Measurement of the centrality dependence of the dijet yield in p+Pb collisions at $\sqrt{s_{NN}}$ = 8.16 TeV with the ATLAS detector

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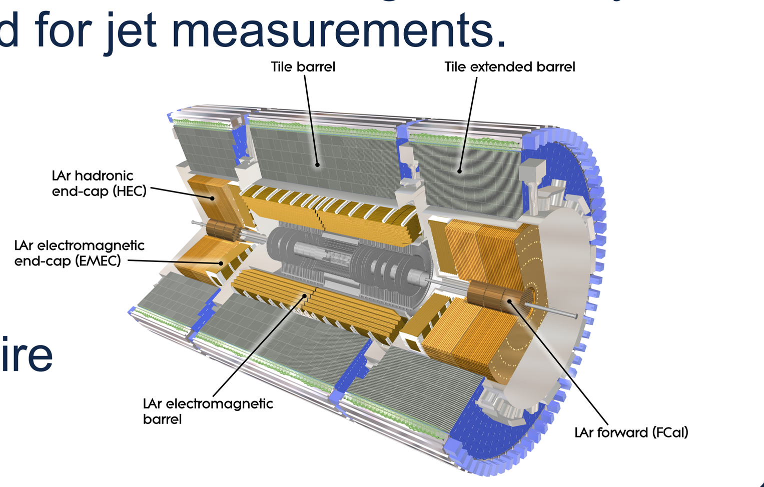
The ATLAS Calorimeter System

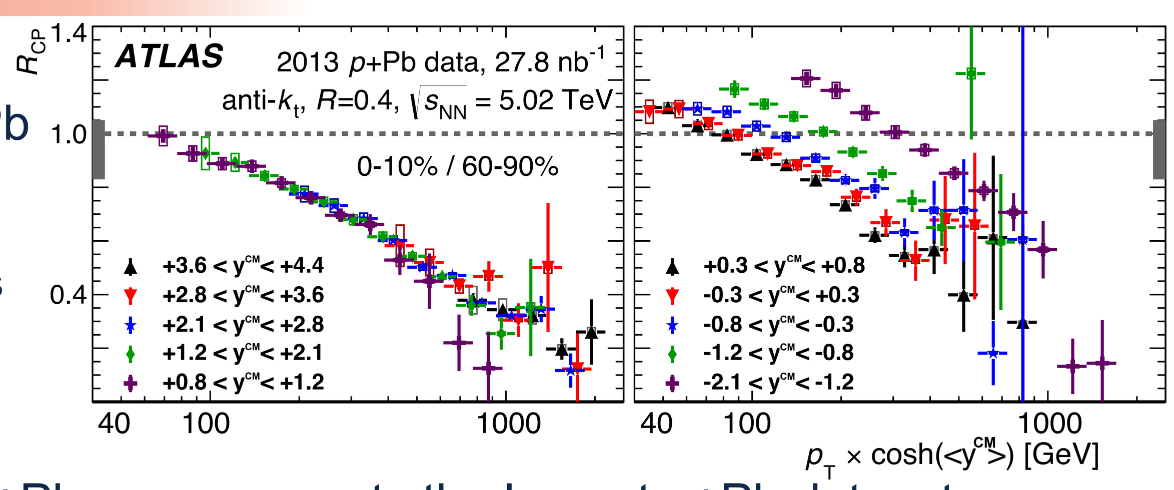
ATLAS is a general purpose detector with almost 4π coverage. Its array of calorimeters make it particularly well suited for jet measurements.

The calorimeter system consists of a liquid-argon (LAr) electromagnetic calorimeter, a steel sampling hadronic calorimeter, a LAr hadronic calorimeter, and two LAr forward calorimeters. The entire system has coverage out to $|\eta|$ < 4.9.[1]



