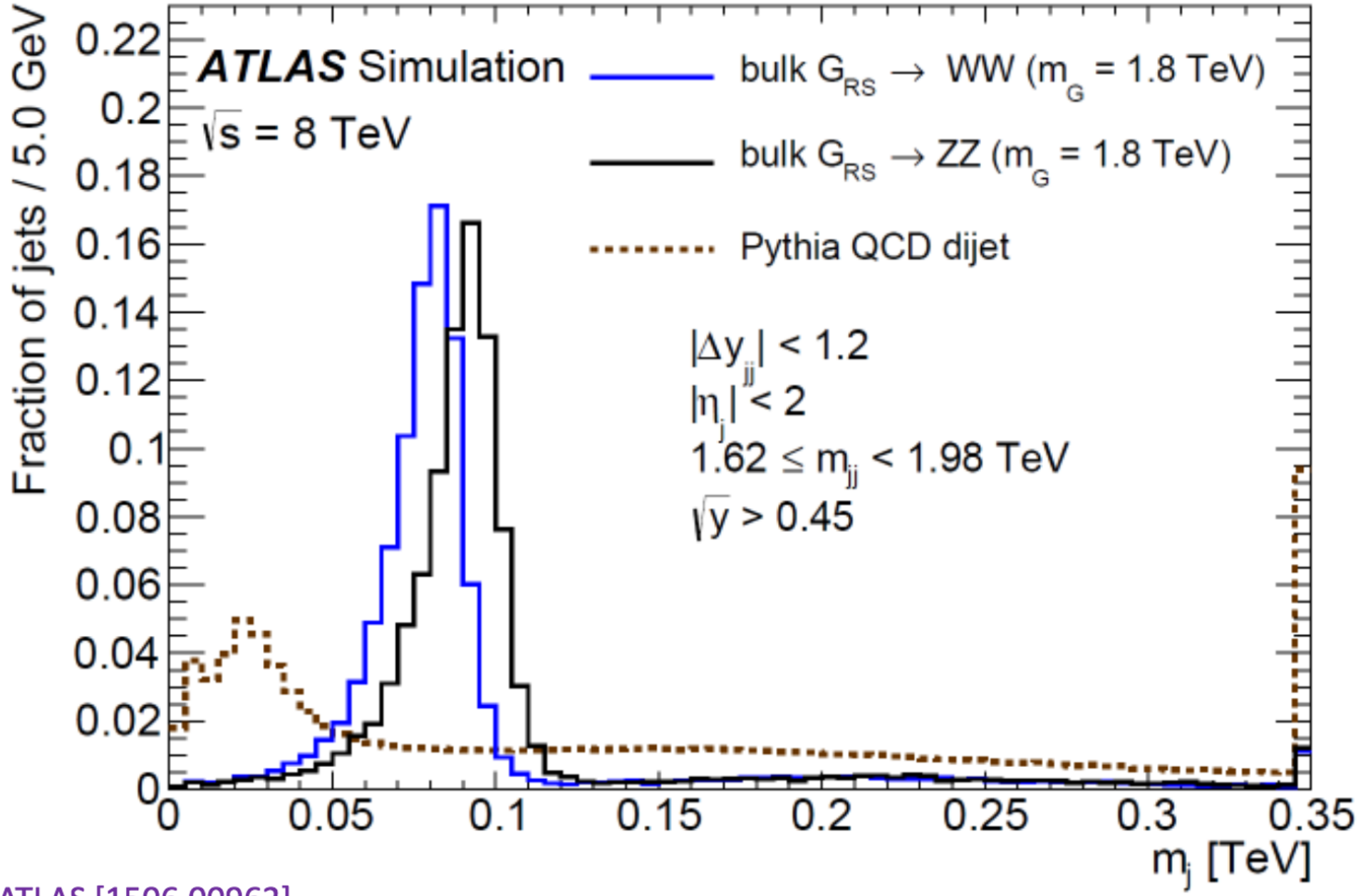
The Diboson Future

Felix Yu (JGU Mainz)
Diboson excess discussion @ GGI
September 23, 2015

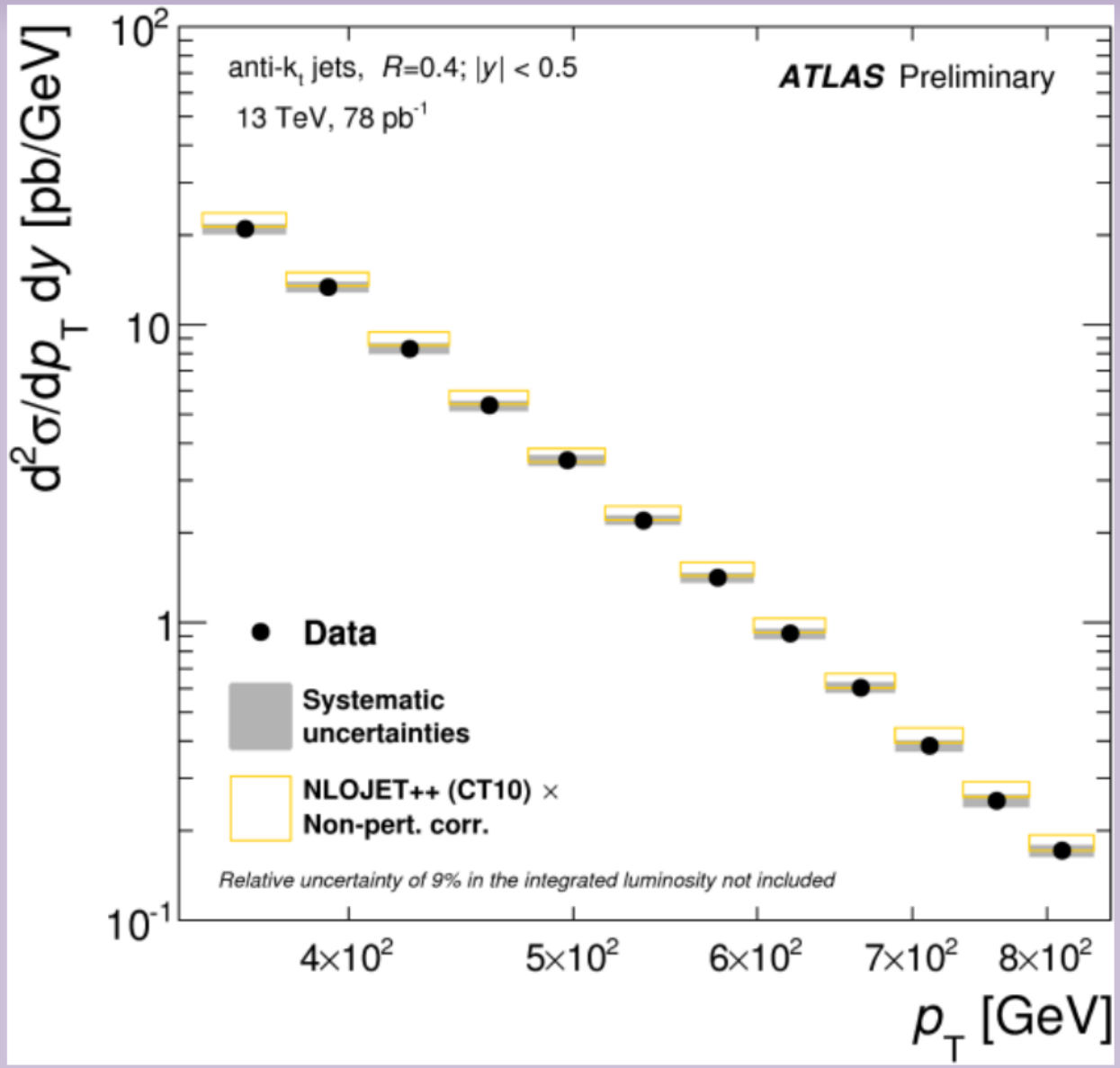
- Analysis improvements
  - State of the art jet substructure – cf. Jesse Thaler
  - Optimize for 2 TeV sensitivity
  - 13 TeV QCD background
- Cross-channels
