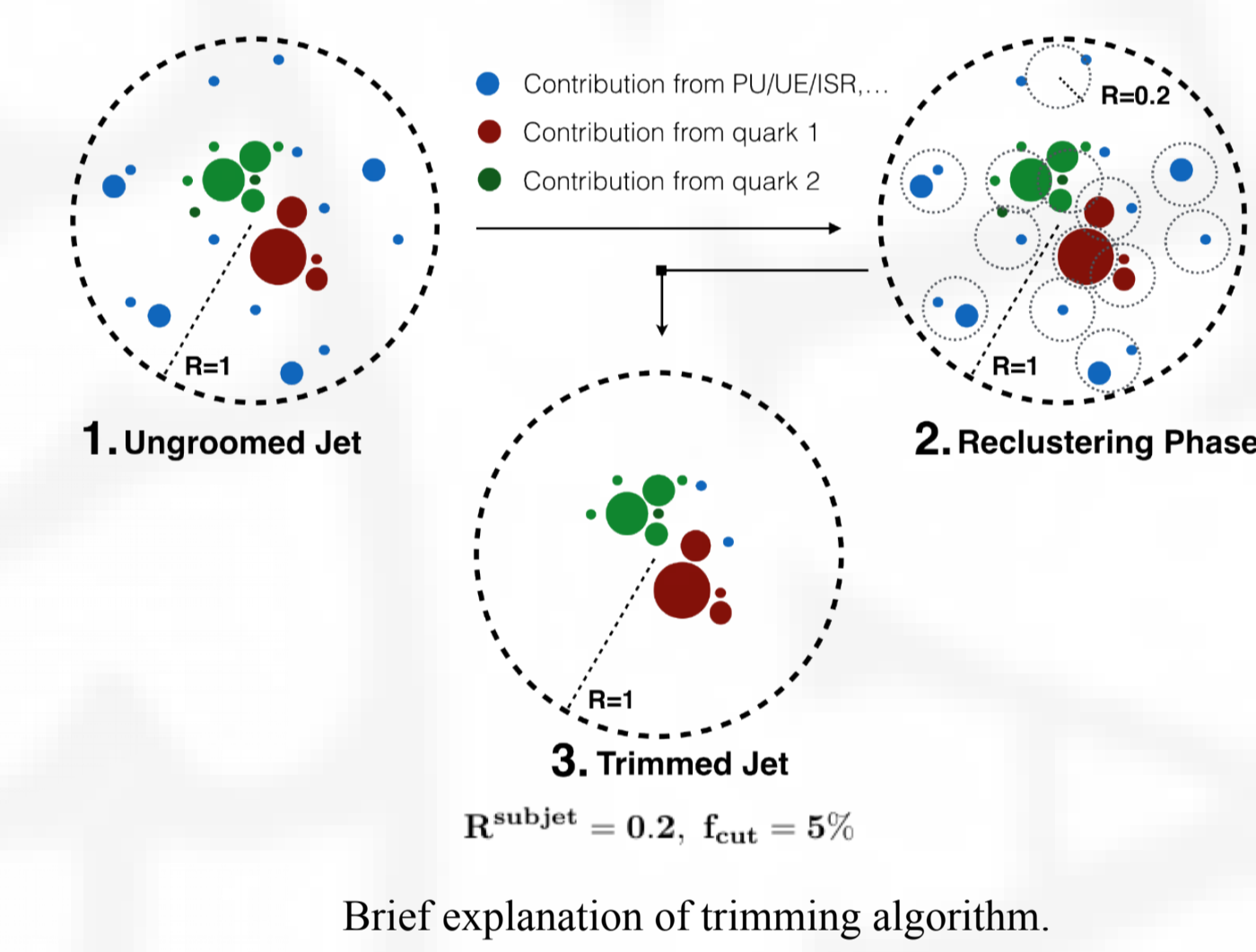


### Jet Topology



Two non-overlapping kinematic regions

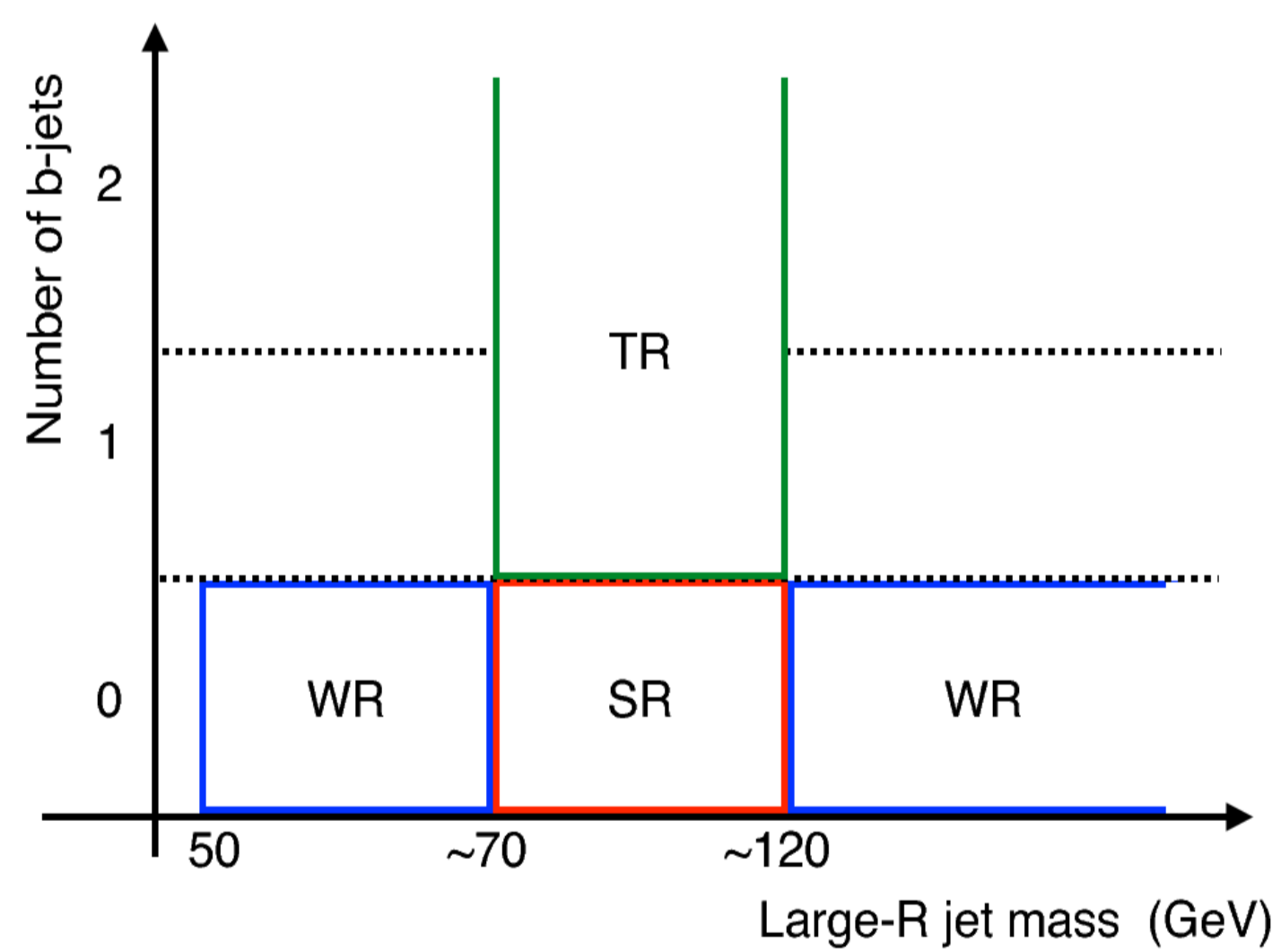
- Resolved:** decay products identified as two Anti-Kt 0.4 jets
- Merged:** at high  $P_T$  the boson is reconstructed as an unique object (Anti-Kt 1.0 jet)
- Pile up rejection: trimming
- Boson identification: substructure techniques [5]