Motivation

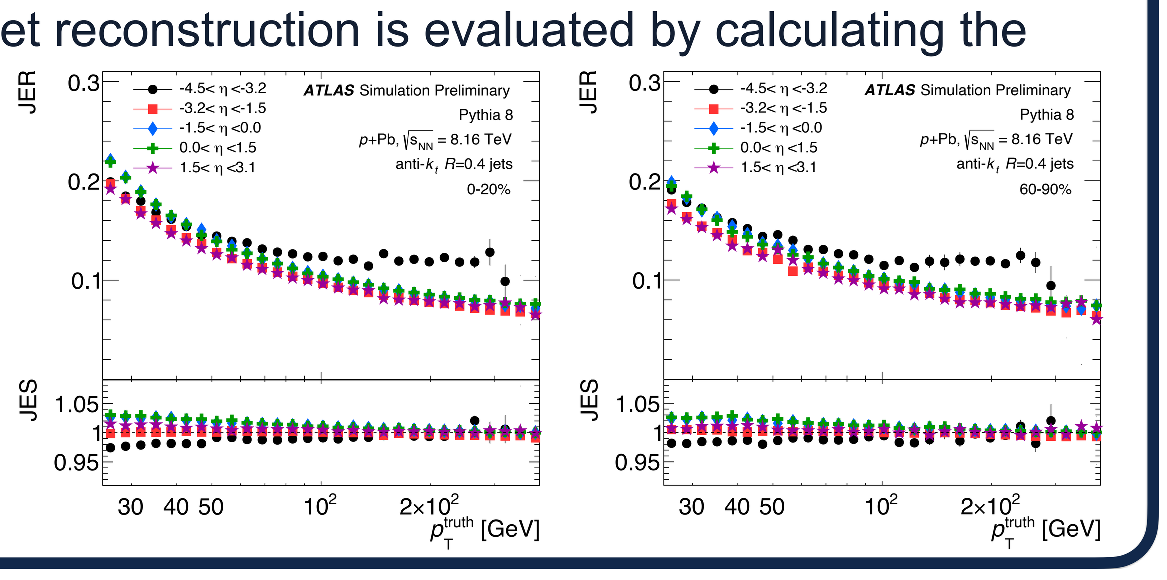
- Expand upon prior successful 5 TeV p+Pb analysis[2]
  - 2D, single jet, lower energy and statistics
  - Suppression found to be a function of the total jet energy
- The 2016 8.16 TeV p+Pb run represents the largest p+Pb dataset collected by ATLAS to date
  - 3D analysis in centrality intervals possible



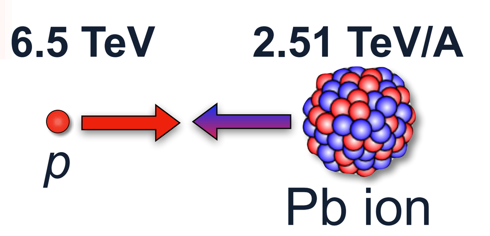
❖2D: p_T, y^{CM}
❖3D: $p_{T,Avg}$, y_b, y^*

Performance

The performance of the jet reconstruction is evaluated by calculating the jet energy scale (JES) and jet energy resolution (JER). The JES and JER are the mean and width of the response (p_T^{reco}/p_T^{truth}) evaluated using Monte Carlo samples.



Details of the Measurement



- Measurement uses anti-k_t R = 0.4 jets at $\sqrt{s_{NN}}$ = 8.16 TeV in p+Pb collisions with 165 nb^{-1} of p+Pb data collected in 2016.

$$p_{T,1} > 30\ \text{GeV},\quad p_{T,2} > 25\ \text{GeV},\quad \text{and}\quad -2.8 < \eta < 4.5$$