  - Self-consistency in VV cross-channels
  - Model-dependent ff, Wh, Zh, hh channels
- Post-discovery discrimination: Rates and shapes
  - Angular observables a la Higgs J^{CP}
  - Either wait for leptonic modes, or try to use hadronic modes

The Diboson Future – QCD at 8 TeV



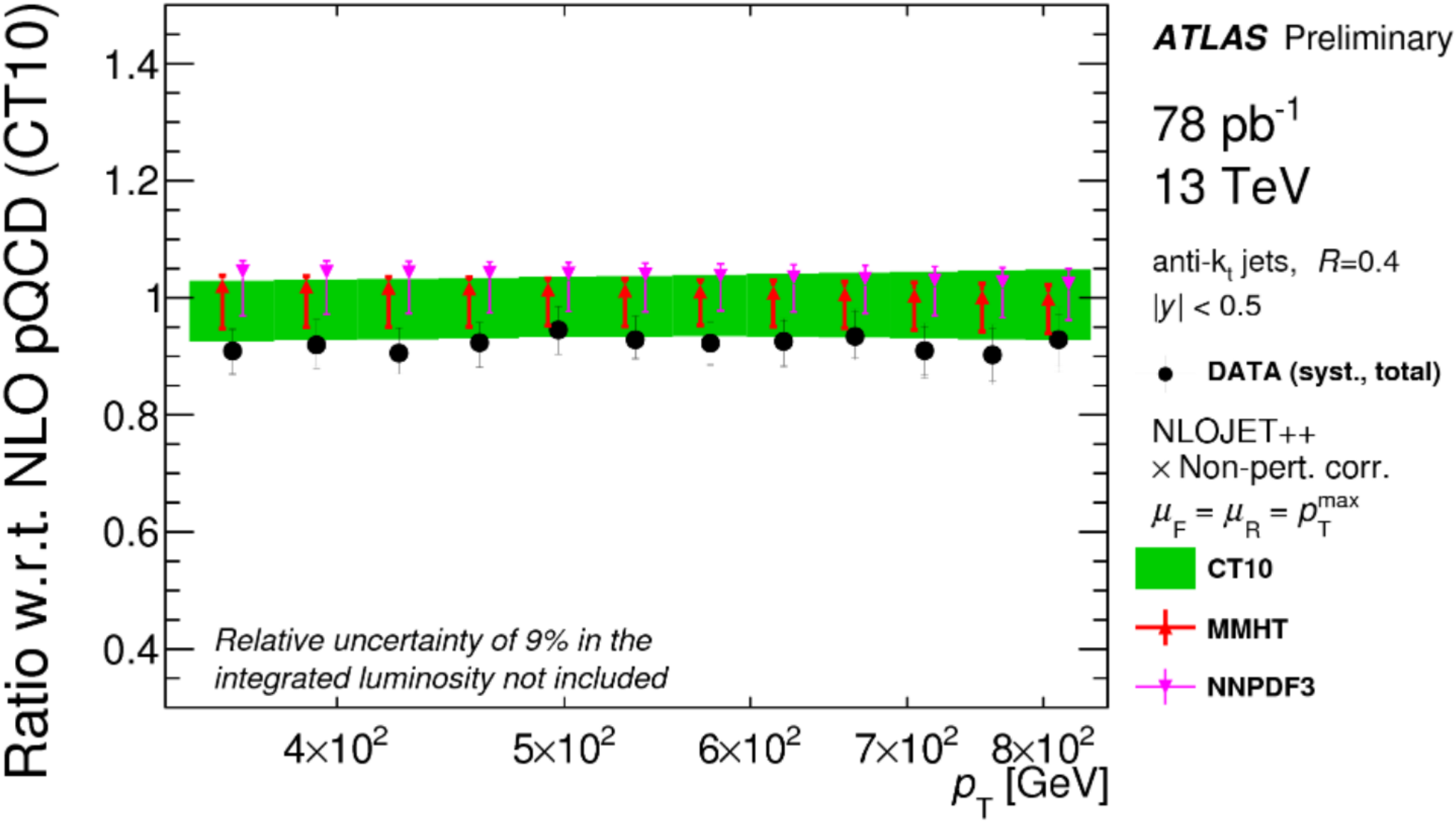
ATLAS [1506.00962]