## Analysis strategy: Signal and Control regions

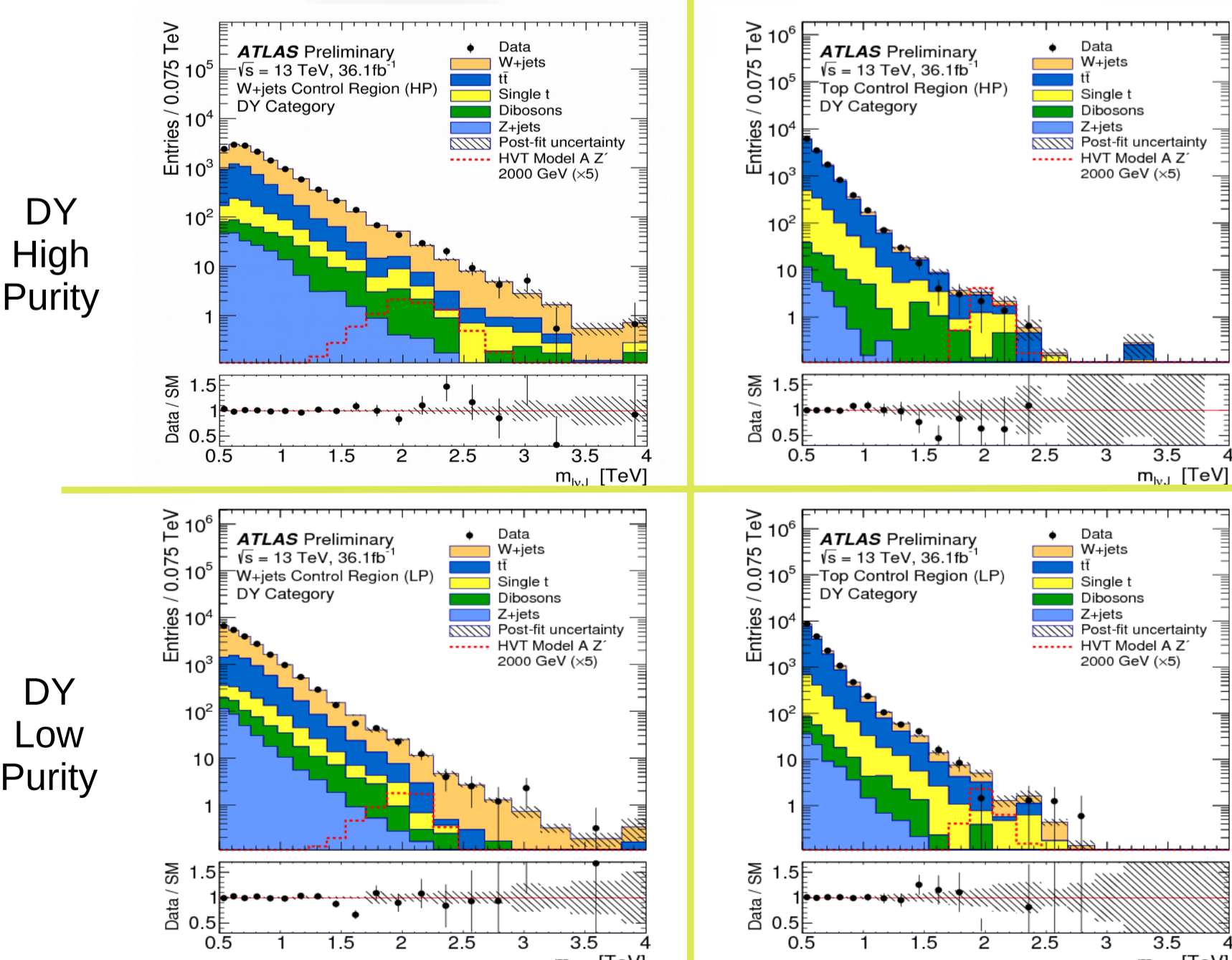
### Signal and control region definitions

- SR:** Signal Region
- TR:** Top Control Region
- WR:** W+jets Control region
- Merged**
  - High purity control regions: Anti-Kt 1.0 jet must satisfy strict substructure cut
  - Low purity control regions: Anti-Kt 1.0 jet must satisfy loose substructure cut
- Resolved**
  - Use di-jet mass instead of Anti-Kt 1.0 jet mass