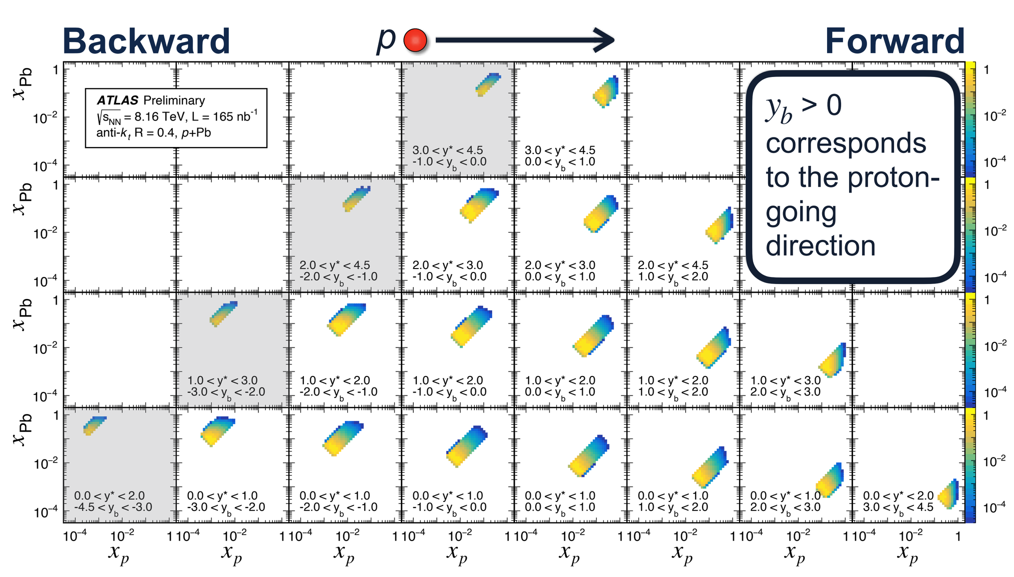
- Chosen kinematic variables allow for full characterization of the partonic scattering system:

$$p_{T,Avg} = \frac{p_{T,1}+p_{T,2}}{2},\quad y_b = \frac{y_1^{CM}+y_2^{CM}}{2},\quad \text{and}\quad y^* = \frac{|y_1^{CM}-y_2^{CM}|}{2}$$

$$x_p \simeq \frac{2p_{T,Avg}}{\sqrt{s}}e^{y_b}\cosh(y^*)$$

$$x_{Pb} \simeq \frac{2p_{T,Avg}}{\sqrt{s}}e^{-y_b}\cosh(y^*)$$

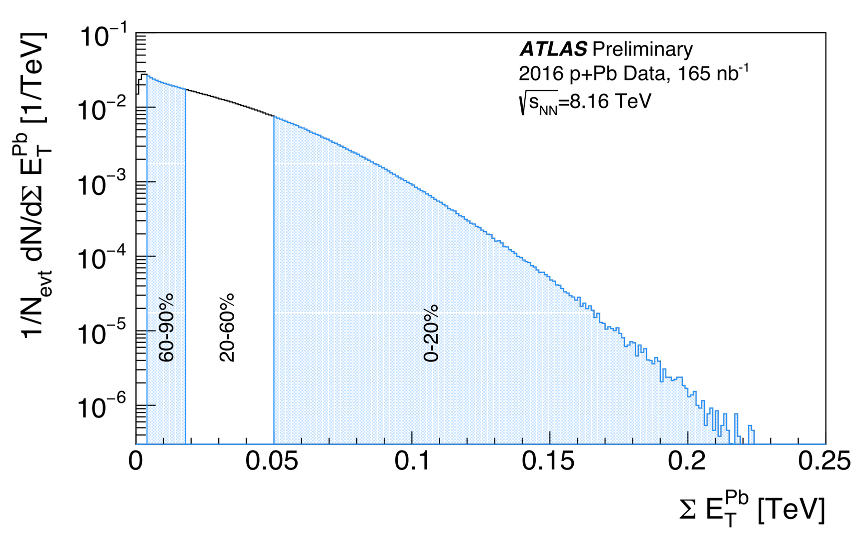
$$m_{1,2} = \sqrt{\hat{s}} = \sqrt{x_p x_{Pb} s}$$



- Jet reconstruction efficiency is >99% in all η regions for $p_T^{truth} > 25$ GeV
- One-dimensional bayesian unfolding in $p_{T,Avg}$ is performed, with an efficiency correction for any residual y_b or y^* migration.
- Centrality intervals are defined by the total transverse energy in the Pb-going FCal, ΣE_T^{Pb}.