The Diboson Future – QCD at 13 TeV



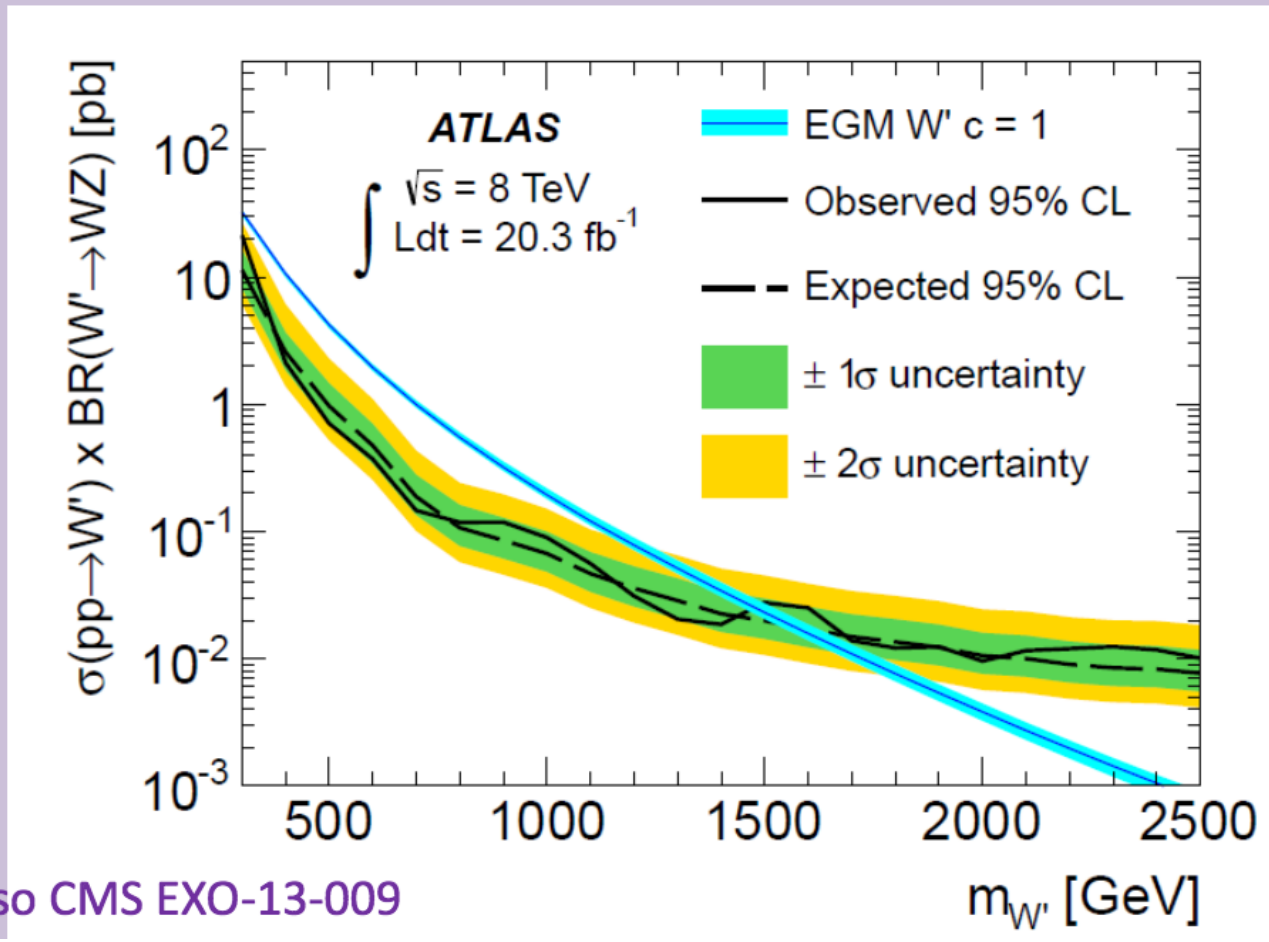
ATLAS-CONF-2015-034

The Diboson Future – QCD at 13 TeV



The Diboson Future – Cross-channels

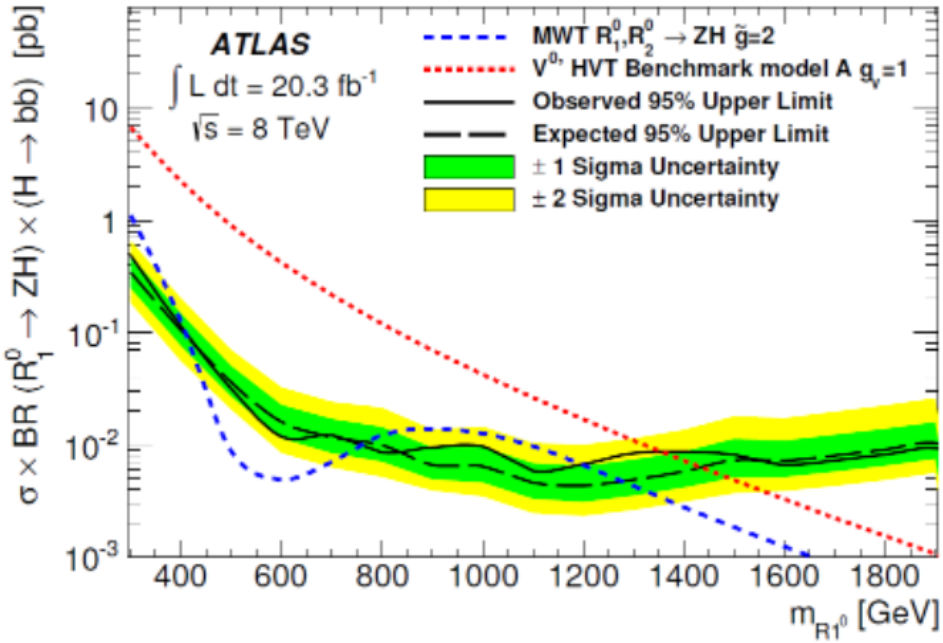
- Need self-consistency for VV interpretation: Want semi-leptonic