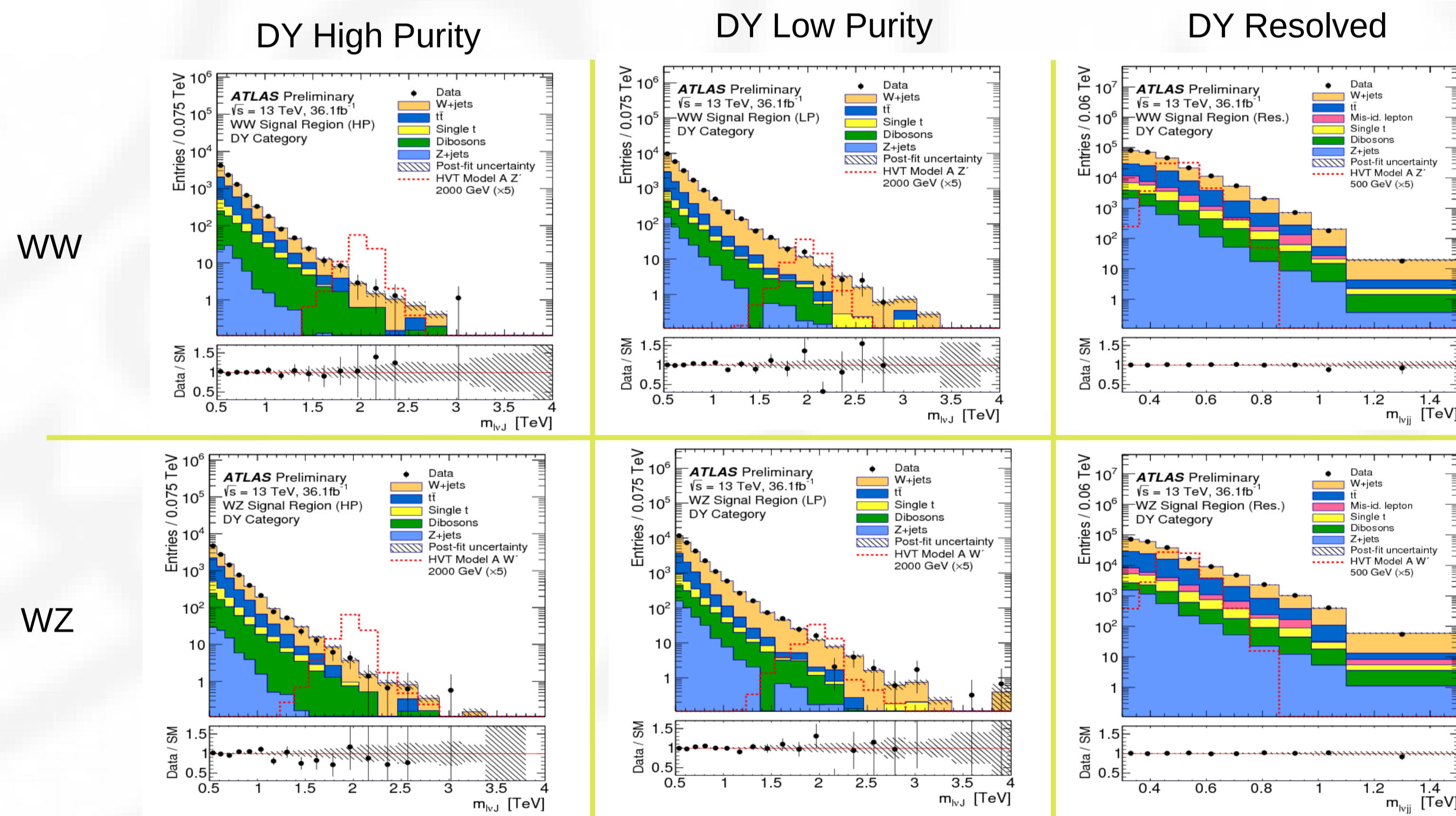
W+jets control region

Top control region



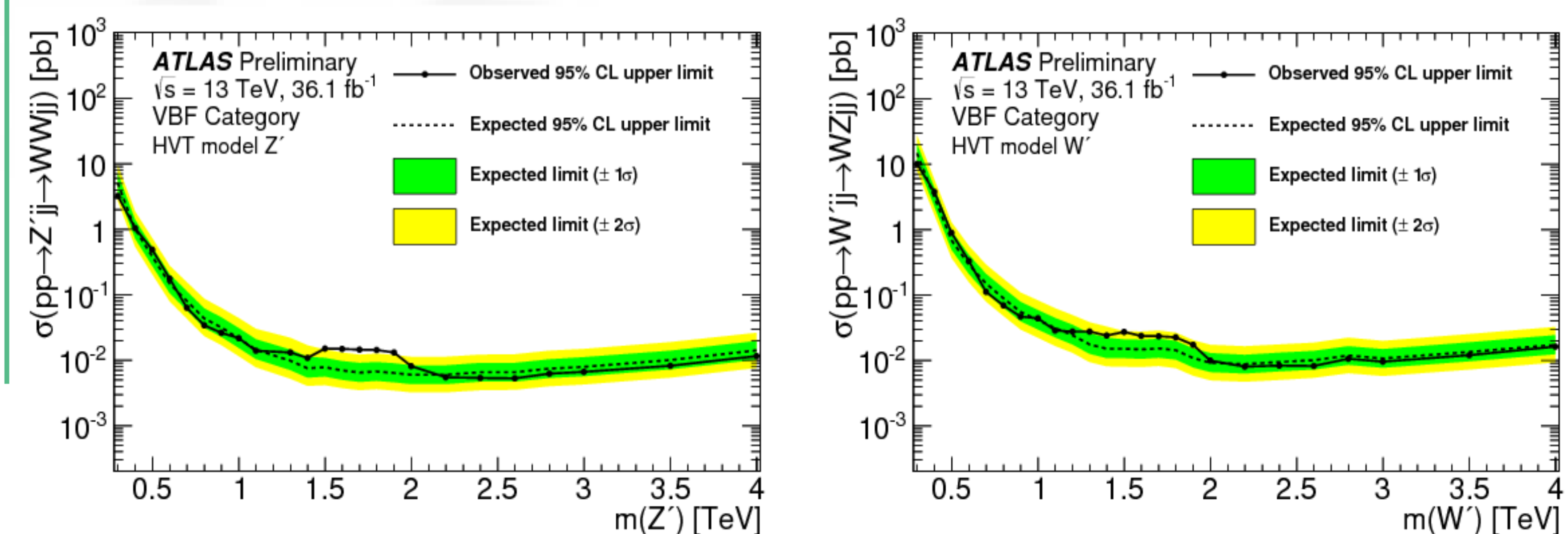
- Event balance:  $P_T^V > 0.4 M_{lv}$
- Neutrino  $P_z$  information:  $M_{lv} = M_W$
- 2 merged categories
  - High Purity:** strict substructure cut for Anti-Kt 1.0 jet ( $\epsilon_s=50\%$ )
  - Low Purity:** events passing loose substructure cut ( $\epsilon_s=80\%$ )
- Background pdf extracted from MonteCarlo
  - W+jets
  - tt
  - Z+jets
  - Single-top
  - SM diboson
- Main systematics:
  - Anti-Kt 1.0 jet D2 Modeling
  - W jets modeling scale

## Results: combined fit to signal and control regions



- Example of post fit  $m_{lv}$  distributions in Drell-Yan signal regions shown on the top
- For VBF categories only upper limits are set (bottom), no exclusion is attempted
- The exclusion limits evaluated using the modified frequentist method  $CL_s$  [8], and profile-likelihood test statistic [9], applied on the binned  $m_{lv}$  distributions in DY categories.

Observed (expected) exclusion limit @95% $CL_s$	HVT Model-A $M_X$ [GeV]	HVT Model-B $M_X$ [GeV]	RSG $G^* K/\bar{M}_p=1 M_{G^*}$ [GeV]
Drell-Yan WW	< 2750 (2840)	< 3090 (3230)	< 1760 (1750)
Drell-Yan WZ	< 2820 (2890)	< 2980 (3240)	-



## REFERENCES:

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