Centrality-Binned Triple Differential Per-Event Dijet Yield

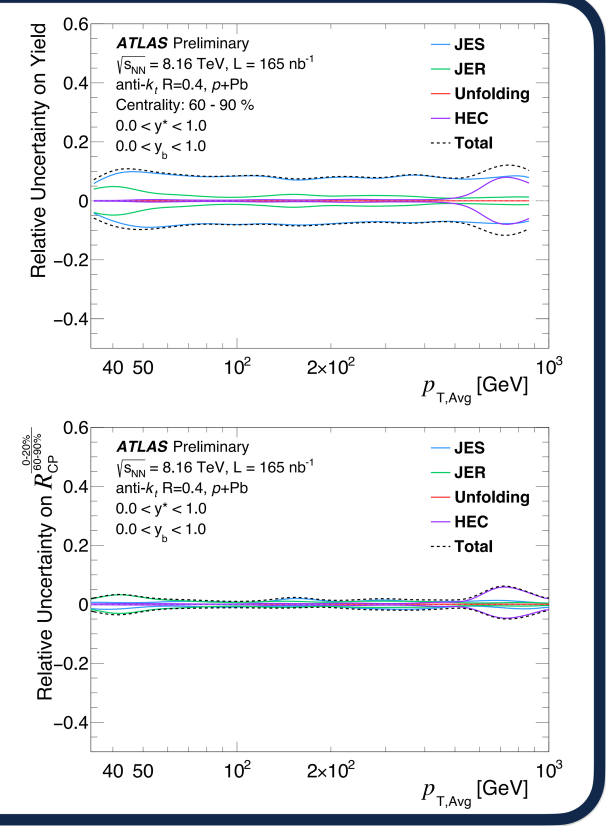
$$\frac{1}{N_{evt}^{cent}}\frac{d^3N_{dijet}^{cent}}{dp_{T,Avg}dy_bdy^*}$$



Systematic Uncertainties

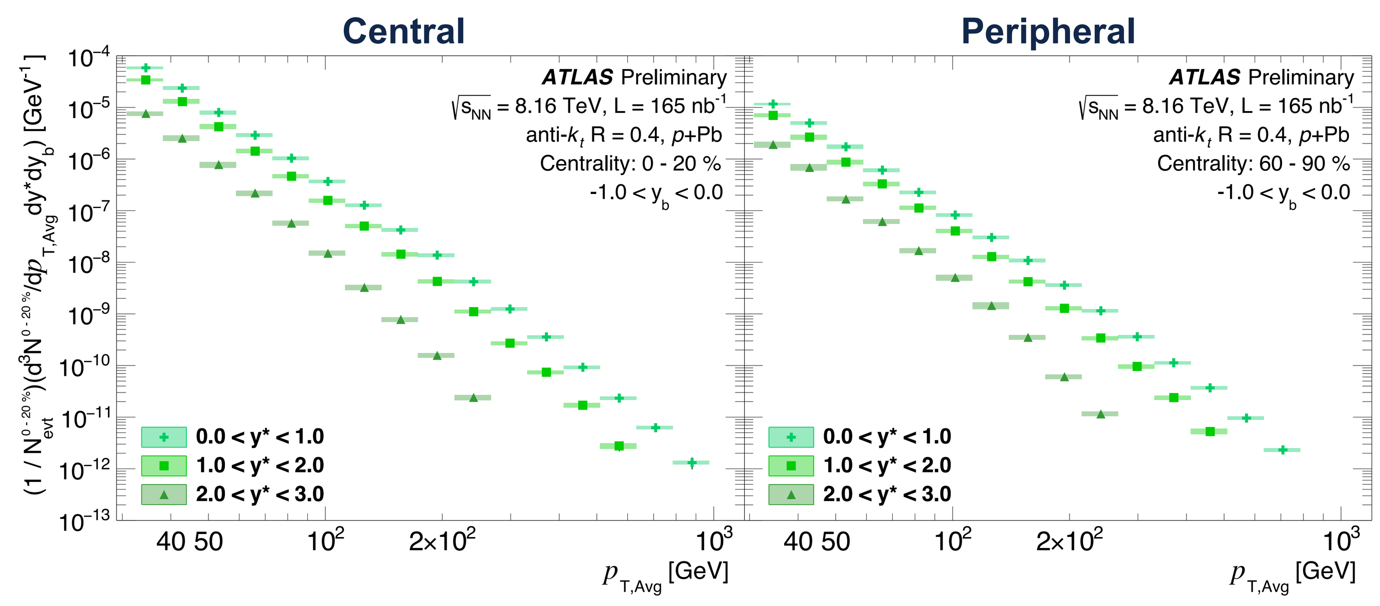
The per-event dijet yield is subject to systematic uncertainties associated with the jet energy scale and resolution, the unfolding procedure, and a systematic due to a sector of the HEC being disabled for the running period. An additional systematic on the nuclear thickness function, T_{AB}, is considered for the R_{CP} measurement.