final states (lvqq or llqq) and fully leptonic to start showing up



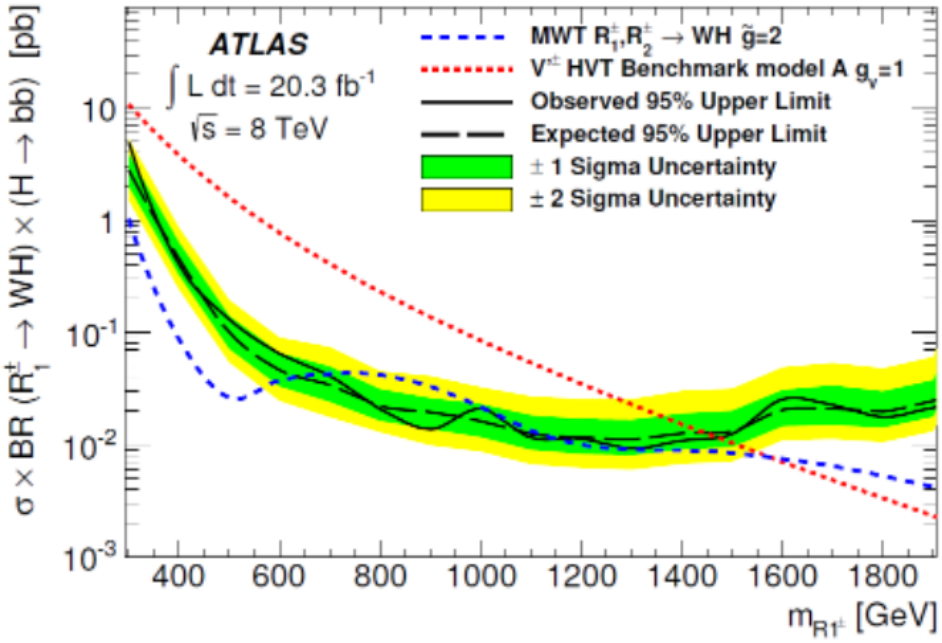
ATLAS [1503.04677], also CMS EXO-13-009

The Diboson Future – Cross-channels

- Other model-dependent decays
  - jj (including bb, tt, tb), ll, lv
  - Wh, Zh, hh



(a) $R_1^0(V'^0) \to ZH, H \to b\bar{b}$

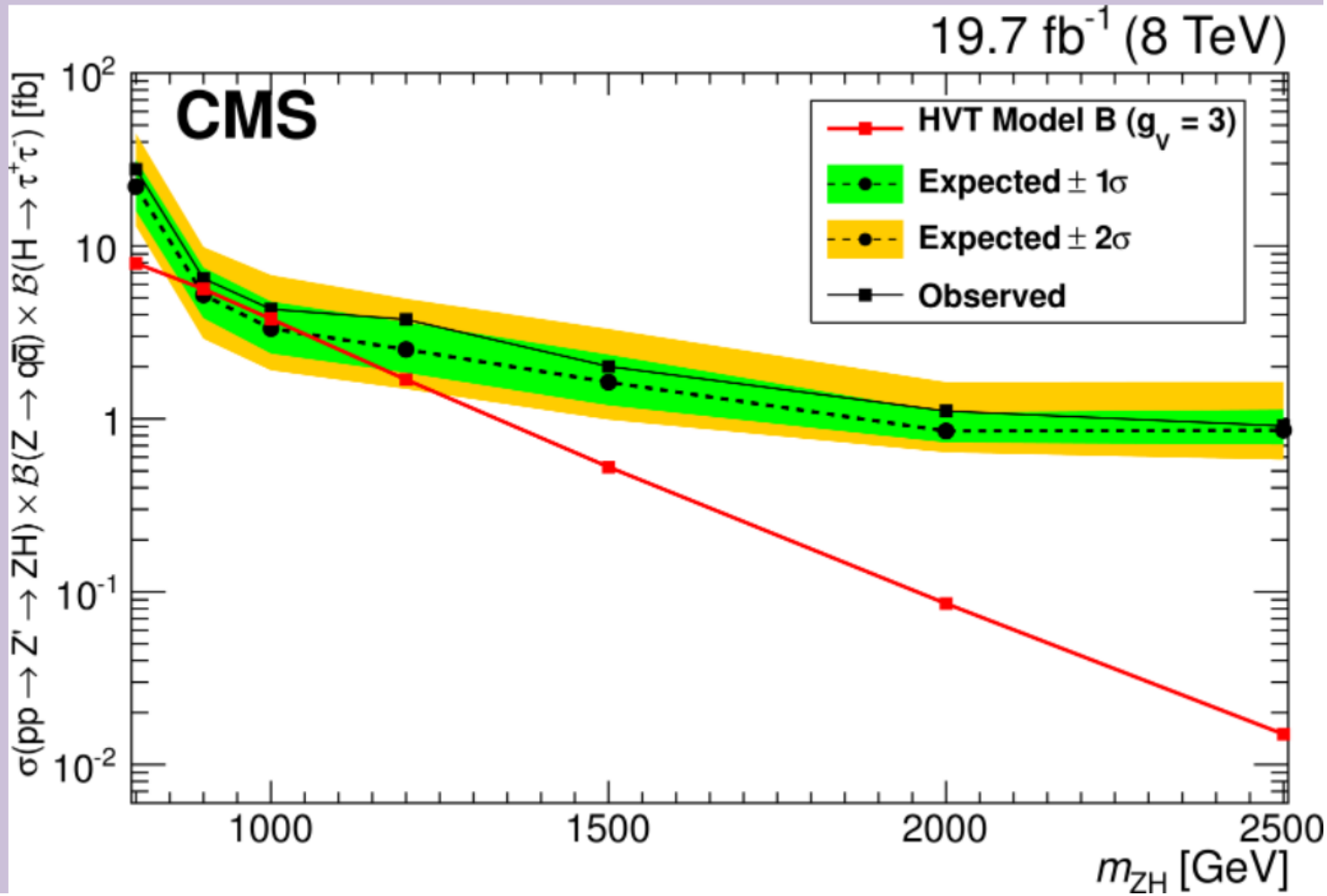


(b) $R_1^{\pm}(V'^{\pm}) \to WH, H \to b\bar{b}$

ATLAS [1503.08089]

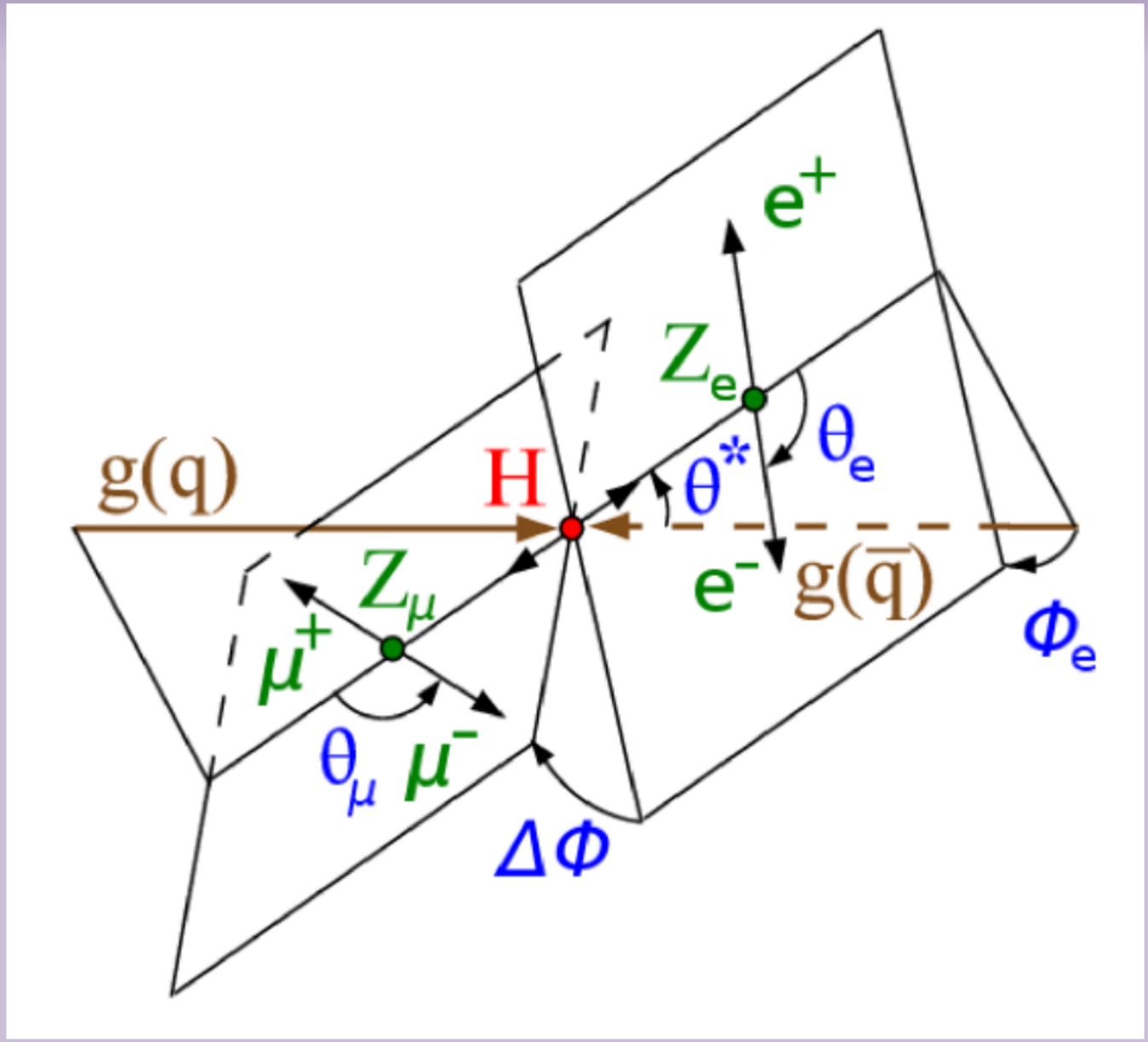
The Diboson Future – Cross-channels

- Other model-dependent decays:
  - jj (including bb, tt, tb), ll, lv
  - Wh, Zh, hh