- JES (JER) is dominant systematic on yield (R_{CP})
- T_{AB} uncertainty shown as red bar, on R_{CP} results
- JES, JER, HEC and T_{AB} systematics treated as correlated in central-to-peripheral ratio



Triple Differential Per-Event Dijet Yield

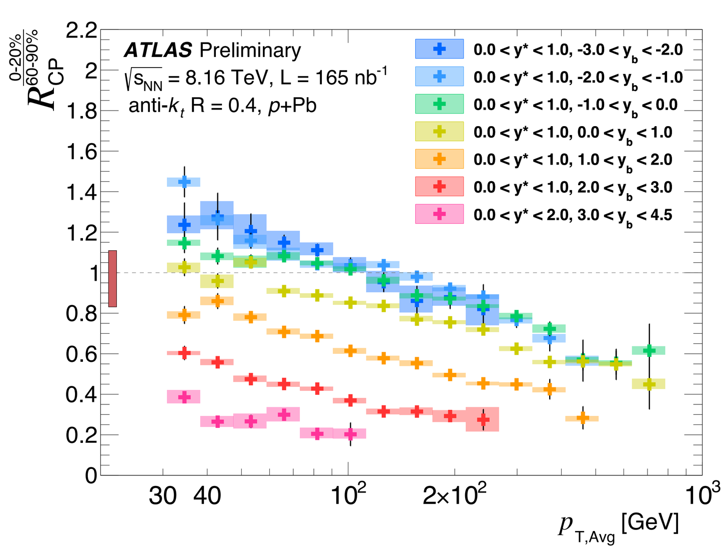
The yield spans 7 orders of magnitude at central rapidities and decreases with $p_{T,Avg}$ and with y^* in each y_b bin.



Central-to-Peripheral Ratio

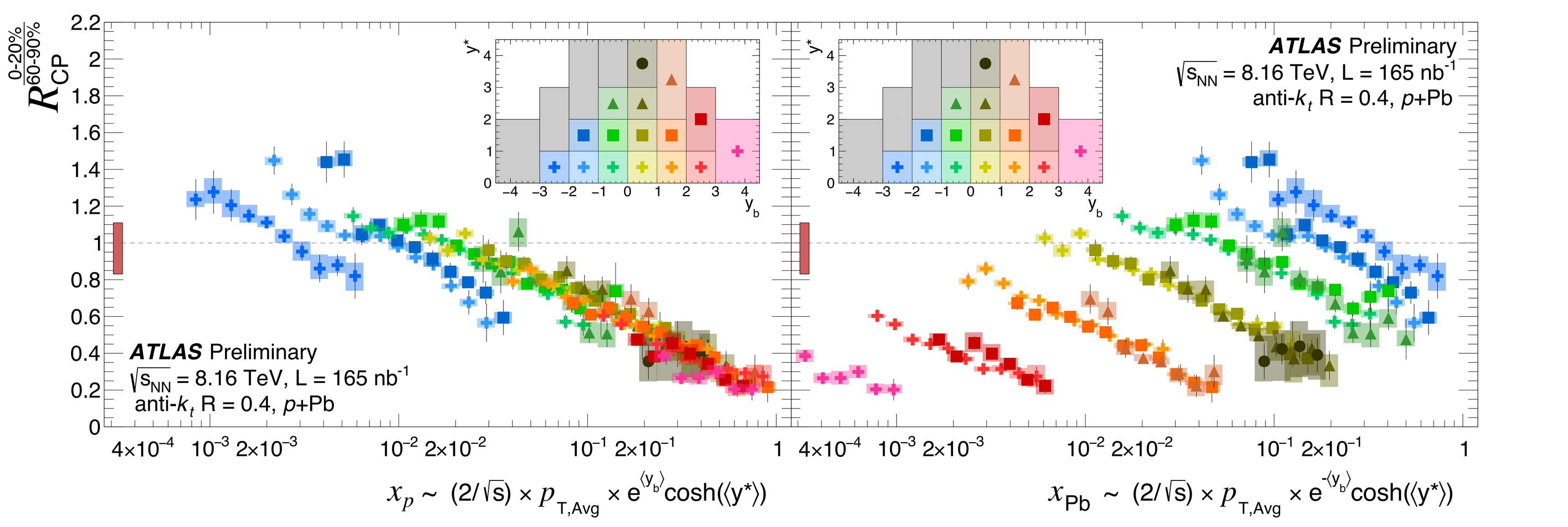
The central-to-peripheral ratio of the per-event dijet yield is constructed to study the centrality dependence of dijet production in p+Pb collisions.