CMS EXO-13-007

The Diboson Future – J^{CP}



The Diboson Future – J^{CP}

Kim, Kong, Lee, Park [1507.06312]

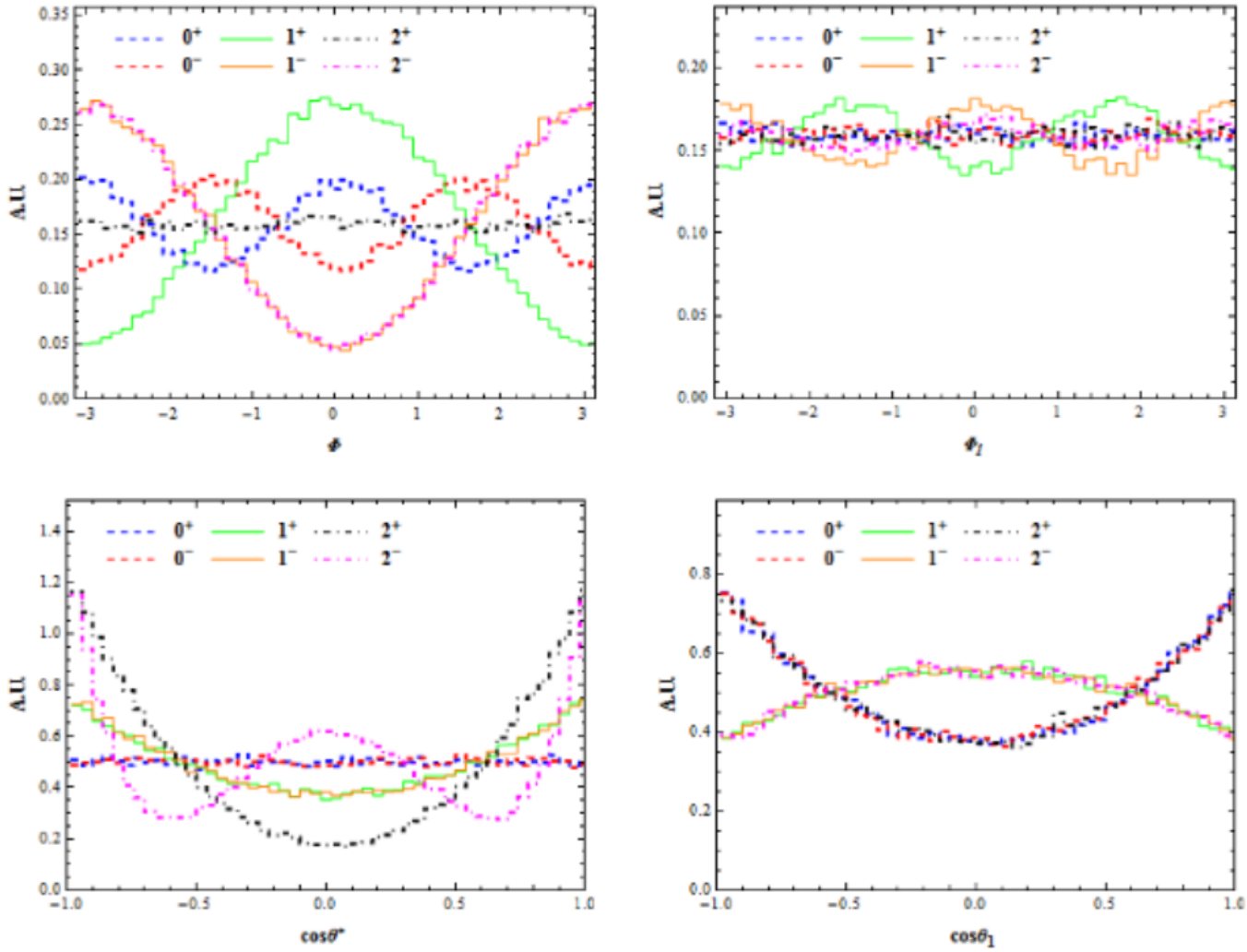
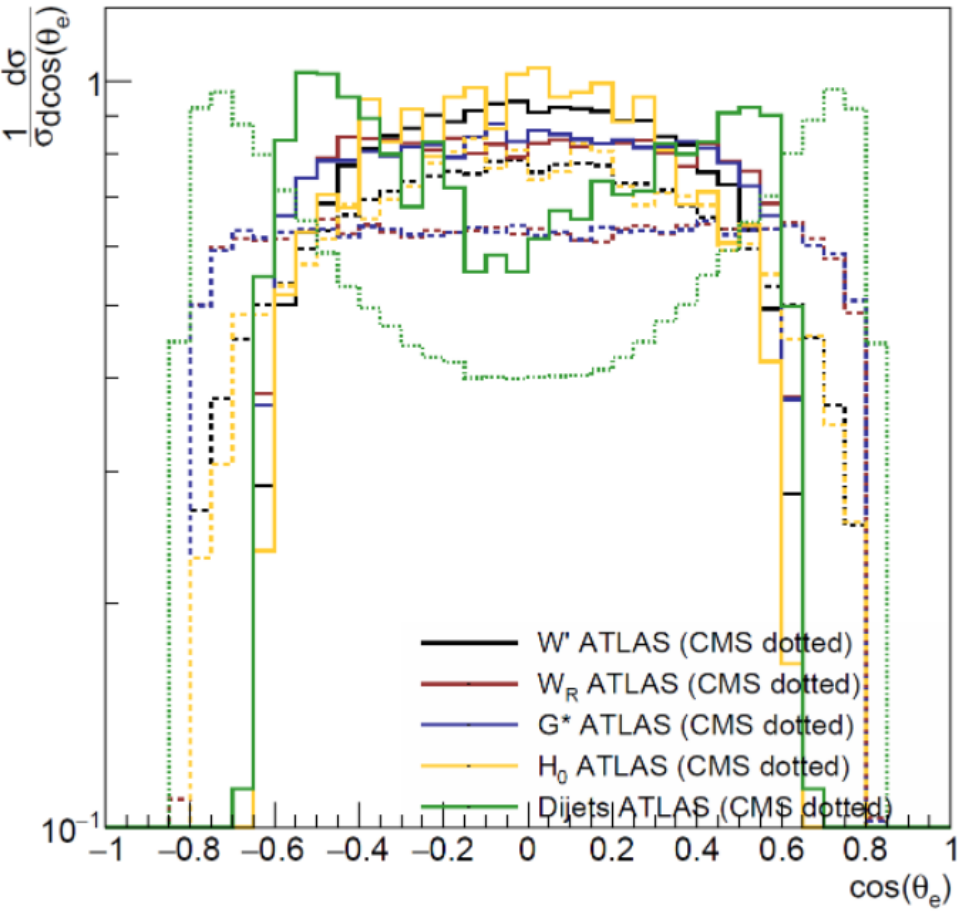
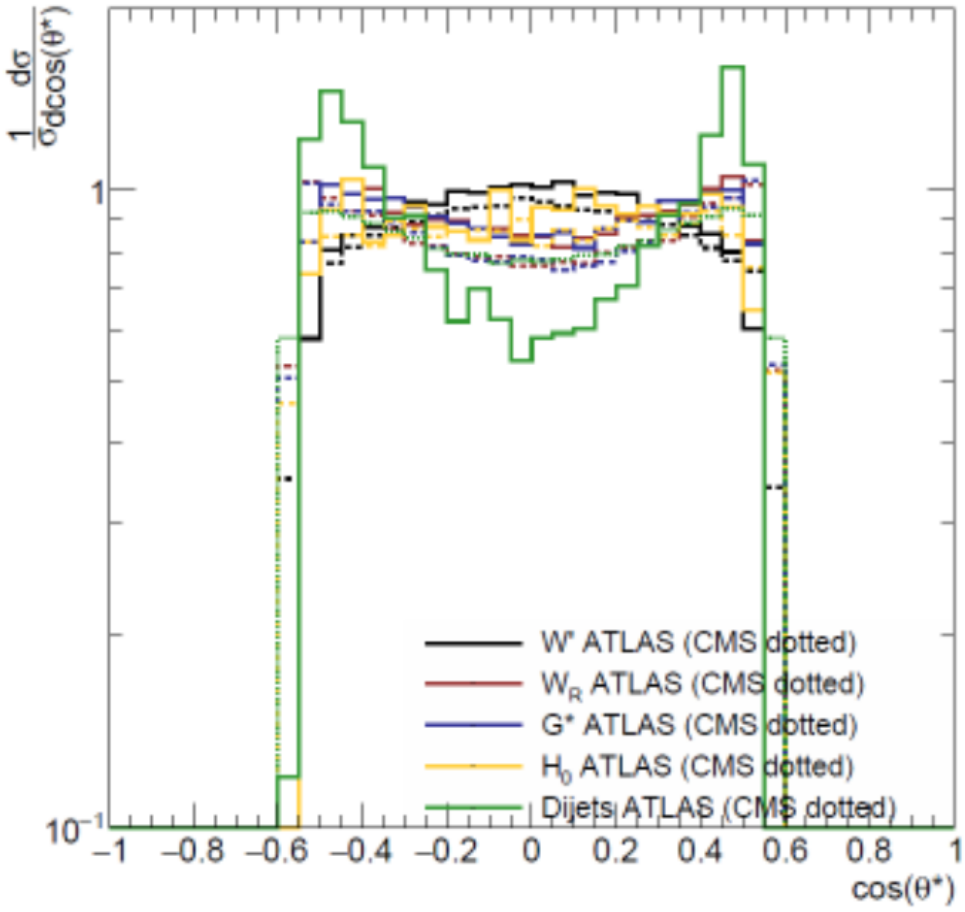


FIG. 6. Unit-normalized distributions in Φ (upper left panel), Φ_1 (upper right panel), $\cos\theta^*$ (lower left panel), and $\cos\theta_1$ (lower right panel) for the resonance decay into two W gauge bosons. The spin and CP state of the resonance of interest is represented by J^{CP}.

The Diboson Future – J^{CP}

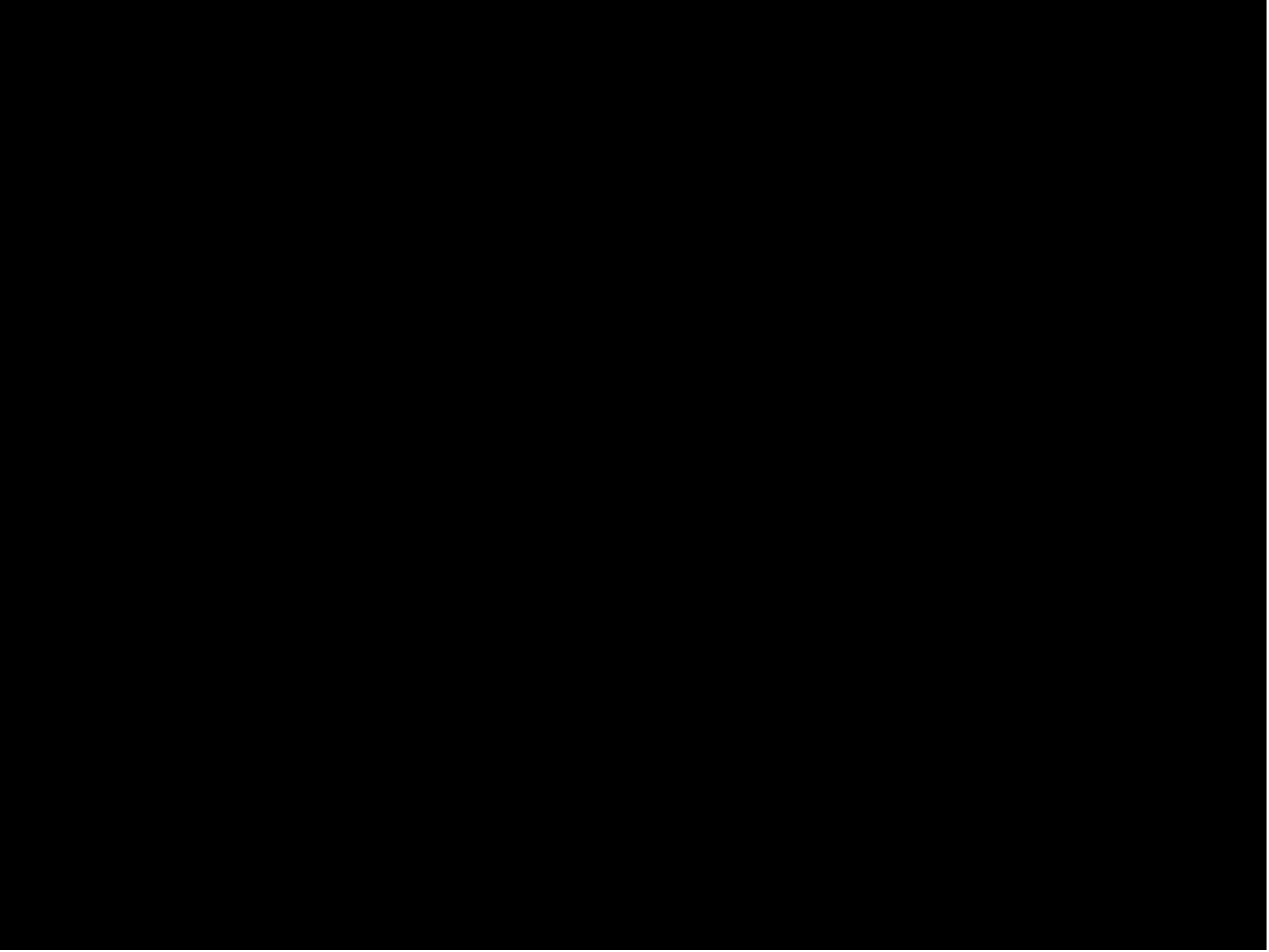
PRELIMINARY





$\cos(\theta_e)$ cliffs caused by subjet p_T imbalance
ATLAS: $\sqrt{y_f} > 0.45$
(CMS: N-subjettiness, $\tau_{21} \leq 0.5$ [high-purity], $0.5 < \tau_{21} < 0.75$)
Malte Buschmann, FY [in preparation]

$\cos(\theta^*)$ cliffs caused by (pseudo-)rapidity difference requirement
ATLAS: $|\Delta y| < 1.2$
CMS: $|\Delta\eta| < 1.3$



$$\Phi = \frac{\vec{P}_1 \cdot (\hat{n}_1 \times \hat{n}_2)}{|\vec{P}_1 \cdot (\hat{n}_1 \times \hat{n}_2)|} \cos^{-1}(\hat{n}_1 \cdot \hat{n}_2) \text{ with } \hat{n}_i = \frac{\vec{u}_i \times \vec{v}_i}{|\vec{u}_i \times \vec{v}_i|},$$

$$\Phi_1 = \frac{\vec{P}_1 \cdot (\hat{n}_1 \times \hat{n}_{sc})}{|\vec{P}_1 \cdot (\hat{n}_1 \times \hat{n}_{sc})|} \cos^{-1}(\hat{n}_1 \cdot \hat{n}_{sc}) \text{ with } \hat{n}_{sc} = \frac{\hat{z} \times \vec{P}_1}{|\hat{z} \times \vec{P}_1|},$$

$$\cos\theta^* = \frac{\vec{P}_1 \cdot \hat{z}}{|\vec{P}_1|},$$

$$\cos\theta_1 = -\frac{\vec{P}_2 \cdot \vec{u}_1}{|\vec{P}_2||\vec{u}_1|}.$$

Kim, Kong, Lee, Park [1507.06312]

$$\Delta\eta \leq 1.2\ (1.3)$$

$$y = 0.45^2 \approx 0.20\ (1/3^2 \approx 0.11)$$

$$|\cos\theta_{q_1}| \lesssim \frac{1-y}{1+y}$$

$$\cos\theta^* = \cos\left(2\arctan e^{-\frac{\Delta\eta}{2}}\right)$$

$$|\cos\theta^*| \leq 0.537\ (0.572)$$

$$|\cos\theta_{q_1}| \lesssim 0.663\ (0.800)$$

Malte Buschmann, FY [in preparation]