$$R_{CP}^{\frac{0-20\%}{60-90\%}}(p_{T,Avg}, y_b, y^*) = \frac{\frac{1}{\langle T_{AB}^{0-20\%}\rangle}\frac{1}{N_{evt}^{0-20\%}}\frac{d^3N_{dijet}^{0-20\%}}{dp_{T,Avg}dy_bdy^*}}{\frac{1}{\langle T_{AB}^{60-90\%}\rangle}\frac{1}{N_{evt}^{60-90\%}}\frac{d^3N_{dijet}^{60-90\%}}{dp_{T,Avg}dy_bdy^*}}$$



- Increased suppression observed for dijets characterized by larger forward boost and by scatterings at higher hard-scale $p_{T,Avg}$
- Possible to directly map the results to approximated parton-level kinematics by rescaling the abscissa of each experimental point

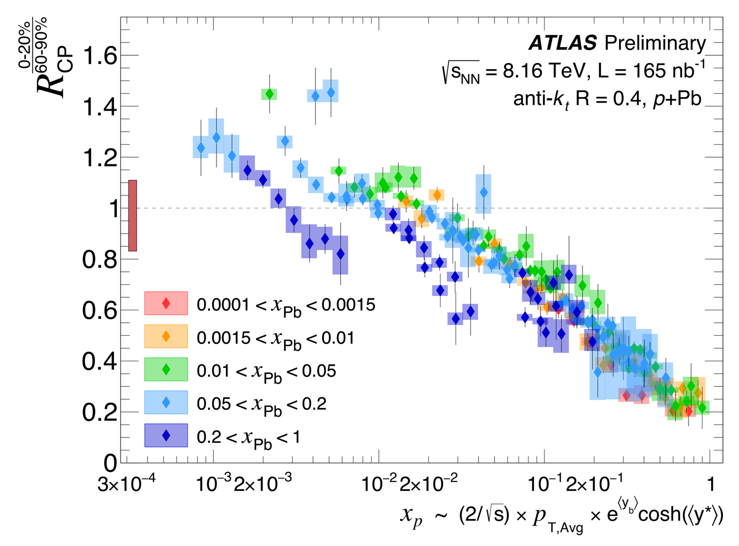
The parton-level kinematics can be approximated by using the average value of y_b and y^* in each kinematic bin, and the midpoint of each $p_{T,Avg}$ bin.



- Log-linear decrease in R_{CP} observed as a function of x_p, when moving towards proton's valence region. This trend breaks down when approaching low-x_p.
- For each slice in y_b, a log-linear trend with increasing suppression when moving toward higher x_{Pb} is observed. Overall, there is more suppression as low-x_{Pb} is approached.
- Observed results suggest that the trend is governed by physics effects similar to those probed in the inclusive production of jets in p+Pb collisions at 5.02 TeV.
- Backward-most bins excluded due to the sizable impact of the fiducial cut applied to ensure no contamination from jets in the Pb-going FCal.

The results can be analyzed as a function of the approximated x_p in intervals of x_{Pb}.

- Highest suppression observed corresponds to the lowest x_{Pb} interval
- Log-linear structure breaks-down for results in the Pb valence region



[1]ATLAS Collaboration, JINST 3 (2008) S08003. [2]ATLAS Collaboration, PLB 748 (2015) 392–413.

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